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Pressure, Temperature and Wind Variations at Heliopolis, Egypt, associated with the warm and cold sectors of a depression

By J. Durward, M.A.

Some rather striking oscillations of wind, temperature, humidity and pressure occurred at Heliopolis and other stations in Egypt during the period February 1st to 2nd, 1928, in a warm sector and behind a cold front, and the following short account of the situation may be of interest.

After January 29th a surface current from between east and south became established over Egypt. The current was found from pilot balloon ascents to be of no great depth—varying between 2,000 and 6,000 feet. On the day for which the synoptic chart is reproduced (see Fig. 1) the current was about 6,000 feet deep. Maximum temperatures in Upper Egypt and the Sudan had been above normal for several days. On January 31st the difference from normal was 20° F. at Helwan and Aswan and 22° F. at Minya. The continuance of the south-east current on February 1st therefore meant a very hot day in the Cairo district but the exceptionally high temperature recorded, viz., 95° F., seems to have been peculiar to Heliopolis only.

As will be seen by the autographic records which are reproduced (see Figs. 2 (a) (b) and (c)) the advance of the warm south-east current was periodically checked by the arrival of much cooler air from west or north-west. This cooler air lay over the cultivated area around the Nile where the night temperatures would naturally be lower. Actually the minimum at Giza (8 miles south-west of Heliopolis) was 7° lower than at Heliopolis. The wind direction oscillated between SE and NW

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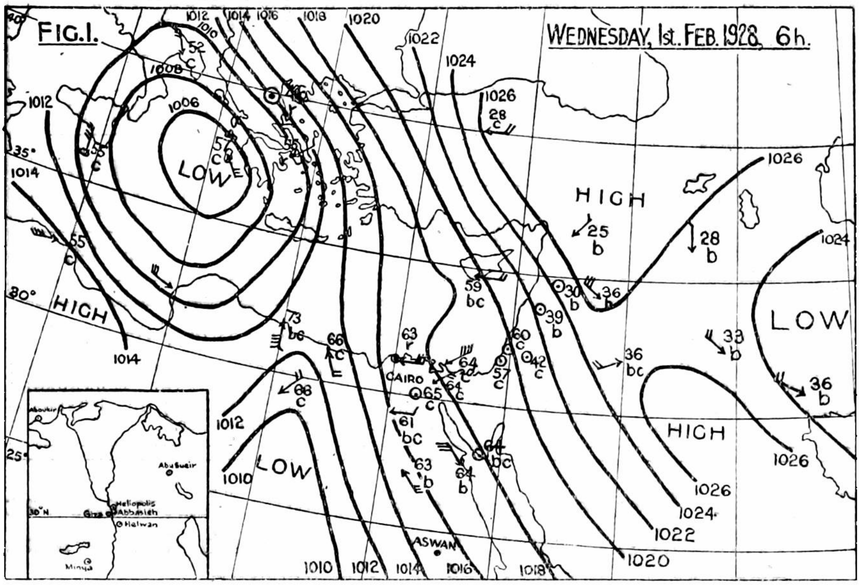
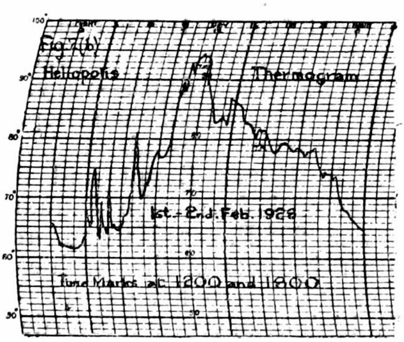
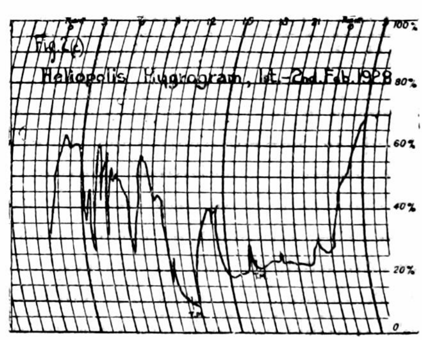
and temperature variations of 13° and humidity variations of 30 per cent. occurred from 3h. G.M.T. sometimes within a few minutes. It looks as if between the warm air over the desert



and the cooler air to the westward a sort of quasi-stationary front existed and the occasional upward movement of the warm air allowed the cooler air to reach this station at times, though the velocity of the westerly wind recorded in the vicinity of the front was naturally negligible. A temporary cessation of upward movement allowed the south-east current to advance





again and temperature to rise. From 10h. to 12h. 30m. G.M.T. the wind blew from SE with an average velocity of 4-5 m.p.h., and temperature rose to 95° F. This is probably a record for this part of Egypt for so early a date as February 1st; the highest temperature recorded in February at Abbassieh (2 miles from Heliopolis) since 1869 being 95.5° F. on February 28th, 1895. The maximum at Heliopolis was 9°

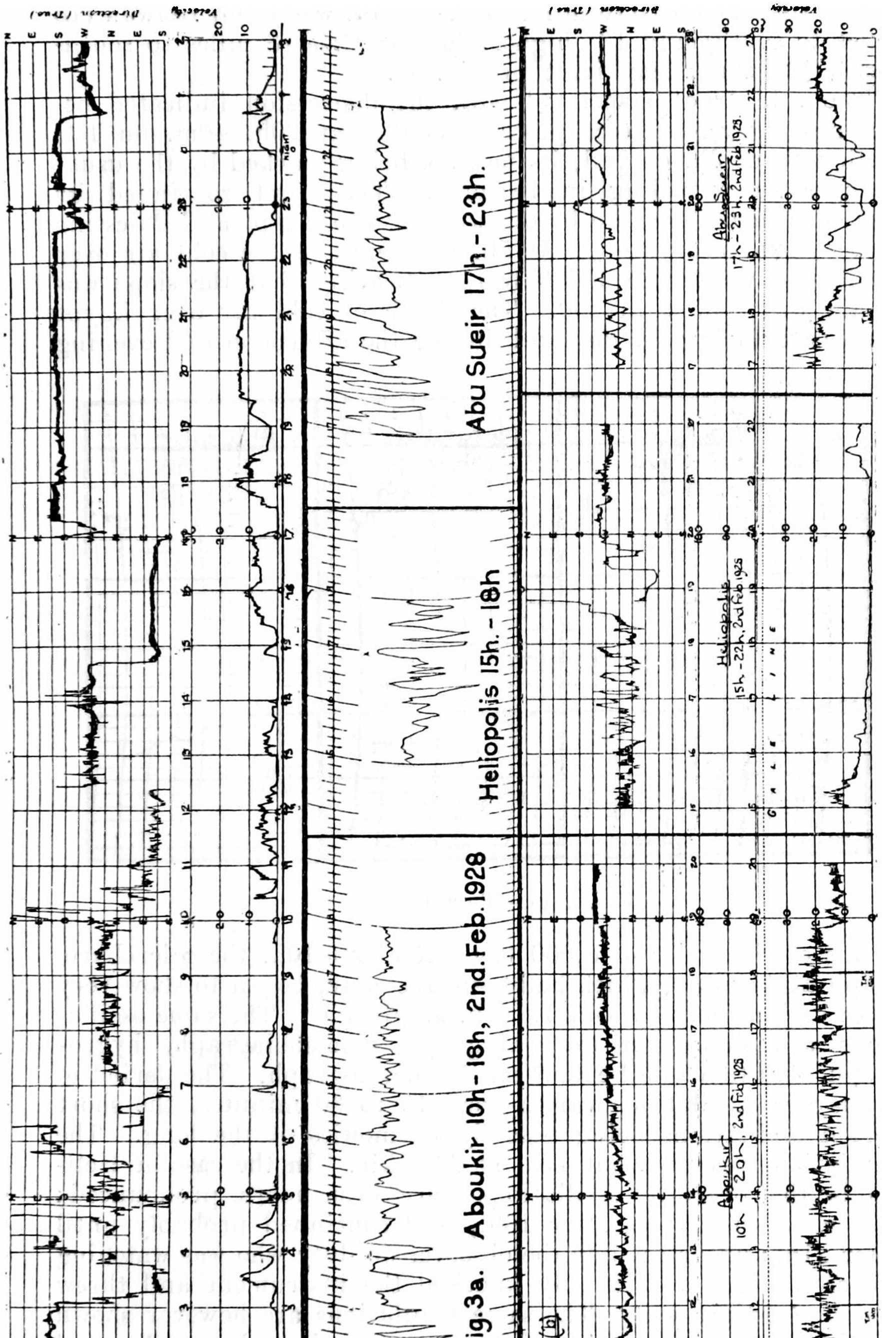


FIG. 2 (A)—WIND DIRECTION AND VELOCITY (M.P.H.). FIG. 3 (A)—MICROBA ROGRAMS. FIG. 3 (B)—WIND DIRECTION AND VELOCITY (M.P.H.).

higher than at Cairo (6 miles to west-south-west) and Helwan (18 miles to south) and 13° higher than at Giza (8 miles to south-west), (see small map inset in Fig. 1).

