97-84278-21

Fitzroy, Robert

Barometer manual. Board of Trade. 1861...5th ed.

London

1861

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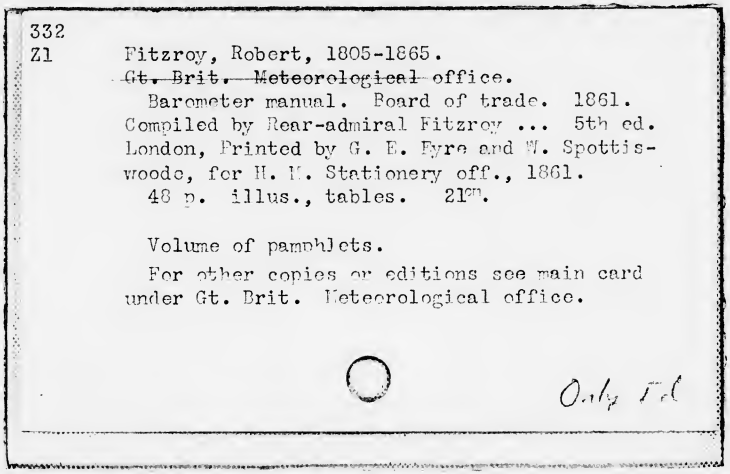

332
Z1 Fitzroy, Robert, 1805-1865.
~~Gt. Brit. Meteorological~~ office.
Barometer manual. Board of trade. 1861.
Compiled by Rear-admiral Fitzroy ... 5th ed.
London, Printed by G. E. Eyre and W. Spottis-
woode, for H. M. Stationery off., 1861.
48 p. illus., tables. 21cm.

Volume of pamphlets.

For other copies or editions see main card
under Gt. Brit. Meteorological office.

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TECHNICAL MICROFORM DATA

FILM SIZE: 35mm REDUCTION RATIO: 9:1 IMAGE PLACEMENT: IA (IIA) IB IIB

DATE FILMED: 12-9-97 INITIALS: PB

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332
21
No. 13

BAROMETER MANUAL.

BOARD OF TRADE.

1861.

COMPILED BY REAR-ADMIRAL FITZROY, F.R.S.

FIFTH EDITION.

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.
AND SOLD BY
D. POTTER, *Agent for the Admiralty Charts*, 31, POULTRY,
AND 11, KING STREET, TOWER HILL.
1861.

4053. *Price One Shilling.*

CAUTIONS.

A Barometer, for a weather glass, should be placed where it may be seen at any time, in a good light, at the eye level.

It should be set regularly—by a duly authorized person—twice a day.

An explanatory Card, and a Manual, should be accessible near the barometer: and should be carefully *studied*.

In an Anercid, a metallic, or a wheel barometer, the motion of the hand corresponds to that of mercury in an independent instrument; but such substitutes should be occasionally verified by comparison

The *average* height of the barometer, in England, at the *sea level*, is about 29·95 inches: and the average temperature of air in low situations, exposed but shaded, is nearly 50 degrees.

In order to compare a barometer with others, at different places, each should be reduced, by an allowance proportioned to elevation above the sea; and for temperature.

For each hundred feet the barometer is above the mean sea level, add one tenth of an inch to the observed height; and, for close comparison, when desired, *subtract* three hundredths of an inch for each *ten* degrees which the attached thermometer shows above 32°: or add equally *below* the freezing point.

The thermometer is usually about one degree lower, for each three hundred feet of its elevation *above* about fifty feet from the ground.

In general, wind affects barometers more than rain: and temperature is affected by the *direction* of wind, prevailing, or coming, more than by time of day, or night; or even by state of sky (while unexposed to *radiation*).

[11,213—1000—1/62.]

EXPLANATORY OF

WEATHER GLASSES

IN NORTH LATITUDE.

IN OTHER LATITUDES SUBSTITUTE THE WORD SOUTH, OR SOUTHERLY OR SOUTHWARD, FOR NORTH, &c. THROUGHOUT THESE PAGES.

THE BAROMETER RISES for Northerly wind, (including from North-west, by the *North*, to the Eastward,) for dry, or less wet weather,—for less wind,—or for more than one of these changes:—	THE BAROMETER FALLS for Southerly wind, (including from South-east, by the *South*, to the Westward,) for wet weather,—for stronger wind,—or for more than one of these changes:—
EXCEPT on a few occasions when rain (or snow) comes from the Northward with *strong* wind.	EXCEPT on a few occasions when *moderate* wind with rain (or snow) comes from the Northward.
For change of wind towards *any* of the above directions:— A THERMOMETER FALLS.	For change of wind towards the *upper* of the above directions:— A THERMOMETER RISES.

Moisture, or dampness, in the air (shown by a hygrometer), increases BEFORE or with rain, fog, or dew.

On barometer scales the following contractions may be useful in *North* latitude:—

RISE	FALL
FOR	FOR
N. ELY.	S. WLY.
NW.-N.-E.	SE.-S.-W.
DRY	WET
OR	OR
LESS	MORE
WIND.	WIND.
EXCEPT	EXCEPT
WET FROM	WET FROM
N. ED.	N. ED.

And the following Summary may be useful *generally* in *any* latitude:—

RISE	FALL
FOR	FOR
COLD	WARM
DRY	WET
OR	OR
LESS	MORE
WIND.	WIND.
EXCEPT	EXCEPT
WET FROM	WET FROM
COOLER SIDE.	COOLER SIDE.

TO FORETELL WEATHER.

1. FAMILIAR as the practical use of weather-glasses is, at sea as well as on land, only those who have long watched their indications, and compared them carefully, are really able to conclude more than that the rising glass* USUALLY foretells less wind or rain, a falling barometer more rain or wind, or both; a high one fine weather, and a low the contrary. But useful as these general conclusions are *in most cases*, they are *sometimes* erroneous, and then remarks may be rather hastily made, tending to discourage the inexperienced.

2. By attention to the following observations (the results of many years' practice and many persons' experience) any one not accustomed to use a barometer may do so without much difficulty.

3. The barometer shows whether the air is getting lighter or heavier, or is remaining in the same state. The quicksilver falls as the air becomes lighter, rises as it becomes heavier, and remains at rest in the glass tube while the air is unchanged in weight. Air presses on everything within about forty miles of the world's surface, like a *much* lighter ocean, at the bottom of which we live—not feeling its weight, because our bodies are full of air,† but feeling its currents, the winds. Towards any place from which the air has been drawn by suction,‡ air presses with a force or weight of nearly fifteen pounds on a square inch of surface. Such a pressure holds the limpet to the rock, when, by contracting itself, the fish has made a place without air§ under its shell. Another familiar instance is that of the fly which walks on the ceiling with feet that stick. The barometer tube, emptied of air, and filled with pure mercury, is turned

* Glass, barometer, column, mercury, quicksilver, or hand.
† Or atmosphere, or the atmospheric fluid which we breathe.
‡ Or exhaustion.
§ A vacuum.

down into a cup or cistern containing the same fluid, which, feeling the weight of air, is so pressed by it as to balance a column of about thirty inches (more or less) in the tube, where no air presses on the top of the column.

4. If a long pipe, closed at one end only, were emptied of air, filled with water, the open end kept in water, and the pipe held upright, the water would rise in it more than thirty feet. In this way water barometers have been made. A proof of this effect is shown by any well with a sucking pump—up which, as is commonly known, the water will rise nearly thirty feet, by what is called suction, which is, in fact, the pressure of air towards an empty space.

5. The *words* on the old scales of barometers should not be so much regarded for weather indications as the rising or falling of the mercury; for, if it stand at *Changeable* (29·50), and then rise towards *Fair* (30·00), it presages a change of wind or weather, though not so great as if the mercury had risen higher; and, on the contrary, if the mercury stand above *fair*, and then fall, it presages a change, though not to so great a degree as if it had stood lower: besides which, neither the direction, nor force of wind, nor elevation above the sea level, are in any way noticed on such scales. It is not from the point at which the mercury may stand that we are alone to form a judgment of the state of the weather, but from its *rising* or *falling*, and from the movements of immediately preceding days as well as hours, keeping in mind effects of change of *direction*, and dryness or moisture as well as alteration of force or strength of wind.

6. The barometer is said to be *falling*, when the mercury in the tube is sinking, at which time its upper surface, if large, is *sometimes* concave or hollow; or when the hand (see page 2) moves to the left. The barometer is *rising*, when the mercurial column is lengthening; its upper surface being convex or rounded: or when the hand moves to the right.

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7. In temperate climates, towards the higher latitudes, the quicksilver ranges, or rises and falls, nearly three inches—namely, between about thirty inches and nine-tenths (30·9), and less than twenty-eight inches (28·0) on *extraordinary* occasions; but the usual range is from about thirty inches and a half (30·5), to about twenty-nine inches. Near the Line, or in equatorial places, the range is but a few tenths, except in storms, when it *sometimes* falls to twenty-seven inches.

8. The sliding-scale (vernier) divides the tenths into ten parts each, or hundredths of an inch. The number of divisions on the vernier exceeds, *or*, is less than that in an equal space of the fixed scale, by one.

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9. By a thermometer the *weight* of air is *not* shown. No air is within the tube. None can get in. But the bulb of the tube is full of mercury which contracts by cold, and swells with heat—according to which effect the thread of metal in the small tube is drawn down or pushed up so many degrees: and thus shows the temperature.*

10. If a thermometer have a piece of linen or muslin tied loosely round the bulb, wetted enough to keep it *damp* by a strip or thread dipping into a cup of water, it will show less heat than a dry one, in proportion to the dryness of the air, and quickness of drying.† In very damp weather, with or *before* rain, fog, or dew, two such thermometers will be nearly alike.‡

11. For ascertaining the dryness or moisture of air, the readiest and surest method is the comparison of two verified thermometers; one dry, the other *just* moistened and *kept so*. Cooled by evaporation as much as the state of the air admits—the moist (or wet) bulb thermometer shows a temperature nearly equal to that of the other one when the atmosphere is extremely damp or moist; but lower at other times,—in proportion to the dryness of air, and consequent evaporation,—as far as twelve or fifteen degrees in this climate; twenty or even more elsewhere. From three to eight degrees of difference is usual in England; and about seven is considered healthy for inhabited rooms. The thermometers should be near each other, but not *within* three inches. §

12. The thermometer fixed or attached to a barometer, intended to be used only as a weather-glass, shows the temperature of air about it nearly—but does not show the temperature of mercury within exactly. It does so, however, near enough for ordinary practical purposes—provided that no sun, nor fire, nor lamp heat is allowed to act on the instrument partially.

13. The mercury in the cistern and tube being affected by cold or heat, makes it advisable to consider this when endea-

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* Thirty-two degrees is the point at which fresh water begins to freeze, or ice to thaw. Salt water at 28°.

† Evaporation.

‡ Their difference, subtracted from the lower, gives the dew point (nearly).

§ See Memorandum in Appendix.

vouring to foretell coming weather by the length of the column, and indispensable when making comparisons with other instruments.

14. Briefly, the barometer shows weight, tension, or pressure of the air; the thermometer—heat and cold, or temperature; and the wetted thermometer, compared with a dry one, the degree of moisture or dampness.*

15. It should always be remembered that the state of the air *foretells coming* weather, rather than shows the weather that is *present*—(an invaluable fact too often overlooked)—that the longer the time between the signs and the change foretold by them, the longer such altered weather will last; and on the contrary, the less the time between a warning and a change, the shorter will be the continuance of such foretold weather.

16. To know the state of the air, not only barometer and thermometers should be watched, but the appearances of the sky should be vigilantly noticed.

17. If the barometer has been about its ordinary height, say near thirty inches, at the sea level,† and is steady, or rising—while the thermometer falls, and dampness becomes less—North-westerly, Northerly, or North-easterly wind—or less wind—less rain or snow—may be expected.

