WIND AND WEATHER

ALEXANDER McADIE

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WIND AND WEATHER

How the Wind Ruffles the Top of a Fog Bank

Frontispiece

WIND
AND
WEATHER

BY

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Observatory

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LIST OF ILLUSTRATIONS

WIND AND WEATHER

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THE TOWER OF THE WINDS

In Athens on the north side and near the base of the hill on which the upper city—the Acropolis—is built, there is a small temple still standing, altho its walls were completed twenty-two centuries ago. It is known as the Tower of the Winds; but as a matter of fact, the citizens of Athens used it to tell the hour of the day and the seasonal position of the sun. It was a public timepiece. It served as a huge sun dial. Water from a spring on the hillside filled the basins of a water clock in the basement of the Tower. And so, whether the day was clear or cloudy the measure of the outflow of water indicated the time elapsed. Also there were markings or dials on each of the eight walls of the temple, and the position of the shadow of a marker indicated the seasonal advance or retreat of the sun as it moved north from the time of the winter solstice and then south after the summer solstice.

The sun is not an accurate time keeper and no one to-day runs his business or keeps engagements on sun time. But the old Athenians were quite content to do so; and their Tower served excellently for their needs. And they did what we moderns fail to do, namely, give distinctive names to the winds. They represented figuratively the characteristics of the weather as the wind blew from each of the eight cardinal directions.

The allegorical figures of the winds used in this little book are reproductions of the eight bas-reliefs in the library of the Blue Hill Observatory, placed there by the late Professor A.

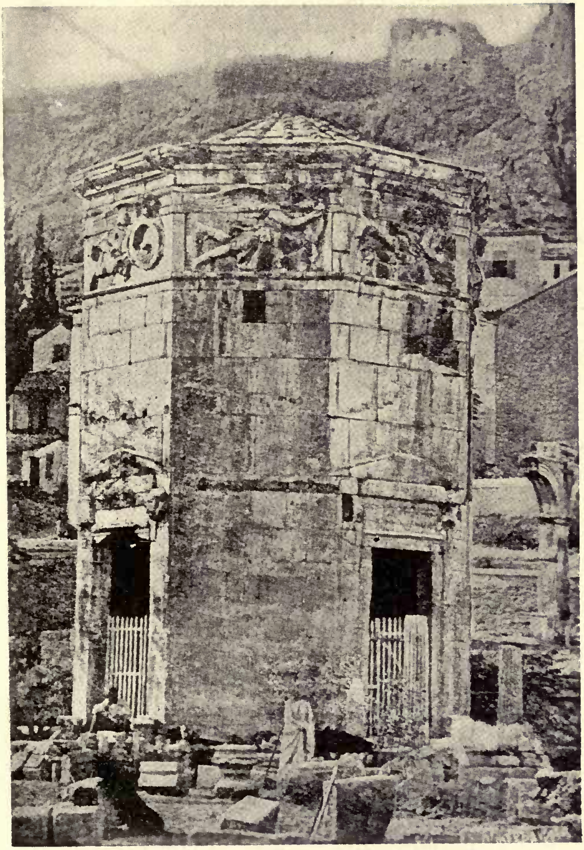


FIG. 1. THE TOWER OF THE WINDS
Erected in Athens, on the north side of the Acropolis, B. C. 150

Lawrence Rotch. They are copied from the frieze of the Tower of the Winds at Athens.

* * * *

THE NAMES OF THE WINDS

Boreas, the north wind, is perhaps the most important of all winds. At Athens this a cold, boisterous wind from the mountains of Thrace. The noise of the gusts is so loud that the Greek sculptor symbolized the tumult by placing a conch shell in the mouth of Boreas. His modern namesake, the Bora of the Adriatic, is the same noisy, blustering, cold wind-rush from the north.

The northeast wind Kaikias is a trifle more pleasant looking than Boreas, but still not much to brag about. Master of the squall and thunderstorm, he carries in his shield an ample supply of hailstones, ready to spill them on defenseless humanity. He might well serve as the patron saint of air raiders dropping their bombs on helpless humans below.

Apheliotes, the east wind, is a graceful youth, with arms full of flowers, fruit and wheat. Naturally this was a favorite wind, blowing in from the sea, with frequent light showers. Some of us who dwell on the Atlantic Coast, in more northern latitudes than Athens, do not always regard with favor the east wind, associating it with chilly, damp and sombre weather. Yet it is the harbinger of good—tempering the cold of winter and the heat of summer. It is an angel of mercy in mid-summer when the temperature is above the nineties and there is no air stirring. Then it is, that we all welcome the refreshing wind from the sea.

