M.O. 371.

The Meteorological Magazine

Air Ministry: Meteorological Office

Vol. 69

July 1934

No. 822

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

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The Drought of 1933–4

In various parts of Europe and North America a period of deficient rainfall began late in 1932 or early in 1933 and has continued with little intermission through the remainder of 1933 and the early months of 1934, resulting in a serious shortage of water in many districts. In England and Wales the drought may be said to have made its first appearance in November, 1932, and it seemed best to begin this investigation with that month. The progress of the drought is shown graphically in fig. 1, which represents the cumulative excesses or deficiencies of rainfall in each month since November 1st, 1932, as percentages of the normal annual total. The zero of each curve is the line drawn through the left hand extremity. A rising curve in any month shows that the rainfall in that month was above normal, a falling curve shows that it was below normal. An accumulated excess of rain is indicated by a position of the curve above the zero line, an accumulated deficiency by a position of the curve below the zero line. Each pair of horizontal lines is separated by a distance equal to 10 per cent of the annual normal; thus the topmost curve for England and Wales shows that the accumulated deficiency had reached 10 per cent by the end of January, 1933. The heavy rains of February and March eased the situation, and the deficiency did not again reach 10 per cent until August. In December it amounted to 20 per cent, and in February, 1934, it reached 30 per cent, since then it has fluctuated about the latter figure. The figure at the right hand end of each curve shows the accumulated deficiency at the end of May, 1934.

Since in Europe there is no reason to suppose that over a long period of years there is a net accumulation or loss of water, we may suppose that under normal conditions the incomings in the form of rainfall balance the outgoings in the form of evaporation from the ground, water surfaces or vegetation, run-off in rivers, and loss of water in various ways through human action. The balance is maintained by means of a reserve of water in the soil and underlying rocks, which supplies springs and wells through a dry period. In long periods of heavy rainfall this reserve grows, though it is unfortunately true that the water from isolated heavy storms is liable to run quickly to the sea so that a large part of it is lost. In times of drought the reserve decreases, for not only is the rainfall less, but generally speaking a smaller proportion of the amount which actually reaches the ground percolates through the soil. Thus the curves of the figure may be regarded as analogous to a balance sheet between income and expenditure; a rising curve shows that the water wealth of the country has increased, a falling curve shows that it has diminished.

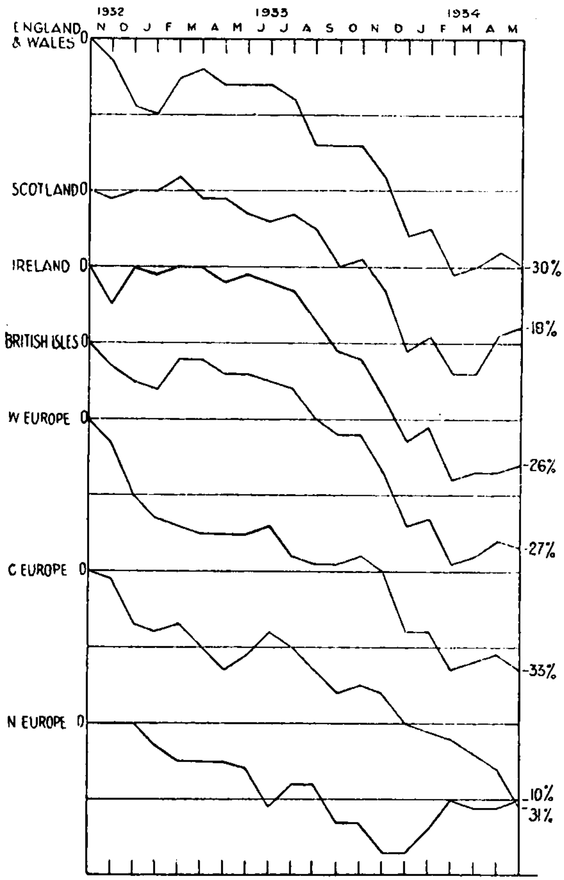

FIG. 1

The figures have been expressed in percentages of the annual rainfall rather than in actual amounts in inches because percentages give a better picture of the situation than do actual amounts. A deficiency of 4 in. in a district with an average annual rainfall of 20 in. is fully as serious as a deficiency of 8 in. in a rainfall of 40 in. The former region is on the threshold of drought even in years when the rainfall is almost up to normal, while the rainier region has a much greater margin of safety.

The percentage deficiencies can be readily converted into inches of rain by means of the following table, which shows the average annual rainfall of each of the regions for which curves are given in the figure :—

	in.		in.
England and Wales ...	35	Europe—	
Scotland	50	west	33
Ireland	43	central	33
British Isles	41	north	30

For the British Isles the accumulated deficiency by the end of May, 1934, was 27 per cent. This does not sound very alarming, but even if the weather turns wet in July, several months of abnormally heavy rain will be required to restore the balance. In the past sixty years the rainiest period of six successive months has been May to October, 1903, when the total exceeded the normal for those months by 9·1 in. or 22 per cent of the annual normal. It is true that autumn and early winter usually include the months of heaviest rainfall and least evaporation, when the reserves of water in the soil are replenished after the losses of summer even in a moderately dry season, but this year the accumulated deficiency is so great that even if the next six months are as wet as the wettest period of six months in the past sixty years, it seems doubtful if they will succeed in entirely making good our depleted reserves.

This is especially true of England and Wales, where in spite of the marked break in the drought during February and March, 1933, the accumulated deficiency at the end of May, 1934, was as much as 30 per cent. The heavy rainfall of February and March, 1933, was very fortunate for England for as a result the dry summer which followed passed without serious difficulties. In Scotland and Ireland the drought did not begin until April or May, 1933, and in these countries, especially Scotland, the accumulated deficiency is less than in England ; moreover, in these relatively rainier countries the margin of safety is much greater than in England, and little has been heard of the shortage of water there.

The drought has been most severe in the Thames valley, and at Richmond the accumulated deficiency at the end of May, 1934, was as much as 48 per cent of the annual total. This abnormally dry region includes those parts of England which normally have the least rainfall of the British Isles, and the rural parts of Essex with no elaborate organisation for water supply have suffered severely.

In western and central Europe the progress of the drought has been very similar to the British Isles, but owing largely to the absence of a wet period in the spring of 1933 the deficiency became noticeable early, especially in western Europe. In central Europe it was to some extent relieved by good summer rains, but thereafter it grew rapidly and by the end of May, 1934, amounted to a third of the normal annual rainfall. At this time the rivers, especially the Rhine, had fallen to a very low level. In northern Europe the deficiency never reached 20 per cent and at the end of May, 1934, amounted to only 10 per cent, while in southern and eastern Europe (which are not shown in fig. 1) the total rainfall from November, 1932, to May, 1934, was about normal. Eastern Europe in fact, had a slight excess, but here the normal rainfall is small, and in spite of a rainy summer in 1933, the persistent failure of the winter rains in 1933–4 is already causing difficulties.

Detailed figures for each month are not readily available for the United States, but it is clear that the drought has been even more severe than in western Europe. This is clearly shown by the map, fig. 2, which shows the rainfall of the 17 months, January, 1933, to

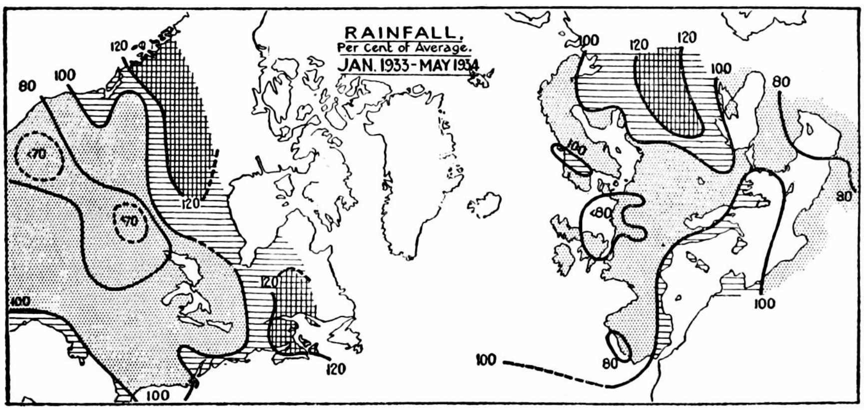

FIG. 2

May, 1934, as a percentage of the normal for those months. Areas with a rainfall below normal are stippled, while those with an excess are shaded. Areas for which no observations are yet available are left blank. The stippled areas, which are those with deficient rainfall, are seen to include the greater part of western and central Europe and practically the whole of the United States. The deficiency can only be regarded as serious however in the regions enclosed within the lines of 80 per cent; these include most of England and the neighbouring part of north-west Europe, a small part of Portugal, and a very large area in the central and western United States. In two regions, including the states of Nevada in the Far West and North and South Dakota in the Middle West, the amount is actually below 70 per cent, and as these states have a small average rainfall (Nevada 8·9 in., North Dakota 17·4 in., South Dakota 20·3 in.) the effect is far more disastrous than in Europe. In the western United States the total rainfall of January to May, 1933, was about normal, and the drought did not begin until June. By the end of February, 1934, the accumulated deficiency in the Dakotas was 30 per cent, and by April this had risen to more than 40 per cent.