18. On the contrary—if a fall takes place, with a rising thermometer and increased dampness, wind and rain may be expected from the South-eastward, Southward, or South-westward.

19. In winter, a fall, with low thermometer, foretells snow.

20. Exceptions to these rules occur when a Northerly wind, with wet (rain, hail, or snow), is impending, before which the barometer often *rises* (on account of the *direction* of the coming wind alone) and deceives persons who, from that sign only (the rising,) expect fair weather.

21. When the barometer is rather below its ordinary height, say down to near twenty-nine inches and a half (at the sea level,) a rise foretells less wind, or a change in its direction towards the Northward,—or less wet; but when it has been

* The two thus combined, making a (Mason) hygrometer; for which, however, some kinds of hair, grass, or seaweed may be a substitute, though very inferior.

† It differs, or stands lower, about the tenth of an inch for each hundred feet of height directly upwards, or vertically, above the sea; its *average* height being 29·95 inches at the mean sea level in England: which height may be called "par" for that level. Allowances must, therefore, be made for barometers on high land or in buildings; each different elevation having its own (normal) line of pressure, or par height.

very low, about twenty-nine inches—the first *rising* usually precedes, or indicates, *strong* wind—at times heavy squalls—from the North-westward—Northward—or North-eastward—*after* which violence a gradually rising glass foretells improving weather—if the thermometer falls. But, if the warmth continue, probably the wind will back (shift against the sun's course), and more Southerly, or South-westerly wind will follow: especially if the barometer rise is sudden.

22. The most dangerous shifts of wind, or the *heaviest* Northerly gales, happen *soon* after the barometer *first* rises from a very low point: or, if the wind veers *gradually*, at some time afterwards,—with a *rising* glass.

23. Indications of approaching change of weather, and the direction and force of winds, are shown less by the height of the barometer, than by its falling or rising. Nevertheless, a height of more than thirty (30·0) inches (at the level of the sea) is indicative of fine weather and *moderate* winds; *except* from East to North, *occasionally*, whence it *may* blow strongly.

24. A rapid rise of the barometer indicates unsettled weather. A slow movement the contrary; as does likewise a *steady* barometer, which, when continued, and with dryness, foretells very fine weather, lasting for some time.

25. A rapid and considerable fall is a sign of stormy weather, and rain (or snow). Alternate rising and sinking, or oscillation, indicates unsettled and threatening weather.

26. The greatest depressions of the barometer are with gales from SE., S., or SW.; the greatest elevations, with wind from NW., N., or NE.,—or with calm.

27. Though the barometer generally falls with a Southerly, and rises with a Northerly wind, the contrary *sometimes* occurs; in which cases, the Southerly wind is usually dry with fine weather, or the Northerly wind is violent and accompanied by rain, snow, or hail; perhaps with lightning.

28. When the barometer sinks considerably, much wind, rain (perhaps with hail), or snow, will follow; with or without lightning. The wind will be from the Northward, if the thermometer is low (for the season)—from the Southward, if the thermometer is high. Occasionally a low glass is followed or attended by lightning *only*; while a storm is beyond the horizon.

29. A sudden fall of the barometer, with a Westerly wind, is sometimes followed by a violent storm from NW., or North or NE.

30. If a gale sets in from the E. or SE., and the wind veers by the South, the barometer will continue falling until the wind is near a marked change, when a lull *may* occur; after which, the gale will soon be renewed, perhaps suddenly and violently, and the veering of the wind towards the NW., North, or NE. will be indicated by a rising of the barometer with a fall of the thermometer.

31. Three causes (at least)* appear to effect a barometer:—

32. *First.* The direction of the wind—the North-east wind tending to raise it most—the South-west to lower it the most, and wind from points of the compass between them proportionally as they are nearer one or the other extreme point.

33. N.E. and S.W. may therefore be called the wind's *poles.*

34. The range, or difference of height shown, due to change of *direction only*, from one of these bearings to the other (supposing strength or force, and moisture to remain the same), amounts in these latitudes to about *half an inch* (as read off).†

35. *Second.* The amount—taken by itself—of vapour, moisture, wet, rain, or snow, in the wind, or current of air (direction and strength remaining the same), seems to cause a change amounting, in an extreme case, to about half an inch.

36. *Third.* The strength or force alone of wind, from any quarter (moisture and direction being unchanged), is preceded, or foretold, by a fall or rise, according as the strength will be greater or less, ranging, in an extreme case, to more than two inches.

37. Hence, supposing the three causes to act together—in extreme cases—the height would vary from near thirty-one inches (30·90) to about twenty-seven inches (27·00), which has happened, though rarely; (and even in *tropical* latitudes).

38. In general, the three causes act much less strongly, and are less in accord; so that ordinary varieties of weather occur much more frequently than extreme changes.

39. Another general rule requires attention; which is, that the wind usually *appears* to veer, shift, or go round *with the sun* (right-handed, or from left to right),‡ and that when it does not

* Electrical effects are yet too little known.

† Very important, but too seldom considered.

‡ *With* watch-hands in the Northern hemisphere: but the *contrary in South latitude.* This, however, is only *apparent*; the wind is actually circulating in the *contrary* direction: as a circle, or circular figure, turned horizontally, while moved across a map, or chart, will explain better than words.

do so, or backs, *more* wind or bad weather may be expected, instead of improvement, after a short interval.

40. It is not by any means intended to discourage attention to what is usually called "weather wisdom." On the contrary, every prudent person will combine observation of the elements with such indications as he may obtain from instruments: and will find that the more accurately the two sources of foreknowledge are compared and combined, the more satisfactory their results will prove.

41. A barometer begins to rise considerably before the conclusion of a gale, sometimes even at its commencement. Although it falls lowest before high winds, it frequently sinks very much before heavy rain. The barometer falls, but *not always*, on the approach of thunder and lightning.* Before and during the *earlier* part of settled weather it usually stands high, and is stationary; the air being dry.

42. Instances of fine weather, with a low glass, occur, however rarely, but they are always preludes to a *duration* of wind or rain, *if not both.*

43. After very warm and calm weather, a squall or storm, with rain, may follow; likewise at any time when the atmosphere is *heated* much above the *usual* temperature of the season; and when there is, or recently has been, much electric (or magnetic) disturbance in the atmosphere.

44. Allowance should *invariably* be made for the previous state of the glasses during *some days, as well as some hours*, because their indications *may* be affected by distant causes, or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighbouring regions, but not visible to each observer whose barometer feels their effect.

45. There may be heavy rains or violent winds beyond the horizon and the view of an observer, by which his instruments may be affected considerably, though no particular change of weather occurs in his immediate locality.

46. It may be repeated that the longer a change of wind or weather is foretold before it takes place, the longer the presaged weather will last: and, conversely, the shorter the warning, the less time whatever causes the warning, whether wind or a fall of rain or snow, will continue.

* Thunder clouds rising from *north-eastward*, against the wind, do not usually cause a fall of the barometer.

47. Sometimes severe weather from the Southward, *not lasting long*, may cause no great fall, because followed by a *duration* of wind from the Northward: and at times the barometer may fall with Northerly winds and fine weather, apparently against these rules, because a *continuance* of Southerly wind is about to follow. By such changes as these one may be misled, and calamity may be the consequence; if not duly forewarned.

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48. A few of the more marked signs of weather—useful alike to seaman, farmer, and gardener, are the following:

49. Whether clear or cloudy—a rosy sky at sunset presages fine weather:—a red sky in the morning bad weather, or much wind (perhaps rain):—a grey sky in the morning, fine weather:—a high dawn, wind:—a low dawn, fair weather.*

50. Soft-looking or delicate clouds foretell fine weather, with moderate or light breezes:—hard edged oily-looking clouds,—wind. A dark, gloomy, blue sky is windy;—but a light, bright blue sky indicates fine weather. Generally, the *softer* clouds look, the less wind (but perhaps more rain) may be expected;—and the harder, more "greasy," rolled, tufted, or ragged,—the stronger the coming wind will prove. Also—a bright yellow sky at sunset presages wind; a pale yellow, wet:—and thus by the prevalence of red, yellow, or grey tints, the coming weather may be foretold very nearly:—indeed, if aided by instruments, almost exactly.

51. Small inky-looking clouds foretell rain:—light scud clouds driving across heavy masses show wind and rain; but, if alone, may indicate wind only.

52. High upper clouds crossing the sun, moon, or stars, in a direction different from that of the lower clouds, or the wind then felt below,—foretell a change of wind.†

53. After fine clear weather, the first signs, in the sky, of a coming change, are usually light streaks, curls, wisps, or mottled patches of white distant clouds, which increase, and are followed by an overcasting of murky vapour that grows into cloudiness. This appearance, more or less oily, or watery, as wind or rain will prevail, is an infallible sign.

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* A "high dawn" is when the first indications of daylight are seen above a bank of clouds. A "low dawn" is when the day breaks on or near the horizon, the first streaks of light being very low down.

† In the tropics, or regions of trade winds, there is generally an upper and counter current of air, with very light clouds, which is not an indication of any approaching change. In middle latitude such upper currents are not so evident, except before a change of weather, because their vapour is *uncondensed*, and therefore invisible.

54. Usually, the higher and more distant such clouds seem to be,—the more gradual, but general, the coming change of weather will prove.

55. Light, delicate, quiet tints or colours, with soft undefined forms of clouds, indicate and accompany fine weather: but gaudy, or unusual hues, with hard, definitely outlined clouds, foretell rain, and probably strong wind.

56. Misty clouds forming, or hanging on heights, show wind and rain coming—if they remain, increase, or descend. If they rise, or disperse—the weather will improve or become fine.

57. When sea birds fly out early, and far to seaward, moderate wind and fair weather may be expected. When they hang about the land, or over it, sometimes flying inland, expect a strong wind, with stormy weather. As many creatures besides birds are affected by the approach of rain or wind, such indications should not be slighted by an observer who wishes to foresee weather, or compare its variations.

58. There are other signs of a coming change in the weather known less generally than may be desirable, and therefore worth notice; such as,—when birds of long flight, rooks, swallows, or others, hang about home, and fly up and down or low—rain or wind may be expected. Also when animals seek sheltered places, instead of spreading over their usual range; when pigs carry straw to their sties; when smoke from chimneys does not ascend readily (or straight upwards during calm), an unfavourable change is probable.

59. Dew is an indication of fine weather; so is fog. Neither of these two formations occur under an overcast sky, or when there is much wind. One sees fog occasionally rolled away, as it were, by wind—but seldom or never *formed* while it is blowing.

60. Remarkable clearness of atmosphere near the horizon: distant objects, such as hills, unusually visible, or raised (by refraction)*—and what is called "a good *hearing* day," may be mentioned among signs of wet, if not wind, to be expected.

61. More than usual twinkling of the stars; indistinctness or apparent multiplication of the moon's horns; halos; "wind-dogs,"†—and the rainbow; are more or less significant of

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* Much refraction is a sign of easterly wind, veering southward.

† Fragments or pieces (as it were) of rainbows (sometimes called "wind-galls") seen on detached clouds.

increasing wind, if not approaching rain, with or without wind.*

62. Near land, in sheltered harbours, in valleys, or over low ground, there is usually a marked diminution of wind—during part of the night—and a dispersion of clouds. At such times an eye on an overlooking height may see an extended body of vapour below (rendered visible by the cooling of night) which *seems* to check the wind.

63. The dryness or dampness of the air, and its temperature (for the season,) should *always* be considered—*with other* indications of change, or continuance, of wind and weather.

64. On land, generally, there is more difficulty in ascertaining the real direction of the wind, in practice, than there is at sea—where sails, or a vane and a compass, are always at hand, uninfluenced by heights, or eddy winds.

65. Some observers notice smoke, others clouds (seldom going with the *local* wind, *below*, though generally correct as respects the *prevailing* wind), some mark the vane or weathercock, while only a few of the lighthouse and telegraph observers know how their points of reference bear by the world (or map) or even by a magnetic needle, of which the *variation* is still less often known within a point of the compass (if indeed *understood*).

