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TREE GROWTH AS A MEASUREMENT OF RAINFALL.

Visitors to botanical museums are familiar with the appearance of a cross-section of a large tree, showing the consecutive rings of annual growth, by which its age may be measured. In some cases the museum authorities have numbered the rings and placed labels against those corresponding to historical events. In the museum at Wellington, for instance, the history of geographical exploration is thus set forth on a section of a great kauri pine, which was a tree of substantial growth before Columbus set out on his first voyage, was many feet in diameter when the tainui—the canoe which carried the first Maoris to New Zealand—landed upon that island, and had added only a few inches to its circumference since Captain Cook touched those shores.

Two years ago Mr. A. E. Douglass, of the University of Arizona, paid us a visit in London, and described the method which he had been pursuing in connection with sections of the great pine trees of the Western States, in order to determine not the age only of the tree, but the character of the various seasons during which the concentric layers had been added to its girth. We were able on that occasion to help Mr. Douglass to obtain sections of European trees, the place and date of the felling of which could be fixed, so that he could apply the long records of European rainfall to the appropriate years' growth and obtain the direct test of the accuracy of his method of meteorological retrospect.

Mr. Douglass has sent us an interesting monograph entitled "A Method of Estimating Rainfall by the Growth of Trees," published by the American Geographical Society, in their Bulletin for May, 1914, in which he describes in detail the methods and the preliminary results of his researches. The particular region dealt with was Prescott, a district in the northern plateau of Arizona, where the seasonal distribution of rainfall makes a very marked contrast between the growing and the resting period of the year, and where the giant pine trees form a library of archives extending back for many centuries. The method required the comparison of a number of tree sections, for it would obviously be impossible to accept the evidence of one series of rings, unless it were in harmony with several others compiled by the trees growing in the same neighbourhood. The work was not altogether so simple as might appear, for cases were found in which more than one ring was added in a single year, and others in which the growth rings of two years were so close together as to be merged in one. The reasoning by which the difficulties of interpretation were overcome is set out at length by Mr. Douglass in his paper, but we are unable here to do more than to refer to the conclusions which he drew from the research which he describes.

In order to adapt the long record of tree growth deduced from the Arizona pines to the study of meteorological cycles, Mr. Douglass proceeded as follows. He constructed a curve, and corrected it empirically for age by "drawing a long, sloping, nearly straight line through it from end to end, averaging its growth, and then calculating the percentage of departure of each year from this line. In order to bring out the longer variations the curve was smoothed by 20-year overlapping means. The result gives four conspicuous crests about the years 1400, more or less, 1560, 1710, and 1865, suggesting a very long period. A period of 33·8 years fits very well since 1730, with a total amplitude of some 25 per cent., and very poorly before that, yet without entire discordance. The last crest came in 1900. This we readily identify as the well-known Brückner period. The most persistent of the longer periods seems to be approximately 21 years in length, with an average amplitude of 20 per cent. (10 per cent. from the mean), and its last crest in 1892. This pulsation is well marked from 1400 to 1520 ; then in the next hundred years it has three or four glaring discrepancies ; finally from 1610 to the present time it is again strongly marked and very regular. Dr. W. J. S. Lockyer, in his "Discussion of Australian Meteorology," finds a pronounced 19-year cycle in barometric pressures in Australia and South America. The 21-year period was worked out independently in 1907 and 1908, from an early and crude tree record of 200 years. It seems quite possible that these two periods are the same. If so, and if my interpretation of the tree curves is correct, the real value is likely to be closer to 21 years, since the time interval here investigated is about ten times as long as his. . . . . the application becomes more evident when the minor variations are smoothed. . . . . In nearly all parts of the long, 500-year cycle, there are plain suggestions of an 11-year variation. By tracing these throughout the record, the most satisfactory period is found to have a length of very nearly 11·4 years, which is practically the sunspot cycle. The average double amplitude of the tree period is 16 per cent. The average form of this cycle during different portions of the last five centuries has been ascertained, from which it appears that it is not uniform throughout. In general the curve shows two maxima and two minima : from 1400 to 1670, the second is the deeper and its recurrence most regular ; from then to 1790 the curve flattens out and has less marked cyclic character, or the period of the cycle is varying ; from that time to the present, there are again two minima, but the first is more conspicuous. By comparing the crests of this cycle with the respective crests in the tree curve, one can see to what degree the tree varies on that particular cycle. Correlation between tree growth and sunspot variation is not confined to the American region here investigated. A series of measures on thirteen tree sections (Pinus sylvestris) from the forest of Eberswalde, near Berlin, Germany, the first of a number of series to be made on North European pine trees, discloses a striking time relation of similar character. A final comparison of the 11-year cycle with the mean sunspot curve and with two meteorological elements, temperature and rainfall, on the adjacent California coast, gives a significant series of curves."

Mr. Douglass concludes as follows : " Further research will probably show other, and perhaps still more important, relationship between the growth of vegetation, meteorological elements and changes in the sun. Meanwhile, the methods of computing rainfall from tree growth must be still further perfected. Already, however, the original purpose of the work here outlined has been accomplished. A connection has been found between tree growth and rainfall, a curve of tree growth has been made for at least one locality, apparent climatic cycles have been observed and indications of association between meteorological and astronomical phenomena have been found. But the most important part of all, I hope, has been the origin and development of a method of estimating rainfall, capable of extension to other regions, and of adaptation to other branches of science."

REVIEWS.

Dew-Ponds, History, Observation, and Experiment. By EDWARD A. MARTIN, F.G.S. London. T. Werner Laurie, Ltd. [Not dated, 1915 ?] Size $7\frac{1}{2} \times 5$. Pps. 208.

THE researches on dew-ponds carried out by Mr. Martin, have already been referred to in this Magazine, **44** (1909) pp. 57 and 77. The results are now summarised in the small volume before us, where in five chapters Mr. Martin deals with I. Their age and history ; II. Theories of dew-pond action ; III. Varying modes of dew-pond construction ; IV. Experiment and observation ; V. Summary and Conclusions. There is also an appendix, mentioning the particular ponds which had come under the Author's observation.

Mr. Martin's results entirely confirm the opinion we have frequently expressed regarding the predominant part played in the filling and maintenance of these ponds by rainfall, and the negligible quantity of the additions by direct condensation of dew. Mr. Martin finds as of course all meteorologists understood, that ponds on the summit of the South Downs are, to some extent, replenished by precipitation from mist, especially when trees stand near the pond, and he points out that this very obvious action had been so fully appreciated in some localities as to give to those artificial saucers of water the name of mist pond.

