Official No. 3.

FISHERY BAROMETER MANUAL.

COMPILED UNDER THE DIRECTION OF THE METEOROLOGICAL COUNCIL,

By ROBERT H. SCOTT, M.A., F.R.S.,

SECRETARY OF THE METEOROLOGICAL OFFICE.

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PREFACE.

A large number of barometers have been lent by the Meteorological Office, to be set up at small seaports and fishing villages; and the National Lifeboat Institution has also supplied barometers to its stations.

The Meteorological Office likewise issues to many ports and fishing stations telegraphic warnings on the occurrence of any atmospheric disturbance that seems likely to give rise to gales or storms on or near the coasts.

A copy of the Daily Weather Report issued by the Office can also be supplied, free of cost, to any port at which arrangements are made for its proper public exhibition.

The object of the present work (which is based on a similar publication issued in 1864 by Admiral FitzRoy) is to convey to the classes likely to be interested in

these subjects, at the small ports or fishing stations before mentioned, a popular explanation of the nature of the instruments employed in obtaining indications of probable changes of the weather, and of the manner in which those indications are dealt with in making forecasts. It also contains an elementary view of some of the more important facts relating to the storms which most commonly occur on the coasts of the United Kingdom.

By order of the Council.

ROBERT H. SCOTT,

Secretary.

Meteorological Office,
July 8, 1887.

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FISHERY OR COAST DIAGRAM.

Barometer and Thermometer at London *Month* December *Year* 1886.

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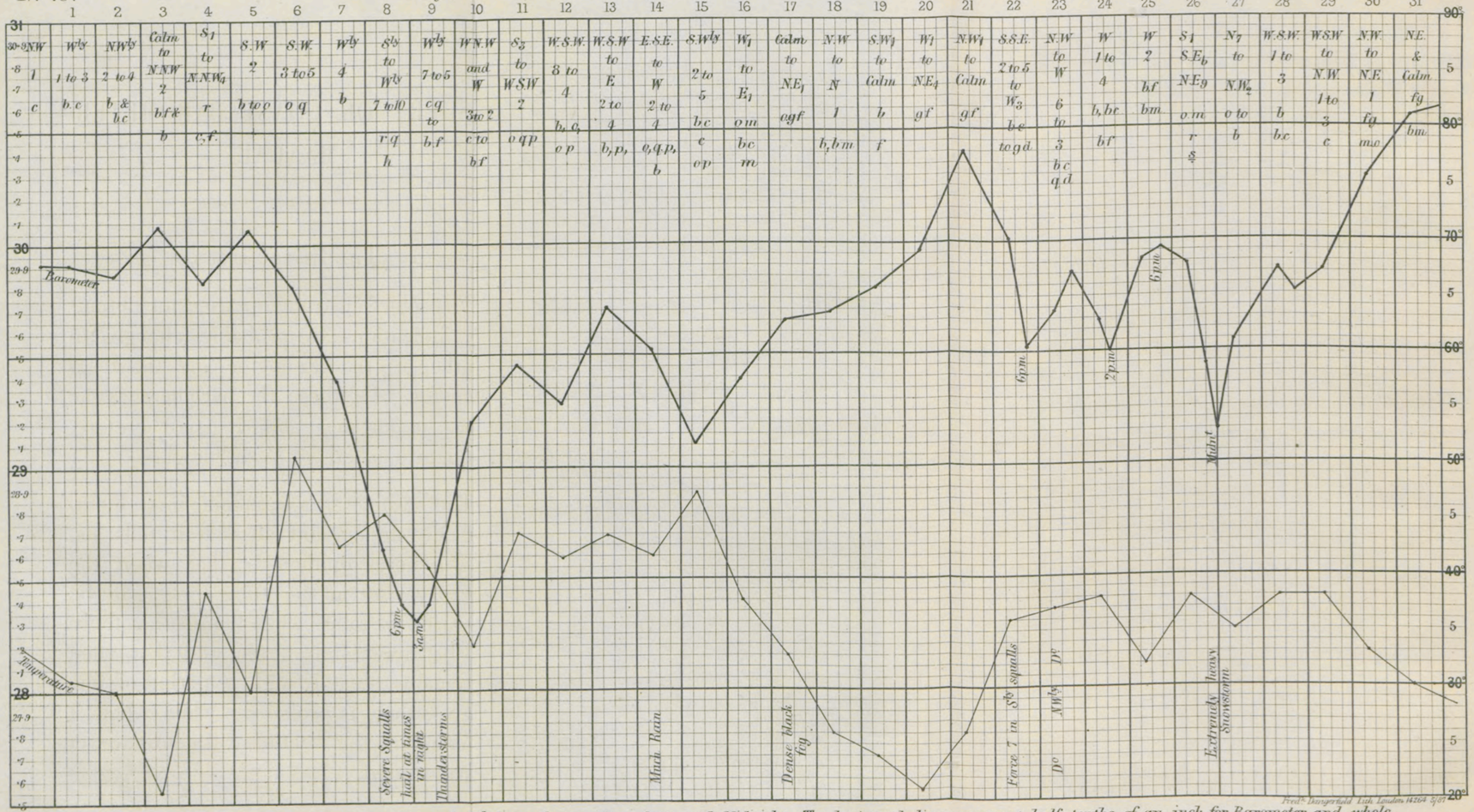

Notes. *The vertical (time) lines are drawn for each 6th hour; 6 a.m., Noon, 6 p.m. and Midnight. The horizontal lines represent half-tenths of an inch for Barometer and whole degrees for Thermometer. The angles made by the drawn lines with those of the form are useful as aids to foretelling weather.*
(This form may be placed in a frame or on a board, but the side scales must not be hidden by the frame.)

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FISHERY OR COAST BAROMETER MANUAL.

The Instruments.

Introduction.

The chief instruments used for obtaining indications of probable changes in weather are the barometer and the thermometer. Of these the barometer is the more important, and it is, therefore, frequently called a "Weather glass."

The barometer is a familiar instrument, but few understand all that it tells us. The general opinion is that when the mercury *rises* in the tube there will be less wind or rain; when it *falls* that there will be more wind or rain, and that when it remains steadily high a period of fine dry weather is probable; while when it remains low the weather will continue wet and unsettled.

These interpretations are usually correct, but sometimes wrong, as will be shown in the subsequent pages.

Description of a barometer.

BAROMETER.—The barometer in its simplest form consists of a straight glass tube a little less than three feet long, closed at one end. This being filled quite full of mercury, the open end is temporarily covered by the finger, and the tube turned over with the closed end upwards; the open end is then plunged into a cup or cistern also filled with mercury, and the finger is removed without allowing any air to get into the tube. The mercury in such a tube will sink when the finger is removed until the top of the column stands at a height of about thirty inches above the level of the mercury in the cistern.

The space in the tube above the top of the column of mercury contains no air. This is called a *vacuum*.

The mercury in the tube of a barometer rises when the whole pressure or weight of the air becomes greater, falls when it

becomes less, and remains at rest when the pressure or weight is unchanged.

Atmospherical pressure.

The air, like all other substances, has weight, and it presses on everything at the surface of the earth with a force or weight of nearly fifteen pounds on a square inch of surface, one cubic foot of it, at the level of the sea, weighing more than 500 grains. We are not conscious of this pressure as our bodies are surrounded on all sides by air, and are partly filled with air, and are thus supported on all sides by the same pressure. The pressure of the air on the surface of the mercury in the cup is communicated to the mercury in the tube, and as the space at the top of the tube contains no air, and is not open to the pressure of the air without, the pressure in the tube from below is balanced by the weight of the mercury standing in the tube.

Now, the weight of mercury is such that a column 30 inches in height, in the tube of a barometer, will press on the mercury in the cistern, and so endeavour to fall in the tube, with nearly the same

force as the air outside the tube presses on the free surface of the mercury, and so endeavours to hold up the mercury in the tube, or, in other words, the 30 inches of mercury will nearly balance the pressure of the atmosphere, which is about 15 lbs. on the square inch.

Water barometers.

If the liquid in the barometer were water instead of mercury, the height of the column required to balance the pressure of the atmosphere would be more than 30 feet, because mercury is thirteen and a half times heavier than water. Water barometers and glycerine barometers have been made, but the water barometers are liable to freeze, and have other drawbacks besides their extremely inconvenient size. However, in an ordinary pump, use is made of the fact on which the principle of the barometer depends, that the pressure of the air will support a long column of water in a tube that is closed at the top, the lower end of which is plunged in water. The sucker of the pump forms a closed top to it, and by its means the air is drawn from the

The pump.

pipe leading to the barrel, and the pressure from above being removed, the pressure from below forces up the water, so that in a good pump which "holds its charge," or does not let in air as it is worked, the water may be raised to a level of nearly 30 feet above the surface of the water in the well below.

Management of barometer.

The barometer should be placed in a good light, where it may be seen at all times by seafaring persons, fishermen, boatmen, and others. It should be set two or three times daily, at regular hours, by a properly authorized person, in the manner about to be explained.

Words on scale.

The words *fair*, *change*, *rain*, &c., which are often printed on the scales of barometers are of little value. The changes of level of the mercury are greater in winter than in summer, and the height of the column is likewise dependent on elevation above the sea level and other circumstances, so that the same scale of words could not suit all seasons or all places, even if the level of the mercury

alone indicated the condition of the weather, which is very far from being the case. It is not to the mere height of the mercury in a barometer on a particular day that we are to look in order to judge of the weather, but to the fact of its having *risen* or *fallen* or *remained steady* since the day before or the last time it was set, and even this alone will not supply conclusive evidence, as will be explained subsequently.

