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A New Handbook of Climatology

By Sir GILBERT WALKER, C.S.I., F.R.S.

It is twenty years since the publication of the revised and enlarged third edition of Hann's *Handbook of Climatology,* which contained in its three volumes about 1,500 pages and was unrivalled in its wealth of reliable information as well as in its scientific discussion of essential principles. There is now therefore a need, both for theoretical and economic purposes, of a book in which the great mass of information that has accumulated in the meantime should be made available; and Messrs. Bornträger, of Berlin, have agreed to bring it out with Dr. Köppen, of Graz, and Dr. Geiger, of Munich, as general editors. Readers of Köppen's *Klimate der Erde,* with its original system of classification, will be confident that the work could not be in better hands, and will be filled with admiration at the vitality which enables such a task to be undertaken by one whose eightieth birthday was celebrated two years ago.

The scheme of the handbook is that it shall contain about twice as much as Hann's, and be provided with more tables, arranged on a uniform plan; in fact the tables are regarded as the most valuable element. The text consists of a general and a regional portion. The first volume, of 768 pages, deals with the factors which determine climate, and its distribution over the earth when classified according to Köppen's system; it also includes the chief effects on other features of nature and on mankind. Sections in this part have been allotted to Milanko-

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vitch, Conrad, Köppen, Geiger, Wagner, Borchardt and K. Wegener.

The regional portion, in volumes 2 to 5, handles the climates of the different parts of the earth and the most important sources of information regarding them; agricultural and hygienic conditions are considered as well as those of pure meteorology. North America has been allotted to R. de C. Ward and C. F. Brooks; Central America to K. Sapper; South America to K. Knoch; Greenland to A. Wegener; north-west Europe to B. J. Birkeland and N. J. Föyn; central and south Europe to E. Alt; Russia and central Asia to L. Berg, A. Kaminskij and E. Rubinstein; Nearer Asia to L. Weickmann; British India to Sir Gilbert Walker; Japan, China and Micronesia to T. Okada; Further India and the East Indies to C. Braak; Australia and New Zealand to T. Griffith Taylor; Polynesia to K. Wegener; the Antarctic to W. Meinardus; west and central Africa to R. Geiger; east Africa to G. Castens; and the Oceans to E. Kuhlbrodt.

The regional portion is to contain about 2,400 pages, of which about 1,000 are devoted to tables on a uniform plan; of charts there are to be about 320 in black and white and 16 in colours.

The amount of labour involved in collecting the regional data is so great as to lie beyond the powers of some of the individuals responsible; and a satisfactory result would be impossible without co-operation of the heads of a number of meteorological services. This has been generously promised by Canada, the United States, India, Mexico, and presumably other countries.

It will be seen that the handbook is neither a text-book nor a collection of everything that has been published on climate; but aims at a critical selection of essential features, arranged on a uniform plan for reference by all with a slight meteorological equipment.

The Life and Work of Sir Norman Lockyer*

Through the happy inspiration of Sir Richard Gregory, this book, which deals with the life and work of Sir Norman Lockyer, is cast in a rather novel form. The first half consists of a biographical sketch of Lockyer's life, while the second half consists of a series of chapters by different writers, who discuss different aspects of Lockyer's work, and show the relation of his ideas to those which are current to-day.

The biographical sketch was prepared by Lady Lockyer and Miss Lockyer with the assistance of Professor Dingle, and the

*By T. Mary Lockyer and Winifred L. Lockyer with the assistance of Prof. H. Dingle. Size $8\frac{3}{4} \times 5\frac{3}{4}$in. pp xii + 474. *Illus*, London, Macmillan and Co. 1928. 18s. net.

personal details of Lockyer's life are described in a clear and simple style. Lockyer was born in 1836, and after an education whose bias appears to have been literary rather than scientific, was nominated to an established clerkship at the War Office in February, 1858. In was in the scanty leisure afforded by his official duties that he became an enthusiastic astronomical observer. It was probably through his drawings of the planet Mars that his name first came to be widely known, but in the next few years he produced many astronomical papers. Lockyer for many years followed a plan that when he sent a paper to the Royal Astronomical Society for publication, he also prepared an account of his discoveries in popular language, for publication in the *Spectator*. Would that some of our meteorological colleagues would follow the same plan!

A weekly review called the *Reader* started in January, 1863, by J. M. Ludlow and Tom Hughes, who were Lockyer's colleagues at the War Office and his neighbours at Wimbledon, gave Lockyer scope for his marked gift of clear exposition of the scientific discoveries of the day. He became its scientific editor, and his contributions aroused considerable interest. The review was, however, a financial failure, and the last number appeared in June, 1865. During this time Lockyer was devoting his nights to astronomical observation, and his days to work at the War Office. In December, 1865, he was made editor of the new Army Regulations. We also find him devising a new form of pay sheet suitable for use by all units.

Fame came to Lockyer from the results of his application of the spectroscope in astronomy. He believed that it should be possible to see the spectrum of the prominences in daylight. His first attempt was unsuccessful, owing to the small dispersion of his spectroscope, but when after long delay a suitable spectroscope was available in October, 1868, he was immediately successful. In the meantime, however, a French physicist, Janssen, had hit on the same idea, and had actually succeeded several months before Lockyer. One result was the striking of a gold medal by the French Government to commemorate the discovery; another was a life-long friendship between Lockyer and Janssen.

Lockyer's activities covered a very wide field, but not the least of his achievements was the establishment of the weekly journal, *Nature*, in 1869, while he was still a clerk at the War Office. Nor must the part played by Messrs. Macmillan in this matter be overlooked. Every year from its inception until 1899, the annual balance sheet for *Nature* came out on the wrong side, and it was only through the mutual trust between editor and publisher that the journal continued to exist. Before Lockyer resigned the editorship to its present holder, Sir Richard Gregory, in 1919, *Nature* had been set on a firm basis. The value of this journal to the scientific worker of to-day needs no elaboration, but a letter from Benjamin Gould, who had just established an observatory in the lonely region of Cordoba, in the Argentine, shows how inspiring the weekly arrival of *Nature* was to an isolated worker.

From 1870 to 1878 Lockyer was occupied by his duties as Secretary of the Royal Commission under the Chairmanship of the Duke of Devonshire, to inquire into scientific instruction and research; and with the exhibition of scientific instruments held in 1876. In 1879 the Solar Physics Observatory was established at South Kensington with Lockyer in charge. He was Professor of Astronomy in the Royal College of Science until 1902, and remained Director of the Solar Physics Observatory until it was removed from South Kensington to Cambridge.

Lockyer's contributions to astrophysics cannot be briefly summarised with any justice to their magnitude. He was a leader at the time when this science was little more than a new-born babe, and his observations of spectra of the different parts of the sun, of the stars, and of elements in the laboratory, were solid additions to knowledge. His name is perhaps most frequently associated with the meteoritic hypothesis of the origin of stars and stellar systems, and with the idea of the dissociation of the chemical elements at such high temperatures as are to be found in the stars. But his work was many-sided, and he found time in the midst of his preoccupation with spectroscopy to investigate the orientation of Egyptian temples, British stone circles and other ancient monuments. And from time to time we find him putting up a vigorous fight to save the site at South Kensington from the danger of underground railways and the intrusion of buildings of a non-scientific character. Lockyer's motto in life might well have been "Whatsoever thy hand findeth to do, do it with thy might."

His work was characterised by boldness of conception and fertility of imagination rather than by minute accuracy of detail, and some of his observational evidence, particularly that relating to the supposed existence of spectral lines common to different elements, was very decidedly shaky, and was so regarded by his contemporaries.

Not the least of Lockyer's gifts was his gift for friendship. He counted among his intimate friends such men as T. H. Huxley, Janssen, Tennyson, Sir Michael Foster, Dr. Isaac Roberts, to name but a few. The assistance of his many friends counted for much in keeping *Nature* in existence in its early days. Nor must the devotion of his assistants be forgotten. Among his assistants at South Kensington were A. Fowler, now Yarrow Professor of the Royal Society, Sir Richard Gregory, the present editor of *Nature*, and Professor Raphael Meldola, men whose names are familiar to all scientific workers.

