The Meteorological Magazine

Vol. 72

(Eighteenth of the New Series)

1937

Published by the Authority of the Meteorological Committee. Air Ministry. Meteorological Office.

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 ;
26 York Street, Manchester 1 ; 1 St. Andrew's Crescent, Cardiff ;
80 Chichester Street, Belfast ;
or through any bookseller

INDEX

ERRATA

See pages 49, 73, 121, 170, 293

ILLUSTRATIONS

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

Feb., 1937

No. 853

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

Editorial

The first number of Volume 72 of the *Meteorological Magazine* appears in a new cover, which has been designed by Mr. E. H. Clarke. The design formerly in use was adopted in February, 1920, the first number to be published by the Meteorological Office. The new design, with its somewhat conventionalised representation of a meteorological station, carries on the tradition begun by G. J. Symons with a representation, on the cover of *Symons's Meteorological Magazine*, of the Observatory on Ben Nevis.

Special Importance of Actinometric and Solar Climatic Investigations in Different Rivieras of the World*

By WLAD. GORCZYNSKI, D.Sc.

Although the name of "Riviera" is common enough and extensively used, we find till now no scientific classification and very few investigations concerning the climatic and other aspects of a Riviera. We need, however, such a classification and methodical study of this important problem, fascinating not only from scientific but also from various practical points of view. First of all we should not forget that there exist several rivieras in different continents of the earth. In addition to the well-known Mediterranean Riviera, we

* This communication was read by the author on September 16th, 1936, at the Oxford meeting of the International Commission of Solar Radiation. See also *The Meteorological Magazine* 71, 1936, pp. 1–5 and 29–33.

find four other important Rivieras, viz.: certain coasts of California and of South America; various portions of the littoral of Chile and perhaps also of Argentina and of Uruguay; of South Africa near Cape Town; and of the corner of south-west Australia.

On the other hand, each of the above-named Rivieras can be conveniently divided into some subdivisions and similar portions. Without entering into the details of the classification, we note that the Mediterranean Riviera is naturally divided into three principal parts, Occidental, Central and Oriental. The same can be said, and certain subdivisions established, for the four big Rivieras situated in other continents.

The condition of the brightness of the sky or sunniness is not sufficient for the attribution of a Riviera climatic type: this climate should be characteristically mild especially during winter. The conditions of sunniness and mildness should be scientifically determined by using some appropriate numerical limits. We shall also notice that a mild type of climate implies not only certain limits for the air-temperature, but also certain conditions of climatic "comfort" relating to the humidity, rain and wind. As a general rule, an efficient protection by surrounding mountains seems to be necessary for a proper Riviera in order to maintain a sufficiently mild climate. Desert and the semi-desert places (even situated on the shores as we see in some parts of North Africa) prove that abundant sunshine alone can not be considered as sufficient condition for a Riviera type of climate.

On the other hand, there exist some sunny climates, particularly in winter, at more elevated places above the sea level, but too rigorous and windy to be classified as a Riviera. Finally there are some climates with a pleasant temperature but so monotonously warm throughout the year, or with so much humidity that the necessary conditions of sufficient climatic comfort are not present.

We see therefore that the problem of a scientific definition and classification of a Riviera is complicated enough and should be methodically examined, discussed and established; this must be done above all from the point of view of actinometry and of climatology: general, medical and local (microclimatic studies). Besides their scientific aspect, the various Rivieras have great economic significance, very important for the general life of humanity, for tourists and residents, for the establishment of sanatoria, especially for actinotherapy, for acclimatizations of plants, and so on.

All this justifies fully and incites still more the organization of special research and measurements in climatic localities. In order to be able to "sell" sunny weather efficiently, as the whole tourist industry endeavours to do, it is necessary to provide a good organization of the material life with some festivals; but in addition, it is important to secure also appropriate studies and measurements proper for the scientific interpretation and comparison of the natural resources of each individual Riviera.

The actual " Rivierology " has hitherto been confined to the issue of illustrated booklets and pamphlets for propaganda ; they contain general information and addresses for practical use, but are designed above all to praise and emphasize the beauty and natural charm of these enchanting places. But, in our modern era, it is no longer considered sufficient to praise, but the people demand to be convinced. It is necessary to prove, by means of special studies and scientific measurements, of what the natural resources and advantages of each climatic station really consist. With this methodical procedure on a scientific basis it would be possible to establish the true character of each locality and even to discover some new particularities of climatic cure perhaps unsuspected till now. It is necessary to create a scientific " Rivierology," based on actinometric studies and on climatological data, but applied also to various practical problems connected with these.

A New Distant Reading Anemometer

By J. S. Dines, M.A.

(*Superintendent of Instruments, Meteorological Office*).

Pressure tube anemometers have, for many years past, been installed at the principal Meteorological Office reporting stations and have admirably fulfilled requirements in giving a continuous record of wind speed and direction. Recently a demand has arisen, principally at aerodromes, for an anemometer in which the head can be placed at a considerable distance from the recording portion. It is very desirable, on an aerodrome, that the recorder should be in the main office block where the chart can be seen by the meteorological officer and the pilots. The anemometer mast, if placed on this building, would be a considerable danger to flying and it is therefore necessary to locate it at some point on the outskirts of the aerodrome which may be half a mile or more from the office block. In the case of the pressure tube anemometer the relative positions of the head and recorder are somewhat strictly controlled by the necessity for leading the pressure and suction given by the head through connecting pipes to the velocity recorder and coupling the vane by a direction rod to the direction recorder. Pressure and suction pipes are now made of 1 in. diameter to provide a free flow of air and avoid damping the movement of the float. These tubes may be 100 ft. long without harm. So far as the writer is aware no tests have been carried out to ascertain the extreme permissible length. It is probable that lengths up to 150 or 200 ft. might be used without serious deterioration of the record but it would be undesirable to place the recorder at a greater distance from the head than this. As regards wind direction, it is found in practice best to mount the vane immediately above the recorder so that a straight direction rod can be used to couple the two. It would be possible, by the introduction of bevel gears, to take the movement round corners but the practical limitations to this are obvious. The normal pressure tube anemometer cannot therefore be made to fulfil the functions of a distant reading anemometer, and when the need for such arose a few years ago the Instruments Division of the Meteorological Office was asked to design a suitable instrument. The conditions to be fulfilled were as follows :—

(1) A record of velocity and direction must be given in which not only the mean wind is shown but also the gusts and lulls and momentary changes in direction.

(2) The records of velocity and direction should be on the same chart, one above the other, in order that striking features in the one record can readily be correlated with those in the other.

(3) In addition it was felt that it would be advantageous if the instrument could be designed to use the same chart as the normal pressure tube recorder. Anemometer records in addition to meeting the immediate operational needs on the aerodrome are subsequently analysed for statistical purposes and if the records of the distant reading anemometer could be made identical with those of the normal recorder, the statistical data obtained from the two instruments would be strictly comparable and further, the same tabulating scales could be used for carrying out the analysis.

A survey of the existing literature was first made to see if there were any instruments already on the market which fulfilled the required conditions or could readily be made to do so. This search was fruitless ; it did not appear that any existing instrument fulfilled condition (1) above in a satisfactory manner even if (2) and (3) were neglected. It therefore became necessary to attack the problem *de novo*. The recording at a distance of wind velocity and direction forms two independent problems. A satisfactory solution for direction was arrived at first and a description of the direction recorder will therefore be given first. In the course of the inquiry the matter was discussed with the Superintendent of the Admiralty Research Laboratory who pointed out that electrical units are available which, when suitably connected, have the property of turning in phase with each other. These units are in general appearance not unlike direct current dynamos though the windings are of a special character. If a pair of units are taken and the two armatures are fed with alternating current from the same source while the field windings are suitably connected together by three wires, any angular rotation given to one armature will be accurately reproduced by the other. The units are made in this country by the British Thomson-Houston Company under the name of "Selsyn Units." It is clear that if sufficient turning moment is given to operate a standard M.O. pattern twin-pen direction recorder, these Selsyn units would solve the problem of recording wind direction at a distance. All that would be

[facing p. 4

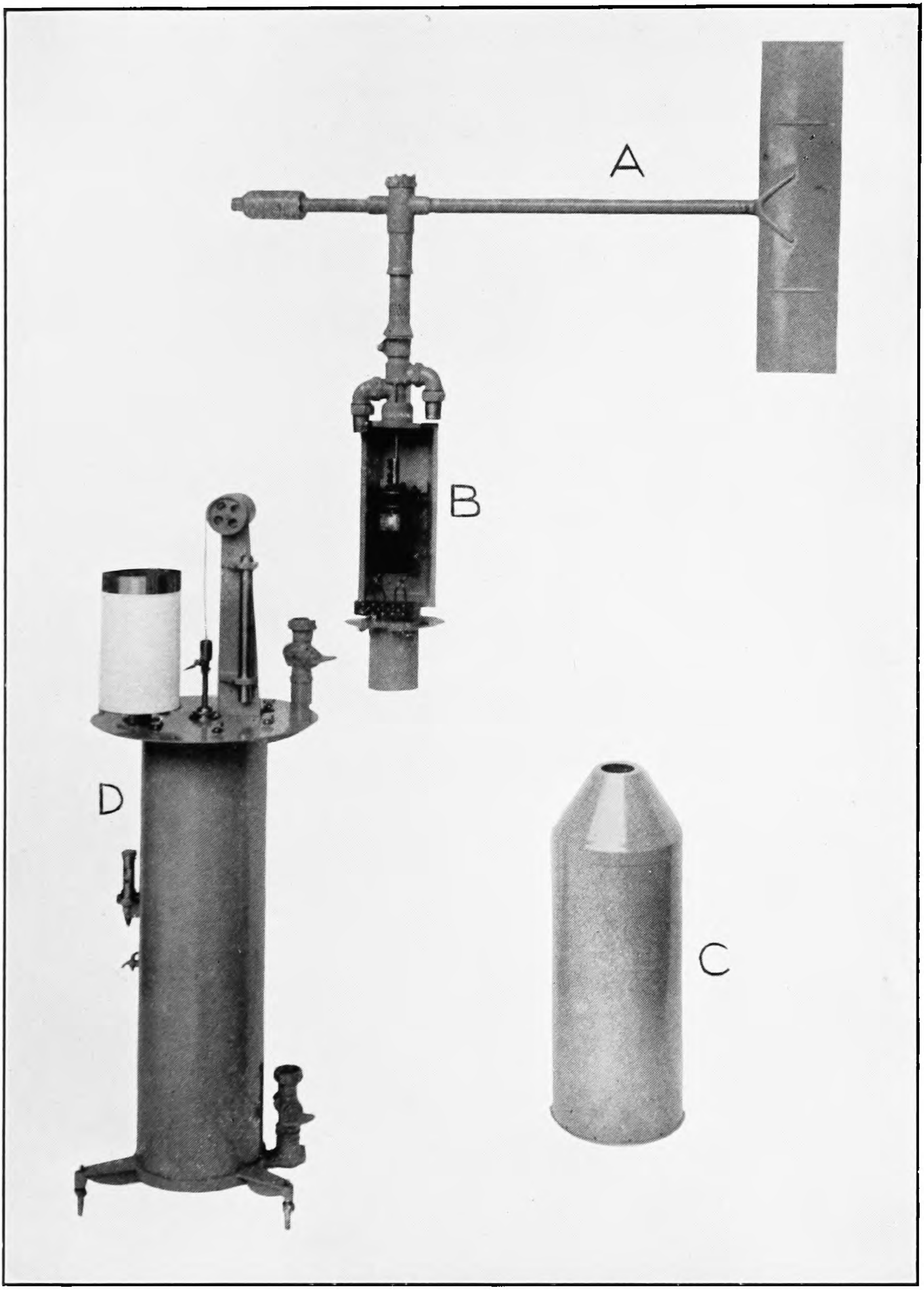


FIG 1

facing p. 5]

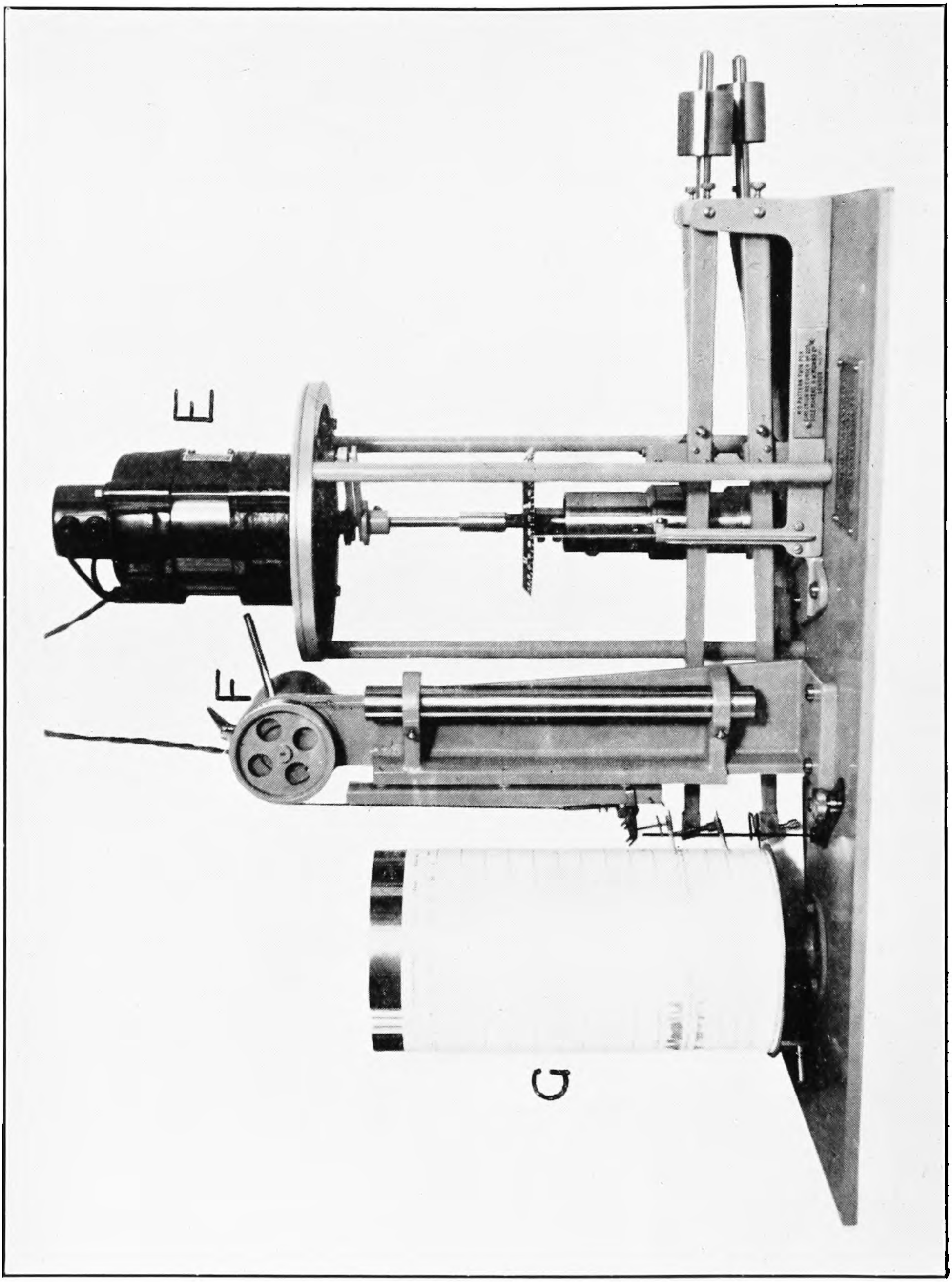


FIG. 2

necessary would be to mount one unit beneath the vane, coupling the armature direct to the vane, while the second unit would be mounted above the direction recorder to which it would be coupled through a suitable universal joint. The chief doubt about the effectiveness of this method concerned the adequacy of the turning moment given by the Selsyn units. In the initial installation, therefore, the largest size of unit was purchased and fitted to a direction recorder and after some preliminary trials in the Meteorological Office the equipment was installed at Cranwell aerodrome, the recorder being mounted 1,200 yards from the head. This instrument proved to be completely successful and has now been running for more than a year without trouble. The design has therefore been incorporated in the Meteorological Office pattern of distant reading anemometer. Experience at Cranwell showed that the turning moment given by the large size Selsyn units was more than adequate to drive the direction recorder. These large units use considerably more current than the smaller sizes and it was therefore decided to use a smaller unit in future instruments. Fig. 1 shows the lay-out now adopted. A standard Meteorological Office type streamline vane A is mounted on a special housing which contains the Selsyn unit B, to which it is connected by a short direction rod. The Selsyn unit is protected from the weather by the shield C which is identical with the standard conical shield fitted to pressure tube anemometers except that it is extended a few inches at the bottom. Fig. 2 shows the recording mechanism where E is the second Selsyn unit mounted immediately above the M.O. pattern twin-pen direction recorder The only important departure from standard in this recorder lies in the mounting of the helix which is modified to reduce the turning resistance to a minimum. The rotating parts are also lightened to reduce inertia forces. High tension alternating current at 220 volts is fed to each of the two Selsyns from the mains while three wires are used to connect the two sets of field windings. These connecting wires can be a mile or more in length without introducing any hindrance to the working of the Selsyns.

While the tests were being carried out at Cranwell on the direction recorder, experiments were also being conducted with a velocity recorder but it was found that this did not meet the requirements laid down above and a fresh solution had to be sought. If it were possible to obtain units similar to the Selsyn units but of smaller size and light construction, a ready solution for the velocity recorder might be obtained in the following manner. One unit would be mounted above the standard pressure tube velocity recorder and coupled to the float rod by a light chain passing over a pulley mounted on the Selsyn spindle. A linear movement of the float would then be transformed to an angular rotation of the armature of the Selsyn unit. A similar arrangement on a second unit at the other end of the line would reconvert the angular movement to a linear movement of the pen. It is essential that the units should be of light construction as the force moving the pressure tube float in light winds is extremely small and the inertia of a heavy Selsyn unit would prevent an accurate record being obtained of the gusts in these circumstances. Unfortunately, Selsyn units are not at present made in this country which are light enough to meet the requirements but it was learned on inquiry that much lighter units are obtainable in the United States under the trade name " Autosyn ". A pair of these units was purchased and a trial instrument which was made up in the Meteorological Office workshop proved so successful that it was decided to adopt this type of transmission for velocity as well as direction. The method of construction will be clear from Figs. 1 and 2. Fig. 1 shows the pressure tube recorder D, termed the velocity control unit, with a light chain from the pen rod running over a pulley about $2\frac{1}{2}$ in. in diameter attached to the spindle of the Autosyn unit, a small balance weight hanging from the opposite side of the pulley serving to keep the chain in tension. This balance weight is protected by a tube and is not visible in the photograph. The second unit is shown in Fig. 2 at F on the left of the Selsyn which drives the direction recorder. A light pen carriage is supported by a chain from a pulley identical with that mounted on the first unit and an adjustable balance weight hung from the other side of the pulley counteracts the weight of the pin carriage. These Autosyn units require alternating current at 32 volts and a small transformer is therefore needed to transform down the voltage from the mains. The field windings require three connecting wires as in the case of the Selsyns. The clock drum G fitted to the electrical anemometer is identical with that used on normal pressure tube recorders. The complete recorder has now been running on the roof of the Meteorological Office at South Kensington for some time satisfactorily. The design of the velocity recorder has not been subjected to as thorough a test as that of the direction recorder for the reason already stated, but there is no reason to doubt that it will be equally successful. A satisfactory solution both for velocity and direction has therefore been reached and it will be noted that all three of the conditions laid down above as essential or desirable have been fulfilled. The record given reproduces gusts and lulls and momentary changes in direction. Velocity and direction are recorded on the same chart and this chart is identical with that used for the normal pressure tube recorder. A record obtained from the instrument is reproduced in the lower part of Fig. 3.

A question may naturally be asked as to the accuracy of the records. In the case of velocity the question can easily be answered. A clock drum and recording pen can be fitted to the velocity control unit D. The resistance to turning of the Autosyn units is so slight that the movement of the pen will not be hindered and this record

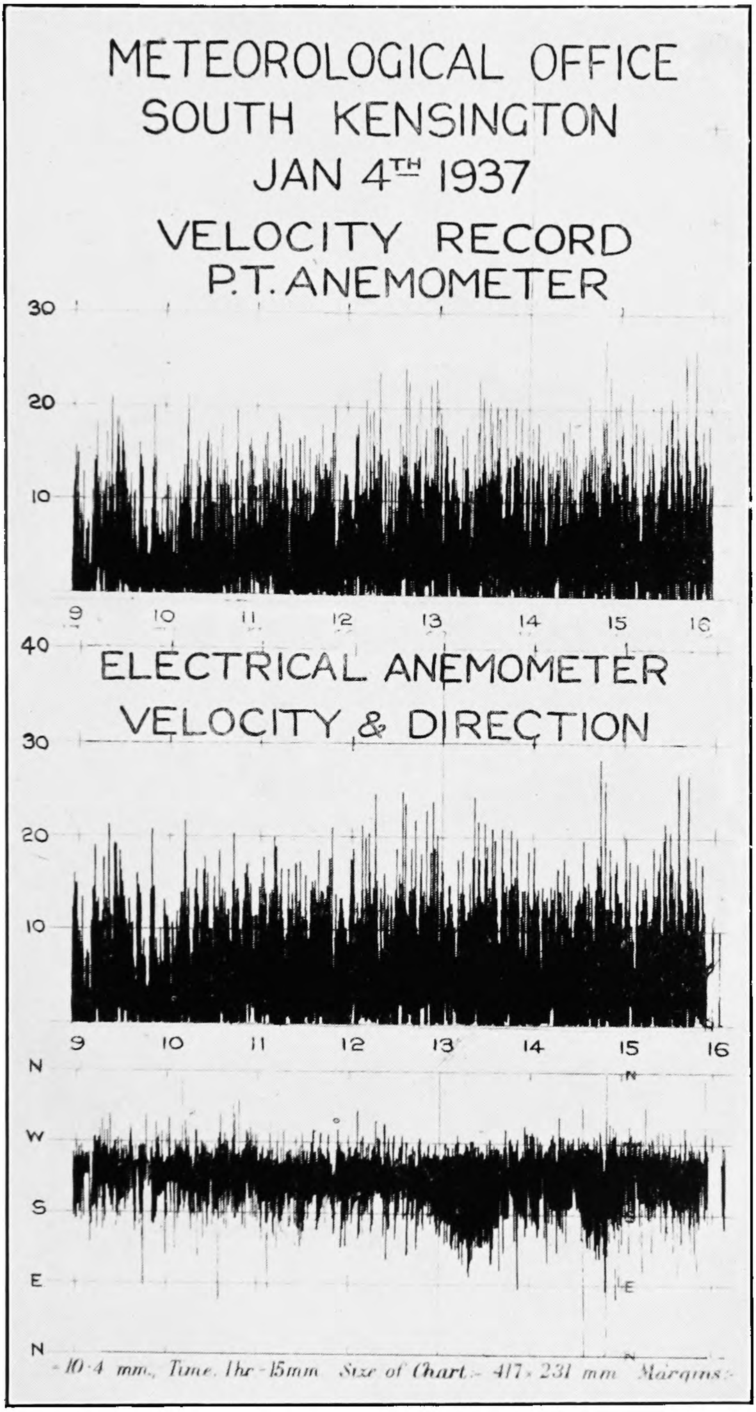

METEOROLOGICAL OFFICE
SOUTH KENSINGTON
JAN 4TH 1937
VELOCITY RECORD
P.T. ANEMOMETER
30
20
10
9
10
11
12
13
14
15
16
40
ELECTRICAL ANEMOMETER
VELOCITY & DIRECTION
30
20
10
9
10
11
12
13
14
15
16
N
W
S
E
N
10·4 mm., Time. 1hr - 15mm Size of Chart.- 417 x 231 mm Margins:

FIG. 3

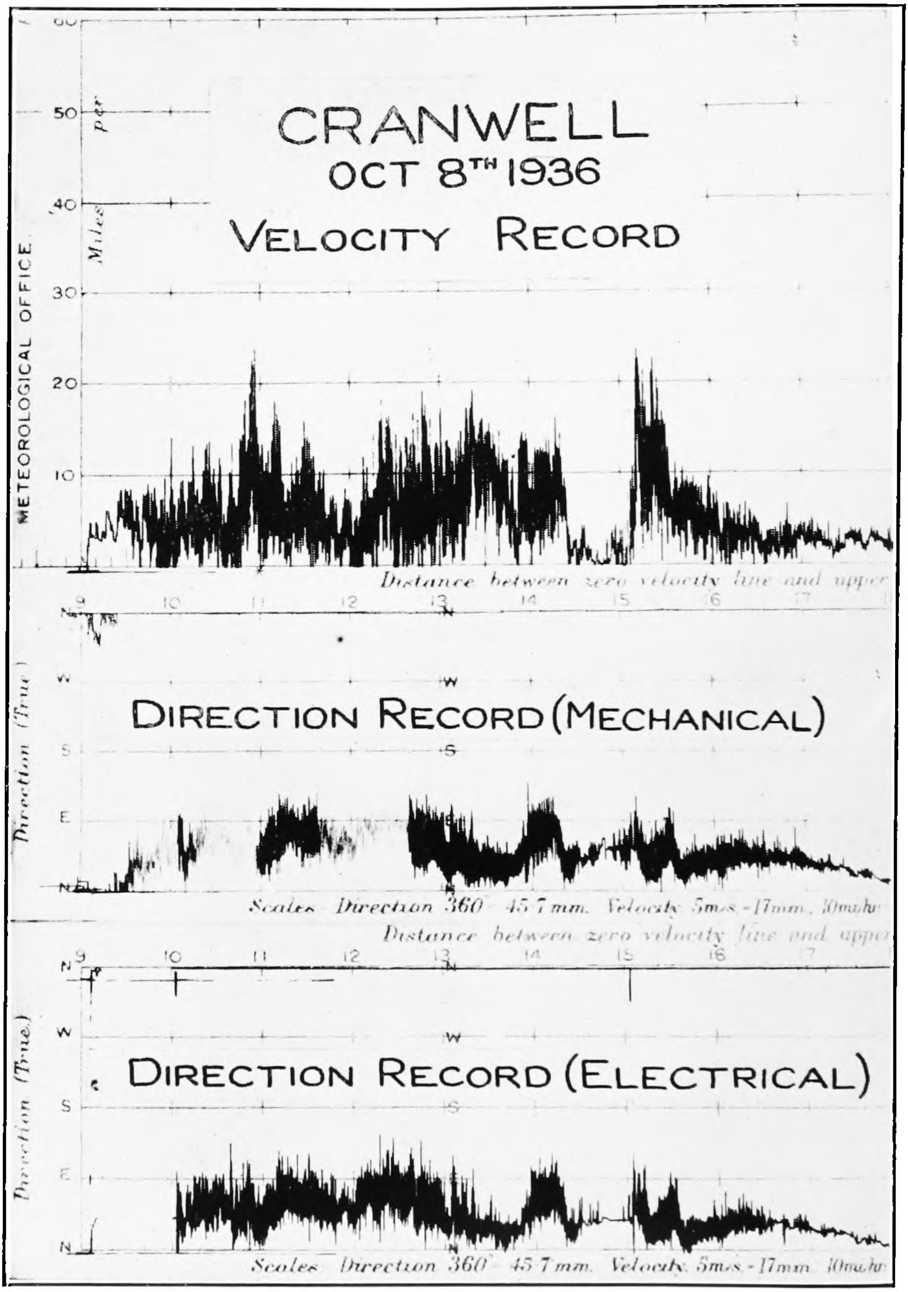

CRANWELL
OCT 8TH 1936
VELOCITY RECORD
METEOROLOGICAL OFFICE
Miles per
50
40
30
20
10
Distance between zero velocity line and upper
9
10
11
12
13
14
15
16
17
DIRECTION RECORD (MECHANICAL)
Direction (True)
N
W
S
E
Scales Direction 360° 45·7 mm. Velocity 5m/s.=17mm. 10mi/hr
Distance between zero velocity line and upper
DIRECTION RECORD (ELECTRICAL)
Direction (True.)
Scales Direction 360° 45·7 mm. Velocity 5m/s.=17mm. 10mi/hr

FIG. 4

will be identical with that given by a normal pressure tube recorder. If, therefore, the record is compared with the record given at the other end of the line by the distant reading anemometer, the errors introduced by the distant reading gear can be assessed. Errors may arise from two causes.

(*a*) Any slight lack of accuracy with which one Autosyn unit follows the other under static conditions, and

(*b*) Inertia effects which will be specially pronounced in gusty winds when the float is moving up and down rapidly.

The errors under (*a*) can readily be tested by moving the float of the control unit D up in steps of 10 m.p.h. and noting how closely the pen of the recording unit F follows each step. The error was found not to exceed 1 m.p.h. at any part of the scale. Over the lower parts of the scale up to 50 m.p.h. the error did not exceed 0·3 m.p.h. To assess the value of errors arising under (*b*), charts taken on the roof of the Meteorological Office were measured up. The electrical recorder was here mounted close to the head and velocity control unit, but experience at Cranwell shows that the interposition of long connecting wires does not affect the working of Selsyn units and there is no reason why it should affect the Autosyn units. The Meteorological Office is surrounded on most sides by buildings higher than itself so that the exposure is extremely bad and a very gusty record is obtained, the vane in some cases boxing the compass frequently. When the wind is west the exposure gives a very gusty record but the vane does not box the compass. With a wind of average strength of about 10–15 m.p.h. the gusts in this case rise to 30–35 m.p.h. In these circumstances the gusts at the two ends of the line are found not to differ by more than about 1 m.p.h. when the calibration error mentioned under (*a*) above has been allowed for. The accuracy of reproduction may be judged by comparison of the two velocity records shown in Fig. 3 which were taken in a moderate SW. wind. At the time these records were taken there was a small error in adjustment which caused the electrical recorder to read 1 m.p.h. higher than the pressure tube at 20–30 m.p.h. under static conditions and this error is clearly seen by comparing the gusts shown in the two records. With a strong S. wind the vane boxes the compass frequently and the velocity pen on one occasion was making rapid excursions from zero to 40 m.p.h. Such a record would never be obtained in any normal exposure but even in this case the gusts at the recording end did not show an overrun exceeding 2 m.p.h. The same method of direct comparison cannot be adopted for wind direction as it is not possible to mount a twin-pen direction recorder below the wind vane when this is coupled to a Selsyn unit. At Cranwell the distant reading anemometer head was mounted alongside the standard pressure tube recorder and direct comparison could be made between the records obtained from the two instruments. On days when the wind was fairly steady in direction the agreement was excellent. On gusty days when the vanes were swinging through 90° or more, the electrical recorder magnified some of the excursions of the pen by ten or twenty degrees but the general character of the record is well reproduced, as will be seen from Fig. 4, in which a pair of direction records from Cranwell are shown. Owing to the fact that it was decided to use smaller Selsyn units in recorders made subsequently to that in use at Cranwell and also to lighten the rotating parts, the results obtained at Cranwell cannot be taken as necessarily applicable to the new instrument but it is believed that the electrical recorder will lead to no serious distortion of the movement of the vane as recorded on the chart.

When the anemometer is set up at a station the control portion needs connecting to the recording portion by a number of wires. The number required depends upon whether electrical energy is available at both ends of the line or at one end only. In the latter case a pair of wires will be needed to convey the alternating current to the remote end, two sets of three wires to connect the field windings of the Selsyn and Autosyn units and in addition a telephone circuit is desirable to enable an operator at one end to speak to the operator at the other end when adjustments are being made. A total of 10 wires is therefore required. If alternating current is available at both ends this number can be reduced to 8.

No attempt has been made here to give a detailed description of the instrument. It is felt that detailed drawings and a close specification would be out of place in the pages of the *Meteorological Magazine*. These have, however, been prepared in the Meteorological Office and are available for consultation by anyone who is seriously interested in the design.

The Weather of 1936 in the Northern Pennines

Data from the station at Moor House (1,840 ft.) in Upper Teesdale covering the years 1932–5 have been published in earlier issues of this magazine* and in the *Quarterly Journal of the Royal Meteorological Society* for 1936. The averages of temperature for the year 1936 are given in Table I together with the extremes and dates of occurrence for each month and the rainfall.

During the year "snow lay," that is, snow covered more than half the surrounding country at the level of the station, on about 93 days, of which about 20, 29, 20 and 10 days occurred in the months January to April respectively: "snow lying" was also reported on June 1st, on two days in October and about 11 days in December. Drifts of course were to be found here and there over much longer periods. The heavy drifting fall of February 28th–29th,

* Vol. 68, 1933, p. 180, and Vol. 67, 1932, p. 206.

was noteworthy; the Teesdale–Alston road was only dug out sufficiently to allow the passage of cars ten days later, as digging was necessary for about five miles and for long distances the snow was six feet deep.

TABLE I

	Mean °F.	Mean Max. °F.	Mean Min. °F.	Extremes and dates °F.	°F.	Rainfall in.
Jan.	31·8	34·3	29·3	46 (9)	16 (14, 15)	8·71
Feb.	30·1	34·3	25·9	41 (18)	14 (4, 12)	2·80
Mar.	36·5	39·6	33·4	52 (23, 24)	25 (16)	4·45
Apr.	35·6	41·9	29·3	54 (27)	18 (21)	1·96
May	44·4	52·4	36·4	65 (16)	30 (sev.)	1·57
June	49·8	57·7	41·9	74 (21)	31 (2)	4·06
July	51·4	56·6	46·2	68 (6)	40 (22)	9·93
Aug.	54·3	60·7	47·9	71 (28)	41 (7, 27)	4·34
Sept.	51·7	56·7	46·6	65 (sev.)	34 (28, 29)	8·33
Oct.	42·2	47·9	36·5	57 (4)	29 (sev.)	7·79
Nov.	37·5	41·9	33·1	54 (21)	26 (25)	9·32
Dec.	34·5	38·3	30·7	45 (17)	11 (7)	9·24
Year	41·7	46·9	36·4	74 (21. vi)	11 (7. xii)	72·50

Temperatures showed no outstanding extremes, but again it is clear that the greatest extremes of cold are most likely to occur following a burst of arctic air. Minimum temperatures of 16° F. on January 14th, and 14° F. on February 4th, occurred under these conditions, at the beginning of cold spells; and the lowest temperature of the year, 11° F. on December 7th, occurred with the axis of a wedge of high pressure just to the west of northern England, again following a burst of arctic air and at the beginning of a week of temperatures rather below normal. The anticyclonic spell in November, however, which was marked by so much fog in the lowlands, gave mild sunny weather on the high moors, with a remarkable maximum temperature of 54° F. on November 21st, associated with the subsidence of particularly warm air above an inversion; this was commented on in this magazine for December, 1936, p. 254. On this day the range of temperature at Moor House was 54° F. to 30° F., compared with 46° F. to 27° F. at Durham Observatory. In contrast, the low maxima associated with cloudy north-easterly weather when rain or snow is falling are noteworthy; the maximum temperature on April 13th was only 32° F., and for the twelve successive days, April 11th–22nd, the highest temperature reached was 40° F.; again, on June 3rd, the maximum was only 39° F., on a day of persistent cold rain from the north-east.

Rainfall for the year amounted to 72·5 in.; February, April and May were dry; the last week of August and the first few days of

October gave the only other dry periods. The gauge is read weekly. July gave nearly ten inches of rain, and was a particularly cloudy and cool month. Indeed, temperature only rose above 68° F. on six days in 1936, as compared with an average of 17 days in the three previous years.

G. MANLEY.

OFFICIAL PUBLICATION

The following publication has recently been issued :—

PROFESSIONAL NOTES

No. 74. *A comparison of the records of two anemometers at different heights at Southport.* By W. C. Kaye, B.Sc. (M.O. 336n.)

This publication gives the results of the comparison of wind velocities recorded at two different heights, 59 feet and 42 feet above ground, at Southport (Lancashire). Higher velocities were always recorded by the instrument at the greater height, but the rates of the two velocities were found to vary with the direction of the wind, the strength of the wind, the season of the year and the hour of the day. The average values showed, on the whole, good agreement with the result derived from the formula, due to Hellmann, used in the Meteorological Office for reducing wind velocities to a standard height.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are—

February 22nd, 1937. *The evaporation of water from plane and cylindrical surfaces.* By R. W. Powell and E. Griffiths. (London, Trans. Instn. chem. Engrs., 13, 1935, pp. 175–98.) *Opener*—Mr. E. Ll. Davies, M.Sc.

March 8th, 1937. *Weather forecasting by analysis of meteorological charts.* By J. van Mieghem. (Institut Belge de Recherches Radio-scientifiques, Vol. 6; Paris, 1936.) (In French.) *Opener*—Mr. C. V. Ockenden, B.Sc.

Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday, January 20th, at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F.Inst.P., President, was in the Chair.

The Report of the Council for 1936 was read and adopted, and the Council for 1937 duly elected, Dr. Whipple being re-elected President.

The Buchan Prize, which is awarded biennially for papers contributed to the Society's publications during a period of five years, was presented to Mr. Charles Sumner Durst, B.A.

Dr. F. J. W. Whipple delivered an address on " Kew Observatory and the development of meteorological instruments in the nineteenth century ", of which the following is an abstract :—

Kew Observatory has been a centre for scientific research since 1842 when the use of the building was granted by the Crown to the British Association. The first Superintendent, Francis Ronalds, designed apparatus for the investigation of atmospheric electricity and was a pioneer in the application of photography to recording meteorological elements. Under his successors, John Welsh and Balfour Stewart, the photographic apparatus was perfected. Beckley's anemograph and recording rain-gauge were also developed. The records of sets of meteorological instruments were skilfully combined by Galton in the charts published by the Meteorological Office in the *Quarterly Weather Report* wherein the sequence of weather at seven observatories was displayed. The work of Kew Observatory as a standardizing institution was also of great importance to meteorologists.

Correspondence

To the Editor, *Meteorological Magazine*

Deficiency of Rain on the Caledonian Canal

It has recently come to my notice that there was an exceptional deficiency of rainfall along the Caledonian Canal during the first six months of 1936.

I do not think attention has previously been called to this fact, which is well illustrated by the accompanying data for the two stations, Fort Augustus and Fort William.

By the end of	Fort Augustus.			Fort William.		
	Total Rainfall.	Deviation from Average.	Percentage of Average.	Total Rainfall.	Deviation from Average.	Percentage of Average.
	mm.	mm.	%	mm.	mm.	%
January ...	47	−90	34	82	−160	34
February ...	84	−159	35	158	−271	37
March ...	125	−211	37	237	−359	40
April ...	156	−245	39	298	−410	42
May ...	181	−281	39	351	−454	44
June ...	206	−308	40	415	−478	46

It will be seen that at the end of June the deficiency amounted to 60 per cent of the average at Fort Augustus and to 54 per cent at Fort William. A decided deficiency was general in northern Scotland, the rainfall for the six months amounting to only 53 per cent of the average at Stornoway.

P. S. HALL.

Woodlands, Farnborough, Hants, January 22nd, 1937.

Wet Harvests in North Wales

As we have recently passed through a very unfavourable harvest period in this district, particularly as far as hay was concerned, the following details of a similar but worse occurrence in 1816 may be of interest.

The reference occurs on page 8 of *Cwm Eithin* by Hugh Evans (Y Brython Press, Liverpool, 1933). Cwm Eithin is in the mountains of Denbighshire, and I give some of the remarks, translated into English. " Great famine and want occurred in the district during the Napoleonic Wars, which was increased by a number of bad harvests. The dearth reached its height in 1816 in north Wales, when at Cwm Eithin only three or four dry days were experienced from the beginning of May to the end of October. It was impossible to dry the corn, or bake it, as it was like dough or clay." Thus the chief trouble was not the crops failing to grow, but the difficulty in harvesting them. This year in Denbighshire the trouble, though not nearly so bad, was due to similar causes. Hay was being carted not far from here after October 1st, this year.

The wet harvest of 1816 is also mentioned in *Gwaith Walter Davies, Gwallter Mechain* (Carmarthen, 1868).

S. E. Ashmore.

Llannerch Gardens, St. Asaph, Flintshire, December 25th, 1936.

Aeroplane Struck by Lightning

On January 13th, 1937, SU–ABN (Capt. Jackson) of Misr Airlines Cairo was struck by lightning 8 miles north-west of Nazareth. The pilot reports that the cloud which he was near and from which the flash emanated did not appear particularly dangerous ; rain was falling from it and it was of anvil shape, but it was of no great depth and seemed quite unimportant as compared with the towering cumulus and cumulo-nimbus which were in the vicinity.

The flash was forked and of blue or violet colour ; one portion passed in front of the machine and the other struck the fixed aerial post over the roof of the control cabin. There was a loud bang but no damage was done as the wireless aerial was wound in and the set earthed.

The compass is believed to have swung violently in an anti-clockwise direction at the time although this is not certain. On being tested next day it was found to have developed errors of $\pm 28°$.

J. Durward.

Airport, Baghdad, January 16th, 1937.

Saline Deposit by Strong Winds

With reference to Mr. Ashmore's interesting letter in the January number of this magazine I should like to mention that a few days after the great mid-September gale in 1935 I went down to Ditchling, Sussex, at the foot of the South Downs. The foliage of many magnificent oaks and other trees was completely " scorched " in a manner that had clearly nothing to do with the encroachment of autumn. Although the situation is protected from direct sea winds by the wall of the South Downs, it is extremely probable that spray was carried over the escarpment by this south-westerly tempest. Since, however, a slight degree of " scorching " was also noticed far inland around London (as at Hampstead) it may be that another factor operates in severe summer gales—desiccation of the leaves through excessive evaporation, at any rate if there is not much accompanying rainfall. Nevertheless this does not rule out the possible effect of salt far inland, for I believe that sea-salt has been detected in exposed situations after severe storms right in the interior of England.

L. C. W. BONACINA.

15, *Christchurch Road, London, N.W.2, January 26th,* 1937.

Wind Circulation around the Meteorological Station, Catterick October 15th, 1936

In order to follow the movements of air in eddies formed in the neighbourhood of obstacles, it was decided that a suitable mode of approach could be made by using " thistledown," which at this time of the year is in fair abundance. When the down attached to each seed is suitably spread out the rate of fall in quiescent air is particularly small, the down taking at times as much as 10 seconds to fall 4 ft. The weight of down attached to each seed is particularly small, so that it was thought that such small weights with a slow rate of descent would indicate very small movements in the air. One, placed near the main pipe leading to the radiator, indicated every time in a marked manner the convection current associated with the pipe. Within the office they have indicated very small wind currents from windows and doors which have been shut.

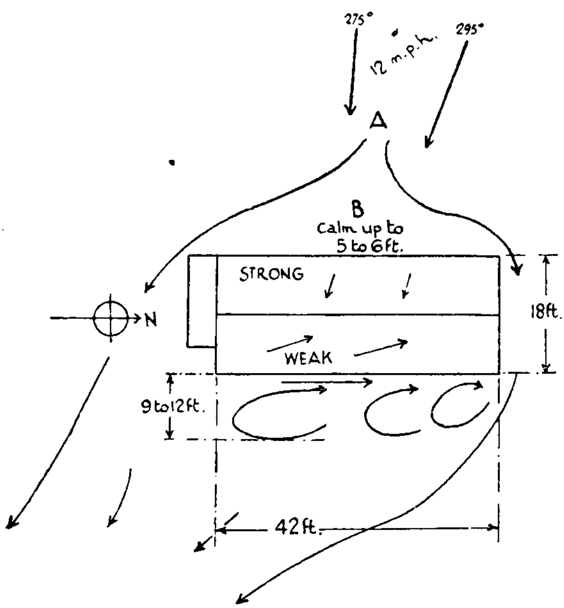


FIG. 1.—SECTION IN PLAN

It was decided to attempt with thistledown an examination of the wind currents in the neighbourhood of the meteorological station. The wind velocity, read from the Dines anemometer at a height of 45 ft. above the surface, was 12–14 m.p.h. from between 275° and 295°. The down was released from numerous positions around the meteorological office, and the resultant flow is indicated in the Figs. 1 and 2, both in plan and in vertical section.

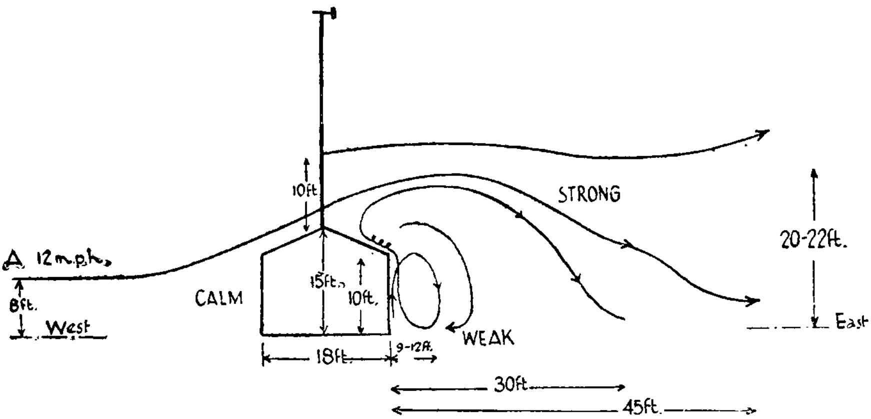


FIG. 2.—VERTICAL SECTION

Down released at the point "A" at a height of 6 ft., in general, went laterally around the office but at a little higher height; with my arm stretched upwards, they went in general over the roof and descended nearly to the earth about 30 to 40 ft. on the leeside. Down released at " B," even up to about 6 ft., usually fell to earth a few feet away, indicating very little air movement. On the roof to windward there was a strong wind, the down being carried rapidly away at first, reaching its highest point about 9 to 12 ft. to leeward of the wall and then descending to earth 30 to 45 ft. to leeward. The highest point reached was about 6 ft. above the ridge, the descent from the highest point to the ground being made in about 4 seconds. Down released on the roof to leeward indicated a weak wind from south to north mainly, but it usually advanced towards the ridge, and was carried quickly away eastwards to descend to earth 9 to 12 ft. to leeward. The weak southerly wind on the leeward roof was corroborated by cigarette smoke near the slates.

One trajectory to leeward was remarkable and is indicated in Figs. 3 and 4.

On the lee side of the building the wind was southerly with a marked vertical component near the wall, but north-westerly with a marked downward component 9 to 12 ft. from the wall.

Down released from the anemometer mast, 10 ft. above the ridge, seem to be unaffected by the building, for they had little downward or upward components, seeming to partake in the general flow. Below this point they were brought down to earth at various distances, usually well beyond 30 ft. to leeward.

Between 9 and 45 ft. from the wall to leeward there was definitely a downward current, the speed timed from its fall from the highest point to earth being 5 ft./sec. If we deduct from this the speed of

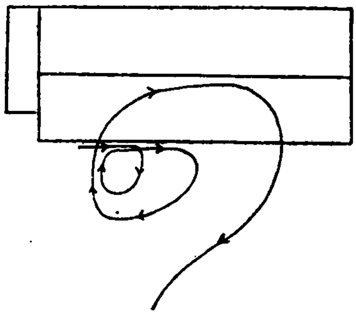


FIG. 3.—TRAJECTORY TO LEEWARD (PLAN)

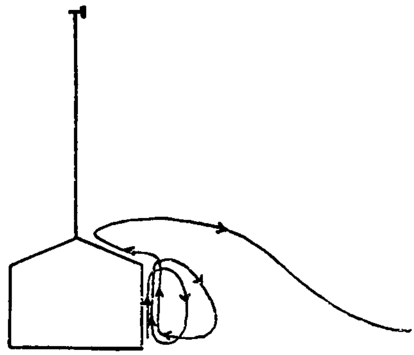


FIG. 4.—TRAJECTORY TO LEEWARD (VERTICAL)

fall of the down in quiescent air, which, with the ones used, was certainly not as great as 1 ft./sec., 4 ft./sec. gives a fair measure of the downward velocities occurring.

At times it became difficult to follow the down owing to the white background of cloud, and when the wind later increased, accompanied by much cloud, no further observations were possible.

W. R. MORGANS.

Mr. Joseph Baxendell and the Fernley Observatory

In June last Mr. Joseph Baxendell retired from the post of Borough Meteorologist to the Corporation of Southport, a position which he had occupied since 1887. As Borough Meteorologist, Mr. Baxendell was Superintendent of the Fernley Observatory, a post formerly held by his father. The name of Baxendell is thus inseparably connected with the history of the Fernley Observatory, that is to say with the history of a meteorological enterprise unique of its kind. The retiring superintendent guided its fortunes for nearly half a century and his relinquishment of that responsibility is an event which calls for more than ordinary notice.

The Fernley Observatory takes its name from Mr. John Fernley, J.P., a retired cotton spinner. Mr. Fernley had been impressed with certain favourable peculiarities of the climate of the Lancashire coast and he decided to establish and give to the Corporation of Southport a model meteorological station, to be located in Hesketh Park. This was done in the summer of 1871 and it was arranged that the first superintendent of the new Fernley Observatory should be Mr. Joseph Baxendell (later F.R.S.), who was then Time-determining Astronomer and Waterworks Meteorologist to the Southport Corporation. The elder Baxendell was a distinguished astronomer, well known as an observer and discoverer of variable stars. His wife was the sister of Norman R. Pogson, C.I.E., for many years Government Astronomer at Madras, and almost as active an investigator of variable stars as Baxendell himself. Their son, the subject of the present notice, was born in 1869 at Crumpsall, now a part of Manchester. He was a delicate child and was precluded by ill-health from being educated at any public school or college. His education was therefore undertaken by his parents and one or two friends. It is not surprising in the circumstances that young Baxendell's training had a strongly scientific trend and that he soon became interested in his father's astronomical and meteorological work. On account of his weak health he found it necessary to abandon his efforts to continue the astronomical observational work and he devoted himself to meteorology. His work in this direction bore early fruit, for on the death of his father in 1887, Joseph Baxendell was appointed to be his successor as Superintendent of the Fernley Observatory on the recommendation of Sir Henry Roscoe, backed by the support of the Town Clerk and the Medical Officer of Health of Southport. Thus the delicate youth of eighteen entered upon the duties which he performed with great distinction for nearly 50 years.

Mr. Baxendell's interest in periodicities was stimulated at a very early age by the work of his father and uncle on variable stars, and it is of interest to note that he had found the periodicity of 5·1 years in Lancashire rainfall even before the death of his father. His subsequent work on the confirmation of this periodicity, and on the investigation of other meteorological periodicities is too well known to need reiteration here. His other statistical investigations included valuable work on the land and sea breezes of Southport and on the association of rainfall with wind direction, summaries of which are to be found in recent annual reports of the Fernley Observatory. As a result of Baxendell's great interest in the details of local climatology we possess certain data for Southport which could only be evaluated for other observatories by a most laborious analysis.

Mr. Baxendell also made important contributions to meteorology as a designer of instruments. The best known of his achievements in this sphere are his "anemoscope," or wind-direction recorder, and the Fernley recording rain-gauge which he designed in co-operation with James Halliwell. The Baxendell anemoscope is still the most satisfactory form of wind-direction recorder which we possess and it was used in the Cardington investigation of wind structure* where it was more important to record the wind direction with great accuracy than to have the records of velocity and direction on one sheet. Mr. Baxendell also designed a "combined head" to actuate both a Dines velocity recorder and a direction recorder

* See *London, Geophys. Mem.* 6, No. 54, 1932.

through a single mast, and he was among the first to recognise the importance of using pipes of wide diameter to transmit the pressure and suction from the Dines head to the recorder. He was responsible, in addition, for the design of several other instruments, and a number of improvements to standard instruments have resulted from his suggestions.

During the later years of his service Mr. Baxendell devoted much thought and labour to the problem of remedying a defect in the Southport meteorological records which had gradually become more serious with the passing of the years. This was the deterioration of the site in Hesketh Park by the growth of trees. Finally, he was able to secure the establishment of a new observing station in Bedford Road Park, Birkdale, where, so far as it is humanly possible to foresee, the exposure of the instruments will remain unimpaired in perpetuity.

Those of us who have had the privilege of working in association with Mr. Baxendell have learnt to regard him as a wise counsellor, ready at all times to place his great knowledge and experience at our disposal. To such a man, retirement from an official appointment can never mean the relinquishment of interest in the work to which he has devoted his life. We wish him many years of pleasant leisure in which to add to the services which he has already rendered with unstinted zeal to the science of meteorology.

E. G. BILHAM.

The Floods in the United States

During the last half of January the Ohio River rose in a flood which proved to be the highest in living memory. The latter months of 1936 were abnormally rainy, the fall for September to December inclusive being nearly 1½ times the average in the valley of the Ohio and the Mississippi above Memphis. At the end of the year the ground was in a waterlogged condition, and during most of January, 1937 the heavy rain continued, so that by the 18th many fields in the Ohio valley were inundated. From that date the situation rapidly became serious. On January 21st the Little Miami and Ohio rivers broke through the levees at Cincinnati and flooded a large area, and by the 26th the level of the Ohio at that city was 80 ft., exceeding by 9 ft. the previous record of 71·1 ft. which occurred in 1883. Cincinnati was without drinking water, a serious fire was raging due to the igniting of floating petrol, and an outbreak of typhoid was feared. Other cities were in similar difficulties and on January 27th it was estimated that a million people were homeless.

By January 29th the floods in the Mississippi were rising rapidly in their turn. Cairo, at the junction of the Ohio and Mississippi, was isolated, and on the last day of the month the water level stood at 59½ ft., 3 ft. higher than in the great Mississippi flood of 1927. The levees all along the river have been reinforced since that date however, and additional protection was being added at all danger points. Early in February the level at Cairo was beginning to fall, and the engineers were confident that the great cities further down the river would be saved.

REVIEWS

The climate of the Gulf of St. Lawrence and surrounding regions in Canada and Newfoundland, as it affects aviation. By W. E. Knowles Middleton. Canadian Meteorological Memoirs, Vol. I, No. 1. Size $9\frac{3}{4}$ in. × $6\frac{1}{2}$ in., pp. 40. *Illus.* Ottawa, 1935.

It is significant of the close relationship which exists between progress in aviation and in meteorology that the first issue of a new series of memoirs to be published by the Meteorological Service of Canada should be concerned with the climate of Newfoundland and adjacent areas from the aviation standpoint. Hitherto this region has attracted the attention of the general climatologist almost exclusively on account of the juxtaposition there of the Gulf Stream and the cold Labrador current, with which is associated a high frequency of sea fogs in spring and summer. By reason, however, of the importance which Newfoundland has now assumed in connexion with the development of regular trans-Atlantic air services, the publication of a summary of our present knowledge of the somewhat wider aspects of its climatology is particularly welcome.

The author, who has some personal knowledge of the regions concerned, regards his memoir as consisting primarily of 13 diagrams, 27 charts and 12 tables, but these are supplemented by useful discussions of the individual elements, i.e., pressure and winds, temperature, thunderstorms, snow, fog, and cloud. Twenty of the charts depict wind roses, which are available for 6 well-distributed stations and are exhibited for the heights :—surface, 500, 1,000, 2,000 and 3,000 metres, with one chart per season for each height. The observations on which the upper wind roses are based cover, in most cases, the three years 1929–31 and were originally instituted to provide data for use in connexion with trans-Atlantic airship routes. The actual number of observations on which each individual wind rose is based might, however, with advantage, have appeared on the charts. The scale to which the surface roses are drawn appears, incidentally, to be 1 mm. = 4 per cent and not 5 per cent as stated on p.4 of the memoir. These charts demonstrate forcibly the predominance of westerly upper winds at all heights and seasons.

Since a considerable part of the text and tables of the memoir is concerned with fog it is to be regretted that the statistics regarding this element cannot be regarded as satisfactory. Not only are occasions of bad visibility due to snow or other obscurity sometimes included with those of true fog and designated by the comprehensive, though unfortunate, title of "thick weather," but no mention is made of the limit of horizontal visibility which has been adopted by the observers in reporting fog. When the present reviewer was recently studying the meteorology of Newfoundland in some detail it was clearly revealed that observations of fog at Newfoundland stations had not been made on a uniform basis, and the need for the provision of reliable visibility data conforming to international standards accordingly became very obvious. It is, for instance, extremely unlikely that the values given in Table II for the number of days per year with fog at St. John's and Cape Race, i.e., 13 and 189 respectively, are mutually comparable, even after due allowance is made for the inclusion in the Cape Race values of days with bad visibility due to atmospheric obscurity other than true fog.

Subsequent memoirs in this series will be awaited with interest. The synoptic meteorology of Newfoundland will constitute a fascinating line of research, to which the upper air observations now being taken regularly will be a valuable contribution.

S. P. PETERS.

Der Scirocco (*Hamsin*) *Palästinas* by Dr. D. Ashbel, Folia Medicinæ Internæ Orientalia, Vol. I, 1934–5, Fasc. 3–4, Jerusalem, 1936.

In this study Dr. Ashbel adds some interesting detail to the mental picture of the Hamsin (or Khamsin), the hot dry wind of the Middle East. The Hamsin in Syria is a hot easterly wind, not to be confused however with the cold easterly Sharkia which also occurs in winter. The shade temperature may exceed 100° F., and may be higher on the mountains than in the Dead Sea valley, yet the solar radiation is weak, and the high temperature is attributed partly to adiabatic warming of descending air, partly to long-wave radiation from a high-level moist tropical current. The rate of cooling is small or negative, resulting in unpleasant physiological effects. On the ground the humidity is very low and evaporation enormous, while the electric potential difference is very abnormal. The paper is enriched by tables giving hourly values of the meteorological elements at Jerusalem on selected Hamsin days compared with normal values, and by reproductions of thermograms and hygrograms from Jerusalem and the Dead Sea, making a most interesting and valuable study.

BOOKS RECEIVED

Solar Radiation and weather Studies. By C. G. Abbot, Washington D.C., Smithson. Misc. Coll. Vol. 94, No. 10, 1935.

Regenval in Nederlandsch-Indië. By Dr. J. Boerema. Kon. Magn. Meteor. Obs. Batavia. Verh. No. 24, Vol. IV. Maps of the mean annual and monthly rainfall in Celebes.

The statistical tables from which the maps have been drawn are contained in Vol. I of Verh. No. 24 which was reviewed in the *Meteorological Magazine*, **68**, 1933, p. 21.

OBITUARY

Canon William Frederick Archibald Ellison.—We regret to record the death on December 31st, 1936 of Canon W. F. A. Ellison, Director of Armagh Observatory. Canon Ellison was a scholar of Trinity College, Dublin; he was ordained in 1890 and became rector of Monart, County Wexford in 1902. Six years afterwards he was instituted rector of Fethard, which position he held until 1918, when he was appointed Director of Armagh Observatory. Throughout his life Canon Ellison was devoted to the study of astronomy, as well as meteorology; he was the author of "The Amateur's Telescope" and of many articles on astronomy. He was interested in the mechanical as well as the observational side of astronomy and was well known as a maker of mirrors for reflecting telescopes. He became a Fellow of the Royal Astronomical Society in 1918 and of the Royal Meteorological Society in 1919; in 1932 he was appointed a member of the Royal Irish Academy and he became a Canon of Armagh Cathedral in the same year. He leaves a widow and two sons, one of whom is a member of the staff of Sherborne School.

E. G. Bilham.

Sir William J. Keith, K.C.S.I.—The death took place on January 22nd of Sir William Keith of Saint Margaret's, Dunbar. A son of the late Mr. Davidson Keith and elder brother of Professor A. Berriedale Keith, he was born at Portobello in 1873 and was educated in turn at the Royal High School, Edinburgh University and Christ Church, Oxford. In 1895 he entered the Indian Civil Service, taking first place in the final examination of the following year. In the course of a distinguished career in Burma he held many important offices and was Governor of the province from 1925–30. He was made a Knight in 1925 and Knight Commander of the Star of India in 1928.

On retiring from the Indian Civil Service in 1930 Sir William Keith took up residence at Dunbar, becoming a member of the Town Council and a Magistrate, and devoting his great energies to local affairs. Amongst other matters he was instrumental in starting a climatological station of the Health Resort class and in its efficiency he always maintained a close interest.

He is survived by Lady Keith (only daughter of Sir Harvey Adamson, K.C.S.I.), and a son and two daughters.

A. H. R. Goldie.

NEWS IN BRIEF

Professor Dr. Julius Bartels has been appointed Professor of Meteorology in the University of Berlin.

The sixteenth Annual Dinner of the staff of the Meteorological Office, Shoeburyness, was held at the Palace Hotel, Southend-on-Sea, on Saturday, February 6th. The guests were Mr. J. S. Dines, M.A., Superintendent for Army Services and Instruments, and Col. F. N. C. Rossiter, R.A., M.C., Superintendent of Experiments, Shoeburyness. A number of past members of the staff were present.

The Weather of January, 1937

A large area of low pressure occupied the northern North Atlantic and Arctic, with a centre below 985 mb. extending from Iceland to the south of Greenland and a minor centre below 995 mb. north-east of Spitsbergen. A steep gradient for westerly winds occupied the mid-Atlantic between 40° and 50° N., while between the Faroes and Scandinavia there was a steep gradient for southerly winds. Pressure was high in the east, exceeding 1030 mb. over most of Russia and southern Finland, with a steep gradient towards the Arctic Ocean. In America pressure was high off the Atlantic coast of the United States, decreasing steadily south-westwards to a low pressure area over New Mexico, a distribution favourable to south-easterly winds bringing much moisture from the Gulf of Mexico to the Mississippi basin. Over most of Europe, Canada, northern United States and south-west North Atlantic pressure was considerably above normal, the greatest excesses being 18 mb. at Kuopio (Finland), 19·8 mb. at Kodiak (Alaska) and 7·9 mb. near Nantucket (Mass.), while pressure was below normal over most of the North Atlantic and southern United States, the greatest deficits being 12·8 mb. at Julianehaab (Greenland) and 3·3 mb. near S. Antonio (Texas).

Temperature was above normal over Great Britain, the Faroes, Iceland, east Greenland, the Arctic Ocean, Scandinavia, Finland and northern Russia and Siberia, the excess reaching very high values in the north. The means of 12·4° F. at Myggbukta in east Greenland and 27·7° F. at Spitsbergen were both 17° F. above normal. In the north-west of Siberia the temperatures were especially abnormal, the figures north of the Arctic circle decreasing from about 10° F. in the west to —3° F. in the east, in place of normal temperatures for January 20 to 25 degrees lower. Germany and eastern Europe on the other hand were abnormally cold, the means being well below freezing point even in Germany, and 4° to 7° F. below normal. Western Europe and Switzerland enjoyed mild weather, the mean of 34·3° F. at Zurich being 4·5° F. above the average. Ireland and the Azores were relatively cool.

Rainfall was excessive over Iceland and Jan Mayen, most of the British Isles, France, Switzerland, Austria, Hungary and the Balkans, but deficient over nearly all the east of Europe and western Siberia, a large part of the latter being almost rainless.

Dull and unsettled weather, with frequent rain and gales, prevailed generally over the British Isles, while temperature was generally much above normal except for the wintry spell towards the end of the month. A maximum of 57° F. was recorded at Dublin on the 3rd and at Bradford and Manchester on the 22nd, while minimum temperatures did not fall below 50° F. on several nights, 52° F. at Sealand on the 3rd. The rainfall was generally in excess, being twice the normal in parts of south-east England, while the rainfall at Valentia and Aberdeen was the highest for January since records commenced at these places in 1866 and 1871 respectively. From the 1st to 6th depressions passed in an east-north-easterly direction to the north of the British Isles, giving moderate to strong SW. to W. winds, increasing to gale force at times with mild unsettled weather and intermittent rain, heavy locally; 2·90 in. were recorded at Festiniog (Merioneth) on the 5th and 1·10 in. at Campsea Ashe (Suffolk) on the 1st. Snow fell on the higher ground in many parts of Scotland on the 1st, 4th and 5th, while thunderstorms were experienced at Oban on the 1st and locally in Ireland on the 3rd and 4th. Good sunshine records were obtained in east Scotland and north-east England on the 1st, 4·7 hrs. at Dunbar, and in south-east and east England on the 5th, 6·4 hrs. at Dover. On the 7th and 8th an interval of mainly sunny quiet weather occurred as a ridge of high pressure passed eastwards across the country—between 5 and 7 hours bright sunshine were experienced at many places on both days, Worthing had 7·2 hrs. on the 7th and 7·3 hrs. on the 8th. Some mist or fog occurred on the 8th, mainly in the east. The aurora borealis was observed clearly from Scotland, north England and north Devon on the 7th. By the 9th the depression over Iceland was influencing the weather of Scotland and Ireland, and from then to the 25th pressure was low over the Atlantic and winds were generally S.–SW., moderate to strong. In the eastern districts, however, mainly light or moderate winds prevailed between the 10th and 15th, but after this the depressions moving over the Atlantic approached nearer the British Isles, and the frequent gales of the west and north spread also at times to the eastern districts. Beaufort force 10 was recorded in north Scotland on the 17th, 18th, 21st, 25th and 26th, while among the highest gusts recorded during the month were 83 m.p.h. at Holyhead on the 17th and 80 m.p.h. at Lizard on the 20th. Mist or fog occurred frequently in south Scotland, the Midlands and eastern counties from the 11th to 15th; on the 14th at Manchester and on the 15th at Mildenhall and Catterick temperature failed to rise above the freezing point owing to the persistence of fog. Rain was frequent during this period and heavy at times in the west, 2·50 in. at Holne (Devon) and 2·08 in. at Brechfa (Carmarthen) on the 12th, and 2·58 in. and 2·00 in. at Borrowdale (Cumberland) on the 14th and 18th respectively, while snow occurred on the hills in Scotland and Ireland on the 15th and 16th, and more generally in Scotland, north Ireland, north England, the Midlands and Devon on the 17th–20th. Widespread floods were reported from the Midlands and eastern and southern counties from the 24th onwards. Good sunshine records were obtained in south-east England on the 10th, north England, south Scotland and Ireland on the 14th, and more generally on the 16th and 19th–21st. Thunderstorms occurred in south Scotland and Ireland on the 22nd and 23rd. During the 23rd the wind backed to SE., but the weather remained mild until the 25th. By the 26th the winds had become east and, with the air supply drawn from the cold continental regions, temperature fell considerably except in south Ireland and south-west England where the cold air did not penetrate until the 29th. Maximum temperatures were below freezing point on the 29th at many places in the eastern counties and the Midlands, 28° F. was the maximum that day at Rothamsted and Upper Heyford. Snow, sleet or hail occurred at most places from the 27th to 30th. In parts of north England snow was lying to a depth of 4 to 6 inches on the 29th and 30th. Gales were almost continuous in north Scotland from the 25th to 31st and strong winds or gales were general over the country on the 27th and 28th. Thunderstorms occurred in south Ireland on the 26th and in south-west England on the 30th. In the south milder conditions returned on the 30th and spread northwards to all districts on the 31st. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	29	+2	Chester ...	43	−10
Aberdeen ...	42	−5	Ross-on-Wye ...	40	−15
Dublin	51	−6	Falmouth ...	31	−29
Birr Castle ...	42	−7	Gorleston ...	60	+4
Valentia... ...	32	−12	Kew	40	+4

Kew, Temperature, Mean 42·8° F., Diff. from normal + 3·8° F.

Miscellaneous notes on weather abroad culled from various sources.

Fine but very cold weather was experienced in northern Italy early in the month. In Switzerland, after a period of dry weather, snow fell generally on the 4th—on the 7th and 8th however, the weather was mild, but on the 9th snow fell again generally, to a depth of 1 to 3 ft. Fog and penetrating cold were experienced in Madrid on the 11th and 12th. Gales occurred in the Grecian Archipelago about the 12th. Heavy snow had fallen in Bulgaria by the 15th and thirteen people had been frozen to death. Heavy snow stopped all rail and road traffic over most of continental Denmark about the 15th to 19th. On the 18th and 19th a severe gale swept across southern Scandinavia, north Germany and the Baltic doing considerable damage to shipping—three ships with their entire crews were lost, two in the Baltic and one in the North Sea. On the 19th, in north Germany, the canals were frozen and there was deep snow, while in south Germany and Switzerland mild weather with heavy rain prevailed. By the 20th however there was cold and snow again in Switzerland. Severe gales were again experienced over the North Sea and Norway on the 22nd, 24th and 25th. Navigation closed at Sulina (Roumania) on the 22nd. Heavy rain occurred in Madrid from about the 24th to 27th. A severe south-westerly gale, accompanied by hail and torrential rain, occurred in Portugal and south Spain on the 25th–28th, doing much damage to shipping, many vessels being sunk inside Leixoes (Oporto), and Gibraltar Harbour damaged. This was followed by floods in various parts of Portugal. Intense cold prevailed in eastern Poland towards the end of the month. Strong winds prevailed off the north and west French coasts during most of the later part of the month, increasing at times to gale force. Storms and heavy snowfalls occurred generally over south Scandinavia and the Baltic on the 29th–31st. In spite of the efforts of icebreakers, the steamers of the Trelleborg-Sassnitz train-ferry services were fast in the ice on the 31st and those of the Storebelt (Denmark) service were drifting away with the ice floes on February 1st. A German tanker sank off Borkum Reef on the 29th, with eleven of the crew, owing to storms. Low temperature with intermittent heavy snowfalls occurred around Vienna during the last 10 days of the month. (*The Times*, January 4th to February 2nd.)

Five natives and eight oxen were killed in a storm which destroyed a kraal on a farm near Vrede, Orange Free State, on the 4th. Strong winds, increasing at times to gales, were experienced along the coast of French Morocco about the 24th to 29th. (*The Times*, January 5th–30th).

At the beginning of the month snow fell generally in and around Jerusalem and much damage was done to the Jaffa orange and grapefruit crops by widespread storms throughout Palestine. The *Aikoku Maru* sunk during a heavy snowstorm on the 12th off Shakotan Cape (Yezo, Japan). Dense fog occurred near Canton about the 20th. (*The Times*, January 5th–21st).

Rain to a depth of $\frac{1}{2}$ to $1\frac{1}{2}$ in. fell soon after the middle of the month in the pastoral areas of South Australia, putting an end to the drought. The total rainfall for the month in Australia was above normal in Northern Territory, South Australia, Victoria and Tasmania, mainly below normal in Queensland, but variable in distribution in Western Australia and New South Wales. (*The Times*, January 20th and cable.)

Navigation closed generally at Quebec on the 2nd, but two tramp steamers convoyed by ice breakers were making their way to the sea on the 3rd. On the 10th Canada had the unusual experience of a thaw in January. In the United States temperature was considerably above normal in the Atlantic Coast States, most of the Gulf States, Ohio Valley, Tennessee and Lake Regions, above normal at first, becoming low in the Mississippi-Missouri Valleys and considerably below normal in the mountain region and along the Pacific Coast. Precipitation was mainly above normal, becoming below normal generally after the middle of the month except in the Ohio Valley and parts of the Atlantic States and Lake Regions. Severe and widespread floods occurred in the Ohio and Mississippi Valleys†. (*The Times*, January 4th–30th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, January, 1937

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	1015·4	SW.4	46	50	94	0·58	0·0	r_0–r 0h.–20h.
2	1020·6	SW.4	39	49	77	—	0·1	r_0 12h. 15h., and 21h.
3	1026·9	WSW.4	49	53	81	—	0·0	
4	1017·9	SSW.5	48	49	87	0·04	0·0	r–r_0 20h.–22h.
5	1020·3	W.3	36	45	64	—	5·0	
6	1005·5	WSW.4	41	54	79	0·19	0·0	r_0 2h–10h., 20h.–22h.
7	1017·1	W.5	43	48	56	0·03	6·5	r 1h.
8	1035·7	SW.1	33	44	78	—	5·2	xf early and late.
9	1033·4	S.4	32	45	74	—	1·6	x early.
10	1027·7	SSE.3	31	44	57	—	6·8	x early and late.
11	1025·4	S.2	32	48	86	—	0·4	f 7h.–10h.
12	1020·7	S.4	37	48	88	0·01	0·0	r_0 17h.–18h.
13	1018·6	SW.2	47	52	94	0·11	0·0	r_0–r 1h.–9h.
14	1021·5	N.3	41	43	86	0·16	0·0	r_0–r 0h.–10h.
15	1016·1	WSW.1	36	41	87	—	0·1	m 9h.–13h.
16	1006·4	WSW.3	38	45	66	0·13	4·1	r–r_0 6h.–11h.
17	1004·1	SSE.4	33	46	74	0·17	2·6	r_0–r 16h.–24h.
18	981·5	S.4	43	50	87	0·31	0·5	r_0–r 0h.–17h.
19	996·4	W.2	34	43	76	trace	4·8	m 9h., pr_0 20h.
20	1007·5	SSE.4	32	46	71	0·03	4·8	x early r 17h.–24h.
21	1001·1	SSW.4	43	51	80	0·34	2·0	r 0h.–6h., 14h.–15h.
22	1006·2	S.4	48	52	89	0·27	0·0	r–r_0 1h.–14h.
23	1007·2	SE.3	45	50	92	0·49	0·0	r 4h.–13h., f 10h.
24	990·4	SE.5	50	53	84	0·34	0·0	r_0 6h.–9h., 13h.–22h.
25	994·3	ESE.2	46	49	83	0·01	0·3	r–r_0 20h.–24h.
26	1001·9	NE.2	37	37	89	0·04	0·0	r_0 0h.–4h., f 10h.–16h.
27	991·0	ENE.5	36	44	70	—	1·5	f 8h.–11h.
28	985·6	NE.5	36	37	81	0·02	0·0	r_0 3h.–5h., r_0s_0 10h.
29	991·7	NE.4	29	31	85	0·01	0·0	is_0 7h.–18h.
30	992·0	E.2	29	45	93	0·20	0·0	s2h.–4h., r 15h.–19h.
31	996·7	S.2	41	49	81	0·26	1·4	r–r_0 18h.–21h.
*	1008·9	—	39	47	80	3·76	1·5	* Means or Totals.

General Rainfall for January, 1937

England and Wales ...	185	per cent of the average 1881–1915.
Scotland	162	
Ireland	178	
British Isles	176	

† See p. 17.

Rainfall : January, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	3·47	187	*War* .	Birminghm, Edgbaston	3·69	183
Sur .	Reigate, Wray Pk. Rd..	5·78	241	*Leics* .	Thornton Reservoir ...	4·48	227
Kent .	Tenterden, Ashenden...	5·56	259	,, .	Belvoir Castle...........	2·79	157
,, .	Folkestone, Boro. San.	4·88	...	*Rut* .	Ridlington	3·37	182
,, .	Margate, Cliftonville....	3·87	234	*Lincs* .	Boston, Skirbeck.........	3·56	220
,, .	Eden'bdg., Falconhurst	6·94	283	,, .	Cranwell Aerodrome...	3·02	176
Sus .	Compton, Compton Ho.	7·56	238	,, .	Skegness, Marine Gdns.	3·28	190
,, .	Patching Farm..........	5·96	229	,, .	Louth, Westgate.........	4·10	189
,, .	Eastbourne, Wil. Sq....	5·73	217	,, .	Brigg, Wrawby St.......	3·09	...
Hants.	Ventnor, Roy.Nat.Hos.	6·05	235	*Notts* .	Worksop, Hodsock......	3·40	192
,, .	Fordingbridge, Oaklnds	6·69	242	*Derby*.	Derby, L. M. & S. Rly.	2·99	150
,, .	Ovington Rectory.......	9·39	347	,, .	Buxton, Terr. Slopes...	6·52	146
,, .	Sherborne St. John......	6·18	265	*Ches* .	Bidston Obsy............	1·86	88
Herts .	Royston, Therfield Rec.	4·06	235	*Lancs*.	Manchester, Whit. Pk.	3·06	122
Bucks.	Slough, Upton...........	4·23	227	,, .	Stonyhurst College......	3·51	82
,, .	H. Wycombe, Flackwell	4·43	204	,, .	Southport, Bedford Pk.	1·62	63
Oxf .	Oxford, Radcliffe........	3·34	185	,, .	Ulverston, Poaka Beck	...	...
N'hant	Wellingboro, Swanspool	3·46	187	,, .	Lancaster, Greg Obsy.	2·77	79
,, .	Oundle	2·51	...	,, .	Blackpool	2·38	87
Beds .	Woburn, Exptl. Farm...	3·16	185	*Yorks*.	Wath-upon-Dearne......	3·11	162
Cam .	Cambridge, Bot. Gdns.	2·88	192	,, .	Wakefield, Clarence Pk.	3·45	180
,, .	March.....................	2·72	170	,, .	Oughtershaw Hall.......	7·95	...
Essex.	Chelmsford, County Gdns	3·77	246	,, .	Wetherby, Ribston H..	2·98	145
,, .	Lexden Hill House......	3·65	...	,, .	Hull, Pearson Park......	2·53	140
Suff .	Haughley House.........	3·35	...	,, .	Holme-on-Spalding......	2·70	143
,, .	Rendlesham Hall........	4·68	257	,, .	West Witton, Ivy Ho.	4·85	153
,, .	Lowestoft Sec. School...	4·13	247	,, .	Felixkirk, Mt. St. John.	3·21	161
,, .	Bury St. Ed., WestleyH.	4·20	234	,, .	York, Museum Gdns....	2·81	159
Norf. .	Wells, Holkham Hall...	3·74	258	,, .	Pickering, Hungate......	3·63	174
Wilts .	Porton, W.D. Exp'l. Stn	5·98	260	,, .	Scarborough..............	4·07	203
,, .	Bishops Cannings........	4·96	214	,, .	Middlesbrough...........	1·94	121
Dor .	Weymouth, Westham.	4·66	192	,, .	Baldersdale, Hury Res.	4·53	139
,, .	Beaminster, East St....	6·71	193	*Durh* .	Ushaw College............	3·58	175
,, .	Shaftesbury, Abbey Ho.	5·56	214	*Nor* .	Newcastle, Leazes Pk...	2·97	150
Devon.	Plymouth, The Hoe....	4·90	147	,, .	Bellingham, Highgreen	4·44	155
,, .	Holne, Church Pk. Cott.	14·35	232	,, .	Lilburn Tower Gdns....	3·34	162
,, .	Teignmouth, Den Gdns.	7·00	246	*Cumb*.	Carlisle, Scaleby Hall...	2·76	111
,, .	Cullompton	7·41	229	,, .	Borrowdale, Seathwaite	22·00	175
,, .	Sidmouth, U.D.C.........	4·23	...	,, .	Thirlmere, Dale Head H.	15·51	191
,, .	Barnstaple, N. Dev.Ath	5·31	163	,, .	Keswick, High Hill......	8·59	170
,, .	Dartm'r, Cranmere Pool	17·70	...	*West* .	Appleby, Castle Bank...	2·61	82
,, .	Okehampton, Uplands.	13·64	268	*Mon* .	Abergavenny, Larchf'd	7·12	211
Corn .	Redruth, Trewirgie......	8·52	201	*Glam* .	Ystalyfera, Wern Ho....	9·87	156
,, .	Penzance, Morrab Gdns.	5·76	152	,, .	Cardiff, Ely P. Stn.......	...	...
,, .	St. Austell, Trevarna...	7·72	180	,, .	Treherbert, Tynywaun.	15·96	...
Soms .	Chewton Mendip.........	6·90	180	*Carm* .	Carmarthen, Model&P.S.	8·29	189
,, .	Long Ashton............	4·43	155	*Pemb* .	St. Ann's Hd. C. Gd. Stn.	5·06	153
,, .	Street, Millfield..........	4·19	...	*Card* .	Aberystwyth	4·56	...
Glos .	Blockley	4·07	...	*Rad* .	BirmW.W.Tyrmynydd	10·97	174
,, .	Cirencester, Gwynfa....	4·76	190	*Mont* .	Lake Vyrnwy	...	...
Here .	Ross-on-Wye............	4·63	167	*Flint* .	Sealand Aerodrome.....	2·57	...
Salop.	Church Stretton.........	4·73	187	*Mer* .	Blaenau Festiniog	10·20	109
,, .	Shifnal, Hatton Grange	2·97	153	,, .	Dolgelley, Bontddu......	6·88	121
Staffs.	Market Drayt'n, Old Sp.	3·00	136	*Carn* .	Llandudno	3·03	126
Worc .	Malvern, Free Library...	3·67	166	,, .	Snowdon, L. Llydaw 9..	18·65	...
,, .	Ombersley, Holt Lock.	2·78	145	*Ang* .	Holyhead, Salt Island...	3·26	112
War .	Alcester, Ragley Hall...	2·93	152	,, .	Lligwy	3·04	...

Rainfall: January, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	4·30	128	*R&C* .	Achnashellach	...	...
Guern.	St. PeterP't.Grange Rd	5·25	179	,, .	Stornoway,MathesonRd	...	...
Wig .	Pt. William, Monreith.	3·35	103	*Suth* .	Lairg	5·51	168
,, .	New Luce School	5·66	140	,, .	Tongue	...	...
Kirk .	Dalry, Glendarroch	9·09	163	,, .	Melvich	4·82	146
Dumf.	Dumfries, Crichton R.I.	4·59	151	,, .	Loch More, Achfary	8·18	112
,, .	Eskdalemuir Obs.	9·14	169	*Caith* .	Wick	3·90	159
Roxb .	Hawick, Wolfelee	4·61	144	*Ork* .	Deerness	5·88	170
Peeb .	Stobo Castle	6·66	222	*Shet* .	Lerwick	4·85	114
Berw .	Marchmont House	3·11	138	*Cork* .	Dunmanway Rectory	11·59	185
E.Lot.	North Berwick Res.	...	...	,, .	Cork, University Coll.	9·04	224
Midl .	Edinburgh, Blackfd. H.	2·04	116	,, .	Mallow, Longueville	11·32	290
Lan .	Auchtyfardle	5·19	...	*Kerry.*	Valentia Obsy.	11·71	213
Ayr .	Kilmarnock, Kay Pk.	4·55	...	,, .	Gearhameen	15·30	151
,, .	Girvan, Pinmore	7·79	165	,, .	Bally McElligott Rec.	8·23	...
,, .	Glen Afton, Ayr San.	11·24	220	,, .	Darrynane Abbey	10·72	214
Renf .	Glasgow, Queen's Pk.	3·64	109	*Wat* .	Waterford, Gortmore	6·43	177
,, .	Greenock, Prospect H.	9·39	137	*Tip* .	Nenagh, Cas. Lough	7·51	190
Bute .	Rothesay, Ardencraig	6·73	150	,, .	Roscrea, Timoney Park	5·35	...
,, .	Dougarie Lodge	6·35	147	,, .	Cashel, Ballinamona	7·01	187
Arg .	Lock Sunart, G'dale	10·33	146	*Lim* .	Foynes, Coolnanes	6·76	179
,, .	Ardgour House	11·72	...	*Clare* .	Inagh, Mount Callan	10·87	...
,, .	Glen Etive	...	...	*Wexf* .	Gorey, Courtown Ho.	7·65	245
,, .	Oban	8·65	...	*Wick* .	Rathnew, Clonmannon.	6·75	...
,, .	Poltalloch	...	...	*Carl* .	Bagnalstown,FanaghH.	7·31	233
,, .	Inveraray Castle	15·74	192	,, .	Hacketstown Rectory	7·35	207
,, .	Islay, Eallabus	7·29	156	*Leix* .	Blandsfort House	5·76	176
,, .	Mull, Benmore	11·70	86	*Offaly.*	Birr Castle	4·48	158
,, .	Tiree	4·82	113	*Kild* .	Straffan House	3·07	119
Kinr .	Loch Leven Sluice	3·77	120	*Dublin*	Dublin, Phoenix Park	2·89	123
Fife .	Leuchars Aerodrome	2·92	160	*Meath.*	Kells, Headfort	4·63	147
Perth .	Loch Dhu	12·40	136	*W.M* .	Moate, Coolatore	3·56	...
,, .	Crieff, Strathearn Hyd.	4·63	115	,, .	Mullingar, Belvedere	4·57	142
,, .	Blair Castle Gardens	8·72	262	*Long* .	Castle Forbes Gdns	...	...
Angus.	Kettins School	5·02	192	*Gal* .	Galway, Grammar Sch.	6·09	164
,, .	Pearsie House	7·97	...	,, .	Ballynahinch Castle	8·67	139
,, .	Montrose, Sunnyside	4·15	209	,, .	Ahascragh, Clonbrock.	5·91	152
Aber .	Balmoral Castle Gdns.	11·80	428	*Rosc* .	Strokestown, C'node	4·87	156
,, .	Logie Coldstone Sch.	...	...	*Mayo.*	Blacksod Point	8·88	175
,, .	Aberdeen, Observatory.	4·96	228	,, .	Mallaranny	7·11	...
,, .	New Deer School House	5·04	216	,, .	Westport House	7·86	169
Moray	Gordon Castle	3·78	187	,, .	Delphi Lodge	15·74	159
,, .	Grantown-on-Spey	3·82	158	*Sligo* .	Markree Castle	5·39	138
Nairn.	Nairn	2·61	131	*Cavan.*	Crossdoney, Kevit Cas.	4·48	...
Inv's .	Ben Alder Lodge	9·40	...	*Ferm* .	Newtwnbtlr, Crom Cas.	4·83	145
,, .	Kingussie, The Birches.	6·92	...	*Arm* .	Armagh Obsy	4·62	183
,, .	Loch Ness, Foyers	...	...	*Down.*	Fofanny Reservoir	10·03	...
,, .	Inverness, Culduthel R.	3·59	141	,, .	Seaforde	4·86	154
,, .	Loch Quoich, Loan	20·79	...	,, .	Donaghadee, C. G. Stn.	4·29	169
,, .	Glenquoich	15·52	113	*Antr* .	Belfast, Cavehill Rd.	...	...
,, .	Arisaig House	7·74	125	,, .	Aldergrove Aerodrome.	4·48	164
,, .	Glenleven, Corrour	11·49	134	,, .	Ballymena, Harryville.	5·08	137
,, .	Fort William, Glasdrum	12·83	...	*Lon* .	Garvagh, Moneydig	6·50	...
,, .	Skye, Dunvegan	6·28	...	,, .	Londonderry, Creggan.	6·29	175
,, .	Barra, Skallary	5·13	...	*Tyr* .	Omagh, Edenfel	6·15	174
R&C .	Alness, Ardross Castle.	4·52	119	*Don* .	Malin Head	5·56	...
,, .	Ullapool	4·80	104	,, .	Killybegs, Rockmount.	2·85	...

Climatological Table for the British Empire, August, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1019·8	+ 4·5	80	47	71·2	54·7	62·9	+ 1·2	55·9	88	7·5	0·48	− 1·76	6	5·9	41
Gibraltar	1017·1	+ 0·6	80	65	76·4	69·2	72·8	...	68·1	88	6·2	0·00	...	0	...	...
Malta	1016·6	+ 1·8	88	69	82·4	71·9	77·1	− 2·0	70·9	76	2·3	0·16	+ 0·02	1	11·0	81
St. Helena	1016·5	− 0·9	65	51	60·7	53·5	57·1	− 0·3	54·7	93	9·2	1·03	− 1·46	19	...	...
Freetown, Sierra Leone	1013·5	+ 2·4	84	69	80·7	72·7	76·7	...	73·2	87	8·3	27·45	− 9·12	24	...	...
Lagos, Nigeria	1014·1	+ 1·1	83	69	80·9	72·1	76·5	− 1·4	71·9	85	8·5	1·12	− 1·52	5	5·4	44
Kaduna, Nigeria	1011·9	...	95	64	82·9	67·5	75·2	+ 1·3	69·8	90	8·5	5·74	− 6·58	16	4·3	35
Zomba, Nyasaland	1017·6	+ 0·7	80	47	74·3	54·0	64·1	− 0·8	58·2	68	4·9	0·11	− 0·26	2	...	...
Salisbury, Rhodesia	1021·6	+ 1·3	82	37	72·4	45·0	58·7	− 1·5	50·3	50	2·2	0·47	+ 0·41	3	9·1	79
Cape Town	1020·2	− 0·1	86	40	65·8	49·6	57·7	+ 2·1	51·1	85	5·4	3·27	− 0·10	10	...	...
Johannesburg	1021·5	+ 1·4	77	31	66·9	44·1	55·5	+ 1·1	43·2	44	0·9	0·00	− 0·51	0	10·1	90
Mauritius	1020·3	− 0·2	79	52	75·7	58·5	67·1	− 1·4	62·8	65	4·8	0·56	− 1·79	12	7·2	63
Calcutta, Alipore Obsy.	1000·3	− 0·7	93	77	89·2	79·7	84·5	+ 1·3	79·5	89	8·2	6·00	− 7·38	13*	...	...
Bombay	1005·7	− 0·2	87	74	85·5	76·5	81·0	+ 0·2	76·7	85	8·6	9·27	− 5·18	16*	...	...
Madras	1004·9	− 0·6	98	72	93·9	77·2	85·5	− 0·5	75·8	74	8·2	5·99	+ 1·45	13*	...	...
Colombo, Ceylon	1010·2	+ 0·9	87	74	85·0	77·1	81·1	− 0·1	77·2	79	6·9	1·15	− 2·09	6	7·7	63
Singapore	1009·6	+ 0·1	89	73	85·5	75·8	80·7	− 0·4	77·1	83	7·1	4·48	− 3·47	23	5·7	47
Hongkong	1004·7	− 0·1	91	74	87·8	78·1	82·9	+ 0·8	78·6	81	6·8	21·31	+ 6·91	19	7·1	55
Sandakan	1008·6	...	90	72	87·5	74·4	80·9	− 0·9	75·9	83	7·8	9·59	+ 1·70	17	...	...
Sydney, N.S.W.	1013·6	− 4·6	81	44	67·4	50·2	58·8	+ 3·8	51·8	63	4·4	1·36	− 1·61	11	7·0	64
Melbourne	1010·8	− 7·2	70	33	59·6	44·7	52·1	+ 1·1	46·7	71	7·3	1·72	− 0·15	19	4·4	41
Adelaide	1013·5	− 5·8	72	42	63·1	47·3	55·2	+ 1·3	50·5	73	6·4	2·08	− 0·45	17	5·1	47
Perth, W. Australia	1015·9	− 3·0	71	42	64·8	52·0	58·4	+ 2·4	53·1	76	6·7	7·26	+ 1·61	24	5·8	53
Coolgardie	1015·6	− 3·7	81	35	65·1	43·9	54·5	+ 0·9	49·4	68	3·5	0·31	− 0·68	4	...	...
Brisbane	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hobart, Tasmania	1002·9	−10·5	61	32	53·3	41·0	47·1	− 0·9	42·4	67	6·2	3·12	+ 1·29	25	4·8	46
Wellington, N.Z.	1013·3	− 1·8	61	33	54·7	44·8	49·7	+ 1·1	47·3	79	6·8	4·68	+ 0·19	20	4·3	41
Suva, Fiji	1013·6	− 0·6	85	63	79·4	68·3	73·9	+ 0·3	68·7	79	5·6	3·03	− 5·26	13	6·3	55
Apia, Samoa	1010·6	− 1·7	86	65	83·5	72·1	77·8	0·0	73·5	74	3·8	7·64	+ 4·01	12	7·6	65
Kingston, Jamaica	1012·3	− 1·2	91	70	88·7	73·7	81·2	− 0·3	73·2	83	4·0	3·94	+ 0·39	8	7·0	55
Grenada, W.I.	1011·2	− 1·4	90	71	87	73	80·0	+ 0·3	74	79	6	6·01	− 3·32	16	...	...
Toronto	1015·6	+ 0·2	97	50	79·0	58·9	68·9	+ 1·7	59·6	74	4·7	1·75	− 1·04	6	7·8	56
Winnipeg	1014·7	+ 1·5	102	42	79·3	53·5	66·4	+ 2·6	53·1	84	4·4	0·50	− 1·66	2	7·4	51
St. John, N.B.	1014·9	− 0·4	85	47	69·3	53·2	61·3	+ 0·7	57·0	82	6·0	2·65	− 1·21	14	6·7	48
Victoria, B.C.	1018·2	+ 1·3	82	48	69·1	53·5	61·3	+ 1·6	56·3	78	3·9	0·66	+ 0·02	3	10·9	76

(35701) Wt. 19/32 1125 2/37 Hw. G. 377

FIG. 1.—FOG CLIMBING THE JUDEAN DESERT TO THE JERUSALEM MOUNTAINS

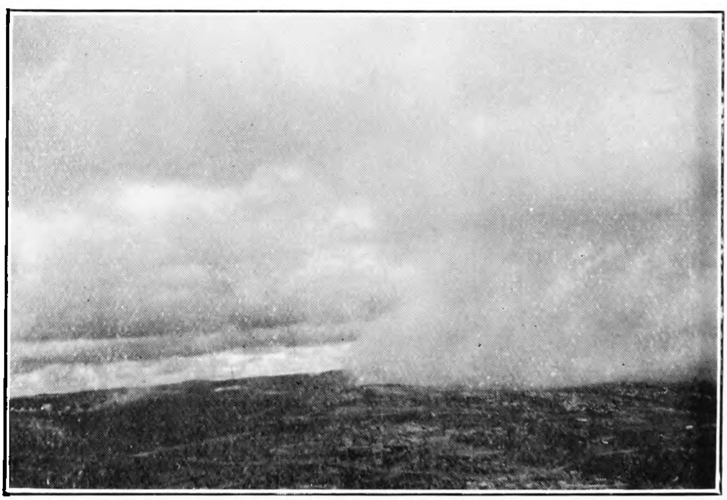


FIG. 2.—FOG FIXED ON THE TOP OF THE MOUNTAIN WITH AN ANGLE TO THE EAST

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

Mar., 1937

No. 854

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

The Fogs which ascend from the Dead Sea to the mountains of Jerusalem.

By DR. D. ASHBEL

(*Hebrew University, Jerusalem*)

A curious and interesting phenomenon, unnoticed up to now, is the heavy fog which reaches Jerusalem from the east. The reason for this lack of attention lies probably in the fact that Jerusalem is situated on the slope of the mountain to the west of Mount Olive, so that when standing in the city one does not see all that happens on the other side of the mountain, in the Judean desert and the Jordan valley. Between November and May, on winter days, appears the fog which originates in the Jordan valley, as it climbs the brooks of the Judean desert at a rate of 5–8 Km./hr. These fogs arrive at Mount Olive and Mount Scopus in the forenoon hours, stay there for a few hours and disappear in the afternoon. It sometimes happens that the fog remains during the whole afternoon and may even grow heavier by an additional stream of new cold air, as was the case on December 27th, 1935. Only on very rare occasions does the fog continue to rise from the Jordan valley all night, as on July 1st, 1936.

The fog does not pass the mountain line to the west, save at exceptional places in the "neck" of the mountain, as between Kfar-Tur and the German Sanatorium, or between the Sanatorium and the University. The mountain line itself is an impassable western boundary for the fog, although its thickness reaches several hundred metres. The fog remains fixed on the eastern slope of the mountain, in proximity to its top, as a wall, forming an angle of

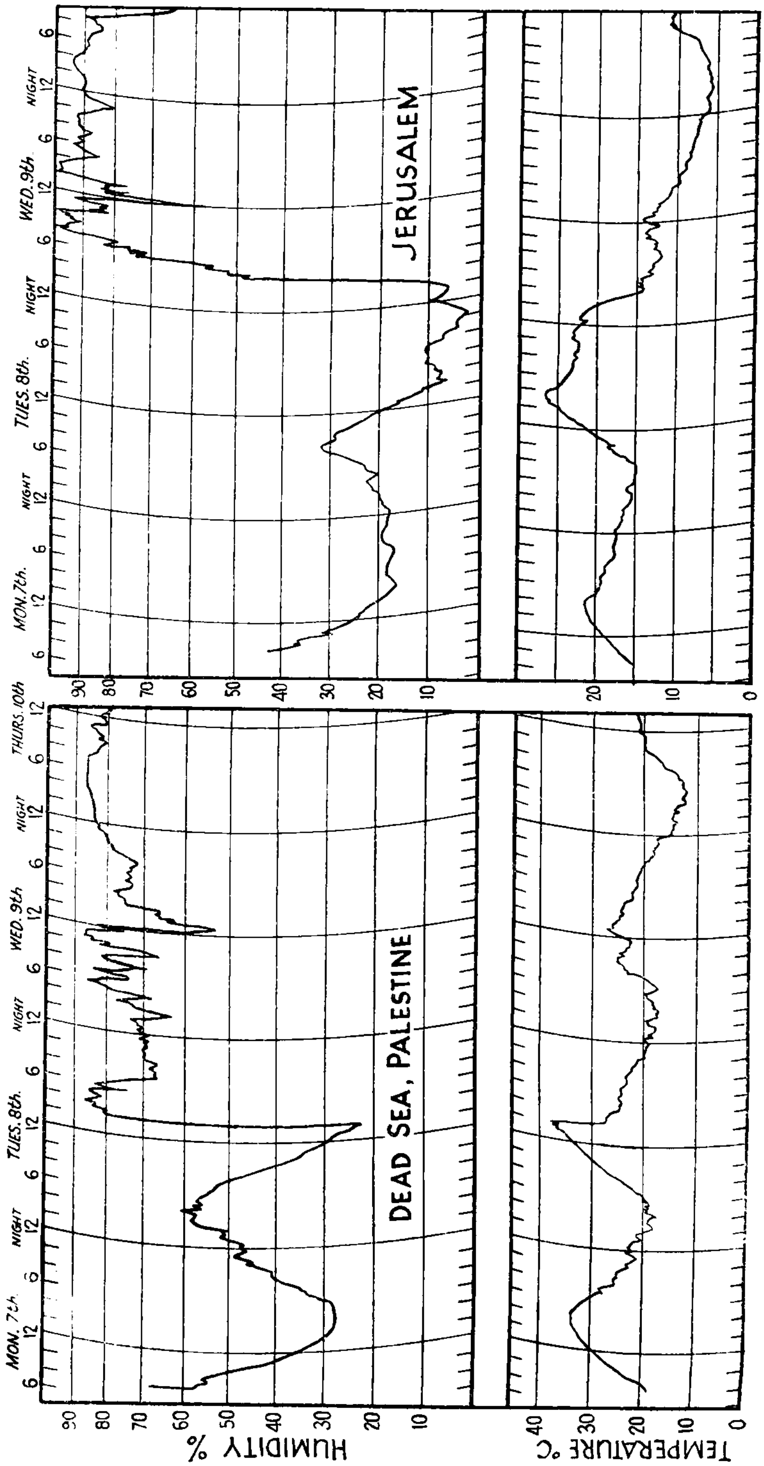


Fig. 3.—Cold air arrival at the Dead Sea and 12 hours later at Jerusalem

about 60° to the east. Thanks to the smoke rising from the burning garbage at a distance of 5 Km. from Jerusalem to the north, it is possible to determine that a western current rises above the fog and probably by pushing it eastward causes its inclination to the east.

The formation of this fog depends on a cold air stream which descends into the Jordan valley in the rear of a barometric depression. This air pushes the warm local air upwards. As this air rises, condensation of vapours takes place from a certain limit upward at a slow rate. The cold air slowly fills the Jordan valley. The rising air spreads over the western slopes of the mountains (Judean, Ephraim and Galileen mountains) and presumably also over the eastern slopes (Moab mountain). I have seen such a fog not only in Jerusalem and the Ephraim mountains, but also during a journey from Nazareth to Tiberias, on the mountains between Nazareth and Kfar Turan, as it spreads and advances over the ground from the east.

The cold air which fills the Jordan valley does not always come from the west or the south-west. A cold air wave may sometimes come from the north or north-east and fill the Jordan valley before reaching the mountains of western Trans-Jordan. It keeps on filling the valley until it reaches its border, the mountain tops, and then it also spreads above them westward. Such an interesting case happened on March 8th, 1932. The cold air then reached the Dead Sea valley 12 hours before reaching Jerusalem (Fig. 3). At first the air temperature in the Dead Sea depression fell rapidly 11° C. during one hour, immediately after noon, and afterwards continued to fall in the afternoon and night hours about an additional 11° C. Only 12 hours after the fall in the temperature in the Dead Sea depression the cold air reached Jerusalem also, about an hour after midnight, and the relative humidity of the air rose at once to the maximum, whereas the temperature fell 8–9° C.

The conditions prevailing on misty days are not so extreme, but each case was preceded in the Jordan valley by sufficiently warm weather and only upon the arrival of the cold air in the rear of the barometric depression, did the formation of the fog start. The appearance of the fog as it creeps from the Jordan valley along the brooks of the desert towards the mountain tops has become already a sure sign of the end of rainy weather, although this phenomenon may repeat itself.

In recent years, I noted the following cases of Dead Sea fogs which reached Jerusalem: January 20th and 21st, 1932; January 6th, 1933, November 8th and December 11th, 1934, January 9th and 16th, November 26th and December 27th, 1935; January 7th, 8th, 12th, 14th and 15th, 1936. Of these, the case of December 27th, 1935 was the most interesting one. It occurred after a khamsin period of several days' duration which ended on December 26th, accompanied by a front of heavy hailstorms throughout the country. On the same day, at 3 p.m., heavy hailstorms occurred in Jerusalem, Tiberias, Tel Mond (on the shore), Ain Harod, Ayeleth Hashachar and Kfar Giladi; i.e., from the northern part of the country to its southern part. The greatest damage was done in the neighbourhood of Tel Mond on the shore, where the water equivalent of the hail

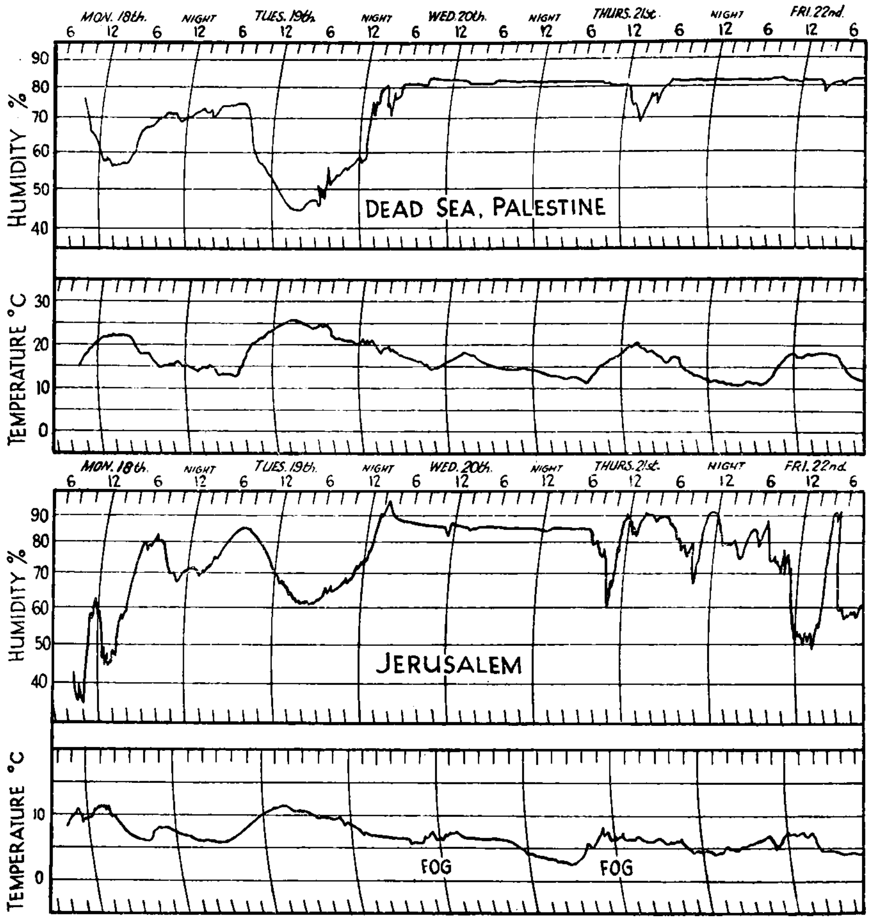


FIG. 4—CONDITIONS AT DEAD SEA AND JERUSALEM DURING EASTERN FOG.

amounted to 45 mm. This hail fell during three-quarters of an hour and devastated the plantations. In Kfar Giladi and Ain Harod the falling hailstones were as large as dove's eggs and also caused considerable damage. On the following day, in the early morning hours, a heavy fog arose from the Jordan valley towards the mountains of Jerusalem and lasted the whole day. It was reinforced in the afternoon hours, seemingly by the addition of new cold air, and also gave up its excess of water as rain (3·75 mm.). Such rain from the east is not at all usual here, but the farmers of the eastern Yesreel valley informed me of several cases of clouds coming from the east and giving rain in their region in small quantities.

The Weather at Malta

Certain meteorological phenomena common enough in one part of the world, may be rare and of outstanding interest in other parts. The tornado is an example of this. On the other hand, a phenomenon which is universally common may have a significance peculiar to a particular place. For instance, a north-easterly gale at flood tide demands special precautions in the Port of London and a north-easterly gale or strong wind calls for special care in the Grand Harbour at Malta. Accordingly, the following description of the weather at Malta on November 24th, 1936, may be of interest, as phenomena coming under both the above categories were experienced on that day. The sequence was as follows: moderate gregale; heavy thunderstorms; a tornado; strong gregale.

A moderate gregale is a north-easterly wind of force 5 to 7 and a strong gregale is a north-easterly gale; the word "gregale" being derived from the local word for Greece, which country lies to the north-east of Malta. The Grand Harbour is exposed to the north-east and a persistent strong wind from this direction may raise sufficient swell in the harbour to necessitate special precautions being taken lest ships at anchor drag their moorings. With a strong gregale blowing, ships have to raise steam and be prepared to leave port at short notice.

On November 24th, 1936, a moderate gregale occurred in the morning and a strong gregale in the afternoon. Between these two events, however, a thunderstorm with intense rainfall occurred at Valletta and, at about the same time, a tornado caused considerable structural damage at the Royal Air Force Station at Hal Far (8 miles from Valletta) and also at the village of Ghaxak nearby.

To examine the sequence of events in conjunction with the synoptic situation, reference should first be made to the 19h.* chart for the previous day on which were indicated a shallow depression over Algeria and a small anticyclone over Cirenaica. The upper winds at Malta were light easterly and at Tripoli moderate easterly in the lower layers, veering to SW. by 13,000 ft. At 5h. the next morning, a depression was indicated between Malta and Tripoli. Information was meagre, however, as African reports were available only from coastal stations of Tunisia and Tripolitania and there were no reports from Libya or Cirenaica. It was not possible, therefore, to estimate accurately the depth of this depression nor yet to locate any fronts with confidence. At 8h. the depression was indicated with its centre somewhere between Malta and Tripolitania. From Malta to Tripoli, however, is 200 miles and no reports were received from the islands between Malta and the Tunisian coast, so that it was still not possible to gauge the depth of the depression.

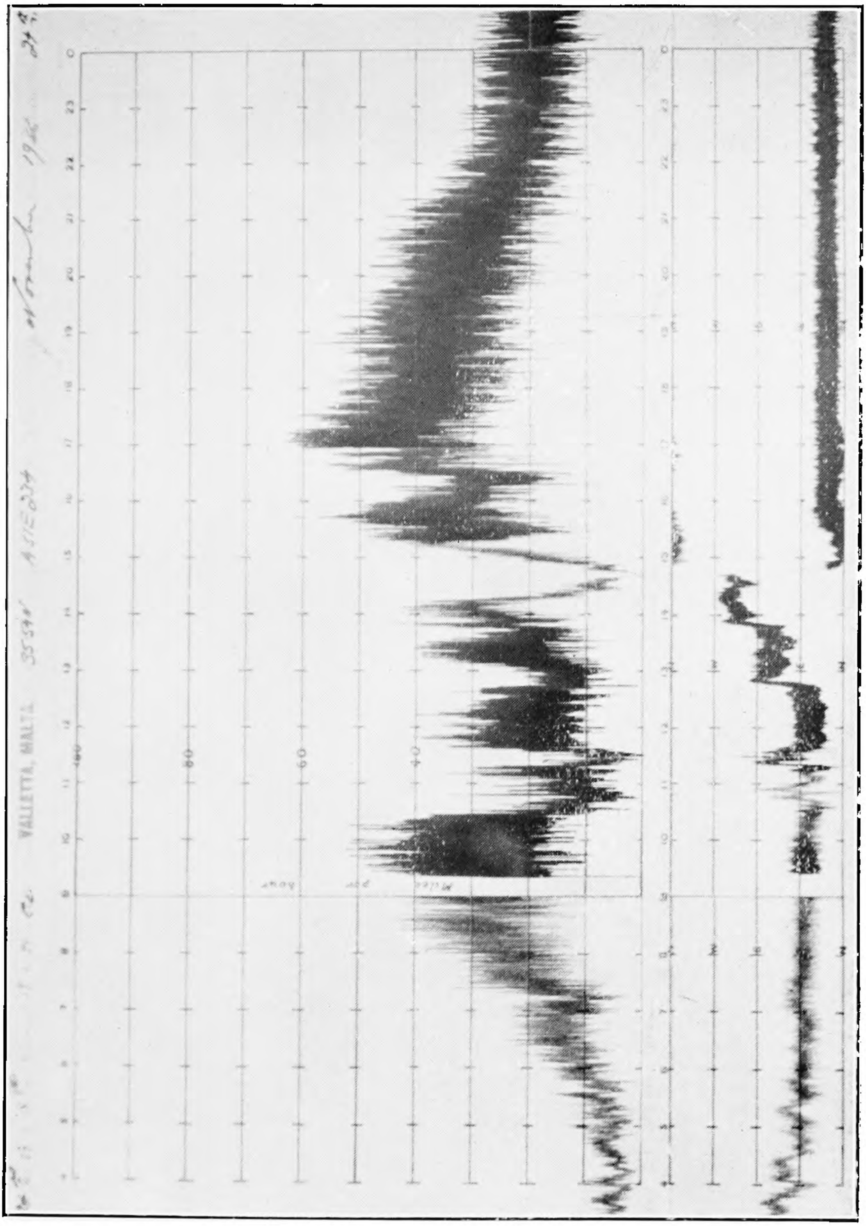
(*All times are Central European Time, 1 hour ahead of G.M.T.)

The upper wind at Tripoli (WSW. 44 m.p.h. at 3,000 ft.) gave a hint that the pressure gradient north of Tripoli was fairly steep, although the upper wind at Malta was only 15 m.p.h. from ESE. at 3,000 ft. The surface wind at Malta was, however, increasing rapidly from ENE. by this time and warning of a moderate gregale was issued to the harbour authorities. It was apparent then, either that the depression was deepening or that it was already deep and moving towards Malta. Undoubtedly a discontinuity passed over Malta between 10h. and 11h. for a thunderstorm with very heavy rainfall (45·7 mm. in $1\frac{1}{2}$ hours) occurred at Valletta and at about 10h. 40m. a small tornado preceded by heavy hail and thunder passed over Hal Far and Ghaxak.

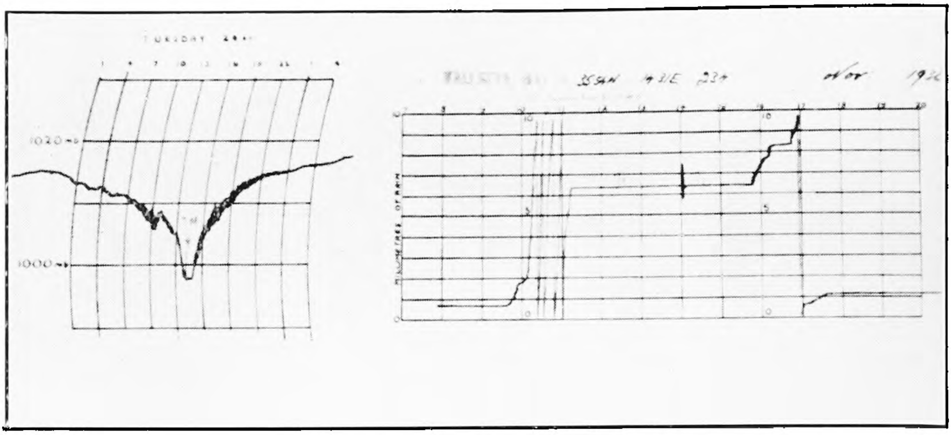
The tornado was small but during its brief life it caused considerable damage. The roofs of two hangars were ripped off, one being carried 200 yards and the other 100 yards. Both hangars were completely destroyed and over twenty aircraft damaged more or less seriously. From the aerodrome the tornado passed northwards and was next reported from the village of Ghaxak 2 miles away where it demolished four stone houses. Nothing more was heard of it after this. The path of the tornado was quite narrow ; a wind sock about 170 yards from the damaged hangars being almost unaffected. There seems but little doubt that the damage was caused primarily by the sudden large reduction in pressure combined with a strong vertical current and not by the horizontal component of the wind. This view is supported in several ways. First, the hangars were closed and therefore destruction could not have been caused by any " umbrella " or " parachute " effect. Secondly, aircraft hands who were at work inside the hangars described the feeling as though their eardrums were being blown out and it was also stated that the wind did not appear to be abnormally strong. Thirdly, a press photograph taken of the damage at Ghaxak gives the impression that the walls of the damaged houses were burst outwards.

Several waterspouts were also observed from Hal Far and from H.M.S. *Hood* at about this time. From this vessel, which was anchored east of Hal Far, one of these waterspouts was seen to move towards the coast in Hal Far direction so that it seems probable that the tornado originated as a waterspout.

