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EDINBURGH; or from THE METEOROLOGICAL OFFICE, SOUTH KENSINGTON, LONDON, S.W.7.

The Thunderstorms of July, 1923

The Genesis of the Storms

THE widespread thunderstorms which occurred during the warm weather of the first half of last month followed a period singularly free from disturbances of this kind. The abnormal June of this year, the weather of which was dominated by the persistence of high pressure off the western coasts, was practically thunderless, and of the stations in the long list in the *Monthly Weather Report,* only three—Oxford, Whitby and St. Aubin's, Jersey—have any entry of thunderstorms,* and these only one each.

The warm spell commenced on Thursday, July 5th, with the simultaneous filling up of a deep depression near Iceland and the growth of an anticyclone over the Continent, and by the next day a south-easterly current was flowing over the whole kingdom, carrying warm air to the extreme west and north-west coasts, Oban, for example, recording the noteworthy maximum of 80° F. This condition was, however, only transitory, and was followed by the development of a depression west of Ireland and the gradual spreading of south-westerly winds back again over the British Isles, during Saturday, July 7th and Sunday, July 8th. The first outburst of thunderstorms accompanied this change of air supply, the 1h. chart of July 7th showing their simultaneous occurrence down the western coasts at Stornoway,

*Actually there was a *pukka* thunderstorm at St. Aubin's on the 1st. "Thunder heard" was reported at Whitby on the 27th. As to Oxford, no details are available.

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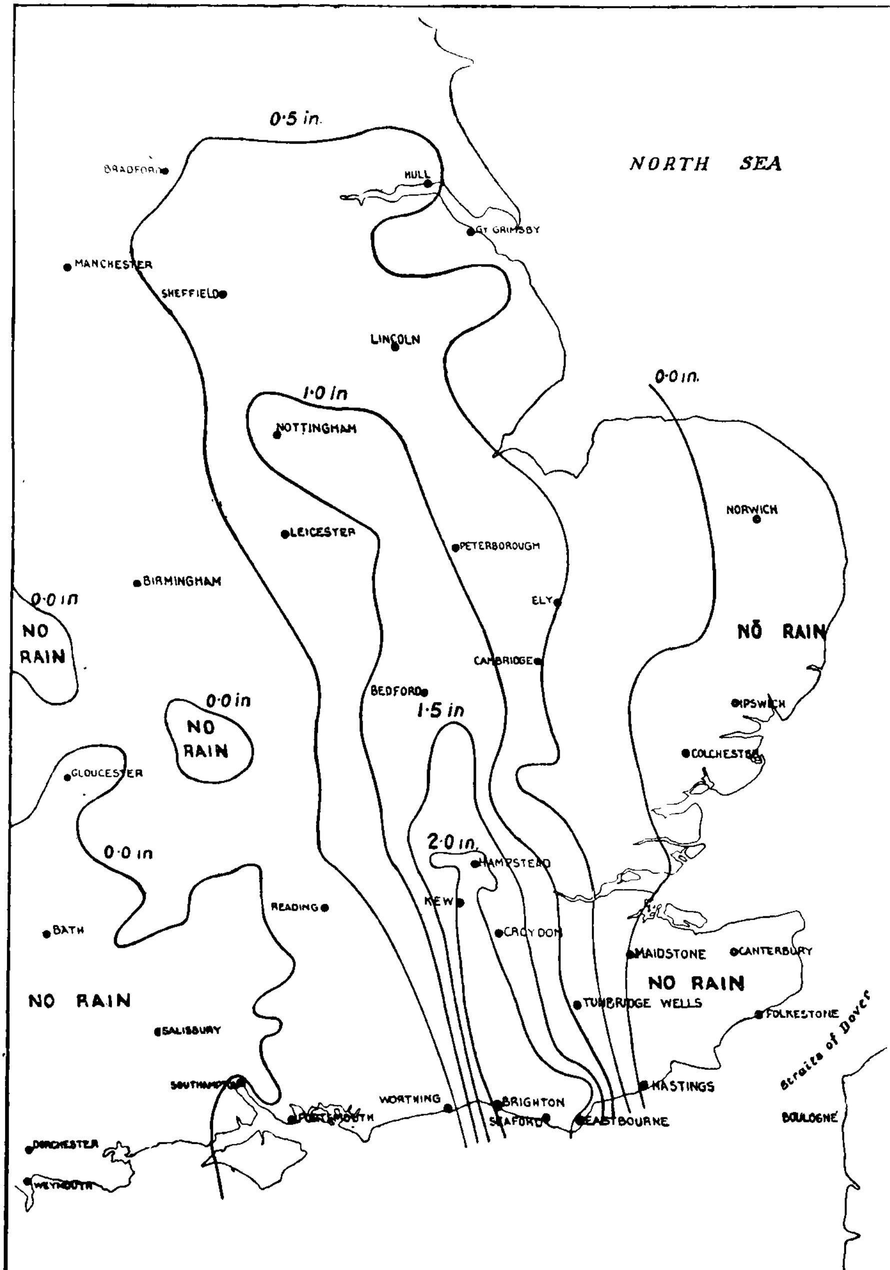
Pembroke, Scilly and the Channel Islands. The line of storms progressed eastwards over the whole kingdom, but the greatest intensity was reached in the north of England and Scotland, where some serious damage was done. In the Carrbridge district of Inverness-shire, on the afternoon of the 8th, flood-water resulting from what is popularly known as a " cloudburst " swept away bridges and caused considerable damage to railway embankments. Yorkshire, too, suffered from very severe storms, and in the Holmfirth district a labourer was killed by lightning on the evening of the 7th.

A second series of storms occurred during the period from the evening of the 9th to the morning of the 11th. This time the theatre of operations was the eastern portion of England and of Scotland, and the series opened late on the 9th with a memorable all-night storm which affected London, and of which some details are given below. Of the remaining storms during this phase, those which occurred in the area round London on Tuesday evening, July 10th, deserve mention. Unlike the storm of the previous night these were preceded by a violent squall of wind. Mr. A. Latchmore, writing from Hitchin, states that his anemometer recorded an increase of wind from calm to gale force in the course of 5 mins. and his barograph at the same time showed an almost instantaneous rise of about 3 mb., followed quickly by a fall of 1·5 mb. At Croydon a wind speed of 53 miles per hour was reached in a gust, and reports of squalls were received from a number of other places. The storm, though only lasting about 2 hours, was very violent in the Windsor area, and the Lower Chapel of Eton College was struck. The depression off the west of Ireland reached its greatest intensity on Monday, July 9th, when the general drift of air over the British Isles was from a southerly point, at any rate a few thousand feet above the surface. The next two days saw the northward movement of this depression and the formation, by the Wednesday afternoon, of a ridge of relatively high pressure across these Islands, linking up the Continental anticyclone with one near the Azores.

Under these conditions there was a temporary freedom from thunderstorms, but by the evening of Thursday, July 12th, a shallow depression had moved up from France to the Channel, and a third series of storms commenced, chiefly affecting the south-west of England and the west Midlands, where some violent storms occurred. A death due to lightning was reported from Totnes.

The end of the warm spell and of the thundery conditions came on Sunday, July 15th, when a general change set in which resulted in the establishment of a " westerly type " over the British Isles.



DISTRIBUTION OF RAINFALL ACCOMPANYING THUNDERSTORM OF JULY 9TH. – 10TH 1923

An account of the London storm based on data available at the time was published in *Nature* of July 21st. It was there mentioned that the chief rainfall was confined to a narrow belt of the country running from SSE to NNW across London, and the rainfall map now published, based on about 200 returns received up to the time of writing, illustrates this. Further returns will no doubt necessitate some modification of the isohyetals, but they certainly represent the main features of the distribution.

Several outstanding falls were reported from places lying within the 2 in. isohyetal. Mr. J. Nicholas recorded a fall of 2·96 in. at an altitude of about 200 feet on the Downs behind Brighton, while a fall of 2·94 in. was measured at Crawley, Sussex, by Mr. N. Longley, following a partial drought lasting 40 days with a total rainfall of only 0·32 in. The largest fall, however, was, as far as reports go at present, 3·21 in. at Seaford, registered by Mr. T. Davys Manning. Other notable falls were 2·80 in. at Burgh Heath, Surrey, reported by Mr. E. M. Taylor, and 2·56 in. at the Hampstead Observatory, the largest fall measured in London.