Lockyer approached meteorology from a standpoint which was novel at that time. He had great faith in the possibilities of meteorology, and believed that solar physics and meteorology should go hand in hand. He used the method of "curve parallels" to investigate world weather, and derived results which are now more frequently expressed in terms of coefficients of correlation or of periodogram analyses. He found that heat pulses in the sun had their counterpart in pulses in monsoon rainfall, in the rainfall of the Nile and Mississippi valleys, and in the pressure over India and elsewhere. He found a barometric surge or "see-saw" of pressure between a region covering a large part of Asia, Australia and eastern Africa, and a region covering most of the American continent. This result was confirmed by Bigelow, and has been stated since in terms of coefficients of correlation by Sir Gilbert Walker. In the opinion of the reviewer, the value of Lockyer's contribution to meteorology is not sufficiently recognised to-day.

Lady Lockyer and Miss Lockyer and their collaborators are to be congratulated on the production of a volume which is full of interest and inspiration. It describes not only a man, but an epoch in the history of astrophysics. The evolution of the War Office clerk into the scientist of world-wide fame is worthy of close study by all who have any interest in things scientific. Moreover, the chapters in the latter half of the book, dealing with the relation of Lockyer's ideas to the astrophysics of to-day form an admirable introduction to some of the latest ideas in that science. Of the production of the book, by Messrs. Macmillan, with whom Lockyer was so long associated as editor of *Nature*, we need say no more than that it reaches the highest standard.

D. BRUNT.

OFFICIAL NOTICE.

Certification of Balloon Meteorographs

For many years past, the balloon meteorograph designed by the late Mr. W. H. Dines has been the standard instrument for use in the exploration of the upper air from British stations. From time to time instrument makers have been approached from outside sources to supply the meteorographs, and the need has been felt for some means of ensuring that instruments supplied in this way are satisfactory. To meet this need, it has been decided to place at the disposal of manufacturers the testing facilities which exist at Kew Observatory. For a fee of 7s. 6d., meteorographs will be tested and certified if in accordance with the official specification. Further particulars of this service may be obtained on application to the Director, Meteorological Office, South Kensington, London, S.W.7.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings will be :—

January 28th.—*Results of visibility measurements in Karlsruhe and comparative investigations.* By A. Peppler (Karlsruhe, Abh. Badischen Landeswetterwarte, No. 6, 1927) (in German). *Opener.*—Mr. C. D. Stewart, B.Sc.

February 11th—*Solar activity and long-period weather changes.* By H. H. Clayton (Smithsonian Misc. Coll., 78, No. 4, 1926). *Opener.*—Mr. B. C. V. Oddie, B.Sc.

NOTE—The dates of the Discussions of this session are one week earlier than those originally stated in the *Meterological Magazine*, September, 1928, p. 184.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, December 19th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the Chair.

L. H. G. Dines, M.A.—The Dines Float Barograph.

This instrument was designed by the late Mr. W. H. Dines about 20 years ago, and has been in use at the Observatories of the Meteorological Office for a number of years. It is a pen-recording barograph, of which the leading feature is the care taken to reduce friction in the mechanism. The record will indicate barometric oscillations of amplitudes down to one or two tenths of a millibar. The instrument is described in detail, and calculations are appended showing how to compute the scale value and how to adjust the device provided to render the readings independent of temperature.

Opening the discussion, the President pointed out that the float barograph was an ingenious scientific adaptation of the old wheel or clock barometer. Dr. Whipple pointed out that it was actually superior in several respects to the photo-barograph, and urged that its manufacture should be taken up on a commercial scale.

Dr. J. Glasspoole, M.Sc., Ph.D.—The distribution of the average seasonal rainfall over Europe.

The proportion of the average annual rain falling in the seasons in different parts of Europe can be considered as of three main types. In western Europe there is abundant rain at all seasons with a minimum in summer and a maximum in winter. In the Mediterranean region there is very little rainfall at all during the summer, while there is generally a preponderance at this season in central Europe. In the three months June to August only one-fiftieth of the average annual rain falls in the south of Spain, while more than half the annual amount falls in the same period in north-eastern Russia. The paper includes maps showing the proportion of the average annual rain falling in each season. These maps emphasise that the distribution of the rainfall amongst the seasons depends very largely on the physical features, especially on the distance from the sea and the arrangement of mountain and plain.

The discussion emphasised the practical value of the paper. It was also remarked that while there were ready explanations for the distribution of winter and summer rains, it was very difficult to account for the excess of rainfall in autumn in western Europe.

The Buchan Prize of the Royal Meteorological Society for 1929 has been awarded to Dr. Harold Jeffreys, D.Sc., F.R.S., for the following papers contributed to the *Quarterly Journal* of the Society during the years 1924-1927 :—" The cause of cyclones " ; " On fluid motions produced by differences of temperature and humidity " ; " On the dynamics of geostrophic winds " ; and " Cyclones and the general circulation."

Correspondence

To the Editor, *The Meteorological Magazine*

Grass Minimum Temperatures

The standard specification for the exposure of a grass minimum thermometer is " one or two inches above the ground which should be covered with short grass." Some recent observations at South Farnborough showed very considerable differences between two thermometers both exposed in the standard way on sites in close proximity. The results were stimulatingly surprising and in a discussion about them with Mr. J. S. Dines, the question of the character of the grass covering was raised. As he was shortly afterwards visiting Farnborough, he made a point of examining the grass and found the one site covered with a carpet of short grass and moss while on the other site the bare earth could be seen betwen the blades of grass. The grass minimum temperatures on this second site were usually lower than on the first site, the average difference for 50 nights between August 9th and October 8th, 1928, was 5°F., the largest difference being 12°F. I am led to suggest the following explanation of the differences.

It seems likely that on the second site the bare earth radiates " to the sky " and becomes colder than the air above it : the layers (of air) of minute thickness just above the surface become then each colder than the next layer above it so that there is a progressive increase of temperature from the surface upwards : a very stable condition, made more stable by the blades of grass stopping any horizontal movement of the enmeshed air.

On the first site, on the other hand, the effective radiating surface will be the top of the carpet of short grass and moss. This will become colder than the layer of air entangled in the grass and moss beneath it and colder also than the surface of the ground underneath. This condition will be unstable; and there will be a continued minute turbulence which will distribute the " cold " through a rather more extensive layer of air. Moreover, the process of cooling the grass, air and earth beneath the radiating upper surface of the carpet will be much slower than if radiation were directly effective.

This result naturally suggests that the standard specification is not sufficiently precise to secure comparable records. Possibly the thermometer should be placed on a standard square board either bare or covered with artificial " blades " of grass of uniform length and evenly distributed. It would be necessary to place the board in such surroundings that the temperatures in proximity to it would not be lower than those over the board itself, and to fix it so that its surface was level with the surface of the earth (not of the grass) to prevent the cold air running off the board and producing a more or less horizontal exchange of heat. Conduction of heat upwards from the earth beneath the surface must play a part, but normally this will be of a lower order of magnitude than the quantity involved in radiation (or even evaporation).

January 5th, 1929. E. GOLD.

Aurora off the Coast of Ireland

A note regarding a display of aurora which I observed off the coast of Ireland, in the St. George's Channel on October 18th, 1928, may be of interest.

The night was fine and clear, sky practically cloudless. There had been a faint glow in the northern sky all the evening and at 23h. 10m. G.M.T. several patches of brighter light appeared low down on the horizon. Five minutes later these resolved into a number of distinct beams of light about 10 degrees in length and extending nearly vertically from north to north-north-west. These lasted with some brilliance until 23h. 30m. G.M.T. and the glow faded shortly after.

The beams appeared to vary in intensity during their most brilliant phase and were a very pale green in colour.

R. H. STENHOUSE.

R.M.S.P. " Sabor," Rio de Janeiro, Brazil. December 8th, 1928.