Euros, the southeast wind, and neighbor to Apheliotes, is a cross old fellow, intent on the business of cloud making. He alone of all the winds carries nothing in his hands. In the New Testament he becomes Euroclydon, wind of the waves. He is no friend of the sailor; and the seasick traveler prays to be rid of his company.

The figure on the south face of the tower, Notos, is the master of the warm rain. He carries with him a water jar which has just been emptied. Compare his light flowing robes and half-clad neck and arms with the close fitting jacket of old Boreas. At his shrine, hydraulic engineers well might worship.

Next, the Mariner's wind, Lips, the southwest favoring breeze bringing the ships speedily into harbor; yes, into that Piraeus, famed in classic history. Incidentally it is the southwest wind which differentiates the climate of Great Britain from that of Labrador. This wind makes Northwest Europe habitable; while on the other side of the Atlantic, in similar latitudes, but under the influence of prevailing northwest winds, we find Labrador—a section certainly misnamed, for it is not the abode of farmers, as the name implies—but barren and bleak. What a difference it would make thruout this region if the Gulf Stream continued north, close to the shore, and the prevailing winds were *from the east*. Our North Atlantic Coast would then be *the land of zephyrs*, using the word in the sense of pleasant. gentle winds.

Zephyros, the west wind, is represented as a graceful youth, scantily clad, with his arms filled with flowers. In Greece this wind traversed the Ionian Sea and the Gulf of Corinth before reaching Athens. It is quite unlike our west wind which blows across a continent, and is continuously robbed of its water vapor on the long passage. The Ionian wind is pleasantly moist and refreshing.

Fig. 2. Boreas—The North Wind

Last of all, but by no means least important, is Skiron, lord of gusty northwest gales. Freezing in winter, parching in summer, he carries with him a brazen fire basket and spills a generous stream of hot air on all below. His husky Highness might not inappropriately adorn legislative halls and editorial sanctums. He would displace the blindfolded lady holding scales very much out of balance. Think of the deep significance of his presence.

In our country the northwest is of all winds, except the west, most persistent. For 1600 hours in a year, this wind is with us. Joining forces with the west wind, these directions prevail one third of the time. These northwest-west winds also have the greatest speed and gustiness. The climate of the United States is essentially determined by the prevalence of the north, northwest and west winds.

* * * *

FORECASTING THE WEATHER

In old days, the *haruspices* (for this is what the Romans called weather men in the days of Caesar) proclaimed the will of the gods by consulting the entrails of some freshly killed animal. Evidently these haruspices did not always make correct forecasts; for there were some Romans who openly questioned their worth. Cato, the Censor, is on record as saying "that he wondered how one haruspex could look another in the face without laughing!"

The modern professional forecaster would scorn to consult the entrails. There are however many amateur forecasters who foretell weather by their aches and rheumatic pains. Probably there is a high correlation factor between body sensations and dampness; and some individuals are quite sensitive to changes in both relative and absolute humidity.

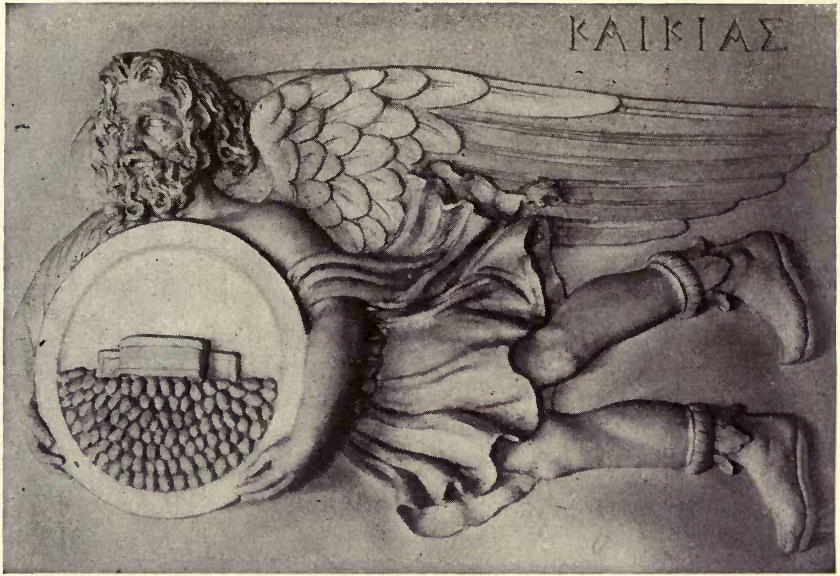


Fig. 3. Kaikias—The Northeast Wind

This, however, does not always mean that a storm is approaching. Humidity or dampness is only one factor and may be quite local, whereas most storms are wide-spread.