66. Such persons should be advised to *mark* a true east and west line, *about the time of the equinox*, by the sun at rising or setting; and by it give their bearings, or directions of wind. And they should take its direction from that of the *lower* clouds, (when they are not very distant,) compared with that of vanes and smoke,—in preference to any other indication.

67. Much more care is required in noticing the veering, shift, turn, or gyration of the wind, than has usually been thought necessary. Very rarely has the way the wind *went round* been noticed in ordinary registers: though of consequence.

68. These shiftings or veerings of wind—being caused, generally, by the progression of circuits, or cyclonic movements, of the atmosphere, which succeed or *counteract* each other, variously impinging against air at rest, or moving differently—require much attention, especially in forecasts of weather. (*Weathercasts?*)

69. With respect to the "normal levels," or lines, or barometric heights, (namely, the *means*, above and below which instruments range, at places of various elevations,) often, indeed generally,

* *Remarkable* clearness is a bad sign. The "young moon with the old moon in her arms" (Burns, Herschel, and others) is a sign of bad weather in the temperate zones or middle latitudes, (probably) because the air is then exceedingly clear and transparent.

used on the Continent of Europe—it may be repeated that our word "par" may be a synonym, for use: thus—(say) twenty-four hundredths (or whatever it may be) above, or below par.

70. Wherever practicable, the vertical difference between any such level, and that of the ocean, should be ascertained, as each ten feet of rise lowers the barometer about eleven thousandths of an inch. This sea level should be that of the ocean itself—at mean half tide—a level which should be the universal standard of reference throughout the globe.

71. "Weather glasses" were used even before the 18th century. Among others, De Foe watched and registered them in 1703 (see his account of "The Great Storm"): but it is an instance of the necessity for *repeating* information, that, generally speaking, even *now* so little complete use is made of these instruments, however familiar, common, and inexpensive they have become.

72. Like seamanship, ability to foretell weather is acquired, by degrees, practically, and has not been *hitherto* attained by books;—though it may *now* be, in consequence of numerous recorded observations and opinions, brought together in late years, very carefully considered, and published at the lowest price by Government:—without claiming copyright.

73. Instructions being thus available, based on scientific as well as practical conclusions—by such help, *properly studied*, any one may become "weather-wise" who will notice, even once a day, the indications of the heavens, of thermometers, and of a barometrical instrument.

74. As all these barometric instruments often, if not usually, show what may be expected a day or even days in advance, rather than the weather of the present or next few hours, and as wind, or its *direction*, affects them much more than rain or snow, due allowance should always be made for days as well as for hours to come.*

75. Annexed is a table of average temperatures between eight and nine o'clock A.M. near London, which may be used (with allowance for ordinary differences between Greenwich temperatures and others) to assist in foretelling the direction and nature of coming wind and weather.

76. The thermometer (shaded and in open air) when much *higher*, between eight and nine A.M., than the average, indicates southerly or westerly wind (tropical); but when considerably lower, the reverse or northerly (polar) currents of air.

* See "Wind-currents" in pages 34 and 35.

77. These indications are not yet so generally familiar as they ought to become, being easily marked, and very useful.

78. The average temperatures at Greenwich; in the shade and open air, between eight and nine A.M., are nearly the mean temperature of each twenty-four hours, taking the year through, around London; and, with allowance for the differences between the *means* of Greenwich temperatures, and those of other places, may be taken for the British Islands, generally, as follows For about the middle of—

January	37°	July	62°
February	39°	August	61°
March	41°	September	57°
April	46°	October	50°
May	53°	November	43°
June	59°	December	39°

and proportionally between each middle period.

79. Marked distinction is advisable between such instruments, observations, and instructions as are intended only for indicating changes of weather, or its duration, and those of a superior kind required for comparisons and elaborate deductions for scientific purposes.

80. To know whether a tube with mercury has been well boiled (as it is called) by holding and turning it over a charcoal fire, it is unnecessary to watch the tedious process. Subsequent examination of the metal in the glass tube, with a lens, and its "click" at the *top* of the tube, give unfailing evidences of the presence or absence of air, whether boiled or otherwise treated.

81. To verify the graduation thoroughly (not at a few casual heights *only*, by comparison with another barometer,) artificial pressure or exhaustion must be obtained by placing the instrument under the receiver of an air pump.

82. This is done at Kew Meteorological Observatory very completely: and it is *necessary* for accurate scientific barometers, though not for mere weather glasses.

83. While saying so much of the mercurial barometer, it would be an injustice to the Aneroid not to mention that twelve years' experience of this small and *very* portable barometer—at sea, on land, and travelling,—has induced its *high* recommendation (when *set properly*) as an excellent weather glass for small vessels or boats.

84. The Aneroid, or a Sympiesometer, requires a little *occasional* adjustment to a good mercurial barometer (as a standard) by turning the back screw of the former very gently and slightly, or by altering the pointer of the Sympiesometer.

85. Now that the exclusive patent for making Aneroid barometers has expired, it is to be hoped and expected that our opticians will produce trustworthy and even yet more portable instruments, on the same principle mainly,—but improved in manufacture, as well as in the principle itself.

86. One kind may soon be anticipated—exactly compensated for changes of temperature, accurately (not *equally*) graduated on the disc surface—and as superior to the common Aneroid as a chronometer is to a cheap watch: but this instrument must be comparatively expensive.

87. Another description (a modification of this admirable French instrument) may be considerably cheaper and *smaller* than the present popular one. It may be a "pocket weather glass" (so to speak), suitable for fishermen, pilots, or seafaring persons employed in boats, or small coasting vessels, — without space to suspend, or means to provide, a mercurial barometer.

88. By comparison with the Weather Report (meteorological), now published daily in the Times, Shipping Gazette, and other Newspapers, any one may ascertain the state of a barometer, aneroid, or sympiesometer; or his own *elevation above the sea level;* provided that the comparison is made, between eight and nine in the morning, with two or three published observations, for the same time, at places *nearest* to him, on different sides.

89. These daily statements of the weather, and indications of verified, as well as reliable *standard* instruments, show to those who are interested,—and who regularly compare the accurate simultaneous observations thus generally available,—not only what were the general and various states of atmosphere over Great Britain, Ireland, and the west of Europe—from Copenhagen to Lisbon,—the same, or the previous morning (according to the time of day, and the newspaper referred to); but by such comparisons enable a useful degree of foreknowledge of weather, during the coming day or two, or even few following days, to be attained by any observant and considerate person.

90. Every day the Shipping Gazette (if morning papers are not seen) now affords the means of verifying and correcting such a "Storm warner," without taking it to any other place, or person, for comparison.

APPENDIX.

Although the preceding remarks are probably sufficient for their principal purpose—these pages may fall into the hands of persons more familiar with the subject, to whom the following observations may be addressed, as some of the *reasons* for what has been so briefly outlined.

As the mercurial column rises with increase of pressure by the atmosphere, and descends when the pressure diminishes, it indicates a greater or less accumulation of air, which, like other fluid, such as water (when heaped above its average level or reduced below it, from *whatever cause*),—will have a tendency to fall or rise till the general equilibrium is restored. An observer may be under the centre of such accumulation or depression, he may be more or less distant from it, though within the *influence* of whatever horizontal movement of air may be caused by such *temporary* increase or diminution of pressure. Hence the barometer shows, and generally foretells, changes of wind; but as complications always occur, and as changes are of greater or less extent, affecting or extending through a wider or more limited area, accompanied by hygrometric and electrical alterations, it is extremely difficult at times to say beforehand what *particular* change of weather is to be expected, and at what interval of time; although after the event the correspondence of barometric changes with those of the weather can be readily traced. However, notwithstanding occasional perplexity, the general character of weather during the next few days may be predicted by an observer who understands the nature and use of this instrument and the thermometer, and has watched them in the few immediately preceding days.

In endeavouring to foretell weather, the general peculiarity should *always* be remembered, that the barometric column usually stands higher with Northeasterly than it does with South-westerly winds; or, with winds from the polar regions higher than with those from the direction of the equator. Hence the highest columns are observed with Northerly winds in northern latitudes, and with Southerly in the southern hemisphere.

In middle latitudes there is an average difference of about half an inch, other things being similar, between the heights of the mercury with North-easterly, and with South-westerly winds (as read off).

The steadier the column, or the more gradually it moves, the more lasting in character will the weather be, because it shows a more balanced state of the atmosphere; and conversely, if otherwise. In the tropics, when the barometric column moves contrary to its *usual* daily motion, inferior weather may be expected (temporarily), because the normal air currents are disturbed.

This regular movement, whether tidal, or otherwise connected with the sun's influence, (rather than that of the moon)—very sensible in tropical latitudes, but more or less marked even elsewhere—amounts to nearly two-tenths of an inch between the tropics, the highest being at about nine, and the lowest near three o'clock—but varying locally, to about one hour sooner or later than these times.

Some movements of the atmosphere may be illustrated by reference to the motion of water drawn off from a reservoir by a small opening below; or by similar *upward* draught through a syphon; or by a gradual pouring in at the upper surface.

From a slight motion at the commencement, affecting only that portion of the fluid adjoining either of those places of diminution or increase, gradually all the water becomes influenced, and acquires more or less rapid movement. But suppose a long reservoir or canal of fluid which has two such points of loss, or two of such filling (as imagined above), and that one of either is near each end of the vessel. If each aperture be opened at the same moment, equal effects will be caused in each half of the fluid towards either end of the vessel, but in the middle there must be a neutral point at which the water falls or rises, yet has no horizontal motion. And in the case of fluid drawn off, or diminished in weight, at one end, while increased at the other, the *whole* body of water will move similarly to that in the former vessel, but unequally. Hence it is evident, that before horizontal motion occurs, an augmentation or a diminution of pressure must take place somewhere more or less remote:—and so it is with the lighter fluid, our atmosphere,—which has centres, lines, or areas of depression towards which currents flow (*and thence go elsewhere*).

Such considerations show, in some degree, why the barometric changes usually precede, but sometimes only accompany, changes of weather: and, though very rarely, occur without any sensible alteration in the wind current of the atmosphere. An observer may be near a central point towards which the surrounding

fluid tends,—or from which it diverges. He may be at the very farthest limit of the portion of fluid that is so influenced. He may be at an intermediate point—or he may be between bodies of atmosphere tending towards opposite directions.*

It has been said, that "a whirlwind which sets an extended portion of the atmosphere into a state of rapid revolution diminishes the pressure of the atmosphere over that portion of the earth's surface, and most of all at the centre of the whirl. The depth of the compressing column of air will, at the centre, be least, and its weight will be diminished in proportion to the violence of the wind." But this has been controverted—with respect to the *general* effect of air in horizontal motion, and the depth of the column in question.

Certainly there are two kinds of whirlwinds—one caused by rarefaction, tending to lighten vertical pressure under the vortex, though not, perhaps, under all the current drawn towards it; and the other, a consequence of opposing winds, which occasion huge eddies or whirlwinds of compression.

Some whirlwinds are accompanied by rushes from the upper atmosphere, or from cooler spaces, which, mingling with warmer and moister air near the sea, cause dense clouds. About their centre it sometimes happens that the barometer falls as much as two or even three inches, thus showing a diminution of atmospheric pressure by nearly a *tenth part;* when it must be expected, from physical considerations alone, that very dense clouds would be formed.†

To render these pages rather more useful at sea, in *any* part of the world, a few words about squalls and hurricanes are here submitted for the young officer, placed in charge of a watch at sea.

Generally, squalls are preceded, or accompanied, or followed by clouds; but the very dangerous "white squall" (of the West Indies and other places) is indicated only by a rushing *sound,* and by white wave crests, along the water.

"Descending squalls" come slanting downwards, off high

* Considerations of vertical, horizontal, or other circuits, consequent on tendencies towards a centrical area, or compression between antagonistic currents, are given elsewhere in these pages.