Unusual Thunderstorm Phenomena

In one or two recent numbers of your magazine, I have noticed references to a " click " accompanying a stroke of lightning. During a thunderstorm which occurred here this afternoon I heard this noise accompanying an unusually close stroke followed within a second by the thunder. Subsequent queries elicited the information that the click was heard by the observer of this station and also by one of the clerks. The fact that this office is liberally supplied with overhead wires for the electric light and telephone services is rather in favour of Mr. McAdie's suggestion as published in your number for August, 1928.

NOEL P. SELLICK.

Dept. of Agriculture, Salisbury, Southern Rhodesia. *November* 23*rd*, 1928.

The Appearance of the Sun and Moon through a Cloud

For some time past I have thought that the appearance of the disc of the sun or moon seen through a cloud depends on whether the cloud consists of ice-crystals or water-drops. Alto-stratus clouds consist usually, though not always, of ice-crystals, and the blurred appearance of the sun is well known, the example in the *Observer's Handbook* being typical. The photograph of fracto-stratus on Plate XVII of that publication (also reproduced in Plate II of *Cloud Forms*) shows the sun's disc just visible, with sharp edges, and I think this holds for all water-drop clouds, if the exact position of the sun or moon can be made out at all. The fact that some alto-stratus consist of water-drops, often with a corona, seemed to present a difficulty, but this has now been removed by the publication of a photograph by Prof. A. McAdie* showing a very good corona in alto-stratus clouds, with the edges of the sun's disc perfectly sharp. There remains the possibility of the disc being blurred by high clouds, and a feeble corona being produced by a lower layer, or by the lower part of a diffuse mass of alto-stratus, but this does not affect the point at issue. It would be interesting to have the opinions of observers on this question.

The blurred appearance is sometimes described as "watery," but if it can only be produced by ice-crystals the term is misleading.

C. K. M. DOUGLAS.

December 13*th*, 1928.

NOTES AND QUERIES

Lapse Rates in Polar and Equatorial Air

The statement is sometimes made that the lapse rate of temperature is greater in a current of polar air than in an equatorial one. The writer has lately made inquiry into this question, the results of which may be worth putting on record.

The material employed was the whole of the British sounding balloon data from 1911 onwards. The method of the investigation was to find occasions on which the whole atmosphere was moving either from a southerly or a northerly direction at a

* *Observations and Investigations made at the Blue Hill Observatory*, 1927.

considerable speed, while at the same time the temperature at a height of one kilometre was in the cases of the southerly winds above the normal for the time of year, and in those of the northerly ones below the normal. Under these circumstances it was assumed that the northerly current had a polar origin and the southerly one an equatorial.

The actual criteria employed for the purpose were first that in every case the balloon fell at least 100 kilometres from the starting point, second that the direction of the falling point lay for the southerly winds between 20° west of north and 45° east of north and for the northerly winds between 45° west of south and 45° east of south. Third, that the direction of the geostrophic wind at the time of the start did not differ from that of the run of the balloon by more than 32°. These criteria proved to be so exacting that only eight cases of equatorial air and ten of polar were found on occasions when balloon soundings were made during the period of 17 years covered.

The mean results are given in the table below.

	Excess of the temperature at 1 km. over the mean for the time of year.	Pressure at Mean Sea Level.	Lapse Rates in degrees abs. per km. between heights given in kilometres.						
			0-1	1-2	2-3	3-4	4-5	5-6	6-7
Equatorial air	+3·6 a.	1009·5 mb.	4·3	4·7	6·4	6·3	6·7	7·4	7·2
Polar air	—5·3 a.	1016·8 mb.	7·9	4·3	5·9	5·9	6·3	6·8	6·5

In each case the mean of the geostrophic wind was 10 m/s. Near the surface the polar air has appreciably the greater lapse rate, while from above 1km. it seems to have a rather smaller one. It will be seen, however, that the mean pressure was smaller in the case of the equatorial air, and low pressure is on the average found to be associated with a larger lapse rate, hence it is not certain that the higher lapse rate above 1km. can fairly be attributed to properties of the equatorial air, and it would seem that the only significant difference between the two rows of the table is the higher lapse rate below 1km. in the polar air.

The number of observations is too small to base any final conclusion on the result, but is enough to illustrate any pronounced tendency. It seems to show that it is difficult to establish statistically any pronounced systematic difference between the thermal structures of polar and equatorial air currents.

L. H. G. Dines.

The Liverpool Observatory and Tidal Institute

The Times of December 12th contains a message from Liverpool to the effect that the Bidston Observatory, which was maintained by the Mersey Docks and Harbour Board, and the Tidal Institute, which was established by the University, are to be combined into a single institute under the above title, to be governed by a joint committee of the Dock Board and the University.

The Observatory was founded in 1845 on the Waterloo Dock Pierhead, its objects being the communication of time to the port, the testing and rating of chronometers, astronomical observations and meteorological observations. In 1867 the reconstruction of the Waterloo Dock necessitated the removal of the Observatory, and in 1869 it was moved to a new site on Bidston Hill, which has been occupied ever since. The objects for which the Observatory was established have been faithfully carried out for many years, but the development of wireless telegraphy, which enabled a time signal to be broadcast from Greenwich over the whole country, has recently decreased the practical importance of the local time-service, and consequently of the astronomical observations. The testing and rating of chronometers has been maintained, and the meteorological observations have, if anything, increased in importance. The Tidal Institute was established in 1919, and quickly achieved recognition as the centre of tidal information for the British Empire.

The Director of the new combined Institute will be Professor J. Proudman, F.R.S., of the University, while Dr. A. T. Doodson will become Assistant Director, and will reside at the Observatory.

New Site for Instruments at Aberdeen

In consequence of extensions to the buildings of King's College, Aberdeen, the site of the Stevenson screen and rain gauge, from which observations have been obtained for many years for publication in the *Daily, Weekly and Monthly Weather Reports* of the Meteorological Office, was moved to a new site about 170 yards away to the northeast, on June 1st, 1928. A Dines pressure tube anemometer has occupied another site in an open field 500 yards away to the east of King's College since September, 1922. The new site is not suitable for the anemometer nor the anemometer site for the thermometers and rain gauge: it is hoped that one site may eventually be found for all the ordinary meteorological instruments.

The hourly readings of temperature for Aberdeen, which are published in the *Observatories Year Book* of the Meteorological Office, will, however, continue to be taken from the north wall screen, which is too high up to be appreciably affected by the new buildings.

New Meteorological Service in Chile

A Naval Meteorological Service has been established in Chile under the Ministry of Marine, to work in collaboration with the Central Meteorological Institute of the Ministry of Education. The new service is charged with forecasting for the Navy and Merchant Service and the coastal regions, the study and investigation of scientific methods, contributions to the international study of meteorological phenomena and the preparation of wind charts for maritime and aerial navigation.

Brazilian Daily Weather Reports

In pursuance of his policy for developing the Brazilian Meteorological Service, Senor Sampaio Ferraz has now initiated the publication of a *Daily Weather Report*. The first number was issued on September 1st, 1928, and contains a synoptic weather chart for 9h. (Noon G.M.T.) of the day of issue, a short summary of the weather of the past 24 hours, and a forecast of the weather for the next day. Data for 74 stations are also included, together with hydrological and upper-air information. The issue of these Daily Weather Reports is especially welcome, as previously the Argentine was the only country in South America to issue reports daily.

The Meteorological Conditions for Deserts

The *Geographical Journal* for July, 1928, contains an interesting review of a book by Hans Mortensen, "Der Formenschatz der Nordchilenischen Wüste," published in 1927. The old idea of a desert as a waste of shifting sand applies only to the margins of the Chilean desert; its heart is dead and motionless as the moon, covered by a skin of compacted dust or a layer of stones, but no sand. The wind, having no tools, cannot abrade, and the land forms are those of running water resulting from the torrential rains which occur at intervals of ten years or more.

The climatic causes of desert formation are fully discussed, and the author successively eliminates temperatures, wind velocity and cloudiness as unable to account for the most extreme conditions; amount of rainfall is also ruled out, but its rarity may be an important contributory cause. The most important factor is shown to be the deficiency of rainfall below evaporation, the difference amounting to 160in. a year in the heart of the desert. The characteristic dust skin is formed by excessive evaporation of the soil moisture, derived from occasional rain or from hygroscopic absorption by the saline ground.

