UNITED STATES COAST AND GEODETIC SURVEY OFFICE.

THE EASTERN OBLIQUE ARC OF THE UNITED STATES

AND

OSCULATING SPHEROID

(TREASURY DEPARTMENT)

U. S. COAST AND GEODETIC SURVEY

O. H. TITTMANN

SUPERINTENDENT

GEODESY

THE EASTERN OBLIQUE ARC OF THE UNITED STATES

AND

OSCULATING SPHEROID

By CHAS. A. SCHOTT, Assistant, Coast and Geodetic Survey

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Treasury Department,
Office of the Secretary,
Washington, July 16, 1901.

Sir: It affords me pleasure to approve the publication of the discussion of the Eastern Oblique Arc of the United States, herewith presented to the public.

It appears that the value of this arc to geodesy is very great, but that the results are only incidental to the immediate purposes for which the triangulation was made. The results, however, could not have been obtained if the general plan of the Coast Survey had been less systematic or comprehensive. Thus, in applied science, as well as in many other things, the far-sighted wisdom of our earlier statesmen, who gave direction to our beloved country's policies, has borne fruit.

Respectfully,

L. J. Gage, *Secretary.*

Mr. O. H. Tittmann,
Superintendent Coast and Geodetic Survey, Washington, D. C.

LETTER OF SUBMITTAL.

TREASURY DEPARTMENT,
OFFICE OF THE COAST AND GEODETIC SURVEY,
Washington, D. C., July 16, 1901.

SIR: I have the honor to submit to you for publication the manuscript of Special Publication No. 7, giving the results of the completed measurements of the Eastern Oblique Arc of the United States.

This is the second of the publications intended to give the results of the principal arc measurements made by this Service, and like the first, which relates to the Transcontinental Arc of the Thirty-ninth Parallel, it was prepared by Assistant Charles A. Schott, whose knowledge, mature experience, and ability fitted him especially for the task.

The Eastern Oblique Arc, though treated separately, intersects the Transcontinental Arc, and the two triangulations have several lines in common. The former extends from the Bay of Fundy to the Gulf of Mexico, and parallels the Appalachian mountain system, while the latter crosses the axes of the great mountain systems of this country, and extends from the Atlantic to the Pacific Ocean.

Invaluable as the Transcontinental Arc is as a contribution to geodesy and the geography of our country, it does not in itself contain the data for determining the figure of the earth.

The Oblique Arc, however, contains within itself all that is necessary for determining the dimensions of a spheroid which corresponds most nearly with the existing geoid within the area covered by triangulation. It is unique in that it is the first one which utilizes on a grand scale a measurement oblique to the meridian. The peculiar power of an oblique arc for determining the compression of the earth was pointed out by Tobias Mayer (1723–1762), but the first practical application of such an arc to geodesy was made by Bessel. This was before the introduction of telegraphic longitudes had made it possible to utilize such an arc to its fullest extent.

The results of previous discussions of parts of this arc led to the abandonment by this Survey, in 1880, of Bessel's spheroid of reference and the adoption of Clarke's (of 1866), and the final discussion of the complete arc here presented sustains the grounds on which the change from one spheroid to the other was made.

Taken in connection with the Transcontinental Arc of the Thirty-ninth Parallel, this discussion has enabled the Survey to decide upon the retention of the Clarke's spheroid and to adopt geographic coordinates for the whole extent of this country based on a uniform system. Further information as to these standard coordinates for geographic purposes, which differ slightly from those here published in connection with the Eastern Oblique Arc treated independently of other triangulations, will be published in due time.

Very respectfully,

O. H. TITTMANN, *Superintendent.*

The SECRETARY OF THE TREASURY.

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THE EASTERN OBLIQUE ARC OF THE UNITED STATES, FROM MAINE TO LOUISIANA, 1833-1898.

INTRODUCTION.

The general course of this inclined arc is indicated in the title, and is shown on a projection with elliptical outline * facing Part IV of this publication. The triangulation upon which it is based begins at Calais, Maine, on the St. Croix River, opposite the Canadian boundary, in latitude 45° 11′ 09″·4, and in longitude 67° 16′ 57″·9 west of Greenwich, and, following the trend of the Appalachian chain of mountains, reaches the Gulf coast at Dauphin Island, near Mobile Bay, and terminates at New Orleans, Louisiana, in latitude 29° 57′ 24″·4, and in longitude 90° 04′ 24″·4 west of Greenwich.

The geodetic line covers 23° 30′ 57″, and its total length is 2 612·3 kilometers, or 1 623·2 statute miles, with an azimuth of 57° 30′·7 at Calais and of 223° 22′·5 at New Orleans, as counted from south around by west. Its extremes differ 15° 13′ 45″·0 in latitude and 22° 47′ 26″·5 in longitude, and in its course it traverses sixteen States. †

Near the middle of the arc the triangulation crosses the thirty-ninth parallel, and for some distance in Maryland and Virginia the same triangulation is used in discussing the oblique arc as was employed in the discussion of the arc of the thirty-ninth parallel, an important feature, as will appear in the following pages.

Looking at the gradual development of this arc, extending over two-thirds of a century, it can be seen that in its historical aspect it is readily divisible into several well-defined groups, and as a whole it will appear that its existence must be ascribed to necessity rather than to any preconceived idea of measuring such an oblique arc.

Previous to the invention of the telegraphic method of determining differences of longitude, first employed in October, 1846, by the U. S. Coast Survey, in determining the difference of longitude between Washington and Philadelphia, and up to a somewhat later epoch, when the great accuracy of the method had been fully demonstrated, oblique arcs as well as arcs of the parallel were held in small esteem by geodesists, for the reason that the earlier methods did not determine differences of longitude with a degree of accuracy comparable with that obtained in observations for latitude. Consequently their attention was almost exclusively confined in practice to the measure of meridional arcs from which to deduce the earth's magnitude. Compared with an arc of the parallel, an arc inclined to the meridian is less favorably conditioned for discussing the figure of the earth on account of the greater effect of any uncertainty in the measure of

* A Lambert equivalent zenithal projection extended over a planisphere.

† See Map A (in pocket).

azimuths, and greater accuracy is demanded in the latter case than is required when the arcs follow a meridian or parallel.

Oblique arcs should no longer be regarded with any special disfavor, and while they entail very much more labor, comparatively, when they are utilized in determining the figure of the earth, they are well adapted, when of sufficient extent, for the determination of an osculating spheroid for the region covered by them. The existence of the arc discussed in this publication is the result of the necessity for a main triangulation binding together the detached surveys of the harbors on the Atlantic coast and forming a base upon which all subordinate triangulation along the coast could be brought into accord.

The immediate object of the main triangulation was thus to secure uniformity and systematic treatment for both the astronomic and geodetic measures in the preparation of the geographic position of the trigonometric stations. This was a leading idea from the beginning of the Survey under its first Superintendent, and when fully developed resulted in the work under discussion.

There could be no doubt of the necessity of firmly binding together in this way the small tertiary triangulation and traverse measures along the coast which wind, unbroken, following the indentations of the coast, from the Canadian boundary to Cape Florida and thence into the Gulf of Mexico, following the coast to the Mexican boundary.

The measurement of the oblique arc was thus identical with the progress of the ordinary operations of the Survey in this portion of the country.

The first period, covering the years 1833 to 1844, witnessed the execution of the work from central Long Island, New York, to the head-waters of Chesapeake Bay, uniting on the way the surveys at New York, New York, and Philadelphia, Pennsylvania, and this work was nearly all completed under Superintendent Hassler.

During the second period Superintendent Bache, pursuing the same general plan, had the work carried from Rhode Island to the Canadian boundary, at Calais, Maine, on the St. Croix River, and this work was completed in 1859.

In 1865 the branch primary triangulation across the State of Connecticut, connecting the main scheme with some older work in this region, was completed. This period closed in 1871, when the Potomac River was reached and crossed.

In the third period, covering the years 1873–1877, the work was extended to the Atlanta base, in Georgia.

The fourth period begins in 1885 and extends to 1898, and during this time the work was extended to Mobile, Alabama.

The triangulation between Mobile and New Orleans, Louisiana, was done between 1846 and 1874.

While the field work, as completed, apparently covers a very long period, the first measures dating back to the year 1833 and the last measures being made in 1898, as has been stated, this interval contained many years when no work was done upon this arc. The slow rate of progress was thus only apparent, as it depended upon and was subordinate to the ordinary requirements of the Survey on this part of the coast, and of the general operations of which it was only an incidental feature.

Part I deals mainly with the base lines and Part II with the intervening triangulation.

The astronomic determinations of latitude, longitude, and azimuths are numerous and well distributed over the whole arc. There are available, for the computation and comparison of geodetic and astronomic positions, results at 71 latitude stations, at 17 longitude, and at 55 azimuth stations. The latitudes depend almost exclusively on observations with zenith telescopes, and the longitudes on telegraphic transmission of time. The azimuths depend upon a variety of methods, using the pole star most frequently. Abstracts of the individual and final results of the astronomic measures are presented in Part III of this publication. The distribution of the astronomic stations over the region covered by the arc is shown on Map B (in pocket), and the two maps A and B have the same scale as the similar maps accompanying U. S. Coast and Geodetic Survey Special Publication No. 4, containing the discussion of the transcontinental arc of the parallel in latitude 39° N.

Part IV contains the comparison of the geodetic and astronomic measures and the determination of an osculating spheroid for the region covered by the arc.

Preliminary publication of the greater portion of this arc has already been made in the following reports of the Survey: Report for 1865, Appendix No. 21, pp. 187–203, "Results of the primary triangulation of the coast of New England from the northeastern boundary to the vicinity of New York;" Report for 1866, Appendix No. 8, pp. 49–54, "Report on the geodetic connection of the primary base lines in New York and Maryland, their degree of accordance and accuracy of the primary triangulation intervening, with the resulting angles and distances as finally adjusted," and Report for 1878, Appendix No. 8, pp. 92–120, "On the adjustment of the primary triangulation between the Kent Island and the Atlanta base lines." These reports contain also more or less complete accounts of the six base lines located in the arc.

Other references will be given in their proper place. The present publication is complete in itself, and while no important facts or statements are omitted, much simplification has been effected by referring to the publication above mentioned, covering the transcontinental arc of the parallel, the same general treatment and method of reduction of the triangulation having been employed in reducing that arc as is used in the following discussion of the oblique arc.

PART I.

THE BASE LINES AND BASE NETS.

THE BASE LINES AND BASE NETS.

A. GENERAL REMARKS.

The unit of length is the same as that used from the beginning of the Survey until 1889, viz, an iron bar, 1 meter long, standardized at Paris in 1799 and brought to this country by Mr. F. R. Hassler in 1805. Its use was discontinued after the receipt of the new prototype platinum meters in November, 1889. This meter, known on the Survey as the Committee Meter, is an end measure and is represented by an iron bar with square end surfaces, now slightly defaced by corrosion and perhaps by use. It will suffice to refer the reader to the full account given of this meter in Part I of the "Transcontinental Triangulation and the American Arc of the Parallel" across the United States in the vicinity of latitude 39°, published by the Coast and Geodetic Survey in 1900. In that publication, after some historical notes, the results of the numerous comparisons, direct and indirect, by different observers, by different methods and at different times, are completely set forth, and the final conclusion is reached that this bar at 0° C. represents so nearly the length of the prototype meter that no reliable value of the difference can be stated. The weighted mean of all comparisons gave the result $1^{m}+0{\cdot}2\mu\pm0{\cdot}6\mu$, and in all computations depending upon this standard it has been taken as equal in length to the prototype meter with a probable error of about three-quarters of a micron.

There are six base lines irregularly distributed along the arc, and they are described in the order of location, beginning in the extreme northeast and ending on the Gulf coast. For each line all needful information is given in connection therewith, such as position, physical features, elevation above sea level, apparatus used for the measure, name of observer, computation of length and final result, with its probable error.

A sketch of each base net is presented, and it is followed by the abstracts of horizontal directions, observed and adjusted, for each station forming part of the net. These abstracts contain the following information: County and State, date of measure, instrument used and observer's name, and also, in the first column, the number of each direction. These numbers, when in parentheses, indicate the corresponding corrections as given by the net adjustment. In the great majority of cases *direction* theodolites were employed, and for these Bessel's method * of reduction at the station was used. When *repeating* theodolites were used the station adjustment followed the ordinary method † of combination with the introduction of relative weights. Below the abstracts of directions resulting from station adjustment there is given the probable error of a single observa-

* See T. W. Wright's "Treatise on the Adjustment of Observations," New York, 1884, pp. 315–322.
† Ibid., p. 139 and foll.; also p. 217 and foll.

tion of a direction (mean of the direct and reversed series) deduced from $e_1^2 = \frac{0.455 \Sigma \Delta^2}{n - s - d + 1}$, where n = number of observations, s = number of series, d = number of directions, and Δ = differences of observed and adjusted values.

The figure adjustment of the triangulation generally proceeds on the supposition of equal weights to all directions used in the adjustment, except, as in the case of the Epping base net adjustment, where special weights are introduced.* To carry weight equations from the station adjustment into the figure adjustment is not practiced or favored in the Survey on account of the increased complexity and the doubtful advantage of the proceeding. The errors brought to light by geometrical conditions, and which have been called triangle-combination errors, are of a different character from those developed by a comparison of the measures made at a station, where defects of centering at observing and observed stations, effects of large local deflections of the vertical at a station, persistent lateral refraction along a line, etc., do not show; that is to say, weights pertaining to one operation are not those proper for the next operation. Further particulars of figure adjustment with statement of formulæ may be found in "The Transcontinental Triangulation," Part I.

For the computation of the sides of the triangles Legendre's theorem was used, and since none of the lines of the oblique arc are very long the spherical excess was computed by the simple formula

$$\frac{ab \sin C}{2\rho_m \rho_n \sin 1''}$$

where C = the plane angle included by the sides a and b and the subscripts to ρ refer to the radius of curvature in the meridian and in the prime vertical. Appendix No. 9, Coast and Geodetic Survey Report for 1894, page 291, contains a table to facilitate the computation of the spherical excess, the argument being the latitude of the center of the triangle. The computation of the geodetic positions along the oblique arc is made according to the formulæ and tables in the same appendix, the differences in latitude, longitude, and azimuth for two points of known distance and azimuth being given by

$$\begin{cases} -\Delta\varphi = s \cos \alpha.\ B + s^2 \sin^2 \alpha.\ C + (\delta\varphi)^2\ D - h\ s^2 \sin^2 \alpha.\ E \\ \Delta\lambda = s \sin \alpha \sec \varphi'.\ A \\ -\Delta\alpha = \Delta\lambda \sin \tfrac{1}{2}(\varphi + \varphi') \sec \tfrac{1}{2}(\Delta\varphi) + (\Delta\lambda)^3\ F \end{cases}$$

where

$$\begin{array}{l|l} \varphi' = \varphi + \Delta\varphi & \text{and} -\delta\varphi = s \cos \alpha.\ B + s^2 \sin^2 \alpha.\ C - hs^2 \sin^2 \alpha.\ E \\ \lambda' = \lambda + \Delta\lambda & \quad \text{also } h = s \cos \alpha.\ B. \\ \alpha' = \alpha + \Delta\alpha + 180^\circ & \end{array}$$

The factors A, B, C, D, E, and F are tabulated and refer to Clarke's spheroid of 1866. Their logarithmic values are given for every minute of angle between latitudes of 18° and 72°.

A description of each station used in the base nets is given. The description of the other stations of the triangulation can be obtained upon application to the Coast and Geodetic Survey, Washington, District of Columbia.

*When special weights are introduced for the several directions at a station, they are deduced from the rough expression of the square of the probable error given by $e_1^2 = \frac{0.455 \Sigma \Delta^2}{s\,[xx]}$ where [xx] represents the diagonal coefficient of the direction in the normal equation.

EPPING BASE. VIEW OF LINE AS GRADED FOR MEASUREMENT.

EPPING BASE. PLACING APPARATUS OVER A MARK.

B. THE BASE LINES OF THE EASTERN OBLIQUE ARC, THEIR MEASUREMENT, RESULTING LENGTH, PROBABLE ERROR, AND ADJUSTMENT OF BASE NETS.

1. THE EPPING BASE LINE AND BASE NET, MAINE, 1857.

Location, measurement, and resulting length of the Epping base line, Maine, 1857.

The site of this base is on Epping Plains, near Cherryfield, Washington County, Maine. A reconnaissance of the locality was made in 1853, and the measurement of the base followed in July and August, 1857, under the immediate direction of Superintendent A. D. Bache. The Annual Report for 1865, Appendix No. 21, pages 189–191, contains a full account of the measure and of the result. It will therefore suffice to present here only the salient points of the operation.

The measure was made with the Bache-Würdemann contact-level compensating apparatus, and is the sixth primary line where this apparatus was employed, the Dauphin Island base, Alabama, being the first, an account of which is given further on (q. v.). The apparatus is fully described with illustrations in Coast Survey Report for 1854, Appendix No. 35, and reprinted in Coast Survey Report for 1873, Appendix No. 12. The essential part of the apparatus consists of two 6-meter bars, one of brass and one of iron, placed parallel to each other, one being above the other and firmly connected at one end. At the opposite or free end is the lever of compensation, so proportioned in its arms with respect to the actual and differential expansion and contraction with changes of temperature that the end of the apparatus remains at a constant distance from the opposite end. The spirit-level contact piece terminates in an agate, ground to a knife edge, whereas the agate at the opposite presents a slightly convex surface. The apparatus was standardized by means of a standard 6-meter iron bar, the length of which was determined at different times in terms of the Committee Meter.

The length of this base is about 8·72 kilometers (or 5·42 statute miles), its middle point is in latitude 44° 40′·8 and in longitude 67° 53′·1, with a mean azimuth of 106° 54′. Much labor had to be spent preparing the ground for the measure by leveling it, removing bowlders, and overcoming other obstacles, the handling of the apparatus demanding a wide and fairly smooth roadway. The average height of the tubes above the mean tide level of the Atlantic was 76·45 meters. The 6-meter base bars or tubes were compared with the standard 6-meter bar just before and immediately after the base measure. Taking the length of the latter and its coefficient of expansion as determined in 1860 and published by Assistant J. E. Hilgard in Coast Survey Report for 1862, Appendix No. 26, viz, $5{\cdot}999\,941 \pm 2$ meters, and $0{\cdot}000\,011\,54 \pm 4$ for the centigrade scale, the following results for the length of the tubes were obtained: Three sets of 23 comparisons, made with Saxton's reflecting comparator* on July 16th and 17th, gave tube No. 1 shorter than the standard (at 18°·3C.) $1\,300{\cdot}4 \pm 2{\cdot}0$ divisions of the comparator and tube No. 2 shorter $1\,088{\cdot}7 \pm 2{\cdot}2$

* The instrument is known as Saxton's pyrometer, and it is described in detail, with illustrations, in the Report of the Superintendent of Weights and Measures for 1856, and the Report of the same bureau for 1862 contains, on page 249, a general description of it. One turn of the screw equals 357·11 scale divisions and one scale division equals 1·36 microns. The head is divided into 100 divisions.

divisions; again, after the base measure, on August 6th and 7th, from 4 sets of 27 comparisons, tube No. 1 shorter than the standard (at 21°·0C.) $\underset{\pm 3.3}{1\ 411.8}$ divisions and from 4 sets of 23 comparisons tube No. 2 shorter $\underset{\pm 2.9}{1\ 195.3}$ divisions. Having regard to the weights, the above comparisons give the values for length of tubes,

$$\text{for No. } 1_2,\ \underset{\pm\ 4\ 9}{5.999\ 459\ 0} \text{ meters,*}$$

$$\text{for No. } 2,\ \underset{\pm\ 4\ 9}{5.999\ 750\ 6} \text{ meters.}$$

Although the comparisons of the tubes with the standard bar were made with rising and falling temperatures, there remained an uncertainty respecting the indication of the thermometers in air giving the temperature of the metallic bar even within ¼°. Further, some allowance had to be made for any defect in the mechanical compensation, for possible error in making contacts and transfers to the ground, and for other small uncertainties in connection with the base measure, and this was arbitrarily fixed as $\pm 9.7\ \mu$. The probable error of the length of a tube during the measure was taken as $\sqrt{(4.9)^2 + (9.7)^2} = \pm 10.9\ \mu$, hence that for the whole length $= 1\ 453 \times 10.9\ \mu = 0.0158^{m}$, which equals $\frac{1}{551\ 000}$ part of the length. In this case, as in that of the other bases of this arc, except the Atlanta base, the *single* measure fails to provide proper means for a more reliable value of the probable error of the length. We have for the length of the Epping base:

1 452 tubes of mean length,	$8\ 711^{m}.4262$
One odd tube, No. 1,	$+5.9994$
Correction for inclination of tubes,	-2.8040
Defect of last tube at East Base,	$+1.4250$
Reduction to half-tide level of ocean,	-0.1044
Resulting length of base,	$8\ 715^{m}.9422 \pm 0^{m}.0158$
And its logarithm, $3.94031434 \pm 0.00000079$	

The Epping base net and results of its adjustment.

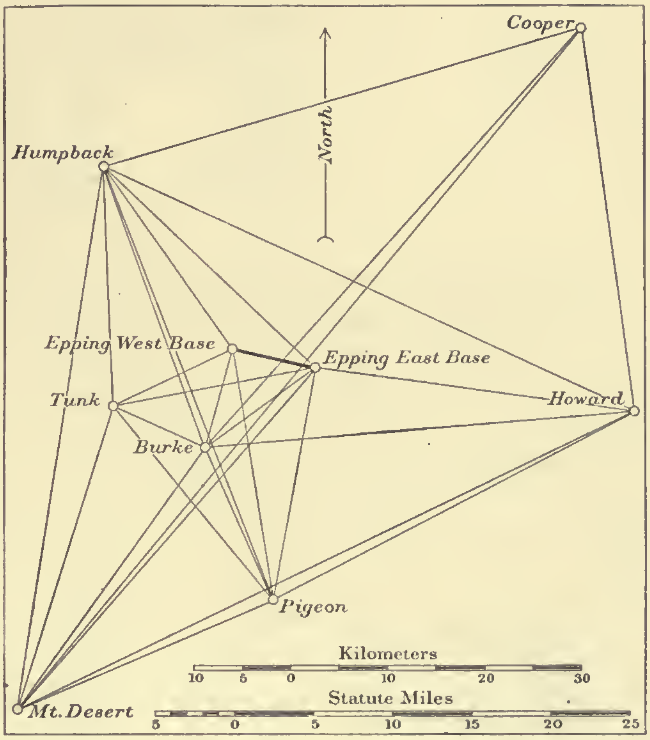
As shown on the following sketch, this net of triangles is included within the primary quadrilateral Humpback, Mount Desert, Howard, and Cooper, and involves 6 geodetic points. The figure is a very strong one and demands that 35 geometric conditions be satisfied. The reduction of this base net is complicated on account of the employment of both direction and repeating theodolites, five of the stations having been occupied with the latter instruments.

An account of the adjustment of this base net is contained in Coast Survey Report for 1864, Appendix No. 14, and may be referred to for particulars; the results are here transcribed, except that the notation has been changed for one more convenient. In connection with the station abstracts there is added a column containing the approxi-

*Comparing these values with the corresponding values of 1847 (Dauphin Island base) and of 1872-73 (Atlanta base), it will be seen that the lengths are not invariable, but it should be noted that one of the agates of tube 1 was accidentally broken in 1855, and after the new agate was substituted the tube was found to be 0.430 millimeter shorter than before.

mate value of the probable error of a resulting direction, depending on the formula $\varepsilon_1^2 = \frac{0{\cdot}455\ \Sigma\Delta^2}{s\ (\text{diag. coeff't})}$ in case of direction observations. In case of repetitions the probable error will depend upon the comparison of a resulting angle with each of its 20 measures (each of 3 repetitions direct and 3 repetitions reversed), from which an average and approximate value of the probable error of a *single* measure of an angle and of a direction has been derived, as well as the probable error of a *resulting* direction. We have approximately from the 20 measures of each angle the probable error of a single observation of an angle $e_\angle = 0{\cdot}845\ \frac{[v}{\sqrt{n\ (n-v)}}$ *hence the probable error of a single observation ($3\,D.$ and $3\,R.$) of a direction $e_1 = e_\angle/\sqrt{2}$, also approximately for a resulting direction $\varepsilon_1 = e_1/\sqrt{20}$. The last column of the abstracts contains the final adjusted directions, the first direction having again been made zero by subtracting the correction to the initial direction from each of the corrections to the other directions, as given in the preceding column. †

No. 4.



In the adjustment of the base net special weights were assigned to the directions, as explained at length in Coast Survey Report for 1864. If we deduce the probable error of a direction from the closing errors in the sum of the angles of the 46 triangles, we find from the sum of the squares of these errors the mean closing error of a triangle $= \sqrt{\frac{54{\cdot}49}{46}} = \pm 1''{\cdot}09$, hence the probable error of a direction $= 0{\cdot}674 \times 1{\cdot}09/\sqrt{6} = \pm 0''{\cdot}30$.

On the other hand, the average value of the probable error of observation of the 116 directions in the net is about $\pm 0''{\cdot}24$, whence the triangle combination error $\varepsilon_c = \sqrt{(0{\cdot}30)^2 - (0{\cdot}24)^2} = \pm 0''{\cdot}17$ (nearly), and the square of this was added as a *constant* to each of the previously deduced squares of the observing errors. We then have $\varepsilon^2 = \varepsilon_1^2 + \varepsilon_c^2$ and the weight to any direction $p = \frac{1}{\varepsilon^2}$. The values of p thus have

* The half bracket indicates sum of similar quantities, disregarding their signs.

† The mean of the 4 values of e_1 derived from a single measure ($D.$ and $R.$) with the 75^{cm} theodolite is $\pm 1''{\cdot}04$ and the mean of the 5 values of e_1 derived from a single measure ($3D.$ and $3R.$) with the 25^{cm} repeating theodolite is $\pm 1''{\cdot}16$, or one measure with the first instrument is about equal in accuracy to three with the latter.

smaller range than they would have had without the addition of the constant; still the maximum weight is to the minimum weight as 5·4 to 1. The effect of the introduction of weights is small in cases like the present, a base net of great complexity and fair measures.

There was no special necessity for a reduction of the horizontal measures to sea level on account of the elevation of the signals sighted. The following table gives the approximate heights of the ground at the stations:

	Meters.	Feet.
Epping East Base,	77·6	255
Epping West Base,	72·9	239
Burke,	129·5	425
Tunk,	350·5	1 150
Pigeon,	95·9	315
Humpback,	451	1 480
Mount Desert,	464·9	1 525
Howard,	82·0	269
Cooper,	224	735

The largest reduction for latitude 45° and $\alpha = 45°$ (nearly that of the line Epping East Base to Mount Desert) would amount to only $0''·025$, a correction so small that it may be neglected.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the base net, 1856–1859.

Epping East Base, Washington County, Maine. September 17 to September 29, 1859. 25cm repeating theodolite No. 43. C. O. Boutelle, observer. Telescope 14 meters above ground.

No. of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Corrections from base net adjustment.	Final seconds in triangulation.
		°	′	″	″	″	″
1	Mount Desert	0	00	00 ·00	±0 ·27	0·000	00 ·000
2	Burke	13	34	42 ·40	0 ·28	−0 ·556	41 ·844
3	Tunk	39	21	25 ·46	0 ·27	+1 ·035	26 ·495
4	Epping West Base	65	11	55 ·30	0 ·31	−0 ·476	54 ·824
5	Humpback	92	52	56 ·31	0 ·28	−0 ·157	56 ·153
6	Howard	235	22	32 ·46	0 ·28	−0 ·582	31 ·878
7	Pigeon	329	07	59 ·80	0 ·29	−0 ·878	58 ·922

Probable error of a single observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 0''·94$. Number of angles adjusted, 14.

Epping West Base, Washington County, Maine. October 11 to October 16, 1859. 25cm repeating theodolite No. 43. C. O. Boutelle, observer. Telescope 14 meters above ground.

No. of directions.	Objects observed.	°	′	″	″	″	″
8	Epping East Base	0	00	00 ·00	±0 ·19	0 ·000	00 ·000
9	Pigeon	64	55	08 ·30	0 ·20	+0 ·951	09 ·251
10	Burke	89	03	11.75	0 ·25	−0 ·422	11 ·328
11	Tunk	138	04	57 ·08	0 ·23	−0· 122	56 ·958
12	Humpback	217	36	38 ·06	0 ·24	+0 ·551	38 ·611

Probable error of a single observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 0''·96$. Number of angles adjusted, 6.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the base net, 1856–1859—continued.

Burke, Washington County, Maine, September 30 to October 10, 1859. 25cm repeating theodolite No. 43. C. O. Boutelle, observer.

No. of directions.	Objects observed.	Resulting directions from station adjustment. °	′	″	Approximate probable errors. ″	Corrections from base net adjustment. ″	Final seconds in triangulation. ″
13	Humpback	0	00	00·00	±0·32	0·000	00·000
14	Epping West Base	35	50	55·63	0·36	+0·529	56·159
15	Cooper	62	44	36·70	0·33	+1·178	37·879
16	Epping East Base	75	10	31·48	0·33	+0·609	32·089
17	Howard	105	30	16·64	0·33	−0.891	15·749
18	Pigeon	176	58	51·30	0·34	−0·397	50·903
19	Mount Desert	236	09	13·84	0·34	−0.442	13·398
20	Tunk	315	37	52·99	0·34	+0·326	53·316

Probable error of a single observation (3*D.* and 3*R.*) of a direction, $e_1 = \pm 0''.94$. Number of angles adjusted, 14.

Tunk, Hancock County, Maine. October 27 to October 31, 1859. 25cm repeating theodolite No. 43. C. O. Boutelle, observer.

No. of directions.	Objects observed.	°	′	″	″	″	″
21	Humpback	0	00	00·00	±0·48	0·000	00·000
22	Epping West Base	67	44	56·53	0·48	−0·836	55·694
23	Epping East Base	83	49	30·54	0·46	+0·070	30·610
24	Burke	118	30	08·38	0·46	−0·875	07·505
25	Pigeon	144	27	29·16	0·46	+0·154	29·314
26	Mount Desert	201	11	04·45	0·47	−0·224	04·226
	Saunders	275	58	53·08	0·51	.....	......

Probable error of a single observation (3*D.* and 3 *R.*) of a direction, $e_1 = \pm 1''·37$. Number of angles adjusted, 12.

Pigeon, Washington County, Maine. October 19 to 25, 1859. 25cm repeating theodolite No. 43. C. O. Boutelle, observer.

No. of directions.	Objects observed.	°	′	″	″	″	″
27	Mount Desert	0	00	00·00	±0·27	0·000	00·000
	Saunders	45	00	42·99	0·29	.....	......
28	Tunk	74	49	02·86	0·27	−0·326	02·534
29	Burke	90	12	38·14	0·25	+0·477	38·617
30	Humpback	92	09	19·50	0·26	−0·033	19·467
31	Epping West Base	104	56	40·61	0·26	+1·482	42·092
32	Epping East Base	123	57	37·17	0·27	+0·303	37·473
33	Howard	176	41	31·69	0·25	+0·536	32·226

Probable error of a single observation (3*D.* and 3*R.*) of a direction, $e_1 = \pm 1''.11$. Number of angles adjusted, 14.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the base net, 1856–1859—continued.

Humpback, Hancock County, Maine. July 19 to September 6, 1858. 75[cm] direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

No. of directions.	Objects observed.	Resulting directions from station adjustment. °	′	″	Approximate probable errors. ″	Corrections from base net adjustment. ″	Final seconds in triangulation. ″
34	Cooper	0	00	00·000	±0·150	.....	00·000
	Azimuth Mark	39	37	40·23	0·163	.....	40·403
35	Howard	39	45	46.385	0·126	+0·605	46·990
36	Epping East Base	59	43	10·401	0·136	+0·135	10·536
37	Epping West Base	69	38	48·051	0·151	+0·084	48·135
38	Pigeon	84	09	57·099	0·125	−0·223	56·876
39	Burke	85	14	25·280	0·142	−0·086	25·195
40	Tunk	102	22	11·498	0·143	+0·093	11·591
41	Mount Desert	114	33	50·877	0·090	+0·779	51·656
	Ragged Mountain	154	28	20·545	0·132	.....	......
	Saunders	165	12	47·118	0·131	.....	......
	Mount Harris	180	36	29·988	0·169	.....	.....

Number of positions of circle, V. Probable error of a single observation of a direction, $e_1 = \pm 0''{\cdot}91$.

Mount Desert, Hancock County, Maine. August 14 to October 14, 1856. 75[cm] direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

No. of directions.	Objects observed.	°	′	″	″	″	″
	Isle au Haut	0	00	00·000	±0·141	.....	......
	Ragged Mountain	33	39	21·332	0·108	.....	......
	Mount Harris	70	54	51·931	0·121	.....	......
	Saunders	93	48	58·382	0·103	.....	......
	Azimuth Mark	122	49	25·136	0·098	.....	......
42	Humpback	144	20	00·152	0·078	0·000	00·000
		0	00	00·000			
43	Tunk	153	19	24·878	0·107	+0·206	24·932
		8	59	24·726			
44	Burke	171	09	49·736	0·148	− 0·399	49·185
		26	49	49·584			
45	Cooper	175	20	34·430	0·115	+0·068	34·346
		31	00	34·278			
46	Epping East Base	176	36	26·634	0·132	−0·062	26·420
		32	16	26·482			
47	Howard	199	47	46·624	0·132	+0·756	47·228
		55	27	46·472			
48	Pigeon	201	46	49·121	0·110	+0·390	49·358
		57	26	48·969			

Number of positions of circle, V. Probable error of a single observation of a direction, $e_1 = \pm 0''{\cdot}86$.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the base net, 1856–1859—continued.

Howard, Washington County, Maine. July 15 to August 8, 1859. 75^{cm} direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

No. of directions.	Objects observed.	Resulting directions from station adjustment. °	′	″	Approximate probable errors. ″	Corrections from base net adjustment. ″	Final seconds in triangulation. ″
49	Pigeon	0	00	00·000	±0·140	0·000	00·000
50	Mount Desert	1	19	25·944	0·177	−0·112	25·832
51	Burke	22	02	34·126	0·213	−0·968	33·158
52	Epping East Base	33	30	40·141	0·191	+0·204	40·345
53	Humpback	51	03	41·505	0·173	+1·231	42·736
54	Cooper	108	01	27·996	0·114	+0·022	28·018
	Azimuth Mark	123	51	19·227	0·110	.....	19·290
	Trescott Rock	173	43	51·973	0·191	.....	......
	Grand Manan	189	28	45·843	0·161	.....	......

Number of positions of circle, V. Probable error of a single observation of a direction, $e_1 = \pm 1''{\cdot}19$.

Cooper, Washington County, Maine. August 30 to September 16, 1859. 75^{cm} direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

No. of directions.	Objects observed.	°	′	″	″	″	″
	Chamcook	0	00	00·000	±0·117	.....	......
	Prince Regents Redoubt	38	36	49·082	0·197	.....	......
	Grand Manan	54	40	14·493	0·238	.....	.....
	Trescott Rock	68	43	51·687	0·161	.....	.....
55	Howard	108 0	56 00	09·385 00·000	0·133	0·000	00·000
56	Mount Desert	157 48	47 50	00·789 51·404	0·188	+0·641	52·045
57	Burke	160 51	11 15	40·754 31·369	0·149	+0·578	31·948
58	Humpback	192 83	12 16	43·014 33·629	0·259	−0·587	33·042
	Azimuth Mark	294 185	13 16	08·804 59·419	0·127	.....	59·577

Number of positions of circle, V. Probable error of a single observation of a direction, $e_1 = \pm 1''{\cdot}19$.

EPPING BASE NET ADJUSTMENT.

Observation equations.

I $$0=+2.17807+0.40132(5)-0.37895(4)+0.61094(32)-1.53850(31)+0.81302(3$$
$$-2.01607(37)+1.20305(36)-0.02237(7)+0.92756(30)$$

II $$0=+0.283+(8)-(12)+(37)-(36)+(5)-(4)$$

III $$0=-0.698+(32)-(30)+(38)-(36)+(5)-(7)$$

IV $$0=-0.807+(31)-(30)+(38)-(37)+(12)-(9)$$

V $$0=-6.12588+0.80064(31)+5.39998(24)+10.47161(39)-11.22604(38)-6.20062(30)$$
$$+0.75443(37)-0.16782(12)-0.30212(10)+0.46994(9)$$

Observation equations—continued.

VI	$0=+1.292+(10)-(9)+(31)-(29)+(18)-(14)$
VII	$0=+0.768+(18)-(13)+(39)-(38)+(30)-(29)$
VIII	$0=+0.08483+0.25700(16)-0.54841(14)+0.29141(13)+0.75443(39)-1.95748(37)$
	$+1.20305(36)+0.40132(5)+0.16676(2)-0.56808(4)$
IX	$0=-0.788+(16)-(13)+(39)-(36)+(5)-(2)$
X	$0=-1.34263+0.18284(11)-0.65278(10)+0.46994(9)+0.80064(31)-1.56540(29)$
	$+0.76476(28)+0.43254(25)-0.60454(24)+0.17200(22)$
XI	$0=-2.555+(20)-(18)+(29)-(28)+(25)-(24)$
XII	$0=-1.726+(25)-(22)+(11)-(9)+(31)-(28)$
XIII	$0=-0.68771+0.31512(32)-1.07988(29)+0.76476(28)+0.43254(25)-0.73688(24)$
	$+0.30434(23)+0.43596(3)-0.65063(2)+0.21467(7)$
XIV	$0=-0.929+(16)-(20)+(24)-(23)+(3)-(2)$
XV	$0=-1.58338+0.73062(23)-0.81676(22)+0.08614(21)+0.32768(40)-1.53073(37)$
	$+1.20305(36)+0.40132(5)-0.83606(4)+0.43474(3)$
XVI	$0=+0.153+(40)-(37)+(12)-(11)+(22)-(21)$
XVII	$0=+0.22432+0.65422(44)-1.98508(43)+1.33086(42)+0.97432(41)-1.65748(40)$
	$+0.68316(39)+0.21525(13)-0.25436(20)+0.03911(19)$
XVIII	$0=-0.907+(13)-(19)+(44)-(42)+(41)-(39)$
XIX	$0=-1.117+(41)-(40)+(21)-(26)+(43)-(42)$
XX	$0=-1.83218+2.20947(46)-2.62575(44)+0.41628(42)+0.37484(41)-0.81586(39)$
	$+0.44102(36)+0.03977(5)-0.91152(2)+0.87175(1)$
XXI	$0=+1.271+(2)-(1)+(46)-(44)+(19)-(16)$
XXII	$0=-0.44146+0.67443(30)-0.73156(28)+0.05713(27)+0.18656(48)-1.51742(43)$
	$+1.33086(42)+0.97432(41)-1.61457(40)+0.64025(38)$
XXIII	$0=-1.358+(30)-(27)+(48)-(42)+(41)-(38)$
XXIV	$0=+0.92970+0.44102(39)-1.02088(36)+0.57986(35)+0.66575(53)-1.70358(52)$
	$+1.03783(51)+0.35990(17)-0.41562(16)+0.05572(13)$
XXV	$0=+0.303+(2)-(6)+(52)-(51)+(17)-(16)$
XXVI	$0=-0.134+(36)-(35)+(53)-(52)+(6)-(5)$
XXVII	$0=-1.36912+0.66575(53)-1.00027(52)+0.33452(50)+0.49153(47)-0.82493(46)$
	$+0.33340(42)+0.14829(41)-0.72815(36)+0.57986(35)$
XXVIII	$0=-1.716+(1)-(6)+(52)-(50)+(47)-(46)$
XXIX	$0=+0.51527+0.35890(41)-0.57388(38)+0.21498(35)+0.17014(53)+8.94070(49)$
	$-9.11084(50)+5.94358(48)-6.07800(47)+0.13442(42)$
XXX	$0=-0.056+(33)-(27)+(48)-(47)+(50)-(49)$
XXXI	$0=-1.75954+0.33673(58)-5.33719(57)+5.00046(56)+2.88157(45)-3.29785(44$
	$+0.41628(42)+0.37484(41)-0.39237(39)+0.01753(34)$
XXXII	$0=+1.216+(19)-(15)+(57)-(56)+(45)-(44)$
XXXIII	$0=+0.380+(41)-(34)+(58)-(56)+(45)-(42)$
XXXIV	$0=+0.82217+4.83153(57)-5.00046(56)+0.16893(55)+0.01479(54)-0.57145(51$
	$+0.55666(50)+0.38566(47)+2.49591(44)-2.88157(45)$
XXXV	$0=-1.463+(47)-(45)+(56)-(55)+(54)-(50)$

[The log differences for 1″ are given in units of the fifth place of decimals.]

The reciprocals of the weights introduced for the several directions are as follows:

Dir's	1/p	Dir's	1/p	Dir's	1/p	Dir's	1/p	Dir's	1/p	Dir's	1/p
1	0·102	11	0·084	21	0·259 (max.)	31	0·098	41	0·038	51	0·076
2	0·108	12	0·087	22	0·256	32	0·102	42	0·036 (min.)	52	0·067
3	0·105	13	0·132	23	0·237	33	0.094	43	0·042	53	0·060
4	0·128	14	0·157	24	0·241	34	0·053	44	0·052	54	0·043
5	0·108	15	0·138	25	0·239	35	0·046	45	0·043	55	0·048
6	0·110	16	0·139	26	0·250	36	0·049	46	0·048	56	0·066
7	0·112	17	0·142	27	0·105	37	0·053	47	0·048	57	0·052
8	0·065	18	0·148	28	0·104	38	0·046	48	0·042	58	0·097
9	0·070	19	0·144	29	0·094	39	0·050	49	0·050		
10	0·093	20	0·146	30	0·098	40	0·051	50	0·062		

The correlate and normal equations may be found in Coast Survey Report for 1864, pp. 132–136,* the resulting corrections to the several directions are as follows:

	″		″		″		″		″		″
(1) =	+0·213	(11) =	−0·342	(21) =	+0·281	(31) =	+1·125	(41) =	+0·583	(51) =	−1·056
(2)	−0·343	(12)	+0·331	(22)	−0·555	(32)	−0·054	(42)	−0·143	(52)	+0·115
(3)	+1·248	(13)	−0·117	(23)	+0·351	(33)	+0·179	(43)	+0·063	(53)	+1·143
(4)	−0·263	(14)	+0·412	(24)	−0·594	(34)	−0·196	(44)	−0·542	(54)	−0·066
(5)	+0·056	(15)	+1·061	(25)	+0·435	(35)	+0·409	(45)	−0.075	(55)	−0·226
(6)	−0·369	(16)	+0·492	(26)	+0·057	(36)	−0.061	(46)	−0·205	(56)	+0·415
(7)	−0·665	(17)	−1·008	(27)	−0·357	(37)	−0·112	(47)	+0·613	(57)	+0·352
(8)	−0·220	(18)	−0·514	(28)	−0·683	(38)	−0.419	(48)	+0.247	(58)	−0.813
(9)	+0·731	(19)	−0·559	(29)	+0·120	(39)	−0·282	(49)	−0·089		
(10)	−0·642	(20)	+0·209	(30)	−0·390	(40)	−0·103	(50)	−0·201		

For check† we have $\Sigma(p\,vv) = +171{\cdot}31$
and $-[w\ C] = +171{\cdot}44$.

The probable error of a direction of unit weight is therefore $0{\cdot}674\sqrt{\frac{[pvv]}{c}} = 0{\cdot}674\sqrt{\frac{171{\cdot}4}{35}} = \pm 1''.49$.

The reciprocal of the average weight of a direction, or $1/p$ equals $0{\cdot}100$, hence the probable error of an observed direction equals $1{\cdot}49\sqrt{\frac{1}{p}} = \pm 0''{\cdot}47$ and that of an angle $\pm 0''.67$.

Resulting angles and sides of the Epping base net, Maine. ‡

No.	Stations.	Observed angles. °	′	″	Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distance in meters.
1	Burke	39	19	35·850	+0·080	35·930	0·079	3·940 314 34	8 715·942
	Epping West Base	89	03	11·750	−0·422	11·328	0·080	4·138 343 64	13 751·296
	Epping East Base	51	37	12·900	+0·080	12·980	0·079	4·032 670 78	10 781·291
2	Tunk	16	04	34·010	+0·906	34·916	0·068	3·940 314 34	8 715·942
	Epping West Base	138	04	57·080	−0·122	56·958	0·067	4·322 778 80	21 027·072
	Epping East Base	25	50	29·840	−1·511	28·329	0·068	4·137 328 24	13 719·183

* With changed notation, the present one being more convenient for printing as well as for writing.

† It is not quite exact, for the reason that after the general figure adjustment had been made the third decimals of the corrections to the directions were not assured and had to be further treated; see Report for 1864, p. 137. On page 136 of that report correlate xxxi for 24,943 read 34,943.

‡ Published in Coast Survey Report for 1865, pp. 197–199.

Resulting angles and sides of the Epping base net, Maine—continued.

No.	Stations.	Observed angles. °	′	″	Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
3	Tunk	50	45	11 ·850	0 ·039	11 ·811	0 ·094	4 ·032 670 78	10 781 ·291
	Epping West Base	49	01	45 ·330	+0 ·300	45 ·630	0 ·094	4 ·021 662 33	10 511 ·443
	Burke	80	13	02 ·640	+0 ·203	02 ·843	0 ·095	4 ·137 328 24	13 719 ·183
4	Tunk	34	40	37 ·840	−0 ·945	36 ·895	0 ·106	4 ·138 343 64	13 751 ·296
	Epping East Base	25	46	43 ·060	+1 ·591	44 ·651	0 ·106	4 ·021 662 33	10 511 ·443
	Burke	119	32	38 ·490	+0 ·283	38 ·773	0 ·107	4 ·322 778 80	21 027 ·072
5	Pigeon	19	00	56 ·560	−1 ·180	55 ·380	0 ·178	3 ·940 314 34	8 715 ·942
	Epping West Base	64	55	08 ·300	+0 ·951	09 ·251	0 ·178	4 ·384 324 57	24 228 ·391
	Epping East Base	96	03	55 ·500	+0 ·402	55 ·902	0 ·177	4 ·424 896 92	26 600 ·936
6	Pigeon	33	44	59 ·030	−0 ·174	58 ·856	0 ·197	4 ·138 343 64	13 751 ·296
	Burke	101	48	19 ·820	−1 ·005	18 ·815	0 ·197	4 ·384 324 56	24 228 ·390
	Epping East Base	44	26	42 ·600	+0 ·322	42 ·922	0 ·198	4 ·238 847 61	17 331 ·957
7	Pigeon	49	08	34 ·310	+0 ·629	34 ·939	0 ·405	4 ·322 778 80	21 027 ·072
	Tunk	60	37	58 ·620	+0 ·084	58 ·704	0 ·405	4 ·384 324 57	24 228 ·391
	Epping East Base	70	13	25 ·660	+1 ·913	27 ·573	0 ·406	4 ·417 660 18	26 161 ·352
8	Pigeon	14	44	02 ·470	+1 ·006	03 ·476	0 ·099	4 ·032 670 78	10 781 ·291
	Burke	141	07	55 ·670	−0 ·925	54 ·745	0 ·100	4 ·424 896 91	26 600 ·936
	Epping West Base	24	08	03. 450	−1 ·373	02 ·077	0 ·099	4 ·238 847 61	17 331 ·957
9	Pigeon	30	07	37 ·750	+1 ·809	39 ·559	0 ·295	4 ·137 328 24	13 719 ·183
	Tunk	76	42	32 ·630	+0 ·990	33 ·620	0 ·296	4 ·424 896 91	26 600 ·936
	Epping West Base	73	09	48 ·780	−1 ·073	47 ·707	0 ·295	4 ·417 660 18	26 161 ·352
10	Pigeon	15	23	35 ·280	+0 ·803	36 ·083	0 ·101	4 ·021 662 33	10 511 ·443
	Tunk	25	57	20 ·780	+1 ·029	21 ·809	0 ·102	4 ·238 847 61	17 331 ·957
	Burke	138	39	01 ·690	+0 ·723	02 ·413	0 ·102	4 ·417 660 18	26 161 ·352
11	Humpback	9	55	37 ·650	−0 ·051	37 ·599	0 ·105	3 ·940 314 34	8 715 ·942
	Epping East Base	27	41	01 ·010	+0 ·320	01 ·330	0 ·106	4 ·370 860 02	23 488 ·756
	Epping West Base	142	23	21 ·940	−0 ·551	21 ·389	0 ·106	4 ·489 329 42	30 855 ·275
12	Humpback	25	31	14 ·879	−0 ·220	14 ·659	0 ·352	4 ·138 343 64	13 751 ·296
	Epping East Base	79	18	13 ·910	+0 ·400	14 ·310	0 ·352	4 ·496 419 39	31 363 ·129
	Burke	75	10	31 ·480	+0 ·609	32 ·089	0 ·353	4 ·489 329 43	30 855 ·276
13	Humpback	42	39	01 ·097	−0 ·042	01 ·055	0 ·441	4 ·322 778 80	21 027 ·072
	Epping East Base	53	31	30 ·850	−1 ·192	29 ·658	0 ·441	4 ·397 174 17	24 955 ·954
	Tunk	83	49	30 ·540	+0 ·070	30 ·610	0 ·441	4 ·489 329 43	30 855 ·276
14	Humpback	24	26	46 ·698	−0 ·358	46 ·340	0 ·525	4 ·384 324 57	24 228 ·391
	Epping East Base	123	44	56 ·510	+0 ·721	57 ·231	0 ·525	4 ·687 346 90	48 679 ·590
	Pigeon	31	48	17 ·670	+0 ·335	18 ·005	0 ·526	4 ·489 329 42	30 855 ·275

Resulting angles and sides of the Epping base net, Maine—continued.

No.	Stations.	Observed angles. °	′	″	Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distance in meters.
15	Humpback	15	35	37 ·229	−0 ·169	37 ·060	0 ·167	4 ·032 670 78	10 781 ·291
	Epping West Base	128	33	26 ·310	+0 ·973	27 ·283	0 ·168	4 ·496 419 39	31 363 ·129
	Burke	35	50	55 ·630	+0 ·529	56 ·159	0 ·167	4 ·370 860 03	23 488 ·757
16	Humpback	32	43	23 ·447	+0 ·009	23 ·456	0 ·268	4 ·137 328 24	13 719 ·182
	Epping West Base	79	31	40 ·980	+0 ·674	41 ·654	0 ·268	4 ·397 174 17	24 955 ·954
	Tunk	67	44	56 ·530	−0 ·836	55 ·694	0 ·268	4 ·370 860 03	23 488 ·757
17	Humpback	14	31	09 ·048	−0 ·308	08 ·740	0 ·242	4 ·424 896 91	26 600 ·936
	Epping West Base	152	41	29 ·760	−0 ·399	29 ·361	0 ·242	4 ·687 346 91	48 679 ·590
	Pigeon	12	47	21 ·110	+1 ·515	22 ·625	0 ·241	4 ·370 860 04	23 488 ·757
18	Humpback	17	07	46 ·218	+0 ·178	46 ·396	0 ·195	4 ·021 662 33	10 511 ·443
	Burke	44	22	07 ·010	−0 ·326	06 ·684	0 ·195	4 ·397 174 18	24 955 ·954
	Tunk	118	30	08 ·380	−0 ·875	07 ·505	0 ·195	4 ·496 419 40	31 363 ·130
19	Humpback	1	04	28 ·181	+0 ·138	28 ·319	0 ·024	4 ·238 847 61	17 331 ·957
	Pigeon	1	56	41 ·360	−0 ·509	40 ·851	0 ·024	4 ·496 419 39	31 363 ·129
	Burke	176	58	51 ·300	−0 ·397	50 ·903	0 ·025	4 ·687 346 91	48 679 ·590
20	Humpback	18	12	14 ·399	+0 ·316	14 ·715	0 ·321	4 ·417 660 18	26 161 ·352
	Pigeon	17	20	16 ·640	+0 ·293	16 ·933	0 ·320	4 ·397 174 18	24 955 ·954
	Tunk	144	27	29 ·160	+0 ·154	29 ·314	0 ·321	4 ·687 346 91	48 679 ·590
21	Mount Desert	5	26	36 ·898	+0 ·337	37 ·235	0 ·129	4 ·138 343 64	13 751 ·296
	Burke	160	58	42 ·360	−1 ·051	41 ·309	0 ·129	4 ·674 354 00	47 244 ·798
	Epping East Base	13	34	42 ·400	−0 ·557	41 ·843	0 ·129	4 ·531 878 92	34 031 ·330
22	Mount Desert	23	17	01 ·756	−0 ·268	01 ·488	0 ·532	4 ·322 778 80	21 027 ·072
	Tunk	117	21	33 ·910	−0 ·294	33 ·616	0 ·533	4 ·674 354 00	47 244 ·798
	Epping East Base	39	21	25 ·460	+1 ·034	26 ·494	0 ·533	4 ·528 065 36	33 733 ·807
23	Mount Desert	25	10	22 ·487	+0 ·451	22 ·938	0 ·496	4 ·384 324 57	24 228 ·391
	Epping East Base	30	52	00 ·200	+0 ·878	01 ·078	0 ·496	4 ·465 731 76	29 223 ·468
	Pigeon	123	57	37 ·170	+0 ·303	37 ·473	0 ·497	4 ·674 354 00	47 244 ·798
24	Mount Desert	32	16	26 ·482	−0 ·062	26 ·420	1 ·231	4 ·489 329 43	30 855 ·276
	Humpback	54	50	40 ·476	+0 ·643	41 ·119	1 ·231	4 ·674 354 00	47 244 ·798
	Epping East Base	92	52	56 ·310	−0 ·157	56 ·153	1 ·230	4 ·761 268 03	57 712 ·253
25	Mount Desert	17	50	24 ·858	−0 ·605	24 ·253	0 ·297	4 ·021 662 33	10 511 ·443
	Tunk	82	40	56 ·070	+0 ·651	56 ·721	0 ·297	4 ·531 878 93	34 031 ·330
	Burke	79	28	39 ·150	+0 ·768	39 ·918	0 ·298	4 ·528 065 36	33 733 ·807
26	Mount Desert	30	36	59 ·385	+0 ·788	60 ·173	0 ·428	4 ·238 847 61	17 331 ·957
	Burke	59	10	22 ·540	−0 ·045	22 ·495	0 ·428	4 ·465 731 76	29 223 ·468
	Pigeon	90	12	38 ·140	+0 ·476	38 ·616	0 ·428	4 ·531 878 92	34 031 ·330

Resulting angles and sides of the Epping base net, Maine—continued.

No.	Stations.	Observed angles. °	′	″	Correction.	Spherical angles.	Spherical excess.	Log distances.	Distance in meters.
27	Mount Desert	26	49	49 ·584	−0 ·399	49 ·185	0 ·749	4 ·496 419 39	31 363 ·129
	Humpback	29	19	25 ·597	+0 ·864	26 ·461	0 ·750	4 ·531 878 92	34 031 ·330
	Burke	123	50	46 ·160	+0 ·442	46 ·602	0 ·749	4 ·761 268 03	57 712 ·253
28	Mount Desert	48	27	24 ·243	+0 ·183	24 ·426	0 ·624	4 ·417 660 18	26 161 ·352
	Tunk	56	43	35 ·290	−0 ·378	34 ·912	0 ·624	4 ·465 731 76	29 223 ·468
	Pigeon	74	49	02 ·860	−0 ·327	02 ·533	0 ·623	4 ·528 065 36	33 733 ·807
29	Mount Desert	8	59	24 ·726	+0 ·206	24 ·932	0 ·257	4 ·397 174 18	24 955 ·954
	Humpback	12	11	39 ·379	+0 ·686	40 ·065	0 ·257	4 ·528 065 36	33 733 ·807
	Tunk	158	48	55 ·550	+0 ·225	55 ·775	0 ·258	4 ·761 268 03	57 712 ·253
30	Mount Desert	57	26	48 ·969	+0 ·389	49 ·358	1 ·202	4 ·687 346 91	48 679 ·590
	Humpback	30	23	53 ·778	+1 ·002	54 ·780	1 ·202	4 ·465 731 76	29 223 ·468
	Pigeon	92	09	19 ·500	−0 ·033	19 ·467	1 ·201	4 ·761 268 03	57 712 ·253
31	Howard	11	28	06 ·005	+1 ·171	07 ·186	0 ·271	4 ·138 343 64	13 751 ·296
	Burke	30	19	45.160	−1 ·500	43 ·660	0 ·271	4 ·543 117 55	34 923 ·483
	Epping East Base	138	12	09 ·940	+0 ·026	09 ·966	0 ·270	4 ·663 658 76	46 095 ·524
32	Howard	33	30	40 ·141	+0 ·204	40 ·345	0 ·714	4 ·384 324 56	24 228 ·390
	Pigeon	52	43	54 ·520	+0 ·233	54 ·753	0 ·714	4 ·543 117 54	34 923 ·482
	Epping East Base	93	45	27 ·340	−0 ·297	27 ·043	0 ·713	4 ·641 374 53	43 789 ·958
33	Howard	17	33	01 ·364	+1 ·028	02 ·392	0. 555	4 ·489 329 43	30 855 ·276
	Epping East Base	142	29	36 ·150	−0 ·424	35 ·726	0 ·554	4 ·794 490 45	62 300 ·345
	Humpback	19	57	24 ·016	−0 ·470	23 ·546	0 ·555	4 ·543 117 54	34 923 ·482
34	Howard	32	11	14 ·197	+0 ·316	14 ·513	1 ·148	4 ·674 354 00	47 244 ·798
	Mount Desert	23	11	19 ·990	+0 ·818	20 ·808	1 ·148	4 ·543 117 54	34 923 ·482
	Epping East Base	124	37	27 ·540	+0 ·582	28 ·122	1 ·147	4 ·863 228 98	72 984 ·221
35	Howard	22	02	34 ·126	−0 ·968	33 ·158	0 ·640	4 ·238 847 61	17 331 ·957
	Pigeon	86	28	53 ·550	+0 ·059	53 ·609	0 ·641	4 ·663 658 75	46 095 ·523
	Burke	71	28	34 ·660	+0 ·494	35 ·154	0 ·640	4 ·641 374 53	43 789 ·958
36	Howard	29	01	07 ·379	+2 ·199	09 ·578	1 ·177	4 ·496 419 39	31 363 ·129
	Burke	105	30	16 ·640	−0 ·891	15 ·749	1 ·178	4 ·794 490 46	62 300 ·346
	Humpback	45	28	38 ·895	−0 ·690	38 ·205	1 ·177	4 ·663 658 76	46 095 ·524
37	Howard	20	43	08 ·182	−0 ·856	07 ·326	1 ·006	4 ·531 878 92	34 031 ·330
	Mount Desert	28	37	56 ·888	+1 ·155	58 ·043	1 ·006	4 ·663 658 76	46 095 ·524
	Burke	130	38	57 ·200	+0 ·449	57 ·649	1 ·006	4 ·863 228 98	72 984 ·221
38	Howard	51	03	41 ·505	+1 ·231	42 ·736	1 ·794	4 ·687 346 91	48 679 ·590
	Pigeon	84	32	12 ·190	+0 ·569	12 ·759	1 ·793	4 ·794 490 44	62 300. 345
	Humpback	44	24	10 ·714	−0 ·828	09 ·886	1 ·794	4 ·641 374 53	43 789 ·958

Resulting angles and sides of the Epping base net, Maine—continued.

No.	Stations.	Observed angles. °	′	″	Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
39	Howard	1	19	25·944	−0·112	25·832	0·062	4·465 731 76	29 223·468
	Pigeon	176	41	31·690	+0·535	32·225	0·063	4·863 228 98	72 984·221
	Mount Deser	1	59	02·497	0·367	02·130	0·062	4·641 374 53	43 789·958
40	Howard	49	44	15·561	+1·344	16·905	2·933	4·761 268 03	57 712·253
	Mount Desert	55	27	46·472	+0·756	47·228	2·933	4·794 490 45	62 300·345
	Humpback	74	48	04·492	+0·174	04·666	2·933	4·863 228 98	72 984·221
41	Cooper	32	00	62·260	−1·165	61·095	1·389	4·496 419 39	31 363·129
	Burke	62	44	36·700	+1·178	37·878	1·389	4·720 893 20	52 588·793
	Humpback	85	14	25·280	−0·085	25·195	1·390	4·770 508 08	58 953·295
42	Cooper	2	24	39·965	−0·063	39·902	0·194	4·531 878 92	34 031·330
	Mount Desert	4	10	44·694	+0·467	45·161	0·195	4·770 508 08	58 953·295
	Burke	173	24	37·140	−1·620	35·520	0·194	4·967 744 25	92 841·949
43	Cooper	51	15	31·369	+0·578	31·947	1·559	4·663 658 76	46 095·524
	Howard	85	58	53·870	+0·990	54·860	1·560	4·770 508 08	58 953·295
	Burke	42	45	39·940	−2·069	37·871	1·559	4·603 402 14	40 123·808
44	Cooper	34	25	42·225	−1·228	40·997	2·333	4·761 268 03	57 712·253
	Mount Desert	31	00	34·278	+0·069	34·347	2·333	4·720 893 21	52 588·794
	Humpback	114	33	50·877	+0·779	51·656	2·334	4·967 744 25	92 841·949
45	Cooper	83	16	33·629	−0·587	33·042	1·772	4·794 490 46	62 300·346
	Howard	56	57	46·491	−1·209	45·282	1·771	4·720 893 21	52 588·794
	Humpback	39	45	46·385	+0·605	46·990	1·771	4·603 402 14	40 123·808
46	Cooper	48	50	51·404	+0·641	52·045	2·371	4·863 228 98	72 984·221
	Howard	106	41	62·052	+0·134	62·186	2·371	4·967 744 25	92 841·949
	Mount Desert	24	27	12·194	+0·688	12·882	2·371	4·603 402 14	40 123·808

Descriptions of stations.

Epping East Base.—The station is in Washington County, Maine, at an angle in the road from Epping village to Columbia, and directly upon the edge of the escarpment of the Epping Plains.

The *subsurface mark* is the intersection of cross lines on a copper bolt in granite block 2 feet long, set 3·5 feet below the surface of the ground. A platform of concrete about 5 feet square and 1 foot thick was prepared above this, with an opening in the center, through which the subsurface mark could be seen. This formed the foundation for the *surface mark*, a large granite block, 3 feet square, carefully dressed, and, when in place, projecting about 6 inches above the surface of the ground, with a copper bolt and cross lines in its center. Upon this was placed a monument of marble 3·28 feet high and 1·64 feet square, resting upon three feet, each about 3 inches in diameter and 1 inch high. The inscriptions on the sides are as follows: north face, "U. S. Coast Survey;" south "1857;" east, "Base No. 9;" west, "A. D. Bache, Supt." The apex is 4 inches above its sides, and on its four faces are the letters, N, E, S, & W, respectively.

A perpendicular to the base at the center of the monument passes through the intersections of cross lines in copper bolts in tops of two granite reference monuments, 3·5 feet long and 1 foot square, set at distance of 36 and 72 meters north of station.

When the station was visited in 1884, these reference monuments were found undisturbed, also a third, not described, with a hole drilled in top, 108 meters north of the station. The marble monument was then found overturned and broken, but the granite surface mark remained undisturbed, except that the head of the copper bolt had been hammered so that the cross lines were no longer visible.

Epping West Base.—This station is about 2 miles west of Schoodiac Hill, and has no *subsurface mark.*

The *surface mark* is the intersection of cross lines on a copper bolt in a monument 3 feet square, made from the solid ledge by cutting away the rock to a depth of 6 or 8 inches around it.

Similar marks 1 foot square were made north and south of the center in a line perpendicular to the base, with copper bolts and cross lines placed in position.

Over the surface mark was placed the monument of marble of same dimensions as that described for Epping East Base.

When visited in 1884 the marble monument was found overthrown and broken, while the copper bolt had been hammered so that no cross lines were visible. The mark south of the center was in perfect condition. The one to the north had been destroyed by vandals, but the remains of the hole in which the copper bolt had been placed could be distinguished. The distance from the station to these marks is about 10 meters.

Burke.—This station is on the southernmost one of a range of rocky hills about 3 miles west of Cherryfield village and about 20 rods north of the line between Mount Steuben and Cherryfield. It is *marked* by hole in a granite ledge at the north end of a small hollow on the summit of the hill, and it is about 3 feet below highest part of ledge, which is too narrow for a signal.

Tunk.—This station is on a mountain of the same name, the most commanding mountain (except Mount Desert) east of the Penobscot River. It is about 1 mile north of the stage road from Ellicott to Cherryfield and about 3 miles west of the nearest house in Cherryfield. It is *marked* by a hole drilled in a granite ledge about 150 feet southwest of the highest part of the summit and about 4 feet below it.

Pigeon.—This station is on the highest part of a hill close to the ocean on the western side of the outlet of Narraguagus River. It commands the coast from Frenchmans Bay to Head Harbor Island, and is 9 miles from Cherryfield. It is *marked* by a hole drilled in a flat rock. In range to Mount Desert, 53·25 feet distant; to Saunders, 56·25 feet distant; to Humpback, 35·33 feet distant, and to Mitten Mountain, 36·83 feet distant, there are holes and piles of stone.

Humpback.—This station is on the mountain of the same name, near the western line of Brewster Township. The highest point of the mountain is about 400 feet northeast of the station and is 4 or 5 feet above it. It is marked by a hole drilled in the rock. Range marks, consisting of holes drilled in the rock and heaps of stones, were made toward Harris, Saunders, and Mount Desert, distant 14, 17·42, and 13·50 feet, respectively.

Mount Desert.—This station is marked by a copper bolt in a ledge which is in the center of a small depression in the large bare rock and 22¼ inches easterly from the southeast corner of a crevice.

Single range marks, consisting of a hole in the rock, were made toward Peaked, Blue, and Ragged mountains, distant from center 53·17, 17·52, and 21·83 feet, respectively. Toward Saunders and Harris there were two such marks, distant, in the first instance, 35·92 and 142·50 feet, while in the latter, 19·92 and 136·60 feet from the center of the station.

Howard.—This station is on a steep, precipitous hill, about 6 miles below Machiasport and near Bucks Harbor. It is marked by a drill hole in a rock. Range marks were established toward Mount Desert, Humpback, and Cooper, distant 33·67, 66·25, and 21·30 feet, respectively. When visited in 1884, the station was recovered.

Cooper.—This station is on the northern end of the summit of Western Ridge, about one-fourth mile west of the road running through the village of Cooper and about three-eighths of a mile northwest of Cooper Church. It is marked by a drill hole in a broad, flat granite ledge. Range marks, consisting of drill holes in the rock, were made toward Mount Desert and Humpback, distant 22·80 and 19·65 feet, respectively.

2. THE MASSACHUSETTS BASE LINE, MASSACHUSETTS, 1844.

Location, measurement, and resulting length of the Massachusetts base line, Massachusetts, 1844.

This base was the third and last one measured with the Hassler base apparatus and followed within a few months the measure of the Kent Island base. Its site is on the Boston and Providence Railroad, in Bristol County, Massachusetts, and about 12 kilometers (7½ statute miles) to the northward and eastward of Providence, Rhode Island. An account of this base is given in the Coast Survey Report for 1865, Appendix No. 21, page 189, and little need be said here respecting the apparatus, a description of which can be found in the account of the measurement of the Fire Island and Kent Island bases. Its middle point is in latitude 41° 58′·9 and in longitude 71° 15′·3, the mean azimuth is 27° 49′·2, and its length 17⅓ kilometers (or nearly 10¾ statute miles). There are but two bases in the United States (both in California) which exceed this length.

The line was measured by Assistant Edmund Blunt during September, October, and November, 1844. As in the case of the two bases previously measured by the Survey, but one measure was made. The length adopted for the compound 8-meter bar rests upon the comparisons of 1844–45, with the resulting length of 7·999 8716 meters at 0° C. ± 55 (see account of the Kent Island base). The mean temperature of the bar during the measurement was 14°·92 C. (or 58°·85 F.); the average elevation of the apparatus above the half-tide level at Boston Harbor was $44^{m}·83$. The record at this base is deficient in details.

The resulting length of the base is as follows:

2 165 boxes	17 319^{m}·7221
Correction for excess of temperature	+ 3·2383
Correction for inclination	— 0·5629
Fractional part of a box at Northeast Base	+ 3·9999
Correction for 10° difference of temperature for above	— 0·0003
Additional length measured by scale	+ 0·1012
Reduction to half-tide level	— 0·1220
Resulting length of base	17 326^{m}·3763

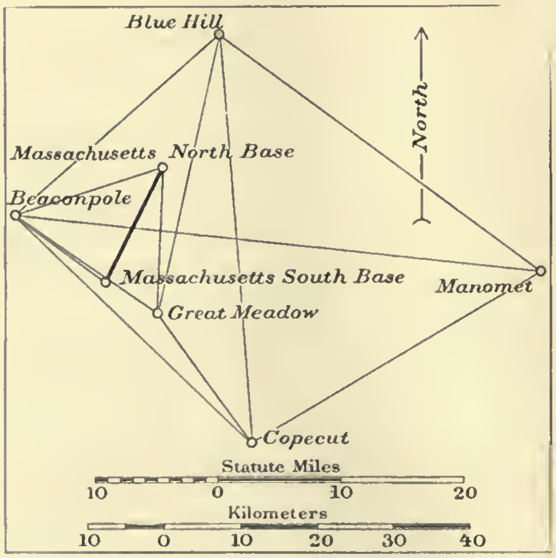
To form an estimate of the accuracy of this measure, we find, from the probable error assigned to the base bars, that of the base to be $\pm 0^{m}\cdot 0119$. With reference to temperature, 702 boxes were laid with rising and 579 with falling temperature, and for the rest of the boxes the temperature was stationary. The assumed probable error from this condition and probable lag, and from graduation error is $\pm 0^{m}\cdot 0332$, and the probable error from instability of the microscopes is taken as $\pm 0^{m}\cdot 0059$. Combining these three independent values, we get for the probable error of the base $\pm 0^{m}\cdot 0358$, which equals $\frac{1}{483980}$ of its length. We have, therefore, the final result for the length of the Massachusetts base $17\ 326\cdot 3763$ meters, and its logarithm $4\cdot 238\ 70774$.

$$17\ 326\cdot 3763 \pm \cdot 0358 \qquad 4\cdot 238\ 70774 \pm 90.$$

The connection of the Massachusetts base with the main triangulation.

The Massachusetts base is connected with the main triangulation in an unusual way—that is, with a base net so simple as to render a special adjustment of it unnecessary. The conditional equations, therefore, which subsist between the three northern base-lines were extended to reach directly to the Massachusetts base without any intervention of a special base net adjustment. The diagram shows the direct connection of the base with the triangulation of the New England States, the quadrilateral Beacon Pole, Copecut, Manomet, and Blue Hill being an integral part thereof. One advantage which the base possesses over the other two is its great length.

No. 5.



The following table gives the approximate elevation above the Atlantic of the stations adjacent to the base:

	Meters.	Feet.
Massachusetts South Base	33	108
Massachusetts North Base	70	231
Beacon Pole	167	548
Great Meadow	80·5	264
Copecut	107·5	353
Manomet	120	394
Blue Hill	194	635

Descriptions of stations.

The descriptions of these old stations are very meager. The following information is all that could be gathered:

Massachusetts South Base, 1844.—The station is located on the Boston and Providence Railroad, in Bristol County, Massachusetts. For a ground mark a stone of the following dimensions was buried: Length, 4 feet 7½ inches; base, 12 inches square; top, 6 inches square. A copper bolt, on which there is a cross mark (+), driven in the stone defines the starting point of the measure. The stone is 8 feet from the eastern rail of the Boston and Providence Railroad, there being but one track laid. "Another stone is placed on the west side of the road in the line toward Beaconpole Hill, 6 inches being above ground, and distant 33 feet from the termination of the base."*

Massachusetts North Base, 1844.—The station is marked by a brick tower, stated by G. Bradford to be 44 feet in height, when reoccupied October 18, 1884. The center of the station is indicated by a brass bolt in the center of a stone, thus +. It is central with the tower. The cap stone (of 1844) had a mean diameter of 0·32 meter.

Beaconpole, 1844.—This station is located about 2 miles northeasterly from the village of Cumberland Hill. The station was visited and reoccupied in September, 1884, by Assistant G. Bradford, who remarks: "Found here, guided by E. H. Pickering, an old resident, a copper (brass?) bolt set in lead and filling a hole drilled in a ledge of rock some 30 feet in diameter, which occupies the summit of the elevation." A tripod signal was built over the station in 1884. There is also a description of 1896 by H. B. Wood, of the "Survey of the Commonwealth of Massachusetts."

Copecut, 1844.—Station on Copecut Hill between Fall River and New Bedford. Assistant G. Bradford found here in November, 1884, a copper bolt in a rock, presumably the center of the station. A large pile of stones was found about the bolt, covering it. The place is surrounded with bushes and small trees, and is difficult to find without a guide. The road to it through the woods is extremely rough. A tripod signal was built here in 1884.

Great Meadow, 1845.—This is one of the Borden Survey stations; about 3 miles north of west of Rehoboth village, 7 miles from Taunton, and 12 from Providence, Rhode Island. Assistant G. Bradford, in September, 1884, found here a hole in the rock, where, an old resident says, the signal once stood. The trees have grown up, and are now to the northward and westward some 40 to 50 feet high. The following description is by Assistant C. H. Van Orden, in 1889: "The hill is well known and is called Great Meadow Hill by the people about North Rehoboth. It is best approached from the south side. It is a large flat hill, with a growth of timber on the east and west sides. Directly north of the station is an open lot or meadow, noticeable from a distance."

Manomet, 1845.—Near Plymouth, Massachusetts. Assistant C. O. Boutelle states, in his record of the latitude observations of July, 1867: "The triangulation station at Manomet has been more permanently marked by drilling three holes, forming an equilateral triangle around the copper bolt, and each hole is distant 6 inches from it. The two holes south of the bolt are east and west from each other and the third hole is north from the bolt. Each hole is five-eighths of an inch in diameter and 2 inches deep." In September, 1877, Assistant G. A. Fairfield writes: "Visited this station and found it undisturbed; had no difficulty in finding the rock with copper bolt and three drill holes."

Blue Hill, 1845.—Near Dedham, Massachusetts. The Coast Survey station is distant from the Borden survey station of Blue Hill 8·337 meters, and the azimuth of the Borden station is 11° 16′, as deduced from computation of December, 1884. The Borden station was located in the middle of a square inclosure of stones. In November, 1886, Assistant C. H. Van Orden visited the station and found the Coast Survey copper bolt (outside the old Borden inclosure) in good order. Borden's "Blue Hill" is *under* the stone tower of the "Blue Hill Observatory."

The private meteorological observatory at this place was established by Mr. A. L. Rotch in 1885. It is a two-story circular tower, 12 feet in diameter inside and 25 feet high, built of the broken stone found on the hill. Extending southward from this

*From original record of the base measurement.

tower is a one-story, hip-roof house, built of stone, with a wooden shed attached. (See heliotype in Annals of the Astronomical Observatory of Harvard College, Volume XX, Cambridge, 1896). There is also a description of 1896 by H. B. Wood of the "Survey of the Commonwealth of Massachusetts." A sketch shows the Coast Survey station with reference to the tower.

3. THE FIRE ISLAND BASE LINE AND BASE NET, NEW YORK, 1834.

Location, measurement, and resulting length of the Fire Island Base Line, New York, 1834.

The site of this base is on the southern shore of Long Island, New York, on the narrow Fire Island beach between the Great South Bay and the Atlantic Ocean, and distant nearly 80 kilometers, or 50 statute miles, to the east from New York City. It was the first and only primary base measured by Superintendent F. R. Hassler, and the measurement was made with an apparatus of his own design. He has left a full description, with illustrations, in detail, of this apparatus in the Transactions of the American Philosophical Society, Philadelphia, Pennsylvania, new series, 1825, Volume II, pages 273–286. The essential parts of the apparatus are enumerated in No. 12 of his catalogue of instruments, which probably dates back to the year 1816. These parts appear to have been made by Troughton, of London, in 1813. Two other primary base lines were measured with the same apparatus, viz, the Kent Island and the Massachusetts bases.

The beach over which the measure extended is sandy, interspersed with low hummocks and ridges, and subject to changes from storms, which caused the west end of the base to be finally lost, notwithstanding a strong timber protection surrounded the hillock. The eastern terminal point was further removed from the beach, which caused a bend in the line close to the monument, and necessitated the measure of an angle at the bend. The insecurity of this exposed base and the danger of its loss caused the transfer of its length, a few years later, to be made to a primary line located on the central hills of Long Island. The base net, therefore, in this case consists simply of a quadrilateral.

The length of the base is about 14 kilometers (or 8¾ statute miles). The central point is in latitude 40° 38′·9, and in longitude 73° 08′·1. The mean of the forward and backward azimuths is 72° 56′·8. For convenience of reference, a brief description of the Hassler base apparatus is repeated here from his description, and further remarks on this subject will be found in connection with the Kent Island base. It makes use of one measuring bar and of optical contact. The bar is 8 meters in length and is composed of four 2-meter iron bars placed in contact lengthwise. These pieces are of square section* and are firmly held together by means of collars clamped over the bar ends and bringing them together by means of screw bolts. The whole or compound bar is supported on 15 rollers, resting on a wooden beam, itself adjustable upon another similar support. The whole is placed in the bottom of a wooden trough. There are eight thermometers, two placed on the upper surface of each of the single bars to ascertain their temperature. A sector for measuring the inclination is attached to one end of the supporting beam, and all required mechanical appliances for the adjustment and alignment of the bar, as well as for the manipulation of the micrometer microscopes, are provided. The trough itself rests upon five trestles. The two microscopes are likewise mounted upon trestles. For alignment of the base the trough or box carries at one end a small telescope and at the opposite end a short vertical pin to

* The same as that of the Committee Meter.

FERDINAND RUDOLPH HASSLER (1770-1843).

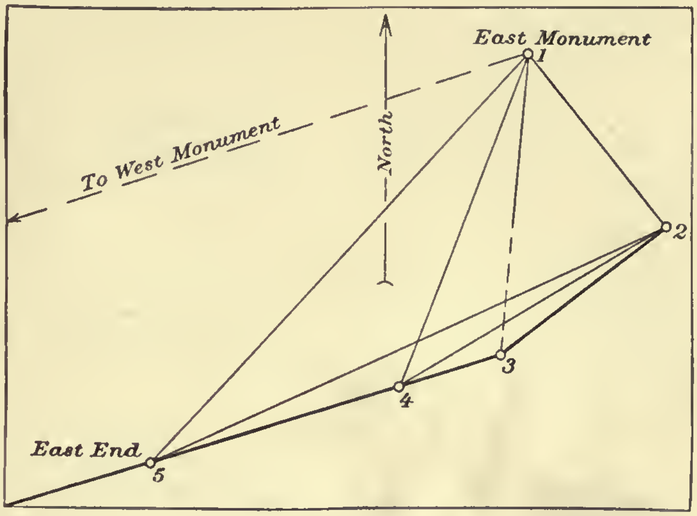
define the axis of the apparatus and the direction of the line of measure. The microscopes admit of adjustment for verticality of axis. Their objectives are composed of two half lenses of different foci, one for pointing on spider threads stretched across small central half-circular notches cut vertically into the end faces of the protruding measuring bar, the other focus serving for a verification of the steadiness of the optical axis, the pointing being made upon cross lines ruled on an ivory plate resting on the support below the microscope.

For the standardization of the measuring bar repeated comparisons were made at different times by different observers and by different means. The Hassler double end-meters, known as bars A, B, C, and D, were first compared in February and March, 1817, with the Committee Meter and a standardized iron *à bout* meter by Lenoir. In the same year Hassler determined their coefficient of expansion and found it 0·000 006 963 for Fahrenheit's scale or 0·000 012 534 for the Centigrade scale, a value somewhat large yet probably applying to these particular bars, but this could not be verified, the bars having long since been lost. In May, 1834, and March, 1835, in connection with the Fire Island base, comparisons were made involving the Troughton brass scale and the Committee Meter. The last comparisons date from 1844–45, and were made with a Bessel level-contact comparator, using the Lenoir iron meter. The results were, for the combined length at 0°C:

From comparisons of 1817	$\Sigma = 7^{m}{\cdot}999\ 9506$
From comparisons of 1834–35	8·000 0414*
	± 242
From comparisons of 1844–45	7·999 8716
	± 55

When the comparisons in 1835 in connection with the Fire Island base had been made an examination of bars A and B showed them to be rusty. After cleaning them they were again compared, and the new 1835 value $\Sigma = 7^{m}{\cdot}999\ 9764$ resulted. The last observations indicate a decided apparent shortening, which has not been accounted for satisfactorily except it be due to the manner in which the 8-meter bar was built up. Upon the whole, it has been thought best to adopt the Hassler value of 1834–35 for the reduction of the Fire Island base as representing the conditions then existing.

No. 6.



But one measure of the base was made, owing probably to the labor and time required to measure such a long line. The measure was made during the months of August, September, and October, 1834. The above diagram shows the condition at

* The value found in connection with the Fire Island base.

the eastern end. The distances 2 to 3, 3 to 4, and 4 to 5 were measured with the base apparatus, and the angular horizontal directions of the fine and heavy lines at the points 1, 2, 3, 4, and 5 were obtained by means of a theodolite. Calling West Base No. 6, the points 6, 5, 4, and 3 were placed in line. For reduction of the measured length of the base to sea level, the average height of the bar above the half-tide level of the Atlantic was taken as 2·75 meters. The mean temperature of the bar during measurement was 26°·60 C. (or 79°·90 F.). The resulting length from West Base to East End was as follows:

1 725 boxes	13 800^{m}·0714
Correction for excess of temperature over 0°C	+ 4·6031
Correction for inclination	− 0·2055
Reduction to half-tide level of ocean	− 0·0060
Resulting length	13 804^{m}·4630

Similarly we have the short measures at the eastern end.

Line measured	2 to 3	5 to 4	3 to 4
Number of boxes	14	17	7
Corresponding length	112^{m}·0006	136^{m}·0007	56^{m}·0003
Correction for expansion	+0·0216	+0·0276	+0·0119
Correction for inclination	−0·0650	−0·0268	−0·0038
Defect of last box at eastern end	+0·8203	....	+1·1380
Resulting length	112^{m}·7775	136^{m}·0015	57^{m}·1464

In the adjustment of the linear and angular measures, it has been assumed that the former require no correction; the figure adjustment of 1, 2, 3, 4, and 5 involves two angle, two side, and two distance or length equations,* and the resulting length for line 5 to *1* was 294·752 meters. If West Base be designated as 6, then by the known distances 6 to 5 and 1 to 5 and the known angles, the angle at 6 between East End and East Base is found equal to 36′ 41″·3, whence the final length West Base to East Base becomes 14 058·9709 meters and its logarithm 4·147 953 53.

To ascertain the probable error of this result, we estimate that of the line 6 to 5 as ±0^{m}·000 0242 for each box, hence for the whole distance ±0^{m}·0417. Respecting the temperature of the bar, 455 boxes being placed with rising temperature, 553 with stationary temperature, and 717 with falling temperature, and assuming a possible error in temperature of 2°, the probable error of the base might be ±0^{m}·029. The effect of the graduation error is estimated at ±0^{m}·023 or ±0^{m}·0370 for combined effect. The probable error arising from instability of microscopes was assumed to be ±0^{m}·000 127 and the total effect ±0^{m}·0053. These are the principal sources of error and when combined produce ±0^{m}·057 for the line 6 to 5. To obtain the probable error for the line between the monuments ±0^{m}·013 was added, hence the probable error of the base as estimated is $\sqrt{(0·057)^2 + (0·013)^2} = \pm 0^{m}·0585$.

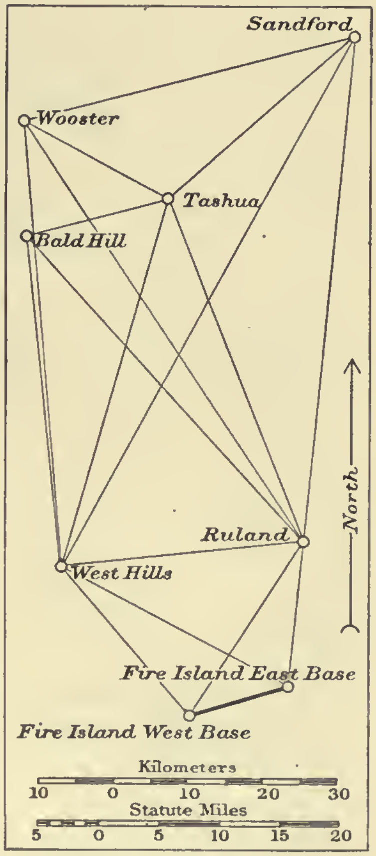
This equals $\frac{1}{240\ 270}$ part of the whole length, the corresponding value in the logarithm of the length $\pm \frac{\Delta l M}{l} = 0·000\ 001\ 807$. Consequently, the final result for the length of the Fire Island base is $\begin{matrix}14\ 058·9709 \\ \pm\ ·0585\end{matrix}$ meters, and its logarithm $\begin{matrix}4·147\ 953\ 53 \\ \pm\ \ \ \ \ \ \ \ 1\ 81\end{matrix}$

* All measures involved in this adjustment were found satisfactory.

The. Fire Island base net and results of its adjustment.

In this net we include the quadrilateral which transfers the measured base to the so-called mountain base, and the two other quadrilaterals, one within the other, which start from this derived base. The line Wooster to Sandford will be the connecting link with the northeastern triangulation, and the line West Hills to Bald Hill will form the link for the southwestern branch.

No. 7.



The elevations of the stations above the sea level are very moderate and the horizontal directions needed but very small corrections, the maximum being less than 0″·02, but no account of this was taken when less than 0″·003. The approximate heights of the trigonometric stations are as follows:

	Meters.	Feet.
West Hills	117	383
Ruland	104	341
Tashua *	185·3	608
Bald Hill	196	643
Wooster	305	1 000
Sandford	273	895

The ends of the base are between 2 and 3 meters above the sea. In this figure we have a combination of very old work with later work. The measures of horizontal angles by Superintendent Hassler date from 1833 and were made with a 60^{cm} theodolite, first employed at station Weasel in 1817. Subsequently he used the 75^{cm} theodolite, first employed at station West Hills in 1836. This last instrument was in continuous use till November, 1873, when it met with an accident at station Sawnee, Georgia. It was struck by a tornado and, notwithstanding its weight of 300 pounds, was hurled from its stand and irreparably damaged.

In consequence of the work added between 1862 and 1865, and the reoccupation of three of the old stations, a new adjustment of the base net became necessary. Weights had to be introduced in consequence of the unequal values of the resulting directions due to the relatively small number of series in the older work. It was done by the same method as already explained in connection with the adjustment of the Epping base net. From the closing of 17 triangles we have the mean error of a triangle $\sqrt{\frac{12·15}{17}} = \pm 0''·84$ and of an angle $\frac{0·84}{\sqrt{3}} = \pm 0''·49$ and the probable error of a direction $0·674 \times \frac{0·49}{\sqrt{2}} = \pm\ 0''·23$. The approximate average probable error of a direction from station adjustment resulting from 36 directions is $e_0 = \pm 0''·19$, hence the square of the triangle combination

* Derived from spirit levels.

error e^2_c equals $(0{\cdot}23)^2-(0{\cdot}19)^2$ or $e_c = \pm 0''{\cdot}13$, that is, the combination error is but slightly less than the observing error e_o. If e^2_c is added to each value of e^2_o we get the weight of each direction $p = 1/(e^2_c+e^2_o)$. Among the values of e_o there was one exceptionally large, and, omitting it, we find $e_o = \pm 0''{\cdot}18$, hence $e_c = \sqrt{(0{\cdot}233)^2-(0{\cdot}183)^2} = \pm 0{\cdot}144$ and $p = 1/[(0{\cdot}144)^2+e_o^2]$, and in order to make the average sum of the reciprocals of the weights nearly unity, the values of $1/p$ were multiplied by 13. The range in these relative weights is still large, the ratio of the greatest to the least being as 16 to 1, but it would have been as 144 to 1 had not the equalizing device been introduced. Comparing the old with the present results they are found to be nearly the same. For the side Wooster to Sandford we have old log. distance (Coast Survey Report for 1865, pages 201–202) 4·669 171 1 and by the present adjustment 4·669 171 0, which log. difference corresponds to a linear difference of but 2 centimeters. For the side Bald Hill to West Hills we have old log. distance (Coast Survey Report for 1866, page 52) 4·648 135 3, and by the present adjustment 4·648 135 6, corresponding to a linear difference of 4 centimeters.

A preliminary publication of results of the triangulation about this base and vicinity was made in 1851 in the Coast Survey Report of that date, pages 222 and following. A second publication will be found in the Coast Survey Report for 1865, pages 201–202. These results are now superseded.

Abstracts of horizontal directions at stations forming the Fire Island Base Net. 1833–1865.

Fire Island East Base, Suffolk County, New York. October 1 to October 8, 1837. F. R. Hassler, observer. 75^{cm} direction theodolite No. 1. Circle used in VI positions.

No. of directions.	Object observed.	Resulting directions from station adjustment.	Approximate probable error.	Correction from net adjustment.	Final seconds.
		° ′ ″	″	″	″
4	Fire Island West Base	0 00 00·000	±0·32	+0·426	00·426
5	West Hills	44 48 25·129	0·27	−1·086	24·043
6	Ruland*	112 32 52·403	0·22	+0·330	52·755
		+0·022			

Fire Island West Base, Suffolk County, New York. October 16 to October 24, 1837. F. R. Hassler, observer. 75^{cm} direction theodolite No. 1. Circle used in VI positions.

No. of directions.	Object observed.	Resulting directions from station adjustment.	Approximate probable error.	Correction from net adjustment.	Final seconds.
		° ′ ″	″	″	″
1	West Hills	0 00 00·000	±0·30	+0·397	00·397
2	Ruland*	73 39 46·131	0·19	−0·386	45·832
		+0·087			
3	Fire Island East Base	113 49 51·571	0·29	+0·158	51·729

* The correction for eccentricity, as indicated, refers to Ruland of 1865 since the station occupied in 1865 does not perfectly agree with the old station of 1837.

Abstracts of horizontal directions at stations forming the Fire Island base net, 1833–1865—continued.

Ruland, Suffolk County, New York. August 19 to September 16, 1837. F. R. Hassler, observer. 75[cm] direction theodolite No. 1. Circle used in VI positions. June 11 to July 27, 1865. G. W. Dean, observer. Same instrument. Circle used in V positions.

		°	′	″	″
1837	Fire Island East Base	0	00	00·000	±0·14
	Fire Island West Base	27	17	02·651	
				+0·065	
	West Hills	78	54	02·221	
				+0·114	
1865	West Hills	0	00	00·000	±0·09
	Wooster	61	26	28·009	0·08
				+0·047	
	Tashua*	73	59	43·262	0·07
				+0·047	
	Sandford*	101	19	14·917	0·09
				+0·047	

Adopted results at Ruland:

No. of directions.	Object observed.	Resulting directions from station adjustment.			Approximate probable error.	Reduction to sea level.	Seconds reduced to sea level.	Correction from net adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
7	Fire Island East Base	0	00	00·000	±0·14	.....	......	−0·020	59·980
8	Fire Island West Base	27	17	02·716	0·22	.....	......	−0·310	02·406
9	West Hills	78	54	02·335	0·35	.....	......	+0·266	02·601
10	Bald Hill †	132	08	56·733	0·27	−0·012	56·721	+0·131	56·852
11	Wooster	140	20	30·391	0·08	−0·018	30·373	+0·040	30·413
12	Tashua	152	53	45·644	0·07	−0·008	45·636	−0.134	45·502
13	Sandford	180	13	17·299	0·09	+0·004	17·303	+0·192	17·495

West Hills, Suffolk County, New York. October 18 to December 1, 1836. F. R. Hassler, observer. 75[cm] direction theodolite No. 1. Circle used in VI positions. July 18 to August 15, 1865. G. W. Dean, observer. Same instrument. Circle used in V positions.

		°	′	″	″
1836.	Ruland	0	00	00·000	±0·31
	Fire Island East Base	33	21	31·070	0·33
				−0·136	
	Fire Island West Base	54	43	16·203	0·38
				−0·136	
1865.	Wooster	0	00	00·000	±0·06
	Azimuth Mark	7	26	21·398	0·06
				+0·370	
	Tashua	21	35	06·485	0·05
				−0·009	
	Sandford	33	58	36·554	0·08
				−0·023	
	Ruland	89	14	44·819	0·07
				−0·078	

* The correction +0″·047 refers to the direction of heliotrope to station of 1836; the other corrections refer the old measures to Ruland station of 1865, since the stations of 1837 and 1865 do not quite coincide. No notice is taken of those observations of 1837 which are superseded by new observations of 1865.

† Mean value, as derived differentially from West Hills and Tashua.

Abstracts of horizontal directions at stations forming the Fire Island base net, 1833–1865—continued.

No notice is taken of those measures of 1836, which are superseded by new measures of 1865. The corrections for eccentricity are indicated; instead of increasing the direction to Ruland by 0″·136 this amount is subtracted from the measures of the base ends.

Resulting directions at West Hills:

No. of directions.	Object observed.	Resulting directions from station adjustment.			Approximate probable error.	Reduction to sea level.	Seconds reduced to sea level.	Correction from net adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
15	Wooster	0	00	00·000	±0·06	−0·003	59·997	+0·169	00·166
	Azimuth Mark	7	26	21·768	0·06	.....	......	.....	......
16	Tashua	21	35	06·476	0·05	+0·006	06·482	−0·099	06·383
17	Sandford	33	58	36·531	0·08	+0·014	36·545	−0·089	36·456
18	Ruland	89	14	44·741	0·32	.....	......	+0·226	44·967
19	Fire Island East Base	122	36	15·675	0·33	.....	......	−0·400	15·275
20	Fire Island West Base	143	58	00·808	0·38	.....	......	+0·406	01·214
	Harrow*	269	17	04·256	0·16	.....	......	.....	......
	Round Hill*	331	59	49·211	0·33	.....	......	.....	......
14	Bald Hill*	359	21	01·916	0·25	−0·003	01·913	−0·123	01·790

Tashua, Fairfield County, Connecticut. August 25 to September 16, 1833. F. R. Hassler, observer. 75^{cm} direction theodolite No. 1. Circle used in III positions. September 2 to October 21, 1863. G. W. Dean, observer. Same instrument. Circle used in V positions.

		°	′	″	″	″	″	″	″
30	Ruland	0	00	00·000	±0·08	.....	......	+0·082	00·082
31	West Hills †	38	20	42·522	0·09	.....	......	+0·085	42·630
				+0·023					
32	Bald Hill ‡	96	34	59·438	0·44	+0·006	59·444	+0·078	59·522
33	Wooster	138	32	49·096	0·06	−0·015	49·081	−0·241	48·840
	Good Hill	200	12	56·834	0·08	.....	......	.....	......
29	Sandford	249	56	26·327	0·06	+0·017	26·344	+0·107	26·451
	Mount Carmel	259	24	22·837	0·12	.....	......	.....	......

Sandford, New Haven County, Connecticut. September 9 to November 4, 1862. G. W. Dean, observer. 75^{cm} direction, theodolite No. 1. Circle used in V positions.

		°	′	″	″	″	″	″	″
21	Ruland	0	00	00·000	±0·11	.....	......	−0·264	59·736
22	West Hills †	23	24	41·547	0·12	.....	......	+0·482	42·037
				+0·008					
23	Tashua	42	36	58·413	0·12	+0·011	58·424	−0·330	58·094
24	Wooster	69	03	33·113	0·24	+0·009	33·122	+0·356	32·478
	Azimuth Mark	85	20	30·246	0·15	.....	......	.....	......
	Ivy	147	34	47·646	0·15	.....	......	.....	......
	Mount Tom	190	09	54·581	0·12	.....	......	.....	......
	Box	221	37	22·062	0·10	.....	......	.....	......
	Mount Carmel	298	46	08·532	0·44	.....	......	.....	......

* The results are mean values derived differentially from Tashua and Ruland.

† Correction for eccentricity indicated.

‡ Mean value deduced from differences with West Hills and Ruland in 1833 and 1863.

Abstracts of horizontal directions at stations forming the Fire Island base net, 1833–1865—continued.

Wooster, Fairfield County, Connecticut. July 14 to October 10, 1864. G. W. Dean, observer. 75^{cm} direction theodolite No. 1. Circle used in V positions.

No. of directions.	Object observed.	Resulting directions from station adjustment.			Approximate probable error.	Reduction to sea level.	Seconds reduced to sea level.	Correction from net adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
	Ivy	0	00	00 ·000	±0 ·07	.....	......	.....	......
25	Sandford	53	47	59 ·208	0 ·07	+0 ·009	59 ·217	−0 ·069	59 ·148
26	Tashua	95	57	47 ·652	0 ·08	−0 ·009	47 ·643	+0 ·285	47 ·928
27	Ruland	124	51	45 ·938	0 ·08	.....	......	+0 ·005	45 ·943
28	West Hills*	154	10	38 ·493	0 ·07	.....	......	−0 ·147	38 ·378
				+ 0 ·032					

Bald Hill, Fairfield County, Connecticut. July 23 to August 18, 1833. F. R. Hassler, observer. 60^{cm} direction theodolite No. 2. Circle used in VI positions.

No. of directions.	Object observed.	°	′	″	″	″	″	″	″
34	Tashua	0	00	00 ·000	±0 ·22	+0 ·006	00 ·006	−0 ·103	59 ·903
35	Ruland	62	40	12 ·802	0 ·60	.....	......	+1 ·433	14 ·291
				+ 0 ·056†					
36	West Hills	99	31	40 ·835	0 ·27	.....	......	−0 ·213	40 ·622
	Harrow	121	42	18 ·609	0 ·19	.....	......	.....	......
	Round Hill	158	36	54 ·002	0 ·40	.....	......	.....	......

FIRE ISLAND BASE NET.

Observation equations.

I	$0=+0{\cdot}945-(1)+(3)-(4)+(5)-(19)+(20)$
II	$0=-0{\cdot}158-(2)+(3)-(4)+(6)-(7)+(8)$
III	$0=+0{\cdot}027-(1)+(2)-(8)+(9)-(18)+(20)$
IV	$0=+0{\cdot}462-(15)+(17)-(22)+(24)-(25)+(28)$
V	$0=-0{\cdot}988-(9)+(13)-(17)+(18)-(21)+(22)$
VI	$0=+0{\cdot}321-(9)+(11)-(15)+(18)-(27)+(28)$
VII	$0=-0{\cdot}236-(12)+(13)-(21)+(23)-(29)+(30)$
VIII	$0=+0{\cdot}072-(16)+(18)-(9)+(12)-(30)+(31)$
IX	$0=+1{\cdot}026-(15)+(16)-(26)+(28)-(31)+(33)$
X	$0=+0{\cdot}093-(14)+(16)-(31)+(32)-(34)+(36)$
XI	$0=+1{\cdot}432-(14)+(18)-(9)+(10)-(35)+(36)$
XII	$0=-9{\cdot}5+2{\cdot}99(4)-2{\cdot}12(5)-0{\cdot}87(6)+4{\cdot}08(7)-5{\cdot}74(8)+1{\cdot}66(9)+1{\cdot}49(18)-5{\cdot}38(19)+3{\cdot}89(20)$
XIII	$0=+4{\cdot}2+1{\cdot}56(9)-1{\cdot}14(11)-0{\cdot}42(13)+4{\cdot}87(21)-6{\cdot}92(22)+2{\cdot}05(24)-0{\cdot}38(25)-3{\cdot}75(27)$ $+4{\cdot}13(28)$
XIV	$0=+3{\cdot}0+0{\cdot}60(9)-4{\cdot}68(12)+4{\cdot}08(13)+8{\cdot}71(16)-9{\cdot}58(17)+2{\cdot}29(21)-6{\cdot}05(22)+3{\cdot}76(23)$ $+0{\cdot}87(18)$
XV	$0=-0{\cdot}8+0{\cdot}60(9)-9{\cdot}46(11)+8{\cdot}86(12)+5{\cdot}32(15)-6{\cdot}19(16)+0{\cdot}87(18)+2{\cdot}51(26)-3{\cdot}82(27)$ $+1{\cdot}31(28)$
XVI	$0=+1{\cdot}4+1{\cdot}57(9)-7{\cdot}13(10)+5{\cdot}56(12)-5{\cdot}15(14)-5{\cdot}15(16)+0{\cdot}00(18)-0{\cdot}24(30)-1{\cdot}30(31)$ $+1{\cdot}54(32)$

*Correction for eccentricity indicated. †Correction to refer the old to the new station of 1865.

Reciprocals of the weights or values of $\frac{13}{p}$

1	1·2	10	1·2	19	1·7	28	0·3
2	0·9	11	0·4	20	2·1	29	0·3
3	1·6	12	0·3	21	0·4	30	0·4
4	1·4	13	0·4	22	0·5	31	0·4
5	1·4	14	1·1	23	0·5	32	2·8
6	0·7	15	0·3	24	1·0	33	0·3
7	0·5	16	0·3	25	0·3	34	0·9
8	0·9	17	0·4	26	0·4	35	4·9
9	1·9	18	1·6	27	0·4	36	1·2

Normal equations.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
0=+0·945	9·4	+3·0	+3·3									+10·161				
0=−0·158		6·0	−1·8									−12·001				
0=+0·027			8·6		−3·5	−3·5		−3·5			−3·5	+14·105	+2·964	−0·252	−0·252	+2·983
0=+0·462				2·8	−0·9	+0·6			+0·6				+6·863	−0·807	−1·203	
0=−0·988					5·2	+3·5	+0·8	+3·5			+3·5	−0·770	−8·540	+1·775	+0·252	−2·983
0=+0·321						4·9		+3·5	+0·6		+3·5	−0·770	−0·681	+0·252	−3·207	−2·983
0=−0·236							2·3	−0·7					−2·116	+4·000	−2·658	−1·764
0=+0·072								4·9	−0·7	−0·7	+3·5	−0·770	−2·964	−3·765	+4·767	−0·194
0=+1·026									2·0	+0·7			+1·239	+2·613	−4·064	−1·025
0=+0·093										6·7	+2·3			+2·613	−1·857	−2·378
0=+1·432											11·9	−0·770	−2·964	+0·252	+0·252	−17·204
0=−9·5												147·085	+4·920	+3·966	+3·966	+4·951
0=+4·2													53·630	+26·487	+13·445	+4·653
0=+3·0														102·061	−26·719	−19·473
0=−0·8															90·100	+26·132
0=+1·4																119·437

Resulting values of correlates.

$C_1=-0·4899$	$C_5=+1·1956$	$C_9=-0·8014$	$C_{13}=+0·0750$
$C_2=+0·5886$	$C_6=-0·1550$	$C_{10}=+0·1145$	$C_{14}=-0·0807$
$C_3=+0·1590$	$C_7=-0·3553$	$C_{11}=-0·2924$	$C_{15}=-0·0361$
$C_4=+0·2016$	$C_8=-0·5471$	$C_{12}=+0·1348$	$C_{16}=-0·0563$

Resulting corrections to observed directions.

	"		"		"		"
(1)=	+0·397	(10)=	+0·131	(19)=	−0·400	(28)=	−0·148
(2)	−0·387	(11)	+0·040	(20)	+0·406	(29)	+0·107
(3)	+0·158	(12)	−0·134	(21)	−0·264	(30)	+0·082
(4)	+0·426	(13)	+0·192	(22)	+0·482	(31)	+0·085
(5)	−1·086	(14)	−0·123	(23)	−0·329	(32)	+0·078
(6)	+0·330	(15)	+0·169	(24)	+0·355	(33)	−0·240
(7)	−0·019	(16)	−0·099	(25)	−0·069	(34)	−0·103
(8)	−0·310	(17)	−0·089	(26)	+0·284	(35)	+1·433
(9)	+0·266	(18)	+0·226	(27)	+0·005	(36)	−0·214

Probable error of an observed direction.

$$=0·674\sqrt{\frac{4·134}{16}}$$

$$=\pm 0''·34$$

Check: $-[wC]=4·133$ and $[pvv]=4·135$.

Resulting angles and sides of the Fire Island base net.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
− 7+ 8	Ruland	27	17	02·716	−0·290	02·426	0·218	4·147 953 5	14 058·971
− 4+ 6	Fire Island East Base	112	32	52·425	−0·096	52·329	0·217	4·452 173 4	28 325·23
− 2+ 3	Fire Island West Base	40	10	05·353	+0·544	05·897	0·217	4·296 291 1	19 782·95
−19+20	West Hills	21	21	45·133	+0·806	45·939	0·296	4·147 953 5	14 058·971
− 4+ 5	Fire Island East Base	44	48	25·129	−1·512	23·617	0·296	4·434 543 0	27 198·38
− 1+ 3	Fire Island West Base	113	49	51·571	−0·239	51·332	0·296	4·547 828 6	35 304·38
−18+20	West Hills	54	43	16·067	+0·180	16·247	0·026	4·452 173 4	28 325·23
− 8+ 9	Ruland	51	36	59·619	+0·576	60·195	0·625	4·434 543 0	27 198·38
− 1+ 2	Fire Island West Base	73	39	46·218	−0·783	45·435	0·626	4·522 397 2	33 296·39
−18+19	West Hills	33	21	30·934	−0·626	30·308	0·547	4·296 291 1	19 782·95
− 7+ 9	Ruland	78	54	02·335	+0·286	02·621	0·547	4·547 828 5	35 304·37
− 5+ 6	Fire Island East Base	67	44	27·296	+1·416	28·712	0·547	4·522 397 1	33 296·39
−30+31	Tashua	38	20	42·545	+0·003	42·548	1·344	4·522 397 1	33 296·39
− 9+12	Ruland	73	59	43·301	−0·400	42·901	1·345	4·712 561 3	51 589·50
−16+18	West Hills	67	39	38·259	+0·325	38·584	1·344	4·695 847 6	49 641·81
−27+28	Wooster	29	18	52·587	−0·152	52·435	1·683	4·522 397 1	33 296·39
− 9+11	Ruland	61	26	28·038	−0·226	27·812	1·683	4·776 212 1	59 732·69
−15+18	West Hills	89	14	44·744	+0·057	44·801	1·683	4·832 520 7	68 001·85
−26+27	Wooster	28	53	58·295	−0·280	58·015	0·621	4·695 847 6	49 641·81
−30+33	Tashua	138	32	49·081	−0·323	48·758	0·620	4·832 520 7	68 001·85
−11+12	Ruland	12	33	15·263	−0·174	15·089	0·621	4·348 836 2	22 327·30
−26+28	Wooster	58	12	50·882	−0·432	50·450	0·959	4·712 561 3	51 589·50
−31+33	Tashua	100	12	06·536	−0·326	06·210	0·959	4·776 212 0	59 732·68
−15+16	West Hills	21	35	06·485	−0·268	06·217	0·959	4·348 836 2	22 327·30
−21+22	Sandford	23	24	41·555	+0·746	42·301	1·902	4·522 397 1	33 296·39
− 9+13	Ruland	101	19	14·968	−0·074	14·894	1·903	4·914 715 9	82 170·49
−17+18	West Hills	55	16	08·196	+0·316	08·512	1·902	4·838 030 8	68 870·11
−22+23	Sandford	19	12	16·869	−0·812	16·057	0·736	4·712 561 3	51 589·50
−16+17	West Hills	12	23	30·063	+0·010	30·073	0·737	4·527 058 6	33 655·70
−29+31	Tashua	148	24	16·201	−0·022	16·079	0·736	4·914 716 0	82 170·50
−21+23	Sandford	42	36	58·424	−0·066	58·358	1·317	4·695 847 6	49 641·81
−12+13	Ruland	27	19	31·667	+0·326	31·993	1·318	4·527 058 6	33 655·70
−29+30	Tashua	110	03	33·656	−0·024	33·632	1·318	4·838 030 8	68 870·11
−22+24	Sandford	45	38	51·567	−0·126	51·441	2·320	4·776 212 0	59 732·68
−15+17	West Hills	33	58	36·548	−0·257	36·291	2·320	4·669 171 0	46 684·31
−25+28	Wooster	100	22	39·308	−0·079	39·229	2·321	4·914 716 0	82 170·50

Resulting angles and sides of the Fire Island base net—continued.

No.	Stations.	Observed angles. ° ′ ″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
−21+24	Sandford	69 03 33 ·122	+0 ·621	33 ·743	2 ·540	4 ·832 520 7	68 001 ·85
−11+13	Ruland	39 52 46 ·930	+0 ·152	47 ·082	2 ·540	4 ·669 170 9	46 684 ·30
−25+27	Wooster	71 03 46 ·721	+0 ·074	46 ·795	2 ·540	4 ·838 030 9	68 870 ·13
−23+24	Sandford	26 26 34 ·698	+0 ·686	35 ·384	0 ·592	4 ·348 836 2	22 327 ·30
−29−33	Tashua	111 23 37 ·263	+0 ·348	37 ·611	0 ·592	4 ·669 171 1	46 684 ·32
−25+26	Wooster	42 09 48 ·426	+0 ·355	48 ·781	0 ·592	4 ·527 058 8	33 655 ·71
−34+35	Bald Hill	62 40 12 ·852	+1 ·536	14 ·388	0 ·826	4 ·695 847 6	49 641 ·81
−30+32	Tashua	96 34 59 ·444	−0 ·004	59 ·440	0 ·826	4 ·744 375 8	55 510 ·58
−10+12	Ruland	20 44 48 ·915	−0 ·265	48 ·650	0 ·826	4 ·296 541 1	19 794 ·34
−35+36	Bald Hill	36 51 27 ·977	−1 ·646	26 ·331	1 ·253	4 ·522 397 1	33 296 ·38
− 9+10	Ruland	53 14 54 ·386	−0 ·135	54 ·251	1 ·253	4 ·648 135 7	44 477 ·02
−14+18	West Hills	89 53 42 ·828	+0 ·349	43 ·177	1 ·253	4 ·744 375 9	55 510 ·60
−34+36	Bald Hill	99 31 40 ·829	−0 ·110	40 ·719	0 ·735	4 ·712 561 3	51 589 ·50
−31+32	Tashua	58 14 16 ·899	−0 ·007	16 ·892	0 ·735	4 ·648 135 6	44 477 ·01
−14+16	West Hills	22 14 04 ·569	+0 ·024	04 ·593	0 ·734	4 ·296 541 3	19 794 ·35

Descriptions of base net stations.

Fire Island West Base, Long Island, New York. The base was located in a most insecure position, close to the beach of the narrow strip of land known as Fire Island, and with its western terminus not far from the Fire Island Light-House. The locality is subject to total changes of aspect, due to drifting sands and inundations and erosions from high tides. This being well known, Superintendent Hassler connected it directly with the line Ruland-West Hills, which he called his "Mountain base." This connection was made by means of a quadrilateral of which all angles were measured.

It appears that the station was originally marked by a red sandstone post, with cross lines upon its upper surface.

It has been reported that the station is destroyed.

Fire Island East Base, Long Island, New York. This end of the base of 1834 was subjected to the same physical conditions of exposure which rendered the opposite end insecure. It was originally marked with a stone post.

Nothing is known as to the date when the station succumbed to the destructive influences surrounding it.

Ruland, Suffolk County, New York. This station was located by Superintendent Hassler in 1833, on Rulands hill, in Smithtown, Long Island, about halfway between the northern and southern turnpike at Patchogue. It is on the highest hill in the neighborhood. The point is on the summit (about 20 feet in diameter), the ground sloping down all around the station. It was marked by a stoneware crock, with its top 16 inches below the surface. Oyster shells are scattered about the place to assist in finding it. In 1837 the station was found in good condition.

The place was visited by Assistant C. O. Boutelle in 1860, who re-marked the station for greater security. Four stone posts were placed to the north, south, east, and west of the center stone post. On the upper surface of the center stone post the intersection of two lines marks the position of the center point of the Hassler crock of 1833. Around each post concrete was placed to secure it firmly in position. Upon the center stone was placed a stout stub of locust wood into the top of which, level with the ground, a copper tack was driven, marking the center point. A fuller description is given in the record of 1865, when the station was reoccupied.

West Hills, Suffolk County, New York. This station was established by Superintendent Hassler in 1836. It is marked by a red sandstone post, 4 feet high and 1 foot square, sunk in the ground, with stones well packed around it; the intersection of diagonal cross lines upon the top marks the station point. A crock, which had before served as station mark, was placed upon the post and a nail in a wooden peg driven centrally through it marks the station. Upon the side of the post facing Harrow were cut the initials U. S. C. S.

The station was reoccupied in 1865, and again described.

The place is 4 miles from Huntington and 7 miles from Farmingdale railroad station. The point is on the summit of a hill. An examination had been made in 1860, when the stone post appeared not to have been disturbed, but the crock was broken and the stub decayed.

To mark the point more securely, posts arranged about the center post, north, south, east, and west of the station, were sunk to a level with the surface of the ground. A stout wooden stub, with a nail driven into it, was placed over the center of the old post to mark the station. Some further remarks are given in the 1865 description.

Tashua, Fairfield County, Connecticut. This station is located in Trumbull township, Fairfield County, Connecticut. It was established and occupied by Superintendent Hassler in 1833. The station was reoccupied in 1863 by the party of Superintendent Bache, by whom the following description is given:

"The station point is marked by a copper bolt inserted in the top of a granite post sunk 2 feet below the surface of the ground. Four similar posts, 8 inches square and 2½ feet in length, were adjusted 6 feet distant to the north, east, south, and west of the center point. The tops of the posts are marked by two lines intersecting at right angles and the letters U. S. C. S. Four directions to signals visible from the station are marked by copper tacks driven into hickory stubs at distances 171 feet 3 inches toward Ruland, 121 feet 7 inches toward West Hills, 73 feet 9 inches toward Wooster, and 70 feet 3 inches toward tower in Warren."

Sandford, New Haven County, Connecticut, 1862. This geodetic point is located on the highest and most western summit of Sandford Mountain, 5 feet from a pile of stones which marks the boundry line between New Haven and Bethany townships. The point is marked by the center of a half-inch drill hole in the top of a granite post which is 2½ feet in length and 1 foot square at the upper surface. Two cross lines and the letters U. S. C. S. are cut on its top, which is 1½ feet below the general surface of the ground. For greater security four granite posts, each 2½ feet long and 6 inches square at the top, were sunk into the ground at points about 6 feet to the north, east, south, and west of the station. The tops of these posts were flush with the ground. To this description Assistant G. W. Dean adds the following: "The top of the stone post marking the station was sunk 20 inches below the plane of the four surrounding stones.

A copper bolt was driven into the central stone and the center accurately marked by intersecting lines. A cedar stub was placed immediately over the center of the granite post, the top of which was flush with the ground and firmly secured with earth. The station point was further marked by a composition nail driven into the top of the cedar stub."

Bald Hill, Fairfield County, Connecticut. This station was established in 1833 by Superintendent Hassler and occupied by him in that year.

The hill is situated in Wilton Township, about 4 miles south of Ridgefield. The station was visited by Assistant Farley in 1868, who found fragments of an earthenware crock (of the pattern of the Hassler crocks, or cones, as he called them), and marks cut on three rocks, but he was not able to identify the marks owing to the (apparent) loss of the original description of the station by Superintendent Hassler and by Assistant Blunt in 1866. What made the search at the place more difficult was the fact that rock blasting had been going on there for some time. A second visit in 1869 elicited no certain information from want of application of proper means. The place was next examined by Assistant G. Bradford in 1882 and 1884, when, by means of the determination of a temporary signal, the location of the crock (cone) placed by Assistant Blunt in 1866 was readily discovered. It is assumed that this crock occupies the position of the Hassler crock, because Assistant Blunt is said to have put it in the place of the fragments of the older one. The station appears to have been recovered.

Wooster, Fairfield County, Connecticut. This station was established in 1864 by the party of Superintendent Bache. It is located in Ridgefield Township, about 4 miles southwest of Danbury, on Wooster Mountain, known to the residents in the vicinity as Pine Hill.

The station point is marked by a copper bolt, and is located on the highest point of gneiss which crops out near the summit of the mountain. The top of the ledge is quite limited, its length east and west being about 25 feet.

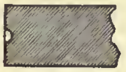
4. THE KENT ISLAND BASE LINE, BASE NET AND EXTENSION, MARYLAND, 1844.

Location, measurement, and resulting length of the Kent Island base line, Maryland, 1844.

Kent Island, in Queen Anne County, Maryland, on the western shore of which the base was measured, is situated on the east side of Chesapeake Bay, and is nearly opposite Annapolis Harbor. Originally it was intended as a check on the main triangulation which extended from the Fire Island base southward and westward, but its position near the latitude of 39° rendered it desirable to incorporate it in the eastern part of the transcontinental triangulation.

An account of the measure and length of this base is contained in the Coast Survey Report for the year 1866, supplement to Appendix No. 8, page 140, and again in Special Publication No. 4; "The Transcontinental Triangulation."

The middle point of the base is in latitude 38° 56'·1, and in longitude 76° 21'·2, the mean azimuth is 14° 35'·4, and the length 8·7 kilometers (or 5·4 statute miles). The surface of this part of the island is slightly undulating, and the line crosses cultivated fields, with some portions covered by swamps and woods. The elevation is very little above the surface of the bay. The shore is subject to erosion, in consequence of which the terminal monuments, each consisting of an upright stone surface mark with a copper bolt in a piece of slate below the surface, the whole being protected by rubble masonry, have disappeared.

The base was measured by Assistant J. Ferguson, in May and June, 1844, by means of the same apparatus as was used for the measure of the Fire Island base ten years before. It is known as the Hassler base apparatus,* and consists of four rectangular iron bars each 2 meters long, put together endwise and aligned in a wooden trough. The protruding ends of this 8-meter bar have semicircular notches  across which was stretched a spider thread; over this was mounted, on an independent stand, an adjustable micrometer microscope, by means of which the measure was held while the bar was brought forward into a new position. All needed adjustments for the apparatus were provided for and the temperature of the bar was read from thermometers attached to the top of the 2-meter bars placed in the bottom of the trough, which is supposed to have been covered with canvas. At the end of a day's work or at other times when necessary, the end of the last bar laid was transferred to the ground, generally by a plummet. Only one measure was made, and the total time consumed was a little over one month.

The four 2-meter bars made by Troughton, of London, about 1813 were standardized in 1817 by Hassler, by using the Committee Meter, in 1834–35 by using the Troughton brass scale, and finally, in 1844–45, by Superintendent Bache, J. Saxton, and W. Würdemann, by using a Bessel comparator, with the following results:

In 1817	$\Sigma = 7^{m}\cdot999\ 9506$	at 0° C.
1834–35	8·000 0414	"
1835	†7·999 9764	"
1844–45	7·999 8716	"
	± 55	

This last value, after verification in July, 1854, was finally adopted for the two bases measured with this apparatus in 1844. The coefficient of expansion of the bar which was determined in 1817 by Hassler at Newark, viz, 0·000 012 534 for the centigrade scale, was adopted and, though somewhat large, may nevertheless be true for these particular bars, now lost. The mean temperature of the bar during measurement of the base was 25°·18 C. (or 77°·33 F.). The deduced length of the base is as follows:

1 086 boxes	$8687^{m}\cdot8606$
Excess of last box over end mark at South Base, as measured by Bar D and scale	−2·0508
Correction for excess (25°·44 C.) of temperature of bars over 0° C. and graduation error of thermometers (−0°·255 C.)	+2·7424
Correction for inclination of boxes	1·0007
Reduction to half-tide level of bay for surface elevation and height of boxes $5^{m}\cdot0$	−0·0069
Resulting length of base	$8687^{m}\cdot5446$

The probable error of this value can only be estimated, since the base was measured but once. Supposing the combined length of the four 2-meter bars subject to $\pm 20\mu$, the effect on the base will be $\pm 0^{m}\cdot022$; an assumed error of $\pm\frac{1}{50}$ part in the

* For a description, with illustrations, of the apparatus, see the Transactions of the American Philosophical Society, Philadelphia, Pennsylvania, for the year 1825, pp. 273–286. See also the preceding account of the Fire Island base measurement.

† Result of comparisons made after cleaning two of the 2-meter bars which were found rusty when examined.

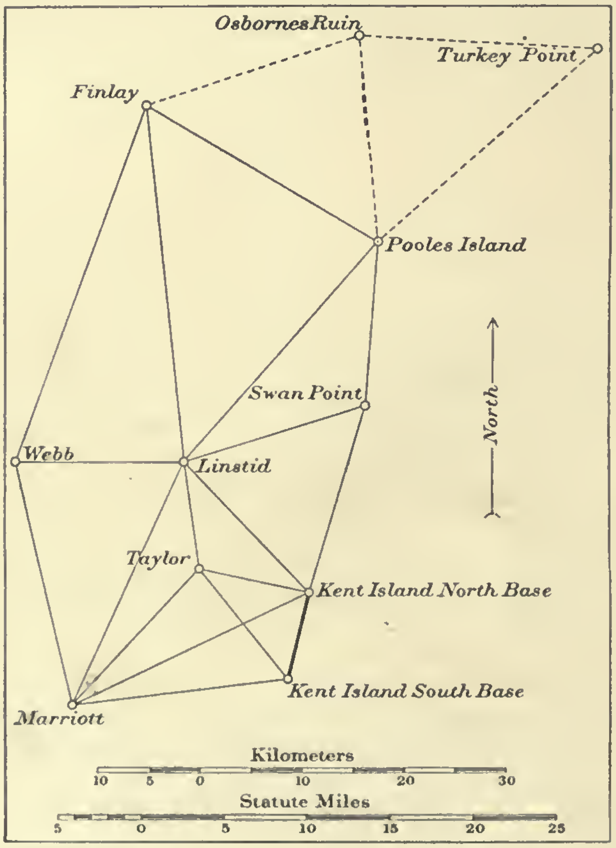
coefficient of expansion would produce $\pm 0^{m}\cdot 055$; again, the effect for imperfect temperature correction, for inequality in number of boxes laid with rising and with falling temperatures, may be taken as $\pm 0^{m}\cdot 034$; other minor uncertainties may be omitted. Combining the several values for probable error gives $\pm 0^{m}\cdot 068$, equal to $\frac{1}{27800}$ of the length nearly. This may be taken to represent the measuring error, and to include the probable error due to our practical unit of length, the Committee Meter, taken as $\pm \frac{3}{4}\mu$.

Resulting length of Kent Island base, $8\,687\cdot 5446$ meters and its logarithm,
$\pm\cdot 0680$

$3\cdot 938\,897\,05$
$\pm 3\;40$

Kent Island base net and results of adjustment.

The following abstracts of observed and adjusted directions at the nine stations forming the base net proper, as well as the conditional equations and results of its adjustment with resulting length of triangle sides, were copied from Part I, Special Publication No. 4, "The Transcontinental Triangulation," and from Part III of the same publication the results of two triangles* to the northward of the net and of 35 triangles to the westward and southward of the base.† The triangles of this last extension are shown on the following sketch:



* Shown on the above sketch by dotted lines.

† For adjustment of this work see Special Publication No. 4, "The Transcontinental Triangulation."

The heights of the stations above the half-tide level of the ocean are small and approximately as follows:

	Meters.
Kent Island North Base	5
Kent Island South Base	5
Taylor	29
Marriott	76
Linstid	48
Webb	72
Swan	8
Pooles Island	4
Finlay	150
Osbornes Ruin	90
Turkey Point	25

The approximate heights of stations along the Blue Ridge extension are as follows:

	Meters.
Hill	84
Soper	143
Stabler	174
Peach Grove	159
Sugar Loaf	390
Maryland Heights	444
Bull Run	419
Mount Marshall	1 028
Fork	1 174
Clark	334
Humpback	1 110
Spear	492
Tobacco Row	895

No corrections to the observed horizontal directions on account of altitude were applied, as they are too small in comparison with the angular corrections required by the net adjustment to be considered. In latitude 39° the correction to a direction for height of station sighted becomes $0''\cdot000\ 066 \sin 2\ \alpha.h$, hence the maximum correction would still be less than $0''\cdot08$, whereas the net adjustment in this region in several instances calls for angular corrections exceeding $1''$.

The results of the triangle side computations between the Kent Island and the Atlanta base lines, published in Coast and Geodetic Survey Report for 1878, pages 94–112, are now superseded. A portion of this work was readjusted in reducing the transcontinental triangulation and the results are reproduced in this publication.

Abstracts of resulting horizontal directions, observed and adjusted, at the stations forming the base net, 1844–1897.

Kent Island South Base, Queen Anne County, Maryland. May 30 to June 4, 1847. 30^{cm} repeating theodolite No. 11. E. Blunt, observer. (Observations in 1844 by J. Ferguson superseded by above.)

Number of directions.	Object observed.	Resulting directions from station adjustment. °	′	″	Corrections from base net adjustment. ″	Final seconds. ″
1	Marriott	0	00	00·00	+0·03	00·03
2	Taylor	58	53	46·24	+0·06	46·30
3	Kent Island North Base	111	41	18·25	−0·09	18·16

Probable error of a single observation of a direction (6 *D*. and 6 *R*.), $e_1 = \pm 0''{\cdot}69$.

Kent Island North Base, Queen Anne County, Maryland. May 21 to 28, 1847. 30^{cm} repeating theodolite No. 11. E. Blunt, observer. (Observations in 1844–'45 by J. Ferguson superseded by above.)

Number of directions.	Object observed.	°	′	″	″	″
4	Kent Island South Base	0	00	00·00	+0·19	00·19
5	Marriott	50	05	05·36	−0·47	04·89
6	Taylor	88	35	36·91	−0·12	36·79
7	Linstid	121	02	04·33	+0·16	04·49
8	Swan Point	181	09	45·47	+0·24	45·71

Probable error of a single observation of a direction (6 *D*. and 6 *R*.), $e_1 = \pm 0''{\cdot}68$.

Swan Point, Kent County, Maryland. October 16 to 21, 1848. 30^{cm} repeating theodolite No. 11. E. Blunt, observer. (Observations in 1845 by J. Ferguson superseded by above.)

Number of directions.	Object observed.	°	′	″	″	″
34	Kent Island North Base	0	00	00·00	−0·23	$\overline{59{\cdot}77}$
35	Linstid	56	08	57·92	+0·52	58·44
36	Pooles Island	169	16	25·51	−0·29	25·22

Probable error of a single observation of a direction (6 *D*. and 6 *R*.), $e_1 = \pm 1''{\cdot}35$.

Taylor, Anne Arundel County, Maryland. June 8 to 16, 1847. 30^{cm} repeating theodolite No. 11. E. Blunt, observer. (Observations in 1844 by J. Ferguson superseded by above.)

Number of directions.	Object observed.	°	′	″	″	″
10	Kent Island North Base	0	00	00·00	+0·36	00·36
11	Kent Island South Base	38	36	52·37	−0·23	52·14
12	Marriott	119	32	44·32	+0·53	44·85
9	Linstid	247	12	54·29	−0·66	53·63

Probable error of a single observation of a direction (6 *D*. and 6 *R*.), $e_1 = \pm 0''{\cdot}66$.

Pooles Island, Harford County, Maryland. May 17 to 27, 1848. 30^{cm} repeating theodolite No. 11. E. Blunt. observer. (Observations in 1845 by J. Ferguson superseded by above.)

Number of directions.	Object observed.	°	′	″	″	″
31	Swan Point	0	00	00·00	+0·30	00·30
32	Linstid	36	22	15·13	+0·17	15·30
33	Finlay	116	06	54·92	−0·47	54·45
	Osbornes Ruin	170	34	06·56	....	.....
	Turkey Point	225	05	01·56	....	.....

Probable error of a single observation of a direction (6 *D*. and 6 *R*.), $e_1 = \pm 0''{\cdot}69$.

Abstracts of resulting horizontal directions, observed and adjusted, at the stations forming the base net, 1844–1897—continued.

Webb, Anne Arundel County, Maryland. July 10 to August 14, 1848. 60^{cm} direction theodolite No. 2. A. D. Bache, observer. October 21 to December 2, 1850. 75^{cm} direction theodolite No. 1. A. D. Bache, observer. September 18 to 25, 1868. 75^{cm} direction theodolite No. 1. C. O. Boutelle, observer.

Number of directions.	Object observed.	Resulting directions from station adjustment. °	′	″	Corrections from base net adjustment. ″	Final seconds. ″
26	Linstid	0	00	00·00	−0·02	59·98
27	Marriott	76	16	06·19	+0·25	06·44
	Hill	129	26	58·53	0·00*	58·53
	Soper	178	32	04·72	0·00*	04·72
	Stabler	186	55	11·56	−0·02*	11·54
	Azimuth Mark	275	40	01·37	....	.....
25	Finlay	289	44	43·01	−0·23	42·78

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot94$.
Number of positions of circle in 1848, XXXIII; in 1850 and 1868, V.

Marriott, Anne Arundel County, Maryland. November 18 to December 9, 1846. 30^{cm} repeating theodolite No. 11. E. Blunt, observer. May 18 to June 18, 1849. 60^{cm} direction theodolite No. 2. A. D. Bache, observer.

Number of directions.	Object observed.	°	′	″	″	″
	Hill	0	00	00·00	−0·29*	59·71
	Soper	32	06	10·36	+0·38*	10·74
13	Webb	70	08	37·17	−0·24	36·93
	Azimuth Mark	82	23	48·68	....	.....
14	Linstid	107	33	48·30	+0·34	48·64
15	Taylor	125	56	32·84	−0·20	32·64
16	Kent Island North Base	147	53	16·80	−0·10	16·70
17	Kent Island South Base	166	06	54·12	+0·19	54·31

Probable error of a single observation of a direction (6 *D.* and 6 *R.*) in 1846, $e_1 = \pm 0''\cdot67$ and of a direction (*D.* and *R.*) in 1849, $e_1 = \pm 1''\cdot10$. Number of positions of circle, XI.

Linstid, Anne Arundel County, Maryland. May 24 to June 26, 1848. 60^{cm} direction theodolite No. 2. A. D. Bache, observer. January 8 to 31, 1897. 30^{cm} repeating theodolite No. 16. F. W. Perkins and W. B. Fairfield, observers. Telescope elevated above ground 27·89 meters. (Observations in 1844–45 by J. Ferguson superseded by above.)

Number of directions.	Object observed.	°	′	″	″	″
18	Finlay	0	00	00·00	+0·70	00·70
19	Pooles Island	46	42	57·73	−0·18	57·55
	Clough	69	13	07·73	....	.....
20	Swan Point	77	13	16·97	−0·52	16·45
	Hope	102	07	23·10	....	.....
21	Kent Island North Base	140	56	37·60	−0·26	37·34
22	Taylor	175	43	02·43	+0·75	03·18
23	Marriott	209	40	11·28	−0·50	10·78
24	Webb	275	58	53·59	+0·02	53·61

Probable error of a single observation of a direction (*D.* and *R.*) in 1848, $e_1 = \pm 1''\cdot12$ and of a direction (6 *D.* and 6 *R.*) in 1897, $e_1 = \pm 0''\cdot73$.
Number of positions of circle, XVII.

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* From adjustment of Kent Island extension.

Abstracts of resulting horizontal directions, observed and adjusted, at the stations forming the base net, 1844–1897—continued.

Finlay, Baltimore County, Maryland. August 29 to September 11, 1844. 60cm direction theodolite No. 2. J. Ferguson, observer. October 15 to December 27, 1896. 30cm repeating theodolite No. 16. G. A. Fairfield, observer. Telescope above ground 1·5 meters.

Number of directions.	Object observed.	Resulting directions from station adjustment.			Corrections from base net adjustment.	Final seconds.
		°	′	″	″	″
	Osbornes Ruin	0	00	00·00	....	.....
	Still Pond	30	48	41·95	....	.....
28	Pooles Island	48	03	34·15	+0·48	34·63
	Clough	55	23	20·93	....	.....
29	Linstid	101	36	01·26	−0·72	00·54
30	Webb	127	19	37·46	+0·25	37·71

Probable error of a single observation of a direction (*D.* and *R.*) in 1844, $e_1 = \pm\, 1''{\cdot}52$ and of a direction (6 *D.* and 6 *R.*) in 1896, $e_1 = \pm\, 0''{\cdot}65$. Number of positions of circle in 1844, VI.

BASE NET ADJUSTMENT; MARRIOTT TO FINLAY.

Observation equations.

I $0=+1{\cdot}05-(2)+(3)-(4)+(6)-(10)+(11)$

II $0=-0{\cdot}62-(5)+(6)-(10)+(12)-(15)+(16)$

III $0=+0{\cdot}49-(1)+(3)-(4)+(5)-(16)+(17)$

IV $0=-2{\cdot}31-(6)+(7)-(9)+(10)-(21)+(22)$

V $0=+2{\cdot}97+(9)-(12)-(14)+(15)-(22)+(23)$

VI $0=-1{\cdot}37-(13)+(14)-(23)+(24)-(26)+(27)$

VII $0=-1{\cdot}87+(18)-(24)-(25)+(26)-(29)+(30)$

VIII $0=+2{\cdot}73-(18)+(19)-(28)+(29)-(32)+(33)$

IX $0=+1{\cdot}26-(19)+(20)-(31)+(32)-(35)+(36)$

X $0=-1{\cdot}07-(7)+(8)-(20)+(21)-(34)+(35)$

XI $0=-39+17{\cdot}1(4)-17{\cdot}6(5)+0{\cdot}5(6)+26{\cdot}4(10)-29{\cdot}8(11)+3{\cdot}4(12)+24{\cdot}9(15)-63{\cdot}9(16)+39{\cdot}0(17)$

XII $0=+31+26{\cdot}4(5)-59{\cdot}5(6)+33{\cdot}1(7)+63{\cdot}4(14)-115{\cdot}6(15)+52{\cdot}2(16)+30{\cdot}3(21)-61{\cdot}6(22)$
$+31{\cdot}3(23)$

XIII $0=-28+7{\cdot}3(5)-19{\cdot}4(7)+12{\cdot}1(8)+27{\cdot}5(13)-52{\cdot}3(14)+24{\cdot}8(16)+7{\cdot}6(25)-12{\cdot}7(26)$
$+5{\cdot}1(27)+15{\cdot}5(28)-59{\cdot}2(29)+43{\cdot}7(30)+28{\cdot}6(31)-32{\cdot}4(32)+3{\cdot}8(33)+14{\cdot}2(34)-5{\cdot}2(35)$
$-9{\cdot}0(36)$

The correlate and normal equations, when established and solved, gave the following values of corrections to the angular directions:

	$''$		$''$		$''$		$''$
(1)=	+0·031 0	(10)=	+0·359 9	(19)=	−0·184 9	(28)=	+0·475 8
(2)	+0·059 7	(11)	−0·232 2	(20)	−0·518 0	(29)	−0·724 7
(3)	−0·090 7	(12)	+0·529 1	(21)	−0·264 5	(30)	+0·249 0
(4)	+0·189 7	(13)	−0·239 4	(22)	+0·747 4	(31)	+0·295 7
(5)	−0·471 6	(14)	+0·341 1	(23)	−0·499 6	(32)	+0·173 0
(6)	−0·116 7	(15)	−0·195 4	(24)	+0·016 6	(33)	−0·468 7
(7)	+0·164 2	(16)	−0·101 2	(25)	−0·230 1	(34)	−0·227 6
(8)	+0·237 3	(17)	+0·194 8	(26)	−0·021 3	(35)	+0·516 1
(9)	−0·656 8	(18)	+0·703 0	(27)	+0·251 4	(36)	−0·288 5

Checks: Sum of + corrections 55·35 and $\Sigma\, pvv = +4{\cdot}867$
Sum of − corrections 55·32 $\quad -\Sigma\, wC = +4{\cdot}872$

Mean error of an observed direction $m_1 = \sqrt{\dfrac{[pvv]}{n}} = \pm 0''{\cdot}61$ where n = number of conditions.

Mean error of an angle $m_L = m_1 \sqrt{2} = \pm 0''{\cdot}87$ and probable error of the same $\pm 0''{\cdot}59$.

EXTENSION OF THE KENT ISLAND BASE NET TO THE NORTHWARD.

Abstracts of resulting horizontal directions, observed and adjusted at stations to the north of the net.

Osbornes Ruin, Harford County, Maryland. September 23 to October 2, 1844. 60^{cm} direction theodolite No. 2. J. Ferguson, observer. August 17 to September 20, 1896. 30^{cm} repeating theodolite No. 16. G. A. Fairfield, observer. Telescope 14·17 meters above ground in 1896.

Object observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Turkey Point	0	00	00·00	+0·11	00·11
Pooles Island	81	27	17·53	−0·06	17·47
Finlay	158	56	33·29	−0·09	33·20
Principio	324	49	48·33	....	.....

Probable error of a single observation of a direction (D. and R.) in 1844, $e_1 = \pm 1''{\cdot}33$ and of a direction (6 D. and 6 R.) in 1896, $e_1 = \pm 0''{\cdot}35$. Number of positions of circle in 1844, VI.

Turkey Point, Cecil County, Maryland. May 31 to June 17, 1845. 60^{cm} direction theodolite No. 2. J. Ferguson, observer. September 30 to October 19, 1896. 35^{cm} direction theodolite No. 10. J. Nelson, observer. Telescope 2·08 meters above ground in 1896.

	°	′	″	″	″
Pooles Island	0	00	00·00	+0·65	00·65
Osbornes Ruin	44	01	48·72	−0·44	48·28
Principio	131	14	41·24	....	.....

Probable error of a single observation of a direction (D. and R.) in 1845, $e_1 = \pm 1''{\cdot}49$ and of a direction in 1896, $e_1 = \pm 0''{\cdot}62$.

Number of positions of circle in 1845, VI; and in 1896, XII.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the extension of the Kent Island base net to the westward and southward.

Hill, Prince George County, Maryland. June 18 to July 15, 1846. 60^{cm} direction theodolite No. 2. A. D. Bache, observer. August 8 to October 4, 1850. 75^{cm} direction theodolite No. 1. A. D. Bache and A. A. Humphreys, observers. October 9 to November 12, 1868. 75^{cm} direction theodolite, No. 1. C. O. Boutelle, observer. Telescope 16·76 meters above ground in 1868.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Peach Grove	0	00	00·00	−0·30	59·70
Causten	5	54	28·96	....	.....
Sugar Loaf	37	48	42·47	+0·10	42·57
Stabler	65	16	57·50	+0·20	57·70
Soper	69	14	40·71	−0·31	40·40
Azimuth Mark	125	08	23·97	....	.....
Webb	125	08	24·12	+0·12	24·24
Marriott	181	48	56·12	+0·20	56·32

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''{\cdot}90$. Number of positions of circle in 1846 and 1850, V; in 1868, VII.

Soper, Montgomery County, Maryland. June 19 to July 23, 1850. 75^{cm} direction theodolite No. 1. A. D. Bache, observer.

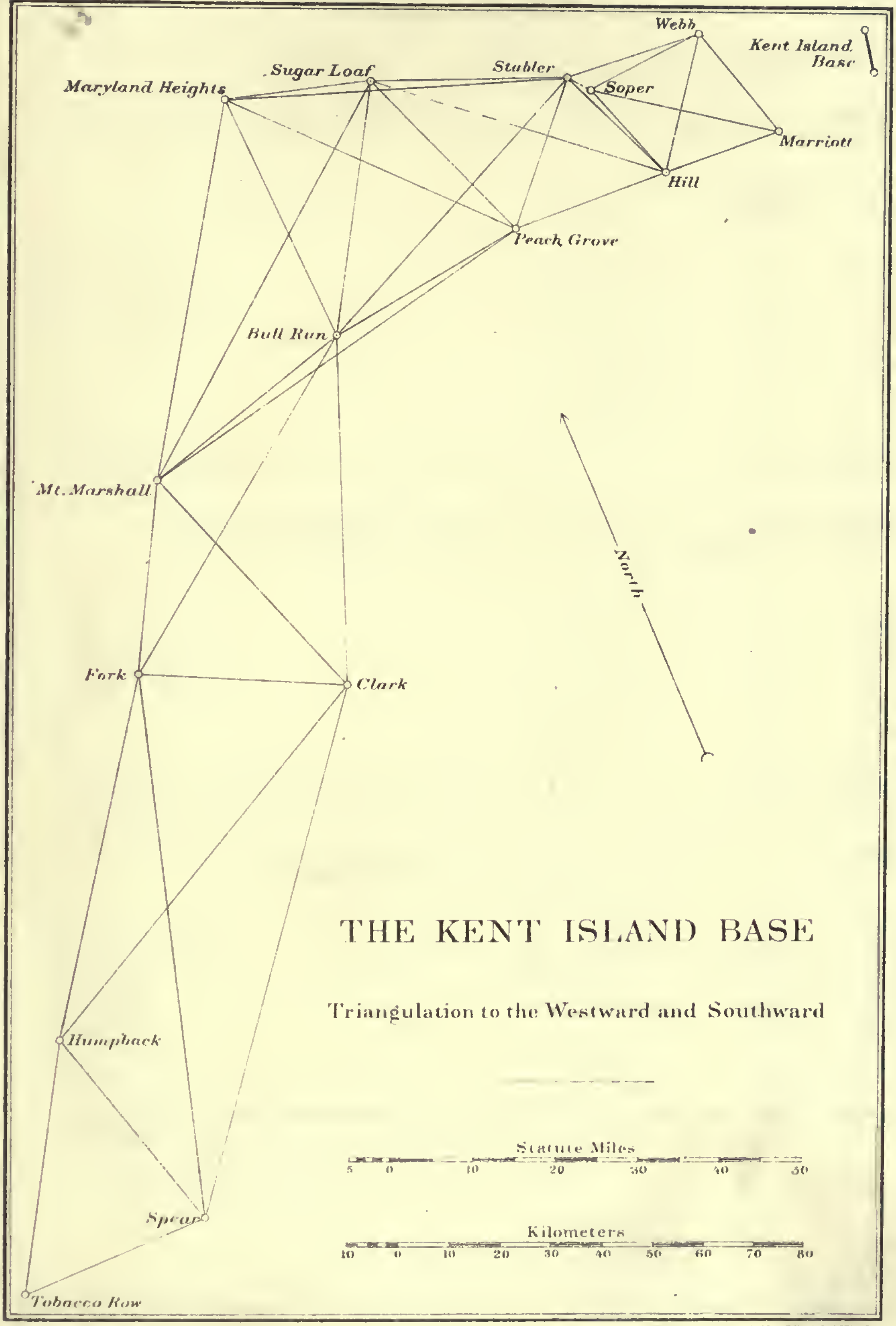
Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Webb	0	00	00·00	−0·08	59·92
Marriott	39	41	37·08	−0·17	36·91
Hill	75	01	10·92	+0·24	11·16
Azimuth Mark	89	30	15·00	....	.....
Causten	122	09	57·30	....	.....
Stabler	233	17	.....	....	09·98

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''{\cdot}91$. Number of positions of circle, V.

Stabler, Montgomery County, Maryland. July 17 to September 3, 1869. 75^{cm} direction theodolite No. 1. C. O. Boutelle, observer. Instrument 16·76 meters above ground.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Hill	0	00	00·00	−0·24	59·76
Peach Grove	63	40	03·06	−0·37	02·69
Bull Run	87	11	16·57	+0·04	16·61
Maryland Heights	131	27	54·59	+0·06	54·65
Sugar Loaf	134	09	42·34	+0·48	42·82
Webb	297	19	37·68	+0·01	37·69
Soper	342	13	41·17	0·00	41·17

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''{\cdot}08$. Number of positions of circle, VII.



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Abstracts of resulting horizontal directions observed and adjusted at stations forming the extension of the Kent Island base net to the westward and southward—continued.

Peach Grove, Fairfax County, Virginia. October 11 to November 8, 1869, and July 28 to August 15, 1870. 75^cm direction theodolite No. 1. C. O. Boutelle, observer. Telescope 13·72 meters above ground.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Mount Marshall	0	00	00 ·00	−0 ·36	59 ·64
Bull Run	4	36	29 ·66	+0 ·18	29 ·84
Maryland Heights	58	32	34 ·06	−0 ·50	33 ·56
Sugar Loaf	79	59	52 ·76	+0 ·06	52 ·82
Stabler	143	47	23 ·85	+0 ·35	24 ·20
Causten	187	26	02 ·78	....	.....
Hill	194	50	24 ·85	+0 ·27	25 ·12

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''·02$. Number of positions of circle, VII.

Sugar Loaf, Frederick County, Maryland. August 18 to November 19, 1879. 50^cm direction theodolite No. 113. C. O. Boutelle, F. D. Granger, and J. B. Boutelle, observers.

	°	′	″	″	″
Reference Mark	0	00	00 ·00	....	.....
Bull Run	45	27	15 ·79	+0 ·72	16 ·51
Mount Marshall	65	36	50 ·72	−0 ·11	50 ·61
Maryland Heights	120	27	54 ·38	+0 ·10	54 ·48
Stabler	306	43	36 ·06	−0 ·46	35 ·60
Hill	325	05	.....	....	39 ·25
Peach Grove	352	26	27 ·18	−0 ·26	26 ·92

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''·60$. Number of positions of circle, XI.

Mount Marshall, Rappahannock County, Virginia. July 18 to September 7, 1874. 35^cm direction theodolite No. 10. A. T. Mosman, observer.

	°	′	″	″	″
Fork	0	00	00 ·00	....	.....
Maryland Heights	184	15	49 ·56	−0 ·26	49 ·30
Sugar Loaf	202	41	37 ·50	+0 ·36	37 ·86
Bull Run	225	17	06 ·78	+0 ·19	06 ·97
Peach Grove	229	31	29 ·99	−0 ·28	29 ·71
Clark	311	50	33 ·98	....	.....
Peters	336	20	36 ·44	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''·29$. Number of positions of circle, XI.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the extension of the Kent Island base net to the westward and southward—continued.

Bull Run, Fauquier County, Virginia. September 22 to November 28, 1871. 75[cm] direction theodolite No. 1. C. O. Boutelle, observer.

Objects observed.	Results of local adjustment. °	′	″	Correction from figure adjustment. ″	Final seconds. ″
Azimuth Mark	0	00	00·00	....	.....
Clark	1	07	09·35	....	.....
Fork	33	03	17·51	....	.....
Mount Marshall	53	39	05·53	+0·11	05·64
Maryland Heights	157	20	07·15	+0·49	07·64
Sugar Loaf	190	54	06·98	−0·68	06·30
Stabler	225	12	03·95	+0·08	04·03
Peach Grove	242	29	57·85	0·00	57·85

Probable error of a single observation of a direction ($D.$ and $R.$), $e_1 = \pm 1''\cdot 09$. Number of positions of circle, VII.

Maryland Heights, Washington County, Maryland. September 16 to October 28, 1870. 75[cm] direction theodolite No. 1. C. O. Boutelle, observer.

Objects observed.	°	′	″	″	″
Sugar Loaf	0	00	00·00	−0·18	59·82
Azimuth Mark	0	57	03·66	....	.....
Stabler	3	33	53·32	−0·24	53·08
Peach Grove	30	31	14·53	+0·84	15·37
Bull Run	71	25	27·26	−0·50	26·76
Mount Marshall	106	43	12·67	+0·08	12·75

Probable error of a single observation of a direction ($D.$ and $R.$), $e_1 = \pm 0''\cdot 93$. Number of positions of circle, VII.

Clark, Orange County, Virginia. July 24 to September 5, 1871. 75[cm] direction theodolite No. 1. C. O. Boutelle, observer.

Objects observed.	°	′	″	″	″
Spear	0	00	00·00	−0·12	59·88
Peters	11	21	47·00	....	.....
Humpback	24	09	37·37	−1·35	36·02
Azimuth Mark	55	29	20·96	....	.....
Fork	78	26	10·17	+0·97	11·14
Mount Marshall	122	25	05·12	+0·02	05·14
Bull Run	163	19	47·57	+0·48	48·05

Probable error of a single observation of a direction ($D.$ and $R.$), $e_1 = \pm 1\cdot 03$. Number of positions of circle, VII.

Abstracts of resulting horizontal directions observed and adjusted at stations forming the extension of the Kent Island base net to the westward and southward—continued.

Fork, Madison County, Virginia. October 12 to December 24, 1874. 35^{cm} direction theodolite No. 10. A. T. Mosman, observer. July 18 to August 6, 1879. 50^{cm} direction theodolite No. 114. Same observer.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Peaked	0	00	00 ·00	....	.....
Slate Springs	20	16	00 ·96	+0 ·98	01 ·94
Mount Marshall	136	25	13 ·62	+0 ·39	14 ·01
Bull Run	161	06	37 ·64	−1 ·01	36 ·63
Clark	224	16	58 ·68	−0 ·86	57 ·82
Peters	270	56	24 ·51	....	.....
Spear	303	52	39 ·51	−0 ·10	39 ·41
Humpback	322	58	40 ·96	−0 ·20	40 ·76
Elliott Knob	353	33	11 ·50	+0 ·80	12 ·30

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 24$. Number of positions of circle, XI in 1874 and in 1879.

Humpback, Nelson County, Virginia. June 8 to 29, 1875. 35^{cm} direction theodolite No. 10. A. T. Mosman, observer. May 11 to June 6, 1878. 50^{cm} direction theodolite No. 114. Same observer. August 18 to 28, 1879. 50^{cm} direction theodolite No. 114. A. T. Mosman and W. B. Fairfield, observers.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Jarman	0	00	00 ·00	....	.....
Clark	24	30	20 ·46	+1 ·37	21 ·83
Peters	31	40	01 ·24	....	.....
Spear	126	14	25 ·02	+0 ·44	25 ·46
Long Mountain	154	41	57 ·10	....	.....
Tobacco Row	173	06	07 ·68	−0 ·87	06 ·81
Bald Knob	230	26	24 ·65	+0 ·17	24 ·82
Elliott Knob	265	35	01 ·13	−1 ·03	00 ·10
Slate Springs	300	08	53 ·99	−0 ·57	53 ·42
Fork	357	28	32 ·18	+0 ·33	32 ·51

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 43$. Number of positions of circle, XI.

Spear, Buckingham County, Virginia. July 30 to August 29, 1875. 35^{cm} direction theodolite No. 10. A. T. Mosman, observer.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Willis	0	00	00 ·00	....	.....
Long Mountain	113	14	26 ·50	....	.....
Flat Top	150	15	15 ·49	....	.....
Tobacco Row	160	17	43 ·42	+0 ·22	43 ·64
Humpback	233	59	02 ·50	−0 ·44	02 ·06
Fork	266	07	14 ·11	+0 ·05	14 ·16
Peters	283	15	22 ·59	....	.....
Clark	288	05	31 ·91	+0 ·17	32 ·08

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 37$. Number of positions of circle, XI.

Abstracts of resulting horizontal directions observed and adjusted at the stations forming the extension of the Kent Island base net to the westward and southward—continued.

Tobacco Row, Amherst County, Virginia. September 14 to 23, 1875. 35^{cm} direction theodolite No. 10. A. T. Mosman, observer. September 6 to 9, 1879. 50^{cm} direction theodolite No. 114. Same observer.

Objects observed.	Results of local adjustment.			Correction from figure adjustment.	Final seconds.
	°	′	″	″	″
Flat Top	0	00	00 ·00	....	.....
Bald Knob	54	31	49 ·35	−0 ·65	48 ·70
Humpback	140	52	23 ·38	+0 ·86	24 ·24
Spear	200	19	28 ·80	−0 ·21	28 ·59
Long Mountain	272	56	37 ·39	....	.....
Smith	318	30	40 ·14	....	.....
Cahas	345	42	24 ·62	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 43$. Number of positions of circle in 1875, XI.