Rise and fall of the barometer.

The barometer is said to be *falling*, though somewhat incorrectly, when the mercury in the tube is sinking, at which time its surface is sometimes slightly concave or hollow. The barometer is said to be *rising* when the mercury in the tube is rising, at which time its surface is usually convex or rounded. The hand of a wheel barometer or aneroid moves to the right when the mercury rises; to the left when it falls.

Range of the barometer.

In both Temperate Zones, and therefore in these islands, the mercury is found to rise and fall, or to range through a space of nearly three inches, measuring

from the lowest position observed on some *extraordinary* occasions to the highest observed on others, namely, between thirty inches and nine-tenths (30·9), and twenty-eight inches (28·0) or even a little lower. The usual range is from 30·5 in. to about 29·0 in. In the Torrid Zone or near the Equator the range is much less, being only a few tenths of an inch, except in very severe storms or hurricanes, in which the level sometimes falls as low as 27·0 in.

Barometrical levelling.

On the top of a mountain the barometer does not give so high a reading as it does close to the sea. The reason is that there is a lesser thickness of air above it than at lower stations. Accordingly, the pressure of the air is not so great, and the level of the mercury does not stand so high. The difference of reading is about an inch for each 1,000 feet of height measured vertically upwards. The average level of the mercury in England in the latitude of London is about 29·95 inches, and accordingly, on a hill 950 feet high in the neighbourhood of London (say Leith Hill, in Surrey, 967

feet), the average reading would be about 29·0 inches. It follows from this that the height of a mountain may be measured by comparing the readings of two barometers taken at the same time, one at the summit, and the other at the foot of the mountain.

The vernier.

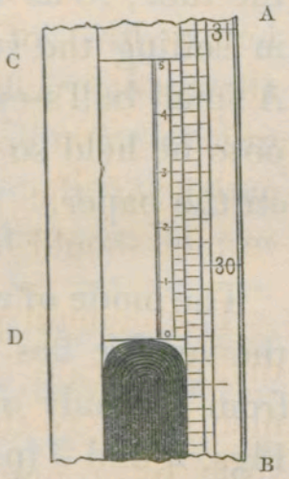
A sliding scale, called a Vernier (from its inventor, Captain Vernier, in 1631), is provided for most barometers, to assist in measuring the height of the column of mercury. It is invariably used in making accurate observations. In some instruments it is so constructed as to divide the tenths into ten parts each, or into hundredths of an inch, in others it allows of readings being taken to still greater minuteness. The following explanation of the principle and use of the vernier should be carefully studied.

The general principle of this moveable dividing scale is that a length of the vernier equal to that occupied on the fixed scale by a number of divisions less or greater by one than some round number, is divided into that round number of equal

parts. In English barometers the fixed scale is divided into inches, tenths, and half-tenths, each of which last is therefore ·050 of an inch. Twenty-five spaces in the vernier are made to coincide with twenty-four of the smallest divisions of the fixed scale; therefore, a space on the scale is larger than a space on the vernier by the twenty-fifth part of ·050, that is to say, ·002 inch, consequently the vernier exhibits differences of ·002 of an inch.

The vernier is moved by a rack and pinion. To set it for reading, turn the milled-head of the pinion so as to bring the *lower* edge of the vernier (D) exactly on a level with the top of the mercurial column. When set properly, the front edge of the vernier, the top of the mercury, and the back edge of the vernier should be in the line of sight, which line will thus just touch the *middle* and *upper*-

Fig. 1.



The vernier.

most point of the convex or curved surface of the mercury in the tube. Great care should be taken to acquire the habit of setting the vernier with the eye exactly on a level with the top of the mercury, that is, with the line of sight at right angles to the tube, which, while the observation is being made, should hang *freely*, in a truly vertical position, not being disturbed by the instrument being held, or even touched, because any inclination will cause the column to rise in the tube.

A piece of white paper placed behind the tube, so as to reflect the light, assists in setting the vernier accurately at night. A small bull's-eye lamp may for this purpose be held so as to throw a strong light on the paper.

The mode of reading off the height when the vernier has been set may be learned from a study of the following diagrams, Figs. 2 and 3 (p. 12), in which A B represents part of the scale, and C D the vernier, the lower edge D of which is supposed to

Reading the vernier.

have been brought down so as to coincide exactly with the top of the mercurial column, which is shaded. The scale is readily understood; in Figs. 2 and 3 (p. 12) B is 29·000 inches; the first line or division above B is 29·050; the second line or division 29·100, and so on. The first thing is to note the scale division just below D, and the next is to find out the division of the vernier which is in a line with a division of the scale. In figure (2), (p. 12), the lower edge of the vernier, D, is represented in exact coincidence with scale division 29·5; the barometer therefore reads 29·500 inches. Studying the vernier attentively in this position, it will be perceived that while the top, C, again coincides with a line on the scale, the other divisions of the vernier are more or less separated from the divisions of the scale nearest to them. As was before pointed out, one division of the vernier is ·002-inch smaller than one division of the scale, consequently, with the vernier in the position shown in Fig. 2, the division *a* is ·002 inch below the nearest line *z* of the scale. If, therefore, the vernier be

Reading the vernier.

moved upward, so as to place *a* in a line with *z*, the edge D would be raised ·002 inch, and it would read 29·502, and this would be the height of D on the scale. In like manner, it is seen that *b* on the vernier is ·004 inch below the line next

Fig. 2.

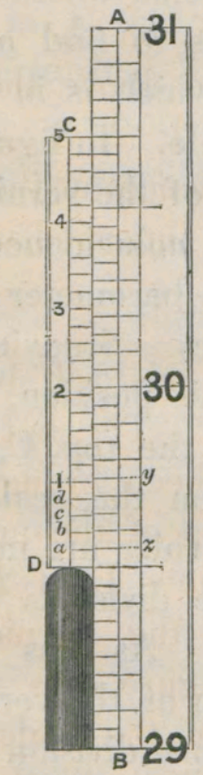
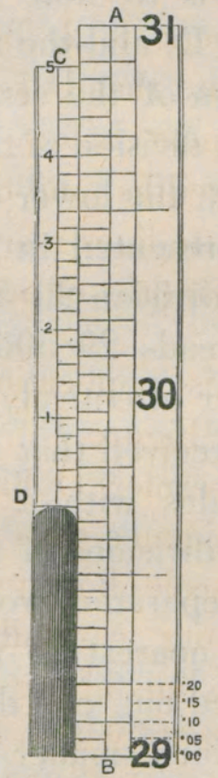


Fig. 3.



above it *on the scale*; *c*, ·006 inch below that next above it; *d*, ·008 inch from that next above it; and 1, on the vernier, is

·010 below *y* on the scale. Hence, if the lines *b*, *c*, *d*, and 1 be moved in succession into line with the divisions next above them, D would be raised ·004, ·006, ·008, and ·010 in succession, and would read 29·504, 29·506, 29·508, and 29·510. Thus, coincidences of lines on the vernier and the scale at the numbers 1, 2, 3, 4, 5, on the vernier, indicate that D is raised above the scale line next below it by 1, 2, 3, 4, or 5 hundredths, and coincidences at the intermediate lines mark the intermediate even thousandths of an inch.

Reading the vernier.

This application of this will be seen from Figure (3), p. 12. The bottom of the vernier D having been brought into coincidence with the top of the mercury, the scale line just below D is 29·650. Looking carefully up the vernier, the third line above the figure 3 is seen to lie evenly with a line on the scale. The number 3 indicates ·030, and the third subdivision ·006, so that D is ·036 above the scale line next below it, and thus we get—

Reading the vernier.

Reading on scale - 29·650

Reading on vernier - { ·030 / ·006

Actual reading - 29·686 inches.

Sometimes two pairs of lines will appear to be coincident; in which case the intermediate thousandth of an inch should be set down as the reading. Thus, suppose coincidences appear corresponding to 29·684 or 29·686, then 29·685, half-way between them, should be adopted.

Recently the Meteorological Council have adopted a form of vernier which allows of barometrical readings being taken to the nearest half-hundredth, or 0·005 of an inch. The divisions of the fixed scale are each ~~0·50~~ inch; nine of these are taken as the length of the vernier, which is therefore 0·45 inch. This length is divided into ten equal parts, consequently each division of the vernier is ·045 inch. Thence the difference of

0·05

length between a division of the scale and one of the vernier is

·050 — ·045 = ·005 inch.

Attached thermometer.

The thermometer attached to a barometer is intended to show the temperature of the mercury within the tube of the barometer. The column of mercury in the tube, as well as the scale by which it is measured, gets longer or shorter according as it is warmer or colder, quite independently of any change in the pressure of the air, as will be explained in the next paragraph. It is therefore necessary to allow for this by reducing all observations to a certain temperature, and 32°, on the freezing point (p. 17), has been adopted for this, the correction being *minus* if the temperature of the attached thermometer is higher, and *plus* if lower than 32°.

Description of a thermometer.