1928, Another Wet Year

Although 1928 was the sixth successive year in which the rainfall over the British Isles as a whole was in excess of the average, the year is more likely to be remembered, in southeastern England at any rate, for its sunshine and a summer favourable to holiday makers. It will be recalled that since about 1907 wet years have predominated. Initially the excesses were contributed more especially by wet winters, but of more recent years the summers have been particularly wet. In each of the six summers since 1921 the rainfall has exceeded the average over the country generally, so that the summer of 1928 stands out in comparison as unusually dry although the deficiency was only 4 per cent. Out of the previous 12 summers only 1919 and 1921, with deficiencies of 17 and 27 per cent., received less than the average.

April, May, July and September were all dry over the British Isles, but only September was markedly so. The general fall over England and Wales for September was rather less than half the average, and it was the driest September for 18 years, *i.e.*, since 1910, when the general fall was only one quarter of the usual amount. Although several towns experienced a restricted water-supply during the late summer this was probably due to the increasing demands having been met in previous summers by the abnormally heavy rains, and should not be taken as an indication of an abnormal drought. Apart from December, when there was a small deficiency, the rainfall of the other months was in excess of the average. January was the wettest month of the year, with more than twice the usual amount. Over the country generally it was the wettest January since comparable statistics became available in 1870. So far as can be ascertained the total of 7·7in. recorded at Manchester, was the largest there for over 135 years. It is noticeable that even in this wet month the characteristic feature of the year, an excess of sunshine, was apparent in many districts. October, with 150 per cent., was the wettest October since 1916, when the general fall was 162 per cent. During November more than 34in. of rain fell at the head of Borrowdale in the English Lake District.

Among the more striking incidents in the rainfall of the year was the severe storm at Gunn to the east of Barnstaple on August 28th, when for 10 minutes frozen ice of various shapes fell with great violence, destroying vegetation and cutting off the stalks of corn. Two hours after the storm a large number of pieces were found as large as a sixpence and half an inch thick. There was also a violent thunderstorm at Armagh on August 29th when 1·69in. was recorded in 50 minutes, of which 1in. fell in 20 minutes. The hailstones were as big as nuts or marbles and choked up the gutters and drains so that much flooding occurred. So intense a fall is a rare occurrence especially in Ireland. The year 1928 will also be remembered for one of the worst Thames floods in history, caused by a gale in the North Sea which coincided with a high spring tide on January 7th. London also suffered from a " tornado " which caused much damage during the evening of October 22nd, although it is reported as having lasted no longer than 30 seconds.

The most remarkable feature of the rainfall of 1928 was the large area with an excess in Ireland and in the western half of the British Isles, especially in the English Lake District and in the Southern Uplands of Scotland where the excess amounted to 50 per cent. Locally in both districts 1928 was the wettest year in the 60 years of comparable data. The rainfall appears to have exceeded 90 per cent. of the average everywhere and only about one-twentieth of the total area recorded less than the average. Deficiencies were confined almost entirely to stations in the east of England, occurring over an area in the neighbourhood of the Wash, including most of Suffolk and Norfolk and stretching from the coast as far west as Bedford and Lincoln and along a narrow coastal strip as far north as Berwick-on-Tweed. Less than the average was recorded in the neighbourhood of Keith in Banffshire and at Llandudno.

Over England and Wales more than 130 per cent. was recorded between Ventnor and Brighton, round Bala and Lake Vyrnwy and over a large area in the northwest. In Scotland more than 130 per cent. occurred over most of the southwest and more than 140 per cent. was recorded over two large areas, the western half of the Southern Uplands and from the Isle of Mull to the Grampians. The fall exceeded 150 per cent. only in the former region and reached 160 per cent. locally near Langholm. In Ireland falls of 120 per cent. were widespread and more than 130 per cent. was recorded in the neighbourhood of Cork, in Kerry and Connemara, to the north of the Mourne Mountains and between the mountains of Donegal and Londonderry. The rainfall in Ireland was remarkable in that it exceeded the average everywhere and we have to go back to 1903 to find a similar year of so widespread an excess.

From information at present available the following general values for 1926 have been computed :—

England and Wales	39.8	in.	113	per cent of average 1881-1915
Scotland	62.4		124	
Ireland	54.1		125	
British Isles	48.9		118	

The annual general values for England and Wales were considerably exceeded in 1924 and 1927. Over Scotland and Ireland the rainfall was much more remarkable. During the last 60 years the rainfall of 1928 over Ireland has only been exceeded once, in 1872 with 128 per cent., while in Scotland only the three years 1872, 1877 and 1903 were wetter with 134, 131 and 129 per cent. Over the country as a whole 1928 was as wet as 1927. Since comparable statistics became available in 1868 there have been only four wetter years, 1872, 1877, 1882 and 1903, when the general percentage values were 137, 127, 120 and 127 respectively.

J. GLASSPOOLE.

Parallel Weather Sequences

In a discussion of any season of abnormal weather, it is natural to make a comparison with a previous season of similar abnormality. An interesting example of such a comparison is illustrated in the *Meteorological Magazine* for April, 1926, where the changes of pressure during January, February, March and April, 1912, are compared month by month with those of December, 1925, and of January, February and March, 1926. The way in which the two sequences run parallel for four full months is very striking, and it seemed worth while to make a systematic search through the monthly charts of deviation of pressure from normal illustrated in *Geophysical Memoirs*, No. 31,* to see whether such sequences are so frequent that they must be due to similar causes leading to similar results, or whether they are so rare that their occurrence may be attributed to coincidence.

It was first of all necessary to group the maps roughly into classes according to the distribution of pressure deviation from normal. This had been done in the memoir, but it was found that the types and sub-types used there were too numerous and too detailed for this purpose. The maps were therefore grouped into four classes according to their intrinsic similarity with reference chiefly to the British Isles, all individual distributions in a group giving approximately a similar type of weather. The four classes are briefly as follows :—

(1) Pressure above normal near or over the British Isles with pressure below normal directly to the south-east.

(2) Pressure above normal near or over the British Isles with pressure below normal directly to the north-west.

(3) Pressure below normal near or over the British Isles with pressure above normal directly to the south-east.

(4) Pressure below normal near or over the British Isles with pressure above normal directly to the north-west.

Class (1) gives mainly fine weather over the British Isles with a weakening of the normal south-westerly winds; class (2) on the other hand gives mainly fine weather with a strengthening of the south-westerly winds. Classes (3) and (4) give generally rainy weather, in class (3) of the orographic type and in class (4) of the cyclonic type.

The classification of the maps was completed up to May, 1928, with the exception of January to September, 1922, for which

*London, Air Ministry, Meteorological Office. *Geophysical Memoirs*, No. 31. Classification of Monthly Charts of Pressure Anomaly over the Northern Hemisphere, by C. E. P. Brooks and W. A. Quennell.

months the data were not readily available. This gave a series of 548 maps to be examined, between January, 1873, and May, 1928, broken between 1900 and 1910 and in 1922. The investigation was directed towards discovering any runs of four months in different years in which the same sequence of classes occurred in corresponding months of the year or in the series one month before or one month after. For example, the months October, November, December and the following January were compared with the same months of all the other years, and also with September to December and with November to February of all the other years. Thus the months of October, 1878, to January, 1879, gave the sequence (4, 1, 1, 1), and the same sequence of classes was found in the months of November, 1916, to February, 1917 (Fig. 1). In this way about 22,000 comparisons were made, resulting in the finding of 221 pairs of similar sequences. It then remained to be discovered how this number compares with the number of pairs which would be expected on the supposition that there is no real connexion between the weather of one month and the next.

The four types are not of equally frequent occurrence, being distributed as follows:—(1) 28 per cent; (2) 22 per cent.; (3) 36 per cent; (4) 14 per cent.