The storm apparently developed over the Channel and rain is reported as having commenced about 20h. 30m. (Greenwich time) at Seaford, after which it spread NNW at a speed of about 25 miles per hour, a direction and speed in close agreement with the upper wind current between 6,000 and 18,000 feet shown by pilot-balloon ascents on the evening of the 9th. Rain was continuous in the south for something over six hours and at one stage must have been falling simultaneously over most of the strip shown in the accompanying diagram.

M. A. GIBLETT.

The Great Storm in London

THE thunderstorm of July 9th—10th was probably the severest recorded in the London area since that of May 31st, 1911. Both storms occurred under very similar pressure distributions, a narrow neck of relatively low pressure lying over southern England between anticyclonic systems to the north-east and south-west. Sheet lightning was first seen at Chelsea at 22h.* in an ESE direction, thunder being first heard at 22h. 13m. The storm rose to a maximum intensity between 23h. 30m. and 24h. with a most spectacular display of lightning to the south and thunder overhead. A second phase of intensity occurred between 3h. and 4h. on the 10th with the active development of

* All times are G.M.T.

a centre in the NE. Thunder was last heard at 4h. 54m. The brontometer record gave the following number and rate of flashes :—

Time.	Number of Flashes.	Average per Minute.	Max. number in one Minute.
22h.—23h.	600.	10	17
23h.—24h.	1,540	26	47
24h.— 1h.	1,327	22	33
1h.— 2h.	1,129	19	30
2h.— 3h.	1,008	17	28
3h.— 4h.	1,320	22	37
6 Hours	6,924	19	47

(On August 22nd, 1917, at 20h. 30m., during a short storm, a flash rate of 50 per minute was obtained ; during the past 14 years, in south-east England, over a large number of storms, the average flash rate is 12 per minute).

The storm apparently occurred at a high altitude, and a very marked feature was the predominance of cloud to cloud discharges. The cloud forms were alto-stratus, alto-cumulus and false cirrus. I was unable definitely to identify cumulo-nimbus before 3h. 30m., and at that hour it was not well developed. Rain commenced at 22h. 48m., the period of heaviest rainfall lying between 23h. 30m. and 4h.

Further storms occurred on the 10th from 7h. 25m. to 7h. 45m., and from 17h. 45m. to 18h. 50m. During the latter, on the sudden commencement of rain at 18h. 30m., a very rapid disintegration of cumulo-nimbus to a degraded form of mammato-cumulus was observed.

SPENCER RUSSELL.

Cycling through the Thunderstorm

MY experiences in the thunderstorms of Saturday, July 7th, might prove of some interest.

At about 5.40 p.m. on July 7th I was cycling southwards towards Whitchurch. I could see a thunderstorm in progress ahead of me and eventually ran into it at a point about 2 miles north of Whitchurch. Some of the lightning flashes struck me as being very close, and after several in quick succession there came one which I felt rather than saw. Coincident with its arrival were the following : a loud report like a pistol shot close to my right ear ; a violent but momentary convulsion of my arms and shoulders ; and a "burnt-metallic" taste on my tongue.

As I rode on and thought over the matter I was about to come to the conclusion that the sensations were the outcome of nerves and imagination when, about a quarter of a mile further on, the same thing happened, every sensation being as before except that the explosive sound seemed to be in my head. By this time I had reached the rain area of the storm and, dismounting, took shelter under a hedge; but though the storm continued with considerable violence in the immediate vicinity and, I understand, did much damage, I did not again experience any physical tremors, nor did I hear any reports coincident with the flashes.

I have come to the conclusion that I suffered a minor shock which was minimised by the insulation afforded by the pneumatic tyres. Incidentally, there were no lasting physical ill-effects.

F. W. JUDE.

Civil Aerodrome, Chorlton-cum-Hardy, Manchester, July 13th 1923.

Variability of Tropical Climates—II.

By STEPHEN S. VISHER, Ph.D. (Chicago).

Variation in the Rainfall.

VARIATIONS in rainfall have perhaps even greater significance than variations in temperature or wind. The indications are that in respect to dependability of precipitation, the lower latitudes are notably less fortunate than are middle latitudes. In order to compare the variability of rainfall in the tropical half of the globe with that of higher latitudes, I have inspected the official records for many cities in both zones. The selection was impartial, being determined solely by whether or not the data were readily available. The comparison is between the greatest and least annual precipitation officially recorded before a recent year. The length of the record varies, but in general it is shorter in low than in higher latitudes, and hence tends to lessen the apparent range in lower latitudes. Tables 3 and 4 give the figures to the nearest one-tenth inch for a few of the stations examined. It will be noticed that the maximum amount of rainfall received in a year was less than twice the minimum for Chicago and Paris, and only a trifle more than twice the minimum in the case of London and Wellington, N.Z. Very few middle or high latitude cities appear to have experienced three times as much precipitation in their wettest year as in their driest. Madrid, Washington, D.C., and Vladivostok are exceptions, as are some cities in southern Europe, while Buenos Aires, Rome and San Francisco are notable for having received about four times as much. However, many geographers class Rome, San Francisco and Buenos Aires as sub-tropical. Furthermore, Madrid and Vladivostok have an average rainfall of less than 20 in., and thus are more subject to large percentage changes than is the case where the normal rainfall is heavier.

TABLE 3.—EXTREME ANNUAL RANGE IN RAINFALL IN MID-LATITUDES.

City.	Latitude.	Average Rainfall. in.	Driest Year. in.	Wettest Year. in.
Buenos Aires ...	35 S	36·8	21·5	80·7
Chicago	42 N	33·5	24·5	45·9
London	51 N	24·0	18·2	38·2
Madrid	40 N	16·2	9·1	27·5
Paris	49 N	21·9	16·4	29·6
Rome...	42 N	32·6	12·7	57·9
San Francisco ...	38 N	22·8	9.3	38·8
Vladivostok	43 N	19·5	9·4	33·6
Washington	39 N	43·8	18·8	61·0
Wellington, N.Z. ...	42 S	49·7	30·0	67·7

Turning now to the lower latitudes: among scattered cities having 30 in. of rainfall or more, on the average, in no case was the officially recorded rainfall of the wettest year less than twice that of the driest. Only in Calcutta and Caracas did the ratio fall as low as 2·25. In Johannesburg it was 2·5; in Hongkong 2·75; in Colombo and Honolulu about 3; in Manila about 3·5; in Madras 4·5; in Singapore 5; and in Rio de Janeiro 13·4. All these cities have an average rainfall of 30 in. or over and the mean for the group of cities is 58·7 in. in contrast with a mean of 30·1 in. for the cities of Table 3. Since percentage fluctuations tend to become smaller as the total rainfall increases, the great fluctuations experienced by these tropical cities are all the more notable.

TABLE 4.—EXTREME ANNUAL RANGE IN RAINFALL IN LOW LATITUDES.

City.	Latitude.	Average Rainfall. in.	Driest Year. in.	Wettest Year. in.
Calcutta	22 N	62·0	39·4	89·3
Caracas	11 N	30·0	23·7	47·4
Colombo	7 N	83·8	51·6	139·7
Hongkong	22 N	84·1	45·8	119·7
Honolulu	21 N	31·3	14·6	45·0
Johannesburg ...	26 S	31·6	21·7	50·0
Madras	13 N	49·0	18·5	88·4
Manila	15 N	76·3	35·7	117·0
Rio de Janeiro ...	23 S	46·8	4·7	63·5
Singapore	1 N	92·0	32·7	158·7

If tropical and sub-tropical cities having an average rainfall of less than 20 in. are included in the comparison, even more violent ranges are disclosed. For example, Cairo and San Diego each received about 6·3 times as much rainfall in their wettest year as in their driest; Athens 7 times; Helwan 18 times and Onslow 47 times. None of the cities of Table 4, except Singapore, happen to be close to the equator. However, extreme fluctuations occur almost under the equator even on oceanic islands.

At Malden Island (lat. 4° 1′ S, long. 154° 58′ W) for example, the annual totals of rainfall have varied from 3·95 in. in 1908 to 63·41 in. in 1905. At Ocean Island (lat. 0° 52′ S, long. 169° 35′ E), nearly 2,000 miles west of Malden Island and within a degree of the equator, the range has been between 19·15 in. in 1909 and 158·93 in. in 1905 (141·02 in. in 1911). There was likewise a range of from 74 rainy days in 1910 to 232 in 1911.

The great variability illustrated by these two mid-Pacific islands is the more notable because insular climates are commonly thought to be exceptionally uniform, particularly if near the equator and not dominated by nearby continental masses, nor within hurricane regions. Neither of these two is in a hurricane region, both are far from land and close to the equator.

