M.O. 403.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 71

Mar. 1936

No. 842

LONDON: PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses: Adastral House, Kingsway, London, W.C.2; 120 George Street, Edinburgh 2; York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff; 80 Chichester Street, Belfast; or through any Bookseller.

Measurements of Solar Radiation. Instruments and Some Results

By Ladislas Gorczynski, D.Sc.

(*Member of the International Commission of Solar Radiation*)

Part II

Some results of solarimetric measurements.—As found from direct readings on sufficiently clear days and permanent solarigraphic registrations in all weather conditions, the intensity of diffuse radiation shows, with a cloudless sky, regular diurnal and seasonal variations depending on the altitude of the sun above the horizon. It is important to state that the values of diffuse radiation at the Riviera are very similar to those obtained in other regions for the same cloud and weather conditions. I note here particularly the important paper by W. H. Dines "Observations on radiation from the sky" (*Geophysical Memoirs No.* 18, *Meteorological Office, London,* 1921), where it is stated that, in Great Britain, dense and heavy cloud sheets supply about the same diffuse solar radiation as a clear sky does; on the other hand, broken clouds showing much white, reflect the most radiation.

The following data show the variations of the intensity of diffuse sky radiation (in gr. cal. min. cm^2), with the sun's altitude, at Nice, France and Warsaw, Poland.

Sun's Altitude	45°	30°	15°	5°
Clear days, Nice	0·14	0·12	0·09	..
Clear days, Warsaw	0·17	0·12	0·08	0·07
Half covered sky (Warsaw)	0·28	0·19	0·11	0·05
Overcast sky (Warsaw)	..	0·13	0·07	0·04

The changing amount and kind of clouds and veils cause very important differences in the values of diffuse sky radiation. I cannot enter here into details*, but I mention the following general conclusions obtained from comparisons between the values calculated by solarimeter method with the corresponding duration of bright sunshine.

The chief result is that the increase of daily totals of diffuse sky radiation is by no means directly proportional to the sunshine duration. From a certain initial value with a completely covered sky during the whole day (duration 0·0), the amount of the diffuse radiation begins to increase very rapidly owing to intermittent appearances of the sun. The highest daily amounts of sky radiation were observed at the Riviera for a sunshine duration from 2 (in winter) to 4 hours (in summer) during the whole day, which corresponds nearly to a quarter of the possible sunshine duration in these seasons. The maxima are frequently more than twice as great as corresponding amounts obtained with overcast or perfectly clear days, as may be seen from the following example, where the sunshine duration of 0·0 hours corresponds to completely overcast days with dense clouds and 0 to overcast days with some clear intervals.

Example :

Duration of insolation in hours

	0·0	0	2	4	6	8	11	14 hours
	Totals of diffuse sky radiation in gr. cal. per day							
January	55	75	100	65	50	40	..	..
July ...	120	210	290	305	290	250	170	115

In Table I are given the daily totals not only for diffuse but also for the total (sun and sky) radiation at Nice. The results are given separately for clear days only and for all days of each month without any exception.

We see in Table I, the important part played by the sky radiation in the total (sun and sky) values. The ratio of 30 per cent found at the Riviera is still more considerable (40–50 per cent or even more) in north-west and central Europe. Let me repeat that (as results from Table I) the sky radiation decreases (while the total radiation increases), when we consider clear days only instead of all days.

* See the author's paper published in *C.R. Soc. Sci. Varsovie*, **27**, 1934, pp. 32–44, under the title "Interdependence between the amount of diffuse sky radiation and the duration of sunshine" (Polish with English summary).

TABLE I.—DAILY TOTALS (MEAN MONTHLY VALUES DURING THE PERIOD 1931–3) OF DIFFUSE (SKY) AND TOTAL (SUN AND SKY) SOLAR RADIATION AT NICE, FRANCE. (Gr. cal. per day and cm². of horizontal surface.)

Months	All days Diff.	All days Total.	Clear days Diff.	Clear days Total.
January	57	194	40	257
February	89	268	59	363
March	106	336	66	503
April	136	478	81	628
May	170	577	101	747
June	201	646	107	789
July	157	685	108	805
August	162	622	131	730
September	133	427	100	532
October	93	296	65	383
November	75	181	47	282
December	63	155	38	231

Annual means (per day) { All days — Diff. 120, Total 406, Ratio 30%
Clear days only — Diff. 79, Total 521, Ratio 15%

Some results of pyrheliometric measurements.—From numerous series of pyrheliometric and solarimetric data obtained at the Riviera by direct readings and by means of automatically recording

TABLE II.—HOURLY VALUES OF SOLAR RADIATION INTENSITY DURING CLEAR DAYS ONLY AND THE "ALL DAYS" TOTALS FOR WHOLE MONTHS AND YEAR AT NICE (means for 1931–3).

Intensity for 21st of each month	Intensity, Clear Days Only (gr. cal. min. cm².)						All Days	
	Pyrheliometry Normal incidence			Solarimetry Horizontal surface			Totals for whole months	
	8h. 16h.	10h. 14h.	True noon	True noon	10h. 14h.	8h. 16h.	Pyrh. (normal)	Sol. (horizontal)
January ...	0·71	1·18	1·27	0·68	0·52	0·13	11·2	6·0
February ...	0·93	1·23	1·29	0·87	0·71	0·28	12·2	7·6
March	1·11	1·28	1·33	1·10	0·94	0·50	13·9	10·4
April	1·16	1·31	1·35	1·32	1·13	0·69	17·3	14·3
May	1·16	1·29	1·33	1·41	1·23	0·78	20·1	17·9
June	1·12	1·24	1·27	1·41	1·22	0·80	18·9	19·4
July	1·10	1·22	1·26	1·36	1·17	0·76	23·3	21·2
August	1·06	1·21	1·26	1·24	1·05	0·64	23·1	19·3
September ...	1·04	1·23	1·28	1·08	0·92	0·49	16·4	12·8
October... ...	0·96	1·23	1·29	0·89	0·73	0·30	14·9	9·2
November ...	0·78	1·18	1·26	0·66	0·51	0·13	10·1	5·4
December ...	0·55	1·14	1·25	0·60	0·43	0·07	9·7	4·8
Annual totals (all days) in Kg. cal. per cm².							191·1	148·3

instruments, a small abstract is given in Table II. All values were frequently compared with an Ångstrom compensation pyrheliometer and are expressed in the Smithsonian scale.

The great differences between pyrheliometric and solarimetric values in the morning and evening hours are due to the low altitude of the sun over the horizon. At Nice (latitude 43·7° N.) the fraction sin *h* varies, at true noon, between 0·39 (December 21st) and 0·94 (June 21st). On the other hand the fact that sometimes in summer the total (sun and sky) radiation on a horizontal surface is greater than the direct solar radiation at normal incidence is due to the diffuse component from the whole sky (the direct sun component being during summer not very different in both cases).

Finally it is interesting to note the highest intensity values from pyrheliometric measurements. For two very distant stations: Nice (period 1928–33) and Sloutzk near Leningrad (1914–26), we find the following monthly maxima (directly measured and not reduced) in gr. cal., min. cm². by normal incidence :

Month	Nice	Sloutzk
January	1·41	1·09
February	1·46	1·26
March	**1·51**	1·41
April	1·48	**1·43**
May	1·49	1·40
June	1·45	1·41
July	1·45	1·38
August	*1·42*	1·35
September	**1·46**	1·34
October	1·44	1·28
November	1·41	1·12
December	*1·40*	*0·96*
Year	1·51	1·43

Two maxima (first in spring, second in autumn) are characteristic not only for the Riviera, but also for other regions although sometimes in a less accentuated manner. The great advantage of the solar climate of the Riviera consists first of all in the relatively abundant sunshine with strong intensity of solar radiation even in winter, while in this season all the northern part of Europe has very cloudy and frequently foggy weather.

Some comparisons between the Riviera and other European regions.— In Table III short comparisons are given between Nice and some other places of the European continent. The values could not be established for exactly the same periods of observations. We see that the differences are very great in winter, relatively small in the summer months; while in June the ratio (Nice) : (Helsinki) is nearly 3 : 2, we find 16 : 1 in December. The inhabitants of Finland and of many other places in Scandinavia or north-western Europe receive then not only a very small amount of solar radiation but also, almost wholly in the form of diffuse sky light, bright sunshine being rare in winter in this part of Europe.

TABLE III.—SOLAR RADIATION TOTALS, RECEIVED DIRECTLY FROM THE SUN AND DIFFUSELY FROM THE SKY (in Kg. cal. per cm^2. of the horizontal surface).

	December	June	Year
Nice, Riviera (lat. 43·7° N.)	4·8	19·4	148
Paris, France (lat. 48·8° N.)	2·0	14·7	98
Warsaw, Poland (lat. 52·2° N.) ...	1·0	15·1	91
Rothamsted, England (lat. 51·8° N.)	1·1	12·3	74
London, South Kensington (lat. 51·5° N.)	1·0	12·3	73
Helsinki, Finland (lat. 60·2° N.) ...	0·3	14·2	75

We see that the solar climate of London, though frequently foggy in winter, has monthly totals not very different in this season from many other places in central Europe, and higher than in the north of this continent.

As concerns Nice, it is well to keep in mind that there are in southern Europe three principal parts of the Riviera, namely :—

(1) Western Riviera.—Mediterranean and Atlantic coasts of the Iberian peninsula with Barcelona and Sitges in Catalonia. An especially long sunshine duration is to be found between Alicante, Almeria and Malaga ; other southern Spanish and Portuguese coasts from Lisbon to Oporto have also a remarkable solar climate but unfortunately little explored hitherto.

(2) Central Riviera including the French coast (St. Raphaël–Cannes–Nice–Menton) and various parts of the Italian coasts with San Remo as the chief place. Several Mediterranean isles show also, at least in certain parts of their coasts, characteristic features of the sunny climate of the Riviera.

