

<h1>The Meteorological Magazine</h1>	
	Vol. 69
	<b>August 1934</b>
	No. 823
Air Ministry: Meteorological Office	

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

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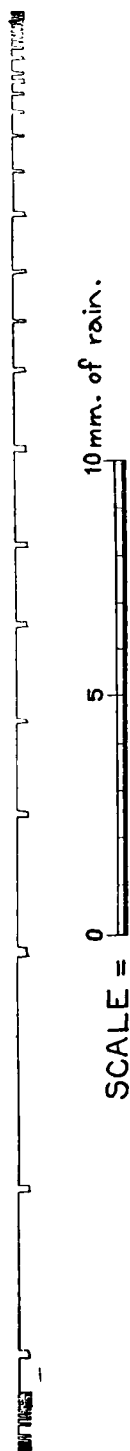
## A fifth of an inch in a Minute

By F. J. W. WHIPPLE, Sc.D.

The autographic rain-gauges which are in general use are well designed for recording rainfall hour by hour or even five minutes by five minutes. The records fail, however, to provide the answer to the questions how much rain fell in a minute and what was the instantaneous intensity of the rainfall. The gauge, which is generally known at Kew Observatory as the storm gauge, but which is better described as the minute by minute gauge, was designed to record as accurately as possible the amount of rain falling in each minute.

The chart used in this gauge is mounted on a drum to which a float is attached so that as the float chamber is filled with rain-water the drum rotates. A pen writing on the chart is displaced at each minute by the action of an electromagnet. The distance between the minute marks is a measure of the rainfall. The electric current which actuates the electromagnet is controlled by a relay in the same circuit as the time-markers of the seismographs. There are a few other details which may be mentioned. An 8-inch gauge is used. The orifice of the funnel has been enlarged, however, to 3.8 cm., so as to allow hail stones to fall through at once. The funnel does not communicate with the float chamber but with a side tube. This provision also is made to deal with hail. The hail stones float on the water in the side tube and affect the common level in side tube and float chamber as much as the equivalent amount of water. The side tube and float chamber have diameters 3.8 cm. and 10.2 cm.,

## KEW OBSERVATORY. MINUTE BY MINUTE RAINGAUGE.



JULY 18<sup>th</sup>., 1934. TOTAL RECORDED = 30.1 mm.

FIG. 1.

respectively. The scale of the record is about nine times the normal scale for rainfall. The circumference of the drum being about 40 cm. one revolution corresponds with 45 mm. of rain and to allow for the possibility of as much as 200 mm. in a day the traces of the pen have to be kept separate. To this end the axle carrying drum, float and counterpiece has a screw thread and rides on skew wheels. Until recently ink was used on the pen, but a metallic pen writing on metallic paper has now been adopted. This has got over the difficulty that a pen repeating the same mark over and over again is sure to make blots.

The minute by minute gauge has been in use since 1928, but the wide opening for the reception of hail stones was not made until May, 1931, after a storm in which it appeared that the equivalent of 1 cm. of rain had reached the float chamber in the course of a minute. There was no way to decide whether the water reaching the chamber had remained for some minutes as hail melting in the funnel and therefore the reading was not accepted.

The storm of July 18<sup>th</sup>, 1934, has provided measurements which are not affected by the mixture of hail with the rain, that is to say the water equivalent of the hail is included with the rain.

Fig. 1 is a reproduction of the original record of this storm and the amounts falling minute by minute are graphed in Fig. 2. It will be seen that in the second, third and fourth minutes after the commencement of the heavy rain the amounts were 3.4, 5.0 and 2.9 mm. The highest rainfalls in stated times from one to sixteen minutes are given in Table 1. The highest fall in one minute was 5.0 mm., i.e., 0.2 in. More than a centimetre of rain fell in three minutes and more than an inch (25.4 mm.) in thirteen minutes. The last two readings would just fail to qualify for inclusion as

“very rare falls” in the British Rainfall classification. There is no entry for less than  $1\frac{1}{2}$  minutes in the British Rainfall List of known “Rainfalls of Very Rare Intensity lasting for one Hour or Less.” The measurements\* by Symons of 0·10 in. in  $\frac{1}{2}$  minute and 0·17 in. in 1 minute at Camden Square on June 23rd, 1878, might have been quoted there. The Kew Observatory observation of 0·20 in. in one minute may be included in future.

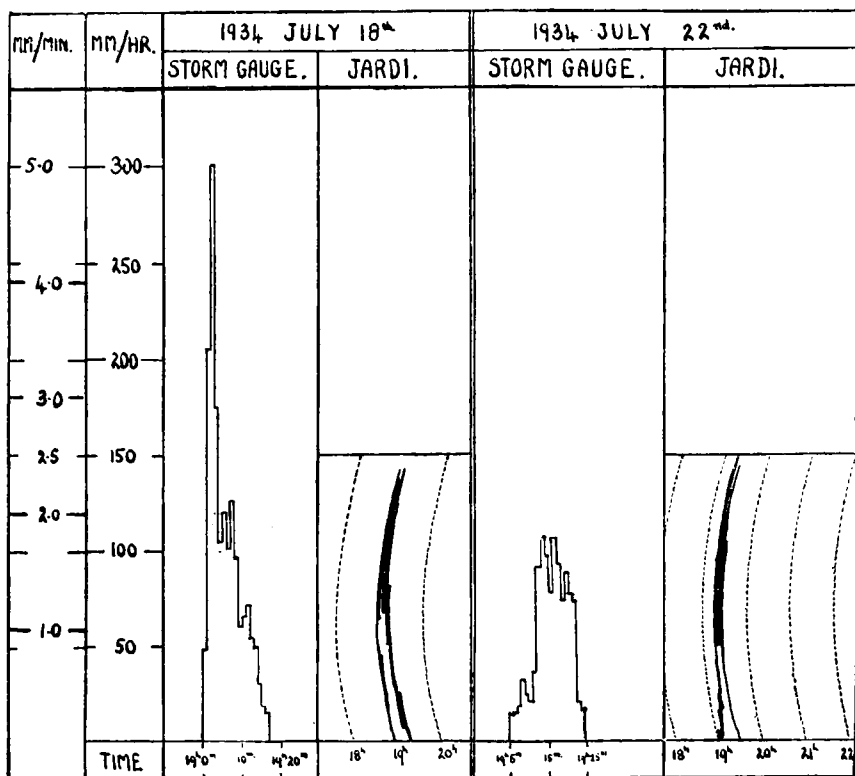


FIG. 2.—RAINFALL INTENSITY, KEW OBSERVATORY, JULY 18<sup>TH</sup> AND 22<sup>ND</sup>, 1934  
The Jardí records are reproduced by tracing. The storm gauge records are graphs of minute by minute readings.

According to the minute by minute gauge the rainstorm on Sunday, July 22nd, was not so severe at Kew Observatory as that of July 18th. The records for the second day are illustrated in Fig. 2. It is hardly necessary to add that both these storms were very local in their effects. It appears that on the second occasion the rainfall was much heavier about a mile from the Observatory.

The aim of the Jardí rain-gauge is to provide a continuous record of the rate of the rainfall. The instrument, which has been described in *British Rainfall*, 1930, p. 284, is constructed with a small float

\* cf. *Meteorological Magazine* 59, 1924, p. 151.

chamber containing a float carrying a tapered spike. This spike passes through an aperture in the bottom of the chamber. When the rainfall is heavy the chamber is filled and the spike is withdrawn, leaving an annulus through which the water runs away. The tapering is so contrived that the lift of the float may be proportional to the rate of rainfall. Records of the Jardi gauge are reproduced in Fig. 2. It will be seen that on July 18th, when the minute by minute gauge indicated a maximum rate of fall of 300 mm./hr. the pens of the Jardi instrument did not reach the top of its range 150 mm./hr. The most likely explanation of the discrepancy is that half of the precipitation in the other gauge was hail. The second day the Jardi recorded 150 mm./hr. though the highest of the

TABLE I.—THE HIGHEST RAINFALL IN STATED TIMES, KEW OBSERVATORY, JULY 18TH, 1934

Time.	Rainfall		Hourly rate.	Time.	Rainfall.		Hourly rate.
Min.	mm.	in.	mm. in.	Min.	mm.	in.	mm. in.
1	5.0	0.20	300 12	9	21.7	0.85	145 5.7
2	8.5	0.33	255 10.0	10	22.7	0.89	136 5.3
3	11.3	0.44	226 8.8	11	23.9	0.94	131 5.1
4	13.3	0.52	200 7.8	12	24.9	0.98	125 4.9
5	15.3	0.60	184 7.2	13	25.7	1.01	119 4.7
6	16.9	0.66	169 6.6	14	26.5	1.04	114 4.5
7	19.1	0.75	164 6.4	15	26.9	1.06	108 4.3
8	20.7	0.81	155 6.1	16	27.3	1.07	104 4.0

minute by minute readings was only equivalent to 106 mm./hr. It may be that this difference is genuine, and that the instantaneous rate was 40 per cent. greater than the average rate for a minute, or again that the rain fell heavier at the one spot than the other 100 yards away. We need not stress the difference; it is satisfactory that two instruments of such varied construction are not more inconsistent. It may be added that the two gauges would serve the needs of different classes of the community. For the engineer who wants to know how much rain has fallen or can fall in a short period the minute by minute gauge should be useful. On the other hand, the Jardi gives a record which is readily compared with a pressure tube anemogram, and is therefore the record for the student of dynamical meteorology.