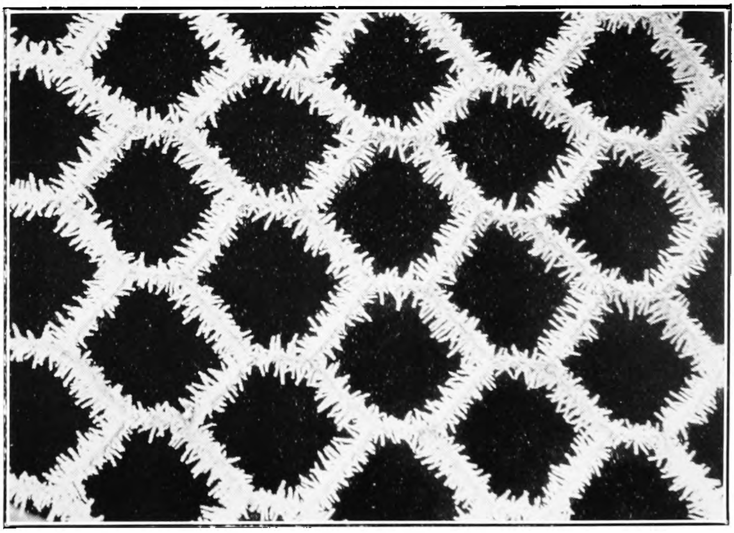
The 11h. chart showed that the depression was more vigorous than previously had been indicated and that the front was a discontinuity between cool air, which had passed over the Balkans and southern Italy and reached Malta from a north-westerly direction, and comparatively warm air coming up from the Gulf of Sidra. This front curved east-north-east and then south-east from Malta and finally down towards Libya. During the early part of the morning the depression apparently deepened and at 11h. it was situated between Malta and the Gulf of Gabes with its centre nearer



ANEMOGRAM, VALLETTA, MALTA, NOVEMBER 24TH, 1936



BAROGRAM AND RAINFALL RECORD, VALLETTA, MALTA, NOVEMBER 24TH, 1936



RIME ON WIRE NETTING AT ESKDALEMUIR OBSERVATORY,
10.50 G.M.T., JANUARY 14TH, 1937 (*see p.* 41)

Malta. At this time its direction of travel was easterly as shewn by the rapidly rising barometer at Lampedusa and by an equally rapid fall of pressure at Malta. The anemogram indicated that at about 12h. 45m. and 13h. 50m. further fronts passed across Malta although the temperature and humidity records do not offer any further evidence on this point.

From 13h. pressure fell rapidly reaching its lowest value between 14h. and 15h. By 14h. 40m. the wind had dropped fairly rapidly to calm to become NE. and rose rapidly to between 30 and 40 m.p.h. a short time afterwards. There seems little doubt that the centre of the depression passed almost directly over Malta and all the phenomena associated with the " eye of the storm " were experienced. At 11h. the sky was completely covered with low cloud ; by 13h. the cloud had decreased to 4 tenths and this partial clearance lasted for about two hours after which the sky clouded over again. After the passage of the centre, the wind increased very rapidly and eventually reached force 9 from about NE., moderating gradually as the centre moved away eastwards.

A full understanding of the causes underlying this sequence of weather is hampered by the paucity of observations from northern Africa, the distance of Malta from the nearest reporting station and by the absence of upper air information between the mornings of November 23rd and 25th.

It seems probable, however, that the sequence of events was as follows. Cool air was drawn round the shallow depression over Algeria and comparatively warm air round the small anticyclone over Cirenaica. These two air masses probably met in the region of Tripolitania and a small depression developed early on the 24th. As it developed the depression drew in cold air which had arrived indirectly from the Balkans. This caused a rapid deepening and gave rise to the discontinuities shewn on the anemogram. As development took place over the sea and the horizontal extent of the depression was small, it was not clearly shewn on the synoptic charts until it was quite close to Malta. During the early part of its life it moved north-west travelling in the circulation round the shallow depression over Algeria, but subsequently its motion was governed by the general westerly current existing at the higher levels. An estimate of the horizontal extent of the depression as it passed Malta may be obtained from a measurement of the barograph trace. The rapid fall and rapid rise occurred within about three hours. The velocity of the depression itself cannot be gauged exactly from the charts owing to the difficulty in placing the centre, but it seems unlikely that it moved at a greater speed than 60 m.p.h. Hence the deep part of the depression was probably not more than 180 miles in diameter.

A. C. Best
E. L. Clinch

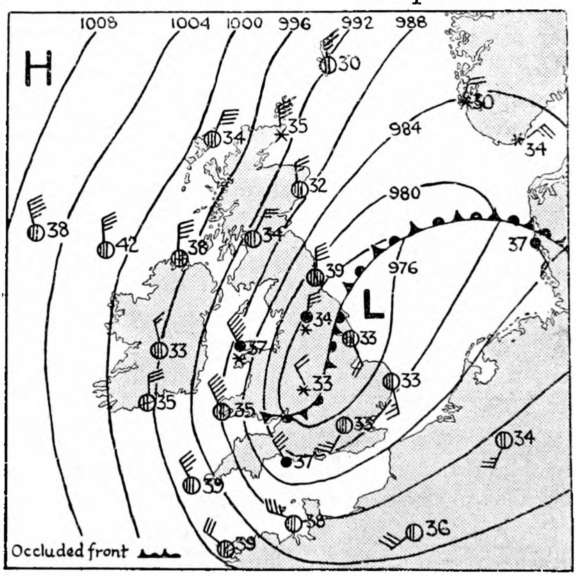
The Blizzard of February 27th—March 1st, 1937

The month of February ended with a blizzard which was the worst experienced in this country since February 1933* and was also comparable with the great storm of January 1881*.

From the meteorological point of view it is interesting to compare the synoptic situations with which these three storms were associated. The depression which was associated with the 1881 storm possessed well-marked warm and cold fronts, the air in the warm sector being tropical air which had been drawn from low latitudes over the Atlantic.

The 1933 storm was due to a depression which developed in the polar air; associated with this depression were two fronts, a warm front and a cold front but the air in the warm sector was definitely of polar origin though slightly warmer than the air outside the sector. The synoptic situation which produced the recent storm was the result of the combination of a polar air depression and a depression which originally possessed a supply of warm air.

On February 25th, 1937, a complex depression, the main centre being a polar air depression, was almost stationary over the Atlantic to the west of Ireland. Another depression with which were associated two occlusions, one being a back-bent occlusion, was situated about 300 miles north of the Azores. The depression north of the Azores had formed on the coast of North Carolina in America and during its passage eastwards had deepened and occluded. This depression continued to travel eastwards and to deepen; it then turned north-east, became associated with the polar air depression, and eventually became the main centre. The polar air depression rotated around the main centre and eventually became a trough. At 1 a.m. on Saturday, February 27th, the depression was centred over west Ireland, it moved east-north-east and at 6 p.m. on Saturday was centred over the North Sea just off the Yorkshire coast. During Saturday, winds



SYNOPTIC CHART, 7H., FEBRUARY 28TH, 1937.

Meteorological Magazine 68, 1933, pp. 29–34.

became northerly over most of the country and freshened considerably, increasing to gale force in exposed places. The cold northerly current brought with it snow or sleet to all districts except east and south-east England, the falls being heaviest in Scotland and extreme north England. During Sunday, February 28th, the depression moved south-south-west and then south-east, moving across to Belgium. As a result the wind freshened considerably, the gale being extremely severe in the Irish Sea, and snow spread to east and south-east England. The occluded fronts moved southwards with the depression and gave rise to very heavy falls of snow, particularly in north England and north Wales. This northerly current was essentially unstable and even after the passage of the occlusions instability showers of snow continued.

The great storm of 1881 was most severe in Wales, the Midlands and south England, while the storm of 1933 was very severe in south Wales and south Ireland and maintained a fair degree of severity in the Midlands and north England. The severity of the present blizzard was greatest in north England and north Wales and heavy drifts of snow were also reported from Scotland.

The snow commenced to fall in Scotland early on Saturday, February 27th, 1937, and aided by the strong wind huge drifts of snow rapidly gathered. Early on Saturday afternoon many roads were completely blocked by snowdrifts as deep as 13 ft. and cars and omnibuses were unable to proceed and had to be abandoned. Trains were delayed and the train from Stranraer, which was expected at midnight Saturday in Glasgow, did not arrive until 11 a.m. on Sunday morning. Not only was the traffic on both roads and rail impeded by snowdrifts but an added danger and impediment were obstacles such as trees and telephone poles which were blown down by the gale. The snow continued in Scotland throughout Sunday and some roads were still impassable on Monday, March 1st.

In north England and north Wales sleet or snow commenced to fall on Saturday and snow continued throughout Sunday. On Sunday falls of up to 2 ft. were reported, with drifts as deep as 12 ft. The equivalent rainfalls in the period 9 a.m. Saturday to 5 p.m. Sunday were Harrogate 1·01 in., Ilkley 0·93 in. and Rhyl 0·91 in. On Sunday the gale was extremely severe in north Wales and north England—a gust of 107 m.p.h. being recorded at 4 a.m. at Holyhead, a record for this station. Roads were blocked by snowdrifts and by trees and telephone poles; cars and omnibuses, having to be abandoned, were almost buried in the snow, while considerable difficulty was experienced in keeping the railway lines clear. Most parts of north Wales and many parts of north England were isolated by a general breakdown of the telephone service, while in addition electricity supplies failed in many places. As a result of this electricity failure the B.B.C. relay transmitter in north Wales was closed until Tuesday morning, March 2nd. By Monday the gale had abated and apart from a few scattered showers, no further snow fell. Many roads however were still impassable and villages continued to be isolated from neighbouring towns.

In the Midlands, south Wales and south-west England the blizzard was not quite so severe as it was in the north. Snowdrifts 3 to 4 ft. in depth gathered along many roads, while a large number of trees, some 60 to 80 ft. high, and telephone poles were blown down in many places.

East and south-east England appear to be the districts which suffered least from the storm though some roads in Surrey were closed with snowdrifts 4 ft. 6 in. in depth. As a result of the fall of snow in south-east England, the Thames, which was already at a high level, continued to rise and on Monday at Windsor it was 3 ft. 10 in. above normal, the highest level reached this winter.

Both along the east coasts of England and Scotland and in the Irish Sea shipping was imperilled during the week-end. Many ships in the Irish Sea were damaged by the severe buffeting which they received. Heavy seas were also reported along the east coasts of Scotland and England. At Arbroath in Scotland a schoolboy was swept into the sea, by a wave which burst over the harbour protection wall, and was drowned. According to the Yorkshire coastguards the gale was the worst experienced along the east coast of Yorkshire for the last 10 years. Gorleston lifeboat rescued three men from a vessel which went ashore on the Yarmouth beach, while because of reports of ships in danger, Redcar and Teesmouth lifeboat crews stood by for nearly 12 hours.

J. H. Brazell.

OFFICIAL PUBLICATION

The following publication has recently been issued :—

Monthly normals of percentage frequencies of surface and upper winds over Malta, Egypt, Palestine, Trans-Jordan and Iraq. Mainly between the years 1921 and 1932. (M.O. 405.)

The results of over 30,000 pilot balloon ascents are analysed according to wind direction and velocity ; percentage frequencies are shown for the surface and for certain heights above mean sea level, namely, 1,500, 3,000, 6,000 and 10,000 feet. This publication marks a further step in the work of presenting in an accessible form the averages of meteorological elements for which observational data are steadily accumulating in the records of the Meteorological Office. It forms the first of a new series of publications which will deal with the factors of most importance for aviation : wind, cloud and visibility. The form adopted is that recommended by the International Commission for Air Navigation (Appendix G) ; further publications will deal with the other factors for these stations abroad and also for stations in the British Isles.

Royal Meteorological Society

The monthly meeting of the Society was held on Wednesday, February 17th, at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F.Inst.P., President, was in the Chair.

Dr. C. E. P. Brooks gave a brief account of the meteorological circumstances of the recent floods in the United States of America.

The following papers were read and discussed :—

R. C. Sutcliffe, Ph.D.—The sea breeze at Felixstowe.

The pilot-balloon ascents for a period of ten years are analysed in order to study the sea breeze effect on upper winds from the surface to 5,500 ft. When sea breezes replace land-breezes during the course of the day, the vector change in speed normal to the coast is in the order of 15 m.p.h. in the layer up to 500 ft., and decreases with height to become negligible above about 2,500 ft. The sea breeze has an average depth of 1,500 ft., but there is no evidence of an increased outflow to form a returning current up to the highest level considered. There is also an added component parallel to the coast of about 5 m.p.h. with the land to the left. When the sea breeze is continuous owing to a general current off the sea there is very little increase in the speed, but the wind definitely backs during the course of the day.

E. G. Bilham, B.Sc., D.I.C., with the assistance of E. F. Relf, F.R.S.—The dynamics of large hailstones.

The form of the relation between terminal velocity and diameter is deduced from values of the drag coefficient obtained from observations on spheres towed by aeroplanes. Values of the terminal velocity are calculated for various mean specific gravities and it is concluded that an upper limit, about 1·5 lb., is set to the mass attainable by a spherical hailstone, by aerodynamical considerations.

W. P. Digby, M.I.Mech.E., M.I.E.E.—The photometric study of atmospheric pollution.

The author describes a photometric method of comparing the loss of reflecting value through tarnishing of polished metal plates and shows for different metals simultaneously exposed in the same place, the wide daily and seasonal effects of changes in the polluting media in the atmosphere. The different rates of tarnishing of the same metal plates exposed during the same week in rural, London and industrial areas are very marked. Extreme cases in Westminster for polished copper are losses of 38 per cent and 50 per cent in 5 hours in December fogs, whereas on four successive days in February, 1936, the loss in 5 hours varied between 5 per cent and 11 per cent. For a summer day in 1935 a 10 per cent loss in 24 hours seems normal. For short periods of, say, 1 to 2 days in the winter and a week in the summer, copper is a good indicator. For longer periods "fine" silver is better. Aluminium responds slowly, while the useful range of nickel appears to be between those of copper and of silver. In two appendices, the loss of reflection value is correlated with independent measurements of sulphur in the atmosphere. Further lines of research are indicated.

Correspondence

To the Editor, *Meteorological Magazine*

Brilliant Optical Phenomena

There has been for most of the morning a wonderful display of optical phenomena. The halo of 22° was only faintly visible but the two mock suns lying on it have been dazzlingly bright and the mock sun ring has been almost complete although in places rather faint. The halo of 46° has not been visible but the arc of contact (upper) to it has been very brilliant indeed, rivalling the brightest rainbow. The mock suns " occidens " and " oriens " have also been plainly visible at times shining with a greenish white light. Also the mock sun " sepentris " (anthelion) was faintly visible for a brief period at 11.55 a.m. The colouring of the mock suns on the 22° halo was at times very marked showing red, yellow, green and faint blue. The sky was 8 tenths covered with cirrostratus of medium density; wind WNW. force 3.

Another display of optical phenomena was observed on February 10th, between 2.20 and 2.40 p.m., consisting of the 22° halo, the 46° halo, both nearly complete, the mock suns on the 22° halo and the upper arc of contact to the 22° halo. The sky was 9 tenths covered with fairly dense cirrostratus. This set of haloes however was not as bright or as lasting as the set of February 11th.

J. M. BRIERLEY.

Rodwell, South Petherton, Somerset, February 11th, 1937.

Weather Changes on the West African Air Route

The article in the November, 1936 issue of the *Meteorological Magazine*, p. 227, on the above subject was read by me with great interest. It so happened that I viewed the passage of a front across Kano on April 22nd, 1936. As your readers are no doubt aware, the west African mail route (Khartoum to Kano) was opened up at the beginning of February, 1936. Although February is a harmattan month in Northern Nigeria, the pilots were fortunate in that they experienced but little of the dust haze which is normally associated with the dry easterly winds from equatorial Africa. The weather during March and the first half of April was nearly ideal for flying, and it was not expected that any storms would occur until May or June, at the break of the hot season.

There were obvious cloud indications of the approach of a storm on the morning of April 22nd. " Strong tendency for thunderstorm Kano Area " was wirelessed and telegraphed to Maiduguri to reach the pilot before his departure on the last 300 mile lap of his trans-central African flight. In spite of this warning, the pilot decided to risk it and took off at 11h. 45m. G.M.T. from Maiduguri, a lonely outpost of the Empire, about 80 miles south-west of Lake Chad. Hardly had he done so when the sky at Kano became even more ominous. A vain endeavour was made to get in touch with the plane but the atmospherics were too intense and the pilot had doubtless wound in his aerial.

At 13h. 50m. a dust storm broke from the north-east and lasted for about 20 minutes during which period the visibility was less than 200 yards. The wind speed, however, could not have been more than 30 m.p.h. By the time the plane arrived at 14h. 45m. the storm had passed and the pilot made his landing on the aerodrome in comparatively fine weather. At 15h. 30m. a thunderstorm came up from the west against the surface easterly wind and lasted intermittently till 21h.

It will interest Mr. Durward to know that a similar set of meteorological phenomena was experienced at Kano during the preceding evening. A slight dust storm came up from the west at 17h. and at 19h. a thunderstorm broke from the north-east. The morning temperatures at Kano and Zinder (about 130 miles north of Kano) on the 21st, were 86° F. and 91° F. On the 22nd, at the same observation hours the temperatures were 81° F. and 82° F. The corresponding barometric pressures were :—

	21st	22nd
Kano	1007·1 mb.	1008·8 mb.
Zinder	1007·1 „	1009·0 „

UPPER WIND OBSERVATIONS AT KANO AND ZINDER ON APRIL 21ST AND 22ND, 1936

Height.	21st				22nd			
	Kano.		Zinder.		Kano.		Zinder.	
ft.	°	m.p.h.	°	m.p.h.	°	m.p.h.	°	m.p.h.
2,000	..	..	WSW.	37	..	..	W.	29
3,000	SW'W.	16	W.	36	WNW.	23	W'S.	26
5,000	WSW.	19	SW'S.	13	W.	22	..	..
7,000	..	..	S.	7	W'N.	23	..	..
10,000	..	..	SE.	8	W'S.	5	..	..

D. E. SMITH.

Survey Dept., Lagos, Nigeria, January, 1937.

NOTES AND QUERIES

Rime on Wire Netting

The photograph, reproduced opposite page 35, of rime on wire netting ($1\frac{1}{2}$ in. mesh) was taken at Eskdalemuir Observatory on January 14th, 1937, at 10h. 50m. G.M.T. Mr. Pilsbury writes that the meteorological conditions prevailing there between 10h. and 11h. on that day were:—temperature, 23·2° F. at 10h. rising steadily to 24·3° F. at 11h.; humidity, 100 per cent throughout; pressure, 993·4 mb. (station level) steady; wind, calm; visibility, 220 yds., wet fog throughout.

It is interesting to note that there was no rime on the netting at 7h. when the temperature was 24·0° F., humidity 96 per cent, visibility 550 yds. and the wind calm. The rime began to melt soon after the photograph was taken.

The Persistent Rainfall of January and February, 1937

During the exceptional drought of the 25 months November, 1932 to November, 1934, the total rainfall over the British Isles was 12·4 in. less than the average. Although both 1935 and 1936 were wet, the deficiency was not made up until the persistent rains of January and February, 1937.

The general values for the two months January and February, 1937, are set out below:—

	England and Wales.		Scotland.		Ireland.		British Isles.
	In.	Percentage of average.	In.	Percentage of average.	In.	Percentage of average.	Percentage of average.
January ...	5·5	185	7·9	162	7·2	178	176
February ...	5·6	218	5·7	136	5·5	158	182

Over the British Isles as a whole, January 1937 was only slightly wetter than January 1936, with 154 per cent, but since 1870 there were but three wetter Januaries, viz., 1872, 1877 and 1928 with 181, 192 and 203 per cent respectively.

The totals for January reached twice the average over large areas, e.g. to the south-east of a line drawn roughly from Okehampton to Norwich, the Grampians and adjacent districts, the southern uplands of Scotland and the south of Ireland. At both Balmoral Castle and Braemar the totals of 11·80 in. and 13·41 in. respectively exceeded four times the average. At Braemar it was not only the wettest January but by far the wettest month since records began there in 1866.

The large totals were due mainly to the frequent cyclonic rains during the fourteen days, the 12th to 25th. Over the Thames Valley above Teddington the general rainfall for this period amounted to 3·5 in. out of a total for the month of 4·5 in.; at Princetown Prison it was 9·7 in. out of 14·3 in.; at Watendlath Farm, in the English Lake District, 12·3 in. out of 17·8 in.; on Snowdon 8·0 in. out of 17·6 in. (7·3 in. occurring for the 3rd to 5th); and at Balmoral Castle 9·4 in. out of 11·8 in.

February, 1937, ranks as the wettest February over the British Isles as a whole since 1870, apart from that of 1923, with 204 per cent, although February 1915 was about as wet as February 1937.

The totals for February exceeded the average in all parts of the British Isles, except the north-west of Scotland, and exceeded twice the average over most of southern and central districts of England. Many stations in these regions recorded the wettest February since before 1870, e.g. Camden Square (London), Slough (Bucks.), Oxford, Salisbury and Bidston Observatory.

Over the British Isles as a whole the total rainfall for the two months January to February, 1937, exceeded that for any similar period back to 1870.

The totals for January and February together were most remarkable in parts of Suffolk, Kent, Hampshire, Devon and Aberdeenshire where they exceeded 250 per cent of the average, as much as 306 per cent being recorded at Ovington Rectory, near Winchester. At Camden Square (London) the total was 7·80 in., or 221 per cent, and more than that recorded in any similar period since the record commenced there in 1858, the next largest amount being 7·62 in. in January and February, 1866. The duration of rainfall was 163 hours, the largest amount in the series back to 1881, although 161 hours occurred in January and February, 1919. At Tenterden, in Kent, the total of 10·35 in. exceeded that of any similar period back to 1863, the next largest amount being 8·88 in. in 1900. At Oxford the total of 8·07 in. was the largest since 1815, that of 1915 giving 6·53 in.

Over the Thames Valley above Teddington the general rainfall for January and February was 9·2 in., exceeding that of any similar period since before 1881, the next wettest period being that of 1915 with 8·5 in. This large amount was due mainly to the frequent rains, no one of which was especially remarkable, during the period January 12th to February 28th, when some rain fell on every day but three. The wettest periods were the five days January 20th to 24th with 1·8 in., the six days February 2nd to 7th with 1·8 in. and the seven days February 21st to 27th with 1·9 in.

An outstanding feature of the rainfall of individual Februaries is its variability. Of the four driest calendar months on record, viz., February 1932, March 1929, June 1925 and February 1891 (each with about half an inch), two are Februaries. On the other hand, the Februaries of 1915, 1923 and 1937 (each with about 6 inches) were wetter than any March, April, May, June or July on record. This wide range is due to the fact that in some years the marked frequency of orographical and cyclonic rains, which is typical of winter months and is brought about by an increased intensity in the wind drift from the Atlantic, continues well into February, whereas in other years quieter weather, with light winds, typical of the spring months, sets in earlier than usual.

J. Glasspoole.

Persistent South-east Gales in the North Sea

Throughout the period from January 11th to February 1st, the pressure distribution controlling the weather of western Europe was dominated by two outstanding features—the persistence of the continental high over western Russia (pressure at Leningrad was 1030 mb. or more during much of this period and in the neighbourhood of 1050 mb. on the 23rd, 24th and 25th) and the intensity of depressions on the North Atlantic. Consequently in north-west Europe there was a high frequency of winds from between south and east. An extremely cold current of continental air which spread across Germany and the eastern part of the North Sea, seemed to be an impregnable barrier to the eastward motion of Atlantic depressions and associated fronts. The effect of any deepening of low pressure systems in the Atlantic west of Ireland therefore resulted in a steepening of the pressure gradient between the deepening centre and Scandinavia. Wind reached gale force quickly in all exposed districts, especially in the North Sea between the mountainous plateaux of Norway and Scotland. During the 26th and 27th the continental high spread north-westwards towards Greenland, while a depression over Newfoundland moved at an unusually high speed (about 60 m.p.h.) east-south-east across the Atlantic to north-west Spain. Easterly winds and continental air invaded the whole of the British Isles, the region of gales being displaced along with the boundary zone of the cold air to the southern North Sea. By February 1st the north-west extension of the anticyclone had already disappeared, and during the 2nd and 3rd the anticyclone itself, attacked simultaneously by deepening Arctic, Atlantic, and Mediterranean disturbances, was displaced quickly south-eastwards. By the morning of the 4th, mild maritime polar air had extended across the whole of the British Isles and spread almost to Norway, associated with relatively light winds.

The anemograms for Kirkwall are of considerable interest during this period, more especially from January 23rd onwards. During the early hours of the 24th the wind increased to gale force from SSE., as a deepening depression moved eastwards towards western Ireland. With a further steady increase of wind during the day, an average velocity of 53 m.p.h. was reached between 16h. and 17h., and a gust of 82 m.p.h. at 17h. 10m. Thereafter the wind force decreased somewhat, but remained above or near gale force till the morning of February 1st, with occasional gusts exceeding 60 m.p.h. How constant in direction such a strong and pronounced stream of cold continental air can be is extremely well illustrated by the Kirkwall records of this period: the direction trace is almost continuously between S. and SE., and without exception between S. and E., from the afternoon of January 23rd to the morning of February 2nd.

The anemograms for Lerwick are of a similar nature. They, likewise, show a remarkable persistence of SE. winds, reflecting the persistence of the continental anticyclone and frequent gales heralding the approach of deepening low pressure systems on the Atlantic. Throughout January 25th, the wind maintained an average velocity of 50 m.p.h., with gusts frequently exceeding 70 m.p.h. The highest gust of 83 m.p.h. was recorded at 15h. on that day.

The observer at Deerness states that such a remarkable series of SE. gales with " tempestuous " seas has not been known in Orkney in living memory and that considerable coast erosion has been caused. During the latter half of January several S.O.S. messages were sent out from shipping disabled by the gales between Norway and Scotland, involving two adventurous rescues. On January 20th, the crew of the Norwegian steamer *Frym* was rescued in the North Sea by the liner *Venus :* a breeches-buoy was effective after both lifeboats had been destroyed by the waves. On the 25th, the *Jupiter* and the *Venus* were standing by the *Veni* off the Norwegian coast, while unsuccessful attempts to rescue the crew were made by other ships. The *Venus* was compelled to leave for Bergen owing to shortage of oil, but later in the day the *Jupiter* was able to take the *Veni* in tow.

It need hardly be stressed that the extreme cold and frequent snow squalls associated with the persistent air mass added greatly to the rigours of existence in these gale-swept regions. In the Shetlands, influenza was rampant, many homes were repeatedly swept by seas, medical stores were depleted, and no mails left the island for a week.

F. E. LUMB.

Meteorological averages for periods with incomplete records

In computing averages of meteorological factors a familiar problem is to determine the best way of dealing with missing observations. This note concerns only a trivial point but the result is interesting.

Certain averages for the period 1927–36 were being prepared, but in some cases the station had closed down during the last few years. It was suggested that for these stations the ten-year period should be made up by including years prior to 1927. The following analysis shows, however, that it is better to give the means for the partial periods, that the introduction of other years is likely to make the average worse rather than better unless more than half the years are missing.

Let the required mean over the full period of N years be M, but suppose that m years only are available and n missing, so that $m + n = N$. Let the known mean for the m years be M_m and the unknown mean for the n years be M_n. From the definition of a mean value

$$NM = m\,M_m + n\,M'_n$$

In order to make up the full number of N years we introduce n years from outside the period, so obtaining a mean M'. If the mean over these n years is M'_n then

$$NM' = mM_m + nM'_n$$

The problem is to decide which of the two means M_m or M' is likely to be the closer approximation to the unknown M.

In general, $M-M_m$ and $M-M'$ are as likely to be positive as negative and $M-M_m$ is probably greater (or less) than $M-M'$ according as the standard deviation of $M-M_m$ is greater (or less) than that of $M-M'$.

The standard deviation of the sum or difference of two independent quantities is the square root of the sum of the squares of their individual standard deviations. The expressions $M-M'$ and $M-M_m$ are not sums of independent quantities but by using the two equations above, the inequality is easily transformed to standard deviation of (M_n-M_m) greater than or less than the standard deviation of $(M_n-M'_n)$ where the means are independent.

The required conditions are therefore

s.d. M_m + s.d. M_n greater than or less than s.d. M'_n + s.d. M_n

i.e., s.d. M_m greater or less than s.d. M'_n

or m less than or greater than n

or $m + n$ equal to N but less than or greater than $2n$

since the standard deviation of the mean of a number of observations decreases as the number increases.

As N is the total number of observations and n the number of missing observations this proves the proposition stated above.

R. C. Sutcliffe.

Meteorology in the Royal Astronomical Society of Canada

The Journal of the Royal Astronomical Society of Canada contains frequent papers on Canadian meteorology. In the issue for July to August, 1936, Andrew Thomson discusses "Sunspots and weather forecasting in Canada," and D. A. MacLulich "Sunspots and the abundance of animals," while in the issue for September, W. E. Knowles Middleton and F. Graham Millar write on "Temperature profiles in Toronto."

The upshot of Thomson's paper is that there are no definite relations between sunspot numbers and the weather in Canada, and since also it is not possible to forecast sunspot numbers, long-range weather forecasting by this means is not practicable. This conclusion is doubtless correct, but the analysis is not very critical and only annual means are used. The break-down of the correlation between sunspots and the levels of the central African lakes was not due to the deepening of the Shire River, as stated on the first page, as this river has no connexion with lakes Victoria and Albert.

MacLulich gives a critical examination of the returns of furs of lynx and hare in Canada, and shows convincingly that the cycle in the abundance of these animals has no definite relation to the sunspot cycle, as has often been postulated, and therefore cannot be taken as evidence of a relation between sunspots and climate. The fur cycle is very similar to the sunspot cycle in appearance, but its length is only about ten years instead of eleven.

The paper by Middleton and Millar is an extremely interesting study of the microclimatology of a large city. Toronto is on the north shore of Lake Ontario, and the ground rises fairly steadily northward by about 300 ft. in five miles, except for two shallow valleys. Further north, outside the limits of the city, is a large deep valley. Temperature readings were taken at various times and seasons by means of a nickel resistance thermometer shielded from radiation and mounted 2 ft. in front of a motor car and about 27 in. from the ground. The profile on a bright summer day clearly shows the influence of the lake, but most striking are those of clear calm nights, when every little irregularity in the ground is shown up clearly by the thermograph record. A run at midnight showed an "almost unbelievable" inversion of more than 27° F. between the floor of the large valley and the hillside 100 ft. above, and even a slight dip of about 20 ft. caused a drop of more than 10° F. in the temperature. The effect of buildings and open spaces also appears on the record, and the effect on humidity, shown by readings of a sling psychrometer, also appears to be of interest. Unlike the first two, this paper has no obvious connexion with astronomy, but the Royal Astronomical Society of Canada is to be congratulated on its publication.

REVIEW

Manual of Meteorology, Vol. II. New and Revised Edition. By Sir Napier Shaw, LL.D., Sc.D., F.R.S., with the assistance of Elaine Austin, M.A. 8vo, $10\frac{1}{4}$ in. × $7\frac{1}{2}$ in. pp. XLVIII + 472. *Illus.* Cambridge University Press, 1936. 36*s*. net.

It is a sincere compliment to the value of the "Manual of Meteorology," and a testimony to the confident esteem in which Sir Napier Shaw is held by his fellow workers, that a book of this size, on a subject which can hardly be expected to appeal to a very wide circle, should appear in a second edition within 8 years. It is also a notable proof of the author's energy and enthusiasm that he has revised Volume II so soon after the last volume of his Manual was completed.

The preface points out that a complete revision of the presentation of meteorological data from the point of view of 1935 instead of 1927 is not possible. But there are very copious references to the most recent literature, especially at the end of the book, in Chap. X, which includes a table giving details of the most recent maps of meteorological elements, and a very long and apparently exhaustive bibliography of publications of data of the Upper Air.

We do not notice much alteration in the treatment of the origin and history of the pressure irregularities of the Westerlies. The author still maintains his belief in the importance of the Greenland ice cap in this connexion—" with cold air descending on either side of a ridge some 1,200 miles long and capable of attaining anywhere very high velocities, one cannot lightly set aside its influence for the behaviour of the surface air of the northern hemisphere" (p. 419). This remark is made with reference to the somewhat different conclusions that have been drawn by the British Arctic Air Route Expedition, 1930–1.

There is a superficial but by no means negligible improvement in this new edition in the printing of the numerous full-page charts of isotherms, isobars, etc., by hemispheres (though there is no change in the course of the isopleths). In the previous edition the lines were printed in colour, which at first sight seemed a welcome innovation after the usual black. But in practice some of the colours proved difficult to read, especially in a poor light, so that the new luxury was a disappointment. In the present edition all the isopleths are in black, and the body of the maps is in colour. This gives easy legibility while improving the pleasant colour effect and leads us to hope that publishers may extend the use of colours for maps and diagrams in such books as this.

W. G. Kendrew.

BOOKS RECEIVED

The Climate of Palestine during the year 5694 (1933–34) and Table of Rainfall in the upper Euphrates, Syria, Lebanon, Palestine, the Sinai Peninsula and lower Egypt during the winter 5694 (1933–34). By Dr. D. Ashbel of the Hebrew University, Jerusalem, Tel-Aviv, 1936.

The temperature at Jerusalem, Oct. 1930–*Oct.* 1935. By Dr. D. Ashbel (reprint from the Bulletin of the Jewish Palestine Exploration Society). Jerusalem, 1935.

The Cyclone Season 1931–1932 *and the Cyclone Season* 1932–33 *at Mauritius.* By N. R. McCurdy, B.Sc., Royal Alfred Observatory, Misc. Publ. Nos. 14 and 15, Port Louis, 1933 and 1934.

OBITUARY

Oliver Lanard Fassig, Ph.D.—We regret to learn of the death of Dr. O. L. Fassig on December 6th, 1936, at Washington, D.C., owing to a motor accident. Dr. Fassig was born at Columbus, Ohio, on April 5th, 1860, and graduated at Ohio State University in 1882. After taking special courses at Yale and Berlin Universities he was awarded the Ph.D. degree by the John Hopkins University in 1899. In 1883 he entered the Signal Corps at Washington, D.C., and from June, 1888, to February, 1896, he was bibliographer and librarian at the Central Office during which time he compiled the notable " Bibliography of Meteorology " published by the Signal Service. From 1900–19, with the exception of three years (1909–12) at Puerto Rico and two years (1905–7) as Director of upper air research at Mt. Weather, he was in charge of the station at Baltimore. While there he wrote an exhaustive report on the climate and weather of Baltimore and devised a recorder for the time of beginning of rainfall. In 1919 Dr. Fassig returned to Puerto Rico and organised successfully the West Indies and Caribbean climate and forecasting service of the United States Weather Bureau, including the hurricane warning service. He wrote many valuable papers on hurricanes and also nearly completed a comprehensive study of the climate of Puerto Rico, which is to be published shortly. In 1930 he was appointed chief of the climatological division of the Weather Bureau and had introduced new efficiencies and enlarged the usefulness of the climatic data before his retirement in 1932. From then until his death he was research associate at the Blue Hill Observatory, Harvard.

ERRATA

FEBRUARY, 1937, p. 17, 10th line from bottom, *for* " in 1883 " *read* " in 1884."

FEBRUARY, 1937, p. 20, 2nd line, *for* " Canon William Frederick Archibald Ellison " *read* " Canon William Frederick Archdall Ellison."

The Weather of February, 1937

The broadcast climatological data for February cover, for the first time, the whole northern hemisphere north of 50°. Pressure was lowest over the North Atlantic, an area below 995 mb. extending westwards from the Shetland Isles, while a secondary centre of low pressure, about 1001 mb., lay to the north-west of Nova Zemlya, and another centre, about 1004 mb., over the Aleutian Islands. Pressure was highest (1031 mb.) near Semipalatinsk in south-western Siberia; other anticyclonic centres were south of Lisbon (1022 mb.), eastern Greenland (1015 mb.) and northern Canada (1018 mb.). Winds were mainly westerly over the British Isles and France, south-westerly or southerly over eastern Europe and westerly over northern Asia. Pressure was above normal over Labrador, most of Greenland, Morocco and south-western Siberia, and below normal over most of Europe, the North Atlantic, Arctic and Canada, the deficit exceeding 15 mb. in the north of Germany.

The coldest area was in northern Canada, where the mean temperature was just below −40° F., about 30° below normal, while at Verkhoïansk in Siberia the mean was −33° F., which is 15° above normal. The isotherm of 0° F. passed north of Spitsbergen but included the greater part of Siberia and Canada. In Europe temperatures increased westwards from about 10° F. in the east of Russia to 20° F. at Moscow and Leningrad, 25° F. over most of Norway, 36° F. at Berlin and Vienna, 45–50° F. in France and 54° F. at Lisbon. In the British Isles the mean was about 38° F. in Scotland, 41–47° F. in England and 42–45° F. in Ireland. In North America the isotherm of 32° F. extended south of 40° N. west of the Great Lakes, temperature rising southwards to 54° at San Diego and 56° at New Orleans. The greater part of Europe was a few degrees above normal, but Scandinavia and northern Scotland were below normal.

Precipitation was generally heavy in the west of Europe, exceeding 4 in. over most of the British Isles, western and northern France, Belgium and Holland, but decreased steadily eastwards to about 2 in. in Russia and was negligible over most of Siberia. Precipitation was generally above normal in Europe, except northern Norway and the east of Russia.

The weather of the British Isles during February was unsettled, with frequent gales and rainfall much in excess of the normal in most parts of the country.* Temperature was above normal in the south but below normal in the north, while sunshine was generally deficient in the south but in excess in the north. From the 1st–5th a complex area of low pressure lay to the west and north of the British Isles while secondaries passed across the country giving generally mild unsettled rainy weather with longer bright periods in the north and heavy rain in the south, 3·25 in. on the 2nd and 1·71 in. on the 4th at Holne, Devon, 2·04 in. at Ystalyfera, Glamorgan on the 2nd, and in the south-east, 1·31 in. at Compton, Sussex, on the 4th. Gales occurred in the north on the 1st, in the south-west on the 3rd and in the north-west on the 4th–5th, while slight fog or mist was experienced locally. The 6th, and in Scotland, the 7th also, were dry sunny days as a ridge of high pressure passed across the country, 8·3 hrs. bright sunshine were recorded at Clacton on the 6th and 7·6 hrs. at Tiree on the 7th. On the 7th–9th a complex depression passed across the country giving dull rainy weather generally with gales in the south-west at times and snow in Scotland, east Ireland, north England and the Midlands. Flooding occurred in the Thames Valley, eastern counties and Kent. In the rear of the depression the 9th, 10th and 11th were sunny days with cold W–NW. winds becoming NW–N., and showers of rain, hail, sleet or snow. Sharp frost was experienced on the night of the 11th–12th when 15° F. was recorded at Penrith and Ross-on-Wye, and thunderstorms occurred locally on the 9th and 10th in the north and Midlands. An unusually brilliant display of the aurora borealis was observed from Waringstown, Co. Down on the 9th. From the 12th–19th pressure was again low to the north-west with mainly SW. winds becoming NW. for a brief spell on the 17th.

---

* *See* p. 42.

Temperature was rather low at first but rose above normal from the 14th onwards, 57° F. was the maximum at Sealand on the 14th and at Greenwich on the 15th. Mist or fog occurred generally in England, south Scotland and east Ireland on the 14th and 15th and thunderstorms in north-west Ireland on the 15th and in east England, the Midlands and west Ireland on the 16th, while gales were experienced in the north-west and west on the 13th–17th. Rain fell on most days with some sleet or snow in the north and west. From the 20th–23rd cold, moderate to strong NW. winds prevailed with wintry precipitation at times—especially in the south on the 21st—but considerable sunshine each day; Ilkley and Catterick had 9·2 hrs. on the 23rd. On the 24th there was a change to milder weather and SE. winds in the south as a complex depression remained centred off south-west Ireland from the 24th–26th but conditions continued cold in the north. Temperature in the south rose above 50° F. generally on the 25th and 26th and rain occurred in most parts especially the south-west—snow in the north. Gales were again experienced at exposed places and floods were reported on the 26th from many parts of the south and Midlands. Thunderstorms occurred locally in south England, the Midlands and south-west Ireland on the 25th–27th. On the 27th and 28th this depression passed across the country and heavy snow occurred generally over the whole country on the evening of the 27th and on the 28th even as far south as Guernsey. Accompanied by strong northerly gales the drifts exceeded several feet in depth in places.† The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	71	+16	Chester ...	63	+1
Aberdeen ...	101	+31	Ross-on-Wye ...	58	−11
Dublin	85	+10	Falmouth ...	63	−17
Birr Castle ...	69	+3	Gorleston ...	78	+3
Valentia... ...	50	−16	Kew	63	−2

Kew, Temperature, Mean 43·9° F., Diff. from normal + 2·8° F.

Miscellaneous notes on weather abroad culled from various sources.

Severe storms were experienced in the North Sea on the 1st and ice conditions off the north-east coast of Denmark were severer than usual at the beginning of the month. For about the first ten days, the weather was generally mild with intermittent snow in Switzerland; a landslip cut the main road and railway near Oberried on Lake Brienz about the 7th; about the 12th, snow fell again generally and conditions were good for skiing the following week, although temperatures were rather high. In France, continued heavy rain early in the month resulted in floods between Dunkirk and Hazebrouck, along the Lys Valley and in eastern Brittany on the 8th and 9th; the Seine also had risen and many of the lower

† *See* p. 36.

Paris quays were under water. Owing to strong northerly winds 65 fishermen and 9 horses from Finland were stranded on ice-floes in the Baltic about the 8th, and with difficulty brought to land. Dense fog was reported from Tarifa (Spain) on the 13th and Boulogne on the 14th. Six skiers were killed on the 14th by an avalanche which fell from a slope in the Monte Rosa owing to the comparatively mild weather. After heavy snow and a sudden rise of temperature an immense avalanche occurred about the 17th near St. Jean de Maurienne carrying uprooted trees with it and wrecking a power station. Persistent rain during the previous few days caused floods in several places near Brussels about the 23rd through the overflowing of two rivers. Rain and snowfalls between the 21st and 23rd caused several landslips and some unusually large avalanches in the Alps. Navigation was opened at Sulina (Roumania) on the 25th. Bitterly cold weather with heavy falls of snow occurred generally in Switzerland and France on the 27th and 28th and snow fell along the south coast of the Bay of Biscay, an unusual occurrence at this time of year; in western France north-westerly gales were experienced. (*The Times, February 3rd*–March 2nd.)

Unusually severe floods in the eastern Transvaal and Mozambique which have damaged railways and roads were reported on the 13th—100 natives and 2,000 cattle were stated to have been drowned in Mozambique. By the 18th railway communications between Johannesberg and Lourenço Marques had been re-established but the flood position was still serious. (*The Times*, February 15th–19th.)

Heavy rain—unusual at this season—fell in Bombay on the 11th. (*The Times*, February 12th).

Extensive rains occurred on the 14th–16th in the pastoral and agricultural areas of South Australia and floods in the far north caused washaways. The total rainfall for the month in Australia was generally below normal except in South Australia, and parts of Tasmania and of Queensland. (*The Times*, February 18th and Cable).

Five people died as the result of a severe snowstorm in Washington State about the 2nd and an ice blockade which is unusual in February extended in all directions seawards from St. John's Newfoundland on the 5th. Floods occurred in southern California on the 7th as the result of torrential rains and melting snow—3 people were drowned. A thunderstorm was experienced in the Ottawa Valley on the 8th. The first duststorm of the year blew over parts of Texas, Oklahama and Kansas on the 7th and another severe duststorm occurred throughout Kansas, Colorado, Oklahama and Texas on about the 15th–19th. During the month the flood-water which did so much damage to the Ohio Valley in January passed down the 800 miles of the Mississippi from Cairo (Illinois) to the Gulf of Mexico without causing any serious breaches in the defences. Sudden floods in Illinois and Wisconsin on the 21st due to extremely heavy rains caused the deaths of 5 people; by the 22nd the water was receding fast. Considerable damage was done in New York by gales on the night of the 21st. Owing to heavy rain and the rapid melting of the snow, floods throughout Ontario on the 22nd did much damage. In the United States temperature was above normal in the Lake Region, mainly above normal in the eastern and middle States but below normal along the Pacific coasts, while precipitation was variable in distribution. (*The Times*, February 2nd–26th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, February, 1937

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	997·0	SW.5	45	51	71	0·02	5·8	r–r_0 5h.–6h.
2	1007·3	SSW.4	40	51	81	0·07	0·3	d_0–r 17h.–21h.
3	1004·1	SW.5	49	54	74	0·08	0·0	r–r_0 4h.–11h.
4	999·8	SSW.5	49	53	76	0·30	1·1	r 1h–9h., 20h.–24h.
5	987·5	NNW.4	47	49	88	0·36	0·0	r–r_0 0h.–13h.
6	1010·9	W.4	37	48	58	—	6·9	x early.
7	996·6	E.3	36	42	94	0·61	0·0	r–r_0 9h.–23h.
8	984·6	SW.4	41	52	81	0·04	1·4	r_0 6h.–7h., 18h.–21h.
9	1003·7	W.4	37	45	55	0·06	5·8	p R hq 10h.
10	1006·2	WNW.4	36	46	54	—	6·5	
11	1007·1	NW.4	37	44	60	—	3·6	r_0s_0 14h.
12	1013·3	WSW.2	31	43	69	0·20	2·8	x f early, r 19h.–24h.
13	1009·3	NW.2	36	45	86	0·09	0·0	r_0 0h.–10h.
14	1017·7	SSW.3	41	53	92	0·06	0·0	r_0 0h.–7h., 21h.–22h.
15	1020·1	SW.3	49	55	83	0·03	1·0	r_0 0h.–3h., 23h.–24h.
16	1005·4	W.6	49	51	90	0·24	2·9	r 0h.–3h., rkq 13h.
17	1003·6	WNW.4	36	49	62	—	1·9	r_0 4h., 13h.
18	1015·5	SSW.3	34	49	94	0·03	0·0	r_0–d_0 10h.–15h.
19	1001·4	SSW.3	46	54	92	0·09	0·0	r_0–r 9h.–14h.
20	1009·7	W.4	40	48	56	—	5·5	pr_0 13h.
21	1010·5	WSW.4	39	47	59	0·02	5·0	pr_0 3h., r_0 18h.–24h.
22	994·3	NW.3	42	44	67	0·68	2·3	r 0h.–10h., pr 13h.
23	1006·3	WNW.4	32	45	56	—	7·2	x early and late.
24	999·9	SE.4	34	44	78	0·40	0·0	r 7h.–9h., 15h.–24h.
25	996·2	SSE.3	41	52	90	0·30	0·2	r 0h.–9h., 14h.–17h.
26	991·4	S.5	39	50	94	0·20	0·2	r_0 9h.–16h., pRh 17h.
27	981·0	S.W5	41	48	81	0·10	2·1	pr during day.
28	977·1	NNW.4	32	36	88	0·08	0·0	s–s_0 9h.–11h., 15h.
*	1002·1	—	40	48	76	4·05	2·2	* Means or Totals.

General Rainfall for February, 1937

England and Wales ...	218	per cent of the average 1881–1915.
Scotland	136	
Ireland	158	
British Isles	182	

Rainfall : February, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	4·33	260	*War* .	Birminghm, Edgbaston	3·89	230
Sur .	Reigate, Wray Pk. Rd.	4·79	219	*Leics* .	Thornton Reservoir	3·49	209
Kent .	Tenterden, Ashenden	4·79	243	,, .	Belvoir Castle	2·85	171
,, .	Folkestone, Boro. San.	5·10	...	*Rut* .	Ridlington	3·39	207
,, .	Margate, Cliftonville	3·68	266	*Lincs* .	Boston, Skirbeck	2·60	178
,, .	Eden'bdg., Falconhurst	5·55	251	,, .	Cranwell Aerodrome	2·59	173
Sus .	Compton, Compton Ho.	6·43	244	,, .	Skegness, Marine Gdns.	2·28	149
,, .	Patching Farm	5·47	248	,, .	Louth, Westgate	2·28	119
,, .	Eastbourne, Wil. Sq.	5·73	258	,, .	Brigg, Wrawby St.	1·83	...
Hants.	Ventnor, Roy.Nat.Hos.	5·37	255	*Notts* .	Worksop, Hodsock	2·50	162
,, .	Fordingbridge, Oaklnds	6·13	246	*Derby*.	Derby, L. M. & S. Rly.	3·80	235
,, .	Ovington Rectory	6·84	263	,, .	Buxton, Terr. Slopes	8·93	238
,, .	Sherborne St. John	5·24	239	*Ches* .	Bidston Obsy	4·46	266
Herts .	Royston, Therfield Rec.	3·05	198	*Lancs*.	Manchester, Whit. Pk.	4·72	246
Bucks.	Slough, Upton	4·64	273	,, .	Stonyhurst College	6·16	184
,, .	H. Wycombe, Flackwell	4·48	232	,, .	Southport, Bedford Pk.	4·55	217
Oxf .	Oxford, Radcliffe	4·73	289	,, .	Ulverston, Poaka Beck	6·79	184
N'hant	Wellingboro, Swanspool	3·18	198	,, .	Lancaster, Greg Obsy.	5·73	199
,, .	Oundle	2·49	...	,, .	Blackpool	5·02	224
Beds .	Woburn, Exptl. Farm	4·16	281	*Yorks*.	Wath-upon-Dearne	3·39	207
Cam .	Cambridge, Bot. Gdns.	2·60	203	,, .	Wakefield, Clarence Pk.	4·32	252
,, .	March	2·30	178	,, .	Oughtershaw Hall	8·20	...
Essex .	Chelmsford, County Gdns	3·83	259	,, .	Wetherby, Ribston H.	4·53	262
,, .	Lexden Hill House	3·59	...	,, .	Hull, Pearson Park	2·49	150
Suff .	Haughley House	2·80	...	,, .	Holme-on-Spalding	3·34	199
,, .	Rendlesham Hall	3·78	270	,, .	West Witton, Ivy Ho.	6·13	214
,, .	Lowestoft Sec. School	2·67	190	,, .	Felixkirk, Mt. St. John.	3·92	232
,, .	Bury St. Ed., WestleyH.	3·17	212	,, .	York, Museum Gdns.	2·98	197
Norf. .	Wells, Holkham Hall	2·26	153	,, .	Pickering, Hungate	4·01	231
Wilts .	Porton, W.D. Exp'l. Stn	4·80	242	,, .	Scarborough	3·25	194
,, .	Bishops Cannings	6·33	298	,, .	Middlesbrough	2·26	174
Dor .	Weymouth, Westham.	5·59	258	,, .	Baldersdale, Hury Res.	4·82	160
,, .	Beaminster, East St.	6·87	227	*Durh* .	Ushaw College	3·47	218
,, .	Shaftesbury, Abbey Ho.	4·18	182	*Nor* .	Newcastle, Leazes Pk	3·68	240
Devon.	Plymouth, The Hoe	7·26	245	,, .	Bellingham, Highgreen	4·33	171
,, .	Holne, Church Pk. Cott.	14·98	272	,, .	Lilburn Tower Gdns	3·58	180
,, .	Teignmouth, Den Gdns.	5·88	221	*Cumb*.	Carlisle, Scaleby Hall	3·85	173
,, .	Cullompton	6·69	240	,, .	Borrowdale, Seathwaite	19·00	170
,, .	Sidmouth, U.D.C.	5·73	...	,, .	Thirlmere, Dale Head H.	11·04	145
,, .	Barnstaple, N. Dev.Ath	6·44	237	,, .	Keswick, High Hill	6·49	131
,, .	Dartm'r, Cranmere Pool	17·20	...	*West* .	Appleby, Castle Bank	4·03	136
,, .	Okehampton, Uplands.	9·76	224	*Mon* .	Abergavenny, Larchf'd	6·43	202
Corn .	Redruth, Trewirgie	7·67	203	*Glam* .	Ystalyfera, Wern Ho.	10·76	210
,, .	Penzance, Morrab Gdns.	7·39	221	,, .	Treherbert, Tynywaun.	14·76	...
,, .	St. Austell, Trevarna	9·25	241	,, .	Cardiff, Penylan	6·39	217
Soms .	Chewton Mendip	7·60	226	*Carm* .	Carmarthen, Model & P.S.	7·40	193
,, .	Long Ashton	5·16	220	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	4·50	169
,, .	Street, Millfield	4·73	...	*Card* .	Aberystwyth	6·14	...
Glos .	Blockley	4·59	...	*Rad* .	BirmW.W.Tyrmynydd	10·10	192
,, .	Cirencester, Gwynfa	5·01	222	*Mont* .	Lake Vyrnwy	10·53	232
Here .	Ross-on-Wye	3·51	174	*Flint* .	Sealand Aerodrome	4·89	...
Salop.	Church Stretton	5·56	253	*Mer* .	Blaenau Festiniog	13·93	187
,, .	Shifnal, Hatton Grange	4·44	274	,, .	Dolgelley, Bontddu	8·83	199
Staffs.	Market Drayt'n, Old Sp.	4·57	264	*Carn* .	Llandudno	4·22	216
Worc .	Malvern, Free Library	4·52	251	,,	Snowdon, L. Llydaw 9.	19·28	...
,, .	Ombersley, Holt Lock.	3·95	241	*Ang*	Holyhead, Salt Island	4·57	187
War .	Alcester, Ragley Hall	3·57	216	,, .	Lligwy	6·71	...

Rainfall: February, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	7·61	239	*R&C*	Achnashellach	8·07	111
Guern.	St. PeterP't.Grange Rd	6·47	263	,,	Stornoway, C.GuardStn.	4·16	...
Wig	Pt. William, Monreith.	6·04	196	*Suth*	Lairg	5·35	173
,,	New Luce School	7·85	205	,,	Tongue	4·70	135
Kirk	Dalry, Glendarroch	6·63	131	,,	Melvich	4·35	145
Dumf.	Dumfries, Crichton R.I.	4·45	144	,,	Loch More, Achfary	7·34	111
,,	Eskdalemuir Obs	6·48	131	*Caith*	Wick	3·47	153
Roxb	Hawick, Wolfelee	4·90	150	*Ork*	Deerness	4·78	159
Peeb	Stobo Castle	4·69	170	*Shet*	Lerwick	3·21	102
Berw	Marchmont House	3·73	179	*Cork*	Dunmanway Rectory	7·40	126
E.Lot	North Berwick Res	2·61	167	,,	Cork, University Coll.	4·30	115
Midl	Edinburgh, Blackfd. H.	3·02	182	,,	Mallow, Longueville	4·99	147
Lan	Auchtyfardle	4·09	...	*Kerry*	Valentia Obsy	7·19	138
Ayr	Kilmarnock, Kay Pk	4·76	...	,,	Gearhameen	12·50	140
,,	Girvan, Pinmore	6·10	143	,,	Bally McElligott Rec.	5·84	...
,,	Glen Afton, Ayr San.	7·03	160	,,	Darrynane Abbey	6·75	148
Renf	Glasgow, Queen's Pk	4·57	155	*Wat*	Waterford, Gortmore	4·96	154
,,	Greenock, Prospect H.	5·86	104	*Tip*	Nenagh, Cas. Lough	5·33	171
Bute	Rothesay, Ardencraig	5·56	139	,,	Roscrea, Timoney Park	4·79	...
,,	Dougarie Lodge	6·04	160	,,	Cashel, Ballinamona	4·69	148
Arg	Lock Sunart, G'dale	4·74	79	*Lim*	Foynes, Coolnanes	5·16	162
,,	Ardgour House	8·42	...	*Clare*	Inagh, Mount Callan	9·87	...
,,	Glen Etive	...	...	*Wexf*	Gorey, Courtown Ho.	5·17	184
,,	Oban	4·47	...	*Wick*	Rathnew, Clonmannon.	5·11	...
,,	Poltalloch	5·70	132	*Carl*	Bagnalstown, Fanagh H.	3·76	148
,,	Inveraray Castle	8·60	127	,,	Hacketstown Rectory	4·64	155
,,	Islay, Eallabus	5·63	134	*Leix*	Blandsfort House	5·04	188
,,	Mull, Benmore	...	...	*Offaly*	Birr Castle	4·15	181
,,	Tiree	2·94	85	*Kild*	Straffan House	4·22	194
Kinr	Loch Leven Sluice	3·95	140	*Dublin*	Dublin, Phoenix Park	3·27	183
Fife	Leuchars Aerodrome	2·89	165	*Meath*	Kells, Headfort	5·16	190
Perth	Loch Dhu	8·50	114	*W.M*	Moate, Coolatore	4·31	...
,,	Crieff, Strathearn Hyd.	3·52	100	,,	Mullingar, Belvedere	4·76	171
,,	Blair Castle Gardens	3·05	109	*Long*	Castle Forbes Gdns	5·15	181
Angus	Kettins School	3·35	143	*Gal*	Galway, Grammar Sch.	4·46	147
,,	Pearsie House	3·40	...	,,	Ballynahinch Castle	8·28	162
,,	Montrose, Sunnyside	2·57	140	,,	Ahascragh, Clonbrock	4·49	145
Aber	Balmoral Castle Gdns.	3·01	116	*Rosc*	Strokestown, C'node	4·26	161
,,	Logie Coldstone Sch	2·31	111	*Mayo*	Blacksod Point	4·61	114
,,	Aberdeen, Observatory	2·32	113	,,	Mallaranny	7·64	...
,,	New Deer School House	3·67	172	,,	Westport House	4·76	121
Moray	Gordon Castle	3·28	171	,,	Delphi Lodge	10·31	122
,,	Grantown-on-Spey	...	...	*Sligo*	Markree Castle	5·47	159
Nairn	Nairn	1·83	102	*Cavan*	Crossdoney, Kevit Cas.	4·88	...
Inv's	Ben Alder Lodge	4·14	...	*Ferm*	Newtwnbtlr, Crom Cas.	4·13	141
,,	Kingussie, The Birches	2·84	...	*Arm*	Armagh Obsy	3·44	155
,,	Loch Ness, Foyers	...	...	*Down*	Fofanny Reservoir	9·33	...
,,	Inverness, Culduthel R.	2·34	104	,,	Seaforde	6·04	198
,,	Loch Quoich, Loan	7·29	...	,,	Donaghadee, C. G. Stn.	4·59	199
,,	Glenquoich	9·49	92	*Antr*	Belfast, Cavehill Rd	...	...
,,	Arisaig House	4·01	81	,,	Aldergrove Aerodrome	4·15	172
,,	Glenleven, Corrour	...	...	,,	Ballymena, Harryville	5·72	176
,,	Fort William, Glasdrum	...	...	*Lon*	Garvagh, Moneydig	4·72	...
,,	Skye, Dunvegan	4·35	...	,,	Londonderry, Creggan	4·59	144
,,	Barra, Skallary	4·62	...	*Tyr*	Omagh, Edenfel	4·46	150
R&C	Alness, Ardross Castle	3·57	108	*Don*	Malin Head	3·85	...
,,	Ullapool	4·23	99	,,	Killybegs, Rockmount	3·24	...

Climatological Table for the British Empire, September, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1016·5	− 0·9	74	42	65·7	53·6	59·7	+ 2·4	54·9	90	8·3	2·81	+ 0·94	16	3·0	24
Gibraltar	1017·4	+ 0·2	85	60	77·7	67·5	72·6	...	66·0	83	5·2	0·11	...	2	...	...
Malta	1018·1	+ 1·8	88	65	80·2	70·7	75·5	− 0·5	68·4	72	2·9	0·20	− 1·07	4	10·1	81
St. Helena	1015·7	− 0·3	63	53	60·9	54·0	57·5	+ 0·1	54·4	92	9·7	0·85	− 1·33	10	...	...
Freetown, Sierra Leone	1012·9	+ 2·4	87	70	82·8	73·3	78·1	...	74·8	89	8·0	26·43	− 2·05	27	...	...
Lagos, Nigeria	1013·3	+ 1·1	86	71	82·9	74·0	78·5	− 0·2	73·7	86	9·0	1·77	− 3·82	12	3·1	26
Kaduna, Nigeria	1014·0	...	95	65	86·5	68·0	77·3	+ 2·0	70·7	89	8·1	12·65	+ 1·15	21	5·5	45
Zomba, Nyasaland	1014·5	+ 0·9	88	50	78·5	58·1	68·3	− 1·2	61·9	65	4·5	0·03	− 0·31	2	...	...
Salisbury, Rhodesia	1018·0	+ 1·4	86	38	77·6	48·4	63·0	− 3·4	51·7	39	1·0	0·00	− 0·28	0	10·1	84
Cape Town	1020·9	+ 1·8	84	43	68·3	52·3	60·3	+ 2·4	53·0	80	6·0	2·52	+ 0·28	10	...	...
Johannesburg	1018·7	+ 1·0	81	30	69·2	44·4	56·8	− 2·6	45·8	48	2·0	0·28	− 0·68	2	9·9	83
Mauritius	1019·6	− 0·6	82	56	77·4	63·0	70·2	+ 0·1	64·2	64	5·1	1·09	− 0·21	19	8·4	70
Calcutta, Alipore Obsy.	1005·2	+ 0·7	92	75	89·0	78·3	83·7	+ 0·5	79·5	90	7·0	19·83	+ 9·82	17*	...	...
Bombay	1006·8	− 1·2	89	75	86·4	76·9	81·7	+ 0·8	77·3	87	7·1	5·72	− 4·96	13*	...	...
Madras	1006·2	− 0·3	99	73	92·9	77·8	85·3	+ 0·1	77·2	75	6·4	1·93	− 2·92	6*	...	...
Colombo, Ceylon	1009·5	− 0·4	88	73	85·3	75·8	80·5	− 0·7	76·7	77	7·4	8·09	+ 3·33	18	6·1	50
Singapore	1009·3	− 0·5	89	73	85·8	76·0	80·9	− 0·2	77·6	81	6·1	5·85	− 0·94	15	6·7	55
Hongkong	1008·2	− 0·1	90	70	86·3	76·9	81·6	+ 0·6	75·5	74	5·8	12·38	+ 2·69	10	7·5	61
Sandakan	1008·6	...	91	72	88·7	75·1	81·9	+ 0·2	76·9	82	7·4	16·73	+ 7·40	14	...	...
Sydney, N.S.W.	1019·0	+ 2·9	85	43	67·1	48·9	58·0	− 1·2	52·5	60	3·2	1·29	− 1·57	10	9·3	78
Melbourne	1019·1	+ 3·3	74	33	60·5	43·1	51·8	− 2·3	48·1	70	7·5	1·03	− 1·41	17	4·7	40
Adelaide	1021·3	+ 3·8	86	37	66·2	46·5	56·3	− 0·8	50·1	56	6·3	0·67	− 1·38	13	6·1	52
Perth, W. Australia	1019·1	+ 1·1	80	40	70·4	52·8	61·6	+ 3·4	53·9	58	5·5	1·75	− 1·67	9	8·3	70
Coolgardie	1019·2	+ 2·0	92	32	72·9	46·4	59·7	+ 1·0	50·5	49	2·3	0·10	− 0·57	1	...	...
Brisbane	1019·7	+ 2·1	87	49	76·0	54·1	65·1	− 0·1	58·1	60	3·0	0·84	− 1·16	5	9·3	78
Hobart, Tasmania	1012·4	+ 1·4	66	36	57·7	42·1	49·9	− 1·1	44·5	59	6·0	1·27	− 0·80	18	6·5	55
Wellington, N.Z.	1010·0	− 4·6	66	35	56·6	43·6	50·1	− 1·5	47·1	69	6·4	2·44	− 1·53	16	6·4	54
Suva, Fiji	1015·3	+ 1·0	86	64	78·8	69·1	73·9	− 0·6	69·2	80	7·7	7·03	− 0·66	16	4·1	34
Apia, Samoa	1012·0	− 0·2	86	68	84·2	72·5	78·3	+ 0·1	75·0	74	4·2	4·72	− 0·39	12	8·1	68
Kingston, Jamaica	1012·1	− 0·1	91	69	88·8	72·4	80·6	− 0·9	71·6	84	3·7	0·57	− 3·46	4	7·1	58
Grenada, W.I.	1011·8	0·0	88	70	86	73	79·5	− 0·8	73	74	5	10·86	+ 2·87	19	...	...
Toronto	1017·9	+ 0·1	87	37	71·5	53·8	62·7	+ 2·4	56·0	85	4·4	2·90	+ 0·23	11	7·0	56
Winnipeg	1012·9	− 0·9	90	24	67·6	45·5	56·5	+ 2·8	46·7	87	5·4	2·05	− 0·17	5	5·6	44
St. John, N.B.	1017·6	+ 0·2	72	34	61·5	48·5	55·0	− 0·9	51·8	88	6·9	5·59	+ 1·85	17	4·8	38
Victoria, B.C.	1018·1	+ 1·7	73	43	62·1	47·7	54·9	− 1·2	52·7	84	5·3	1·39	− 0·42	8	7·7	61

(36189) Wt. 19/32 1,125 3/37 Hw. G. 377

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

April, 1937

No. 855

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

Light Winds in the London Area

The *Monthly Weather Report* contains each month a table (Table II), giving, among other data, the number of hours with winds having velocities between certain limits at each of the stations where an anemometer is installed. Similar information for the whole year is given in the *Annual Summary of the Monthly Weather Report.* The table includes data from three stations in the London area, namely, South Kensington, Kew Observatory and Croydon Aerodrome. Attention was first directed to the phenomenon which is the subject of this note by the results summarized in Table I, which refers to the year 1935. It will be seen that in 1935 there were only 13 hours at South Kensington with a wind speed exceeding 24 m.p.h. as compared with 95 hours at Kew and 371 hours at Croydon. In the category 13 to 24 m.p.h., which includes moderate and fresh winds, we again have the lowest frequency at South Kensington and the highest at Croydon. In the next category, light winds 4 to 12 m.p.h., the order is reversed, as might be expected. Finally, we come to " light airs and calms " (less than 4 m.p.h.) and here we find the really interesting feature of the table, namely the fact that these very light winds were very decidedly less frequent at South Kensington in 1935, than at either Kew or Croydon.

A brief examination of the data for earlier years showed that the results for 1935 were not exceptional, and it was therefore thought worth while to look into the matter a little more closely. Results from the South Kensington anemometer are available from the year 1930, and it was thus possible to determine the monthly average frequency of winds under 4 m.p.h. for the period of 7 years

TABLE I. FREQUENCY OF WINDS OF STATED VELOCITY IN 1935. (Total duration in hours, and percentages).

Station.		Above 38 m.p.h.	25 to 38 m.p.h.	13 to 24 m.p.h.	4 to 12 m.p.h.	Less than 4 m.p.h.
South Kensington.	hours ...	0	13	1723	6322	702
	percentage	*0*	*0·15*	*20*	*72*	*8*
Kew Observatory.	hours ...	0	95	2083	5025	1557
	percentage	*0*	*1·1*	*24*	*57*	*18*
Croydon ...	hours ...	0	371	2969	4177	1243
	percentage	*0*	*4*	*34*	*48*	*14*

1930 to 1936. The data for the other two stations were averaged over the same period and the results are given in Table II. Here the averages are given in the form of percentages of the total time.

A period of only seven years is of course far too short to give reliable monthly averages of the frequency of any element, and it will be seen that the variations from month to month of the values in Table II are very irregular. We may presume, however, that all

TABLE II. PERCENTAGE FREQUENCIES OF WINDS OF LESS THAN 4 M.P.H. (Averages for 7 years 1930–6).

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	%	%	%	%	%	%	%	%	%	%	%	%	%
South Kensington	13	9	13	10	11	12	10	15	15	9	13	15	12
Kew Observatory	21	16	20	15	20	19	19	27	23	19	23	22	21
Croydon ...	13	12	12	8	13	15	15	20	19	11	17	15	14

three stations were similarly affected by general factors causing fluctuations above or below normal and that the results give a fairly reliable indication of the relative frequencies of very light winds and calms at the three stations. We conclude therefore that, (*a*) winds of less than 4 m.p.h. are little more than half as frequent in central London as at Kew Observatory in all months; and (*b*) winds of less than 4 m.p.h. are decidedly less frequent in central London than at Croydon, from May to November; from December to April the frequencies in the two areas tend to be about the same.

The anemometers at South Kensington, Kew and Croydon are all of the modern Dines pattern, and in each case the instrument is installed above the roof of a large building. The sites, however, differ considerably. At South Kensington the anemometer head is 30 ft. above the roof of the Science Museum, 110 ft. above ground and 137 ft. above sea level; the "effective height" is judged to be 30 ft., because the head is higher by that amount than the general roof level of the buildings in the vicinity. The flow of air is highly turbulent; the mean velocity in gusts is nearly double the mean wind velocity and in lulls the velocity often decreases to zero. At Kew, the anemometer head is 75 ft. above ground and 92 ft. above sea level; park land surrounds the Observatory for some distance, but on the western side there is a row of tall trees about 300 yards from the building. At Croydon the anemometer is mounted above the control tower of the airport; the head is 105 ft. above ground and 313 ft. above sea level.

Of the three instruments, Croydon has the best exposure; it is also the highest above sea level and has the greatest effective height above ground. The results for Croydon and Kew given in Table I are completely in harmony with expectations based on these considerations. In regard to South Kensington, the general tendency is for the mean wind speed to be reduced by the frictional resistance of the buildings which cover a large proportion of the ground in London. This accounts for the infrequency of winds exceeding 12 m.p.h. and for the large percentage of winds with velocities between 4 and 12 m.p.h. It appears, however, that very light winds and calms are subject to a different form of topographical control, otherwise we should find a very high frequency of these winds at South Kensington.

Several other stations recorded a low frequency of strong winds in 1935, but in all cases except South Kensington the proportion of winds of less than 4 m.p.h. was correspondingly high; thus at Balmakewan there were only 44 hours in which the mean velocity exceeded 24 m.p.h. but there were 3,221 hours under 4 m.p.h. In general high durations of very light winds were recorded inland and low durations on the coast, but there were some exceptions. Only two other inland stations recorded a lower duration than South Kensington, namely Cardington and Birmingham. In both these cases the anemometer is at an abnormal height above ground, and at Birmingham the instrument is also in a large city. At most coastal stations the duration of winds below 4 m.p.h. was similar to that observed at South Kensington.

It is well known that the lull of wind at night is related to the cooling of the ground by radiation and the establishment of a surface inversion of temperature. It is also well known that the temperature at night in the middle of London is higher than in the outer suburbs or in neighbouring rural situations. It seems probable, therefore, that there are frequent occasions when an inversion has become established at Kew and Croydon up to the height of the anemometer head, while at South Kensington the lapse rate of temperature at the level of the anemometer remains normal. The night temperature of London tends to approximate to that of the sea coast rather than to that of an inland rural situation and it is of interest to find that London also resembles the coast in respect to the frequency of very light winds and calms. This fact is not merely one of academic interest; it must have an important bearing on such matters as the formation and distribution of town fog, and the dispersal of poison gas in the event of the use of such a method by an enemy in an aerial attack on London and other large cities.

E. G. BILHAM.

Work of the British Group of the International Commission of Snow

In the spring of 1936, Professor J. E. Church, of the United States, President of the newly formed International Commission of Snow which is under the International Association of Hydrology, itself a division of the International Union of Geodesy and Geophysics, requested Mr. G. Seligman to arrange British co-operation at the first meeting of the Commission to be held in Edinburgh in the following September. Mr. Seligman then took counsel with a few people likely to be interested in the matter, and all agreed that it would be unthinkable to allow such a gathering to take place in the capital of Scotland without British participation therein. Accordingly Mr. Seligman who was to act as Chairman of a British contingent, lost no time in approaching every meteorologist, geographer, hydrologist, glaciologist and geologist in Great Britain who could be remembered as having done any definite work in any aspect of its scientific study of snow. The result was that by the time the autumn came round British representation was quite as strong as that of many other countries whose units had been formed earlier, numbering 16, of whom 10 came to Edinburgh. From the British section four papers were communicated; one by Capt. W. N. McClean on the influence of snow and ice on river-discharge measurements in the Highlands of Scotland; one by Dr. F. Loewe on the maintenance of the Greenland ice-sheet; and two by Mr. L. C. W. Bonacina on (1) problems of drifting snow in the British Isles with special reference to the Scottish Highlands, and (2) factors controlling the distribution of snowfall over the globe. Thus two of the papers, as befitted the occasion, discussed snowfall in our own country. Every paper read, or submitted to the Conference, will eventually appear in the *Proceedings of the International Association of Scientific Hydrology.*

Up to date (March, 1937) the British group or section of the International Snow Commission consists of the following:—G. Seligman, H. R. Mill, F. C. Debenham, C. K. M. Douglas, A. R. Glen, A. E. H. Tutton, G. Manley, R. Moss, W. N. McClean, K. S.

Sandford, J. M. Wordie, T. G. Longstaff, L. Hawkes, W. R. Higginbottom, E. A. M. Wedderburn, H. MacRobert, A. H. R. Goldie, and L. C. W. Bonacina.

The President of the International Commission, Professor Church, had expressed a wish that in the interval between the Edinburgh gathering and the next at Washington in 1939, the different national units should pursue a domestic policy of their own, and so it was decided in Edinburgh on September 16th, 1936, to hold the first independent meeting of the British group in London on December 11th, 1936. This was held at 5 p.m. in a room kindly placed at the disposal of the group by the Royal Geographical Society. At this meeting domestic policy was discussed, followed by the reading of three papers, and a short account of the proceedings will now be given.

In relation to domestic policy Mr. Wordie was anxious to form a British Glacier group of the International Commission of Glaciers of the International Union of Geodesy and Geophysics, akin to the Snow group, and suggested that the two groups should hold joint meetings to which other persons interested in the study of snow and ice should also be invited. Thus it seemed to follow automatically that a new body should be formed consisting of members of the two commissions together with other interested persons. This view was unanimously supported, and on the proposal of Dr. Longstaff seconded by Mr. Bonacina it was decided to form such a body —to be known as the Snow and Ice Association. Before the decision was taken, however, Mr. Bonacina represented that it was first of all necessary to view snow and ice in proper perspective in relation to other natural phenomena, and showed that a special society for their investigation could actually be justified. A difficulty was to find a name for a science including all the varied forms of ice on the earth's surface. Glaciology would do, but is unfortunately by convention limited to the study of glaciers, and such terms of Greek derivation as "Cryology" or "Chionology" sound utterly barbarous. Hence it was resolved to fall back on plain Anglo-Saxon, and call the new body simply, as already stated, a "Snow and Ice Association".

The following papers were then read :—

(1) "The firn structure of the North-East Land Ice Cap". By R. Moss.

(2) "Survey of snowfall in the British Isles and problems needing investigation in the Scottish snow-beds". By L. C. W. Bonacina.*

(3) "Notes on the snowfall in northern England". By G. Manley.

The next meeting of the British group will take place on April 23rd, 1937, when further steps will be taken in the organization of the new Snow and Ice Association, a paper will be read by Mr. Odell on ice and snow erosion, and a discussion will be opened by

* To be published in an early number of *Discovery*.

Mr. Bonacina on the meaning to be attached to the " fall " of snow in cases of long-distance mass drifting. Mr. G. Seligman will act as Chairman and Secretary for the time being, and is anxious to enrol as many members as possible among those to whom a study of snow and ice might be of interest, including geographers, geologists, physicists, mountaineers, ski-runners and others.

It will thus be seen that the British group of the International Snow Commission is, on the one hand, endeavouring to promote the study of the snowfall of these islands, and, on the other, to fit itself to give advice on snow problems to polar or high mountain expeditions about to leave these shores.

L. C. W. BONACINA.

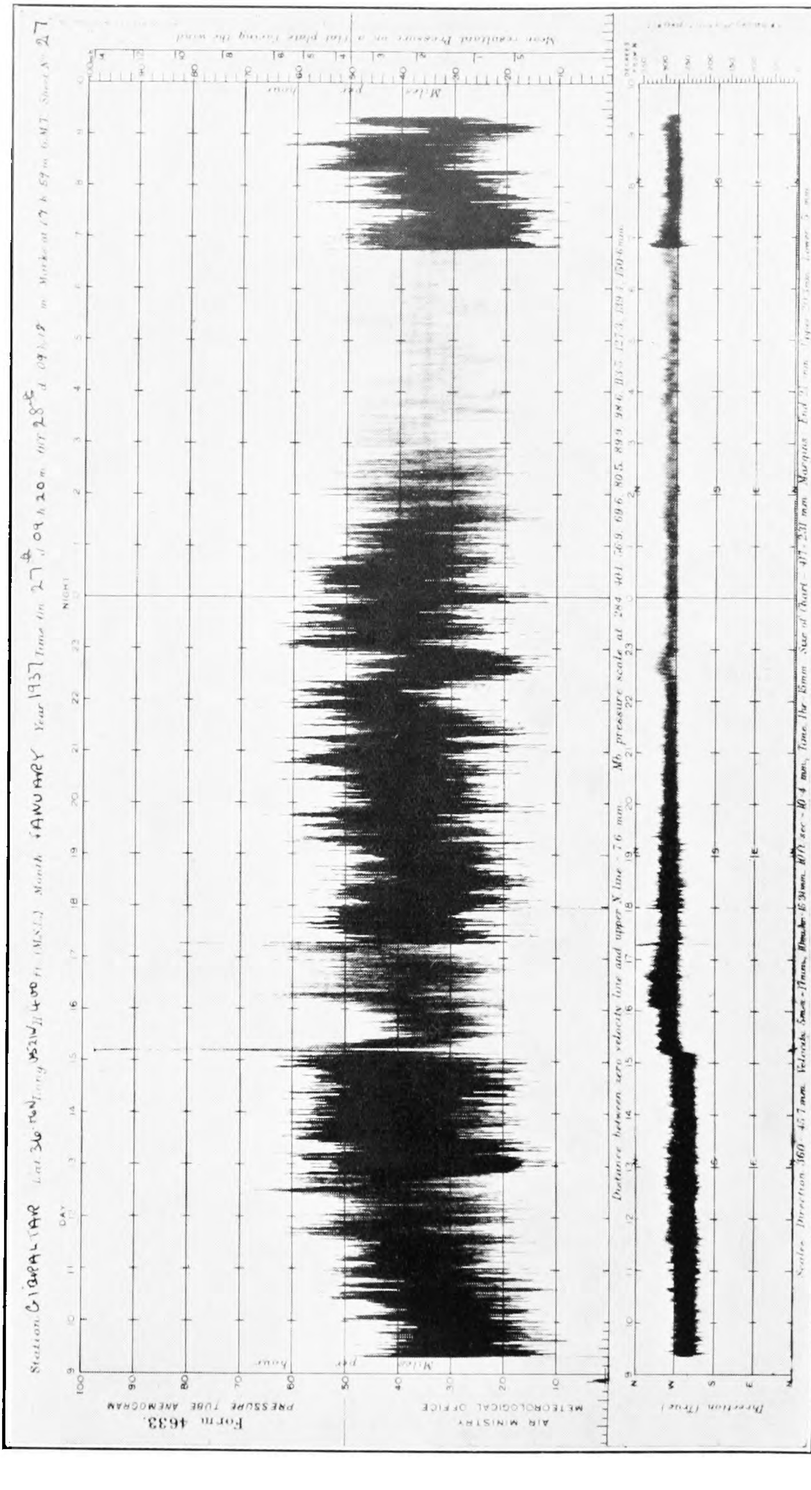
Iberian Peninsula swept by Severe Gales

Between January 26th and 28th, 1937, the Iberian peninsula was swept by very severe gales, much structural damage being done on land and at sea. At Leixoes (Oporto) at least sixteen trawlers and two steam lighters were sunk while at Setubal the British steamship *Terneuzen* was driven ashore.

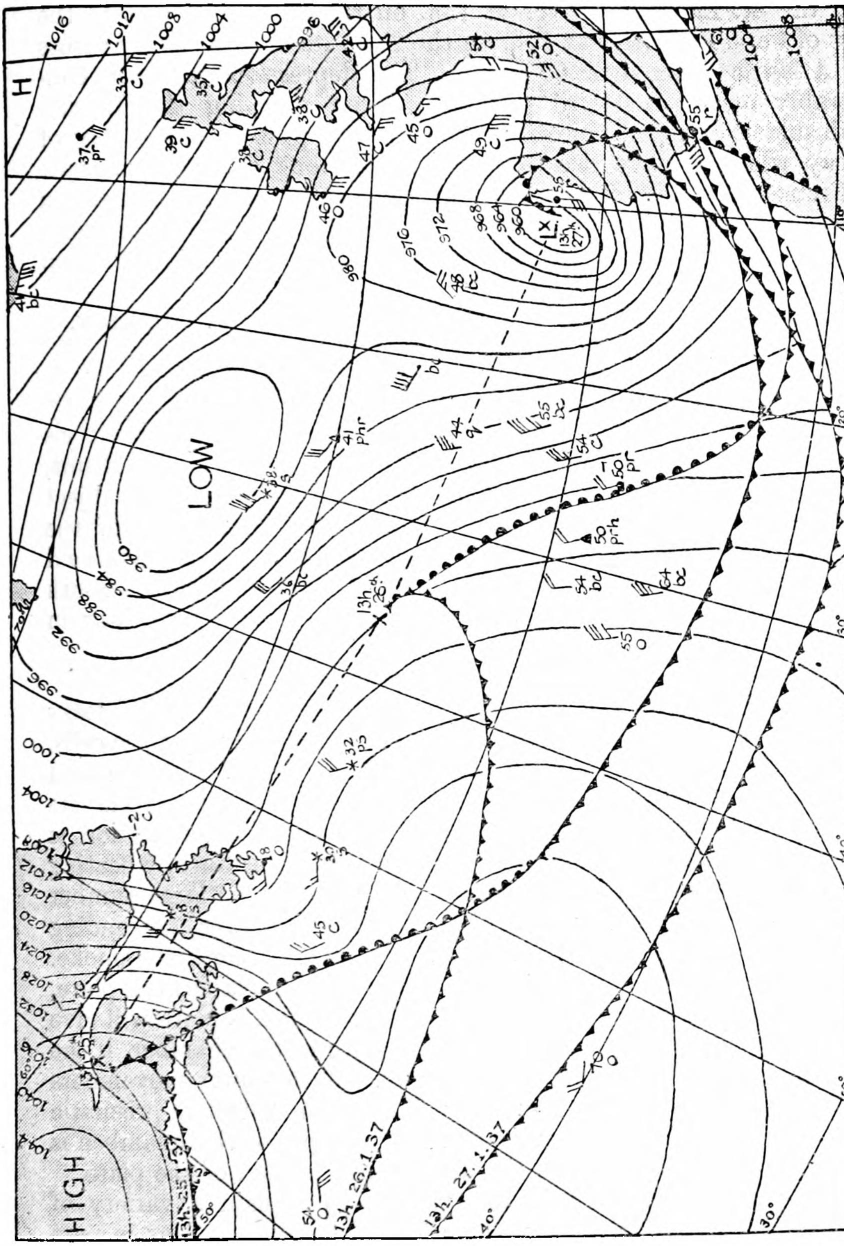
Gibraltar experienced the full force of the gales, the wind there reaching momentarily in a gust at 15h. 10m. on the 27th, a velocity of 98 m.p.h. (See Fig. 1). The P. and O. liner, *Strathnaver*, after landing passengers at Gibraltar on the 27th, was compelled to seek shelter in Algeciras roadstead during the night, the passengers being marooned ashore until the following day, when they were re-embarked. The Union Castle Liner, *Llangibby Castle*, was unable to anchor in the harbour in the afternoon of the 27th, steamed out to sea and spent the night to the east of Gibraltar. The steamers *City of Durban* and *Langleetarn*, moored alongside the west side of North Mole Admiralty Harbour were unable to cast-off, and smashed the wall facing for about 60 feet, both steamers having several plates bent. An Italian steamship, the *Spartivento*, went ashore in the side of the bay quite near to the spot where in the previous April the P. and O. liner, *Ranpura*, carrying the Chinese art treasures, which had been on exhibition in London, went ashore. Shipping at Gibraltar was at a standstill, services to Tangier and Algeciras being suspended and also the patrol of the Straits by insurgent warships.

The fourth destroyer flotilla, which was on its way from England to Gibraltar, encountered the full strength of the gale and very rough seas. The *Beagle*, with its foremast and wireless carried away, reached Gibraltar escorted by the *Brazen* and two other destroyers. Only three destroyers were able to make the harbour on the evening of the 27th, the rest of the flotilla being compelled to spend the night at sea; the aircraft carrier *Courageous* was also unable to moor alongside the south mole or make harbour. The gale abated at Gibraltar on the morning of the 28th.

The gales extended as far south as Casablanca where they, together



Anemogram, Gibraltar, January 27th–28th, 1937



Warm front Cold front Occlusion

WEATHER CHART, NORTH ATLANTIC, 13h. JANUARY 27th, 1937 with the heavy seas, caused much damage to the harbour; many coastal roads were also rendered impassable.

The gales were associated with a depression which was centred near the St. Lawrence River at 13h. on the 25th, and just to the west of Cape Finisterre at 13h. on the 27th, its mean velocity across the Atlantic being over 60 m.p.h. The depression deepened considerably on its eastward passage. Upon reaching the Iberian Peninsula it changed course, slowed up and passed to the Bay of Biscay where it gave rise to severe gales along the western coast of France. In Fig. 2 the path of the centre of the depression between January 25th and 27th, is indicated together with approximate positions of associated fronts at 13h. on the 25th, 26th and 27th respectively.

J. CRICHTON.

Royal Meteorological Society

The Symons Memorial Lecture was delivered at the Society's monthly meeting on Wednesday, March 17th, by Prof. D. Brunt, Professor of Meteorology in the University of London, on the subject of " Natural and artificial clouds ". By kind permission of the Imperial College of Science and Technology, the meeting was held in the Royal College of Science, Imperial Institute Road, South Kensington. Dr. F. J. W. Whipple, F.Inst.P., President, was in the Chair.

The following is an abstract of the lecture :—

" The motions which occur when an unstable layer of fluid breaks down have been found to be in the form of polygonal prismatic cells, in which the motion at the centre of the cell is upward, when the fluid is a liquid. In air, it is shown that while the motions in deep layers resemble those in liquids, except that the direction of motion is reversed, the motion in shallow layers of air made unstable by heating from below is different in appearance, and consists of a large number of ascending currents, surrounded by much slower descending currents. The motion of the air is made visible by cigarette smoke.

When the air is bounded at its upper limit by a movable glass plate, it is found that the shearing produced by moving this plate will give long rolls extending through the whole length of the chamber, if the upper plate is moved sufficiently rapidly. With slower movements of the upper plate, the chamber is filled with distorted prismatic cells, and with very slow movements of the plate, the chamber is filled with rolls transverse to the direction of motion of the plate.

These experimental results are applied to explain a variety of cloud forms, which are thus presumably to be explained as in part due to the effects of instability. Among these clouds are those which consist of small cloudlets on a background of blue sky, cloud sheets which show a series of clear holes, and clouds in rolls, which may be analogous to either the longitudinal rolls found in the laboratory with rapid shearing of the top plate, or to the transverse rolls found with slow shearing of the upper plate. Some comparison is given of the evidence of ascending currents in the atmosphere found by gliding pilots. A film shows the forms taken by unstable layers during the process of breakdown, as well as of some clouds which closely resemble the structures obtained in the laboratory."

Correspondence

To the Editor, *Meteorological Magazine*

Cover Designs of the Meteorological Magazine

On reading the note in your February number on the new design for the cover it strikes me that some of your readers may care to be reminded that in Mr. Symons's time and up to 1903 the cover bore no design but merely the title in capital letters.

Mr Symons died in 1900 and when I came into sole control of the British Rainfall Organization in 1903 I asked Mr. M. J. Dawson, F.R.I.B.A., to design the cover depicting the Ben Nevis Observatory, which first appeared in Vol. 39 (1904) and was superseded in 1920.

HUGH ROBERT MILL.

Hill Crest, Dormans Park, East Grinstead, Sussex, March 2nd, 1937.

Abnormal Rainfall at Bognor Regis

Mr. D. S. Hancock, of Greenways School, Bognor Regis, Sussex, has expressed the abnormal rainfall at his meteorological station during 1937 in an unusual and interesting way. The following table shows the dates on which the accumulated totals amounted to 9 in. and 12 in. respectively in each year since 1929.

	Total Rainfall.	
	9 inches.	12 inches.
1929 ...	July 5	August 12
1930 ...	April 23	July 15
1931 ...	May 21	July 14
1932 ...	May 21	July 13
1933 ...	May 6	June 20
1934 ...	June 28	August 23
1935 ...	April 25	June 11
1936 ...	April 1	June 14
1937 ...	February 24	March 12

The total of 9 in. was reached 37 days earlier than in any previous year, and the total of 12 in. no fewer than 91 days earlier.

Night Radiation during the Cold Spell of March, 1937

The cold weather which set in over this country on February 28th, and persisted in varying degrees of severity until the middle of March, produced some remarkably low night minima from screen and radiation thermometers, and some of the values obtained at Goff's Oak, Herts, may be of interest.

The mean minimum temperature of the air (screen) for the period February 28th to March 12th, was 31·5° F., and on many nights the terrestrial radiation was considerable, the minimum on the grass falling below 32° F. on every night during this period.

The night of March 9th to 10th produced a particularly severe frost, the screen minimum being as low as 23·3° F., and being a clear, calm night, there was a pronounced inversion near the surface of the ground, the grass minimum being 15·7° F. This was the sharpest ground frost recorded in this district in the month of March since the year 1933.

The mean wind velocity as estimated by a three-cup anemometer at 23 ft. above the ground, was only 1·3 m.p.h., and the resultant effect of radiation is shown in the curve, Fig. 1.

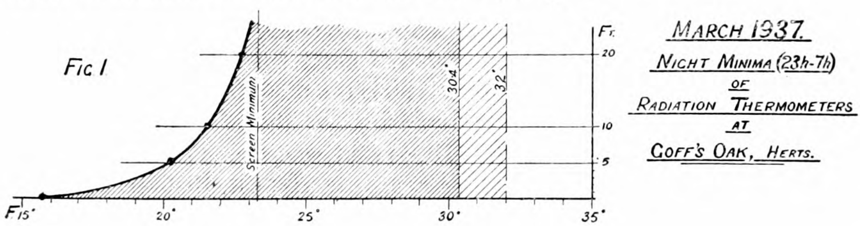


FIG. 1

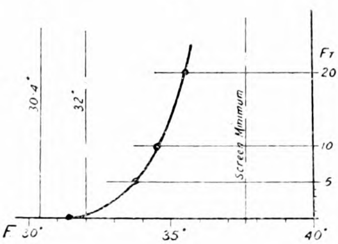


FIG. 2.

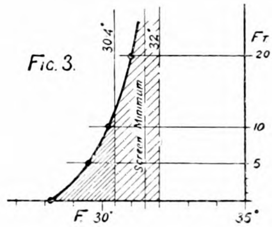


FIG. 3.

Radiation was particularly active on the night of March 11th to 12th, and as may be seen in Fig. 2, the minima at 5 ft., 10 ft. and 20 ft., were 3·8° F., 3·1° F. and 2·1° F., respectively, below the minimum in the screen. These figures show the greatest deviation of minima on any night of the 250 nights in the past two years for which radiation data are available at these levels. The mean wind velocity on this occasion was 6·4 m.p.h., so that although the sky was free of cloud, the inversion near the ground was not so pronounced as in the former case ; but the values obtained give further indication of the high radiation activity associated with maritime cyclonic air,* the air in this case having moved, in the previous 48 hours, across the English Channel and Brittany from the Bay of Biscay, the air flow being associated with a vigorous depression which, on the morning of the 12th, was centered at the mouth of the Bristol Channel.

The mean curve for this cold spell is shown in Fig. 3., and it is interesting to note that the mean minimum at 10 ft. above the ground

* See *Meteorological Magazine*, 71, 1936, p. 286.

was 30·2° F., 0·2° F. below the value fixed to determine the occurrence of ground frosts.

Doubtless this has had considerable effect in retarding the growth of fruit trees, and, in tending to delay budding, will go far to save the crops from damage by frost occurring early in the month of May.

DONALD L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Herts, March 20th, 1937.

Blizzard of March 11th—13th in Ulster

Mr. J. Porter, of Moneydig, Garvagh, Co. Londonderry, writes that "the general opinion here is that the storm of March 11th and 12th is easily the greatest since April, 1917. Snow began to fall here at 3.30 p.m. on the 11th and never ceased for an hour to Saturday the 13th at 12.30 p.m....... An hour after the snow commenced the temperature fell below 32° F. in the screen and except for about 1 hour after 2.30 p.m. on the 12th, when it rose to 33° F., it was at or below 32° F. to 10.30 a.m. on the 13th....... The average depth of the snow here was about 10 in. The rainwater measured 0·33 in.; this seems a small amount but the snow was very dry, also owing to the high wind the gauge probably didn't catch its proper share. Drifts on some of the roads here were 5 ft. deep and on exposed situations 10 or 12 ft. The main road from Kilrea to Belfast was completely closed for 3 days....... This is very unusual for Ireland. Belfast was very badly affected and the milk supply had to be brought across from Scotland, the farmers being unable to get through the enormous drifts....... The farmers in mountainous districts are very badly hit owing to the storm occurring at the beginning of the lambing season."

Mr. D. Dewar, of the Meteorological Station, R.A.F., Aldergrove, Co. Antrim, writes that "after a spell of cold weather with northerly winds and wintry showers snow began to fall about noon on March 11th and continued with short breaks until the morning of the 13th. Driven by a strong north-easterly wind the snow soon began to form drifts and by midnight on the 11th many vehicles had had to be abandoned. By the morning of the 12th practically all roads in the province were impassable for wheeled traffic and many railway services had to be cancelled. Drifts up to 10 ft. deep had accumulated near Aldergrove. Snow continued with short breaks throughout the day and night of the 12th but by the morning of the 13th the wind had decreased to moderate and the snowfall had become light. Owing to the stoppage of communications food supplies were running short in outlying districts but by the 14th most main roads were passable with care. Five persons lost their lives through the blizzard. Such severe conditions are seldom experienced in northern Ireland.

The synoptic chart for 7h. on the 11th showed a deep depression to the south-west of Ireland, moving slowly north-eastwards, with a front running from south of Valentia to Calshot moving slowly north. By 7h. on the 12th the front had travelled to a line Holyhead to Flamborough but was only moving very slowly northwards. This retardation of the speed of the front caused the prolonged snowfall. On the morning of the 13th the depression was centred over northern England, filling up and moving slowly north-eastwards.

The effect of Lough Neagh in raising the air temperature was strikingly shown by a track of land on the west shore, about half a mile wide, remaining free from snow. At 18h. on the 11th the temperature at Aldergrove was 31° F. with an east-north-easterly force 7 wind and in view of these conditions it is rather remarkable that a track of seven miles over shallow water should have been able to raise the temperature sufficiently to turn the snow to sleet or rain."

Intense Thunderstorm

A very sharp—though short—thunderstorm passed over here to-day. I was, at the time, in the buildings of Orley Farm School, a few hundred yards from this house. One flash seemed to be right overhead, and almost instantly—before the thunder—I heard a sharp click answering very closely to the " vit " described by Mr. Breton and other correspondents in the *Meteorological Magazine* for June, July and August, 1928. I had just been arranging some electric lights, and my first impression was that a fuse had been blown at the other end of the room I was in ; but this was not the case. It was heard by boys and masters all over the long building and gave most of them the impression that the lightning-conductor had been struck. It seems to me possible that a discharge from the conductor might have accounted for the " click." I have not yet discovered any damage.

HUGH GARDNER.

Oakhurst, Mount Park, Harrow-on-the-Hill, March 17th, 1937.

Lunar Rainbow

A comparatively rare phenomenon in the nature of a lunar rainbow was observed at Croydon on February 26th, 1937. Cloudless conditions with bright moonshine prevailed until 3h. 30m., when low cloud, cumulus and stratocumulus, at an estimated height of 2,500 ft., rapidly increased to 5 tenths accompanied by a slight shower at 3h. 55m. Almost immediately an arc, pure white in colour, rising to about 45°, and covering an area approximately north-north-east to east-north-east appeared.

The moon's position at that time was estimated at south-west to west-south-west, and was unobscured. A lunar halo was noted half an hour later, when high and medium cloud formed rapidly.

R. A. RASEY.

Meteorological Station, Croydon Airport, Surrey, March 4th, 1937.

NOTES AND QUERIES

Relative Humidity above the Desert at Ismailia, Egypt

During 1932 two series of observations were made of relative humidity at heights of 4, 55 and 154 ft. above the desert at Ismailia. A hygrograph and dry- and wet-bulb thermometers were exposed in standard Stevenson screens at each of these heights; the proper working of the hygrograph was checked by frequent comparison with readings of the dry- and wet-bulb hygrometers. Records were obtained for the different heights as follows: March 1st to April 14th at 4 and 154 ft., April 1st to 14th at 55 ft. and June 17th to July 18th at 4 and 154 ft. The values for each hour were tabulated and mean values computed for each of the months March, April, June and July. The curves of diurnal variation of relative humidity

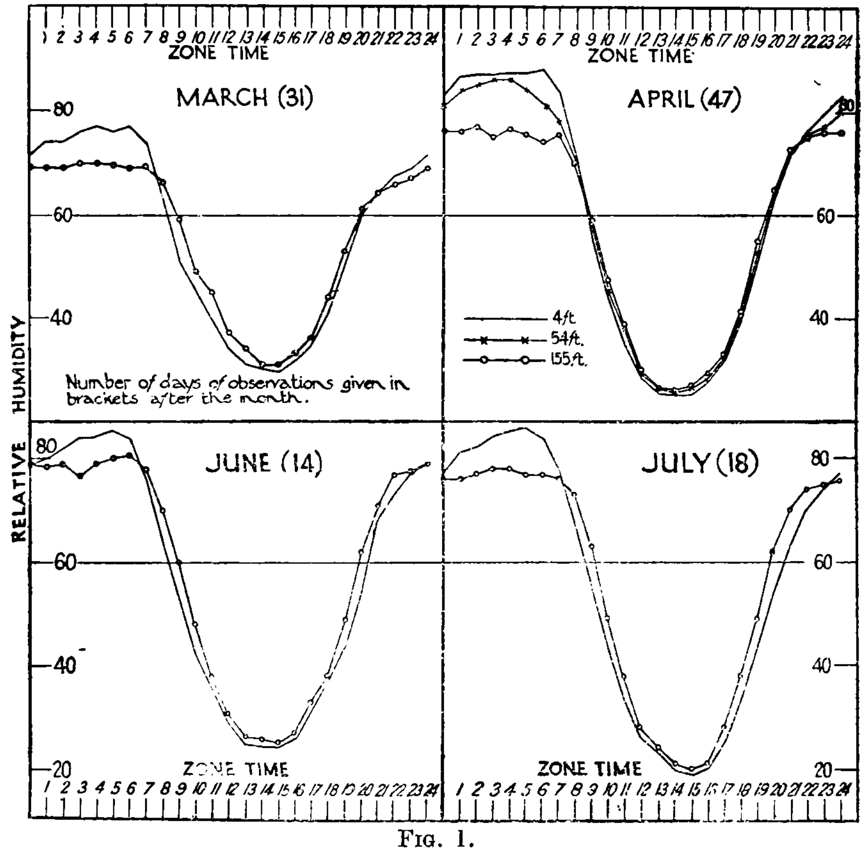


FIG. 1.

obtained from these mean values are given in Fig. 1. The decrease of relative humidity with height at night and slight increase with height during the day will be associated with the diurnal variation of the lapse rate of temperature.

Individual records shew that during the night fluctuations in relative humidity near the surface are generally small but that the fluctuations become larger with increasing height above the surface. A typical case of such fluctuations was the night of April 5th–6th. The hygrograms and thermograms for 4, 55 and 154 ft. are given in Fig. 2 and it will be seen that the fluctuations increase with height. Wind at 50 ft. was northerly, 3 to 7 m.p.h. throughout the night except for two periods of calm, 23h. to 0h. 30m. and 1h. 20m. to 2h. 20m. The decrease in relative humidity at 154 ft. after 0h. 30m. was associated with an increase in wind velocity at 50 ft. from calm to 7 m.p.h. by 1h. while the minimum at 55 and 154 ft. at 2h. 35m. coincided with a wind velocity maximum of 10 m.p.h. at 50 ft. Further, the relative humidity maxima and minima at 55 and 154 ft. coincide respectively with temperature minima and maxima at these heights.

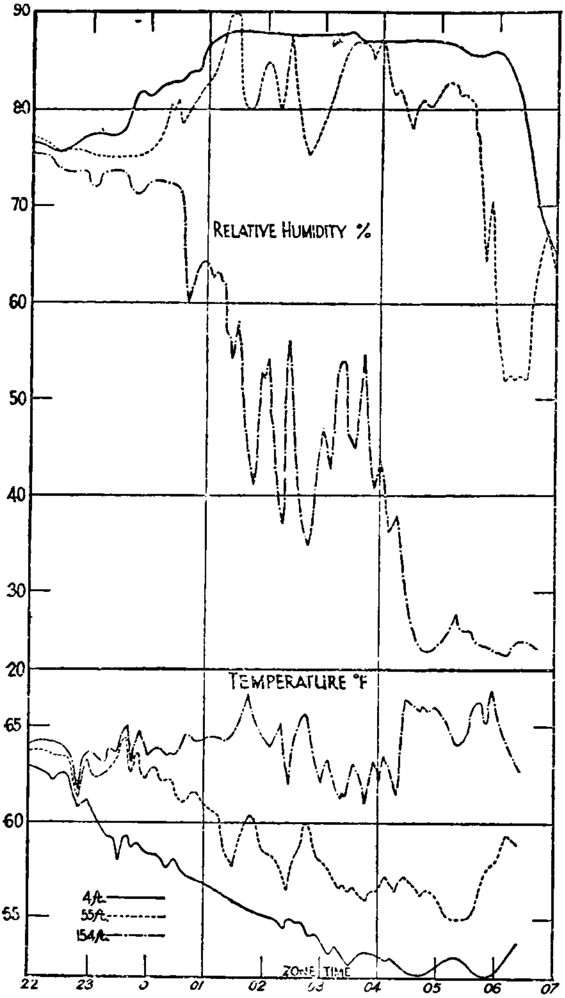


FIG. 2.

WILLIAM D. FLOWER.

Rainfall, January to March, 1937

The persistent rains, which were a feature of the weather of January and February, 1937, continued also into March. Some details of the rainfall of January and February were given on pp. 42–3 of this magazine. Nearly all stations in the British Isles recorded a rainfall in excess of the average for both January and February, but during March the excess was continued only in the east of Great Britain and the east of Ireland. During March there was a deficiency over the greater part of Scotland, over the north-western half of Ireland and over the north-west of England and Wales. A few stations recorded more than twice the usual amount, e.g., in parts of Kent, Cambridge, Northumberland, Co. Cork and Co. Wexford. On the other hand there was less than half the average in the north-west of Ireland and over the Western Highlands of Scotland, with only 22 per cent in parts of the latter area.

The general rainfall over the British Isles for the three months is estimated to be :—

England and Wales	14·8 in.
Scotland	16·7 „
Ireland	16·5 „
British Isles	16·3 „

The total rainfall over the British Isles was more than that recorded in any similar period back to 1870, as much as 15·5 in. being recorded in January to March, 1928. The rainfall of January to March, 1937, has, however, been exceeded in three consecutive calendar months, e.g., November, 1929 to January, 1930, with 21·6 in., or December, 1914 to February, 1915, with 19·3 in. Utilising the general values for England and Wales published in the special article in *British Rainfall*, 1931, pp. 299–306, it appears that the rainfall of January to March, 1937, over England and Wales, exceeded that of any similar period since before 1727.

At most stations in England and Wales the total rainfall January to March, 1937, exceeded the average for the first four months of the year and in the south-eastern half of England for the first five months. At Wellingborough the total reached the average up to mid-June, at Camden Square (London) up to the beginning of July and at Tenterden, in Kent, up to the last week of August.

The rainfall January to March, 1937, varied from 80 per cent of the average at Stornoway to 240 per cent at Tenterden, in Kent. In the west of Scotland and to the north of the Caledonian Canal there was less than the average, with more than 150 per cent over the Grampians. There was more than 150 per cent over the whole of England and Wales, apart from the area to the west of the Pennines and the north-western half of Wales. Falls of more than twice the average were confined to the south-east of a line drawn roughly from Dartmoor to Norfolk, with 225 per cent in the extreme south-east. In Ireland falls of more than 150 per cent were confined to the south-eastern half with 225 per cent in Co. Wexford.

The Great Ouse catchment area received about 190 per cent of the average for this period. The total rainfall from January 1st to March 21st varied over the area from 7·5 in. to 10 in. It was everywhere more than one-third of the average for the whole year and more than 40 per cent of the annual average in the south and east of the catchment area. The peak condition of flooding in this area occurred about March 17th.

J. Glasspoole.

REVIEW

On the vertical wind distribution in anticyclones, extratropical and tropical cyclones under the influence of eddy viscosity. By B. Haurwitz. Beitr. Geophys. Leipzig, Vol. 47, 1936, pp. 206–14.

This paper is essentially a sequel to a previous paper (On the change of wind with elevation under the influence of viscosity in curved air currents. *Beitr. Geophys. Leipzig, 45, 1935, pp. 243–67*) wherein the author has shewn that the gradient wind level is lower in cyclones than in anticyclones, since in the former the centrifugal force counteracts the effect of friction while it acts in the same direction in anticyclones. From this it follows that in cyclones the angle between pressure gradient and surface wind decreases with increasing distance from the centre and increases in anticyclones. In the present paper the author examines some figures due to Loomis referring to cyclones and anticyclones over the Atlantic Ocean and Europe and over the United States of America and finds reasonable qualitative confirmation of this latter deduction.

The case of the tropical cyclone is then considered and the author finds that at a distance of 20Km. from the centre and after making certain assumptions as to gradient velocity, the coefficient of eddy viscosity, etc., the wind direction becomes normal to the pressure gradient at an elevation as low as 400m. This elevation decreases nearer the centre and it is suggested that this decrease in the vertical extent of the inflow of air may partially explain the phenomenon of the " eye of the storm ".

Finally, some figures due to Chambers shewing the angle between the pressure gradient and the wind in a cyclone in the Arabian Sea are examined. Here the quantitative agreement with the theory is as good as could be expected, bearing in mind the approximations employed and the unsatisfactory nature of the data.

The frequent references to the author's earlier paper make it very desirable to have a copy of that work at hand while reading this sequel.

A. C. Best.

BOOKS RECEIVED

Die Münchener Registrierballonfahrten im Jahre, 1934. By Peregrin Zistler and Hermann Zierl. Appendix to Deutsches Meteorologisches Jahrbuch für Bayern, 1934.

Falmouth Observatory, Meteorological Notes and Tables for the years 1935 *and* 1936, also additional meteorological tables for the lustrum 1931–1935 with mean values for 65 years (1871–1935). By W. T. Hooper, Falmouth, 1936 and 1937.

Measurement of vertical currents in the atmosphere, mainly of thermal origin, with pilot balloons. By K. R. Ramanathan and K. P. Ramakrisnan, India Meteor. Dept., Sci. Notes, Vol. VI, No. 67.

OBITUARY

John Hunter, O.B.E., J.P., A.M.I.C.E.—We regret to record the death on March 12th of Mr. John Hunter of Quarry Bank, Belper, in his 84th year. Mr. Hunter established a meteorological station at Field Head House, Belper, in 1876. He transferred his station to Northfield in 1883 and to Quarry Bank in 1899. From 1880 to 1911 summaries of the observations were published in the *Meteorological Record* of the Royal Meteorological Society, and from 1912 to 1934 in the *Monthly Weather Report*. In February, 1935, on the death of his wife who had assisted him for many years in his climatological work, Mr. Hunter was obliged to discontinue the greater part of his observations. The rainfall record is, however, complete to the end of 1936, and thus covers the long period of 60 years. By the death of Mr. Hunter, the Meteorological Office has lost one of its oldest voluntary observers, and the town of Belper a greatly respected and distinguished citizen.

Albert Richard Simpkins.—We regret to record the death on March 13th of Mr. A. R. Simpkins in his 82nd year. He entered the Office in September, 1876, at the age of 20, being introduced by Captain Toynbee, the Marine Superintendent at that period. After serving for 37 years in the Forecast Division, he was transferred to the Statistical Division in 1913 and from that time was responsible for the compilation of the *Weekly Weather Report* and *Monthly Weather Report*. After becoming Principal Assistant he retired from the Office on December 31st, 1920. Mr. Simpkins was a man of kindly personality and a valued worker in the Baptist Church.

NEWS IN BRIEF

Mr. J. B. Espiner of Ivy House, West Witton, Leyburn, Yorks, informs us that he has for disposal a complete series of *British Rainfall* for the years 1871 to 1935 in good condition. Anyone wishing to purchase these should communicate direct with Mr. Espiner.

The Senate of the University of London has conferred the degree of M.Sc. (Meteorology) on Mr. J. E. Belasco of the Forecast Division.

ERRATA

FEBRUARY, 1937, p. 15, last line *for* " Southport " *read* " Manchester " p. 16, 7th line from bottom *for* " James Halliwell " *read* " Frank Lees Halliwell."

MARCH, 1937.—On p. 49 it was stated that in northern Canada the mean temperature for February was just below −40° F. This was incorrect; the temperatures on the north coast of Canada were between —20° F. and —30° F., increasing to about —10° F. in 60° N.

MARCH, 1937, p. 29, 8th line from bottom *for* "July 1st, 1936" *read* "January 7th, 1936".

The Weather of March, 1937

The average pressure distribution during March was rather abnormal. Pressure exceeded 1020 mb. over a large area extending from the Mississippi Valley across central Canada and the Arctic Ocean to central and southern Siberia. Pressure exceeded 1025 mb. in Saskatchewan, over almost the whole of the Arctic Ocean and in southern and central Siberia, where it reached 1030 mb. In the North Atlantic a long trough of pressure below 1005 mb. extended on both sides of the 50th parallel from Newfoundland to France and Holland. In central Canada and over Greenland, Iceland and the Arctic, pressure was more than 5 mb. above normal, the excess reaching 10 mb. between north-east Greenland and Cape Chelyuskin. By contrast, pressure was more than 10 mb. below normal over southern England.

Temperature was below 0° F. over northern Canada, the Arctic and northern Siberia, the lowest figure being —26° F. at Cape Chelyuskin. In North America, temperature increased rapidly southward to 17° F. at Winnipeg, 33° F. at Chicago, 59° F. at New Orleans and 73° F. at Key West. In Europe temperature increased south-westwards from about 20° F. in the north of Sweden to 30° F. in southern Norway, 40° F. in the Rhine valley and 50–55° F. on the Mediterranean coast; in the British Isles the figures were 36–37° F. in Scotland, 38–42° F. in England and Ireland. Temperatures were above normal on the Pacific coast of North America, central, western and northern Canada, Spitsbergen, Finland, Russia, central Europe, Italy and the Balkans, the excess being 10° F. at Spitsbergen. Temperature was below normal over most of the United States, eastern Canada, Scandinavia, western Europe and the whole of northern and central Asia, the deficiency reaching 11° F. at Eneseisk; the British Isles were about 4° F. below normal.

Precipitation was variable but was generally above normal over England, central Europe, Russia and Finland and deficient in Scandinavia.

Cold weather prevailed generally over the British Isles during March, with much sleet and snow and sharp frosts; the number of days with sleet or snow constituted new records at Croydon, Birmingham and Eskdalemuir. Precipitation was above normal in most parts, but considerably below normal in west and south Scotland and north Wales. On the 1st moderate to strong cold northerly winds prevailed with snow generally and gales in the west. By the 2nd the gales had abated and temperature was rising, so that on the 3rd maximum temperatures were generally above 45° F. and reached 51° F. at Ventnor. From the 4th to 9th depressions passed in an easterly direction to the south of the British Isles and cold weather prevailed generally with, until the 7th, moderate to strong easterly winds becoming light and variable on the 9th and 10th. Maximum temperatures were mostly below 40° F., and did not exceed 34° F. at Manchester and Sheffield on the 6th, while a minimum temperature of 4° F. was recorded in the screen at Dalwhinnie on the 8th. Good sunshine records were obtained in Scotland on the 7th and 8th and in Ireland on the 8th, 10·3 hrs. at Tiree on the 7th and 10·0 hrs. at Aldergrove on the 8th. Rain was general during this period and heavy locally in Ireland and south England on the 6th, 7th and 10th, 1·58 in. at Gorey, Co. Wexford on the 7th and 1·07 in. at Selborne, Hampshire, on the 7th, while sleet or snow occurred at most places even as far south as Falmouth and Valentia. Mist or fog were reported from many parts of England on the 10th. From the 11th–13th a deep depression moved slowly north-eastwards from the mouth of the Bristol Channel to north England giving snow generally except in the south and unusually heavy snowstorms in north Ireland* and south Scotland. Thunderstorms were reported from Birmingham and Ross-on-Wye on the 11th, while gales were experienced locally in the west, Holyhead had a gust of 77 m.p.h. on the 11th. In the south the weather was mild on the 11th, temperatures exceeding 50° F. locally. On the 14th a depression passed eastwards along the English Channel giving gales at Scilly and rain in the south. This was followed by a wedge of high pressure and the 15th was a cool sunny day over the country generally, with 10·7 hrs. bright sunshine at Armagh and 10·5 hrs. at Nairn, Malin Head and Ross-on-Wye. From the 16th to 20th pressure was low to the west and mild unsettled weather prevailed with winds between S. and E. and some rain or sleet (heavy locally on the 16th), though considerable bright periods. Owing to the continuous rains extensive flooding took place in the Fenlands †and following the thawing of the snow floods occurred in the north. Thunderstorms were experienced locally in England and Ireland on the 17th, 18th and 20th, while fog occurred in parts of south Scotland and north England on the 17th–20th, and in eastern England on the 20th. On the 20th the winds backed to N. and from then to the 27th pressure was high to the west. Cold sunny anticyclonic conditions prevailed at times, but frequently the complex low-pressure area to the east brought rain, sleet and snow to all districts. 11·8 hrs. bright sunshine were experienced at Torquay on the 26th and 11·6 hrs. at Oban on the 27th. From the 28th to 30th the anticyclone to the west passed across the country and the weather was mainly sunny,

---

* See p 67. † See p. 70.

especially in the north with, however, wintry showers. On the 30th a depression was approaching Ireland and with the change to southerly winds the weather became mild in the south and west with rain in Ireland and gales in the west and north, a gust of 76 m.p.h. being recorded at Valentia on the 30th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	141	+32	Chester ...	97	−17
Aberdeen ...	99	−10	Ross-on-Wye...	101	−15
Dublin	118	+3	Falmouth ...	145	+9
Birr Castle ...	110	−1	Gorleston ...	139	+11
Valentia... ...	133	+17	Kew	112	+4

Kew, Temperature, Mean 40·2° F., Diff. from normal — 3·7° F.