† Even in ordinary changes of weather it is interesting, as well as useful, to mark the formation or disappearance of clouds, caused by cooler and warmer currents of air mixing, or intermingling: Clouds, watched closely through a telescope, are seldom, if ever, at rest, or unchanging.

land,* or from upper regions of atmosphere. They are dangerous, being sometimes violently strong: like short hurricanes.

A squall cloud that one can see through, or under, is not likely to bring, or be accompanied by, so much wind as a dark continued cloud extending beyond the horizon. That the comparative hardness or softness of clouds foretells more or less wind or rain, was stated in pages 12 and 13. The expressions "hardening up," "softening," or "looking greasy," are familiar to seamen: and such very sure, as well as distinct, indications are the appearances so designated, that they can hardly be unnoticed or mistaken.

The rapid or slow rise of a squall cloud—its more or less disturbed look—that is, whether its body is much agitated, and changing form continually,—with broken clouds, or scud, flying about—or whether the mass of cloud is shapeless and nearly quiet, though floating onwards across the sky—foretells more or less wind accordingly, whether with, or without, rain, hail, or snow.

An officer of a watch, with a good eye for clouds and signs of changing weather, may save his men a great deal of unnecessary exposure, as well as work, besides economising sails, spars, and rigging,—to an extent often too little appreciated.

In some of the old "saws" about wind and weather, there is so much truth that, though trite and simple, their insertion here can hardly be objectionable.

Adverting to the barometer, it has been said:—

When rise begins, after *low,*
Squalls expect and clear blow.

Or:—*First* rise, after very low,
Indicates a stronger blow.

Also:—Long foretold, long last:
Short notice, soon past.

To which may be added:—In squalls—
When rain comes before wind,
Halyards, sheets, and braces mind.

And:—When wind comes before rain,
Soon you may make sail again.

Also, *generally* speaking:—
When the glass falls low,
Prepare for a blow;
When it *has* risen high,
Let all your kites fly.†

* Williwaw (Whirl-awa?) of the old sealers and whalers.

† Seamen call the light sails, used only in very fine weather, "flying kites."

To these short maxims—well known, in practice, to the experienced,—a very concise but sure rule may be added for avoiding the centrical or more dangerous parts of a hurricane, cyclone, typhoon, tornado, or other circuitous storm.

With your face toward the wind, in North latitude, the centre of the circuit, or rotatory storm, will be nearly square to your right. In South latitude, nearly square to your left.

The apparent veering of the wind, and nearing or distancing the dangerous space just around the centrical area, depend on your position in the curvilinear sweep.

Draw a circle;—mark the direction of the rotation or circulation, by an arrow with the head towards the left hand (against the movement of a watch's hands) in North latitudes; but towards the right (or with the hands of a watch) if in South latitude. The direction of the wind, and the bearing of the centre, show your position in the circuit, (perhaps hundreds of miles across, or in length) while the veering of the wind, or the contrary, its change in strength, the barometer, and thermometer, will show how the cyclone is moving bodily—over an extensive region,—horizontally—or perhaps inclined, at a certain angle, to the horizontal plane.

Draw a line, (axial) through the centre, to show this direction, beyond the circle, both ways.

If the observer be stationary, in North latitude, and the centre pass on his polar side, he will experience a change of wind from Southward by the West towards North; but if it pass between him and the Equator, the change will be from Southward by the East towards North, and then Westward; contrariwise in South latitude: as his place in outline circles will show more clearly than words. The roughest sketch or diagram, indicating the various directions of wind, the course of the cyclone's centre, and its two semicircles, will show more plainly than descriptions —which must necessarily vary with each case, and are tedious, if not bewildering.

Cyclonology is simple enough as to these great characteristic effects; but causes must be the philosopher's study, rather than that of the young practical seaman:—else one might show how all the great Easterly trade winds—the no less important anti-trades,* or prevalent Westerly winds,—and their complicated eddying offsets, are all (on greater or smaller scales) alternating,

* Herschel's Meteorology.

or circulating, or crossing breadths, or zones of atmosphere, superposed or laterally contiguous,—between which, at varying, but usually rare intervals, occur those strong eddies, or storms, (sometimes *consecutive*) called hurricanes—typhoons—tornadoes —or cyclones.

The great easterly and westerly movements—so clearly shown by philosophers to be the consequences of cool polar currents of air—warm equatorial currents—and diurnal rotation of the earth;* are grand ruling phenomena of meteorology—to which storms, and all local changes, occurring but occasionally, are subordinate and exceptional. Further investigations into electrical and chemical peculiarities will probably throw additional light, perhaps the strongest, on meteorological science.

In the previous observations, general reference has been made to mercurial barometers of the ordinary kind; but, excepting the construction of the instruments themselves, those observations apply to all barometers, wheel—aneroid—or metallic—and likewise, of course to the sympiesometer, which is a modified barometer. But as these four last-mentioned instruments are scarcely so familiar as the simpler form of barometer, it may be useful to add a few words, about each of them, in this place.

The WHEEL barometer has a syphon tube, partly filled with mercury, on which, at the short or open end of the tube, a float moves, to which a line is attached that moves on a wheel, or arc, carrying a balanced index.†

ANEROID barometers, if occasionally compared with good mercurial columns, and adjusted, are similar in their indications, and as valuable; but it must be remembered that they are not independent instruments; that they are set originally by a barometer,‡ require adjustment occasionally, and *may* deteriorate in time, though perhaps slowly.§

* Dove's Law of Storms. Daniells, Hadley, and Halley.

† For a barometer of this kind, Admiral Milne invented self-registering mechanism that answers well, with the improvements since added.

‡ A small turnscrew being applied gently to the screw head at the back. This is often necessary, on receiving or first using an aneroid that has long been lying by, or that has been shaken by travelling.

§ I have one that has been used continually, during twelve years, which has not yet deteriorated.

The aneroid is quick in showing the variation of atmospheric pressure, and to the navigator who knows the difficulty, at times, of using barometers, this instrument is a great boon, for it can be placed anywhere, quite out of harm's way, and is not affected by the ship's motion, although faithfully giving indication of increased or diminished pressure of air.* In ascending or descending elevations, the hand of the aneroid may be seen to move (like the hand of a watch), showing the height above the level of the sea, or the difference of level between places of comparison.†

The principle on which it is constructed may be explained in a few words, without going into minute detail of its various parts. The tension of a body of air, which in a common barometer acts on the mercury, in the aneroid presses on a small circular metal box, from which *nearly* all air is extracted; and to this box is connected, by nice mechanical arrangement, the hand visible over the face of the instrument. When the atmospheric pressure is lessened on the vacuum box, a spring acting on levers, turns the hand to the left, and when the pressure increases, the spring is affected differently, the hand being turned to the right. It acts in any position, but as it *often varies several hundredths with such a change*, it should be held uniformly, *while read off*, one way or the other.

The expansion and contraction of metals under varying temperatures, caused doubts as to the accuracy of the aneroid under such changes; but they were partly removed by introducing into the vacuum box a small portion of gas, as a compensation for the effects of heat or cold. The gas in the box, changing its bulk on a change of temperature, was intended to compensate for the effect on the metals of which the aneroid is made. But besides this, a further and more reliable compensation has lately been effected by a combination of brass and steel.‡

METALLIC barometers, by Bourdon, (in *outer* shape and size like aneroids) have not yet been tested in very moist, hot, or cold air for a sufficient time. They are likewise dependent or secondary instruments, and liable to deterioration. For limited employment, when sufficiently compared, they may be very

* It is a good weather glass—to be suspended on or near the upper deck, for easy reference;—and is unlikely to be injured by mere concussion of air, or vibration of wood, when guns are fired.

† Allowing 0·001 of an inch for each foot.

‡ The manufacture of these useful auxiliary instruments (originally French, by Vidi,) has increased much latterly: and as the patent has expired, they may now be very much improved.

useful, especially in a few cases of electrical changes, *not foretold or shown by mercury*, which these seem to indicate.

The SYMPIESOMETER has been considered to be more sensitive than the marine barometer, falling sooner, and rising earlier: but this was partly in consequence of the marine barometer tube being contracted *unduly* to prevent oscillation or "pumping." In the sympiesometer a gas is used, which presses on the confined surface of the liquid with an uniform pressure at an equal state of temperature. The liquid is raised or depressed by an increase or diminution in the density of the atmosphere, and change of temperature is allowed for, by the sliding scale of the instrument being always set to agree with the height of the mercury in the attached thermometer, bringing the *pointer* on the sliding scale of the sympiesometer to the same degree on the inverted scale (over which it slides) as is indicated by the thermometer. The height of the fluid, as then shown by the sliding scale, indicates the pressure of the atmosphere.

As the instrument is delicate, great care should be taken, in carrying or handling, to keep the top always upwards, and to exclude casual rays of the sun, or a fire, or lamp.

Oil sympiesometers *seem* to be affected more than the barometer, by lightning or electricity. That they, and the hermetically sealed vials, erroneously called "STORM GLASSES," are influenced by a cause besides pressure and temperature, appears now to be certain; and that this must be of an electric character seems evident.

VERNIER READING.

HESITATION is sometimes felt by young seamen, at first using the vernier of a barometer, for want of some such explanation as the following is intended to be.

The general principle of this moveable dividing scale is, that the total number of the smallest spaces or subdivisions of the vernier are made equal, taken altogether, to one less, or more, than that number of the smallest spaces in an equal length of the fixed scale.

For example: ten spaces on the vernier being made equal to nine, or eleven, on the scale; each vernier space is one tenth less, or more, than a scale space; and if the first line or division of the vernier agree exactly with any line of the scale, the next line of the vernier must be one tenth of a tenth (or one hundredth) of an inch from agreement with the next *scale* division; the following vernier line must be two hundredths out, and so on: there-

fore, the number of such differences (from the next tenth on the scale) at which a vernier line agrees with a scale line, when set, is the number of hundredths to be added to the said tenth; (in a common barometer, reading only to hundredths of an inch).

The vernier of a barometer reading to thousandths of an inch is on a similar principle, though differently divided. In this application of it, generally, twenty-five vernier spaces equal twenty-four of the scale spaces, which are each half a tenth, or five hundredths of an inch; therefore, the difference between one of the vernier and one of the scale is two-tenths of a hundredth, or two thousandths of an inch [25)·050(·002].

This is the usual graduation of scientific barometers; but for ordinary purposes, as weather glasses, a division, or reading, to the hundredth of an inch, is sufficient.

When set properly, the vernier straight edge, the top of the mercury, and the observer's eye, should be on the same level; the edge (or pointer) just *touching** the middle and uppermost point of the column.

Great care should be taken to look thus square, or at right angles, to the scale.

Light, or something white, at the *back* of the tube, assists in accurately setting the vernier, and may be shifted about, to aid by itself, or by reflection, in reading off.

THE ANEROID has been recommended, in these pages, as a weather-glass; but it may increase its usefulness to append a table for measuring heights (approximately) by this, or any barometer, which can be compared with another, or itself, at a higher or lower station.

If the measure of a height rather greater than the aneroid will commonly show, be required, it may be *re-set* thus:—When at the upper station (*within its range*), and having noted the reading carefully, touch the screw behind so as to bring back the hand a few inches (if the instrument will admit), then read off and start again. *Reverse the operation when descending.* This may add some inches of measure *approximately.*

As the barometer falls about one tenth of an inch for each of the first few hundred feet above the sea level, but varies when it becomes much more elevated:† due allowances should always be made in observing, when on very high land.

* Like the sun's edge or limb, touching the sea horizon, as seen inverted when using a sextant.

† Depending on pressure, temperature, and tension of vapour.

It should not be overlooked that the tides are affected by atmospheric pressure, so much that a rise of one inch in the barometer will have a corresponding fall in the tides of from about nine to fifteen inches, or on an average one foot for each inch;* and that as vessels sometimes enter docks, or even harbours, where they have scarcely a foot of water more than their draught;—and as docking, as well as launching large ships, requires close calculation of height of water, the state of the barometer becomes of additional consequence on such important occasions.