## Thunderstorms in July, 1934

A fair amount of thunderstorm activity occurred during July, thunder being heard in London, Calshot and Lympne on six days,

at Cranwell and Ross-on-Wye on four days, and at places so widely scattered as Shoburyness, Gorleston, Birmingham, Inchkeith (Firth of Forth) and Dublin on three days.

At the beginning of the month the weather was generally very fine. On the morning of July 11th a thunderstorm was reported from a ship in the Bay of Biscay, where a trough of low pressure was moving north-east towards the British Isles. Thunderstorms occurred in the southern part of England and Ireland on the 11th and 12th. The amounts of rainfall were, however, generally quite insignificant. On the 13th, 14th, 17th, 18th, 19th, 21st, night of 22-23rd, 24th and from 29th to 31st thunderstorms were again prevalent, especially so on 12th, 13th, 18th and 24th. There were heavy falls of rain locally on 12th, 13th, 17th, 18th, 22nd, 24th, 25th, but so far as information is available falls within the London district were heavy only on 13th, 18th, night of 22-23rd, and 24th.

During the periods of thunderstorms up to July 24th the British Isles were covered alternately by shallow "lows" which moved over the country either from the south or from the north-west, and by unstable currents from the north-west which followed the passage of the "lows" eastward. Thus:—

On the 12th—Shallow "lows" moved in from the Atlantic.

On the 13th and 14th—Unstable north-west current in rear of "lows" which had moved east.

On the 17th and 18th—Shallow "low" developed over England out of trough from Atlantic.

On the 19th—"Low" moved east and unstable north-west currents set in.

On the 22nd—Shallow "low" spread north from south-south-west.

On the 23rd-24th—"Low" moved east and pressure remained irregular with unstable NW. winds.

The thunderstorm period of 29th to 31st was associated with the approach of a depression from the Atlantic, the warm and cold fronts of which crossed most of the British Isles.

It has been known for a long time that the synoptic situations described above are, at any rate in summer and apart from extreme north-west districts, favourable for the development of thunderstorms. That is mainly a result of experience, and intelligent consideration of the question is only possible when observations for the upper air are also taken into account. It is known that thunderstorms are the results of violent convection in the atmosphere, brought about either (1) by forced ascent of warm damp air at a front or (2) by inherent instability in an air column, produced usually by rapid heating of damp surface layers after a period of sunny hours, often combined with advection of abnormally cold air at a height of 15,000 or more feet. In such a case partially saturated air at the surface would rise along the dry adiabatic under the influence of the heating effects from the ground, until it reached the temperature of saturation. The saturated air would then move rapidly upwards in

an unstable manner along the saturated adiabatic, unless in doing so it met potentially warmer air. If there were no such potentially warmer air, or if the amount of such air were small, the chances of the formation of a thunderstorm would be respectively more or less considerable. This statement of the case is not a complete one, for a thunderstorm probably draws air from layers two or three thousand feet above the ground as well as from layers near the ground.

If now we turn to the results of aeroplane ascents at Duxford (Cambridge), as plotted on tephigrams, and use as far as possible ascents made in the afternoon\* we find that the air over Duxford was unstable on July 13th, 14th, 18th (very pronounced), 21st (doubtful) and 24th. The ascents showed that violent convection in the air at Duxford was practically impossible or very unlikely on July 11th, 12th, 17th, 19th, 20th, 23rd. There was no ascent on Sunday, July 22nd. On most of these last-named days pronounced inversions of temperature occurred at moderate heights which effectively prevented convection, while on some of them the humidity in layers near the ground was so low that the lower layers of air did not possess sufficient potential temperature or entropy to cause convection.

In using tephigrams it has to be remembered that any result derived from them is applicable only to an area near the place of ascent which is (i) in the same kind of air, and (2) is likely to undergo changes of temperature and humidity similar to those at the place of observation. It would, for example, be incorrect to attempt to apply the results to a place beyond a warm or cold front. It is for reasons of this kind that the ascents at Duxford do not and cannot be expected to explain the occurrence of all the thunderstorms which occurred in other parts of the country.

R. CORLESS.

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The following reports and extracts from letters received show the intensity of some of the heavier falls experienced between July 12th and 22nd.

On the 12th the observer at Bettws-y-Coed, Denbighshire, reports that 3·18 in. fell in under 2 hours but that "within a mile each way very little rain fell." On the same day the observer at Trowbridge, Wiltshire, recorded 1·88 in. of which 1·15 in. fell in 1 hour from 16h.-17h. (G.M.T.); at Kimbolton, near Leominster, 1·57 in. was recorded from 14h. 15m. to 15h. (G.M.T.); and at Frinton (Suffolk), 2·70 in. were recorded during the day.

On the 13th a fall of 2·07 in. in a thunderstorm of 2 hours' duration was recorded at Sway, in Hampshire, and 3·32 in. occurred at Gorleston.

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\* If morning ascents are used, an estimate of maximum temperature in the afternoon is made, and it is assumed that vapour content will not appreciably change between the times of the two ascents.

On the 17th 2·20 in. fell at Fleetwood (Lancashire).

Mr. M. W. Binns reports that he recorded 1·05 in. on the 18th at Lutterworth (Leicester). "It was a wild storm. Most of the precipitation occurred in  $20\frac{1}{4}$  minutes, the total duration being  $30\frac{1}{2}$  minutes. Large transparent hailstones,  $\frac{7}{16}$  in. in diameter, swept before a strong out-blowing wind (force 6-7) from S. by W., and these were driven northward where, two miles away, some still lay next morning. It is almost certain some of the catch was lost owing to the hail being so heavy."

On the 18th, also 2·15 in. were recorded between 17h. 30m. and 18h. 30m. (G.M.T.) in a thunderstorm accompanied by hail at Castleton (Yorks.).

Mr. D. A. Worthington, of Woodland Way, West Wickham (Kent), reports that 4·55 in. of rain and hail fell there in 1 hr. 40 mins. from 18h. 40m. to 20h. 30m. (G.M.T.) on July 22nd. "At 18h. 50m. I was outside the house and noted the intense stagnation of the air. . . a few heavy drops fell, but it was not until 18h. 55m. that it became very heavy. Thunder and lightning then rapidly approached from the north and rain increased to a heavy torrent. About 19h. 5m. this suddenly changed to a sheet of hail driven by a fierce squall from the north, but within five minutes the hail turned to rain, which fell with an even greater intensity. This continued till 20h. 15m. when it lessened and at 20h. 30m. it was only normal heavy rain. Thunder and lightning were almost directly overhead and the lightning appeared to average some 10 flashes a minute. I was unable to make a close study of the storm as our house soon became nearly full of drenched folk sheltering from the storm. Although on top of the hill water poured over the lawns and ran round the house in torrents."

Mr. Derek Schove, of Beckenham Road, West Wickham (Kent), says: "In the storm of July 22nd, I recorded 3·75 in. with a standard gauge. The heavy rain apparently did not occur anywhere in the locality until 7.45 p.m. (B.S.T.) when it began here to last for about 80 minutes. However, the centre of the rain seemed to be to the south or south-east of us, clear sky being observed to the south-west, and often to the north-east, north and north-west. Lightning centres began to the west or north-west with a few sharp "blue" flashes and moved slowly to the south and east of the village, increasing in frequency, but apparently changing to a reddish colour (haze?) and passing from cloud to cloud. The intensity of the flashes would be remarkable in any case, but more so in view of the fact that until 9.15 scarcely any flashes were observed more than  $\frac{1}{2}$  mile distant from my house. The damage done was not large however, and rumours of fireballs proved difficult to analyse. At one such place, however, among more serious damage, a smoky trace was observable along the frieze and, where the bend in the wall occurred the lightning had sparked across and

left a deep "rifle-shot" hole about  $\frac{1}{16}$  in. diameter. Peculiar red-brown marks appeared in an unaffected room and soot and brick were blown out from the downstairs grates to strike the opposite wall. The barometer trace rose only .02 in. at the onset of the heavy rain but continued rising until 8.50 p.m. when it had risen .06 in."

At Bromley (Kent) rain commenced on the 22nd at 19h. 10m. and in the period from then until 20h. 30m., 1.40 in. was recorded. The Engineer to the West Kent Main Sewerage Board states that "the storm of July 22nd did not affect Bexley, Crayford or Dartford."

Mr. J. H. J. Burt reports that at Tooting Common his hyetograph chart indicates "that during the thunderstorm of the evening of July 22nd, 1934, an inch fell in the first 16 minutes and that within half an hour one inch and a half fell. It left off at about 9.10, and I then had to syphon, as the container was full. I did not consider the lightning very severe and only two flashes synchronised with the clap."

At Barcombe, near Lewes, 1.11 in. fell in 45 minutes during the late afternoon on the same day.

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## Correspondence

To the Editor, *Meteorological Magazine*

### The Halo Complex in Holland, May 26th

The halo complex witnessed by Messrs. C. E. P. Brooks and C. Braak\* near Nijmegen was part of a remarkable phenomenon of great brilliancy and long duration observed in a great part of the Netherlands.