So many other regions in low latitudes experience an unreliable rainfall that it seems unnecessary to do more than mention the famines produced by droughts in India and in southern China or the destructive floods in the same countries. Tropical Australia has perhaps even worse droughts and floods, and is saved from terrible famines only by the sparseness of the population and the skill used in reducing losses to a minimum. The annual range at Onslow in tropical West Australia, for instance, was from 0·57 in. in 1912 to 26·96 in. in 1900 and the average yearly deviation from normal in that region has been about 50 per cent. of the average rainfall.

Excessive falls in short periods afford other illustrations of the uncertainty of rainfall. In tropical Australia, on more than 400 days in a 25 year period more than 10 in. of rain fell in 24 hours according to the official rainfall records, while in temperate Australia there have been very few recorded instances of such heavy rainfalls—none in Victoria or South Australia and only two in Tasmania (max. of 18·1 in. in three days). In tropical Australia, more than 30 in. has been officially recorded as falling in 24 hours on 4 different days. The maximum was 35·71 in. at Crohamhurst, Queensland, Feb. 2, 1893. However, 60 in. fell in three consecutive days at Mt. Molloy, Queensland. At Suva, Fiji, it frequently happens that more than 10 in. of rain fall within 24 hours; there were 4 cases in the 7 years 1906-12. The maximum has been 26·5 in. in less than 4 hours on Aug. 8, 1906. What is believed to be the world's record for officially measured rainfall in 24 consecutive hours occurred near Manila on Feb. 14-15, 1911 (1,168 mm., 46 in.). The other stations at which this maximum has been approached are also in low latitudes, namely, Cherrapunji, India, June 14, 1876, 40·8 in.; Funkiko, Formosa, 40·7 in. Aug. 31, 1911 and Hononu, Hawaii, 31·9 in., Feb. 20, 1918.

With such sharp annual and daily extremes as these, it is reasonable to expect great monthly extremes. At Malden

Island, mentioned above, for example, the range in officially recorded rainfall from 1890 to 1918 was as follows :—

TABLE 5.—MONTHLY VARIATION IN RAINFALL AT MALDEN ISLAND.

Jan.	from	0·00 in.	to	19·48 in.		July	from	0·59 in.	to	10·10 in.	
Feb.	,,	0·00 ,,	,,	9·27 ,,		Aug.	,,	0·18 ,,	,,	5·56 ,,	
Mar.	,,	0·15 ,,	,,	25·65 ,,		Sept.	,,	0·05 ,,	,,	3·03 ,,	
Apr.	,,	0·47 ,,	,,	12·34 ,,		Oct.	,,	0·00 ,,	,,	5·27 ,,	
May	,,	0·29 ,,	,,	12·30 ,,		Nov.	,,	0·00 ,,	,,	8·72 ,,	
June	,,	0·00 ,,	,,	12·49 ,,		Dec.	,,	0·00 ,,	,,	8·20 ,,	

The four months November, 1891, to February, 1892, received a total of only 0·72 in. while the four months January to April, 1915, received over 60 in. The number of rainy days per year varied from 30 to 144. The Philippines show scarcely less violent extremes. In the 16 year period 1903-18, 42 of the 70 stations had a total of about 160 months with no rainfall, while at the other extreme, the wettest months at about half the 70 stations exceeded 40 in. of rain and had less than 20 in. in the case of only 8 stations. This variation is only partly seasonal, for a month which is very dry one year may be excessively wet another. Severe and wide-spread droughts, with over 100 days without rain, are contrasted with destructive floods caused by rainfalls of more than 20 in. in a day or two. Even at Hilo, on the wet side of Hawaii, where the rainfall averages 139·4 in. a year and is relatively reliable, a 13 year period shows that the monthly amounts have varied widely, *e.g.*, January from 0·5 in. to 38·6 in., February from 1·9 in. to 32·5 in.

That the great variation from year to year in rainfall discussed in the foregoing pages is not local is suggested by various data. For example, the mean rainfall of the entire Hawaiian group (150 stations) was more than twice as great in 1919 as in 1918 (112·9 in. *v.* 54·5 in.). Likewise in the Philippines during the droughts such as that referred to in a preceding paragraph, nearly all of the 70 stations are affected similarly.

Another sort of variation in rainfall which is prominent in the tropics is the seasonal type. Very few tropical localities receive their rainfall as evenly distributed throughout the year as is common in many parts of middle latitudes. Distinct wet and dry seasons are the rule. The rainy summers and dry winters of India and China are well known. Most of tropical Australia also receives almost no rain for six months and from 15 in. to 50 in. or more in the other six months. Hawaii, and many other places near the margins of the tropics receive much of their rainfall in winter, while still other parts of the tropics have two wet and two dry seasons.

In order to compare the monthly variability of rainfall in low and middle latitudes, a planimeter measurement was made of Supan's Map of Percentage Range of Mean Monthly Rainfall in Bartholomew's *Atlas of Meteorology.* This map shows four types of regions: (1) where the wettest month is less than 10 per cent. rainier than the driest month; (2) where the wettest month is from 10-20 per cent. rainier than the driest; (3) where the range is from 20-30 per cent.; and (4) where it is over 30 per cent. Tables 6 and 7 show the approximate area and the percentage of each type, by continents. Table 6 concerns middle latitudes (30° to 60°); Table 7 concerns low latitudes (30° N to 30° S.)

TABLE 6.—PERCENTAGE RANGE OF MEAN MONTHLY RAINFALL, LATITUDES 30° TO 60°.

	Range under 10 %		Range 10—20 %		Range 20—30 %		Range over 30 %	
	Sq. Mi. ×10⁶	%	Sq. Mi. ×10⁶	%	Sq. Mi. ×10⁶	%	Sq. Mi. ×10⁶	%
Europe ...	1·77	65	·88	34	·03	1	0	0
N. America ...	2·06	43	2·62	54	·14	3	0	0
S. America ...	·23	26	·55	60	·13	14	0	0
Asia	·22	3	2·65	34	3·75	49	1·13	14
Africa ...	·05	15	·23	44	·47	41	0	0
Australia ...	·36	47	·40	52	·005	1	0	0
Total & Means	4·69	26	7·33	42	4·53	25	1·13	7

TABLE 7.—PERCENTAGE RANGE OF MEAN MONTHLY RAINFALL, LATITUDES 30° N TO 30° S.

	Range under 10 %		Range 10—20 %		Range 20—30 %		Range over 30 %	
	Sq. Mi. ×10⁶	%	Sq. Mi. ×10⁶	%	Sq. Mi. ×10⁶	%	Sq. Mi. ×10⁶	%
N. America ...	0	0	·46	39	·70	61	0	0
S. America ...	·12	2	4·91	76	1·31	21	·04	1
Asia	·10	2	·96	23	2·56	60	·63	15
Africa ...	0	0	2·28	20	8·86	78	·21	2
Australia ...	·16	7	·63	28	1·32	59	·13	6
E. Indies ...	·43	36	·72	63	·01	1	0	0
Total & Means	·81	3	9·96	38	14·76	55	1·01	4

It will be seen that low altitudes have over three times as large an area possessing a monthly variability of over 20 per cent. as is the case in mid-latitudes and twice as large a percentage of their total area has this range. The one large area in mid-latitudes mapped as in the fourth, the most extreme type of rainfall variability is the little known Tibetan Plateau, which has little agricultural value because of its great altitude. Furthermore, the month of least precipitation in mid-latitudes commonly is in the winter, when plants require little moisture, while the wettest month usually is in summer. On the other hand, the driest month of the tropics is also a hot month, with active evaporation. This unfortunate combination is very hard on plants and is the reason for the lack of forests in many places having a large annual rainfall. For instance, parts of tropical

Australia having over 80 in. of rain in a year possess no real forest because several months are extremely dry and hot. In respect to the more uniform rainfall type, where the range between the driest and wettest months is less than 10 per cent., mid-latitudes have nearly six times as large an area as low latitudes. This type comprises about 26 per cent. of the total land area of mid-latitudes, while it makes up only 3 per cent. of low latitudes. Other interesting comparisons come out on further study of these tables.