The month of May was exceedingly dry, with only 14 per cent of normal in North Dakota and 20 per cent in South Dakota, and the accumulated deficiency rose to 48 per cent, or nearly half the rainfall of a normal year. The ground became so dry that the wind swept up great clouds of dust, which spread eastwards over the greater part of the country and reached New York as the phenomenal " black blizzard " of May 11th. In the British Isles the effects of the drought have been to some extent mitigated by the full reserves available from the rainfall of preceding years, which had been up to normal, but in the western and northern parts of the United States the preceding five years had been generally dry and the country had not recovered from the severe drought of 1930.

Finally, it may be of interest to compare the drought of 1933–4 with the well known droughts of 1887 and 1921. In the British Isles the driest period set in about the beginning of July, 1933, and was to some extent broken by the rains of March and April, 1934, so that we may regard its duration (leaving on one side the question of what may happen in the future) as the eight months July, 1933, to February, 1934. These eight months may be compared with the similar periods of February to September, 1921, and February to September, 1887, with the following results :—

	Percentage of normal.		
	1933–4	1921	1887
England and Wales	66	60	68
Scotland	73	87	78
Ireland	64	81	67
British Isles	67	74	71

Thus it appears that in England and Wales the drought of July, 1933, to February, 1934, was more severe than that of 1887, but less so than that of 1921. This bare comparison does not fully represent the situation however, for in 1933–4 the drought included the rainy months of winter, whereas the other two droughts merely accentuated the usual relative dryness of spring and summer. Moreover the drought of 1931 followed on a long period which had been wetter than usual, while the winter of 1932–3, as we may have seen, was on the whole rather dry. Taking into account these two considerations we may regard the drought from July, 1933 to February, 1934, as of about the same severity as the eight months drought of 1921 in England. In Scotland, Ireland and the British Isles as a whole, the eight months of drought of 1933–4 was undoubtedly the most severe in the past 60 years.

Water Supply from Roofs

In view of the attention which has been given recently to the question of utilising roofs as collectors of rainfall for the purpose of domestic water supply, the following calculations may be of interest. Their object is to ascertain the most favourable relationship between "effective" roof area and storage capacity, the average daily consumption and the average rainfall of the place being given.

The term "effective roof area" is used to represent the horizontal area on the ground to which the roof is equivalent as a collector of rainfall. The relation between the effective roof area and the actual roof area depends upon such factors as the material of which the roof is made, its pitch, its height above ground, etc. In the absence of published data on the subject, it would be necessary to ascertain the effective area by comparing the run-off from the roof with the readings of a rain-gauge over a period of months. For the purpose of the present calculation, it is necessary to assume that the ratio of run-off to rainfall is constant. This assumption is probably correct for practical purposes in the case of a roof covered with impervious material, but may not be quite correct in the case of a roof covered with porous tiles, which probably absorb and subsequently evaporate a larger percentage of summer rains than of winter rains. The conclusions arrived at are therefore to be regarded as provisional and subject to correction in the light of actual run-off data.

The problem to be discussed is "what must be the effective roof area and what must be the capacity of the storage tank if a roof-supply is to provide for a stated average daily consumption, even during the worst periods of drought?"

Consider first the simple case in which the roof area is so related to the mean annual rainfall that the yield is just sufficient to meet normal requirements. To fix ideas let us take 1,000 sq. ft. as the roof area and 24 in. as the mean annual rainfall. An inch of rain on a square foot is equivalent to half a gallon of water very nearly. Consequently the annual yield would be 12,000 gallons or about 33 gallons per day, which might prove adequate for a small family. 24 in. happens to be the mean annual rainfall at Huntingdon. From data published in the "Book of Normals, Section V," we obtain the figures in the second column of Table I, showing how the yield of 12,000 gallons is distributed through a normal year at that particular place. The difference between yield and consumption (taken as 1,000 gallons per calendar month) is shown in the third column. The last column shows the aggregate difference between yield and consumption, reckoned from the beginning of the year to the end of each calendar month. It will be seen that the stock available on January 1st would be depleted to the extent of 920 gallons by the end of May, this deficiency being gradually reduced to zero by the end of the year. In this particular example, therefore, we see that a storage capacity of the order of 1,000 gallons is required merely to meet the fluctuations occasioned by the normal seasonal variation of rainfall.

Coming now to drought conditions, we find on examining published statistics that during a dry sequence of years, the aggregate rainfall in 10 years may be of the order of 10 per cent below the long period average. In other words, starting from a fixed epoch, we must face the possibility of coping with an aggregate deficiency amounting to a year's rainfall or more. In the example chosen, therefore, storage of at least 12,000 gallons would be necessary to meet such an emergency.

TABLE I

Month.	*Yield of Roof.*	*Difference (Yield-Consumption).*	*Progressive Total.*
	gallons	gallons	gallons
January	820	− 180	− 180
February	690	− 310	− 490
March	840	− 160	− 650
April	770	− 230	− 880
May	960	− 40	− 920
June	1,090	+ 90	− 830
July	1,280	+ 280	− 550
August	1,210	+ 210	− 340
September	910	− 90	− 430
October	1,340	+ 340	− 90
November	1,040	+ 40	− 50
December	1,050	+ 50	0
	12,000		

It is clear that a more reasonable figure for the storage could be arrived at by reducing the consumption or by increasing the roof area. For a quantitative treatment of the problem we need to know the maximum deficiency of rainfall in the worst droughts of specified duration, and this information is provided by a formula due to J. Glasspoole*, viz. :—

$$R_D = 8{\cdot}33\,M - 11\sqrt{M}$$

where R_D is the rainfall, expressed as a percentage of the annual normal, in the driest recorded period of M months. This formula applies with fair accuracy to any place in the British Isles, for values of M greater than 2.

To simplify calculations it is better to express R_D as a percentage of the average monthly rainfall, when the formula becomes

$$R_D = 100\,M - 132\sqrt{M} \qquad \text{.......................... (1)}$$

We assume that this formula tells us the minimum run-off from the

* "The Reliability of Rainfall over the British Isles." *London, Trans. Inst. Water Engin.* **35,** 1930, p. 174.

roof, expressed as a percentage of the long-period average monthly run-off.

Let us suppose that the monthly consumption is constant and equal to A per cent. of the average monthly run-off. The consumption in M months, expressed in the units adopted in (1) is therefore AM and the deficiency D after M months of worst shortage is given by

$$D = AM - R_D$$

$$\text{or } D = (A - 100)\, M + 132\sqrt{M} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

D being also expressed as a percentage of the average monthly run-off. By differentiating D with respect to M and equating the result to 0 we obtain the value of M for which the deficiency is a maximum. The differentiation gives

$$A - 100 + \frac{66}{\sqrt{M}} = 0$$

$$\text{whence } \sqrt{M} = \frac{66}{100 - A}$$

and the value of the maximum deficiency is obtained by substituting this value of M in (2). Putting $A = 90$, we obtain $\sqrt{M} = 6{\cdot}6$, $M = 43{\cdot}6$ and $D = 435$. That is to say, if the average consumption is equal to 90 per cent of the average run-off, the maximum depletion of reserve stocks will occur after 43·6 months of drought and will be equivalent to 435 per cent of the average monthly run-off measured over a long period. This depletion is equivalent to $\frac{435}{90}$ or 4·8 months' consumption. Similarly we find that by making $A = 80$ the maximum depletion comes to the equivalent of 2·7 months' consumption, while $A = 70$ gives a maximum deficiency equivalent to 2·1 months' consumption. These figures, combined with a knowledge of the rainfall of the district, make it possible to calculate the size of the storage reservoir to be provided if the effective roof area and the average daily consumption are known. Alternatively, they provide the means of calculating the roof area required when a decision has been made as to the maximum amount of storage that can be economically provided. It has to be remembered that the calculations only give the maximum depletion to be expected during the most intense conditions of drought and it cannot safely be assumed that the storage tank would be full at the beginning of the period of maximum rainfall deficiency. With this consideration in mind it would appear unwise to provide less than 3 months' storage, in a case where the roof area is such that the run-off exceeds normal consumption by 25 per cent.