* * * *

THE WEATHER MAP

The official forecaster consults a daily weather map and certain auxiliary maps which show changes in pressure and temperature for twelve hours or more. He examines closely the contours of pressure as shown on the map. The synoptic map, as it is called, because it is a glance at weather conditions over a large area at one and the same moment, is a map on which are plotted pressure, temperature, wind direction, velocity and rainfall. The lines of equal pressure or isobars generally curve and inclose what is known as a cyclonic centre, or depression or LOW. The arrows point in, but not exactly toward the centre of the depression.

On the map there will probably appear also an area of high pressure where the surface air flows leisurely outward and away from the place of highest pressure. Such an area is called an anticyclone, a word first used by Sir Francis Galton in 1863 to designate not only high pressure, but general flow of the air in a reversed or opposite direction to that of the low area or cyclone. The word cyclone was first used by Piddington in 1843 in describing the flow of the air in the typhoons of the East Indian Seas. It is from the Greek and literally means the coils of a serpent. The word cyclone must possess some special merit in the minds of journalists for it is quite commonly misused for tornado in descriptions of the smaller and more destructive storm.

* * * *

THE LOW

Cyclone is simply the generic name for a large rotating air mass. It is a barometric depression or LOW and is characterized by a flow of air inward and around a moving centre. The air circulation is counter-clockwise in the northern hemisphere and clockwise in the south.

Perhaps if the earth stopped rotating and there was no planetary circulation, with the great west-moving trades and east-moving "westerlies," the arrows on the weather map would all point directly toward the centre of the LOW; but, as things are, there are some very good reasons why air can not move directly into a LOW, that is at right angles to the isobars.

Moreover, the weather map does not indicate the true flow of the air, for observations of the wind made at the ground tell only a part of the story of the balance which the flowing air must maintain under the action of various forces, such as gravitation, rotational deflection, centrifugal tendency, and the various expansion and compression forces.

The winds near the ground are modified both in velocity and direction by friction. The free flow is often interfered with by topography.

* * * *

THE TRUE AIR FLOW

One must rise above the ground some distance to get the true air flow, or what is known as the gradient wind, the flow which balances the gradient, i.e. a flow along the isobars. The gradient velocity is found about 300 metres above the ground, and the gradient direction a little higher. The lower clouds as a rule

FIG. 4. APHELIOTES—THE EAST WIND

indicate true wind values very well; and so, it is desirable in studying winds to use cloud directions and velocities rather than surface values. In cloud work a nephoscope is essential. The unaided eye, unless properly shielded, suffers from the glare of a sunlit sky; and moreover, there are no fixed points or references. A black mirror, with suitable sighting rods and measuring devices, enables an observer to follow the cloud, estimate its height and determine with accuracy the direction from which it is moving. There is an average difference of 30 degrees between the cloud direction and the surface wind; the upper direction being more to the right. At times the directions may be opposite.

It may seem surprising but few of us, except at sunrise and sunset, really see what is going on in cloud land.

Some meteorologists hold that the

circulation of air 3000 to 5000 metres above the ground controls the path and perhaps the intensity of storms. It is therefore important to know something of the flow at high levels if we would improve the forecasts.

* * * *

LIMITATIONS OF MAP

The weather map fails to indicate what shifts of direction and changes in velocity are likely to occur. The forecaster tries to anticipate these, but he bases his conclusions chiefly upon an expected movement of the low area; using the accumulated records of the paths of past storms. But each storm is in reality a law unto itself; and while we know something of the relations between pressure and flow of the air; as yet we know very little about the relations of wind and weather. The problem is compli-

Fig. 5. Euros—The Southeast Wind

cated by the behavior of the load of water vapor.

The Chief Forecaster of one of the great national weather services recently wrote:

> "Despite the fact that maps have now been drawn day by day for over half a century, we may safely say that no two maps have been identical."

It is perhaps unfortunate that so much attention has been given to the cyclone or depression or LOW, and comparatively little to the HIGH or anticyclone. For we are now beginning to understand that while there may seem at first to be nothing specially noteworthy about a mass of air where the pressure varies from 1020 to 1040 kilobars, that is, 2 to 4 per cent *above* a standard atmosphere, with isobars irregularly curved and feeble surface winds, yet the anticyclone is more important than the cyclone in determining weather sequence; for the progressive motion of the cyclone depends largely upon the strength of the anticyclone.

* * * *

OCEAN STORMS

Sir Napier Shaw, who has written much on the weather of the British Isles, may be quoted here.

> "Anyone who is interested in the weather is always on the lookout for 'lows' and is very keen to know whether he is going to be on the south of the centre or the north of it. He is, of course, interested in the anticyclone too, because as long as an anticyclone is there, there cannot be a depression; but it is the depression which has the life and movement about it, giving it a claim to the attention of everybody who wants to know what the weather and its changes are going to be.