THERMOMETER. — This instrument shows heat and cold, but is not affected by changes of the pressure of the air. It consists of a glass tube of very small

The thermometer.

bore, closed at one end, and united at the other to a bulb, which is filled with mercury.* Almost all substances swell or expand when they are heated, and shrink or contract when they are cooled. When the thermometer is heated the mercury in the bulb expands and can no longer be contained in the bulb, and its excess, in the form of a thin thread of mercury, rises in the tube. When the instrument is cooled the mercury shrinks, and the thin thread becomes shorter, as it subsides towards the bulb. Thus, then, by observing the length of the thread of mercury in the tube, as measured by the graduation at its side, the thermometer shows the temperature at the time.

Graduation of a thermometer.

The indications of a thermometer are recorded in *degrees*, not in *inches* like the barometer. There are two fixed points on the scale by which thermometers are graduated, viz., that at which ice melts,

* Thermometers intended for use in very cold climates are filled with spirit, which, practically, does not freeze, instead of mercury, which does.

and that at which water boils. In the thermometers in use in England, the distance between these two points is divided into 180 parts, or Degrees. The point at which ice melts, measured on this scale, is thirty-two degrees (32°) and that at which water boils, when the barometer reading is 30 inches, is two hundred and twelve degrees (212°).* Graduation of a thermometer.

The usual range of a thermometer in the shade in the open air, in England, is about seventy degrees, viz., from 10° to 80°. In very hard frosts the temperature sometimes falls below 10°, and on very hot summer days it rises above 80°. If the instrument is exposed direct to the rays of the sun, the mercury may rise much higher, and at night, if exposed to radiation to a clear sky, may fall many degrees below what would be due to the temperature of the air. The range of the thermo- Range of temperature.

* This graduation is the earliest adopted, namely, by Fahrenheit, at the beginning of the eighteenth century. Another form of graduation is the Centigrade, in which the freezing point counts as 0°, and the boiling point as 100°.

Range of temperature.

meter is greater in many other countries, especially in the interior of the Northern Continents, North America, and Asia, where the winters are much colder and the summers much hotter than here. In islands of small extent in the warmer regions of the earth the range is often much less than in the British Isles.

Description of hygrometer, or dry and wet bulb thermometer.

HYGROMETER. — This instrument measures the dampness of the air. There are several kinds of hygrometers, but the easiest to make and to manage consists of a pair of thermometers placed near each other. If one of these be fitted with a piece of thin linen fastened tightly round the bulb, and this coating be kept damp by means of a few threads of darning cotton or lamp wick, which are tied loosely round the stem so as to touch the linen, and have their lower ends dipping into a cup of water placed close to the thermometer, it will usually show a temperature lower than that shown by the other thermometer which is near it, the *depression* of the wet bulb being dependent on the degree of dryness of the air.

Principle of the hygrometer.

A thermometer fitted in the manner described above is called a *wet bulb thermometer* to distinguish it from an ordinary thermometer which has its bulb *dry*.

The wet bulb thermometer is cooled by evaporation. When the atmosphere is very damp or moist, during or just before rain or when fog is prevalent or dew is forming, there is little or no evaporation, and the two thermometers read very nearly alike, but at other times the wet bulb reads lower than the dry, because the water dries off from the linen coating, and in order to dry off or to be evaporated it requires heat, which it takes from the thermometer itself. The evaporation is greater, as the air is drier, and accordingly the difference in readings between the dry and the wet bulb is then also greater. The difference sometimes amounts to ten or fifteen degrees in this climate, and to twenty or even more in other parts of the world.

To ensure correct records of the temperature and moisture of the air, the dry

Thermometer screens.

and wet bulb thermometers should be placed in a stand or screen, the four sides of which are protected by "jalousies," that is narrow sloping boards overlapping each other, so as to let in the air freely while they keep out direct and reflected rays of the sun, and also rain and snow.

Rules to explain the Indications of the Instruments.

Indications of the instruments.

The barometer shows the *pressure* of the air.

The dry bulb thermometer (in the shade) shows heat and cold, or the *temperature* of the air.

The wet bulb thermometer, compared with the dry, or the hygrometer, shows the degree of moisture, or the *dampness* of the air.

Indications precede changes.

Changes in weather almost always give some warning of their coming, and the instruments are usually affected before the wind actually begins to blow or the rain to fall; thus the instruments may be said to enable us to feel the pulse of the atmosphere. We shall also see, a little further on, how the appearance of the sky will aid us in forming an opinion as to probable weather. But the length of time

which passes between the first indication of a change of weather and its actual setting in, is not always the same.

A barometer tells more about *wind* than about *rain*.

The barometer, feeling the pressure of the air, shows at once when that pressure is changing in amount. When the pressure is unequal over a tract of country the air begins to move, to re-establish uniformity of pressure, and thus WIND is caused. Hence the barometer by its changes, shows pretty accurately when wind or change of wind may be expected. A change of weather comes almost always with a change of wind, and because landsmen generally, particularly farmers and gardeners, care more about rain or snow than about wind, these classes have got into the habit of looking at the barometer in order to see whether the weather is going to be wet or dry.

Used without discretion, the barometer is almost as likely to mislead the person consulting it as to guide him aright. The barometer has but two motions, *rising* and *falling*, by which to indicate all changes of weather; and any conclusions drawn from

its movements require to be checked by observations of temperature, moisture of the air, the present and previous direction and force of wind, and the state of the sky, before a correct opinion can be formed as to what may be expected.

The barometer and wind.

There is no direct relation between the height of the barometer at any one place and the direction of the wind, as was formerly generally supposed. Both the height of the barometer and the direction of the wind depend on the general conditions of weather over extensive areas.

The barometer and temperature.

Temperature, subject to the changes that follow the seasons of the year or the time of day, is influenced in the first instance, by the direction of the wind, which may come from hot or cold regions, and in the second, by the height of the barometer, for the higher the barometer the lower is the temperature of all winds, except in hot summer weather.

The barometer and humidity.

The dampness of the air, the amount of cloud, and the chance of rain, as well as its amount, are all connected to some

extent with atmospheric pressure, and, roughly speaking, they are all great when the barometer is low, and small when the barometer is high.

The barometer as a "weather-glass."

The foregoing statements, based on the experience of many years, justify the application of the term "weather-glass" to the barometer, but they also show that many other things have to be taken into consideration, besides observations of the mere height of the mercury in that instrument, if we wish to form a judgment as to coming weather by means of instrumental observations.

It is by the changes in the readings of the barometer, and by the rapidity with which these changes take place, considered in connection with the changes in direction and force of the wind, that we chiefly judge of the disturbances which are in progress in the atmosphere, and of the changes of weather which may be impending.

If the readings of the barometer be taken carefully at equal intervals of time,

it will be found that changes are nearly always taking place, and it is from the character of these changes and their amount in connection with corresponding changes in the wind, that useful forecasts may be made of approaching storms.

Setting the barometer.

The barometer should, therefore, be set and read by a duly authorized and qualified person at regular hours, and in doubtful weather more frequently, and the readings entered on the diagram (Plate I.) If such a record is not kept, any person who consults the barometer will have no means of knowing when the instrument was last set, or at what rate any change he may notice is taking place.

Importance of Telegraphic Weather Reports.

It will be clearly understood from what has been said, that although much can be learned by an intelligent use of the barometer, still a much more correct opinion may be formed from a knowledge of its state at several neighbouring stations, such as is to be gained from the Daily Telegraphic Weather Reports, and from warnings sent down from the Meteorological Office.

Buys Ballot's law.

From the law discovered by Professor Buys Ballot, of Utrecht, and first announced in Europe about 20 years ago, we can tell what wind may blow, or be expected to blow, at a group of adjacent places, if we know the readings of the barometer.

The law is stated in the following terms :

"Stand with your back to the wind, and the barometer will be lower on your left hand than on your right."

This is the law for the Northern Hemisphere, for the Southern Hemisphere the words "left" and "right" should be interchanged.

Thus the wind will be or may be expected to be—

Easterly when the pressure is highest in the North, lowest in the South ;
Southerly when highest in East lowest in West ;
Westerly „ „ South „ North ;
Northerly „ „ West „ East.

Next, as to the velocity of the wind. This depends, at least in a great measure,

on the amount of the difference of barometrical readings over a given distance.

Law of "veering" and "backing" of wind.

Besides these rules for the relations between the wind and the height of the barometer, there is another about the way in which the wind changes, which is very important. It is well known to every sailor, and is contained in the following couplet—

When the wind shifts against the sun,
Trust it not, for back it will run.

The wind usually shifts *with watch-hands*, i.e., from left to right in front of you. A change in this direction is called *veering*.

Thus an East wind shifts to West through South-east, South, and South-west, and a West wind shifts to East through North-west, North, and North-east.

If the wind shifts in the opposite way, viz., from West to South-west, South, and South-east, the change is called *backing*, and it generally indicates that a new storm

is approaching. The reasons for this will be explained further on.

However, slight shifts of wind do not follow this rule exactly, thus for instance, the wind often shifts from South-west to South and back again.

The Daily Weather Charts.

Daily weather charts, how they are drawn.

As the Daily Weather Charts are now exhibited publicly at some fifty stations situated round the Coast, it seems desirable to give a short explanation of the mode of preparation, and of the meaning of the charts.

Observations of pressure, temperature (dry and wet thermometers), wind, rain, and weather are made at 8 a.m. daily at 60 stations situated in these islands, and the adjacent parts of the Continent of Europe, and are telegraphed to London. Several observers telegraph again at 2 p.m. and 6 p.m., giving observations taken at those hours.

The observations as they come in are entered on large maps, lines are then drawn through all the places in which the pressure is the same for each successive tenth of an inch.

Isobars.