If R is the mean annual rainfall in inches and B the effective roof area in square feet, the annual run-off is $\frac{R.B}{12}$ cubic feet or $\frac{R.B \times 6{\cdot}25}{12}$ gallons. The average daily yield, is, therefore,

$\frac{R.B \times 6{\cdot}25}{12 \times 365}$ gallons. If W is the mean daily consumption in gallons, and storage equivalent to 3 months' consumption can be provided, the above considerations suggest that W should not exceed 80 per cent of the average daily yield. This gives

$$W = \frac{80}{100} \times \frac{R.B. \times 6{\cdot}25}{12 \times 365}$$

which reduces to $W = {\cdot}00114\ R.B.$ .... (3)

$$\text{or } B = 876\ \frac{W}{R} \qquad \text{..(4)}$$

From (4) it is found that a daily consumption of 40 gallons would require a roof area of 1,400 sq. ft. in a region with an annual rainfall of 25 in. The capacity of the storage reservoir would need to be 91 × 40 or 3,640 gallons, or, say, 4,000 gallons to be on the safe side. The figures both for roof area and storage capacity are rather high, which suggests that it may not often be practicable to use a roof as the sole source of domestic water supply in the drier regions of the British Isles. The owner of such an installation would have the satisfaction of knowing, however, that his supply was capable of withstanding the worst recorded droughts, and also that every rain which wetted his roof would replenish his reserves—a comfort denied to the user of a failing well during a summer drought. This consideration should, at least, stimulate residents in drought-stricken areas to make adequate provision for storing the run-off from existing roofs. In round figures, 50 gallons will result from an inch of rain per 100 sq. ft. of roof area and storage on this scale must be provided if the run-off from that relatively small amount of rain is not to be wasted.

E. G. Bilham.

Abercromby in Modern Dress*

Abercromby's " Weather " written nearly fifty years ago was called " a popular exposition of the nature of weather changes from day to day." It was a skin full of good wine. There are not many wine skins 50 years old which will stand filling with new wine. The experiment in this case has been successful, owing largely to the skill of the new author, who has given us a book containing an excellent, and eminently readable, description of the present-day knowledge of weather. Although, in accordance with modern sentiment, the words " popular exposition " have been omitted from the title, I think they do, nevertheless, correctly describe the work.

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* *Weather. The nature of weather changes from day to day.* By Ralph Abercromby. New edition, revised and largely rewritten by A. H. R. Goldie, M.A., F.R.S.E. Size 8½ × 5½ in. pp. xii + 274. *Illus.* London, Kegan Paul, Trench, Trubner & Co., Ltd., 1934, 10s. 6d.

Of the original work two chapters, number II on Synoptic Charts and number XIII on Types and Spells of Weather, have been reproduced with little change. The other fourteen chapters and the introduction are either wholly or substantially new. The book is a little shorter than the original, but not so much shorter as the number of pages would suggest (472 pages in the old and 274 pages in the new), because the size of the pages in the new book is larger than in the old. The old book was divided into two sections, Elementary and Advanced. In the new book that division has been abandoned.

The two chapters mentioned (II and XIII) are the longest in the book, and between them make up about a quarter of it. The other chapters, which are relatively short, deal concisely with cloud—the structure of cyclones—autographic records—wind—temperature—diurnal, local, seasonal, and secular, variation of weather—the general circulation of the atmosphere—line squalls and thunderstorms—tornadoes and revolving storms; and then there are three new chapters on the upper air—visibility and fog—and practical applications. There are also about seventy illustrations. While the two chapters on synoptic charts and on types and spells of weather are historically of great interest, I do not think they are as good as the other parts of the book. Not infrequently the statements in them contain enough truth not to be entirely wrong, but they do not convey a right impression of present-day knowledge. I may illustrate by one or two examples.

> On p. 17 we find it stated that "if you give a meteorologist a chart of the world with the isobars only marked on it . . . . he could write down very nearly the kind of weather which would be experienced everywhere." It is certain that he could not: he would be profoundly wrong if he tried to do it. And yet there is an element of truth in the idea.
>
> On p. 20: "The character of the weather and the direction of the wind depend entirely on the shape of the isobars." Replace "entirely" by "largely" and the statement is broadly true, but as it stands it is contrary to daily experience.
>
> On p. 24: "Suppose the cyclone stood still for a week, then the observer would see a watery sky for a week without any rain falling." Again this is not correct. If a cyclone is stationary there are still changes of weather at an individual place, because the air moving in a system plays its part and the weather does not depend only on the motion of the system itself.

I think, for the benefit of those—and I hope they will be many—who imbibe their knowledge of the weather from this book, it would be well, either by footnotes or by a cautionary preliminary note to Chapter II, to indicate where statements in the chapter should be taken *cum grano salis*, or in conjunction with modifying information elsewhere. When I was reading Chapter II, I thought it was a fine effort on the part of the author to add the dotted line in the diagram of the weather of a cyclone (Fig. 3). Additions to an old picture usually detract from its value, but this addition does the contrary and definitely improves the picture.

The chapter on the upper air is excellent. It gives a good general account of the fascinating results of modern investigations by balloons, by the spectroscope and by "sound-ranging." The chapter on clouds, too, is a great improvement on the old work, and the inclusion of the well-reproduced plates of cloud types adds pleasure to the profit. I miss "altocumulus castellatus," a type with some, as yet unexplained, prognostic significance, when a period of fine weather is going to break up in thunderstorms. Clouds really need a book to themselves—they cannot be adequately treated in a book on weather in general. Chapter V, on the structure of cyclones, is regarded as supplementary to Chapter II. It describes well the general principles of the modern development based on the idea of fronts or surfaces of separation between air of different qualities. This chapter should prove most useful in enabling the general reader to understand synoptic charts and to prepare for the day when general inferences will normally include a description of fronts and air-masses and their probable development. In the chapter on spells and types of weather, the reproduction of a chart of weather in the northern hemisphere for July 12th, 1933, illustrates very vividly the advances which have been made since the other charts in the chapter (which were taken from the original work) were drawn.

The question to which the reader of a review naturally wants an answer is this : Is the book worth buying for anyone ? Is it worth buying for me ? Well this book is worth buying if you know some physics and a little meteorology, or much meteorology and a little physics, or if you are a beginner keen on knowing something about present-day meteorology. If you are already an expert, it will interest you to see your subject described clearly and in some places provokingly : e.g. "the data required for the construction of synoptic charts are the readings of any instrument," or again, "when the veil of cirro-status reaches the horizon in one direction but leaves a segment of sky clear in the other direction it may be regarded as indicating the northern edge of a disturbance."

There is a slip and an elided comma on page 2 ; the elided comma makes it appear that the unit of pressure is the dyne instead of the dyne per cm^2. The slip makes it appear that the pressure due to the weight of a gramme per unit area is one unit of pressure whereas it is really about 981 units of pressure. In this connexion, a useful approximate relationship to remember is that the pressure of the atmosphere—about 1000 mb.—is also, approximately, the same as the pressure of a layer of water 10 metres thick or, more vividly, about the same as the pressure on one's back (area 500 cm.^{2}) in a motor car accelerating in one second of time from rest to a speed of 200 m.p.h.

E. GOLD.

Official Publication

The following publication has recently been issued :—

PROFESSIONAL NOTES.

No. 65. *The winds of Berbera : discussion of observations made under the supervision of R. S. Taylor, M.B., Ch.B., Principal Medical Officer.* By C. E. P. Brooks, D.Sc., and C. S. Durst, B.A. (M.O. 336*e*.)

Berbera lies on the southern shore of the deep narrow trough occupied by the Gulf of Aden ; it experiences a NE. monsoon from October to May and a SW. monsoon from June to September. The structure of these two wind currents is studied in detail, using the records of a pressure-tube anemograph from May, 1931 to April, 1933, and a series of pilot-balloon soundings made almost daily (sometimes both morning and evening) from April 24th, 1931 to the end of July, 1932. Typical anemograms are illustrated and discussed and the measurements of the whole series are expressed as monthly and hourly resultants, while the diurnal and seasonal variation of upper winds is represented by wind roses at various levels. Finally the structure of the monsoons, and of the diurnal variations superposed on them, is discussed in the light of the temperature variations over the Gulf of Aden and the adjacent land, and of the character of the gustiness shown by the anemograms.