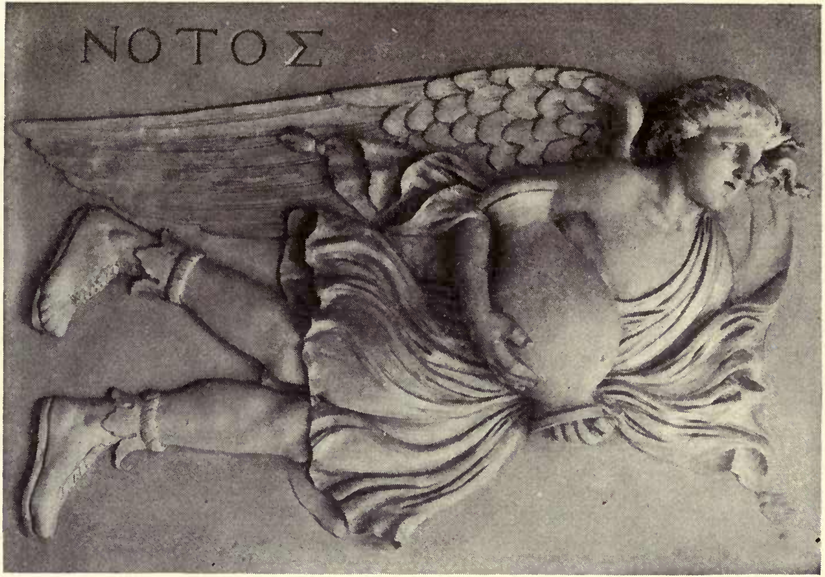


Fig. 6. Notos—The South Wind

"This has been recognized from the very earliest days of weather maps with isobars. The depressions which pass over our shores (Great Britain) mostly come from the west. Some of them come all the way from America; one or two have been traced from the west coast of Africa and so have crossed the Atlantic twice, first to the westward and then to the eastward. Some have come all the way from a sort of parent 'low' in the North Pacific Ocean. So general is the tendency for 'lows' to go eastward that it was thought at one time, particularly by the 'New York Herald,' that their departure from the American Coast and subsequent arrival on our own shores could be notified by cable, and we (the British) might thus be forewarned of their approach, some three or four days in advance. The attempt was made by the 'New York

Herald' acting in co-operation with the Meteorological Offices of the United Kingdom and France. But a depression keeps to no beaten track; it has as many paths for its centre as there are lines in a bundle of hay. Though groups can be picked out there are many strays, and, moreover, the depression changes its shape and intensity while it travels, so that if you lose sight of it for a day you cannot be at all sure of its identity."

* * * *

TRANSCONTINENTAL STORMS

If there is so much uncertainty in forecasting the path of a disturbance at sea, how much more uncertain must it be on land? Elaborate statistics of the average daily movement of various types of storms have been officially published. The average speed of storms

FIG. 7. LIPS—THE SOUTHWEST WIND

(not wind speeds) across the United States is 11 metres per second or 25 miles an hour. Storms travel more rapidly in winter than in summer, about half again as fast; that is, summer storms travel 20 miles, and winter storms 30 miles, an hour.

The paths vary widely; from the Gulf storms moving northeast and West Indian hurricanes recurving on the southern coast, to the storms from Alberta and the west which move south and east. Ten types of storms, classified according to the place of origin, are recognized by the official forecasters of the United States. These are North Pacific, Alberta, Northern Rocky Mountain, Colorado, Central, South Pacific, Texas, East Gulf, South Atlantic and West Indian Hurricanes. A better nomenclature would be (1) Alberta, (2) Washington, (3) Kootenay, (4) Utah, (5) Kansas, (6) California, (7) Texas,

(8) Louisiana, (9) Florida, and (10) Hurricanes.

* * * *

HURRICANES

Type 10 is the general class of tropical storms occurring chiefly in the summer and fall which, drifting west, slowly work northward. Similar storms are the typhoons and baguios of the East Indian and China Seas.

The path and point of recurvature will be determined by the position of the Bermuda Hyperbar, that is, the seasonal anticyclone of the Atlantic. This accounts for the swinging east and north of these tracks as the season progresses; for the hyperbar is slowly displaced east, the maximum displacement occurring in September.

Individual anticyclones also influence individual hurricanes. Thus a hurricane passing west over Havana, will go

BASE MAP BY GOODE

Fig. 8. All Storms Lead to New England

farther west if a vigorous "high" is spreading southeast over the Gulf States. And when this "high" passes seaward, the hurricane will work around the southwest quadrant of the "high," recurving and moving northeast.