The cold front associated with the depression indicated between Italy and Greece passed Aboukir at 20h. 40m. on 1st, Heliopolis at 3h. on 2nd, its passage being marked by the usual changes on recording instruments. The front continued its eastward movement and by 6h. was between Egypt and Palestine and at 12h. near Gaza. At 5h. the depth of the cold air over Heliopolis was about 2,500 feet, indicating that the slope was of the order of 1 in 200. The depth of cold air over Egypt increased during the day and during the afternoon and evening

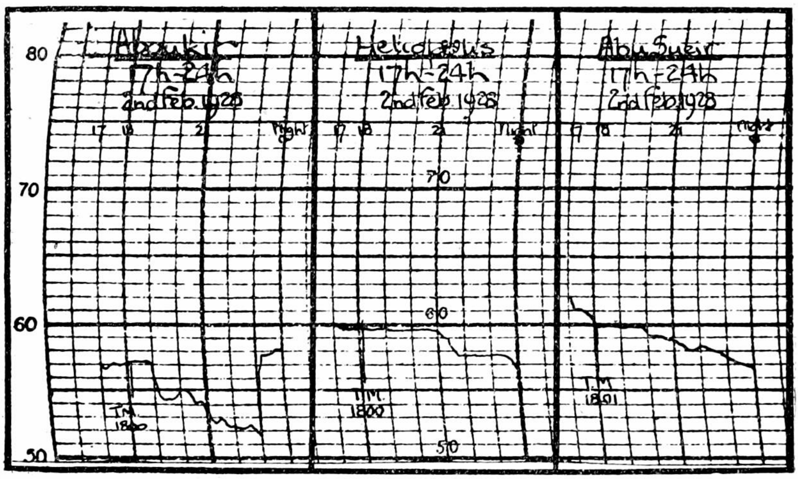


FIG. 3(c).—THERMOGRAMS.

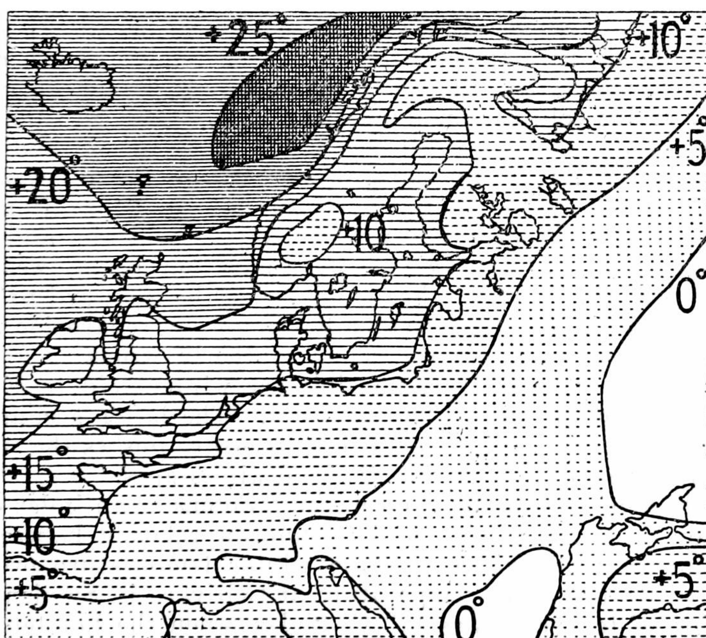
it was of the order of 8,000 feet. At about 10h. the microbarograph at Aboukir, which had been unsteady, began to show very large oscillations of about 1.8 mb. amplitude. The same oscillations are shown on the barograph, anemobiagraph, hygrograph, and to a small extent on the thermograph. The period of the larger oscillations varies from 10 to 60 minutes, the short period oscillations being possibly harmonics of the long. The oscillations ceased about 17h. at Aboukir. In the case of Heliopolis the pressure oscillations were even more pronounced; they commenced just after 16h., and continued probably until after 21h.; unfortunately the observer on duty who was watching the oscillations accidentally knocked the instrument and threw it out of adjustment. The same oscillations are however shown on the instrument at Abu Sueir, commencing about 17h. and ending at 22h. The wind velocity at Heliopolis was almost calm and the changes in wind direction were much more pronounced than at other stations, amounting to about 180°.

It will be noted that at Aboukir a colder supply of air arrived from south-west about 19h. and continued until 23h. This air arrived at Heliopolis between 21h. and 22h. and at Abu Sueir between 22h. and 23h. The essential features of the autographic records from all three stations are reproduced in Fig. 3 (a) (b) (c). Whilst the pressure oscillations were in evidence rain fell intermittently at all three stations and at Heliopolis much mammato-cumulus developed.

The chief point of interest is the large amplitude of the pressure waves. The amplitude of waves induced at the surface of separation of two currents is usually of the order of ½ mb., and one rather inclines to the idea that these oscillations are not due to waves set up at such a surface (in this case about 8,000 feet high) but that they are due to the eviction of air up secondary cold fronts present in the polar current. The intermittent character of the slight precipitation which occurred during the oscillations seem to be in favour of this view.

Influence of the Gulf Stream on the Winter Temperature of Europe

That the winter temperature of the north-west coast of Norway and the ocean to westward is abnormally high for its latitude is well known. The "isanomaly," or excess over the mean tem-



(*Reproduced from Met. Zs.*, 43, 1926, *p.* 401) perature of the latitude, reaches 27° C. near the Lofoten Islands in January (Fig. 1 after Ekholm) but decreases rapidly inland, the decrease in the western part of the Swedish mountains being 1° C. per 10 km. This high winter temperature is attributed to the influence of the Gulf Stream, but J. W. Sandström* has recently set out a new theory of the way in which the abnormality is related to the air circulation in the region.

The interior of the continent is occupied by dry, cold and heavy continental air, which moves from east to west, from northern Europe towards the Atlantic. It pushes beneath the warm, humid and light Atlantic air, which moves eastward over Europe above the layer of cold air. The former movement sometimes causes a wind analogous to the Bora, and the latter, where it crosses the mountains, results in a Föhn effect. There is a considerable body of evidence for this circulation. In January, 1924, which was a very cold month, the resultant wind direction shows a general drift from south over Scandinavia, combined with a component towards the Atlantic. Surface wind roses show that east winds prevail at Bodö on the Norwegian coast, but south and south-west winds at Röst, a little way out to sea. At a height of 2,000 to 3,000 metres the clouds move from west to east, and cloud caps on the mountains always point towards east in winter. The surface of separation between the warm and cold air in winter is clearly shown on the east of the north Swedish mountains by a horizontal line, above which the trees are black with thaw, while below it they are white with rime.

Sandström discusses this surface of separation or "Scheidefläche" in detail. Its position depends on the strength of the south winds from the Atlantic on the western side and the greater density of the cold air on the eastern side. Owing to the effect of the earth's rotation, southerly winds in western Scandinavia exercise an eastward pressure. The greater the difference of temperature and the steeper the surface of separation, the greater will be the westward pressure of the cold air, and when this predominates, the surface of separation moves westward as a cold front. On the other hand, when the eastward pressure of strong Atlantic winds prevails, the surface of separation moves eastward as a warm front. Thus southerly winds in western Scandinavia are mainly responsible for winter cold in Europe by preventing the removal of cold air. The latter accumulates in consequence of radiation until its pressure pushes the surface of separation so far west that the cold air escapes.