(3) Eastern Riviera where the central part of the Dalmatian shores and small adjacent isles (e.g. Split, Dubrovnik or Ragusa, Hvar, etc., in Yugoslavia) are no less favoured than Nice from the solar climatic point of view. The natural prolongation of the eastern Riviera is formed by the Greek coasts and eastern Mediterranean isles. Most of the latter (e.g. Cyprus) have a long sunshine duration and represent a transition to the sunny lands of Egypt and Asia Minor with Arabia.

The Mediterranean type of climate is to be found not only in the south of Europe, but its main features are repeated in four other continents, namely, in California, in the South American Riviera, in South Africa (district round Cape Town) and in the south-west corner of West Australia. Unfortunately the solar climate of all these sunny lands is very little known as yet.

Fronts and Depressions

By C. K. M. DOUGLAS, B.A.

The following notes do not profess to contain anything new, but discuss certain aspects of a complex subject on which there is no complete agreement. In very many cases there is reasonably good agreement in the diagnoses of competent frontologists, but in others there is a difference of opinion. Some of the conditions in which disagreement may arise are referred to below. The opinions expressed are of course personal, but they are in general accord with the modern Bergen practice, as shown on their published charts. Professor J. Bjerknes has expressed substantial agreement with them.

(1) *Fronts and barometric tendencies.*—The extent to which sea-level pressure depends on tropospheric temperature is sometimes over-estimated. It is essential to draw a clear distinction between the factors determining the origin and development of atmospheric disturbances, and the simpler, but very limited, problem of the relation between sea-level pressure and the weight of the various layers of air. It is almost certain that in general the lower layers are ultimately the most important, though the upper troposphere and stratosphere also play a part and cannot be ignored. The weights of the various layers can be directly observed, and it has been known for over 30 years that in the British Isles and western and central Europe the troposphere is, on the average, colder over the depression than over the anticyclone, and that the stratosphere has an important influence. This is due mainly to the frequency of occluded depressions, but it must be remembered that intense depressions of frontal type* everywhere tend to be occluded at the centre through much more than half their total duration. S. Petterssen† has stated that "the deepening process and the occlusion process are only two different aspects of the same phenomenon ". It follows that the deeper the depression the more likely it is to be occluded at the centre. Petterssen also says "symmetrical wave cyclones occlude with a velocity which is directly proportional to the deepening of the pressure system ". This rule refers only to the rate of deepening of any given depression. When we consider different depressions, it is only too obvious that the intensity attained has a poor correlation with the initial size of the warm sector, and that the rate of deepening is not directly proportional to the amount of warm air displaced. Occasionally, though rarely, pressure becomes really low at the centre of a depression with a large warm sector. On October 11th, 1933, a depression centred near the Humber had a pressure of about 982 mb.

---

* If the term "frontal type" is given a sufficiently wide interpretation, all intense depressions in temperate and high latitudes are included.

† Practical rules for prognosticating the movement and the development of pressure centres. *U.G.G.I., Ass. Met. Proc. Verb., Lisbon,* 1933, II, 1935, p. 57.

at the centre, and still had a very large warm sector, though it had certainly deepened by fully 20 mb. since its origin.

It is widely recognised that the pressure fluctuation at sea level due to a moving depression can in a very rough manner be analysed into tropospheric and stratospheric fluctuations or "waves", and that the high-level depression comes over from the rear of a sea-level depression and overtakes it during its deepening, the high depression probably itself intensifying to some extent. Thus obviously the use of barometric tendencies for frontal diagnosis requires discrimination, like everything else in synoptic meteorology. The fall of pressure over the warm sector of a deepening depression is due largely to the upper "wave". During the greater part of the development the barometric tendency in the warm sector near the centre gives a good measure of the rate of deepening, as Petterssen has shown*. At a later stage, when the warm sector is narrow and the depression is developing a strong circulation the rule often breaks down. At Holyhead on November 16th, 1928†, pressure fell 5 mb. in an hour in a narrow and vanishing tip of a warm sector, and the centre was only deepening by 1 mb. per hour. The remaining fall of 4 mb. was due to the fact that the tip of the warm sector had been twisted round in front of the centre, which was overtaking it and also developing a forward elongation. None of the fall can be attributed to warming in the troposphere, but it must be remembered that if the only temperature change is the adiabatic cooling due to the fall of pressure at a fixed level, then the fall of pressure decreases upwards considerably.

A steady or rising barometer in the tropical air is rare near the centre of a depression but is quite common near the boundary, when the depression is receding and a warm anticyclone is advancing or spreading. The commencement of a barometric rise, perhaps with a slow veer of wind, does not necessarily mean that even a smooth front has passed (*see* for example October 28th, 1935). In doubtful cases the air should be traced back.

Within 500 miles or so of the centre of an intense depression the cold front or occlusion quickly sweeps round ahead of the barometric trough. Its passage is often marked by a sudden rise of pressure, followed by a further fall, slower than before but still occasionally very rapid. At Stornoway on the night of October 18th–19th, 1935, the sudden rise was followed by a fall of 26 mb. in 8 hours, the greatest fall in 3 hours being 12 mb. This was an exceptional case, but more moderate falls (say 3 to 5 mb. in 3 hours) are common in similar situations, which occur more often on our north-west seaboard than elsewhere.

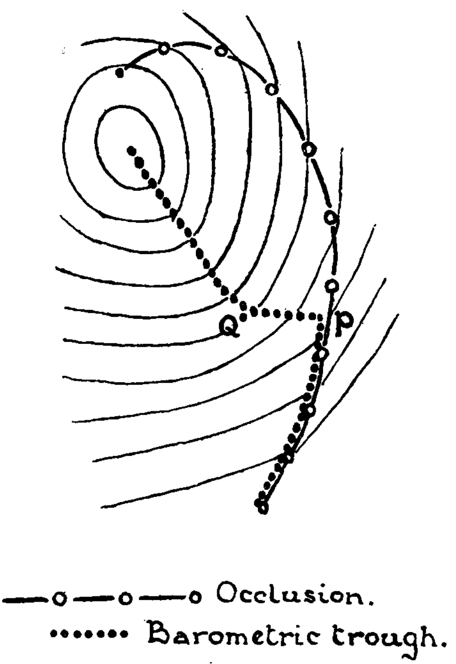
The 7h. chart of September 17th, 1935, showed an intense occluded depression moving north-east with its centre off Tynemouth. Its

---

* *Geofys. Publ., Oslo,* **10**, No. 2, 1933, p. 83.

† *London, Quart. J. R. Met. Soc.,* **56**, 1930, p. 124, Fig. 3.

structure was typical, and is illustrated by the diagram. The occlusion is marked as on the International section of the *Daily Weather Report*, and the barometric trough is shown by a dotted line. South of the point P, which was about 500 miles from the centre, the two lines coincided. In the region PQ the barometric minimum was of a flattened type, while from Q to the centre the isobars at the trough were of a normal rounded type, with no front. The gradient wind at 250 miles from the isobaric centre was of the order of 70 m.p.h. between 1h. and 7h. (reduced from 100 m.p.h. by the correction for the curvature of the path of the air), while the speed of the trough was 40 m.p.h. Thus the air at 2,000 ft. flowed round the curved trough at an average speed of 30 m.p.h. In Scotland on October 19th the flow across the trough was about 40 m.p.h., and in all really intense depressions there is a flow of this type, so that a front cannot possibly remain at the trough. As a rule minor secondary cold fronts move quickly round the trough. Near the western seaboard in winter there are frequent instability squalls, one of which is sure to occur close to the trough, but in eastern districts in winter the final trough often passes without precipitation.



Attention is called to a paper by E. Palmén,* and another by J. Bjerknes,† in which it is shown that the passage of troughs of the type we are considering was accompanied by practically no change of tropospheric temperature.

(2) *Back-bent occlusions.*—The essential condition for the formation of a back-bent occlusion is the motion of the centre of the depression along the occlusion, or along the tip of a warm sector which is being progressively occluded. So long as the motion of the centre is exactly parallel to the isobars in the warm sector, no back-bent occlusion can develop. We have already noted that when a depression becomes intense there is a marked tendency for an occlusion

---

* Registrierballonaufstiege in einer tiefen Zyklone. *Helsingsfors, Mitt. Met. Inst. Univ.*, **26**, 1935.

† Investigations of selected European Cyclones by means of Serial Ascents. *Geofys. Publ., Oslo*, **11**, No. 4, 1935.

or vanishing warm sector to be twisted round ahead of the centre, and the formation of a back-bent occlusion soon follows, usually some 200 or 300 miles in length. In certain conditions back-bent occlusions form in less intense depressions, and in a few special cases may exceed 500 miles in length. If there is a definite flat portion at the bottom of a barograph curve due to a deep depression, it almost certainly corresponds to the region between the occlusion (possibly the cold front) and the back-bent occlusion. On other occasions pressure falls in this region. Subsequently the back-bent occlusion itself swings round the centre, and moves well ahead of the barometric trough. The case recently discussed by J. Bjerknes* was of this type. There was continuous rain just ahead of the final trough, but this was considered to be non-frontal.

The swinging round of the shrinking warm sector ahead of the centre often leads to the development of a second centre, and the centres then have a mutual rotation, the rear one (the original primary) usually filling up and ending as a trough. It is often tempting to draw a long back-bent occlusion along such a trough, but this practice is generally unjustified. In the first place, the development of a second centre is a substitute for the motion of the original centre along the occlusion, so that this centre develops no back-bent occlusion. In the second place, in a dumb-bell vortex system there is a rotation of each component vortex in addition to the mutual rotation, so that there is a flow of air round the trough outside the original centre, while inside it there is a distortion in the opposite direction.