Miscellaneous notes on weather abroad culled from various sources.

Severe snowstorms were experienced in northern Italy on the 1st and a big avalanche fell above Blatten in the Lötschental about the 3rd completely covering an uninhabited hamlet. A gale occurred at Salonica on the 2nd. On the 14th and 15th severe gales were experienced along the western and southern coasts of France causing much damage, considerable flooding and some loss of life while floods, landslips and avalanches with some loss of life were reported from northern Italy and snow again fell on the Alps down to the 3,000 ft. level. Gales were again experienced on the French Atlantic coast on the 17th causing fresh floods, and heavy rain in Switzerland on the 21st caused many rivers to overflow while in the Engadine yellow snow was reported. Heavy rain occurred in the neighbourhood of Madrid on the 17th and snowstorms on the 23rd. Owing to an unusual ice jam 20 miles above Riga there was serious flooding in the Daugava Valley, Latvia about the 23rd. Heavy rain caused floods in the Avignon region about the 23rd and a snowstorm blocked many roads and railways in Switzerland on the 24th. A gale occurred in the western Mediterranean about the 26th. Snow fell generally in Germany over Easter and heavy snow with avalanches occurred in the higher regions and heavy rain with flooding in the lower regions in Switzerland. Serrières en Chautagne near Aix les Bains was partly destroyed by the overflowing of the river Prairie about the 27th. Easterly gales occurred in Iceland on the 30th. Ice formed no obstruction to navigation at Kalmar on the 30th. (*The Times*, March 3rd–April 1st.)

Sandstorms occurred generally in north Egypt on the 2nd. (*The Times*, March 3rd.)

An overloaded steamer capsized during a storm on the lake near Yunnanfu (China) about the 24th, all the 130 passengers except 2 being drowned. (*The Times*, March 25th.)

A hurricane struck Darwin (Northern Territory) about the 10th causing damage estimated at £95,000. The total rainfall for the month in Australia was mainly above normal in Queensland, New

South Wales, Tasmania and the southern part of Western Australia and generally below normal elsewhere. (Cable and *The Times*, March 12th–13th.)

A tornado struck Harbour Island (Bahamas) on the 30th, killing 1 woman and destroying 9 houses. In the United States temperature was generally above normal during the week ending the 9th, becoming mainly below normal later while precipitation was on the whole below normal. (*The Times*, April 1st and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, March, 1937

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	998·0	NW.4	32	40	58	0·01	2·2	ps_0 5h.–10h.
2	998·6	W.3	35	43	59	0·03	2·6	pr_0–r_0 13h.–23h.
3	1002·2	S.2	34	47	68	—	2·8	
4	996·9	ENE.5	36	45	55	—	0·7	x early f 9h.
5	1001·0	NNE.4	35	39	78	0·19	0·0	r 17h.–22h.
6	1010·2	NNE.2	33	40	73	0·06	1·0	rs 0h.–3h., 23h.–24h.
7	1003·3	NE.4	33	37	80	0·61	0·4	rs–s 0h.–11h.
8	1005·1	NE.4	34	37	70	—	0·0	s_0 9h.
9	1000·6	NNE.4	32	39	57	—	3·4	
10	1001·3	SE.3	26	40	58	0·02	0·7	xf till 10h., rs 14h.
11	984·6	S.4	36	51	73	0·52	1·3	r 2h.–11h., 14h.–21h.
12	984·6	S.5	38	49	83	0·10	4·0	pr 12h.–23h.
13	986·5	WSW.3	39	46	66	0·09	5·2	rR 0h.–3h.
14	978·4	N.4	36	40	93	0·49	0·0	rs 3h.–10h.
15	1011·4	W.5	35	45	45	—	9·7	
16	1011·5	SSE.5	30	46	76	0·13	0·0	r_0 12h.–21h.
17	1000·7	S.4	46	54	75	0·21	2·2	tl PRH 14h.
18	1001·2	SSW.5	45	54	67	0·02	6·0	pr 7h.–9h.
19	1002·4	S.3	42	52	78	0·03	1·9	prh 12h., pr 13h.–14h.
20	1001·7	SSE.3	36	55	61	—	7·8	F till 9h.
21	1004·3	N.3	40	46	84	0·02	0·0	r_0 0h.–9h.
22	1002·7	NNE.4	36	41	56	0·01	3·5	r_0s_0 7h.–10h.
23	1007·4	N.4	30	42	58	trace	6·0	r_0s_0 19h.–20h.
24	1016·2	W.3	31	49	58	—	8·2	x early, r_0 24h.
25	1013·3	W.3	38	49	53	0·17	8·1	r_0 0h.–3h., 20h.–24h.
26	1009·4	WNW.4	33	45	40	0·06	9·0	r_0s_0 0h.–1h., s_0 16h.–19h.
27	1012·8	NNW.3	31	46	57	—	6·7	x early.
28	1019·2	NE.3	30	47	51	—	6·4	x early.
29	1025·5	ENE.3	31	45	50	—	3·1	x early.
30	1027·9	E.3	33	44	60	—	0·0	
31	1018·9	SE.3	39	53	48	—	9·4	m 21h.
*	1004·4	—	35	45	64	2·76	3·6	* Means or Totals.

General Rainfall for February, 1937

England and Wales ...	139	per cent of the average 1881–1915.
Scotland	77	
Ireland	109	
British Isles	115	

Rainfall : March, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	2·96	162	*War*	Birminghm, Edgbaston	2·64	138
Sur .	Reigate, Wray Pk. Rd.	3·64	156	*Leics* .	Thornton Reservoir	2·99	163
Kent .	Tenterden, Ashenden	4·70	219	,, .	Belvoir Castle	2·80	155
,, .	Folkestone, Boro. San.	4·92	...	*Rut* .	Ridlington	3·05	175
,, .	Margate, Cliftonville	3·22	202	*Lincs* .	Boston, Skirbeck	3·03	194
,, .	Eden'bdg., Falconhurst	3·67	148	,, .	Cranwell Aerodrome	2·14	153
Sus .	Compton, Compton Ho.	4·04	146	,, .	Skegness, Marine Gdns.	2·53	153
,, .	Patching Farm	3·88	180	,, .	Louth, Westgate	2·52	119
,, .	Eastbourne, Wil. Sq.	4·36	193	,, .	Brigg, Wrawby St.	1·90	...
Hants.	Ventnor, Roy.Nat.Hos.	4·34	212	*Notts* .	Worksop, Hodsock	1·78	105
,, .	Fordingbridge, Oaklnds	3·36	144	*Derby*.	Derby, L. M. & S. Rly.	2·12	123
,, .	Ovington Rectory	...	...	,, .	Buxton, Terr. Slopes	4·36	106
,, .	Sherborne St. John	4·10	183	*Ches* .	Bidston Obsy	1·31	69
Herts .	Royston, Therfield Rec.	3·61	197	*Lancs*.	Manchester, Whit. Pk.	1·35	60
Bucks.	Slough, Upton	2·93	166	,, .	Stonyhurst College	1·79	49
,, .	H. Wycombe, Flackwell	3·31	165	,, .	Southport, Bedford Pk.	1·24	56
Oxf .	Oxford, Radcliffe	3·05	185	,, .	Ulverston, Poaka Beck	2·53	65
N'hant	Wellingboro, Swanspool	3·30	185	,, .	Lancaster, Greg Obsy.	1·56	49
,, .	Oundle	3·36	...	,, .	Blackpool	1·36	57
Beds .	Woburn, Exptl. Farm	3·27	191	*Yorks*.	Wath-upon-Dearne	2·52	145
Cam .	Cambridge, Bot. Gdns.	3·52	240	,, .	Wakefield, Clarence Pk.	2·41	134
,, .	March	3·10	196	,, .	Oughtershaw Hall	3·69	...
Essex .	Chelmsford, County Gdns	2·48	143	,, .	Wetherby, Ribston H.	2·19	112
,,	Lexden Hill House	2·81	...	,, .	Hull, Pearson Park	2·08	114
Suff .	Haughley House	2·72	...	,, .	Holme-on-Spalding	2·79	154
,, .	Rendlesham Hall	2·50	149	,, .	West Witton, Ivy Ho.	3·20	103
,,	Lowestoft Sec. School	2·01	125	,, .	Felixkirk, Mt. St. John.	2·62	133
,, .	Bury St. Ed., WestleyH.	3·66	194	,, .	York, Museum Gdns.	2·26	134
Norf.	Wells, Holkham Hall	3·22	198	,, .	Pickering, Hungate	3·08	155
Wilts	Porton, W.D. Exp'l. Stn	4·17	211	,, .	Scarborough	3·63	202
,, .	Bishops Cannings	3·63	161	,, .	Middlesbrough	2·93	187
Dor .	Weymouth, Westham.	4·21	204	,, .	Baldersdale, Hury Res.	2·55	82
,, .	Beaminster, East St.	4·68	160	*Durh* .	Ushaw College	3·93	178
,, .	Shaftesbury, Abbey Ho.	4·14	176	*Nor* .	Newcastle, Leazes Pk.	2·57	125
Devon.	Plymouth, The Hoe	4·84	166	,, .	Bellingham, Highgreen	2·78	95
,, .	Holne, Church Pk. Cott.	7·81	145	,, .	Lilburn Tower Gdns.	5·39	203
,, .	Teignmouth, Den Gdns.	5·70	219	*Cumb*.	Carlisle, Scaleby Hall	...	...
,, .	Cullompton	4·96	108	,, .	Borrowdale, Seathwaite	...	...
,, .	Sidmouth, U.D.C.	4·62	...	,, .	Thirlmere, Dale Head H.	5·40	83
,, .	Barnstaple, N. Dev.Ath	3·31	126	,, .	Keswick, High Hill	3·05	68
,, .	Dartm'r, Cranmere Pool	9·30	...	*West* .	Appleby, Castle Bank	1·85	69
,, .	Okehampton, Uplands.	7·71	186	*Mon* .	Abergavenny, Larchf'd	4·96	163
Corn .	Redruth, Trewirgie	6·17	171	*Glam* .	Ystalyfera, Wern Ho.	3·77	70
,, .	Penzance, Morrab Gdns.	6·06	189	,, .	Treherbert, Tynywaun.	5·35	
,, .	St. Austell, Trevarna	6·43	187	,, .	Cardiff, Penylan	3·72	118
Soms .	Chewton Mendip	4·85	136	*Carm* .	Carmarthen, Model&P.S.	3·22	81
,, .	Long Ashton	3·48	137	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	2·74	106
,, .	Street, Millfield	3·76	...	*Card* .	Aberystwyth	1·76	...
Glos .	Blockley	3·71	...	*Rad* .	BirmW.W.Tyrmynydd	4·72	88
,, .	Cirencester, Gwynfa	3·70	166	*Mont* .	Lake Vyrnwy	3·80	89
Here .	Ross-on-Wye	4·11	202	*Flint* .	Sealand Aerodrome	1·95	...
Salop.	Church Stretton	3·28	139	*Mer*	Blaenau Festiniog	...	...
,, .	Shifnal, Hatton Grange	2·43	132	,, .	Dolgelley, Bontddu	3·08	62
,, .	Cheswardine Hall	2·21	...	*Carn* .	Llandudno	1·61	79
Worc	Malvern, Free Library	2·94	152	,, .	Snowdon, L. Llydaw 9.	5·85	...
,, .	Ombersley, Holt Lock.	2·66	157	*Ang* .	Holyhead, Salt Island	1·54	59
War .	Alcester, Ragley Hall	3·16	184	,, .	Lligwy	1·45	...

Rainfall: March, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	3·59	121	*R&C*	Achnashellach	2·01	28
Guern.	St. PeterP't.Grange Rd.	5·10	207	,,	Stornoway, C.GuardStn.	1·96	...
Wig	Pt. William, Monreith.	1·43	50	*Suth*	Lairg	2·82	91
,,	New Luce School	1·96	55	,,	Tongue	...	...
Kirk	Dalry, Glendarroch	3·07	68	,,	Melvich	2·31	81
Dumf.	Dumfries, Crichton R.I.	1·68	60	,,	Loch More, Achfary	4·37	68
,,	Eskdalemuir Obs.	3·21	66	*Caith*	Wick	1·96	86
Roxb	Hawick, Wolfelee	2·72	81	*Ork*	Deerness	2·55	91
Peeb	Stobo Castle	2·02	70	*Shet*	Lerwick	2·15	68
Berw	Marchmont House	3·76	142	*Cork*	Dunmanway Rectory	5·50	112
E.Lot	North Berwick Res.	2·17	115	,,	Cork, University Coll.	...	...
Midl	Edinburgh, Blackfd. H.	1·70	86	,,	Mallow, Longueville	6·24	215
Lan	Auchtyfardle	1·43	...	*Kerry*	Valentia Obsy.	4·94	109
Ayr	Kilmarnock, Kay Pk.	·86	...	,,	Gearhameen	6·80	84
,,	Girvan, Pinmore	2·27	60	,,	Bally McElligott Rec.	2·79	...
,,	Glen Afton, Ayr San.	2·09	50	,,	Darrynane Abbey	4·34	106
Renf	Glasgow, Queen's Pk.	1·33	51	*Wat*	Waterford, Gortmore	5·04	185
,,	Greenock, Prospect H.	1·65	34	*Tip*	Nenagh, Cas. Lough	2·36	76
Bute	Rothesay, Ardencraig	2·16	60	,,	Roscrea, Timoney Park	2·72	...
,,	Dougarie Lodge	2·82	81	,,	Cashel, Ballinamona	2·72	100
Arg	Lock Sunart, G'dale	1·19	21	*Lim*	Foynes, Coolnanes	1·99	68
,,	Ardgour House	1·08	...	*Clare*	Inagh, Mount Callan	3·16	...
,,	Glen Etive	...	...	*Wexf*	Gorey, Courtown Ho.	6·12	265
,,	Oban	·38	...	*Wick*	Rathnew, Clonmannon.	5·26	...
,,	Poltalloch	1·58	41	*Carl*	Bagnalstown, Fanagh H.	4·62	191
,,	Inveraray Castle	1·40	22	,,	Hacketstown Rectory	4·61	165
,,	Islay, Eallabus	2·13	56	*Leix*	Blandsfort House	4·45	170
,,	Mull, Benmore	2·50	24	*Offaly*	Birr Castle	2·06	86
,,	Tiree	...	...	*Kild*	Straffan House	3·74	161
Kinr	Loch Leven Sluice	2·66	89	*Dublin*	Dublin, Phoenix Park	4·72	242
Fife	Leuchars Aerodrome	2·61	134	*Meath.*	Kells, Headfort	3·12	113
Perth	Loch Dhu	2·70	41	*W.M*	Moate, Coolatore	2·66	...
,,	Crieff, Strathearn Hyd.	2·68	84	,,	Mullingar, Belvedere	2·66	99
,,	Blair Castle Gardens	1·72	66	*Long*	Castle Forbes Gdns	2·12	72
Angus.	Kettins School	2·92	120	*Gal*	Galway, Grammar Sch.	1·45	48
,,	Pearsie House	3·50	...	,,	Ballynahinch Castle	2·62	51
,,	Montrose, Sunnyside	2·58	124	,,	Ahascragh, Clonbrock.	1·80	54
Aber	Balmoral Castle Gdns.	5·31	186	*Rosc*	Strokestown, C'node	1·93	70
,,	Logie Coldstone Sch.	4·49	173	*Mayo.*	Blacksod Point	...	...
,,	Aberdeen, Observatory.	2·70	112	,,	Mallaranny	2·05	...
,,	New Deer School House	3·34	129	,,	Westport House	2·52	65
Moray	Gordon Castle	2·72	117	,,	Delphi Lodge	4·59	55
,,	Grantown-on-Spey	...	...	*Sligo*	Markree Castle	1·60	47
Nairn.	Nairn	1·39	74	*Cavan.*	Crossdoney, Kevit Cas.	1·63	...
Inv's	Ben Alder Lodge	2·26	...	*Ferm*	Newtwnbtlr, Crom Cas.	1·44	47
,,	Kingussie, The Birches.	2·39	...	*Arm*	Armagh Obsy	2·29	97
,,	Loch Ness, Foyers	1·97	61	*Down.*	Fofanny Reservoir	9·17	...
,,	Inverness, Culduthel R.	1·61	73	,,	Seaforde	4·38	150
,,	Loch Quoich, Loan	1·35	...	,,	Donaghadee, C. G. Stn.	2·92	133
,,	Glenquoich	2·80	29	*Antr*	Belfast, Queen's Unvrsty	3·43	...
,,	Arisaig House	1·05	22	,,	Aldergrove Aerodrome.	2·71	108
,,	Glenleven, Corrour	...	...	,,	Ballymena, Harryville.	3·65	116
,,	Fort William, Glasdrum	1·20	...	*Lon*	Garvagh, Moneydig	2·37	...
,,	Skye, Dunvegan	1·81	...	,,	Londonderry, Creggan.	1·54	48
,,	Barra, Skallary	1·28	...	*Tyr*	Omagh, Edenfel	1·98	63
R&C	Alness, Ardross Castle.	3·49	107	*Don*	Malin Head	·96	...
,,	Ullapool	1·89	45	,,	Killybegs, Rockmount.	...	...

Climatological Table for the British Empire, October, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and ½ Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Per-cent-age of possi-ble.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0-10	in.	in.			
London, Kew Obsy.	1019·5	+ 5·5	65	33	56·1	42·8	49·5	− 1·4	44·5	89	6·9	1·79	− 0·91	11	2·9	27
Gibraltar	1018·9	+ 1·7	74	53	67·9	59·5	63·7	...	58·2	83	5·1	1·90	...	10	...	...
Malta	1015·2	− 0·8	80	52	71·8	63·7	67·7	− 3·2	62·2	77	6·7	1·52	− 1·35	13	5·5	49
St. Helena	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Freetown, Sierra Leone	1012·4	+ 2·5	89	69	85·6	73·2	79·4	...	75·2	83	4·6	10·09	− 2·53	27	...	...
Lagos, Nigeria	1012·1	+ 1·1	87	71	84·1	74·1	79·1	− 0·6	75·4	87	8·0	13·88	+ 6·11	18	5·3	44
Kaduna, Nigeria	1011·7	...	100	61	89·4	66·5	77·9	+ 1·6	71·0	87	5·3	4·82	+ 2·07	9	8·1	68
Zomba, Nyasaland	1010·7	− 0·1	92	57	85·7	64·4	75·1	+ 1·0	66·8	61	4·3	0·89	− 0·63	6	...	...
Salisbury, Rhodesia	1011·6	+ 0·8	89	51	82·1	58·0	70·1	− 0·6	59·1	49	3·3	3·43	+ 2·30	9	8·4	67
Cape Town	1018·9	+ 1·5	89	41	70·5	53·0	61·7	+ 0·5	55·3	76	5·2	0·95	− 0·70	11	...	...
Johannesburg	1012·9	− 0·6	80	43	72·8	50·6	61·7	− 1·1	51·6	84	4·4	1·47	− 1·09	8	8·9	70
Mauritius	1017·6	− 0·6	84	62	80·8	66·4	73·6	+ 0·9	68·5	66	5·3	3·37	+ 1·97	18	8·4	67
Calcutta, Alipore Obsy.	1010·4	+ 1·0	93	70	87·7	75·0	81·3	+ 2·0	75·7	88	3·9	4·75	− 0·15	12*	...	...
Bombay	1010·7	+ 0·9	97	73	90·1	76·2	83·1	+ 0·7	75·5	78	2·3	0·01	− 1·66	0*	...	...
Madras	1009·2	+ 0·3	97	72	89·7	76·2	82·9	+ 0·6	77·3	80	6·0	8·16	− 2·99	9*	...	...
Colombo, Ceylon	1010·8	+ 0·8	86	72	85·2	75·1	80·1	− 0·4	77·1	79	6·6	10·69	− 2·67	19	7·9	66
Singapore	1010·0	+ 0·3	89	71	84·6	74·7	79·7	− 1·4	76·9	83	8·0	11·57	+ 3·50	23	4·5	37
Hongkong	1014·1	+ 0·4	88	65	82·6	71·0	76·8	− 0·1	66·5	55	3·3	1·89	− 3·05	3	8·2	71
Sandakan	1009·2	...	90	73	87·4	74·8	81·1	− 0·3	76·9	83	8·5	9·29	− 1·04	17	...	...
Sydney, N.S.W.	1012·7	− 2·1	97	51	74·1	57·2	65·7	+ 2·1	58·6	52	5·3	1·15	− 1·70	6	8·2	64
Melbourne	1012·7	− 2·1	81	39	67·4	47·9	57·7	0·0	51·8	58	7·7	2·40	− 0·23	17	5·2	40
Adelaide	1015·9	− 0·1	91	44	70·6	52·3	61·5	− 0·5	54·2	52	7·3	2·43	+ 0·70	14	6·0	47
Perth, W. Australia	1017·8	+ 1·0	95	47	70·6	53·4	62·0	+ 1·2	54·9	57	5·2	1·00	− 1·22	10	9·2	72
Coolgardie	1015·3	+ 0·4	97	45	77·4	50·8	64·1	+ 0·4	52·5	41	2·5	0·09	− 0·57	1	...	...
Brisbane	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hobart, Tasmania	1005·6	− 4·7	69	38	61·7	45·9	53·8	− 0·3	47·4	56	6·5	1·65	− 0·61	16	7·0	53
Wellington, N.Z.	1013·2	+ 0·1	70	38	60·3	48·8	54·5	+ 0·1	52·0	79	7·7	3·33	− 0·75	14	5·5	42
Suva, Fiji	1013·2	0·0	89	65	81·4	70·6	76·0	+ 0·2	72·8	83	6·6	27·31	+ 19·02	22	5·7	46
Apia, Samoa	1011·1	− 0·4	87	71	85·1	74·6	79·9	+ 1·5	76·7	79	6·0	12·97	+ 6·59	17	6·2	50
Kingston, Jamaica	1011·7	+ 0·2	91	68	87·9	72·4	80·1	− 0·4	72·0	90	3·8	3·79	− 3·67	8	3·6	31
Grenada, W.I.	1011·1	+ 0·3	90	71	87	73	80	− 0·1	74	74	4	1·62	− 6·14	11	...	...
Toronto	1017·3	− 0·2	73	21	56·8	41·2	49·0	+ 0·4	42·9	87	6·1	2·44	− 0·13	14	4·7	42
Winnipeg	1016·6	+ 1·7	80	−5	45·7	25·1	35·4	− 5·3	27·8	78	6·4	1·00	− 0·37	8	4·2	39
St. John, N.B.	1016·6	+ 0·8	68	22	53·7	39·5	46·6	+ 1·3	43·9	83	6·9	4·88	+ 0·34	12	4·5	41
Victoria, B.C.	1020·5	+ 3·4	76	41	59·2	47·5	53·3	+ 3·0	50·9	85	6·4	0·96	− 1·61	8	4·6	42

(36589) Wt.20/31 1,125 4/37 Hw. G.377

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

May, 1937

No. 856

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; 26 York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff; 80 Chichester Street, Belfast; or through any bookseller.

Problems of Modern Forecasting

In recent years there has appeared an excellent series of articles entitled "Problems of Modern Meteorology," which left the reader with the impression that meteorology was less problematical than he had supposed. Each subject was allocated to a man who was something of a specialist in it, and he outlined the extent of present-day knowledge, with only a hint regarding the facts on which we are entirely ignorant. Perhaps the future is to the scientist so indefinite that he declines to let his fancy lead where reason cannot follow. Such can be the prerogative of meteorology, as of any other science; but, to many, meteorology is hardly separable from forecasting. Indeed, the forecaster is the retailer selling not what he chooses, but what his customers demand, and the meteorologist is his wholesaler.

What the forecaster requires, then, is a "Problems of Modern Forecasting," or, more humbly, "Mysteries of Modern Forecasting." Subjects we know all about (as far as anything can be said to be known in meteorology) would be excluded, and the book would deal with matters on which our knowledge is indefinite and uncoordinated, as well as with the relatively unknown corners of darkest meteorology. One feels it would form a slim volume with a very large index, but its possibilities are infinite.

The difficulties to which I have referred are to be found particularly in those most important subjects of fog and thunderstorm forecasting.

To forecast either is one matter. To explain in a lucid and reasoned manner how to do so, with the help of all the literature ever written, is an almost impossible task, as anyone who has attempted to teach forecasting knows only too well.

Our literature on fog leads up to the celebrated paper by Willett in which he classifies and sub-divides to an alarming but impressive degree all types of fog known to man ; while in the micrometeorology of visibility there is some pretty work. How well we know our nuclei ! Their source, their size, their numbers, movements and hygroscopic properties are (relatively) an open book to us. The growth from the nucleus to a thick fog is plain sailing, apart from a regrettable obscurity about the actual birth of the droplet. Generally speaking, we can tell the scientific questioner everything he would want to know about the fog we had last week, but unfortunately, once his admiration begins to wane, he wants to know if there will be a fog to-night. As far as I am aware not a single meteorological paper offers direct help to the forecaster in enabling him, in a general case, to use his charts for precise information on this point. Far more hopeless is it to attempt to answer those most frequent questions (which to a pilot are quite reasonable inquiries), such as :—Will the visibility at Croydon be down to 500 yards by two o'clock ? How deep will the fog be ? What time will it clear ?

Thunderstorms are important from the pilot's point of view without being a widespread menace like fog, and to the man in the street are one of the most important items of weather. Nevertheless it is scarcely an exaggeration to say that the literature in the English language on the forecasting of thunderstorms is of negligible value to the forecaster. We have an imposing knowledge of atmospheric electricity. We know all about ions, their size, speed, distribution and numbers. We know what becomes of them, and there are those who claim to know where they come from ; at any rate, so long as we have them they cannot move in contradiction to our equations. From the discovery of electrical separation when the skin is blown off a water-drop, we have progressed to intriguing and controversial thunderstorm theories. If we do not know the exact meteorological and electrical mechanism of the thundercloud, at least we have plenty of plausible possibilities. Unfortunately the man in the street is not concerned with this aspect of the matter, but merely with whether the resulting precipitation falls on his head or his umbrella.

It is in a sympathetic rather than an irreverent frame of mind that one describes the process by which a forecaster considers the possibility of convective thunderstorms. He makes (in some way best known to himself) an estimate of the maximum temperature ; he draws in pencil on the tephigram some sketchy and tentative lines ; puts his head on one side and studies his handiwork from different viewpoints, and perhaps makes a comparison with yesterday's similar effort. Finally, he decides that things look rather unstable, and so to that inseparable and comprehensive partnership, " bright intervals and showers," is added the impressive warning, " with perhaps local thunderstorms."

The present writer feels that the subjects of fog and thunderstorm forecasting are fruitful and not unduly difficult fields of research, and the scattered knowledge one finds among forecasters supports this view. In the absence of organised research, a fact usually overlooked is that there must be this vast store of ideas already waiting to be coordinated. Every forecaster is necessarily a research worker, in that no two charts are alike, and it is probable that everyone knows something that no one else has realised. The forecaster is a shy creature, from long experience of having to hide his ignorance under a cloak of confidence, but as a first step the *Meteorological Magazine* is in a position to do a great deal by means of an organised section devoted solely to the needs of the forecaster, both in matters he would like to know and in those he ought to know. (How many of us, for instance, can say why the isobars in the warm sector of a depression are more or less straight ?). Progress is more likely to come from a pooling of ideas and observational experience than from haphazard scraps of research. The *Meteorological Magazine*, by undertaking the work of coordination, could do much in developing those branches of meteorology which are directly essential to the forecaster.

C. J. BOYDEN.

[We welcome Mr. Boyden's stimulating article, though his conclusion is perhaps a little unjust. Contributions on forecasting are always welcome, but forecasters seem to be either more occupied or more diffident than other meteorologists, and rarely commit their thoughts to print. If a regular feature on the lines suggested is to be successful, it is the practical forecasters themselves who must make it so ; the most the Editor can do is cordially to invite those, who have ideas, problems or interesting experiences in forecasting to discuss, to write to him about them.—Editor *M.M.*]

Dust Devils and Desiccation in West Africa

The climate of the northern areas of our own and other west African colonies is influenced to a large extent by the dry easterly harmattan wind. This wind, which may on occasion blow from an east-north-east or north-east direction is impregnated with fine dust. On the cessation of the strong upward convection currents which are prevalent during hot midday and early afternoon hours, regular deposits of this fine dust occur ; I have heard it described in England as red dust, but from my own personal observations in the northern provinces of Nigeria I would describe it as of a greyish white colour and resembling in appearance a very fine sand.

The real harmattan months in Northern Nigeria are December, January, and February, but there are transitional periods, mid-October to the end of November, during the change over from moist south-westerly to dry north-easterly winds, as well as March to mid-April, when the reverse operation is taking place. It is a fair approximation to assume that the harmattan blows for five months out of every twelve and that dust deposits are taking place daily during that period. I understand that the daily deposit has never yet been measured. From my own very approximate eye observations I should say that it may amount to about one five-hundredth of an inch a day. If we reckon 150 days to five months it works out at $\frac{3}{10}$ in. a year or 30 in. in 100 years.

What is the origin of harmattan dust ? As far as I am aware no chemical analysis has ever been carried out.* It seems fairly certain, however, that it is the fine dust which forms part and parcel of the sandy scrub country which is found both in Northern Nigeria and in the southern Sahara of French West Africa. There are two aspects of the transport of this fine dust to be considered. On certain days during the harmattan season the easterlies may have a wind force of anything from 20 to 25 m.p.h. On these days the most casual observer can see successive surface waves being carried along by the air current. These waves have an apparent depth of about 20 ft. On days during which the harmattan becomes a light easterly or north-easterly the formation of numerous small dust devils can be observed, more especially over large sandy tracts, during the late morning and early afternoon hours. These dust devils are of very frequent occurrence and you may quite easily see 20 or 30 in one day. They are of small diameter (about 15 or 20 ft.) and columns of fine dust can be seen extending right up into the sky as far as the eye can see. This is the true harmattan dust, sucked up from the heavier surface sand and being carried at high altitudes by the prevailing easterly or north-easterly wind.

In a recent number of the *Geographical Magazine* Professor Stebbing of Edinburgh University gave his impressions of a rapid tour through the northern territories of certain west African colonies (he commenced at the Ivory Coast Colony and proceeded eastwards as far as Northern Nigeria) and quoted much evidence to show that the Sahara was slowly but surely encroaching upon and desiccating the northern areas of these colonies. His statements have given rise to a lot of controversy particularly in Nigeria.

---

* This is not strictly correct. An analysis of a small sample of harmattan dust has been carried out by the Department of Agriculture, Nigeria. It apparently contains an excessive content of silt and clay which by tending to poach and clod after wet weather would impede drainage and aeration and make cultivation difficult. It is also possible that the low amount of organic matter would result in a deficient supply of nitrogen. On the other hand, the high exchangeable base figure indicates that there is a sufficiency of mineral plant food.

Apparently there is no geological evidence to show that any such encroachment is taking place. Some of his quoted instances of desiccation cannot be accepted as evidence. Had he visited some of these parts at a different time of the year he would have found flourishing vegetation instead of sandy scrub. This is known by Europeans who have spent many years in Northern Nigeria and have an extensive knowledge of the different aspects presented by the soil of Northern Nigeria immediately prior to and after the rainy season. That a certain area of territory exists which was formerly arable land and is now sandy scrub is not denied. Many colonists believe, however, that this is due to the primitive methods of cultivation employed by the West African native and not in any way to the encroachment of the Sahara.

Of one thing, however, we can be definitely certain. The dry harmattan from the Sahara is annually bringing a considerable amount of fine dust or sand into the West African colonies. The harmattan blows for nearly half the year and then its place is taken by the moist south-westerly from the Gulf of Guinea. It might be said that this SW. wind would be capable of returning the harmattan dust to the Sahara, but I hardly think this is possible. It is only in the north amongst the large sandy tracts of Northern Nigeria and French West Africa that we have the incubation grounds of sand storms and dust devils. Temperatures in the south are much lower, and because of that and the gradual disappearance of these sandy tracts as you proceed coastwards the formation of dust devils and the consequent elevation of dust to a high altitude for transport by the prevailing wind is of a much rarer occurrence. It may also be noted that the periods of the south-westerly occur during the rainy season when there are a considerable number of cloudy and overcast days. On these days the convection currents cannot be vigorous enough to give the necessary lift to the fine dust.

I understand that it has been suggested that a belt of trees planted near the northern boundary of Nigeria would serve to prevent the "desiccation". If by desiccation is meant the deposit of fine harmattan dust I cannot agree. It is carried at a much higher altitude than any tree could ever attain. Trees might, however, impede the surface waves of dust to which I have made allusion above, and by preventing the rapid evaporation of rainfall, give rise to an increased vegetation.

D. E. SMITH.

Royal Meteorological Society

The monthly meeting of the Society was held on Wednesday, April 21st in the Society's rooms at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F. Inst. P., President, was in the Chair.

Major H. C. Gunton, M.B.E., gave a short talk on " Phenological and ecological records—lepidoptera." Major Gunton described phenological observations of lepidoptera in 1936 in relation to those of previous years, with special reference to effects of meteorological conditions on first dates of appearance and interference with emergence. A brief account was also given of the initiation of a scheme for observing and recording variations in abundance in relation to meteorological and other conditions.

The following papers were read and discussed :—

A. R. Meetham, M.A., D.Phil.—The correlation of the amount of ozone with other characteristics of the atmosphere.

Day to day variations in the total amount of atmospheric ozone are shown to be more closely correlated with those of potential temperatures in the stratosphere than with those of any other function of temperature and pressure, or with those of any other geophysical phenomenon yet investigated. A method of correlating with a certain variable associated with surface pressure distribution is exploited, and of three upper air phenomena considered the height of the tropopause is found to have the closest correlation with this variable. A speculative explanation of the close connexion of the amount of ozone with other characteristics of the atmosphere is offered.

E. G. Bilham, B.Sc. D.I.C.—A screen for sheathed thermometers.

After a brief survey of the history of the Stevenson thermometer screen, a new form is described in which the four sheathed thermometers, maximum, minimum, dry-bulb and wet-bulb, are all arranged approximately horizontally. This arrangement allows of a considerable reduction in the size and weight of the screen, and also has other advantages over the standard arrangement in which the dry- and wet-bulb thermometers are placed vertically.

E. W. Hewson, M.A. (Beit Scientific Research Fellow).—The application of wet-bulb potential temperature to air mass analysis, III.

This paper describes a method of using the vertical wet-bulb potential temperature distribution in the warm sector of a depression to estimate the amount of precipitation which that depression will give at a later time. The actual results of applying this method to a number of depressions have been included.

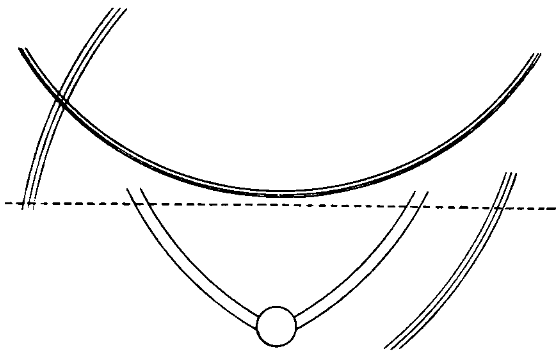
Correspondence

To the Editor, *Meteorological Magazine*

Parhelion and Anthelion at Bognor Regis on Successive Days

On April 11th, at 18h. 15m., I observed a parhelion at 22° to the south of, and horizontally to the sun. The mock sun appeared larger than the sun, but this was no doubt due to the indefiniteness of its whitish outline. The mock sun was red on the half nearest the sun, with greenish tints, fading to white, towards the south. There were faint traces of halo visible above and below the mock sun for about 1° or 2°. The phenomenon persisted even after the sun itself was obscured by stratocumulus vesperalis, and lasted till 18h. 30m.

On April 12th, at 11h. 22m. with my back to the sun (which was partly covered by high altocumulus, but exhibited no halo or corona effects), I noticed a faint white inverted "bow," whose lower rim appeared to be a little below the altitude of the sun. At 11h. 29m. the inverted "bow" was cut by a vertical arc near its southern extremity. This second arc was brighter and coloured red on the inside. At 11h. 30m. the patch of blue sky against which these arcs had appeared was obscured by cirrostratus and high altocumulus, but almost as soon as the first series were hidden, another group of arcs appeared, all of which seemed to be lower in altitude than their predecessors. This time there was a definite anthelion at the junction of the two inner arcs. All traces of the anthelion and its accompanying arcs had become obscured by 11h. 32m. Thundery conditions prevailed, and the general direction of both upper and lower winds was from the south-east.



ANTHELION OBSERVED AT BOGNOR REGIS, APRIL 12TH, 1937

Note :—Portions above dotted line appeared before the anthelion and only relative positions of upper and lower half of diagram can be assumed.

D. S. HANCOCK.

Greenways School, Bognor Regis, Sussex, April 13th, 1937.

Halo Phenomena of April 19th, 1937

Brilliant halo phenomena were widespread in the British Isles on April 19th. The earliest report comes from Dublin, where Prof. J. J. Nolan sent a careful account by one of his students, Mr. H. Kearney, at University College ; the phenomena began at 7h. 45m. and included parts of the 22° halo, two brilliant parhelia, just outside the intersection of the 22° halo and mock sun ring, merging into a segment of the mock sun ring and tapering away from the sun for a distance of 22°, and a vertical sun pillar through the sun. The display ended at 8.30 a.m. Haloes were also reported from Sealand, Cheshire, at 11h. 45m., Stonyhurst at 11h. 50m., Aberdeen and Ross-on-Wye at noon, and Birmingham at 13h. (All times so far as known are G.M.T.)

In south-east England the display was more complex. At

Hastings, Mr. A. E. Moon wrote: "In addition to the halo of 22° there was also present the 46° halo which was rather indistinct when the system was first observed but was readily discernible about 16h. 46m. On either side of the sun were parhelia; that on the left was the brighter, and each had short 'tails' extending outwards. With the aid of the black mirror a portion of the parhelic circle could be traced inside the 22° halo to the sun, and at 17h. a short sun pillar was visible above and below the sun. The most striking objects, however, were the upper contact arcs of the haloes. The 46° contact arc was quite brilliant between 16h. 45m. and 17h. and remained visible after the rest of the system had faded. The red, orange, green, and blue coloration was easily distinguishable in this contact arc. It was noted that the red colour in both parhelia and the two contact arcs was towards the sun. The sky at the time was covered with a uniform sheet of cirrostratus and as early as 14h. 53m. there were indications of the 22° halo with two fairly distinct parhelia with 'tails'."

At Lympne, Kent, Mr. E. Clarke observed complete circles of 22° and 46° (apart from the small segments cut off by the horizon), arcs of upper contact to each circle, mock suns to the right and left of the circle of 22°, and a mock sun ring extending from pole to pole with a mock sun of 90° to the north. A light patch in the sky to the south where the other mock sun of 90° should have appeared could not be clearly identified as a mock sun owing to the patchy nature of the sky at that point. All the colours, from red through yellow to blue, could be clearly distinguished, by the naked eye in the arcs of contact and mock suns of 22°, and with the aid of dark glasses in the two circles. The arc on the circle of 46° was particularly brilliant; it extended over a quarter-circle, and had a definition of colours as marked as in the average rainbow. A true shade of violet could not be discerned, but there was, inside the blue, a tint about half-way between blue and violet.

More or less similar displays were seen by Mr. D. Waterer at Knap Hill, Woking (including also a paranthelion 90° from the sun), by Mr. N. Phillips at Broadstairs, Kent, by Mr. B. B. Osmaston at Westgate-on-Sea, by Captain J. E. Turner at Margate and by Mr. C. Ingram at Benenden, Kent. The halo system was visible at Woking from 15h. 55m. to 16h. 5m., Kew Observatory from 16h. 10m., to 16h. 30m., Epsom at 16h. 15m., Hastings from 16h. 30m. to 17h., Lympne from 16h. 40m. to 17h. 30m., Benenden at 17h., Broadstairs and Margate from 17h. to 17h. 40m.

An interesting feature of the display was the definite progression from west-north-west to east-south-east. Apart from the isolated occurrence at Aberdeen, the places from which reports were received lie on either side of the direct line from Dublin to Kent, and the phenomena traversed this distance of nearly 340 miles at a more or less uniform speed of about 37 miles an hour.

On the morning of April 19th a deep depression was centred between southern Greenland and Iceland. At 7h. G.M.T. a warm front, moving eastwards, extended north-westwards from the Bay of Biscay and Valentia, cirrus being observed in west Scotland and central England, altocumulus and altostratus in Ireland and in the west of England. By 10h., the front lay just to the east of Valentia and Blacksod. Cirrus was reported from east Scotland and thence southwards through Catterick and Cherbourg while rain had reached north-west Ireland. At 16h. the front lay across east Ireland ; cirrus was seen in the extreme east of England, altostratus and altocumulus in central and north-east England, and rain had reached east Scotland, Wales, north-west and south-west England. By 18h. altostratus had reached the North Sea and at 22h. it was raining in London. From upper-air soundings made at Aldergrove and Mildenhall it is estimated that the slope of the surface of the incoming warm air was approximately 1 in 100, while nephoscope observations indicated that the cirrus moved from north-west at a speed varying between 40 and 70 m.p.h. The transitory halo phenomena were thus associated with the eastward motion of this front across Ireland to England.

Auroral Display of April 24th–25th, 1937

The development of exceptional solar activity between April 21st and 23rd, 1937, and the passage of an immense sunspot group across the sun's central meridian on April 24th heralded a fine auroral display, which was visible at least as far south as Buckinghamshire, during the night of April 24th–25th. Until about 23h. 30m. (G.M.T.) the sky over this part of the Chiltern Hills was heavily clouded, but within the next quarter of an hour there was a rapid clearance from the north, and at 23h. 45m., while preparing to make some telescopic observations, I noticed a bluish-green glow, extending at its apex to an altitude of 5° or 6°, above the northern horizon. At first I took this for moonlight on a distant bank of mist or fog over the Plain of Aylesbury. After a minute or two, however, the true nature of the phenomenon was evidenced by the appearance of flickering radial "streamers." These assumed the form of three shafts of reddish light (pale rose-carmine is, I believe, the correct description of the shade) diverging from the middle of the ill-defined auroral arch. At about 23h. 55m. the summit of the central ray, initially the brightest of the three, reached an angular elevation which measurement showed to be 31°. Both this and the north-western beam soon faded, but the north-eastern streamer, flickering in such a manner as to call to mind a display of lightning behind far-off clouds, persisted with little diminution of intensity until 0h. 12m. At that time the auroral arch began to disappear, and with it the remaining ray. By 0h. 15m. the spectacle was over.

Its brilliance was, of course, much impaired by the opposing glare of the moon, which was only 16 hours short of the full.

I am informed by Mr. Hugh Gardner, of Harrow on the Hill, that he witnessed striking manifestations of the aurora from Carbost, in the Isle of Skye, on the evenings of both April 25th and April 27th. He reports that between 22h. 30m. and 23h. on the former date the apex of the auroral arch was slightly south of the zenith, and that the associated rays appeared to stretch down from overhead rather than upwards from the horizon. Mr. Gardner adds that he has seen the phenomenon several times in the course of previous visits to Scotland, but never a finer exhibition of it. The display of April 27th, he says, was less pronounced. On the night of April 24th the sky over Carbost was clouded.

In a letter published in *The Times* of April 29th, Father Rowland, S. J., of the Stonyhurst College Observatory, stated that the greatest magnetic disturbance recorded there since February 7th, 1929, occurred on the night of April 24th–25th, 1937. The peak of the " storm " on the latter occasion was reached between 22h. and 1h., thus covering the period of my observations.

E. L. HAWKE.

" *Ivinglea,*" *Dagnall, Bucks, May 2nd, 1937.*

The Decline of April

April has been once again a cloudy and unsettled month, and for the 16th time in 20 years its aggregate of rain at Greenwich has exceeded the official average.

From 1881 to 1915 April was the driest month of the year at that station. Since then, however, its mean fall of rain has increased by nearly 45 per cent, making it, for the period 1917 to 1936, the fourth wettest month of the twelve. For the country as a whole the increase is in the neighbourhood of 25 per cent.

Coincident with the increased rainfall, and equally striking, has been the reduction in April sunshine during the last two decades. For whereas, prior to 1917, the expectation of sunny hours at Kew was 158, it has since shrunk to about 128, representing the loss of an hour a day. In all except three of the last 19 Aprils there has been a sunshine deficit, compared to the 1881–1915 standard.

During the twenty-two years ending in 1914 there were seven Aprils yielding more than 200 sunny hours apiece, which is equal to the normal allowance for June. In a similar period of time since 1915 there has not been one such April. Besides which, the last 18 years have brought forth the two dullest Aprils ever known at Kew since registration was begun there in 1880.

It is interesting to note that, while the quality of April has deteriorated, that of September has undergone improvement in modern times; the month having become drier, sunnier and warmer than it once was. It would appear, in short, that summer nowadays is tending to begin and finish rather later. At the same time, February shows a disposition to supplant January as the coldest month of the year.

Thus, while no appreciable change of climate as a whole is easily discerned, it seems as though a slight forward shift of the seasons may be taking place at present, modifying the character of some individual months.

L. PROTHEROE SMITH.

6b, Nevern Square, London, S.W.5, May 3rd, 1937.

Interesting case of St. Elmo's Fire

It has been noted on many occasions in Khartoum that the human hair, silk wearing apparel and blankets, to mention only a few cases, frequently collect a charge of static electricity as indicated by an unmistakable crackling sound when they are touched. A particularly pronounced case occurred on the evening of March 6th, 1937 : a bed had been made up on an angareeb (native bed made of rope on a wood framework) at about 6 p.m., just about sunset, and when the outside blanket was approached soon after 10 p.m. a spark, which appeared to be at least half an inch long, was observed to pass between it and the person's nose. A sharp prick was experienced at the tip of the nasal organ.

In the case of the adjoining bed smaller sparks were observed to pass between the blankets and fingertips, where a tingling sensation was felt.

On the day in question there had been a considerable amount of sand haze and driven sand during the forenoon but this had cleared by midday. It seems probable, however, that the electric charges which accumulated on the blankets on this occasion were due to the production of electricity by friction between the particles of sand carried up by the wind.

The case described is not an isolated occurrence and it may be taken as a normal happening at least during the winter months.

WILLIAM D. FLOWER.

Meteorological Service, Khartoum, March 14th, 1937.

Cross-Section of a Lightning Flash

During a sudden thunderstorm accompanied by hail at Basrah on February 1st, 1937 at 6h. G.M.T. a man was struck by lightning and killed at the airport. Three coolies were at work on No. 7 run-way, about 200 yards from the hangar and 600 yards from the terminal building. One of these died instantly : the others, 6 and 12 yards from him, fell to the ground suffering from shock.

A post-mortem examination of the body six hours later revealed signs of burning on the right flank and right thigh in small spots and in disorder. Bruises were also found in the pleura and pericardium, and the heart contained black flowing blood. The other organs were normal. The coolie nearest to the man who was killed suffered slight burns on his chest. There were no further marks on either body.

Interesting traces were left by the lightning. At the spot a hole from which smoke issued for some little time and several small depressions were found. The hole was of sufficient diameter to admit an ordinary lead pencil to a depth of $3\frac{1}{2}$ in., which is the depth of the bituminous layer of the run-way over the natural subsoil. The axis of the hole was inclined at about 8 degrees to the vertical: total depth $3\frac{1}{2}$ in., diameter at the surface 1 in. narrowing to $\frac{5}{16}$ in. in $\frac{1}{4}$ in. which diameter was maintained to the foot. There were three small depressions about $\frac{1}{8}$ in. deep, at $1\frac{3}{4}$ in., $1\frac{7}{8}$ in. and $5\frac{3}{4}$ in. respectively from the main hole, and three faint ones at $2\frac{15}{16}$ in., $7\frac{1}{4}$ in. and 8 in.

Presumably the current passed to earth through the channel it bored for itself in the bitumen. The diameter of this affords an interesting estimate of the actual cross section of the path of the electric current in a lightning flash and is smaller than that postulated as a maximum.

The main current must have been accompanied by small off-shoots which passed from the body of the man but were unable to burn a deeper channel in the bitumen. Accordingly it appears that in this case the electricity travelled downwards: the earth must thus have been positively charged with respect to the cloud.

J. L. Galloway.

Airport, Basrah, Iraq, April 10th, 1937.

Absence of Snow on west side of Lough Neagh

Mr. Dewar's reference to the absence of snow from the western side of Lough Neagh after the severe easterly blizzard of mid-March 1937 is most interesting; but I should like to suggest an alternative explanation to his, which in the circumstances seems to me more likely to be the correct one.

Lough Neagh is in a shallow basin with a wide margin of low-lying ground around it. The easterly wind piled up great drifts on the eastern or windward side of the lough, and the advance of the drifting snow must have been arrested by the open water of the lake itself. On the western or the lee side of the lough no drift snow would be arriving, and the wind would be too strong to permit of much settling of snow on the ground till a sufficient width of ground had been traversed—about half a mile from the shore.

It is not clear from Mr. Dewar's letter whether the turning of snow to sleet or rain on the western side of Lough Neagh was merely inferred or actually observed. Granted that this very likely took place in the opening stages of the blizzard I think the warming effect would be obliterated in a prolonged severe storm of this type, partly because the water of the lough would soon be chilled by the great quantity of snow falling into it or drifting into it from the east, and partly because the dense masses of falling snow would soon chill down the air on the west side.

L. C. W. BONACINA.

15, Christchurch Road, London N.W.3. April 23rd, 1937.

NOTES AND QUERIES

A Meteorological Chronology to A.D. 1450*

For a full understanding of the history and development of our country, some knowledge of its meteorological background is essential. Most studies in pre-history now include a section on climatic changes, the material for which is provided by geological and biological data, but when we come into the historical period, we have little beyond the scattered references to weather in the various annals and other literary documents. Hence the collection and discussion of these references is an important research, which has been carried out most thoroughly by Mr. Britton. Similar compilations have been made in the past, but partially, uncritically and without adequate documentation. That the present work is free from these defects is shown by the list of references, which occupies thirteen pages of an appendix.

The period covered by the author begins with an entry from the Irish Annals assigned to B.C. 2668, though the historical accuracy of these early dates is regarded as exceedingly problematical. This "Traditional Period" is followed by the Roman Period, with the first definitely authentic date in B.C. 55. The Saxon Period begins with the invasion of Hengist and Horsa about A.D. 450, but many of the entries are still somewhat legendary, including unfortunately the picturesque three-year drought so miraculously ended by St. Wilfrid in 681 (and also, dare we add, the existence of Horsa himself). With the 9th century records become more detailed and reliable and for the remainder of the period the entries are arranged by centuries.

Mr. Britton is admirably qualified by his wide and recondite reading for the difficult task which he has so successfully undertaken. Most of the historical records are in Latin; where necessary he has himself translated these and also texts in Norman-French and other obscure dialects, and he adds to many of the entries brief notes on the most probable interpretation to be assigned to them. The compilation will no doubt be referred to frequently in future discussions of climatic change in the British Isles, and to aid this purpose

*London, Geophys. Mem. No. 70, 1937. A meteorological chronology to A.D. 1450. By C. E. Britton, B.Sc.

it ends with an index of the more noteworthy meteorological events—severe winters, heavy snows, marine floods, years with notable wet or dry periods and hot summers. At the moment it is appropriate to remark that wet periods occur in this index just twice as frequently as dry periods.

C. E. P. BROOKS.

Altocumulus Type Cloud formed by an Aeroplane

During the morning aeroplane ascent at Aldergrove on March 10th, 1937, three cases of cloud formation by the machine were observed.

The first occurred at 8h. 24m. when the pilot was flying level at 700 mb. (about 8,900 ft.) in a west to east direction. A narrow band of cloud was observed, gradually widening and becoming diffuse but remaining clearly visible until about 8h. 40m. when it had merged into the general cloud. Rough measurements were made by holding a pencil at arm's length and subsequent calculations gave the width of the band at the time of formation as about 100 ft. while the total length of the cloud trail formed was about 5,000 ft. The temperature at 700 mb. was $-0\cdot5°$ F.

At 8h. 35m. the machine was flying level from north to south at 600 mb. (about 12,800 ft.) temperature $-17°$ F. and a narrow band of cloud again formed behind it. In this case it was observed that the densest cloud appeared to form for some distance on either side of the wings while the path of the machine was marked by a thin layer.

The third case was observed at 8h. 40m. when the machine was flying level in a west to east direction at 550 mb. (about 15,000 ft.) temperature $-23\cdot5°$ F. A narrow band of cloud again formed behind the machine and gradually broadened. At 8h. 50m. it resembled a narrow band of altocumulus and afterwards merged into other cloud. Rough measurements gave the width of the band as about 150 ft. and its length as about 6,500 ft.

The pilot of the aircraft did not notice the phenomenon and an attempt to communicate with him by wireless and obtain notes was unsuccessful.

The 7h. chart showed a depression centred over France with pressure high to the north-west of the British Isles. The sky at the time was about 8 tenths covered with stratocumulus and altocumulus. The 7h. 15m. balloon showed that the wind velocity was less than 10 m.p.h. up to 10,000 ft. Near the surface the direction was NW. but veered gradually to 180° at 10,000 ft.

The above cases appear to be unusual owing to the considerable vertical extent (6,000 ft.) of the layer in which the formation was possible. Previous cases described in the *Meteorological Magazine**†

* See *Meteorological Magazine* 66, 1931, p. 89.

† See *Meteorological Magazine* 67, 1932, p. 139.

have given the formation as taking place within a layer usually 100 to 200 ft. thick but in one case 1,000 to 2,000 ft. thick.

The cloud formation observed in this case appears to support the process of formation suggested by W. H. Bigg* rather than that advanced by J. S. Smith†. The machine was several miles away and flying towards me in the second case and I had a front view of the formation. Twin billowy streams were being formed on either side of the machine, not a single stream subsequently divided by the aeroplane's rudder unit. The cloud at the moment of formation was similar to the bow wave of a fast ship. D. Dewar.

REVIEWS

Der mittlere Höhenwind von De Bilt nach Pilotballonbeobachtungen (1922–1931). By W. Bleeker. De Bilt, K. Ned. Meteor. Inst. No. 102. Med. en Verh. 38. pp. 109 (Dutch) + 16 (German Summary).

The author has made a thorough analysis of the pilot balloon observations made at De Bilt at 8h. and 13h. daily (weather permitting) over a period of 10 years (1922–1931). The observations have been classified according to the surface wind direction into the four quadrants, and the various tables contain monthly, seasonal and yearly results for morning and midday, and for the different quadrants.

Two difficulties commonly arise in any attempt to obtain a good representative value for the average wind at any level. First, the actual number of observations decreases rapidly with height; and secondly, the percentage number of occasions on which observations can be made to any height varies considerably with the quadrant of the surface wind. The author has considerably overcome these difficulties, first by substituting values for the missing data at higher levels, using the corresponding data at lower levels and assuming an average "lapse-rate" of wind velocity and direction with height, and secondly, by weighting the mean value in each quadrant and at each level according to the number of surface observations.

The mean wind velocity has its maximum at all levels in January. The minimum at the surface occurs in September, but moves towards April in the upper layers. This spring minimum in the upper layers coincides with the time of greatest vertical mixing to great heights and with the time of smallest temperature difference between the subtropical and polar regions.

The tables showing the change of velocity with height indicate the presence of two minima in each season and quadrant. An analysis of all spring observations up to a height of 3,000 metres for a period of 24 years shows two minima in each of the south and west quadrants, and a single wide flat minimum in each of the north and east quad-

* See *Meteorological Magazine* 66, 1931, p. 89.
† See *Meteorological Magazine* 67, 1932, p. 139.

rants, the effect being most pronounced in the morning. The explanations put forward for these minima are numerous and conflicting.

The mean yearly transfer of air is from the south-west at the surface, but veers with height, being from the west at 3,500 metres, and about 15° north of west at 9,000 metres. The low tropopause in winter and spring is considered an accompanying phenomenon of the positive component from the north in the mean transfer of air in the upper layers in these seasons.

Systematic differences exist between the morning and midday values of the mean air transfer. The differences in the lower layers are the result of turbulence and land and sea breezes. The influence of the sea breeze is clearly shown in an analysis of all summer ascents which reached a height of 1,000 metres; e.g. surface winds in the east quadrant in the morning have a southerly component, which is more pronounced at 500 metres, but at midday the surface winds actually have a northerly component. In the upper layers the motion from the south and west increases at midday, especially in spring and summer, but Bleeker's values for the diurnal variation of winds in the upper layers do not agree very well with those found at other European stations. A more detailed analysis shows that the diurnal changes vary greatly with the quadrant, probably as a result of convective influences. Bleeker believes that there exists a large system of land and sea breezes; the normal land and sea breezes produce a periodic air movement in the atmosphere, reaching to great heights.

The text is in Dutch, but the German summary is excellent, and the tables, 50 in number, contain many interesting results. A similar treatment of pilot balloon data at a good network of stations would add greatly to our statistical knowledge of the general circulation.

J. Harding.

Las horas de sol en Igueldo. By Mariano Doporto. Trabajos del Observatorio de Igueldo (San Sebastian). Publ. No. 7. San Sebastian, 1935.

At the beginning of May, 1928, a Campbell-Stokes sunshine recorder was installed at the Observatory of Igueldo, west of San Sebastian, on the north coast of Spain. The six years of record available to the end of April, 1935, are fully discussed in this memoir by the Director of the Observatory. The average duration of bright sunshine in a year is 1760 hours. This total, surprisingly small (it is less than that of many of our south-coast resorts and more than a hundred hours below the average for Guernsey) is accounted for mainly by the Pyrenees to the south, which frequently carry an orographic cloud cap hiding the sun throughout the day. Even apart from cloud the mountains cause some loss; the author remarks that this is compensated by other parts where the horizon is depressed, but at this low level the sun can rarely burn the card. Simultaneous measurements with a pyrheliometer show that the record ceases when the intensity of the sun's rays fell below 0·20 gramme-calories per sq. cm. per minute. Only seven days records were lost, six of them through burning of the card which had been excessively dried by the strong Föhn-like south wind to which the Observatory is subject.

Pilot Balloon Observations made in the Netherlands Indies. Batavia, Kon. magn, met. Obs., January, 1936.

A valuable new series of pilot balloon observations from the Netherlands Indies first appeared under the above heading in January, 1936. The data are issued monthly, and include observations of the direction and velocity of the wind at various levels up to about 6 Km. taken once or twice daily at a number of stations in the Netherlands Indies. A casual examination of the data reveals several interesting features, some of which have been published before, e.g. in Shaw's " Manual of Meteorology ". It is to be hoped that a complete analysis of the observations over a number of years will appear at some future date.

BOOKS RECEIVED

Totland Bay, Isle of Wight, Meteorological observations for the years 1934 *and* 1935 *with extremes and averages for preceding years.* By J. Dover, M.A., Newport, Isle of Wight, 1935 and 1936.

Deutsches Meteorologisches Jahrbuch für 1933. Freistaat Sachsen. Edited by Prof. Dr. E. Alt. Jahrgang 51, Dresden, 1936.

OBITUARY

John McDougal Field, F.R.A.S.—We regret to learn of the death of Mr. J. McDougal Field on April 11th at the age of 60. As a young man Mr. Field entered the Edinburgh City Observatory on Calton Hill. Here he worked under the late Sir William Peck, the City Astronomer, whom he ultimately succeeded in the charge of the observatory. At the time of his death he was engaged on an investigation dealing with the variation in the timing of stars. His interests were not confined to astronomy and for 40 years he was mainly responsible for the meteorological station on Calton Hill. To many thousands of young people, members of literary societies and similar organizations whom Mr. Field has shown over the Observatory buildings and lectured on the equipment, his kindly personality will be a pleasant memory. During the War Mr. Field served on the Western Front with the Meteorological Section of the Royal Engineers.

H. E. Carter.

We regret to learn of the death on December 18th, 1936, at the age of 80, of Dr. Andrija Mohorovičić, formerly Director of the Geophysical Institute at Zagreb, member of the Yugoslave Academy of Sciences and Arts and tit. extr. Professor of the University of Zagreb. Dr. Mohorovičić organised the Geophysical Institute at Zagreb and is well-known for his work on seismology.

We regret to learn of the death on March 29th of Commandant A. Carvalho Brandão, formerly Director of the Marine Meteorological Service of Portugal.

NEWS IN BRIEF

It was announced in the list of Coronation Honours that Dr. J. M. Stagg, Senior Technical Officer in the Meteorological Office has been made an Officer of the Order of the British Empire.

The Weather of April, 1937

An area of low pressure (below 1006 mb.) lay over Iceland, southern Greenland and the northern North Atlantic, with a minor centre (below 1010 mb.) over the Adriatic Sea, and another area below 1005 mb. over the Aleutian Islands. Areas of high pressure (above 1020 mb.) lay south of the Azores and over Russia and Finland. Pressure was 8 mb. below normal over the central North Atlantic, 5 mb. below normal in north-western Siberia and 10 mb. above normal near the White Sea and in south-eastern Siberia.

Temperature was below 20° F. over most of northern Siberia, below 30° F. over Spitsbergen, Bear Island and the Arctic coast of Russia, rising to 45° F. in Scotland, southern Norway and the Baltic coast of Germany. Temperatures were between 45° and 50° F. in Ireland, England, Belgium, Holland, Germany and most of European Russia ; 50°–55° F. in France, 55°–60° F. in Italy and Greece. Temperatures were 10°–12° F. above normal in Spitsbergen and Bear Island, 10°–15° F. above normal in northern Scandinavia, Finland and Russia, and 0°–5° F. below normal in Italy, south-eastern Europe and the greater part of Siberia.

Rainfall generally differed little from normal except in central and south-eastern Europe, where falls of 4–5 in. in many places were twice or three times the normal.

For the first three weeks of the month the British Isles came under the influence of depressions travelling in the neighbourhood, and the weather was unsettled. During this period temperatures were mainly above the average in the south and west but were lower in the east and north ; rainfall was above the average in most of England and Ireland, the weather was dull generally but there were isolated good records of sunshine ; there were strong winds and gales on parts of the coast at the beginning and in the middle of the month. The early hours of the 1st were cold in east and south-east England, the minimum temperature being 24° F. at Cranwell, 25° F. at South

Farnborough, and 28° F. at York, Cambridge and Rothamsted; Cranwell recorded 16° F. on the grass, South Farnborough 17° F., Greenwich 19° F., and Marlborough and Rothamsted 20° F. Ground frost occurred again in many parts of England, including London on the morning of the 4th; on that day weather was rather cold in east Scotland and north-east England, the maximum temperature at Edinburgh, Marchmont and Durham being 41° F. Again between the 13th and 16th weather was cool in these districts, the maximum temperature being 43° F. on some of these days at Aberdeen, Dundee, Edinburgh, Marchmont and Durham. Fog developed on many days during the first half of the month; it was most frequent in eastern England and the Midlands, but it occurred also in western England, on the south coast, in Scotland and in eastern Ireland. It was fairly widespread on the mornings of the 4th–6th; on the 8th it persisted all day on the north Scottish coasts; it was rather widespread again between the 13th and 16th. Rain fell on most days during the first three weeks, though not as a rule in large amounts. There were thunderstorms in the west on the 4th and in many parts on the 7th. During a thunderstorm at Henley-on-Thames on the 7th exceptionally large hailstones fell; several, which were picked up and measured by Mr. E. M. Page of Norman Avenue, were an inch in diameter; the largest was 1¼ inches and weighed ¼ oz. There were thunderstorms locally in the west again on the 10th, and in southern England and the Midlands between the 13th and 16th. On the 10th, when there was a thunderstorm at Nailsworth, Glos., the day's rainfall was 2·22 in. On the same day 1·52 in. fell at Calne, Castle Walk, Wilts., and more than an inch at Blockley, Glos., Wantage, Lockinge, Berks., and Upperlands, Ardtara, Co. Londonderry. There was heavy rain in Wales on the 16th when more than an inch fell at Llangynhafal, Denbigh, and 1·30 in. at Dolgelly, Bontddu, Merioneth. The best sunshine records during the early part of the month were 9 hours at Southport on the 1st, 9·8 hours at Hastings on the 3rd and 9·4 hours on the 4th; more than 11 hours was registered at Portsmouth and Brighton on the 11th, Gorleston on the 12th, and Falmouth and Cullompton on the 17th. Strong winds and gales mainly on the northern and western coasts were reported on the 1st, 2nd, 16th and 17th, and on the south-east coasts and in the English Channel on the 16th and 20th. The highest gusts recorded were 75 m.p.h. at the Lizard and 71 m.p.h. at Scilly, both on the 20th. On the 23rd an anticyclone was spreading from the south-west over the British Isles and the weather improved generally; day temperatures rose and 66° F. was recorded at Gortmore, Co. Waterford on the 23rd and at Plymouth and Birr Castle on the 24th. More than 13 hours of bright sunshine was registered at Gorleston, Clacton, Norwich and Margate on the 24th and at Hastings, Stonyhurst and Southport on the 26th; Inverness registered 14 hours on the 26th. Nights were cold in parts of Scotland and northern England on the 26th and 27th when minimum temperatures were 4 or 5° F. below the freezing point; 21° F. was recorded on the grass at Dumfries and Newton Rigg on the 26th. At the end of the month high day temperatures were reached in the north, for example 69° F. at Nairn and Marchmont and 70° F. at Dundee on the 30th; whereas in the south-east, with cool north-easterly winds many day maxima were under 50° F.; 45° F. was the highest temperature reached at Felixstowe, Gorleston and Rothamsted on the 29th and again at Gorleston on the 30th. Fog occurred locally in many districts between the 25th and 30th. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	105	−45	Chester ...	121	−18
Aberdeen ...	81	−63	Ross-on-Wye ...	102	−40
Dublin	..	..	Falmouth ...	121	−66
Birr Castle ...	70	−82	Gorleston ...	69	−95
Valentia... ...	100	−61	Kew	102	−44

Kew, Temperature, Mean 50·0° F., Diff. from normal + 2·3° F.

Dense fog was experienced off the Dutch coast on the 5th and 6th, and local fog over the North Sea on the 4th and 10th. About the 20th a landslip caused by heavy rainfall blocked the road at Douanne on Lake Bienne, Switzerland, and at Albertville, Savoy a new landslip took place on the Rocheplate mountains blocking the main road. Fog occurred in the Baltic Sea on the 19th. By the 27th a fortnight's almost incessant rain had caused floods in Yugoslavia and the Danube had flooded parts of Widin in Bulgaria. (*The Times*, April 5th–28th.)

Owing to the high wind a P. and O. liner grounded twice in the Suez Canal on the 10th. By the 30th serious famine prevailed in southern Morocco owing to the prolonged drought; it is stated that in the affected areas nothing has grown for 18 months. (*The Times*, April 12th–May 1st.)

Many fishermen were caught in a typhoon off the west coast of Sakhalin on the night of the 21st. The monsoon reached the Rangoon area about the 29th, which is earlier than usual. (*The Times*, April 23rd–30th.)

The total rainfall for the month in Australia was below normal except in parts of Western Australia (Cable).

The spring thaw rapidly melting the snows caused serious flooding in central Canada about the 7th and as a result of an ice jam the Rideau River overflowed its banks flooding part of a suburb of Ottawa. A part of western Ontario was seriously inundated by the flooding of the Thames and Grand Rivers and their tributaries on the 27th. Owing to heavy rain the Conemaugh and Stony Creek rivers overflowed their banks on the 26th so that Johnstown, Pennsylvania, was flooded for the third time in a year. Parts of

Maryland and northern West Virginia were also flooded and on the 27th–28th the upper Ohio also overflowed its banks. Most of these floods were receding late on the 28th. In the United States during the first half of the month temperature was generally below normal while rainfall was irregular in distribution; during the third week temperature was above normal except in Florida and the extreme north-west, and rainfall was mainly somewhat below normal. (*The Times*, April 8th–29th, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, April, 1937

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	1009·3	ESE.2	30	53	48	—	3·8	f till 9h.
2	994·3	ENE.3	41	53	88	0·58	0·0	r_0 5h.–11h., r 18h.–[24h.
3	1000·3	ESE.2	41	59	66	0·01	5·9	r 0h.
4	1007·8	NNE.2	33	56	67	—	2·6	Fe–f till 13h.
5	1009·4	SW.1	41	59	78	—	3·5	Fe–f till 11h.
6	1013·7	SSE.2	43	60	61	—	0·9	f till 12h., r_0 11h.
7	1010·4	S.4	51	56	96	0·09	0·1	r 10h.–14h., t 17h.
8	1013·8	SW.4	50	59	59	—	0·7	pr_0 14h., 15h.
9	1008·4	SSE.4	49	61	63	—	0·2	
10	994·2	S.4	52	60	79	0·29	2·3	r 3h.–9h.
11	1004·0	W.3	45	57	52	0·02	6·4	r 4h.–7h.
12	1005·4	NE.3	43	57	62	—	4·3	w early, r_0 9h.
13	1000·5	ENE.4	41	57	71	0·02	0·0	r 9h.–10h.
14	997·3	NNE.3	48	56	78	—	1·1	pr_0 14h., 18h.
15	1008·8	W.2	44	51	84	0·05	0·0	pr_0 2h., r 20h.–24h.
16	994·1	SSW.3	46	55	84	0·28	4·9	r 0h.–3h., 18h.–19h.
17	1007·9	W.4	45	50	80	0·14	0·0	r_0 0h.–14h., 20h.–[24h.
18	1009·9	W.2	43	51	72	0·02	0·6	r_0 0h.–4h., 21h.
19	1011·6	WSW.3	44	58	53	0·03	6·6	r_0 0h.–2h.
20	997·2	S.4	47	56	84	0·25	0·6	r 12h.–20h., t 17h.
21	1015·3	WNW.3	41	55	56	0·01	10·2	pr 2h., 13h.–15h.
22	1017·1	WSW.4	45	61	70	0·07	1·3	r–r_0 0h.–6h.
23	1022·2	NW.3	48	62	54	—	10·1	
24	1022·3	NNE.2	49	58	66	—	0·9	
25	1021·5	NNW.3	40	55	51	—	13·3	
26	1020·1	NNW.3	38	53	53	—	7·1	
27	1018·8	W.1	37	60	59	0·10	6·0	r_0 16h., 20h.–24h.
28	1024·3	NNE.2	50	53	87	0·03	0·1	r_0 0h.–5h., 10h., 19h.
29	1030·4	NNE.3	43	49	71	—	2·1	
30	1030·8	ENE.2	43	58	65	—	6·5	m 21h.
*	1010·7	..	44	56	69	1·98	3·4	* Means or totals.

General Rainfall for April, 1937

England and Wales ...	152	per cent of the average 1881–1915.
Scotland	71	
Ireland	113	
British Isles	122	

Rainfall : April, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	2·64	171
Sur .	Reigate, Wray Pk. Rd.	3·46	207
Kent .	Tenterden, Ashenden	2·50	154
,, .	Folkestone, Boro. San.	2·62	...
,, .	Margate, Cliftonville	1·93	143
,, .	Eden'bdg., Falconhurst	2·72	146
Sus .	Compton, Compton Ho.	3·63	182
,, .	Patching Farm	2·38	135
,, .	Eastbourne, Wil. Sq.	3·05	167
Hants.	Ventnor, Roy.Nat.Hos.	2·13	127
,, .	Fordingbridge, Oaklnds	2·17	119
,, .	Ovington Rectory	2·47	131
,, .	Sherborne St. John	2·29	129
Herts .	Royston, Therfield Rec.	2·91	185
Bucks.	Slough, Upton	2·23	156
,, .	H. Wycombe, Flackwell	2·59	159
Oxf .	Oxford, Radcliffe	2·63	165
N'hant	Wellingboro, Swanspool	3·02	203
,, .	Oundle	1·94	...
Beds .	Woburn, Exptl. Farm	2·54	169
Cam .	Cambridge, Bot. Gdns.	2·52	185
,, .	March	3·13	237
Essex.	Chelmsford, County Gdns	2·77	216
,, .	Lexden Hill House	2·89	...
Suff .	Haughley House	2·28	...
,, .	Rendlesham Hall	2·72	191
,, .	Lowestoft Sec. School	1·71	116
,, .	Bury St. Ed., Westley H.	3·33	217
Norf. .	Wells, Holkham Hall	2·27	177
Wilts .	Porton, W.D. Exp'l. Stn	2·02	121
,, .	Bishops Cannings	4·16	206
Dor .	Weymouth, Westham.	2·13	128
,, .	Beaminster, East St.	2·46	104
,, .	Shaftesbury, Abbey Ho.	1·67	78
Devon.	Plymouth, The Hoe	3·39	149
,, .	Holne, Church Pk. Cott.	5·87	162
,, .	Teignmouth, Den Gdns.	2·67	133
,, .	Cullompton	3·43	151
,, .	Sidmouth, U.D.C.	2·63	...
,, .	Barnstaple, N. Dev.Ath	2·64	124
,, .	Dartm'r, Cranmere Pool	7·00	...
,, .	Okehampton, Uplands.	5·25	165
Corn .	Redruth, Trewirgie	3·94	137
,, .	Penzance, Morrab Gdns.	3·17	130
,, .	St. Austell, Trevarna	4·57	162
Soms .	Chewton Mendip	3·72	125
,, .	Long Ashton	2·62	120
,, .	Street, Millfield	1·99	...
Glos .	Blockley	3·64	...
,, .	Cirencester, Gwynfa	2·98	159
Here .	Ross-on-Wye	1·87	98
Salop.	Church Stretton	2·09	97
,, .	Shifnal, Hatton Grange	2·29	136
,, .	Cheswardine Hall	2·64	151
Worc .	Malvern, Free Library	2·31	128
,, .	Ombersley, Holt Lock.	1·78	117
War .	Alcester, Ragley Hall	2·72	161
War .	Birminghm, Edgbaston	2·86	164
Leics .	Thornton Reservoir	2·72	160
,, .	Belvoir Castle	2·79	182
Rut .	Ridlington	3·25	207
Lincs .	Boston, Skirbeck	2·50	185
,, .	Cranwell Aerodrome	2·70	204
,, .	Skegness, Marine Gdns.	2·81	210
,, .	Louth, Westgate	2·80	168
,, .	Brigg, Wrawby St.	3·39	...
Notts .	Worksop, Hodsock	2·51	171
Derby.	Derby, L. M. & S. Rly.	2·13	131
,, .	Buxton, Terrace Slopes	4·66	159
Ches .	Bidston Obsy	2·82	173
Lancs.	Manchester, Whit. Pk.	2·64	138
,, .	Stonyhurst College	2·78	103
,, .	Southport, Bedford Pk.	2·78	150
,, .	Ulverston, Poaka Beck	3·43	114
,, .	Lancaster, Greg Obsy.	3·26	145
,, .	Blackpool	3·07	164
Yorks.	Wath-upon-Dearne	2·65	167
,, .	Wakefield, Clarence Pk.	2·74	163
,, .	Oughtershaw Hall	4·20	...
,, .	Wetherby, Ribston H.	...	...
,, .	Hull, Pearson Park	3·63	233
,, .	Holme-on-Spalding	4·38	264
,, .	West Witton, Ivy Ho.	3·17	148
,, .	Felixkirk, Mt. St. John.	2·56	153
,, .	York, Museum Gdns	3·48	217
,, .	Pickering, Hungate	2·52	151
,, .	Scarborough	3·26	209
,, .	Middlesbrough	2·15	157
,, .	Baldersdale, Hury Res.	2·75	114
Durh .	Ushaw College	2·71	143
Nor .	Newcastle, Leazes Pk	2·68	168
,, .	Bellingham, Highgreen	2·00	93
,, .	Lilburn Tower Gdns	1·55	78
Cumb.	Carlisle, Scaleby Hall	2·70	138
,, .	Borrowdale, Seathwaite	7·75	112
,, .	Thirlmere, Dale Head H.	5·13	108
,, .	Keswick, High Hill	2·12	69
West .	Appleby, Castle Bank	1·79	92
Mon .	Abergavenny, Larchf'd	2·61	103
Glam .	Ystalyfera, Wern Ho.	4·18	110
,, .	Treherbert, Tynywaun.	6·26	...
,, .	Cardiff, Penylan	3·84	153
Carm .	Carmarthen, M. & P. Sch.	3·11	109
Pemb .	St. Ann's Hd, C. Gd. Stn.	1·90	97
Card .	Aberystwyth	2·70	...
Rad .	Birm W.W. Tyrmynydd	5·14	139
Mont .	Lake Vyrnwy	4·25	141
Flint .	Sealand Aerodrome	3·17	...
Mer .	Blaenau Festiniog	8·43	151
,, .	Dolgelley, Bontddu	5·28	145
Carn .	Llandudno	2·56	151
,, .	Snowdon, L. Llydaw 9.	14·70	...
Ang .	Holyhead, Salt Island	1·93	93
,, .	Lligwy	3·00	...

Rainfall: April, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	4·09	167	*R&C*	Achnashellach	1·87	33
Guern.	St.Peter P't.Grange Rd.	2·84	141	„	Stornoway, C.GuardStn.	1·78	...
Wig	Pt. William, Monreith	2·76	125	*Suth*	Lairg	·33	14
„	New Luce School	2·88	108	„	Tongue	...	...
Kirk	Dalry, Glendarroch	3·30	108	„	Melvich	·44	19
Dumf.	Dumfries, Crichton R.I.	3·28	148	„	Loch More, Achfary	1·60	33
„	Eskdalemuir Obs.	2·90	85	*Caith*	Wick	1·15	58
Roxb	Hawick, Wolfelee	1·79	79	*Ork*	Deerness	·92	44
Peeb	Stobo Castle	...	...	*Shet*	Lerwick	1·39	61
Berw	Marchmont House	1·42	70	*Cork*	Dunmanway Rectory	4·55	110
E.Lot	North Berwick Res.	·93	67	„	Cork, University Coll.	3·50	134
Midl	Edinburgh, Blackfd. H.	1·10	75	„	Mallow, Longueville	3·18	130
Lan	Auchtyfardle	1·51	...	*Kerry*	Valentia Observatory	3·33	91
Ayr	Kilmarnock, Kay Park	1·71	...	„	Gearhameen	6·30	110
„	Girvan, Pinmore	3·35	113	„	Bally McElligott Rec.	2·46	...
„	Glen Afton, Ayr San.	2·93	98	„	Darrynane Abbey	3·45	100
Renf	Glasgow, Queen's Park	1·92	97	*Wat*	Waterford, Gortmore	3·45	138
„	Greenock, Prospect H.	2·81	77	*Tip*	Nenagh, Castle Lough	2·94	117
Bute	Rothesay, Ardencraig	3·16	106	„	Roscrea, Timoney Park	3·16	...
„	Dougarie Lodge	2·54	89	„	Cashel, Ballinamona	3·51	143
Arg	Loch Sunart, G'dale	3·31	79	*Lim*	Foynes, Coolnanes	2·80	115
„	Ardgour House	3·75	...	*Clare*	Inagh, Mount Callan	4·33	...
„	Glen Etive	3·72	67	*Wexf*	Gorey, Courtown Ho.	3·64	166
„	Oban	1·72	...	*Wick*	Rathnew, Clonmannon	3·37	...
„	Poltalloch	3·36	111	*Carl*	Bagnalstown, Fenagh H.	3·00	131
„	Inveraray Castle	3·84	83	„	Hacketstown Rectory	3·37	127
„	Islay, Eallabus	3·02	105	*Leix*	Blandsfort House	3·06	117
„	Mull, Benmore	7·10	92	*Offaly*	Birr Castle	2·66	124
„	Tiree	2·46	100	*Kild*	Straffan House	2·11	107
Kinr	Loch Leven Sluice	1·73	90	*Dublin*	Dublin, Phoenix Park	1·52	84
Fife	Leuchars Aerodrome	1·86	117	*Meath.*	Kells, Headfort	2·21	88
Perth	Loch Dhu	4·00	84	*W.M*	Moate, Coolatore	2·53	...
„	Crieff, Strathearn Hyd.	2·15	98	„	Mullingar, Belvedere	3·01	127
„	Blair Castle Gardens	·67	32	*Long*	Castle Forbes Gdns.	2·43	102
Angus	Kettins School	1·44	79	*Gal*	Galway, Grammar Sch.	2·58	109
„	Pearsie House	1·70	...	„	Ballynahinch Castle	2·93	83
„	Montrose, Sunnyside	1·93	106	„	Ahascragh, Clonbrock	3·06	120
Aber	Balmoral Castle Gdns.	·96	45	*Rosc*	Strokestown, C'node	2·61	119
„	Logie Coldstone Sch.	1·41	70	*Mayo*	Blacksod Point	...	...
„	Aberdeen Observatory	1·05	56	„	Mallaranny	3·70	...
„	New Deer School House	·80	40	„	Westport House	2·71	100
Moray	Gordon Castle	·45	26	„	Delphi Lodge	5·04	88
„	Grantown-on-Spey	...	...	*Sligo*	Markree Castle	2·73	103
Nairn	Nairn	·60	40	*Cavan*	Crossdoney, Kevit Cas.	2·37	...
Inv's	Ben Alder Lodge	·90	...	*Ferm*	Crom Castle	2·16	84
„	Kingussie, The Birches	·58	...	*Arm*	Armagh Obsy.	2·27	108
„	Loch Ness, Foyers	...	...	*Down*	Fofanny Reservoir	5·20	...
„	Inverness, Culduthel R.	·32	19	„	Seaforde	3·09	118
„	Loch Quoich, Loan	3·06	...	„	Donaghadee, C. G. Stn.	2·57	128
„	Glenquoich	...	...	*Antr*	Belfast, Queen's Univ.	2·49	112
„	Arisaig House	1·86	52	„	Aldergrove Aerodrome	2·64	125
„	Glenleven, Corrour	...	...	„	Ballymena, Harryville	2·49	94
„	Fort William, Glasdrum	...	...	*Lon*	Garvagh, Moneydig	3·09	...
„	Skye, Dunvegan	2·74	...	„	Londonderry, Creggan	2·80	109
„	Barra, Skallary	1·86	...	*Tyr*	Omagh, Edenfel	2·49	95
R&C	Alness, Ardross Castle	·46	19	*Don*	Malin Head	1·94	...
„	Ullapool	·61	20	„	Dunkineely	2·84	...

Climatological Table for the British Empire, November, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	Absolute. Min.	Mean Values. Max.	Mean Values. Min.	Mean Values. ½ Max. and Min.	Diff. from Normal	Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	Diff. from Normal.	Days.	BRIGHT SUNSHINE. Hours per day.	Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1012·9	− 1·7	56	32	48·4	39·0	43·7	+ 0·2	41·1	92	7·9	2·79	+ 0·57	17	1·4	15
Gibraltar	1017·0	− 1·0	67	47	61·5	52·2	56·9	...	51·3	79	4·8	6·65	...	14	...	...
Malta	1015·4	− 0·5	73	52	66·7	58·4	62·5	− 1·4	57·9	79	5·0	7·76	+ 4·19	16	5·5	54
St. Helena	1013·2	− 0·7	70	53	61·5	54·5	58·0	− 1·6	55·3	91	9·8	0·77	− 0·41	10	...	...
Freetown, Sierra Leone	1011·1	+ 1·9	89	71	85·4	74·7	80·1	...	76·3	84	5·4	10·91	+ 5·79	16	...	...
Lagos, Nigeria	1010·3	+ 0·2	90	72	86·9	75·8	81·3	− 0·4	76·6	87	6·9	5·33	+ 2·66	12	6·8	58
Kaduna, Nigeria	1011·3	...	96	57	92·6	62·5	77·5	+ 1·3	66·6	81	3·2	0·00	− 0·21	0	8·8	76
Zomba, Nyasaland	1009·0	+ 0·1	91	62	86·5	66·9	76·7	+ 1·1	69·8	69	5·0	7·26	+ 2·18	10	...	...
Salisbury, Rhodesia	1010·9	+ 1·2	91	56	80·5	60·3	70·4	− 0·3	61·5	61	5·7	3·80	+ 0·20	13	6·2	48
Cape Town	1016·4	+ 0·6	89	51	75·0	57·8	66·4	+ 2·0	59·1	63	2·9	0·21	− 0·88	5	...	...
Johannesburg	1012·0	− 0·3	86	45	72·2	52·8	62·5	− 1·2	55·5	67	6·5	6·68	+ 1·72	15	7·9	59
Mauritius	1015·8	− 0·3	90	67	83·8	70·0	76·9	+ 1·4	71·8	70	5·6	1·85	+ 0·27	17	9·2	71
Calcutta, Alipore Obsy.	1014·2	+ 0·9	89	58	85·0	67·0	76·0	+ 2·5	67·2	81	1·9	0·00	− 0·65	0*	...	...
Bombay	1011·3	− 0·7	95	72	89·1	75·0	82·1	+ 1·5	73·4	77	5·0	2·31	+ 1·86	5*	...	...
Madras	1011·7	+ 0·4	87	66	84·8	73·4	79·1	+ 0·2	75·9	88	6·8	14·53	+ 0·92	16*	...	...
Colombo, Ceylon	1011·5	+ 1·5	89	72	84·7	73·9	79·3	− 0·7	76·2	80	6·0	15·89	+ 4·13	23	6·7	57
Singapore	1010·0	+ 0·6	88	73	84·9	75·0	79·9	− 0·7	76·1	82	8·1	12·01	+ 2·10	24	4·4	37
Hongkong	1018·4	+ 0·8	84	60	76·3	66·1	71·2	+ 1·6	64·8	68	3·9	0·17	− 1·57	2	7·6	69
Sandakan	1009·6	...	90	73	86·4	74·7	80·5	− 0·4	77·1	85	7·2	19·53	+ 4·81	18	...	...
Sydney, N.S.W.	1013·5	− 0·3	100	49	75·7	58·5	67·1	+ 0·1	59·8	53	6·1	0·29	− 2·56	5	8·9	65
Melbourne	1015·2	+ 0·8	96	42	70·6	49·8	60·2	− 1·1	53·9	54	7·0	1·81	− 0·42	13	6·5	46
Adelaide	1016·9	+ 1·7	104	44	78·0	53·6	65·8	− 1·2	56·5	41	5·8	0·54	− 0·61	6	8·5	61
Perth, W. Australia	1015·1	− 0·3	103	51	79·2	59·7	69·5	+ 3·4	59·4	47	4·5	0·46	− 0·34	5	9·5	69
Coolgardie	1013·0	− 0·4	105	49	86·0	59·2	72·6	+ 1·9	58·8	41	3·2	1·03	+ 0·44	4	...	...
Brisbane	·															
Hobart, Tasmania	1009·8	+ 0·2	84	40	65·6	48·1	56·9	− 0·3	49·6	50	6·3	1·92	− 0·55	17	7·4	51
Wellington, N.Z.	1007·4	− 4·7	73	41	62·3	49·9	56·1	− 0·7	53·2	72	7·9	6·09	+ 2·57	16	6·2	43
Suva, Fiji	1009·7	− 1·4	91	67	84·3	72·7	78·5	+ 1·4	73·4	76	6·1	10·40	+ 0·61	20	8·0	62
Apia, Samoa	1008·4	− 1·1	89	68	85·0	73·2	79·1	+ 0·4	75·9	77	5·4	7·85	− 1·98	13	7·4	58
Kingston, Jamaica	1012·0	− 0·4	91	68	87·7	71·5	79·6	+ 0·3	70·2	87	3·4	0·59	− 2·44	6	8·2	73
Grenada, W.I.	1011·4	+ 0·8	87	72	85	73	79	− 0·5	73	78	5	9·41	+ 0·95	17	...	...
Toronto	1017·0	− 0·3	64	3	41·2	27·4	34·3	− 2·7	...	...	6·8	1·30	− 1·33	13	3·5	36
Winnipeg	1019·9	+ 2·5	56	−7	30·2	11·8	21·0	− 0·3	16·8	76	5·2	1·09	+ 0·02	11	3·4	37
St. John, N.B.	1012·9	− 1·7	56	6	40·6	26·0	33·3	− 3·4	30·6	88	7·3	3·59	− 0·82	15	2·9	30
Victoria, B.C.	1025·9	+10·0	56	34	49·1	40·2	44·7	+ 0·2	43·8	88	6·7	1·35	− 4·06	13	3·8	41

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

(37002) Wt. 20/31 1125 5/37 Hw. G.377/6

Climatological Table for the British Empire, November, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1012·9	− 1·7	56	32	48·4	39·0	43·7	+ 0·2	41·1	92	7·9	2·79	+ 0·57	17	1·4	15
Gibraltar	1017·0	− 1·0	67	47	61·5	52·2	56·9	...	51·3	79	4·8	6·65	...	14	...	...
Malta	1015·4	− 0·5	73	52	66·7	58·4	62·5	− 1·4	57·9	79	5·0	7·76	+ 4·19	16	5·5	54
St. Helena	1013·2	− 0·7	70	53	61·5	54·5	58·0	− 1·6	55·3	91	9·8	0·77	− 0·41	10	...	...
Freetown, Sierra Leone	1011·1	+ 1·9	89	71	85·4	74·7	80·1	...	76·3	84	5·4	10·91	+ 5·79	16	...	...
Lagos, Nigeria	1010·3	+ 0·2	90	72	86·9	75·8	81·3	− 0·4	76·6	87	6·9	5·33	+ 2·66	12	6·8	58
Kaduna, Nigeria	1011·3	...	96	57	92·6	62·5	77·5	+ 1·3	66·6	81	3·2	0·00	− 0·21	0	8·8	76
Zomba, Nyasaland	1009·0	+ 0·1	91	62	86·5	66·9	76·7	+ 1·1	69·8	69	5·0	7·26	+ 2·18	10	...	...
Salisbury, Rhodesia	1010·9	+ 1·2	91	56	80·5	60·3	70·4	− 0·3	61·5	61	5·7	3·80	+ 0·20	13	6·2	48
Cape Town	1016·4	+ 0·6	89	51	75·0	57·8	66·4	+ 2·0	59·1	63	2·9	0·21	− 0·88	5	...	...
Johannesburg	1012·0	− 0·3	86	45	72·2	52·8	62·5	− 1·2	55·5	67	6·5	6·68	+ 1·72	15	7·9	59
Mauritius	1015·8	− 0·3	90	67	83·8	70·0	76·9	+ 1·4	71·8	70	5·6	1·85	+ 0·27	17	9·2	71
Calcutta, Alipore Obsy.	1014·2	+ 0·9	89	58	85·0	67·0	76·0	+ 2·5	67·2	81	1·9	0·00	− 0·65	0*	...	...
Bombay	1011·3	− 0·7	95	72	89·1	75·0	82·1	+ 1·5	73·4	77	5·0	2·31	+ 1·86	5*	...	...
Madras	1011·7	+ 0·4	87	66	84·8	73·4	79·1	+ 0·2	75·9	88	6·8	14·53	+ 0·92	16*	...	...
Colombo, Ceylon	1011·5	+ 1·5	89	72	84·7	73·9	79·3	− 0·7	76·2	80	6·0	15·89	+ 4·13	23	6·7	57
Singapore	1010·0	+ 0·6	88	73	84·9	75·0	79·9	− 0·7	76·1	82	8·1	12·01	+ 2·10	24	4·4	37
Hongkong	1018·4	+ 0·8	84	60	76·3	66·1	71·2	+ 1·6	64·8	68	3·9	0·17	− 1·57	2	7·6	69
Sandakan	1009·6	...	90	73	86·4	74·7	80·5	− 0·4	77·1	85	7·2	19·53	+ 4·81	18	...	...
Sydney, N.S.W.	1013·5	− 0·3	100	49	75·7	58·5	67·1	+ 0·1	59·8	53	6·1	0·29	− 2·56	5	8·9	65
Melbourne	1015·2	+ 0·8	96	42	70·6	49·8	60·2	− 1·1	53·9	54	7·0	1·81	− 0·42	13	6·5	46
Adelaide	1016·9	+ 1·7	104	44	78·0	53·6	65·8	− 1·2	56·5	41	5·8	0·54	− 0·61	6	8·5	61
Perth, W. Australia	1015·1	− 0·3	103	51	79·2	59·7	69·5	+ 3·4	59·4	47	4·5	0·46	− 0·34	5	9·5	69
Coolgardie	1013·0	− 0·4	105	49	86·0	59·2	72·6	+ 1·9	58·8	41	3·2	1·03	+ 0·44	4	...	...
Brisbane																
Hobart, Tasmania	1009·8	+ 0·2	84	40	65·6	48·1	56·9	− 0·3	49·6	50	6·3	1·92	− 0·55	17	7·4	51
Wellington, N.Z.	1007·4	− 4·7	73	41	62·3	49·9	56·1	− 0·7	53·2	72	7·9	6·09	+ 2·57	16	6·2	43
Suva, Fiji	1009·7	− 1·4	91	67	84·3	72·7	78·5	+ 1·4	73·4	76	6·1	10·40	+ 0·61	20	8·0	62
Apia, Samoa	1008·4	− 1·1	89	68	85·0	73·2	79·1	+ 0·4	75·9	77	5·4	7·85	− 1·98	13	7·4	58
Kingston, Jamaica	1012·0	− 0·4	91	68	87·7	71·5	79·6	+ 0·3	70·2	87	3·4	0·59	− 2·44	6	8·2	73
Grenada, W.I.	1011·4	+ 0·8	87	72	85	73	79	− 0·5	73	78	5	9·41	+ 0·95	17	...	...
Toronto	1017·0	− 0·3	64	3	41·2	27·4	34·3	− 2·7	...	...	6·8	1·30	− 1·33	13	3·5	36
Winnipeg	1019·9	+ 2·5	56	−7	30·2	11·8	21·0	− 0·3	16·8	76	5·2	1·09	+ 0·02	11	3·4	37
St. John, N.B.	1012·9	− 1·7	56	6	40·6	26·0	33·3	− 3·4	30·6	88	7·3	3·59	− 0·82	15	2·9	30
Victoria, B.C.	1025·9	+10·0	56	34	49·1	40·2	44·7	+ 0·2	43·8	88	6·7	1·35	− 4·06	13	3·8	41

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

(37002) Wt. 20/31 1125 5/37 Hw. G. 377/6

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

June, 1937

No. 857

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

Monthly Broadcasts of Climatological Data

At the International Meteorological Conference at Copenhagen in 1929 Prof. A. Wagner proposed that monthly mean values for selected stations should be broadcast as promptly as possible by wireless telegraphy. After considerable discussion the arrangements were completed and ratified at the Conference at Warsaw in 1935. They provided for the broadcasting of mean pressure in millibars (in low latitudes millibars and tenths), mean temperature in degrees and tenths, total precipitation in centimetres and for certain stations resultant air transport for the month. The issues would be in two stages: national broadcasts of a fairly close network of stations as early as possible and at latest on the 5th of the following month, and inter-continental broadcasts of a selection of these, to follow as speedily as possible. For comparison normals were to be circulated, as far as possible for the period 1901 to 1930, which has been adopted as the standard for climatological purposes.

The first group of these broadcast climatological messages were issued from a number of European countries in June 1936, giving the data for May, and these were used in preparing the summary of "The Weather of May 1936" in the *Meteorological Magazine.* The number of issues gradually grew; data for Russia and Siberia were broadcast in September and in March 1937 figures for a number of stations in Canada and the United States were received for the first time. Some of the stations are in the most remote regions of both Asia and America.

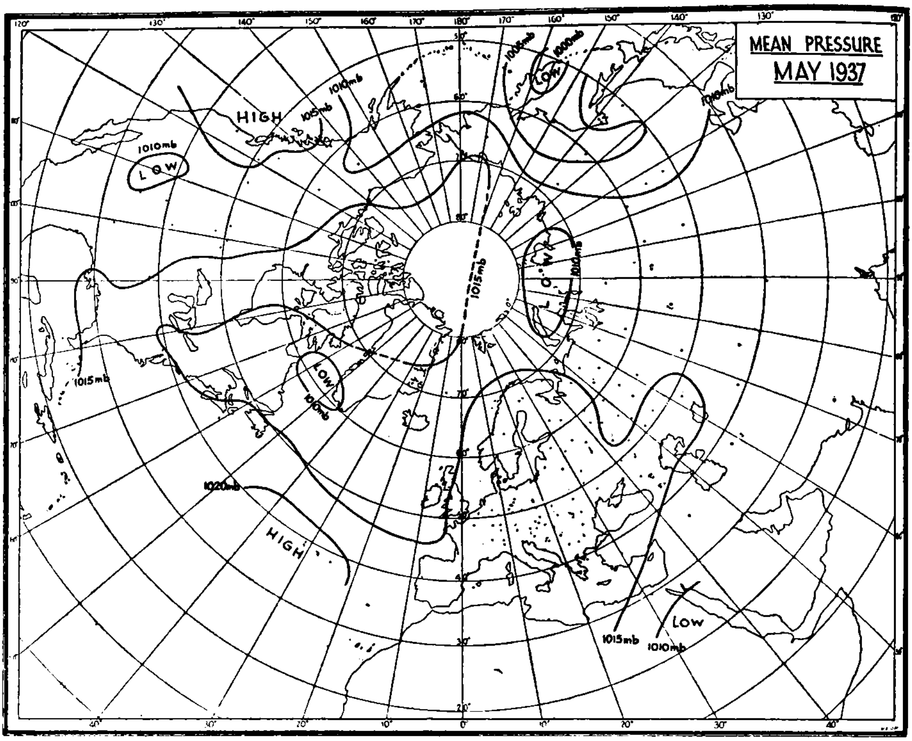

MEAN PRESSURE
MAY 1937
HIGH
LOW
1010mb
1015mb
1020mb
1005mb
1000mb
LOW
HIGH
LOW
1015mb
1010mb

FIG. 1

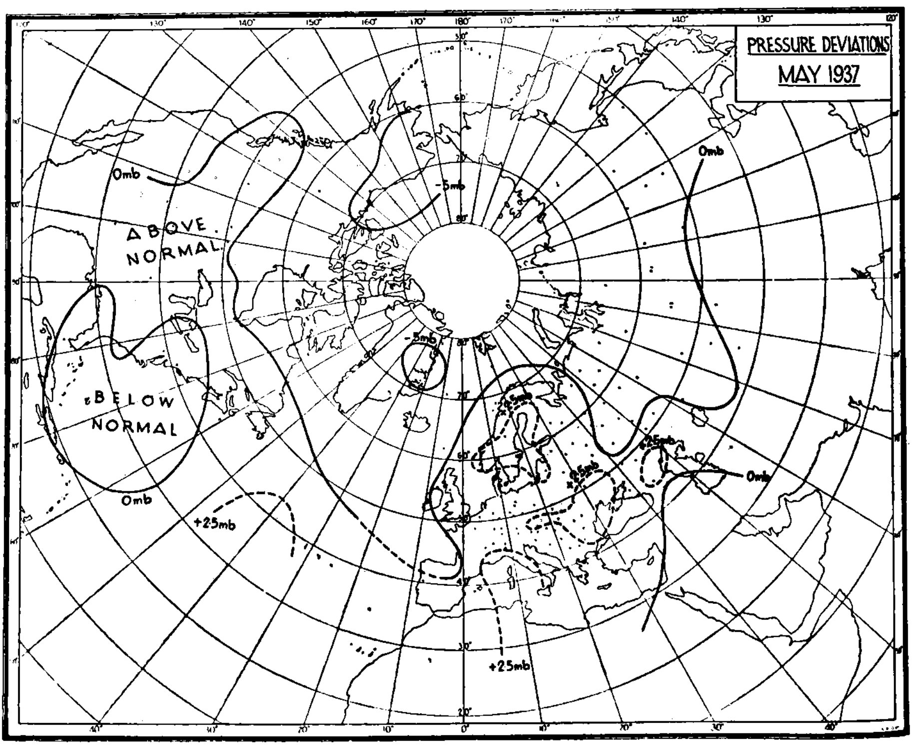

PRESSURE DEVIATIONS
MAY 1937
ABOVE NORMAL
BELOW NORMAL
0mb
-5mb
+2·5mb
-2·5mb

FIG. 2

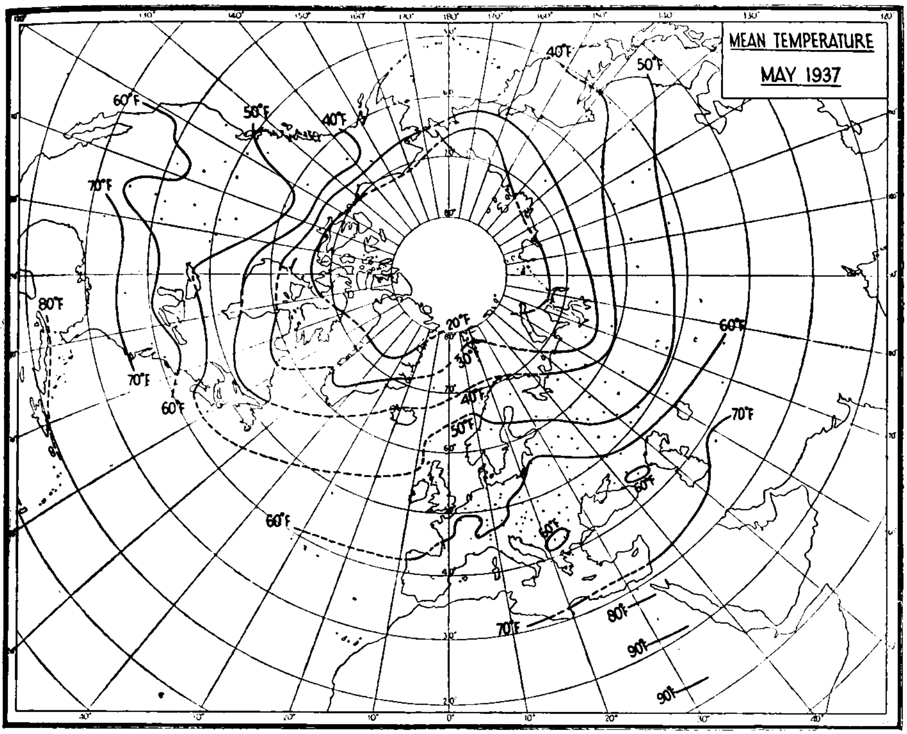

MEAN TEMPERATURE
MAY 1937
40°F
50°F
60°F
70°F
80°F
90°F
20°F
30°F

FIG. 3

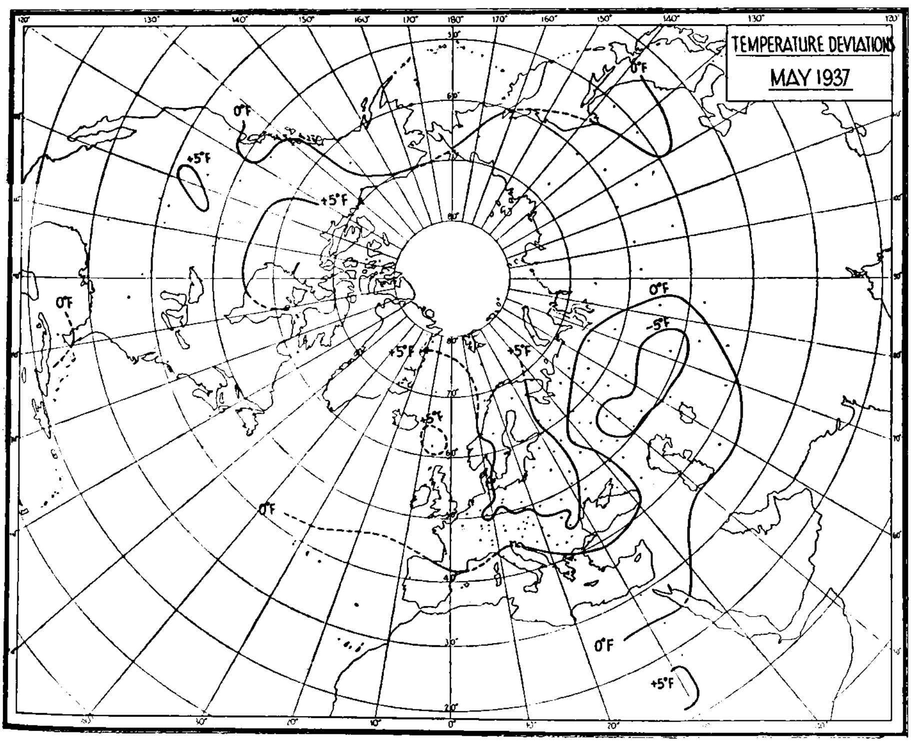

TEMPERATURE DEVIATIONS
MAY 1937
0°F
+5°F
-5°F

FIG. 4

The broadcasts for Europe, northern and central Asia, Canada and the United States are now almost complete. The results for May are shown in Figs. 1–4. It was not possible to print the actual data on the maps, but the positions of most of the stations are shown by dots. A remarkable feature is the number of stations in high latitudes, especially north of Russia and Siberia, which give a good picture of conditions around the North Pole.

Fig. 1 shows the mean pressure for May 1937. The distribution was on the whole remarkably uniform. The highest pressure, 1023 mb., occurs in the Azores anticyclone, from which a large flat area of pressure above 1015 mb. extends over the whole of Europe. Most of the stations in this area reported a pressure of 1017 mb. Relatively high pressure occurs also in a ridge from the Gulf of Mexico across the Great Lakes to the Arctic and also off the Pacific coast of North America, the latter extending to Honolulu, off the area of the map, where the mean was 1018 mb. A deep depression (below 1000 mb.) is shown over southern Kamschatka, and shallow lows over the south-western United States, southern Greenland, the Arctic coast of Siberia and the Nile valley; at Juba in 5° N., 31½° E. the mean pressure was 1002 mb.

Fig. 2 shows the deviations of pressure from normal. This map also is rather featureless, and it is less complete than Fig. 1, as normals are not yet available for all stations. Europe was in general 2–3 mb. above normal and most of the United States and southern Canada 1–2 mb. above normal while the Arctic regions and Siberia showed a small deficit of pressure, exceeding 5 mb. only in three small areas.

Fig. 3 shows the mean temperature. This is constructed from the data for stations at low altitudes (below 800 metres) and the figures have not been corrected to mean sea level. The range extends from below 20° F. over most of the Arctic Ocean (14° F. at Wrangel Island) to above 90° F. in the Nile valley (94° F. at Aswan). Further south the temperature decreases again. The isotherms over the sea are based on island and coastal stations and are broken to show that they do not necessarily represent the mean air temperature over the sea itself. The characteristic northward swing of the isotherms from west to east over the Atlantic is well shown. In the British Isles temperatures ranged from 56° F. at Kew to 49° F. at Aberdeen; a small area with temperatures between 49° F. and 50° F. over eastern Scotland and the Shetland Isles was accidentally omitted from the map.

Fig. 4 shows the deviations of temperature from normal. The whole of Europe and the greater part of North America were above normal, the deviation exceeding 5° F. over north-eastern Europe, Scandinavia and northern Canada, while the Nile valley was also abnormally warm; over the British Isles the excess ranged from 1° F. at Valentia to 3° F. at Stornoway. The main areas of deficient temperature included western Siberia and the northern Pacific coasts of America and Asia.

It was not possible to show the rainfall data cartographically. Over most of Europe the rainfall was 2–3 in., rising to 4 in. or more locally in central Europe, the Balkans and the Caucasus region, the greatest rainfall reported being 22 cm. (9 in.) at Sofia, 14 cm. (nearly 6 in.) above normal. In America the rainfall was generally about two inches but was heavy in the south-east, reaching 24 cm. (nearly 10 in.) at Key West, Florida, where it was 6 in. above normal. Elsewhere the abnormalities were not great; the western plains of the United States were generally dry, but over Europe and Asia the distribution was irregular.

In spite of the fact that the usual days for broadcasting, June 5th and 6th, occurred at a week-end, the figures had been received and plotted in the Meteorological Office by the evening of the 7th, a remarkable fruit of international organization applied to meteorology.

Aerology of the Karakorum Mountains*

In the extreme north-east of Kashmir, between the western Himalaya and the western branch of the Kuenlun, stretches the great mountain region known as the Karakorum with its steep and mighty peaks—60 summits exceed 22,000 ft.—and its great glaciers.

There is still much to be learned about the climate of Tibet and central Asia and the meteorological observations made by the three Dutch expeditions to the Karakorum add a little more to our knowledge of the weather conditions in that part of the globe.

The expeditions took place from June to October, 1922, from May to October, 1925 and from June to July, 1930. The observations, made with the aid of instruments supplied by the Royal Dutch Geographical Society and the Royal Dutch Meteorological Institute, are discussed both collectively and individually. It is noted that the differences in height of the regions explored is considerable and that only a few observations are available for the same levels. One cannot, as the author admits himself, place too much value on the data obtained—particularly some of the individual observations. Since, moreover, the computation, for a particular level, of values of temperature, relative humidity, etc., was made by using all the available observations at 250 m. above or below this level, there is some doubt as to the order of accuracy of such data. Nevertheless, these observations, which are given in tabular form at the end of the article, afford useful material for discussion. The author analyses,

* BLEEKER, W., Meteorologisches zu den 3 holländischen Karakorum-Expeditionen. Reprinted from *Amsterdam, Proc. Acad. Sci.*, 39, 1936, Nos. 6, 7 and 8.

for each month June to September, the observations of temperature, humidity, pressure, wind and precipitation and he arrives at some interesting but tentative conclusions.

To review them in detail would require a large amount of space, so the writer must content himself with a few remarks on the most interesting findings.

By the beginning of June, the track of the disturbances (mostly old occluded depressions) which cross north-west India roughly from the west to east has receded northward and only the extreme north of Chitral and Kashmir is affected, and then only occasionally. The disturbances usually begin to cross the extreme north of India again in October. It is surprising how these disturbances, which may travel from the Mediterranean and Asia Minor right across Persia and Afghanistan, traversing many mountain ranges en route, maintain their activity. Sometimes they give birth in the plains of India to new disturbances or secondaries—complete with "fronts" and an isobaric system similar to that associated with European depressions. The writer agrees with the author that the observations made between June 29th and July 10th, 1929 indicate, although rather late in the year, the easterly passage of a disturbance to the north of the point of observation. A föhn wind from the north-west, clear skies and exceptionally good visibility are phenomena commonly experienced in the rear of these disturbances.

Instability showers are frequent and fairly general in north Kashmir during the summer months, but in the south—especially in July and August—there is often an invasion of the monsoon current brought northwards by the monsoon depressions which usually travel from the Bay of Bengal north-westwards towards Rajputana and the Sind and which sometimes develop secondaries over the north Punjab.

To a very great extent the interior of Kashmir and the mountain ranges to the north are sheltered from the effect of the monsoon by the Panjal range, but, on the other hand, there is no doubt that the air which penetrates north-eastwards beyond this range is sometimes sufficiently laden with moisture to produce copious precipitation in Baltistan right up to the Karakorum country—the eastern end of which does not lie completely in the wind shadow of the peaks of the western Himalaya. This is mentioned because the author emphasises the difference which the observations, taken mainly between heights of 3 and 5 Km., reveal between the summer climate of the Hunza district and the eastern Karakorum. A comparison of the data for the two areas shows that conditions in the Hunza district—although the general run of the valleys is approximately the same—are on the average distinctly cooler (about 3 to 5° F.) and appreciably dryer with less cloud and less precipitation than those of the eastern Karakorum. It is pointed out in the article that the differences may be due partly to orographical causes. The valleys in the Hunza area (which lies to the west of the Karakorum) are steeper and the mountain slopes more precipitous than in the eastern Karakorum where the landscape has more the appearance of a plateau. The effect of insolation would therefore be greater in the latter area. Consequently there would be more turbulence—which might account for the tendency for humidity to increase with height in the eastern Karakorum. The author adds, however, that in this area the wind from 5 to 7 Km. in the free atmosphere (mainly west-south-west) has a larger southerly component than the wind (mainly westerly) in the Hunza district and suggests the possibility that these winds do not have the same origin, that is, that they belong to different air masses.