Four types give $(4)^4$, *i.e.*, 256 possible sequences of four months, and the probability of occurrence of each of these 256 sequences with a random distribution was calculated on the assumption that the above distribution of frequencies held for each season as well as for the whole year. This is not strictly accurate, but the arithmetic involved in the full computation would have been prohibitive. Actually the distribution during January and July was as follows:—

January ... (1) 33%, (2) 19%, (3) 37%, (4) 11%.
July ... (1) 36%, (2) 20%, (3) 33%, (4) 11%.

The probability that any two series of four months selected at random would have the same sequence is the sum of the squares of the probabilities of occurrence of the 256 possibles. For example, the probability of occurrence of the sequence (3, 3, 1, 1) is $0.36^2 \times 0.28^2 = 0.0102$, and the probability of two series selected at random both giving this sequence is $(0.0102)^2 = 0.000103$, or approximately 2 in the 22,000 distributions. A similar computation was carried out for each of the 256 possible sequences and the result showed that with a random distribution, 22,000 comparisons should give 132 similar pairs. The number actually found, 221, is appreciably higher and suggests that there is a real tendency for similar sequences to occur at about the same time in different years; and consequently that there is some physical connexion between the weather of successive months.

By far the most frequent parallels were given by runs of four

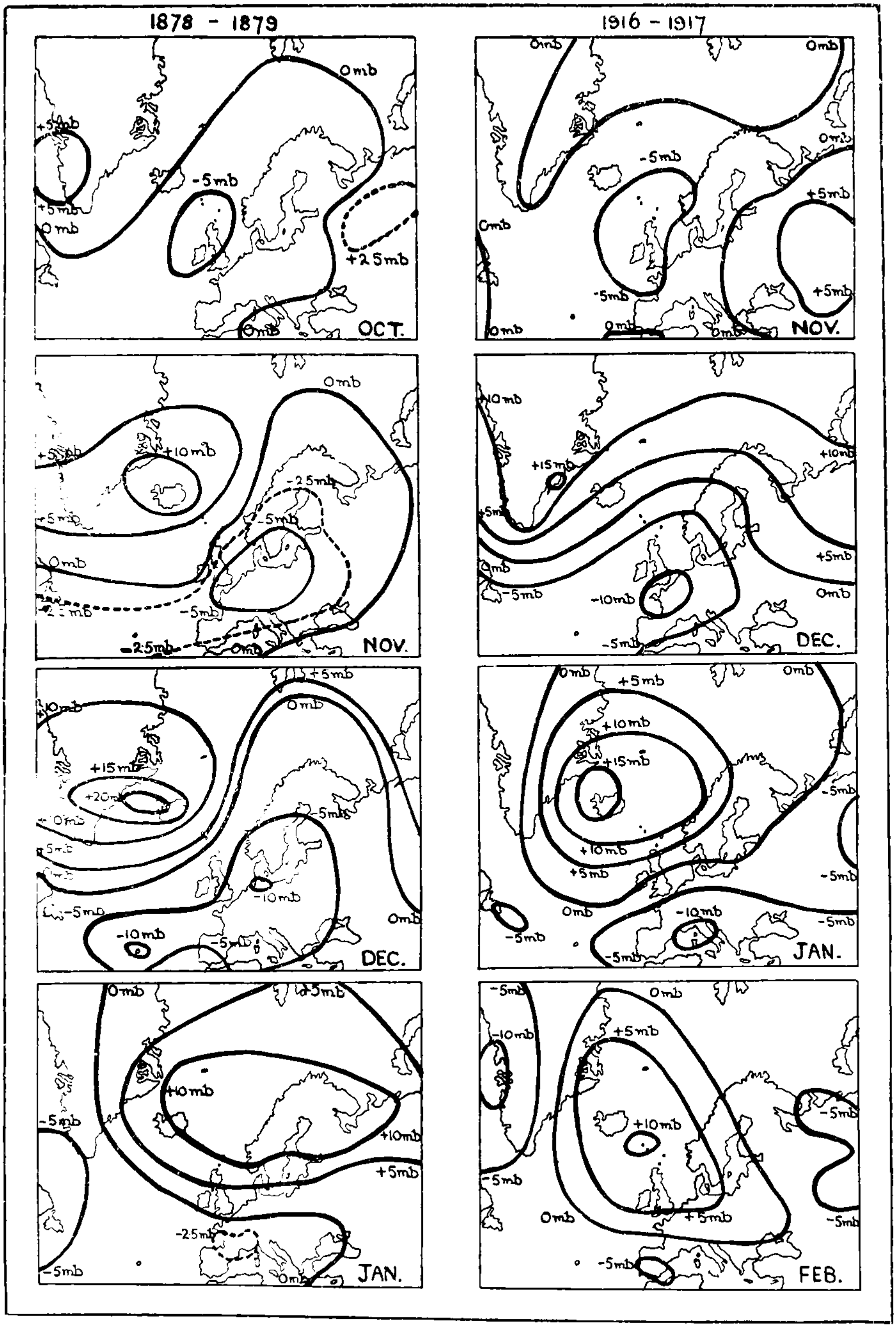

Fig. 1. Pressure Anomalies.

examples of type 3, there being 32 such pairs during the period, all starting in late spring or in summer. As the expectation for the whole year is only 7, it appears that once type 3 is established it tends to persist during the summer months.

TABLE I. WEATHER DURING THREE PARALLEL SEQUENCES.

	1st Month.	2nd Month.	3rd Month	4th Month
1878 October to 1879 January.	Cyclonic type, wet and at times cold.	Wet at first, then cold and foggy.	Cold and wintry, dry on the whole.	Sharp frosts, dry on the whole, but with some snow.
1916 November to 1917 February.	Often wet and stormy; sometimes cold, but mostly mild.	Remarkably quiet; cold, variable precipitation.	Cold, wintry, much snow in many places.	Unusually severe frost, very dry.
1887 December to 1888 March.	Changeable and unsettled.	Quiet, foggy and damp, but not rainy.	Dry and cold.	Changeable, squally and wet, temperature low.
1924 January to April.	Warm and unsettled, mainly rather wet.	Dull and very dry, cool in England.	Cold and very dry, sunny in England.	Mainly cool and dull.
1898 July to October.	Mostly fair and dry, thunderstorms at the end of the month.	Mostly fair, warm and dry.	Changeable in W and N, elsewhere fair and very dry especially in eastern half.	At first mostly fair and dry, then gales and heavy rain.
1926 July to October.	Fair and warm, with occasional breaks and widespread thunderstorms.	Warm and mainly fine, rainfall irregular but below normal generally.	Warm, very dry in southern England and Ireland.	Unsettled, first few days unusually warm, last fortnight very cold.

Although these pairs of sequences show sufficient similiarity when a broad view is taken of the pressure distribution over western Europe, the classes are wide enough to permit of considerable variation in individual cases. The corresponding sequences were therefore more closely scrutinised by going back to the original maps, and the final result gave 108 pairs of sequences which could be regarded as showing good agreement and as giving substantially the same weather over the British Isles in corresponding months. The best examples are as follows:—

(*a*) 1878, October, to 1879, January, and 1916, November, to 1917, February.
(*b*) 1887, December, to 1888, March, and 1924, January to April.
(*c*) 1898, July to October, and 1926, July to October.

The charts showing the isanomalies of the first example are given in Fig. 1. The weather during the corresponding months was on the whole, very similar, and the remarks in Table I are taken from the *Monthly Weather Report* of the Meteorological Office, with the exception of 1878 and 1879, for which years the remarks are taken from *Symons's Meteorological Magazine.*

W. A. QUENNELL.

Obituary

We regret to learn of the death of Lady Strachey, widow of Sir Richard Strachey, Chairman of the Meteorological Council of the Royal Society, 1883-1905, on December 14th, 1928, at the age of 88.

We regret to learn that Mr. Andrew Watt, formerly Secretary of the Scottish Meteorological Society, died suddenly on January 9th, 1929.

News in Brief

We are glad to learn that a Chair of Meteorology and Climatology has been created in the University of Salonica. The post has been accepted by Dr. E. G. Mariolopoulos, formerly chief of the Meteorological Section of the National Observatory of Athens. Dr. Mariolopoulos will also become Director of the Meteorological and Climatological Institute, which has been formed in connexion with the University.