(3) *Secondary Cold Fronts.*—In high latitudes pronounced fronts are commonly formed between maritime polar and arctic air. Occasionally these fronts come down over the British Isles, and may even develop there. More frequently secondary cold fronts form in a polar current which is being progressively heated by a warm sea surface, which gives rise to a horizontal temperature gradient. The development from this into a series of minor fronts is closely related to the breakdown of stability in the vertical. The instability may result in violent squalls, but the temperature at a fixed place often subsequently recovers its original level. The squalls are often of limited horizontal extent. The drawing of long secondary cold fronts can often be made in diverse ways, none of them necessarily right. One of the least probable structures is a front extending into the centre of a depression, like the spoke of a wheel. Small rotary systems often form in unstable air, and the passage of such a system produces effects resembling those at a front (e.g. veer of wind, barometric rise following a fall), so that great care is needed.

(4) *Centres of fully-developed depressions.*—The motion of a front is approximately determined by the component of motion at right angles to it in the colder air mass (i.e. the air mass which does

---

* Loc. cit.

not ascend), and it is a matter of observation that cold fronts or cold occlusions travel roughly with the component of gradient wind. In the case of all fronts the possible departures from gradient velocity can be placed within certain limits. Near the centres of depressions this fact is not always given sufficient weight. In an intense depression the rotation quickly twists up the occlusion and must destroy it as a genuine discontinuity. So long as a strong rotation persists, further fronts cannot readily develop. At a distance of 200 miles from the centre, the air at 2,000 ft. probably occasionally makes the complete circuit in under 24 hours, but more often within 36 hours. In the region immediately to west and north-west of the British Isles, where the sea temperature is fairly uniform, frontogenesis is impossible in these conditions. In a region like the Newfoundland Banks a temperature difference will develop at the surface, but cannot readily extend upwards where the rotary motion is strong. Superficial temperature difference might have an important trigger effect when instability is developed over the warmer part of the sea. When a dying depression is centred over or near the British Isles temperature differences between land and sea, or orographic influence, combined with instability, may give heavy rainfall. In the rainy region (perhaps 3 or 4 or more counties) the surface temperature is relatively low, but the upper air temperature is generally somewhat higher than in the adjacent air, owing to the latent heat set free. The rain area may travel a considerable distance from its place of origin.

The angular type of isobar is not at all typical of fully developed depressions. It should be noted that the barograph curve corresponding with angular isobars is of angular form. The upward kink, often associated with an instability squall, does not in itself indicate angular isobars, but rather an isobaric kink similar to that of the barogram, but downward when the isobar is followed from left to right.

(5) *Precipitation and fronts.*—We have noted above that very minor fronts in unstable conditions may give heavy rainfall. Sometimes the front becomes vanishingly small. J. Bjerknes* has used the term " non-frontal rainfall " to describe a case of steady rain in Belgium, and the Bergen charts sometimes mark rain areas without fronts. To base a front on rainfall alone involves arguing in a circle. It is of course arguable that an elongated rain area must imply a front, but even that is by no means certain, unless the definition of a front is made so wide as greatly to limit its value. A normal horizontal temperature gradient would give some shearing motion aloft, which might in suitable conditions produce an elongated rain area, analogous to elongated cloud cells.

Sometimes a real line of discontinuity with all the properties of an occlusion seems to develop in unstable air, and I suggest that a new term might be introduced to cover such cases. It also sometimes

* Loc. cit.

happens that two depressions originating far apart, originally with quite separate fronts, become joined in such a way that there is to all appearance a single typical occlusion. The charts of September 23rd–24th, 1934 and of November 17th–19th, 1935 illustrate this development, and provide evidence that a so-called " occlusion " is liable to be formed by convergence, without a previous warm sector.

(6) *Drawing of doubtful fronts.*—Some of the difficulties have been mentioned and there are others not referred to here. Even if complete upper air information were available, there would be marginal cases, owing to the complexity of the actual air mass structure. When one has to rely on indirect evidence the situation is worse, as there is no single atmospheric feature not subject to other influences. When conditions are complex, plausible reasons can always be given for various solutions, but these do not constitute scientific evidence. The importance of agreement in scientific matters is great—indeed in the long run it is difficult to see what other criterion can be obtained for the reality of a scientific generalisation. In the pioneering stage personal views and provisional hypotheses are inevitable, but frontal analysis has now dominated synoptic meteorology for 16 years, and is no longer a new study. Personally I believe that the sphere of agreement is capable of extension, but that in order to describe certain groups of phenomena, the frontal ideas must be extended and supplemented by others.

Fronts should obviously not be published when there is a large element of doubt, though some interpolation is often inevitable on the Atlantic, not only with fronts but with isobars. On working charts forecasters must use the methods they find most practically useful, but they should be cautious in their interpretation, both from the point of view of a proper understanding of the atmosphere, and of future progress. If a forecast depends only on the movement of areas of rain and low cloud across the country, any method of marking them on the chart would serve, and the concept of a " front " is not necessarily brought into real use. Merely to call all bad weather areas " fronts " diverts attention from other factors which deserve fuller investigation.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, February 19th, in the Society's rooms at 49, Cromwell Road, South Kensington, Dr. F. J. W. Whipple, F.Inst.P., President, in the Chair.

The following papers were read and discussed :—

C. K. M. Douglas, B.A.—Rainfall from above 6,000 *ft., in relation to upper wind and fronts.*

Rainfall from above 6,000 ft., and the movement of rain areas with the winds at those levels, are of importance in forecasting, and sometimes cause difficulties. A suggested classification of "thermal" upper winds is into ideal frontal, frontal zonal, and non-frontal types. The upper wind system of an ideal front is briefly discussed. Non-frontal "thermal" winds sometimes cause an exceptional forward extension of a rain area (example on May 8th, 1934). A rain area is also liable to travel in an abnormal manner along a front, owing to upper winds of frontal zonal type (example on October 22nd, 1935). Quasi-frontal and non-frontal rainfall, in connexion with which upper winds are often important, are discussed briefly. In an appendix it is shown that the angle of slope of a surface of discontinuity should increase as a depression deepens, and that in consequence large-scale energy transformations are probably related only to converging and diverging movements over large areas, and only indirectly to surfaces of discontinuity.

David Lloyd.—Rainfall and loss over the Vyrnwy catchment area.

Rain falling over a catchment area is partly recovered in stream flow. In specific periods, rainfall is equated to stream flow plus loss. The loss is affected by several causal agents. Consequently in periods of similar rainfall the resulting stream flow varies. The relation of stream flow to rainfall is deduced by analysing data from the Vyrnwy catchment area, where water is impounded by the Liverpool Corporation Water Undertaking. Records are available over a period of fifty years. Annual loss is correlated with associated rainfall and temperature data by a recent statistical method after M. Ezekial, which overcomes the inflexibility of Pearsonian methods. The functional effects of rainfall and temperature in terms of loss are described numerically and graphically. The percentage of the variance in loss due to differences in those causal agents suggests the reason why loss cannot be related to rainfall without taking into consideration other casual factors. The relations are produced descriptive of conditions at the area with and without a reservoir.

John Glasspoole, Ph.D. and Dugald S. Hancock.—The distribution over the British Isles of the average duration of bright sunshine: monthly and annual maps and statistics.

In the paper the available information as to the distribution of bright sunshine over the British Isles is reviewed. Maps are included defining the distribution of average amounts of bright sunshine during each month and the year. Estimates are also given of the general sunshine for each month and year over England and Wales, Scotland, Ireland and the British Isles as a whole.

Correspondence

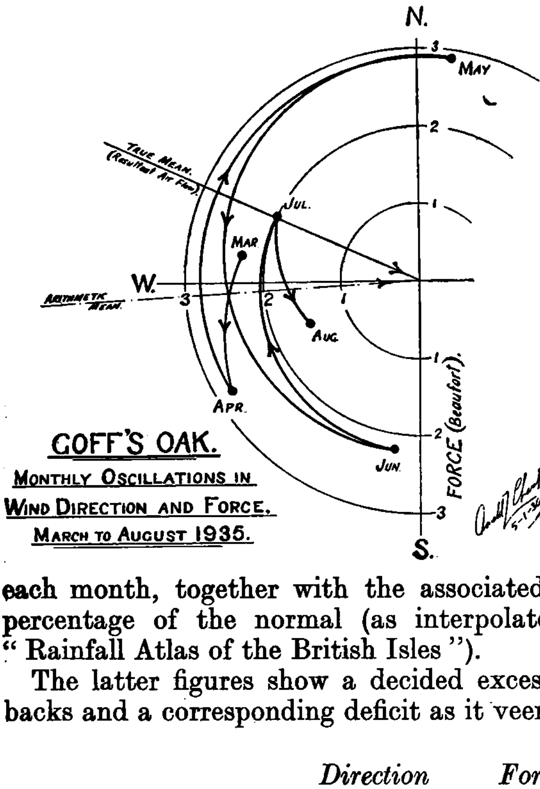
To the Editor, *Meteorological Magazine*

Periodic Oscillations in Wind Direction and Force

The weather changes, relative to movements of centres of excess and deficit of pressure, as set out by Mr. S. E. Ashmore and Dr. Brooks in the issue of this magazine for March 1935, have had an interesting parallel in the changes of wind during the months of March to August, 1935 at Goff's Oak, Herts.

Based on observations of wind taken at 7h. and 23h. (civil time) at this station, the wind appears to have performed five distinct oscillations, as if the atmosphere had been disturbed by a huge tidal wave.

The oscillations commenced with a mean wind of force 2·3 from 279° in March, reached the greatest phase at force 2·9 from 9° in May and then falling off in both angular swing and force each month, to the value of force 1·5 from 249° in August.



The attached diagram shows these changes from month to month, and the damping out of the oscillation after the month of May is clearly apparent, being regular about the arithmetic mean* for the period.

The table below shows the numerical values of each month, together with the associated rainfall expressed as a percentage of the normal (as interpolated from isohyets in the "Rainfall Atlas of the British Isles").