The book is pleasantly written and repays perusal, not only on account of the elaborate system of observations which show how strenuously the author tested the old superstition of the action of dew, but also for the practical hints he gives as to the construction of ponds on high Downs, where a supply of water must be very valuable to farmers. There are frequent references, although not always sufficiently full or definite, to previous work on dew and dew-ponds, but we greatly miss a systematic bibliography which the extent of Mr. Martin's researches must have made a comparatively easy matter. We trust that, should the book reach a second edition, a full bibliography will be added. The illustrations include a number of excellent photographs of dew-ponds and diagrams showing their formation.

The Thermometer and its Family Tree ; The Mountains of Cloudland and Rainfall Humidity ; its effect on our health and comfort ; The Barometer as the Foot Rule of the Air ; Practical Hints for Amateur Weather Forecasters. Five Pamphlets by P. R. JAMESON, F.R.Met.Soc., Rochester, N.Y. Taylor Instrument Companies. Size 8 x 5. Pp. (each 24). Price 10 cents (each).

THIS is a series of dainty booklets with extremely attractive and well designed pictorial covers, and well illustrated in the text. They are written in a fresh and interesting style, likely to turn the attention of a casual reader to the study of the atmosphere, and with a few obvious modifications they should prove as useful in the United Kingdom as in the United States. In "The Barometer as a Foot Rule of the Air," it is rather surprising to find that most of the space is devoted to Aneroids, and that there is no illustration of a mercurial barometer, while in "The Mountains of Cloudland and Rainfall," the suggestion is made that a tipping bucket rain gauge recording on a dial in hundredths of an inch, is more accurate than a direct reading instrument. No doubt, both the points to which we take exception would stand if the mechanism employed always remained as perfect as when first put together, but experience shows that the greatest accuracy over a long period is obtained by direct eye measurements.

THE WET WINTER OF 1914—15.

WHILST it is as yet too early to prepare any complete account of the rainfall of the past winter, an examination of the tables of rainfall of each month, which appear in this Magazine, provides a preliminary idea of the distribution of rainfall in relation to the average, and of the districts in which the fall has been most excessive.

Taking the British Isles as a whole four months, November and December, 1914, and January and February, 1915, were all wet, and of these December and February were, relatively to the average, the wettest. The fall in November was below the average in the south of Ireland and south-west of Wales, but above it in all other parts of the British Isles, and rose to 50 per cent. above in parts of the north. December was wet everywhere, especially in the south, more than twice the average falling over an area which embraced the east of Ireland and the whole of England south of the Pennines. More than two and a half times the average fell in the south-east of England, and more than three times the average in Sussex. The excess in December was smallest along the west coasts of Ireland and Scotland, where it was below 50 per cent. The rainfall of January exceeded the average in England and Wales, reaching twice that amount at a few stations in England, again chiefly in the south-east. The average was also exceeded in the west of Scotland and Ireland, where the excess in December was least marked, but less than the average fell in the south and east of Ireland and the interior of Scotland, the deficiency in one or two instances amounting to nearly 40 per cent. The general fall was, however, above the average in both countries. In February more than twice the average rainfall was again recorded in the south of England and Wales, in Yorkshire, and in the south and east of Scotland.

The following table shows the general rainfall of each of the four months in terms of percentages of the average for each of the great divisions of the country, as calculated from the monthly tables.

General Rainfall, November, 1914—February, 1915.

	England & Wales. per cent.	Scotland. per cent.	Ireland. per cent.	British Isles. per cent.
November, 1914......	133	134	124	131
December, 1914......	201	152	187	183
January, 1915........	148	109	115	127
February, 1915.......	196	166	176	181
Nov., 1914—Feb., 1915	168	139	150	155

It will be seen that the excessive rainfall of the winter generally ulminated in England and Wales, where December and February each had practically double the average fall. Taking the whole period together the British Isles experienced a rainfall more than 50 per cent. in excess of the average, Scotland and Ireland having rather less than this proportion, and England and Wales rather more. It is not possible in the time at our disposal to compare this remarkable record with those of past wet winters, but there seems little doubt that no winter in the last half century had a higher rainfall over the country as a whole. The rainfall of the four months was more than double the average over a part of the south-east of England, including London, Surrey, and Sussex, and was half as much again as the average over the whole of England, except the portion north of the Tees, over the centre of Scotland, and over the east and centre of Ireland. The excess was least pronounced in the north of Scotland.

The fact that the area with highest rainfall lay in the south of England gives a special interest to the maps of the distribution of rainfall over the Thames Valley district, which appear each month in this Magazine. There is no large area in the British Isles for which the general rainfall has been determined for so long a period as for the Thames Valley above Teddington, and we are able to refer to statistics for each month from 1883. Comparing the general fall for the past four months with the average of this period we get the following table :—

General Rainfall of the Thames Valley.

	General Rainfall.	Average.	Difference from Average.	Percentage of Average.
November, 1914......	3·56	2·66	+ ·90	134
December, 1914......	7·21	2·75	+4·46	262
January. 1915........	3·85	2·14	+1·71	180
February, 1915.......	4·57	1·81	+2·76	250
Nov., 1914—Feb., 1915	19·19	9·36	+9·83	205

During the 32 years, one month only, October, 1891, with 7·41 in., has had a larger general rainfall than December, 1914. Two months only have had a larger rainfall in relation to the average than either December, 1914, or February, 1915, viz., September, 1896, with 315 per cent., and February, 1900, with 277 per cent., of the average. There has been no period of four months, previous to the past winter, in which the aggregate general rainfall over the Thames Valley was so much as double the average, the nearest approach to this state of things having been from December 1911, to March, 1912, inclusive, when 17·18 in., or 194 per cent. of the average fell. During the famous Thames Valley floods of the autumn of 1894, the greatest excess noted in a period of four months, was from August-November, 1894, when the general rainfall amounted to 136 per cent. of the average.

ROYAL METEOROLOGICAL SOCIETY.

A Meeting of the Society was held on February 17th, at the Surveyors' Institution, Westminster, Captain H. G. Lyons, F.R.S., President, in the Chair.