* * * *

STORM RENDEZVOUS

Altho storms originate or are first detected in nine different sections, it is a fact worth mentioning that they all leave the United States in the vicinity of New England or Nova Scotia. Some of the southern depressions starting near the coast, pass to sea south of New York, but in general an observer standing on Plymouth Rock can virtually encompass within a radius of 500 kilometres, 300 miles, the paths of ninety per cent of the storms that traverse the country.

Thus a storm that originates in Texas (7) will probably pass close to Cape Cod.

Likewise, types (3) and (5); while the other types may pass a little to the north or south. See Chart, Paths of Storms.

* * * *

STORM PATHS

Forecasting then would seem to be very easy; for one would only have to know the place of origin of the storm and the rate of travel, to foretell exactly the time of arrival. Unfortunately these are only the average paths; and as with most mean values, represent a value not often experienced in fact. These paths then are not paths which any given storm will follow. One must recall the story of the operating surgeon who gave the average age of his patients in the operating room as 35. There were but two patients, one 69 years old and the other 1 year old.

As a matter of fact the path of any individual depression depends upon sever-

FIG. 9. ZEPHYROS—THE WEST WIND

al factors, some of which are:—the prevailing eastward drift of the air; the extent and motion of some anticyclone advancing before the "LOW"; the duration and speed of relatively dry cold tongues of air from the north; and the supply of water vapor brought from southern waters by south winds. A depression can make little headway if to the north or east the normal path is blocked by what is known as a stagnant "HIGH." So therefore, if the anticyclone is a slow mover, a Texas storm, which would normally pass not far from southern New England, may be deflected farther north than when the HIGH moved rapidly east. So too, with the storms which originate in the western part of the country. A slow moving HIGH will prevent the LOW following it, from moving east at a normal rate along the usual path.

Anticyclones then, are the real weather

controls. There are various types, but all drift from the north or west. Occasionally they enter the country from the Pacific, but the great majority come from Alberta and move leisurely southeast, often reaching the South Atlantic States; but more frequently recurving and passing to the north.

* * * *

STAGNANT HIGHS

HIGHS are sometimes reinforced and this results in what is called a stagnant HIGH. A good illustration of such a slow moving HIGH and its consequences occurred during the last week of January, 1922.

A surge of cold air from Alberta or farther north reached the international boundary January 21st and spread slowly eastward, reaching the Great Lakes on the 24th and the St. Lawrence Valley two days later. Then seemingly it halted or moved slowly westward, retrograding. In three days, that is, on the 29th, the centre of the HIGH was apparently 500 miles *west* of where it had been on the 27th. After the 29th it followed a normal track, moving slowly southeast, reaching the Atlantic near Long Island.

Meanwhile a depression on the south coast of Texas on the 25th, moved across the Gulf of Mexico, passing over Southern Florida on the 27th and advanced steadily northeast, reaching Cape Hatteras in 24 hours. Owing to the presence of the anticyclone referred to above, the depression recurved off Hatteras. The result was a memorable snow storm in Northern Virginia and Maryland. At 8 p.m. January 27th, there had been a fall of 5 cms. (2 inches). Within the following twenty hours the average depth in the city of Washington was 66 cms. (26 inches).

The weight of the snow caused the collapse of the roof of the Knickerbocker Theatre and the death of 97 persons.

The total snowfall in various coast cities was:

Raleigh	24 cms.*
Richmond	48 "
Washington	71 "
Baltimore	67 "
Wilmington	46 "
Philadelphia	31 "
Trenton	27 "
New York	18 "
New Haven	8 "
Boston	1 "

*Note: To convert to inches multiply by 0.4.

The table shows clearly how the snow was formed. On the east side of the LOW a stream of air, relatively warm, carried a load of water vapor, approximately 13 grams in each cubic metre.

BASE MAP BY GOODE

FIG. 10. PATHS OF HIGH AND LOW, GREAT SNOW STORM OF JANUARY 27-28, 1922

This current was steered around the north side of the LOW and met the north-northeast wind. Under the new conditions the air saturated could hold only 2 or 3 grams; and so condensation and heavy precipitation resulted. The region of maximum snowfall was near Washington, and it will be seen that there is a proportional decrease north and south. The snowfall at Washington was the heaviest ever known at that city.

Unlike most storms, there was no strong cold northwest wind blowing into the depression. The temperature rose slowly. It was less a contrast of winds than a steady slow outward push of the anticyclone, and the consequent turning of the path of the cyclone eastward.

* * * *

LAWS OF FORECASTING

Buys Ballot's Law.

"If you stand with your back to the wind the pressure decreases toward your left, and increases toward your right."

For navigators, this law is more generally expressed in the words of the Hydrographic Office on "Cyclonic Storms."