The latter figures show a decided excess of rainfall as the wind backs and a corresponding deficit as it veers.

		Direction	*Force*	*Rainfall* %
March	...	279°	2·3	26
April	...	240°	2·8	220
May	...	9°	2·9	85
June	...	189°	2·2	143
July	...	295°	2·0	27
August	...	249°	1·5	79

The effect on the rainfall is as one would expect, but to have regular alternations of dry and wet months, coupled with such marked oscillations in air flow over a period of six consecutive months is

* The arithmetic mean was obtained by extracting the mean of twice the average of the monthly means; the first average being taken with the value for May as 9° and the second with this value as 369°.

remarkable. The momentum of this huge surge of air must have been tremendous, and its resultant effect on the weather in this locality goes far to confirm the belief that our climate is indeed decidedly variable.

DONALD. L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Waltham Cross, Herts, January 10th, 1936.

Glazed Frost and Ice Pellets, February 11th and 13th

An interesting example of glazed frost occurred on February 11th in southern England. Mr. Norman E. Neville at Fareham writes: "At 9 a.m. rain fell, and immediately it made contact with exposed ground, became ice. It formed large globules of ice in my rain-gauge and on the top of the Stevenson Screen. All windows facing east became coated with thick ice, making the appearance of crinkled glass. . . . After this 'glazed rain' came hard pellets of snow (not hail) and finally softer flakes of snow. Around the street lampshades icicles formed at least six inches long. Walls of buildings facing east became sheets of shining ice making reflection possible at night when the street lamps went up."

Mr. R. S. Breton describes the same storm at Niton, Isle of Wight: "Immediately the strong ESE. gale subsided to a moderate breeze rain began to fall with the temperature at 29° and continued heavily from 8.30 a.m. till 1 p.m., accompanied by small hail later and a little snow for 10 minutes at 11.15. Grass, hedges, trees and buildings soon became encrusted with clear ice, and the country-side at the end of the storm was completely white as if snow had fallen. When examined, the conglomeration could be seen to consist of ice and tiny clear hailstones. The amount of rainfall was about 0·75 in. I examined one of the wire supports to the electric cable standing exposed on the top of the cliff and found it to be embedded in an elliptical casing of clear ice, over half an inch thick at the two sides. Evergreens were much bent over by the weight of the ice and in some cases boughs broke under their burden. There were icicles everywhere. The frost, which held all day, increased as soon as the sky cleared at night. At sunrise we had a truly marvellous picture of beauty, the hedges and trees glittering (without rime) and reflecting all kinds of extraordinary colours until the sun's power was enough to send the icy particles tinkling to the ground."

On February 13th at Garvagh, Co. Derry, Mr. J. Porter described a fall of ice pellets: "After a rather cold day, on which the maximum temperature in the screen reached 39° F., ice particles began to fall at about 6.30 p.m., continuing, for the most part slightly, up to 10.30 p.m. On examination they appeared to be very irregular in shape and size, varying from 'pin heads' to a little larger than coarse sugar; they were quite clear or transparent and just resembled broken ice. The wind was south, light to moderate, and the atmosphere hazy or misty. No low clouds could be detected but during the day what appeared to be cirrostratus spread up from the south and at 6 p.m. the sky was completely overcast."

Thunderstorms Associated with a Warm Front

In connexion with the note by Mr. R. P. Batty in the November issue of the *Meteorological Magazine* dealing with the occurrence of a thunderstorm as a warm front passed over Cranwell on September 24th 1935, I would like to draw attention to some further interesting features. A thunderstorm was associated with the passage of the warm front referred to by Batty not only at Cranwell but also at Holyhead at 11h. 48m. G.M.T., Sealand at 13h. G.M.T., and Birmingham between 13h. and 17h. G.M.T. which suggests that this phenomenon was a feature of the warm front over a distance of about 70 miles from the centre of the depression. Thunderstorms also occurred at Ross-on-Wye and Mildenhall at the passage of the cold front and this, taken in conjunction with the cases of thunderstorms at the warm front, suggests that instability was fairly easily produced in the warm air.

The synoptic situation was similar to that which gave a warm front thunderstorm at Valentia on November 9th 1929. Each warm front was associated with a newly-developed secondary. Both secondaries moved rapidly and increased in intensity as the depression passed across the British Isles. In November 1929 the secondary first appeared off south-west Ireland, pressure about 1008 mb. at 13h. G.M.T. on the 9th, and by 7h. G.M.T. on the 10th was over Tynemouth, pressure about 995 mb.; while in September 1935 the depression was first indicated about 300 miles west of Valentia, pressure 1008 mb. at 13h. G.M.T. on the 23rd, and by 7h. G.M.T. on the 25th was over Terschelling, pressure about 992 mb.

WILLIAM D. FLOWER

Meteorological Station, R.A.F., Sealand, Chester, December 18th, 1935.

Lunar Halo and Corona

Throughout the early part of the evening of Tuesday, February 4th, the sky was free from cloud and greyish blue in colour. From about 19h. 30m. G.M.T., to 21h. 30m. a small jagged (not circular) patch of thin haze surrounded the moon. At 21h. 30m. the moon was surrounded by a thin halo or ring of haze fully 40° in diameter. For a period of 15 minutes up to 22h., numerous straight lines of haze were faintly seen across the circle below its centre running parallel to the horizon. At 22h. 30m. a circular disk of haze which had covered the moon for a short period showed (for 15 minutes) very distinct rings in the prismatic colours; the outer ring was 10° in diameter. The large outer halo was still visible. By 23h. a veil of thick white haze and countless small clouds had spread over the entire sky.

At sunrise on February 7th six arcs of red cloud or haze stretched across the sky from due north to south. No other clouds were present. The red gradually faded out later to almost clear sky.

S. M. JAMESON.

Butterwick, Barton-le-Street, Malton, Yorkshire, February, 5th, 1936.

NOTES AND QUERIES

"Greenhouse" Effect in the Upper Atmosphere

The experiment was recently made of wrapping a Dines balloon meteorograph up in a number of layers of thin cellophane, and sending it up attached to a balloon in the usual manner to determine what temperature would be attained at great heights when the sun was shining. Two such soundings were made from Sealand this winter, one reaching a height of 13½ Km. and the other 6½ Km. The results obtained were of much the same type in both cases, and the following table is based on the former one, a sounding made near midday on February 1st, 1936.

Height Km.... ...	0·7	1·7	2·7	3·1	3·9	5·2	6·8	7·7	8·7	11·3	13·3
	°A.	°A.	°A.	°A.	°A.	°A.	°A.	°A.	°A.	°A.	°A.
Temperature of air ...	275	269	263	260	255	245	231	223	215	224	224
Temperature inside cellophane case—											
Ascent	285	288	307	308	303	292	280	276	282	302	308
Descent... ...	288	288	289	289	285	280	283	289	293	302	308

The temperature of the external air was determined from an independent sounding made an hour later with a normal instrument. As far as can be ascertained there were no high clouds present, though the sky was nearly covered with clouds of various heights up to 2 Km. The vertical velocity of the balloon during the ascent was about 3½ metres per second, and on the descent probably about 10 metres per second near the top falling off to about 5 near the ground.

The special jacketing of the meteorograph was effected by first placing a layer of black paper round the cylindrical case and then adding about five layers of thin cellophane and tying loosely. The thickness of the laminated jacket thus formed was about 8 mm. At the two ends of the case the cellophane was drawn together and tied tightly to keep out currents of air.

The elevation of the sun was about 18° above the horizon. It will be seen from the table that up to a height of 7 Km. the vertical velocity of the balloon has an appreciable effect on the temperature inside the cellophane, the higher velocity of the descent coinciding with a lower temperature. Above 7 Km. the effect is less and above

10 Km., it is negligible. From 7 Km. upwards the temperature continually increases with height, being 85° A. above that of the external air at 13½ Km. The latter result is to be expected, because the radiant heat absorbed by the black paper is mainly got rid of again by convection of the air in the narrow spaces between the layers of cellophane ; the less the density of the air the less heat it can carry, but the radiant heat from the sun remains the same. The experiment demonstrates the ease with which a body may be maintained at a high temperature in the stratosphere provided that the sun be above the horizon.

L. H. G. DINES.

REVIEWS

Atlas climatique de la Grèce. By. E. G. Mariolopoulos and A. N. Livathinos. Size 20 in. by 14 in. Observatoire National D'Athènes. Athens, 1935.

This lavishly produced climatological atlas contains no fewer than 118 charts, mostly of the full size of 13 by 11 inches, on a scale of 1/3,000,000. They are based on the records of 83 stations, of which 37 are rainfall stations, the whole being controlled by the first order Observatory of Athens. The positions of the stations are shown on a contour map and also, with the heights and periods of observation, in a table. The standard adopted is the thirty year period 1900–29, but not all the stations were in operation continuously throughout this period, and it does not appear that incomplete periods have been corrected for the missing years.

Temperature is represented by 13 charts showing the mean for each month and for the year, computed by the formula (8h. + 14h. + 2 × 21h.)/4, which is within about 0·1° C. of the 24-hour mean, and reduced to mean sea level at the rate of 0·6° C. per 100 metres. There is also a chart of annual range, and charts of the number of days (per thousand between November and April inclusive) of minima of 0° C. or less, and of the dates of first and last frosts. It would have been clearer if the actual number of days had been given ; it requires some mental arithmetic to determine that a frequency of 4 per thousand represents the occurrence of two frosts in thirty years.

Monthly charts of relative humidity are given, but data could be used for only 28 stations. For the lines of equal humidity the authors employ the term " isohygres ". Monthly charts of isonephs are based on 35 stations ; these, like the charts of humidity, show the direct means of three observations a day. There are also charts of the annual frequency of clear and overcast days, but for some unstated reason the authors adopt as criteria means of 1·3 tenths or less and 8·7 tenths or more instead of the customary criteria of less than 2 tenths and more than 8 tenths.