A paper entitled "The Influence of Weather Conditions upon the Amount of Nitric Acid and of Nitrous Acid in the Rainfall at and near Melbourne, Australia," by Mr. G. Anderson, was read, in the absence of the author, by Col. H. Mellish. Whilst necessarily dealing at some length with the chemical processes employed, the author studied his observations in the light of the weather conditions prevailing at the time when the rain samples were collected, previous investigations of the amount of oxidised nitrogen in rain water having been conducted almost entirely from the standpoint of the agricultural chemist, and irrespective of the associated weather. Experiments were carried out simultaneously at Melbourne and at Canterbury, six miles distant. Samples of each day's rainfall, from November, 1912, to February, 1914, inclusive, were analysed, to find the amounts of nitrates and nitrites present, but as a comparison of the records of the two stations established beyond doubt, the existence of impurities in the rainfall of Melbourne, the Canterbury record alone was used for the investigation. In regard to the relative proportions, nitrates appeared always to be in excess of nitrites, and the excess reached a maximum in summer and a minimum in winter, showing a close relation to the temperature curve. In examining the daily results in conjunction with the weather charts, the conditions at 9 a.m. on the previous day were considered as representing the prevailing weather type for the twenty-four hours. Nine weather types were distinguished, according to the grouping of the isobars. A graphic study of the results justified the conclusion that the total amount of nitrates dissolved in the rain was a function of the weather type, the smallest amounts being present during antarctic depressions, the largest during tropical depressions and intermediate amounts in the case of weather under both influences. In all cases the great bulk of the combined nitrogen appeared to be contained in the first ·05 in. of rain falling. In conclusion Mr. Anderson stated that experiments were also being made to discover the influence (if any) of geographical position upon the oxidised nitrogen constants for the different types of weather. If these constants did not vary greatly from point to point, it would be possible to estimate with certainty the annual amounts of oxidised nitrogen contributed by the rain to the soil from a knowledge of the number and types of the rainstorms at any place during the year. At this stage it was considered safe to predict that in tropical Australia the annual amounts contributed were comparatively large.

A discussion followed, in the course of which Dr. E. J. Russel, compared the results obtained with those studied at Rothamsted and elsewhere. These confirmed in most respects those of Mr. Anderson, but the amounts obtained were smaller and samples analysed from the Outer Hebrides and from Iceland showed still less than at Rothamsted. Nitrogen, in the form of ammonia, constantly emanated from the soil, and he suggested that this might be partly the source of atmospheric oxides of nitrogen. This was supported by the fact that the greatest quantities were noticed in types of weather in which the wind came from the land, rather than from the sea, and samples obtained at the Butt of Lewis were almost entirely free from ammonia.

Dr. A. Scott, F.R.S., criticising Mr. Anderson's theory of the equal production of nitric and nitrous acids, laid stress on the instability of the nitrous, which rapidly oxidised to form nitric acid.

The following gentlemen also spoke : Prof. W. Dunstan, F.R.S., Dr. W. N. Shaw, F.R.S., Capt. D. Wilson-Barker, Mr. M. J. R. Dunstan, and Dr. C. Chree, F.R.S.

A paper on "Pilot Balloon Observations," by Mr. Geddes, was read in his absence, by Mr. J. S. Dines. Mr. Geddes classified the ascents according to the manner in which the balloon was lost to view, differentiating the various types of clouds in which many of the balloons disappeared, and discussed the apparent influence on the vertical velocity which these types exerted. Beneath clouds of the cumulus type there was a strong tendency to an increase in the vertical velocity when nearing the base of the clouds. Mr. J. S. Dines exhibited some diagrams of his own observations, which showed that this effect was not always present.

In regard to the author's discussion of the altitude at which the gradient velocity was attained, both Dr. W. N. Shaw and Dr. C. Chree criticised the pre-supposition of the force of this wind, which appeared to have influenced unduly the conclusions drawn from the observations.

The following new Fellows were elected to the Society : Messrs. Vivian Gabriel, George Matthews, and A. D. Richie.

Correspondence.

To the Editor of Symons's Meteorological Magazine.

THE SEASONS: A REJOINDER.

TOUCHING Mr. Aldridge's disagreement with my arrangement of the seasons I hold that by putting a somewhat narrow consideration like air-temperature alone, before the various effects directly associated with the height and power of the sun, and the intensity and duration of day-light, he is substituting the secondary for the primary meaning of the seasonal groups.

I should like to accentuate my point by a practical illustration or two. I once asked a fine old lady who had observed the round of many a year at her west-country farm, what she considered to be the depth of winter, and she promptly replied, the season when the days just "open and close"—that is, around the December solstice. If Arctic rigours of frost and snow came in February the season was, nevertheless, early spring to that lady's imagination.

Again, who can observe the illumined northern horizon, with the midnight sun not many degrees below it, on any clear English June night, without realizing that the climax of the year has been reached, and remembering those lines of Wordsworth on the longest day?

"Summer ebbs :—each day that follows
Is a reflux from on high,
Tending to the darksome hollows
Where the frosts of winter lie."

The division of the year into solstitial and equinoctial groups is really our only solid bed-rock; moreover, it is mathematically precise, and of world-wide signification, whereas purely meteorological and phenological arrangements of the seasons are indefinite, overlapping, and often of merely local application. If, as Mr. Aldridge would have it, autumn *primarily* means tinted and falling leaves, then according to horse-chestnut and lime, the season falls in southern England early in September, but according to oak and elm, not till late October, whilst the ivy has the eccentric habit of having its floral *spring* in October.

With regard to the rival claimants, May and August, for the third place among the summer months, it should be noted that May not only has more sunshine in accordance with its solstitial position, but the month is for some meteorological reason, the sunniest of the English year, notwithstanding that June, and to a small extent, July, are more solstitial with longer days. As for the cold snaps in May, for which Mr. Aldridge would disqualify the month as a summer candidate, all that can be said about them is that they are more pronounced in severity than, but not very different in type from, those chilly periods from which even July is not free.

Finally, Mr. Aldridge refers to the rigours of February, 1895, as indicating winter, and not spring. Now both February, 1895, and December, 1890, had the same mean temperature in London, but to the intense cold of December, 1890, was added the gloom of the winter solstice, with the result that that month was climatically the most formidable that has been experienced in the south of England during the quarter of a century now just ended.

L. C. W. BONACINA.

February 21st, 1915.

FORECASTING WEATHER BY MEANS OF CORRELATION.

Mr. Hampton Brown comments on the possibility of forecasting weather by means of correlation, but unfortunately, when the formula is considered by which the forecast is made, it is seen at once that the chance of a successful forecast is very small, unless the correlation is very high.

This will appear from the following special case. Both the height of the barometer and the mean temperature, taken as a departure from the month's mean, from one day to the next, are highly correlated, the coefficients being about ·80. If the correlation were efficient for the purpose of forecasting, any local Observer should be able to forecast to-morrow's weather from to-day's, but he cannot do so, neither is the reason far to seek.