Such irregular rainfall distribution as has been mentioned in the foregoing pages is decidedly unfavourable to most kinds of land life, as well as to roads, buildings and many other works of man. But the foregoing aspects of tropical rainfall are not the only unfavourable ones. Another, although perhaps less important contrast between the rainfall régime of low and middle latitudes, is the rate of fall. While not strictly an illustration of undependability, nevertheless its effects are similar, for the beneficial results of rain vary sharply with the rate of fall. In general, in low latitudes much of the precipitation occurs during local thunderstorms and heavy falls occur suddenly. A few minutes after a downpour, the sun often shines hotly. In middle latitudes, on the other hand, a much larger proportion of the precipitation occurs in general rains, when for several hours or occasionally for several days, a gentle fall occurs. Therefore a larger percentage of the fall has time to soak into the ground in mid-latitudes than in low latitudes, and there is correspondingly less run-off and soil erosion. Hence in middle latitudes a larger share of the rainfall normally is available for the plants than in the tropics. Likewise, because of slower evaporation, less moisture is required.

(*To be concluded*)

Official Publications

The following publications have recently been issued :—

PROFESSIONAL NOTES—

No. 31. *The relation between the height reached by a pilot balloon and its ascending velocity.* By J. Wadsworth, M.A.

No. 32. *A note on the upper air observations taken in North Russia in* 1919. By W. H. Pick, B.Sc.

ADVISORY COMMITTEE ON ATMOSPHERIC POLLUTION. Eighth Annual Report; for the year ending March 31st, 1922.

Correspondence

To the Editor, *The Meteorological Magazine*

Symbols for Driftsnow

I AGREE entirely in the amplified definition of "Ice crystals in the air" given on page 111 of *The Meteorological Magazine* for June, 1923.

As to the meaning and use of the symbol †→, I beg leave to express a different opinion, as this symbol in Sweden is used exclusively when snow is really falling, and days with †→ are consequently reckoned amongst those with precipitation.

Westman introduced in his Observations at Treurenberg Bay, Spitzbergen, in 1899-1900, the symbol Ⱥ→ for driftsnow when no precipitation occurs, and this symbol was afterwards adopted by the Observatories at Vassijaure, 1905 to 1912, and Abisko since 1913. In Swedish we have different names for the two phenomena, viz.: *Snöyra*, precipitation, and *Yrsnö*, without precipitation, and thus the introduction of a new symbol has seemed quite natural to us.

I am aware that it is not always easy in Arctic regions to distinguish whether precipitation is produced or not, but when mountains are in the neighbourhood one has generally the possibility at moments to realize if there is †→, or Ⱥ→ extending to several hundreds of metres upwards.

I should thus suggest, that †→ be exclusively used when precipitation occurs, and Ⱥ→ introduced, or else this last phenomenon not be noted at all. BRUNO ROLF.

Meteorological Bureau, Stockholm 2, July 5th, 1923.

Something like a Rainfall

The *Report of the Saõ Paulo Railway* (Brazil) for 1922, tells of damage done to the Serra (or "mountain") section of the railway by abnormal rainfall in March of that year. During the period March 1st to 10th, the rainfall at the Alto da Serra was no less than 35·9 in., which constituted a record so far as the Railway Company's observations go. During the first three days of the period no less than 24·5 in. of rain fell.

Railway traffic was not interrupted during the first two days, and there was only a partial interruption on the third day. On the fifth day, however, a large slip took place above the Upper Inclines, and as a result some 4,000 tons of boulder and earth came down, which completely blocked the upper line. Various slips took place later on, necessitating somewhat extensive work in the construction of drains and retaining walls. The total cost directly and indirectly of these slips may be set down as approximately £25,000. JOHN MOORE.

40, Fitz William Square, Dublin, August 4th, 1923.

Vertical Visibility, Wind and Dust.

IN the July, 1923, issue of the *Meteorological Magazine* it is stated under the heading "The first Samples of Dust from the Upper Air," that "it will be seen that the stronger wind held by far the greater number of dust particles in suspension."

This confirms admirably a result very recently obtained by the present writers in an investigation on "The Vertical Visibility at Cranwell, Lincolnshire, from February, 1922, to June, 1923," described in a paper which it is hoped will be published shortly.

The result in question was obtained by comparing the wind velocity at a height of 2,000 feet with the vertical visibility prevailing and will be seen in the following table:—

Vertical Visibility and Wind Velocity at 2,000 *feet.*

Wind Velocity 2,000 ft.	No. of Cases.	Vertical Visibility (Percentages).				
		Excellent.	Good.	Fair.	Indifferent.	Bad.
Below 12 m.p.h. ...	31	20%	55%	16%	3%	6%
12—24 m.p.h. ...	70	24%	42%	27%	3%	4%
Above 24 m.p.h. ...	63	12%	38%	33%	5%	12%

The table shows that there is a progressive decrease in the sum of "excellent" and "good" vertical visibility from the low velocities to the high.

W. H. PICK.
S. P. PETERS.

R.A.F. (Cadet) College, Cranwell, Lincs., July 21st, 1923.

Hail at Nottingham

AFTER a very warm day (max. temp. 88° F.) a sudden sharp thunderstorm at 19h. G.M.T. on the 7th produced 0·49 in. of rain here in eight minutes. It was accompanied by hailstones, mostly flattened, half an inch in diameter and a quarter of an inch in thickness; the largest I have seen here since September 3rd, 1916, when stones an inch in diameter fell. The thunderstorm in the early hours of July 10th was not so violent, but was of much greater duration, lasting five hours. Rain fell to a depth of 1·12 in.

ARNOLD B. TINN.

107, *Burford Road, Nottingham, July 31st,* 1923.

Pilot Balloons, Lightning and Oxides of Nitrogen.

It will be remembered that through the enterprise of Major J. M. MacLulich and Mr. H. Harries, advantage has been taken of the despatch of balloons from Brighton in connection with a local advertising scheme, and information of scientific interest has been obtained from time to time.

Recently Mr. Harries sent to the Meteorological Office a collapsed balloon with the following report:—

> " At 10.45 a.m. on June 1st, 1923, balloons were sent off, under the impression that they would reach the north-west and west of France, but all the cards thus far returned show that they dropped in Sussex, Hants and Devon. Amongst them E.596, which descended at Braishfield, near Romsey, Hants, and was picked up at 5 p.m. on the 5th, the finder enclosing the card and the envelope to Major MacLulich by post, but making no statement as to the condition of the envelope. What is left of the latter is enclosed herewith for examination.
>
> " You will see that while the neck of the balloon remains uninjured, it is still quite fresh, the whole of the rest of the rubber has perished; it is in a rotten state and crumbles between the fingers. Submitted to ordinary fire the edges of the rubber would have curled up, but that is not so in this case. Major MacLulich thinks the collapse was due to lightning, an electric discharge bursting it and imparting to it the burnt appearance. It looks like over-vulcanised rubber."

Principal Skinner of the Chelsea Polytechnic, who has been so good as to interest himself in the matter, writes as follows:—

> " I gave the fragments of the rubber ballon that you sent to a student, Mr. A. S. Houghton, B.Sc., suggesting to him that the effect might be due to ozone. He found that the unchanged portion of the rubber round the neck was not bleached by ozone; and then he tried the action of the brown oxides of nitrogen produced from dilute nitric acid and a fragment of copper. He found the oxides of nitrogen bleached the rubber and made it brittle like the attacked part of the balloon. The rubber is rendered brittle, transparent and scaly. Assuming that the effect took place before the balloon reached the earth, it would appear that oxides of nitrogen could have produced the effect. Such oxides of nitrogen may have been formed in the air by electric discharges, as is well known."

It is somewhat unfortunate that the history of the balloon in question is not more definitely known; four days elapsed from the time it was despatched to the time it was picked up. It would be of interest to learn of any instances in which balloons are definitely known to have come down perished.

Meteorology on the Cairo to Baghdad Aerial Route.

A CHAIN of Royal Air Force Meteorological Stations extends from Aboukir, on the Mediterranean littoral, near Alexandria, to Baghdad, with the exception of a distance of 469 miles between Amman, situated 2,600 ft. above mean sea level, on the hills east of the Jordan Valley, and Ramadi on the Euphrates, there being no occupied aerodromes in this desert area. (Once a day at about 6 a.m. G.M.T. weather reports for Beirut, Damascus, Deir ez Zor, and Palmyra are received at Baghdad from the French Meteorological Service in Syria, which has arranged for their transmission by W/T from Beirut.)

The Royal Air Force stations are manned by personnel who carry on their normal flying and wireless duties in addition to meteorological work, and who have been locally trained by the Officers who took the meteorological course in England in 1920. Observations are taken three times a day at most stations, and pilot balloon ascents are made early each morning and also during the day when the aeroplanes are *en route.* A synoptic weather and upper wind report containing the observations from all R.A.F. stations in the area is broadcasted daily from Headquarters, Middle East, at 6h. 30m. G.M.T., and other supplementary reports are issued during the morning. In the evening the 18h. observations are broadcasted at about 18h. 45m. from the stations of the aerial route, and the collective message is passed by the station at Amman to 'Iraq. Whenever fog or storm conditions occur at any aerodrome all the other stations are immediately informed. Such warnings are followed by an "all clear" message as soon as the conditions referred to are passed.