There is only one Campbell-Stokes sunshine recorder in Greece, that at the Observatory of Athens, and the charts of insolation are based on the mean cloudiness, assuming that the percentage of possible duration of sunshine is the complement of the percentage cloudiness. This relation does not hold in the British Isles in winter, but it is stated to be true for Athens.

Precipitation is represented by full-page coloured charts of monthly and annual rainfall, and by smaller charts of frequencies of rain-days (per month), and of hail, snow and thunderstorms (per thousand), but the meaning of the charts is not very clear. Finally there are a series of very useful charts of monthly mean pressures and wind-roses. The whole atlas forms a most valuable contribution to climatology of the eastern Mediterranean, and we look forward to receiving the companion volume of text, which is in the press.

C. E. P. Brooks.

Unsolved Problems of Science. By A. W. Haslett. Size 8 in. × 5½ in., pp. XI + 317. *Illus.* London, G. Bell and Sons, Ltd., 1935, 7*s.* 6*d.* net.

Popular scientific writers so frequently enlarge on the wonders and triumphs of science that the humble worker in one particular field, painfully aware of the gaps and uncertainties of his own knowledge, might perhaps be excused if he concluded that his own science was being outstripped by others in the race for new knowledge. For this reason he should welcome this book, which shows that other sciences too have their problems, unsolved and perhaps unsolvable. Mr. Haslett displays a wide knowledge, ranging from astronomy and physics to geology, archaeology and biology ; the chapters on physics are especially good, and really succeed in conveying in simple language a good idea of the present position of our knowledge of the constitution of matter.

The one meteorological chapter is however rather disappointing, dealing interestingly but almost exclusively with the practical problem of long range weather forecasting, and ignoring completely the more fundamental questions of the cycle of radiation, or the ultimate cause of oscillations within the atmosphere. Of course one must keep a sense of proportion and not expect a general book to consider all the subjects raised in the Royal Meteorological Society's " Problems of Modern Meteorology ", but one would at least have expected some discussion of the great problem of climatic changes.

A book like this does good service by introducing workers in one science to the lines along which their colleagues in other branches are thinking. The chapter on " Mathematics or Common Sense ? " is especially valuable in this connexion. It is shown that while atoms in the mass, whether solid, liquid or gaseous, act according to known laws, the behaviour of individual atoms is unpredictable.

A similar position is not unknown in meteorology ; for example in thundery weather we can foresee the probable behaviour of the whole air-mass over southern England, but not of that particular portion of it which is over, for example, Kew Observatory.

Several problems of radiation are discussed in the chapter on " Messages from Space " which also deals with the highest sounding balloon ascents, sound waves, meteors, and cosmic rays. There is an interesting paradox about the temperature of inter-stellar space. This is now known to be occupied by a very tenuous " cosmic cloud ", which is believed to be at a high temperature—some thousands of degrees. This high temperature however is rather an abstraction, for any solid body, such as a meteor, which traverses space would probably be intensely cold. If scientists ever succeed in penetrating these regions, the interpretation of the instrumental records will apparently be something of a problem.

The Climate of the Netherlands West Indies. By Dr. C. Braak. K. Ned. Meteor. Inst. No. 102, Med. en Verh. 36, pp. 85 (Dutch) + 32 (English Summary). *Illus. s* Gravenhage, 1935.

Dr. C. Braak continues his climatic survey of the Dutch colonies by a careful and thorough-going account of the data from Surinam (Dutch Guiana) and the Dutch islands of the West Indies.

Meteorologists generally have heard so little about this region in the past that it comes as a surprise to meet the great amount of data collected here—in Surinam 53 rainfall stations are listed ; these are mostly near the coast, but the stations in the interior suffice to enable simple monthly charts of isohyets to be drawn. In the various islands of the Antilles there are 34 stations, but the rainfall distribution is not mapped.

The most complete data exist for Paramaribo in Surinam, including a rainfall series which is almost complete from 1847 to 1933, hourly means of rainfall, pressure, wind, mean and extreme temperature, humidity, sunshine, nebulosity, earth temperatures and phenomena ; there are also data for four second-order stations in the Antilles, and even summaries of upper winds in Curaçao up to 13 Km. The whole publication is admirably compiled, with numerous tables and as usual, an excellent summary in English. The area, though not notable for extremes of climate (except that some of the islands are subject to drought), is one of great meteorological interest, and the work is a valuable addition to the literature.

BOOKS RECEIVED

Deutsches Meteorologisches Jahrbuch, 1931 *and* 1932. Freistaat Sachsen. Edited by Prof. Dr. E. Alt, Jahrg. 49 and 50, Dresden, 1933 and 1934.

Remarkable lightning photographs by C. G. Abbot, Washington, D.C., Smiths. Misc. Coll., Vol. 92, No. 12.

OBITUARY

Professor Luigi de Marchi.—We regret to learn of the death of Prof. L. de Marchi, at Padua on February 16th, 1936. Born at Milan on May 16th, 1857, he was educated at Pavia, where he received the degree of Doctor in Mathematics and Physics in 1880. He continued his studies in meteorology, publishing a text-book on "General Meteorology" in 1888 and on "Climatology" in 1890. In 1895 he broke new ground with a prize essay on " The Cause of the Glacial Period," in which the spread of the ice sheets is attributed to a fall of temperature due to a decrease in the transparency of the atmosphere. He returned to this subject in 1911 and again in 1935. In 1903 he became Reader in Meteorology and Librarian of the University of Pavia, and he was later appointed Professor of Physical Geography at Padua.

In recent years Prof. de Marchi played a large part in the organisation of scientific work in Italy. He was President of the Italian National Council for Research and of the Italian Commission for the Second Polar Year ; in the latter capacity he was co-opted a member of the International Commission for the Polar Year. He was first President, and at his death, Honorary President of the International Commission for the study of Climatic Variations, appointed by the International Union of Geography, and one of his last actions was to urge the creation of National Committees for the Study of Climatic Changes in all countries, charged with the preparation of national bibliographies and the pursuit of historical researches. The study of climatic changes was in fact one of the dominant interests of his long and busy life.

Richard Bentley.—We regret to learn of the death, on February 23rd, at the age of 81, of Mr. R. Bentley. He had been named after his grandfather, who founded the famous publishing house of Bentley and Son, subsequently taken over by Messrs. Macmillan in 1898. Mr. Bentley was President of the Royal Meteorological Society in 1905 and 1906, when he addressed the Fellows on " The Growth of Instrumental Meteorology " and " The Meteorology of Daily Life." Amongst his other contributions to meteorology, mention should be made of his rainfall record, which he continued after his father's death in 1895 at his residence at Upton, Slough. This record had been commenced there in the autumn of 1873. For many years Mr. Bentley sent a monthly report of his record to the British Rainfall Organization, and his return could be readily recognised by the handwriting, the extremely clear figures and the use of red ink to emphasize any unusual meteorological event. Mr. Bentley summarised the sixty years rainfall record and his temperature record covering thirty-six years in two pamphlets, published in 1934. In these pamphlets acknowledgment is given to Mr. George Baker, the deputy observer for over forty years. Mr. Bentley always maintained his interest in meteorology and completed himself the return for January, 1936, adding his comments in red ink, "eclipse of moon was itself eclipsed by weather." J. GLASSPOOLE.

Thomas Frederick Prosser.—It is with great regret that we learn of the death at the early age of 25 of Mr. T. F. Prosser, F.R.Met.Soc., meteorological observer and crop recorder at the Royal Agricultural College, Cirencester. Mr. Prosser was educated at the Cirencester Grammar School and joined the clerical staff of the Royal Agricultural College in 1928. He took charge of the climatological station at the College, which, after a period of inactivity, had recently been reconstituted as a Crop-Weather Station participating in the Agricultural Meteorological Scheme. Mr. Prosser showed great interest in this work, and made occasional contributions to this magazine and to the journal of the Royal Meteorological Society, besides furnishing regular weekly and monthly reports to local newspapers. His death on January 25th, 1936, deprives us of a valued co-operating observer.

We regret to learn of the death on February 7th, 1936, of Father Joseph de Moidrey, Director of the Lu-kia-pang Observatory from 1908 to 1932.

NEWS IN BRIEF

Prof. W. J. Humphreys, who retired on December 31st, 1935, after 30 years' service as meteorological physicist in the United States Weather Bureau, has become a collaborator of the Bureau to carry on research and advise on technical problems.

The 35th anniversary of the scientific career of the Academician B. P. Moultanovski, Director of the Institute for long-range forecasting was celebrated at the Central Physical Laboratory, Leningrad, on March 2nd, 1936.

Mrs. K. M. Dean of Kynaston Place, Much Marcle, Gloucestershire, informs us that she has a 5 in. rain-gauge of standard pattern which she desires to sell. Anyone wishing to purchase this should communicate direct with Mrs. Dean.

The Weather of February, 1936

Pressure was much above normal over the whole of the Arctic, the excess reaching 14 mb. at Mygbugten in north-east Greenland. A belt of pressure deficit in about 40° N. extended from the Pacific coast of America at least as far as the Caspian, with centres near Salt Lake City (— 6 mb.) and Brest (— 12 mb.). Temperature was above normal at Spitsbergen and in central and south-west Europe, but below normal in Scandinavia, 7°–11° in northern Norrland. Precipitation was mainly deficient in Spitsbergen and northern and central Europe being only 30 per cent. of the normal in north Gothaland.

From the 3rd to 14th a low pressure area lay over the North Atlantic giving a mean pressure of 988 mb. in 50° N., 30° W., while an anticyclone covered central Europe (Prague 1026 mb.). From the 15th to 24th the depression was centred over Scotland where pressure was below 995 mb. and the anticyclone had retreated to Siberia. The last few days of the month were characterised by extremely high pressure over Spitsbergen and a slight gradient for easterly winds over the British Isles.