If to-day's temperature be 10° above the mean and the correlation between to-day's and to-morrow's temperature be ·80, then the most likely value for to-morrow is 8° above the mean, the 8° being formed by multiplying 10° by ·80. So far so good, but the most probable value is not by any means that which will certainly occur. In the long run the mean of the days which follow days that are 10° above the mean will be 8° above the mean, but the rule does not hold for the individual day, and the question is by how much is the forecast likely to be wrong. Naturally this depends upon the extent to which any day's temperature is likely to vary from its mean, and some measure of this variability must be adopted. It is usual to take a quantity called the standard deviation, which, in this special case, is about 6° F. This means that two days out of three, or nearly so, are within 6° F. of their own special mean, and one out of three departs from it by more than 6° F. Now, employing the correlation coefficient, ·80, to-morrow's temperature can be estimated with a correctness of $6° \times \sqrt{1-\cdot 80^2}$, *i.e.*, 3°·6 F., instead of 6° F. That is, a pure guess at to-morrow's temperature will, in one case out three, be more than 6° F. out, but using the correlation with to-day's temperature (our ·80) one forecast out of three will be more than 3°·6 out. The badness of the guess, so to speak, is reduced in the ratio of 6° to 3°·6, and in general where r is the correlation coefficient the ratio is $1 : \sqrt{1-r^2}$.

In the following table values of $\sqrt{1-r^2}$ for a few values of r are given :

r.	·10	·50	·70	·80	·90	·95	·98
$\sqrt{1-r^2}$	·99	·87	·71	·60	·44	·32	·20

From this it appears that correlation coefficients are practically useless for the purpose of forecasting, unless they are very high indeed. A value of ·50 only makes the forecast 13 per cent. better than a pure and simple guess ; ·95 is required to improve a guess in the ratio of 1 to 3 ; and ·98 for the ratio of 1 to 5.

The statistical treatment of questions of this kind is really very simple, and if one is willing to accept without proof a few formulæ very little knowledge of mathematics is required. It would well repay any meteorologist to learn how to use the more elementary statistical methods, for by them certain conclusions can be reached which are absolutely trustworthy within known and well defined limits.

W. H. DINES.

RAINFALL OF THE PAST AUTUMN AND WINTER.

The amount of rain measured at Clifton during the four months, November and December, 1914, and January and February, 1915, is 19·58 in., which is about 8 in. in excess of the average of 37 years' observations by Dr. Burder, 1853-89.

I have compared this heavy fall with previous meteorological records of this district back to 1853, but cannot find a parallel. During the similar four months of 1876-7, I measured 18·42 in. of rain, and in 1911-12, 18·54 in. were recorded at Clifton. These are the heaviest amounts in 62 years, and are each about an inch less that the exceessive fall of the four months just ended.

W. F. DENNING.

Bristol, March 2nd, 1915.

METEOROLOGICAL NEWS AND NOTES.

The wreck of two German Zeppelin Airships in Denmark in February, drew the attention of the Press to the fact that the daily barometric maps of the air over Western Europe are as vital to the navigation of these vessels as the Admiralty Charts of the North Sea are to the navigation of war ships. *The Times* reported that the Danish Meteorological Institute at Copenhagen had stated that the loss of these air ships was directly due to the action of the British Meteorological Office in suppressing the daily telegrams from British stations, on which alone the probability of the snow squalls which proved fatal to the Zeppelins could be foretold. This opinion, in which we fully concur, should reconcile all patriotic British subjects to the retarded appearance of the Daily Weather Reports in the present unprecedented circumstances.

British Rainfall, 1914, now in course of compilation, will contain an innovation in the shape of the publication of the total annual rainfall at each station in millimetres as well as inches. In order to admit an additional column in the general table the width of the page will be slightly increased, but the height will remain unchanged, so that the volume will range with its predecessors on the shelf.

RAINFALL TABLE FOR FEBRUARY, 1915.

STATION.	COUNTY.	Lat. N. ° ′	Long. W. [*E.] ° ′	Height above Sea. ft.	RAINFALL OF MONTH. Aver. 1875—1909. in.	1915. in.
Camden Square	*London*	51 32	0 8	111	1·66	3·42
Tenterden	*Kent*	51 4	*0 41	190	1·90	4·41
Arundel (Patching)	*Sussex*	50 51	0 27	130	2·17	4·50
Fawley (Cadland)	*Hampshire*	50 50	1 22	52	2·28	5·45
Oxford (Magdalen College)	*Oxfordshire*	51 45	1 15	186	1·62	3·08
Wellingborough (Swanspool)	*Northampton*	52 18	0 41	155	1·70	2·28
Shoeburyness	*Essex*	51 31	*0 48	13	1·19	1·61
Bury St. Edmunds (Westley)	*Suffolk*	52 15	*0 40	226	1·59	2·72
Geldeston [Beccles]	*Norfolk*	52 27	*1 31	38	1·41	2·94
Polapit Tamar [Launceston]	*Devon*	50 40	4 22	315	2·95	8·78
Rousdon [Lyme Regis]	,,	50 41	3 0	516	2·50	5·44
Stroud (Upfield)	*Gloucestershire*	51 44	2 13	226	2·12	4·57
Church Stretton (Wolstaston)	*Shropshire*	52 35	2 48	800	2·17	5·04
Boston	*Lincolnshire*	52 58	0 1	11	1·53	2·15
Worksop (Hodsock Priory)	*Nottinghamshire*	53 22	1 5	56	1·64	2·67
Mickleover Manor	*Derbyshire*	52 54	1 32	280	1·71	2·38
Macclesfield	*Cheshire*	53 15	2 7	501	2·30	3·64
Southport (Hesketh Park)	*Lancashire*	53 39	2 59	38	2·07	3·55
Arncliffe Vicarage	*Yorkshire, W.R.*	54 8	2 6	732	4·88	10·07
Wetherby (Ribston Hall)	,, ,,	53 59	1 24	130	1·71	3·46
Hull (Pearson Park)	,, *E.R.*	53 45	0 20	6	1·78	3·42
Newcastle (Town Moor)	*Northumberland*	54 59	1 38	201	1·63	2·60
Borrowdale (Seathwaite)	*Cumberland*	54 30	3 10	423	10·96	20·40
Cardiff (Ely)	*Glamorgan*	51 29	3 13	53	3·07	5·48
Haverfordwest	*Pembroke*	51 48	4 58	90	3·42	7·89
Aberystwyth (Gogerddan)	*Cardigan*	52 26	4 1	83	3·09	6·31
Llandudno	*Carnarvon*	53 20	3 50	72	2·11	3·56
Cargen [Dumfries]	*Kirkcudbright*	55 2	3 37	80	3·42	11·10
Marchmont House	*Berwick*	55 44	2 24	498	2·15	2·94
Girvan (Pinmore)	*Ayr*	55 10	4 49	207	3·87	8·48
Glasgow (Queen's Park)	*Renfrew*	55 53	4 18	144	2·70	4·49
Inveraray (Newtown)	*Argyll*	56 14	5 4	17	5·71	9·53
Mull (Quinish)	,,	56 34	6 13	35	4·45	5·67
Dundee (Eastern Necropolis)	*Forfar*	56 28	2 57	199	1·91	4·48
Braemar	*Aberdeen*	57 0	3 24	1114	2·55	7·89
Aberdeen (Cranford)	,,	57 8	2 7	120	2·36	4·13
Gordon Castle	*Moray*	57 37	3 5	107	1·95	2·93
Fort Augustus (S. Benedict's)	*E. Inverness*	57 9	4 41	68	4·20	3·31
Loch Torridon (Bendamph)	*W. Ross*	57 32	5 32	20	7·53	8·37
Dunrobin Castle	*Sutherland*	57 59	3 56	14	2·58	3·41
Wick	*Caithness*	58 26	3 6	77	2·23	2·51
Killarney (District Asylum)	*Kerry*	52 4	9 31	178	4·99	9·99
Waterford (Brook Lodge)	*Waterford*	52 15	7 7	104	3·18	5·38
Nenagh (Castle Lough)	*Tipperary*	52 54	8 24	120	2·89	4·98
Ennistymon House	*Clare*	52 57	9 18	37	3·44	6·06
Gorey (Courtown House)	*Wexford*	52 40	6 13	80	2·75	5·21
Abbey Leix (Blandsfort)	*Queen's County*	52 56	7 17	532	2·55	4·66
Dublin (FitzWilliam Square)	*Dublin*	53 21	6 14	54	1·93	3·28
Mullingar (Belvedere)	*Westmeath*	53 29	7 22	367	2·67	5·11
Crossmolina (Enniscoe)	*Mayo*	54 4	9 16	74	4·20	6·62
Cong (The Glebe)	,,	53 33	9 16	112	3·72	5·99
Collooney (Markree Obsy.)	*Sligo*	54 11	8 27	127	3·20	5·93
Seaforde	*Down*	54 19	5 50	180	2·81	5·94
Bushmills (Dundarave)	*Antrim*	55 12	6 30	162	2·56	3·07
Omagh (Edenfel)	*Tyrone*	54 36	7 18	280	2·68	4·26