In the morning of May 26th six different forms were seen; the halos of 22° and 46°, the tangent arcs, the parhelia, the parhelic ring and an infra-lateral arc. At about 10h. (Amsterdam Summer Time) the phenomenon was obscured by low clouds. In the afternoon, about 18h., again six forms were present: the halo of 22° and its upper tangent arc, the parhelia and the parhelic ring, the pillar and the circumzenithal arc. It must be remarked that the observer at Abcoude (south-east of Amsterdam) drew the pillar in quite the same manner as Dr. Brooks.

The halo remained visible until sunset and appeared again around the rising moon at 22h. The same particulars were seen, moreover the great halo and the circumzenithal arc were present simultaneously. All seven forms were observed at Amsterdam.

In the morning of May 27th, between 0h. and 1h., the halo complex disappeared behind cumulus.

S. W. VISSER.

*Leersum, Holland, July 14th, 1934.*

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\* See *Meteorological Magazine*, **69**, 1934, p. 122, and De Halo van 26 Mei, 1934, by Dr. S. W. Visser, *Hemel en Dampkring* **32**, 1934, pp. 261-5.



### Strange Sunset Effect

The notice in the June *Meteorological Magazine* of a "Strange Sunset Effect" observed in Hampshire by Mr. W. L. Baxter, on October 11th, 1933, leads me to report a similar effect observed by me at Angra do Heroismo, Terceira Isl., Azores, a few days before that date, on October 4th, 1933.

Similar shafts of pale-rose light were observed for a few minutes beginning at 17h. 30m., Azores Time, on the eastern horizon, radiating from a point diametrically opposite the sun just set. The point of radiation (possibly an anthelium) I could not see, as it was hidden by a big cumulus behind a line of mountains. I also observed that the shafts were moving slowly to the right around the supposed anthelium.

I was informed a few days later by the superintendent of our observatory at Ponta Delgada, Mr. Miranda, that a similar phenomenon was observed there at sunset on the same date, by himself and Dr. Lugeon, who was then on his way back to Lisbon and Warsaw.

It is also worthy to report that on April 2nd last we experienced the lowest temperature this year in the Azores. A minimum of  $3.2^{\circ}\text{C}$ . was registered at the Flores station, which is exceptional for the year and much more exceptional for the month of April in the Azores. I was coming back from a tour of inspection to our observatories in Flores and Faial and, while crossing from Graciosa to Terceira, at 9h. I had the opportunity—very rare indeed—of seeing the tops of the mountains in Saint Georges, Pico and Terceira Islands covered with snow above an altitude of 2,000 ft. I took some pictures of the mountain of Santa Barbara, in Terceira, covered with snow as it was never seen before. It is interesting to note that an anticyclone was extending from Iceland by the eastern coasts of Greenland to the Azores, which is also a quite exceptional situation.

J. AGOSTINHO.

*Angra do Heroismo, Terceira, Azores. June 30th, 1934.*

With reference to Mr. W. L. Baxter's letter in the June issue of the *Meteorological Magazine*, the effect he observed was witnessed here in the evening of Friday, July 6th, 1934. Seen from the north-west corner of Croydon aerodrome the rays were practically white. The same effect was observed here three or four years ago, but then the rays were decidedly pink. In each case the sky was cloudless and the sunset light very brilliant. I have not yet found any explanation for the phenomenon.

W. HAYES.

*Wallington, Surrey, July 10th, 1934.*

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### Weekly Weather Reports

The library at Kew Observatory contains an almost complete set of the climatological publications of the Meteorological Office. Until

recently there were many years for which the *Weekly Weather Report* had been left unbound, but now from Vol. III, 1880 onwards all the reports are bound. We have the weekly issues for 1878 with one exception, No. 22, but all the 1879 issues are missing. Unfortunately the Meteorological Office does not possess spare copies of the reports in question. It may be that broken sets of the *Weekly Weather Report* have been preserved at some climatological station and that the numbers required in the Kew Observatory library could be spared. To facilitate a search it should be noted that for these first two years the *Weekly Weather Report* was printed on pages 10 in. by 6 in. ; the pages of volume III are larger, 12½ in. by 8¾ in.

If anyone can help me to make up the Observatory set I shall be very grateful.

F. J. W. WHIPPLE.

*Kew Observatory, Richmond, Surrey, May 30th, 1934.*

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### **The Height of the Tropopause at Calgary, Alberta, and Goderich, Ontario, during the Second International Polar Year, 1932-3**

During the International Polar Year sounding balloons were sent up from Calgary, Alberta, latitude 51° 2', longitude 114° 2' W., and Goderich, Ontario, latitude 43° 45', longitude 81° 37' W., on the second Wednesday and Thursday of each month during the year. The instrument used was a modified Dines meteorograph in that the temperature element in the Dines instrument was replaced by an element made of thermostat metal. The ascents were all made in the evening so that radiation did not affect the instruments. The recovery of the balloons was remarkably good, one or both being found at each of the stations in practically every month.

The chart gives the height in geodynamic metres of the tropopause for each of the ascents, and the figures give the absolute temperature of the tropopause. One set of curves is for Goderich and the other for Calgary.

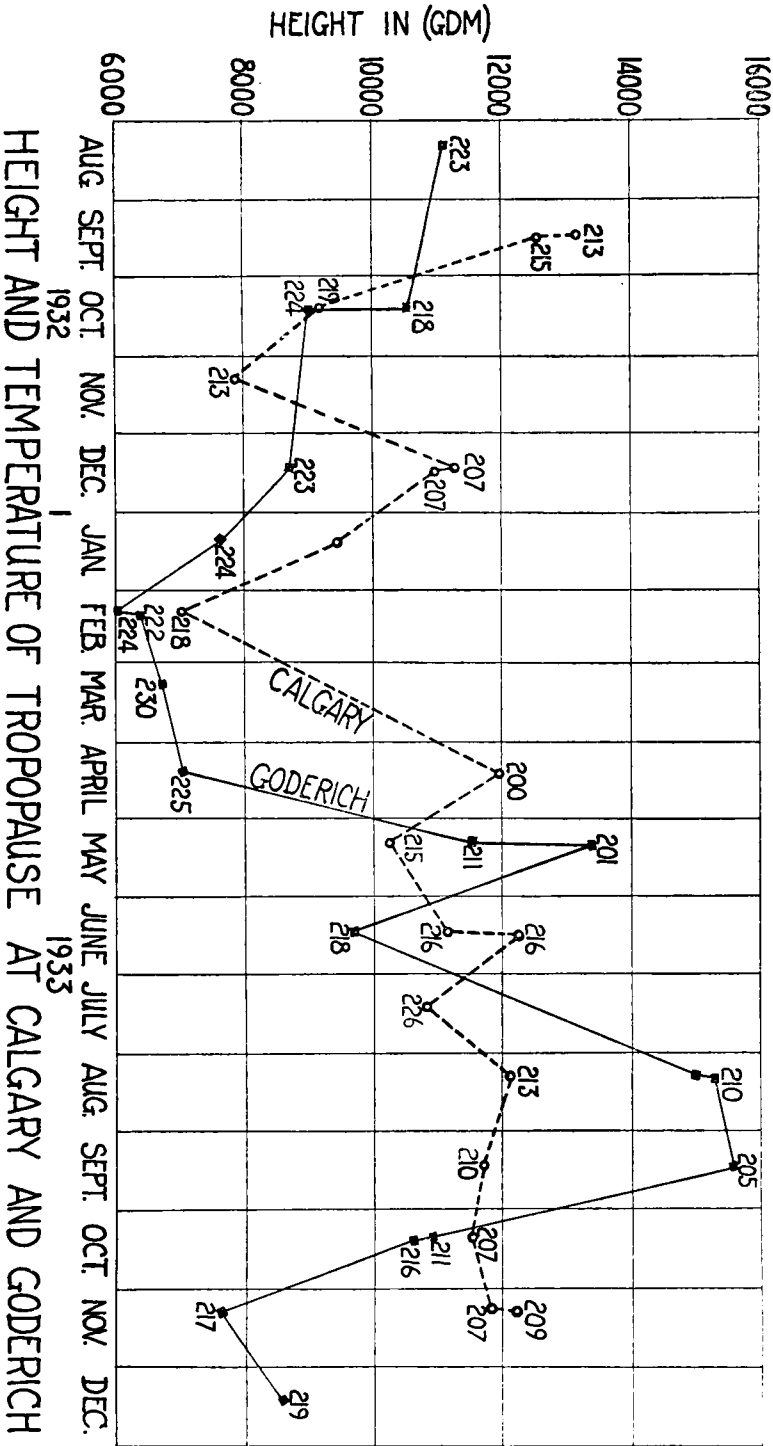
It is interesting to note that in February the height of the tropopause was about 6,000 gdm. at Goderich on both days and 7,000 at Calgary. On this occasion the heights obtained by the U.S. Weather Bureau at Omaha, Nebraska, and Elmvale, North Dakota, were about 6,000 metres, showing that at this period the tropopause was very low over the whole of the southern part of Canada and the northern part of the United States.

The curves indicate that the tropopause is lowest in the winter months and highest in the summer. This is in agreement with results obtained from ascents at Woodstock, made during the years 1911-4.

J. PATTERSON.

*The Meteorological Office, Toronto, Canada, May 30th, 1934.*

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### Unusual Anemometer Record

The copy of the anemometer record from Amman for March 4th, 1934 shown on the opposite page, is probably of a most unusual type and will be of general interest.