Royal Meteorological Society

The last monthly meeting of the present session was held on Wednesday, June 20th, at 49, Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

At the beginning of the meeting Mr. H. W. L. Absalom gave an account of a small whirlwind which visited the village of Dunton, about 12 miles east of Ilford and a mile north-west of the Laindon Hills, on the evening of June 6th, damaging timber bungalows, fences and telegraph poles and uprooting trees.

Mr. S. K. Banerji then gave a brief account of recent meteorological work in India.

The following papers were read :—

Sir Napier Shaw, F.R.S.—The Natural History of Weather.

The paper describes an arrangement of the meteorological data for a station with special reference to the encouragement of the study of nature.

I. S. Astapowitsch.—Air waves caused by the fall of the meteorite on June 30th, 1908 in central Siberia.

The writer gives a short review of the investigation of the fall of the meteorite in central Siberia on June 30th, 1908, and gives the results of the barograph records obtained by him at the time of his research expeditions of 1930 and 1932. The time of fall of the meteorite and the force of the explosion were determined by examination of various independent sources. The air wave was recorded by microbarograms in Japan, China, India and perhaps America.

F. J. W. Whipple, Sc.D.—On phenomena related to the great Siberian meteor.

This paper is supplementary to one published by the author in 1930.* Additional evidence with regard to the illumination of the sky during the nights following the arrival of the meteor is summarised. In view of the fact that recorded observations of this phenomenon are confined to the north of Europe it is suggested that the meteor had a tail which was captured by the earth's atmosphere. The airwaves produced by the meteor were recorded at Batavia and at Washington as well as at several places in Europe.

S. E. Ashmore, B.Sc.—The splashing of rain.

The connexion between the rate of rainfall and the splashing produced by it from a horizontal surface has been studied experimentally for a large number of surfaces which may be used as the surroundings for rain-gauges. The splashing from ice and water has also been investigated. The results may be utilised :—

(1) In forming an estimate of the number of occasions on which the rainfall recorded by a standard gauge is too large on account of insplashing.

(2) In deciding on the best material on which to set up a rain-gauge or sink an evaporation tank. Suggestions are given on how to eliminate the effects of outsplashing from evaporimeters.

W. R. Baldwin-Wiseman, M.Sc.—The cartographic study of drought.

This paper presents a method of setting out rainfall statistics for drought periods. In order to illustrate this method the famous drought in Queensland during 1902 has been investigated. Maps are given defining the progress of this drought, the rainfall being expressed as deficiencies from the average for groups of consecutive months.

Correspondence

To the Editor, *Meteorological Magazine*

Whirlwind at Shooter's Hill.

I believe you like to hear of anything happening out of the ordinary with regard to the weather. On Sunday, June 17th, at 12.15 p.m.,

* *London, Q.J.R. Meteor. Soc.* 56, 1930, p. 287.

I was on my allotment which is situated within a half-mile of the top of Shooter's Hill on the north-east side.

I was talking to a friend when we were startled by the violent banging of a door. A man was standing outside his shed when the door crashed up against him, hitting him on the forehead and nearly putting him out. The cause of the disturbance was a whirlwind which had struck the door and when we looked it was picking up pieces of stick, leaves, etc., and hurling them in the air; the force of the wind I should say was operating at an angle of 45°.

My friend and I could see the whirlwind approaching us, he moved one way and I the other and it passed in between us; all the while throwing things in the air, it passed over a bed of iris and some of the flowers were thrown in the air about 20 ft. It also shifted two sheets of corrugated iron but did not lift them. It then picked up a sheet of brown paper and carried it up to a height of between 150 to 200 ft.

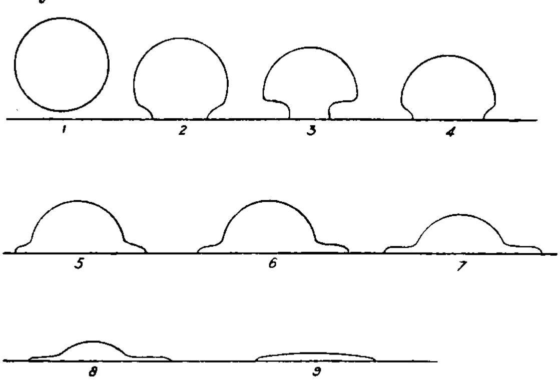
We watched its progress for about a quarter of a mile, when it passed over a school and we saw clouds of dust rise above the school.

S. THEOBALD.

9, Isla Road, Plumstead, S.E.18, June 21st, 1934.

An Unusual Sunset

The following observations of the sunset made on the evening of June 3rd, 1934, from The Great Orme, Llandudno, North Wales, may be of interest :—



The apparent shape of the Sun went through the changes shown in the sketches over a period of about 15 minutes before sunset. The visibility was such that the Irish Coast was very faintly visible.

I cannot recollect the exact details of the change from the "mushroom" shape of figs. 2–4, to the "Bowler Hat" shape of the later phases.

W. A. OWEN.

Research Department, Woolwich, S.E.18. June 8th, 1934.

A Phenomenon accompanying Lightning

Referring to the letter of Mr. J. E. Belasco in the *Meteorological Magazine* for May, I called attention to the "sound of lightning" in *Nature* a few years ago, and many others wrote to say they too had heard the sound. I heard of it first as a very small boy from a nurse who told me that if lightning came very close it made a swishing sound. In riper years I quite disbelieved this until three employees who were working in a field, one at one end, the others two hundred yards away, all described the phenomena as having occurred when a very vivid flash of lightning struck a farm about a quarter of a mile away. A letter to *Nature* describing the phenomenon elicited a number of letters from others who had heard the sound. The noise has been compared to a red-hot poker being plunged into water, the tearing of canvas, the sudden arc of an electric short circuit. It is only heard when lightning is very close and the sequence seems to be lightning, swish, thunder. But one observer who heard the sound a number of times during a thunderstorm in the Indian Ocean describes the swish as coming before the lightning. It has been suggested that perhaps the swish always occurs before the lightning but that the faint sound is heard more slowly than the bright light is seen. If this is really the case the swish may be caused by a brush discharge from points round the observer, similar in nature to the small spitting brush discharge that may be seen to occur on a Wimshurst machine immediately before a large spark. On the other hand, photographs of lightning show that a flash often ramifies near the ground into one large flash and it may be a great number of small ones. It seems to me that the swish may be caused by one or more quite small branches which have reached the earth at points nearer the observer than the main flash.

I have heard the sound myself, subsequently to the above-mentioned correspondence in *Nature*; the sequence in my mind was lightning, swish, thunder, but they all came so close together that a small fraction of a second must have separated the lightning from the thunder, and I suspect that the lightning conductor on my house was struck. The swishing noise was heard by at least two other people in the house and by two people in two cottages about fifty yards from the house.

C. J. P. CAVE.

Stoner Hill, Petersfield, Hants. May 22nd, 1934.

Thunderstorms of June 25th.

After a period of 20 months (October 21st, 1932, to June 24th, 1934) in which no day yielded as much as 0·75 in. of rain, this district caught the full force of one of the severe thunderstorms that were drifting in the stagnant region between shallow depressions over Cornwall and the Netherlands on June 25th last. Light showers from a canopy of low stratiform cloud before 11h. (G.M.T.) were followed by sunshine setting up strong convection until about 12¼h., when a large cumulonimbus cloud of particularly lurid aspect began to overspread the sky from south-west and south. The storm developed quickly as it approached, and at 12h. 44m. it broke overhead. From then until soon after 13h. rain was torrential and lightning almost incessant: several of the flashes (which were of a brilliant blue colour) came to earth in the immediate vicinity of the climatological station, while one, at 13h. 2m., accompanied by a shattering crash of thunder like the report of a large gun close at hand, definitely shook the ground for a fraction of a second. Two houses near-by were struck, and the local telephone service was put out of action.