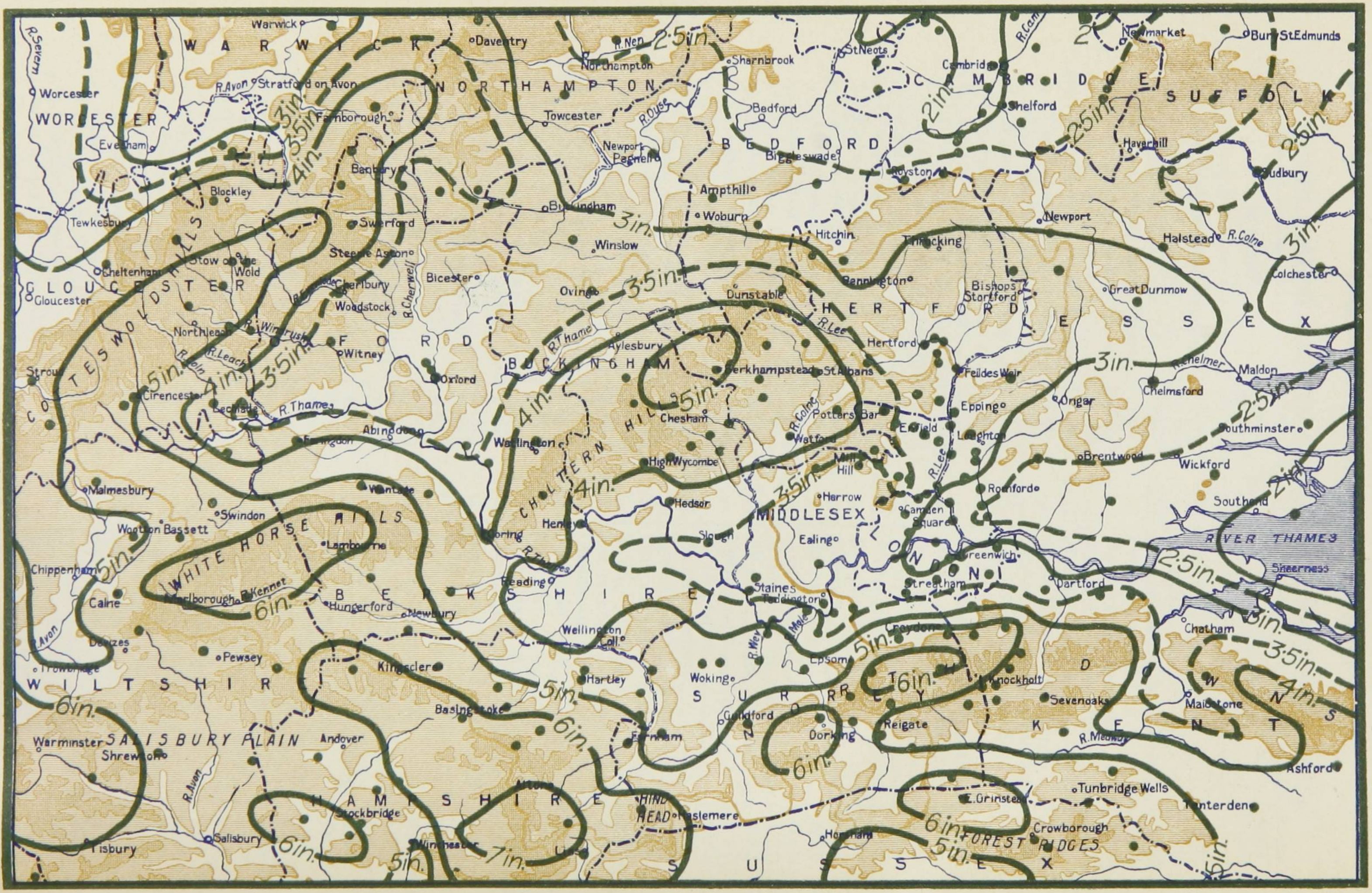
RAINFALL TABLE FOR FEBRUARY, 1915—*continued.*