The meteorological messages are passed from station to station by means of wireless, and continuous wireless touch is also maintained with all machines in the air so that pilots are kept constantly informed of the weather and upper wind conditions in the districts towards which they are flying. Delay in transmission of weather information is certain to lead to increased petrol consumption—for the most economical height is very variable—and delay under certain conditions may lead to loss of life in the districts towards which they are flying.

In going east from Cairo the machines follow a north-easterly course along the fringe of the Delta cultivation, cross the Suez Canal and from there strike a course for Ramleh, which is situated between Jerusalem and Jaffa. From Ismailia to Ramleh the route is never far from the sea coast. The distance between Cairo and Ramleh is only 266 miles, and at no point does the height above mean sea level exceed 270 ft. ; yet the variation in the weather conditions in most months is great, *e.g.*, in January, 1922, 6mm. of rain fell at Heliopolis, 197 mm. at Ramleh. Such variation in rainfall and in corresponding cloud amount emphasises the importance to pilots of accurate and punctual weather reports. From Ramleh the machines proceed inland to Amman and thence across the desert to Baghdad. At Ramadi, the first station on the route in 'Iraq, information is provided in the form of ground signals.

In the 'Iraq area the "Shamal" blows during the summer months and precipitation in measurable quantities is unusual. In the winter, on the other hand, the weather is unsettled with considerable precipitation, and the ground winds variable, though the upper winds are definitely westerly, indeed of many hundreds of upper air observations near the Baghdad end of the route practically no single wind was observed at 10,000 ft. having an easterly component.

Thunderstorms occur occasionally in the winter season in lower Egypt, and heavy thunderstorms are not uncommon in 'Iraq during the spring transition period, 3 or 4 being the monthly average for both April and May.

An Open Scale Meteorograph

A METEOROGRAPH with very open scales has been constructed recently at Benson Observatory, primarily for use in determining the height of fogs. The record is made in ink on a drum turning once an hour. Three pens show, respectively, height above ground, relative humidity and temperature. The height recording pen is actuated by a battery of three aneroid boxes and multiplying levers; humidity is recorded by the centre pen, the hygrometer hairs being set fan-wise to ensure quick response to changes, and the temperature pen is controlled by a bi-metallic spiral of very thin metal. The hygrograph and thermograph are not intended to work to any great degree of accuracy but the altigraph is made as accurate as possible; the chart can be read to within 100 ft. or less to an upper limit of about 3,000 ft.

A photograph of the instrument is reproduced on the plate facing page 166. The method of operation is to sling freely by means of a piece of elastic several yards long, fastened at one end to the cross bar of the instrument and at its upper end to the neck of a small captive balloon. The oval wire guard is provided to prevent damage or disturbance to the working parts. A balloon of about 5 feet in diameter is required, and the procedure recommended is to send the balloon conveying the meteorograph up to a considerable height as quickly as possible and to haul it in slowly.

Dr. T. Royds has been appointed Director of the Kodaikanal and Madras Observatories in succession to Mr. J. Evershed, who retired on February 25th, 1923, after thirteen years service.

The Calibration of the Dines Balloon Meteorograph

THE standard method of calibration of the Balloon Meteorograph designed by Mr. W. H. Dines is described in the *Computers' Handbook*, Section II., Sub-section 2, 1916. The meteorograph is placed in a cylinder half filled with petrol, the temperature of which can be controlled; when the pressure inside this cylinder is appropriate a jerk is given to the instrument by means of a small hammer actuated by an electro-magnet placed below the floor of the cylinder. The drawback to this method is that the mark made by the scratching point on the electroplated sheet is rather fuzzy.

An improvement has recently been devised by Mr. L. H. G. Dines. In building the meteorograph he fixes an arm about 1¼ inches long at right angles to, and near the bottom of, the invar rod, which is one element of the bimetallic thermometer. When the instrument is to be calibrated a special light armature is hung from this arm. It takes the form of a thin strip of sheet iron which hangs horizontally about 1mm. above the floor of the cylinder. It is backed with a piece of cork such that the whole floats in petrol in neutral equilibrium, and therefore normally puts no strain on any part of the meteorograph.

When the magnet beneath the floor is "energised" the arm is pulled and the couple set up in the invar rod bends it slightly. The result is a very small relative motion between the rod and the german silver strip, and a corresponding movement of the scratching point. The mark made on the plate is sharp, and the record is more accurately deciphered than under the old system.

The Distribution of Forecasts by Telephone

As was mentioned in the *Meteorological Magazine* for May, 1923, *p.* 83, new facilities for the distribution of forecasts by telephone have been provided by the Post Office since May 1st. It is only necessary for telephone subscribers to ring up the operator at the local exchange at or after 5 p.m. to obtain the forecast for the following night and day. No charge is made beyond the local call fee.

We are informed that the number of calls for forecasts during May, the first month in which the system was in force, was approximately 10,350. So far as comparison can be drawn, the facility, in accordance with its purpose, has been utilised more freely by the subscribers in the rural areas than by those in areas which are primarily industrial. The advantages to the farmer of a forecast at such an hour as 5 p.m. are manifest especially at times when there is a risk of frost, and it is anticipated that as the system becomes better known its use will become general.

The Production by Lightning of a Shadow-Picture on Bare Boards

DURING the storm of July 9th—10th a remarkable "photograph" of a waste-paper basket was made by lightning on the floor of a Mincing Lane office, that of Messrs. Thompson Bros. & Co.

The impression had made on bare, unpolished, ordinary flooring boards, and consists of a bleached image of the basket, which was apparently lying across the boards with its open end roughly towards south. The direction of the length of the boards is about perpendicular to Mincing Lane and Mark Lane.

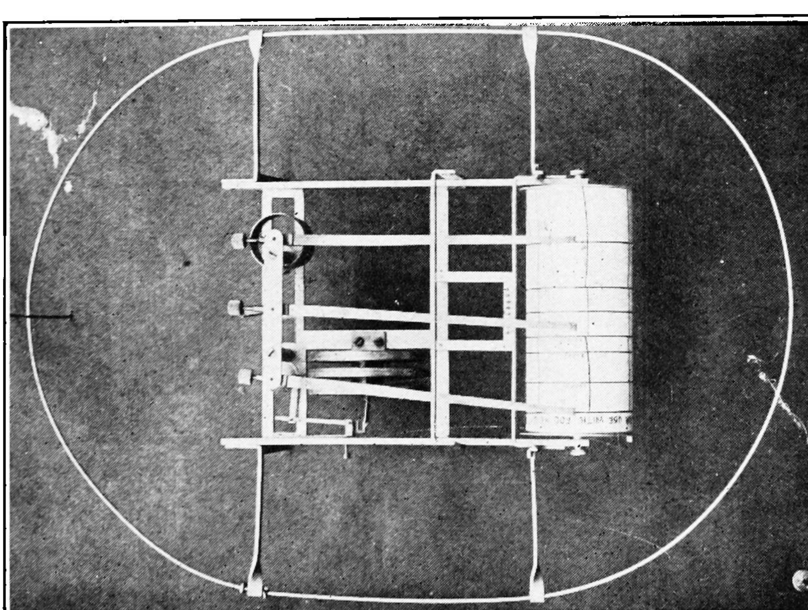
The discovery was made next morning by the staff as they entered the door of the office. The cleaners had been in previously and had disturbed everything but had apparently not noticed the impression. They could not recollect anything definite about the position of the basket when they first entered the office. So far as could be seen, no other similar image was obtained of any other object. The waste-paper basket is of the ordinary wicker type, very old and begrimed, otherwise calling for no remark.

The roof is of clear glass, some 14 or 15 feet high. On each side running parallel to Mark Lane and Mincing Lane are very tall blocks of buildings, and the room in which the impression was made is on the ground floor, in fact, it is merely part of the space between the buildings roofed over. The firm being rice merchants and samples being handled continually, no doubt much rice is trampled on the floor.