Measurements made with the special " Storm " gauge, described and pictured in the August, 1932, issue of this magazine (Vol. 67, p. 160), gave the rainfall as 0·50 in. for the seven minutes 12h. 44m. to 12h. 51m., and 1·23 in. for the 22 minutes 12h. 44m. to 13h. 6m., when the downpour ceased quite suddenly. During the latter interval the standard gauge, 30 yards distant, also logged 1·23 in. There was no hail. The road running along the bottom of the valley was flooded—nine or ten inches deep in places—but only for a short time. So rapid was the infiltration of the water through the surface layers of the soil (sand and gravel over chalk), parched as they were by the long spell of droughty weather, that by 15h. there was no trace of " sponginess " about the lawn. At 9h. next morning the entry " dry ground " was unhesitatingly made in the register for the 47th day in succession.

During the storm the thermograph showed a precipitate fall of temperature: as nearly as can be judged from the chart, there was a decrease of 13°F., from 68°F. to 55°F., within five minutes.

E. L. HAWKE.

Caenwood, Rickmansworth, Herts. June 30th, 1934.

While observing the thunderstorm which developed here on the evening of the 25th, I noticed that there were two distinct layers of cloud. The upper layer was apparently moving from south-west and the lower, which appeared as an even sheet of dark cloud, came from the north-west, and apart from occasional breaks, soon covered the whole sky. The surface wind was NNE. but on the approach of the lower cloud, backed to WNW.

Thunder was first heard at 17h. 23m. G.M.T. but since no lightning was then visible, I assume that the discharge was between the two cloud sheets.

Finally both layers of cloud appeared to slowly move away to east-north-east, and on reaching the zenith, heavy rain fell which lasted 67 minutes. After the storm clouds had passed, the wind veered again in feeble gusts to north-east and a brilliant rainbow appeared in the south-east. The weather map for 18h. on the 25th, published in the *Daily Telegraph* on the 26th, shows a shallow depression over southern England, covering London; and another off the coast of Norfolk.

I do not know if the former depression had a well marked warm sector, but it seems probable that the lower cloud and surface wind originated to the north of the depression off Norfolk and were undercutting the warmer currents from the south-west in the depression over London, and the higher clouds were produced by this warm air being forced up over the northerly current from the North Sea.

The thunderstorm itself apparently developed at the warm front of the depression over London.

DONALD L. CHAMPION.

187, *High Street, Waltham Cross. June 28th*, 1934.

Thunderstorm of June 28th in the Isle of Wight

A severe thunderstorm passed over the centre and south-east of the Isle of Wight, last Thursday afternoon week, June 28th. My brother at Carisbrooke (I.W.), reports that two storms came up from the north-east and north-west simultaneously and broke over Newport, eventually passing south-east over Sandown, Shanklin and Ventnor. Flooding occurred over a wide area, and many houses were struck by lightning including my Father's at Shanklin. The storm lasted from about 3–4 p.m. (B.S.T.) and produced ½ in. of rain in 20 minutes at Newport, the rainfall for the day there being 0·63 in. and 0·36 in. at Shanklin 9 miles away to the south-east. Sandown had only 0·11 in., but Ventnor 0·31 in. The feature of the storm was the extraordinary hailstorm that accompanied it. My brother tells me that he was in his car during the storm and when every flash came, the engine cut out and the car stopped. The hail stones were as big as marbles and just as hard—for over an hour after the storm, they were still on the ground ! He ends up his letter to me by saying " To give you some idea of the force of the hail, I found a partridge sitting on her nest dead—the hail had killed her ! The Isle of Wight is usually free of such visitations. This storm is the third severe one we have had in Shanklin since last spring, which is most unusual ! May 29th and September 26th last year gave thunderstorms right over the town, but last Thursday week's (June 28th) beat the two previous storms for its severity !

J. E. COWPER.

22, *Broad Street, Birmingham. July 6th*, 1934.

NOTES AND QUERIES

New Ascents to the Stratosphere

According to the *National Geographic Magazine* for April, the National Geographic Society, Washington, D.C., is co-operating with the U.S. Army Air Corps and other donors in a new ascent to the stratosphere. The balloon will be manned by Major W. E. Kepner and Capt. A. W. Stevens, who hope to carry out a programme of scientific work including the collection of samples of the air in the stratosphere, determination of electric gradient, observations of cosmic rays and of ozone content and photography at great height. According to *The Times*, Dr. Max Cosyns, who accompanied Professor Picard on his second ascent to the stratosphere, has completed his preparations for a new ascent.

Review

High lapse-rates of temperature and their diurnal variation in the surface layers of the atmosphere over northern India. By Barkat Ali. Reprinted from Gerlands Beiträge zur Geophysik, Vol. 39, p. 121, 1933.

This paper discusses the results of nine sounding balloon ascents made on three days at Agra up to a height of about 400 metres. The temperature recording was made more than usually sensitive, so that fairly reliable records of temperature could be obtained for height intervals of 10 m., although unfortunately the probable instrumental errors were not precisely determined. The variation of temperature with height, which is shown in graphs and tables for the various ascents, does not contain any surprises ; possibly none could be expected without the use of much more delicate apparatus. From the results the co-efficient of eddy diffusion (k) is calculated for one of the days of ascent from Brunt's equation $\frac{d\theta}{dt} = k\frac{d^2\theta}{dh^2}$. It is found that k increases from the surface where it is of the order of 10^4 c.g.s. units, up to a maximum of $3 \cdot 6 \times 10^4$ at 50 m. for the ascent at 8h. 55m., and to a maximum of $10 \cdot 8 \times 10^4$ at 170 m. for the ascent at 12h. 5m., the temperature gradient in both cases being super-adiabatic in the lowest layers. The height at which k attains its greatest value would appear to the reviewer to indicate a maximum vertical extent of the convectional eddies of about 50m. in the early morning and 170 m. at midday.

A. F. CROSSLEY.

NEWS IN BRIEF

Mr. D. M. Little has been appointed Chief of the Aerological Division of the Central Office, Washington, D.C., in succession to Mr. W. R. Gregg now Chief of the Weather Bureau.

The Howard Prize of the Royal Meteorological Society has been awarded for 1934 to Cadet Eric Kingsley Ballard, of H.M.S. *Conway* for the best essay on " Cloud Forms ".

The Weather of June, 1934

Pressure was below normal over North America, except over the North-West Territory of Canada and western Mexico, over the North Atlantic, southern Europe and Russia, and above normal over the rest of Europe, north Africa, Iceland and Spitsbergen. The greatest excesses were 6·7 mb. at Barrow and 5·3 mb. at Isafjord and the greatest deficits 4·2 mb. at 40°N., 90°W. and 4·5 mb. at 40°N., 40°W. In Sweden temperature was generally about normal and the rainfall variable, being more than 200 per cent of the normal at Gotland, but below normal in the north.

The chief features of the weather of June over the British Isles were the general deficiency of rainfall, the warm spell from the 16th to 18th and the excess of sunshine in Ireland and north Scotland. On the 1st the high pressure to the west of the British Isles spread eastwards over the country and became more intense. Thunderstorms were experienced in south-east England on that day with heavy rain in the Channel Isles but generally the weather was fair to fine. Fine sunny weather continued in the north and west until the 7th but in the south and east conditions occasionally became cloudy with slight rain owing to shallow continental depressions. Sunshine records were good generally except in the south-east, over 15hrs. bright sunshine being recorded at several places in Scotland Ireland and north England on the 2nd–5th, with 16·0hrs. at Tiree on the 5th. On the 6th and 7th the continental depression spread across the southern British Isles giving cloudy to dull weather with local thunderstorms on the 7th and 8th and a little mist or fog. By the 9th, however, pressure was again high and from the 9th–13th fair or fine weather with local mist or fog was generally experienced, cool in the north but warm in the south. Sunshine records were especially good on the 10th–12th with 16·0hrs. at Tiree on the 11th and at Stornoway on the 12th. By the 14th, however, the north and west came under the influence of the large depression over the North Atlantic which was moving north-east and weather there became unsettled with rain, heavy at times, but bright intervals, while in the south conditions remained mainly fair or fine until the 19th. Several places in Dorset, Somerset, Worcester and Gloucester reported an absolute drought from the 1st to 17th and a few places in Wiltshire one from the 1st–20th. Temperature rose above 80°F. in parts of the south on the 16th–18th and 91°F. was reported at Greenwich on the 17th. From the 18th to 28th the depressions followed a more southerly course and the unsettled cooler weather spread from the north and west over the whole country. On the 22nd westerly winds reached gale force in parts of north England. Thunderstorms occurred in many parts of England on the 23rd, 25th and 28th and also in Scotland on the 27th and 28th, and heavy rain was experienced locally, among the heaviest falls being 1·45 in. at Borrowdale (Cumberland) on the 18th, 1·57 in. at Marchmont (Berwick) on the 21st, 1·25 in. at Falconhurst (Kent), 1·27 in. at Malmesbury (Wiltshire) on the 24th and 1·50 in. at Brushford (Somerset) on the 25th. Flooding occurred in a few places for a short time. During this period sunshine records were variable but Lerwick (Shetland Isles) had 17·3hrs. on the 23rd and 17·4hrs. on the 24th, and

Kirkwall (Orkneys) 16·5hrs. on the 24th. On the 28th an anti-cyclone over the Atlantic extended also over the British Isles giving mainly fair or fine conditions with a rise of temperature on the 30th, 80°F. being exceeded in parts of the south on that day. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	228	+60	Liverpool ...	214	+10
Aberdeen ...	204	+23	Ross-on-Wye ...	198	−12
Dublin	203	+17	Falmouth ...	240	+18
Birr Castle ...	183	+22	Gorleston ...	203	− 5
Valentia... ...	189	+13	Kew	205	+ 6

Miscellaneous notes on weather abroad culled from various sources.