The Simms Gold Medal of the Royal Aeronautical Society for the best paper on any subject allied to aeronautics, has been awarded to Captain F. Entwistle, B.Sc., Superintendent of the Aviation Services Division, for his paper on "Fog," read before the Society on December 8th, 1927.

The Weather of December, 1928

The weather of December was very variable. During the first few days the weather was mild and anticyclonic with light westerly winds and much sunshine, although mist or fog was experienced in the early mornings. On the 6th a depression passing across the country was associated with rain in most districts, the amounts, however, were small, among the largest being 0·37in. at Kilmarnock. In the rear of this depression the winds became northerly and cold and there were showers of snow, hail or sleet and bright intervals. From the 7th to the 15th the temperature was low and the frosts severe; the lowest minima of the month occurred during this period when 18°F. was recorded in the screen at Burnley on the 9th and 11°F. on the ground at Rhayader on the 15th. Day temperatures failed to reach 32°F. in places on the 14th and 15th, the maximum being 29°F. at Oxford on the 14th and at Ross-on-Wye on the 15th. On the other hand, the duration of bright sunshine exceeded 6½ hrs. at several places on the 7th, 8th, 9th and 14th, and over 7 hrs. at a few places, *e.g.*, 7·4 hrs. at Bognor on the 8th. This period of sunshine was interrupted temporarily on the 9th and 10th when a depression centred to the west of the British Isles was associated with gales and heavy rain in Ireland and western England, *e.g.*, 2·47in. fell at Fofanny (Down) on the 10th. On the 15th there was a general change to milder southwesterly conditions and rain fell heavily in the west on the 15th and in Scotland on the 16th, 5·45in. occurred at Fofanny (Co. Down) and 2·24in. at Delphi (Mayo) on the 15th. This was followed by a bright sunny day on the 17th when between 6 and 7 hours bright sunshine was recorded at many places. Slight precipitation occurred on most of the next few days with much mist and fog in the mornings and severe frost at night. From the 24th the weather was unsettled with strong winds, local gales and occasional heavy precipitation until nearly the end of the month when the northern part of the country came under the influence of an anticyclone to the north and west of the British Isles. Precipitation was most general on the 25th, 27th and 29th, 3·24in. fell at Tynywaun (Glamorgan) on the 25th and 1·97in. at Filleigh (Devon) on the 27th. The sunshine totals for the month were generally below normal except in the eastern districts. The distribution for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	22	−1	Valentia	32	−9
Aberdeen	43	+7	Liverpool	33	−10
Dublin	40	−8	Falmouth	43	−12
Birr Castle	38	−5	Kew	47	+10

Pressure was above normal over the whole of western Europe, Iceland and the northern North Atlantic to Newfoundland and Bermuda, the greatest excess being 7·1mb. at Malin Head (north Ireland). Pressure was below normal at Spitsbergen. Temperature was above normal except in the British Isles, Portugal and the extreme northeast of Sweden. The excess in central Sweden and Spitsbergen amounted to between 4°F. and 5°F. Rainfall was below normal in Scandinavia and central Europe but above normal at Spitsbergen. The deficit was as much as 40 per cent. in Svealand and Gothaland.

It is reported that a severe storm occurred on the 2nd in the Gulf of Finland and wrecked the Finnish ship *Neptun*. Heavy falls of snow were reported from Austria at the beginning of the month and part of the railway line between Austria and Switzerland was blocked. Snow was also very plentiful in the higher parts of Switzerland and traffic was rendered difficult owing to avalanches, some villages and chalets being cut off for several days. In some districts of the Bernese Oberland and Canton Valais the snowfall is reported to have been the heaviest for the time of year within living memory. Towards the end of the month nearly 7,000 acres in the district north of Termonde (Holland) were under water, a violent gale and high tide causing the Scheldt to overflow its banks. A glazed frost occurred in Munich on the morning of the 26th rendering the streets dangerous, many persons sustained injuries.

Heavy floods occurred in Smyrna about the 7th. Widespread and heavy falls of snow occurred in Afghanistan about the 27th.

A cloudburst was reported from Shabani (southern Rhodesia) on the 27th, causing the deaths of 14 natives working in the asbestos mines; 2½in. of rain is said to have fallen in 20 minutes.

Abnormally heavy rain in Jamaica at the beginning of the month caused landslips and much damage to main roads. On the 23rd eastern Canada had the first severe blizzard of the winter; the snowfall was sufficiently heavy to block communications and impede traffic. Temperature was above normal in the United States at the beginning of the month but a severe cold spell swept across the country during the second week. There was a return to warmer conditions during the third week but over Christmas the conditions were variable.

The special message from Brazil states that the rainfall in the northern regions was scarce with 1·81in. below normal, and the rainfall distribution in the central and southern regions irregular with 0·31in. above normal and 0·31in. below normal respectively. Nine anticyclones passed across the country and windstorms were experienced in the extreme south. Cotton, cocoa and wheat crops were gathered in good condition. At Rio de Janeiro pressure was 0·7mb. below normal and temperature 0·9°F. below normal.

Rainfall, 1928—General Distribution

	Dec.	Year	
England and Wales ...	88	113	per cent. of the average 1881-1915.
Scotland	96	124	
Ireland	96	125	
British Isles	92	118	

