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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.

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* 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.

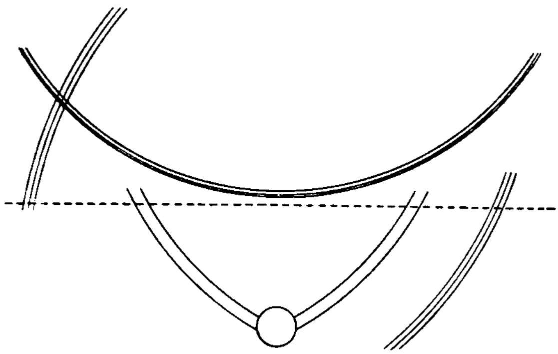
Correspondence

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 —0·5° 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 —23·5° 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 $1\frac{1}{4}$ inches and weighed $\frac{1}{4}$ 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.–
3	1000·3	ESE.2	41	59	66	0·01	5·9	r 0h. [24h.
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.–
18	1009·9	W.2	43	51	72	0·02	0·6	r_0 0h.–4h., 21h. [24h.
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.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	2·64	171	*War* .	Birminghm, Edgbaston	2·86	164
Sur .	Reigate, Wray Pk. Rd..	3·46	207	*Leics* .	Thornton Reservoir ...	2·72	160
Kent .	Tenterden, Ashenden...	2·50	154	,, .	Belvoir Castle	2·79	182
,, .	Folkestone, Boro. San.	2·62	...	*Rut* .	Ridlington	3·25	207
,, .	Margate, Cliftonville....	1·93	143	*Lincs* .	Boston, Skirbeck	2·50	185
,, .	Eden'bdg., Falconhurst	2·72	146	,, .	Cranwell Aerodrome...	2·70	204
Sus .	Compton, Compton Ho.	3·63	182	,, .	Skegness, Marine Gdns.	2·81	210
,, .	Patching Farm	2·38	135	,, .	Louth, Westgate	2·80	168
,, .	Eastbourne, Wil. Sq....	3·05	167	,, .	Brigg, Wrawby St	3·39	...
Hants .	Ventnor, Roy.Nat.Hos.	2·13	127	*Notts* .	Worksop, Hodsock	2·51	171
,, .	Fordingbridge, Oaklnds	2·17	119	*Derby* .	Derby, L. M. & S. Rly.	2·13	131
,, .	Ovington Rectory	2·47	131	,, .	Buxton, Terrace Slopes	4·66	159
,, .	Sherborne St. John	2·29	129	*Ches* .	Bidston Obsy	2·82	173
Herts .	Royston, Therfield Rec.	2·91	185	*Lancs* .	Manchester, Whit. Pk.	2·64	138
Bucks .	Slough, Upton	2·23	156	,, .	Stonyhurst College	2·78	103
,, .	H. Wycombe, Flackwell	2·59	159	,, .	Southport, Bedford Pk.	2·78	150
Oxf .	Oxford, Radcliffe	2·63	165	,, .	Ulverston, Poaka Beck	3·43	114
N'hant	Wellingboro, Swanspool	3·02	203	,, .	Lancaster, Greg Obsy.	3·26	145
,, .	Oundle	1·94	...	,, .	Blackpool	3·07	164
Beds .	Woburn, Exptl. Farm...	2·54	169	*Yorks* .	Wath-upon-Dearne	2·65	167
Cam .	Cambridge, Bot. Gdns.	2·52	185	,, .	Wakefield, Clarence Pk.	2·74	163
,, .	March	3·13	237	,, .	Oughtershaw Hall	4·20	...
Essex .	Chelmsford, County Gdns	2·77	216	,, .	Wetherby, Ribston H..	...	...
,, .	Lexden Hill House	2·89	...	,, .	Hull, Pearson Park	3·63	233
Suff .	Haughley House	2·28	...	,, .	Holme-on-Spalding	4·38	264
,, .	Rendlesham Hall	2·72	191	,, .	West Witton, Ivy Ho.	3·17	148
,, .	Lowestoft Sec. School...	1·71	116	,, .	Felixkirk, Mt. St. John.	2·56	153
,, .	Bury St. Ed., Westley H.	3·33	217	,, .	York, Museum Gdns....	3·48	217
Norf. .	Wells, Holkham Hall...	2·27	177	,, .	Pickering, Hungate	2·52	151
Wilts .	Porton, W.D. Exp'l. Stn	2·02	121	,, .	Scarborough	3·26	209
,, .	Bishops Cannings	4·16	206	,, .	Middlesbrough	2·15	157
Dor .	Weymouth, Westham.	2·13	128	,, .	Baldersdale, Hury Res.	2·75	114
,, .	Beaminster, East St....	2·46	104	*Durh* .	Ushaw College	2·71	143
,, .	Shaftesbury, Abbey Ho.	1·67	78	*Nor* .	Newcastle, Leazes Pk...	2·68	168
Devon .	Plymouth, The Hoe....	3·39	149	,, .	Bellingham, Highgreen	2·00	93
,, .	Holne, Church Pk. Cott.	5·87	162	,, .	Lilburn Tower Gdns....	1·55	78
,, .	Teignmouth, Den Gdns.	2·67	133	*Cumb* .	Carlisle, Scaleby Hall...	2·70	138
,, .	Cullompton	3·43	151	,, .	Borrowdale, Seathwaite	7·75	112
,, .	Sidmouth, U.D.C	2·63	...	,, .	Thirlmere, Dale Head H.	5·13	108
,, .	Barnstaple, N. Dev.Ath	2·64	124	,, .	Keswick, High Hill	2·12	69
,, .	Dartm'r, Cranmere Pool	7·00	...	*West* .	Appleby, Castle Bank...	1·79	92
,, .	Okehampton, Uplands.	5·25	165	*Mon* .	Abergavenny, Larchf'd	2·61	103
Corn .	Redruth, Trewirgie	3·94	137	*Glam* .	Ystalyfera, Wern Ho....	4·18	110
,, .	Penzance, Morrab Gdns.	3·17	130	,, .	Treherbert, Tynywaun.	6·26	...
,, .	St. Austell, Trevarna...	4·57	162	,, .	Cardiff, Penylan	3·84	153
Soms .	Chewton Mendip	3·72	125	*Carm* .	Carmarthen, M. & P. Sch.	3·11	109
,, .	Long Ashton	2·62	120	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	1·90	97
,, .	Street, Millfield	1·99	...	*Card* .	Aberystwyth	2·70	...
Glos .	Blockley	3·64	...	*Rad* .	BirmW.W.Tyrmynydd	5·14	139
,, .	Cirencester, Gwynfa....	2·98	159	*Mont* .	Lake Vyrnwy	4·25	141
Here .	Ross-on-Wye	1·87	98	*Flint* .	Sealand Aerodrome	3·17	...
Salop .	Church Stretton	2·09	97	*Mer* .	Blaenau Festiniog	8·43	151
,, .	Shifnal, Hatton Grange	2·29	136	,, .	Dolgelley, Bontddu	5·28	145
,, .	Cheswardine Hall	2·64	151	*Carn* .	Llandudno	2·56	151
Worc .	Malvern, Free Library..	2·31	128	,, .	Snowdon, L. Llydaw 9..	14·70	...
,, .	Ombersley, Holt Lock.	1·78	117	*Ang* .	Holyhead, Salt Island...	1·93	93
War .	Alcester, Ragley Hall...	2·72	161	,, .	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,FenaghH.	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.	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