In the following Table, the *difference* between the number of feet opposite the height of a barometer, at one station, and that opposite to the height at another station, is their *approximate* difference of elevation.

The consecutive differences, it will be seen, range from 85 feet to 140 feet for equal tenths of an inch between 31 and 18 inches. At 26 inches the difference is nearly 100 feet.

Authorities are rather at variance on this subject, but for *moderate* heights, with an average pressure and temperature, one hundredth of an inch to a foot vertical, may be used practically.

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* Sir James Ross—M. Daussy.

Difference Table for Elevations.

Barometer Inches.	Height in feet.	Barometer Inches.	Height in feet.	Barometer Inches.	Height in feet.
31·0	0	26·8	3829	22·6	8317
30·9	85	26·7	3927	22·5	8434
30·8	170	26·6	4025	22·4	8551
30·7	255	26·5	4124	22·3	8669
30·6	341	26·4	4223	22·2	8787
30·5	427	26·3	4323	22·1	8906
30·4	513	26·2	4423	22·0	9025
30·3	600	26·1	4524	21·9	9145
30·2	687	26·0	4625	21·8	9266
30·1	774	25·9	4726	21·7	9388
30·0	862	25·8	4828	21·6	9510
29·9	950	25·7	4930	21·5	9632
29·8	1038	25·6	5033	21·4	9755
29·7	1126	25·5	5136	21·3	9878
29·6	1215	25·4	5240	21·2	10002
29·5	1304	25·3	5344	21·1	10127
29·4	1393	25·2	5448	21·0	10253
29·3	1482	25·1	5553	20·9	10379
29·2	1572	25·0	5658	20·8	10506
29·1	1662	24·9	5763	20·7	10633
29·0	1753	24·8	5869	20·6	10760
28·9	1844	24·7	5976	20·5	10889
28·8	1935	24·6	6083	20·4	11018
28·7	2027	24·5	6190	20·3	11148
28·6	2119	24·4	6297	20·2	11278
28·5	2211	24·3	6405	20·1	11409
28·4	2303	24·2	6514	20·0	11541
28·3	2396	24·1	6623	19·9	11673
28·2	2489	24·0	6733	19·8	11805
28·1	2582	23·9	6843	19·7	11939
28·0	2675	23·8	6953	19·6	12074
27·9	2769	23·7	7064	19·5	12210
27·8	2864	23·6	7175	19·4	12346
27·7	2959	23·5	7287	19·3	12483
27·6	3054	23·4	7399	19·2	12620
27·5	3149	23·3	7512	19·1	12757
27·4	3245	23·2	7625	19·0	12894
27·3	3341	23·1	7729	18·9	12942
27·2	3438	23·0	7854	18·8	13080
27·1	3535	22·9	7969	18·7	13219
27·0	3633	22·8	8085	18·6	13358
26·9	3731	22·7	8201	18·5	13498

MARINE BAROMETER

SUPPLIED TO

HER MAJESTY'S NAVY.

This instrument should be suspended in a good light for reading, but out of the reach of sunshine or the heat of a fire or lamp. It should be as nearly amidships, and exposed as little to sudden changes of temperature, gusts of wind, or injuries, as possible. In a ship-of-war it might be below the lowest battery or gun-deck.* Light should have access to the back of the tube, to admit of setting the index so as to have its lower edge a tangent to the surface of the mercury—the eye being on the same level, which is known by the back and front edges of the index being in one line with the mercury surface. White paper or card may reflect light for setting the vernier correctly. The height of the cistern above or below the water-line should be ascertained, and entered on the register (to the nearest foot, only).

It is desirable to place the barometer in such a position as not to be in danger of a side blow, and also sufficiently far from the deck above to allow for the spring of the metal arm in cases of sudden movements of the ship.

If there is risk of the instrument striking anywhere when the vessel is much heeled, it will be desirable to put some soft padding on that place, or to check movement in that direction by a light elastic cord; in fixing which, attention must be paid to have it acting only where risk of a blow begins, not interfering otherwise with the free swing of the instrument: a very light cord attached above, when possible, will be least likely to interfere injuriously.

The vernier, in some standard barometers, reads to the two thousandth (·002) part of an inch. Every long line cut on the vernier corresponds to ·01 part; each small division on the scale is ·05; the hundredth parts on the vernier being added to the five when its lower edge is next above one of the short lines;

* Or taken down when clearing for action.

or written down as shown by the figures on the vernier only, when next above one of the divisions marking tenths.

In other instruments the vernier reads only to hundredths.

In placing this barometer, it is only necessary to fix the instrument carefully, as indicated in the above directions, and give a few gentle taps with the fingers on the bottom, to move the mercury. Without further operation it will usually be ready for observation in less than an hour.

When moving the instrument, or replacing it in its case, the mercury should be allowed to run gently up to the top of the tube, by holding the barometer for a few minutes inclined at an angle. The vernier should be brought down to the bottom of the scale. No other adjustment for portability is required. During carriage, it ought to be kept with the cistern end uppermost, or lying flat, the former position being preferable.

If the mercury should not descend at first by a few gentle taps, use sharper (but of course without violence), by which, and two or three taps, with the finger ends, on the tube—between the scale and the tangent screw—the mercury will be made to begin to descend. In a well boiled tube the mercury often adheres *much* to the top of the tube.

When reading off from a barometer, it should hang *freely*, not being *inclined* by holding, or even by a touch.

Sometimes, though rarely at sea, the mercury seems *stopped*. If so, take down the instrument (after *sloping*), reverse it, tap the tube gently for a few minutes, while the cistern end is upwards, and then replace it as before.

In the barometers now in general use by meteorologists on land, the diameters of the tubes are nearly equal throughout their whole length, and a provision is made for adjusting the mercury in the cistern to the zero point, previous to reading the height of the top of the column. The object of the latter arrangement, it is well known, is to avoid the necessity of applying a correction to the readings for the difference of capacity between the cistern and the tube. At sea, barometers of this construction cannot be used. Part of the tube of the marine barometer must be very much contracted to prevent "pumping," and the motion of the ship would render it impracticable to adjust the mercury in the cistern to the zero point. In the barometer usually employed on shore, the index error is the same throughout the whole range of scale readings, if the instrument

be properly made; but in nearly all the barometers which had been employed at sea till recently the index correction varied through the range of scale readings, in proportion to the difference of capacity between the cistern and the tube. To find the index correction for a land barometer, comparison with a standard, at any part of the scale at which the mercury may happen to be, is generally considered sufficient. To test the marine barometer is a work of much more time, since it is necessary to find the correction for scale readings at about each half inch throughout the range of atmospheric pressure to which it may be exposed; and it becomes necessary to have recourse to artificial means of changing the pressure of the atmosphere on the surface of the mercury in the cistern.

The barometers to be thus tested are placed, together with a standard, in an air-tight chamber, to which an air pump is applied, so that, by partially exhausting the air, the standard can be made to read much lower than the lowest pressure to which marine barometers are likely to be exposed; and by compressing the air it can be made to read higher than the mercury ever stands at the level of the sea. The tube of the standard is contracted similarly to that of the marine barometer, but a provision is made for adjusting the mercury in its cistern to the zero point. Glass windows are inserted in the upper part of the iron air-chamber, through which the scales of the barometers may be seen; but as the verniers cannot be moved in the usual way from outside the chamber, a provision is made for reading the height of the mercury independent of the verniers attached to the scales of the respective barometers. At a distance of some five or six feet from the air-tight chamber a vertical scale is fixed. The divisions on this scale correspond exactly with those on the tube of the standard barometer. A vernier and telescope are made to slide on the scale by means of a rack and pinion. The telescope has two horizontal wires, one fixed and the other moveable by a micrometer screw, so that the difference between the height of the column of mercury and the nearest division on the scale of the standard, and also of all the other barometers placed by the side of it for comparison, can be measured either with the vertical scale and vernier or the micrometer wire. The means are thus possessed of testing barometers for index error in any part of the scale, through the whole range of atmospheric pressure to which they are likely to be exposed, and the usual practice is to test them at every half inch from 27·5 to 31 inches.

In this way barometers of various other descriptions have been tested, and some errors found to be so large that a few barometers read half an inch and upwards too high, while others read as much too low. In some cases those which were correct in one part of the scale were found to be from half an inch to an inch wrong in other parts. These barometers were of an old and ordinary not to say inferior construction. In some the mercury would not descend lower than about 29 inches, owing to a fault very general in the construction of many common barometers till lately in frequent use:—the *cistern was not large enough* to hold the mercury which descended from the tube in a *low atmospheric pressure.*

In the Government Marine Barometers the diameter of the cistern is about an inch and a quarter, and that of the tube about a quarter of an inch. The scale, instead of being divided into inches in the usual way, is shortened in the proportion of about 0·04 of an inch for every inch. The object of shortening the scale is to avoid the necessity of applying a correction for difference of capacity between the cistern and the tube. The perfection with which this is done may be judged of from the fact, that of the first twelve barometers tested at the Liverpool Observatory with an apparatus exactly similar to that used at Kew (whence these instruments were sent by railway, after being tested and certified), the index corrections in the pressures from 28 to 31 inches, in three of them, were the same; two differed 0·001 of an inch; and for the remainder the differences ranged from 0·002 to 0·006 of an inch. The corrections for capacity were therefore considered perfect, and, with one unimportant exception, agreed with those given at Kew.

In order to check the pumping of the mercury at sea, the tubes of these barometers are so contracted, through a few inches, that, when first suspended, the mercury is ten or twenty minutes in falling from the top of the tube to its proper level. When used on shore, this contraction of the tube causes the marine barometer to be *sometimes* a little behind an ordinary land barometer, the tube of which is not contracted. The amount varies according to the rate at which the mercury is rising or falling, and ranges from 0·00 to 0·02 of an inch. As the motion of the ship at sea causes the mercury to pass more rapidly through the contracted tube, the readings are almost the same there as they would be if the tube were not contracted, and in no case do they differ enough to be of importance in maritime use.

A new Marine Barometer—for Her Majesty's Service—adapted likewise to *general* purposes—is somewhat different from barometers previously made, in points of detail, rather than principle:—1. The glass tube is packed with vulcanised india rubber, which checks vibration, from concussion—but does not hold it rigidly, or prevent expansion. 2. It does not oscillate, (or pump) though extremely sensitive. 3. The scale is porcelain, *very legible,* and not liable to change. 4. There is no iron anywhere—(to *rust*). 5. Every part can be unscrewed, examined, or cleaned, by any careful person. 6. There is a *spare* tube, fixed in a cistern, filled with boiled mercury, and *marked* for adjustment in this, or *any similar* instrument.

Although, for various reasons, these new barometers are graduated to hundredths *only*—they will be found accurate to *that* degree, the second decimal of an inch.

They are packed with vulcanised india rubber, in order that (by this, and a peculiar strength of glass tube) guns may be fired near these instruments without causing injury to them by ordinary concussion.

It is hoped that all such instruments, for the Public Service at Sea, will be quite similar—so that *any* spare tube will fit *any* barometer.

To Shift a Tube.—Incline slowly—and take down the barometer, allowing the mercury to fill the upper part. Lay the instrument on a table, unscrew the outer cap, at the joining just below the cistern swell, then unscrew the tube *and* cistern, by turning the cistern gently, against the sun, or *the left,* and draw out the tube very carefully without *bending* it in the least,—*turning* it a little if required, as moved. Then insert the new tube very cautiously, screw in, and adjust to the mark. Attach the cap, and suspend the barometer for use.

If the mercury does not immediately quit the top of the tube, tap the cistern end rather sharply. In a well boiled tube, with a good vacuum, the mercury hangs, at times, adhesively.