The impression had the appearance of a photographic print of the waste-paper basket lying on its side on a piece of photographic paper, as might be obtained by means of a point source of light nearly directly overhead, but perhaps slightly towards the south. It was so clear and unblurred that it is not likely that the same effect would be obtained if the "printing" were repeated, unless the source of light were in substantially the same position every time. The boards carrying the "photograph" have been cut out and are now in the Science Museum. Unfortunately the image seems to be fading. Our illustration is from a photograph taken at the Museum and reproduced by the courtesy of the Director. Photographs taken *in situ* show the image rather more distinctly but with exaggerated perspective. As will be noticed in the illustration opposite images of the ribs (apparently the ribs nearest the ground) can be seen as well as the complete images of the rim, the girdle and the bottom of the basket.

The image is seen most distinctly with oblique lighting. It can not be detected, however, when the wood is examined at close quarters with a lens.

A SHADOW-PICTURE PRODUCED BY LIGHTNING.



AN OPEN SCALE METEOROGRAPH.

It should also be placed on record that the spot where the image appeared was such a centre of traffic that the possibility of the picture being work that an idle hand could have done seems to be excluded. The principals of Messrs. Thompson Bros. are convinced of the genuineness of the phenomenon.

Brazilian Meteorological Service, 1921-1923

A REPORT which has recently been issued by Dr. Sempaio Ferraz, Director of the Brazilian Meteorological Service, shows the rapid progress which has been made in the development of the service since its reorganisation in June, 1921. Previous to that date, there were 97 second and third order climatological stations, and 57 rainfall and co-operative stations. These numbers have now been increased to 152 and 237, respectively. The inspection of stations, which was very seldom done before 1921, is now actively carried out all over the country. Year-books have been published for each of the years 1911-1918, and a book of Normals issued.

The forecast service, which was almost non-existent prior to 1921, is now showing great activity. Daily forecasts for the Southern States, based on synoptic data from 80 stations in Brazil, 18 in the Argentine and 6 in Uruguay, are distributed from Rio de Janeiro and St. Paulo. Two additional distributive centres are to be established this year in St. Catherina and Parana. A storm signal service is in operation along the coast, and every four hours the coastal radio stations, 12 in number, broadcast the weather at the time. In the large towns, flags are used to indicate the anticipated weather changes. Upper air work is carried out at 7 pilot balloon stations, and 2 kite stations are being constructed. The work, however, is much hampered by the difficulty of transporting hydrogen to the aerological stations. A flood service for the Parahyba River has been inaugurated and a similar service is being arranged for the Amazon, where floods occasion considerable destruction amongst cattle. All the leading newspapers now publish a ten-days bulletin, giving the condition of the most important crops and pasture lands and how they have been affected by the weather. Our readers will also remember the special telegram from Brazil, which is published each month in this magazine, at the end of the notes on the weather.

Exposure of Thermometers in India

THE results of an investigation of the merits of different thermometer screens, conducted by Mr. J. H. Field, at Agra, are summarised in a memoir "on exposures of thermometers in India," recently published by the Indian Meteorological Department. It is announced that "it has now been decided to replace as opportunity offers the expensive open shed, which has so long been the standard in this country, by some form of Stevenson screen, and thus to secure truer records, immunity from the effects of changing environment and all the advantages of economy."

News in Brief

The *Philosophical Magazine* for July, 1923, contains a paper by Dr. Harold Jeffreys on *The effect of a steady wind on the sea-level near a straight shore.* The way in which high tides occur after persistent on-shore or along-shore wind is a subject of great interest to meteorologists, and it is a matter for congratulation that mathematical analysis has now been applied to the problem.

Mr. L. G. H. Lee, headmaster of Park Street Council School, Raunds, Wellingborough, has received an appointment as one of His Majesty's Inspectors of Schools. Mr. Lee, who has maintained a meteorological station at Raunds since 1904 and served in the Meteorological Section of the Royal Engineers from 1915 to 1919, has introduced weather study into the curriculum of the older boys with great success.

The Weather of July, 1923

WESTERLY winds with mainly overcast skies and a temperature slightly below normal prevailed during the first few days of the month, but after the 4th the continental anticyclone spread north-westwards and the weather over the British Isles became fine and sunny with high day temperatures and warm nights. Maxima of 90° F. and over were recorded locally in south and east England and in the Midlands on the 6th, 7th and 11th, but were more general on the 12th and 13th when some records were broken, *e.g.*, 85° F. on the 12th was the highest maximum ever registered at Falmouth Observatory; actually the highest temperature recorded during the month was 96° F. at Camden Square, London. The nights also were remarkably warm during this hot spell, the temperature at Westminster, not falling below 70° F. throughout the night of the 12th to 13th. At Kew Observatory, Lympne, and even at Tavistock on the edge of Dartmoor, 845 ft. above mean sea level the minimum temperature for the same night was 68° F.

Thunderstorms developed in the west and north about the 6th and continued at times throughout the following week. On the 8th, floods associated with a severe thunderstorm caused considerable damage at Carrbridge, Inverness; while on the night of the 9th to 10th the storms lasted throughout the night in London and the neighbouring counties, only passing northwards on the morning of the 10th. Heavy rainfalls were associated with these thunderstorms, some of the heaviest falls being 81 mm. at Seaford, 65 mm. at Hampstead 52 mm. at Kew on the night 9th to 10th and 34 mm. at Ross-on-Wye on the 13th, when there was a rapid drop of temperature of 18° in twenty minutes.

After the middle of the month depressions from the Atlantic spread further south across the British Isles, causing cooler, cloudier weather with much rain at times and occasionally strong westerly winds on exposed parts of the coast.

During the first half of the month, western Europe was visited by a "heat wave." In Holland, where it lasted nearly a fortnight, 150 deaths from heat occurred, while grass fires, due to the high temperature, were reported from several parts of Italy. Between the 14th and 17th thunderstorms caused much damage to crops in Switzerland, floods occurred in several cantons and some lightning casualties were reported. The wheat harvest in France promises to be very good, and in Greece the yield is reported as excellent, in some parts surpassing that of last year by 130 per cent. The Rumanian crops are also satisfactory.

Plentiful rains are reported from the upper districts of the Yemen, south-western Arabia.

At the beginning of the month much anxiety was felt with regard to the crops in India, for there had been a prolonged break in the monsoon. During the next few days, however, Bombay experienced torrential rains, the greatest fall being 12 inches in 24 hours. By the 18th sufficient rains had fallen in western India and good cotton and rice crops are now expected. The grain crops are late, however, and a satisfactory yield is doubtful. Considerable damage by floods was reported from Mysore on the second week of July.

Rainfall was on the whole above normal in Western Australia, Queensland and Tasmania, and below normal in South Australia, New South Wales and Victoria.

A violent storm visited Uruguay about the middle of the month, five lives were lost and much damage was done in Monte Video. The special message from Brazil states that rainfall in the south was 20 mm. above normal but irregular and generally below normal in the north and scanty in the central districts, 22 mm. below normal. Temperature was below normal on the whole and mild frosts were experienced in the South, causing some damage to the coffee crops.

Rainfall July, 1923: General Distribution

England and Wales	103	per cent. of the average 1881-1915	
Scotland	112	,,	,, ,,
Ireland	92	,,	,, ,,
British Isles	103	,,	,, ,,