"Since the wind circulates counter-clockwise in the northern hemisphere, the rule in that hemisphere is to face the wind, and the storm centre will be at the right hand. If the wind traveled in exact circles, the centre would be eight points (90 degrees) to the right when looking directly in the wind's eye. But the wind follows a more or less spiral path inward which brings the centre from eight to twelve points (90 to 135 degrees), to the right of the wind. The centre will bear more nearly eight points from the direction of the lower clouds than from the surface wind."

Fig. 11. Skiron—The Northwest Wind

The law given on the preceding page is named after C. H. D. Buys Ballott, a Dutch meteorologist. It was announced in a paper published in the *Comptes rendus* in 1857. Two American writers on the Winds, J. H. Coffin and William Ferrell, had however earlier found the law to hold.

* * * *

While most of us study storms from a window at home and are not called upon to handle a ship in a storm, yet it may not be out of place to include here the diagram of the winds in an ideal storm and give the rules for maneuvering. See Figure 12. The Winds in an Idealized Storm. The rules apply only to storms in the northern hemisphere.

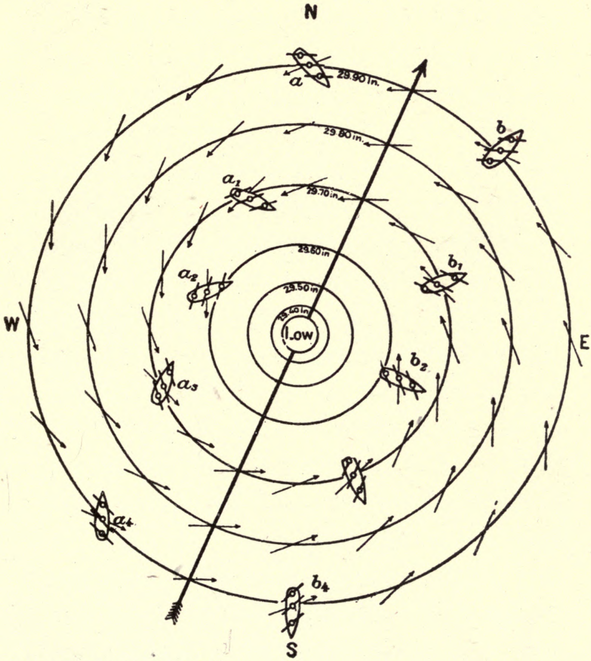
"*Right or dangerous semicircle*,—Steamers: Bring the wind on the starboard bow, make as much way as possible, and if obliged to heave-to, do so head to sea.

Sailing vessels: Keep close-hauled on the starboard tack, make as much way as possible, and if obliged to heave-to, do so on the starboard tack.

Left or navigable semicircle,—Steam and sailing vessels: Bring the wind on the starboard quarter, note the course and hold it. If obliged to heave-to, steamers may do so stern to sea; sailing vessels on the port tack.

On the storm track in front of center,—Steam and sailing vessels: Bring the wind two points on the starboard quarter, note the course and hold it, and run for the left semicircle, and when in that semicircle manoeuvre as above.

On the storm track, in rear of center,—Avoid the center by the best practicable route, having due regard to the tendency of cyclones to recurve to the southward and eastward.



FROM HYDROGRAPHIC OFFICE

FIG. 12. THE WINDS IN AN IDEALIZED STORM

The law of the turning of the wind with altitude.

A casual observation of the lower clouds where no means of measuring small angles is available will not usually show any difference between the motion of the clouds and the surface wind; but with the upper clouds the case is different, and one readily detects a difference.

Several thousand observations with various agencies, such as kites and pilot balloons and more especially measurements made with theodolites and nephoscopes, show that there is a definite twist to the right with elevation. The amount of the deflection is shown in Figure 13. Turning of the Wind with Altitude. Here the average yearly values are given for directions and velocities. Thus if the mean wind direction at Blue Hill is from a point a little to the north of west, 306 grads or 275 degrees, and the mean velocity 7 metres per second; the clouds at 1000 metres elevation will move from 312 or 280 degrees and at a speed of approximately 11 metres per second (24 miles an hour).

These however, are average values. In individual cases the difference between surface winds and stratus clouds may be considerably greater. It may be as much as 180 degrees; that is, the cloud may move directly opposite to the wind. In general there will be a difference of 10 to 20 degrees.

* * * *

WIND AND RAIN

The law of wind direction, approximate cooling and rain.

When the lower clouds are moving from the north or northwest, without sharply defined edges, the LOW is east or northeast of the observer; and rain or snow is not likely unless there is a rapidly falling temperature.