RAINFALL OF MONTH (*con.*)					RAINFALL FROM JAN. 1.				Mean Annual 1875-1909.	STATION.
Diff. from Av. in.	% of Av.	Max. in 24 hours. in.	Max. in 24 hours. Date.	No. of Days	Aver. 1875—1909. in.	1915. in.	Diff. from Aver. in.	% of Av.	in.	
+1·76	206	·45	8	18	3·49	7·54	+4·05	216	25·11	Camden Square
+2·51	232	·97	13	19	4·04	7·63	+3·59	189	27·64	Tenterden
+2·33	208	·75	8	18	4·76	9·55	+4·79	201	30·48	Patching
+3·17	239	·85	16	20	5·03	9·63	+4·60	192	31·87	Cadland
+1·46	190	·40	13	20	3·40	5·92	+2·52	174	24·58	Oxford
+ ·58	134	·39	7	16	3·60	4·79	+1·19	133	25·20	Swanspool
+ ·42	135	·28	13	20	2·52	3·57	+1·05	142	19·28	Shoeburyness
+1·13	171	·40	13	19	3·29	5·42	+2·13	165	25·40	Westley
+1·53	208	·32	13	23	2·94	6·32	+3·38	215	23·73	Geldeston
+5·83	298	1·31	13	24	6·54	13·88	+7·34	213	38·27	Polapit Tamar
+2·94	217	·85	16	24	5·44	9·00	+3·56	165	33·54	Rousdon
+2·45	216	·89	16	21	4·45	7·55	+3·10	169	29·81	Stroud
+2·87	233	·69	13	21	4·68	10·12	+5·44	216	32·41	Wolstaston
+ ·62	141	·44	13	19	3·07	4·70	+1·63	153	23·35	Boston
+1·03	163	·41	13	17	3·34	4·82	+1·48	144	24·46	Hodsock Priory
+ ·67	139	·44	14	14	3·66	5·14	+1·48	140	26·65	Mickleover
+1·34	158	·43	7	19	4·96	9·33	+4·37	188	34·73	Macclesfield
+1·48	171	·46	18	22	4·62	7·53	+2·91	163	32·70	Southport
+5·19	206	1·25	16	22	11·14	19·79	+8·65	177	61·49	Arncliffe
+1·75	203	·46	13	15	3·60	6·88	+3·28	191	26·87	Ribston Hall
+1·64	192	·85	13	20	3·48	6·26	+2·78	179	26·42	Hull
+ ·97	160	·50	7	23	3·53	4·72	+1·19	134	27·94	Newcastle
+9·44	186	3·30	26	22	24·40	37·19	+12·79	152	129·48	Seathwaite
+2·41	178	1·34	16	28	6·72	9·58	+2·86	143	42·28	Cardiff
+4·47	231	1·00	10	20	8·11	12·19	+4·08	150	46·81	Haverfordwest
+3·22	205	1·00	18	24	7·00	13·02	+6·02	186	45·46	Gogerddan
+1·45	169	·47	2	21	4·62	7·13	+2·51	155	30·36	Llandudno
+7·68	325	2·15	26	20	7·52	14·63	+7·11	195	43·47	Cargen
+ ·79	137	·29	2	21	4·55	5·22	+ ·67	115	33·76	Marchmont
+4·61	219	1·07	26	22	8·65	15·03	+6·38	173	49·77	Girvan
+1·79	166	·99	26	21	6·23	6·80	+ ·57	109	35·97	Glasgow
+3·82	167	2·05	1	24	13·05	17·25	+4·20	132	68·67	Inveraray
+1·22	127	·88	1	23	10·00	13·83	+3·83	138	56·57	Quinish
+2·57	234	1·05	7	21	3·92	6·42	+2·50	164	28·64	Dundee
+5·34	309	1·59	7	21	5·47	11·37	+5·90	208	34·93	Braemar
+1·77	175	·92	7	20	4·72	7·55	+2·83	160	32·73	Aberdeen
+ ·98	150	·47	14	20	3·94	5·40	+1·46	137	30·34	Gordon Castle
— ·89	79	·51	1	23	9·78	7·62	—2·16	78	44·53	Fort Augustus
+ ·84	111	1·35	1	22	16·95	19·19	+2·24	113	83·93	Bendamph
+ ·83	132	·60	8	15	5·33	...	...	...	31·90	Dunrobin Castl
+ ·28	113	...	...	...	4·71	4·66	— ·05	99	29·88	Wick
+5·00	200	1·05	3	28	10·93	15·40	+4·47	141	54·81	Killarney
+2·20	169	·97	16	18	6·96	7·67	+ ·71	110	39·57	Waterford
+2·09	172	1·02	8	23	6·77	10·25	+3·48	152	39·43	Castle Lough
+2·62	176	·70	26	25	7·74	12·99	+5·25	168	46·52	Ennistymon
+2·46	190	1·16	16	18	5·94	7·61	+1·67	128	34·99	Courtown Ho.
+2·11	183	·61	26	21	5·70	8·31	+2·61	146	35·92	Abbey Leix
+1·35	170	·43	26	20	4·07	5·38	+1·31	132	27·68	Dublin
+2·44	192	·95	26	23	5·77	10·38	+4·61	180	36·15	Mullingar.
+2·42	158	·81	3	26	9·55	13·40	+3·85	140	52·87	Enniscoe
+2·27	161	·55	2	25	8·51	12·31	+3 80	145	48·90	Cong
+2·73	185	·73	9	25	7·07	11·62	+4·55	165	42·71	Markree
+3·13	212	1·84	16	18	6·22	8·54	+2·32	137	38·91	Seaforde
+ ·51	120	·36	28	21	5·75	5·69	— ·06	99	37·56	Dundarave
+1·58	159	·55	16	24	6·14	8·75	+2·61	142	39·38	Omagh

SUPPLEMENTARY RAINFALL, FEBRUARY, 1915.