A comparison with the upper air data for Agra (obtained by means of sounding balloons over the plains of the United Province) shows that the temperature between 4 and 6 Km. in both districts is apparently several degrees higher than at Agra. Also, the author adds, according to the charts in Wagner's well-known treatise* on the south-west monsoon, one would expect the winds at 4 and 5 Km. both at Agra and in the two regions in question to belong to the same air mass. Why then is the air over the mountains apparently so much warmer than over the plains ? It is admitted that the estimation of the free air temperature in the mountain region may be incorrect by a degree or two but a study of available pilot balloon ascents and observational data on the height of the snow line lend support to the conclusion that Wagner's charts for the 4–5 Km. levels need modification and that the winds at this level at Agra and in the eastern Karakorum belong to different air masses. It is realised, of course, that one must take into consideration the fact that the westerly winds of the Hunza area must cross the towering mountains of the Hindu Kush whereas the more southerly winds of the eastern Karakoram would have much smaller ranges to negotiate. At 6 Km. the observed wind directions in both districts agreed well with extrapolated stream lines of air flow at 6 Km. prepared by Wagner. The writer must point out, however, that the charts of Wagner were based on the mean wind data for June, July and August and June is not a truly monsoon month in northern India. Moreover, the data used for heights above the 3 Km. level were very scanty.

If the author will refer to the paper by Ramanathan and Ramakrishnan on the structure of monsoon depressions† he will now find a more detailed analysis of upper air temperatures and the streamlines of air flow for each month May, June and July. The charts for July are particularly instructive as they indicate the surfaces of discontinuity between continental air, fresh and old

---

* Wagner, A. Zur Aerologie des indischen Monsuns, *Beitr. Geophys., Leipzig*, 30, 1931, p. 196.

† Ramanathan, K. R. and Ramakrishnan, K. P. The Indian south-west monsoon and the structure of depressions associated with it. *Poona, India met. Dep.* 26, Part II, 1933.

monsoon air. The occasional inflow of mixed monsoon air between 4 and 6 Km. into the eastern Karakorum may be inferred from Figs. 16 and 17. It has already been pointed out that the relatively low range of the Panjal may not completely dry off the air masses which pass over it. On the other hand it appears reasonably certain that the air of the Hunza district would be almost completely and continuously continental. Hence the observed differences of climate between these two particular regions.

The meteorological information obtained by the three Dutch expeditions is undoubtedly of considerable value and must be taken into consideration when future investigations of the structure of the south-west monsoon are made. R. G. VERYARD.

Royal Meteorological Society

The monthly meeting of the Society was held on Wednesday, May 26th, at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F.Inst. P., President, was in the Chair.

The following papers were read and discussed :—

E. W. Hewson, M.A. (Beit Scientific Research Fellow).—The application of wet-bulb potential temperature to air mass analysis. III. Rainfall in depressions.

This paper was postponed from the April meeting. For abstract see p. 86.

E. Kidson, M.A., D.Sc., F.Inst.P.—The cyclone series in the Caribbean Sea, October 17-24, 1935.

It has been held by some who have applied frontal methods of analysis to tropical cyclones, that it is the air that comes across the equator which acts as the cold air. The author has twice passed through the Caribbean Sea during disturbed periods, and the present paper is a study of the weather experienced : the information available indicates that the cold air came from the north and that the air from across the equator was the warm mass.

C. S. Durst, B.A.—The revolving storm of tropical origin which travelled across the Atlantic in September, 1936.

During the first week of September, 1936, a tropical revolving storm moved over the Atlantic. Its behaviour relative to the polar front is described, and it is shown that it retained its character of a revolving fluid almost to the Irish coast.

Correspondence

To the Editor, *Meteorological Magazine*

Clouds caused by Aeroplanes

At 10h. on March 31st, while in the neighbourhood of Hove, Sussex, my attention was caught by a thin spear of snow-white cloud, projecting in a dead straight line above a patch of much "dirtier" white fractocumulus. The lower cloud gradually caught up and over-ran the " spear ", and in the patch of blue sky to windward (south-east) I then observed that there were two parallel bands of cloud stretching up-wind for about 2 miles, where they were lost above another group of fractocumulus.

As I watched, these lines slowly unwound in corkscrew spirals, but although they lost their clear-cut definition and " whiteness," their general direction remained the same. The unwinding quite definitely started to windward and did not reach the leading edge of the first line I had seen till 10h. 15m. By 10h. 17m. breaks had begun to appear in the two lines, which became increasingly difficult to trace against a background of cirrostratus and cirrocumulus. The latter formed in two sets of waves : the main one running from south-east to north-west with subsidiary waves (apparently) above them from north-west to south-east.

There was neither sign nor sound of the two planes which in my opinion must have caused the "line" clouds which when first observed were far too regular to have been formed by other than mechanical means.

D. S. HANCOCK.

Greenways School, Bognor Regis, Sussex, April 1st. 1937.

Six Solar Haloes in Eight Days

These occurred May 27th to 30th and June 2nd and 3rd; a series unusual in my experience. Indeed in the six years 1930–5, the nearest are five days, Oct. 1st to 7th, in 1930, March 13th to 18th, 1931, and May 11th to 17th, 1933; 7 days in all being noted for that month.

Those of May 27th, 28th and June 2nd, 1937, were well marked and prolonged, strikingly so on the 28th. In the May haloes high level cloud streaks stretched and seemed to move from north-east to south-west. On the 27th and 30th the visible cloud formed a thin blanket, though hardly obscuring much sunshine, whilst there was also low level haze. On the 27th the Mendip rampart, distant 8 to 15 miles from north-west to north-east, was obscured. The halo, though bright, was almost a dusky yellow monotint, brighter in the centre and about $1\frac{3}{4}°$ wide, with the inner space only slightly dull. On the 30th, with the nearer Mendips just visible, the conditions were similar but the halo hardly as bright.

Visibility on the 28th was somewhat exceptional. The broad cloud streaks alternated with bands of clear sky down to the south-east and north-west sky lines. Not only were Brean Down and Steep Holm in the Bristol Channel clearly visible, 20 and 24 miles distant from a point on the Poldens at a height of 250 ft., but the low Welsh area between Barry and Cardiff fairly so, fully thirty miles off. This also was just visible on the 29th. From or before 9 a.m. to 4 p.m. on the 28th the sunshine was hardly dimmed and the thermometer at 76° was the highest here for the year. But below this tenuous haze between 2 and 3 p.m., a very delicate alto-cirrus began to appear at the south-west point of the halo. It quickly became iridescent, lasting so for about an hour as it enlarged to about 15° by 5°. Otherwise, the sky within the halo remained of a uniform and unusually dark grey shade. Continuing to spread and thicken the whole halo was hidden soon after 5.45 p.m. The very uniform halo was about 2° across with a bright, sharply defined centre of ½°, half a dusky red, half green blue, shading off respectively to dull red and a creamy white, brighter than the adjacent cirrus haze. By 5 o'clock all the south-west quadrant was obscured by the expanding cloud, no longer iridescent after 3 o'clock. Gradually most of the streaks to north-west and south-east were obscured and the rest of the halo.

That on the 29th appeared for two or three short intervals, showing only the ½° of bright colours. The last, on June 3rd, resembled those of the 27th and 2nd, but only lasted about ¾ hour about 2 o'clock. None developed any type of accessories, nor did the few glimpses of the moon exhibit any lunar phenomena. By June 4th upper air conditions completely changed after a mild night, bringing a slight shower in the afternoon, the first since May 26th. All through barometric variation was very slight, about 30·20 in. to 30·45 in. Night temperatures until the 4th varied from about 42° to 46°. All times given are G.M.T.

J. EDMUND CLARK.

Street, Somerset, June 4th, 1937.

[Mr. G. A. Clarke, of Aberdeen Observatory, reports that he observed a solar halo every day during the week May 23rd to 29th inclusive and adds that he believes that this is unique in his experience. Ed. *M.M.*].

NOTES AND QUERIES

Anemometer Mast Belts

On Wednesday, May 5th, as I was walking along a country road I saw a Post Office linesman with his telephone, belt and irons. He was led to tell me what he had been doing, and I made a remark about the belt which he then showed me. I said we had similar belts but they were found to be rather heavy. He replied that the belt was heavy but he always wore it when he went up the poles. He said that when he was younger he had not considered it necessary always to put on the belt but one day he fell from a pole and broke his ankle.

I note the incident in the hope that it may be of some use in encouraging meteorologists who have to ascend anemometer masts to use belts without waiting to be individually convinced as this Post Office linesman had been.

E. GOLD.

Aurorae at Eskdalemuir, April 25th–28th and May 4th, 1937

On the nights of April 25th–28th inclusive, and of May 4th, active aurorae were observed at Eskdalemuir Observatory. The following is a brief account of the displays, taken from notes, and of the associated magnetic disturbance of April 26th–27th. All times mentioned are G.M.T. The aurorae of April 25th–28th were seen under a full moon. The visibility was over 18 miles in each case, and there was practically no cloud. The angular elevations given are of the highest point of the arches under consideration.

April 25th.—A greenish arch, elevation 4°, was first observed at 21h. 40m. From then until 22h. 33m. this gradually rose in the sky, broadened, and became brighter with dark sky underneath. Streamers, and less frequently, curtains appeared at intervals, particularly to the north-east. From 22h. 36m. to 22h. 44m. the display was at its maximum; the arch broke up into undulating curtains, whilst countless streamers swept the northern sky. A brilliant purple glow, which first appeared in the west, changed to crimson and extended from west to east through the zenith. From 22h. 45m. to 23h. 59m. the display was less intense, the main features being the formation of arches which gradually broke up into diffuse nebulous patches, whilst streamers and bundles of rays were frequent.

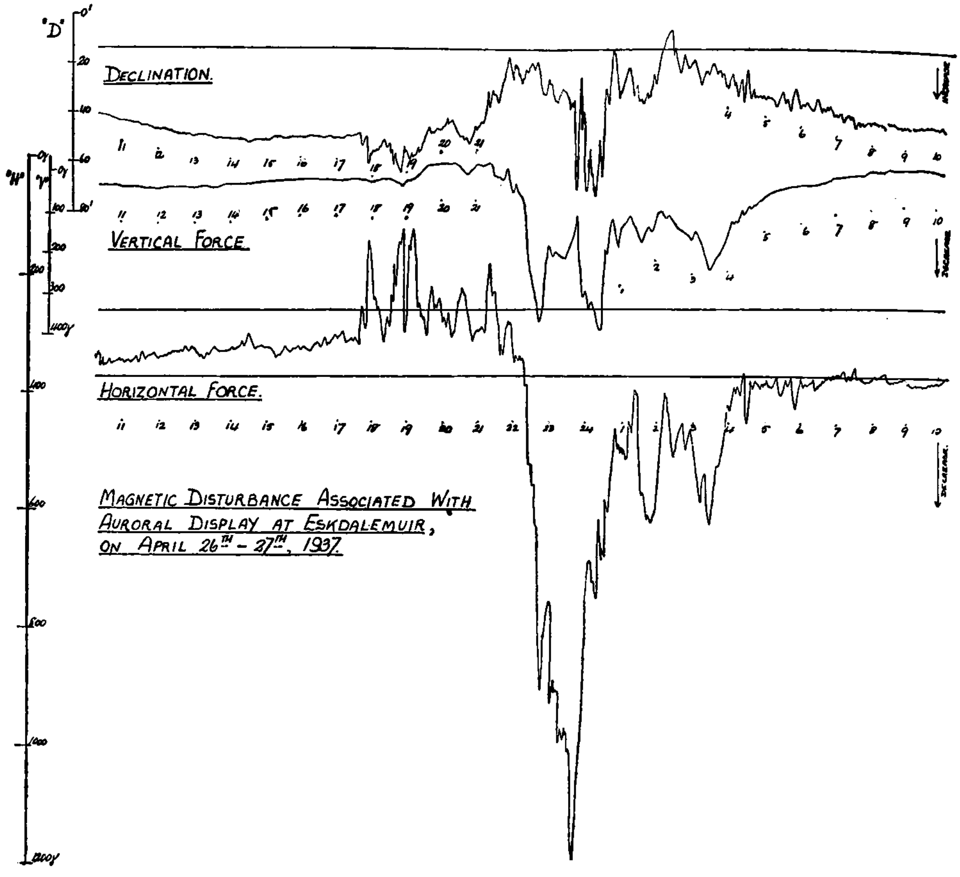
April 26th.—At 22h. 15m. a brilliant greenish arch, elevation 12°, was first seen. This gradually rose in elevation, an interesting point being that the arch consisted of major and minor arcs of different curvatures. From 22h. 23m. to 22h. 30m. the arch was covered to a greater or lesser extent with undulating greenish drapery. At 22h. 32m. the arch broke up into draperies and streamers, which seemed to radiate from some point below the horizon. At 22h. 24m. the display consisted of a double arch, the two curves meeting at points on the horizon, the azimuth of these points being 270° and 55°, and the elevation of the arches 60° and 37°. These arches gradually rose in elevation in the sky until they formed parallel bands nearly overhead. At 23h. 40m. most of the northern sky was covered in draperies, whilst the outstanding feature was the appearance of parallel flickering bands, orientated east to west, which swept through the zenith to disappear southwards. The display reached its maximum at 23h. 52m. A corona formed overhead with rays and draperies radiating northwards, whilst crimson and green glows appeared to the west and north. After 0h. 2m. the display rapidly decreased in intensity.

April 27th.—At 21h. 45m. a reddish glow and faint streamers were first seen. This developed into a moderately bright arch, elevation 6°, at 22h. 15m., with bright rays at intervals.

April 28th.—At 21h. 40m. a brilliant, greenish, vertical bundle of rays moved from north-west to west taking about five minutes, afterwards fading slowly.

May 4th.—At 22h. 20m. a moderately bright glow was seen to the north, with faint streamers to north-east. This deteriorated to a faint glow at 22h. 45m., and was obscured by cloud at 23h.

MAGNETIC DISTURBANCE, *April 26th-27th*, 1937.—Considerable disturbance was shown on the magnetic traces for April 26th–27th, especially in H, the range in this element being the largest since 1928.



The disturbance commenced at approximately 17h. 40m. on the 26th and continued until 7h. on the 27th. The maximum value of 16719γ in H was reached at 18h. 54m. After reaching its maximum H was continuously disturbed, and from a value of 16481γ (·16481 C.G.S. units) at 22h. 17m. it fell rapidly to a minimum of 15613γ at 23h. 45m. From this minimum H rose in a series of jerks to 16436γ at 1h. 22m. The disturbance continued, but with much less severity, until 7h. on the 27th.

Principal disturbance in D took place between 0h. 27m. when a maximum of 13° 55·8′ was reached, and 2h. 30m. when a minimum value of 12° 55·5′ was recorded. Disturbance was very pronounced between 0h. 10m. and 2h. 30m. when very rapid changes occurred.

The maximum value of 44985γ in V was reached at 21h. 19m. on the 26th, and a minimum value of 44566γ was recorded at 0h. 30m. on the 27th. A feature of the V disturbance was a sudden fall from 44931γ at 22h. 10m. to 44591γ at 22h. 50m. V then rose to 44854γ at 23h. 50m. and fell to its minimum value of 44566γ at 0h. 30m. on the 27th.

J. B. BECK.
D. W. RHEAD.

Aurorae at Leuchars and Fort Augustus, April 26th–30th.

Aurorae were seen by Mr. S. T. A. Mirrlees and Mr. H. H. Lamb at Leuchars on April 26th–30th.

According to these observations, on April 26th rays, first seen at 21h. 0m. G.M.T., quickly developed, reaching a maximum at 21h. 35m. when there were four distinct bundles between west and north-east, those in the centre having a greenish tinge. A little later the outer ones became pink and shortly before 22h. 0m. the whole structure faded. At 22h. 5m. an arc developed and the rays reappeared. but without colour: the arc became double and later manifold. At 23h. 35m. the rays were moving rapidly from the west and reached south of the zenith. When at their brightest the rays were judged to be 5–10 times as bright as searchlight beams.

Conditions were less favourable at Leuchars on the 27th, the sky becoming clouded after a double arc with vertical rays, some pink, in similar positions to those of the 26th, had been observed. Less remarkable displays were also seen at Leuchars on April 28th and 30th.

On the 27th the display was also seen from several places further north including Fort Augustus where Mr. F. E. Dixon, from 23h. 30m. to 24h. 0m., observed a rayed arc associated with draperies and finally at about 23h. 50m. a faint flame aurora. The colour was green throughout.

REVIEW

The daily temperature period for a linear variation of the Austausch coefficient, by B. Haurwitz. Transactions of the Royal Society of Canada. Third Series, Sec. 3, Vol. 30, 1936.

It has been assumed by several investigators when studying the diurnal variation of temperature at various heights that the Austausch coefficient is independent of height. This undoubtedly simplifies the work but leads to results which do not agree with the observed facts.

In this paper the author assumes that the Austausch coefficient is a linear function of the height and obtains a solution of the equation relating temperature to time and height in terms of Bessel functions. He then shows that if the Austausch coefficient is calculated from the ratio of the amplitudes of the temperature variation at two heights, assuming that the former does not vary in this layer, the value obtained may be much less than the average value. Similarly, if the coefficient is assumed to be constant and is calculated from the times of maximum temperature, the value obtained will not be the average value if, in fact, the coefficient varies linearly with height.

Accordingly the author develops a method of calculating the Austausch coefficient from the lag of the time of maximum temperature at two heights, assuming that the former varies linearly with height. This method involves the use of numerical values of the kei and ker functions. It is set out very clearly and a table of values of the Bessel functions involved is given in the form in which they are required for the computation.

Although not primarily concerned with observational material the author gives an example of the computation based on assumed values for the lag of the time of maximum temperature at 100m. and 200m.

A slight modification of the method for use when the variation of the Austausch coefficient with height is small is also shown and the paper closes with an example of this method based upon some figures due to Schmidt which refer to the Eiffel Tower.

A. C. Best.

BOOKS RECEIVED

Hourly rainfall at Lahore. By V. Doraiswamy Iyer, B.A., and V. Lakshminarasimhan, B.A., India Meteor. Dept., Sci. Notes, Vol. VI, No. 68.

A statistical analysis of the distribution of the south-west monsoon rainfall at Akola. By V. Satakopan, M.A., India Meteor. Dept., Sci. Notes Vol. VII, No. 69.

OBITUARY

James Hermann Field, C.S.I.—In the early morning of May 19th Mr. J. H. Field, C.S.I., passed away at his home at Reigate to the sorrow of many friends in this country and India. A member of the staff of the India Meteorological Department for 24 years and Director for a little over three years, he played an important part in developing the Meteorological Service of India into one of the most efficient and up-to-date meteorological services in the Empire. A loyal assistant to Sir Gilbert Walker, his chief for over twenty years; a friend to all his colleagues, both European and Indian; an efficient and conscientious servant of Government, he was a splendid example of the Englishmen who, leaving Home to serve India, have laid the foundations on which that great country is building its future.

Field was born on December 23rd, 1872, and was educated at Highgate School and Finsbury Technical College. For a short time he practised as an electrical engineer with a partner in Victoria Street, London, but in 1898 he retired from the business and went to St. John's College, Cambridge.

He did not take his degree until 1904, as his course at Cambridge was interrupted for two years by service in South Africa in the Boer War. Soon after taking his degree Field was invited by Sir John Eliot to join the staff of the India Meteorological Department, then being reorganized with Sir Gilbert Walker as the new Director-General of Observatories.

To give an account of Field's work in India would involve writing a history of the India Meteorological Department during the last thirty years and this is neither the time nor the place for such a history. I must limit my remarks to the two outstanding features of Field's work, namely, his upper air research and the building of the Poona Meteorological Office, as these are the two things for which he will always be remembered.

When Field arrived in India practically nothing was known of the upper air over India—or, indeed, of any other tropical continent. With Sir Gilbert Walker's permission and encouragement Field immediately threw himself into the investigation. His early observations were made with kites, but as Simla was not a suitable place for observations he took his apparatus first to Karachi and then to Belgaum, near the west coast, with the object of investigating upper air conditions during the south-west monsoon. During the hot weather he carried out observations with sounding balloons at Jhang in the Punjab, one of the hottest spots in India. Field designed all his own kites and instruments and made the latter with his own hands in a very rudimentary workshop in Simla. In 1907 Field returned to England on leave and took the opportunity of making kite ascents from the ship as she crossed the Indian Ocean.

Little more than experimental work was done until 1912 when the Government of India decided to establish an upper air observatory at Agra. The new observatory, designed by Field, was completed in 1914 after which he remained in charge of it until he succeeded Walker as Director-General of Observatories in 1924. The upper air work at Agra is now well-known ; soundings of the upper air were made by means of balloons and instruments designed or adapted by Field, and Agra became the centre of a network of stations making observations of upper air currents by means of pilot balloons.

Unfortunately the Great War broke out a few months after the establishment of the new observatory and the scientific programme had to be reduced for several years to what could be carried on by routine methods in the hands of Indian assistants. Field himself returned to England to undertake war work at the Admiralty Experimental Station, Shandon, in 1918.

On the return of more normal conditions the work at Agra was taken up again with Field in charge and W. A. Harwood as Assistant Director. Up to that time very little had been published of all the work done, either experimental or observational. Field and Harwood set to work to write up the results, Field writing a full account of the instruments and methods used and Harwood the scientific discussion of the data. Field's article was published as an introduction to a series of memoirs by Harwood entitled "The Free Atmosphere in India," and is his main contribution to meteorological literature.

For the amount of work carried out and the importance of that work Field's contribution to scientific literature is unusually small; but the value of his work cannot be estimated by the amount of writing he did; it was his enthusiasm, his power of impressing with the importance of the work his non-scientific superiors in the Government of India, and the co-operation he inspired in his staff at Agra, which make Field's work outstanding.

Just before retiring in 1924 Sir Gilbert Walker received the approval of the Government of India to his suggestion to remove the headquarters of the India Meteorological Department from Simla to Poona. This was a change very near to the heart of Field who had always considered that the impossibility of carrying out upper air observations from Simla made that station totally unfitted for the headquarters of a meteorological service. One of his first duties on becoming Director-General of Observatories was to design the new building for the Department in Poona. The verdict of all who have seen the new office is that it is one of the best designed Meteorological Offices in the world and worthy of the great meteorological service it houses. Unfortunately Field himself did not see the completion of his work for he left India on March 3rd, 1927, on twelve months' leave preparatory to retirement and the new office was not officially opened until July, 1928.

On his retirement Field returned to England and served on the Council of the Royal Meteorological Society.

In 1929 owing to the loss of aircraft in the Bay of Gibraltar due to air turbulence caused by the Rock in high winds, Field was invited to undertake an investigation. He carried out a notable piece of work, first investigating the air currents about a model of the Rock in a wind tunnel at the National Physical Laboratory and then by means of kites and balloons, checking the results obtained in the tunnel by observations in the Bay of Gibraltar. The results have proved of great value to the pilots of aircraft flying in the neighbourhood of the Rock.

In 1931 Field married Mrs. Salter, the widow of Mr. M. de. C. S. Salter, for several years the Superintendent of the British Rainfall Organization, who survives him.

I cannot close this short account of Field's scientific work without adding a personal note. Field was my best friend; we "chummed" together for several years in Simla and we have remained in close personal contact and uninterrupted friendship for over 30 years. A man of retiring disposition, he had character stamped on every lineament and he had great influence with the high officials of the

Government of India. Honesty and integrity were the essence of his being—in fact his honesty in small matters was occasionally embarrassing. His generosity was unbounded as his friends and relations, but very few others, know. When I was raising funds for instruments to be used on the Antarctic Expedition he gave me by far the largest donation I received and one sufficient to remove all my difficulties. Probably the highest evidence of his fine character is in the cordial relationship which existed between him and his Indian staff; from bearer and chaprassie to chief clerk and scientific assistant, they all respected and trusted Field Sahib.

G. C. SIMPSON.

NEWS IN BRIEF

Prof. W. L. Bragg, F.R.S., who has held the Langworthy Chair of Physics in the University of Manchester since 1919, has been appointed Director of the National Physical Laboratory in succession to the late Sir Joseph Petavel K.B.E., F.R.S.

The Institute of Meteorology and the Institute of Physical Geography which hitherto have been two separate institutions of the University of Latvia, Riga, are now united under the name of the "Institute of Geophysics and Meteorology" with Prof. Dr. Rudolf Meyer, head of the combined institute.

We learn that Dr. Mario Bossolasco, Professor of the University of Turin, has been appointed Professor of Geophysics and Geodesy in the University of Messina.

ERRATUM

MAY 1937, p. 94, line 8, *for* "March 10th" *read* "March 9th".

MAY, 1937, p. 87. Halo phenomena of April 19th, 1937. The times given for the halo observed by Mr. H. Kearney at University College, Dublin, are in British Summer Time not G.M.T.

The Weather of May, 1937

The weather of May over the British Isles generally was fine, sunny and warm at the beginning and end of the month with a cool unsettled period especially in the south and east from about the 8th to 22nd. Sunshine totals exceeded the normal in west Scotland, west England and Ireland but were deficient in the south and east, while rainfall was above normal generally except in Scotland and north and east Ireland. Thunderstorms were frequent and mist or fog occurred locally on many days. From the 1st to

3rd pressure remained high over the British Isles and fine quiet warm conditions prevailed, 73° F. was reached at Tottenham, South Farnboro', Mildenhall and Tunbridge Wells on the 3rd and 71° F. at Fort Augustus on the 2nd, while over 13 hrs. bright sunshine were registered at several stations on the 2nd and 3rd, 14·0 hrs. at Tiree on the 2nd. On the 3rd thunderstorms were widespread in England and south Scotland. On the 4th a trough of low pressure passed north-eastwards across the country giving slight rain in most parts and on the night of the 6th–7th rain also fell generally, but otherwise until the 8th the weather continued mainly fair with much sun on the 5th, and also in the east and north on the 6th. Mist or fog occurred locally on the 2nd and 3rd and was prevalent on the west coast on the night of the 6th–7th and again the next night in the south. Gales were experienced early on the 5th at Stornoway and later the same day at Spurn Head. By the evening of the 8th the approaching depression on the Atlantic had brought rain to the south-west and from then to the 15th pressure was mainly low over the country and the weather generally cool and unsettled in the south and east but with much sun most days in west Scotland, west England and Ireland; 16·0 hrs. were recorded at Tiree on the 13th. On Coronation Day while cloudy unsettled weather occurred in most parts of England with heavy thunder showers in the south sometimes accompanied by hail (at Rowledge, Surrey the recreation ground was at one time white with hail), over 14 hrs. bright sunshine were recorded at Tiree, Stornoway and Dalwhinnie and over 13 hrs. in parts of north Ireland. Local mist or fog was reported on several days during this period. From the 15th–17th a ridge of high pressure lay over the country giving generally fair sunny weather, except in the south-east where considerable cloud developed on the 15th and 16th and some mist or fog. Thunderstorms occurred in south Scotland, north England and Ireland on the 17th. From then to the 22nd depressions crossed the country. The weather was unsettled with frequent and sometimes heavy rain but considerable sunny periods; 2·33 in. fell at Rendlesham (Suffolk) on the 20th and 1·66 in. at Borrowdale (Cumberland) on the 22nd. Thunderstorms were again general on the 20th and 21st. From the 23rd to 26th, pressure was low to the west and high to the east and temperature rose considerably. Warm sunny days were experienced in the east but rain with sunny intervals in the west. On the 25th and 26th however, thunderstorms were widespread and often accompanied by heavy rain, 1·50 in. fell at Nettlebed, Oxford, on the 25th. From the 27th to 31st fine warm sunny anticyclonic conditions prevailed over the country except the extreme north where depressions further north and west brought gales on the 27th, 30th and 31st, and rain at times. In the south-east maximum temperatures reached 80° F. in places on the 29th and 30th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	236	+57	Chester ...	182	+16
Aberdeen ...	164	−6	Ross-on-Wye...	199	+13
Dublin	209	+29	Falmouth ...	185	−22
Birr Castle ...	213	+44	Gorleston ...	198	−25
Valentia... ...	221	+37	Kew	173	−25

Kew, Temperature, Mean 56·1° F., Diff. from normal + 1·6° F.

Miscellaneous notes on weather abroad culled from various sources.

A cloudburst occurred at Voula on the sea-coast 12 miles south-east of Athens on the 5th during which a K.L.M. air liner was forced down. Dense fog was experienced in the Gulf of Danzig about the 9th and fog was reported off the west coast of Holland and in the River Weser on the 11th. The ice had gone and navigation was reopened at Uleaborg, Finland on the 13th. Thick fog was experienced on Orësund on the 14th. One of the pylons at the Radio Toulouse broadcasting station was struck by lightning during a violent storm on the 17th. Fog occurred near Istanbul on the 19th. A severe south-westerly gale over central and eastern Switzerland on the 20th did much damage to the orchards near the Lake of Lucerne; on the same day there was a fall of yellow sand at Muttenz in Canton Basle and a heavy fall of red sand in the Engadine. The gale extended also into Upper Bavaria on the 21st, where it did much damage to the fishing boats on the Chiemsee. After floods in Thuringia two days earlier severe storms broke over central Germany on the 21st followed by floods. On the 22nd severe storms accompanied by hail and floods swept over south-western Poland causing loss of life and much damage to property—it is believed that 40 people were drowned. A thunderstorm of exceptional violence broke over Budapest on the 23rd and was followed by torrential rain causing floods in the vicinity. Early on the 24th there was unusually heavy rain preceded by thunder and lightning and accompanied by gales in the neighbourhood of Belgrade; the rain later turned to hail and some streets were reported to be 3 ft. deep in ice. Many people also were drowned in Bulgaria as the result of heavy rain between the 23rd and 26th. Thunderstorms and fog were reported on Oslo Fjord on the 27th. (*The Times*, May 6th–31st.)

Duststorms occurred on the North-West Frontier on the 8th and a heat wave was sweeping over north-west India about the 19th. On the 18th the monsoon burst in Rangoon. (*The Times*, May 10th–19th.)

The total rainfall for the month in Australia was considerably below the normal except in South Australia, Western Australia and Tasmania where at some places it was above normal. (Cable).

Floods occurred in Vermont, New Hampshire, and in Massachusetts

(*Continued on p. 128*)

Rainfall : May, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	2·89	164	*War* .	Birminghm, Edgbaston	2·50	116
Sur .	Reigate, Wray Pk. Rd..	2·41	132	*Leics* .	Thornton Reservoir ...	2·35	117
Kent .	Tenterden, Ashenden...	2·86	182	,, .	Belvoir Castle...........	3·48	165
,, .	Folkestone, Boro. San.	3·09	...	*Rut* .	Ridlington	3·78	187
,, .	Margate, Cliftonville....	2·43	154	*Lincs* .	Boston, Skirbeck.........	5·29	292
,, .	Eden'bdg., Falconhurst	2·62	141	,, .	Cranwell Aerodrome...	3·64	200
Sus .	Compton, Compton Ho.	2·54	114	,, .	Skegness, Marine Gdns.	3·94	232
,, .	Patching Farm..........	2·13	115	,, .	Louth, Westgate.........	3·28	159
,, .	Eastbourne, Wil. Sq....	2·57	155	,, .	Brigg, Wrawby St.......	2·90	...
Hants.	Ventnor, Roy.Nat.Hos.	1·70	100	*Notts* .	Worksop, Hodsock......	3·39	170
,, .	Fordingbridge, Oaklnds	2·85	137	*Derby*.	Derby, L. M. & S. Rly.	2·20	115
,, .	Ovington Rectory.......	3·06	141	,, .	Buxton, Terrace Slopes	2·42	78
,, .	Sherborne St. John......	3·10	160	*Ches* .	Bidston Obsy.............	3·44	181
Herts .	Royston, Therfield Rec.	3·12	161	*Lancs*.	Manchester, Whit. Pk.	1·86	88
Bucks.	Slough, Upton............	2·73	162	,, .	Stonyhurst College......	2·05	72
,, .	H. Wycombe, Flackwell	3·57	196	,, .	Southport, Bedford Pk.	1·89	90
Oxf .	Oxford, Radcliffe........	2·62	140	,, .	Ulverston, Poaka Beck	2·04	64
N'hant	Wellingboro, Swanspool	3·93	203	,, .	Lancaster, Greg Obsy.	2·06	83
,, .	Oundle	3·01	...	,, .	Blackpool	1·80	83
Beds .	Woburn, Exptl. Farm...	3·94	203	*Yorks*.	Wath-upon-Dearne......	2·68	117
Cam .	Cambridge, Bot. Gdns.	2·51	143	,, .	Wakefield, Clarence Pk.	2·96	150
,, .	March.......................	3·78	218	,, .	Oughtershaw Hall.......	2·94	...
Essex.	Chelmsford, County Gdns	2·54	176	,, .	Wetherby, Ribston H..	3·63	175
,, .	Lexden Hill House......	2·12	...	,, .	Hull, Pearson Park......	3·40	176
Suff .	Haughley House.........	2·59	...	,, .	Holme-on-Spalding......	2·62	115
,, .	Rendlesham Hall........	3·87	253	,, .	West Witton, Ivy Ho.	4·06	181
,, .	Lowestoft Sec. School...	2·35	146	,, .	Felixkirk, Mt. St. John.	2·73	145
,, .	Bury St. Ed., WestleyH.	2·48	136	,, .	York, Museum Gdns....	3·45	173
Norf. .	Wells, Holkham Hall...	3·19	196	,, .	Pickering, Hungate......	2·48	127
Wilts .	Porton, W.D. Exp'l. Stn	2·42	141	,, .	Scarborough..............	3·47	171
,, .	Bishops Cannings........	2·25	115	,, .	Middlesbrough...........	2·51	131
Dor .	Weymouth, Westham.	3·28	201	,, .	Baldersdale, Hury Res.	3·12	122
,, .	Beaminster, East St....	3·28	159	*Durh* .	Ushaw College............	3·09	143
,, .	Shaftesbury, Abbey Ho.	2·40	114	*Nor* .	Newcastle, Leazes Pk...	2·68	135
Devon.	Plymouth, The Hoe....	2·70	130	,, .	Bellingham, Highgreen	3·09	129
,, .	Holne, Church Pk. Cott.	4·68	149	,, .	Lilburn Tower Gdns....	3·52	153
,, .	Teignmouth, Den Gdns.	2·56	123	*Cumb*.	Carlisle, Scaleby Hall...	3·46	145
,, .	Cullompton	2·41	111	,, .	Borrowdale, Seathwaite	...	...
,, .	Sidmouth, U.D.C........	2·62	...	,, .	Thirlmere, Dale Head H.	3·19	67
,, .	Barnstaple, N. Dev.Ath	1·92	95	,, .	Keswick, High Hill......	1·92	60
,, .	Dartm'r, Cranmere Pool	4·00	...	*West* .	Appleby, Castle Bank...	3·03	138
,, .	Okehampton, Uplands.	2·73	101	*Mon* .	Abergavenny, Larchf'd	2·28	85
Corn .	Redruth, Trewirgie......	2·37	103	*Glam* .	Ystalyfera, Wern Ho....	2·99	86
,, .	Penzance, Morrab Gdns.	1·85	84	,, .	Treherbert, Tynywaun.	3·24	...
,, .	St. Austell, Trevarna...	3·22	133	,, .	Cardiff, Penylan..........	2·35	96
Soms .	Chewton Mendip.........	2·58	97	*Carm* .	Carmarthen, M. & P. Sch.	2·12	74
,, .	Long Ashton............	2·56	121	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	1·13	59
,, .	Street, Millfield..........	2·21	...	*Card* .	Aberystwyth	1·54	...
Glos .	Blockley	2·70	...	*Rad* .	BirmW.W.Tyrmynydd	2·39	69
,, .	Cirencester, Gwynfa....	2·12	103	*Mont* .	Lake Vyrnwy	2·90	92
Here .	Ross-on-Wye............	2·38	112	*Flint* .	Sealand Aerodrome......	2·66	...
Salop.	Church Stretton.........	2·14	86	*Mer* .	Blaenau Festiniog	1·75	34
,, .	Shifnal, Hatton Grange	2·67	130	,, .	Dolgelley, Bontddu......	2·66	80
,, .	Cheswardine Hall........	3·02	136	*Carn* .	Llandudno	1·64	92
Worc .	Malvern, Free Library...	2·96	137	,, .	Snowdon, L. Llydaw 9..	3·45	...
,, .	Ombersley, Holt Lock.	2·33	114	*Ang* .	Holyhead, Salt Island...	·75	38
War .	Alcester, Ragley Hall...	2·35	114	,, .	Lligwy	1·34	...

Rainfall: May, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem....	1·70	68	*R&C* .	Achnashellach	2·96	66
Guern.	St.Peter P't.Grange Rd.	4·04	237	„ .	Stornoway,C.GuardStn.	2·65	...
Wig .	Pt. William, Monreith.	2·14	91	*Suth* .	Lairg	1·64	65
„ .	New Luce School.........	2·24	79	„ .	Tongue	...	...
Kirk .	Dalry, Glendarroch......	2·59	83	„ .	Melvich.....................	1·07	52
Dumf.	Dumfries, Crichton R.I.	1·63	63	„ .	Loch More, Achfary....	1·93	44
„ .	Eskdalemuir Obs........	2·59	78	*Caith* .	Wick........................	·69	33
Roxb .	Hawick, Wolfelee........	3·60	154	*Ork* .	Deerness	·36	18
Peeb .	Stobo Castle.............	...	...	*Shet* .	Lerwick	2·60	124
Berw .	Marchmont House......	3·68	149	*Cork* .	Dunmanway Rectory...	3·06	90
E.Lot .	North Berwick Res.....	2·83	142	„ .	Cork, University Coll...	1·94	86
Midl .	Edinburgh, Blackfd. H.	2·52	123	„ .	Mallow, Longueville....	2·36	106
Lan .	Auchtyfardle	1·47	...	*Kerry*.	Valentia Observatory...	3·33	105
Ayr .	Kilmarnock, Kay Park	1·53	...	„ .	Gearhameen...............	...	...
„ .	Girvan, Pinmore.........	1·61	54	„ .	Bally McElligott Rec...	2·35	...
„ .	Glen Afton, Ayr San....	2·11	70	„ .	Darrynane Abbey.......	2·53	94
Renf .	Glasgow, Queen's Park	1·58	65	*Wat* .	Waterford, Gortmore...	1·71	75
„ .	Greenock, Prospect H..	1·74	50	*Tip* .	Nenagh, Castle Lough.	...	...
Bute .	Rothesay, Ardencraig...	1·75	58	„ .	Roscrea, Timoney Park	...	...
„ .	Dougarie Lodge..........	1·45	53	„ .	Cashel, Ballinamona....	2·92	124
Arg .	Loch Sunart, G'dale....	3·64	102	*Lim* .	Foynes, Coolnanes......	1·85	79
„ .	Ardgour House..........	3·99	...	*Clare* .	Inagh, Mount Callan....	2·52	...
„ .	Glen Etive...............	...	...	*Wexf* .	Gorey, Courtown Ho...	1·08	49
„ .	Oban.....................	2·36	...	*Wick* .	Rathnew, Clonmannon.	1·23	...
„ .	Poltalloch................	2·54	88	*Carl* .	Bagnalstown,Fenagh H.	1·40	57
„ .	Inveraray Castle.........	2·85	73	„ .	Hacketstown Rectory...	1·34	51
„ .	Islay, Eallabus............	1·89	71	*Leix* .	Blandsfort House.......	2·03	83
„ .	Mull, Benmore...........	4·70	63	*Offaly*.	Birr Castle................	2·74	123
„ .	Tiree	2·53	101	*Kild* .	Straffan House...........	1·66	75
Kinr .	Loch Leven Sluice.......	1·81	74	*Dublin*	Dublin, Phoenix Park..	1·16	56
Fife .	Leuchars Aerodrome...	2·37	122	*Meath*.	Kells, Headfort..........	1·81	67
Perth .	Loch Dhu.................	2·50	55	*W.M* .	Moate, Coolatore.........	2·27	...
„ .	Crieff, Strathearn Hyd.	2·96	119	„ .	Mullingar, Belvedere...	1·85	75
„ .	Blair Castle Gardens....	2·68	132	*Long* .	Castle Forbes Gdns......	3·28	127
Angus.	Kettins School...........	1·74	65	*Gal* .	Galway, Grammar Sch.	2·35	95
„ .	Pearsie House...........	2·39	..	„ .	Ballynahinch Castle....	4·40	122
„ .	Montrose, Sunnyside...	2·11	103	„ .	Ahascragh, Clonbrock.	3·55	128
Aber .	Balmoral Castle Gdns..	1·73	75	*Rosc* .	Strokestown, C'node.....	...	...
„ .	Logie Coldstone Sch....	2·00	80	*Mayo*.	Blacksod Point..........	1·70	73
„ .	Aberdeen Observatory.	1·52	65	„ .	Mallaranny	2·38	...
„ .	New Deer School House	1·49	68	„ .	Westport House.........	2·12	75
Moray	Gordon Castle...........	1·81	85	„ .	Delphi Lodge............	4·72	78
„ .	Grantown-on-Spey	1·03	44	*Sligo* .	Markree Castle..........	1·66	61
Nairn.	Nairn	1·19	66	*Cavan*.	Crossdoney, Kevit Cas..	1·56	...
Inv's .	Ben Alder Lodge.........	3·26	...	*Ferm* .	Crom Castle..............	1·45	52
„ .	Kingussie, The Birches.	1·27	...	*Arm* .	Armagh Obsy............	1·08	45
„ .	Loch Ness, Foyers	1·25	51	*Down*.	Fofanny Reservoir......	1·94	...
„ .	Inverness, Culduthel R.	1·25	68	„ .	Seaforde	·93	73
„ .	Loch Quoich, Loan......	4·05	...	„ .	Donaghadee, C. G. Stn.	·88	39
„ .	Glenquoich...............	...	...	*Antr* .	Belfast,Queen's Univ....	1·23	53
„ .	Arisaig House...........	2·81	81	„ .	Aldergrove Aerodrome.	·95	42
„ .	Glenleven, Corrour......	...	...	„ .	Ballymena, Harryville.	2·19	77
„ .	Fort William, Glasdrum	...	...	*Lon* .	Garvagh, Moneydig....	1·59	...
„ .	Skye, Dunvegan.........	2·69	...	„ .	Londonderry, Creggan.	2·15	82
„ .	Barra, Skallary..........	2·99	...	*Tyr* .	Omagh, Edenfel.........	2·10	81
R&C .	Alness, Ardross Castle.	1·83	70	*Don* .	Malin Head..............	2·17	...
„ .	Ullapool	1·47	58	„ .	Dunkineely...............	...	...

Climatological Table for the British Empire, December, 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy....	1019·7	+ 6·0	55	28	46·8	37·9	42·3	+ 0·9	39·8	89	6·7	1·38	− 0·91	14	1·9	24
Gibraltar	1023·9	+ 3·6	62	45	57·6	50·7	54·1	...	49·7	80	5·8	2·69	...	12	...	...
Malta....................	1021·4	+ 5·2	65	45	60·7	52·3	56·5	− 1·4	51·3	74	6·6	3·33	− 0·38	13	4·8	50
St. Helena	1012·1	− 1·2	69	55	66·3	57·6	61·9	+ 0·2	58·7	90	8·9	1·65	+ 0·32	10	...	...
Freetown, Sierra Leone	1011·5	+ 2·3	89	72	86·2	75·5	80·9	...	75·4	80	3·4	0·48	− 0·94	3	...	...
Lagos, Nigeria	1010·5	+ 0·5	90	68	86·5	75·1	80·8	− 1·0	74·2	86	6·3	2·42	+ 1·61	3	6·5	55
Kaduna, Nigeria	1012·9	...	96	46	88·4	59·1	73·7	+ 0·4	58·5	61	1·5	1·33	+ 1·33	1	8·9	78
Zomba, Nyasaland	1008·8	+ 0·3	90	52	81·9	64·0	72·9	− 0·2	67·6	75	7·1	5·85	− 5·02	13	...	...
Salisbury, Rhodesia...	1009·6	+ 0·7	88	51	81·0	58·7	69·9	+ 0·3	61·7	61	5·5	2·03	− 4·06	10	6·6	50
Cape Town	1014·0	− 0·3	103	52	76·7	59·0	67·9	0·0	59·9	62	3·4	1·19	+ 0·38	6	...	...
Johannesburg	1010·1	+ 0·4	87	47	78·7	57·0	67·9	+ 2·4	57·9	61	4·1	1·95	− 3·48	12	8·6	63
Mauritius	1012·6	− 1·4	88	67	83·7	71·6	77·6	− 0·7	73·9	74	6·4	13·84	+ 9·11	21	7·4	56
Calcutta, Alipore Obsy.	1014·5	− 1·2	83	52	79·0	59·6	69·3	+ 2·8	60·3	86	1·1	1·27	+ 1·03	1*	...	...
Bombay	1012·4	− 1·1	92	60	85·6	68·9	77·3	− 0·1	65·9	68	0·7	0·00	− 0·05	0*	...	...
Madras	1012·1	− 1·4	86	67	84·0	71·9	77·9	+ 1·2	72·9	83	6·8	1·94	− 3·41	3*	...	...
Colombo, Ceylon	1010·1	− 0·2	88	67	84·8	72·8	78·8	− 0·7	74·7	79	7·1	7·94	+ 2·82	16	6·1	52
Singapore................	1009·0	− 0·7	88	72	85·3	74·5	79·9	0·0	76·6	82	6·9	10·62	+ 0·06	20	5·2	43
Hongkong................	1018·5	− 1·2	81	53	70·5	60·7	65·6	+ 2·6	60·2	75	6·0	0·37	− 0·66	5	5·0	47
Sandakan	1008·4	...	90	73	86·7	75·2	80·9	+ 0·7	77·1	87	8·5	19·03	+ 0·39	20	...	...
Sydney, N.S.W..........	1012·8	+ 0·9	94	59	77·6	65·8	71·7	+ 1·6	66·0	69	7·2	4·83	+ 1·97	18	6·2	44
Melbourne	1012·2	− 0·5	90	47	75·5	56·9	66·2	+ 1·4	60·5	71	8·2	2·65	+ 0·38	21	4·9	33
Adelaide	1012·5	− 0·7	101	47	81·0	59·9	70·5	− 0·6	61·2	50	7·1	3·42	+ 2·42	10	6·6	46
Perth, W. Australia ...	1018·0	+ 4·8	96	56	82·6	63·9	73·3	+ 2·5	63·0	54	4·5	1·36	+ 0·80	5	10·3	72
Coolgardie	1011·0	− 0·2	105	51	88·1	62·0	75·1	− 0·6	62·4	52	3·3	1·48	+ 0·79	8	...	...
Brisbane.................	1013·0	+ 1·0	95	63	84 9	68·4	76·7	+ 0·3	68·7	58	5·8	1·80	− 3·09	8	8·5	62
Hobart, Tasmania......	1013·7	+ 4·0	86	45	66·1	53·0	59·5	− 0·7	55·1	67	8·3	4·30	+ 2·31	17	4·8	31
Wellington, N.Z.	1015·9	+ 3·7	72	42	63·8	51·0	57·4	− 2·8	54·5	72	6·3	4·43	+ 1·21	13	7·2	48
Suva, Fiji	1010·5	+ 1·9	88	67	84·5	73·7	79·1	+ 0·1	73·7	75	6·4	12·06	− 0·46	15	7·3	55
Apia, Samoa	1007·5	− 0·8	88	72	86·1	74·7	80·4	+ 1·1	76·7	79	6·3	11·38	− 2·51	21	5·9	46
Kingston, Jamaica	1013·4	− 0·6	89	65	86·1	68·6	77·3	− 0·4	67·0	86	2·2	1·12	− 0·47	9	6·3	57
Grenada, W.I.	1011·5	− 0·3	87	71	85	73	79	+ 0·8	73	74	5	6·80	− 0·40	19	...	...
Toronto..................	1021·6	+ 4·0	53	5	37·7	25·2	31·5	+ 4·4	...	...	7·5	3·37	+ 0·90	13	2·7	30
Winnipeg	1017·2	− 1·5	40	−26	17·5	1·9	9·7	+ 3·9	...	...	5·1	0·75	− 0·19	11	2·0	24
St. John, N.B.	1022·8	+ 8·8	49	3	36·7	18·9	27·8	+ 3·4	24·2	81	6·6	8·20	+ 4·03	16	2·9	33
Victoria, B.C............	1014·1	− 2·6	53	29	46·1	39·1	42·6	+ 1·5	40·1	84	8·1	8·35	+ 2·61	26	2·0	24

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

Climatological Table for the British Empire, Year 1936

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1013·7	− 1·7	85	22	56·6	44·3	50·5	+ 0·3	45·7	87	7·5	23·74	− 0·06	168	3·6	27
Gibraltar	1016·8	− 1·1	89	43	66·0	57·3	61·7	...	56·8	83	5·5	46·97	...	119	...	...
Malta	1015·2	− 0·2	96	41	69·9	60·7	65·3	− 0·8	59·7	75	4·6	17·01	− 2·85	79	8·2	67
St. Helena	1014·3	− 0·2	71	51	63·9	56·8	60·3	− 1·2	57·7	92	9·3	27·90	− 2·12	222	...	...
Freetown, Sierra Leone	1012·0	+ 2·3	95	67	85·3	73·5	79·4	...	75·2	83	6·6	144·40	− 12·83	190	...	...
Lagos, Nigeria	1011·6	+ 0·8	93	68	85·4	75·4	80·4	− 0·3	75·4	86	7·5	62·28	− 9·70	116	5·5	46
Kaduna, Nigeria	1009·9	...	101	46	89·2	65·8	77·5	+ 1·1	67·3	75	5·4	46·29	− 7·54	108	7·5	62
Zomba, Nyasaland	1012·6	+ 0·2	92	47	78·6	60·7	69·7	+ 0·3	65·1	75	6·0	52·19	− 2·35	121	...	...
Salisbury, Rhodesia	1015·2	+ 0·5	91	33	76·5	53·3	64·9	− 0·4	57·1	61	4·3	28·92	− 2·63	107	7·6	63
Cape Town	1018·0	+ 1·0	103	38	71·7	54·3	63·0	+ 0·7	55·0	76	4·3	20·17	− 4·87	95	...	...
Johannesburg	1016·1	+ 0·4	87	24	70·0	49·4	59·7	0·0	50·6	63	3·6	29·87	− 3·35	91	8·4	69
Mauritius	1016·0	− 0·1	90	52	80·9	67·7	74·3	+ 0·3	69·8	71	5·2	48·77	− 0·89	232	8·1	67
Calcutta, Alipore Obsy.	1007·4	− 0·2	107	50	88·2	71·8	80·0	+ 1·2	72·3	85	4·9	70·22	+ 5·90	99*	...	...
Bombay	1008·8	− 0·4	101	60	86·8	74·3	80·6	0·0	73·3	78	4·4	58·43	− 13·76	80*	...	...
Madras	1008·2	− 0·6	105	65	90·4	75·9	83·1	0·0	75·7	...	6·5	44·25	− 5·31	71*	...	...
Colombo, Ceylon	1010·2	+ 0·5	92	67	85·7	75·1	80·4	− 0·6	76·0	76	6·6	100·16	+ 20·03	177	6·9	57
Singapore	1009·4	− 0·1	92	71	86·0	75·7	80·8	− 0·1	77·1	81	6·9	85·51	− 9·61	211	5·7	47
Hongkong	1012·7	+ 0·2	92	43	77·2	67·9	72·6	+ 0·3	67·5	76	6·9	69·79	− 15·94	135	5·6	47
Sandakan	1009·2	...	92	72	87·7	75·1	81·4	+ 0·1	77·1	83	7·8	148·21	+ 23·42	189	...	...
Sydney, N.S.W.	1016·2	+ 0·3	100	41	71·1	55·9	63·5	+ 0·4	57·7	67	5·5	30·22	− 17·26	130	7·0	59
Melbourne	1016·1	− 0·2	106	33	67·9	49·6	58·8	+ 0·4	52·8	68	6·7	24·30	− 1·17	187	5·5	45
Adelaide	1017·4	+ 0·3	104	37	72·6	53·1	62·9	− 0·1	55·1	57	6·0	19·34	− 1·84	123	6·7	55
Perth, W. Australia	1017·0	+ 0·6	105	38	74·2	56·5	65·4	+ 1·2	56·5	60	5·1	30·64	− 3·73	118	8·0	66
Coolgardie	1015·7	− 0·2	109	30	77·8	52·9	65·4	+ 0·9	55·1	55	3·3	7·43	− 2·84	48	...	...
Brisbane	1015·9	0·0	99	40	78·1	60·1	69·1	+ 0·2	62·1	65	4·5	21·77	− 23·52	101	7·8	65
Hobart, Tasmania	1013·2	+ 0·7	92	32	61·7	46·8	54·3	− 0·1	48·2	64	6·3	19·60	− 4·19	177	5·8	48
Wellington, N.Z.	1014·5	− 0·2	79	33	59·7	48·2	54·0	− 1·4	51·1	76	6·9	56·80	+ 8·76	173	5·4	45
Suva, Fiji	1011·5	+ 0·2	94	63	83·2	72·3	77·8	+ 0·8	73·0	81	6·6	129·93	+ 12·79	236	5·9	49
Apia, Samoa	1009·6	− 0·7	89	65	85·1	74·3	79·7	+ 1·2	76·1	78	5·6	105·14	− 4·57	198	6·8	56
Kingston, Jamaica	1012·7	− 1·0	92	65	87·3	71·5	79·4	+ 0·1	70·5	83	3·6	36·34	+ 2·75	79	6·0	50
Grenada, W.I.	1011·3	− 0·9	90	70	85·4	72·8	79·1	+ 0·2	74	75	5	68·60	− 5·99	206	...	...
Toronto	1016·0	− 0·6	105	− 3	54·5	38·3	46·4	+ 1·2	...	...	6·3	24·69	− 6·60	116	5·7	47
Winnipeg	1016·4	+ 0·2	108	−43	44·3	22·9	33·6	− 1·0	...	...	4·9	15·41	− 4·77	9	5·8	47
St. John, N.B.	1014·3	− 0·3	85	−10	49·2	34·2	41·7	+ 0·5	38·1	81	6·8	47·87	− 0·21	160	4·8	39
Victoria, B.C.	1017·2	+ 0·5	82	9	55·5	44·1	49·8	+ 0·4	47·6	81	6·2	29·20	− 1·11	152	6·1	50
Addendum: St. Helena—October	1015·0	−0·3	65	52	59·7	53·8	56·7	−1·6	54·9	97	10·0	4·21	+2·90	27	...	

(*Continued from p. 123*)

about the 15th and many landslips were also reported. Part of Fairbanks, Alaska, was under water on the 16th as the Tanana and Chena Rivers were blocked by loose ice. Dense fog was experienced off Nantucket on the 28th. In the United States temperature was mainly above normal in the western and Gulf States, below normal in the Ohio Valley and Lake Region and variable in the eastern States, while rainfall was in general below normal. (*The Times*, May 17th–29th, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, May 1937

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see vol. 69, 1934, p. 1).
			Min.	Max.				
	mb.		°F.	°F	%	in.	hrs.	
1	1026·4	E.3	44	58	63	—	5·5	z 9h.
2	1020·8	NE.3	46	65	66	—	7·8	
3	1009·9	E.2	46	69	50	—	8·2	m till 9h.
4	1014·7	WSW.2	48	63	62	—	5·4	mw 7h.
5	1022·8	WNW.4	44	59	36	—	11·8	pr_0 7h.
6	1026·3	WSW.3	40	60	47	0·02	4·2	pr_0 16h., r 21h., 24h.
7	1022·4	W.3	51	66	63	0·22	5·4	r–r_0 0h.–5h.
8	1020·4	ENE.3	50	55	75	—	0·0	w early.
9	1010·9	E.3	45	52	95	0·18	0·0	r–r_0 5h.–19h.
10	1010·6	SSW.2	49	62	57	—	3·3	[15h.
11	1004·8	E.3	48	62	95	0·39	2·5	R 8h.–9h., r–r_0 11h.–
12	1006·6	NNE.3	42	58	73	0·25	0·3	pr 16h., r 18h.–24h.
13	1008·9	NW.2	48	55	81	0·07	0·1	r_0–r 0h.–5h.
14	1010·2	NE.2	43	58	68	—	0·5	Fe–f till 12h., r_0 15h.
15	1013·8	NNE.4	48	53	72	—	0·0	
16	1018·6	NNE.2	45	53	71	—	0·1	d_0 7h., w 21h.
17	1015·4	E.3	45	61	62	—	10·7	
18	1012·7	NE.4	42	56	67	trace	0·4	ir_0 16h.–24h.
19	1007·6	Calm	49	64	87	0·13	2·9	r_0–r 0h.–12h.
20	1007·4	S.2	45	66	62	0·05	6·2	r_0–r 22h.–24h.
21	1006·3	WSW.4	53	61	55	0·54	5·4	r_0–r 0h.–9h., pr_0 15h.
22	1016·5	S.4	46	58	87	0·01	0·4	pr_0–id_0 7h.–21h.
23	1020·5	S.4	55	71	62	0·04	8·0	r–r_0 23h.–24h.
24	1019·3	SW.3	55	74	63	0·01	12·7	r_0 0h.
25	1018·6	S.3	56	78	54	trace	11·8	pr_0 2h.–3h., l 22h.
26	1015·8	SE.2	59	73	60	0·22	3·9	TLR 1h.–4h., 15h.
27	1026·8	W.2	49	69	55	—	10·4	w early.
28	1026·5	S.2	49	75	49	—	13·5	w early.
29	1022·8	SW.3	56	80	50	—	10·9	
30	1019·8	W.3	56	74	62	—	7·9	w early.
31	1019·1	WSW.2	55	67	45	—	12·8	
*	1016·2	...	49	64	64	2·15	5·6	* Means or Totals.

General Rainfall for May, 1937

England and Wales ...	136	per cent of the average 1881–1915.
Scotland	78	
Ireland	80	
British Isles	107	

(37437) Wt.20/31 1,125 6/37 Hw G.377/6

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

July, 1937

No. 858

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; 26 York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff; 80 Chichester Street, Belfast; or through any bookseller.

British Wind-Direction Periodicities

By Joseph Baxendell

Previous to the Great War, investigators of meteorological periodicities devoted little or no attention to the important element wind direction, although soundly based hints that it would probably prove a not unfruitful field in that connexion had been published by my father so long ago as in the eighteen-sixties, and repeated later. The subject was doubtless neglected partly because observations of the direction of the wind are not so easily handled as air pressure and temperature means and rainfall totals, and partly in view of the harmful effects which the large proportion of calms in the wind entries seemed likely to exert on any results that might be, or ought to have been, obtainable from them. How to deal most fairly with the numerous cases of calm which long and reliable records of direction were found to contain, was a more difficult problem than commonly supposed, and was, indeed, thought to be a more serious matter than subsequent experience has shown it to be.

However, on the erection of my first recording anemoscope at Marshside, Southport, I determined to endeavour to eliminate calms at their source, by, (*a*) making the instrument as sensitive as possible, (*b*) giving it a very elevated exposure, and (*c*) adopting as the hour's direction when free movement of the vane had been virtually absent, the mean position which the pen had occupied during the hour. The Hartnups had long acted very similarly at Bidston; and the late Mr. William Ellis had striven, while he could, to greatly reduce the number of hourly entries of calm at the Royal Observatory, Greenwich.

On looking through the summarised records so obtained at Marshside since 1898, I noticed, some years ago, that if the durations of all winds from NW., N. and NE. were grouped together, the periodicity of 5·1 years which I had previously found in much (especially Lancashire) rainfall and other meteorological data, stood out with singularly isolated clearness and quite surprising amplitude. The series of nearly a century of hourly records of wind direction at the Royal Observatory was therefore examined, and notwithstanding the very numerous entries of calms that it contains in many (especially the later) years, the same or 5·1 year cycle was found to be unmistakably in evidence, practically throughout, and, in general, of substantial amplitude* ; although this periodicity does certainly seem to be distinctly more pronounced in Lancashire than at Greenwich. Subsequent examination, by Dr. C. E. P. Brooks and Miss T. Hunt,† of a laborious general collection which they had made of London wind-direction data extending over about 1½ centuries, resulted in very satisfactory confirmation of my principal conclusions. We, however, found that while the oscillation was normally a nearly north to south (very slightly east of north to west of south) one, there had been a spell, of approximately 24 years' duration, mainly in the seventies and eighties of last century, during which it was a much more nearly east to west swing, and this interval contained several 5·1 year periods of outstanding amplitude.

But much of Great Britain is affected also by three other very noteworthy wind-direction periodicities of the order of a few years, viz., (*a*) Dr. Brooks' and Miss Hunt's 3 year, chiefly an east to west one (a cycle frequently found in other meteorological data in south-eastern England, and weakly present in Lancashire, but said to vanish in Scotland) ; (*b*) Dr. Goldie's most interesting recurrence of 3·8 years in W. wind frequency in northern Britain,‡ persisting there almost continuously from as far backwards as the records he examined extend, but virtually inoperative in London ; and (*c*) a very marked cycle of 1·9 years (and therefore apparently an exact second harmonic of the nearly 3·8 year term), which I recently found in the duration of N. and NE. winds at Marshside, Southport. Some considerably longer fluctuations also exist.

On the appearance of Dr. Goldie's elaborate and stimulating paper,‡ it seemed desirable to examine the Southport wind-direction data further, and, on doing so, it quickly became evident that a periodicity of nearly 3·8 years had been in regular operation in the frequency of W., NW. and N. winds (W. ones forming the bulk of the group) ever since the War. Pronounced maxima occurred at

---

* *London, Quart. J.R. met Soc.*, 51, 1925, p.371.

† *London, Met. Mag*, 68, 1933, p.155.

‡ *London, Quart. J.R. met Soc.*, 62, 1936, p.81.

the following times (as will be readily seen from the accompanying smoothed diagram of the monthly durations of those wind currents, prepared from hourly tabulations of autographic records) :—

DATES OF MAXIMA OF $3\frac{3}{4}$ YEAR OSCILLATION OF FREQUENCY OF W., NW. AND N. WINDS, AT MARSHSIDE, SOUTHPORT

Beginning of August, 1919.	Middle of December, 1930.
Beginning of August, 1923.	Beginning of July, 1934.
Middle of January, 1927.	

Rather curiously and suggestively, the intervals have been alternately about 4 and $3\frac{1}{2}$ years.

It is very interestingly significant that the phases of this cycle at Southport are practically the reverse of those over northern Britain, a fact largely explained by the average air-pressure diagrams given in Goldie's Paper.

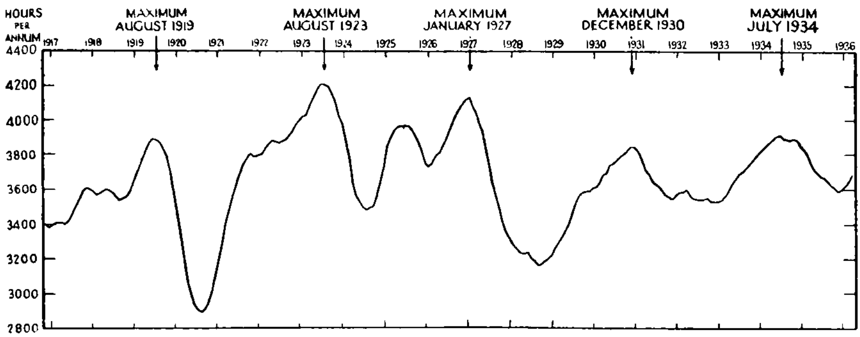


FIG. 1.—DURATION OF W., NW. AND N. WINDS AT MARSHSIDE, SOUTHPORT; SMOOTHED AS DESCRIBED ON P. 132 TO EXHIBIT THE NEARLY 3·8 YEAR CYCLE.

Previous to the War, this nearly 3·8 year fluctuation of W. wind frequency had been weak south of the Border ; it invaded northern England in a very energetic form about 20 years ago, and since then the mean amplitude of its first harmonic component at Southport, as determined by accurate analysis, shows that the full range from minimum to maximum of the sine curve (after Mr. E. G. Bilham's useful corrections for the effects of the grouping and smoothing of the data, have been applied), expressed in hours per annum, has averaged 16 per cent of the mean annual duration of the affected winds. This is not a small amount ; but, owing to the unsymmetrical shape of the observed curve, the actual range is considerably larger —quite materially so even after much smoothing.

I have now, at Dr. F. J. W. Whipple's suggestion, further examined the nearly 1·9 year periodicity in Southport's NE. and E. winds, and have found that, although the phase angle has not appreciably altered as between the earlier and later halves of the 20 periods' data available, the amplitude of this oscillation has been greatly increased ever since the War—in fact decidedly more than doubled, the full range (i.e., twice the amplitude) of the first harmonic component having, during the last 10 periods, averaged no less than

29 per cent of the mean annual duration of those winds. And this notwithstanding that the actual times of maxima and minima of this oscillation are extremely irregular (probably largely owing to " interference ").

There can be little doubt that these two periodicities are liable to be affected by somewhat abrupt forms of periodicity action-centre migration, the last of which occurred at about the time when several of the oldest and best authenticated meteorological cycles, in various countries, sustained staggering blows, of one kind ar another.

The observers of those most interesting celestial objects, the long-period variable stars, are prepared for striking unexpected dislocations ; and some of these changes, moreover, take the form of phase-reversals, of which it now remains for me to mention an interesting instance in meteorology.

I originally detected the nearly 1·9 year cycle a number of years ago, in Southport and other Lancashire rainfall statistics ; and then, on analysing the hundred years' records of that element at Bolton (where the long early series at " The Folds ", and the subsequent observations at Queen's Park, together constitute a continuous—believed fairly homogeneous—record), I found that this periodicity had been unmistakably operative there the whole time. On, however, dividing the observations into three successive " blocks ", of approximately a third of a century apiece, the first block yielded a phase angle practically opposite to those of the two later blocks (which latter were virtually identical). Looking through the data in detail, but smoothed to eliminate the annual and semi-annual terms, which are large, it quickly became apparent that approximate phase reversal occurred about the year 1867, since which there has been no appreciable change in the angle. The amplitude had been materially larger prior to the reversal than it was subsequently, until the War ; after that it was, until recently, larger than ever.

So far as I have been able to determine it, the average length of Dr. Goldie's cycle lies between 3·75 and 3·80 years. That of mine seems to be between 1·87 and 1·90 years. It is therefore possible that the two may be, respectively, a third, and a sixth, of the sunspot period. These are, roughly, east to west oscillations. The north to south swing, of 5·1 years, and its associates, do not appear to bear any relation to solar physical phenomena.

The diagram accompanying this article has been produced by taking running 12 monthly totals (of the westerly, etc., affected winds), in order to eliminate the annual and semi-annual terms, and then further smoothing by forming running means of tens of those totals, so as to diminish the disturbing effects upon the curve of the large and very irregular second-order component.

I should like to say, with emphasis, that I by no means maintain that anything approaching full justice can be done to these and other noteworthy meteorological recurrences, by mathematical analysis.

The diagram shows that the rise from minimum to maximum of the 3·8 year period generally occupies much more time that the fall from maximum to minimum, and that a " hump " occurred during the rise, in four out of the five cases shown; but it is obvious that little or no predictive value would attach to the coefficients of any computed higher harmonic than the first. And, similarly, it would be very disingenuous, and frequently quite misleading, to apply strictly mathematical tests (of the usual kind) for reality, to even the first harmonic component of such meteorological cycles. As Dr. Goldie has well expressed it, in a letter from which he kindly permits me to quote :—" These are cases where mathematical criteria of reality cannot from a physical point of view have an application, because the assumptions underlying such criteria are not likely to be justified ".

We are dealing with oscillations resembling, by their quasi-periodic character, the light changes of many of the long-period variable stars, and the course of our own sun's spot curve. In meteorological data, the smoothness of the run of the mean curve derived from many periods of a given cycle ; the repetition, in general form, of the oscillation numerous times in immediate succession ; the accordance of the phase angles obtained from the separate earlier and later halves of records of some length, or of such portions of those records as contain no phase reversals ; and the finding of virtually identically situated periodogram peaks in records of different meteorological elements, at places far apart ; lie the strongest evidences of reality. Experienced astronomers frequently feel justified by vastly less proof, in placing a comparatively recently discovered fluctuating star in their official catalogues of known, long-period variables. Nor have they any hesitation in conventionally styling as "periodic", persistent variations which are obviously, in reality, of only a quasi-periodic character, and therefore never susceptible of exact prediction.

Royal Meteorological Society

The monthly meeting of the Society was held on Wednesday, June 16th at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F.Inst.P., President, was in the Chair.

The following papers were read and discussed :—

F. Loewe, Ph.D.—A period of warm winters in western Greenland and the temperature see-saw between western Greenland and central Europe.

Particulars are given regarding the big rise in winter temperatures in Greenland and its more oceanic climate during the last fifteen years. Observations covering sixty years show a marked negative correlation of simultaneous temperatures between western Greenland and the regions around the Baltic Sea. This temperature see-saw can be explained by the simultaneous pressure anomalies over Iceland and the Norwegian Sea and the changes of the meridional pressure gradient over the northern Atlantic.

Lt.-Col. E. Gold, D.S.O., F.R.S.—Modifications of the float of the Dines anemometer to increase or decrease the range of velocity.

The range of velocity which can be recorded by the Dines anemometer can be increased by putting weights on the float. The maximum range of the Dines anemometer with a float of normal weight is 122·5 m.p.h.; this can be increased to 137 m.p.h. by weighting the float so that its maximum height will be 15·4 cm. (6 in.) above its zero level. These limitations are due to the fact that at these velocities air from the inside of the float begins to bubble through to the space in the container outside. If the float is weighted so that it does not rise at all above the zero level, air begins to bubble through at a wind speed of 178 m.p.h. If an anemometer is required which will record on a linear scale velocities higher than 122·5 m.p.h., the dimensions of the float must be changed. This change can be made by altering the shape of the interior of the float and an increase of the range up to 150 m.p.h. can be obtained in this way without increasing the height of the container. If a greater range is required it is necessary not only to alter the shape of the float, but also to increase its length. The length of the existing float is approximately 47 cm. If this length is increased to 91 cm. and the necessary change of shape is also made, velocities up to 200 m.p.h. can be recorded. The exact numerical dimensions of the float for these cases and for cases of a more open scale also have been calculated.

C. J. Boyden, B.A.—A method of predicting night minimum temperatures.

A simple general relationship, which appears to be applicable in any climate, is found connecting monthly mean values of maximum and minimum dry-bulb temperatures with mean wet-bulb temperatures. The formula is extended for predicting individual minimum temperatures on nights when there is no appreciable change of air mass between the times of maximum and minimum temperature, allowance being made for wind speed, cloudiness and fog formation.

J. S. Farquharson, M.A.—Haboobs and instability in the Sudan.

The dust storms of the Sudan, called " haboobs," are shown to be associated with thunder squalls. Several haboobs are discussed, with particular reference to upper winds and upper air temperatures. Conditions associated with instability in the Sudan are indicated, a unique series of upper air temperatures being of value in this connexion. A series of photographs taken with the co-operation of the R.A.F. illustrates the conditions in some of the haboobs.

The Council of the Royal Meteorological Society has awarded the Howard Prize for 1937 to Cadet Ralph Wills of H.M.S. *Conway*

School Ship. The subject of the competition was an essay on "The meteorology of the voyages of discovery to America and to South Africa."

Correspondence

To the Editor, *Meteorological Magazine*

Optical Phenomena observed in Pembrokeshire

Mr. William Phelps, Rock Cottage, Amroth, Pembrokeshire, has sent details of optical phenomena he observed at 9.45 a.m. B.S.T. on June 24th. The phenomenon consisted of the halo of 22°, parhelic circle, and brightly prismatic parhelia at the intersections. The halo was coloured. In the south-east the parhelic circle was invisible owing to low cloud. Mr. Phelps states also that inside the parhelic circle and the halo were faint indications of another circle, also coloured. I cannot explain this last observation.

S. E. ASHMORE.

11, Percy Road, Wrexham, Denbighshire, North Wales, July, 4th, 1937.

[A similar phenomenon is described in the article on "The Halo phenomena of May and June, 1935," published in the *Meteorological Magazine* for July, 1935, p. 133. Ed. *M.M.*]

Solar Haloes in May

With reference to Mr. J. Edmund Clark's letter, and the appended note of observations by Mr. G. A. Clarke, which appeared in the June number of the *Meteorological Magazine,* I find that a number of solar haloes were seen here during the last fortnight of May this year. During these two weeks haloes were noted on the 20th, 23rd, 27th, 28th, 29th, and 30th. On the 30th a 22° halo appears to have persisted throughout the day, otherwise they do not seem to have been in any way remarkable.

It is interesting to note that the period of their occurrence falls during one of the months found by C. Visser on statistical analysis to show a maximum frequency for halo phenomena in Holland, namely April and May.

C. STUART BAILEY.

Longbridge, 76, Woodcote Valley Road, Purley, Surrey, June 30th 1937.

Searchlight Rainbow at Aldershot

As I was leaving Rushmore Arena, Aldershot about 0015 on June 6th, 1937, at the conclusion of the Aldershot Tattoo, I witnessed what I believe to be a very remarkable phenomenon.

Continuous moderate rain was falling at the time and to enable the audience to clear the arena powerful searchlights, situated from 50 to 100 ft. above the ground, were concentrated upon the exits. These searchlights were some 300 yards immediately behind me and reflected a brilliant artificial rainbow, apparently 100 ft. in diameter and approximately 150 ft. ahead, the ends disappearing abruptly into masses of spectators. Rain could be distinctly seen falling through the arc giving it a glimmering sheen, and as the searchlight moved, which it occasionally did, backwards and forwards, up and down, it gave a very curious effect especially when another searchlight with its attendant rainbow crossed or intermingled with it.

G. F. HILLMAN.

Meteorological Station, South Farnborough, Hampshire, June 22nd, 1937.

Midsummer Frosts

In the September, 1934, issue of this magazine it was reported that the latest " spring " frost registered in the screen since the establishment of the Rickmansworth climatological station in 1929 had been on June 10th, 1932, and the earliest " autumn " frost on August 26th, 1934. There had thus been an interval of 76 days during which the air temperature did not once fall to the freezing point. It may be of interest to mention that the length of this frost-free period has now been reduced to 56 days by the occurrence of a minimum of 31·0° F. in the screen at 4h. G.M.T. on June 30th, 1937. As there were readings of 33·9° F. on July 19th, 1932, 32·8° F. on July 27th, 1936, and 32·2° F. on July 31st, 1935, it appears probable that the notably " continental " climate of the enclosed valley in which the Rickmansworth meteorological station is situated is capable of producing an occasional frost even at the height of summer.

E. L. HAWKE.

Ivinglea, Dagnall, Bucks., July 6th, 1937.

Snow on the Grampians

On June 9th, 1937, a considerable snowbank was found on the Grampian Hills near Montrose. The situation was at 1,500 ft. above sea level in an entrenched gully, some 80 ft. below the general level of the hillside, on the southward-facing slope above Water of Tarf, Glen Esk. The aspect of the snowbank was south-east, well shielded by the wall of the gully from the late afternoon and evening sun. The drift was about 25 yards long by 15 yards up-slope; and the depth varied from 1 to 4 ft. at the most sheltered end. The snow was melting slowly at the base and along the upper edges; but the drift was firm in texture and consisted of rather big grains. Steps were kicked in the surface which held well for climbing.

There is little snow left on the hills in spite of the heavy falls of March. Some other small patches were seen in the same gully and in other sheltered spots; but the summits have been clear of snow for more than a month, and the open northern faces of the hills are also bare of snow.

H. H. LAMB.

Meteorological Station, Montrose, Forfar, June 12th, 1937.

Intense Gloom at Rotherham

The weather of the past month has shown no unusual features with the exception of the unusual period of intense gloom which afflicted this district for a number of hours on the 24th. The present writer has no recollection of any similar visitation outside the winter months.

The forenoon was overcast with slight mist but about 14h. G.M.T., the sky began to darken and at 14h. 30m. artificial light was necessary and had to be used until 20h. when the gloom dispersed and a ground mist developed.

With the exception of a very slight shower at 15h. 30m. and a further shower from 18h. 45m. to 19h. 20m., no rain fell. These two showers gave a total of only 0·02 in. Wind was calm to variable in the forenoon and early afternoon, but by 17h. a NNE. breeze of force 2 sprang up.

The colour of the light which reached the surface was of a reddish-brown tint which rather indicated that the light had been filtered through a dense mass of overhead fog and that only light of long wave length was capable of penetrating the cloud layer.

Information which reached me later showed that in the centre of the town, the darkness between 16h. and 17h. was almost complete, an affliction which we, in this district two miles out of the town, were fortunately spared.

LESLIE ATKINSON.

187, Broom Lane, Rotherham, July 1st, 1937.

Resident Observer Wanted

In the *Meteorological Magazine* for 1922, p. 66, you recorded the circumstances in which the Royal Meteorological Society took over the lease of 62, Camden Square, as a gift from the Trustees of the British Rainfall Organization, on condition that the Society undertook the maintenance of the meteorological observations. These observations were begun by Mr. G. J. Symons in 1858 and form a remarkably homogeneous and accurate series. They are, moreover, of special value because they represent very fairly the conditions existing in a closely built-up area in London.

In order to provide as far as possible for the maintenance of the station in perpetuity the Society has recently purchased the freehold of the property and the Council has given much thought to the arrangements for taking the observations. The house will shortly become vacant and it is the Council's desire to find, if possible, a new tenant interested in meteorology who would undertake the rôle of "resident observer". The Council hopes, therefore, that you will be good enough to bring this matter to the notice of readers of the *Meteorological Magazine*. I shall be pleased to furnish full details in response to a communication addressed to the Society at 49, Cromwell Road, London, S.W.7.

E. L. HAWKE,
Hon. Secretary.

Royal Meteorological Society, 49 Cromwell Road, London, S.W.7, June 23rd, 1937.

NOTES AND QUERIES

Thunderstorm at the Aerological Station, Vacoas, Mauritius

From February 10th to 24th, 1937, owing to the presence of low pressure centres to the south, Mauritius experienced a spell of hot, humid weather with very light northerly winds. For this period the mean temperature was 80·6° F., the mean relative humidity 82 per cent and the mean wind velocity 3·9 m.p.h., with comparatively small variations from these mean values.

This unpleasant type of weather was terminated on the 25th through the extension north-eastwards of an anticyclone centred to the south-west. With the arrival of this "cold" front cooler easterly winds began to establish themselves during the morning of the 25th and there resulted a violent thunderstorm of short duration which was directly overhead at the Vacoas aerological station from about 12h. 0m. to 12h. 30m. (local standard time).

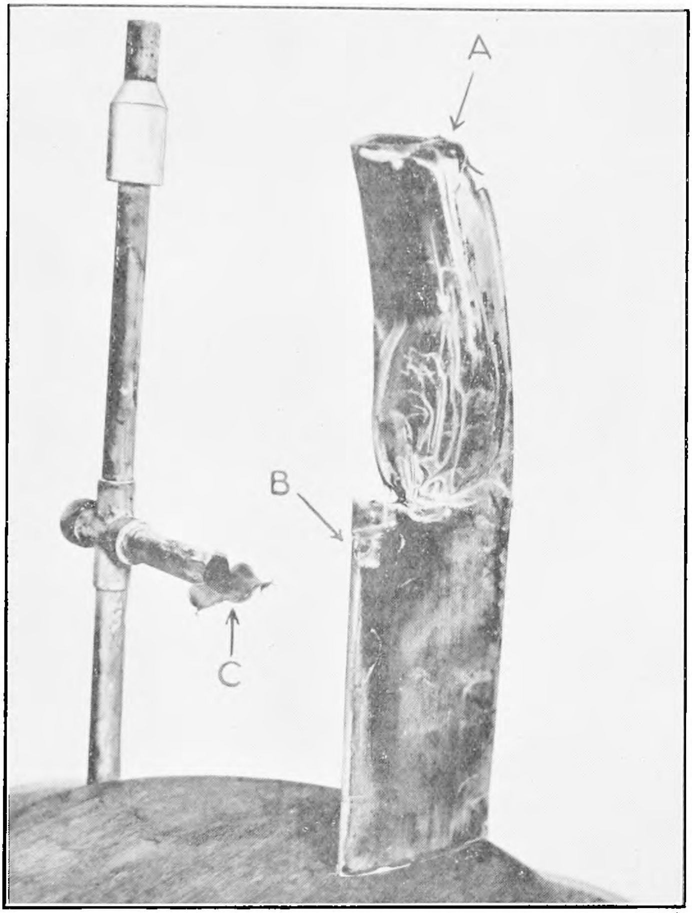
During this time four lightning flashes struck at or near the station damaging telephonic and lighting circuits. One hit an electric light pole near the entrance. In the office the lighting wires fused and the shades and lamps that they were carrying fell to the floor and shattered. Next, the overhead telephone wires were hit, fusing 18 inches of S.W.G. copper wire and leaving marks on the outside office wall that indicated sparking of at least 1 foot. A fuse-box lid blew off and hit a workman who was sheltering nearby. A third flash struck and tore off the vane of a Dines anemometer. The vane, at a height of 100 ft., is the highest point in the immediate vicinity. The vane was badly damaged as shewn by the photograph on the opposite page.

The rainfall during the storm was torrential, 76 mm. being recorded in 90 minutes, with a maximum rate of fall of 42 mm. in 23 minutes. The rainfall chart shews that this intense fall was perfectly recorded by the Casella natural-syphon gauge. Two funnels are used with this gauge, one of 8 in. diameter for ordinary records and one of $5\frac{1}{16}$ in. diameter during heavy falls, but on this occasion the smaller funnel had not been substituted.

N. R. MCCURDY.
M. HERCHENRODER.

Thunderstorms of June 10th, 1937

Severe thunderstorms were experienced in many parts of south-east England on the evening of June 10th. The following accounts bring out special features of interest in connexion with these storms.



DINES ANEMOMETER VANE STRUCK BY LIGHTNING, MAURITIUS, FEBRUARY 25TH, 1937

A. Highest point of vane where lightning struck.
B. Hole made of about ½in. length.
C. Path taken by lightning through the head, as indicated by a number of pitted marks, and thence down the mast to earth.

Mr. C. J. P. Cave of Stoner Hill, Petersfield, writes that " The thunderstorm of June 10th was not particularly severe here, the rainfall amounting to only 0·24 in., but it was very remarkable for the extraordinary darkness and for the great rapidity with which it came on. An interesting point at a late stage in the storm was the length of time the thunder lasted. I timed a number of peals ; few lasted less than one minute, several lasted 80 seconds, one 95 seconds, and two 100 seconds. This would imply a length of some 20 miles for the longer flashes, which were of course from cloud to cloud. The great length of the flashes was seen later on when the storm had passed away so far that no thunder could be heard ; occasional flashes were seen above the horizon to the north and north-west ; one of these subtended an angle of about 90° along the horizon. Since the thunder was quite inaudible the very nearest point of the lightning must have been at least 12 miles away giving a minimum length of some 24 miles for the flash."

Mr. D. Schove of St. David's College, South Eden Park Road, Beckenham, Kent, writes that " A peculiar form of lightning was observed in the storm of June 10th, 1937, in which what was apparently some secondary effect travelled—relatively slowly—from the ' stem ' to the ' branches ' of the main flash. It thus appeared as if the lightning itself was moving or rather uncoiling, so that we were tempted to christen it the ' Uncoiling Rope ' flash.

This flash was observed four times directly over Langley Park, West Wickham, Kent, about 9 p.m. (Summer Time), and the wave in at least three cases moved from a northerly to a southerly point. As far as I know this is the only record of such a flash*, and while the cause seems obscure, it may prove significant to mention the other peculiarities of that particular storm.

At 8·15 p.m. an unusually regular and well marked cloud front stretched from north-west to south-east, and stratus clouds approaching the storm from the east were sucked under, and rolled in rapidly-whirling masses of mummified cloud, suggesting tornado formation. Neither the rain nor the thunder was remarkable, but the lightning showed an unusual ' ability for bending ' and ' looped ' and ' crossed ' flashes appeared again and again."

Mr. B. Mannoch of Kuchbewani, 19 Hythe Road, Worthing, writes that " At about 18h. 35m. G.M.T. on June 10th, while I was watching the rather active thunderstorm which passed over Worthing that evening, I noticed a discharge almost directly overhead, which gave a peculiar sound about eight seconds later. Instead of the usual noise, there was a distinct note of a frequency about 100c/sec., which lasted for perhaps ½ sec. while being interrupted by intervals of reduced intensity. The only plausible explanation that has occurred to me is that a resonance between two layers of air at different

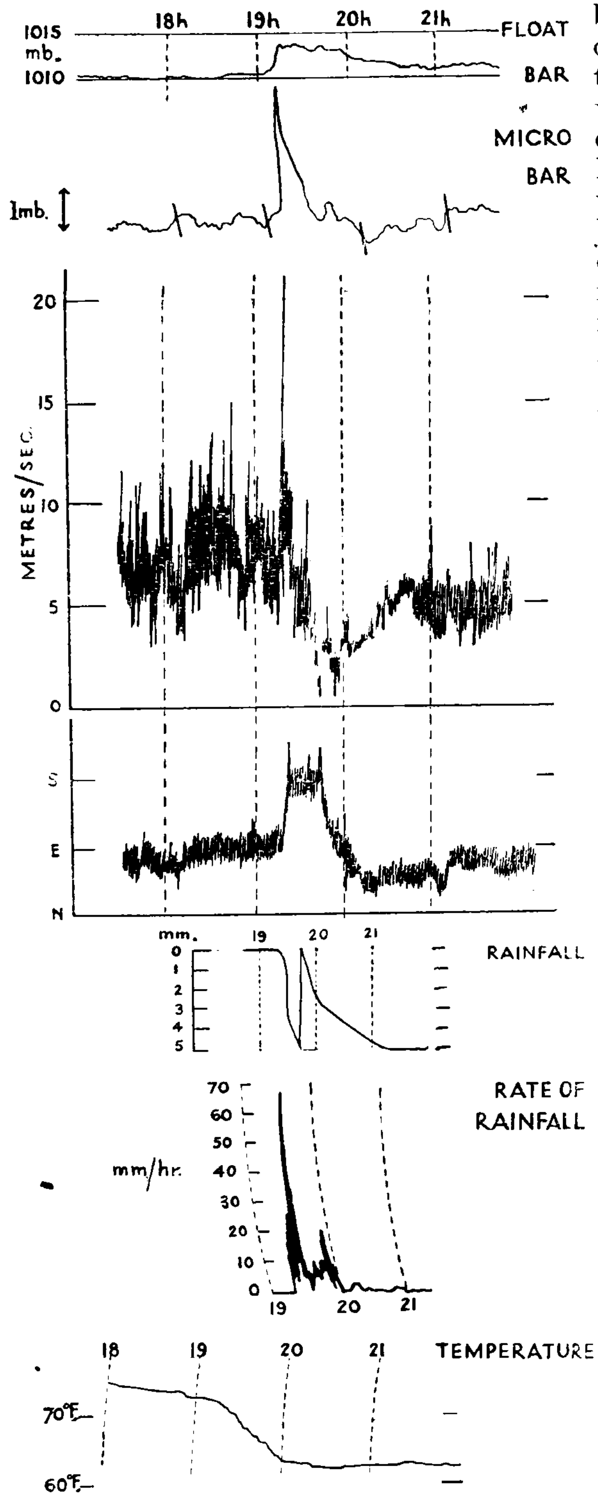
* This form of lightning is described from personal observation by Sir George Simpson under the heading " Rocket Lightning " in the Thirty-second Robert Boyle Lecture, Oxford, 1930, pp. 10–1. Ed *M.M.*

temperatures may have been set up by internal reflection, and this seems possible in view of the fact that, so far as I could judge, the note was free from harmonics. This seems to me to be a very curious and unusual phenomenon."

Mr. A. E. Moon of 39, Clive Avenue, Clive Vale, Hastings, writes that "On June 10th an unusually severe thunder squall occurred here. Conditions at 18h. (G.M.T.) were cloudy and warm with a moderate NNE. wind...........The first thunder was heard to the south at 18h. 32m. at a considerable distance. By 18h. 42m. lightning was seen and the distance then was about 7 miles. By this time the clouds to the south were intensely black. The vanguard cloud passed overhead at 18h. 45m. accompanied by a sudden squall of wind from the south-south-west and it was sufficiently dark to make it difficult to read out of doors. The upper winds were from 155° at 5,000 ft. approx. at 18h. and from 170° at 1,500–2,000 ft. at 18h. 45m. After the passage of the front of the squall cloud lightning and thunder occurred at frequent intervals. Rain of large drops began at 18h. 33m. but this ceased for a short time. Rain began again suddenly and heavily at 18h. 46m. becoming torrential by 18h. 52m. followed a minute later by large hailstones. At 18h. 55m. the rain was driven along like smoke before a SE. wind which almost reached gale force in gusts and visibility at this time was reduced to 200 yards...... All lightning flashes were decidedly pink in colour and were in majority cloud to cloud discharges. It was particularly noted that on numerous occasions 2 or 3 distinct flashes followed the same path in rapid succession. Rainfall amounted to 0·77 in. from 18h. 33m. to 19h. 30m. There was evidence of minor damage, such as fallen trees. A 'tidal wave' is reported to have occurred at Hastings at 18h. 45m."

Mr. Webb, the resident observer at Kew Observatory, writes that "An occlusion crossed the observatory between 19h. and 20h. G.M.T. on June 10th and was accompanied by a fairly severe thunderstorm lasting from 19h. 15m. to 21h. 30m. Weather during the afternoon had been partly cloudy with dry air, a steady falling barometric pressure and a maximum temp. of 77° F. at 16h. 20m. Traces of altocumulus castellatus were observed during the afternoon.

Soon after 19h. the sky became very dark and turbulence was apparent with the development of some very well-defined mammato cumuli at 3,000–4,000 ft. to the south of the observatory. At 19h. 10m. these clouds were moving almost due north while the surface wind was as yet E. At 19h. 20m. the wind record shows a pronounced line squall with a maximum gust of 21·4 m./sec. (48 m.p.h.) and a sudden veer in direction from E. to S'E. (see diagram opposite). The pressure rose sharply from 1010 mb to 1013 mb, a rise of 3 mb in as many minutes. The wind velocity fell away to 2 m./sec. at 19h. 45m. Lightning and thunder were first observed at 19h. 15m., 2 miles to the south-south-east, the storm being apparently centred in the south-east and moving northwards. Temperature fell fairly rapidly from 72° F. at 19h. 10m. to 63° F. at 20h. At 19h. 45m. the wind



backed from S'E. to E. once again and then to NE. at 20h. 10m., velocity 5m./sec. The cloud was now a higher uniform sheet with fractonimbus below and the storm covered a very wide front in the east moving westwards. Heavy rain fell from 19h. 20m. to 20h. and moderate rain 20h. to 21h. Almost all the lightning was from cloud to cloud and some flashes spanned great distances, one at 19h. 59m. started in the north-west, passed within 1 mile to the east of the observatory and continued to the south-east. Another noteworthy flash occurred at 20h. 17m. one mile to the north of the observatory and appeared to hang in the air for an appreciable time and then split into a line of beads as it died away. Lightning occurred mainly in the east and north and eventually passed to the north-west, the last flash being observed in the north-west at 21h. 30m. Altogether 10mm. of rain were recorded, the maximum rate being 67 mm./hr. at 19h. 30m."

A Useful Atlas for Meteorologists

The new " University Atlas," edited by George Philip and H. C. Darby, and published by George Philip and Son, Ltd. at the price of half a guinea, gives unusual prominence to climatic characteristics. The introduction is followed by seven pages of graphs showing for each month the mean daily maximum and minimum temperature, and the average pressure and rainfall, while inset figures give the height of the station in feet, the mean annual range of temperature and the annual rainfall. Each sheet is headed by a map showing the positions of the stations—a very useful feature. This section includes data for no fewer than 206 stations, 30 of which are in the British Isles. The sources of the data and periods covered by the averages are not given but it is stated that many of them refer to an interval of 35 years. The world maps, which are a modification of the " Mollweide Interrupted Homolographic " projection, include temperature (January, July, Year and annual range), isobars and winds (January, July), rainfall (Winter, Summer, Year, rainfall regimes), cloudiness, climatic regions and sea surface temperature, while the orographical map of each continent (and of the British Isles) is accompanied by a set of more detailed climatic maps. The printing and colouring of all the maps reaches a high standard of excellence.

C. E. P. Brooks.

The Wettest Place in the British Isles

Hugh Walpole, in " A Prayer for my Son," published recently, writes :—" For now on the rocky and uncertain path to Seathwaite, Rockshaw drove them at snail's pace. They tumbled into the wettest place in Great Britain . . . .". It is time that Seathwaite, in Borrowdale, should no longer be referred to as the wettest place. Actually there are several small areas very nearly twice as wet. This common error has apparently been perpetuated because meteorological literature has supplied no precise statement to replace it. Salter, in his " Rainfall of the British Isles," gives a map which shows that the average rainfall exceeds 150 in. in Snowdonia, the English Lake District, on Ben Nevis, and over a small area at the head of the River Garry, in the western Highlands of Scotland. These are definitely the four wettest areas in the British Isles. Mill, in the preface to the Rainfall Atlas, refers to an area near Llyn Llydaw on Snowdon as " one of the wettest spots in the British Isles, where the average probably exceeds 200 inches ".

This lack of precision in meteorological literature has been due mainly to the absence of direct observations at spots most likely to be the wettest, viz., the summits of the highest mountains in these four areas. From a consideration of the records now available and a study of the general relation of the average rainfall to the configuration of the land, estimates can be made of the maximum rainfall in each of these four localities.

Snowdonia provides the most detailed series of observations. The rain-gauges were set up on the eastern flank of Snowdon by Mr. Gethin Jones for the North Wales Power Co. The steady increase in the rainfall from Cwm Dyli westwards to the summit is shown in the table below :—

	Altitude.	*Average annual rainfall.*
	ft.	in.
Cwm Dyli	310	112
Wenallt	1,050	141
Delta	1,435	154
Llyn Llydaw	1,450	171
Copper Mine	1,480	180
Glaslyn	2,500	198

The summit of Snowdon (3,560 ft.) is only about 500 yds. to the south-west of Glaslyn and the record at Glaslyn probably gives very nearly the maximum rainfall on Snowdon. It is concluded therefore that the average annual rainfall over a small area near the summit of Snowdon reaches a maximum of 200 in.

From Seathwaite to Scafell Pikes (3,210 ft.) and Sca Fell (3,160 ft.) we have the following records :—

	Altitude.	*Average annual rainfall.*
	ft.	in.
Seathwaite	423	129
Stockley Bridge	585	138
Stye Head	1,100	150
Styehead Tarn	1,472	153
Sprinkling Tarn	1,985	159

The average rainfall probably exceeds 150 in. over an area including Sca Fell, Scafell Pikes and Great End and extending eastwards to Bow Fell and Allen Crags. In view of the isolated position of Sca Fell and Scafell Pikes the maximum rainfall is considered to be no more than 185 in.

Although Ben Nevis is loftier than Snowdon (attaining an altitude of 4,406 ft.) it is more isolated and therefore offers less obstruction to the SW. winds which may slide round without being forced to ascend. All the rainfall records show that Ben Nevis is not as wet as Snowdon at similar distances from the summits. The computed average for the record, maintained at Ben Nevis Observatory, is 165 in., which, although greater than that at Seathwaite Farm, is appreciably less than that recorded in the other three localities.

It is of interest to recall that the Rev. R. P. Dansey in an article in this magazine for March, 1905, suggested that a corrie just below the summit of Ben Nevis and at the head of Allt-a-Inhuilinn might well prove to be the wettest spot in the British Isles. Actually, however, this contention was based on his knowledge that snow was swept off the summit and accumulated in such corries, to form a more or less permanent snowbed. In this note, however, we are dealing with precipitation, without being concerned with what happens to it subsequently.

The rainfall increases steadily westwards up the River Garry from Invergarry on Loch Oich towards the main mountain ridge where an altitude of 3,140 ft. is attained on Sgurr na Ciche. The only records at the head of the valley are at Glenquoich, Kinlochquoich and Loan at altitudes of 569, 580 and 650 ft. respectively. Loan and Kinlochquoich with 163 and 125 in., are at distances from the main summit of 2½ and 4½ miles, while at corresponding distances from Snowdon the values are 146 and 130 in. It is inferred from these records and the general distribution of the average rainfall in relation to the configuration of the land that the rainfall on Sgurr na Ciche, at the head of the River Garry, is comparable with that on Snowdon, reaching over a small area a maximum of 200 in. a year.

It is clear therefore that appreciable areas in Snowdonia, the English Lakes, on Ben Nevis and at the head of the River Garry in Inverness-shire are wetter than Seathwaite (with 129 in.). The average rainfall probably reaches 200 in. over small areas near the summit of Snowdon and on Sgurr na Ciche at the head of the River Garry, and these two areas rank as the wettest in the British Isles. Seathwaite Farm does not even rank as the wettest habitation, for Pen-y-Gwrhyd Hotel (to the east of Snowdon) and Kinlochquoich Lodge (at the head of the River Garry) are equally wet, while Ben Nevis Observatory, which was occupied for a few years, is much wetter.

J. GLASSPOOLE.

REVIEW

Introduction à l'étude dynamique du climat. By George Canellopoulos, Athens, 1936.

The term "dynamical climatology" was proposed in 1930 by Bergeron* for the study of collective processes, suitable examples for these latitudes being quasi-stationary weather types. This principle forms a logical extension of the ideas of masses and fronts to the catalogues of isobaric types, of which several have been drawn up for the use of the forecaster, and promises to give some addition to precision in forecasting when more regional studies are available. So far, only a few studies on these lines have been published, and the present work is designed to examine the possibility of making a dynamical study of the climate of Greece.

* Richtlinien einer dynamischen Klimatologie. *Met. Z. Braunschweig,* 47, 1930, pp. 246–62.

Since there are no available data of upper-air temperature in Greece, it is necessary to choose a control station where disturbing effects such as orography and radiation are too small to prevent the ordinary observations of temperature from being representative. The station chosen is the small island of Lemnos, and an examination is made of the temperature data for the winter periods of the years 1927–34.

Five types of air mass are distinguished, the two principal being :—

(i) H—masses of air reaching the Ægean Sea from north, when pressure is high over the Balkans and low to south,

(ii) M—Mediterranean masses travelling to north or north-east. The properties of each type are discussed and tables are given showing the mean temperature associated with each. Further studies are proposed in which other seasons and other districts of Greece will be considered. This work forms a useful addition to the literature of the dynamical study of climate.

S. T. A. MIRRLEES.

BOOKS RECEIVED

Las "temperaturas sentidas" en la Península Ibérica.—By Dr Walter Knoche. Publicaciones de la Sociedad Geográfica Nacional, Series B, No. 75, Madrid 1936.

NEWS IN BRIEF

Mrs. J. H. Field of Hoath, Lonesome Lane, Reigate, Surrey, has for sale several volumes of meteorological publications formerly belonging to Mr. J. H. Field, whose death is referred to in the June, 1937, number of this magazine. The books include the *Meteorological Magazine*, March, 1866, to date; *British Rainfall* complete; the *Quarterly Journal of the Royal Meteorological Society* bound, 1906–19, unbound, 1920–2, April to October 1923, 1926, January 1927, 1928–9, 1931–6; "Manual of Meteorology" by Sir Napier Shaw, Vols. 2 and 4; "Scientific papers of Lord Rayleigh" 4 vols.; "Climatic atlas of India" and "The Earth" by H. Jeffreys. Any readers interested should write direct to Mrs. Field.

We learn that Prof. Wladimir Köppen, the eminent Graz meteorologist, has been awarded the shield of nobility by the German Chancellor.

A Leverhulme Research Fellowship has been awarded to Mr. G. Seligman, Chairman of the British Group of the International Commission of Snow whose subject will be "To examine the transition of firn snow into glacier ice"; and a Leverhulme Research Grant has been awarded to Mr. G. Manley, M.A., B.Sc., Senior lecturer in Geography at Durham University, whose subject will be "A study of the Helm wind of the northern Pennines."

The Weather of June, 1937

For the first time the broadcast climatic data for June include stations in India, Australia, New Zealand and the western Pacific. The chart for mean pressure shows an anticyclone exceeding 1020 mb. over the Azores extending as far as Valentia in Ireland, pressure decreasing northwards to 1005 mb. at Spitsbergen, and slowly eastwards across Europe to below 1010 mb. in Siberia. South-eastwards the decrease was more rapid to a minimum below 995 mb. in north-west India, rising again to 1005 mb. over Burma. Another anticyclone (above 1015 mb.) extended from Hawaii to the Pacific coast of North America with a small outlier south of the Great Lakes; a depression (below 1010 mb.) occupied Alaska. An intense anticyclone, above 1025 mb., lay south of Tasmania, the isobar of 1015 mb. including nearly the whole of Australia and New Zealand. Pressure was 5 mb. above normal west of Ireland and in central Russia, 10 mb. above normal over Tasmania, and more than 5 mb. below normal over most of the Arctic, including Alaska, Spitsbergen and Jan Mayen and the Taimyr Peninsula.

Mean temperature was still below freezing point on the Taimyr Peninsula and Fridtjof Nansen Land and only 33° F. in Resolution Island, Baffin Bay. In America temperature increased rapidly southwards to 60° from the interior of Alaska to the Great Lakes and the south of Nova Scotia, 70° in latitude 40° N., and 80° in latitude 34° N., but the Pacific coast was below 60° as far south as Victoria, B.C. In the British Isles temperatures rose from 50° at Lerwick to 61° at Kew; most of Europe was between 60° and 70°, the latter figure being exceeded from the Riviera to Greece. Most of Siberia south of 60° N., was above 60° F. In the Nile Valley temperatures varied from 80° at Cairo to 93° at Khartoum and Kareima, decreasing again southwards. Shaibah in Iraq gave a mean of 96° F. In India temperatures were everywhere above 80° and exceeded 90° in the north and north-west. In the southern hemisphere temperatures were 80° F. in New Guinea and the Solomon Islands and 79° at Darwin and Samoa; most of Australia was between 50° and 60°; Tasmania and most of New Zealand were between 40° and 50°. Temperature was more than 5° F. above normal over northern Canada, 2–5° above over most of Europe and more than 5° above normal near the White Sea, but elsewhere deviations were generally small.

Rainfall was 1–2 in. over the British Isles, 2–4 in. over most of Europe, 1—2 in. over Siberia and more than 3 in. over most of the United States, reaching 9 inches at New Orleans. Some heavy totals were reported from India, nearly 20 in. at Bombay and Calcutta and 30 in. at Port Blair. In Australia there was no rain in the north and less than an inch over most of the south, Perth being an exception with 9 in. Totals in New Zealand varied but were mostly 3–4 in.

Rainfall was generally somewhat below normal in Europe and the British Isles (except parts of Scotland). In America the coastal regions were above normal, the interior generally below. India was generally near the normal except at Port Blair, 5 in. above. In Australia and New Zealand the rainfall was generally deficient except at Perth.

The outstanding features of the weather of June over the British Isles were the warm sunny spell during the first part of the month in south and east England, the frequency of thundery conditions in England, the deficiency of sun in parts of Ireland and the number of gales in the extreme north of Scotland. Rainfall was for the most part below average. During the 1st and 2nd quiet cool anticyclonic weather prevailed mainly, with considerable sunshine, 12·7 hrs. at Ventnor on the 1st and at Eastbourne on the 2nd—ground frosts occurred at several inland places but in the Shetland Isles north-westerly gales were experienced on both days. By the evening of the 2nd the ridge of high pressure had passed eastwards to the North Sea and from then to the 8th pressure was low to the north and west. Rain fell frequently except in the south and east until the 6th, 4·43 in. at Festiniog (Merioneth) in the 48 hours ending 9h. on the 4th, and 1·32 in. at Hawkshead (Lancashire) on the 3rd, but after this date there were showers and much sunshine. Thick fog was experienced at times from the 4th to 6th along the south-west coasts and at Eskdalemuir and on the 5th in north Scotland. In the south-east this was a warm sunny period ; the 5th and 6th were the sunniest days with 15 hrs. bright sunshine at many places, while temperature rose generally over 70° F. and on the 6th exceeded 80° F. in parts of London. The 8th was a cooler day in the south with some rain ; in north and central Ireland thunderstorms were experienced. On the 9th a ridge of high pressure developed across England moving northwards and for 3 days temperature rose again, exceeding 80° F. on the 11th at many places in the south and reaching 85° F. at Greenwich and Camden Square and 82° F. at Tunbridge Wells. Severe thunderstorms were widespread in England on the nights of the 10th* and 11th. Meanwhile the weather was cool in the north and west with south-westerly gales in north Scotland on the 10th. Some mist or fog developed locally at times but sunshine records were good over the whole country, 16·1 hrs. at Inchkeith on the 10th. On the 12th pressure was high over the Shetlands but a depression off our south-west coasts brought rain in that neighbourhood on that day. Heavy rain was also experienced in eastern and northern England on the 13th and 14th owing to a shallow depression which was developing over the North Sea, 2·47 in. at Driffield (Yorkshire) on the 14th and 1·56 in. at Troutbeck (Cumberland) on the 13th. Thunderstorms were experienced in the Midlands and northern England on the 13th. From the 15th to 20th the depression to the east moved slowly southward and cool northerly

* See p. 138.

winds and unsettled weather prevailed but with considerable sunshine especially in the west. Thunderstorms were experienced in south Scotland and north England on the 16th and in England on the 17th to 20th. Ground frost occurred locally inland in the north on the 18th and 21st. After some fog in the early morning the 21st was a brilliantly sunny day 10 to 15 hrs. being recorded generally except in parts of the Irish Free State where there was slight local rain. After this another depression over Denmark moved away north-westwards while the anticyclone over the Atlantic gradually extended across the British Isles. Rain occurred generally on the 22nd with thunderstorms in the south but from then to the 26th the weather was fair to cloudy with occasional slight local mist or drizzle, though the depression centred to the north caused gales in north Scotland on the 25th and 26th. From the 27th to 30th the depressions to the north moved on a more southerly course bringing unsettled weather with rain at times mainly in the west and north but long periods of sunshine. Gales were again felt locally in Scotland on the 27th to 29th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	154	−13	Chester ...	162	−33
Aberdeen ...	187	+6	Ross-on-Wye ...	184	−23
Dublin	113	−69	Falmouth ...	209	−18
Birr Castle ...	104	−56	Gorleston ...	230	+21
Valentia... ...	165	−8	Kew	208	+5

Kew, Temperature, Mean 60·7° F., Diff. from normal + 0·8° F.

Miscellaneous notes on weather abroad culled from various sources.

A heat wave was experienced in Austria and Poland early in the month and extended later to Germany. By the 11th serious fires had broken out in several villages in Poland, and at Berlin on the 11th temperature rose to 97° F. a record there for June since at least 1830. On the 12th temperature fell generally. A violent storm swept Bordeaux about 8 p.m. on the 9th causing considerable damage to property. Lourtier, Canton Valais, in which 65 houses and barns were badly damaged by a flow of mud, was evacuated about the 17th owing to a threatened landslip. In consequence of the melting of the snows the level of the Swiss lakes rose considerably about the middle of the month and Lower Zug and Lucerne overflowed their banks at several points. In Carinthia a period of heavy rain succeeded the great heat of the early part of the month. A severe hailstorm lasting about ¼ hour did much damage in Venice on the night of the 20th. (*The Times*, June 11th–22nd.).

Rain showers, the prelude to the monsoon occurred in Bombay and Poona on the 12th. Severe storms were experienced near Akyab about the 18th. (*The Times*, June 14th–19th).

Drought prevailed in southern Saskatchewan about the middle of the month. Dense fog occurred off the coast of New Jersey on the 3rd and off north Newfoundland on the 26th. In the United States, temperature was above normal along the western and eastern coasts, the Ohio Valley and Lake Region during the first half of the month becoming cooler later while in the Mississippi–Missouri Valley and Mountain Region temperature was low early in the month, becoming much above normal during the week ending the 22nd. The rainfall distribution was irregular (*The Times*, June 5th–28th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, June 1937

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	1018·1	NNW.4	49	62	52	—	8·3	w early.
2	1022·0	NNW.2	47	63	51	—	7·2	
3	1018·8	WSW.3	46	65	55	—	8·2	r_0 19h.–20h.
4	1017·8	SW.3	56	72	62	—	4·0	w evening.
5	1018·3	WSW.3	55	74	56	—	9·8	
6	1016·0	S.4	51	79	47	—	14·3	w early.
7	1014·2	SW.3	59	77	59	—	12·4	
8	1017·9	SSW.3	52	67	78	0·06	6·7	r_0–r 11h.–14h.
9	1016·1	S.2	47	71	50	0·02	7·0	r_0–r 15h.–18h.
10	1012·9	NE.4	54	77	54	0·41	6·7	TLR 19h.–22h.
11	1014·5	WSW.2	59	81	60	—	11·4	l 22h.
12	1019·7	WSW.3	62	77	61	trace	8·4	pr_0 1h.–2h.
13	1020·3	SSE.3	59	70	82	0·52	4·4	rR 7h.–11h.
14	1024·8	W.2	54	71	64	—	5·0	
15	1026·2	NE.3	57	64	72	0·02	3·4	pr_0 during day.
16	1025·2	WNW.3	51	63	61	0·01	1·2	pr 17h., r_0 19h.–22h.
17	1021·9	NNW.4	49	61	67	—	4·1	pr_0 13h.
18	1017·6	NW.3	49	63	48	0·41	6·2	r 20h., TLR 21h.–22h.
19	1013·8	NE.2	48	61	55	0·02	5·3	r–r_0 0h.–5h.
20	1015·7	N.2	50	63	69	0·19	3·3	r 1h.–7h., TLR 17h.
21	1020·0	W.2	47	68	52	—	11·4	w early.
22	1015·6	WNW.3	53	72	43	0·13	10·7	r_0 18h.–24h.
23	1015·8	NNW.2	53	67	49	—	11·0	r_0 0h.–1h.
24	1015·5	NE.3	54	66	53	—	5·0	
25	1019·9	SW.2	49	69	56	—	4·3	d_0 7h.
26	1020·6	NNW.2	52	68	64	—	2·4	
27	1017·9	NNW.2	57	72	56	—	7·6	
28	1011·0	SW.3	53	74	53	—	8·3	pr_0 21h.
29	1011·3	NNW.3	55	62	61	0·01	7·8	pr 12h., 14h., 17h.
30	1017·6	SW.4	47	64	63	—	2·7	pr_0 12h., 17h.
*	1017·9	...	53	69	58	1·81	6·9	* Means or Totals.