Sandström regards the wind at the Lofotens as an index of the state of the Gulf Stream and he finds a relation between the direction of these winds and the winter temperature over the whole of Europe. The temperature at Gellivare in Sweden, over a period of ten years was 11° C. higher when the Lofoten wind

*Uber den Einfluss des Golfstromes auf die Wintertemperatur in Europa. *Met. Zs.*, 43, 1926, p. 401.

was WNW. than when it was SSW. The results of the whole of Europe are shown by a series of 36 charts, for winds at the Lofotens differing by 10 degrees of azimuth. The progressive changes in the wind direction give such uniform changes in the temperature distribution as to produce almost a cinematograph effect. There are four main types: (1) WNW. winds at Lofoten bring warmth to northern Europe and cold to southern Europe; (2) NNE. and ESE. winds bring cold to northern Europe and waımth to southern Europe; (3) S. winds bring cold to Europe and warmth to the North Atlantic; (4) ENE. winds bring warmth to Europe and cold to the North Atlantic. The charts bring out a marked similarity between the temperature anomalies in central Russia and in Greenland, both places having an opposite deviation to that over the North Atlantic.

Sandström lays stress on the probable importance of the Lofoten wind direction in long range weather forecasting, as a criterion of the influence of the Gulf Stream on the weather of Europe.

A. WALTERS.

Discussions at the Meteorological Office

March 12th. *Ratio of heat losses by conduction and by evaporation from any water surface.* By I. S. Bowen (Physic Rev., Minneapolis, Minn., 27, 1926, pp. 779-87. *Evaporation from lakes.* By N. W. Cummings and B. Richardson (*idem.*, 30, 1927, pp. 527-34) and other papers. *Opener*—Mr. R. Corless, M.A.

In the first paper it is shown by a method partly empirical, partly physical, that when a vessel containing water is exposed to the sky there is a definite ratio between the quantity of heat lost by the water by conduction and convexion to the air, and the quantity of heat extracted from the water as latent heat of evaporation. The relation is given by the equation—

$$\frac{\text{Heat lost by conduction, \&c., to the air}}{\text{Heat lost by evaporation}} = 46\left(\frac{T_w - T_a}{P_w - P_a}\right)\frac{p}{760}$$

where T_w = temperature of water surface in degrees Centigrade.

T_a = temperature of air (dry bulb) in degrees Centigrade.

P_w = saturation vapour pressure at temperature T_w expressed in millimetres of mercury.

P_a = pressure of vapour actually present in the air, in millimetres.

p = barometer reading in millimetres.

The ratio of the two quantities of heat is called Bowen's ratio.

The ordinary formula for the computation of vapour pressure by means of observations of the dry and wet bulbs is the particular case of this equation which is obtained by putting the ratio equal to -1.

In the second paper the authors outline a method of computing evaporation from any water surface by means of an equation which expresses the balance between the energy received and the energy lost and stored by the body of the water. The energy received consists of the radiation from sun and sky which actually penetrates through the water surface. The energy lost consists of (1) back radiation from the water surface to the sky, (2) heat lost by conduction and convexion to the air, (3) heat lost by evaporation and (4) heat lost by conduction through the sides of the vessel and by any other process which may be effective. The energy stored can be measured by the increase in temperature of the body of the water, in conjunction with the mass of the water. Of these quantities that marked (2) can be expressed in terms of (3) by the use of Bowen's ratio. A method is described for dealing with the incoming and back radiations, which depends on taking observations of evaporation and of temperature on a control pan of water. Having given the temperature conditions of the body of water of which the evaporation is required it then becomes possible to compute the evaporation from that body.

The method was tested by comparing the evaporation from large tanks with that from the control pan with satisfactory results. R. CORLESS.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday evening, March 21st, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, being in the chair. As is customary in March, the meeting took the form of a lecture (The Symons Memorial Lecture), which was delivered by Mr. H. W. Newton, of the Royal Observatory, Greenwich. The lecture was illustrated by numerous lantern slides and the following is an abstract.

The Sun's Cycle of Activity.

The cycle of activity through which the sun passes in a period of about 11 years is shown by various solar phenomena. There is the well-known variation in the number of sunspots and in the concomitant phenomena of bright calcium and hydrogen flocculi at higher levels. Above these is the region of prominences and dark hydrogen markings which show only a partial relation to the spot-zones. The extended and outermost envelope of the sun—the corona—also undergoes a cyclical change. The cause of this 11-year period, though seemingly within the sun, is not known, and phase and amplitude of a cycle ahead cannot be predicted with accuracy. Sunspots are probably vortical in origin and are the centres of strong magnetic fields whose polarities, when similar spots are compared, have been found to be opposite in successive 11-year cycles.

A theory dealing with the sun's general circulation and that of spots in particular has been advanced by V. Bjerknes.*

Measures of the solar-constant and of the sun's ultra-violet radiation indicate a change with the solar cycle. A similar variation in the reception of wireless signals is also suspected. The occurrence of terrestrial magnetic storms and the corresponding state of the sun was briefly considered. With increasing international co-operation, solar outbursts can be followed more thoroughly in the hope of furthering our knowledge of these solar-terrestrial relationships.

Correspondence

To the Editor, *The Meteorological Magazine*

Lasting Qualities of Small Rubber Balloons

The Apia Observatory receives monthly shipments of balloons from Canada. In the rain season from December to March few ascents are made so that balloons are frequently held over for four months. Although the mean temperature is 82° F., and the relative humidity 85 per cent., there is little deterioration if the balloons are plentifully covered with talc, packed separately, each in a sealed envelope and kept in an air-tight box. Balloons exposed to light and air deteriorate rapidly, and red or black coloured balloons perish sooner than uncoloured balloons.

When the balloons burst in air usually the fabric tears completely apart into two pieces of approximately equal size. There is seldom evidence of a gradual leak at pinholes.

ANDREW THOMSON.

Apia Observatory, Apia, Samoa. January 10th, 1928.

Glazed Frost

In the January number of the *Meteorological Magazine*, Capt. C. K. M. Douglas raises the question as to whether a really severe ice storm has been recorded in this country. Two instances of severe glazed frost are recorded in the scarce pamphlet *Frostiana.* The first occurred in December, 1672, in the west of England, and is stated to have been accompanied with extensive damage to trees. One observer states, "I weighed the sprig of an ash tree, of just three-quarters of a pound, the ice of which weighed sixteen pounds." The second case was in February, 1809. The victims in this instance were over a hundred birds at Malling. A boy found them upon the ground

* Solar Hydrodynamics. By V. Bjerknes. Astro. J. Chicago, Ill. 64, 1926, pp. 93-121.

with their bodies completely glazed over with a coating of ice after a rain which froze upon falling. A buzzard hawk after a severe struggle succeeded in freeing himself from the ice and regained his freedom, but many of the rooks and larks perished.

In the *Natural History of Selborne*, Gilbert White alludes to this phenomenon under the name of Frozen Sleet. He refers to an occasion when many rooks, attempting to fly, fell from the trees with their wings frozen together by the sleet, that froze as it fell. He gives the date of this as January 20th, but does not state the year.

C. E. Britton.

New Ranges, Shoeburyness. February 7th, 1928.

Annual Variation of Cirrus Cloud

In the *Meteorological Magazine* for October, 1927, p. 215, Dr. J. R. Sutton gives results concerning the annual variation of cirrus cloud at Kimberley, South Africa, over a period 1900-1925; and in his Table I, which deals with those occasions when cirrus cloud of any kind was observed alone in the sky, he finds that there were definite maxima and minima in the year both with regard to frequency and to quantity.

With intent to find whether any similar conclusions hold for this area—Cranwell, Lincs—we have examined the Cranwell data for the eight years 1920-1927 along practically the same lines as used by Mr. Sutton in arriving at his Table I, but can find no trace of any definite monthly maxima or minima, either in frequency or in quantity. Although this is a negative result it is thought that its recording may not lack entirely in interest, even though the number of occurrences of cirrus cloud of any kind alone in the sky was not great at Cranwell in the relatively short period examined.

W. H. Pick.
G. A. Wright.

R.A.F. Cadet College, Cranwell, Lincolnshire. January 25th, 1928.

Notes on a Meteorological Phenomenon heard at Seskin, February 8th, 1928

A sound locally known as "wind in the mountains," was heard here all day. When first noticed before 8h. it sounded like the noise of a motor running, and distinct from the noise of the wind. It was persistent, unvarying except in the degree of loudness, and without anything like throbbing. In the afternoon its volume of sound was like that of the rush of a heavy train through a tunnel near by. (There is no railway tunnel within about twenty miles. It seemed to come from the

Comeragh mountains, a few miles to the south-west. One man who has lived in the district all his life had thought it was the noice of the Millvale stream, but as that is a slow flowing, shallow stream more than a mile away such an explanation does not seem likely.

Locally it is considered a presage of storm and rain. It was heard also about a fortnight ago for a short time we understand.