Div.	STATION.	Rain inches	Div.	STATION.	Rain inches.
II.	Warlingham, Redvers Road	6·00	XI.	Lligwy	3·35
,,	Ramsgate	2·81	,,	Douglas	5·30
,,	Hailsham	5·37	XII.	Stoneykirk, Ardwell House	5·60
,,	Totland Bay, Aston House	4·53	,,	Carsphairn Shiel	13·30
,,	Stockbridge, Ashley	6·45	,,	Beattock, Kinnelhead	8·84
,,	Grayshott	6·57	,,	Langholm, Drove Road	9·46
III.	Harrow Weald, Hill House	3·38	XIII.	Meggat Water, Cramilt Lodge	...
,,	Caversham, Rectory Road	4·09	,,	North Berwick Reservoir	1·91
,,	Pitsford, Sedgebrook	2·27	,,	Edinburgh, Royal Observaty.	1.94
,,	Woburn, Milton Bryant	3·04	XIV.	Maybole, Knockdon Farm	4·59
,,	Chatteris, The Priory	1·67	XV.	Ballachulish House	9·59
IV.	Elsenham, Gaunts End	3·20	,,	Campbeltown, Witchburn	5·92
,,	Colchester, Hill Ho., Lexden	3·26	,,	Holy Loch, Ardnadam	10·67
,,	Ipswich, Rookwood, Copdock	3·38	,,	Islay, Eallabus	5·40
,,	Blakeney	2·81	,,	Tiree, Cornaigmore	4·69
,,	Swaffham	2·83	XVI.	Dollar Academy	6·00
V.	Bishops Cannings	5·06	,,	Balquhidder, Stronvar	11·89
,,	Wimborne, St. John's Hill	6·56	,,	Glenlyon, Meggernie Castle	10·91
,,	Ashburton, Druid House	11·89	,,	Blair Atholl	6·32
,,	Cullompton	5·91	,,	Coupar Angus	6·62
,,	Lynmouth, Rock House	7·87	,,	Montrose, Sunnyside Asylum.	4·52
,,	Okehampton, Oaklands	8·78	XVII.	Alford, Lynturk Manse	4·87
,,	Hartland Abbey	5·90	,,	Fyvie Castle	5·17
,,	Probus, Lamellyn	7·64	,,	Keith Station	4·33
,,	North Cadbury Rectory.	4·87	XVIII.	Rothiemurchus	...
VI.	Clifton, Pembroke Road	4·40	,,	Loch Quoich, Loan	15·60
,,	Ross, The Graig	4·15	,,	Drumnadrochit	2·84
,,	Shifnal, Hatton Grange	2·53	,,	Skye, Dunvegan	6·36
,,	Droitwich	3·63	,,	Lochmaddy, Bayhead	4·87
,,	Blockley, Upton Wold	4·54	,,	Glencarron Lodge	6·16
VII.	Market Overton	3·30	XIX.	Invershin	2·70
,,	Market Rasen	2·96	,,	Melvich	3·10
,,	Bawtry, Hesley Hall	2·27	,,	Loch Stack, Achfary	5·99
,,	Derby, Midland Railway	2·63	XX.	Dunmanway, The Rectory	11·10
,,	Buxton	5·85	,,	Glanmire, Lota Lodge	7·25
VIII.	Nantwich, Dorfold Hall	3·28	,,	Mitchelstown Castle	5·75
,,	Chatburn, Middlewood	4·63	,,	Darrynane Abbey	8·83
,,	Lancaster, Strathspey	5·12	,,	Clonmel, Bruce Villa	6·01
IX.	Langsett Moor, Up. Midhope	5·44	,,	Newmarket-on-Fergus, Fenloe	4·55
,,	Scarborough, Scalby	3·77	XXI.	Laragh, Glendalough	8·99
,,	Ingleby Greenhow	4·98	,,	Ballycumber, Moorock Lodge	3·55
,,	Mickleton	4·10	,,	Balbriggan, Ardgillan	3·09
X.	Bellingham, High Green Manor	4·18	XXII.	Ballynahinch Castle	7·04
,,	Ilderton, Lilburn Cottage	3·85	,,	Woodlawn	4·21
,,	Keswick, The Bank	9·51	,,	Westport, St. Helens	6·58
XI.	Llanfrechfa Grange	6·00	,,	Dugort, Slievemore Hotel	7·77
,,	Treherbert, Tyn-y-waun	15·89	,,	Mohill Rectory	4·73
,,	Carmarthen, The Friary	8·41	XXIII.	Enniskillen, Portora	4·62
,,	Fishguard Goodwick Station.	7·56	,,	Dartrey [Cootehill]	4·83
,,	Crickhowell, Tal-y-maes	8·50	,,	Warrenpoint, Manor House	4·71
,,	New Radnor, Ednol	7·80	,,	Banbridge, Milltown	3·60
,,	Birmingham W W., Tyrmynydd	11·13	,,	Belfast, Cave Hill Road	4·32
,,	Lake Vyrnwy	...	,,	Ballymena Harryville	5·46
,,	Llangynhafal, Plâs Draw	4·13	,,	Londonderry, Creggan Res.	3·57
,,	Dolgelly, Bryntirion	8·31	,,	Dunfanaghy, Horn Head	3·90
,,	Bettws-y-Coed, Tyn-y-bryn	...	,,	Killybegs	5·46

THAMES VALLEY RAINFALL. — FEBRUARY, 1915.



ALTITUDE SCALE

Below 250 feet	250 to 500 feet	500 to 1000 feet	Above 1000 feet

SCALE OF MILES
0 5 10 15 20

Symons's Meteorological Magazine.

Watershed of River Thames above Teddington, and River Lee above Feildes Weir

Rainfall Stations reporting ... ...
Isohyetals.

THE WEATHER OF FEBRUARY.

UNSETTLED weather with strong southerly or south-westerly winds or gales prevailed at the beginning of the month, when a large depression spread over the British Isles from the Atlantic. Heavy rain fell over Ireland and along the west coast of Great Britain, there being 2·71 in. at Ardnadam on the 1st, 2·22 in. at Delphi (Co. Mayo), on the 2nd, and rather more than 2·00 in. at Seathwaite on each day. More than 1·50 in. was recorded at many Scottish stations on the 3rd, and equally heavy falls occurred in the northern half of the Kingdom on the 5th, with heavy hail at Waterford. Temperature was generally high and shade maxima exceeding 50° occurred in all parts of the Kingdom on the 3rd, and 55° or 56° at some stations in Ireland and the north-west and north of Great Britain. A depression off the west of Ireland extended eastward and moved in a northerly direction on the 7th, causing a south-easterly gale and heavy rain or snow on the west coast of Scotland. Local thunderstorms occurred in many places in the south of England on the 8th, at Aberdovey on the 9th, at Blacksod and Scilly on the 10th, and at Jersey on the 11th. On the latter day thick fog prevailed in many parts of England and caused two motor accidents at Mansfield. An unusually deep depression passed across the south of England to the Continent on the 13th, and occasioned south-easterly to south-westerly gales with heavy rain over the southern counties. At Holne (Devon) the fall amounted to 2·47 in. Unsettled conditions continued and on the 16th heavy rain fell over a large area in the south-west of England and snow in the south of Ireland. Many stations in South Wales and Devon had over 2·00 in., and at Treherbert there was 3·51 in., and at Holne 3·44 in. The River Dart at Holne Bridge rose 10 or 12 inches in the night. The continuous heavy rains resulted in high floods in many low-lying districts in the south of England at the end of the third week. Heavy snow fell during the afternoon and evening of the 22nd over the south of England, lying to a depth of 6 inches at Mildenhall and Harrow. Low temperature prevailed from the 23rd to the 25th, shade minima of 12° being reported at Fort Augustus, 13° at West Linton, 15° at Marlborough, and 17° at Llangammarch Wells. The weather during the last week, though less wet than in several preceding weeks, continued unsettled. More than 2·00 in. of rain fell at numerous stations in the Western Highlands and the Lake District on the 26th. There was snow over Scotland and in the Peak District on the 27th and 28th and a thunderstorm with vivid lightning occurred in Derbyshire on the evening of the 28th.