Rainfall Table for July, 1923

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent. of Av.
Lond.	Camden Square	3·24	82	136	*Leics*	Leicester Town Hall	3·55	90	...
Sur .	Reigate, Hartswood	3·19	81	...	,, .	Belvoir Castle	3·91	99	161
Kent.	Tenterden, View Tower	·56	14	27	*Rut* .	Ridlington	3·64	93	...
,, .	Folkestone, Boro. San.	·59	15	...	*Linc.*	Boston, Skirbeck	2·11	54	96
,, .	Broadstairs	...	..	...	,, .	Lincoln, Sessions House	3·97	101	179
,, .	Sevenoaks, Speldhurst.	1·96	50	...	,, .	Skegness, Estate Office.	...	..	...
Sus .	Patching Farm	1·58	40	66	,, .	Louth, Westgate	3·81	97	152
,, .	Eastbourne, Wilm. Sq.	3·20	81	146	,, .	Brigg	2·96	75	127
,, .	Tottingworth Park	2·45	62	98	*Notts.*	Worksop, Hodsock	3·03	77	...
Hants	Totland Bay, Aston	1·35	34	70	*Derby*	Mickleover, Clyde Ho.	6·14	156	251
,, .	Fordingbridge, Oaklnds	·80	20	40	,, .	Buxton, Devon. Hos.	...	..	...
,, .	Portsmouth, Vic. Park.	·75	19	37	*Ches.*	Runcorn, Weston Pt.	4·32	110	157
,, .	Ovington Rectory	1·18	30	46	,, ..	Nantwich, Dorfold Hall	3·38	86	...
,, .	Grayshott	1·53	39	63	*Lancs*	Bolton, Queen's Park .	4·87	124	...
Berks	Wellington College	1·51	38	73	,, ..	Stonyhurst College	6·10	155	158
,, .	Newbury, Greenham	1·52	39	68	,, ..	Southport, Hesketh	2·93	74	102
Herts.	Bennington House	2·77	70	114	,, ..	Lancaster, Strathspey.	4·48	114	...
Bucks	High Wycombe	2·26	57	115	*Yorks*	Sedbergh, Akay	6·76	172	151
Oxf. .	Oxford, Mag. College	1·36	35	60	,, .	Wath-upon-Dearne	3·82	97	152
Nor .	Pitsford, Sedgebrook	3·44	87	146	,, .	Bradford, Lister Pk.	3·25	83	118
,, .	Eye, Northolm	2·89	73	...	,, .	Oughtershaw Hall	6·01	153	...
Beds.	Woburn, Crawley Mill.	3·53	90	150	,, .	Wetherby, Ribston H.	2·95	75	118
Cam.	Cambridge, Bot. Gdns.	2·09	53	97	*ERY*	Hull, Pearson Park	2·83	72	121
Essex	Chelmsford, CountyLab	1·01	26	...	,, .	Holme-on-Spalding	5·12	130	...
,, .	Lexden, Hill House	1·72	44	...	,, .	Lowthorpe, The Elms.	2·59	66	113
Suff .	Hawkedon Rectory	1·62	41	66	*NRY*	West Witton, Ivy Ho.	2·79	71	...
,, .	Haughley House	1·81	46	...	,, .	Pickering, Hungate	4·56	116	...
Norf.	Beccles, Geldeston	3·34	85	143	,, .	Middlesbrough	2·29	58	89
,, .	Norwich, Eaton	3·30	84	127	,, .	Baldersdale, Hury Res.	2·76	70	89
,, .	Blakeney	2·66	68	118	*Durh.*	Ushaw College	1·76	45	63
,, .	Swaffham	2·81	71	110	*Nor* .	Newcastle, Town Moor.	2·77	70	105
Wilts.	Devizes, Highclere	·89	23	...	,, .	Bellingham Manor	2·59	66	...
Dor .	Evershot, Melbury Ho.	1·13	29	45	,, .	Lilburn Tower Gdns.	1·50	38	...
,, .	Weymouth, Westham	.86	22	48	*Cumb*	Penrith, Newton Rigg.	2·67	68	93
,, .	Shaftesbury, Abbey Ho.	1·62	41	63	,, .	Carlisle, Scaleby Hall .	2·36	60	72
Devon	Plymouth, The Hoe	·89	23	32	,, .	Seathwaite	9·20	234	109
,, .	Polapit Tamar	1·60	41	59	*Glam.*	Cardiff, Ely P. Stn.	2·27	58	73
,, .	Ashburton, Druid Ho.	1·29	33	42	,, .	Treherbert, Tynywaun	5·76	146	...
,, .	Cullompton	1·45	37	54	*Carm*	Carmarthen Friary	2·82	72	80
,, .	Sidmouth, Sidmount	1·03	26	41	,, .	Llanwrda, Dolaucothy.	3·88	99	89
,, .	Filleigh, Castle Hill	2·71	69	...	*Pemb*	Haverfordwest, Portf'd	...	..	...
,, .	Hartland Abbey	3·08	78	...	*Card.*	Gogerddan	5·43	138	...
Corn.	Redruth, Trewirgie	1·23	31	40	,, .	Cardigan, County Sch.	2·20	56	...
,, .	Penzance, Morrab Gdn.	1·19	30	44	*Brec.*	Crickhowell, Talymaes	3·00	76	...
,, .	St. Austell, Trevarna	·94	24	28	*Rad* .	Birm.W.W.Tyrmynydd	4·63	118	113
Som	Street, Hind Hayes	1·52	39	...	*Mont.*	Lake Vyrnwy	4·39	111	128
Glos. .	Clifton College	3·00	76	106	*Denb.*	Llangynhafal	2·77	70	...
,, .	Cirencester	1·94	49	73	*Mer* .	Dolgelly, Bryntirion	7·93	201	186
Here.	Ross, County Obsy.	2·76	70	123	*Carn.*	Llandudno	2·22	56	93
,, .	Ledbury, Underdown.	4·05	103	179	,, .	Snowdon, L. Llydaw 9	12·95	329	...
Salop	Church Stretton	2·67	68	109	*Ang* .	Holyhead, Salt Island.	2·95	75	113
,, .	Shifnal, Hatton Grange	4·54	115	202	,, .	Lligwy	3·28	83	...
Staff.	Tean, The Heath Ho.	5·55	141	191	*Man.*	Douglas, Boro' Cem.	...	..	...
Worc.	Ombersley, Holt Lock.	2·22	56	104	*Guer.*	St. Peter Port, Grange.	1·87	48	93
,, .	Blockley, Upton Wold.	2·78	71	114	*Wigt.*	Stoneykirk, Ardwell Ho	3·34	85	115
War	Farnborough	2·81	71	110	,, .	Pt. William, Monreith .	3·51	89	...
,, .	Birminghm, Edgbaston	4·30	109	185	*Kirk.*	Carsphairn, Shiel.	6·48	165	...

Rainfall Table for July, 1923—*continued*

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent. of Av.
Kirk.	Dumfries, Cargen	4·38	111	135	*Caith*	Loch More, Achfary	8·20	208	153
Dum	Drumlanrig	5·93	151	173	,,	Wick	2·75	70	105
Roxb	Branxholme	2·09	53	69	*Ork.*	Pomona, Deerness	3·11	79	121
Selk.	Ettrick Manse	4·66	118	...	*Shet.*	Lerwick	1·87	47	82
Berk.	Marchmont House	1·80	46	59	*Cork.*	Caheragh Rectory	3·22	82	...
Hadd	North Berwick Res.	1·15	29	45	,,	Dunmanway Rectory	2·83	72	73
Midl	Edinburgh, Roy. Obs.	2·85	72	109	,,	Ballinacurra	2·45	62	88
Lan.	Biggar	3·96	101	137	,,	Glanmire, Lota Lo.	3·01	77	104
Ayr.	Kilmarnock, Agric. C.	3·69	94	119	*Kerry*	Valencia Obsy.	...	..	...
,,	Girvan, Pinmore	5·03	128	138	,,	Gearahameen	4·20	107	...
Renf.	Glasgow, Queen's Pk.	3·70	94	127	,,	Killarney Asylum	2·51	64	76
,,	Greenock, Prospect H.	4·76	121	121	,,	Darrynane Abbey	3·54	90	93
Bute.	Rothesay, Ardencraig.	5·09	129	129	*Wat.*	Waterford, Brook Lo.	2·21	56	68
,,	Dougarie Lodge	3·90	99	...	*Tip.*	Nenagh, Cas. Lough	3·58	91	114
Arg.	Glen Etive	6·92	176	...	,,	Tipperary	3·33	85	...
,,	Oban	4·60	117	...	,,	Cashel, Ballinamona	2·57	65	89
,,	Poltalloch	6·32	161	155	*Lim.*	Foynes, Coolnanes	3·76	96	122
,,	Inveraray Castle	...	..	...	,,	Castleconnell Rec.	5·03	128	...
,,	Islay, Eallabus	5·62	143	165	*Clare*	Inagh, Mount Callan	7·29	185	...
,,	Mull, Benmore	8·20	208	...	,,	Broadford, Hurdlest'n.	5·06	129	...
,,	Mull, Quinish	5·76	146	142	*Wexf*	Newtownbarry	2·41	61	...
Kinr.	Loch Leven Sluice	2·13	54	74	,,	Gorey, Courtown Ho.	2·37	60	81
Perth	Loch Dhu	5·95	151	123	*Kilk.*	Kilkenny Castle	2·06	52	73
,,	Balquhidder, Stronvar.	...	..	...	*Wic.*	Rathnew, Clonmannon	2·21	56	...
,,	Crieff, Strathearn Hyd.	2·90	74	98	*Cars.*	Hacketstown Rectory	3·39	86	98
,,	Blair, Castle Gardens	2·75	70	...	*QCo.*	Blandsfort House	2·42	61	77
,,	Coupar Angus School	1·89	48	80	,,	Mountmellick	2·24	57	...
Forf.	Dundee, E. Necropolis.	3·02	77	110	*KCo.*	Birr Castle	2·87	73	97
,,	Pearsie House	1·90	48	...	*Dubl.*	Dublin, FitzWm. Sq.	2·52	64	98
,,	Montrose, Sunnyside	2·11	54	80	,,	Balbriggan, Ardgillan	2·62	67	97
Aber.	Braemar Bank	2·22	56	87	*W.M*	Athlone, Twyford	...	..	...
,,	Logie Coldstone Sch.	2·01	51	68	,,	Mullingar, Belvedere	3·12	79	98
,,	Aberdeen, Cranford Ho	2·31	59	78	*Long*	Castle Forbes Gdns.	1·77	45	57
,,	Fyvie Castle	2·89	73	...	*Gal.*	Galway, Waterdale	4·78	121	...
Mor	Gordon Castle	1·49	38	47	,,	Woodlawn	...	..	...
,,	Grantown-on-Spey	3·09	79	101	*Mayo*	Crossmolina, Enniscoe	4·50	114	124
Na.	Nairn, Delnies	2·03	51	76	,,	Mallaranny	5·81	147	...
Inv.	Ben Alder Lodge	4·12	105	...	,,	Westport House	2·21	56	71
,,	Kingussie, The Birches	2·61	66	...	,,	Delphi Lodge	7·80	198	...
,,	Fort Augustus	2·83	72	101	*Sligo*	Markree Obsy.	2·60	66	60
,,	Loch Quoich, Loan	11·00	279	...	*Ferm*	Enniskillen, Portora	1·98	50	...
,,	Glenquoich	9·04	230	141	*Arm.*	Armagh Obsy.	2·22	56	61
,,	Inverness, Culduthel R.	1·81	46	...	*Down*	Warrenpoint	2·24	57	...
,,	Arisaig, Faire-na-Squir	6·13	156	...	,,	Seaforde	2·56	65	80
,,	Fort William	8·63	219	178	,,	Donaghadee	3·19	81	96
,,	Skye, Dunvegan	4·27	109	...	,,	Banbridge, Milltown	2·81	71	86
,,	Barra, Castlebay	2·24	57	...	*Antr.*	Belfast, Cavehill Rd.	2·83	72	...
R&C	Alness, Ardross Cas.	3·50	89	116	,,	Glenarm Castle	2·33	59	...
,,	Ullapool	4·37	111	...	,,	Ballymena, Harryville	3·61	92	105
,,	Torridon, Bendamph.	6·71	170	124	*Lon.*	Londonderry, Creggan	3·81	97	104
,,	L. Carron, Plockton	5·32	135	...	*Tyr.*	Donaghmore	2·97	75	...
,,	Stornoway	3·78	96	125	,,	Omagh, Edenfel	3·72	95	109
Suth.	Dunrobin Castle	3·44	87	120	*Don.*	Malin Head	3·79	96	133
,,	Lairg	3·08	78	...	,,	Letterkenny Hos	3·02	77	86
,,	Forsinard	...	..	...	,,	Dunfanaghy	...	..	...
,,	Tongue Manse	3·53	90	115	,,	Narin, Kiltoorish	3·21	81	...
,,	Melvich School	4·26	108	152	,,	Killybegs, Rockmount.	5·75	146	131