About 16½h. the SSW wind here was very light, the trees not moving but the sound was as described above, then suddenly a strong wind sprang up here which within two hours had reached force 8 or 9. The gale continued until after midnight but had lessened by 3h. Only 3.1 mm. fell of rain during the night. At 18½h. and possibly later the sound from the direction of the mountains could be heard apart from the noise of the gale.

On February 1st, 1923, a similar occurrence was reported to you from here, but then the noise was much louder and lasted for a much shorter period.*

L., G., and I. GRUBB.

Seskin, Carrick-on-Suir, Ireland. February 12th, 1928.

[Carrick-on-Suir is fifteen miles, as the crow flies from the coast and separated from it by ground rising in places to about 1,000 feet.—ED., *M.M.*]

Meteorological Facilities for the Public

I think it deserves to be more widely known what useful facilities for meteorological information are provided by the Borough of Hastings. On the Esplanade in a convenient position near the Pier there is a large instrument shelter, adapted from the Stevenson pattern, standing above a small bed of low shrubs. The shelter has glass windows on the north side and is divided into three compartments. In the centre is a barograph and the side compartments contain a hygrometer, and a set of standard maximum, minimum and dry thermometers respectively. The readings are posted up daily together with the records of rainfall and sunshine. It is obviously most convenient to be able to consult public instruments at any hour in this way, and it is to be hoped that the idea will be taken up by other towns which have a meteorological service. It was most gratifying to observe the interest shown by the public, for I constantly saw passers-by stopping to read the instruments, and indeed the pavement is visibly worn by this traffic! Besides being a convenience this display must do much to stimulate interest in the science and is all the more desirable on that account.

IVAN D. MARGARY.

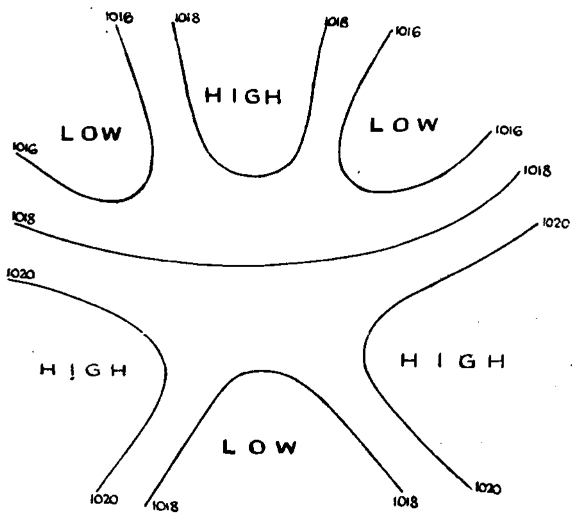
Chartham Park, East Grinstead. March 16th, 1928.

* See *Meteorological Magazine,* 58 (1923), p. 58.

NOTES AND QUERIES

An Unusual Pressure Distribution

A col or region where two highs and two lows meet is a well known and fairly common type of pressure distribution. It is equally possible to have three highs and three lows meeting, thus forming a sort of star-shaped col. Such a pressure distribution must be rare and has not been thought worthy of a distinctive name. The region surrounding the British Isles was occupied by a system of this type on the morning of March 5th, 1928.



Highs lay to the northward, south-westward and east-ward with a low between each pair of highs. The situation was complicated by the fact that pressure in the northern half of the system was somewhat lower than in the corresponding sections of the southern half as shown in the figure which gives a schematic representation of the pressure system. It will be seen that on the outer part of the system highs and lows alternated around the circumference, forming the star-shaped col. Near the centre the formation is somewhat different and perhaps the simplest way of looking at it is to regard the two 1020 isobars and the two 1018 isobars which comprise the southern part as forming a normal col, while the simple low which should occupy the 1018 isobar to the north is replaced by two lows separated by a high. The diagram is purely schematic, the isobars on the actual map being in the central region very contorted so that the tracing of them was not a simple matter, even to one used to this work.

J. S. Dines.

Brilliant Halo Phenomena

A very fine display of solar halo phenomena occurred during the afternoon of Saturday, February 25th, and was witnessed from many places in England. The halo of 22° was observed generally, and some observers saw also the halo of 46°. The two parhelia ("sun dogs" or "mock suns") which are associated with the points of intersection of the halo of 22° and the horizontal plane through the sun were striking features of the display. Many observers reported the occurrence of "an upper arc of contact" to the halo of 22°; this, however, took the form of a pair of horns converging at the highest part of the halo circle of 22°. Each horn was curved downward at its extremity where, according to two observers, it became merged in the circle of the halo of 46°. Mr. J. S. Dines estimated that the angle between the horns was 120° at 4.30 p.m., and that it steadily decreased until it became less than 90° after sunset. A few observers saw a "sun pillar" stretching vertically upwards from the sun, and in Devonshire and on the South Downs the circumzenithal arc passing horizontally through the sun was also observed.

R. CORLESS.

Exhibit at the Royal Institution

At the request of the Managers of the Royal Institution, the Director of the Meteorological Office arranged an exhibit of instruments, charts and diagrams at the Conversazione held on Friday, March 9th, when a discourse on "The Sun's Outer Atmosphere" was given by Professor Edward A. Milne, F.R.S., Beyer Professor of Applied Mathematics, University of Manchester.

The instruments exhibited were those in official use for the measurement of solar radiation, and included the Campbell-Stokes sunshine recorder, Mark II, the tropical pattern sunshine recorder, the Callendar radiation recorder (receiver), the Gorczynski solarimeter, the Michelson actinometer and the sky photometer, the last being a recently designed instrument for the estimation of the brightness of the sky during gloomy periods. Records obtained with the self-recording instruments were exhibited, and the three instruments last mentioned were demonstrated in use.

The charts and diagrams exhibited illustrated the wind structure research now being carried out at the Meteorological Office, Cardington. They included actual records obtained with quick-run clocks, diagrams illustrating some of the results so far obtained, and photographs of the apparatus used during the experiments.

Two synoptic charts illustrating the meteorological conditions associated with the snowstorm of December 26th, 1927, and the Thames flood of January 7th, 1928, were also shown.

A. H. NAGLE.

Meteorological Units

In a letter addressed to the Meteorological Office, M. Seletsky, who writes from Kiev, Union of Soviet Socialist Republics, out-lines certain proposals for the more consistent application of the decimal system in units, particularly as applied to meteorology.

For the unit of time, instead of dividing the day into 86,400 seconds, M. Seletsky proposes to divide it into 100,000 units. The new unit would be called the "tempe," and its multiples the "chrone" (1/100th part of the day), "decichrone" (1/1,000th part), &c. Since the unit of time enters into the specification of g a new pressure unit is involved. This unit (the "neobar") would not differ much from the present units, 750 neobars being equivalent to 753.6 millimetres of mercury, or to 1,004.7 millibars. For units of length, by subdividing the earth's entire circumference, instead of its quadrant (as in the original definition of the metre) a new series would be obtained approximately equal to 0.4 mm., 4 mm., &c. For temperature, it is proposed to adopt a scale on which the "absolute zero"—taken as − 273.4° C.—is the zero and the ice-point is taken as 350°. Thus one centigrade degree would be equivalent to 1.28 new degrees, 300 on the new scale would be approximately the freezing point of mercury, and 400 equivalent to 102° F. On this scale most published values of temperature would fall between 300 and 400 and the initial 3 could be discarded in printing.

All suggestions towards getting uniformity and consistency in scientific matters are interesting; but we feel that even if the inconveniences of the present units were greater than they are, the practical difficulties of making the changes proposed would be insuperable.

Rainfall, run-off and evaporation

Although observations of run-off are made for a number of catchment areas in this country, few comparisons with rainfall measurements have been published. A recent paper* is, therefore, of particular interest. It deals with records covering 15 to 20 years for 11 areas in the southern half of Sweden. The areas concerned lie roughly between the latitudes of Edinburgh and the Shetlands, and vary in size from 50 to 1,100 thousand acres. The annual general rainfall varies from 22 to 35 in. The difference between the measured rainfall and run-off gives the evaporation, and for the whole period the mean annual amounts for the areas vary between 13 and 15 in. This is a very satisfactory agreement, and the mean value of 14 in. for the evaporation is in striking accord with the value frequently adopted in water supply schemes in this country.