General Rainfall for June, 1937

England and Wales ...	71	per cent of the average 1881–1915
Scotland	103	
Ireland	78	
British Isles	81	

Rainfall : June, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	1·49	74	*War* .	Birminghm, Edgbaston	·82	35
Sur .	Reigate, Wray Pk. Rd..	1·95	94	*Leics* .	Thornton Reservoir ...	·62	29
Kent .	Tenterden, Ashenden...	1·84	97	,, .	Belvoir Castle...........	·56	29
,, .	Folkestone, Boro. San.	1·71	...	*Rut* .	Ridlington	1·12	58
,, .	Margate, Cliftonville....	1·83	104	*Lincs* .	Boston, Skirbeck.........	1·92	105
,, .	Eden'bdg., Falconhurst	2·57	117	,, .	Cranwell Aerodrome...	1·19	71
Sus .	Compton, Compton Ho.	1·01	41	,, .	Skegness, Marine Gdns.	1·58	88
,, .	Patching Farm..........	·96	48	,, .	Louth, Westgate.........	1·26	58
,, .	Eastbourne, Wil. Sq....	1·35	73	,, .	Brigg, Wrawby St.......	1·57	...
Hants.	Ventnor, Roy.Nat.Hos.	·85	46	*Notts* .	Worksop, Hodsock......	1·33	67
,, .	Fordingbridge, Oaklnds	·81	43	*Derby*.	Derby, The Arboretum	·89	38
,, .	Ovington Rectory.......	1·74	75	,, .	Buxton, Terrace Slopes	1·74	54
,, .	Sherborne St. John......	1·62	76	*Ches* .	Bidston Obsy.............	1·81	82
Herts .	Royston,Therfield Rec.	2·89	129	*Lancs*.	Manchester, Whit. Pk.	1·19	45
Bucks.	Slough, Upton............	1·99	97	,, .	Stonyhurst College......	3·74	122
,, .	H. Wycombe, Flackwell	1·49	74	,, .	Southport, Bedford Pk.	1·87	86
Oxf .	Oxford, Radcliffe.........	1·56	70	,, .	Ulverston, Poaka Beck	3·04	94
N'hant	Wellingboro, Swanspool	1·44	69	,, .	Lancaster, Greg Obsy.	2·68	105
,, .	Oundle	1·23	...	,, .	Blackpool	2·25	103
Beds .	Woburn, Exptl. Farm...	1·49	76	*Yorks*.	Wath-upon-Dearne......	1·55	70
Cam .	Cambridge, Bot. Gdns.	1·52	72	,, .	Wakefield,Clarence Pk.	1·39	65
,, .	March......................	1·34	68	,, .	Oughtershaw Hall.......	3·20	...
Essex .	Chelmsford,County Gdns	2·31	120	,, .	Wetherby, Ribston H..	...	...
,, .	Lexden Hill House......	2·25	...	,, .	Hull, Pearson Park......	1·32	64
Suff .	Haughley House.........	·96	...	,, .	Holme-on-Spalding......	1·62	74
,, .	Rendlesham Hall........	1·32	70	,, .	West Witton, Ivy Ho.	1·33	65
,, .	Lowestoft Sec. School...	·66	36	,, .	Felixkirk, Mt. St. John.	1·45	66
,, .	Bury St. Ed., WestleyH.	1·79	85	,, .	York, Museum Gdns....	1·74	84
Norf. .	Wells, Holkham Hall...	1·34	68	,, .	Pickering, Hungate......	1·01	48
Wilts .	Porton, W.D. Exp'l. Stn	1·49	77	,, .	Scarborough..............	1·22	66
,, .	Bishops Cannings........	1·50	62	,, .	Middlesbrough...........	1·69	90
Dor .	Weymouth, Westham.	·57	32	,, .	Baldersdale, Hury Res.	1·35	57
,, .	Beaminster, East St....	1·36	60	*Durh* .	Ushaw College...........	1·47	68
,, .	Shaftesbury,Abbey Ho.	·76	33	*Nor* .	Newcastle, Leazes Pk...	2·85	135
Devon.	Plymouth, The Hoe....	1·33	62	,, .	Bellingham, Highgreen	1·11	48
,, .	Holne, Church Pk. Cott.	1·78	62	,, .	Lilburn Tower Gdns....	1·49	72
,, .	Teignmouth, Den Gdns.	·93	48	*Cumb*.	Carlisle, Scaleby Hall...	1·71	68
,, .	Cullompton	·75	35	,, .	Borrowdale, Seathwaite	8·75	143
,, .	Sidmouth, U.D.C........	·70	...	,, .	Thirlmere, Dale Head H.	3·63	88
,, .	Barnstaple, N. Dev.Ath	1·03	58	,, .	Keswick, High Hill......	2·12	73
,, .	Dartm'r,Cranmere Pool	2·40	...	*West* .	Appleby, Castle Bank...	1·30	57
,, .	Okehampton, Uplands.	1·30	47	*Mon* .	Abergavenny, Larchf'd	1·27	52
Corn .	Redruth, Trewirgie......	2·09	84	*Glam* .	Ystalyfera, Wern Ho....	4·02	107
,, .	Penzance, Morrab Gdns.	1·21	55	,, .	Treherbert, Tynywaun.	3·87	...
,, .	St. Austell, Trevarna...	1·77	68	,, .	Cardiff, Penylan..........	1·10	44
Soms .	Chewton Mendip.........	1·66	56	*Carm* .	Carmarthen,M. & P. Sch.	2·43	82
,, .	Long Ashton............	1·41	56	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	·86	43
,, .	Street, Millfield..........	·74	...	*Card* .	Aberystwyth	1·88	...
Glos .	Blockley	2·08	...	*Rad* .	Birm W.W.Tyrmynydd	1·59	49
,, .	Cirencester, Gwynfa....	1·30	54	*Mont*	Lake Vyrnwy	...	...
Here .	Ross-on-Wye............	1·06	49	*Flint* .	Sealand Aerodrome......	1·22	...
Salop.	Church Stretton.........	1·48	61	*Mer* .	Blaenau Festiniog	6·84	114
,, .	Shifnal, Hatton Grange	·88	39	,, .	Dolgelley, Bontddu......	3·26	92
,, .	Cheswardine Hall........	·94	38	*Carn* .	Llandudno	1·09	57
Worc .	Malvern, Free Library...	1·22	92	,, .	Snowdon, L. Llydaw 9..	11·25	...
,, .	Ombersley, Holt Lock.	·92	41	*Ang* .	Holyhead, Salt Island...	2·35	109
War .	Alcester, Ragley Hall...	·79	35	,, .	Lligwy	2·74	...

Rainfall : June, 1937 : Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem....	3·04	126	*R&C* .	Achnashellach	4·10	103
Guern.	St.Peter P't.Grange Rd.	·62	33	,, .	Stornoway,C.GuardStn.	3·43	...
Wig .	Pt. William, Monreith.	2·93	125	*Suth* .	Lairg........................	2·27	109
,, .	New Luce School.........	3·33	115	,, .	Tongue	...	...
Kirk .	Dalry, Glendarroch......	3·00	108	,, .	Melvich.....................	2·96	153
Dumf.	Dumfries, Crichton R.I.	2·56	107	,, .	Loch More, Achfary....	4·50	122
,, .	Eskdalemuir Obs........	3·94	125	*Caith* .	Wick	2·77	154
Roxb .	Hawick, Wolfelee........	1·24	53	*Ork* .	Deerness	2·70	147
Peeb .	Stobo Castle.............	1·49	64	*Shet* .	Lerwick	4·29	241
Berw .	Marchmont House......	1·45	63	*Cork* .	Dunmanway Rectory...	1·57	45
E.Lot .	North Berwick Res.....	1·70	102	,, .	Cork, University Coll...	...	...
Midl .	Edinburgh, Blackfd. H.	1·00	50	,, .	Mallow, Longueville....	·96	44
Lan .	Auchtyfardle	2·05	...	*Kerry*.	Valentia Observatory...	2·00	63
Ayr .	Kilmarnock, Kay Park	3·25	...	,, .	Gearhameen..............	3·00	60
,, .	Girvan, Pinmore.........	3·16	109	,, .	Bally McElligott Rec...	1·06	...
,, .	Glen Afton, Ayr San....	3·00	100	,, .	Darrynane Abbey.......	1·06	34
Renf .	Glasgow, Queen's Park	2·17	94	*Wat* .	Waterford, Gortmore...	1·65	63
,, .	Greenock, Prospect H..	2·96	90	*Tip* .	Nenagh, Castle Lough.	1·44	59
Bute .	Rothesay, Ardencraig...	4·53	148	,, .	Roscrea, Timoney Park	2·19	...
,, .	Dougarie Lodge..........	3·38	124	,, .	Cashel, Ballinamona....	1·04	46
Arg .	Loch Sunart, G'dale....	4·10	127	*Lim* .	Foynes, Coolnanes......	...	...
,, .	Ardgour House..........	7·94	...	*Clare* .	Inagh, Mount Callan....	2·74	...
,, .	Glen Etive................	8·67	184	*Wexf* .	Gorey, Courtown Ho...	1·44	59
,, .	Oban........................	4·12	...	*Wick* .	Rathnew, Clonmannon.	1·11	...
,, .	Poltalloch..................	4·80	157	*Carl* .	Bagnalstown,Fenagh H.	1·58	64
,, .	Inveraray Castle.........	7·01	177	,, .	Hacketstown Rectory...	...	...
,, .	Islay, Eallabus............	3·72	142	*Leix* .	Blandsfort House.......	2·20	85
,, .	Mull, Benmore............	15·20	193	*Offaly*.	Birr Castle................	2·05	89
,, .	Tiree	2·49	98	*Kild* .	Straffan House..........	1·60	70
Kinr .	Loch Leven Sluice.......	2·42	111	*Dublin*	Dublin, Phoenix Park..	1·31	66
Fife .	Leuchars Aerodrome...	1·93	116	*Meath.*	Kells, Headfort..........	1·95	73
Perth .	Loch Dhu..................	4·60	110	*W.M* .	Moate, Coolatore........	...	...
,, .	Crieff, Strathearn Hyd.	2·00	76	,, .	Mullingar, Belvedere...	2·57	99
,, .	Blair Castle Gardens....	1·41	71	*Long* .	Castle Forbes Gdns......	1·89	73
Angus.	Kettins School...........	1·49	72	*Gal* .	Galway, Grammar Sch.	2·09	82
,, .	Pearsie House...........	1·75	...	,, .	Ballynahinch Castle....	3·30	93
,, .	Montrose, Sunnyside...	1·95	118	,, .	Ahascragh, Clonbrock.	1·97	70
Aber .	Balmoral Castle Gdns..	·73	43	*Rosc* .	Strokestown, C'node.....	...	...
,, .	Logie Coldstone Sch....	1·07	55	*Mayo*.	Blacksod Point..........	2·79	100
,, .	Aberdeen Observatory.	1·26	74	,, .	Mallaranny	4·92	...
,, .	New Deer School House	1·72	86	,, .	Westport House.........	1·82	67
Moray	Gordon Castle...........	2·26	111	,, .	Delphi Lodge............	6·72	117
,, .	Grantown-on-Spey	...	...	*Sligo* .	Markree Castle..........	1·83	62
Nairn.	Nairn	1·83	104	*Cavan.*	Crossdoney, Kevit Cas..	1·87	...
Inv's .	Ben Alder Lodge.........	2·38	...	*Ferm* .	Crom Castle..............	2·23	82
,, .	Kingussie, The Birches.	1·32	...	*Arm* .	Armagh Obsy............	2·15	85
,, .	Loch Ness, Foyers	1·31	59	*Down*.	Fofanny Reservoir......	2·59	...
,, .	Inverness, Culduthel R.	1·52	80	,, .	Seaforde	2·54	92
,, .	Loch Quoich, Loan......	10·41	...	,, .	Donaghadee, C. G. Stn.	2·44	105
,, .	Glenquoich................	...	...	*Antr* .	Belfast,Queen's Univ....	...	...
,, .	Arisaig House...........	4·25	130	,, .	Aldergrove Aerodrome.	2·99	124
,, .	Glenleven, Corrour......	...	...	,, .	Ballymena, Harryville.	2·80	96
,, .	Fort William, Glasdrum	4·92	...	*Lon* .	Garvagh, Moneydig....	2·20	...
,, .	Skye, Dunvegan.........	3·79	...	,, .	Londonderry, Creggan.	2·51	86
,, .	Barra, Skallary..........	2·00	...	*Tyr* .	Omagh, Edenfel.........	2·83	100
R&C .	Alness, Ardross Castle.	1·09	48	*Don* .	Malin Head..............	2·06	...
,, .	Ullapool	1·77	75	,, .	Dunkineely................	2·21	...

Climatological Table for the British Empire, January, 1937

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1009·4	− 8·2	54	29	46·9	37·9	42·4	+ 2·0	39·6	90	7·7	3·76	+ 2·00	21	1·5	18
Gibraltar	1021·1	− 0·4	62	45	58·5	51·0	54·7	− 0·2	51·3	82	6·6	5·43	...	11	...	...
Malta	1020·8	+ 3·8	68	43	59·2	51·0	55·1	− 0·2	50·0	75	5·7	2·02	− 1·19	8	5·6	56
St. Helena	1011·0	− 1·3	74	58	68·8	60·3	64·5	+ 1·1	61·0	93	9·7	0·57	− 1·47	9	...	...
Freetown, Sierra Leone	1010·3	+ 1·2	91	70	87·4	74·8	81·1	...	74·0	78	2·2	0·00	− 0·41	0	...	...
Lagos, Nigeria	1009·9	+ 0·3	91	68	87·4	73·1	80·3	− 0·6	71·9	85	4·6	0·00	− 1·04	0	6·0	51
Kaduna, Nigeria	1013·7	...	94	50	87·1	56·7	71·9	− 1·5	51·2	40	0·9	0·00	0·00	0	8·8	77
Zomba, Nyasaland	1007·0	− 0·6	84	54	80·7	64·8	72·7	− 0·1	69·7	82	8·0	18·02	+ 6·92	23	...	...
Salisbury, Rhodesia	1008·4	− 0·8	87	55	80·7	60·1	70·4	+ 0·7	63·0	67	7·3	4·72	...	16	6·9	53
Cape Town	1013·1	− 0·3	90	56	79·4	62·7	71·1	+ 1·2	62·6	65	2·1	1·15	+ 0·47	5	...	...
Johannesburg	1009·5	− 0·3	86	50	75·7	56·6	66·1	− 0·6	59·4	76	5·3	8·45	+ 2·28	18	6·5	48
Mauritius	1009·7	− 2·2	88	67	83·8	72·9	78·3	− 1·0	74·8	78	6·6	10·12	+ 2·36	22	8·2	62
Calcutta, Alipore Obsy.	1015·0	− 0·2	83	49	77·1	53·5	65·3	− 1·3	53·8	82	1·3	0·00	− 0·42	0*	...	...
Bombay	1012·7	− 0·9	89	61	82·6	64·8	73·7	− 1·8	62·8	70	2·1	0·00	− 0·10	0*	...	...
Madras	1013·2	− 0·9	85	64	83·9	68·6	76·3	+ 0·1	69·9	78	6·0	0·07	− 1·07	0*	...	...
Colombo, Ceylon	1010·7	− 0·1	89	69	85·5	73·0	79·3	− 0·2	73·5	75	5·4	3·43	+ 0·18	14	7·7	65
Singapore	1009·3	− 1·1	89	70	86·0	74·2	80·1	+ 0·4	75·7	81	7·2	8·16	− 1·73	14	5·9	49
Hongkong	1018·1	− 1·6	76	49	66·3	58·0	62·1	+ 1·9	57·3	76	7·0	2·77	+ 1·45	5	4·5	41
Sandakan	1008·9	...	90	72	85·8	74·8	80·3	+ 0·5	76·8	88	8·9	19·58	+ 0·18	22	...	...
Sydney, N.S.W.	1008·4	− 4·0	98	61	79·9	66·6	73·3	+ 1·7	66·3	63	6·6	2·12	− 1·55	13	8·2	58
Melbourne	1009·6	− 3·3	99	49	75·1	54·6	64·9	− 2·5	57·2	58	7·5	2·54	+ 0·65	11	6·3	44
Adelaide	1011·5	− 1·5	102	50	80·5	58·9	69·7	− 4·0	59·6	48	6·4	2·42	+ 1·70	10	7·7	55
Perth, W. Australia	1011·2	− 1·3	98	51	84·0	63·6	73·8	0·0	62·6	51	2·2	0·02	− 0·32	1	11·4	82
Coolgardie	1009·5	− 1·9	110	52	88·9	63·3	76·1	− 1·3	62·2	52	3·2	1·04	+ 0·58	3	...	...
Brisbane	1009·3	− 2·0	96	64	87·5	70·3	78·9	+ 1·7	70·8	59	4·8	1·57	− 4·88	5	9·7	71
Hobart, Tasmania	1005·3	− 5·0	82	44	67·6	51·5	59·5	− 2·5	53·0	59	6·9	3·38	+ 1·55	16	7·0	47
Wellington, N.Z.	1006·2	− 7·1	73	45	65·8	53·5	59·7	− 2·8	56·2	73	6·5	3·18	− 0·15	12	7·5	51
Suva, Fiji	1007·1	− 0·4	94	72	88·9	76·6	82·7	+ 2·8	77·5	78	6·4	8·78	− 2·65	22	7·0	53
Apia, Samoa	1007·3	− 0·6	90	71	86·1	75·2	80·7	+ 1·7	77·3	79	6·3	15·20	− 1·85	27	7·1	56
Kingston, Jamaica	1014·1	− 1·0	89	65	86·4	68·5	77·5	+ 0·7	66·2	85	3·0	1·13	+ 0·17	6	...	...
Grenada, W.I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toronto	1022·3	+ 4·4	53	11	37·4	24·9	31·1	+ 8·9	...	...	7·9	5·18	+ 2·39	15	2·5	27
Winnipeg	1022·7	+ 1·8	15	−37	−3·7	−22·2	−12·9	− 6·0	...	...	4·6	1·02	+ 0·01	18	3·0	35
St. John, N.B.	1023·1	+ 7·6	47	− 3	34·4	17·1	25·7	+ 6·5	22·0	74	6·9	4·09	− 0·71	11	3·6	39
Victoria, B.C.	1018·4	+ 2·4	45	19	34·7	27·6	31·1	− 7·9	28·4	73	6·7	2·32	− 2·22	16	2·7	31

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

[illegible]

(37874) Wt. 20/31 1125 7/37 Hw. G. 377/6

Climatological Table for the British Empire, January, 1937

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1009·4	− 8·2	54	29	46·9	37·9	42·4	+ 2·0	39·6	90	7·7	3·76	+ 2·00	21	1·5	18
Gibraltar	1021·1	− 0·4	62	45	58·5	51·0	54·7	− 0·2	51·3	82	6·6	5·43	...	11	...	...
Malta	1020·8	+ 3·8	68	43	59·2	51·0	55·1	− 0·2	50·0	75	5·7	2·02	− 1·19	8	5·6	56
St. Helena	1011·0	− 1·3	74	58	68·8	60·3	64·5	+ 1·1	61·0	93	9·7	0·57	− 1·47	9	...	...
Freetown, Sierra Leone	1010·3	+ 1·2	91	70	87·4	74·8	81·1	...	74·0	78	2·2	0·00	− 0·41	0	...	...
Lagos, Nigeria	1009·9	+ 0·3	91	68	87·4	73·1	80·3	− 0·6	71·9	85	4·6	0·00	− 1·04	0	6·0	51
Kaduna, Nigeria	1013·7	...	94	50	87·1	56·7	71·9	− 1·5	51·2	40	0·9	0·00	0·00	0	8·8	77
Zomba, Nyasaland	1007·0	− 0·6	84	54	80·7	64·8	72·7	− 0·1	69·7	82	8·0	18·02	+ 6·92	23	...	...
Salisbury, Rhodesia	1008·4	− 0·8	87	55	80·7	60·1	70·4	+ 0·7	63·0	67	7·3	4·72	...	16	6·9	53
Cape Town	1013·1	− 0·3	90	56	79·4	62·7	71·1	+ 1·2	62·6	65	2·1	1·15	+ 0·47	5	...	...
Johannesburg	1009·5	− 0·3	86	50	75·7	56·6	66·1	− 0·6	59·4	76	5·3	8·45	+ 2·28	18	6·5	48
Mauritius	1009·7	− 2·2	88	67	83·8	72·9	78·3	− 1·0	74·8	78	6·6	10·12	+ 2·36	22	8·2	62
Calcutta, Alipore Obsy.	1015·0	− 0·2	83	49	77·1	53·5	65·3	− 1·3	53·8	82	1·3	0·00	− 0·42	0*	...	...
Bombay	1012·7	− 0·9	89	61	82·6	64·8	73·7	− 1·8	62·8	70	2·1	0·00	− 0·10	0*	...	...
Madras	1013·2	− 0·9	85	64	83·9	68·6	76·3	+ 0·1	69·9	78	6·0	0·07	− 1·07	0*	...	...
Colombo, Ceylon	1010·7	− 0·1	89	69	85·5	73·0	79·3	− 0·2	73·5	75	5·4	3·43	+ 0·18	14	7·7	65
Singapore	1009·3	− 1·1	89	70	86·0	74·2	80·1	+ 0·4	75·7	81	7·2	8·16	− 1·73	14	5·9	49
Hongkong	1018·1	− 1·6	76	49	66·3	58·0	62·1	+ 1·9	57·3	76	7·0	2·77	+ 1·45	5	4·5	41
Sandakan	1008·9	...	90	72	85·8	74·8	80·3	+ 0·5	76·8	88	8·9	19·58	+ 0·18	22	...	...
Sydney, N.S.W.	1008·4	− 4·0	98	61	79·9	66·6	73·3	+ 1·7	66·3	63	6·6	2·12	− 1·55	13	8·2	58
Melbourne	1009·6	− 3·3	99	49	75·1	54·6	64·9	− 2·5	57·2	58	7·5	2·54	+ 0·65	11	6·3	44
Adelaide	1011·5	− 1·5	102	50	80·5	58·9	69·7	− 4·0	59·6	48	6·4	2·42	+ 1·70	10	7·7	55
Perth, W. Australia	1011·2	− 1·3	98	51	84·0	63·6	73·8	0·0	62·6	51	2·2	0·02	− 0·32	1	11·4	82
Coolgardie	1009·5	− 1·9	110	52	88·9	63·3	76·1	− 1·3	62·2	52	3·2	1·04	+ 0·58	3	...	...
Brisbane	1009·3	− 2·0	96	64	87·5	70·3	78·9	+ 1·7	70·8	59	4·8	1·57	− 4·88	5	9·7	71
Hobart, Tasmania	1005·3	− 5·0	82	44	67·6	51·5	59·5	− 2·5	53·0	59	6·9	3·38	+ 1·55	16	7·0	47
Wellington, N.Z.	1006·2	− 7·1	73	45	65·8	53·5	59·7	− 2·8	56·2	73	6·5	3·18	− 0·15	12	7·5	51
Suva, Fiji	1007·1	− 0·4	94	72	88·9	76·6	82·7	+ 2·8	77·5	78	6·4	8·78	− 2·65	22	7·0	53
Apia, Samoa	1007·3	− 0·6	90	71	86·1	75·2	80·7	+ 1·7	77·3	79	6·3	15·20	− 1·85	27	7·1	56
Kingston, Jamaica	1014·1	− 1·0	89	65	86·4	68·5	77·5	+ 0·7	66·2	85	3·0	1·13	+ 0·17	6	...	...
Grenada, W.I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toronto	1022·3	+ 4·4	53	11	37·4	24·9	31·1	+ 8·9	...	...	7·9	5·18	+ 2·39	15	2·5	27
Winnipeg	1022·7	+ 1·8	15	−37	−3·7	−22·2	−12·9	− 6·0	...	...	4·6	1·02	+ 0·01	18	3·0	35
St. John, N.B.	1023·1	+ 7·6	47	− 3	34·4	17·1	25·7	+ 6·5	22·0	74	6·9	4·09	− 0·71	11	3·6	39
Victoria, B.C.	1018·4	+ 2·4	45	19	34·7	27·6	31·1	− 7·9	28·4	73	6·7	2·32	− 2·22	16	2·7	31

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

Errata. Salisbury—There was a change of site on July 1st, 1936. For period July—December and Year, pressure differences from normal should be corrected by −1·9 and rainfall differences should be deleted.

(37874) Wt. 20/31 1125 7/37 Hw. G. 377/6

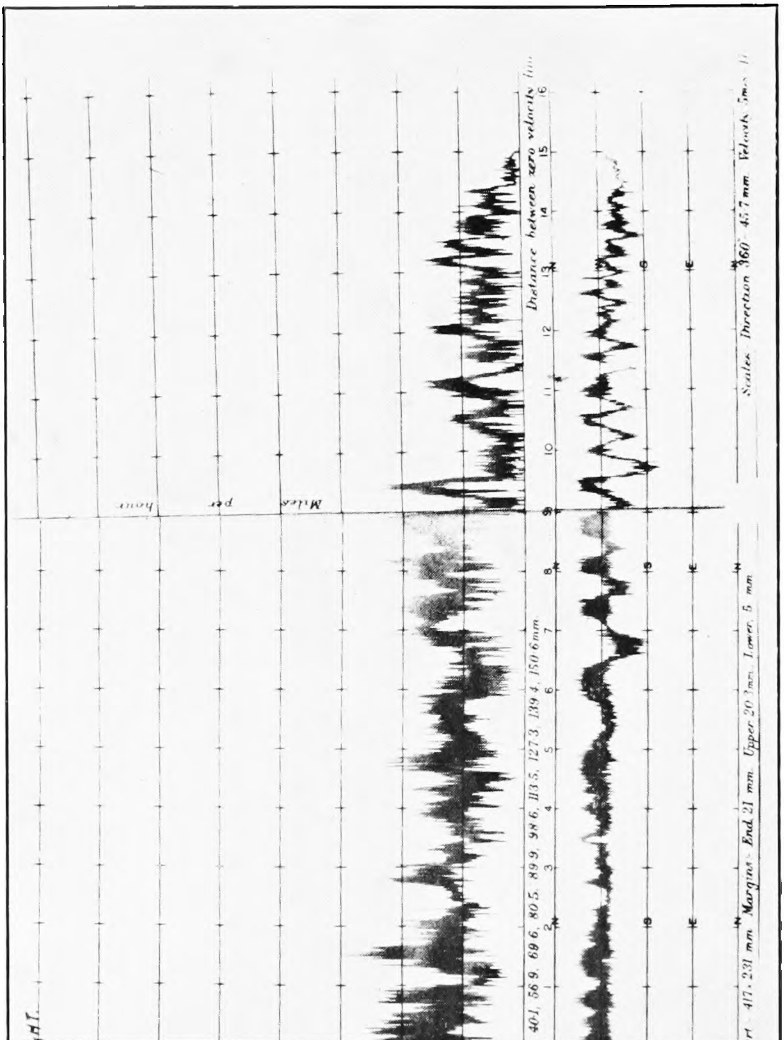


FIG. 1.—ANEMOGRAM, ABBOTSINCH, NOVEMBER 16TH, 1936 (see p. 157)

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

August, 1937

No. 859

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

The Unequal Heating of Land and Water

Dr. E. Kidson, Director of the Meteorological Service of New Zealand, in a letter to the *Meteorological Magazine* quotes the common assumption that the greater heating effect of solar radiation on land surfaces than on the sea is caused mainly by the smaller specific heat of the soil, and asks for a discussion of this point. The problem might be discussed on the basis of either the diurnal or annual variation of temperature. The general principles are more or less the same in each case, but the annual variation is complicated by the transport of heat in ocean currents, seasonal variations in rainfall and cloudiness, etc., and it seems best to confine the discussion to the diurnal variation.

From various sources the mean daily range of the sea surface is estimated as about 0·7° F. The mean daily range of the land surfaces of the globe is much more difficult to estimate, as direct measurements are rare, but a rough figure can be obtained indirectly. From some figures for 131 well distributed stations between latitudes 40° N. and 40° S., I estimated the average difference between mean daily maximum and mean daily minimum over land areas as 19° F., the figures being:—small islands 11° F., coast 14° F., inland 22° F. No systematic observations of the daily range of temperature at the surface of the ground are available for a variety of places, but from various scattered data it appears to average between two and three times the daily range of screen temperature on open ground in clear weather. In cloudy weather and also under trees the ground temperature probably differs little from the screen temperature. We can assume a mean of 30° F. as a conservative estimate between 40° N. and 40° S. The daily range at the surface of the ground is thus of the order of forty or fifty times as great as that at the surface of the sea.

The surface of the ground and the uppermost layers of the sea gain heat during the day mainly by absorbing radiation from the sun and sky, and lose heat at night mainly by radiation outwards to the sky. Let us consider first the absorption of radiation during the day. The processes involved are quite different for land and water surfaces. The thermal conductivity of sea water is very small, and the amount of heat which passes downwards by molecular conduction is negligible. On the other hand water transmits solar radiation fairly well, and the short-wave radiation reaching a water surface from above penetrates and warms the upper layers. Only a small fraction of the radiation reaches a depth of 25 metres however, and the greater part of the warming effect is confined to the upper third of this depth. The uppermost layers of the water are also affected by vertical circulation caused by convection, eddies and breaking waves, which tends to equalise the temperature. At times this equalisation may extend to a depth of 20 or 30 metres, but at other times a thin surface layer of highly warmed water may be formed. As a rough approximation we may assume that the radiation received by the ocean is uniformly distributed through a layer 10 metres deep.

The ground is opaque and immobile, and the whole of the radiation is absorbed at the surface, where the temperature rises rapidly. Heat can only penetrate below the surface by conduction, with perhaps a small effect by percolation of rain-water or circulation of air. The thermal conductivity of soil or rock is low, and the diurnal range of temperature decreases very rapidly with depth. Hourly observations of earth temperature are rare, but some figures obtained by L. Herr* at Leipzig show that the range decreases to less than a tenth of the surface value at a depth of only 35 cm. If alongside a patch of undisturbed soil we placed a thermally insulated pan of soil which could be kept at a uniform temperature throughout by constant stirring, the depth of the pan could be only 10 cm. or less if its temperature were to be always the same as that of the undisturbed surface. The actual thickness of the layer in this hypothetical pan would vary greatly according to the nature of the ground. Loose dry soil or sand containing a great deal of air is almost a non-conductor, and the heat penetrates only a very short distance ; a surface of this nature warms or cools very rapidly. A temperature of 172° F. has been recorded at the surface of dry

*Bodentemperaturen unter besonderer Berücksichtigung der äusseren meteorologischen Faktoren. Berlin, 1936.

dune sand in the Sahara. Solid rock is a better conductor and heat penetrates into it to a greater depth than into sand, hence it warms more slowly and retains its heat for a longer period, but even in such material the process of conduction is slow and the daily variation of temperature is small below about 10 cm. Thus the solar heat, which in the oceans is spread through a layer some 10 metres thick, is confined on the land to a layer of only about one hundredth of that thickness.

At night the surfaces of both sea and land begin to cool, but here also cooling operates in a different way in each. As the surface layer of the sea cools by radiation, its density increases and it becomes heavier than the underlying layers. A vertical circulation is set up, which keeps the upper layers well mixed and at the same temperature. Thus the cooling by night, like the heating by day, is uniformly distributed through a layer of the order of 10 metres deep. On the other hand the loss of heat from the surface of the ground can only be made good by the slow process of conduction from the underlying layers, and the cooling by night extends only to the same small depth as the warming by day. This great difference in the depths to which diurnal heating and nocturnal cooling extend in land and sea is ample explanation of the contrast in the daily ranges of temperature on the ground and at the sea surface.

A point is often made of the cooling effect of evaporation. According to G. Wüst* the average evaporation from the oceans is 93 cm. a year, from the land only 42 cm. As however evaporation from the land is largely confined to the day, while that from the sea is probably more continuous, the net effect on the difference of the daily range appears to be negligible.

We can now consider the effect of the accumulated heat on temperature. The specific heat of sea water is between 1 and 0·99, that of rock about 0·2. The specific heat of loose sand or dry soil may be even less, but that of wet soil would be greater. The same amount of heat would therefore raise the temperature of a gramme of rock about five times as much as it would raise the temperature of a gramme of water. Rock is about 2·5 times as heavy as sea water, but soil, sand and many rocks are porous and contain much air or water. The effective density of the ground surface may be about twice that of the sea. Thus if the same amount of heat were applied to layers of ground and of sea of the same thickness, the rise of temperature of the ground would be about two and a half times that of the sea. While the small specific heat of rock is one factor in the great range of temperature of the ground, it is a very small one, being only about one fortieth as effective as the difference in the depth to which the daily heating and cooling penetrate in land and water.

It would appear from the rough calculations given above that the

---

**Länderk. Forsch., Stuttgart, Festschr. Krebs,* 1936, p. 353.

daily range of the ground surface should be about 250 times that of the sea instead of only forty or fifty times, as it actually is. The difference is of course due mainly to the fact that outward radiation is proportional to the fourth power of the absolute temperature. The radiation from the sea varies little, but the land radiates far more by day than by night. This enormously decreases the daily range of temperature of the ground surface without greatly affecting that over the sea.

C. E. P. Brooks.

Wave Motion in the Upper Air

Many examples of periodic wave motion in the atmosphere recorded on anemograms and barograms have been examined and described by various writers* but no upper air data have usually been available at the actual time and place of the occurrence.

An occurrence of definite and regular wave motion on the anemometer record was noticed at Abbotsinch on the morning of November 16th, 1936, and several pilot balloon ascents were made to note what changes, if any, occurred in the upper air. Balloons with tails attached, and with a normal lift of 500 ft. per minute were released at frequent intervals and, as far as possible at the crests and troughs of waves as recorded by the anemometer. The oscillations were also well marked on the record of the anemometer at Coats Observatory, Paisley, which is situated about two miles due south of the anemometer at Abbotsinch aerodrome. The times of occurrence of the oscillations were almost identical at the two stations as shown in Table I.

The wave motion became apparent at 1h. 30m. and continued until the early afternoon. At first the time gap between wave crests was approximately one hour but this period decreased progressively to 40, 30 and finally about 20 minutes, gradually damping out and finally disappearing about 14h. The oscillations appeared on both the direction and velocity records at Abbotsinch but are well marked on the direction trace only, at Coats Observatory. Generally speaking the crests and troughs of the waves correspond on both the velocity and direction records.

Wave motion was also apparent on both the barogram and hygrogram, although on the former the oscillations were small. Those on the hygrogram were well marked and coincided with those on the anemogram on most occasions. No fluctuations in temperature were apparent on the thermogram which is in agreement with the

*Shaw, Sir Napier; Manual of Meteorology, Vol. III, pp. 28–31 (Fig. 12). Gold, E.; Wind in Britain (Fig. 26). *London Quart. J. R. met. Soc.* 62, 1936, p. 167. Goldie, A. H. R.; *London Quart. J. R. met. Soc.* 51, 1925, p. 239. Ley, C. H.; *London Quart. J. R. met. Soc.* 37, 1911, p. 33.

opinion expressed by Shaw in the "Manual of Meteorology," Vol. III, p. 28.

A photograph of the anemogram for the day in question is shown in Fig. 1 which forms the frontispiece to this number of the magazine. Table I gives the time of occurrence of the crests of the waves as shown by the two anemometers and the hygrogram.

TABLE I.—TIMES OF WAVE CRESTS

Abbotsinch.			Coats Observatory, Paisley.
Anemometer.		Hygrogram.	Anemometer.
Velocity. h. m.	Direction. h. m.	h. m.	Direction. h. m.
1 30	...	1 15	1 30
2 45	2 45	1 50	1 50
3 50	3 30	2 45	2 45
4 50	4 00	3 50	3 30
5 50	6 10	...	4 50
6 55	...	6 50	—
7 30 (small)	7 20	7 20	7 10
8 00	8 05	7 50	7 55
8 45	8 45	8 40	8 40
9 25	9 25	9 20	9 15
...	10 00	10 10	9 50
10 30	10 30	10 30	10 25
11 05	11 00	11 00	10 55
11 35	11 35	11 35	11 25
12 00	11 55	12 10	11 50
...	12 35	...	12 15
...	12 55	...	12 35
13 00	13 10	13 10	12 50
...	...	...	13 10
13 30	13 30	13 35	13 20
13 45	13 45	...	13 55
14 05	...	...	...

The balloons were released as detailed below :—

No. 1 released at 11h. 7m. at crest of wave on anemometer.
No. 2 ,, 11h. 22m. at trough ,, ,, ,,
No. 3 ,, 11h. 39m. at crest ,, ,, ,,
No. 4 ,, 11h. 47m. at trough ,, ,, ,,
No. 5 ,, 11h. 58m. at crest ,, ,, ,,
No. 6 ,, 12h. 47m. at crest ,, ,, ,,
No. 7 ,, 13h. 45m. at crest ,, ,, ,,

The chief feature found in the results of the pilot balloon ascents is the variation in the rate of ascent, see Table II. Each ascent shows the existence of alternating phases of upward and downward vertical currents. In No. 1 ascent a mean up current of 135 ft./min. existed to a height of 3,200 ft. followed by a down current of 235 ft./min. between 3,200 ft. and 3,800 ft. and then between 3,800 ft. and 4,300 ft. an up current of 100 ft./min. Each of the ascents showed similar characteristics but in successive ascents the upward and

Table II.—Vertical Velocity of the balloons

Time	No. 1, Crest		No. 2, Trough		No. 3, Crest		No. 4, Trough		No. 5, Crest		No. 6, Crest		No. 7, Crest	
	Height	Vertical Velocity	Height	Vertical Velocity	Height	Vertical Velocity	Height	Vertical Velocity	Height	Vertical Velocity	Height	Vertical Velocity	Height	Vertical Velocity
min.	ft.	ft./min.	ft.	ft./min.	ft.	ft./min.	ft.	ft./min.	ft.	ft./min.	ft.	ft./min.	ft.	ft./min.
1	485	− 15	425	− 75	565	+ 65	450	− 50	595	+ 95	620	+ 120	560	+ 60
2	1,100	+ 115	850	− 75	1,270	+ 205	910	− 40	1,210	+ 115	1,230	+ 110	1,080	+ 20
3	1,670	+ 70	1,300	− 50	1,830	+ 60	1,050	− 360	1,860	+ 150	1,740	+ 10	1,620	+ 40
4	2,400	+ 230	1,750	− 50	2,400	+ 70	1,270	− 280	2,670	+ 310	2,150	− 90	2,230	+ 110
5	3,170	+ 270	...		2,700	− 200	1,500	− 270	3,600	+ 430	2,510	− 140	2,750	+ 20
6	3,460	− 210	...		2,920	− 280	1,830	− 170	4,300	+ 200	3,300	+ 290	3,250	0
7	3,700	− 260	...		3,000	− 420	2,500	+ 170	4,450	− 350	3,500	− 300	3,500	− 250
8	4,300	+ 100	...		...		3,300	+ 300	4,050	− 900	4,000	0	3,800	− 200
9	...		...		...		4,100	+ 300	4,040	− 500	4,300	− 200	4,500	+ 200
10	...		...		...		4,700	+ 100	4,650	+ 110	5,200	+ 400	5,100	+ 100
11	...		...		...		5,100	− 100	5,500	+ 350	6,100	+ 400	5,750	+ 150
12	...		...		...		5,320	− 280	6,200	+ 200	6,800	+ 200	6,450	+ 300
13	...		...		...		5,380	− 440	6,800	+ 100	7,800	+ 500	7,100	+ 150
14	...		...		...		5,500	− 380	7,650	+ 350	8,200	− 100	7,700	+ 100
15	...		...		...		6,100	+ 100	8,500	+ 350	8,300	− 400	8,350	+ 150
16	...		...		...		6,400	− 200	9,100	+ 100	8,500	− 300	8,900	+ 50
17	...		...		...		7,100	+ 200	9,450	− 150	8,800	− 200	9,400	0
18	...		...		...		8,000	+ 400	9,500	− 350	9,700	+ 400	9,800	− 100
19	...		...		...		8,700	+ 200	...		10,300	+ 100	10,200	− 100
20	...		...		...		9,000	− 200	...		...		10,600	− 100
21	...		...		...		...		...		...		11,000	− 100
22	...		...		...		...		...		...		11,500	0
23	...		...		...		...		...		...		12,100	+ 100

downward currents were interchanged. Ascent No. 4 consisted of up and down currents in layers as shown in the following table :—

Surface to 1,800 ft.	down	current	195 ft./min.
1,800 ft. —4,700 ,,	up	,,	220 ,,
4,700 ,, —5,500 ,,	down	,,	300 ,,
5,500 ,, —6,100 ,,	up	,,	100 ,,
6,100 ,, —6,500 ,,	down	,,	200 ,,
6,500 ,, —8,800 ,,	up	,,	270 ,,

From further examination of the results it will be seen that the balloons released at the crests of the waves, as shown on the anemogram, at 11h. 7m. and 11h. 39m. (Ascents Nos. 1 and 3) had an upward vertical motion of about 100 ft./min. (in excess of the normal lift), for the first four minutes, followed by a period in a downward current of 200 to 300 ft./min. (see Table II) whereas those balloons released in troughs of waves, Ascents Nos. 2 and 4, showed the existence of a downward current of about 60 ft./min. for the first four minutes, and 195 ft./min. for the first six minutes respectively. In the latter ascent a descending current of 300 ft./min. was encountered for the 3rd, 4th and 5th minutes followed in the next four minutes by a mean up current of 220 ft./min. These up and down currents were found to exist in the later ascents in layers of varying thickness to heights of between 9,000 ft. and 12,000 ft. at which heights the balloons were either lost or abandoned owing to the tails being indistinguishable.

It is therefore evident that the balloons, instead of proceeding upwards along a straight track equal to a lift of 500 ft./min., followed an undulating path.

From the foregoing remarks we may therefore say that :—

(1) the atmosphere exhibited a periodic wave motion at least up to heights of between 9,000 ft. and 12,000 ft., and

(2) the occurrence of wave crests, as shown by the autographic records at the surface, coincided with an upward current of air in the layers below approximately 2,000 ft., and the wave troughs when down currents existed in the lowest layers.

Table II shows the vertical motion of the balloons for each minute throughout the ascents and discloses the abnormal behaviour of the balloons and the magnitude of the vertical currents. In most cases these currents, up and down, are of the order of 200 to 300 ft./min. but in ascent No. 5 the balloon actually was forced down when at about 4,000 ft., in spite of the 500 ft./min. free lift, showing a descent of 400 ft., in the 8th minute, representing a downward current of 900 ft./min. In four minutes the balloon only ascended 200 ft. instead of 2,000 ft.

The direction of the upper winds (at 2,000 ft.) was very nearly the same in all the results so that the balloons released in the trough of waves, when the surface wind was about 200°, (at 11h. 22m. and 11h. 47m.) veered 90° to 100° between the surface and 2,000 ft.

while those balloons released at crests of waves veered only 20° to 30° in the same period. The results of each balloon ascent are given in Table III.

TABLE III.—PILOT BALLOON RESULTS SHOWING WIND DIRECTION AND VELOCITY FOR THE ASCENTS NOS. 1 TO 7.

Height.	No. 1 Crest.	No. 2 Trough.	No. 3 Crest.	No. 4 Trough.	No. 5 Crest.	No. 6 Crest.	No. 7 Crest.
ft.	° m.p.h.	° m.p.h.	° m.p.h.	° m.p.h.	° m.p.h.	° m.p.h.	° m.p.h.
Surface	258 12	193 3	247 6	204 4	265 11	275 6	235 8
1,000	280 19	255 10	263 12	270 15	280 17	250 10	260 13
2,000	290 21	...	273 14	293 26	290 17	285 10	278 11
3,000	291 22	...	287 25	303 23	290 21	290 25	278 17
4,000	294 33	...	...	295 18	292 24	265 13	300 20
5,000	...	...	...	275 21	283 19	250 15	263 11
6,000	...	...	...	290 13	280 17	257 12	250 12
7,000	...	...	...	300 13	300 17	265 13	250 12
8,000	...	...	...	290 17	298 19	270 11	250 16
9,000	...	...	...	...	273 20	280 25	280 20
10,000	...	...	...	...	293 23	285 27	280 20
11,000	...	...	...	...	...	290 33	290 32
12,000	...	...	...	...	...	295 35	287 38
13,000	...	...	...	...	...	290 33	290 31
14,000	...	...	...	...	...	287 37	290 32
15,000	...	...	...	...	...	293 37	285 40
16,000	...	...	...	...	...	...	285 45
17,000	...	...	...	...	...	...	288 54

On the day in question a feeble ridge of high pressure which had formed behind an occlusion, covered Scotland. The sky in the morning was almost clear but gradually became covered with cirrus and cirrostratus. No low cloud existed during the time in which balloon ascents were made. In the early afternoon altocumulus and altostratus began to spread from the west. Nephoscope observations of cirrus cloud showed a general current from west at between 70 and 80 m.p.h.

The occlusion which passed Abbotsinch on the day before, November 15th, at about 10h. was accompanied by a very sudden pressure rise of over 2 mb. and a sharp veer of wind. After the passage of the occlusion squalls occurred at approximately 2-hourly intervals. The period became obliterated temporarily on the anemogram during the night but oscillations continued on the barogram, being superimposed on the fall and subsequent rise. It may be considered that the wave motion really commenced at 10h. on the 15th, with a two-hourly period gradually damping down to a period of one hour early on the 16th. On the 16th, a warm front was advancing northwards over Ireland which accounted for the cirrus cloud and the cirrostratus cloud gradually degenerating, and indicating a lowering of the surface of discontinuity.

R. T. ANDREWS.

OFFICIAL PUBLICATION

The following publication has recently been issued :—

PROFESSIONAL NOTES

No. 76. *The effects of obstacles on sunshine records.* By E. G. Bilham, B.Sc., D.I.C. (M.O. 336p.).

At certain meteorological stations some sunshine is cut off near sunrise and sunset by obstacles such as hills, buildings or trees. The duration of sunshine cut off in this way on a day of uninterrupted sunshine may be calculated from astronomical considerations but information has not hitherto been available in regard to the effect of such a cut-off on the monthly and annual averages. The hourly averages for certain stations with unobstructed horizons have now been employed to evaluate the cut-off due to obstacles of altitudes up to 12 degrees in different latitudes and in the several months of the year. The results show that the loss is small, when reckoned as a percentage of the mean daily duration, for obstacles of the kinds met with in practice. In general, the loss due to an obstacle of stated altitude is smaller in summer than in winter, and is smaller at a southern station such as Falmouth than at a northern station such as Aberdeen.

Correspondence

To the Editor, *Meteorological Magazine*

A "Remarkable" Fall of Rain

I am writing to let you know that in a thunderstorm here at 8·45 p.m. lasting 12½ minutes, we had 1·03 in. of rain. As I left the house to take the measure of the storm a flash of lightning struck and scored a tall Cupressus Lawsonia from top to bottom less than 30 ft. from me. Altogether a very exciting quarter of an hour, on the evening of July 18th.

R. G. W. BUSH

Lingfield House, Lingfield, Surrey, August 7th, 1937.

Thunderstorms at Street, Somerset, July 15th, 1937

At 9 a.m. B.S.T. here on July 15th, a distant rumbling became intermittent in the north and west. A faint flash in the north at 9.30 was followed by others never very bright nor was the thunder loud. Rain began about 9.20 growing torrential by 9.25 and continuing so to about 9.48. Then quickly growing lighter from the south-west, the rain ceased by 9.50 and only a normal cloudiness remained. Some fairly large hailstones fell from 9.40 to 9.43. The total fall was 1·21 in. in the 25 minutes falling almost vertically from about north, a slight wind only blowing; none before. The first downfall quickly flooded the roads but rarely to reach door steps. The aneroidograph had fallen to 29·90 in. (1012·5 mb.) at midnight. Then a very slight " cup " associated with a few heavy drops (only a " trace " to measure) preluded a slightly wavy fall to 29·85 in. (1010·8 mb.) at 8 a.m., when to 8.30 a.m. and again 10.30 to 11.15 a.m. it gave two " cups " of 0·005 in. (0·2 mb.) At 11.20 thunder began again to the west. This soon passed to the north. The more frequent vivid lightning and louder thunder were accompanied by heavy rain though less so than before ten. The thunder ceased about 12.30 and the rain moderated by 12.35 ; 0·82 in. more were measured at 12·45. Later the rate rose again so that the total at 4.15 was 3·20 in. in nearly three hours. The ensuing drizzle brought the 24 hours total 9 a.m. to 9 a.m. to 3·23 in.

The records at seven other stations within about 1 mile radius of Portway confirm this total as they varied from 3·14 in. at Hindhayes, Street, to 3·42 in. at High Street, Street, for the 15th.

J. E. CLARK.

Portway, Street, Somerset, July 22nd, 1937.

Damage by Lightning

The photograph on the opposite page shows the damage caused by lightning to the concrete base of the hatch (flood-gate) on the River Piddle here at Wareham during a storm on the night of May 25th–26th, 1937.

It seems probable that the flash which caused the damage shown in the photograph travelled down the railway metal forming the end of the fence, came in contact with a piece of re-enforcing in the concrete parapet of the aquaduct, and so blew out the concrete. There is no sign of scorch on the fence at this point, and none on the metal of the hatch.

Since taking the photograph we have found that 100 yds. away on the right hand side of the photograph, the top strand of fence wire was cut through for some 10 ft. and that the galvanising of the wire is scorched. An ash tree close to the fence at that point was apparently struck at the same time, as a few of the leaves are burnt and a piece of bark low down on the base of the trunk has been blown out.

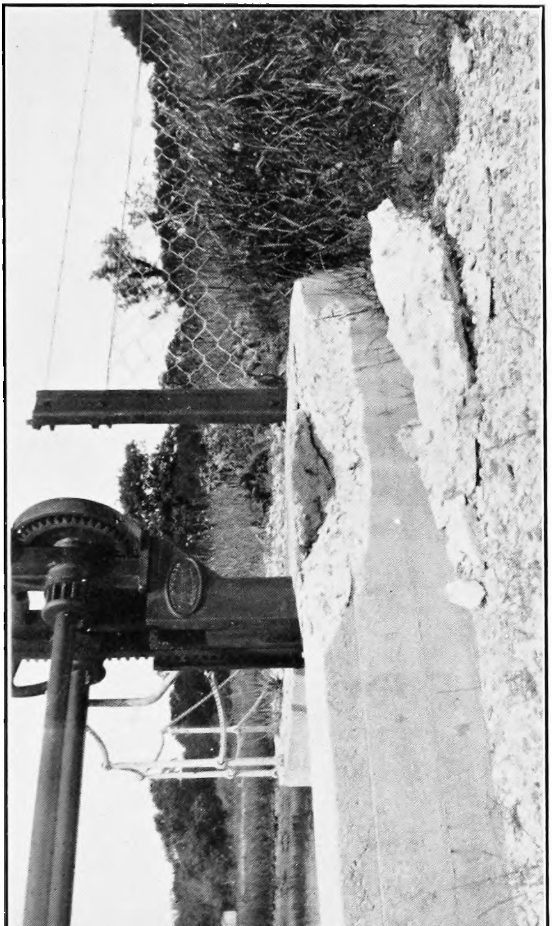
NINA STURDY.

Trigon, Wareham, Dorset, June 8th, 1937.

A Brilliant Fragment of Halo

About 8 p.m., B.S.T., on July 2nd, after a warm sunny day with cumulus, a rapid development of cirrus occurred with patches of cirrostratus. One of the latter as seen from Hampstead was over the sun, and showed a striking development of lines and streaks. Every few minutes a small but very brilliant arc of a halo with prismatic colours appeared in this comparatively dense patch of cirrostratus, and one of these could be seen through the streaks

[*facing p. 162*



FLOOD-GATE ON THE RIVER PIDDLE, WAREHAM, DAMAGED BY LIGHTNING, MAY 25TH—26TH, 1937.

and fibres. I did not note whether these coloured arcs belonged to the 46° or 22° halo but I can say that the colours showed the halo sequence with red inside, and that they appeared at intervals sometimes on one side of the sun sometimes on the other. Once when this coloured arc appeared it was crossed by the lines in question, but this does not mean that they were causing the colours because on the other occasions the arc was clear.

Later near the edge of the same cloud I noticed a patch of iridescence further complicating the whole set of phenomena.

L. C. W. BONACINA.

15, Christchurch Road, London, N.W.7, July 4th, 1937.

Rain from Altocumulus Clouds

During the four days February 18th to 20th, 1937, showers were experienced at many places in central Sudan. While the occurrence of slight rain over this area during February is not unknown the associated cloud types on the present occasion are a matter of interest.

A cold front orientated roughly north-north-east and south-south-west passed Khartoum during the evening of February 16th. Some cirrostratus cloud had preceded the passage of the front and this persisted with the addition of altocumulus during the night; altocumulus castellatus developed during the early hours of the 17th at Khartoum, but the total amount of cloud did not exceed 6 tenths until the evening of the 17th, when the sky became almost covered with a single layer of dense altocumulus, or high stratocumulus, at about 12,000 ft. This cloud persisted throughout the night and rain, composed of very large drops and having the characteristics of a thunder shower, fell at intervals between 2 a.m. and 4.30 a.m. The intensity of rainfall varied considerably and even though locally in Khartoum the roads became very wet, there was nothing measurable in the rain-gauge.

The sky was three-quarters to almost completely covered with altocumulus, but only a single layer, throughout the rest of the 18th and also for the next three days at an average height of 12,000 ft. During the 18th portions of the cloud exhibited extremely well-defined mammillations.

Observations by aircraft on the 18th confirm that the base of the cloud was at 12,000 ft.; the upper and lower limits of the cloud layer were well-defined and the average thickness of the cloud sheet was 800 ft. It was particularly noted that there were no cumulus heads rising out of the cloud sheet. At the time that the above observations were made precipitation was taking place. Showers were also experienced on each of the three following nights and although a full moon permitted excellent conditions for observing the cloud types no case of altocumulus castellatus was noticed.

It is difficult to understand why there should have been rain from the cloud sheet described since the large drops which fell on all occasions would appear to indicate fairly strong vertical currents.

The upper winds throughout the period were N. to NNE. near the ground and gradually backed to SSW. or S. at about 10,000 ft. with a gradual decrease in speed with height so that the showers may have been connected with the wind distribution in the vertical; on the 21st when no rain occurred the upper winds were very light at all heights and at 10,000 ft. only backed to about WSW.

WILLIAM D. FLOWER.

Meteorological Service, Khartoum, A.E. Sudan, March 20th, 1937.

A Peculiar Cloud Formation

At 10h. 38m. G.M.T. on July 20th, my attention was drawn to a large cumulus cloud about five miles away to west-south-west. Depending from a point on the base of the cloud was a thin sharply defined streak tapering down to a point. The height of the cloud was estimated at between 2,000 and 3,000 ft., and the length of the streak at about 300 ft. The duty pilot reported having watched it for about 20 minutes. We ourselves watched it for four minutes, during which time it did not appear to alter in any way. At 10h. 42m. however, it commenced to disappear from the bottom end, and vanished within two seconds. It did not appear to disperse, but rather to shorten rapidly.

A. ERIC MAYERS.

Meteorological Station, R.A.F., Driffield, Yorkshire, July 28th, 1937.

NOTES AND QUERIES

Agricultural Meteorology in India

The close dependence of plant growth on climate has long been recognised. In recent years attention has been directed towards the details of this relation. The so-called microclimate—the meteorological conditions within and immediately around a growing crop—has been investigated; statistical relationships between weather and crop yield have been sought in connexion with crop forecasts; and some study has been made of radiation and moisture exchange between soil and atmosphere.

For the past five years the Agricultural Meteorological Branch of the India Meteorological Department, under the Director-General, Dr. C. W. B. Normand, has vigorously developed these lines of work, both independently and in collaboration with the Agricultural Departments. The results have been published in the Departmental Reports, in the *Proceedings of the Indian Academy of Science*, in *Current Science* and elsewhere. They range from a preliminary statistical study of the influence of weather and prices on the area sown to cotton in the Bombay Presidency, to the moisture relationships between the soil and the adjacent air. Considerable attention is being given to the border-line between meteorology and soil physics : heat convection from the ground to the air ; short-period variations in nocturnal radiation from the sky ; the factors controlling soil temperature and moisture content ; all of these are the subject of published papers.

Among the interesting points brought out is the small depth of soil that is affected by the diurnal evaporation and condensation of moisture. Samples taken under field conditions at Poona showed no diurnal variation in moisture content even 1 inch below the surface. This result is, of course, in harmony with recent physical work on the movement of soil moisture, which shows that the soil water is relatively static. Water in excess of a certain moisture content (whose value is fairly characteristic of each soil type) percolates to lower levels ; while loss of moisture occurs primarily by evaporation *in situ* into the pore-spaces and thence by diffusion into the atmosphere, and there is little or no movement towards the depleted area of water from the adjacent areas to replace the loss.

Soil temperature, on the other hand, seems to be more responsive to soil type. A preliminary report is given of an experiment in which marked changes of temperature were caused by covering the local Poona soil with very thin layers of other soils and substances so as to obtain white, black and coloured surfaces.

Although much of the work of the Branch is necessarily of a preliminary nature, definite progress has been made in applying the methods to agricultural problems which, in India, are intimately connected with the date of the monsoon and its intensity.

B. A. KEEN.

Construction of Thermometer Screens

For the benefit of meteorological observers who wish to make their thermometer screens themselves, or have them made by a local carpenter, the Meteorological Office, Air Ministry, has revised an illustrated pamphlet that contains the necessary information. It retains the number of a former pamphlet (Form 63) of a similar character now out of print, but the title has been changed to "Instructions for making Thermometer Screens of the Stevenson type". The types of screen dealt with are the standard, which takes maximum, minimum, dry- and wet-bulb thermometers, the modified form of this to take a thermograph and hygrograph instead of the thermometer, the large type designed to hold the four thermometers as well as the thermograph and hygrograph, and lastly the small screen for housing four thermometers of the sheathed type only, in a horizontal position as described by Mr. E. G. Bilham in the *Quarterly Journal of the Royal Meteorological Society* for July, 1937, p. 309. Screens for use at sea are not included in this pamphlet. Constructional details are also given of both wooden and steel stands for the various screens. A new feature is the inclusion of a list of materials required for each item. The price is 6*d.*, and the pamphlet can be obtained through any bookseller or from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2.

Frosts in Spring, Summer and early Autumn

The table below shows the average number of days with a minimum temperature of 32° F. or lower, in the screen, for each month from April to October at representative stations. The table was prepared in order to comply with a Resolution of the International Meteorological Committee, and acknowledgments are due to the local observers who were good enough to extract the data from their own past records.

AVERAGE NUMBER OF DAYS WITH MINIMUM TEMPERATURE 0° C. (32° F.) OR BELOW AT REPRESENTATIVE STATIONS.
April–October, 1901–25

	Latitude. (North)	Longitude.	Height above M.S.L.	April	May	June	July	Aug.	Sept	Oct.
			ft.							
Aberdeen ...	57° 10′	2° 6′W	37	4·0	0·5	0	0	0	0	1·5
Eskdalemuir*	55° 19′	3° 12′W	794	13·8	5·0	0·5	0	0·3	2·1	6·1
Durham ...	54° 46′	1° 35′W	336	7·0	1·4	0·2	0	0	0·2	2·6
Rothamsted	51° 48′	0° 22′W	420	6·8	1·0	0	0	0	0·3	2·5
Oxford (Radcliffe Observatory) ...	51° 46′	1° 16′W	208	4·0	0·3	0	0	0	0	1·8
Birmingham (Edgbaston)	52° 29′	1° 56′W	535	3·4	0	0	0	0	0	0·3
Greenwich (Royal Observatory)	51° 29′	0° 00	149	3·1	0·2	0	0	0	0	1·1
Kew Observatory ...	51° 28′	0° 19′W	18	2·6	0	0	0	0	0·1	1·0
Eastbourne...	50° 46′	0° 14′E	35	1·6	0	0	0	0	0	0·2
Totland Bay	50° 41′	1° 33′W	140	1·1	0	0	0	0	0	0·2
Stonyhurst...	53° 51′	2° 28′W	377	3·8	0·7	0	0	0	0	1·2
Liverpool (Bidston)	53° 24′	3° 4′W	198	1·0	0	0	0	0	0	0
Southport ...	53° 37′	3° 0′W	35	2·8	0·3	0	0	0	0	0·8
Newquay ...	50° 25′	5° 4′W	190	0·8	0	0	0	0	0	0
Armagh ...	54° 21′	6° 39′W	204	4·7	0·5	0	0	0	0	1·8
Valentia Observatory...	51° 56′	10° 15′W	30	0·3	0	0	0	0	0	0·2

* 1911–1925.

In considering the data it is necessary to remember (*a*) that the figures refer to the period 1901–25, specified in the Resolution, and (*b*) that the averages are expressed only to the nearest 0·1 of a day.

The occurrence of one reading of 32° F. or lower in a particular month during the 25-year period would give an average of ·04, which would be rounded off to "0" in the table. During the period considered one frost was registered at Oxford in September, at Edgbaston in May, at Kew in May, at Stonyhurst in June and at Bidston in October. The only station where no frost occurred in any month from May to October was Newquay, Cornwall.

REVIEWS

Forests and Floods in New Hampshire by Dr. Henry I. Baldwin and Dr. Charles F. Brooks. Publication No. 47, New England Regional Planning Commission, Boston, Mass., December, 1936.

New Hampshire, sloping down from hills in the west to the Atlantic coast, is liable to disastrous floods, especially in spring, when heavy rain combines with the rapid melting of the winter snow to pour great quantities of water into the rivers. For example on March 9th–21st, 1936, in the Mount Washington region a rainfall of 14 to 22 inches and 6 to 10 inches of melted snow combined to make totals up to 30 inches of water, giving the greatest flood of the century.

It has long been known that forests have the property of holding up water and so making the flow of rivers more even, but Dr. Baldwin and Dr. C. F. Brooks in this detailed investigation add precision to the qualitative statement. Forests intercept both snow and rain, and some of the intercepted precipitation is evaporated without reaching the ground. More important is their effect in preserving the snow cover by sheltering it from wind and sun, for a layer of snow can hold up almost its own volume of rain-water. The more absorbent soil of the forest and the layer of litter also help to hold water. Evergreens, especially spruce and fir, are naturally more effective than deciduous trees, but they are also the most valuable lumber and the first to be cut. Thus there is a tendency for the protective effects of the forests to diminish and the authors advise a programme of conservation or re-afforestation of critical areas, which though costly would be much less so than the construction of flood-control reservoirs.

C. E. P. BROOKS.

The Physical State of the Upper Atmosphere. By B. Haurwitz. Reprinted from the Journal of the Royal Astronomical Society of Canada, October, 1936–February, 1937.

By the use of aircraft, sounding balloons and pilot balloons we have obtained a fairly comprehensive knowledge of the mean state of the atmosphere up to a height of about 30 kilometres. Of conditions above this height we know comparatively little and of that little much is still rather speculative. Although we are, at present, unable to send instruments to these greater heights there is a variety of phenomena which provide data for inferences and deductions concerning some of the characteristics of that part of the atmosphere beyond our reach. Observations of this type are being made almost daily in one form or another to augment our knowledge. Probably owing to the rapid way in which our knowledge of the higher levels is changing the ordinary textbook of meteorology has comparatively little to say about these inaccessible regions and most of the information is to be found only in the publications of scientific societies and the like. Thus the author of this little book has performed a very useful service in rendering this knowledge more accessible.

The book is based upon a series of eight public lectures delivered in April, 1936, and which formed a survey of the then extant knowledge of the upper atmosphere. The first nine chapters deal with the Troposphere and Stratosphere, Mother-of-Pearl and Noctilucent Clouds, Meteors, the Light of the Night Sky, Propagation of Electric Waves and Ionization, the Diurnal Variations of Terrestrial Magnetism, the Aurora, Ozone, and Anomalous Propagation of Sound. The tenth and last chapter suggests the probable composition and structure of the atmosphere up to about 200 Km. in the light of the evidence available.

In dealing with each of the subjects mentioned above the author gives a brief survey of the present knowledge on the subject and also shows what deductions may be made therefrom about the physical state of the upper atmosphere. For example in the chapter on the "Diurnal Variations of Terrestrial Magnetism" we are told that these variations must be considered as magnetic effects of current systems above the earth. The "dynamo" theory of Schuster and Chapman which purports to explain these currents is outlined, some supporting evidence is given and some of the difficulties are mentioned. The drift-current theory is also briefly described and the author concludes that the evidence is as yet insufficient to decide between the two theories.

The specialist in his own subject will, perhaps, find little of interest but the scientific inquirer who is venturing into more or less unfamiliar regions will find an admirable digest, not sufficiently detailed to discourage but containing nevertheless most of the essential facts as we know them to-day. Finally, for the reader who is sufficiently attracted to wish to delve deeper into the subject and examine the evidence for himself there is an excellent bibliography of nearly 130 articles, papers or books.

A. C. BEST.

British Health Resorts, Spa, Seaside, Inland, including Australia, Canada, Cyprus, New Zealand, South Africa and British West Indies. Official Handbook of the British Health Resorts Association. Size $9\frac{3}{4}$ in. × $6\frac{1}{4}$ in., pp. 288. *Illus.* London, 1937, 2*s.* 6*d.* net.

While keeping the plan of the book essentially the same, the fifth edition of this Handbook has been enlarged by the addition of one or two new features. Amongst them may be noted a valuable chapter on climatology by L. C. W. Bonacina. On p. 148 will be found a synopsis of the "attractions" offered by British Resorts during the invalids' winter. New information is given in a condensed form as regards the sunshine and rainfall in many resorts; the latter is divided into the fall during the day and during the night—an important factor from the visitors' point of view. Cyprus is included as a health resort for the first time; its role as a summer hill station in the near East and as a winter resort for English travellers should give it a double qualification as a place of recovery.

The whole of the material has again been carefully revised by a sub-committee of the Association with the object of making the book indispensable for the doctor advising his patients where best to seek the change of air they need and for the intelligent layman seeking a suitable place for temporary or permanent residence.

Unfortunately the price of the handbook this year is more than double last year's being now 2*s.* 6*d.* A more attractive cover might increase its popularity.

BOOKS RECEIVED

Royal Alfred Observatory, Mauritius. Annual Report, 1935. Results of magnetical and meteorological observations for March to December, 1935, and January to May, 1936. Port Louis, 1936 and 1937.

Boletin de Agricultura Suplements de Meteorologia. Bogota, 1934.

Liquid-propellant rocket development. By R. H. Goddard. Smithson, Misc. Coll. Vol. 95, No. 3, Washington, D.C., 1936.

OBITUARY

Mungo McCallum Fairgrieve, M.A., F.R.S.E.—The death took place in Edinburgh on August 4th of Mr. M. McC. Fairgrieve, who was formerly the head of the Science Department of Edinburgh Academy. He collaborated with his colleague, the late J. Tudor Cundall, in the writing of scientific text-books which were in use at the Academy. In 1915, he set up a rainfall station at the Academy and for 20 years sent copies of the observations for inclusion in the annual volumes of *British Rainfall.* He was elected a Fellow of the Scottish Meteorological Society in 1909 and of the Royal Society of Edinburgh in 1910, and contributed papers to both. After the amalgamation of the Scottish Meteorological Society with the Royal Meteorological Society he continued his Fellowship and served as Secretary in the years 1934–6. A few years ago Mr. Fairgrieve was involved in a motor accident resulting in the loss of a leg. He made a remarkable recovery but the injury had a weakening effect on his health and two years ago he had a breakdown from which he never fully recovered.

NEWS IN BRIEF

We learn that the honorary degree of doctor of science has been conferred upon Sir Napier Shaw by the University of Athens in connexion with the University's centenary celebrations.

The Senate of the University of London has conferred the degree of B.Sc. (Engineering) on Mr. W. M. James, Technical Assistant III of the Marine Division.

ERRATUM

July 1937, p. 147, line 19, *for* "4th" *read* "5th".

The Weather of July, 1937

An area of low pressure extended from Greenland across northern and central Europe to western Asia with a centre below 1010 mb. over Iceland and another centre below 1000 mb. over Iraq, while an area of high pressure above 1020 mb. extended over the southern North Atlantic and a second high pressure area (above 1015 mb.) lay over Spitsbergen and north-west Siberia. Pressure was slightly below normal over the North Atlantic and southern and eastern Europe and above normal over most of north-west Europe and Bear Island where the excess amounted to 6 mb.

Mean temperature was below 40° F. in north Greenland, Franz Josef Land and the north of Novaya Zemlya and between 40° and 50° F. from south Greenland across Spitsbergen to the Arctic coasts of Russia. The 60° F. isotherm passed south of Ireland across north England and then followed the Norwegian coast until just south of Tromso, where it turned eastwards and extended across the White Sea. Most of southern Europe, south Russia and the western Mediterranean was between 70° and 80° F. and from the Black Sea temperature increased south-eastwards to the Persian Gulf where 100° F. was exceeded. Temperature was above normal over Europe, south-west Asia and the Nile Valley with the exception of a narrow belt below normal extending from Italy across Czecho-Slovakia to Lithuania and central Russia and an area over the southern British Isles and eastern Scotland. Temperature was as much as 5° F. above normal in northern Scandinavia and the Persian Gulf.

Rainfall was between 1 and 2 in. over north and south Russia, Scandinavia, France and west Germany increasing to 3–4 in. over east Germany, Czecho-Slovakia and to 4–5 in. over central Russia, while no rain fell generally over the Mediterranean and Iraq. Rainfall was mainly below normal in Europe and Iraq except in parts of Sweden, Germany, Czecho-Slovakia and Estonia. At Båstad, Skåne (Sweden) 6·26 in. of rain fell on the 27th, the greatest amount ever measured in 24 hours in Sweden.

The main characteristics of the weather of July over the British Isles were the deficiency of sunshine, the heavy rain accompanying some of the thunderstorms, maximum temperatures often below normal and the frequency of fog off the south-west coasts. A new low July record for sunshine was set up at Cranwell where the month's total was 93 hours less than the average and the previous low record was equalled at Lympne for observations subsequent to 1920 at both stations. Rainfall totals were variable except in southern Ireland where Valentia recorded the wettest July since 1866. Light to moderate westerly winds backing SW. to S. prevailed generally on the 1st and 2nd with considerable sun in the south and east but rain generally in the west and north, becoming heavy in Ireland—2·20 in. at Valentia and 1·83 in. at Omagh (Co. Tyrone)—on the 2nd, and in south Scotland on the 3rd. Thunderstorms were reported locally in northern England on the 3rd and in south Scotland on the 4th. Thick morning mist or fog occurred off the south-west coasts on the 1st and 2nd. In the south and east temperature rose above 70° F. on the 2nd and above 80° F. with over 10 hrs. bright sunshine on the 3rd; 87° F. was recorded in London and 86° F. at Deal, and 14·1 hrs. sunshine at Gorleston on that day. With the change to northerly winds in the rear of the depression centred over north England maximum temperatures in the south and east were about 20° F. lower on the 4th than on the previous day, Deal 65° F. From then to the 13th depressions moving north-east from the Atlantic brought generally cool unsettled weather with frequent rain and not much sun except on odd days, while morning mist or fog was experienced off the south-west coasts. A thunderstorm occurred at Edinburgh on the 7th; Scotland, east England and the Midlands had further storms on the 9th and the eastern counties again on the 10th. From the 13th to 15th, while a complex depression passed across the country from the Atlantic, another depression moved north from France. Temperature rose generally in England and east Scotland on the 13th and exceeded 80° in the south and east on the 14th and 15th. A severe and extensive series of thunderstorms developed in south and central Ireland on the 14th; the storms crossed England during the 15th reaching the east coast during the night. Exceptionally heavy rain accompanied these storms and caused flooding in several places, the heaviest falls being chiefly in Lincolnshire and Somerset; 5·46 in. at Boston (Lincolnshire); 4·19 in. at Pensford (Somerset); 3·94 in. at Angersleigh (Somerset) in 10¼ hrs. from 6.45 a.m. to 5 p.m.; 3·70 in. at Glentham (Lincolnshire); and at Lincoln 1·70 in. of the total of 2·65 in. fell in ½ hr. from 6 to 6.30 p.m.* A ridge of high pressure following these depressions brought sunny but somewhat cooler weather to Scotland and Ireland on the 15th, to the whole country on the 16th and to the east on the 17th; 15·0 hrs. bright sunshine were recorded at Bath on the 16th and 14·9 hrs. at Margate and Aberdeen on the 17th. On the 18th and

* See also p. 161.

19th temperature was again high, reaching 79° F. at Tunbridge Wells on the 18th and Norwich on the 19th. Thunderstorms were experienced in south and east England and the Midlands on both these days. At Edenbridge (Kent) during the thunderstorm 1·40 in. of rain fell in 25 minutes from 8.45 to 9.10 p.m. on the 19th.* Morning mist or fog occurred off the south-west coasts from the 13th to 21st and occasionally locally on other coasts. From the 19th to 25th a complex area of low pressure passed across the country giving cool unsettled weather with rain most days but some sun. The 20th and 24th, however, were dry sunny days in the south. On the 25th an anticyclone over the Atlantic was spreading eastwards over the British Isles and from then to the 30th pressure was high over the country. Slight rain occurred over Scotland and Ireland on the 27th, but generally until the 30th the weather was dry and cool with little sun except in isolated districts, mainly in Scotland and later also in Wales. The 30th was a sunnier day generally, and the 31st was dry, warm and sunny with, however, much morning mist or fog. Thunderstorms occurred in east England on the 24th and in south Scotland on the 27th. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	103	−42	Chester ...	140	−33
Aberdeen ...	127	−25	Ross-on-Wye ...	126	−66
Dublin	130	−40	Falmouth ...	180	−37
Birr Castle ...	101	−48	Gorleston ...	153	−58
Valentia... ...	97	—60	Kew	135	−59

Kew, Temperature, Mean 63·7° F., Diff. from normal — 0·8° F.

Miscellaneous notes on weather abroad culled from various sources.

A storm did much damage north of Valenciennes (Nord) on the 10th, and several people were injured. A violent hailstorm over Ferrara (Emilia) and the surrounding district on the 26th caused much damage to crops, etc., and injured 6 people. Dense fog occurred near Catalan Bay about the 23rd. Severe thunderstorms were experienced in northern Italy and the Riviera on the 31st and August 1st, with a subsequent fall of temperature; many cellars were flooded (*The Times*, July 7th–August 2nd).

A violent storm lasting two days occurred on Lake Molro on the eastern border of the Belgian Congo about the middle of the month—several waterspouts were observed (*The Times*, July 27th).

During a gale off the north-west coasts of Australia early in the month the mother ship of the Japanese pearling fleet sank off the mouth of Liverpool River. The total rainfall for the month in Australia was below normal except in parts of Queensland and Tasmania (Cable and *The Times*, July 10th).

---

* See also p. 161.

In the United States temperature was generally above normal, except in the eastern and central States at the beginning of the month and in the south-eastern States at the end of the month; rainfall was mainly below normal. A heat-wave crossed Canada about the 6th to 12th, and about the 14th the long-continued drought in Canada was broken when heavy rain fell generally (*The Times*, July 7th–16th and *Washington D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin*).

Daily Readings at Kew Observatory, July, 1937

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	1018·8	W.3	60	73	65	—	6·1	pr_0 12h.–13h.
2	1019·0	SSW.2	62	77	62	—	2·5	
3	1012·0	SSE.4	63	82	54	—	9·8	
4	1018·2	SW.4	60	64	66	—	0·0	
5	1021·0	SW.3	51	70	58	—	3·4	
6	1014·6	S.3	55	67	77	0·10	0·1	r_0 4h.–7h., 20h.–21h.
7	1013·9	WNW.3	59	68	63	—	4·4	
8	1021·4	SW.2	53	69	47	—	11·3	
9	1015·2	SSW.4	55	64	75	0·04	0·9	r 12h.–14h.
10	1014·1	WNW.4	54	65	56	0·04	2·7	pr morning.
11	1018·6	SW.3	52	69	59	0·02	6·3	d 20h.–23h.
12	1016·0	SSW.1	59	69	81	0·02	0·0	r_0–r 9h.–10h.
13	1017·1	W.3	64	76	66	—	7·4	
14	1014·7	S.3	59	79	56	—	10·8	
15	1004·7	S.2	61	81	66	0·10	3·7	tlr 15h., r_0 18h.–22h.
16	1015·7	W.4	57	73	47	0·03	12·6	r–r_0 2h.–5h.
17	1023·5	SSW.3	54	72	65	—	1·9	w early.
18	1023·1	SW.2	60	78	62	—	2·0	
19	1019·8	WSW.2	60	75	70	0·50	0·8	TLR 18h.–19h., R [20h.
20	1019·9	NNW.2	55	73	55	—	9·4	
21	1012·0	SW,4	59	71	58	0·06	2·5	r_0–r 14h.–15h.
22	1011·8	W.4	55	65	51	—	4·6	
23	1006·8	SSW.4	55	70	88	0·04	3·3	d_0 5h.–8h., id_0 to 13h.
24	1008·3	WSW.3	52	69	52	—	8·3	
25	1012·1	W.3	56	66	65	—	2·2	
26	1018·2	WNW.2	57	66	63	—	0·7	
27	1019·1	WSW.2	57	64	59	—	0·0	
28	1017·2	NNE.3	55	67	57	—	5·3	
29	1015·8	NNE·2	54	70	55	—	6·4	
30	1016·5	ENE.3	51	66	70	—	0·2	
31	1019·2	NE.3	56	67	70	—	5·6	
*	1016·1	—	57	70	63	0·95	4·4	* Means or Totals.

General Rainfall for July, 1937

England and Wales ...	84	per cent of the average 1881–1915.
Scotland	126	
Ireland	141	
British Isles	109	

Rainfall : July, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond	Camden Square	·53	22	*War*	Birminghm, Edgbaston	2·74	118
Sur	Reigate, Wray Pk. Rd.	1·37	61	*Leics*	Thornton Reservoir	3·26	131
Kent	Tenterden, Ashenden	·84	40	,,	Belvoir Castle	5·59	230
,,	Folkestone, Boro. San.	1·77	...	*Rut*	Ridlington	1·98	79
,,	Margate, Cliftonville	·77	39	*Lincs*	Boston, Skirbeck	7.37	335
,,	Eden'bdg., Falconhurst	2·20	96	,,	Cranwell Aerodrome	2·89	124
Sus	Compton, Compton Ho.	1·73	61	,,	Skegness, Marine Gdns.	1·71	78
,,	Patching Farm	1·62	67	,,	Louth, Westgate	1·72	69
,,	Eastbourne, Wil. Sq.	1·42	65	,,	Brigg, Wrawby St.	2·88	...
Hants	Ventnor, Roy.Nat.Hos.	1·57	78	*Notts*	Worksop, Hodsock	2·27	100
,,	Fordingbridge, Oaklnds	1·86	93	*Derby*	Derby, The Arboretum	2·83	115
,,	Ovington Rectory	1·02	40	,,	Buxton, Terrace Slopes	3·66	93
,,	Sherborne St. John	·98	44	*Ches*	Bidston Obsy	1·56	60
Herts	Royston, Therfield Rec.	3·62	144	*Lancs*	Manchester, Whit. Pk.	2·19	66
Bucks	Slough, Upton	1·22	64	,,	Stonyhurst College	2·15	56
,,	H. Wycombe, Flackwell	1·83	91	,,	Southport, Bedford Pk.	1·89	66
Oxf	Oxford, Radcliffe	1·38	58	,,	Ulverston, Poaka Beck	3·32	73
N'hant	Wellingboro, Swanspool	1·71	75	,,	Lancaster, Greg Obsy.	2·30	66
,,	Oundle	1·60	...	,,	Blackpool	1·97	67
Beds	Woburn, Exptl. Farm	1·21	54	*Yorks*	Wath-upon-Dearne	2·69	107
Cam	Cambridge, Bot. Gdns.	1·98	92	,,	Wakefield, Clarence Pk.	2·59	102
,,	March	1·98	83	,,	Oughtershaw Hall	3·17	...
Essex	Chelmsford, County Gdns	1·73	81	,,	Wetherby, Ribston H.	...	...
,,	Lexden Hill House	·91	...	,,	Hull, Pearson Park	2·64	113
Suff	Haughley House	1·11	...	,,	Holme-on-Spalding	1·61	62
,,	Rendlesham Hall	1·30	56	,,	West Witton, Ivy Ho.	1·91	73
,,	Lowestoft Sec. School	1·67	74	,,	Felixkirk, Mt. St. John.	1·26	46
,,	Bury St. Ed., WestleyH.	1·81	72	,,	York, Museum Gdns.	1·75	69
Norf.	Wells, Holkham Hall	2·80	121	,,	Pickering, Hungate	1·56	58
Wilts	Porton, W.D. Exp'l. Stn	1·08	55	,,	Scarborough	2·06	85
,,	Bishops Cannings	1·78	71	,,	Middlesbrough	1·04	41
Dor	Weymouth, Westham.	4·47	248	,,	Baldersdale, Hury Res.	1·74	54
,,	Beaminster, East St.	3·39	130	*Durh*	Ushaw College	2·59	93
,,	Shaftesbury, Abbey Ho.	2·71	105	*Nor*	Newcastle, Leazes Pk.	2·64	103
Devon	Plymouth, The Hoe	1·78	65	,,	Bellingham, Highgreen	2·64	80
,,	Holne, Church Pk. Cott.	1·54	43	,,	Lilburn Tower Gdns.	2·55	103
,,	Teignmouth, Den Gdns.	1·32	57	*Cumb*	Carlisle, Scaleby Hall	2·63	80
,,	Cullompton	2·53	94	,,	Borrowdale, Seathwaite	7·75	98
,,	Sidmouth, U.D.C.	2·64	...	,,	Thirlmere, Dale Head H.	4·12	71
,,	Barnstaple, N. Dev.Ath	3·07	114	,,	Keswick, High Hill	2·95	77
,,	Dartm'r, Cranmere Pool	4·40	...	*West*	Appleby, Castle Bank	2·89	91
,,	Okehampton, Uplands.	2·19	68	*Mon*	Abergavenny, Larchf'd	3·93	158
Corn	Redruth, Trewirgie	1·87	61	*Glam*	Ystalyfera, Wern Ho.	3·69	80
,,	Penzance, Morrab Gdns.	1·61	59	,,	Treherbert, Tynywaun.	4·05	...
,,	St. Austell, Trevarna	2·15	64	,,	Cardiff, Penylan	3·12	101
Soms	Chewton Mendip	3·89	111	*Carm*	Carmarthen, M. & P. Sch.	...	...
,,	Long Ashton	3·99	141	*Pemb*	St. Ann's Hd, C. Gd. Stn.	3·12	126
,,	Street, Millfield	5·27	...	*Card*	Aberystwyth	3·13	...
Glos	Blockley	2·67	...	*Rad*	BirmW.W.Tyrmynydd	2·86	70
,,	Cirencester, Gwynfa	2·39	93	*Mont*	Lake Vyrnwy	3·37	98
Here	Ross-on-Wye	3·41	150	*Flint*	Sealand Aerodrome	1·42	...
Salop	Church Stretton	2·63	107	*Mer*	Blaenau Festiniog	5·16	66
,,	Shifnal, Hatton Grange	3·45	153	,,	Dolgelley, Bontddu	3·25	76
,,	Cheswardine Hall	3·44	127	*Carn*	Llandudno	·94	42
Worc	Malvern, Free Library	2·78	122	,,	Snowdon, L. Llydaw 9.	9·95	...
,,	Ombersley, Holt Lock.	2·52	118	*Ang*	Holyhead, Salt Island	2·18	84
War	Alcester, Ragley Hall	3·55	149	,,	Lligwy	1·94	...

Rainfall : July, 1937 : Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	4·20	137	*R&C*	Achnashellach	3·81	74
Guern.	St.Peter P't.Grange Rd.	1·78	88	,,	Stornoway, C.GuardStn.	1·60	...
Wig	Pt. William, Monreith	5·56	198	*Suth*	Lairg	3·37	108
,,	New Luce School	4·67	137	,,	Tongue	...	...
Kirk	Dalry, Glendarroch	5·26	147	,,	Melvich	3·36	120
Dumf.	Dumfries, Crichton R.I.	3·18	103	,,	Loch More, Achfary	3·83	72
,,	Eskdalemuir Obs.	4·48	109	*Caith*	Wick	1·96	75
Roxb	Hawick, Wolfelee	3·80	123	*Ork*	Deerness	1·65	64
Peeb	Stobo Castle	4·25	147	*Shet*	Lerwick	1·46	69
Berw	Marchmont House	2·65	87	*Cork*	Dunmanway Rectory	...	...
E.Lot	North Berwick Res.	3·19	124	,,	Cork, University Coll.	3·21	118
Midl	Edinburgh, Blackfd. H.	5·37	190	,,	Mallow, Longueville	4·19	167
Lan	Auchtyfardle	3·87	...	*Kerry*	Valentia Observatory	8·77	232
Ayr	Kilmarnock, Kay Park	5·03	...	,,	Gearhameen	9·80	171
,,	Girvan, Pinmore	3·74	102	,,	Bally McElligott Rec.	6·48	...
,,	Glen Afton, Ayr San.	6·01	143	,,	Darrynane Abbey	8·11	213
Renf	Glasgow, Queen's Park	3·60	123	*Wat*	Waterford, Gortmore	4·34	136
,,	Greenock, Prospect H.	4·15	106	*Tip*	Nenagh, Castle Lough.	...	...
Bute	Rothesay, Ardencraig	4·94	125	,,	Roscrea, Timoney Park	...	...
,,	Dougarie Lodge	5·85	185	,,	Cashel, Ballinamona	5·14	180
Arg	Loch Sunart, G'dale	5·06	109	*Lim*	Foynes, Coolnanes	5·30	171
,,	Ardgour House	9·22	...	*Clare*	Inagh, Mount Callan	10·85	...
,,	Glen Etive	...	...	*Wexf*	Gorey, Courtown Ho.	2·52	86
,,	Oban	7·15	...	*Wick*	Rathnew, Clonmannon	2·06	...
,,	Poltalloch	7·38	179	*Carl*	Bagnalstown, Fenagh H.	3·65	116
,,	Inveraray Castle	9·50	191	,,	Hacketstown Rectory	3·19	92
,,	Islay, Eallabus	5·86	172	*Leix*	Blandsfort House	3·71	118
,,	Mull, Benmore	10·20	101	*Offaly*	Birr Castle	3·85	130
,,	Tiree	3·38	93	*Kild*	Straffan House	3·59	127
Kinr	Loch Leven Sluice	...	...	*Dublin*	Dublin, Phoenix Park	1·74	65
Fife	Leuchars Aerodrome	3·64	140	*Meath*	Kells, Headfort	3·90	123
Perth	Loch Dhu	6·65	138	*W.M*	Moate, Coolatore	...	...
,,	Crieff, Strathearn Hyd.	4·39	148	,,	Mullingar, Belvedere	4·08	128
,,	Blair Castle Gardens	4·24	166	*Long*	Castle Forbes Gdns.	...	...
Angus	Kettins School	4·68	181	*Gal*	Galway, Grammar Sch.	...	...
,,	Pearsie House	4·70	...	,,	Ballynahinch Castle	9·27	224
,,	Montrose, Sunnyside	3·90	148	,,	Ahascragh, Clonbrock	5·74	165
Aber	Balmoral Castle Gdns.	3·32	130	*Rosc*	Strokestown, C'node	...	...
,,	Logie Coldstone Sch.	...	...	*Mayo*	Blacksod Point	...	...
,,	Aberdeen Observatory	3·93	140	,,	Mallaranny	...	...
,,	New Deer School House	...	...	,,	Westport House	3·95	127
Moray	Gordon Castle	3·07	96	,,	Delphi Lodge	11·59	175
,,	Grantown-on-Spey	...	...	*Sligo*	Markree Castle	6·39	186
Nairn	Nairn	3·15	118	*Cavan*	Crossdoney, Kevit Cas.	4·14	...
Inv's	Ben Alder Lodge	5·09	...	*Ferm*	Crom Castle	4·13	119
,,	Kingussie, The Birches	2·68	...	*Arm*	Armagh Obsy	3·28	113
,,	Loch Ness, Foyers	3·15	104	*Down*	Fofanny Reservoir	5·26	...
,,	Inverness, Culduthel R.	2·58	99	,,	Seaforde	3·90	122
,,	Loch Quoich, Loan	6·36	...	,,	Donaghadee, C. G. Stn.	2·59	93
,,	Glenquoich	6·31	98	*Antr*	Belfast, Queen's Univ.	...	...
,,	Arisaig House	5·38	108	,,	Aldergrove Aerodrome	4·36	156
,,	Glenleven, Corrour	...	...	,,	Ballymena, Harryville	4·99	145
,,	Fort William, Glasdrum	...	...	*Lon*	Garvagh, Moneydig	5·38	...
,,	Skye, Dunvegan	4·61	...	,,	Londonderry, Creggan	5·17	141
,,	Barra, Skallary	2·04	...	*Tyr*	Omagh, Edenfel	5·84	172
R&C	Alness, Ardross Castle	...	...	*Don*	Malin Head	4·80	...
,,	Ullapool	2·69	85	,,	Dunkineely	...	...

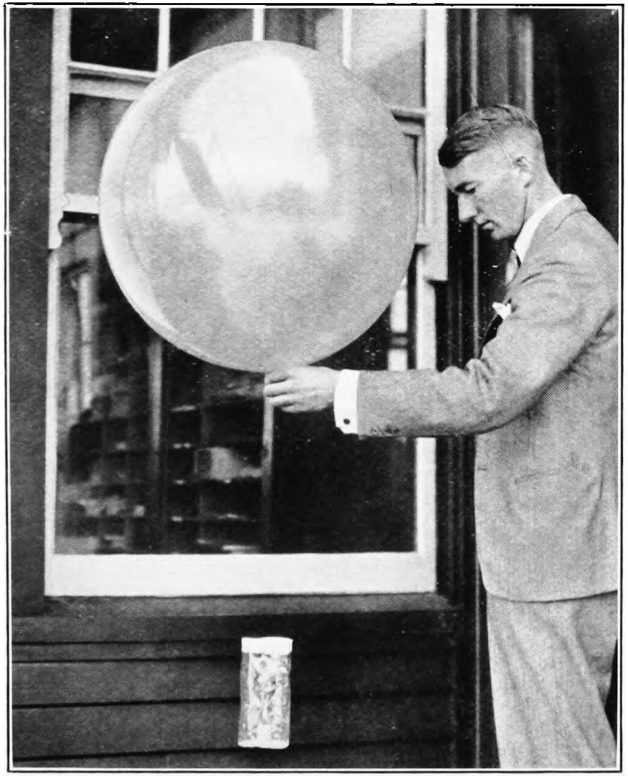
Climatological Table for the British Empire, February, 1937

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 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....	1002·8	−13·2	55	31	48·0	39·0	43·5	+ 2·8	40·4	89	7·6	4·05	+ 2·51	22	2·2	23
Gibraltar	1020·6	+ 0·6	67	46	61·0	52·4	56·7	+ 0·9	52·1	83	4·8	0·19	...	3	...	...
Malta....................	1013·2	− 2·9	67	43	59·8	51·8	55·8	+ 0·5	51·2	77	5·9	2·67	+ 0·47	8	6·5	60
St. Helena	1011·9	− 0·3	75	60	71·4	62·3	66·9	+ 1·7	63·1	93	9·1	2·00	− 0·68	13	...	...
Freetown, Sierra Leone	1010·5	+ 1·4	91	75	88·3	77·4	82·9	...	76·6	78	4·7	0·01	− 0·29	1	...	...
Lagos, Nigeria	1009·9	+ 0·2	90	72	88·2	76·9	82·5	0·0	76·6	89	6·7	2·77	+ 0·87	8	6·8	57
Kaduna, Nigeria	1012·4	...	96	56	91·3	59·7	75·5	− 1·4	55·3	46	2·9	0·00	− 0·02	0	8·6	73
Zomba, Nyasaland	1007·6	− 0·5	86	50	80·3	64·9	72·6	+ 0·6	69·5	81	8·0	7·11	− 3·54	17	...	...
Salisbury, Rhodesia...	1009·1	− 1·0	83	55	78·0	61·0	69·5	+ 0·7	63·3	82	8·5	8·13	...	18	4·4	35
Cape Town	1013·1	− 0·3	98	51	82·9	61·7	72·3	+ 2·0	64·4	64	2·3	0·28	− 0·30	4	...	...
Johannesburg	1010·3	− 0·3	80	51	75·1	57·0	66·1	+ 0·5	60·1	79	6·2	5·85	+ 0·63	14	7·4	52
Mauritius	1009·7	− 1·3	90	71	86·0	74·7	80·3	+ 1·0	77·2	83	6·1	5·09	− 3·31	20	7·6	59
Calcutta, Alipore Obsy.	1013·3	0·0	88	57	80·3	62·9	71·6	+ 0·4	64·1	89	5·4	5·43	+ 4·44	7*	...	...
Bombay	1012·1	− 0·6	85	64	81·9	68·9	75·4	− 0·3	67·7	78	1·6	0·55	+ 0·52	1*	...	...
Madras	1012·0	− 0·9	88	66	86·0	71·9	78·9	+ 1·2	73·6	82	5·2	0·00	− 0·30	0*	...	...
Colombo, Ceylon	1011·0	+ 0·2	90	71	86·6	73·6	80·1	− 0·3	76·4	77	4·6	7·09	+ 5·15	8	9·3	78
Singapore...............	1010·4	+ 0·2	90	71	86·1	74·8	80·5	+ 0·3	76·4	81	6·5	7·54	+ 0·92	13	6·1	51
Hongkong...............	1018·4	− 0·2	79	46	66·2	57·5	61·9	+ 2·8	57·2	78	7·5	0·31	− 1·52	6	3·7	32
Sandakan	1011·1	...	88	73	86·9	75·4	81·1	+ 0·9	77·1	85	7·8	4·58	− 5·39	13	...	...
Sydney, N.S.W.........	1015·6	+ 1·7	91	59	77·1	65·5	71·3	0·0	65·4	67	5·8	1·30	− 2·90	11	7·0	52
Melbourne	1015·8	+ 1·3	95	49	79·8	57·3	68·5	+ 0·9	60·8	63	5·9	1·63	− 0·08	7	7·7	57
Adelaide	1015·2	+ 0·9	99	54	85·0	62·7	73·9	− 0·1	63·1	51	5·0	0·79	+ 0·07	5	9·1	69
Perth, W. Australia ...	1013·3	+ 0·3	108	55	86·8	64·9	75·9	+ 1·8	62·0	45	4·8	0·41	− 0·04	2	9·9	75
Coolgardie	1012·8	+ 0·4	105	52	90·5	63·8	77·1	+ 0·9	62·5	52	2·3	0·38	− 0·47	2	...	...
Brisbane.................	1012·6	+ 0·1	97	63	82·5	67·8	75·1	− 1·4	68·3	65	6·6	5·25	− 1·09	12	5·5	41
Hobart, Tasmania......	1018·2	+ 5·0	79	48	67·8	54·4	61·1	− 1·2	55·1	67	7·5	1·03	− 0·45	7	6·0	44
Wellington, N.Z.	1013·4	− 2·4	73	44	64·1	51·3	57·7	− 4·9	54·3	73	6·6	4·22	+ 1·08	11	7·1	52
Suva, Fiji	1007·2	− 0·6	93	74	87·9	76·8	82·3	+ 2·0	77·7	83	6·8	8·29	− 2·43	22	6·5	51
Apia, Samoa	1008·4	0·0	89	73	85·3	75·5	80·4	+ 1·4	77·4	81	7·1	15·85	+ 0·56	19	5·4	43
Kingston, Jamaica	1014·8	− 0·5	88	65	84·5	67·6	76·1	− 0·4	65·6	85	1·3	0·10	− 0·50	2	7·6	66
Grenada, W.I.	1011·2	− 2·3	89	71	87	73	80	+ 2·9	73	74	4	1·83	− 0·95	17	...	...
Toronto..................	1014·8	− 3·2	50	5	33·8	22·0	27·9	+ 6·8	...	...	7·4	2·21	− 0·17	11	3·7	35
Winnipeg	1015·6	− 6·2	34	−33	12·1	− 6·5	2·8	+ 2·7	...	...	5·2	1·18	+ 0·44	13	4·1	41
St. John, N.B.	1012·2	− 1·7	48	3	32·9	18·5	25·7	+ 5·8	20·8	77	7·3	2·16	− 1·74	11	4·3	41
Victoria, B.C...........	1011·7	− 4·9	53	26	42·8	34·4	38·6	− 1·9	36·1	86	8·3	5·23	− 1·97	19	2·5	25

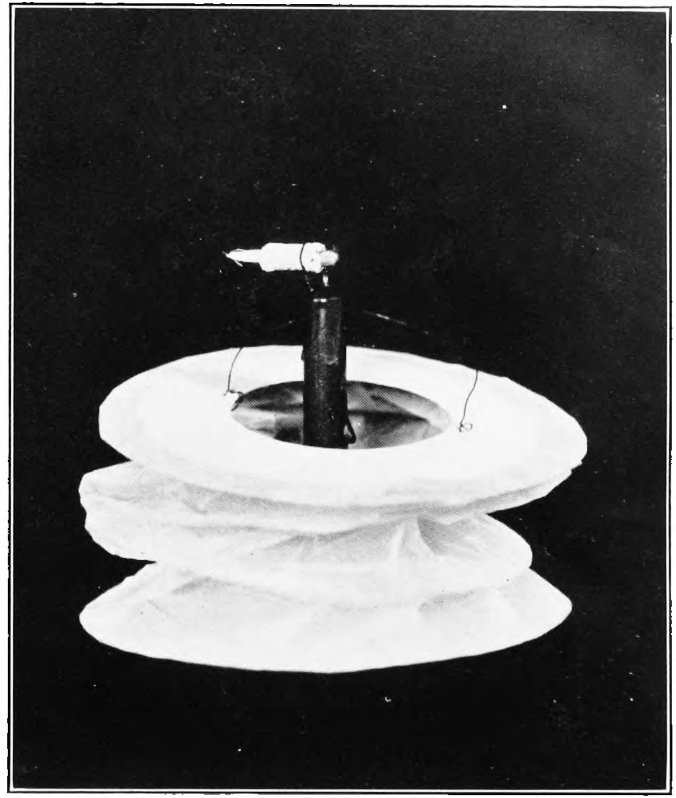
* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(38363) Wt. 20/31 1125 8/37 Hw. G. 377/6

facing p. 177.]



CELLOPHANE LANTERN FOR NIGHT ASCENTS WITH PILOT BALLOONS (*see p.* 178).



THE USE OF A FUSE TO LIGHT A CANDLE.

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72
Sept., 1937
No. 860

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; 26 York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff; 80 Chichester Street, Belfast; or through any bookseller.

Pilot Ballooning at Night

The Use of a Fuse to Light a Candle

By F. J. W. Whipple, Sc.D.

The usual method of determining the velocity of the upper winds at night is to send up a pilot balloon carrying a small Chinese lantern and to make observations with a theodolite. The candle in the Chinese lantern is lit shortly before the balloon is released. There is considerable difficulty in preventing the candle from being blown out at the start. The difficulty is reduced by carrying the lantern at the end of a piece of elastic, but I am told that this method is not entirely successful when there is a strong wind and that it is almost impossible to send up a lighted lantern from a ship at sea.

In an article in the April–May 1937 number of the *Journal of the American Meteorological Society* p. 154, Mr. A. F. Spilhaus has described a new method of finding the upper wind at night. He sends up a balloon carrying a fuse which sets light to magnesium flares at intervals. The flares are photographed by a whole-sky camera like the Robin Hill camera. This is a very pretty idea but there is the obvious drawback that it takes time to develop the plate and make a set of measurements with a microscope before the bearings of the flashes can be ascertained. Moreover the fuse cannot be relied on to produce flashes at equal intervals so an observer must stand by to time all the flashes during the ascent of the balloon.

After I had read Spilhaus's paper it occurred to me that it would be practicable to use a fuse to light a candle and thereby obviate the difficulty generally encountered in sending up a balloon carrying a lantern. The experiment was tried successfully on July 22nd when three balloons were sent up from Kew Observatory. One could watch a balloon fade out of sight and wait until half a minute later a brilliant star suddenly appeared in the sky. This happened in two of our trials; the third was a failure.

The fuses used in the experiments were cut from the cord soaked in lead nitrate solution such as is used for observations in atmospheric electricity. The cord is woven with a hole down the middle. Each fuse was about 10 mm. long; a short piece of wood cut from a safety match and carrying the head of the match was inserted in the fuse which was then fixed to the candle by a piece of thin steel wire. In preliminary experiments it was found that there was a risk of the glowing ash of the fuse falling on the base of the lantern and setting it on fire, some time after the candle was alight. It did not seem possible to prevent the ash falling, but a suggestion of Mr. H. W. Baker's was adopted and the lanterns were well wetted before use.

Naturally one cannot be certain as to why the second of our three trials was a failure, but a possible explanation is that the wire holding the fuse was gripping it too tightly so that the incandescence was not able to travel past the wire. Certainly the failure cannot be attributed to the wind. The stronger the draught the better a fuse burns.

It may be of interest to mention that observers with no previous experience were able to keep the lanterns in sight until 15 minutes and 18 minutes respectively after the release of the balloons. From Kew we were watching tiny lanterns with Christmas-tree candles travelling across unsuspecting Battersea, seven miles away, at a height of a mile and a half.

Cellophane Lanterns for night ascents with Pilot Balloons

By L. N. Larsen
(of the Meteorological Office, Wellington, New Zealand).

Somewhat over a year ago, it became necessary for the first time in the New Zealand Service, to make pilot balloon observations regularly before daylight each morning. After some experimenting, a lantern was devised which has given excellent results. The walls are made of cellophane and, since the writer has seen no reference to this material being used elsewhere, the following notes might, it was thought, prove of general interest.

The ordinary tissue-paper lantern as recommended by the Meteorological Office, London, is more flimsy and more liable to catch fire than one of cellophane. Moreover, the former, even if the paper is saturated with thin oil, as well as diffusing the light coming from the source, absorbs a considerable fraction of it, while with the latter the absorption is negligible. Photometric tests indicated that the intensity of illumination from a cellophane lantern was 1·5 that from one made of tissue paper. Since the lantern, of whatever type, soon becomes a point source, the greater size of the bright surface in the case of the tissue-paper proves to be of no advantage. Actual experience showed that, with the same source of illumination, it was possible to follow the cellophane lantern to considerably greater distances.

Almost all the night ascents at Wellington were made by one man, from the release to the final recording. The theodolite used was by E. R. Watts & Son and was fitted with electric flash lighting for reading the scales. It had variable field-illumination but the latter was not generally used.

The lantern finally adopted as being most efficient under all conditions was made of cellophane 3½ in. diameter by 7 in. high, with a 2 in. aperture in the top. The weight including a wax candle of ¾ in. diameter by ¾ in. long was 10–11 gm. Attachment to the balloon was made by a thread 3 ft. long.

Flights up to 41 minutes duration, reaching an altitude of 6,200 metres and a distance of 12 Km. have been obtained with this type. Lanterns were successfully launched, when the wind velocity ranged from 5 to 55 miles per hour, and remained alight in wind speeds up to 66 miles per hour. The balloons used were mainly of 90 in. circumference rising at 150 metres/minute. Recently, however, the 70 in. balloon with a 10 gm. lantern and rising at 140 metres/minute has been adopted.

As regards the source of light much the best results have been obtained with ordinary candles of the dimensions specified. The amount of illumination is sufficient, and generally greater than that provided by the type of electric lamp which is sometimes used. The candle, also, maintains its brightness whereas the electric lamp decreases in intensity.

Cellophane lanterns can be made quickly as follows: Cut from stiff white paper two sets of circular discs, 5 in. and 3½ in. in diameter, for top and bottom respectively. Punch four holes near the edge of each of the smaller pieces for ventilation purposes, and make some smaller perforations about the centre. A circular aperture 2 in. in diameter is made in the top pieces, and small slots cut round the outer edge ¾ in. in towards the centre. With the edges turned up all round to the depths of the cuts, this makes a top which is conveniently fitted and provides some shelter from draughts. A sheet of uncoloured cellophane 11¼ in. × 8 in. is wrapped around a closed tin of 3½ in. diameter, and the edges lapped and gummed together with cellophane paste. The cellophane is allowed to project beyond the top of the tin. The bottom of the lantern is placed on the latter and the overlapping cellophane pasted down on to it. The tin is then removed and a candle end of the correct length, which has previously been burned until the meniscus has completely formed is fixed to the bottom of the lantern by means of a few drops of melted wax. The candle is pressed down firmly, and the wax penetrating the perforations in the paper ensures a firm grip. Paste is next applied to the turned-up edge of the paper top which is then slipped inside the cellophane to the required depth with the projections upward. This completes the process. The handle is made of a loop of fine wire or coarse thread.

Ordinary cellophane is used and not the waterproof variety. If desired, cellophane lanterns, can, like paper lanterns be packed flat for storage, but it would be advisable then, to have them made with a flat top.

[Trials of cellophane lanterns were made at the suggestion of Mr. P. N. Skelton, by the British Meteorological Office in 1933. There was some divergence of opinion among observers, but the conclusion was that there was little to choose between cellophane and paper, at any rate up to 10,000 ft. Above that height paper was thought to be better, but on one occasion a lantern of cellophane and one of paper were followed simultaneously up to 15,000 ft. (actual distance not known).—D. N. HARRISON.]

Rainfall and Run-off from Intermittent Streams

Data regarding the flow of our great rivers, such as the Thames, are of considerable value to water engineers and the like, but some useful facts regarding local climate may be derived from systematic eye observations of the flow of streams in the vicinity of the observer. Observations of intermittent streams are of considerable interest, because one is able to note the period of flow after the cessation of rainfall, and, conversely, the period of rainfall before the re-commencement of flow ; which data give a measure of the evaporation and percolation in the soil within the boundary of the catchment area.

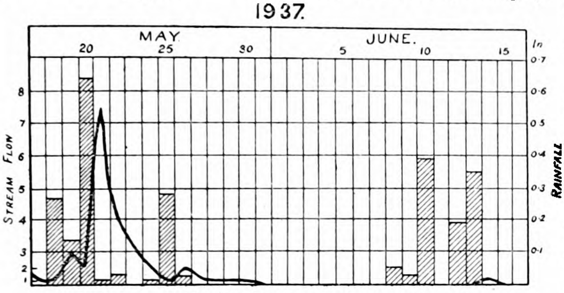
During the past three years, observations of the flow of Cuffley Brook, Herts, have been made each day at about 7.45 a.m. This brook, which is an intermittent stream, drains an area of about five square miles* and flows almost all winter and spring, but dries up for varying periods in the summer and autumn months.

The surface of the catchment area consists of about 50 per cent clay, 30 per cent gravel and 20 per cent Reading beds and alluvium. Of this area 65 per cent is grass land and about 35 per cent woodland. The flow of the stream is estimated by eye observation of the approximate depth of water observed each morning to be flowing over the

---

* See *Meteorological Magazine*, 70, 1935, p. 209.

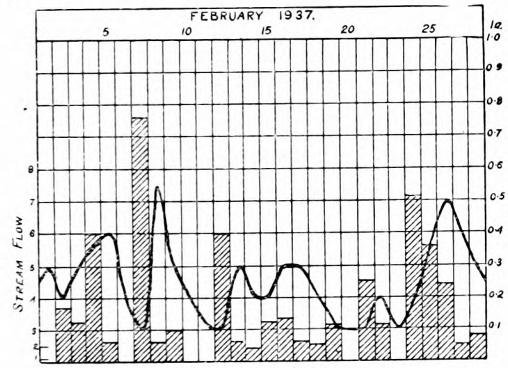
concrete invert of a bridge, and recorded on an arbitrary scale from 0 = bed dry, 1 = trace of water flowing (less than 1 in. depth), to 8 = more than 24 in. depth of water flowing.



Rainfall shown by shaded columns.

FIG. 1

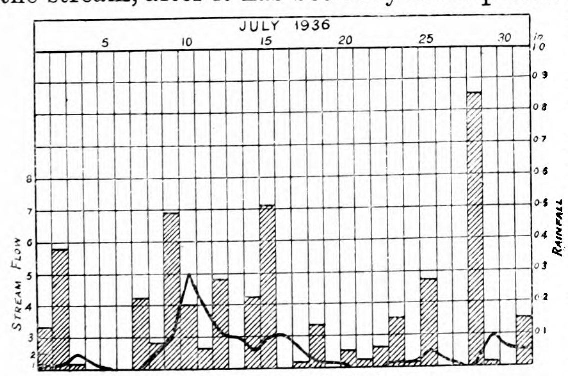
A typical curve of flow is shown, plotted against the corresponding rainfall, in Fig. 1. It will be noted that after the heavy rainfall associated with the thunderstorm on the night of May 20th, the stream rose rapidly and the main flow (run-off) lasted about four days. The thunderstorm of the night of May 25th caused a brief, slight increase in flow, and thence for five days the flow gradually fell off to zero, apparently indicating percolation into the stream-bed from the adjacent soil. The stream was dry for 14 days until the aggregate fall of five rain-days, totalling exactly 1·00 in., gave a trace of flow on the morning of June 15th, which flow, however, had ceased before the observation hour the next morning.



Rainfall shown by shaded columns.

FIG. 2

From data available, it appears that the minimum rainfall required to re-start the flow of the stream, after it has been dry for a period of five or more days, is of the order of 0·50 in.; but the figure varies considerably with the time of the year, the average value being about 0·80 in. Since, however, in every case the actual time of commencement of flow is not known, and in the case of the heavier falls may be some hours before the fixed hour of observation, it seems reasonable to assume that the value of 0·50 in. represents the total



Rainfall shown by shaded columns.

FIG. 3.

amount of moisture which the soil can hold before percolation, or run-off, commences from the catchment area.

An interesting contrast between the stream-flow in winter and summer is shown in the curves for the months of February, 1937, and July, 1936, Figs. 2 and 3. The attached table gives the numerical values of stream-flow, rainfall, etc., for these particular months.

	July, 1936.	February, 1937.
Number of raindays	22	22
Total rainfall	4·29 in.	4·24 in.
Maximum daily fall	0·85 in.	0·76 in.
Number of days flowing ...	22	28
Mean flow	1·55	4·46
Maximum daily flow	5·0	7·5

It will be seen that although the number of raindays is identical, and total falls are approximately equal, the mean flow in February, 1937, was nearly three times as great as in July, 1936. The lower figure for the latter month is apparently due to losses by evaporation, since the mean difference between the solar maxima and shade maxima was 52·8° F. in July, 1936, against a corresponding figure of 27·4° F. in February, 1937.

DONALD L. CHAMPION.

Frontal Irregularity in the Bristol Channel

At 14h. G.M.T. on July 17th, 1937, the writer observed a peculiar distribution of mist in the Bristol Channel. The observation was made from the cliffs near St. Athans, Glamorgan, from which point an extensive view up and down the Channel is possible. The sky was covered with a sheet of thick altostratus and on the Glamorgan side there was no low cloud; the surface wind was approximately WSW., 10 m.p.h. A portion of the view towards the English coast is shown in the sketch, Fig. 1. Looking up Channel towards the Somerset coast it was observed that the Quantock Hills were in cloud, the base being about 600 ft. above mean sea level. Westward of the Quantocks the low cloud thinned out until from Minehead to Lynmouth there was only a line of cumuli, base still at 600 ft. The vertical extent of each cumulus was not more than 300 ft. but was large compared with the cross sectional area. This low cloud was near the Somerset and Devon coast line and above the cloud the visibility was excellent; the whole of the detail of the cliffs and high ground around Dunkerry Hill and Exmoor being visible. But below the cloud base there was a distinct curtain of mist. This mist extended right down to the surface of the sea and the top edge of it in the gaps between the low cloud appeared to be continuous with the cloud base and quite sharp even when viewed through binoculars. There was a good distribution of ships in the Channel and as far as could be ascertained the mist did not extend more than four miles from the Somerset and Devon coast. The mist appeared to be perfectly uniform and was thin enough to allow the darker colouring of the far coast to show through; it was in this way totally different from sea fog.

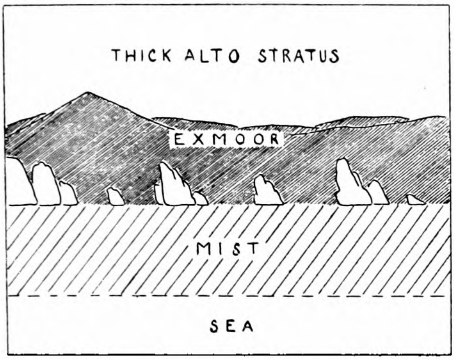


FIG. 1—SKETCH OF VIEW TOWARD ENGLISH COAST.

Down-channel the mist seemed to thin out and disappear somewhere near the Great Hangman (Coombe Martin), but there was some cloud on the hills south-west of Coombe Martin. It was noticed at the time that the whole of the phenomenon lay along the part of the coast where the fall from the high ground to the sea is very sharp: the land rises to 800 ft. within half a mile of the shore for nearly the whole of this stretch of coast. Unfortunately, owing to circumstances it was impossible for the writer to watch the phenomenon for more than half an hour, but during this time it was noticed that each small cumulus seemed to grow as they drifted eastward.

At the time of the observation a cold front, which had passed about two hours previously, was lying along the Mendips; the warm front lay several miles further eastward, both fronts moving forward at a speed of about 20 m.p.h. The cold front stretched south-westwards and was then linked to the next warm front which was approaching Devonshire from the south-west. It will be noticed that the surface wind was still off-shore on the Devon coast even behind the cold front, and the explanation of the rather peculiar distribution of visibility is, in the opinion of the writer, that when the cold air swept in, it did not immediately fall to the surface of the sea after rising over the Devon hills. In fact a pocket of warm air was left under the lee of the Devon and Somerset coast; and so we have the rather unusual condition of lowest cloud on the lee side of the range of high ground. (There is nothing unusual in the idea of an air mass overshooting in this manner: a similar case can be watched where sea fog approaches a high headland. The sea fog rises above and "breaks" over the headland in a similar manner to a breaking water wave). The interesting and important point from the view of the forecaster is that the lee side of high ground is the very place that is usually spoken of as being least likely to have low cloud; it is usually considered that the windward side of a range of high ground would have the worst conditions, but in the case under discussion the lee side was inferior to even the tops of the high ground. Whether there were similar pockets of warm air in the hollows of the high ground on Exmoor could not be observed; but as the top of the layer of poor visibility was not higher in the narrow valleys opening onto this part of the coast, it is considered that such small pockets were rather improbable.

The factors instrumental in the appearance of the phenomenon therefore appear to be a long range of hills with a well-marked escarpment on the lee side and, in all probability, a not too vigorous flow of air. It is difficult to see how the phenomenon could persist for long with a very turbulent air mass and so probably a fairly smooth approach over the hilltops for the cold air and a slow smooth movement of the warm air, as is possible over sea, are also necessary conditions. It was rather unfortunate that the time during which the phenomenon lasted was unobtainable, for if the explanation here given is correct it is evident that these conditions would be unstable. The rather small scale but vertically elongated cumuli observed were considered to be evidence of this instability.

C. J. M. Aanensen.

OFFICIAL NOTICE

Discussions at the Meteorological Office

The series of meetings for the discussion of recent contributions to meteorological literature especially in foreign and colonial journals, will be resumed at the Meteorological Office, South Kensington, during the session 1937-8. The meetings will be held on alternate Mondays at 5 p.m., beginning on Monday, October 18th, 1937, when Sir George Simpson, K.C.B., C.B.E., F.R.S., will give an account of the results of the Meeting of the International Meteorological Committee to be held at Salzburg in September.