The weather of February over the British Isles was mainly cold with sunshine above the normal except in south-west England and east Scotland and rainfall in excess in England, but deficient in Scotland and Ireland. Frosts were more frequent than usual. Mild unsettled conditions with rain in most places prevailed generally on the 1st as a depression passed eastwards across the country, but on the 2nd the winds were cold and northerly and there was much sun in the north and west. On the 3rd a ridge of high pressure crossed the country from the Atlantic, and from then to the 14th high pressure was maintained over or to the east of the British Isles, while depressions to the west influenced a varying amount of our western districts. Except in the south-west, conditions were of a wintry nature during this period and precipitation was mainly slight or moderate. Snow occurred generally in Scotland, north England and north Ireland and also on the 11th–13th in parts of south England and south Ireland. In the south-west precipitation was heavy at times especially on the 10th, when 3·10 in. were recorded at Dunmanway (Co. Cork) and 2·40 in. at the Scilly Isles. Southerly gales were experienced in the north and west on the 6th and 7th and south-easterly gales in the south-west on the 8th–11th—Beaufort force 10 was reached at the Lizard and St. Ann's Head on the 10th, and gusts of 92 m.p.h. and 88 m.p.h. were recorded at Valentia and the Scilly Isles respectively on the same day. Much sunshine occurred on the 3rd, 4th, 8th, 9th and 12th, in the south-east on the 7th and north on the 10th and 11th, over 8½ hours being recorded at several places in the south on these days. Mist or fog was prevalent from the 12th–14th and also occurred locally on the 5th and 6th. Except in the south-west temperature was low during this time and frost widespread—a maximum of 28° F. was recorded at Rhayader on the 11th, while temperature in the screen fell to 7° F. at Dalwhinnie and 11° F. at Huddersfield on the 13th, and on the ground to −2° F. at Dalwhinnie and 6° F. at Eskdalemuir and Penrith on the 13th. From the 15th–22nd complex low pressure areas passed in a north-easterly direction across the country. Conditions became milder on the 16th, and temperature was generally above normal until the 22nd, a maximum of 55° F. being reached at Manchester, Leamington and London on the 18th. Fog was widespread on the 15th–17th. Rain occurred most days and was heavy in the south on the 17th, when 2·02 in. fell at Holne (Devon), while snow was recorded in the north and Midlands on the 19th and 21st–22nd. On the 17th the winds increased to gale force in the south-west, and southerly gales were experienced in parts of the west and north on the 18th, continuing intermittently in the north until the 22nd. From the 23rd–29th depressions moved south-eastwards across the country and the weather became generally cold again with slight precipitation most days—snow was reported from many places. Fog occurred locally in south-east England and the Midlands, and on the 28th a thunderstorm was reported from Markree Castle. There was litle sun during the second half of the month except on the 20th, when 9·0 hours were recorded at Lowestoft. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	81	+27	Chester ...	67	+ 8
Aberdeen ...	63	− 4	Ross-on-Wye ...	80	+25
Dublin	73	− 2	Falmouth ...	64	−15
Birr Castle ...	67	+ 3	Gorleston ...	75	0
Valentia... ...	72	+ 7	Kew	75	+14

Miscellaneous notes on weather abroad culled from various sources

A whirlwind in the Tremolat district near Bordeaux on the 3rd stripped roofs of tiles and uprooted trees. A strong south-westerly gale culminating in torrential rain was blowing in Switzerland on the 1st—on the 2nd the temperature dropped and snow fell generally. A gale occurred in the Gulf of Genoa on the 5th. Two lightvessels near Helsinki left their stations owing to ice about the 6th. Temperature fell generally over the whole of central and western Europe about the 9th—many rivers in the low country in Switzerland were frozen by the 10th, and six deaths occurred. Heavy snow fell in Germany on the 9th, and unusually heavy snowfalls were experienced in Austria, Hungary, the Balkans and north Italy about the 10th, while bitterly cold weather with strong winds was general in France—both here and in Germany ice on the roads caused many minor accidents. A severe northerly gale followed by heavy snowstorms did great damage on the 11th and 12th in the Balkans, Turkey and the Black Sea ports; severe gales also occurred at the same time over the Adriatic Sea and as far east as Palestine and north Egypt—numerous lighters were sunk and much material damage done, while 92 deaths were reported in Bulgaria and 32 in Turkey. Mild weather prevailed generally in the lower parts of Switzerland on the 15th–18th, though in the Engadine and central Switzerland there was frost. Ice was obstructing navigation at Kalmar on the 18th. Fog occurred generally in extreme north-west Germany on the 3rd, 18th and 20th. Heavy continuous rains in Spain and Portugal were accompanied by serious floods about the 20th, especially near Seville, Zamora, Regua and Santarem—many villages were isolated, houses collapsed, and at Seville six people were drowned. By the 23rd the floods were subsiding, the port of Seville being re-opened to navigation on the 24th, and the Douro river almost normal near Oporto on the 27th. From the 16th–26th heavy snowstorms were experienced in Denmark —all traffic was snowbound, villages isolated and the food supply of Copenhagen endangered. A protracted spell of unusually cold weather occurred in Finland towards the end of the month so that the ice-breakers could keep only the ports of Hangö and Abo open. (*The Times*, February 3rd–29th.)

One of the most disastrous hailstorms experienced in the Northern Transvaal occurred on the edge of the foothills of Springbok Flats on the 1st. An enormous low black cloud was seen to approach—" About 3 in. of rain fell in a few minutes and then came the hail, which consisted of jagged lumps of ice. In 30 minutes the hail was lying everywhere to a depth of 3 ft." 19 natives and many cattle were killed and whole crops obliterated. Storms occurred over Southern Rhodesia on the 8th. A landslip following a storm destroyed part of Masisi, a village in Costermansville (Belgian Congo) about the 18th, and 31 Congolese lost their lives. The premature " little rains " continued in Abyssinia during the month. Extensive damage was done along the Algerian coast by a gale on the 27th and 28th.—(*The Times*, February 3rd–29th).

A blizzard said to be the worst for many years swept over Tokyo on the 4th—all traffic was snowbound. At the beginning of the month the sea was frozen along the entire coast of the Gulf of Chihli and the ice extended more than 50 miles seawards—Tientsin, Chefoo and other ports were closed. Heavy snowstorms were also experienced in north and central China. An improvement in the weather about the 9th caused the ice to break up, but Tientsin was again icebound on the 20th. Lahore experienced an exceptionally heavy hailstorm about the 26th, when some of the hailstones were said to weigh 11½ grams. (*The Times*, February 6th–28th.)

Rainfall for Australia was below normal except in parts of Queensland, South Australia and New South Wales. Early in February a severe cyclone swept practically the whole of the North Island of New Zealand. The damage caused by wind and rain was considerable, especially in the Manawatu and Taranaki divisions. Heavy stock losses occurred in Waikato and adjoining districts, and floods damaged many farms in Hawke's Bay. All traffic and communications were disorganised and nine men lost their lives. (Cable, *The Times*, February 4th–5th, and report from the Bank of New South Wales.)

Temperature was considerably below normal in the United States during most of the month, only rising above normal locally to the west of the Rockies about the middle and towards the end of the month. Precipitation was very variable, but above normal in several parts. About the 4th there was a slight thaw in New York State and floods were experienced in the south. Except for the short interval about the 18th, intense cold and intermittent heavy snowfalls prevailed over the whole of North America from the 6th–24th; on the 16th 50° F. was registered at Williston (N. Dakota) and—56° F. at Battleford (Saskatchewan). Dust storms occurred in the central States on the 24th and floods in many parts later in the month. A tornado swept across southern California on the 12th. (*The Times*, February 4th–28th, and *Washington, D.C., U.S. Dept. Agric. Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, February, 1936

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see vol. 69, 1934, p. 1).
	mb.		°F.	°F.	%	in.	hrs.	
1	987·7	WSW.3	45	50	84	0·11	0·8	r 7h.–8h. r_0 21h.
2	987·8	NW.2	42	46	71	0·26	0·9	r 5h.–7h.; 15h.–17h.
3	1003·0	NW.4	34	40	60	—	4·1	x early.
4	1017·7	NW.2	27	37	57	—	7·0	x early & late.
5	1024·5	SE.2	28	42	57	—	0·0	x early.
6	1031·1	SE.3	35	44	57	—	5·2	x early.
7	1033·5	SE.3	30	38	53	—	6·8	x early.
8	1023·4	E.5	28	37	62	—	7·0	
9	1012·2	E.4	30	40	62	—	6·6	x early.
10	1018·4	E.6	35	38	53	—	3·2	
11	1010·6	E.4	27	31	47	—	0·0	
12	1020·8	E.3	25	39	53	—	3·6	x early. f. 9h.–13h.
13	1019·7	E.3	25	42	58	—	2·3	fx early.
14	1008·7	E.4	31	43	60	—	5·6	x early.
15	998·4	Calm.	35	41	100	0·09	0·0	Fd_0 all day.
16	1000·6	Calm.	32	38	85	—	2·2	f evening.
17	996·9	SSW.3	33	51	86	0·08	1·2	fd_0 early.
18	984·7	SSW.4	45	53	84	0·32	1·5	r 0h.–6h., pr 14h.
19	991·0	S.3	41	51	92	0·07	0·6	r–d_0 4h.–15h.
20	1010·5	SW.3	36	49	60	—	7·9	x early.
21	1006·6	WNW.2	42	48	70	0·04	0·2	r_0 0h.–5h.
22	995·5	ESE.4	28	45	96	0·35	0·0	r–r_0 7h.–17h.
23	995·6	WNW.2	38	42	71	0·04	0·1	r–r_0 1h.–7h.
24	1002·6	NE.1	31	43	81	0·04	0·0	r 23h.–24h.
25	1019·8	NNE.3	36	39	72	0·09	0·0	r–r_0 0h.–7h.
26	1015·7	SW.3	35	43	58	trace	0·7	r_0 18h.–23h.
27	995·4	WSW.2	40	46	66	0·07	4·5	r_0–r 0h.–6h. & 10h.
28	988·8	NNE.2	32	41	77	—	2·6	F till 11h.
29	986·8	NW.2	34	39	81	0·04	0·2	ir_0 10h.–24h.
*	1006·5	—	34	43	69	1·61	2·6	* Means or totals.