In considering the seasonal evaporation attention has had to be directed also to the amount of snow in the area, to the

*WALLÉN AXEL. Eau tombée, débit et évaporation dans la Suède méridionale. *Geog. Ann. Stockholm*, 9, 1927, pp. 181—208.

changes in the levels of the lakes and to the amount of water stored in the ground. The distribution of the rainfall and run-off is discussed in detail for one typical area. In Sweden October is relatively dry and the time of most evaporation is rather later than in the British Isles. According to the evaporation the most natural division of the year is into the two parts, the five months June to October, when the run-off is small, and the seven months November to May with a large run-off. The net monthly loss from the area is greatest in May and June (that in May being comparable with that of June owing to the smaller rainfall). In June and July the evaporation exceeds the actual rainfall. November is the month of greatest net gain (especially as storage in the lakes), since in the preceding months the rainfall is smaller and in the following months the run-off is greater. There is a gradual change in the monthly values for the storage between these two extremes.

The marked relation between the annual values of rainfall and run-off is demonstrated by "dot diagrams" for each area, the values of run-off being corrected for the amounts stored in the lakes. This relationship has been demonstrated in this country for the Exe Valley.* The correlation coefficients for the 11 areas vary from + 0.98 to + 0.95 and regression equations are given connecting the rainfall and run-off. Using the mean annual values for the areas the correlation coefficient is + 0.996 and the regression equation $D=1.06P—15.8$ where D and P are run-off and rainfall in inches respectively, which corresponds to a nearly constant evaporation for all values of rainfall. From each equation a value is calculated for the annual rainfall which would give no run-off. This "limit of dryness" is reached with an annual rainfall of 14—15 in. Such a small rainfall would be a most unusual occurrence, either in Sweden or in this country.

The mean rainfall and run-off is considered separately for the summer and winter periods, due allowances being made for storage in the lakes and soil and as snow during the winter. It is estimated that there is 10 in. of evaporation during the five summer months, *i.e.*, 70 per cent. of the total annual amount. For seven selected areas the individual values are given for the summer months not only for the rainfall, run-off and calculated evaporation, but for the calculated amounts stored in the lakes and the soil, both as means for the whole period and for dry and wet years separately. It is found that while the rainfall, run-off and amounts stored in the lakes and in the soil vary considerably from dry to wet summers the evaporation is nearly constant. The conclusion is also arrived at that if the rainfall of the summer

* The Investigation of Rivers. Final Report. By A. Strahan, N. F. Mackenzie, H. R. Mill and J. S. Owens, published by the Royal Geographical Society, London.

five months in the southern half of Sweden does not exceed 9 in., there is some risk of the cessation of the flow of certain lakes and from small catchment areas, while the larger areas will also be without run-off if in addition the reserves have been used up by the end of May.

It is stated that the largest error arises in the measurement of snow. Comparisons between the fall of snow as computed from rain-gauge readings and the subsequent run-off suggest that on the average the former measurements are about 10 per cent. too small. In the catchment areas under consideration less than one-quarter of the total precipitation occurs in the form of snow leading to a probable annual error of from 1 in. to 0.5 in. It is suggested that the net errors are not large, but that the rainfall and therefore the evaporation have been under-estimated rather than over-estimated.

The annual values for evaporation are more uniform than is generally the case; while this is in part due to the greater precision with which the evaporation has been determined, it is also probably connected with the occurrence in each area of lakes of considerable size, the extent varying from 4 to 16 per cent. of the whole catchment area. In areas devoid of large water surfaces the evaporation is usually found to be less in dry years, while the evaporation from a free water surface is greater. Since the average rainfall is small these areas have a natural advantage for the determination of evaporation. In a recent investigation* dealing with the area drained by the River Garry in the Western Highlands of Scotland the rainfall was nearly four times greater, so that there was in that case a much greater risk of error in determining the rainfall and therefore also the evaporation.

In the case of the Thames Valley above Teddington the loss has varied from 15 to 22 in. with a mean of 19 in. during the last 20 seasonal years. All the loss is not, however, evaporation, since there is in addition the percolation into the chalk giving the artesian supply in London itself.

It is unfortunate that the evaporation of any catchment area can only be measured by indirect methods. In this paper the factors on which the correct determination of this amount depend seem to have been evaluated with greater precision than is usually possible.

J. GLASSPOOLE.

Das Wetter

Our well-known contemporary *Das Wetter* celebrates the first number of its 45th annual volume by a number of changes. It

* Rainfall and flow-off, River Garry, Inverness-shire. By W. N. McClean, *Water and Water Engin., London.* 29, 1927, pp. 475—486.

is recalled that the magazine was founded by R. Assmann in 1882 under the title *Monatschrift für praktische Witterungskunde*, which was changed to *Das Wetter* in 1884. Throughout its whole history however *Das Wetter* has devoted considerable space to the practical applications of meteorology, and with the development of flying, and the growth of borderland sciences such as agricultural meteorology, these practical aspects have come to take the chief place in its pages. The title has accordingly been changed to *Zeitschrift für Angewandte Meteorologie: Das Wetter*. The number of pages in each number has been increased; a still more welcome change is from Gothic type to Roman.

Reviews

The Energy of the Winds. By V. H. Ryd, Copenhagen, Danske Meteor. Inst. Medd. 7. Meteorological Problems No. 2. Size 10 × 7 in., pp. 96. *Illus.* Copenhagen, 1927.

This paper is to some extent a continuation of an earlier paper on the *Travelling Cyclone*, by the same author. In it he discusses the possible sources from which the winds derive their kinetic energy. The paper has rather the appearance of a small text-book than of an original paper. It begins by discussing the thermodynamical equations, and gives a very large number of transformations of these equations. The equations are also given in a collected form in Appendix I, where they number 34. To the students of meteorology the reading of the paper may be recommended as a useful exercise in the algebra of thermodynamics, apart from the theoretical discussion of its main theme.

In the preface the author enumerates four sources from which, according to earlier writers, the energy of winds may be derived:—

(a) Potential energy due to gravity.
(b) Potential energy of the horizontal pressure distribution.
(c) Direct transformation into kinetic energy of the heat received from the sun.
(d) Latent heat of water-vapour set free by condensation.

In his subsequent discussion the author states that the first of these is the only important source. In discussing the second, he enumerates the types of energy of air, and shows that, by including internal energy, gravitational potential energy, and kinetic energy, he has taken into account all the forms of energy which need be considered.* It is in any case difficult to see how any potential energy which might be associated with a pressure distribution could be con-

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* cf. The supply of energy from and to atmospheric eddies. By L. F. Richardson, *London, Proc. R. Soc. A.*, 97, 1920, pp. 354—73.

verted into kinetic energy of winds, since strong winds and strong pressure gradients occur simultaneously, and as the pressure gradients die away, so do the winds. We do not find pressure gradients disappearing and being replaced by strong winds. With regard to the direct transformation of solar radiation into kinetic energy, there is no evidence that this takes place in the atmosphere, the transformation of the energy of solar radiation being first into gravitational potential energy, which in turn may be transformed into kinetic energy. The author does not give any consideration to the effect of latent heat of water vapour set free by condensation, though the importance of this factor, in conjunction with gravitational potential energy, is obviously of great importance in the atmosphere.

In the course of the paper, it is emphasised that if a cyclone is to be formed by the removal of air vertically, the rising air must be removed horizontally by a strong wind in the upper layers. The author regards the westerly winds which occur in the upper air, in accordance with the observed horizontal gradients of temperature in the atmosphere, as the effective agents for removal of the superfluous air. But at a later stage he appears to regard the existence of the strong upper currents as sufficient for the establishment of a cyclone by convection.

The final chapter deals with the origin and development of cyclones. Here the author assumes that the effect of strong winds, generated in regions where the horizontal temperature gradients are intense, blowing into regions where the horizontal temperature gradients are slighter, would be to cause the air to be displaced towards high pressure, on account of the pressure gradient being insufficient to balance the deviating force. The result would be to give a small cyclonic centre in the upper air. The author's discussion of the mode of growth of the cyclonic circulation down to the ground is obscure. The present reviewer has not been able to satisfy himself that the existence of strong upper winds, together with a small cyclonic centre in the upper air, will by the action mentioned in the last paragraph produce the depression of middle latitudes as we know it.

There are three appendices to the paper, the first being a collection of 34 equations derived in the course of the paper, the second giving a brief discussion of the relation of work to energy, and the third giving some general remarks on theories of the origin of cyclones.

While the reviewer is not able to agree with all the arguments of the author, he feels that much credit is due to the latter for his endeavour to discuss questions which are seldom discussed in detail.

D. BRUNT.

El Observatorio del Ebro: Idea general sobre el mismo. By P. Ignacio Puig, S.J. Size 9¾ × 6¾, pp. viii + 188, *Illus.* Tortosa, Impr. de Algueró y Baiges 1927. 5 pesetas.