Resulting angles and sides of the Kent Island base net.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances	Distances in meters.
		°	′	″	″	″	″		
1	Taylor	38	36	52 ·37	−0 ·59	51 ·78	0 ·08	3 ·938 897 1	8 687 ·545
	Kent Island North Base	88	35	36 ·91	−0 ·31	36 ·60	0 ·08	4 ·143 529 1	13 916 ·47
	Kent Island South Base	52	47	32 ·01	−0 ·15	31 ·86	0 ·08	4 ·044 816 9	11 087 ·07
2	Marriott	21	56	43 ·96	+0 ·09	44 ·05	0 ·15	4 ·044 816 9	11 087 ·07
	Taylor	119	32	44 ·32	+0 ·17	44 ·49	0 ·15	4 ·411 765 6	25 808 ·67
	Kent Island North Base	38	30	31 ·55	+0 ·36	31 ·91	0 ·15	4 ·266 498 4	18 471 ·34
3	Marriott	40	10	21 ·28	+0 ·39	21 ·67	0 ·21	4 ·143 529 1	13 916 ·47
	Taylor	80	55	51 ·95	+0 ·76	52 ·71	0 ·22	4 ·328 444 0	21 303 ·16
	Kent Island South Base	58	53	46 ·24	+0 ·03	46 ·27	0 ·22	4 ·266 498 5	18 471 ·34
4	Marriott	18	13	37 ·32	+0 ·29	37 ·61	0 ·14	3 ·938 897 1	8 687 ·545
	Kent Island North Base	50	05	05 ·36	−0 ·66	04 ·70	0 ·15	4 ·328 444 1	21 303 ·16
	Kent Island South Base	111	41	18 ·25	−0 ·12	18 ·13	0 ·15	4 ·411 765 8	25 808 ·68
5	Linstid	34	46	24 ·83	+1 ·01	25 ·84	0 ·09	4 ·044 816 9	11 087 ·07
	Kent Island North Base	32	26	27 ·42	+0 ·28	27 ·70	0 ·09	4 ·018 198 2	10 427 ·93
	Taylor	112	47	05 ·71	+1 ·02	06 ·73	0 ·09	4 ·253 398 1	17 922 ·48
6	Linstid	33	57	08 ·85	−1 ·25	07 ·60	0 ·13	4 ·266 498 5	18 471 ·34
	Taylor	127	40	09 ·97	−1 ·18	08 ·79	0 ·13	4 ·417 956 2	26 179 ·19
	Marriott	18	22	44 ·54	−0 ·54	44 ·00	0 ·13	4 ·018 198 2	10 427 ·93
7	Linstid	68	43	33 ·68	−0 ·24	33 ·44	0 ·37	4 ·411 765 7	25 808 ·67
	Kent Island North Base	70	56	58 ·97	+0 ·64	59 ·61	0 ·37	4 ·417 956 2	26 179 ·19
	Marriott	40	19	28 ·50	−0 ·44	28 ·06	0 ·37	4 ·253 398 2	17 922 ·48

Resulting angles and sides of the Kent Island base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
8	Webb	76	16	06·19	+0·27	06·46	0·33	4·417 956 2	26 179·19
	Linstid	66	18	42·31	+0·52	42·83	0·33	4·392 324 7	24 678·84
	Marriott	37	25	11·13	+0·58	11·71	0·34	4·214 204 0	16 375·86
9	Finlay	25	43	36·20	+0·97	37·17	0·49	4·214 204 0	16 375·86
	Linstid	84	01	06·41	+0·69	07·10	0·49	4·574 261 9	37 519·92
	Webb	70	15	16·99	+0·21	17·20	0·49	4·550 316 3	35 507·19
10	Pooles Island	79	44	39·79	−0·64	39·15	0·64	4·550 316 3	35 507·19
	Linstid	46	42	57·73	−0·89	56·84	0·63	4·419 418 8	26 267·50
	Finlay	53	32	27·11	−1·20	25·91	0·63	4·462 716 4	29 021·27
11	Swan Point	56	08	57·92	+0·74	58·66	0·25	4·253 398 2	17 922·48
	Kent Island North Base	60	07	41·14	+0·07	41·21	0·25	4·272 151 1	18 713·33
	Linstid	63	43	20·63	+0·26	20·89	0·26	4·286 689 1	19 350·36
12	Swan Point	113	07	27·59	−0·81	26·78	0·23	4·462 716 4	29 021·27
	Linstid	30	30	19·24	−0·33	18·91	0·23	4·204 626 3	16 018·66
	Pooles Island	36	22	15·13	−0·12	15·01	0·24	4·272 151 2	18 713·34
13	Osbornes Ruin	77	29	15·76	−0·04	15·72	0·37	4·419 418 8	26 267·50
	Pooles Island	54	27	12·11	−1·20	10·91	0·36	4·340 289 4	21 892·20
	Finlay	48	03	34·63	−0·17	34·46	0·36	4·301 337 0	20 014·14
14	Turkey Point	44	01	48·72	−1·09	47·63	0·39	4·301 337 0	20 014·14
	Pooles Island	54	30	55·00	+1·19	56·19	0·39	4·370 101 8	23 447·78
	Osbornes Ruin	81	27	17·53	−0·17	17·36	0·40	4·454 483 8	28 476·32

Western and southern extension of Kent Island base net.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
15	Hill	56	40	32·00	+0·08	32·08	0·46	4·392 324 7	24 678·84
	Webb	53	10	52·09	0·00	52·09	0·46	4·373 719 9	23 643·94
	Marriott	70	08	36·93	+0·29	37·22	0·47	4·443 721 1	27 779·29
16	Soper	39	41	37·08	−0·09	36·99	0·49	4·392 324 7	24 678·84
	Webb	102	15	58·28	0·00	58·28	0·48	4·577 012 1	37 758·27
	Marriott	38	02	26·57	−0·38	26·19	0·49	4·376 775 6	23 810·89
17	Soper	75	01	10·92	+0·32	11·24	0·43	4·443 721 1	27 779·29
	Webb	49	05	06·19	0·00	06·19	0·42	4·337 076 1	21 730·82
	Hill	55	53	43·41	+0·43	43·84	0·42	4·376 775 8	23 810·90
18	Soper	35	19	33·84	+0·41	34·25	0·40	4·373 719 9	23 643·94
	Marriott	32	06	10·36	+0·67	11·03	0·40	4·337 076 2	21 730·82
	Hill	112	34	15·41	+0·51	15·92	0·40	4·577 012 2	37 758·28
19	Stabler	44	54	03·49	−0·01	03·48	0·08	4·376 775 7	23 810·90
	Webb	8	23	06·84	−0·02	06·82	0·08	3·691 882 4	4 919·06
	Soper	126	42	.....	....	49·94	0·08	4·432 017 4	27 040·67

Wetern and southern extension of Kent Island base net—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
20	Stabler	62	40	22 ·32	−0 ·26	22 ·06	0 ·53	4 ·443 721 1	27 779 ·29
	Webb	57	28	13 ·03	−0 ·02	13 ·01	0 ·54	4 ·420 998 3	26 363 ·21
	Hill	59	51	26 ·62	−0 ·08	26 ·54	0 ·54	4 ·432 017 4	27 040 ·67
21	Stabler	17	46	18 ·83	−0 ·245	18 ·585	0 ·034	4 ·337 076 1	21 730 ·82
	Soper	158	15	.....	....	58 ·820	0 ·033	4 ·420 998 3	26 363 ·21
	Hill	3	57	43 ·21	−0 ·514	42 ·696	0 ·034	3 ·691 882 5	4 919 ·06
22	Peach Grove	51	03	01 ·00	−0 ·08	00 ·92	0 ·62	4 ·420 998 3	26 363 ·21
	Stabler	63	40	03 ·06	−0 ·13	02 ·93	0 ·62	4 ·482 609 8	30 381 ·54
	Hill	65	16	57 ·50	+0 ·50	58 ·00	0 ·61	4 ·488 456 8	30 793 ·34
23	Sugar Loaf	18	22	.....	....	03 ·65	0 ·62	4 ·420 998 3	26 363 ·21
	Stabler	134	09	42 ·34	+0 ·73	43 ·07	0 ·61	4 ·778 281 4	60 017 ·99
	Hill	27	28	15 ·03	+0 ·10	15 ·13	0 ·62	4 ·586 513 6	38 593 ·45
24	Sugar Loaf	45	42	51 ·12	+0 ·20	51 ·32	0 ·95	4 ·488 456 8	30 793 ·34
	Stabler	70	29	39 ·28	+0 ·85	40 ·13	0 ·94	4 ·607 957 7	40 546 ·91
	Peach Grove	63	47	31 ·09	+0 ·30	31 ·39	0 ·95	4 ·586 513 6	38 593 ·45
25	Sugar Loaf	27	20	.....	....	47 ·66	0 ·95	4 ·482 609 8	30 381 ·54
	Hill	37	48	42 ·47	+0 ·40	42 ·87	0 ·95	4 ·607 957 8	40 546 ·92
	Peach Grove	114	50	32 ·09	+0 ·22	32 ·31	0 ·94	4 ·778 281 4	60 017 ·99
26	Maryland Heights	3	33	53 ·32	−0 ·059	53 ·261	0 ·104	4 ·586 513 6	38 593 ·45
	Sugar Loaf	173	44	18 ·32	+0 ·562	18 ·882	0 ·104	4 ·830 573 0	67 697 ·56
	Stabler	2	41	47 ·75	+0 ·419	48 ·169	0 ·104	4 ·465 432 7	29 203 ·35
27	Maryland Heights	30	31	14 ·53	+1 ·02	15 ·55	0 ·79	4 ·607 957 7	40 546 ·91
	Sugar Loaf	128	01	27 ·20	+0 ·36	27 ·56	0 ·79	4 ·798 611 0	62 894 ·26
	Peach Grove	21	27	18 ·70	+0 ·56	19 ·26	0 ·79	4 ·465 432 7	29 203 ·35
28	Maryland Heights	26	57	21 ·21	+1 ·08	22 ·29	1 ·63	4 ·488 456 8	30 793 ·34
	Stabler	67	47	51 ·53	+0 ·43	51 ·96	1 ·63	4 ·798 611 1	62 894 ·28
	Peach Grove	85	14	49 ·79	+0 ·86	50 ·65	1 ·64	4 ·830 573 0	67 697 ·56
29	Bull Run	33	33	59 ·83	−1 ·16	58 ·67	1 ·20	4 ·465 432 7	29 203 ·35
	Maryland Heights	71	25	27 ·26	−0 ·31	26 ·95	1 ·20	4 ·699 551 7	50 067 ·01
	Sugar Loaf	75	00	38 ·59	−0 ·62	37 ·97	1 ·19	4 ·707 753 2	51 021 ·49
30	Bull Run	67	51	56 ·80	−0 ·40	56 ·40	2 ·70	4 ·830 573 0	67 697 ·56
	Maryland Heights	67	51	33 ·94	−0 ·26	33 ·68	2 ·71	4 ·830 553 5	67 694 ·52
	Stabler	44	16	38 ·02	+0 ·02	38 ·04	2 ·71	4 ·707 753 2	51 021 ·49
31	Bull Run	85	09	50 ·70	−0 ·49	50 ·21	1 ·77	4 ·798 611 0	62 894 ·26
	Maryland Heights	40	54	12 ·73	−1 ·33	11 ·40	1 ·78	4 ·616 253 0	41 328 ·82
	Peach Grove	53	56	04 ·40	−0 ·68	03 ·72	1 ·78	4 ·707 753 3	51 021 ·51
32	Bull Run	34	17	56 ·97	+0 ·76	57 ·73	1 ·62	4 ·586 513 6	38 593 ·45
	Sugar Loaf	98	43	39 ·73	+1 ·18	40 ·91	1 ·61	4 ·830 553 5	67 694 ·52
	Stabler	46	58	25 ·77	+0 ·44	26 ·21	1 ·62	4 ·699 551 6	50 067 ·00

Western and southern extension of Kent Island base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
33	Bull Run	51	35	50 ·87	+0 ·68	51 ·55	1 ·37	4 ·607 957 7	40 546 ·91
	Sugar Loaf	53	00	48 ·61	+0 ·98	49 ·59	1 ·37	4 ·616 253 0	41 328 ·82
	Peach Grove	75	23	23 ·10	−0 ·12	22 ·98	1 ·38	4 ·699 551 7	50 067 ·01
34	Bull Run	17	17	53 ·90	−0 ·08	53 ·82	0 ·70	4 ·488 456 8	30 793 ·34
	Stabler	23	31	13 ·51	+0 ·41	13 ·92	0 ·70	4 ·616 253 1	41 328 ·83
	Peach Grove	139	10	54 ·19	+0 ·18	54 ·37	0 ·71	4 ·830 553 6	67 694 ·53
35	Mount Marshall	18	25	47 ·94	+0 ·62	48 ·56	1 ·79	4 ·465 432 7	29 203 ·35
	Maryland Heights	106	43	12 ·67	+0 ·26	12 ·93	1 ·78	4 ·946 793 1	88 469 ·41
	Sugar Loaf	54	51	03 ·66	+0 ·21	03 ·87	1 ·79	4 ·878 122 3	75 530 ·49
36	Mount Marshall	41	01	17 ·22	+0 ·45	17 ·67	1 ·88	4 ·707 753 2	51 021 ·49
	Maryland Heights	35	17	45 ·41	+0 ·57	45 ·98	1 ·88	4 ·652 400 4	44 915 ·93
	Bull Run	103	41	01 ·62	+0 ·38	02 ·00	1 ·89	4 ·878 122 2	75 530 ·47
37	Mount Marshall	45	15	40 ·43	−0 ·01	40 ·42	3 ·90	4 ·798 611 0	62 894 ·26
	Maryland Heights	76	11	58 ·14	−0 ·76	57 ·38	3 ·91	4 ·934 439 0	85 988 ·24
	Peach Grove	58	32	34 ·06	−0 ·15	33 ·91	3 ·90	4 ·878 122 3	75 530 ·49
38	Mount Marshall	22	35	29 ·28	−0 ·17	29 ·11	1 ·29	4 ·699 551 7	50 067 ·01
	Sugar Loaf	20	09	34 ·93	−0 ·83	34 ·10	1 ·29	4 ·652 400 5	44 915 ·94
	Bull Run	137	15	01 ·45	−0 ·78	00 ·67	1 ·30	4 ·946 793 1	88 469 ·41
39	Mount Marshall	26	49	52 ·49	−0 ·63	51 ·86	2 ·91	4 ·607 957 7	40 546 ·91
	Sugar Loaf	73	10	23 ·54	+0 ·15	23 ·69	2 ·91	4 ·934 439 1	85 988 ·25
	Peach Grove	79	59	52 ·76	+0 ·41	53 ·17	2 ·90	4 ·946 793 1	88 469 ·41
40	Mount Marshall	4	14	23 ·21	−0 ·468	22 ·742	0 ·242	4 ·616 253 0	41 328 ·82
	Bull Run	171	09	07 ·68	+0 ·111	07 ·791	0 ·241	4 ·934 439 0	85 988 ·24
	Peach Grove	4	36	29 ·66	+0 ·532	30 ·192	0 ·242	4 ·652 400 4	44 915 ·93
41	Clark	40	54	42 ·45	+0 ·46	42 ·91	2 ·07	4 ·652 400 4	44 915 ·93
	Mount Marshall	86	33	27 ·01	−0 ·25	26 ·76	2 ·06	4 ·835 447 1	68 461 ·61
	Bull Run	52	31	56 ·29	+0 ·24	56 ·53	2 ·07	4 ·735 883 3	54 435 ·63
42	Fork	24	41	24 ·02	−1 ·40	22 ·62	1 ·02	4 ·652 400 4	44 915 ·93
	Mount Marshall	134	42	53 ·03	−0 ·19	52 ·84	1 ·03	4 ·883 177 2	76 414 ·75
	Bull Run	20	35	48 ·13	−0 ·52	47 ·61	1 ·02	4 ·577 810 2	37 827 ·72
43	Fork	87	51	45 ·06	−1 ·25	43 ·81	1 ·29	4 ·735 883 3	54 435 ·63
	Mount Marshall	48	09	26 ·02	+0 ·05	26 ·07	1 ·30	4 ·608 327 0	40 581 ·40
	Clark	43	58	54 ·95	−0 ·94	54 ·01	1 ·30	4 ·577 810 3	37 827 ·73
44	Fork	63	10	21 ·04	+0 ·15	21 ·19	2 ·34	4 ·835 447 1	68 461 ·61
	Bull Run	31	56	08 ·16	+0 ·76	08 ·92	2 ·34	4 ·608 326 9	40 581 ·39
	Clark	84	53	37 ·40	−0 ·48	36 ·92	2 ·35	4 ·883 177 2	76 414 ·75
45	Humpback	27	01	48 ·28	+1 ·04	49 ·32	2 ·46	4 ·608 326 9	40 581 ·39
	Fork	98	41	42 ·28	+0 ·67	42 ·95	2 ·47	4 ·945 819 1	88 271 ·22
	Clark	54	16	32 ·80	+2 ·32	35 ·12	2 ·46	4 ·860 307 4	72 494 ·89

Western and southern extension of Kent Island base net—continued.

No.	Stations.	Observed angles. ° ′ ″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
46	Spear	32 08 11·61	+0·49	12·10	2·13	4·860 307 4	72 494·89
	Humpback	128 45 52·84	+0·11	52·95	2·14	5·026 395 5	106 266·29
	Fork	19 06 01·45	−0·10	01·35	2·13	4·649 283 4	44 594·71
47	Spear	54 06 29·41	+0·61	30·02	3·26	4·945 819 1	88 271·22
	Humpback	101 44 04·56	−0·93	03·63	3·27	5·028 099 9	106 684·15
	Clark	24 09 37·37	−1·23	36·14	3·26	4·649 283 4	44 594·71
48	Spear	21 58 17·80	+0·12	17·92	3·59	4·608 326 9	40 581·39
	Fork	79 35 40·83	+0·77	41·60	3·59	5·028 100 0	106 684·17
	Clark	78 26 10·17	+1·08	11·25	3·59	5·026 395 5	106 266·29
49	Tobacco Row	59 27 05·42	−1·08	04·34	1·37	4·649 283 4	44 594·71
	Humpback	46 51 42·66	−1·31	41·35	1·37	4·577 326 2	37 785·59
	Spear	73 41 19·08	−0·66	18·42	1·37	4·696 339 5	49 698·07

Determination of the probable error of the length of the sides Osbornes Ruin to Turkey Point, and Tobacco Row to Spear.

In connection with the Kent Island base net the probable error of the side Linstid to Finlay was rigorously computed, and was found to be ±0·33 meters; which equals $\frac{1}{107800}$ part of the length of the side. There are three triangles between this side and the side Osbornes Ruin to Turkey Point; but, instead of computing the additional probable error arising from their measure separately, it will suffice, when estimating the probable error of the chain of triangles between the Fire Island and Kent Island bases to include these three triangles as part of the chain; otherwise, the probable error of the line may be taken as about $\frac{1}{100000}$ part of the length.

For the extension southward the probable error of the side Webb to Marriott was rigorously computed and found to equal ±0·22 meters, which is about $\frac{1}{112200}$ part of the length. For that part of the triangulation lying between Webb to Marriott and Fork to Clark the probable error was found to be $\frac{1}{103000}$ part of the length, and the same fraction may be used for the extension thence to the line Tobacco Row to Spear.

Descriptions of the base-net stations are given in the account of the Transcontinental Triangulation, etc., Special Publication No. 4, Washington, 1900.

5. THE ATLANTA BASE AND BASE NET, GEORGIA, 1872–73.

Location, measurement, and resulting length of the Atlanta base line, 1872–73.

The Atlanta base is located on Peach Tree Ridge, Georgia, about 24 kilometers (or 15 statute miles) northeast of the city of Atlanta. It is the seventh and last base measured with the Bache–Würdemann apparatus, and is the only one measured with it more than once. It is 9⅓ kilometers (or 5·81 statute miles) in length and was measured three times. There is a very full description of the operations in Coast Survey Report for 1873, Appendix No. 12, pages 123–131, and the description of the apparatus is given in Coast Survey Report for 1854, Appendix No. 35, and in Coast Survey Report for 1873, Appendix No. 12. Further remarks will be found in the account of the Dauphin Island and the Epping bases in this publication. It will also appear from the seven values collected on page 131 of the Report for 1873 that the average accuracy reached with this apparatus is about $\frac{1}{500\,000}$ part of the length measured. In view of the complete publication already made, it will suffice to give the present account in an abbreviated form.

The middle point of the base is in latitude 33° 54′·4 and longitude 84° 16′·5, with a mean azimuth 52° 08′·2. The measurements were made by Assistant C. O. Boutelle. The first and second measures were made in opposite directions in November and December, 1872, and in January, 1873, and the third was made in July and August, 1873. The three measures were accomplished in 17, 13, and 14 working days, respectively. In connection with these several measures the tubes* were frequently compared for length with the standard bar, which was immersed in glycerin during the July and September comparisons.

The summit of the ridge is narrow and crooked, but the slope of the measurement was confined within the maximum inclination the tubes would bear, namely, 5°. A gulch near the southwest end was crossed on trestlework consisting of two separate structures. The approximate elevation above sea level is 320 meters. The terminals are marked by granite monuments and the subdivisions of the line by small granite posts.

The length of the 6-meter standard bar is $5^{m}\cdot999\,941 \pm 2$ at 0° C., and its coefficient of expansion $0\cdot000\,011\,54 \pm 4$. The numerous comparisons made for standardization of the tubes and for testing their compensation showed that the latter was still close; that is, about 21 parts of 22 remained compensated between the range of temperature 0° to 22° C., but between the temperatures from 22° to 38° C. the tubes compensated only about 10 parts in 11. The comparisons were made with the Saxton reflecting comparator No. 1, for which we have for the period November, 1872, to January, 1873, one division at 4½° C. equal $1\cdot384 \pm 3$ microns and at 19° C. $1\cdot378 \pm 3$ microns, values answering for the case of the first and second base measures In connection with the third measure, observations in July and September, 1873, gave 1 div. $= 1\cdot376\,\mu$. We have also 1 turn of the screw at the temperatures 4°, 19°, and 28° C. equal to 350·9, 352·3, and $353\cdot06 \pm \cdot18$ scale divisions, respectively.

As the result from the above comparisons we have the following values for the length of the tubes, in which the uncertainty from the length of the standard is included:

For first and second measures:

$$\begin{cases} \text{Tube } 1_3 = 5^{m}\cdot999\,999\,7 + 0\cdot000\,003\,37\,(t - 11^{\circ}\cdot2\text{ C.}) \\ \qquad\qquad \pm 14\,4 \\ \text{Tube } 2\ \ = 5\ \ \cdot999\,647\,8 + 0\cdot000\,004\,84\,(t - 11^{\circ}\cdot2\text{ C.}) \\ \qquad\qquad \pm 19\,3 \end{cases}$$

and fer third measure

$$\begin{cases} \text{Tube } 1_3 = 6^{m}\cdot000\,084\,6 + 0\cdot000\,009\,54\,(t - 27^{\circ}\cdot6\text{ C.}) \\ \qquad\qquad \pm 11\,2 \\ \text{Tube } 2\ \ = 5\ \ \cdot999\,730\,3 + 0\cdot000\,008\,01\,(t - 27^{\circ}\cdot8\text{ C.}) \\ \qquad\qquad \pm 11\,6 \end{cases}$$

*Before making the comparisons tube No. 1 was supplied with a new agate. The Borda scale or differential thermometer as applied to the tubes is shown on plate No. 18 in the Coast Survey Report for 1873.

The minimum temperature at which the tubes were used was — 7°·7 C., and many were laid with temperatures below the freezing point; the maximum temperature at which the tubes were used was 41°·7 C., and many were laid with temperatures above 38° C. The three thermometers attached to each tube were read and the mean values were corrected for graduation errors. The maximum inclination of a tube laid was 4°·7, and there were a great many with inclinations of 4°. The ruggedness of the ground caused the sum of the inclination corrections for the whole base to mount up to $10^{m}\cdot2212$ in the first and to $10^{m}\cdot0375$ in the last measure. Fractional parts of a tube at the base monuments and intermediate marks were measured with the brass Lenoir meter of the Survey, which is of standard length at 13°·6 C.

The following table shows the temperature of the tubes during the measures of the several parts of the base, their lengths as measured, corrected for inclination, but not reduced to sea level, and exhibits the difference of the individual measures from the mean of the three measures:

Subdivisions of base.	Temperatures.			Resulting length.			Mean.	Discrepancies.		
	First measure.	Second measure.	Third measure.	First measure.	Second. measure.	Third measure.		First measure.	Second measure.	Third measure.
	C. °	C. °	C. °					*mm.*	*mm.*	*mm.*
SW to I	15·13	5·62	34·33	1 635·974 9	1 635·968 0	1 635·966 4	1 635·969 8	−5·1	+1·8	+3·4
I to II	5·10	9·44	33·94	1 642·313 6	1 642·317 3	1 642·312 5	1 642·314 4	+0·8	−2·9	+1·9
II to M	6·84	4·28	32·56	1 234·383 3	1 234·388 0	1 234·391 8	1 234·387 7	+4·4	−0·3	−4·1
M to IV	11·06	2·97	32·03	1 348·886 2	1 348·880 6	1 348·885 1	1 348·884 0	−2·2	+3·4	−1·1
IV to V	14·02	5·57	31·96	1 785·709 0	1 785·704 8	1 785·705 2	1 785·706 3	−2·7	+1·5	+1·1
V to NE	11·31	12·92	30·74	1 691·692 0	1 691·692 5	1 691·681 5	1 691·688 7	−3·3	−3·8	+7·2
Whole base	10·58	6·80	32·59	9 338·959 0	9 338·951 2	9 338·942 5	9 338·950 9			

The frequent changes of sign in the above discrepancies may be taken as a favorable indication that the lengths of the tubes were correctly determined. In order to obtain the data required to reduce each part of the base to sea level, two lines of spirit levels were carried over it, double zenith distances of Stone Mountain were measured for difference of height at Southwest Base, Middle Base, and Northeast Base, and reciprocal observations were made at Stone Mountain. A line of spirit levels was carried from Stone Mountain, in 1873–74, to Augusta, Georgia; between this place and Port Royal the railroad levels were utilized, and the elevations refer to Atlantic half tide at Beaufort, South Carolina. The resulting height of Stone Mountain is $513^{m}\cdot95$, and allowing $1^{m}\cdot52$ for the elevation of the tubes above the ground, the average elevation of the tubes above the half-tide level becomes $321^{m}\cdot5$, and the reduction of the base to sea level $-\frac{h\,l}{\rho} = -0^{m}\cdot4710$. Whence we get for the length of the base the values

$$\left.\begin{array}{r} 9\,338^{m}\cdot4880 \\ 4802 \\ 4715 \end{array}\right\} \text{mean } 9\,338\cdot479\,9 \text{ meters.}$$

Combining the *mean* of the two winter measures with the value of the summer measure, we get 9 338·477 8 meters. We have also the distance Southwest Base to Middle Base 4 $512^{m}\cdot447$, and from Middle Base to Northwest Base 4 826·032 meters. The horizontal angles measured at these three base stations and at Stone Mountain afford a check on the measure. Starting with the first or shorter distance and using the adjusted angular measures, the length of the base thus trigonometrically deduced comes out 9 338^{m}·502, or 22^{mm} in excess of the direct linear measure.

For the probable error of the measure of the base we have the following data: Probable error from uncertainty in length of tubes in 1 556 tubes, $1\,556 \times 14{\cdot}0\,\mu = \pm 0^{m}{\cdot}021\,78$. For mere measuring error we have, after forming the values $\Sigma\,\delta_1^2$, $\Sigma\,\delta_2^2$, $\Sigma\,\delta_3^2$, etc., where the δ's are taken from the preceding table of differences from the mean of three measures, assumed of equal weight, the probable error of the base from these measures $= \pm\,0{\cdot}674 \left(\frac{\Sigma\,\delta_1^2 + \Sigma\,\delta_2^2 + \Sigma\,\delta_3^2 + \ldots}{n(n-1)}\right)^{1/2}$ where $n = 3$, hence the result $= \pm\,0^{m}{\cdot}003\,85$, which includes errors arising from defective compensation, errors of contact, of transfer to ground or to monuments, of alignment and inclination, etc.

Supposing an uncertainty in h of 1 meter, the reduction to sea level changes $\pm\,1^{mm}{\cdot}46$.

Combining the values we get the probable error of the base

$$\sqrt{(21{\cdot}78)^2 + (3{\cdot}85)^2 + (1{\cdot}46)^2} = \pm\,22^{mm}{\cdot}2,$$

which equals $\frac{1}{421\,000}$ part of the length.

The resulting length of the base is 9 338·477 8 meters, and its logarithm 3·970 276 09
± 22 2 ±1 03

Adjustment of the Atlanta base net.

The base is connected with the principal triangulation by a rather complex system of triangles, which made the placing of the boundary of the net to some extent an arbitrary act, except in so far as the labor involved set a limit to it. The net as it had been selected and adjusted in 1876 is here retained as satisfactory. The only change that could be made would be the introduction of the small corrections to the horizontal directions for height of object observed upon, which it was not customary to introduce at that time.

The heights of the 10 stations involved are as follows:

Approximate heights of stations above the Atlantic Ocean.

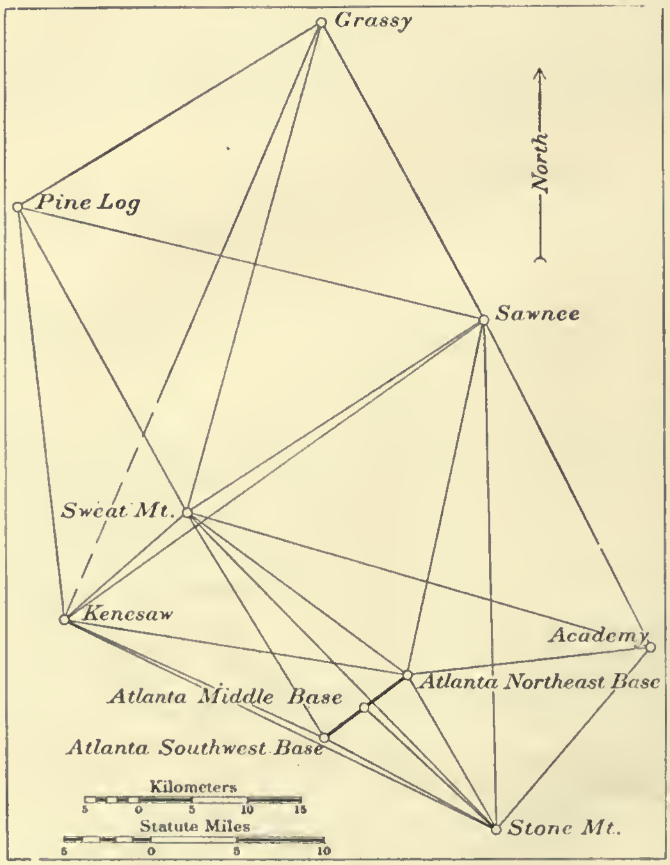
	Meters.	Feet.
Atlanta Southwest Base	318·5	1 045
Atlanta Northeast Base	326	1 070
Atlanta Middle Base	325	1 068
Stone Mountain*	514	1 686
Academy	346	1 136
Kenesaw	551	1 809
Sweat Mountain	516	1 694
Sawnee	600	1 967
Pine Log	713	2 340
Grassy	1 003	3 290

*Elevation from spirit levels, 513^{m}·95.

This reduction of the directions to sea level, a maximum in the case of line Pine Log to Grassy, is less than $0''\cdot07$, and in general it is less than one-half of this amount. It is therefore fully covered by the observing error of the directions which on the average amounts to $\frac{14\cdot4}{77}$ or $0''\cdot19$; besides, a number of directions require corrections in the figure adjustment of more than $1''$.

As shown in the diagram, the net comprises 10 stations which were occupied between 1872 and 1874; two observers were engaged in the work and three different instruments were employed, one being a repeating theodolite. The adjustment of the observations of directions at a station was made by Bessel's method, and the results are presented in the abstracts, where, for convenience, the resulting corrections due to the figure or net adjustment have been added. The latter computation involved 29 conditions which had to be satisfied. Here weights to the directions were introduced, depending upon the same principle as explained in the case of the adjustment of the Epping base net. In accordance with the method of application of weights to the directions in a net adjustment, we derive the mean error of a triangle from the sum of the squares of the closing errors of the 30 triangles involved and find $\sqrt{\frac{91\cdot1}{30}} = \pm1''\cdot74$; hence also the probable error of a direction, $0\cdot674\sqrt{\frac{91\cdot1}{180}} = \pm0''\cdot48$. Further we have the average value of the probable error of a direction derived from the measures and given in column 4 of the abstracts of directions $= \pm0''\cdot19$, whence the square of the triangle combination error $\varepsilon_c^2 = (0''\cdot48)^2 - (0''\cdot19)^2 = 0''\cdot20$ nearly. This value was added as a constant to each previously deduced square of the observing error; hence $\varepsilon^2 = \varepsilon_1^2 + \varepsilon_c^2$ and the weight of each direction, $p = \frac{1}{\varepsilon^2}$. The reciprocals of these values after division by $0\cdot22$ for the sake of convenience are tabulated further on.

No. 12.



Abstracts of horizontal directions at stations forming the Atlanta base net, 1873–1874.

Atlanta Middle Base,* De Kalb County, Georgia. January 11 to 30, 1873. C. O. Boutelle, observer. 75^{cm} direction theodolite No. 1. Circle used in VII positions.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable error.	Correction from figure adjustment.	Final seconds.
		°	′	″	″	″	″
2	Atlanta Northeast Base	0	00	00·000	±0·12	0·078	59·922
3	Stone Mountain	80	14	23·381	0·14	+0·193	23·574
1	Atlanta Southwest Base	180	00	00·037	0·12	−0·115	59·922
					Mean correction	0·000	

Probable error of a single observation of a direction (*D.* and *R.*), $e_2 = \pm 0''\cdot 75$.

Atlanta Southwest Base, De Kalb County, Georgia. February 10 to 22, 1873. C. O. Boutelle, observer. Instrument as before. Circle used in VII positions.

Number of directions.	Objects observed.	°	′	″	″	″	″
5	Kenesaw	0	00	00·000	±0·15	+0·026	00·026
6	Sweat Mountain	34	24	39·322	0·14	−0·130	39·192
4	Atlanta Middle Base and Northeast Base	118	38	10·842	0·12	−0·114	10·728
7	Stone Mountain	184	22	33·046	0·11	+0·219	33·265
	Atlanta, City Hall spire	271	16	31·46	....	.....	......
	Atlanta, Capitol flagstaff	273	14	57·08	....	.....	......
					Mean correction	0·000	

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 68$.

Atlanta Northeast Base, Gwinnett County, Georgia. February 27 to March 21, 1873. Observer and instrument as before. Circle used in VII positions.

Number of directions.	Objects observed.	°	′	″	″	″	″
12	Stone Mountain	0	00	00·000	±0·15	+0·082	00·082
8	Atlanta Middle Base and Southwest Base	82	49	01·328	0·13	+0·371	01·699
9	Kenesaw	129	23	28·311	0·14	+0·904	29·215
10	Sweat Mountain	156	57	34·651	0·15	+0·070	34·721
11	Sawnee	222	15	52·840	0·17	−0·601	52·239
13	Academy	293	13	58·560	0·16	−0·826	57·734
					Mean correction	0·000	

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 90$.

*This station was occupied eccentrically $0^{m}\cdot 0423$ off the line connecting Northeast Base and Southwest Base and the above directions are reduced to the line.

Abstracts of horizontal directions at stations forming the Atlanta base net, 1873-1874—continued.

Kenesaw, Cobb County, Georgia. June 25 to July 18, 1873. F. P. Webber, observer. Instrument as before. Circle used in VII positions.

Number of directions.	Objects observed.	Resulting directions from station adjustment. °	′	″	Approximate probable error. ″	Correction from figure adjustment. ″	Final seconds. ″
16	Sweat Mountain	0	00	00 ·000	±0 ·20	+0 ·049	00 ·049
17	Sawnee	4	36	07 ·630	0 ·20	+0 ·110	07 ·740
15	Atlanta Northeast Base	50	03	37 ·342	0 ·28	+0 ·226	37 ·568
14	Atlanta Southwest Base	64	50	59 ·613	0 ·27	+0 ·290	59 ·903
18	Stone Mountain	66	36	11 ·903	0 ·24	−1 ·056	10 ·847
	Carnes	224	20	15 ·036	0 ·36	.....	15 ·063
	Lavender	252	07	00 ·675	0 ·54	.....	00 ·702
19	Pine Log	303	37	21 ·586	0 ·41	+0 ·543	22 ·129

Mean correction +0 ·027

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''·81$.

Sweat Mountain, Cobb County, Georgia. September 10 to October 3, 1873. F. P. Webber, observer. Instrument as before. Circle used in VII positions.

Number of directions.	Objects observed.	°	′	″	″	″	″
22	Kenesaw	0	00	00 ·000	±0 ·11	+0 ·016	00 ·016
	Carnes	32	34	43 ·053	0 ·26	.....	......
26	Pine Log	100	54	55 ·825	0 ·21	−0 ·273	55 ·552
25	Grassy	145	16	24 ·035	0 ·18	+0 ·529	24 ·564
23	Sawnee	186	42	56 ·639	0 ·21	+0 ·669	57 ·308
27	Academy	236	54	39 ·846	0 ·27	−1 ·131	38 ·715
21	Atlanta Northeast Base	257	37	42 ·923	0 ·25	−0 ·835	42 ·088
24	Stone Mountain	266	39	06 ·616	0 ·19	+0 ·916	07 ·532
20	Atlanta Southwest Base	279	15	38 ·289	0 ·18	−0 ·183	38 ·106

Mean correction −0 ·036

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''·25$.

Stone Mountain, De Kalb County, Georgia. December 11 to December 20, 1873. C. O. Boutelle, observer. 50^{cm} direction theodolite No. 3. Circle used in XI positions.

Number of directions.	Objects observed.	°	′	″	″	″	″
	Spire near flagstaff	0	00	00 ·000	±0 ·23	.....	......
38	Kenesaw	40	54	49 ·578	0 ·26	−0 ·375	49 ·203
36	Atlanta Southwest Base	43	32	11 ·836	0 ·19	−0 ·245	11 ·591
35	Atlanta Middle Base *	58	02	13 ·204	0 ·17	−0 ·314	12 ·890
39	Sweat Mountain	60	57	46 ·579	0 ·24	+0 ·915	47 ·494
37	Atlanta Northeast Base	74	58	48 ·469	0 ·10	−0 ·649	47 ·820
40	Sawnee	103	57	45 ·410	0 ·14	+0 ·627	46 ·037
41	Academy	145	43	17 ·505	0 ·20	+0 ·119	17 ·624
	Alcova	207	54	55 ·333	0 ·21	.....	......

Mean correction +0 ·011

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''·14$.

* Result reduced to Middle Base in line, reduction = $-0''·092$.

Abstracts of horizontal directions at stations forming the Atlanta base net, 1873–1874—continued.

Sawnee, Forsyth County, Georgia. October 7 to November 12, 1873. C. O. Boutelle, observer. 75cm direction theodolite No. 1. November 26 to December 4, 1873. Same observer. 50cm direction theodolite No. 3. Circle used in VII and IV positions, respectively.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable error.	Correction from figure adjustment.	Final seconds.
		°	′	″	″	″	″
	Azimuth Mark	0	00	00 ·000	±0 ·09	.....	......
	Alcova	5	59	50 ·203	0 ·24	.....	......
34	Academy	13	35	48 ·306	0 ·26	+0 ·847	49 ·153
31	Stone Mountain	38	56	35 ·773	0 ·23	+1 ·311	37 ·084
28	Atlanta Northeast Base	52	13	32 ·259	0 ·21	−0 ·274	31 ·985
29	Kenesaw	93	53	42 ·795	0 ·25	−0 ·856	41 ·939
30	Sweat Mountain	96	00	32 ·086	0 ·22	−0 ·396	31 ·690
33	Pine Log	142	50	58 ·425	0 ·17	−0 ·353	58 ·072
32	Grassy	191	04	26 ·154	0 ·22	−0 ·244	25 ·910
	Blood	240	44	00 ·564	0 ·24	.....	......
	Yonah	263	11	38 ·044	0 ·31	.....	......
	Skitt	273	57	55 ·373	0 ·32	.....	......
	Currahee	286	09	07 ·228	0 ·22	.....	......
					Mean correction	+0 ·005	

Ninety-two series were measured with theodolite No. 1, and 40 with theodolite No. 3.
Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\!\cdot 34$.

Grassy, Pickens County, Georgia. July 13 to 31, 1874. C. O. Boutelle, observer. 50cm direction theodolite No. 3. Circle used in XI positions.

Number of directions.	Objects observed.	°	′	″	Approximate probable error ″	Correction from figure adjustment ″	Final seconds ″
44	Sawnee	0	00	00 ·000	0 ·07	+0 ·228	00 ·228
43	Sweat Mountain	43	29	35 ·631	0 ·16	+0 ·299	35 ·930
42	Kenesaw	51	39	33 ·335	0 ·23	−1 ·408	31 ·927
45	Pine Log	86	41	37 ·031	0 ·13	+0 ·753	37 ·784
	Johns	31	59	17 ·050	0 ·26	.....	......
	Cohutta	183	15	38 ·960	0 ·18	.....	......
	Blood	261	37	28 ·061	0 ·15	.....	......
	Skitt	297	13	10 ·620	0 ·16	.....	..
					Mean correction	−0 ·032	

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 91$.

Abstracts of horizontal directions at stations forming the Atlanta base net, 1873–1874—continued.

Pine Log, Bartow County, Georgia. July 29 to September 17, 1874. F. P. Webber, observer.
30cm repeating theodolite No. 32.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable error.	Correction from figure adjustment.	Final seconds
		°	′	″	″	″	″
	Carnes	0	00	00·000	±0·10	.....	......
	Indian	22	30	38·597	0·13	.....	......
	Coosa	36	17	34·507	0·12	.....	......
	Lavender	46	28	35·508	0·08	.....	......
	Gulf	70	19	50·280	0·12	.....	......
	Johns	84	39	43·143	0·12	.....	......
	Cohutta	141	29	12·849	0·14	.....	......
49	Grassy	193	10	40·009	0·13	−0·600	39·409
48	Sawnee	238	15	36·125	0·11	+0·598	36·723
47	Sweat Mountain	285	37	11·880	0·12	−0·541	11·339
46	Kenesaw	308	19	38·586	0·10	+0·542	39·128
	Lost Mountain	323	54	52·071	0·15	.....	......
	Pine Mountain	347	59	11·443	0·14	.....	......
					Mean correction	0·000	

Observations made in sets of 3 *D.* and 3 *R.* measures.
Probable error of a single observation of a direction (6 repetitions), $e_1 = \pm 1''\cdot 23$.

Academy, Gwinnett County, Georgia. December 4 to 10, 1874. C. O. Boutelle, observer.
50cm direction theodolite No. 3. Circle used in XI positions.

		°	′	″	″	″	″
53	Stone Mountain	0	00	00·000	±0·10	−0·716	59·284
50	Atlanta Northeast Base	42	29	26·166	0·14	+1·837	28·003
51	Sweat Mountain	65	30	02·687	0·16	−0·061	02·626
52	Sawnee	112	53	42·731	0·22	−1·167	41·564
					Mean correction	−0·027	

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 95$.

ATLANTA BASE NET ADJUSTMENT.

Observation equations.

I	0 = +0·037 − (2) + (1)
II	0 = −0·225 − (2) + (3) − (35) + (37) − (12) + (8)
III	0 = −0·219 − (4) + (7) − (36) + (37) − (12) + (8)
IV	0 = −0·411 − (6) + (7) − (36) + (39) − (24) + (20)
V	0 = −0·367 − (6) + (4) − (8) + (10) − (21) + (20)
VI	0 = +1·410 − (14) + (18) − (38) + (36) − (7) + (5)
VII	0 = +0·733 − (15) + (18) − (38) + (37) − (12) + (9)
VIII	0 = −0·284 − (5) + (6) − (20) + (22) − (16) + (14)
IX	0 = +2·497 − (10) + (13) − (50) + (51) − (27) + (21)
X	0 = −4·228 − (37) + (41) − (53) + (50) − (13) + (12)

Observation equations—continued.

XI	$0=+2.331-(38)+(40)-(31)+(29)-(17)+(18)$
XII	$0=+1.971-(9)+(11)-(28)+(29)-(17)+(15)$
XIII	$0=+4.351-(11)+(13)-(50)+(52)-(34)+(28)$
XIV	$0=+2.296-(10)+(11)-(28)+(30)-(23)+(21)$
XV	$0=+0.154-(48)+(47)-(26)+(23)-(30)+(33)$
XVI	$0=-1.831-(33)+(32)-(44)+(45)-(49)+(48)$
XVII	$0=-1.313-(26)+(25)-(43)+(45)-(49)+(47)$
XVIII	$0=-0.301-(22)+(26)-(47)+(46)-(19)+(16)$
XIX	$0=+0.152-0.095(4)+0.095(7)-0.026(8)+0.026(12)-1.505(35)+0.814(36)+0.691(37)$
XX	$0=+3.124-0.116(4)+0.021(6)+0.095(7)+0.531(20)+0.795(21)-1.326(24)+0.344(36)$ $+0.499(37)-0.843(39)$
XXI	$0=+9.942-0.226(8)+0.199(9)+0.027(12)-7.676(14)+0.798(15)+6.878(18)$ $-4.941(36)+0.344(37)+4.596(38)$
XXII	$0=+0.436+0.140(8)-0.199(9)+0.060(10)+0.699(14)-0.798(15)+0.099(16)$ $-0.565(20)+0.531(21)+0.034(22)$
XXIII	$0=+2.004+1.883(21)-1.326(24)-0.557(27)+0.917(37)-0.843(39)-0.074(41)$ $+0.726(50)-0.496(51)-0.230(53)$
XXIV	$0=-0.915-0.916(15)+0.207(17)+0.709(18)-1.128(28)+0.237(29)+0.892(31)$ $-0.692(37)+0.311(38)+0.380(40)$
XXV	$0=+2.359+0.628(28)-0.892(31)+0.264(34)+0.306(37)-0.380(40)+0.074(41)$ $-0.305(50)+0.075(52)+0.230(53)$
XXVI	$0=-2.792+0.403(9)-0.500(10)+0.097(11)+0.176(15)+2.439(16)-2.616(17)$ $+0.220(28)-5.705(29)+5.485(30)$
XXVII	$0=+0.463+0.223(23)-0.238(25)+0.016(26)-0.222(43)+0.210(44)+0.012(45)$ $+0.194(47)-0.404(48)+0.210(49)$
XXVIII	$0=+1.619-2.7557(16)+2.6157(17)+0.1400(19)+5.7048(29)-5.9022(30)+0.1974(33)$ $+0.5032(46)-0.6971(47)+0.1939(48)$
XXIX	$0=+5.491-2.6157(16)+2.6157(17)-0.4212(22)+0.4212(25)+5.7048(29)-5.6861(30)$ $-0.0187(32)+1.8885(42)-2.1104(43)+0.2219(44)$

Equations of correlatives.

v	$\frac{1}{p}$	
$(1)=$	1.0	$(+C_1)$
$(2)=$	1.0	$(-C_1-C_2)$
$(3)=$	1.0	$(+C_2)$
$(4)=$	1.0	$(-C_3+C_5-0.095\,C_{19}-0.116\,C_{20})$
$(5)=$	1.0	$(+C_6-C_8)$
$(6)=$	1.0	$(-C_4-C_5+C_8+0.021\,C_{20})$
$(7)=$	1.0	$(+C_3+C_4-C_6+0.095\,C_{19}+0.095\,C_{20})$
$(8)=$	1.0	$(+C_2+C_3-C_5-0.026\,C_{19}-0.226\,C_{21}+0.140\,C_{22})$
$(9)=$	1.0	$(+C_7-C_{12}+0.199\,C_{21}-0.199\,C_{22}+0.403\,C_{26})$
$(10)=$	1.0	$(+C_5-C_9-C_{14}+0.060\,C_{22}-0.500\,C_{26})$
$(11)=$	1.0	$(+C_{12}-C_{13}+C_{14}+0.097\,C_{26})$

Equations of correlatives —continued.

$v \quad \frac{1}{p}$

$(12) = 1\cdot0(-C_2-C_3-C_7+C_{10}+0\cdot026\ C_{19}+0\cdot027\ C_{21})$

$(13) = 1\cdot0(+C_9-C_{10}+C_{13})$

$(14) = 1\cdot2(-C_6+C_8-7\cdot676\ C_{21}+0\cdot699\ C_{22})$

$(15) = 1\cdot3(-C_7+C_{12}+0\cdot798\ C_{21}-0\cdot798\ C_{22}-0\cdot916\ C_{24}+0\cdot176\ C_{26})$

$(16) = 1\cdot1(-C_8+C_{18}-0\cdot099\ C_{22}+2\cdot4394\ C_{26}-2\cdot7557\ C_{28}-2\cdot6157\ C_{29})$

$(17) = 1\cdot1(-C_{11}-C_{12}+0\cdot207\ C_{24}-2\cdot6157\ C_{26}+2\cdot6157\ C_{28}+2\cdot6157\ C_{29})$

$(18) = 1\cdot2(+C_6+C_7+C_{11}+6\cdot878\ C_{21}+0\cdot709\ C_{24})$

$(19) = 1\cdot7(-C_{18}+0\cdot1400\ C_{28})$

$(20) = 1\cdot0(+C_4+C_5-C_8+0\cdot531\ C_{20}-0\cdot565\ C_{22})$

$(21) = 1\cdot2(-C_5+C_9+C_{14}+0\cdot795\ C_{20}+0\cdot531\ C_{22}+1\cdot883\ C_{23})$

$(22) = 1\cdot0(+C_8-C_{18}+0\cdot034\ C_{22}-0\cdot4212\ C_{29})$

$(23) = 1\cdot1(-C_{14}+C_{15}+0\cdot2230\ C_{27})$

$(24) = 1\cdot0(-C_4-1\cdot326\ C_{20}-1\cdot326\ C_{23})$

$(25) = 1\cdot0(+C_{17}-0\cdot2385\ C_{27}+0\cdot4212\ C_{29})$

$(26) = 1\cdot1(-C_{15}-C_{17}+C_{18}+0\cdot0155\ C_{27})$

$(27) = 1\cdot2(-C_9-0\cdot557\ C_{23})$

$(28) = 1\cdot1(-C_{12}+C_{13}-C_{14}-1\cdot128\ C_{24}+0\cdot628\ C_{25}+0\cdot220\ C_{26})$

$(29) = 1\cdot2(+C_{11}+C_{12}+0\cdot237\ C_{24}-5\cdot7048\ C_{26}+5\cdot7048\ C_{28}+5\cdot7048\ C_{29})$

$(30) = 1\cdot1(+C_{14}-C_{15}+5\cdot4851\ C_{26}-5\cdot9022\ C_{28}-5\cdot6861\ C_{29})$

$(31) = 1\cdot1(-C_{11}+0\cdot892\ C_{24}-0\cdot892\ C_{25})$

$(32) = 1\cdot1(+C_{16}-0\cdot0187\ C_{29})$

$(33) = 1\cdot0(+C_{15}-C_{16}+0\cdot1974\ C_{28})$

$(34) = 1\cdot2(-C_{13}+0\cdot264\ C_{25})$

$(35) = 1\cdot0(-C_2-1\cdot505\ C_{19})$

$(36) = 1\cdot1(-C_3-C_4+C_6+0\cdot814\ C_{19}+0\cdot344\ C_{20}-4\cdot941\ C_{21})$

$(37) = 1\cdot0(+C_2+C_3+C_7-C_{10}+0\cdot691\ C_{19}+0\cdot499\ C_{20}+0\cdot344\ C_{21}+0\cdot917\ C_{23}-0\cdot692\ C_{24}+0\cdot306\ C_{25})$

$(38) = 1\cdot2(-C_6-C_7-C_{11}+4\cdot596\ C_{21}+0\cdot311\ C_{24})$

$(39) = 1\cdot2(+C_4-0\cdot843\ C_{20}-0\cdot843\ C_{23})$

$(40) = 1\cdot0(+C_{11}+0\cdot380\ C_{24}-0\cdot380\ C_{25})$

$(41) = 1\cdot1(+C_{10}-0\cdot074\ C_{23}+0\cdot074\ C_{25})$

$(42) = 1\cdot1(+1\cdot8885\ C_{29})$

$(43) = 1\cdot0(-C_{17}-0\cdot2219\ C_{27}-2\cdot1104\ C_{29})$

$(44) = 1\cdot0(-C_{16}+0\cdot2097\ C_{27}+0\cdot2219\ C_{29})$

$(45) = 1\cdot0(+C_{16}+C_{17}+0\cdot0122\ C_{27})$

$(46) = 1\cdot0(+C_{18}+0\cdot5032\ C_{28})$

$(47) = 1\cdot0(+C_{15}+C_{17}-C_{18}+0\cdot1939\ C_{27}-0\cdot6971\ C_{28})$

$(48) = 1\cdot0(-C_{15}+C_{16}-0\cdot4039\ C_{27}+0\cdot1939\ C_{28})$

$(49) = 1\cdot0(-C_{16}-C_{17}+0\cdot2100\ C_{27})$

$(50) = 1\cdot0(-C_9+C_{10}-C_{13}+0\cdot726\ C_{23}-0\cdot305\ C_{25})$

$(51) = 1\cdot0(+C_9+0\cdot496\ C_{23})$

$(52) = 1\cdot1(+C_{13}+0\cdot075\ C_{25})$

$(53) = 1\cdot0(-C_{10}-0\cdot230\ C_{23}+0\cdot230\ C_{25})$

Normal equations.

No.		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}
1	0=+0·037	+2	+1																	
2	−0·225		+6	+3		−1		+2			−2									+2·144
3	−0·219			+6·1	+2·1	−2	−2·1	+2			−2									−0·0664
4	−0·411				+6·3	+2	−2·1		−2											−0·8004
5	−0·367					+6·2			−2	−2·2					−2·2					−0·069
6	+1·410						+6·7	+2·4	−2·2			+2·4								+0·8004
7	+0·733							+6·7			−2	+2·4	−2·3							+0·665
8	−0·284								+6·3										−2·1	
9	+2·497									+6·4	−2			+2	+2·2					
10	−4·228										+6·1			−2						−0·665
11	+2·331											+6·8	+2·3							
12	+1·971												+6.7	−2·1	+2·1					
13	+4·351													+6·4	−2·1					
14	+2·296														+6·5	−2·2				
15	+0·154															+6·3	−2	+2·1	−2·1	
16	−1·831																+6·1	+2		
17	−1·313																	+6·1	−2·1	
18	−0·301																		+6·9	
19	+0·152																			+3·49076
20	+3·124																			
21	+9·942																			
22	+0·436																			
23	+2·004																			
24	−0·915																			
25	+2·359																			
26	−2·792																			
27	+0·463																			
28	+1·619																			
29	0=+5·491																			

No.	C_{20}	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}
1										
2	+0·499	+ 0·091	+0·140	+0·917	−0·692	+0·306				
3	+0·3316	+ 5·5261	+0·140	+0·917	−0·692	+0·306				
4	+0·541	+ 5·4351	−0·565	+0·3144						
5	−0·560	+ 0·226	−1 2822	−2·2596			− 0·500			
6	+0·2834	+ 6·5145	0·8388		+0·4776					
7	+0·499	+ 2·217	+0·8384	+0·917	+0·9764	+0·306	+ 0·1742			
8	−0·510	− 9·2112	+1·3289				− 2·6829		+ 3·03127	+ 2·45607
9	+0·954		+0·5772	+1·706		+0·305	+ 0·500			
10	−0·499	− 0·317		−0·0424	+0·692	−0·7596				
11		+ 2·7384			−0·0669	+0·6012	− 3·9684		+ 3·96849	+ 3·96849
12		+ 0·8384	−0·8384		+0·1067	−0·6908	− 4·2876		+ 3·96849	+ 3·96849
13				−0·726	−1·2408	+0·7615	+ 0·145			
14	+0·954		+0·5772	+2·2596	+1·2408	−0·6908	+ 6·3885	−0·2453	− 6·49242	− 6·25471
15							− 6·0335	+0·82605	+ 5·79882	+ 6·25471
16								−0·8114	− 0·0035	− 0·24247
17								−0·03755	− 0·6971	+ 2·5316
18			+0·0749				+ 2·6829	−0·17685	− 2·06877	− 2·45607
19	+0·67287	− 4·17989	−0·00364	+0·63365	−0·47817	+0·21145				
20	+4·05354	− 1·69802	+0·20656	+4·86502	−0·34531	+0·15269				
21		+180·71371	−7·33772	+0·31545	+6·37872	+0·10526	+ 0·26278			
22			+2·14648	+1·19985	+0·95026		− 0·02717		− 0·30010	− 0·29917
23				+8·91109	−0·63456	+0·00025				
24					+4·82271	−2·01060	− 2·70072		+ 2·21804	+ 2·21804
25						+1·78886	+ 0·15198			
26							+86·73579		−89·58581	−87·90629
27								+0·45004	− 0·21348	+ 0·41437
28									+94·10164	+91·42521
29										+98·45205

Resulting Correlates.

$C_1 = -0\cdot115\ 09$	$C_{11} = +0\cdot083\ 78$	$C_{21} = -0\cdot137\ 98$
$C_2 = +0\cdot193\ 18$	$C_{12} = -0\cdot350\ 90$	$C_{22} = -1\cdot132\ 88$
$C_3 = -0\cdot071\ 44$	$C_{13} = -0\cdot982\ 35$	$C_{23} = +0\cdot952\ 70$
$C_4 = +0\cdot110\ 00$	$C_{14} = -1\cdot305\ 71$	$C_{24} = +0\cdot383\ 71$
$C_5 = -0\cdot378\ 51$	$C_{15} = -0\cdot851\ 29$	$C_{25} = -1\cdot046\ 58$
$C_6 = -0\cdot337\ 23$	$C_{16} = -0\cdot234\ 29$	$C_{26} = +0\cdot755\ 58$
$C_7 = +0\cdot050\ 86$	$C_{17} = +0\cdot978\ 52$	$C_{27} = +0\cdot689\ 15$
$C_8 = -0\cdot362\ 70$	$C_{18} = -0\cdot131\ 58$	$C_{28} = +1\cdot339\ 40$
$C_9 = +0\cdot411\ 93$	$C_{19} = +0\cdot080\ 01$	$C_{29} = -0\cdot677\ 99$
$C_{10} = +0\cdot255\ 74$	$C_{20} = -1\cdot726\ 74$	

and resulting corrections to observed directions:

	"		"		"		"
(1) =	−0·1151	(11) =	−0·6010	(21) =	−0·8348	(31) =	+1·3112
(2)	−0·0781	(12)	+0·0825	(22)	+0·0159	(32)	−0·2437
(3)	+0·1932	(13)	−0·8262	(23)	+0·6689	(33)	−0·3526
(4)	−0·1144	(14)	+0·2901	(24)	+0·9164	(34)	+0·8473
(5)	+0·0255	(15)	+0·2258	(25)	+0·5286	(35)	−0·3136
(6)	−0·1304	(16)	+0·0491	(26)	−0·2729	(36)	−0·2452
(7)	+0·2194	(17)	+0·1102	(27)	−1·1311	(37)	−0·6491
(8)	+0·3708	(18)	−1·0555	(28)	−0·2745	(38)	−0·3747
(9)	+0·9042	(19)	+0·5427	(29)	−0·8561	(39)	+0·9150
(10)	+0·0695	(20)	−0·1826	(30)	−0·3963	(40)	+0·6273

	"		"
(41) =	+0·1186	(48) =	+0·5984
(42)	−1·4084	(49)	−0·5995
(43)	+0·2994	(50)	+1·8370
(44)	+0·2284	(51)	−0·0606
(45)	+0·7526	(52)	−1·1669
(46)	+0·5424	(53)	−0·7156
(47)	−0·5413		

We have the probable error of a direction of unit weight $0\cdot674\sqrt{\frac{[pvv]}{c}} = 0\cdot674\sqrt{\frac{24\cdot4}{29}}$ or $\pm 0''\cdot62$ nearly, and since the average reciprocal of the weights is $1\cdot07$, the probable error of an observed direction is nearly $\pm 0''\cdot65$.

Resulting angles and sides of the Atlanta base net.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Stone Mountain	31	26	36 ·633	−0 ·404	36 ·229	0 ·128	3 ·970 276 1	9 338 ·478
	Atlanta Southwest Base	65	44	22 ·204	+0 ·334	22 ·538	0 ·128	4 ·212 738 2	16 320 ·68
	Atlanta Northeast Base	82	49	01 ·328	+0 ·289	01 ·617	0 ·128	4 ·249 470 6	17 761 ·13
2	Stone Mountain	14	30	01 ·368	−0 ·068	01 ·300	0 ·062	3 ·654 412 0	4 512 ·446
	Atlanta Southwest Base	65	44	22 ·204	+0 ·334	22 ·538	0 ·062	4 ·215 648 2	16 430 ·40
	Atlanta Middle Base	99	45	36 ·656	−0 ·308	36 ·348	0 ·062	4 ·249 470 5	17 761 ·13
3	Stone Mountain	16	56	35 ·265	−0 ·335	34 ·930	0 ·066	3 ·683 590 2	4 826 ·032
	Atlanta Middle Base	80	14	23 ·381	+0 ·271	23 ·652	0 ·066	4 ·212 738 2	16 320 ·68
	Atlanta Northeast Base	82	49	01 ·328	+0 ·289	01 ·617	0 ·067	4 ·215 648 3	16 430 ·41
4	Sweat Mountain	21	37	55 ·366	+0 ·652	56 ·018	0 ·192	3 ·970 276 1	9 338 ·478
	Atlanta Northeast Base	74	08	33 ·323	−0 ·301	33 ·022	0 ·192	4 ·386 815 7	24 367 ·76
	Atlanta Southwest Base	84	13	31 ·520	+0 ·016	31 ·536	0 ·192	4 ·401 456 3	25 203 ·24
5	Sweat Mountain	12	36	31 ·673	−1 ·099	30 ·574	0 ·184	4 ·249 470 6	17 761 ·13
	Stone Mountain	17	25	34 ·743	+1 ·160	35 ·903	0 ·184	4 ·386 815 7	24 367 ·76
	Atlanta Southwest Base	149	57	53 ·724	+0 ·350	54 ·074	0 ·183	4 ·609 872 2	40 726 ·04
6	Sweat Mountain	9	01	23 ·693	+1 ·752	25 ·445	0 ·136	4 ·212 738 2	16 320 ·68
	Atlanta Northeast Base	156	57	34 ·651	−0 ·013	34 ·638	0 ·137	4 ·609 872 2	40 726 ·04
	Stone Mountain	14	01	01 ·890	−1 ·564	00 ·326	0 ·136	4 ·401 456 3	25 203 ·24
7	Academy	42	29	26 ·166	+2 ·552	28 ·718	0 ·290	4 ·212 738 2	16 320 ·68
	Stone Mountain	70	44	29 ·036	+0 ·768	29 ·804	0 ·290	4 ·358 117 9	22 809 ·61
	Atlanta Northeast Base	66	46	01 ·440	+0 ·908	02 ·348	0 ·290	4 ·346 400 3	22 202 ·42
8	Academy	23	00	36 ·521	−1 ·897	34 ·624	0 ·337	4 ·401 456 3	25 203 ·24
	Atlanta Northeast Base	136	16	23 ·909	−0 ·896	23 ·013	0 ·336	4 ·649 026 8	44 568 ·38
	Sweat Mountain	20	43	03 ·077	+0 ·296	03 ·373	0 ·337	4 ·358 117 9	22 809 ·61
9	Academy	65	30	02 ·687	+0 ·655	03 ·342	0 ·763	4 ·609 872 2	40 726 ·04
	Stone Mountain	84	45	30 ·926	−0 ·796	30 ·130	0 ·763	4 ·649 026 8	44 568 ·38
	Sweat Mountain	29	44	26 ·770	+2 ·047	28 ·817	0 ·763	4 ·346 400 3	22 202 ·42
10	Kenesaw	14	47	22 ·271	+0 ·064	22 ·335	0 ·185	3 ·970 276 1	9 338 ·48
	Atlanta Northeast Base	46	34	26 ·983	+0 ·534	27 ·517	0 ·185	4 ·424 374 8	26 568 ·98
	Atlanta Southwest Base	118	38	10 ·842	−0 ·140	10 ·702	0 ·184	4 ·506 615 3	32 108 ·15
11	Kenesaw	16	32	34 ·561	−1 ·281	33 ·280	0 ·343	4 ·212 738 2	16 320 ·68
	Atlanta Northeast Base	129	23	28 ·311	+0 ·822	29 ·133	0 ·344	4 ·646 394 5	44 299 ·06
	Stone Mountain	34	03	58 ·891	−0 ·274	58 ·617	0 ·343	4 ·506 615 3	32 108 ·15
12	Kenesaw	1	45	12 ·290	−1 ·346	10 ·944	0 ·030	4 ·249 470 6	17 761 ·13
	Atlanta Southwest Base	175	37	26 ·954	−0 ·194	26 ·760	0 ·031	4 ·646 394 5	44 299 ·06
	Stone Mountain	2	37	22 ·258	+0 ·130	22 ·388	0 ·031	4 ·424 374 8	26 568 ·98

Resulting angles and sides of the Atlanta base net—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
13	Kenesaw	64	50	59·613	+0·241	59·854	0·310	4·386 815 7	24 367·76
	Sweat Mountain	80	44	21·711	+0·199	21·910	0·310	4·424 374 8	26 568·98
	Atlanta Southwest Base	34	24	39·322	−0·156	39·166	0·310	4·182 214 9	15 213·00
14	Kenesaw	50	03	37·342	+0·177	37·519	0·317	4·401 456 3	25 203·24
	Sweat Mountain	102	22	17·077	+0·851	17·928	0·318	4·506 615 2	32 108·15
	Atlanta Northeast Base	27	34	06·340	−0·835	05·505	0·317	4·182 214 9	15 213·00
15	Kenesaw	66	36	11·903	−1·105	10·798	0·524	4·609 872 2	40 726·04
	Sweat Mountain	93	20	53·384	−0·901	52·483	0.524	4·646 394 5	42 299·06
	Stone Mountain	20	02	57·001	+1·290	58·291	0·524	4·182 214 9	15 213·00
16	Sawnee	25	20	47·467	+0·464	47·931	0·599	4·346 400 3	22 202·42
	Academy	112	53	42·731	−0·452	42·279	0·598	4·679 227 4	47 777·93
	Stone Mountain	41	45	32·095	−0·509	31·586	0·599	4·538 334 2	34 540·94
17	Sawnee	13	16	56·486	−1·586	54·900	0·320	4·212 738 2	16 320·68
	Stone Mountain	28	58	56·941	+1·276	58·217	0·320	4·536 834 8	34 421·90
	Atlanta Northeast Base	137	44	07·160	+0·683	07·843	0·320	4·679 227 4	47 777·93
18	Sawnee	38	37	43·953	−1·122	42·831	0·629	4·358 117 9	22 809·61
	Academy	70	24	16·565	−3·004	13·561	0·629	4·536 834 8	34 421·90
	Atlanta Northeast Base	70	58	05·720	−0·225	05·495	0·629	4·538 334 2	34 540·94
19	Sawnee	43	46	59·827	−0·122	59·705	0·668	4·401 456 3	25 203·24
	Atlanta Northeast Base	65	18	18·189	−0·670	17·519	0·668	4·519 739 5	33 093·26
	Sweat Mountain	70	54	46·284	−1·504	44·780	0·668	4·536 834 8	34 421·90
20	Sawnee	82	24	43·780	−1·244	42·536	0·961	4·649 026 8	44 568·38
	Academy	47	23	40·044	−1·106	38·938	0·960	4·519 739 5	33 093·26
	Sweat Mountain	50	11	43·207	−1·800	41·407	0·960	4·538 334 3	34 540·95
21	Sawnee	57	03	56·313	−1·707	54·606	1·125	4·609 872 2	40 726·04
	Stone Mountain	42	59	58·831	−0·288	58·543	1·125	4·519 739 5	33 093·26
	Sweat Mountain	79	56	09·977	+0·248	10·225	1·124	4·679 227 4	47 777·93
22	Sawnee	54	57	07·022	−2·167	04·855	1·599	4·646 394 5	44 299·06
	Stone Mountain	63	02	55·832	+1·002	56·834	1·598	4·683 359 5	48 234·69
	Kenesaw	62	00	04·273	−1·166	03·107	1·599	4·679 227 4	47 777·93
23	Sawnee	41	40	10·536	−0·582	09·954	0·935	4·506 615 3	32 108·15
	Atlanta Northeast Base	92	52	24·529	−1·505	23·024	0·936	4·683 359 5	48 234·69
	Kenesaw	45	27	29·712	+0·116	29·828	0·935	4·536 834 8	34 421·90
24	Sawnee	2	06	49·291	+0·460	49·751	0·050	4·182 214 9	15 213·00
	Kenesaw	4	36	07·630	+0·061	07·691	0·050	4·519 739 5	33 093·26
	Sweat Mountain	173	17	03·361	−0·653	02·708	0·050	4·683 359 5	48 234·69

Resulting angles and sides of the Atlanta base net—continued.

No.	Station.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
	Pine Log	22	42	26 ·706	+1 ·084	27 ·790	0 ·415	4 ·182 214 9	15 213 ·00
25	Sweat Mountain	100	54	55 ·825	−0 ·289	55 ·536	0 ·416	4 ·587 666 4	38 696 ·03
	Kenesaw	56	22	38 ·414	−0 ·494	37 ·920	0 ·415	4 ·516 084 1	32 815 ·89
	Pine Log	70	04	02 ·461	−0 ·056	02 ·405	1 ·383	4 ·683 359 5	48 234 ·69
26	Sawnee	48	57	15 ·630	+0 ·503	16 ·133	1 ·383	4 ·587 666 5	38 696 ·04
	Kenesaw	60	58	46 ·044	−0 ·433	45 ·611	1 ·383	4 ·651 920 1	44 866 ·28
	Pine Log	47	21	35 ·755	−1 ·140	34 ·615	0 ·918	4 ·519 739 5	33 093 ·26
27	Sawnee	46	50	26 ·339	+0 ·044	26 ·383	0 ·918	4 ·516 084 1	32 815 ·89
	Sweat Mountain	85	48	00 ·814	+0 ·942	01 ·756	0 ·918	4 ·651 920 1	44 866 ·28
	Grassy	43	29	35 ·631	+0 ·071	35 ·702	0 ·889	4 ·519 739 5	33 093 ·26
28	Sawnee	95	03	54 ·068	+0 ·153	54 ·221	0 ·889	4 ·680 284 1	47 894 ·33
	Sweat Mountain	41	26	32 ·604	+0 ·140	32 ·744	0 ·889	4 ·502 751 9	31 823 ·79
	Grassy	43	12	01 ·400	+0 ·453	01 ·853	0 ·931	4 ·516 084 1	32 815 ·89
29	Sweat Mountain	44	21	28 ·210	+0 ·802	29 ·012	0 ·931	4 ·525 240 9	33 515 ·13
	Pine Log	92	26	31 ·871	+0 ·058	31 ·929	0 ·932	4 ·680 284 1	47 894 ·33
	Grassy	86	41	37 ·031	+0 ·524	37 ·555	0 ·903	4 ·651 920 1	44 866 ·28
30	Sawnee	48	13	27 ·729	+0 ·109	27 ·838	0 ·902	4 ·525 240 9	33 515 ·13
	Pine Log	45	04	56 ·116	+1 ·198	57 ·314	0 ·902	4 ·502 751 9	31 823 ·79
	Kenesaw	31	09	......	.....	48 ·202	1 ·290	4 ·502 751 9	31 823 ·79
31	Grassy	51	39	33 ·335	−1 ·637	31 ·698	1 ·290	4 ·683 359 5	48 234 ·69
	Sawnee	97	10	43 ·359	+0 ·612	43 ·971	1 ·291	4 ·785 444 9	61 016 ·17
	Kenesaw	29	48	......	.....	57 ·408	0 ·995	4 ·525 240 9	33 515 ·13
32	Pine Log	115	08	58 ·577	+1 ·142	59 ·719	0 ·994	4 ·785 444 9	61 016 ·17
	Grassy	35	02	03 ·696	+2 ·161	05 ·857	0 ·995	4 ·587 666 5	38 696 ·04
	Kenesaw	26	33	......	.....	40 ·511	0 ·352	4 ·680 284 1	47 894 ·33
33	Grassy	8	09	57 ·704	−1 ·708	55 ·996	0 ·352	4 ·182 214 9	15 213 ·00
	Sweat Mountain	145	16	24 ·035	+0 ·513	24 ·548	0 ·351	4 ·785 444 9	61 016 ·17

Descriptions of stations.

Atlanta Southwest Base.—This station is in De Kalb County, Georgia, about 12 miles northeast of Atlanta, near and to the east of the track of the Southern Railway. It is situated on the northwestern slope of a small hill, 20 meters from and 8 feet below the summit. It is 100 meters south of Humphrey's house.

This end of the base has both a surface and an underground mark. The lower mark is a hole drilled in a copper bolt in the top of a granite post 2 feet long and 6 inches square. The top of this post is 3½ feet below that of a large granite monument covering it, the upper mark being in this upper monument. The upper block is 3·3 feet square at base and 3 feet square at top and 2·5 feet high; it rests on a brick platform, laid in cement, 5 feet square and 1 foot high, with hole 1 foot square in center, through which the top of lower monument may be seen. A drill hole at the intersection of two cross lines, in a copper bolt driven into the center of the top of the upper block, marks the station. Over the upper monument is placed a granite shaft bearing the usual inscriptions on its faces. The station is further defined as the center of a square whose side is $24^{m}\cdot75$, each angular point of the square being a drill hole at the intersection of cross lines in a copper bolt driven into the top of a stone post 3 feet long and 6 inches square at top. The center of each reference mark is 18 meters from the station, and diagonal grooves are cut in top of each, with an arrowhead pointing to the station.

Atlanta Northeast Base.—This station is at a road crossing on the Southern Railway, near Norcross, Gwinnett County, Georgia. It is on the west side of the road and the west side of the railroad, on the place of J. H. Maloney. The station is marked exactly as described at Atlanta Southwest Base.

Atlanta Middle Base.—The station is in De Kalb County, Georgia, upon a small knoll in edge of woods 65 feet northwest of the Southern Railway and about a quarter of a mile northeast of the railroad station at Doraville. The underground mark is the center of the mouth of a short-necked bottle. The surface mark is a drill hole at the intersection of cross lines in the head of a copper bolt driven into a granite post, 1 foot square and 3 feet long, with diagonal grooves cut in the top, one in line with the base and the other perpendicular to it. The copper bolt with the cross lines and drill hole is placed at the intersection of the grooves. Around this central monument are buried four reference marks, two in line with the base and two in a line perpendicular to it. Each of the granite posts is 7 inches square and 3 feet long, and has in its top a diagonal groove with an arrowhead pointing to the station, from which the center of each reference mark is 5 feet distant.

Stone Mountain.—This station is in De Kalb County, Georgia, on the well-known mountain of that name, about 15 miles N. 76° E. from Atlanta, and about 1 mile from the post-office, Stone Mountain, on the Georgia Railroad, De Kalb County, Georgia.

The station is marked by a copper bolt in the solid granite of the mountain. Around the bolt the rock is cut down to a level in a circle of 3½ feet radius, the bolt being the center. In the periphery of this circle are six equidistant holes 3½ feet apart and 2 inches deep.

Academy.—This station is on the highest point of Academy Hill, in Lawrenceville, the county seat of Gwinnett County, Georgia.

The underground mark is the mouth of a bottle 3 feet below the surface. Over this is a granite post 30 inches long and 7 inches square, with the letters U. S. C. S. cut in top. Around the central monument are placed four reference marks about 30° W. of S., 30° N. of W., 30° E. of N., and 30° S. of E. The center of the SW. reference mark is 4 feet 6 inches from the center of the station, and the center of the other marks is 5 feet distant from station. In the top of each reference mark is a diagonal groove with an arrowhead pointing toward the station.

Kenesaw.—This station is on the highest part of Kenesaw Mountain, about 3 miles northwest of Marietta, Cobb County, Georgia. The station is reached by following the Marietta and Cartersville road for about 2½ miles from the Kenesaw House, in Marietta, and then following the road which turns to the left, near a covered well, and finally along the spur of the mountain to the summit. The underground mark is a cross in the head of a copper bolt driven into a hole drilled in the solid rock 2 feet 1¾ inches below the surface. Above this is planted a granite post 5 inches square, with the top projecting 2 inches above the ground. The intersection of two cross lines in the top of the post marks the station. The letters U. S. C. S. were also cut in top of post. The station has three reference marks—A, B, and C—these being the intersections of cross lines cut in the heads of copper bolts driven into holes drilled in the rock. The distances of these points from the station are 6·65 feet, 11·35 feet, and 11·19 feet, respectively. The angles subtended at the station by lines from A to B, B to C, and C to A are 170° 59′, 47° 06′, and 141° 55′, respectively.

Sweat Mountain.—This station is in Cobb County, Georgia, the nearest post-office being Woodstock, almost 4 miles distant in a direct line on the Atlanta, Knoxville and Northern Railroad. The station is on top of the mountain, about 1½ miles from Mr. Dial's house, and is reached by following the Marietta and Cumming road to a point 9¾ miles from Marietta, near Mr. Garrison's, and then taking the road along the southeast ridge of the mountain.

The station is marked by a copper bolt driven in a hole drilled in the rock very near the edge, and has three reference marks, A, B, and C, which are copper bolts driven in drill holes in the most solid rocks available. These points are 6·2 feet, 7·67 feet, and 12·3 feet, respectively, from the station. Taking the line to Kenesaw, S. 48°33′ W., as the initial or zero direction, and measuring angles counter-clock-wise, the directions of A, B, and C are 3° 19′ 30″, 83° 44′ 30″, and 231° 12′ 30″, respectively.

Sawnee.—This station is on the most prominent or central peak of Sawnee Mountain, in Cumming Township, Forsyth County, Georgia, about 2 miles NE. of Cumming and 12 miles from Buford, on the Southern Railway.

The station was marked temporarily by a copper tack driven in a stub, with similar stubs for reference marks. The permanent marks are supposed to be the usual central marks with four reference marks.

Pine Log.—This station is on Pine Log Mountain, Cherokee County, Georgia, about 7 miles north of Wolf Pen. The station is reached by going east from Cartersville, to Wolf Pen; thence 9 miles to Moore's Iron Furnace; thence 3 miles to Mr. Lewis' house; thence to the station on top of the mountain.

The underground mark is the neck of a jug 2 feet 6 inches beneath the surface. The surface mark is the intersection of cross lines on the top of a granite post 5 inches square, planted above the jug, the top of post projecting above the ground. The letters U. S. C. S. were cut in the angles of the cross lines. Around the station are four granite reference marks similar to the central monument, to the north, east, south, and west, each distant 6 feet from the station. In the top of each is cut an arrowhead pointing to the station.

Grassy.—This station is on top of Grassy Mountain, 3,290 feet high, in Pickens County, Georgia, about 6 miles in a direct line east of Jasper, the county seat, on the Atlanta, Knoxville and Northern Railroad. The station marks are supposed to be the usual central monument, and four reference marks to the north, east, south, and west, each 5 feet distant from the station.

6. THE DAUPHIN ISLAND BASE LINE AND BASE NET, ALABAMA, 1847.

Location, measurement, and resulting length of the Dauphin Island base line, Alabama, 1847.

When reconnoitering for a primary base line on the coast of Alabama and Mississippi in 1845, Assistant F. H. Gerdes selected a site on Dauphin Island, and a preliminary measurement was made with a chain in 1845–46. The measurement was made during May and June, 1847, by A. D. Bache, Superintendent of the Coast Survey. A full account of this measurement, and the only one published, will be found in Coast and Geodetic Survey Report for 1889, Appendix No. 17, pages 479–491, which permits of giving less space to it here than would otherwise be demanded.

This is the *first* base line measured with the Bache-Würdemann contact-level compensating apparatus, six meters in length, designed in 1845, and constructed at the Survey Office in 1845–46. A description of this apparatus, with illustrations of its detail construction, is contained in Coast Survey Report for 1854, Appeudix No. 35, pages 103–108, by E. B. Hunt, Lieutenant, U. S. A., and Assistant, Coast Survey. This article was reprinted in Coast Survey Report for 1873, Appendix No. 12, pages 132–136, with a supplement describing improvements. The *last* basc line measured with the apparatus was the Atlanta base in 1873. It was compared in 1877, but its employment in the field closed with its use in 1873. It was superseded by an apparatus less complex, less cumbersome, and more easily transported, using a contact slide, and either with or without the principle of compensatiou.

The average elevation of the island is but little more than 1 meter above the mean level of the Gulf. The line passes over sand, generally bare, but in part it is covered with low grass or rushes. To prepare the ground for the measure a number of sand ridges had to be leveled and a few gullies, cut by the sea, had to be crossed. The leugth of the base is 10·66 kilometers (or 6·62 statute miles). Its terminal points were marked with stone monuments and (so called) milestones were set along the line. In August, 1852, a hurricane swept over the island, causing the sea to wash over the line and disturb several of the intermediate marks and the monument at West Base. Certain verification marks having been recovered, part of the line was remeasured in 1855 by Assistants F. H. Gerdes and J. E. Hilgard, and the line was further secured in 1857 by the insertion of screw piles as marks. The marks were recovered in 1898 by Assistant W. B. Fairfield. The middle point is in latitude $30^\circ 14'{\cdot}7$ and in longitude $88^\circ 11'{\cdot}6$, with mean azimuth $84^\circ 13'$.

The length and compensation of the Bache-Würdemann apparatus depends entirely on the length and the coefficient of expansion of the 6-meter iron standard bar, prepared in 1847 and known as No. 1. It was standardized by means of numerous comparisons made between the years 1847 and 1882. The elaborate comparisons and determinations of 1860, made by Assistant J. E. Hilgard at the Smithsonian Institution, are described in Coast Survey Report for 1862, Appendix No. 26, pages 248–255. The coefficient of expansion was found to be $0{\cdot}000\ 011\ 54_{\pm 4}$ for the centigrade scale (or $0{\cdot}000\ 006\ 41_{\pm 2}$ for the Fahrenheit scale). The weighted (assumed) mean of the most trustworthy observations,

ALEXANDER DALLAS BACHE (1806-1867).

namely, those of 1860, 1877, and 1882 (the last by the writer), gave the final value: Length of the 6-meter (*à bout*) standard (No. 1) at 0° C. = $\underset{\pm 3}{5{\cdot}999\ 949}$ meters*, whereas the 1860 determination gave $\underset{\pm 2}{5{\cdot}999\ 941}$ meters, the difference being only 8 μ in 6 meters. It was thought well to adhere to the 1860 value as the one in good accord with the coefficient of expansion then found. It was found that the compensating bars or "tubes" of the apparatus did not retain an invariable length at different times, probably owing to the great length of the apparatus and wear on the compensating lever, so that for each base their length had to be specially determined. At Dauphin Island tubes 1 and 2 were intercompared in May and June, before and after the base measure, and tube 2 was likewise compared with the standard bar. The results were, tube 1 longer than tube 2, $\underset{\pm 1\ 4}{0^{m}{\cdot}000\ 021\ 6}$: on May 11 and 12 tube 2, at about 23°·6 C., with probably rising temperature, was found equal to $\underset{\pm 11\ 0}{6^{m}{\cdot}000\ 057\ 3}$, and on June 10, at about 25°·0 C., with probably falling temperature, tube 1 was equal to $\underset{\pm 11\ 0}{6^{m}{\cdot}000\ 064\ 0}$. Equating these measures with consideration of their weights, we get:

$$\text{Length of tube 1, } \underset{\pm 11\ 0}{6^{m}{\cdot}000\ 071\ 0}$$

$$\text{Length of tube 2, } \underset{\pm 11\ 0}{6^{m}{\cdot}000\ 050\ 3}$$

The adjustment of the compensation apparatus for changes of temperature was made in 1846 by Superintendent A. D. Bache, with the result that the lengths of the tubes were found practically invariable during the range of natural temperatures as well as at different rates of change of temperature.

The probable error assigned to the deduced length of the tubes may be taken to include all uncertainty arising from the direct comparisons with the standard, and that of the standard itself, but excluding uncertainty due to any imperfect compensation during the measure. The temperature of the tubes was taken from three thermometers attached to each tube, which gave an average of 30°·0 C. during the field operations, while that of standardization was 24°·3 C.; the probable error of the length of each tube was accordingly increased to $\pm 0^{m}{\cdot}000\ 014\ 6$. The maximum inclination of a tube during measurement but slightly exceeded 1°; the excess of length of 1777th tube over the west end of the base was measured with a brass meter scale, having regard for its temperature.

* For further particulars see the account of the length of the El Paso base in Colorado, 1879, in Special Publication No. 4, "The Transcontinental Triangulation."

We have for the length of the base:

1 776 tubes of mean length	10 656^{m}·107 6
1 additional tube No. 1	+6·000 1
Excess of last tube at west base	−0·171 3
Correction to reduce to mean value of a double measure of 97 tubes	+0·000 1
Correction for inclination of tubes	−0·095 8
Reduction to half-tide level of Gulf	−0·003 1
Resulting length of base	10 661^{m}·837 6

We have also the following resulting distances from the east end of the base to the several so-called milestones:

To first milestone	1 608^{m}·015 6
To second milestone	3 216·032 5
To third milestone	4 824·048 2
To fourth milestone	6 432·063 9
To fifth milestone	8 040·079 8
To west end of tube 1532	9 192·008 1
To sixth milestone	9 648·095 6
To west end of tube 1658	9 948·005 8
To sixth and a half milestone	10 452·103 7

The hurricane of August, 1852, having displaced milestones V, VI, and VI½, as well as the monument at West Base, that portion of the old line between the verification marks at the east end of tubes No. 1533 and No. 1659 was remeasured in May, 1855, by means of the 4-meter contact-slide apparatus,* with iron rods, Nos. 1 and 2. Their lengths at 0°C. were: No. 1, 3^{m}·999 937 7, and No. 2, 3^{m}·999 909 8.

The length remeasured is as follows:

188 rods of mean length, at 30°·67 C.	752^{m}·251 8	
1 rod No. 1, at 34°·4 C.	4.001 5	
Excess of last rod over line	−0·260 0	
Reduction to sea level	−0·000 2	
Resulting length	755^{m}·993 1	Original length of 1847, 755^{m}·9977

A screw pile was inserted in the line at a distance 9 942^{m}·798 4 from the east end of the base.

The probable error of the assigned length of the base arising from the uncertainty in the length of tubes is $\pm$ 0^{m}·025 94; that due to contact and transfer errors during the measurement (which occupied seventeen working days) is estimated at $\pm$ 0^{mm}·01$\sqrt{1\ 776}$ or $\pm$ 0^{m}·000 42 and $\pm$ 0^{mm}·082$\sqrt{68}$ or $\pm$ 0^{m}·000 68, respectively.† Combining these probable errors, we find the square root of the sum of the squares = $\pm$ 0^{m}·026 0, which equals $\frac{1}{410\ 000}$ (nearly) of the length and corresponds to a logarithmic difference in the length of 0·000 001 06. Hence the final value for the length of the Dauphin Island base, in terms of the prototype meter = 10 661^{m}·837 6, and its logarithm = 4·027 832 06.
$\pm$ ·026 0 $\pm$ 1 06

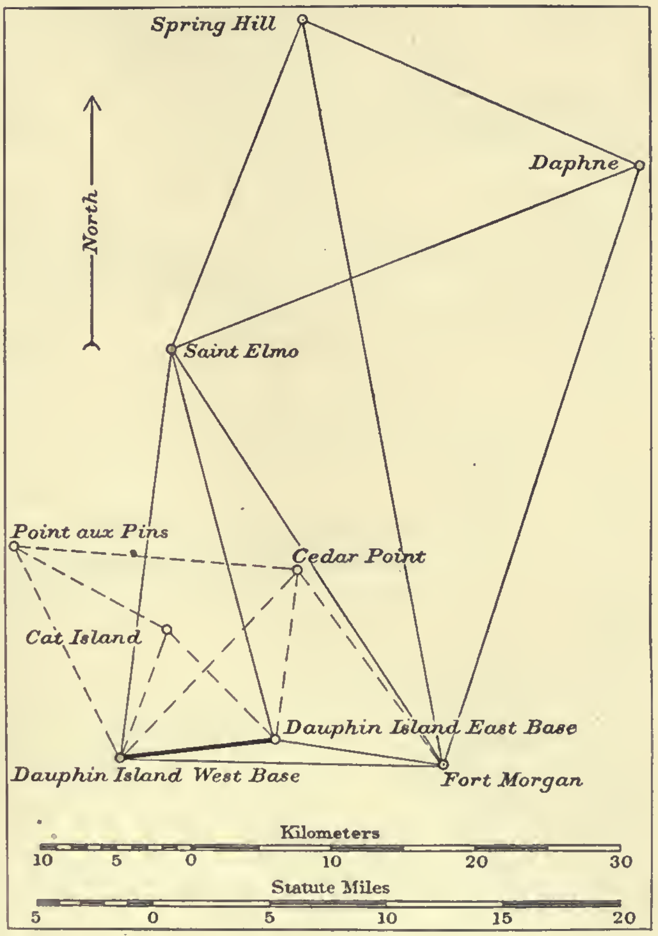
* For description of this subsidiary apparatus see Coast Survey Report for 1856, Appendix No. 60.

† An account of the experiments for contact and transfer errors, Coast and Geodetic Survey Report for 1889, p. 485.

The Dauphin Island base net and results of its adjustment.

This net, as shown in the figure, represents measures executed at two periods widely differing in date. The older work of 1846, 1847, 1848, in charge of Assistant F. H. Gerdes, which includes the base measure, is exhibited in the diagram by lines of dashes, while the later work of 1897–98, in charge of Assistant W. B. Fairfield, is shown by full lines. It was at first the intention to adjust the whole of the measures at the stations connected with the base, but when the computation starting from the Atlanta Base was carried through the adjusted triangulation and had reached the Dauphin Island Base, there was found an almost perfect accord between its length as derived from the Atlanta Base and as measured directly. No further adjustment, therefore, was demanded on this account, but for the triangulation to the westward toward New Orleans—that is, for the old triangulation—the three stations, Cat Island, Cedar Point, and Point aux Pins, required to be brought into perfect relationship with the base and with the position of Fort Morgan. There is no line from Dauphin Island East Base to Fort Morgan in the old work, and besides, the direction from West Base to Fort Morgan is not in harmony with the later measure.

No. 14.

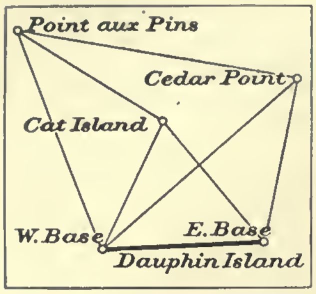


In the fourth column of the following abstracts of directions the twelve corrections to directions numbered 53 to 64 are those which resulted from the adjustment of the fifth section of the triangulation southwest of the Atlanta Base, comprised between the lines Creagh to Pollard on the north and Fort Morgan to Dauphin Island West Base on the south. The corrections to directions numbered 1 to 16 are those pertaining to and resulting from the present adjustment of the old measures. The ground at the stations is but a few meters above the level of the Gulf.

For the details of the adjustment of the triangulation to the northward of the

Dauphin Island Base and of Fort Morgan, see the record and results of the fifth and last section of the triangulation in Alabama (1895–1898).

No. 15.



The small diagram shows the adjusted figure, or the old base net upon which the survey to the westward depends. An independent start is made directly from the base. Respecting the position of Fort Morgan, the single triangle Dauphin Island West Base, Cedar Point, Fort Morgan, from the 1847–48 measures, has been added to the other triangles. The measures at Fort Morgan in 1847, by Assistant R. H. Fauntleroy, were made in connection with his observations for azimuth, and the azimuth station was occupied for the measure of the horizontal angles.

Abstracts of horizontal angles and directions at stations of the Dauphin Island base net.

Dauphin Island East Base, Mobile County, Alabama. February, 1846. F. H. Gerdes, observer. Theodolite No. 6. Circle used in IV positions. January and June, 1848. F. H. Gerdes, observer. 45^{cm} direction theodolite No 4. Circle used in V positions.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from net adjustment.	Final seconds.
		°	′	″	″	″
5	Dauphin Island West Base	0	00	00·00	+0·05	00·05
6	Cat Island	52	04	29·67	−0·28	29·39
7	Cedar Point	103	52	29·53	+0·23	29·76

Dauphin Island East Base, reoccupied August 1 to 30, 1897, and March 6 to 9, 1898. W. B. Fairfield, observer. 30^{cm} repeating theodolites Nos. 16 and 32.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
58	Dauphin Island West Base	0	00	00·00	+0·23	00·23
59	St. Elmo	80	51	20·71	−0·08	20·63
60	Daphne	125	25	47·09	+0·56	47·65
61	Fort Morgan	197	27	36·91	−0·71	36·20
	Also,					
	Dauphin Island West Base	0	00	00·00	+0·23	00·23
	Point aux Pins, 1898	46	19	52·90	....	.....
	Middle Bay Light-House	125	53	38·37	....	.....
	Fort Morgan Light-House	197	58	04·81	....	.....
	Sand Island Light-House	224	55	51·14	....	.....

Abstracts of horizontal angles and directions at stations of the Dauphin Island base net—continued.

Dauphin Island West Base, Mobile County, Alabama. November, 1847. F. H. Gerdes, observer. 45^{cm} direction theodolite No. 4. Circle used in V positions. January, 1848. F. H. Gerdes, observer. Instrument as before. Circle used in III positions.

Number of directions.	Objects observed.	Results from station adjustment. ° ′ ″	Corrections from net adjustment. ″	Final seconds. ″
	Petit Bois	0 00 00·00	....	.....
	Grand Batture	45 15 13·69	....	.....
1	Point aux Pins	81 33 33·52	+0·14	33·66
2	Cat Island	128 34 20·89	+0·24	21·13
3	Cedar Point	151 37 06·72	−0·49	06·23
4	Dauphin Island East Base	190 01 23·58	+0·10	23·68
	Fort Morgan*	198 58 49·75	....	.....

Dauphin Island West Base, reoccupied September 1 to 6, 1897, and February 23 to 27, 1898. W. B. Fairfield, observer. 30^{cm} repeating theodolite No. 32.

Number of directions.	Objects observed.	Results from station adjustment. ° ′ ″	Corrections from adjustment of fifth section. ″	Final seconds. ″
	Casotte	0 00 00·00	....	.....
	Point aux Pins, 1898	46 29 59·46	....	.....
62	St. Elmo	73 18 25·29	+0·17	25·46
63	Dauphin Island East Base	151 58 46·46	−0·74	45·72
	Baylor's West Base, 1892	156 02 30·71	....	.....
64	Fort Morgan Quarantine flagstaff	158 33 57·96	....	.....
	Fort Morgan	160 56 08·79	+0·56	09·35
	Sand Island Light-House	174 34 48·52	....	.....
	Horn Island Light-House	333 31 03·21	....	.....

Fort Morgan, Baldwin County, Alabama. March, 1846, and May, 1846. F. H. Gerdes, observer. Theodolite No. 6. Circle used in III positions. December, 1847. J. E. Hilgard, observer. 45^{cm} direction theodolite No. 4. Circle used in V positions.

Number of directions.	Objects observed.	Results from station adjustment. ° ′ ″	Corrections from net adjustment. ″	Final seconds. ″
	Azimuth Mark	0 00 00·00	....	.....
53	Dauphin Island West Base	65 00 30·90	+0·45	31·35
	Cedar Point	115 44 45·50	....	.....

* The measures of the angle between East Base and Fort Morgan in 1848 and 1897 differ 3″·84; probably the object observed upon was not well centered over the station. The direction is not interlaced with other directions at the station, and no use has been made of it in the present adjustment.

Abstracts of horizontal angles and directions at stations of the Dauphin Island base net—continued.

Fort Morgan, reoccupied June 14 to 20, 1897, and January 20 to 23, 1898. W. B. Fairfield, observer. 30cm repeating theodolite No. 16 used in 1897, and 30cm repeating theodolite No. 32 in 1898.

Number of directions.	Objects observed.	Results from station adjustment. °	′	″	Corrections from adjustment of fifth section. ″	Final seconds. ″
53	Dauphin Island West Base	0	00	00 ·00	+0 ·45	00 ·45
54	Dauphin Island East Base	8	30	12 ·65	+0 ·23	12 ·88
	Baylor's West Base, 1892	10	02	56 ·90	....	....
	Point aux Pins, 1898	27	38	10 ·50	....	....
55	St. Elmo	55	51	43 ·92	−0 ·23	43 ·69
56	Spring Hill	73	56	39 ·86	−0 ·58	39 ·28
	Middle Bay Light-House	89	35	36 ·84	....	....
57	Daphne	102	05	04 ·52	+0 ·14	04 ·66
	Sand Island Light-House	296	55	25 ·96	....	....

Cedar Point, Mobile County, Alabama. April 23 to 28, 1848. F. H. Gerdes, observer. 30cm theodolite. Circle used in III positions.

Number of directions.	Objects observed.	Results from station adjustment. °	′	″	Corrections from net adjustment. ″	Final seconds. ″
	Fort Morgan	0	00	00 ·00	....	.....
8	Dauphin Island East Base	44	10	49 ·67	−0 ·07	49 ·60
9	Dauphin Island West Base	81	54	02 ·57	+0 ·17	02 ·74
10	Point aux Pins	133	36	22 ·92	−0 ·10	22 ·82

Cat Island, Mobile County, Alabama. April 15 to 16, 1846. F. H. Gerdes, observer. Theodolite No. 6. May 19, 1847. J. E. Hilgard, observer. May, 1848. F. H. Gerdes, observer.

		°	′	″	″	″
14	Dauphin Island East Base	0	00	00 ·00	+0 ·10	00 ·10
15	Dauphin Island West Base	66	28	28 ·62	−0 ·19	28 ·43
16	Point aux Pins	163	50	05 ·99	+0 ·10	06 ·09

Point aux Pins, Mobile County, Alabama. May 23 to June 1, 1848. F. H. Gerdes, observer. 30cm theodolite. Circle used in III positions.

		°	′	″	″	″
11	Cedar Point	0	00	00·00	+0 ·32	00 ·32
12	Cat Island	22	36	33 ·45	−0 ·29	33 ·16
13	Dauphin Island West Base	58	14	08 ·33	−0 ·03	08 ·30
	Petit Bois	105	51	21 ·51	....	.....
	Grand Batture	147	05	47 ·69	....	.....

DAUPHIN ISLAND BASE NET ADJUSTMENT.

Observation equations.

I $0=-1{\cdot}00-(3)+(4)-(5)+(7)-(8)+(9)$

II $0=+1{\cdot}25-(1)+(3)-(9)+(10)-(11)+(13)$

III $0=+0{\cdot}76-(2)+(4)-(5)+(6)-(14)+(15)$

IV $0=-0{\cdot}65-(1)+(2)-(12)+(13)-(15)+(16)$

V $0=-0{\cdot}4+1{\cdot}63(13)-2{\cdot}93(12)+1{\cdot}30(11)+1{\cdot}66(10)-4{\cdot}38(9)+2{\cdot}72(8)-0{\cdot}52(7)+2{\cdot}16(5)$
$-1{\cdot}64(6)+0{\cdot}27(16)+0{\cdot}65(15)-0{\cdot}92(14)$

The solution of the normal equations gives the values of the correlatives:

$$C_1=+0{\cdot}2645$$
$$C_2=-0{\cdot}2234$$
$$C_3=-0{\cdot}1617$$
$$C_4=+0{\cdot}0783$$
$$C_5=+0{\cdot}0726$$

and the corrections to the directions are:

	''		''
(1)=	+0·145	(9)=	+0·170
(2)	+0·240	(10)	−0·103
(3)	−0·488	(11)	+0·318
(4)	+0·103	(12)	−0·291
(5)	+0·054	(13)	−0·027
(6)	−0·281	(14)	+0·095
(7)	+0·227	(15)	−0·193
(8)	−0·067	(16)	+0·098

The mean error of a direction, $\sqrt{\frac{0{\cdot}73}{5}}=\pm0''{\cdot}38$ and the probable error $=\pm0''{\cdot}26$.

Resulting angles and sides of the Dauphin Island base net.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Cedar Point	37	43	12·90	+0·24	13·14	0·09	4·027 832 1	10 661·838
	Dauphin I'd. East Base	103	52	29·53	+0·17	29·70	0·10	4·228 357 0	16 918·31
	Dauphin I'd. West Base	38	24	16·86	+0·59	17·45	0·10	4·034 458 5	10 825·76
2	Point aux Pins	58	14	08·33	−0·35	07·98	0·21	4·228 357 0	16 918·31
	Cedar Point	51	42	20·35	−0·27	20·08	0·21	4·193 605 1	15 617·27
	Dauphin I'd. West Base	70	03	33·20	−0·63	32·57	0·21	4·271 975 5	18 705·77
3	Cat Island	66	28	28·62	−0·29	28·33	0·08	4·027 832 1	10 661·84
	Dauphin I'd. East Base	52	04	29·67	−0·33	29·34	0·07	3·962 492 9	9 172·61
	Dauphin I'd. West Base	61	27	02·69	−0·14	02·55	0·07	4·009 213 8	10 214·42
4	Point aux Pins	35	37	34·88	+0·26	35·14	0·09	3·962 492 9	9 172·61
	Cat Island	97	21	37·37	+0·29	37·66	0·09	4·193 605 2	15 617·27
	Dauphin I'd. West Base	47	00	47·37	+0·10	47·47	0·09	4·061 419 1	11 519·11
5	Fort Morgan (1847)	50	44	14·6	+0·1	14·7	0·2	4·228 357 0	16 918·31
	Dauphin I'd. West Base	47	21	43·0	+0·2	43·2	0·2	4·206 143 7	16 074·73
	Cedar Point	81	54	02·6	+0·2	02·8	0·3	4·335 120 3	21 633·17

Descriptions of Stations.

Dauphin Island East Base.—This station is on Dauphin Island, at the entrance of Mobile Bay about 7 miles from the west end of the island and 3½ miles from the east end, near the western edge of the pine woods which cover the eastern end of the island.

The station was recovered and reoccupied in 1897 and marked as follows:

In a bed of cement 5½ feet square, extending 6 feet below the surface, are two pieces of drain tile 2 feet long and 4 inches in diameter, each placed with its axis vertical, one above the other, the lower extending 7 inches below the bottom of the cement. A pine pole 6 feet long and 2 inches in diameter is driven down through the pipes until its top is 16 inches below the top of the upper tile. Above this pole in the upper pipe are placed vertically, one above the other, two copper bolts, each 8 inches long and 3¼ inches in diameter, a cross on each bolt marking the station, the upper mark being 3 feet below the surface. The bolts are held in place by cement, with which the remaining space of the pipes is filled. Above the top of the upper pipe a cavity 1 foot square and 6 inches deep is left in the cement. Over this cavity, still embedded in cement, the four original granite blocks of the base of the monument of 1847 are built, as originally, in two courses, the top of the upper course projecting 2 inches above the surface. A copper bolt in the top of one of the blocks of the upper course is directly over the cross on the bolt in the pipe and marks the station. The original granite shaft is placed on this foundation and cemented down over the copper bolt, its apex again marking the station. On the north, east, south, and west faces of the shaft are inscribed, respectively, "A. D. Bache, Suptdt.," "U. S. Coast Survey," "1847," "Base No. 5." The station is witnessed by two marks in the same vertical line, one on the surface and one underground, in prolongation of the base line, 144·1025 meters east of the extremity and just in the edge of the pine woods. The underground mark is a cross in an iron bolt in the top of a tile pipe 2 feet long embedded vertically in a mass of cement 2 feet in diameter, the top of the pipe being 3 feet below the surface. Above this pipe is placed a granite block 1 foot square and 2½ feet long, the top of block being flush with the surface and containing a copper bolt as the surface mark.

Dauphin Island West Base.—This station is on the western end of Dauphin Island. In 1847 the station was within one-half mile of the extremity of the island, while in 1897 the island extended 3½ miles west of it. In September, 1897, the distance was reduced by a storm which washed away 1 mile of the western end of the island. The station is marked as described at Dauphin Island East Base, except that the cement at this station is 6 feet square and 5 feet deep and only one piece of tile pipe was put in.

Fort Morgan.—The station is near the center of the northwest bastion (No. 2) of Fort Morgan, at the entrance to Mobile Bay. The station of 1846 was recovered and reoccupied in 1892 and again in 1897–98.

The earthenware vessel used originally was left in its place, filled with cement, and a nail was placed in its center to mark the station, the top of the nail being 2½ feet below the surface. Above this was placed vertically a section of tile drain pipe inclosed in a nail keg, both filled with cement. In the pipe are two spike nails, one above the other, making additional marks. The head of the upper nail is just beneath the brick floor.

Cat Island.—This station is on Cat Island, in Mississippi Sound, north of Dauphin Island. The station of 1845 was marked by a buried earthenware cone. In 1855 a new station was established near the old one.

Cedar Point.—This station is on Mon Louis Island, on the western side of Mobile Bay. The station is situated on the eastern extremity of the island, on a narrow strip of beach, among marshes. In 1846 an earthenware cone was buried as the station mark, and copper nails were driven in blazed trees with the following directions and distances: One northwest, 9 feet 4 inches; one northeast, 18 feet; one southwest, 32 feet 6 inches, as reference marks.

Point aux Pins.—On the point of land of the same name which extends southward into Mississippi Sound, just west of Bayou Batture. In 1846 the station was marked by an earthenware cone buried 3 feet under the surface. In 1848 four poles 4 feet long and 6 inches in diameter were inserted around the undisturbed cone, the station being the point of intersection of two perpendicular lines determined by four copper nails driven in the tops of these poles.

St. Elmo.—The station is in Mobile County, Alabama, about 2 miles east of St. Elmo, on the Louisville and Nashville Railroad, and about one-half mile south of Otis's mill. The station is in the northwest corner of N. E. ¼ of S. E. ¼ of S. E. ¼ of S. E. ¼ of N. W. ¼, sec. 19, T. 6 S., R. 2 W., and is distant from the northwest corner of section 19, 3426 feet, and bears from said corner 313° 43′ true.

The underground mark is the intersection of cross lines on top surface of limestone post, 6 inches square and 18 inches long, buried vertically, with top 3 feet below surface of ground. The letters U. S. C. G. S. are cut in the angles of the cross lines. Six inches above this is another limestone post, 6 inches square and 28 inches long, its top level with the surface of the ground and marked as the lower stone.

Daphne.—This station is in Baldwin County, Alabama, about one-half mile northeast of the court-house at Daphne. The station is in the southwest corner of the S. W. ¼ of S. W. ¼ of N. E. ¼ of N. E. ¼ of N. E. ¼, sec. 19, T. 5 S., R. 2 E. Distance from the northeast corner of section 19 to station is 882 feet, and the station bears S. 44° 17′ W. (true) from the northeast corner of section 19.

A 1-gallon stone jug was buried, bottom up, and a small hole in the center of the bottom, 3 feet below the surface, is the underground mark. A limestone post 6 inches square and 30 inches long was placed in a vertical position 6 inches above the jug, the surface mark being the intersection of cross lines on its top surface, which is flush with the ground. The letters U. S. C. G. S. are cut in the usual manner in the angles of the cross lines.

Spring Hill.—The station is about 7 miles northwest of Mobile, on the highest part of Spring Hill, on the land of Judge H. Anstell, about 40 feet north of the fence line of main road and about 200 yards west of road going to Whistler, and also about 200 yards west of station Spring Hill on electric road.

The station is marked as Daphne, except that the jug is buried mouth up, the center of mouth being the underground mark. The following true bearings and distances were measured: Oak tree, No. 1, N. 62° 33′ 10″ E., 103 feet; oak stump, No. 2, N. 18° 17′ 20″ W., 39 feet 9 inches; oak stump, No. 3, S. 95° 46′ 25″ W., 44 feet 7 inches; fence line, S. 29° 47′ E., 39 feet 11 inches.

C. SYNOPSIS OF THE MEASUREMENTS AND RESULTS OF THE BASE LINES OF THE OBLIQUE ARC.

No.	Name of line.	State.	Date of measure.	Chief of party and observer.	Apparatus used.
1	Epping Base	Me.	1857, July and Aug.	A. D. Bache	Bache-Würdemann
2	Massachusetts Base	Mass.	1844, Sept. to Nov.	E. Blunt	Hassler
3	Fire Island Base	N. Y.	1834, Aug. to Oct.	F. R. Hassler	Hassler
4	Kent Island Base	Md.	1844, May and June	J. Ferguson	Hassler
5	Atlanta Base	Ga.	1872, Nov. and Dec. 1872, Dec. and 1873, Jan. 1873, July and Aug.	C. O. Boutelle	Bache-Würdemann
6	Dauphin Island Base	Ala.	1847, May and June	A. D. Bache	Bache-Würdemann

No.	Name of line.	Resulting length in meters and probable error.	Logarithm of preceding numbers.	Approximate probable error in terms of length.
1	Epping Base	8 715 ·9422 ± 158	3 ·940 314 34 ± 79	$\frac{1}{552000}$
2	Massachusetts Base	17 326 ·3763 ± 358	4 ·238 707 74 ± 90	$\frac{1}{484000}$
3	Fire Island Base	14 058 ·9709 ± 585	4 ·147 953 53 ± 1 81	$\frac{1}{240000}$
4	Kent Island Base	8 687 ·5446 ± 680	3 ·938 897 05 ± 3 40	$\frac{1}{128000}$
5	Atlanta Base	9 338 ·4778 ± 222	3 ·970 276 09 ± 1 03	$\frac{1}{421000}$
6	Dauphin Island Base	10 661 ·8376 ± 260	4 ·027 832 06 ± 1 06	$\frac{1}{410000}$

PART II.

THE MAIN TRIANGULATION.

THE MAIN TRIANGULATION BETWEEN THE BASE LINES OR NETS.

A. GENERAL TREATMENT OF THE REDUCTION OF THE MAIN TRIANGULATION BETWEEN CALAIS, MAINE, AND NEW ORLEANS, LOUISIANA.

Since the early and partial publications of preliminary results of the various parts of this triangulation, as referred to in Part I, changes have taken place, not only in the field work by additional stations or measures, but also in the office work of computation in respect to the general treatment, and due to the experience gained in the meantime. Nevertheless, it was desirable to retain as much as possible of the older reductions, such as the computations of the base lines, the local adjustments of the horizontal directions, and the adjustment of the base nets. That part of the oblique arc which is in common with the arc of the parallel of $\varphi = 39°$ is retained unchanged.

When dealing with the treatment of the portion of the oblique arc traversing the New England States, it became necessary to introduce the station Mount Washington, New Hampshire, into the scheme, and to consider the most advantageous manner by which the three base lines (or their nets), the Epping, the Massachusetts, and the Fire Island bases, could be brought into perfect accord. This was to be done with due regard to the labor involved in the establishment and solution of a large number of equations. At the same time attention had to be given to the circumstance of the intersection of the oblique arc with a triangulation, now nearly completed, which can be used for the discussion of an arc of the parallel, in latitude $42\frac{1}{2}°$, from Cape Cod to the State of Iowa, executed partly by the U. S. Lake Survey and partly by the U. S. Coast and Geodetic Survey for this and other purposes. Further, attention had to be given to non-interference with the full development of the large triangulation in the States of New Hampshire and Vermont, which has Killington, Vermont, as a central station. After due consideration it was decided to retain unchanged the adjustment of the Epping base net as made in June, 1864, and to adjust the triangulation between the three bases, so as to preserve the length of the side Humpback to Mount Desert (of the Epping base net), the Massachusetts base, and the side Wooster to Sandford (of the Fire Island base net). This scheme involves the simultaneous solution of 57 equations, two of which are length equations, each containing a large number of terms. The results from the old but less perfect scheme differ very little, and within the uncertainties of the measures, from those now obtained, and also indicate the excellent accord of the relations of the newly added station to the surrounding stations. The small extension of the Epping base net from the side Cooper to Howard to the boundary on the St. Croix River was afterwards treated by itself.

The stretch of triangulation between the base nets of the Fire Island base and the Kent Island base starts from the line Bald Hill to West Hills, and ends on the line

Osbornes Ruin to Turkey Point, and the latter line, being a part of the adjusted triangulation of the arc of the parallel in $\varphi=39°$, is preserved as given in Special Publication No. 4, "The Transcontinental Triangulation."

The adjustment involved the solution of 35 equations, of which the conditional or observation equation for accord of length of sides contains 89 terms. The triangulation lying between the line Osbornes Ruin to Turkey Point, Maryland, and the line Tobacco Row to Spear, Virginia, is retained unchanged as given in Special Publication No. 4.

Upon reaching latitude 36° the triangulation splits into two branches, one, the western and later one, passing through Tennessee, the other and older one through North Carolina. They unite again in northern Georgia. The angular measures on the western branch were made with an inferior instrument. A study of the local adjustments of this triangulation and of the approximate computatious which were available indicated that the angle measures did not possess quite the same accuracy as those of the eastern branch and could lend no additional value to the triangulation to the southward. Moreover, there are no astronomic observatious of any kind connected with this triangulation. For these reasons the western or Tennessee branch was not used as a part of the arc, and the computation between the Kent Island and Atlanta bases was carried through the eastern branch.

Proceeding southwestward from the line Tobacco Row to Spear to the Atlanta base, the adjustment was made in three parts.

The complex strong figure between the lines Tobacco Row to Spear and Buffalo to Moore was first adjusted and involved the solution of 24 equations. The influence of the Atlanta base was then extended by the adjustment of the section of the triangulation from the line Sawnee to Grassy to the line Benn to King, involving the solution of 41 equations, and finally the remaining portion, forming a central figure about the station Poore, was adjusted, involving the solution of 13 equations, including a length equation introduced for the purpose of bringing the lengths derived from the two bases into accord.

The reasons for dispersing the small outstanding discrepancy in this particular figure are given in the portion of this publication which treats of its adjustment.

The fortunate circumstance that the Atlanta and the Dauphin Island bases, when connected through the chain of intervening triangles or more complex figures, proved to be in almost exact accord, as was shown by the several adjusted pieces of triangulation gradually joined together as the field work progressed, made it possible to retain all of these five partial adjustments. This carried the results to the Dauphin Island base net at the line Spring Hill to Daphne.

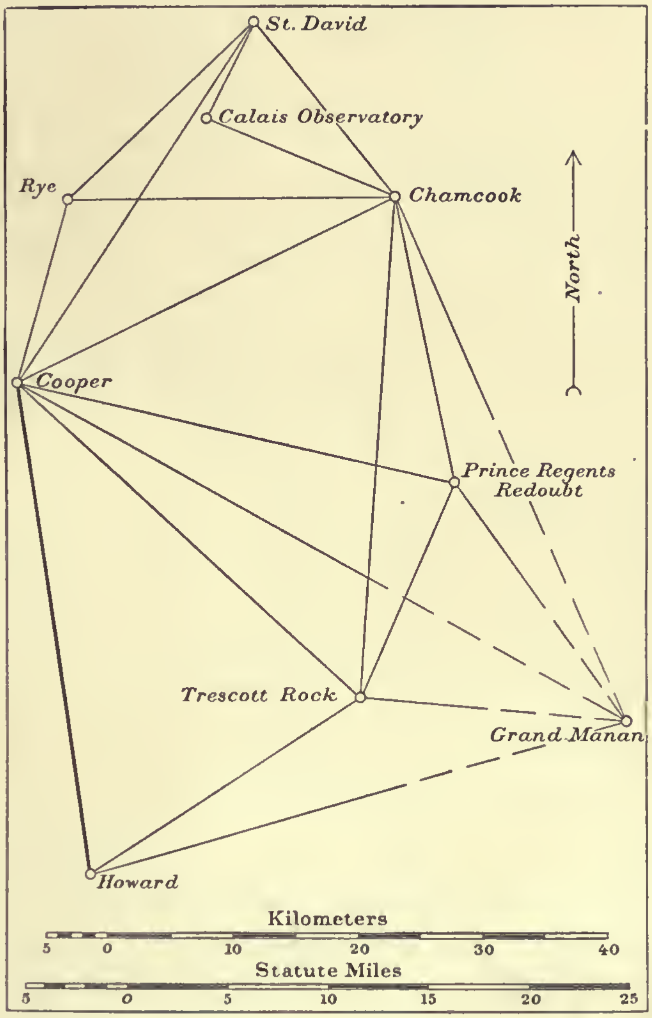
It was thought highly desirable to extend the oblique arc as far as the city of New Orleans, where it meets with and terminates at a well-determined astronomic station. It was known that the small coast triangulation along the Gulf from Mobile Bay westward was inferior in accuracy to first-class work. Nevertheless a rediscussion and new adjustment showed that it could be used to extend the arc to New Orleans. The whole of this triangulation is old, and the inferiority of the work is due to the difficulties encountered on account of the climatic conditions along the Gulf coast, and particularly to the effects of severe hurricanes passing across this region, which rendered it difficult to preserve the stations from one season to another. It was also most important to include the station at New Orleans in the discussion of the local deflections of the plumb line at stations approaching and in close proximity to the Gulf of Mexico.

B. THE TRIANGULATION.

I. NORTHEASTERN TERMINUS TO EPPING BASE NET.

The extension of the triangulation from the primary line Cooper to Howard, of the Epping base net, to and across the Canadian boundary at the St. Croix River is shown on the following diagram. The geometric figure is a strong one and demanded for its

No. 16.



adjustment that 13 conditional equations be satisfied. Equal unit weights were given to the directions, excepting the initial line Cooper to Howard, to which a double weight was assigned.

The angles measured with the repeating circle were generally made up of 20 sets, each of three repetitions direct and three repetitions reversed for every angle; these results, when combinations existed among the measured angles, were adjusted at each station. The probable error of an observation of an angle (3 *D.* and 3 *R.*) is given by $e_{\angle} = 0{\cdot}674 \sqrt{\frac{[v\,v]}{n-1}}$ and that of a direction by $e_1 = e_{\angle} / \sqrt{2}$.

The approximate elevations of the stations above the half-tide level of the Atlantic are as follows:

	Meters.	Feet.
Chamcook	197	647
Trescott Rock	94	310
Prince Regents Redoubt	60	197
Grand Manan	128	420
Calais, observatory	46	150
Howard	82	269
Cooper	225	738

No reductions to the horizontal directions for heights were required.

Abstracts of resulting horizontal directions observed and adjusted at stations of the triangulation extending to the Canadian boundary, 1859 to 1861.

Howard, Washington County, Maine. July and August, 1859. 75cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers. From abstract given in Part I of this publication we have:

No. of directions.	Objects observed.	Resulting directions from station adjustment.	Corrections from preceding figure adjustment.	Resulting directions.	Corrections from present figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″
	Pigeon	0 00 00 ·000	−0 ·089	00 ·000	.....	00 ·000
1	Cooper	108 01 27 ·996	−0 ·066	28 ·018	.....	28 ·018
2	Trescott Rock	173 43 51 ·973	−0 ·026	52 ·036	−0 ·398	51 ·638
3	Grand Manan	189 28 45 ·843	−0 ·026	45 ·906	+0 ·267	46 ·173
		Mean correction	−0 ·026			

Cooper, Washington County, Maine. August and September, 1859. 75cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers. 25cm repeating theodolite No. 74. October 23, 1867. C. H. Boyd, observer.

No. of directions.	Objects observed.	Resulting directions from station adjustment.	Corrections from preceding figure adjustment.	Resulting directions.	Corrections from present figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″
6	Chamcook	0 00 00 ·000	−0 ·068	00 ·000	+0 ·004	00 ·000
7	Prince Regents Redoubt	38 36 49 ·082	−0 ·068	49 ·082	−0 ·951	48 ·127
8	Grand Manan	54 40 14 ·493	−0 ·068	14 ·493	+0 ·646	15 ·135
9	Trescott Rock	68 43 51 ·687	−0 ·068	51 ·687	−0 ·058	51 ·625
10	Howard	108 56 09 ·385	−0 ·226	09 ·227	.....	......
	Mount Desert	157 47 00 ·789	+0 ·415	01 ·272	.....	......
4	Rye (Boyd)*	309 17 27 ·536	−0 ·068	27 ·536	−0 ·802	26 ·730
5	Saint David (Boyd)*	329 01 51 ·167	−0 ·068	51 ·167	+1 ·117	52 ·280
		Mean correction	−0 ·068			

Probable error of an observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 1''{\cdot}0$.

* Number of sets of repetition observations, 2.

Abstracts of resulting horizontal directions observed and adjusted at stations of the triangulation extending to the Canadian boundary, 1859 to 1861—continued.

Chamcook, New Brunswick. October 22 to October 28, 1859. 75cm direction theodolite No. 1. G. W. Dean, observer. 25cm repeating theodolite No. 74. C. H. Boyd, observer, 1867.

No. of directions.	Objects observed.	Results from station adjustment.	Corrections from present adjustment.	Final seconds.
		° ′ ″	″	″
16	Grand Manan	0 00 00 ·000	+0 ·491	00 ·000
		±0 ·139		
17	Prince Regents Redoubt	11 23 35 ·285	−0 ·150	34 ·644
		±0 ·135		
18	Trescott Rock	28 17 21 ·691	−0 ·160	21 ·040
		±0 ·141		
19	Cooper	88 44 50 ·139	−0 ·723	48 ·925
		±0 ·173		
20	Rye (Boyd)*	115 16 24 ·874	+0 ·344	24 ·727
21	Calais, observatory (Boyd)*	138 46 22 ·644	+0 ·319	22 ·472
22	Saint David (Boyd)*	165 22 52 ·991	−0 ·120	52 ·380

Probable error of an observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 1'' \cdot 3$. Probable error of a single observation of a direction, $e_1 = \pm 1'' \cdot 08$.

Trescott Rock, Washington County, Maine. November 1 to 7, 1861. 30cm repeating theodolite No. 30. C. H. Boyd, observer.

		° ′ ″	″	″
11	Howard	0 00 00 ·000	+0 ·178	00 ·000
12	Cooper	74 05 21 ·565	−0 ·107	21 ·280
13	Chamcook	124 54 05 ·165	−0 ·173	04 ·814
14	Prince Regents Redoubt	145 27 05 ·458	+0 ·356	05 ·637
15	Grand Manan	215 10 26 ·975	−0 ·253	26 ·544

Number of sets of angles, 5; probable error of an observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 1'' \cdot 1$.

Prince Regents Redoubt, Washington County, Maine. October 4 to 21, 1861. 30cm repeating theodolite No. 30. C. H. Boyd, observer.

		° ′ ″	″	″
23	Grand Manan	0 00 00 ·000	−0 ·371	00 ·000
24	Trescott Rock	60 06 12 ·074	−0 ·214	12 ·231
25	Cooper	138 37 25 ·265	+0 ·519	26 ·155
26	Chamcook	202 39 25 ·281	+0 ·067	25 ·719

Number of sets of observations, 7; probable error of an observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 1'' \cdot 1$.

* Number of sets of repetition observations, 3.

Abstracts of resulting horizontal directions observed and adjusted at stations of the triangulation extending to the Canadian boundary, 1859 to 1861—continued.

St. David, New Brunswick. September 30 to October 2, 1867. 25^{cm} repeating theodolite No. 74. C. H. Boyd, observer.

No. of directions.	Objects observed.	Results from station adjustment.	Corrections from present adjustment.	Final seconds.
		° ′ ″	″	″
27	Chamcook	0 00 00 ·000	−0 ·153	00 ·000
28	Calais, observatory	67 11 50 ·342	−0 ·319	50 ·176
29	Cooper	72 23 49 ·293	+0 ·908	50 ·353
30	Rye	87 05 40 ·032	−0 ·436	39 ·749

Number of sets of observations, 3; probable error of an observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 1''\cdot 1$.

Rye, Washington County, Maine. October 24–25, 1867. 25^{cm} repeating theodolite No. 74. C. H. Boyd, observer.

		° ′ ″	″	″
31	St. David	9 00 00 ·000	−0 ·720	00 ·000
32	Chamcook	42 47 52 ·302	+0 ·531	53 ·553
33	Cooper	145 33 44 ·604	+0 ·190	45 ·514

Number of sets of observations, 2; probable error of an observation (3 *D.* and 3 *R.*) of a direction, $e_1 = \pm 1''\cdot 4$.

Calais, observatory, Washington County, Maine. October 17–18, 1867. 25^{cm} repeating theodolite No. 74. C. H. Boyd, observer.

		° ′ ″	″	″
34	St. David	0 00 00 ·000	+0 ·319	00 ·000
35	Chamcook	86 11 40 ·903	−0 ·319	40 ·265

FIGURE ADJUSTMENT.

Observation equations.

I $0 = +0\cdot625 - (1) + (2) - (9) + (10) - (11) + (12)$

II $0 = -2\cdot090 - (7) + (9) - (12) + (14) - (24) + (25)$

III $0 = +0\cdot691 - (6) + (9) - (12) + (13) - (18) + (19)$

IV $0 = +1\cdot981 - (6) + (7) - (25) + (26) - (17) + (19)$

V $0 = -1\cdot531 - (4) + (6) - (19) + (20) - (32) + (33)$

VI $0 = -1\cdot485 - (4) + (5) - (29) + (30) - (31) + (33)$

VII $0 = -0\cdot506 - (20) + (22) - (27) + (30) - (31) + (32)$

VIII $0 = +1\cdot241 - (21) + (24) - (27) + (28) - (34) + (35)$

IX $0 = +2\cdot18 - 0\cdot095(1) + 1\cdot439(2) - 1\cdot344(3) - 0\cdot249(10) + 1\cdot544(9) - 1\cdot295(8) - 0\cdot597(11) - 0\cdot454(12) + 1\cdot051(15)$

X $0 = -0\cdot70 - 1\cdot213(9) + 1\cdot295(8) - 0\cdot082(6) + 0\cdot454(12) - 0\cdot339(15) - 0\cdot115(13) - 0\cdot119(19) + 0\cdot625(18) - 0\cdot506(16)$

XI $0 = +4\cdot31 - 1\cdot176(8) + 1\cdot439(7) - 0\cdot263(6) - 0\cdot445(25) + 1\cdot503(23) - 1\cdot058(26) - 0\cdot047(19) - 2\cdot103(16) + 2\cdot150(17)$

XII $0 = +1\cdot38 - 0\cdot254(15) + 0\cdot816(14) - 0\cdot562(13) - 0\cdot176(24) + 1\cdot234(23) - 1\cdot058(26) - 0\cdot693(18) - 2\cdot103(16) + 2\cdot796(17)$

XIII $0 = -2\cdot60 - 0\cdot172(6) - 0\cdot415(4) + 0\cdot587(5) - 0\cdot422(19) + 0\cdot598(20) - 0\cdot176(22) + 0\cdot802(29) - 0\cdot011(27) - 0\cdot791(30)$

It was not deemed necessary to set down the correlate equations, as they are readily formed. The directions (1) and (10) each have the weight 2.

Normal equations.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}
0= +0·625	+5	−2	−2						−0·039	+1·667			
0= −2·090		+6	+2	−2					+1·998	−1·667	−1·884	+0·992	
0= +0·691			+6	+2	−2				+1·998	−2·444	+0·216	+0·131	−0·250
0= +1·981				+6	−2					−0·037	−1·108	−3·854	−0·250
0= −1·531					+6	+2	−2			+0·037	−0·216		+1·263
0= −1·485						+6	+2						−0·591
0= −0·506							+6	+2					−1·554
0= +1·241								+6					−0·165
0= +2·18									+9·6407	−4·1123	+1·5229	−0·2670	
0= −0·70										+4·1502	−0·4316	+0·7817	+0·0643
0= +4·31											+16·1466	+13·4081	+0·0651
0= +1·38												+16·4398	
0= −2·60													+2·3820

Resulting correlates:

C_1= −0·044 62　　C_8= −0·318 64
C_2= +0·175 49　　C_9= −0·222 77
C_3= −0·061 44　　C_{10}= −0·109 49
C_4= −0·152 83　　C_{11}= −0·428 84
C_5= −0·074 77　　C_{12}= +0·221 47
C_6= +0·264 38　　C_{13}= +1·462 42
C_7= +0·456 00

and the resulting corrections to directions:

	″		″		″		″		″
(1)*	=+0·0329	(8)	= +0·6510	(15)	= −0·2534	(22)	= −0·1200	(29)	= +0·9984
(2)	−0·3652	(9)	−0·0525	(16)	+0·4913	(23)	−0·3712	(30)	−0·4364
(3)	+0·2994	(10)*	+0·0054	(17)	−0·1498	(24)	−0·2145	(31)	−0·7204
(4)	−0·7965	(11)	+0·1776	(18)	−0·1605	(25)	+0·5191	(32)	+0·5308
(5)	+1·1228	(12)	−0·1072	(19)	−0·7233	(26)	+0·0666	(33)	+0·1896
(6)	+0·0097	(13)	−0·1733	(20)	+0·3437	(27)	−0·1535	(34)	+0·3186
(7)	−0·9453	(14)	+0·3562	(21)	+0·3186	(28)	−0·3186	(35)	−0·3186

Probable error of an observed direction, $0{\cdot}674\sqrt{\frac{7{\cdot}36}{13}} = \pm 0''{\cdot}51$

* Directions (1) and (10) were given double weight in the adjustment.

Resulting angles and sides of the triangulation between the Epping base net and the northeastern terminus of the arc.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Trescott Rock	74	05	21 ·565	−0 ·285	21 ·280	0 ·832	4 ·603 402 1	40 123 ·81
	Howard	65	42	24 ·018	−0 ·398	23 ·620	0 ·833	4 ·580 099 7	38 027 ·67
	Cooper	40	12	17 ·540	+0 ·058	17 ·598	0 ·833	4 ·430 277 0	26 932 ·52
2	Grand Manan	44	16	......	.....	52 ·451	1 ·565	4 ·603 402 1	40 123 ·81
	Howard	81	27	17 ·888	+0 ·267	18 ·155	1 ·564	4 ·754 589 2	56 831 ·51
	Cooper	54	15	54 ·734	−0 ·646	54 ·088	1 ·565	4 ·668 845 2	46 649 ·31
3	Grand Manan	19	25	......	.....	32 ·875	0 ·288	4 ·430 277 0	26 932 ·52
	Howard	15	44	53 ·870	+0 ·664	54 ·534	0 ·288	4 ·342 006 7	21 978 ·94
	Trescott Rock	144	49	33 ·025	+0 ·431	33 ·456	0 ·289	4 ·668 845 2	46 649 ·31
4	Grand Manan	24	51	......	.....	19 ·577	0 ·444	4 ·580 099 7	38 027 ·67
	Trescott Rock	141	05	05 ·410	−0 ·146	05 ·264	0 ·443	4 ·754 589 1	56 831 ·50
	Cooper	14	03	37 ·194	−0 ·704	36 ·490	0 ·444	4 ·342 006 7	21 978 ·94
5	Prince Regents Redoubt	60	06	12 ·074	+0 ·157	12 ·231	0 ·339	4 ·342 006 7	21 978 ·94
	Grand Manan	50	10	......	.....	27 ·880	0 ·339	4 ·289 384 2	19 470 ·82
	Trescott Rock	69	43	21 ·517	−0 ·610	20 ·907	0 ·340	4 ·376 239 0	23 781 ·49
6	Prince Regents Redoubt	78	31	13 ·191	+0 ·734	13 ·925	0 ·593	4 ·580 099 7	38 027 ·67
	Trescott Rock	71	21	43 ·893	+0 ·463	44 ·356	0 ·593	4 ·565 481 2	36 768 ·95
	Cooper	30	07	02 ·605	+0 ·893	03 ·498	0 ·593	4 ·289 384 2	19 470 ·82
7	Prince Regents Redoubt	138	37	25 ·265	+0 ·890	26 ·155	0 ·488	4 ·754 589 2	56 831 ·51
	Grand Manan	25	19	......	.....	08 ·304	0 ·489	4 ·565 481 2	36 768 ·95
	Cooper	16	03	25 ·411	+1 ·596	27 ·007	0 ·489	4 ·376 239 2	23 781 ·50
8	Chamcook	88	44	50 ·139	−1 ·215	48 ·924	1 ·327	4 ·754 589 2	56 831 ·51
	Grand Manan	36	34	......	.....	59 ·925	1 ·328	4 ·529 929 0	33 878 ·88
	Cooper	54	40	14 ·493	+0 ·641	15 ·134	1 ·328	4 ·666 298 1	46 376 ·51
9	Chamcook	28	17	21 ·691	−0 ·652	21 ·039	0 ·757	4 ·342 006 7	21 978 ·94
	Grand Manan	61	26	......	.....	19 ·501	0 ·757	4 ·609 948 2	40 733 ·17
	Trescott Rock	90	16	21 ·810	−0 ·080	21 ·730	0 ·756	4 ·666 298 0	46 376 ·50
10	Chamcook	60	27	28 ·448	−0 ·563	27 ·885	1 ·015	4 ·580 099 7	38 027 ·67
	Trescott Rock	50	48	43 ·600	−0 ·066	43 ·534	1 ·015	4 ·529 929 1	33 878 ·88
	Cooper	68	43	51 ·687	−0 ·062	51 ·625	1 ·014	4 ·609 948 2	40 733 ·17
11	Chamcook	11	23	35 ·285	−0 ·642	34 ·643	0 ·182	4 ·376 239 1	23 781 ·49
	Grand Manan	11	15	......	.....	51 ·622	0 ·182	4 ·371 372 7	23 516 ·50
	Prince Regents Redoubt	157	20	34 ·719	−0 ·438	34 ·281	0 ·182	4 ·666 298 0	46 376 ·50

Resulting angles and sides of the triangulation between the Epping base net and the northeastern terminus of the arc—continued.

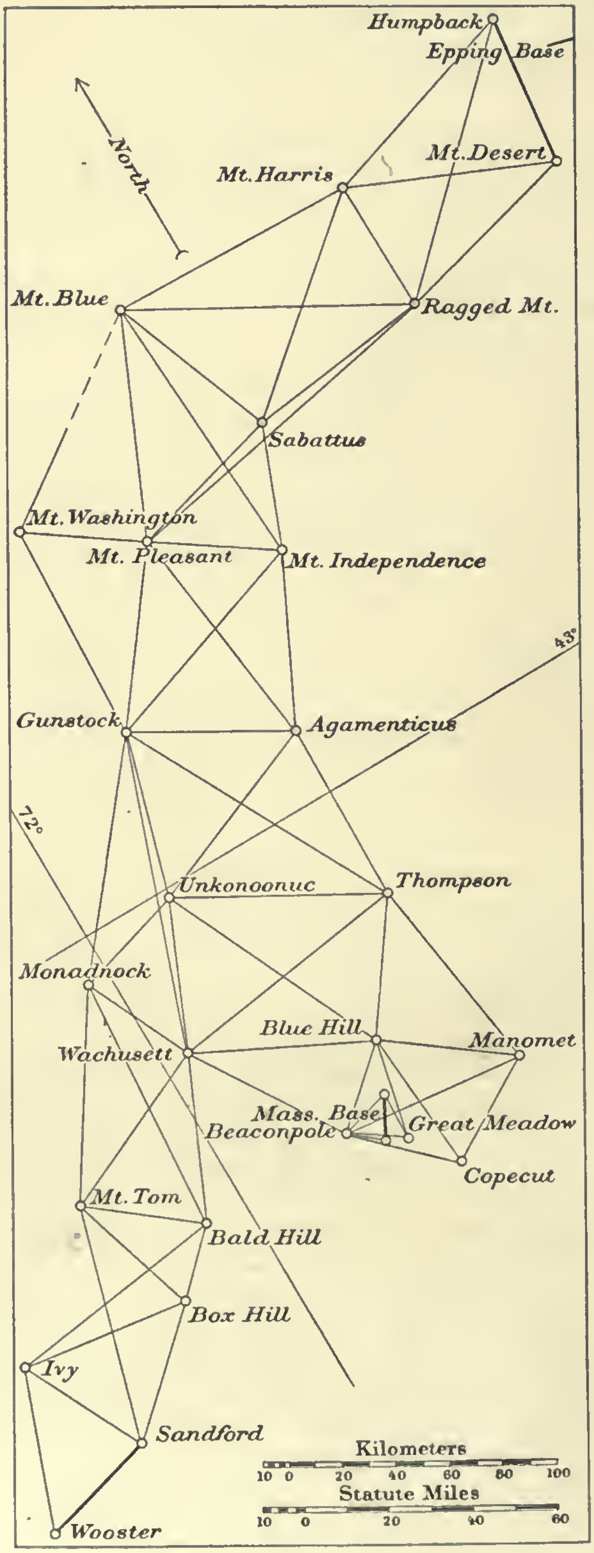
No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
12	Chamcook	16	53	46 ·406	−0 ·011	46 ·395	0 ·235	4 ·289 384 2	19 470 ·82
	Prince Regents Redoubt	142	33	13 ·207	+0 ·281	13 ·488	0. 236	4 ·609 948 2	40 733 ·17
	Trescott Rock	20	33	00 ·293	+0 ·530	00 ·823	0 ·235	4 ·371 372 7	23 516 ·50
13	Chamcook	77	21	14 ·854	−0 ·574	14 ·280	0 ·657	4 ·565 481 2	36 768 ·95
	Prince Regents Redoubt	64	01	60 ·016	−0 ·452	59 ·564	0 ·657	4 ·529 929 1	33 878 ·88
	Cooper	38	36	49 ·082	−0 ·955	48 ·127	0 ·657	4 ·371 372 8	23 516 ·51
14	Rye	102	45	52 ·302	−0 ·342	51 ·960	0 ·344	4 ·529 929 1	33 878 ·88
	Chamcook	26	31	34 ·735	+1 ·067	35 ·802	0 ·344	4 ·190 727 0	15 514 ·11
	Cooper	50	42	32 ·464	+0 ·806	33 ·270	0 ·344	4 ·429 504 7	26 884 ·67
15	St. David	72	23	49 ·293	+1 ·061	50 ·354	0 ·510	4 ·529 929 1	33 878 ·88
	Chamcook	76	38	02 ·852	+0 ·603	03 ·455	0 ·509	4 ·538 830 5	34 580 ·44
	Cooper	30	58	08 ·833	−1 ·113	07 ·720	0 ·510	4 ·262 199 9	18 289 ·42
16	St. David	87	05	40 ·032	−0 ·283	39 ·749	0 ·319	4 ·429 504 7	26 884 ·67
	Chamcook	50	06	28 ·117	−0 ·463	27 ·654	0 ·319	4 ·315 000 5	20 653 ·82
	Rye	42	47	52 ·302	+1 ·252	53 ·554	0 ·319	4 ·262 200 0	18 289 ·42
17	St. David	14	41	50 ·739	−1 ·345	49 ·394	0 ·153	4 ·190 727 0	15 514 ·11
	Cooper	19	44	23 ·631	+1 ·920	25 ·551	0 ·153	4 ·315 000 4	20 653 ·82
	Rye	145	33	44 ·604	+0 ·910	45 ·514	0 ·153	4 ·538 830 5	34 580 ·44
18	Calais Observatory	86	11	40 ·903	−0 ·637	40 ·266	0 ·117	4 ·262 200 0	18 289 ·42
	St. David	67	11	50 ·342	−0 ·165	50 ·177	0 ·117	4 ·227 816 4	16 897 ·26
	Chamcook	26	36	30 ·347	−0 ·439	29 ·908	0 ·117	3 ·914 328 3	8 209 ·72

2. EPPING BASE NET TO MASSACHUSETTS BASE AND TO FIRE ISLAND BASE NET, MAINE, NEW HAMPSHIRE, MASSACHUSETTS, RHODE ISLAND, AND CONNECTICUT, 1844–1882.

The main triangulation which connects and is based upon the three northern base lines is among the most elaborate pieces of field work ever executed by the Survey. It was steadily continued and completed by Superintendent Bache and his party in twenty years. Only one station (Mount Washington) was afterwards included in the scheme. There are also several subordinate stations, not referred to here, which, in addition to what is furnished by the principal stations, effects the junction with the subordinate, secondary, and tertiary work covering the greater part of the coast line of Massachusetts, New Hampshire, and Maine.

With the exception of the angles at the Massachusetts base, all angular directions were measured by means of the great (so called) 75^{cm} theodolite, and the station results were deduced by application of Bessel's least square method of reduction. The accuracy reached is quite commensurate with the amount of labor spent, both in the

No. 21.


Humpback
Epping Base
North
Mt. Harris
Mt. Desert
Mt. Blue
Ragged Mt.
Sabattus
Mt. Washington
Mt. Pleasant
Mt. Independence
43°
Gunstock
Agamenticus
72°
Unkonoonuc
Thompson
Monadnock
Blue Hill
Manomet
Wachusett
Mass. Base
Beaconpole
Great Meadow
Copecut
Mt. Tom
Bald Hill
Box Hill
Ivy
Sandford
Wooster
Kilometers
10 0 20 40 60 80 100
Statute Miles
10 0 20 40 60

field and in the office. This may be seen in the closing errors of the 52 triangles as well as in the numerical constants of the 57 conditional equations. The first adjustment of this triangulation, made in 1866 under the writer's direction, avoided the heavy work of solving simultaneously this large number of equations by dividing the whole work into three parts, but in this discussion it was decided to treat the adjustment rigorously as a whole. The new results, however, differ but slightly from the older ones. The directions in the new adjustment are corrected for effect of altitude of the stations sighted, and the observations made at and upon Mount Washington are now incorporated into the general scheme.

Approximate heights of stations above the average level of the Atlantic Ocean.

	Meters.	Feet.		Meters.	Feet.
Humpback	451	1 480	Manomet	120	394
Mount Desert	465	1 525	Blue Hill	194	635
Mount Harris	381	1 251	Beaconpole	167	548
Ragged Mountain	397	1 301	Monadnock	966	3 168
Sabattus	244	800	Wachusett	616	2 022
Mount Blue	976	3 202	Mount Tom	372	1 220
Mount Pleasant	615	2 018	Bald Hill (Tolland County)	393	1 290
Mount Washington	1 920	6 300	Box Hill	259	850
Mount Independence	153	501	Ivy	498	1 634
Gunstock	732	2 402	Sandford	273	895
Agamenticus	222	728	Wooster	305	1 000
Unkonoonuc	411	1 348	Copecut	108	353
Thompson	83	271	Great Meadow	81	265

Observation equation LVI is the length equation between the Epping base (referred to the line Humpback to Mount Desert) and the Massachusetts base, showing a discrepancy of but 57 units in the seventh place of decimals in the logarithms, and the corresponding equation No. LVII is the length equation between the Massachusetts base and the Fire Island base (referred to the line Sandford to Wooster) and shows a discrepancy of but 26 units. Weights to the 131 directions are introduced on the same principle as was done in 1866, which takes care of the circumstance that the relative weights, when the directions are combined to form triangles, are very different from and only partly resemble the weights deduced from the station adjustment alone. Experience has shown that the former are at least of equal if not greater importance than the latter.

The maximum closing error in the sum of the angles of any one triangle is but 2″·0 and the average closing error of a triangle, found by squaring the 52 errors, is given by $\sqrt{\frac{44\cdot 47}{52}} = \pm 0''\cdot 92$; hence the probable error of a direction is $0\cdot 674 \frac{0\cdot 92}{\sqrt{6}} = \pm 0''\cdot 255$. On the other hand the approximate probable error of a direction derived from the *station* adjustment alone* is found from the average square $\frac{3\cdot 056}{131}$, viz, $e_s = \sqrt{0\cdot 0233} = \pm 0''\cdot 153$; hence the square of the combination error or $e_c^2 = (0\cdot 255)^2 - (0\cdot 153)^2 = (0\cdot 204)^2$. To each of the values of e_s^2, therefore, was added $(0\cdot 204)^2$ or $0\cdot 040$ in order

*See resulting probable errors of the direction presented further on with the abstracts of the horizontal measures.

to get $E^2 = \frac{1}{p}$, but in order to make the average value of the 131 cases equal to unity this was multiplied by 15·75; hence the final reciprocals of weights used in the adjustment further on.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882.

Humpback, Hancock County, Maine. July 19 to September 6, 1858. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Corrections from net adjustment.	Corrected directions.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″	″	″
	Cooper	0	00	00·000	±0·15	−0·196	00·000	.....	00·00	....	.....
	Azimuth Mark	39	37	40·230	0·16	−0·023	40·403	.....	.....	....	.....
	Mount Desert	114	33	50·877	0·09	+0·583	51·656	+0·008	51·66	....	.....
3	Ragged Mountain	154	28	20·545	0·13	−0·023	20·718	+0·022	20·74	+0·36	21·10
	Saunders	165	12	47·118	0·13	−0·023	47·291	.....	.....	....	.....
4	Mount Harris	180	36	29·988	0·17	−0·023	30·161	+0·010	30·17	−0·44	29·73
					Mean correction	−0·023					

Circle used in V positions.

Mount Desert, Hancock County, Maine. August 14 to October 14, 1856. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″	″	″
	Isle au Haut	0	00	00·000	±0·14	−0·006	00·000	.....	00·00	....	.....
1	Ragged Mountain	33	39	21·332	0·11	−0·006	21·332	+0·009	21·34	−0·05	21·29
2	Mount Harris	70	54	51·931	0·12	−0·006	51·931	−0·017	51·91	+0·10	52·01
	Saunders	93	48	58·382	0·10	−0·006	58·382	.....	.....	....	.....
	Azimuth Mark	122	49	25·136	0·10	−0·006	25·136	.....	.....	...	.....
	Humpback	144	20	00·152	0·10	−0·143	00·015	+0·008	00·02	....	...
					Mean correction	−0·006					

Circle used in V positions.

Mount Harris, Penobscot County, Maine. July 25 to October 17, 1855. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
	Thomas Hill, Bangor	0	00	00·000	±0·11	.....	00·00	....	.....
	Azimuth Mark	1	16	32·750	0·12	.....	.....	....	.....
	Peaked Mountain	9	50	32·207	0·13	.....	.....	....	.....
5	Humpback	13	14	12·055	0·09	+0·013	12·07	−0·01	12·06
	Saunders	29	29	47·495	0·09	.....	.....	....	.....
6	Mount Desert	53	46	37·312	0·09	−0·020	37·29	+0·07	37·36
	Isle au Haut	85	58	21·672	0·11	.....	.....	....	.....
7	Ragged Mountain	118	55	14·559	0·11	0·000	14·56	+0·06	14·62
8	Sabattus	170	57	33·572	0·12	+0·013	33·58	−0·01	33·57
9	Mount Blue	213	17	48·992	0·13	−0·009	48·98	−0·11	48·87

Circle used in V positions.

MOUNT DESERT.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882—continued.

Ragged Mountain, Waldo County, Maine. August 9 to November 21, 1854. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
	Cape Small	0	00	00·000	±0·13	.....	00·00	....	.....
10	Mount Pleasant	32	27	39·339	0·19	+0·010	39·35	+0·39	39·74
11	Sabattus	35	05	22·195	0·17	+0·003	22·20	−0·27	21·93
12	Mount Blue	72	13	02·447	0·12	−0·049	02·40	+0·11	02·51
13	Mount Harris	130	54	59·344	0·11	0·000	59·34	−0·20	59·14
	Azimuth Mark	131	32	49·928	0·16	.....	.....	....	.....
	Saunders	171	43	10·933	0·12	.....	.....	....	.....
14	Humpback	179	05	58·378	0·18	+0·025	58·40	0·00	58·40
15	Mount Desert	208	31	00·500	0·11	+0·011	00·51	+0·04	00·55
	Isle au Haut	241	08	17·507	0·19	.....	.....	....	.....

Circle used in V positions.

Mount Blue, Franklin County, Maine. August 29 to November 5, 1853. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
	Peaked Mountain	0	00	00·000	±0·14	.....	00·00	....	.....
	Saunders	7	35	33·784	0·17	.....	.....	....	.....
16	Mount Harris	8	46	42·896	0·18	−0·003	42·89	−0·24	42·65
17	Ragged Mountain	35	42	23·708	0·16	−0·019	23·69	+0·15	23·84
	Cape Small	74	11	02·283	0·20	.....	.....	....	.....
18	Sabattus	76	57	34·640	0·15	−0·008	34·63	+0·15	34·78
19	Mount Independence	94	02	02·938	0·30	0·000	02·94	−0·20	02·74
20	Mount Pleasant	121	17	49·712	0·15	+0·027	49·74	+0·03	49·77

Circle used in IV positions.

Sabattus, Androscoggin County, Maine. June 18 to August 16, 1853. 75 cm direction theodolite No. 1. A. D. Bache, C. O. Boutelle, J. E. Hilgard, and G. W. Dean, observers.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
23	Mount Blue	0	00	00·000	±0·11	−0·032	$\overline{59·97}$	−0·21	$\overline{59·76}$
	Azimuth Mark	17	56	05·204	0·17	.....	.....	....	.....
24	Mount Harris	69	29	07·402	0·18	+0·021	07·42	+0·16	07·58
25	Ragged Mountain	101	37	20·637	0·17	+0·005	20·64	+0·24	20·88
	Cape Small	172	59	00·194	0·14	.....	.....	....	.....
21	Mount Independence	222	21	04·158	0·13	+0·007	04·16	−0·07	04·09
22	Mount Pleasant	275	46	51·399	0·14	+0·014	51·41	−0·02	51·39

N. B. The observation of the direction to Mount Washington is too weak to be admissible.
Circle used in IV positions.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882--continued.

Mount Pleasant, Oxford County, Maine. July 2 to August 16, 1851. 75 cm direction theodolite No. 1. A. D. Bache, W. P. Trowbridge, and G. W. Dean, observers.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
26	Mount Blue*	0	00	00 ·000	±0 ·10	+0 ·043	00 ·04	−0 ·11	59 ·93
27	Sabattus	51	26	46 ·938	0 ·12	+0 ·006	46 ·94	+0 ·13	47 ·07
28	Ragged Mountain	54	39	35 ·737	0 ·14	+0 ·007	35 ·74	−0 ·20	35 ·54
	Cape Small	83	01	37 ·055	0 ·11	.....	.....	....	....
29	Mount Independence	100	12	48 ·045	0 ·09	−0 ·008	48 ·04	−0 ·49	47 ·55
	Ossipee	146	17	24 ·539	0 ·08	.....	.....	....	.....
30	Agamenticus	147	14	47 ·657	0 ·14	−0 ·003	47 ·65	+0 ·77	48 ·42
31	Gunstock	192	06	52 ·382	0 ·09	+0 ·040	52 ·42	−0 ·23	52 ·19
34	Mount Washington	279	18	34 ·810	0 ·24	−0 ·102	34 ·71	+0 ·38	35 ·09

Circle used in V positions.

Mount Independence, Cumberland County, Maine. September 2 to October 19, 1849. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
39	Mount Blue	0	00	00 ·000	±0 ·14	−0 ·002	00 ·00	+0 ·36	00 ·36
	Azimuth Mark	0	44	36 ·450	0 ·16	.....	.....	....	.....
40	Sabattus	25	16	42 ·166	0 ·15	+0 ·010	42 ·18	+0 ·02	42 ·20
	Cape Small	87	33	03 ·048	0 ·16	.....	.....	....	.....
36	Agamenticus	207	51	14 ·438	0 ·17	+0 ·010	14 ·45	−0 ·30	14 ·15
	Ossipee	241	49	46 ·990	0 ·20	.....	.....	....	.....
37	Gunstock	253	42	01 ·296	0 ·20	+0 ·023	01 ·32	−0 ·60	00 ·72
38	Mount Pleasant	307	28	23 ·886	0 ·13	−0 ·033	23 ·85	+0 ·29	24 ·14

N. B.—Observation of direction to Mount Washington too rough for use.

Circle used in VI positions.