The dates for subsequent meetings will be as follows:—

November 1st, 15th, 29th, December 13th, 1937; January 17th, 31st, February 14th, 28th, March 14th, 1938.

The Director of the Meteorological Office wishes it to be known that visitors are welcomed at these meetings.

Correspondence

To the Editor, *Meteorological Magazine*

Sand Devils

On August 17th about 1300 local time on the Iraq Petroleum Company's aerodrome at Haditha, I had an opportunity (for which I have waited for 10 years) to be in the centre of a large dust devil.

It must be admitted that the experience although unpleasant was very instructive.

The devil as seen from a distance would have been described as having clockwise rotation, rather violent, diameter 20–30 ft., height 300–400 ft. moving if anything slightly into wind.

The actual phenomenon viewed from the interior was somewhat different. First the amount of sand or dust in vigorous rotation was small compared with the amount of sand being raised because about two-thirds of the disturbance was moving linearly and rotation was occurring on the right-hand edge (when facing the direction towards which "devil" was moving). As the wind was from NW. this means that the vigorous clockwise rotation was occurring on the western side. Secondly the air in the disturbance which was not affected by the rotation was moving considerably faster than the undisturbed air. In other words there was a velocity discontinuity at either side of an area 20–30 ft. wide and it was on the discontinuity on the western side that all the rotation was occurring. There may have been a temperature discontinuity as well but I had no means of ascertaining this. Thirdly the advance of the disturbance was characterised by a disturbance of the surface of the ground similar to what happens when dusty ground is watered by the rose of a watering can or water cart. There seemed to be some agency hitting the ground and forcing the dust to rise; the agency can only be descending air.

One eddy formed immediately I entered the disturbance but its life was very short; another formed almost immediately after and became very vigorous carrying sand and dust up to height of 500 ft. The whole thing collapsed about 1½ minutes later when entering the Iraq Petroleum Company's camp. The actual life of the disturbance is not known as it appeared from behind sand dunes but it was probably about 10 minutes.

In this case then the mechanism seemed to be roughly as follows. Over a front of 20–30 ft. the air from some higher level was descending and this air of higher velocity than its environment maintained its identity for some time. The action of the descending air was to force the sand upwards. Rotatory movement was occurring only on the right hand boundary and the direction was clockwise; presumably had the rotation occurred on the left side the rotation would have been anti-clockwise, but there was no indication of this occurring at all; on the left-hand side the line separating clear air from dust-laden air remained a well-defined straight line throughout the whole life of the disturbance.

J. Durward.

Meteorological Service, Airport, Baghdad, August 18th, 1937.

Cold Weather in Australia

A correspondent writing from Melbourne under date June 29th, 1937 says, " we usually get sea fogs, two or three at a time, but this year twenty right off, some very dense and not clearing until 2 or 3 p.m., coming on again at night. Now we are having heavy frosts 'like snow' in appearance, followed by a sunshiny day." My correspondent encloses a newspaper cutting describing the River Yarra coated with ice $\frac{1}{4}$ in. thick.

G. C. WOOLDRIDGE.

51, Nithsdale Avenue, Market Harborough, August 2nd, 1937.

Exceptionally Good Visibility.

The following note has been received from Mr. Seton Gordon of Upper Duntuilm, Isle of Skye.

" On Monday, August 30th, I was able to see the main island of St. Kilda not only from the top of Bruach na Frithe (Cuillin) but, descending in the afternoon, from the corrie almost 1000 ft. below the summit. The distance is I think about 95 miles. From the hill top I could also see Boreray and its stacks where the gannets nest. Very bad weather has followed that extreme visibility and this is the 6th consecutive day of storm."

The wettest place in the British Isles

In the July number of the *Meteorological Magazine* Dr. Glasspoole, writing on the subject of the wettest spots in Great Britain, ignores the record of the old gauge at The Stye at the head of Borrodale in Cumberland, 1,077 ft. above sea-level. This gauge frequently recorded over 200 in., and on three occasions more than 240 in., namely, 1872 (244), 1923 (247), and 1928 (250). This gauge has apparently been discontinued, but I feel sure that its average would have been quite 180 in.

F. J. WARDALE.

Shrewton, Wilts, August 3rd, 1937.

[The computed average rainfall at The Stye, referred to by Mr. Wardale, is 181 in. and attention had been given to this and all other records in the district. Values were quoted, however, for existing gauges which had been inspected and which gave a measure of the increase in rainfall towards the main mountain masses. The heavy rainfall at The Stye is due presumably mainly to Great Gable, but the main masses are further south as mentioned in the article.—J. GLASSPOOLE.]

Dry period on Dartmoor

Mr. Chaplin, who spent the period May to July 1937 at Okehampton, has drawn my attention to the unusually dry weather experienced there. The record maintained at Uplands, Okehampton, since July 1919 shows that the total rainfall for the three months May to July 1937, viz. 6·22 in. was less than that for the similar period in any other year except 1921, when the total was only 4·76 in. It was very dry also at Newbridge, Dartmoor, a station 1,500 ft. above mean sea level, where the rainfall for the three months was only 7·10 in.

L. F. LEWIS.

Thunderstorms of July 19th, 1937

On the evening of July 19th two thunderstorms broke over Horndon-on-the-hill, during the first of which I was watching from my front window, when a ball of fire, simultaneous with a deafening crash of thunder that seemed to convulse the whole region, appeared over the garden bed, not more than 10 or 12 ft. from the window. It was about 18 in. in diameter, and a streak of lightning led down from above on the left, while another came from the ground on the right. The ball was as round as the sun and of the same colour. Although it is difficult to judge of distance under such exciting conditions, it could not have been very far away because there were bushes and trees on the other side of the road, higher than the luminous ball, which would have hidden it from me had it been further off. Two horses were struck and killed by one of the two storms the same evening, so perhaps we had a narrow escape. A similar ball struck a house at Laindon.

JAMES RHODES.

The Elms, Horndon-on-the-hill, Essex, August 12th, 1937.

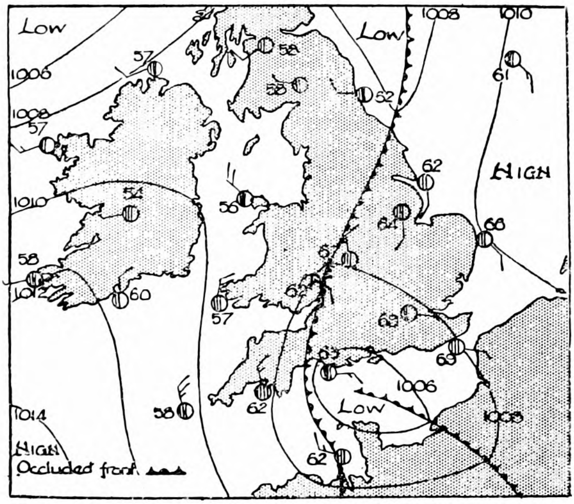
NOTES AND QUERIES

Thunderstorms of July 15th, 1937

On July 15th severe thunderstorms occurred over a wide area in England and Wales, the area extending from north Wales and Somerset and Dorset in the west to the east coast of England. In many areas, notably Gloucester, Somerset and Dorset the storms were accompanied by unusually heavy falls of rain. The following notes relate to the storms as experienced in the Bristol Area. All times are B.S.T.

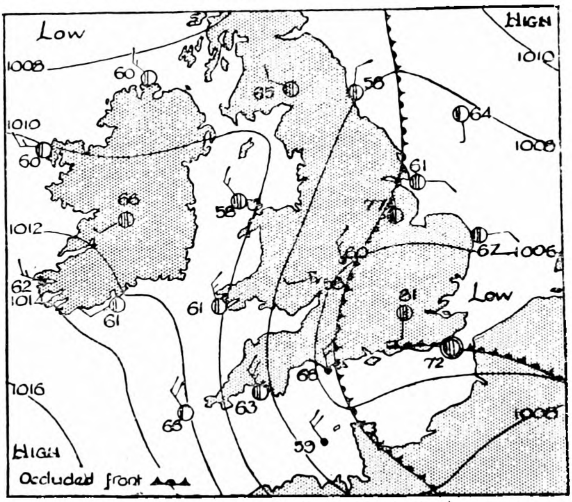
Two distinct storms could be recognised. In the first the rain commenced at Whitchurch at 9.15 a.m. and lasted until 10.45, the storm attaining its greatest intensity shortly after 10.0. During this period 1·12 in. (28·4 mm.) rain fell, of which 0·39 in. (10 mm.) fell in 4 minutes during the period of heaviest rainfall. The second storm broke over Whitchurch shortly before noon and during the period of heaviest rain was of comparable intensity to the first storm. Rain continued without cessation from shortly before noon till

5.40 p.m. yielding 2·16 in. (54·8 mm.) of which 1·28 in. (32·6 mm.) fell between noon and 1 p.m. Further occasional slight rain occurred and not until near dusk did the cloud break. Thunder was last heard at 2.45 p.m. In the City of Bristol severe flooding occurred in the low-lying portions of the city, the storm water invading shops and cellars while whole streets were rendered impassable for a time. The storms, occurring as they did when business and office people were going to their work and during the lunch hour, caused much personal discomfort and inconvenience. The total rainfall for the period 8 a.m. to 7 p.m. at Whitchurch and Horfield amounted to 3·29 in. (84 mm.) and 3·43 in. (87 mm.) respectively. The total fall at Horfield was the largest measured there since 1879 when 3·50 in. (89 mm.) were recorded.



SYNOPTIC CHART, 7H., JULY 15TH, 1937.

An examination of the weather charts showed an occlusion extending southwards through Wick to west of Scilly on the evening of the 14th. The system moved slowly eastwards: at Holyhead a thunderstorm occurred about midnight while an observer at Lynmouth reported "slight rain or drizzle about 1 a.m. B.S.T. followed by two peals of thunder about 2 a.m. with moderate rain. By 6 a.m. slight drizzle was falling, becoming intermittent later and ceasing by about 10 a.m." On the 15th the eastward motion was made very slow by a depression which, centred north



SYNOPTIC CHART, 13H., JULY 15TH, 1937

of Bordeaux on the morning of the 14th, had meanwhile moved north to mid-channel by the morning of the 15th. By the early hours of the 16th, the entire system had crossed the east coast of England with the general establishment of north-westerly winds at all levels. At Mildenhall on the morning of the 16th, the upper air was cooler at all levels as compared with the morning of the 15th, by 14° F, at 5,000 ft., 12° F at 10,000 ft., 9° F at 15,000 ft. and 3° F at 25,000 ft.

The intensity and duration of the rainfall was apparently mainly caused by the marked contrast and convergence between the warm moist air from France and the inflowing cooler air from the north-west and the slowing down of the eastward motion of the frontal system over west England.

P. I. MULHOLLAND.

At Beer, South Devon, there were slight showers from thundery clouds at a high level, many of them dissolving, after 21h. G.M.T. on July 14th. On the 15th thunder was frequent from 6 till 12h. G.M.T. The earlier storms were detached, but the main storm (about 9 to 11h.) was in a continuous belt moving slowly from west to east, though the individual cumulonimbus clouds moved from south to north, the height of their base being estimated as not less than 5,000 ft. The lower wind (fractostratus clouds) backed slowly from N. to NW. In south-west England the frontal action was mainly up aloft, though convergence in the lower air no doubt helped the storm. The very high temperatures in western France on the previous evening (93° F. at Rochefort) were significant. Severe storms coming over the Channel are always preceded by high temperature in France.

It was an interesting case of a front from the west, acting as a cold front, moving into a depression of entirely different origin.

C. K. M. DOUGLAS.

Thunderstorms in August

Although in England, August, 1937 was, on the whole, a dry month with an unusual number of days with no measurable rain, severe thunderstorms occurred at times, which were accompanied in some instances by heavy falls of rain in short periods of time. Thunderstorms were reported from a number of places on the 4th; in northern districts of London, flooding resulted from the heavy rain (at Hornsey 1.18 in. of rain fell in 40 minutes). On the 11th, thundery rains occurred locally in eastern England and we read in the press that 1.12 in. fell in about 60 minutes at Ely, Cambridgeshire. Thunderstorms were widespread in western and north-western England and the Midlands on the 12th. We read that at Newport, Monmouthshire, 1.71 in. of rain was recorded in 2 hours and that the hill tops in the direction of Caerleon were white with hail. The observer at

Oughtershaw Hall, Yorkshire, notes that at 3.50 p.m. on the 12th there was a sudden downpour of rain with thunder and lightning and hail like pieces of ice. The Wharfe became a torrent and trees and wooden bridges were swept away. In rather less than 2 hours 2.21 in. of rain fell.

The severe thunderstorms on the 13th were scattered throughout the British Isles, rainfall totals for the 24 hours ended on the evening of the 13th, amounting to 3.89 in., 2.56 in., 2.54 in. and 2.13 in. at such widely separated stations as Montrose, Portland, Nairn and Kew Observatory respectively while the total at Warrington was 3.16 in. for the 24 hours ending on the morning of the 14th. In London, streets were flooded and traffic disorganised over a wide area; at Hornsey 2.53 in. fell in 2 hours, at Kingston Grammar School 2.15 in. in 2 hours and at Kew Observatory 2.05 in. in 105 minutes.

Heavy hail was a feature of thunderstorms experienced in south-east England on the 30th. *The Times* of the 31st reported; "A pilot arriving (at Croydon) from France said that on the whole route from the south coast the ground appeared to be covered with hailstones .... At Wallington, Surrey, hailstones, some of them measuring $\frac{3}{4}$ in. in diameter, fell for half an hour". We hear from a resident at Bromley, Kent, that "hail which fell at about 5.30 p.m. was still on the roof (between the gables) when I left the next morning, and also a small patch in the garden." The rainfall recorded at Bromley, Kent, was 1.65 in., nearly all of which fell in one hour.

L. F. LEWIS.

The Prediction of Minimum Screen Temperatures at Aldergrove on Winter Nights

An investigation into minimum temperature prediction at Aldergrove on similar lines to that conducted at Larkhill, and noted by Mr. Andrews in the *Meteorological Magazine* for April 1934, p. 61 has been undertaken. Data were available for the years 1929–36.

The amount of cooling (T–M) was plotted against (T–D) as suggested by Col. Gold* and the following formula derived (see Fig. 2):—

$$(T\text{–}M) = -3{\cdot}5 + \tfrac{1}{4}T + \tfrac{11}{20}(T - D).$$

where T = 16h. temperature in °F.
M = minimum temperature in °F.
and D = dew point temperature at 16 h.

Comparing formulae for Larkhill, Catterick and Aldergrove we have:—

Larkhill	$(T - M) =$	$5{\cdot}5 + \frac{3}{20}\,T + \frac{2}{5}\,(T - D).$
Catterick	$(T - M) =$	$-7 + \frac{7}{20}\,T + \frac{1}{2}\,(T - D).$
Aldergrove	$(T - M) =$	$-3{\cdot}5 + \frac{1}{4}\,T + \frac{11}{20}\,(T - D).$

*London, Met. Mag., 69, 1934, p. 88.

Thus for a set of given conditions there is less cooling at Aldergrove than at either Larkhill or Catterick.

Conditions at the Aldergrove site are undoubtedly influenced, with

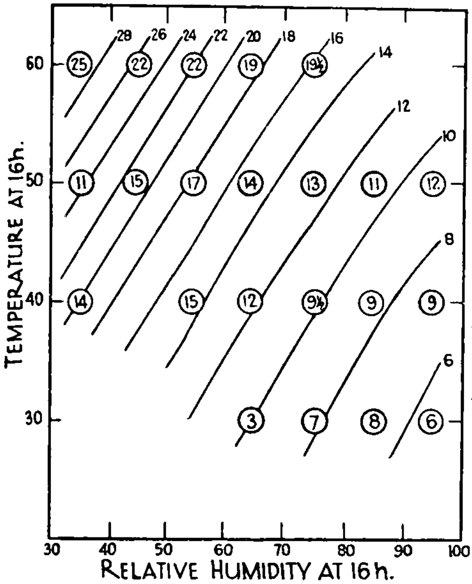


Fig. 1

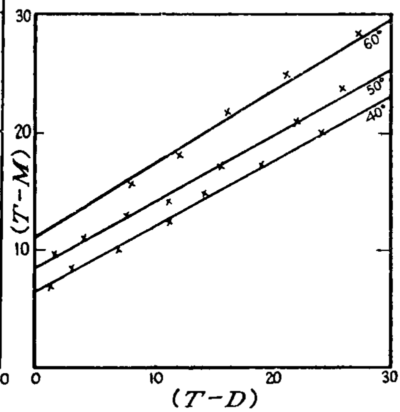


Fig. 2

westerly winds, by the proximity of Lough Neagh, a shallow stretch of water 140 sq. miles in extent and lying only two miles to the west. Temperatures of Lough Neagh at a point on the eastern shore have

TABLE I

Mean difference between 16h. temperature and minimum screen temperature on clear or partly clear nights at Aldergrove, October to March, 1929—36.

Temperature 16h.	25°–34°F.	35°–44°F.	45°–54°F.	55°–64°F.
Wind Velocity (m.p.h.) ...	0–12	0–12	0–12	0–12
Rel. Hum. 16h.	Temperature Difference $(T-M)$°F.			
90–100 per cent	(6)	9	12	..
80– 89 ,, ...	8	9	11	..
70– 79 ,, ...	7	9½	13	15½
60– 69 ,, ...	(3)	12	14	(19)
50– 59 ,, ...	..	15	17	22
40– 49 ,, ...	..	..	(15)	(22)
30– 39 ,, ...	..	(14)	(11)	(25)

Figures in brackets indicate 5 occasions or less.

been taken daily during 1936 and a rough analysis indicates that the water temperature fluctuates widely from day to day, the range of fluctuation naturally being less than that of the screen temperature. The main effect of the proximity of this large expanse of water is presumably to increase the humidity, hence the decreased cooling compared with Larkhill and Catterick. On calm nights a drainage of cold air from the higher ground to the east must be considered.

A comparison of the three results shows the final term fairly constant and bears out Mr. Flower's deduction† that the amount of cooling is dependent largely on locality.

This investigation also brought out the fact that the number of nights cloudless throughout to be expected during the winter months, October to March, is surprisingly small, the Aldergrove results giving only 7 per cent over the winters 1929–36.

W. F. PEATFIELD.

Was the Failure of the Spanish Armada due to Storms?*

It has for long been almost a commonplace of history that the complete failure of the Spanish Armada in 1588 was due mainly to unseasonably stormy weather. Mr. Holland Rose, after a detailed analysis of the circumstances attending the expedition, reverses this dictum and finds that the winds favoured the Spanish as often as the English fleet, but that the Spaniards completely failed to take advantage of their opportunities.

The meteorological history of these two eventful months begins with the Spanish fleet advancing up the Channel on July 20th with a light SW. wind. On the 23rd both fleets were becalmed off Portland Bill, but on the 24th a NE. wind sprang up at dawn, shifting later to SE. and then to SSW. Again on the 25th off the Isle of Wight a calm gave place to a freshening westerly wind, which continued until the 28th. On the 29th the decisive battle of Gravelines was fought in a moderate SSW. wind, veering to WSW.

The defeated Spaniards fled northwards before south-westerly winds, strong about August 5th. Two ships were lost on the coast of Norway, but the greater part of the fleet passed safely between the Orkneys and Shetlands with the aid of a timely NE. wind—which might well have been regarded as an interposition of Providence not against them but in their favour. From August 8th to 15th the wind was mainly south-easterly, keeping the Armada safely away from the west coast of Scotland. There was a storm off Rockall on August 22nd, but it was not until September that the broken fleet, approaching too near the west of Ireland in quest of water which could have been taken aboard with ease from northern Scotland, was caught and shattered by westerly gales on the 2nd and 10th.

Bearing in mind the seas traversed, we must agree with the

†*London, Met. Mag.*, 69, 1934, p. 232.

* By J. Holland Rose. Reprinted from the *Proceedings of the British Academy*, Vol. 22. London, Price 3*s*. net.

author that this record presents nothing beyond what should have been reasonably expected and guarded against. The thesis is admirably presented and makes a valuable addition to the literature of weather and war.

C. E. P. Brooks.

REVIEW

Meteorology of Great Floods in the eastern United States. By Charles F. Brooks and Alfred H. Thiessen. Reprinted from the Geographical Review, Vol. 27, No. 2, April, 1937, pp. 269–90.

The unprecedented floods in the Ohio River in January, 1937, briefly described in the *Meteorological Magazine* for February, p. 17, were due to extremely heavy rainfall concentrated along a rather narrow belt in the eastern States. The authors examine the meteorological situation accompanying this heavy rainfall and compare it with previous floods. In all cases the heavy rain was associated with a sharply defined front between a great current of warm moist tropical air from the Gulf of Mexico and Carribbean Sea, driven north by a persistent anticyclone near Bermuda, and a wedge of cold polar continental air from Canada. Under these conditions, while the eastern United States is abnormally warm, the west is abnormally cold. In January, 1937, oranges were freezing in southern California while they were ripening too fast in Florida. The greatest floods occur in winter and early spring not because the rainfall is heaviest then but because the frozen or saturated ground facilitates run-off. The melting of snow seldom contributes much directly to great floods but it may help to maintain the temperature contrast between the warm and cold air masses, and so intensify the rainfall along the front.

BOOKS RECEIVED

The dependence of terrestrial temperatures on the variations of the sun's radiation. By C. G. Abbot. Smithson. Misc. Coll., Vol. 95, No. 12, Washington D.C., 1936.

Bulletin de l'Observatoire de Talence (Gironde), 3rd Series, Nos. 19–26, Talence, 1936 and 1937.

NEWS IN BRIEF

We learn that Professor V. Conrad of Vienna University has been elected an honorary member by the Hungarian Meteorological Society, Budapest.

We learn that Dr. E. G. Mariolopoulos has resumed his post of Professor of Meteorology at the University of Salonica and Director of the Meteorological and Climatological Institute of the University.

The Weather of August, 1937

Pressure was highest north of the Azores and east of the White Sea, reaching about 1024mb. in each area. Pressure was below 1005mb. between Iceland and Greenland and over the New Siberian Islands, and below 1000mb. north of the Persian Gulf. Over Europe pressure decreased eastwards from 1019mb. in Ireland to 1011mb. in south-eastern Russia. No data were received for North America. Pressure was above normal over the northern half of Europe, the excess being more than 5 mb. from Ireland to the Urals and reaching 12mb. east of the White Sea. Pressure was below normal over southern Europe and south-western Asia and over most of the Arctic, the deficit reaching 7mb. in Greenland.

Temperature was lowest (31.5° F.) at Cape Chelyuskin. The isotherm of 40° F. ran from east Greenland in 70° N. across the north of Spitsbergen and Novaya Zemlya and along the arctic coast of Russia. Most of Ireland, Scotland, and the north of Scandinavia, Finland, northern Russia and the greater part of Siberia were between 50° and 60° F. England and the greater part of Europe were between 60° and 65° F., the Mediterranean lands 70–80° F. and the Nile Valley 83–94° F. The highest temperature reported, 99.5°, was at Shaibah near the Persian Gulf. Temperatures were more than 5° F. above normal over Scandinavia and Finland and east of the Caspian and 4–6° F. below normal in western Siberia; elsewhere the deviations were small. The British Isles and western Europe were 1–4° F. above normal.

Rainfall was abundant in central Europe, falls of 4–5 in. being nearly twice the normal for August, but the British Isles and Scandinavia were in general relatively dry. The Mediterranean lands, as is usual at this season, were dry.

In the southern hemisphere pressure was above 1020mb. over New Zealand and 1018 to 1021mb. over the southern half of Australia and Tasmania, decreasing northwards to an area of low pressure (1009mb.) over the Bismarck Archipelago. Pressure was more than 5mb. above normal over New Zealand and Tasmania, but below normal over Australia north of 32° N., New Guinea, the Bismarck Archipelago, and the islands of the west Pacific south of 10° S.

Temperature was about 80° F. in 10° S., decreasing southwards over Australia to 70° F. in 18° S., 60° F. in 25° S., and 50° F. along the south coast. In New Zealand the temperature decreased from 50° F. in the north to 45° F. in the south. New Zealand and the southern half of Australia were generally about 2° F. above normal; elsewhere the deviations were irregular.

In Australia the northern and central regions had little or no rain, while in the south and east totals were generally between 1 and 3 in. but the differences from normal were slight. New Zealand was relatively dry.

Apart from local thunderstorms the weather over the British Isles during August was mainly warm, dry and sunny, but with much morning mist or fog. Sunshine totals were above normal except along the eastern and northern coasts, Ilfracombe reporting over 60 hours more than the average, and rainfall showed a marked deficiency over the greater part of the country. New low rainfall records were registered at Gorleston (0.28 in.) where the records began in 1871 and at Cranwell (0.43 in.) where records began in 1917 and absolute droughts were established at a number of places in southern England. At Kew Observatory it was the warmest August since 1932 and at Renfrew the mean maximum of 67.6° F. was the highest for August since records began there in 1920. From the 1st to 4th a belt of high pressure covered the British Isles giving warm sunny weather generally with much morning mist or fog, which however on the 2nd and 3rd lasted throughout the day on parts of the east coast. Over 13 hrs. bright sunshine occurred at several places in the west and north on these days, 14.6 hrs. at Lerwick on the 2nd, and 13.9 hrs. at Morecambe on the 3rd. On the 4th a depression approaching from the Atlantic caused rain generally in Ireland and west Scotland and from then to the 19th depressions passed across the country in an easterly direction at first with their main centres to the north of the British Isles, but later with their centres further south. Apart from thunderstorms the weather continued generally fair and sunny in the south with rain locally on the 6th, 9th, 10th, and 16th, but unsettled conditions with rain at times though long bright periods were experienced in Scotland, Ireland and north England. Thunderstorms occurred in England and south Scotland on the 3rd, 4th and 6th, were widespread over the whole of the British Isles on the 12th to 14th and in Scotland on the 18th, those on the 12th to 14th being accompanied in some places by heavy rain which caused flooding*. The sunniest days of the period over the country generally were the 7th, 8th and 15th, 14.8 hrs. at Morecambe on the 7th, 13.8 hrs. at Bude on the 8th and 13.7 hrs. at Chester on the 15th, and in the south most days except the 14th were sunny. Temperature was high generally between the 5th and 13th, reaching 92° F. at Greenwich on the 6th and Tunbridge Wells on the 7th and exceeding 80° F. at many places on several days. On the 13th in the rear of one of the depressions passing across the country temperatures fell somewhat and remained about normal until after the 19th. Much morning mist or fog was experienced on the 5th, 6th, 10th to 13th, and occasionally lasted during the day in parts of the eastern coasts, the English Channel and St. George's Channel. On the 19th a wedge of high pressure extended north-east from the anticyclone near the Azores and from then to the 29th pressure remained high over the country generally with fair sunny weather except in the northern

* See p. 189.

districts which came at times under the influence of the depressions to the north—this was especially so on the 24th to 25th when the rain area from the depression to the north extended over Ireland, Scotland and north England with gales in north Scotland on the 24th. In the south-west the sunny days continued until the 30th, but in the south-east after the 25th the days though dry were mainly overcast. Temperature was high generally exceeding 70° F. at many places in the south on most days while among the largest amounts of sunshine recorded were 13.8 hrs. at Morecambe on the 21st and 13.5 hrs. at Tiree on the 26th. Much morning mist or fog occurred during this time. Temperature fell generally in the north on the 29th and thunderstorms occurred in many parts of England on the 30th, sometimes accompanied by hail. By the 31st a deep depression was approaching from the Atlantic and rain fell generally in the west and north. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	116	−12	Chester ...	185	+26
Aberdeen ...	127	−13	Ross-on-Wye...	202	+30
Dublin	165	+11	Falmouth ...	229	+33
Birr Castle ...	160	+23	Gorleston ...	160	−37
Valentia... ...	164	+16	Kew	210	+27

Kew, Temperature, Mean 65·5° F., Diff. from normal + 2·8° F.

Miscellaneous notes on weather abroad culled from various sources.

The great glacier lake of Demmevann above the Hardangerfjord burst its confines on the 11th and the resultant flood of water, boulders and iceblocks fell into the Simo Valley and destroyed 16 farms—the 130 inhabitants clambered up the mountainside to safety. The flood originated in the glacier of Hardangerjockel near Rembesdalskjaak above Lake Demmevann. A waterspout struck the zone between Borgovecchio and Gea Marina (north Italy) on the 16th, killing four children and injuring 50 people. During a violent thunderstorm, accompanied by hail and heavy rain, at Massa, on the west coast of Italy, thousands of birds were dashed from the trees there and killed. A large avalanche which is an unusual event at this season, occurred on the Blickenspitze in Tirol owing to a sudden fall in the temperature. (*The Times*, August 12th–30th.)

More than 50 people have been drowned as the result of extensive floods in various districts of Burma at the beginning of the month. A fortnight's incessant heavy rain caused the rivers Gogra and Rapti in the central and eastern parts of the United Provinces to overflow their banks by the 18th isolating hundreds of villages—by the 23rd the flood waters were gradually subsiding. Delhi and east Punjab on the other hand were suffering from lack of rain. (*The Times*, August 4th–24th.)

Many bush and forest fires had been experienced in Newfoundland by the 9th owing to the prolonged heat and drought. Violent thunderstorms occurred in New York State on the 11th and again on the 22nd, after which the prolonged heat wave with high humidity ended. In the United States temperature was above normal, especially in the Missouri Valley about the middle of the month, while rainfall was mainly below normal during the first part of the month becoming generally above normal in the eastern and central States later. (*The Times*, August 6th–24th, and *Washington D.C.*, *U.S. Dept. Agric.*, *Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, August, 1937

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	1023·4	NE.3	55	76	62	—	9·0	
2	1023·6	NE.2	55	76	65	—	11·4	w early.
3	1019·9	NW.1	55	81	56	—	8·3	w m early.
4	1017·7	S.2	57	82	51	—	6·8	w early.
5	1018·7	SW.2	62	80	52	—	5·1	pr_0 8h.–9h.
6	1016·6	SSW.3	59	85	48	—	12·2	w early.
7	1014·8	N.2	62	82	51	—	12·2	w early.
8	1019·4	N.2	58	77	46	—	11·2	
9	1020·6	SW.3	58	79	46	—	11·7	
10	1017·7	SW.3	64	76	60	0·10	3·1	r_0 2h.–3h., R 16h.–17h.
11	1013·8	WSW.2	63	78	67	trace	4·3	r_0 3h.–4h.
12	1012·2	NE.3	60	80	55	—	9·6	tl 21h.
13	1008·0	N.3	63	72	79	2·14	2·0	TLR 15h.–17h.
14	1008·2	W.2	62	69	96	0·53	0·0	R 12h.–13h. & 16h.–17h.
15	1012·6	W.4	51	67	47	—	11·0	
16	1010·1	SW.3	54	69	59	0·21	5·8	r_0–r 17h.–20h., R 20h.–21h.
17	1007·8	W.3	59	72	58	—	7·7	pr_0 2h.
18	1016·2	SW.3	58	72	57	—	3·4	
19	1020·5	W.4	55	68	47	—	10·1	w early.
20	1022·0	NW.3	52	68	52	—	7·9	w early.
21	1019·7	NW.4	56	66	76	—	5·7	r_0 8h. & 10h.
22	1021·7	N.2	54	71	61	—	9·5	w evening.
23	1021·6	N.2	52	75	51	—	10·5	w early.
24	1020·6	SSW.2	54	77	53	—	10·5	w early.
25	1021·6	Calm	56	76	55	—	3·9	w early.
26	1025·6	NE.3	59	69	71	—	0·5	w m early.
27	1027·0	NE.2	58	64	74	—	0·0	d_0 8h.
28	1022·4	NNW.1	55	67	75	—	1·9	w evening.
29	1021·2	N.1	55	71	66	—	2·8	w early.
30	1020·4	SSW.2	53	75	64	—	4·4	w early.
31	1018·4	S.2	55	77	61	—	7·6	w m early.
*	1018·2	—	57	74	60	2·98	6·8	* Means or Totals.

General Rainfall for August, 1937

England and Wales ...	46	per cent of the average 1881–1915.
Scotland	91	
Ireland	76	
British Isles	63	

Rainfall : August, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	1·34	61	*War* .	Birmingham, Edgbaston	·97	36
Sur .	Reigate, Wray Pk. Rd.	1·50	61	*Leics* .	Thornton Reservoir	·67	24
Kent .	Tenterden, Ashenden	1·63	71	,, .	Belvoir Castle	·76	29
,, .	Folkestone, Boro. San.	1·01	...	*Rut* .	Ridlington	1·40	56
,, .	Margate, Cliftonville	1·42	74	*Lincs* .	Boston, Skirbeck	·59	25
,, .	Eden'bdg., Falconhurst	2·53	97	,, .	Cranwell Aerodrome	·43	16
Sus .	Compton, Compton Ho.	1·77	57	,, .	Skegness, Marine Gdns.	·73	30
,, .	Patching Farm	1·54	61	,, .	Louth, Westgate	·53	19
,, .	Eastbourne, Wil. Sq.	1·80	73	,, .	Brigg, Wrawby St.	1·49	...
Hants.	Ventnor, Roy.Nat.Hos.	1·64	82	*Notts* .	Worksop, Hodsock	·20	8
,, .	Fordingbridge, Oaklnds	1·20	46	*Derby*.	Derby, The Arboretum	·30	11
,, .	Ovington Rectory	1·28	47	,, .	Buxton, Terrace Slopes	1·35	31
,, .	Sherborne St. John	1·29	53	*Ches* .	Bidston Obsy	1·63	53
Herts .	Royston, Therfield Rec.	1·10	43	*Lancs*.	Manchester, Whit. Pk.	1·23	36
Bucks.	Slough, Upton	1·28	59	,, .	Stonyhurst College	2·89	57
,, .	H. Wycombe, Flackwell	1·45	60	,, .	Southport, Bedford Pk.	1·37	39
Oxf .	Oxford, Radcliffe	·44	19	,, .	Ulverston, Poaka Beck	2·52	47
N'hant	Wellingboro, Swanspool	2·28	96	,, .	Lancaster, Greg Obsy.	2·64	58
,, .	Oundle	1·11	...	,, .	Blackpool	2·02	56
Beds .	Woburn, Exptl. Farm	2·36	102	*Yorks*.	Wath-upon-Dearne	·27	11
Cam .	Cambridge, Bot. Gdns.	·88	37	,, .	Wakefield, Clarence Pk.	·56	22
,, .	March	1·60	67	,, .	Oughtershaw Hall	4·34	...
Essex.	Chelmsford, County Gdns	·71	33	,, .	Wetherby, Ribston H.	1·18	43
,, .	Lexden Hill House	1·13	...	,, .	Hull, Pearson Park	·77	26
Suff .	Haughley House	·85	...	,, .	Holme-on-Spalding	·96	36
,, .	Rendlesham Hall	1·41	71	,, .	West Witton, Ivy Ho.	1·41	48
,, .	Lowestoft Sec. School	·44	20	,, .	Felixkirk, Mt. St. John.	1·39	49
,, .	Bury St. Ed., Westley H.	3·06	118	,, .	York, Museum Gdns.	1·79	71
Norf.	Wells, Holkham Hall	1·21	50	,, .	Pickering, Hungate	1·80	70
Wilts.	Porton, W.D. Exp'l. Stn	1·13	50	,, .	Scarborough	·74	27
,, .	Bishops Cannings	·93	30	,, .	Middlesbrough	1·13	41
Dor .	Weymouth, Westham.	...	...	,, .	Baldersdale, Hury Res.	1·33	38
,, .	Beaminster, East St.	1·07	34	*Durh* .	Ushaw College	2·14	74
,, .	Shaftesbury, Abbey Ho.	1·78	61	*Nor* .	Newcastle, Leazes Pk.	2·55	90
Devon.	Plymouth, The Hoe	·86	28	,, .	Bellingham, Highgreen	3·00	85
,, .	Holne, Church Pk. Cott.	·90	20	,, .	Lilburn Tower Gdns.	2·94	104
,, .	Teignmouth, Den Gdns.	1·38	61	*Cumb*.	Carlisle, Scaleby Hall	2·09	51
,, .	Cullompton	·99	33	,, .	Borrowdale, Seathwaite	6·00	55
,, .	Sidmouth, U.D.C.	1·59	...	,, .	Thirlmere, Dale Head H.	3·85	50
,, .	Barnstaple, N. Dev.Ath	1·33	39	,, .	Keswick, High Hill	3·15	60
,, .	Dartm'r, Cranmere Pool	2·00	...	*West* .	Appleby, Castle Bank	1·57	48
,, .	Okehampton, Uplands.	·99	23	*Mon* .	Abergavenny, Larchf'd	1·09	37
Corn .	Redruth, Trewirgie	1·19	35	*Glam* .	Ystalyfera, Wern Ho.	1·26	20
,, .	Penzance, Morrab Gdns.	·63	20	,, .	Treherbert, Tynywaun.	1·04	...
,, .	St. Austell, Trevarna	·55	15	,, .	Cardiff, Penylan	·38	9
Soms .	Chewton Mendip	·97	22	*Carm* .	Carmarthen, M. & P. Sch.	1·80	38
,, .	Long Ashton	2·01	57	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	·73	23
,, .	Street, Millfield	1·58	...	*Card* .	Aberystwyth	1·35	...
Glos .	Blockley	·81	...	*Rad* .	BirmW.W.Tyrmynydd	1·04	19
,, .	Cirencester, Gwynfa	·59	20	*Mont* .	Lake Vyrnwy	2·13	41
Here .	Ross-on-Wye	·87	34	*Flint* .	Sealand Aerodrome	1·47	...
Salop.	Church Stretton	1·39	43	*Mer* .	Blaenau Festiniog	4·60	45
,, .	Shifnal, Hatton Grange	·73	26	,, .	Dolgelley, Bontddu	1·10	20
,, .	Cheswardine Hall	·96	29	*Carn* .	Llandudno	1·67	59
Worc .	Malvern, Free Library	·43	15	,, .	Snowdon, L. Llydaw 9.	6·85	...
,, .	Ombersley, Holt Lock.	1·29	48	*Ang* .	Holyhead, Salt Island	1·61	51
War .	Alcester, Ragley Hall	1·26	45	,, .	Lligwy	·98	...

Rainfall : August, 1937 : Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem....	2·20	58	*R&C* .	Achnashellach	3·38	51
Guern.	St.Peter P't.Grange Rd.	·43	18	,, .	Stornoway,C.GuardStn.	4·05	...
Wig .	Pt. William, Monreith.	2·23	58	*Suth* .	Lairg........................	2·25	71
,, .	New Luce School.........	2·89	65	,, .	Skerray Borgie...........	1·82	...
Kirk .	Dalry, Glendarroch......	3·60	75	,, .	Melvich.....................	2·14	72
Dumf.	Dumfries, Crichton R.I.	2·25	59	,, .	Loch More, Achfary....	3·44	59
,, .	Eskdalemuir Obs........	3·85	75	*Caith* .	Wick........................	3·09	112
Roxb .	Hawick, Wolfelee........	2·91	87	*Ork* .	Deerness	2·35	82
Peeb .	Stobo Castle.............	3·44	97	*Shet* .	Lerwick	1·93	69
Berw .	Marchmont House......	2·87	87	*Cork* .	Dunmanway Rectory...	...	...
E.Lot .	North Berwick Res.....	...	...	,, .	Cork, University Coll...	1·78	53
Midl .	Edinburgh, Blackfd. H.	4·13	129	,, .	Mallow, Longueville....	1·72	55
Lan .	Auchtyfardle	3·92	...	*Kerry*.	Valentia Observatory...	2·96	62
Ayr .	Kilmarnock, Kay Park	3·34	...	,, .	Gearhameen..............	3·60	47
,, .	Girvan, Pinmore.........	3·80	85	,, .	Bally McElligott Rec...	2·45	...
,, .	Glen Afton, Ayr San....	2·44	45	,, .	Darrynane Abbey.......	3·21	74
Renf .	Glasgow, Queen's Park	3·57	101	*Wat* .	Waterford, Gortmore...	1·85	49
,, .	Greenock, Prospect H..	3·69	68	*Tip* .	Nenagh, Castle Lough.	...	...
Bute .	Rothesay, Ardencraig...	4·24	87	,, .	Roscrea, Timoney Park	...	...
,, .	Dougarie Lodge..........	4·67	110	,, .	Cashel, Ballinamona....	2·44	70
Arg .	Loch Sunart, G'dale....	5·64	99	*Lim* .	Foynes, Coolnanes......	2·02	52
,, .	Ardgour House..........	4·37	...	*Clare* .	Inagh, Mount Callan....	4·76	...
,, .	Glen Etive................	4·74	63	*Wexf* .	Gorey, Courtown Ho...	1·47	44
,, .	Oban........................	3·69	...	*Wick* .	Rathnew, Clonmannon.	1·35	...
,, .	Poltalloch..................	4·29	88	*Carl* .	Bagnalstown,Fenagh H.	2·48	71
,, .	Inveraray Castle.........	7·19	109	,, .	Hacketstown Rectory...	4·21	104
,, .	Islay, Eallabus...........	3·68	84	*Leix* .	Blandsfort House.......	2·13	54
,, .	Mull, Benmore...........	9·40	80	*Offaly*.	Birr Castle................	3·33	87
,, .	Tiree	3·54	84	*Kild* .	Straffan House...........	3·86	102
Kinr .	Loch Leven Sluice.......	5·50	144	*Dublin*	Dublin, Phoenix Park..	2·34	74
Fife .	Leuchars Aerodrome...	3·42	111	*Meath*.	Kells, Headfort..........	3·51	85
Perth .	Loch Dhu..................	5·20	77	*W.M* .	Moate, Coolatore.........	2·22	...
,, .	Crieff, Strathearn Hyd.	4·05	96	,, .	Mullingar, Belvedere...	2·27	54
,, .	Blair Castle Gardens....	2·76	82	*Long* .	Castle Forbes Gdns......	2·67	65
Angus.	Kettins School...........	4·28	117	*Gal* .	Galway, Grammar Sch.	2·86	69
,, .	Pearsie House...........	2·88	...	,, .	Ballynahinch Castle....	3·91	71
,, .	Montrose, Sunnyside...	5·44	195	,, .	Ahascragh, Clonbrock.	3·51	84
Aber .	Balmoral Castle Gdns..	1·74	57	*Rosc* .	Strokestown, C'node.....	...	...
,, .	Logie Coldstone Sch....	1·96	62	*Mayo*.	Blacksod Point..........	4·85	106
,, .	Aberdeen Observatory.	2·71	99	,, .	Mallaranny	6·32	...
,, .	New Deer School House	1·79	60	,, .	Westport House.........	3·55	88
Moray	Gordon Castle...........	2·60	82	,, .	Delphi Lodge.............	7·65	89
,, .	Grantown-on-Spey	2·20	69	*Sligo* .	Markree Castle..........	3·97	92
Nairn.	Nairn	5·43	225	*Cavan*.	Crossdoney, Kevit Cas..	3·14	...
Inv's .	Ben Alder Lodge.........	3·32	...	*Ferm* .	Crom Castle..............	4·11	99
,, .	Kingussie, The Birches.	2·57	...	*Arm* .	Armagh Obsy............	2·93	81
,, .	Loch Ness, Foyers	3·65	119	*Down*.	Fofanny Reservoir......	4·13	...
,, .	Inverness, Culduthel R.	5·67	222	,, .	Seaforde	2·41	64
,, .	Loch Quoich, Loan......	3·18	...	,, .	Donaghadee, C. G. Stn.	2·76	83
,, .	Glenquoich................	4·25	52	*Antr* .	Belfast,Queen's Univ....	3·26	113
,, .	Arisaig House............	4·51	78	,, .	Aldergrove Aerodrome.	3·36	93
,, .	Glenleven, Corrour......	...	...	,, .	Ballymena, Harryville.	4·14	97
,, .	Fort William, Glasdrum	4·56	...	*Lon* .	Garvagh, Moneydig....	4·80	...
,, .	Skye, Dunvegan.........	6·84	...	,, .	Londonderry, Creggan.	4·08	88
,, .	Barra, Skallary..........	2·68	...	*Tyr* .	Omagh, Edenfel.........	3·99	93
R&C .	Alness, Ardross Castle.	...	...	*Don* .	Malin Head..............	3·13	...
,, .	Ullapool	1·68	47	,,	Dunkineely................	3·55	...

Climatological Table for the British Empire, March, 1937

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 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.	1004·6	— 8·8	55	26	45·3	34·5	39·9	— 3·3	35·1	87	7·1	2·76	+ 1·07	18	3·6	31
Gibraltar	1016·0	— 1·1	63	45	59·0	50·4	54·7	— 2·9	50·4	82	6·1	5·35	...	17	...	...
Malta	1014·3	+ 0·1	75	46	63·2	53·5	58·3	+ 1·2	53·5	77	4·2	0·83	— 0·65	3	8·6	72
St. Helena	1010·5	— 1·9	74	62	70·6	63·7	67·1	+ 2·0	64·8	95	9·4	6·06	+ 2·04	27	...	...
Freetown, Sierra Leone	1009·7	+ 0·7	91	71	88·0	76·1	82·1	...	76·6	79	5·3	6·01	+ 4·85	7	...	...
Lagos, Nigeria	1008·9	0·0	94	73	89·8	78·5	84·1	+ 0·7	77·8	85	6·8	5·05	+ 1·30	7	7·6	63
Kaduna, Nigeria	1009·4	...	99	59	97·0	64·0	80·5	— 0·6	60·2	47	2·5	0·05	— 0·49	1	9·1	76
Zomba, Nyasaland	1008·2	— 1·4	86	60	81·0	64·6	72·8	+ 1·5	68·5	78	6·6	2·07	— 7·01	8	...	...
Salisbury, Rhodesia	1010·4	— 1·1	85	48	80·3	56·8	68·5	+ 0·3	61·8	67	4·0	2·53	...	8	8·4	69
Cape Town	1014·1	— 0·4	94	53	78·4	60·0	69·2	+ 1·1	60·1	78	5·2	1·86	+ 0·98	6	...	...
Johannesburg	1011·2	— 1·2	82	41	75·8	53·6	64·7	+ 1·3	55·9	66	3·0	2·63	— 1·81	10	9·2	75
Mauritius	1010·6	— 1·3	87	70	83·8	73·4	78·6	+ 0·6	75·7	83	6·6	9·14	+ 0·55	19	6·9	57
Calcutta, Alipore Obsy.	1009·1	— 0·8	97	61	91·2	69·6	80·4	+ 0·2	70·0	80	3·9	0·38	— 1·00	1*	...	...
Bombay	1009·5	— 1·4	90	67	84·9	71·5	78·2	— 1·3	70·2	74	2·1	0·00	— 0·02	0*	...	...
Madras	1009·6	— 1·3	93	68	88·9	73·8	81·3	+ 0·2	75·7	76	4·0	0·00	— 0·34	0*	...	...
Colombo, Ceylon	1009·4	— 0·7	89	71	87·2	74·3	80·7	— 1·1	77·4	75	4·6	6·48	+ 2·20	11	9·1	75
Singapore	1008·2	— 1·5	92	72	87·9	75·8	81·9	+ 0·7	77·8	78	5·9	6·93	+ 0·47	13	7·5	62
Hongkong	1012·5	— 3·5	81	51	68·6	61·4	65·0	+ 1·7	62·2	89	9·1	3·45	+ 0·51	17	1·7	14
Sandakan	1008·8	...	90	74	88·5	76·1	82·3	+ 1·3	77·5	80	6·7	0·65	— 7·82	8	...	...
Sydney, N.S.W.	1016·6	+ 0·3	95	56	77·1	63·3	70·2	+ 0·9	64·1	68	5·8	9·06	+ 4·08	13	6·8	56
Melbourne	1017·0	+ 0·1	92	48	77·1	54·9	66·0	+ 1·5	58·9	68	4·5	1·24	— 0·94	10	7·4	60
Adelaide	1017·6	+ 0·5	98	50	83·9	61·9	72·9	+ 3·0	61·5	44	4·7	1·05	+ 0·03	6	7·8	64
Perth, W. Australia	1014·2	— 1·1	95	52	81·6	61·8	71·7	+ 0·5	61·3	57	3·4	0·15	— 0·66	6	9·7	80
Coolgardie	1013·9	— 1·0	99	47	81·5	60·2	70·9	— 1·0	61·7	69	5·0	4·86	+ 3·92	9	...	...
Brisbane	1015·1	+ 0·7	97	63	81·8	66·4	74·1	— 0·2	68·4	73	5·1	7·26	+ 1·49	12	6·5	54
Hobart, Tasmania	1015·9	+ 1·7	87	45	67·1	52·1	59·6	+ 0·3	53·7	64	6·3	1·47	— 0·23	11	6·4	52
Wellington, N.Z.	1017·4	+ 0·2	74	43	64·4	53·8	59·1	— 1·5	56·0	82	8·5	2·22	— 1·11	13	5·4	44
Suva, Fiji	1008·4	0·0	92	72	86·2	75·6	80·9	+ 0·8	76·7	83	6·3	17·53	+ 3·04	26	5·8	48
Apia, Samoa	1008·1	— 1·1	89	71	85·6	74·2	79·9	+ 0·6	77·3	81	6·0	16·15	+ 2·17	26	6·0	49
Kingston, Jamaica	1013·1	— 1·8	89	66	85·5	69·0	77·3	+ 0·2	67·0	81	1·6	0·01	— 1·01	1	7·7	64
Grenada, W.I.	1011·0	— 2·0	90	71	86	73	79·5	+ 1·7	73	74	4	1·35	— 1·31	16	...	...
Toronto	1015·2	— 2·1	45	9	34·7	22·5	28·6	— 1·0	...	...	5·9	1·48	— 0·93	12	4·9	41
Winnipeg	1023·4	+ 4·2	48	—21	26·5	7·7	17·1	+ 2·1	...	...	6·4	0·28	— 0·88	7	5·4	45
St. John, N.B.	1007·1	— 7·0	47	5	35·4	20·7	28·1	— 0·3	23·1	72	5·6	2·66	— 1·88	14	5·4	45
Victoria, B.C.	1014·1	— 1·8	61	36	51·7	40·6	46·1	+ 2·6	43·0	82	8·0	1·35	— 1·08	13	4·2	35
Addendum: Grenada, W.I.—January—	1011·3	— 1·5	88	71	85	72	78·5	+ 1·4	73	74	5	5·53	+ 1·15	[illegible]		

38704) Wt. 20/31 1125 9/37 Hw. G. 377/6

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

Oct., 1937

No. 861

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

The Electrical Structure of Thunderclouds

Of the many theories that have been put forward to explain the mechanism of thunderstorms there are two which still find considerable support, viz:—Wilson's influence theory and Simpson's breaking-drop theory. Until recently the evidence for and against these theories has been derived almost wholly from observations made at the surface of the earth, and it seemed that no further advance towards the correct solution of the problem could be made except by means of direct observations of the distribution of electricity in and above thunderclouds. A method of obtaining such observations was devised at Kew Observatory in 1934, and an account of the results which have since been obtained has been published recently*.

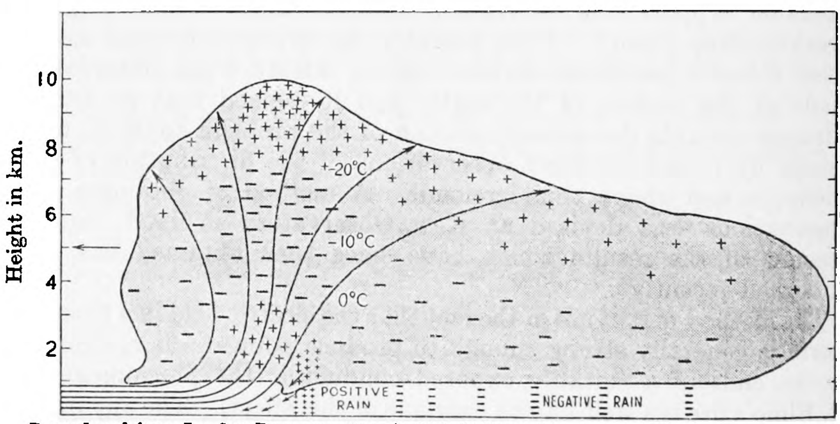
The method makes use of the fact that the electric field in a thunderstorm is generally strong enough to produce point-discharge current at the ends of a suitably exposed conductor (the phenomenon of St. Elmo's fire is a well-known example of this effect). The apparatus, which was carried up by a sounding balloon, consisted essentially of a thin wire about 20 m. long hanging vertically from a recording device that indicated, by means of pole-finding paper, in which direction, up or down the wire, the point-discharge current flowed;

* "The Distribution of Electricity in Thunderclouds," by Sir George Simpson. K.C.B., D.Sc., F.R.S. and F. J. Scrase, M.A., B.Sc., *London Proc. roy. Soc.* A, **161**, 1937, pp. 309–52.

an aneroid recorder for determining the height was included in the apparatus. From the direction of the point-discharge current the sign of the electric field producing it was determined and the distribution of positive and negative electricity at various heights was deduced from this.

A statistical examination of 31 soundings which yielded good records showed that in nearly every case there was evidence of positive electric charge in the upper parts of the thunderclouds, and in about two-thirds of the cases there was negative charge in the lower parts of the clouds. On the other hand, there were a number of occasions in which there was a positive charge at the base of the cloud as well as in the upper part, the negative charge lying between the two. An examination of the data, obtained from ground apparatus as well as from balloon soundings, for individual storms showed that the lower positive charge was generally concentrated in a relatively small region near the front part of the base of the cloud and was associated with the heaviest rain which was positively charged. Estimates of the temperatures at various heights in the clouds showed that the region of separation between the negative charge and the upper positive charge occurred at levels where the temperature was well below the freezing point; the lower region of positive charge occurred at the base of the cloud where the temperature was above the freezing point.

From these results it is concluded that a well-developed thundercloud has a structure similar to that shown in the generalised diagram reproduced in Fig. 1. In this diagram the charges in the



Reproduced from London Proc. roy. Soc. A, 161, 1937, p. 350.

FIG. 1—GENERALISED DIAGRAM SHOWING AIR CURRENTS AND DISTRIBUTION OF ELECTRICITY IN A TYPICAL HEAT THUNDERSTORMS.

cloud and on the rain are indicated by positive and negative signs; the unbroken lines with arrow-heads represent stream-lines of air, their distance apart being proportional to the wind velocity. There is a strong upward current of air in the base of the cloud near the front and it is just above this strong current that the lower region of positive charge is located; to the rear of this region the vertical air current is weaker and the heavy rain which falls out is positively charged. Apart from the local concentration of positive electricity the lower half of the cloud is negatively charged. The upper part of the cloud is positively charged and the region of separation between this upper positive charge and the negative charge occurs at a level where the temperature is between $-10°$ and $-20°$ C.

It was natural to see, first of all, whether either of the current theories could satisfactorily explain the results of the investigation. According to Simpson's theory, when a raindrop breaks up into smaller drops the water becomes positively charged and the air negatively charged. The negative charge attaches itself to the cloud particles, which are carried upwards in the ascending air currents, leaving positively charged drops behind. As a result of this separation of electricity the positive charge is concentrated in regions near the base of the cloud where ascending currents can support large quantities of water whilst the negative electricity is distributed with the cloud particles in the middle and upper parts of the cloud. Now the results of the soundings support the breaking-drop theory in the following particulars: (*a*) regions of positive electricity are found in the lower parts of the cloud where the temperature is above the freezing point and (*b*) these regions are closely associated with the more active parts of the storms where ascending air currents are highly developed and where the heavy rain occurs. Thus the theory explains the concentration of positive electricity in the base of the cloud; it also accounts for part of the negative electricity higher up in the cloud but the breaking of drops certainly does not explain the positive charge found at the top of all the thunderclouds investigated. At first sight it seemed as if Wilson's theory would fill the gap left by Simpson's theory since the former was put forward to account for the positive electricity at the top of a thundercloud and negative electricity below. The basis of Wilson's theory is that drops of water suspended in an electric field have charges of opposite sign induced on their upper and lower halves. As the drops fall in ionised air they tend to gain a net charge by attracting the ions of opposite sign to the charge on their lower halves. An essential part of the theory is that the drops must fall more rapidly than the electric field drives the ions downwards, otherwise the upper halves would also attract ions and no net charge would be gained. The result of the process is that in, say, a field which was initially positive the drops carry down a negative charge to the lower part of the cloud whilst positive charge is left to accumulate at the top, the initial positive field being thereby increased. Now the results of the soundings showed that the boundary between the positive electricity in the upper part of the cloud and the negative in the lower, was in every case in a region where the temperature was well below freezing point and generally below −10° C. In this part of the cloud the precipitation must be in the form of ice crystals (the cloud particles themselves may be supercooled water, but on coalescing they would immediately freeze). These crystals cannot play the part of raindrops in Wilson's theory for they are almost perfect non-conductors and do not become electrically polarised; moreover, their rate of fall relative to the air is slow. It appears then, that Wilson's influence theory does not explain the separation of electricity in the upper part of the thunder-clouds. On the other hand there is little doubt that this upper separation of charge is associated with the presence of ice crystals. Probably the mechanism by which this separation of electricity is brought about is the same as that which produces strong electric fields during blizzards in polar regions; these fields are nearly always positive, *i.e.*, in the same direction as the field in the upper part of a thundercloud. Simpson has suggested that the impact of ice crystals results in the ice becoming negatively charged and the air positively charged; the general settling of the crystals relative to the air would cause a separation of electricity with positive charge above the negative.

The final conclusion is that there are two different physical processes taking place in a thundercloud to produce the electrical effects: one is confined to the upper parts of the cloud where the temperature is below the freezing point and the other occurs in the lower part of the cloud where the temperature is above the freezing point. It is believed that the former is connected with the presence of ice crystals and that the latter is explained by the electrification due to the breaking of raindrops.

The Five Year Cycle in the Circulation of the Atmosphere over the British Isles

By C. E. P. Brooks, D.Sc.

In his interesting article on "British Wind-Direction Periodicities" published in the *Meteorological Magazine* for July, Mr. Baxendell refers to various periodicities of a few years in the frequency of winds from different directions at Southport. One of the most interesting of these, of slightly over five years, was discovered by Mr. Baxendell himself.*

A few years ago Miss T. M. Hunt and I tabulated long series of resultants of wind direction frequencies at London, Edinburgh and Dublin† and one of the first uses made of these figures was a preliminary investigation of periodicities of wind direction in London.‡ The results were of sufficient interest to decide me to carry out the

* *London, Quart. J.R. met. Soc.*, 51, 1925, p. 371.
† *London, Quart. J.R. met. Soc.*, 59, 1933, p. 375.
‡ *London, Met. Mag.*, 68, 1933, p. 155.

analysis in greater detail in order to study the variations of the atmospheric circulation involved. The analysis of the periodicity of just over five years has now been completed.

In the published tabulations* the resultants, calculated from frequencies of wind from different directions irrespective of force, were given only for the winter and summer seasons and for the year. It was first necessary to calculate the resultants for spring and autumn also, in order to have a continuous series of seasonal values; at the same time the data were extended to 1936. The figures for each season were expressed as components from north and east, and these were analysed separately. Seasonal means of pressure were also calculated for Stykkisholm (Iceland), Edinburgh, London, Paris and Valentia, though the last series is relatively short.

The method adopted to investigate the periodicity was a simple arithmetical one. Each interval of five years, or 20 seasonal values, was regarded as one oscillation with a length of five years, and the values of a and b were evaluated in the expression

$$w = a \sin t + b \cos t.$$

Overlapping sums of six successive a's and b's were formed, and from each pair of sums the amplitude and phase angle of the 5-year periodicity were calculated for the 30-year interval. The phase angles were plotted and most of the graphs showed a slow decrease of phase, indicating that the trial period of five years was too short. The best fitting straight line was then worked out in each case by the method of least squares, weighting according to the amplitude. This process gave the most probable lengths of the cycle of about five years as follows :—

TABLE I.—CALCULATED LENGTHS OF PERIODICITY.

		Years.	Period.
London ...	N. component ...	5·04	1715–44, 1772–1936.
	E. component ...	5·05	
Edinburgh ...	N. component ...	5·05	1787–1936.
	E. component ...	5·14	
Dublin ...	N. component ...	5·05	1726–65, 1831–50, 1872–1936.
	E. component ...	?	
Stykkisholm ...	Pressure ...	5·08	1846–1935.
Edinburgh ...	Pressure ...	5·06	1817–1906.
London ...	Pressure ...	5·18	1787–1936.
Paris	Pressure ...	5·11	1757–1936.

It will be seen that the calculated lengths of the cycle in the N. component of wind direction frequency at all three places and in the E. component at London, agree very closely. At Edinburgh and Dublin the E. component is very small. The pressure data gave less concordant results, confirming a statement by Mr. Baxendell

* *London, Quart. J.R. met. Soc.*, 59, 1933, p. 375.

that the periodicity is much more clearly shown in the frequency of northerly winds than in pressure. At Edinburgh the pressure data for the years from 1772–1816 and 1907–36 showed no evidence of a periodicity of about five years, but the period 1817–1906 showed a periodicity of 5·06 years very clearly.

From these results it appeared that over two centuries or more the most probable length of the oscillation was not 5·1 or 5·09 years as previously supposed, but more nearly 5·05 years. The detailed study of the plotted phase angles for the N. component shows, however, that it has varied from time to time. At London it was 5·09 years from 1715 to 1797, 5·03 years from 1802 to 1887 and again 5·09 years from 1887 onwards. At Edinburgh there were breaks about 1840 and 1860, while at Dublin the length was about 5·0 years from 1726 to 1765 and 5·1 years from 1831 to 1936.

Assuming, however, a length of 5·05 years throughout in all series we have the following sine terms, with zero at January 1st, 1931. The amplitudes of the wind components are expressed as percentages of all observations, those of the pressures in millibars. The last column gives the standard deviations of the seasonal resultants or means in the same units.

TABLE II—SINE TERMS OF 5·05 YEAR PERIODICITY.

			S.D.
London 1715–1936	... N. component ...	1·4 sin (t + 108)	14
	E. component ...	1·0 sin (t + 87)	16
London 1772–1936	... N. component ...	2·0 sin (t + 98)	...
	E. component ...	1·3 sin (t + 77)	...
Edinburgh ...	... N. component ...	3·0 sin (t + 67)	13
	E. component ...	0·8 sin (t + 49)	15
Dublin	... N. component ...	1·7 sin (t + 47)	11
	E. component ...	0·4 sin (t + 74)	15
Stykkisholm ...	... Pressure	0·77 sin (t + 39)	4·0
Edinburgh ...	... Pressure	0·31 sin (t + 73)	2·7
London	... Pressure	0·18 sin (t + 154)	2·8
Paris	... Pressure	0·13 sin (t + 185)	2·9
Valentia (1867–1936)	... Pressure	0·21 sin (t + 108)	3·6

Mr. Baxendell places a maximum in the five year cycle of frequency of N. and NE. winds at Southport at the end of April 1926, which gives the phase on January 1st, 1931 as 63°, in good agreement with Edinburgh and Dublin. The results of the early series (1715–44) in London do not fit in very well with the later observations, so the sine terms were re-calculated for the interval 1772–1936.

A comparison of the phase angles of the N. and E. components throws some light on the nature of the wind oscillation. At all three stations the difference between the two components is less than 30°. Hence at each station these two components reach their positive values at nearly the same time, become zero and then again reach their greatest negative values almost simultaneously. In other words, a component from NNE. reaches its maximum, dies away and is replaced by a component from SSW. The resultant wind direction oscillates without veering or backing appreciably.

The sine terms for pressure are of great interest. The amplitude increases progressively from Paris to Iceland, and the phase angle decreases. This strongly suggests a wave of pressure advancing from south-south-east to north-north-west and increasing in amplitude as it does so. Measuring approximate distances along a line from Paris to Stykkisholm, we have the following data for the wave :

	Paris.	London.	Dublin.	Edinburgh.	Stykkisholm.
Distance (Km)	0	420	665	910	2340
Time (yrs)	0	0·44	1·08	1·58	2·08
Amplitude (mb) ...	0·13	0·18	0·21	0·31	0·77

It occurred to me that traces of this curious wave of pressure might be shown in the frequencies of occurrence of different types of anomalies of monthly mean pressure distribution as classified by myself and Miss W. A. Quennell*. I accordingly analysed the frequencies of each type and sub-type for a 5-year periodicity, using the data for 1873–1900 and 1910–35 inclusive. I found that types II D 6 and II E both showed a well-marked 5-year periodicity, with a much smaller reverse effect in the opposite types I D 6 and I E. The frequencies, expressed as percentages of all types, are as follows, the figures entered to year 1 being the sums of the frequencies in 1876, 1881, 1886, etc., those entered to year 2 the sums of 1877, 1882 and so on.

Year.	1	2	3	4	5
Type II D 6	9	4	3	8	11
„ II E	4	3	7	10	5
„ I D 6	2	5	3	5	1
„ I E	5	5	3	2	4

None of the other types or sub-types showed a noticeable 5-year periodicity. Now II D 6 is characterised by a deficit of pressure centred north of Iceland, and II E by a deficit of pressure over the Arctic Ocean generally. The two types are fairly similar, and a combination of them is shown in Fig. 1. The values assigned to the isopleths are arbitrary and inserted merely for illustration.

If the sums of II D 6 and II E in the table are expressed as a sine series, the phase angle (zero at January 1st, 1931) is found to be 150°. These types reach their maximum frequency approximately

* *London, Geophys. Mem.* 4, No. 31, 1926.

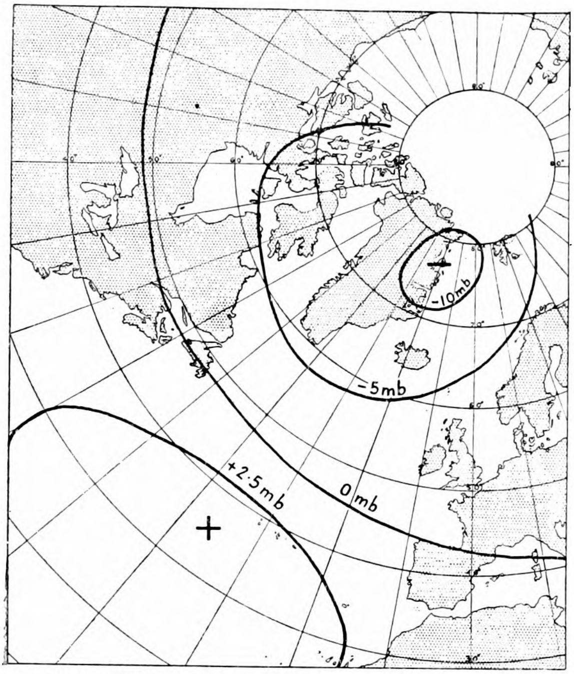


FIG. 1.—COMBINATION OF TYPES II D 6 AND II E.

a year after the 5-year pressure wave at Stykkisholm reaches its minimum. This lag is about equal to that to be expected from the rate of progression of the pressure wave from Paris to Stykkisholm. In other words, about the time that the minimum of the wave would be expected to reach north-east Greenland, there is a greater tendency for the deviations from normal to take the distribution shown in Fig. 1 than at other times.

The variations of the resultant winds in the 5·05 year cycle fit in excellently with the variations of pressure distribution. This was shown by constructing a series of generalised charts from the sine terms in Table II putting $t = 0, 1, 2, 3$ and 4 years. The map for $t = 0$ (*i.e.* January 1st, 1931 and multiples of 5·05 years before or after) is reproduced in Fig. 2 as a specimen. Here the direction of the arrows represents the direction of the resultant wind and the length of the arrows their constancy. The figures represent deviations of pressure in hundredths of a millibar and isopleths of pressure deviation have been drawn. A wind arrow for Southport has been added from Mr. Baxendell's data.

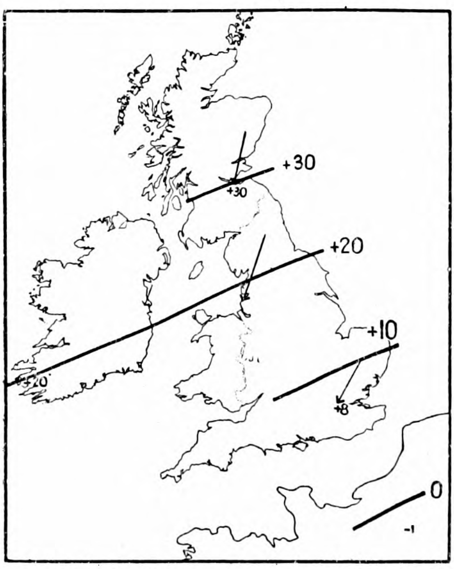


FIG. 2.—5·05 YEAR CYCLE, STAGE t=0. DEVIATIONS OF PRESSURE AND RESULTANT WIND FROM NORMAL.

The result of this investigation is to show that the 5·05 year cycle in the resultant wind direction in the British Isles is in some way associated with the advance northwards of a series of pressure waves, which are very small in France and southern England but increase rapidly in amplitude as they approach Iceland. The focus towards which these waves are directed apparently lies in the Arctic regions near the north of Greenland. I have termed them " waves " but this does not imply that they necessarily take the form of sine curves. Fig. 3 shows the average variations of pressure at Edinburgh and Stykkisholm in the cycle of 5·05 years. The curves are constructed from seasonal means, unsmoothed. At Edinburgh

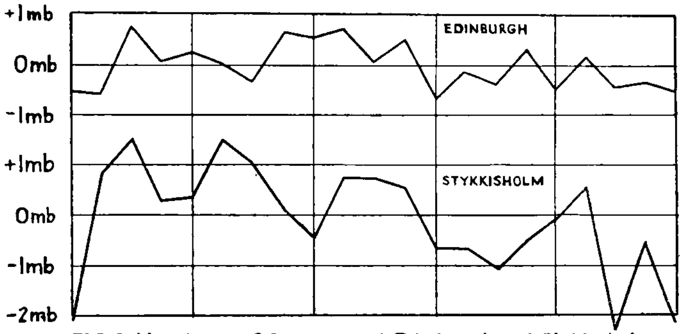


FIG 3 Variations of Pressure at Edinburgh and Stykkisholm in 5·05 year cycle.

the curve though irregular is fairly symmetrical, but at Stykkisholm the variation is more of the " saw-tooth " type, a rapid rise from minimum to maximum being followed by a slow oscillating fall from maximum to minimum. The change is curiously suggestive of the passage of a tide of the open sea into the tidal bore of a river, but whether the analogy has any significance is another matter.

OFFICIAL PUBLICATIONS

The following publications have recently been issued :—

Annual Report *of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the year ended March* 31, 1937.

The year under review was a period of planning and preparation in the Meteorological Office with the object of providing the greatly extended meteorological services required by the expanding Royal Air Force and the increased flying on civil air routes both in Great Britain and overseas. Additional officers were recruited and trained to staff the many new meteorological stations required on service and civil aerodromes in Great Britain and in connexion with the Empire Air Routes, both trans-Atlantic and eastwards. The Office also has been called upon to provide officers to take up appointments created by other services to meet the needs of Empire Air Routes.

In order to carry out a special programme of meteorological observations and investigation over the North Atlantic an officer has been attached to the s.s. *Manchester Port* for a year, *i.e.* to make eight round voyages between England and Canada.

Much attention has been given to the problem of the issue of warnings of the formation of ice on aircraft, which has been brought to the fore by the increased amount of flying within clouds now carried out by all types of aircraft.

PROFESSIONAL NOTES

No. 77. Variations of temperature at Oxford 1815–1934. BY LILIAN F. LEWIS, B.Sc. (M.O. 336*q*.)

The paper contains a comprehensive analysis of the mean monthly and annual temperatures at Oxford from 1815–1934. An examination of the data shows that variations of temperature from the normal are considerably greater in the winter months, December, January and February than in any other month.

The second part of the note is concerned with an investigation of the records with regard to the secular trend of temperature. A curve, representing the variations in the twenty-year averages of mean annual temperature, is found to be definitely periodic. It has been suggested that the climate in middle latitudes of the northern hemisphere is tending to become somewhat milder and if the statistics for Oxford were available only since 1870, the curve would give some support to this suggestion, but the complete curve shows that similar mild periods have occurred previously. A curve representing approximately the annual range of temperature indicates that conditions were unusually equable during the first quarter of the twentieth century.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are—

November 1st, 1937. *The evaporation of water from plane and cylindrical surfaces.* By R. W. Powell and E. Griffiths. (London, Trans. Instn. chem. Engrs., 13, 1935, pp. 175–98.) *Opener*—Mr. E. Ll. Davies, M.Sc.

November 15th, 1937. *The mean transport of air in the Indian and South Pacific Oceans* and *Outlines of Philippine frontology.* Both by C. E. Deppermann. (Manila Weather Bureau 1935 and 1936.) *Opener*—Mr. R. A. Watson, B.A.

Correspondence

To the Editor, *Meteorological Magazine*

Snowfall at Nottingham

May I suggest that the work of the British Group of the International Snow Commission would be appreciably helped if meteorological observers were to give more attention to the incidence and depth of snow.

During the past twenty-two years I have kept a record of snow days, days with snow lying, and depth of snowfall at Nottingham, and the following table gives the average values for each month over this period. No snow occurred in the four months June to September.

	Jan.	Feb.	Mar.	Apr.	May	Oct.	Nov.	Dec.	Year
Days with snow ...	4·7	5·2	4·9	2·6	0·3	0·3	1·5	3·4	22·9
Days with snow lying	4·1	4·5	3·0	0·8	0·0	0·1	1·0	3·5	17·0
Depth of snowfall in inches	2·3	3·2	2·2	0·5	0·0	0·0	0·4	1·3	9·9

In my records a day with " snow lying " is a day on which snow is definitely lying during the period and not merely at the hour of the morning observation. Days on which the ground may be whitened for a brief period by a snow shower are not counted as days with snow lying. The " morning observation " rule for snow lying is open to some objection. The ground might be free from snow at 9 a.m. on a certain day, but it might be covered by 10 a.m. and remain so all day. If a mild wind set in clearing the snow before the next morning's observation, no record would be made of " snow lying ", although actually it had been lying for hours. In keeping my record of " depth of snowfall " I have entered the actual depth of snow falling and lying each day as accurately as possible. I adopted the depth of ¼ inch as a minimum amount in much the same way that ·01 inch is used as the unit of rainfall. Depths under, say about one-eighth of an inch, I entered as trace, but such days were counted as days with " snow lying ", provided that at least half of the ground was covered. In very cold weather a mere sprinkling of snow may cover the ground for a day or two. The term " depth of snow " in my record excludes snow and sleet which thaws as it reaches the ground. In most registers, I imagine, no record is kept as to depth of snow falling beyond notes of the amount in considerable falls.

Systematic records of depths of snow all over the country on a basis such as I have outlined would produce interesting and useful data. The value of such records would be greatly increased were they standardised by rules formulated by the Meteorological Office.

ARNOLD B. TINN.

Kenilworth, Calstock Road, Woodthorpe, Nottingham, August 30th, 1937.

Lowest Rainfall for August, 1937

From the *Meteorological Magazine* I find that no station showed a lower rainfall total in August than the 0·18 in. recorded here. The closest approach was the return from Hodsock Priory, Worksop, 61 miles east-south-east from here, where 0·20 in. was measured. At Wath-upon-Dearne, 6 miles north, 0·27 in. fell.

Through the courtesy of the Borough Engineer for Rotherham

I am able to give herewith a selection of the readings of his gauges :—

Kimberworth Central School	... ...	0·17 in.
Aldwarke Sewage Works	... ...	0·13 in.
Spurley Hey Central School	... ...	0·12 in.

In view of these figures is it possible that a very circumscribed area in and about Rotherham has had the meteorological distinction of being the driest part of the British Isles in August, 1937 ?

A partial drought of 52 days started on July 22nd and ended on September 12th, during which period the total rainfall amounted to 0·36 in.

L. ATKINSON.

136, Broom Lane, Rotherham, Yorkshire, September 24th, 1937.

Remarkable Gloom in Dyffryn Clwyd

A spell of gloom occurred at Trefnant, in the Clwyd Valley, this afternoon, that I think should be recorded. After two or three cold days, the air this morning became warmer and felt humid, with a light NNE. wind. At 3 p.m. B.S.T. it became gloomy and the aspect of the sky caused me to prepare to record a thunderstorm. However, nothing came except a few drops of rain at 3·5 p.m. The darkness increased and after a few minutes it was impossible to see indoors without artificial light. Very heavy rain occurred from 3·28 p.m. to about 4·10 p.m., the gloom steadily growing thicker, and it was at its worst at 5 p.m., when the sky was practically indistinguishable. Even the gardeners had to stop work through inability to see, and rooks and jackdaws congregated at 4·55 p.m. and began to roost. This is an extraordinary happening in an area such as ours, so far remote from industrial areas.

Gradually after 5 p.m. the light got better until 5·35 p.m. when it was normal for a dull wet autumn day. It was dead calm throughout at the surface, with a very slow cloud drift from north-north-east. At the thickest of the gloom the colour was strongly yellow. I imagine from the appearance of things that an inversion was present and the wind, not being strong enough to dispel factory smoke, drifted slowly along charged with soot, and that we actually had Lancashire smoke fog in North Wales.

S. E. ASHMORE.

Llannerch Gardens, St. Asaph, Flintshire, North Wales, September, 13th, 1937.

Aurora at Boscombe Down on September 11th, 1937

A good auroral display was observed this morning (September 11th) as I was cycling from Salisbury to Boscombe Down aerodrome (in a northerly direction) from 2h. 45m. G.M.T., to 3h. 30m. G.M.T. The glow when first seen extended upwards from about 5° or 10° above the horizon and consisted of diffuse streaks of white light. After about 4 or 5 minutes it assumed a dull pinkish hue and streamers were observed upwards to an elevation of 30° to 40°

approximately. Subsequently the intensity of the display varied considerably; the light increased to a maximum which lasted for 10 to 12 minutes and then faded to a diffuse patch of light up to about 15° to 20° elevation, finally disappearing almost completely. After 5 or 6 minutes the phenomenon reappeared and the same sequence was repeated. The sky was cloudless, visibility 8 to 12 miles, wind northerly, 5 to 6 m.p.h., temperature 39° F.

W. A. A. KINGE.

Meteorological Station, R.A.F., Boscombe Down, Wilts., September 11th, 1937.

NOTES AND QUERIES

The Daily Range of Temperature

In the article entitled "The Unequal Heating of Land and Water" in the August issue of the *Meteorological Magazine,* some estimates are given of the mean daily range of temperature over land surfaces. The estimates are derived from values of mean daily maximum and mean daily minimum temperatures. That is a very common method of studying questions related to the diurnal variation of temperature, but it is as well to remind ourselves occasionally that it gives an extremely inaccurate idea of the true diurnal range of temperature, that is to say the average amount by which the temperature in the afternoon exceeds that in the early morning.

The proper method of examining this question is to study averages of hourly values, such as those which are available for the principal observatories. That is the only method that would occur to anyone who wanted to study the diurnal variation of pressure, of wind, or of almost any other element. In the case of temperature it happens to be the custom to tabulate daily extremes—mainly because it happens to be very easy to observe the daily extremes. We have acquired the habit of referring to the maximum temperature as the "day temperature" and the minimum temperature as the "night temperature", and of regarding the "mean daily range", as measured by the average difference between these quantities, as an approximation to the average daily rise of temperature due to insolation.

That is a mistaken idea, as we may see at once by a study of the data for Kew Observatory. The averages of hourly values for the period 1871–1915 are given in *Hourly Values from Autographic Records* 1915, 1916 and 1917. They are in degrees on the absolute tercentesimal scale; when converted to degrees Fahrenheit we find that the range of the hourly mean varies from 3·9° F. in December to 13·7° F. in June. Actually, the true diurnal range slightly exceeds the value found in this way because the highest and lowest points on the curve may not occur at exact hours, but the error is very small. We do not possess averages of daily extremes for the same period, but we have the values for 1881–1915 published in the "Book of Normals", Section I. These give us "mean daily ranges" varying from 8·5° F. in January to 16·8° F. in June. Thus the daily range derived from readings of maximum and minimum thermometers is about double the true diurnal range in winter, and 23 per cent greater than the true diurnal range in summer. On the average for the whole year the range of daily extremes exceeds the true diurnal range by about 40 per cent at Kew.

The explanation of these discrepancies lies, of course, in the fact that solar radiation is not the only factor in causing the reading of the maximum thermometer to exceed that of the minimum thermometer. If we could expose self-registering thermometers at a point out at sea where there is no appreciable diurnal variation of temperature, we should still find substantial differences between the maximum and minimum daily readings, due to the casual and non-periodic changes arising from variations in the source of the air supply. A small daily range would also arise from the seasonal variation. In the neighbourhood of the British Isles the daily range due to such causes would appear to be 3° F. to 5° F., the variation being smaller in summer than in winter.

I do not wish to suggest that the author of the article was unfamiliar with the facts outlined above. I venture to think that the magnitude of the error made by the common method of determining the diurnal range of temperature may not, however, be fully appreciated by some of your readers. That is my excuse for troubling you with this note.

E. G. Bilham.

Rainfall experienced during 1937

The incidence of rainfall so far experienced during 1937 over the British Isles, and more especially over England and Wales, is worthy of special comment. The early part of the year was abnormally wet, and details of the persistent rains of January to February were given on pp. 42–3 and of January to March on pp. 70–1 of this magazine.

Over the British Isles as a whole the rainfall of each of the first five months of the year, viz., January to May, exceeded the average. Over England and Wales all five months were also wetter than usual, but over Scotland only the first two and over Ireland only the first four months gave more than usual. Details of the general rainfall January to May, 1937 and the average values are given in Table I. The total experienced over England and Wales as a whole was comparable with that over Scotland and Ireland, although on the average England and Wales are appreciably drier. The total of 21·2 in. exceeds the average amount by as much as 8·6 in., and is greater than that of any similar period back to before 1870. The next wettest first five months of the year back to 1870 were those of 1920, 1877 and 1872 with 17·5 in., 18·4 in., and 17·6 in., respectively.

Table I also gives details of the rainfall June to September, 1937. The total was again most striking over England and Wales, being

TABLE I

	England and Wales	Scotland	Ireland
	in.	in.	in.
January–May, 1937	21·2	21·2	21·8
January–May. Average*	12·6	19·1	16·5
June–September, 1937	8·1	15·1	14·3
June–September. Average* ...	11·2	15·1	13·5

* For the period 1881–1915.

3·1 in. less than the average, whereas over both Scotland and Ireland the rainfall approximated closely to the average. The total of 8·1 in. over England and Wales compares with 8·0 in., 8·2 in., and 7·0 in. for similar periods during 1933, 1929 and 1921, respectively.

In spite of the fact that the total rainfall over England and Wales for January to September, 1937 is as much as 5·5 in. above the average, the incidence of four consecutive dry months, June to September, has resulted in the ground at the beginning of October being generally dry with only small storages of water for supply in many localities.

J. GLASSPOOLE.

REVIEW

The climates of the continents. By W. G. Kendrew, M.A., 3rd edition. Size 9 in. × 5½ in., pp. xii + 473. *Illus.* Oxford. At the Clarendon Press, 1937. 21*s*. net.

Mr. Kendrew's book has become a classic of English climatology. Published first in 1922 to " fill a gap in the sources available for the study of the earth " it rapidly went out of print; a second edition which appeared in 1927 was reprinted in 1930, and a third edition has now followed in 1937.

The general arrangement of the volume is identical with the earlier editions, but nevertheless the changes are considerable even though they are chiefly concerned with details only. The whole of the text has been reset, the tables have been revised and many of the maps and diagrams have been redrawn in order to incorporate the most recent information. This applies especially to the maps of temperature, rainfall and wind; most of these are new and take into consideration much of the vast amount of information published in the climatological atlases of the several countries that have recently appeared. The new edition carries a much enlarged bibliography which now appears at the end of the book instead of at the beginning and is classified geographically according to the continents.

The whole is a very readable volume. Statistics are there for those who like them, but they are kept apart from the text which is amply illustrated by no less than 160 charts and diagrams. The text is not confined to a description of the data, the reader of a chapter is left with a vivid conception of the type of weather that is experienced and this is due very largely to the number of quotations interspersed in the text giving descriptions by local residents of some of the notable happenings of the weather.

To criticise the details of the facts presented would require a reviewer of encyclopaedic knowledge and is beyond the capacity of the present writer. One point however may be noted. Recent memoirs on the depressions of eastern Asia by Father Gherzi of the Zi-ka-wei Observatory and by members of the staff of the Nanking Research Institute have shown that in the winter and spring months the precipitation in these depressions differs very notably from that of the depressions of western Europe in that it falls almost entirely in the rear of the depression after the passage of the cold front. It is apparently carried by the E. and SE. winds as Mr. Kendrew suggests but it falls only after these winds have been undercut by the cold northerly winds in the rear; according to the old Chinese proverb "Rainfall bearers are the north-easters". A summary of the main facts of these depressions would form a useful addition to the volume; their characteristics are comparatively little known to western meteorologists and they have an important influence on the climate of eastern Asia.

One of the facts which the reading of the volume brings home is the importance of orographic features and of ocean currents in determining the climate of any locality; they are referred to in almost every chapter. As the one refers to the land and the other to the sea a single chart of the world would carry them both, and might well form a frontispiece even on small scale to any new edition that may be called for.

The index runs to some 13 pages. It is limited almost entirely to geographical names, though the names of certain local winds are also included; it appears however to be adequate to its purpose. For anyone accustomed to revised editions the necessity of checking the entries against the final text is illustrated; a chance reference revealed the fact that entries for page 313 were assigned to 312 apparently on account of a transposition of the pages in the proof stage.

The title of the book is itself a challenge. Mr. Kendrew has provided English speaking peoples with an excellent volume on "The Climates of the Continents" will he, or any other enterprising meteorologist, provide a companion volume on the corresponding features of the oceans.

E. E. Austin.

BOOKS RECEIVED

Estudios Meteorologicos de Colombia, 1931–1935. Bogota, 1936.

Mysore Meteorological Memoirs No. XI. Monthly and annual means of hourly values of weather elements, Bangalore Observatory, 1915–1929. Bangalore, 1935.

OBITUARY

Richard Inwards.—We regret to learn of the death on September 30th of Mr. Richard Inwards. Mr. Inwards was born at Houghton Regis on April 22nd, 1840, and so lived to within three years of his century. From an early age he was interested in meteorology and astronomy, joining the Royal Meteorological Society in 1862 ; his work as a mining expert and mine manager carried him into many distant parts of the world, and he accumulated a great fund of knowledge concerning the various weather beliefs current in the form of proverbs in various countries. In 1893 he published a collection of these " proverbs, sayings and rules concerning the weather " under the title of " Weather Lore." This well-known book went through three editions, the last appearing in 1898, and is still a valuable source of information.

Mr. Inwards took a very active part in the work of the Royal Meteorological Society. He served as President in 1894 and 1895, taking as the subjects of his addresses " Weather Fallacies " and " Meteorological Observatories." He also served as Treasurer and for twenty years he took a large share in editing the *Quarterly Journal*. In his later years he was a well-known figure in Highgate, and in the early 1920's he was often to be seen walking in Parliament Hill Fields. He also played chess and retained his faculties so well that long after his 80th birthday he could hold his own with much younger men. He was by many years the Senior Fellow of the Royal Meteorological Society and the Council sent him telegrams of congratulation on each successive lustrum that he completed. Mr. Inwards never married, but his loss will be felt by a wide circle of friends among the older meteorologists.

NEWS IN BRIEF

We learn that Dr. Heinrich v. Ficker, Professor of Meteorology at the University of Berlin has been appointed Professor of Geophysics at the University of Vienna and Director of the Zentralanstalt für Meteorologie und Geodynamik.

With effect from July 1st, 1937, the newly established independent Meteorological Service of Burma took over the duties of issuing weather reports and forecasts for air routes in Burma, work which was previously performed by the Calcutta Office of the India Meteorological Department.

The Weather of September, 1937

In the northern hemisphere pressure was lowest (1000 mb.) over Iceland where it was 6–8 mb. below normal, and highest (1,024 mb., 4 mb. above normal) west of the Azores. There was thus an unusually steep gradient for westerly winds over the Atlantic, west of the British Isles, continuing as a gradient for south-westerly winds over Scandinavia and the eastern Baltic. The Azores anticyclone was continued as a narrow ridge of high pressure (1,016 mb.) along the Alps, broadening out eastwards into a weak anticyclone (1,019 mb., 3–4 mb. above normal) north of the Caspian. Over most of Asia and North America pressure was rather uniform, between 1015 and 1018 mb., and the deviations from normal were small.

The mean temperature for 18 days at the north pole was 9°F., but most of the Arctic coasts of Asia and America were about 35° F., rising to 39° at Spitsbergen and Bear Island. In Europe temperature increased from 45° F. in the north of Norway to 50° in the Shetlands, central Scandinavia and Finland, 60° south of the English channel and across the Alps and central Europe and 70° from Gibraltar across southern Italy, Greece and the Black Sea and north of the Caspian; upper Egypt was still above 90° F. Most of central Siberia lay between 40° and 50° F., but on the Pacific coast temperature increased from 58° F. in 50° N. to 75° F. at Shanghai and 82° F. at Hongkong. In America and northern Canada temperature was below 40° F., rising to 50° F. from central Alaska to south of Hudson Bay, 60° F. in about 45° N., 70° F. in 35° N. and 80° F. on the Gulf Coast of the United States. Temperatures were generally above normal, especially north of the Black Sea and Caspian, where the excess was 8°–10° F.; in Alaska, north-west and west Canada, excess 4°–6° F., and the coast of Newfoundland and Nova Scotia, excess 5° F. The British Isles were 1° F. above normal in the north-west and 1° F. below normal at Kew. The eastern United States, the Alps and central Siberia were also slightly below normal.

Precipitation was heavy (4–8 in.) on the coast of north-west Europe, where it was generally about 1½ times the normal, decreasing rapidly eastwards ; it was also abnormally heavy in parts of southern Europe. In America the falls of 1–2 in. were generally somewhat below normal.

In Australasia pressure was highest (1020 mb.) between New South Wales and New Caledonia and west of Perth (West Australia) while a large area below 1010 mb. extended from French Indo-China across the Philippines. Most of Australia was about 1016–1019 mb., New Zealand 1012–1014 mb. The deviations from normal were generally small, but reached +4 mb. at Sydney. Temperature decreased from 80° F. over Indo-China, Siam, Malaya, the Philippines and the Northern Territory of Australia to 70° F. in about lat. 21° S, 60° F. in lat. 28° S. in the west and 35° S. in eastern Australia and 50° F. south of Tasmania. In New Zealand temperature decreased from 53° F. in the north to 47° F. in the south. The deviations from normal were generally small but Victoria and Tasmania were about 2° F. above normal and central Australia 3° F. below normal. Much of Australia was rainless but about an inch fell in New South Wales and 1–3 in. on the south coast. In New Zealand and Tasmania the rainfall was heavier (3–6 in.) but in both countries the falls were generally below normal.

Over the British Isles during September temperature was above the average at the beginning and end of the month but below the average in the middle of the month. Both rainfall and sunshine were in general about the average except that rainfall was considerably in excess in south Ireland and sunshine in the Midlands and east Scotland, while there was a marked deficiency of sunshine in Ireland. There was also much early morning mist or fog. From the 1st to 6th a deep depression centred to the north-west of the British Isles caused generally unsettled warm weather with frequent rain in the north and west, 2·06 in. at Inagh (Co. Clare) on the 4th and 1·56 in. at Troutbeck (Cumberland) on the 5th. In the south some rain occurred in most parts on the 1st, 2nd and 7th, but otherwise until the 9th conditions there were mainly dry and sunny, 11·1 hrs. bright sunshine were experienced at Point of Ayre on the 2nd and over 10 hrs. at many places in the south on the 3rd to 6th and in north England and Scotland on the 5th. On the 7th to 9th the depression to the north moved away eastwards but on the 9th a deepening depression moved south-east across the south-western districts to France causing rain in most parts except the north. Gales were experienced in the north-west and north on the 5th to 9th. After the 8th there was a general drop in temperature with the change to northerly winds, maxima had reached 80° F. at Cambridge, Norwich and Oxford on the 7th, but a maximum of 51° F. was reported from Waterford on the 9th and of 52° F. at Cullompton on the 10th. From the 10th to 12th cold anticyclonic weather prevailed with much sun on the 10th and 11th, but overcast skies on the 12th. From then to the 22nd pressure was generally low over the country except on the 14th and 21st when ridges of higher pressure passed across. During this period the weather was unsettled. Thunderstorms were frequent, being reported from some part or other of the country on each day from the 13th to 20th inclusive—they were most widespread on the 17th—while hail was recorded at a few places and a gale in north-west Ireland on the 21st. Morning mist or fog occurred locally, becoming more general on the 19th, 21st and 22nd when it was thick in places. Temperature continued low for the time of year—on a few nights screen minima as low as 30° F. to 35° F. were recorded—though between about the 15th to 18th maxima approached nearer the average. With the change to southerly winds veering south-west on the 22nd, temperature rose again generally reaching 70° F. at a few places. On the 23rd and 24th dry sunny anticyclonic conditions with morning mist or fog prevailed in the south but the north and west came under the influence of a depression to the north which was moving eastwards. Gales were reported from the north-west on the 24th. A trough of low pressure extending from this depression passed across the south on the 25th causing the wet weather to spread south followed by cold northerly winds. In the north the 25th was a sunny day, Aberdeen had 10·2 hrs. bright sunshine. On the 26th there was a return to warm sunny conditions in the south and east owing to the influence of the anticyclone extending from Scandinavia to the Mediterranean while a depression lay to the west. This depression brought slight rain to the north and south on the 27th, while central districts had considerable sunshine. From the 28th to 30th the south came under the influence of an anticyclone passing from the Atlantic to the continent while the north and, from the evening of the 29th, Ireland were influenced by deep depressions to the north moving eastwards which caused considerable rain at times. In the south there was much mist or fog on the mornings of the 29th and 30th, but much sunshine on all three days which extended at times to the north as well. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	102	− 8	Chester ...	138	+ 8
Aberdeen ...	160	+34	Ross-on-Wye ...	153	+17
Dublin	113	−17	Falmouth ...	160	+ 2
Birr Castle ...	92	−27	Gorleston ...	152	− 6
Valentia... ...	100	−27	Kew	153	+ 7

Kew, Temperature, Mean 57·5° F., Diff. from normal − 1·0° F.

Miscellaneous notes on weather abroad culled from various sources.

Severe gales were reported on all coasts of France on the 11th and 12th. A sudden cold spell was experienced in Switzerland and Austria about the 13th, snow falling down to the 3,000 ft. level. Thunderstorms accompanied by torrential rains swept the Riviera on the night of the 13th and floods were experienced in the Rhone Valley about the 20th. Persistent heavy rain for a fortnight caused the waters of Lake Como to rise so much on the 20th that the town of Como was partly flooded—most of the rivers in northern Italy were in flood by the 20th and the mountains covered with snow (*The Times*, September 13th–22nd).

After many months of drought abundant rain fell in southern Morocco about the 16th. Twenty Algerians and many cattle were swept away by flooded rivers as the result of heavy rains in the Department of Oran about the 27th (*The Times*, September 17th–28th).

A typhoon which formed east of Manila at the end of August passed across Hongkong during the early hours of September 2nd—this was followed by a tidal wave which swept ¼ mile inland and overwhelmed two villages, Taipo and Taipo Market. About 400 people were killed or drowned and much material damage was done both on land and sea. Floods occurred in the Honan province and also along other parts of the Yellow River about the 9th. A typhoon swept across south-west Japan on the 11th killing 18 people and injuring 119, while many houses were damaged and flooded (*The Times*, September 3rd–13th).

A severe storm swept across Nova Scotia about the 12th and a hurricane on the 15th, destroying nearly half the apple crop (*The Times*, September 14–16th).

Daily Readings at Kew Observatory, September, 1937

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	1013·8	SW.4	59	73	66	—	1·1	d_0 21h.–23h.
2	1015·4	SW.3	58	72	71	0·12	5·6	PR 14h. r_0–23h.–24h.
3	1018·8	WSW.3	59	71	47	trace	9·0	r_0 0h.–2h.
4	1024·9	S.2	48	70	49	—	10·3	w early.
5	1020·3	SW.3	48	72	53	—	9·7	w early.
6	1018·5	SW.3	53	75	52	—	7·6	w early.
7	1019·0	SW.3	61	76	63	—	7·3	
8	1025·2	N.2	57	68	44	0·03	8·2	r_0–r 4h.–6h.
9	1021·0	WNW.1	48	60	82	0·25	0·6	r–r_0 12h.–17h. r_0 19h.–[21h.
10	1020·6	NNW.3	45	60	49	—	6·0	w early.
11	1020·2	N.4	45	57	57	—	5·7	
12	1019·3	N.2	47	58	56	0·03	1·2	r–r_0 17h.–23h.
13	1002·0	N.1	51	60	69	0·55	1·2	r_0 1h.–4h. tlR 15h.–[16h.
14	1003·7	NW.2	47	62	51	—	7·0	
15	993·4	SSW.4	53	66	68	0·07	3·5	r_0–r 2h.–5h., 14h.–16h.
16	990·3	SSE.2	43	62	71	0·07	4·3	pr 10h.–17h. tl 14h.
17	988·0	S.3	50	63	75	0·57	2·1	R 7h.,9h.–10h., tl 10h.
18	999·5	SW.3	48	64	55	—	9·9	w early and late.
19	1001·9	N.3	45	57	88	0·16	0·0	wf early R–r 12h.–15h.
20	1009·1	N.3	46	58	64	0·04	3·4	pr 13h., 14h., 16h.
21	1016·6	SW.2	41	58	71	—	1·3	w early.
22	1013·7	S.3	50	65	60	—	4·3	w early.
23	1022·4	WSW.1	41	66	63	—	7·5	Fe early.
24	1021·1	SW.3	43	65	65	—	5·4	Fe early.
25	1020·8	NE.1	55	57	91	0·13	0·0	r_0–r 2h.–11h., 14h.–[19h.
26	1018·8	SSE.3	56	71	66	—	9·3	w early.
27	1014·8	E.1	52	71	75	0·01	0·1	f to 10h., r_0 11h., 18h.
28	1019·0	W.3	55	65	57	—	6·4	w late.
29	1022·0	SW.2	44	67	65	—	8·4	Fe early. f late.
30	1016·0	S.3	45	66	59	—	6·7	Fe early.
*	1013·7	—	50	65	63	2·04	5·1	* Means or Totals.

General Rainfall for September, 1937

England and Wales ...	97	per cent of the average 1881–1915.
Scotland	85	
Ireland	133	
British Isles	101	

Rainfall: September, 1937: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	1·54	85	*War* .	Birminghm, Edgbastor	1·99	111
Sur .	Reigate, Wray Pk. Rd..	1·99	96	*Leics* .	Thornton Reservoir ...	1·86	99
Kent .	Tenterden, Ashenden...	2·72	127	,, .	Belvoir Castle...........	·97	52
,, .	Folkestone, Boro. San.	3·11	...	*Rut* .	Ridlington	1·35	70
,, .	Margate, Cliftonville....	2·50	127	*Lincs* .	Boston, Skirbeck.........	1.41	80
,, .	Eden'bdg., Falconhurst	2·16	95	,, .	Cranwell Aerodrome...	·75	42
Sus .	Compton, Compton Ho.	2·19	79	,, .	Skegness, Marine Gdns.	1·17	65
,, .	Patching Farm..........	2·09	87	,, .	Louth, Westgate.........	·96	48
,, .	Eastbourne, Wil. Sq....	2·62	105	,, .	Brigg, Wrawby St.......	·97	...
Hants.	Ventnor, Roy.Nat.Hos.	2·72	110	*Notts* .	Mansfield, Carr Bank...	1·63	89
,, .	Fordingbridge, Oaklnds	2·70	126	*Derby*.	Derby, The Arboretum	1·58	92
,, .	Ovington Rectory.......	1·73	76	,, .	Buxton, Terrace Slopes	1·50	46
,, .	Sherborne St. John......	2·15	105	*Ches* .	Bidston Obsy.............	2·09	87
Herts .	Royston, Therfield Rec.	1·91	102	*Lancs*.	Manchester, Whit. Pk.	1·02	43
Bucks.	Slough, Upton............	2·44	139	,, .	Stonyhurst College......	2·64	69
,, .	H. Wycombe, Flackwell	3·24	165	,, .	Southport, Bedford Pk.	2·02	73
Oxf .	Oxford, Radcliffe.........	1·98	116	,, .	Ulverston, Poaka Beck	4·25	99
N'hant	Wellingboro, Swanspool	1·27	71	,, .	Lancaster, Greg Obsy.	2·68	79
,, .	Oundle	1·27	...	,, .	Blackpool	2·02	71
Beds .	Woburn, Exptl. Farm...	1·46	82	*Yorks*.	Wath-upon-Dearne......	1·65	104
Cam .	Cambridge, Bot. Gdns.	2·37	147	,, .	Wakefield, Clarence Pk.	1·36	85
,, .	March......................	1·22	68	,, .	Oughtershaw Hall.......	4·26	...
Essex.	Chelmsford, County Gdns	1·28	74	,, .	Wetherby, Ribston H..	1·12	62
,, .	Lexden Hill House......	1·89	...	,, .	Hull, Pearson Park......	1·29	75
Suff .	Haughley House.........	1·13	...	,, .	Holme-on-Spalding......	·90	52
,, .	Rendlesham Hall........	2·54	132	,, .	West Witton, Ivy Ho.	1·52	71
,, .	Lowestoft Sec. School...	2·17	111	,, .	Felixkirk, Mt. St. John.	1·21	66
,, .	Bury St. Ed., WestleyH.	1·70	85	,, .	York, Museum Gdns....	1·06	65
Norf. .	Wells, Holkham Hall...	1·19	63	,, .	Pickering, Hungate......	1·61	84
Wilts .	Porton, W.D. Exp'l. Stn	2·16	123	,, .	Scarborough..............	1·49	83
,, .	Bishops Cannings........	3·14	143	,, .	Middlesbrough...........	1·52	92
Dor .	Weymouth, Westham.	2·13	101	,, .	Baldersdale, Hury Res.	2·60	104
,, .	Beaminster, East St....	3·30	129	*Durh* .	Ushaw College............	1·76	88
,, .	Shaftesbury, Abbey Ho.	3·48	143	*Nor* .	Newcastle, Leazes Pk...	1·67	84
Devon.	Plymouth, The Hoe....	2·32	91	,, .	Bellingham, Highgreen	3·38	141
,, .	Holne, Church Pk. Cott.	3·02	84	,, .	Lilburn Tower Gdns....	1·01	43
,, .	Teignmouth, Den Gdns.	2·23	114	*Cumb*.	Carlisle, Scaleby Hall...	2·69	100
,, .	Cullompton	2·71	120	,, .	Borrowdale, Seathwaite	11·00	117
,, .	Sidmouth, U.D.C........	2.34	...	,, .	Thirlmere, Dale Head H.	7·78	123
,, .	Barnstaple, N. Dev.Ath	4·44	164	,, .	Keswick, High Hill......	5·08	120
,, .	Dartm'r, Cranmere Pool	4·90	...	*West* .	Appleby, Castle Bank...	2·38	94
,, .	Okehampton, Uplands.	3·12	96	*Mon* .	Abergavenny, Larchf'd	1·26	54
Corn .	Redruth, Trewirgie......	3·71	119	*Glam* .	Ystalyfera, Wern Ho....	4·48	103
,, .	Penzance, Morrab Gdns.	4·05	138	,, .	Treherbert, Tynywaun.	4·58	...
,, .	St. Austell, Trevarna...	3·99	125	,, .	Cardiff, Penylan.........	1·94	64
Soms .	Chewton Mendip.........	2·48	81	*Carm* .	Carmarthen, M. & P. Sch.	4·28	119
,, .	Long Ashton...........	2·11	88	*Pemb* .	Pembroke, Stackpole Ct.	3·45	111
,, .	Street, Millfield..........	4·00	180	*Card* .	Aberystwyth	3·36	...
Glos .	Blockley	2·65	...	*Rad* .	BirmW.W.Tyrmynydd	3·22	83
,, .	Cirencester, Gwynfa....	1·82	83	*Mont* .	Lake Vyrnwy	2·19	62
Here .	Ross-on-Wye.............	2·30	120	*Flint* .	Sealand Aerodrome......	1·59	...
Salop.	Church Stretton.........	3·25	160	*Mer* .	Blaenau Festiniog	5·86	82
,, .	Shifnal, Hatton Grange	2·92	151	,, .	Dolgelley, Bontddu......	4·17	98
,, .	Cheswardine Hall........	2·20	108	*Carn* .	Llandudno	2·60	122
Worc .	Malvern, Free Library...	2·46	127	,, .	Snowdon, L. Llydaw 9..	9·60	...
,, .	Ombersley, Holt Lock.	2·80	158	*Ang* .	Holyhead, Salt Island...	2·99	112
War .	Alcester, Ragley Hall...	2·49	140	,, .	Lligwy	2·62	...

Rainfall : September, 1937 : Scotland and Ireland

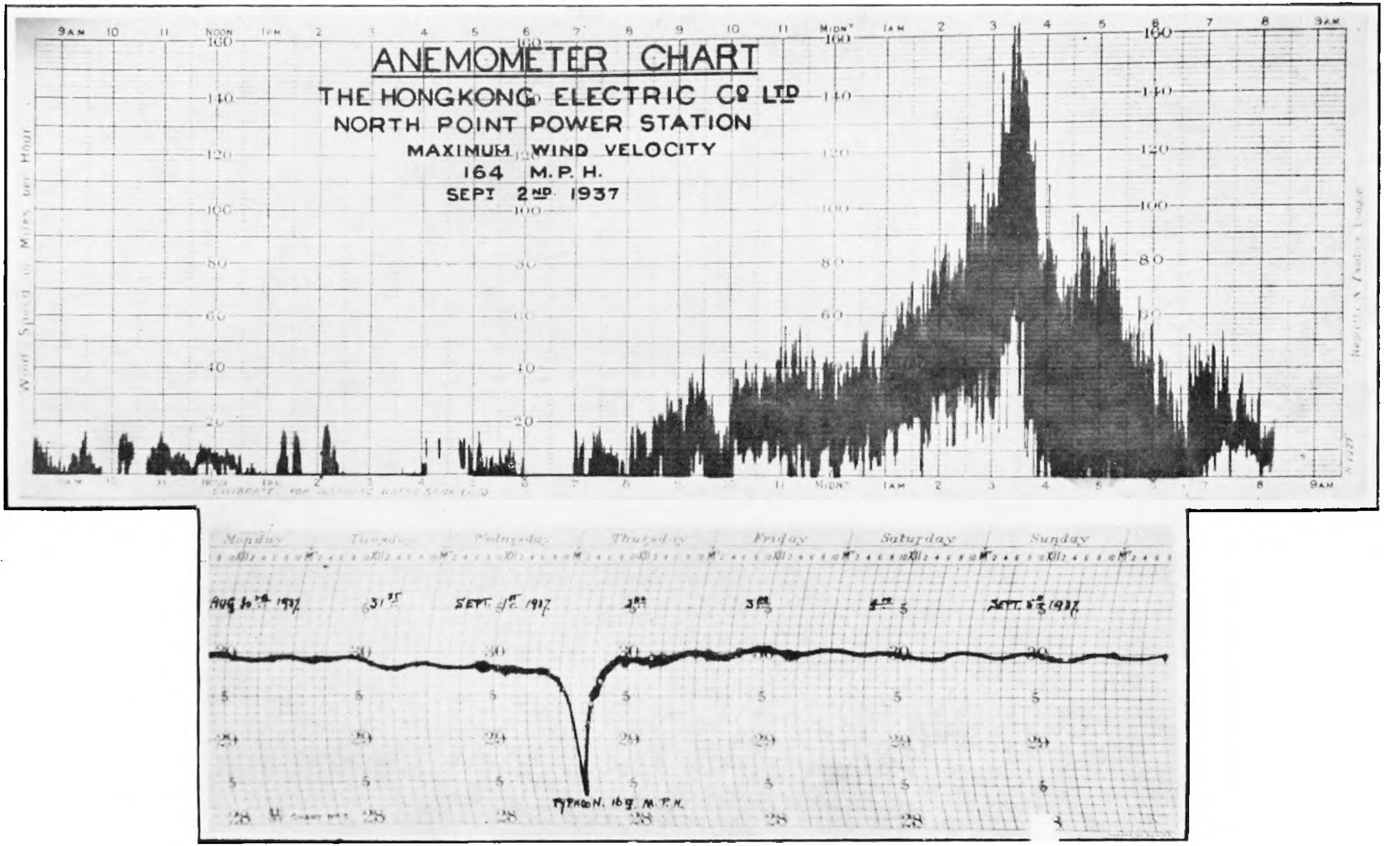
Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem....	2·50	77	*R&C* .	Achnashellach	6·62	91
Guern.	St.Peter P't.Grange Rd.	3·33	128	,, .	Stornoway,C.GuardStn.	4·41	118
Wig .	Pt. William, Monreith.	2·36	81	*Suth* .	Lairg........................	2·06	73
,, .	New Luce School.........	3·23	90	,, .	Skerray Borgie............	2·78	...
Kirk .	Dalry, Glendarroch......	2·56	70	,, .	Melvich......................	2·12	76
Dumf.	Dumfries, Crichton R.I.	2·60	102	,, .	Loch More, Achfary....	5·93	103
,, .	Eskdalemuir Obs........	4·80	130	*Caith* .	Wick..........................	1·75	70
Roxb .	Hawick, Wolfelee........	2·38	93	*Ork* .	Deerness	3·12	108
Peeb .	Stobo Castle..............	...	...	*Shet* .	Lerwick	2·59	93
Berw .	Marchmont House......	1·52	63	*Cork* .	Dunmanway Rectory...	...	...
E.Lot.	North Berwick Res.....	1·03	49	,, .	Cork, University Coll...	3·01	112
Midl .	Edinburgh, Blackfd. H.	1·64	80	,, .	Mallow, Longueville....	3·58	149
Lan .	Auchtyfardle	2·48	...	*Kerry*.	Valentia Observatory...	6·55	158
Ayr .	Kilmarnock, Kay Park	2·55	...	,, .	Gearhameen...............	8·70	143
,, .	Girvan, Pinmore.........	2·88	75	,, .	Bally McElligott Rec...	...	...
,, .	Glen Afton, Ayr San....	3·31	85	,, .	Darrynane Abbey.......	6·12	172
Renf .	Glasgow, Queen's Park	3·53	127	*Wat* .	Waterford, Gortmore...	3·89	143
,, .	Greenock, Prospect H..	4·48	94	*Tip* .	Nenagh, Castle Lough.	...	...
Bute .	Rothesay, Ardencraig...	3·34	82	,, .	Roscrea, Timoney Park	...	...
,, .	Dougarie Lodge..........	2·54	66	,, .	Cashel, Ballinamona....	3·07	127
Arg .	Loch Sunart, G'dale....	...	...	*Lim* .	Foynes, Coolnanes......	3·78	131
,, .	Ardgour House..........	11·70	...	*Clare* .	Inagh, Mount Callan....	10·49	...
,, .	Glen Etive..................	8·55	111	*Wexf* .	Gorey, Courtown Ho...	3·79	153
,, .	Oban.........................	6·25	...	*Wick* .	Rathnew, Clonmannon.	3·16	...
,, .	Poltalloch..................	5·22	114	*Carl* .	Bagnalstown,Fenagh H.	3·17	128
,, .	Inveraray Castle.........	9·45	147	,, .	Hacketstown Rectory...	3·48	124
,, .	Islay, Eallabus............	4·19	100	*Leix* .	Blandsfort House.......	2·96	109
,, .	Mull, Benmore............	8·40	73	*Offaly*.	Birr Castle................	4·00	175
,, .	Tiree	4·53	122	*Kild* .	Straffan House...........	2·26	101
Kinr .	Loch Leven Sluice.......	1·56	61	*Dublin*	Dublin, Phoenix Park..	1·45	76
Fife .	Leuchars Aerodrome...	1·10	57	*Meath*.	Kells, Headfort..........	4·89	184
Perth .	Loch Dhu..................	6·60	115	*W.M* .	Moate, Coolatore.........	5·33	...
,, .	Crieff, Strathearn Hyd.	2·66	93	,, .	Mullingar, Belvedere...	4·76	178
,, .	Blair Castle Gardens....	2·36	100	*Long* .	Castle Forbes Gdns......	4·85	169
Angus.	Kettins School............	1·02	46	*Gal* .	Galway, Grammar Sch.	5·43	172
,, .	Pearsie House............	1·80	...	,, .	Ballynahinch Castle....	9·60	202
,, .	Montrose, Sunnyside...	1·31	66	,, .	Ahascragh, Clonbrock.	5·42	175
Aber .	Balmoral Castle Gdns..	·96	40	*Rosc* .	Strokestown, C'node.....	...	...
,, .	Logie Coldstone Sch....	·50	21	*Mayo*.	Blacksod Point..........	4·20	108
,, .	Aberdeen Observatory.	1·53	69	,, .	Mallaranny	7·08	...
,, .	New Deer School House	1·79	71	,, .	Westport House.........	4·57	129
Moray	Gordon Castle............	1·09	44	,, .	Delphi Lodge.............	11·10	147
,, .	Grantown-on-Spey	1·11	45	*Sligo* .	Markree Castle...........	4·68	138
Nairn.	Nairn	1·13	51	*Cavan*.	Crossdoney, Kevit Cas..	4·30	...
Inv's .	Ben Alder Lodge.........	4·11	...	*Ferm* .	Crom Castle...............	3·65	131
,, .	Kingussie, The Birches.	2·13	...	*Arm* .	Armagh Obsy............	2·35	96
,, .	Loch Ness, Foyers	4·02	137	*Down*.	Fofanny Reservoir......	3·93	...
,, .	Inverness, Culduthel R.	1·62	69	,, .	Seaforde	3·44	125
,, .	Loch Quoich, Loan......	12·65	...	,, .	Donaghadee, C. G. Stn.	1·85	77
,, .	Glenquoich................	9·63	111	*Antr* .	Belfast,Queen's Univ....	1·92	75
,, .	Arisaig House............	5·83	96	,, .	Aldergrove Aerodrome.	2·00	81
,, .	Glenleven, Corrour......	...	...	,, .	Ballymena, Harryville.	2·38	77
,, .	Fort William, Glasdrum	9·33	...	*Lon* .	Garvagh, Moneydig....	3·23	...
,, .	Skye, Dunvegan.........	7·13	...	,, .	Londonderry, Creggan.	3·98	121
,, .	Barra, Skallary..........	4·05	...	*Tyr* .	Omagh, Edenfel.........	3·84	126
R&C .	Alness, Ardross Castle.	...	...	*Don* .	Malin Head................	4·41	...
,, .	Ullapool	3·90	104	,, .	Dunkineely.................	5·31	...