Founded, in 1904, for the study of the effects of solar activity in terrestrial phenomena, the Observatory of the Ebro has fully justified the confidence in its usefulness expressed at the time by eminent meteorologists. The work of the Observatory has expanded progressively, and now embraces all branches of cosmical physics, including seismology, meteorology, terrestrial magnetism and solar physics.

The object of the author of this book, who is Assistant Director of the Observatory, is to give a general account of its work. Besides dealing with the aims and general history of the Institution, he discusses in detail the work of each department, describing the main characteristics of the phenomena observed, the apparatus employed and the results obtained. The book is fully illustrated with photographs and diagrams of buildings and apparatus and reproductions of records. The author has included information hitherto scattered among a number of publications, and the book enables the reader to form a very complete picture of the activities of the Observatory; it is, at the same time, a useful handbook of meteorological information. The production of the book is pleasing, the print being clear and the illustrations, on the whole, very good.

British observers note with pleasure the progress that meteorology is making in Spain, and the author is to be congratulated on producing a book that will assist this progress by making more widely known and understood the valuable work that is being done at the Observatory of the Ebro.

A. H. NAGLE.

Obituary

We regret to learn of the death on February 21st, 1928, at the age of 54, of Professor W. T. Askinazy, Chief of the Section of the Monthly Bulletin of the Central Geophysical Observatory, Leningrad, and Member of the International Commission for Agricultural Meteorology.

The Weather of March, 1928

The weather of March was mainly rather mild and unsettled with a cold wintry spell from about the 7th to 14th. During the first few days pressure was low to the north-west and south-west of the British Isles and the weather unsettled with rain in the north on the 1st, when 0.91 in. fell at Aberdeen, but much sunshine locally at times. On the 4th though the weather was still cloudy in Scotland, the day was brilliantly fine and warm in most of England and Ireland and temperature was abnormally high for the time of year, 68° F. was reached at Greenwich, 64°-67° F. at other London stations and 65° F. at Cambridge, Oxford and Tottenham. Sunshine values of between 9 and 10 hrs. were recorded at some stations in the south. Subsequently high pressure became established over Iceland and Scandinavia with a wedge of high pressure extending southward over the British Isles. Cold air from north Russia flowed over the country and temperature fell considerably. At Kew a record low maximum for the time of year, 32° F., was recorded on the 11th just a week after the record high temperature. Screen minima of 20° F. and below were registered at many places; at Rhayader the screen minimum was as low as 11° F. on the 13th and the grass minimum 7° F. on the 14th. Snow and sleet fell generally from the 8th to 14th. On the evening of the 10th-11th snow occurred as far south and west as the Scilly Isles and Roches Point and on the 12th, 1in. of snow was lying at Guernsey. On the 12th also, "snow lying" to a depth of 8 in. was recorded at Margate, 6 in. at Durham, 5 in. at Glasgow and 3in. at many other places. Bright sunshine was experienced during this period for several hours each day, the outstanding records being 10.3 hrs. at Tiree on the 9th and at Scilly Isles on the 10th. On the 14th there was a change to southerly winds and mild unsettled conditions became established, with much rain on the 18th-20th in the west and north, *e.g.*, 2.05 in. at Fofanny (Down) on the 18th and 1.59 in. at Tynywaun (Glamorgan) on the 19th, and strong southerly winds and gales in the north on the 19th-21st, force 9 (49 m.p.h.) being recorded at Lerwick and Wick on the 21st. A complex low-pressure system remained over or to the west of the British Isles until the 31st. On the 29th a depression off north-west Ireland deepened considerably as it moved eastwards causing high winds and gales in all dističts, force 9 in the extreme north. Much rain also fell, among the heaviest falls being 2.41 in. at Borrowdale and 1.93 in. at Tynywaun (Glamorgan) on the 29th. The 26th and the 28th were the sunniest days of this part of the month, over 10 hrs. being recorded in the south on the 26th and at Inverness on the 28th. The total sunshine for the month was below normal in most districts, the total of 47 hrs. at Aberdeen being 70 hrs. below normal, that of 93 hrs. at Kew being 12 hrs. below normal, while Dublin, Falmouth and Valentia were 31 hrs., 24 hrs. and 18 hrs. below normal respectively.

Pressure was above normal over Scandinavia, Germany, Spitsbergen, Iceland and Bermuda, the greatest excess being 11.3 mb. at Stockholm and below normal over most of the British Isles, south-west Europe, the Azores and Newfoundland, the largest deficit being 8 mb. in about 50° N. 30° W. Except for south Sweden temperature was above normal over western Europe the excess reaching nearly 6° F. at Spitsbergen and northern Norway. Precipitation was above normal at Spitsbergen but below normal over most of western Europe being only a quarter of the normal in south Sweden.

Storms swept over Portugal during the first days of the month, causing serious damage to agriculture, and on the 7th forest fires occurred in Switzerland owing to the drought which had prevailed there since the middle of February. After a fortnight of abnormally fine weather heavy snow fell in Berlin on the 9th and the cold weather extended to Switzerland on the 10th. Snow fell on the mountains down to 3,000 ft. and also on the 11th in the low valleys. These cold conditions prevailed in central Europe until about the 21st and much damage was done to the crops in Austria. Snow fell at Turin, Milan, Bologna and Trieste on the 21st, but on the same day in Switzerland a strong föhn wind caused the snow to melt rapidly causing floods in the Rhône Valley. A quantity of fruit trees also died in the flooded areas of the Principality of Liechtenstein. A gale in northern Germany on the 21st caused the loss of ten lives in an accident to the mine at Liebenwerda. Slight floods were reported from Brittany on the 26th and gales occurred in western France on the 25th, on the Cantabrian coast of Spain and south coast of France on the 29th and 30th, and over the Swiss Alps on the 31st where they were accompanied by much rain.

Heavy snowstorms were reported from the Lebanon on the 6th. A hurricane accompanied by blinding rain swept the Pacific coast of Japan on the 11th and wrecked five Japanese steamers.

A disastrous landslide partly caused by heavy rains occurred at Santos (Brazil) on the 11th, and it is estimated that 150 people were killed. Four hundred people were drowned by the bursting of the dam of the St.Francis reservoir, 45 miles north of Los Angeles on the 13th. It is believed to be due to the accumulation of silt washed down by the recent heavy rain. Five rivers in California and Neveda, fed by the melting snows of the Sierras, overflowed their banks on the 26th causing much damage, and, owing to an ice block on the Saskatchewan river, serious floods occurred in the Pike Lake district on the 30th.

The special message from Brazil states that the rainfall in the northern and southern regions was abundant with 2.5 in. and 1.4 in. above normal respectively but scanty in the central regions with 0.8 in. below normal. Six anticyclones passed across the country and many gales were experienced in the south. The crops generally were doing well. At Rio de Janeiro pressure was 0.8 mb. below normal and temperature 1.6° F. above normal.

Rainfall, March, 1928—General Distribution

England and Wales ...	118	per cent. of the average 1881-1915.
Scotland	125	
Ireland	153	
British Isles	127	