A very deep depression was situated over the eastern Mediterranean on the 4th. The strong south-easterly winds in front caused severe sandstorms; the visibility at M/Y. "Imperia," Mirabello Crete, 250 miles from the African coast being reduced to 100-200 yards owing to dust. At all stations the change in wind speed and direction was normal, *i.e.*, SE'ly. 40-50 m.p.h., becoming SW'ly. 30-40 m.p.h., and finally W.-WNW. 20 m.p.h. At Amman the strength of the SE'ly. wind, 20 m.p.h., was considerably less than at other stations, but as will be observed just before 14h. G.M.T. a gust of 67 m.p.h. occurred suddenly which lasted for a few minutes; the wind then decreased and oscillated between SE. and SW. before commencing to blow from its original direction and with its original speed. The change to SW. may be seen occurring about 17h. G.M.T. A considerable fall of temperature occurred just after the squall.

J. DURWARD.

*R.A.F. Heliopolis, Egypt, April 14th, 1934.*

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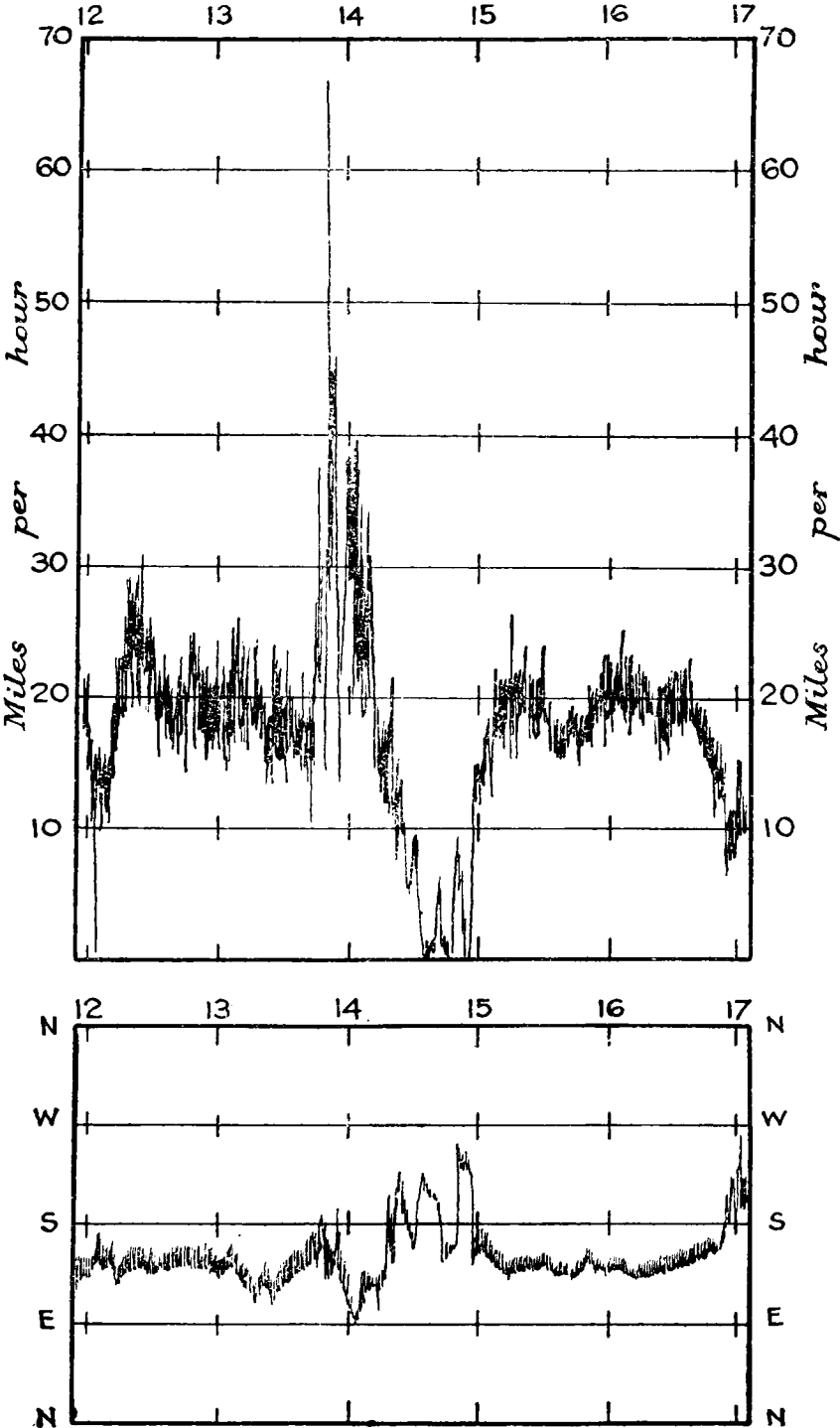
### Summer Rainfall in Iraq

There are only two months in the year, namely July and August, in which rainfall never occurs in central Iraq, but a fall of rain in June is sufficiently remarkable to warrant mention. During the 12 years for which Air Ministry meteorological records exist, rain was recorded at Hinaidi on June 2nd, 1923 (0.4 mm.), and June 1st, 1926 (0.9 mm.), whilst from previous scanty records which exist for Baghdad it appears that during the period 1888 to 1914 rain was recorded in June during three years only.

It is interesting to record, therefore, that on June 10th this year a thunderstorm occurred at Hinaidi, which yielded a measurement of 0.4 mm. As the maximum temperature that day was 111°F. and during the fall of rain the temperature was 102°F., it is probable that the rain-gauge was too hot to allow of all the fall being collected without evaporation.

The rainfall was the result of a distinct line squall which moved from west to east across the country, and was accompanied also by thunder, lightning and thick dust. The squall passed Hinaidi at 16h. G.M.T. (19h. L.T.), giving a sudden rise of wind from almost calm to 41 m.p.h., and a drop in visibility to 50 yards owing to dust. The temperature and humidity traces showed very little variation, but the barograph gave a rise of pressure of 3mb. in about half an hour.

It will be seen that the date this year, June 10th, is the latest in



ANEMOMETER RECORD, AMMAN, MARCH 4TH, 1934.

the summer on which rain has fallen since the British took observations here. It gave rise to the not unexpected comment in the local press that the climate of Iraq was changing !

R. H. MATTHEWS.

*R.A.F., Hinaidi, Iraq, June 12th, 1934.*

## NOTES AND QUERIES

### The Basis of the Expression $\frac{1}{4}(7+13+2 \times 21\text{h.})$ for mean temperature

The combination  $\frac{1}{4}(7 + 13 + 2 \times 21\text{h.})$ , the analysis of which forms part of the subject of a paper by L. Besson discussed at the Meteorological Office on January 15th, is so widely and successfully used as an expression for the 24-hour or "true" mean temperature that it is of interest to search for the physical basis underlying it.

In general, the diurnal variation of temperature can be expressed with sufficient accuracy by the equation :—

$$T = a_0 + a_1 \sin(t + A_1) + a_2 \sin(2t + A_2)$$

This equation has five unknown quantities,  $a_0$ ,  $a_1$ ,  $a_2$ ,  $A_1$  and  $A_2$ , and so cannot be solved directly from observations at three hours only. It happens, however, that the second order term is small in comparison with the first order term, and its phase,  $A_2$ , is fairly constant. This term may therefore be replaced by known quantities without great inaccuracy. The amplitude  $a_2$  is in general rather more than one quarter of  $a_1$ , roughly  $0.3a_1$ , and the phase  $A_2$  is such that the minima occur at about 7h. and 19h., the maxima about 13h. and 1h. The second order term in fact represents the retardation of the minimum temperature from 1h. to 6h. or 7h., the accentuation of the maximum at 13h. (which makes the mean of daily maxima and minima higher than the 24-hour mean) and the relatively rapid fall of temperature in the late afternoon.

In practice we may substitute for  $a_2$  0.15 times the difference between the 13h. and 7h. mean temperatures. If we write I, II and III for the temperatures at 7h., 13h. and 21h. and put  $t = 0$  at 7h., we then have three equations :—

$$\text{I} + .15(\text{II} - \text{I}) = a_0 + a_1 \sin A_1$$

$$\text{II} - .15(\text{II} - \text{I}) = a_0 + a_1 \cos A_1$$

$$\text{III} + .075(\text{II} - \text{I}) = a_0 - .87 a_1 \sin A_1 - .5 a_1 \cos A_1$$

The solution of these equations gives us :—

$$a_0 = .31 \times \text{I} + .27 \times \text{II} + .42 \times \text{III} \quad (1)$$

This is not far from the usual formula :—

$$a_0 = .25 \times \text{I} + .25 \times \text{II} + .5 \times \text{III} \quad (2)$$

The best-fitting expression can also be determined from the hourly data for a number of stations by the method of least squares. I have done this for two groups of stations,\* one in France and the

\*True mean temperature, *Washington, D.C., Mon. Weather Rev.*, 1921, p. 226.

other in the tropics. The French group gave an approximation of formula (2), but the tropical group gave as the best-fitting expression :—

$$a_0 = .33 \times I + .30 \times II + .37 \times III \quad (3)$$

The mean of (2) and (3) is :—

$$a_0 = .29 \times I + .27 \times II + .44 \times III$$

which comes very near the theoretical form calculated in (1). On the mean of 97 stations in the tropics for which hourly figures are given by Hann, expression (3) is accurate to  $0.0^\circ \text{C.}$ , while (1) and (2) give values of  $a_0$   $0.1^\circ \text{C.}$  too low.