Climatological Table for the British Empire, April, 1937

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1010·7	− 3·7	61	31	56·3	43·5	49·9	+ 2·8	44·2	86	8·4	1·98	+ 0·53	16	3·4	25
Gibraltar	1016·8	+ 0·4	71	51	63·9	54·3	59·1	− 1·8	53·8	83	4·7	2·47	...	9	...	...
Malta	1012·6	− 0·8	74	52	67·2	55·3	61·3	+ 0·4	55·6	77	5·1	0·34	− 0·52	5	8·9	68
St. Helena	1011·4	− 1·5	72	61	68·9	62·8	65·9	+ 1·6	64·3	96	9·0	7·09	+ 3·87	26	...	...
Freetown, Sierra Leone	1010·7	+ 1·6	93	73	88·7	76·7	82·7	...	76·7	76	5·5	2·18	− 1·88	6	...	...
Lagos, Nigeria	1010·1	+ 0·7	91	73	88·7	78·9	83·8	+ 1·0	78·1	81	7·1	4·81	− 1·27	5	7·2	59
Kaduna, Nigeria	1009·4	...	101	60	96·5	71·9	84·2	+ 2·7	70·6	64	4·5	1·24	− 1·84	1	8·8	72
Zomba, Nyasaland	1011·9	− 0·6	84	56	79·4	63·0	71·2	+ 1·9	66·3	78	6·0	3·37	− 0·29	8	...	...
Salisbury, Rhodesia	1014·6	− 0·7	84	45	76·9	53·8	65·3	− 0·4	57·9	65	3·9	1·04	...	6	7·3	62
Cape Town	1016·6	+ 0·2	96	49	71·0	54·1	62·5	− 0·7	54·7	83	5·4	2·16	+ 0·29	10	...	...
Johannesburg	1016·1	− 0·2	78	38	69·8	50·1	59·9	− 0·1	50·7	61	3·1	1·75	+ 0·01	7	8·5	74
Mauritius	1012·8	− 1·1	86	65	82·6	70·3	76·5	+ 0·7	73·2	76	5·4	2·63	− 2·49	12	7·6	66
Calcutta, Alipore Obsy.	1006·8	+ 0·5	104	70	96·3	76·8	86·5	+ 0·9	76·1	74	4·3	0·15	− 2·03	1*	...	...
Bombay	1007·9	− 0·9	92	70	88·7	76·4	82·5	− 0·6	75·1	75	2·6	0·01	− 0·04	0*	...	...
Madras	1007·5	− 0·9	94	70	90·0	77·5	83·7	− 1·6	78·0	77	6·3	2·61	+ 1·98	2*	...	...
Colombo, Ceylon	1008·7	0·0	90	70	87·1	75·7	81·4	− 1·3	77·8	79	7·3	10·64	+ 0·91	18	5·7	46
Singapore	1008·0	− 0·9	93	73	86·9	76·5	81·7	+ 0·1	78·3	80	8·3	10·71	+ 3·08	19	4·3	36
Hongkong	1012·9	+ 0·3	86	60	76·4	68·6	72·5	+ 1·7	68·9	84	8·5	2·26	− 3·39	8	4·4	35
Sandakan	1008·5	...	91	74	88·5	76·6	82·5	+ 0·3	78·2	84	7·9	4·01	− 0·48	18	...	...
Sydney, N.S.W.	1016·4	− 2·0	81	49	69·5	56·2	62·9	− 1·8	57·4	73	6·7	5·58	+ 0·06	16	5·5	48
Melbourne	1018·7	− 0·8	83	37	66·3	49·8	58·1	− 1·4	52·7	76	6·8	1·41	− 0·76	16	4·4	39
Adelaide	1020·0	+ 0·2	90	47	71·9	53·9	62·9	− 1·0	55·0	55	6·5	0·66	− 1·06	7	4·7	42
Perth, W. Australia	1016·4	− 2·0	97	52	80·0	59·9	69·9	+ 3·1	60·1	58	3·7	4·05	+ 2·40	10	8·2	73
Coolgardie	1017·3	− 1·0	93	48	79·1	55·1	67·1	+ 2·1	58·1	55	2·4	0·12	− 0·84	2	...	...
Brisbane	1015·0	− 2·6	85	54	79·2	59·3	69·3	− 1·0	61·7	63	2·7	0·92	− 2·85	7	8·5	75
Hobart, Tasmania	1015·7	+ 0·9	81	35	61·0	45·2	53·1	− 2·1	47·1	65	5·6	0·96	− 0·89	12	5·8	53
Wellington, N.Z.	1013·1	− 5·0	73	37	61·3	49·0	55·1	− 2·0	52·0	73	6·6	2·30	− 1·58	14	5·9	54
Suva, Fiji	1010·5	− 0·1	92	72	85·9	75·2	80·5	+ 1·9	76·2	84	6·4	12·13	− 0·08	23	5·6	48
Apia, Samoa	1009·6	− 0·3	89	72	86·0	74·6	80·3	+ 1·4	77·3	80	5·4	9·41	− 0·74	16	7·1	60
Kingston, Jamaica	1013·4	− 0·7	91	69	86·9	71·5	79·2	+ 0·8	69·8	78	2·3	0·58	− 0·66	2	6·8	54
Grenada, W.I.	1011·6	− 0·9	89	71	86	73	79·5	+ 0·6	74	78	5	4·69	+ 2·53	19	...	...
Toronto	1015·1	− 1·0	65	29	49·7	36·8	43·3	+ 1·2	36·7	72	5·8	4·02	+ 1·73	13	5·0	37
Winnipeg	1015·3	− 1·4	61	13	45·7	30·0	37·9	+ 0·2	30·2	85	6·9	2·64	+ 1·24	13	4·6	34
St. John, N.B.	1016·3	+ 2·9	68	23	48·7	31·5	40·1	+ 1·1	35·2	71	6·0	2·61	− 0·90	11	6·3	47
Victoria, B.C.	1015·2	− 2·3	63	37	52·7	42·3	47·5	− 0·4	44·6	83	8·2	2·34	+ 0·82	17	4·1	30

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

(39051) Wt. 20/31 1125 10/37 Hw. G. 377/6



Barogram August 30th to September 5th, 1937

TYPHOON AT HONGKONG, SEPTEMBER 2ND, 1937 (see p. 235)

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

Nov., 1937

No. 862

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

Radiosondages over the North Atlantic

At International Meetings during the past year the Representatives of the National Meteorological Office of France stated that a French ship, *Carimare*, had been stationed in the North Atlantic to collect and retransmit meteorological information from ships and—an entirely new departure—to make radiosondages and transmit the information so obtained for the benefit of meteorological services on both sides of the Atlantic. This is a new and exciting meteorological enterprise.

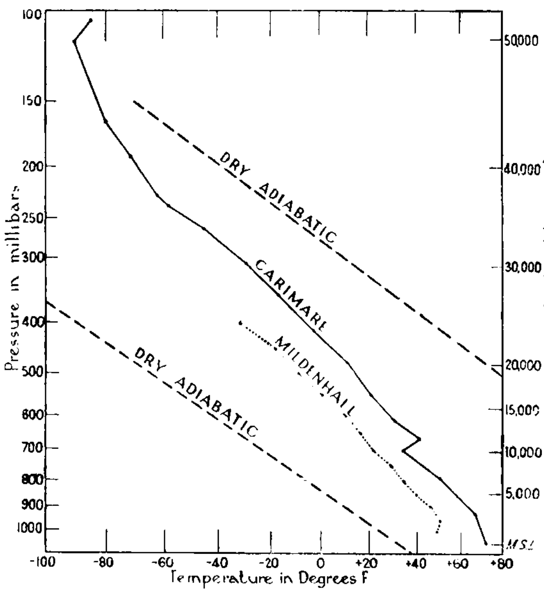
The term "radiosondage" is a convenient term which is used to denote the following procedure:—

A large free balloon which ascends at a rate of about 1,000 ft./min. carries beneath it a wireless transmitter; this instrument transmits wireless signals from which the value of the pressure and the temperature in the atmosphere at the height of the balloon at the moment when the transmission is made, can be evaluated immediately. Thus, within about half an hour of the time of release of the balloon there is available at the receiving station information of the temperature of the atmosphere from the surface up to about 30,000 ft.

On some occasions the balloon rises higher than 60,000 ft. and on these occasions—which it is anticipated will become practically daily—a knowledge of the temperature conditions of the atmosphere throughout the troposphere and well into the stratosphere is rendered available to the meteorologist.

There are many different types of instrument designed to do this. In the instrument used in France the transmitter is making a continuous transmission which is modified intermittently by the instrument giving the pressure and the temperature. The actual values of pressure and temperature are deduced from the relative times at which these interruptions are made.

A record was produced at Salzburg at the meeting of the Commission for Synoptic Weather Information in September, 1937, showing the results obtained by a number of ascents from the *Carimare*, one of which reached 25 Km. or 82,000 ft. That was of great interest to all the synoptic meteorologists present. But it is of even greater interest to receive a message from the *Carimare* giving the actual results at the moment at which the message is transmitted. Such a message was received in the Meteorological Office, London, on November 1st, giving the results of an ascent which reached 16 Km. (about 52,000 ft.). At that height the barometric pressure was 105 mb. and the temperature was —85° F. The results of the ascent are shown in the diagram, and the results of the simultaneous ascent at Mildenhall are shown for comparison. An outstanding feature is the inversion of temperature at a height of 11,000 ft. The stratosphere was reached at a pressure of 117 mb. or a height of 15 Km. (about 50,000 ft.). At the time of the ascent the *Carimare* was in a position Lat. 39° 54′ N.; Long. 38° 92′ W. about 500 miles W. by N. of the Azores. The pressure distribution over the Atlantic at the time of the ascent was briefly: a high pressure south of the Azores (pressure at centre 1,020 to 1,025 mb.) and a low pressure with two centres, one about 1,000 miles due north of the Azores (pressure at centre below 980 mb.) and the other centre about 500 miles further west with pressure at centre about 970 mb. The position of the *Carimare* was in the south-west current on the north-east side of the high pressure area.

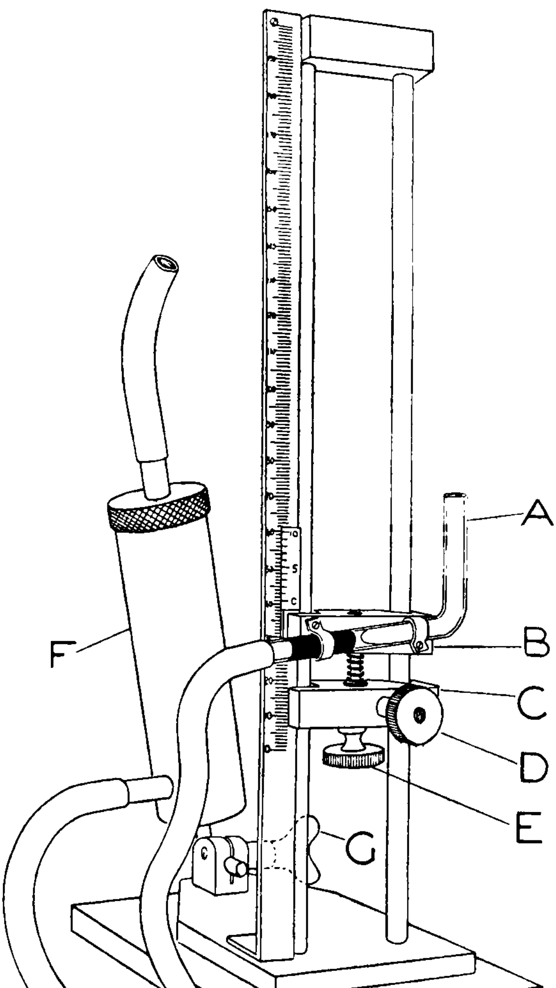


E. GOLD.

A New Manometer

By R. Cranna, M.A., B.Sc.

The small portable manometer described below has been designed primarily to meet the requirements of Meteorological Office inspectors in the periodic testing of pressure tube anemometers, though it is capable of a much wider application. It is simple and rapid to use and capable of an accuracy of ± 0·1 mm. water. Pressure is measured by raising one limb of the manometer until the liquid returns to a fixed mark in the normal way. This method was chosen as it avoids the double setting or scale contraction of any of the modified U tube manometers, and is consequently more likely to yield accurate results. The elaborate zero adjusting mechanism which is frequently a drawback of this type of manometer has been avoided by the use of a tilting reservoir which simplifies construction and at the same time provides a very effective means of adjustment.



The movable limb of the manometer consists of a glass tube A, ¼ in. internal diameter, carried on a brass block B which moves on two vertical guides. In order to magnify the movement of the surface of the liquid the tube A is inclined at 10° to the horizontal, the upper end being bent upwards to form a safety chamber. This angle was chosen as giving a sufficient degree of magnification while retaining a meniscus which can be easily set to a mark on the tube. Any decrease in the angle would require a tube of narrower bore and a consequent increase in the effects of capillarity and stickiness. With the dimensions used an increase of pressure of 0·1 mm. produces a movement along the tube of 0·4 mm.

The mechanical arrangement for setting can be seen clearly on the sketch. The two slides B and C can be moved up and down as one unit. The lower slide C can then be clamped in any position by means of the screw D, the final adjustment being made by the screw E, which passes through a clearance hole in C into a tapped hole in the slide B carrying the tube and vernier. A spiral steel spring between the blocks takes up the backlash, and ensures that the shoulder on E is always in contact with the under surface of the slide C. The second limb of the manometer, which is flexibly connected to A by a length of rubber tubing, consists of a copper reservoir F, 1 in. in diameter. This reservoir can be tilted about a horizontal axis, providing the zero adjustment of the instrument, and can be clamped in position by means of the wing nut G. The surface of the liquid in the reservoir is approximately 1¾ in. above the horizontal axis with the reservoir in the vertical position.

To use the instrument the zero of the vernier is first set against the zero of the scale which runs parallel to the vertical guides. With the reservoir in a vertical position the liquid used is slowly poured into F until the surface of the liquid is slightly above the setting mark on the sloping tube A. The meniscus is then brought back to that mark by slowly tilting the reservoir. When the zero is finally set the reservoir is clamped in position by the wing nut G. The apparatus can then be used in the normal manner, the rough adjustment being made by moving the two slides up or down together, and the final setting by clamping C and using the screw E. To prevent liquid being blown out of the manometer a clip should be fitted on the tube between the source of pressure and the manometer, and the instrument set to approximately the correct value before the pressure is admitted.

It was originally intended to use distilled water as the liquid in the manometer, but it was found that the meniscus in the sloping tube showed a tendency to stick in the bore of the tube after a few days use, no matter how thoroughly the tube was cleaned. This difficulty was overcome by using 90 per cent alcohol which can apparently be used indefinitely without any sluggishness developing. The use of alcohol involves an occasional check to ensure that the specific gravity remains within certain limits depending on the accuracy required, but this can easily be done, either by means of a hydrometer or a check setting against an accurate standard manometer.

OFFICIAL PUBLICATION

The following publication has recently been issued :—

PROFESSIONAL NOTES

No. 82. Ice accretion on aircraft. Notes for pilots. By G. C. SIMPSON, K.C.B., F.R.S. (M.O. 420 b).

The increased amount of flying within clouds now carried out by all types of aircraft has raised in an acute form the problem of issuing warnings of ice accretion on aircraft. A short description of the physical processes connected with the deposit of ice on aircraft is first given, from which it is seen that for ice accumulation to become dangerous it is necessary that there should be an abundance of water in the liquid state at air temperatures below the freezing point. These conditions are met with only in clouds or in rain, and the meteorology of ice accretion, which is next discussed, is mainly concerned with the formation of clouds, the formation of rain and the temperature.

General rules for avoiding the dangers of ice accretion are given, followed by a discussion of the situations in which ice accretion may be encountered. The paper ends with an account of the " Warnings of ice accretion " now issued to pilots, which contain information regarding the height at which the conditions are most favourable for ice formation, and the two heights above and below which danger does not exist.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are :—

November 29th, 1937. *On the deviations of wind from the geostrophic wind in the free atmosphere.* By F. Möller and P. Sieber (Ann. Hydrogr., Berlin, 65, 1937, pp. 312–22) (in German). *Opener,* Mr. R. Frith, M.A., Ph.D.

December 13th, 1937. *Forecasting the dissipation of fog and stratus clouds.* By I. P. Krick (New York, J. aero. Soc. Amer. 4, 1937, pp. 361–71). *Opener,* Mr. A. L. Maidens, B.Sc.

Correspondence

To the Editor, *Meteorological Magazine*

Nocturnal wind sounding by photographic means

In his note on " Pilot Ballooning at Night " in the *Meteorological Magazine* of September, 1937, Dr. F. J. W. Whipple refers to my method of photographic sounding described in the April–May, 1937, number of the *Bulletin of the American Meteorological Society,* and states that the method has " the obvious drawback that it takes time to develop the plate and make a set of measurements with a microscope before the bearings of the flashes can be ascertained."

I regret that my original article gave the impression that the evaluation of the photographic record was made with the aid of a microscope. This would, of course, be a tedious and lengthy process, as Dr. Whipple suggests. Evaluation of my records, however, is actually carried out by simply projecting the negative and throwing the image on to a screen as is done with a normal lantern slide. The screen carries the calibration chart, and bearings of the flashes, therefore, can be read off immediately. As far as the time of development of the plate is concerned, that still remains, but as the record consists purely of black dots on a light field and no gradation of tones is required, a very quick and, therefore, high contrast developer is used, and in practice the plate can be developed, fixed and dried in alcohol within a space of ten to fifteen minutes.

Dr. Whipple states further in his article that another disadvantage of my method is that "the fuse cannot be relied on to produce flashes at equal intervals, so an observer must stand by and time all the flashes during the ascent of the balloon." Numerous tests have shown that the fuse I have been using maintains, to a high degree of accuracy, its rate of burning. This rate, however, does vary with atmospheric pressure, and, therefore, with elevation (as is well known in the case of the fuses utilized in armaments); but this variation of burning rate with atmospheric pressure may be readily established and taken into account in the spacing of the magnesium flashes. Tests have shown that this is practicable.

ATHELSTAN F. SPILHAUS.

New York University, University Heights, New York, U.S.A., October 14th, 1937.

A green moon: Wimbledon Common, October 16th, 1937

Of all the phenomena of meteorological optics there is none that I less expected to see myself than a green moon. However, on Saturday, October 16th, 1937, at about 5.30 p.m., I saw this phenomenon from the banks of Beverley Brook, on the outskirts of Wimbledon Common. With my companion I had been admiring the brilliance of the clouds in the west, long cirrus streaks and altostratus, when we happened to glance at the moon, and noticed with surprise that it appeared to be pale green. I suggested that it might be pale blue, but was confirmed in my impression that it was definitely green. Green it looked when seen through the tube made by my bent fingers, and green it looked when we peered through the trees of a gloomy thicket. The gibbous moon, at an elevation of about 20°, was covered by rather thick cloud, probably altostratus. In the course of five or ten minutes, as the ruddy colours faded in the west, the moon resumed its normal white. An hour later, when it was dark, the moon shone through similar cloud; it looked yellow, as did the cloudy aureole, and there was a very poor corona. The dull red at the edge of the aureole was about half a degree from the moon.

The circumstances indicate that, in this case at any rate, the green moon is to be regarded as an effect of contrast. There was nothing abnormal about the atmosphere; the air was fairly clear, before sunset we could see about four miles, and, moreover, there was no change in air or cloud when the green was disappearing. With the brilliant red illumination of landscape and of the cloud in the south-east, our eyes regarded the pink-tinged cloud as white or grey, and the pure white of the moon ranked as green. It would be interesting to learn whether other observations of green moons have been consistent with this explanation.

F. J. W. WHIPPLE.

Kew Observatory, Richmond, Surrey, October 18th, 1937.

Haze and Sunshine Recorder

The following note by Mr. R. A. Jubb, of this Office, on the effect of haze on the Campbell Stokes sunshine recorder at Goetz Observatory, Bulawayo, Southern Rhodesia, may be of interest:—

" I have seldom known visibility to be as bad as it has been recently. At 6·15 a.m. this morning I examined the sunshine recorder and, although the sun made a small spot on the chart, there was not sufficient heat to burn a trace. The sun shone feebly through the smoke as if shining through thin altostratus. The trace only started at about 7 a.m.—the evening trace stopped about three-quarters of an hour too early as well.

" Pilot balloons are extremely difficult to follow after about ten minutes. The Captain of the South African Air Mail has just informed me that from Livingstone to here, flying at 9,000 ft., the visibility was four miles. The Captain who brought General Smuts up on the morning of the 3rd said the same."

NOEL P. SELLICK.

Meteorological Office, Salisbury, Southern Rhodesia, September 15*th,* 1937.

Halo Complex

This afternoon about 13h. 20m. G.M.T., there was noted in cirrus (with much interruption from lower clouds) the following :—

Halo of 22°.

Parhelia of 22° well coloured and bright.

Parhelic circle, that, allowing for obstruction by lower clouds extended from parhelion to parhelion. At one time the existence of the parhelion of 120° was suspected.

CICELY M. BOTLEY.

Guildables, 17, Holmesdale Gardens, Hastings, September 21st, 1937.

Systematic Records of British Snowfall

In reply to Mr. Tinn's letter in the October issue, may I point out that the Association for the Study of Snow and Ice is at present engaged in devising a plan for the survey of the amount, duration and extent of the upland snowfalls of Great Britain. I very much agree that systematic records all over the country would be of great value. It is however in the uplands that little information, other than of a very general character, is available, and on behalf of the Association I may say that we hope to make a series of records available from representative upland districts at no distant time. We should very greatly welcome the co-operation of readers who live on, or frequently visit the higher hills above 1,000 ft. Further, records carefully kept on Mr. Tinn's or a similar plan at intermediate levels (500–1,000 ft.) would indeed be valuable inasmuch as it is probably at these levels that the greatest fluctuations occur over periods of years.

GORDON MANLEY.

School of Geography, c/o University Offices, Durham, November 5th, 1937.

The excellent suggestions of Mr. A. B. Tinn, in the October issue of this magazine, regarding the acquisition of more detailed observations of the depth of snowfall, days of snow and days with snow lying, deserve much encouragement. The interesting reports on snowfall in this country, contributed by Mr. L. C. W. Bonacina, in *British Rainfall*, 1936, would be much enhanced if accompanied by maps showing the distribution of snow-days and days of snow lying. Such maps would be of particular interest in the data for the northern suburbs of London and, indeed, for all the home counties, because the effect of height and of wind direction would probably be even more pronounced in these areas than it is in the case of rainfall.

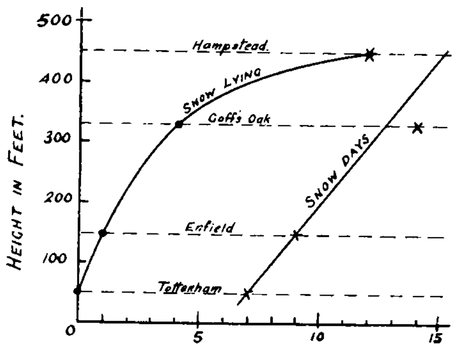


FIG. 1.

Snowfall in the home counties is noticeably fickle and erratic in its distribution, and detailed maps of snowfall in the north London area would furnish some interesting and instructive features.

As an instance, on Sunday, March 14th, 1937, there was, in the morning, fairly heavy "dry" snowfall at this station, yet in a twenty-minute bus journey to Waltham Cross—a distance of but $3\frac{1}{2}$ miles or so, the effect of height was brought out most distinctly. Goff's Oak is at an elevation of 330 ft. above ordnance datum, but on reaching a point about $1\frac{1}{2}$ miles away, at about 250 ft. above M.S.L., the snow was turning to sleet, and at Waltham Cross, at 70 ft. above M.S.L., the precipitation was at least 75 per cent rain.

The number of days each winter during the past three years, on which sleet or snow has fallen, and on which snow was observed to lie at this station (Goff's Oak), is shown below :—

Season.	Days of Sleet or Snow.	Days of Snow Lying.
1934–5	14	6
1935–6	15	12
1936–7	19	5

The depth of snow lying was seldom more than one inch, only three days during this period having exceeded this limit viz :— January 27th, 1935, 4·25 in ; January 17th, 1936, 4·00 in ; and March 7th, 1937, 2·50 in.

Data regarding the snowfall of March, 1937, at Enfield, Tottenham and Hampstead, extracted from the *Monthly Weather Report*, together with the data from this station are given in the attached table, and these values, plotted against height above sea level in Fig. 1, clearly show the effect of height on the snowfall of the northern suburbs of London.

Station.	Height above Sea Level.	Days of Snow.	Days of Snow Lying.
Hampstead	450	12	12
Goff's Oak	330	14	3
Enfield	148	9	1
Tottenham	51	7	0

If the British Group of the International Snow Commission were to supply post cards for entering daily snow data, somewhat on the lines of the cards recently issued by the Meteorological Office for the Fog and Mist Investigation, doubtless they would meet with the response of a high percentage of the thousands of rainfall observers distributed throughout the British Isles.

The results of only five years' observations would surely merit the trouble taken to amass the data.

DONALD L. CHAMPION.

7, Robinson Avenue, Goff's Oak, Herts, October 21st, 1937.

The plan for systematic snowfall observations, illustrated with reference to Nottingham, which Mr. Tinn proposes in the October issue seems to me admirable and if taken up at many places would furnish just the material which, as pointed out by Mr. Champion, is needed to give more precision and detail to my annual snowfall reports on a descriptive basis. There can be no question that the Meteorological Office's system of recording days with "snowlying" according to some accepted definition which apparently first came into use about fifty years ago, is the only satisfactory method of studying snow-cover on comparative lines, though information on the depth of snow may give useful supplementary information. The depth of snow, however, is affected by the notorious variability in the consistency of snow, and still more by drifting which in exposed hilly country takes place on such a large scale as to raise rather troublesome questions as to where the snow really falls. It is satisfactory to be able to report that organized research to extend our knowledge of snowfall in these islands is already being planned, and it is hoped that the first active steps will be taken at the higher levels in Scotland during the coming season.

Mr. Champion's figures showing the relation of snow to altitude in the northern suburbs of London are reasonably clear considering that they only relate to the single month of March, 1937. In so short a period they might easily have been more affected by erratic factors. Nevertheless, the date, Sunday March 14th, 1937, which he selects for illustrating the effect of altitude on a single snowfall is ill-chosen because on that morning London lay in a transition belt between warm and cold air and a rapid change was proceeding. Thus at Hampstead thick snow was falling at 7.0 a.m. which by 9.0 a.m. had turned completely to rain, a very puzzling change since the wind remained NE. and the thermometer kept well below 40°F. The day was rather mild south of the Thames with a maximum of 50°F. at Tunbridge Wells, suggesting that warmer air was climbing over the cold surface NE. wind, whereas to the north in the south Midlands the day remained quite cold, and Mr. Hawke in the Chilterns recorded thick snow all day. Events at Hampstead, therefore, show that Mr. Champion's altitude changes were probably marked by this important time change.

L. C. W. BONACINA.

15, Christchurch Road, London, N.W.3. October 31st, 1937.

A hair-raising experience

Thunderstorm theories have made us familiar with the electrification resulting from the division of water drops, and it is known that large potential gradients are to be found near waterfalls. The same effect is also produced by the discharge of steam from a railway engine for instance, but how great the electric field can be is perhaps not realised.

I was crossing the bridge outside East Croydon Railway Station yesterday evening at the same time as a stationary engine on the track below was producing a cloud of steam, and the wind took this across only a foot or two above my head. I was hatless at the time, and as I passed under the steam I had the feeling that a shower of sparks was falling through it. On looking upwards I realised this could not be so, since the sensation was only on my scalp and not on my face. I found that what was happening was that some of my hair was actually standing on end owing to the strong electric field resulting from the positively charged steam. Had there been less artificial lighting I might even have appeared to onlookers to have been crossing the bridge wearing a halo of St. Elmo's fire!

C. J. BOYDEN.

Meteorological Station, Airport of London, Croydon, September 16th, 1937.

NOTES AND QUERIES

Typhoon at Hongkong, September 2nd, 1937

A typhoon which is described as the most severe on record since the foundation of the Observatory in 1883 struck Hongkong on the night of September 1st-2nd. By the courtesy of Mr. C. Fowler and Mr. T. E. Pearce we are permitted to reproduce a photograph of the anemograph and barograph records obtained at the Hongkong Electric Co., Ltd., as the frontispiece of this number of the magazine. The anemograph recorded a maximum velocity of 164 miles per hour and while no details are available as to the instrument, there appears to be no reason to doubt the approximate accuracy of the record. Details of the typhoon were supplied by an eye-witness, Mr. R. V. Bootle, Chief Officer, R.F.A., *Ebonol.*

The typhoon formed east of Manila and moved rapidly towards Hongkong. The first warning of its approach was given just before 1 a.m. on September 1st. The wind reached gale force about 8 p.m., by which time heavy rain had begun to fall. From 10 p.m. on the 1st to 2 a.m. on the 2nd the wind blew from north-west steadily increasing in velocity. The centre of the typhoon reached Hongkong about 2 a.m., when the wind veered to north, with squalls of phenomenal intensity, exceeding 125 miles per hour which is the limit of the anemograph at the Royal Observatory. After midnight the barometer fell rapidly, reaching 958·3 mb. (28·298 in.) about 3 a.m., the lowest reading ever recorded at the Royal Observatory. According to the anemometer record, the maximum wind velocity occurred about 3.30 a.m. After a short lull, the wind veered with extreme rapidity to the south-east, continuing to blow violently until 4 a.m., after which it gradually subsided. The total rainfall for the 24 hours ending at 10 a.m. was 5·93 in. The typhoon caused great damage to shipping in Hongkong Harbour and to the town itself, while a typhoon wave which swept inland caused many deaths.

Sand Devils

The best examples of this phenomenon I have yet observed occurred near Baghdad west station on June 24th, 1937. My attention was directed to what appeared to be a smallish cumulus cloud (a sufficiently rare phenomenon in itself in summer to warrant the attention of non-meteorologists); the "cloud" was in fact dust which had been carried to a height of about 2,500 ft. by some previous disturbance.

A sand devil appeared on the ground, the spin appearing from the airport about ¾ mile distant to be very violent and anti-clockwise, and almost immediately a thin rotating column of sand appeared from this devil to the base of the "cloud". The rotation could be observed at two or three points of the column as being violently anti-clockwise but the main movement of the sand was upwards. The bottom 1,500 ft. was almost vertical and the top was bent back towards the north.

After a few minutes the devil on the ground disappeared and the whole rotating column likewise vanished suddenly; a few minutes later another disturbance appeared on the ground somewhat further towards the south or south-east, also spinning violently anti-clockwise and the amazing thing was that almost immediately a thin rotating column of sand appeared between this disturbance and what had been originally mistaken for a cumulus cloud.

The interesting feature of these disturbances were (*a*) their great height (*b*) the very violent anti-clockwise movement near the ground and at various points of the trunk and (*c*) the rapidity with which the space between a smallish cloud of dust at 2,500 ft. and a disturbance on the ground became occupied with sand. If the sand composing the column was rising from the ground there must have been an area 3 or 4 ft. in diameter where the upward movement of the air was of the order of 4,000–5,000 ft. per minute.

Another very violent disturbance occurred over the aerodrome itself about ten minutes later. In this case the motion was clockwise but the dust and sand did not rise to any great height, although the quantity involved in the disturbance was very great.

J. DURWARD.

Altocumulus type cloud formed by an aeroplane

I was interested in the account of "Altocumulus type cloud formed by an aeroplane" given by Mr. D. Dewar in the May 1937 number of the *Meteorological Magazine* and am grateful to him for placing the occurrence on record. It is very unusual to find conditions favourable for this cloud formation through a vertical thickness of 6,000 ft., and I should like to emphasize that Mr. Dewar does not imply that the formation of cloud was possible through the whole vertical extent of this layer.

Mr. J. S. Smith and myself, have investigated a considerable number of these occurrences over a series of years, and they include only a few cases of aeroplane cloud formation through a considerable vertical thickness but in every case the formation has been restricted to a series of formations through relatively narrow vertical strata. Mr. Dewar has been good enough to give me further details of his observations which confirm that in this case also the formation occurred at various levels through the 6,000 ft. of height. When a series of cloud formations occur at varying heights it is invariably in the rear or "clearing sector" of complex depression systems, and the *International Section of the Daily Weather Report* confirms that Mr. Dewar's observations were made in these circumstances.

In the more usual cases artificial cloud formation occurs only at one level through a vertical thickness rarely exceeding 1,000 ft. and often much less although as various accounts in this magazine have shown, the horizontal extent of a layer may be such as to give continuous cloud streaks extending for many miles*. As to the causation of the altocumulus type cloud we are satisfied that it is due to condensation caused by the pressure reductions in the slip stream of the aircraft and is normally in evidence at a relatively short distance behind the airscrew. This implies that an aircraft when climbing should more easily produce cloud in suitable conditions and observation confirms this.

F. H. DIGHT.

Auroral Notes

It was expected that there would be frequent aurorae at this time of increasing solar activity, exemplified by the size and number of the sunspots, and recent reports are in agreement with this expectation. There is no record of aurorae in June, July or August, since the sky is never then sufficiently dark in the northern latitudes, where they are most frequently seen, but displays were observed on twelve nights in September. Aurora was noted as far south as Holyhead and Boscombe Down in the early morning of September 11th. At Holyhead three rays, reaching an elevation of about 20°, were seen to move slowly north from north-north-east between 0h. 30m. and 1h. 10m. G.M.T. A little later, from near Boscombe Down, Mr. Kinge noted streamers which attained an elevation of nearly 40° at about 3h.† The glow at times assumed a pinkish hue, and varied considerably in intensity.

Other displays which occurred during the middle of the month were less remarkable, but an exceptionally bright aurora was observed by Mr. Seton Gordon from Duntulm, Skye, around 22h. 45m. G.M.T. on September 30th. The glow stretched from west to east-north-east and reached to south of the zenith, where there were pulsating clouds of light. Rays were also noted. The general brightness was such that it was easily possible to see the time by a watch.

Three nights later, on October 3rd–4th, the finest aurora for many years occurred. From Shetland the display was observed from midnight to 5h., the sky from the zenith to the southern horizon being "ablaze with shifting and coloured beams of light, greens, blues and mauves predominating, pinks and reds less noticeable."

Mr. H. H. Lamb, from near Montrose, watched the commencement of the display. From 21h. to 23h. 30m. G.M.T. only a quiescent glow was present. Arcs, associated with coloured rays, then developed, and activity increased after midnight, when the colour was pale green.

---

* *London, Met. Mag.* 71, 1936, p. 19.

† See *London, Met. Mag.* 72, 1937, p. 212.

Bright rays from east and west met south of the zenith, and the arcs broke up "into irregular curtains." Flame aurora was also observed: "Flickering ripples of light appeared, two to three a second, across the north at about 20° elevation, and mounted the sky to beyond the zenith, ending near the eastern and westernmost shafts which arched the sky. There the ripples seemed to reflect back again as far as the zenith. The time from the appearance of a ripple to its disappearance at the zenith was estimated at 2 seconds or slightly over." The aurora was still at this development when the observations were given up at 0h. 30m.

Apparently the display continued to develop, for Mr. Chamberlain writes from H.M. Coastguard Station at Brixham, Devon, that he saw aurora from 2h. 30m. to 3h. 10m. on October 4th, of an intensity he had previously observed only when at Lerwick, Shetland. He describes the display as consisting of dull red shafts of light from north-east to west-north-west and reaching an elevation of about 20°, being most brilliant between 3h. 0m. and 3h. 5m. *The Times* reports that this aurora was also seen from a trawler off the Cornish coast, "the first time for 20 years that the lights have been seen there."

This aurora was probably associated with a large group of sunspots, visible to the unaided eye; on October 5th the group was centred at approximately 20° W. and very near the equator.

Other days on which aurora was observed, mostly from Scottish stations, were September 1st; 2nd; 9th; 10th; 13th; 15th; 18th; 20th; 22nd; 29th.

F. E. DIXON.

A new series of Memoirs from Japan

We welcome the appearance of the first numbers of the *Meteorological Notes* of the Meteorological Research Institute of the Imperial University of Kyoto. These are printed in Japanese, but each includes a full summary in English on separate duplicated sheets.

The first memoir, by Tatsutoshi Takahashi, discusses the phenomenon of "Sudden rise of air-temperature near ground during the night at the Basin of Kyoto". Several examples of sharp rises at low level but not at high level stations are illustrated and explained by autographic records.

The second note by Shiichi Aoki discusses two examples of typhoons consisting of two different circulatory systems, a "main typhoon" and a "secondary typhoon". This view was first put forward in connexion with the great "Muroto Typhoon" of 1934, described in the Memoirs of the College of Science, Kyoto University, and the present note supplements that paper.

The third note by Tadao Simeno examines two remarkable examples of rapid barometric disturbances, due to the passage of troughs, and discusses the weather situation associated with them.

Old Books on Meteorology

Included in a parcel of meteorological literature recently presented to the Meteorological Office, Edinburgh by Dr. Hill Buchan, son of Alexander Buchan, are two items of interest. One is a small volume entitled " A Companion to the Weather Glass ", published anonymously at Edinburgh in 1796, the contents being " selected from the most approved authors ". The book is a model of conciseness, every paragraph helping the reader " to become acquainted with the nature, construction and use of the instruments herein described and so generally useful ". The instruments mentioned are the barometer, thermometer and hygrometer. More space is devoted to the use of the barometer as an altimeter than to its use as a weather glass, the section on this point being a reprint of Halley's observations, which are noteworthy for the ingenuity of his explanations.

The section on the thermometer includes a long list of boiling points, melting points, climatic extremes and favourable temperatures for different plants. One item inconsistent with the results of recent research* is the reference " —40(°F) Fahrenheit's experiments with freezing mixtures."

A variety of hygrometers are described, using the expansion of wood, the twisting of fibres and the variation in weight of a sponge. Aqueous meteors are then briefly explained, followed by a " form of a register of the weather " strongly reminiscent of M.O. Form 3203. The only strange feature is the wind scale. " By 0 is denoted a perfect calm ; by 1 such a small wind as scarce moved the leaves of trees ; by 4 a hurricane ; and by 2, 3, intermediate forces."

Finally, to make the book of use to readers who have no barometer, the last 10 pages are a summary of the Shepherd of Banbury's well known " Rules to judge the changes of the weather ".

The other item deserving of mention is a larger and older work— " Astro-meteorologica or Aphorisms and Discourses of the Bodies Coelestial, their Natures and Influences ", by J. Goad, published in London in 1686. The dedication to King James II has tempted a cynic to add a pencilled note suggesting that he would have written rather differently 3 years later ; the same pencil has added on another page " the Dedication shows how much he loved it (Holy Writ) by speaking truth ".

Mr. Goad had a rather tedious style but his 500 folio pages include much useful information—prognostics, lists of frosts, earthquakes, comets etc. and weather diaries. Data are extracted from many authors but most of the weather diaries are those kept by the writer himself, though at what place there is no explicit evidence. No kind of numerical wind scale was used.

---

* In *Nature, London,* March 6, 1937, pp. 395-8 it is suggested that 0°F was the lowest temperature attained experimentally by Fahrenheit.

At first sight the diaries seem to be in a curious order, sections being scattered throughout the volume. This is due to the astrological method adopted, the weather being analysed at each principal conjunction and opposition in an endeavour to determine the nature of the influence of each planet on our weather. The possible influence of the moon is also investigated. The results are not very convincing though Mr. Goad had a scientist's technique, answering possible objections before announcing his conclusions.

F. E. DIXON.

[The observations of the Rev. John Goad contained in his " Astro Meteorologica", cover a period 1652–1686. From 1652 until 1660 Goad was living at or near Oxford as he held the living at Yarnton. In 1660 he removed to Tonbridge, Kent, on appointment as headmaster of Tonbridge School. In July, 1661, he became headmaster of Merchant Taylors School and lived in or near London until his death in 1689. The great bulk of the extracts from his weather diary are later than 1661 so that these will mostly refer to London. However, he managed to hold his living at Yarnton until his death, despite the fact that he openly professed Roman Catholicism in 1686. No doubt he would occasionally be in residence there and some of his data would refer to that neighbourhood. The dedication to James II was no doubt inspired by Goad's own popish tendencies. He was suspected of popery in 1681 and was dismissed his headmastership at Merchant Taylors School although probably other influences were at work as well.—C. E. Britton.]

REVIEWS

Grundlagen und Methoden der Periodenforschung. By Dr. phil. Karl Stumpff. $9\frac{1}{2}$ in. $\times$ $6\frac{1}{2}$ in. pp. vii + 332. *Illus.* Berlin, Julius Springer, 1937.

The idea that meteorological phenomena are periodic, popularly expressed in the conception of "weather cycles," developed very early in meteorology, partly no doubt by analogy with astronomy and tidal movements. As early as 1842 Luke Howard announced a weather cycle of 18 years in Great Britain but the statistical basis for this periodicity—a series of observations covering just 18 years—was somewhat inadequate. Later in the century periodicities were multiplied almost indefinitely, but the methods employed were cumbersome and critical tests of reality were rarely applied. The credit for first placing the discovery of hidden periodicities on a sound mathematical basis belongs to Sir Arthur Schuster, who in 1898 described the technique which is now generally known as the Schuster periodogram. Since that date the literature dealing with the critical examination of series of data for periodicities whether " hidden " or of known length, has grown rapidly and somewhat confusedly, scattered through a wide range of scientific periodicals.

In 1934, the Institute for the Investigation of Periodicity which is associated with the Meteorological Institute of the University of Berlin, and of which Dr. Stumpff is Director, set to work to collect, systematise and improve upon this enormous mass of literature, and especially to make it available for the investigation of meteorological periodicities. The exhaustive and valuable book now under review presents the first-fruits of the investigation.

The first chapter lays down the groundwork of the subject in a discussion of various types of series leading up to purely periodic functions. One of the difficulties of the subject is that natural phenomena, even when they are essentially periodic, are in the great majority of cases made up of component periodicities of incommensurable length, so that the series of observations never repeats itself exactly. This chapter includes some useful remarks on interpolation and smoothing, including the limits to which smoothing may permissibly be carried and the ratio in which it reduces the calculated amplitude.

The second chapter deals with harmonic analysis in practice. Simple schematic tables set out methods of calculating the various harmonic components from different numbers of observations. The calculation of waves from a network of observations and their synoptic representation are fully discussed in view of the bearing of these studies on both short-range and long-range weather forecasting, as exemplified in the work of Weickmann and others on symmetry in daily weather charts.

The third chapter introduces the subject of the periodogram proper as developed by Schuster, and this is explored with typical thoroughness. The great disadvantage of harmonic analysis is that the periodicities tested are necessarily integral fractions of the whole series; the great advantage of the spectrum periodogram is that it avoids this difficulty, though special methods may be required to separate periods which differ only slightly in length. The Schuster type of periodogram has, however, its own difficulties, chief among which is its laboriousness, and Stumpff gives us some hints for saving work. This leads to a discussion of the method of phase diagrams and other refinements, including the use of the Hollerith calculating machine, and the chapter ends with an account of aberrant forms of the periodogram and the analysis of broken series.

Chapter 4 deals with the statistical treatment of problems of periodicity, and begins with expectancy and the theory of errors. Distribution in two dimensions introduces the "point-cloud" and the combined treatment of amplitude and phase as a vector, which has interesting applications leading up, for example, to the auto-correlation periodogram. The practical possibilities of this powerful new weapon are, however, less thoroughly discussed than are those of older and better known methods, especially as regards the use of partial correlation.

The fifth chapter describes other analytical methods of determining periodicity. One class of these consists in transforming a curve or series of observations by some operation such as repeated differentation into a series of as many equations as there are unknown periodicities: these equations are then solved algebraically. Many varieties of this type are described, some of them highly ingenious but the author leaves us with the impression that straightforward methods are generally the best. The second class of analytical methods aims at emphasising the differences between the amplitudes of different periodicities so that the larger ones can be readily picked out. The orthodox methods of periodogram analysis are so laborious that it is a great advantage to be able to pass over the uninteresting parts of the spectrum and concentrate on those which are most likely to produce results. The most frequent line of attack is by integration or smoothing.

The last chapter describes the principles of the various mechanical periodograms, most space being devoted to those of an optical or photomechanical type. Even these, however, require lengthy preparation of the data; the ideal machine in which the figures are fed in at one end and the periodicities ground out at the other remains a dream. The book ends with a good bibliography containing 319 entries, not however entirely free from errors.

The author in his introduction expresses the hope that the book contains not only instruction and inspiration for the theorist, but also all necessary information for the practical worker. The former hope is certainly justified, the latter less so, for there was not space in all cases to give practical examples of the application of the methods, but a companion volume is planned to contain a collection of auxiliary tables, formulae and examples for practical use.

C. E. P. BROOKS.

Buchan's Days. A modern guide to weather wisdom. By E. L. Hawke, M.A. Size 7½ in. × 5 in., pp. 231. *Illus.* London, Lovat Dickson Ltd., 1937. 5*s* net.

Whether we agree with its main contentions or not, this little book is both interesting and pleasant to read. Mr. Hawke has a great admiration for Alexander Buchan, whom he describes, in dedicating the book to him, as a great man, much misunderstood. Great he certainly was, as the sketch of his life in the first chapter makes abundantly clear, but among meteorologists his greatness was securely established, especially by his magnificent work on the atmospheric circulation and on the Ben Nevis observations, long before the "Buchan periods" had become a common topic of conversation. The "misunderstanding" refers to the difficulties which some meteorologists have felt in accepting the popular interpretation of Buchan's six cold and three warm spells as recurring almost with the regularity of Christmas, but Mr. Hawke himself agrees that Buchan overstated his case in assigning exact dates to his " periods ", which are to be regarded rather as movable feasts like Easter or Derby Day. The reviewer cannot help thinking that Buchan himself would have deprecated the remarkable pictorial representation forming the end pages, but perhaps the reviewer is prejudiced.

Mr. Hawke leads up to his subject skilfully in a chapter on " weather lore " in which he brings out the traditional beliefs that special types of weather tend to occur at certain times of the year. He then describes how Buchan set out to test these beliefs, with the result that he selected the now famous nine periods, with the proviso that " the commencement of each of these more anomalous periods is subject to variation from year to year ". Each period and its variations are then described in detail, and in Chapter IV : " The doctrine to-day ". (" Doctrine " ; does Mr. Hawke regard its acceptance as a test of faith among meteorologists ?) further support is given to their reality by a consideration of the long series of temperature observations at Greenwich and by the cataloguing of some striking agreements in recent years. He goes on to discuss the causes of such quasi-regular recurrences, but admits that explanation is no more possible for these than for other vagaries of the seasons, ending with some tentative thoughts on mass suggestion as a factor on weather, which were obviously written before the coronation.

The second part of the book, " Round the Year ", abandons Buchan except for some casual references and discusses in a chatty knowledgeable way the chequered course of the thermometer, rain-gauge and sunshine recorder through the months, with some excursions into history. The whole book contains a great deal of information rendered readily accessible by an excellent index.

C. E. P. Brooks.

The Atmospheric Pressure at Mauritius—being a survey and discussion of fifty-six years observations made at the Royal Alfred Observatory. By M. Herchenroder, B.Sc. R. A. Observatory Publications No. 18, Port Louis, 1937.

Mr. Herchenroder has set himself the task of reducing the mass of facts accumulated at the Royal Alfred Observatory to some sort of accessible order. This paper follows " La Pluie à l'île Maurice ". It is easy for the critic to sit back and say " This would I have presented differently ", " A discussion of that is unprofitable ". The retort is that the critic continued to sit and do nothing.

The actual data handled are the hourly readings of pressure obtained from the photographic record of a Kew barograph from 1875 to 1930. There are printed and published data for all but four (1911–4) of these 56 years, but the discussion of standards must have involved much wearying search amongst MSS. almost illegible and partly devoured by insect pests. We have presented to us, finally, tables shewing the value of the barometric pressure for each month and year of the 56 years, and mean values for each day of the year and each hour of the day. The diurnal variations have been analysed into Fourier series and twelve terms are given.

This is a good and solid achievement for which Mr. Herchenroder deserves our thanks. His attempts to make out a case for a slow secular change and two cycles of 9 and 17 years are not convincing. The mean departure of the yearly means from the average is 0·40 millibars. After the yearly means have been "corrected" for secular change the figure is still 0·35 millibars.

The constancy of the yearly mean is a more striking fact than its variation, especially considering the large seasonal variation. Those of us to whom meteorology means the six-hourly synoptic chart of the "westerlies" are liable to forget the regularity of seasonal changes over about one half of the earth's surface. In Mauritius at the time the barometer is falling rapidly from September to November, no individual October had a mean pressure as big as the September 56 years average, and no November mean was as big as the October average.

A table of the average pressure for each day of the year must be available for ready reference in Mauritius, but would find little use in England.

R. A. Watson.

Temperatures of the western North Atlantic from thermograph records. By Phil E. Church. Association d'Océanographie physique. Union Géodésique et Géophysique Internationale. Publication Scientifique No. 4, Liverpool, 1937.

Thirteen sea temperature thermographs are now in operation on eight steamship routes between New York, Boston and Halifax and Bermuda, the West Indies and South America. Twelve hundred thermograms were available for the author's work, which is the first published investigation of sea temperatures, so derived, over an extensive oceanic area. For the period November, 1928, to December, 1933, sufficient data were obtained to construct one hundred charts, synoptic in the sense that each was made from data taken within a week, or occasionally ten days.

The work is a valuable contribution to North Atlantic oceanography. The region from latitude 45° N. to the equator is found to be divisible into five thermal sub-areas: the coastal water inside the 200-metre contour, the "slope water" between the coastal water and the Gulf Stream, the narrow "cold wall" of steep temperature gradient bounding the Gulf Stream, the Gulf Stream, the central Atlantic area and the tropical North Equatorial Current, which is subdivided into three belts. Charts of average temperature, range of temperature and maximum and minimum temperatures are given, and the information obtained is related to climatic and weather conditions. Maximum temperatures for the year are found in the neighbourhood of the 26th parallel, which corresponds to Meyer's line of sub-tropical oceanic convergence and to the axis of the permanent anticyclone.

The new information about the Gulf Stream is particularly interesting, notably its width in different latitudes, its lateral wanderings and the development and life-history of the intrusions of warm water which it sends into the region of the slope water. Departures of Gulf Stream temperatures from the average were noted, with simultaneous but smaller departures in the central Atlantic area. The author considers that the latter exert greater influence in producing weather abnormalities along the eastern United States seaboard than those of the Gulf Stream itself.

E. W. BARLOW.

OBITUARY

Sir John William Moore.—It is with great regret that we record the death at the age of nearly 92 of Sir John William Moore, the eminent Irish physician and meteorologist. To the student of meteorological literature he is best known by his "Meteorology, Practical and Applied," first published in 1894, and re-published in a revised and enlarged form in 1910. Though this book is perhaps little known to the younger generation of meteorologists it is an able and substantial work; it contains, in particular, a valuable section on "The influence of season and of weather on disease," much of which was the result of his own research work. He was the author also of numerous papers dealing mainly with the climatology of Dublin, where he was born on October 23rd, 1845, and where he died on October 12th, 1937, within a few days of his ninety-second birthday. He was personally associated with the meteorological work of the Dublin City Climatological Station, Fitzwilliam Square from the date of its commencement, about 1868. Actually his services as a co-operating observer began even earlier, for *British Rainfall*, 1865, contains readings from Dublin, St. Anne's Street, contributed by J. W. Moore, Esq. Sir John Moore was thus a regular meteorological observer for a period of more than 71 years, a truly remarkable record and one that has never been equalled in our annals.

He was among the most distinguished of Irish physicians, and received the honour of knighthood in 1900 at the completion of two years as President of the Royal College of Physicians of Ireland. His manifold activities included the editorship of the *Dublin Journal of Medical Science* from 1873 to 1920. He was an Honorary Physician-in-Ordinary to H.M. the King in Ireland and an Honorary D.Sc. of Oxford University.

E. G. BILHAM.

We regret to learn of the death on October 11th of Dr. J. R. Sutton, formerly Director of the De Beer's Meteorological Observatory of Kimberley in South Africa, Honorary Member of the Royal Meteorological Society and the author of numerous important works on the climatology of South Africa.

NEWS IN BRIEF

We learn that Dr. G. M. B. Dobson, has been elected to an official fellowship at Merton College, Oxford, and has also been appointed to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

We learn that Captain Georges M. Horsch has been appointed Director General of the National Observatory of Athens.

The Weather of October, 1937

Pressure was above 1020 mb. west of the Azores and in a long belt between about 40° N. and 60° N. from long. 20° E. in central Europe to 110° E. in central Siberia, reaching 1025 mb. north of Lake Baikal; 1020 mb. was also reached in the south of British Columbia. Pressure was below 1000 mb. over the Aleutian Islands and Davis Strait; most of the Arctic was below 1005 mb. and a secondary minimum (1013 mb.) occupied Portugal, Spain and western France. Over Scandinavia there was a steep gradient for south-westerly winds, becoming westerly over northern Russia. Pressure was more than 5 mb. above normal south-east of Newfoundland and in a narrow zone from Denmark to northern Russia; it was 5 mb. below normal over the Aleutian Islands, south Greenland, west Scotland and the Arctic from Spitsbergen eastwards. Elsewhere deviations were slight.

Temperature was below zero in the central regions of the Arctic Ocean, below 10° F. on the coast of Siberia from Cape Chelyuskin to the Lena Delta and below 20° F. over north-eastern Siberia, but south and east Greenland, Bear Island and most of Alaska were above 32° F. Scandinavia was abnormally warm (40–50° F., 5° F. above normal). The British Isles varied from 49° F. in the north to 55° F. in the south; central Europe from 50° F. in the north-east to 55° F. in the west and south; Portugal and the Mediterranean exceeded 60° F. while Malta and Tripoli were above 70° F. and Egypt 75° F. to 90° F. In North America temperature increased from 22° F. on the north coast to 70° F. on the Gulf Coast but western Canada (47–55° F.) was 5–8° F. above normal. Another area of abnormally high temperature included Iceland, east Greenland and Newfoundland, elsewhere temperatures differed little from normal.

Precipitation was from 2 to 4 in. in the British Isles and western France and 1 to 2 in. over northern, central and eastern Europe. In these areas it was generally deficient, but parts of the Mediterranean had abnormally heavy rainfall, exceeding 10 in. at Gibraltar. Most of Siberia had less than an inch. In North America rainfall was generally moderate (1–4 in.) but was excessive on the Gulf Coast.

The main feature in Australasia was an intense anticyclone over New Zealand, exceeding 1020 mb., 10 mb. above normal. Australia differed little from normal. Southern and eastern India were below 1010 mb., and India was generally 2 mb. below normal. Temperature was 1–3° F. below normal in India, but most of Australia was abnormally warm, temperatures of 60° F. and above being recorded on much of the south coast. Rainfall was above normal in central and eastern India and the east coast of Australia including Victoria but deficient over most of the rest of Australia and New Zealand.

The weather over the British Isles during the first part of October was generally mild, and anticyclonic, becoming unsettled with storms and much rain later. Sunshine totals were considerably below normal except in the west; the total of 75 hrs. at Cranwell (Lincolnshire) established a new low record for this station where observations started in 1921. Rainfall was deficient generally except in eastern Scotland and north Wales, while much morning mist or fog was experienced at times. On the 1st, the British Isles lay between two areas of low pressure, one to the north and the other over the Bay of Biscay and rain fell heavily in most districts except the south-east, 1·97 in. was recorded at Scilly. By the 2nd the anticyclone over northern Europe was spreading eastwards and the rain had lessened considerably. Mist and fog were experienced locally on both mornings chiefly in the eastern districts. From then to the 13th pressure was high over the whole country and warm anticyclonic weather prevailed generally though there was considerable cloud on many days. Moderate rain occurred on the south coast of England on the 4th and 5th, in parts of Ireland on the 6th and in north Scotland on the 8th. The 4th and 10th were both sunny days and long periods of bright sunshine were also experienced locally on the 5th, 9th and 11th; 10·8 hrs. at Tynemouth on the 4th and 10·0 hrs. at Scilly and Guernsey on the 5th and Portsmouth, Southsea and Weymouth on the 10th. Mist or fog occurred frequently in the mornings except in the extreme north while maximum temperatures were generally between 55°F and 65°F. From the 14th to 19th pressure was high to the south whilst depressions to the north moving north-east brought mild unsettled stormy weather to the northern districts. Gales were experienced in the extreme north and north-west from the 15th to 18th but generally there was not much rain or sun in the north during this period though considerable cloud. In England the weather was mainly warm and sunny during the day with, however, low minimum temperatures on some nights and from the 16th much morning mist and fog. A maximum temperature of 69°F. was recorded at Bude on the 18th and 10·0 hrs. bright sunshine at Scilly on the same day. On the 20th and 21st pressure was low both to the north and south but mild sunny weather with morning fog continued in the south—in the north and west there was more rain. By the evening of the 21st a complete change of conditions was spreading across the south of the country, putting an end to the drought which had extended since the end of September at some places. On the 22nd a deep depression lay over the country and rain fell heavily both then and on the 23rd, 3·80 in. at Llanerchymedd (Anglesey) on the 23rd and 1·85 in. at Carmarthen on the 22nd. The 24th was generally a sunny day except in the south-west, but from the 23rd to the 26th, strong winds were experienced at times in most parts and gales off the south-west coasts—Scilly reported a gust of 83 m.p.h. and Lizard one of 80 m.p.h. on the 23rd. Thunderstorms were experienced in the west on the 23rd and more generally in the south-west, south and east on the 25th when they were accompanied by hail in some places. The 26th was a sunny day in the south-west but rain continued in the north. On the 27th a ridge of high pressure passed across Ireland and Scotland giving much sun in these countries, 8·8 hrs. at Oban and Tiree and 8·7 hrs. at Valentia and Ballinacurra. From then to the 31st pressure was low, and unsettled weather, with considerable rain at times prevailed and some local morning mist or fog. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ..	62	−15	Chester ..	75	−16
Aberdeen ..	76	−18	Ross-on-Wye	83	−16
Dublin	—	—	Falmouth ..	120	+ 7
Birr Castle ..	95	+ 5	Gorleston ..	81	−34
Valentia ..	95	+ 5	Kew.. ..	82	−14

Kew, Temperature, Mean, 52·6., Diff. from average + 1·0.

Miscellaneous notes on weather abroad culled from various sources.

Torrential rain followed by severe floods was experienced in the Pyrenees during the first 5 or 6 days of the month, and at the same time, severe thunderstorms accompanied by torrential rain which flooded the rivers occurred in Tuscany, doing extensive damage. Heavy rain was also experienced in north Spain early in the month. Dense fog occurred off Cape Finistere on the 20th and off the coasts of Holland and north-west Germany on the 21st. A violent thunderstorm was experienced over Rome and the neighbourhood on the 23rd, causing much damage to the town of Palestrina—2 people were killed. Snow fell, down to the 3,000 ft. level on the Alps, about the 25th, and most of the Alpine passes were closed for vehicular traffic for the winter. Violent rainstorms caused floods which did serious damage to communications in Bosnia (Yugoslavia) about the 25th. A sudden flooding of the Pyrenean rivers about the 28th caused much damage—at Pierresite there was a large landslip and 2 people were drowned. Gales and heavy rain were reported from the Riviera on the 28th, and exceptionally heavy rain in several parts of Spain on the 30th (*The Times,* October 5th—November 1st).

Rain early in the month flooded many parts of Shanghai. Sudden severe floods were experienced in Syria on the 28th to 30th, during which many people were drowned and several villages destroyed (*The Times*, October 8th—November 1st).

A westerly gale blowing at Buenos Aires on the 7th and 8th drove the waters of the River Plate down the estuary causing a water shortage in the city. On the 9th the wind changed and the river returned to normal (*The Times*, October 11th).

Daily Readings at Kew Observatory, October, 1937

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	1011·9	SSE.2	46	66	63	—	2·9	fe till 9h.
2	1012·1	ENE.2	52	67	63	—	2·0	mw early f 9h.
3	1021·3	N.2	56	60	83	—	0·0	r_0 2h and 8h. f till 9h.
4	1033·3	NNW.3	46	61	55	—	8·0	w early and late.
5	1029·5	N.4	48	59	71	—	0·1	
6	1023·4	NE.4	50	57	61	—	0·2	
7	1014·6	NE.3	51	56	78	0·03	0·0	r_0 1h.–10h.
8	1017·2	NE.3	50	60	66	—	0·1	
9	1028·3	NE.1	51	60	58	—	4·3	w early and late.
10	1030·6	NNW.2	39	58	56	—	4·1	Fe till 9h. fe 19h.
11	1025·6	NNE.4	46	58	70	—	5·5	d_0 21h.
12	1025·1	N.3	51	54	87	—	0·0	d_0 9h, 13h and 14h.
13	1026·8	W.2	49	52	68	—	0·5	m 18h.
14	1022·1	WNW.2	42	59	65	—	0·2	
15	1028·3	NW.3	50	60	53	—	5·1	F 20h.
16	1032·3	SW.2	38	59	70	—	7·1	Fe till 9h.
17	1034·6	SSW.2	43	57	69	—	3·7	Fe evening. [18h.
18	1032·0	SSW.1	36	54	88	trace	2·2	Fe till 12h. and from
19	1023·8	E.3	44	58	70	—	4·4	Fe–f till 9h. and from
20	1016·1	SSW.2	47	59	69	—	5·4	Fe till 7h. f.21h. [18h.
21	1009·8	NW.1	40	55	94	trace	0·0	Fe–f all day.
22	997·4	S.4	43	60	68	0·55	3·0	fe till 9h. r 15h.–22h.
23	975·4	S.4	49	55	63	0·48	2·4	r_0–R 7h–22h.
24	989·7	WSW.4	46	53	53	0·01	5·7	pr_0 7h. r_0 22h.–24h.
25	982·2	SSE.5	48	58	79	0·42	2·3	PR from 10h. TLr
26	997·5	S.2	48	58	69	0·01	2·9	r_0 from 23h. [19h.,20h.
27	1003·9	NE.3	48	55	96	0·56	0·0	r_0–r 0h.–19h.
28	1007·5	S.3	53	61	72	0·08	6·3	r_0–r 19h.–24h.
29	998·2	NNE.1	52	58	83	—	0·0	r_0 0h., 3h., 18 h.
30	1001·3	SW.4	50	58	75	0·01	2·6	r_0 4h.–5h., 9h., 18h.
31	1007·9	ESE.2	47	58	71	0·22	0·8	r_0–r 18h.–22h.
*	1014·8	—	47	58	71	2·37	2·6	* Means or Totals.

General Rainfall for October, 1937

England and Wales ...	83	per cent of the average 1881–1915.
Scotland	81	
Ireland	66	
British Isles	80	

Rainfall : October, 1937 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	2·21	84	*Leics* .	Thornton Reservoir ...	2·56	91
Sur .	Reigate, Wray Pk. Rd..	3·32	100	,, .	Belvoir Castle...........	2·30	85
Kent .	Tenterden, Ashenden...	3·76	108	*Rut* .	Ridlington	2·40	85
,, .	Folkestone, Boro. San.	2·65	...	*Lincs* .	Boston, Skirbeck.........	2·13	78
,, .	Margate, Cliftonville....	2·78	95	,, .	Cranwell Aerodrome...	2·21	77
,, .	Eden'bdg., Falconhurst	2·89	80	,, .	Skegness, Marine Gdns.	1·38	50
Sus .	Compton, Compton Ho.	4·02	88	,, .	Louth, Westgate.........	2·10	65
,, .	Patching Farm..........	2·58	65	,, .	Brigg, Wrawby St.......	2·45	...
,, .	Eastbourne, Wil. Sq....	3·27	79	*Notts* .	Mansfield, Carr Bank...	3·63	119
Hants.	Ventnor, Roy.Nat.Hos.	2·37	60	*Derby*.	Derby, The Arboretum	1·81	67
,, .	Fordingbridge, Oaklnds	4·33	104	,, .	Buxton, Terrace Slopes	2·86	55
,, .	Ovington Rectory.......	4·29	106	*Ches* .	Bidston Obsy.............	2·30	70
,, .	Sherborne St. John......	3·11	88	*Lancs*.	Manchester, Whit. Pk.	1·55	47
Herts .	Royston, Therfield Rec.	2·79	103	,, .	Stonyhurst College......	2·07	46
Bucks.	Slough, Upton............	2·92	104	,, .	Southport, Bedford Pk.	2·25	64
Oxf .	Oxford, Radcliffe.........	2·70	93	,, .	Ulverston, Poaka Beck	2·91	53
N'hant	Wellingboro, Swanspool	2·87	114	,, .	Lancaster, Greg Obsy.	1·77	43
,, .	Oundle	1·90	...	,, .	Blackpool	2·78	75
Beds .	Woburn, Exptl. Farm...	2·75	103	*Yorks*.	Wath-upon-Dearne......	2·98	108
Cam .	Cambridge, Bot. Gdns.	2·24	95	,, .	Wakefield, Clarence Pk.	2·66	93
,, .	March......................	1·84	71	,, .	Oughtershaw Hall.......	3·09	...
Essex.	Chelmsford, County Gdns	1·21	49	,, .	Wetherby, Ribston H..	2·29	76
,, .	Lexden Hill House......	1·41	...	,, .	Hull, Pearson Park......	1·71	57
Suff .	Haughley House.........	1·39	...	,, .	Holme-on-Spalding......	2·27	76
,, .	Rendlesham Hall........	2·00	77	,, .	West Witton, Ivy Ho.	2·91	78
,, .	Lowestoft Sec. School...	1·75	63	,, .	Felixkirk, Mt. St. John.	1·97	68
,, .	Bury St. Ed., Westley H.	1·94	72	,, .	York, Museum Gdns....	2·80	104
Norf. .	Wells, Holkham Hall...	2·24	80	,, .	Pickering, Hungate......	2·54	83
Wilts .	Porton, W.D. Exp'l. Stn	4·46	143	,, .	Scarborough...............	2·95	94
,, .	Bishops Cannings........	4·48	135	,, .	Middlesbrough...........	1·23	41
Dor .	Weymouth, Westham.	4·49	123	,, .	Baldersdale, Hury Res.	2·35	59
,, .	Beaminster, East St....	4·80	108	*Durh* .	Ushaw College............	1·95	57
,, .	Shaftesbury, Abbey Ho.	4·41	113	*Nor* .	Newcastle, Leazes Pk...	2·10	68
Devon.	Plymouth, The Hoe....	3·75	95	,, .	Bellingham, Highgreen	2·65	68
,, .	Holne, Church Pk. Cott.	4·64	70	,, .	Lilburn Tower Gdns....	2·78	75
,, .	Teignmouth, Den Gdns.	3·81	98	*Cumb*.	Carlisle, Scaleby Hall...	1·66	50
,, .	Cullompton	3·65	88	,, .	Borrowdale, Seathwaite	6·0(	53
,, .	Sidmouth, U.D.C........	3·35	...	,, .	Thirlmere, Dale Head H.	6·44	74
,, .	Barnstaple, N. Dev.Ath	2·95	65	,, .	Keswick, High Hill......	3·35	60
,, .	Dartm'r, Cranmere Pool	5·10	...	*West* .	Appleby, Castle Bank...	1·35	39
,, .	Okehampton, Uplands.	4·39	73	*Mon* .	Abergavenny, Larchf'd	4·61	110
Corn .	Redruth, Trewirgie......	3·69	70	*Glam* .	Ystalyfera, Wern Ho....	3·54	51
,, .	Penzance, Morrab Gdns.	3·21	69	,, .	Treherbert, Tynywaun.	4·30	...
,, .	St. Austell, Trevarna...	3·15	60	,, .	Cardiff, Penylan..........	4·09	86
Soms .	Chewton Mendip.........	4·46	93	*Carm* .	Carmarthen, M. & P. Sch.	5·88	100
,, .	Long Ashton............	3·32	88	*Pemb* .	Pembroke, Stackpole Ct.	4·85	103
,, .	Street, Millfield..........	3·80	119	*Card* .	Aberystwyth	3·92	...
Glos .	Blockley	3·48	...	*Rad* .	BirmW.W.Tyrmynydd	4·65	70
,, .	Cirencester, Gwynfa....	3·49	105	*Mont* .	Newtown, Penarth Weir	3·66	90
Here .	Ross-on-Wye..............	3·44	104	,,	Lake Vyrnwy	4·26	75
Salop .	Church Stretton.........	4·48	124	*Flint* .	Sealand Aerodrome......	2·46	...
,, .	Shifnal, Hatton Grange	2·20	78	*Mer* .	Blaenau Festiniog	3·95	42
,, .	Cheswardine Hall........	2·67	86	,, .	Dolgelley, Bontddu......	3·45	57
Worc .	Malvern, Free Library...	2·95	99	*Carn* .	Llandudno	3·24	97
,, .	Ombersley, Holt Lock.	2·47	93	,, .	Snowdon, L. Llydaw 9..	7·85	...
War .	Alcester, Ragley Hall...	2·58	94	*Ang* .	Holyhead, Salt Island...	6·40	160
,, .	Birminghm, Edgbaston	2·67	96	,, .	Lligwy	6·43	...

Rainfall: October, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	4·47	99	*R&C* .	Achnashellach	4·32	54
Guern.	St.Peter P't.Grange Rd.	4·20	93	„ .	Stornoway,C.GuardStn.	2·32	47
Wig .	Pt. William, Monreith.	2·89	73	*Suth* .	Lairg	2·19	59
„ .	New Luce School	2·98	64	„ .	Skerray Borgie	2·45	...
Kirk .	Dalry, Glendarroch	3·74	71	„ .	Melvich	2·03	55
Dumf.	Dumfries, Crichton R.I.	4·75	128	„ .	Loch More, Achfary	5·93	76
„ .	Eskdalemuir Obs	3·87	72	*Caith* .	Wick	2·51	85
Roxb .	Hawick, Wolfelee	3·12	81	*Ork* .	Deerness	2·54	67
Peeb .	Stobo Castle	3·44	100	*Shet* .	Lerwick	3·13	85
Berw .	Marchmont House	3·55	93	*Cork* .	Dunmanway Rectory	...	...
E.Lot .	North Berwick Res	3·29	111	„ .	Cork, University Coll.	2·48	64
Midl .	Edinburgh, Blackfd. H.	3·87	141	„ .	Mallow, Longueville	2·62	73
Lan .	Auchtyfardle	4·38	...	*Kerry*.	Valentia Observatory	2·50	45
Ayr .	Kilmarnock, Kay Park	2·81	...	„ .	Gearhameen	3·80	41
„ .	Girvan, Pinmore	3·99	80	„ .	Bally McElligott Rec.	2·44	...
„ .	Glen Afton, Ayr San.	4·91	96	„ .	Darrynane Abbey	2·33	46
Renf .	Glasgow, Queen's Park	4·14	127	*Wat* .	Waterford, Gortmore	3·11	79
„ .	Greenock, Prospect H.	2·84	53	*Tip* .	Nenagh, Castle Lough.	...	...
Bute .	Rothesay, Ardencraig	3·12	71	„ .	Roscrea, Timoney Park	...	...
„ .	Dougarie Lodge	2·73	66	„ .	Cashel, Ballinamona	2·64	74
Arg .	Loch Sunart, G'dale	4·44	67	*Lim* .	Foynes, Coolnanes	1·49	39
„ .	Ardgour House	3·75	...	*Clare* .	Inagh, Mount Callan	1·91	...
„ .	Glen Etive	3·33	41	*Wexf* .	Gorey, Courtown Ho.	2·49	70
„ .	Oban	3·79	...	*Wick* .	Rathnew, Clonmannon.	3·91	...
„ .	Poltalloch	4·52	92	*Carl* .	Bagnalstown, Fenagh H.	2·78	83
„ .	Inveraray Castle	3·94	56	„ .	Hacketstown Rectory	2·61	69
„ .	Islay, Eallabus	4·43	93	*Leix* .	Blandsfort House	3·33	95
„ .	Mull, Benmore	11·20	87	*Offaly*.	Birr Castle	1·93	66
„ .	Tiree	2·23	49	*Kild* .	Straffan House	3·96	139
Kinr .	Loch Leven Sluice	3·37	98	*Dublin*	Dublin, Phoenix Park.	4·45	169
Fife .	Leuchars Aerodrome	3·54	136	*Meath*.	Kells, Headfort	...	...
Perth .	Loch Dhu	3·80	53	*W.M* .	Moate, Coolatore	1·59	...
„ .	Crieff, Strathearn Hyd.	3·62	92	„ .	Mullingar, Belvedere	1·93	62
„ .	Blair Castle Gardens	2·62	85	*Long* .	Castle Forbes Gdns	1·56	48
Angus.	Kettins School	3·28	103	*Gal* .	Galway, Grammar Sch.	1·06	29
„ .	Pearsie House	3·16	...	„ .	Ballynahinch Castle	2·55	43
„ .	Montrose, Sunnyside	3·19	116	„ .	Ahascragh, Clonbrock.	1·03	28
Aber .	Balmoral Castle Gdns.	3·05	85	*Rosc* .	Strokestown, C'node	...	...
„ .	Logie Coldstone Sch.	2·75	85	*Mayo*.	Blacksod Point	2·02	41
„ .	Aberdeen Observatory.	3·37	112	„ .	Mallaranny	2·05	...
„ .	New Deer School House	2·50	66	„ .	Westport House	·89	20
Moray	Gordon Castle	2·32	73	„ .	Delphi Lodge	2·80	29
„ .	Grantown-on-Spey	2·08	70	*Sligo* .	Markree Castle	1·37	34
Nairn.	Nairn	2·32	99	*Cavan*.	Crossdoney, Kevit Cas.	1·96	...
Inv's .	Ben Alder Lodge	2·86	...	*Ferm* .	Crom Castle	1·12	35
„	Kingussie, The Birches.	1·77	...	*Arm* .	Armagh Obsy	2·75	101
„ .	Loch Ness, Foyers	1·99	59	*Down*.	Fofanny Reservoir	4·53	...
„	Inverness, Culduthel R.	2·17	89	„ .	Seaforde	3·62	102
„ .	Loch Quoich, Loan	7·51	...	„ .	Donaghadee, C. G. Stn.	3·49	121
„ .	Glenquoich	4·26	43	*Antr* .	Belfast, Queen's Univ.	3·14	95
„ .	Arisaig House	3·99	68	„ .	Aldergrove Aerodrome.	2·95	98
„ .	Glenleven, Corrour	2·38	39	„ .	Ballymena, Harryville.	2·99	81
„ .	Fort William, Glasdrum	2·83	...	*Lon*	Garvagh, Moneydig	2·34	...
„ .	Skye, Dunvegan	2·79	...	„ .	Londonderry, Creggan.	1·68	46
„ .	Barra, Skallary	3·04	...	*Tyr* .	Omagh, Edenfel	1·10	30
R&C .	Alness, Ardross Castle.	...	...	*Don* .	Malin Head	1·57	...
„ .	Ullapool	2·59	53	„	Dunkineely	1·31	...

Climatological Table for the British Empire, May, 1937

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 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	1016·4	+ 0·5	80	40	63·7	48·4	56·1	+ 1·6	50·0	85	8·5	2·15	+ 0·43	13	5·6	36
Gibraltar	1018·0	+ 1·9	75	52	66·9	57·2	62·1	− 3·4	55·9	79	3·7	0·44	...	5	...	...
Malta	1016·6	+ 2·1	81	56	71·2	60·4	65·8	− 0·1	60·7	78	3·7	0·23	− 0·18	2	9·6	68
St. Helena	1013·1	− 1·4	73	57	68·1	60·7	64·4	+ 2·1	62·3	93	8·1	4·36	+ 1·68	18	...	...
Freetown, Sierra Leone	1011·2	+ 1·7	90	71	86·9	75·0	80·9	...	76·4	79	6·2	8·09	− 3·38	16	...	...
Lagos, Nigeria	1010·7	+ 0·1	91	71	87·3	76·7	82·0	+ 0·2	77·4	84	7·8	10·02	− 0·73	12	7·1	57
Kaduna, Nigeria	1010·0	...	98	69	91·2	72·1	81·7	+ 2·3	73·5	82	7·0	7·02	+ 1·32	16	7·8	62
Zomba, Nyasaland	1015·4	0·0	82	49	76·8	57·1	66·9	+ 1·1	62·4	74	4·5	0·28	− 0·76	2	...	...
Salisbury, Rhodesia	1018·2	0·0	79	37	74·3	47·6	60·9	+ 0·3	53·0	55	1·4	0·03	...	1	8·6	76
Cape Town	1018·9	+ 0·8	91	38	67·0	50·5	58·7	− 0·2	51·8	91	0·6	3·39	− 0·36	12	...	...
Johannesburg	1018·5	− 0·8	76	39	68·2	48·4	58·3	+ 3·9	45·4	40	1·1	0·26	− 0·50	2	9·3	85
Mauritius	1017·0	+ 0·7	84	59	78·6	68·5	73·6	+ 1·0	70·7	81	6·2	11·68	+ 7·76	20	6·3	56
Calcutta, Alipore Obsy.	1003·4	− 0·1	106	72	96·2	79·0	87·6	+ 1·5	79·5	78	5·5	5·47	− 0·09	5*	...	...
Bombay	1007·6	+ 0·2	93	76	90·5	79·4	84·9	− 0·9	77·2	75	3·1	0·00	− 0·55	0*	...	...
Madras	1004·7	− 0·7	106	79	98·0	82·1	90·1	+ 0·3	79·3	65	3·8	0·00	− 1·84	0*	...	...
Colombo, Ceylon	1009·1	+ 0·7	88	73	86·8	77·3	82·1	− 0·7	78·7	82	8·0	18·63	+ 7·69	26	6·1	49
Singapore	1009·1	+ 0·4	88	71	85·6	76·3	80·9	− 1·1	78·2	81	6·7	12·75	+ 6·11	21	5·9	49
Hongkong	1009·4	+ 0·3	90	71	84·0	75·2	79·6	+ 2·2	72·4	69	7·2	11·12	− 0·95	14	5·1	39
Sandakan	1009·4	...	92	74	89·2	76·2	82·7	+ 0·2	77·8	84	7·0	10·90	+ 4·57	14	...	...
Sydney, N.S.W.	1016·2	− 2·4	82	43	68·1	51·6	59·9	+ 1·1	52·4	65	6·5	0·75	− 4·43	7	5·9	57
Melbourne	1015·8	− 3·4	74	35	62·6	47·1	54·9	+ 0·8	49·6	74	7·1	1·25	− 0·91	18	3·7	36
Adelaide	1017·6	− 2·6	83	44	67·0	52·5	59·7	+ 1·7	54·0	71	7·5	3·78	+ 1·06	18	4·2	41
Perth, W. Australia	1016·8	− 1·6	75	46	68·4	54·9	61·7	+ 1·0	59·7	92	7·2	7·34	+ 2·37	21	4·7	45
Coolgardie	1016·7	− 2·4	88	39	69·2	48·3	58·7	+ 1·0	52·9	71	4·1	1·01	− 0·32	5	...	...
Brisbane	1017·6	− 1·0	84	49	75·5	55·1	65·3	+ 0·7	58·3	66	4·3	0·25	− 2·56	5	7·5	69
Hobart, Tasmania	1009·9	− 5·4	73	34	56·7	44·0	50·3	− 0·2	44·7	71	6·1	2·97	+ 1·07	17	4·2	43
Wellington, N.Z.	1013·0	− 2·6	62	39	58·9	46·3	52·6	− 0·2	49·2	85	7·4	3·41	− 1·27	16	3·7	37
Suva, Fiji	1013·3	+ 0·6	87	68	82·4	73·1	77·7	+ 1·2	73·7	87	6·9	16·49	+ 6·42	27	4·3	38
Apia, Samoa	1011·6	+ 0·5	87	69	85·0	74·1	79·5	+ 1·1	75·4	77	5·4	14·86	+ 8·79	17	7·0	61
Kingston, Jamaica	1012·0	− 1·1	89	69	85·6	72·2	78·9	− 0·8	72·2	79	4·0	7·36	+ 2·97	12	5·4	42
Grenada, W.I.	1011·3	− 1·3	89	71	87	73	80	+ 0·3	73	74	4	3·05	− 1·14	15	...	...
Toronto	1014·2	− 0·7	85	37	65·3	47·7	56·5	+ 2·7	48·8	70	6·2	2·90	+ 0·11	13	6·8	46
Winnipeg	1014·0	+ 0·2	87	24	66·5	43·9	55·2	+ 3·2	44·5	83	4·8	2·20	+ 0·20	10	7·8	51
St. John, N.B.	1014·2	+ 0·3	79	34	61·6	43·0	52·3	+ 4·6	47·3	76	6·6	4·52	+ 0·81	15	6·5	44
Victoria, B.C.	1017·6	+ 0·9	71	42	60·6	46·2	53·4	+ 0·4	45·5	84	6·0	0·43	− 0·70	9	8·4	55

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

(39442) Wt. 20/31 1125 11/37 Hw. G. 377/6

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

Dec., 1937

No. 863

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF; 80 CHICHESTER STREET, BELFAST; or through any bookseller.

The Weather of June to November, 1937

The weather of the summer and autumn of 1937, though not strikingly abnormal in this country, shows several features of interest. The regular broadcasts of " Climat " data now provide a means for the rapid and easy discussion of the changes of weather month by month over a considerable area, and the following account is based mainly on the maps regularly prepared in the Meteorological Office from these broadcasts.

The prevailing characteristics of the weather of June to November over most of Europe were general warmth and to a less extent dryness. The high temperatures began in April, when northern Europe was more than 10° F. above normal, while in May most of Europe exceeded the normal by 4° to 8° F., but both these months had an excess of rain in the British Isles. In June and July nearly the whole of Europe enjoyed temperatures a degree or two above normal; rainfall was variable, but deficient in England and the neighbouring parts of Europe. August was very fine and warm in the British Isles, Scandinavia and western Europe. In September the warmth was maintained but apart from Great Britain rainfall was generally in excess. October was again warm and dry, especially in Scandinavia.

The main feature of the pressure distribution during these months was the extension of the Azores anticyclone north-eastwards towards the British Isles. This was well shown in June, when the pressure at

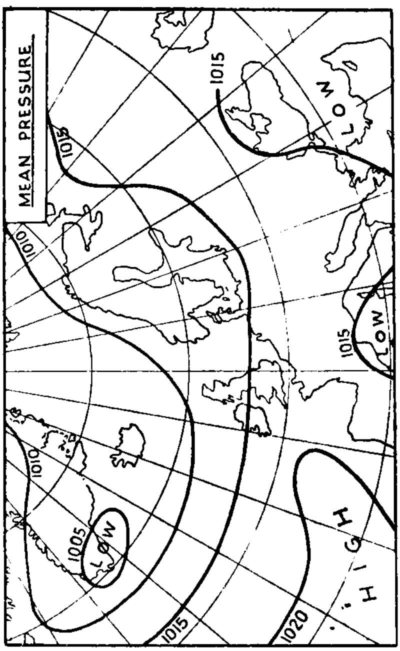


Fig 1

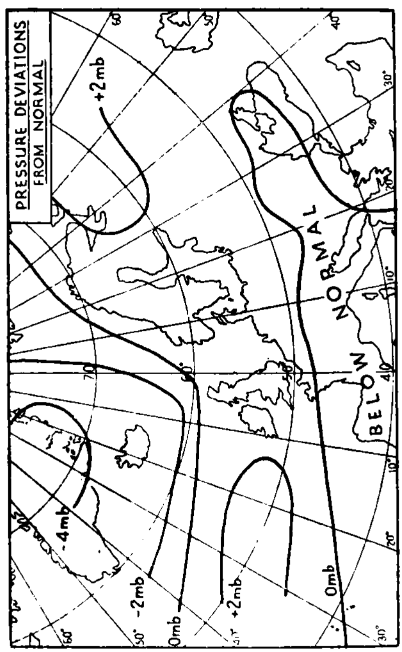


Fig. 2.

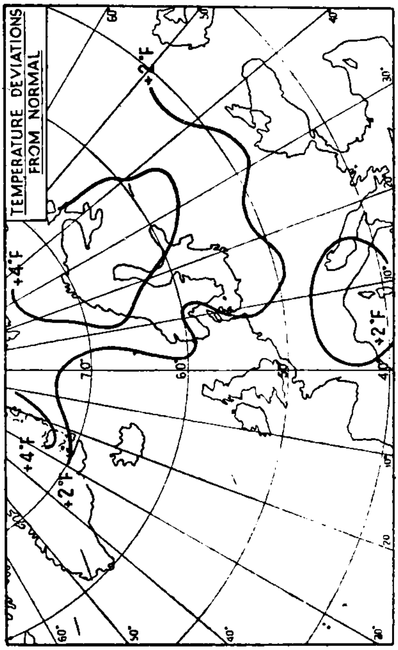


Fig 3

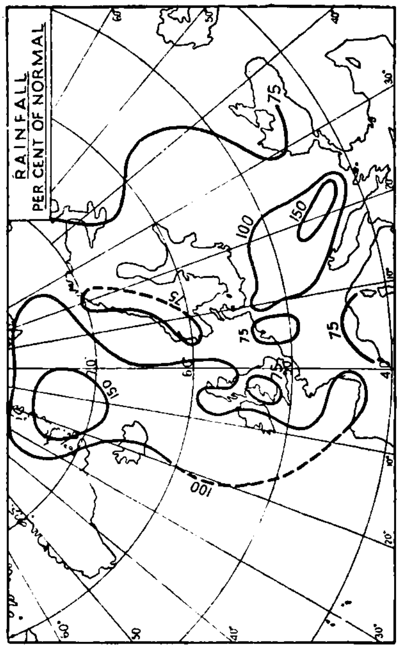


Fig. 4.

THE WEATHER OF JUNE TO OCTOBER, 1937

Valentia, 1020 mb., was only 1 mb. below that of the Azores. The characteristic of this type of distribution is that the isobars, running fairly parallel from west to east over the western Atlantic, open out over southern England, giving divergent winds and very pleasant weather. This feature is clearly seen in Fig. 1, which represents the average pressure distribution during the months of June to October. In July the extension of the Azores anticyclone lay further south, towards the Bay of Biscay, but in August it was again off south-west Ireland. In that month the British Isles and Scandinavia were covered by a ridge of high pressure connecting the Azores anticyclone with another centre over northern Russia. September showed a reversion to a more cyclonic type over the British Isles, but October again gave a slight ridge of high pressure from the Azores across northern England to Russia.

Fig. 2 shows deviations of pressure from normal for the period June to October and brings out clearly the ridge of pressure above normal extending across the British Isles and Scandinavia between centres west of Ireland and in the north of Russia.

Fig. 3 shows the deviations of temperature from normal. The whole area shows an excess, ranging from 0·2° F. at Valentia to 4·9° at Bodö. Fig. 4 gives a simplified representation of the distribution of precipitation as a percentage of normal. The greater part of Great Britain was below normal, but the deficit exceeded 25 per cent only in Wales and neighbouring parts of England. The distribution over Europe was irregular, but only the central areas showed an excess and there were several areas with a deficit of more than 25 per cent.

It was not possible to include the data for November in the charts of Figs. 1–4, but the generally dry, relatively mild weather continued during that month. The Siberian anticyclone was well developed, pressure near the Gulf of Obi being 20 mb. above normal, while the area of high pressure extended westwards across the British Isles, Lerwick being 10 mb. above normal. Pressure was relatively low over the Atlantic west of Ireland. Temperature was again above normal over the whole of Europe except southern Ireland and England, part of France and the Rhine Valley and a small area in Norway; the excess was above 5° F. in Finland and northern Russia. Rainfall was again less than the normal over the whole of the British Isles except Cornwall, the deficient area including the Norwegian coast, the whole of western and central Europe and most of the Mediterranean.

The rainfall over the British Isles generally was below the average in four out of the six months and the rainfall of the other two months, July and September only slightly exceeded the average. The percentage amounts were 81, 63, 80 and 54 during the months June, August, October and November respectively. The general monthly amounts over England and Wales were less than the average during each of the six months June to November. The amounts for August and November were only 46 and 62 per cent of the respective averages. There were six consecutive dry months over England and Wales as recently as April to September, 1933, but only two occasions since 1870 in which each month June to November gave less than the average, viz., 1919 and 1901. The total rainfall June to November, 1937, was 13·6 in. compared with 15·0 in., 14·3 in. and 11·8 in. in 1934, 1933 and 1921 respectively. The rainfall for the first five months of the year, however, was 21·2 in. so that the total for January to November, 1937, is 34·8 in. or only 0·4 in. short of the average for the whole year.

Wind Velocity and Sea Disturbance at Coastal Stations

That land masses, in sheltering coastal seas from the wind, have considerable effect in reducing sea disturbance, and that the length of " fetch " of the wind also plays a major part in the resultant height of waves, is generally accepted ; but with the exception of the works of Dr. Cornish* on the effect of wind in the open sea, there is little data published on the subject, and numerical values connecting wind velocity and sea disturbance around our coasts seem to be entirely absent.

Data regarding the state of the sea and the force of the wind for some twenty odd coastal stations are published each day in the *Daily Weather Report*, and in order to ascertain to what extent exposure affects the sea disturbance for a given velocity, the data from the stations at Tiree, Point of Ayre, Spurn Head and Scilly were extracted from the report each day during the year ending September 30th, 1937.

Tiree is an island station with very open exposure to the west and surrounded by relatively deep water. Point of Ayre, on the Isle of Man, is almost centrally situated in the northern half of the somewhat land-locked Irish Sea. Spurn Head, while entirely sheltered from the west by the mainland of Great Britain, is completely exposed to the east to the comparatively shallow, but relatively extensive North Sea. Scilly, at the entrance to the English Channel, is most exposed to the deep waters of the Atlantic to the south-west, but has shallower water to the east and north.

The state of the sea at these stations was tabulated each day against the corresponding wind direction and force, and the mean disturbance was calculated for each step on the Beaufort Scale for winds from each point of the compass.

The final means of disturbance were then converted into wave amplitude in feet according to the standard scale as defined on p. 151

---

* See *London, Quart. J. R. met. Soc.*, 52, 1926, pp. 145–60.

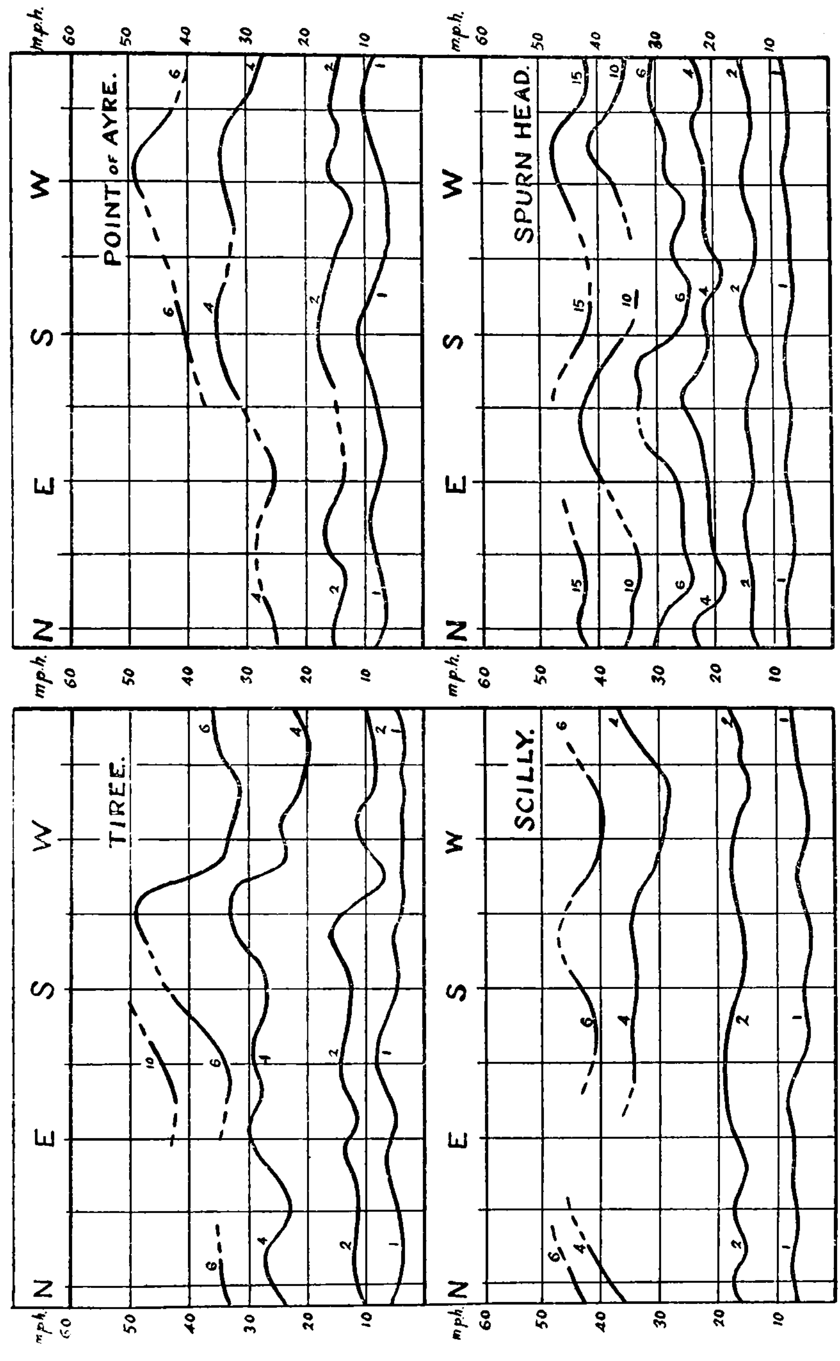

POINT of AYRE.
SPURN HEAD.
TIREE.
SCILLY.
N
E
S
W
m.p.h.
60
50
40
30
20
10

FIG 1.

of the "Meteorological Glossary", 1930 Ed., and the corresponding wind force was converted into velocity in miles per hour according to the scale given on p. 32 of the "Meteorological Glossary", 1930 Ed.

From the figures so obtained, the attached isopleth diagrams (Fig. 1) were prepared. These curves being drawn without smoothing, give a fair representation of the relation between wind velocity and wave amplitude at the respective stations, and are drawn for waves of 1, 2, 4, 6, 10 and 15 ft. amplitude. It will be noted that waves exceeding 10 ft. in amplitude were not experienced at Point of Ayre or at Scilly, and were found at Tiree only with winds above gale force from the south-east. Waves of fifteen or more feet amplitude were recorded with winds of gale force from all directions except the east and south-west at Spurn Point.

In order to ascertain the comparative effect of fetch of the wind on wave amplitude, the mean amplitude for all winds for the whole year was calculated for each station; and the resultant curves are shown in Fig. 2. It will be seen that Point of Ayre, which has the least fetch in all directions, certainly has the least mean amplitude; but in this figure also, it will be seen that the mean amplitude with westerly winds is only a few inches less at Point of Ayre than at Scilly, where the fetch of westerly winds is, in comparison, infinitely greater. It also will be noted that, as a whole, the mean amplitude at Spurn Point exceeds all other stations, and only is exceeded by Tiree with winds from the south-west.

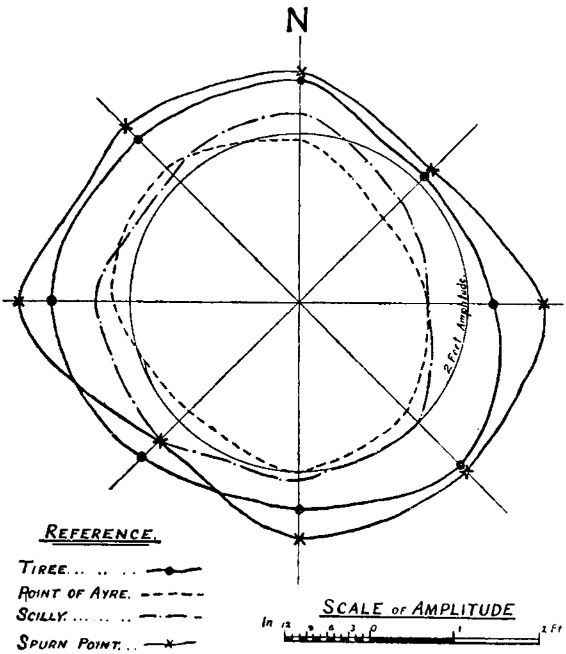


FIG. 2

That the coast line in the immediate vicinity of the observing station has much effect on sea disturbance is clearly shown in Fig. 3. In this figure, the mean amplitude for all winds at Spurn Head is plotted on a map of the district, and here, the sheltering effect of the Lincolnshire Coast on winds from the south-west quadrant is as outstanding as is the marked increase in amplitude with winds blowing down the estuary of the River Humber from the west. In the latter case, the increase in sea disturbance is possibly due to both the wind and the river flowing against the in-coming tides ; in any case, the length of fetch from this azimuth is negligible.

It may be argued that the period under review is far too short for the purpose of the investigation, but, on the other hand, the mean amplitude for a given wind velocity from a specified direction at any station is unlikely to show any appreciable variation from year to

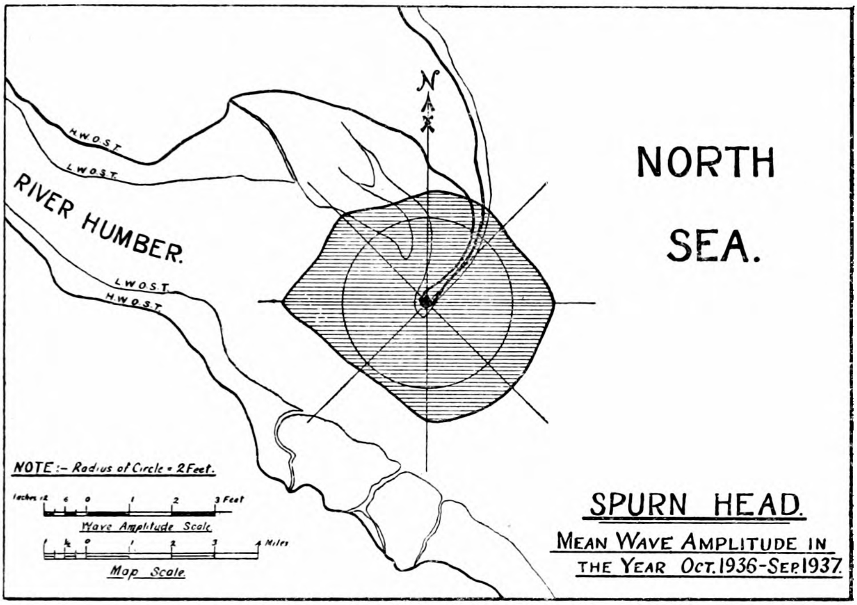


FIG. 3

year, and therefore the ratio between the disturbance at any two or more stations will naturally remain approximately constant ; and it would seem that from the point of view of a coast-wise sailing mariner, there is little difference between the storminess of any of the seas around the coasts of our islands.

From the results obtained, it would seem that the greater depth of sea associated with a longer fetch tends to reduce the sea disturbance, and that the shallower seas are the more easily disturbed by the wind.

In the summary of gales experienced in the several districts of the British and Irish coasts in the forty years, 1876–1915,† it is stated that " the North-West Coast of Ireland is the stormiest and the East Coast of England the least stormy." Doubtless, when considering the frequency of gales, this is correct ; but unless the estimates of sea disturbance from stations on the west coast are unduly modest, it would seem that the North Sea is the more easily disturbed by wind than is the Atlantic, and one is inclined to wonder what happens to the sometimes mountainous seas of the latter, which causes them to lose their amplitude before reaching our western seaboard.

DONALD L. CHAMPION

† See " The Weather of the British Coasts," London, 1918, p. 21.

Problems of Forecasting

Persistence of Residual Showers

During the morning of Tuesday, November 16th, 1937, the southern North Sea between East Anglia and Holland was a region of very uniform pressure and light variable wind, with appropriate fine or foggy weather over the adjacent land areas. Over the maritime area between it was natural to expect no low cloud, and nothing worse to the aviator than haze. It was, therefore, disconcerting when a pilot flying over Kentish Knock light-vessel (lat. 51° 39′ N., long. 1° 41′ E.) at 1000 G.M.T. reported a heavy rain shower from an isolated cumulus cloud, base 1,200 ft., top 6,000 ft. The cloud was at that time stationary as it was met with again without marked change of form or intensity over Kentish Knock by the same pilot at 1100.

The interesting question arises—how could a vigorous shower come to exist under conditions which would normally be associated with no low cloud? A solution is indicated by overnight change of pressure distribution and air motion.

The showery northerly current which prevailed in the North Sea throughout Monday, November 15th, was displaced quickly eastwards during the night of the 15th to 16th, so that by 0700 on the 16th almost the whole of the North Sea was a region of very light winds up to 10,000 ft. at least. It is therefore feasible to suppose that the Kentish Knock shower was one left "suspended" by the rapid retreat eastwards of its means of propulsion—the northerly winds of the 15th. It can conveniently be called a residual shower. With the onset of a south-easterly wind (extending to 6,000 ft. by 1400 at Bircham Newton) during the afternoon of the 16th, this shower "got under way" again, and was presumably the one reported in turn from Felixstowe, Thetford, and King's Lynn, with progressive disintegration into stratocumulus and diminution of intensity.

However, a second problem is immediately raised—how was the shower able to maintain its activity over Kentish Knock after the cessation of the northerly wind, especially as rain appears to have fallen from it continuously? Why did it not quickly die away?

The temperature at North Hinder light-vessel at 0700 on the 16th was 48° F. This, taken in conjunction with the Mildenhall upper air temperatures of that morning, indicates instability for saturated air over the southern North Sea up to 6,000 ft. (in accordance with the reported height of the top of the cumulus over Kentish Knock). It now remains to find a mechanism which could produce convergence. Under such stagnant conditions, the mechanism may have been the land breezes arising from the sharp contrast of temperature between land and sea. These were plainly convergent, being from a westerly point along the east English coast, and from an easterly point along the coasts of Holland and Belgium. There would, therefore, be a tendency for forced ascent of the surface layers of air over the maritime region between the coasts. This tendency would presumably materialise where ascent could most readily take place, i.e., beneath stationary residual shower-clouds, where the air would be saturated by rain. In this way, the life of the shower would be prolonged.

Another shower of slight intensity, from an isolated cumulus cloud (base 2,500 ft.) was reported from Norwich at 1840 on the 16th. In fact, it is quite probable that several residual showers were scattered about in the extreme southern North Sea on the morning of the 16th, and commenced to move north-west during the afternoon, being now resuscitated by turbulence.

In the continental air following behind, showers would be absent. It would then be expected that showers along the east coasts of England and south-east Scotland would be restricted to the first few hours after the establishment of the south-easterly current. This actually was so. Showers at Spurn Head, Tynemouth, and St. Abbs Head were confined to the period 1800 on the 16th to 0700 on the 17th. Thereafter weather was fair.

F. E. Lumb.

OFFICIAL PUBLICATION

The following publication has recently been issued :—

Geophysical Memoirs.

No. 74. *On the travel of seismic waves from the Baffin Bay earthquake of November* 20, 1933. By A. W. Lee, D.Sc. (M.O. 419b).

A large earthquake which occurred in Baffin Bay late on November 20th, 1933, was recorded by seismographs in all parts of the world. The position in relation to the numerous seismological stations in Europe and America was such as to provide material for a precise determination of the times of travel of the earthquake waves for distances of about 40°. The records of 99 observatories were collected and examined at Kew Observatory, and comparisons were made between the times of travel of the primary and secondary waves and those calculated from various tables. A new table for times of travel of secondary waves was computed for distances between 25° and 50°, which gives satisfactory agreement with the observations.

Discussions at the Meteorological Office

The subject for discussion for the next meeting is :—

January 17th, 1938. *An account of the year's meteorological investigations on the North Atlantic Ocean carried out on the s.s. Manchester Port.* Opener, Mr. D. A. Davies, B.Sc.

Royal Meteorological Society

The first meeting of the new session was held on Wednesday, November 17th, at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F.Inst.P., President, was in the Chair.

The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1938 to Dr. G. M. B. Dobson, M.A., D.Sc., F.R.S., F.Inst.P., Reader in Meteorology in the University of Oxford. The medal is awarded biennially for distinguished work in connexion with meteorological science, and will be presented at the Annual General Meeting of the Society on January 19th, 1938.

The following papers were read and discussed :—

T. E. W. Schumann, M.Sc., Ph.D.—The theory of hailstone formation.

A fairly detailed mathematical analysis is presented of the generally accepted theory that the formation of large hailstones is due to the capture of under-cooled water drops which lie in their path. It is shown that the principal factors which determine the ultimate size of a hailstone are its average density, the height at which its nucleus is formed, the average upward velocity of the air and the concentration of condensed water in the region of the atmosphere where the temperature is below 0° C. The interrelation between these various factors is shown by means of a number of curves. It is further demonstrated that the values of water content of the clouds and of upward air velocities, measured or deduced independently, are sufficient to account for the formation of hailstones at least 8 cm. in diameter. The matter of the disposal of the latent heat of the water which solidifies on the surface of the hailstone is also examined in some detail, and it is shown that this heat is disposed of quite effectively, partly by conduction to the surrounding atmosphere and partly by evaporation from the surface of the hailstone. Only in the case where the surface temperature of the hailstone approaches 0° C. does its incapability to get rid of its surplus heat act as a factor retarding its rate of growth, and consequently its ultimate size.

I. D. Margary, M.A.—Report on the phenological observations in the British Isles from December, 1935 to November, 1936.

The year was remarkable for sunlessness generally, and also for wetness in England and Wales, but temperature after a cool winter remained close to normal. The result was a rather gloomy and inclement year due to lack of sunshine and excess of rain rather than to low temperature. Plants generally flowered late, all in the Midlands, nearly all in south-east and south-west England, and south Ireland, but were earlier in Scotland, especially in west Scotland. Floral isakairs show a late strip across southern Ireland and Wales, the Midlands and north-east England, with slight earliness over a wide area in north-east Ireland, the Scottish Lowlands and east coast. Insects were nearly all late in appearing in England, but were very erratic in Scotland and in north Ireland. Spring migrants were generally late, save in Scotland, but the earliest arrivals were early as they just escaped the cooling of April. Spring migrant isophenes show a restriction of the usual early landing areas, with a rather slow advance afterwards. The autumn migrants were mostly early in moving.

H. Fairfield Smith.—Report of a preliminary statistical investigation of flowering dates of plants recorded in the Phenological Reports of the Royal Meteorological Society.

The phenological data collected by the Royal Meteorological Society are examined statistically with reference to the flowering dates of plants. A few representative parts of the available data are analysed in detail, and suggestions are made with regard to future phenological observations.

Correspondence

To the Editor, *Meteorological Magazine*

Typhoon at Hongkong, September 2nd, 1937

With reference to the account of this typhoon, published in the *Meteorological Magazine*, November, 1937, p. 235, Mr. C. Fowler has informed us that in a letter to him, Mr. T. E. Pearce of Hongkong says "as a matter of interest I was informed by the Manager of the Hongkong Electric Co. that the local Government Observatory Authorities tested their anemometer and found it set 3 m.p.h. lower than the correct reading. Such being the case, the wind velocity at the Electric Co.'s Works reached a maximum of 167 m.p.h."

A Green Moon

With reference to the green moon observed by Dr. Whipple (*Meteorological Magazine*, November, 1937, p. 230), I may state I saw it many times, any time, in fact, when at sunset or sunrise the sky was of a reddish hue or sprinkled with clouds coloured in red by the last (or first) rays of the sun just below the horizon.

As Dr. Whipple rightly surmised, it is only an effect of contrast or, better, of complementary colour. As well known, after looking at a red light, you cast your eyes upon a white surface, you see it of a greenish hue, green and red being complementary colours. The circumstances referred to by Dr. Whipple tally fully with this obvious explanation.

M. MOYE.

University of Montpellier, France, November 29th, 1937.

On October 17th, between 6.45 and 7 p.m., when motoring from Peebles to Edinburgh, Mrs. Cairns, my two boys and I observed that the moon was a very attractive and indescribable shade of green, and whilst it may have been like that for some time before we noticed the phenomenon, we could certainly vouch for the fact that the moon appeared in this colour for at least 10 minutes.

At the time there was no visible cloud—only a frosty evening haze on the hill tops, but the moon was above that. However, as we approached Edinburgh there was slight cloud movement which seemed immediately to bring the moon back to its normal brightness.

JAMES CAIRNS.

60, Netherby Road, Leith, November 25th, 1937.

Dr. Whipple's request for information of occasions when the disc of the moon has appeared of a pale green colour prompts me to say that many observations of this phenomenon have been made at Aberdeen, chiefly when the moon is full or nearly so.

Sunsets in this region are often very vivid and the colouring of both sky and cloud is at times very intense and pure. These sunsets are most frequent and best developed with winds between SW. and WNW., and sometimes the colouring endures for an unusually long period and spreads across the whole sky from west to east. At such times the eastern sky becomes suffused with a rose-tinted light superposed upon the normal blue colouring ; the resulting tint being a rosy-purple somewhat akin to that of the " purple light " seen in the west after sunset.

Surrounded by a sky of this colour the bright disc of the moon assumes, by the well-known effect of contrast, a colour complementary to the colour of the sky, and this assumed colour varies between pale apple green and pale emerald green according to whether the sky colour tends towards the purple or towards the red respectively.

It may be of interest to remark that, to eastward, a street of light grey granite houses faces the Observatory, and these houses have been seen also to assume the green tint, just as the moon does. The combined effect of green moon and green houses against the warm glow is rather weird and unearthly.

G. A. CLARKE.

The Observatory, King's College, Aberdeen, November 25th, 1937.

Exceptionally Good Visibility

In the *Meteorological Magazine* of September, 1937, Mr. Seton Gordon mentions a visibility of about 95 miles. The following case may be of interest.

On September 27th, 1937, as we approached the Canaries during a voyage from the Gulf of Guinea to Germany, the Peak of Teneriffe was clearly visible, 125 statute miles distant, in the light of the rising sun. After passing through the group in the middle of the day we could still see from the bridge the Isle of Palma, on the west of the group, sharply silhouetted against the western sky at sunset, at a distance of 190 statute miles ; the island rises to about 7,700 ft., long. 14° 50′ W. But for the oncoming of night the island seemed likely to remain visible for a long time. My own calculation of position and distance was corroborated by the Captain of the vessel.

The conditions were abnormal in the region in many respects. The Trades were found only between lat. 20° 30′ N. and 24° 30′ N., and even there they were weak. On each side it was almost calm and cloudless, and the air was remarkably clear, so that the masts of ships below the horizon stood out sharply. The sea surface temperature was abnormally high, 85°F. on the south side of the Trades (mean 76°F.), and 75°F. on the north side (mean 71°F.) on September 27th, the day of the extreme visibility mentioned above. The weather might be described as " perfect ".

W. G. KENDREW.

Radcliffe Meteorological Station, Oxford, November 21st, 1937.

Lunar Halo with Paraselenae

At between 22h. and 22h. 10m. on November 14th, I had the good fortune to observe the following. In conjunction with a lunar halo were paraselenae, one on either side of the moon but just outside the halo ; also a distinct white band (corresponding with the parhelic circle) passing through the moon and extending some 10 degrees beyond the paraselenae. The sky was hazy at the time with cirro-nebula. It may also be interesting to record that a coloured corona close to the moon was visible at the same time, and appeared to be in relatively high cloud.

A. E. MOON.

39, Clive Avenue, Clive Vale, Hastings, November 22nd, 1937.