General Rainfall for February, 1936.

England and Wales ...	127	per cent. of the average 1881–1915.
Scotland	87	
Ireland	93	
British Isles	112	

Rainfall : February, 1936 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	1·47	88	*Leics* .	Thornton Reservoir	2·97	177
Sur .	Reigate, Wray Pk. Rd.	1·98	90	,, .	Belvoir Castle	1·98	119
Kent .	Tenterden, Ashenden	1·90	97	*Rut* .	Ridlington	1·99	121
,, .	Folkestone, Boro. San.	3·16	...	*Lincs* .	Boston, Skirbeck	2·65	182
,, .	Eden'bdg., Falconhurst	2·20	100	,, .	Cranwell Aerodrome	2·19	146
,, .	Sevenoaks, Speldhurst.	1·99	...	,, .	Skegness, Marine Gdns.	2·28	149
Sus .	Compton, Compton Ho.	3·05	116	,, .	Louth, Westgate	3·08	161
,, .	Patching Farm	2·85	129	,, .	Brigg, Wrawby St.	2·36	...
,, .	Eastbourne, Wil. Sq.	2·26	102	*Notts* .	Worksop, Hodsock	2·67	173
,, .	Heathfield, Barklye	2·60	111	*Derby*.	Derby, L. M. & S. Rly.	1·47	91
Hants.	Ventnor, Roy.Nat.Hos.	3·11	148	,, .	Buxton, Terr. Slopes	3·58	95
,, .	Fordingbridge, Oaklnds	2·72	109	*Ches* .	Runcorn, Weston Pt.	1·96	105
,, .	Ovington Rectory	3·79	146	*Lancs*.	Manchester, Whit. Pk.	1·98	103
,, .	Sherborne St. John	2·16	99	,, .	Stonyhurst College	2·08	62
Herts .	Royston, Therfield Rec.	2·08	135	,, .	Southport, Bedford Pk.	2·28	109
Bucks.	Slough, Upton	...	...	,, .	Lancaster, Greg Obsy.	2·09	72
,, .	H. Wycombe, Flackwell	2·00	104	*Yorks*.	Wath-upon-Dearne	2.54	155
Oxf .	Oxford, Mag. College	1·34	85	,, .	Wakefield, Clarence Pk.	2·88	169
Nor .	Wellingboro, Swanspool	1·92	119	,, .	Oughtershaw Hall	3·35	...
,, .	Oundle	1·65	...	,, .	Wetherby, Ribston H.	...	...
Beds .	Woburn, Exptl. Farm	1·91	129	,, .	Hull, Pearson Park	2·19	132
Cam .	Cambridge, Bot. Gdns.	1·96	153	,, .	Holme-on-Spalding	2·23	133
Essex.	Chelmsford, County Gdns	1·64	111	,, .	West Witton, Ivy Ho.	3·33	116
,, .	Lexden Hill House	2·06	...	,, .	Felixkirk, Mt. St. John.	3·01	178
Suff .	Haughley House	2·50	...	,, .	York, Museum Gdns.	1·99	132
,, .	Campsea Ashe	2·94	214	,, .	Pickering, Hungate	2·66	153
,, .	Lowestoft Sec. School	2·70	193	,, .	Scarborough	2·30	137
,, .	Bury St. Ed., WestleyH.	3·19	213	,, .	Middlesbrough	2·95	227
Norf. .	Wells, Holkham Hall	2·42	163	,, .	Baldersdale, Hury Res.	...	...
Wilts .	Calne, Castle Walk	1·97	...	*Durh* .	Ushaw College	3·88	244
,, .	Porton, W.D. Exp'l. Stn	2·76	139	*Nor* .	Newcastle, D. & D. Inst.	3·37	234
Dor .	Evershot, Melbury Ho.	3·92	125	,, .	Bellingham, Highgreen	2·84	112
,, .	Weymouth, Westham.	3·29	152	,, .	Lilburn Tower Gdns.	4·05	207
,, .	Shaftesbury, Abbey Ho.	2·37	103	*Cumb*.	Carlisle, Scaleby Hall	1·78	80
Devon.	Plymouth, The Hoe	4·96	167	,, .	Borrowdale, Seathwaite	6·50	58
,, .	Holne, Church Pk. Cott.	6·77	123	,, .	Borrowdale, Moraine	5·34	57
,, .	Teignmouth, Den Gdns.	3·77	142	,, .	Keswick, High Hill	3·48	71
,, .	Cullompton	3·13	112	*West* .	Appleby, Castle Bank	1·90	64
,, .	Sidmouth, U.D.C.	2·91	...	*Mon* .	Abergavenny, Larchf'd	3·39	106
,, .	Barnstaple, N. Dev.Ath	2·47	91	*Glam* .	Ystalyfera, Wern Ho.	2·57	50
,, .	Dartm'r, Cranmere Pool	5·70	...	,, .	Cardiff, Ely P. Stn.	1·70	57
,, .	Okehampton, Uplands.	5·61	129	,, .	Treherbert, Tynywaun.	4·35	...
Corn .	Redruth, Trewirgie	7·43	197	*Carm*.	Carmarthen, Coll. Rd.	2·85	77
,, .	Penzance, Morrab Gdns.	7·26	217	*Pemb* .	St. Ann's Hd, C.Gd. Stn.	2·89	109
,, .	St. Austell, Trevarna	7·69	200	*Card* .	Aberystwyth	1·73	...
Soms .	Chewton Mendip	2·96	88	*Rad* .	BirmW.W.Tyrmynydd	3·66	70
,, .	Long Ashton	2·65	113	*Mont* .	Lake Vyrnwy	2·78	61
,, .	Street, Millfield	2·04	...	*Flint* .	Sealand Aerodrome	2·20	...
Glos .	Blockley	2·40	...	*Mer* .	Dolgelley, Bontddu	2·93	66
,, .	Cirencester, Gwynfa	2·42	107	*Carn* .	Llandudno	2·24	115
Here .	Ross, Birchlea	1·99	99	,, .	Snowdon, L. Llydaw 9	7·31	...
Salop.	Church Stretton	2·89	131	*Ang* .	Holyhead, Salt Island	2·47	101
,, .	Shifnal, Hatton Grange	2·11	131	,, .	Lligwy	2·49	...
Staffs.	Market Drayt'n, Old Sp.	1·61	93	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	2·25	137		Douglas, Boro' Cem.	3·71	116
War .	Alcester, Ragley Hall	1·93	117	*Guernsey*			
,, .	Birmingbm, Edgbaston	2·74	162		St. PeterP't.Grange Rd.	4·20	171