C. E. P. BROOKS.

### The Second Volume of World Weather Records\*

In 1927 the Smithsonian Institute, with the aid of a generous grant from Mr. John A. Roebling, published a volume under the title "World Weather Records", which included monthly tables of pressure, temperature and precipitation for 385 land stations in all latitudes from Upernivik in  $72^\circ 47' \text{ N.}$  to Laurie Island in  $60^\circ 44' \text{ S.}$  With a few exceptions, the data for each station covered a continuous period of at least 20 years from 1901 or earlier to the end of 1920. The volume was reviewed, with a brief account of the needs and efforts which resulted in the international collaboration necessary to prepare it, in the *Meteorological Magazine* for November, 1927. This review ended with the words : "in another few years the investigator will find himself faced by the labour of extracting the data for the years 1921 to 1930, to add to those in the present volume, before he is able to begin his calculations. But the international effort so worthily begun cannot be allowed to lapse, and means must be found to issue a supplementary volume every ten years, as envisaged in Professor Exner's original proposal."

Thanks again to the generosity of Mr. Roebling, the means have been found for the first of these supplementary volumes. The general plan follows that of the original collection ; the first 80 pages are devoted to a series of notes on the stations giving the authority, the site, hours of observation, the corrections applied and details of any changes of site or other interruptions to the continuity of the observations. For most stations these details are very complete and add greatly to the utility of the figures. Then follow tables giving the monthly data for the years 1921 to 1930 for the majority of the stations included in the first series, together with the ten-year means.

\**Smithsonian Miscellaneous Collections*, Vol. 90. World Weather Records continued from Vol. 79. 1921-1930, collected from official sources by Dr. G. C. Simpson, Sir Gilbert Walker, Robert C. Mossman and Frances L. Clayton, assembled and arranged for publication by H. Helm Clayton. Published under grant from John A. Roebling (Publication 3218). City of Washington, 1934, pp. vi + 616.

We should have liked to see also the means for the whole period covered by each station from the beginning to 1930, but it must be admitted that the additional computation involved would have been very great, and where so much is given, it would be unfair to ask for more.

Part II of the volume, from pp. 437 to 497, constitutes a new feature of great interest. It is entitled "Ocean and sea-level pressures. Atmospheric pressures over the northern oceans and sea-level pressures at selected land stations, 1921-1930." This section was included in response to a need for reliable meteorological data over the oceans, which in the first volume were represented only by a few island stations. The monthly means were not obtained directly from ships' observations, as are the marine observations for five-degree "squares" included in the Réseau Mondial, but indirectly by estimating values at fixed points from daily isobaric charts over the oceans, mainly the Japanese charts for the North Pacific and the British *Daily Weather Report* which includes the North Atlantic. Experiments showed that the monthly means so obtained could be regarded as accurate to 0.5 mm., and they are accordingly published to the nearest millimetre. It is stated that this unit was chosen because it is used for most of the land stations, and so less conversion was required to obtain uniformity in this section of the tables, but the millibar is now generally recognised as the unit for international studies in meteorology, such as those in connexion with the Polar Year, and conversion to millibars throughout would have well repaid the additional labour involved.

Part III, pp. 495 to 573, gives tables of pressure, temperature and precipitation for a number of stations over long periods, which were received too late for inclusion in the first series of World Weather Records. In Part IV are given a list of errata to the earlier volume, supplementary to the list of errata issued in 1929. Finally, the table of sun-spot relative numbers is carried on to 1930, and there is also a table of mean monthly values of solar radiation for the years 1921 to 1930. There is a double index on the same lines as that to volume 79, giving first an alphabetical list of stations and countries, and secondly a list of stations arranged from west to east in ten-degree zones of latitude, as adopted in the Réseau Mondial. Frequent reference to the first volume has shown that this double index is of great value and fully worth the additional space involved.

One of the most important uses of data of this kind is to plot them on charts. To facilitate the use of the "World Weather Records" for this purpose, the Smithsonian Institution has prepared two maps of the world, one on an elliptical projection and the other hemispherical, showing the positions of all the stations. A slip inserted in the volume states that copies of these charts can be purchased from the Smithsonian Institution at a price of 5 cents per sheet or four dollars per 100. There is no doubt that many scientists — geographers, botanists, etc., as well as meteorologists, will make exten-



sive use of the great mine of information contained in "World Weather Records", and will wish to avail themselves of these maps so thoughtfully provided by the Institution.

We understand that copies of the second series of "World Weather Records", but not of the maps, will be stocked in this country by Messrs. Wheldon and Wesley, Ltd., 2, Arthur Street, W.C.2, and will be on sale at 15s. per copy.

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### REVIEW.

*India Meteorological Department, Memoirs, Vol. XXVI, Part II—The Indian south-west monsoon and the structure of depressions associated with it.* By K. R. Ramanathan, M.A., D.Sc., and K. P. Ramakrishnan, B.A.; Vol. XXVI, Part III.—*On the physical characteristics of fronts during the Indian south-west monsoon.* By N. K. Sur.

These two papers make a contribution to frontal analysis in India during the south-west monsoon, and cover much the same ground. The first discusses the mean upper air winds and temperatures in each of the months May, June, July, and then proceeds to a detailed description of the life-history of two monsoonal depressions which originated in the Bay of Bengal. The second paper discusses four cases of monsoonal depressions. The authors of both papers recognise three chief types of air-mass over India during the monsoon, viz., the fresh monsoon air from west or south-west, the old returning monsoon air from east and north-east and the north-westerly continental air. The last often intervenes between the fresh monsoon current over central and southern India and the easterly current in the north-east of India. This old monsoon air acts as "warm" air, and in ascending over one or both of the other two currents is a principal cause of rain. The investigations do not support the idea of a stationary cyclone derived by Wagner\* from the consideration of mean values. The papers are plentifully supplied with maps, but some of these could have been more legible with advantage.

A. F. CROSSLEY.

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### BOOKS RECEIVED.

*Totland Bay, Isle of Wight. Meteorological Observations for the year 1932 with extremes and averages for preceding years.* By J. Dover, M.A. Newport, Isle of Wight, 1933.

*Some meteorological data for 1930 and 1931.* By Dr. E. Kidson. Wellington, N.Z. Meteorological Office Note No. 11, 1932.

*Meteorological Observations for 1931 Prepared in the Meteorological Office, Wellington.* E. Kidson, D.Sc., Director, New Zealand Dept. of Scientific and Industrial Research. Wellington, N.Z., 1933.

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\* A. Wagner, Zur Aerologie des Indischen Monsuns. *Beitr. Geoph., Leipzig*, Bd. 30, 1931, p. 196.

## OBITUARY.

*Alfred John Rigby.*—We regret to learn of the death of Mr. Rigby, which took place on June 2nd after 21 years of retirement from the Meteorological Office. Mr. Rigby was born in 1847, and at the age of 15 entered the service of Kew Observatory, where he was engaged for 12 years. In 1874 he was appointed to a temporary clerkship in the Observatories Branch of the Office and transferred later to the Telegraphic Section. He afterwards became a senior officer of the Statistical Branch, in which he remained until his retirement in March, 1913. Mr. Rigby enjoyed a robust and vigorous personality. From 1884 onward his time was mainly devoted to the preparation of the *Monthly Weather Report*, which has remained one of the standard publications of the Meteorological Office.

A. T. BENCH.

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## NEWS IN BRIEF.

We learn that General Delcambre retired from the directorship of l'Office National Météorologique, Paris on July 1st. He is succeeded as Director by M. Ph. Wehrlé.

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Rev. G. W. Stewart, of St. Philips, Scalby, Scarborough, informs us that he has for disposal a number of bound volumes of scientific publications, formerly the property of the Rev. W. E. Stewart, whose death was referred to in the April, 1934, number of this magazine. The books include *British Rainfall*, 1886–1921, 1929–32, and a number of volumes of the *Quarterly Journal of the Royal Meteorological Society*, *Monthly Notices Royal Astronomical Society*, *British Astronomical Journal*, *The Observatory* and *Knowledge*. Any persons interested should write direct to the Rev. G. W. Stewart.

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## The Weather of July, 1934.

Pressure was above normal over north and east Russia, Spitsbergen, most of Scandinavia, the British Isles, the Azores, most of Spain, north central Canada and Mexico, the greatest excess being 6·4 mb. at Waigatsch. Pressure was below normal elsewhere in Europe, over the Mediterranean, Madeira, Portugal, the United States, and west, south central, and east Canada, the greatest deficits being 4·1 mb. at 40° N., 40° E. and 3·0 mb. at 40° N., 110° W. Temperature was above normal in Spitsbergen and Scandinavia (over 5° F. in northern Norrland), about normal in Switzerland and below normal in south-west Europe, while rainfall was deficient in western Europe and Spitsbergen and in excess in Scandinavia as a whole.