Climatological Table for the British Empire, February, 1923

STATIONS	PRESSURE: Mean of Day M.S.L.	PRESSURE: Diff. from Normal	TEMPERATURE: Absolute Max.	TEMPERATURE: Absolute Min.	TEMPERATURE: Mean Values Max.	TEMPERATURE: Mean Values Min.	TEMPERATURE: Mean Values ½ max. and min.	TEMPERATURE: Mean Values Diff. from Normal	TEMPERATURE: Mean Wet Bulb	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION: Am'nt	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1003.1	−12·9	55	27	48·3	38·7	43·5	+ 3·4	41·9	87	7·5	71	+ 32	22	1·8	18
Gibraltar	1021·7	+ 2·9	67	44	62·2	50·9	56·5	0·0	52·1	77	5·2	56	− 51	10	...	...
Malta	1013·0	− 2·0	62	47	58·3	51·2	54·7	0·0	51·1	85	6·2	96	+ 45	17	5·2	48
Sierra Leone	1011·3	+ 0·3	92	72	89·5	74·6	82·1	− 0·2	74·2	65	5·1	1	− 6	1	...	...
Lagos, Nigeria	1010·0	− 0·1	91	73	89·0	76·3	82·7	+ 0·6	78·3	75	6·7	31	− 20	2	...	...
Kaduna, Nigeria	1013·1	+ 1·1	95	52	89·8	60·4	75·1	− 3·1	56·2	32	0·4	0	− 5	0	...	...
Zomba, Nyasaland	1007·3	− 0·5	87	61	81·0	65·3	73·1	+ 1·4	...	89	8·4	240	− 36	20	...	...
Salisbury, Rhodesia	1007·0	− 2·9	85	55	78·6	59·4	69·0	+ 0·1	63·8	78	7·3	284	+102	20	...	...
Cape Town	1013·3	− 0·1	100	49	81·3	59·5	70·4	+ 0·4	65·3	65	2·8	4	− 11	5	...	...
Johannesburg	1011·4	+ 0·3	86	50	77·0	56·3	66·7	+ 1·3	58·4	75	5·7	142	+ 12	11	7·8	60
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Calcutta, Alipore Obsy.	1012·1	− 1·2	88	55	80·4	62·4	71·4	+ 0·4	63·0	84	5·0	93	+ 64	*7	...	...
Bombay	1011·7	− 0·9	90	63	82·6	68·5	75·5	− 0·1	65·2	70	2·0	1	0	*0	...	...
Madras	1011·8	− 1·1	88	63	85·3	69·7	77·5	− 0·2	72·9	82	2·8	0	− 8	*0	...	...
Colombo, Ceylon	1010·6	0·0	91	65	87·4	70·4	78·9	− 1·7	75·2	63	3·0	0·3	− 53	1	...	...
Hong Kong	1016·6	− 2·2	79	46	63·8	55·0	59·4	+ 0·3	54·3	72	7·6	10	− 33	8	3·7	32
Sandakan	...	...	88	73	86·3	75·3	80·8	+ 0·7	76·3	80	...	191	− 53	10	...	...
Sydney	1015·8	+ 1·8	102	59	79·8	65·2	72·5	+ 1·3	66·0	67	4·8	12	−104	5	7·3	54
Melbourne	1016·7	+ 2·2	106	50	76·9	56·5	66·7	− 0·7	60·2	58	3·7	15	− 29	5	9·0	64
Adelaide	1015·6	+ 1·3	108	54	91·1	63·5	77·3	+ 3·2	61·1	35	2·8	2	− 15	1	10·4	78
Perth, W. Australia	1013·8	+ 0·7	107	55	86·9	64·4	75·7	+ 1·7	65·0	53	3·1	0	− 12	0	8·0	61
Coolgardie	1012·3	− 0·2	110	55	95·6	65·5	80·5	+ 4·5	65·8	31	4·9	0	− 19	0	...	...
Brisbane	1014·5	+ 2·3	99	62	85·9	68·5	77·2	+ 0·7	71·5	65	4·0	18	−147	5	9·2	71
Hobart, Tasmania	1014·2	+ 0·7	83	45	69·8	51·8	60·8	− 1·6	53·7	58	5·7	19	− 18	11	7·7	55
Wellington, N.Z.	1009·5	− 5·8	74	45	68·2	55·3	61·7	− 0·7	...	70	5·7	37	− 46	14	7·1	52
Suva, Fiji	1007·7	0·0	91	73	85·7	75·5	80·6	+ 0·1	78·5	89	7·4	403	+146	25	...	...
Kingston, Jamaica	1016·9	+ 1·2	89	64	86·0	66·9	76·5	0·0	...	69	4·5	5	− 10	4	...	...
Grenada, W.I.	1015·8	+ 2·4	85	67	81·9	71·0	76·5	− 0·5	70·9	72	4·9	58	− 14	22	...	...
Toronto	1020·2	+ 2·2	43	− 5	26·6	11·0	18·8	− 2·9	15·5	54	1·9	27	− 39	18	...	...
Winnipeg	1022·7	+ 0·9	38	−33	10·3	− 9·1	0·6	+ 1·2	− 1·0	...	3·8	26	+ 6	6	...	...
St. John, N.B.	1015·6	+ 1·5	35	−12	19·4	3·1	11·3	− 8·6	9·3	...	4·9	52	− 47	8	...	...
Victoria, B.C.	1025·2	+ 9·3	51	11	42·3	32·9	37·6	− 2·7	35·2	85	7·0	31	− 59	8	...	...

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.