The lines so drawn are called "isobars," from the contractions of two Greek words

signifying "equal weight," and they indicate that the barometrical reading is equal all along the course of each line.

The lines are usually drawn, as just said, at intervals of one tenth of an inch. Accordingly it will be understood, that if these lines are far apart, the gradients will be slight, and there will be little wind. On the other hand, if these isobars are very close together, it becomes probable that there will be a storm. The chart which shows the barometrical pressure also shows the wind and the state of the sea disturbance.

The wind force is recorded according to Admiral Beaufort's scale* as follows :—

* Note.—A "well-conditioned man-of-war" means a frigate of about the year 1806.

Beaufort's scale.

BEAUFORT'S SCALE OF WIND FORCE.

0. Calm.		
1. Light air	Or, just sufficient to give steerage way.	
2. Light breeze	Or, that in which a well-conditioned man-of-war, with all sail set, and clean full, would go in smooth water from	1 to 2 knots.
3. Gentle breeze		3 to 4 knots.
4. Moderate breeze		5 to 6 knots.
5. Fresh breeze	Royals, &c.	
6. Strong breeze	Single-reefed topsails and top-gallant sails.	
7. Moderate gale	Or, that to which she could just carry in chase, full and by	Double-reefed topsails, jibs, &c.
8. Fresh gale		Triple-reefed topsails, &c.
9. Strong gale		Close-reefed topsails and courses.
10. Whole gale	Or, that with which she could scarcely bear close-reefed main-top-sail and reefed foresail.	
11. Storm	Or, that which would reduce her to storm-stay-sails.	
12. Hurricane	Or, that which no canvas could withstand.	

Explanation of weather maps.

In the charts the different grades of the scale are indicated by differences in the arrows, as follows :—

⟫⟶	indicates forces above	10
⟩⟶	„	8 to 10
⟶	„	5 to 7
⟶	„	1 to 4
⊙	„	dead calm.

The arrows always fly with the wind, and inspection of any weather chart will show that their directions are generally nearly parallel to the isobars.

The sea disturbance is shown by shading.

The second map on the sheet shows the temperature and the weather.

The temperature lines are called "isotherms" (equal heat), and they are generally drawn for each tenth degree Fahrenheit in a manner precisely similar to the isobars.

The weather is entered in letters according to the following notation, which, like the wind scale given above, is due to Admiral Beaufort.

BEAUFORT'S WEATHER NOTATION.

Explanation of weather maps.

b, Blue sky.	*p*, Passing showers.
c, Detached clouds.	*q*, Squally.
d, Drizzling rain.	*r*, Rain.
f, Fog.	*s*, Snow.
g, Dark, gloomy.	*t*, Thunder.
h, Hail.	*u*, Ugly, threatening.
l, Lightning.	*v*, Visibility, unusual transparency.
m, Misty (hazy).	
o, Overcast.	*w*, Dew.

Weather travels over the country.

Any one who examines these charts day by day, for two or three days together, will notice that the appearance of the chart generally changes considerably between one day and the next. It is very seldom that a change of weather or a storm is limited to any single district for more than a few hours at a time, and storms, &c., as a rule, move over the country. Frequently wet weather with a Southerly wind begins in Ireland, at least a day sooner than it does in England. Some changes of weather travel faster than others, and though most of them move from West to East, this is by no means always the case.

We must now proceed to give some slight explanation of the reasons of these changes, referring those of our readers who wish for fuller information to Mr. Abercromby's work, entitled "Principles "of Weather Forecasting by means of "Weather Charts," published by the Meteorological Office.

Not unfrequently, on one of these charts, as in Fig. 4 (p. 35), some of the isobars may be seen in the form of rings, which are generally irregularly oval or egg-shaped. If the innermost ring is very small, and there are several others packed more or less closely round it, the differences of pressure at neighbouring places will be large, and there will probably be a storm blowing where the rings are closest. In such a case, the barometrical reading represented by the innermost isobar will be the lowest on the map, and round that point the wind will blow, *moving against watch-hands* as shown in the following diagram:—

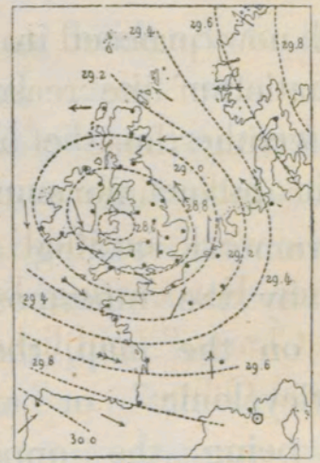


Fig. 4.—29 Nov. 1874 8 am.
(Cyclonic System.)

Such a distribution of barometer readings with its accompanying winds is called a "cyclonic system," a "cyclone," or a "depression." The term cyclone is from a Greek word meaning to whirl round in a circle, as the wind appears to blow in a circle. The word depression refers to the fact that the barometer is low, the level of its column is depressed, within the area affected by the system.

A cyclonic system passing over the British Isles at any time of the year brings on clouds and rain, wherever the wind in it comes from a point between East, round by South, to West. Such a system, when its centre passes over Scotland, commonly produces warm weather

in the south of England in winter, and causes a thaw after frost. In summer it brings cool weather, as the clouds which accompany it obstruct the sunshine.

Anti-cyclonic systems.

If the barometer reading, as in Fig. 5, represented by the innermost isobar is the highest on the map, the system is called "anticyclonic" or an "anticyclone," as being the opposite of a cyclone.

In such a case the isobars always lie further apart than in the cyclonic systems; the differences of pressure are therefore slight, and the winds light. The winds circulate *with watch-hands* (as shown in the following diagram), and therefore in the opposite way to what takes place in cyclones.

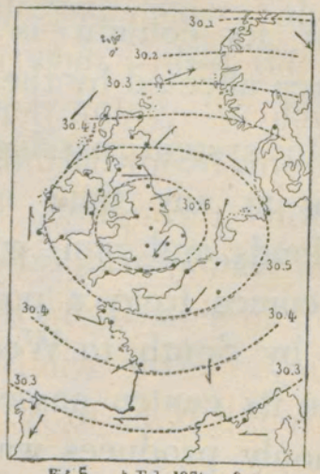


Fig. 5. — 4 Feb. 1874. 8 am.
(Anticyclonic System.)

Anticyclones bring with them dry weather and clear skies. In winter they are usually accompanied by frost, and frequently produce local fogs, but no clouds. In summer they bring fine weather, as there are no clouds to stop the sun's rays.

Motion of cyclonic systems.

The only other points we shall mention are that cyclonic systems usually move comparatively rapidly over the country, in general from some westerly point, never, or at least hardly ever, from an easterly point.

Anticyclones move very slowly.

This fact of the motion of storms explains the law of "veering" and "backing" wind, which has already been stated. On the right-hand side of the track of a cyclonic system, that is on the southern side over our islands, the wind veers from S.E. through S. to W. and N.W., as the system passes by a station. On the left-hand side, or on the northern side over our area, the wind backs from S.E. to E. through N.E. to N.

Motion of storms.

By far the greatest number of the cyclonic systems which affect us in the British Isles, pass to the northward of us, and so the veering winds are much more common than the backing. The backing which has been mentioned as indicating unsettled weather, is a change from N.W. through W. to S. and S.E., which occurs when a second cyclonic system follows one which has just passed over a station.

Changes of the barometer.

In general, whenever the barometer readings change slowly, there is very little danger of a storm, but when they change rapidly, there may be a sudden squall or serious gale.

Now, what has already been said shows us that whenever a storm is blowing, the height of the barometer will be very different at places near each other, so that as a storm travels across the country, the barometer at any station will give signs of its coming and going by the mercury sinking or rising in the tube. This shows us that when the barometer is steady, there is no great likelihood of

a storm being near us, while when it is unsteady, or changes rapidly, there is danger of the wind freshening to a gale. This unsteadiness may be due to mere local causes, so that it is at times very hard to say whether it shows that a serious storm or only a slight squall is coming on.

Changes of the barometer.

When the barometer at any place rises very high (above 30·5 inches), and continues so for some days, it will be due to the existence of an anticyclonic system, the wind will be light, and the weather probably dry, with local fogs, and in winter with frost.

Barometer very high, and steady.

When the barometer is very low (below 29·0 inches) and continues so, there may be calm and even dry weather for a short time, at the centre of a large cyclonic disturbance, but there is great danger of a serious storm, because there will be reason to expect the air from the region of higher pressure without to flow with violence into the district where the readings are low.

Barometer very low, and steady.

Barometer rising gradually.

If the barometer rises gradually from a low level, the weather will usually become drier, and if it has been blowing hard, the wind will become lighter, or perhaps die away to a calm.

Barometer falling gradually.

If the barometer falls gradually from a high level, the weather will usually become damper, and there will be an increased probability of rain, though there will not be much wind as long as the barometer changes slowly.

Sudden changes of the barometer.

A sudden rise of the barometer after it has been steady for some time, is very nearly as bad a sign as a sudden fall, because it shows that the atmosphere is in a disturbed state. In an ordinary gale, the wind often blows hardest when the barometer is just beginning to rise, directly after having been very low. The direction of such gusts is generally from W.N.W. or N.W. in these Islands.

With a rapid rise of the barometer in disturbed weather, severe squalls are

common, though the weather generally improves quickly. Frequently, however, from the tendency of a succession of cyclonic disturbances to follow one another, such a rise is followed by as rapid a fall, when a ridge of high barometer readings passes away and a new depression advances, and in winter beautiful weather and a rime frost are often experienced as the ridge is passing. This accounts for the saying, that a rime frost is a sign of bad weather. Such fine days, between two storms, are called "pet days" in some parts.