Rainfall: December, 1928: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden. Square.........	2·66	111	*Leics* .	Thornton Reservoir ...	2·06	77
Sur .	Reigate, The Knowle...	3·38	113	,, .	Belvoir Castle...........	1·59	65
Kent .	Tenterden, Ashenden...	2·49	80	*Rut* .	Ridlington	2·45	...
,, .	Folkestone, Boro. San.	3·49	...	*Linc* .	Boston, Skirbeck	2·47	115
,, .	Margate, Cliftonville...	3·42	150	,, .	Lincoln, Sessions House	1·65	75
,, .	Sevenoaks, Speldhurst	3·86	...	,, .	Skegness, Marine Gdns	2·09	95
Sus .	Patching Farm	4·09	122	,, .	Louth, Westgate	2·13	76
,, .	Brighton, Old Steyne	3·78	122	,, .	Brigg, Wrawby St. ...	2·07	...
,, .	Tottingworth Park ...	4·23	114	*Notts* .	Worksop, Hodsock ...	2·26	96
Hants.	Ventnor, Roy. Nat. Hos.	3·53	107	*Derby*.	Derby	1·93	74
,, .	Fordingbridge, Oaklnds	...	...	,, .	Buxton, Devon Hos....	3·03	53
,, .	Ovington Rectory	3·78	95	*Ches* .	Runcorn, Weston Pt.	2·21	70
,, .	Sherborne St. John ...	2·80	85	,, .	Nantwich, Dorfold Hall	2·46	...
Berks .	Wellington College ...	...	...	*Lancs*.	Manchester, Whit. Pk.	1·77	55
,, .	Newbury, Greenham...	2·78	87	,, .	Stonyhurst College ...	3·15	65
Herts .	Benington House	2·39	96	,, .	Southport, Hesketh Pk	2·95	91
Bucks.	High Wycombe	...	...	,, .	Lancaster, Strathspey	3·92	...
Oxf . .	Oxford, Mag. College	2·18	94	*Yorks*.	Wath-upon-Dearne ...	1·65	65
Nor .	Pitsford, Sedgebrook...	2·32	96	,, .	Bradford, Lister Pk....	1·99	60
,, .	Oundle	1·74	...	,, .	Oughtershaw Hall......	5·59	...
Beds .	Woburn, Crawley Mill	2·43	104	,, .	Wetherby, Ribston H.	1·33	54
Cam .	Cambridge, Bot. Gdns.	1·81	94	,, .	Hull, Pearson Park ...	1·84	76
Essex .	Chelmsford, County Lab	2·90	131	,, .	Holme-on-Spalding ...	1·57	...
,, .	Lexden, Hill House ...	3·51	...	,, .	West Witton, Ivy Ho.	2·24	...
Suff .	Hawkedon Rectory ...	3·15	130	,, .	Felixkirk, Mt. St. John	1·56	65
,, .	Haughley House	2·44	...	,, .	Pickering, Hungate ...	1·96	...
Norf .	Beccles, Geldeston	...	...	,, .	Scarborough	1·43	60
,, .	Norwich	3·21	123	,, .	Middlesbrough	1·19	61
,, .	Blakeney.................	1·30	59	,, .	Baldersdale, Hury Res.	1·77	...
,, .	Little Dunham	2·90	119	*Durh* .	Ushaw College	1·88	5
Wilts.	Devizes, Highclere......	2·82	92	*Nor* .	Newcastle, Town Moor	1·57	65
,, .	Bishops Cannings	2·99	91	,, .	Bellingham, Highgreen	3·29	...
Dor .	Evershot, Melbury Ho.	3·37	65	,, .	Lilburn Tower Gdns....	2·29	...
,, .	Creech Grange	4·87	...	*Cumb*.	Geltsdale.................	2·97	...
,, .	Shaftesbury, Abbey Ho.	2·33	64	,, .	Carlisle, Scaleby Hall	2·21	69
Devon.	Plymouth, The Hoe ...	4·07	81	,, .	Borrowdale, Rosthwaite	...	...
,, .	Polapit Tamar	5·09	100	,, .	Keswick, High Hill ...	5·18	...
,, .	Ashburton, Druid Ho.	6·49	86	*Glam* .	Cardiff, Ely P. Stn. ...	5·19	100
,, .	Cullompton..............	3·87	88	,, .	Treherbert, Tynywaun	11·44	...
,, .	Sidmouth, Sidmount...	2·79	71	*Carm*.	Carmarthen Friary ...	6·84	119
,, .	Filleigh, Castle Hill ...	6·20	...	,, .	Llanwrda	5·57	81
,, .	Barnstaple. N. Dev. Ath.	5·72	129	*Pemb* .	Haverfordwest, School	...	...
Corn .	Redruth, Trewirgie ...	6·19	99	*Card* .	Aberystwyth	4·16	...
,, .	Penzance, Morrab Gdn.	5·44	96	,, .	Cardigan, County Sch.	5·18	...
,, .	St. Austell, Trevarna...	6·16	101	*Brec* .	Crickhowell, Talymaes	4·60	...
Soms .	Chewton Mendip	4·27	79	*Rad* .	Birm W. W. Tyrmynydd	4·95	60
,, .	Long Ashton	3·75	...	*Mont* .	Lake Vyrnwy...........	5·75	84
,, .	Street, Millfield ...	2·85	...	*Denb* .	Llangynhafal	2·51	...
Glos. .	Cirencester, Gwynfa ...	3·07	92	*Mer* .	Dolgelly, Bryntirion...	5·45	80
Here .	Ross, Birchlea...........	2·53	85	*Carn* .	Llandudno	2·70	87
,, .	Ledbury, Underdown	2·50	89	,, .	Snowdon, L. Llydaw 9	14·55	...
Salop .	Church Stretton.........	2·27	68	*Ang* .	Holyhead, Salt Island	3·93	94
,, .	Shifnal, Hatton Grange	1·75	68	,, .	Lligwy....................	3·45	...
Worc .	Ombersley, Holt Lock	2·02	77	*Isle of Man*			
,, .	Blockley	2·93	...		Douglas, Boro' Cem....	4·41	89
War .	Farnborough	3·03	103	*Guernsey*			
,, .	Birminghm, Edgbaston	1·94	72		St. Peter P't. Grange Rd.	4·42	108

Rainfall: December, 1928: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Stoneykirk, Ardwell Ho	...	...	*Suth* .	Loch More, Achfary ...	8·37	91
,, .	Pt. William, Monreith	4·50	...	*Caith* .	Wick	3·47	113
Kirk .	Carsphairn, Shiel.	8·41	...	*Ork* .	Pomona, Deerness	4·05	97
,, .	Dumfries, Cargen	4·48	83	*Shet* .	Lerwick	5·88	123
Dumf.	Eskdalemuir Obs.	5·90	84	*Cork* .	Caheragh Rectory	7·33	...
Roxb .	Branxholm	2·85	78	,, .	Dunmanway Rectory...	7·76	96
Selk .	Ettrick Manse	5·25	...	,, .	Ballinacurra	4·81	94
Peeb .	West Linton	3·50	...	,, .	Glanmire, Lota Lo. ...	5·68	103
Berk .	Marchmont House......	1·99	71	*Kerry*.	Valentia Obsy.	6·93	104
Hadd.	North Berwick Res. ...	1·79	83	,, .	Gearahameen	12·20	...
Midl .	Edinburgh, Roy. Obs.	1·85	86	,, .	Killarney Asylum	5·05	69
Ayr .	Kilmarnock, Agric. C.	3·70	87	,, .	Darrynane Abbey	6·08	103
,, .	Girvan, Pinmore	6·11	102	*Wat* .	Waterford, Brook Lo...	4·15	88
Renf .	Glasgow, Queen's Pk. .	3·72	88	*Tip* .	Nenagh, Cas. Lough...	4·96	108
,, .	Greenock, Prospect H.	8·28	105	,, .	Roscrea, Timoney Park	3·12	...
Bute .	Rothesay, Ardencraig.	6·86	126	,, .	Cashel, Ballinamona...	3·86	89
,, .	Dougarie Lodge	6·58	...	*Lim* .	Foynes, Coolnanes......	5·11	108
Arg .	Ardgour House	11·60	...	,, .	Castleconnel Rec.	5·39	...
,, .	Manse of Glenorchy ...	8·10	...	*Clare* .	Inagh, Mount Callan...	7·73	...
,, .	Oban	6·78	...	,, .	Broadford, Hurdlest'n.	5·80	...
,, .	Poltalloch	6·40	100	*Wexf*.	Newtownbarry	4·55	...
,, .	Inveraray Castle...	10·09	102	,, .	Gorey, Courtown Ho ..	4·13	108
,, .	Islay, Eallabus	8·65	146	*Kilk* .	Kilkenny Castle.........	3·45	100
,, .	Mull Benmore	...	...	*Wic* .	Rathnew, Clonmannon	4·71	...
,, .	Tiree	6·08	...	*Carl* .	Hacketstown Rectory..	4·15	101
Kinr .	Loch Leven Sluice......	3·61	92	*QCo* .	Blandsfort House	3·50	95
Perth .	Loch Dhu	9·65	96	,, .	Mountmellick...........	4·18	...
,, .	Balquhidder, Stronvar	8·04	...	*KCo* .	Birr Castle	3·52	107
,, .	Crieff, Strathearn Hyd.	4·68	104	*Dubl* .	Dublin, FitzWm. Sq...	2·62	106
,, .	Blair Castle Gardens ...	3·49	92	,, .	Balbriggan, Ardgillan.	3.80	131
,, .	Dalnaspidal Lodge ...	6·60	87	*Me'th* .	Beauparc, St. Cloud...	3·03	...
Forf .	Kettins School	3·09	103	,, .	Kells, Headfort	3·64	95
,, .	Dundee, E. Necropolis	2·30	86	*W.M* .	Moate, Coolatore	3·13	...
,, .	Pearsie House...........	3·15	...	,, .	Mullingar, Belvedere..	3·80	103
,, .	Montrose, Sunnyside...	2·56	87	*Long* .	Castle Forbes Gdns......	2·75	69
Aber .	Braemar, Bank	2·99	84	*Gal* .	Ballynahinch Castle ...	7·49	100
,, .	Logie Coldstone Sch....	2·22	79	,, .	Galway, Grammar Sch.	3·42	...
,, .	Aberdeen, King's Coll.	2·80	87	*Mayo* .	Mallaranny..............	7·99	...
,, .	Fyvie Castle	2·78	...	,, .	Westport House.........	5·16	90
Mor .	Gordon Castle	2·12	79	,, .	Delphi Lodge	13·23	...
,, .	Grantown-on-Spey ...	2·29	84	*Sligo* .	Markree Obsy...........	4·85	103
Na .	Nairn, Delnies	1·83	82	*Cav'n* .	Belturbet, Cloverhill...	2·14	58
Inv .	Kingussie, The Birches	2·86	...	*Ferm* .	Enniskillen, Portora...	3·08	...
,, .	Loch Quoich, Loan ...	13·00	...	*Arm* .	Armagh Obsy...........	2·45	78
,, .	Glenquoich..............	12·50	85	*Down* .	Fofanny Reservoir......	13·59	...
,, .	Inverness, Culduthel R.	2·21	...	,, .	Seaforde	4·46	108
,, .	Arisaig, Faire-na-Squir	6·75	...	,, .	Donaghadee, C. Stn ...	3·45	108
,, .	Fort William	7·77	...	,, .	Banbridge, Milltown...	2·07	72
,, .	Skye, Dunvegan	8·47	...	*Antr* .	Belfast, Cavehill Rd ...	4·17	...
R & C.	Alness, Ardross Cas. ...	4·28	104	,, .	Glenarm Castle	6·45	...
,, .	Ullapool	5·15	...	,, .	Ballymena, Harryville	4·18	94
,, .	Torridon, Bendamph...	10·49	103	*Lon* .	Londonderry, Creggan	3·76	86
,, .	Achnashellach	8·56	...	*Tyr* .	Donaghmore	3·57	...
,, .	Stornoway	5·53	89	,, .	Omagh, Edenfel........	3·48	82
Suth .	Lairg	5·21	...	*Don* .	Malin Head..............	3·43	102
,, .	Tongue	3·44	69	,, .	Dunfanaghy	4·64	...
,, .	Melvich	6·58	158	,, .	Killybegs, Rockmount.	7·20	99