Mount Washington,† Coos County, New Hampshire. Station mark of 1851 and 1860. 30 cm direction theodolite No. 118. July 31 to September 13, 1882. J. A. McNicol, observer (R. D. Cutts, chief of party).

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
	Reference Mark	0	00	00 ·00	±0 ·07	....	.....	....	.....
33	Mount Blue	46	31	41 ·34	0 ·11	+0 ·02	41 ·36	−0 ·13	41 ·23
34	Mount Pleasant	115	27	23 ·90	0 ·13	−0 ·03	23 ·87	−0 ·16	23 ·71
35	Gunstock	174	08	45 ·65	0 ·14	0 ·00	45 ·65	+0 ·30	45 ·95
	Killington	229	44	57 ·67	0 ·17	....	.....	....	.....
	Mount Mansfield	274	18	19 ·08	0 ·14	....	.....	....	.....

Circle used in VII positions.

* Azimuth mark west of Mount Blue 2″·19 ± 0″·11.

† This station was established in September, 1849, by T. McDonnell at the highest part of the mountain. It was marked by a copper bolt inserted in a bowlder by G. A. Fairfield in 1851, and re-marked in 1853 by B. F. West. The pole placed over the mark was observed upon from Mount Independence in 1849, from Ossipee in 1851, and from Sabattus in 1853, but only roughly. The observations from Mount Pleasant in 1851 and from Gunstock in 1860, however, were quite satisfactory. In 1877 C. H. Sinclair visited the station and under the direction of Assistant R. D. Cutts connected geodetically the several eccentric station marks since 1873 and again, in 1880 and 1881, those used by Prof. E. T. Quimby in his survey of the State of New Hampshire. These last observations have no bearing on the oblique arc, the only direction in common being that to Sabattus. Between July 31 and September 13, 1882, Assistant Cutts and Aid J. A. McNicol observed horizontal angles at the station in connection with the survey of New Hampshire, but included the three directions to Mount Blue, Gunstock, and Mount Pleasant. The 30 cm theodolite was then employed.

MOUNT WASHINGTON.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882—continued.

Agamenticus, York County, Maine. August 30 to October 10, 1847. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
	Isle of Shoals	0	00	00 ·000	±0 ·15	.....	00 ·00	....	.....
49	Thompson	16	20	22 ·029	0 ·14	0 ·000	22 ·03	+0 ·39	22 ·42
	Holt	41	28	13 ·964	0 ·17	.....	.....	....	.....
50	Unkonoonuc	83	56	21 ·852	0 ·17	+0 ·015	21 ·87	−0 ·32	21 ·55
	Patuccawa	88	19	23 ·555	0 ·16	.....	.....	....	.....
51	Gunstock	134	44	12 ·364	0 ·13	−0 ·037	12 ·33	+0. 02	12 ·35
52	Mount Pleasant	187	02	56 ·311	0. 14	−0 ·008	56 ·30	−0 ·16	56 ·14
	Ossipee	188	12	18 ·168	0 ·14	.....	.....	....	.....
53	Mount Independence	220	23	53 ·621	0 ·14	+0 ·007	53 ·63	+0 ·01	53 ·64
	Azimuth Mark	307	52	25 ·880	0 ·17	.....	.....	....	.....

Circle used in V positions.

Gunstock,* Belknap County, New Hampshire, July 11 to August 15, 1860. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
	Azimuth Mark	0	00	00 ·000	±0 ·14	.....	00 ·00	....	.....
41	Mount Washington	44	06	20 ·238	0 ·11	+0 ·014	20 ·25	−0 ·40	19 ·85
42	Mount Pleasant	78	13	23 ·269	0 ·11	+0 ·034	23 ·30	−0 ·04	23 ·26
43	Mount Independence	112	33	03 ·490	0 ·11	+0 ·005	03 ·50	+0 ·80	04 ·30
	Ossipee	121	29	34 ·600	0 ·12	.....	.....	....	.....
44	Agamenticus	161	02	47 ·320	0 ·12	−0 ·011	47 ·31	−0 ·08	47 ·23
45	Thompson	192	55	14 ·997	0. 12	−0 ·004	14 ·99	−0 ·20	14 ·79
	Patuccawa	202	52	41 ·124	0 ·11	.....	.....	....	.....
46	Unkonoonuc	237	14	12 ·358	0 ·08	+0 ·013	12 ·37	+0 ·10	12 ·47
47	Wachusett	240	56	10 ·060	0 ·09	+0 ·023	10 ·08	−0 ·40	09 ·68
48	Monadnock	260	13	18 ·732	0 ·07	+0 ·054	18 ·79	+0 ·15	18 ·94

Circle used in V positions.

Unkonoonuc,† Hillsboro County, New Hampshire. August 29 to October 6, 1848. 75 cm direction theodolite No. 1. A. D. Bache, observer. August 25 to 29, 1860. G. W. Dean, observer. Same instrument.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
	Gunstock	0	00	00 ·000	±0 ·07	+0 ·023	00 ·02	+0 ·01	00 ·03
59	Patuccawa	47	43	13 ·998	0 ·12	.....	.....	....	.....
	Agamenticus	53	00	53 ·613	0 ·13	+0 ·008	53. 62	+0 ·11	53 ·73
54	Thompson	103	24	13 ·952	0 ·09	−0 ·004	13. 95	+0 ·02	13 ·97
55	Holt and Azimuth Mark	117	12	51 ·745	0 ·11	.....	.....	....	.....
56	Blue Hill	138	49	11 ·993	0 ·15	−0 ·009	11 ·98	−0 ·35	11 ·63
57	Wachusett	187	30	54 ·272	0 ·07	+0 ·027	54 ·30	+0 ·16	54 ·46
58	Monadnock	235	53	53 ·272	0 ·09	+0 ·032	53 ·30	−0 ·03	53 ·27

Probable error of a single observation (*D.* and *R.*) of a direction, $e_1 = \pm 0'' \cdot 75$. Circle used in V positions, in 1848 and in 1860.

* The station was occupied by Prof. E. T. Quimby in 1878, but only in connection with the survey of New Hampshire; it was reoccupied in September, 1897, by Assistant A. T. Mosman, in connection with western work in Vermont.

† The station was occupied by Prof. E. T. Quimby in July, 1872, in connection with the survey of New Hampshire. He used 25 cm theodolite No. 31. He sighted Monadnock and Patuccawa, but for these observations we have no use here.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882—continued.

Thompson, Essex County, Massachusetts. October 15 to November 24, 1846, and July 27 to August 23, 1847. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
73	Manomet	0	00	00·000	±0·18	−0·002	00·00	+0·10	00·10
74	Blue Hill	44	15	19·752	0·11	+0·011	19·76	+0·14	19·90
75	Wachusett	90	52	38·782	0·12	+0·010	38·79	0·00	38·79
	Holt	104	48	53·491	0·13	.....	.....	....	.....
76	Unkonoonuc	129	22	49·757	0·14	−0·021	49·74	+0·11	49·85
	Patuccawa	154	45	22·283	0·12	.....	.....	....	.....
77	Gunstock	161	29	50·943	0·15	−0·035	50·91	−0·23	50·68
	Azimuth Mark, west	186	35	38·458	0·19	.....	.....	....	.....
	Azimuth Mark, east	190	40	47·449	0·29	.....	.....	....	.....
78	Agamenticus	191	13	43·021	0·12	+0·001	43·02	−0·14	42·88
	Isle of Shoals	201	26	34·383	0·11	.....	.....	....	.....

Circle used in III positions in 1846.

Wachusett, Worcester County, Massachusetts. September 13 to October 16, 1860. 75 cm direction theodolite No. 1. A. D. Bache and G. W. Dean, observers.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
	Azimuth Mark	0	00	00·000	±0·10	.....	00·00	....	.....
65	Bald Hill	18	32	53·177	0·20	+0·017	53·19	+0·07	53·26
66	Mount Tom	60	52	05·024	0·34	+0·016	05·04	−1·17	03·87
67	Monadnock	150	38	43·050	0·13	−0·042	43·01	+0·23	43·24
68	Gunstock	194	20	24·085	0·14	+0·027	24·11	+0·13	24·24
69	Unkonoonuc	198	09	22·750	0·13	+0·018	22·77	−0·07	22·70
	Patuccawa	212	49	54·036	0·12	.....	.....	....	.....
	Holt	249	13	40·236	0·15	.....	.....	....	.....
70	Thompson	255	42	43·548	0·17	+0·001	43·55	−0·05	43·50
71	Blue Hill	289	46	57·469	0·13	−0·009	57·46	−0·02	57·44
72	Beaconpole	320	47	46·873	0·12	−0·009	46·86	+0·15	47·01

Circle used in V positions.

Blue Hill, Norfolk County, Massachusetts. September 14 to October 19, 1845. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
79	Manomet	0	00	00·000	±0·11	−0·007	59·99	+0·14	00·13
80	Copecut	49	17	23·167	0·14	−0·001	23·17	+0·03	23·20
81	Great Meadow	67	01	11·778	0·11	+0·002	11·78	−0·01	11·77
82	Beaconpole	103	11	18·606	0·14	+0·010	18·62	−0·52	18·10
83	Wachusett	170	05	20·382	0·12	−0·028	20·35	+0·20	20·55
84	Unkonoonuc	209	46	13·547	0·13	−0·018	13·53	+0·23	13·76
	Holt	234	48	06·131	0·10	.....	.....	....	.....
	Azimuth Mark	236	05	03·497	0·09	.....	.....	....	.....
85	Thompson	269	23	57·425	0·10	+0·005	57·43	−0·07	57·36

Circle used in VI positions.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882—continued.

Great Meadow, Bristol County, Massachusetts. May 7 to 27, 1845. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.	Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″	″
104	Copecut	0 00 00·000	±0·14	−0·006	59·99	−0·28	59·71
101	Beaconpole	160 29 59·351	0·15	−0·009	59·34	+0·28	59·62
102	Massachusetts North Base	219 19 14·351	0·19	0·000	14·35	−0·24	14·11
103	Blue Hill	229 39 39·080	0·14	+0·005	39.08	+0·20	39·28

Circle used in III positions.

Copecut, Bristol County, Massachusetts. September 7 to October 8, 1844. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.	Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″	″
92	Blue Hill and Azimuth Mark	0 00 00·000	±0·13	−0·002	00·00	−0·19	59·81
93	Manomet	64 08 37·851	0·16	+0·006	37·86	+0·01	37·87
	Indian	140 03 44·563	0·15	.....	.....	....	.....
90	Beaconpole	318 01 08·556	0·13	−0·010	08·55	−0·17	08·38
91	Great Meadow	328 04 06·825	0·15	−0·005	06·82	+0·39	07·21

Circle used in III positions.

Manomet, Plymouth County, Massachusetts. August 25 to September 11, 1845. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.	Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″	″
	Provincetown	0 00 00·000	±0·11	.....	00·00	....	.....
	Indian	120 13 21·474	0·10	.....	.....	....	.....
86	Copecut	172 29 05·212	0·17	+0·006	05·22	+0·07	05·29
87	Beaconpole	209 03 27·009	0·16	−0. 002	27·01	+0·10	27·11
88	Blue Hill	239 03 09·898	0·10	−0·011	09·89	−0·08	09·81
89	Thompson	284 11 54·745	0·13	−0·001	54·74	−0·06	54·68

Circle used in VI positions.

Massachusetts South Base, Bristol County, Massachusetts. September 9 to 17, 1845. 25 cm repeating theodolite No. 11. E. Blunt, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.	Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″	″
105	Beaconpole	0 00 00·000	±0·45	−0·010	59·99	−0·20	59·79
106	Massachusetts North Base	81 00 16·66	0·45	+0·004	16·66	+0·20	16·89

Massachusetts North Base, Bristol County, Massachusetts. September 19 to 29, 1845. 25 cm repeating theodolite No. 11. E. Blunt, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.	Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″	″
107	Great Meadow	0 00 00·000	±0·35	0·000	00·00	+0·26	00·26
108	Massachusetts South Base	25 16 31·173	0·35	+0·002	31·18	−0·09	31·09
109	Beaconpole	70 09 29·812	0·35	+0·006	29·82	−0·17	29·65

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882—continued.

Beaconpote, Providence County, Rhode Island. October 19 to November 23, 1844. 75 cm direction theodolite No. 1. A. D. Bache, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds
		°	′	″	″	″	″	″	″
94	Wachusett	0	00	00 ·000	±0 ·11	−0 ·034	59 ·97	−0 ·26	59 ·71
	Azimuth Mark	35	12	22 ·656	0 ·16	.....	.....	....	.....
95	Blue Hill	82	05	13 ·351	0 ·11	+0 ·012	13 ·36	+0 ·40	13 ·76
96	Massachusetts North Base	105	44	12 ·597	0 ·15	+0 ·002	12 ·60	+0 ·17	12 ·77
97	Manomet	128	54	18 ·252	0 ·16	−0 ·001	18 ·25	−0 ·28	17 ·97
98	Great Meadow	156	45	30 ·025	0 ·09	−0 ·005	30 ·02	−0 ·15	29. 87
99	Massachusetts South Base	159	50	57 ·843	0 ·11	−0 ·002	57 ·84	−0 ·03	57 ·81
100	Copecut	166	12	31 431	0 ·10	−0 ·006	31 ·42	+0 ·13	31 ·55

Circle used in III positions.

Monadnock,* Cheshire County, New Hampshire. July 21 to August 15, 1861. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds
		°	′	″	″	″	″	″	″
60	Gunstock	0	00	00 ·000	±0 ·10	+0 ·042	00 ·04	−0 ·14	59 ·90
61	Unkonoonuc	32	54	52 ·457	0 ·19	+0 ·014	52 ·47	0 ·00	52 ·47
62	Wachusett	117	01	19 ·427	0 ·10	−0 ·026	19 ·40	−0 ·12	19 ·28
63	Bald Hill	145	06	44 ·724	0 ·09	+0 ·004	44 ·73	+0 ·35	45 ·08
64	Mount Tom	173	46	06 ·971	0 ·11	+0 ·019	06 ·99	−0 ·08	06 ·91

Probable error of a single observation (*D.* and *R.*) of a direction, $e_1 = \pm 0''.67$. Circle used in V positions.

Mount Tom,† Tolland County, Connecticut. July 11 to August 16, 1862. 75 cm direction theodolite No. 1. G. W. Dean and R. E. Halter, observers.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds
		°	′	″	″	″	″	″	″
115	Monadnock	0	00	00 ·000	±0 ·10	+0 ·052	00 ·05	+0 ·12	00 ·17
	Azimuth Mark	4	45	13 ·052	0 ·08	.....	.....	....	.....
116	Wachusett	33	28	40 ·690	0 ·09	+0 ·027	40. 72	+0 ·30	41 ·02
117	Bald Hill	95	52	53 ·979	0 ·08	−0 ·023	53 ·96	0 ·00	53 ·96
118	Box Hill	129	18	15 ·047	0 ·09	−0 ·009	15 ·04	−0 ·13	14 ·91
119	Sandford	163	34	58 ·584	0 ·12	+0 ·009	58 ·59	−0 ·33	58 ·26

Circle used in V positions.

Bald Hill, Tolland County, Connecticut. September 12 to 25, 1861, and May 22 to June 7, 1864. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds
		°	′	″	″	″	″	″	″
110	Box Hill	0	00	00 ·000	±0 ·08	+0 ·015	00 ·02	+0 ·21	00 ·23
111	Ivy	34	47	46 ·780	0 ·12	+0 ·007	46 ·79	+0 ·28	47 ·07
112	Mount Tom	80	50	44 ·995	0 ·10	−0 ·022	44 ·97	−0 ·05	44 ·92
113	Monadnock	136	18	39 ·740	0 ·14	+0 ·009	39 ·75	−0 ·61	39 ·14
114	Wachusett	156	07	28 ·560	0 ·12	+0 ·028	28 ·59	+0 ·11	28 ·70

Circle used in V positions in 1861 and 1864.

* This station was occupied by Prof. E. T. Quimby in June, 1872, in connection with the survey of New Hampshire. In September, 1878, the party of Assistant R. D. Cutts reoccupied the station, but neither of these observers made any additions to the measures of the oblique arc.

† This station was occupied in June and July, 1877, by Assistant R. D. Cutts in connection with the survey of Vermont.

Abstracts of horizontal directions as observed and adjusted at the principal stations between the Epping base net, the Massachusetts base, and the Fire Island base net, 1844–1882—continued.

Box Hill, Tolland County, Connecticut. October 9 to 28, 1861. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment. °	′	″	Approximate probable errors. ″	Reductions to sea level. ″	Resulting seconds. ″	Corrections from figure adjustment. ″	Final seconds. ″
120	Sandford	0	00	00·000	±0·13	+0·017	00·02	+0·10	00·12
121	Ivy	49	35	39·881	0·11	−0·007	39·87	−0·08	39·78
122	Mount Tom	114	15	55·751	0·11	−0·013	55·74	+0·28	56·02
123	Bald Hill	179	59	54·087	0·10	+0·024	54·11	−0·28	53·83

Circle used in V positions.

Ivy, Litchfield County, Connecticut. June 29 to August 12, 1863. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″
124	Bald Hill	0	00	00·000	±0·08	+0·007	00·01	−0·04	59·97
125	Box Hill	14	48	02·805	0·09	−0·004	02·80	−0·13	02·67
126	Sandford	71	09	55·842	0·09	−0·013	55·83	−0·12	55·71
127	Wooster	118	50	47·463	0·12	+0·012	47·48	+0·33	47·81

Circle used in V positions.

Sandford, New Haven County, Connecticut. September 9 to November 4, 1862. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	Resulting directions from station adjustment. °	′	″	Approximate probable error. ″	Reduction to sea level. ″	Corrected directions. ″	Corrections from net adjustment. ″	Resulting directions. ″	Corrections from figure adjustment. ″	Final seconds. ″
	Ruland	0	00	00·000	±0·11	.....	.....	−0·264	59·74	....	.....
	West Hills*	23	24	41·547 +0·008	0·12	.....	......	+0·482	42·04	....	.....
	Tashua	42	36	58·413	0·12	+0·011	58·424	−0·330	58·09	....	.....
	Wooster	69	03	33·113	0·24	+0·009	33·122	+0·356	33·48	....	.....
	Azimuth Mark	85	20	30.246	0·15	.....	......	.....	.....	....	.....
128	Ivy	147	34	47·646	0·15	−0·024	......	.....	47·62	+0·25	47·87
129	Mount Tom	190	09	54·581	0·12	+0·012	......	.....	54·59	+0·11	54·70
130	Box Hill	221	37	22·062	0·10	+0·016	......	.....	22·08	+0·02	22·10

Circle used in V positions.

Wooster, Fairfield County, Connecticut. July 14 to October 10, 1864. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	°	′	″	″	″	″	″	″	″	″
131	Ivy	0	00	00·000	±0·07	+0·020	......	.....	00·02	−0·29	59·73
	Sandford	53	47	59·208	0·07	+0·009	59·217	−0·069	59·15	....	.....
	Tashua	95	57	47·652	0·08	−0·009	47·643	+0·285	47·93	....	.....
	Ruland	124	51	45·938	0·08	.....	......	+0·005	45·94	....	.....
	West Hills*	154	10	38·493 +0·032	0·07	.....	......	−0·147	38·38	....	....

Circle used in V positions.

*The correction to direction of West Hills is for eccentricity.

Observation equations.

I	$0=-0{\cdot}45-(1)+(3)-(14)+(15)$
II	$0=+0{\cdot}46-(2)+(4)-(5)+(6)$
III	$0=-0{\cdot}38-(1)+(2)-(6)+(7)-(13)+(15)$
IV	$0=+0{\cdot}09-(7)+(9)-(12)+(13)-(16)+(17)$
V	$0=-0{\cdot}08-(7)+(8)-(11)+(13)-(24)+(25)$
VI	$0=-0{\cdot}66-(8)+(9)-(16)+(18)-(23)+(24)$
VII	$0=+0{\cdot}49-(10)+(12)-(17)+(20)-(26)+(28)$
VIII	$0=+0{\cdot}07-(18)+(20)-(22)+(23)-(26)+(27)$
IX	$0=+0{\cdot}85-(21)+(22)-(27)+(29)-(38)+(40)$
X	$0=+0{\cdot}09-(19)+(20)-(26)+(29)-(38)+(39)$
XI	$0=-1{\cdot}42-(31)+(32)-(34)+(35)-(41)+(42)$
XII	$0=+1{\cdot}20-(36)+(37)-(43)+(44)-(51)+(53)$
XIII	$0=-2{\cdot}02-(29)+(30)-(36)+(38)-(52)+(53)$
XIV	$0=+1{\cdot}22-(30)+(31)-(42)+(44)-(51)+(52)$
XV	$0=+0{\cdot}39-(44)+(45)-(49)+(51)-(77)+(78)$
XVI	$0=+1{\cdot}05-(49)+(50)-(54)+(55)-(76)+(78)$
XVII	$0=+0{\cdot}03-(45)+(46)+(55)-(59)-(76)+(77)$
XVIII	$0=-0{\cdot}27-(55)+(57)-(69)+(70)-(75)+(76)$
XIX	$0=+0{\cdot}61-(45)+(47)-(68)+(70)-(75)+(77)$
XX	$0=-0{\cdot}23-(46)+(48)-(58)+(59)-(60)+(61)$
XXI	$0=+0{\cdot}61-(57)+(58)-(61)+(62)-(67)+(69)$
XXII	$0=+0{\cdot}69-(55)+(56)-(74)+(76)-(84)+(85)$
XXIII	$0=+0{\cdot}37-(70)+(71)-(74)+(75)-(83)+(85)$
XXIV	$0=-1{\cdot}55-(71)+(72)-(82)+(83)-(94)+(95)$
XXV	$0=-0{\cdot}25-(73)+(74)+(79)-(85)-(88)+(89)$
XXVI	$0=-0{\cdot}62-(86)+(87)-(90)+(93)-(97)+(100)$
XXVII	$0=+0{\cdot}84-(80)+(82)-(90)+(92)-(95)+(100)$
XXVIII	$0=+0{\cdot}07-(79)+(80)-(86)+(88)-(92)+(93)$
XXIX	$0=+1{\cdot}10-(80)+(81)-(91)+(92)-(103)+(104)$
XXX	$0=-1{\cdot}41-(90)+(91)-(98)+(100)+(101)-(104)$
XXXI	$0=+1{\cdot}28-(96)+(98)-(101)+(102)-(107)+(109)$
XXXII	$0=-0{\cdot}11-(96)+(99)-(105)+(106)-(108)+(109)$
XXXIII	$0=-1{\cdot}62-(62)+(64)-(66)+(67)-(115)+(116)$
XXXIV	$0=+1{\cdot}10-(63)+(64)-(112)+(113)-(115)+(117)$
XXXV	$0=+1{\cdot}37-(65)+(66)-(112)+(114)-(116)+(117)$
XXXVI	$0=+0{\cdot}96-(110)+(112)-(117)+(118)-(122)+(123)$
XXXVII	$0=+0{\cdot}22-(110)+(111)-(121)+(123)-(124)+(125)$
XXXVIII	$0=+0{\cdot}11-(118)+(119)-(120)+(122)-(129)+(130)$
XXXIX	$0=+0{\cdot}41-(120)+(121)-(125)+(126)-(128)+(130)$
XL	$0=-0{\cdot}99-(126)+(127)+(128)-(131)$
XLI	$0=-3{\cdot}8-2{\cdot}77(1)+3{\cdot}39(2)+4{\cdot}29(3)-3{\cdot}35(4)-1{\cdot}43(13)+1{\cdot}89(14)-0{\cdot}46(15)$
XLII	$0=-1{\cdot}7+0{\cdot}21(11)+1{\cdot}28(12)-1{\cdot}49(13)-3{\cdot}30(16)+4{\cdot}14(17)-0{\cdot}84(18)-0{\cdot}79(23)$
	$+4{\cdot}14(24)-3{\cdot}35(25)$

Observation equations—continued.

XLIII	$0=-1{\cdot}82+4{\cdot}586(10)-4{\cdot}864(11)+0{\cdot}278(12)+0{\cdot}240(17)-0{\cdot}455(18)+0{\cdot}215(20)$
	$+0{\cdot}168(26)-3{\cdot}918(27)+3{\cdot}750(28)$
XLIV	$0=-0{\cdot}8-4{\cdot}70(18)+6{\cdot}85(19)-2{\cdot}15(20)-1{\cdot}68(26)+3{\cdot}53(27)-1{\cdot}85(29)-0{\cdot}46(38)$
	$+4{\cdot}46(39)-4{\cdot}00(40)$
XLV	$0=+1{\cdot}7-4{\cdot}08(19)+4{\cdot}08(20)+3{\cdot}59(26)-3{\cdot}59(32)-4{\cdot}40(33)+5{\cdot}68(34)-1{\cdot}28(35)$
	$-1{\cdot}54(37)+3{\cdot}15(38)-1{\cdot}61(39)-3{\cdot}10(41)+6{\cdot}18(42)-3{\cdot}08(43)$
XLVI	$0=-6{\cdot}2-2{\cdot}03(29)+1{\cdot}96(30)+0{\cdot}07(31)-3{\cdot}08(42)+4{\cdot}94(43)-1{\cdot}86(44)-0{\cdot}16(51)$
	$+3{\cdot}20(52)-3{\cdot}04(53)$
XLVII	$0=+0{\cdot}8-2{\cdot}87(44)+3{\cdot}39(45)-0{\cdot}52(46)+3{\cdot}32(54)-1{\cdot}73(55)-1{\cdot}59(59)-1{\cdot}13(76)$
	$+3{\cdot}69(77)-2{\cdot}56(78)$
XLVIII	$0=-1{\cdot}23-0{\cdot}216(45)+3{\cdot}472(46)-3{\cdot}256(47)-3{\cdot}156(68)+3{\cdot}290(69)-0{\cdot}134(70)$
	$-0{\cdot}265(75)+0{\cdot}600(76)-0{\cdot}335(77)$
XLIX	$0=-1{\cdot}7-2{\cdot}16(45)+7{\cdot}12(46)-4{\cdot}96(48)+3{\cdot}25(60)+3{\cdot}47(61)-0{\cdot}22(62)-1{\cdot}93(67)$
	$+3{\cdot}27(69)-1{\cdot}34(70)-2{\cdot}65(75)+6{\cdot}00(76)-3{\cdot}35(77)$
L	$0=+2{\cdot}4-2{\cdot}98(55)+4{\cdot}83(56)-1{\cdot}85(57)+0{\cdot}06(69)+3{\cdot}11(70)-3{\cdot}17(71)-1{\cdot}81(74)$
	$+1{\cdot}99(75)-0{\cdot}18(76)$
LI	$0=-0{\cdot}7-3{\cdot}11(70)+6{\cdot}61(71)-3{\cdot}50(72)-2{\cdot}16(73)+4{\cdot}15(74)-1{\cdot}99(75)-3{\cdot}65(87)$
	$+5{\cdot}74(88)-2{\cdot}09(89)-0{\cdot}29(94)+2{\cdot}27(95)-1{\cdot}98(97)$
LII	$0=-2{\cdot}0+0{\cdot}49(79)+1{\cdot}54(80)-2{\cdot}03(82)-2{\cdot}84(86)+6{\cdot}49(87)-3{\cdot}65(88)-2{\cdot}95(90)$
	$+2{\cdot}34(92)+0{\cdot}61(93)$
LIII	$0=-0{\cdot}61-0{\cdot}659(80)+0{\cdot}947(81)-0{\cdot}288(82)-1{\cdot}188(90)+1{\cdot}526(91)-0{\cdot}338(92)$
	$-0{\cdot}058(95)+1{\cdot}323(98)-1{\cdot}265(100)$
LIV	$0=+1{\cdot}4-2{\cdot}56(62)+3{\cdot}94(63)-1{\cdot}38(64)-0{\cdot}55(112)+5{\cdot}84(113)-5{\cdot}29(114)-3{\cdot}18(115)$
	$+4{\cdot}28(116)-1{\cdot}10(117)$
LV	$0=-1{\cdot}0-2{\cdot}69(110)+3{\cdot}03(111)-0{\cdot}34(112)-3{\cdot}19(117)+6{\cdot}28(118)-3{\cdot}09(119)$
	$+7{\cdot}97(124)-9{\cdot}37(125)+1{\cdot}40(126)+0{\cdot}60(128)-3{\cdot}44(129)+2{\cdot}84(130)$
LVI	$0=+5{\cdot}7-2{\cdot}77(1)+2{\cdot}77(2)+0{\cdot}94(4)+2{\cdot}46(5)-2{\cdot}46(6)-2{\cdot}31(8)$
	$+2{\cdot}31(9)+0{\cdot}21(11)+0{\cdot}25(13)-0{\cdot}46(15)+0{\cdot}84(16)-2{\cdot}99(18)$
	$+2{\cdot}15(20)-1{\cdot}56(21)+1{\cdot}56(22)+3{\cdot}35(24)-3{\cdot}35(25)+1{\cdot}68(26)$
	$-1{\cdot}68(27)+0{\cdot}07(29)-0{\cdot}07(31)-2{\cdot}04(36)+2{\cdot}04(37)+0{\cdot}46(38)$
	$-0{\cdot}46(40)+3{\cdot}08(42)-3{\cdot}08(43)-0{\cdot}52(44)+0{\cdot}52(46)-0{\cdot}86(49)$
	$+0{\cdot}86(50)+0{\cdot}16(51)-0{\cdot}16(53)-1{\cdot}59(54)-1{\cdot}85(56)+1{\cdot}85(57)$
	$+1{\cdot}59(59)-0{\cdot}06(69)-3{\cdot}44(71)+3{\cdot}50(72)-0{\cdot}18(74)+1{\cdot}31(76)$
	$-1{\cdot}13(78)-2{\cdot}88(81)+2{\cdot}88(82)+1{\cdot}24(84)-1{\cdot}24(85)+0{\cdot}29(94)$
	$-0{\cdot}29(95)-1{\cdot}52(96)+1{\cdot}52(99)-0{\cdot}48(101)+1{\cdot}28(102)-0{\cdot}80(103)$
	$+0{\cdot}33(105)-0{\cdot}33(106)+0{\cdot}76(107)-0{\cdot}76(109)$
LVII	$0=+2{\cdot}6+1{\cdot}85(56)-3{\cdot}72(57)+1{\cdot}87(58)+0{\cdot}22(61)-1{\cdot}60(62)+1{\cdot}38(64)$
	$-2{\cdot}31(65)+2{\cdot}31(66)+3{\cdot}50(71)-3{\cdot}50(72)+2{\cdot}88(81)-2{\cdot}88(82)$
	$-2{\cdot}54(83)+2{\cdot}54(84)-0{\cdot}29(94)+0{\cdot}29(95)+1{\cdot}52(96)-1{\cdot}52(99)$
	$+0{\cdot}48(101)-1{\cdot}28(102)+0{\cdot}80(103)-0{\cdot}33(105)+0{\cdot}33(106)-0{\cdot}76(107)$
	$+0{\cdot}76(109)-0{\cdot}34(110)+0{\cdot}89(112)-0{\cdot}55(114)+3{\cdot}18(115)-3{\cdot}18(116)$
	$-3{\cdot}09(118)+3{\cdot}09(119)-1{\cdot}79(120)+1{\cdot}79(121)+0{\cdot}95(122)-0{\cdot}95(123)$
	$+1{\cdot}40(125)-3{\cdot}32(126)+1{\cdot}92(127)+3{\cdot}44(129)-3{\cdot}44(130)+1{\cdot}54(131)$

Correlate equations.

Corrections.	Reciprocal of weight $1/p$.	
$(1)=$	$0{\cdot}8$	$(-C_1-C_3-2{\cdot}77C_{41}-2{\cdot}77C_{56})$
$(2)=$	$0{\cdot}9$	$(-C_2+C_3+3{\cdot}39C_{41}+2{\cdot}77C_{56})$
$(3)=$	$0{\cdot}9$	$(+C_1+4{\cdot}29C_{41})$
$(4)=$	$1{\cdot}1$	$(+C_2-3{\cdot}35C_{41}+0{\cdot}94C_{56})$
$(5)=$	$0{\cdot}8$	$(-C_2+2{\cdot}46C_{56})$
$(6)=$	$0{\cdot}8$	$(+C_2-C_3-2{\cdot}46C_{56})$
$(7)=$	$0{\cdot}8$	$(+C_3-C_4-C_5)$
$(8)=$	$0{\cdot}9$	$(+C_5-C_6-2{\cdot}31C_{56})$
$(9)=$	$0{\cdot}9$	$(+C_4+C_6+2{\cdot}31C_{56})$
$(10)=$	$1{\cdot}2$	$(-C_7+4{\cdot}586C_{43})$
$(11)=$	$1{\cdot}1$	$(-C_5+0{\cdot}21C_{42}-4{\cdot}864C_{43}+0{\cdot}21C_{56})$
$(12)=$	$0{\cdot}9$	$(-C_4+C_7+1{\cdot}28C_{42}+0{\cdot}278C_{43})$
$(13)=$	$0{\cdot}8$	$(-C_3+C_4+C_5-1{\cdot}43C_{41}-1{\cdot}49C_{42}+0{\cdot}25C_{56})$
$(14)=$	$1{\cdot}1$	$(-C_1+1{\cdot}89C_{41})$
$(15)=$	$0{\cdot}8$	$(+C_1+C_3-0{\cdot}46C_{41}-0{\cdot}46C_{56})$
$(16)=$	$1{\cdot}1$	$(-C_4-C_6-3{\cdot}30C_{42}+0{\cdot}84C_{56})$
$(17)=$	$1{\cdot}0$	$(+C_4-C_7+4{\cdot}14C_{42}+0{\cdot}240C_{43})$
$(18)=$	$1{\cdot}0$	$(+C_6-C_8-0{\cdot}84C_{42}-0{\cdot}455C_{43}-4{\cdot}70C_{44}-2{\cdot}99C_{56})$
$(19)=$	$2{\cdot}0$	$(-C_{10}+6{\cdot}85C_{44}-4{\cdot}08C_{45})$
$(20)=$	$1{\cdot}0$	$(+C_7+C_8+C_{10}+0{\cdot}215C_{43}-2{\cdot}15C_{44}+4{\cdot}08C_{45}+2{\cdot}15C_{56})$
$(21)=$	$0{\cdot}9$	$(-C_9-1{\cdot}56C_{56})$
$(22)=$	$0{\cdot}9$	$(-C_8+C_9+1{\cdot}56C_{56})$
$(23)=$	$0{\cdot}8$	$(-C_6+C_8-0{\cdot}79C_{42})$
$(24)=$	$1{\cdot}1$	$(-C_5+C_6+4{\cdot}14C_{42}+3{\cdot}35C_{56})$
$(25)=$	$1{\cdot}1$	$(+C_5-3{\cdot}35C_{42}-3{\cdot}35C_{56})$
$(26)=$	$0{\cdot}8$	$(-C_7-C_8-C_{10}+0{\cdot}168C_{43}-1{\cdot}68C_{44}+3{\cdot}59C_{45}+1{\cdot}68C_{56})$
$(27)=$	$0{\cdot}9$	$(+C_8-C_9-3{\cdot}918C_{43}+3{\cdot}53C_{44}-1{\cdot}68C_{56})$
$(28)=$	$0{\cdot}9$	$(+C_7+3{\cdot}750C_{43})$
$(29)=$	$0{\cdot}8$	$(+C_9+C_{10}-C_{13}-1{\cdot}85C_{44}-2{\cdot}03C_{46}+0{\cdot}07C_{56})$
$(30)=$	$0{\cdot}9$	$(+C_{13}-C_{14}+1{\cdot}96C_{46})$
$(31)=$	$0{\cdot}8$	$(-C_{11}+C_{14}+0{\cdot}07C_{46}-0{\cdot}07C_{56})$
$(32)=$	$1{\cdot}5$	$(+C_{11}-3{\cdot}59C_{45})$
$(33)=$	$0{\cdot}8$	$(-4{\cdot}40C_{45})$
$(34)=$	$0{\cdot}9$	$(-C_{11}+5{\cdot}68C_{45})$
$(35)=$	$0{\cdot}9$	$(+C_{11}-1{\cdot}28C_{45})$
$(36)=$	$1{\cdot}1$	$(-C_{12}-C_{13}-2{\cdot}04C_{56})$
$(37)=$	$1{\cdot}3$	$(+C_{12}-1{\cdot}54C_{45}+2{\cdot}04C_{56})$
$(38)=$	$0{\cdot}9$	$(-C_9-C_{10}+C_{13}-0{\cdot}46C_{44}+3{\cdot}15C_{45}+0{\cdot}46C_{56})$
$(39)=$	$0{\cdot}9$	$(+C_{10}+4{\cdot}46C_{44}-1{\cdot}61C_{45})$
$(40)=$	$1{\cdot}0$	$(+C_9-4{\cdot}00C_{44}-0{\cdot}46C_{56})$

Correlate equations—continued.

Corrections. Reciprocal of weight $1/p$.

$(41) = 0.8(-C_{11} - 3.10C_{45})$
$(42) = 0.8(+C_{11} - C_{14} + 6.18C_{45} - 3.08C_{46} + 3.08C_{56})$
$(43) = 0.8(-C_{12} - 3.08C_{45} + 4.94C_{46} - 3.08C_{56})$
$(44) = 0.9(+C_{12} + C_{14} - C_{15} - 1.86C_{46} - 2.87C_{47} - 0.52C_{56})$
$(45) = 0.9(+C_{15} - C_{17} - C_{19} + 3.39C_{47} - 0.216C_{48} - 2.16C_{49})$
$(46) = 0.7(+C_{17} - C_{20} - 0.52C_{47} + 3.472C_{48} + 7.12C_{49} + 0.52C_{56})$
$(47) = 0.8(+C_{19} - 3.256C_{48})$
$(48) = 0.7(+C_{20} - 4.96C_{49})$
$(49) = 0.9(-C_{15} - C_{16} - 0.86C_{56})$
$(50) = 1.1(+C_{16} + 0.86C_{56})$
$(51) = 0.9(-C_{12} - C_{14} + C_{15} - 0.16C_{46} + 0.16C_{56})$
$(52) = 0.9(-C_{13} + C_{14} + 3.20C_{46})$
$(53) = 0.9(+C_{12} + C_{13} - 3.04C_{46} - 0.16C_{56})$
$(54) = 0.9(-C_{16} + 3.32C_{47} - 1.59C_{56})$
$(55) = 0.8(+C_{16} + C_{17} - C_{18} - C_{22} - 1.73C_{47} - 2.98C_{50})$
$(56) = 1.0(+C_{22} + 4.83C_{50} - 1.85C_{56} + 1.85C_{57})$
$(57) = 0.7(+C_{18} - C_{21} - 1.85C_{50} + 1.85C_{56} - 3.72C_{57})$
$(58) = 0.8(-C_{20} + C_{21} + 1.87C_{57})$
$(59) = 0.7(-C_{17} + C_{20} - 1.59C_{47} + 1.59C_{56})$
$(60) = 0.8(-C_{20} - 3.25C_{49})$
$(61) = 0.8(+C_{20} - C_{21} + 3.47C_{49} + 0.22C_{57})$
$(62) = 0.8(+C_{21} - C_{33} - 0.22C_{49} - 2.56C_{54} - 1.60C_{57})$
$(63) = 0.8(-C_{34} + 3.94C_{54})$
$(64) = 0.8(+C_{33} + C_{34} - 1.38C_{54} + 1.38C_{57})$
$(65) = 1.3(-C_{35} - 2.31C_{57})$
$(66) = 2.5(-C_{33} + C_{35} + 2.31C_{57})$
$(67) = 0.9(-C_{21} + C_{33} - 1.93C_{49})$
$(68) = 0.9(-C_{19} - 3.156C_{48})$
$(69) = 0.9(-C_{18} + C_{21} + 3.290C_{48} + 3.27C_{49} + 0.06C_{50} - 0.06C_{56})$
$(70) = 1.1(+C_{18} + C_{19} - C_{23} - 0.134C_{48} - 1.34C_{49} + 3.11C_{50} - 3.11C_{51})$
$(71) = 0.9(+C_{23} - C_{24} - 3.17C_{50} + 6.61C_{51} - 3.44C_{56} + 3.50C_{57})$
$(72) = 0.9(+C_{24} - 3.50C_{51} + 3.50C_{56} - 3.50C_{57})$
$(73) = 1.1(-C_{25} - 2.16C_{51})$
$(74) = 0.8(-C_{22} - C_{23} + C_{25} - 1.81C_{50} + 4.15C_{51} - 0.18C_{56})$
$(75) = 0.9(-C_{18} - C_{19} + C_{23} - 0.265C_{48} - 2.65C_{49} + 1.99C_{50} - 1.99C_{51})$
$(76) = 0.9(-C_{16} - C_{17} + C_{18} + C_{22} - 1.13C_{47} + 0.600C_{48} + 6.00C_{49} - 0.18C_{50} + 1.31C_{56})$
$(77) = 1.0(-C_{15} + C_{17} + C_{19} + 3.69C_{47} - 0.335C_{48} - 3.35C_{49})$
$(78) = 0.9(+C_{15} + C_{16} - 2.56C_{47} - 1.13C_{56})$
$(79) = 0.8(+C_{25} - C_{28} + 0.49C_{52})$
$(80) = 0.9(-C_{27} + C_{28} - C_{29} + 1.54C_{52} - 0.659C_{53})$

Correlate equations—continued.

Corrections. Reciprocal of weight $1/p$.

$(81) = 0{\cdot}8(+C_{29}+0{\cdot}947C_{53}-2{\cdot}88C_{56}+2{\cdot}88C_{57})$

$(82) = 0{\cdot}9(-C_{24}+C_{27}-2{\cdot}03C_{52}-2{\cdot}88C_{53}+2{\cdot}88C_{56}-2{\cdot}88C_{57})$

$(83) = 0{\cdot}9(-C_{23}+C_{24}-2{\cdot}54C_{57})$

$(84) = 0{\cdot}9(-C_{22}+1{\cdot}24C_{56}+2{\cdot}54C_{57})$

$(85) = 0{\cdot}8(+C_{22}+C_{23}-C_{25}-1{\cdot}24C_{56})$

$(86) = 1{\cdot}1(-C_{26}-C_{28}-2{\cdot}84C_{52})$

$(87) = 1{\cdot}0(+C_{26}-3{\cdot}65C_{51}+6{\cdot}49C_{52})$

$(88) = 0{\cdot}8(-C_{25}+C_{28}+5{\cdot}74C_{51}-3{\cdot}65C_{52})$

$(89) = 0{\cdot}9(+C_{25}-2{\cdot}09C_{51})$

$(90) = 0{\cdot}9(-C_{26}-C_{27}-C_{30}-2{\cdot}95C_{52}-1{\cdot}188C_{53})$

$(91) = 1{\cdot}0(-C_{29}+C_{30}+1{\cdot}526C_{53})$

$(92) = 0{\cdot}9(+C_{27}-C_{28}+C_{29}+2{\cdot}34C_{52}-0{\cdot}338C_{53})$

$(93) = 1{\cdot}0(+C_{26}+C_{28}+0{\cdot}61C_{52})$

$(94) = 0{\cdot}8(-C_{24}-0{\cdot}29C_{51}+0{\cdot}29C_{56}-0{\cdot}29C_{57})$

$(95) = 0{\cdot}8(+C_{24}-C_{27}+2{\cdot}27C_{51}-0{\cdot}058C_{53}-0{\cdot}29C_{56}+0{\cdot}29C_{57})$

$(96) = 1{\cdot}0(-C_{31}-C_{32}-1{\cdot}52C_{56}+1{\cdot}52C_{57})$

$(97) = 1{\cdot}0(-C_{26}-1{\cdot}98C_{51})$

$(98) = 0{\cdot}8(-C_{30}+C_{31}+1{\cdot}323C_{53})$

$(99) = 0{\cdot}8(+C_{32}+1{\cdot}52C_{56}-1{\cdot}52C_{57})$

$(100) = 0{\cdot}8(+C_{26}+C_{27}+C_{30}-1{\cdot}265C_{53})$

$(101) = 1{\cdot}0(+C_{30}-C_{31}-0{\cdot}48C_{56}+0{\cdot}48C_{57})$

$(102) = 1{\cdot}2(+C_{31}+1{\cdot}28C_{56}-1{\cdot}28C_{57})$

$(103) = 0{\cdot}9(-C_{29}-0{\cdot}80C_{56}+0{\cdot}80C_{57})$

$(104) = 0{\cdot}9(+C_{29}-C_{30})$

$(105) = 3{\cdot}8(-C_{32}+0{\cdot}33C_{56}-0{\cdot}33C_{57})$

$(106) = 3{\cdot}8(+C_{32}-0{\cdot}33C_{56}+0{\cdot}33C_{57})$

$(107) = 2{\cdot}5(-C_{31}+0{\cdot}76C_{56}-0{\cdot}76C_{57})$

$(108) = 2{\cdot}5(-C_{32})$

$(109) = 2{\cdot}5(+C_{31}+C_{32}-0{\cdot}76C_{56}+0{\cdot}76C_{57})$

$(110) = 0{\cdot}7(-C_{36}-C_{37}-2{\cdot}69C_{55}-0{\cdot}34C_{57})$

$(111) = 0{\cdot}9(+C_{37}+3{\cdot}03C_{55})$

$(112) = 0{\cdot}8(-C_{34}-C_{35}+C_{36}-0{\cdot}55C_{54}-0{\cdot}34C_{55}+0{\cdot}89C_{57})$

$(113) = 0{\cdot}9(+C_{34}+5{\cdot}84C_{54})$

$(114) = 0{\cdot}9(+C_{35}-5{\cdot}29C_{54}-0{\cdot}55C_{57})$

$(115) = 0{\cdot}8(-C_{33}-C_{34}-3{\cdot}18C_{54}+3{\cdot}18C_{57})$

$(116) = 0{\cdot}8(+C_{33}-C_{35}+4{\cdot}28C_{54}-3{\cdot}18C_{57})$

$(117) = 0{\cdot}7(+C_{34}+C_{35}-C_{36}-1{\cdot}10C_{54}-3{\cdot}19C_{55})$

$(118) = 0{\cdot}8(+C_{36}-C_{38}+6{\cdot}28C_{55}-3{\cdot}09C_{57})$

$(119) = 0{\cdot}9(+C_{38}-3{\cdot}09C_{55}+3{\cdot}09C_{57})$

$(120) = 0{\cdot}9(-C_{38}-C_{39}-1{\cdot}79C_{57})$

Correlate equations—completed.

Corrections.	Reciprocal of weight $1/p$.

$(121) = 0{\cdot}8(-C_{37}+C_{39}+1{\cdot}79C_{57})$

$(122) = 0{\cdot}8(-C_{36}+C_{38}+0{\cdot}95C_{57})$

$(123) = 0{\cdot}8(+C_{36}+C_{37}-0{\cdot}95C_{57})$

$(124) = 0{\cdot}7(-C_{37}+7{\cdot}97C_{55})$

$(125) = 0{\cdot}8(+C_{37}-C_{39}-9{\cdot}37C_{55}+1{\cdot}40C_{57})$

$(126) = 0{\cdot}8(+C_{39}-C_{40}+1{\cdot}40C_{55}-3{\cdot}32C_{57})$

$(127) = 0{\cdot}9(+C_{40}+1{\cdot}92C_{57})$

$(128) = 1{\cdot}0(-C_{39}+C_{40}+0{\cdot}60C_{55})$

$(129) = 0{\cdot}9(-C_{38}-3{\cdot}44C_{55}+3{\cdot}44C_{57})$

$(130) = 0{\cdot}8(+C_{38}+C_{39}+2{\cdot}84C_{55}-3{\cdot}44C_{57})$

$(131) = 0{\cdot}7(-C_{40}+1{\cdot}54C_{57})$

Normal equations.

		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}
1	0=−0·45	+3·6		+1·6												
2	0=+0·46		+3·6	−1·7												
3	0=−0·38			+4·9	−1·6	−1·6										
4	0=+0·09				+5·5	+1·6	+2·0	−1·9								
5	0=−0·08	.....	.....	.....	.....	+5·8	−2·0									
6	0=−0·66						+5·8		−1·8							
7	0=+0·49							+5·8	+1·8		+1·8					
8	0=+0·07								+5·4	−1·8	+1·8					
9	0=+0·85									+5·4	+1·7			−1·7		
10	0=+0·09	.....	.....	.....	.....	.....	.....	.....	.....	......	+6·4	.....	.....	−1·7		
11	0=−1·42											+5·7			−1·6	
12	0=+1·20												+5·9	+2·0	+1·8	−1·8
13	0=−2·02													+5·5	−1·8	
14	0=+1·22														+5·2	−1·8

Normal equations—continued.

		C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}
15	0=+0·39	+5·5	+1·8	−1·9		−1·9														
16	0=+1·05		+5·5	+1·7	−1·7				−1·7											
17	0=+0·03			+5·0	−1·7	+1·9	−1·4		−1·7											
18	0=−0·27				+5·3	+2·0		−1·6	+1·7	−2·0										
19	0=+0·61					+5·6				−2·0										
20	0=−0·23	.....	.....	.....	.....	....	+4·5	−1·6												
21	0=+0·61							+4·9												−1·7
22	0=+0·69								+5·2	+1·6		−1·6								
23	0=+0·37									+5·4	−1·8	−1·6								
24	0=−1·55										+5·2			−1·7						
25	0=−0·25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+5·2			−1·6					
26	0=−0·62												+5·8	+1·7	+2·1		+1·7			
27	0=+0·84													+5·2	−1·8	+1·8	+1·7			
28	0=+0·07														+5·5	−1·8				
29	0=+1·10															+5·4	−1·9			
30	0=−1·41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+5·4	−1·8		
31	0=+1·28																	+9·0	+3·5	
32	0=−0·11																		+14·4	

Normal equations—continued.

		C_{33}	C_{34}	C_{35}	C_{36}	C_{37}	C_{38}	C_{39}	C_{40}	C_{41}	C_{42}	C_{43}	C_{44}	C_{45}	C_{46}
33	0 = −1·62	+6·6	+1·6	−3·3											
34	0 = +1·10		+4·8	+1·5	−1·5										
35	0 = +1·37	.....	.....	+7·0	−1·5										
36	0 = +0·96				+4·6	+1·5	−1·6								
37	0 = +0·22					+4·7		−1·6							
38	0 = +0·11						+5·1	+1·7							
39	0 = +0·41							+5·1	−1·8						
40	0 = −0·99	.....	.....	.....	.....	.....	.....	.....	+3·4						
41	0 = −3·8									+51·123	+1·705				
42	0 = −1·7										+64·821	+ 0·573	+ 3·95		
43	0 = −1·82											+78·136	− 11·00	+ 1·36	
44	0 = −0·8												+170·86	− 77·26	+ 3·004
45	0 = +1·7	....	.....	.....	.....	.....	.....	.....	.....	....	....	....	....	+185·75	−27·400
46	0 = −6·2														+54·542

Normal equations—completed.

		C_{41}	C_{42}	C_{43}	C_{44}	C_{45}	C_{46}	C_{47}	C_{48}	C_{49}	C_{50}	C_{51}	C_{52}	C_{56}
1		+3·630												+1·848
2		−6·736												−5·395
3		+6·043	+1·192											+6·109
4		−1·144	+5·426	−0·010										+1·355
5		−1·144	−9·662	+5·350	....	......	......	......	......	......	......	......	......	−9·480
6			+7·976	−0·455	− 4·700									+3·929
7			−2·988	−2·037	− 0·806	+1·208								+0·806
8			+0·208	−2·990	+ 7·071	+1·208								+0·880
9				+3·526	− 8·243	−2·835	−1·624							+3·502
10		......	....	+0·081	−11·558	+5·084	−1·624	....	......	......	......	......	......	+0·448
11						−4·225	−2·520							+2·520
12						+0·462	−8·218	−2·583						+6·604
13					+ 1·066	+2·835	−2·228							+2·458
14						−4·944	+2·106	−2·583						−3·132

Normal equations—completed.

		C_{44}	C_{45}	C_{46}	C_{47}	C_{48}	C_{49}	C_{50}	C_{51}	C_{52}	C_{53}	C_{54}	C_{56}	C_{57}
15		....	......	+1·530	−0·360	+0·141	+1·406	.. ....	....	....	....	....	+0·369	
16					−5·659	−0·540	−5·400	−2·222					+0·955	
17					+1·021	+1·750	−1·822	−2·222					−1·928	
18					+0·367	−2·330	+3·368	+2·503	−1·630				+2·528	−2·604
19					+0·639	+0·186	−0·495	+1·630	−1·630					
20		....	......	....	−0·749	−2·430	−3·080	....	....	....	....	....	+0·749	−1·320
21						+2·961	+1·728	+1·349				−2·048	−1·349	+2·644
22					+0·367	+0·540	+5·400	+8·500	−3·320				−2·635	−0·436
23						−0·091	−0·911	−3·035	+4·259				−3·944	+5·436
24								+2·853	−7·051	+ 1·827	+0·213		+3·190	−5·530
25		....	......	... ...	....	....	....	−1·448	−0·777	+ 3·312	....	....	+0·848	
26									−1·670	+12·879	+0·057			
27									−1·816	+ 1·548	+0·133		+2·824	−2·824
28									+4·592	− 0·298	−0·289			
29										+ 0·720	−0·480		−1·584	+1·584
30		....	......	....	....	....	....	....	....	+ 2·655	+0·525	....	−0·480	+0·480
31											+1·058		−0·264	+0·264
32													−1·672	+1·672

Normal equations—completed.

		C_{47}	C_{48}	C_{49}	C_{50}	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}	C_{56}	C_{57}
33				− 1·56					+ 6·912			− 8·479
34									+ 3·214	− 1·961		− 2·152
35		....	....	....	....	....	....	....	− 8·515	− 1·961	....	+ 10·115
36									+ 0·330	+ 8·868		− 3·042
37										− 8·465		− 0·834
38										− 2·437		+ 1·776
39										+ 10·288		− 3·485
40		....	....	....	....	....	....	....	....	− 0·520	....	+ 3·306
41											+ 11·009	
42											+ 26·814	
43											+ 6·849	
44											+ 3·380	
45		....	....	....	....	....	....	....	....	....	+ 33·633	
46		+ 4·804									− 18·595	
47	0=+0·8	+52·693	− 3·768	− 27·64	+ 4·307						− 4·096	
48	0=−1·23		+36·187	+ 32·60	− 0·853	+ 0·93					+ 1·793	
49	0=−1·7			+139·92	−10·125	+ 9·33			+ 0·450		+ 9·489	+ 0·892
50	0=+2·4	....	....	....	+58·728	− 39·07	....	....	....	....	− 1·472	+ 3·767
51	0=−0·7					+135·18	−40·449	−0·106			− 32·680	+ 32·440
52	0=−2·0						+80·820	+2·056			− 5·261	+ 5·261
53	0=−0·61							+7·568			− 2·914	+ 2·914
54	0=+1·4								+98·900	+ 2·61		− 14·998
55	0=−1·0	....	....	....	....	....	....	....	....	+194·42	....	− 56·399
56	0=+5·7										+171·07	− 52·148
57	0=+2·6											+174·110

Resulting values of correlates.

C_1=+0·1207	C_{16}=−0·2409	C_{30}=+0·1223	C_{44}=+0·0449
C_2=−0·1272	C_{17}=+0·1811	C_{31}=−0·1395	C_{45}=+0·0375
C_3=−0·0699	C_{18}=+0·4276	C_{32}=+0·0363	C_{46}=+0·1315
C_4=−0·3218	C_{19}=−0·3196	C_{33}=+0·4168	C_{47}=−0·0635
C_5=+0·1829	C_{20}=+0·1918	C_{34}=−0·5315	C_{48}=+0·0569
C_6=+0·3318	C_{21}=+0·1744	C_{35}=−0·0191	C_{49}=−0·0056
C_7=−0·2663	C_{22}=−0·3624	C_{36}=−0·6061	C_{50}=−0·0143
C_8=+0·1052	C_{23}=+0·1242	C_{37}=+0·2410	C_{51}=−0·0053
C_9=+0·1698	C_{24}=+0·3096	C_{38}=−0·2491	C_{52}=−0·0325
C_{10}=+0·2558	C_{25}=−0·0829	C_{39}=+0·1599	C_{53}=+0·0530
C_{11}=+0·3849	C_{26}=+0·2957	C_{40}=+0·3927	C_{54}=−0·0247
C_{12}=−0·2855	C_{27}=−0·1935	C_{41}=+0·0652	C_{55}=+0·0236
C_{13}=+0·6821	C_{28}=−0·2701	C_{42}=+0·0481	C_{56}=−0·0590
C_{14}=+0·0849	C_{29}=−0·1904	C_{43}=+0·0123	C_{57}=−0·0136
C_{15}=−0·1424			

Resulting corrections to directions.

″	″	″	″
(1)=−0·054	(34)=−0·155	(67)=+0·228	(100)=+0·126
(2)=+0·103	(35)=+0·303	(68)=+0·126	(101)=+0·284
(3)=+0·360	(36)=−0·304	(69)=−0·074	(102)=−0·237
(4)=−0·441	(37)=−0·603	(70)=−0·049	(103)=+0·204
(5)=−0·014	(38)=+0·294	(71)=−0·018	(104)=−0·281
(6)=+0·070	(39)=+0·356	(72)=+0·152	(105)=−0·195
(7)=+0·055	(40)=+0·017	(73)=+0·104	(106)=+0·195
(8)=−0·011	(41)=−0·401	(74)=+0·136	(107)=+0·262
(9)=−0·114	(42)=−0·044	(75)=−0·002	(108)=−0·091
(10)=+0·387	(43)=+0·801	(76)=+0·110	(109)=−0·172

Resulting corrections to directions—continued.

″	″	″	″
(11)=−0·270	(44)=−0·081	(77)=−0·231	(110)=+0·214
(12)=+0·108	(45)=−0·198	(78)=−0·139	(111)=+0·281
(13)=−0·199	(46)=+0·104	(79)=+0·137	(112)=−0·050
(14)=+0·003	(47)=−0·404	(80)=+0·026	(113)=−0·608
(15)=+0·038	(48)=+0·154	(81)=−0·008	(114)=+0·107
(16)=−0·240	(49)=+0·391	(82)=−0·525	(115)=+0·120
(17)=+0·147	(50)=−0·321	(83)=+0·198	(116)=+0·299
(18)=+0·146	(51)=+0·025	(84)=+0·229	(117)=+0·005
(19)=−0·202	(52)=−0·159	(85)=−0·066	(118)=−0·133
(20)=+0·027	(53)=+0·006	(86)=+0·073	(119)=−0·328
(21)=−0·070	(54)=+0·112	(87)=+0·104	(120)=+0·102
(22)=−0·025	(55)=+0·022	(88)=−0·079	(121)=−0·084
(23)=−0·212	(56)=−0·347	(89)=−0·065	(122)=+0·275
(24)=+0·165	(57)=+0·155	(90)=−0·172	(123)=−0·282
(25)=+0·241	(58)=−0·034	(91)=+0·394	(124)=−0·037
(26)=−0·106	(59)=+0·012	(92)=−0·187	(125)=−0·127
(27)=+0·130	(60)=−0·139	(93)=+0·006	(126)=−0·124
(28)=−0·198	(61)=−0·004	(94)=−0·257	(127)=+0·330
(29)=−0·488	(62)=−0·125	(95)=+0·401	(128)=+0·247
(30)=+0·769	(63)=+0·347	(96)=+0·172	(129)=+0·109
(31)=−0·229	(64)=−0·080	(97)=−0·285	(130)=+0·020
(32)=+0·375	(65)=+0·066	(98)=−0·153	(131)=−0·290
(33)=−0·132	(66)=−1·168	(99)=−0·026	

Probable error of a resulting direction $=0{\cdot}674\sqrt{\frac{8{\cdot}6}{57}}=\pm0''{\cdot}26$.

Resulting angles and sides of the triangulation between the Epping base net and the Massachusetts base; also between this base and the Fire Island base net.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Ragged Mountain	29	25	02·11	+0·04	02·15	3·44	4·761 268 0	57 712·253
	Humpback	39	54	29·08	+0·36	29·44	3·44	4·877 280 4	75 384·22
	Mount Desert	110	40	38·68	+0·05	38·73	3·44	5·041 137 6	109 935·4
2	Mount Harris	40	32	25·22	+0·08	25·30	3·79	4·761 268 0	57 712·253
	Humpback	66	02	38·51	−0·44	38·07	3·80	4·909 249 6	81 142·72
	Mount Desert	73	25	08·11	−0·10	38·01	3·79	4·929 927 0	85 099·50
3	Mount Harris	65	08	37·27	−0·02	37·25	3·13	4·877 280 4	75 384·21
	Mount Desert	37	15	30·57	+0·16	30·73	3·13	4·701 544 4	50 297·27
	Ragged Mountain	77	36	01·17	+0·24	01·41	3·13	4·909 249 6	81 142·72
4	Mount Harris	105	41	02·49	+0·07	02·56	3·49	5·041 137 6	109 935·4
	Humpback	26	08	09·43	−0·80	08·63	3·48	4·701 544 4	50 297·27
	Ragged Mountain	48	10	59·06	+0·20	59·26	3·48	4·929 927 0	85 099·50
5	Mount Blue	26	55	40·80	+0·39	41·19	4·02	4·701 544 4	50 297·27
	Mount Harris	94	22	34·42	−0·17	34·25	4·03	5·044 318 1	110 743·5
	Ragged Mountain	58	41	56·94	−0·31	56·63	4·02	4·977 267 1	94 900·20

Resulting angles and sides of the triangulation between the Epping base net and the Massachusetts base; also between this base and the Fire Island base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
	Sabattus	32	08	13·22	+0·08	13·30	3·15	4·701 544 4	50 297·27
6	Mount Harris	52	02	19·02	−0·07	18·95	3·15	4·872 442 9	74 549·19
	Ragged Mountain	95	49	37·14	+0·07	37·21	3·16	4·973 438 4	94 067·25
	Sabattus	69	29	07·45	+0·38	07·83	5·09	4·977 267 1	94 900·20
7	Mount Blue	68	10	51·74	+0·38	52·12	5·08	4·973 438 4	94 067·25
	Mount Harris	42	20	15·40	−0·10	15·30	5·08	4·834 048 9	68 241·56
	Sabattus	101	37	20·67	+0·45	21·12	4·22	5·044 318 1	110 743·5
8	Mount Blue	41	15	10·94	0·00	10·94	4·21	4·872 443 0	74 549·20
	Ragged Mountain	37	07	40·20	+0·38	40·58	4·21	4·834 048 8	68 241·55
	Mount Pleasant	54	39	35·70	−0·09	35·61	8·11	5·044 318 1	110 743·5
9	Mount Blue	85	35	26·05	−0·12	25·93	8·10	5·131 493 6	135 361·0
	Ragged Mountain	39	45	23·05	−0·28	22·77	8·10	4·938 618 6	86 819·76
	Mount Pleasant	51	26	46·90	+0·24	47·14	3·50	4·834 048 9	68 241·56
10	Mount Blue	44	20	15·11	−0·12	14·99	3·50	4·785 231 0	60 986·12
	Sabattus	84	13	08·56	−0·19	08·37	3·50	4·938 618 6	86 819·76
	Mount Pleasant	3	12	48·80	−0·327	48·473	0·391	4·872 443 0	74 549·20
11	Sabattus	174	09	30·77	−0·265	30·505	0·392	5·131 493 6	135 361·0
	Ragged Mountain	2	37	42·85	−0·654	42·196	0·391	4·785 231 0	60 986·12
	Mount Independence	77	48	18·33	−0·28	18·05	1·94	4·785 231 0	60 986·12
12	Mount Pleasant	48	46	01·10	−0·62	00·48	1·94	4·671 377 7	46 922·13
	Sabattus	53	25	47·25	+0·05	47·30	1·95	4·699 925 8	50 110·16
	Mount Independence	25	16	42·18	−0·34	41·84	1·83	4·834 048 9	68 241·56
13	Mount Blue	17	04	28·31	−0·35	27·96	1·82	4·671 377 7	46 922·13
	Sabattus	137	38	55·81	−0·14	55·67	1·82	5·032 067 2	107 663·2
	Mount Independence	52	31	36·15	+0·06	36·21	3·62	4·938 618 6	86 819·76
14	Mount Pleasaut	100	12	48·00	−0·38	47·62	3·62	5·032 067 2	107 663·2
	Mount Blue	27	15	46·80	+0·23	47·03	3·62	4·699 925 8	50 110·16
	Mount Washington	68	55	42·51	−0·02	42·49	3·41	4·938 618 6	86 819·76
15	Mount Blue	30	23	.....	....	02·89	3·41	4·672 640 4	46 950·53
	Mount Pleasant	80	41	25·33	−0·48	24·85	3·41	4·962 918 5	91 816·03
	Gunstock	34	19	40·20	+0·84	41·04	3·03	4·699 925 8	50 110·16
16	Mount Pleasant	19	54	04·38	+0·26	04·64	3·04	4·948 470 6	88 811·79
	Mount Independence	53	46	22·53	+0·90	23·43	3·04	4·855 408 1	71 681·66
	Mount Washington	58	41	21·78	+0·46	22·24	2·85	4·855 408 1	71 681·66
17	Mouut Pleasaut	87	11	42·29	+0·60	42·89	2·84	4·923 248 1	83 800·79
	Gunstock	34	07	03·05	+0·36	03·41	2·85	4·672 640 4	46 950·53

Resulting angles and sides of the triangulation between the Epping base net and the Massachusetts base; also between this base and the Fire Island base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
18	Agamenticus	85	39	41 ·30	−0 ·02	41 ·28	3 ·59	4 ·948 470 6	88 811 ·79
	Gunstock	48	29	43 ·81	−0 ·88	42 ·93	3 ·59	4 ·824 135 1	66 701 ·43
	Mount Independence	45	50	46 ·87	−0 ·30	46 ·57	3 ·60	4 ·805 515 8	63 902 ·20
19	Agamenticus	33	20	57 ·33	+0 ·16	57 ·49	2 ·78	4 ·699 925 8	50 110 ·16
	Mount Pleasant	47	01	59 ·61	+1 ·26	00 ·87	2 ·79	4 ·824 135 1	66 701 ·43
	Mount Independence	99	37	09 ·40	+0 ·60	10 ·00	2 ·79	4 ·953 627 1	89 872 ·56
20	Agamenticus	52	18	43 ·97	−0 ·18	43 ·79	3 ·84	4 ·855 408 1	71 681 ·66
	Gunstock	82	49	24 ·01	−0 ·04	23 ·97	3 ·85	4 ·953 627 0	89 872 ·54
	Mount Pleasant	44	52	04 ·77	−1 ·00	03 ·77	3 ·84	4 ·805 515 8	63 902 ·20
21	Unkonoonuc	53	00	53 ·60	+0 ·10	53 ·70	3 ·25	4 ·805 515 8	63 902 ·20
	Gunstock	76	11	25 ·06	+0 ·19	25 ·25	3 ·25	4 ·890 346 8	77 686 ·72
	Agamenticus	50	47	50 ·46	+0 ·35	50 ·81	3 ·26	4 ·792 336 4	61 992 ·11
22	Thompson	29	43	52 ·11	+0 ·09	52 ·20	3 ·23	4 ·805 515 8	63 902 ·20
	Gunstock	31	52	27 ·68	−0 ·12	27 ·56	3 ·23	4 ·832 776 9	68 041 ·97
	Agamenticus	118	23	50 ·30	−0 ·36	49 ·94	3 ·24	5 ·054 430 8	113 352 ·4
23	Thompson	61	50	53 ·28	−0 ·25	53 ·03	4 ·13	4 ·890 346 8	77 686 ·72
	Unkonoonuc	50	33	20 ·33	−0 ·09	20 ·24	4 ·13	4 ·832 776 9	68 041 ·97
	Agamenticus	67	35	59 ·84	−0 ·71	59 ·13	4 ·14	4 ·910 955 0	81 461 ·99
24	Unkonoonuc	103	34	13 ·93	+0 ·01	13 ·94	4 ·15	5 ·054 430 8	113 352 ·4
	Gunstock	44	18	57 ·38	+0 ·30	57 ·68	4 ·15	4 ·910 955 1	81 462 ·00
	Thompson	32	07	01 ·17	−0 ·34	00 ·83	4 ·15	4 ·792 336 5	61 992 ·13
25	Monadnock	32	54	52 ·43	+0 ·13	52 ·56	1 ·93	4 ·792 336 4	61 992 ·11
	Gunstock	22	59	06 ·42	+0 ·05	06 ·47	1 ·93	4 ·648 835 1	44 548 ·71
	Unkonoonuc	124	06	06 ·72	+0 ·05	06 ·77	1 ·94	4 ·975 287 4	94 468 ·59
26	Wachusett	61	22	19 ·44	−0 ·17	19 ·27	8 ·68	5 ·054 430 8	113 352 ·4
	Gunstock	48	00	55 ·09	−0 ·21	54 ·88	8 ·68	4 ·982 231 4	95 991 ·20
	Thompson	70	37	12 ·12	−0 ·23	11 ·89	8 ·68	5 ·085 731 5	121 823 ·6
27	Wachusett	57	33	20 ·78	+0 ·03	20 ·81	4 ·12	4 ·910 955 0	81 461 ·99
	Unkonoonuc	83	56	40 ·35	+0 ·13	40 ·48	4 ·11	4 ·982 231 3	95 991 ·18
	Thompson	38	30	10 ·95	+0 ·11	11 ·06	4 ·12	4 ·778 830 2	60 093 ·88
28	Wachusett	3	48	58 ·66	−0 ·202	58 ·458	0 ·412	4 ·792 336 4	61 992 ·11
	Gunstock	3	41	57 ·71	−0 ·510	57 ·200	0 ·412	4 ·778 830 3	60 093 ·89
	Unkonoonuc	172	29	05 ·72	−0 ·142	04 ·578	0 ·412	5 ·085 731 4	121 823 ·6
29	Monadnock	117	01	19 ·36	+0 ·01	19 ·37	3 ·21	5 ·085 731 4	121 823 ·6
	Gunstock	19	17	08 ·71	+0 ·56	09 ·27	3 ·22	4 ·654 798 1	45 164 ·59
	Wachusett	43	41	41 ·10	−0 ·10	41 ·00	3 ·21	4 ·975 287 5	94 468 ·60

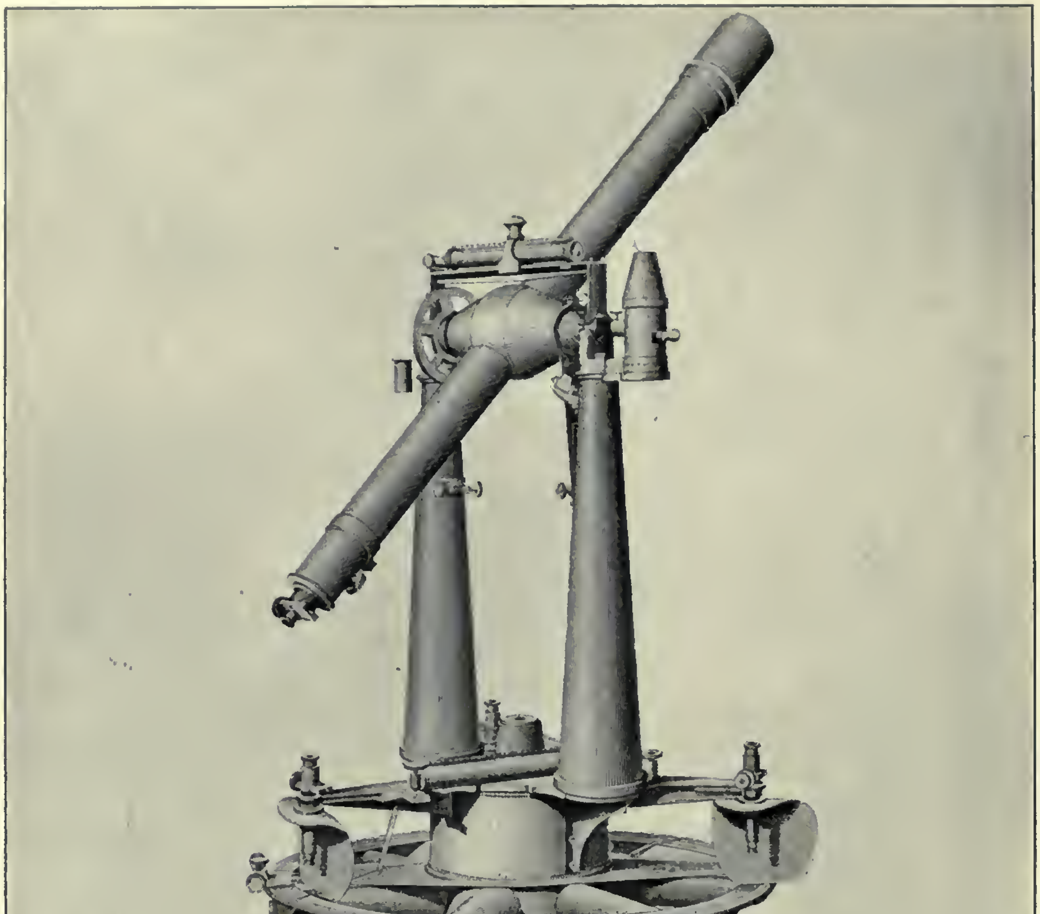
Resulting angles and sides of the triangulation between the Epping base net and the Massachusetts base; also between this base and the Fire Island base net—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
30	Wachusett	47	30	39·76	−0·30	39·46	1·70	4·648 835 1	44 548·71
	Monadnock	84	06	26·93	−0·12	26·81	1·69	4·778 830 2	60 093·88
	Unkonoonuc	48	22	59·00	−0·19	58·81	1·69	4·654 798 1	45 164·59
31	Blue Hill	59	37	43·90	−0·29	43·61	3·74	4·910 955 0	81 461·99
	Unkonoonuc	35	14	58·03	−0·37	57·66	3·74	4·736 332 8	54 492·01
	Thompson	85	07	29·98	−0·03	29·95	3·74	4·973 491 2	94 078·68
32	Blue Hill	99	18	37·08	−0·26	36·82	3·22	4·982 231 4	95 991. 20
	Wachusett	34	04	13·91	+0·03	13·94	3·21	4·736 332 6	54 491·99
	Thompson	46	37	19·03	−0·14	18·89	3·22	4·849 420 1	70 700·11
33	Wachusett	91	37	34·69	+0·06	34·75	3·60	4·973 491 2	94 078·68
	Unkonoonuc	48	41	42·32	+0·50	42·82	3·59	4·849 420 2	70 700·13
	Blue Hill	39	40	53·18	+0·03	53·21	3·59	4·778 830 4	60 093·90
34	Beaconpole	82	05	13·39	+0·66	14·05	2·03	4·849 420 1	70 700·11
	Wachusett	31	00	49·40	+0·17	49·57	2·02	4·565 581 4	36 777·43
	Blue Hill	66	54	01·73	+0·72	02·45	2·02	4·817 279 5	65 656·77
35	Manomet	45	08	44·85	+0·02	44·87	2·47	4·736 332 7	54 492·00
	Blue Hill	90	36	02·56	+0·20	02·76	2·48	4·885 726 8	76 864·67
	Thompson	44	15	19·76	+0·03	19·79	2·47	4·729 513 1	53 643·00
36	Manomet	29	59	42·88	−0·18	42·70	1·62	4·565 581 4	36 777·43
	Beaconpole	46	49	04·89	−0·69	04·20	1·62	4·729 513 0	53 642·99
	Blue Hill	103	11	18·63	−0·66	17·97	1·63	4·855 073 1	71 626·39
37	Copecut	106	07	29·31	+0·18	29·49	1·63	4·855 073 1	71 626·39
	Beaconpole	37	18	13·17	+0·41	13·58	1·63	4·655 000 4	45 185·64
	Manomet	36	34	21·79	+0·03	21·82	1·63	4·647 629 9	44 425·26
38	Copecut	41	58	51·45	−0·01	51·44	1·37	4·565 581 4	36 777·43
	Beaconpole	84	07	18·06	−0·28	17·78	1·38	4·737 944 0	54 694·54
	Blue Hill	53	53	55·45	−0·55	54·90	1·37	4·647 630 0	44 425·27
39	Copecut	64	08	37·86	+0·19	38·05	1·88	4·729 513 1	53 643·00
	Blue Hill	49	17	23·18	−0·11	23·07	1·88	4·655 000 3	45 185·63
	Manomet	66	34	04·67	−0·15	04·52	1·88	4·737 944 1	54 694·55
40	Great Meadow	69	09	39·74	−0·08	39·66	0·70	4·565 581 4	36 777·43
	Beaconpole	74	40	16·66	−0·55	16·11	0·69	4·579 231 4	37 951·71
	Blue Hill	36	10	06·84	−0·52	06·32	0·70	4·365 932 1	23 223·74
41	Great Meadow	130	20	20·91	−0·49	20·42	0·54	4·737 944 1	54 694·55
	Blue Hill	17	43	48·61	−0·03	48·58	0·53	4·339 491 3	21 852·01
	Copecut	31	55	53·18	−0·58	52·60	0·53	4·579 231 4	37 951·71

Resulting angles and sides of the triangulation between the Epping base net and the Massachusetts base; also between this base and the Fire Island base net—completed.

No.	Stations.	Observed angles. °	′	″	Corrections. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
42	Great Meadow	160	29	59·35	+0·565	59·915	0·144	4·647 630 0	44 425·27
	Copecut	10	02	58·27	+0·566	58·836	0·143	4·365 932 1	23 223·74
	Beaconpole	9	27	01·40	+0·279	01·679	0·143	4·339 491 3	21 852·01
43	Massachusetts North Base	70	09	29·82	−0·43	29·39	0·33	4·365 932 1	23 223·74
	Great Meadow	58	49	15·01	−0·52	14·49	0·32	4·324 757 7	21 123·10
	Beaconpole	51	01	17·42	−0·33	17·09	0·32	4·283 145 5	19 193·12
44	Massachusetts South Base	81	00	16·67	+0·39	17·06	0·22	4·324 757 7	21 123·10
	Beaconpole	54	06	45·24	−0·20	45·04	0·22	4·238 707 7	17 326·376
	Massachusetts North Base	44	52	58·64	−0·08	58·56	0·22	4·178 727.3	15 091·32
45	Mount Tom	33	28	40·67	+0·18	40·85	2·62	4·654 798 1	45 164·59
	Monadnock	56	44	47·59	+0·04	47·63	2·61	4·835 503 1	68 470·44
	W chusett	89	46	37·97	+1·40	39·37	2·62	4·913 165 6	81 877·70
46	Bald Hill	19	48	48·84	+0·71	49·55	1·78	4·654 798 1	45 164·59
	Monadnock	28	05	25·33	+0·47	25·80	1·78	4·797 545 0	62 740·07
	Wachusett	132	05	49·82	+0·16	49·98	1·77	4·995 067 2	98 870·61
47	Mount Tom	95	52	53·91	−0·11	53·80	3·29	4·995 067 2	98 870·61
	Monadnock	28	39	22·26	−0·43	21·83	3·28	4·678 180 7	47 662·93
	Bald Hill	55	27	54·78	−0·56	54·22	3·28	4·913 165 6	81 877·70
48	Bald Hill	75	16	43·62	+0·15	43·77	2·44	4·835 503 1	68 470·44
	Mount Tom	62	24	13·24	−0·29	12·95	2·45	4·797 545 0	62 740·07
	Wachusett	42	19	11·85	−1·23	10·62	2·45	4·678 180 7	47 662·93
49	Box Hill	65	43	58·37	−0·56	57·81	1·15	4·678 180 7	47 662·93
	Mount Tom	33	25	21·08	−0·14	20·94	1·15	4·459 356 2	28 797·58
	Bald Hill	80	50	44·95	−0·26	44·69	1·14	4·712 792 2	51 616·93
50	Ivy	14	48	02·79	−0·09	02·70	1·19	4·459 356 2	28 797·58
	Bald Hill	34	47	46·77	+0·07	46·84	1·19	4·808 420 3	64 331·00
	Box Hill	130	24	14·24	−0·20	14·04	1·20	4·933 714 3	85 844·86
51	Sandford	31	27	27·49	−0·09	27·40	2·22	4·712 792 2	51 616·93
	Mount Tom	34	16	43·55	−0·19	43·36	2·22	4·745 910 0	55 707·03
	Box Hill	114	15	55·72	+0·17	55·89	2·21	4·955 070 1	90 171·67
52	Sandford	74	02	34·46	−0·23	34·23	2·31	4·808 420 3	64 331·00
	Ivy	56	21	53·03	0·00	53·03	2·31	4·745 910 0	55 707·03
	Box Hill	49	35	39·85	−0·18	39·67	2·31	4·707 138 1	50 949·29
53	Wooster	53	47	59·13	−0·29	59·42	1·97	4·707 138 1	50 949·29
	Ivy	47	40	51·65	+0·45	52·10	1·97	4·669 171 0	46 684·31
	Sandford	78	31	14·14	+0·25	14·39	1·97	4·791 513 4	61 874·74

30 CM. THEODOLITE.

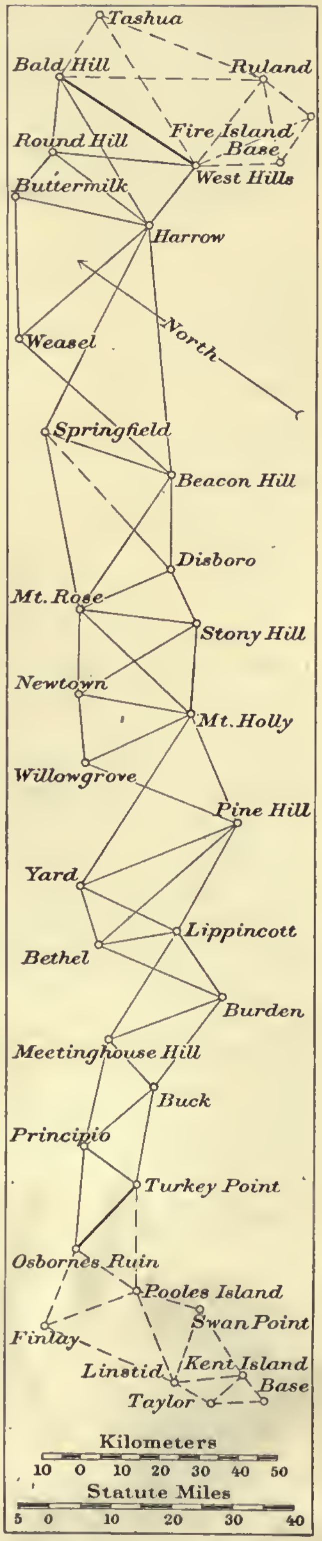


75 CM. THEODOLITE.

3. TRIANGULATION CONNECTING THE FIRE ISLAND BASE NET WITH THE KENT ISLAND BASE NET EXTENDED, CONNECTICUT, NEW YORK, NEW JERSEY, PENNSYLVANIA, DELAWARE, AND MARYLAND. 1833–1845 AND 1865.

The angular measures of this section of the oblique arc date from the year 1833, and were completed in 1845. The triangulation up to 1843 inclusive is essentially the work of Superintendent F. R. Hassler. In its composition it reflects the custom in those early days of including but a few composite figures, such as quadrilaterals or central figures, the chain being made up mainly of triangles. The number of observations taken would now be considered as scanty, yet with the superior instruments Mr. Hassler had procured, his results reached a fair degree of accuracy. The number of series, each including a direct and a reversed set, varied from 11 to 35, with an average of 24. At the six stations which remained to be occupied after his death in November 1843, the observations of his principal assistant show an extreme range in number of series between 10 and 73. The horizontal circle of the theodolite was used at each station in several positions, most frequently in six or three, that is, by shifting the zero division of the graduation either 60° or 120° for each new position. It was Mr. Hassler's practice to observe only at such times as were considered by him favorable or conducive to good results. In 1850–51, in the local or station adjustments, the measures were treated as directions according to Bessel's method, and an adjustment of the triangulation was made in sections. The results were published in the Coast Survey Report for 1851, page 222, and following. Later on, in 1866–67, after the reoccupation of certain stations of the Fire Island base net, and after some revision of the triangulation about the Kent Island base, a new and more systematic adjustment was made, and relative weights to the directions were introduced. These later results were published in the Coast Survey Report for 1866, pages 52–53. A discrepancy of 50 units in the seventh place of decimals of the logarithm of the length was developed by the triangulation, and was distributed in this adjustment by a length equation. A comparison of these results with the present values of the length of the starting line Bald Hill to West Hills, showed a difference in the logarithm of 4 units in the seventh place, whereas the new adjustment in the vicinity of Kent Island base showed no discrepancy on the line Osbornes Ruin to Turkey Point. This fully justified the retention of the adjustment of 1866–67, with but a slight change due to the

No. 22.



gradual dispersion of this small logarithmic discrepancy of 4 units in the seventh place of decimals. The small changes indicated in the angles of the first and second triangles, which do not exceed 0″·21, and in the last or thirtieth triangle of less than half a second, are due to this method of producing an accord.

The correction to the horizontal angles for height of stations observed upon is less than 0″·02, and generally this need not be considered.

The approximate heights of the stations are as follows:

	Meters.	Feet.		Meters.	Feet.
Round Hill	177	582	Willowgrove	132	433
Harrow *	116	379	Pine Hill †	61·4	202
Buttermilk	217	712	Yard	150	493
Weasel *	178	583	Lippincott	43	142
Beacon Hill †	113·7	373	Bethel	125	410
Springfield *	159	523	Burden, less than		500
Mount Rose	127·7	419	Meetinghouse Hill, less than		500
Disboro †	84·2	276	Buck, less than		500
Stony Hill †	71·6	235	Principio, less than		500
Newtown	99	326	Turkey Point	25	82
Mount Holly	55·3	181	Osbornes Ruin	90	295

The fact that the spherical excess of the triangles was computed with reference to the Besselian spheroid is immaterial, as the values from the Clarke spheroid would be the same within the limits of the size of the triangles. The details of this adjustment have not been published, and it is desirable to present here certain leading quantities, but it is essential to bear in mind that the 1866–67 adjustment started from the sides of the triangle Tashua, Ruland, West Hills, as given, and terminated with the side Finlay to Pooles Island. It is therefore slightly longer than the section which is now under consideration. The small corrections to the lines Bald Hill to West Hills and Osbornes Ruin to Turkey Point, due to the readjustment, are not introduced here, but the effect is indicated by the fractional seconds placed in parenthesis and already alluded to above. The mean error of a triangle, derived from the sum of the squares of the closing errors, equals $\sqrt{\frac{73{\cdot}92}{33}} = \pm\, 1''{\cdot}50$, and that of an angle $\pm\, 0''{\cdot}86$, and the probable error of a direction equals $0{\cdot}674\, \frac{1{\cdot}50}{\sqrt{6}} = \pm\, 0''{\cdot}41$. The probable error of a direction, ε_1, as found approximately from the individual measures at each station, is $\pm 0''{\cdot}25$; hence the square of the triangle-combination error $= \varepsilon_c^2 = (0{\cdot}41)^2 - (0{\cdot}25)^2 = 0{\cdot}107$, which quantity was added to each ε_1^2; hence $\frac{1}{p} = \varepsilon_c^2 + \varepsilon_1^2$. The ratio of the greatest to the least value of $\frac{1}{p}$ is as 0·63 to 0·12.

* Determined in 1817. † Result of spirit leveling.

Abstracts of horizontal directions at the principal stations between the Fire Island and the Kent Island base nets, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland, 1833–1845 and 1865.

Bald Hill, Fairfield County, Connecticut. July 23 to August 18, 1833. 60 cm direction theodolite No. 2. F. R. Hassler, observer.

Number of directions.	Objects observed.	Resulting direction from station adjustment.	Approximate probable error.	Reductions to sea level.	Corrections from net adjustment.	Resulting seconds.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″	″	″	″
	Tashua'	0 00 00·000	±0·22	+0·006	−0·103	(59·903)	.....	00·00
	Ruland*	62 40 17·802	0·60	....	+1·433	(14·291)	.....	.....
		+0·056						
8	West Hills	99 31 40·835	0·27	....	−0·213	(40·622)	+0·434	41·27
9	Harrow	121 42 18·609	0·19	....	....	......	−0·954	17·65
10	Round Hill	158 36 54·002	0·40	....	....	......	−0·087	53·91
				Mean correction	0·372			

Circle used in VI positions.

West Hills, Suffolk County, New York. October 18 to December 1, 1836.† 75 cm direction theodolite No. 1. F. R. Hassler, observer. July 18 to August 15, 1865. 75 cm direction theodolite No. 1. G. W. Dean, observer.

Number of directions.	Objects observed.	Resulting direction from station adjustment.	Approximate probable error.	Reductions to sea level.	Corrections from net adjustment.	Resulting seconds.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″	″	″	″
	Wooster	0 00 00·000	±0·06	−0·003	+0·169	(00·166)	.....	00·17
	Azimuth Mark	7 26 21·768	0·06	....	.....	(21·781)	.....	.....
	Tashua‡	21 35 06·476	0·05	+0·006	−0·099	(06·383)	.....	.....
	Sandford	33 58 36·531	0·08	+0·014	−0·089	(36·456)	.....	.....
	Ruland‡	89 14 44·741	0·32	....	+0·226	(44·967)	.....	.....
	Fire Island East Base‡	122 36 15·675	0·33	.....	−0·400	(15·275)	.....	....
	Fire Island West Base‡	143 58 00·808	0·38	.....	+0·406	(01·214)	.....	.....
3	Harrow‡	269 17 04·256	0·16	.....	.....	......	+0·055	04·31
4	Round Hill‡	331 59 49·211	0·33	.....	.....	......	+0·314	49·52
5	Bald Hill‡	359 21 01·916	0·25	−0·003	−0. 123	(01.790)	−0·109	01·81
				Mean correction	0·013			

Round Hill, Fairfield County, Connecticut. July 5 to 18, 1833. 60 cm direction theodolite No. 2. F. R. Hassler, observer.§

Number of directions.	Objects observed.	Results from station adjustment.	Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″
11	Bald Hill	0 00 00·000	±0·25	+0·275	00·27
12	West Hills	93 33 38 594	0·30	−1·264	37·33
13	Harrow	121 52 34·930	0·26	+0·965	35·89
14	Buttermilk ‖	220 22 52·250	0·38	−0·181	48·51
		−3·560			

* The correction refers to Ruland station of 1865.

† Twenty-six series were observed in 1836.

‡ Hassler, observer.

§ Fourteen series were observed.

‖ The reduction indicated is on observer's authority.

Abstracts of horizontal directions at the principal stations between the Fire Island and the Kent Island base nets, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland, 1833–1845 and 1865—continued.

Harrow, Queen's County, New York. November 10 to December 12, 1837. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Twenty-four series were taken.

Number of directions.	Objects observed.	Results from station adjustment. °	′	″	Approximate probable errors. ″	Corrections from adjustment of 1866. ″	Final seconds. ″
18	Beacon Hill	0	00	00·000	±0·31	+0·060	00·06
19	Springfield	32	08	00·764	0·37	+0·438	01·20
20	Weasel *	54	02	55·302	0·24	−0·058	54·21
				−1·032			
21	Buttermilk	110	38	12·742	0·17	−0·133	12·61
22	Round Hill	128	21	16·936	0·16	−0·071	16·86
23	Bald Hill	149	34	06·715	0.34	−0·230	06·48
24	West Hills	217	19	34·439	0·41	+0·213	34·65

Buttermilk, Westchester County, New York. June 11 to 29, 1833. 60 cm direction theodolite No. 2. F. R. Hassler, observer. Eleven series were taken.

		°	′	″	″	″	″
15	Round Hill	0	00	00·000	±0·22	+0·098	00·10
16	Harrow	63	46	44·026	0·22	+0·184	44·21
17	Weasel	137	17	19·193	0·23	−0·291	18·90

Weasel, Passaic County, New Jersey. September 19 to October 23, 1838. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Nineteen series were taken.

		°	′	″	″	″	″
25	Buttermilk	0	00	00·000	±0·22	+0·235	00·23
26	Harrow	49	54	10·775	0·24	+0·100	10·87
27	Beacon Hill	133	03	11·643	0·20	−0·312	11·33

Springfield, Union County, New Jersey. November 6 to 24, 1838. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Twenty series were taken.

		°	′	″	″	″	″
33	Harrow	0	00	00·000	±0·22	−0·348	59·65
34	Beacon Hill	84	13	25·129	0·18	+0·324	25·45
35	Mount Rose	142	41	14·780	0·21	−0·013	14·77

Beacon Hill, Monmouth County, New Jersey. July 8 to 24, 1839. Theodolite No. 1. F. R. Hassler, observer. Nineteen series were taken.

		°	′	″	″	″	″
28	Disboro	0	00	00·000	±0·21	+0·016	00·02
29	Mount Rose	35	06	41·283	0·24	−0·091	41·19
30	Springfield	108	40	25·771	0·21	−0·267	25·50
31	Weasel †	129	30	52·007	0·20	+0·266	52·27
32	Harrow	172	19	04·232	0·17	+0·056	04·29

* The correction is for eccentricity.

† Angle between Weasel and Azimuth Mark, 3° 35′ 36″·95±0″·40.

Abstracts of horizontal directions at the principal stations between the Fire Island and the Kent Island base nets, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland, 1833–1845 and 1865—continued.

Disboro, Mercer County, New Jersey. August 11 to 28, 1839. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Eighteen series were taken.

Number of directions.	Objects observed.	Results from station adjustment.			Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		°	′	″	″	″	″
36	Stony Hill	0	00	00 ·000	±0 ·22	−0 ·097	59 ·90
37	Mount Rose	83	43	38 ·698	0 ·16	+0 ·119	38 ·82
38	Springfield	152	47	13 ·225	0 ·17	−0 ·113	13 ·11
39	Beacon Hill	196	56	34 ·168	0 ·21	+0 ·085	34 ·25

Mount Rose, Mercer County, New Jersey. September 29 to October 17, 1839. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Twenty-one series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
40	Springfield	0	00	00 ·000	±0 ·20	+0 ·016	.00 ·02
41	Beacon Hill	47	58	30 ·192	0 ·20	−0 ·042	30 ·15
42	Disboro	79	38	55 ·096	0 ·25	−0 ·081	55 ·01
43	Stony Hill	115	15	05 ·181	0 ·18	+0 ·088	05 ·27
44	Mount Holly*	146	53	25 ·591	0 ·19	+0 ·033	25 ·62
45	Newtown	191	24	23 ·100	0 ·23	−0 ·033	23 ·07

Stony Hill, Burlington County, New Jersey. September 5 to 24, 1839. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Thirteen series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
46	Mount Holly	0	00	00 ·000	±0 ·23	−0 ·496	59 ·50
47	Newtown	63	09	51 ·295	0 ·21	+0 ·370	51 ·66
48	Mount Rose	102	35	57 ·937	0 ·11	−0 ·018	57 ·92
49	Disboro	163	16	09 ·801	0 ·20	+0 ·118	09 ·92

Mount Holly, Burlington County, New Jersey. November 11 to December 21, 1840. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Thirty-five series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
54	Pine Hill	0	00	00 ·000	±0 ·20	−0 ·411	59 ·59
55	Yard	48	51	18 ·622	0 ·22	+0 ·440	19 ·06
56	Willowgrove	82	09	48 ·442	0 ·13	+0 ·244	48 ·69
57	Newtown	120	08	32 ·708	0 ·22	−0 ·669	32 ·04
58	Mount Rose	150	00	21 ·433	0 ·25	−0 ·218	21 ·21
59	Stony Hill	195	46	03 ·416	0 ·28	+0 ·665	04 ·08

Newtown, Bucks County, Pennsylvania. October 23 to November 13, 1839. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Twenty-three series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
50	Mount Rose	0	00	00 ·000	±0 ·20	+0 ·046	00 ·05
51	Stony Hill	62	24	37 ·993	0 ·18	−0 ·433	37 ·56
52	Mount Holly	105	37	14 ·249	0 ·20	+0 ·718	14 ·97
53	Willowgrove	180	30	56 ·392	0 ·27	−0 ·375	56 ·02

*Angle between Azimuth Mark and Mount Holly, 111° 48′ 53″·25±0″·07.

Abstracts of horizontal directions at the principal stations between the Fire Island and the Kent Island base nets, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland, 1833–1845 and 1865—continued.

Willowgrove, Montgomery County, Pennsylvania. November 18 to December 5, 1839, and November 3, 1840. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Thirty-five series were taken.

Number of directions.	Objects observed.	Results from station adjustment.	Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″
60	Newtown	0 00 00 ·000	±0 ·20	+0 ·279	00 ·28
61	Mount Holly	67 07 37 ·536	0 ·15	−0 ·207	37 ·33
62	Pine Hill	113 13 31 ·865	0 ·22	−0 ·045	31 ·82

Pine Hill, Gloucester County, New Jersey. October 2 to December 20, 1842. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Thirty-five series were taken.

Number of directions.	Objects observed.	Results from station adjustment.	Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″
63	Lippincott	0 00 00 ·000	±0 ·21	−0 ·304	59 ·70
64	Bethel	24 14 38 ·796	0 ·17	−0 ·445	38 ·35
65	Yard	47 06 14 ·531	0 ·16	+0 ·329	14 ·86
66	Willowgrove	92 50 20 ·541	0 ·21	−0 ·026	20 ·51
67	Mount Holly*	144 34 38 ·914	0 ·18	+0 ·450	39 ·17
		−0 ·190			

Yard, Delaware County, Pennsylvania. September 26 to December 1, 1841, and August 18 to September 12, 1842. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Thirty-two series were taken.

Number of directions.	Objects observed.	Results from station adjustment.	Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″
68	Mount Holly	0 00 00 ·000	±0 ·16	−0 ·461	59 ·54
69	Pine Hill	33 40 18 ·813	0 ·13	−0 ·257	18 ·56
70	Lippincott †	81 05 15 ·178	0 ·15	+0 ·521	15 ·70
71	Bethel	125 47 25 ·325	0 ·26	+0 ·262	25 ·59

Bethel, Delaware County, Pennsylvania. December 2 to 13, 1843. 75 cm direction theodolite No. 1. J. Ferguson, observer. Sixteen series were taken. May 4 to 8, 1847. 30 cm repeating theodolite No. 11. E. Blunt, observer. Thirteen sets of 6 repetitions each.

Number of directions.	Objects observed.	Results from station adjustment.	Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		° ′ ″	″	″	″
72	Yard	0 00 00 ·000	±0 ·18	−0 ·223	59 ·78
73	Pine Hill	65 01 53 ·189	0 ·23	+0 ·442	17 ·88
		− 35 ·750			
74	Lippincott	100 16 130 ·880	0 ·26	−0 ·020	49 ·43
		− 81 ·430			
74	Lippincott	0 00 00 ·000	....	−0 ·020	59 ·98
75	Burden	32 48 39 ·502	....	−0 ·135	86 ·69
		+ 47 ·320			

N. B.—The corrections are for eccentricity.

* Direction corrected for eccentricity.

† Angle between Azimuth Mark and Lippincott, 167° 00′ 04″·32±0″·22.

Abstracts of horizontal directions at the principal stations between the Fire Island and the Kent Island base nets, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland, 1833–1845 and 1865—continued.

Lippincott, Gloucester County, New Jersey. August 15 to September 5, 1843. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Thirty-three series were taken.

Number of directions.	Objects observed.	Results from station adjustment.			Approximate probable errors.	Corrections from adjustment of 1866.	Final seconds.
		°	′	″	″	″	″
76	Burden	0	00	00·000	±0·33	+0·472	00·47
77	Meetinghouse Hill	73	07	29·710	0·29	−0·296	29·41
78	Bethel	117	05	58·189	0·16	+0·093	58·28
79	Yard	152	06	60·223	0·22	−0·629	59·59
80	Pine Hill	237	35	48·835	0·26	+0·490	49·32

Burden,* Salem County, New Jersey. September 29 to November 3, 1843. 75 cm direction theodolite No. 1. F. R. Hassler, observer. Twenty-six series were taken. August 22, 1845. 30 cm repeating theodolite No. 11. E. Blunt, observer. Four sets.

Number of directions.	Objects observed.	°	′	″	″	″	″
81	Buck	0	00	00·000	±0·19	−0·146	59·85
82	Meetinghouse Hill	33	22	27·846	0·16	+0·331	28·18
83	Bethel	72	46	31·970	0·33	+0·039	32·01
84	Lippincott	102	51	08·769	0·22	−0·256	08·51

Meetinghouse Hill, Newcastle County, Delaware. September 16 to 26, 1845. 60 cm direction theodolite No. 2 (regraduated). J. Ferguson, observer. Seventeen series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
85	Lippincott	0	00	00·000	±0·27	+0·202	00·20
86	Burden	37	23	53·256	0·30	−0·501	52·75
87	Buck	97	15	50·141	0·18	+0·132	50·27
88	Principio	154	14	56·363	0·44	+0·142	56·50

Buck,† Newcastle County, Delaware. July 29 to August 13, 1845. 60 cm direction theodolite No. 2. J. Ferguson, observer. Seventy-one series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
89	Turkey Point	0	00	00·000	±0·18	+0·131	00·13
90	Principio	37	01	12·453	0·16	−0·211	12·24
91	Meetinghouse Hill	118	14	25·359	0·14	−0·101	25·26
92	Burden	205	00	00·673	0·20	+0·211	00·88
	Deakyne	248	08	11·297	0·21	.....	.....

Principio, Cecil County, Maryland. August 17 to September 5, 1845. 60 cm direction theodolite No. 2. J. Ferguson, observer. Twenty-six series were taken.

Number of directions.	Objects observed.	°	′	″	″	″	″
93	Meetinghouse Hill	0	00	00·000	±0·25	−0·159	59·84
94	Buck	41	47	41·531	0·20	+0·225	41·76
95	Turkey Point	119	25	09·985	0·16	+0·089	10·07
96	Osbornes Ruin	177	02	07·641	0·16	−0·169	07·47

* Last station occupied by Superintendent Hassler. He died November 20, 1843.
† Also designated Buck 2 in some records.

Abstracts of horizontal directions at the principal stations between the Fire Island and the Kent Island base nets, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland, 1833–1845 and 1865—continued.

Turkey Point, Cecil County, Maryland. May 31 to June 17, 1845. 60^{cm} direction theodolite No. 2. J. Ferguson, observer. Seventy-three series were taken.

Number of directions.	Objects observed.	Results from station adjustment.			Approximate probable error.	Correction from adjustment. Special Publication No. 4, 1900.	Resulting seconds.	Correction from adjustment of 1866.	Final seconds.
		°	′	″	″	″	″	″	″
97	Pooles Island	0	00	00·000	±0·17	+0·65	(00·65)	−0·009	59·99
98	Osbornes Ruin	44	01	48·723	0·18	−0·44	(48·28)	+0·158	48.88
99	Principio	131	14	41·244	0·18	....	.....	−0·084	41·16
100	Buck	196	36	01·806	0·38	....	.....	−0·118	01·69

Osbornes Ruin, Harford County, Maryland. September 23 to October 2, 1844. 60^{cm} direction theodolite No. 2. J. Ferguson, observer. Ten series were taken.

Number of directions.	Objects observed.	Results from station adjustment.			Approximate probable error.	Correction from adjustment. Special Publication No. 4, 1900.	Resulting seconds.	Correction from adjustment of 1866.	Final seconds.
		°	′	″	″	″	″	″	″
101	Principio	0	00	00·000	±0·27	....	.....	+0·126	00·13
102	Turkey Point	35	10	11·669	0·39	+0·11	(11·78)	−0·268	11·40
103	Pooles Island	116	37	29·195	0·55	−0·06	(29·13)	−0·461	28·73
104	Finlay	194	06	43·571	0·42	....	.....	+0·414	43·98
				*44·955	....	−0·09	(44·87)	.....	.....

Of the old adjustment of 1866–67, retained here after leaving off a few triangles at both ends, we shall only present the observation equations and the resulting corrections, together with the triangles. The following designations in the old adjustment still need explanation; they are, (1), Ruland to Bald Hill; (2), Tashua to same; (6), Bald Hill to Tashua, and (7), Bald Hill to Ruland:—at the southern end; (103) Osbornes Ruin to Pooles Island; (104), same to Finlay; (97), Turkey Point to Pooles Island; (105), (106), (107), Pooles Island to Finlay, Osbornes Ruin, and Turkey Point, respectively.

I	$0=-1{\cdot}525-(6)+(7)-(1)+(2)$
II	$0=+1{\cdot}433-(7)+(8)-(5)+(1)$
III	$0=+2{\cdot}483-(11)+(12)-(4)+(5)-(8)+(10)$
IV	$0=-1{\cdot}397-(11)+(13)-(22)+(23)-(9)+(10)$
V	$0=-2{\cdot}771-(22)+(24)-(3)+(4)-(12)+(13)$
VI	$0=+0{\cdot}996-(15)+(16)-(21)+(22)-(13)+(14)$
VII	$0=+0{\cdot}686-(25)+(26)-(20)+(21)-(16)+(17)$
VIII	$0=+0{\cdot}741-(31)+(32)-(18)+(20)-(26)+(27)$
IX	$0=-1{\cdot}372-(33)+(34)-(30)+(32)-(18)+(19)$
X	$0=+0{\cdot}571-(40)+(41)-(29)+(30)-(34)+(35)$
XI	$0=+0{\cdot}179-(37)+(39)-(28)+(29)-(41)+(42)$
XII	$0=-0{\cdot}522-(48)+(49)-(36)+(37)-(42)+(43)$
XIII	$0=-1{\cdot}306-(58)+(59)-(46)+(48)-(43)+(44)$

* See result of the measures of 1896 Coast and Geodetic Survey Special Publication, No. 4, p. 354.

XIV $0=-1{\cdot}057-(50)+(52)-(57)+(58)-(44)+(45)$

XV $0=-3{\cdot}351-(57)+(59)-(46)+(47)-(51)+(52)$

XVI $0=+2{\cdot}493-(60)+(61)-(56)+(57)-(52)+(53)$

XVII $0=-1{\cdot}294-(66)+(67)-(54)+(56)-(61)+(62)$

XVIII $0=-1{\cdot}176-(68)+(69)-(65)+(67)-(54)+(55)$

XIX $0=-1{\cdot}959-(72)+(73)-(64)+(65)-(69)+(71)$

XX $0=-2{\cdot}570-(79)+(80)-(63)+(65)-(69)+(70)$

XXI $0=+0{\cdot}780-(72)+(74)-(78)+(79)-(70)+(71)$

XXII $0=+0{\cdot}789-(83)+(84)-(76)+(78)-(74)+(75)$

XXIII $0=+2{\cdot}059-(85)+(86)-(82)+(84)-(76)+(77)$

XXIV $0=-1{\cdot}422-(91)+(92)-(81)+(82)-(86)+(87)$

XXV $0=-0{\cdot}503-(93)+(94)-(90)+(91)-(87)+(88)$

XXVI $0=+0{\cdot}511-(99)+(100)-(89)+(90)-(94)+(95)$

XXVII $0=+0{\cdot}895-(101)+(102)-(98)+(99)-(95)+(96)$

XXVIII $0=+0{\cdot}072-(106)+(107)-(97)+(98)-(102)+(103)$

XXXIX $0=-2{\cdot}098-(108)+(106)-(103)+(104)$

XXX $0=+0{\cdot}31250+0{\cdot}14415(6)-0{\cdot}03534(8)-0{\cdot}55583(1)+0{\cdot}51506(5)-0{\cdot}10881(7)$

XXXI $0=-0{\cdot}19647-0{\cdot}51563(4)+0{\cdot}40701(5)+0{\cdot}53867(22)+0{\cdot}00378(24)-0{\cdot}28033(9)+0{\cdot}15426(10)$
$+0{\cdot}12607(8)+0{\cdot}10862(3)-0{\cdot}54245(23)$

XXXII $0=-0{\cdot}03765-0{\cdot}29742(38)+0{\cdot}21685(39)+0{\cdot}15129(40)+0{\cdot}03846(42)-0{\cdot}06212(29)$
$+0{\cdot}13328(30)-0{\cdot}07116(28)+0{\cdot}08057(37)-0{\cdot}18975(41)$

XXXIII $0=+0{\cdot}29283-0{\cdot}36253(47)+0{\cdot}25601(48)+0{\cdot}31275(57)+0{\cdot}05396(59)-0{\cdot}21414(44)$
$+0{\cdot}16225(45)+0{\cdot}05189(43)+0{\cdot}10652(46)-0{\cdot}36671(58)$

XXXIV $0=+0{\cdot}15673-0{\cdot}40626(70)+0{\cdot}21275(71)+0{\cdot}27191(63)+0{\cdot}19563(65)-0{\cdot}29782(73)$
$+0{\cdot}33601(74)-0{\cdot}03819(72)+0{\cdot}19351(69)-0{\cdot}46754(64)$

XXXV $0=+0{\cdot}50123+0{\cdot}13036(2)+0{\cdot}10862(4)-0{\cdot}10862(3)-0{\cdot}03534(6)-0{\cdot}09074(8)+0{\cdot}12608(10)$
$+0{\cdot}01310(12)-0{\cdot}01310(11)+0{\cdot}03148(13)-0{\cdot}03148(14)-0{\cdot}00378(24)+0{\cdot}00378(22)$
$-0{\cdot}33522(18)+0{\cdot}33522(19)+0{\cdot}10370(15)-0{\cdot}16603(16)+0{\cdot}06233(17)-0{\cdot}20258(26)$
$+0{\cdot}17729(25)+0{\cdot}02529(27)-0{\cdot}22735(32)+0{\cdot}22735(31)+0{\cdot}29946(29)-0{\cdot}29946(28)$
$+0{\cdot}02130(33)-0{\cdot}15051(34)+0{\cdot}12921(35)-0{\cdot}18975(41)+0{\cdot}18975(40)-0{\cdot}21414(44)$
$+0{\cdot}21414(45)+0{\cdot}09031(39)-0{\cdot}06716(37)-0{\cdot}02315(36)+0{\cdot}07124(48)-0{\cdot}11830(49)$
$+0{\cdot}04706(46)+0{\cdot}20502(58)-0{\cdot}20502(59)-0{\cdot}18397(54)+0{\cdot}18397(55)-0{\cdot}05887(50)$
$+0{\cdot}00204(52)+0{\cdot}05683(53)-0{\cdot}29146(61)+0{\cdot}08883(60)+0{\cdot}20263(62)-0{\cdot}16605(67)$
$+0{\cdot}16605(66)+0{\cdot}46753(64)-0{\cdot}46753(63)+0{\cdot}31604(68)-0{\cdot}30825(69)-0{\cdot}00779(71)$
$-0{\cdot}09809(73)+0{\cdot}09809(72)-0{\cdot}32641(74)+0{\cdot}32641(75)+0{\cdot}12401(80)-0{\cdot}12401(78)$
$-0{\cdot}06387(76)+0{\cdot}06387(77)+0{\cdot}36356(83)-0{\cdot}36356(84)+0{\cdot}31962(82)-0{\cdot}31962(81)$
$+0{\cdot}27541(85)-0{\cdot}27541(86)-0{\cdot}13681(87)+0{\cdot}13681(88)-0{\cdot}01192(92)+0{\cdot}01192(91)$
$+0{\cdot}27921(90)-0{\cdot}27921(89)+0{\cdot}23553(93)-0{\cdot}23553(94)-0{\cdot}13354(95)+0{\cdot}13354(96)$
$-0{\cdot}09660(100)+0{\cdot}09660(99)+0{\cdot}21780(98)-0{\cdot}21780(97)+0{\cdot}29881(101)-0{\cdot}29881(102)$
$-0{\cdot}04673(103)+0{\cdot}04673(104)-0{\cdot}15010(107)+0{\cdot}15010(106)+0{\cdot}18919(108)$

It will not be necessary to transcribe here the correlate and normal equations, since the resulting triangles given further on prove the correctness of the solution. The individual corrections to the directions, together with their assigned weights, are as follows:

Correction symbol.	Reciprocal of weight, $\frac{1}{p}$	Correction.	Correction symbol.	Reciprocal of weight, $\frac{1}{p}$	Correction.	Correction symbol.	Reciprocal of weight, $\frac{1}{p}$	Correction.
		″			″			″
(1)	0·180	+0·048	(38)	0·136	−0·113	(74)	0·175	−0·020
(2)	0·301	−0·413	(39)	0·151	+0·085	(75)	0·129	−0·135
(3)	0·133	+0·055	(40)	0·147	+0·016	(76)	0·216	+0·472
(4)	0·216	+0·314	(41)	0·147	−0·042	(77)	0·191	−0·296
(5)	0·170	−0·109	(42)	0·169	−0·081	(78)	0·133	+0·093
(6)	0·155	+0·039	(43)	0·139	+0·088	(79)	0·155	−0·629
(7)	0·467	+2·024	(44)	0·143	+0·033	(80)	0·180	+0·490
(8)	0·180	+0·434	(45)	0·160	−0·033	(81)	0·143	−0·146
(9)	0·143	−0·954	(46)	0·160	−0·496	(82)	0·133	+0·331
(10)	0·267	−0·087	(47)	0·151	+0·370	(83)	0·216	+0·039
(11)	0·169	+0·275	(48)	0·119	−0·018	(84)	0·155	−0·256
(12)	0·197	−1·264	(49)	0·147	+0·118	(85)	0·180	+0·202
(13)	0·175	+0·965	(50)	0·147	+0·046	(86)	0·197	−0·501
(14)	0·251	−0·181	(51)	0·139	−0·433	(87)	0·139	+0·132
(15)	0·155	+0·098	(52)	0·147	+0·718	(88)	0·301	+0·142
(16)	0·155	+0·184	(53)	0·180	−0·375	(89)	0·139	+0·131
(17)	0·160	−0·291	(54)	0·147	−0·411	(90)	0·133	−0·211
(18)	0·203	+0·060	(55)	0·155	+0·440	(91)	0·127	−0·101
(19)	0·244	+0·438	(56)	0·124	+0·244	(92)	0·147	+0·211
(20)	0·165	−0·058	(57)	0·155	−0·669	(93)	0·167	−0·159
(21)	0·136	−0·133	(58)	0·169	−0·218	(94)	0·147	+0·225
(22)	0·133	−0·071	(59)	0·185	+0·665	(95)	0·136	+0·089
(23)	0·229	−0·230	(60)	0·147	+0·279	(96)	0·136	−0·169
(24)	0·275	+0·213	(61)	0·129	−0·207	(97)	0·136	−0·009
(25)	0·155	+0·235	(62)	0·155	−0·045	(98)	0·139	+0·158
(26)	0·165	+0·100	(63)	0·151	−0·343	(99)	0·139	−0·084
(27)	0·147	−0·312	(64)	0·136	−0·445	(100)	0·251	−0·118
(28)	0·151	+0·016	(65)	0·136	+0·329	(101)	0·180	+0·126
(29)	0·165	−0·091	(66)	0·151	−0·026	(102)	0·259	−0·268
(30)	0·151	−0·267	(67)	0·139	+0·450	(103)	0·409	−0·461
(31)	0·147	+0·266	(68)	0·133	−0·461	(104)	0·283	+0·414
(32)	0·136	+0·056	(69)	0·124	−0·257	(105)	.....	.....
(33)	0·155	−0·348	(70)	0·129	+0·521	(106)	0·124	+0·124
(34)	0·139	+0·324	(71)	0·175	+0·262	(107)	0·147	+0·077
(35)	0·151	−0·013	(72)	0·139	−0·223	(108)	0·625	−1·100
(36)	0·155	−0·097	(73)	0·160	+0·442	(109)	.....	.....
(37)	0·133	+0·119						

Probable error of a resulting direction $0·674\sqrt{\frac{16·7}{35}} = \pm 0''·47$.

Resulting angles and sides of the triangulation between the Fire Island base net and the extended net of the Kent Island base.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Round Hill	93	33	38 ·59	−1 ·54	37 ·05	0 ·66	4 ·648 135 6	44 477 ·01
	Bald Hill	59	05	13 ·17 (·38)	−0 ·52	12 ·65	0 ·66	4 ·582 434 1	38 232 ·62
	West Hills	27	21	12 ·70 (·58)	−0 ·42	12 ·28	0 ·66	4 ·311 236 3	20 475 ·58
2	Harrow	67	45	27 ·72	+0 ·45	28 ·17	0 ·68	4 ·648 135 6	44 477 ·01
	Bald Hill	22	10	37 ·77 (·58)	−1 ·39	36 ·38	0 ·68	4 ·258 590 2	18 138 ·03
	West Hills	90	03	57 ·65 (·54)	−0 ·16	57 ·49	0 ·68	4 ·681 716 2	48 052 ·52
3	Harrow	88	58	17 ·50	+0 ·28	17 ·78	0 ·52	4 ·582 434 1	38 232 ·62
	Round Hill	28	18	56 ·34	+2 ·23	58 ·57	0 ·52	4 ·258 590 2	18 138 ·03
	West Hills	62	42	44 ·95	+0 ·26	45 ·21	0 ·52	4 ·531 267 4	33 983 ·45
4	Harrow	21	12	49 ·78	−0 ·16	49 ·62	0 ·50	4 ·311 236 3	20 475 ·58
	Round Hill	121	52	34 ·93	+0 ·69	35 ·62	0 ·50	4 ·681 716 2	48 052 ·52
	Bald Hill	36	54	35 ·39	+0 ·87	36 ·26	0 ·50	4 ·531 267 4	33 983 ·45
5	Buttermilk	63	46	44 ·03	+0 ·09	44 ·12	0 ·33	4 ·531 267 4	33 983 ·45
	Round Hill	98	30	13 ·76	−1 ·15	12 ·61	0 ·33	4 ·573 628 3	37 465 ·22
	Harrow	17	43	04 ·19	+0 ·06	04 ·25	0 ·32	4 ·061 771 2	11 528 ·46
6	Weasel	49	54	10 ·78	−0 ·14	10 ·64	1 ·24	4 ·573 628 3	37 465 ·22
	Buttermilk	73	30	35 ·17	−0 ·48	34 ·69	1 ·24	4 ·671 752 6	46 962 ·65
	Harrow	56	35	18 ·47	−0 ·07	18 ·40	1 ·25	4 ·611 542 6	40 882 ·98
7	Beacon Hill	42	48	12 ·22	−0 ·21	12 ·01	2 ·20	4 ·671 752 6	46 962 ·65
	Weasel	83	09	00 ·87	−0 ·41	00 ·46	2 ·21	4 ·836 466 7	68 622 ·52
	Harrow	54	02	54 ·27	−0 ·12	54 ·15	2 ·21	4 ·747 798 8	55 949 ·84
8	Springfield	84	13	25 ·13	+0 ·67	25 ·80	1 ·91	4 ·836 466 7	68 622 ·52
	Harrow	32	08	00 ·76	+0 ·38	01 ·14	1 ·91	4 ·564 498 1	36 685 ·81
	Beacon Hill	63	38	38 ·46	+0 ·32	38 ·78	1 ·90	4 ·791 009 9	61 803 ·04
9	Mount Rose	47	58	30 ·19	−0 ·06	30 ·13	1 ·25	4 ·564 498 1	36 685 ·81
	Springfield	58	27	49 ·65	−0 ·34	49 ·31	1 ·25	4 ·624 192 9	42 091 ·36
	Beacon Hill	73	33	44 ·49	−0 ·18	44 ·31	1 ·25	4 ·675 473 3	47 366 ·72
10	Disboro	44	09	20 ·94	+0 ·20	21 ·14	0 ·71	4 ·564 498 1	36 685 ·81
	Springfield	27	10	.....	......	15 ·49	0 ·70	4 ·381 086 1	24 048 ·39
	Beacon Hill	108	40	25 ·77	−0 ·28	25 ·49	0 ·71	4 ·698 022 4	49 891 ·02
11	Disboro	113	12	55 ·47	−0 ·03	55 ·44	0 ·50	4 ·624 192 8	42 091 ·35
	Mount Rose	31	40	24 ·90	−0 ·03	24 ·87	0 ·49	4 ·381 086 1	24 048 ·39
	Beacon Hill	35	06	41 ·28	−0 ·11	41 ·17	0 ·49	4 ·420 656 6	26 342 ·48

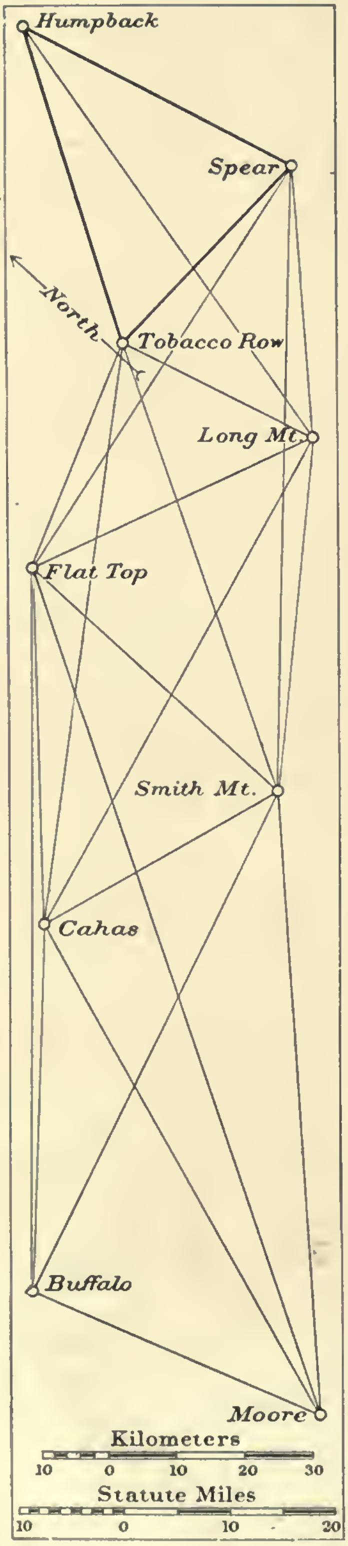
Resulting angles and sides of the triangulation between the Fire Island base net and the extended net of the Kent Island base—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. Distances.	Distances in meters.
		°	′	″	″	″	″		
12	Disboro	69	03	34 ·53	−0 ·23	34 ·30	1 ·04	4 ·675 473 2	47 366 ·71
	Mount Rose	79	38	55 ·10	−0 ·10	55 ·00	1 ·04	4 ·698 022 4	49 891 ·02
	Springfield	31	17	.....	....	33 ·82	1 ·04	4 ·420 656 6	26 342 ·48
13	Stony Hill	60	40	11 ·86	+0 ·14	12 ·00	0 ·39	4 ·420 656 6	26 342 ·48
	Mount Rose	35	36	10 ·08	+0 ·17	10 ·25	0 ·39	4 ·245 277 5	17 590 ·47
	Disboro	83	43	38 ·70	+0 ·22	38 ·92	0 ·39	4 ·477 626 0	30 034 ·89
14	Mount Holly	45	45	41 ·98	+0 ·88	42 ·86	0 ·54	4 ·477 626 0	30 034 ·89
	Mount Rose	31	38	20 ·41	−0 ·05	20 ·36	0 ·55	4 ·342 240 8	21 990 ·79
	Stony Hill	102	35	57 ·94	+0 ·48	58 ·42	0 ·55	4 ·611 856 8	40 912 ·58
15	Newtown	41	12	36 ·26	+1 ·15	37 ·41	0 ·54	4 ·342 240 8	21 990 ·79
	Stony Hill	63	09	51 ·29	+0 ·87	52 ·16	0 ·53	4 ·473 984 7	29 784 ·12
	Mount Holly	75	37	30 ·71	+1 ·33	32 ·04	0 ·54	4 ·509 657 7	32 333 ·87
16	Newtown	105	37	14 ·25	+0 ·67	14 ·92	0 ·51	4 ·611 856 8	40 912 ·58
	Mount Rose	44	30	57 ·51	−0 ·07	57 ·44	0 ·51	4 ·473 984 7	29 784 ·12
	Mount Holly	29	51	48 ·72	+0 ·45	49 ·17	0 ·51	4 ·325 374 2	21 153 ·11
17	Newtown	64	24	37 ·99	−0 ·48	37 ·51	0 ·52	4 ·477 625 9	30 034 ·88
	Mount Rose	76	09	17 ·92	−0 ·12	17 ·80	0 ·52	4 ·509 657 7	32 333 ·87
	Stony Hill	39	26	06 ·64	−0 ·39	06 ·25	0 ·52	4 ·325 374 2	21 153 ·11
18	Willowgrove	67	07	37 ·54	−0 ·49	37 ·05	0 ·48	4 ·473 984 7	29 784 ·12
	Newtown	74	53	42 ·14	−1 ·10	41 ·04	0 ·48	4 ·494 280 7	31 209 ·06
	Mount Holly	37	58	44 ·27	−0 ·91	43 ·36	0 ·49	4 ·298 685 8	19 892 ·33
19	Pine Hill	51	44	18 ·18	+0 ·48	18 ·66	0 ·75	4 ·494 280 7	31 209 ·06
	Willowgrove	46	05	54 ·33	+0 ·16	54 ·49	0 ·75	4 ·456 957 7	28 638 ·99
	Mount Holly	82	09	48 ·44	+0 ·66	49 ·10	0 ·75	4 ·595 230 7	39 375 ·92
20	Yard	33	40	18 ·81	+0 ·20	19 ·01	0 ·93	4 ·456 957 7	28 638 ·99
	Mount Holly	48	51	18 ·62	+0 ·85	19 ·47	0 ·94	4 ·589 931 4	38 898 ·37
	Pine Hill	97	28	24 ·19	+0 ·12	24 ·31	0 ·93	4 ·709 403 7	51 215 ·76
21	Lippincott	85	28	48 ·61	+1 ·12	49 ·73	0 ·69	4 ·589 931 4	38 898 ·37
	Yard	47	24	56 ·37	+0 ·78	57 ·15	0 ·70	4 ·458 328 4	28 729 ·52
	Pine Hill	47	06	14 ·53	+0 ·67	15 ·20	0 ·69	4 ·456 145 5	28 585 ·48
22	Bethel	35	15	32 ·01	−0 ·46	31 ·55	0 ·43	4 ·458 328 4	28 729 ·52
	Pine Hill	24	14	38 ·80	−0 ·10	38 ·70	0 ·43	4 ·310 393 7	20 435 ·90
	Lippincott	120	29	50 ·65	+0 ·39	51 ·04	0 ·43	4 ·632 282 7	42 882 ·76
23	Bethel	100	16	49 ·45	+0 ·20	49 ·65	0 ·28	4 ·456 145 5	28 585 ·48
	Yard	44	42	10 ·15	−0 ·26	09 ·89	0 ·29	4 ·310 393 7	20 435 ·90
	Lippincott	35	01	02 ·03	−0 ·72	01 ·31	0 ·28	4 ·221 948 9	16 670 ·51

Resulting angles and sides of the triangulation between the Fire Island base net and the extended net of the Kent Island base—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
24	Bethel	65	01	17 ·44	+0 ·67	18 ·11	0 ·55	4 ·589 931 4	38 898 ·37
	Yard	92	07	06 ·51	+0 ·52	07 ·03	0 ·55	4 ·632 282 6	42 882 ·75
	Pine Hill	22	51	35 ·74	+0 ·77	36 ·51	0 ·55	4 ·221 948 9	16 670 ·51
25	Burden	30	04	36 ·80	−0 ·30	36 ·50	0 ·34	4 ·310 393 6	20 435 ·89
	Bethel	32	49	26 ·82	−0 ·11	26 ·71	0 ·34	4 ·344 465 5	22 103 ·73
	Lippincott	117	05	58 ·19	−0 ·38	57 ·81	0 ·34	4 ·559 914 6	36 300 ·67
26	Meetinghouse Hill	37	23	53 ·26	−0 ·70	52 ·56	0 ·61	4 ·344 465 5	22 103 ·73
	Lippincott	73	07	29 ·71	−0 ·77	28 ·94	0 ·61	4 ·541 914 0	34 826 ·83
	Burden	69	28	40 ·92	−0 ·59	40 ·33	0 ·61	4 ·532 554 6	34 084 ·32
27	Buck	86	45	35 ·31	+0 ·31	35 ·62	0 ·49	4 ·541 913 9	34 826 ·82
	Meetinghouse Hill	59	51	56 ·89	+0 ·63	57 ·52	0 ·49	4 ·479 550 7	30 168 ·29
	Burden	33	22	27 ·85	+0 ·48	28 ·33	0 ·49	4 ·283 056 5	19 189 ·18
28	Principio	41	47	41 ·53	+0 ·38	41 ·91	0 ·38	4 ·283 056 5	19 189 ·18
	Meetinghouse Hill	56	59	06 ·22	+0 ·01	06 ·23	0 ·39	4 ·382 796 0	24 143 ·27
	Buck	81	13	12 ·91	+0 ·11	13 ·02	0 ·39	4 ·454 159 6	28 455 ·06
29	Turkey Point	65	21	20 ·56	−0 ·03	20 ·53	0 ·32	4 ·382 796 0	24 143 ·27
	Principio	77	37	28 ·45	−0 ·14	28 ·31	0 ·32	4 ·414 063 1	25 945 ·56
	Buck	37	01	12 ·45	−0 ·34	12 ·12	0 ·32	4 ·203 937 1	15 993 ·26
30	Osbornes Ruin	35	10	11 ·67 (11 ·78)	−0 ·40	11 ·27	0 ·31	4 ·203 937 1	15 993 ·26
	Principio	57	36	57 ·66	−0 ·26	57 ·40	0 ·32	4 ·370 101 8	23 447 ·78
	Turkey Point	87	12	52 ·52 (52 ·96)	−0 ·24	52 ·28	0 ·32	4 ·443 000 9	27 733 ·26

No. 23.



4. FIRST SECTION OF THE TRIANGULATION, SOUTH OF THE TRANSCONTINENTAL TRIANGULATION, IN VIRGINIA AND NORTH CAROLINA, 1875–1879.

In connection with the account of the Kent Island base net and its extension to the westward there are given the abstracts of the horizontal directions as well as the adjusted angles and triangle sides between the triangulation stations which connect that base with the sides of the triangle Humpback, Tobacco Row, Spear. It is from this triangle that the triangulation of the oblique arc departs from that of the arc of the parallel and the first section, proceeding to the southward and westward, terminates at the line Buffalo to Moore. Between Humpback and Moore the triangulation is so strengthened by the numerous tie lines that it is not supposed that any measurable error could accumulate within this section; its whole adjustment was therefore made to depend for initial direction and length on the above fixed triangle. In this section there are 24 conditions to be satisfied and 42 directions to be corrected.

The approximate elevations of the stations are as follows:

	Meters.	Feet.
Humpback	1 110·4	3 643
Spear	491·7	1 613
Tobacco Row	894·8	2 936
Long Mountain	436·8	1 433
Flat Top	1 218·7	3 998
Cahas	1 088·4	3 571
Smith Mountain	622·7	2 043
Moore	784·0	2 572
Buffalo	1 210·4	3 971

Corrections to horizontal directions for height of station observed upon were applied. Squaring the closing errors of the triangles we get $\sqrt{\frac{64·64}{28}} = \pm 1''·52$ as the mean error of a triangle, also mean error of an angle $\frac{1''·52}{\sqrt{3}} = \pm 0''·88$ and the probable error of a direction $= \pm 0''·42$.

Abstracts of horizontal directions at stations composing the first section of the triangulation south of the transcontinental triangulation, 1875 to 1879.

Humpback, Nelson County, Virginia. June 8 to 29, 1875. A. T. Mosman, observer. 35cm direction theodolite No. 10. May 11 to June 6, 1878. A. T. Mosman, observer. 50cm direction theodolite No. 114. August 18 to 28, 1879. A. T. Mosman and W. B. Fairfield, observers. 50cm direction theodolite No. 114.

No. of directions.	Objects observed.	Results of local adjustment.	Corrections from figure adjustment transcontinental arc.	Resulting seconds.	Reductions to sea level.	Resulting seconds.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″	″	″	″	″
	Jarman	0 00 00·00	....	.....	....	.....	....	.....
	Spear	126 14 25·02	+0·44	25·46	....	.....	....	.....
1	Long Mountain	154 41 57·10	....	.....	+0·01	(57·11)	+0·46	57·57
	Tobacco Row	173 06 07·68	−0·87	06·81	....	.....	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 28$. Circle used in XI positions.

Spear, Buckingham County, Virginia. July 30 to August 29, 1875. A. T. Mosman, observer. 35cm direction theodolite No. 10.

No. of directions.	Objects observed.	Results of local adjustment.	Corrections from figure adjustment transcontinental arc.	Resulting seconds.	Reductions to sea level.	Resulting seconds.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″	″	″	″	″
	Willis	0 00 00·00	....	.....	....	.....	....	.....
2	Long Mountain	113 14 26·50	....	.....	+0·03	(26·53)	+0·25	26·78
3	Smith Mountain	119 19 24·25	....	.....	+0·04	(24·29)	−0·08	24·21
4	Flat Top	150 15 15·49	....	.....	+0·03	(15·52)	−0·33	15·19
	Tobacco Row	160 17 43·42	+0·22	43·64	....	.....	....	.....
	Humpback	233 59 02·50	−0·44	02·06	....	.....	....	.....

Tobacco Row, Amherst County, Virginia. September 14 to 23, 1875. A. T. Mosman, observer. 35cm direction theodolite No. 10. September 6 to 9, 1879. A. T. Mosman, observer. 50cm direction theodolite No. 114.

No. of directions.	Objects observed.	Results of local adjustment.	Corrections from figure adjustment transcontinental arc.	Resulting seconds.	Reductions to sea level.	Resulting seconds.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″	″	″	″	″
8	Flat Top	0 00 00·00	....	.....	+0·06	(00·06)	+0·93	00·99
	Humpback	140 52 23·38	+0·86	24·24	....	.....	...	.....
	Spear	200 19 28·80	−0·22	28·58	....	.....	....	.. ..
	Willis	208 43 28·06	....	.....	....	.....	....	.....
5	Long Mountain	272 56 37·39	....	.....	−0·02	(37·37)	−0·07	37·30
	Lynchburg	276 15 52·23	....	.....	....	.....	.....	.....
6	Smith Mountain	318 30 40·14	....	.....	+0·04	(40·18)	+0·07	40·25
7	Cahas	345 52 24·62	....	.....	+0·07	(24·69)	−0·87	23·82

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 43$.

Long Mountain, Campbell County, Virginia. October 16 to December 9, 1875. A. T. Mosman, observer. 35cm direction theodolite No. 10.

Number of directions.	Objects observed.	Results from local adjustment.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″
12	Tobacco Row	0 00 00·00	−0·03	59·97	−0·24	59·73
13	Humpback	29 31 39·55	+0·03	39·58	+0·84	40·42
14	Spear	60 19 37·53	+0·03	37·56	−0·50	37·06
	Willis	86 30 44·38	....	.....	.....	.....
9	Smith Mountain	251 12 44·36	+0·04	44·40	+0·47	44·87
10	Cahas	273 58 20·77	+0·04	20·83	−0·47	20·36
11	Flat Top	309 05 12·49	−0·05	12·44	−0·10	12·34
	Azimuth Mark, Lynchburg C. H.	356 02 42·35	....	.....	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 36$. Circle used in XXIII positions.

Abstracts of horizontal directions at stations composing the first section of the triangulation south of the transcontinental triangulation, 1875 to 1879—continued.

Flat Top, Peaks of Otter, Bedford County, Virginia. June 20 to September 2 1876. A. T. Mosman, observer. 35^{cm} direction theodolite No. 10.

Number of directions.	Objects observed.	Results from local adjustment.			Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″
15	Tobacco Row	0	00	00 ·00	+0 ·04	00 ·04	−0 ·28	59 ·76
16	Spear	10	17	00 ·26	+0 ·01	00 ·27	−0 ·13	00 ·14
	Lynchburg	26	12	24 ·16	....	.....	....	.....
17	Long Mountain	42	01	51 ·79	−0 ·02	51 ·77	−0 ·11	51 ·66
18	Smith Mountain	108	18	02 ·38	0 ·00	02 ·38	−0 ·08	02 ·30
19	Moore	138	23	14 ·12	+0 ·05	14 ·17	+0 ·09	14 ·26
20	Cahas	156	09	54 ·25	+0 ·08	54 ·33	+0 ·40	54 ·73
21	Buffalo	157	53	45 ·03	+0 ·08	45 ·11	+0 ·12	45 ·23

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot 36$. Circle used in XXIII positions.

Cahas, Franklin County, Virginia. June 25 to July 13, 1877. A. T. Mosman, observer. 50^{cm} direction theodolite No. 114.

Number of directions.	Objects observed.	Results from local adjustment.			Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″
32	Smith Mountain	0	00	00 ·00	−0 ·02	59 ·98	−0 ·06	59 ·92
33	Moore	90	56	57 ·57	+0 ·03	57 ·60	−0 ·84	56 ·76
34	Buffalo	123	26	54 ·08	+0 ·08	54 ·16	−0 ·15	54 ·01
29	Flat Top	300	01	07 ·25	+0 ·09	07 ·34	+0 ·36	07 ·70
30	Tobacco Row	309	43	37 ·90	+0 ·06	37 ·96	−0 ·38	37 ·58
31	Long Mountain	330	46	17 ·45	+0 ·01	17 ·46	+1 ·07	18 ·53

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 71$. Circle used in XI positions.

Smith Mountain, Pittsylvania County, Virginia. August 6 to September 6, 1877. A. T. Mosman, observer. 50^{cm} direction theodolite No. 114.

Number of directions.	Objects observed.	Results from local adjustment.			Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″
24	Cahas	0	00	00 ·00	−0 ·04	59 ·96	−0 ·19	59 ·77
25	Flat Top	72	09	19 ·84	0 ·00	19 ·84	+0 ·18	20 ·02
26	Tobacco Row	102	22	00 ·94	+0 ·05	00 ·99	+0 ·06	01 ·05
27	Spear	123	12	35 ·99	+0 ·03	36 ·02	−0 ·18	35 ·84
28	Long Mountain	128	00	47 ·72	+0 ·03	47 ·75	−0 ·48	47 ·27
22	Moore	297	18	17 ·97	+0 ·05	18 ·02	+0 ·47	18 ·49
	Bull Mountain	312	53	58 ·97	....	.....	....	.....
23	Buffalo	327	37	19 ·51	+0 ·05	19 ·56	+0 ·13	19 ·69

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 68$. Circle used in XI positions.

Abstracts of horizontal directions at stations composing the first section of the triangulation south of the transcontinental triangulation, 1875 to 1879—continued.

Moore, Stokes County, North Carolina. November 7 to December 26, 1876. A. T. Mosman, observer. 35 cm direction theodolite No. 10. April 21 to May 31, 1877. Same observer and instrument.

Number of directions.	Objects observed.	Results from local adjustment.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″
	Pilot Mountain	0 00 00 ·00	....	.....	....	.....
39	Buffalo	89 04 10 ·07	−0 ·05	10 ·02	−0 ·23	09 ·79
	Azimuth Mark	110 31 01 ·90	....	.....	....	.....
40	Cahas	127 05 24 ·85	+0 ·04	24 ·89	+1 ·48	26 ·37
41	Flat Top	138 23 02 ·84	+0 ·07	02 ·91	−0 ·58	02 ·33
42	Smith Mountain	153 26 57 ·69	+0 ·04	57 ·73	−0 ·68	57 ·05
	Young	314 44 12 ·49	....	.....	....	.....
	Poore	354 21 09 ·66	....	.....	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm 1''\cdot 58$. Circle used in XXIII positions in 1876 and in XXIV positions in 1877.

Buffalo, Floyd County, Virginia. September 25 to October 16, 1876. A. T. Mosman, observer. 35 cm direction theodolite No. 10.

Number of directions.	Objects observed.	Results from local adjustment.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		° ′ ″	″	″	″	″
	Bull Mountain	0 00 00 ·00	....	.....	....	.....
38	Moore	41 36 48 ·92	−0 ·04	48 ·88	+0 ·10	48 ·98
	Pilot Mountain	62 51 49 ·89	....	.....	....	.....
	Young	70 37 50 ·34	....	.....	....	.....
	Poore	99 35 20 ·42	....	.....	....	.....
35	Flat Top	290 26 00 ·73	+0 ·09	00 ·82	−0 ·44	00 ·38
36	Cahas	292 07 56 ·59	+0 ·08	56 ·67	−0 ·04	56 ·63
37	Smith Mountain	316 18 26 ·85	+0 ·02	26 ·87	+0 ·38	27 ·25

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm 1''\cdot 58$. Circle used in XXIII positions.

Observation equations.

I	$0=+1\cdot 12+(1)-(2)-(13)+(14)$
II	$0=-0\cdot 54-(1)+(5)-(12)+(13)$
III	$0=-1\cdot 40-(4)+(8)-(15)+(16)$
IV	$0=-1\cdot 03-(5)+(8)-(11)+(12)-(15)+(17)$
V	$0=+0\cdot 09-(3)+(6)-(26)+(27)$
VI	$0=+1\cdot 60-(2)+(3)-(9)+(14)-(27)+(28)$
VII	$0=-0\cdot 95-(6)+(8)-(15)+(18)-(25)+(26)$
VIII	$0=-1\cdot 74-(7)+(8)-(15)+(20)-(29)+(30)$
IX	$0=-0\cdot 88-(5)+(7)-(10)+(12)-(30)+(31)$
X	$0=+0\cdot 37-(6)+(7)-(24)+(26)-(30)+(32)$
XI	$0=-1\cdot 07-(18)+(21)-(23)+(25)-(35)+(37)$
XII	$0=-0\cdot 63-(20)+(21)+(29)-(34)-(35)+(36)$
XIII	$0=+0\cdot 23-(18)+(19)-(22)+(25)-(41)+(42)$

Observation equations—continued.

XIV | $0=+3.60-(22)+(24)-(32)+(33)-(40)+(42)$

XV | $0=+1.07-(22)+(23)-(37)+(38)-(39)+(42)$

XVI | $0=-6.7+6.33(1)-1.96(2)-2.51(12)+3.71(13)-1.20(14)$

XVII | $0=+0.30-0.196(2)+1.189(4)-0.171(11)+0.291(12)-0.120(14)-0.927(15)+1.160(16)$
$-0.233(17)$

XVIII | $0=-2.0-1.96(5)+2.06(6)-0.10(8)-2.33(15)+3.26(17)-0.93(18)-1.43(25)+4.38(26)$
$-2.95(28)$

XIX | $0=+0.11-1.780(2)+1.976(3)+0.272(5)-0.206(6)-0.438(26)+2.505(27)-2.067(28)$

XX | $0=+2.51-0.010(5)+0.836(7)-0.826(8)-0.299(10)+0.470(11)-0.171(12)-0.877(29)$
$+1.231(30)-0.354(31)$

XXI | $0=+1.1-3.70(9)+5.02(10)-1.32(11)-0.93(17)+2.83(18)-1.90(20)-1.22(29)+3.77(31)$
$-2.55(32)$

XXII | $0=+1.46-0.190(18)+0.656(19)-0.466(20)-0.109(22)+0.177(24)-0.068(25)-0.629(40)$
$+1.054(41)-0.425(42)$

XXIII | $0=-4.60-0.190(18)+7.158(20)-6.968(21)-0.332(23)+0.400(24)-0.068(25)-7.099(35)$
$+7.568(36)-0.469(37)$

XXIV | $0=-16.2-1.09(22)+3.32(23)-2.23(24)-5.43(36)+4.69(37)+0.74(38)-2.69(39)$
$+6.94(40)-4.25(42)$

N. B.—The correlate equations being of a simple character, are not given here.

Normal equations.

No.		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}
1	0=+1.12	+4	−2				+2									
2	0=−0.54		+4		−2					−2						
3	0=−1.40			+4	+2			+2	+2							
4	0=−1.03				+6			+2	+2	+2						
5	0=+0.09	...	...	...	...	+4	−2	−2	...	...	−2	...	...	...	...	...
6	0=+1.60						+6									
7	0=−0.95							+6	+2		+2	−2		−2		
8	0=−1.74								+6	−2	−2		−2			
9	0=−0.88									+6	+2					
10	0=+0.37	...	...	...	...	...	...	...	...	...	+6	...	...	...	−2	...
11	0=−1.07											+6	+2	+2		−2
12	0=−0.63												+6			
13	0=+0.23													+6	+2	+2
14	0=+3.60														+6	+2
15	0=+1.07	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+6

Normal equations—completed.

No.		C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}	C_{24}
1		+ 3·38	+0·076		+ 1·780					
2		− 0·11	−0·291	− 1·96	+ 0·272	+0·161				
3			+0·898	+ 2·23		−0·826				
4		− 2·51	+1·156	+ 7·45	− 0·272	−1·457	+ 0·39			
5		....	....	− 2·32	+ 0·761	....	......	....	....	....
6		+ 0·76	+0·076	− 2·95	− 0·816		+ 3·70			
7			+0·927	+ 5·05	− 0·232	−0·826	+ 2·83	−0·122	− 0·122	
8			+0·927	+ 2·23		+0·446	− 0·68	−0·466	+ 7·158	
9		− 2·51	+0·291	+ 1·96	− 0·272	−0·611	− 1·25			
10		....	....	+ 2·32	− 0·232	−0·395	− 2·55	−0·177	− 0·400	+ 2·23
11				− 0·50			− 2·83	+0·122	+ 0·116	+ 1·37
12						−0·877	+ 0·68	+0·466	+ 0·541	− 5·43
13				− 0·50			− 2·83	−0·592	+ 0·122	− 3·16
14							+ 2·55	+0·490	+ 0·400	− 12·33
15		....	....	....	....	....	....	−0·316	+ 0·137	− 1·10
16	0=− 6·7	+65·41	−0·202		+ 3·489	+0·429				
17	0=+ 0·30		+3·840	+ 1·400	+ 0·349	−0·130	+ 0·442			
18	0=− 2·0			+54·95	+ 3·222	+0·102	− 5·664	+0·274	+ 0·274	
19	0=+ 0·11				+17·929	−0·003				
20	0=+ 2·51	....	....	....	....	+4·131	− 2·386	....	....	....
21	0=+ 1·1						+75·32	+0·348	− 14·138	
22	0=+ 1·46							+2·418	− 3·224	− 2·84
23	0=− 4·60								+207·99	− 45·29
24	0=−16·2									+142·67

Resulting correlates.

$C_1=+0·190$
$C_2=+0·547$
$C_3=+0·093$
$C_4=-0·183$
$C_5=-0·587$
$C_6=-0·554$
$C_7=+0·231$
$C_8=+0·288$
$C_9=+0·767$
$C_{10}=-0·844$
$C_{11}=+0·134$
$C_{12}=+0·146$
$C_{13}=+0·276$
$C_{14}=-0·842$
$C_{15}=+0·051$
$C_{16}=+0·129$
$C_{17}=-0·196$
$C_{18}=+0·0145$
$C_{19}=-0·0569$
$C_{20}=-0·603$
$C_{21}=+0·0231$
$C_{22}=-0·285$
$C_{23}=+0·0233$
$C_{24}=+0·0665$

Resulting corrections to observed directions.

(1)=+0·460
(2) +0·251
(3) −0·079
(4) −0·326
(5) −0·075
(6) +0·068
(7) −0·869
(8) +0·926
(9) +0·468
(10) −0·471
(11) −0·097
(12)=−0·241
(13) +0·836
(14) −0·495
(15) −0·281
(16) −0·134
(17) −0·112
(18) −0·077
(19) +0·089
(20) +0·398
(21) +0·118
(22) +0·474
(23)=+0·130
(24) −0·187
(25) +0·176
(26) +0·062
(27) −0·176
(28) −0·479
(29) +0·359
(30) −0·377
(31) +1·068
(32) −0·061
(33) −0·842
(34)=−0·146
(35) −0·445
(36) −0·039
(37) +0·384
(38) +0·100
(39) −0·230
(40) +1·483
(41) −0·576
(42) −0·677

Probable error of an observed direction $0·674\sqrt{\frac{9·88}{24}}=\pm 0''·41$.

Resulting angles and sides of the first section of the triangulation southwest of the Kent Island base net and extension.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Long Mountain	30	47	57 ·98	−1 ·33	56 ·65	1 ·35	4 ·649 283 4	44 594 ·71
	Humpback	28	27	31 ·65	+0 ·46	32 ·11	1 ·35	4 ·618 077 4	41 502 ·80
	Spear	120	44	35 ·53	−0 ·25	35 ·28	1 ·34	4 ·874 224 9	74 855 ·71
2	Tobacco Row	132	04	13 ·13	−0 ·08	13 ·05	1 ·00	4 ·874 224 9	74 855 ·71
	Humpback	18	24	09 ·70	−0 ·46	09 ·24	0 ·99	4 ·502 886 6	31 833 ·66
	Long Mountain	29	31	39 ·61	+1 ·08	40 ·69	0 ·99	4 ·696 339 6	49 698 ·08
3	Long Mountain	60	19	37 ·59	−0 ·25	37 ·34	0 ·97	4 ·577 326 2	37 785 ·59
	Tobacco Row	72	37	08 ·79	−0 ·07	08 ·72	0 ·98	4 ·618 077 4	41 502 ·80
	Spear	47	03	17 ·11	−0 ·25	16 ·86	0 ·97	4 ·502 886 7	31 833 ·67
4	Flat Top	10	17	00 ·23	+0 ·15	00 ·38	0 ·41	4 ·577 326 2	37 785 ·59
	Tobacco Row	159	40	31 ·48	+0 ·92	32 ·40	0 ·41	4 ·866 398 9	73 518 ·88
	Spear	10	02	28 ·12	+0 ·33	28 ·45	0 ·41	4 ·567 083 6	36 904 ·86
5	Flat Top	31	44	51 ·50	+0 ·02	51 ·52	1 ·56	4 ·618 077 4	41 502 ·80
	Spear	37	00	48 ·99	−0 ·57	48 ·42	1 ·56	4 ·676 543 1	47 483 ·54
	Long Mountain	111	14	25 ·12	−0 ·39	24 ·73	1 ·55	4 ·866 398 9	73 518 ·88
6	Flat Top	42	01	51 ·73	+0 ·17	51 ·90	0 ·99	4 ·502 886 7	31 833 ·67
	Tobacco Row	87	03	22 ·69	+1 ·00	23 ·69	1 ·00	4 ·676 543 2	47 483 ·55
	Long Mountain	50	54	47 ·53	−0 ·14	47 ·39	0 ·99	4 ·567 083 6	36 904 ·86
7	Smith Mountain	20	50	35 ·03	−0 ·24	34 ·79	1 ·96	4 ·577 326 2	37 785 ·59
	Tobacco Row	118	11	11 ·60	+0 ·07	11 ·67	1 ·97	4 ·971 303 1	93 605 ·87
	Spear	40	58	19 ·35	+0 ·08	19 ·43	1 ·96	4 ·842 815 4	69 633 ·05
8	Smith Mountain	4	48	11 ·73	−0 ·30	11 ·43	0 ·35	4 ·618 077 4	41 502 ·80
	Spear	6	04	57 ·76	−0 ·33	57 ·43	0 ·35	4 ·720 334 2	52 521 ·14
	Long Mountain	69	06	53 ·16	−0 ·97	52 ·19	0 ·35	4 ·971 303 0	93 605 ·85
9	Smith Mountain	30	12	41 ·15	−0 ·11	41 ·04	1 ·44	4 ·567 083 6	36 904 ·86
	Flat Top	108	18	02 ·34	+0 ·20	02 ·54	1 ·44	4 ·842 815 2	69 633 ·02
	Tobacco Row	41	29	19 ·88	+0 ·86	20 ·74	1 ·44	4 ·686 522 8	48 587 ·30
10	Smith Mountain	25	38	46 ·76	−0 ·55	46 ·21	1 ·34	4 ·502 886 7	31 833 ·67
	Tobacco Row	45	34	02 ·81	+0 ·14	02 ·95	1 ·34	4 ·720 334 4	52 521 ·17
	Long Mountain	108	47	15 ·57	−0 ·71	14 ·86	1 ·34	4 ·842 815 4	69 633 ·05
11	Smith Mountain	51	03	16 ·18	−0 ·35	15 ·83	3 ·00	4 ·866 398 9	73 518 ·88
	Flat Top	98	01	02 ·11	+0 ·06	02 ·17	2 ·99	4 ·971 303 1	93 605 ·87
	Spear	30	55	51 ·23	−0 ·24	50 ·99	3 ·00	4 ·686 522 9	48 587 ·31
12	Smith Mountain	55	51	27 ·91	−0 ·66	27 ·25	1 ·79	4 ·676 543 2	47 483 ·55
	Flat Top	66	16	10 ·61	+0 ·03	10 ·64	1 ·79	4 ·720 334 3	52 521 ·16
	Long Mountain	57	52	28 ·04	−0 ·56	27 ·48	1 ·79	4 ·686 523 0	48 587 ·33

Resulting angles and sides of the first section of the triangulation southwest of the Kent Island base net and extension—continued.