In London it was generally dull or wet with occasional fine sunny days. The rainfall at Camden Square, 3·42 in., was only exceeded four times in February in the preceding 57 years. The mean temperature, 40°·4, was 0°·7 above the average. The duration of sunshine was 54·5 hours, and of rain 67·2 hours. Evaporation, ·13 in.

Only two small areas in England had rainfall less than 2·00 in., viz., the estuary of the Thames and an area in Cambridge and Huntingdon. Almost the whole of the country south of the Thames had more than 4·00 in., and a large part of Devon and Cornwall more than 8·00 in., with an area on Dartmoor exceeding 15·00 in. Less than 3·00 in. fell over nearly the whole of the central portion of England east of Derby and extending from York to Oxford. Practically the whole of Wales had more than 6·00 in. of rain and considerable areas in the mountainous districts had twice this amount. In Scotland less than 2·00 in. fell on the shores of the Moray Firth and the Firth of Forth, but only along the east coast did the total rainfall fail to reach 4·00 in. Large areas in the western Highlands had more than 10·00. In Ireland there was less than 3·00 in. along the coast of Londonderry and in a small area in the north-east but 5·00 in., or more, fell generally south of Wicklow and west of Athlone. Over a large area in the south-west and another in the Connemara district more than 10·00 in. was recorded.

Over the Kingdom as a whole the general rainfall expressed as a percentage of the average was as follows; England and Wales, 196; Scotland, 166; Ireland 176; British Isles, 181.

Climatological Table for the British Empire, September, 1914.

STATIONS. (*Those in italics are South of the Equator.*)	Absolute. Maximum. Temp.	Date.	Absolute. Minimum. Temp.	Date.	Average. Max.	Min.	Dew Point.	Humidity.	Absolute. Max. in Sun.	Min. on Grass.	Total Rain Depth.	Days.	Aver. Cloud.
	°		°		°	°	°	0-100	°	°	inches		
London, Camden Square	81·6	7	35·5	30	69·6	48·7	50·6	81	122·8	34·0	1·00	9	4·4
Malta	83·8	12	62·0	25	77·1	67·5	...	76	141·0	...	1·34	3	0·9
Lagos	89·0	28*	70·0	3	85·2	73·0	71·1	74	156·2	67·0	·36	3	6·9
Cape Town	76·7	16	41·2	17	63·9	51·6	50·8	77	...	..	3·05	15	5·8
Natal, Durban ...	...	...	...	...	...	...	...	...	...	...	...	...	...
Johannesburg	84·3	28	40·1	21	76·5	52·1	43·2	57	...	40·1	·11	2	0·2
Mauritius	80·2	21	59·4	16‖	77·7	63·9	60·1	71	...	52·5	1·06	14	5·3
Bloemfontein ...	88·3	29	35·4	2	77·3	48·2	...	...	...	...	1·13	3	1·1
Calcutta...	92·2	29†	74·7	8	88·8	77·9	76·9	84	...	71·3	7·24	14	7·7
Bombay... ...	88·5	26	76·4	16	85·6	78·1	76·5	85	135·2	68·3	21·03	23	6·5
Madras	98·0	2	72·1	22	91·8	76·6	75·2	81	162·4	71·1	6·84	11	4·9
Colombo, Ceylon ...	89·5	29	72·8	28	87·4	75·7	74·0	79	161·8	70·0	4·15	18	6·9
Hongkong	92·1	1	73·2	26	85·4	76·2	70·9	73	...	...	19·98	13	5·1
Sydney	78·8	23	45·2	2	66·9	52·7	49·1	70	131·1	39·1	5·21	12	3·9
Melbourne	80·3	6	34·9	14	61·9	44·5	42·0	63	127·1	28·1	1·09	12	4·6
Adelaide	84·6	7	36·5	20	69·4	46·3	42·6	53	146·5	26.4	·60	7	3·1
Perth	86·3	30	41·2	22	71·5	50·8	48·5	62	149·5	34·5	·62	9	3·2
Coolgardie	91·2	20	37·2	22	75·4	48·2	42·4	44	153·2	36·0	·00	0	1·4
Hobart, Tasmania ..	76·9	8	33·0	20	59·9	42·7	38·9	58	123·8	22·3	1·00	11	4·7
Wellington ...	69·0	25	34·0	19	58·8	45·6	43·7	73	128·6	23·0	1·52	7	6·0
Auckland	68·5	26	41·0	10	59·0	47·6	46·7	77	135·0	40·0	1·45	13	5·5
Jamaica, Kingston ..	94·6	9	72·7	1	90·8	74·2	71·6	76	...	...	·82	3	4·5
Grenada	89·0	19‡	72·0	12	86·2	75·5	...	76	136·0	...	6·63	16	3·0
Toronto	86·8	22	36·6	28	71·2	50·8	51·8	79	132·3	32·8	1·54	9	2·7
Fredericton	90·0	22§	30·0	28	70·1	46·1	...	77	...	...	2·51	8	4·1
St. John, N.B. ...	77·0	16	34·1	29	62·9	50·4	50·0	79	...	...	2·91	12	4·2
Alberta, Edmonton ...	78·0	25	30·2	16	60·7	39·5	...	75	129·8	24·5	3·54	13	6·4
Victoria, B.C.	71·1	24	43·8	1	58·6	48·5	...	87	...	...	1·98	12	7·2

* and 29. † and 30. ‡ and 22. ‖ and 28.

Johannesburg.—Bright sunshine 306·5 hours.

Mauritius.—Mean temp. of air 1°·0 above, dew point 0·3 above, and R ·47 in. below, averages. Mean hourly velocity of wind, 11·7 miles.

Bloemfontein.—A very warm month.

COLOMBO.—Mean temp. of air 81°·6, or 0·3° above, dew point 0·5 above, and R ·56 in. above, averages. Mean hourly velocity of wind 5·4 miles.

HONGKONG.—Mean temp. of air 80°·4. Mean hourly velocity of wind 9·0 miles. Bright sunshine 215·0 hours.

Melbourne.—Mean temp. of air 0°·8 below and R 1·25 in. below, averages.

Adelaide.—Mean temp. 0°·8 above average. A very dry month, and with one exception, lowest September rainfall.

Coolgardie.—Temp. of air 3°·4 above average.

Hobart.—Mean temp. of air 0°·5 above, R 1·14 in. below, averages, and record hours of sunshine.

Wellington.—Mean temp. of air 52°·2 or 0°·9 above and R 2·72 in. below, averages. Bright sunshine 196·5 hours.

Auckland.—Remarkably dry, rainfall under half the average. Mean temp. slightly under average.

ALBERTA, EDMONTON.—Wet, damp, and cloudy, with average temp. TSS on 3 days.