Storms occurred in many parts of France on the 2nd and 3rd, a hailstorm near Tarbes devastating acres of crops and orchards. By the 5th, the drought was broken in Russia and heavy rain had been falling for 2 or 3 days. In western Germany, the heavy thunderstorms which interrupted the drought on the 3rd and flooded villages in the Mosel Valley, did little to improve the condition of the crops. Dry, hot weather was experienced in Germany about the 18th, the temperature rose to 92°F. at Würzburg on the 18th and forest fires occurred in the Heimburg district in the Harz Mountains. Much damage was done to crops by a hailstorm on the 19th in the Stedinger district near the mouth of the Weser (north-west Germany). The drought and heat in France proved detrimental to the crops (except the vines) over a large area. Torrential rain fell in Switzerland on the 28th–29th causing the rivers to rise rapidly.—(*The Times*, June 4th–30th).

Showers of rain occurred in Bombay city about the 8th after two days of great heat. In northern India exceptional heat was experienced during the first part of June after a comparatively cool May. Heavy rains in Assam had caused much damage by the 20th and heavy rains in the Himalayas caused disastrous floods in parts of Assam, east Bengal, Cooch Bihar and Bihar later in the month, many villages being submerged and the crops destroyed, 50 people were drowned in Nowgong (Assam).—(*The Times*, June 9th–28th).

A great sandstorm swept over the Khartoum district on the 7th and was followed by heavy rain.—(*The Times*, June 8th).

By the 3rd generous rains had broken the drought in the western and prairie districts of Canada ; these spread across the Dominion and by the 18th good rains had fallen nearly everywhere and the crops generally had benefited greatly. Serious forest fires occurred in the east up to about the 8th. The first rains to break the drought in the Middle States fell on the 3rd and 4th and heavy rain fell in Minnesota and the Dakotas on the 8th. The rainfall, however, continued below normal except locally and along the Atlantic coast. Temperature was generally above normal and a heat wave passed over the Upper Mississippi–Missouri Valley early in the month. A hurricane, accompanied by torrential rains which caused floods and many landslides occurred in San Salvador at the beginning of the month—more than 500 people were drowned. A hurricane coming in from the Gulf of Mexico on the 16th did damage to buildings and crops in Louisiana and Mississippi and caused the death of 7 people.—*The Times*, June 1st–23rd, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*

Daily Readings at Kew Observatory, June, 1934

* Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
	mb.		°F	°F	%	in.	hrs.	
1	1018·3	NNE.3	50	73	61	—	8·5	distant t 19h. 35m.
2	1021·0	NNE.4	52	76	43	—	13·5	
3	1024·3	NE.5	48	64	42	—	14·1	
4	1019·4	NE.3	47	60	74	—	1·4	
5	1016·5	N.3	50	61	49	—	5·7	
6	1014·0	N.4	48	56	61	0·02	3·2	$ir_0$10h.-12h.&16h.-20h.
7	1016·0	NW.1	48	62	41	trace	4·4	pr_0 13h. 45m.
8	1020·0	S.3	46	71	52	trace	7·1	w early. pr_0 17h. 40m.
9	1023·5	S.2	52	73	53	—	7·1	
10	1019·8	E.3	52	76	47	—	9·0	
11	1016·8	NE.3	54	75	45	—	8·5	
12	1020·1	ESE.2	49	70	50	—	8·8	
13	1016·7	WNW.1	46	76	47	—	9·8	[23h. 20m.
14	1019·4	WNW.2	55	74	56	trace	3·7	r_0 17h.50m., 19h.20m.,
15	1024·2	E.3	60	72	59	—	2·6	
16	1022·2	SE.2	55	81	48	—	8·9	
17	1019·4	SW.3	54	84	38	—	12·9	
18	1018·1	SW.4	62	84	45	—	12·7	
19	1006·5	SW.5	58	70	77	trace	1·9	r_0 10h.25m., 16h., 23h.
20	1010·1	NW.3	56	67	65	0·08	8·2	pr_2 11h.25m.–11h.40m.
21	1011·6	SW.3	50	65	76	0·18	0·1	rr_0 10h.–24h.
22	1009·7	W.5	57	69	39	—	13·0	
23	1016·6	E.4	55	69	51	0·09	4·9	tlr 23h.–24h.
24	1012·2	E.2	54	69	79	0·08	0·4	rr_0 0h.–3h., $pr_0$16h.
25	1011·5	E.3	58	74	67	0·15	3·6	f 7h., tlr 20h. 30m.
26	1018·0	SW.2	56	69	59	trace	1·4	f early ; pr_0 13h.
27	1016·7	SW.4	60	68	74	0.22	0·5	r 4h.–8h., 14h.–17h.
28	1014·7	SW.3	50	66	69	0·19	6·6	$tlrr_2$ 17h.–19h.
29	1023·8	N.3	51	67	57	—	7·8	
30	1024·5	NE.4	52	76	49	—	14·7	

* The dates of Sundays are in heavy type.

General Rainfall for June, 1934

England and Wales ...	71	per cent of the average 1881–1915.
Scotland	79	
Ireland	72	
British Isles	74	