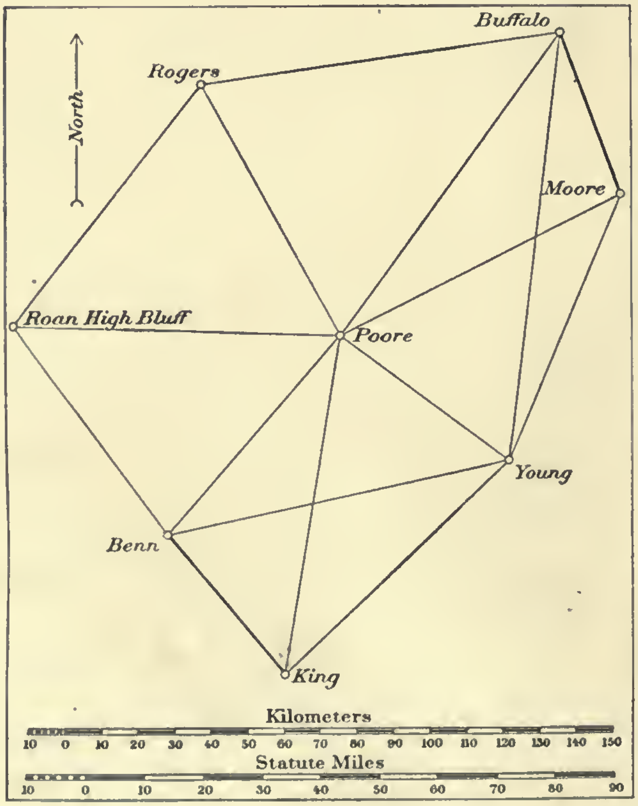
No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
13	Cahas	9	42	30.62	−0.73	29.89	0.67	4.567 083 6	36 904.86
	Flat Top	156	09	54.29	+0.68	54.97	0.68	4.946 643 2	88 438.88
	Tobacco Row	14	07	35.37	+1.79	37.16	0.67	4.727 663 4	53 415.02
14	Cahas	21	02	39.50	+1.44	40.94	2.28	4.502 886 7	31 833.67
	Tobacco Row	72	55	47.32	−0.79	46.53	2.28	4.928 119 5	84 746.06
	Long Mountain	86	01	39.14	+0.23	39.37	2.28	4.946 643 2	88 438.88
15	Cahas	30	45	10.12	+0.71	10.83	1.96	4.676 543 2	47 483.55
	Flat Top	114	08	02.56	+0.51	03.07	1.96	4.928 119 6	84 746.08
	Long Mountain	35	06	51.61	+0.37	51.98	1.96	4.727 663 6	53 415.05
16	Cahas	59	58	52.64	−0.42	52.22	1.63	4.686 522 9	48 587.31
	Flat Top	47	51	51.95	+0.48	52.43	1.63	4.619 220 5	41 612.18
	Smith Mountain	72	09	19.88	+0.36	20.24	1.63	4.727 663 5	53 415.04
17	Cahas	29	13	42.52	−1.13	41.39	1.46	4.720 334 3	52 521.16
	Long Mountain	22	45	36.43	−0.94	35.49	1.46	4.619 220 5	41 612.18
	Smith Mountain	128	00	47.79	−0.30	47.49	1.45	4.928 119 6	84 746.08
18	Cahas	50	16	22.02	+0.32	22.34	2.40	4.842 815 4	69 633.05
	Tobacco Row	27	21	44.51	−0.94	43.57	2.40	4.619 220 6	41 612.19
	Smith Mountain	102	22	01.03	+0.25	01.28	2.39	4.946 643 3	88 438.90
19	Buffalo	25	52	26.05	+0.83	26.88	3.38	4.686 522 9	48 587.31
	Flat Top	49	35	42.73	+0.19	42.92	3.38	4.928 312 3	84 783.69
	Smith Mountain	104	32	00.28	+0.05	00.33	3.37	5.032 535 0	107 779.2
20	Buffalo	1	41	55.85	+0.41	56.26	0.15	4.727 663 5	53 415.04
	Flat Top	1	43	50.78	−0.28	50.50	0.15	4.735 698 3	54 412.45
	Cahas	176	34	13.18	+0.50	13.68	0.14	5.032 534 9	107 779.2
21	Buffalo	24	10	30.20	+0.42	30.62	1.60	4.619 220 5	41 612.18
	Flat Top	123	26	54.18	−0.08	54.10	1.60	4.928 312 3	84 783.69
	Smith Mountain	32	22	40.40	−0.32	40.08	1.60	4.735 698 6	54 412.49
22	Moore	15	03	54.82	−0.10	54.72	2.73	4.686 522 9	48 587.31
	Flat Top	30	05	11.79	+0.17	11.96	2.73	4.971 803 6	93 713.81
	Smith Mountain	134	51	01.82	−0.30	01.52	2.74	5.122 329 4	132 534.6
23	Moore	11	17	38.02	−2.06	35.96	1.83	4.727 663 5	53 415.04
	Cahas	150	55	50.26	−1.20	49.06	1.83	5.122 329 5	132 534.6
	Flat Top	17	46	40.16	+0.31	40.47	1.83	4.920 554 4	83 282.62
24	Moore	26	21	32.84	−2.16	30.68	2.93	4.619 220 5	41 612.18
	Cahas	90	56	57.62	−0.78	56.84	2.94	4.971 803 6	93 713.81
	Smith Mountain	62	41	41.94	−0.66	41.28	2.93	4.920 554 3	83 282.60

Resulting angles and sides of the first section of the triangulation southwest of the Kent Island base net and extension—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
25	Moore	49	18	52·89	−0·35	52·54	4·04	5·032 535 0	107 779·2
	Buffalo	111	10	48·06	+0·55	48·61	4·04	5·122 329 3	132 534·6
	Flat Top	19	30	30·94	+0·03	30·97	4·04	4·676 356 4	47 463·13
26	Moore	38	01	14·87	+1·71	16·58	2·06	4·735 698 6	54 412·49
	Buffalo	109	28	52·21	+0·14	52·35	2·06	4·920 554 3	83 282·60
	Cahas	32	29	56·56	+0·69	57·25	2·06	4·676 356 4	47 463·13
27	Moore	64	22	47·71	−0·45	47·26	3·40	4·928 312 3	84 783·69
	Buffalo	85	18	22·01	−0·28	21·73	3·39	4·971 803 6	93 713·81
	Smith Mountain	30	19	01·54	−0·34	01·20	3·40	4·676 356 4	47 463·13

5. SECOND OR NORTH CAROLINA SECTION OF THE TRIANGULATION SOUTH OF THE TRANSCONTINENTAL TRIANGULATION, IN VIRGINIA AND NORTH CAROLINA, 1876–1895.

No. 24.



This section extends over an area covered by several large triangles which have the centrally located station Poore as one of their points in common. In 1878 when the main triangulation between the lines Buffalo to Moore and Grassy to Sawnee was adjusted, this central figure about Poore had no existence. In consequence of the introduction of this figure some modification in the treatment of the work between the Kent Island and Atlanta bases became necessary. The adjustment of 1878 involved considerable labor, as it included the formation and solution of 41 normal equations. It was desirable to retain this adjustment and interpose the central figure about Poore for the purpose of disposing of whatever error was developed between the bases by the intervening triangulation. The probable error of the measure of the Kent Island base, which is the least accurate of the six bases along the arc, is 34 units in the seventh place of decimals of its logarithm, whereas that of the Atlanta base is but 10 units;

hence the influence of the latter over the triangulation between stations Sawnee and Benn, which constitutes the third section, was retained. In the present central figure the condition was introduced preserving the fixed relation between the two sides marked in the diagram by heavy lines.

The approximate elevations of the stations are as follows:

	Meters.	Feet.		Meters.	Feet.
Poore	817	2 680	King	516	1 693
Young	333	1 093	Rogers	1 746	5 729
Benn	886	2 907	Roan High Bluff	1 913	6 275

From the eleven triangles we derive the mean closing error of a triangle $\sqrt{\frac{56\cdot8}{11}} = \pm 2''\cdot27$, the mean error of an angle $\frac{2\cdot27}{\sqrt{3}} = \pm 1''\cdot31$ and the probable error of a direction $0\cdot674 \frac{2\cdot27}{\sqrt{6}} = \pm 0''\cdot63$.

In the preceding diagram, the two heavy lines are fixed in length, and the dispersion of the discrepancy between the bases, of 24 units in the seventh place of decimals in the logarithm, is accomplished by the adjustment. Attention is called to the fact that in a figure adjustment, when forcing an accord between the fixed lengths of two terminal sides, as is the case here, the conditional equation may be established either with plane angles or with spherical angles, provided in the latter case the terminal sides are corrected for difference between arc and sine. This is readily done by means of the table given in Coast and Geodetic Survey Report for 1894, Appendix No. 9, page 289, below the heading "Table of corrections to longitude for difference in arc and sine."

In establishing the length equation for any unadjusted figure the apparent discrepancy to be dispersed in order to produce accord between two lines whose length is fixed will vary with the angles selected. The true discrepancy to be dispersed can, nevertheless, be obtained from the length equation, provided the length equation be taken last in the solution of the normal equations, thus eliminating all the other unknown quantities; and the discrepancy so derived is the same as would be obtained if the length equation were formed after the entire figure had been adjusted in all other respects.

In the present section the length discrepancy with the uncorrected spherical angles was 78 units; but the true discrepancy outstanding after the other adjustments are made is but 24 units. This is less than the probable error of the measurement of the Kent Island base. The logarithm of the length of line Buffalo to Moore is 4·676 356 4, and that of the line Benn to King, 4·705 136 6.

Abstracts of horizontal directions at stations composing the second or North Carolina section of the triangulation, 1876–1895.

Buffalo, Floyd County, Virginia. September 25 to October 16, 1876. 35 cm direction theodolite No. 10. A. T. Mosman, observer. September 27 to October 1, 1895. 45 cm direction theodolite No. 4. A. H. Buchanan, observer.

Number of directions.	Objects observed.	Result of local adjustment.			Reductions to sea level.	Resulting seconds.	Corrections from adjustment of first section.	Resulting seconds.	Corrections from adjustment of second section.	Final seconds.
		°	′	″	″	″	″	″	″	″
	Bull Mountain	0	00	00 ·00	....	.....	....	.....	....	.....
	Moore	41	36	48 ·92	−0 ·04	48 ·88	+0 ·10	(48 ·98)	....	.....
	Pilot Mountain	62	51	49 ·89	....	.....	....	.....	....	.....
3	Young	70	37	50 ·34	+0 ·01	50 ·35	....	.....	−0 ·63	49 ·72
4	Poore †	99	35	20 ·42	+0 ·05	20 ·47	....	.....	−0 ·19	20 ·28
5	Rogers * †	144	29	13 ·76	+0 ·04	13 ·80	....	.....	+0 ·74	14 ·54
	Flat Top	290	26	00 ·73	+0 ·09	00 ·82	−0 ·44	(00 ·38)	....	.....
	Cahas	292	07	56 ·59	+0 ·08	56 ·67	−0 ·04	(56 ·63)	....	.....
	Smith Mountain	316	18	26 ·85	+0 ·02	26 ·87	+0 ·38	(27 ·25)	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), (Buchanan, observer), $e_1 = \pm 1''\cdot25$. Circle used in XI positions.

Moore, Stokes County, North Carolina. November 7 to December 26, 1876, and April 21 to May 31, 1877. 35 cm direction theodolite No. 10. A. T. Mosman, observer.

Number of directions.	Objects observed.	Result of local adjustment.			Reductions to sea level.	Resulting seconds.	Corrections from adjustment of first section.	Resulting seconds.	Corrections from adjustment of second section.	Final seconds.
		°	′	″	″	″	″	″	″	″
	Pilot Mountain	0	00	00 ·00	....	.....	....	.....	....	.....
	Buffalo	89	04	10 ·07	−0 ·05	10 ·02	−0 ·23	(09 ·79)	....	.....
	Azimuth Mark	110	31	01 ·90	....	.....	....	.....	....	01 ·90
	Cahas	127	05	24 ·85	+0 ·04	24 ·89	+1 ·48	(26 ·37)	....	.....
	Flat Top	138	23	02 ·84	+0 ·07	02 ·91	−0 ·58	(02 ·33)	....	.....
	Smith Mountain	153	26	57 ·69	+0 ·04	57 ·73	−0 ·68	(57 ·05)	....	.....
1	Young	314	44	12 ·49	+0 ·02	12 ·51	....	.....	−0 ·18	12 ·33
2	Poore	354	21	09 ·66	+0 ·05	09 ·71	....	.....	+0 ·12	09 ·83

* Reduction to center −2″·10, applied. † Buchanan, observer.

Abstracts of horizontal directions at stations composing the second or North Carolina section of the triangulation, 1876–1895—continued.

Poore, Wilkes County, North Carolina September 15 to October 11, 1877. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. August 30 to September 17, 1895. 45^{cm} direction theodolite No. 4. A. H. Buchanan, observer. Circle used in XI positions in both years.

Number of directions.	Objects observed.		Result of local adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from adjustment of second section.	Final seconds.
			°	′	″	″	″	″	″	″
	Mark	1877	0	00	00·00	±0·07	....	.....	....	.....
6	Buffalo	1877, 1895	32	47	15·52	0·12	+0·08	15·60	−0·39	15·21
7	Moore	1877	60	05	54·43	0·11	+0·04	54·47	+0·02	54·49
	Mark	1895	60	55	18·32	....	....	.....	....	.....
8	Young	1877	123	21	18·64	0·16	−0·02	18·62	+0·18	18·80
	Anderson	1877	170	22	26·64	0·28	...	.....	....	.....
9	King	1877	185	26	51·63	0·13	+0·01	51·64	−0·15	51·49
10	Benn	1877, 1895	217	22	12·19	0·12	+0·06	12·25	−0·18	12·07
	Mount Mitchell	1877	249	45	08·56	0·54	....	.....	....	.....
11	Roan High Bluff	1895	270	23	04·91	....	−0·02	04·89	+0·36	05·25
12	Rogers	1895	329	46	41·23	....	−0·10	41·13	+0·16	41·29

Probable error of a single observation of a direction (*D.* and *R.*) in 1877, $e_1 = \pm 0''\cdot78$; in 1895, $e_1 = \pm 1''\cdot28$; combined $\pm 0''\cdot99$.

Young, Rowan County, North Carolina. September 22 to November 11, 1876. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Result of local adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from adjustment of second section.	Final seconds.
		°	′	″	″	″	″	″	″
	Azimuth Mark	0	00	00·00	±0·08	....	.....	....	00·00
16	Buffalo	0	01	09·36	0·19	+0·02	09·38	+0·64	10·02
	Mocksville Church	16	37	17·07	0·17	....	.....	....	.....
17	Moore	16	40	18·19	0·14	+0·04	18·23	+0·52	18·75
13	King	218	37	38·28	0·16	+0·04	38·32	−1·40	36·92
	Anderson	237	26	03·64	0·12	....	.....	....	.....
14	Benn	251	11	54·95	0·16	+0·02	54·97	+0·37	55·34
15	Poore	299	32	29·32	0·15	−0·06	29·26	−0·12	29·14

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot83$.

Abstracts of horizontal directions at stations composing the second or North Carolina section of the triangulation, 1876–1895—continued.

Benn, Burke and Cleveland Counties, North Carolina. July 25 to August 22, 1877. 50 cm direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of station adjustment. °	′	″	Approximate probable errors. ″	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
	Reference Mark	0	00	00·00	±0·08				
	Poore	90	24	53·48	0·21				
	Young	128	03	37·66	0·15				
	Anderson	139	52	09·17	0·28				
	King	191	28	17·42	0·16				
	Thicketty	241	16	29·13	0·35				
	Wofford	250	34	52·92	0·19				
	Paris	274	57	27·38	0·20				
	Hogback	282	51	27·03	0·22				
	Mount Mitchell	342	18	31·76	0·43				

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm1''\cdot08$.

July 13 to August 14, 1895. 45 cm direction theodolite No. 4. A. H. Buchanan, observer. Circle used in XI positions.

Number of directions.	Objects observed.	°	′	″	Approximate probable errors.	Reductions to sea level. ″	Resulting seconds. ″	Corrections from figure adjustment.	Final seconds.
	Mark 1895	0	00	00·00		....	.....		
	Roan High Bluff	21	02	06·70		−0·13	06·57		
	Poore	98	00	40·56		+0·06	40·62		

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm1''\cdot30$.

Consolidated results at Benn.

Number of directions.	Objects observed.	°	′	″	Approximate probable errors.	Reductions to sea level. ″	Resulting seconds. ″	Corrections from figure adjustment. ″	Final seconds. ″
	Mark 1877	0	00	00·00		....	.....	....	.....
18	Roan High Bluff	13	26	19·62		−0·13	19·49	−1·25	18·24
19	Poore	90	24	53·48		+0·06	53·54	+0·18	53·72
20	Young	128	03	37·66		+0·01	37·67	−0·81	36·86
	Anderson	139	52	09·17		....	.....	....	.....
	King*	191	28	17·42		−0·04	17·38	....	.....
							+0·23		
	Thicketty	241	16	29·13		....	.....	....	.....
	Wofford	250	34	52·92		....	.....	....	.....
	Paris	274	57	27·38		....	.....	....	.....
	Hogback	282	51	27·03		....	.....	....	.....
	Mount Mitchell	342	18	31·75		....	.....	....	.....

* The line King to Benn being fixed by the southern section.

Abstracts of horizontal directions at stations composing the second or North Carolina section of the triangulation, 1876–1895—continued.

King, Gaston County, North Carolina. November 26 to December 30, 1876, and June 17 to 25, 1877. 50 cm direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI position.

Number of directions.	Objects observed.	Results of station adjustment.			Approximate probable errors.	Reductions to sea level.	Resulting seconds.	Corrections from figure adjustment.	Final seconds.
		°	′	″	″	″	″	″	″
	Azimuth Mark	0	00	00·00	±0·06	....	.....	....	.....
	Benn*	1	34	43·66	0·20	−0·06	43·60	....	.....
							+0·02		
21	Poore	48	36	08·31	0·16	+0·02	08·33	−0·30	08·03
	Anderson	66	51	08·80	0·24	....	.....	....	.....
	Young	85	35	53·17	0·15	+0·02	53·19	+2·05	55·24
	Wofford	284	16	19·00	0·12	....	.....	....	.....
	Paris	293	54	20·10	0·16	....	.....	....	.....
	Thicketty	296	01	01·90	0·26	....	.....	....	.....
	Hogback	307	36	45·89	0·16	....	.....	.....	.....
	Mount Mitchell	345	51	56·4	....	....	.....	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm0''\cdot69$.

Roan High Bluff, Mitchell County, North Carolina. October 11 to 24, 1894. 45 cm direction theodolite No. 4. A. H. Buchanan, observer. Circle used in XI positions.

Number of directions.	Objects observed.	°	′	″	Reductions to sea level ″	Resulting seconds ″	Corrections from figure adjustment ″	Final seconds ″
	Mark	0	00	00·00	....	.....	....	.....
24	Poore	34	17	14·14	−0·01	14·13	−0·39	13·74
25	Benn	84	17	56·57	−0·06	56·51	+1·27	57·78
	Mount Mitchell	137	47	39·29	....	.....	....	.....
	Big Butt	206	45	13·80	....	.....	....	.....
	Chimney	246	08	13·94	....	.....	....	.....
	Big Knob	274	20	49·02	....	.....	....	.....
	Holston	303	26	14·54	....	.....	....	.....
23	Rogers	341	40	13·92	+0·12	14·04	−0·88	13·16

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm1''\cdot33$.

Rogers, Grayson County, Virginia. July 27 to September 22, 1894. 45 cm direction theodolite No. 4. A. H. Buchanan, observer. Circle used in XI positions.

Number of directions.	Objects observed.	°	′	″	Reductions to sea level ″	Resulting seconds ″	Corrections from figure adjustment ″	Final seconds ″
	White Top	0	00	00·00	...	.....	....	.....
	Big Knob	24	09	36·83	....	.....	....	.....
26	Buffalo	194	12	37·64	+0·03	37·67	−0·72	36·95
27	Poore	266	18	26·84	−0·05	26·79	−0·18	26·61
28	Roan High Bluff	334	18	03·89	+0·13	04·02	+0·90	04·92
	Big Butt	349	29	28·01	....	.....	....	.....
	Holston	358	23	29·97	....	.....	....	....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1=\pm1''\cdot32$.

* The line King to Benn being fixed by the southern section.

Observation equations.

I	o = −0·10 − (2) + (4) − (6) + (7)
II	o = +0·57 − (1) + (3) − (16) + (17)
III	o = −1·10 − (1) + (2) − (7) + (8) − (15) + (17)
IV	o = +0·51 − (9) + (10) − (19) + (21)
V	o = −4·65 − (13) + (14) − (20) + (22)
VI	o = −3·31 − (8) + (9) − (13) + (15) − (21) + (22)
VII	o = −0·92 − (4) + (5) + (6) − (12) − (26) + (27)
VIII	o = −1·36 − (11) + (12) − (23) + (24) − (27) + (28)
IX	o = −3·64 − (10) + (11) − (18) + (19) − (24) + (25)
X	o = −0·5 + 3·79(3) − 1·32(4) − 4·08 (6) + 5·15 (7) − 1·07 (8) − 0·48(15) + 7·04(16) − 6·56(17)
XI	o = −5·9 + 0·15(8) + 3·38(9) − 3·53(10) − 3·29(13) + 5·16(14) − 1·87(15) + 1·96(21) − 0·22(22)
XII	o = +1·4 − 3·80(3) + 5·91(4) − 2·11 (5) − 1·87(14) + 3·07(15) − 1·20(16) − 0·49(18) + 3·22 (19) −2·73(20) − 1·61(23) + 3·38(24) − 1·77(25) − 0·68(26) + 1·53(27) − 0·85(28)
XIII	o = +7·8 − 2·55(1) + 2·55(2) + 1·32(4) + 4·08(6) − 4·08(7) − 3·38(9) + 3·38(10) − 0·34(13) +0·82(15) − 0·48(17) − 0·41(19) + 2·80(21) − 2·80(22)

Normal equations.

		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}
1	o = −0·10	+4		−2				−2			+ 7·91		+ 5·91	− 9·39
2	+0·57		+4	+2							− 9·81		− 2·60	+ 2·07
3	−1·10			+6			−2				− 12·30	+ 2·02	− 3·07	+ 7·88
4	+0·52				+4		−2					− 4·95	− 3·22	+ 9·97
5	−4·64					+4	+2					+ 8·23	+ 0·86	− 2·46
6	−3·31						+6				+ 0·59	+ 2·47	+ 3·07	− 7·82
7	−0·92							+6	−2		− 2·76		− 5·81	+ 2·76
8	−1·36								+6	−2			+ 2·61	
9	−3·64									+6		+ 3·53	− 1·44	− 3·79
10	−0·5										+153·25	+ 0·74	− 32·12	−36·64
11	−5·9											+68·74	− 15·39	−17·67
12	+1·4												+106·92	+ 9·00
13	+7·8													+87·75

Resulting correlates.

$C_1 = +0·719$
$C_2 = -0·653$
$C_3 = +1·096$
$C_4 = +1·080$
$C_5 = +0·838$
$C_6 = +0·909$
$C_7 = +0·726$
$C_8 = +0·890$
$C_9 = +1·252$
$C_{10} = -0·003\ 86$
$C_{11} = -0·094\ 0$
$C_{12} = -0·009\ 16$
$C_{13} = -0·101\ 5$

Resulting corrections to observed directions.

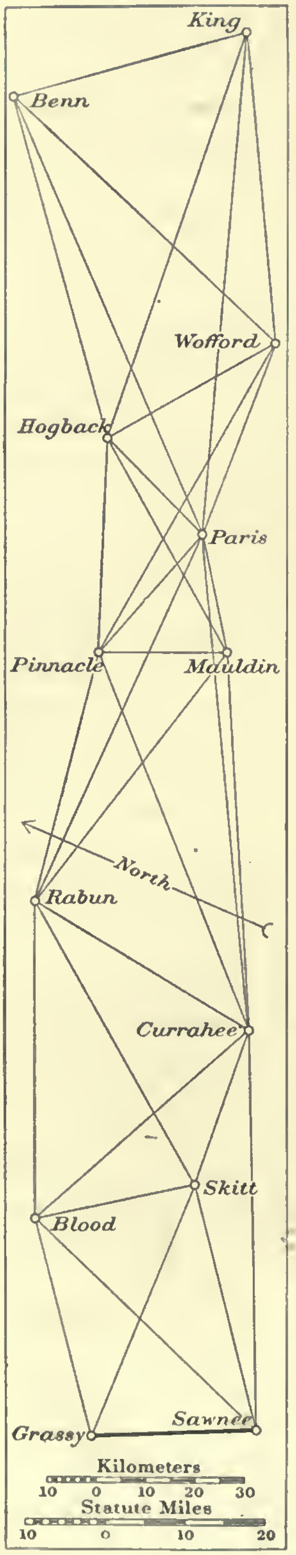
″	″	″	″
(1) = −0·185	(8) = +0·177	(15) = −0·121	(22) = +2·052
(2) +0·118	(9) −0·146	(16) +0·637	(23) −0·875
(3) −0·633	(10) −0·183	(17) +0·517	(24) −[illegible]·593
(4) −0·190	(11) +0·362	(18) −1·248	(25) +1·268
(5) +0·745	(12) +0·164	(19) +0·184	(26) −0·720
(6) −0·391	(13) −1·403	(20) −0·813	(27) −0·178
(7) +0·017	(14) +0·370	(21) −0·297	(28) +0·898

Probable error of an observed direction, $0·674\sqrt{\frac{14·66}{13}} = \pm 0''·72$.

Resulting angles and sides of the second or North Carolina section of the triangulation.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Poore	27	18	38·87	+0·41	39·28	3·51	4·676 356 4	47 463·13
	Buffalo	57	58	31·49	−0·19	31·30	3·51	4·943 028 7	87 705·87
	Moore	94	42	60·08	−0·12	59·96	3·52	5·013 257 0	103 099·6
2	Young	16	39	08·85	−0·12	08·73	2·31	4·676 356 4	47 463·13
	Buffalo	29	01	01·37	−0·63	00·74	2·31	4·904 942 5	80 341·98
	Moore	134	19	57·28	+0·18	57·46	2·31	5·073 639 3	118 478·4
3	Poore	90	34	03·02	+0·57	03·59	5·01	5·073 639 3	118 478·4
	Buffalo	28	57	30·12	+0·44	30·56	5·01	4·758 644 5	57 364·67
	Young	60	28	40·12	+0·76	40·88	5·01	5·013 257 0	103 099·6
4	Poore	63	15	24·15	+0·16	24·31	3·81	4·904 942 5	80 341·98
	Moore	39	36	57·20	+0·30	57·50	3·81	4·758 644 6	57 364·69
	Young	77	07	48·97	+0·64	49·61	3·80	4·943 028 8	87 705·89
5	Rogers	72	05	49·12	+0·54	49·66	5·94	5·013 257 0	103 099·6
	Buffalo	44	53	53·33	+0·93	54·26	5·95	4·883 517 2	76 474·60
	Poore	63	00	34·47	−0·55	33·92	5·95	4·984 727 1	96 544·40
6	Roan High Bluff	52	37	00·09	+0·48	00·57	4·97	4·883 517 2	76 474·60
	Rogers	67	59	37·23	+1·08	38·31	4·98	4·950 523 6	89 232·62
	Poore	59	23	36·24	−0·20	36·04	4·97	4·918 217 4	82 835·67
7	Benn	76	58	34·05	+1·43	35·48	4·23	4·950 523 6	89 232·62
	Roan High Bluff	50	00	42·38	+1·66	44·04	4·24	4·846 167 1	70 172·52
	Poore	53	00	52·64	+0·55	53·19	4·24	4·864 269 1	73 159·22
8	King	36	59	44·86	+2·35	47·21	4·04	4·758 644 5	57 364·67
	Poore	62	05	33·02	−0·32	32·70	4·04	4·925 530 7	84 242·39
	Young	80	54	50·94	+1·28	52·22	4·05	4·973 743 9	94 133·44
9	Benn	37	38	44·13	−1·00	43·13	3·40	4·758 644 5	57 364·67
	Poore	94	00	53·63	−0·36	53·27	3·40	4·971 708 3	93 693·26
	Young	48	20	34·29	−0·49	33·80	3·40	4·846 167 0	70 172·51
10	Benn	101	03	24·07	−0·18	23·89	2·95	4·973 743 9	94 133·44
	Poore	31	55	20·61	−0·04	20·57	2·96	4·705 136 5	50 715·01
	King	47	01	24·71	−0·30	24·41	2·96	4·846 167 1	70 172·52
11	Benn	63	24	39·94	+0·82	40·76	3·60	4·925 530 7	84 242·39
	Young	32	34	16·65	+1·77	18·42	3·60	4·705 136 7	50 715·03
	King	84	01	09·57	+2·05	11·62	3·60	4·971 708 5	93 693·30

No. 25.



6. THIRD OR SOUTH CAROLINA SECTION OF THE TRIANGULATION SOUTH OF THE TRANSCONTINENTAL TRIANGULATION, 1873–1877.

This section completes the connection of the Kent Island and Atlanta bases, as already indicated in the preceding section. The results of the adjustment made in October, 1878, are retained, omitting only the two quadrilaterals lying between the stations Buffalo and King, which were included in the second section. The conditional equations, as well as the normal equations, are presented in full, leaving out the eight triangles between the two stations named above, as they are superseded by the present arrangement. The old, and less convenient, notation of the corrections to the angles has been changed, and the order of the presentation of the triangles has been reversed so as to proceed from the northeast toward the southwest. The third place of decimals in the seconds of the angles was dropped as unnecessary, particularly since no corrections for height of stations observed upon were made, the maximum value of this correction being below 0''·1.

The stations involved and their approximate heights are as follows:

	Meters.	Feet.
Hogback	984·4	3 230
Wofford	267·6	878
Pinnacle	1 047·4	3 436
Paris	626·1	2 054
Mauldin	404·8	1 328
Rabun	1 437·7	4 717
Currahee	530·2	1 740
Blood	1 360·4	4 463
Skitt	632·7	2 076

Relative weights to the directions were introduced in the same way as had been employed in the adjustment of the Atlanta base net. Referring to the explanation there given, the value of the mean closing error of a triangle (derived from 73 cases in the triangulation connecting stations Buffalo, Virginia, and Kenesaw, Georgia) is $\sqrt{\frac{275\cdot5}{73}} = \pm 1''\cdot94$ * and the probable error of a direction is $0\cdot674\ \frac{1\cdot94}{\sqrt{6}} = \pm 0''\cdot54$; also the average probable error of an observed direction (see abstracts) $\varepsilon_1 = \pm 0''\cdot18$, hence $\varepsilon_c^2 = (0\cdot54)^2 - (0\cdot18)^2 = 0\cdot255$, which was added as a constant to the square of each observing error. We have $\varepsilon^2 = \varepsilon_c^2 + \varepsilon_1^2$ and the weight $p = 1/\varepsilon^2$; in order to make the average weight nearly unity, the reciprocal was divided by 0·28. The reciprocal relative weights are tabulated farther on; the minimum value of ε^2 or $\frac{1}{p}$ is 0·5 and the maximum 1·3.

* From the 35 triangles directly involved here we have $\sqrt{\frac{58\cdot4}{35}} = \pm 1''\cdot30$ and the mean error of a direction becomes $\pm 0''\cdot78$.

Abstracts of horizontal directions at stations comprising the third or South Carolina section of the triangulation, 1873–1877.

King, Gaston County, North Carolina. November 26 to December 30, 1876, and June 17–25, 1877. 50[cm] direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Azimuth Mark	0	00	00 ·000	±0 ·06	.....	......
64	Benn	1	34	43 ·656	0 ·20	+0 ·014	43 ·670
	Poore	48	36	08 ·311	0 ·16	.....	......
	Anderson	66	51	08 ·804	0 ·24	.....	......
	Young	85	35	53 ·167	0 ·15	.....	......
61	Wofford	284	16	18 ·996	0 ·12	+0 ·444	19 ·440
62	Paris	293	54	20 ·098	0 ·16	−1 ·724	18 ·374
	Thicketty	296	01	01 ·905	0 ·26	.....	......
63	Hogback	307	36	45 ·893	0 ·16	+0 ·413	46 ·306
	Mount Mitchell	345	51	56 ·4	....	.....	......

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0'' \cdot 69$.

Benn, Burke and Cleveland Counties, North Carolina. July 25 to August 22, 1877. 50[cm] direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Reference Mark	0	00	00 ·000	±0 ·08	.....	......
	Poore	90	24	53 ·479	0 ·21	.....	......
	Young	128	03	37 ·657	0 ·15	.....	......
	Anderson	139	52	09 ·167	0 ·28	.....	......
65	King	191	28	17 ·424	0 ·16	+0 ·230	17 ·654
	Thicketty	241	16	29 ·132	0 ·35	.....	......
66	Wofford	250	34	52 ·916	0 ·19	+0 ·604	53 ·520
67	Paris	274	57	27 ·376	0 ·20	+0 ·705	28 ·081
68	Hogback	282	51	27 ·027	0 ·22	−0 ·568	26 ·459
	Mount Mitchell	342	18	31 ·755	0 ·43	.....	......

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1'' \cdot 08$.

Hogback, Greenville County, South Carolina. August 16 to September 1, 1876. 50[cm] direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
58	Paris	0	00	00 ·000	±0 ·07	−0 ·178	59 ·822
59	Mauldin	15	44	50 ·325	0 ·11	−0 ·038	50 ·287
60	Pinnacle	46	26	55 ·104	0 ·17	+1 ·278	56 ·382
	Mount Mitchell	158	32	15 ·94	0 ·44	.....	......
55	Benn	208	54	59 ·171	0 ·12	−0 ·287	58 ·884
56	King	243	34	02 ·348	0 ·18	−0 ·339	02 ·009
	Thicketty	253	55	03 ·471	0 ·14	.....	......
57	Wofford	282	16	22 ·064	0 ·17	−0 ·416	21 ·648

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0'' \cdot 81$.

Abstracts of horizontal directions at stations comprising the third or South Carolina section of the triangulation, 1873-1877—continued.

Wofford, Spartanburg County, South Carolina. July 6 to August 7, 1876. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Thicketty	0	00	00 ·000	±0 ·09	.....	......
54	King	22	25	08 ·507	0 ·14	+0 ·580	09 ·087
50	Paris	226	05	58 ·853	0 ·16	+0 ·635	59 ·488
51	Pinnacle	235	09	59 ·137	0 ·16	−0 ·656	58 ·481
52	Hogback	264	27	49 ·062	0 ·26	+0 ·862	49 ·924
	Mount Mitchell	300	04	42	....	.....	......
53	Benn	338	50	02 ·589	0 ·15	−1. 343	01 ·246

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''{\cdot}96$.

Pinnacle, Pickens County, South Carolina. August 25 to September 8, 1875. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

		°	′	″	″	″	″
38	Paris	0	00	00 ·000	±0 ·10	+0 ·258	00 ·258
39	Mauldin	48	46	48 ·017	0 ·17	+0 ·032	48 ·049
40	Currahee	117	37	44 ·518	0 ·12	+0 ·269	44 ·787
41	Rabun	153	07	06 ·908	0 ·14	+0 ·856	07 ·764
36	Hogback	321	02	43 ·547	0 ·21	−0 ·887	42 ·660
37	Wofford	347	34	20 ·804	0 ·17	−0 ·637	20 ·167

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''{\cdot}92$.

Paris, Greenville County, South Carolina. September 16 to November 20, 1875. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

		°	′	″	″	″	″
45	Pinnacle	0	00	00 ·000	±0 ·06	−0 ·079	59 ·921
46	Hogback	94	35	47 ·974	0 ·19	+0 ·020	47 ·994
	Propst	109	45	43 ·080	0 ·17	.....	......
47	Benn	115	36	49 ·945	0 ·09	+1 ·183	51 ·128
	Thicketty	142	59	15 ·298	0 ·17	.....	......
48	King	144	27	28 ·012	0 ·21	−0 ·155	27 ·857
49	Wofford	158	30	21 ·824	0 ·21	+0 ·304	22 ·128
	Azimuth Mark	229	12	08 ·277	0 ·17	.....	......
42	Mauldin	308	16	00 ·933	0 ·14	−0 ·755	00 ·178
43	Currahee	314	06	42 ·296	0 ·18	−0 ·947	41 ·349
44	Rabun	343	20	09 ·423	0 ·16	+0 ·320	09 ·743

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''{\cdot}93$.

Abstracts of horizontal directions at stations comprising the third or South Carolina section of the triangulation, 1873-1877—continued.

Mauldin, Pickens County, South Carolina. December 8 to 14, 1875. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
33	Pinnacle	0	00	00·000	±0·07	+0·022	00·022
34	Hogback	61	33	51·967	0·18	−0·598	51·369
35	Paris	79	29	12·823	0·16	+1·215	14·038
31	Currahee	267	13	16·950	0·12	+0·112	17·062
32	Rabun	307	25	59·062	0·11	−0·678	58·384

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 77$.

Rabun, Rabun County, Georgia. July 27 to August 5, 1875. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Walhalla	0	00	00·000	±0·08	.....	......
28	Currahee	51	48	33·214	0·20	−0·351	32·863
29	Skitt	80	53	21·496	0·17	+1·023	22·519
	Yonah	89	51	56·194	0·23	.....	......
30	Blood	110	31	24·370	0·31	−0·354	24·016
25	Pinnacle	304	59	58·119	0·15	−0·987	57·132
26	Paris	315	13	01·555	0·12	−0·220	01·335
27	Mauldin	328	05	38·177	0·14	+0·830	39·007

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 85$.

Currahee, Habersham County, Georgia. September 17 to November 21, 1874. 50^{cm} direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Azimuth Mark	0	00	00·000	±0·07	.....	......
22	Pinnacle	9	31	57·621	0·11	−0·042	57·579
23	Paris	26	01	00·177	0·14	+0·085	00·262
24	Mauldin	27	54	22·374	0·14	+0·369	22·743
18	Sawnee	209	40	29·255	0·14	−0·552	28·703
19	Skitt	229	04	06·507	0·16	−0·432	06·075
	Yonah	254	59	47·703	0·25	.....	......
20	Blood	258	14	09·621	0·15	+0·661	10·282
21	Rabun	331	49	50·248	0·17	−0·090	50·158

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot 80$.

Abstracts of horizontal directions at stations comprising the third or South Carolina section of the triangulation, 1873–1877—continued.

Blood, Union County, Georgia. June 30 to July 15, 1875. 50cm direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Yonah	0	00	00 ·000	±0 ·08	.....	......
15	Skitt	23	53	12 ·312	0 ·17	−0 ·403	11 ·909
16	Sawnee	81	25	11 ·718	0 ·19	+0 ·383	12 ·101
17	Grassy	113	23	06 ·280	0 ·22	+0 ·480	06 ·760
	Cohutta	167	15	34 ·393	0 ·19	.....	......
13	Rabun	307	42	15 ·079	0 ·14	−0 ·221	14 ·858
14	Currahee	355	23	50 ·761	0 ·15	−0 ·195	50 ·566

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\!\cdot\!94$.

Skitt, White County, Georgia. August 14 to 25, 1874. 50cm direction theodolite No. 3. C. O. Boutelle, observer. Circle used in XI positions.

Number of directions.	Objects observed.	Results of local adjustment.			Approximate probable error.	Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″	″
	Yonah	0	00	00 ·000	±0 ·09	.....	......
11	Rabun	33	56	23 ·941	0 ·16	−0 ·105	23 ·836
12	Currahee	82	05	53 ·452	0 ·15	+0 ·510	53 ·962
8	Sawnee	230	31	07 ·207	0 ·17	−0 ·009	07 ·198
9	Grassy	264	50	54 ·066	0 ·14	−0 ·304	53 ·762
10	Blood	319	45	17 ·372	0 ·15	−0 ·092	17 ·280

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\!\cdot\!84$.

Sawnee, Forsyth County, Georgia. October 7 to November 12, 1873, and November 26 to December 4, 1873. 75cm direction theodolite No. 1 and 50cm direction theodolite No. 3. C. O. Boutelle, observer.

Number of directions.	Objects observed.	Results of station adjustment.			Approximate probable error.	Corrections from base net adjustment.	Resulting directions.	Corrections from adjustment of 3d section.	Final seconds.
		°	′	″	″	″	″	″	″
	Azimuth Mark	0	00	00 ·000	±0 ·09	+0 ·005	00 ·005	.....	......
	Alcova	5	59	50 ·203	0 ·24	+0 ·005	50 ·208	.....	......
1	Grassy*	191	04	26 ·154	0 ·22	−0 ·244	25 ·910	−0 ·109	25 ·801
2	Blood	240	44	00 ·564	0 ·24	+0 ·005	00 ·569	+0 ·800	01 ·369
	Yonah	263	11	38 ·044	0 ·31	+0 ·005	38 ·049	.....	......
3	Skitt	273	57	55 ·373	0 ·32	+0 ·005	55 ·378	−0 ·124	55 ·254
4	Currahee	286	09	07 ·228	0 ·22	+0 ·005	07 ·233	−0 ·455	06 ·778

Grassy, Pickens County, Georgia. July 13 to 31, 1874. 50cm direction theodolite No. 3. C. O. Boutelle, observer.

Number of directions.	Objects observed.	Results of station adjustment.			Approximate probable error.	Corrections from base net adjustment.	Resulting directions.	Corrections from adjustment of 3d section.	Final seconds.
		°	′	″	″	″	″	″	″
7	Sawnee*	0	00	00 ·000	±0 ·07	+0 ·228	00 ·228	−0 ·097	00 ·131
	Johns	131	59	17 ·050	0 ·26	.....	......	.....	......
	Cohutta	183	15	38 ·960	0 ·18	−0 ·032	38 ·928	.....	......
5	Blood	261	37	28 ·061	0 ·15	−0 ·032	28 ·029	−1 ·338	26 ·691
6	Skitt	297	13	10 ·620	0 ·16	−0 ·032	10 ·588	+1 ·532	12 ·120

* This direction, which is now considered as fixed, and hence not liable to a further correction, was formerly treated as subject to correction.

Observation equations.

I	$0=+1.938-(6)+(7)-(1)+(3)-(8)+(9)$
II	$0=-2.247-(5)+(7)-(1)+(2)-(16)+(17)$
III	$0=-3.964-(5)+(6)-(9)+(10)-(15)+(17)$
IV	$0=-0.535-(2)+(4)-(18)+(20)-(14)+(16)$
V	$0=+0.731-(3)+(4)-(18)+(19)-(12)+(8)$
VI	$0=+0.727-(20)+(21)-(28)+(30)-(13)+(14)$
VII	$0=+1.572-(10)+(11)-(29)+(30)-(13)+(15)$
VIII	$0=-1.270-(25)+(28)-(21)+(22)-(40)+(41)$
IX	$0=+1.512-(27)+(28)-(21)+(24)-(31)+(32)$
X	$0=-0.559-(39)+(40)-(22)+(24)-(31)+(33)$
XI	$0=-1.311-(26)+(28)-(21)+(23)-(43)+(44)$
XII	$0=-1.195-(23)+(24)-(31)+(35)-(42)+(43)$
XIII	$0=-1.616-(36)+(39)-(33)+(34)-(59)+(60)$
XIV	$0=-2.727-(34)+(35)-(42)+(46)-(58)+(59)$
XV	$0=+0.013-(37)+(38)-(45)+(49)-(50)+(51)$
XVI	$0=-3.463-(57)+(60)-(36)+(37)-(51)+(52)$
XVII	$0=-0.750-(57)+(58)-(46)+(49)-(50)+(52)$
XVIII	$0=+2.755-(47)+(49)-(50)+(53)-(66)+(67)$
XIX	$0=+3.506-(55)+(57)-(52)+(53)-(66)+(68)$
XX	$0=-2.124-(56)+(58)-(46)+(48)-(62)+(63)$
XXI	$0=+0.390-(56)+(57)-(52)+(54)-(61)+(63)$
XXII	$0=-1.867-(65)+(66)-(53)+(54)-(61)+(64)$
XXIII	$0=+0.805-(71)+(65)-(64)+(69)-(81)+(82)$
XXIV	$0=+2.397-(80)+(82)-(71)+(72)-(74)+(75)$
XXV	$0=-3.260-(80)+(81)-(69)+(70)-(73)+(75)$
XXVI	$0=-1.041-(79)+(80)-(75)+(77)-(83)+(84)$
XXVII	$0=+0.802-(86)+(88)-(78)+(79)-(84)+(85)$
XXVIII	$0=+0.905-(86)+(87)-(76)+(77)-(83)+(85)$
XXIX	$0=-0.01-0.153(1)-0.026(3)+0.179(2)-0.308(8)+0.456(9)-0.148(10)+0.337(16)$ $-0.335(17)-0.002(15)$
XXX	$0=+0.50+1.295(3)-0.321(2)-0.974(4)-0.134(16)+0.521(15)-0.387(14)-0.598(18)$ $+0.975(19)-0.377(20)$
XXXI	$0=-1.53-0.336(15)+0.387(14)-0.051(13)-0.425(19)-0.377(20)+0.048(21)$ $+0.749(29)-0.370(30)-0.379(28)$
XXXII	$0=+0.65+0.142(21)-0.634(22)+0.492(24)+0.024(28)-0.945(27)+0.921(26)$ $-0.082(40)+0.266(39)-0.184(38)+0.300(44)-0.166(45)-0.134(42)$
XXXIII	$0=+2.12-0.634(22)-5.749(24)+6.383(23)-0.082(40)+0.266(39)-0.184(38)$ $+2.057(43)-0.166(45)-1.891(42)$
XXXIV	$0=+0.46+0.675(25)+0.493(27)-1.168(26)+0.162(32)-0.201(33)+0.039(35)$ $-0.703(44)+0.537(45)+0.166(42)$

N. B.—The 6 equations, XXIII to XXVIII, refer to the 2 quadrilaterals in the old work, of which no further use is made here. The numbered corrections are as follows: at *King*, Poore (69), Young (70); at *Benn*, Poore (71), Young (72); at *Young*, King (73), Benn (74), Poore (75), Buffalo (76), Moore (77); at *Poore*, Buffalo (78), Moore (79), Young (80), King (81), Benn (82); at *Moore*, Young (83), Poore (84), Buffalo (85); and at *Buffalo*, Moore (86), Young (87), and Poore (88).

Observation equations—continued.

XXXV	0=−0·98+0·184(39)−0·445(38)+0·261(36)+0·039(33)−0·612(35)−0·651(34) +0·200(60)−0·747(59)+0·547(58)
XXXVI	0=+2·60−0·694(38)−0·261(36)+0·955(37)−0·200(60)+0·246(58)−0·046(57) +1·319(51)−1·053(50)−0·266(52)
XXXVII	0=−2·34−0·445(46)−0·103(49)+0·548(47)−0·266(50)+0·325(52)−0·059(53) +1·518(67)−1·184(68)−0·334(66)
XXXVIII	0=+2·17−0·074(46)−0·103(49)+0·177(48)−0·266(50)+0·325(52)−0·059(53) +0·339(68)−0·334(66)−0·005(65)+0·863(62)−1·017(63)+0·154(64)
XXXIX	0=+3·05−0·103(46)−0·738(49)+0·841(48)−0·046(58)+0·309(57)−0·263(56) +1·240(62)−0·488(63)−0·752(61)
XL	0=−0·78−0·174(64)+0·196(69)−0·022(70)−0·353(82)+0·338(81)+0·015(80) +0·516(74)−0·329(73)−0·187(75)
XLI	0=+0·20−0·107(80)−0·408(78)+0·515(79)−0·048(75)+0·704(76)−0·656(77) −0·132(88)+0·379(87)−0·247(86)

The last two equations refer to the quadrilaterals already disposed of.

Normal equations.

		c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9	c_{10}	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}	c_{16}	c_{17}	c_{20}
1	0=+1·938	+5·3	+1	−2		−2·3													
2	0=−2·247		+5·2	+2·1	−2·1														
3	0=−3·964			+6·1				−2											
4	0=−0·535				+6·2	+2·1	−2												
5	0=+0·731	....	....	....	....	+6·4	....	....	....	....	....	....	....	....	....	....	....	....	....
6	0=+0·727						+6·2	+2·2	−2	−2		−2							
7	0=+1·572							+6·2											
8	0=−1·270								+6·0	+2	−2	+2							
9	0=+1·512									+5·9	+2	+2	+2						
10	0=−0·559	....	....	....	....	....	....	....	....	...	+5·9		+2	−1·9	....	....	....	....	....
11	0=−1·311											+6·0	−2						
12	0=−1·195												+6		+2				
13	0=−1·616													+6	−2		+2·1		
14	0=−2·727														+5·9			−1·9	−1·9

Normal equations—continued.

		c_{15}	c_{16}	c_{17}	c_{18}	c_{19}	c_{20}	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}	c_{26}	c_{27}	c_{28}
15	0=+0·013	+5·9	−2	+2·1	+2·1	....	....	....	....	....	....	....	....	....	....
16	0=−3·463		+6·2	+2·1		2·1		·2·1							
17	0=−0·750			+6·1	+2·1	−2·1	+1·9	−2·1							
18	0=+2·755				+6·1	+2			−2						
19	0=+3·506					+6·2		+2·1	−2						
20	0=−2·124	....	....	....	....	....	+6·0	+2	....	...	....	....	....	....	....
21	0=+0·390							+6·1	+2						
22	0=−1·867								+6·1	−2·1					
23	0=+0·805									+6·2	+2·1	−2			
24	0=+2·397										+6·1	+2	−2		
25	0=−3·260	....	....	....	....	....	....	....	....	....	....	+6	−2	....	....
26	0=−1·041												+6	−2	+2
27	0=+0·802													+6·2	+2·2
28	0=+0·905														+6·4

Normal equations—completed.

	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}'	C_{34}	C_{35}	C_{36}	C_{37}	C_{38}	C_{39}
1	+0·8067	+1·6835									
2	−0·4321	−0·2191									
3	−0·9705	−0·5210	+0·3360								
4	+0·1401	−0·2443	−0·0100								
5	−0·2742	−1·1819	−0·4250	……..	……..	……..	……..	……..	……..	……..	……..
6		−0·0100	+0·0440	+0·1180							
7	+0·1460	+0·5210	−1·4780								
8			−0·4270	−0·6700	−0·5520	−0·6750					
9			−0·4270	+1·3190	−5·7490	−0·3472					
10	……..	……..	……..	+0·7780	−5·4630	−0·1809	−0·1489	……..	……..	……..	……..
11			−0·4270	−0·7390	+4·3260	+0·4650					
12				+0·6260	−8·1840	−0·1270	+0·6120				
13				+0·2660	+0·2660	+0·1809	+0·1578	+0·0871			
14				+0·1340	+1·8910	−0·1270	+0·0237	−0·2214	−0·4450	−0·0740	−0·0616

Normal equations—completed.

	C_{32}	C_{33}	C_{34}	C_{35}	C_{36}	C_{37}	C_{38}	C_{39}	C_{40}	C_{41}
15	−0·0162	−0·0162	−0·4833	−0·4005	+0·7924	+0·1527	+0·1527	−0·8118	……..	……..
16				−0·0871	−0·5235	+0·3575	+0·3575	−0·3090		
17				+0·4923	+1·0278	+0·9552	+0·5842	−1·0592		
18					+1·0530	+1·6043	+0·4277	−0·8118		
19					+0·2466	−1·3849	+0·2904	+0·3090		
20	……..	……..	……..	+0·4923	+0·2214	+0·4450	−1·6113	−0·4783	……..	……..
21					+0·2466	−0·3575	−1·3745	+0·8360		
22						−0·2750	−0·1006	+0·7520	−0·1914	
23							−0·1744		−0·3036	
24									−1·0710	+0·0590
25	……..	……..	……..	……..	……..	……..	……..	……..	+0·2470	+0·0590
26									+0·2020	−1·2300
27										+1·0627
28										−0·6335

Normal equations—completed.

		C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}	C_{35}	C_{36}	C_{37}	C_{38}	C_{39}	C_{40}	C_{41}
29	0 = −0·01	+0·6096	−0·1532	+0·0007										
30	0 = +0·50	……..	+5·2265	−0·8813	……..	……..	……..	……..	……..	……..	……..	……..	……..	……..
31	0 = −1·53			+1·4592	−0·0023									
32	0 = +0·65				+2·6467	−2·0404	−1·8550	+0·1226	+0·1149					
33	0 = +2·12					+82·1355	−0·3941	+0·1226	+0·1149					
34	0 = +0·46						+2·9057	+0·0168						
35	0 = −0·98	……..	……..	……..	……..	……..	……..	+1·9540	+0·2841	……..	……..	−0·0226	……..	……..
36	0 = +2·60								+4·4434	+0·1850	+0·1850	−0·0244		
37	0 = −2·34									+4·8588	−0·0949	+0·1295		
38	0 = +2·17										+2·2852	+1·8214	−0·0295	
39	0 = +3·05											+3·8955		
40	0 = −0·78	……..	……..	……..	……..	……..	……..	……..	……..	……..	……..	……..	+0·7207	+0·0074
41	0 = +0·20													+1·6283

Resulting values of correlates.

$C_{1}=-1{\cdot}330\ 62$	$C_{11}=+0{\cdot}248\ 30$	$C_{21}=-0{\cdot}142\ 55$	$C_{31}=+1{\cdot}224\ 74$
$C_{2}=+1{\cdot}137\ 00$	$C_{12}=-0{\cdot}488\ 74$	$C_{22}=+0{\cdot}723\ 09$	$C_{32}=-0{\cdot}214\ 82$
$C_{3}=+0{\cdot}200\ 89$	$C_{13}=+1{\cdot}131\ 56$	$C_{23}=+0{\cdot}957\ 84$	$C_{33}=-0{\cdot}102\ 086$
$C_{4}=+0{\cdot}694\ 67$	$C_{14}=+1{\cdot}433\ 16$	$C_{24}=-1{\cdot}151\ 53$	$C_{34}=-0{\cdot}193\ 85$
$C_{5}=-0{\cdot}510\ 27$	$C_{15}=+0{\cdot}036\ 14$	$C_{25}=+1{\cdot}412\ 85$	$C_{35}=+0{\cdot}454\ 91$
$C_{6}=+0{\cdot}263\ 83$	$C_{16}=-0{\cdot}057\ 86$	$C_{26}=+0{\cdot}424\ 81$	$C_{36}=-0{\cdot}568\ 89$
$C_{7}=-0{\cdot}105\ 40$	$C_{17}=+0{\cdot}223\ 61$	$C_{27}=+0{\cdot}139\ 80$	$C_{37}=+0{\cdot}946\ 19$
$C_{8}=+0{\cdot}855\ 96$	$C_{18}=-0{\cdot}795\ 56$	$C_{28}=-0{\cdot}302\ 7$	$C_{38}=+0{\cdot}934\ 10$
$C_{9}=-0{\cdot}722\ 30$	$C_{19}=+0{\cdot}286\ 98$	$C_{29}=+2{\cdot}692\ 91$	$C_{39}=-1{\cdot}362\ 70$
$C_{10}=+1{\cdot}099\ 17$	$C_{20}=+0{\cdot}840\ 26$	$C_{30}=+0{\cdot}614\ 15$	$C_{40}=-0{\cdot}598\ 29$
			$C_{41}=-0{\cdot}016\ 91$

Reciprocals of weights and resulting corrections to observed directions.

	$\frac{1}{p}$	v $''$		$\frac{1}{p}$	v $''$		$\frac{1}{p}$	v $''$		$\frac{1}{p}$	v $''$
(1)	0·5	−0·1091	(23)	1·0	+0·0854	(45)	0·9	−0·0789	(67)	1·1	+0·7048
(2)	1·1	+0·7998	(24)	1·0	+0·3693	(46)	1·0	+0·0195	(68)	1·1	−0·5683
(3)	1·3	−0·1235	(25)	1·0	−0·9868	(47)	0·9	+1·1827	(69)	1·0	−0·5722
(4)	1·1	−0·4552	(26)	1·0	−0·2197	(48)	1·1	−0·1545	(70)	1·0	+1·4260
(5)	1·0	−1·3379	(27)	1·0	+0·8298	(49)	0·9	+0·3038	(71)	1·1	+0·2130
(6)	1·0	+1·5315	(28)	1·0	−0·3512	(50)	1·0	+0·6347	(72)	1·0	−1·1515
(7)	0·5	−0·0968	(29)	1·0	+1·0227	(51)	1·0	−0·6564	(73)	1·0	−1·2160
(8)	1·0	−0·0088	(30)	1·2	−0·3537	(52)	1·1	+0·8621	(74)	1·0	+0·8429
(9)	1·0	−0·3040	(31)	1·0	+0·1119	(53)	1·0	−1·3426	(75)	1·0	−0·0508
(10)	1·0	−0·0921	(32)	0·9	−0·6783	(54)	1·0	+0·5805	(76)	1·0	+0·2908
(11)	1·0	−0·1054	(33)	0·9	+0·0219	(55)	1·0	−0·2870	(77)	1·0	+0·1331
(12)	1·0	+0·5103	(34)	1·0	−0·5978	(56)	1·0	−0·3393	(78)	1·0	−0·1329
(13)	1·0	−0·2209	(35)	1·0	+1·2153	(57)	1·0	−0·4162	(79)	1·0	−0·2938
(14)	1·0	−0·1946	(36)	1·1	−0·8871	(58)	0·9	−0·1780	(80)	1·0	+0·1564
(15)	1·0	−0·4032	(37)	1·0	−0·6373	(59)	1·0	−0·0382	(81)	1·0	+0·2528
(16)	1·0	+0·3826	(38)	0·9	+0·2581	(60)	1·0	+1·2785	(82)	1·0	+0·0175
(17)	1·1	+0·4797	(39)	1·0	+0·0318	(61)	1·0	+0·4442	(83)	1·0	−0·1220
(18)	1·0	−0·5517	(40)	1·0	+0·2692	(62)	1·0	−1·7239	(84)	1·0	+0·2850
(19)	1·0	−0·4320	(41)	1·0	+0·8560	(63)	1·0	+0·4127	(85)	1·1	−0·3089
(20)	1·0	+0·6610	(42)	1·0	−0·7548	(64)	1·0	+0·0145	(86)	1·1	+0·1893
(21)	1·0	−0·0898	(43)	1·0	−0·9470	(65)	1·0	+0·2301	(87)	1·2	−0·3711
(22)	1·0	−0·0423	(44)	1·0	+0·3201	(66)	1·0	+0·6036	(88)	1·0	+0·1421

Resulting angles and sides of the third or South Carolina section of the triangulation.

No.	Stations.	Observed angles.	Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		° ′ ″	″	″	″		
1	Wofford	43 35 05·92	+1·92	07·84	2·64	4·705 136 6	50 715·02
	Benn	59 06 35·49	+0·38	35·87	2·65	4·800 210 3	63 126·29
	King	77 18 24·66	−0·43	24·23	2·65	4·855 901 2	71 763·10
2	Hogback	34 39 03·18	−0·05	03·13	3·10	4·705 136 6	50 715·02
	Benn	91 23 09·60	−0·80	08 80	3·09	4·950 231 9	89 172·70
	King	53 57 57·76	−0·40	57·36	3·10	4·858 124 0	72 131·33
3	Paris	28 50 38·07	−1·34	36·73	4·15	4·705 136 6	50 715·02
	Benn	83 29 09·95	+0·47	10·42	4·15	5·018 914 1	104 451·4
	King	67 40 23·56	+1·74	25·30	4·15	4·987 882 5	97 248·41
4	Wofford	117 57 19·44	−0·28	19·16	1·89	4·950 231 9	89 172·70
	Hogback	38 42 19·72	−0·08	19·64	1·89	4·800 210 3	63 126·29
	King	23 20 26·90	−0·03	26·87	1·89	4·602 019 6	39 996·28
5	Hogback	73 21 22·89	−0·13	22·76	2·34	4·855 901 2	71 763·10
	Benn	32 16 34·11	−1·17	32·94	2·34	4·602 019 6	39 996·28
	Wofford	74 22 13·53	−2·21	11·32	2·34	4·858 124 1	72 131·35
6	Paris	14 02 53·81	+0·46	54·27	0·93	4·800 210 3	63 126·29
	King	9 37 61·10	−2·17	58·93	0·94	4·638 655 1	43 516·62
	Wofford	156 19 09·65	−0·05	09·60	0·93	5·018 914 1	104 451·4
7	Paris	21 01 01·97	+1·16	03·13	0·82	4·858 124 0	72 131·33
	Hogback	151 05 00·83	+0·11	00·94	0·81	4·987 882 4	97 248·39
	Benn	7 53 59·65	−1·27	58·38	0·82	4·441 543 7	27 640·36
8	Paris	49 51 40·04	−0·18	39·86	1·87	4·950 231 8	89 172·67
	Hogback	116 25 57·65	+0·16	57·81	1·87	5·018 914 0	104 451·4
	King	13 42 25·80	+2·14	27·94	1·87	4·441 543 7	27 640·36
9	Paris	42 53 31·88	−0·88	31·00	2·44	4·855 901 2	71 763·10
	Benn	24 22 34·46	+0·10	34·56	2·44	4·638 655 1	43 516 62
	Wofford	112 44 03·74	−1·98	01·76	2·44	4·987 882 5	97 248·41
10	Paris	63 54 33·85	+0·28	34·13	0·92	4·602 019 5	39 996·27
	Hogback	77 43 37·94	+0·24	38·18	0·92	4·638 655 0	43 516·61
	Wofford	38 21 50·21	+0·23	50·44	0·91	4·441 543 7	27 640·36
11	Pinnacle	38 57 16·45	+1·15	17·60	0·74	4·441 543 9	27 640·37
	Hogback	46 26 55·10	+1·46	56·56	0·75	4·503 290 4	31 863·27
	Paris	94 35 47·97	−0·10	48·07	0·74	4·641 697 6	43 822·55
12	Pinnacle	26 31 37·26	+0·25	37·51	1·23	4·602 019 6	39 996·28
	Hogback	124 10 33·04	+1·70	34·74	1·23	4·869 757 3	74 089·61
	Wofford	29 17 49·92	+1·52	51·44	1·23	4·641 697 5	43 822·53

Resulting angles and sides of the third or South Carolina section of the triangulation—continued.

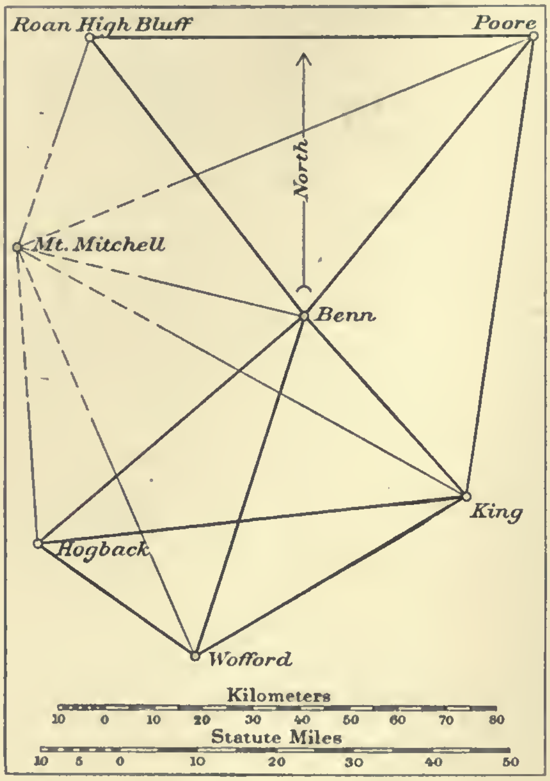
No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
	Pinnacle	12	25	39·20	+0·90	40·10	0·43	4·638 655 1	43 516·62
13	Wofford	9	03	60·28	−1·29	58·99	0·43	4·503 290 4	31 863·27
	Paris	158	30	21·82	+0·38	22·20	0·43	4·869 757 3	74 089·61
	Mauldin	17	55	20·86	+1·81	22·67	0·31	4·441 543 5	27 640·35
14	Hogback	15	44	50·32	+0·14	50·46	0·32	4·386 965 5	24 376·17
	Paris	146	19	47·04	+0·78	47·82	0·32	4·697 196 1	49 796·18
	Mauldin	61	33	51·97	−0·62	51·35	0·94	4·641 697 4	43 822·52
15	Pinnacle	87	44	04·47	+0·92	05·39	0·94	4·697 196 3	49 796·21
	Hogback	30	42	04·78	+1·31	06·09	0·95	4·405 586 3	25 444·05
	Mauldin	79	29	12·82	+1·19	14·01	0·52	4·503 290 3	31 863·26
16	Pinnacle	48	46	48·02	−0·23	47·79	0·52	4·386 965 6	24 376·18
	Paris	51	43	59·07	+0·68	59·75	0·51	4·405 586 3	25 444·05
	Rabun	10	13	03·44	+0·76	04·20	0·63	4·503 290 7	31 863·29
17	Pinnacle	153	07	06·91	+0·60	07·51	0·63	4·909 644 5	81 216·55
	Paris	16	39	50·58	−0·40	50·18	0·63	4·711 876 7	51 508·24
	Rabun	12	52	36·62	+1·05	37·67	0·96	4·386 965 4	24 376·17
18	Paris	35	04	08·49	+1·08	09·56	0·96	4·798 278 1	62 846·08
	Mauldin	132	03	13·76	+1·90	15·66	0·97	4·909 644 2	81 216·49
	Rabun	23	05	40·06	+1·82	41·88	1·08	4·405 586 5	25 444·06
19	Pinnacle	104	20	18·89	+0·82	19·71	1·07	4·798 278 2	62 846·09
	Mauldin	52	34	00·94	+0·70	01·64	1·08	4·711 876 7	51 508·24
	Currahee	16	29	02·56	+0·13	02·69	1·93	4·503 290 0	31 863·24
20	Pinnacle	117	37	44·52	+0·01	44·53	1·93	4·997 790 0	99 492·42
	Paris	45	53	17·70	+0·87	18·57	1·93	4·906 481 9	80 627·26
	Currahee	18	22	24·75	+0·41	25·16	1·62	4·405 586 1	25 444·04
21	Pinnacle	68	50	56·50	+0·24	56·74	1·62	4·876 702 1	75 283·90
	Mauldin	92	46	43·05	−0·09	42·96	1·62	4·906 481 9	80 627·26
	Currahee	1	53	22·20	+0·29	22·49	0·21	4·386 965 3	24 376·16
22	Paris	5	50	41·36	−0·19	41·17	0·21	4·876 702 1	75 283·90
	Mauldin	172	15	55·87	+1·10	56·97	0·21	4·997 789 9	99 492·40
	Currahee	37	42	07·37	+0·05	07·42	2·04	4·711 876 7	51 508·24
23	Rabun	106	48	35·10	+0·63	35·73	2·05	4·906 481 9	80 627·26
	Pinnacle	35	29	22·39	+0·59	22·98	2·04	4·689 285 1	48 897·33
	Currahee	54	11	09·93	+0·17	10·10	3·34	4·909 644 1	81 216·47
4	Rabun	96	35	31·66	−0·13	31·53	3·35	4·997 789 9	99 492·40
	Paris	29	13	27·13	+1·27	28·40	3·34	4·689 285 1	48 897·33

Resulting angles and sides of the third or South Carolina section of the triangulation—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
25	Currahee	56	04	32·13	+0·46	32·59	2·59	4·798 277 9	62 846·04
	Rabun	83	42	55·04	−1·19	53·85	2·59	4·876 702 0	75 283·88
	Mauldin	40	12	42·11	−0·79	41·32	2·58	4·689 285 1	48 897·33
26	Blood	47	41	35·68	+0·02	35·70	2·25	4·689 285 1	48 897·33
	Rabun	58	42	51·16	0·00	51·16	2·25	4·752 074 5	56 503·38
	Currahee	73	35	40·63	−0·75	39·88	2·24	4·802 267 7	63 426·06
27	Skitt	48	09	29·51	+0·62	30·13	1·29	4·689 285 1	48 897·33
	Rabun	29	04	48·28	+1·38	49·66	1·29	4·503 801 0	31 900·76
	Currahee	102	45	43·74	+0·34	44·08	1·29	4·806 272 9	64 013·69
28	Blood	76	10	57·23	−0·18	57·05	1·70	4·806 272 8	64 013·68
	Rabun	29	38	02·87	−1·38	01·49	1·70	4·513 146 5	32 594·66
	Skitt	74	11	06·57	−0·01	06·56	1·70	4·802 267 6	63 426·04
29	Skitt	122	20	36·08	+0·61	36·69	0·75	4·752 074 5	56 503·39
	Blood	28	29	21·55	−0·21	21·34	0·74	4·503 801 1	31 900·76
	Currahee	29	10	03·11	+1·09	04·20	0·74	4·513 146 5	32 594·66
30	Sawnee	45	25	06·66	−1·26	05·40	2·84	4·752 074 4	56 503·38
	Blood	86	01	20·96	+0·58	21·54	2·84	4·898 401 0	79 140·91
	Currahee	48	33	40·37	+1·21	41·58	2·84	4·774 311 9	59 471·92
31	Sawnee	12	11	11·86	−0·34	11·52	0·71	4·503 800 9	31 900·75
	Skitt	148	25	13·76	−0·52	13·24	0·71	4·898 401 0	79 140·91
	Currahee	19	23	37·25	+0·12	37·37	0·71	4·700 538 9	50 180·95
32	Sawnee	33	13	54·81	−0·92	53·89	1·39	4·513 146 5	32 594·66
	Blood	57	31	59·41	+0·78	60·19	1·38	4·700 539 0	50 180·96
	Skitt	89	14	10·16	−0·08	10·08	1·39	4·774 311 9	59 471·92
33	Grassy	35	35	42·56	+2·87	45·43	1·26	4·513 146 5	32 594·66
	Blood	89	29	53·97	+0·88	54·85	1·27	4·748 161 8	55 996·62
	Skitt	54	54	23·31	+0·21	23·52	1·27	4·661 044 1	45 818·84
34	Grassy	62	46	49·64	−1·63	48·01	1·34	4·700 538 9	50 180·95
	Skitt	34	19	46·86	−0·30	46·56	1·34	4·502 751 8	31 823·78
	Sawnee	82	53	29·47	−0·01	29·46	1·35	4·748 161 8	55 996·62
35	Grassy	98	22	32·20	+1·24	33·44	1·23	4·774 311 9	59 471·92
	Blood	31	57	54·56	+0·10	54·66	1·22	4·502 751 8	31 823·78
	Sawnee	49	39	34·66	+0·91	35·57	1·22	4·661 044 3	45 818·86

Adjustment of the position of Mount Mitchell in North Carolina, 1876–1895.

No. 27.



Roan High Bluff, A. H. B., 1894.

Number of directions.	Objects observed.	Directions from previous adjustments.			Corrections.	Final seconds.
		°	′	″	″	″
	Poore	0	00	00 ·00	....	.....
	Benn	50	00	44 ·04	....	.....
1	Mount Mitchell	103	30	25 ·24	−4 ·94	20 ·30
	Rogers	307	22	59 ·43	...	.....

Poore, C. O. B., 1877; A. H. B., 1895.

Number of directions.	Objects observed.	°	′	″	Corrections.	Final seconds.
	King	0	00	00 ·00	....	.....
	Benn	31	55	20 ·57	....	.....
2	Mount Mitchell	64	18	17 ·14	+0 ·37	17 ·51
	Roan	84	56	13 ·76	....	.....
	Rogers	144	19	49 ·80	....	.....

Benn, C. O. B., 1877; A. H. B., 1895.

Number of directions.	Objects observed.	°	′	″	Corrections.	Final seconds.
	King	0	00	00 ·00	....	.....
	Wofford	59	06	35 ·87	....	.....
	Hogback	91	23	08 ·81	....	.....
3	Mount Mitchell	150	50	13 ·90	+5 ·55	19 ·44
	Roan	181	58	00 ·63	....	.....
	Poore	258	56	36 ·11	....	.....

MOUNT MITCHELL.

Adjustment of the position of Mount Mitchell in North Carolina, 1876–1895—continued.

King, C. O. B., 1876–77.

Number of directions.	Objects observed.	Directions from previous adjustments. °	′	″	Corrections. ″	Final seconds. ″
	Wofford	0	00	00 ·00	....	.....
	Hogback	23	20	26 ·87	....	.....
4	Mount Mitchell	61	35	36 ·94	−4 ·99	31 ·95
	Benn	77	18	24 ·23	....	.....
	Poore	124	19	48 ·64	....	.....

Wofford, C. O. B., 1876.

Number of directions.	Objects observed.	°	′	″	Corrections. ″	Final seconds. ″
	King	0	00	00 ·00	....	.....
	Hogback	242	02	40 ·84	....	.....
5	Mount Mitchell	277	39	32 ·86	−5 ·10	27 ·76
	Benn	316	24	52 ·16	....	.....

Hogback, C. O. B., 1876.

Number of directions.	Objects observed.	°	′	″	Corrections. ″	Final seconds. ″
	Benn	0	00	00 ·00	....	.....
	King	34	39	03 ·12	....	.....
	Wofford	73	21	22 ·76	....	.....
6	Mount Mitchell	309	37	16 ·84	−5 ·27	11 ·57

N. B.—Observations from Paris in 1875 were too rough for use.

Conditional equations.

$$1.\ 0=+\ 4{\cdot}3-0{\cdot}92(1)+3{\cdot}98(2)-1{\cdot}86(3)$$
$$2.\ 0=-142{\cdot}0-5{\cdot}87(2)+11{\cdot}35(3)-16{\cdot}28(4)$$
$$3.\ 0=+\ 70{\cdot}0-5{\cdot}02(3)+11{\cdot}69(4)-3{\cdot}17(5)$$
$$4.\ 0=+\ 1{\cdot}1-4{\cdot}03(4)+8{\cdot}47(5)-4{\cdot}17(6)$$

Correlates.

	C_1	C_2	C_3	C_4
1	−0 ·92			
2	+3 ·98	−5 ·87		
3	−1 ·86	+11 ·35	−5 ·02	
4		−16 ·28	+11 ·69	−4 ·03
5			−3 ·17	+8 ·47
6				−4 ·17

Normal equations.

$$0=+\ 4{\cdot}3+20{\cdot}146\,C_1-44{\cdot}474\,C_2+9{\cdot}337\,C_3$$
$$0=-142{\cdot}0\qquad +428{\cdot}318\,C_2-247{\cdot}290\,C_3+65{\cdot}608\,C_4$$
$$0=+\ 70{\cdot}0\qquad +171{\cdot}905\,C_3-73{\cdot}961\,C_4$$
$$0=+\ 1{\cdot}1\qquad +105{\cdot}371\,C_4$$

$$C_1=+5{\cdot}3648$$
$$C_2=+3{\cdot}5738$$
$$C_3=+4{\cdot}9863$$
$$C_4=+1{\cdot}2643$$

″

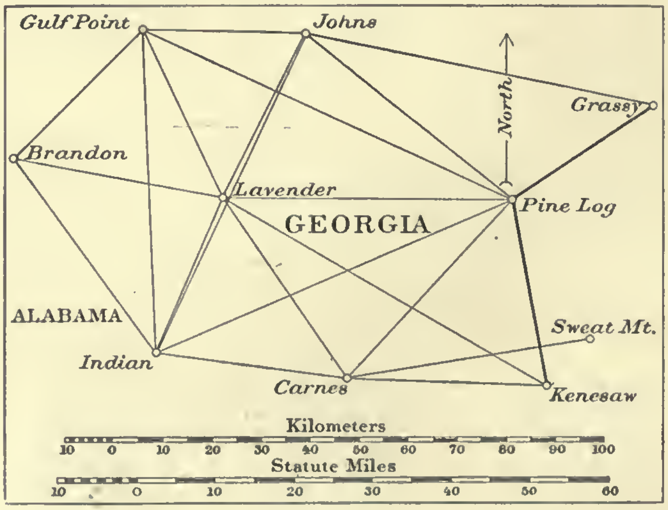
$$(1)=-4{\cdot}94$$
$$(2)=+0{\cdot}37$$
$$(3)=+5{\cdot}55$$
$$(4)=-4{\cdot}99$$
$$(5)=-5{\cdot}10$$
$$(6)=-5{\cdot}27$$

Resulting angles and sides from the adjustment made to determine the position of Mount Mitchell.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Mount Mitchell	95	22	.....	....	48·23	1·89	4·864 269 1	73 159·22
	Roan	53	29	41·20	−4·94	36·26	1·89	4·771 325 0	59 064·29
	Benn	31	07	46·73	−5·55	41·18	1·89	4·579 630 9	37 986·64
2	Mount Mitchell	39	30	.....	....	56·41	3·33	4·846 167 1	70 172·52
	Poore	32	22	56·57	+0·37	56·94	3·34	4·771 325 1	59 064·30
	Benn	108	06	22·21	−5·55	16·66	3·33	5·020 471 2	104 826·53
3	Mount Mitchell	52	57	.....	....	48·39	7·53	4·973 743 9	94 133·44
	Poore	64	18	17·14	+0·37	17·51	7·53	5·026 388 2	106 264·50
	King	62	44	11·70	+4·99	16·69	7·53	5·020 471 2	104 826·53
4	Mount Mitchell	34	04	.....	....	10·80	5·00	4·800 210 3	63 126·29
	King	61	35	36·94	−4·99	31·95	5·00	4·974 551 7	94 308·69
	Wofford	82	20	27·14	+5·10	32·24	4·99	5·026 388 3	106 264·52
5	Mount Mitchell	20	39	.....	....	07·47	1·86	4·602 019 6	39 996·28
	Wofford	35	36	52·02	−5·10	46·92	1·86	4·819 781 3	66 036·08
	Hogback	123	44	05·92	+5·27	11·19	1·86	4·974 551 7	94 308·69

7. FIRST SECTION OF THE TRIANGULATION WEST OF THE ATLANTA BASE NET, GEORGIA AND ALABAMA, 1873–1875.

No. 28.



This triangulation is located in Georgia and Alabama, and is of the same complex character as the Atlanta base net. It depends for the length of its sides upon the Atlanta base, and on the accompanying sketch is shown, by two heavy lines, the connection with the base net.* The section depends for the length of its sides directly

* The computation and adjustment made in 1878 and retained here has no corrections applied to the directions for height of stations observed. These are too small in comparison with the observing error to require special consideration. In a new computation it would have sufficed to limit the *seconds* of the angular directions to two places of decimals.

upon the Atlanta base. It is composed of 22 triangles. The angles were measured by Assistants F. P. Webber and C. O. Boutelle, in the years 1873–74–75, and five different instruments were employed. Weights to the several directions were introduced in the adjustment, depending in part on the approximate probable errors of the observations at a station and in part ou the closing errors of the triangles. We have the mean error of a triangle from the sum of the squares of the closing errors $=\sqrt{\frac{62\cdot586}{22}}=\pm1''\cdot69$, and that of an angle $=\pm0''\cdot97$; also the probable error of a direction $=0\cdot674\frac{1\cdot69}{\sqrt{6}}=\pm0''\cdot46$. From the approximate probable errors of the observed directions, as given in the abstracts of the respective stations, we have the average value $\varepsilon_1=\pm0''\cdot18$, hence the square of the triangle combination error $\varepsilon_c^2=(0\cdot46)^2-(0\cdot18)^2=0\cdot18$, and adding this to the square of ε_1, we have $\varepsilon^2=1/p=\varepsilon_c^2+\varepsilon_1^2$, whence the relative weight p to each direction. We have also the ratio of the greatest to the least weight 2·53 to 1.

The approximate heights of the stations above the Atlantic are as follows:

	Meters.	Feet.
Carnes	396·9	1 302
Lavender	515·2	1 690
Johns	577·4	1 894
Indian	603·4	1 980
Gulf	673·3	2 209
Brandon	511·8	1 679

Abstracts of horizontal directions at stations composing the first section west of the Atlanta base net, 1873–1875.

Kenesaw, Cobb County, Georgia. June 23 to July 18, 1873. 75cm direction theodolite No. 1. F. P. Webber, observer.

Number of directions.	Objects observed.	Resulting directions from previous adjustment of net.			Corrections from adjustment of first section.	Final seconds.
		°	′	″	″	″
	Sweat Mountain	0	00	00·049	.....	.....
7	Carnes	224	20	15·063	−2·019	13·044
8	Lavender	252	07	00·702	+2·009	02·711
	Pine Log	303	37	22·129	.....	......

Pine Log, Bartow County, Georgia. July 29 to September 17, 1874. 30cm repeating theodolite No. 32. F. P. Webber, observer.

Number of directions.	Objects observed.	°	′	″	″	″
2	Carnes	0	00	00·000	−0·710	59·290
3	Indian	22	30	38·597	+1·030	39·627
	Coosa	36	17	34·507	.. ..	......
4	Lavender	46	28	35·508	+0·225	35·733
5	Gulf Point	70	19	50·280	+0·251	50·531
6	Johns	84	39	43·143	+0·471	43·614
	Cohutta	141	29	12·849	.....	......
	Grassy	193	10	39·409	.....	......
	Sweat Mountain	285	37	11·339	.....	......
	Kenesaw	308	19	39·128	.....	......
				Mean correction	+0·253	

Abstracts of horizontal directions at stations composing the first section west of the Atlanta base net, 1873–1875—continued.

Sweat Mountain, Cobb County, Georgia. September 10 to October 3, 1873. 75cm direction theodolite No. 1. F. P. Webber, observer.

Number of directions.	Objects observed.	Resulting directions from previous adjustment of net.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″
	Kenesaw	0 00 00 ·016	.....	......
1	Carnes	32 34 43 ·017	−0 ·203	42 ·814
	Pine Log	100 54 55 ·552	.....	......
	Grassy	145 16 24 ·564	.....	......

Grassy, Pickens County, Georgia. July 13 to 28, 1874. 50cm direction theodolite No. 3. C. O. Boutelle, observer.

Number of directions.	Objects observed.	Resulting directions from previous adjustment of net.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″
	Sawnee	0 00 00 ·228	.....	......
	Sweat Mountain	43 29 35 ·930	.....	......
	Kenesaw	51 39 31 ·927	.....	......
	Pine Log	86 41 37 ·784	.....	......
9	Johns	131 59 17 ·061	−2 ·193	14 ·868
	Cohutta	183 15 38 ·93	.....	......
	Blood	261 37 28 ·06	.....	......
	Skitt	297 13 10 ·62	.....	......

Carnes, Polk County, Georgia. November 17 to December 27, 1873. 30cm repeating theodolite No. 32. F. P. Webber, observer.

Number of directions.	Objects observed.	Results from local adjustment.	Approximate probable error.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″	″
14	Kenesaw	0 00 00 ·000	±0 ·10	−0 ·456	59 ·544
	Lost Mountain	7 04 48 ·139	0 ·14	.....	......
10	Indian	183 44 53 ·383	0 ·12	−1 ·345	52 ·038
	Coosa	230 04 00 ·691	0 ·16	.....	......
11	Lavender	232 44 12 ·747	0 ·12	+0 ·920	13 ·667
12	Pine Log	310 57 24 ·950	0 ·10	−0 ·045	24 ·905
	Pine Mountain	317 59 30 ·451	0 ·14	.....	......
13	Sweat Mountain	348 14 27 ·327	0 ·12	+0 ·934	28 ·261
			Mean correction	−0 ·002	

Abstracts of horizontal directions at stations composing the first section west of the Atlanta base net, 1873–1875—continued.

Lavender, Floyd County, Georgia. October 12, 1874, to January 30, 1875, and August 6 to 12, 1875. 30^{cm} repeating theodolite No. 32. F. P. Webber, observer.

Number of directions.	Objects observed.	Results from local adjustment.			Approximate probable error.	Corrections from adjustment of first section.	Final seconds.
		°	′	″	″	″	″
19	Pine Log	0	00	00 ·000	±0 ·07	+0 ·324	00 ·324
	Pine Mountain	17	49	59 ·135	0 ·16	.....	......
20	Kenesaw	30	20	51 ·197	0 ·11	−1 ·058	50 ·139
21	Carnes	55	18	18 ·473	0 ·10	−0 ·267	18 ·206
	Coosa, mark	63	25	38 ·315	0 ·09	.....	......
15	Indian	111	29	54 ·716	0 ·09	+0 ·234	54 ·950
	Weisner	137	35	38 ·33	0 ·32	.....	......
16	Brandon	189	35	31 ·660	0 ·08	+0 ·171	31 ·831
17	Gulf Point	244	10	24 ·069	0 ·08	+0 ·673	24 ·742
18	Johns	297	42	46 ·291	0 ·11	−0 ·108	46 ·183
	Cohutta	316	04	49 ·376	0 ·12	.....	......
					Mean correction	−0 ·004	

Johns, Walker County, Georgia. May 12 to June 21, 1875. 30^{cm} direction theodolite No. 107. F. P. Webber, observer. Circle used in XXI positions.

Number of directions.	Objects observed.	Results from local adjustment.			Approximate probable error.	Corrections from adjustment of first section.	Final seconds.
		°	′	″	″	″	″
26	Gulf Point	0	00	00 ·000	±0 ·10	+0 ·394	00 ·394
	Pigeon	17	13	25 ·438	0 ·31	.....	......
	High Point	44	15	12 ·782	0 ·20	.....	......
	Cohutta	145	15	56 ·8	....	.....	......
22	Grassy	191	23	00 ·153	0 ·20	−1 ·240	58 ·913
23	Pine Log	217	34	29 ·722	0 ·24	+0 ·672	30 ·394
24	Indian	294	07	26 ·733	0 ·16	+0 ·247	26 ·980
25	Lavender	297	06	13 ·557	0 ·20	−1 ·102	13 ·455
					Mean correction	−0 ·006	

Indian, Cherokee County, Alabama. July 24 to August 21, 1875. 30^{cm} direction theodolite No. 108. F. P. Webber, observer. Circle used in XVII positions.

Number of directions.	Objects observed.	Results from local adjustment.			Approximate probable error.	Corrections from adjustment of first section.	Final seconds.
		°	′	″	″	″	″
29	Lavender	0	00	00 ·000	±0 ·06	−0 ·244	59 ·756
30	Johns	3	14	05 ·050	0 ·17	−0 ·176	04 ·874
	Cohutta	15	28	22 ·9	....	.....	......
	Coosa	16	44	04 ·052	0 ·22	.....	......
31	Pine Log	44	32	11 ·956	0 ·15	+1 ·991	13 ·947
32	Kenesaw	72	53	48 ·127	0 ·12	+0 ·729	48 ·856
33	Carnes	74	49	05 ·144	0 ·15	−0 ·504	04 ·640
	Cheehahaw*	189	16	07 ·563	....	.....	......
	Aurora	259	21	48 ·653	0 ·12	.....	......
27	Brandon	301	16	21 ·883	0 ·16	−0 ·397	21 ·486
28	Gulf Point	335	22	53 ·053	0 ·15	−1 ·418	51 ·635
					Mean correction	−0 ·003	

*Observed December 3 to 19, 1885, by O. H. Tittmann, with 50^{cm} direction theodolite No. 114.

Abstracts of horizontal directions at stations composing the first section west of the Atlanta base net, 1873–1875—continued.

Gulf Point, Walker County, Georgia. September 14 to October 9, 1875. 30cm direction theodolite No. 108. F. P. Webber, F. D. Granger, and J. H. Christian, observers. Circle used in XVII positions.

Number of directions.	Objects observed.	Results from local adjustment.	Approximate probable error.	Corrections from adjustment of first section.	Final seconds.
		° ′ ″	″	″	″
	High Point	0 00 00·000	±0·08	....	......
	Pigeon	28 39 11·071	0·32	.....	......
	Cohutta	55 29 34·156	0·16	.....	......
34	Johns	75 49 36·751	0·25	−1·391	35·360
35	Pine Log	99 04 14·149	0·18	+0·959	15·108
36	Lavender	139 23 30·004	0·14	−0·138	29·866
37	Indian	162 05 54·020	0·20	+0·362	54·382
38	Brandon	210 08 59·511	0·17	+0·054	59·565
	Gunter	250 04 42·408	0·45	.....	......
			Mean correction	−0·031	

Brandon, Dekalb County, Alabama. December 6 to 26, 1875. 30cm direction theodolite No. 108. F. P. Webber, observer.

		° ′ ″	″	″	″
	Aurora	0 00 00·000	±0·11	.....	......
	Gunter	61 36 36·507	0·19	.....	.....
39	Gulf Point	168 10 14·156	0·36	−0·338	13·818
40	Lavender	222 49 54·438	0·30	+0·138	54·576
41	Indian	266 00 43·001	0·31	+0·164	43·165
	Weisner	293 13 43·092	0·21	.....	.....
			Mean correction	−0·011	

Observation equations.

I | $0=-0{\cdot}472-(1)+(2)-(12)+(13)$

II | $0=-0{\cdot}426-(7)+(1)-(13)+(14)$

III | $0=+3{\cdot}167-(8)+(4)-(19)+(20)$

IV | $0=-3{\cdot}443-(11)+(14)-(7)+(8)-(20)+(21)$

V | $0=+0{\cdot}752-(6)+(9)-(22)+(23)$

VI | $0=+0{\cdot}095-(18)+(19)-(4)+(6)-(23)+(25)$

VII | $0=-0{\cdot}544-(10)+(12)-(2)+(3)-(31)+(33)$

VIII | $0=-2{\cdot}505-(10)+(11)-(21)+(15)-(29)+(33)$

IX | $0=-2{\cdot}293-(5)+(6)-(23)+(26)-(34)+(35)$

X | $0=-2{\cdot}034-(28)+(31)-(3)+(5)-(35)+(37)$

XI | $0=-3{\cdot}144-(28)+(30)-(24)+(26)-(34)+(37)$

XII | $0=-0{\cdot}120-(27)+(29)-(15)+(16)-(40)+(41)$

XIII | $0=-1{\cdot}167-(16)+(17)-(36)+(38)-(39)+(40)$

XIV | $0=+0{\cdot}827-(27)+(28)-(37)+(38)-(39)+(41)$

XV | $0=+1{\cdot}382+0{\cdot}8286(14)-1{\cdot}0114(13)+0{\cdot}1828(12)-0.3295(1)+0{\cdot}1664(2)$

XVI | $0=+8{\cdot}023+6{\cdot}6014(14)-6{\cdot}6014(10)-0{\cdot}0398(7)+12{\cdot}5171(33)-12{\cdot}8777(32)+0{\cdot}3606(31)$
$-0{\cdot}6745(2)+0{\cdot}5081(3)$

XVII $0=+8{\cdot}667+6{\cdot}6014(14)-6{\cdot}6014(10)-0{\cdot}5934(21)+0{\cdot}4524(20)+0{\cdot}1410(15)-12{\cdot}8777(32)$
$+0{\cdot}3997(8)-0{\cdot}3997(7)+12{\cdot}8206(33)+0{\cdot}0571(29)$

XVIII $0=+1{\cdot}425-0{\cdot}2868(21)+0{\cdot}1410(15)+0.1458(19)+0{\cdot}3035(33)+0{\cdot}0571(29)-0{\cdot}3606(31)$
$+0{\cdot}3081(2)+0{\cdot}2000(4)-0{\cdot}5081(3)$

XIX $0=-0{\cdot}701-4{\cdot}0061(25)+4{\cdot}0450(24)-0{\cdot}0389(23)-3{\cdot}5115(29)+3{\cdot}7255(30)-0{\cdot}2140(31)$
$+0{\cdot}7414(4)-0{\cdot}2677(6)-0{\cdot}4737(3)$

XX $0=-1{\cdot}290-4{\cdot}1528(25)+4{\cdot}0450(24)+0{\cdot}1078(26)-4{\cdot}1850(29)+3{\cdot}7255(30)+0{\cdot}4595(28)$
$-0{\cdot}6079(36)+0{\cdot}1047(34)+0{\cdot}5032(37)$

XXI $0=-0{\cdot}736+0{\cdot}2662(18)-0{\cdot}1556(17)-0{\cdot}1106(19)-0{\cdot}1047(36)-0{\cdot}3855(34)+0{\cdot}4902(35)$
$-0{\cdot}2677(4)-0{\cdot}5564(6)+0{\cdot}8241(5)$

XXII $0=+0{\cdot}219-0{\cdot}3316(29)+0{\cdot}4595(28)-0{\cdot}1279(27)-0{\cdot}4297(36)+0{\cdot}5032(37)-0{\cdot}0735(38)$
$+0{\cdot}3737(40)-0.2244(41)-0{\cdot}1493(39)$

XXIII $0=-1{\cdot}514-0{\cdot}1106(18)-0{\cdot}3596(20)+0{\cdot}4702(19)-0{\cdot}0389(25)-0{\cdot}4281(22)+0{\cdot}4670(23)$
$-0{\cdot}1674(8)-0{\cdot}2084(9)$

The reciprocals of the relative weights to the several directions introduced into the correlate equations are as follows:

Direction.	$\frac{1}{p}$	Direction.	$\frac{1}{p}$	Direction.	$\frac{1}{p}$	Direction.	$\frac{1}{p}$
1	1·13	12	0·87	23	1·08	34	1·11
2	0·88	13	0·90	24	0·95	35	0·97
3	0·90	14	0·87	25	1·01	36	0·92
4	0·86	15	0·87	26	0·88	37	1·01
5	0·89	16	0·86	27	0·94	38	0·96
6	0·90	17	0·86	28	0·93	39	1·40
7	1·43	18	0·89	29	0·85	40	1·24
8	2·15	19	0·85	30	0·96	41	1·26
9	1·14	20	0·88	31	0·93		
10	0·90	21	0·87	32	0·89		
11	0·89	22	1·01	33	0·93		

The average value of $\frac{1}{p}$ equals 1.

Normal equations.

No.		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
1	0 = −0·472	+3·78	−2·03					−1·75							
2	−0·426		+4·33		+2·30										
3	+3·167			+4·74	−3·03		−[illegible]·71								
4	−3·443				+7.09				−1·76						
5	+0·752	......	......	......	......	+4·13	−1·98	......	......	−1·98	......	......	......	......	......
6	+0·095						+5·59			+1·98					
7	−0·544							+5·41	+1·83		−1·83				
8	−2·505								+5·31				−1·72		
9	−2·293									+5·83	−1·86	+1·99			
10	−2·034	......	......	......	......	......	......	......	......	......	+5·63	+1·94	......	......	−1·94
11	−3·144											+5·84			−1·94
12	−0·120												+6·02	−2·10	+2·20
13	−1·167													+6·24	+2·36
14	+0·827														+6·50
15	+1·382	......	......	......	......	......	......	......	......	......	......	......	......	......	......

Normal equations—completed.

No.		C^{15}	C^{16}	C^{17}	C^{18}	C^{19}	C^{20}	C^{21}	C^{22}	C^{23}
1		−0·55054	−0·59356		+0·27113					
2		+1·25881	+5·80013	+6·31479						
3				−0·46125	+0·04807	+0·63760		+0·13621		−0·35621
4		+0·72088	+5·80013	+6·25978	−0·24952					−0·04346
5		....	....	....	....	+0·19892	....	+0·50076	....	+0·69916
6					−0·04807	−4·88268	−4·19433	−0·60147		−0·04555
7		+0·01261	+18·29765	+17·86441	−0·11081	−0·22731				
8			+17·58216	+18·45481	+0·60590	+2·98477	+3·55724		+0. 28186	
9						−0·19892	+0·02136	−0·33082		−0·50436
10		....	−0·12193	....	+0·12193	+0·22731	+0·08090	+0·25796	+0·08090	....
11						−0·26627	−0·20673	+0·42790	+0·08090	
12				−0·07413	−0·07413	−2·98477	−3·55724		−0·90776	
13							+0·55927	−0·03750	+0·99717	
14							−0·08090		−0·10495	
15		+1·69408	+4·66006	+4·75883	+0·04512	....	....	....	....	....
16	0= +8·023		+371·19343	+373·99329	+2·99686	−0·28839				
17	+8·667			+378·66768	+3·78681	−0·17042	−0·20311		−0·01609	−0·28702
18	+1·425				+0·66659	+0·24549	−0·20311	−0·05975	−0·01609	+0·05827
19	−0·701					+56·34184	+58·16226	−0·03663	+0·98975	+0·13778
20	−1·290	....	....	....	....	....	+61·98784	+0·01375	+1·87200	+0·16316
21	−0·736							+1·44710	+0·04139	−0·07041
22	+0·219								+1·00383	
23	−1·514									+0·84453

Resulting correlates.

$C_1 = -0·3231$	$C_7 = -0·2582$	$C_{13} = +0·9330$	$C_{19} = +2·0506$
$C_2 = -0·7134$	$C_8 = +2·1722$	$C_{14} = -0·8156$	$C_{20} = -2·0409$
$C_3 = +0·4736$	$C_9 = +0·8873$	$C_{15} = -0·6398$	$C_{21} = +0·9664$
$C_4 = +1·1388$	$C_{10} = +0·3726$	$C_{16} = -2·8112$	$C_{22} = +0·8278$
$C_5 = -0·8917$	$C_{11} = -0·2198$	$C_{17} = +2·7477$	$C_{23} = +4·9511$
$C_6 = -0·1688$	$C_{12} = +1·1322$	$C_{18} = -8·2162$	

Resulting corrections to observed directions.

″	″	″	″
(1) = −0·2028	(12) = −0·0452	(23) = +0·6722	(34) = −1·3909
(2) −0·7101	(13) +0·9336	(24) +0·2466	(35) +0·9589
(3) +1·0297	(14) −0·4563	(25) −0·1022	(36) −0·1375
(4) +0·2247	(15) +0·2338	(26) +0·3937	(37) +0·3621
(5) +0·2512	(16) +0·1713	(27) −0·3973	(38) +0·0541
(6) +0·4706	(17) +0·6730	(28) −1·4185	(39) −0·3380
(7) −2·0189	(18) −0·1080	(29) −0·2438	(40) +0·1375
(8) +2·0094	(19) +0·3237	(30) −0·1759	(41) +0·1643
(9) −2·1929	(20) −1·0584	(31) +1·9913	
(10) −1·3448	(21) −0·2671	(32) +0·7289	
(11) +0·9197	(22) −1·2404	(33) −0·5042	

Mean error of a direction of unit weight $\sqrt{\frac{[pvv]}{n}} = \sqrt{\frac{30·1}{23}} = \pm 1''·15$.

The average weight being unity, we have the probable error of an observed direction $= \pm\, 0''·79$.

Resulting angles and sides of the first section west of the Atlanta base net.

No.	Stations.	Observed angles.			Corrections.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Carnes	49	02	35 ·050	−0 ·411	34 ·639	1 ·295	4 ·587 666 4	38 696 ·03
	Pine Log	51	40	20 ·872	−0 ·710	20 ·162	1 ·295	4 ·604 183 7	40 196 ·08
	Kenesaw	79	17	07 ·066	+2 ·018	09 ·084	1 ·295	4 ·701 967 7	50 346 ·31
2	Carnes	37	17	02 ·377	+0 ·979	03 ·356	1 ·348	4 ·516 084 0	32 815 ·88
	Pine Log	74	22	48 ·661	−0 ·710	47 ·951	1 ·349	4 ·717 436 4	52 171 ·87
	Sweat Mountain	68	20	12 ·535	+0 ·203	12 ·738	1 ·348	4 ·701 967 7	50 346 ·31
3	Carnes	11	45	32 ·673	−1 ·390	31 ·283	0 ·362	4 ·182 214 9	15 213 ·00
	Sweat Mountain	32	34	43 ·001	−0 ·203	42 ·798	0 ·362	4 ·604 183 7	40 196 ·08
	Kenesaw	135	39	44 ·986	+2 ·019	47 ·005	0 ·362	4 ·717 436 4	52 171 ·87
4	Lavender	30	20	51 ·197	−1 ·382	49 ·815	1 ·946	4 ·587 666 4	38 696 ·03
	Pine Log	98	08	56 ·380	+0 ·225	56 ·605	1 ·945	4 ·879 770 2	75 817 ·63
	Kenesaw	51	30	21 ·427	−2 ·010	19 ·417	1 ·946	4 ·777 750 8	59 944 ·70
5	Lavender	24	57	27 ·276	+0 ·791	28 ·067	1 ·204	4 ·604 183 7	40 196 ·08
	Kenesaw	27	46	45 ·639	+4 ·028	49 ·667	1 ·204	4 ·647 387 9	44 400 ·50
	Carnes	127	15	47 ·253	−1 ·376	45 ·877	1 ·203	4 ·879 770 2	75 817 ·63
6	Lavender	55	18	18 ·473	−0 ·591	17 ·882	1 ·854	4 ·701 967 7	50 346 ·31
	Pine Log	46	28	35 ·508	+0 ·935	36 ·443	1 ·854	4 ·647 387 9	44 400 ·50
	Carnes	78	13	12 ·203	−0 ·965.	11 ·238	1 ·855	4 ·777 750 8	59 944 ·70
7	Johns	26	11	29 ·569	+1 ·912	31 ·481	1 ·453	4 ·525 240 8	33 515 ·12
	Grassy	45	17	39 ·277	−2 ·193	37 ·084	1 ·453	4 ·732 129 0	53 967 ·09
	Pine Log	108	30	56 ·266	−0 ·471	55 ·795	1 ·454	4 ·857 350 9	72 003 ·05
8	Lavender	62	17	13 ·709	+0 ·432	14 ·141	1 ·695	4 ·732 129 0	53 967 ·09
	Johns	79	31	43 ·835	−0 ·773	43 ·062	1 ·694	4 ·777 750 8	59 914 ·70
	Pine Log	38	11	07 ·635	+0 ·246	07 ·881	1 ·695	4 ·576 176 5	37 685 ·69
9	Indian	44	32	11 ·956	+2 ·235	14 ·191	1 ·641	4 ·777 750 8	59 944 70
	Lavender	111	29	54 ·716	−0 ·091	54 ·625	1 ·640	4 ·900 488 9	79 522 ·29
	Pine Log	23	57	56 ·911	−0 ·805	56 ·106	1 ·641	4 ·540 524 3	34 715 ·57
10	Indian	41	18	06 ·906	+2 ·167	09 ·073	3 ·215	4 ·732 129 0	53 967 ·09
	Johns	76	32	57 ·011	−0 ·425	56 ·586	3 ·216	4 ·900 488 9	79 522 ·29
	Pine Log	62	09	04 ·546	−0 ·559	03 ·987	3 ·215	4 ·859 108 3	72 295 ·01
11	Lavender	173	47	08 ·425	+0 ·342	08 ·767	0 ·120	4 ·859 108 3	72 295 ·01
	Johns	2	58	46 ·824	−0 ·348	46 ·476	0 ·120	4 ·540 524 3	34 715 ·57
	Indian	3	14	05 ·050	+0 ·067	05 ·117	0 ·120	4 ·576 176 5	37 685 ·69
12	Indian	30	16	53 ·188	−2 ·495	50 ·693	1 ·299	4 ·701 967 7	50 346 ·31
	Pine Log	22	30	38 ·597	+1 ·740	40 ·337	1 ·299	4 ·582 375 3	38 227 ·45
	Carnes	127	12	31 ·567	+1 ·299	32 ·866	1 ·298	4 ·900 488 9	79 522 ·29

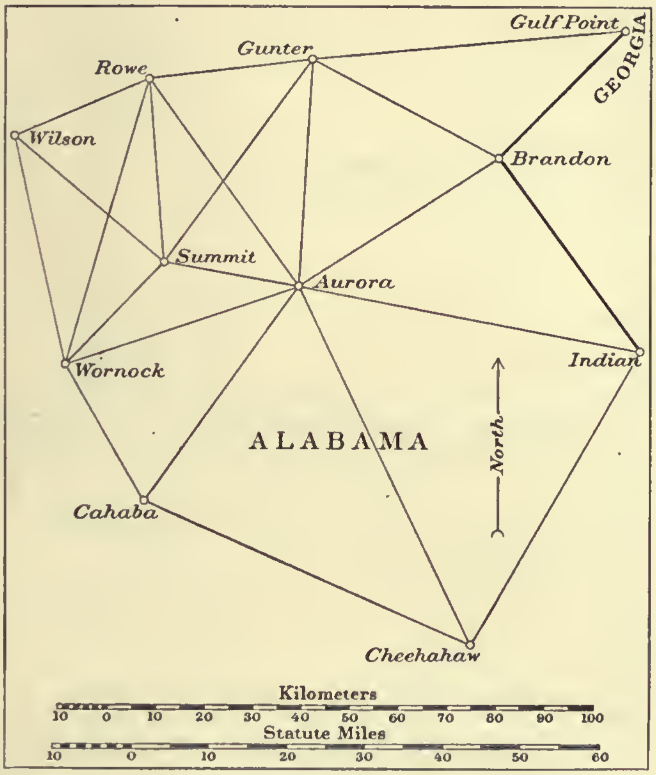
Resulting angles and sides of the first section west of the Atlanta base net—continued.

No.	Stations.	Observed angles. °	′	″	Corrections. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
13	Indian	74	49	05 ·144	−0 ·261	04 ·883	1 ·086	4 ·647 387 9	44 400 ·50
	Lavender	56	11	36 ·243	+0 ·501	36 ·744	1 ·085	4 ·582 375 3	38 227 ·44
	Carnes	48	59	19 ·364	+2 ·265	21 ·629	1 ·085	4 ·540 524 3	34 715 ·57
14	Gulf Point	23	14	37 ·398	+2 ·351	39 ·749	0 ·944	4 ·732 129 0	53 967 ·09
	Johns	142	25	30 ·278	−0 ·278	30 ·000	0 ·944	4 ·921 107 1	83 388 ·67
	Pine Log	14	19	52 ·863	+0 ·220	53 ·083	0 ·944	4 ·529 538 0	33 848 ·38
15	Gulf Point	40	19	15 ·855	−1 ·096	14 ·759	1 ·713	4 ·777 750 8	50 944 ·70
	Pine Log	23	51	14 ·772	+0 ·026	14 ·798	1 ·713	4 ·573 619 2	37 464 ·44
	Lavender	115	49	35 ·931	−0 ·349	35 ·582	1 ·713	4 ·921 107 0	83 388 ·67
16	Gulf Point	63	33	53 ·253	+1 ·254	54 ·507	0 ·963	4 ·576 176 5	37 685 ·69
	Johns	62	53	46 ·443	+0 ·496	46 ·939	0 ·962	4 ·573 619 2	37 464 ·44
	Lavender	53	32	22 ·222	−0 ·781	21 ·441	0 ·962	4 ·529 537 9	33 848 ·38
17	Gulf Point	63	01	39 ·871	−0 ·597	39 ·274	4 ·164	4 ·900 488 9	79 522 ·29
	Pine Log	47	49	11 ·683	−0 ·779	10 ·904	4 ·164	4 ·820 337 1	66 120 ·64
	Indian	69	09	18 ·903	+3 ·410	22 ·313	4 ·163	4 ·921 107 0	83 388 ·67
18	Gulf Point	22	42	24 ·016	+0 ·500	24 ·516	0 ·810	4 ·540 524 3	34 715 ·57
	Lavender	132	40	29 ·353	+0 ·440	29 ·793	0 ·811	4 ·820 337 1	66 120 ·64
	Indian	24	37	06 ·947	+1 ·175	08 ·122	0 ·810	4 ·573 619 2	37 464 ·44
19	Gulf Point	86	16	17 ·269	+1 ·754	19 ·023	1 ·893	4 ·859 108 3	72 295 ·01
	Johns	65	52	33 ·267	+0 ·147	33 ·414	1 ·892	4 ·820 337 1	66 120 ·64
	Indian	27	51	11 ·997	+1 ·243	13 ·240	1 ·892	4 ·529 537 9	33 848 ·38
20	Brandon	43	10	48 ·563	+0 ·027	48 ·590	1 ·248	4 ·540 524 3	34 715 ·57
	Lavender	78	05	36 ·944	−0 ·062	36 ·882	1 ·248	4 ·695 837 9	49 640 ·70
	Indian	58	43	38 ·117	+0 ·155	38 ·272	1 ·248	4 ·637 099 2	43 360 ·99
21	Brandon	54	39	40 ·282	+0 ·475	40 ·757	1 ·122	4 ·573 619 2	37 464 ·44
	Gulf Point	70	45	29 ·507	+0 ·191	29 ·698	1 ·121	4 ·637 099 2	43 360 ·99
	Lavender	54	34	52 ·409	+0 ·501	52 ·910	1 ·122	4 ·573 188 9	37 427 ·33
22	Brandon	97	50	28 ·845	+0 ·502	29 ·347	1 ·559	4 ·820 337 1	66 120 ·64
	Gulf Point	48	03	05 ·491	−0 ·308	05 ·183	1 ·560	4 ·695 837 9	49 640 ·70
	Indian	34	06	31 ·170	−1 ·021	30 ·149	1 ·560	4 ·573 188 9	37 427 ·33
23	Indian	28	21	36 ·171	−1 ·262	34 ·909	2 ·509	4 ·587 666 4	38 696 ·03
	Pine Log	74	10	59 ·469	+1 ·030	60 ·499	2 ·509	4 ·894 214 2	78 381 ·61
	Kenesaw	77	27	......	.....	32 ·118	2 ·508	4 ·900 488 9	79 522 ·29
24	Indian	72	53	48 ·127	+0 ·973	49 ·100	2 ·204	4 ·879 770 2	75 817 ·63
	Lavender	81	09	03 ·519	+1 ·292	04 ·811	2 ·203	4 ·894 214 2	78 381 ·61
	Kenesaw	25	57	......	.....	12 ·700	2 ·204	4 ·540 524 3	34 715 ·57
25	Carnes	176	15	06 ·617	+0 ·888	07 ·505	0 ·085	4 ·894 214 2	78 381 ·61
	Indian	1	55	17 ·017	−1 ·232	15 ·785	0 ·085	4 ·604 183 7	40 196 ·08
	Kenesaw	1	49	......	.....	36 ·965	0 ·085	4 ·582 375 3	38 227 ·45

8. THE SECOND SECTION OF THE TRIANGULATION WEST OF THE ATLANTA BASE NET, GEORGIA AND ALABAMA, 1875–1887.

This section is of the same complex composition as the preceding section; it is shown on the following sketch; for distances and positions it depends upon the two sides marked by heavy lines. Eight observers took part in the work, which was executed between the years 1875 and 1887, but this includes an interval of eight

No. 29.



years during which the work was suspended. The figure comprises 8 new stations connected by 16 triangles and the adjustment involves 18 conditions to be satisfied. From the sum of the squares of the closing errors of the triangles we have the mean error $\sqrt{\frac{29{\cdot}54}{16}} = \pm 1''{\cdot}36$ and that of an angle $\pm 0''{\cdot}78$, also the probable error of a direction $= 0{\cdot}674\,\frac{1{\cdot}36}{\sqrt{6}} = \pm 0''{\cdot}37$. Unit weight was assigned to each direction.

The approximate elevations of the stations are as follows:—

	Meters.	Feet.		Meters.	Feet.
Gunter	436	1 430	Wilson	360	1 180
Aurora	428	1 404	Wornock	435	1 428
Rowe	461	1 512	Cahaba	461	1 513
Summit	360	1 181	Cheehahaw	734	2 407

Abstracts of horizontal directions at stations composing the second section of the triangulation west of the Atlanta base net, 1875–1887.

Gulf Point, Walker County, Georgia. September 14 to October 9, 1875. 30^{cm} direction theodolite No. 108. F. P. Webber, F. D. Granger, and J. H. Christian, observers.

Number of directions.	Objects observed.	Resulting directions from adjustment of first section. °	′	″	Corrections from adjustment of second section. ″	Final seconds. ″
	High Point	0	00	59·969	.....	59·969
	Pigeon	28	39	11·040	.....	......
	Cohutta	55	29	34·125	.....	......
5	Gunter	250	04	42·377	+0·057	42·434

Brandon, Dekalb County, Alabama. December 6 to 17, 1875. 30^{cm} direction theodolite No. 108. F. P. Webber, observer.

Number of directions.	Objects observed.	°	′	″	″	″
3	Aurora	0	00	59·989	−0·337	59·652
4	Gunter	61	36	36·496	+0·938	37·434
	Gulf Point	168	10	13·818	.....	......
	Indian	266	00	43·165	.....	......
	Weisner	293	13	43·081	.....	......

Indian, Cherokee County, Alabama. July 24 to August 18, 1875. 30^{cm} direction theodolite No. 108. F. P. Webber, observer. December 3 to 19, 1885. 50^{cm} direction theodolite No. 114. O. H. Tittmann, observer.

Number of directions.	Objects observed.	°	′	″	″	″
	Lavender	0	00	59·756	.....	59·756
	Cohutta, Grassy Mountain	15	28	22·9	.....	......
	Coosa	16	44	04·052	.....	......
1	Cheehahaw	189	16	07·560	−0·469	07·091
2	Aurora	259	21	48·650	−1·844	46·806
	Brandon	301	16	21·486	.....	......
	Gulf Point	335	22	51·635	.....	......

Gunter, Marshall County, Alabama. July 21 to August 15, 1877. 30^{cm} direction theodolite No. 108. F. D. Granger, observer.

Number of directions.	Objects observed.	°	′	″	″	″
18	Rowe	0	00	00·00	+0·45	00·45
14	Gulf Point	179	48	34·80	−1·12	33·68
15	Brandon	213	19	17·80	+0·60	18·40
16	Aurora	276	52	01·30	−0·17	01·13
17	Summit	311	07	24·82	+0·24	25·06

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''\cdot58$. Circle used in XVII positions.

Abstracts of horizontal directions at stations composing the second section of the triangulation west of the Atlanta base net, 1875–1887—continued.

Aurora, Etowah County, Alabama. June 6 to 20, 1877. 30[cm] direction theodolite No. 108. F. P. Webber, observer. April 14 to May 8, 1886. 50[cm] direction theodolite No. 114. O. H. Tittmann, observer.

Number of directions.	Objects observed.	Resulting directions from adjustment of first section. °	′	″	Corrections from adjustment of second section. ″	Final seconds. ″
	Azimuth Mark	0	00	00·00	....	00·00
6	Indian	33	25	53·76	−0·06	53·70
	Weisner	38	53	43·30	....	.....
7	Cheehahaw	87	46	50·31	−0·28	50·03
8	Cahaba	148	48	14·92	+0·20	15·12
9	Wornock	184	04	18·77	+0·05	18·82
10	Summit	216	19	35·52	+0·07	35·59
11	Rowe	257	36	10·13	−0·05	10·08
	Moore	275	36	11·38	....	.....
12	Gunter	294	28	55·38	−0·62	54·76
13	Brandon	349	19	38·19	+0·68	38·87

Probable error of a single observation of a direction (*D.* and *R.*) in 1877, $e_1 = \pm 1''·80$. Circle used in XVII positions.

Probable error of a single observation of a direction (*D.* and *R.*) in 1886, $e_1 = \pm 0''·79$. Circle used in VII positions.

Rowe, Madison County, Alabama. September 3 to October 9, 1877. 30[cm] direction theodolite No. 108. F. D. Granger and J. H. Christian, observers.

Number of directions.	Objects observed.	°	′	″	″	″
23	Wilson	0	00	00·00	+0·63	00·63
	Trinity	33	55	19·77	....	.....
	Capshaw	83	58	30·88	....	.....
19	Gunter	200	33	04·41	+0·11	04·52
	Moore	246	19	38·60	....	.....
20	Aurora	260	32	25·11	−0·76	24·35
21	Summit	290	47	00·66	+0·27	00·93
22	Wornock	311	16	48·15	−0·25	47·90

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 1''·27$. Circle used in XVII positions.

Summit, Blount County, Alabama. October 20 to 27, 1877. 30[cm] direction theodolite No. 108. F. D. Granger and J. H. Christian, observers. October 31 to November 10, 1878. Same instrument. C. O. Boutelle and J. B. Boutelle, observers.

Number of directions.	Objects observed.	°	′	″	″	″
24	Aurora	0	00	00·00	−0·39	59·61
25	Wornock	117	35	21·57	+0·87	22·44
26	Wilson	204	57	48·65	−0·04	48·61
27	Rowe	251	31	08·14	−0·03	08·11
28	Gunter	292	24	39·81	−0·42	39·39
	Moore	306	45	30·51	....	.....

Probable error of a single observation of a direction (*D.* and *R.*) in 1877, $e_1 = \pm 1''·21$, and in 1878, $e_1 = \pm 1''·35$. Circle used in XVII positions in both years.

Abstracts of horizontal directions at stations composing the second section of the triangulation west of the Atlanta base net, 1875–1887—continued.

Wilson, Morgan County, Alabama. June 28 to July 25, 1878. 50cm direction theodolite No. 113. C. O. Boutelle and J. B. Boutelle, observers.

Number of directions.	Objects observed.	Resulting directions from adjustment of first section.			Corrections from adjustment of second section.	Final seconds.
		°	′	″	″	″
	Somerville Court-House	0	00	00 ·00	....	.....
	Smithers	6	20	08 ·64	....	.....
29	Rowe	47	10	35 ·95	−0 ·35	35 ·60
30	Summit	111	24	19 ·56	−0 ·51	19 ·05
31	Wornock	150	23	34 ·89	+0 ·87	35 ·76
	Penit	256	06	15 ·28	....	.....
	Capshaw	352	59	40 ·80	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''.75$. Circle used in XI positions.

Wornock, Blount County, Alabama. August 16 to 31, 1878. 50cm direction theodolite No. 113. C. O. Boutelle and J. B. Boutelle, observers. January 20 to 25, 1887. 30cm repeating theodolite No. 16. O. H. Tittmann and J. H. Turner, observers.

		°	′	″	″	″
34	Summit	0	00	00 ·00	−0 ·98	59 ·02
35	Aurora	30	09	21 ·57	−0 ·20	21 ·37
36	Cahaba	109	43	58 ·02	+0 ·94	58 ·96
32	Wilson	306	21	39 ·14	−0 ·23	38 ·91
33	Rowe	334	25	29 ·11	+0 ·48	29 ·59

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''.59$. Circle used in XI positions.

Cheehahaw, Talladega and Clay counties, Alabama. January 11 to February 16, 1886. 50cm direction theodolite No. 114. O. H. Tittmann, J. H. Turner, and J. E. McGrath, observers.

		°	′	″	″	″
	Horn	0	00	00 ·00	....	.....
	Alpine	27	39	56 ·44	....	.....
37	Cahaba	63	41	15 ·86	−0 ·19	15 ·67
38	Aurora	104	45	29 ·69	−1 ·03	28 ·66
39	Indian	160	19	03 ·33	+1 ·22	04 ·55
				Mean correction	0 ·00	

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 \pm 0''.91$. Circle used in VII positions.

Cahaba, Saint Clair County, Alabama. March 8 to 31, 1886. 50cm direction theodolite No. 114. O. H. Tittmann and J. E. McGrath, observers.

		°	′	″	″	″
40	Wornock	0	00	00 ·00	−0 ·48	59 ·52
41	Aurora	65	09	22 ·94	−0 ·69	22 ·25
42	Cheehahaw	143	03	52 ·83	+1 ·16	53 ·99
	Alpine	171	08	59 ·72	....	.....
	Laurel	217	19	44 ·87	....	.....
				Mean correction	0 ·00	

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''.99$. Circle used in VII positions.

Observation equations.

I	$0=-0{\cdot}77+(6)-(13)+(3)-(2)$
II	$0=-0{\cdot}84+(15)-(14)+(5)-(4)$
III	$0=-1{\cdot}81+(16)-(15)+(4)-(3)+(13)-(12)$
IV	$0=+0{\cdot}25+(24)-(28)+(17)-(16)+(12)-(10)$
V	$0=+0{\cdot}82+(20)-(19)+(18)-(16)+(12)-(11)$
VI	$0=+0{\cdot}02+(21)-(19)+(18)-(17)+(28)-(27)$
VII	$0=-0{\cdot}23+(30)-(29)+(23)-(21)+(27)-(26)$
VIII	$0=+0{\cdot}29+(34)-(32)+(31)-(30)+(26)-(25)$
IX	$0=-2{\cdot}82+(31)-(29)+(23)-(22)+(33)-(32)$
X	$0=-2{\cdot}05+(35)-(34)+(25)-(24)+(10)-(9)$
XI	$0=-0{\cdot}64+(39)-(38)+(7)-(6)+(2)-(1)$
XII	$0=-1{\cdot}50+(42)-(41)+(8)-(7)+(38)-(37)$
XIII	$0=-0{\cdot}78+(41)-(40)+(36)-(35)+(9)-(8)$
XIV	$0=+14{\cdot}0+2{\cdot}34(2)+2{\cdot}51(5)+2{\cdot}18(6)+1{\cdot}49(12)-3{\cdot}67(13)+3{\cdot}18(14)-4{\cdot}23(15)+1{\cdot}05(16)$
XV	$0=+2{\cdot}8-1{\cdot}96(10)+2{\cdot}40(11)-0{\cdot}44(12)-3{\cdot}09(16)+4{\cdot}93(17)-1{\cdot}84(18)+0{\cdot}01(19)+3{\cdot}61(20)-3{\cdot}62(21)$
XVI	$0=+1{\cdot}7-4{\cdot}84(21)+5{\cdot}64(22)-0{\cdot}80(23)-1{\cdot}02(29)+3{\cdot}62(30)-2{\cdot}60(31)-1{\cdot}55(32)+4{\cdot}40(33)-2{\cdot}85(34)$
XVII	$0=+2{\cdot}3-3{\cdot}34(9)+5{\cdot}74(10)-2{\cdot}40(11)-3{\cdot}61(20)+9{\cdot}25(21)-5{\cdot}64(22)-4{\cdot}40(33)+8{\cdot}02(34)-3{\cdot}62(35)$
XVIII	$0=+17{\cdot}4-0{\cdot}76(1)+3{\cdot}10(2)+1{\cdot}00(3)-1{\cdot}14(4)-1{\cdot}05(15)+1{\cdot}30(16)-0{\cdot}25(18)-1{\cdot}22(19)+2{\cdot}94(20)-1{\cdot}72(22)-1{\cdot}44(33)+1{\cdot}83(35)-0{\cdot}39(36)-2{\cdot}42(37)+3{\cdot}86(38)-1{\cdot}44(39)-0{\cdot}97(40)+1{\cdot}42(41)-0{\cdot}45(42)$

Normal equations.

No.		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}
1	0=−0·77	+4		−2								−2			+3·51				−2·10
2	−0·84		+4	−2											−4·90				+0·09
3	−1·81			+6	−2	−2									+0·12	−2·65			+0·21
4	+0·25				+6	+2	−2				−2				+0·44	+9·54		−5·74	−1·30
5	+0·82	...	...	...	...	+6	+2	...	...	...	...	...	...	..	+0·44	+2·01	......	−1·21	+2·61
6	+0·02						+6	−2								−10·40	−4·84	+9·25	+0·97
7	−0·23							+6	−2	+2						+3·62	+8·68	−9·25	
8	+0·29								+6	+2	−2						−7·52	+8·02	
9	−2·82									+6							−2·07	+1.24	+0·28
10	−2·05	...	...	...	...	...	...	...	...	...	+6	...	...	−2	......	−1·96	+2·85	−2·56	+1·83
11	−0·64											+6	−2		+0·16				−1·44
12	−1·50												+6	−2					+4·41
13	−0·78													+6				+0·28	+0·17
14	+14·0														+61·32	−3·90			+13·06
15	+2·8	...	...	...	...	...	...	...	...	...	...	...	..	...	......	+73.17	+17·52	−63·53	+7·04
16	+1·7																+106·66	−118·80	−16·04
17	+2·3																	+277·05	−1·20
18	+17·4																		+60·00

Resulting correlates.

$C_1=+1{\cdot}079$	$C_7=+0{\cdot}150$	$C_{13}=+0{\cdot}807$
$C_2=+0{\cdot}526$	$C_8=+0{\cdot}107$	$C_{14}=-0{\cdot}187$
$C_3=+1{\cdot}076$	$C_9=+0{\cdot}361$	$C_{15}=-0{\cdot}0357$
$C_4=+0{\cdot}593$	$C_{10}=+0{\cdot}980$	$C_{16}=-0{\cdot}153$
$C_5=+0{\cdot}125$	$C_{11}=+0{\cdot}727$	$C_{17}=-0{\cdot}068$
$C_6=+0{\cdot}177$	$C_{12}=+1{\cdot}011$	$C_{18}=-0{\cdot}340$

Resulting Corrections to observed directions.

″	″	″	″
(1) = −0 ·469	(11) = −0 ·048	(21) = +0 ·267	(31) = +0 ·866
(2) −1 ·844	(12) −0 ·621	(22) −0 ·255	(32) −0 ·231
(3) −0 ·337	(13) +0 ·683	(23) +0 ·633	(33) +0 ·477
(4) +0 ·938	(14) −1 ·121	(24) −0 ·387	(34) −0 ·982
(5) +0 ·057	(15) +0 ·598	(25) +0 ·873	(35) −0 ·203
(6) −0 ·056	(16) −0 ·170	(26) −0 ·043	(36) +0 ·940
(7) −0 ·284	(17) +0 ·240	(27) −0 ·027	(37) −0 ·188
(8) +0 ·204	(18) +0 ·453	(28) −0 ·416	(38) −1 ·028
(9) +0 ·054	(19) +0 ·113	(29) −0 ·355	(39) +1 ·217
(10) +0 ·067	(20) −0 ·759	(30) −0 ·511	(40) −0 ·477
			(41) −0 ·687
			(42) +1 ·164

Probable error of an observed direction $0·674\sqrt{\frac{17·65}{18}} = \pm 0''·67$.

Resulting angles and sides of the second section of the triangulation west of the Atlanta base net.

No.	Stations.	Observed angles.			Corrections.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Aurora	44	06	15 ·57	−0 ·74	14 ·83	2 ·00	4 ·695 837 9	49 640 ·70
	Brandon	93	59	16 ·82	−0 ·34	16 ·48	2 ·00	4 ·852 202 7	71 154 ·56
	Indian	41	54	32 ·84	+1 ·85	34 ·69	2 ·00	4 ·677 999 5	47 643 ·04
2	Gunter	33	30	43 ·00	+1 ·72	44 ·72	1 ·32	4 ·573 188 9	37 427 ·34
	Gulf Point	39	55	42 ·81	+0 ·06	42 ·87	1 ·32	4 ·638 579 6	43 509 ·05
	Brandon	106	33	37 ·32	−0 ·94	36 ·38	1 ·33	4 ·812 764 0	64 977 ·65
3	Gunter	63	32	43 ·50	−0 ·77	42 ·73	1 ·55	4 ·677 999 5	47 643 ·04
	Brandon	61	36	36 ·51	+1 ·28	37 ·79	1 ·54	4 ·670 389 7	46 815 ·51
	Aurora	54	50	42 ·81	+1 ·30	44 ·11	1 ·54	4 ·638 579 6	43 509 ·05
4	Summit	67	35	20 ·19	+0 ·03	20 ·22	1 ·11	4 ·670 389 7	46 815 ·51
	Gunter	34	15	23 ·52	+0 ·41	23 ·93	1 ·11	4 ·454 925 1	28 505 ·27
	Aurora	78	09	19 ·86	−0 ·69	19 ·17	1 ·10	4 ·695 149 2	49 562 ·05
5	Rowe	59	59	20 ·70	−0 ·87	19 ·83	1 ·28	4 ·670 389 7	46 815 ·51
	Gunter	83	07	58 ·70	+0 ·62	59 ·32	1 ·27	4 ·729 782 6	53 676 ·31
	Aurora	36	52	45 ·25	−0 ·57	44 ·68	1 ·28	4 ·511 149 9	32 445 ·16
6	Rowe	90	13	56 ·25	+0 ·16	56 ·41	1 ·02	4 ·695 149 2	49 562 ·05
	Gunter	48	52	35 ·18	+0 ·21	35 ·39	1 ·03	4 ·572 115 2	37 334 ·92
	Summit	40	53	31 ·67	−0 ·39	31 ·28	1 ·03	4 ·511 149 9	32 445 ·16
7	Summit	108	28	51 ·86	−0 ·36	51 ·50	0 ·85	4 ·729 782 6	53 676 ·31
	Rowe	30	14	35 ·55	+1 ·03	36 ·58	0 ·86	4 ·454 925 2	28 505 ·27
	Aurora	41	16	34 ·61	−0 ·12	34 ·49	0 ·86	4 ·572 115 1	37 334 ·91
8	Wilson	64	13	43 ·61	−0 ·16	43 ·45	0 ·89	4 ·572 115 2	37 334 ·92
	Rowe	69	12	59 ·34	+0 ·37	59 ·71	0 ·89	4 ·588 392 3	38 760 ·76
	Summit	46	33	19 ·49	+0 ·02	19 ·51	0 ·89	4 ·478 573 3	30 100 ·47

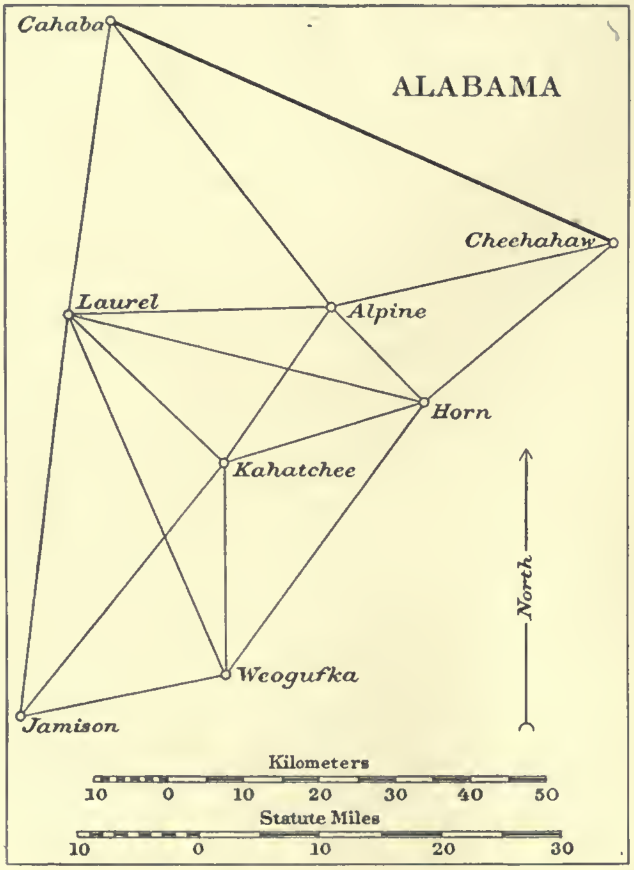
Resulting angles and sides of the second section of the triangulation west of the Atlanta base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
9	Wornock	25	34	30 ·89	−1 ·46	29 ·43	0 ·69	4 ·572 115 2	37 334 ·92
	Rowe	20	29	47 ·49	−0 ·52	46 ·97	0 ·69	4 ·481 194 5	30 282 ·69
	Summit	133	55	46 ·57	−0 ·90	45 ·67	0 ·69	4 ·794 398 5	62 287 ·16
10	Wornock	53	38	20 ·86	−0 ·75	20 ·11	0 ·99	4 ·588 392 3	38 760 ·76
	Wilson	38	59	15 ·33	+1 ·38	16 ·71	0 ·99	4 ·481 194 6	30 282 ·70
	Summit	87	22	27 ·08	−0 ·92	26 ·16	1 ·00	4 ·681 981 5	48 081 ·88
11	Wilson	103	12	58 ·94	+1 ·22	60 ·16	1 ·20	4 ·794 398 5	62 287 ·16
	Rowe	48	43	11 ·85	+0 ·89	12 ·74	1 ·19	4 ·681 981 5	48 081 ·88
	Wornock	28	03	49 ·97	+0 ·71	50 ·68	1 ·19	4 ·478 573 3	30 100 ·47
12	Wornock	55	43	52 ·46	−0 ·68	51 ·78	2 ·19	4 ·729 782 6	53 676 ·31
	Rowe	50	44	23 ·04	+0 ·50	23 ·54	2 ·19	4 ·701 488 3	50 290 ·77
	Aurora	73	31	51 ·36	−0 ·10	51 ·26	2 ·20	4 ·794 398 5	62 287 ·16
13	Wornock	30	09	21 ·57	+0 ·78	22 ·35	0 ·65	4 ·454 925 1	28 505 ·27
	Summit	117	35	21 ·57	+1 ·26	22 ·83	0 ·64	4 ·701 488 1	50 290 ·75
	Aurora	32	15	16 ·75	+0 ·01	16 ·76	0 ·65	4 ·481 194 4	30 282 ·69
14	Cheehahaw	55	33	33 ·64	+2 ·24	35 ·88	3 ·97	4 ·852 202 7	71 154 ·56
	Aurora	54	20	56 ·55	−0 ·23	56 ·32	3 ·97	4 ·845 763 8	70 107 ·39
	Indian	70	05	41 ·09	−1 ·37	39 ·72	3 ·98	4 ·909 145 1	81 123 ·21
15	Cahaba	77	54	29 ·89	+1 ·85	31 ·74	3 ·27	4 ·909 145 1	81 123 ·21
	Aurora	61	01	24 ·61	+0 ·49	25 ·10	3 ·28	4 ·860 804 4	72 577 ·90
	Cheehahaw	41	04	13 ·83	−0 ·84	12 ·99	3 ·28	4 ·736 436 7	54 505 ·05
16	Cahaba	65	09	22 ·94	−0 ·21	22 ·73	1 ·34	4 ·701 488 2	50 290 ·76
	Wornock	79	34	36 ·45	+1 ·14	37 ·59	1 ·34	4 ·736 436 8	54 505 ·06
	Aurora	35	16	03 ·85	−0 ·15	03 ·70	1 ·34	4 ·505 134 1	31 998 ·83

9. THE THIRD SECTION OF THE TRIANGULATION WEST OF THE ATLANTA BASE NET, ALABAMA, 1886–1890.

This section forms a compact figure connecting at each end on a single line both with the preceding and the following sections. It covers a portion of the valley of the Coosa River and comprises 6 stations, whose approximate heights are as follows:

No. 30.



	Meters.	Feet.
Alpine	473	1 551
Laurel	480	1 576
Horn	588	1 930
Kahatchee	396	1 300
Weogufka	352	1 155
Jamison	255	835

The observers employed almost exclusively a repeating theodolite for the angular measures of this section. In the adjustment unit weight was given to all directions. The mean closing error derived from the 13 triangles of the figure equals $\sqrt{\frac{23\cdot 4}{13}} = \pm 1''\cdot 34$ and the mean error of an angle $= \pm 0''\cdot 77$, also the probable error of a direction $= 0\cdot 674 \frac{1\cdot 34}{\sqrt{6}} = \pm 0''\cdot 37$.

The observations of 1888 at stations Laurel and Horn by Assistant F. W. Perkins were made at night upon lights. Subsequent to this date all horizontal measures of the primary triangulation between these stations and the Gulf coast were made at night by Assistants F. W. Perkins and W. B. Fairfield. Advantage was thus taken of the greater transparency of the atmosphere and of the better seeing during the night as compared with the day. On long or difficult lines two or three lights arranged vertically were shown at the same station.

Abstracts of horizontal directions at stations composing the third section of the triangulation west of Atlanta base net, 1886–1890.

Cheehahaw, Talladega and Clay Counties, Alabama. January 11 to February, 16 1886. 50^{cm} direction theodolite No. 114. O. H. Tittmann, J. H. Turner and J. E. McGrath, observers.

Number of directions.	Objects observed.	Results from adjustment of second section.			Corrections from adjustment of third section.	Final seconds.
		°	′	″	″	″
1	Horn	0	00	00·00	+0·01	00·01
2	Alpine	27	39	56·44	−0·04	56·40
	Cahaba	63	41	15·67	....	.....

Cahaba, St. Clair County, Alabama. March 8 to 31, 1886. 50^{cm} direction theodolite No. 114. O. H. Tittmann and J. E. McGrath, observers.

Number of directions.	Objects observed.					
		°	′	″	″	″
	Wornock	0	00	59·52	....	.....
	Cheehahaw	143	03	53·99	....	.....
3	Alpine	171	08	59·72	+0·57	60·29
4	Laurel	217	19	44·87	−0·62	44·25

Alpine, Talladega County, Alabama. February 10 to March 9, 1887. 30^{cm} repeating theodolite No. 16. O. H. Tittmann and J. H. Turner, observers.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections for third section.	Final seconds.
		°	′	″	″	″
7	Horn	0	00	00·00	+0·47	00·47
8	Kahatchee	79	16	54·51	+0·55	55·06
9	Laurel	131	56	48·89	−0·34	48·55
	Cahaba	186	00	40·66	−0·64	40·02
	Cheehahaw	301	54	18·60	−0·04	18·56

Horn, Talladega and Clay Counties, Alabama. March 22 to April 5, 1887. 30^{cm} repeating theodolite No. 16. O. H. Tittmann and J. H. Turner, observers. May 16 to 22, 1888. Instrument as before. O. H. Tittmann, J. H. Turner and F. W. Perkins, observers.

Number of directions.	Objects observed.					
		°	′	″	″	″
13	Alpine	0	00	00·00	−0·59	59·41
14	Cheehahaw	94	14	22·53	+0·03	22·56
10	Weogufka	260	49	34·86	−0·27	34·59
11	Kahatchee	298	04	03·82	−0·02	03·80
12	Laurel	327	42	18·11	+0·84	18·95

Laurel, Shelby County, Alabama. May 11 to 28, 1887. 30^{cm} repeating theodolite No. 16. O. H. Tittmann and J. H. Turner, observers. April 27 to May 10, 1888. Instrument as before. F. W. Perkins and W. B. Fairfield, observers.

Number of directions.	Objects observed.					
		°	′	″	″	″
15	Cahaba	0	00	00·00	+0·65	00·65
16	Alpine	79	45	28·59	+0·04	28·63
17	Horn	95	31	01·66	−0·40	01·26
18	Kahatchee	124	56	26·94	−0·33	26·61
19	Weogufka	147	58	16·93	−0·06	16·87
	Columbiana	172	50	15·95	....	.....
20	Jamison	178	28	38·93	+0·10	39·03

Abstracts of horizontal directions at stations composing the third section of the triangulation west of Atlanta base net, 1886–1890—continued.

Kahatchee, Talladega County, Alabama. April 18 to 28, 1887. 30^{cm} repeating theodolite No. 16. O. H. Tittmann and J. H. Turner, observers.

Number of directions.	Objects observed.	Results from station adjustment. °	′	″	Corrections for third section. ″	Final seconds. ″
25	Jamison	0	00	00·00	0·00	00·00
	Columbiana	41	54	02·20	....	.....
21	Laurel	93	59	09·51	+0·30	09·81
22	Alpine	176	08	20·52	−0·44	20·08
23	Horn	214	55	31·04	−0·04	31·00
24	Weogufka	320	17	33·35	+0·18	33·53

Weogufka, Coosa County, Alabama. May 28 to June 1 and December 5 to 1888 to January 17, 1889. 30^{cm} repeating theodolite No. 16. F. W. Perkins and W. B. Fairfield, observers. Telescope $1^{m}·9$ above the ground.

Number of directions.	Objects observed.	°	′	″	″	″
28	Kahatchee	0	00	00·00	−0·18	59·82
29	Horn	37	23	29·76	+0·20	29·96
	Wetumpka	164	03	00·15	....	.....
	Wilder	200	00	45·06	....	.....
26	Jamison	260	22	41·69	−0·12	41·57
27	Laurel	336	43	24·84	+0·11	24·95
				Mean correction	0·00	

Jamison, Chilton County, Alabama. February 1 to March 5, 1889, and May 7 to 14, 1890. 30^{cm} repeating theodolite No. 16. F. W. Perkins and W. B. Fairfield, observers. Telescope $2^{m}·1$ above the ground.

Number of directions.	Objects observed.	°	′	″	″	″
30	Laurel	0	00	00·00	−0·19	59·81
31	Kahatchee	32	28	40·43	+0·10	40·53
32	Weogufka	73	08	57·60	+0·09	57·69
	Wilder	151	38	56·43	....	.....
	Perry	231	10	29·86	....	.....
				Mean correction	0·00	

Observation equations.

I | $0=-1·22+(6)-(5)+(3)-(2)$

II | $0=-1·08+(14)-(13)+(7)-(6)+(2)-(1)$

III | $0=+2·11+(16)-(15)+(4)-(3)+(5)-(9)$

IV | $0=+1·99+(22)-(21)+(18)-(16)+(9)-(8)$

V | $0=+0·11+(23)-(22)+(8)-(7)+(13)-(11)$

VI | $0=-1·55+(29)-(27)+(19)-(17)+(12)-(10)$

VII | $0=-0·85+(29)-(28)+(24)-(23)+(11)-(10)$

VIII | $0=-1·03+(31)-(30)+(20)-(18)+(21)-(25)$

IX | $0=+0·25+(32)-(31)+(25)-(24)+(28)-(26)$

X | $0=-0·67+(32)-(30)+(20)-(19)+(27)-(26)$

XI | $0=-2·7-4.02(1)+6·91(2)+5·96(3)-2·02(4)-3·33(12)+3·17(13)+0·16(14)-0·38(15)$
$+7·84(16)-7·46(17)$

Observation equations—continued.

XII $0=-0{\cdot}4-1{\cdot}13(11)+3{\cdot}33(12)-2{\cdot}20(13)-5{\cdot}37(16)+7{\cdot}46(17)-2{\cdot}09(18)-0{\cdot}29(21)+2{\cdot}91(22)-2{\cdot}62(23)$

XIII $0=+6{\cdot}0-2{\cdot}77(10)+6{\cdot}47(11)-3{\cdot}70(12)-3{\cdot}73(17)+8{\cdot}68(18)-4{\cdot}95(19)-4{\cdot}89(27)+7{\cdot}65(28)-2{\cdot}76(29)$

XIV $0=-3{\cdot}1-3{\cdot}39(18)+4{\cdot}95(19)-1{\cdot}56(20)+0{\cdot}36(26)+4{\cdot}89(27)-5{\cdot}25(28)-3{\cdot}31(30)+5{\cdot}76(31)-2{\cdot}45(32)$

Normal equations.

No.		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}
1	0 = −1·22	+4	−2	−2								− 0·95			
2	−1·08		+6			−2						+ 7·92	+ 2·20		
3	+2·11			+6	−2							+ 0·24	− 5·37		
4	+1·99				+6	−2			−2			− 7·84	+ 6·48	+ 8·68	− 3·39
5	+0·11					+6		−2				+ 3·17	− 6·60	− 6·47	
6	−1·55						+6	+2			−2	+ 4·13	− 4·13	− 0.02	+ 0·06
7	−0·85							+6		−2			+ 1·49	− 1·17	+ 5·25
8	−1·03								+6	−2	+2		+ 1 80	− 8·68	+ 10·90
9	+0·25									+6	+2			+ 7·65	− 13·82
10	−0·67										+6			+ 0·06	− 1·12
11	−2·7											+241.94	−115·82	+ 40·15	
12	−0·4												+121·48	− 65·60	+ 7·09
13	+6·0													+267·03	−118·00
14	−3·1														+140·17

Resulting correlates.

$C_1=-0{\cdot}003$
$C_2=+0{\cdot}034$
$C_3=-0{\cdot}645$
$C_4=-0{\cdot}985$
$C_5=-0{\cdot}437$

$C_6=+0{\cdot}727$
$C_7=-0{\cdot}495$
$C_8=-0{\cdot}678$
$C_9=-0{\cdot}677$
$C_{10}=+0{\cdot}809$

$C_{11}=-0{\cdot}0115$
$C_{12}=+0{\cdot}0389$
$C_{13}=+0{\cdot}0134$
$C_{14}=+0{\cdot}0184$

Resulting corrections to observed directions.

″	″	″	″
(1) = +0·012	(9) = −0·340	(17) = −0·399	(25) = +0·001
(2) −0·042	(10) −0·269	(18) −0·334	(26) −0·125
(3) +0·573	(11) −0·015	(19) −0·057	(27) +0·106
(4) −0·622	(12) +0·845	(20) +0·102	(28) −0·176
(5) −0·642	(13) −0·593	(21) +0·296	(29) +0·195
(6) −0·037	(14) +0·032	(22) −0·435	(30) −0·192
(7) +0·471	(15) +0·649	(23) −0·044	(31) +0·105
(8) +0·548	(16) +0·041	(24) +0·182	(32) +0·087

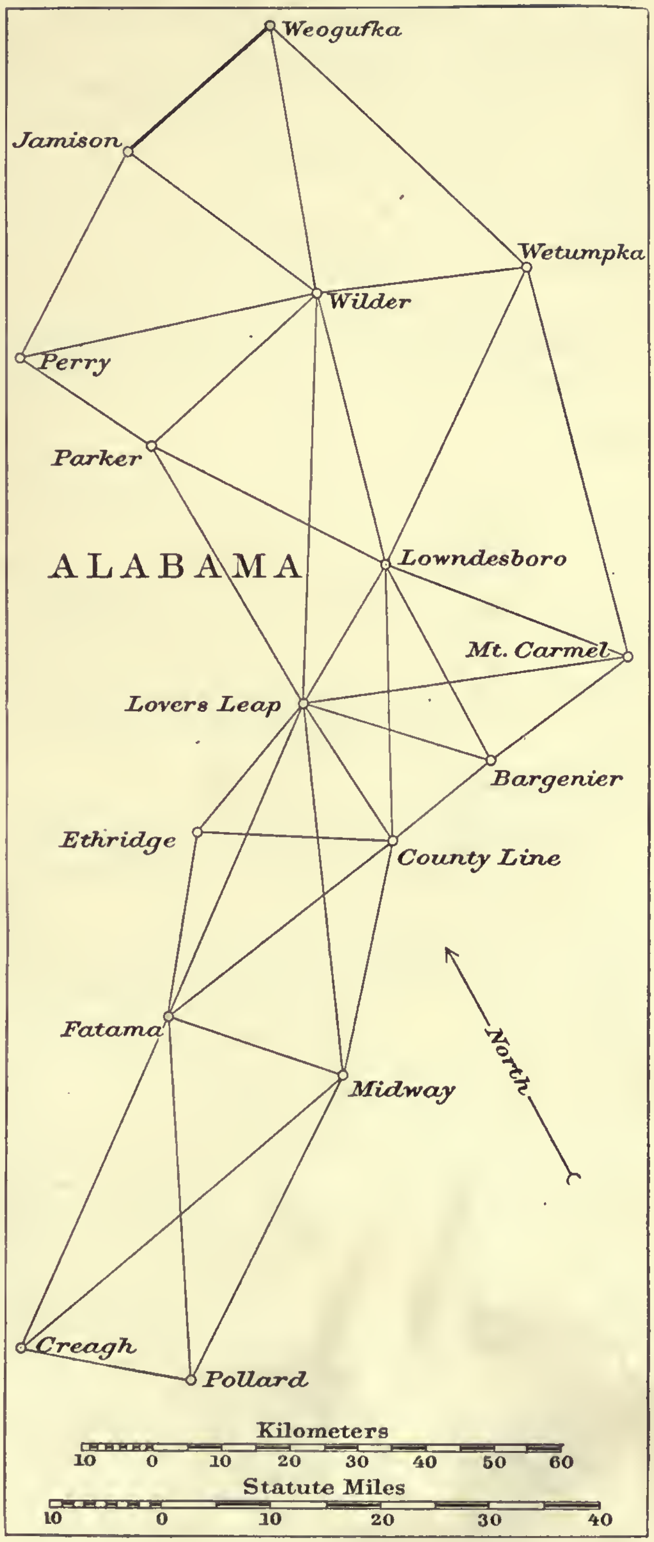
Probable error of an observed direction $0{\cdot}674\sqrt{\frac{4{\cdot}08}{14}}=\pm0''{\cdot}36$.