The main features of the weather of July over the British Isles were marked excess of sunshine in all areas, high temperatures in most

parts, deficiency of rain in many districts, and frequent thunderstorms between the 11th and 22nd. Sunshine values at Holyhead and Ross-on-Wye were the highest reported at these stations for July since records began in 1914 and 1915 respectively. The rainfall at Holyhead was the lowest value for July measured at that station since records began in 1871. At Southport, July 1934 was the warmest month of any name in the 63 years' history of the Fernley Observatory, the mean temperature ( $64.5^{\circ}\text{F.}$ ) being  $4.7^{\circ}\text{F.}$  above the July average—the previous warmest month there was August, 1911. From the 1st to 11th mainly anticyclonic conditions prevailed, and the weather continued fine, sunny and warm though slight rain fell in north Scotland and north Ireland at times. Thunder was heard locally in north England on the 6th and 7th, and a thunderstorm was reported from Auchincruive (Ayr) on the 6th. Temperature rose gradually at the beginning of this period and exceeded  $85^{\circ}\text{F.}$  in many places from the 6th to 11th;  $90^{\circ}\text{F.}$  was recorded at Collumpton (Devon) on the 10th,  $89^{\circ}\text{F.}$  at Sealand on the 11th, and  $88^{\circ}\text{F.}$  at Southport, Chester and Bath on the 10th, and at Rhyl on the 9th and 11th and Cheltenham on the 8th. Good sunshine records were obtained from all parts throughout the period, and especially on the 3rd, 5th and 8th to 11th; 16.5 hrs. were recorded at Stornoway on the 9th and 16.0 hrs. at Dalwhinnie on the 9th and at Tiree on the 8th. Kew recorded 131.9 hrs. bright sunshine in the first 10 days, which constitutes a record since observations began there in 1880. Some mist or fog, however, occurred locally. From the 11th to 22nd shallow disturbances crossed the country giving cooler thundery weather, getting warmer again about the 17th, with light to moderate winds, freshening locally occasionally. Thunderstorms, severe in some places, occurred over a wide area on the 11th, 12th, 13th, 14th, 17th, 18th, 19th, 21st and 22nd.\* These caused some structural damage and temporary flooding as the rain was heavy locally; 4.55 in. fell at West Wickham (Kent) on the 22nd.† Sunshine values were variable, but considerable sunny periods were enjoyed at most places over the whole country. Some mist or fog occurred at times. From the 23rd to 29th, pressure was low to the north and high to the south-west, giving moderate W. winds strengthening to high winds or gales locally from the 26th to 28th. Beaufort force 9 was reported from Spurn Head at 13 h. on the 26th, and a gust of 61 m.p.h. from Liverpool on the 28th. The weather was generally warm and unsettled with occasional rain or drizzle and cooler periods in most areas, but also considerable warm sunny intervals, particularly in the south. Thunderstorms occurred in the south on the 24th. On the 30th and 31st the northerly depression became centred more to the west of the British Isles and more general rain was experienced in the west and north and thunderstorms in east and south-east England. The distribution of bright

\* See p. 160.

† For other heavy falls, see p. 162.

sunshine for the month was as follows:—

Diff. from			Diff. from		
	Total	normal		Total	normal
	(hrs.)	(hrs.)		(hrs.)	(hrs.)
Stornoway ...	167	+19	Liverpool ...	244	+61
Aberdeen ...	186	+35	Ross-on-Wye ...	271	+83
Dublin ...	217	+45	Falmouth ...	276	+55
Birr Castle ...	195	+47	Gorleston ...	274	+68
Valentia... ..	182	+24	Kew ... ..	281	+86

*Miscellaneous notes on weather abroad culled from various sources.*

A cloudburst occurred near Nikopol, in the Danube Valley, at the beginning of the month causing floods, and 18 people were killed. No rain fell in Switzerland during the first 10 days of the month and the temperature was unusually high. Drought was also experienced during this period in Germany, where numerous forest and heath fires occurred. Violent thunderstorms accompanied by hail, which did much damage to crops, occurred in parts of southern and eastern France on the 14th and 15th. Rainfall of tropical intensity fell in Galicia between the 16th and 18th, and floods of unprecedented severity were experienced there from the 17th to 22nd. By the 19th the Dunajec, San, Raba and Sola rivers had begun to subside, but the Vistula, north of Cracow, continued to rise. Heavy rain fell throughout Poland on the 22nd–25th, but the level of the Vistula at Warsaw fell as the dams in the Sandomierz district gave way on the 22nd. By the 26th, however, conditions had improved and sunny weather was reported after violent thunderstorms during the preceding night. A spell of intensely hot weather in northern Italy was broken on the 21st by violent thunderstorms accompanied by hail—the most serious damage was done in Piedmont and in the Novara region. Thunderstorms and hail also did much damage over a wide area south of Lugano on the 21st and in southern France on the 22nd. (*The Times*, July 4th–27th.)

The floods in Assam and east Bengal had begun to subside by the beginning of the month. Ninety people were killed and over 1,000 head of cattle perished in floods in three villages in northern Afghanistan. A heavy fall of rain which began on the 10th caused serious floods in the prefectures of Toyama, Ishikawa and Niigata, in Japan. Widespread floods were also reported about the same time in the basins of the Sungari and Nonni rivers in Manchuria, and by the 24th over 100,000 people had been affected by floods in southern Korea. Drought and high temperatures prevailed generally in the Lower Yangtze region throughout the month, but a typhoon swept across east central China on the 22nd. The monsoon in India was generally weak during the middle of the month, but resumed normal activity near the end except over the plains of north-west India. (*The Times*, July 3rd–30th.)

A severe blizzard swept through the Otago Province of New Zealand on the 1st and 2nd.. (*The Times*, July 2nd.)

Hot dry weather was experienced in west Canada during the week ending the 19th, but a severe storm passed across southern and western Ontario on the 6th, and a considerable fall of rain improved the conditions there during the first fortnight. A tornado swept over four Illinois counties on the 11th. Temperature was above normal generally in the United States except about the middle of the month in parts of the Atlantic and Gulf States and towards the end of the month along the Pacific coast, while precipitation was mainly below normal. (*The Times*, July 9th–20th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

### Daily Readings at Kew Observatory, July, 1934

* Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see p. 1).
			Min.	Max.				
	mb.		°F	°F	%	in.	hrs.	
1	1025.3	NNE.3	57	78	51	—	13.7	
2	1025.2	NNW.2	60	78	48	—	11.0	
3	1026.2	CALM	57	77	47	—	8.9	
4	1023.9	W.1	54	80	50	—	12.1	w early.
5	1020.1	ENE.3	53	77	40	—	14.8	
6	1021.8	E.4	56	79	40	—	13.9	w early.
7	1024.3	E.3	58	82	37	—	14.1	w early.
8	1024.8	E.3	57	83	27	—	15.2	w early.
9	1023.1	E.4	58	80	38	—	12.3	
10	1019.0	E.4	57	81	16	—	14.9	
11	1014.6	E.5	57	83	29	—	14.0	w early.
12	1010.2	SW.1	61	71	82	0.04	0.2	rr <sub>0</sub> 11h.–13h.
13	1008.5	SW.1	61	74	88	0.55	0.7	rRtl 12h.–14h. & 20h.
14	1012.3	N.2	59	71	51	—	3.9	
15	1019.8	W.3	53	74	44	—	10.2	
16	1022.7	W.3	62	74	58	—	1.9	
17	1018.9	S.2	54	83	45	—	13.7	w early.
18	1010.1	NNE.4	64	79	41	1.28	9.2	RHtl 18h. 20m.–
19	1014.7	WSW.3	56	76	42	—	11.1	[19h.30m.
20	1008.8	SSE.2	54	80	46	—	11.1	
21	1006.5	E.3	62	75	53	0.17	3.4	ir <sub>0</sub> 2h.–8h. t 16h.
22	1009.4	NNW.2	58	77	58	0.78	6.3	tlrR 18h. 10m –
23	1014.4	NNW.3	60	73	42	—	7.6	[20h. 40m.
24	1015.9	NNE.3	56	67	93	0.35	4.2	irr <sub>0</sub> 9h.–21h. ; tlr 11h.
25	1019.0	W.3	55	74	57	—	4.7	f till after 7h. [–13h.
26	1016.3	WSW.4	58	79	60	—	10.7	
27	1017.7	W.4	57	70	47	—	9.0	
28	1011.1	WSW.5	56	75	48	—	6.6	
29	1011.3	WSW.4	59	74	73	0.61	3.1	pr 13h., t 18h. 30m.
30	1011.0	SSW.3	62	80	59	—	12.0	
31	1006.1	SW.4	63	77	58	0.61	6.8	pr 11h. 20m.

\* The dates of Sundays are in heavy type.