Sudden changes of the barometer.

Meaning of instrumental indications.

It is found, that if a calculation is made of the mean height of the barometer, and the mean temperature and humidity in these Islands, corresponding to winds blowing from each point of the compass, the point at which the barometer reading is highest, and the temperature and humidity lowest, is near N.E., while the point at which the barometer reading is lowest and the temperature and humidity highest, is nearly opposite to it, or about S.W. On the East coast of North

Meaning of instrumental indications.

America, as at Halifax, the coldest winds are about N.W., and the warmest about S.E.

Speaking in the most general terms, the air flows *out from* the region of local greatest cold, and *in to* the region of local greatest heat, because cold air is heavier than warm air, but it is modified in its flow by various agencies, among which the rotation of the earth on its axis, which imparts an eastward motion to the whole atmosphere, is the most important. It is to this cause that is due the deflection in the Northern Hemisphere of all Northerly winds to an apparent Easterly course, and of all Southerly winds to an apparent Westerly course; and by the combination of these tendencies the peculiar directions of the cyclonic and anti-cyclonic winds are also produced. Further information on this subject will be found in the "Barometer Manual for the use of Seamen."

From what has been said, it will be understood, that when the barometer

rises, accompanied by a change of wind, the weather usually becomes colder, while, when the barometer falls, accompanied by a change of wind, the weather usually becomes warmer.

Weather Signs.

Weather signs.

Many of the ordinary signs of change of weather are familiar to every one, but it is very difficult to give a satisfactory list of them.

Fishermen, shepherds, gamekeepers, and others, whose occupations oblige them to be out of doors at all hours and in all weathers, can often make *for their own neighbourhood*, from local signs, a very good guess as to the weather for a day or two in advance, and it must be admitted that scientific meteorologists, with apparently the most complete machinery for gaining a knowledge of weather at command, may often be more at fault in foretelling weather for a particular district then many an old country-man whose wits for weather-wisdom have been sharpened by his mode of life.

Local weather signs.

The great difficulty in dealing with local signs arises from their being peculiarly local, so that any one of the persons

experienced in interpreting the weather signs of his own district, will be quite at a loss if taken out of his own particular locality and asked to form a judgment of the weather in a different part of the country, from the local signs current there.

In the preparation of forecasts, the Meteorological Office feels seriously the want among its reporters of the local knowledge possessed by many fishermen at the stations from which information is obtained.

The following list of general signs is greatly abridged from Admiral FitzRoy's Barometer Manual :—

Colour of the sky.

" Light, delicate, quiet tints or colours,
" with soft, indefinite forms of clouds, in-
" dicate and accompany fine weather: but
" gaudy or unusual hues, with hard, defi-
" nitely outlined clouds, foretell rain, and
" probably strong wind.

Clouds.

" Small inky-looking clouds foretell
" rain :—light scud clouds driving across

Clouds. " heavy masses show wind and rain; but,
" if alone, may indicate wind only—pro-
" portionate to their motion.

" 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 cloud,
" 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.

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

" 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.

Dew. " Dew is an indication of coming fine
" weather. Its formation never *begins*

" under an overcast sky, or when there is
" much wind.

" Remarkable clearness of atmosphere, Clearness of the air.
" especially near the horizon: distant ob-
" jects, such as hills, unusually visible, or
" well defined; 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, in a
" short time. When smoke from chim-
" neys does not ascend readily (straight
" upwards during calm), unfavourable
" change is probable.

" Near land, in sheltered harbours, in Wind dying down at night.
" valleys, or over low ground, there is
" usually a marked diminution of wind
" and a dispersion of clouds during the
" early part of the night."

During bright weather and Westerly Cirrus clouds: their indications.
(N.W. to S.W.) airs or light winds, the
appearance of very high clouds, of the
Mares Tail type, moving from the North-
westward, is usually an indication of a
backing of the wind to the Southward,

Cirrus clouds: their indications.

and its increase in force, probably to a fresh or strong gale. This movement of the very high clouds under such conditions is a very decided indication of bad weather, if at the same time a batch of such clouds be rising in the West, and the barometer, after rising, is inclined to fall again.

Again, when the wind is Westerly or North-westerly of moderate strength, if high hair-like or thready clouds appear moving from N. or N.N.E., they very commonly portend a great increase of wind from the North-westward, with snow, sleet, or soft hail in winter.

Again, if the wind be Easterly, and high clouds appear, similar to those just mentioned, but moving steadily from S.S.W., they point to an increase in the force of the Easterly wind; and during sultry summer weather, to the early approach of thunderstorms, followed probably by a shift of wind to the South-westward.

In all these cases, however, the direction of the wind at the surface must be noted; and it may be added that the

value of the sign is increased when it occurs after a spell of exceptional bright weather, and a sudden rise of the barometer.

Weather and Storms.

Weather.

A few remarks as to the ordinary varieties of weather, and storms, may be of use.

A complete shift "with the sun."

We shall start with the prevalent wind in these islands, which blows from the S.W. If the wind shifts through W. to N., the barometer rises and the thermometer falls. While this change is going on we have in winter snow, in spring sleet, and in summer, if the weather be hot, thunderstorms, after which the weather gets cooler. If the wind draws further round through N. to N.E., the weather becomes clearer, the barometer high, and the air dry; and in winter there is generally a hard frost. After a frost, as soon as the barometer begins to fall the wind veers to E., thin streaks of whitish clouds cover the sky, and the snow which falls comes from the S. wind which has set in aloft already. If the barometer falls quickly the snow turns to rain, while the wind veers further through S.E. and S. to S.W.

Signs of Southerly wind.

The change from a clear sky to a cloudy one almost always begins with the appearance of long streaks of cloud. At night we often see rings round the moon when such clouds as these are observed. If the streaks reach right across the sky, forming what is called a "Noah's Ark," we know that the wind above us has begun to blow already, and that wet weather is sure to follow.

Rings round sun and moon.

There are two kinds of rings which occasionally appear round the moon or sun.

Coronæ or burrs.

Those which appear close to the luminary are called "coronæ," and exhibit colours like the rainbow. They are produced when any thin cloud passes between us and the moon or sun, or the sky is overcast by a thin veil of cloud. In the latter case the rings are often indistinct, and frequently show nothing more than a sort of burr, and the appearance is generally a sign of rain, but not necessarily of a storm.

Halos and mock suns, &c.

The other kind of rings, called "halos," usually appear as broad rings at

Halos and mock suns.

some distance from the luminary, somewhat coloured, reddish inside, bluish outside, though moonlight is hardly strong enough to show the colours. Occasionally bright spots, mock moons, or mock suns are seen on, or rather a little outside, the ring, and on a level with the luminary. This kind of ring is a nearly certain sign of a serious disturbance of weather, and frequently of a storm, except during frost.

Halos are very frequently observed in the Arctic Regions. They are due to the presence of frozen mist in the air, through which the light from the sun or moon passes on its way to the observer's eye.

Reason that atmosphere clears before rain.

A reason why the air often clears and mountains appear closer just before rain is that after a long spell of dry weather there is a great deal of dust in the air, and when the air gets damp, as it does just before rain, the moisture settles on the dust and makes it sink, leaving the air clear.

Rainbow.

Our rain comes generally from the West, so that a clear sunset is a proof

that the weather will be fine for a little time, as there are no clouds near us on the West side. On the same principle the saying— Rainbow.

A rainbow in the morning
Is the sailor's warning;
A rainbow at night
Is the shepherd's delight,

may be explained. In the morning the sun is to the East of us and the clouds which occasion the rainbow to the West, and therefore likely to come over us. In the evening, if we see a rainbow, it must be in the East, and the sun must be shining in the West.

Sky clearing at night not a certain sign of fine weather.

However, after a wet day the whole of the sky often clears at night. This is not a certain sign of fine weather following. The clouds may, and often do, form just as heavily after sunrise next morning. This is probably due to the fact that the action of the sun in raising vapour in the air is suspended at night but resumed again in the morning.

Thunderstorms.

Thunderstorms generally occur when the weather is warm for the season;

Thunder-storms.

they are produced by sudden changes of temperature in considerable masses of air, either by the mixture of, or deflexion of, currents at different elevations. They are most frequent in these islands in summer, but are also very common in stormy weather in autumn on our West and North coasts. In summer the weather is generally cooler after a thunderstorm than before it, as the precipitation of rain necessarily equalizes the temperature of the air immediately over the place where the storm occurred with the upper and cooler strata from which the rain fell.

Storms.

The storms which are felt on our coasts are generally South-westerly storms, during which the wind may blow from any point between S.E., round by S., to W. and W.N.W.

South-westgales.

In winter, after a prevalence of Easterly winds, if the barometer begins to fall, and the thermometer to rise, a gale which commences to blow from S.E. will most probably veer to S.W., while the barometer falls constantly. As soon as the wind passes the S.W. point, the barometer begins to rise, a heavy shower of rain falls, and a strong W.N.W. or N.W. wind may follow, after which the sky clears, and the weather becomes colder. This is a precise description of what usually happens when a cyclonic disturbance passes to the eastward on the north side of a station.

South-westgales.

In some rare cases this N.W. wind may be followed by a N. or N.E. wind.

Wind backing.