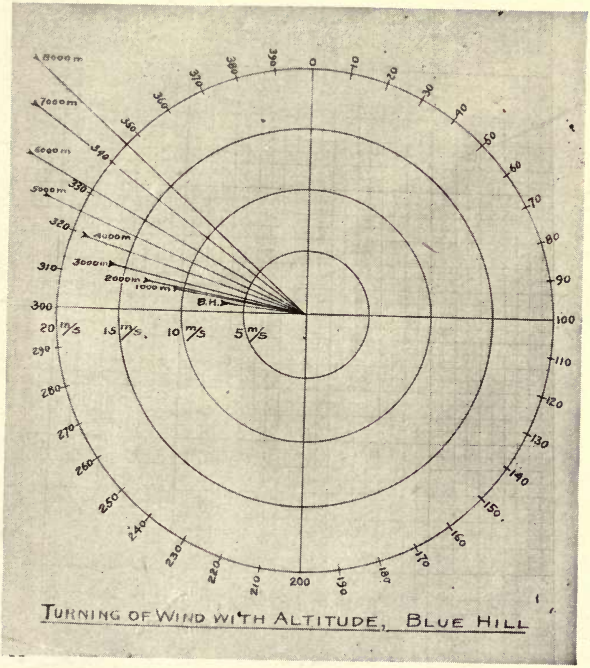


FIG. 13. TURNING OF WIND WITH ALTITUDE

When a stream of warm air with a high absolute humidity flows north on the east side of a LOW, and a cold northwest wind follows quickly after the LOW, rain or snow may be expected.

Any rapid chilling of warm, moist air produces cloudiness and rain or snow; but a cold stream blowing into a warm area will not produce as much rain as a warm stream blowing into a cold area.

* * * *

DURATION OF WIND

The average duration of wind from various directions is as follows:

From the north about 16 hours each week; from the northeast, the same; from the east, 11 hours; from the southeast, 10 hours; from the south, 24 hours; from the southwest, 27 hours; from the west, 33 hours; and from the northwest 31 hours.

During an individual disturbance lasting about 36 hours, we may have 8 hours of southwest wind; 4 hours of west wind, backing during the next 4 hours to south; 2 hours of south wind; 2 hours of southeast wind; 2 hours of east wind; 8 hours northeast wind and 4 hours north wind, 2 hours northwest, when it may be considered that a new pressure distribution prevails.

The above values hold only for a storm moving with normal velocity. LOWS are often blocked by slow moving HIGHS in advance. In such cases the duration of east winds is greater.

THE WINDS OF A YEAR

The following table shows the marked increase in the prevalence of northwest and west winds during winter months, the decrease in north winds during July, the increase in northeast winds in May, also in east winds; the increase of south and southwest winds in July; and the falling off of southeast winds in December. See Table, page 72.

In cities near the Atlantic Coast, a continuance of northeast wind, especially in the fall and winter months, results in frequent altho not necessarily heavy rains. On the other hand a period of continued northwest and west wind is a dry period.

In summer, southeast and east winds bring fog and cooler weather; while southwest winds are favorable for the development of thunderstorms.

* * * *

TABLE I.—Number of Hours the Wind Blows from Different Directions.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Boreas.....(N)	98	74	71	70	60	40	59	59	67	80	82	96	850
Kaikias...(NE)	41	46	65	94	101	55	79	79	77	91	48	30	819
Apheliotes..(E)	34	37	52	58	63	48	51	51	52	58	34	31	576
Euros.....(SE)	37	37	45	41	54	45	62	62	52	45	39	34	534
Notus......(S)	82	66	95	99	143	155	128	128	118	93	81	65	1245
Lips......(SW)	112	77	81	79	118	170	135	135	133	108	119	131	1402
Zephyros...(W)	180	177	155	125	107	137	125	125	108	131	169	194	1732
Skiron...(NW)	160	162	183	154	98	94	105	105	113	138	148	163	1607