### General Rainfall for July, 1934

England and Wales	...	56	} per cent of the average 1881–1915.
Scotland	...	108	
Ireland	...	68	
British Isles	...	70	

**Rainfall : July, 1934 : England and Wales**

Co.	STATION.	In.	Per cent of Av.	Co.	STATION.	In.	Per cent of Av.
<i>Lond</i>	Camden Square.....	·94	39	<i>Leics</i>	Thornton Reservoir ...	1·28	52
<i>Sur</i>	Reigate, Wray Pk. Rd..	2·20	98	„	Belvoir Castle.....	2·76	114
<i>Kent</i>	Tenterden, Ashenden...	1·30	62	<i>Rut</i>	Ridlington .....	·85	34
„	Folkestone, Boro. San.	2·22	...	<i>Lincs</i>	Boston, Skirbeck.....	1·29	59
„	Eden'bdg., Falconhurst	1·88	82	„	Cranwell Aerodrome...	2·94	126
„	Sevenoaks, Speldhurst.	1·46	...	„	Skegness, Marine Gdns.	·87	40
<i>Sus</i>	Compton, Compton Ho.	1·49	53	„	Louth, Westgate.....	1·62	65
„	Patching Farm.....	1·31	55	„	Brigg, Wrawby St.....	1·00	...
„	Eastbourne, Wil. Sq....	1·04	47	<i>Notts</i>	Worksop, Hodsock.....	1·85	81
„	Heathfield, Barklye....	2·53	101	<i>Derby</i>	Derby, L. M. & S. Rly.	·97	41
<i>Hants</i>	Ventnor, Roy.Nat.Hos.	·35	17	„	Buxton, Terr. Slopes...	2·72	69
„	Fordingbridge, Oaklnds	1·32	66	<i>Ches</i>	Runcorn, Weston Pt....	1·57	57
„	Ovington Rectory.....	2·36	91	<i>Lancs</i>	Manchester, Whit. Pk.	2·14	65
„	Sherborne St. John.....	2·45	110	„	Stonyhurst College.....	2·17	56
<i>Herts</i>	Welwyn Garden City ...	1·48	64	„	Southport, Bedford Pk.	1·29	45
<i>Bucks</i>	Slough, Upton.....	1·51	79	„	Lancaster, Greg Obsy.	2·27	65
„	H. Wycombe, Flackwell	·87	43	<i>Yorks</i>	Wath-upon-Deerne.....	1·42	57
<i>Oxf</i>	Oxford, Mag. College...	1·08	48	„	Wakefield, Clarence Pk.	1·74	69
<i>Nor</i>	Pitford, Sedgebrook...	·92	39	„	Oughtershaw Hall.....	3·00	...
„	Oundle .....	2·61	...	„	Wetherby, Ribston H.	1·80	72
<i>Beds</i>	Woburn, Exptl. Farm...	1·29	68	„	Hull, Pearson Park.....	1·17	50
<i>Cam</i>	Cambridge, Bot. Gdns.	1·26	58	„	Holme-on-Spalding.....	1·91	74
<i>Essex</i>	Chelmsford, County Lab	1·85	87	„	West Witton, Ivy Ho.	1·26	48
„	Lexden Hill House.....	1·14	...	„	Felixkirk, Mt. St. John.	3·46	127
<i>Suff</i>	Haughley House.....	1·37	...	„	York, Museum Gdns....	1·52	60
„	Campsea Ashe.....	1·71	74	„	Pickering, Hungate.....	1·82	68
„	Lowestoft Sec. School...	...	...	„	Scarborough.....	1·79	74
„	Bury St. Ed., Westley H.	1·05	42	„	Middlesbrough.....	1·56	61
<i>Norf.</i>	Wells, Holkham Hall...	1·02	44	„	Baldersdale, Hury Res.	2·93	91
<i>Wilts</i>	Calne, Castleway.....	1·39	57	<i>Durh</i>	Ushaw College.....	2·07	74
„	Porton, W.D. Exp'l. Stn	1·38	70	<i>Nor</i>	Newcastle, Town Moor.	2·25	85
<i>Dor</i>	Evershot, Melbury Ho.	·70	27	„	Bellingham, Highgreen	3·54	107
„	Weymouth, Westham.	·12	7	„	Lilburn Tower Gdns....	1·52	62
„	Shaftesbury, Abbey Ho.	·97	38	<i>Cumb</i>	Carlisle, Scaleby Hall...	2·67	82
<i>Devon</i>	Plymouth, The Hoe....	·41	15	„	Borrowdale, Seathwaite	4·00	51
„	Holne, Church Pk. Cott.	·68	19	„	Borrowdale, Moraine...	2·88	45
„	Teignmouth, Den Gdns.	·41	17	„	Keswick, High Hill....	1·53	40
„	Cullompton .....	1·96	73	<i>West</i>	Appleby, Castle Bank...	1·69	53
„	Sidmouth, U.D.C.....	·36	...	<i>Mon</i>	Abergavenny, Larchfd	2·16	87
„	Barnstaple, N. Dev. Ath	·39	14	<i>Glam</i>	Ystalyfera, Wern Ho....	1·24	27
„	Dartm'r, Cranmere Pool	2·00	...	„	Cardiff, Ely P. Stn.....	1·13	36
„	Okehampton, Uplands.	1·40	43	„	Treherbert, Tynywaun.	2·68	...
<i>Corn</i>	Redruth, Trewirgie.....	·85	28	<i>Carm</i>	Carmarthen, Priory St..	·34	10
„	Penzance, Morrab Gdn.	·58	21	<i>Pemb</i>	Haverfordwest, School.	...	...
„	St. Austell, Trevarna...	·63	19	<i>Card</i>	Aberystwyth .....	1·75	...
<i>Soms</i>	Chewton Mendip.....	1·25	36	<i>Rad</i>	Birm W.W. Tyrmynydd	2·55	62
„	Long Ashton.....	1·70	60	<i>Mont</i>	Lake Vyrnwy .....	1·21	35
„	Street, Millfield.....	·94	38	<i>Flint</i>	Sealand Aerodrome.....	·69	29
<i>Glos</i>	Blockley .....	1·19	...	<i>Mer</i>	Dolgelley, Bontddu.....	2·02	90
„	Cirencester, Gwynfa...	2·24	87	<i>Carn</i>	Llandudno .....	·88	39
<i>Here</i>	Ross, Birchlea.....	·71	31	„	Snowdon, L. Llydaw 9.	3·73	...
<i>Salop</i>	Church Stretton.....	1·65	67	<i>Ang</i>	Holyhead, Salt Island...	·42	16
„	Shifnal, Hatton Grange	1·66	74	„	Llwygy .....	·34	...
<i>Staffs</i>	Market Drayt'n, Old Sp.	1·25	46	<i>Isle of Man</i>			
<i>Worc</i>	Ombersley, Holt Lock.	·79	37		Douglas, Boro' Cem....	·46	15
<i>War</i>	Alcester, Ragley Hall...	1·09	46	<i>Guernsey</i>			
„	Birmingham, Edgbaston	1·00	43		St. Peter P't. Grange Rd.	08	4