Rainfall : June, 1934 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square	1·13	56	*Leics* .	Thornton Reservoir	·96	44
Sur .	Reigate, Wray Pk. Rd.	·82	39	,, .	Belvoir Castle	·72	38
Kent .	Tenterden, Ashenden	2·10	110	*Rut* .	Ridlington	·97	51
,, .	Folkestone, Boro. San.	·94	...	*Lincs* .	Boston, Skirbeck	·58	32
,, .	Eden'bdg., Falconhurst	2·11	96	,, .	Cranwell Aerodrome	·63	38
,, .	Sevenoaks, Speldhurst.	1·74	...	,, .	Skegness, Marine Gdns.	1·89	115
Sus .	Compton, Compton Ho.	1·92	77	,, .	Louth, Westgate	1·83	85
,, .	Patching Farm	1·47	73	,, .	Brigg, Wrawby St.	1·76	...
,, .	Eastbourne, Wil. Sq.	1·45	79	*Notts* .	Worksop, Hodsock	1·20	61
,, .	Heathfield, Barklye	1·48	70	*Derby* .	Derby, L. M. & S. Rly.	·48	21
Hants .	Ventnor, Roy.Nat.Hos.	1·25	68	,, .	Buxton, Terr. Slopes	1·68	52
,, .	Fordingbridge, Oaklnds	1·01	55	*Ches* .	Runcorn, Weston Pt.	2·11	82
,, .	Ovington Rectory	1·41	61	*Lancs* .	Manchester, Whit. Pk.	2·04	77
,, .	Sherborne St. John	1·52	71	,, .	Stonyhurst College	2·64	86
Herts .	Welwyn Garden City	1·92	92	,, .	Southport, Hesketh Pk.	1·96	90
Bucks .	Slough, Upton	1·12	54	,, .	Lancaster, Greg Obsy.	2·65	103
,, .	H. Wycombe, Flackwell	1·03	51	*Yorks* .	Wath-upon-Dearne	1·92	86
Oxf .	Oxford, Mag. College	1·48	69	,, .	Wakefield, Clarence Pk.	1·48	69
Nor .	Pitsford, Sedgebrook	...	...	,, .	Oughtershaw Hall	3·68	...
,, .	Oundle	1·06	...	,, .	Wetherby, Ribston H.	1·89	90
Beds .	Woburn, Exptl. Farm	1·28	65	,, .	Hull, Pearson Park	1·22	59
Cam .	Cambridge, Bot. Gdns.	...	...	,, .	Holme-on-Spalding	1·40	64
Essex .	Chelmsford, County Lab	1·35	71	,, .	West Witton, Ivy Ho.	1·54	75
,, .	Lexden Hill House	1·03	...	,, .	Felixkirk, Mt. St. John.	1·49	68
Suff .	Haughley House	1·18	...	,, .	York, Museum Gdns.	2·11	102
,, .	Campsea Ashe	·88	46	,, .	Pickering, Hungate	1·25	59
,, .	Lowestoft Sec. School	1·56	86	,, .	Scarborough	1·18	64
,, .	Bury St. Ed., WestleyH.	1·60	76	,, .	Middlesbrough	2·34	124
Norf. .	Wells, Holkham Hall	·84	43	,, .	Baldersdale, Hury Res.	2·18	92
Wilts .	Calne, Castleway	1·14	50	*Durh* .	Ushaw College	2·38	110
,, .	Porton, W.D. Exp'l. Stn	1·28	66	*Nor* .	Newcastle, Town Moor.	2·00	92
Dor .	Evershot, Melbury Ho.	1·47	64	,, .	Bellingham, Highgreen	2·46	107
,, .	Weymouth, Westham.	1·16	65	,, .	Lilburn Tower Gdns.	2·56	124
,, .	Shaftesbury, Abbey Ho.	·89	38	*Cumb* .	Carlisle, Scaleby Hall	3·67	146
Devon .	Plymouth, The Hoe	1·67	77	,, .	Borrowdale, Seathwaite	6·00	98
,, .	Holne, Church Pk. Cott.	2·48	86	,, .	Borrowdale, Moraine	5·76	118
,, .	Teignmouth, Den Gdns.	1·26	64	,, .	Keswick, High Hill	2·55	87
,, .	Cullompton	1·90	90	*West* .	Appleby, Castle Bank	1·77	77
,, .	Sidmouth, U.D.C.	1·36	...	*Mon* .	Abergavenny, Larchf'd	1·18	48
,, .	Barnstaple, N. Dev.Ath	1·55	69	*Glam* .	Ystalyfera, Wern Ho.	3·31	88
,, .	Dartm'r, Cranmere Pool	3·40	...	,, .	Cardiff, Ely P. Stn	1·56	63
,, .	Okehampton, Uplands.	2·78	100	,, .	Treherbert, Tynywaun.	3·25	...
Corn .	Redruth, Trewirgie	1·98	79	*Carm* .	Carmarthen, Priory St.	2·06	72
,, .	Penzance, Morrab Gdn.	1·80	81	*Pemb* .	Haverfordwest, School.	...	...
,, .	St. Austell, Trevarna	1·89	73	*Card* .	Aberystwyth	2·06	...
Soms .	Chewton Mendip	2·18	74	*Rad* .	BirmW.W.Tyrmynydd	2·12	65
,, .	Long Ashton	1·56	62	*Mont* .	Lake Vyrnwy	3·09	98
,, .	Street, Millfield	·82	38	*Flint* .	Sealand Aerodrome	·86	40
Glos .	Blockley	1·64	...	*Mer* .	Dolgelley, Bontddu	2·35	68
,, .	Cirencester, Gwynfa	1·84	77	*Carn* .	Llandudno	1·30	68
Here .	Ross, Birchlea	·89	41	,, .	Snowdon, L. Llydaw 9.	7·73	...
Salop .	Church Stretton	1·75	72	*Ang* .	Holyhead, Salt Island	1·55	72
,, .	Shifnal, Hatton Grange	1·43	64	,, .	Lligwy	1·89	...
Staffs .	Market Drayt'n, Old Sp.	·73	30	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	·89	39		Douglas, Boro' Cem.	2·94	119
War .	Alcester, Ragley Hall	1·04	46	*Guernsey*			
,, .	Birminghm, Edgbaston	1·02	44		St. PeterP't.Grange Rd.	170	92

Rainfall: June, 1934: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig .	Pt. William, Monreith.	1·78	76	*Suth* .	Melvich	1·86	96
,, .	New Luce School	2·16	75	,, .	Loch More, Achfary	2·16	58
Kirk .	Dalry, Glendarroch	2·22	80	*Caith* .	Wick	1·06	59
,, .	Carsphairn, Shiel	4·32	108	*Ork* .	Deerness	1·10	60
Dumf.	Dumfries, Crichton, R.I.	1·95	82	*Shet* .	Lerwick	1·09	61
,, .	Eskdalemuir Obs	2·59	82	*Cork* .	Caheragh Rectory	...	...
Roxb .	Branxholm	2·27	101	,, .	Dunmanway Rectory	2·75	79
Selk .	Ettrick Manse	2·38	66	,, .	Cork, University Coll	1·63	64
Peeb .	West Linton	2·38	...	,, .	Ballinacurra	1·58	61
Berw .	Marchmont House	2·87	124	,, .	Mallow, Longueville	1·71	77
E.Lot .	North Berwick Res	1·91	115	*Kerry* .	Valentia Obsy	2·45	77
Midl .	Edinburgh, Roy. Obs.	2·47	123	,, .	Gearhameen	2·80	56
Lan .	Auchtyfardle	2·12	...	,, .	Darrynane Abbey	3·00	95
Ayr .	Kilmarnock, Kay Pk	2·03	...	*Wat* .	Waterford, Gortmore	1·42	54
,, .	Girvan, Pinmore	2·15	74	*Tip* .	Nenagh, Cas. Lough	2·06	84
Renf .	Glasgow, Queen's Pk	1·96	85	,, .	Roscrea, Timoney Park	1·67	...
,, .	Greenock, Prospect H.	2·82	85	,, .	Cashel, Ballinamona	1·46	63
Bute .	Rothesay, Ardencraig	3·36	...	*Lim* .	Foynes, Coolnanes	1·69	65
,, .	Dougarie Lodge	2·96	...	,, .	Castleconnel Rec	1·64	...
Arg .	Ardgour House	3·08	...	*Clare* .	Inagh, Mount Callan	3·10	...
,, .	Glen Etive	2·74	58	,, .	Broadford, Hurdlest'n.	2·59	...
,, .	Oban	2·65	...	*Wexf* .	Gorey, Courtown Ho	2·03	83
,, .	Poltalloch	2·89	97	*Wick* .	Rathnew, Clonmannon.	2·22	...
,, .	Inveraray Castle	3·41	86	*Carl* .	Hacketstown Rectory	...	...
,, .	Islay, Eallabus	2·43	93	*Leix* .	Blandsfort House	1·57	61
,, .	Mull, Benmore	3·20	41	,, .	Mountmellick	1·59	...
,, .	Tiree	3·49	137	*Offaly* .	Birr Castle	1·93	83
Kinr .	Loch Leven Sluice	2·45	112	*Dublin*	Dublin, FitzWm. Sq	1·37	70
Perth .	Loch Dhu	...	...	,, .	Balbriggan, Ardgillan	1·50	74
,, .	Balquhidder, Stronvar.	2·42	...	*Meath*.	Beauparc, St. Cloud	1·96	...
,, .	Crieff, Strathearn Hyd.	1·52	58	,, .	Kells, Headfort	1·57	59
,, .	Blair Castle Gardens	1·00	51	*W.M* .	Moate, Coolatore	1·94	...
Angus.	Kettins School	1·03	50	,, .	Mullingar, Belvedere	2·07	80
,, .	Pearsie House	·93	...	*Long* .	Castle Forbes Gdns	2·06	80
,, .	Montrose, Sunnyside	·71	43	*Gal* .	Galway, Grammar Sch.	2·53	...
Aber .	Braemar, Bank	1·39	71	,, .	Ballynahinch Castle	3·48	98
,, .	Logie Coldstone Sch	1·42	73	,, .	Ahascragh, Clonbrock.	2·50	89
,, .	Aberdeen, King's Coll.	1·20	70	*Mayo*.	Blacksod Point	1·78	64
,, .	Fyvie Castle	1·51	72	,, .	Mallaranny	3·44	...
Moray	Gordon Castle	2·21	108	,, .	Westport House	1·59	59
,, .	Grantown-on-Spey	...	...	,, .	Delphi Lodge	4·33	75
Nairn.	Nairn	1·23	70	*Sligo* .	Markree Obsy	1·91	65
Inv's .	Ben Alder Lodge	1·75	...	*Cavan*.	Crossdoney, Kevit Cas.	1·90	...
,, .	Kingussie, The Birches.	1·03	...	*Ferm* .	Enniskillen, Portora	1·83	...
,, .	Inverness, Culduthel R.	1·49	...	*Arm* .	Armagh Obsy	1·40	56
,, .	Loch Quoich, Loan	...	...	*Down*.	Fofanny Reservoir	1·41	...
,, .	Glenquoich	3·66	74	,, .	Seaforde	1·18	43
,, .	Arisaig, Faire-na-Sguir.	3·88	...	,, .	Donaghadee, C. Stn.	1·42	61
,, .	Fort William, Glasdrum	2·71	...	,, .	Banbridge, Milltown	1·49	58
,, .	Skye, Dunvegan	3·12	...	*Antr* .	Belfast, Cavehill Rd	2·58	...
,, .	Barra, Skallary	2·67	...	,, .	Aldergrove Aerodrome.	2·79	116
R&C .	Alness, Ardross Castle.	2·43	108	,, .	Ballymena, Harryville.	2·43	83
,, .	Ullapool	1·55	66	*Lon* .	Garvagh, Moneydig	2·02	...
,, .	Achnashellach	3·65	92	,, .	Londonderry, Creggan.	2·58	91
,, .	Stornoway	1·89	82	*Tyr* .	Omagh, Edenfel	1·80	64
Suth .	Lairg	1·52	73	*Don* .	Malin Head	4·13	...
,, .	Tongue	1·78	87	,, .	Killybegs, Rockmount.	2·43	...