In about ten minutes the mercurial column should be nearly right, but as local temperature affects the brass, as well as the mercury, slowly and unequally, it may be well to defer any *exact comparisons with other instruments* for some hours.

Wind-currents.

Wherever currents of wind, either the main currents, equatorial, or polar, (of which all others are more or less *compounded*), or any other streams of air, meet or mutually oppose, their tendency is to cause a calm,—or a gyration; and if the latter, *almost* always in one direction, *against* watch hands in the northern hemisphere, *with* the watch in south latitude.

Currents from a pole move towards the equator and towards the west also and those from the equator move towards the east while going toward a pole. Their mutual action in opposition occasions a movement of the intermediate air, rotatory, in one direction only; a consequence of antagonistic air currents, as well as of *convergence of meridians and differing latitudes.*

In the southern hemisphere a contrary effect, or *with* the watch, is certain, on similar principles, as well as by proof from practical experience; and it is very important that these gyrations should be clearly understood and relied on by seamen—many mistakes having been made by confusing the cases of cyclone centres passing *between* the pole and observer, or the *contrary.*

Successive, or rather, *consecutive* cyclones, circuits, or gyrations, often affect one another, acting as temporary mutual checks, until a combination and joint action occur; their union then causing greater effects than either alone: as may be seen even in water—almost as in storms.

Between the tropics and the polar regions, or in temperate zones, the main currents are incessantly active, more or less antagonistic, from the causes above mentioned, and usually superposed. Air in *motion* must *go on* somewhere, however altered.

Wherever considerable changes of temperature, development of electricity, heavy rain, much snow, or these in combination, cause temporary disturbance of atmospheric equilibrium (or a much altered *tension* of air) these grand agents of nature, the two great currents, speedily move by the *least resisting lines,* to restore equilibrium, or fill the *comparative* void. Probably, one current arrives or acts *sooner* than the other,—but invariably collision occurs, of some kind or degree, usually occasioning a circuit, a cyclonic or ellipsonic gyration; little *noticed* when gentle, or moderate in force: or when not horizontal.

As there must be resistance to moving air (or conflicting currents), to cause gyration, and as there are no such causes, on a large scale, near the equator, there are no *such* storms in very low latitudes (except local squalls).

It is at some distance, ten to twenty degrees, from the equator, that hurricanes are generally felt in their violence.

They originate in or near those hot and densely-clouded spaces, sometimes mentioned as the "*cloud-ring,*"* where aggregated aqueous vapour is at times condensed into heavy rain, (partly with vivid electrical action) and a comparative vacuum is suddenly caused, towards which air rushes from all sides. That which arrives from a higher latitude has a westwardly,† that from a lower *comparative* eastwardly tendency,‡ due to the earth's rotation, and to the change of latitude, whence a chief cause of the cyclone's invariable rotation in one direction, as above explained.

The hurricane or cyclone is impelled to the *west* in *low* latitudes, because the tendency of *both* currents there is to the westward, *along the surface:* although one, the tropical, is *much less so,* and diminishing until actually altered to eastwardly near the tropic, after which its conserved equatorial rotatory force is more and more evident, while the *westwardly* tendency of the polar current *diminishes;* and therefore, at that latitude, hurricane cyclones cease to move westward (re-curve), then go towards the pole, and subsequently (in some cases) almost eastwardly, though in general towards the north-eastward.

Daily published Weather Tables.

As some persons are not yet sufficiently aware of the precise objects of the daily published weather tables, it may be recapitulated, that as the greater and more important changes of weather and wind are *preceded,* as well as accompanied, by notable alterations in the state of the atmosphere:—such changes, being indicated at *some* places sooner than at others, around the British Islands, may give frequent premonitions; and, therefore, that great *differences* of pressure (or tension) shown by barometer; of temperature, of dryness or moisture, and direction of wind, should be remarked as *signs of change, likely to occur soon.*

It will be observed, on any *continued* comparison of weather reports, that during the stronger winds a far greater degree of uniformity and regularity is shown than during the prevalence of moderate or light breezes: and this should be remembered,—because when neither of the greater and more extensive atmo-

* Maury's Physical Geography of the Sea. † Moving towards West.
‡ Towards East

spheric currents is sweeping across the British islands,—currents of which the causes are remote, and on a large scale,—the nature or character of our winds approaches, and is rather like, that of land and sea breezes in low latitudes: especially in summer.

Either the cooler sea wind is drawn in, over land heated by the summer sun; or cold air from frosty heights, snow-covered lands, or chilly valleys, moves toward the sea, which is so *uniform in temperature* for many weeks together, changing so *slowly*, and but little, in comparison with land, during the year. These light *variables* may then be numerous, at one time, and around the compass, on the various coasts of the British islands.

Frequently it has been asked, "In this country, *how much rise or fall* of the glasses may foretell remarkable change, or a dangerous storm?"

To which can *now* be replied,—great and general changes or storms are *usually* shown by falls of barometer exceeding an inch; and by differences of temperature exceeding about ten degrees. A tenth of an inch an hour, during some hours, is a fall indicating a storm, or very heavy rain, or much snow. The more rapidly such changes occur, the greater probability there is of dangerous atmospheric commotion. Wherever the lower (polar) current fails, or *begins* to fail, there the upper descends or incorporates itself, more or less rapidly.

Where a note of interrogation is inserted in a report it shows that the number next to it is doubted at the Central Office, on account of an apparent discrepancy, or some suspected inaccuracy. Adjacent stations are such excellent checks on each other that any error of importance is soon observed, and generally corrected.

Summaries and Forecasts of Weather—Weathercasts.

An endeavour to give some premonition of weather expected during the next two or three days, having been publicly undertaken; it may be useful to explain here what is actually attempted as well as the principles by which the *forecasts* are regulated.*

* Various suggestions have been made with a view to exhibit daily, by maps, useful facts respecting weather; but, in this country, the expense of making, transmitting, and publishing *enough, and sufficiently soon*, to be really valuable, has impeded actual organization of such a system—beyond, if not better than, that established by the Board of Trade, which includes only twenty selected stations.

The printing, publishing, and quick circulation of such ever-varying data as *daily maps* must have, requiring from 70 to 100 distinct symbols or types, and a key to them, more or less at hand, *for the public*—are practical obstacles, irrespective of expense, hardly to be overcome by individual means, or even by a private association.

These weathercasts are made daily, if not twice a day, and are modified or altered on each occasion, if it seems advisable according to the following *principles*, and telegraphic reach.

Four districts, following, are separately considered.

1. North Britain (including from the Moray Firth to the middle of Northumberland) coastwise.
2. Ireland—generally; around the *coasts*.
3. East Coast (from Northumberland to the Thames).
4. South England (from the Thames round to Wales).

As space must be limited, and as *some* words are used in *different senses* by different persons, extreme care must be taken in selecting for such brief, general, and yet *sufficiently* definite sentences, those only which will suit the purpose.

Such words as are on our *published* scales of force, or nature of wind and weather, are *generally* understood, and therefore should be used preferably to less distinct expressions.*

In saying, on any day, what the probable character of the weather will be till some following day or days, at the foot of a table showing its observed nature that very morning, a limited degree of information is offered, for about two or three days in advance, which is as far as may be yet trusted, generally; though at times a longer premonition might be given, with sufficient accuracy to be of use.

Minute, or special details, such as of rain in showers at *particular places*, or merely *local squalls*, are avoided, but the general or average characteristics, those expected to be principally prevalent (with some exceptions) until the following day, and perhaps the next, including the nights, *not* those of the weather actually present, or *reported*, are *cautiously* expressed.

In several publications emanating from this Department, especially the daily Weather Reports, and various papers or pamphlets, are materials available for attaining a practical knowledge of this branch of Meteorology, and facility for utilising it in a beneficial manner.†

When in doubt, distrusting the indications, or inferences from them (duly considered on purely scientific principles, and checked by experience) *nothing* is said: or the words "*Uncertain*," "*Doubtful*," &c. may be used, rather than a *guess*,—which is not admissible *at any time*.

Ordinary variations of *cloudiness*, or clear sky, or rain, of a

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* See page 40.

† These publications are sold at the lowest cost of paper and print only for public use in any manner; and unrestricted by copyright.

local, or only temporary character, are not noticed usually: but a broad general *average*, or *prevalence*, is kept in view, referring to a day, or more, in *advance*, and to a *district* rather than only to *one* time or place.

The great practical difficulty is, in separating the effect, on the mind, of present and *evident* states of air, weather, and clouds, from abstract considerations of what may be *expected* before or during the next following days. The morning weathercast may, and mostly will be read *late*; or on the following morning.

As meteorological instruments usually foretell important changes, by at least a day or more, we have to consider what wind and weather may be expected with the morning observations collated with the previous days', as indicative of the coming weather and wind, at *each* place; to take an *average* of those *expectations*, for each district, collectively, *in groups*, and then to trace, either mentally, or on a map, the probable movements of air currents or circuits, in considerable spaces of atmosphere.

Thus, for example, a barometrical height of 29·50 inches, with 60 degrees of temperature, may indicate (if continued a certain time) fresh south-west wind and mild air, probably cloudy, perhaps rainy; being the general accompaniments of such weather, in autumn or spring: and at *those* seasons (selected here as *intermediate*) about 30·50 inches, with 40 degrees, *or less*, would foretell, and accompany north-easterly wind, dry weather, and usually a clear sky.

The usually *lower* currents stop, cease, or extend along the surface, lengthwise, alternately and *incessantly*, while moving also (*laterally*) towards the east. Thus, a polar stream may push southward, while a contrary current presses, also along the surface, for a time, towards the north, between that and a stream more to the eastward,—while these, and others similar, have a general uniform motion, sideways, towards the east.

The alternation of these currents, sometimes intermixed, sometimes superposed, sometimes adjacent, though contrary in direction, along the surface of land or sea: their eddies, and the manner in which one rushes down, into, or between portions of the other—(being *always* ready *above*), is alone an interesting dynamical study. When a few hundred miles extent of polar current has passed a place, and its supply (vis a tergo) fails,—it must *go on*, though diverted and altered, or *return*, mixed with upper or southerly current, till their combination is effected—(and the *chilly* southwester is succeeded by a warm

one). Accordingly, the first indications of *failing* polar, and beginning southerly influence, are, in general, telegraphically shown in the north—a very curious, and, for a time, perplexing fact.*

Those who are most concerned about approaching changes, who are going to sea, or on a journey, or a mere excursion; those who have gardening, agricultural, or other out-door pursuits in view—may often derive useful *cautionary* notices from these published *expectations* of weather—although (from the nature of the subject) they can be but *scanty*, and, under present circumstances, but imperfect probabilities.

Outline maps, with moveable windmarkers, and cyclone glasses, or transparent horn, should be used to aid in forecasting weather; and due consideration should be given to the probable position, direction, and degree of progress of that centrical area, or *node*, around which the principal currents usually circulate, or turn, more or less, when they meet and alter, combine with, or succeed one another.

Objection has been taken to such forecasts as these, because they cannot be precisely correct,—for all places. It is, however, considered by many persons that general, comprehensive expressions, in aid of local observers, who can form independent judgments from the tables and their own instruments, respecting their immediate vicinity, *though not so well for distant places*, may be useful, as well as interesting: while to an unprovided or otherwise uninformed person, an idea of the kind of weather that is probable cannot be otherwise than acceptable, provided that he is in no way *bound* to act in accordance.

Like the storm signals, such notices should be merely *cautionary*,—to denote anticipated disturbances *somewhere* over these islands,—without being in the least degree compulsory.

Certain it is, that although our conclusions may be incorrect—our judgment erroneous—the laws of Nature, and the signs afforded to man, are invariably true. Accurate interpretation is the real deficiency.

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* Our present stations seem to be sufficient, *nearly*, for our British *special* purposes.

Wind.