If the wind "backs" from N.W. towards W. and S.W. and continues strong, the bad weather is almost sure to continue.

In winter the storms are often accompanied by thunder and lightning.

Most of these gales are felt first on the west coast of Ireland, and later at stations lying to the eastward. Accordingly, if the change of direction of the wind takes place rapidly, the storm may be blowing from N.W. on the coast of Ireland, while it is only beginning to blow from S. or S.S.E. on the east coast of England.

North-easterly storms.

North-easterly storms are not so common on our shores as those from the South-west. They are very dangerous on the east coast, as they do not give so much warning of their approach as S.W. gales. The weather generally becomes colder before they begin to blow.

These N.E. storms do not "veer" to the same extent as the S.W. winds; they very seldom change their direction more than 2 or 3 points, while a shift of wind *with the sun* through 6 or 7 points is very common in the case of South-west storms.

Storm Warnings.

The object for which the service of Weather Telegraphy was originally organized nearly 30 years ago, was to enable the Meteorological Department under Admiral FitzRoy to issue Storm Warnings. The conditions on which these warnings are now issued to the coasts of the British Islands are stated in the following Circular.

TELEGRAPHIC WEATHER INTELLIGENCE.

Circular Telegraphic Weather Intelligence.

The Meteorological Office issues (free of charge) to ports and fishing stations approved of by the Board of Trade, notices of atmospherical disturbances on or near the coasts of the British Islands.

SIGNALS.

The fact that such a notice has been received at any station is made known by hoisting a **Cone**, which is three feet high and three feet wide at base, and appears as a triangle when hoisted.

SOUTHERLY GALE.

Circular Telegraphic Weather Intelligence.

The **Cone** *point downwards* means that gales, or strong winds, are probable, at first from the Southward (from S.E. round by S. to N.W.)

Should it appear likely that a gale beginning from between W. and N.W. is likely to *veer* towards N. or N.E., the *North* Cone is hoisted in preference to the *South* Cone.

NORTHERLY GALE.

The **Cone** *point upwards* means that gales, or strong winds, are probable, at first from the Northward (from N.W. round by N. to S.E.)

Should it appear likely that a gale beginning from between E. and S.E. is likely to *veer* towards S. or S.W., the *South* Cone is hoisted in preference to the *North* Cone.

SUDDEN SHIFTS OF WIND.

It must be remembered, that a Southerly wind is much more likely to veer quickly to a point North of West than a Northerly wind is to veer to a point South of East, and that a gale from East is more likely to *back* to the *Northward* than to *veer* to the *Southward*.

Accordingly, when the South Cone is hoisted and the anchorage or harbour is exposed to the North-West, it is advisable to bear in mind that a gale commencing at South-West may shift suddenly to North-West.

ON HOISTING THE SIGNALS.

The signal is to be kept flying until dusk, and then lowered to avoid unnecessary wear and tear, but to be hoisted again at daylight next morning; and so on until the end of 48 hours from the time at which the message was issued from London, unless orders to lower the

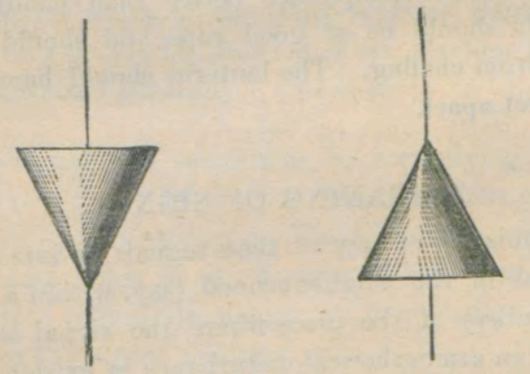
signal are received previously. The time of issue is always marked on the telegram. Circular Telegraphic Weather Intelligence.

At dusk, whenever a signal ought to be flying if it were daylight, a night signal may be hoisted in place of the Cone, consisting of three lanterns hung on a triangular frame, point downward (for South Cone), or point upwards (for North Cone) as the case may be. They should be kept burning until late in the evening, say 9 or 10 o'clock, or longer if the local authorities should think it important.

CAUTIONARY SIGNALS.

DAY SIGNALS.

South Cone. North Cone.

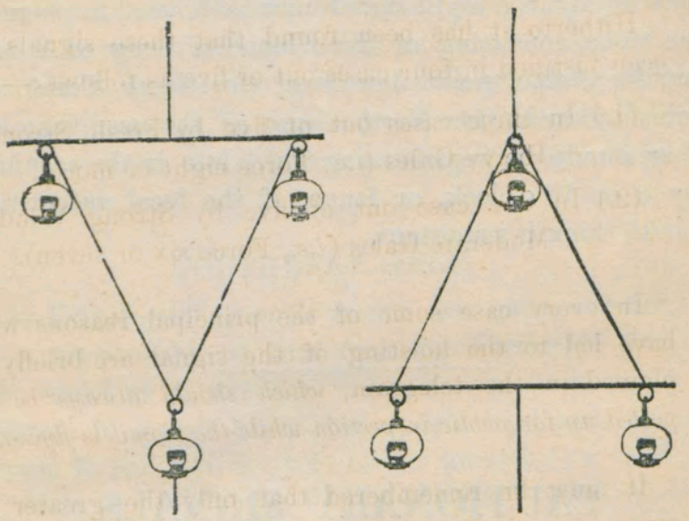


Gale probably from the Southward.

Gale probably from the Northward.

NIGHT SIGNALS (instead of the above),

Lights in Triangle.



Three lanterns and one yard, 4 ft. long, will be sufficient.

These signals may be made with any lanterns, showing white or any colour, but the lanterns should be *all alike*. Red is best. Lamps are better than candles. The halliards should be of good rope, and should be protected from chafing. The lanterns should hang at least three feet apart.

MEANING OF SIGNAL.

The hoisting of any of these signals is intended as a sign that in the neighbourhood (say, within a distance of 50 miles) of the place where the signal is hoisted, there is an atmospherical disturbance in existence which will *probably* cause a gale from the quarter indicated by the signal used, and the knowledge of which is likely to be of use to the sailors and fishermen on that part of the coast. Its meaning is simply, "Look out! It is

"probable that bad weather of such-and-such a character "is approaching you."

Hitherto it has been found that these signals have been justified in four cases out of five as follows:—

(1.) In three cases out of five by Fresh, Strong, or Heavy Gales (*i.e.*, Force eight or more).

(2.) In one case out of five by Strong Winds or Moderate Gales (*i.e.*, Force six or seven).

In every case some of the principal reasons which have led to the hoisting of the signal are briefly explained in the telegram, *which should always be kept posted up for public inspection while the signal is flying.*

It must be remembered that only the greater and more general disturbances of the atmosphere can be made known by this method. Local changes of less extent must be indicated to observers by their own instruments and by local signs of weather, &c.

A regular study of the Daily Weather Report will be found very useful, as showing what weather has lately been prevalent generally. (*See below.*)

The signal will sometimes be kept flying after the gale is over; this is the case because often one gale is followed by another before the 48 hours are out. In every case when it is thought at the Meteorological Office that immediate danger is over, orders are issued to lower the signal at once.

SUPPLY OF WEATHER INTELLIGENCE.

A copy of the daily Weather Report, with Chart, will be supplied by post, free of cost, to any port where the

Circular Telegraphic Weather Intelligence.

authorities will undertake to exhibit it to the public as soon as received.*

The Office is also prepared to send by telegraph to any port important information which may reach it, and which the authorities at the port may wish to have, if these authorities will bear half the expense of transmission of the messages. This intelligence is quite independent of the warnings, which are transmitted free.

As examples of the kind of information which might be supplied may be cited.—Statements as to the weather at certain points of the Coast, either daily or whenever there is any atmospheric disturbance of consequence, though not amounting to a storm.

Such messages ought to reach the port, at latest, about noon on any day that they are issued. The system, wherever tried, has been found to be very useful.

In addition, it should be said that the Meteorological Office will supply the canvas shapes (and lanterns to such places as require them) on loan, but in all cases the local authorities must undertake the charges incidental to the hoisting of the signal, such as flagstaff and gear, oil, &c., and also to the keeping of the apparatus in repair, painting, &c.

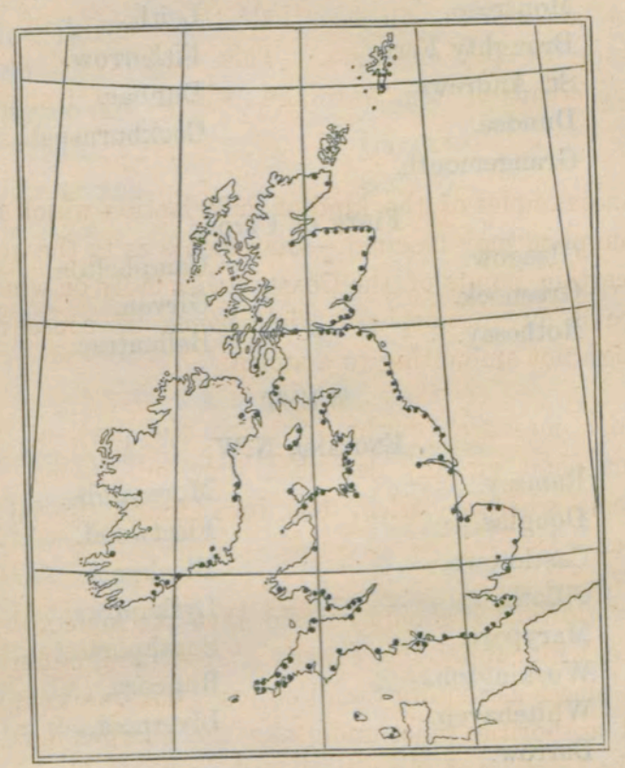
The following is the list of stations at which the storm signals are exhibited at present (February 1887), arranged

* The subscription for a copy for private use is £1. a year, to cover the cost of postage.

according to the Coasts on which they are situated :—

List of Storm Signal Stations.