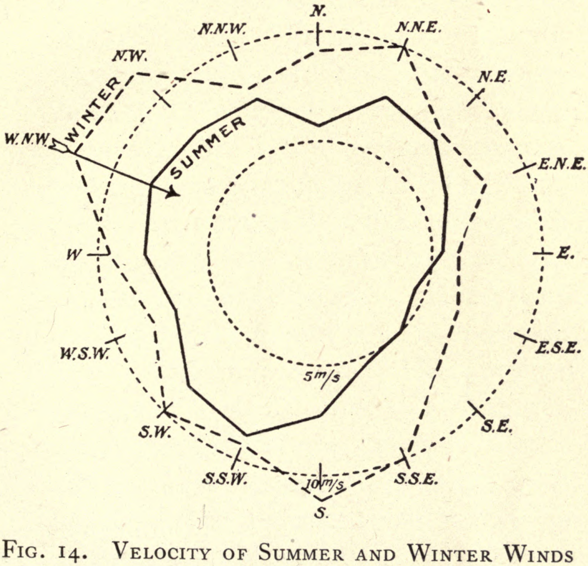


Fig. 14. Velocity of Summer and Winter Winds in Metres per Second

THE SEA BREEZE

When the weather has been clear and moderately warm for two or more days, and the winds are light and variable, there may occur on the third day a moderate wind from the east, known as the sea-breeze. This occurs during anticyclonic conditions. Preceding the sea-breeze, the winds are very light, there are no clouds, and the temperature rises rapidly during the forenoon. This heating is due to a slow dynamic compression as the air slowly descends and the surface air does not flow away. There is no cooling because there is no evaporation due to air movement. The absolute humidity is low, often less than ten grams per cubic metre. Cumulus clouds do not form because there is no uplift of the lower air and consequently no chance for condensation of whatever water vapor may be present. No thunder-heads form notwithstanding the heat. The heat, while dry, is nevertheless extremely trying to men and animals. Relief comes in the early hours of the afternoon by the arrival of the sea-breeze.

The usual explanation of the origin of the sea-breeze is that the land being excessively warm, the air over a relatively cool ocean moves in to take the place of the warm and therefore lighter air, which it is assumed has risen. Unfortunately for this explanation, the air over the land has *not* risen; but on the contrary is falling slowly. Again the sea-breeze does not begin at the place where the temperature contrast is greatest, namely, just inside the shore line; but comes in from the sea. Nor does the flow extend far inland, which would be the case if there were up-rising currents. The sea-breeze is very shallow, generally not extending upward more than 200 metres, and often not above 100 metres. It does not penetrate far inland, as a rule not more than 15 kilometres, 9 miles.

The sea-breeze is probably caused by a slow descent of dry, warm air, on an incline sloping from northeast to southwest. As it reaches the surface it is twisted more to the right; that is, becomes an east wind. It carries inland with it some of the air over the ocean which is much cooler and heavily saturated.

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MUGGY DAYS

There are certain days, more noticeable in summer than at other times, when the air is heavily laden with water vapor; and there is little or no cooling of the body due to evaporation. We perspire freely but as the sweat does not evaporate, there is a constantly increasing amount of water on the skin.

It is not altogether a question of temperature, for another day may have as high or even higher temperature. It is essentially a matter of ventilation. On muggy days we are somewhat in the condition of the unfortunate prisoners in the Black Hole at Calcutta. They did not die by poisoning, as has generally been accepted, that is, lack of sufficient oxygen and an excess of carbon dioxide; but because they were unable to keep the skin sufficiently cool. There was no ventilation; no movement of the air and the body became over-heated and exhaustion followed. No matter how

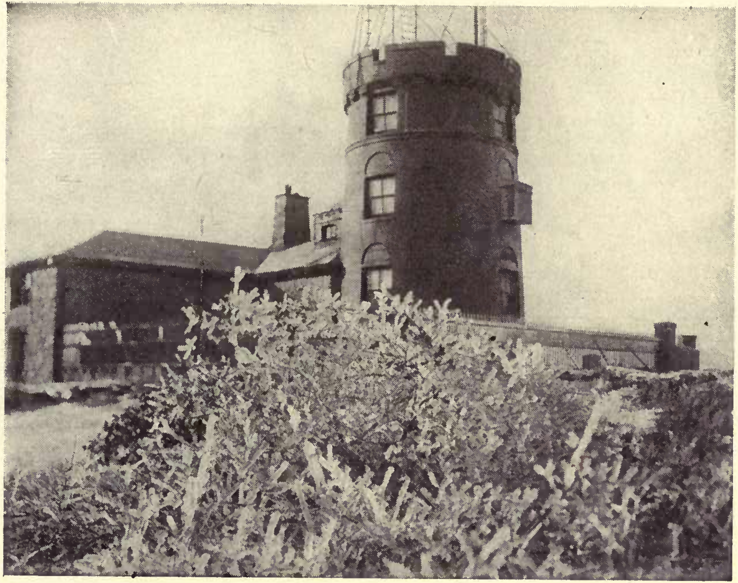

Fig. 15. Blue Hill Observatory During Ice Storm, November 29-30, 1922

much water there may be on the skin if the surrounding space is saturated, one feels oppressed. A vigorous fanning of the air helps evaporation and cools us. That is why a brisk northwest wind routs a muggy condition.

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CASTILIAN DAYS

John Hay wrote of such days spent in Spain. We who live in a land where the winds are more boisterous, occasionally experience what we call a perfect day. Such days have easterly winds of two metres per second or less than five miles an hour. The temperature is midway between freezing and normal body temperature or about 70° F. The relative humidity is approximately 75% and the absolute humidity 12 grams per cubic metre. The table on page 72 explains the paucity of perfect days. The gusty, boisterous winds, Skiron and Zephyros, blow too frequently.

Perhaps certain of our national characteristics may be traceable to this flow of the air and our climatic environment.