The following Method is used to indicate the State of Weather, and Force of Wind, at Sea:—in Lighthouses, and at many Stations on Land, besides the telegraphic.

b	Blue sky	*also*	1
c	Clouds (detached)		2
d	Drizzling rain.		
f	Foggy		3
g	Gloomy.		
h	Hail		4
l	Lightning.		
m	Misty (hazy)		5
o	Overcast (dull) (*also* g)		6
p	Passing showers.		
q	Squally.		
r	Rain		7
s	Snow		8
t	Thunder. Lightning		9
u	Ugly (threatening) appearance of weather.		
v	Visibility. Objects at a distance unusually visible.		
w	Wet dew.		

Note.—A letter repeated augments its signification :—thus f f very foggy, r r heavy rain, r r r heavy and continuing rain.

0	Calm.
1	Steerage way.
2	Clean-full—from 1 to 2 knots.
3	Ditto 3 to 4 knots.
4	Ditto 5 to 6 knots.
5	With royals.
6	Top gallant sails over single reefs.
7	Two reefs in top sails.
8	Three reefs in top sails.
9	Close reefed main top sail and courses.
10	Closed reefed top sails and reefed fore sail.
11	Storm stay sails.
12	Hurricane.

From 2 to 10 being supposed "close hauled."

The above method is very general, and, in practice, it answers well; not only for seamen, but even for popular use, on land, by *estimating* the force of wind, proportionally, between the extremes of its slightest motion, and its utmost violence.

Equivalents for French Words descriptive of Weather.

Beau	Fine	b*	1†
Belle	Smooth, still	—	—
Brouillard	Fog	f	3
Brumeux-se	Foggy, wintry	g	—
Ciel	Sky	—	—
Clair-e	Clear	b	1
Couvert-e	Overcast	o	6
Coup (de vent)	Heavy squall	q q or q̲	—
Eclair	Lightning	l	—
Eclaireux-se	Lightning around	ll or l̲	—
Faible	Light, slight	—	—
Fort-e	Much, strong	(— or • or repetition)	—
Grains	Squally	q or q̲	—
Grand-e	Great, much	(— or • or repeated letter)	—
Grêle	Hail	h	4
Humide-ité	Damp, humidity	—	—
Intense-ité	Intense-ity	(— or • or a repetition)	—
Legèr-e-ment	Light-ly	—	—
Mauvais-e	Bad, threatening	u	—
Nuleux-se	Misty, hazy, obscure	m	5
Neige-ant	Snow-ing	s	8
Nuage-s-eux-se	Cloud-s-y	c	2
Orage-ux	Storm-y	q w w	—
Pluie-s	Rain-s	r r	7
Pluvieux-se	Rainy	r	—
Presque	Almost, slight	—	—
Rafales	Sudden squalls	q	—
Serein-e	Serene, settled	b c	1
Sombre	Gloomy, dark	g or g g	6
Tempête	Tempest	w w q q	—
Tempestueux-se	Tempestuous	—	—
Tonnerre, eclair	Thunder, lightning	t	9
Tonnant-e	Thundery	t t	9
Très	Very, excessively	(— or • or a repetition)	—

* Beaufort Letters, with additions. † Telegraphing Numbers 1 to 9.

Wind Scales.

Sea Scale.		Wind.		Land Scale.
0 to 3	=	Light	=	0 to 1
3 „ 5	=	Moderate	=	1 „ 2
5 „ 7	—	Fresh	=	2 „ 3
7 „ 8	—	Strong	=	3 „ 4
8 „ 10	—	Heavy	=	4 „ 5
10 „ 12	—	Violent	=	5 „ 6

Pressure in Pounds (Avoirdupois.)		(Land Scale.)		Velocity in Miles (Hourly.)
½	—	1	=	10
5	—	2	=	32
10	=	3	=	45
21	—	4	=	65
26	=	5	=	72
32	=	6	=	80

BAROMETER.

MILLIMETRES AND ENGLISH INCHES.

Mill.	Inches.	Mill.	Inches.	Mill.	Inches.	Mill.	Inches.
712	28·032	731	28·780	750	29·528	769	30·276
3	·071	2	·819	1	·568	770	·316
4	·111	3	·859	2	·607	1	·355
5	·150	4	·898	3	·646	2	·394
6	·190	5	·938	4	·686	3	·434
7	·229	6	28·977	5	·725	4	·473
8	·268	7	29·016	6	·764	5	·512
9	·308	8	·056	7	·804	6	·552
720	28·347	9	·095	8	·843	7	·591
1	·386	740	29·134	9	·882	8	·631
2	·426	1	·174	760	·922	9	·670
3	·465	2	·213	1	29·961	780	30·709
4	·505	3	·253	2	30·001	1	·749
5	·544	4	·292	3	·040	2	·788
6	·583	5	·331	4	·079	3	·827
7	·623	6	·371	5	·119	4	·867
8	·662	7	·410	6	·158	5	·906
9	·701	8	·449	7	·197	6	·945
730	28·741	749	29·489	768	30·237	787	30·985

Proportional Parts.

Mill.	Inch.
0·1	0·004
0·2	·008
0·3	·012
0·4	·016
0·5	·020
0·6	·024
0·7	·028
0·8	·032
0·9	0·035

English Inches—and Millimetres.

Inches	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09	Inches
28·0	mm. 711·2	mm. 711·4	mm. 711·7	mm. 712·0	mm. 712·2	mm. 712·5	mm. 712·7	mm. 713·0	mm. 713·2	mm. 713·5	28·0
·1	13·7	14·0	14·2	14·5	14·7	15·0	15·3	15·5	15·8	16·0	·1
·2	16·3	16·5	16·8	17·0	17·3	17·5	17·8	18·0	18·3	18·6	·2
·3	18·8	19·1	19·3	19·6	19·8	20·1	20·3	20·6	20·8	21·1	·3
·4	21·3	21·6	21·9	22·1	22·4	22·6	22·9	23·1	23·4	23·6	·4
·5	23·9	24·1	24·4	24·7	24·9	25·2	25·4	25·7	25·9	26·2	·5
·6	26·4	26·7	26·9	27·2	27·4	27·7	28·0	28·2	28·5	28·7	·6
·7	29·0	29·2	29·5	29·7	30·0	30·2	30·5	30·7	31·0	31·3	·7
·8	31·5	31·8	32·0	32·3	32·5	32·8	33·0	33·3	33·5	33·8	·8
·9	34·0	34·3	34·6	34·8	35·1	35·3	35·6	35·8	36·1	36·3	·9
29·0	736·6	736·8	737·1	737·4	737·6	737·9	738·1	738·4	738·6	738·9	29·0
·1	39·1	39·4	39·6	39·9	40·1	40·4	40·7	40·9	41·2	41·4	·1
·2	41·7	41·9	42·2	42·4	42·7	42·9	43·2	43·4	43·7	44·0	·2
·3	44·2	44·5	44·7	45·0	45·2	45·5	45·7	46·0	46·2	46·5	·3
·4	46·7	47·0	47·3	47·5	47·8	48·0	48·3	48·5	48·8	49·0	·4
·5	49·3	49·5	49·8	50·1	50·3	50·6	50·8	51·1	51·3	51·6	·5
·6	51·8	52·1	52·3	52·6	52·8	53·1	53·4	53·6	53·9	54·1	·6
·7	54·4	54·6	54·9	55·1	55·4	55·6	55·9	56·1	56·4	56·7	·7
·8	56·9	57·2	57·4	57·7	57·9	58·2	58·4	58·7	58·9	59·2	·8
·9	59·4	59·7	60·0	60·2	60·5	60·7	61·0	61·2	61·5	61·7	·9
30·0	762·0	762·2	762·5	762·8	763·0	763·3	763·5	763·8	764·0	764·3	30·0
·1	64·5	64·8	65·0	65·3	65·5	65·8	66·1	66·3	66·6	66·8	·1
·2	67·1	67·3	67·6	67·8	68·1	68·3	68·6	68·8	69·1	69·4	·2
·3	69·6	69·9	70·1	70·4	70·6	70·9	71·1	71·4	71·6	71·9	·3
·4	72·1	72·4	72·7	72·9	73·2	73·4	73·7	73·9	74·2	74·4	·4
·5	74·7	74·9	75·2	75·5	75·7	76·0	76·2	76·5	76·7	77·0	·5
·6	77·2	77·5	77·7	78·0	78·2	78·5	78·8	79·0	79·3	79·5	·6
·7	79·8	80·0	80·3	80·5	80·8	81·0	81·3	81·5	81·8	82·1	·7
·8	82·3	82·6	82·8	83·1	83·3	83·6	83·8	84·1	84·3	84·6	·8
30·9	784·8	785·1	785·4	785·6	785·9	786·1	786·4	786·6	786·9	787·1	·9
	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09	

Proportional Parts.

Inch.	Mill.
0·001	0·03
·002	·05
·003	·08
·004	·10
·005	·13
·006	·15
·007	·18
·008	·20
0·009	0·23

THERMOMETER.

FAHRENHEIT.

Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.
1°	−17°2	−13°8	51°	10°6	8°4
2	16·7	13·3	52	11·1	8·9
3	16·1	12·9	53	11·7	9·3
4	15·6	12·4	54	12·2	9·8
5	15·0	12·0	55	12·8	10·2
6	14·4	11·6	56	13·3	10·7
7	13·9	11·1	57	13·9	11·1
8	13·3	10·7	58	14·4	11·6
9	12·8	10·2	59	15·0	12·0
10	12·2	9·8	60	15·6	12·4
11	−11·7	− 9·3	61	16·1	12·9
12	11·1	8·9	62	16·7	13·3
13	10·6	8·4	63	17·2	13·8
14	10·0	8·0	64	17·8	14·2
15	9·4	7·6	65	18·3	14·7
16	8·9	7·1	66	18·9	15·1
17	8·3	6·7	67	19·4	15·6
18	7·8	6·2	68	20·0	16·0
19	7·2	5·8	69	20·6	16·4
20	6·7	5·3	70	21·1	16·9
21	− 6·1	− 4·9	71	21·7	17·3
22	5·6	4·4	72	22·2	17·8
23	5·0	4·0	73	22·8	18·2
24	4·4	3·6	74	23·3	18·7
25	3·9	3·1	75	23·9	19·1
26	3·3	2·7	76	24·4	19·6
27	2·8	2·2	77	25·0	20·0
28	2·2	1·8	78	25·6	20·4
29	1·7	1·3	79	26·1	20·9
30	1·1	0·9	80	26·7	21·3
31	− 0·6	− 0·4	81	27·2	21·8
32	0·0	0·0	82	27·8	22·2
33	+ 0·6	+ 0·4	83	28·3	22·7
34	1·1	0·9	84	28·9	23·1
35	1·7	1·3	85	29·4	23·6
36	2·2	1·8	86	30·0	24·0
37	2·8	2·2	87	30·6	24·4
38	3·3	2·7	88	31·1	24·9
39	3·9	3·1	89	31·7	25·3
40	4·4	3·6	90	32·2	25·8
41	+ 5·0	+ 4·0	91	32·8	26·2
42	5·6	4·4	92	33·3	26·7
43	6·1	4·9	93	33·9	27·1
44	6·7	5·3	94	34·4	27·6
45	7·2	5·8	95	35·0	28·0
46	7·8	6·2	96	35·6	28·4
47	8·3	6·7	97	36·1	28·9
48	8·9	7·1	98	36·7	29·3
49	9·4	7·6	99	37·2	29·8
50	+10·0	+ 8·0	100	37·8	30·2

CENTIGRADE.