Resulting angles and sides of the third section of the triangulation west of the Atlanta base net.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Alpine	115	53	37 ·94	+0 ·61	38 ·55	1 ·38	4 ·860 804 4	72 577 ·90
	Cahaba	28	05	05 ·73	+0 ·57	06 ·30	1 ·37	4 ·579 566 6	37 981 ·02
	Cheehahaw	36	01	19 ·23	+0 ·04	19 ·27	1 ·37	4 ·676 196 3	47 445 ·64
2	Horn	94	14	22 ·53	+0 ·62	23 ·15	0 ·49	4 ·579 566 6	37 981 ·02
	Alpine	58	05	41 ·40	+0 ·51	41 ·91	0 ·48	4 ·509 625 5	32 331 ·47
	Cheehahaw	27	39	56 ·44	−0 ·05	56 ·39	0 ·48	4 ·247 564 0	17 683 ·33
3	Laurel	79	45	28 ·59	−0 ·61	27 ·98	1 ·14	4 ·676 196 3	47 445 ·64
	Cahaba	46	10	45 ·15	−1 ·20	43 ·95	1 ·13	4 ·541 410 1	34 786 ·45
	Alpine	54	03	51 ·77	−0 ·30	51. 47	1 ·13	4 ·591 482 6	39 037 ·55
4	Horn	32	17	41 ·89	−1 ·44	40 ·45	0 ·39	4 ·541 410 1	34 786 ·45
	Laurel	15	45	33 ·07	−0 ·44	32 ·63	0 ·39	4 ·247 564 0	17 683 ·33
	Alpine	131	56	48 ·89	−0 ·81	48 ·08	0 ·38	4 ·685 086 5	48 426 ·88
5	Kahatchee	82	09	11 ·01	−0 ·73	10 ·28	0 ·59	4 ·541 410 1	34 786 ·45
	Laurel	45	10	58 ·35	−0 ·37	57 ·98	0 ·58	4 ·396 361 0	24 909 ·27
	Alpine	52	39	54 ·38	−0 ·89	53 ·49	0 ·58	4 ·445 918 0	27 920 ·17
6	Kahatchee	38	47	10 ·52	+0 ·39	10 ·91	0 ·37	4 ·247 564 0	17 683 ·33
	Alpine	79	16	54 ·51	+0 ·08	54 ·59	0 ·36	4 ·443 056 7	27 736 ·82
	Horn	61	55	56 ·18	−0 ·58	55 ·60	0 ·37	4 ·396 361 0	24 909 ·27
7	Kahatchee	120	56	21 ·53	−0 ·34	21 ·19	0 ·57	4 ·685 086 5	48 426 ·88
	Laurel	29	25	25 ·28	+0 ·07	25 ·35	0 ·56	4 ·443 056 8	27 736 ·83
	Horn	29	38	14 ·29	+0 ·86	15 ·15	0 ·56	4 ·445 918 0	27 920 ·17
8	Weogufka	60	40	04 ·92	+0 ·09	05 ·01	1 ·66	4 ·685 086 5	48 426 ·88
	Laurel	52	27	15 ·27	+0 ·34	15 ·61	1 ·66	4 ·643 871 6	44 042 ·46
	Horn	66	52	43 ·25	+1 ·12	44 ·37	1 ·67	4 ·708 307 5	51 086 ·66
9	Weogufka	37	23	29 ·76	+0 ·37	30 ·13	0 ·63	4 ·443 056 7	27 736 ·82
	Kahatchee	105	22	02 ·31	+0 ·23	02 ·54	0 ·62	4 ·643 871 6	44 042 ·46
	Horn	37	14	28 ·96	+0 ·25	29 ·21	0 ·63	4 ·441 562 6	27 641 ·56
10	Weogufka	23	16	35 ·16	−0 ·28	34 ·88	0 ·47	4 ·445 918 0	27 920 ·17
	Laurel	23	01	49 ·99	+0 ·28	50 ·27	0 ·47	4 ·441 562 4	27 641 ·55
	Kahatchee	133	41	36 ·16	+0 ·11	36 ·27	0 ·48	4 ·708 307 5	51 086 ·66
11	Jamison	32	28	40 ·43	+0 ·30	40 ·73	0 ·99	4 ·445 918 0	27 920 ·17
	Laurel	53	32	11 ·99	+0 ·44	12 ·43	0 ·99	4 ·621 350 2	41 816 ·74
	Kahatchee	93	59	09 ·51	+0 ·29	09 ·80	0 ·98	4 ·714 915 2	51 869 ·88
12	Jamison	40	40	17 ·17	−0 ·02	17 ·15	0 ·63	4 ·441 562 5	27 641 ·55
	Kahatchee	39	42	26 ·65	−0 ·18	26 ·47	0 ·63	4 ·432 911 3	27 096 ·38
	Weogufka	99	37	18 ·31	−0 ·05	18 ·26	0 ·62	4 ·621 350 2	41 816 ·74
13	Jamison	73	08	57 ·60	+0 ·28	57 ·88	1 ·14	4 ·708 307 5	51 086 ·66
	Laurel	30	30	22 ·00	+0 ·16	22 ·16	1 ·14	4 ·432 911 3	27 096 ·38
	Weogufka	76	20	43 ·15	+0 ·23	43 ·38	1 ·14	4 ·714 915 2	51 869 ·88

10. THE FOURTH SECTION OF THE TRIANGULATION WEST OF THE ATLANTA BASE NET, ALABAMA, 1888–1895.

No. 31.



The triangulation between the preceding terminal line and the southern limiting line, Creagh to Pollard, follows the valleys of the Coosa and Alabama rivers. It is abundantly supplied with check lines, making 30 conditions in the adjustment. The linear development is 209 kilometers (or 130 statute miles). The whole of the scheme lies south of latitude 33° and the natural elevation of all the spurs available for stations is less than 220 meters (or 722 feet); farther south the ground slopes gradually to the level of the Gulf. The approximate elevations of the stations are as follows:

	Meters.	Feet.
Perry	206	677
Wilder	216	710
Wetumpka	172	565
Parker	170	558
Lowndesboro	121	396
Mount Carmel	192	629
Lovers Leap	169	556
Bargenier	178	583
County Line	173	568
Ethridge	143	470
Fatama	165	540
Midway	171	562
Creagh	133	435
Pollard	121	397

The observations of the primary directions were made at night upon lights mounted over the respective stations.

At Pollard station it was necessary to mount the theodolite on a wooden structure

46·53 meters (or 152½ feet) above the ground, in order to raise it above the high woods obstructing the lines of sight.

Squaring the closing errors of the triangles we get the mean error $\sqrt{\frac{32{\cdot}8}{28}} = \pm 1''{\cdot}08$ and the mean error of an angle $\frac{1{\cdot}08}{\sqrt{3}} = \pm 0''{\cdot}63$, also the probable error of a direction, $\pm 0''{\cdot}30$.

Abstracts of horizontal directions at stations composing the fourth section of the triangulation west of the Atlanta base net, Alabama, 1888–1895.

Jamison, Chilton County, Alabama. February 1 and March 5, 1889, and May 7 to 14, 1890. 30^cm repeating theodolite No. 16. F. W. Perkins and W. B. Fairfield, observers. Telescope 2^m·1 above the ground.

Number of directions.	Objects observed.	Results from adjustment of third section.			Corrections from adjustment of fourth section.	Final seconds.
		°	′	″	″	″
	Laurel	0	00	59·81	....	.....
	Weogufka	73	08	57·69	....	.....
3	Wilder	151	38	56·43	−0·82	55·61
4	Perry	231	10	29·86	+0·05	29·91
				Mean correction	−0·15	

Weogufka, Coosa County, Alabama. May 28 to June 1, and December 5, 1888, to January 17, 1889. 30^cm repeating theodolite No. 16. F. W. Perkins and W. B. Fairfield, observers.

		°	′	″	″	″
	Kahatchee	0	00	59·82	....	.....
1	Wetumpka	164	03	00·15	+0·67	00·82
2	Wilder	200	00	45·06	+0·14	45·20
	Jamison	260	22	41·57	....	.....
				Mean correction	+0·14	

Wilder, Autauga County, Alabama. June 13 to July 28, 1890. 30^cm repeating theodolite No. 16. F. W. Perkins, observer. Telescope 20^m·3 above the ground.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fourth section.	Final seconds.
		°	′	″	″	″
5	Wetumpka	0	00	00·00	−0·32	59·68
	Montgomery, Capitol	36	00	43·94	....	.....
6	Lowndesboro	84	05	39·74	−0·74	39·00
7	Lovers Leap	99	41	48·39	−0·03	48·36
8	Parker	145	24	54·49	+0·16	54·65
9	Perry	176	38	20·73	+0·14	20·87
10	Jamison	226	24	43·90	+0·84	44·74
11	Weogufka	267	32	52·91	−0·05	52·86

Abstracts of horizontal directions at stations composing the fourth section of the triangulation west of the Atlanta base net, Alabama, 1888–1895—continued.

Perry, Chilton County, Alabama. July 30 to August 6, 1890. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer. Telescope $1^{m}\cdot 7$ above the ground.

Number of directions.	Objects observed.	Results from station adjustment. °	′	″	Corrections from adjustment of fourth section. ″	Final seconds. ″
12	Jamison	0	00	00 ·00	−0 ·09	59 ·91
13	Wilder	50	42	04 ·96	−0 ·06	04 ·90
14	Parker	96	51	15 ·25	+0 ·15	15 ·40

Wetumpka, Elmore County, Alabama. March 6 to May 23, 1892. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer. Telescope $1^{m}\cdot 8$ above the ground.

Number of directions.	Objects observed.	°	′	″	″	″
19	Mount Carmel	0	00	00 ·00	+0 ·30	00 ·30
	Montgomery, Capitol	15	36	22 ·25	.....	.....
20	Lowndesboro	39	09	11 ·09	+0 ·12	11 ·21
21	Wil·	97	04	34 ·94	+0 ·35	35 ·29
22	Weogufka	148	39	47 ·96	−0 ·77	47 ·19

Parker, Autauga County, Alabama. August 8 to 28, 1890. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer.

Number of directions.	Objects observed.	°	′	″	″	″
15	Perry	0	00	00 ·00	−0 ·18	59 ·82
16	Wilder	102	37	25 ·30	−0 ·17	25 ·13
17	Lowndesboro	172	09	44 ·08	+0 ·08	44 ·16
18	Lovers Leap	203	32	39 ·76	+0 ·27	40 ·03

Lowndesboro, Lowndes County, Alabama. March 26 to April 25, 1892. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer. Telescope $20^{m}\cdot 3$ above the ground.

Number of directions.	Objects observed.	°	′	″	″	″
23	Parker	0	00	00 ·00	−0 ·10	59 ·90
24	Wilder	49	08	27 ·40	+0 ·93	28 ·33
25	Wetumpka	87	07	28 ·24	−0 ·13	28 ·11
	Montgomery, Capitol	101	49	48 ·45	....	.....
26	Mount Carmel	171	58	00 ·86	−0 ·20	00 ·66
27	Bargenier	214	18	04 ·20	−0 ·24	03 ·96
28	County Line	241	53	56 ·76	+0 ·03	56 ·79
29	Lovers Leap	274	05	53 ·00	−0 ·29	52 ·71

Mount Carmel, Crenshaw County, Alabama. May 26 to June 1, 1892. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer.

Number of directions.	Objects observed.	°	′	″	″	″
39	Bargenier	0	00	00 ·00	+0 ·39	00 ·39
40	Lovers Leap	28	34	48 ·68	−0 ·03	48 ·65
41	Lowndesboro	56	34	12 ·39	+0 ·01	12 ·40
	Montgomery, Capitol	104	47	10 ·94	....	.....
42	Wetumpka	112	34	33 ·92	−0 ·37	33 ·55

Abstracts of horizontal directions at stations composing the fourth section of the triangulation west of the Atlanta base net, Alabama, 1888–1895—continued.

Lovers Leap, Lowndes County, Alabama. June 4 to 20, 1892. 30^{cm} direction theodolite No. 135. W. B. Fairfield, observer. Telescope 7^{m}·5 above the ground. Circle used in XVII positions.

Number of directions.	Objects observed.	Results from station adjustment. °	′	″	Corrections from adjustment of fourth section. ″	Final seconds. ″
32	Lowndesboro	0	00	00 ·00	+0 ·04	00 ·04
33	Mount Carmel	49	52	45 ·80	+0 ·55	46 ·35
34	Bargenier	75	30	10 ·39	−0 ·04	10 ·35
35	County Line	115	27	55 ·55	+0 ·11	55 ·66
36	Midway	142	57	02 ·18	+0 ·16	02 ·34
37	Fatama	171	54	21 ·51	−0 ·34	21 ·17
38	Ethridge	185	50	02 ·19	−0 ·09	02 ·10
30	Parker	297	17	01 ·14	−0 ·31	00 ·83
31	Wilder	330	38	43 ·38	−0 ·08	43 ·30

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\!\cdot\!84$.

Ethridge, Dallas County, Alabama. June 6 to 11, 1892. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer.

		°	′	″	″	″
53	Lovers Leap	0	00	00 ·00	+0 ·24	00 ·24
54	County Line	51	57	27 ·06	−0 ·45	26 ·61
55	Fatama	153	22	20 ·95	+0 ·21	21 ·16

Bargenier, Lowndes County, Alabama. March 18 to April 7, 1892. 30^{cm} direction theodolite No. 135. W. B. Fairfield, observer. Circle used in XVII positions.

		°	′	″	″	″
43	County Line	0	00	00 ·00	+0 ·29	00 ·29
44	Lovers Leap	53	59	14 ·24	+0 ·07	14 ·31
45	Lowndesboro	98	41	16 ·61	+0 ·21	16 ·82
	Montgomery, Capitol	132	30	40 ·19	....	.....
46	Mount Carmel	179	47	04 ·09	−0 ·57	03 ·52

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\!\cdot\!72$.

County Line, Lowndes County, Alabama. May 10 to 16, 1892. 30^{cm} direction theodolite No. 135. W. B. Fairfield, observer. Circle used in XVII positions.

		°	′	″	″	″
52	Bargenier	0	00	00 ·00	−0 ·44	59 ·56
47	Midway	138	31	49 ·80	−0 ·27	49 ·53
48	Fatama	177	24	01 ·35	+0 ·19	01 ·54
49	Ethridge	216	16	28 ·96	+0 ·38	29 ·34
50	Lovers Leap	273	56	58 ·28	−0 ·42	57 ·86
51	Lowndesboro	306	17	06 ·94	+0 ·56	07 ·50

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\!\cdot\!87$.

Abstracts of horizontal directions at stations composing the fourth section of the triangulation west of the Atlanta base net, Alabama, 1888–1895—continued.

Fatama, Wilcox County, Alabama. October 2 to November 26, 1895. 30^cm direction theodolite No. 145. G. A. Fairfield, observer. Telescope 15^m·8 above the ground. Circle used in XII positions.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fourth section.	Final sections.
		°	′	″	″	″
59	Midway	0	00	00·00	−0·04	59·96
60	Pollard	67	24	18·64	+0·33	18·97
61	Creagh	96	02	10·39	−0·12	10·27
56	Ethridge	262	09	32·81	−0·09	32·72
57	Lovers Leap	274	51	31·72	−0·11	31·61
58	County Line	301	52	12·15	+0·03	12·18

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot58$.

Midway, Monroe County, Alabama. September 19 to October 20, 1895. 30^cm repeating theodolite No. 16. F. W. Perkins, observer. Telescope 34^m·5 above the ground.

		°	′	″	″	″
62	Pollard	0	00	00·00	−0·31	59·69
63	Creagh	23	41	51·42	+0·21	51·63
	Lookout Hill	50	50	15·83	....	.....
64	Fatama	82	29	45·86	−0·11	45·75
65	Lovers Leap	148	24	01·80	+0·10	01·90
66	County Line	165	29	48·23	+0·11	48·34

Creagh, Clarke County, Alabama. August 9 to September 10, 1895. 30^cm direction theodolite No. 135. G. A. Fairfield, observer. Telescope 12^m·4 above the ground. Circle used in XVI positions.

		°	′	″	″	″
	White	0	00	00·00	....	.....
70	Fatama	196	20	14·53	−0·30	14·23
71	Midway	221	30	12·95	+0·41	13·36
72	Pollard	270	04	55·03	−0·11	54·92
	Red Hill	320	37	14·96	....	.....

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''\cdot76$.

Pollard, Monroe County, Alabama. August 29 to September 13, 1895. 30^cm repeating theodolite No. 16. F. W. Perkins, observer. Telescope 46^m·5 above the ground.

		°	′	″	″	″
	Red Hill	0	00	00·00	....	.....
	White	55	52	09·60	....	.....
67	Creagh	93	01	16·79	−0·01	16·78
68	Fatama	170	38	48·06	+0·12	48·18
69	Midway*	200	44	46·47	−0·11	46·36

*The correction $-0''\cdot09$ was applied for eccentricity.

Observation equations.

I	$0=+1.84-(2)+(3)-(10)+(11)$
II	$0=+1.92-(1)+(2)+(5)-(11)-(21)+(22)$
III	$0=-1.60-(3)+(4)-(9)+(10)-(12)+(13)$
IV	$0=-0.19-(8)+(9)-(13)+(14)-(15)+(16)$
V	$0=+1.24-(5)+(6)-(20)+(21)-(24)+(25)$
VI	$0=-2.19-(6)+(8)-(16)+(17)-(23)+(24)$
VII	$0=-0.87-(7)+(8)-(16)+(18)-(30)+(31)$
VIII	$0=-0.72-(17)+(18)+(23)-(29)-(30)+(32)$
IX	$0=+0.63-(19)+(20)-(25)+(26)-(41)+(42)$
X	$0=+1.21-(26)+(27)-(39)+(41)-(45)+(46)$
XI	$0=-0.02-(27)+(29)-(32)+(34)-(44)+(45)$
XII	$0=+1.65-(33)+(34)-(39)+(40)-(44)+(46)$
XIII	$0=+0.08-(34)+(35)-(43)+(44)-(50)+(52)$
XIV	$0=+0.80-(27)+(28)-(43)+(45)-(51)+(52)$
XV	$0=+1.69-(35)+(38)-(49)+(50)-(53)+(54)$
XVI	$0=-0.97-(48)+(49)-(54)+(55)-(56)+(58)$
XVII	$0=-0.20-(37)+(38)-(53)+(55)-(56)+(57)$
XVIII	$0=-0.61-(47)+(48)-(58)+(59)-(64)+(66)$
XIX	$0=+0.09-(35)+(36)-(47)+(50)-(65)+(66)$
XX	$0=-0.33-(59)+(60)-(62)+(64)-(68)+(69)$
XXI	$0=+0.14-(60)+(61)-(67)+(68)-(70)+(72)$
XXII	$0=+0.11-(62)+(63)-(67)+(69)-(71)+(72)$
XXIII	$0=+4.3-2.90(1)+4.10(2)+0.82(3)-0.39(4)-1.72(12)+3.74(13)-2.02(14)+0.47(15)+0.31(16)-0.78(17)-1.32(20)+2.99(21)-1.67(22)-1.82(23)+4.52(24)-2.70(25)$
XXIV	$0=+3.8+6.39(6)-7.54(7)+1.15(8)+0.78(16)-4.23(17)+3.45(18)+1.08(30)-3.74(31)+2.66(32)$
XXV	$0=+6.0-0.22(5)+7.76(6)-7.54(7)-2.58(19)+3.90(20)-1.32(21)-3.74(31)+5.52(32)-1.78(33)-3.96(40)+5.38(41)-1.42(42)$
XXVI	$0=-1.4-2.32(26)+3.55(27)-1.23(29)-0.55(32)+4.39(33)-3.84(34)-2.47(39)+3.86(40)-1.39(41)$
XXVII	$0=+2.3+2.80(27)-4.03(28)+1.23(29)+0.55(32)-3.06(34)+2.51(35)+0.15(50)-1.55(51)+1.40(52)$
XXVIII	$0=+1.3-0.75(35)+8.49(37)-7.74(38)-2.61(48)+3.94(49)-1.33(50)-6.81(56)+9.35(57)-2.54(58)$
XXIX	$0=+1.5+2.65(35)-4.05(36)+1.40(37)+4.13(57)-5.44(58)+1.31(59)+0.26(64)-6.84(65)+6.58(66)$
XXX	$0=+5.6+0.87(59)-4.72(60)+3.85(61)+4.51(62)-4.79(63)+0.28(64)+0.61(70)-1.86(71)+1.25(72)$

Normal equations.

		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}
1	0=+1·84	+4	−2	−2															
2	+1·92		+6			−2													
3	−1·60			+6	−2														
4	−0·19				+6		−2	−2											
5	+1·24	....	....	....	....	+6	−2	....	....	−2	....	....	....	....	....	....	....	....	....
6	−2·19						+6	+2	−2										
7	−0·87							+6	+2										
8	−0·72								+6			−2							
9	+0·63									+6	−2								
10	+1·21	....	....	....	....	....	....	....	....	....	+6	−2	+2	....	−2	....	....	....	....
11	−0·02											+6	+2	−2	+2				
12	+1·65												+6	−2					
13	+0·08													+6	+2	−2			
14	+0·80														+6				
15	+1·69	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+6	−2	+2	....
16	−0·97																+6	+2	−2
17	−0·20																	+6	
18	−0·61																		+6

Normal equations—completed.

		C_{19}	C_{20}	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}
1						− 3·28							
2						+ 2·34		+ 1·10					
3						+ 4·25							
4						− 5·92	− 0·37						
5		......	......	......	......	− 2·91	+ 6·39	+ 2·76	....	....	....	....	....
6						+ 5·25	− 10·25	− 7·76					
7						− 0·31	+ 6·54	+ 3·80					
8						− 1·04	+ 9·26	+ 5·52	+ 0·68	− 0·68			
9						+ 1·38		− 0·32	− 0·93				
10		......	......	......	......	....	....	+ 5·38	+ 6·95	+ 2·80	....	....	....
11							− 2·66	− 5·52	− 8·07	− 5·18			
12								− 2·18	− 1·90	− 3·06			
13		−2							+ 3·84	+ 6·82	+ 0·58	+ 2·65	
14									− 3·55	− 3·88			
15		+2	......	......	......	....	....	....	....	− 2·36	− 12·26	− 2·65	....
16											+ 10·82	− 5·44	
17											− 0·07	+ 2·73	
18		+2	−2								− 0·07	+ 13·07	+ 0·59
19	0=+0·09	+6								− 2·36	− 0·58	+ 6·72	
20	−0·33	......	+6	−2	+2	....	....	....	....	....	....	− 1·05	− 9·82
21	+0·14			+6	+2								+ 9·21
22	+0·11				+6								− 6·19
23	−4·3					+92·50	+ 3·54	− 9·10					
24	+3·8						+151·64	+135·11	− 1·46	+ 1·46			
25	+6·0	......	......	......	......	....	....	+234·99	−33·61	+ 3·04	....	....	....
26	−1·4								+76·75	+19·87			
27	+2·3									+45·94	− 2·08	+ 6·65	
28	+1·3										+296·91	+ 62·33	
29	+1·5											+163·90	+ 1·21
30	+5·6	......	......	......	......	....	....	....	....	....	....	....	+86·61

Resulting correlates.

$C_1 = -0.780$	$C_{11} = +0.284$	$C_{21} = +0.242$
$C_2 = -0.731$	$C_{12} = -0.249$	$C_{22} = -0.237$
$C_3 = +0.055$	$C_{13} = +0.108$	$C_{23} = +0.0218$
$C_4 = +0.193$	$C_{14} = -0.397$	$C_{24} = -0.0086$
$C_5 = -0.418$	$C_{15} = -0.390$	$C_{25} = +0.0183$
$C_6 = +0.409$	$C_{16} = +0.058$	$C_{26} = -0.0760$
$C_7 = -0.043$	$C_{17} = +0.155$	$C_{27} = -0.1070$
$C_8 = +0.345$	$C_{18} = +0.200$	$C_{28} = -0.0184$
$C_9 = -0.345$	$C_{19} = +0.067$	$C_{29} = -0.0237$
$C_{10} = -0.326$	$C_{20} = +0.123$	$C_{30} = -0.0944$

Resulting corrections to observed directions.

	''		''		''		''
(1)=	+0·668	(19)=	+0·298	(37)=	−0·344	(55)=	+0·213
(2)	+0·138	(20)	+0·116	(38)	−0·093	(56)	−0·088
(3)	−0·817	(21)	+0·354	(39)	+0·387	(57)	−0·115
(4)	+0·046	(22)	−0·767	(40)	−0·029	(58)	+0·034
(5)	−0·317	(23)	−0·104	(41)	+0·012	(59)	−0·036
(6)	−0·739	(24)	+0·926	(42)	−0·371	(60)	+0·327
(7)	−0·031	(25)	−0·132	(43)	+0·289	(61)	−0·121
(8)	+0·163	(26)	−0·195	(44)	+0·073	(62)	−0·312
(9)	+0·138	(27)	−0·243	(45)	+0·213	(63)	+0·215
(10)	+0·835	(28)	+0·034	(46)	−0·575	(64)	−0·110
(11)	−0·049	(29)	−0·286	(47)	−0·267	(65)	+0·095
(12)	−0·092	(30)	−0·311	(48)	+0·190	(66)	+0·111
(13)	−0·056	(31)	−0·080	(49)	+0·375	(67)	−0·005
(14)	+0·149	(32)	+0·039	(50)	−0·423	(68)	+0·119
(15)	−0·183	(33)	+0·550	(51)	+0·563	(69)	−0·114
(16)	−0·173	(34)	−0·037	(52)	−0·438	(70)	−0·300
(17)	+0·083	(35)	+0·113	(53)	+0·235	(71)	+0·413
(18)	+0·272	(36)	+0·163	(54)	−0·448	(72)	−0·113

Probable error of an observed direction $0·674\sqrt{\frac{7·77}{30}} = \pm 0''·34.$

Resulting angles and sides of the fourth section of the triangulation west of the Atlanta base net.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Wilder	41	08	09·01	−0·88	08·13	0·81	4·432 911 3	27 096·38
	Jamison	78	29	58·74	−0·82	57·92	0·80	4·605 982 4	40 362·91
	Weogufka	60	21	56·51	−0·14	56·37	0·81	4·553 909 0	35 802·14
2	Wetumpka	51	35	13·02	−1·12	11·90	1·03	4·605 982 4	40 362·91
	Wilder	92	27	07·09	−0·27	06·82	1·04	4·711 520 4	51 466·00
	Weogufka	35	57	44·91	−0·53	44·38	1·03	4·480 740 5	30 251·06
3	Perry	50	42	04·96	+0·04	05·00	1·05	4·553 909 0	35 802·14
	Jamison	79	31	33·43	+0·86	34·29	1·06	4·657 953 4	45 493·93
	Wilder	49	46	23·17	+0·70	23·87	1·05	4·548 055 3	35 322·81
4	Parker	102	37	25·30	+0·01	25·31	0·68	4·657 953 4	45 493·93
	Perry	46	09	10·29	+0·21	10·50	0·67	4·526 629 6	33 622·47
	Wilder	31	13	26·24	−0·03	26·21	0·67	4·383 230 1	24 167·41

Resulting angles and sides of the fourth section of the triangulation west of the Atlanta base net—continued.

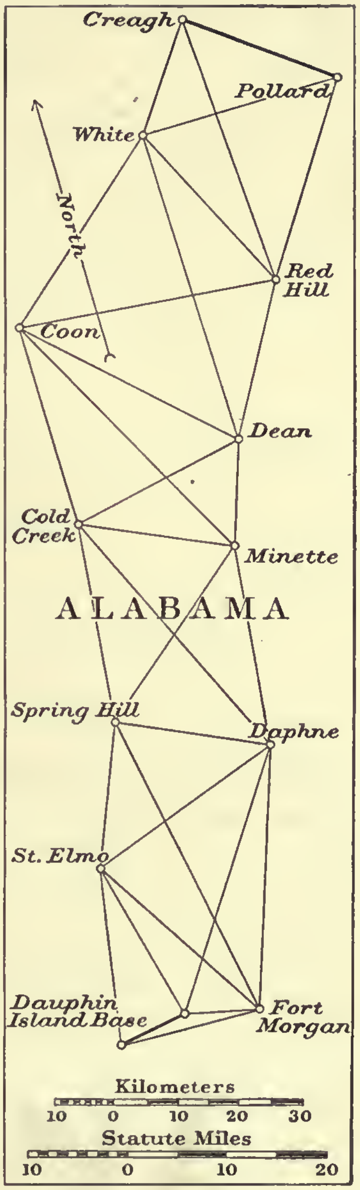
No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distance in meters.
5	Lowndesboro	37	58	60·84	−1·06	59·78	1·06	4·480 740 5	30 251·06
	Wilder	84	05	39·74	−0·42	39·32	1·07	4·689 252 3	48 893·63
	Wetumpka	57	55	23·85	+0·24	24·09	1·06	4·619 619 2	41 650·40
6	Lowndesboro	49	08	27·40	+1·03	28·43	1·04	4·526 629 6	33 622·47
	Parker	69	32	18·78	+0·26	19·04	1·04	4·619 619 5	41 650·43
	Wilder	61	19	14·75	+0·90	15·65	1·04	4·591 081 3	39 001·50
7	Lovers Leap	33	21	42·24	+0·23	42·47	1·22	4·526 629 6	33 622·47
	Parker	100	55	14·46	+0·45	14·91	1·23	4·778 394 1	60 033·57
	Wilder	45	43	06·10	+0·19	06·29	1·22	4·641 191 1	43 771·46
8	Lovers Leap	62	42	58·86	+0·35	59·21	0·75	4·591 081 3	39 001·50
	Parker	31	22	55·68	+0·19	55·87	0·75	4·358 925 0	22 852·04
	Lowndesboro	85	54	07·00	+0·18	07·18	0·76	4·641 191 2	43 771·47
9	Lowndesboro	135	02	34·40	+1·21	35·61	0·57	4·778 394 1	60 033·57
	Lovers Leap	29	21	16·62	+0·12	16·74	0·57	4·619 619 4	41 650·42
	Wilder	15	36	08·65	+0·71	09·36	0·57	4·358 924 9	22 852·04
10	Mount Carmel	56	00	21·53	−0·38	21·15	1·54	4·689 252 3	48 893·63
	Lowndesboro	84	50	32·62	−0·07	32·55	1·53	4·768 888 1	58 733·80
	Wetumpka	39	09	11·09	−0·18	10·91	1·54	4·570 946 7	37 234·60
11	Bargenier	81	05	47·48	−0·79	46·69	0·66	4·570 946 7	37 234·60
	Lowndesboro	42	20	03·34	−0·05	03·29	0·67	4·404 518 7	25 381·59
	Mount Carmel	56	34	12·39	−0·37	12·02	0·67	4·497 668 4	31 453·46
12	Lovers Leap	49	52	45·80	+0·51	46·31	0·70	4·570 946 7	37 234·60
	Lowndesboro	102	07	52·14	−0·09	52·05	0·71	4·677 654 1	47 605·17
	Mount Carmel	27	59	23·71	+0·04	23·75	0·70	4·358 924 8	22 852·03
13	Lovers Leap	75	30	10·39	−0·08	10·31	0·52	4·497 668 4	31 453·46
	Lowndesboro	59	47	48·80	−0·04	48·76	0·53	4·448 358 9	28 077·53
	Bargenier	44	42	02·37	+0·14	02·51	0·53	4·358 924 8	22 852·03
14	Bargenier	125	47	49·85	−0·65	49·20	0·49	4·677 654 1	47 605·17
	Lovers Leap	25	37	24·59	−0·58	24·01	0·49	4·404 518 6	25 381·58
	Mount Carmel	28	34	48·68	−0·42	48·26	0·49	4·448 358 9	28 077·53
15	County Line	86	03	01·72	−0·01	01·71	0·34	4·448 358 9	28 077·53
	Lovers Leap	39	57	45·16	+0·15	45·31	0·35	4·257 120 0	18 076·73
	Bargenier	53	59	14·24	−0·22	14·02	0·35	4·357 278 3	22 765·56
16	County Line	32	20	08·66	+0·99	09·65	0·40	4·358 924 9	22 852·04
	Lovers Leap	115	27	55·55	+0·07	55·62	0·39	4·586 280 5	38 572·75
	Lowndesboro	32	11	56·24	−0·32	55·92	0·40	4·357 278 4	22 765·56

Resulting angles and sides of the fourth section of the triangulation west of the Atlanta base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
	County Line	53	42	53·06	−1·00	52·06	0·48	4·497 668 4	31 453·46
17	Lowndesboro	27	35	52·56	+0·28	52·84	0·48	4·257 120 1	18 076·74
	Bargenier	98	41	16·61	−0·08	16·53	0·47	4·586 280 5	38 572·75
	Ethridge	51	57	27·06	−0·68	26·38	0·44	4·357 278 3	22 765·56
18	Lovers Leap	70	22	06·64	−0·21	06·43	0·45	4·434 991 6	27 226·49
	County Line	57	40	29·32	−0·80	28·52	0·44	4·387 868 6	24 426·92
	Fatama	27	00	40·43	+0·15	40·58	0·80	4·357 278 3	22 765·56
19	Lovers Leap	56	26	25·96	−0·46	25·50	0·80	4·620 873 4	41 770·86
	County Line	96	32	56·93	−0·61	56·32	0·80	4·697 224 2	49 799·41
	Fatama	39	42	39·34	+0·12	39·46	0·60	4·434 991 6	27 226·49
20	Ethridge	101	24	53·89	+0·66	54·55	0·61	4·620 873 3	41 770·85
	County Line	38	52	27·61	+0·19	27·80	0·60	4·427 241 8	26 744·95
	Ethridge	153	22	20·95	−0·02	20·93	0·24	4·697 224 2	49 799·41
21	Lovers Leap	13	55	40·68	+0·25	40·93	0·25	4·427 241 9	26 744·96
	Fatama	12	41	58·91	−0·03	58·88	0·25	4·387 868 7	24 426·92
	Midway	83	00	02·37	+0·22	02·59	0·80	4·620 873 3	41 770·85
22	Fatama	58	07	47·85	−0·07	47·78	0·79	4·553 155 5	35 740·08
	County Line	38	52	11·55	+0·46	12·01	0·79	4·421 772 2	26 410·23
	Midway	65	54	15·94	+0·21	16·15	1·11	4·697 224 2	49 799·41
23	Fatama	85	08	28·28	+0·08	28·36	1·11	4·735 254 5	54 356·87
	Lovers Leap	28	57	19·33	−0·51	18·82	1·11	4·421 772 4	26 410·25
	County Line	135	25	08·48	−0·16	08·32	0·49	4·735 254 5	54 356·87
24	Midway	17	05	46·43	+0·02	46·45	0·48	4·357 278 4	22 765·56
	Lovers Leap	27	29	06·63	+0·05	06·68	0·48	4·553 155 5	35 740·08
	Pollard	30	05	58·41	−0·23	58·18	1·08	4·421 772 3	26 410·24
25	Fatama	67	24	18·64	+0·36	19·00	1·08	4·686 818 9	48 620·44
	Midway	82	29	45·86	+0·20	46·06	1·08	4·717 767 0	52 211·60
	Creagh	25	09	58·42	+0·71	59·13	1·18	4·421 772 3	26 410·24
26	Fatama	96	02	10·39	−0·09	10·30	1·19	4·790 720 0	61 761·81
	Midway	58	47	54·44	−0·32	54·12	1·18	4·725 276 4	53 122·24
	Creagh	73	44	40·50	+0·19	40·69	1·13	4·717 767 0	52 211·60
27	Fatama	28	37	51·75	−0·45	51·30	1·13	4·415 967 1	26 059·56
	Pollard	77	37	31·27	+0·12	31·39	1·12	4·725 276 4	53 122·24
	Pollard	107	43	29·68	−0·11	29·57	1·03	4·790 720 0	61 761·81
28	Creagh	48	34	42·08	−0·53	41·55	1·02	4·686 818 9	48 620·44
	Midway	23	41	51·42	+0·53	51·95	1·02	4·415 967 1	26 059·56

11. THE FIFTH AND LAST SECTION OF THE TRIANGULATION WEST OF THE ATLANTA BASE NET AND JUNCTION WITH THE DAUPHIN ISLAND BASE, 1895–1898.

No. 32.



This section extends to the Gulf at Mobile Bay and effects the junction with the Dauphin Island base line. It is composed of ten stations exclusive of the base stations, and presents a series of quadrilaterals. The stations are of very moderate height. Their approximate heights above the Gulf level are as follows:

	Meters.	Feet.
White	120	393
Red Hill	95	311
Coon	81	265
Dean	86	284
Cold Creek	83	274
Minette	73	240
Spring Hill	64	210
Daphne	46	152
St. Elmo	40	132
Fort Morgan	8	27
Dauphin Island East Base	1	3
Dauphin Island West Base	1	3

The country being well timbered and cutting impracticable, it was necessary to elevate the theodolite on scaffolds ranging from $12^{m}{\cdot}4$ to $46^{m}{\cdot}5$ in height, with several 37^{m} high. All observing was done at night on signal lights.

The mean closing error derived from 28 triangles composing the figure equals $\sqrt{\frac{38{\cdot}23}{28}} = \pm 1''{\cdot}17$; the mean error of an angle is $\pm 0''{\cdot}68$, and the probable error of a direction, $0{\cdot}674 \frac{1{\cdot}17}{\sqrt{6}} = \pm 0''{\cdot}34$.

For the several sections these last values are very nearly equal notwithstanding the number of observers, of instruments, and methods, and other circumstances, such as elevation of instruments, day or night observations, etc. The values of the probable error of a direction for the second, third, fourth, and fifth sections average $\pm 0''{\cdot}34$, which indicates that the triangulation of Alabama is of a high degree of accuracy.

Abstracts of horizontal directions at stations composing the fifth and last section of the triangulation west of the Atlanta base net, 1895–1898.

Creagh, Clarke County, Alabama. August 9 to September 10, 1895. 30^{cm} direction theodolite No. 135. G. A. Fairfield, observer. Circle used in XVI positions. Telescope 12^{m}·4 above the ground.

Number of directions.	Objects observed.	Results from adjustment of fourth section.			Corrections of fifth section.	Final seconds.
		°	′	″	″	″
4	White	0	00	00·00	+0·16	00·16
	Pollard	270	04	54·92	.....	.....
3	Red Hill	320	37	14·96	+0·31	15·27

Pollard, Monroe County, Alabama. August 29 to September 13, 1895. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer. Telescope 46^{m}·5 above the ground.

		°	′	″	″	″
1	Red Hill	0	00	00·00	−0·40	$\overline{59·60}$
2	White	55	52	09·60	+0·17	09·77
	Creagh	93	01	16·78	.....	.....

White, Clarke County, Alabama. September 17 to 25, 1895. 30^{cm} direction theodolite No. 145. G. A. Fairfield, observer. Telescope 27^{m}·9 above the ground. Circle used in XII positions.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
5	Creagh	0	00	00·00	−0·38	$\overline{59·62}$
6	Pollard	52	55	48·49	+0·19	48·68
7	Red Hill	116	57	48·60	+0·12	48·72
8	Dean	141	23	19·31	+0·07	19·38
9	Coon	192	52	41·17	0·00	41·17

Probable error of a single observation of a direction (*D.* and *R.*), $e_1 = \pm 0''.59$.

Red Hill, Baldwin County, Alabama. July 21 to 24, 1895. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer. Telescope 36^{m}·8 above the ground.

		°	′	″	″	″
10	Dean	0	00	00·00	+0·17	00·17
11	Cold Creek	26	51	17·10	−0·31	16·79
12	Coon	67	01	49·80	−0·22	49·58
13	White	124	29	52·41	−0·13	52·28
14	Creagh	148	09	19·38	+0·31	19·69
15	Pollard	184	35	44·23	+0·18	44·41

Coon, Washington County, Alabama. August 7 to 20, 1895. 30^{cm} repeating theodolite No. 16. F. W. Perkins, observer. Telescope 31^{m}·0 above the ground.

		°	′	″	″	″
16	White	0	00	00·00	+0·18	00·18
17	Red Hill	46	37	07·81	0·00	07·81
18	Dean	82	26	17·11	−0·56	16·55
19	Minette	101	08	54·33	+0·16	54·49
20	Cold Creek	129	46	38·59	+0·23	38·82

Abstracts of horizontal directions at stations composing the fifth and last section of the triangulation west of the Atlanta base net, 1895-1898—continued.

Dean, Baldwin County, Alabama. July 28 to 31, 1895. 30cm repeating theodolite No. 16. F. W. Perkins, observer. Telescope 24m·9 above the ground.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
21	Minette	0	00	00·00	+0·15	00·15
22	Cold Creek	58	57	45·47	−0·14	45·33
23	Coon	112	24	09·45	+0·48	09·93
24	White	158	28	36·00	−0·65	35·35
25	Red Hill	189	33	14·05	+0·16	14·21

Cold Creek, Mobile County, Alabama. December 1 to 9, 1895. F. W. Perkins and G. A. Fairfield, observers. April 18 to May 1, 1897. W. B. Fairfield, observer. 30cm repeating theodolite No. 16. Telescope 31m above the ground.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
26	Coon	0	00	00·00	−0·24	59·76
27	Red Hill	56	39	59·33	+0·01	59·34
28	Dean	79	13	14·83	+0·42	15·25
29	Minette	113	48	34·16	−0·09	34·07
30	Daphne	156	54	45·74	−0·10	45·64
	Mobile, Court-House tower	172	09	04·4	....	.....
31	Spring Hill	191	47	54·07	0·00	54·07

Minette, Baldwin County, Alabama. April 9 to 15, 1897. 30cm repeating theodolite No. 16. W. B. Fairfield, observer. Telescope 37m above the ground.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
32	Daphne	0	00	00·00	−0·37	59·63
	Mobile, Court-House tower	32	20	20·40	....	.....
	Mobile, transit pier (public square)	33	02	05·48	....	.....
33	Spring Hill	45	32	20·09	+0·45	20·54
34	Cold Creek	101	58	51·79	−0·02	51·77
35	Coon	139	32	34·86	+0·15	35·01
36	Dean	188	25	49·05	−0·22	48·83

Spring Hill, Mobile County, Alabama. April 4 to June 3, 1897. 30cm repeating theodolite No. 16. W. B. Fairfield, observer. Telescope 37m above the ground.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
37	Cold Creek	0	00	00·00	+0·03	00·03
38	Minette	45	34	11·13	−0·49	10·64
	Mobile, transit pier	82	03	43·44	....	.....
	Mobile, Court-House tower	83	20	20·54	....	.....
39	Daphne	103	31	00·32	−0·22	00·10
	Middle Bay Light-House	145	00	31·92	....	.....
40	Fort Morgan	156	27	50·23	+0·28	50·51
41	St. Elmo	187	37	06·49	+0·40	06·89

Abstracts of horizontal directions at stations composing the fifth and last section of the triangulation west of the Atlanta base net, 1895–1898—continued.

Daphne, Baldwin County, Alabama. May 4 to 15, 1897, and March 18 to 19, 1898. 30 cm repeating theodolite No. 16. W. B. Fairfield, observer. Telescope 36·9 meters above the ground.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
42	Fort Morgan	0	00	00·00	+0·39	00·39
	Sand Island Light-House	1	36	05·71	....	.....
	Middle Bay Light-House	13	51	14·53	....	.....
43	Dauphin Island East Base	14	23	22·41	−1·11	21·30
44	St. Elmo	55	47	34·33	−0·03	34·30
45	Spring Hill	98	54	47·03	+0·32	47·35
	Mobile, Court-House tower	111	23	46·96	....	.....
	Mobile, transit pier	111	34	43·93	....	.....
46	Cold Creek	140	30	40·66	+0·04	40·70
47	Minette	175	25	38·47	+0·40	38·87

St. Elmo, Mobile County, Alabama. June 5 to 7, 1897, and January 31 to February 18, 1898. 30 cm repeating theodolite No. 16 in 1897 and 30 cm repeating theodolite No. 32 in 1898. W. B. Fairfield, observer. Telescope 37·1 meters above the ground.

Number of directions.	Objects observed.	°	′	″	″	″
48	Spring Hill	0	00	00·00	−0·30	$\overline{59}$·70
49	Daphne	52	46	41·22	+0·04	41·26
	Middle Bay Light-House	93	42	19·17	....	.....
50	Fort Morgan	130	45	49·03	+0·22	49·25
	Sand Island Light-House	137	29	48·87	....	.....
51	Dauphin Island East Base	146	48	03·63	0·00	03·63
52	Dauphin Island West Base	167	16	23·72	+0·05	23·77
	Point aux Pins 1898	192	38	47·34	....	.....

Fort Morgan, Baldwin County, Alabama. June 14 to 20, 1897, and January 20 to 24, 1898. 30 cm repeating theodolites Nos. 16 and 32. W. B. Fairfield, observer. Telescope 14·2 meters above the ground.

Number of directions.	Objects observed.	°	′	″	″	″
53	Dauphin Island West Base	0	00	00·00	+0·45	00·45
54	Dauphin Island East Base	8	30	12·65	+0·23	12·88
	Baylor's West Base 1892	10	02	56·90	....	.....
	Point aux Pins 1898	27	38	10·50	....	.....
55	St. Elmo	55	51	43·92	−0·23	43·69
56	Spring Hill	73	56	39·86	−0·58	39·28
	Middle Bay Light-House	89	35	36·84	....	.....
57	Daphne	102	05	04·52	+0·14	04·66
	Sand Island Light-House	296	55	25·96	....	.....

Abstracts of horizontal directions at stations composing the fifth and last section of the triangulation west of the Atlanta base net, 1895–1898—continued.

Dauphin Island East Base, Mobile County, Alabama. August 2 to 30, 1897. 30^{cm} repeating theodolites Nos. 16 and 32. W. B. Fairfield, observer. Telescope 23·4 meters above the ground up to August 27, after which only 14·2 meters.

Number of directions.	Objects observed.	Results from station adjustment.			Corrections from adjustment of fifth section.	Final seconds.
		°	′	″	″	″
58	Dauphin Island West Base	0	00	00·00	+0·23	00·23
	Point aux Pins 1898	46	19	52·90	....	.....
59	St. Elmo	80	51	20·71	−0·08	20·63
60	Daphne	125	25	47·09	+0·56	47·65
61	Fort Morgan	197	27	36·91	−0·71	36·20
	Sand Island Light-House	224	55	51·14	....	.....

Dauphin Island West Base, Mobile County, Alabama. September 1 to 6, 1897, and February 23 to 27, 1898. 30^{cm} repeating theodolite No. 32. W. B. Fairfield, observer. Telescope 23·4 meters above the ground.

		°	′	″	″	″
	Casotte 1898	0	00	00·00	....	.....
	Point aux Pins 1898	46	29	59·46	....	.....
62	St. Elmo	73	18	25·29	+0·17	25·46
63	Dauphin Island East Base	151	58	46·46	−0·74	45·72
	Baylor's West Base 1892	156	02	30·71	....	.....
64	Fort Morgan	160	56	08·79	+0·56	09·35
	Sand Island Light-House	174	34	48·52	....	.....
	Horn Island Light-House	333	31	03·21	....	.....

Observation equations.

I	$0=-0·56-(2)+(4)-(5)+(6)$
II	$0=-0·57-(1)+(3)-(14)+(15)$
III	$0=-0·80-(1)+(2)-(6)+(7)-(13)+(15)$
IV	$0=+0·21-(7)+(9)-(12)+(13)-(16)+(17)$
V	$0=+1·27-(10)+(12)-(17)+(18)-(23)+(25)$
VI	$0=+1·94-(8)+(9)-(16)+(18)-(23)+(24)$
VII	$0=-2·07-(18)+(20)-(22)+(23)-(26)+(28)$
VIII	$0=-0·57-(11)+(12)-(17)+(20)-(26)+(27)$
IX	$0=+0·99-(21)+(22)-(28)+(29)-(34)+(36)$
X	$0=-0·40-(19)+(20)-(26)+(29)-(34)+(35)$
XI	$0=+0·89-(29)+(31)-(33)+(34)-(37)+(38)$
XII	$0=-0·71-(29)+(30)-(32)+(34)-(46)+(47)$
XIII	$0=-1·17-(32)+(33)-(38)+(39)-(45)+(47)$
XIV	$0=-1·31-(39)+(41)-(44)+(45)-(48)+(49)$
XV	$0=-1·14-(39)+(40)-(42)+(45)-(56)+(57)$
XVI	$0=-0·13-(42)+(44)-(49)+(50)-(55)+(57)$
XVII	$0=+0·46-(50)+(52)-(53)+(55)-(62)+(64)$
XVIII	$0=-2·02-(53)+(54)+(58)-(61)-(63)+(64)$
XIX	$0=-1·69-(43)+(44)-(49)+(51)-(59)+(60)$

Observation equations—continued.

XX $0=+2{\cdot}87-(42)+(43)-(54)+(57)-(60)+(61)$

XXI $0=-3{\cdot}4-1{\cdot}43(1)+4{\cdot}21(2)+2{\cdot}57(3)-2{\cdot}57(4)-3{\cdot}59(13)+4{\cdot}80(14)-1{\cdot}21(15)$

XXII $0=-1{\cdot}9+4{\cdot}11(7)-4{\cdot}63(8)+0{\cdot}52(9)+1{\cdot}99(16)-4{\cdot}90(17)+2{\cdot}91(18)+0{\cdot}48(23)-3{\cdot}49(24)$
$+3{\cdot}01(25)$

XXIII $0=-6{\cdot}6+3{\cdot}26(10)-4{\cdot}15(11)+0{\cdot}89(12)+2{\cdot}91(17)-4{\cdot}85(18)+1{\cdot}94(20)+0{\cdot}40(26)-5{\cdot}07(27)$
$+4{\cdot}67(28)$

XXIV $0=+5{\cdot}4+4{\cdot}28(18)-6{\cdot}22(19)+1{\cdot}94(20)+0{\cdot}40(26)-3{\cdot}45(28)+3{\cdot}05(29)+0{\cdot}14(34)-1{\cdot}84(35)$
$+1{\cdot}70(36)$

XXV $0=-1{\cdot}4-0{\cdot}45(29)+3{\cdot}02(30)-2{\cdot}57(31)-2{\cdot}07(32)+3{\cdot}47(33)-1{\cdot}40(34)-1{\cdot}87(45)+2{\cdot}37(46)$
$-0{\cdot}50(47)$

XXVI $0=-4{\cdot}7+0{\cdot}22(39)-3{\cdot}49(40)+3{\cdot}27(41)+1{\cdot}43(42)-3{\cdot}68(44)+2{\cdot}25(45)+4{\cdot}43(55)-6{\cdot}45(56)$
$+2{\cdot}02(57)$

XXVII $0=+14{\cdot}2-8{\cdot}20(42)+10{\cdot}59(43)-2{\cdot}39(44)+0{\cdot}15(49)+7{\cdot}33(50)-7{\cdot}48(51)-2{\cdot}07(54)$
$+1{\cdot}94(55)+0{\cdot}13(57)$

XXVIII $0=-21{\cdot}8+7{\cdot}33(50)-12{\cdot}97(51)+5{\cdot}64(52)+14{\cdot}09(53)-16{\cdot}03(54)+1{\cdot}94(55)+0{\cdot}42(62)$
$-13{\cdot}78(63)+13{\cdot}36(64)$

Normal equations.

No.		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}
1	0=−0·56	+4		−2															
2	−0·57		+4	+2															
3	−0·80			+6	−2														
4	+0·21				+6	−2	+2		−2										
5	+1·27	...	...	...	...	+6	+2	−2	+2	...	...	...	...	...	...	...	...	...	...
6	+1·94						+6	−2											
7	−2·07							+6	+2	−2	+2								
8	−0·57								+6		+2								
9	+0·99									+6	+2	−2	−2						
10	−0·40	...	...	...	...	...	...	...	...	...	+6	−2	−2	...	...	...	...	...	...
11	+0·89											+6	+2	−2					
12	−0·71												+6	+2					
13	−1·17													+6	−2	−2			
14	−1·31														+6	+2	−2		
15	−1·14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+6	+2		
16	−0·13																+6	−2	
17	+0·46																	+6	+2
18	−2·02																		+6

Normal equations—completed.

No.		C19	C20	C21	C22	C23	C24	C25	C26	C27	C28
1				− 6·78							
2				− 2·01							
3				+ 8·02	+ 4·11						
4				− 3·59	−10·48	+ 2·02					
5		....	....	....	+10·34	−10·13	+ 4·28	....	....	....	....
6					+ 2·10	− 4·85	+ 4·28				
7					− 2·43	+11·06	− 6·19				
8					+ 4·90	− 1·40	+ 1·54				
9						− 4·67	+ 8·06	+ 0·95			
10		....	....	....	....	+ 1·54	+ 8·83	+ 0·95	....	....	....
11							− 2·91	− 6·99			
12							− 2·91	+ 1·27			
13								+ 6·91	− 2·03		
14		−2						− 1·87	+ 8·98	+ 2·54	
15		....	+2	....	.....	.....	.....	− 1·87	+ 5·58	+ 8·33	....
16		+2	+2						− 7·52	+ 11·18	+ 5·39
17									+ 4·43	− 5·39	− 0·90
18			−2							− 2·07	− 2·98
19	0 = − 1·69	+6	−2						− 3·68	− 20·61	− 12·97
20	+ 2·87	....	+6	.....	.....	......	.....	.....	+ 0·59	+ 20·99	+ 16·03
21	− 3·4			+70·37							
22	− 1·9				+96·51	− 28·37	+12·45				
23	− 6·6					+112·07	−32·95				
24	+ 5·4						+88·43	− 1·57			
25	− 1·4	....	....	.....	.....			+43·58	− 4·21	......	......
26	− 4·7								+108·88	+ 5·93	+ 8·59
27	+14·2									+302·87	+ 187·69
28	−21·8										+1081·57

Resulting correlates.

$C_1 = +0{\cdot}377$	$C_{10} = +0{\cdot}084$	$C_{19} = +0{\cdot}082$
$C_2 = +0{\cdot}091$	$C_{11} = -0{\cdot}028$	$C_{20} = -0{\cdot}479$
$C_3 = +0{\cdot}188$	$C_{12} = -0{\cdot}063$	$C_{21} = +0{\cdot}843$
$C_4 = +0{\cdot}363$	$C_{13} = +0{\cdot}458$	$C_{22} = +0{\cdot}0718$
$C_5 = -0{\cdot}060$	$C_{14} = +0{\cdot}302$	$C_{23} = +0{\cdot}0325$
$C_6 = -0{\cdot}400$	$C_{15} = +0{\cdot}383$	$C_{24} = -0{\cdot}0387$
$C_7 = -0{\cdot}014$	$C_{16} = +0{\cdot}177$	$C_{25} = -0{\cdot}0107$
$C_8 = +0{\cdot}171$	$C_{17} = -0{\cdot}159$	$C_{26} = +0{\cdot}0307$
$C_9 = -0{\cdot}149$	$C_{18} = +0{\cdot}230$	$C_{27} = -0{\cdot}0563$
		$C_{28} = +0{\cdot}0367$

Corrections.

″	″	″	″
(1) = −0·400	(17) = −0·005	(33) = +0·449	(49) = +0·035
(2) +0·166	(18) −0·560	(34) −0·016	(50) +0·222
(3) +0·308	(19) +0·157	(35) +0·155	(51) −0·003
(4) +0·160	(20) +0·229	(36) −0·215	(52) +0·048
(5) −0·377	(21) +0·149	(37) +0·028	(53) +0·446
(6) +0·189	(22) −0·135	(38) −0·486	(54) +0·229
(7) +0·120	(23) +0·480	(39) −0·220	(55) −0·230
(8) +0·068	(24) −0·651	(40) +0·276	(56) −0·581
(9) 0·000	(25) +0·156	(41) +0·402	(57) +0·136
(10) +0·166	(26) −0·243	(42) +0·392	(58) +0·230
(11) −0·306	(27) +0·006	(43) −1·115	(59) −0·082
(12) −0·223	(28) +0·420	(44) −0·031	(60) +0·561
(13) −0·128	(29) −0·087	(45) +0·316	(61) −0·709
(14) +0·314	(30) −0·095	(46) +0·038	(62) +0·174
(15) +0·177	(31) −0·001	(47) +0·400	(63) −0·736
(16) +0·180	(32) −0·373	(48) −0·302	(64) +0·561

Probable error of an observed direction $0·674\sqrt{\frac{7·38}{28}} = \pm 0''·35$.

Resulting angles and sides of the fifth and last section of the triangulation west of the Atlanta base net.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	White	52	55	48·49	+0·57	49·06	0·44	4·415 967 1	26 059·56
	Creagh	89	55	05·08	+0·16	05·24	0·43	4·514 017 4	32 660·09
	Pollard	37	09	07·18	−0·17	07·01	0·44	4·295 003 8	19 724·40
2	Red Hill	36	26	24·85	−0·14	24·71	0·75	4·415 967 1	26 059·56
	Creagh	50	32	20·04	+0·31	20·35	0·75	4·529 843 1	33 872·18
	Pollard	93	01	16·78	+0·40	07·18	0·74	4·641 590 9	43 811·78
3	Red Hill	60	05	51·82	+0·30	52·12	0·78	4·514 017 4	32 660·09
	White	64	01	60·11	−0·07	60·04	0·77	4·529 843 1	33 872·18
	Pollard	55	52	09·60	+0·57	10·17	0·78	4·493 964 7	31 186·36
4	White	116	57	48·60	+0·49	49·09	0·47	4·641 590 9	43 811·78
	Creagh	39	22	45·04	−0·15	44·89	0·46	4·493 964 8	31 186·37
	Red Hill	23	39	26·97	+0·44	27·41	0·46	4·295 004 0	19 724·41
5	Coon	46	37	07·81	−0·18	07·63	0·93	4·493 964 7	31 186·36
	White	75	54	52·57	−0·12	52·45	0·92	4·619 293 4	41 619·17
	Red Hill	57	28	02·61	+0·09	02·70	0·93	4·558 422 2	36 176·14
6	Dean	31	04	38·05	+0·81	38·86	0·54	4·493 964 7	31 186·36
	White	24	25	30·71	−0·05	30·66	0·54	4·397 629 6	24 982·14
	Red Hill	124	29	52·41	−0·30	52·11	0·55	4·697 157 5	49 791·76
7	Dean	77	09	04·60	−0·32	04·28	0·81	4·619 293 4	41 619·17
	Coon	35	49	09·30	−0·56	08·74	0·81	4·397 629 5	24 982·13
	Red Hill	67	01	49·80	−0·39	49·41	0·81	4·594 429 9	39 303·38

Resulting angles and sides of the fifth and last section of the triangulation west of the Atlanta base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
8	Coon	82	26	17 ·11	−0 ·74	16 ·37	1 ·20	4 ·697 157 5	49 791 ·76
	White	51	29	21 ·86	−0 ·07	21 ·79	1 ·19	4 ·594 430 0	39 303 ·39
	Dean	46	04	26 ·55	−1 ·13	25 ·42	1 ·19	4 ·558 422 3	36 176 ·15
9	Cold Creek	79	13	14 ·83	+0 ·66	15 ·49	0 ·78	4 ·594 429 9	39 303 ·38
	Coon	47	20	21 ·48	+0 ·79	22 ·27	0 ·79	4 ·468 673 0	29 422 ·05
	Dean	53	26	23 ·98	+0 ·62	24 ·60	0 ·79	4 ·507 002 9	32 136 ·82
10	Cold Creek	56	39	59 ·33	+0 ·25	59 ·58	1 ·13	4 ·619 293 4	41 619 ·17
	Coon	83	09	30 ·78	+0 ·24	31 ·02	1 ·12	4 ·694 251 8	49 459 ·74
	Red Hill	40	10	32 ·70	+0 ·08	32 ·78	1 ·13	4 ·507 002 9	32 136 ·82
11	Dean	130	35	28 ·58	+0 ·29	28 ·87	0 ·48	4 ·694 251 8	49 459 ·74
	Cold Creek	22	33	15 ·50	+0 ·42	15 ·92	0 ·47	4 ·397 629 6	24 982 ·14
	Red Hill	26	51	17 ·10	−0 ·47	16 ·63	0 ·47	4 ·468 673 1	29 422 ·06
12	Minette	86	26	57 ·26	−0 ·20	57 ·06	0 ·35	4 ·468 673 0	29 422 ·05
	Cold Creek	34	35	19 ·33	−0 ·51	18 ·82	0 ·36	4 ·223 609 6	16 734 ·38
	Dean	58	57	45 ·47	−0 ·28	45 ·19	0 ·36	4 ·402 402 0	25 258 ·17
13	Minette	48	53	14 ·19	−0 ·37	13 ·82	0 ·52	4 ·594 429 9	39 303 ·38
	Coon	18	42	37 ·22	+0 ·72	37 ·94	0 ·52	4 ·223 609 8	16 734 ·39
	Dean	112	24	09 ·45	+0 ·34	09 ·79	0 ·51	4 ·683 316 4	48 229 ·90
14	Cold Creek	113	48	34 ·16	+0 ·16	34 ·32	0 ·63	4 ·683 316 4	48 229 ·90
	Coon	28	37	44 ·26	+0 ·07	44 ·33	0 ·63	4 ·402 402 0	25 258 ·17
	Minette	37	33	43 ·07	+0 ·17	43 ·24	0 ·63	4 ·507 003 0	32 136 ·83
15	Spring Hill	45	34	11 ·13	−0 ·51	10 ·62	0 ·62	4 ·402 402 0	25 258 ·17
	Cold Creek	77	59	19 ·91	+0 ·09	20 ·00	0 ·61	4 ·539 029 5	34 596 ·29
	Minette	56	26	31 ·70	−0 ·47	31 ·23	0 ·62	4 ·469 457 8	29 475 ·27
16	Daphne	34	54	57 ·81	+0 ·36	58 ·17	0 ·63	4 ·402 402 0	25 258 ·17
	Cold Creek	43	06	11 ·58	−0 ·01	11 ·57	0 ·63	4 ·479 341 0	30 153 ·73
	Minette	101	58	51 ·79	+0 ·36	52 ·15	0 ·63	4 ·635 156 6	43 167 ·47
17	Daphne	76	30	51 ·44	+0 ·08	51 ·52	0 ·63	4 ·539 029 5	34 596 ·29
	Spring Hill	57	56	49 ·19	+0 ·27	49 ·46	0 ·63	4 ·479 341 0	30 153 ·73
	Minette	45	32	20 ·09	+0 ·82	20 ·91	0 ·63	4 ·404 704 4	25 392 ·44
18	Spring Hill	103	31	00 ·32	−0 ·25	00 ·07	0 ·61	4 ·635 156 6	43 167 ·47
	Cold Creek	34	53	08 ·33	+0 ·10	08 ·43	0 ·62	4 ·404 704 3	25 392 ·43
	Daphne	41	35	53 ·63	−0 ·28	53 ·35	0 ·62	4 ·469 457 7	29 475 ·27
19	St. Elmo	52	46	41 ·22	+0 ·34	41 ·56	0 ·47	4 ·404 704 4	25 392 ·44
	Spring Hill	84	06	06 ·17	+0 ·62	06 ·79	0 ·46	4 ·501 323 3	31 719 ·28
	Daphne	43	07	12 ·70	+0 ·35	13 ·05	0 ·47	4 ·338 386 5	21 796 ·49
20	Fort Morgan	28	08	24 ·66	+0 ·72	25 ·38	0 ·91	4 ·404 704 4	25 392 ·44
	Spring Hill	52	56	49 ·91	+0 ·50	50 ·41	0 ·91	4 ·633 149 4	42 968 ·43
	Daphne	98	54	47 ·03	−0 ·08	46 ·95	0 ·92	4 ·725 827 4	53 189 ·68

Resulting angles and sides of the fifth and last sections of the triangulation west of the Atlanta base net—continued.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
21	Fort Morgan	46	13	20·60	+0·36	20·96	0·96	4·501 323 3	31 719·28
	St. Elmo	77	59	07·81	+0·19	08·00	0·95	4·633 149 6	42 968·45
	Daphne	55	47	34·33	−0·42	33·91	0·96	4·560 278 0	36 331·05
22	Fort Morgan	18	04	55·94	−0·35	55·59	0·51	4·338 386 4	21 796·48
	St. Elmo	130	45	49·03	+0·52	49·55	0·51	4·725 827 4	53 189·68
	Spring Hill	31	09	16·26	+0·13	16·39	0·51	4·560 277 8	36 331·03
23	Dauphin Island East Base	116	36	16·20	−0·63	15·57	0·26	4·560 277 9	36 331·04
	St. Elmo	16	02	14·60	−0·22	14·38	0·25	4·050 203 4	11 225·44
	Fort Morgan	47	21	31·27	−0·46	30·81	0·25	4·475 527 2	29 890·09
24	Dauphin Island West Base	87	37	43·50	+0·39	43·89	0·55	4·560 277 9	36 331·04
	St. Elmo	36	30	34·69	−0·17	34·52	0·55	4·335 134 2	21 633·87
	Fort Morgan	55	51	43·92	−0·68	43·24	0·55	4·478 516 1	30 096·51
25	Dauphin Island West Base	78	40	21·17	−0·91	20·26	0·27	4·475 527 2	29 890·09
	St. Elmo	20	28	20·09	+0·05	20·14	0·27	4·027 831 9	10 661·83
	Dauphin Island East Base	80	51	20·71	−0·31	20·40	0·26	4·478 516 0	30 096·50
26	Dauphin Island East Base	162	32	23·09	+0·94	24·03	0·03	4·335 134 2	21 633·87
	Fort Morgan	8	30	12·65	−0·22	12·43	0·03	4·027 831 9	10 661·83
	Dauphin Island West Base	8	57	22·33	+1·30	23·63	0·03	4·050 203 5	11 225·44
27	Dauphin Island East Base	44	34	26·38	+0·64	27·02	0·80	4·501 323 3	31 719·28
	St. Elmo	94	01	22·41	−0·04	22·37	0·80	4·654 020 6	45 083·81
	Daphne	41	24	11·92	+1·09	13·01	0·80	4·475 527 4	29 890·10
28	Dauphin Island East Base	72	01	49·82	−1·27	48·55	0·41	4·633 149 5	42 968·44
	Daphne	14	23	22·41	−1·51	20·90	0·41	4·050 203 3	11 225·44
	Fort Morgan	93	34	51·87	−0·09	51·78	0·41	4·654 020 6	45 083·81

Remarks on the accord of the Atlanta and Dauphin Island bases.—The distance between the middle points of these bases, when measured through the middle line of the triangulation connecting them, is 677 kilometers or 421 statute miles.* The total number of geometrical conditions demanded by this triangulation in order to remove its inconsistencies is 142, to which number one more condition would have to be added to bring out the length of the second base as measured. The simultaneous solution of so large a number of equations being impracticable, the actual adjustment was made in parts. When the Dauphin Island base was reached a very small difference † was found in the computed length, as derived from the Atlanta base, and the measured length, a matter of accident, but a very satisfactory one, since no further labor was needed to bring about a closer accord.

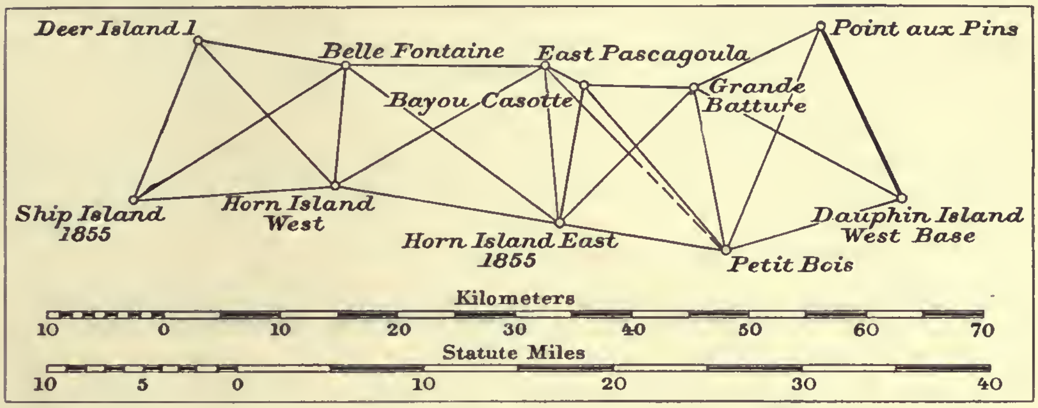
* It is made up of the several parts as follows: In base net, 42 kilometers; first section, 98 kilometers; second section, 88 kilometers; third section, 80 kilometers; fourth section, 209 kilometers; and fifth section, 160 kilometers.

† One and a half units in the seventh place of decimals in the logarithm.

12. THE FIRST SECTION OF THE TRIANGULATION WEST OF THE DAUPHIN ISLAND BASE NET, ALABAMA AND MISSISSIPPI, 1846–1855.

Proceeding from the base net westward, the triangulation is contracted in dimensions and possesses an inferior degree of accuracy as compared with the triangulation north of the base. This change is primarily due to unfavorable atmospheric conditions and to the difficulty of preserving the stations for a few years in a low country, subject to storms and severe hurricanes, which cause alterations in the shore line, overflow of

No. 33.



the ground, and destruction of the stations. When the localities were revisited in another year several of the stations could not be recovered, and new stations had to be established in their places. The width of the triangulation was limited by the width of Mississippi Sound, along which it extends. The observers were Assistants F. H. Gerdes and J. E. Hilgard. In 1854–55 a Gambey repeating theodolite was used, and for these measures the resulting seconds are given to the nearest tenth. The section extends from the Dauphin Island base net to the line Deer Island 1 to Ship Island 1855, a distance of about 56 kilometers or 35 statute miles. The connected series of quadrilaterals terminates here.

Abstracts of horizontal directions at stations of the first section of the triangulation west of Dauphin Island base net.

Point aux Pins, Mobile County, Alabama. May and June, 1848. F. H. Gerdes, observer.

Number of directions.	Objects observed.	Results of station adjustment.			Corrections from first section.	Resulting seconds.	Corrections from base net.	Final seconds.
		°	′	″	″	″	″	″
	Cedar Point	0	00	00·00	....	.....	+0·32	00·32
	Cat Island	22	36	33·45	....	.....	−0·29	33·16
	Dauphin Island West Base	58	14	08·33	....	.....	−0·03	08·30
3	Petit Bois	105	51	21·51	−0·05	21·46	....	.....
4	Grande Batture	147	05	47·69	−0·03	47·66	....	.....

Abstracts of horizontal directions at stations of the first section of the triangulation west of Dauphin Island base net—continued.

Dauphin Island West Base, Mobile County, Alabama. November, 1847 and January, 1848. F. H. Gerdes, observer.

Number of directions.	Objects observed.	Results of station adjustment. °	′	″	Corrections from first section. ″	Resulting seconds. ″	Corrections from base net. ″	Final seconds. ″
1	Petit Bois	0	00	00·00	−0·17	59·83	....	.....
2	Grande Batture	45	15	13·69	+0·36	14·05	....	......
	Point aux Pins	81	33	33·52	.....	.....	+0·14	33·66

Petit Bois, Jackson County, Mississippi. June, 1846. F. H. Gerdes, observer. Theodolite No. 6 used in III positions.

Number of directions.	Objects observed.	°	′	″	″	Final seconds. ″
5	Horn Island East 1855 *	0	00	00·00	−0·41	59·59
6	Bayou Casotte	42	36	12·87	+0·70	13·57
7	Grande Batture	71	28	26·37	−0·64	25·73
8	Point aux Pins	104	36	32·24	+0·26	32·50
9	Dauphin Island West Base	155	25	46·00	+0·09	46·09

Grande Batture, Jackson County, Mississippi. July, 1846. F. H. Gerdes, observer. 45cm theodolite No. 4. September and October, 1847. J. E. Hilgard, observer. Theodolite No. 6 used in V positions.

Number of directions.	Objects observed.	°	′	″	″	Final seconds. ″
10	Point aux Pins	0	00	00·00	−0·06	59·94
11	Dauphin Island West Base	54	50	01·60	−0·18	01·42
12	Petit Bois	105	37	27·05	+0·30	27·35
13	Horn Island East 1855 *	158	42	11·77	−0·39	11·38
14	Bayou Casotte	209	13	36·14	+0·32	36·46

Horn Island East 1855, Jackson County, Mississippi. February and March, 1847. F. H. Gerdes and J. E. Hilgard, observers. 45cm direction theodolite No. 4. (V to X positions.) December, 1854, to April, 1855. J. E. Hilgard, observer. Repeating theodolite.

Number of directions.	Objects observed.		°	′	″	″	Final seconds. ″
21	East Pascagoula	1847	0	00	00·00	+0·03	00·03
22	Bayou Casotte	1847	14	10	58·73	+0·12	58·85
23	Grande Batture	1847	48	41	07·72	+0·72	08·44
24	Petit Bois	1847	104	07	58·38	+0·33	58·71
19	Horn Island West	1854–5	287	05	56·0	−1·02	54·98
20	Belle Fontaine	1854–5	313	55	53·0	−0·19	52·81

Bayou Casotte, Jackson County, Mississippi. July and August, 1847. F. H. Gerdes, observer. Theodolite No. 4. (V positions.) September, 1847. J. E. Hilgard, observer. Theodolite No. 6.

Number of directions.	Objects observed.	°	′	″	″	Final seconds. ″
15	Grande Batture	0	00	00·00	−0·48	59·52
16	Petit Bois	47	31	37·80	+0·75	38·55
17	Horn Island East 1855 *	94	58	25·76	−0·64	26·12
	Horn Island West	153	29	14·20	....	.....
	Belle Fontaine	180	49	13·30	....	.....
18	East Pascagoula	202	51	05·38	+0·37	05·75

* The observations of 1847 were reduced to the position of 1855.

Abstracts of horizontal directions at stations of the first section of the triangulation west of Dauphin Island base net—continued.

East Pascagouta, Jackson County, Mississippi. August, 1847. F. H. Gerdes, observer. Theodolite No. 4. (V positions.) April, 1854, and January, 1855. J. E. Hilgard, observer. Repeating theodolite. Elevation of ground, 16 feet; of tripod, 14 feet.

Number of directions.	Objects observed.	Results of station adjustment. °	′	″	Corrections from first section. ″	Final seconds. ″
25	Bayou Casotte	0	00	00·00	—0·21	59·79
26	Petit Bois	20	42	28·49	—1·31	27·18
27	Horn Island East 1855 *	57	56	20·18	+0·26	20·44
	Azimuth Mark	96	22	50·60	....	.....
28	Horn Island West	122	43	25·0	+0·65	25·65
29	Belle Fontaine	153	09	16·2	+0·61	16·81

Horn Island West, Jackson County, Mississippi. August to November, 1848. F. H. Gerdes, observer. Repeating theodolite. March, 1854, May and November, 1855. J. E. Hilgard, observer. Repeating theodolite.

		°	′	″	″	″
30	Ship Island 1855	0	00	00·0	0·0	00·0
31	Deer Island 1	54	48	36·8	—0·7	36·1
	Monk Point	78	59	18·8	...	....
32	Belle Fontaine	100	06	34·9	+0·3	35·2
33	East Pascagoula	153	53	60·2	—0·5	59·7
34	Horn Island East 1855	196	12	49·2	+0·9	50·1

Belle Fontaine, Jackson County, Mississippi. April, October, and November, 1855. J. E. Hilgard, observer. Repeating theodolite.

		°	′	″	″	″
35	East Pascagoula	0	00	00·0	—0·7	59·3
36	Horn Island East 1855	38	42	55·8	+0·4	56·2
37	Horn Island West	95	46	44·0	0·0	44·0
38	Ship Island 1855	147	26	07·2	0·0	07·2
39	Deer Island 1	191	39	39·1	+0·4	39·5

Ship Island 1855, Harrison County, Mississippi. June and July, 1848. F. H. Gerdes. Repeating theodolite. November, 1855. J. E. Hilgard, observer. Repeating theodolite.

		°	′	″	″	″
	Cat Island	0	00	00·0	...	.....
	Mississippi City	49	20	56·9	...	.....
	Biloxi Light	87	13	41·8	...	.....
40	Deer Island 1	116	14	11·7	+0·5	12·2
41	Belle Fontaine	148	10	50·2	—1·0	49·2
42	Horn Island West	176	24	50·7	+0·5	51·2
	Chandeleur Light 1855	268	06	00·8	...	.....

* Observations of 1847 referred to the position of 1855.

Abstracts of horizontal directions at stations of the first section of the triangulation west of Dauphin Island base net—continued.

Deer Island 1, Jackson County, Mississippi. October, November, and December, 1855. J. E. Hilgard, observer. Repeating theodolite.

Number of directions.	Objects observed.	Results of station adjustment.			Corrections from first section.	Final seconds.
		°	′	″	″	″
43	Belle Fontaine	0	00	00 .0	+0 .1	00 .1
	Monk Point	0	19	13 .2	...	....
44	Horn Island West	38	49	05 .7	+0 .1	05 .8
45	Ship Island 1855	103	49	51 .4	−0 .1	51 .3
	Mississippi City	174	34	46 .1	...	....
	Biloxi Light	194	35	56 .5	...	....

Observation equations.

I	$0=-1.74-(1)+(2)-(7)+(9)-(11)+(12)$
II	$0=-0.51-(2)+(4)-(10)+(11)$
III	$0=-1.28-(3)+(4)-(7)+(8)-(10)+(12)$
IV	$0=+0.09-(6)+(7)-(12)+(14)-(15)+(16)$
V	$0=+0.07-(5)+(6)-(16)+(17)-(22)+(24)$
VI	$0=-1.15-(13)+(14)-(15)+(17)-(22)+(23)$
VII	$0=-1.57-(17)+(18)-(21)+(22)-(25)+(27)$
VIII	$0=-1.0-(19)+(20)-(32)+(34)-(36)+(37)$
IX	$0=-1.7-(20)+(21)-(27)+(29)-(35)+(36)$
X	$0=+0.1-(28)+(29)-(32)+(33)-(35)+(37)$
XI	$0=+1.0-(30)+(31)-(40)+(42)-(44)+(45)$
XII	$0=-1.4-(31)+(32)-(37)+(39)-(43)+(44)$
XIII	$0=+1.4-(38)+(39)-(40)+(41)-(43)+(45)$
XIV	$0=+4.8+2.09(1)-4.95(2)-2.40(3)+2.36(4)+3.00(7)-3.22(8)+0.22(9)$
XV	$0=+8.2+2.29(5)-6.11(6)+3.82(7)-0.51(12)-1.74(13)+2.25(14)+3.05(22)-3.06(23)$ $+0.01(24)$
XVI	$0=-4.84+0.229(5)-0.229(6)+3.035(16)-3.035(18)+0.834(21)-0.835(22)+0.001(24)$ $+3.46(25)-3.592(26)+0.132(27)$
XVII	$0=+2.0+4.17(19)-6.20(20)+2.03(21)-0.19(27)-3.58(28)+3.77(29)+1.76(32)-1.54(33)$ $-0.22(34)$
XVIII	$0=-9.0+1.49(30)-3.57(31)+2.08(32)-0.22(37)-2.16(38)+2.38(39)+2.17(40)-3.38(41)$ $+1.21(42)$

Normal equations.

No.		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}
1	0 = −1·74	+6	−2	+2	−2										− 9·82	− 4·33			
2	0 = +0·51		+4	+2											+ 7·31				
3	0 = −1·28			+6	−2										− 1·46	− 4·33			
4	0 = +0·09				+6	−2	+2								+ 3·00	+12·69	+ 3·264		
5	0 = +0·07	…	…	…	…	+6	+2	−2	…	…	…	…	…	…	…	−11·44	− 2·658	…	…
6	0 = −1·15						+6	−2								− 2·12	+ 0·834		
7	0 = −1·57							+6		−2						+ 3·05	− 8·031	− 2·22	
8	0 = −1·0								+6	−2	+2		−2					−12·35	− 2·30
9	0 = −1·7									+6	+2						+ 0·702	+12·19	
10	0 = +0·1	…	…	…	…	…	…	…	…	…	+6	…	−2	…	…	…	…	+ 4·05	− 2·30
11	0 = +1·0											+6	−2	+2					− 6·02
12	0 = −1·4												+6	+2				+ 1·76	+ 8·25
13	0 = +1·4													+6					− 1·01
14	0 = +4·8														+59·617	+11·46			
15	0 = +8·2	…	…	…	…	…	…	…	…	…	…	…	…	…	…	+84·185	− 0·6201	…	…
16	0 = −4·84																+44·8039	+ 1·6679	
17	0 = +2·0																	+92·5323	+ 3·6608
18	0 = −9·0																		+47·2672

Resulting correlates.

$C_1 = +0·0965$	$C_{10} = -0·5309$
$C_2 = -0·0831$	$C_{11} = +0·2551$
$C_3 = +0·1404$	$C_{12} = +0·3376$
$C_4 = -0·0306$	$C_{13} = -0·4014$
$C_5 = +0·3323$	$C_{14} = -0·03628$
$C_6 = +0·5085$	$C_{15} = -0·06853$
$C_7 = +1·4771$	$C_{16} = +0·36560$
$C_8 = +0·8785$	$C_{17} = -0·03300$
$C_9 = +1·2697$	$C_{18} = +0·17487$

Resulting corrections to observed directions.

	″		″		″
(1) =	−0·171	(16) =	+0·747	(31) =	−0·707
(2)	+0·359	(17)	−0·636	(32)	+0·296
(3)	−0·054	(18)	+0·367	(33)	−0·480
(4)	−0·028	(19)	−1·016	(34)	+0·886
(5)	−0·406	(20)	−0·187	(35)	−0·739
(6)	+0·698	(21)	+0·030	(36)	+0·391
(7)	−0·638	(22)	+0·122	(37)	−0·028
(8)	+0·257	(23)	+0·718	(38)	+0·024
(9)	+0·088	(24)	+0·332	(39)	+0·352
(10)	−0·057	(25)	−0·212	(40)	+0·526
(11)	−0·180	(26)	−1·313	(41)	−0·992
(12)	+0·302	(27)	+0·261	(42)	+0·467
(13)	−0·389	(28)	+0·649	(43)	+0·064
(14)	+0·324	(29)	+0·614	(44)	+0·084
(15)	−0·478	(30)	+0·005	(45)	−0·146

Probable error of an observed direction $0·674\sqrt{\frac{11·28}{18}} = \pm 0''·53$

Resulting angles and sides of the first section of the triangulation west of Dauphin Island base net.

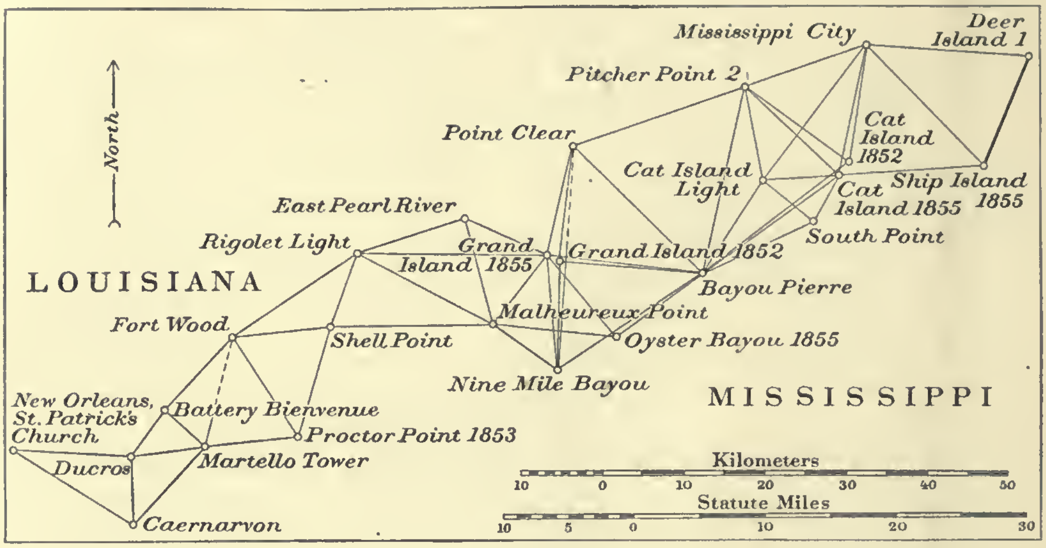
No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distances in meters.
		°	′	″	″	″	″		
1	Petit Bois	50	49	13 ·76	−0 ·17	13 ·59	0 ·20	4 ·193 605 2	15 617 ·27
	Point aux Pins	47	37	13 ·21	−0 ·05	13 ·16	0 ·19	4 ·172 673 0	14 882 ·40
	Dauphin Island West Base	81	33	33 ·66	+0 ·17	33 ·83	0 ·19	4 ·299 478 8	19 928 ·69
2	Grande Batture	54	50	01 ·60	−0 ·12	01 ·48	0 ·15	4 ·193 605 2	15 617 ·27
	Point aux Pins	88	51	39 ·39	−0 ·03	39 ·36	0 ·15	4 ·281 040 2	19 100 ·30
	Dauphin Island West Base	36	18	19 ·97	−0 ·36	19 ·61	0 ·15	4 ·053 513 2	11 311 ·32
3	Grande Batture	105	37	27 ·05	+0 ·36	27 ·41	0 ·13	4 ·299 478 8	19 928 ·69
	Point aux Pins	41	14	26 ·18	+0 ·03	26 ·21	0 ·13	4 ·134 862 4	13 641 ·51
	Petit Bois	33	08	05 ·87	+0 ·89	06 ·76	0 ·12	4 ·053 513 1	11 311 ·32
4	Grande Batture	50	47	25 ·45	+0 ·48	25 ·93	0 ·17	4 ·172 673 0	14 882 ·40
	Dauphin Island West Base	45	15	13 ·69	+0 ·53	14 ·22	0 ·17	4 ·134 862 2	13 641 ·50
	Petit Bois	83	57	19 ·63	+0 ·73	20 ·36	0 ·17	4 ·281 040 0	19 100 ·29
5	Horn Island East 1855	55	26	50 ·66	−0 ·39	50 ·27	0 ·15	4 ·134 862 3	13 641 ·51
	Grande Batture	53	04	44 ·72	−0 ·69	44 ·03	0 ·14	4 ·121 942 0	13 241 ·65
	Petit Bois	71	28	26 ·37	−0 ·23	26 ·14	0 ·15	4 ·196 033 9	15 704 ·85
6	Bayou Casotte	47	31	37 ·80	+1 ·23	39 ·03	0 ·10	4 ·134 862 3	13 641 ·51
	Grande Batture	103	36	09 ·09	+0 ·02	09 ·11	0 ·10	4 ·254 684 9	17 975 ·66
	Petit Bois	28	52	13 ·50	−1 ·34	12 ·16	0 ·10	3 ·950 829 6	8 929 ·55
7	Bayou Casotte	47	26	47 ·96	−1 ·38	46 ·58	0 ·14	4 ·121 942 0	13 241 ·65
	Petit Bois	42	36	12 ·87	+1 ·10	13 ·97	0 ·13	4 ·085 225 7	12 168 ·18
	Horn Island East 1855	89	56	59 ·65	+0 ·21	59 ·86	0 ·14	4 ·254 684 7	17 975 ·65
8	Bayou Casotte	94	58	25 ·76	−0 ·16	25 ·60	0 ·09	4 ·196 033 9	15 704 ·85
	Grande Batture	50	31	24 ·37	+0 ·71	25 ·08	0 ·09	4 ·085 225 8	12 168 ·18
	Horn Island East 1855	34	30	08 ·99	+0 ·60	09 ·59	0 ·09	3 ·950 829 4	8 929 ·55
9	East Pascagoula	57	56	20 ·18	+0 ·47	20 ·65	0 ·03	4 ·085 225 8	12 168 ·18
	Bayou Casotte	107	52	39 ·62	+1 ·01	40 ·63	0 ·04	4 ·135 600 2	13 664 ·70
	Horn Island East 1855	14	10	58 ·73	+0 ·09	58 ·82	0 ·03	3 ·546 295 3	3 518 ·00
10	East Pascagoula	20	42	28 ·49	−1 ·10	27 ·39	0 ·02	4 ·254 684 8	17 975 ·65
	Bayou Casotte	155	19	27 ·58	−0 ·38	27 ·20	0 ·02	4 ·326 812 5	21 223 ·28
	Petit Bois	3	58	....	....	05 ·47	0 ·02	3 ·546 295 4	3 518 ·00
11	East Pascagoula	37	13	51 ·69	+1 ·57	53 ·26	0 ·15	4 ·121 942 0	13 241 ·65
	Petit Bois	38	38	.....	....	08 ·51	0 ·15	4 ·135 600 0	13 664 ·70
	Horn Island East 1855	104	07	58 ·38	+0 ·30	58 ·68	0 ·15	4 ·326 812 5	21 223 ·28
12	Belle Fontaine	38	42	55 ·8	+1 ·1	56 ·9	0 ·1	4 ·135 600 1	13 664 ·70
	East Pascagoula	95	12	56 ·0	+0 ·4	56 ·4	0 ·2	4 ·337 600 5	21 757 ·07
	Horn Island East 1855	46	04	07 ·0	+0 ·2	07 ·2	0 ·2	4 ·196 838 0	15 733 ·96

Resulting angles and sides of the first section of the triangulation west of Dauphin Island base net—continued.

No.	Stations.	Observed angles.			Correc-tion.	Spher-ical angles.	Spher-ical excess.	Log. dis-tances.	Distances in meters.
		°	′	″	″	″	″		
13	Horn Island West	42	18	49·0	+1·4	50·4	0·2	4·135 600 1	13 664·70
	East Pascagoula	64	47	04·8	+0·4	05·2	0·2	4·263 971 9	18 364·19
	Horn Island East 1855	72	54	04·0	+1·0	05·0	0·2	4·287 827 7	19 401·16
14	Horn Island West	96	06	14·3	+0·6	14·9	0·2	4·337 600 5	21 757·07
	Belle Fontaine	57	03	48·2	−0·4	47·8	0·2	4·263 972 4	18 364·22
	Horn Island East 1855	26	49	57·0	+0·8	57·8	0·1	3·994 618 9	9 876·86
15	Horn Island West	53	47	25·3	−0·8	24·5	0·1	4·196 838 0	15 733·96
	Belle Fontaine	95	46	44·0	+0·7	44·7	0·2	4·287 827 8	19 401·17
	East Pascagoula	30	25	51·2	0·0	51·2	0·1	3·994 618 7	9 876·85
16	Deer Island 1	38	49	05·7	0·0	05·7	0·1	3·994 618 8	9 876·86
	Belle Fontaine	95	52	55·1	+0·4	55·5	0·1	4·195 161 4	15 673·34
	Horn Island West	45	17	58·1	+1·0	59·1	0·1	4·049 199 0	11 199·50
17	Ship Island 1855	28	14	00·5	+1·5	02·0	0·2	3·994 618 8	9 876·86
	Belle Fontaine	51	39	23·2	0·0	23·2	0·1	4·214 177 2	16 374·84
	Horn Island West	100	06	34·9	+0·3	35·2	0·1	4·312 896 4	20 554·00
18	Ship Island 1855	31	56	38·5	−1·5	37·0	0·1	4·049 199 0	11 199·50
	Deer Island 1	103	49	51·4	−0·2	51·2	0·2	4·312 896 2	20 553·99
	Belle Fontaine	44	13	31·9	+0·3	32·2	0·1	4·169 209 4	14 764·18
19	Ship Island 1855	60	10	39·0	−0·1	38·9	0·1	4·195 161 4	15 673·34
	Deer Island 1	65	00	45·7	−0·2	45·5	0·2	4·214 177 3	16 374·85
	Horn Island West	54	48	36·8	−0·7	36·1	0·2	4·169 209 5	14 764·19

13. SECOND AND LAST SECTION OF THE TRIANGULATION WEST OF THE DAUPHIN ISLAND BASE NET, MISSISSIPPI AND LOUISIANA, 1850–1874.

No. 34.



The second and last section of the triangulation stretches west from the line Deer Island 1 to Ship Island 1855 and reaches the astronomic station in the city of New Orleans, Louisiana, a distance of 132 kilometers, or 82 statute miles. It is of secondary and somewhat irregular character as to size and shape of its component parts, yet possesses sufficient accuracy to render it useful in the discussion of the geodetic and astronomic measures of the southern portion of the oblique arc.

When within 34 kilometers, or 21 statute miles, of New Orleans the triangles are apparently left without a check, but here we can take advantage of a well-determined and independent length of the terminal side Martello Tower to Bienvenue. This is furnished by its direct connection, through a small but otherwise well conditioned and adjusted river triangulation, with the Magnolia base line, situated about 60 kilometers, or 37¼ statute miles, farther down the Mississippi River.* This base was measured by Assistant C. H. Boyd in January, 1872. Its length is, roughly, 3·6 kilometers, or 2¼ statute miles,† and the corresponding length of side Martello Tower to Bienvenue is 6 233·42 meters. The length for this same line, starting from the Dauphin Island base in the old unadjusted computation of 1880, is 6 233·02. The discrepancy was removed by dispersing this difference in the adjustment between this side and the side Deer Island 1 to Ship Island 1855, at the same time preserving the four intermediate and adjusted parts, as explained farther on.

In this branch of the triangulation it was found sufficient to give the resulting angles either from the station adjustment or from direct measure, as the case may be, to the nearest tenth of a second; further, the special tabulation of these results could be dispensed with, since they are given in the presentation of the triangles.

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* See sketch of triangulation, plate No. 19, Coast and Geodetic Survey Report for 1879.

† Logarithm of length of Magnolia base, 3·558 068 3.

The names of the observers and dates of execution of the triangulation for each station are as follows:

Name of station.	Observer.	Month and year.
Mississippi City	S. A. Gilbert	May, 1851
	J. E. Hilgard	Apr. and Oct., 1855
Cat Island 1852	S. A. Gilbert	May, 1851
		Jan., 1852
Cat Island 1855	J. E. Hilgard	Sept. and Dec., 1855
	R. E. Halter	Feb. and May, 1857
Pitcher Point 2	S. A. Gilbert	Apr. and May, 1851
	J. E. Hilgard	Oct. and Dec., 1855
Cat Island Light	S. A. Gilbert	May, 1850
	J. E. Hilgard	Dec., 1855
	J. S. Harris and R. E. Halter	Feb. and May, 1857
South Point	J. S. Harris, R. E. Halter and S. Harris	Feb. and May, 1857
Bayou Pierre	S. A. Gilbert	Feb., 1852
	R. E. Halter and S. Harris	Feb., 1857
Point Clear	S. A. Gilbert	Mar., 1852
Grand Island 1852	S. A. Gilbert	Feb. and Mar., 1852
Grand Island 1855	J. E. Hilgard	May and June, 1855
Oyster Bayou 1855	S. A. Gilbert	Dec., 1852
	J. E. Hilgard	June, 1855
Nine Mile Bayou	S. A. Gilbert	Mar., May, and Dec., 1852
Malheureux Point	J. E. Hilgard	June and Aug., 1855
East Pearl River	J. E. Hilgard	June, 1855
Rigolet Light	S. A. Gilbert	June, 1852
	J. E. Hilgard	May, June, and Dec., 1855
	S. Harris and R. E. Halter	Jan., Mar., and May, 1858
Shell Point	J. E. Hilgard	Aug. and Dec., 1855
	S. Harris	Feb. and Mar., 1858
Fort Wood	J. E. Hilgard	June, 1855
	R. E. Halter	Feb., 1858
Proctor 1853	S. A. Gilbert	Mar., 1853
Martello Tower	S. A. Gilbert	Mar., 1853
	C. H. Boyd	Mar., 1874
Battery Bienvenue	S. A. Gilbert	Mar., 1853
Ducros	C. H. Boyd	Apr., 1873
		Mar., 1874
Saint Patrick's Church, New Orleans	C. H. Boyd	Mar. and Apr., 1874
Astro. Observatory, Canal and Basin streets, New Orleans	S. Harris	Apr., 1858
Caernarvon	C. H. Van Orden and C. H. Boyd	Mar., 1873
	C. H. Boyd	Mar., 1874

That branch of the triangulation which reaches New Orleans by way of the Rigolets and Lake Pontchartrain could not be utilized in consequence of a break in the survey at the eastern end of the lake; the old station marks, diligently searched for in 1898, have entirely disappeared. The junction made via Lake Borgne, as presented here, is direct and the corrections due to adjustment are small.

Leaving the line Deer Island to Ship Island 1855 and passing over two triangles, the first special adjustment comprises the figure Mississippi City, Pitcher Point 2, Cat Island 1852, Cat Island 1855, Cat Island Light, South Point, and Bayou Pierre. (See sketch, p. 226.) It involves 12 condition or observation equations and 30 corrections to directions numbered as follows:

At Mississippi City	1. Cat Island 1852.
" " "	2. Cat Island 1855.
" " "	3. Cat Island Light.
" " "	4. Pitcher Point 2.
At Pitcher Point 2	5. Mississippi City.
" " "	6. Cat Island 1852.
" " "	7. Cat Island 1855.
" " "	8. Cat Island Light.
" " "	9. Bayou Pierre.
At Cat Island 1855	10. South Point.
" " " "	11. Bayou Pierre.
" " " "	12. Cat Island Light.
" " " "	13. Pitcher Point 2.
" " " "	14. Mississippi City.
At Cat Island 1852	15. Bayou Pierre.
" " " "	16. Pitcher Point 2.
" " " "	17. Mississippi City.
At Cat Island Light	18. Pitcher Point 2.
" " " "	19. Mississippi City.
" " " "	20. Cat Island 1855.
" " " "	21. South Point.
" " " "	22. Bayou Pierre.
At Bayou Pierre	23. Pitcher Point 2.
" " "	24. Cat Island Light.
" " "	25. Cat Island 1852.
" " "	26. Cat Island 1855.
" " "	27. South Point.
At South Point	28. Bayou Pierre.
" " "	29. Cat Island Light.
" " "	30. Cat Island 1855.

Observation equations.

$$\text{I}\quad 0=+0\cdot3-(2)+(4)-(5)+(7)-(13)+(14)$$

$$\text{II}\quad 0=+0\cdot4-(2)+(3)-(12)+(14)-(19)+(20)$$

$$\text{III}\quad 0=-0\cdot9-(3)+(4)-(5)+(8)-(18)+(19)$$

$$\text{IV}\quad 0=+1\cdot4-(1)+(4)-(5)+(6)-(16)+(17)$$

$$\text{V}\quad 0=-5\cdot4-(6)+(9)-(15)+(16)-(23)+(25)$$

$$\text{VI}\quad 0=+0\cdot9-(10)+(12)-(20)+(21)-(29)+(30)$$

$$\text{VII}\quad 0=\ \ 0\cdot0-(21)+(22)-(24)+(27)-(28)+(29)$$

$$\text{VIII}\quad 0=+1\cdot1-(10)+(11)-(26)+(27)-(28)+(30)$$

$$\text{IX}\quad 0=+0\cdot5-3\cdot25(2)+4\cdot58(3)-1\cdot33(4)-1\cdot02(5)+3\cdot87(7)-2\cdot85(8)+0\cdot18(18)+1\cdot88(19)$$
$$-2\cdot06(20)$$

$$\text{X}\quad 0=+13\cdot6-2\cdot85(7)+14\cdot11(8)-11\cdot26(9)-3\cdot34(11)+5\cdot19(12)-1\cdot85(13)-6\cdot09(18)+6\cdot09(22)$$
$$+5\cdot37(24)-5\cdot37(26)$$

$$\text{XI}\quad 0=-12\cdot7+1\cdot33(1)-1\cdot33(2)-6\cdot09(8)+6\cdot09(9)-1\cdot85(12)+3\cdot14(13)-1\cdot29(14)+0\cdot34(15)$$
$$-1\cdot64(16)+1\cdot30(17)+3\cdot51(18)+0\cdot18(20)-3\cdot69(22)-2\cdot47(23)+2\cdot47(25)$$

$$\text{XII}\quad 0=+3\cdot8-3\cdot34(10)+4\cdot75(11)-1\cdot41(12)-2\cdot20(20)+2\cdot48(21)-0\cdot28(22)-3\cdot41(24)$$
$$+11\cdot56(26)-8\cdot15(27)$$

Correlates and resulting corrections.

	$''$	$''$	$''$
$C_1=-0{\cdot}185$	(1) $=+0{\cdot}156$	(11) $=-0{\cdot}446$	(21) $=-0{\cdot}122$
$C_2=+0{\cdot}119$	(2) $-0{\cdot}084$	(12) $-0{\cdot}117$	(22) $-0{\cdot}100$
$C_3=+0{\cdot}398$	(3) $-0{\cdot}198$	(13) $+0{\cdot}401$	(23) $-0{\cdot}948$
$C_4=-0{\cdot}064$	(4) $+0{\cdot}125$	(14) $-0{\cdot}156$	(24) $-0{\cdot}044$
$C_5=+0{\cdot}776$	(5) $-0{\cdot}167$	(15) $-0{\cdot}752$	(25) $+0{\cdot}948$
$C_6=+0{\cdot}088$	(6) $-0{\cdot}840$	(16) $+0{\cdot}726$	(26) $-0{\cdot}008$
$C_7=+0{\cdot}142$	(7) $-0{\cdot}120$	(17) $+0{\cdot}026$	(27) $+0{\cdot}051$
$C_8=-0{\cdot}313$	(8) $-0{\cdot}061$	(18) $-0{\cdot}157$	(28) $+0{\cdot}171$
$C_9=+0{\cdot}0177$	(9) $+1{\cdot}188$	(19) $+0{\cdot}312$	(29) $+0{\cdot}054$
$C_{10}=+0{\cdot}0010$	(10) $+0{\cdot}316$	(20) $+0{\cdot}068$	(30) $-0{\cdot}225$
$C_{11}=+0{\cdot}0695$			
$C_{12}=-0{\cdot}0273$			

The second special figure submitted to adjustment is composed of the stations given below:

At Bayou Pierre	1. Nine Mile Bayou.	At Grand Island 1855	11. Point Clear.
" " "	2. Grand Island 1852.	" " " "	12. Bayou Pierre.
" " "	3. Grand Island 1855.	" " " "	13. Nine Mile Bayou.
" " "	4. Point Clear.		
		At Nine Mile Bayou	14. Grand Island 1855.
At Point Clear	5. Bayou Pierre.	" " " "	15. Grand Island 1852.
" " "	6. Grand Island 1852,	" " " "	16. Point Clear.
" " "	7. Grand Island 1855.	" " " "	17. Bayou Pierre.
At Grand Island 1852	8. Point Clear.		
" " " "	9. Bayou Pierre.		
" " " "	10. Nine Mile Bayou.		

Observation equations.

$$
\begin{array}{r|l}
\text{I} & 0=-\ 3{\cdot}2-(2)+(4)-(5)+(6)-(8)+(9) \\
\text{II} & 0=\ \ 0{\cdot}0-(1)+(2)-(9)+(10)-(15)+(17) \\
\text{III} & 0=-\ 1{\cdot}3-(3)+(4)-(5)+(7)-(11)+(12) \\
\text{IV} & 0=-\ 0{\cdot}2-(1)+(3)-(12)+(13)-(14)+(17) \\
\text{V} & 0=-63{\cdot}5-2{\cdot}51(1)+5{\cdot}23(2)-2{\cdot}72(4)-1{\cdot}34(5)+1{\cdot}34(6)-15{\cdot}28(8)+15{\cdot}28(10)-29{\cdot}69(15) \\
 & \qquad +30{\cdot}89(16)-1{\cdot}20(17) \\
\text{VI} & 0=-31{\cdot}6-2{\cdot}45(1)+5{\cdot}25(3)-2{\cdot}80(4)-1{\cdot}23(5)+1{\cdot}23(7)-12{\cdot}02(11)+12{\cdot}02(13)-23{\cdot}61(14) \\
 & \qquad +24{\cdot}73(16)-1{\cdot}12(17)
\end{array}
$$

Correlates and resulting corrections.

	$''$	$''$
$C_1=+0{\cdot}473$	(1) $=-0{\cdot}033$	(10) $=+0{\cdot}311$
$C_2=\ \ 0{\cdot}030$	(2) $-0{\cdot}386$	(11) $-0{\cdot}171$
$C_3=+0{\cdot}047$	(3) $-0{\cdot}011$	(12) $+0{\cdot}065$
$C_4=-0{\cdot}018$	(4) $+0{\cdot}430$	(13) $+0{\cdot}106$
$C_5=+0{\cdot}0223$	(5) $-0{\cdot}563$	(14) $-0{\cdot}225$
$C_6=+0{\cdot}0103$	(6) $+0{\cdot}503$	(15) $-0{\cdot}632$
	(7) $+0{\cdot}060$	(16) $+0{\cdot}944$
	(8) $-0{\cdot}814$	(17) $-0{\cdot}087$
	(9) $+0{\cdot}503$	

The third special figure treated by itself involves stations Bayou Pierre, Grand Island 1855, Nine Mile Bayou, Oyster Bayou 1855, and Malheureux Point.

At Bayou Pierre	1. Oyster Bayou 1855	At Oyster Bayou 1855	6. Malheureux Point
At Grand Island 1855	2. Oyster Bayou 1855	" " "	7. Grand Island 1855
" " "	3. Malheureux Point	" " "	8. Bayou Pierre
At Nine Mile Bayou	4. Malheureux Point	At Malheureux Point	9. Grand Island 1855
At Oyster Bayou 1855	5. Nine Mile Bayou	" " "	10. Oyster Bayou 1855
		" " "	11. Nine Mile Bayou

Observation equations.

I $0=-1 \cdot 1-(1)+(2)-(7)+(8)$

II $0=-2 \cdot 0-(2)+(3)-(6)+(7)-(9)+(10)$

III $0=-3 \cdot 9+(3)-(4)-(9)+(11)$

IV $0=-32 \cdot 23-11 \cdot 07(1)+0 \cdot 64(2)-4 \cdot 13(5)-0 \cdot 10(7)+4 \cdot 23(8)$

V $0=-4 \cdot 6-3 \cdot 15(2)-2 \cdot 18(3)-2 \cdot 63(5)+2 \cdot 95(6)-0 \cdot 32(7)-0 \cdot 21(9)+3 \cdot 98(10)-3 \cdot 77(11)$

Correlates and resulting corrections.

	″	″
$C_1=-1 \cdot 138$	$(1)=-2 \cdot 29$	$(7)=+0 \cdot 54$
$C_2=-0 \cdot 522$	$(2)\quad -0 \cdot 82$	$(8)\quad +0 \cdot 17$
$C_3=+1 \cdot 421$	$(3)\quad +0 \cdot 62$	$(9)\quad -0 \cdot 93$
$C_4=+0 \cdot 310$	$(4)\quad -1 \cdot 42$	$(10)\quad -0 \cdot 01$
$C_5=+0 \cdot 129$	$(5)\quad -1 \cdot 62$	$(11)\quad +0 \cdot 94$
	$(6)\quad +0 \cdot 90$	

The next quadrilateral—Grand Island 1855, Malheureux Point, Rigolet Light, East Pearl River—is treated by itself.

At Grand Island 1855	1. Malheureux Point	At Rigolet Light	7. East Pearl River
" " " "	2. Rigolet Light	" " "	8. Grand Island 1855
" " " "	3. East Pearl River	" " "	9. Malheureux Point
At Malheureux Point	4. Rigolet Light	At East Pearl River	10. Grand Island 1855
" " "	5. East Pearl River	" " " "	11. Malheureux Point
" " "	6. Grand Island 1855	" " " "	12. Rigolet Light

Observation equations.

I $0=+3 \cdot 0-(1)+(2)-(4)+(6)-(8)+(9)$

II $0=+0 \cdot 4-(1)+(3)-(5)+(6)-(10)+(11)$

III $0=-1 \cdot 7-(4)+(5)-(7)+(9)-(11)+(12)$

IV $0=-41 \cdot 9-0 \cdot 68(1)+5 \cdot 99(2)-5 \cdot 31(3)-2 \cdot 04(4)+3 \cdot 68(5)-1 \cdot 64(6)-5 \cdot 39(7)+7 \cdot 50(8)-2 \cdot 11(9)$

Correlates and resulting corrections.

	″	″	″
$C_1=-0 \cdot 784$	$(1)=-0 \cdot 13$	$(5)=+0 \cdot 59$	$(9)=-0 \cdot 89$
$C_2=+0 \cdot 748$	$(2)\quad +0 \cdot 71$	$(6)\quad -0 \cdot 44$	$(10)\quad -0 \cdot 75$
$C_3=+0 \cdot 420$	$(3)\quad -0 \cdot 57$	$(7)\quad -1 \cdot 76$	$(11)\quad +0 \cdot 33$
$C_4=+0 \cdot 249$	$(4)\quad -0 \cdot 14$	$(8)\quad +2 \cdot 65$	$(12)\quad +0 \cdot 42$

Finally the length of the sides Deer Island 1 to Ship Island 1855 and Battery Bienvenue to Martello Tower were brought into accord by adjustment of the intervening triangulation, but *leaving the preceding adjusted parts unaltered.* There were 6 triangles, the sums of whose angles were equated to $180° + \varepsilon$, respectively, and the length equation constituted the seventh condition to be satisfied. This adjustment was made by angle corrections, the 16 angles being marked from A to Q as follows:

Designation of angles.	At stations.	Between stations.
A	Deer Island 1	Ship Island 1855 and Mississippi City.
B	Mississippi City	Deer Island 1 and Ship Island 1855.
C	Ship Island 1855	Cat Island 1855 and Mississippi City.
D	Cat Island 1855	Mississippi City and Ship Island 1855.
E	Pitcher Point 2	Bayou Pierre and Point Clear.
F	Point Clear	Pitcher Point 2 and Bayou Pierre.
G	Malheureux Point	Shell Point and Rigolet Light.
H	Shell Point	Rigolet Light and Malheureux Point.
I	Rigolet Light	Shell Point and Fort Wood.
K	Fort Wood	Rigolet Light and Shell Point.
L	Shell Point	Proctor Point 1853 and Fort Wood.
M	Proctor Point 1853	Fort Wood and Shell Point.
N	Proctor Point 1853	Martello Tower and Fort Wood.
O	Martello Tower	Fort Wood and Proctor Point 1853.
P	Martello Tower	Battery Bienvenue and Fort Wood.
Q	Battery Bienvenue	Fort Wood and Martello Tower.

When a letter designating an angle is inclosed in a parenthesis, it designates the corresponding correction.

In establishing the 6 angle equations the plane angles already corrected were employed. Thus we have

I. $0 = (A) + (B) + (R_1)$

II. $0 = (C) + (D) + (R_2)$

etc., where R_1, R_2, ... refer to the third angle of the triangle.

VII. $0 = -32.5 + 0.73\,(A) - 2.31\,(B) + 1.81\,(C) - 0.50\,(D) + 1.36\,(E) - 0.98\,(F) + 3.53\,(G) - 0.79\,(H) + 2.88\,(I) - 3.69\,(K) + 0.80\,(L) - 1.80\,(M) + 0.99\,(N) - 0.78\,(O) - 4.12\,(P) - 3.92\,(Q)$

where -32.5 is the discrepancy of length in the sixth place of decimals of the logarithm.

The corresponding corrections are—

	″		″		″		″
(A) =	+0.5	(E) =	+0.5	(I) =	+1.3	(N) =	+0.4
(B)	−0.7	(F)	−0.4	(K)	−1.4	(O)	−0.3
(C)	+0.6	(G)	+1.1	(L)	+0.5	(P)	−1.7
(D)	−0.4	(H)	−0.7	(M)	−0.6	(Q)	−1.6

Resulting angles and sides of the second and last section of the triangulation west of the Dauphin Island base net.

No.	Stations.	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distances in meters.
1	Mississippi City	42	21	51.4	−0.7	50.7	0.2	4.169 209	14 764.17
	Deer Island 1	70	44	54.7	+0.4	55.1	0.3	4.315 662	20 685.3
	Ship Island 1855	66	53	14.8	+0.1	14.9	0.2	4.304 316	20 151.9
2	Cat Island 1855	76	28	33.5	−0.5	33.0	0.3	4.315 662	20 685.3
	Mississippi City	54	10	30.6	−0.3	30.3	0.2	4.236 793	17 250.2
	Ship Island 1855	49	20	56.9	+0.5	57.4	0.2	4.207 942	16 141.4
3	Pitcher Point 2	64	00	12.7	+0.1	12.8	0.1	4.207 942	16 141.4
	Mississippi City	57	37	19.0	+0.2	19.2	0.2	4.180 886	15 166.5
	Cat Island 1855	58	22	29.1	−0.6	28.5	0.2	4.184 451	15 291.5
4	Cat Island Light	48	15	01.4	−0.3	01.1	0.1	4.207 942	16 141.4
	Mississippi City	24	39	28.5	−0.1	28.4	0.1	3.955 511	9 026.32
	Cat Island 1855	107	05	30.9	0.0	30.9	0.2	4.315 551	20 680.0
5	Cat Island Light	94	54	55.4	+0.2	55.6	0.1	4.180 886	15 166.5
	Pitcher Point 2	36	22	02.3	+0.1	02.4	0.1	3.955 511	9 026.32
	Cat Island 1855	48	43	01.8	+0.5	02.3	0.1	4.058 394	11 439.2
6	Cat Island Light	46	39	54.0	+0.5	54.5	0.1	4.184 451	15 291.5
	Pitcher Point 2	100	22	15.0	+0.1	15.1	0.2	4.315 551	20 680.0
	Mississippi City	32	57	50.5	+0.3	50.8	0.1	4.058 394	11 439.2
7	South Point	79	59	12.0	−0.3	11.7	0.1	3.955 511	9 026.32
	Cat Island Light	43	50	36.5	−0.2	36.3	0.0	3.802 717	6 349.17
	Cat Island 1855	56	10	12.5	−0.4	12.1	0.0	3.881 619	7 614.11
8	Bayou Pierre	31	43	28.0	+0.1	28.1	0.1	3.881 619	7 614.11
	Cat Island Light	82	28	30.3	0.0	30.3	0.1	4.157 014	14 355.4
	South Point	65	48	02.0	−0.1	01.9	0.1	4.120 824	13 207.6
9	Bayou Pierre	10	19	10.9	+0.1	11.0	0.0	3.802 717	6 349.17
	Cat Island 1855	23	53	36.2	−0.8	35.4	0.0	4.157 012	14 355.3
	South Point	145	47	14.0	−0.4	13.6	0.0	4.299 466	19 928.1
10	Cat Island 1852	58	23	12.2	−0.7	11.5	0.2	4.184 451	15 291.5
	Pitcher Point 2	63	58	09.4	−0.7	08.7	0.2	4.207 760	16 134.7
	Mississippi City	57	38	40.3	0.0	40.3	0.1	4.180 939	15 168.4
11	Bayou Pierre	40	28	33.9	+1.9	35.8	0.2	4.180 939	15 168.4
	Pitcher Point 2	58	33	52.1	+2.0	54.1	0.3	4.299 670	19 937.5
	Cat Island 1852	80	57	29.4	+1.5	30.9	0.3	4.363 173	23 076.7
12	Bayou Pierre	19	04	....	...	14.9	0.1	4.058 394	11 439.2
	Pitcher Point 2	22	09	46.5	+1.2	47.7	0.1	4.120 822	13 207.5
	Cat Island Light	138	45	57.8	−0.1	57.7	0.1	4.363 172	23 076.6

Resulting angles and sides of the second and last section of the triangulation west of the Dauphin Island base net—continued.

No.	Stations	Observed angles. °	′	″	Correction. ″	Spherical angles. ″	Spherical excess. ″	Log. distances.	Distance in meters.
13	Point Clear	64	54	08 ·4	−1 ·3	07 ·1	0 ·4	4 ·363 173	23 076 ·7
	Pitcher Point 2	57	06	43 ·1	−0 ·3	42 ·8	0 ·3	4 ·330 386	21 398 ·6
	Bayou Pierre	57	59	12 ·1	−0 ·9	11 ·2	0 ·4	4 ·334 601	21 607 ·3
14	Grand Island 1852	84	46	36 ·7	+1 ·3	38 ·0	0 ·2	4 ·330 386	21 398 ·6
	Point Clear	57	34	03 ·6	+1 ·1	04 ·7	0 ·2	4 ·258 550	18 136 ·4
	Bayou Pierre	37	39	17 ·1	+0 ·8	17 ·9	0 ·2	4 ·118 166	13 127 ·0
15	Nine Mile Bayou	60	20	44 ·1	+0 ·5	44 ·6	0 ·2	4 ·258 550	18 136 ·4
	Grand Island 1852	79	41	19 ·3	−0 ·2	19 ·1	0 ·2	4 ·312 446	20 532 ·7
	Bayou Pierre	39	57	57 ·2	−0 ·3	56 ·9	0 ·2	4 ·127 275	13 405 ·3
16	Grand Island 1855	83	22	26 ·6	+0 ·2	26 ·8	0 ·2	4 ·330 386	21 398 ·6
	Point Clear	59	38	59 ·8	+0 ·6	60 ·4	0 ·2	4 ·269 285	18 590 ·2
	Bayou Pierre	36	58	32 ·9	+0 ·5	33 ·4	0 ·2	4 ·112 517	12 957 ·4
17	Nine Mile Bayou	52	39	39 ·2	−1 ·0	38 ·2	0 ·4	4 ·330 386	21 398 ·6
	Point Clear	49	43	....	...	08 ·1	0 ·3	4 ·312 446	20 532 ·7
	Bayou Pierre	77	37	14 ·3	+0 ·5	14 ·8	0 ·4	4 ·419 772	26 288 ·9
18	Grand Island 1855	77	18	47 ·2	+0 ·1	47 ·3	0 ·2	4 ·312 446	20 532 ·7
	Bayou Pierre	40	38	41 ·4	0 ·0	41 ·4	0 ·2	4 ·137 007	13 709 ·0
	Nine Mile Bayou	62	02	31 ·8	+0 ·1	31 ·9	0 ·2	4 ·269 286	18 590 ·3
19	Oyster Bayou 1855	94	05	44 ·8	−0 ·4	44 ·4	0 ·2	4 ·269 285	18 590 ·2
	Grand Island 1855	43	33	07 ·2	−0 ·8	06 ·4	0 ·1	4 ·108 621	12 841 ·7
	Bayou Pierre	42	21	07 ·3	+2 ·3	09 ·6	0 ·1	4 ·098 857	12 556 ·2
20	Oyster Bayou 1855	81	20	57 ·2	+2 ·2	59 ·4	0 ·0	4 ·137 007	13 709 ·0
	Nine Mile Bayou	64	53	....	...	19 ·9	0 ·1	4 ·098 857	12 556 ·2
	Grand Island 1855	33	45	40 ·1	+0 ·8	40 ·9	0 ·1	3 ·886 843	7 706 ·25
21	Malheureux Point	56	26	46 ·2	+0 ·9	47 ·1	...	4 ·098 857	12 556 ·2
	Grand Island 1855	77	47	23 ·5	+1 ·5	25 ·0	...	4 ·168 083	14 725 ·9
	Oyster Bayou 1855	45	45	48 ·3	−0 ·4	47 ·9	...	4 ·033 214	10 794 ·8
22	Malheureux Point	84	22	34 ·6	+1 ·9	36 ·5	...	4 ·137 007	13 709 ·0
	Grand Island 1855	44	01	43 ·4	+0 ·6	44 ·0	...	3 ·981 100	9 574 ·14
	Nine Mile Bayou	51	35	38 ·1	+1 ·4	39 ·5	...	4 ·033 214	10 794 ·8
23	Malheureux Point	27	55	48 ·4	+0 ·9	49 ·3	...	3 ·886 843	7 706 ·25
	Oyster Bayou 1855	35	35	08 ·9	+2 ·5	11 ·4	...	3 ·981 100	9 574 ·14
	Nine Mile Bayou	116	28	....	...	59 ·3	...	4 ·168 083	14 725 ·9
24	Rigolet Light	29	13	63 ·2	−3 ·5	59 ·7	...	4 ·033 214	10 794 ·8
	Grand Island 1855	52	42	52 ·3	+0 ·8	53 ·1	...	4 ·245 179	17 586 ·5
	Malheureux Point	98	03	07 ·5	−0 ·3	07 ·2	...	4 ·340 165	21 885 ·9
25	East Pearl River	55	47	55 ·6	+1 ·1	56 ·7	...	4 ·033 214	10 794 ·8
	Grand Island 1855	72	04	21 ·5	−0 ·5	21 ·0	...	4 ·094 055	12 418 ·1
	Malheureux Point	52	07	43 ·3	−1 ·0	42 ·3	...	4 ·012 962	10 303 ·0

Resulting angles and sides of the second and last section of the triangulation west of the Dauphin Island base net—continued.

No.	Stations.	Observed angles.			Correction.	Spherical angles.	Spherical excess.	Log. distances.	Distance in meters.
		°	′	″	″	″	″		
26	East Pearl River	89	09	45 ·8	+0 ·9	46 ·7	...	4 ·245 179	17 586 ·5
	Malheureux Point	45	55	24 ·2	+0 ·1	24 ·3	...	4 ·101 598	12 635 ·7
	Rigolet Light	44	54	48 ·3	+0 ·7	49 ·0	...	4 ·094 054	12 418 ·1
27	East Pearl River	144	57	41 ·4	+1 ·2	42 ·6	...	4 ·340 165	21 885 ·9
	Grand Island 1855	19	21	29 ·2	−1 ·3	27 ·9	...	4 ·101 599	12 635 ·7
	Rigolet Light	15	40	45 ·1	+4 ·4	49 ·5	...	4 ·012 961	10 303 ·0
28	Shell Point	69	28	43 ·5	−0 ·8	42 ·7	...	4 ·245 179	17 586 ·5
	Rigolet Light	79	39	33 ·4	−0 ·5	32 ·9	...	4 ·266 540	18 473 ·1
	Malheureux Point	30	51	43 ·4	+1 ·0	44 ·4	...	3 ·983 750	9 632 ·74
29	Fort Wood	29	40	09 ·7	−2 ·1	07 ·6	...	3 ·983 750	9 632 ·74
	Rigolet Light	36	11	18 ·6	+0 ·6	19 ·2	...	4 ·060 338	11 490 ·5
	Shell Point	114	08	33 ·7	−0 ·5	33 ·2	...	4 ·249 405	17 758 ·4
30	Proctor Point 1853	49	28	30 ·7	−1 ·0	29 ·7	...	4 ·060 338	11 490 ·5
	Fort Wood	61	18	27 ·9	−0 ·3	27 ·6	...	4 ·122 559	13 260 ·5
	Shell Point	69	13	02 ·5	+0 ·2	02 ·7	...	4 ·150 236	14 133 ·0
31	Martello Tower	69	35	34 ·5	−0 ·3	34 ·2	...	4 ·150 236	14 133 ·0
	Fort Wood	45	31	....	...	02 ·8	...	4 ·031 758	10 758 ·7
	Proctor Point 1853	64	53	22 ·6	+0 ·4	23 ·0	...	4 ·135 271	13 654 ·3
32	Battery Bienvenue	95	19	50 ·3	−1 ·6	48 ·7	...	4 ·135 271	13 654 ·3
	Fort Wood	27	02	....	...	08 ·0	...	3 ·794 728	6 233 ·44
	Martello Tower	57	38	05 ·0	−1 ·7	03 ·3	...	4 ·063 829	11 583 ·2
33	Ducros	45	40	33 ·0	0 ·0	33 ·0	0 ·0	3 ·794 727	6 233 ·42
	Bienvenue	82	00	03 ·1	+0 ·1	03 ·2	0 ·1	3 ·935 932	8 628 ·44
	Martello Tower	52	19	23 ·9	0 ·0	23 ·9	0 ·0	3 ·838 615	6 896 ·27
34	Caernarvon	44	49	59 ·7	+1 ·3	61 ·0	0 ·1	3 ·935 932	8 628 ·44
	Ducros	95	18	19 ·8	+1 ·4	21 ·2	0 ·1	4 ·085 848	12 185 ·6
	Martello Tower	39	51	36 ·7	+1 ·3	38 ·0	0 ·0	3 ·894 517	7 843 ·63
35	Saint Patrick's Church (center)	27	11	44 ·4	−0 ·2	44 ·2	0 ·1	3 ·894 517	7 843 ·63
	Ducros	97	16	17 ·0	−0 ·3	16 ·7	0 ·1	4 ·231 066	17 024 ·2
	Caernarvon	55	31	59 ·6	−0 ·2	59 ·4	0 ·1	4 ·150 739	14 149 ·4

14. SOME STATISTICS OF THE TRIANGULATION.

In the following table will be found some statistics relating to the triangulation.

In the third column is given the number of triangles contained in this discussion, including those few triangles of which but two angles were measured. In the next column is given the mean error of an angle derived from the relation $m = \sqrt{\frac{\Sigma \Delta^2}{3n}}$, where Δ = closing error of a triangle and n the number of triangles; in the last column is given the more precise measure of accuracy, namely, the probable error of an observed direction derived from the adjustment of the triangulation, given by the formula: $e_1 = 0{\cdot}674\sqrt{\frac{[pvv]}{c}}$ where v = the correction required by the figure adjustment, p its weight, usually unity, and c = number of conditions that entered into the adjustment.

Locality or name.	State.	Number of triangles.	Mean error of an angle.	Number of conditions satisfied.	Probable error of an observed direction.
			"		"
Epping base net.	Maine.	46	±0·63	35	±0·47
Northeastern boundary section.	Maine.	18	0·74	13	0·51
New England section, connecting three base lines.	Me., N. H., Mass., R. I., Conn.	53	0·53	57	0·26
Fire Island base net.	Connecticut, New York.	17	0·49	16	0·34
Section connecting the Fire Island and Kent Island bases.	N. Y., N. J., Penn., Del., Md.	33	0·86	35	0·47
Kent Island base net.	Maryland.	12	0·96	13	0·41
Allegheny section, to Humpback—Spear.*	Maryland and Virginia.	28	0·94	22	0·35
First section south of the transcontinental triangulation.	Virginia and North Carolina.	28	0·88	24	0·41
Second, or North Carolina section.	Virginia and North Carolina.	11	1·31	13	0·72
Third, or South Carolina section.	N. C., S. C., Ga.	35	0·78	41	0·62
Atlanta base net.	Georgia.	33	1·00	29	0·65
First section west of Atlanta base net.	Georgia and Alabama.	25	0·97	23	0·79
Second section west of Atlanta base net.	Alabama.	16	0·78	18	0·67
Third section west of Atlanta base net.	Alabama.	13	0·77	14	0·36
Fourth section west of Atlanta base net.	Alabama.	28	0·63	30	0·34
Fifth and last section west of Atlanta base net.	Alabama.	28	0·68	28	0·35
Dauphin Island base net.†	Alabama.	5	0·51	5	0·26
First section west of Dauphin Island base net.	Alabama and Mississippi.	19	0·78	18	0·53
Second section west of Dauphin Island base net.	Alabama and Mississippi.	35	1·20	27	0·78
Total number of triangles		483		461	
Weighted mean			±0·82		±0·51

* Estimated for two quadrilaterals beyond line Mount Marshall to Bull Run.
† Of little weight on account of the small extent.

C. RESULTING GEOGRAPHIC POSITIONS OF THE PRINCIPAL STATIONS OF THE TRIANGULATION BETWEEN CALAIS, MAINE, AND NEW ORLEANS, LOUISIANA, BASED UPON THE CLARKE SPHEROID OF 1866 AND THE DATA OF THE TRANSCONTINENTAL TRIANGULATION.

The geographic positions in the following list are those used in this investigation of the figure and size of the earth. They conform to those published in Special Publication No. 4, "The Transcontinental Triangulation." These positions, as well as those in Special Publication No. 4, are not intended to be used for geographic purposes, and do not conform to the principal lists heretofore published for that purpose, namely, for Massachusetts, in the Report for 1894, Appendix No. 10; Rhode Island, in the Report for 1885, Appendix No. 8; and Connecticut, in the Report for 1888, Appendix No. 8.

On March 13, 1901, the Superintendent adopted a uniform standard for the whole United States, to which all positions intended for geographic purposes are to be reduced and which is to be known as the United States Standard Datum. The New England positions referred to above are based upon the United States Standard Datum. The corrections required to reduce the positions here published to the United States Standard vary at different parts of the arc, and in general fall between the limits $\Delta\varphi = +1''{\cdot}9$ to $+2''{\cdot}1$, $\Delta\lambda = -0''{\cdot}5$ to $-0''{\cdot}8$, $\Delta\alpha = -1''$ to $+2''$.

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
New Brunswick.	° ′ ″	° ′ ″	° ′ ″			
Chamcook	45 07 28·347	345 52 03·60	165 55 08·78	Prince Regents Redoubt	4·371 372 8	23 516·51
	67 05 02·797	63 13 17·88	242 57 00·70	Cooper	4·529 929 1	33 878·88
Grand Manan	44 44 51·626	93 12 51·10	273 01 08·65	Trescott Rock	4·342 006 7	21 978·94
	66 49 54·371	143 23 18·98	323 15 43·07	Prince Regents Redoubt	4·376 239 0	23 781·49
St. David	45 15 00·878	319 44 57·74	139 51 21·33	Chamcook	4·262 200 0	18 289·42
	67 14 03·514	46 50 37·49	226 42 28·44	Rye	4·315 000 5	20 653·82
Maine.						
Agamenticus	43 13 22·638	2 36 55·92	182 35 23·16	Thompson	4·832 776 9	68 041·97
	70 41 33·831	70 12 55·05	249 36 10·39	Unkonoonuc	4·890 346 8	77 686·72
Burke	44 35 54·036	235 13 08·22	55 19 08·45	Epping East Base	4·138 343 6	13 751·30
	67 58 31·319	337 01 27·04	157 05 01·62	Pigeon	4·238 847 6	17 331·96
Calais Observatory	45 11 03·778	206 54 46·96	26 56 47·91	St. David	3·914 328 3	8 209·72
	67 16 53·919	293 06 27·23	113 14 51·42	Chamcook	4·227 816 4	16 897·26
Cooper	44 59 11·570	351 53 09·93	171 56 10·98	Howard	4·603 402 1	40 123·80
	67 28 03·393	75 09 42·97	254 42 27·80	Humpback	4·720 893 2	52 588·79
Epping East Base	44 40 07·844	277 06 58·49	97 25 23·31	Howard	4·543 117 5	34 923·48
	67 49 58·595	10 52 25·53	190 50 00·47	Pigeon	4·384 324 6	24 228·39
Epping West Base	44 41 29·938	286 51 55·17	106 56 21·42	Epping East Base	3·940 314 3	8 715·94
	67 56 17·247	15 55 06·50	195 53 32·29	Burke	4·032 670 8	10 781·29

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Maine—continued.	° ′ ″	° ′ ″	° ′ ″			
Howard	44 37 44·677	65 14 08·80	244 39 11·85	Mount Desert	4·863 229 0	72 984·22
	67 23 46·486	114 58 25·70	294 28 14·79	Humpback	4·794 490 4	62 300·34
Humpback	44 51 48·770	9 16 19·46	189 11 24·63	Mount Desert	4·761 268 0	57 712·25
	68 06 38·896	75 18 57·53	254 35 06·04	Mount Harris	4·929 927 0	85 099·50
Mount Blue	44 43 39·450	341 59 11·59	162 10 16·31	Sabattus	4·834 048 9	68 241·56
	70 20 34·175	26 19 26·58	205 59 17·53	Mount Pleasant	4·938 618 6	86 819·76
Mount Desert	44 21 03·308	78 30 45·89	257 52 02·56	Ragged Mountain.	4·877 280 4	75 384·21
	68 13 38·729	115 46 16·62	295 07 31·34	Mount Harris	4·909 249 6	81 142·72
Mount Harris	44 39 52·920	52 18 27·54	231 39 24·14	Sabattus	4·973 438 4	94 067·24
	69 08 55·730	94 38 42·84	273 48 19·48	Mount Blue	4·977 267 1	94 900·20
Mount Independence	43 45 31·774	26 55 48·38	206 40 27·15	Agamenticus	4·824 135 1	66 701·43
	70 19 15·306	72 46 34·95	252 03 08·40	Gunstock	4·948 470 6	88 811·78
Mount Pleasant	44 01 34·698	306 12 05·15	126 32 58·37	Mount Independence	4·699 925 8	50 110·16
	70 49 22·903	38 06 09·79	217 43 27·36	Gunstock	4·855 408 1	71 681·66
Pigeon	44 27 16·964	159 01 42·47	338 52 24·67	Humpback	4·687 346 9	48 679·59
	67 53 25·321	243 33 55·23	63 54 42·96	Howard	4·641 374 5	43 789·96
Prince Regents Redoubt	44 55 09·523	23 21 55·30	203 17 47·74	Trescott Rock	4·289 384 2	19 470·82
	67 00 41·010	101 53 09·22	281 33 48·83	Cooper	4·565 481 2	36 768·95
Ragged Mountain	44 12 43·434	84 26 23·93	263 47 37·44	Sabattus	4·872 442 9	74 549·19
	69 09 06·369	180 16 01·14	0 16 08·59	Mount Harris	4·701 544 4	50 297·27
Rye	45 07 22·680	269 30 22·00	89 44 53·68	Chamcook	4·429 504 7	26 884·67
	67 25 32·890	12 16 13·96	192 14 27·44	Cooper	4·190 727 0	15 514·11
Sabattus	44 08 35·858	24 31 20·64	204 21 16·42	Mount Independence	4·671 377 7	46 922·13
	70 04 44·734	77 57 07·94	257 26 04·67	Mount Pleasant	4·785 231 0	60 986·12
Trescott Rock	44 45 30·338	57 50 42·10	237 38 34·60	Howard	4·430 277 0	26 932·52
	67 06 32·099	131 56 03·38	311 40 52·33	Cooper	4·580 099 7	38 027·67
Tunk	44 38 21·352	244 50 15·71	64 56 52·13	Epping West Base	4·137 328 2	13 [illegible]9·18
	68 05 41·166	295 35 27·52	115 40 29·44	Burke	4·021 662 3	10 511·44
New Hampshire.						
Gunstock	43 31 02·306	300 32 51·33	121 00 45·86	Agamenticus	4·805 515 8	63 902·20
	71 22 12·299	49 43 23·05	219 13 02·94	Monadnock	4·975 287 4	94 468·59
Monadnock	42 51 39·141	336 14 22·31	156 23 22·41	Wachusett	4·654 798 1	45 164·59
	72 06 31·641	32 59 09·94	212 37 15·13	Mount Tom	4·913 165 6	81 877·70
Mount Washington	44 16 12·057	3 39 08·74	183 36 23·95	Gunstock	4·923 248 1	83 800·79
	71 18 14·620	236 02 04·01	56 42 29·47	Mount Blue	4·962 918 5	91 816·03
Unkonoonuc	42 58 57·845	24 06 11·10	203 54 01·87	Wachusett	4·778 830 2	60 093·87
	71 35 20·266	72 29 09·91	252 07 55·50	Monadnock	4·648 835 1	44 548·71
Massachusetts.						
Blue Hill	42 12 41·933	116 02 50·31	295 31 36·62	Wachusett	4·849 420 1	70 700·11
	71 06 53·495	155 43 43·52	335 24 28·28	Unkonoonuc	4·973 491 2	94 078·68
Copecut	41 43 15·238	133 18 12·60	313 02 35·32	Beaconpole	4·647 630 0	44 425·27
	71 03 37·477	175 17 04·04	355 14 52·96	Blue Hill	4·737 944 0	54 694·54
Great Meadow	41 52 43·127	123 44 54·33	303 35 33·64	Beaconpole	4·365 932 1	23 223·74
	71 13 03·129	192 54 33·99	12 58 41·54	Blue Hill	4·579 231 4	37 951·71
Manomet	41 55 36·706	59 44 28·05	239 25 42·09	Copecut	4·655 000 3	45 185·63
	70 35 28·985	126 18 32·57	305 57 29·89	Blue Hill	4·729 513 1	53 643·00

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Massachusetts—cont'd.	° ′ ″	° ′ ″	° ′ ″			
Massachusetts North	42 03 04·581	2 34 33·83	182 34 08·81	Great Meadow	4·283 145 5	19 193·12
Base.	71 12 25·718	72 44 03·22	252 34 16·55	Beaconpole	4·324 757 7	21 123·10
Massachusetts South	41 54 47·907	126 46 52·66	306 41 01·58	Beaconpole	4·178 727 3	15 091·32
Base.	71 18 16·951	207 47 09·72	27 51 04·66	Massachusetts North Base	4·238 707 7	17 326·38
Thompson	42 36 39·930	351 21 40·40	171 27 17·43	Manomet	4·885 726 8	76 864·68
	70 43 50·053	120 44 30·14	300 09 30·63	Unkonoonuc	4·910 955 9	81 461·99
Wachusett	42 29 18·755	24 17 32·42	204 04 58·96	Bald Hill	4·797 545 0	62 740·07
	71 53 14·835	66 36 43·04	246 05 55·97	Mount Tom	4·835 503 1	68 470·44
Rhode Island.						
Beaconpole	41 59 40·450	146 50 03·48	326 32 26·18	Wachusett	4·817 279 5	65 656·77
	71 27 02·094	228 55 17·53	49 08 47·86	Blue Hill	4·565 581 4	36 777·43
Connecticut.						
Bald Hill (Fairfied Co.)	41 12 47·787	354 16 31·28	174 18 35·50	West Hills	4·648 135 6	44 477·01
	73 28 42·425	53 21 43·93	233 14 00·54	Round Hill	4·311 236 3	20 475·58
Bald Hill (Tolland Co.)	41 58 23·851	47 57 30·50	227 47 12·01	Box Hill	4·459 356 2	28 797·59
	72 11 55·844	82 45 17·34	262 04 10·02	Ivy	4·933 714 3	85 844·86
Box Hill	41 47 57·748	47 47 18·30	227 27 37·22	Sandford	4·745 910 0	55 707·03
	72 27 22·205	97 22 57·97	276 52 12·72	Ivy	4·808 420 3	64 331·00
Ivy	41 52 16·434	20 54 57·85	200 44 26·86	Wooster	4·791 513 4	61 874·74
	73 13 28·707	333 14 05·75	153 25 02·99	Sandford	4·707 138 1	50 949·29
Mount Tom	42 14 28·749	308 30 08·92	128 48 15·19	Bald Hill	4·678 180 7	47 662·93
	72 38 55·874	16 12 13·22	196 00 09·83	Sandford	4·955 070 1	90 171·67
Round Hill	41 06 11·097	355 06 36·16	175 07 57·15	Harrow	4·531 267 4	33 983·45
	73 40 26·520	93 36 48·78	273 31 24·58	Buttermilk	4·061 771 2	11 528·46
Sandford	41 27 40·743	29 14 57·16	208 56 10·16	West Hills	4·914 716 0	82 170·50
	72 57 00·074	74 53 48·60	254 32 26·29	Wooster	4·669 171 0	46 684·31
Tashua	41 15 35·778	16 39 34·41	196 32 40·09	West Hills	4·712 561 3	51 589·50
	73 15 02·083	74 53 51·31	254 44 50·56	Bald Hill	4·296 541 3	19 794·35
Wooster	41 21 01·906	296 42 15·07	116 51 40·62	Tashua	4·348 836 2	22 327·30
	73 29 18·883	354 55 05·52	174 57 33·87	West Hills	4·776 212 0	59 732·68
New York.						
Buttermilk	41 06 34·358	337 18 08·70	157 24 52·90	Harrow	4·573 628 3	37 465·22
	73 48 39·626	50 48 43·39	230 33 55·67	Weasel	4·611 542 6	40 882·98
Fire Island East Base	40 40 01·370	72 59 54·96	252 53 42·31	Fire Island West Base	4·147 953 5	14 058·97
	73 03 20·690	185 32 47·29	5 33 40·57	Ruland	4·296 291 1	19 782·95
Fire Island West Base	40 37 47·708	139 03 50·98	318 55 34·92	West Hills	4·434 543 0	27 198·38
	73 12 52·757	212 43 36·41	32 50 43·00	Ruland	4·452 173 4	28 325·23
Harrow	40 47 53·430	46 46 40·35	226 23 41·32	Beacon Hill	4·836 466 7	68 622·52
	73 38 22·949	78 54 41·49	258 26 35·67	Springfield	4·791 009 9	61 803·04
Ruland	40 50 39·695	84 27 43·20	264 12 18·67	West Hills	4·522 397 1	33 296·39
	73 01 59·070	158 27 26·10	338 18 51·86	Tashua	4·695 847 6	49 641·81
West Hills	40 48 52·117	84 14 38·01	264 06 14·93	Harrow	4·258 590 2	18 138·03
	73 25 33·130	146 57 23·22	326 47 37·59	Round Hill	4·582 434 1	38 232·62
New Jersey.						
Beacon Hill	40 22 24·457	54 04 37·07	233 55 44·04	Disboro	4·381 086 1	24 048·39
	74 13 42·595	89 11 18·23	268 52 02·79	Mount Rose	4·624 192 8	42 091·35
Burden	39 31 46·807	92 19 43·45	272 06 19·93	Buck	4·479 550 7	30 168·29
	75 22 53·468	125 42 11·79	305 29 34·66	Meetinghouse Hill	4·541 913 9	34 826·82

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
New Jersey—cont'd.	° ′ ″	° ′ ″	° ′ ″			
Disboro	40 14 46 ·206	36 59 09 ·68	216 54 21 ·32	Stony Hill	4 ·245 277 5	17 590 ·47
	74 27 26 ·539	120 42 48 ·60	300 32 27 ·66	Mount Rose	4 ·420 656 6	26 342 ·48
Lippincott	39 43 18 ·439	15 13 27 ·12	195 10 52 ·12	Burden	4 ·344 465 5	22 103 ·73
	75 18 50 ·435	88 20 56 ·06	268 05 42 ·10	Meetinghouse Hill	4 ·532 554 6	34 084 ·32
Mount Holly	40 00 06 ·997	37 44 05 ·93	217 36 13 ·36	Pine Hill	4 ·456 957 7	28 638 ·99
	74 47 20 ·003	86 35 25 ·41	266 12 20 ·93	Yard	4 ·709 403 7	51 215 ·76
Mount Rose	40 22 01 ·305	336 08 37 ·91	156 14 09 ·32	Stony Hill	4 ·477 625 9	30 034 ·88
	74 43 26 ·437	52 17 55 ·71	232 10 17 ·61	Newtown	4 ·325 374 2	21 153 ·11
Pine Hill	39 47 51 ·982	73 01 33 ·85	252 49 15 ·97	Lippincott	4 ·458 328 4	28 729 ·52
	74 59 36 ·725	120 07 49 ·05	299 52 39 ·94	Yard	4 ·589 931 4	38 898 ·37
Springfield	40 41 20 ·056	342 40 01 ·47	162 45 02 ·54	Beacon Hill	4 ·564 498 1	36 685 ·81
	74 21 25 ·878	41 07 50 ·79	220 53 32 ·66	Mount Rose	4 ·675 473 3	47 366 ·72
Stony Hill	40 07 10 ·408	53 38 10 ·91	233 30 10 ·43	Mount Holly	4 ·342 240 8	21 990 ·79
	74 34 53 ·452	116 48 03 ·07	296 34 55 ·12	Newtown	4 ·509 657 7	32 333 ·87
Weasel	40 52 34 ·725	280 28 06 ·31	100 49 34 ·50	Harrow	4 ·671 752 6	46 962 ·65
	74 11 12 ·916	3 37 06 ·77	183 35 29 ·31	Beacon Hill	4 ·747 798 8	55 949 ·84
Pennsylvania.						
Bethel	39 50 44 ·107	312 12 38 ·26	132 19 24 ·93	Lippincott	4 ·310 393 6	20 435 ·89
	75 29 25 ·964	345 02 04 ·97	165 06 15 ·62	Burden	4 ·559 914 6	36 300 ·67
Newtown	40 15 01 ·301	337 47 32 ·53	157 52 38 ·39	Mount Holly	4 ·473 984 7	29 784 ·12
	74 55 14 ·585	52 41 13 ·57	232 34 02 ·22	Willowgrove	4 ·298 685 8	19 892 ·33
Willowgrove	40 08 29 ·820	299 41 39 ·27	119 53 55 ·03	Mount Holly	4 ·494 280 7	31 209 ·06
	75 06 22 ·930	345 47 33 ·76	165 51 54 ·70	Pine Hill	4 ·595 230 7	39 375 ·92
Yard	39 58 22 ·673	347 17 37 ·09	167 20 26 ·24	Lippincott	4 ·456 145 5	28 585 ·48
	75 23 14 ·426	31 59 46 ·98	211 55 48 ·61	Bethel	4 ·221 948 9	16 670 ·51
Delaware.						
Buck	39 32 24 ·651	67 06 19 ·17	246 55 43 ·41	Turkey Point	4 ·414 063 1	25 945 ·56
	75 43 55 ·784	104 07 31 ·29	283 57 06 ·28	Principio	4 ·382 796 0	24 143 ·27
Meetinghouse Hill	39 42 44 ·148	5 21 32 ·18	185 20 44 ·31	Buck	4 ·283 056 5	19 189 ·18
	75 42 40 ·734	62 20 38 ·41	242 09 24 ·37	Principio	4 ·454 159 6	28 455 ·06
Maryland.						
Finlay*	39 24 25 ·852	354 34 26 ·29	174 35 54 ·68	Linstid	4 ·550 316 3	35 507 ·19
	76 31 29 ·080	20 18 03 ·46	200 12 20 ·76	Webb	4 ·574 261 9	37 519 ·92
Hill*	38 53 52 ·767	94 38 26 ·59	274 25 17 ·09	Peach Grove	4 ·482 609 8	30 381 ·54
	76 52 50 ·328	159 55 24 ·59	339 51 27 ·46	Stabler	4 ·420 998 3	26 363 ·21
Kent Island North Base*	38 58 24 ·429	64 41 00 ·08	244 30 52 ·03	Marriott	4 ·411 765 7	25 808 ·67
	76 20 27 ·924	135 37 59 ·69	315 32 31 ·31	Linstid	4 ·253 398 2	17 922 ·48
Kent Island South Base*	38 53 51 ·787	82 53 40 ·15	262 44 29 ·64	Marriott	4 ·328 444 0	21 303 ·16
	76 21 58 ·789	141 47 26 ·42	321 43 41 ·57	Taylor	4 ·143 529 1	13 916 ·47
Linstid*	39 05 19 ·591	24 16 04 ·75	204 11 23 ·97	Marriott	4 ·417 956 2	26 179 ·19
	76 29 09 ·376	90 34 47 ·58	270 27 37 ·96	Webb	4 ·214 204 0	16 375 ·86
Marriott*	38 52 25 ·417	96 37 35 ·04	276 27 23 ·21	Hill	4 ·373 719 9	23 643 ·94
	76 36 35 ·724	166 46 12 ·26	346 43 44 ·42	Webb	4 ·392 324 7	24 678 ·84
Maryland Heights*	39 20 25 ·561	358 43 10 ·54	178 43 40 ·38	Bull Run	4 ·707 753 2	51 021 ·49
	77 43 00 ·445	34 00 56 ·52	213 42 33 ·59	Mount Marshall	4 ·878 122 3	75 530 ·49

* Stations in common with and fixed by the transcontinental triangulation.

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distances.	Distance in meters.
Maryland—continued.	° ′ ″	° ′ ″	° ′ ″			
Osbornes Ruin *	39 27 52·796	355 38 26·43	175 39 06·70	Pooles Island	4·301 337 0	20 014·14
	76 16 53·430	73 07 42·15	252 58 25·92	Finlay	4·340 289 4	21 892·20
Principio	39 35 34·552	1 34 34·59	181 34 22·88	Turkey Point	4·203 937 0	15 993·26
	76 00 17·006	59 11 31·99	239 00 57·80	Osbornes Ruin	4·443 000 9	27 733·26
Pooles Island *	39 17 05·681	41 27 16·64	221 18 51·52	Linstid	4·462 716 4	29 021·27
	76 15 49·954	121 11 55·79	301 02 00·38	Finlay	4·419 418 8	26 267·50
Soper *	39 05 09·703	268 49 18·14	88 59 42·70	Webb	4·376 775 7	23 810·90
	76 57 01·286	343 50 29·38	163 53 07·29	Hill	4·337 076 1	21 730·82
Stabler *	39 07 15·569	43 31 30·39	223 22 16·17	Peach Grove	4·488 456 8	30 793·34
	76 59 07·050	114 01 10·52	293 45 41·37	Sugar Loaf	4·586 513 6	38 593·45
Sugar Loaf *	39 15 42·412	32 29 22·28	212 17 39·05	Bull Run	4·699 551 7	50 067·01
	77 23 37·423	107 30 00·24	287 17 43·59	Maryland Heights	4·465 432 7	29 203·35
Swan Point *	39 08 28·277	15 47 58·81	195 45 40·90	Kent Island North Base	4·286 689 1	19 350·36
	76 16 49·060	71 56 57·47	251 49 10·42	Linstid	4·272 151 1	18 713·33
Taylor *	38 59 46·243	42 39 34·28	222 34 07·97	Marriott	4·266 498 5	18 471·34
	76 27 56·483	170 19 43·07	350 18 57·15	Linstid	4·018 198 2	10 427·93
Turkey Point *	39 26 56·156	50 19 42·97	230 10 02·89	Pooles Island	4·454 483 8	28 476·32
	76 00 35·405	94 21 30·60	274 11 09·07	Osbornes Ruin	4·370 101 8	23 447·78
Webb *	39 05 24·413	39 54 36·51	219 46 51·13	Hill	4·443 721 1	27 779·29
	76 40 30·733	97 22 49·52	277 11 05·40	Stabler	4·432 017 4	27 040·67
Virginia.						
Buffalo	36 47 44·069	228 57 42·54	49 14 21·99	Cahas	4·735 698 6	54 412·49
	80 28 39·565	253 08 13·16	73 41 04·05	Smith Mountain	4·928 312 3	84 783·69
Bull Run *	38 52 51·450	22 30 41·85	202 19 28·81	Clark	4·835 447 1	68 461·61
	77 42 13·145	75 02 38·38	254 43 51·26	Mount Marshall	4·652 400 4	44 915·93
Cahas	37 06 59·770	225 48 35·67	46 04 19·60	Flat Top	4·727 663 5	53 415·04
	80 00 57·165	285 47 27·89	106 03 44·13	Smith Mountain	4·619 220 5	41 612·18
Clark *	38 18 38·975	63 09 16·78	242 36 05·03	Humphack	4·945 819 1	88 271·22
	78 00 12·025	117 25 51·89	297 10 28·99	Fork	4·608 326 9	40 581·39
Flat Top	37 27 04·683	249 54 24·62	70 08 44·49	Tobacco Row	4·567 083 6	36 904·86
	79 34 58·928	291 56 16·53	112 14 21·89	Long Mountain	4·676 543 2	47 483·55
Fork *	38 28 42·681	35 52 11·94	215 34 15·71	Humpback	4·860 307 4	72 494·88
	78 24 57·999	66 26 43·47	245 53 18·19	Elliott Knob	4·933 878 8	85 877·38
Humphack *	37 56 53·769	88 32 08·02	267 57 00·80	Bald Knob	4·922 915 2	83 736·58
	78 53 57·777	123 40 43·29	303 25 22·28	Elliott Knob	4·640 543 9	43 706·28
Long Mountain	37 17 25·480	192 40 49·96	12 47 40·77	Humpback	4·874 224 9	74 855·71
	79 05 10·772	163 09 09·28	343 05 20·80	Tobacco Row	4·502 886 7	31 833·67
Mount Marshall *	38 46 31·688	341 17 18·02	161 24 45·90	Clark	4·735 883 3	54 435·64
	78 12 10·813	29 26 44·10	209 18 45·18	Fork	4·577 810 3	37 827·73
Peach Grove *	38 55 10·601	84 11 21·80	263 53 30·60	Bull Run	4·616 253 0	41 328·82
	77 13 47·327	159 34 44·78	339 28 32·69	Sugar Loaf	4·607 957 7	40 546·91
Rogers	36 39 33·968	332 46 32·04	153 00 20·50	Poore	4·883 517 2	76 474·60
	81 32 42·378	40 46 10·34	220 24 47·93	Roan High Bluff	4·918 217 4	82 835·67
Smith Mountain	37 00 49·354	178 13 04·37	358 12 27·17	Flat Top	4·686 522 9	48 587·31
	79 33 57·454	234 04 31·61	54 21 54·41	Long Mountain	4·720 334 3	52 521·16

* Stations in common with and fixed by the transcontinental triangulation.