Climatological Table for the British Empire, January, 1934

STATIONS.	PRESSURE. Mean of Day M.S.L. mb.	PRESSURE. Diff. from Normal. mb.	TEMPERATURE. Absolute. Max. °F.	TEMPERATURE. Absolute. Min. °F.	TEMPERATURE. Mean Values. Max. °F.	TEMPERATURE. Mean Values. Min. °F.	TEMPERATURE. Mean Values. ½ Max. and ½ Min. °F.	TEMPERATURE. Mean Values. Diff. from Normal. °F.	TEMPERATURE. Mean. Wet Bulb. °F.	Relative Humidity. %	Mean Cloud Am'nt 0–10	PRECIPITATION. Am'nt. in.	PRECIPITATION. Diff. from Normal. in.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
London, Kew Obsy	1020·8	+ 3·2	56	22	44·4	34·7	39·5	+ 0·6	36·7	90	7·8	1·20	− 0·56	18	1·44	17
Gibraltar	1026·7	+ 5·2	69	40	61·6	45·4	53·5	− 1·4	46·1	80	4·4	0·12	− 4·52	2	...	...
Malta	1020·0	+ 3·0	61	41	56·8	48·1	52·5	− 2·8	48·0	75	6·6	5·31	+ 2·10	20	4·49	45
St. Helena	1011·1	− 0·6	73	59	68·0	60·7	64·3	+ 0·3	61·8	96	9·2	3·29	...	22	...	...
Freetown, Sierra Leone	1012·3	+ 1·5	92	62	86·2	67·5	76·9	− 4·4	72·7	78	3·2	0·00	− 0·41	0	...	...
Lagos, Nigeria	1009·8	+ 0·2	90	67	87·4	73·4	80·4	− 0·5	73·0	88	2·1	0·20	− 0·84	2	6·4	55
Kaduna, Nigeria	1008·5	...	96	53	88·8	55·7	72·3	− 1·1	52·1	35	0·8	0·00	0·00	0	9·1	79
Zomba, Nyasaland	1006·4	− 1·5	87	60	81·4	64·6	73·0	+ 0·2	68·3	74	6·1	5·47	− 5·63	18	...	...
Salisbury, Rhodesia	1009·1	− 0·9	87	55	80·0	59·7	69·9	+ 0·2	63·4	69	6·1	7·19	− 0·13	18	8·3	63
Cape Town	1013·0	− 0·4	103	52	82·8	61·2	72·0	+ 2·1	61·9	65	2·7	0·54	− 0·14	3	...	...
Johannesburg	1011·1	+ 0·6	82	50	73·9	56·1	65·0	− 1·7	59·6	81	6·5	12·03	+ 5·86	18	6·3	46
Mauritius	1010·1	− 1·8	90	69	84·9	73·4	79·2	− 0·1	73·8	69	7·1	6·96	− 0·80	22	7·8	59
Calcutta, Alipore Obsy.	1014·1	− 1·1	86	45	77·6	55·5	66·5	− 0·1	56·2	84	2·7	0·00	− 0·42	0*	...	...
Bombay	1012·0	− 1·6	92	53	81·9	64·1	73·0	− 2·5	60·3	63	3·1	0·00	− 0·10	0*	...	...
Madras	1011·8	− 2·3	84	65	82·4	70·3	76·3	+ 0·1	71·9	85	6·2	2·05	+ 0·91	3*	...	...
Colombo, Ceylon	1009·6	− 1·2	89	69	84·0	72·1	78·1	− 1·4	73·5	78	6·2	12·22	+ 8·97	17	4·9	42
Singapore	1009·2	− 1·2	87	67	82·6	70·9	76·7	− 3·0	73·6	84	8·5	18·94	+ 9·05	18	3·8	32
Hongkong	1021·2	+ 1·5	69	43	61·1	52·3	56·7	− 3·5	50·0	65	6·8	0·47	− 0·85	5	4·7	43
Sandakan	1008·4	...	88	70	85·2	73·7	79·5	− 0·3	76·1	89	8·0	33·96	+ 14·56	28	...	...
Sydney, N.S.W.	1013·3	+ 0·9	103	57	78·7	65·1	71·9	+ 0·3	66·2	65	5·8	2·35	− 1·32	12	8·2	58
Melbourne	1013·6	+ 0·7	103	49	78·7	57·7	68·2	+ 0·8	60·7	59	6·0	3·59	+ 1·70	10	7·2	50
Adelaide	1013·2	+ 0·2	110	53	89·8	65·1	77·5	+ 3·6	60·8	29	4·4	0·46	− 0·26	3	10·2	72
Perth, W. Australia	1010·7	− 1·8	110	59	87·8	66·3	77·1	+ 3·3	66·2	55	4·2	0·27	− 0·07	3	10·1	73
Coolgardie	1008·6	− 2·9	111	56	97·5	66·1	81·8	+ 4·4	65·5	43	3·8	0·99	+ 0·53	4	...	...
Brisbane	1013·7	+ 2·4	92	62	82·3	67·4	74·9	− 2·3	68·4	63	7·0	3·26	− 3·19	9	8·2	60
Hobart, Tasmania	1013·1	+ 2·8	91	47	69·9	53·4	61·7	− 0·3	55·2	58	7·2	1·00	− 0·83	10	6·8	46
Wellington, N.Z.	1011·6	− 1·7	77	39	67·3	53·0	60·1	− 2·4	56·0	69	6·7	2·03	− 1·30	13	7·1	48
Suva, Fiji	1009·0	+ 1·5	95	72	88·4	75·9	82·1	+ 2·2	76·8	78	6·0	9·18	− 2·25	22	7·1	54
Apia, Samoa	1008·9	+ 1·0	88	72	85·4	75·0	80·2	+ 1·2	76·5	81	6·9	15·25	− 1·80	27	7·2	56
Kingston, Jamaica	1015·1	0·0	87	65	84·3	66·9	75·6	− 1·2	65·9	89	2·5	0·68	− 0·28	5	6·9	62
Grenada, W.I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toronto	1018·5	+ 0·6	43	− 9	32·6	19·0	25·8	+ 3·6	23·2	75	8·7	1·12	− 1·67	8	1·5	16
Winnipeg	1017·9	− 3·0	39	−39	17·6	−5·9	5·9	+ 9·8	...	...	5·5	0·01	− 0·90	1	2·7	31
St. John, N.B.	1016·4	+ 0·9	41	−16	25·5	6·5	16·0	− 3·2	12·7	75	6·4	2·29	− 2·51	8	3·4	37
Victoria, B.C.	1019·4	+ 3·4	52	34	46·5	40·4	43·5	+ 4·5	41·7	91	8·2	7·27	+ 2·73	24	2·0	23

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

(21764) Wt. 25/32 1,000 7/34 Hw. G.377/6