**Rainfall : July, 1934 : Scotland and Ireland**

Co.	STATION.	In.	Per cent of Av.	Co.	STATION.	In.	Per cent of Av.
<i>Wig</i>	Pt. William, Monreith.	2.58	92	<i>Suth</i>	Melvich.....	4.91	175
"	New Luce School.....	2.57	76	"	Loch More, Achfary....	7.83	146
<i>Kirk</i>	Dalry, Glendarroch.....	2.92	81	<i>Caith</i>	Wick.....	2.30	87
"	Carsphairn, Shiel.....	3.39	65	<i>Ork</i>	Deerness .....	...	...
<i>Dumf.</i>	Dumfries, Crichton, R.I.	2.11	69	<i>Shet</i>	Lerwick .....	1.80	79
"	Eskdalemuir Obs.....	2.53	62	<i>Cork</i>	Caheragh Rectory.....	3.13	...
<i>Roxb</i>	Braxholm.....	2.69	89	"	Dunmanway Rectory...	3.75	96
<i>Selk</i>	Ettrick Manse.....	2.26	51	"	Cork, University Coll...	2.20	81
<i>Peeb</i>	West Linton.....	3.38	...	"	Ballinacurra.....	1.79	64
<i>Berw</i>	Marchmont House.....	1.92	63	"	Mallow, Longueville....	1.95	78
<i>E.Lot</i>	North Berwick Res.....	2.68	104	<i>Kerry</i>	Valentia Obsy.....	2.73	72
<i>Midl</i>	Edinburgh, Roy. Obs.	2.83	100	"	Gearhameen.....	4.80	83
<i>Lan</i>	Auchtyfardle .....	2.77	...	"	Darrynane Abbey.....	2.94	77
<i>Ayr</i>	Kilmarnock, Kay Pk....	3.08	...	<i>Wat</i>	Waterford, Gortmore...	.73	23
"	Girvan, Pinmore.....	2.47	93	<i>Tip</i>	Nenagh, Cas. Lough....	2.13	68
<i>Renf</i>	Glasgow, Queen's Pk....	2.22	76	"	Roscrea, Timoney Park	3.06	...
"	Greenock, Prospect H.	2.85	73	"	Cashel, Ballinamona....	1.78	61
<i>Bute</i>	Rothsay, Ardenraig....	3.35	...	<i>Lim</i>	Foynes, Coolnanes.....	2.08	67
"	Dougarie Lodge.....	2.23	...	"	Castleconnel Rec.....	1.83	...
<i>Arg</i>	Ardgour House.....	7.80	...	<i>Clare</i>	Inagh, Mount Callan....	5.26	...
"	Glen Etive.....	7.27	125	"	Broadford, Hurdlest'n.	2.62	...
"	Oban.....	3.46	...	<i>Wexf</i>	Gorey, Courtown Ho....	1.70	58
"	Poltalloch.....	3.84	94	<i>Wick</i>	Rathnew, Clonmannon..	.65	...
"	Inveraray Castle.....	4.40	88	<i>Carl</i>	Hacketstown Rectory...	1.42	41
"	Islay, Eallabus.....	3.05	90	<i>Leix</i>	Blacksod House.....	.74	24
"	Mull, Benmore.....	13.50	129	"	Mountmellick .....	1.13	...
"	Tiree.....	3.32	92	<i>Offaly</i>	Birr Castle.....	1.80	61
<i>Kinr</i>	Loch Leven Sluice.....	3.66	127	<i>Dublin</i>	Dublin, FitzWm. Sq....	1.26	49
<i>Perth</i>	Loch Dhu.....	...	...	"	Balbriggan, Ardgillan...	.59	22
"	Balquhidder, Stronvar.	3.40	...	<i>Meath</i>	Beauparc, St. Cloud....	.98	...
"	Crieff, Strathearn Hyd.	2.69	91	"	Kells, Headfort.....	.78	25
"	Blair Castle Gardens...	3.41	133	<i>W.M.</i>	Moate, Coolatore.....	1.81	...
<i>Angus</i>	Kettins School.....	3.55	137	"	Mullingar, Belvedere...	2.09	66
"	Pearsie House.....	4.11	...	<i>Long</i>	Castle Forbes Gdns.....	1.53	49
"	Montrose, Sunnyside...	2.43	92	<i>Gal</i>	Galway, Grammar Sch.	...	...
<i>Aber</i>	Braemar, Bank.....	4.11	160	"	Ballynahinch Castle....	5.15	124
"	Logie Coldstone Sch....	3.34	113	"	Ahascragh, Clonbrock..	1.58	45
"	Aberdeen, King's Coll.	1.72	61	<i>Mayo</i>	Blacksod Point.....	4.16	132
"	Fyvie Castle.....	3.01	93	"	Mallaranny .....	5.02	...
<i>Moray</i>	Gordon Castle.....	3.03	95	"	Westport House.....	3.27	105
"	Grantown-on-Spey .....	4.47	146	"	Delphi Lodge.....	8.66	131
<i>Nairn</i>	Nairn .....	4.06	152	<i>Sligo</i>	Markree Obsy.....	2.42	70
<i>Inv's</i>	Ben Alder Lodge.....	2.67	...	<i>Cavan</i>	Crossdoney, Kevit Cas..	2.20	...
"	Kingussie, The Birches.	5.09	...	<i>Ferm</i>	Enniskillen, Portora....	...	...
"	Inverness, Culduthel R.	4.67	...	<i>Arm</i>	Armagh Obsy.....	2.52	87
"	Loch Quoich, Loan.....	...	...	<i>Down</i>	Fofanny Reservoir.....	2.60	...
"	Glenquoich .....	...	...	"	Seaforde .....	2.05	64
"	Arisaig, Faire-na-Sguir.	...	...	"	Donaghadee, C. Stn.	1.56	56
"	Fort William, Glasdrum	...	...	"	Banbridge, Milltown....	1.98	61
"	Skye, Dunvegan.....	5.47	...	<i>Antr</i>	Belfast, Cavehill Rd....	3.12	...
"	Barra, Skallary.....	4.73	...	"	Aldergrove Aerodrome.	3.13	112
<i>R&amp;C</i>	Alness, Ardross Castle.	7.14	235	"	Ballymena, Harryville.	2.35	69
"	Ullapool .....	4.94	156	<i>Lon</i>	Garvagh, Moneydig....	3.10	...
"	Achnashellach .....	5.92	115	"	Londonderry, Creggan.	3.40	93
"	Stornoway .....	5.21	169	<i>Tyr</i>	Omagh, Edenfel.....	2.26	67
<i>Suth</i>	Lairg.....	4.59	147	<i>Don</i>	Malin Head.....	2.84	...
"	Tongue .....	4.65	152	"	Killybegs, Rockmount.	...	...

## Climatological Table for the British Empire, February, 1934

STATIONS.	PRESSURE.		TEMPERATURE.							Relative Humidity.	Mean Cloud Am't	PRECIPITATION.			BRIGHT SUNSHINE.	
	Mean of Day M.S.L.	Diff. from Normal.	Absolute.		Mean Values.							Am't.	Diff. from Normal.	Days.	Hours per day.	Per-centage of possible.
			Max.	Min.	Max.	Min.	1 and 2 Min.	Diff. from Normal.	Wet Bulb.							
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	%	0-10	in.	in.				
London, Kew Obsy.....	1030.7	+14.7	53	24	44.1	31.8	37.9	33.6	87	7.3	0.22	1.32	4	2.74	28	
Gibraltar.....	1021.5	+1.5	65	36	59.8	46.9	53.3	46.4	79	6.1	1.46	3.05	6	...	...	
Malta.....	1019.2	+3.1	67	41	58.2	48.5	53.3	47.5	69	5.8	1.19	1.01	7	7.09	66	
St. Helena.....	1011.1	-0.4	72	59	68.8	62.0	65.4	62.8	95	8.8	4.71	...	24	...	...	
Freetown, Sierra Leone.....	1012.7	+1.9	91	65	86.8	67.9	77.3	74.5	81	1.8	0.07	0.23	1	...	...	
Lagos, Nigeria.....	1009.7	0.0	91	70	89.0	76.4	82.7	75.0	82	3.4	0.00	1.90	0	6.02	51	
Kaduna, Nigeria.....	1009.4	...	99	54	91.6	57.7	74.7	53.6	36	1.0	0.00	0.02	0	9.2	78	
Zomba, Nyasaland.....	1006.5	-1.4	86	62	81.3	64.1	72.7	68.6	77	7.4	10.03	0.57	22	...	...	
Salisbury, Rhodesia.....	1008.7	-1.4	85	51	79.1	59.7	69.4	62.7	72	6.2	7.73	0.91	11	7.2	57	
Cape Town.....	1013.1	-0.3	100	57	83.9	62.9	73.4	62.8	68	3.2	0.46	0.12	6	...	...	
Johannesburg.....	1010.9	-0.3	80	45	75.0	54.8	64.9	57.8	70	4.7	1.09	4.13	9	8.6	66	
Mauritius.....	1012.2	+1.2	88	70	84.7	72.5	78.6	74.3	73	6.1	1.20	7.20	19	9.7	76	
Calcutta, Alipore Obsy.....	1011.6	-1.7	96	49	83.1	61.6	72.3	61.9	85	3.5	0.08	0.91	0*	...	...	
Bombay.....	1011.6	-1.1	95	59	85.6	68.0	76.8	67.2	75	1.9	0.00	0.03	0*	...	...	
Madras.....	1012.1	-0.8	91	59	85.2	66.5	75.9	71.3	89	2.5	0.00	0.30	0*	...	...	
Colombo, Ceylon.....	1010.7	-0.1	90	63	85.9	71.0	78.5	73.2	74	4.1	2.81	0.87	10	8.9	75	
Singapore.....	1009.8	-0.4	89	69	84.7	70.8	77.7	74.2	82	7.8	6.07	0.55	15	5.6	47	
Hongkong.....	1018.9	+0.3	76	47	66.2	56.0	61.1	54.7	67	4.8	1.51	0.32	5	6.5	57	
Sandakan.....	1010.3	...	88	70	84.3	72.7	78.5	75.3	90	8.4	25.56	14.59	24	...	...	
Sydney, N.S.W.....	1014.0	+0.1	90	58	76.5	64.7	70.6	66.9	73	6.0	8.60	4.40	13	6.5	48	
Melbourne.....	1015.2	+0.7	102	50	78.0	57.9	67.9	61.4	64	6.4	1.10	0.61	8	6.9	51	
Adelaide.....	1014.9	+0.7	109	51	86.9	62.4	74.7	60.6	37	4.0	0.14	0.58	3	10.0	75	
Perth, W. Australia.....	1011.6	-1.4	109	54	88.5	67.4	77.9	64.2	49	5.5	0.16	0.29	4	8.6	65	
Coalgardie.....	1010.6	-1.9	109	55	96.8	71.6	84.2	64.2	41	4.2	0.00	0.85	0	...	...	
Brisbane.....	1013.9	+1.4	93	62	83.2	67.0	75.1	69.5	68	5.9	16.16	9.82	10	8.2	63	
Hobart, Tasmania.....	1014.2	+1.0	99	47	72.2	53.4	62.8	55.2	60	7.2	1.27	0.21	7	6.9	50	
Wellington, N.Z.....	1017.5	+1.7	77	47	68.0	55.3	61.7	57.4	74	6.5	3.51	0.37	11	7.5	55	
Suva, Fiji.....	1009.6	+1.8	94	72	86.7	74.1	80.4	75.9	84	6.7	19.95	9.23	24	5.9	46	
Apia, Samoa.....	1010.1	+1.7	89	70	85.0	74.6	79.8	76.4	82	7.5	11.54	3.75	18	...	...	
Kingston, Jamaica.....	1015.9	+0.6	86	65	83.7	67.1	75.4	66.3	89	3.0	3.77	3.17	9	6.8	59	
Grenada, W.I.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
Toronto.....	1024.0	+6.0	34	-21	18.6	1.8	10.2	6.1	63	5.4	0.00	2.38	0	4.8	46	
Winnipeg.....	1023.7	+1.9	41	-36	15.4	-6.3	4.5	...	...	5.2	0.08	0.66	1	3.6	36	
St. John, N.B.....	1014.6	+0.7	42	-20	21.0	2.9	11.9	7.1	73	5.8	1.82	2.08	4	4.7	45	
Victoria, B.C.....	1018.1	+1.5	54	35	50.6	40.7	45.7	41.4	83	5.5	1.54	1.72	9	5.0	49	

\* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.