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Virginia—continued.	° ′ ″	° ′ ″	° ′ ″			
Spear*	37 33 40·751	90 43 50·62	270 28 12·08	Tobacco Row	4·577 326 2	37 785·59
	78 45 47·192	164 25 09·04	344 20 08·66	Humpback	4·649 283 4	44 594·72
Tobacco Row*	37 33 53·594	124 40 32·20	304 16 16·15	Bald Knob	4·849 042 8	70 638·72
	79 11 26·704	211 01 07·74	31 11 50·01	Humpback	4·696 339 5	49 698·07
North Carolina.						
Benn	35 33 52·827	220 18 10·43	40 35 51·27	Poore	4·846 167 0	70 172·51
	81 39 38·032	257 56 53·55	78 32 18·85	Young	4·971 708 4	93 693·28
King	35 12 25·649	141 33 39·31	321 21 34·31	Benn	4·705 136 6	50 715·02
	81 18 46·057	225 34 50·93	45 58 00·43	Young	4·925 530 7	84 242·39
Mount Mitchell	35 45 51·44	196 27 56·26	16 32 08·81	Roan High Bluff	4·579 630 9	37 986·64
	82 15 55·02	291 50 44·49	112 11 53·77	Benn	4·771 325 1	59 064·30
Moore	36 23 51·403	158 33 32·10	338 26 34·89	Buffalo	4·676 356 4	47 463·13
	80 16 59·756	196 34 48·69	16 44 24·74	Cahas	4·920 554 3	83 282·60
Poore	36 02 45·446	216 00 54·42	36 25 06·19	Buffalo	5·013 257 0	103 099·60
	81 09 24·748	243 19 33·69	63 50 32·14	Moore	4·943 028 7	87 705·88
Roan High Bluff	36 05 33·179	273 01 48·50	93 36 44·46	Poore	4·950 523 6	89 232·61
	82 08 44·634	323 02 32·54	143 19 34·95	Benn	4·864 269 1	73 159·22
Young	35 44 12·276	126 52 52·65	306 34 58·00	Poore	4·758 644 5	57 364·67
	80 38 51·665	204 00 42·26	24 13 34·64	Moore	4·904 942 5	80 341·98
South Carolina.						
Hogback	35 10 10·003	232 22 49·92	52 44 43·12	Benn	4·858 124 0	72 131·33
	82 17 26·782	305 44 12·69	125 56 27·81	Wofford	4·602 019 6	39 996·28
Mauldin	34 49 16·196	157 26 59·56	337 23 19·17	Pinnacle	4·405 586 3	25 444·05
	82 38 05·506	236 56 13·57	57 03 53·95	Paris	4·386 965 5	24 376·17
Paris	34 56 27·015	203 23 41·77	23 27 50·87	Hogback	4·441 543 7	27 640·36
	82 24 40·474	267 18 15·89	87 34 37·37	Wofford	4·638 655 1	43 516·62
Pinnacle	35 01 58·585	249 39 13·79	69 54 47·43	Hogback	4·641 697 5	43 822·54
	82 44 30·447	288 36 31·38	108 47 53·70	Paris	4·503 290 4	31 863·27
Wofford	34 57 30·072	200 18 39·13	20 28 10·18	Benn	4·855 901 2	71 763·10
	81 56 07·174	243 53 46·98	64 15 15·08	King	4·800 210 3	63 126·29
Georgia.						
Academy	33 57 30·366	82 42 39·78	262 34 27·87	Atlanta Northeast Base	4·358 117 9	22 809·61
	83 59 28·860	153 06 53·34	333 01 11·19	Sawnee	4·538 334 2	34 540·94
Atlanta Middle Base	33 54 19·447	232 08 09·06	52 09 31·84	Atlanta Northeast Base	3·683 590 2	4 826·03
	84 16 38·136	312 22 32·71	132 26 55·60	Stone Mountain	4·215 648 3	16 430·41
Atlanta Northeast Base	33 55 55·564	126 18 04·86	306 10 41·94	Sweat Mountain	4·401 456 3	25 203·24
	84 14 09·791	191 36 22·37	11 38 54·02	Sawnee	4·536 834 8	34 421·90
Atlanta Southwest Base	33 52 49·530	232 06 51·76	52 09 31·84	Atlanta Northeast Base	3·970 276 1	9 338·48
	84 18 56·758	297 51 14·29	117 56 54·30	Stone Mountain	4·249 470 6	17 761·13
Blood	34 44 20·949	246 34 02·45	66 55 53·35	Rabun	4·802 267 7	63 426·06
	83 56 13·609	294 15 38·14	114 34 46·12	Currahee	4·752 074 5	56 503·39
Carnes	33 59 33·442	223 31 55·32	43 44 36·86	Pine Log	4·701 967 7	50 346·31
	85 00 50·358	272 34 29·97	92 49 04·34	Kenesaw	4·604 183 7	40 196·08
Currahee	34 31 42·855	188 10 26·00	8 13 02·19	Rabun	4·689 285 1	48 897·33
	83 22 33·706	244 14 58·60	64 40 16·60	Mauldin	4·876 702 1	75 283·90
Grassy	34 29 08·280	232 01 27·85	52 14 54·33	Blood	4·661 044 2	45 818·85
	84 19 53·408	267 37 13·27	87 57 55·37	Skitt	4·748 161 8	55 996·62

*Stations in common with and fixed by the transcontinental triangulation.

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Georgia—continued.	° ′ ″	° ′ ″	° ′ ″			
Gulf Point	34 37 29·827	270 21 36·61	90 34 11·56	Johns	4·529 537 9	33 848·38
	85 28 02·824	356 37 55·63	176 39 21·02	Indian	4·820 337 1	66 120·65
Johns	34 37 20·912	308 08 41·55	128 24 21·18	Pine Log	4·732 129 0	53 967·09
	85 05 54·122	27 40 24·62	207 33 57·13	Lavender	4·576 176 5	37 685·70
Kenesaw	33 58 32·066	172 06 13·42	352 04 16·70	Pine Log	4·587 666 4	38 696·03
	84 34 46·078	228 28 51·33	48 32 59·86	Sweat Mountain	4·182 214 9	15 213·00
Lavender	34 19 17·249	269 51 11·27	90 13 13·30	Pine Log	4·777 750 8	59 944·70
	85 17 18·719	325 09 29·15	145 18 44·08	Carnes	4·647 387 9	44 400·50
Pine Log	34 19 16·000	236 55 16.98	57 05 38·84	Grassy	4·525 240 9	33 515·13
	84 38 14·012	282 00 14·29	102 16 20·11	Sawnee	4·651 920 1	44 866·28
Rabun	34 57 53·468	261 24 26·47	81 43 38·88	Pinnacle	4·711 876 7	51 508·24
	83 17 59·673	284 30 08·34	104 52 57·92	Mauldin	4·798 278 1	62 846·07
Sawnee	34 14 09·823	150 29 47·95	330 24 01·28	Grassy	4·502 751 8	31 823·78
	84 09 39·192	233 23 17·41	53 38 08·81	Skitt	4·700 538 9	50 180·95
Skitt	34 30 18·269	142 52 18·89	322 44 59·48	Blood	4·513 146 5	32 594·66
	83 43 20·214	265 12 55·59	85 24 41·92	Currahee	4·503 801 0	31 900·76
Stone Mountain	33 48 19·771	149 23 30·53	329 20 30·22	Atlanta Northeast Base	4·212 738 2	16 320·68
	84 08 46·239	220 08 00·33	40 13 11·06	Academy	4·346 400 3	22 202·42
Sweat Mountain	34 03 59·138	149 27 55·40	329 21 48·91	Pine Log	4·516 084 1	32 815·89
	84 27 21·883	235 15 57·16	55 25 53·73	Sawnee	4·519 739 5	33 093·26
Alabama						
Alpine	33 24 40·292	141 33 51·36	321 23 17·60	Cahaba	4·676 196 3	47 445·64
	86 12 27·492	257 27 29·92	77 40 41·45	Cheehahaw	4·579 566 6	37 981·02
Aurora	34 08 45·503	236 06 31·43	56 21 03·04	Brandon	4·677 999 5	47 643·04
	86 11 01·111	280 12 46·25	100 38 16·17	Indian	4·852 202 7	71 154·56
Bargenier	31 59 14·452	135 47 09·65	315 40 32·78	Lovers Leap	4·448 358 9	28 077·53
	86 36 51·350	180 29 12·15	0 29 17·59	Lowndesboro	4·497 668 4	31 453·46
Brandon	34 23 05·005	224 31 17·22	44 41 00·81	Gulf Point	4·573 188 9	37 427·34
	85 45 13·034	322 21 46·56	142 32 50·86	Indian	4·695 837 9	49 640·70
Cahaba	33 44 45·118	215 23 39·56	35 35 07·67	Aurora	4·736 436 7	54 505·05
	86 31 33·365	293 18 11·30	113 42 00·72	Cheehahaw	4·860 804 4	72 577·90
Cat Island	30 18 54·274	316 16 59·55	136 19 12·69	Dauphin Island East Base	4·009 213 8	10 214·42
	88 12 38·851	22 45 27·88	202 44 20·97	Dauphin Island West Base	3·962 492 9	9 172·61
Cedar Point	30 20 42·488	8 07 41·93	188 07 13·05	Dauphin Island East Base	4·034 458 5	10 825·76
	88 07 17·561	45 50 55·07	225 47 06·07	Dauphin Island West Base	4·228 357 0	16 918·31
Cheehahaw	33 29 05·692	154 46 13·71	334 33 42·57	Aurora	4·909 145 1	81 123·20
	85 48 31·422	210 19 49·60	30 32 36·45	Indian	4·845 763 8	70 107·39
Cold Creek	30 57 25·027	178 54 28·95	358 54 16·99	Coon	4·507 002 9	32 136·82
	88 05 20·666	258 07 44·44	78 17 03·22	Dean	4·468 673 0	29 422·05
Coon	31 14 48·358	229 07 38·35	49 16 37·46	White	4·558 422 2	36 176·14
	88 05 43·811	275 44 45·98	95 58 16·99	Red Hill	4·619 293 4	41 619·17
County Line	31 57 50·224	175 38 53·09	355 38 18·09	Lovers Leap	4·357 278 3	22 765·56
	86 48 12·714	261 41 54·81	81 47 55·63	Bargenier	4·257 120 0	18 076·73
Creagh	31 36 11·130	232 48 02·18	53 02 09·41	Fatama	4·725 276 4	53 122·24
	87 41 03·677	306 32 42·87	126 39 37·61	Pollard	4·415 967 1	26 059·56
Daphne	30 36 05·762	114 19 01·13	294 11 37·90	Spring Hill	4·404 704 4	25 392·44
	87 54 16·946	190 49 52·66	10 51 41·67	Minette	4·479 341 0	30 153·73

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Alabama—continued.	° ′ ″	° ′ ″	° ′ ″			
Dauphin Island East	30 14 54·447	165 06 03·75	345 03 37·99	St. Elmo	4·475 527 2	29 890·09
Base	88 08 14·813	281 42 19·32	101 45 46·33	Fort Morgan	4·050 203 4	11 225·44
Dauphin Island West	30 14 19·561	264 11 23·52	84 14 43·35	Dauphin Island East Base	4·027 831 9	10 661·83
Base	88 14 51·558	273 08 47·15	93 15 33·90	Fort Morgan	4·335 134 2	21 633·87
Dean	31 00 40·292	131 43 27·82	311 33 54·72	Coon	4·594 429 9	39 303·38
	87 47 15·226	208 52 32·11	28 56 27·58	Red Hill	4·397 629 5	24 982·13
Ethridge	32 04 43·931	245 52 52·05	66 00 24·52	Lovers Leap	4·387 868 6	24 426·92
	87 03 29·565	297 50 18·42	117 58 24·57	County Line	4·434 991 6	27 226·49
Fatama	31 53 31·091	219 09 31·86	39 15 12·97	Ethridge	4·427 241 8	26 744·95
	87 14 13·528	258 52 11·33	79 05 56·77	County Line	4·620 873 3	41 770·85
Fort Morgan	30 13 40·307	149 07 17·14	329 01 23·61	St. Elmo	4·560 278 0	36 331·05
	88 01 23·757	195 20 38·09	15 24 14·17	Daphne	4·633 149 6	42 968·45
Fort Morgan, Ast. Az.	30 13 40·301	93 15 36·00	273 08 49·27	Dauphin Island West Base	4·335 120 3	21 633·17
Station 1847	88 01 23·784	143 59 50·69	323 56 52·27	Cedar Point	4·206 143 7	16 074·73
Gunter	34 34 04·490	297 43 27·43	117 57 40·83	Brandon	4·638 579 6	43 509·05
	86 10 20·627	1 16 10·17	181 15 47·32	Aurora	4·670 389 7	46 815·51
Horn	33 17 50·262	135 37 34·97	315 33 11·83	Alpine	4·247 564 0	17 683·33
	86 04 28·886	229 51 58·12	50 00 45·06	Cheehahaw	4·509 625 5	32 331·47
Indian	34 01 47·608	201 16 29·13	21 21 05·89	Lavender	4·540 524 3	34 715·57
	85 25 31·412	276 05 34·01	96 19 22·45	Carnes	4·582 375 3	38 227·45
Jamison	32 55 54·510	218 27 36·25	38 36 44·49	Kahatchee	4·621 350 2	41 816·74
	86 38 21·461	259 07 53·40	79 17 10·87	Weogufka	4·432 911 3	27 096·38
Kahatchee	33 13 36·299	214 45 04·57	34 50 06·42	Alpine	4·396 361 0	24 909·27
	86 21 37·002	253 32 15·48	73 41 39·37	Horn	4·443 056 7	27 736·82
Laurel	33 23 49·014	187 32 11·55	7 34 01·55	Cahaba	4·591 482 6	39 037·55
	86 34 52·286	267 17 39·53	87 29 59·89	Alpine	4·541 410 1	34 786·45
Lovers Leap	32 10 07·200	177 27 23·26	357 26 43·40	Parker	4·641 191 1	43 771·46
	86 49 18·648	240 10 22·47	60 17 06·35	Lowndesboro	4·358 925 0	22 852·04
Lowndesboro	32 16 15·581	146 11 13·53	326 03 47·53	Parker	4·591 081 3	39 001·50
	86 36 41·140	195 19 41·96	15 23 28·61	Wilder	4·619 619 3	41 650·41
Midway	31 43 03·463	137 05 59·66	316 59 59·11	Fatama	4·421 772 3	26 410·24
	87 02 49·417	220 06 02·24	40 13 44·76	County Line	4·553 155 5	35 740·08
Minette	30 52 07·453	112 50 33·81	292 43 03·26	Cold Creek	4·402 402 0	25 258·17
	87 50 43·649	199 17 30·87	19 19 18·03	Dean	4·223 609 6	16 734·38
Mount Carmel	32 01 14·072	81 43 25·91	261 34 58·84	Bargenier	4·404 518 7	25 381·58
	86 20 54·584	138 17 37·94	318 09 14·30	Lowndesboro	4·570 946 7	37 234·60
Parker	32 33 46·821	153 54 03·18	333 50 22·76	Perry	4·383 230 1	24 167·41
	86 50 33·110	256 31 28·49	76 42 44·26	Wilder	4·526 629 6	33 622·47
Perry	32 45 31·190	236 59 07·26	57 09 25·61	Jamison	4·548 055 3	35 322·81
	86 57 21·552	287 41 12·26	107 56 10·47	Wilder	4·657 953 4	45 493·93
Point Aux Pins	30 22 01·836	300 03 57·05	120 07 05·54	Cat Island	4·061 419 1	11 519·11
	88 18 51·990	335 41 32·18	155 43 33·50	Dauphin Island West Base	4·193 605 2	15 617·27
Pollard	31 27 46·614	204 17 09·00	24 24 18·11	Fatama	4·717 767 0	52 211·60
	87 27 50·666	234 23 07·18	54 36 13·60	Midway	4·686 818 9	48 620·44
Red Hill	31 12 30·412	153 26 19·69	333 21 45·01	White	4·493 964 7	31 186·36
	87 39 39·490	213 32 11·80	33 38 20·43	Pollard	4·529 843 1	33 872·18

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Alabama—continued.	° ′ ″	° ′ ″	° ′ ″			
Rowe	34 32 19·964	264 12 11·28	84 24 09·49	Gunter	4·511 149 9	32 445·16
	86 31 26·930	354 26 07·69	174 27 27·52	Summit	4·572 115 2	37 334·91
St. Elmo	30 30 32·402	198 15 34·06	18 17 44·69	Spring Hill	4·338 386 5	21 796·49
	88 13 03·031	251 02 15·61	71 11 48·08	Daphne	4·501 323 3	31 719·28
Spring Hill	30 41 44·505	190 40 37·82	10 42 23·26	Cold Creek	4·469 457 8	29 475·27
	88 08 46·420	236 14 48·44	56 24 02·58	Minette	4·539 029 5	34 596·29
Summit	34 12 13·980	215 20 58·80	35 31 34·10	Gunter	4·695 149 2	49 562·05
	86 29 05·522	282 56 19·01	103 06 28·15	Aurora	4·454 925 1	28 505·27
Weogufka	32 58 39·195	178 54 29·13	358 54 18·02	Kahatchee	4·441 562 5	27 641·55
	86 21 16·659	216 17 59·26	36 27 10·16	Horn	4·643 871 6	44 042·46
Wetumpka	32 32 01·458	111 27 30·94	291 17 49·29	Wilder	4·480 740 5	30 251·06
	86 11 38·672	163 02 42·85	342 57 30·12	Weogufka	4·711 520 4	51 466·00
White	31 27 35·857	216 23 55·91	36 27 48·11	Creagh	4·295 003 9	19 724·40
	87 48 27·684	269 19 44·97	89 30 30·60	Pollard	4·514 017 4	32 660·09
Wilder	32 37 59·434	157 42 34·34	337 37 51·32	Jamison	4·553 909 0	35 802·14
	86 29 38·754	198 50 42·47	18 55 14·50	Weogufka	4·605 982 4	40 362·91
Wilson	34 25 05·140	243 29 09·45	63 39 07·40	Rowe	4·478 573 3	30 100·47
	86 49 03·198	307 42 52·90	127 54 08·01	Summit	4·588 392 3	38 760·76
Wornock	33 59 46·272	220 24 31·96	40 31 41·84	Summit	4·481 194 5	30 282·69
	86 41 52·288	330 08 31·89	150 14 16·83	Cahaba	4·505 134 1	31 998·83
Mississippi.						
Bellefontaine	30 20 30·277	269 35 12·7	89 40 10·3	East Pascagoula	4·196 838 0	15 733·96
	88 42 34·781	5 21 57·4	185 21 40·0	Horn Island West	3·994 618 8	9 876·86
Bayou Casotte	30 19 42·575	273 40 46·49	93 43 34·91	Grande Batture	3·950 829 4	8 929·55
	88 30 47·883	8 39 12·09	188 38 37·58	Horn Island East 1855	4·085 225 7	12 168·18
Cat Island 1852	30 14 14·036	133 46 36·0	313 43 09·2	Pitcher Point 2	4·180 939	15 168·37
	89 04 04·370	192 09 47·4	12 10 51·7	Mississippi City	4·207 760	16 134·67
Cat Island 1855	30 14 13·864	192 11 08·4	12 12 12·8	Mississippi City	4·207 942	16 141·43
	89 04 04·655	268 39 41·4	88 45 06·2	Ship Island 1855	4·236 793	17 250·15
Cat Island Light	30 13 48·673	170 07 52·7	350 07 15·7	Pitcher Point 2	4·058 394	11 439·16
	89 09 40·973	265 02 48·3	85 05 37·6	Cat Island 1855	3·955 511	9 026 32
Deer Island 1	30 21 41·040	281 11 25·1	101 14 52·9	Bellefontaine	4·049 199 0	11 199·51
	88 49 26·110	320 00 30·8	140 03 40·9	Horn Island West	4·195 161 4	15 673·34
East Pearl River	30 10 56·193	290 33 51·7	110 36 52·8	Grand Island 1855	4·012 962	10 302·96
	89 31 27·272	346 21 48·4	166 22 43·3	Malheureux Point	4·094 055	12 418·09
East Pascagoula	30 20 33·593	296 30 53·20	116 31 52·72	Bayou Casotte	3·546 295 3	3 518·00
	88 32 45·725	354 27 13·86	174 27 38·76	Horn Island East 1855	4·135 600 2	13 664·70
Grande Batture	30 19 23·846	244 29 58·38	64 33 11·54	Point Aux Pins	4·053 513 2	11 311·32
	88 25 14·320	299 19 59·87	119 25 13·89	Dauphin Island West Base	4·281 040 2	19 100·30
Horn Island East 1855	30 13 11·901	223 08 47·17	43 12 09·83	Grande Batture	4·196 033 9	15 704·85
	88 31 56·341	278 35 37·43	98 39 43·74	Petit Bois	4·121 942 0	13 241·65
Horn Island West	30 15 10·928	239 09 04·5	59 14 19·1	East Pascagoula	4·287 827 7	19 401·16
	88 43 09·330	281 27 54·9	101 33 33·8	Horn Island East 1855	4·263 971 9	18 364·19
Mississippi City	30 22 46·232	275 39 51·7	95 46 11·4	Deer Island 1	4·304 316	20 151·90
	89 01 57·046	318 01 42·5	138 06 03·6	Ship Island 1855	4·315 662	20 685·31
Petit Bois	30 12 07·389	170 08 09·88	350 07 25·80	Grande Batture	4·134 862 2	13 641·50
	88 23 46·844	254 05 30·25	74 09 59·67	Dauphin Island West Base	4·172 673 0	14 882·40

Stations.	Latitude and longitude.	Azimuth.	Back azimuth.	To stations.	Log. distance.	Distance in meters.
Mississippi—continued.	° ′ ″	° ′ ″	° ′ ″			
Pitcher Point 2	30 19 54·661	249 45 00·5	69 49 32·0	Mississippi City	4·184 451	15 291·53
	89 10 54·368	313 45 13·3	133 48 39·9	Cat Island 1855	4·180 886	15 166·52
Point Clear	30 15 47·120	249 17 24·4	69 23 46·1	Pitcher Point 2	4·334 601	21 607·32
	89 23 30·982	314 11 31·4	134 16 19·7	Bayou Pierre	4·330 386	21 398·63
Ship Island 1855	30 14 26·509	204 59 18·5	25 01 16·3	Deer Island 1	4·169 209 5	14 764·19
	88 53 19·661	265 09 57·4	85 15 04·8	Horn Island West	4·214 177 3	16 374·85
South Point	30 11 13·376	128 55 16·1	308 53 24·6	Cat Island Light	3·881 619	7 614·11
	89 05 59·440	208 54 27·7	28 55 25·5	Cat Island 1855	3·802 717	6 349·17
Louisiana.						
Battery Bienvenue	29 59 02·847	219 38 18·8	39 40 36·8	Fort Wood	4·063 829	11 583·21
	89 52 51·433	314 58 07·5	134 59 29·6	Martello Tower	3·794 728	6 233·44
Bayou Pierre	30 07 42·355	192 15 30·9	12 17 03·3	Pitcher Point 2	4·363 173	23 076·66
	89 13 57·793	232 44 06·7	52 49 05·1	Cat Island 1852	4·299 670	19 937·47
Caernarvon	29 51 49·307	177 55 53·0	357 55 47·7	Ducros	3·894 517	7 843·63
	89 55 15·512	222 45 53·9	42 48 27·7	Martello Tower	4·085 847	12 185·60
Ducros	29 56 03·880	216 56 53·5	36 58 10·7	Battery Bienvenue	3·838 614 1	6 896·27
	89 55 26·070	262 37 26·5	82 40 05·7	Martello Tower	3·935 932 2	8 628·44
Fort Wood	30 03 52·460	236 08 50·4	56 13 26·9	Rigolet Light	4·249 405	17 758·45
	89 48 15·553	265 48 58·1	85 52 32·5	Shell Point	4·060 338	11 490·48
Grand Island 1852	30 08 49·748	191 44 45·8	11 45 36·1	Point Clear	4·118 166	13 127·02
	89 25 10·952	276 31 23·8	96 37 01·8	Bayou Pierre	4·258 550	18 136·35
Grand Island 1855	30 08 58·526	193 49 33·5	13 50 31·8	Point Clear	4·112 517	12 957·37
	89 25 26·819	277 12 00·3	97 17 46·3	Bayou Pierre	4·269 285	18 590·24
Malheureux Point	30 04 24·258	218 30 25·7	38 32 31·7	Grand Island 1855	4·033 214	10 794·79
	89 29 37·958	302 54 02·2	122 55 32·5	Nine Mile Bayou	3·981 100	9 574·14
Martello Tower	29 56 39·747	192 37 33·0	12 38 28·7	Fort Wood	4·135 271	13 654·35
	89 50 06·982	262 13 07·3	82 16 25·8	Proctor Point 1853	4·031 758	10 758·66
New Orleans, St. Patrick's Church	29 56 45·248	275 07 42·1	95 12 04·4	Ducros	4·150 739 1	14 149·44
	90 04 11·530	302 19 26·4	122 23 53·6	Caernarvon	4·231 066 2	17 024·18
Nine Mile Bayou	30 01 35·344	174 31 12·1	354 30 47·6	Grand Island 1855	4·137 007	13 709·04
	89 24 37·900	239 24 32·1	59 26 36·1	Oyster Bayou 1855	3·886 843	7 706·25
Oyster Bayou 1855	30 03 42·646	140 47 35·5	320 45 06·7	Grand Island 1855	4·098 857	12 556·16
	89 20 30·242	234 53 19·9	54 56 36·7	Bayou Pierre	4·108 621	12 841·65
Proctor Point 1853	29 57 26·888	147 09 48·9	327 07 25·8	Fort Wood	4·150 236	14 133·05
	89 43 29·441	196 38 18·8	16 39 29·7	Shell Point	4·122 559	13 260·47
Rigolet Light	30 09 13·411	255 27 45·4	75 31 35·2	East Pearl River	4·101 598	12 635·66
	89 39 04·455	300 22 34·6	120 27 18·8	Malheureux Point	4·245 179	17 586·48
Shell Point	30 04 19·492	200 01 05·8	20 02 07·6	Rigolet Light	3·983 750	9 632·74
	89 41 07·675	269 29 48·7	89 35 34·3	Malheureux Point	4·266 540	18 473·11

D. ADDITIONAL GEOGRAPHIC POSITIONS OF ASTRONOMIC STATIONS FOR WHICH TRIANGLES ARE NOT GIVEN IN THIS PAPER AND WHICH WERE DERIVED DIFFERENTIALLY.

Stations.	Latitude.			Longitude.		
	°	′	″	°	′	″
Maine.						
Bangor	44	48	14·19	68	47	01·20
Cape Small	43	46	41·24	69	50	45·20
Farmington	44	40	20·78	70	09	18·40
Isles of Shoals, astronomic latitude station	42	59	12·87	70	36	51·19
Massachusetts.						
Cambridge, Cloverden Observatory	42	22	44·28	71	07	18·46
Cambridge, Harvard Observatory	42	22	51·48	71	07	44·74
Indian	41	25	44·75	70	40	41·54
Shootflying	41	41	05·34	70	20	50·59
Rhode Island.						
Spencer	41	40	41·25	71	29	41·52
New York.						
New York, Rutherford Observatory	40	43	49·37	73	59	15·13
Delaware.						
Cape Henlopen Light-House, astronomic azimuth station *	38	46	39·42	75	05	03·52
Dover, astronomic latitude station	39	09	18·59	75	31	24·56
Dover, astronomic longitude station	39	09	18·59	75	31	24·51
Maryland.						
Rockville, astronomic latitude station	39	05	09·08	77	09	37·20
District of Columbia.						
Causten	38	55	33·16	77	04	24·37
Georgetown University Observatory	38	54	27·81	77	04	39·61
Seaton	38	53	26·82	77	00	00·10
United States Coast and Geodetic Survey Office, transit in yard	38	53	10·01	77	00	32·71
United States Naval Observatory, old site, dome	38	53	40·12	77	03	06·68
United States Naval Observatory, Georgetown Heights, center of clock room	38	55	14·89	77	04	02·80
Virginia.						
Charlottesville, McCormick Observatory	38	01	55·91	78	31	21·15
Elliott Knob, astronomic azimuth station *	38	09	57·22	79	18	51·84
Strasburg, astronomic latitude station	38	59	27·81	78	21	39·74
Strasburg, astronomic longitude station	38	59	27·82	78	21	39·54
North Carolina.						
Statesville, astronomic longitude station	35	46	54·34	80	53	40·44

* Stations in common with and fixed by the transcontinental triangulation.

Stations.	Latitude.			Longitude.		
Georgia.	°	′	″	°	′	″
Atlanta, astronomic station	33	44	56·10	84	23	19·41
Alabama.						
Lower Peach Tree, astronomic station	31	50	18·51	87	32	43·37
Mobile, astronomic station	30	41	28·91	88	02	33·83
Montgomery, astronomic station	32	22	37·37	86	18	00·92
Louisiana.						
New Orleans, astronomic station of 1858	29	57	18·05	90	04	25·14
New Orleans, astronomic station of 1880 and 1895	29	56	51·51	90	04	12·16

E. ADDITIONAL GEODETIC AZIMUTHS COMPUTED DIRECTLY FROM THE GIVEN POSITIONS OF THE TWO STATIONS.

Stations.	Azimuth.			Back azimuth.			To stations.
Maine.	°	′	″	°	′	″	
Cape Small	155	18	59·9	335	09	17·1	Sabattus
Massachusetts.							
Cambridge, Harvard Observatory, dome	356	25	25·1	176	25	59·5	Blue Hill
Indian	135	36	02·6	315	20	49·5	Copecut
Shootflying	143	03	19·5	322	53	33·9	Manomet
Spencer	185	57	36·5	5	59	22·8	Beaconpole
District of Columbia.							
Causten	210	54	38·3	30	59	17·2	Soper
Seaton	265	32	42·33	85	37	12·16	Hill

PART III.

THE ASTRONOMIC MEASURES.

III. THE ASTRONOMIC MEASURES.

A. RESULTS FOR LATITUDE AT THE ASTRONOMIC STATIONS OF THE OBLIQUE ARC.

1. GENERAL STATEMENT.

The area covered by the triangulation extending from Maine to Louisiana is well supplied with astronomic latitudes, determined by the Horrebow-Talcott method. The number of stations is 71, irregularly distributed over the arc, as may be seen in the general sketch* of the location of the astronomic stations. In the northeastern half of the arc there are twice as many stations as in the other half. In some localities the stations are closely clustered, as in latitudes 38° 45′ to 40°, and in latitudes 44° to 45°, but upon the whole a satisfactory number of fairly well distributed stations are available for the study of the local and regional deflections of the vertical.

At nearly all the stations the latitude was determined with a zenith telescope. At four stations the determination depends entirely upon observations made with Airy's Zenith Sector.† At two stations both the above instruments were used, and at one of these a transit in the prime vertical was also used. At a few stations observations were made with other instruments, as stated in the abstracts of results. The results for latitude are here presented in the form used in the discussion of the arc of the parallel, but for those stations which are in common with that arc the final values alone are given. What has been said respecting instruments, observations, and method of reduction of latitudes in the publication of the arc of the parallel applies equally well to the present publication, and that publication should be consulted for further details.

The observations used extend over the interval between the years 1846 and 1898. The observations made before that time have been superseded by the introduction of new measures, using more refined methods and superior instruments. Some results at the Harvard College Observatory and the old Naval Observatory at Washington are incorporated in the table of results. The reduction of the observations for latitude was examined with a view of improving the mean star places, and in those cases where the residual, or difference of result from any pair of stars from the indiscriminate mean of all, was greater than 3½ times the probable error of the result from that pair, the mean places of these stars were recomputed.

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* See Map *B* in pocket.

† For discussion of the results obtained by using this instrument, see Special Publication No. 4, "The Transcontinental Triangulation," United States Coast and Geodetic Survey, Washington, D. C., 1900.

The method of determining mean places of stars was to abstract from all available catalogues the north polar distances and to apply to them such systematic corrections as were known to attach to the catalogues (principally determined by the researches of Professor Lewis Boss). These north polar distances were next reduced to a common epoch, usually the year 1890, using the given precessional values and approximate values for the proper motion, and applying relative weights conformable to a well-proportioned system, embracing the catalogues in general. Finally the most probable corrections to the assumed north polar distances and proper motions were derived by application of the method of least squares; the probable errors of these quantities likewise became known. For convenience of reference the star numbers given in the abstracts are those of the British Association Catalogue; when not contained therein, the number in parenthesis ( ) refers to the Greenwich Ten Year Catalogue of 1880; a number in brackets [ ] refers to the Coast Survey Catalogue given in Appendix No. 7 of the Report for 1876; an asterisk attached to any star number directs attention to the fact that the star is also used in another pair or pairs at that station. The observed component of a close double star is identified by the subscript letters P, F, and M, meaning preceding, following, or mean, respectively.

Referring to the abstracts of results at the several stations the column headed "Adopted seconds of mean N. P. D." contains the seconds of the star's mean north polar distance for the beginning of the year of observation, as adopted in the latitude computation; the column headed n' gives the number of observations made upon the pair; the column headed w gives the relative weight assigned to the result from the pair; the last column, headed v, exhibits the residual of the result from each pair from the weighted mean of all the pairs.

The probable errors and relative weights as given in the abstracts were determined as follows:

Let n = the total number of observations at a station and n' = the number upon any pair, also p = the number of pairs, and Δ = the difference of each individual result from the mean result from *that* pair, then the probable error of a single observation for latitude is given by

$$e^2 = \frac{0{\cdot}455\ \Sigma\Delta^2}{n-p}$$

For the determination of relative weights w we need $e_{\frac{\delta\delta}{2}}$ or the value of the probable error of the mean of two declinations of a pair; this may be obtained either from the catalogue mean places or more directly from the latitude observations themselves. The probable error e_p of a mean result from any pair is given by $e^2_p = \frac{0{\cdot}455\ \Sigma v^2}{p-1}$, where the v's arise both from errors of observation and errors of declination, and are found by subtracting the particular values φ_1, φ_2, φ_3, ... , of which there are p in number from φ or the mean latitude of all.

The probable errors e_{p_1}, e_{p_2}, etc. of the latitudes φ_1, φ_2, etc. are given by:

$$e^2_{p_1} = e^2_{\frac{\delta\delta}{2}} + \frac{e^2}{n_1} \qquad e^2_{p_2} = e^2_{\frac{\delta\delta}{2}} + \frac{e^2}{n_2} \quad \text{etc.,}$$

where $e^2_{\frac{\delta\delta}{2}} = e^2_p - \varepsilon^2$ and $\varepsilon^2 = \frac{e^2}{p}\left[\frac{1}{n_1} + \frac{1}{n_2} + \quad . \quad . \quad . \quad \right]$; hence the weights w become:

$$w_1 = \left(e^2_{\frac{s s}{2}} + \frac{e^2}{n_1}\right)^{-1} \qquad w_2 = \left(e^2_{\frac{s s}{2}} + \frac{e^2}{n_2}\right)^{-1} \quad \text{etc.}$$

There are exceptional cases in which these expressions do not apply. When a north or south star is connected after reversal of instrument, with two south or two north stars, the weight assigned to *each* of the two pairs or doublets so formed is two-thirds of that given by the general expression, and in case of triplets the weight is but one-half. Several stars observed on one side of the zenith may occur with several stars observed on the opposite side; in such a case the combination may be broken up into ordinary pairs or into doublets or triplets and the weights determined as indicated above. When a single or close zenith star is observed with instrument direct and instrument reversed, the expression for the weight becomes $w = \left(2e^2_{\frac{s s}{2}} + \frac{e^2}{n_1}\right)^{-1}$

Two values can be obtained for $e^2_{\frac{s s}{2}}$, one from the star catalogues $\frac{\Sigma e^2_{s}}{4}$, where the summation extends over the two stars of the group, and the other from the latitude observations $e^2_p - \varepsilon^2$, and the larger of the two values was used.

The resulting latitude† is given by

$$\varphi = \frac{w_1 \varphi_1 + w_2 \varphi_2 + \ldots}{w_1 + w_2 + \ldots}$$

and its probable error by

$$e^2_\varphi = \frac{0{\cdot}455 \, \Sigma w (\Delta\varphi)^2}{(p-1)\Sigma w}$$

2. DETAILS AT STATIONS.

1. *Calais*, Maine.—G. W. Dean. Zenith telescope No. 4. September 2 to 29, 1857. One division of level = 1″·00. One turn of micrometer = 43″·64.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 350	*6 365	30·60	48·27	5	3	45 11 10·09	−0·69
*6 365	6 372	48·27	13·37	5	3	10·30	−0·90
6 394	6 419	09·46	03·35	5	5	09·23	+0·17
6 475	6 520	25·14	57·12	1	2	09·70	−0·30
6 480	*6 496	45·94	25·32	5	3	09·25	+0·15
6 491	*6 496	14·34	25·32	5	3	09·00	+0·40
6 547	6 555	35·88	13·12	3	4	09·26	+0·14
6 566	6 593	55·50	17·87	4	4	09·89	−0·49
6 629	6 690	08·47	16·56	2	3	08·36	+1·04
*6 635	6 651	19·32	40·97	5	3	10·27	−0·87
*6 635	6 667	19·32	58·60	5	3	10·09	−0·69
6 687	6 711	09·55	50·24	4	4	10·21	−0·81
6 721	6 745	43·40	35·79	3	4	10·96	−1·56
6 717	*6 769	50·98	04·90	3	2	08·54	+0·86
6 741	*6 769	41·70	04·90	4	3	08·30	+1·10

† The details of the method of making and reducing astronomic observations used in the Coast and Geodetic Survey are published in the Report for 1897–98, Appendix No. 7, "Determination of Time, Longitude, Latitude, and Azimuth."

1. *Calais*, Maine—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	n	Latitude.	v
		″	″			° ′ ″	″
6 763	*6 817	18 ·35	43 ·16	4	3	45 11 10 ·33	−0 ·93
6 764	*6 817	45 ·64	43 ·16	5	3	09 ·90	−0 ·50
6 784	6 847	08 ·90	00 ·62	2	3	07 ·84	+1 ·56
6 851	*6 924	39 ·80	17 ·30	4	3	08 ·54	+0 ·86
*6 924	6 998	17 ·30	43 ·00	1	1	07 ·45	+1 ·95
6 944	6 994	44 ·21	27 ·00	2	3	09 ·63	−0 ·23
7 060	7 131	59 ·69	28 ·60	4	4	08 ·48	+0 ·92
7 062	*7 119	21 ·70	09 ·75	6	3	08 ·99	+0 ·41
7 091	*7 119	38 ·11	09 ·75	6	3	09 ·65	−0 ·25
7 176	7 194	38 ·28	00 ·80	5	5	08 ·98	+0 ·42
7 204	7 215	47 ·69	55 ·60	4	4	09 ·40	0 ·00
7 241	7 268	39 ·50	43 ·00	5	5	09 ·40	0 ·00
7 277	*7 294	53 ·13	30 76	3	2	08 ·86	+0 ·54
*7 294	7 383	30 ·76	41 ·63	3	2	08 ·67	+0 ·73
7 301	*7 333	08 ·22	27 ·17	6	3	09 ·94	−0 ·54
*7 333	7 345	27 ·17	28 ·33	6	3	09 ·92	−0 ·52
7 365	7 385	10 ·66	47 ·27	6	5	10 ·30	−0 ·90
7 398	7 488	10 ·65	09 ·62	3	4	08 ·63	+0 ·77
7 465	7 494	54 ·87	47 ·30	6	5	09 ·18	+0 ·22
7 521	7 560	37 ·40	42 ·03	7	5	10 ·43	−1 ·03
*7 623	7 699	26 ·31	30 ·74	6	3	09 ·54	−0 ·14
*7 623	*7 707	26 ·31	40 ·53	3	2	10 ·03	−0 ·63
7 693	*7 707	44 ·43	40 ·53	4	3	09 ·47	−0 ·07
*7 718	7 721	22 ·51	28 ·68	3	2	10 ·11	−0 ·71
*7 718	7 731	22 ·51	18 ·35	2	2	09 ·98	−0 ·58
*7 753	7 778	56 ·34	06 ·19	4	3	09 ·13	+0 ·27
*7 753	7 782	56 ·34	31 ·74	4	3	09 ·32	+0 ·08
7 766	*7 798	54 ·51	18 ·40	6	3	09 ·63	−0 ·23
*7 798	7 829	18 ·40	53 ·93	4	3	10 ·16	−0 ·76
7 815	7 880	10 ·98	16 ·71	4	4	08 ·62	+0 ·78
7 845	7 906	26 ·22	09 ·07	5	5	09 ·86	−0 ·46
7 923	7 973	31 ·43	46 ·55	4	4	07 ·89	+1 ·51
7 972	7 999	48 ·35	44 ·54	4	4	08 ·70	+0 ·70
8 023	*8 082	29 ·46	27 ·80	4	3	08 ·56	+0 ·84
*8 028	8 059	37 ·47	57 ·50	5	3	09 ·25	+0 ·15
*8 028	*8 082	37 ·47	27 ·80	5	2	09 ·18	+0 ·22
8 114	8 171	56 ·00	28 ·62	5	5	09 ·46	−0 ·06
8 188	*8 211	20 ·70	35 ·97	5	3	10 ·30	−0 ·90
*8 211	8 268	35 ·97	39 ·86	5	3	09 ·22	+0 ·18
51	60	51 ·52	11 ·75	5	5	08 ·63	+0 ·77
92	*158	05 ·53	16 ·41	4	3	09 ·71	−0 ·31
*158	169	16 ·41	51 ·35	5	3	09 ·92	−0 ·52

Indiscriminate mean=45° 11′ 09″·38.
Weighted mean =45 11 09 ·40±0″·06.
ε=±0″·67.

243 observations, 57 pairs.

[Reduction to A=0″·00.]

2. *Cooper*, Maine.—E. Goodfellow. Zenith telescope No. 5. September 8 to 18, 1859. One division of level=0″·96 from observations at this station. One turn of micrometer=41″·416 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 365	6 372	42·25	06·93	6	12	44 59 13·06	−0·46
6 404	6 428	28·30	32·64	6	12	12·42	+0·18
6 473	6 476	33·20	54·70	6	12	12·55	+0·05
6 497	6 500	57·59	04·66	4	9	12·20	+0·40
6 491	6 496	05·02	15·97	2	6	13·35	−0·75
6 542	6 586	54·00	26·25	5	11	12·24	+0·36
6 602	6 612	30·86	11·47	5	11	13·02	−0·42
6 657	*6 662	19·92	24·50	5	5	12·98	−0·38
*6 662	6 674	24·50	04·41	6	6	11·97	+0·63
*6 662	6 676	24·50	09·87	6	6	12·04	+0·56
6 730	*6 817	33·80	25·32	6	8	12·21	+0·39
6 734	*6 817	14·20	25·32	6	8	12·03	+0·57
6 857	6 895	32·78	10·09	6	12	12·75	−0·15
*6 930	6 940	55·22	40·40	6	8	12·67	−0·07
*6 930	6 943	55·22	32·27	6	8	12·70	−0·10
*6 957	6 970	48·49	51·27	6	6	12·21	+0·39
*6 957	7 024	48·49	22·70	6	6	11·88	+0·72
*6 957	7 051	48·49	19·74	6	6	13·05	−0·45
7 060	7 131	36·32	04·62	4	9	12·10	+0·50
7 152	*7 176	27·25	12·79	6	8	12·66	−0·06
*7 176	7 194	12·79	35·04	6	8	12·37	+0·23
7 213	7 262	31·52	21·73	6	12	12·44	+0·16
7 268	*7 333	15·44	58·81	6	8	13·08	−0·48
7 301	*7 333	40·50	58·81	6	8	12·81	−0·21
7 428	7 444	30·58	49·10	6	12	12·48	+0·12
7 455	7 477	41·58	38·88	6	12	13·11	−0·51
7 501	7 503	12·63	48·21	5	11	12·19	+0·41
7 533	7 568	03·43	33·26	6	12	12·65	−0·05
7 595	7 607	44·38	50·73	6	12	11·92	+0·68
7 611	7 627	06·91	12·34	6	12	12·34	+0·26
7 693	7 708	09·71	19·01	6	12	13·35	−0·75
7 721	*7 749	53·76	34·68	6	8	13·02	−0·42
7 731	*7 749	43·18	34·68	6	8	13·19	−0·59
7 789	7 798	06·30	42·31	6	12	12·32	+0·28
7 803	7 845	50·58	49·58	5	11	13·00	−0·40
7 880	7 888	39·73	54·17	6	12	13·39	−0·79
7 913	7 950	39·83	31·60	6	12	12·22	+0·38

Indiscriminate mean = 44° 59′ 12″·59.
Weighted mean = 44 59 12 ·60±0″·05.
$e = \pm 0''\cdot 52$.
209 observations, 37 pairs.
[Reduction to △ = +0″·04.]

3. *Humpback*, Maine.—A. T. Mosman. Zenith telescope No. 5. July 26 to August 19, 1858. One division of level = 0″ ·66. One turn of micrometer = 41″ ·416 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
5 628	5 677	28 ·68	07 ·80	8	13	44 51 47 ·33	+0 ·23
5 747	5 801	24 ·73	02 ·21	8	13	47 ·32	+0 ·24
5 886	*5 937	14 ·84	31 ·00	8	9	48 ·28	−0 ·72
5 895	*5 937	10 ·07	31 ·00	7	9	47 ·16	+0 ·40
5 990	5 997	57 ·91	28 ·45	8	13	46 ·99	+0 ·57
6 013	6 109	06 ·91	24 ·09	8	13	47 ·23	+0 ·33
6 246	*6 349	46 ·63	07 ·40	8	9	47 ·78	−0 ·22
6 258	*6 349	58 ·60	07 ·40	8	9	47 ·68	−0 ·12
6 364	6 428	34 ·31	36 ·50	5	12	47 ·40	+0 ·16
6 404	6 476	31 ·92	59 ·00	5	12	48 ·11	−0 ·55
6 497	6 500	02 ·32	09 ·46	8	13	47 ·28	+0 ·28
6 553	6 601	10 ·36	19 ·83	8	13	47 ·30	+0 ·26
6 697	6 711	16 ·63	42 ·70	8	13	47 ·43	+0 ·13
6 731	*6 754	01 ·71	36 ·42	8	9	47 ·60	−0 ·04
*6 754	6 779	36 ·42	50 ·04	7	9	47 ·03	+0 ·53
6 817	6 895	34 ·24	19 ·90	8	13	47 ·70	−0 ·14
6 930	6 943	05 ·46	42 ·80	10	14	47 ·66	−0 ·10
6 957	6 970	59 ·05	02 ·73	8	13	46 ·76	+0 ·80
6 985	7 022	12 ·07	44 ·87	8	13	47 ·17	+0 ·39
*7 062	7 101	09 ·98	37 ·80	9	9	47 ·28	+0 ·28
*7 062	7 114	09 ·98	22 ·64	9	9	46 ·88	+0 ·68
7 152	7 176	39 ·50	25 ·53	10	14	47 ·64	−0 ·08
7 204	7 281	34 ·47	28 ·63	9	14	47 ·24	+0 ·32
7 306	7 317	01 ·42	03 ·81	8	13	47 ·58	−0 ·02
7 398	7 448	55 ·77	07 ·85	8	13	47 ·94	−0 ·38
7 469	7 477	00 ·53	54 ·45	8	13	47 ·93	−0 ·37
7 489	7 505	20 ·09	03 ·20	8	13	48 ·04	−0 ·48
7 533	*7 568	19 ·60	49 ·35	9	9	47 ·30	+0 ·26
*7 542	7 623	27 ·70	09 ·63	8	9	48 ·18	−0 ·62
*7 542	*7 568	27 ·70	49 ·35	7	6	47 ·54	+0 ·02
7 683	7 721	01 ·20	11 ·22	8	13	48 ·40	−0 ·84
7 731	7 749	00 ·73	52 ·37	9	14	48 ·13	−0 ·57
7 789	7 798	24 ·31	00 ·34	9	14	47 ·50	+0 ·06
7 843	7 848	10 ·59	38 ·90	6	12	47 ·56	0 ·00
7 880	7 888	58 ·30	12 ·75	8	13	47 ·80	−0 ·24
7 913	7 950	58 ·56	50 ·46	9	14	47 ·24	+0 ·32
7 999	8 023	25 ·40	10 ·18	8	13	48 ·10	−0 ·54

Indiscriminate mean = 44° 51′ 47″·55.
Weighted mean = 44 51 47 ·56 ± 0″·05.
$e = \pm 0''\cdot 36$.
296 observations, 37 pairs.
[Reduction to △ = −0″·43.]

4. *Bangor*, Maine. E. Goodfellow. Zenith telescope No. 5. September 7 to October 10, 1857. One division of level $=0''.86$. One turn of micrometer $=41''.397$.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
6 427	6 477	40 ·80	38 ·79	5	10	44 48 11 ·88	+0 ·99
6 496	6 497	25 ·33	07 ·05	2	7	13 ·07	−0 ·20
6 500	6 534	14 ·26	59 ·63	2	7	12 ·02	+0 ·85
6 579	6 593	43 ·94	17 ·87	6	10	12 ·27	+0 ·60
*6 697	6 711	24 ·11	50 ·24	6	7	13 ·07	−0 ·20
*6 697	6 765	24 ·11	01 ·83	6	7	12 ·55	+0 ·32
6 771	6 824	19 ·63	24 ·22	6	10	13 ·45	−0 ·58
6 849	*6 881	27 ·82	05 ·78	4	6	12 ·68	+0 ·19
6 860	*6 881	27 ·48	05 ·78	5	6	12 ·91	−0 ·04
6 930	6 944	15 ·70	44 ·21	6	10	12 ·85	+0 ·02
6 959	7 001	54 ·82	30 ·58	6	10	13 ·11	−0 ·24
7 027	*7 062	45 ·20	21 ·96	6	7	12 ·93	−0 ·06
*7 062	7 114	21 ·96	34 ·80	6	7	12 ·34	+0 ·53
7 171	7 219	44 ·19	38 ·12	6	10	12 ·99	−0 ·12
7 233	7 253	52 ·89	08 ·96	5	10	12 ·80	+0 ·07
7 290	7 306	01 ·32	15 ·33	6	10	12 ·46	+0 ·41
7 398	7 448	10 ·65	23 ·15	6	10	13 ·23	−0 ·36
7 455	*7 477	12 ·40	10 ·02	6	7	13 ·54	−0 ·67
*7 477	7 480	10 ·02	18 ·72	4	6	12 ·62	+0 ·25
7 488	7 505	09 ·62	19 ·17	6	10	12 ·21	+0 ·66
7 548	7 565	53 ·03	50 ·24	6	10	11 ·97	+0 ·90
7 623	7 708	26 ·31	53 ·84	5	10	13 ·17	−0 ·30
*7 668	7 721	30 ·54	28 ·68	5	6	13 ·39	−0 ·52
*7 668	7 731	30 ·54	18 ·35	6	7	13 ·31	−0 ·44
*7 727	7 743	54 ·43	17 ·33	3	5	13 ·21	−0 ·34
*7 727	7 770	54 ·43	14 ·68	4	6	13 ·36	−0 ·49
7 749	7 843	09 ·97	28 ·90	6	10	12 ·37	+0 ·50
7 875	*7 914	35 ·61	15 ·26	5	6	13 ·02	−0 ·15
*7 914	7 973	15 ·26	46 ·55	6	7	12 ·78	+0 ·09
7 999	8 023	44 ·54	29 ·46	6	10	13 ·07	−0 ·20
8 059	*8 118	57 ·50	23 ·82	5	6	12 ·71	+0 ·16
8 082	*8 118	27 ·80	23 ·82	6	7	13 ·44	−0 ·57
8 126	8 171	07 ·92	28 ·62	6	10	13 ·89	−1 ·02
8 279	*8 374	47 ·87	03 ·23	6	7	13 ·82	−0 ·95
8 338	*8 374	06 ·88	03 ·23	6	7	13 ·19	−0 ·32
46	109	42 ·28	13 ·48	6	10	13 ·19	−0 ·32
80	164	42 ·58	54 ·68	6	10	13 ·00	−0 ·13
*254	310	32 ·53	04 ·91	3	5	13 ·13	−0 ·26
*254	321	32 ·53	07 ·83	3	5	12 ·67	+0 ·20
263	335	31 ·24	33 ·09	3	8	12 ·70	+0 ·17
395	450	19 ·90	41 ·40	6	10	12 ·27	+0 ·60

Indiscriminate mean $=44°\ 48'\ 12''.90$.

Weighted mean $=44\ \ 48\ \ 12\ .87 \pm 0''.05$.

$e = \pm 0''.38$.

213 observations, 41 pairs.

[Reduction to $\triangle = 0''.00$.]

5. *Farmington*, Maine. C. O. Boutelle. Zenith telescope No. 5. October 8 to November 6, 1866. One division of level = 0″·90. One turn of micrometer = 41″·48.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
6 599	6 697	12·0	16·7	5	5	44 40 19·49	+0·05
6 723	6 806	56·4	34·6	5	5	19·85	−0·31
6 824	6 875	03·5	23·7	6	6	19·40	+0·14
6 928	6 937	45·5	11·0	7	6	20·06	−0·52
6 973	7 024	42·6	03·2	7	6	18·79	+0·75
7 091	7 114	51·0	44·6	6	6	19·27	+0·27
7 233	7 241	54·2	38·6	6	6	19·78	−0·24
7 253	7 306	08·0	10·4	6	6	19·40	+0·14
7 368	7 387	16·6	16·0	6	6	19·09	+0·45
7 444	7 449	03·6	51·5	6	6	19·05	+0·49
7 474	7 482	48·6	30·0	6	6	19·26	+0·28
7 524	7 560	04·6	15·7	6	6	19·97	−0·43
7 627	7 700	15·4	27·4	8	6	19·01	+0·53
7 746	7 765	16·7	57·4	8	6	18·37	+1·17
7 845	7 850	41·5	46·0	7	6	19·57	−0·03
7 888	7 901	44·7	46·8	7	6	20·17	−0·63
7 950	7 983	21·5	46·0	5	5	20·29	−0·75
7 994	8 059	37·6	01·0	6	6	19·27	+0·27
8 037	8 082	51·7	31·5	6	6	19·02	+0·52
8 114	8 118	00·0	27·4	5	5	20·38	−0·84
8 159	8 188	02·5	22·8	6	6	19·43	+0·11
8 212	8 231	07·0	12·6	7	6	19·27	+0·27
8 279	8 284	48·0	11·0	6	6	19·70	−0·16
4	46	57·5	42·0	6	6	19·52	+0·02
67	83	25·1	46·5	6	6	20·07	−0·53
158	201	18·0	46·7	6	6	18·67	+0·87
244	285	14·0	55·6	6	6	19·77	−0·23
314	334	18·7	26·5	6	6	18·96	+0·58
425	441	18·4	06·3	6	6	19·73	−0·19
492	540	48·4	23·0	5	5	18·64	+0·90
610	647	51·4	10·7	5	5	19·00	+0·54
691	700	56·0	09·5	5	5	19·70	−0·16
721	786	11·6	55·7	5	5	19·55	−0·01

5. *Farmington*, Maine—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.		v
		//	//			° ′	//	//
6 930	6 944	43 ·4	07 ·5	7	6	44 40	20 ·06	−0 ·52
6 996	7 062	03 ·0	36 ·2	8	6		19 ·46	+0 ·08
7 085	7 101	51 ·6	00 ·5	6	6		19 ·57	−0 ·03
7 171	7 254	50 ·0	28 ·6	8	6		19 ·91	−0 ·37
7 278	7 313	05 ·6	06 ·0	7	6		19 ·35	+0 ·19
7 365	7 373	00 ·0	05 ·0	7	6		19 ·45	+0 ·09
7 399	7 401	51 ·0	53 ·0	6	6		18 ·26	+1 ·28
7 469	7 477	57 ·0	50 ·0	6	6		20 ·23	−0 ·69
7 488	7 505	47 ·8	56 ·0	7	6		19 ·45	+0 ·09
7 548	7 554	27 ·5	07 ·2	6	6		20 ·18	−0 ·64
7 565	7 598	22 ·5	35 ·0	7	6		18 ·86	+0 ·68
*7 668	7 721	55 ·7	52 ·5	6	4		19 ·96	−0 ·42
*7 668	7 731	55 ·7	43 ·0	5	4		19 ·10	+0 ·44
7 753	7 813	18 ·8	50 ·1	6	6		18 ·86	+0 ·68
7 855	7 915	20 ·6	25 ·8	6	6		19 ·59	−0 ·05
7 958	7 967	18 ·5	14 ·2	6	6		19 ·29	+0 ·25
8 023	8 126	36 ·0	10 ·5	6	6		19 ·88	−0 ·34
8 158	8 211	59 ·3	36 ·0	7	6		18 ·66	+0 ·88
8 224	8 237	03 ·5	28 ·0	6	6		19 ·51	+0 ·03
52	79	44 ·5	22 ·2	6	6		20 ·02	−0 ·48
173	232	37 ·6	22 ·8	6	6		20 ·57	−1 ·03
239	299	44 ·1	19 ·5	6	6		20 ·36	−0 ·82
395	450	27 ·0	52 ·8	6	6		19 ·36	+0 ·18
588	630	56 ·3	43 ·3	6	6		18 ·26	+1 ·28
668	679	21 ·6	45 ·2	6	6		20 ·81	−1 ·27
705	727	03 ·8	48 ·5	6	6		19 ·54	0 ·00
785	871	31 ·0	05 ·0	5	5		20 ·58	−1 ·04
962	963	04 ·5	46 ·5	5	5		20 ·76	−1 ·22
981	995	00 ·0	44 ·4	5	5		20 ·58	−1 ·04
1 006	1 083	12 ·6	01 ·3	6	6		18 ·49	+1 ·05
1 129	1 139	39 ·0	51 ·5	6	6		20 ·02	−0 ·48
1 219	1 254	49 ·7	57 ·5	6	6		20 ·42	−0 ·88

Indiscriminate mean 44° 40′ 19″·55.
Weighted mean =44 40 19 ·54±0″·05.
$e = \pm 0''\cdot 55$.
397 observations, 65 pairs.
[Reduction to $\triangle = 0''\cdot 00$.]

6. *Mount Harris*, Maine.—G. W. Dean.. Zenith telescope No. 2. First series. August 15 to 24, 1855. One division of level =1″·16. One turn of micrometer =44″·803 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
5 840	5 922	35 ·25	36 ·72	5	11	44 39 54 ·25	+0 ·44
6 129	6 218	26 ·04	05 ·44	5	11	55 ·20	−0 ·51
6 232	6 311	37 ·00	04 ·40	3	9	54 ·88	−0 ·19
6 237	6 318	24 ·70	48 ·24	3	9	54 ·32	+0 ·37
6 335	6 394	30 ·40	16 ·96	3	9	54 ·12	+0 ·57
6 372	6 392	19 ·81	38 ·24	2	7	55 ·08	−0 ·39
6 419	6 466	10 ·93	58 ·34	5	11	55 ·07	−0 ·38
*6 477	6 497	47 ·66	16 ·62	3	6	54 ·04	+0 ·65
*6 477	6 553	47 ·66	25 ·85	2	5	55 ·18	−0 ·49
*6 623	6 651	51 ·94	54 ·43	5	7	54 ·43	+0 ·26
*6 623	6 667	51 ·94	12 ·59	5	7	53 ·95	+0 ·74
6 711	6 723	05 ·36	21 ·21	5	11	54 ·92	−0 ·23
6 731	6 754	25 ·28	00 ·98	5	11	54 ·82	−0 ·13
6 824	6 875	42 ·20	09 ·08	5	11	54 ·73	−0 ·04
6 928	6 937	41 ·81	05 ·18	6	11	54 ·45	+0 ·24
6 973	*7 024	40 ·25	08 ·02	6	7	54 ·11	+0 ·58
6 978	*7 024	03 ·28	08 ·02	4	7	55 ·01	−0 ·32
7 062	*7 114	45 ·20	58 ·23	5	7	53 ·98	+0 ·71
7 091	*7 114	02 ·02	58 ·23	5	7	54 ·62	+0 ·07
7 233	7 241	19 ·18	06 ·10	5	11	54 ·90	−0 ·21
7 253	7 306	35 ·81	43 ·49	5	11	54 ·92	−0 ·23
7 368	7 387	56 ·50	58 ·31	5	11	54 ·36	+0 ·33
7 399	7 401	35 ·19	36 ·22	5	11	54 ·30	+0 ·39
7 469	7 477	46 ·90	41 ·18	4	10	55 ·64	−0 ·95
7 488	7 505	41 ·12	50 ·84	5	11	55 ·31	−0 ·62
7 524	7 560	00 ·92	14 ·76	5	11	55 ·47	−0 ·78
7 571	*7 611	10 ·83	13 ·60	5	7	54 ·19	+0 ·50
7 584	*7 611	58 ·95	13 ·60	5	7	54 ·20	+0 ·49
7 651	7 693	43 ·49	18 ·07	5	11	54 ·98	−0 ·29
7 746	7 765	30 ·45	12 ·20	5	11	54 ·22	+0 ·47
7 845	7 850	02 ·93	07 ·71	5	11	54 ·86	−0 ·17
7 962	*7 999	47 ·80	22 ·81	3	6	55 ·14	−0 ·45
*7 999	8 023	22 ·81	08 ·00	2	5	55 ·49	−0 ·80
8 037	8 082	24 ·29	06 ·94	4	10	53 ·83	+0 ·86
8 114	8 128	35 ·50	53 ·70	5	11	54 ·72	−0 ·03
8 156	*8 188	55 ·49	00 ·36	5	7	54 ·44	+0 ·25
8 159	*8 188	39 ·44	00 ·36	5	7	54 ·79	−0 ·10
8 212	8 231	45 ·25	51 ·97	5	11	55 ·08	−0 ·39
8 237	8 261	06 ·22	04 ·35	5	11	54 ·33	+0 ·36
8 279	8 284	27 ·94	51 ·44	4	10	54 ·81	−0 ·12

Indiscriminate mean =44° 39′ 54″·68.
Weighted mean =44 39 54 ·69±0″·05.
$e=\pm 0''\cdot 37$.

179 observations, 40 pairs.

6. *Mount Harris*, Maine.—G. W. Dean. Zenith telescope No. 10. Second series. August 6 to 27, 1855. One division of level =0″·632, from observations at this station. One turn of micrometer =39″·522 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
5 731	5 797	25 ·48	26 ·99	5	16	44 39 54 ·99	—0 ·48
5 840	5 922	35 ·25	36 ·72	6	17	54 ·43	+0 ·38
5 944	6 036	05 ·88	09 ·54	5	16	54 ·37	+0 ·14
6 129	6 218	26 ·04	05 ·44	5	16	54 ·66	—0 ·15
6 232	6 311	37 ·00	04 ·40	5	16	54 ·81	—0 ·30
6 237	6 318	24 ·70	48 ·24	4	15	54 ·41	+0 ·10
6 335	6 394	30 ·40	16 ·96	3	14	54 ·61	—0 ·10
6 372	6 392	19 ·81	38 ·24	2	11	54 ·52	—0 ·01
*6 419	6 456	10 ·93	24 ·22	5	11	55 ·38	—0 ·87
*6 419	6 466	10 ·93	58 ·34	5	11	55 ·15	—0 ·64
*6 477	6 497	47 ·66	16 ·62	5	11	53 ·65	+0 ·86
*6 477	6 553	47 ·66	25 ·85	5	11	54 ·76	—0 ·25
6 566	6 581	05 ·37	03 ·90	5	16	54 ·84	—0 ·33
*6 623	6 651	51 ·94	54 ·43	5	11	54 ·77	—0 ·26
*6 623	6 667	51 ·94	12 ·59	5	11	54 ·70	—0 ·19
6 711	6 723	05 ·36	21 ·21	6	17	54 ·73	—0 ·22
6 731	6 754	25 ·28	00 ·98	6	17	54 ·19	+0 ·32
6 824	6 875	42 ·20	09 ·08	6	17	54 ·36	+0 ·15
6 928	6 937	41 ·81	05 ·18	5	16	54 ·44	+0 ·07
6 973	*7 024	40 ·25	08 ·02	6	11	54 ·63	—0 ·12
6 978	*7 024	03 ·28	08 ·02	6	11	55 ·01	—0 ·50
7 062	*7 114	45 ·20	58 ·23	6	11	53 ·97	+0 ·54
7 091	*7 114	02 ·02	58 ·23	6	11	54 ·38	+0 ·13
7 233	7 241	19 ·18	06 ·10	6	17	54 ·18	+0 ·33
7 253	7 306	35 ·81	43 ·49	5	16	54 ·58	—0 ·07
*7 368	7 377	56 ·50	31 ·10	5	11	54 ·24	+0 ·27
*7 368	7 387	56 ·50	58 ·31	5	11	54 ·29	+0 ·22
7 399	7 401	35 ·19	36 ·22	5	16	54 ·05	+0 ·46
7 469	7 477	46 ·90	41 ·18	6	17	54 ·57	—0 ·06
7 488	7 505	41 ·12	50 84	6	17	54 ·79	—0 ·28
7 524	7 560	00 ·92	14 ·76	6	17	54 ·69	—0 ·18
7 571	*7 611	10 ·83	13 ·60	6	11	54 ·22	+0 ·29
7 584	*7 611	58 ·95	13 ·60	6	11	54 ·37	+0 ·14
7 651	7 693	43 ·49	18 ·07	6	17	54 ·76	—0 ·25
7 746	7 765	30 ·45	12 ·20	5	16	53 ·77	+0 ·74
7 789	7 798	18 ·05	53 ·50	5	16	54 ·43	+0 ·08
7 845	7 850	02 ·93	07 ·71	4	15	54 ·12	+0 ·39
7 879	*7 888	16 ·69	08 ·20	3	9	54 ·48	+0 ·03
7 880	*7 888	54 ·02	08 ·20	2	8	54 ·34	+0 ·17
7 913	7 950	54 ·44	46 ·74	5	16	54 ·41	+0 ·10
7 962	*7 999	47 ·80	22 ·81	5	11	54 ·85	—0 ·34
*7 999	8 023	22 ·81	08 ·00	5	11	55 ·34	—0 ·83
8 037	8 082	24 ·29	06 ·94	5	16	54 ·11	+0 ·40

6. *Mount Harris*, Maine. Second series—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
8 114	8 128	35 ·50	53 ·70	5	16	44 39 54 ·83	−0 ·32
8 156	*8 188	55 ·49	00 ·36	5	11	54 ·23	+0 ·28
8 159	*8 188	39 ·44	00 ·36	5	11	54 ·69	−0 ·18
8 212	8 231	45 ·25	51 ·97	5	16	54 ·41	+0 ·10
8 237	8 261	06 ·22	04 ·35	5	16	54 ·20	+0 ·31
8 279	8 284	27 ·94	51 ·44	5	16	55 ·13	−0 ·62

Indiscriminate mean =44° 39′ 54″ ·52.
Weighted mean =44 39 54 ·51±0″ ·04.
$e=\pm 0''\cdot 29$.
248 observations, 49 pairs.

6. *Mount Harris*, Maine.—E. Goodfellow. Zenith telescope No. 10. Third series. September 12 to 25, 1855. One division of level=0″·632. One turn of micrometer=39″·507 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
*6 419	6 456	10 ·93	24 ·22	1	2	44 39 54 ·74	+0 ·05
*6 419	6 466	10 ·93	58 ·34	1	2	54 ·09	+0 ·70
*6 477	6 497	47 ·66	16 ·62	5	6	54 ·17	+0 ·62
*6 477	6 553	47 ·66	25 ·85	5	6	55 ·24	−0 ·45
6 566	6 581	05 ·37	03 ·90	6	9	55 ·02	−0 ·23
*6 623	6 651	51 ·94	54 ·43	6	6	54 ·86	−0 ·07
*6 623	6 667	51 ·94	12 ·59	6	6	54 ·74	+0 ·05
6 711	6 723	05 ·36	21 ·21	5	9	54 ·43	+0 ·36
6 731	6 754	25 ·28	00 ·98	5	9	55 ·50	−0 ·71
6 824	6 875	42 ·20	09 ·08	6	9	54 ·74	+0 ·05
6 928	6 937	41 ·81	05 ·18	6	9	54 ·45	+0 ·34
6 973	*7 024	40 ·25	08 ·02	6	6	54 ·42	+0 ·37
6 978	*7 024	03 ·28	08 ·02	6	6	54 ·30	+0 ·49
7 062	7 114	45 ·20	58 ·23	6	9	54 ·88	−0 ·09
7 233	7 241	19 ·18	06 ·10	6	9	53 ·74	+1 ·05
7 253	7 306	35 ·81	43 ·49	6	9	55 ·44	−0 ·65
*7 368	7 377	56 ·50	31 ·10	5	6	54 ·12	+0 ·67
*7 368	7 387	56 ·50	58 ·31	6	6	54 ·59	+0 ·20
7 399	7 401	35 ·19	36 ·22	6	9	54 ·37	+0 ·42
7 469	7 477	46 ·90	41 ·18	6	9	55 ·30	−0 ·51
7 488	7 505	41 ·12	50 ·84	6	9	55 ·45	−0 ·66
7 524	7 560	00 ·92	14 ·76	6	9	54 ·91	−0 ·12
7 571	*7 611	10 ·83	13 ·60	4	5	54 ·66	+0 ·13
7 584	*7 611	58 ·95	13 ·60	7	6	54 ·59	+0 ·20
7 651	7 693	43 ·49	18 ·07	6	9	55 ·02	−0 ·23
7 746	7 765	30 ·45	12 ·20	6	9	53 ·80	+0 ·99
7 789	7 798	18 ·05	53 ·50	6	9	55 ·03	−0 ·24
7 845	7 850	02 ·93	07 ·71	6	9	54 ·88	−0 ·09
7 879	*7 888	16 ·69	08 ·20	3	5	55 ·09	−0 ·30

6. *Mount Harris*, Maine. Third series—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		//	//			° ′ //	//
7 880	*7 888	54 ·02	08 ·20	3	5	44 39 55 ·47	−0 ·68
7 913	7 950	54 ·44	46 ·74	6	9	55 ·00	−0 ·21
7 962	*7 999	47 ·80	22 ·81	6	6	55 ·23	−0 ·44
*7 999	8 023	22 ·81	08 ·00	6	6	55 ·92	−1 ·13
8 037	8 082	24 ·29	06 ·94	6	9	54 ·37	+0 ·42
8 114	8 128	35 ·50	53 ·70	6	9	55 ·28	−0 ·49
8 156	*8 188	55 ·49	00 ·36	7	6	54 ·47	+0 ·32
8 159	*8 188	39 ·44	00. 36	6	6	54 ·90	−0 ·11
8 212	8 231	45 ·25	51 ·97	5	9	54 ·89	−0 ·10
8 237	8 261	06 ·22	04 ·35	6	9	53 ·80	+0 ·99
8 279	8 284	27 ·94	51 ·44	6	9	55 ·38	−0 ·59

Indiscriminate mean $= 44° \; 39' \; 54'' \cdot 78$.
Weighted mean $= 44 \; 39 \; 54 \; \cdot 79 \pm 0'' \cdot 05$.
$e = \pm 0'' \cdot 44$.
218 observations, 40 pairs.

Collection of results at station, Mount Harris, Maine.

G. W. Dean, Z. T. No. 2	$\varphi = 44° \; 39' \; 54'' \cdot 69 \pm 0'' \cdot 05$.
G. W. Dean, Z. T. No. 10	$54 \; \cdot 51 \pm 0 \; \cdot 04$.
E. Goodfellow, Z. T. No. 10	$54 \; \cdot 79 \pm 0 \; \cdot 05$.
Mean adopted	$\varphi = 44 \; 39 \; 54 \; \cdot 66 \pm 0 \; \cdot 04$.

[Reduction to $\triangle = + 0'' \cdot 21$.]

7. *Howard*, Maine.—E. Goodfellow. Zenith telescope No. 5. July 13 to 23, 1859. One division of level $= 1'' \cdot 015$ from observations at this station. One turn of micrometer $= 44'' \cdot 418$ from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		//	//			° ′ //	//
*5 113	5 122	03 ·14	02 ·30	3	5	44 37 48 ·84	+0 ·40
*5 113	5 130	03 ·14	11 ·88	3	5	48 ·46	+0 ·78
5 210	5 259	33 ·98	10 ·14	4	8	48 ·44	+0 ·80
5 244	5 249	51 ·44	49 ·95	4	8	48 ·85	+0 ·39
5 307	5 321	49.85	07 ·30	5	8	49 ·43	−0 ·19
5 388	5 400	37 ·00	08 ·78	6	9	48 ·85	+0 ·39
5 440	5 459	53 ·61	07 ·76	6	9	49 ·59	−0 ·35
5 466	5 514	46 ·87	53 ·35	6	9	48 ·61	+0 ·63
5 523	5 568	20 ·48	58 ·80	6	9	49 ·58	−0 ·34
5 604	5 643	21 ·97	54 ·20	6	9	49 ·06	+0 ·18
5 658	5 747	20 ·74	30 ·21	6	9	49 ·35	−0 ·11
5 823	5 883	41 ·88	20 ·28	4	8	49 ·61	−0 ·37
5 834	5 937	45 ·90	33 ·85	4	8	49 ·42	−0 ·18
5 990	5 997	00 ·05	28 ·65	6	9	49 ·46	−0 ·22
6 095	*6 109	08 ·06	24 ·52	6	6	48 ·89	+0 ·35
*6 109	6 162	24 ·52	13 ·58	5	6	50 ·02	−0 ·78

7. *Howard*, Maine—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 231	*6 272	43 ·88	00 ·41	6	6	44 37 49 ·45	−0 ·21
*6 251	*6 272	27 ·97	00 ·41	7	6	50 ·13	−0 ·89
*6 316	6 322	25 ·89	07 ·80	7	6	49 ·32	−0 ·08
*6 316	6 341	25 ·89	61 ·60	7	6	48 ·67	+0 ·57
6 372	6 392	06 ·93	23 ·96	6	9	49 ·07	+0 ·17
*6 419	6 456	55 ·79	08 ·00	5	6	50 ·00	−0 ·76
*6 419	6 466	55 ·79	41 ·82	5	6	49 ·78	−0 ·54
6 476	6 493	54 ·68	45 ·16	4	8	48 ·87	+0 ·37
6 477	6 553	29 ·81	04 ·95	4	8	48 ·72	+0 ·52
6 566	6 581	44 ·00	39 ·63	6	9	49 ·03	+0 ·21
*6 623	6 667	25 ·49	44 ·64	6	6	50 ·18	−0 ·94
*6 623	6 651	25 ·49	27 ·29	6	6	49 ·91	−0 ·67
*6 723	6 806	50 ·67	34 ·56	6	4	49 ·78	−0 ·54
*6 723	6 765	50 ·67	45 ·19	6	4	49 ·79	−0 ·55
*6 723	6 813	50 ·67	18 ·18	6	4	49 ·84	−0 ·60
6 824	6 875	06 ·26	30 ·30	6	9	49 ·00	+0 ·24
*6 928	6 937	00 ·92	23 ·23	6	4	48 ·98	+0 ·26
*6 928	6 967	00 ·92	24 ·65	6	4	48 ·57	+0 ·67
*6 928	6 997	00 ·92	21 ·93	6	4	48 ·26	+0 ·98
*7 027	7 062	22 ·54	58 ·26	6	6	49 ·19	+0 ·05
*7 027	7 091	22 ·54	14 ·19	6	6	49 ·64	−0 ·40
7 100	7 112	15 ·10	19 ·10	6	9	48 ·84	+0 ·40
7 233	*7 253	26 ·48	42 ·08	6	6	49 ·52	−0 ·28
*7 253	7 306	42 ·08	47 ·51	6	6	49 ·40	−0 ·16

Indiscriminate mean $= 44° \ 37' \ 49''·26$.
Weighted mean $= 44 \ \ 37 \ \ 49 \ ·24 \pm 0''·05$.
$e = \pm 0''·45$.
221 observations, 40 pairs.
[Reduction to △ = − 0″·56.]

8. *Mount Desert*, Maine.—S. Harris. Zenith telescope No. 5. First series. August 18 to September 5, 1856. One division of level $= 0''·73$ from observations at this station. One turn of micrometer $= 41''·42$ from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 062	*6 129	02 ·90	26 ·14	5	15	44 21 06 ·38	+0 ·13
6 068	*6 129	45 ·46	26 ·14	7	21	06 ·56	−0 ·05
*6 255	6 268	57 ·91	07 ·44	6	18	06 ·51	0 ·00
*6 255	6 357	57 ·91	23 ·53	7	21	06 ·33	+0 ·18
6 395	*6 429	18 ·80	06 ·94	6	18	05 ·85	+0 ·66
*6 429	6 522	06 ·94	47 ·75	6	15	06 ·14	+0 ·37
6 553	6 583	20 ·45	05 ·45	6	27	06 ·39	+0 ·12
6 629	6 637	14 ·87	38 ·62	6	27	06 ·19	+0 ·32
6 687	6 722	16 ·61	23 ·34	6	27	06 ·13	+0 ·38

8. *Mount Desert*, Maine. First series—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
*6 769	6 799	14 ·17	48 ·16	6	18	44 21 06 ·66	−0 ·15
*6 769	6 830	14 ·17	17 ·70	6	18	06 ·50	+0 ·01
6 849	6 865	37 ·00	58 ·58	6	27	06 ·61	−0 ·10
6 879	6 932	30 ·59	18 ·37	6	27	06 ·11	+0 ·40
6 979	6 994	11 ·65	38 ·32	6	27	06 ·29	+0 ·22
7 022	7 062	07 ·50	33 ·49	6	27	06 ·45	+0 ·06
7 073	7 153	24 ·90	42 ·83	4	19	06 ·73	−0 ·22
7 219	7 253	51 ·17	22 ·37	4	19	06 ·42	+0 ·09
7 220	7 256	10 ·37	16 ·11	5	23	06 ·34	+0 ·17
7 310	7 368	23 ·23	41 ·98	6	27	06 ·40	+0 ·11
7 416	7 461	25 ·02	59 ·25	6	27	06 ·57	−0 ·06
7 521	7 548	52 ·76	09 ·52	6	27	06 ·42	+0 ·09
7 569	7 595	20 ·84	33 ·83	6	27	06 ·91	−0 ·40
7 615	7 623	50 ·84	43 ·04	6	27	06 ·68	−0 ·17
7 721	7 754	46 ·19	32 ·42	6	27	07 ·04	−0 ·53
7 731	7 778	35 ·83	24 ·41	7	32	06 ·99	−0 ·48
7 800	7 803	14 ·36	44 ·64	5	23	06 ·72	−0 ·21
7 855	*7 858	24 ·55	35 ·05	6	18	06 ·80	−0 ·29
*7 858	7 882	35 ·05	26 ·94	7	21	06 ·30	+0 ·21
7 894	7 913	52 ·06	34 ·79	6	18	06 ·02	+0. 49
8 141	8 188	32 ·05	40 ·54	5	23	06 ·99	−0 ·48
8 284	8 344	31 ·40	44 ·73	6	27	06 ·60	−0 ·09
8 366	8 374	17 ·12	22 ·62	7	32	06 ·44	+0 ·07

Indiscriminate mean = 44° 21′ 06″ ·48.
Weighted mean = 44 21 06 ·51 ± 0″ ·03.
$e = \pm$ 0″ ·46.
189 observations, 32 pairs.
[Reduction to △ = −1″ ·88.]

8. *Mount Desert*, Maine.—E. Goodfellow. Zenith telescope No. 5. Second series. September 18 to October 5, 1856. One division of level = 0″ ·716 from observations at this station. One turn of micrometer = 41″·421 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
*6 255	6 268	57 ·91	07 ·44	5	5	44 21 06 ·25	+0 ·28
*6 255	6 357	57 ·91	23 ·53	5	5	06 ·06	+0 ·47
6 395	*6 429	18 ·80	06 ·94	7	5	05 ·68	+0 ·85
*6 429	6 522	06 ·94	47 ·75	6	5	06 ·06	+0 ·47
6 553	6 583	20 ·45	05 ·45	6	8	06 ·97	−0 ·44
6 629	6 637	14 ·87	38 ·62	6	8	06 ·22	+0 ·31
6 687	6 722	16 ·61	23 ·34	6	8	05 ·63	+0 ·90
*6 769	6 799	14 ·17	48 ·16	5	5	06 ·55	−0 ·02
*6 769	6 830	14 ·17	17 ·70	6	5	06 ·43	+0 ·10
6 849	6 865	37 ·00	58 ·58	6	8	06 ·55	−0 ·02

8. *Mount Desert*, Maine. Second series—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 879	6 932	30 ·59	18 ·37	7	8	44 21 06 ·61	−0 ·08
6 979	6 994	11 ·65	38 ·32	6	8	05 ·77	+0 ·76
7 022	7 062	07 ·50	33 ·49	6	8	06 ·66	−0 ·13
7 073	7 153	24 ·90	42 ·83	5	7	06 ·78	−0 ·25
7 219	7 253	51 ·17	22 ·37	4	7	07 ·32	−0 ·79
7 220	7 256	10 ·37	16 ·11	4	7	06 ·14	+0 ·39
7 310	7 368	23 ·23	41 ·98	6	8	06 ·42	+0 ·11
7 416	7 461	25 ·02	59 ·25	6	8	06 ·09	+0 ·44
7 521	7 548	52 ·76	09 ·52	6	8	06 ·73	−0 ·20
7 569	7 595	20 ·84	33 ·83	6	8	07 ·23	−0 ·70
7 615	7 623	50 ·84	43 ·04	7	8	06 ·07	+0 ·46
7 721	7 754	46 ·19	32 ·42	6	8	07 ·11	−0 ·58
7 731	7 778	35 ·83	24 ·41	6	8	07 ·39	−0 ·86
7 800	7 803	14 ·36	44 ·64	4	7	07 ·73	−1 ·20
7 855	*7 858	24 ·55	35 ·05	6	5	06 ·20	+0 ·33
*7 858	7 882	35 ·05	26 ·94	6	5	06 ·00	+0 ·53
7 894	7 913	52 ·06	34 ·79	6	8	06 ·73	−0 ·20
8 141	8 188	32 ·05	40 ·54	6	8	07 ·32	−0 ·79
8 284	8 344	31 ·40	44 ·73	6	8	06 ·21	+0 ·32
8 366	8 374	17 ·12	22 ·62	4	7	06 ·19	+0 ·34

Indiscriminate mean = 44° 21′ 06″ ·50.
Weighted mean = 44 21 06 ·53 ± 0″ ·07.
$e = \pm$ 0″ ·41.
171 observations, 30 pairs.
[Reduction to △ = − 1″ ·88.]

9. *Ragged Mountain*, Maine.—G. W. Dean. Zenith telescope No. 5. First series. August 18 to September 7, 1854. One division of level = 0″·71 from observations at this station. One turn of micrometer = 41″·426 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
5 596	5 617	02 ·60	50 ·57	2	9	44 12 43 ·02	−0 ·10
5 795	5 847	14 ·25	10 ·82	4	10	43 ·17	−0 ·25
5 874	5 911	45 ·86	55 ·20	5	10	43 ·45	−0 ·53
5 922	5 978	33 ·71	47 ·28	5	10	43 ·50	−0 ·58
6 006	6 030	30 ·72	40 ·79	6	11	42 ·12	+0 ·80
6 052	6 082	57 ·22	39 ·45	6	11	43 ·51	−0 ·59
6 177	6 223	04 ·82	40 ·99	6	11	42 ·94	−0 ·02
6 241	6 316	08 ·99	36 ·74	6	11	42 ·47	+0 ·45
6 395	*6 429	25 ·72	14 ·28	6	7	43 ·01	−0 ·09
*6 429	6 522	14 ·28	58 ·88	5	7	42 ·65	+0 ·27
6 534	*6 583	16 ·49	17 ·41	5	7	42 ·26	+0 ·66
6 659	6 711	44 ·88	12 ·92	6	11	42 ·90	+0 ·02
6 734	6 806	54 ·74	18 ·22	5	10	42 ·47	+0 ·45

9. *Ragged Mountain*, Maine. First series—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		"	"			° ′ "	"
6 763	6 813	42 ·42	03 ·10	6	11	44 12 43 ·14	−0 ·22
6 824	6 915	51 ·20	37 ·67	5	7	43 ·25	−0 ·33
*6 915	6 928	37 ·67	52 ·01	5	7	43 ·12	−0 ·20
6 940	7 024	31 ·54	19 ·33	5	10	43 ·45	−0 ·53
7 098	7 126	44 ·25	36 ·50	6	11	43 ·11	−0 ·19
7 171	7 253	22 ·17	49 ·23	6	11	42 ·71	+0 ·21
7 278	7 336	50 ·85	57 ·30	6	11	42 ·84	+0 ·08
7 385	7 448	32 ·98	09 ·03	6	11	43 ·65	−0 ·73
7 512	7 566	03 ·20	58 ·74	6	11	42 ·82	+0 ·10
7 595	7 623	06 ·75	16 ·38	6	11	43 ·14	−0 ·22
7 679	7 695	19 ·74	29 ·98	6	11	42 ·41	+0 ·51
7 721	7 754	21 ·09	07 ·98	6	11	43 ·32	−0 ·40
7 731	7 778	10 ·96	00 ·03	6	11	43 ·56	−0 ·64
7 894	*7 983	29 ·04	34 ·41	5	7	42 ·75	+0 ·17
7 913	*7 983	13 ·08	34 ·41	5	7	42 ·41	+0 ·51
5 828	5 840	08 ·28	31 ·00	4	10	41 ·84	+1 ·08
5 900	5 972	29 ·61	20 ·83	4	10	42 ·27	+0 ·65
6 056	6 062	51 ·88	00 ·75	3	10	42 ·92	0 ·00
6 068	6 129	43 ·58	26 ·00	3	10	42 ·80	+0 ·12
6 079	6 178	10 ·83	40 ·90	2	9	42 ·65	+0 ·27
6 234	6 318	41 ·27	50 ·48	5	10	43 ·09	−0 ·17
6 238	6 311	46 ·34	06 ·55	5	10	43 ·30	−0 ·38
6 477	*6 571	52 ·10	26 ·74	2	6	42 ·84	+0 ·08
6 496	*6 571	39 ·21	26 ·74	2	6	43 ·43	−0 ·51
6 497	*6 583	21 ·36	17 ·41	2	6	43 ·33	−0 ·41
6 687	6 722	30 ·87	38 ·90	4	10	42 ·49	+0 ·43
6 740	6 867	49 ·65	34 ·41	4	10	42 ·82	+0 ·10
6 926	6 975	33 ·73	45 ·95	5	10	43 ·53	−0 ·61
6 986	7 076	04 ·20	54 ·08	5	10	43 ·02	−0 ·10
7 048	7 085	29 ·07	13 ·97	5	10	43 ·31	−0 ·39
7 243	7 337	29 ·75	02 ·50	4	10	41 ·49	+1 ·43
7 569	*7 615	53 ·44	24 ·00	1	4	43 ·22	−0 ·30
7 570	*7 615	04 ·44	24 ·00	1	4	42 ·67	+0 ·25
7 782	7 843	25 30	24 ·04	5	10	43 ·45	−0 ·53
*7 855	7 879	01 ·25	34 ·92	5	7	42 ·52	+0 ·40
*7 855	7 880	01 ·25	12 ·50	5	7	42 ·70	+0. 22

Indiscriminate mean $=44° 12′ 42''·92$.
Weighted mean $=44\ 12\ 42\ ·92 \pm 0''·05$.
$e = \pm\ 0''·25$.
228 observations, 49 pairs.
[Reduction to $\triangle = +0''·40$.]

9. *Ragged Mountain*, Maine.—S. Harris. Zenith telescope No. 5. Second series. September 11 to October 6, 1854. One division of level =0″·77 from observations at this station. One turn of micrometer =41″·420 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 052	6 082	57 ·22	39 ·45	3	8	44 12 42 ·49	+0 ·51
6 177	6 223	04 ·82	40 ·99	2	6	43 ·05	−0 ·05
6 241	6 316	08 ·99	36 ·74	2	6	41 ·69	+1 ·31
6 395	*6 429	25 ·72	14 ·28	4	7	42 ·92	+0 ·08
*6 429	6 522	14 ·28	58 ·88	5	7	42 ·32	+0 ·68
6 534	6 583	16 ·49	17 ·41	3	8	42 ·15	+0 ·85
6 659	6 711	44 ·88	12 ·92	6	12	42 ·96	+0 ·04
6 734	6 806	54 ·74	18 ·22	6	12	42 ·72	+0 ·28
6 763	6 813	42 ·42	03 ·10	6	12	43 ·62	−0 ·62
6 824	*6 915	51 ·20	37 ·67	4	7	43 ·33	−0 ·33
*6 915	6 928	37 ·67	52 ·01	6	8	42 ·73	+0 ·27
6 940	7 024	31 ·54	19 ·33	5	11	42 ·62	+0 ·38
7 098	7 126	44 ·25	36 ·50	7	13	42 ·84	+0 ·16
7 171	7 253	22 ·17	49 ·23	7	13	43 ·02	−0 ·02
7 278	*7 336	50 ·85	57 ·30	5	7	42 ·76	+0 ·24
7 385	7 448	32 ·98	09 ·03	4	10	43 ·86	−0 ·86
7 512	7 566	03 ·20	58 ·74	4	10	43 ·21	−0 ·21
7 595	7 623	06 ·75	16 ·38	4	10	43 ·42	−0 ·42
7 679	7 695	19 ·74	29 ·98	2	6	42 ·41	+0 ·59
7 721	*7 754	21 ·09	07 ·98	3	6	43 ·77	−0 ·77
7 731	*7 754	10 ·96	07 ·98	4	7	43 ·74	−0 ·74
7 894	*7 983	29 ·04	34 ·41	4	7	42 ·86	+0 ·14
7 913	*7 983	13 ·08	34 ·41	4	7	42 ·45	+0 ·55
*6 238	6 311	46 ·34	06 ·55	1	3	42 ·79	+0 ·21
*6 238	6 318	46 ·34	50 ·48	1	3	42 ·37	+0 ·63
6 477	*6 571	52 ·10	26 ·74	4	7	42 ·66	+0 ·34
6 496	*6 571	39 ·21	26 ·74	4	7	43 ·41	−0 ·41
6 687	6 722	30 ·87	38 ·90	6	12	42 ·60	+0 ·40
6 740	6 867	49 ·65	34 ·41	6	12	43 ·13	−0 ·13
6 926	6 975	33 ·73	45 ·95	3	8	43 ·88	−0 ·88
6 986	7 076	04 ·20	54 ·08	2	6	43 ·11	−0 ·11
7 048	7 085	29 ·07	13 ·97	5	11	43 ·05	−0 ·05
7 243	*7 336	29 ·75	57 ·30	3	6	43 ·21	−0 ·21
7 782	7 843	25 ·30	24 ·04	5	11	43 ·52	−0 ·52
*7 855	7 879	01 ·25	34 ·92	3	6	43 ·15	−0 ·15
*7 855	7 880	01 ·25	12 ·50	4	7	43 ·04	−0 ·04

Indiscriminate mean = 44° 12′ 42″ ·97.
Weighted mean = 44 12 43 ·00 ± 0″ ·05.
$e = \pm$ 0″ ·47.
147 observations, 36 pairs.
[Reduction to △ = + 0″·40.]

Combination of results.

G. W. Dean φ = 44° 12′ 42″ ·92 ± 0″ ·05.
S. Harris 43 ·00 ± 0 ·05.
Mean 42 ·96 ± 0 ·04.
[Reduction to △ = + 0″ ·40.]

10. *Sabattus*, Maine.—J. E. Hilgard. Zenith telescope No. 1. June 29 to July 14, 1853. One division of level $=3''\cdot2$. One turn of micrometer $=45''\cdot52$.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
4 943	4 974	58·00	18·00	4	4	44 08 37·35	+0·38
5 079	5 085	33·50	03·51	3	3	39·26	−1·53
*5 094	5 152	34·30	32·30	2	2	39·30	−1·57
*5 094	5 216	34·30	53·07	2	2	38·92	−1·19
5 168	5 177	55·40	57·60	3	3	38·50	−0·77
5 348	5 440	26·90	59·56	6	5	38·04	−0·31
5 483	5 490	50·25	29·50	6	5	37·95	−0·22
5 596	5 617	55·50	43·50	3	3	37·54	+0·19
5 592	5 621	37·60	44·40	2	3	37·68	+0·05
5 692	5 705	20·40	10·56	4	4	36·96	+0·77
5 714	5 734	01·73	13·80	4	4	37·98	−0·25
5 747	5 785	57·00	05·00	4	4	37·64	+0·09
5 828	5 840	03·60	26·80	4	4	36·47	+1·26
5 900	5 972	26·00	18·30	3	3	36·11	+1·62
5 922	5 978	30·80	44·62	3	3	38·24	−0·51
5 991	6 047–8	33·40	35·15	3	3	38·49	−0·76
6 006	6 030	29·00	39·57	3	3	37·08	+0·65
6 052	6 082	55·50	37·80	2	3	38·47	−0·74
6 079	6 178	09·50	41·50	3	3	37·80	−0·07
6 237	6 289	25·53	59·80	2	3	38·37	−0·64
*6 238	6 311	47·73	08·00	2	2	37·29	+0·44
*6 238	6 318	47·73	52·40	2	2	35·83	+1·90
6 357	*6 428	31·00	55·50	3	2	36·90	+0·83
6 390	*6 428	51·40	55·50	3	2	36·90	+0·83
6 391	*6 428	18·20	55·50	3	2	36·83	+0·90
6 368	6 429	18·50	18·30	3	3	38·45	−0·72
6 453	6 586	16·60	02·00	1	1	37·13	+0·60
6 480	6 522	01·03	04·00	4	4	38·55	−0·82
6 582	6 612	18·35	49·40	4	4	38·02	−0·29
6 625	6 644	14·50	57·00	4	4	37·47	+0·26
6 667	6 687	25·20	38·60	4	4	37·81	−0·08
6 737	6 758	32·02	38·84	4	4	37·23	+0·50
6 783	6 836	31·20	24·30	2	3	36·79	+0·94
6 835	6 905	45·36	24·50	4	4	38·27	−0·54
6 856	6 937	57·60	25·50	1	1	38·24	−0·51

Indiscriminate mean $=44°\ 08'\ 37''\cdot71$.
Weighted mean $=44\ \ 08\ \ 37\ \cdot73\pm0''\cdot09$.
$e=\pm0''\cdot77$.

110 observations, 35 pairs.

[Reduction to $\triangle=-0''\cdot15$.]

11. *Mount Pleasant*, Maine.—G. W. Dean. Zenith telescope No. 5. July 20 to August 19, 1851. One division of level = 1″·58 from observations at this station. One turn of micrometer = 41″·400 from circumpolar observations at this station and Cape Small, Maine.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
5 484	5 502	58 ·15	16 ·00	4	12	44 01 36 ·53	−0 ·09
5 497	5 552	03 ·20	10 ·80	1	7	36 ·65	−0 ·21
5 602	5 717	33 ·12	53 ·44	3	11	36 ·06	+0 ·38
5 604	*5 629	27 ·70	03 ·72	5	9	35 ·96	+0 ·48
*5 629	5 693	03 ·72	55 ·16	5	9	35 ·92	+0 ·52
5 840	5 860	18 ·15	55 ·68	6	14	35 ·60	+0 ·84
5 922	5 978	24 ·62	38 ·73	6	14	36 ·67	−0 ·23
5 986	6 079	56 ·15	08 ·36	6	14	36 ·59	−0 ·15
6 129	6 268	25 ·98	14 ·90	5	13	37 ·28	−0 ·84
6 178	6 216	43 ·15	40 ·77	6	14	35 ·93	+0 ·51
6 238	6 318	50 ·51	56 ·89	4	12	36 ·43	+0 ·01
*6 255	6 349	05 ·32	25 ·76	5	9	35 ·77	+0 ·67
*6 255	6 355	05 ·32	07 ·90	6	9	35 ·98	+0 ·46
6 390	*6 428	58 ·25	03 ·50	5	9	36 ·67	−0 ·23
6 391	*6 428	24 ·80	03 ·50	6	9	36 ·10	+0 ·34
6 530	6 556	12 ·40	49 ·59	6	14	36 ·92	−0 ·48
6 566	*6 599	27 ·50	44 ·18	6	9	36 ·32	+0 ·12
*6 599	6 659	44 ·18	05 ·21	5	9	35 ·95	+0 ·49
6 667	6 687	39 ·76	52 ·67	6	14	37 ·23	−0 ·79
6 712	6 740	52 ·92	13 ·38	6	14	36 ·91	−0 ·47
†2 872	6 784	29 ·34	58 ·94	6	14	36 ·12	+0 ·32
6 763	*6 849	07 ·06	23 ·50	5	9	36 ·91	−0 ·47
*6 849	6 895	23 ·50	28 ·56	6	9	36 ·44	0 ·00
6 915	6 928	06 ·50	25 ·13	5	13	35 ·74	+0 ·70
6 932	6 940	09 ·68	03 ·80	6	14	36 ·68	−0 ·24
6 943	6 970	55 ·73	18 ·08	6	14	36 ·48	−0 ·04
7 008	7 062	51 ·78	32 ·16	6	14	36 ·31	+0 ·13
7 022	7 076	04 ·05	28 ·67	6	14	36 ·71	−0 ·27
*7 098	7 117	20 ·23	52 ·21	5	9	36 ·45	−0 ·01
*7 098	7 126	20 ·23	13 ·46	6	9	36 ·80	−0 ·36
7 171	7 333	00 ·03	52 ·15	6	14	36 ·41	+0 ·03
7 243	7 336	09 ·67	49 ·65	6	14	36 ·99	−0 ·55
7 385	7 448	18 ·69	54 ·90	6	14	36 ·71	−0 ·27
7 398	7 411	40 ·13	05 ·86	6	14	35 ·63	+0 ·81
7 636	7 721	19 ·39	13 ·79	6	14	36 ·12	+0 ·32
7 643	7 731	35 ·07	04 ·28	5	13	36 ·75	−0 ·31
7 679	*7 800	11 ·41	44 ·47	5	9	36 ·44	0 ·00
*7 800	7 850	44 ·47	20 ·58	6	9	36 ·23	+0 ·21
7 843	7 871	16 ·83	41 ·58	6	14	36 ·15	+0 ·29
7 894	7 948	25 ·01	17 ·65	6	14	36 ·43	+0 ·01

†Groombridge.

11. *Mount Pleasant*, Maine—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 901	†3 901	26·44	39·98	6	14	44 01 36·51	−0·07
8 058	8 076	00·00	19·65	6	14	36·80	−0·36
8 171	8 224	27·40	55·36	5	13	36·46	−0·02
8 229	8 261	22·70	24·00	2	10	36·80	−0·36

Indiscriminate mean $= 44° \; 01' \; 36''.42$.
Weighted mean $= 44 \;\; 01 \;\; 36 \;\; .44 \pm 0''.04$.
$e = \pm 0''.30$.
236 observations, 44 pairs.
[Reduction to △ = + 0″·05.]

12. *Cape Small*, Maine.—G. W. Dean. Zenith telescope. September 17 to October 10, 1851. One division of level = 1″·598 from observations at this station. One turn of micrometer = 41″·429 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 497	6 522	35·57	13·96	6	18	43 46 43·13	+0·56
6 571	6 583	43·98	35·34	6	18	43·72	−0·03
6 599	6 659	44·20	05·20	6	18	43·48	+0·21
6 667	6 697	40·00	09·20	6	18	44·32	−0·63
6 673	6 712	01·34	55·24	6	18	43·26	+0·43
6 745	6 754	24·42	33·70	7	18	43·63	+0·06
6 849	6 895	23 55	28·55	6	18	44·29	−0·60
6 851	6 928	35·46	23·13	7	18	43·24	+0·45
6 932	6 943	09·65	56·30	6	18	43·75	−0·06
6 983	6 996	29·56	48·50	7	18	43·20	+0·49
7 008	7 076	52·45	28·65	7	18	43·69	0·00
7 024	7 126	53·63	13·46	6	18	43·30	+0·39
7 100	7 171	50·48	00·12	7	18	44·26	−0·57
7 204	7 262	07·46	11·69	6	18	43·08	+0·61
7 277	7 301	15·44	31·10	6	18	44·26	−0·57
7 317	7 333	42·19	52·26	5	18	43·32	+0·37
7 345	7 383	54·64	10·06	6	18	43·60	+0·09
7 398	7 411	40·36	05·70	6	18	43·42	+0·27
7 448	7 462	54·90	43·25	6	18	43·96	−0·27
7 503	7 544	54·30	02·48	6	18	43·98	−0·29
7 582	7 607	07·09	03·56	6	18	43·79	−0·10
7 598	7 614	42·00	33·81	6	18	43·53	+0·16
7 731	7 813	04·22	22·40	6	18	43·03	+0·66
7 843	7 871	16·70	41·60	6	18	44·17	−0·48
7 803	7 894	14·73	24·76	6	18	43·77	−0·08
7 882	7 901	58·92	26·46	6	18	43·50	+0·19
7 906	7 983	01·18	31·20	6	18	43·99	−0·30
8 028	8 058	33·27	59·80	6	18	43·99	−0·30
†3 952	*8 076	24·35	18·88	6	12	43·53	+0·16

† Groombridge.

12. *Cape Small*, Maine—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
*8 076	8 115	18 ·88	26 ·85	6	12	43 46 43 ·76	−0 ·07
8 114	8 212	53 ·60	04 ·50	6	18	43 ·99	−0 ·30
8 171	8 261	27 ·40	24 ·28	6	18	43 ·91	−0 ·22
180	259	20 ·60	35 ·44	6	18	43 ·87	−0 ·18
330	337	15 ·12	43 ·42	6	18	43 ·85	−0 ·16
487	502	43 ·50	46 ·84	6	18	43 ·80	−0 ·11
649	673	01 ·28	47 ·40	6	18	43 ·15	+0 ·54
706	727	38 ·58	58 ·10	6	18	43 ·95	−0 ·26
819	877	49 ·66	22 ·98	5	18	43 ·63	+0 ·06
915	947	04 ·20	53 ·30	6	18	43 ·71	−0 ·02
953	1 043	27 ·56	25 ·90	6	18	43 ·91	−0 ·22

Indiscriminate mean $= 43° 46′ 43″·69$.
Weighted mean $= 43\ 46\ 43\ ·69 \pm 0·04$.
$e = \pm 0″·23$.
243 observations, 40 pairs.
[Reduction to $\triangle = -0″·21$.]

13. *Mount Independence*, Maine.—A. D. Bache and G. Davidson. Zenith sector No. 1. First series. September 21 to October 27, 1849. Mean value of one division of level = 0″·721. (Levels No. 3.)

Stars north of zenith.					Stars south of zenith.				
Stars.	Adopted seconds of mean N. P. D.	n'	Latitude.	v	Stars.	Adopted seconds of mean N. P. D.	n'	Latitude.	v
	″		° ′ ″	″		″		° ′ ″	″
16	06 ·00	4	43 45 35 ·22	−0 ·21	58	07 ·46	4	43 45 34 ·02	+0 ·14
169	30 ·02	5	34 ·84	+0 ·17	100	28 ·50	4	35 ·58	−1 ·42
180	00 ·20	4	34 ·78	+0 ·23	259	14 ·80	4	34 ·99	−0 ·83
330	53 ·80	4	35 ·23	−0 ·22	337	22 ·00	3	34 ·88	−0 ·72
474	02 ·30	1	34 ·78	+0 ·23	502	23 ·60	3	34 ·53	−0 ·37
487	20 ·50	3	35 ·16	−0 ·15	649	36 ·00	3	32 ·98	+1 ·18
673	21 ·50	3	34 ·03	+0 ·98	727	31 ·48	3	33 ·95	+0 ·21
706	12 ·40	3	35 ·76	−0 ·75	877	54 ·20	4	35 ·02	−0 ·86
819	21 ·20	4	34 ·05	+0 ·96	915	33 ·70	3	34 ·19	−0 ·03
947	22 ·40	3	35 ·84	−0 ·83	953	56 ·30	3	33 ·98	+0 ·18
1 043	52 ·44	6	35 ·19	−0 ·18	2 485	09 ·18	3	33 ·56	+0 ·60
3 048	10 ·77	4	35 ·42	−0 ·41	6 355	14 ·10	8	34 ·29	−0 ·13
5 937	05 ·30	4	35 ·83	−0 ·82	6 429	33 ·71	6	34 ·40	−0 ·24
6 091	28 ·90	8	35 ·15	−0 ·14	6 497	45 ·01	4	33 ·26	+0 ·90
6 522	23 ·84	1	34 ·20	+0 ·81	6 571	55 ·50	4	32 ·60	+1 ·56
6 583	47 ·30	3	36 ·62	−1 ·61	6 673	15 ·30	2	34 ·04	+0 ·12
6 712	08 ·10	4	36 ·32	−1 ·31	6 745	40 ·70	4	35 ·27	−1 ·11
6 754	50 ·06	3	34 ·55	+0 ·46	6 784	15 ·26	4	33 ·29	+0 ·87
6 928	45 ·54	4	33 ·32	+1 ·69	6 851	54 ·00	4	33 ·62	+0 ·54
6 983	51 ·30	4	33 ·84	+1 ·17	6 996	10 ·60	3	33 ·94	+0 ·22
7 076	52 ·10	4	35 ·70	−0 ·69	7 008	14 ·72	4	32 ·69	+1 ·47

13. *Mount Independence*, Maine. First series—continued.

Stars north of zenith.					Stars south of zenith.				
Stars.	Adopted seconds of mean N. P. D.	n'	Latitude.	v	Stars.	Adopted seconds of mean N. P. D.	n'	Latitude.	v
	″		° ′ ″	″		″		° ′ ″	″
7 171	25·40	7	43 45 33·84	+1·17	7 100	14·58	3	43 45 34·88	−0·72
7 262	38·68	3	34·81	+0·20	7 204	34·00	4	32·91	+1·25
7 301	58·80	4	36·12	−1·11	7 277	42·80	4	34·75	−0·59
7 317	10·18	2	33·56	+1·45	7 333	20·60	3	34·31	−0·15
7 345	23·20	2	34·04	+0·97	7 336	24·56	4	34·47	−0·31
7 411	35·80	3	33·60	+1·41	7 368	23·80	5	34·05	+0·11
7 448	25·50	4	36·24	−1·23	7 383	39·40	3	32·82	+1·34
7 503	25·75	5	35·82	−0·81	7 398	10·10	4	36·68	−2·52
7 582	39·85	3	35·73	−0·72	7 462	14·10	4	34·46	−0·30
7 598	15·40	4	34·74	+0·27	7 544	34·80	4	33·57	+0·59
7 643	08·81	6	35·42	−0·41	7 607	36·70	4	33·91	+0·25
7 782	54·00	2	37·07	−2·06	7 614	07·16	3	33·28	+0·88
7 813	58·00	4	34·18	+0·83	7 731	39·20	4	34·37	−0·21
7 871	18·50	5	33·07	+1·94	7 803	50·75	3	33·04	+1·12
7 882	35·96	3	35·52	−0·51	7 843	53·50	2	35·15	−0·99
7 894	01·80	4	36·01	−1·00	7 901	03·73	4	33·99	+0·17
7 983	09·40	3	35·17	−0·16	7 948	55·31	3	34·78	−0·62
8 058	38·50	5	36·50	−1·49	8 028	11·85	5	34·71	−0·55
8 115	06·04	4	33·86	+1·15	8 076	58·20	3	33·67	+0·49
8 261	04·20	4	34·99	+0·02	8 171	06·95	4	35·07	−0·91
8 310	26·40	4	34·46	+0·55	8 229	02·57	4	34·88	−0·72

160 observations, 42 stars. 157 observations, 42 stars.

$\varphi_n = 43°\ 45'\ 35''.01$. $\varphi_s = 43°\ 45'\ 34''.16$.

$$\varphi = \tfrac{1}{2}(\varphi_n + \varphi_s) = 43°\ 45'\ 34''.58 \pm 0''.07.$$

13. *Mount Independence*, Maine.—G. W. Dean. Zenith telescope No. 2. Second series. September 20 to October 20, 1849. One division of level = 0″·90 from observations at this station. One turn of micrometer = 44″·880 from the latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 368	6 427	32·92	13·94	1	2	43 45 33·67	+0·66
6 497	6 522	45·01	23·84	4	5	33·48	+0·85
6 571	6 583	55·50	47·30	4	5	34·28	+0·05
6 673	6 712	15·30	08·10	4	5	34·83	−0·50
6 745	6 754	40·70	50·06	5	6	34·49	−0·16
6 851	6 928	54·00	45·54	5	6	33·45	+0·88
6 983	6 996	51·30	10·60	4	5	33·25	+1·08
7 008	7 076	14·72	52·10	4	5	33·11	+1·22
7 100	7 171	14·58	25·40	5	6	34·80	−0·47
7 204	7 262	34.00	38·68	4	5	33·82	+0·51
7 277	7 301	42·80	58·80	4	5	34·65	−0·32

13. *Mount Independence*, Maine. Second series—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 317	7 333	10·18	20·60	5	6	43 45 34·01	+0·32
7 345	7 383	23·20	39·40	4	5	33·82	+0·51
7 448	7 462	25·50	14·10	4	5	33·74	+0·59
7 503	7 544	25·75	34·80	4	5	33·92	+0·41
7 582	7 607	39·85	36·70	4	5	33·85	+0·48
7 731	7 813	39·20	58·00	5	6	33·32	+1·01
7 843	7 871	53·50	18·50	4	5	34·16	+0·17
7 882	7 901	35·96	03·73	4	5	33·79	+0·54
8 028	8 058	11·85	38·50	5	6	34·35	−0·02
8 076	8 115	58·20	06·04	4	5	35·19	−0·86
8 171	8 261	06·95	04·20	4	5	34·31	+0·02
180	259	00·20	14·80	3	5	34·27	+0·06
330	337	53·80	22·00	3	5	34·30	+0·03
7 398	7 411	10·10	35·80	6	6	34·97	−0·64
7 598	7 614	15·40	07·16	7	6	34·70	−0·37
7 803	7 894	50·75	01·80	6	6	35·32	−0·99
487	502	20·50	23·60	6	6	35·64	−1·31
649	673	36·00	21·50	6	6	34·70	−0·37
706	727	12·40	31·48	5	6	35·28	−0·95
819	877	21·20	54·20	6	6	34·66	−0·33
915	947	33·70	22·40	6	6	35·14	−0·81
953	1 043	56·30	52·44	6	6	34·37	−0·04

Indiscriminate mean $= 43° 45' 34''·29$.
Weighted mean $= 43\ 45\ 34\ ·33 \pm 0''·08$.
$e = \pm 0''·52$.
151 observations, 33 pairs.
[Reduction to △ $= -0''·03$.]
Resulting latitude by combination of series $= 43° 45' 34''·47 \pm 0''·06$.

14. *Gunstock*, New Hampshire.—J. H. Toomer. Zenith telescope No. 5. July 11 to August 9, 1860. One division of level $= 0''·948$ from observations at this station. One turn of micrometer $= 41''·391$ from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
5 400	5 417	18·63	53·62	8	14	43 31 03·24	+0·57
5 479	5 499	09·30	24·77	7	14	03·24	+0·57
5 541	5 599	17·84	35·36	9	15	03·25	+0·56
5 629	*5 731	05·31	53·90	7	9	03·67	+0·14
5 658	*5 731	27·34	53·90	8	10	03·50	+0·31
5 785	5 863	40·02	58·20	8	14	03·76	+0·05
5 918	5 931	48·28	19·58	8	14	04·14	−0·33
6 079	6 087	15·06	48·61	8	14	03·22	+0·59
*6 147	6 184	20·29	50·90	7	9	03·15	+0·66
*6 147	6 216	20·29	31·23	7	9	03·41	+0·40

14. *Gunstock*, New Hampshire—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
*6 235	6 246	46 ·72	43 ·73	8	10	43 31 03 ·90	−0 ·09
*6 235	6 258	46 ·72	55 ·44	8	10	03 ·87	−0 ·06
6 365	6 428	39 ·25	28 ·78	7	14	03 ·95	−0 ·14
6 456	6 470	03 ·76	52 ·24	7	14	04 ·21	−0 ·40
6 493	6 520	40 ·51	42 ·42	7	14	03 ·74	+0 ·07
6 599	6 626	49 ·11	18 ·76	8	14	03 ·62	+0 ·19
6 648	6 681	59 ·50	14 ·64	8	14	03 ·70	+0 ·11
6 734	6 771	06 ·10	54 ·19	7	14	03 ·73	+0 ·08
*6 861	6 940	48 ·55	29 ·95	7	9	03 ·80	+0 ·01
*6 861	6 943	48 ·55	21 ·80	7	9	04 ·21	−0 ·40
*6 983	7 022	52 ·00	22 ·25	7	9	04 ·23	−0 ·42
*6 983	7 048	52 ·00	19 ·67	7	9	04 ·09	−0 ·28
7 064	*7 132	18 ·51	49 ·71	7	9	03 ·88	−0 ·07
7 105	*7 132	39 ·91	49 ·71	7	9	04 ·73	−0 ·92
7 174	7 233	58 ·31	13 ·31	7	14	04 ·21	−0 ·40
7 297	7 345	38 ·90	45 ·46	7	14	04 ·05	−0 ·24
5 643	*5 666	00 ·85	07 ·58	3	6	03 ·72	+0 ·09
*5 666	5 752	07 ·58	17 ·49	4	7	03 ·84	−0 ·03
5 788	5 795	50 ·44	42 ·70	8	14	04 ·21	−0 ·40
5 853	5 886	27 ·70	22 ·00	8	14	03 ·75	+0 ·06
5 911	5 929	14 ·74	39 ·71	7	14	03 ·47	+0 ·34
6 095	6 162	08 ·63	13 ·31	6	13	04 ·45	−0 ·64
6 231	*6 316	42 ·56	23 ·72	8	10	04 ·15	−0 ·34
6 251	*6 316	26 ·59	23 ·72	9	10	04 ·27	−0 ·46
6 392	6 421	20 ·43	18 ·35	7	14	04 ·01	−0 ·20
6 495	6 516	27 ·38	44 ·53	6	13	03 ·58	+0 ·23
6 542	6 629	48 ·49	49 ·29	6	13	03 ·09	+0 ·72
6 656	*6 720	58 ·16	38 ·07	6	8	03 ·92	−0 ·11
*6 720	6 728	38 ·07	20 ·67	6	8	03 ·21	+0 ·60
6 745	6 779	11 ·43	33 ·02	6	13	04 ·48	−0 ·67
6 824	6 851	57 ·28	11 ·96	7	14	04 ·21	−0 ·40
6 881	6 915	36 ·89	40 ·08	8	14	03 ·58	+0 ·23
6 962	6 996	22 ·23	09 ·68	7	14	03 ·90	−0 ·09
7 027	7 112	11 ·21	06 ·95	7	14	04 ·31	−0 ·50
7 158	7 198	49 ·66	35 ·97	7	14	03 ·08	+0 ·73
7 241	*7 333	59 ·45	44 ·63	7	9	04 ·04	−0 ·23
7 253	*7 333	28 ·64	44 ·63	7	9	04 ·51	−0 ·70

Indiscriminate mean $=43° 31' 03''·84$.
Weighted mean $=43\ 31\ 03\ ·81\pm0''·05$.
$e=\pm0''·50$.
333 observations, 47 pairs.
[Reduction to $\triangle=+1''·33$.]

15. *Agamenticus*, Maine.—T. J. Lee. Zenith telescope Military Academy. First series. September 15 to October 10, 1847. One division of level = 1″·28. One turn of micrometer = 44″·791 from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 582	6 662	54 ·24	47 ·00	3	2	43 13 25 ·79	−0 ·84
6 735	6 744	56 ·90	28 ·90	5	3	25 ·06	−0 ·11
6 758	6 834	26 ·63	00 ·50	4	3	23 ·81	+1 ·14
7 377	*7 461	28 ·16	18 ·13	5	2	26 ·16	−1 ·21
7 387	*7 461	55 ·84	18 ·13	5	2	26 ·21	−1 ·26
*7 533	*7 571	18 ·00	19 ·17	5	1	25 ·76	−0 ·81
*7 533	*7 584	18 ·00	10 ·37	4	1	24 ·03	+0 ·92
*7 533	*7 586	18 ·00	31 ·50	5	1	25 ·70	−0 ·75
*7 542	*7 571	25 ·30	19 ·17	4	1	24 ·62	+0 ·33
*7 542	*7 584	25 ·30	10 ·37	3	1	23 ·07	+1 ·88
*7 542	*7 586	25 ·30	31 ·50	4	1	24 ·70	+0 ·25
7 607	7 668	10 ·00	21 ·80	5	3	25 ·09	−0 ·14
7 693	7 718	36 ·97	16 ·70	5	3	25 ·24	−0 ·29
7 755	7 798	19 ·70	17 ·07	6	4	24 ·88	+0 ·07
7 829	7 958	56 ·32	18 ·00	6	4	25 ·56	−0 ·61
*7 997	*8 039	00 ·80	54 ·20	5	2	24 ·60	+0 ·35
*7 997	*8 077	00 ·80	17 ·60	5	2	24 ·93	+0 ·02
*8 146	*8 039	31 ·74	54 ·20	5	2	24 ·41	+0 ·54
*8 146	*8 077	31 ·74	17 ·60	5	2	24 ·74	+0 ·21
*8 256	8 188	08 ·48	38 ·90	7	3	24 ·25	+0 ·70
*8 256	8 268	08 ·48	00 ·32	7	3	24 ·73	+0 ·22
8 374	*7	20 ·87	39 ·60	2	1	25 ·00	−0 ·05
4	*7	15 ·67	39 ·60	3	2	22 ·78	+2 ·17
32	68	39 ·66	33 ·26	4	3	25 ·08	−0 ·13
164	182	11 ·90	11 ·13	4	3	26 ·18	−1 ·23
253	395	47 ·50	31 ·04	2	2	25 ·50	−0 ·55
412	430	15 ·52	30 ·52	3	2	24 ·43	+0 ·52

Indiscriminate mean = 43° 13′ 24″·90.
Weighted mean = 43 13 24 ·95 ± 0″·10.
$e = \pm 0''{\cdot}99$.
121 observations, 27 pairs.
[Reduction to △ = −0″·11.]

15. *Agamenticus*, Maine.—A. D. Bache, R. H. Fauntleroy, C. O. Boutelle. Zenith sector No. 1. Second series. October 4 to November 15, 1847. Mean value of one division of level = 0″·727.

Stars north of zenith.					Stars south of zenith.				
Stars.	Adopted seconds of mean. N. P. D.	n'	Latitude.	v	Stars.	Adopted seconds of mean. N. P. D.	n'	Latitude.	v
	″		° ′ ″	″		″		° ′ ″	″
7 091	38 ·10	1	43 13 25 ·78	−0 ·23	7 277	09 ·90	5	43 13 25 ·47	−0 ·70
7 171	50 ·60	5	25 ·42	+0 ·13	7 398	39 ·75	4	24 ·89	−0 ·12
7 345	51 ·60	5	25 ·72	−0 ·17	7 462	44 ·90	5	24 ·26	+0 ·51
7 560	24 ·60	6	26 ·55	−1 ·00	7 731	14 ·50	3	24 ·45	+0 ·32

15. *Agamenticus*, Maine. Second series—continued.

Stars north of zenith.					Stars south of zenith.				
Stars.	Adopted seconds of mean N. P. D.	n'	Latitude.	v	Stars.	Adopted seconds of mean N. P. D.	n'	Latitude.	v
	$''$		° ′ ″	$''$		$''$		° ′ ″	$''$
7 705	41 ·17	2	43 13 24 ·88	+0 ·67	7 777	41 ·80	2	43 13 24 ·48	+0 ·29
7 815	10 ·06	2	26 ·93	−1 ·38	7 850	34 ·00	3	25 ·65	−0 ·88
7 888	36 ·40	2	27 ·46	−1 ·91	7 972	58 ·60	3	24 ·89	−0 ·12
7 906	15 ·90	4	25 ·04	+0 ·51	7 994	41 ·00	1	25 ·25	−0 ·48
8 036	42 ·56	3	26 ·34	−0 ·79	8 136	07 ·52	4	24 ·30	+0 ·47
8 107	39 ·28	2	23 ·72	+1 ·83	8 345	05 ·26	2	24 ·71	+0 ·06
8 224	13 ·20	2	25 ·35	+0 ·20	58	47 ·60	3	23 ·17	+1 ·60
8 231	30 ·50	4	27 ·05	−1 ·50	480	43 ·20	3	24 ·96	−0 ·19
8 289	40 ·30	4	24 ·21	+1 ·34	566	40 ·50	3	24 ·69	+0 ·08
16	45 ·75	3	23 ·71	+1 ·84	656	22 ·00	3	25 ·13	−0 ·36
100	07 ·90	5	25 ·52	+0 ·03	821	24 ·20	2	25 ·63	−0 ·86
180	39 ·20	2	26 ·61	−1 ·06	912	13 ·48	2	24 ·46	+0 ·31
330	32 ·48	1	24 ·32	+1 ·23	981	26 ·90	1	24 ·68	+0 ·09
404	29 ·28	2	25 ·86	−0 ·31					
735	03 ·30	1	25 ·06	+0 ·49					

$\varphi_n = 43° \; 13' \; 25''·55.$ $\varphi_s = 43° \; 13' \; 24''·77.$

56 observations, 19 stars. 49 observations, 17 stars.

$\varphi = \frac{1}{2}(\varphi_n + \varphi_s) = 43° \; 13' \; 25''·16 \pm 0''·11.$

[Reduction to △ = − 0″·11.]

15. *Agamenticus*, Maine.—A. D. Bache, R. H. Fauntleroy, G. Davidson. Transit No. 2 in prime vertical. Third series. October 18 to November 26, 1847.

Stars.	Adopted seconds of mean N. P. D.	n'	w	Latitude.	v
	$''$			° ′ ″	$''$
6 355	20 ·24	4	4	43 13 24 ·92	+0 ·05
7 022	49 ·40	4	4	24 ·67	+0 ·30
8 023	42 ·25	4	4	24 ·65	+0 ·32
60	32 ·05	2	2	25 ·53	−0 ·56
7 972	58 ·72	2	2	24 ·06	+0 ·91
8 229	42 ·18	2	2	25 ·33	−0 ·36
963	17 ·40	1	1	25 ·27	−0 ·30
1 320	02 ·25	1	1	25 ·65	−0 ·68
1 398	08 ·00	1	1	26 ·72	−1 ·75

Indiscriminate mean = 43° 13′ 25″·00.
Weighted mean = 43 13 24 ·97 ± 0″·14.
$e = \pm 0''·44.$
21 observations, 9 stars.
[Reduction to △ = 0″·00.]

Combination of results for latitude referred to △.

By zenith telescope	43° 13′ 24″·84 ± 0″·10.
By zenith sector	43 13 25 ·05 ± 0 ·11.
By transit in prime vertical	43 13 24 ·97 ± 0 ·14.
Weighted mean	43 13 24 ·96 ± 0 ·06.

16. *Isles of Shoals*, Maine.—T. J. Lee. Zenith telescope Military Academy. August 4 to 22, 1847. One division of level = 1″·283. One turn of micrometer = 44″·962.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
*6 079	*6 150	05 ·35	16 ·40	7	2	42 59 12 ·97	0 ·00
*6 079	*6 234	05 ·35	50 ·39	5	2	12 ·88	+0 ·09
*6 079	*6 238	05 ·35	56 ·06	7	2	12 ·69	+0 ·28
*6 348	*6 150	11 ·59	16 ·40	7	2	13 ·49	−0 ·52
*6 348	*6 234	11 ·59	50 ·39	5	2	13 ·08	−0 ·11
*6 348	*6 238	11 ·59	56 ·06	7	2	13 ·15	−0 ·18
6 547	6 601	30 ·04	26 ·95	5	4	12 ·35	+0 ·62
6 642	*6 735	22 ·52	56 ·90	6	3	12 ·86	+0 ·11
6 647	*6 735	17 ·00	56 ·90	5	3	13 ·69	−0 ·72
6 762	6 818	38 ·20	54 ·00	6	5	13 ·03	−0 ·06
*6 882	*6 932	14 ·28	50 ·85	7	2	12 ·68	+0 ·29
*6 882	*6 970	14 ·28	01 ·15	7	2	12 ·22	+0 ·75
*6 883	*6 932	12 ·86	50 ·85	6	2	13 ·04	−0 ·07
*6 883	*6 970	12 ·86	01 ·15	6	2	12 ·62	+0 ·35
*6 979	*6 932	49 ·30	50 ·85	7	2	12 ·33	+0 ·64
*6 979	*6 970	49 ·30	01 ·15	8	3	12 ·10	+0 ·87
7 013	7 024	18 ·04	39 ·00	8	6	13 ·34	−0 ·37
7 105	7 152	17 ·50	54 ·90	7	6	13 ·44	−0 ·47
7 188	7 220	26 ·02	15 ·30	7	6	11 ·89	+1 ·08
7 281	7 368	59 ·00	53 ·00	8	6	13 ·70	−0 ·73
7 474	7 658	44 ·74	06 ·60	6	5	13 ·52	−0 ·55

Indiscriminate mean = 42° 59′ 12″ ·91.
Weighted mean = 42 59 12 ·97 ± 0″ ·09.
$e = \pm 1''\cdot 12$.
137 observations, 21 pairs.
[Reduction to △ = − 0″ ·10.]

17. *Unkonoonuc*, New Hampshire.—J. S. Ruth. Zenith telescope No. 5. September 16 to October 8, 1848. One division of level = 1″·064. One turn of micrometer = 46″·615 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 372	6 468	42 ·02	19 ·13	3	5	42 58 59 ·29	+0 ·05
6 496	6 547	07 ·00	23 ·59	3	5	59 ·50	−0 ·16
6 583	6 648	53 ·00	21 ·01	5	8	58 ·77	+0 ·57
6 697	6 777	31 ·50	16 ·38	6	9	59 ·12	+0 ·22
6 813	6 830	56 ·42	29 ·86	6	9	59 ·07	+0 ·27
6 865	6 915	14 ·40	35 ·56	4	7	58 ·77	+0 ·57
6 965	7 022	02 ·38	37 ·95	3	5	58 ·20	+1 ·14
7 048	7 112	37 ·61	32 ·51	4	7	59 ·07	+0 ·27
7 153	7 204	22 ·60	47 ·13	5	8	58 ·92	+0 ·42
7 281	7 368	45 ·25	38 ·20	7	10	59 ·61	−0 ·27
7 480	7 554	40 ·10	58 ·50	4	7	58 ·71	+0 ·63
7 614	7 727	23 ·82	32 ·06	4	7	58 ·99	+0 ·35

17. *Unkonoonuc*, Maine—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
7 765	7 845	15 ·00	11 ·10	4	7	42 58 59 ·65	−0 ·31
7 894	8 023	´21 ·11	23 ·00	2	4	59 ·66	−0 ·32
8 054	8 097	03 ·00	46 ·00	3	5	59 ·71	−0 ·37
8 268	8 284	40 ·30	11 ·44	4	7	59 ·60	−0 ·26
8 296	8 355	25 ·50	50 ·92	3	5	59 ·80	−0 ·46
120	146	28 ·92	11 ·73	4	7	58 ·41	+0 ·93
173	198	35 ·00	54 ·70	4	7	59 ·02	+0 ·32
224	244	36 ·26	06 ·34	4	7	58 ·88	+0 ·46
337	404	41 ·15	10 ·25	3	5	60 ·36	−1 ·02
441	502	44 ·10	42 ·00	3	5	59 ·40	−0 ·06
535	581	02 ·55	12 ·71	4	7	60 ·13	−0 ·79
610	644	09 ·68	42 ·80	3	5	59 ·47	−0 ·13
673	772	38 ·88	49 ·28	3	5	59 ·51	−0 ·17
821	897	08 ·60	23 ·48	4	7	60 ·60	−1 ·26
921	1 001	16 ·00	35 ·80	3	5	58 ·85	+0 ·49
1 066	1 123	22 ·02	54 ·56	3	5	60 ·68	−1 ·34
1 175	1 293	45 ·83	35 ·14	4	7	59 ·47	−0 ·13
1 424	1 520	00 ·00	49 ·50	3	5	59 ·98	−0 ·64

Indiscriminate mean = 42° 58′ 59″ ·37.
Weighted mean = 42 58 59 ·34 ± 0″ ·07.
$e = \pm 0'' \cdot 67$.
115 observations, 30 pairs.
[Reduction to △ = 0″ ·00.]

18. *Thompson*, Massachusetts.—T. J. Lee. Zenith telescope, Military Academy. September 19 to October 16, 1846. One division of level = 1″ ·32. One turn of micrometer = 45″ ·064, from observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
*6 640	6 690	41 ·46	36 ·72	11	6	42 36 37 ·16	+0 ·86
*6 640	6 691	41 ·46	17 ·04	5	3	38 ·16	−0 ·14
6 737	6 810	27 ·48	37 ·30	9	8	38 ·72	−0 ·70
6 861	*6 966	00 ·77	30 ·14	3	2	38 ·72	−0 ·70
6 862	*6 966	34 ·07	30 ·14	12	7	37 ·82	+0 ·20
7 024	7 143	50 ·20	15 ·50	14	11	37 ·38	+0 ·64
7 246	7 310	35 ·11	42 ·50	14	11	38 ·89	−0 ·87
7 418	7 482	04 ·80	43 ·00	13	11	37 ·99	+0 ·03
7 595	7 627	18 ·20	50 ·20	5	5	37 ·97	+0 ·05
7 651	7 706	15 ·95	18 ·00	7	7	37 ·88	+0 ·14
7 812	7 914	35 ·43	40 ·95	12	10	38 ·48	−0 ·46
7 973	8 052	16 ·80	43 ·60	12	10	37 ·49	+0 ·53
8 104	8 182	28 ·20	18 ·00	12	10	37 ·97	+0 ·05

Indiscriminate mean = 42° 36′ 38″ ·05.
Weighted mean = 42 36 38 ·02 ± 0″ ·10.
$e = \pm 0'' \cdot 87$.
129 observations, 13 pairs.
[Reduction to △ = +0″ ·25.]

19. *Wachusett*, Massachusetts.—J. H. Toomer. Zenith telescope No. 5. September 25 to October 16, 1860. One division of level $=0''\cdot91$, from observations at this station. One turn of micrometer $=41''\cdot413$, from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
6 654	6 662	22 ·35	17 ·63	5	7	42 29 15 ·68	+0 ·45
6 698	6 723	33 ·70	43 ·15	8	13	16 ·25	−0 ·12
6 764	6 777	21 ·19	33 ·73	6	11	15 ·81	+0 ·32
6 851	6 865	11 ·93	20 ·68	8	13	15 ·87	+0 ·26
6 895	6 915	00 ·17	40 ·08	7	12	16 ·29	−0 ·16
6 932	6 968	37 ·09	59 ·74	7	12	15 ·75	+0 ·38
7 007	*7 073	22 ·04	37 ·95	6	5	16 ·49	−0 ·36
7 062	*7 073	46 ·54	37 ·95	8	7	16 ·36	−0 ·23
*7 073	7 091	37 ·95	02 ·23	8	7	16 ·67	−0 ·54
7 158	7 171	49 ·66	06 ·24	7	12	15 ·75	+0 ·38
7 215	7 256	17 ·17	22 ·34	6	11	16 ·34	−0 ·21
7 301	7 320	26 ·64	39 ·39	9	14	16 ·23	−0 ·10
7 337	7 345	18 ·75	45 ·46	6	11	15 ·94	+0 ·19
7 368	7 401	43 ·80	20 ·14	6	11	15 ·68	+0 ·45
7 431	7 453	35 ·45	08 ·60	8	13	15 ·80	+0 ·33
7 474	7 533	22 ·60	47 ·04	7	12	15 ·14	+0 ·99
7 571	*7 605	49 ·14	22 ·46	7	8	15 ·95	+0 ·18
7 586	*7 605	59 ·94	22 ·46	7	8	15 ·96	+0 ·17
7 646	7 721	12 ·78	36 ·20	7	12	16 ·65	−0 ·52
7 676	7 731	30 ·20	25 ·53	8	13	16 ·77	−0 ·64
7 749	7 798	17 ·07	24 ·30	7	12	16 ·49	−0 ·36
7 812	7 914	21 ·96	19 ·15	7	12	16 ·29	−0 ·16
7 932	*7 983	51 ·78	40 ·03	7	8	16 ·65	−0 ·52
7 948	7 962	28 ·08	12 ·97	7	12	16 ·66	−0 ·53
*7 983	7 994	40 ·03	33 ·40	7	8	16 ·58	−0 ·45
8 054	*8 079	10 ·36	28 ·34	9	9	15 ·85	+0 ·28
8 075	*8 079	33 ·90	28 ·34	9	9	15 ·45	+0 ·68
8 126	8 136	08 ·91	52 ·90	8	13	15 ·95	+0 ·18
8 212	8 224	06 ·10	00 ·02	6	11	16 ·15	−0 ·02
8 277	8 296	03 ·60	26 ·00	7	12	15 ·78	+0 ·35
*8 324	8 344	11 ·74	24 ·50	7	6	15 ·67	+0 ·46
*8 324	8 366	11 ·74	56 ·90	7	6	15 ·71	+0 ·42
*8 324	46	11 ·74	42 ·10	8	7	15 ·27	+0 ·86

19. *Wachusett*, Massachusetts—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
92	109	03 ·44	13 ·69	7	12	42 29 16 ·78	—0 ·65
130	175	37 ·40	15 ·60	6	11	16 ·65	—0 ·52
229	244	08 ·78	10 ·68	6	11	15 ·77	+0 ·36
285	314	52 ·48	05 ·71	7	12	16 ·03	+0 ·10
339	345	45 ·70	15 ·99	7	12	16 ·01	+0 ·12
412	446	08 ·90	09 ·44	6	11	16 ·60	—0 ·47
469	498	20 ·78	01 ·35	6	11	17 ·07	—0 ·94
535	556	24 ·84	18 ·68	6	11	16 ·57	—0 ·44
576	*590	40 ·27	55 ·90	7	8	15 ·95	+0 ·18
579	*590	38 ·08	55 ·90	7	8	16 ·16	—0 ·03
656	673	36 ·80	13 ·10	8	13	16 ·09	+0 ·04
706	761	05 ·80	22 ·40	6	11	15 ·84	+0 ·29
802	838	24 ·50	51 ·90	6	11	16 ·12	+0 ·01

Indiscriminate mean=42° 29′ 16″·12.
Weighted mean =42 29 16 ·13±0″·04.
$e=\pm0''\cdot60$.
322 observations, 46 pairs.
[Reduction to △=+0″·95.]

20. *Harvard College Observatory*, Cambridge, Massachusetts.—The report of Dr. B. A. Gould to the Superintendent of the United States Coast Survey, dated Cambridge, November, 1865, and printed in the Report for 1865, gives the following information respecting the latitude of this observatory:

"Prof. B. Peirce in 1845 found from transit observations in the prime vertical by Messrs. W. C. Bond, J. D. Graham, and G. P. Bond the following values for the latitude of the observatory:

W. C. Bond, 62 observations,	42° 22′ 48″ ·83
J. D. Graham, 41 observations,	48 ·29
G. P. Bond, 65 observations,	48 ·86
Mean by weights	42 22 48 ·60

"This result has been used to the present time. The adoption of later determinations of the declinations of the 5 stars observed would somewhat diminish the resultant value; but there seems little doubt that this value should be lessened by about half a second, unless strong local disturbances of the plumb-line exist in the vicinity."*

Other references will be found in the American Ephemeris and Nautical Almanac for 1855 and in Memoirs of the American Academy of Natural Sciences, II, 203.

The reduction to the center of the dome is −0″·55, hence the latitude of the dome 42° 22′ 48″·05 with estimated probable error ±0″·22 which is adopted.†

*This last remark has no bearing on the result here needed.

†The Ephemeris for 1888 gives 42° 22′ 48″·3, and that of 1889, 42° 22′ 47″·6, for which values no explanation is offered.

21. *Cloverden Observatory*, Cambridge, Massachusetts.*—B. A. Gould, J. Searles, and C. H. F. Peters. Zenith telescope No. 5. August to October, 1855. One division of level =0″·88. One turn of micrometer =41″·369.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 372	6 426	20·70	15·11	18	9	42 22 40·79	+0·18
6 452	6 497	38·78	17·17	20	9	40·36	+0·61
6 728	6 769	59·05	21·26	18	9	41·83	−0·86
6 861	6 882	36·40	55·43	17	8	41·40	−0·43
6 912	6 932	02·71	28·75	21	9	39·86	+1·11
7 073	7 091	36·14	01·98	21	9	41·31	−0·34
7 158	7 171	51·81	09·23	19	9	40·65	+0·32
7 188	7 193	42·34	13·63	19	9	41·53	−0·56
7 219	7 297	03·34	51·01	18	9	40·81	+0·16
7 368	7 401	56·26	35·34	17	8	40·69	+0·28
7 431	7 453	51·20	25·16	16	8	40·88	+0·09
7 503	7 521	51·13	08·56	15	8	41·30	−0·33
7 765	7 800	10·30	32·35	12	8	41·13	−0·16
7 950	7 978	46·46	06·80	12	8	41·78	−0·81
8 054	8 079	47·34	04·57	14	8	41·31	−0·34
8 284	8 310	50·33	26·02	12	8	41·21	−0·24
8 324	8 344	51·07	04·50	12	8	40·41	+0·56
92	109	43·70	53·78	10	7	40·37	+0·60
158	219	55·22	25·28	11	8	40·84	+0·13

Indiscriminate mean =42° 22′ 40″·97.
Weighted mean =42 22 40 ·97±0″·08.
e =±0″·67.
302 observations, 19 pairs.
[Reduction to center of dome of Harvard College Observatory =+7″·20.]

22. *Mount Tom*, Massachusetts.—E. Goodfellow. Zenith telescope No. 5. July 18 to August 11, 1862. One division of level = 0″·76 from observations at this station. One turn of micrometer = 41″·380 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
5 157	5 168	25·88	43·00	1	3	42 14 27·08	+0·54
5 249	5 252	23·24	17·25	5	7	27·61	+0·01
5 295	5 338	08·47	42·79	5	7	28·20	−0·58
5 376	5 453	30·19	49·83	3	6	28·00	−0·38
5 463	5 496	23·00	22·67	6	8	27·48	+0·14
5 512	5 530	21·76	16·74	6	8	28·33	−0·71
5 549	5 619	57·65	19·40	5	7	27·52	+0·10
5 602	5 643	52·26	14·21	5	7	27·60	+0·02
5 624	5 629	15·64	18·76	5	7	28·32	−0·70
5 775	5 790	54·97	05·14	5	7	26·49	+1·13

*See report by Dr. B. A. Gould dated November, 1865, in U. S. Coast Survey Report for 1865. These results were revised and in part improved in 1870.

22. *Mount Tom*, Massachusetts—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
5 763	5 776	20.25	16·56	6	8	42 14 27·89	−0·27
5 795	5 842	51·53	56·08	5	7	27·57	+0·05
5 944	5 997	25·05	34·80	5	7	28·12	−0·50
6 013	6 062	13·10	08·91	4	7	27·06	+0·56
6 021	6 079	46·00	16·63	4	7	28·70	−1·08
6 109	6 193	25·77	46·98	4	7	26·83	+0.79
6 147	6 185	19·41	15·68	4	7	27·56	+0·06
6 162	6 218	12·05	58·43	5	7	28·05	−0·43
6 300	6 373	22·39	00·18	5	7	27·60	+0·02
6 341	6 410	13·82	51·41	3	6	27·09	+0·53
6 466	6 516	28·62	35·12	5	7	27·95	−0·33
6 475	6 493	03·15	31·03	4	7	26·66	+0·96
6 534	6 551	35·24	51·12	5	7	27·00	+0·62
6 530	6 553	16·57	47·72	5	7	27·96	−0·34
6 655	6 602	45·29	12·25	5	7	26·78	+0·84
6 659	6 698	50·65	17·80	5	7	27·23	+0·39
6 718	6 745	17·11	55·49	5	7	28·14	−0·52
6 740	6 748	45·32	56·32	5	7	27·08	+0·54
6 771	6 799	38·24	56·31	5	7	27·86	−0·24
6 827	6 834	41·92	42·35	5	7	27·75	−0·13
6 847	6 879	14·06	31·87	6	8	28·18	−0·56
6 862	6 882	03·06	48·48	5	7	27·67	−0·05
6 930	6 941	24·48	25·44	5	7	27·23	+0·39
6 957	6 976	16·56	12·58	5	7	27·36	+0·26
6 985	6 998	28·51	46·80	6	8	27·15	+0·47
7 073	7 091	15·92	37·80	5	7	28·72	−1·10

Indiscriminate mean =42° 14′ 27″·61.
Weighted mean =42 14 27 ·62±0″·06.
$e=\pm0''\cdot45$.
172 observations, 36 pairs.
[Reduction to △=+0″·91.]

23. *Manomet*, Massachusetts.—C. O. Boutelle, F. H. Agnew, and C. S. Peirce. Zenith telescope No. 5. July 8 to August 21, 1867. One division of level = 0″·951 from observations at this station. One turn of micrometer = 41″·423 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude	v
		″	″			° ′ ″	″
4 812	4 843	31·30	13·40	6	5	41 55 34·56	+0·79
4 873	4 949	15·00	14·00	6	5	35·12	+0·23
4 961	4 974	18·20	36·60	7	5	34·94	+0·41
5 058	5 085	52·26	08·20	7	5	35·31	+0·04
5 181	5 204	30·50	45·00	7	5	35·61	−0·26
5 336	5 463	59·00	06·90	7	5	35·23	+0·12
5 512	5 525	03·00	06·00	7	5	35·56	−0·21
*5 541	5 574	12·40	53·60	5	3	34·24	+1·11
*5 541	5 575	12·40	26·80	5	3	34·04	+1·31
5 628	5 702	31·40	06·00	6	5	35·92	−0·57
5 714	5 797	23·37	25·30	7	5	34·47	+0·88
5 847	*5 871	02·80	39·00	6	3	35·11	+0·24
*5 871	5 886	39·00	47·10	7	3	35·74	−0·39
*5 931	5 950	37·47	26·50	5	3	35·82	−0·47
*5 931	5 951	37·47	08·70	5	3	35·84	−0·49
*5 997	6 062	45·05	13·54	5	3	35·80	−0·45
*5 997	6 068	45·05	54·80	5	3	35·48	−0·13
*6 185	6 232	07·85	22·73	6	3	34·83	+0·52
*6 185	6 237	07·85	05·41	6	3	36·53	−1·18
6 341	6 373	00·60	44·10	6	5	33·99	+1·36
6 429	6 470	23·95	21·12	6	5	35·75	−0·40
6 522	6 547	54·08	42·92	6	5	34·36	+0·99
6 571	6 623	11·30	33·50	6	5	34·82	+0·53
6 637	6 681	25·50	25·60	6	5	35·29	+0·06
6 698	6 734	40·00	09·67	6	5	34·81	+0·54
6 763	*6 784	56·38	48·50	6	3	35·46	−0·11
6 764	*6 784	23·90	48·50	6	3	35·43	−0·08
6 810	6 932	31·00	24·74	6	5	35·55	−0·20
6 962	*6 990	07·00	43·02	6	3	36·24	−0·89
6 965	*6 990	38·12	43·02	6	3	36·00	−0·65
7 062	7 103	24·40	11·48	6	5	35·06	+0·29
5 168	5 271	42·80	30·00	6	5	34·90	+0·45
5 295	5 388	01·00	54·40	6	5	35·66	−0·31
5 444	5 459	57·01	18·40	4	5	36·81	−1·46
5 530	5 560	56·94	50·99	6	5	36·72	−1·37
5 602	5 752	29·54	55·80	5	5	34·80	+0·55
5 795	5 863	16·72	31·01	5	5	36·70	−1·35
5 927	5 937	24·95	56·80	6	5	35·87	−0·52
*6 223	6 311	25·50	37·50	6	3	35·08	+0·27
*6 223	6 318	25·50	20·80	6	3	34·72	+0·63
†1 631	*6 427	17·75	03·82	6	3	36·70	−1·35

23. *Manomet*, Massachusetts—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
†1 633	*6 427	21 ·25	03 ·82	6	3	41 55 34 ·85	+0 ·50
6 456	6 520	34 ·62	08 ·00	5	5	35 ·82	−0 ·47
6 530	6 534	50 ·92	09 ·19	5	5	35 ·91	−0 ·56
6 582	6 629	53 ·36	04 ·14	5	5	34 ·02	+1 ·33
6 673	‡2 872	09 ·04	25 ·16	6	5	34 ·63	+0 ·72
6 714	6 748	39 ·90	13 ·50	6	5	34 ·73	+0 ·62
6 758	6 867	40 ·71	30 ·44	5	5	34 ·42	+0 ·93
6 973	6 976	31 ·50	18 ·20	5	5	35 ·24	+0 ·11
7 035	7 067	18 ·53	25 ·20	6	5	34 ·43	+0 ·92
7 055	7 152	02 ·17	45 ·62	6	5	35 ·62	−0 ·27
7 215	7 246	47 ·65	57 ·30	5	5	35 ·71	−0 ·36
7 256	7 281	47 ·80	25 ·30	6	5	35 ·43	−0 ·08
7 306	7 320	56 ·35	01 ·20	6	5	35 ·30	+0 ·05
5 321	5 341	30 ·50	48 ·69	2	4	35 ·60	−0 ·25
5 535	5 619	52 ·27	56 ·15	3	5	34 ·45	+0 ·90
5 747	5 853	14 ·64	54 ·19	8	5	35 ·39	−0 ·04
5 978	6 106	24 ·18	04 ·14	6	5	35 ·55	−0 ·20
6 238	6 368	27 ·78	37 ·64	7	5	35 ·33	+0 ·02
6 497	6 530	19 ·57	50 ·92	6	5	35 ·68	−0 ·33
6 603	6 698	46 ·00	40 ·00	6	5	35 ·43	−0 ·08
6 745	6 769	15 ·20	40 ·88	7	5	35 ·78	−0 ·43
6 847	6 940	27 ·90	16 ·70	7	5	35 ·47	−0 ·12
6 983	6 997	35 ·50	53 ·00	7	5	36 ·15	−0 ·80
7 041	7 119	44 ·76	07 ·44	6	5	36 ·16	−0 ·81
7 143	7 176	55 ·00	30 ·50	7	5	35 ·59	−0 ·24
7 204	7 243	35 ·44	38 ·09	5	5	34 ·90	+0 ·45
7 253	7 260	54 ·48	06 ·98	5	5	35 ·64	−0 ·29
7 277	7 333	36 ·50	05 ·30	6	5	35 ·66	−0 ·31
7 385	7 455	16 ·22	38 ·12	6	5	35 ·68	−0 ·33
§5 241	7 505	01 ·30	39 ·30	7	5	35 ·32	+0 ·03
7 533	‖4 739	52 ·74	30 ·94	7	5	33 ·98	+1 ·37
7 542	7 585	02 ·52	44 ·70	7	5	36 ·52	−1 ·17
7 623	7 636	39 ·55	49 ·67	7	5	35 ·29	+0 ·06
7 696	*7 706	45 ·94	12 ·22	7	3	34 ·86	+0 ·49
7 698	*7 706	38 ·55	12 ·22	7	3	35 ·32	+0 ·03
7 754	7 757	16 ·20	57 ·06	5	5	35 ·65	−0 ·30

Indiscriminate mean $= 41° 55′ 35″·36$.
Weighted mean $= 41\ 55\ 35\ ·35 \pm 0″·05$.
$e = \pm 0″·30$.

456 observations, 77 pairs.

[Reduction to $\triangle = 0″·00$.]

†Greenwich, 12-year catalogue. ‡Groombridge. §Radcliffe. ‖Armagh.

24. *Sandford*, New York.—E. Goodfellow. Zenith telescope No. 5. September 11 to October 8, 1862. One division of level = 0″·687. One turn of micrometer = 41″·40.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 421	6 468	10 ·54	18 ·18	2	4	41 27 41 ·10	−0 ·63
6 427	6 470	21 ·44	43 ·64	4	5	40 ·55	−0 ·08
6 475	6 495	03 ·15	17 ·94	5	5	39 ·46	+1 ·01
6 520	6 556	32 ·56	49 ·71	3	5	40 ·35	+0 ·12
6 530	6 571	16 ·54	40 ·61	3	5	41 ·46	−0 ·99
6 555	6 589	45 ·29	03 ·05	3	5	40 ·50	−0 ·03
6 629	6 652	36 ·40	51 ·67	5	5	39 ·24	+1 ·23
6 698	6 717	17 ·87	12 ·73	5	5	40 ·80	−0 ·33
6 731	6 765	30 ·32	20 ·21	5	5	41 ·00	−0 ·53
6 779	6 806	16 ·02	08 ·63	5	5	39 ·74	+0 ·73
6 818	6 827	39 ·77	41 ·23	5	5	39 ·84	+0 ·63
6 861	6 866	29 ·70	20 ·41	5	5	40 ·28	+0 ·19
6 867	6 882	18 ·43	48 ·14	5	5	40 ·50	−0 ·03
6 937	6 962	52 ·17	00 ·85	5	5	41 ·08	−0 ·61
6 965	6 967	31 ·46	51 ·70	5	5	40 ·78	−0 ·31
6 970	6 975	19 ·59	18 ·96	5	5	40 ·78	−0 ·31
7 027	7 041	48 ·64	42 ·55	5	5	40 ·11	+0 ·36
7 013	7 060	30 ·34	01 ·41	5	5	40 ·61	−0 ·14
7 084	7 112	38 ·26	42 ·64	5	5	40 ·21	+0 ·26
7 120	7 164	14 ·32	53 ·66	5	5	41 ·52	−1 ·05
7 153	7 194	28 ·30	56 ·08	5	5	40 ·52	−0 ·05
7 182	7 204	15 ·88	41 ·47	3	5	39 ·08	+1 ·39
7 198	7 213	10 ·26	51 ·72	3	5	40 ·30	+0 ·17
7 220	7 275	46 ·93	19 ·00	5	5	40 ·99	−0 ·52
7 297	7 333	11 ·23	16 ·10	5	5	40 ·47	0 ·00
7 345	7 373	17 ·46	04 ·10	5	5	41 ·09	−0 ·62
7 365	7 368	57 ·34	14 ·60	5	5	39 ·11	+1 ·36
7 387	7 410	15 ·27	24 ·12	5	5	39 ·87	+0 ·60
7 418	7 449	02 ·07	53 ·50	5	5	41 ·42	−0 ·95
7 455	7 462	55 ·34	53 ·56	5	5	39 ·58	+0 ·89
7 474	7 495	50 ·94	54 ·45	5	5	40 ·38	+0 ·09
7 503	7 505	00 ·96	58 ·97	5	5	40 ·79	−0 ·32
7 544	7 554	04 ·43	11 ·92	5	5	40 ·38	+0 ·09
7 571	7 582	13 ·99	06 ·68	5	5	41 ·30	−0 ·83
7 585	7 595	07 ·30	54 ·97	5	5	41 ·39	−0 ·92

Indiscriminate mean = 41° 27′ 40″ ·47.
Weighted mean = 41 27 40 ·47 ± 0″ ·08.
$e = \pm 0''\cdot 39$.

161 observations, 35 pairs.

[Reduction to △ = − 0″·39.]

25. *West Hills*, New York.—A. T. Mosman. Zenith telescope No. 5. August 8 to 24, 1865. One division of level = 0″·76 from observations at this station. One turn of micrometer = 41″·397 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
5 617	5 644	08 ·60	07 ·17	6	16	40 48 50 ·85	−0 ·79
5 643	5 677	34 ·15	52 ·20	4	14	49 ·69	+0 ·37
5 658	5 703	00 ·26	57 ·82	2	10	50 ·31	−0 ·25
5 702	5 734	54 ·09	20 ·97	4	14	49 ·67	+0 ·39
5 714	5 801	12 ·37	33 ·63	6	16	49 ·51	+0 ·55
5 752	5 798	44 ·57	42 ·17	4	14	49 ·66	+0 ·40
5 840	5 856	17 ·00	03 ·62	6	16	49 ·69	+0 ·37
5 842	5 911	08 ·18	30 ·90	6	16	50 ·14	−0 ·08
5 874	5 944	26 ·89	33 ·18	7	16	49 ·97	+0 ·09
5 922	5 950	06 ·55	21 ·74	6	16	49 ·69	+0 ·37
5 978	6 030	16 ·50	57 ·54	4	14	49 ·99	+0 ·07
6 005	6 079	39 ·91	18 ·50	5	15	50 ·27	−0 ·21
6 013	6 082	18 ·60	46 ·33	4	14	50 ·14	−0 ·08
6 147	6 246	19 ·20	36 ·34	6	16	50 ·86	−0 ·80
6 231	*6 311	34 ·70	43 ·54	6	10	50 ·33	−0 ·27
6 251	*6 311	19 ·58	43 ·54	7	11	49 ·91	+0 ·15
6 373	6 438	50 ·58	06 ·00	6	16	49 ·76	+0 ·30
6 387	6 410	49 ·80	40 ·32	6	16	49 ·53	+0 ·53
6 421	6 427	59 ·06	09 ·70	6	16	50 ·17	−0 ·11
6 468	6 516	04 ·95	20 ·19	0	16	50 ·06	0 ·00
6 473	6 493	06 ·94	16 ·96	6	16	49 ·75	+0 ·31
6 534	6 566	19 ·74	08 ·09	5	15	50 ·22	−0 ·16
6 553	6 579	32 ·65	49 ·90	6	16	49 ·52	+0 ·54
6 581	6 656	04 ·86	24 ·97	6	16	50 ·21	−0 ·15
6 635	6 690	26 ·65	17 ·90	6	16	50 ·40	−0 ·34
6 698	6 721	57 ·50	42 ·01	6	16	50 ·07	−0 ·01
6 711	*6 728	49 ·64	40 ·82	7	11	49 ·94	+0 ·12
*6 728	6 765	40 ·82	53 ·18	6	10	50 ·50	−0 ·44
6 748	6 762	30 ·36	07 ·17	5	15	49 ·83	+0 ·23
6 810	*6 818	50 ·75	12 ·44	6	10	49 ·99	+0 ·07
*6 818	6 866	12 ·44	51 ·90	6	10	49 ·33	+0 ·73
6 827	6 863	14 ·45	19 ·10	6	16	50 ·93	−0 ·87
6 868	6 905	00 ·27	24 ·45	6	16	50 ·37	−0 ·31
6 876	6 937	40 ·77	23 ·10	6	16	50 ·15	−0 ·09
6 915	6 965	52 ·48	00 ·62	7	16	50 ·09	−0 ·03
6 966	6 976	04 ·42	40 ·94	6	16	49 ·87	+0 ·19
6 983	6 998	56 ·65	15 ·02	6	16	50 ·15	−0 ·09
7 022	7 041	25 ·46	07 ·86	7	16	50 ·47	−0 ·41
7 064	7 117	19 ·71	01 ·71	7	16	50 ·21	−0 ·15

Indiscriminate mean = 40° 48′ 50″ ·06.
Weighted mean = 40 48 50 ·06 ± 0″ ·04.
$e = \pm 0''\cdot 34$.