Centigrade.	Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.
−17°	1°4	−13°6	11°	51°8	8°8
16	3·2	12·8	12	53·6	9·6
15	5·0	12·0	13	55·4	10·4
14	6·8	11·2	14	57·2	11·2
13	8·6	10·4	15	59·0	12·0
12	10·4	9·6	16	60·8	12·8
11	12·2	8·8	17	62·6	13·6
−10	14·0	− 8·0	18	64·4	14·4
9	15·8	7·2	19	66·2	15·2
8	17·6	6·4	20	68·0	16·0
7	19·4	5·6	21	69·8	16·8
6	21·2	4·8	22	71·6	17·6
5	23·0	4·0	23	73·4	18·4
4	24·8	3·2	24	75·2	19·2
3	26·6	2·4	25	77·0	20·0
2	28·4	1·6	26	78·8	20·8
− 1	30·2	− 0·8	27	80·6	21·6
0	32·0	0·0	28	82·4	22·4
+ 1	33·8	+ 0·8	29	84·2	23·2
2	35·6	1·6	30	86·0	24·0
3	37·4	2·4	31	87·8	24·8
4	39·2	3·2	32	89·6	25·6
5	41·0	4·0	33	91·4	26·4
6	42·8	4·8	34	93·2	27·2
7	44·6	5·6	35	95·0	28·0
8	46·4	6·4	36	96·8	28·8
9	48·2	7·2	37	98·6	29·6
+10	50·0	+ 8·0	38	100·4	30·4

Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.
−14°	0°5	−17°5	9°	52°3	11°3
13	2·8	16·3	10	54·5	12·5
12	5·0	15·0	11	56·8	13·8
11	7·3	13·8	12	59·0	15·0
−10	9·5	−12·5	13	61·3	16·3
9	11·8	11·3	14	63·5	17·5
8	14·0	10·0	15	65·8	18·8
7	16·3	8·8	16	68·0	20·0
6	18·5	7·5	17	70·3	21·3
5	20·8	6·3	18	72·5	22·5
4	23·0	5·	19	74·8	23·8
3	25·3	3·8	20	77·0	25·0
2	27·5	2·5	21	79·3	26·3
− 1	29·8	− 1·3	22	81·5	27·5
0	32·0	0·0	23	83·8	28·8
+ 1	34·3	+ 1·3	24	86·0	30·0
2	36·5	2·5	25	88·3	31·3
3	38·8	3·8	26	90·5	32·5
4	41·0	5·0	27	92·8	33·8
5	43·3	6·3	28	95·0	35·0
6	45·5	7·5	29	97·3	36·3
7	47·8	8·8	30	99·5	37·5
+ 8	50·0	+10·0	31	101·8	38·8

ARRANGEMENT of the DAILY WEATHER REPORT. 1861.

Eight A.M.

day	B.	E.	M.	D.	F.	C.	I.	S.
Nairn.....	.....	.....	.....	.....	.....	.....	.....	.....
Aberdeen.....	.....	.....	.....	.....	.....	.....	.....	.....
&c.	.....	.....	.....	.....	.....	.....	.....	.....

EXPLANATION.

B.—Barometer corrected and reduced to 32° at mean sea level: each ten feet of vertical rise, causing about one hundredth of an inch *diminution;* and each ten degrees, above 32°, causing nearly three hundredths *increase.* E.—Exposed thermometer in shade. M.—Moistened bulb (for evaporation and dew point). D.—Direction of wind (true—two points *left* of magnetic). F.—Force (1 to 12—estimated). C.—Cloud (1 to 9). I.—Initials: b.—blue sky; c.—clouds (detached); f.—fog; h.—hail; l.—lightning; m.—misty (hazy); o.—overcast (dull); r.—rain; s.—snow; t.—thunder. S.—Sea-disturbance (1 to 9). Z.—Calm.

Beaufort Scale.

1 = b = blue (sky).
2 = c = clouds (detached).
3 = f = fog, foggy.
4 = h = hail.
5 = m = misty (haze).
6 = o = overcast.
7 = r = rain, rainy.
8 = s = snow.
9 = t = thunder—lightning.
And a line under, or a dash, or a dot, is for MUCH of either character.

TABLE of French and English words, for the state of the Sea, or "Sea-disturbance"; corresponding with their equivalent numbers, for telegraphing by groups of five figures each, instead of words.

État de la Mer.	State of Sea, or Sea disturbance.	Equivalents.
Calme	Dead calm	0
Assez calme	Calm	1
Très belle	Very smooth	1
Belle	Smooth	2
Tranquille	Still	2
Faible houle	Scarcely any swell	3
Petite houle	Slight swell	3
Un peu houleuse	Some swell	3
Un peu de mer	Rather rough	4
Risée	Squally	4
Agitée	Disturbed irregularly	4
Clapoteuse	Breaking sea	5
Houleuse	Much swell	5
Très houleuse	High swell	6
Moutonneuse	Crested waves	7
Creusée	Cross sea	7
Grosse houle	Great swell	8
Haute mer	High sea	8
Très-grosse mer	Very large and high sea	9

MEMORANDUM RESPECTING A MOISTENED THERMOMETER (DAMP OR WET BULB), USED IN COMPARISON WITH A DRY ONE, AS A HYGROMETER, ON MASON'S PRINCIPLE (*referred to in p.* 7).

The two thermometers should be without cases, or guards, hung in the shade, in still air, near each other, but not within a less distance than two or three inches. They should be as free from radiations as possible (from walls,* &c.)

Rain should be kept off the dry bulb. The cup, or glass, or other small holder of water for moistening the damp bulb, ought not to be under or too near the dry one, lest it should be affected. This little reservoir should be on one side of the damp bulb—that furthest from the dry thermometer.

A small *strip* of linen or cotton rag, or "book muslin," tied slightly round, or half round the bulb; or common cotton wick opened and tied loosely round the glass stem, close to the bulb, so as to lie on it, and reaching two or three inches from its lower part, should dip and remain in the water—which may be any water, fresh or salt, at the temperature of the atmosphere. Observations are incorrect if made while the water is either colder or warmer than the air, therefore the water holder should be replenished *after,* or some little time *before* observing.

Sometimes, at sea, when the water has been many degrees warmer than the air (as in the Gulf Stream for instance), a thermometer bulb has been moistened with it, and an observation incorrectly made almost immediately, by which the temperature of evaporation appeared to be higher than that of the air at the time; the moistened thermometer reading higher than the dry one—(of course, a fallacy).

If one were to use hot, or iced water, such an effect would be shewn in an extreme degree. Water or wine is often cooled similarly by evaporation—a wet cloth being tied round the bottle, placed in a draught of air; or the bottle (*earthen* jar rather) being porous, and allowing evaporation.

But as the objects of observing the temperature of evaporation are special, and have *intercomparison* as a principal one, these thermometers should be in *still* air. Draughts or currents of wind hasten evaporation, and therefore lower temperature more or less rapidly, according to their velocity, or strength, which may vary considerably. (Hence the idea of *swinging* a moistened bulb is fallacious, as it cannot be done uniformly.)

* House walls, heated ground or stones, windows of warm rooms, areas near

The writer has had four *pairs* of such thermometers in use during a considerable time, and has found them accord perfectly, ranging in external air from a difference of fifteen degrees, during the summer, to one degree, in very damp weather—in and near London. He has seldom found a pair agree nearer than 1° in their reading (however exactly in accordance when both dry) unless the bulb which should have been dry was affected by rain, or dew, or the damp of the other when *too near;* in short, by *moisture,* when the bulb ought to have been perfectly dry.

The muslin, cotton, or other rag, should be washed frequently (once or twice a week), by pouring water over it (as it hangs), and should be changed occasionally (once or twice a month), according to its quality, and exposure to *dust* or blacks. Accuracy depends much on this care for cleanliness.

Cotton wick is as good a material, for conveying the moisture (by capillary action) to the bulb, as muslin or linen, when opened out a little, kept clean, and renewed frequently, by simple tying round the bulb neck.

In our climate, the *usual* difference between the thermometer readings ranges from two to twelve degrees (when the arrangement is good) in *outer* air; and from five to eight degrees in doors, in a *frequented* room, or passage, *without much fire.*

Between hot and dry climates, and very damp ones, the range out of doors has been found as much as even thirty degrees. (In India, Africa, and Australia.)

The difference between the dry and the damp, taken from the *damp* reading, gives the Dew-point,* *nearly* (when the air temperature is between freezing point and eighty degrees).

When the moistened thermometer is frozen, no reading need be taken for ordinary purposes; as, although *evaporation* continues, and may be noted, if the bulb be wetted beforehand, and an observation made before the moisture is frozen—it is *slower* afterwards, although continuing, and may much mislead.

In frost, therefore, it is scarcely worth noting, except as an experiment; but this signifies less, because at such a time the air is very dry, and, for ordinary purposes, its state then will be known sufficiently.

* The temperature at which air gives up its aqueous vapour (invisible while gas) in dew. Greater or more rapid condensation of vapour appears in rain, snow, or hail.

Storm-Warning Signals.

A STAFF and two canvas shapes being provided, the following use will be made of them occasionally; perhaps once or twice in a month, on a yearly average.

One shape, that of a drum (or cylinder) has the appearance of a black square of (not less than) three feet (seen from any point of view) when suspended.

The other shape, a cone (not less than) three feet high, appears triangular (from any point of view) when suspended.

A cone, with the point upwards, shows that a gale is *probable;* at first from the *northward.* NORTH CONE.

A cone, with the point downwards, shows that a gale is *probable;* at first from the *southward.* SOUTH CONE.

A DRUM, alone, shows that stormy winds may be expected from nearly opposite quarters successively.

A cone and drum give warning of dangerous winds, the probable *first* direction being shown by the position of the cone, point up, above the drum, for northerly (or polar) wind, down, and below, for southerly.

Whenever such a signal is shown (in consequence of a telegram from London) it will be kept up, shown distinctly, till dusk of *that day only,* unless otherwise specially directed.

These cautionary or warning signals advert to winds during some part of the next nights and two or three days; therefore due *vigilance* should prevail (until the weather is again thoroughly settled), but without suspending *departures* or any operations *unnecessarily.*

A conspicuous place should be selected for signalling; near the telegraph station.

If conveniently practicable the signal pole or staff should be in view of seafaring persons and of the nearest coast guard.

When both these objects cannot be attained without too great distance from the telegraph station, one only—that of visibility to some of the seafaring community—should be secured; and in this case a message should be sent to the nearest coast guard, and charged to this department at the authorized tariff.

Further *local* notice will be given, it is confidently hoped, by *local interests* and *authorities.*

London can warn principal outports. The Coast-guard may repeat the warning as far as means allow, and *extension* of such cautionary notices can be effected by *private* assistance along

It should be remembered that only the greater and more *general* disturbances of the atmosphere are to be made known by this method (Warning Signals), not merely local or sudden changes (however violent or dangerous) which are not felt at a certain distance, and do not therefore affect other localities. Local changes may be indicated to observers at such places, by their own instruments,—by signs of the weather,—and by due consideration of the Weather Reports for a few previous days.

Much inequality of electricity, atmospheric pressure, or temperature; great fall or rise of the barometer; sudden or rapid alternations; great falls of rain or snow, foretell more or less wind, with its usual accompaniments, either in some places only, or throughout an extensive area of hundreds, if not thousands, of miles.

Speaking *generally*, there is far less occasion to give warning of *southerly* gales, by signals, than of northerly; because those from the southward are preceded by notable signs of the atmosphere, such as a falling barometer, and a temperature higher than usual *at the season;* whereas, on the contrary, dangerous storms from a polar quarter (north-west to north-east, and eastward,) are sometimes sudden, and generally are preceded by a *rising* barometer, which often misleads persons, especially if accompanied by a temporary lull of, perhaps a day or two, with a fallacious appearance of fine weather (caused by one circuit, or cyclone, following and influencing a preceding similar, though probably inferior movement).

Lastly, it should be kept in mind, that these signals are merely *cautionary*, to give notice of much atmospheric disturbance over some considerable part of the British Islands, without being in the least degree *compulsory*, or interfering with individual judgment on any occasion.

WARNING SIGNALS.



Gale probably from the northward. *Gale probably from the southward.* *Dangerous winds may be expected from nearly opposite quarters successively.* *Dangerous wind probably at first from the northward.* *Dangerous wind probably at first from the southward.*

END OF
TITLE