Their positions are shown on the accompanying map, Fig. 6.



Map showing positions of signal stations.

NORTH.

SCOTLAND.—EAST COAST.

Dunrossness.	Inverness.
Lerwick.	Nairn.
Scalloway.	Burghead.
Wick.	Lossiemouth.
Kirkwall.	Buckie.
Holborn Head.	Cullen.

Portsoy.
Banff.
Fraserburgh.
Peterhead.
Aberdeen.
Stonehaven.
Montrose.
Broughty Ferry.
St. Andrews.
Dundee.
Grangemouth.
Bo'ness.
Anstruther.
Pittenweem.
Burntisland.
Granton.
Newhaven.
Leith.
Fisherrow.
Dunbar.
Cockburnspath.

FIRTH OF CLYDE.

Glasgow.
Greenock.
Rothesay.
Campbelton.
Girvan.
Ballantrae.

WEST.

ENGLAND, N.W.

Ramsey.
Douglas.
Castletown.
Silloth.
Maryport.
Workington.
Whitehaven.
Barrow.
Morecambe.
Fleetwood.
Blackpool.
Lytham.
Southport.
Runcorn.
Liverpool.

ENGLAND, W.

Connah's Quay.
Port Penrhyn.
Holyhead.
Port Dinorwic.
Carnarvon.
Aberystwith.
Milford.
Pembrey.
Swansea.
Llanelly.
Briton Ferry.
Porthcawl.
Penarth.
Cardiff.
Newport.
Weston-super-Mare.
Burnham.

IRELAND, E.

Belfast.
Donaghadee.
Howth.
Kingstown.

IRELAND, S. AND S.W.

New Ross.
Dunmore, East.
Dungarvan.
Youghal.
Queenstown.
Passage.
Kinsale.
Cork.
Tralee.
Limerick.
Galway.

SOUTH.

ENGLAND, S.W.

Ilfracombe.
Appledore.
Boscastle.
Port Isaac.
Newquay.
Hayle.
Scilly.
St. Sennen.
Penzance.
Falmouth.
Pendennis.
Mevagissey.
Plymouth.
Teignmouth.
Exmouth.

ENGLAND, S.

Guernsey.
St. Helier's } Jersey.
Gorey }
Weymouth.
Poole.
Cowes.
Ryde.
Portsmouth.
Littlehampton.
Brighton.
Newhaven.
Hastings.
Rye.
Sandgate.
Dover.
Margate.

List of Storm Signal Stations.

EAST.

ENGLAND, E.

Eyemouth.	Bridlington.
Berwick-on-Tweed.	Hull.
Tynemouth.	Goole.
S. Shields.	Grimsby.
Sunderland.	Boston.
Middlesborough.	Sutton Bridge.
Redcar.	Lynn.
Whitby.	Sheringham.
Filey.	Cromer.

ENGLAND, S.E.

Yarmouth.	Chatham.
Southwold.	Sheerness.
Ipswich.	Faversham.
Harwich.	

Some of these stations, being at small fishing villages, have no local telegraph offices, and to such places the warnings must be sent by special messengers. This necessarily entails some delay in the delivery of the messages, but even with these disadvantages, the testing of the warnings, the results of which will be seen from the tables at pp. 69 and 70, show that they are of very great utility.

The testing of the warnings is conducted in the following manner. The

The testing of storm warnings.

intelligence issued is compared with the weather experienced on the coasts, as indicated by the various self-recording anemometers, by the telegraphic reporters, and by several gentlemen who have volunteered to observe for the office.

In order to render the information as to the weather experienced on our coasts still more complete, the Meteorological Office has obtained from the various Lighthouse Commissioners the original log-books from some of the most exposed lightships and lighthouses.

The coasts are subdivided into nine districts, as will be seen in the table. Two large tracts of coast are entirely omitted: viz., the west of Ireland from the Shannon to Malin Head, and the west of Scotland from the Mull of Cantyre to Cape Wrath. No warnings are issued to any place within the limits indicated, except to Galway, and the amount of information as to the weather received from the omitted tracts of coast is, as yet, scanty.

The testing of storm warnings.

It should be remembered that in analysing the reports, all observations of the wind in which the force *exceeded* 7 (a "moderate gale") or the velocity exceeded 40 miles an hour, have been quoted as instances of the occurrence of a gale; but it has not been considered that the signal was hoisted late or was hauled down too soon, unless the force of 9 (a "strong gale") or the velocity of 50 miles an hour, was reached prior to the issue of the order to hoist, or subsequent to the issue of the order to lower.

In the Summaries all cases in which the signal has been shown to be late by a single report either of force 9, or of a velocity of 50 miles an hour, have been specially noted.

Testing of storm warnings.

RETURN of the Result of the Comparison between the Warnings issued and the Weather experienced in 1885.

Coasts.	Total No. of Orders to hoist and repetitions.	Per-centages.			Total Warnings late. Force 9 reached at two Stations before issue.	Total Warnings partially late. Force 9 reached at one Station before issue.	Storms for which no Warning was issued.
		Warnings justified by subsequent Gales. Force 8 and upwards.	Warnings justified by subsequent strong Winds. Forces 6 and 7.	Warnings not justified by subsequent Weather.			
Ireland, South -	74	63	22	13	—	1	Jan. 28, Feb. 6, April 5.
,, East -	79	40	34	25	—	—	April 5.
Scotland, East -	65	65	20	14	—	1	April 20,* Sept. 30, Oct. 1.*
,, West -	56	52	25	21	—	1	— —
England, North-west -	78	50	23	24	1	1	Jan. 28.†
,, West -	65	63	15	19	—	2	Oct. 4.
,, South -	79	58	23	18	—	—	Feb. 8,‡ Aug. 12,‡ Oct. 4.
,, South-east -	36	66	16	16	—	—	— —
,, East -	59	46	32	20	—	—	— —
Totals - -	591	—	—	—	1	6	
Per-centages -	—	55·3	24·0	19·5	0·2	1·0	

* These gales were not felt south of Aberdeen.
† Warnings too late to be of practical use.
‡ Warnings issued to Devon and Cornwall; gale extended up Channel.

Comparison of results for 1885 with previous years.

The following table contains a comparative statement of the storm warnings and their results in 1885, and in the ten preceding years:—

Years.	Total No. of Warnings issued.	Warnings justified by subsequent Gales.	Warnings justified by subsequent strong Winds.	Total Warnings justified.	Warnings not justified by subsequent Weather.
1875	248	41·1	35·1	76·2	21·0
1876	265	61·1	21·5	82·6	11·7
1877	475	53·3	25·9	79·2	16·4
1878	485	56·7	20·8	77·5	17·9
1879	509	50·5	25·1	75·6	20·6
1880	390	58·2	24·6	82·8	13·3
1881	454	58·6	23·3	81·9	14·8
1882	503	61·4	21·1	82·5	14·9
1883	610	56·2	21·6	77·8	20·8
1884	461	66·4	20·0	86·4	12·1
1885	591	55·3	24·0	79·3	19·5

It is evident from the last column of the table of results for 1885 that a number of gales visited our coasts, for which the office failed to issue warnings. In some of these cases the warnings had been issued to part of the coast, but in others the storm was missed altogether. The experience of all the European Meteorological organizations is that, occasionally,

this unfortunate occurrence must happen, as storms come on us from the Atlantic and sometimes travel with too great rapidity for it to be possible to issue timely warnings during daylight. At night the telegraph offices are generally closed.

Atlantic telegrams.

With a view of overcoming this difficulty, if possible, the Office has for the last two or three years obtained telegrams from the Chief Signal Office, Washington, giving information of storms on the Western Atlantic, reports of which had been received from steamers arriving at American ports. If a steamer encounters a storm to the westward of the meridian of 45° W. it is probable that she will reach the American coast early enough to furnish a report that may reach London by telegraph before the storm reaches the European coast, supposing that it travels the whole way across the Atlantic. This very interesting tentative service is still going on, under an arrangement come to between the French Meteorological Office and our own. The information thus obtained has not hitherto

Atlantic telegrams.

been of any practical utility for the purpose of forecasting probable weather; it will, however, be continued for a sufficient time to test its value more completely.

For the last 10 years occasional telegrams from the Weather Bureau of the "New York Herald," announcing the approach of storms from the Atlantic, have been published in English and other European newspapers. These warnings have at times been carefully compared with the weather subsequently experienced in these islands, and it has been found that not more than one quarter of the announcements were followed by serious gales in these islands. Of late the wording of the telegrams has been changed, and the announcement now usually made is that a storm is lying, say, off the coast of Newfoundland, and that it will probably disturb the weather of the British Isles and adjacent coast of the Continent at a certain date. These telegrams are much more frequently verified than those sent at first, for the

Atlantic telegrams.

experience of meteorologists shows that when an important disturbance arises over the Atlantic, near Newfoundland, it usually travels to the eastward, and approaches near enough to our west coasts to affect the weather, at least in Ireland.