Erratum: Chelmsford, County Gdns., January, for 4·19/274 read 4·13/270

Rainfall: February, 1936: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	1·94	63	*Suth* .	Melvich	1·61	54
,, .	New Luce School	2·63	69	,, .	Loch More, Achfary	2·99	45
Kirk .	Dalry, Glendarroch	3·03	60	*Caith* .	Wick	1·48	65
,, .	Carsphairn, Shiel	4·03	61	*Ork* .	Deerness	2·09	69
Dumf.	Dumfries, Crichton R.I.	2·13	69	*Shet* .	Lerwick	2·89	91
,, .	Eskdalemuir Obs	3·52	71	*Cork* .	Caheragh Rectory	...	...
Roxb .	Hawick, Wolfelee	3·81	117	,, .	Dunmanway Rectory	6·77	116
Selk .	Ettrick Manse	3·84	83	,, .	Cork, University Coll	6·05	162
Peeb .	West Linton	3·23	...	,, .	Ballinacurra	5·79	155
Berw .	Marchmont House	3·95	190	,, .	Mallow, Longueville	4·57	134
E.Lot.	North Berwick Res	2·75	176	*Kerry*.	Valentia Obsy	3·59	69
Midl .	Edinburgh, Blackfd. H.	2·44	147	,, .	Gearhameen	6·50	73
Lan .	Auchtyfardle	2·33	...	,, .	Bally McElligott Rec	2·70	...
Ayr .	Kilmarnock, Kay Pk	1·54	...	,, .	Darrynane Abbey	4·80	104
,, .	Girvan, Pinmore	1·94	45	*Wat* .	Waterford, Gortmore	4·57	142
Renf .	Glasgow, Queen's Pk	1·75	58	*Tip* .	Nenagh, Cas. Lough	...	...
,, .	Greenock, Prospect H.	3·74	67	,, .	Roscrea, Timoney Park	...	...
Bute .	Rothesay, Ardencraig	3·02	...	,, .	Cashel, Ballinamona	2·85	90
,, .	Dougarie Lodge	2·15	...	*Lim* .	Foynes, Coolnanes	2·07	65
Arg .	Ardgour House	3·97	...	,, .	Castleconnel Rec	1·77	...
,, .	Glen Etive	...	...	*Clare* .	Inagh, Mount Callan	4·28	...
,, .	Oban	2·75	...	,, .	Broadford, Hurdlest'n.	1·87	...
,, .	Poltalloch	2·98	69	*Wexf* .	Gorey, Courtown Ho	3·75	133
,, .	Inveraray Castle	4·64	68	*Wick* .	Rathnew, Clonmannon.	3·73	...
,, .	Islay, Eallabus	...	...	*Carl* .	Hacketstown Rectory	2·88	96
,, .	Mull, Benmore	...	...	*Leix* .	Blandsfort House	2·03	76
,, .	Tiree	...	...	*Offaly*.	Birr Castle	1·78	78
Kinr .	Loch Leven Sluice	...	...	*Dublin*	Dublin, FitzWm. Sq	1·69	89
Fife .	Leuchars Aerodrome	3·53	202	,, .	Balbriggan, Ardgillan	1·86	95
Perth .	Loch Dhu	...	...	*Meath*.	Beauparc, St. Cloud	1·78	...
,, .	Balquhidder, Stronvar.	3·45	...	,, .	Kells, Headfort	1·89	70
,, .	Crieff, Strathearn Hyd.	2·80	80	*W.M* .	Moate, Coolatore	1·70	...
,, .	Blair Castle Gardens	1·66	60	,, .	Mullingar, Belvedere	2·07	75
Angus.	Kettins School	3·70	158	*Long* .	Castle Forbes Gdns	2·16	76
,, .	Pearsie House	3·49	...	*Gal* .	Galway, Grammar Sch.	1·80	...
,, .	Montrose, Sunnyside	2·72	148	,, .	Ballynahinch Castle	4·48	88
Aber .	Braemar, Bank	2·00	70	,, .	Ahascragh, Clonbrock.	2·42	78
,, .	Logie Coldstone Sch	...	...	*Mayo*.	Blacksod Point	...	...
,, .	Aberdeen, Observatory.	1·91	93	,, .	Mallaranny	4·48	...
,, .	Fyvie Castle	3·28	146	,, .	Westport House	3·85	98
Moray	Gordon Castle	1·29	67	,, .	Delphi Lodge	6·28	75
,, .	Grantown-on-Spey	1·52	72	*Sligo* .	Markree Castle	2·13	62
Nairn.	Nairn	1·40	78	*Cavan*.	Crossdoney, Kevit Cas.	2·23	...
Inv's .	Ben Alder Lodge	1·67	...	*Ferm* .	Enniskillen, Portora	1·80	...
,, .	Kingussie, The Birches.	1·58	...	*Arm* .	Armagh Obsy	1·77	80
,, .	Inverness, Culduthel R.	1·89	...	*Down*.	Fofanny Reservoir	4·79	...
,, .	Loch Quoich, Loan	3·50	...	,, .	Seaforde	3·57	117
,, .	Glenquoich	...	...	,, .	Donaghadee, C. G. Stn.	2·32	100
,, .	Fort William, Glasdrum	3·19	...	,, .	Banbridge, Milltown	...	...
,, .	Skye, Dunvegan	2·53	...	*Antr* .	Belfast, Cavehill Rd	2·60	...
,, .	Barra, Skallary	2·28	...	,, .	Aldergrove Aerodrome.	1·72	71
R&C .	Alness, Ardross Castle.	3·34	101	,, .	Ballymena, Harryville.	2·29	71
,, .	Ullapool	1·71	40	*Lon* .	Garvagh, Moneydig	1·75	...
,, .	Achnashellach	...	...	,, .	Londonderry, Creggan.	2·18	68
,, .	Stornoway	2·24	50	*Tyr* .	Omagh, Edenfel	2·07	69
Suth .	Lairg	3·14	101	*Don* .	Malin Head	...	...
,, .	Tongue	2·46	70	,, .	Killybegs, Rockmount.	1·81	...

Climatological Table for the British Empire, September, 1935

STATIONS.	PRESSURE. Mean of Day M.S.L. mb.	PRESSURE. Diff. from Normal. mb.	TEMPERATURE. Absolute. Max. °F.	TEMPERATURE. Absolute. Min. °F.	TEMPERATURE. Mean Values. Max. °F.	TEMPERATURE. Mean Values. Min. °F.	TEMPERATURE. Mean Values. ½ Max. and ½ Min. °F.	TEMPERATURE. Mean Values. Diff. from Normal °F.	TEMPERATURE. Mean. Wet Bulb. °F.	Relative Humidity. %	Mean Cloud Am'nt 0–10	PRECIPITATION. Am'nt. in.	PRECIPITATION. Diff. from Normal. in.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
London, Kew Obsy.	1012·1	− 5·3	71	39	65·7	51·4	58·5	+ 1·4	53·5	88	7·2	2·55	+ 0·68	18	5·0	40
Gibraltar	1017·4	+ 0·2	94	61	81·2	66·0	73·6	+ 1·2	64·0	81	5·4	0·85	− 0·46	3	...	...
Malta	1016·1	− 0·2	87	63	80·4	71·6	76·0	0·0	70·4	77	3·1	0·63	− 0·64	3	9·7	78
St. Helena	1015·6	0·0	62	52	59·1	53·4	56·3	− 1·1	54·0	92	9·9	2·33	...	19	...	...
Freetown, Sierra Leone	1012·9	+ 0·7	87	69	83·3	71·8	77·5	− 1·6	75·2	89	7·8	34·38	+ 5·90	26	...	...
Lagos, Nigeria	1012·9	+ 0·7	86	72	83·6	74·7	79·1	+ 0·4	74·7	85	8·9	2·32	− 3·27	17	4·4	36
Kaduna, Nigeria	1009·2	...	88	66	84·6	68·1	76·3	+ 1·0	71·4	89	7·9	13·34	+ 1·84	26	5·7	47
Zomba, Nyasaland	1012·0	− 1·7	90	52	82·9	59·9	71·4	+ 1·9	61·3	52	1·4	0·08	− 0·26	1	...	...
Salisbury, Rhodesia	1013·4	− 1·8	92	48	82·2	54·2	68·2	+ 1·8	54·8	36	1·4	0·33	+ 0·05	2	8·7	73
Cape Town	1019·8	+ 0·7	75	40	64·3	49·5	56·9	− 1·0	51·7	83	5·7	2·10	− 0·14	16	...	...
Johannesburg	1014·3	− 1·5	81	40	71·2	47·7	59·5	+ 0·1	46·1	40	0·4	0·23	− 0·73	5	8·7	73
Mauritius	1019·7	− 0·5	81	60	76·5	64·0	70·3	+ 0·2	65·8	69	5·7	1·44	+ 0·14	19	7·8	65
Calcutta, Alipore Obsy.	1002·8	− 1·7	94	77	89·4	79·3	84·3	+ 1·1	79·6	89	7·3	6·67	− 3·34	12*	...	...
Bombay	1006·8	− 1·2	87	73	84·3	75·4	79·9	− 1·0	75·9	88	7·0	11·90	+ 1·22	16*	...	...
Madras	1005·8	− 0·7	97	74	91·9	77·0	84·5	− 0·7	75·8	74	6·9	2·98	− 1·87	6*	...	...
Colombo, Ceylon	1010·3	+ 0·4	86	71	84·6	75·9	80·3	− 0·9	76·4	77	6·7	3·80	− 0·96	17	7·5	62
Singapore	1009·5	− 0·3	89	72	86·9	76·8	81·9	+ 0·8	77·9	80	5·4	4·03	− 2·76	10	7·3	60
Hongkong	1008·1	− 0·2	89	65	83·1	74·7	78·9	− 2·1	74·3	79	7·2	7·37	− 2·32	17	5·1	42
Sandakan	1008·7	...	92	72	89·3	74·9	82·1	+ 0·4	76·7	79	7·1	12·69	+ 3·36	16	...	...
Sydney, N.S.W.	1016·0	− 0·1	79	44	66·0	49·5	57·7	− 1·5	52·7	63	4·8	2·16	− 0·70	14	7·0	59
Melbourne	1015·8	0·0	74	36	63·7	44·5	54·1	0·0	49·6	70	5·2	1·99	− 0·45	16	6·5	55
Adelaide	1015·2	− 2·3	79	43	67·8	49·1	58·5	+ 1·4	52·4	60	5·3	2·77	+ 0·72	11	6·9	58
Perth, W. Australia	1017·1	− 0·9	68	45	64·3	50·5	57·4	− 0·8	52·7	70	6·0	3·41	− 0·01	18	6·4	54
Coolgardie	1014·3	− 2·8	87	36	71·1	44·4	57·7	− 1·0	50·8	55	1·6	0·02	− 0·65	1	...	...
Brisbane	1016·0	− 1·6	82	46	73·8	54·6	64·2	− 1·0	57·6	62	3·6	3·49	+ 1·49	8	7·6	64
Hobart, Tasmania	1014·4	+ 3·4	66	37	57·9	43·0	50·5	− 0·5	45·4	66	5·7	0·79	− 1·28	16	6·1	52
Wellington, N.Z.	1019·8	+ 5·2	63	34	53·7	41·5	47·6	− 4·0	45·6	74	6·6	4·80	+ 0·83	13	6·5	55
Suva, Fiji	1013·2	− 1·1	88	63	79·9	70·7	75·3	+ 0·8	71·0	86	8·2	14·05	+ 6·36	26	3·2	27
Apia, Samoa	1011·1	− 1·1	87	71	85·3	74·5	79·9	+ 1·7	75·8	75	4·7	7·00	+ 1·89	15	8·2	68
Kingston, Jamaica	1011·6	− 0·6	94	72	88·5	74·5	81·5	0·0	72·5	81	6·2	6·98	+ 2·95	7	3·7	30
Grenada, W.I.	...	...	87	71	84	74	79	− 1·3	73	74	6	11·10	+ 3·11	18	...	...
Toronto	1016·9	− 0·9	82	33	67·7	49·9	58·8	− 1·7	52·3	81	5·2	3·20	+ 0·53	13	6·4	51
Winnipeg	1015·3	+ 1·5	82	28	62·3	41·7	52·0	− 1·7	42·7	90	5·2	1·63	− 0·59	14	5·3	42
St. John, N.B.	1014·6	− 2·8	71	41	62·1	48·3	55·2	− 0·7	50·9	83	6·4	3·93	+ 0·19	16	5·7	45
Victoria, B.C.	1015·8	− 0·6	79	45	65·0	50·4	57·7	+ 1·6	50·7	91	2·5	1·18	− 0·63	5	9·0	72

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

(30851) Wt. 18/32 1050 3/36 Hw. G.377/6