Rainfall: March, 1928: England and Wales

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond.	Camden Square	1·39	76	*Leics.*	Thornton Reservoir	1·86	101
Sur.	Reigate, The Knowle	2·18	99	,,	Belvoir Castle	1·19	66
Kent	Tenterden, Ashenden	1·86	87	*Rut*	Ridlington	1·97	...
,,	Folkestone, Boro. San.	1·56	...	*Linc*	Boston, Skirbeck	1·94	124
,,	Margate, Cliftonville	1·74	109	,,	Lincoln, Sessions House	1·66	107
,,	Sevenoaks, Speldhurst	1·96	...	,,	Skegness, Marine Gdns	1·26	76
Sus	Patching Farm	2·71	126	,,	Louth, Westgate	1·66	78
,,	Brighton, Old Steyne	2·85	141	,,	Brigg, Wrawby St.	2·26	...
,,	Tottingworth Park	2·54	102	*Notts*	Worksop, Hodsock	1·85	110
Hants	Ventnor, Roy. Nat. Hos.	2·47	120	*Derby*	Derby	1·70	99
,,	Fordingbridge, Oaklnds	2·90	124	,,	Buxton, Devon Hos.	...	...
,,	Ovington Rectory	3·56	137	*Ches*	Runcorn, Western Pt.	1·80	89
,,	Sherborne St. John	2·28	102	,,	Nantwich, Dorfold Hall	1·81	...
Berks	Wellington College	1·61	81	*Lancs*	Manchester, Whit. Pk.	1·76	78
,,	Newbury, Greenham	2·96	130	,,	Stonyhurst College	2·59	70
Herts	Benington House	1·79	99	,,	Southport, Hesketh Pk	2·02	91
Bucks	High Wycombe	2·21	113	,,	Lancaster, Strathspey	3·40	...
Oxf.	Oxford, Mag. College	1·66	109	*Yorks*	Wath-upon-Dearne	2·84	163
Nor	Pitsford, Sedgebrook	1·63	93	,,	Bradford, Lister Pk.	3·43	141
,,	Oundle	1·08	...	,,	Oughtershaw Hall	6·40	...
Beds	Woburn, Crawley Mill	1·56	91	,,	Wetherby, Ribston H.	2·59	133
Cam	Cambridge, Bot. Gdns.	1·08	136	,,	Hull, Pearson Park	2·97	163
Essex	Chelmsford, CountyLab	2·14	124	,,	Holme-on-Spalding	2·34	...
,,	Lexden, Hill House	2·84	...	,,	West Witton, Ivy Ho.	4·51	...
Suff	Hawkedon Rectory	1·97	104	,,	Felixkirk, Mt. St. John	2·70	137
,,	Haughley House	1·95	...	,,	Pickering, Hungate	2·92	...
Norf	Beccles, Geldeston	1·24	72	,,	Scarborough	2·85	158
,,	Norwich, Eaton	1·68	88	,,	Middlesbrough	2·12	135
,,	Blakeney	1·56	95	,,	Baldersdale, Hury Res.	2·62	...
,,	Little Dunham	1·87	98	*Durh*	Ushaw College	3·00	136
Wilts	Devizes, Highclere	2·10	100	*Nor*	Newcastle, Town Moor	2·54	120
,,	Bishops Cannings	2·22	99	,,	Bellingham. Highgreen	4·50	...
Dor	Eversholt, MelburyHo.	3·87	129	,,	Lilburn Tower Gdns.	3·81	...
,,	Creech Grange	3·54	...	*Cumb*	Geltsdale	3·26	...
,,	Shaftesbury, Abbey Ho.	2·23	95	,,	Carlisle, Scaleby Hall	2·65	108
Devon	Plymouth, The Hoe	4·72	162	,,	Borrowdale, Rosthwaite	9·45	...
,,	Polapit Tamar	4·72	158	,,	Keswick, High Hill	4·48	...
,,	Ashburton, Druid Ho.	6·35	142	*Glam*	Cardiff, Ely P. Stn.	4·59	143
,,	Cullompton	3·75	137	,,	Treherbert, Tynywaun	9·10	...
,,	Sidmouth, Sidmount	3·07	126	*Carm*	Carmarthen Priory	4·17	110
,,	Filleigh, Castle Hill	3·87	...	,,	Llanwrda, Dolaeothy	4·80	104
,,	Barnstaple. N. Dev. Ath.	3·67	140	*Pemb*	Haverfordwest, School	5·85	171
Corn	Redruth, Trewirgie	7·51	208	*Card*	Gogerddan	2·45	71
,,	Penzance, Morrab Gdn.	5·60	175	,,	Cardigan, County Sch.	3·68	...
,,	St. Austell, Trevarna	7·28	212	*Brec*	Crickhowell, Talymaes	4·80	...
Soms	Chewton Mendip	4·57	128	*Rad*	BirmW.W.Tyrmynydd	4·54	85
,,	Street, Hind Hayes	2·59	...	*Mont*	Lake Vyrnwy	4·08	95
Glos.	Clifton College	...	...	*Denb*	Llangynhafal	1·60	...
,,	Cirencester, Gwynfa	3·00	130	*Mer*	Dolgelly, Bryntirion	2·80	57
Here	Ross, Birchlea	4·10	202	*Carn*	Llandudno	1·63	75
,,	Ledbury, Underdown	3·67	193	,,	Snowdon, L. Llydaw 9	10·90	...
Salop	Church Stretton	3·32	141	*Ang*	Holyhead, Salt Island	2·88	110
,,	Shifnal, Hatton Grange	1·39	76	,,	Lligwy	2·68	...
Worc	Ombersley, Holt Lock	2·10	123	*Isle of Man*			
,,	Blockley, Upton Wold	2·65	123		Douglas, Boro' Cem.	4·11	139
War	Farnborough	2·47	117	*Guernsey*			
,,	Birminghm, Edgbaston	2·27	119		St. PeterP't. GrangeRd.	3·53	143

Rainfall : March, 1928 : Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, ArdwellHo	4·73	182	*Suth* .	Loch More, Achfary ...	3·66	57
,, .	Pt. William, Monreith	5·44	...	*Caith* .	Wick	1·69	74
Kirk .	Carsphairn, Shiel.	8·35	...	*Ork* .	Pomona, Deerness	2·35	84
,, .	Dumfries, Cargen	5·96	165	*Shet* .	Lerwick	2·38	76
Dumf.	Eskdalemuir Obs.	6·71	137	*Cork* .	Caheragh Rectory	6·06	...
Roxb .	Branxholm	4·49	155	,, .	Dunmanway Rectory...	6·79	138
Selk .	Ettrick Manse	7·06	...	,, .	Ballinacurra	5·91	208
Peeb .	Castlecraig	...	...	,, .	Glanmire, Lota Lo. ...	7·80	252
Berk .	Marchmont House......	4·12	155	*Kerry*.	Valentia Obsy.	5·40	119
Hadd.	North Berwick Res. ...	1·78	95	,, .	Gearahameen	8·70	...
Midl .	Edinburgh, Roy. Obs.	1·48	83	,, .	Killarney Asylum	5·31	113
Ayr .	Kilmarnock, Agric. C.	2·04	73	,, .	Darrynane Abbey	5·73	140
,, .	Girvan, Pinmore	5·86	156	*Wat* .	Waterford, Brook Lo...	5·69	207
Renf .	Glasgow, Queen's Pk. .	2·87	110	*Tip* .	Nenagh, Cas. Lough...	4·10	133
,, .	Greenock, Prospect H.	5·58	113	,, .	Roscrea, Timoney Park	3·78	...
Bute .	Rothesay, Ardencraig.	5·37	150	,, .	Cashel, Ballinamona...	4·46	162
,, .	Dougarie Lodge	4·86	...	*Lim* .	Foynes, Coolnanes......	3·07	104
Arg .	Ardgour House	5·84	...	,, .	Castleconnel Rec.	3·41	...
,, .	Manse of Glenorchy ...	6·72	...	*Clare* .	Inagh, Mount Callan...	4·69	...
,, .	Oban	3·52	...	,, .	Broadford, Hurdlest'n.	3·16	...
,, .	Poltalloch	5·84	152	*Wexf* .	Newtownbarry	8·29	...
,, .	Inveraray Castle...	4·82	76	,, .	Gorey, Courtown Ho ..	8·56	370
,, .	Islay, Eallabus	5·03	132	*Kilk* .	Kilkenny Castle.........	4·38	192
,, .	Mull, Benmore	10·30	...	*Wic* .	Rathnew, Clonmannon	7·83	...
,, .	Tiree	...	...	*Carl* .	Hacketstown Rectory..	7·69	275
Kinr .	Loch Leven Sluice......	3·15	105	*QCo* .	Blandsfort House	4·82	184
Perth .	Loch Dhu	11·70	177	,, .	Mountmellick...........	4·03	...
,, .	Balquhidder, Stronvar	7·01	...	*KCo* .	Birr Castle	3·24	135
,, .	Crieff,Strathearn Hyd.	6·39	200	*Dubl* .	Dublin, FitzWm. Sq...	3·99	206
,, .	Blair Castle Gardens ...	6·16	235	,, .	Balbriggan, Ardgillan.	4·18	208
Forf .	Kettins School	5 56	253	*Me'th* .	Beaupare, St. Cloud...	3 78	...
,, .	Dundee, E. Necropolis	4·67	226	,, .	Kells, Headfort	3·96	144
,, .	Pearsie House...........	6·23	...	*W.M* .	Moate, Coolatore	2·97	...
,, .	Montrose, Sunnyside...	3·99	192	,, .	Mullingar, Belvedere..	3·06	103
Aber .	Braemar, Bank	4·93	165	*Long* .	Castle Forbes Gdns......	3·36	114
,, .	Logie Coldstone Sch....	3·06	118	*Gal* .	Ballynahinch Castle ...	4·48	87
,, .	Aberdeen, King's Coll.	3·57	148	,, .	Galway, Grammar Sch.	3·72	...
,, .	Fyvie Castle	3·01	...	*Mayo* .	Mallaranny...............	3·31	...
Mor .	Gordon Castle	1·66	72	,, .	Westport House.........	3·46	89
,, .	Grantown-on-Spey ...	1·68	64	,, .	Delphi Lodge............	6·81	...
Na .	Nairn, Delnies	1·57	84	*Sligo* .	Markree Obsy............	3·57	103
Inv .	Ben Alder Lodge	...	...	*Cav'n* .	Belturbet, Cloverhill...	3·20	116
,, .	Kingussie, The Birches	2·18	...	*Ferm* .	Enniskillen, Portora...	2·81	...
,, .	Loch Quoich, Loan ...	18·00	...	*Arm* .	Armagh Obsy............	3·17	135
,, .	Glenquoich	8·83	91	*Down* .	Fofanny Reservoir......	14·62	...
,, .	Inverness, Culduthel R.	2·45	...	,, .	Seaforde	6·56	225
,, .	Arisaig, Faire-na-Squir	3·86	...	,, .	Donaghadee, C. Stn ...	4·44	202
,, .	Fort William	6·03	88	,, .	Banbridge, Milltown...	3·31	151
,, .	Skye, Dunvegan	5·57	...	*Antr* .	Belfast, Cavehill Rd ...	3·65	...
R & C.	Alness, Ardross Cas. ...	3·89	119	,, .	Glenarm Castle	5·90	...
,, .	Ullapool	2·80	...	,, .	Ballymena, Harryville	4·22	134
,, .	Torridon, Bendamph...	5·73	76	*Lon* .	Londonderry, Creggan	3·41	107
,, .	Achnashellach	4·16	...	*Tyr* .	Donaghmore	3·95	...
,, .	Stornoway	3·48	85	,, .	Omagh, Edenfel.........	3·62	115
Suth .	Lairg	2·53	...	*Don* .	Malin Head..............	2·32	100
,, .	Tongue	2·71	81	,, .	Dunfanaghy	2·57	70
,, .	Melvich	1·92	67	,, .	Killybegs, Rockmount.	3·43	67