223 observations, 39 pairs.

[Reduction to △ = − 0″ ·16.]

26. *New York*, New York.—E. Goodfellow. Zenith telescope No. 5. June 22 to 25, 1858. One division of level = 0''·845. One turn of micrometer = 41''·516.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		"	"			° ′ "	"
4 640	4 726	05 ·82	41 ·06	3	4	40 43 47 ·72	+0 ·67
4 804	4 808	05 ·42	11 ·96	3	4	47 ·72	+0 ·67
4 845	4 864	41 ·90	57 ·76	4	5	47 ·28	+1 ·11
4 885	4 897	13 ·08	06 ·54	4	5	48 ·06	+0 ·33
*4 952	5 000	35 ·82	49 ·77	4	3	48 ·86	−0 ·47
*4 952	5 036	35 ·82	11 ·25	4	3	47 ·36	+1 ·03
5 113	5 204	50 ·58	01 ·05	4	5	49 ·10	−0 ·71
5 244	5 313	39 ·10	51 ·66	4	5	47 ·53	+0 ·86
5 336	*5 400	27 ·68	58 ·95	4	3	48 ·86	−0 ·47
5 385	*5 400	45 ·50	58 ·95	4	3	49 ·63	−1 ·24
5 448	5 502	14 ·58	14 ·87	4	5	48 ·24	+0 ·15
5 599	5 677	20 ·95	08 ·13	4	5	48 ·14	+0 ·25
*5 752	5 798	06 ·46	09 ·57	4	3	48 ·50	−0 ·11
*5 752	5 860	06 ·46	23 ·12	4	3	47 ·58	+0 ·81
*5 902	5 967	29 ·36	09 ·81	4	3	48 ·95	−0 ·56
*5 902	5 988	29 ·36	48 ·41	4	3	48 ·62	−0 ·23
6 005	*6 079	27 ·06	13 ·80	4	3	48 ·95	−0 ·56
*6 079	6 223	13 ·80	36 ·38	2	3	48 ·82	−0 ·43
6 251	6 318	29 ·16	41 ·44	3	4	49 ·58	−1 ·19
6 387	6 410	11 ·34	06 ·13	3	4	49 ·17	−0 ·78
6 476	6 491	59 ·38	09 ·58	4	5	49 ·13	−0 ·74
6 534	6 579	55 ·92	25 ·75	4	5	48 ·06	+0 ·33
6 648	6 687	13 ·28	02 ·72	4	5	48 ·51	−0 ·12
6 697	6 740	16 ·61	17 ·46	4	5	48 ·02	+0 ·37

Indiscriminate mean = 40° 43′ 48''·43.
Weighted mean = 40 43 48 ·39 ± 0''·09.
$e = \pm 0''·45$.
90 observations, 24 pairs.
[Reduction to center of transit or △ = + 0''·21.]

27. *Beacon Hill* New Jersey.—J. B. Baylor. Zenith telescope No. 4. July 24 to August 27, 1875. One division of level $=2''\cdot04$. One turn of micrometer $=43''\cdot462$ from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
5 400	5 411	46 ·88	03 ·00	3	6	40 22 27 ·73	+0 ·08
5 432	*5 463	23 ·74	17 ·20	5	4	28 ·95	−1 ·14
*5 463	5 479	17 ·20	20 ·84	7	5	27 ·77	+0 ·04
5 523	5 546	29 ·40	04 ·37	5	7	26 ·86	+0 ·95
5 629	5 677	47 ·64	56 ·00	5	7	26 ·78	+1 ·03
5 703	5 785	58 ·75	53 ·32	6	7	27 ·58	+0 ·23
*5 801	5 828	22 ·52	43 ·46	7	5	27 ·59	+0 ·22
*5 801	5 860	22 ·52	29 ·70	6	5	28 ·60	−0 ·79
5 931	5 937	01 ·51	19 ·66	7	7	28 ·15	−0 ·34
5 997	*6 082	01 ·30	53 ·10	6	5	28 ·02	−0 ·21
*6 082	6 095	53 ·10	16 ·61	7	5	28 ·64	−0 ·83
6 193	6 203	37 ·14	56 ·45	7	7	26 ·95	+0 ·86
*6 232	6 246	12 ·63	21 ·59	7	5	28 ·08	−0 ·27
*6 232	6 258	12 ·63	31 ·66	7	5	27 ·65	+0 ·16
6 300	6 348	55 ·06	58 ·33	7	7	28 ·30	−0 ·49
6 357	6 404	29 ·60	29 ·83	6	7	27 ·30	+0 ·51
6 438	6 463	25 ·60	50 ·95	6	7	28 ·31	−0 ·50
6 476	6 497	45 ·92	41 ·16	7	7	27 ·62	+0 ·19
6 530	6 547	10 ·05	01 ·35	6	7	27 ·66	+0 ·15
6 571	6 579	25 ·20	41 ·80	7	7	27 ·41	+0 ·40
6 602	6 681	52 ·77	28 ·68	7	7	27 ·38	+0 ·43
6 697	6 714	09 ·04	40 ·44	6	7	27 ·10	+0 ·71
6 728	6 771	22 ·43	47 ·42	7	7	27 ·50	+0 ·31
6 800	6 830	28 ·50	24 ·52	6	7	27 ·61	+0 ·20
6 862	6 933	00 ·07	17 ·42	6	7	27 ·46	+0 ·35
5 596	5 604	35 ·60	10 ·20	3	6	27 ·39	+0 ·42
5 951	6 033	29 ·80	01 ·85	5	7	28 ·24	−0 ·43
6 084	6 091	15 ·09	44 ·68	5	7	28 ·11	−0 ·30
6 184	6 223	40 ·87	16 ·26	5	7	27 ·87	−0 ·06
6 238	6 335	16 ·80	40 ·07	5	7	28 ·26	−0 ·45
6 711	6 718	32 ·99	36 ·89	6	7	28 ·26	−0 ·45
6 745	6 765	09 ·51	30 ·62	5	7	28 ·67	−0 ·86
6 810	6 867	22 ·04	14 ·83	5	7	28 ·97	−1 ·16

Indiscriminate mean $=40°\ 22'\ 27''\cdot84$.
Weighted mean $=40\ \ 22\ \ 27\ \ \cdot81\pm0''\cdot07$.
$e=\pm0''\cdot42$.
195 observations, 33 pairs.
[Reduction to $\triangle=0''\cdot00$.]

28. *Mount Rose*, New Jersey.—J. E. Hilgard. Zenith telescope No. 2. July 19 to August 3, 1852 One division of level=1″·00, from observations at this station. One turn of micrometer=44″·750, from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
†2 285	5 302	52 ·45	25 ·61	3	4	40 22 05 ·00	+0 ·41
5 338	5 432	00 ·55	48 ·80	4	6	05 ·54	−0 ·07
1 211	5 383	13 ·80	40 ·84	3	4	05 ·26	+0 ·15
1 276	5 382	31 ·31	17 ·60	3	4	04 ·62	+0 ·79
5 463	5 479	54 ·75	58 ·92	4	6	05 ·75	−0 ·34
5 489	1 448	57 ·60	00 ·94	4	6	05 ·60	−0 ·19
5 628	5 686	47 ·42	40 ·14	3	4	05 ·65	−0 ·24
5 674	5 740	24 ·66	19 ·65	4	6	04 ·66	+0 ·75
5 702	5 728	35 ·40	50 ·42	3	4	05 ·89	−0 ·48
5 785	5 922	59 ·46	26 ·36	4	6	04 ·83	+0 ·58
5 821	5 823	14 ·00	10 ·50	3	4	04 ·56	+0 ·85
5 941	5 972	41 ·66	16 ·26	4	6	05 ·48	−0 ·07
5 967	‡1 539	54 ·96	43 ·10	3	4	05 ·14	+0 ·27
6 178	6 255	42 ·61	04 ·12	3	4	06 ·62	−1 ·21
6 216	6 223	39 ·73	43 ·30	3	4	05 ·52	−0 ·11
6 322	*6 348	24 ·26	58 ·45	4	4	05 ·00	+0 ·41
6 341	*6 348	39 ·21	58 ·45	3	3	05 ·23	+0 ·18
6 460	6 563	05 ·74	49 ·76	3	4	05 ·84	−0 ·43
6 487	6 586	44 ·76	08 ·27	3	4	05 ·29	+0 ·12
6 585	6 625	19 ·80	20 ·26	3	4	06 ·29	−0 ·88
6 623	6 690	10 ·44	52 ·60	4	6	04 ·93	+0 ·48
6 648	6 697	53 ·77	01 ·73	3	4	06 ·33	−0 ·92
6 735	6 749	26 ·44	06 ·40	3	4	06 ·70	−1 ·29
*6 817	*6 817	27 ·66	27 ·66	4	6	04 ·84	+0 ·57

Indiscriminate mean=40° 22′ 05″·44.
Weighted mean =40 22 05 ·41±0″·08.
$e=\pm 0''\cdot 82$.
81 observations, 24 pairs.
[Reduction to △ =0″·00.]

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† Groombridge. ‡ Greenwich 12 year Cat. 1845.

29. *Yard*, Pennsylvania.—J. E. Hilgard. Zenith telescope No. 6. October 17 to November 2, 1854. One division of level=0″·80. One turn of micrometer=76″·15, from circumpolar obsevations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
7 029	7 085	43·69	13·97	6	13	39 58 28·58	+0·81
*7 091	7 131	14·03	06·40	4	6	29·63	−0·24
*7 091	7 132	14·03	02·45	4	6	29·98	−0·59
7 141	7 144	29·97	09·66	3	6	29·16	+0·23
7 182	7 194	58·31	39·23	8	17	29·63	−0·24
7 213	7 253	38·34	49·23	4	9	29·60	−0·21
7 260	*7 297	02·53	01·90	4	6	29·46	−0·07
7 277	*7 297	34·06	01·90	6	9	30·04	−0·65
7 313	7 326	53·78	49·71	1	2	29·90	−0·51
7 363	7 372	11·25	56·30	4	9	28·54	+0·85
*7 399	7 469	50·15	02·33	1	1	29·40	−0·01
*7 399	7 480	50·15	05·90	6	9	29·54	−0·15
7 402	7 462	59·78	57·01	5	11	29·66	−0·27
7 521	7 554	24·76	21·78	4	9	29·36	+0·03
7 560	7 607	30·78	13·72	5	11	28·64	+0·75
7 610	7 674	31·90	00·40	4	9	29·39	0·00
7 696	*7 712	31·90	21·34	4	6	29·53	−0·14
7 698	*7 712	24·82	21·34	4	6	28·83	+0·56
7 727	7 731	46·90	10·96	4	9	28·36	+1·03
7 757	7 787	51·26	27·72	6	13	30·54	−1·15
7 805	7 851	26·30	45·57	6	13	29·20	+0·19
7 878	7 908	45·53	46·02	2	4	29·08	+0·31
7 937	7 973	05·55	44·06	5	11	29·72	−0·33
7 984	8 037	01·43	43·56	2	4	30·57	−1·18
8 059	8 156	56·11	15·17	5	11	30·30	−0·91
8 082	*8 159	26·10	59·20	2	3	29·29	+0·10
8 114	*8 159	54·80	59·20	5	7	29·51	−0·12
8 177	8 187	20·32	43·13	5	11	29·40	−0·01
8 206	8 231	48·41	11·18	4	9	28·78	+0·61
8 279	8 299	47·96	23·42	5	11	29·57	−0·18
8 312	8 314	27·22	07·98	2	4	29·81	−0·42
8 355	26	50·42	41·42	3	6	29·35	+0·04
32	46	19·17	41·97	3	6	29·17	+0·22
60	67	11·90	23·95	3	6	30·08	−0·69
80	87	25·14	08·70	3	6	28·75	+0·64
114	156	14·77	18·54	3	6	28·30	+1·09
166	180	19·38	20·51	4	9	29·31	+0·08

Indiscriminate mean=39° 58′ 29″·41.
Weighted mean =39 58 29 ·39±0″·06.
$e=\pm0''\cdot68$

148 observations, 37 pairs.

[Reduction to $\triangle$=0″·00.]

For the abstracts of results corresponding to the astronomic latitudes of the following stations, numbered from 30 to 53, inclusive, that is, for stations common to the transcontinental arc and the oblique arc, see "The Transcontinental Triangulation" United States Coast and Geodetic Survey Special Publication No. 4; Washington, D. C., 1900. The final summary of the results for latitude includes the adopted latitude at these stations:

30. Principio, Md.
31. Maryland Heights, Md
32. Pooles Island, Md.
33. Sugar Loaf, Md.
34. Dover, Del.
35. Webb, Md.
36. Soper, Md.
37. Rockville, Md.
38. Taylor, Md.
39. Strasburg, Va.
40. Cape May, N. J.
41. Causten, D. C.
42. Naval Observatory (new), D. C.
43. Hill, Md.
44. Naval Observatory (old), D. C.
45. Seaton, D. C.
46. Coast and Geodetic Survey Office, D. C.
47. Bull Run, Va.
48. Marriott, Md.
49. Cape Henlopen, Del.
50. Clark, Va.
51. Elliott Knob, Va.
52. Charlottesville, Va.
53. Long Mountain, Va.

54. *Moore*, North Carolina.—J. B. Baylor. Zenith telescope No. 2. First series. November 8 to December 6, 1876. One division of level=1″·06. One turn of micrometer=44″·867 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 943	7 973	44 ·53	43 ·67	7	3	36 23 55 ·62	−0 ·54
8 068	8 071	54 ·41	58 ·91	6	3	55 ·67	−0 ·59
8 107	8 146	18 ·72	01 ·91	6	3	53 ·85	+1 ·23
8 171	8 206	12 ·67	32. 56	7	3	54 ·87	+0 ·21
8 245	8 256	42 ·10	29 ·75	5	2	54 ·88	+0 ·20
7	26	02 ·79	21 ·38	9	3	54 ·29	+0 ·79
100	109	28 ·90	55 ·78	7	3	55 ·65	−0 ·57
130	153	19 ·20	08 ·34	6	3	55 ·84	−0 ·76
219	264	32 ·13	08 ·30	7	3	54 ·63	+0 ·45
318	349	08 ·41	09 ·42	6	3	55 ·27	−0 ·19
388	438	19 ·60	28 ·61	6	3	56 ·16	−1 ·08
456	476	19 ·26	23 ·30	6	3	55 ·18	−0 ·10
518	568	26 ·68	31 ·00	7	3	54 ·89	+0 ·19
595	615	45 ·44	48 ·21	8	3	55 ·16	−0 ·08
656	661	00 ·44	47 ·91	6	3	54 ·99	+0 ·09
740	791	23 ·64	07 ·52	4	2	56 ·87	−1 ·79
796	827	34 ·62	52 ·24	5	2	55 ·89	−0 ·81
863	903	14 ·63	20 ·50	7	3	56 ·73	−1 ·65
915	953	57 ·00	28 ·81	7	3	53 ·70	+1 ·38
981	1 017	39 ·36	01 ·35	6	3	53 ·59	+1 ·49
1 030	1 057	37 ·46	31 ·60	7	3	53 ·84	+1 ·24
1 099	1 126	19 ·53	24 ·60	6	3	54 ·97	+0 ·11

Indiscriminate mean=36° 23′ 55″·12.
Weighted mean =36 23 55 ·08±0″·13.
$e=\pm 1''\cdot 06$.
140 observations, 22 pairs.
[Reduction to △=−0″·04.]

54. *Moore*, North Carolina.—W. B. Fairfield. Zenith telescope No. 2. Second series. November 23 to December 6, 1876. One division of level=1″·06. One turn of micrometer=44″·867 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 943	7 973	44 ·53	43 ·67	6	3	36 23 56 ·04	−1 ·22
8 068	8 071	54 ·41	58 ·91	6	3	55 ·14	−0 ·32
8 107	8 146	18 ·72	01 ·91	5	3	53 ·95	+0 ·87
8 171	8 206	12 ·67	32 ·56	6	3	55 ·13	−0 ·31
8 245	8 256	42 ·10	29 ·75	6	3	54 ·87	−0 ·05
7	26	02 ·79	21 ·38	6	3	53 ·82	+1 ·00
100	109	28 ·90	55 ·78	6	3	55 ·55	−0 ·73
130	153	19 ·20	08 ·34	6	3	55 ·41	−0 ·59
219	264	32 ·13	08 ·30	6	3	52 ·76	+2 ·06
318	349	08 ·41	09 ·42	6	3	55 ·41	−0 ·59
388	438	19 ·60	28 ·61	6	3	54 ·86	−0 ·04
456	476	19 ·26	23 ·30	7	3	55 ·69	−0 ·87
518	568	26 ·68	31 ·00	7	3	53 ·58	+1 ·24
595	615	45 ·44	48 ·21	6	3	54 ·50	+0 ·32
656	661	00 ·44	47 ·91	5	3	55 ·21	−0 ·39
740	791	23 ·64	07 ·52	6	3	56 ·47	−1 ·65
863	903	14 ·63	20 ·50	6	3	54 ·90	−0 ·08
915	953	57 ·00	28 ·81	6	3	54 ·03	+0 ·79
981	1 017	39 ·36	01 ·35	6	3	55 ·37	−0 ·55
1 030	1 057	37 ·46	31 ·60	6	3	53 ·76	+1 ·06
1 099	1 126	19 ·53	24 ·60	6	3	54 ·74	+0 ·08

Indiscriminate mean=36° 23′ 54″·82.
Weighted mean =36 23 54 ·82±0″·13.
$e=\pm 0''\cdot 67$.
126 observations, 21 pairs.
[Reduction to △=−0″·04.]
Adopted value =36° 23′ 54″·95±0″·09.
[Reduction to △=−0″·04.]

55. *Young*, North Carolina.—H. W. Blair. Zenith telescope No. 4. First series. October 14 to 21, 1876. One division of level=2″·20. One turn of micrometer=43″·388 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 856	6 858	21 ·95	36 ·45	6	2	35 44 22 ·88	−1 ·35
6 962	6 966	31 ·57	08 ·15	5	2	22 ·90	−1 ·37
7 022	7 029	20 ·95	32 ·26	6	2	21 ·63	−0 ·10
7 174	7 194	35 ·03	55 ·55	6	2	20 ·68	+0 ·85
7 253	7 256	53 ·08	46 ·94	6	2	20 ·27	+1 ·26
7 399	[1 909]	21 ·60	45 ·81	6	2	23 ·20	−1 ·67
7 465	7 521	59 ·09	33 ·74	6	2	22 ·88	−1 ·35
7 585	7 598	20 ·17	49 ·61	6	2	20 ·50	+1 ·03
7 712	7 746	00 ·12	20 ·31	6	2	20 ·36	+1 ·17
7 914	7 972	20 ·45	46 ·74	6	2	21 ·36	+0 ·17
8 082	8 160	15 ·54	41 ·38	5	2	20 ·84	+0 ·69
8 114	8 131	43 ·23	17 ·15	5	2	20 ·35	+1 ·18
8 195	8 211	41 ·56	17 ·48	5	2	21 ·28	+0 ·25
8 229	8 256	05 ·86	29 ·75	5	2	22 ·23	−0 ·70

Indiscriminate mean=35° 44′ 21″·53.
Weighted mean =35 44 21 ·53±0″·20.
$e=\pm 0''\cdot 67$.
79 observations, 14 pairs.
[Reduction to △=+0″·01.]

55. *Young*, North Carolina.—J. B. Boutelle. Zenith telescope No. 4. Second series. October 24 to 31, 1876. One division of level=2″·20. One turn of micrometer=43″·388 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 664	7 755	22 ·67	49 ·24	6	3	35 44 21 ·34	+0 ·13
7 961	7 975	17 ·66	56 ·80	6	3	20 ·95	+0 ·52
8 153	8 182	46 ·26	23 ·80	6	3	21 ·05	+0 ·42
8 203	8 231	06 ·13	54 ·25	6	3	21 ·45	+0 ·02
8 370	7	37 ·17	02 ·79	6	3	23 ·26	−1 ·79
28	[20]	57 ·40	15 ·97	6	3	22 ·18	−0 ·71
120	173	10 ·57	19 ·13	6	3	22 ·05	−0 ·58
198	215	40 ·18	27 ·77	6	3	22 ·61	−1 ·14
244	269	57 ·98	30 ·00	6	3	21 ·07	+0 ·40
283	345	18 ·68	08 ·80	6	3	20 ·58	+0 ·89
395	404	17 ·46	18 ·60	6	3	20 ·77	+0 ·70
488	515	34 ·53	31 ·11	6	3	21 ·68	−0 ·21
558	592	04 ·50	17 ·70	6	3	20 ·41	+1 ·06
628	675	58 ·85	44 ·30	6	3	21 ·17	+0 ·30

Indiscriminate mean = 35° 44′ 21″·47.
Weighted mean = 35 44 21 ·47 ± 0″·15.
$e=\pm 0''\cdot 64$.
84 observations, 14 pairs.
[Reduction to △=+0″·01.]
Adopted value = 35° 44′ 21″·50 ± 0″·12.
[Reduction to △=+0″·01.]

56. *King*, North Carolina.—H. W. Blair. Zenith telescope No. 5. First series. December 5 to 13, 1876. One division of level=0″·98. One turn of micrometer=41″·420 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
8 052	8 058	02 ·66	55 ·58	5	5	35 12 13 ·37	−0 ·11
8 125	8 160	17 ·61	41 ·38	5	5	12 ·56	+0 ·70
8 206	8 212	32 ·56	48 ·85	5	5	13 ·34	−0 ·08
8 261	8 324	05 ·06	51 ·04	5	5	13 ·92	−0 ·66
8 345	4	23 ·30	38 ·41	5	5	14 ·17	−0 ·91
67	120	05 ·85	10 ·57	5	5	13 ·38	−0 ·12
170	180	31 ·20	05 ·37	5	5	12 ·60	+0 ·66
218	269	33 ·05	30 ·00	5	5	12 ·39	+0 ·87
330	365	11 ·58	22 ·90	5	5	14 ·19	−0 ·93
456	488	19 ·26	34 ·53	5	5	13 ·10	+0 ·16
522	577	13 ·05	56 ·04	5	5	12 ·90	+0 ·36
649	698	47 ·89	37 ·60	5	5	14 ·06	−0 ·80
727	759	02 ·43	38 ·34	5	5	13 ·85	−0 ·59
813	829	19 ·96	53 ·73	5	5	13 ·97	−0 ·71
885	901	48 ·09	18 ·50	5	5	13 ·24	+0 ·02
941	967	46 ·75	50 ·22	5	5	13 ·37	−0 ·11
999	1 007	58 ·94	02 ·63	5	5	13 ·61	−0 ·35
1 034	1 043	05 ·15	55 ·90	5	5	12 ·43	+0 ·83
1 058	1 084	37 ·11	26 ·24	5	5	12 ·60	+0 ·66
1 117	1 174	01 ·72	24 ·00	5	5	12 ·20	+1 ·06

Indiscriminate mean=35° 12′ 13″·26.
Weighted mean =35 12 13 ·26±0″·10
$e=\pm0''\cdot31$.
100 observations, 20 pairs.
[Reduction to $\triangle$=+16″·07.]

56. *King*, North Carolina.—J. B. Boutelle. Zenith telescope No. 5. Second series. December 12 to 20, 1876. One division of level=0''·98. One turn of micrometer=41''·561 from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		''	''			° ' ''	''
8 256	†4 172	29·75	54·74	5	4	35 12 13·39	−0·02
8 364	8 370	30·10	37·17	5	4	13·24	+0·13
26	92	21·38	43·09	5	4	14·25	−0·88
101	153	37·13	08·34	5	4	14·22	−0·85
178	189	03·04	13·57	5	4	14·34	−0·97
198	264	40·18	08·30	5	4	13·62	−0·25
283	349	18·68	09·42	5	4	14·08	−0·71
515	561	31·11	18·20	5	4	12·39	+0·98
569	628	34·25	58·85	5	4	12·43	+0·94
682	735	21·44	03·14	5	4	12·58	+0·79
769	785	46·25	56·30	5	4	12·69	+0·68
842	863	51·60	14·63	5	4	13·32	+0·05
904	912	59·45	05·47	5	4	13·62	−0·25
947	966	51·12	59·89	5	4	12·20	+1·17
983	1 025	37·96	09·77	5	4	14·40	−1·03
1 069	1 099	29·64	19·53	5	4	12·70	+0·67
1 123	1 132	17·54	03·57	5	4	14·30	−0·93
1 155	1 210	32·11	41·87	5	4	13·26	+0·11
1 289	1 287	25·64	29·74	5	4	13·05	+0·32
1 301	1 311	42·80	43·20	5	4	13·40	−0·03

Indiscriminate mean = 35° 12' 13''·37.
Weighted mean = 35 12 13 ·37±0''·11.
$e = \pm 0''·34$.
100 observations, 20 pairs.
[Reduction to △=+16''·07.]
Adopted value = 35° 12' 13''·31±0''·07.
[Reduction to △=+16''·07.]

† Groombridge.

57. *Paris*, South Carolina.—J. B. Boutelle. Zenith telescope No. 5. First series. October 4 to 17, 1875. One division of level=0″·944. One turn of micrometer=41″·514 from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 810	6 830	22 ·04	24 ·52	5	5	34 56 31 ·60	+0 ·46
6 876	6 882	04 ·16	42 ·50	6	5	33 ·13	−1 ·07
6 941	7 007	08 ·57	35 ·26	6	5	32 ·61	−0 ·55
7 029	7 061	43 ·72	10 ·03	5	5	33 ·00	−0 ·94
*7 103	*7 103	35 ·32	35 ·32	5	3	31 ·44	+0 ·62
7 152	7 158	10 ·61	41 ·85	5	5	31 ·08	+0 ·98
7 200	7 262	29 ·45	45 ·40	5	5	31 ·10	+0 ·96
7 271	7 377	31 ·86	37 ·85	5	5	30 ·63	+1 ·43
7 448	7 450	47 ·08	53 ·92	5	5	32 ·30	−0 ·24
7 512	7 520	29 ·36	33 ·53	5	5	31 ·93	+0 ·13
7 554	7 607	42 ·05	24 ·88	5	5	32 ·44	−0 ·38
7 664	7 683	40 ·76	07 ·67	5	5	32 ·38	−0 ·32
7 731	7 777	04 ·25	22 ·80	5	5	33 ·06	−1 ·00
7 798	7 850	54 ·74	00 ·34	6	5	32 ·21	−0 ·15
7 888	7 900	58 ·00	09 ·09	5	5	32 ·73	−0 ·67
7 914	7 932	40 ·15	10 ·15	6	5	32 ·33	−0 ·27
7 972	8 032	05 ·77	41 ·03	5	5	31 ·57	+0 ·49
8 052	8 056	22 ·06	26 ·86	5	5	31 ·71	+0 ·35
8 182	8 188	43 ·65	23 ·73	6	5	31 ·90	+0 ·16
8 206	8 212	52 ·60	08 ·68	6	5	32 ·18	−0 ·12
8 227	8 252	29 ·70	26 ·95	5	5	31 ·90	+0 ·16
8 280	8 300	57 ·77	53 ·55	5	5	31 ·77	+0 ·29

Indiscriminate mean=34° 56′ 32″·05.
Weighted mean =34 56 32 ·06±0″·10.
$e=\pm 0''\cdot 36$.
116 observations, 22 pairs.
[Reduction to △=−0″·87.]

57. *Paris*, South Carolina.—H. W. Blair. Zenith telescope No. 5. Second series. October 18 to 25, 1875. One division of level = 0″·944. One turn of micrometer = 41″·386 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 204	7 213	49·16	03·74	5	6	34 56 31·57	+0·29
7 260	†2 065	19·40	53·66	5	6	32·02	−0·16
7 437	7 455	41·01	34·65	5	6	32·68	−0·82
7 495	7 553	28·93	41·30	5	6	31·30	+0·56
7 606	7 642	40·50	32·40	5	6	31·56	+0·30
7 674	7 696	59·05	27·52	5	6	31·72	+0·14
7 738	7 796	37·82	26·07	5	6	31·70	+0·16
7 807	7 855	58·19	35·56	5	6	30·88	+0·98
7 871	7 912	17·85	07·72	5	6	31·32	+0·54
8 003	8 013	19·56	16·54	5	6	32·21	−0·35
8 028	8 097	50·74	58·93	5	6	31·57	+0·29
8 099	8 171	14·18	32·48	5	6	32·54	−0·68
8 261	8 324	25·03	11·09	5	6	32·06	−0·20
8 345	4	43·34	58·21	5	6	32·06	−0·20
82	92	37·80	03·14	5	6	32·39	−0·53
102	121	25·44	05·15	5	6	31·92	−0·06
189	215	33·37	47·45	5	6	32·03	−0·17
226	250	01·01	55·02	5	6	32·71	−0·85
*334	*334	33·49	33·49	5	3	33·33	−1·47
339	370	56·08	44·07	5	6	30·99	+0·87
416	454	55·00	21·54	5	6	30·90	+0·96
470	508	54·50	18·61	5	6	32·13	−0·27

Indiscriminate mean = 34° 56′ 31″·88.
Weighted mean = 34 56 31 ·86 ± 0″·08.
$e = \pm 0''·27$.
110 observations, 22 pairs.
[Reduction to △ = −0.″87.]
Adopted value = 34° 56′ 31″·96 ± 0″·07.
[Reduction to △ = − 0·″87.]

† Radcliffe Catalogue.

58. *Currahee*, Georgia.—H. W. Blair. Zenith telescope No. 5. First series. September 28 to October 8, 1874. One division of level = 0″·94 from observations at this station. One turn of micrometer = 41″·381 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 571	6 599	31 ·74	22 ·34	5	5	34 31 37 ·32	+0 ·43
6 637	6 656	40 ·03	22 ·44	5	5	38 ·05	−0 ·30
6 697	6 739	16 ·54	26 ·40	5	5	38 ·32	−0 ·57
6 764	6 794	26 ·47	20 ·20	5	5	37 ·73	+0 ·02
6 824	6 839	51 ·47	49 ·75	5	5	37 ·53	+0 ·22
6 858	6 895	54 ·76	42 ·24	5	5	37 ·60	+0 ·15
6 944	6 963	45 ·15	08 ·25	6	5	37 ·64	+0 ·11
*6 998	*6 998	35 ·87	35 ·87	5	3	38 ·33	−0 ·58
7 008	7 067	35 ·17	02 ·51	5	5	38 ·03	−0 ·28
7 094	7 105	10 ·28	49 ·94	5	5	38 ·46	−0 ·71
7 215	7 257	18 ·44	40 ·94	5	5	38 ·50	−0 ·75
7 275	7 301	35 ·60	12 ·52	5	5	38 ·09	−0 ·34
7 350	7 377	29 ·42	52 ·53	5	5	36 ·15	+1 ·60
7 402	7 444	00 ·33	01 ·55	5	5	36 ·19	+1 ·56
7 474	7 480	43 ·96	51 ·78	5	5	38 ·29	−0 ·54
7 528	7 548	08 ·14	17 ·84	5	5	36 ·64	+1 ·11
7 606	7 612	57 ·12	25 ·68	5	5	37 ·30	+0 ·45
7 641	7 683	13 ·87	24 ·94	5	5	38 ·12	−0 ·37
7 705	7 706	54 ·13	10 ·13	5	5	36 ·97	+0 ·78
7 807	7 820	16 ·25	43 ·26	5	5	37 ·22	+0 ·53
7 855	7 856	53 ·84	06 ·71	5	5	38 ·05	−0 ·30
7 915	7 923	56 ·37	13 ·32	5	5	37 ·81	−0 ·06
7 953	8 003	51 ·15	38 ·76	5	5	38 ·41	−0 ·66
8 023	8 032	01 ·48	00 ·52	5	5	38 ·59	−0 ·84
8 076	8 079	55 ·39	57 ·83	5	5	38 ·55	−0 ·80
8 097	8 128	18 ·56	40 ·85	5	5	38 ·29	−0 ·54
8 158	8 182	21 ·79	03 ·50	5	5	37 ·36	+0 ·39
8 250	8 280	03 ·95	17 ·82	5	5	37 ·60	+0 ·15

Indiscriminate mean = 34° 31′ 37″·75.
Weighted mean = 34 31 37 ·75 ± 0″·09.
$e = \pm 0''\!\cdot 32$.
141 observations, 28 pairs.
[Reduction to △ = + 6″·21.]

58. *Currahee*, Georgia.—J. B. Boutelle. Zenith telescope No. 5. Second series. October 12 to 21, 1874. One division of level = 0″·94 from observations at this station. One turn of micrometer = 41″·381 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 754	6 827	22 ·53	51 ·94	5	3	34 31 37 ·06	+0 ·65
6 868	6 881	31 ·94	21 ·70	5	3	37 ·31	+0 ·40
6 957	7 027	09 ·44	32 ·21	5	3	37 ·87	−0 ·16
7 174	7 256	00 ·45	14 ·00	5	3	36 ·94	+0 ·77
†4 502	7 326	13 ·63	08 ·54	5	3	37 ·62	+0 ·09
7 372	7 387	08 ·66	18 ·50	5	3	37 ·70	+0 ·01
7 437	7 561	56 ·30	15 ·31	5	3	37 ·53	+0 ·18
7 565	7 623	12 ·59	42 ·42	6	3	36 ·88	+0 ·83
7 674	7 718	16 ·28	25 ·96	5	3	37 ·90	−0 ·19
7 749	7 796	10 ·35	44 ·12	6	3	37 ·72	−0 ·01
7 825	7 900	18 ·79	26 ·68	5	3	36 ·93	+0 ·78
7 912	7 961	26 ·43	55 ·62	5	3	37 ·19	+0 ·52
8 052	8 110	41 ·45	15 ·02	5	3	39 ·61	−1 ·90
8 136	8 159	18 ·26	24 ·47	5	3	38 ·77	−1 ·06
8 299	8 307	45 ·87	43 ·29	5	3	39 ·37	−1 ·66
7	14	42 ·54	20 ·15	5	3	37 ·00	+0 ·71

Indiscriminate mean = 34° 31′ 37″·71.
Weighted mean = 34 31 37 ·71 ± 0″·14.
$e = \pm$ 0″·49.
82 observations, 16 pairs.
[Reduction to △ = + 6″·21.]
Adopted value = 34° 31′ 37″.75 ± 0″·08.
[Reduction to △ = +6″·21.]

† Armagh, 1840.

59. *Lavender*, Georgia.—F. P. Webber. Zenith telescope No. 3. October 20 to November 4, 1874. One division of level=1″·20. One turn of micrometer=46″·60 determined from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 310	7 350	12 ·79	29 ·42	8	3	34 19 16 ·41	−0 ·60
7 553	7 582	57 ·49	49 ·75	6	3	16 ·67	−0 ·86
7 607	7 614	41 ·51	09 ·32	5	3	16 ·12	−0 ·31
7 643	7 664	07 ·12	56 ·90	5	3	16 ·02	−0 ·21
7 712	7 729	34 ·99	56 ·79	6	3	14 ·73	+1 ·08
7 820	7 856	43 ·26	06 ·71	7	3	14 ·87	+0 ·94
7 879	7 923	29 ·57	13 ·32	5	3	14 ·45	+1 ·36
7 997	8 059	22 ·27	25 ·08	6	3	15 ·62	+0 ·19
8 097	8 118	17 ·90	50 ·30	5	3	17 ·32	−1 ·51
8 149	8 158	33 ·81	21 ·79	5	3	16 ·08	−0 ·27
8 282	8 300	12 ·56	13 ·53	5	3	15 ·65	+0 ·16
79	101	42 ·48	17 ·29	5	3	17 ·15	−1 ·34
121	156	25 ·11	40 ·70	5	3	16 ·17	−0 ·36
180	214	44 ·91	36 ·50	5	3	15 ·14	+0 ·67
305	339	55 ·35	15 ·39	5	3	14 ·73	+1 ·08
377	395	30 ·80	55 ·68	8	3	16 ·51	−0 ·70
560	572	52 ·73	20 ·70	6	3	14 ·42	+1 ·39
587	644	13 ·00	11 ·68	5	3	17 ·40	−1 ·59
7 559	7 568	50 ·89	32 ·05	5	3	15 ·70	+0 ·11
7 641	7 668	13 ·87	39 22	5	3	17 ·22	−1 ·41
7 855	7 900	53 ·84	26 ·68	5	3	15 ·58	+0 ·23
7 962	8 032	47 ·41	00 ·52	6	3	16 ·25	−0 ·44
8 058	8 131	34 ·35	56 ·50	5	3	14 ·58	+1 ·23
8 160	8 224	21 ·00	27 ·85	7	3	15 ·88	−0 ·07
142	169	16 ·58	14 ·80	5	3	16 ·07	−0 ·26
219	247	11 ·45	40 ·63	5	3	15 ·56	+0 ·25
321	343	38 ·90	47 ·53	6	3	14 ·55	+1 ·26

Indiscriminate mean=34° 19′ 15″·81.
Weighted mean =34 19 15 ·81 ± 0″·12.
e=±0″·65.
151 observations, 27 pairs.
[Reduction to △=+1″·24.]

60. *Sawnee*, Georgia.—H. W. Blair. Zenith telescope No. 5. First series. October 6 to 17, 1873. One division of level=1″·00. One turn of micrometer=41″·429 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
6 583	6 644	23 ·20	31 ·63	5	9	34 14 04 ·14	+0 ·26
*6 698	*6 698	57 ·40	57 ·40	6	5	04 ·00	+0 ·40
6 723	6 739	03 ·41	34 ·50	6	10	05 ·35	−0 ·95
6 762	6 769	02 ·04	50 ·67	5	9	03 ·91	+0 ·49
6 779	6 827	41 ·98	01 ·14	5	9	03 ·62	+0 ·78
6 805	6 867	02 ·00	33 ·66	5	9	03 ·25	+1 ·15
6 839	6 856	59 ·13	50 ·15	5	9	05 ·10	−0 ·70
6 881	6 896	29 ·63	03 ·28	5	9	04 ·18	+0 ·22
6 890	6 928	25 ·31	32 ·49	5	9	03 ·65	+0 ·75
6 975	6 983	21 ·39	29 ·70	5	9	04 ·47	−0 ·07
7 006	7 029	58 ·44	06 ·66	5	9	04 ·18	+0 ·22
7 055	7 107	52 ·05	44 ·24	5	9	04 ·69	−0 ·29
7 143	7 171	41 ·57	21 ·34	5	9	04 ·43	−0 ·03
7 188	7 241	56 ·99	05 ·54	5	9	04 ·73	−0 ·33
7 257	7 281	55 ·52	03 ·05	5	9	04 ·76	−0 ·36
7 310	7 351	26 ·74	04 ·85	5	9	03 ·58	+0 ·82
7 368	7 398	34 ·57	12 ·15	5	9	04 ·84	−0 ·44
7 474	7 501	00 ·25	31 ·16	5	9	04 ·62	−0 ·22
7 553	7 582	13 ·72	06 ·17	5	9	04 ·02	+0 ·38
7 607	7 614	58 ·14	26 ·05	5	9	04 ·63	−0 ·23
7 641	7 668	31 ·36	56 ·41	5	9	05 ·32	−0 ·92
7 712	7 727	52 ·43	14 ·32	5	9	04 ·20	+0 ·20
7 820	7 806	01 ·40	25 ·13	5	9	04 ·13	+0 ·27
7 882	7 900	11 ·16	45 ·36	5	9	04 ·67	−0 ·27
7 923	7 931	32 ·07	57 ·97	5	9	04 ·37	+0 ·03
7 945	7 958	07 ·43	06 ·07	5	9	05 ·22	−0 ·82

Indiscriminate mean=34° 14′ 04″·39.
Weighted mean =34 14 04 ·40±0″·07.
$e=\pm 0''\cdot 28$.
132 observations, 26 pairs.
[Reduction to △=+6″·89.]

60. *Sawnee*, Georgia.—A. H. Scott. Zenith telescope No. 5. Second series. October 30 to November 15, 1873. One division of level=1″·00. One turn of micrometer=41″·429 from circumpolar observations at this station

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 137	7 166	45·90	30·31	5	4	34 14 03·85	+0·30
7 306	7 361	32·55	14·07	5	4	04·61	−0·46
7 380	7 449	33·30	04·16	5	4	04·26	−0·11
7 559	7 568	07·17	48·19	5	4	03·79	+0·36
7 590	7 612	30·80	42·39	6	4	04·23	−0·08
7 674	7 749	33·52	27·99	6	4	03·53	+0·62
7 855	7 893	12·23	02·81	6	4	04·01	+0·14
7 913	7 958	18·59	06·26	6	4	03·12	+1·03
8 114	8 146	42·11	01·00	5	4	04·12	+0·03
8 282	8 300	32·54	33·50	4	3	03·52	+0·63
92	142	43·14	36·50	6	4	05·59	−1·44
164	181	40·52	22·62	6	4	05·53	−1·38
224	227	23·05	47·09	6	4	04·88	−0·73
305	314	14·80	13·77	5	4	02·95	+1·20
352	365	21·18	20·62	6	4	03·90	+0·25

Indiscriminate mean=34° 14′ 04″·13.
Weighted mean =34 14 04 ·15±0″·14.
e=±0″·51.
82 observations, 15 pairs.
[Reduction to ⚠=+ 6″·89.]
Value adopted =34° 14′ 04″·20±0″·08.
[Reduction to ⚠=+6″·89.]

61. *Aurora*, Alabama.—F. P. Webber. Zenith telescope No. 2. May 28 to June 20, 1877. One division of level = 1″·006. One turn of micrometer = 45″·852 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
4 057	4 127	18·90	15·10	5	3	34 08 48·72	−1·27
4 148	4 156	59·48	38·60	5	3	47·74	−0·29
4 274	4 305	05·20	32·60	5	3	46·65	+0·80
4 335	4 367	21·00	45·50	5	3	47·59	−0·14
4 406	4 456	10·50	15·22	5	3	46·90	+0·55
4 684	4 753	09·88	43·18	6	3	46·49	+0·96
4 870	4 876	10·73	23·05	6	3	48·73	−1·28
4 958	4 969	24·70	18·32	6	3	48·30	−0·85
5 026	5 031	25·07	42·24	5	3	49·43	−1·98
5 075	5 084	00·52	25·75	4	3	46·56	+0·89
5 130	5 143	56·38	13·00	5	3	46·94	+0·51
5 177	5 252	46·80	03·60	5	3	47·51	−0·06
5 295	5 321	48·80	13·57	5	3	46·53	+0·92
5 432	5 479	43·01	37·63	5	3	46·12	+1·33
5 502	5 587	53·64	53·78	5	3	48·17	−0·72
5 834	5 927	04·50	56·25	5	3	47·11	+0·34
5 937	5 991	25·10	21·83	6	3	47·36	+0·09
6 091	6 094	45·85	26·60	5	3	49·32	−1·87
6 151	6 203	10·25	54·18	5	3	48·28	−0·83
4 242	4 303	44·50	45·85	5	3	46·73	+0·72
4 597	4 701	45·45	36·44	5	3	47·56	−0·11
4 751	4 845	38·25	40·23	5	3	47·47	−0·02
4 905	4 980	16·66	23·48	5	3	47·14	+0·31
5 185	5 313	24·14	08·06	5	3	47·11	+0·34
5 322	5 388	10·41	30·48	5	3	46·80	+0·65
5 463	5 525	34·73	27·79	5	3	46·55	+0·90

Indiscriminate mean = 34° 08′ 47″·45.
Weighted mean = 34 08 47 ·45 ± 0″·12.
$e = \pm$ 0″·60.
133 observations, 26 pairs.
[Reduction to △ = + 0″·26.]

62. *Atlanta Middle Base*, Georgia.—F. P. Webber. Zenith telescope No. 5. September 4 to 27, 1872. One division of level = 1″·00. One turn of micrometer = 41″·427 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
6 109	6 134	29·76	28·00	5	7	33 54 21·68	+0·14
6 452	6 487	22·16	14·00	5	7	20·98	+0·84
6 583	6 595	29·28	00·70	5	7	21·48	+0·34
6 656	6 676	36·16	38·41	5	7	21·80	+0·02
6 697	6 724	31·80	22·20	5	7	22·15	−0·33
6 739	6 763	42·25	15·73	5	7	22·03	−0·21
6 777	6 800	53·80	54·70	5	7	20·64	+1·18
6 839	6 881	08·50	41·09	5	7	20·96	+0·86
6 928	6 952	44·30	25·72	6	7	21·53	+0·29
6 978	7 027	00·10	55·03	5	7	22·91	−1·09
7 061	7 067	44·70	26·26	5	7	21·63	+0·19
7 164	7 213	48·05	43·15	5	7	21·99	−0·17
7 336	7 368	43·24	49·31	5	7	21·60	+0·22
7 431	7 450	32·92	40·10	5	7	21·62	+0·20
7 520	7 548	21·88	50·34	5	7	21·41	+0·41
7 602	7 607	13·42	14·82	5	7	22·47	−0·65
7 631	7 664	15·78	31·15	5	7	21·69	+0·13
7 695	7 712	16·75	09·92	5	7	20·63	+1·19
7 754	7 796	47·44	19·82	5	7	21·74	+0·08
7 880	7 914	39·28	35·30	5	7	21·75	+0·07
7 948	7 958	41·79	25·00	5	7	21·86	−0·04
8 032	8 037	39·11	55·81	5	7	20·60	+1·22
8 054	8 071	18·20	16·60	5	7	21·52	+0·30
8 115	8 131	33·68	36·09	5	7	22·19	−0·37
8 203	8 224	25·61	06·67	5	7	22·24	−0·42
8 250	8 268	44·62	39·20	5	7	21·67	+0·15
8 330	8 370	26·62	57·53	5	7	22·46	−0·64
63	83	36·22	45·87	5	7	20·84	+0·98
120	158	30·40	18·53	5	7	22·44	−0·62
168	197	25·29	16·07	5	7	21·51	+0·31
6 475	6 542	18·47	44·58	5	7	21·69	+0·13
6 678	6 721	57·08	47·84	5	7	22·41	−0·59
6 745	6 758	33·62	58·97	5	7	22·22	−0·40
6 780	6 805	16·12	11·64	5	7	21·69	+0·13
6 865	6 868	27·14	54·36	5	7	21·31	+0·51
6 962	6 975	14·50	32·30	5	7	22·07	−0·25
7 041	7 117	46·98	37·15	6	7	21·00	+0·82
7 146	7 153	35·47	23·88	5	7	22·44	−0·62
7 166	7 223	42·98	55·00	5	7	22·03	−0·21
7 256	7 260	40·85	00·03	5	7	21·54	+0·28
7 350	7 417	57·93	02·61	5	7	21·71	+0·11
7 453	7 465	04·57	01·52	5	7	22·77	−0·95

Atlanta Middle Base, Georgia—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
7 544	7 571	23 ·41	32 ·50	5	7	33 54 21 ·55	+0 ·27
7 668	7 674	13 ·61	55 ·06	6	7	21 ·96	−0 ·14
7 727	7 733	31 ·64	00 ·75	5	7	22 ·27	−0 ·45
7 901	7 923	55 ·06	50 ·55	5	7	22 ·36	−0 ·54
7 937	7 995	25 ·96	57 ·88	5	7	22 ·87	−1 ·05
8 052	8 076	19 ·57	34 ·05	5	7	22 ·33	−0 ·51
8 125	8 147	36 ·34	32 ·05	5	7	21 ·55	+0 ·27
8 212	8 284	08 ·20	11 ·50	5	7	22 ·37	−0 ·55
8 300	8 364	53 ·12	50 ·24	6	7	21 ·13	+0 ·69
54	101	40 ·84	57 ·45	5	7	22 ·45	−0 ·63
152	178	04 ·34	22 ·39	5	7	22 ·32	−0 ·50
198	217	59 ·42	28 ·50	5	7	22 ·09	−0 ·27

Indiscriminate mean $= 33° \ 54' \ 21''·82$

Weighted mean $= 33 \ \ 54 \ \ 21 \ \ ·82 \pm 0''·05$

$e = \pm 0''·33$

274 observations, 54 pairs.

[Reduction to $\triangle = +0''·40$.]

63. *Atlanta*, Georgia.—C. H. Sinclair. Meridian telescope No. 13. January 1 to 22, 1880. One division of level $= 2''·7$ at 33° F. and $2''·64$ at 75°·2 F. One turn of micrometer $= 77''·783$ from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
522	592	00 ·00	08 ·80	6	4	33 44 58 ·83	+0 ·47
628	657	49 ·20	44 ·71	6	4	58 ·42	+0 ·88
682	706	13 ·04	28 ·85	5	3	59 ·38	−0 ·08
819	842	12 ·40	50 ·72	6	4	59 ·25	+0 ·05
897	921	25 ·63	26 ·10	6	4	58 ·63	+0 ·67
974	981	56 ·90	43 ·72	4	3	60 ·44	−1 ·14
1 006	1 052	02 ·67	08 ·58	4	3	59 ·58	−0 ·28
1 065	1 087	55 ·80	32 ·79	4	3	58 ·99	+0 ·31
(557)	1 129	37 ·76	52 ·20	4	3	59 ·12	+0 ·18
1 139	1 192	07 ·20	03 ·10	5	3	59 ·48	−0 ·18
1 214	(654)	14 ·60	58 ·22	5	3	58 ·19	+1 ·11
1 254	1 272	34 ·60	55 ·50	4	3	60 ·51	−1 ·21
1 301	1 346	05 ·68	25 ·50	5	3	58 ·30	+1 ·00
1 307	1 365	42 ·75	53 ·25	5	3	60 ·26	−0 ·96
1 382	1 393	08 ·00	17 ·50	5	3	58 ·92	+0 ·38
1 409	1 424	33 ·80	55 ·20	5	3	59 ·45	−0 ·15
1 460	1 456	43 ·50	29 ·50	5	3	59 ·66	−0 ·36
(772)	1 492	22 ·02	04 ·80	5	3	61 ·14	−1 ·84
1 500	1 504	03 ·40	32 ·12	4	3	58 ·85	+0 ·45

Indiscriminate mean $= 33° \ 44' \ 59''·34$.

Weighted mean $= 33 \ \ 44 \ \ 59 \ \ ·30 \pm 0·12$.

$e = \pm 0''·50$.

93 observations, 19 pairs.

[Reduction to $\triangle = +0''·08$.]

64. *Kahatchee*, Alabama.—O. B. French. Zenith telescope No. 2. June 3 to 9, 1898. One division of level = 1″·211, as determined by E. G. Fischer, 1891. One turn of micrometer = 46″·376 from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
4 729	4 741	11·45	36·36	4	13	33 13 39·87	+0·03
*4 748	*(2 232)	38·32	04·04	2	5	39·49	+0·41
*4 748	*(2 237)	38·32	56·63	4	7	39·45	+0·45
4 762	*(2 237)	18·51	56·63	2	5	38·99	+0·91
*(2 232)	*4 792	04·04	14·73	2	5	40·45	−0·55
*(2 237)	*4 792	56·63	14·73	4	7	40·07	−0·17
4 830	4 847P	12·97	40·08	4	13	39·95	−0·05
4 873	4 907P	13·70	36·85	5	14	39·80	+0·10
4 936	4 939	39·62	51·24	5	14	39·72	+0·18
4 967	(2 339)	41·07	32·25	5	14	40·29	−0·39
(2 350)	(2 358)	47·42	21·87	4	12	40·54	−0·64
*5 098	(2 396)	33·99	53·58	4	9	39·58	+0·32
*5 098	(2 399)	33·99	09·15	3	8	39·78	+0·12
5 143	5 155	31·89	04·40	4	13	39·40	+0·50
5 181	5 216	38·78	32·52	4	13	40·43	−0·53
5 287	*5 322	51·95	44·83	4	9	40·30	−0·40
(2 486)	*5 322	44·46	44·83	3	3	39·60	+0·30
5 388	5 462	59·76	56·50	4	13	39·60	+0·30
5 509	5 523	17·33	38·06	4	13	39·92	−0·02

Indiscriminate mean = 33° 13′ 39″·85.
Weighted mean = 33 13 39 ·90 ± 0″·06.
$e = \pm 0''\cdot 31$.
71 observations, 19 pairs.
[Reduction to △ = + 0″·39.]

65. *Montgomery*, Alabama.—G. W. Dean. Zenith telescope No. 5. March 22 to 28, 1856. One division of level = 0″·929 as determined at this station. One turn of micrometer = 41″·45 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
3 109	3 112	11·18	07·13	5	14	32 22 45·66	−0·25
3 140	3 176	14·08	17·90	5	14	45·68	−0·27
3 202	3 220	16·72	42·66	5	14	45·19	+0·22
3 241	3 255	46·01	48·07	4	13	45·14	+0·27
3 307	3 327	18·20	55·11	4	13	44·34	+1·07
3 331	3 352	54·00	00·86	4	13	45·42	−0·01
3 399	3 423	39·20	29·80	4	13	45·95	−0·54
3 515	3 522	16·10	00·00	6	14	45·93	−0·52
*3 545	3 548	26·90	16·96	6	10	45·09	+0·32
*3 545	3 560	26·90	19·90	6	10	44·89	+0·52
3 580	3 621	57·80	23·07	6	14	45·35	+0·06
*3 634	3 665	27·20	27·00	5	9	44·80	+0·61

65. *Montgomery*, Alabama—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		"	"			° ′ ″	"
*3 634	3 670	27 ·20	15 ·40	5	9	32 22 44 ·96	+0 ·45
3 704	3 736	23 ·04	50 ·53	6	14	45 ·86	−0 ·45
3 760	3 776	44 ·44	55 ·07	5	14	45 ·38	+0 ·03
3 825	3 837	26 ·18	07 ·13	5	14	45 ·81	−0 ·40
3 885	3 911	38 ·35	24 ·17	5	14	45 ·15	+0 ·26
3 931	3 954	09 ·98	08 ·27	5	14	45 ·75	−0 ·34
3 964	3 973	52 ·30	42 ·17	5	14	45 ·41	0 ·00
*3 990	4 057	51 ·22	19 ·75	5	9	45 ·14	+0 ·27
*3 990	4 059	51 ·22	37 ·41	5	9	45 ·60	−0 ·19
4 079	4 121	05 ·62	49 ·60	5	14	45 ·64	−0 ·23
4 127	*4 188	13 ·94	55 ·48	4	9	45 ·66	−0 ·25
4 184	*4 188	25 ·76	55 ·48	5	9	45 ·56	−0 ·15
4 203	4 229	22 ·14	39 ·46	5	14	44 ·72	+0 ·69
4 240	4 258	37 ·09	56 ·60	4	13	45 ·67	−0 ·26
4 287	4 351	18 ·35	47 ·80	5	14	45 ·40	+0 ·01
4 384	4 390	46 ·34	04 ·56	5	14	45 ·67	−0 ·26
4 421	4 457	26 ·53	52 ·70	5	14	44 ·95	+0 ·46
4 468	4 538	38 ·73	47 ·78	5	14	44 ·80	+0 ·61
4 553	*4 596	03 ·16	14 ·57	5	9	45 ·69	−0 ·28
4 566	*4 596	23 ·37	14.57	5	9	45 ·10	+0 ·31
4 609	4 618	52 ·22	10 ·25	5	14	45 ·26	+0 ·15
4 632	4 640	28 ·13	29 ·75	5	14	45 ·66	−0 ·25
4 694	4 714	35 ·61	32 ·09	2	9	45 ·66	−0 ·25
4 699	4 729	32 ·67	57 ·47	2	9	46 ·01	−0 ·60
4 753	4 827	53 ·46	50 ·70	2	9	45 ·94	−0 ·53
4 789	4 853	55 ·76	58 ·71	2	9	46 ·03	−0 ·62
4 902	4 961	08 ·17	41 ·02	2	9	45 ·50	−0 ·09
4 993	5 026	17 ·16	38 ·94	2	9	45 ·80	−0. 39

Indiscriminate mean = 32° 22′ 45″ ·43.
Weighted mean = 32 22 45 ·41 ± 0″ ·04.
$e = \pm 0''$ ·29.
181 observations, 40 pairs.
[Reduction to △ or center of State House = + 0″ ·22.]

66. *Lower Peach Tree*, Alabama.—E. Goodfellow. Zenith telescope No. 5. April 4 to 16, 1857. One division of level = 0″·99 from observations at this station. One turn of micrometer = 41″·481 from circumpolar observations at Mobile, Alabama.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
2 740	2 792	29 ·03	27 ·05	4	5	31 50 21 ·03	+0 ·16
2 841	2 860	02 ·68	56 ·19	4	5	21 ·68	−0 ·49
2 912	2 952	21 ·76	15 ·52	4	5	20 ·75	+0 ·44
2 995	*3 075	18 ·92	52 ·87	4	3	21 ·79	−0 ·60
3 047	*3 075	54 ·29	52 ·87	4	3	21 ·04	+0 ·15
3 095	3 106	01 ·10	17 ·82	3	4	22 ·37	−1 ·18
3 140	3 228	28 ·60	24 ·15	5	5	21 ·16	+0 ·03
3 246	3 265	14 ·00	47 ·50	4	5	20 ·22	+0 ·97
3 278	3 341	25 ·27	54 ·68	5	5	20 ·61	+0 ·58
3 355	3 399	23 ·50	56 ·05	4	5	21 ·95	−0 ·76
3 406	3 421	29 ·83	10 ·38	4	5	21 ·37	−0 ·18
3 505	3 522	24 ·07	18 ·09	4	5	20 ·74	+0 ·45
3 545	3 602	45 ·00	16 ·58	4	5	22 ·41	−1 ·22
3 610	3 650	34 ·50	50 ·40	4	5	21 ·40	−0 ·21
3 661	3 685	21 ·90	56 ·73	4	5	20 ·61	+0 ·58
3 691	3 729	20 ·64	59 ·19	4	5	21 ·37	−0 ·18
3 725	3 788	21 ·84	30 ·80	5	5	20 ·88	+0 ·31
3 862	3 885	15 ·50	58 ·02	4	5	22 ·38	−1 ·19
3 915	3 952	11 ·30	55 ·06	6	5	20 ·64	+0 ·55
3 981	3 995	40 ·12	43 ·39	5	5	20 ·71	+0 ·48
*4 017	4 027	37 ·15	39 ·20	6	4	20 ·76	+0 ·43
*4 017	4 072	37 ·15	21 ·00	4	3	20 ·16	+1 ·03

Indiscriminate mean = 31° 50′ 21″·18.
Weighted mean = 31 50 21 ·19 ± 0″·10.
$e = \pm 0''\cdot 53$.
95 observations, 22 pairs.
[Reduction to △ = 0″·00.]

67. *Coon*, Alabama.—O. B. French. Zenith telescope No. 2. May 21 to 26, 1898. One division of level=1″·211 as determined April 23, 1891. One turn of micrometer=46″·325 from circumpolar observations at this station and at Kahatchee, Alabama.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
4 122	4 140	56·10	51·58	4	20	34 14 48·26	−0·44
4 222	4 257	01·51	03·45	5	24	47·77	+0·05
4 268P	4 300	21·18	44·39	5	15	47·86	−0·04
4 347	4 352	29·62	42·79	5	24	47·78	+0·04
4 387	4 433	58·04	25·56	4	21	47·93	−0·11
4 480	4 506	44·10	44·33	4	21	48·00	−0·18
4 513	4 536	12·91	42·60	2	10	47·11	+0·71
(2 122)	4 591	19·62	54·04	4	21	47·88	−0·06
4 607	(2 158)	39·79	50·40	5	21	47·91	−0·09
*4 727	(2 232)	49·88	04·04	4	14	48·06	−0·24
*4 727	(2 237)	49·88	56·63	4	14	48·19	−0·37
4 803	4 823	17·95	42·80	5	15	47·88	−0·06
4 843	4 873	19·29	13·70	5	24	47·46	+0·36
(2 288)	4 706	35·02	34·43	5	19	47·29	+0·53

Indiscriminate mean = 31° 14′ 47″·81.
Weighted mean = 31 14 47 ·82 ± 0″·05.
$e = \pm 0''·34$.
61 observations, 14 pairs.
[Reduction to △ = −0″·03.]

68. *Mobile*, Alabama.—E. Goodfellow. Zenith telescope No. 5. December 11, 1856 to January 3, 1857. One division of level = 0″·69. One turn of micrometer = 41″·481 from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
215	259	01·20	57·08	5	6	30 41 33·86	−0·44
283	307	47·90	56·18	6	6	32·68	+0·74
330	341	37·96	36·70	6	6	32·32	+1·10
*425	427	27·05	44·09	6	4	32·55	+0·87
*425	431	27·05	26·03	7	4	33·11	+0·31
446	*492	24·74	53·32	6	4	33·28	+0·14
469	*492	34·76	53·32	6	4	32·97	+0·45
510	523	40·06	59·27	6	6	33·00	+0·42
556	566	30·03	58·50	6	6	33·00	+0·42
576	630	51·79	38·00	6	6	31·99	+1·43
648	661	14·22	32·61	6	6	33·88	−0·46

68. *Mobile*, Alabama—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		"	"			° ′ ″	"
697	*710	13 ·48	26 ·80	6	4	30 41 33 ·58	−0 ·16
698	*710	15 ·75	26 ·80	6	4	34 ·13	−0 ·71
735	798	33 ·78	44 ·90	6	6	32 ·86	+0 ·56
872	915	09 ·44	50 ·42	6	6	33 ·27	+0 ·15
921	963	18 ·03	09 ·06	6	6	34 ·02	−0 ·60
986	993	15 ·97	15 ·73	6	6	33 ·85	−0 ·43
1 006	1 064	28 ·69	01 ·30	6	6	33 ·33	+0 ·09
1 095	*1 123	20 ·70	18 ·58	7	3	33 ·69	−0 ·27
*1 123	1 146	18 ·58	01 ·62	6	3	34 ·24	−0 ·82
*1 123	1 154	18 ·58	09 ·00	7	3	34 ·23	−0 ·81
1 189	*1 219	50 ·57	37 ·60	6	3	33 ·68	−0 ·26
*1 219	1 257	37 ·60	55 ·27	6	3	33 ·77	−0 ·35
*1 219	1 260	37 ·60	00 ·23	6	3	34 ·47	−1 ·05
1 323	1 328	59 ·92	26 ·34	7	6	33 ·32	+0 ·10
1 337	*1 414	22 ·60	08 ·84	5	4	32 ·68	+0 ·74
1 342	*1 414	22 ·80	08 ·84	7	4	33 ·60	−0 ·18
1 445	1 468	50 ·53	47 ·40	6	6	33 ·52	−0 ·10
1 492	1 528	41 ·55	34 ·60	6	6	34 ·50	−1 ·08
1 557	*1 609	02 ·42	13 ·00	7	4	32 ·83	+0 ·59
1 591	*1 609	27 ·12	13 ·00	5	4	32 ·43	+0 ·99
1 629	*1 648	33 ·21	36 ·54	6	4	33 ·67	−0 ·25
1 632	*1 648	34 ·83	36 ·54	6	4	32 ·91	+0 ·51
1 669	1 768	45 ·50	52 ·88	6	6	33 ·15	+0 ·27
1 845	1 925	56 ·45	28 ·05	6	6	33 ·32	+0 ·10
*1 935	1 951	05 ·36	10 ·19	6	4	33 ·20	+0 ·22
*1 935	2 016	05 ·36	54 ·31	6	4	33 ·48	−0 ·06
2 067	2 155	47 ·13	13 ·70	6	6	34 ·29	−0 ·87
2 182	2 228	33 ·06	16 ·11	5	6	33 ·57	−0 ·15
2 306	2 409	28 ·40	10 ·93	6	6	34 ·37	−0 ·95
2 423	2 429	19 ·10	18 ·03	4	5	33 ·37	+0 ·05
2 441	2 444	28 ·79	08 ·55	6	6	33 ·17	+0 ·25
2 463	2 563	34 ·28	05 ·83	6	6	34 ·38	−0 ·96

Indiscriminate mean $= 30^\circ\ 41'\ 33''\cdot 43$.
Weighted mean $= 30\ \ 41\ \ 33\ \ \cdot 42 \pm 0''\cdot 06$.
$e = \pm\ 0''\cdot 46$.

258 observations, 43 pairs.

[Reduction to △ (Episcopal Church.) = − 10″·72.]

69. *East Pascagoula*, Mississippi.—R. H. Fauntleroy. Zenith Telescope No. 1. June 25 to July 26, 1847. One division of level = 0″·90. One turn of micrometer = 45″·502 from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n′	w	Latitude.	v
		″	″			° ′ ″	″
5 463	5 563	10 ·60	57 ·00	2	12	30 20 41 ·19	−0 ·27
5 628	5 724	12 ·36	17 ·13	1	6	40 ·87	+0 ·05
5 667	5 749	50 ·65	01 ·25	3	19	40 ·43	+0 ·49
5 795	5 940	39 ·77	19 ·77	2	12	40 ·79	+0 ·13
5 802	5 853	29 ·78	31 ·96	2	12	40 ·91	+0 ·01
5 953	6 006	12 ·40	19 ·20	3	19	40 ·57	+0 ·35
6 013	6 094	44 ·92	09 ·65	2	12	41 ·08	−0 ·16
6 052	6 143	49 ·24	12 ·10	1	6	40 ·82	+0 ·10
6 155	6 216	39 ·79	44 ·99	1	6	40 ·44	+0 ·48
*6 224	6 418	14 ·98	57 ·12	3	12	41 ·71	−0 ·79
*6 224	6 420	14 ·98	29 ·64	3	12	40 ·60	+0 ·32
6 269	6 373	23 ·53	48 ·06	4	24	41 ·51	−0 ·59
6 428	*6 615	18 ·42	13 ·29	4	12	40 ·70	+0 ·22
6 476	*6 615	46 ·40	13 ·29	3	9	40 ·62	+0 ·30
6 460	6 583	27 ·50	59 ·08	2	8	41 ·26	−0 ·34
6 626	*6 644	42 ·71	42 ·24	3	12	40 ·76	+0 ·16
*6 644	6 717	42 ·24	07 ·50	3	12	40 ·80	+0 ·12
6 720	6 744	17 ·06	27 ·39	3	19	40 ·98	−0 ·06
6 748	6 833	58 ·80	17 ·10	3	19	40 ·32	+0 ·60
6 772	*6 865	20 ·15	23 ·86	3	12	40 ·67	+0 ·25
6 805	*6 865	48 ·38	23 ·86	3	12	41 ·10	−0 ·18
6 891	6 932	53 ·88	51 ·27	4	24	40 ·85	+0 ·07
6 910	6 970	51 ·61	01 ·18	3	19	40 ·18	+0 ·74
6 985	7 088	11 ·75	47 ·30	4	24	40 ·52	+0 ·40
7 062	7 223	18 ·98	24 ·77	3	19	40 ·68	+0 ·24
7 091	7 257	37 ·60	47 ·31	3	19	40 ·78	+0 ·14
7 125	7 182	09 ·10	26 ·39	5	29	41 ·22	−0 ·30
7 215	7 269	04 ·05	25 ·41	5	29	40 ·51	+0 ·41
7 324	7 401	35 ·18	34 ·71	2	12	41 ·21	−0 ·29
7 350	7 448	53 ·53	56 ·16	3	19	41 ·16	−0 ·24
7 476	7 527	50 ·78	29 ·07	4	24	41 ·14	−0 ·22
7 488	*7 561	47 ·00	25 ·73	3	12	40 ·63	+0 ·29
7 589	*7 561	08 ·90	25 ·73	3	12	40 ·24	+0 ·68
7 642	7 662	28 ·69	31 ·69	3	19	40 ·69	+0 ·23
7 606	7 705	22 ·40	41 ·54	2	12	41 ·79	−0 ·87
*7 689	7 754	12 ·97	12 ·49	3	12	41 ·42	−0 ·50
*7 689	7 778	12 ·97	04 ·36	3	12	41 ·42	−0 ·50
*7 766	7 795	51 ·04	22 ·52	2	8	41 ·00	−0 ·08
*7 766	7 809	51 ·04	42 ·31	1	4	41 ·72	−0 ·80
7 812	7 827	16 ·86	10 ·45	3	19	41 ·24	−0 ·32

69. *East Pascagoula*, Mississippi—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		"	"			° ′ "	"
7 845	7 912	29 ·35	51 ·70	1	6	30 20 41 ·39	—0 ·47
7 888	7 908	36 ·03	56 ·60	4	24	40 ·96	—0 ·04
7 953	7 996	23 ·16	27 ·29	4	24	41 ·67	—0 ·75
7 975	8 115	43 ·12	25 ·60	1	6	40 ·68	+0 ·24
8 036	8 149	09 ·30	43 ·83	3	19	41 ·04	—0 ·12
8 153	8 218	17 ·58	46 ·45	1	6	40 ·35	+0 ·57
8 262	8 282	42 ·75	11 ·98	2	12	40 ·59	+0 ·33
8 322	8 331	42 ·55	01 ·65	2	12	40 ·93	—0 ·01

Indiscriminate mean = 30° 20′ 40″ ·92.
Weighted mean = 30 20 40 ·92 ± 0″ ·04
$e = \pm 0'' \cdot 39$.
129 observations, 48 pairs.
[Reduction to △ = 0″ ·00.]

70. *Fort Morgan*, Alabama.—R. H. Fauntleroy. Zenith telescope No. 1. March 23 to April 30, 1847. One division of level = 0″ ·91 from observations at this station. One turn of micrometer = 45″ ·570 from latitude observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		"	"			° ′ "	"
2 650	2 673	34 ·45	58 ·17	4	24	30 13 47 ·92	—0 ·03
2 725	2 765	32 ·42	38 ·00	4	24	48 ·22	—0 ·33
2 844	2 889	22 ·03	00 ·70	4	24	47 ·91	—0 ·02
2 970	3 075	57 ·03	33 ·87	4	24	48 ·08	—0 ·19
3 105	3 140	59 ·36	03 ·52	7	42	47 ·75	+0 ·14
3 182	3 251	31 ·55	45 ·44	8	48	47 ·78	+0 ·11
3 325	3 368	42 ·30	44 ·12	10	59	47 ·96	—0 ·07
3 402	3 532	33 ·40	33 ·90	13	77	47 ·67	+0 ·22
3 592	3 682	19 ·97	44 ·80	15	91	48 ·20	—0 ·31
3 758	3 843	17 ·75	32 ·04	16	100	47 ·52	+0 ·37
3 868	3 910	42 ·68	32.31	13	77	48 ·13	—0 ·24
3 949	3 979	02 ·56	29 ·34	14	83	48 ·08	—0 ·19
4 094	4 123	33 ·95	00 ·95	11	67	47 ·66	+0 ·23
4 228	*4 303	34 ·28	52 ·92	10	59	47 ·92	—0 ·03
4 271	*4 303	12 ·79	52 ·92	10	59	48 ·10	—0 ·21
4 341	4 423	20 ·69	42 ·65	8	48	47 ·73	+0 ·16
4 596	4 637	31 ·28	38 ·80	7	42	47 ·84	+0 ·05
4 699	4 737	56 ·67	33 ·72	5	30	47 ·67	+0 ·22
4 792	4 874	20 ·54	04 ·89	3	18	47 ·91	—0 ·02

Indiscriminate mean = 30° 13′ 47″ ·90.
Weighted mean = 30 13 47 ·89 ± 0″ ·03.
$e = \pm 0'' \cdot 41$.
166 observations, 19 pairs.
[Reduction to △ = 0″ ·00.]

71. *New Orleans*, Louisiana.—J. Kincheloe. Zenith telescope No. 5. January 16 to February 10, 1858. One division of level $= 0''.845$ from observations at this station. One turn of micrometer $= 41''.516$ from circumpolar observations at this station.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		$''$	$''$			° ′ ″	$''$
707	727	28 ·20	01 ·40	6	5	29 57 25 ·17	+0 ·11
745	749	05 ·00	04 ·29	6	5	24 ·43	+0 ·85
766	772	47 ·04	06 ·90	5	5	24 ·73	+0 ·55
806	*905	39 ·33	32 ·23	6	4	24 ·61	+0. 67
885	*905	19 ·58	32 ·23	6	4	24 ·66	+0 ·62
*981	999	51 ·91	04 ·94	6	4	26 ·01	−0 ·73
*981	1 034	51 ·91	04 ·31	6	4	25 ·30	−0 ·02
1 066	1 084	12 ·74	13 ·68	6	5	24 ·90	+0 ·38
1 107	1 123	43 ·34	54 ·32	6	5	25 ·29	−0 ·01
1 221	1 269	04 ·42	09 ·78	6	5	25 ·39	−0 ·11
*1 323	1 335	41 ·66	43 ·73	6	4	26 ·35	−1 ·07
*1 323	1 343	41 ·66	44 ·52	6	4	25 ·30	−0 ·02
1 376	1 414	17 ·23	52 ·98	6	5	25 ·50	−0 ·22
1 449	1 476	09 ·60	59 ·92	6	5	25 ·70	−0 ·42
1 492	1 527	28 ·29	37 ·70	6	5	24 ·06	+1. 22
1 571	1 602	13 ·98	18 ·08	6	5	25 ·83	−0 ·55
1 631	1 651	54 ·99	03 ·30	6	5	24 ·88	+0 ·40
1 690	1 778	59 ·50	12 ·50	6	5	24 ·16	+1 ·12
1 834	*1 897	21 ·76	52 ·84	6	4	25 ·88	−0 ·60
1 862	*1 897	04 ·98	52. 84	4	3	24 ·89	+0 ·39
1 935	1 970	04 ·66	28 ·33	6	5	24 ·43	+0 ·85
*1 981	2 014	11 ·46	28 ·15	6	4	26 ·05	−0 ·77
*1 981	2 021	11 ·46	28 ·61	5	3	26 ·45	−1 ·17
2 084	*2 155	20 ·45	18 ·90	6	4	25 ·60	−0 ·32
2 090	*2 155	07 ·88	18 ·90	6	4	26 ·17	−0 ·89
2 200	2 228	10 ·10	23 ·24	6	5	24 ·72	+0 ·56
2 237	2 254	19 ·61	03 ·50	4	5	25 ·72	−0 ·44
2 301	2 340	43 ·35	34 ·80	6	5	25 ·51	−0 ·23
*2 440	2 464	30 ·55	13 ·88	6	4	25 ·66	−0 ·38
*2 440	2 485	30 ·55	16 ·34	6	4	24 ·43	+0 ·85
*2 504	2 514	15 ·25	33 ·86	6	4	25 ·23	+0 ·05
*2 504	2 551	15 ·25	55 ·30	6	4	24 ·42	+0 ·86
2 639	2 691	01 ·88	10 ·23	6	5	26 ·01	−0 ·73
2 731	2 798	11 ·66	29 ·84	6	5	26 ·14	−0 ·86
2 892	2 971	40 ·62	46 ·44	6	5	25 ·25	+0 ·03
3 000	*3 016	39 ·43	09 ·33	6	4	24 ·97	+0 ·31
3 002	*3 016	46 ·66	09 ·33	6	4	25 ·29	−0 ·01
3 035	3 075	02 ·40	06 ·70	6	5	26 ·03	−0 ·75
3 123	3 162	46 ·78	56 ·49	6	5	25 ·58	−0 ·30
3 182	3 227	16 ·62	38 ·06	6	5	24 ·87	+0 ·41

71. *New Orleans*, Louisiana—continued.

Pairs of stars.		Adopted seconds of mean N. P. D.		n'	w	Latitude.	v
		″	″			° ′ ″	″
3 242	3 286	41 ·74	46 ·78	6	5	29 57 26 ·12	−0 ·84
3 313	3 327	35 ·86	29 ·75	6	5	24 ·02	+1 ·26
3 358	3 359	29 ·64	37 ·80	4	5	25 ·35	−0 ·07
3 381	3 398	43 ·32	44 ·40	6	5	25 ·56	−0 ·28

Indiscriminate mean $= 29^\circ\ 57'\ 25''\cdot29$.
Weighted mean $= 29\ \ 57\ \ 25\ \ \cdot28 \pm 0''\cdot07$

$e = \pm 0''\cdot43$.

256 observations, 44 pairs.

[Reduction to $\triangle = 0''\cdot00$.]

3. SUMMARY OF RESULTS FOR LATITUDE.

No.	Name of station.	State.	Resulting latitude.			Probable error of result.
			°	′	″	″
1	Calais	Me.	45	11	09 ·40	±0 ·06
2	Cooper	Me.	44	59	12 ·60	0 ·05
3	Humpback	Me.	44	51	47 ·56	0 ·05
4	Bangor	Me.	44	48	12 ·87	0 ·05
5	Farmington	Me.	44	40	19 ·54	0 ·05
6	Mount Harris	Me.	44	39	54 ·66	0 ·04
7	Howard	Me.	44	37	49 ·24	0 ·05
8	Mount Desert	Me.	44	21	06 ·51	0 ·03
9	Ragged Mountain	Me.	44	12	42 ·96	0 ·04
10	Sabattus	Me.	44	08	37 ·73	0 ·09
11	Mount Pleasant	Me.	44	01	36 ·44	0 ·04
12	Cape Small	Me.	43	46	43 ·69	0 ·04
13	Mount Independence	Me.	43	45	34 ·47	0 ·06
14	Gunstock	N. H.	43	31	03 ·81	0 ·05
15	Agamenticus	Me.	43	13	24 ·96	0 ·06
16	Isles of Shoals	Me.	42	59	12 ·97	0 ·09
17	Unkonoonuc	N. H.	42	58	59 ·34	0 ·07
18	Thompson	Mass.	42	36	38 ·02	0 ·10
19	Wachusett	Mass.	42	29	16 ·13	0 ·04
20	Cambridge, Harvard College Observatory	Mass.	42	22	48 ·05	0 ·22
21	Cambridge, Cloverden Observatory	Mass.	42	22	40 ·97	0 ·08
22	Mount Tom	Mass.	42	14	27 ·62	0 ·06
23	Manomet	Mass.	41	55	35 ·35	0 ·05
24	Sandford	Conn.	41	27	40 ·47	0 ·08
25	West Hills	N. Y.	40	48	50 ·06	0 ·04
26	New York	N. Y.	40	43	48 ·39	0 ·09
27	Beacon Hill	N. J.	40	22	27 ·81	0 ·07
28	Mount Rose	N. J.	40	22	05 ·41	0 ·08
29	Yard	Pa.	39	58	29 ·39	0 ·06

*Center of dome.

3. SUMMARY OF RESULTS FOR LATITUDE—continued.

No.	Name of station.	State.	Resulting latitude.			Probable error of result.
			°	′	″	″
30	Principio	Md.	39	35	32 ·81	±0 ·04
31	Maryland Heights	Md.	39	20	32 ·10	0 ·04
32	Pooles Island	Md.	39	17	17 ·52	0 ·15
33	Sugar Loaf	Md.	39	15	49 ·71	0 ·10
34	Dover	Del.	39	09	13 ·62	0 ·06
35	Webb	Md.	39	05	25 ·21	0 ·04
36	Soper	Md.	39	05	10 ·69	0 ·09
37	Rockville	Md.	39	05	10 ·45	0 ·03
38	Taylor	Md.	38	59	46 ·08	0 ·12
39	Strasburg	Va.	38	59	31 ·49	0 ·09
40	Cape May	N. J.	38	55	44 ·74	0 ·06
41	Causten, Washington	D. C.	38	55	32 ·18	0 ·06
42	Naval Observatory (new), Washington *	D. C.	38	55	13 ·91	0 ·06
43	Hill	Md.	38	53	52 ·31	0 ·05
44	Naval Observatory (old), Washington †	D. C.	38	53	38 ·79	0 ·03
45	Seaton, Washington	D. C.	38	53	25 ·20	0 ·15
46	Coast and Geodetic Survey Office, Washington ‡	D. C.	38	53	07 ·43	0 ·02
47	Bull Run	Va.	38	52	56 ·79	0 ·07
48	Marriott	Md.	38	52	25 ·12	0 ·06
49	Cape Henlopen	Del.	38	46	40 ·00	0 ·05
50	Clark	Va.	38	18	39 ·80	0 ·06
51	Elliott Knob	Va.	38	09	57 ·51	0 ·11
52	Charlottesville	Va.	38	02	00 ·95	0 ·14
53	Long Mountain	Va.	37	17	28 ·72	0 ·09
54	Moore	N. C.	36	23	54 ·95	0 ·09
55	Young	N. C.	35	44	21 ·50	0 ·12
56	King	N. C.	35	12	13 ·31	0 ·07
57	Paris	S. C.	34	56	31 ·96	0 ·07
58	Currahee	Ga.	34	31	37 ·75	0 ·08
59	Lavender	Ga.	34	19	15 ·81	0 ·12
60	Sawnee	Ga.	34	14	04 ·20	0 ·08
61	Aurora	Ala.	34	08	47 ·45	0 ·12
62	Atlanta Middle Base	Ga.	33	54	21 ·82	0 ·05
63	Atlanta	Ga.	33	44	59 ·30	0 ·12
64	Kahatchee	Ala.	33	13	39 ·90	0 ·06
65	Montgomery	Ala.	32	22	45 ·41	0 ·04
66	Lower Peach Tree	Ala.	31	50	21 ·19	0 ·10
67	Coon	Ala.	31	14	47 ·82	0 ·05
68	Mobile	Ala.	30	41	33 ·42	0 ·06
69	East Pascagoula	Miss.	30	20	40 ·92	0 ·04
70	Fort Morgan	Ala.	30	13	47 ·89	0 ·03
71	New Orleans	La.	29	57	25 ·28	0 ·07

* Center of clock-room. † Center of small dome. ‡ Station in yard.

B. THE RESULTS FOR LONGITUDE AT THE ASTRONOMIC STATIONS OF THE OBLIQUE ARC.

1. GENERAL STATEMENT.

Connected with the arc there are fourteen well determined longitude stations available for comparison of geodetic and astronomic longitudes. The stations are marked by their appropriate sign on the general Map B (in pocket), and are irregularly distributed over the region of the arc. Within the limits of the city of Washington there are four longitude stations, all within a few kilometers of one another, and consequently under the same general influence of zenithal deflection. These four stations have been treated as one in this discussion. The following stations are common to the arc of the parallel in latitude 39° and to the oblique arc: Cape May, New Jersey; Dover, Delaware; three* of the Washington, District of Columbia, stations; Strasburg, Virginia, and Charlottesville, Virginia.

The longitudes here given depend on the standard longitude system of the United States, as presented in the Report of the U. S. Coast and Geodetic Survey for the year 1897, Appendix No. 2, "The telegraphic longitude net of the United States and its connection with that of Europe, 1866–1896."† (pp. 197–261.)

Six of the arc stations are standard stations, i. e., Calais, Maine; Cambridge, Massachusetts, Harvard Observatory; Cape May, New Jersey; Washington, District of Columbia, Naval Observatory (old); Atlanta, Georgia, and New Orleans, Louisiana. For these stations, particulars and full abstracts of the individual results are given in the Report for 1897. It suffices, therefore, to present only the dates and results at these stations, but for the remaining stations, abstracts are given to the same extent as in the Report for 1897, together with all necessary explanation. In nearly every case of a telegraphic determination of a difference of longitude the observers exchanged places after one-half of the proposed observations had been made, in order to effectively eliminate differences of personal equations. All these longitudes count from Greenwich, positive to the westward. The probable error of any one of the adjusted standard longitude determinations is $\pm 0^s\cdot05$, and none of the probable errors of the longitudes used in this discussion exceeds $\pm 0^s\cdot09$.

*A fourth, named Seaton (east of the United States Capitol), established in 1849, was not a station of sufficient importance to be included in the general longitude net.

†For an abstract of this paper see Gould's Astronomical Journal, No. 412 (September 14, 1897).

2. RESULTS FOR LONGITUDE PREVIOUSLY PUBLISHED.

Results for longitude of stations forming part of the standard longitude net of the United States or closely connected therewith.

[Taken from Coast and Geodetic Survey Report for 1897, p. 254.]

Name of station.	Point of reference.	Longitude west of Greenwich.					
		h.	*m.*	*s.*	°	′	″
Calais, Maine.	Transit.	4	29	07·857	67	16	57·86
Cambridge, Massachusetts.	Dome of Harvard College Observatory.	4	44	31·046	71	07	45·69
Cape May, New Jersey.	Transit.	4	59	43·045	74	55	45·68
Washington, District of Columbia.	Dome of old Naval Observatory.	5	08	12·153	77	03	02·30
Atlanta, Georgia.	Transit, 1896.	5	37	33·338	84	23	20·07
New Orleans, Louisiana.	Transit, 1880 and 1895, Lafayette Square.	6	00	16·763	90	04	11·44
Charleston, South Carolina.*	Citadel Square, transit.	5	19	44·076	79	56	01·14

From the same Report we have two more of the Washington stations, pp. 257–259. and 261.

Name of station.	Point of reference.	Longitude west of Greenwich.					
		h.	*m.*	*s.*	°	′	″
Washington, District of Columbia.	Clock-room, new Naval Observatory.	5	08	15·784	77	03	56·76
Washington, District of Columbia.	Coast and Geodetic Survey Office, transit.	5	08	01·709	77	00	25·64

Results for longitude of stations in the Arc of the Thirty-ninth Parallel.

Name of station.	Point of reference.	Longitude west of Greenwich.					
		h.	*m.*	*s.*	°	″	″
Dover, Delaware †	Transit, 1897	5	02	05·230	75	31	18·45
Strasburg, Virginia †	Transit, 1881	5	13	26·380	78	21	35·70
Charlottesville, Virginia †	McCormick Observatory	5	14	05·340	78	31	20·10

3. ABSTRACTS OF RESULTS FOR DIFFERENCE OF LONGITUDE AND ADJUSTMENT OF THE LONGITUDES OF THE REMAINING STATIONS ‡ CONNECTED WITH THE ARC.

DIFFERENCE OF LONGITUDE BETWEEN *BANGOR*,§ ME., AND *CALAIS*, ME.

Date.	Observers at— Bangor.	Observers at— Calais.	Difference of longitude. *m.* *s.*	Means. *m.* *s.*	*m.* *s.*
1857.					
Sept. 18	E. Goodfellow	G. W. Dean	6 00·275	6 00·275	6 00·316
23			00·330		
25			00·268		
26			00·229		
Oct. 10	G. W. Dean	E. Goodfellow	6 00·341	6 00·357	
12			00·362		
17			00·367		

	h.	*m.*	*s.*	*s.*
Bangor (transit) west of Calais (transit),		6	00·316	± 0·015.
Longitude of Calais,	4	29	07·857	± 0·05.
Longitude of Bangor (transit),	4	35	08·173.	

* This result is added because it is needed further on.

† These stations are included in the discussion of the arc of the 39th parallel and all necessary details are published in Coast and Geodetic Survey Special Publication No. 4, "The Transcontinental Triangulation," Washington, D. C., 1900.

‡ Published for the first time.

§ The longitude of this station was differentially determined from Cambridge, Massachusetts, in November and December, 1851, but the result was found to be weak and unsatisfactory, the observers not interchanging places, hence no use was made of those observations.

DIFFERENCE OF LONGITUDE BETWEEN *SEATON STATION*,* WASHINGTON, D. C., AND *NAVAL OBSERVATORY* (OLD), WASHINGTON, D. C.

Date, 1867.	From western signals.	From eastern signals.	W.-E.	Mean western and eastern signals.
	s.	s.	s.	s.
June 4	12 ·70	12 ·67	+0 ·03	12 ·68
6	·60	·60	0 ·00	·60
10	·70	·69	+0 ·01	·69
11	·63	·61	+0 ·02	·62
21	·75	·69	+0 ·06	·72
29	·68	·69	−0 ·01	·69
			Mean .	12 ·667

Observers: G. W. Dean, in charge of party, E. Goodfellow and other observers; three were engaged in the work at the Naval Observatory and two at Seaton, but no interchange of observers took place. The results were corrected for the personal equation of the observers derived from observations made for this purpose.

Naval Observatory (Meridian Circle) west of Seaton (transit)		12^s ·667 ±0^s ·013
Reduction to center of dome at Observatory		−0 ·033
Difference of longitude Naval Observatory (old) and Seaton, transit		12 ·634 ±0^s ·013
Longitude of dome, Naval Observatory (old)	5^h 08^m 12^s ·153	
Longitude of Seaton (transit)	5 07 59 ·519	
Same, as adjusted	5 07 59 ·520	

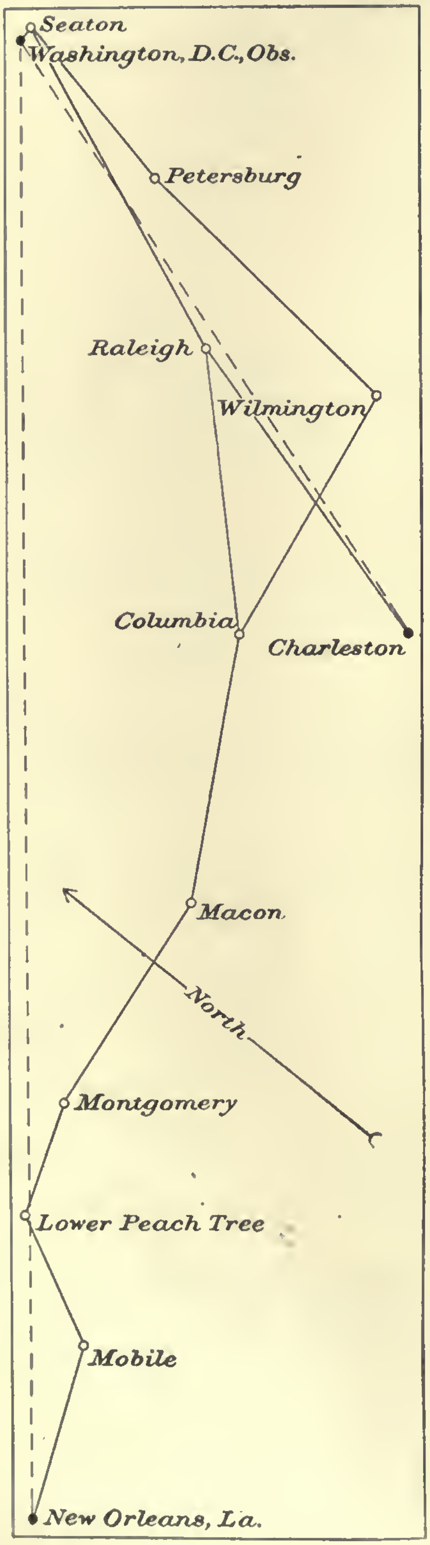
DIFFERENCE OF LONGITUDE BETWEEN *STATESVILLE*, N. C., AND *WASHINGTON*, D. C.

Date. 1878–79.	Observers at— Statesville.	Observers at— Washington.	From western or Statesville signals.	From eastern or Washington signals.	W.-E.	Mean of western and eastern signals.	Personal equation.	Difference of longitude. $\Delta\lambda$	Weights. p.	Difference. v.
			m. s.	m. s.	s.	m. s.	s.	m. s.		s.
Dec. 19	E. Smith	G. W. Dean	15 22 ·62	15 22 ·55	0 ·07	15 22 ·58	−0 ·06	15 22 ·52	7	+0 ·04
23			·53	·58	−0 ·05	·56		·50	3	+0 ·02
24			·49	·42	0 ·07	·46		·40	6	−0 ·08
25			·57	·51	0 ·06	·54		·48	6	0 ·00
				Weighted mean		15 22 ·54				
Jan. 2	G. W. Dean	E. Smith	15 22 ·48	15 22 ·42	0 ·06	15 22 ·45	+0 ·06	15 22 ·51	9	+0 ·03
3			·44	·39	0 ·05	·42		·48	16	0 ·00
10			·32	·29	0 ·03	·30		·36	3	−0 ·12
				Weighted mean		15 22 ·42		15 22 ·477 ± 0 ·016		

Statesville (transit), west of Washington (transit),	0^h 15^m 22^s ·477
Reduction to center of dome at the old Naval Observatory,	+0 ·124
Statesville (transit) west of the dome of old Naval Observatory,	0 15 22 ·601
Longitude of dome of old Naval Observatory,	5 08 12 ·153
Longitude of Statesville (transit),	5 23 34 ·754

*This station was established in 1849, to be used in place of the United States Naval Observatory, where it was found both inconvenient and unsatisfactory to make observations, as it interfered with the regular duties of the observatory staff. It was located east of the Capitol, in an open field, on Fifth street east, near A street north, now covered by buildings. Telegraphic connection with the Naval Observatory (old) was made in 1867; distance by wire, 5½ kilometers, or 3½ statute miles, nearly.

No. 38.



In order to reach the longitudes of Montgomery, Lower Peach Tree, and Mobile, Alabama, it was necessary to make a special adjustment of certain intermediary longitude stations, which bind them together and connect them with the standard net. They are Petersburg, Virginia, 1852; Raleigh, North Carolina, 1853; Charleston, South Carolina, 1853; Wilmington, North Carolina, 1854 and 1856; Columbia, South Carolina, 1854 and 1856; Macon, Georgia, 1855; Montgomery, Alabama, 1856; Lower Peach Tree, Alabama, 1857, and Mobile, Alabama, 1857 and 1858.*

DIFFERENCE OF LONGITUDE BETWEEN *PETERSBURG*, VA., AND *SEATON STATION*, D. C.

Date, 1852.	Number of stars.	Difference of longitude. m. s.
July 7	15	1 35 ·583
9	21	·636
21	13	·617
22	6 and 14	·559
Aug. 2	9	·545
7	17	·597
	Mean	1 35 ·589 ±0 ·009 s

The observers were A. D. Bache and G. W. Dean, at Petersburg, and L. F. Pourtales, at Seaton Station. The observers did not interchange places. Their personal equations were ascertained by direct observations taken at various times. The results, as given here, are corrected accordingly. Giving weights to the individual results in proportion to the number of stars observed each night, we get $\Delta\lambda = 1^m\ 35^s{\cdot}591 \pm 0^s{\cdot}0220$.

Petersburg (transit) west of Seaton (transit), $1^m\ 35^s{\cdot}591 \pm 0^s{\cdot}022$.

DIFFERENCE OF LONGITUDE BETWEEN *RALEIGH*, N. C., AND *SEATON STATION*, D. C.

Date. 1853.	Number of stars.	Difference of longitude. m. s.
Apr. 21	5	6 32 ·742
26	23	·992
28	23	·894
30	16	·987
Mean		6 32 ·904 ±0 ·039 s.
Weighted mean		6 32 ·87 ±0 ·044

The observers were B. A. Gould at Raleigh and

* Details at these stations published for the first time. See also report by Dr. B. A. Gould in Coast Survey Report for 1864, Appendix No. 12, pp. 115, 116.

L. F. Pourtales at Seaton Station. The personal equation correction was determined from direct and indirect comparisons. The results given here are corrected accordingly.*

Raleigh (transit) west of Seaton (transit) $6^m\ 32^s{\cdot}873 \pm 0^s{\cdot}044$.

DIFFERENCE OF LONGITUDE BETWEEN *CHARLESTON*, S. C., AND *RALEIGH*, N. C.

Date.	Number of stars.	Difference of longitude.
1853.		m. s.
Apr. 29	3	5 12·007
May 6	15	·061
14	13	·164
	Mean	5 12·077±0·031 s

Observers: At Charleston, L. R. Gibbes; at Raleigh, B. A. Gould. The personal equation correction being unknown, the probable error of the result is raised to $\pm 0^s{\cdot}15$.

Charleston, Gibbes Observatory (transit) west of Raleigh (transit) $5^m\ 12^s{\cdot}\ 08 \pm 0^s{\cdot}15$.

Reduction of Gibbes Observatory to Citadel Square (transit) at Charleston.† $-\ 0^s{\cdot}396$.

Charleston, Citadel Square (transit) west of Raleigh (transit) $5^m\ 11^s{\cdot}684 \pm 0^s{\cdot}150$.

DIFFERENCE OF LONGITUDE BETWEEN *WILMINGTON*, N. C., AND *PETERSBURG*, VA.

Date.	Number of stars.	Observers at— Wilmington.	Petersburg.	Difference of longitude.	Difference of longitude referred to D.‡ and P.‡ and means.		
1854.				m. s.	m. s.	m. s.	m. s.
May 8	4	G. W. Dean.	B. A. Gould.	2 11·213	2 11·244	2 11·234	2 11·340
27	13	G. W. Dean. A. D. Bache.	L. F. Pourtales.	·239	·219		
June 5	24	G. W. Dean.	L. F. Pourtales.	·239	·239		
14	5	L. F. Pourtales.	G. W. Dean.	·451		2 11·445	
17	2			·480			
20	27			·449			
23	23			·399			

Wilmington (transit) west of Petersburg (transit),§ $2^m\ 11^s{\cdot}340 \pm 0^s{\cdot}033$.

DIFFERENCE OF LONGITUDE BETWEEN *COLUMBIA*, S. C., AND *RALEIGH*, N. C.

Date.	Number of stars.	Observers at— Columbia.	Raleigh.	Difference of longitude.	Mean $\Delta\lambda$	
1854.				m. s.	m. s.	m. s.
Jan. 21	23	B. A. Gould.	G. W. Dean.	9 35·821	9 35·942	9 35·862±0s·041
Feb. 5	14			36·064		
21	23	G. W. Dean.	B. A. Gould.	9 35·787	9 35·983	
Mar. 12	10			35·779		

Columbia (transit) west of Raleigh (transit),§ $9^m\ 35^s{\cdot}862 \pm 0^s{\cdot}041$.

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* For further remarks on the methods used at this and some other stations representing the stage of the development of telegraphic longitude determinations, see Coast Survey Report for 1853, pp. 56–57. A part of the work done at Raleigh is used as an example of a method for determining differences of longitude, in Vol. 1 of Chauvenet's Spherical and Practical Astronomy, 5th edition, 1887.

† The observation for difference of longitude of Charleston, South Carolina, and Seaton Station, District of Columbia, in February, 1850, was experimental in character, and too weak for use here.

‡ D. for Dean and P. for Pourtales.

§ See remarks by Dr. Gould in Coast Survey Report for 1854, pp. 45, 50, 51, 55, 56, and *123–*133, for Raleigh and Columbia.

DIFFERENCE OF LONGITUDE BETWEEN *MACON*, GA., AND *COLUMBIA*, S. C.

Date.	Number of stars.	Observers at— Macon.	Columbia.	Difference of longitude.		Mean $\Delta\lambda$.
1855.				*m.* *s.*	*m.* *s.*	*m.* *s.* *s.*
Jan. 16	15	G. W. Dean.	E. Goodfellow.	10 22·205	10 22·368	10 22·250±0·051
18	21			·518		
Feb. 8	12			·380		
14	19	E. Goodfellow.	G. W. Dean.	10 22·029	10 22·132	
22	22			21·963		
28	20			22·059		
Mar. 9	21			22·479		

Macon (transit) west of Columbia (transit), $10^{m}\ 22^{s}{\cdot}250 \pm 0^{s}{\cdot}051$.

DIFFERENCE OF LONGITUDE BETWEEN *COLUMBIA*, S. C., AND *WILMINGTON*, N. C.

Date.	Number of stars.	Observers at— Columbia.	Wilmington.	Difference of longitude.		Mean $\Delta\lambda$.
1856.				*m.* *s.*	*m.* *s.*	*m.* *s.* *s.*
Jan. 9	12	G. W. Dean.	E. Goodfellow.	12 21·748	12 21·762	12 21·731±0·028
10	21			·744		
15	13			·878		
16	24			·680		
Feb. 10	25	E. Goodfellow.	G. W. Dean.	12 21·740	12 21·700	
17	19			·660		

Columbia (transit) west of Wilmington (transit), $12^{m}\ 21^{s}{\cdot}731 \pm 0^{s}{\cdot}028$.

DIFFERENCE OF LONGITUDE BETWEEN *MONTGOMERY*, ALA., AND *MACON*, GA.

Date.	Number of stars.	Observers at— Montgomery.	Macon.	Difference of longitude.		Mean $\Delta\lambda$.
1856.				*m.* *s.*	*m.* *s.*	*m.* *s.* *s.*
Mar. 23	11	G. W. Dean.	E. Goodfellow.	10 41·568	10 41·531	10 41·570±0·015
Apr. 3	21			·501		
7	23			·569		
8	17			·488		
12	21	E. Goodfellow.	G. W. Dean.	10 41·727	10 41·609	
18	23			·595		
21	30			·595		
24	24			·520		

Montgomery (transit) west of Macon (transit), $10^{m}\ 41^{s}{\cdot}570 \pm 0^{s}{\cdot}015$.

DIFFERENCE OF LONGITUDE BETWEEN *LOWER PEACH TREE*, ALA., AND *MONTGOMERY*, ALA.

Date.	Number of stars.	Observers at— Lower Peach Tree.	Montgomery.	Difference of longitude.		Mean $\Delta\lambda$.
1857.				*m.* *s.*	*m.* *s.*	*m.* *s.* *s.*
Apr. 2	31	G. W. Dean.	E. Goodfellow.	4 58·798	4 58·800	4 58·789±0·016
6	14			·723		
7	27			·736		
10	13			·943		
19	31	E. Goodfellow.	G. W. Dean.	4 58·790	4 58·778	
20	26			·795		
23	18			·752		
28	33			·774		

Lower Peach Tree (transit) west of Montgomery (transit), $4^{m}\ 58^{s}{\cdot}789 \pm 0^{s}{\cdot}016$.

DIFFERENCE OF LONGITUDE BETWEEN *MOBILE*, ALA., AND *LOWER PEACH TREE*, ALA.

Date.	Number of stars.	Observers at— Mobile.	Observers at— Lower Peach Tree.	Difference of longitude.		Mean Δλ.
1857.				m. s.	m. s.	m. s. s.
May 21	34	G. W. Dean.	E. Goodfellow	1 59·795	1 59·730	1 59·768 ±0·016
24	38			·730		
25	22			·637		
26	34			·757		
June 2	41	E. Goodfellow.	G. W. Dean	1 59·889	1 59·806	
6	11			·786		
7	38			·742		

Mobile (transit) west of Lower Peach Tree (transit) $1^{m}\ 59^{s}{\cdot}768 \pm 0^{s}{\cdot}016$.

DIFFERENCE OF LONGITUDE BETWEEN *NEW ORLEANS*, LA., AND *MOBILE*, ALA.

Date.	Number of stars.	Observers at— New Orleans.	Observers at— Mobile.	Difference of longitude.		Mean Δλ.
1858.				m. s.	m. s.	m. s. s.
Jan. 19	7	E. Goodfellow.	D.* and M.*	8 07·012	8 07·038	8 07·147 ±0·022
Feb. 8	12		D.	07·075		
15	18		D. and M.	06·963		
16	22		D. and M.	07·022		
17	32		M.	07·079		
19	36.		D. and M.	07·074		
Mar. 1	30	G. W. Dean.	E. Goodfellow	8 07·396	8 07·256	
26	23			·230		
Apr. 2	15			·141		

New Orleans, Basin street, west of Mobile (transit), $8^{m}\ 07^{s}{\cdot}147 \pm 0^{s}{\cdot}022$.
Reduction to station Lafayette Square . — 0 ·866.
Δλ New Orleans, Lafayette Square, and Mobile 8 06 ·281 ± 0 ·022.

Adjustment of secondary telegraphic longitude stations to the standard telegraphic longitude net of the United States.

Referring to the preceding diagram, which shows the connection of the longitude stations between Washington and New Orleans, it is seen that the three circuits demand as many conditions to be satisfied. The conditional or observation equations are established as follows†:

	Stations.	Δλ	Corrections.	$\frac{1}{p}$
		m. s.		
Δλ	New Orleans and Mobile	8 06·281	(1)	5
Δλ	Mobile and Lower Peach Tree	1 59·768	(2)	3
Δλ	Lower Peach Tree and Montgomery	4 58·789	(3)	3
Δλ	Montgomery and Macon	10 41·570	(4)	2
Δλ	Macon and Columbia	10 22·250	(5)	26
Δλ	Columbia and Raleigh	9 35·862	(6)	17
Δλ	Raleigh and Seaton	6 32·873	(7)	19
Δλ	Seaton and Washington (Old Naval Observatory)	—0 12·634	(8)	2
	Σ	52 04·759		

* D. stands for G. W. Dean and M. for A. T. Mosman.

† The numbers in column $\frac{1}{p}$ equal 10000 times the square of probable error.

True value in standard system $52^m\ 04^s{\cdot}610$, hence the first observation equation:

$$0=+0^s{\cdot}149+(1)+(2)+(3)+(4)+(5)+(6)+(7)-(8)$$

		m.	s.		
$\Delta\lambda$	Columbia and Wilmington	12	21·731	(9)	8
$\Delta\lambda$	Wilmington and Petersburg	2	11·340	(10)	11
$\Delta\lambda$	Petersburg and Seaton	1	35·591	(11)	5
	Σ	16	08·662		

		m.	s.		
$\Delta\lambda$	Raleigh and Seaton	6	32·873	(7)	19
$\Delta\lambda$	Columbia and Raleigh	9	35·862	(6)	17
	Σ	16	08·735		

hence the second equation:

$$0=+0^s{\cdot}073+(6)+(7)-(9)-(10)-(11)$$

		m.	s.		
$\Delta\lambda$	Charleston and Raleigh	5	11·684	(12)	225
$\Delta\lambda$	Raleigh and Seaton	6	32·873	(7)	19
$\Delta\lambda$	Seaton and Washington (Old Naval Observatory)	−0	12·634	(8)	2
	Σ	11	31·923		

True $\Delta\lambda$ in standard system $11^m\ 31^s{\cdot}923$, hence third equation

$$0=0^s{\cdot}000-(12)-(7)+(8)$$

Correlate equations.

Corr.	$\frac{1}{p}$	C_1	C_2	C_3
(1)	5	+1		
(2)	3	+1		
(3)	3	+1		
(4)	2	+1		
(5)	26	+1		
(6)	17	+1	+1	
(7)	19	+1	+1	−1
(8)	2	−1		+1
(9)	8		−1	
(10)	11		−1	
(11)	5		−1	
(12)	225			−1

Normal equations.

$$\left\{\begin{array}{l} 0=+0{\cdot}149\ \ +77C_1+36C_2-21C_3 \\ 0=+0{\cdot}073\ \ +36C_1+60C_2-19C_3 \\ 0=\ \ 0{\cdot}000\ \ -21C_1-19C_2+246C_3 \end{array}\right.$$

$C_1=-0{\cdot}001\ 93$
$C_2=-0{\cdot}000\ 11$
$C_3=-0{\cdot}000\ 17$

	s.		s.
(1)	−0·0096	(7)	−0·0355
(2)	−0·0058	(8)	+0·0035
(3)	−0·0058	(9)	+0·0009
(4)	−0·0039	(10)	+0·0012
(5)	−0·0502	(11)	+0·0006
(6)	−0·0347	(12)	+0·0383

Resulting longitudes.

	h.	m.	s.	°	′	″
λ Washington, Old Naval Observatory Dome	5	08	12·153	77	03	02·295
Δλ Washington and Seaton			−12·6375			
λ Seaton (transit)	5	07	59·5155	76	59	52·732
Δλ Seaton and Petersburg	+	1	35·5916			
λ Petersburg (transit)	5	09	35·1071	77	23	46·606
Δλ Petersburg and Wilmington	+	2	11·3412			
λ Wilmington (transit)	5	11	46·4483	77	56	36·724
Δλ Wilmington and Columbia	+	12	21·7319			
λ Columbia (transit)	5	24	08·1802	81	02	02·703
Check:						
Δλ Seaton and Raleigh	+	6	32·8375			
λ Raleigh (transit)	5	14	32·3530	78	38	05·295
Δλ Raleigh and Columbia	+	9	35·8273			
λ Columbia (transit)	5	24	08·1803	81	02	02·704
Further—						
Δλ Columbia and Macon	+	10	22·1998			
λ Macon (transit)	5	34	30·3801	83	37	35·701
Δλ Macon and Montgomery	+	10	41·5661			
λ Montgomery (transit)	5	45	11·9462	86	17	59·193
Δλ Montgomery and Lower Peach Tree	+	4	58·7832			
λ Lower Peach Tree (transit)	5	50	10·7294	87	32	40·941
Δλ Lower Peach Tree and Mobile	+	1	59·7622			
λ Mobile (transit)	5	52	10·4916	88	02	37·374
Δλ Mobile and New Orleans, Lafayette Square	+	8	06·2714			
λ New Orleans, Lafayette Square	6	00	16·7630	90	04	11·445

If the above results are compared with those obtained in the preliminary adjustment of the telegraphic longtitude system as it stood in 1884,* it will be seen that the present longitudes are about one-tenth of a second of time greater than those found in 1884. This is mainly due to the introduction into the system of the fourth cable line across the Atlantic Ocean in 1892.

The probable errors given in the summary of results are close approximations.

* Report of 1884, Appendix No. 11, pp. 407–430; and Report for 1897, Appendix No. 2, pp. 197–261.

4. SUMMARY OF RESULTS FOR LONGITUDE.

No.	Station.	State.	Referred to.	Longitude °	′	″	Probable error. ″
1	Calais	Me.	Transit	67	16	57 ·86	±0 ·75
2	Bangor, Thomas Hill	Me.	Transit	68	47	02 ·60	0 ·78
3	Cambridge, Harvard Observatory	Mass.	Dome	71	07	45 ·69	0 ·75
4	Cape May	N. J.	Transit	74	55	45 ·68	0 ·75
5	Dover	Del.	Transit	75	31	18 ·45	0 ·79
6	Washington, Seaton Station	D. C.	Transit	76	59	52 ·73	0 ·78
7	Washington, Coast and Geodetic Survey Office	D. C.	Transit	77	00	25 ·64	0 ·78
8	Washington, Naval Observatory (old)	D. C.	Dome	77	03	02 ·30	0 ·75
9	Washington, Naval Observatory (new)	D. C.	Clock-Room	77	03	56 ·76	0 ·78
	Petersburg, Roslyn Station	Va.	Transit	77	23	46 ·61	0 ·84
	Wilmington, De Rosset Station	N. C.	Transit	77	56	36 ·72	1 ·0
10	Strasburg	Va.	Transit	78	21	35 ·70	0 ·80
11	Charlottesville	Va.	Observatory	78	31	20 ·10	0 ·80
	Raleigh, State House Grounds	N. C.	Transit	78	38	05 ·30	1 ·0
	Charleston, Citadel Square	S. C.	Transit	79	56	01 ·14	0 ·78
12	Statesville, near Simenton College	N. C.	Transit	80	53	41 ·31	0 ·80
	Columbia, Capitol Square	S. C.	Transit	81	02	02 ·70	1 ·2
	Macon, Academy Square	Ga.	Transit	83	37	35 ·70	1 ·3
13	Atlanta	Ga.	Transit	84	23	20 ·07	0 ·80
14	Montgomery, Capitol Hill	Ala.	Transit	86	17	59 ·19	1 ·1
15	Lower Peach Tree, Wilson County	Ala.	Transit	87	32	40 ·94	1 ·1
16	Mobile, Public Square	Ala.	Transit	88	02	37 ·37	1 ·0
17	New Orleans, 1895, Lafayette Square	La.	Transit	90	04	11 ·44	0 ·80

C. RESULTS FOR AZIMUTH AT THE ASTRONOMIC STATIONS OF THE OBLIQUE ARC.

The stations where an azimuth was determined astronomically are quite numerous and are distributed over the whole extent of the arc. There are 56 azimuth stations, 14 of which are *in common* with the arc of the parallel in latitude 39°. All necessary details in regard to the observations at these stations are given in the published discussion of that arc. Some of the particulars are republished in this discussion in the proper place.

The various methods employed by the Coast and Geodetic Survey for the determination of azimuths, together with the required formulæ and their numerical application, are so fully set forth in Appendix No. 14, Coast and Geodetic Survey Report for 1880, pp. 261–286, and in a later edition, Appendix No. 7, Coast and Geodetic Survey Report for 1897–98, pp. 377–407, that no further reference is required. It will suffice for a full exhibit of the azimuthal results to present for each station the following particulars—the method employed, instrument used, stars observed, the arrangement and composition of sets of observations, the number of measures and position of circle or instrument, and any other details pertaining to the operation; the names of the observers, and, finally, the individual results in the form of an abstract, together with their probable errors.

The apparent places of stars are taken directly from the American Ephemeris or derived from Gould's "Standard Places of Fundamental Stars," Washington, 1866 (second edition), except in a very few cases.

The probable error of the result of a single set and that for the resulting azimuth of the mark are due to observing errors and exclude the probable error in the star's catalogue place. When referring the azimuth of the mark to the triangulation, the probable error of the referring angle is not given, as in general it is not accurately determinable. The local adjustment of the horizontal directions at a station include that of the mark, and the angle between the mark and the direction of a line in the triangulation was corrected by applying to it the *mean* shift or average correction to all the directions at the station in the second or figure adjustment. The probable error of any resulting azimuth of a line in the triangulation may be estimated as not less than one-half of a second. One-third of a second has been taken for the probable error of an observed direction, resulting from the figure adjustment, whence $\pm 0''.47$ for the angle "mark and line." Combining this with $\pm 0''.25$ as the probable error of the measure of the azimuth of the mark, we get $\pm 0''.53$ for an approximation of the probable error of a resulting azimuth of a line. For ordinary or less precise work this value may rise to three-fourths of a second.

1. COOPER, MAINE.

$\varphi = 44° \ 59'.2.$ $\qquad \lambda = 67° \ 28'.1$ west of Greenwich.

The 75^{cm} direction theodolite No. 1 (Troughton & Simms) was mounted over the triangulation station. Focal length of telescope, 115 centimeters; clear aperture, 7·5 centimeters. The azimuth mark was located upon a hill to the north of the station and distant about 2 miles. Light was shown through an aperture three-fourths of an inch in diameter; for day observations a wand 1 foot in length and 1 inch in breadth was placed above the center of the aperture. A set of observations on Polaris generally consisted of 3 observations of the mark, telescope direct, and 3 observations telescope reversed, followed by 5 observations of the star, with the necessary time and level record; the instrument was then reversed and the observations were repeated in the reverse order. In case of λ Ursæ Minoris 6 observations were made upon the star both before and after reversal. One division of level = 1″·43. Observers, G. W. Dean and R. E. Halter. Probable error of a single result for azimuth ± 0″·89.

Summary of results for azimuth at Cooper, Maine.

Polaris near eastern elongation.				λ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1859.		° ′ ″	″	1859.		° ′ ″	″
Sept. 9	IV	2 49 47·53	+0·85	Sept. 9	IV	2 49 47·49	+1·50
12	V	48·06	+0·32	12	V	47·94	+1·05
14	I	50·07	−1·69	14	I	49·09	−0·10
15	II	46·58	+1·80	15	II	50·69	−1·70
16	III	47·80	+0·58	16	III	47·93	+1·06
18	III	49·08	−0·70	18	IV	50·82	−1·83
19	V	49·56	−1·18				
	Mean	2 49 48·38±0·31			Mean	2 49 48·99±0·40	

	° ′ ″
Mean of groups	2 49 48·68
Diurnal aberration	−0·31
Azimuth of Mark	177 10 11·63 ±0″·25
Angle between Mark and Howard	185 16 59·58
Azimuth of Howard	351 53 12·05

2. HOWARD, MAINE.

$\varphi = 44°37'.8$ $\qquad \lambda = 67°23'.8$

Theodolite No. 1 was mounted over the station. The mark was located upon a hill about 1½ miles north of the station. Light was shown through an aperture three-fourths of an inch in diameter; a wand 1 foot high and 1 inch wide was placed above the aperture to serve as day mark. In the case of Polaris a set of observations consisted of 3 pointings on the mark with telescope direct, 3 pointings on the mark with telescope reversed, followed by 5 pointings on the star, or 6 in case of δ Ursæ Minoris, with the necessary level and time records; the instrument was then reversed and the above observations were repeated in the reverse order. One division of level = 1″·43. Observers, G. W. Dean and R. E. Halter. Probable error of a single result for azimuth ± 0″·80.

Summary of results for azimuth at Howard, Maine.

δ Ursæ Minoris near upper culmination.				α Ursæ Minoris near eastern elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1859.		° ′ ″	″	1859.		° ′ ″	″
July 18	I	7 46 04·72	−0·33	July 18	I	7 46 03·35	+0·41
21	II	[08·34*]	——	20	II	05·49	−1·73
23	III	05·05	−0·66	21	II	05·63	−1·87
24	IV	04·72	−0·33	23	III	04·50	−0·74
25	V	02·33	+2·06	24	IV	03·17	+0·59
29	II	05·13	−0·74	25	V	03·46	+0·30
				28	V	03·43	+0·33
				29	I	01·72	+2·04
				Aug. 6	IV	02·84	+0·92
				8	III	04·00	−0·24
Mean		7 46 04·39 ±0·35		Mean		7 46 03·76 ±0·25	
Diurnal aberration		+0·33		Diurnal aberration		+0·31	

	° ′ ″
Mean of groups	7 46 04·40
Azimuth of Mark	187 46 04·40±0″·27
Angle between Mark and Pigeon	123 51 19·29
Azimuth of Pigeon	63 54 45·11

3. HUMPBACK, MAINE.

$\varphi = 44° \; 51'\cdot 8 \qquad \lambda = 68° \; 06'\cdot 6.$

Theodolite No. 1 was mounted over the trigonometric station. The mark was located in an open field estimated to be about 2 miles from the station, light was shown through an aperture three-fourths of an inch in diameter, and for day observations a wand 1 foot high and 1 inch wide was placed vertically above it. A set of observations consisted of 3 pointings on the mark, telescope direct, and 3 pointings telescope reversed, 5 pointings on the star for α Ursæ Minoris and 6 for δ Ursæ Minoris. The instrument was then reversed and the observations were repeated in the reverse order; the necessary time and level records were made for both positions of the instrument. One division of level = 1″·43. Observer, G. W. Dean. Probable error of a single result for azimuth ± 0″·86.

Summary of results for azimuth at Humpback, Maine.

δ Ursæ Minoris near upper culmination.				α Ursæ Minoris near eastern elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1858.		° ′ ″	″	1858.		° ′ ″	″
Aug. 9	III	114 20 12·86	−0·07	Aug. 9	III	114 20 13·11	−1·01
13	IV	12·39	+0·40	12	III	11·37	+0·73
14	V	12·51	+0·28	13	IV	11·00	+1·10
16	I	11·52	+1·27	14	V	10·71	+1·39
17	II	14·68	−1·89	16	I	11·63	+0·47
				17	II	13·65	−1·55
				19	II	14·17	−2·07
				20	IV	10·84	+1·26
				23	V	11·13	+0·97
				25	I	13·34	−1·24
Mean		114 20 12·79 ±0·35		Mean		114 20 12·10 ±0·28	
Diurnal aberration		+0·33		Diurnal aberration		+0·31	

	° ′ ″
Mean of groups	114 20 12·76
Azimuth of Mark	294 20 12·76±0″·22
Angle between Mark and Cooper	39 37 40·40
Azimuth of Cooper	254 42 32·36

* Rejected by Peirce's criterion.

4. MOUNT DESERT, MAINE.

$\varphi=44° 21'·1.$ $\lambda=68° 13'·6.$

Theodolite No. 1 was mounted over the triangulation station. The mark was established near Hulls Cove, and is distant from the station about 4 miles. Light was shown through an aperture one inch in diameter, and above this a wand was adjusted vertically for day observations. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings telescope reversed, 5 pointings on α Ursæ Minoris or 6 on λ Ursæ Minoris. The instrument was then reversed and the observations were repeated in reverse order; time and level records were made for both positions. One division of level 1″·53. Observers, A. D. Bache and G. W. Dean. Probable error of a single result for azimuth ± 0″·80.

Summary of results for azimuth at Mount Desert, Maine.

α Ursæ Minoris, near eastern elongation.				λ Ursæ Minoris, near upper culmination.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1856.		° ′ ″	″	1856.		° ′ ″	″
Aug. 30	II	12 19 08·89	+0·66	Sept. 1	II	12 19 11·08	−1·04
Sept. 1	II	09·20	+0·35	2	III	07·65	+2·39
2	III	09·24	+0·31	3	IV	10·88	−0·84
3	III	07·63	+1·92	4	V	10·61	−0·57
4	IV	09·89	−0·34	7	I	08·78	+1·26
5	V	11·09	−1·54	18	III	11·26	−1·22
7	I	08·77	+0·78				
9	I	10·86	−1·31				
16	IV	09·79	−0·24				
17	V	10·10	−0·55				
	Mean	12 19 09·55±0·22			Mean	12 19 10·04±0·41	

	°	′	″
Mean of groups	12	19	09·79
Diurnal aberration			− 0·31
Azimuth of Mark	167	40	50·52±0″·20
Angle between Mark and Ragged Mountain	89	10	03·95
Azimuth of Ragged Mountain	78	30	46·57

5. MOUNT HARRIS, MAINE.

$\varphi = 44° 39'·9.$ $\lambda = 69° 08'·9.$

Theodolite No. 1 was mounted over the triangulation station. The mark was located upon the south side of the old stage road from Dixmont to Hampden, about 2½ miles from Dixmont village; light was shown through an aperture 1 inch in diameter, and for day observations a wand 1 foot high and 1 inch wide was placed over it; the lower half of this wand was covered with black cotton cloth and the upper half with white cotton cloth. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings telescope reversed, 5 pointings on the star if α Ursæ Minoris or 6 if λ Ursæ Minoris. The instrument was then reversed and the observations were repeated in the reverse order; time and level records were made for both positions. One division of level = 1″·54. Observers, A. D. Bache and G. W. Dean. Probable error of a single result for azimuth ± 0″·98.

Summary of results for azimuth at Mount Harris, Maine.

α Ursæ Minoris near eastern elongation.				λ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1855.		° ′ ″	″	1855.		° ′ ″	″
Aug. 29	V	62 37 29·32	+1·03	Aug. 30	V	62 37 30·58	+1·08
30	V	29·19	+1·16	Sept. 4	IV	32·85	−1·19
Sept. 3	IV	30·25	+0·10	5	III	30·68	+0·98
4	IV	30·97	−0·62	6	II	32·93	−1·27
5	III	[26·22]*	——	8	I	31·28	+0·38
6	III	29·68	+0·67				
8	II	29·68	+0·67				
10	I	30·90	−0·55				
11	I	33·47	−3·12				
12	II	31·48	−1·13				
14	III	28·62	+1·73				
	Mean	62 37 30·35±0·30			Mean	62 37 31·66±0·35	

	° ′ ″
Mean by groups	62 37 31·00
Diurnal aberration	+0·31
Azimuth of Mark	242 37 31·31±0″·25
Angle between mark and Humpback	11 57 39·31
Azimuth of Humpback	254 35 10·62

6. RAGGED MOUNTAIN, MAINE.

$\varphi = 44° \; 12'{\cdot}7. \qquad \lambda = 69° \; 09'{\cdot}1.$

Theodolite No. 1 was mounted over the triangulation station. The mark was located about 2½ miles from the station and was arranged in the usual manner. A set of observations generally consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on the star, with time and level record. The instrument was then reversed and the observations repeated in reverse order. One division of level = 1″·54. Observers, A. D. Bache and G. W. Dean. Probable error of a single result for azimuth ± 0″·66.

Summary of results for azimuth at Ragged Mountain, Maine.

α Ursæ Minoris near eastern elongation.				λ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1854.		° ′ ″	″	1854.		° ′ ″	″
Aug. 25	I	0 53 54·66	+0·23	Aug. 25	I	0 53 56·00	−1·12
29	II	54·22	+0·67	Sept. 15	IV	54·68	+0·20
30	II	53·34	+1·55	16	V	53·96	+0·92
Sept. 4	II	56·39	−1·50				
11	III	55·55	−0·66				
13	III	55·82	−0·93				
15	IV	54·00	+0·89				
16	V	55·16	−0·27				
	Mean	0 53 54·89±0·24			Mean	0 53 54·88±0·40	

	° ′ ″
Mean by groups	0 53 54·89
Diurnal aberration	+0·31
Azimuth of Mark	180 53 55·20 ±0″·20
Angle between Mark and Mount Pleasant	99 05 10·20
Azimuth of Mount Pleasant	81 48 45·00

* Rejected by Peirce's criterion.

7. CAPE SMALL, MAINE.

$\varphi = 43° 46'.7$. $\lambda = 69° 50'.8$.

Theodolite No. 1 was mounted over the triangulation station. The mark was about 1½ miles from the station, no other particulars given in the record. A set of observations consisted generally of 3 pointings on the mark, telescope direct, 3 pointings on the mark, telescope reversed, 5 observations of the star with time and level record. The instrument was then reversed and the observations were repeated in reverse order. One division of level = 0''.97. Observers, A. D. Bache, W. P. Trowbridge, and C. O. Boutelle. Probable error of a single result for azimuth ± 0''.96.

Summary of results for azimuth at Cape Small, Maine.

α Ursæ Minoris near upper culmination.				α Ursæ Minoris near elongations.				
Date.	Position.	Mark E. of N.	Δ	Date.	Elongation.	Position.	Mark E. of N.	Δ
1851.		° ' ''	''	1851.			° ' ''	''
Oct. 14	I	8 40 15.66	−0.44	Oct. 16	E	I	8 40 12.50	+1.94
15	I	17.03	−1.81	17	E	II	13.36	+1.08
16	II	13.44	+1.78	17	W	III	14.01	+0.43
17	III	15.35	−0.13	18	E	IV	16.18	−1.74
20	V	14.66	+0.56	20	E	V	16.17	−1.73
23	IV	15.17	+0.05					
	Mean	8 40 15.22±0''.30				Mean	8 40 14.44±0''.50	

	° ' ''
Mean of groups	8 40 14.83
Diurnal aberration	+0.31
Azimuth of Mark	188 40 15.14±0''.29
Angle between Mark and Sabattus	33 21 11.63
Azimuth of Sabattus	155 19 03.51

8. SABBATTUS, MAINE.

$\varphi = 44° 08'.6$. $\lambda = 70° 04'.7$.

Theodolite No. 1 was mounted over the triangulation station. The mark was placed on the gable of a barn about 3 miles distant from the station, and it showed under an angle of depression of 1½°.

A set of observations consisted generally of 3 pointings on the mark with telescope direct, 3 pointings on same, telescope reversed; 5 pointings on the star, if near culmination, but 3 pointings only when near elongation, with time and level records. The instrument was then reversed and the observations repeated in reverse order. Value of 1 division of level 0''.97. Observers, A. D. Bache and G. W. Dean. Probable error of a single result for azimuth ± 1''.00.

Summary of results for azimuth at Sabattus, Maine.

α Ursæ Minoris near lower culmination.				α Ursæ Minoris near upper culmination.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1853.		° ' ''	''	1853		° ' ''	''
July 13	V	0 06 24.89	+0.39	July 13	V	0 06 25.83	−1.02
14	I	26.07	−0.79	14	I	23.79	+1.02
15	II	22.75	+2.53				
22	III	27.40	−2.12				
Mean		0 06 25.28		Mean		0 06 24.81	
Diurnal aberration		+0.31		Diurnal aberration		+0.31	

Summary of results for azimuth at Sabattus, Maine—continued.

α Ursæ Minoris near eastern elongation.				1007 T. Y. C. near western elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1853.		° ′ ″	″	1853.		° ′ ″	″
July 22	IV	0 06 25 ·00	−1 ·30	July 24	IV	0 06 23 ·61	−0 ·08
24	IV	23 ·18	+0 ·52	25	III	23 ·44	+0 ·09
25	III	24 ·15	−0 ·45				
30	II	22 ·46	+1 ·24				
Mean		0 06 23 ·70		Mean		0 06 23 ·53	
Diurnal aberration		+0 ·31		Diurnal aberration		+0 ·31	

	° ′ ″ ″
Mean by culminations	0 06 25 ·35±0 ·46
Mean by elongations	23 ·93±0 ·24
Mean of groups	0 06 24 ·64
Azimuth of Mark	180 06 24 ·64±0 ·29
Angle between Mark and Mount Independence	204 24 58 ·87
Azimuth of Mount Independence	24 31 23 ·51

9. MOUNT INDEPENDENCE, MAINE.

$\varphi=43° \; 45'.6.$ $\lambda=70° \; 19'.3.$

Theodolite No. 1 was mounted over the triangulation station. The mark was located nearly north of the station and distant about 3 miles. A set of observations generally consisted of 2 or 3 pointings on the mark with telescope direct, 2 or 3 pointings on same, telescope reversed, 5 observations on the star with time and level record; the instrument was then reversed and the observations repeated in reverse order. One division of level $=0''.97$. Observer: A. D. Bache. Probable error of a single result for azimuth$\pm0''.65$.

Summary of results for azimuth at Mount Independence, Maine.

α Ursæ Minoris near eastern elongation.				α Ursæ Minoris and δ Ursæ Minoris near western elongation.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W of N.	Δ
1849.		° ′ ″	″	1849.		° ′ ″	″
Sept. 19	V	0 10 49 ·48	−0 ·05	Oct. 9	VI	0 10 49 ·69	−0 ·21
20	VI	49 ·14	+0 ·29	11	I	48 ·60	+0 ·88
21	VII	49 ·32	+0 ·11	12	II	50 ·85	−1 ·37
Oct. 12	I	50 ·10	−0 ·67	13	VII	50 ·20	−0 ·72
13	II	47 ·27	+2 ·16	14	III	49 ·93	−0 ·45
14	III	50 ·46	−1 ·03	14	IV	48 ·82	+0 ·66
18	IV	50 ·21	−0 ·78	15	V	48 ·26	+1 ·22
	Mean	0 10 49 ·43±0″ ·27			Mean	0 10 49 ·48±0″ ·24	

	° ′ ″
Mean of groups	0 10 49 ·45
Diurnal aberration	−0 ·31 ″
Azimuth of Mark	179 49 10 ·86±0 ·17
Angle between Mark and Agamenticus	207 06 37 ·74
Azimuth of Agamenticus	26 55 48 ·60

10. MOUNT PLEASANT, MAINE.

$\varphi=44^\circ\ 01'\cdot6.$ $\lambda=70^\circ\ 49'\cdot4.$

Theodolite No. 1 was mounted over the triangulation station. The mark was placed nearly in line with Mount Blue, on the summit of the next ridge and about 1 mile distant from the station. The angle between the mark and Mount Blue was measured micrometrically with the eye-piece micrometer of the theodolite. The angle of depression of the wand placed over the mark was 2½°. A set of observations consisted of 3 pointings on the mark with telescope direct, 3 pointings on same, telescope reversed, 5 observations of the star with time and level record; the instrument was then reversed and similar observations were made with their order reversed. One division of level = 0″·97. Observers: A. D. Bache, C. O. Boutelle, and W. P. Trowbridge, U. S. E. Probable error of a single result for azimuth ± 0″·90.

Summary of results for azimuth at Mount Pleasant, Maine.

α Ursæ Minoris near lower culmination.				α Ursæ Minoris near upper culmination.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1851.		° ′ ″	″	1851.		° ′ ″	″
July 22	IV	25 59 18·30	+0·76	July 31	V	25 59 17·63	+1·66
Aug. 3	I	19·17	−0·11	Aug. 2	V	20·64	−1·35
8	II	17·77	+1·29	5	III	19·61	−0·32
14	II	21·00	−1·94				
	Mean	25 59 19·06±0″·48			Mean	25 59 19·29±0″·60	

	° ′ ″
Mean of groups	25 59 19·16.
Diurnal abberration	+0·31.
Azimuth of Mark	205 59 19·47±0″·34.
Angle between Mark and Mount Blue	02·09.
Azimuth of Mount Blue	205 59 21·56.

11. AGAMENTICUS, MAINE.

$\varphi=43^\circ\ 13'\cdot4.$ $\lambda=70^\circ\ 41'\cdot6.$

Theodolite No. 1 was mounted over the triangulation station. The mark was situated on a hill about 2 miles distant. A set of observations consisted of 3 pointings on the mark, telescope direct; 3 pointings on same, telescope reversed; 5 pointings on star with time and level records; the instrument was then reversed and similar observations were made in the reverse order. One division of level = 0″·97 *. Observer: A. D. Bache. Probable error of a single result for azimuth ±1″·02.

* The instrument was generally kept leveled.

Summary of results for azimuth at Agamenticus, Maine.

α Ursæ Minoris near eastern elongation.				α Ursæ Minoris near western elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1847.		° ′ ″	″	1847.		° ′ ″	″
Sept. 17	IV	114 08 59·57	−1·16	Sept. 21	IV	114 08 60·64	−1·75
22	V	60·57	−2·16	22	V	58·12	+0·77
Oct. 4	I	57·92	+0·49	Oct. 5	I	59·83	−0·94
14	II	58·31	+0·10	15	II	58·18	+0·71
16	III	55·68	+2·73	17	III	57·68	+1·21
	Mean	114 08 58·41±0″·56			Mean	114 08 58·89±0″·38	

	°	′	″
Mean of groups	114	08	58·65
Diurnal aberration			+0·31 ″
Azimuth of Mark	294	08	58·96±0·32
Angle between Mark and Thompson	291	32	03·45
Azimuth of Thompson	2	36	55·51

12. GUNSTOCK, NEW HAMPSHIRE.

$\varphi = 43° 31' \cdot 0$. $\lambda = 71° 22' \cdot 2$.

Theodolite No. 1 was mounted over the triangulation station. The mark was located upon the highest point of rock on the summit of Mount Belknap, about three-fourths of a mile from the station; light was shown through a three-fourths inch aperture, above which was placed vertically a wand 1 foot high and 1 inch wide for day observations. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on the star if Polaris, or 6 if δ or 24 Ursæ Minoris, with time and level record. The instrument was then reversed and the observations repeated in the reverse order. Value of 1 division of level = 1″·00. Observers, G. W. Dean and R. E. Halter. Probable error of a single result for azimuth ±0″·82.

Summary of results for azimuth at Gunstock, New Hampshire.

α Ursæ Minoris near eastern elongation.				δ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1860.		° ′ ″	″	1860.		° ′ ″	″
July 24	II	40 29 49·54	+0·36	July 24*	II	40 29 51·40	−1·53
25	III	50·66	−0·76	25*	III	52·90	−3·03
27	III	48·23	+1·67	27	III	49·01	+0·86
28	IV	49·06	+0·84	28	IV	48·63	+1·24
30	I	49·68	+0·22	30	I	48·80	+1·07
31	II	50·50	−0·60	31	II	50·03	−0·16
Aug. 1	V	49·94	−0·04	Aug. 1	V	48·12	+1·75
2	IV	51·38	−1·48	2	V	49·48	+0·39
3	I	50·10	−0·20	3	I	50·48	−0·61
Mean		40 29 49·90±0″·21		Mean		40 29 49·87±0″·34	
Diurnal aberration		−0·31		Diurnal aberration		−0·33	

	°	′	″
Mean of groups	40	29	49·57 ″
Azimuth of Mark	139	30	10·43±0·18
Angle between Mark and Mount Pleasant	78	13	23·17
Azimuth of Mount Pleasant	217	43	33·60

*The results for July 24 and 25 are from observations of 24 Ursæ Minoris and of δ Ursæ Minoris.

13. UNKONOONUC, NEW HAMPSHIRE.

$\varphi=42^\circ\ 59'\cdot 0.$ $\lambda=71^\circ\ 35'\cdot 3.$

Theodolite No. 1 was mounted over the triangulation station. For an azimuth mark a lamp with reflector was set up at Holt station about 34 miles distant from Unkonoonuc. A set of observations generally consisted of 2 pointings on the mark, telescope direct, 2 pointings on same, telescope reversed, 5 pointings on the star, with time and level record. The instrument was then reversed and the operations repeated in the reverse order. One division of level = 0″·96. Observer, A. D. Bache. Probable error of a single result for azimuth ±1″·64.

Summary of results for azimuth at Unkonoonuc, New Hampshire.

α Ursæ Minoris near eastern elongation.

Date.	Position.	Mark E. of N.	Δ
1848.		° ′ ″	″
Sept. 28	V	133 48 14·44	−3·27
Oct. 5	IV	07·83	+3·34
5	III	10·21	+0·96
6	I	13·50	−2·33
6	II	09·85	+1·32
Mean		133 48 11·17±0″·82	

α, β, and ζ Ursæ Minoris near western elongation.

Date.	Position.	*	Mark E. of N.	Δ
1848.			° ′ ″	″
Oct. 5	IV	β	133 48 11·84	+0·63
5	III	ζ	08·09	+4·38
5	III	α	12·76	−0·29
5	IV	α	13·01	−0·54
5	V	α	12·41	+0·06
6	II	β	13·63	−1·16
6	II	α	16·17	−3·70
6	I	α	11·87	+0·60
Mean			133 48 12·47±0″·53	

	°	′	″
Mean of groups	133	48	11·82
Diurnal aberration			+0·31
Azimuth of Mark	313	48	12·13±0·45
Angle between Mark and Gunstock	117	12	51·75
Azimuth of Gunstock	196	35	20·38

14. THOMPSON, MASSACHUSETTS.

$\delta=42^\circ\ 36'\cdot 6.$ $\lambda=70^\circ\ 43'\cdot 8.$

Theodolite No. 1 was mounted over the triangulation station. The mark was situated in a northerly direction on a high rocky bluff, distant from the station about one-third of a mile. Over the small opening in the box was placed a wand, a half inch wide, for day observations.* A set of observations generally consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on the star, with time and level† records. The instrument was then reversed and the operations were repeated in the reverse order. Chief of party, A. D. Bache. Probable error of a single result for azimuth ±0″·84.

* Two azimuth marks were put up; the results were referred to the western one as being better determined than the other; the angle between the marks was 4° 05′ 08″·99±0″·34.

† The instrument was generally kept leveled.

Summary of results for azimuth at Thompson, Massachusetts.

α Ursæ Minoris near eastern elongation.				α Ursæ Minoris near western elongation.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1846.		° ′ ″	″	1846.		° ′ ″	″
Oct. 26	I	2 02 39·76	−0·44	Nov. 5	I	2 02 41·73	−0·84
Nov. 8	II	38·06	+1·26	7	II	39·96	+0·93
Dec. 1	III	40·13	−0·81	24	III	40·98	−0·09
	Mean	2 02 39·32±0″·43			Mean	2 02 40·89±0″·35	

	° ′ ″
Mean of groups	2 02 40·10
Diurnal aberration	−0·31 ″
Azimuth of Mark	177 57 20·21±0·34
Angle between Mark and Manomet	186 35 38·35
Azimuth of Manomet	351 21 41·86

15. WACHUSETT, MASSACHUSETTS.

$\varphi=42^\circ\ 29'\cdot3.$ $\lambda=71^\circ\ 53'\cdot2.$

Theodolite No. 1 was mounted over the triangulation station. The mark was located upon the highest point of Little Wachusett Mountain, about 1¾ miles distant; light was shown through a ¾-inch aperture, and day observations were made on a wand 1 foot high and 1 inch wide, mounted over the aperture. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on α Ursæ Minoris (or 6 on λ Ursæ Minoris) with time and level records. The instrument was then reversed and similar observations were made in the reverse order. Value of one division of level 1″·00. Observers, G. W. Dean and R. E. Halter. Probable error of a single result for azimuth ±0″·42.

Summary of results for azimuth at Wachusett, Massachusetts.

α Ursæ Minoris near eastern elongation.				λ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1860.		° ′ ″	″	1860.		° ′ ″	″
Sept. 26	I	174 15 12·63	−0·34	Sept. 26	I	174 15 12·08	+0·04
28	V	11·95	+0·34	28	V	12·82	−0·70
29	IV	12·71	−0·42	29	IV	12·78	−0·66
30	III	12·67	−0·38	30	III	11·52	+0·60
Oct. 3	II	13·24	−0·95	Oct. 3	II	12·11	+0·01
6	IV	12·13	+0·16	6	V	11·40	+0·72
7	I	12·62	−0·33				
8	II	11·42	+0·87				
9	III	11·27	+1·02				
	Mean	174 15 12·29±0″·15			Mean	174 15 12·12±0″·17	

	° ′ ″
Mean of groups	174 15 12·21
Diurnal aberration	−0·31
Azimuth of Mark	5 44 48·10±0″·11
Angle between Mark and Bald Hill	18 32 53·35
Azimuth of Bald Hill	24 17 41·45

16. HARVARD OBSERVATORY, MASSACHUSETTS.

$\varphi=42^\circ\ 22'\cdot8$. $\lambda=71^\circ\ 07'\cdot7$.

Troughton and Simms transit, Coast Survey No. 5, was mounted on the west transit pier of Harvard Observatory. The mark was a bull's-eye lantern, showing through a hole of ¼ inch diameter in a box placed on a trestle 21 feet high and strongly braced. The mark was found to be about 7″·5 west of north, and was on the same level as the old north mark for the east transit. The aperture appeared at an altitude of 0° 6′ as seen from the west transit. A board 2 by 2 feet, painted in alternate stripes of black and white, 4 inches wide, served for day mark. Micrometric differences were measured between the verticals of the mark and star as it passed the meridian, and times were recorded on chronograph; a set of observations generally consisted of 10 pointings on the mark, clamp west, 10 pointings, clamp east, and of 9 transits of the star. Levels were recorded. One division of level =0″·96; the value of one turn (100 divisions) of the eyepiece micrometer was found to be =44″·81 from the transits themselves. Observer, A. T. Mosman. Probable error of a single result for azimuth ±0″·40.

Summary of results for azimuth at Harvard Observatory, Massachusetts.

Date.	δ Ursæ Minoris at lower culmination.	51 Cephei at upper culmination.	λ Ursæ Minoris at lower culmination.
	Mark West of North.		
1869.	″	″	″
Jan. 28	...	8·84	....
Feb. 1	7·60	7·85	....
4	4·63*	6·89	....
5	7·80	8·28	....
7	7.22	7·49	7.47
13	7·57	7·29	....
17	7·13	9·01	8·07
19	8·47	8·80	7·61
25	7·83	9·11	8·02
27	....	7·92	8·68
28	5·65	8·18	7·00
Mar. 1	6·30	7·16	8·20
9	7·84	7·49	7·30
11	8·61	7·94	....
12	7·92	....	....
Means	7·50±0″·16	8·02±0″·13	7·79±0″·13

	°	′	″
Mean of δ and λ Ursæ Minoris at upper transit			7·65
Mean of 51 Cephei at lower transit			8·02
Mean			7·84
Diurnal aberration			−0·31
Azimuth of Mark	179	59	52·47±0″·13
Angle between Mark and Blue Hill	176	23	05·48
Azimuth of Blue Hill	356	22	57·95
Difference of azimuths, transit and dome		+2	28·42
Azimuth center of dome to Blue Hill	356	25	26·4

*Rejected.

17. BLUE HILL, MASSACHUSETTS.

$\varphi=42^\circ\ 12'\cdot 7.\qquad \lambda=71^\circ\ 06'\cdot 9.$

Theodolite No. 1 was mounted over the triangulation station. A set of observations consisted of 3 pointings on the mark,* telescope direct, 3 pointings on same, telescope reversed, and 5 pointings on the star, with time and level records. The instrument was then reversed and the preceding operations repeated in the reverse order. The instrument was kept leveled. Chief of party, A. D. Bache. Probable error of a single result for azimuth $\pm 0''\cdot 89$.

Summary of results for azimuth at Blue Hill, Massachusetts.

α Ursæ Minoris near western elongation.				α Ursæ Minoris near eastern elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1845.		° ′ ″	″	1845.		° ′ ″	″
Sept. 24	III	2 02 33·78	−0·42	Sept. 25	III	2 02 30·25	+2·62
27	IV	33·75	−0·39	26	IV	33·28	−0·41
Oct. 1	VI	34·49	−1·13	27	IV	33·91	−1·04
2	I	34·59	−1·23	28	II	33·29	−0·42
3	II	30·99	+2·37	29	V	33·32	−0·45
13	V	32·57	+0·79	Oct. 1	VI	31·94	+0·93
				2	I	34·07	−1·20
	Mean	2 02 33·36 ±0″·38			Mean	2 02 32·87±0″·34	

	°	′	″
Mean of groups	2	02	33·11
Diurnal aberration			−0·31
Azimuth of Mark	182	02	33·42±0·25
Angle between Mark and Manomet	123	54	56·63
Azimuth of Manomet	305	57	30·05

18. SHOOTFLYING, MASSACHUSETTS.

$\varphi=41^\circ\ 41'\cdot 1.\qquad \lambda=70^\circ\ 20'\cdot 8.$

Theodolite No. 1 was mounted over the triangulation station. The azimuth mark was distant from the station about 1¾ miles. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, and 5 pointings on star, with time and level records. The instrument was then reversed and the operations repeated in the reverse order. Instrument was kept leveled. Chief of party, A. D. Bache. Probable error of a single result for azimuth $\pm 0''\cdot 86$.

* No particulars given in record respecting the azimuth mark.

Summary of results for azimuth at Shootflying, Massachusetts.

α Ursæ Minoris near eastern elongation.				α Ursæ Minoris near western elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1845.		° ′ ″	″	1845.		° ′ ″	″
Aug. 1	III	49 08 12 ·15	+0 ·52	Aug. 1	III	49 08 15 ·13	−1 ·40
4	IV	12 ·03	+0 ·64	3	IV	15 ·18	−1 ·45
5	V	11 ·88	+0 ·79	4	V	11 ·18	+2 ·55
7	I	14 ·19	−1 ·52	7	I	13 ·52	+0 ·21
8	VI	12 ·16	+0 ·51	9	VI	13 ·01	+0 ·72
12	II	13 ·51	−0 ·84	12	II	14 ·35	−0 ·62
13	III	12 ·80	−0 ·13				
	Mean	49 08 12 ·67±0″ ·22			Mean	49 08 13 ·73±0″ ·42	

	° ′ ″	
Mean of groups	49 08 13 ·20	
Diurnal aberration	+0 ·31	″
Azimuth of Mark	229 08 13 ·51	±0 ·24
Angle between Mark and Manomet	86 04 50 ·77	
Azimuth of Manomet	143 03 22 ·74	

19. INDIAN, MASSACHUSETTS.

$\varphi = 41° \ 25'·7. \qquad \lambda = 70° \ 40'·7.$

Theodolite No. 1 was mounted over the triangulation station. A pole at Prospect Hill served for a day mark, but several lights were used for reference marks. It was found, however, that the day and night observations upon the Cape Poge Light, the West Chop Light, and the Tarpaulin Cove Light were discordant, the verticals through the centers of the light-houses and through their focal reflectors not being coincident. A set of observations generally consisted of several pointings on one or more of the marks with telescope direct and reversed, and 6 pointings on the star with time and level records. The instrument was then reversed and the operations repeated in the reverse order. Instrument was kept leveled. Observers: A. D. Bache and C. O. Boutelle. Probable error of a single result for azimuth ±1″·40.

Summary of results for azimuth at Indian, Massachusetts.

α Ursæ Minoris near western elongation.				α Ursæ Minoris near eastern elongation.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1845.		° ′ ″	″	1845.		° ′ ″	″
July 9	VI	140 37 36 ·62	+3 ·03	July 10	VI	140 37 41 ·56	−1 ·64
12	I	43 ·03	−3 ·38	11	I	40 ·68	−0 ·76
13	II	41 ·90	−2 ·25	12	I	38 ·69	+1 ·23
14	III	37 ·78	+1 ·87	13	II	37 ·98	+1 ·94
15	IV	40 ·25	−0 ·60	15	III	40 ·08	−0 ·16
16	IV	42 ·55	−2 ·90	17	IV	39 ·51	+0 ·41
17	V	36 ·31	+3 ·34	18	V	40 ·94	−1 ·02
18	VI	38 ·78	+0 ·87				
	Mean	140 37 39 ·65±0″ ·64			Mean	140 37 39 ·92±0″ ·33	

	° ′ ″	
Mean of groups	140 37 39 ·78	
Diurnal aberration	−0 ·31	″
Azimuth of Mark	39 22 20 ·53	±0 ·36
Angle between Mark and Copecut	96 13 38 ·29	
Azimuth of Copecut	135 35 58 ·82	

20. COPECUT, MASSACHUSETTS.

$\varphi=41^\circ\ 43'.3.$ $\lambda=71^\circ\ 03'.6.$

Theodolite No. 1 was mounted over the triangulation station. A small telescope was placed a few feet from the great theodolite to serve as collimator; it proved, however, to be very unsteady, and even for day observations the cross threads had to be artificially illuminated. For the observations near the eastern elongation eyepiece C was attached to the theodolite;* value of one division of its micrometer$=0''.54$. The station Blue Hill was used for a day mark. A set of observations of Polaris near eastern elongation generally consisted of one dozen micrometric observations between mark and star, telescope direct, and the same number with telescope reversed; also 5 circle readings on collimator, instrument direct, and 5 readings, instrument reversed. In connection with the observations near western elongation the star was pointed at a number of times, with instrument direct and reversed; times and levels were recorded. The instrument was kept leveled. Observer: A. D. Bache. Probable error of a single result for azimuth $\pm 1''.15$.

Summary of results for azimuth at Copecut, Massachusetts.

α Ursæ Minoris near eastern elongation.				α Ursæ Minoris near western elongation.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1844.		° ′ ″	″	1844.		° ′ ″	″
Sept. 24	III	4 42 51.41	+1.21	Sept. 26	III	4 42 56.84	−1.78
27	IV	52.03	+0.59	27	IV	55.19	−0.13
30	V	52.74	−0.12	29	V	56.55	−1.49
Oct. 1	V	53.20	−0.58	30	V	52.86	+2.20
2	V	54.26	−1.64	Oct. 1	V	55.04	+0.02
4	V	53.05	−0.43	4	V	53.87	+1.19
5	V	51.95	+0.67				
8	V	52.29	+0.33				
	Mean	4 42 52.62 ± 0″.21			Mean	4 42 55.06 ± 0″.42	

	° ′ ″	″
Mean of groups	4 42 53.84	
Diurnal aberration	−0.31	
Azimuth of Mark	175 17 06.5	±0.31
Angle between Mark and Blue Hill	0.00	
Azimuth of Blue Hill	175 17 06.5	

21. BEACONPOLE, RHODE ISLAND.

$\varphi=41^\circ\ 59'.7.$ $\lambda=71^\circ\ 27'.0.$

Theodolite No. 1 was mounted over the triangulation station. Observations were made in sets consisting generally of 3 to 6 pointings on the mark and on the star, with telescope direct, and the same number of pointings with telescope reversed; the instrument was kept leveled. Observer: A. D. Bache. Probable error of a single result for azimuth $\pm 0''.69$.