The Release of Pilot Balloons and Lanterns in turbulent Winds

In the discussion of equipment and methods for the night ascent of pilot balloons I find little reference to the fitting of a paper cap, threaded above the lantern, to obviate the risk of the candle being extinguished on release. I do not know with whom the idea originated but a personal method, using the cap, evolved during five years of regular night ascents at Croydon may be of interest.

With strong winds, eddies between the Administrative Block (from the roof of which the ascents were made) and the hotel to the north, and hangars to the south, frequently carry the balloon and lantern 40 ft. downwards towards the ground and buffet them severely.

A length, about 3½ ft., of stiffish string is used to suspend the lantern. This has an advantage over thread in that it is easily gripped in the teeth, freeing both hands to light the candle and extend the lantern. In cold weather it is more easily held, and the elimination of any factor likely to cause fumbling at the moment of release is most desirable. On the string is previously threaded a sheet of thin typing paper, 11 in. by 8 in., rolled into a cone and secured so with a pin. This size allows a minimum overhang of about half an inch when slipped down over the lighted lantern. Incidentally the size of the illuminated objective is increased by about 50 per cent. With the balloon held by the neck, the string held taut with the other hand just above the cap—the lantern being steadied by the outstretched hand—and with an inclined swinging release down the wind, the use of an elastic inset becomes unnecessary.

Using this method, no difficulty was experienced with squally winds of force 5, and ascents were frequently made on occasions of force 6.

Dr. Whipple* mentions the difficulty of carrying out night ascents from a ship at sea. Some practice in the simultaneous release of balloon and lantern is necessary, but it is thought that, if it has not already been tried, the method described would increase the chances of survival of the first turbulent minute, at the same time affording a larger objective during the earlier part of the ascent, when the apparent motion is greatest and the balloon requires most frequently to be " picked-up."

F. B. SWAIN.

Meteorological Station, R.A.F., Heliopolis, Egypt, October 8th, 1937.

NOTES AND QUERIES

Ground Rainbows

An interesting correspondence took place in *The Times* for November 17th–23rd on the subject of " ground rainbows ". It was begun by Lord Dulverton, who wrote that on November 5th at Tadmarton Heath golf course near Banbury there was a thick fog until about 11.30 a.m. The ground was covered with a dense carpet of cobwebs saturated with particles of moisture. At 11.45 a brilliant sun broke through the fog, and Lord Dulverton and his companion, stepping on the fairway running due north, observed a perfect rainbow flat on the grass. It started at their feet and ran in an elliptical form to both sides of the fairway. It was faint compared with an ordinary rainbow in the sky, but was otherwise identical. When they turned from due north to due west the form of the rainbow also changed and instead of being elliptical became almost rectangular, one branch running north, the other east. The phenomenon lasted for about 1½ hours.

In addition to accounts of ground haloes and of true rainbows, this letter elicited descriptions of two very similar observations. One, made by Mr. J. Hills at Eton, which was almost identical with that described by Lord Dulverton. Mr. Farquharson Robertson, on the other hand, saw the horizontal rainbow at 7.30 a.m. on October 20th near Sevenoaks, when it took the form of a straight line stretching down the fairway in front of him.

Dr. F. J. W. Whipple has sent to the *Meteorological Magazine* the

---

* *London Met. Mag.*, 72, 1937, p. 117.

following comments on Lord Dulverton's observation. The light rays which constitute a rainbow form a circular cone, the axis of which points to the observer's head. With the sun low down (at Banbury on November 5th at midday the elevation would be $22\frac{1}{2}°$) the cone is cut by a horizontal surface in one branch of a hyperbola. It seems that at first Lord Dulverton noticed only the nearer part of the hyperbolic curve, the curve being cut off by the rough ground beyond the fairway. Later he had a chance to look along fairways on appropriate bearings and noticed the more distant parts of the curve. The asymptotes of the hyperbola would have been inclined at about 70°, in close enough agreement with Lord Dulverton's impression that the branches ran to north and east.

It may be added that shortly after sunrise, with the eye of the observer nearly on the level of the water drops, the horizontal rainbow would take approximately the form of two straight lines meeting at an angle of about 84°, and Mr. Farquharson Robertson evidently saw each arm in turn under these conditions.

The horizontal rainbow has been recorded as seen on a water surface on several occasions. Apparently it has not previously been described in detail in meteorological literature as occurring on gossamer, though Pernter and Exner mention its existence under the name *arc-en-terre*. Kokichi Otobe* has described a method of constructing an artificial horizontal rainbow by means of a glass plate, about 70cm. square, coated with lamp black and sprayed with fine drops of water.

Naval Meteorology

The Admiralty have established a branch of the Hydrographic Department to take over the administrative duties connected with meteorology in the Fleet. The new Admiralty branch is to be known as the Naval Meteorological Branch of the Hydrographic Department and Captain L. G. Garbett, R.N. (retd.), has been placed in charge with the title Chief Superintendent of Naval Meteorology.

The change will involve a reorganization in the Meteorological Office, the remaining duties of the old Naval Division, of which Captain Garbett has been in charge since 1921, being allocated to other Divisions.

REVIEWS

Hann-Süring, Lehrbuch der Meteorologie. Fünfte vollständig neubearbeitete Auflage. Edited by Prof. Dr. R. Süring. Size, $10\frac{1}{2}$ in. × $7\frac{1}{4}$ in. Part I, pp. 1–96, Part II, pp. 97–192. *Illus.* Leipzig, 1937.

For many years Hann-Süring has served as a mine of information on all aspects of meteorology, so much so that it has always appeared wise to begin any new investigation by first consulting this book.

* *Tokyo, J. met. Soc. Japan*, 38, 1917, No. 2.

One could always count that if any earlier work had been done on the subject in question, it would be mentioned in Hann-Süring. And now there is appearing a new edition, under the general editorship of Professor Süring, who is being assisted by seven distinguished meteorologists, Professors Bartels, Mügge, Robitsch, and Weickmann, and Drs. Götz, Möller, and Müller.

The task facing the collaborators who are producing the new edition is no easy one. The earlier editions were encyclopaedic, but since the number of active meteorologists is increasing yearly, the number of papers on meteorological subjects is increasing with great rapidity, and so it becomes increasingly difficult to bring within the covers of one book any complete account of the present state of the subject. The general arrangement of the new edition appears to follow fairly closely that of the last edition. So far, two parts, each of 96 pages, have appeared, and eight further parts are to appear at an early date. From the contents of the two parts in hand it can be seen that an attempt is being made to cover the whole field of meteorology.

It is not the intention of the present reviewer to give a catalogue of the contents of the available parts of the work. They deal with questions of radiation, composition of the atmosphere in its widest sense, and the treatment of observations of temperature. An idea of the way in which completeness is attempted may be gathered from the fact that, in the section dealing with the diurnal variation of temperature are given the equations for the computation of the terms in the Fourier series which represent the daily variation. In practice one would require to know at what stage it would cease to be worth while evaluating any further harmonics in the Fourier series, but no guidance is given in this matter. Now if the standard deviation of the original figures to be analysed is σ, and if the amplitudes of the harmonic terms already computed are, say, R_1 and R_2, then it is readily shown that the standard deviation σ' of the figures obtained when the original data are corrected for these two terms is given by

$$\sigma'^2 = \sigma^2 - \tfrac{1}{2}(R_1^2 + R_2^2)$$

If this standard deviation σ' comes out a very small quantity, there can be no further harmonics of appreciable amplitude in the observations. If the book is to serve as a complete guide to the discussion of observations by the method of harmonic analysis, then it would appear desirable that such results as the formula quoted above should be given. It is admittedly difficult to find room in one book for every conceivable result or method of analysis, and the present reviewer is inclined to think that when the sixth edition eventually has to be prepared, in the future, such matter as methods of computation will have to be omitted.

But on other parts of the subject the discussion leaves little to be desired, and the references to original papers are numerous and up to date, some papers which appeared in 1936 being mentioned in the text. Hann's approximate form of the expression for the saturated adiabatic lapse rate is given, though the correct expression is quite as easy to derive. But everywhere in the text one finds complete references to every work of note on every branch of the subject of meteorology, and it is impossible to overestimate the amount of work which has gone into the making of the book, or its value to the practical meteorologist. And it is no reflection on the appreciation of its utility to add that naturally one does not accept the authors' estimate of all the works cited in the text. Meteorology will however cease to be an interesting subject for study when we all agree on all points.

We shall look forward with some eagerness to the appearance of the remaining parts of the book, which is going to fill a definite want of all active workers in meteorology.

D. BRUNT.

Weather Rambles. By W. J. Humphreys, C.E., Ph.D. Size $7\frac{3}{4}$ in. × $5\frac{1}{2}$ in., pp. vii + 266. *Illus.* London, Baillière, Tindall and Cox, 1937. 11*s.* 6*d.* net.

In this pleasant little volume Dr. Humphreys, ensconced in his armchair, lets his pen wander through many odd by-ways of meteorology. He begins with some " tall stories " about tornadoes, changes casually to the " ice-ribbon plant " and the freaks of snow, and then branches off into one of his favourite topics, meteorological noises. The sixth and seventh rambles discuss what would happen if Greenland's icy mountains should happen to melt, and how we are just now " teetering " on the edge of an ice age. A chapter on economic meteorology is followed by a long digression, largely historical, into the composition of the atmosphere, from its main constituents down to the " odds and ends", including dust. Next comes an account of the structure of the atmosphere—troposphere, stratosphere, ionosphere, planetary winds, fronts, inversions and bumps—an impression of the overwhelming heating power of the sun compared with the stars, and a discussion of the origin of dew. There are three rambles among the facts, figures and theories about rain, a chat on hunting, and finally some remarks about " home-made weather ".

The book thus covers most of the domain of the weather in an easy haphazard fashion, and at the end the reader will have learnt quite a lot of meteorology without effort. The author has the knack of driving home his lesson with a joke or an epigram, for example, it would be hard to phrase the effect of weather on scent more tersely than " dry dog, nice doggie ; wet dog, phew ! " It will suffice to add that the book is well printed and illustrated with a variety of beautiful photographs.

C. E. P. BROOKS.

BOOKS RECEIVED

Further evidence on the dependence of terrestrial temperatures on the variations of solar radiation. By C. G. Abbot. Smithson. Misc. Coll., Vol. 95, No. 15, Washington, D.C., 1936.

Klima, Witterung und Wetter in Deutsch-Ostafrika. By Prof. Dr. G. Castens. Reprinted from the Deutsch-Ostafrika Gestern und Heute, Berlin.

The Weather of November, 1937

The Siberian anticyclone was very well-developed, pressure exceeding 1030 mb. over the greater part of Siberia between longitudes 55° E. and 120° E. A ridge of high pressure, about 1017 mb. extended westwards across Europe to Great Britain and there was a small anticyclone over east Greenland. Pressure was generally low over the Arctic and North Atlantic, the lowest pressures being 999 mb. north of Labrador, 1004 mb. at Bear Island and 1005 mb. near the Aleutian Islands. Over most of North America pressure was very uniform, about 1019 mb. The greatest deficits of pressure from normal were 9 mb. at the Azores and 7 mb. at Jan Mayen; the greatest excesses were 20 mb. in north-west Siberia, 10 mb. at Lerwick and 6 mb. in Arctic Canada.

The abnormal gradient for south-westerly winds over northern Russia and north-west Siberia was reflected in abnormally high temperatures, 10°–13° F. above normal, in north-west Siberia. Even at Viliousk in north-eastern Siberia, not far from the "cold pole," the mean was −18° F. compared with a normal of −31° F. In northern Canada on the other hand, under anticyclonic conditions, Chesterfield had a mean temperature of −6° F. compared with a normal of 0° F. In southern Siberia and the south-eastern United States temperatures were abnormally low, the deficit reaching 11° F. at Alma Ata, but most of Europe enjoyed a relatively mild month. In the British Isles only a small part of Scotland fell below 40° F. Precipitation was generally moderate, being less than normal over western Europe and most of North America, but above normal in south-eastern Europe and the Atlantic coast of the United States.

No broadcast data were received for Australia, New Zealand and the west Pacific. Data for the East Indies show that pressure did not differ greatly from normal. Temperature was above normal in Siam, reaching 82° F. at Rangsit, but was only about 75° F., 2° F. below normal, over much of the Dutch East Indies. Rainfall was abnormally heavy (several times the average) in parts of Indo China and the Philippines.

The main features of the weather of November over the British Isles were a general deficiency of rain, frequent mist or fog, and temperature considerably below normal in the south but about normal in the north. At Eskdalemuir, Renfrew and Leuchars the total rainfall for November was the lowest recorded since observations began at these places in 1910, 1921 and 1922 respectively. Sunshine records were very variable ; at Valentia and Lympne the totals were 52 per cent and 36 per cent above normal respectively, while at Aldergrove the total was the lowest for November since records began there in 1927. On the 1st the weather was generally mild and unsettled with considerable rain in south-east England but much sun in west Scotland and west Ireland, 8·1 hrs. bright sunshine at Valentia and 7·9 hrs. at Tiree, but 1·66 in. of rain at Peaslake (Surrey). By the 2nd a ridge of high pressure had developed across the British Isles connecting the anticyclones over Russia and to the south of the Azores. During the next few days this ridge moved south-eastwards, while a deep depression advancing towards the western coasts gave rainy weather there with strong winds and gales on the 3rd and 4th. Elsewhere there was considerable mist or fog, though locally at a few places much sun. Maximum temperatures during this time were mainly between 50° and 60° F. By the 5th an anticyclonic wedge once more covered the British Isles. Conditions continued mainly anticyclonic from then to the 15th, though a shallow depression over the Bay of Biscay brought rain over most of England and Ireland on the 7th and 8th, and depressions over Scandinavia moving south caused northerly gales over the North Sea on the 10th with some rain along the eastern coasts on most days from the 9th to 15th and sleet or snow in north Scotland. Very little sun was experienced between the 5th and 8th, and temperature was generally above normal with some local mist or fog. With the change to northerly winds on the 9th temperature fell considerably, but there was frequently much sun in all districts, 8·5 hrs. at Torquay on the 10th. Towards the end of this period maximum temperatures below 40° F. were experienced at a few places and some sharp ground frosts occurred, 8° F. being registered on the ground at Rhayader and 10° F. at Marlborough on the 14th. Much mist and fog occurred on the 15th and 16th when a deepening depression was approaching the south-west. This caused strong S. to SE. winds or gales on the western coasts and in Scotland from the 16th to 18th and generally unsettled weather with heavy rain at times, 2·58 in. at Holne (Devon) on the 17th, 2·07 in. at Fofanny (Co. Down) on the 18th and 1·36 in. at East Ayton (Yorkshire) on the 19th. Temperature rose above 55° F. in the south-west on the 17th and 18th but remained low elsewhere. From then to the 22nd pressure was low over the country and the weather cold and unsettled with considerable rain at times but long bright periods. Snow occurred in several parts of Scotland and north England on the 19th and 20th, and sleet and hail generally. A thunderstorm was reported from Aberdeen on the 19th, and sharp frost on the 21st when 9° F. was recorded on the ground at Marlborough. On the 23rd a ridge of high pressure to the north of Scotland was moving south while the depression over the Bay of Biscay brought mild weather temporarily to southern England with slight rain. From then to the 28th the high pressure area moved south and covered the country so that cold mainly dry weather with much mist or fog prevailed generally in the south while in the north the westerly winds until the 26th brought warmer clearer conditions. With the subsequent change to northerly winds the weather became colder temporarily also in the north. On the 28th a deep depression was approaching from the Atlantic, bringing mild unsettled weather with considerable rain at times to the country generally on the 29th and 30th. Strong S. to SW. winds occurred in the west on the 29th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ..	41	− 5	Chester ..	61	+ 8
Aberdeen ..	44	−15	Ross-on-Wye	53	−10
Dublin	52	−19	Falmouth ..	77	+ 1
Birr Castle ..	52	− 9	Gorleston ..	45	−21
Valentia ..	96	+33	Kew.. ..	46	− 7

Kew, Temperature, Mean, 41·9, Diff. from average — 2·4.

In consequence of continuous rain, flooding occurred in the Bormida Valley (lying between Piedmont and Liguria) at the beginning of the month. Dense fog was experienced in the eastern English Channel on the 2nd and 3rd. Floods caused by the melting of the abnormally early snows were reported in Andorra on the 4th, and flooding caused a temporary interruption of the Air-France service between Paris and Cannes on the 5th. Gales occurred off the Lisbon Coast on the 18th, and renewed floods caused great damage in Portugal on the 20th. There was dense fog on the Netherlands and north French coasts on the 20th and and 21st, causing damage to shipping. (*The Times*, November 4th–23rd.)

On the 10th drought was reported throughout the greater part of South Africa. (*The Times*, November 11th.)

The severe floods recorded in Syria at the end of October were reported to be subsiding on the 1st, although many villages were still cut off. Nine Arabs were reported to have been drowned and 200 to have been rendered homeless by floods in the Beersheba district. A typhoon occurred off the Philippines on the 11th and about 26 lighters were sunk. Heavy rain fell near Shanghai on the 15th and 16th. Gales were experienced off Hokkaido on the 19th. (*The Times*, November 2nd–20th.)

The total rainfall for the month was deficient over Victoria and Tasmania, but generally above normal over the rest of Australia, being about three times the normal on the north-east coast of New South Wales. (Cable.)

The first heavy snowfall of the season occurred in New England, New York State and Ontario on the 21st, causing the death of eight people and doing much damage to property. In Jamaica 70 people were drowned by extensive flooding due to the heavy rains of the 20th and 23rd—a landslip, 200 acres in extent buried part of the Crown Reservation, and further rain on the 25th–29th caused another landslip. (*The Times*, November 23rd–December 1st.)

Gales were experienced on the North Atlantic on the 1st–3rd, and again on the 16th. (*The Times*, November 3rd–17th.)

Daily Readings at Kew Observatory, November, 1937

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	1000·8	N.2	48	54	96	0·56	0·0	fe early, r 10h.–18h.
2	1012·3	SSW.1	45	49	95	—	0·0	Fe–f most of day.
3	1018·5	SSW.2	46	50	95	0·01	0·0	Fe–f most of day.
4	1020·4	S.1	43	55	83	—	0·8	Fe early, w late.
5	1021·7	NE.2	42	52	79	—	0·0	w late.
6	1020·8	E.3	44	50	83	0·01	0·0	d_0f 9h.–11h.
7	1017·6	E.2	47	53	87	0·08	0·0	f 10h.–17h.
8	1017·8	E.2	47	54	79	0·11	0·0	r–r_0 23h.–24h.
9	1021·9	NNE.4	49	50	59	—	4·0	r–r_0 0h.–7h.
10	1017·3	NW.4	35	46	72	—	4·7	x early.
11	1021·0	NNW.4	38	48	74	—	1·5	w 18h.
12	1023·7	NW.2	36	49	63	—	5·4	x 21h.
13	1021·8	NW.2	29	42	61	—	6·0	f till 12h., x 21h.
14	1019·6	WNW.2	27	42	61	—	6·2	x early, f 8h.–10h.
15	1020·3	WSW.2	29	46	81	—	2·6	f 8h.–11h., F 21h.
16	1017·7	E.2	37	43	87	—	0·0	Fe–f till 17h.
17	1004·8	E.4	37	42	74	—	0·0	d_0 13h., r_0 24h.
18	995·2	ENE.4	39	44	94	0·03	0·0	f 9h.–15h., d_0 20h.21h.
19	992·9	SW.4	43	48	66	0·13	5·8	r–r_0 0h.–6h.
20	1006·4	NNW.3	34	41	73	—	1·1	x early, fx late.
21	1011·6	Calm.	25	32	96	—	0·0	Fx all day.
22	1011·0	SE.2	29	47	89	0·09	0·0	f till 11h., r 22h.–24h.
23	1014·0	SE.2	42	52	90	0·20	0·5	r_0–r 0h.–7h.
24	1019·9	NE.3	44	49	70	—	0·9	
25	1028·8	WSW.1	30	39	93	—	2·3	F–f all day.
26	1025·5	WSW.1	28	43	86	—	3·0	F–f all day.
27	1023·1	NE.1	28	46	96	—	0·0	F till 13h.
28	1033·6	SW.1	30	39	96	—	0·4	Fx all day.
29	1028·9	SW.3	29	45	61	trace	1·2	Fe early, r_0 23h.
30	1018·1	SSW.3	39	51	95	0·15	0·0	r_0 0h.–3h., 16h.–22h.
*	1016·9	—	37	47	81	1·38	1·5	* Means or Totals.

General Rainfall for November, 1937

England and Wales ...	62	per cent of the average 1881–1915.
Scotland	30	
Ireland	61	
British Isles	54	

Rainfall: November, 1937: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	1·26	53	*Leics* .	Thornton Reservoir ...	1·69	75
Sur .	Reigate, Wray Pk. Rd..	2·11	68	,, .	Belvoir Castle...........	1·23	55
Kent .	Tenterden, Ashenden...	1·18	39	*Rut* .	Ridlington	1·77	77
,, .	Folkestone, Boro. San.	1·35	...	*Lincs* .	Boston, Skirbeck........	2·02	101
,, .	Margate, Cliftonville....	1·10	46	,, .	Cranwell Aerodrome...	1·20	64
,, .	Eden'bdg., Falconhurst	1·51	43	,, .	Skegness, Marine Gdns.	2·41	112
Sus .	Compton, Compton Ho.	2·61	69	,, .	Louth, Westgate.........	2·22	86
,, .	Patching Farm.........	1·89	53	,, .	Brigg, Wrawby St.......	1·72	...
,, .	Eastbourne, Wil. Sq....	1·31	37	*Notts* .	Mansfield, Carr Bank...	1·53	63
Hants.	Ventnor, Roy.Nat.Hos.	2·07	65	*Derby*.	Derby, The Arboretum	1·53	68
,, .	Fordingbridge, Oaklnds	1·55	45	,, .	Buxton, Terrace Slopes	1·99	43
,, .	Ovington Rectory.......	2·62	79	*Ches* .	Bidston Obsy............	1·48	59
,, .	Sherborne St. John......	1·33	47	*Lancs*.	Manchester, Whit. Pk.	1·94	73
Herts .	Royston, Therfield Rec.	1·76	76	,, .	Stonyhurst College......	1·56	35
Bucks.	Slough, Upton............	1·20	54	,, .	Southport, Bedford Pk.	1·37	44
Oxf .	Oxford, Radcliffe.........	1·22	53	,, .	Ulverston, Poaka Beck	2·34	42
N'hant	Wellingboro, Swanspool	1·74	81	,, .	Lancaster, Greg Obsy.	1·53	38
,, .	Oundle	1·70	...	,, .	Blackpool	1·52	44
Beds .	Woburn, Exptl. Farm...	1·84	82	*Yorks*.	Wath-upon-Dearne......	1·68	82
Cam .	Cambridge, Bot. Gdns.	1·79	93	,, .	Wakefield, Clarence Pk.	1·97	93
,, .	March......................	1·60	78	,, .	Oughtershaw Hall.......	1·91	...
Essex.	Chelmsford, County Gdns	1·93	86	,, .	Wetherby, Ribston H..	1·82	78
,, .	Lexden Hill House......	1·55	...	,, .	Hull, Pearson Park......	2·56	117
Suff .	Haughley House.........	1·29	...	,, .	Holme-on-Spalding......	2·07	95
,, .	Rendlesham Hall........	1·21	55	,, .	West Witton, Ivy Ho.	1·74	50
,, .	Lowestoft Sec. School...	1·46	62	,, .	Felixkirk, Mt. St. John.	2·27	93
,, .	Bury St. Ed., Westley H.	1·60	70	,, .	York, Museum Gdns....	1·92	92
Norf. .	Wells, Holkham Hall...	1·63	76	,, .	Pickering, Hungate......	2·10	84
Wilts .	Porton, W.D. Exp'l. Stn	1·22	47	,, .	Scarborough..............	2·30	93
,, .	Bishops Cannings.......	1·80	63	,, .	Middlesbrough...........	2·19	103
Dor .	Weymouth, Westham.	2·59	84	,, .	Baldersdale, Hury Res.	1·38	37
,, .	Beaminster, East St....	2·39	60	*Durh* .	Ushaw College...........	1·49	59
,, .	Shaftesbury, Abbey Ho.	1·60	50	*Nor* .	Newcastle, Leazes Pk...	1·91	81
Devon.	Plymouth, The Hoe....	2·99	82	,, .	Bellingham, Highgreen	1·07	31
,, .	Holne, Church Pk. Cott.	5·52	86	,, .	Lilburn Tower Gdns....	1·23	37
,, .	Teignmouth, Den Gdns.	2·72	85	*Cumb*.	Carlisle, Scaleby Hall...	0·75	25
,, .	Cullompton	2·31	67	,, .	Borrowdale, Seathwaite	4·50	35
,, .	Sidmouth, U.D.C........	1·65	...	,, .	Thirlmere, Dale Head H.	2·92	31
,, .	Barnstaple, N. Dev.Ath	2·09	53	,, .	Keswick, High Hill......	1·25	22
,, .	Dartm'r, Cranmere Pool	4·70	...	*West* .	Appleby, Castle Bank...	0·34	10
,, .	Okehampton, Uplands.	3·03	57	*Mon* .	Abergavenny, Larchf'd	1·91	50
Corn .	Redruth, Trewirgie......	3·53	72	*Glam* .	Ystalyfera, Wern Ho....	4·53	69
,, .	Penzance, Morrab Gdns.	3·48	76	,, .	Treherbert, Tynywaun.	4·50	...
,, .	St. Austell, Trevarna...	3·34	68	,, .	Cardiff, Penylan..........	2·40	59
Soms .	Chewton Mendip.........	3·11	73	*Carm* .	Carmarthen, M. & P. Sch.	2·81	55
,, .	Long Ashton............	2·05	65	*Pemb* .	Pembroke, Stackpole Ct.	2·59	59
,, .	Street, Millfield..........	1·60	59	*Card* .	Aberystwyth	2·01	...
Glos .	Blockley	1·46	...	*Rad* .	BirmW.W.Tyrmynydd	1·92	29
,, .	Cirencester, Gwynfa....	1·71	57	*Mont* .	Newtown, Penarth Weir	...	...
Here .	Ross-on-Wye.............	1·19	47	,,	Lake Vyrnwy	2.40	43
Salop.	Church Stretton.........	1·94	66	*Flint* .	Sealand Aerodrome......	1·70	...
,, .	Shifnal, Hatton Grange	1·56	65	*Mer* .	Blaenau Festiniog	5·20	54
,, .	Cheswardine Hall........	1·45	56	,, .	Dolgelley, Bontddu......	2·11	34
Worc .	Malvern, Free Library...	1·42	56	*Carn* .	Llandudno	1·36	47
,, .	Ombersley, Holt Lock.	1·44	63	,, .	Snowdon, L. Llydaw 9..	6·60	...
War .	Alcester, Ragley Hall...	1·83	79	*Ang* .	Holyhead, Salt Island...	1·85	45
,, .	Birminghm, Edgbaston	1·57	66	,, .	Lligwy	2·51	...

Rainfall: November, 1937: Scotland and Ireland

Co.	STATION.	In.	Per cent of Av.	Co.	STATION.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem.	2·37	50	*R&C* .	Achnashellach	2·67	29
Guern.	St.Peter P't.Grange Rd.	2·82	67	,, .	Stornoway,C.GuardStn.	2·23	38
Wig .	Pt. William, Monreith.	1·68	39	*Suth* .	Lairg	·91	23
,, .	New Luce School	1·48	29	,, .	Skerray Borgie	2·61	...
Kirk .	Dalry, Glendarroch	1·44	24	,, .	Melvich	2·01	50
Dumf.	Dumfries, Crichton R.I.	·98	28	,, .	Loch More, Achfary	4·27	50
,, .	Eskdalemuir Obs	1·19	21	*Caith* .	Wick	1·46	46
Roxb .	Hawick, Wolfelee	·76	20	*Ork* .	Deerness	1·83	47
Peeb .	Stobo Castle	·65	20	*Shet* .	Lerwick	2·13	54
Berw .	Marchmont House	·70	23	*Cork* .	Cork, University Coll.	3·57	89
E.Lot .	North Berwick Res	·51	23	,, .	Roches Point, C.G. Stn.	3·87	92
Midl .	Edinburgh, Blackfd. H.	·24	11	,, .	Mallow, Longueville	4·59	123
Lan .	Auchtyfardle	·81	...	*Kerry*.	Valentia Observatory	5·61	103
Ayr .	Kilmarnock, Kay Park	·61	...	,, .	Gearhameen	6·80	70
,, .	Girvan, Pinmore	·73	14	,, .	Bally McElligott Rec.	2·84	...
,, .	Glen Afton, Ayr San.	1·14	21	,, .	Darrynane Abbey	3·44	67
Renf .	Glasgow, Queen's Park	·53	14	*Wat* .	Waterford, Gortmore	3·14	85
,, .	Greenock, Prospect H.	1·76	27	*Tip* .	Nenagh, Castle Lough.	1·80	45
Bute .	Rothesay, Ardencraig	1·53	30	,, .	Cashel, Ballinamona	2·98	86
,, .	Dougarie Lodge	2·93	56	*Lim* .	Foynes, Coolnanes	...	...
Arg .	Loch Sunart, G'dale	1·95	26	*Clare* .	Inagh, Mount Callan	4·11	...
,, .	Ardgour House	2·25	...	*Wexf* .	Gorey, Courtown Ho.	2·39	68
,, .	Glen Etive	...	...	*Wick* .	Rathnew, Clonmannon.	2·20	...
,, .	Oban	1·97	...	*Carl* .	Bagnalstown,Fenagh H.	2·57	77
,, .	Poltalloch	2·15	38	,, .	Hacketstown Rectory	2·14	45
,, .	Inveraray Castle	2·50	30	*Leix* .	Blandsfort House	1·84	55
,, .	Islay, Eallabus	2·63	49	*Offaly*.	Birr Castle	1·47	47
,, .	Mull, Benmore	5·20	36	*Kild* .	Straffan House	1·56	50
,, .	Tiree	1·81	37	*Dublin*	Dublin, Phoenix Park	2·17	77
Kinr .	Loch Leven Sluice	·48	13	,, .	Balbriggan, Ardgillan	2·36	82
Fife .	Leuchars Aerodrome	·52	23	*Meath*.	Kells, Headfort	1·60	47
Perth .	Loch Dhu	1·10	13	*W.M* .	Moate, Coolatore	1·11	...
,, .	Crieff, Strathearn Hyd.	·39	9	,, .	Mullingar, Belvedere	1·39	38
,, .	Blair Castle Gardens	·61	17	*Long* .	Castle Forbes Gdns	1·04	29
Angus.	Kettins School	·25	8	*Gal* .	Galway, Grammar Sch.	2·13	52
,, .	Pearsie House	·45	...	,, .	Ballynahinch Castle	3·40	57
,, .	Montrose, Sunnyside	·67	25	,, .	Ahascragh, Clonbrock.	1·44	36
Aber .	Balmoral Castle Gdns.	·78	21	*Rosc* .	Strokestown, C'node	1·02	30
,, .	Logie Coldstone Sch.	1·07	35	*Mayo*.	Blacksod Point	3·79	73
,, .	Aberdeen Observatory.	1·65	56	,, .	Mallaranny	2·73	...
,, .	New Deer School House	2·15	64	,, .	Westport House	3·11	63
Moray	Gordon Castle	1·73	60	,, .	Delphi Lodge	6·76	65
,, .	Grantown-on-Spey	1·11	37	*Sligo* .	Markree Castle	1·61	38
Nairn .	Nairn	·62	26	*Cavan*.	Crossdoney, Kevit Cas.	1·79	...
Inv's .	Ben Alder Lodge	·68	...	*Ferm* .	Crom Castle	1·97	57
,, .	Kingussie, The Birches.	·42	...	*Arm* .	Armagh Obsy	1·26	44
,, .	Loch Ness, Foyers	...	...	*Down*.	Fofanny Reservoir	5·05	...
,, .	Inverness, Culduthel R.	·57	22	,, .	Seaforde	2·11	56
,, .	Loch Quoich, Loan	2·41	...	,, .	Donaghadee, C. G. Stn.	1·69	55
,, .	Glenquoich	2·71	23	*Antr* .	Belfast, Queen's Univ.	1·69	50
,, .	Arisaig House	2·42	36	,, .	Aldergrove Aerodrome.	·69	21
,, .	Glenleven, Corrour	...	...	,, .	Ballymena, Harryville.	1·45	36
,, .	Fort William, Glasdrum	1·06	...	*Lon* .	Garvagh, Moneydig	1·44	...
,, .	Skye, Dunvegan	3·25	...	,, .	Londonderry, Creggan.	1·59	39
,, .	Barra, Skallary	2·41	...	*Tyr* .	Omagh, Edenfel	2·22	58
R&C.	Alness, Ardross Castle.	...	...	*Don* .	Malin Head	2·59	...
,, .	Ullapool	1·83	34	,,	Dunkineely	1·53	...

Climatological Table for the British Empire, June, 1937

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 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....	1018·1	+ 1·4	81	47	68·9	52·3	60·6	+ 1·6	53·4	78	6·7	1·81	− 0·34	11	6·9	42
Gibraltar	1017·3	0·0	80	58	73·3	61·3	67·3	− 3·2	59·7	77	3·7	0·11	...	2	...	...
Malta...........	1016·2	+ 1·0	89	64	81·0	69·3	75·1	+ 2·4	68·2	71	3·8	trace	− 0·09	0	10·4	72
St. Helena	1015·8	− 0·5	68	55	64·3	57·7	61·0	+ 1·2	57·7	88	8·8	1·76	− 1·06	13	...	...
Freetown, Sierra Leone	1012·7	+ 2·4	89	69	86·4	73·2	79·8	...	75·7	80	5·5	10·66	− 9·38	24	...	...
Lagos, Nigeria	1012·8	+ 0·4	89	74	85·7	76·3	81·0	+ 1·5	76·3	87	8·2	20·04	+ 1·56	17	5·3	43
Kaduna	1012·0	...	93	66	87·8	69·8	78·8	+ 2·3	72·3	84	6·3	5·63	− 1·46	13	7·9	62
Zomba, Nyasaland	1016·2	− 1·5	82	46	75·2	53·6	64·4	+ 1·5	59·4	72	2·5	0·87	+ 0·39	2	...	...
Salisbury, Rhodesia...	1019·6	− 1·0	78	36	72·6	44·0	58·3	+ 1·4	49·1	47	1·3	0·00	...	0	8·5	77
Cape Town	1019·9	− 0·2	71	43	61·9	50·7	56·3	+ 0·6	51·4	93	6·4	8·05	+ 3·55	19	...	...
Johannesburg	1021·2	− 0·5	68	31	62·0	42·4	52·2	+ 1·5	39·7	34	0·1	00·0	− 0·14	0	9·7	92
Mauritius	1018·3	− 0·5	79	54	75·9	61·9	68·9	− 0·5	66·9	77	4·9	1·06	− 1·35	13	6·9	63
Calcutta, Alipore Obsy.	998·5	− 1·2	99	74	91·5	79·4	85·5	+ 0·4	80·4	87	8·2	17·52	+ 5·61	13*	...	...
Bombay	1003·6	− 0·4	94	73	88·4	78·9	83·7	− 0·3	78·2	81	6·6	18·32	− 1·55	16*	...	...
Madras	1002·7	− 1·1	105	77	99·9	82·9	91·4	+ 1·4	75·9	56	8·1	1·75	− 0·22	1*	...	...
Colombo, Ceylon	1008·7	+ 0·1	86	74	85·3	78·7	82·0	+ 0·4	78·0	78	7·6	6·17	− 1·15	18	8·0	64
Singapore...........	1008·8	− 0·1	89	73	86·8	77·8	82·3	+ 0·8	78·2	79	7·6	4·88	− 1·99	12	6·4	53
Hongkong...........	1004·7	− 1·1	90	71	85·8	78·3	82·1	+ 0·7	78·0	84	8·6	13·27	− 2·43	25	4·0	30
Sandakan	1008·7	...	92	72	89·7	75·9	82·8	+ 1·1	77·5	84	6·8	7·17	− 0·33	13	...	...
Sydney, N.S.W.........	1018·9	+ 1·0	68	44	59·7	48·2	53·9	− 0·8	49·9	83	7·3	15·80	+ 11·06	20	3·5	35
Melbourne	1022·4	+ 3·9	61	30	54·6	37·8	46·2	− 4·2	40·9	92	5·5	1·25	− 0·81	10	4·4	45
Adelaide	1021·0	+ 1·6	68	38	60·6	45·4	53·0	− 0·6	48·4	77	5·6	1·94	− 1·14	14	4·6	47
Perth, W. Australia ...	1018·2	+ 0·2	71	36	64·9	48·4	56·7	− 0·1	50·9	73	5·8	8·97	+ 2·03	13	5·5	55
Coolgardie	1019·4	+ 0·5	71	34	62·0	42·2	52·1	− 0·7	47·2	77	4·1	1·01	− 0·25	4	...	...
Brisbane...........	1016·9	− 1·4	71	43	67·4	51·0	59·2	− 1·0	52·1	66	4·0	0·73	− 2·06	8	6·9	66
Hobart, Tasmania......	1025·1	+10·8	52	30	48·9	37·3	43·1	− 3·9	38·3	81	5·0	1·31	− 0·92	12	4·2	46
Wellington, N.Z.	1016·6	+ 1·7	60	34	49·5	41·3	45·4	− 4·1	43·0	80	7·2	3·33	− 1·44	21	2·8	30
Suva, Fiji	1013·0	− 0·6	89	67	82·1	71·6	76·9	+ 2·2	72·6	83	5·7	2·23	− 4·48	14	5·4	49
Apia, Samoa	1011·4	− 0·2	86	71	84·9	73·6	79·3	+ 1·5	75·2	76	4·7	0·65	− 4·70	9	8·2	73
Kingston, Jamaica	1013·8	0·0	91	71	88·1	74·2	81·1	− 0·2	73·0	76	5·0	0·70	− 3·40	3	6·0	45
Grenada, W.I.	1011·6	− 1·7	87	70	84	73	78·5	− 0·5	73	74	6	6·00	− 2·25	22	...	...
Toronto...........	1013·3	− 1·4	84	48	74·5	57·3	65·9	+ 2·1	58·7	76	4·1	3·64	+ 0·98	12	9·0	58
Winnipeg	1011·9	+ 0·1	90	36	75·0	49·9	62·5	+ 0·2	51·7	84	4·1	2·32	− 0·79	11	10·1	62
St. John, N.B.	1012·6	− 0·9	78	46	67·4	51·2	59·3	+ 2·8	55·6	84	7·0	4·61	+ 1·34	16	6·6	42
Victoria, B.C...........	1015·2	− 1·6	82	48	65·9	51·0	58·5	+ 1·5	54·0	77	5·5	2·21	+ 1·37	14	7·7	48

(39846) Wt. 20/31 1125 12/37 Hw. G. 377/6

M.O. 411.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 72

Jan., 1938

No. 864

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; 26 YORK STREET, MANCHESTER 1; 1 ST. ANDREW'S CRESCENT, CARDIFF: 80 CHICHESTER STREET, BELFAST; or through any bookseller.

The Weather of 1937

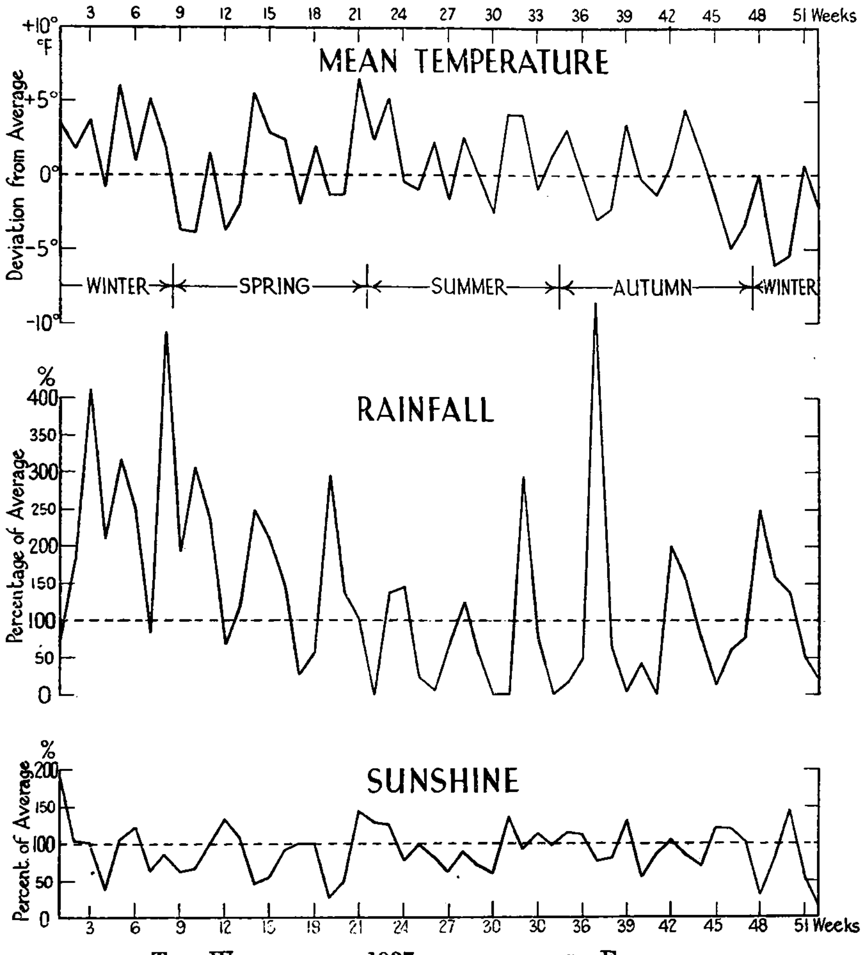
From the somewhat incomplete data at present available it appears that the year 1937 was generally dull, wet in England and Wales and dry on the whole in Scotland.

Among notable features of the weather of the year were the exceptional rainfall experienced in England and Wales during the run of five consecutive wet months January to May, the heavy snowstorms of February 27th–28th and March 11th–13th, the severe floods in the Fenlands around the middle of March, the coldness of March, the marked deficiency of sunshine in April and July, the deficiency of rainfall in England and Wales during the six successive dry months June to November, the occasional severe thunderstorms during the summer months, the frequent and sometimes thick fog in November and the considerable frost and snow of the period December 4th–21st.

Considering the British Isles as a whole the months January to May inclusive and July were wet, while September received about the average rainfall. January and February were exceptionally wet, the total for the two months exceeded that for any similar period back to 1870. The greatest deficiencies occurred in August and November; August was unusually dry in parts of England (at Oxford it was the driest August since 1822) and November was exceptionally dry in Scotland, where it was the driest November on record at a number of widely separated stations and at Edinburgh it was the driest in a record covering 160 years. The incidence of rainfall in England and Wales was remarkable; the total rainfall of the first five months was greater than in any similar period back to before 1870 while a deficiency was recorded in each of the next six months. An unusual number of absolute droughts were experienced in this dry period—for example, at Oxford from July 25th–August 11th, August 17th–31st and October 7th–21st. A detailed account of the rainfall of the year is given in a subsequent article. The snowfall of the year deserves comment. The storms of January 29th–31st were severe in some parts; undrifted snow was 15 inches deep in Aberdeenshire and 10 inches deep in Fife. The snowstorm of February 27th–28th was noteworthy; it was accompanied by a northerly gale which caused deep drifts and many roads were blocked; on the 28th undrifted snow was reported to be 14 inches deep at Macclesfield and roughly 24 inches deep at Buxton. In March, sleet and snow were exceptionally frequent and the storms of the 11th–13th were severe in the north of England, south Scotland and Northern Ireland. They were accompanied by strong north-easterly winds and deep drifts accumulated; practically all the roads in the province of Ulster were impassable for wheeled traffic and in Scotland also roads in all parts of the country were blocked. Again in December snow fell frequently between the 4th and 21st; in many parts the falls were heavy at times and roads were rendered impassable; the condition was aggravated by frost.

Mean temperature for the year very slightly exceeded the average in England and was about average elsewhere. Of the individual months March and December were cold generally while November was cold over most of England; over Scotland as a whole March was the coldest month of that name since 1919, and the period December 5th–20th was unusually cold generally. A screen minimum temperature of 0°F. was registered at Braemar on March 8th and at Dalwhinnie on December 13th. In the remaining nine months, mean temperature on the whole exceeded the average though the differences were slight in July and September; the excess was greatest in April and August. February was very mild in southern England, and May in Scotland. A warm spell occurred generally in the last 8 or 9 days of May and temperatures approaching or somewhat exceeding 80°F. were registered at a number of stations in England on the 25th, 29th and 30th. The highest temperature of the year was recorded generally in the early part of August; the absolute values registered in standard screens in the constituent countries were:—(England and Wales) 92°F. at Canterbury and Tunbridge Wells on August 7th; (Scotland) 84°F. at Ruthwell on August 1st; (Ireland) 82°F. at Hazelhatch on August 2nd.

Sunshine was almost everywhere deficient, the deficiency being greatest in Ireland and eastern England; at Birr Castle, Cranwell, Shoeburyness and Aldergrove it was the dullest year since observations were first taken in 1881, 1921, 1919 and 1927 respectively, and at Phoenix Park, Dublin, it was the dullest year apart from 1912, since records were started in 1881. In general, with respect to the average the sunniest months were February, May and August and the dullest April and July. Considerable variations, however, occurred in different districts; February was very sunny in Scotland and



THE WEATHER OF 1937 IN SOUTH-EAST ENGLAND

Weekly variations from long period averages computed from observations at five representative stations.

decidedly dull in south-west England; in March there was a large excess in the extreme north and west of Scotland and in north-west Ireland and a marked deficiency locally in north-east England. May and August were notably sunny in the west and north; in September there was a considerable deficiency in Ireland and a decided excess on the east coast of Scotland. In November, the pronounced variations in England were doubtless due to the incidence of fog ; in south-east England, the percentage of the average ranged from 66 at Greenwich to 161 at Wye, Kent. In the closing month of the year a marked excess of sunshine was enjoyed over most of Scotland and a substantial deficiency occurred, for the most part, in England.

Gales occurred frequently in the west and north during January and February. January was one of the stormiest months on record in the Orkneys and Shetlands. On February 28th a gust of 107 m.p.h was registered at Holyhead.

The diagram on page 279 shows the weekly variations in temperature, rainfall and sunshine in south-east England in 1937. The variations are given in the form of deviation from the average of temperature and percentages of the average of rainfall and sunshine. The district value is the arithmetic mean of the values for the following stations :—Kew Observatory, Margate, Hastings, Southampton and Marlborough.

L. F. LEWIS.

The Rainfall during 1937

Over England and Wales the incidence of rainfall during 1937 was unprecedented. The rainfall of each of the five months January to May exceeded the average, while the following six months June to November were all relatively dry. There is no other year in the series back to 1727 giving such a well marked change during the year. The total rainfall during the five months January to May was as much as 21·2 in. or 8·6 in. in excess of the average. This total exceeded by 2·8 in. the next wettest January to May since 1870. The six months June to November gave 13·6 in., a deficiency of 5·1 in. A similar run of six consecutive dry months occurred only in 1919 and 1901 since 1870.

On the other hand over Scotland dry months predominated during 1937. The eight months March to May and August to December each gave less than the average, although the deficiency was marked only in November, which had less than one-third of the average. Over Ireland there were six wet months, viz., January to April, July and September and the totals approximated more closely to the average.

The two wettest months of the year in each country were January and February. The driest month was June over England and Wales, November over Scotland, while over Ireland May and June were equally dry with 2·2 in.

General values for each month are set out in the following table, both as percentages of the average and in actual inches of rainfall.

A comparison of the general values for the British Isles for 1937 with those for earlier years brings out the following interesting points. 1937 adds another wet January to the sequence, which commenced about 1918, during which wet months predominate. The wet February of 1937, on the other hand, stands out in marked contrast with recent Februarys, those of 1932 and 1934 having only 13 and 24 per cent. respectively. June, 1937, continued the sequence which commenced about 1913 in which dry Junes predominated.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	%	%	%	%	%	%	%	%	%	%	%	%
England and Wales	185	218	139	152	136	71	84	46	97	83	62	108
Scotland ...	162	136	77	71	78	103	126	91	85	81	30	76
Ireland ...	178	158	109	113	80	78	141	76	133	66	61	71
British Isles ...	176	182	115	122	107	81	109	63	101	80	54	93
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
England and Wales	5·5	5·6	3·7	3·2	3·1	1·7	2·4	1·5	2·5	3·3	2·2	4·2
Scotland ...	7·9	5·7	3·1	2·1	2·3	2·9	4·7	4·1	3·4	4·0	1·6	4·5
Ireland ...	7·2	5·6	3·7	3·1	2·2	2·2	4·8	3·2	4·2	2·7	2·6	3·5
British Isles ...	6·7	5·9	3·7	3·1	2·8	2·1	3·5	2·5	3·1	3·4	2·3	4·4

The rainfall of August, 1937, was similar to that of recent Augusts, being less than the average. The rainfall of September, 1937, was again above the average. It will be recalled that wet Septembers predominated during the period 1870 to 1887 and dry Septembers from 1905 to 1917. Since then there has been a reversion to wetter Septembers. Of recent years October, November and December have generally given less than the average. October, 1937, is the second consecutive dry October; of the last six Novembers, four have been dry and of the last thirteen Decembers as many as ten have been dry.

Provisional estimates of the general rainfall for 1937 over the countries generally are given below in actual inches and as percentages, together with the corresponding values for 1936.

	1937		1936	
	in.	%	in.	%
England and Wales	39·0	111	38·4	109
Scotland	46·3	92	47·3	94
Ireland	44·9	104	45·5	105
British Isles	43·5	105	43·5	105

The values for 1937 are remarkably similar to those for 1936. Over England and Wales 1937 was not as wet as 1935; over Scotland 1937 was drier than any year since 1902, with the one exception of 1933; over Ireland 1937 was not as wet as either 1936 or 1934.

The rainfall was less than the average over most of the Pennines and region to the west, most of Wales, north Devon and near Grimsby. Falls of rather less than 80 per cent. occurred in the English Lake District. Falls of more than 120 per cent. were confined to a large area in the south-east of England extending to Dartmoor, Wellingborough and Doncaster. Some of the largest percentage values were 151 at Shoeburyness, 135 at both Totland Bay, Isle of Wight, and Royston in Hertfordshire. The total of 38·57 in. recorded at Totland Bay was the largest since the record commenced there in 1888, the next largest being that of 37·33 in. in 1915.

Over Scotland falls exceeding the average were confined almost entirely to the eastern half of the country and to the south of the Moray Firth, with 120 per cent. in the neighbourhood of Dundee and Montrose. There was less than 80 per cent. over most of the area to the north-west of the Caledonian Canal.

Over Ireland the rainfall was more uniform. In general it was below the average in the northern half and above the average in the southern half and in the extreme north-east. As much as 110 per cent. occurred near Belfast, Dublin, Waterford and Valentia Observatory.

J. GLASSPOOLE.

Fog over the Christmas Holiday 1937

Anticyclonic weather in winter is usually either dull with persistent low cloud sheets or the sky is almost cloudless with widespread early morning fog which often persists once it has formed. The weather over the Christmas holiday proved no exception to this general rule. At 0700 G.M.T. on Christmas Eve an anticyclone was centred over France, and the British Isles lay within an extensive mild south-westerly air current with high dew points, cloudy skies and drizzle. At the same time a cold front was orientated NE–SW just off the western Irish coast. This front moved quickly south-eastward across the country, and behind it there was a rapid rise of pressure and a decrease in the pressure gradient over England. Dew points in the new air supply were of the order 40°–45°F.; with light winds and clear skies prevailing behind the cold front, temperatures fell to 29°–38°F. in the Midlands and widespread radiation fog developed in the early morning of Christmas Day. At 0700 G.M.T. on that day the cold front was located east to west along the southern counties of England and its rate of travel had decreased to about 10 m.p.h. Mist or moderate fog had already developed during the night in the mild moist air in advance of the front, and the thickening of the fog in the London area was partly due to a fall of temperature associated with clearing skies just before sunrise behind the front, and probably also due to mixing of the two air currents in the slowly moving frontal zone. The rapid rise of pressure behind the front caused the anticyclone to move northwards, and by 1300 G.M.T. on Christmas Day the central area covered most of England and north and central France.

On Christmas morning the fog in London and the Home Counties was, as usual, patchy and while some places enjoyed bright sunshine artificial lighting was necessary in others. The fog was also drifting slowly so that places that had been clear in the morning became foggy after midday. Conditions became worse as temperatures fell during the afternoon, and by dusk visibilities of 5 yards or less were common over a large part of England. In many parts road traffic was brought to a standstill, trains were delayed and shipping was affected in the Thames and also in the Straits of Dover. Several Football League matches had to be postponed or abandoned. Another outstanding feature was the partial clearance in southern districts towards midnight. This was brought about by the coagulation and deposition of the minute water droplets, caused by drizzle falling from a cloud layer, which had spread in over the fog, associated with a warm front which at 1800 G.M.T. extended from north-east Ireland to Devon and was moving slowly north-east.

By 1300 on the 26th the anticyclone had become established over the southern Baltic but still covered the British Isles. Fog was again widespread but generally not so dense as on Christmas Day and the advent of a drier easterly current from the Continent kept the south free from serious fog. There was fog again on the third day of the holiday but this was local and chiefly confined to the Midlands and north of England.

Fog during some part of the Christmas period has been a feature of the past six years in England. It is fortunate in some respects that the worst visibilities occurred on Christmas Day 1937 rather than on Christmas Eve, as happened in 1935, although the inquiries received at the Meteorological Office testified to the large number of stranded motorists.

W. H. Bigg.

A Cause of Error in Self-Recording Rain-Gauges

All autographic rain-gauges are provided with a device which returns the recording pen to zero after it has reached the top of the chart; most gauges employ a form of automatic syphon. Every type of automatic syphon gauge suffers from the common defect that precipitation which falls during the time occupied in emptying the float chamber is lost. The actual loss depends on the type of syphon, the capacity of the float chamber and the intensity of rainfall.

The present writer has recently investigated this point, with special reference to the Dines Tilting Syphon gauge, and the results are given here as being of interest to all rainfall observers, especially at Meteorological Office stations. It should be remembered in all that follows, that the general principles are applicable to all automatic syphon gauges, and are not confined to any one instrument.

In the Dines Tilting Syphon rain-gauges constructed according to the Meteorological Office specification, the syphon empties the float chamber in 15 to 20 seconds (measured while no water is entering the receiver). The " travel " of the recording pen represents 5 mm. of rainfall.

The losses of record which occur at each syphoning during rainfalls of various intensities can be deduced from these two facts :—

Let t seconds be the syphoning interval, measured while no rain enters the receiver. Then water is removed from the float chamber at a rate equivalent to $300/t$ mm./min. of rainfall. But if rain is falling simultaneously into the receiver at the rate of x mm./min., the effective rate at which water is removed is $(300/t) - x$ mm./min., and the time (T seconds) occupied in emptying the chamber becomes

$$T = \frac{300}{\frac{300}{t} - x} \text{ seconds.}$$

The loss of precipitation (L mm.) during syphoning is therefore

$$L = \frac{300}{\frac{300}{t} - x} \times \frac{x}{60} \text{ mm.}$$

$$= \frac{5x}{\frac{300}{t} - x} \text{ mm.} \quad \ldots \quad \ldots \quad (1)$$

In order to construct the " characteristic curve " showing the variation of L with different rates of rainfall for any given instrument, it is only necessary to find the time (t seconds) occupied in syphoning while no water enters the receiver, and to substitute this value in equation (1), using varying values of rainfall (x mm./min.).

Characteristic curves for $t = 15$, 17 and 20 are shown in Fig. 1 for values of x between 0 and 8 mm./min. Experiments were made to test the accuracy of these curves, using a gauge whose t interval was 17 seconds.

Water was led into the receiver at a controllable rate, and the times taken (t_a seconds) for the pen to rise from zero to 5 mm. on the chart and (t_b seconds) to return to zero were noted. The rate of rainfall (x mm./min.) represented by the flow of water is given by $x = 300/t_a$ mm./min., while the loss during syphoning (L mm.) is given by $L = 5t_b/t_a$ mm. Several observations were made, varying the flow of water each time, and the values obtained are plotted (thus :—o) in Fig. 1. It will be noted that, while the points are in good general agreement with the $t = 17$ curve, there is considerable " scatter". This is due mainly to variations in the pressure of the water mains. It was unfortunately impossible owing to limited time to obtain a complete series of readings.

One most important point was, however, brought out; the instrument functioned perfectly until the rate of flow of water was increased to above 5 mm./min. At rates in excess of this value the syphon would empty the float chamber, but having done so would not " break", but continued to dribble the water out as fast as it poured in. Rainfall of more than this intensity however, is not likely to occur in nature, at least in this country. It can therefore be stated with a degree of certainty that the Dines Tilting Syphon rain-gauge will record rainfall of intensities up to 5 mm./min. (nearly 12 in./hr.) with losses at each syphoning varying as shown in Fig. 1.

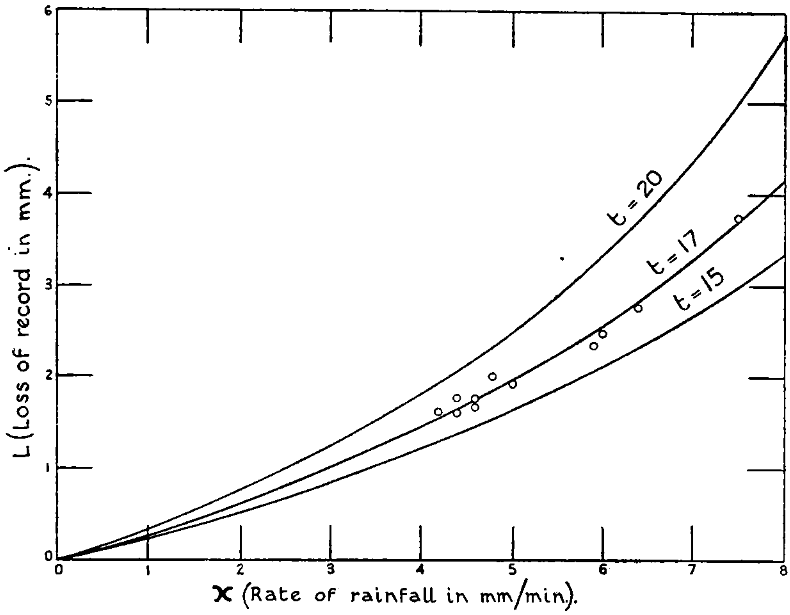


FIG. 1.—CHARACTERISTIC CURVES OF LOSSES FOR DINES TILTING SYPHON RECORDING RAIN-GAUGE, USING A FUNNEL OF DIAMETER 11·3 IN.

The foregoing discussion relates to the standard instrument which is fitted with a funnel of diameter 11·3 in. It is suggested that in tropical and other countries where rainfalls exceeding 5 mm./min. may be expected, the gauge could be modified by fitting an 8-inch funnel, i.e. one whose area is one half that of the standard. The instrument would then record 10 mm. of rainfall between the syphoning operations, so that the losses during syphoning would be only half as frequent. They would also be individually less in amount, for applying reasoning similar to that shown above, the loss at syphoning is given by

$$L = \frac{10x}{\frac{600}{t} - x} \text{ mm.}$$

The characteristic loss curves for gauges fitted with 8-inch funnels are shown in Fig. 2, for $t = 15$, $t = 20$. The only disadvantage in fitting a funnel smaller than the standard is that the recorder would not be so sensitive in slight rainfalls. On the other hand, the gauge would record rainfall of intensities up to 10 mm./min. (nearly 24 in./hr.).

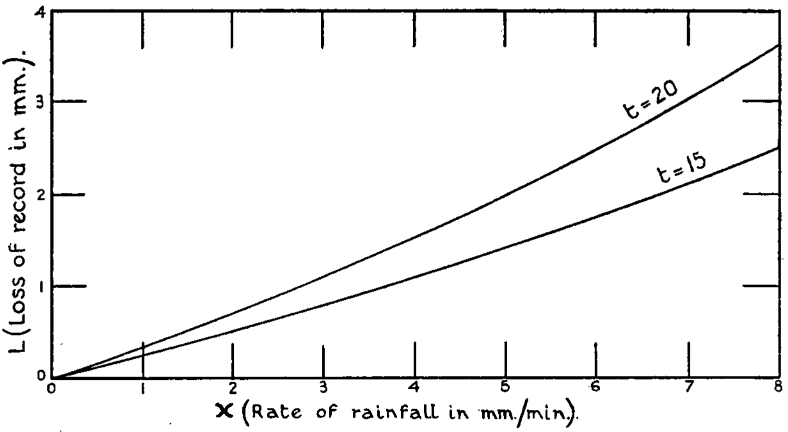


FIG. 2.—CHARACTERISTIC CURVES OF LOSSES FOR DINES TILTING SYPHON RECORDING RAIN-GAUGE, USING A FUNNEL OF DIAMETER 8 IN.

It is of interest in connexion with the above discussion to note that Mr. J. L. Galloway writes from Basra Airport that a Dines Tilting Syphon gauge is in operation there, and that it is 15 ft. 3 in. away from a standard 8-inch M.O. gauge, both being set in concrete. After a storm early in the morning of November 22nd, in which the mean wind speed was 24 m.p.h., with a maximum gust of 49 m.p.h., 29·0 mm. of rain was found in the check gauge. The Dines Tilting Syphon gauge had recorded only 25·2 mm.; of this, 16 mm. was recorded on the chart in 12 minutes, and during this time the gauge syphoned four times. It syphoned again later during rainfall at the rate of about 5 mm./hr. Mr. Galloway concludes that the discrepancy of 3·8 mm. was mainly due to losses occurring during the first four syphoning intervals, and suggests that a device be added whereby the rain caught during the period of syphoning is held and admitted to the float chamber only when the syphoning is finished. He found on experiment that the syphoning interval for the gauge (t in the above discussion) was about 17 secs.

Referring to Fig. 1, it will be seen that the whole loss of 3·8 mm. can be accounted for by assuming that the rate of rainfall during syphoning was about 2·8 mm./min. This is excessive in view of the figures quoted. Part of the discrepancy however, is probably due to the different amounts of insplashing and turbulence which would occur in high winds with gauges exposed with their rims at different heights, especially above concrete (see *British Rainfall*, 1910, p. 75 and the *Meteorological Magazine*, 66, 1931, p. 153).

It would be interesting to learn at what heights the rims of the gauges are set.

The writer is indebted to Mr. J. S. Dines for his advice on the preparation of this note.

L. S. MATTHEWS.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are :—

January 31st, 1938. *On the influence of pressure changes upon weather.* By P. Sieber. Beitr. Phys. frei. Atmos., Leipzig, 23, 1936, pp. 249-74. (In German.) *Opener.*—Dr. A. G. Forsdyke.

February 14th, 1938. *The return of radio waves from the middle atmosphere.* By R. A. Watson Watt, A. F. Wilkins and E. G. Bowen. London, Proc. roy. Soc., 161 (A), 1937, pp. 181–96. *Opener.*—Dr. G. M. B. Dobson, F.R.S.

Royal Meteorological Society

The monthly meeting of the Society was held on Wednesday December 15th at 49, Cromwell Road, South Kensington. Dr. F. J. W. Whipple, F.Inst.P., President, was in the Chair.

The following papers were read and discussed :—

C. W. B. Normand, M.A., D.Sc.—On instability from water vapour.

This paper summarises the general criteria for the stability of a particle and of a layer in the atmosphere under conditions when condensation may bring the latent heat of water vapour into play. It discusses briefly the relationship between "Feuchtlabilität" (Refsdal), latent instability (Normand) and convective instability (Rossby), and gives the reasons for the introduction in India of the classification based on latent instability. The conditions for latent instability are defined with the aid of the tephigram, and an example is given to show how by generating latent instability within a closed system, e.g., by raising the wet-bulb temperature in the lower layers and leaving all else unchanged, the energy available for transformation into kinetic energy may rise from zero to the equivalent of a wind of 50 m.p.h. throughout the system, without taking account of the energy that may become available from the evaporation of raindrops in descending air. If, however, evaporation from raindrops takes place in the descending air in a thermo-dynamically efficient manner, the available energy in the closed system of the chosen example is nearly trebled, i.e., the equivalent average velocity rises to more than 90 m.p.h.

C. W. B. Normand, M.A., D.Sc.—Kinetic energy liberated in an unstable layer.

Kinetic energy is released when an unstable super-adiabatic layer of constant lapse-rate $\varepsilon\Gamma$ rights itself (where Γ is the adiabatic lapse-rate and $\varepsilon > 1$). The average kinetic energy can be computed analytically by Margules's method or graphically on the tephigram. By Margules's method, a good approximate formula for the resulting average velocity is shown in this paper to be

$$v = \text{constant} \times \Delta p/\Pi \sqrt{(\varepsilon - 1)\,\Theta}$$

where Π and Θ are the mean pressure and temperature of the column and Δp is the pressure difference between the top and bottom of the column. The method of the tephigram gives the average energy to be equivalent to one-sixth the area of a parallelogram of which the diagonals are the initial and final temperature curves of the column. Some examples are numerically evaluated by these methods and the results show close agreement with values previously calculated by a longer and more laborious method by Littwin.

C. S. Durst, B.A., and R. C. Sutcliffe, B.Sc., Ph.D.—The importance of vertical motion in the development of tropical revolving storms.

The problem discussed is that of the mechanism for the eviction of air from tropical revolving storms. By the examination of the equations of motion it is found that this eviction could be explained by the convection of air from layers of greater velocity to those of less velocity.

C. J. Boyden, B.A.—The mechanics of the depression: some criticisms and a contribution.

Attention is called to certain serious gaps and obscurities in our understanding of the birth and development of the depression. The paper concludes with a discussion of the effect of isobaric curvature on wind speeds in different parts of the depression, and the resulting convergence and divergence.

Correspondence

To the Editor, *Meteorological Magazine*

False Minimum Temperature at Goetz Observatory

The thermometric equipment at Goetz Observatory consists of a rather large double louvred screen containing the standard thermometers and a small bimetallic thermograph in which the coil element is quite open and unshielded. The continuous temperature records are obtained from a distance recording mercury-in-steel wet and dry bulb thermograph housed in a tunnel continuously aspirated and the whole protected by a double louvred screen somewhat smaller than the thermometer screen. The former is twenty yards from the latter and nineteen feet from the office.

On November 30th, 1937 the observatory was struck by a thunderstorm at about 13h. 10m. S.A.M.T. The wind velocity reached 58 m.p.h. and 0·68 in. of rain fell in fifteen minutes.

The recording dry bulb trace fell from about 86° F. to 68° F. in twenty minutes and remained between 68° F. and 67° F. for ten minutes, the wet bulb rose nearly 2° F. at first and then fell from 66° F. to 59·5° F., and remained there for ten minutes running parallel with the dry. The relative humidity therefore remained well below saturation, and the evaporating power of the air was considerable.

The bimetallic thermograph fell at the same time, but continued to 60° F. and recovered very rapidly to 64° F. and the standard minimum recorded 60·2° F. It was perfectly clear that rain had blown right through the screen and wet everything. On the evidence it appears that the small thermograph and minimum recorded wet bulb temperatures and that the minimum temperature 60·2° F. was incorrect.

NOEL P. SELLICK.

Meteorological Office, Salisbury, Southern Rhodesia, December 14th, 1937.

The North Wales Coastal Climate

I believe that many of the public and possibly some meteorologists do not realize what an extremely favourable climate exists on the north Wales coast between Great Orme's Head and Mostyn, and particularly between Llanddulas and Prestatyn. Rhyl and Abergele with average rainfalls of only 25·80 in. and 28·40 in. respectively, and Llandudno with an average temperature of 50·3° F.—the coast eastwards not differing materially—together constitute a remarkable combination of dryness and mildness. I consider that such a combination is probably not exceeded if even obtained elsewhere in Britain. This section of coast has quite the least rainfall of any part of the western seaboard from Cornwall to Caithness. On the east coast of Britain, which is a little drier, it is decidedly colder in every county from Kent to Caithness. Also any coastal places or areas on the west coast which are in winter milder—such as Holyhead, St. Davids Head, north Devon and Cornwall—are all considerably wetter.

On the south coast of England in winter Cornwall is undoubtedly milder, but in Devon it is apt to be as cold, or colder than hereabouts, whilst to the east of Devon night frosts are more frequent, and also more severe than on this coast.

In summer the maxima here and along the coast—though tempered by sea breezes when gradients are not sufficient to produce a land wind—are much higher than at Holyhead, or on the coast of Pembroke, north Devon and Cornwall. In conclusion I may just mention that on the morning of Sunday, November 14th last, when a screen temperature of 17° F. was registered at Manchester, the minimum at Holyhead was 42° F. or no less than 25° F. warmer than Manchester. Even Falmouth and Penzance reported 35° F. and 34° F. as their screen minima that morning.

SYDNEY WILSON.

Tremycoed, Abergele, December 3rd, 1937.

Crepuscular Rays

At 15h. 28m. today I was cycling from Tremeirchion to Rhuallt, on the eastern side of Moel Maen Efa in the Clwyd range of mountains. Visibility was abnormally good and parallel bands of cirrus ran across the sky from north-west to south-east, travelling up from the south-west. One of these bands lay on the north-east horizon, and from a point in this layer diametrically opposite to the setting sun there radiated dark shafts in appearance exactly similar to those commonly seen in the west at sunset.

Reports have been made before of crepuscular rays seen extending to the zenith or even past it, but in this case it was not a continuation of normal rays beginning in the west, as only a part near the north-east horizon was visible. The rays were visible for about fifteen minutes, after which they faded with the onset of dusk.

S. E. ASHMORE.

Llannerch Gardens, St. Asaph, Flintshire, North Wales, December 25th, 1937.

Sunset Phenomenon

The phenomenon described below was observed at Khartoum on November 5th, 1937 and it may be of interest to readers of the *Meteorological Magazine.*

The sky was clear of clouds and at sunset the portion above the eastern horizon below an elevation of about 40° became reddish in colour. This reddish shade gradually spread higher in the sky and finally reached the western horizon. At the same time the colour in the east changed successively to orange, yellow, pale green, dark blue and violet each of which spread upwards in turn. Within less than ten minutes the colours of the spectrum were visible across the sky in bands extending from north to south. The red and orange in the west and the purple in the east were most pronounced while the green and blue were faint.

Subsequently the eastern sky became dark and the colours were gradually effaced as though a hood—" the hood of night "—had been drawn across the sky.

WILLIAM D. FLOWER.

Meteorological Service, Khartoum, A.E. Sudan. December 14th, 1937.

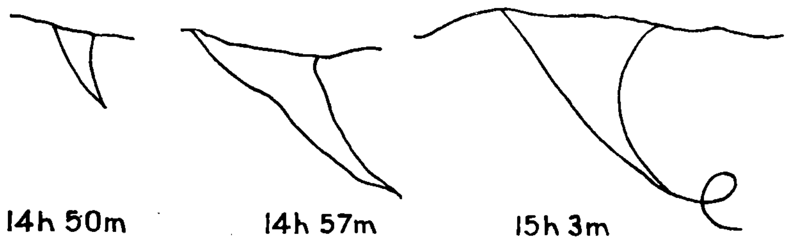
NOTES AND QUERIES

Waterspout at Cranwell, October 25th, 1937

A waterspout or funnel-shaped cloud occurred about two and a half miles south of the Meteorological Office, Cranwell, between 14h. 50m. and 15h. 5m. on October 25th, 1937. It was preceded by vivid lightning, thunder and rain, and it was whilst watching the lightning that the growth and decay of the waterspout were seen by the staff.

When first seen, it was only a small protuberance hanging down from the front of a cumulonimbus cloud of line squall type, whose base was approximately 700 ft. from the ground. This protuberance rapidly increased in size downwards until it had assumed a well-marked funnel shape. The successive phases of the growth are shown in the following sketches made at the time.

From other observations made by reliable observers, and from inquiries made in the district, the position of the waterspout at the period of maximum intensity has been fixed as being at two and a half miles due south of this office and half a mile south-west of Rauceby. Observers close to the waterspout stated that it was seen to be twisting and turning quickly. The staff here observed that it developed a distinct curl to the tail as is shown in the sketch. At this



stage the pendant thinned considerably and the middle portion floated out almost horizontally behind the upper vertical portion. It then appeared to curl anticlockwise (as seen from above) and drop a tail downwards. At about the same time a black mass, very much like a smoke bomb in appearance, dropped from the main cloud partly down the pendant and remained there for some moments before gradually disappearing. The pendant then became much thinner, the lower part oscillating up and down several times before finally retracting. Then the whole waterspout disappeared. The passage of the waterspout across the comb nephoscope was observed, and it was calculated that the approximate length of the tail below the cloud was, at its maximum, 500 ft., with the end of the pendant at 200 ft. above the ground.

During the accompanying thunderstorm the anemogram showed a distinct veer from SE'E. to SSW., and the velocity dropped for three or four minutes to almost nothing. This storm moved from SSW. to NNE., and the upper wind at 12h. measured 160°, 27 m.p.h. at 1,000 ft.; 185°, 35 m.p.h. at 2,000 ft.; 190°, 43 m.p.h. at 3,000 ft.; and 190°, 45 m.p.h. at 4,000 ft. In general a south-westerly current was superimposed over a surface south-easterly one.

So far as has been ascertained, this waterspout does not appear to have caused any damage. This is quite likely to be correct, as the area affected was open fields. It is known that a somewhat similar phenomenon which occurred the same afternoon at North and South Kelsey, some thirty miles north of Cranwell, did cause considerable damage.

G. A. Wright.

Rainfall and Water Supply

Two important contributions have recently been made to the subject of the water resources of this country. In November, Mr. E. G. Bilham read a paper on " Weather and water supply " at the Public Works, Roads and Transport Congress*, and on December 10th the Institution of Water Engineers received the report of its Joint Committee with the British Rainfall Organization and the Royal Meteorological Society, appointed " To consider methods of determining the general rainfall over any area ".

Mr. Bilham briefly analysed the variations of general rainfall over England and Wales from year to year and remarked that we appear to be passing through a period of relatively abundant rainfall. From 1854 to 1858 there were five successive dry years over England, and what has happened once may happen again. He then gave mathematical expressions for the relations between rainfall and run-off in the Thames and Severn valleys, and ended with figures of the smallest rainfalls which can reasonably be expected in various intervals of time.

The report of the Joint Committee was more comprehensive, covering the whole subject of measurement of rainfall and its integration over a definite area.

The various types of rain-gauge are illustrated, the orthodox exposure for the gauge is described and errors due to over- or under-exposure are explained. The principles governing the adequate representation of an area of any size by a network of gauges are set out, and the methods of computing the average annual and monthly rainfall from records of various lengths down to a few months are fully described. The whole report is a mine of information as well as a model of lucid exposition and of illustrations which really illustrate.

REVIEW

The Air Almanac.—Ephemeral sheets for 1937, October 1st to December 31st. Prepared by H.M. Nautical Almanac Office on behalf of the Air Ministry. Size $9\frac{1}{2}$ in. by 6 in. London, H.M. Stationery Office, 1937. Price 2*s*. 6*d*. net.

For many years the Abridged Nautical Almanac has catered for the requirements of the navigator wishing to determine his position by means of the observation of celestial bodies. The surface navigator can afford to spend the time taken by the interpolations and conversions required in the use of the Abridged Nautical Almanac, but the air navigator, working in poor conditions in a fast-moving aircraft, requires his astronomical data directly in the form in which he wishes to use it. The Air Almanac has been produced by H.M. Nautical Almanac Office to the general requirements of the Air Ministry for the purpose of meeting this want.

* Reprinted in *Wat. and Wat. Engng., London*, 39, 1937, p. 603.

For the Sun, Moon, Venus, Mars, Jupiter, Saturn and the fifty brightest stars, the ephemeral sheets of this Almanac provide the Greenwich Hour Angle and Declination, tabulated at convenient intervals of mean time. All the quantities given are for mean time of the meridian of Greenwich, at intervals of one hour for the Sun and Moon, six hours for the planets and two days for the stars. Intermediate tables are provided for determining the values of these quantities at intermediate times. Tables of sunrise, moonrise, etc., are not included as these would not normally be required during flights made by aircraft.

With the development of long-distance flying the appearance of this Almanac is very timely and should prove of great value to pilots on such routes as those lying over the oceans. It is produced in very convenient loose leaf form to meet the requirements of easy reference and compactness.

J. S. Farquharson.

BOOK RECEIVED

Jaarboek, Koninklijk Nederlandsch Meteorologisch Instituut, 1935. A. Meteorologie, B. Aard-Magnetisme (Nos. 97 and 98). Utrecht, 1936.

OBITUARY

We regret to learn of the death on December 26th, 1937, of Mrs. Dines, widow of W. H. Dines, F.R.S., and express our sympathy with her two sons, who are members of the Staff of the Office.

NEWS IN BRIEF

M. Charles Maurain has been awarded 15,000 fr. under the Fondation Villemot for researches in terrestrial magnetism and atmospheric electricity carried out under his direction at the new geophysical observatory at Chambon-la-Forêt, Loiret.

It was announced in the New Year's Honours List that Dr. C. W. B. Normand, Director-General of Observatories, Government of India, has been made a Commander of the Order of the Indian Empire.

ERRATA

June, 1936, p. 105, line 22. The words " the Atlantic " should be deleted, as resultant winds for each two-degree square of the Atlantic are published in De Bilt, K. Ned. Meteor. Inst., Publ. No. 110. Oceanographische en meteorologische waarnemingen in den Atlantischen Oceaan. Kaarten. Amsterdam, 1918, 1922, 1931, Utrecht, 1926.

December, 1937, p. 265. Between first and second lines *insert* " above sea level, and our position was lat. 29° 27′ N."

The Weather of December, 1937

The Siberian anticyclone was well developed, pressure exceeding 1030 mb. between 60° and 110° W. and reaching 1034 mb. at Irkutsk. From this centre ridges of high pressure (above 1020 mb.) extended westwards across Finland and Sweden and eastwards along the Arctic coast of Siberia into North America where a secondary anticyclone gave a mean of 1026 mb. Pressure was 10 mb. or more above normal over the White Sea and Arctic Ocean between Iceland and Dickson, the excess reaching 17 mb. at Archangelsk. Over most of Europe pressure was deficient by more than 5 mb. in Switzerland, north-east Italy, Roumania and Southern Russia ; elsewhere the departures from normal were small.

Owing to the influence of the northern anticyclone temperature and precipitation were below normal over northern and western Europe and central Siberia, the deficit of temperature reaching — 15° F. at Yeniseisk and — 8° F. at Vitegra. At Yakutsk near the "cold pole" the mean temperature of — 38° F. was however 2° F. above normal, and in southern Russia and south-west Siberia temperatures were mostly well above normal. Temperatures were below 0° F. over most of Siberia north of 60° N. and between 100° and 120° E. they extended as far south as 45° N. In the British Isles the mean temperatures of 37°–43° F. were about 2° F. below normal ; rainfall was deficient except on the east coast. In North America temperatures were above normal in the west and north-east but below normal in the interior of Canada. Temperatures below 0° F. were recorded north of about 55° N. except in the west. Heavy rains (48 inches or more) fell in Oregon, British Columbia and the east coast of Newfoundland and Nova Scotia ; elsewhere amounts differed little from normal.

No broadcast data were received for India, Australia or New Zealand.

The main feature of the weather of December was the occurrence of two cold spells, one in the early part of the month, and the other about the 18th–20th. In the first there were heavy falls of snow over most of the country, causing serious dislocation of road traffic and disorganising the telephone services in Scotland and the southern counties. Later glazed roads added to the transport difficulties. The last ten days were milder with considerable fog. Sunshine was well below average except in Scotland and locally in south-west England and Ireland. In south Scotland, however, sunshine aggregates were 50 per cent. above average. Rainfall was below normal in Scotland, Ireland and the western districts of England and Wales, but on parts of the east coast exceeded 150 per cent. of the monthly normal. A complex system of disturbances passed slowly eastwards across the country during the earlier part of the month maintaining unsettled weather with gales locally. The 1st was generally mild with maximum temperatures between 50° and

60°F. and minima of 51° F. at Guernsey and 49° F. at Brighton; fog was widespread and rainfall heavy in the south. Temperatures gradually decreased until the 4th over the whole country and heavy rainfalls were recorded on the 2nd, 2·11 in. at Ferriby Sluice, Lincoln and 1·90 in. in east Yorkshire. There was little sunshine except in west Scotland and Ireland where Abbotsinch had 6·2 hrs. on the 3rd and Eskdalemuir 5·2 hrs. Snow fell generally on the 4th and the wind reached gale force in the south-west. Fog developed in many parts of Scotland and the north, and there the snow continued until the 6th. Sharp ground frosts on the 7th caused icebound roads; low temperatures were general, Dalwhinnie recording 8° F. in the screen and 3° F. on the ground, and Lympne 20° F. in the screen and 16° F. on the ground. In the south-west there was much sun, but thunderstorms developed over the Isle of Wight and 4·14 in. of snow and sleet was measured at Newport. Thunderstorms were also reported from Scotland. Snow fell heavily in the south on the 8th and on most days in Scotland and the north until the 11th; the snow causing a serious railway accident near Falkirk on the 10th. Temperatures were low again on the 10th with 12° F. registered at Rhayader. A deep depression moving south-east brought gales at Fort Augustus and in the English Channel, and fog was general. Some sunshine was experienced on the 12th in the north and Midlands, but snow persisted in the east. Temperatures rose in England on the 13th and 14th but fell in Scotland, Dalwhinnie registering a minimum of 0° F.; southern Scotland was swept by a blizzard, drifts of 10 ft. being general. Fog was widespread on the 13th and 14th and rain fell in the south 1·64 in. being recorded at St. Austell, Cornwall. An anticyclone moving south from Iceland on the 16th brought colder weather and sunshine, over six hours being experienced in many parts of the country on the 17th. Fog developed again on the 18th, and occurred daily until the 28th. Temperatures were low and severe frosts were experienced on the 18th–20th; the snow which fell on the 19th froze, giving glazed frosts in the southern districts. A depression moved north-eastwards from Ireland on the 20th and heavy rain fell in the south-west, while north-west Ireland had gales on the 20th and 22nd. Temperature rose about 20° F. generally from the 20th to 24th, when high maxima were recorded, e.g. 57° F. at Sealand and 56° F. at Nairn and Birr Castle. Temperature remained high, and fog developed on the 25th, being particularly dense in the London area, see p. 282. On the 26th an anticyclone extended from south England to the Baltic, and temperatures fell in England on the 27th but remained high in Scotland, the minimum at Fort Augustus being 48° F. The decrease of temperature extended over the whole country by the 29th when a minimum of 24° F. was recorded at Ayr, and on the 30th 27° F. was recorded at Fort Augustus. There was little sun in England during the later part of the month, but west Ireland had 6 hrs. on the 29th, and southern Scotland 5 hrs. on the 31st. Snow fell in southern England on the 30th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ..	37	+15	Chester ..	25	−16
Aberdeen ..	29	+ 8	Ross-on-Wye	48	0
Dublin	34	−12	Falmouth ..	60	+ 7
Birr Castle ..	37	− 6	Gorleston ..	31	−10
Valentia ..	45	+ 6	Kew.. ..	25	−12

Kew, Temperature, Mean, 38·8, Diff. from average − 2·6.

Miscellaneous notes on weather abroad culled from various sources.

Fog was reported off the north-west German coast on the 1st causing damage to shipping. A storm along the coast of France from the Spanish frontier to the mouth of the Gironde on the 2nd and 3rd caused interruption of navigation. There was heavy snow in Sweden between the 1st and 3rd when 30 in. fell in Stockholm. Snow was reported from Spain on the 14th. Heavy rains persisted throughout Andalusia on the 15th. In consequence of continued heavy rain extensive flooding occurred in Rome in the middle of the month, the Tiber reaching a height of 55·5 ft. on the 17th only 2 in. short of its 1900 record ; the Littorio airport was flooded. Floods were also reported from Naples on the 15th. During a snowstorm on the 22nd 24 lives were lost in a shipwreck in the Bosphorus. Severe frosts were registered in Switzerland on the 28th, Pontresina recording − 14° F. Snowstorms disorganised traffic in Rumania on the 30th and two people were frozen to death. Ice on the rails caused the derailment of a train in the Haute Loire on the 31st and two people were killed. Navigation closed on the 31st in the Vasa district of the Gulf of Bothnia. (*The Times,* December 3rd, 1937–January 3rd, 1938.)

Eight native mineworkers were killed in a Rand mine when lightning struck a wire on the headshaft and detonated charges 4,000 ft. below ground. Heavy rains throughout the Cape Province on the 16th and 17th broke the drought which was becoming disastrous. Nine natives were killed by lightning on the 25th near Johannesburg. (*The Times*, December 13th–28th.)

The total rainfall for the month was generally deficient over Australia except in South Australia, Tasmania and parts of Victoria and New South Wales. The Australian steamer *Saros* was wrecked on Cape Everard, Victoria, in a fog on the 25th. (Cable and *The Times*, December 28th.)

Two days continuous rain caused the washing away of a railway conduit near St. John's, Newfoundland on the 6th—two men were killed. New York State experienced one of the worst blizzards in its history on the 8th–10th, snowdrifts were 15 ft. high, and nine people died as a result of the storm. A cold wave swept over the south-eastern States at the same time and citrus crops were seriously damaged. The Pacific coast experienced a series of storms and a 70 m.p.h. gale on the 10th made air travel impossible. Navigation closed at Quebec on the 11th. Snow fell heavily in Canada during the first two weeks of the month, Ontario reporting as much as during the whole of last winter. Sleet and drizzle which fell in New York on the 31st turned to ice on the roads, disorganising traffic and causing the death of two people. (*The Times*, December 9th, 1937–January 3rd, 1938.)

Heavy gales on the Atlantic on the 25th caused damage to the liner *Shipper*. Gales and snow were reported in the western Atlantic on the 28th. (*The Times*, December 29th–30th.)

Daily Readings at Kew Observatory, December, 1937

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	1003·9	SSW.3	48	52	85	0·39	0·9	r 5h.–9h. & 15h.–24h.
2	986·4	NE.2	44	46	90	0·84	0·0	r_0–r 0h.–19h.
3	996·4	NNW.4	42	45	83	0·01	0·0	r_0 9h.–10h. pr_0 18h.
4	1007·6	SSW.3	36	40	77	0·20	0·0	rs 14h.–16h. r 24h.
5	994·0	WNW.4	34	43	66	0·07	1·4	r–r_0 0h.–6h.
6	994·4	SSW.2	28	36	85	—	2·1	f till 15h. F 21h.
7	996·3	NE.2	31	37	85	—	0·0	f till 15h.
8	1001·6	NNE.4	35	39	88	0·08	0·0	d_0–r_0 15h.–24h.
9	1000·9	NNW.4	34	38	89	0·16	0·0	r_0 0h.–7h. rs 8h.–9h.
10	1008·9	SSW.3	32	37	87	0·38	0·4	r_0–r 18h.–24h.
11	990·4	SSW.2	37	44	93	0·03	1·2	r_0 9h.–11h.
12	1002·9	W.4	36	39	62	trace	5·9	pr_0 5h.
13	984·1	S.4	32	44	91	0·97	0·0	r_0–r 7h.–24h.
14	983·0	SSE.2	33	39	90	trace	3·2	r_0 to 1h. x 7h. F 21h.
15	997·9	NW.3	32	39	82	trace	0·1	r_0 10h.–13h. x 21h.
16	1009·2	NNW.4	30	40	84	0·01	0·1	s 6h. r_0 11h. and 14h.
17	1019·9	NNW.3	36	41	79	—	0·1	r_0 17h.–18h.
18	1020·1	W.2	29	37	77	—	4·4	x early and late.
19	1016·6	NE.2	27	36	93	0·16	0·0	rs–s 3h–11h. F to 24h.
20	1018·5	SE.2	25	35	97	—	1·1	Fx till 13h.
21	1011·0	SE.2	33	41	92	trace	0·0	id_0 14h. and 18h.–22h.
22	1017·0	SSW.4	41	50	92	—	0·0	d_0 21h.
23	1024·7	W.3	49	52	81	0·03	2·7	d_0 5h.–7h. f 19h.
24	1028·9	SSW.4	38	52	90	trace	0·6	r_0 22h.–23h.
25	1037·1	S.2	47	48	99	trace	0·7	Fe most of day.
26	1039·2	E.2	37	45	97	0·02	0·0	Fe–Fd_0 till 15h.
27	1039·4	NE.3	33	39	76	—	0·0	id_0 13h.–17h. f 15h.
28	1033·7	NW.2	35	43	87	0·01	0·0	
29	1031·3	NE.4	40	42	84	0·02	0·0	id_0 all day.
30	1032·3	NE.3	36	40	77	trace	0·0	r_0 9h.–10h.
31	1029·2	N.3	34	42	88	0·02	0·0	ir_0 14h.–20h.
*	1011·5	—	36	42	85	3·44	0·8	* Means or totals.

General Rainfall, 1937

	Dec.	Year	
England and Wales	108	111	per cent of the average 1881–1915.
Scotland	76	92	
Ireland	71	104	
British Isles ...	93	105	

Rainfall: December, 1937: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square.........	3·92	164	*Leics* .	Thornton Reservoir ...	2·45	91
Sur .	Reigate, Wray Pk. Rd..	4·22	133	,, .	Belvoir Castle...........	1·96	80
Kent .	Tenterden, Ashenden...	3·95	127	*Rut* .	Ridlington	2·42	96
,, .	Folkestone, Boro. San.	7·45	...	*Lincs* .	Boston, Skirbeck.........	2·50	116
,, .	Margate, Cliftonville....	4·64	203	,, .	Cranwell Aerodrome...	1·66	75
,, .	Eden'bdg., Falconhurst	3·77	114	,, .	Skegness, Marine Gdns.	2·87	130
Sus .	Compton, Compton Ho.	4·78	114	,, .	Louth, Westgate.........	3·69	132
,, .	Patching Farm..........	3·85	115	,, .	Brigg, Wrawby St.......	4·13	...
,, .	Eastbourne, Wil. Sq....	4·95	142	*Notts* .	Mansfield, Carr Bank...	3·29	113
Hants.	Ventnor, Roy.Nat.Hos.	6·32	192	*Derby*.	Derby, The Arboretum	2·18	80
,, .	Fordingbridge, Oaklnds	3·86	97	,, .	Buxton, Terrace Slopes	4·64	82
,, .	Ovington Rectory.......	4·99	126	*Ches* .	Bidston Obsy.............	2·89	109
,, .	Sherborne St. John......	3·06	93	*Lancs*.	Manchester, Whit. Pk.	2·33	72
Herts .	Royston, Therfield Rec.	3·08	133	,, .	Stonyhurst College......	1·89	39
Bucks.	Slough, Upton...........	3·40	135	,, .	Southport, Bedford Pk.	2·02	63
Oxf .	Oxford, Radcliffe.........	1·90	77	,, .	Ulverston, Poaka Beck	...	...
N'hant	Wellingboro, Swanspool	2·21	94	,, .	Lancaster, Greg Obsy.	2·39	55
,, .	Oundle	2·25	...	,, .	Blackpool	2·43	74
Beds .	Woburn, Exptl. Farm...	2·44	104	*Yorks*.	Wath-upon-Dearne......	3·60	152
Cam .	Cambridge, Bot. Gdns.	2·20	114	,, .	Wakefield, Clarence Pk.	2·02	83
,, .	March......................	3·46	164	,, .	Oughtershaw Hall.......	3·66	...
Essex.	Chelmsford, County Gdns	3·68	166	,, .	Wetherby, Ribston H..	2·25	92
,, .	Lexden Hill House......	3·72	...	,, .	Hull, Pearson Park......	4·78	198
Suff .	Haughley House.........	2·27	...	,, .	Holme-on-Spalding......	3·41	139
,, .	Rendlesham Hall........	3·37	143	,, .	West Witton, Ivy Ho.	3·89	107
,, .	Lowestoft Sec. School...	4·01	172	,, .	Felixkirk, Mt. St. John.	5·06	210
,, .	Bury St. Ed., WestleyH.	3·14	130	,, .	York, Museum Gdns....	2·42	108
Norf. .	Wells, Holkham Hall...	2·53	123	,, .	Pickering, Hungate......	4·69	186
Wilts .	Porton, W.D. Exp'l. Stn	3·52	112	,, .	Scarborough..............	4·83	203
,, .	Bishops Cannings........	2·54	77	,, .	Middlesbrough...........	3·71	191
Dor .	Weymouth, Westham.	3·81	109	,, .	Baldersdale, Hury Res.	2·98	80
,, .	Beaminster, East St....	5·29	111	*Durh* .	Ushaw College...........	6·64	265
,, .	Shaftesbury, Abbey Ho.	4·22	117	*Nor* .	Newcastle, Leazes Pk...	6·25	266
Devon.	Plymouth, The Hoe....	5·24	105	,, .	Bellingham, Highgreen	5·34	147
,, .	Holne, Church Pk. Cott.	7·42	88	,, .	Lilburn Tower Gdns....	5·16	196
,, .	Teignmouth, Den Gdns.	3·85	91	*Cumb*.	Carlisle, Scaleby Hall...	1·93	60
,, .	Cullompton	3·40	78	,, .	Borrowdale, Seathwaite	8·15	53
,, .	Sidmouth, U.D.C.........	3·21	...	,, .	Thirlmere, Dale Head H.	7·23	68
,, .	Barnstaple, N. Dev.Ath	3·92	88	,, .	Keswick, High Hill......	2·88	43
,, .	Dartm'r, Cranmere Pool	7·20	...	*West* .	Appleby, Castle Bank...	2·10	53
,, .	Okehampton, Uplands.	3·74	53	*Mon* .	Abergavenny, Larchf'd	3·26	73
Corn .	Redruth, Trewirgie......	4·58	73	*Glam* .	Ystalyfera, Wern Ho....	5·23	63
,, .	Penzance, Morrab Gdns.	5·85	103	,, .	Treherbert, Tynywaun.	7·06	...
,, .	St. Austell, Trevarna...	6·59	108	,, .	Cardiff, Penylan.........	2·24	45
Soms .	Chewton Mendip.........	2·90	54	*Carm* .	Carmarthen, M. & P. Sch.	5·52	93
,, .	Long Ashton...........	2·10	54	*Pemb* .	Pembroke, Stackpole Ct.	4·77	98
,, .	Street, Millfield..........	2·37	72	*Card* .	Aberystwyth	2·97	...
Glos .	Blockley	2·50	...	*Rad* .	BirmW.W.Tyrmynydd	5·40	66
,, .	Cirencester, Gwynfa....	2·24	67	*Mont* .	Newtown, Penarth Weir	...	...
Here .	Ross-on-Wye............	2·15	72	,,	Lake Vyrnwy	4.80	70
Salop.	Church Stretton.........	3·42	102	*Flint* .	Sealand Aerodrome......	2·61	...
,, .	Shifnal, Hatton Grange	2·79	109	*Mer* .	Blaenau Festiniog	6·52	57
,, .	Cheswardine Hall........	4·12	146	,, .	Dolgelley, Bontddu......	3·73	54
Worc .	Malvern, Free Library...	2·29	83	*Carn* .	Llandudno	1·89	65
,, .	Ombersley, Holt Lock.	1·78	68	,, .	Snowdon, L. Llydaw 9..	14·60	...
War .	Alcester, Ragley Hall...	2·09	85	*Ang* .	Holyhead, Salt Island...	4·01	96
,, .	Birmingbm, Edgbaston	2·54	94	,, .	Lligwy	3·63	...

Rainfall: December, 1937: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
I. Man	Douglas, Boro' Cem....	4·48	91	*R&C* .	Achnashellach	...	...
Guern.	St.Peter P't.Grange Rd.	6·45	158	,, .	Stornoway,C.GuardStn.	2·40	40
Wig .	Pt. William, Monreith.	5·36	118	*Suth* .	Lairg....................	1·94	48
,, .	New Luce School.........	4·09	74	,, .	Skerray Borgie...........	2·63	...
Kirk .	Dalry, Glendarroch......	3·55	50	,, .	Melvich..................	...	...
Dumf.	Dumfries,Crichton R.I.	2·55	63	,, .	Loch More, Achfary....	2·76	30
,, .	Eskdalemuir Obs........	4·79	68	*Caith* .	Wick......................	2·20	71
Roxb .	Hawick, Wolfelee........	4·12	99	*Ork* .	Deerness	2·22	53
Peeb .	Stobo Castle.............	3·10	82	*Shet* .	Lerwick	3·76	84
Berw .	Marchmont House......	5·95	212	*Cork* .	Cork, University Coll...	2·47	48
E.Lot .	North Berwick Res.....	4·20	195	,, .	Roches Point, C.G. Stn.	2·43	46
Midl .	Edinburgh, Blackfd. H.	2·34	100	,, .	Mallow, Longueville....	2·95	60
Lan .	Auchtyfardle	2·06	...	*Kerry*.	Valentia Observatory...	5·05	76
Ayr .	Kilmarnock, Kay Park	2·67	...	,, .	Gearhameen..............	7·10	57
,, .	Girvan, Pinmore.........	3·35	56	,, .	Bally McElligott Rec...	3·05	...
,, .	Glen Afton, Ayr San....	3·19	50	,, .	Darrynane Abbey.......	3·97	67
Renf .	Glasgow, Queen's Park	2·36	56	*Wat* .	Waterford, Gortmore...	2·51	55
,, .	Greenock, Prospect H..	4·15	53	*Tip* .	Nenagh, Castle Lough.	2·80	61
Bute .	Rothesay, Ardencraig...	3·33	61	,, .	Cashel, Ballinamona....	2·15	50
,, .	Dougarie Lodge..........	2·96	54	*Lim* .	Foynes, Coolnanes......	...	...
Arg .	Loch Sunart, G'dale....	1·40	16	*Clare* .	Inagh, Mount Callan....	4·54	...
,, .	Ardgour House..........	4·83	...	*Wexf* .	Gorey, Courtown Ho...	2·81	74
,, .	Glen Etive...............		...	*Wick* .	Rathnew, Clonmannon.	2·77	...
,, .	Oban......................	2·20	...	*Carl* .	Bagnalstown,Fenagh H.	2·15	57
,, .	Poltalloch................	1·88	29	,, .	Hacketstown Rectory...	2·82	69
,, .	Inveraray Castle.........	5·36	54	*Leix* .	Blandsfort House.......	2·12	58
,, .	Islay, Eallabus............	3·26	55	*Offaly*.	Birr Castle...............	1·94	59
,, .	Mull, Benmore...........	6·40	38	*Kild* .	Straffan House...........	1·77	58
,, .	Tiree	2·61	50	*Dublin*	Dublin, Phoenix Park..	1·74	69
Kinr .	Loch Leven Sluice.......	3·12	79	,, .	Balbriggan, Ardgillan...	...	...
Fife .	Leuchars Aerodrome...	3·19	129	*Meath*.	Kells, Headfort..........	2·14	56
Perth .	Loch Dhu.................	4·60	46	*W.M* .	Moate, Coolatore.........	2·21	...
,, .	Crieff, Strathearn Hyd.	2·65	59	,, .	Mullingar, Belvedere...	2·06	56
,, .	Blair Castle Gardens....	1·66	43	*Long* .	Castle Forbes Gdns......	...	...
Angus.	Kettins School...........	2·50	76	*Gal* .	Galway, Grammar Sch.	2·89	63
,, .	Pearsie House...........	·74	...	,, .	Ballynahinch Castle....	5·00	67
,, .	Montrose, Sunnyside...	4·12	148	,, .	Ahascragh, Clonbrock.	2·50	53
Aber .	Balmoral Castle Gdns..	3·64	108	*Rosc* .	Strokestown, C'node.....	2·27	61
,, .	Logie Coldstone Sch....	4·70	167	*Mayo*.	Blacksod Point..........	6·43	105
,, .	Aberdeen Observatory.	4·31	134	,, .	Mallaranny	5·87	...
,, .	New Deer School House	3·85	113	,, .	Westport House.........	4·62	80
Moray	Gordon Castle...........	2·81	104	,, .	Delphi Lodge............	10·49	86
,, .	Grantown-on-Spey	3·40	125	*Sligo* .	Markree Castle..........	3·91	82
Nairn.	Nairn	1·56	70	*Cavan*.	Crossdoney, Kevit Cas..	2·60	...
Inv's .	Ben Alder Lodge.........	2·79	...	*Ferm* .	Crom Castle..............	2·71	65
,, .	Kingussie, The Birches.	1·31	...	*Arm* .	Armagh Obsy............	2·24	72
,, .	Loch Ness, Foyers	...	...	*Down*.	Fofanny Reservoir......	8·64	...
,, .	Inverness, Culduthel R.	·97	36	,, .	Seaforde	5·33	129
,, .	Loch Quoich, Loan......	1·87	...	,, .	Donaghadee, C. G. Stn.	4·52	142
,, .	Glenquoich...............	4·07	28	*Antr* .	Belfast,Queen's Univ....	4·20	114
,, .	Arisaig House...........	1·87	26	,, .	Aldergrove Aerodrome.	...	...
,, .	Glenleven, Corrour......	2·70	29	,, .	Ballymena, Harryville.	4·45	100
,, .	Fort William, Glasdrum	3·54	...	*Lon* .	Garvagh, Moneydig....	3·51	...
,, .	Skye, Dunvegan.........	4·75	...	,, .	Londonderry, Creggan.	3·15	72
,, .	Barra, Skallary..........	3·47	...	*Tyr* .	Omagh, Edenfel.........	2·82	67
R&C.	Tain, Ardlarach.........	1·01	32	*Don* .	Malin Head..............	2.54	...
,,	Ullapool	1·37	22	,,	Dunkineely...............	3·15	...

Climatological Table for the British Empire, July, 1937

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1016·2	+ 0·4	82	52	70·7	56·8	63·7	+ 0·9	56·8	80	7·7	0·95	− 1·22	10	4·4	27
Gibraltar	1015·6	− 1·2	88	63	77·2	66·8	72·0	− 2·8	65·9	84	3·3	0·00	...	0	...	...
Malta	1014·6	− 0·1	95	67	82·7	70·5	76·6	− 1·7	70·0	69	0·7	0·00	− 0·05	0	12·7	89
St. Helena	1016·9	− 0·5	65	53	61·0	55·3	58·1	+ 0·3	55·9	94	9·6	4·95	+ 0·88	23	...	...
Freetown, Sierra Leone	1013·6	+ 2·6	86	69	81·6	72·5	77·1	...	74·8	87	8·2	45·38	+ 9·80	28	...	...
Lagos, Nigeria	1014·9	+ 0·9	85	70	81·7	74·9	78·3	+ 0·3	74·5	89	9·0	18·07	+ 7·57	19	2·8	23
Kaduna, Nigeria	1012·6	...	88	66	83·5	69·6	76·5	+ 2·9	71·3	90	8·5	10·26	− 0·36	19	5·4	43
Zomba, Nyasaland	1017·1	− 1·5	79	47	70·3	52·4	61·3	− 0·7	56·8	72	5·6	0·30	− 0·05	3	...	...
Salisbury, Rhodesia	1021·9	− 0·5	77	38	68·4	42·0	55·2	− 0·9	46·9	54	2·2	0·00	...	...	9·0	80
Cape Town	1021·9	+ 0·6	73	41	62·7	46·8	54·7	0·0	48·3	86	6·0	5·92	+ 2·30	13	...	...
Johannesburg	1024·4	− 0·5	67	23	58·7	36·3	47·5	− 2·9	37·7	57	0·8	0·06	− 0·27	1	9·3	87
Mauritius	1018·4	− 2·1	79	53	75·4	62·1	68·7	+ 0·4	66·0	78	4·9	2·94	+ 0·66	20	7·1	65
Calcutta, Alipore Obsy.	997·9	− 1·3	93	78	88·9	80·2	84·5	+ 0·8	80·3	89	8·9	10·92	− 1·78	17*	...	...
Bombay	1002·7	− 1·2	87	73	84·5	76·2	80·3	− 1·1	77·4	90	9·4	30·42	+ 6·15	30*	...	...
Madras	1003·6	− 0·9	100	73	94·7	78·2	86·5	− 1·1	75·4	69	8·9	3·70	− 0·14	11*	...	...
Colombo, Ceylon	1009·1	0·0	86	73	84·7	76·9	80·8	− 0·4	77·1	80	7·4	3·98	− 0·45	14	6·1	49
Singapore	1009·0	+ 0·1	88	73	85·9	78·2	82·1	+ 0·8	77·3	80	6·9	2·87	− 3·92	13	7·2	59
Hongkong	1003·8	− 0·9	91	75	88·0	78·8	83·4	+ 0·9	79·4	82	6·7	19·31	+ 4·89	21	7·7	58
Sandakan	1008·1	...	91	72	89·1	74·9	82·0	+ 0·2	76·9	84	7·7	10·84	+ 4·12	15	...	...
Sydney, N.S.W.	1023·5	+ 5·2	73	41	62·4	45·0	53·7	+ 1·0	47·0	72	4·0	3·29	− 1·51	11	6·4	63
Melbourne	1023·4	+ 4·5	62	32	56·9	40·4	48·7	0·0	42·9	77	6·6	1·21	− 0·65	10	3·8	37
Adelaide	1025·4	+ 5·2	65	38	59·5	43·5	51·5	− 0·4	46·2	77	7·0	1·90	− 0·74	14	4·7	47
Perth, W. Australia	1025·2	+ 6·2	73	37	64·2	46·0	55·1	− 0·1	48·4	68	4·0	2·53	− 4·03	11	7·0	69
Coolgardie	1025·4	+ 5·5	69	30	62·5	39·1	50·8	− 0·4	44·8	69	2·3	0·09	− 0·78	2	...	...
Brisbane	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hobart, Tasmania	1018·0	+ 4·3	62	33	53·7	41·5	47·6	+ 1·9	41·7	72	5·0	1·09	− 1·09	12	4·2	45
Wellington, N.Z.	1017·3	+ 3·4	59	33	50·5	40·6	45·5	− 2·5	43·7	84	7·0	3·93	− 1·70	16	4·1	43
Suva, Fiji	1014·7	+ 0·7	84	65	78·5	69·7	74·1	+ 0·7	69·8	85	7·7	4·76	− 0·17	27	2·8	25
Apia, Samoa	1011·2	− 0·7	88	71	85·2	74·1	79·7	+ 2·5	75·3	76	4·3	2·02	− 0·96	10	8·4	74
Kingston, Jamaica	1014·3	− 0·4	94	72	90·1	74·3	82·2	+ 0·5	72·5	76	3·6	0·22	− 1·40	4	8·2	63
Grenada, W.I.	1012·0	− 1·3	89	71	86	72	79·0	− 0·2	73	74	6	5·71	− 3·72	20	...	...
Toronto	1014·0	− 0·4	95	47	80·6	62·2	71·4	+ 2·3	63·2	77	3·8	2·92	+ 0·08	8	8·9	59
Winnipeg	1012·9	+ 0·6	92	45	80·9	58·3	69·6	+ 3·2	58·5	86	4·9	2·83	− 0·27	9	8·2	52
St. John, N.B.	1013·8	+ 0·2	87	51	73·0	55·0	64·0	+ 3·6	59·6	82	6·3	0·76	− 2·87	11	9·1	60
Victoria, B.C.	1018·2	+ 0·9	73	50	67·9	52·3	60·1	0·0	55·6	74	4·0	0·01	− 0·41	1	11·7	75

* For Indian stations [illegible]

(40259) Wt. 20/31 1125 1/38 Hw. G. 377/6

Climatological Table for the British Empire, July, 1937

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1016·2	+ 0·4	82	52	70·7	56·8	63·7	+ 0·9	56·8	80	7·7	0·95	− 1·22	10	4·4	27
Gibraltar	1015·6	− 1·2	88	63	77·2	66·8	72·0	− 2·8	65·9	84	3·3	0·00	...	0	...	...
Malta	1014·6	− 0·1	95	67	82·7	70·5	76·6	− 1·7	70·0	69	0·7	0·00	− 0·05	0	12·7	89
St. Helena	1016·9	− 0·5	65	53	61·0	55·3	58·1	+ 0·3	55·9	94	9·6	4·95	+ 0·88	23	...	...
Freetown, Sierra Leone	1013·6	+ 2·6	86	69	81·6	72·5	77·1	...	74·8	87	8·2	45·38	+ 9·80	28	...	...
Lagos, Nigeria	1014·9	+ 0·9	85	70	81·7	74·9	78·3	+ 0·3	74·5	89	9·0	18·07	+ 7·57	19	2·8	23
Kaduna, Nigeria	1012·6	...	88	66	83·5	69·6	76·5	+ 2·9	71·3	90	8·5	10·26	− 0·36	19	5·4	43
Zomba, Nyasaland	1017·1	− 1·5	79	47	70·3	52·4	61·3	− 0·7	56·8	72	5·6	0·30	− 0·05	3	...	...
Salisbury, Rhodesia	1021·9	− 0·5	77	38	68·4	42·0	55·2	− 0·9	46·9	54	2·2	0·00	...	...	9·0	80
Cape Town	1021·9	+ 0·6	73	41	62·7	46·8	54·7	0·0	48·3	86	6·0	5·92	+ 2·30	13	...	...
Johannesburg	1024·4	− 0·5	67	23	58·7	36·3	47·5	− 2·9	37·7	57	0·8	0·06	− 0·27	1	9·3	87
Mauritius	1018·4	− 2·1	79	53	75·4	62·1	68·7	+ 0·4	66·0	78	4·9	2·94	+ 0·66	20	7·1	65
Calcutta, Alipore Obsy.	997·9	− 1·3	93	78	88·9	80·2	84·5	+ 0·8	80·3	89	8·9	10·92	− 1·78	17*	...	...
Bombay	1002·7	− 1·2	87	73	84·5	76·2	80·3	− 1·1	77·4	90	9·4	30·42	+ 6·15	30*	...	...
Madras	1003·6	− 0·9	100	73	94·7	78·2	86·5	− 1·1	75·4	69	8·9	3·70	− 0·14	11*	...	...
Colombo, Ceylon	1009·1	0·0	86	73	84·7	76·9	80·8	− 0·4	77·1	80	7·4	3·98	− 0·45	14	6·1	49
Singapore	1009·0	+ 0·1	88	73	85·9	78·2	82·1	+ 0·8	77·3	80	6·9	2·87	− 3·92	13	7·2	59
Hongkong	1003·8	− 0·9	91	75	88·0	78·8	83·4	+ 0·9	79·4	82	6·7	19·31	+ 4·89	21	7·7	58
Sandakan	1008·1	...	91	72	89·1	74·9	82·0	+ 0·2	76·9	84	7·7	10·84	+ 4·12	15	...	...
Sydney, N.S.W.	1023·5	+ 5·2	73	41	62·4	45·0	53·7	+ 1·0	47·0	72	4·0	3·29	− 1·51	11	6·4	63
Melbourne	1023·4	+ 4·5	62	32	56·9	40·4	48·7	0·0	42·9	77	6·6	1·21	− 0·65	10	3·8	37
Adelaide	1025·4	+ 5·2	65	38	59·5	43·5	51·5	− 0·4	46·2	77	7·0	1·90	− 0·74	14	4·7	47
Perth, W. Australia	1025·2	+ 6·2	73	37	64·2	46·0	55·1	− 0·1	48·4	68	4·0	2·53	− 4·03	11	7·0	69
Coolgardie	1025·4	+ 5·5	69	30	62·5	39·1	50·8	− 0·4	44·8	69	2·3	0·09	− 0·78	2	...	...
Brisbane	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hobart, Tasmania	1018·0	+ 4·3	62	33	53·7	41·5	47·6	+ 1·9	41·7	72	5·0	1·09	− 1·09	12	4·2	45
Wellington, N.Z.	1017·3	+ 3·4	59	33	50·5	40·6	45·5	− 2·5	43·7	84	7·0	3·93	− 1·70	16	4·1	43
Suva, Fiji	1014·7	+ 0·7	84	65	78·5	69·7	74·1	+ 0·7	69·8	85	7·7	4·76	− 0·17	27	2·8	25
Apia, Samoa	1011·2	− 0·7	88	71	85·2	74·1	79·7	+ 2·5	75·3	76	4·3	2·02	− 0·96	10	8·4	74
Kingston, Jamaica	1014·3	− 0·4	94	72	90·1	74·3	82·2	+ 0·5	72·5	76	3·6	0·22	− 1·40	4	8·2	63
Grenada, W.I.	1012·0	− 1·3	89	71	86	72	79·0	− 0·2	73	74	6	5·71	− 3·72	20	...	...
Toronto	1014·0	− 0·4	95	47	80·6	62·2	71·4	+ 2·3	63·2	77	3·8	2·92	+ 0·08	8	8·9	59
Winnipeg	1012·9	+ 0·6	92	45	80·9	58·3	69·6	+ 3·2	58·5	86	4·9	2·83	− 0·27	9	8·2	52
St. John, N.B.	1013·8	+ 0·2	87	51	73·0	55·0	64·0	+ 3·6	59·6	82	6·3	0·76	− 2·87	11	9·1	60
Victoria, B.C.	1018·2	+ 0·9	73	50	67·9	52·3	60·1	0·0	55·6	74	4·0	0·01	− 0·41	1	11·7	75

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

(40259) Wt. 20/31 1125 1/38 Hw. G. 377/6