Climatological Table for the British Empire, October, 1927.

STATIONS	PRESSURE		TEMPERATURE								Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean								
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb				Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	° F.	° F	° F.	° F.	° F.	° F.	° F.	%	0—10	in.	in.				
London, Kew Obsy.	1017·8	+ 3·8	64	34	57·4	44·6	51·0	+ 1·1	46·9	94	8·4	1·27	− 1·43	11	2·3	21
Gibraltar	1016·3	− 0·9	78	58	71·9	62·6	67·3	+ 1·2	61·9	86	6·6	3·48	+ 0·17	12	..	..
Malta	1016·5	− 0·1	82	58	72·8	64·5	68·7	− 2·2	64·9	86	5·1	0·35	− 2·52	6	7·1	63
St. Helena	1014·6	+ 2·3	64	53	60·3	54·3	57·3	− 1·5	55·2	94	9·7	1·56	− 0·35	17	..	..
Sierra Leone	1012·1	+ 0·5	91	69	86·6	72·1	79·3	− 0·8	75·7	83	6·5	12·63	+ 0·01	25	..	..
Lagos, Nigeria	1012·0	+ 0·3	86	70	84·7	74·2	79·5	0·0	75·6	83	3·8	13·33	+ 5·57	22	..	..
Kaduna, Nigeria	1015·0	+ 2·7	90	58	87·2	62·1	74·7	− 1·6	72·2	78	1·7	5·93	+ 3·75	17	..	..
Zomba, Nyasaland	1011·1	+ 0·2	90	56	85·1	62·4	73·7	− 0·4	..	83	3·3	0·26	− 1·26	5	..	..
Salisbury, Rhodesia	1010·7	− 0·4	89	53	82·8	58·0	70·4	− 0·3	60·7	54	3·3	2·26	+ 1·12	8	8·5	68
Cape Town	1018·4	+ 1·0	88	47	72·1	54·8	63·5	+ 2·3	56·6	73	3·7	0·77	− 0·87	7	..	..
Johannesburg	1014·8	+ 0·7	87	43	73·1	53·3	63·2	+ 0·5	52·5	54	3·8	4·68	+ 2·12	9	6·6	52
Mauritius	1019·3	+ 1·1	83	57	78·8	64·0	71·4	− 1·3	67·5	64	5·5	1·49	+ 0·11	14	9·3	74
Bloemfontein	..	..	91	44	81·1	52·7	66·9	+ 2·3	56·0	58	4·3	1·23	− 0·45	4	..	..
Calcutta, Alipore Obsy.	1009·6	+ 0·2	92	69	89·8	75·3	82·5	+ 1·8	76·2	86	3·1	2·92	− 1·27	4*	..	..
Bombay	1010·6	+ 0·8	93	75	87·6	77·8	82·7	+ 0·4	76·5	85	3·6	7·30	+ 5·63	7*	..	..
Madras	1010·0	+ 1·1	96	72	91·6	76·5	84·1	+ 1·8	76·6	77	5·5	2·46	− 9·26	7*	..	...
Colombo, Ceylon	1011·8	+ 1.5	89	71	86·9	74·6	80·7	+ 0·4	77·4	73	6·6	10·12	− 3·00	19	8·2	68
Hongkong	1014·6	+ 1·0	88	60	79·6	70·9	75·3	− 1·6	69·0	71	4·2	5·42	+ 0·57	7	7·5	65
Sandakan	..	..	91	73	88·6	74·9	81·7	+ 0·2	77·0	84	..	12·49	+ 2·49	16	..	..
Sydney	1017·9	+ 3·0	98	42	72·2	55·7	63·9	+ 0·4	58·3	61	5·1	3·48	+ 0·27	17	6·9	55
Melbourne	1017·7	+ 3·0	92	38	70·4	50·4	60·4	+ 2·8	54·0	58	5·8	2·45	− 0·14	10	5·9	45
Adelaide	1017·9	+ 1·9	91	43	75·1	52·6	63·9	+ 2·0	54·2	42	5·6	0·48	− 1·26	5	7·7	60
Perth, W. Australia	1017·6	+ 0·8	86	45	71·3	53·5	62·4	+ 1·4	56·9	61	5·1	2·67	+ 0·49	13	8·3	65
Coolgardie	1015·6	+ 0·4	90	43	78·4	50·8	64·6	+ 1·0	54·1	43	3·9	0·12	− 0·62	1	..	..
Brisbane	1019·5	+ 3·3	83	51	76·3	59·2	67·7	− 2·1	62·6	64	5·4	7·15	+ 4·58	12	8·6	68
Hobart, Tasmania	1014·5	+ 3·9	80	37	63·7	46·4	55·1	+ 1·1	48·2	57	6·7	1·43	− 0·83	17	7·2	55
Wellington, N.Z.	1016·1	+ 3·0	71	38	62·2	49·6	55·9	+ 1·6	52·2	67	5·4	1·92	− 2·16	8	6·7	51
Suva, Fiji	1013·2	0·0	87	67	81·4	71·7	76.5	+ 0·5	73·0	82	8·0	17·93	+ 10·13	22	3·5	28
Apia, Samoa	1012·1	+ 0·6	87	73	85·1	75·1	80·1	+ 1·7	77·4	77	5·6	12·90	+ 6·84	18	6·9	56
Kingston, Jamaica	1010·6	− 0·9	92	71	87·3	73·2	80·3	− 0·2	73·1	89	5·8	10·56	+ 3·10	17	6·1	52
Grenada, W.I.	1007·1	− 3·5	92	70	87·4	76·4	81·9	+ 1·8	77·6	79	5·2	10·00	+ 2·35	19	..	..
Toronto	1015·3	− 2·7	77	35	61·2	44·8	53·0	+ 6·1	46·2	83	5·2	2·19	− 0·27	11	5·7	51
Winnipeg	1013·2	− 2·1	75	29	54·6	37·2	45·9	+ 5·1	38·1	87	5·8	3·17	+ 1·74	9	3·7	34
St. John, N.B.	1012·9	− 3·6	72	29	55·3	44·0	49·7	+ 4·4	47·2	86	6·7	5·01	+ 0·47	15	...	..
Victoria, B.C.	1015·8	− 1·8	64	38	55·5	46·2	50·9	+ 0·5	48·5	86	8·1	4·74	+ 2·19	19	3·6	33

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.