*One turn of eyepiece micrometer equals 100 divisions.

Summary of results for azimuth at Beaconpole, Rhode Island.

α Ursæ Minoris near western elongation.				α Ursæ Minoris near eastern elongation.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1884.		° ′ ″	″	1844.		° ′ ″	″
Oct. 31	I	2 02 26 ·23	−1 ·03	Nov. 1	I	2 02 25 ·41	+1 ·02
Nov. 1	I	25 ·91	−0 ·71	2	I	25 ·96	+0 ·47
8	III	25 ·47	−0 ·27	8	III	27 ·34	−0 ·91
10	III	25 ·46	−0 ·26	9	III	26 ·77	0 ·34
16	II	23 ·63	+1 ·57	17	II	26 ·55	−0 ·12
18	II	24 ·51	+0 ·69	19	II	26 ·55	−0 ·12
	Mean	2 02 25 ·20±0″ ·27			Mean	2 02 26 ·43±0″ ·18	

	°	′	″
Mean of groups	2	02	25 ·82
Diurnal aberration			+0 ·31 ″
Azimuth of Mark	182	02	26 ·13±0 ·20
Angle between Mark and Blue Hill	46	52	51 ·11
Azimuth of Blue Hill	228	55	17 ·24

22. SPENCER, RHODE ISLAND.

$\varphi=41^\circ\ 40'\cdot 7.$ $\lambda=71^\circ\ 29'\cdot 7.$

Theodolite No. 1 was mounted over the triangulation station. Two azimuth marks were used; their angular difference is 4° 04′ 12″·64±0″·18. All measures were reduced to the eastern mark. The observations were made in irregular sets of a number, a dozen, more or less, of micrometric measures between the star and the mark, with telescope direct and telescope reversed. The value of one division of the eyepiece micrometer was 0″·57; it was not used in connection with western elongation of August 14. One division of level C=0″·96, but the instrument was generally kept leveled.* Observer, A. D. Bache. Probable error of a single result for azimuth ±1″·25.

Summary of results for azimuth at Spencer, Rhode Island.

α Ursæ Minoris near eastern elongation.			α Ursæ Minoris near western elongation.		
Date.	Mark E. of N.	Δ	Date.	Mark E. of N.	Δ
1844.	° ′ ″	″	1844.	° ′ ″	″
Aug. 13	2 02 00 ·95	+1 ·95	Aug. 14	2 02 04 ·59	−2 ·73
14	02 ·67	+0 ·23	15	02 01 ·50	+0 ·36
15	04 ·34	−1 ·44	16	01 59 ·48	+2 ·38
16	04 ·02	−1 ·12			
17	04 ·26	−1 ·36			
21	01 ·17	+1 ·73			
Mean	2 02 02 ·90±0″ ·43		Mean	2 02 01 ·86±1″ ·01	

	°	′	″
Mean of groups	2	02	02 ·38
Diurnal aberration			+0 ·31 ″
Azimuth of Mark	182	02	02 ·69±0 ·42
Angle between Mark and Beaconpole.	356	04	29 ·67
Azimuth of Beaconpole	185	57	33 ·02

* On August 17 and 21 the star was observed direct and reflected.

23. MOUNT TOM, MASSACHUSETTS.

$\varphi = 42^\circ\ 14'\cdot 5.$ $\lambda = 72^\circ\ 38'\cdot 9.$

Theodolite No. 1 was mounted over the triangulation station. The mark was located near the Prospect House on Mount Holyoke; a light was shown through a three-fourths-inch aperture in the box; a wand above the opening was used in daytime. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on α Ursæ Minoris (6 in the case of δ Ursæ Minoris), with time and level records. The instrument was then reversed and a series of like observations was made in the reverse order. One division of level = 1″·00. Observers, G. W. Dean and R. E. Halter. Probable error of a single result for azimuth ±0″·77.

Summary of results for azimuth at Mount Tom, Massachusetts.

α Ursæ Minoris near eastern elongation.				δ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1862.		° ′ ″	″	1862.		° ′ ″	″
July 27	I	37 22 35·20	−1·28	July 27	I	37 22 36·74	−2·06
30	II	33·98	−0·06	30	II	34·39	+0·29
Aug. 1	I	33·81	+0·11	Aug. 1	II	34·62	+0·06
3	III	35·59	−1·67	3	III	34·92	−0·24
4	IV	34·30	−0·38	4	IV	33·93	+0·75
7	V	32·22	+1·70	7	V	34·16	+0·52
8	V	32·15	+1·77	10	III	34·01	+0·67
10	IV	34·09	−0·17				
Mean		37 22 33·92±0″·29		Mean		37 22 34·68±0″·25	
Diurnal aberration		+0·31		Diurnal aberration		−0·33	

	°	′	″
Mean of groups	37	22	34·62 ″
Azimuth of Mark	217	22	34·62±0·20
Angle between Mark and Monadnock	4	45	12·88
Azimuth of Monadnock	212	37	21·74

24. SANDFORD, CONNECTICUT.

$\varphi = 41^\circ\ 27'\cdot 7.$ $\lambda = 72^\circ\ 57'\cdot 0.$

Theodolite No. 1 was mounted over the triangulation station. An azimuth mark was placed on the highest hill in a westerly direction, and about 1½ miles from the station. The aperture was three-fourths of an inch in diameter, and a wand 1 foot high and 1 inch wide was placed vertically over it. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on the star if Polaris, 6 if λ Ursæ Minoris, with time and level records. The instrument was then reversed and the observations repeated in the reverse order. One division of level = 1″·00. Observers, G. W. Dean and R. E. Halter. Probable error of a single result for azimuth ± 1″·20.

Summary of results for azimuth at Sandford, Connecticut

α Ursæ Minoris near eastern elongation.				λ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1862.		° ′ ″	″	1862.		° ′ ″	″
Sept. 9	I	88 49 04·79	−0·54	Sept. 10	I	88 49 07·10	−1·96
10	I	05·95	−1·70	21	II	06·81	−1·67
11	II	07·83	−3·58	22	III	04·14	+1·00
21	II	04·96	−0·71	23	IV	05·67	−0·53
22	III	02·35	+1·90	25	V	03·79	+1·35
23	IV	03·24	+1·01	26	IV	06·03	−0·89
25	V	03·37	+0·88	27	II	02·43	+2·71
26	V	03·58	+0·67				
27	III	02·18	+2·07				
	Mean	88 49 04·25±0″·41			Mean	88 49 05·14±0″·44	

	°	′	″
Mean of groups	88	49	04·69
Diurnal aberration			−0·31 ″
Azimuth of Mark	91	10	55·62±0·30
Angle between Mark and Ruland	85	20	30·34
Azimuth of Ruland	5	50	25·28

25. WEST HILLS, NEW YORK.

$\varphi=40^\circ\ 48'\cdot8.$ $\lambda=73^\circ\ 25'\cdot6.$

Theodolite No. 1 was mounted nearly over the triangulation station. The azimuth mark was placed near the station Huntington, 4⅛ kilometers distant from West Hills station.* A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on same, telescope reversed, 5 pointings on the star, if Polaris, 6 if δ Ursæ Minoris, with time and level records. The instrument was then reversed and similar observations were made with their order reversed. One division of level = 1″·00. Observer, G. W. Dean. Probable error of a single result for azimuth ±0″·57.

Summary of results for azimuth at West Hills, New York.

α Ursæ Minoris near eastern elongation.				δ Ursæ Minoris near upper culmination.			
Date.	Position.	Mark E. of N.	Δ	Date.	Position.	Mark E. of N.	Δ
1865.		° ′ ″	″	1865.		° ′ ″	″
Aug. 4	V	2 23 58·23	+1·00	Aug. 4	V	2 23 58·63	+0·55
8	IV	59·02	+0·21	8	IV	58·55	+0·63
9	II	60·87	−1·64	9	II	58·72	+0·46
11	I	58·21	+1·02	11	I	58·76	+0·42
12	III	60·61	−1·38	12	III	59·68	−0·50
15	V	58·46	+0·77	15	IV	60·00	−0·82
16	II	58·85	+0·38	16	I	59·94	−0·76
18	III	59·62	−0·39				
Mean		2 23 59·23±0″·25		Mean		2 23 59·18±0″·17	
Diurnal aberration		+0·31		Diurnal aberration		+0·33	

	°	′	″
Mean of groups	2	23	59·53
Reduction to station			+0·40 ″
Azimuth of Mark	182	23	59·93±0·15
Angle between Mark and Wooster	7	26	21·61
Azimuth of Wooster	174	57	38·32

*The geodetic station was found to be 0·47 of an inch SW. of the point at which the azimuth observations were made; the correction to the azimuth when referred to the geodetic station is +0″·40.

26. BEACON HILL, NEW JERSEY.

$\varphi=40^\circ\ 22'\cdot4.$ $\lambda=74^\circ\ 13'\cdot7.$

The Troughton & Simms transit, Coast Survey No. 5, was mounted over the station; focal length of telescope $1^{m}\cdot17$, clear aperture 70^{mm}, magnifying power about 80. Value of one division of eyepiece micrometer $0''\cdot4480\pm0''\cdot0001$ at 21° C. One division of level $0''\cdot96$; pivot inequality $+0^{s}\cdot017$ for clamp west. The mark was located about 8 miles north of the station and light was shown through a 1-inch aperture. In connection with the observations for time micrometric measures between the verticals of mark and star were made for the determination of azimuth. A set of observations consisted of 15 transits of δ Ursæ Minoris and an equal number of transits of 51 Cephei over the micrometer thread set in advance to a whole turn between 0 and 14; the mark was observed 10 times with clamp east and an equal number of times with clamp west; the level was generally read before and after each set. Observer, G. W. Dean. Probable error of a single result for azimuth $\pm0''\cdot81$ for δ Ursæ Minoris and $\pm0''\cdot67$ for 51 Cephei.

Summary of results for azimuth at Beacon Hill, New Jersey.

δ Ursæ Minoris near upper culmination.				51 Cephei near lower culmination.			
Date.	Clamp.	Mark W. of N.	Δ	Date.	Clamp.	Mark W. of N.	Δ
1875.		″	″	1875.		″	″
Aug. 19	E	7·95	−0·86	Aug. 19	E	7·90	−0·24
21	W	5·53	+1·56	21	W	6·07	+1·59
25	W	8·63	−1·54	25	W	8·78	−1·12
26	E	6·11	+0·98	26	E	7·21	+0·45
27	W	6·50	+0·59	27	W	7·41	+0·25
28	E	7·81	−0·72	28	E	8·59	−0·93
Mean		7·09±0″·33		Mean		7·66±0″·27	
Diurnal aberration		−0·33		Diurnal aberration		−0·30	

	°	′	″
Mean of groups	0	0	7·06
Azimuth of Mark	179	59	52·94±0·21
Angle between Mark and Weasel	3	35	36·95
Azimuth of Weasel	183	35	29·89

27. MOUNT ROSE, NEW JERSEY.

$\varphi=40^\circ\ 22'\cdot1.$ $\lambda=74^\circ\ 43'\cdot4.$

The 60^{cm} direction theodolite No. 2 was mounted over the triangulation station and 15 feet above the ground. The mark was 1·20 kilometers distant. A set of observations consisted of 3 pointings on the mark, telescope direct, 3 pointings on the same, telescope reversed, and 5 pointings on the star, telescope direct, and 5 pointings on the same, telescope reversed, with time and level records. One division of level $=1''\cdot25$. Observer, J. E. Hilgard, assisted by G. W. Stevens. Probable error of a single result for azimuth $\pm1''\cdot07$.

Summary of results for azimuth at Mount Rose, New Jersey.

α Ursæ Minoris near eastern elongation.

Date.	Position.	Mark E. of N.	Δ
1852.		° ′ ″	″
Aug. 13	I	75 58 03·48	−0·72
14	II	03·50	−0·74
14	II	00·78	+1·98
15	III	00·30	+2·46
16	IV	03·48	−0·72
18	V	04·33	−1·57
19	III	03·42	−0·66
	Mean	75 58 02·76±0″·40	

α Ursæ Minoris near western elongation.

Date.	Position.	Mark E. of N.	Δ
1852.		° ′ ″	″
Aug. 13	I	75 57 63·38	−2·08
14	II	59·94	+1·36
15	III	61·24	+0·06
17	V	60·42	+0·88
19	IV	61·50	−0·20
	Mean	75 58 01·30±0″·40	

	° ′ ″
Mean of groups	75 58 02·03
Diurnal aberration	+0·31 ″
Azimuth of Mark	255 58 02·34±0·31
Angle between Mark and Mount Holly	111 48 53·25
Azimuth of Mount Holly	7 46 55·59

28. YARD, PENNSYLVANIA.

$\varphi=39°\ 58'\!\cdot\!5.$ $\lambda=75°\ 23'\!\cdot\!2.$

The 60^{cm} direction theodolite No. 2 was mounted over the triangulation station. A set of azimuth observations consisted of 3 pointings on the mark and 3 pointings on the star, with telescope direct, and the same number of pointings on mark and star with telescope reversed. Times and levels were recorded. One division of level $=0''\!\cdot\!94$. Observer, J. E. Hilgard. Probable error of a single result for azimuth $\pm0''\!\cdot\!99$.

Summary of results for azimuth at Yard, Pennsylvania.

α Ursæ Minoris at various hour angles.

Date.	Position.	Mark E. of N.	Δ
1854.		° ′ ″	″
Oct. 27	V	0 17 31·87	+2·07
Nov. 1	IV	34·23	−0·29
1	III	36·89	−2·95
2	I	33·68	+0·26
2	V	34·15	−0·21
5	III	32·72	+1·22
5	V	34·37	−0·43
5	IV	32·26	+1·68
5	II	35·32	−1·38
6	I	33·94	0·00
Mean		0 17 33·94±0″·31	
Diurnal aberration		+0·31	

	° ′ ″ ″
Azimuth of Mark	180 17 34·25±0·31
Angle between Mark and Lippincott	167 00 04·32
Azimuth of Lippincott	347 17 38·57

29. PRINCIPIO, MARYLAND.*

$\varphi=39° 35'.5.$ $\lambda=76° 00'.3.$

The 60^{cm} direction theodolite No. 2 was mounted over the triangulation station; the mark was at Carpenter's Point, about 3½ miles distant. A single result for azimuth is derived from 19 sets, each consisting of: 3 pointings on the mark, reversal of instrument; 3 pointing on the mark, 4 to 6 pointings on the star, followed by the same operations in the reverse order, with the necessary noting of time and level readings; circle used in V positions. Observer, R. D. Cutts. Probable error of a single result ± 1''.75.

Results for azimuth from observations of α Ursæ Minoris near eastern elongation, in August and September, 1866.

	° ′ ″
Mark west of south	3 05 07.20
Diurnal aberration	+0.32
Azimuth of Mark	3 05 07.52 ± 0''.40
Angle between Mark and Turkey Point	1 30 24.01
Azimuth of Turkey Point	1 34 43.51

30. CAPE HENLOPEN LIGHT-HOUSE, DELAWARE.

$\varphi=38° 46'.7.$ $\lambda=75° 05'.1.$

The 30^{cm} direction theodolite No. 135 was mounted over the eccentric geodetic station, about 15 meters north of the center of the Light-House; the mark was at Brandywine Shoal Light-House. A single result for azimuth is derived from 49 sets. each consisting of a pointing on the mark, a pointing on the star, reversal of instrument and pointings on star and mark, noting of times and level readings. Circle used in XVII positions. Observer, O. B. French. Probable error of a single result ± 1''.76 for α Ursæ Minoris and ± 0''.97 for λ Ursæ Minoris.

Results for azimuth from observations of α Ursæ Minoris and λ Ursæ Minoris at various hour angles, in September, 1897.

	° ′ ″ ″
Mark W. of N., 28 results from observations of α Ursæ Minoris	6 14 23.21 ± 0.33
Mark W. of N., 21 results from observations of λ Ursæ Minoris	22.19 ± 0.21
Weighted mean according to the probable errors	22.48 ± 0.18
Indiscriminate mean of 49 sets	22.77
Mean value adopted	22.62
Diurnal aberration	−0.32
Azimuth of Mark	173 45 37.70 ± 0.21
Reduction to center of Cape Henlopen Light-House	−20.37
Azimuth, Cape Henlopen Light-House to Brandywine Shoal Light-House	173 45 17.33

*For the complete abstract and combination of results for azimuth at this and the succeeding 13 stations, all of which are *common* to the Arc of the 39th Parallel and the Oblique Arc, see "The Transcontinental Triangulation" U. S. Coast and Geodetic Survey, Special Publication No. 4, Washington, D. C., 1900.

31. MARRIOTT, MARYLAND.

$\varphi=38° \ 52'.4$. $\lambda=76° \ 36'.6$.

The 60cm direction theodolite No. 2 was mounted over the triangulation station. A single result for azimuth is derived from a set of observations consisting of about one dozen pointings on the star, one half with telescope direct and one-half with telescope reversed, and corresponding pointings on the mark, with noting of times and level readings. Circle used in XI positions. Observers: A. D. Bache, J. Hewston, jr., and G. Davidson. Probable error of a single result $\pm 1''.92$.

Results for azimuth from observations of α, δ, and λ Ursæ Minoris near eastern elongation and of α, β, θ, and ζ Ursæ Minoris and of α Ursæ Majoris near western elongation, June, 1849.

	° ′ ″ ″
Mark W. of N., from 8 stars near eastern elongation	0 58 27 .38±0 .68
Mark W. of N., from 8 stars near western elongation	28 .56±0 .71
Mean, Mark west of north	27 .97
Diurnal aberration	−0 .31
Azimuth of Mark	179 01 32 .34±0 .48
Angle between Mark and Hill	82 23 48 .98
Azimuth of Hill	96 37 43 .36

32. WEBB, MARYLAND.

$\varphi=39° \ 05'.4$. $\lambda=76° \ 40'.5$.

The 75^{cm} direction theodolite No. 1 was mounted over the triangulation station. The mark was about 1 mile distant. A single result for azimuth is derived from a set of observations consisting of 6 pointings on the mark, one-half of which with telescope direct and the other half with telescope reversed; 12 pointings on the star, one-half with telescope direct and one-half with telescope reversed; finally 6 more pointings on the mark as before, noting time and level readings. Circle used in V positions. Observers, A. D. Bache and G. W. Dean. Probable error of a single result $\pm 0''.67$.

Results for azimuth from observations of α Ursæ Minoris near eastern and western elongations, in October and November, 1850.

	° ′ ″ ″
Mark E. of N. α Ursæ Minoris, 5 sets near eastern elongation	6 07 45 .42±0 .28
Mark E. of N. α Ursæ Minoris, 5 sets near western elongation	45 .69±0 .35
Mean, Mark east of north	6 07 45 .56
Diurnal aberration	+0 .32
Azimuth of Mark	186 07 45 .88±0 .21
Angle between Mark and Soper	97 07 56 .64
Azimuth of Soper	88 59 49 .24

33. HILL, MARYLAND.

$\varphi=38° \ 53'.9$. $\lambda=76° \ 52'.8$.

The 75^{cm} direction theodolite No. 1 was mounted over the triangulation station. Mark in line to station Webb. A single result for azimuth is derived from 13 sets of observations, each consisting of 6 pointings on the mark, half with telescope direct and half with telescope reversed; 10 pointings on the star, half with telescope direct and half with telescope reversed, and finally 6 pointings on the mark as before, with noting of times and level readings. Circle used in V positions. Observers, A. D. Bache and G. W. Dean. Probable error of a single result $\pm 0''.83$.

Results for azimuth from observations of α Ursæ Minoris near eastern and western elongations and of λ Ursæ Minoris near upper culmination, in September and October, 1850.

	°	′	″	″
Mark E. of N., 5 results from α Ursæ Minoris near eastern elongation	39	46	56 ·83±0 ·42	
Mark E. of N., 5 results from α Ursæ Minoris near western elongation			57 ·77±0 ·31	
Mark E. of N., 3 results from λ Ursæ Minoris near upper culmination			61 ·01	Not used.
Mean, Mark east of north			57 ·30	
Diurnal aberration			+0 ·32	
Azimuth of Mark	219	46	57 ·62±0 ·26	
Angle between Mark and Webb			00 ·27	
Azimuth of Webb	219	46	57 ·89	

34. SOPER, MARYLAND.

$\varphi=39°\ 05'.2.$ $\lambda=76°\ 57'.0.$

The 75^cm direction theodolite No. 1 was mounted over the triangulation station, the mark being to the southward, distant 442 meters. A single result for azimuth is derived from 10 sets of observations, each consisting of 6 pointings on the mark, 10 pointings on the star, one-half with telescope direct and half with telescope reversed, 6 pointings on the mark, with noting of times and level readings. In case of culminations the above operations were repeated. Circle used in V positions. Observer, A. D. Bache. Probable error of a single result ±0″·92.

Result for azimuth from observations of α Ursæ Minoris near lower culmination, λ Ursæ Minoris near eastern elongation, and δ Ursæ Minoris near western elongation, in July, 1850.

	°	′	″
Mark east of north, indiscriminate mean	178	19	38 ·22
Diurnal aberration			+0 ·32 ″
Azimuth of Mark	358	19	38 ·54±0 ·29
Angle between Mark and Webb	89	30	15 ·08
Azimuth of Webb	268	49	23 ·46

35. SEATON, DISTRICT OF COLUMBIA.

$\varphi=38°\ 53'.4.$ $\lambda=77°\ 00'.0.$

The 75^cm direction theodolite No. 1 was mounted over the triangulation station, and the mark was on the tower of the Soldiers' Home, about 3½ miles distant. A single result for azimuth is derived from 34 sets, each set of observations consisting of 8 pointings on the mark and 8 pointings on the star, one-half with telescope direct and one-half in reversed position. The star was observed alternately direct and reflected in mercury, times noted. The circle was used in VII positions. Observer, C. O. Boutelle. Probable error of a single result ±0″·72.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in December, 1868, and January, 1869.

	°	′	″
Mark west of north	10	01	13 ·73
Diurnal aberration			−0 ·32 ″
Azimuth of Mark	169	58	46 ·59±0 ·18
Angle between Mark and Hill	95	34	07 ·17
Azimuth of Hill	265	32	53 ·76

36. CAUSTEN, DISTRICT OF COLUMBIA.

$\varphi = 38° 55'.5$. $\lambda = 77° 04'.4$.

The 75^{cm} direction theodolite No. 1 was mounted over the triangulation station, and the mark was about a quarter of a mile distant. A single result for azimuth is derived from a set of observations consisting of 6 pointings on the mark, one-half with telescope direct and one-half with telescope reversed, 10 pointings on the star, one-half with telescope direct, and one-half, telescope reversed; finally, 6 more pointings on the mark with times noted and levels read. For culminations two sets were taken and coupled, one made before, the other after culmination. Circle used in V positions. Observer, G. W. Dean. Probable error of a single result, star near elongation $\pm 0''.88$ and star near culmination $\pm 1''.08$.

Results for azimuth from observations of α Ursæ Minoris near eastern elongation and near lower culmination, in May and June, 1851.

	°	′	″ ″
Mark E. of N., 3 observations near eastern elongation	30	52	60.62±0.51
Mark E. of N., 5 observations near lower culmination			59.29±0.48
Mean, Mark east of north			59.955
Diurnal aberration			+0.315
Azimuth of Mark	210	53	00.27±0.37
Angle between Mark and Soper	0	01	41.51
Azimuth of Soper	210	54	41.78

37. SUGAR LOAF, MARYLAND.

$\varphi = 39° 15'.8$. $\lambda = 77° 23'.6$.

The 50^{cm} direction theodolite No. 113 was mounted over the triangulation station, and the mark was near the railroad station at Barnsville 3.8 miles distant. Thirty-three sets of observations were made, each consisting of a pointing on the mark, 2 pointings on the star, one direct, the other reflected in mercury, reversal of instrument, observations as before, but in reversed order, times noted. The circle was used in XI positions. Observers, C. O. Boutelle and F. D. Granger. Probable error of a single result $\pm 1''.02$.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in October and November, 1879.

	°	′	″
Azimuth of Mark, east of north	167	01	59.96
Diurnal aberration			+0.32 ″
Azimuth of Mark	347	01	60.28±0.20
Angle between Mark and Bull Run	45	27	16.51
Azimuth of Bull Run	32	29	16.79

38. MARYLAND HEIGHTS, MARYLAND.

$\varphi = 39° 20'.5$. $\lambda = 77° 43'.0$.

The 75^{cm} direction theodolite No. 1 was mounted over the triangulation station; the mark was on a hill back of Knoxville distant about 3½ miles. Thirty-five sets of observations were taken, each set consisting of a pointing on the mark, 2 pointings on the star, one direct, the other reflected in mercury, reversal of instrument and series of observations, as before, but in the reverse order, times noted. The circle was used in V positions. Observers, C. O. Boutelle and F. D. Granger. Probable error of a set or single result $\pm 1''.10$.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in October, 1870.

	°	′	″
Mark east of north	108	14	43·46
Diurnal aberration			+0·32 ″
Azimuth of Mark	288	14	43·78±0·18
Angle between Mark and Bull Run	70	28	23·10
Azimuth of Bull Run	358	43	06·88

39. BULL RUN, VIRGINIA.

$\varphi=38° 52'.9$. $\lambda=77° 42'.2$.

The 75[cm] direction theodolite No. 1 was mounted over the triangulation station; the mark was on High Point Mountain about 1½ miles distant. Thirty-five sets for azimuth were taken, each consisting of a pointing on the mark, 2 pointings on the star, first direct, second reflected in mercury, reversal of instrument and series of similar observations in the reverse order, times noted. Circle used in VII positions. Observer, C. O. Boutelle. Probable error of a set or single result $\pm 1''.20$.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in October and November, 1871.

	°	′	″
Mark west of north	158	36	29·98
Diurnal aberration			−0·32 ″
Azimuth of Mark	21	23	30·34±0·20
Angle between Mark and Peach Grove	242	29	57·81
Azimuth of Peach Grove	263	53	28·15

40. CLARK, VIRGINIA.

$\varphi=38° 18'.7$. $\lambda=78° 00'.2$.

The 75[cm] direction theodolite No. 1 was mounted over the triangulation station; mark at Rapidan railroad station, nearly 5·54 kilometers distant. Thirty-five sets of observations were taken, each set consisting of a pointing on the mark, 2 pointings on the star, one direct, the other reflected in mercury, reversal of instrument and series of observations, as before, but in the reverse order, times noted. The circle was used in V positions. Observer, C. O. Boutelle. Probable error of a single set or result $\pm 1''.09$.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in August, 1871.

	°	′	″
Mark west of north	85	30	59·64
Diurnal aberration			−0·32 ″
Azimuth of Mark	94	29	00·68±0·18
Angle between Mark and Bull Run	107	50	27·09
Azimuth of Bull Run	202	19	27·77

41. LONG MOUNTAIN, VIRGINIA.

$\varphi=37° 17'.5$. $\lambda=79° 05'.2$.

The 35[cm] direction theodolite No. 10 was mounted over the triangulation station; the mark was on belfry of court-house at Lynchburg, about 10 miles distant. Forty-six sets of observations were made, each set consisting of a pointing on the mark, 2 pointings on the star, one direct, the other reflected in mercury, reversal of instrument and series of observations, as before, but in the reverse order, times noted. The circle was used in XXIII positions. Observer, A. T. Mosman. Probable error of a set or of a single result $\pm 1''\cdot 54$.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in November, 1875.

	°	′	″
Mark west of north	20	48	13·11
Diurnal aberration			−0·32 ″
Azimuth of Mark	159	11	47·21±0·23
Angle between Mark and Spear	64	16	54·53
Azimuth of Spear	223	28	41·74

42. ELLIOTT KNOB, VIRGINIA.

$\varphi = 38^\circ\ 10'\cdot 0 \qquad \lambda = 79^\circ\ 18'\cdot 9$

The 50^{cm} direction theodolite No. 114 was mounted over the triangulation station, and the collimator was mounted on a brick pier 29 feet distant. Thirty sets of observations were made, each set consisting of a pointing on collimator, 2 pointings on the star; one direct, the other reflected in mercury, times noted, reversal of instrument and series of observations, as before, but in the reverse order. The circle was used in X positions. Observer, A. T. Mosman. Probable error of a single result $\pm 1''\cdot 50$.

Result for azimuth from observations of α Ursæ Minoris at various hour angles, in August, 1878.

	°	′	″
Collimator east of north	1	41	34·52
Diurnal aberration			+0·32 ″
Azimuth of Collimator	181	41	34·84±0·27
Angle between Collimator and Humpback	121	43	49·53
Azimuth of Humpback	303	25	24·37

43. MOORE, NORTH CAROLINA.

$\varphi = 36^\circ\ 23'\cdot 9. \qquad \lambda = 80^\circ\ 17'\cdot 0.$

The Simms transit, Coast Survey No. 8, was mounted in the meridian of the triangulation station, 7 feet to the north. Focal length of telescope $1^m\cdot 10$, clear aperture 7^{cm}, magnifying power 45, pivot inequality for clamp west $+0^s\cdot 02$; resulting value of one division of eyepiece micrometer before November 15, $0''\cdot 4870$ and after changing focus to the close of the series $0''\cdot 4804 \pm 0''\cdot 0002$. Value of one division of level $B = 1''\cdot 11$.

In connection with the observations for time, those for azimuth proper consist of micrometric measures between the verticals of the star and mark. The light at the mark was shown through a ¾-inch aperture; it was distant from the station 5½ miles and appeared under an angle of depression of $2^\circ\ 25'$.

A set of observations generally consisted of 7 or 11 transits (times noted by a sidereal chronometer) of the star over the micrometer thread set in advance to a whole or to half a turn, instrument clamp west. In connection with these, from 5 to 10 pointings were made on the mark, with clamp east, and the same number with clamp west. The level was recorded with each set. When measuring the horizontal angle between the mark and the line to Buffalo the transit instrument was used as a collimator. The right ascensions of the stars were taken from the best sources available. Observer, A. T. Mosman. Probable error of a single result for azimuth as derived from all the stars $\pm 1''\cdot 10$.

Summary of results for azimuth at Moore, North Carolina.

[The tabular results include the correction for diurnal aberration.]

Date. 1876.	Star observed near upper culmination.	Mark E. of N. ″	Mean ″
Nov. 15	1879 T. Y. C.	23·96	22·90
	α Urs. Min.	21·83	
Nov. 21	11 Cephei	21·31	
	79 Draconis	24·28	22·99
	α Urs. Min.	23·38	
Nov. 22	β Cephei	25·08	
	11 Cephei	24·89	24·80
	α Urs. Min.	24·42	
Nov. 24	11 Cephei	24·24	
	226 Cephei	24·16	23·07
	α Urs. Min.	20·81	
Nov. 26	11 Cephei	25·14	
	79 Draconis	22·81	23·53
	226 Cephei	22·63	
Dec. 1	79 Draconis	26·68	
Dec. 2	11 Cephei	27·82	
	79 Draconis	26·63	25·20
	γ Cephei	22·37	
	α Urs. Min.	23·97	
Dec. 3	11 Cephei	25·99	
	79 Draconis	25·17	
	γ Draconis	24·17	25·15
	4 163 Groom.	25·73	
	α Urs. Min.	24·67	
Dec. 5	226 Cephei	26·33	
	γ Cephei	22·69	24·24
	4 163 Groom.	24·24	
	α Urs. Min.	23·71	

Date. 1876.	Star observed near lower culmination.	Mark E. of N. ″	Mean ″
Nov. 15	ι Draconis	25·69	22·66
	32 Camelo.	19·63	
Nov. 21	ι Draconis	24·84	25·47
	32 Camelo.	26·10	
Nov. 22	ι Draconis	21·21	
	9 Draconis	21·91	20·89
	32 Camelo.	19·56	
Nov. 24	ι Draconis	23·30	22·88
	9 Draconis	22·46	
Nov. 26	ι Draconis	23·22	
	9 Draconis	22·63	23·21
	λ Draconis	23·78	
Dec. 1	9 Draconis	23·15	
Dec. 2	9 Draconis	21·37	
	λ Draconis	22·76	
	4 Draconis	22·71	21·44
	κ Draconis	20·99	
	32 Camelo.	19·39	
Dec. 3	32 Urs. Maj.	22·54	
	9 Draconis	22·55	
	4 Draconis	20·92	21·26
	κ Draconis	20·92	
	32 Camelo.	19·39	
Dec. 5	9 Draconis	23·20	
	κ Draconis	21·43	22·19
	32 Camelo.	21·94	

Daily mean values of mark E. of N. from stars at upper and at lower culminations:

	″	″
Nov. 15	22·78	±0·55
21	24·23	0·50
22	22·85	0·45
24	22·98	0·50
26	23·37	0·45
Dec. 1	24·91	0·78
2	23·32	0·37
3	23·20	0·34
5	23·21	0·42
Weighted mean	23·30	±0·15

	°	′	″	″
Azimuth of Mark	180	00	23·30	±0·15
Angle between Mark and Buffalo	21	26	52·11	
Azimuth of Buffalo	158	33	31·19	

44. YOUNG, NORTH CAROLINA.

$\varphi = 35° \ 44'.4.$ $\lambda = 80° \ 38'.9.$

The 50[cm] direction theodolite (Würdemann) No. 3 was mounted over the triangulation station. The azimuth mark was placed on top of a barn on Solomon Hall Place, distant 4·86 miles, and the light was shown through an aperture ½ inch in diameter. A set of observations consisted of a pointing on the mark, telescope direct, 2 observations, with time record of the star, one pointing with image direct, the other with image reflected in mercury.* The telescope was then reversed and 2 observations on star, direct and reflected, and a pointing of the mark, telescope reversed, completed the set. Observer, C. O. Boutelle. Probable error of a single result for azimuth $\pm 1''.14$.

Summary of results for azimuth at Young, North Carolina.

α Ursæ Minoris at various hour angles.				α Ursæ Minoris at various hour angles.			
Date.	Position.	Mark E. of N.	Mean by positions.	Date.	Position.	Mark E. of N.	Mean by positions.
1876.		° ′ ″	″	1876.		° ′ ″	″
Oct. 10	I	7 20 25·04		Oct. 12	VI	7 20 26·09	
	I	26·20	24·33		VI	22·93	23·76
	I	21·75			VI	22·26	
	II	25·85			VII	26·07	
	II	23·79	24·60		VII	24·72	24·87
	II	24·16			VII	23·83	
Oct. 11	III	22·73			VIII	26·36	
	III	22·46	23·14		VIII	24·78	25·68
	III	24·23			VIII	25·89	
	IV	25·08		Oct. 13	IX	26·21	
	IV	22·22	23·29		IX	26·94	25·68
	IV	22·57			IX	23·88	
	V	22·67			X	23·13	
	V	22·24	22·38		X	21·94	22·76
	V	22·23			X	23·22	
					XI	24·57	
					XI	26·92	26·16
					XI	27·00	
					Mean	7 20	24·24±0″·26

	°	′	″
Mean, Mark east of north	7	20	24·24
Diurnal aberration			+0·31 ″
Azimuth of Mark	187	20	24·55±0·26
Angle between Mark and Poore	299	32	29·14
Azimuth of Poore	126	52	53·69

* The mercury was covered by a mosquito net to prevent any disturbance of the surface by wind.

45. KING, NORTH CAROLINA.

$\varphi=35^{\circ}\ 12'.2 \qquad \lambda=81^{\circ}\ 18'.8.$

The 50^{cm} direction theodolite No. 3 was mounted over the triangulation station. The azimuth mark was placed on the roof of a store near Kings Mountain R. R. station, distant 2·79 miles from King, and light was shown from a bulls-eye lantern through a hole of ¾-inch diameter. A set of observations consisted of a pointing on the mark, telescope direct, 2 observations of the star, one with image direct, the other with image reflected in mercury, with time record. The instrument was then reversed and 2 observations of the star were made, one direct, the other a reflected image, and one pointing on the mark concluded the set. Observer, C. O. Boutelle. Probable error of a single result for azimuth ±0″·98.

Summary of results for azimuth at King, North Carolina.

α Ursæ Minoris at various hour angles.				α Ursæ Minoris at various hour angles.			
Date.	Position.	Mark W. of N.	Mean by positions.	Date.	Position.	Mark W. of N	Mean by positions.
1877.		° ′ ″	″	1877.		° ′ ″	″
May 28	I	40 01 07·13		May 30	VII	40 01 09·32	
	I	05·11	06·24		VII	05·94	07·32
	I	06·47			VII	06·70	
	II	08·72		May 31	VIII	08·14	
	II	09·16	08·00		VIII	07·64	07·13
	II	06·12			VIII	05·60	
May 29	III	05·90			IX	09·31	
	III	06·24	06·30		IX	09·55	09·29
	III	06·77			IX	09·02	
	IV	06·71		June 1	X	05·25	
	IV	05·99	05·81		X	04·69	05·15
	IV	04·74			X	05·50	
	V	06·51			XI	07·94	
	V	06·21	06·40		XI	07·91	07·93
	V	06·49			XI	07·94	
May 30	VI	06·90			Mean	40 01	07·07±0″·25
	VI	08·37	08·19				
	VI	09·31					

	°	′	″
Mean, Mark west of north	40	01	07·07
Diurnal aberration			−0·31 ″
Azimuth of Mark	139	58	53·24±0·25.
Angle between Mark and Benn*	1	34	43·7
Azimuth of Benn	141	33	36·9

* This angle is somewhat uncertain owing to large corrections to directions Young and Paris, required by the adjustment of the triangulation.

46. PARIS, SOUTH CAROLINA.

$\varphi = 34° \ 56'·5.$ $\lambda = 82° \ 24'·7.$

The 50^{cm} theodolite No. 3 was mounted over the triangulation station. The azimuth mark was 1·4 miles distant from the station, and the light was shown through an opening one-half inch in diameter. A set of observations consisted of a pointing on the mark with telescope direct, 2 observations of the star, one with image direct, the other with image reflected in mercury, with time record. The instrument was then reversed, and 2 more observations of the star, direct and reflected, were made, and the set was completed by an observation on the mark. Observer, C. O. Boutelle. Probable error of a single result for azimuth $\pm 1''·15$.

Summary of results for azimuth at Paris, South Carolina.

α Ursæ Minoris at various hour angles.				α Ursæ Minoris at various hour angles.			
Date.	Position.	Mark E. of N.	Mean by positions.	Date.	Position.	Mark E. of N.	Mean by positions.
1875.		° ′ ″	″	1875.		° ′ ″	″
Oct. 23	I	157 59 59·18		Oct. 31	VII	157 59 64·76	
Oct 24	I	58·54	59·30		VII	62·16	62·59
	I	59·25			VII	60·84	
	I	60·22		Nov. 1	VIII	61·15	
Oct. 25	II	58·05			VIII	61·95	61.20
	II	61·99	60·64		VIII	60·51	
	II	61·88		Nov. 17	IX	58·37	
Oct. 26	III	59·75			IX	62·37	61.05
	III	64·61	62·42		IX	62·41	
	III	62·90		Nov. 18	X	58·15	
Oct. 27	IV	59·20		Nov. 20	X	61·16	59.54
	IV	61·63	60·40		X	59·31	
	IV	60·36			XI	61·88	
Oct. 28	V	59·73	60·98		XI	62·63	61.94
	V	62·24			XI	61·31	
Oct. 30	VI	59·63			Mean	157 59	60·99±0″·21
	VI	61·93	60·87				
	VI	61·06					

	°	′	″
Mean, Mark east of north	158	00	00·99
Diurnal aberration			+0·31 ″
Azimuth of Mark	158	00	01·30±0·21
Angle between Mark and Wofford	70	41	46·13
Azimuth of Wofford	267	18	15·17

47. CURRAHEE, GEORGIA.

$\varphi=34°\ 31'\cdot6.$ $\lambda=83°\ 22'\cdot6.$

The 50^{cm} theodolite No. 3 was mounted over the triangulation station. The mark was placed on the roof of a store at Toccoa village, distant between 3 and 4 miles, and was about 600 feet below the top of the mountain; the light was shown through an opening three-fourths of an inch in diameter and appeared under an angle of depression of less than 2°. A set of observations consisted of a pointing on the mark with telescope direct, 2 observations of the star, one by direct vision, the other by image reflected in mercury, with time record. The instrument was then reversed and the preceding observations were repeated in the reverse order. Observer, C. O. Boutelle. Probable error of a single result for azimuth $\pm1''\cdot47$.

Summary of results for azimuth at Currahee, Georgia.

α Ursæ Minoris at various hour angles.

Date.	Position.	Mark E. of N.	Mean by positions.
1874.		° ′ ″	
Oct. 2[illegible]	I	36 20 40·63	″
	I	39·60	40·46
	I	41·14	
	II	38·55	
	II	38·33	37·77
	II	36·42	
Oct. 29	III	39·93	
	III	38·32	39·72
	III	40·90	
	IV	36·74	
	IV	35·76	36·12
	IV	35·85	
Oct. 30	V	37·42	
	V	37·14	37·96
	V	39·31	
	VI	38·37	
	VI	38·45	37·81
	VI	36·62	

α Ursæ Minoris at various hour angles.

Date.	Position.	Mark E. of N.	Mean by positions.
1874.		° ′ ″	
Nov. 2	VII	36 20 38·36	″
	VII	38·31	38·67
	VII	39·34	
Nov. 4	VIII	36·50	
Nov. 6	VIII	36·58	36·16
	VIII	35·39	
Nov. 13	IX	32·50	
	IX	33·15	32·89
	IX	33·02	
	X	40·28	
	X	37·01	37·87
	X	36·31	
Nov. 14	XI	35·77	
Nov. 15	XI	35·51	36·06
	XI	36·89	
	Mean	36 20	37·41±0″·42

	°	′	″
Mean, Mark east of north	36	20	37·41
Diurnal aberration			+0·31 ″
Azimuth of Mark	216	20	37·72±0·42
Angle between Mark and Rabun	331	49	50·17
Azimuth of Rabun	188	10	27·89

48. SAWNEE, GEORGIA.

$\varphi = 34° 14'{\cdot}1.$ $\lambda = 84° 09'{\cdot}7.$

The 75[cm] direction theodolite No. 1 was mounted over the triangulation station. The azimuth mark was placed on a hill north of the village of Cumming, 2·7 miles distant from Sawnee; light was shown through a half-inch opening and appeared under an angle of depression of 2° 38′·7. A set of observations consisted of a pointing on the mark with telescope direct, 2 observations of the star, one of image direct, the other of image reflected in mercury with time record. The instrument was then reversed and the preceding observations were repeated but in the reverse order. Observer, C. O. Boutelle. Probable error of a single result for azimuth ±1″·50.

Summary of results for azimuth at Sawnee, Georgia.

α Ursæ Minoris at various hour angles.				α Ursæ Minoris at various hour angles.			
Date.	Position.	Mark E. of N.	Mean by positions.	Date.	Position.	Mark E. of N.	Mean by positions.
1873.		° ′ ″	″	1873.		° ′ ″	″
Oct. 13	IV	139 25 19·01		Oct. 17	I	139 25 17·96	
	IV	21·17			I	21·95	
	IV	19·67	19·18		I	18·66	20·86
	IV	17·90			I	21·28	
	IV	18·15		Oct. 21	I	24·47	
Oct. 14	V	17·25			II	16·05	
	V	21·62			II	18·75	
	V	22·08	19.84		II	14·71	16·67
Oct. 15	V	16·07			II	16·60	
	V	22·17			II	17·24	
	VI	19·95		Oct. 22	III	16·90	
	VI	19·98			III	16·66	
	VI	18·31	19·05		III	16·01	17·16
	VI	17·62			III	19·12	
	VI	19·38			III	17·13	
Oct. 16	VII	20·64			Mean	139 25	19·06±0″·41
	VII	21·18					
	VII	20·90	20·68				
	VII	21·00					
	VII	19·69					

	°	′	″
Mean, Mark east of north	139	25	19·06
Diurnal aberration			+0·31 ″
Azimuth of Mark	319	25	19·37±0·41
Angle between Mark and Currahee	286	09	06·75
Azimuth of Currahee	245	34	26·12

49. ATLANTA MIDDLE BASE, GEORGIA.

$\varphi=33^\circ\ 54'\cdot 3 \qquad \lambda=84^\circ\ 16'\cdot 6.$

The 75^{cm} theodolite No. 1 was mounted over the triangulation station. The azimuth mark was located at the north end of the base, 3 miles distant from Middle Base; light was shown through a half inch aperture.* A set of observations consisted of a pointing on the mark with telescope direct, 2 observations of the star, one observation with star direct, the other with image reflected in mercury, with time record. The instrument was then reversed and the preceding operations were repeated, but in the reverse order. Observer, C. O. Boutelle. Probable error of a single result for azimuth $\pm 1''\cdot 61$.

Summary of results for azimuth at Atlanta Middle Base, Georgia.

α Ursæ Minoris at various hour angles.				α Ursæ Minoris at various hour angles.			
Date.	Position.	Mark E. of N.	Mean by position.	Date.	Position.	Mark E. of N.	Mean by position.
1873.		° ′ ″	″	1873.		° ′ ″	″
Jan. 11	I	52 08 03·16		Jan. 24	V	52 08 10·16	
	I	04·02			V	07·12	
Jan. 12	I	06·30	04·76		V	08·06	07·24
	I	05·37			V	05·44	
	I	04·93			V	05·44	
Jan. 14	II	06·33		Jan. 27	VI	07·51	
	II	03·35			VI	08·35	
	II	04·92	04·44	Jan. 31	VI	08·82	09·04
	II	03·90			VI	09·46	
	II	03·70			VI	11·08	
Jan. 21	III	07·82		Feb. 4	VII	07·68	
	III	08·99		Feb. 5	VII	05·08	
	III	10·47	09·55	Feb. 8	VII	04·97	05·88
	III	09·26			VII	06·86	
	III	11·23			VII	04·83	
Jan. 23	IV	10·01			Mean	52·08	07·16±0″·55
	IV	08·75					
	IV	09·82	09·13				
	IV	09·96					
	IV	07·37					

	° ′ ″	
Mean, Mark east of north	52 08 07·16	
Diurnal aberration	+0·31	
Azimuth of Mark	232 08 07·47	±0″·55
Reduction to base line	−1·81	
Reduction to center at Northeast Base	−0·37	
Angle between Northeast Base and Stone Mountain	80 14 23·65	
Azimuth of Stone Mountain	312 22 28·94	

* The station is 1·665 inches, or 0^{m}·0423 to the west and north out of line of the base; the center of aperture was 9^{mm}·7 east of Northeast Base.

50. LAVENDER, GEORGIA.

$\varphi=34° \ 19'·3$ $\lambda=85° \ 17'·3$

The 30^{cm} repeating theodolite No. 32 was mounted over the triangulation station. Focal length of telescope 54^{cm}; aperture 5^{cm}; magnifying power 28 and 48.* The azimuth mark was located at the secondary station Coosa, 6·9 miles distant, and nearly at the same height as Lavender. For the first fifteen nights the light was shown through a three-fourths inch opening; after that it was enlarged to 1½ inches. A set of observations consisted of 12 repetitions of the horizontal angle between mark and star, one-half of these with telescope direct and one-half with telescope reversed, and observing the star alternately direct and reflected in mercury. Observer, F. P. Webber. Probable error of a single result for azimuth $\pm 1''·92$.

Summary of results for azimuth at Lavender, Georgia.

Date.	α Ursæ Minoris at various hour angles. Mark E. of N.			Δ	Date.	α Ursæ Minoris at various hour angles. Mark E. of N.			Δ
1874.	°	′	″	″	1874.	°	′	″	″
Nov. 13	153	16	53·25	6·28	Nov. 25	153	16	41·82	5·15
			47·01	0·04	Nov. 29			43·90	3·07
			52·25	5·28				49·62	2·65
Nov. 21			51·45	4·48				43·03	3·94
			48·40	1·43				48·11	1·14
			50·68	3·71	Nov. 30			47·27	0·30
			44·27	2·70				47·23	0·26
			48·48	1·51				46·94	0·03
Nov. 23			46·37	0·60				48·28	1·31
			45·26	1·71				44·00	2·97
			48·94	1·97				42·78	4·19
			44·46	2·51	Dec. 2			45·73	1·24
Nov. 25			47·44	0·47				47·33	0·36
			47·06	0·09				47·08	0·11
			43·71	3·26	Mean	153	16	46·97±0″.36	

	°	′	″
Mean, Mark east of north	153	16	46·97
Diurnal aberration			+0·31
Azimuth of Mark	153	16	47·28±0″.36
Angle between Mark and Kenesaw	33	04	48·17
Azimuth of Kenesaw	300	11	59·11

* Two eyepieces were used at this station.

51. AURORA, ALABAMA.

$\varphi=34^\circ\ 08'.8$. $\lambda=86^\circ\ 11'.0$.

The 30^{cm} direction theodolite No. 108 (Troughton & Simms) was mounted over the triangulation station. Focal length of telescope $0^{m}.75$, aperture $7^{cm}.5$, magnifying power 60. This instrument was used here for the first time.* The azimuth mark was seen under an angle of depression of $0^\circ\ 37'.3$. A set of observations consisted of a pointing on the mark with telescope direct, followed by 2 observations of the star, one with image direct, the other with image reflected in mercury. The telescope was then reversed and the star and mark were observed as before, but in the reverse order. Observer, F. P. Webber. Probable error of a single result for azimuth $\pm 3''.08$.

Summary of results for azimuth of Aurora, Alabama.

α Ursæ Minoris at various hour angles.				α Ursæ Minoris at various hour angles.			
Date.	Position.	Mark E. of N.	Means.	Date.	Position.	Mark E. of N.	Means.
1877.		° ′ ″	″	1877.		° ′ ″	″
June 19	I	66 46 50.5	49.4	June 25	X	66 46 46.7	47.5
June 20	I	48.3			X	48.3	
	II	45.9	44.3		XI	49.3	50.0
	II	42.8			XI	50.7	
	III	43.8	48.1		XII	53.4	52.8
	III	52.4			XII	52.3	
	IV	54.5	53.7		XIII	58.2	57.3
June 24	IV	52.9			XIII	56.4	
	V	58.6	59.3	June 26	XIV	54.9	55.8
	V	59.9			XIV	56.7	
	VI	54.4	54.6		XV	51.6	52.2
	VI	54.9			XV	52.7	
	VII	47.7	48.2		XVI	48.1	48.4
	VII	48.8			XVI	48.7	
	VIII	46.4	44.7		XVII	47.0	49.1
	VIII	42.9		June 27	XVII	51.2	
	IX	47.5	46.0		Mean	66 46	$50.67 \pm 0''.72$
	IX	44.4					

	°	′	″	
Mean, Mark east of north	66	46	50.67	
Diurnal aberration			+0.31	
Azimuth of Mark	246	46	50.98	$\pm 0''.72$
Angle between Mark and Brandon	349	19	38.37	
Azimuth of Brandon	236	06	29.35	

* The graduation of the horizontal circle was afterwards found to be defective.

52. KAHATCHEE, ALABAMA.

$\varphi=33^\circ\ 13'.7.$ $\lambda=86^\circ\ 21'.6.$

The 25^{cm} repeating theodolite (Gambey) No. 63 was mounted over the triangulation station. The azimuth mark was located near the station Horn, distant 17·3 miles; light was shown from a signal lamp. A set of observations consisted of 6 repetitions of the horizontal angle between mark and star, 3 with telescope direct and 3 with telescope reversed, with the requisite time and level readings. One-third of the sets measured the angle star and mark. Value of one division of level$=2''.67$ at 24° C. Observer, O. B. French. Probable error of a single result for azimuth $\pm 0''.98$.

Summary of results for azimuth at Kahatchee, Alabama.

α Ursæ Minoris at various hour angles.						α Ursæ Minoris at various hour angles.					
Date.	Mark E. of N.			Δ		Date.	Mark E. of N.			Δ	
1898.	°	′	″	″		1898.	°	′	″	″	
June 6	73	32	12·3	−0·2		June 7	73	32	09·8	−2·7	
			12·1	−0·4		June 8			11·7	−0·8	
			13·7	+1·2					12·1	−0·4	
			11·8	−0·7					12·7	+0·2	
			10·8	−1·7					12·4	−0·1	
			11·2	−1·3					13·0	+0·5	
			15·7	+3·2					13·4	+0·9	
			12·3	−0·2					13·0	+0·5	
			15·6	+3·1					13·9	+1·4	
			14·0	+1·5					13·6	+1·1	
			14·0	+1·5					12·1	−0·4	
			15·1	+2·6					12·8	+0·3	
			13·4	+0·9					12·2	−0·3	
			11·0	−1·5		June 9			11·7	−0·8	
June 7			13·6	+1·1					13·4	+0·9	
			09·4	−3·1					11·6	−0·9	
			11·8	−0·7					12·1	−0·4	
			11·2	−1·3					11·3	−1·2	
			10·3	−2·2		Mean	73	32	12·49±0″·16		

	°	′	″
Mean, Mark east of north	73	32	12·49
Diurnal aberration			+0·31
Azimuth of Mark	253	32	12·80±0·16
Angle between Mark and Horn			0·00
Azimuth of Horn	253	32	12·80

53. ETHRIDGE, ALABAMA.

$\varphi = 32° \; 04'.7. \qquad \lambda = 87° \; 03'.5.$

The 25^{cm} repeating theodolite (Gambey) No. 63 was mounted over the triangulation station. The azimuth mark was placed over the station Lovers Leap, distant 15·2 miles. A set of observations consisted of 6 repetitions of the horizontal angle between mark and star, 3 with telescope direct and 3 with telescope reversed, with the requisite time and level record. One-half of the sets were made with the angle mark and star, the other with star and mark. Value of one division of level 2″·67 at 24° C. Observer, O. B. French. Probable error of a single result for azimuth ±0″·95.

Summary of results for azimuth of Ethridge, Alabama.

Date.	α Ursæ Minoris at various hour angles. Mark E. of N.	Δ	Date.	α Ursæ Minoris at various hour angles. Mark E. of N.	Δ
1898.	° ′ ″	″	1898.	° ′ ″	″
June 16	65 52 46·9	+2·1	June 23	65 52 48·7	+0·3
	48·0	+1·0		47·9	+1·1
	46·0	+3·0	June 24	48·4	+0·6
	50·0	−1·0		50·0	−1·0
June 23	48·1	+0·9		50·0	−1·0
	45·7	+3·3		49·3	−0·3
	48·4	+0·6		51·1	−2·1
	49·9	−0·9		50·0	−1·0
	48·9	+0·1		49·0	0·0
	49·1	−0·1		50·0	−1·0
	48·4	+0·6		51·9	−2·9
	47·6	+1·4		49·2	−0·2
	48·6	+0·4		48·9	+0·1
	49·4	−0·4		49·9	−0·9
	47·2	+1·8		50·0	−1·0
	49·8	−0·8		51·6	−2·6
			Mean	65 52 49·00±0″·17	

	° ′ ″
Mean, Mark east of north	65 52 49·00
Diurnal aberration	+0·31 ″
Azimuth of Mark	245 52 49·31±0·17
Angle between Mark and Lovers Leap	0·00
Azimuth of Lovers Leap	245 52 49·31

54. FORT MORGAN, ALABAMA.

$\varphi=30^\circ\ 13'.8$. $\lambda=88^\circ\ 01'.4$.

The 60^{cm} direction theodolite No. 2 (Troughton) was mounted over the triangulation station; focal length of telescope, 78^{cm}; aperture, 52^{cm}; magnifying power, 30 and 40.* A set of observations consisted generally of 3 pointings on the mark, telescope direct, and 3 pointings on same, telescope reversed; from 3 to 6 observations of the star, telescope direct, with time and level record. The instrument was then reversed and the preceding observations of star and mark were repeated, but in the reverse order. Some sets begin and end with 6 pointings on the mark, the reversal of the instrument taking place in the middle of the star observations. Value of one division of level, prior to April 21, 1″.66; after that date 2″.92. Observer, R. H. Fauntleroy. Probable error of a single result for azimuth ±0″.75.

Summary of results for azimuth at Fort Morgan, Alabama.

α Ursæ Minoris near western elongation.

Date.	Position.	Mark W. of N.	Δ
1847.		° ′ ″	″
Apr. 12	I	151 44 59.42	+0.94
13	II	59.16	+1.20
May 5	III	62.32	−1.96
9	V	59.64	+0.72
10	IV	61.01	−0.65
12	II	60.58	−0.22
	Mean	151 44 60.36±0″.33	

α Ursæ Minoris near eastern elongation.

Date.	Position.	Mark W. of N.	Δ
1847.		° ′ ″	″
Apr. 12	I	151 44 59.32	+0.72
16	II	58.48	+1.56
26	III	60.55	−0.51
May 9	V	60.67	−0.63
10	IV	61.18	−1.14
	Mean	151 44 60.04±0″.33	

	°	′	″
Mean of groups	151	44	60.20
Diurnal aberration			−0.31
Azimuth of Mark	28	15	00.11±0.23
Angle between Mark and Cedar Point	115	44	45.50
Azimuth of Cedar Point	143	59	45.61

* Two eyepieces used.

EAST PASCAGOULA, MISSISSIPPI.

$\varphi = 30° \; 20'·7.$ $\qquad \lambda = 88° \; 32'·8.$

The 60^{cm} direction theodolite No. 2 (Troughton) was mounted over the triangulation station; focal length of telescope, 78^{cm}; aperture, 5·2^{cm}; magnifying power, 30 and 40.* A set of observations generally consisted of 6 pointings on the mark, telescope direct, 6 observations of the star, with time and level record. The instrument was then reversed and the preceding observations were repeated, but in the reverse order. One division of level =2″·92. Observer, R. H. Fauntleroy. Probable error of a single result for azimuth ±1″·18.

Summary of results for azimuth at East Pascagoula, Mississippi.

α Ursæ Minoris near eastern elongation.				α Ursæ Minoris near western elongation.			
Date.	Position.	Mark W. of N.	Δ	Date.	Position.	Mark W. of N.	Δ
1847.		° ′ ″	″	1847.		° ′ ″	″
June 12	II	147 06 16·97	+1·77	June 14	I	147 06 14·47	+3·25
13	III	17·55	+1·19	15	III	19·04	−1·32
14	I	20·10	−1·36	18	V	20·15	−2·43
15	V	20·78	−2·04	26	IV	18·27	−0·55
18	IV	18·17	+0·57	July 9	II	17·90	−0·18
24	V	18·85	−0·11	12	III	16·50	+1·22
	Mean	147 06 18·74±0″·41			Mean	147 06 17·72±0″·55	

	°	′	″
Mean of groups	147	06	18·23
Diurnal aberration			−0·31 ″
Azimuth of Mark	32	53	42·08±0·34
Angle between East Pascagoula and Bayou Casotte	96	22	50·81
Azimuth of Bayou Casotte	296	30	51·27

* Two eyepieces used.

56. CAT ISLAND 1855, MISSISSIPPI.

$\varphi = 30° \ 14' \cdot 2$. $\lambda = 89° \ 04' \cdot 1$.

The 75^{cm} transit Coast Survey No. 9 (Würdemann) was mounted over the triangulation station. A mark was placed in the vertical of the western elongation, and the horizontal difference between star and mark measured by means of the pivot micrometer, which is ordinarily employed for adjusting the transit in azimuth.* A set of observations consisted of 2 pointings on the mark and 6 on the star, with time and level record, one-half of these observations being made with clamp east, the other with clamp west. Value of one division of micrometer $2''\cdot18$, and of one division of level $2''\cdot0$. Observer, J. E. Hilgard. Probable error of a single result for azimuth $\pm0''\cdot57$.

Summary of results for azimuth at Cat Island 1855,† Mississippi.

α Ursæ Minoris near western elongation.

Date.	Mark W. of N.			Δ
1855.	°	′	″	″
Dec. 5	1	41	10·20	−0·67
			09·71	−0·18
			09·55	−0·02
			08·81	+0·72
			08·33	+1·20
			10·58	−1·05
Mean	1	41	09·53±0″·23	

	°	′	″
Mean, Mark west of north	1	41	09·53
Diurnal aberration			−0·31 ″
Azimuth of Mark	178	18	50·78±0·23
Angle between Mark and Mississippi City	13	52	23·54
Azimuth of Mississippi City	192	11	14·32

* The instrument was overturned in a storm and the threads of its diaphragm were broken; a new single thread was put in and served for the time and azimuth observations.

† The triangulation of which this station is a part is of secondary character with respect to size and precision, and there is no check of the above result for azimuth, suc as, for instance, repeating the measures on other dates. The elongation occurred about the 3d of the above 6 consecutive measures.

PART IV.

DETERMINATION OF AN OSCULATING SPHEROID FOR THE REGION COVERED BY THE TRIANGULATION.

TREASURY DEPARTMENT

U. S. COAST AND GEODETIC SURVEY

O. H. TITTMANN, SUPERINTENDENT.

LOCATION OF PRINCIPAL ARC MEASURES AND AREAS OF OSCULATING SPHEROIDS

1901

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON D. C.

DETERMINATION OF AN OSCULATING SPHEROID FOR THE REGION COVERED BY THE TRIANGULATION.

A. COMPARISONS OF THE ASTRONOMIC AND GEODETIC RESULTS AT STATIONS CONNECTED WITH THE OBLIQUE ARC.

Parts II and III contain the necessary statements and results for the next operation, namely, the direct comparison of the astronomic latitudes, longitudes, and azimuths with their corresponding values derived geodetically by development of the triangulation upon the Clarke spheroid of 1866. In doing this the geodetic data for the station *Hays, Kansas*, as given in the account of the transcontinental triangulation and arc of the parallel in latitude 39°, have been adhered to. They are:

$$\left\{\begin{array}{ll} \varphi_0 = 38^\circ\ 54'\ 50''.180 & \\ \lambda_0 = 99\ \ 16\ \ 16.730 & \\ \alpha_0 = 359\ \ 44\ \ 19.00 & \text{Hays to La Crosse.} \end{array}\right.$$

We shall thus secure systematic positions which, if desirable, may be made at once available for a determination of an osculating spheroid based upon a surface of wider geographic limits than is contemplated in this discussion.

As early as the year 1879 the writer made a preliminary comparison of the astronomic and geodetic measures then available.* The stations included extend from Calais, Maine, to Atlanta, Georgia. That discussion furnished the first comprehensive information of the relative magnitude and distribution of the outstanding differences between the astronomic and geodetic results in the United States, the latter as developed on each of two reference spheroids. It led to the adoption of the Clarke spheroid of 1866 for use by the Coast and Geodetic Survey.

As a matter of general interest, the location of the principal arc measures and areas of osculating spheroids is shown on a Lambert equivalent zenithal projection upon a meridional plane and transferred from a hemi- to a plani-sphere,* constructed by Adolph Lindenkohl, of the Drawing Division, Coast and Geodetic Survey, for this special use. Lambert himself pointed out how the whole surface of the sphere could be represented, a fact stated again in Littrow's admirable work, Chorographie, etc., von J. J. Littrow, Wien, 1833, page 126.

* U. S. Coast and Geodetic Survey Report for 1879, Appendix No. 8, pp. 110–123.

1. THE ASTRONOMIC LATITUDE STATIONS.

The following table of the comparison of the astronomic and geodetic determinations of latitudes consists of the collection of the latitude results derived from direct observation, given in full in Part III. To these results have been added the reduction to sea level, and the reduction to the average position of the earth's pole of rotation. The tabular geodetic latitude is that of the corresponding astronomic station, the local reduction for any difference of position between the two stations having been applied.

The reduction to sea level.—As a consequence of the earth's rotation producing a slight curvature of the vertical of a station in the plane of the meridian concave toward the pole, a small correction to the observed latitude is required, which is given by the expression

$$i = -\tfrac{1}{5820}\, h \sin 2\varphi$$

where h, or height, is given in meters and i in seconds of arc. The value of the factor $-0.000\,172 \sin 2\varphi$ for different latitudes is as stated below:

For $\varphi = 50°$	$-0''.000\ 169$
45	172
40	167
35	161
30	149

The reduction for variation of pole.—The advisability of introducing into the present discussion of the astronomic and geodetic measures corrections for variation in the position of the earth's axis of rotation largely depended upon the degree of reliability of the values of such corrections. The origin of this motion is at this time imperfectly understood, and the uncertainty in the correction for variation is here considerably increased on account of the early dates of many of our latitude observations, some dating back more than half a century.

In consequence of the importance of the subject the International Geodetic Association for the measurement of the earth has organized a special service for the purpose of procuring data for the study and elucidation of the law of this variation which was first definitely formulated by Dr. S. C. Chandler. The association selected a small number of stations suitably located around the earth, near the parallel of north latitude, 39° 08′ 10″, at which it is intended to prosecute refined latitude observations for a series of years. The range of the variation is small, about 0″.3 from a mean value, and it requires, consequently, the utmost attainable precision as regards instruments and method in order to bring its periods and ranges into clear evidence.*

The probable error of a correction to an observed latitude may be estimated at ±0″.04 for the past decade, but for the earlier dates of our observations this needs to be increased.

These small corrections for variation of latitude, while yet very uncertain, could have no sensible influence upon the results of this investigation for determining a representative spheroid, nor would these small corrections be of any consequence in connection

* When comparing Dr. Chandler's *predicted* results of the motion of the pole for the years 1890 to 1897½, with results deduced directly from observation, a comparatively large discord is noticed in some places, as might be expected in such an inquiry, nor are these modern observations free from considerable uncertainty.

with the local deflections of the vertical, the average magnitude of which, namely, $2''.4$,* has been deduced from a large number of comparisons. It has, however, been concluded to apply these small and as yet rather uncertain corrections in the present investigation. The corrections to all latitude results were computed by Chandler's formulæ† except for a few stations where none were needed and for four stations occupied in 1897 and 1898 where Dr. Albrecht's results were introduced in preference, as contained in his report on the state of the latitude variation at the close of the year 1899 [Centralbureau der Internationalen Erdmessung, Berlin, 1900].

About one-half of the corrections thus computed were found to be below $0''.1$, a very few reached $0''.2$, and none exceeded $0''.25$. For the whole arc these corrections balance.

The effect of the variation of the position of the pole upon observed differences of longitude is small enough to be negligible and the same is true with reference to the observed azimuths, for which the probable error of observation always exceeds the small correction due to the polar variation.

The headings of the following summary of results need no explanation. The geodetic latitudes were in all cases referred to the astronomic station unless the two stations happened to be located on the same parallel or to be identical in position. The relative position of the stations is stated in the preceding abstracts and the reductions there given are applied to the geodetic latitude with the sign reversed. The last column contains the apparent local deflection of the vertical in the plane of the meridian or the difference ($A-G$) of the two values in the two preceding columns.

* Probable error in the direction of the vertical from all parts of India except portions under Himalayan attraction is about $\pm 2''.8$. (Annual Report of the Survey of India, 1893-94.)

† Astronomical Journal (Gould's), No. 446, October 14, 1898. The formulæ are, for the coordinates,

$$\begin{cases} x = r_1 \sin (t - T_1)\, \theta + 0''.095 \sin (\odot - 308^\circ) \\ y = r_1 \cos (t - T_1)\, \theta + 0''.110 \cos (\odot - 3^\circ) \end{cases}$$

Where

$$\begin{aligned} T_1 &= 2\,412\,646 + 427.0\, E - 0.08\, E^2 \\ \theta &= 0^\circ.843 + 0.000\,316\, E \\ r_1 &= 0''.125 + 0.05 \sin (2\,414\,363 - t) \times 0^\circ.015 \end{aligned}$$

Here t and T_1 are expressed in Julian dates, t is the epoch of observation, T_1 any epoch when the pole of the figure passes the Greenwich meridian between Greenwich and the instantaneous pole of rotation (this *latter* taken as the origin of the coordinates x and y), E is the number of periods, θ the daily angular motion, r_1 the radius vector, and $\odot$ the sun's longitude at the time t.

The variation of latitude $\varDelta\varphi = \varphi - \varphi_0 = x \sin \lambda - y \cos \lambda$, where λ equals the longitude of the place *west* of Greenwich, φ the observed and φ_0 the corrected latitude, as referred to the average or fixed position of the pole.

The day number in the expression for T_1 corresponds to the 1st of July, 1893, and that in parenthesis in the expression for r_1 to the 14th of March, 1898. The direction of the motion of the pole is from west to east.

Comparison of astronomic and geodetic latitudes.

No.	Name of latitude station.	State.	Year and month of observation.	Observed astronomic latitude.	Reduction— To sea level.	Reduction— To average pole.	Seconds— Of astronomic latitude.	Seconds— Of geodetic latitude.*	A–G
				° ′ ″	″	″	″	″	″
1	Calais	Me.	1857 Sept.	45 11 09·40	−0·01	0·00	09.39	03·78	+5·61
2	Cooper	Me.	1859 Sept.	44 59 12·60	−0·04	−0·07	12·49	11·53	+0·96
3	Humpback	Me.	1858 July and Aug.	44 51 47·56	−0·08	−0·11	47·37	49·20	−1·83
4	Bangor	Me.	1857 Sept. and Oct.	44 48 12·87	−0·01	+0·03	12·89	14·19	−1·30
5	Farmington	Me.	1866 Oct. and Nov.	44 40 19·54	−0·12	−0·07	19·35	20·78	−1·43
6	Mount Harris	Me.	1855 Aug. and Sept.	44 39 54·66	−0·07	+0·09	54·68	52·71	+1·97
7	Howard	Me.	1859 July	44 37 49·24	−0·01	−0·06	49·17	45·24	+3·93
8	Mount Desert	Me.	1856 Aug., Sept., Oct.	44 21 06·51	−0·08	+0·09	06·52	05·19	+1·33
9	Ragged Mountain	Me.	1854 Aug., Sept., Oct.	44 12 42·96	−0·07	+0·04	42·93	43·03	−0·10
10	Sabattus	Me.	1853 June and July	44 08 37·73	−0·04	−0·02	37·67	36·01	+1·66
11	Mount Pleasant	Me.	1851 July and Aug.	44 01 36·44	−0·11	−0·09	36·24	34·65	+1·59
12	Cape Small	Me.	1851 Sept. and Oct.	43 46 43·69	−0·01	+0·02	43·70	41·45	+2·25
13	Mount Independence	Me.	1849 Sept. and Oct.	43 45 34·47	−0·03	+0·12	34·56	31·80	+2·76
14	Gunstock	N. H.	1860 July and Aug.	43 31 03·81	−0·12	+0·02	03·71	00·98	+2·73
15	Agamenticus	Me.	1847 Sept., Oct., Nov.	43 13 24·96	−0·04	0·00	24·92	22·75	+2·17
16	Isles of Shoals	Me.	1847 Aug.	42 59 12·97	0·00	0·00	12·97	12·87	+0·10
17	Unkonoonuc	N. H.	1848 Sept. and Oct.	42 58 59·34	−0·07	+0·07	59·34	57·85	+1·49
18	Thompson	Mass.	1846 Sept. and Oct.	42 36 38·02	−0·01	−0·03	37·98	39·68	−1·70
19	Wachusett	Mass.	1860 Sept., Oct.	42 29 16·13	−0·10	−0·01	16·02	17·80	−1·78
20	Cambridge, Harvard College Observatory	Mass.	1844, 1845	42 22 48·05	−0·01	....	48·04	51·48	−3·44
21	Cambridge, Cloverden Observatory	Mass.	1855 Aug., Sept., Oct.	42 22 40·97	−0·01	....	40·96	44·28	−3·32
22	Mount Tom	Mass.	1862 July and Aug.	42 14 27·62	−0·06	+0·06	27·62	27·84	−0·22
23	Manomet	Mass.	1867 July and Aug.	41 55 35·35	−0·02	+0·08	35·41	36·71	−1·30
24	Sandford	Conn.	1862 Sept. and Oct.	41 27 40·47	−0·05	+0·15	40·57	41·13	−0·56
25	West Hills	N. Y.	1865 Aug.	40 48 50·06	−0·02	−0·12	49·92	53·28	−3·36
26	New York	N. Y.	1858 June	40 43 48·39	0·00	−0·13	48·26	49·16	−0·90
27	Beacon Hill	N. J.	1875 July and Aug.	40 22 27·81	−0·02	+0·14	27·93	24·46	+3·47
28	Mount Rose	N. J.	1852 July	40 22 05·41	−0·02	−0·09	05·30	01·30	+4·00
29	Yard	Pa.	1854 Oct., Nov.	39 58 29·39	−0·03	+0·03	29·39	22·67	+6·72
30	Principio	Md.	1866 July, Aug., Sept.	39 35 32·81	−0·01	−0·05	32·75	34·55	−1·80
31	Maryland Heights	Md.	1870 Sept., Oct., Nov.	39 20 32·10	−0·07	+0·16	32·19	26·30	+5·89
32	Pooles Island	Md.	1847 June and July	39 17 17·52	0·00	0·00	17·52	13·52	+4·00
33	Sugar Loaf	Md.	1879 Oct.	39 15 49·71	−0·07	−0·10	49·54	43·65	+5·89
34	Dover	Del.	1897 May	39 09 13·62	0·00	−0·15	13·47	18·59	−5·12
35	Webb	Md.	1850 Oct. and Nov.	39 05 25·21	−0·01	+0·15	25·35	24·16	+1·19
36	Rockville	Md.	1891, 1892	39 05 10·45	−0·03	....	10·42	09·08	+1·34
37	Soper	Md.	1850 June and July	39 05 10·69	−0·02	−0·06	10·61	09·80	+0·81
38	Taylor	Md.	1847 May	38 59 46·08	−0·01	0·00	46·07	46·34	−0·27
39	Strasburg	Va.	1881 June	38 59 31·49	−0·03	+0·10	31·56	27·82	+3·74
40	Cape May	N. J.	1881 May, 1891 May	38 55 44·69	0·00	−0·06	44·63	46·53	−1·90
41	Causten, Washington	D. C.	1851 May and June	38 55 32·18	−0·02	−0·14	32·02	32·81	−0·79
42	U. S. new Naval Observatory, Washington.	D. C.	1893 May, 1897 June, 1893, 1894, 1895, 1896	38 55 13·91	−0·01	−0·16	13·74	14·89	−1·15
43	Hill	Md.	1850 Aug. and Sept.	38 53 52·31	−0·01	+0·06	52·36	52·24	+0·12
44	U. S. old Naval Observatory, Washington	D. C.	1861 to 1864, 1866 to 1888, 1893	38 53 38·79	−0·01	....	38·78	40·12	−1·34
45	Seaton, Washington	D. C.	1850 June	38 53 25·20	0·00	−0·08	25·12	26·82	−1·70
46	U. S. Coast and Geodetic Survey Office, Washington	D. C.	1891 Aug., 1892 Aug., 1894 Aug.	38 53 07·43	0·00	−0·08	07.35	10·00	−2·65
47	Bull Run	Va.	1871 Sept. and Oct.	38 52 56·79	−0·07	0·00	56·72	52·08	+4·64

* For reference data see introductory remarks to Part IV.

Comparison of astronomic and geodetic latitudes—Continued.

No.	Name of latitude station.	State.	Year and month of observation.	Observed astronomic latitude.	Reduction— To sea level.	Reduction— To average pole.	Seconds— Of astronomic latitude.	Seconds— Of geodetic latitude.	$A-G$
				° ′ ″	″	″	″	″	″
48	Marriott	Md.	1846 June, 1849 May and June	38 52 25·12	−0·01	−0·06	25·05	25·68	−0·63
49	Cape Henlopen	Del.	1897 Sept.	38 46 40·00	0·00	−0·12	39·88	39·98	−0·10
50	Clark	Va.	1871 July, Aug.	38 18 39·80	−0·06	−0·14	39·60	39·22	+0·38
51	Elliott Knob	Va.	1878 July	38 09 57·51	−0·23	−0·20	57·08	57·51	−0·43
52	Charlottesville, McCormick Observatory	Va.	1882 Aug.	38 01 60·95	−0·03	+0·17	61·09	55·91	+5·18
53	Long Mountain	Va.	1875 Oct. and Nov.	37 17 28·72	−0·07	+0·19	28·84	25·50	+3·34
54	Moore	N. C.	1876 Nov. and Dec.	36 23 54·95	−0. 13	+0·23	55·05	51·44	+3·61
55	Young	N. C.	1876 Oct.	35 44 21·50	−0·05	+0·24	21·69	12·27	+9·42
56	King	N. C.	1876 Dec.	35 12 13·31	−0·08	+0·19	13·42	09·58	+3·84
57	Paris	S. C.	1875 Oct.	34 56 31·96	−0·10	+0·19	32·05	27·88	+4·17
58	Currahee	Ga.	1874 Sept. and Oct.	34 31 37·75	−0·08	+0·07	37·74	36·64	+1·10
59	Lavender	Ga.	1874 Oct. and Nov.	34 19 15·81	−0·08	+0·02	15·75	16·01	−0·26
60	Sawnee	Ga.	1873 Oct. and Nov.	34 14 04·20	−0·10	−0·07	04·03	02·93	+1·10
61	Aurora	Ala.	1877 May and June	34 08 47·45	−0·07	+0·25	47·63	45·24	+2·39
62	Atlanta Middle Base	Ga.	1872 Sept.	33 54 21·82	−0·05	−0·11	21·66	19·05	+2·61
63	Atlanta	Ga.	1880 Jan.	33 44 59·30	−0·04	+0·02	59·28	56·10	+3·18
64	Kahatchee	Ala.	1898 June	33 13 39·90	−0·06	−0·10	39·74	35·91	+3·83
65	Montgomery	Ala.	1856 Mar. and Apr.	32 22 45·41	−0·01	−0·16	45·24	37·37	+7·87
66	Lower Peach Tree	Ala.	1857 Apr.	31 50 21·19	−0·02	−0·17	21·00	18·51	+2·49
67	Coon	Ala.	1898 May	31 14 47·82	−0·01	−0·07	47·74	48·39	−0·65
68	Mobile	Ala.	1856 Dec.	30 41 33·42	0·00	+0·10	33·52	28·91	+4·61
69	East Pascagoula	Miss.	1847 June and July	30 20 40·92	0·00	−0·01	40·91	33·59	+7·32
70	Fort Morgan	Ala.	1847 Mar. and Apr.	30 13 47·89	0·00	−0·01	47·88	40·30	+7·58
71	New Orleans	La.	1858 Jan. and Feb.	29 57 25·28	0·00	+0·08	25·36	18·05	+7·31

Review of the preceding latitudinal deflections.—Taking in the whole number of comparisons, there is a preponderance of plus signs in the values of $(A-G)$, viz: 44 with a + and 27 with a − sign. This inequality is most marked in the southern part of the arc where the positive signs predominate, and this is especially the case for stations near the Gulf coast. The mean deflection of the last 4 stations is $+6''\cdot6$, apparently indicating a deviation of the plumb line directed toward the Gulf. The average value of $(A-G)$ is $+\frac{112}{71}=+1''\cdot6$. There are several localities where the latitude stations are crowded together, and, consequently, are subject to the same regional deviation. For each of these localities it is desirable to substitute a single station of average or representative value. There are 6 such cases, the latitudes in each group being contained within a space of about $1'$. For these groups we have adopted the following values:

Groups.	Value of $A-G$. ″
20, 21	−3·38
27, 28	+3·73
35, 36, 37	+1·11
38, 39	+1·74
40, 41, 42	−1·28
43, 44, 45, 46, 47, 48	−0·26

These values, when substituted for the respective tabular numbers, make

$$\frac{\Sigma(A-G)}{n}=+\frac{106}{59}=+1''\cdot8 \text{ nearly.}$$

Of these differences 39 are positive and 20 negative. The resulting average (+1″·8) may be regarded as representing the difference between the standard latitude of the transcontinental arc of the parallel of 39° and that of the eastern oblique arc. This discordance of nearly 2″ in the standard latitudes of the arcs at their intersection is not surprising when we examine the regional changes in the values of $(A-G)$ along the arc of the parallel. There are 109 astronomic latitudes connected with the arc of the parallel and 71 with the oblique arc. Of these, 24 are common to both; consequently, 156 independent latitude stations are involved in the discussions of the two arcs.

2. The Astronomic Longitude Stations.

Comparison of astronomic and standard geodetic longitudes.

No.	Name of longitude station and State.	Object of reference.	Observed astronomic longitude.	Seconds of geodetic longitude.*	A-G.
			° ′ ″	″	″
1	Calais, Me.	Transit	67 16 57·86	53·92	+3·94
2	Bangor, Me.	Transit	68 47 02·60	01·20	+1·40
3	Cambridge, Mass.	Center of dome, Harvard Observatory.	71 07 45·69	44·74	+0·95
4	Cape May, N. J.	Transit	74 55 45·68	48·03	−2·35
5	Dover, Del.	Transit	75 31 18·45	24·51	−6·06
6	Washington, D. C.	Seaton, transit	76 59 52·73	60·10	−7·37
7	Washington, D. C.	Coast and Geodetic Survey Office, transit	77 00 25·64	32·71	−7·07
8	Washington, D. C.	Old Naval Observatory, small dome	77 03 02·30	06·68	−4·38
9	Washington, D. C.	New Naval Observatory, center clock room	77 03 56·76	62·80	−6·04
10	Strasburg, Va.	Transit	78 21 35·70	39·54	−3·84
11	Charlottesville, Va.	McCormick Observatory, transit	78 31 20·10	21·15	−1·05
12	Statesville, N. C.	Transit, near Simenton College	80 53 41·31	40·44	+0·87
13	Atlanta, Ga.	Transit, 1896	84 23 20·07	19·41	+0·66
14	Montgomery, Ala.	Transit	86 17 59·19	60·92	−1·73
15	Lower Peach Tree, Ala.	Transit	87 32 40·94	43·37	−2·43
16	Mobile, Ala.	Transit	88 02 37·37	33·83	+3·54
17	New Orleans, La.	Transit, 1880 and 1895, Lafayette Square	90 04 11·44	12·16	−0·72

Review of the preceding longitudinal deflections.—Before examining the tabular values $(A-G)$ it is desirable to contract the table on account of the regional deflections about Washington by admitting only one in the place of the four closely packed stations. The average value of $(A-G)$ for numbers 6, 7, 8, 9 is −6″·22. For these, number 9 or the New Naval Observatory value −6″·04 has been substituted. The distribution of the 14 stations over the whole arc is fairly uniform. They show an average deflection of $(A-G) =$ −0″·92, the plumb line apparently being attracted to the westward. This amount might be expected from the location of the arc. Thus for one-half of the stations, either on account of proximity to the Atlantic coast or in consequence of their location to the east of the principal mountain chains, or for both reasons, negative values of $(A-G)$ might be expected. These values are as follows:

	″	
Cambridge	+0·95	
Cape May	−2·35	
Dover	−6·06	
Washington	−6·04	Average value = −2″·50.
Strasburg	−3·84	
Charlottesville	−1·05	
Statesville	+0·87	

* For reference date see introductory remarks to Part IV.

The value at New Orleans also has a negative sign, though the above reasons do not apply to this location.

It has already been remarked in the account of the transcontinental triangulation and arc of the parallel in latitude 39° that Cape May, though directly located on the coast, is distant about 213 kilometers (115 nautical miles) from the actual, but submerged, continental border.* At Calais we find the largest, yet moderate, positive deflection $+3''\cdot94$, which probably, in a measure, is due to the attraction of the mass of Nova Scotia lying directly to the eastward of the station. Respecting the remaining 6 stations no special features appear to be present, and the deviations may be indifferently + or −, the average value being $+0''\cdot45$.

3. The Astronomic Azimuth Stations.

Comparison of astronomic and geodetic azimuths of sides of the triangulation.

No.	Name of azimuth station.	State.	Year of observation.	Reference station.	Astronomic azimuth of line.			Geodetic azimuth.†	*A–G.*
					°	′	″	″	″
1	Cooper	Me.	1859	Howard	351	53	12·05	09·93	+2·12
2	Howard	Me.	1859	Pigeon	63	54	45·11	42·96	+2·15
3	Humpback	Me.	1858	Cooper	254	42	32·36	27·80	+4·56
4	Mount Desert	Me.	1856	Ragged Mountain	78	30	46·57	45·89	+0·68
5	Mount Harris	Me.	1855	Humpback	254	35	10·62	06·04	+4·58
6	Ragged Mountain	Me.	1854	Mount Pleasant	81	48	45·00	41·73	+3·27
7	Cape Small	Me.	1851	Sabattus	155	18	63·51	59·9	+3·6
8	Sabattus	Me.	1853	Mount Independence	24	31	23·51	20·64	+2·87
9	Mount Independence	Me.	1849	Agamenticus	26	55	48·60	48·38	+0·22
10	Mount Pleasant	Me.	1851	Mount Blue	205	59	21·56	17·53	+4·03
11	Agamenticus	Me.	1847	Thompson	2	36	55·51	55·92	−0·41
12	Gunstock	N. H.	1860	Mount Pleasant	217	43	33·60	27·36	+6·24
13	Unkonoonuc	N. H.	1848	Gunstock	196	35	20·38	16·68	+3·70
14	Thompson	Mass.	1846	Manomet	351	21	41·86	40·40	+1·46
15	Wachusett	Mass.	1860	Bald Hill	24	17	41·45	32·42	+9·03
16	Harvard Observatory (dome)	Mass.	1869	Blue Hill	356	25	26·4	25·1	+1·3
17	Blue Hill	Mass.	1845	Manomet	305	57	30·05	29·89	+0·16
18	Shootflying	Mass.	1845	Manomet	143	03	22·74	19·5	+3·2
19	Indian	Mass.	1845	Copecut	135	35	58·82	62·6	−3·8
20	Copecut	Mass.	1844	Blue Hill	175	17	06·5	04·04	+2·5
21	Beaconpole	R. I.	1844	Blue Hill	228	55	17·24	17·53	−0·29
22	Spencer	R. I.	1844	Beaconpole	185	57	33·02	36·5	−3·5
23	Mount Tom	Mass.	1862	Monadnock	212	37	21·74	15·13	+6·61
24	Sandford	Conn.	1862	Ruland	5	50	25·28	15·86	+9·42
25	West Hills	N. Y.	1865	Wooster	174	57	38·32	33·87	+4·45
26	Beacon Hill	N. J.	1875	Weasel	183	35	29·89	29·32	+0·57
27	Mount Rose	N. J.	1852	Mount Holly	7	46	55·59	58·26	−2·67
28	Yard	Pa.	1854	Lippincott	347	17	38·57	37·09	+1·48
29	Principio	Md.	1866	Turkey	1	34	43·51	34·59	+ 8·92
30	Cape Henlopen Light-House	Del.	1897	Brandywine Light-House	173	45	17·33	15·29	+ 2·04
31	Marriott	Md.	1849	Hill	96	37	43·36	35·04	+ 8·32
32	Webb	Md.	1850	Soper	88	59	49·24	42·70	+ 6·54
33	Hill	Md.	1850	Webb	219	46	57·89	51·13	+ 6·76
34	Soper	Md.	1850	Webb	268	49	23·46	18·14	+ 5·32
35	Seaton	D.C.	1869	Hill	265	32	53·76	42·33	+11·43
36	Causten	D.C.	1851	Soper	210	54	41·78	38·3	+ 3·5
37	Sugar Loaf	Md.	1879	Bull Run	32	29	16·79	22·28	− 5·49
38	Maryland Heights	Md.	1870	Bull Run	358	43	06·88	10·54	− 3·66

* Page 837 of Special Publication No. 4. "The Transcontinental Triangulation."

† For reference data see introductory remarks to Part IV.

Comparison of astronomic and geodetic azimuths of sides of the triangulation—continued.

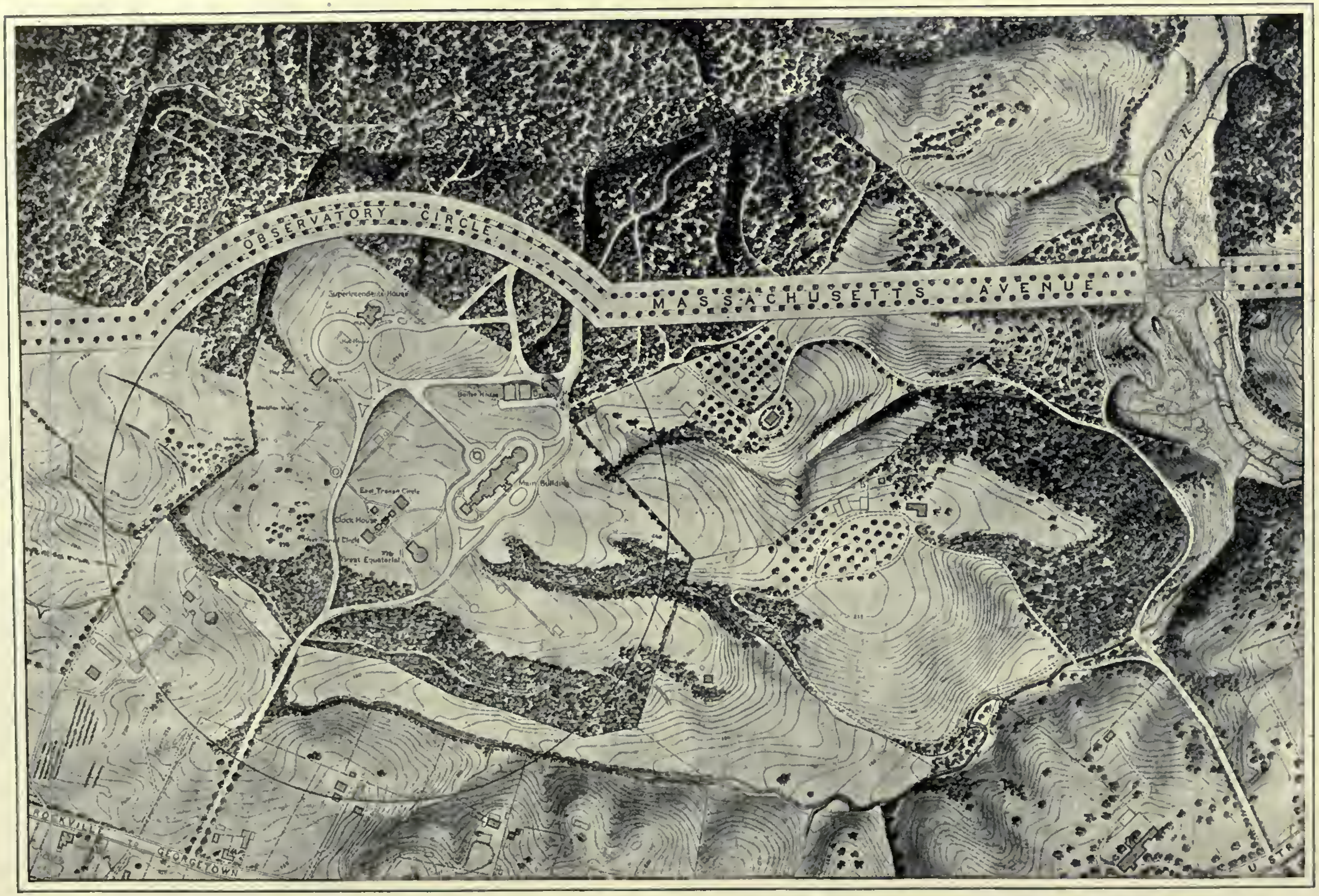
No.	Name of azimuth station.	State.	Year of observation.	Reference station.	Astronomic azimuth of line.			Geodetic azimuth.	$A-G$.
					°	′	″	″	″
39	Bull Run	Va.	1871	Peach Grove	263	53	28·15	30·60	− 2·45
40	Clark	Va.	1871	Bull Run	202	19	27·77	28·81	− 1·04
41	Long Mountain	Va.	1875	Spear	223	28	41·74	46·62	− 4·88
42	Elliott Knob	Va.	1878	Humpback	303	25	24·37	22·28	+ 2·09
43	Moore	N.C.	1876	Buffalo	158	33	31·19	32·10	− 0·91
44	Young	N.C.	1876	Poore	126	52	53·69	52·65	+ 1·04
45	King	N.C.	1877	Benn	141	33	36·9	39·3	− 2·4
46	Paris	S.C.	1875	Wofford	267	18	15·17	15·89	− 0·72
47	Currahee	Ga.	1874	Rabun	188	10	27·89	26·00	+ 1·89
48	Sawnee	Ga.	1873	Currahee	245	34	26·12	28·93	− 2·81
49	Atlanta Middle Base	Ga.	1873	Stone Mountain	312	22	28·94	32·71	− 3·77
50	Lavender	Ga.	1874	Kenesaw	300	11	59·11	61·08	− 1·97
51	Aurora	Ala.	1877	Brandon	236	06	29·35	31·43	− 2·08
52	Kahatchee	Ala.	1898	Horn	253	32	12·80	15·48	− 2·68
53	Ethridge	Ala.	1898	Lovers Leap	245	52	49·31	52·05	− 2·74
54	Fort Morgan	Ala.	1847	Cedar Point	143	59	45·61	50·69	− 5·08
55	East Pascagoula	Miss.	1847	Bayou Casotte	296	30	51·27	53·20	− 1·93
56	Cat Island 1855	Miss.	1855	Mississippi City	192	11	14·3	08·4	+5·9(?)

Review of the preceding azimuthal deflections.—We recognize as their main feature systematic but small positive deflections, i. e., plumb line attracted westward for that part of the arc which lies north of the thirty-ninth parallel, and small negative deflections for the part south of that parallel, thus showing for the whole arc a small predominating plus value of $\frac{\Sigma(A-G)}{n}=+\frac{86\cdot7}{56}=+1''\cdot55$. Omitting the last azimuth, No. 56, as doubtful,* and using No. 33 instead of the six closely clustered values in the vicinity of Washington, i. e., Nos. 31, 32, 33, 34, 35, 36, the average value for the oblique arc becomes $\frac{\Sigma(A-G)}{n}=+\frac{45\cdot7}{50}=+0''\cdot91$. This represents the discrepancy between the average azimuths of the arc of the parallel in latitude 39° and of the oblique arc, and, considering its small size, the general azimuthal directions of the two arcs may be taken as being in satisfactory accord. A remarkable feature in the tabular values of $(A-G)$, and one that had been known for a long time, is the large regional deflection existing in that part of the triangulation common to the two arcs. The average deflection observed at the six stations—Marriott, Webb, Hill, Soper, Seaton, and Causten—is $+7''\cdot0$, the plumb line being attracted to the westward. If we convert this value into a corresponding longitudinal quantity, we have $\Delta\lambda=-\Delta\alpha \sin\varphi=-11''\cdot1$, which agrees in sign but exceeds in amount the mean value $(A-G)=-6''\cdot2$, as found from the four longitudinal deflections in this region obtained at stations, only one of which is identical with any of those named above.

Considering that the present adopted azimuth depends upon 73 azimuth determinations or stations of the triangulation along the 39th parallel, any new or independent correction that might be deduced for standard value in the oblique arc would probably not differ from it by as much as one second.

*The last value of our table is marked as doubtful for the reason that the accuracy both of the astronomic and geodetic measures is inferior to that of the other tabular results; and, moreover, its appearance with a large positive value (pointing to westerly deflection) in a region where minus values predominate imparts to it an anomalous character, especially in a flat region of quaternary formation without any surface indications to justify or account for a reversal in the direction of the disturbed normal of the place. No further use will be made of this station in connection with azimuths.

NAVAL OBSERVATORY.



PLAN OF NAVAL OBSERVATORY GROUNDS.

B. DETERMINATION OF A SPHEROID MOST NEARLY REPRESENTING THAT PART OF THE EARTH'S SURFACE LYING BETWEEN MAINE AND LOUISIANA AND ALONG THE REGION COVERED BY THE TRIANGULATION.

The method and formulæ employed.

After having assumed a reference spheroid representing the figure of the earth as closely as may be, and placed in position thereon, and having developed the triangulation upon its surface, the problem next to be solved is to determine corrections to the dimensions of the reference spheroid which shall make the sum of the squares of the apparent discrepancies between geodetic and astronomic results a minimum. In other words, we are to determine a representative or osculatory spheroid which shall most nearly harmonize these measures, necessarily leaving outstanding the mere local deflections of the vertical at the stations involved.

For this purpose it has been thought most expedient to follow the theoretical development as presented by Capt. A. R. Clarke, R. E., in the *Account of the Principal Triangulation of Great Britain and Ireland.** In this work the method is developed and applied to the computation of a spheroid whose dimensions were in best accord with the curvature of the surface of these countries.

Let P be any point on the actual irregular or disturbed surface (2) and P_1 its projection upon the surface of a regular or reference spheroid (1); through P on the surface (2) let a system of rectangular axes of coordinates ξ, η, ζ, be drawn, so that ξ is directed to the north, η to the east, and ζ to the zenith. For any two points A and B connected by triangulation let φ, φ' be their observed or apparent latitudes, $\Delta\lambda$ their observed or apparent difference of longitude; also, let the direction of the meridian be observed at each place. If A_1, B_1 are the projections of A and B and s their distance, and α the observed azimuth of B at A, and α' the reverse azimuth, or that of A at B, and if φ_1, φ_1', α_1, α_1', and $\Delta\lambda_1$ refer to the points A_1, B_1, then

$$\varphi_1=\varphi+\xi \qquad \varphi_1'=\varphi'+\xi'$$
$$\alpha_1=\alpha+\eta\tan\varphi \qquad \alpha_1'=\alpha'+\eta'\tan\varphi'$$
$$\Delta\lambda_1=\Delta\lambda-\eta'\sec\varphi'+\eta\sec\varphi$$

Also let (φ'), (α'), $(\Delta\lambda)$, be the numerical results which should obtain for the point B by starting the computation from the observed latitude and given longitude of A and the observed direction of the meridian at A, together with the known distance s, then the following relations will hold. They are the fundamental equations (18), page 620 of the Ordnance Survey publication mentioned above.†

$$\xi'=(\varphi')-\varphi'+(\cos\Delta\lambda)\xi+(\sin\varphi\sin\Delta\lambda)\eta-\left(\frac{v}{\rho}\cos\alpha_1'\right)\delta\theta+Q\varepsilon$$

$$-\sec\varphi'\eta'=(\Delta\lambda)-\Delta\lambda+(\tan\varphi'\sin\Delta\lambda)\xi+\left(\frac{\sin\theta\cos\alpha'}{\cot\varphi\cos\varphi'}-\sec\varphi\right)\eta+(\sec\varphi'\sin\alpha_1')\delta\theta$$

$$\tan\varphi'\eta'=(\alpha')-\alpha'-(\sec\varphi'\sin\Delta\lambda)\xi+\left(\frac{\sin\varphi\cos\Delta\lambda}{\cos\varphi'}\right)\eta-(\tan\varphi'\sin\alpha')\delta\theta$$

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* Ordnance Survey, London, 1858, pp. 609 and following. See also Chapter XII of Clarke's Geodesy; Oxford, 1880.

† Cf. Helmert, Höhere Geodäsie, Vol. 1, pp. 535-536. Leipzig, 1880.

where

$$Q=\frac{\rho}{v}\cdot\frac{\varphi'-\varphi}{(1-e^2)^2}\cos^2 \tfrac{1}{4}(\varphi+3\varphi') \qquad \text{and} \qquad \delta\theta=-\gamma\theta-\tfrac{1}{2}\cdot\frac{\theta\sin^2\varphi}{1-e^2\sin^2\varphi}\cdot\varepsilon$$

These equations may be written in the form:

$$\begin{aligned}\xi'&=k_1+a_1\xi+b_1\eta+c_1u+e_1v\\ \eta'&=k_2+a_2\xi+b_2\eta+c_2u+e_2v\\ \eta'&=k_3+a_3\xi+b_3\eta+c_3u+e_3v\end{aligned}$$

The values of the absolute terms are:

k_1=(calculated – observed) latitude
k_2=(observed – calculated) longitude$\times\cos\varphi'$
k_3=(calculated – observed) azimuth$\times\cot\varphi'$

Here ξ=deflection of the vertical in the plane of the meridian at the initial station, positive when the tangent to the actual surface is elevated to the north of the station.

η=deflection of the vertical in the plane at right angles to the meridian at the initial station, positive when the tangent to the actual surface is elevated to the eastward.

Similarly ξ' and η' represent deflections of the vertical in the meridian and in the prime vertical planes for any other point whose latitude is φ', the latitude of the initial point being φ.

θ is the arc distance of the initial point from any other point.

α, the azimuth at the initial point of any other point.

α', the reverse azimuth or that from any point to the initial one. The azimuths count from north toward the east.

$\Delta\lambda$ is the difference of longitude between the initial and any other point; west longitudes are considered positive; $\Delta\lambda=\lambda'-\lambda$.

It may be remarked here that the observations for difference of longitude give the same kind of information as those for azimuth, so that the first set of equations may be used as a confirmation or check of the other set.

The quantities θ, α, α', φ, φ', $\Delta\lambda$ are geodetic values.

For evaluating the quantities $Q\varepsilon$ and $\delta\theta$ in the preceding equations, we have for v or length of line normal to the surface and terminating at the minor axis

$$v=\frac{a}{(1-e^2\sin^2\varphi)^{1/2}}$$

and for ρ the radius of curvature

$$\rho=\frac{a(1-e^2)}{(1-e^2\sin^2\varphi)^{3/2}}$$

Putting

$$100\frac{v}{\rho}=\mu \qquad \text{and} \qquad \frac{\rho}{v}\cdot\frac{100}{(1-e^2)^2}\cos^2 \tfrac{1}{4}(\varphi+3\varphi')=\mu'$$

hence

$$\mu=100\frac{[1-e^2\sin^2 \tfrac{1}{2}(\varphi'+\varphi)]^{3/2}}{(1-e^2)(1-e^2\sin^2\varphi)^{1/2}} \qquad \text{and} \qquad \mu'=\frac{(100)^2}{\mu}\cdot\frac{\cos^2 \tfrac{1}{4}(\varphi+3\varphi')}{(1-e^2)^2}$$

also writing

u(arc 100″) for γ and v(arc 100″) for ε, then

$Q\varepsilon=\mu'(\varphi'-\varphi)\sin 1''v$

$-\delta\theta=100\,\theta\sin 1''u+100\,g\,\theta\sin 1''v$, where g is a constant, viz:

$$g=\frac{\frac{1}{2}\sin^2\varphi}{1-e^2\sin^2\varphi}$$

If a=equatorial radius of reference spheroid and $e^2=\frac{a^2-b^2}{a^2}$ the square of its eccentricity, the respective values of the corrected spheroid become

$$a+\gamma a \text{ and } e^2+\varepsilon$$

The corrections to the semiaxis major and to the square of the eccentricity are then

$$a\,(\text{arc } 100'')u \text{ and } (\text{arc } 100'')v$$

where u and v are to be derived from the solution of the equations.

The coefficients in the equations (18) in simplified form are as follows:

$$\begin{cases} a_1=\cos \varDelta\lambda \\ b_1=\sin\varphi\sin\varDelta\lambda \\ c_1=\mu\,\theta\cos\alpha' \\ e_1=\mu g\,\theta\cos\alpha'+\mu'(\varphi'-\varphi) \end{cases} \quad \begin{cases} a_2=-\sin\varphi'\sin\varDelta\lambda \\ b_2=\cos\varphi'/\cos\varphi-(\sin\theta\cos\alpha')\tan\varphi \\ c_2=100\,\theta\sin\alpha' \\ e_2=100\,g\,\theta\sin\alpha' \end{cases} \quad \begin{cases} a_3=-\sin\varDelta\lambda/\sin\varphi' \\ b_3=\sin\varphi\cos\varDelta\lambda/\sin\varphi' \\ c_3=100\,\theta\sin\alpha' \\ e_3=100\,g\,\theta\sin\alpha' \end{cases}$$

The values of θ and α' are to be computed from the known geodetic latitudes and longitudes of the initial and any other astronomic point of the triangulation. θ and α' may be computed by the inversion of the formulæ for direct position computation as given in the Report for 1894, Appendix No. 9, pages 284–286. No extreme accuracy is required in the computation of the respective coefficients, and it is found that the Survey formulæ when rigorously employed in their reversed application—viz, given two positions to find their distance and azimuths—answer well up to the limit here required* where θ does not exceed 14°.

The values of μ and μ' are to be tabulated for convenient intervals of latitude and of sufficient extent to cover the limits of the triangulation.

In applying the preceding method and formulæ for the determination of an improved spheroid most nearly conforming to the surface under consideration, a suitable initial station must be chosen, preferably centrally located in order to keep the values of θ as small as possible. The United States (New) Naval Observatory on Georgetown Heights, Washington, District of Columbia, has been adopted for this station; its geographic position refers to the center of the clock room, for which we have the geodetic latitude 38° 55′ 14″·89 and the geodetic longitude 77° 04′ 02″·80, these figures being based upon the same data as the positions in the transcontinental triangulation.† In this system the position of station Hays, Kansas, is in latitude 38° 54′ 50″·180 and in longitude 99° 16′ 16″·730. The maximum value of θ for the extreme northeast station is less than 10° and for the extreme southwest station slightly less than 14°. The initial station also fairly represents an average local deflection of the plumb line for the region about the District of Columbia, and the point being common to the two arcs, additional equations of condition, depending upon other stations of the arc of the parallel than those at present included, can readily be incorporated, if desirable.

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*The additional terms in $\varDelta\varphi$ given on p. 285 must be included in the computation. A rough check on θ and α may be had by the use of the spherical formulæ, $\cos\theta=\cos\varphi\cos\varphi'\cos\varDelta\lambda+\sin\varphi\sin\varphi'$ and $\sin\alpha=\cos\varphi\sin\varDelta\lambda/\sin\theta$.

†The new observatory was connected by local triangulation with the Coast and Geodetic Survey triangulation by Prof. W. Harkness, Astronomical Director, in 1893 and 1894, and by Assistant E. D. Preston in 1894. The work of Assistant C. Junken in 1881 is involved in the adjustment of the geodetic connection.

Collection of certain constants and tabular quantities required in the computation for establishing the conditional equations.

For Clarke's spheroid of 1866 we have

$$\log a = 6{\cdot}804\ 698\ 57$$
$$\log b = 6{\cdot}803\ 223\ 78$$
$$\log e^2 = \bar{7}{\cdot}830\ 502\ 57$$

with the following data for the reference station,

$$\varphi = 38^\circ\ 55'\ 14''{\cdot}9$$
$$\lambda = 77\ \ 04\ \ 02\ {\cdot}8$$
$$\log g = \bar{9}{\cdot}296\ 391$$

Values of log μ sin 1″ between latitudes 30° and 45°.

φ'		φ'		φ'	
30°	6·687 692	35°	6·687 509	40°	6·687 321
30½	674	35½	490	40½	302
31	655	36	471	41	283
31½	637	36½	453	41½	264
32	619	37	434	42	245
32½	600	37½	415	42½	226
33	582	38	396	43	207
33½	564	38½	377	43½	188
34	546	39	359	44	169
34½	527	39½	340	44½	150
				45	131
$\Delta(½)^\circ = 18{\cdot}3$		$\Delta(½)^\circ = 18{\cdot}8$		$\Delta(½)^\circ = 19{\cdot}0$	

Values of log μ′ sin 1″ between latitudes 30° and 45½°.

φ′		Δ10′	φ′		Δ10′	φ′		Δ10′
30°00′	6·544 00	119	35°00′	6·505 67	137	40°00′	6·461 66	158
10	42 81	120	10	04 30	138	10	60 08	158
20	41 61	120	20	02 92	138	20	58 50	159
30	·540 41	121	30	·501 54	139	30	·456 91	159
40	39 20	121	40	·500 15	140	40	55 32	160
50	37 99	122	50	·498 75	141	50	53 72	161
31	·536 77	123	36	·497 34	141	41	·452 11	161
10	35 54	123	10	95 93	142	10	50 50	162
20	34 31	124	20	94 51	142	20	48 88	163
30	·533 07	124	30	·493 09	143	30	·447 25	164
40	31 83	125	40	91 66	143	40	45 61	164
50	30 58	125	50	90 22	144	50	43 97	165
32	·529 33	126	37	·488 78	145	42	·442 32	166
10	28 07	127	10	87 33	146	10	40 66	167
20	26 80	128	20	85 87	146	20	38 99	167
30	·525 52	128	30	·484 41	147	30	·437 32	168
40	24 24	129	40	82 94	148	40	35 64	169
50	22 95	129	50	81 46	148	50	33 95	169
33	·521 66	130	38	·479 98	149	43	·432 26	170
10	20 36	130	10	78 49	150	10	30 56	171
20	19 06	131	20	76 99	150	20	28 85	172
30	·517 75	132	30	·475 49	151	30	·427 13	173
40	16 43	132	40	73 98	152	40	25 40	173
50	15 11	133	50	72 46	152	50	23 67	174
34	·513 78	134	39	·470 94	153	44	·421 93	175
10	12 44	134	10	69 41	153	10	20 18	176
20	11 10	135	20	67 88	154	20	18 42	176
30	·509 75	135	30	·466 34	155	30	·416 66	177
40	08 40	136	40	64 79	156	40	14 89	178
50	07 04	137	50	63 23	157	50	13 11	178
35	6·505 67		40	6·461 66		45	·411 33	179
						10	09 54	180
						20	07 74	181
						30	6·405 93	

Selection of stations for which the results of comparison of astronomic and geodetic data were admitted into the equations of condition.

In a preceding table there has been exhibited a comparison of the astronomic and geodetic *latitudes* for 71 stations. If all of these were included in the discussion, the labor of computation would be unnecessarily great, since practically the same accuracy of the results can be attained by a judicious selection of a much smaller number of latitude stations, provided they are uniformly distributed over the whole region of the arc.

The following table contains these selected stations with their geodetic positions (to the nearest half second), together with the computed distances θ and azimuths α' to the reference station at Washington, D. C. For these stations the value, $\Sigma\,(A-G) \div n = +2''\cdot 1$, is nearly the same as that previously derived from all the stations after the mean value for each of the 6 groups had been introduced in place of the separate values.

No.	Name of latitude station.	Geodetic latitude φ'.	Geodetic longitude λ'.	$\varphi'-\varphi$	$\lambda'-\lambda$.	θ	α'.
		° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
1	Calais	45 11 04	67 16 54	+6 15 49	− 9 47 09	9 34 49	232 42 56
2	Cooper	44 59 11·5	67 28 03	+6 03 56·5	− 9 36 00	9 21 22	233 03 11
3	Humpback	44 51 49	68 06 39	+5 56 34	− 8 57 24	8 55 16	231 27 55
4	Farmington	44 40 21	70 09 18·5	+5 45 06	− 6 54 44·5	7 42 59	224 19 19
5	Mount Desert	44 21 03	68 13 39	+5 25 48	− 8 50 24	8 32 35	233 42 02
6	Mount Pleasant	44 01 35	70 49 23	+5 06 20	− 6 14 40	6 55 15	224 43 13
7	Mount Independence	43 45 32	70 19 15	+4 50 17	− 6 44 48	7 00 00	228 41 55
8	Agamenticus	43 13 22·5	70 41 34	+4 18 07·5	− 6 22 29	6 26 47	230 24 31
9	Unkonoonuc	42 58 58	71 35 20	+4 03 43	− 5 28 43	5 47 45	227 27 59
10	Thompson	42 36 40	70 43 50	+3 41 25	− 6 20 13	6 03 04	234 39 19
11	Mount Tom	42 14 28	72 38 56	+3 19 13	− 4 25 07	4 43 10	226 52 28
12	Manomet	41 55 37	70 35 29	+3 00 22	− 6 28 34	5 46 18	240 51 31
13	Sandford	41 27 41	72 57 00	+2 32 26	− 4 07 03	4 02 33	232 31 34
14	West Hills	40 48 53	73 25 33	+1 53 38	− 3 38 30	3 22 33	237 09 52
15	Beacon Hill	40 22 24·5	74 13 42·5	+1 27 09·5	− 2 50 20·5	2 37 27	237 24 50
16	Yard	39 58 23	75 23 14	+1 03 08	− 1 40 49	1 40 14	231 36 39
17	Principio	39 35 34·5	76 00 17	+0 40 19·5	− 1 03 46	1 03 46	231 12 50
18	Pooles Island	39 17 13·5	76 15 50	+0 21 58·5	− 0 48 13	0 43 24	239 55 48
19	Washington*	38 55 15	77 04 03	0·0	0·0	0	... .
20	Cape Henlopen L. H.	38 46 40	75 05 03·5	−0 08 35	− 1 58 59·5	1 33 04	275 53 29
21	Clark	38 18 39	78 00 12	−0 36 36	+ 0 56 09	0 57 08	49 59 24
22	Elliott Knob	38 09 57·5	79 18 52	−0 45 17·5	+ 2 14 49	1 54 45	66 08 42
23	Long Mountain	37 17 25·5	79 05 11	−1 37 49·5	+ 2 01 08	2 16 35	43 45 26
24	Moore	36 23 51·5	80 17 00	−2 31 23·5	+ 3 12 57	3 35 02	44 24 15
25	Young	35 44 12	80 38 52	−3 11 03	+ 3 34 49	4 16 14	40 50 55
26	King	35 12 09·5	81 18 46	−3 43 05·5	+ 4 14 43	5 01 43	41 11 54
27	Currahee	34 31 36·5	83 22 34	−4 23 38·5	+ 6 18 31	6 41 44	47 16 55
28	Sawnee	34 14 03	84 09 39	−4 41 12	+ 7 05 36	7 22 20	48 36 15
29	Atlanta	33 44 56	84 23 19·5	−5 10 19	+ 7 19 16·5	7 50 20	46 45 07
30	Kahatchee	33 13 36	86 21 37	−5 41 39	+ 9 17 34	9 24 59	50 17 08
31	Montgomery	32 22 37	86 18 01	−6 32 38	+ 9 13 58	9 56 43	46 24 38
32	Lower Peach Tree	31 50 18·5	87 32 43	−7 04 56·5	+10 28 40	11 04 59	47 31 10
33	Coon	31 14 48	88 05 44	−7 40 27	+11 01 41	11 49 45	46 40 41
34	Mobile	30 41 29	88 02 34	−8 13 46	+10 58 31	12 11 09	44 41 43
35	Fort Morgan	30 13 40	88 01 24	−8 41 35	+10 57 21	12 30 30	43 11 11
36	New Orleans (1858)	29 57 18	90 04 25	8 57 57	+13 00 22	13 57 12	46 41 30

* United States Naval Observatory, Georgetown Heights.

The data for the computation of the distances of the several astronomic *longitude stations* from the reference station and of the azimuths of the latter from each of the stations are contained in the following table:

No.	Name of longitude station.	Geodetic latitude. φ'	Geodetic longitude. λ'	$\Delta\lambda$	θ	α'
		° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
1	Calais	45 11 04	67 16 54	− 9 47 09	9 34 49	232 42 56
2	Bangor	44 48 14	68 47 01	− 8 17 02	8 30 58	229 18 11
3	Cambridge	42 22 51·5	71 07 45	− 5 56 18	5 40 42	234 33 00
4	Cape May	38 55 46·5	74 55 48	− 2 08 15	1 39 46	270 22 17
5	Dover	39 09 18·5	75 31 24·5	− 1 32 38·5	1 13 19	259 28 40
6	Washington *	38 55 15	77 04 03	0	0	.. .. ..
7	Strasburg	38 59 28	78 21 39·5	+ 1 17 36·5	1 00 30	93 34 20
8	Charlottesville †	38 01 56	78 31 21	+ 1 27 18	1 26 40	51 42 23
9	Statesville	35 46 54	80 53 40	+ 3 49 37	4 22 14	43 04 37
10	Atlanta	33 44 56	84 23 19·5	+ 7 19 16·5	7 50 20	46 45 03
11	Montgomery	32 22 37	86 18 01	+ 9 13 58	9 56 43	46 24 38
12	Lower Peach Tree	31 50 18·5	87 32 43	+10 28 40	11 04 59	47 31 10
13	Mobile	30 41 29	88 02 34	+10 58 31	12 11 09	44 41 43
14	New Orleans (1895)	29 56 51·5	90 04 12	+13 00 09	13 57 22	46 39 50

The data for the computation of the distances of the several astronomic *azimuth stations* from the initial station and of the azimuths of the latter from the various stations will be found in the following table, together with the resulting values of θ and α'.

As was the case with the latitudes, we have here a surplus of stations at which astronomic azimuths were measured. Much labor may therefore be saved without incurring any sensible loss of accuracy in the results by the selection of a more limited number of stations uniformly distributed, as nearly as may be, over the whole arc and properly representing the deflection over every part of it. For these 34 positions the average value of $(A-G)$ is $1''.9$, the same value found from all the stations.

* United States Naval Observatory, Georgetown Heights, Washington, D. C.

† McCormick Observatory.

No.	Name of azimuth station.	Geodetic latitude φ′.	Geodetic longitude λ′.	θ	α′
		° ′ ″	° ′ ″	° ′ ″	° ′ ″
15	Cooper	44 59 11 .5	67 28 03	9 21 22	233 03 11
16	Humpback	44 51 49	68 06 39	8 55 16	231 27 55
17	Mount Desert	44 21 03	68 13 39	8 32 35	233 42 02
18	Mount Harris	44 39 53	69 08 56	8 13 45	228 35 51
19	Sabattus	44 08 36	70 04 45	7 23 11	227 31 20
20	Agamenticus	43 13 22 .5	70 41 34	6 26 47	230 24 31
21	Gunstock	43 31 02	71 22 12	6 16 52	225 01 01
22	Unkonoonuc	42 58 58	71 35 20	5 47 45	227 27 59
23	Blue Hill	42 12 42	71 06 53 .5	5 35 25	236 01 39
24	Mount Tom	42 14 29	72 38 56	4 43 11	226 52 19
25	Sandford	41 27 41	72 57 00	4 02 33	232 31 34
26	West Hills	40 48 53	73 25 33	3 22 33	237 09 52
27	Mount Rose	40 22 01	74 43 26	2 18 45	232 09 32
28	Yard	39 58 23	75 23 14	1 40 14	231 36 39
29	Principio	39 35 34 .5	76 00 17	1 03 46	231 12 50
30	Cape Henlopen Light-House	38 46 40	75 05 03 .5	1 33 04	275 53 29
31	Hill	38 53 53	76 52 50	0 08 50	278 55 34
32	Maryland Heights	39 20 26	77 43 00	0 39 20	129 29 27
33	Bull Run	38 52 51	77 42 13	0 29 48	85 11 54
34	Clark	38 18 39	78 00 12	0 57 08	49 59 24
35	Long Mountain	37 17 25 .5	79 05 11	2 16 35	43 45 26
36	Elliott Knob	38 09 57	79 18 52	1 54 45	66 08 42
37	Moore	36 23 51 .5	80 17 00	3 35 02	44 24 15
38	Young	35 44 12	80 38 52	4 16 14	40 50 55
39	King	35 12 25 .5	81 18 46	5 01 31	41 13 54
40	Paris	34 56 27	82 24 40 .5	5 50 10	45 34 04
41	Currahee	34 31 43	83 22 34	6 41 40	47 17 31
42	Atlanta Middle Base	33 54 19	84 16 38	7 39 52	47 11 11
43	Lavender	34 19 17	85 17 19	8 02 13	52 50 26
44	Aurora	34 08 45 .5	86 11 01	8 44 14	54 21 31
45	Kahatchee	33 13 36	86 21 37	9 24 59	50 17 08
46	Ethridge	32 04 44	87 03 29 .5	10 36 57	47 14 05
47	Fort Morgan	30 13 40	88 01 24	12 30 30	43 11 11
48	East Pascagoula	30 20 33 .5	88 32 46	12 44 17	44 43 51

Conditional or observation equations derived from latitude comparisons.

″				
$\xi_{1}=-5\cdot61$	$+0\cdot9854\xi$	$-0\cdot1068\eta$	$-10\cdot1651u$	$+3\cdot7759v$
$\xi_{2}=-0\cdot96$	$+0\cdot9860$	$-0\cdot1048$	$-9\cdot8505$	$+3\cdot6825$
$\xi_{3}=+1\cdot83$	$+0.9878$	$-0\cdot0978$	$-9\cdot7350$	$+3\cdot6082$
$\xi_{4}=+1\cdot43$	$+0\cdot9927$	$-0\cdot0756$	$-9\cdot6700$	$+3\cdot4683$
$\xi_{5}=-1\cdot33$	$+0.9881$	$-0\cdot0965$	$-8\cdot8595$	$+3\cdot3677$
$\xi_{6}=-1\cdot59$	$+0\cdot9941$	$-0\cdot0683$	$-8\cdot6143$	$+3\cdot1483$
$\xi_{7}=-2\cdot76$	$+0\cdot9951$	$-0\cdot0738$	$-8\cdot0935$	$+3\cdot0268$
$\xi_{8}=-2\cdot17$	$+0\cdot9938$	$-0\cdot0697$	$-7\cdot1973$	$+2\cdot7441$
$\xi_{9}=-1\cdot49$	$+0\cdot9954$	$-0\cdot0600$	$-6\cdot8641$	$+2\cdot5997$
$\xi_{10}=+1\cdot70$	$+0\cdot9939$	$-0\cdot0693$	$-6\cdot1328$	$+2\cdot4135$
$\xi_{11}=+0\cdot22$	$+0\cdot9970$	$-0\cdot0484$	$-5\cdot6524$	$+2\cdot1731$
$\xi_{12}=+1\cdot30$	$+0\cdot9936$	$-0\cdot0709$	$-4\cdot9244$	$+2\cdot0272$
$\xi_{13}=+0\cdot56$	$+0\cdot9974$	$-0\cdot0451$	$-4\cdot3093$	$+1\cdot7109$
$\xi_{14}=+3\cdot36$	$+0\cdot9980$	$-0\cdot0399$	$-3\cdot2074$	$+1\cdot3042$
$\xi_{15}=-3\cdot47$	$+0\cdot9988$	$-0\cdot0311$	$-2\cdot4765$	$+1\cdot0117$
$\xi_{16}=-6\cdot72$	$+0\cdot9996$	$-0\cdot0184$	$-1\cdot8179$	$+0\cdot7376$
$\xi_{17}=+1\cdot80$	$+0\cdot9998$	$-0\cdot0116$	$-1\cdot1667$	$+0\cdot4758$
$\xi_{18}=-4\cdot00$	$+0\cdot9999$	$-0\cdot0088$	$-0\cdot6352$	$+0\cdot2619$
$\xi_{19}=+1\cdot15$	$+1\cdot0000$	$0\cdot0000$	$0\cdot0000$	$0\cdot0000$
$\xi_{20}=+0\cdot10$	$+0\cdot9994$	$-0\cdot0217$	$+0\cdot2790$	$-0\cdot0978$
$\xi_{21}=-0\cdot38$	$+0\cdot9999$	$+0\cdot0103$	$+1\cdot0730$	$-0\cdot4466$
$\xi_{22}=+0\cdot43$	$+0\cdot9992$	$+0\cdot0246$	$+1\cdot3556$	$-0\cdot5496$
$\xi_{23}=-3\cdot34$	$+0\cdot9994$	$+0\cdot0221$	$+2\cdot8818$	$-1\cdot2281$
$\xi_{24}=-3\cdot61$	$+0\cdot9984$	$+0\cdot0353$	$+4\cdot4882$	$-1\cdot9447$
$\xi_{25}=-9\cdot42$	$+0\cdot9980$	$+0\cdot0392$	$+5\cdot6629$	$-2\cdot5008$
$\xi_{26}=-3\cdot84$	$+0\cdot9973$	$+0\cdot0465$	$+6\cdot6332$	$-2\cdot9595$
$\xi_{27}=-1\cdot10$	$+0\cdot9939$	$+0\cdot0690$	$+7\cdot9634$	$-3\cdot5375$
$\xi_{28}=-1\cdot10$	$+0\cdot9923$	$+0\cdot0776$	$+8\cdot5469$	$-3\cdot7925$
$\xi_{29}=-3\cdot18$	$+0\cdot9918$	$+0\cdot0801$	$+9\cdot4168$	$-4\cdot2428$
$\xi_{30}=-3\cdot83$	$+0\cdot9869$	$+0\cdot1014$	$+10\cdot5494$	$-4\cdot6986$
$\xi_{31}=-7\cdot87$	$+0\cdot9870$	$+0\cdot1008$	$+12\cdot0241$	$-5\cdot5387$
$\xi_{32}=-2\cdot49$	$+0\cdot9833$	$+0\cdot1143$	$+13\cdot1250$	$-6\cdot0530$
$\xi_{33}=+0\cdot65$	$+0\cdot9816$	$+0\cdot1202$	$+14\cdot2331$	$-6\cdot6521$
$\xi_{34}=-4\cdot61$	$+0\cdot9817$	$+0\cdot1196$	$+15\cdot1918$	$-7\cdot2431$
$\xi_{35}=-7\cdot58$	$+0\cdot9818$	$+0\cdot1194$	$+15\cdot9952$	$-7\cdot7455$
$\xi_{36}=-7\cdot31$	$+0\cdot9743\xi$	$+0\cdot1414\eta$	$+16\cdot7861u$	$-7\cdot9819v$

Conditional equations derived from longitude comparisons.

″				
η_{1}=+2·78	+0·1206ξ	+0·9873η	−13·3036u	−2·6324v
η_{2}=+0·99	+0·1015	+0·9899	−11·2689	−2·2298
η_{3}=+0·70	+0·0697	+0·9958	− 8·0733	−1·5975
η_{4}=−1·83	+0·0234	+0·9998	− 2·9021	−0·5743
η_{5}=−4·70	+0·0170	+0·9998	− 2·0968	−0·4146
η_{6}=−4·70	0·0000	+1·0000	0·0000	0·0000
η_{7}=−2·98	−0·0142	+0·9999	+ 1·7565	+0·3476
η_{8}=−0·83	−0·0157	+0·9998	+ 1·9786	+0·3915
η_{9}=+0·71	−0·0390	+0·9978	+ 5·2098	+1·0309
η_{10}=+0·55	−0·0708	+0·9932	+ 9·9653	+1·9719
η_{11}=−1·46	−0·0859	+0·9893	+12·5722	+2·4877
η_{12}=−2·06	−0·0959	+0·9870	+14·2656	+2·8228
η_{13}=+3·04	−0·0972	+0·9841	+14·9586	+2·9599
η_{14}=−0·62	−0·1123ξ	+0·9801η	+17·7166u	+3·5058v

Conditional equations derived from azimuth comparisons.

″				
η_{15}=− 2·12	+0·2359ξ	+0·8762η	−13·0504u	−2.5823v
η_{16}=− 4·58	+0·2207	+0·8797	−12·1795	−2·4100
η_{17}=− 0·70	+0·2198	+0·8880	−12·0170	−2·3778
η_{18}=− 4·63	+0·1960	+0·8852	−10·7734	−2·1318
η_{19}=− 2·96	+0·1747	+0·8954	− 9·5081	−1·8814
η_{20}=+ 0·44	+0·1621	+0·9117	− 8·6702	−1·7156
η_{21}=− 6·57	+0·1442	+0·9079	− 7·7540	−1·5343
η_{22}=− 3·97	+0·1400	+0·9173	− 7·4540	−1·4750
η_{23}=− 0·18	+0·1544	+0·9300	− 8·0914	−1·6011
η_{24}=− 7·28	+0·1146	+0·9318	− 6·0119	−1·1896
η_{25}=−10·66	+0·1084	+0·9464	− 5·5994	−1·1080
η_{26}=− 5·15	+0·0972	+0·9593	− 4·9506	−0·9796
η_{27}=+ 3·14	+0·0631	+0·9692	− 3·1873	−0·6307
η_{28}=− 1·77	+0·0456	+0·9775	− 2·2853	−0·4522
η_{29}=−10·78	+0·0291	+0·9856	− 1·4459	−0·2861
η_{30}=− 2·54	+0·0552	+1·0025	− 2·6928	−0·5329
η_{31}=− 8·38	+0·0052	+1·0005	− 0·2538	−0·0502
η_{32}=+ 4·47	−0·0179	+0·9910	+ 0·8830	+0·1747
η_{33}=+ 3·04	−0·0177	+1·0008	+ 0·8638	+0·1709
η_{34}=+ 1·32	−0·0264	+1·0133	+ 1·2729	+0·2519
η_{35}=+ 6·41	−0·0582	+1·0363	+ 2·7478	+0·5437
η_{36}=− 2·66	−0·0634	+1·0159	+ 3·0528	+0·6041
η_{37}=+ 1·23	−0·0945	+1·0571	+ 4·3768	+0·8660
η_{38}=− 1·44	−0·1069	+1·0735	+ 4·8751	+0·9646
η_{39}=+ 3·40	−0·1284	+1·0867	+ 5·7809	+1·1439
η_{40}=+ 1·03	−0·1626	+1·0922	+ 7·2736	+1·4393
η_{41}=− 2·75	−0·1939	+1·1017	+ 8·5856	+1·6989

Conditional equations derived from azimuth comparisons—continued.

$\eta_{42}=+5''.61$	-0.2250	$+1.1173$	$+9.8130$	$+1.9417$
$\eta_{43}=+2.89$	-0.2536	$+1.1028$	$+11.1790$	$+2.2120$
$\eta_{44}=+3.07$	-0.2823	$+1.1051$	$+12.3928$	$+2.4522$
$\eta_{45}=+4.09$	-0.2947	$+1.1315$	$+12.6422$	$+2.5016$
$\eta_{46}=+4.37$	-0.3266	$+1.1650$	$+13.6023$	$+2.6916$
$\eta_{47}=+8.72$	-0.3775	$+1.2252$	$+14.9407$	$+2.9564$
$\eta_{48}=+3.30$	-0.3939ξ	$+1.2187\eta$	$+15.6464u$	$+3.0961v$

Formation of normal equations.

The types of a latitude observation equation and of a longitude and azimuth equation are:

$$\xi_p = m + a\xi + b\eta + cu + ev$$
$$\eta_q = n + a'\xi + b'\eta + c'u + e'v$$

then ξ, η, u, and v are to be determined so as to make a minimum the quantity

$$\Sigma(m+a\xi+b\eta+cu+ev)^2 + w\Sigma(n+a'\xi+b'\eta+c'u+e'v)^2$$

whence the normal equations:

$$0=(am)+w(a'n)+[aa]\xi+[ab]\eta+[ac]u+[ae]v$$
$$0=(bm)+w(b'n)+[ab]\xi+[bb]\eta+[bc]u+[be]v$$
$$0=(cm)+w(c'n)+[ac]\xi+[bc]\eta+[cc]u+[ce]v$$
$$0=(em)+w(e'n)+[ae]\xi+[be]\eta+[ce]u+[ee]v$$

where

$$[aa]=(aa)+w(a'a')$$
$$[ab]=(ab)+w(a'b')$$

For equal weight to the several equations w becomes unity, as will be assumed in the first of our combinations.

The relative weights of the observation equations.

The equations involving the comparisons of the latitudes and longitudes may be considered as of fairly equal weight, the result of the introduction of the telegraphic method for the determination of differences of longitudes; thus arcs of the meridian and arcs of the parallel may now be combined as of equal importance as far as the astronomic data are concerned.

It is quite evident, however, that the azimuthal equations are certainly of inferior value, considering that they are directly affected by the accumulation of error in the angular measures of the triangles by means of which the geodetic azimuths are carried forward. If unit weight is assigned to each of the latitude and longitude equations, a fraction only can be assigned for the weight of an azimuth equation. There is no principle by means of which the exact ratio of the weights could be ascertained, but the comparison of the mean values of the squares of the ξ's and of the η's, which shows that the latter is generally the larger of the two, sufficiently indicates the need of the introduction of relative weights. There is no reason why the average deflections in the meridian and in the prime vertical or in any azimuthal plane should be of different magnitude.

The resulting values of the ξ's and η's, or the remainders, in the equations for the several stations may be taken as representing the actual local or regional deviations of the vertical of the geoid at these places as compared with the normal or geometric direction; in other words, they exhibit the difference between the disturbed and the regular or undisturbed direction of gravity within the geographic limits of the investigation. As a matter of course these values are affected to a relatively small extent by the unavoidable errors of observation.

For the case in hand, as shown in the following solution, we have the mean value of the squares of the discrepancies in φ and λ, equal to $\frac{589{\cdot}6}{50}=11{\cdot}8$, and the mean value of the squares of the differences in α, equal to $\frac{789{\cdot}2}{34}=23{\cdot}2$, or about double the former; which indicates that the azimuth equations should not have more than half weight.

This solution presents the results for a spheroid representing the curvature of the surface along the arc without distinguishing relatively between the measures of latitudes, longitudes, and azimuths.

Resulting normal equations.

From the latitude observations:

$$\begin{array}{l|rrrr}
0=-\ 74{\cdot}4532 & +35{\cdot}4844\xi & +\ 0{\cdot}0953\eta & +\ 35{\cdot}6977u & -\ 25{\cdot}0643v \\
0=-\ 4{\cdot}0791 & & +\ 0{\cdot}2032 & +\ 22{\cdot}6054 & -\ 9{\cdot}7844 \\
0=-526{\cdot}5026 & & & +2571{\cdot}4804 & -1121{\cdot}6132 \\
0=+253{\cdot}3814 & & & & +\ 494{\cdot}2387
\end{array}$$

From the longitude observations:

$$\begin{array}{l|rrrr}
0=+\ 0{\cdot}4477 & +\ 0{\cdot}0760\xi & -\ 0{\cdot}1950\eta & -\ 10{\cdot}2707u & -\ 2{\cdot}0324v \\
0=-\ 10{\cdot}4552 & & +13{\cdot}8089 & +\ 40{\cdot}1059 & +\ 7{\cdot}9363 \\
0=-\ 49{\cdot}5751 & & & +1414{\cdot}6253 & +\ 279{\cdot}9192 \\
0=-\ 9{\cdot}8110 & & & & +\ 55{\cdot}3890
\end{array}$$

From the azimuth observations:

$$\begin{array}{l|rrrr}
0=-\ 17{\cdot}9120 & +\ 1{\cdot}1515\xi & -\ 1{\cdot}4576\eta & -\ 52{\cdot}7266u & -\ 10{\cdot}4331v \\
0=-\ 13{\cdot}1179 & & +35{\cdot}1172 & +\ 41{\cdot}5066 & +\ 8{\cdot}2132 \\
0=+833{\cdot}7203 & & & +2453{\cdot}3579 & +\ 485{\cdot}4576 \\
0=+164{\cdot}9719 & & & & +\ 96{\cdot}0600
\end{array}$$

hence by combination:

$$\mathrm{I.}\left\{\begin{array}{l|rrrr}
0=-\ 91{\cdot}9175 & +36{\cdot}7119\xi & -\ 1{\cdot}5573\eta & -\ 27{\cdot}2996u & -\ 37{\cdot}5298v \\
0=-\ 27{\cdot}6522 & & +49{\cdot}1293 & +\ 104{\cdot}2179 & +\ 6{\cdot}3651 \\
0=+257{\cdot}6426 & & & +6439{\cdot}4636 & -\ 356{\cdot}2364 \\
0=+408{\cdot}5423 & & & & +\ 645{\cdot}6877
\end{array}\right.$$

The solution gives—

$$\left\{\begin{array}{ll}
\xi=+1{\cdot}895\ 898 & \text{with residuals } 0{\cdot}0000 \\
\eta=+0{\cdot}862\ 056 & 0{\cdot}0000 \\
u=-0{\cdot}077\ 671\ 6 & 0{\cdot}0002 \\
v=-0{\cdot}573\ 878 & 0{\cdot}0002
\end{array}\right.$$

whence we get $\gamma a = -240{\cdot}2$ and the equatorial radius becomes 6 378 206·4 − 240·2 = 6 377 966·2 meters; we have also $\varepsilon = v$ (arc 100″) = −0·000 278 22, hence the new e^2 = 0·006 768 7 − 0·000 278 2 = 0·006 490 5

Let $\varepsilon_1 = \frac{1}{2}e^2$ and $\frac{a-b}{a}$ or the compression $= \frac{1}{c}$, then

$$\frac{1}{c} = \varepsilon_1 + \tfrac{1}{2}\varepsilon_1^2 + \tfrac{1}{2}\varepsilon_1^3 + \tfrac{5}{8}\varepsilon_1^4 + \ldots\ldots = 0{\cdot}003\ 250\ 5$$

hence the compression $= \frac{1}{307{\cdot}6}$; the resulting value of b is 6 377 966·2 − 20 737·7 = 6 357 228·5 meters.

Substituting the values found for ξ, η, u, and v in the equations of condition we obtain for each station the outstanding deflections. These quantities are also needed for the determination of the probable errors of the dimensions of the spheroid just obtained when these residuals are treated as accidental errors.

Resulting values of ξ and η at the observing stations.

No.	Station.	ξ ″	No.	Station.	ξ ″
1	Calais	−5·20	19	Washington	+3·05
2	Cooper	−0·52	20	Cape Henlopen	+2·06
3	Humpback	+2·32	21	Clark	+1·70
4	Farmington	+2·02	22	Elliott Knob	+2·55
5	Mount Desert	−0·77	23	Long Mountain	−0·94
6	Mount Pleasant	−0·89	24	Moore	−0·92
7	Mount Independence	−2·04	25	Young	−6·52
8	Agamenticus	−1·35	26	King	−0·73
9	Unkonoonuc	−0·61	27	Currahee	+2·26
10	Thompson	+2·63	28	Sawnee	+2·36
11	Mount Tom	+1·27	29	Atlanta	+0·47
12	Manomet	+2·35	30	Kahatchee	+0·01
13	Sandford	+1·76	31	Montgomery	−3·67
14	West Hills	+4·74	32	Lower Peach Tree	+1·93
15	Beacon Hill	−1·99	33	Coon	+5·33
16	Yard	−5·12	34	Mobile	+0·33
17	Principio	+3·51	35	Fort Morgan	−2·41
18	Pooles Island	−2·21	36	New Orleans	−2·07

Resulting values of ξ and η at the observing stations—continued.

No.	Station.	η ″	No.	Station.	η ″
1*	Calais	+6·41	25	Sandford	−8·55
2	Bangor	+4·19	26	West Hills	−3·20
3	Cambridge	+3·24	27	Mount Rose	+4·71
4	Cape May	−0·38	28	Yard	−0·46
5	Dover	−3·41	29	Principio	−9·60
6	Washington	−3·84	30	Cape Henlopen Light-House	−1·07
7	Strasburg	−2·49	31	Hill	−7·46
8	Charlottesville	−0·37	32	Maryland Heights	+5·13
9	Statesville	+0·51	33	Bull Run	+3·71
10	Atlanta	+0·37	34	Clark	+1·90
11	Montgomery	−3·17	35	Long Mountain	+6·68
12	Lower Peach Tree	−4·12	36	Elliott Knob	−2·48
13	Mobile	+0·85	37	Moore	+1·12
14	New Orleans	−3·37	38	Young	−1·65
15†	Cooper	+1·58	39	King	+3·00
16	Humpback	−1·07	40	Paris	+0·27
17	Mount Desert	+2·79	41	Currahee	−3·81
18	Mount Harris	−1·44	42	Atlanta Middle Base	+4·28
19	Sabattus	−0·04	43	Lavender	+1·23
20	Agamenticus	+3·20	44	Aurora	+1·12
21	Gunstock	−4·04	45	Kahatchee	+2·08
22	Unkonoonuc	−1·48	46	Ethridge	+2·15
23	Blue Hill	+2·46	47	Fort Morgan	+6·20
24	Mount Tom	−5·10	48	East Pascagoula	+0·61

We have $\Sigma\xi\xi$ and $\Sigma\eta\eta$ before and after change of spheroid.

	Old spheroid.	New spheroid.
From latitude equations	506·5	265·9
From longitude equations	83·1	141·5
From azimuth equations	789·2	519·8
From all equations	1 378·8	927·2

The precision of the adjusted or resulting value of the length of the equatorial radius and of the compression as found from the measure of the arc.

To find the probable errors of the elements of the resulting spheroid we have to determine the mean error of a single observation or that of the unit of weight, as well as the weights of the values of u and v as obtained from the solution of the normal equations, whence the probable error of the result for the equatorial radius a, and for the compression $\frac{a-b}{a}$, or $\frac{1}{c}$, readily follows.

Substituting the values of ξ, η, u and v resulting from the solution of the normal equations in the equations of condition, the residuals represent the respective deflections at the stations. Squaring and summing up these residuals, we get $m^2 = \frac{[pvv]}{n_0 - \nu}$,

* Values 1 to 14 from longitude equations. † Values 15 to 48 from azimuth equations.

where m=mean error of the unit of weight, n_0 the number of observations or stations, and n the number of normal equations or unknowns. The weight of any one of the unknowns is found in the usual way by means of the solution of the modified normal or weight equations; thus, for the third unknown u and for the preceding hypothesis of equal weight to the observations we have:

$$\begin{cases} 0=+36\cdot7119\,q_1-\ 1\cdot5573\,q_2-\ 27\cdot2996\,q_u-\ 37\cdot5298\,q_3' \\ 0=\qquad\qquad +49\cdot1293\ +\ 104\cdot2179\ +\ 6\cdot3651 \\ 1=\qquad\qquad\qquad +6\,439\cdot4636\ -356\cdot2364 \\ 0=\qquad\qquad\qquad\qquad +645\cdot6877 \end{cases}$$

Here q_u is the reciprocal of the weight of u or, as usually written, $=\frac{1}{p_u}$, and the mean error of u or m_u is given by $m_u=m\sqrt{p_u}=m\sqrt{q_u}$; whence follows r_a, the probable error of a, and by the same method that of the compression is obtained from $m_v=m\sqrt{q_v}$.

Applying this to the results of hypothesis (1), which assigns equal weight ($w=1$) to the observation equations, we get $m=\sqrt{\frac{927}{84-4}}=\pm3''\cdot40$; the weight equations in connection with u and v give:

$$\begin{cases} q_1=+0\cdot0002213 \\ q_2=-0\cdot0003659 \\ q_u=+0\cdot0001682 \\ q_3=+0\cdot0001092 \end{cases} \quad\text{and}\quad \begin{cases} q_4=+0\cdot0018212 \\ q_5=-0\cdot0003946 \\ q_6=+0\cdot0001092 \\ q_v=+0\cdot0017188 \end{cases}$$

hence $m_u=\pm0\cdot0441$, and the corresponding value $m_a=136\cdot4$, and the probable error of a or $r_a=\pm92\cdot0$ meters. From the second set of weight equations we get $m_v=\pm0\cdot1400$ and the corresponding value $m_c=\pm3\cdot3$, also the probable error of c or $r_c=\pm2\cdot2$. The complete results by hypothesis (1) are therefore: Length of equatorial radius, 6 377 966±92 meters and the compression $\frac{1}{307\cdot6\pm2\cdot2}$.

Resulting spheroid.

The following is the determination of a spheroid most nearly coinciding with the surface of that part of the United States which is traversed by the oblique arc from the St. Croix River at Calais, Me., to the delta of the Mississippi River at New Orleans, La.

In consequence of the uncertainty respecting the proper weighting of the azimuth equations, four sets of normal equations were established, and the results for equatorial radius and compression were deduced for the several hypotheses: $w=1$, ½, ⅓, and ¼.

The normal equations and results are as stated below:

Hypothesis I, $w=1$

$$\begin{cases} 0=-\ 91\cdot9175 \\ 0=-\ 27\cdot6522 \\ 0=+257\cdot6426 \\ 0=+408\cdot5423 \end{cases} \begin{matrix} +36\cdot7119\xi & -\ 1\cdot5573\eta & -\ 27\cdot2996u & -\ 37\cdot5298v \\ & +49\cdot1293 & +\ 104\cdot2179 & +\ 6\cdot3651 \\ & & +6439\cdot4636 & -356\cdot2364 \\ & & & +645\cdot6877 \end{matrix}$$

Hypothesis II, $w=½$

$$\begin{cases} 0=-\ 82\cdot9615 \\ 0=-\ 21\cdot0932 \\ 0=-159\cdot2176 \\ 0=+326\cdot0563 \end{cases} \begin{matrix} +36\cdot1361\xi & -\ 0\cdot8285\eta & -\ 0\cdot9363u & -\ 32\cdot3132v \\ & +31\cdot5707 & +\ 83\cdot4646 & +\ 2\cdot2585 \\ & & +5212\cdot7846 & -598\cdot9652 \\ & & & +597\cdot6577 \end{matrix}$$

Hypothesis III $w=\frac{1}{3}$

$$\left\{\begin{array}{lrrrr} 0=-\ 79{\cdot}9762 & +35{\cdot}9442\xi & -\ 0{\cdot}5856\eta & +\ \ 7{\cdot}8515u & -\ 30{\cdot}5744v \\ 0=\ \ 18{\cdot}9069 & & +25{\cdot}7178 & +\ 76{\cdot}5468 & +\ \ 0{\cdot}8896 \\ 0=-298{\cdot}1709 & & & +4803{\cdot}8917 & -679{\cdot}8748 \\ 0=+298{\cdot}5610 & & & & +581{\cdot}6477 \end{array}\right.$$

Hypothesis IV $w=\frac{1}{4}$

$$\left\{\begin{array}{lrrrr} 0=-\ 78{\cdot}4835 & +35{\cdot}8483\xi & -\ 0{\cdot}4641\eta & +\ 12{\cdot}2454u & -\ 29{\cdot}7050v \\ 0=-\ 17{\cdot}8138 & & +22{\cdot}7914 & +\ 73{\cdot}0880 & +\ \ 0{\cdot}2052 \\ 0=-367{\cdot}6476 & & & +4599{\cdot}4452 & -720{\cdot}3296 \\ 0=+284{\cdot}8134 & & & & +573{\cdot}6427 \end{array}\right.$$

Hypothesis		I	II	III	IV
Weight of azimuth equations		1	½	⅓	¼
Values from solution of equations	ξ	+1·89590	+1·87994	+1·87237	+1·86779
	η	+0·86206	+0·85433	+0·84018	+0·82657
	u	−0·077672	−0·038624	−0·015909	−0·0010345
	v	−0·573878	−0·485852	−0·43476	−0·401375
Equatorial radius in meters	a	6 377 966	6 378 087	6 378 157	6 378 203
Probable error of same	r_a	±92	±91	±90	±90
Compression $(a-b)\ /\ a$ and probable error of denominator		$\frac{1}{307{\cdot}6\pm2{\cdot}2}$	$\frac{1}{305{\cdot}5\pm2{\cdot}1}$	$\frac{1}{304{\cdot}5\pm1{\cdot}9}$	$\frac{1}{303{\cdot}7\pm1{\cdot}8}$

Examining the contents of this table, it is evident, in the first place, that whatever value for w is adopted the general result will be but slightly influenced; that is, the value of the equatorial radius remains close to the value of Clarke's spheroid of 1866 (6 378 206), whereas the value of the compression remains slightly smaller than that of the Besselian spheroid $\left(\frac{1}{299{\cdot}2\pm3{\cdot}2}\right)$; and, in the second place, that the curvature of that part of the surface under consideration does not differ to any very marked extent from that which would be exhibited by a representative spheroid for the whole earth.

There is therefore but little choice between the above results. The deflections at the initial station remain about the same, viz, $1''{\cdot}88$ in the meridian and $0''{\cdot}85$ at right angles thereto; the radius a varies but 237 meters between the extremes and the probable errors remain practically unchanged, while with decrease of weight the compression slowly increases approaching the Besselian value. The resulting values of η or the deflections at the several stations increase necessarily in magnitude as the weight of the azimuth equations is diminished, and in Hypothesis IV the larger ones appear to indicate $w=\frac{1}{4}$ as a limiting value.

The spheroid of *hypothesis III* is apparently the most acceptable, as it preserves a proper balance between the magnitudes of the opposing deflections in longitude and in azimuth,* and *it has been adopted as representing the result of the present investigation.* The resulting values of ξ and η on this hypothesis are as follows, the numbers referring to the same stations as in the preceding tabulation under hypothesis I.

*The substitution of the respective values of ξ, η, u and v in the equations of condition derived from latitude, longitude, and azimuth comparisons, give for $[pvv]$ and hypotheses I to IV:

From comparisons of φ' s	265·9	265·5	266·0	266·0.
From comparisons of λ' s	141·5	111·6	98·3	91·4.
From comparisons of α' s	519·8	½(561·3)	⅓(593·9)	¼(616·8).

In the discussion of the ordnance survey of Great Britain and Ireland Clarke adopts the weight ⅓ as most suitable.

	ξ_{III}		η_{III}		η_{III}
	″		″		″
1	−5·34	1	+5·19	15	+0·39
2	−0·65	2	+3·16	16	−2·19
3	+2·18	3	+2·50	17	+1·68
4	+1·87	4	−0·64	18	−2·42
5	−0·89	5	−3·61	19	−0·91
6	−1·02	6	−3·85	20	+2·40
7	−2·15	7	−2·31	21	−4·76
8	−1·45	8	−0·21	22	−2·18
9	−0·70	9	+0·96	23	+1·71
10	+2·55	10	+0·23	24	−5·66
11	+1·19	11	−2·07	25	−9·11
12	+2·30	12	+2·87	26	−3·65
13	+1·71	13	+2·16	27	+4·39
14	+4·68	14	−1·81	28	−0·63
15	−2·03			29	−9·76
16	−5·16			30	−1·33
17	+3·48			31	−7·52
18	−2·24			32	+5·19
19	+3·02			33	+3·77
20	+1·98			34	+1·98
21	+1·69			35	+6·90
22	+2·53			36	−2·24
23	−0·96			37	+1·50
24	−0·94			38	−1·24
25	−6·52			39	+3·47
26	−0·75			40	+0·90
27	+2·23			41	−3·08
28	+2·34			42	+5·12
29	+0·44			43	+2·22
30	−0·03			44	+2·21
31	−3·72			45	+3·19
32	+1·87			46	+3·34
33	+5·25			47	+7·52
34	+0·24			48	+1·99
35	−2·52				
36	−2·17				

The probable error of a single latitude is $0·674\sqrt{\dfrac{266·0}{36-4}} = \pm 1''·94$ as computed from the 36 latitude discrepancies and that of a single latitude or longitude $0·674\sqrt{\dfrac{364·3}{50-4}} = \pm 1''·90$ as computed from the 36 latitude and the 14 longitude discrepancies.

Comparison with Other Spheroids.

The following table is presented for convenience of reference or comparison of the resulting spheroid with a few other spheroids (of revolution):

Spheroid of—	Equatorial radius a in meters.	Polar semi-diameter b in meters.	$a-b$.	Compression $(a-b)/a$.
Bessel, 1841. From 10 arcs of the meridian, total amplitude 50° 34′.	6 377 397	6 356 079	21 318	1/299·15 ±3·15
Clarke, 1858.* Special spheroid for surface of Great Britain and Ireland. Range in latitude 12°, the same in longitude; 75 astronomic stations.	6 378 494 ±90	6 355 746	22 748	1/280·4 ±8·3
Clarke, 1866. From five meridional arcs, total amplitude 76° 35′.	6 378 206	6 356 584	21 622	1/295·0
Clarke, 1880.* From five meridional arcs and longitudinal measures, total amplitude 88° 59′·8 equatorial degrees.	6 378 249	6 356 515	21 734	1/293·5
U. S. Coast and Geodetic Survey, 1900. Eastern Oblique Arc of the United States. Total amplitude 23° 31′; 84 astronomic stations.	6 378 157 ±90	6 357 210	20 947	1/304·5 ±1·9
Harkness, 1891. From "The Solar Parallax and Related Constants," Washington, 1891, p. 138.	6 377 972 ±125	6 356 727 ±99	21 245	1/300·2 ±3·0

* For conversion of English feet into meters Clarke's determination of 1866 was used, viz: 1 ft. = 0·30479727 m.
1 m. = 3·2808693 ft.

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