Climatological Table for the British Empire, July, 1928.

STATIONS	PRESSURE: Mean of Day M.S.L. (mb.)	PRESSURE: Diff. from Normal (mb.)	TEMPERATURE Absolute: Max. (°F.)	Absolute: Min. (°F.)	Mean Values: Max. (°F.)	Mean Values: Min. (°F.)	Mean Values: ½ max. and min. (°F.)	Mean Values: Diff. from Normal (°F.)	Mean Wet Bulb (°F.)	Relative Humidity (%)	Mean Cloud Am'nt (0—10)	PRECIPITATION: Am'nt (in.)	PRECIPITATION: Diff. from Normal (in.)	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
London, Kew Obsy.	1019.4	+ 3.6	87	50	74.8	55.8	65.3	+ 2.6	56.0	76	5.2	2.06	− 0.11	9	9.1	58
Gibraltar	1017.5	+ 0.7	99	63	83.0	70.9	77.0	+ 2.2	67.6	75	2.6	0.00	− 0.03	0	..	..
Malta	1016.9	+ 1.6	95	68	85.7	73.5	79.6	+ 1.3	71.8	70	0.5	0.00	− 0.05	0	12.6	88
St. Helena	1017.4	+ 3.7	67	50	62.7	54.6	58.7	− 0.3	57.0	98	8.7	2.03	− 2.00	15	..	..
Sierra Leone	1014.3	+ 1.6	89	70	82.7	72.1	77.4	− 1.2	74.9	89	9.1	33.15	− 2.43	30	..	..
Lagos, Nigeria	1012.8	− 1.0	84	70	81.3	74.2	77.7	− 0.3	74.4	85	6.7	2.53	− 8.15	12	..	..
Kaduna, Nigeria	1015.9	+ 1.9	89	63	83.8	66.0	74.9	+ 1.3	70.2	87	1.2	13.46	+ 5.26	24	..	..
Zomba, Nyasaland	1020.6	+ 2.1	76	47	70.3	51.5	60.9	− 1.1	..	61	4.5	0.03	− 0.32	1	..	..
Salisbury, Rhodesia	1020.8	+ 0.7	76	35	69.6	40.1	54.9	− 1.2	47.4	54	1.5	0.00	− 0.03	0	10.1	90
Cape Town	1022.6	+ 1.3	84	37	64.6	49.8	57.2	+ 2.5	49.9	79	5.0	1.56	− 2.09	5	..	..
Johannesburg	1026.3	+ 1.8	69	30	62.3	41.6	51.9	+ 1.4	38.9	36	0.9	0.00	− 0.33	0	9.9	93
Mauritius	1020.4	0.0	79	55	74.5	63.5	69.0	+ 0.7	66.0	78	4.9	2.15	− 0.34	24	7.4	67
Bloemfontein	..	..	71	27	63.9	31.3	47.6	+ 0.3	34.3	51	0.6	0.00	− 0.38	0	..	..
Calcutta, Alipore Obsy.	999.6	+ 0.4	93	76	88.8	79.1	83.9	+ 0.4	79.6	90	8.7	22.12	+ 9.61	26*	..	..
Bombay	1003.9	0.0	90	75	85.7	77.0	81.3	0.0	77.6	87	8.5	30.93	+ 6.66	27*	..	..
Madras	1004.2	− 0.3	103	75	96.4	80.1	88.3	+ 0.9	75.0	64	7.8	3.04	− 0.90	12*	..	..
Colombo, Ceylon	1009.4	+ 0.2	87	73	85.1	77.5	81.3	+ 0.2	76.7	77	9.1	5.65	− 0.78	10	5.8	46
Hongkong	1004.3	− 0.5	93	76	88.5	79.9	84.2	+ 1.7	79.9	81	6.0	4.78	− 8.60	14	9.1	68
Sandakan	..	..	91	73	88.1	74.9	81.5	− 0.3	77.1	81	..	4.02	− 2.53	11	..	..
Sydney	1016.8	− 1.7	73	41	63.1	47.9	55.5	+ 2.8	48.9	73	5.4	6.66	+ 1.82	9	5.5	54
Melbourne	1016.4	− 2.7	63	32	57.0	42.7	49.9	+ 1.3	44.2	77	5.7	0.65	− 1.18	9	4.5	46
Adelaide	1017.3	− 3.1	70	36	60.4	45.9	53.1	+ 1.4	46.8	70	6.5	2.79	+ 0.14	14	4.6	46
Perth, W. Australia	1017.4	− 1.6	71	40	63.0	48.2	55.6	+ 0.4	51.6	76	6.5	11.89	+ 5.44	21	5.1	50
Coolgardie	1018.7	− 1.2	74	31	62.2	40.2	51.2	0.0	45.2	74	2.2	0.85	− 0.06	6	..	..
Brisbane	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hobart, Tasmania	1011.0	− 2.8	61	35	54.9	43.0	48.9	+ 3.5	43.0	72	5.7	1.72	− 0.42	18	4.6	49
Wellington, N.Z.	1015.6	+ 1.7	59	37	53.6	42.8	48.2	+ 0.5	45.4	76	5.9	3.52	− 2.11	10	3.9	41
Suva, Fiji	1012.5	− 1.7	85	62	78.9	67.9	73.4	− 0.2	69.1	77	5.8	5.56	+ 0.96	20	6.4	57
Apia, Samoa	1011.3	− 0.7	86	68	82.6	72.6	77.6	+ 0.4	74.7	79	4.8	8.76	+ 6.12	15	6.5	57
Kingston, Jamaica	1014.4	− 0.3	94	71	89.8	73.6	81.7	0.0	71.5	79	4.3	0.31	− 1.31	2	7.9	60
Grenada, W.I.	1010.7	− 2.5	90	71	86.9	74.3	80.6	+ 1.6	76.4	81	5.7	7.70	− 2.09	23	..	..
Toronto	1013.7	− 0.4	90	52	79.4	60.4	69.9	+ 1.7	63.0	74	4.5	5.64	+ 2.60	14	8.8	58
Winnipeg	1013.6	+ 0.9	90	48	77.1	57.7	67.4	+ 1.2	59.2	88	6.0	4.44	+ 1.28	14	7.8	49
St. John, N.B.	1013.8	+ 0.1	80	50	69.9	54.6	62.3	+ 1.9	58.4	78	6.5	4.14	+ 0.51	10	6.8	44
Victoria, B.C.	1016.5	− 0.2	90	50	68.9	53.2	61.1	+ 0.8	55.7	73	4.4	0.25	− 0.11	2	11.6	74

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