It may be interesting, before leaving the subject of storms, to give the following table of the number and proportion of general gales on different parts of our coasts during the 15 years 1871–1885 inclusive, which has been prepared in the Meteorological Office. A gale is called "general" when it is reported at more than half the stations situated in the district. The figures giving the monthly percentages are represented

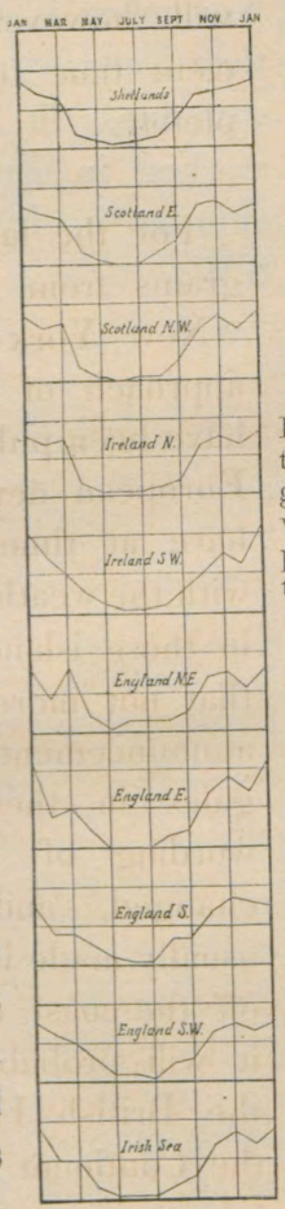


Fig. 7.
Monthly distribution of Gales.

Proportion of gales on various parts of the coast.

Proportion of gales on various parts of the coast.

graphically in the accompanying diagram, Fig. 7, p. 73. It will be noticed that November is almost always more stormy than December, and that the maximum of storminess in March, which is especially marked in England N.E., entirely disappears in Ireland S.W. and England S.W.

—	Monthly per-centages of the Total Number of General Gales reported in each District in the 15 years, 1871–1885 inclusive.												Total Number of General Gales.	Per-centages of the Total Number of General Gales reported in each District arranged according to the Four Quadrants.			
	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		N.E.	S.E.	S.W.	N.W.
The Shetlands -	16	13	11	3	1	1	2	3	6	13	14	15	281	14	29	30	26
Scotland, East -	15	13	12	4	1	—	—	3	6	15	16	13	229	9	23	33	35
Scotland, North-west -	17	14	15	3	1	—	1	1	5	13	16	13	275	7	16	44	33
Ireland, North -	16	14	15	3	1	1	1	2	4	13	15	13	198	6	18	42	34
Ireland, South-west -	21	14	10	5	2	1	1	2	6	10	15	12	277	5	16	62	17
The Irish Sea -	18	10	10	3	1	1	1	3	6	14	17	14	265	7	14	50	28
England, North-east -	16	9	16	4	1	3	3	3	5	14	15	11	172	17	18	40	25
England, East -	22	8	10	4	—	—	—	3	4	14	18	14	160	15	11	57	16
England, South -	15	8	8	5	2	1	1	7	7	14	17	16	190	8	5	54	33
England, South-west -	15	12	10	6	2	2	1	5	6	13	15	13	328	6	15	46	32

Proportion of gales on various parts of the coast.

WEATHER FORECASTING.

Weather forecasting.

The task of endeavouring to predict the weather day by day is much more difficult than that of giving warning of the greater disturbances produced by storms. This weather forecasting was first undertaken by Admiral FitzRoy in this country, but after his death the service was suspended, and was only taken up again, after the lapse of more than 10 years, in 1877. The present practice in the issue of forecasts is described in the following extract from the Annual Report of the Office.

ISSUE OF FORECASTS.

Descriptions of the actual state of the weather, and forecasts *for not more than one day in advance*, are prepared at the Meteorological Office* as under :—

---

* Good Friday and Christmas Day are reckoned as Sundays.

* *Note.*—FORECASTS FOR PRIVATE SUBSCRIBERS.—Any person can be supplied with a copy of 11 a.m. Forecasts, once on each week day* on payment of a subscription of ten shillings per annum, or 2*s.* 6*d.* per official quarter *or any part thereof, in addition to the cost of transmission;* the charges will therefore be, by *letter* post, 9*s.*, by *book* post, 5*s.* 9*d.* per quarter.

FORECASTS FOR CLUBS.—Forecasts drawn up at 11 a.m., for all the districts are supplied to Clubs, for a subscription of ten shillings per annum. These are delivered free, by hand, to Clubs situated in or near

ON WEEK DAYS.

Notice relating to forecasts.

(1.) At 11 a.m. (from the morning reports), for the 24 hours ending at Noon on the day following the date of issue. This issue is intended especially for the early editions of the evening papers, for the clubs, and for exhibition at certain selected stations.

(2.) At 3.30 p m. (from the morning and afternoon reports), for the day following that of issue. This set of Forecasts is not intended for

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Pall Mall. Special arrangements are made for delivery at a greater distance by hand or by post.

SUBSCRIBERS FOR THE LITHOGRAPHED COPY OF THE DAILY REPORT have the 11 a.m. Forecast incorporated with their Report on each week. The subscription for the Report is—

For delivery by hand, where feasible, £2 *per annum;*
Do. by book post £1 „

INQUIRIES as to the WEATHER.

INQUIRIES PERSONALLY OR BY MESSENGER.—Any person applying at the Meteorological Office between 11 a.m. and 8 p.m. on week days, and 7 p.m. and 8 p.m. on Sundays, can be supplied in writing with the latest information in the possession of the Office and with the latest forecast issued for any specified district, on payment of one shilling for each inquiry.

INQUIRIES BY LETTER.—Application may be made by letter, enclosing thirteen pence in stamps if the reply is to be *by post*, and one shilling in stamps in addition to the cost of the reply, consisting of ten words, exclusive of the address, if the reply is to be *by telegraph*.

INQUIRIES BY TELEGRAPH.—Any person may obtain *by telegraph* from the Meteorological Office the latest information as to the weather in any district of the United Kingdom by payment of a fee of 1*s.* In addition to the cost of a telegram and reply to any post office, the telegram containing the inquiry must be addressed as follows:

WEATHER,
LONDON,

The payment for the reply should be for ten words in addition to the address.

Notice relating to forecasts.

general publication, but a copy is exhibited regularly at the door of the Meteorological Office.

(3.) At 8.30 p.m. (from the 6 p.m. reports), for the day following that of issue. These are now supplied gratis to any newspaper or news agency which may apply for them, and send for them regularly.

The forecasts are made for the following districts:—

0. Scotland, North.
1. Scotland, East.
2. England, N.E.
3. England, East.
4. Midland Counties.
5. England, South.
6. Scotland, West (with Isle of Man).
7. England, N.W. (with North Wales).
8. England, S.W. (with South Wales).
9. Ireland, North.
10. Ireland, South.

The descriptions and forecasts are posted at the doors of the Meteorological Office, 116, Victoria Street, S.W., on week days, for the inspection of the public. Copies, or extracts from them, are communicated under the conditions stated in the note, but no information which is not substantially included in them can be supplied.

The districts into which the United Kingdom has been divided for the purposes of forecasting are the same as those

adopted for the Weekly Weather Report, which is published for agricultural and sanitary purposes. This division was originally made with reference to the agricultural character of the different parts of the country, thus,—the west of Scotland, the north-west and south-west of England, and the whole of Ireland, are mainly grazing districts, while the rest may be taken as corn-producing. It is evident that, as the different districts are very large, and comprise land very differently situated with regard to hill, valley, &c., &c., the weather cannot always be exactly the same over the whole of each district. Thus, rain may fall on the weather side of a range of hills, while the lee side has fine weather. Again, fogs may form in river valleys and over low-lying meadows, while the air will be quite clear over the rising ground near by.

Weather forecasting.

Accordingly, the forecasts are only intended to give a very general idea of the weather which may be expected to prevail.

The forecasts are regularly tested by the information from the succeeding day

The testing of forecasts.

given in the Daily Weather Report, and the results of this testing appear in the Annual Reports of the Office. The following are the figures for the year 1885, the last which have been published :—

SUMMARY OF RESULTS OF 8 P.M. FORECASTS, 1885.

Districts.	Percentages.				Total percentage of Success.
	Complete Success.	Partial* Success.	Partial* Failure.	Total Failure.	
SCOTLAND, N. -	55	31	9	5	86
„ E. -	50	35	10	5	85
ENGLAND, N.E. -	53	34	10	3	87
„ E. -	53	31	11	5	84
MIDLAND COUNTIES	51	34	11	4	85
ENGLAND, S. -	57	31	9	3	88
SCOTLAND, W. -	48	30	12	10	78
ENGLAND, N.W. -	48	32	12	8	80
„ S.W. -	50	32	12	6	82
IRELAND, N. - -	46	35	11	8	81
„ S. -	46	33	12	9	79
Summary -	51	32	11	6	83

* Note "partial" implies "more than half."

The following is a summary of the results for the last six years :— Testing of forecasts.

—	Complete Success.	Partial Success.	Partial Failure.	Total Failure.	Total percentage of Success.
1880	35	40	16	9	75
1881	34	44	16	6	78
1882	44	35	13	8	79
1883	48	33	11	8	81
1884	51	31	11	7	82
1885	51	32	11	6	83

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74. Hourly Readings, 1885. Part I. (In the Press.)

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