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Meteorology at the Centenary Meeting of the British Association for the Advancement of Science, London, 1931

For the first time in its existence, the British Association met in London, from September 23rd to 30th. The number of members exceeded 5,000, among whom were many meteorologists, not only from this country, but also from abroad, and meteorological subjects occupied a considerable place in the programme.

On Thursday, September 24th, following the Presidential Address to Section A by Sir J. J. Thomson, O.M., F.R.S., several meteorological papers were read in the Department of Cosmical Physics, the chair being taken by Dr. G. C. Simpson. Dr. J. Bjerknes, under the title "Tropopause Waves," described the thermal structure of cyclones and anticyclones in the troposphere and stratosphere, and showed how in a series of depressions and highs the tropopause forms a series of undulations or waves. The mechanism of these is briefly as follows: where a tongue of polar air projects southwards, the tropical current passes across it, from west to east, and has thereby necessarily an upward component on the western slope and a downward component on the eastern slope of it. Above the region of upward motion, the air must spread out horizontally, and this horizontal divergence creates an anticyclonic curl. Above the region of descending motion the air must converge and that creates a cyclonic curl. The lines of flow in the upper

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part of the tropical current therefore assume an " S " shape with anticyclonic curvature over the westward and cyclonic curvature over the eastward slope of the polar tongue. Since the tropopause is tilting downwards towards the pole, the horizontal undulation of the westerly current of the upper troposphere causes a high tropopause at the places of pole-ward elongation and a low tropopause at the places of equator-ward elongation. The aerological observations also give the expected evidence for the tropopause crest over the western and the tropopause trough over the eastern slope of the tongue of polar air. The linking mechanism of tropopause and polar front waves thus defines a certain difference of phase angle between the two systems, but it does not point out any one of the wave systems as being the primary one.

Sir Gilbert Walker, in a paper on " Stratified clouds," described laboratory experiments carried out at the Imperial College of Science and Technology which reproduced typical cloud structures. An unstable liquid at rest forms a polygonal structure, usually rising in the middle of each polygon and descending at the edges, this being analogous to detached polygonal clouds separated by channels of blue sky. The reverse structure is rarely seen, rising at the edges and descending in the middle, forming a network in cloud round a series of holes or patches of blue sky. But in a wind channel in which the motion is indicated by titanium tetrachloride the air always descends in the middle of the polygons. When the air in the channel is moving rapidly with different velocities in different layers giving a marked shearing effect, a structure of longitudinal rolls or strips appears, also familiar in cloud forms. A smaller amount of shear gives a rectangular structure, while a yet smaller shear leads to transverse strips often possessing the forms characteristic of sand ripples. Cloud-photographs were shown illustrating these features.

Dr. C. G. Abbot then described " Twenty-five years' study of solar radiation," giving an account of the methods employed and results obtained by the Astrophysical Observatory of the Smithsonian Institution in measuring the solar constant, the distribution of energy through the solar spectrum and in different parts of the sun's disc. He showed how the agreement between observations in different parts of the world demonstrates the reality of changes of solar radiation, and briefly outlined the possibilities of solar studies for long-range forecasting. These subjects will occupy volume 5 of the *Annals of the Astrophysical Observatory of the Smithsonian Institution*, now about to be issued from the press.

Dr. F. J. W. Whipple read a paper on " The circulation of electricity through the atmosphere," of which the following is an abstract :—

Continuous records of the air-earth current are now available at Kew

Observatory, and provide new information with regard to the circulation of electricity through the atmosphere.

The potential of the Kennelly-Heaviside layer in the upper atmosphere is of the order 3×10^5 volts. Over the oceans the air-earth current is of about the same strength in the northern summer and the southern summer, so that it may be assumed that the mean potential of the K.H. layer is the same at all seasons. On the other hand there is a well-marked diurnal variation, the potential gradient over the oceans being 15 per cent. below the mean at 5h. G.M.T. and 20 per cent. above the mean at 19h. G.M.T. The potential of the K.H. layer must vary in the same way.

The fluctuations in the air-earth current at a place like Kew, where there is considerable atmospheric pollution, are governed partly by the potential difference between the K.H. layer and the ground and partly by the resistance of the air. It is estimated that in summer the resistance of a column reaching right up to the K.H. layer and with 1cm.^{2} cross-section varies between $2{\cdot}2\times10^{21}$ ohms at 2h. and $3{\cdot}3\times10^{21}$ ohms at 18h. whilst in winter the range is between $3{\cdot}4\times10^{21}$ ohms at 5h. and $8{\cdot}7\times10^{21}$ ohms at 17h. The resistance increases steadily during the hours in which pollution is being produced. The estimates are of the right order of magnitude, but the ratios are of more significance than the exact figures.

Potential gradient depends on the strength of the current and on the resistance of the air near the ground. The double oscillation of potential gradient in the course of the day is explained by the double oscillation in resistance. The specific resistance of the air has minima in the early morning and in the afternoon. The difference between the types of variation of total resistance of the atmosphere and of specific resistance close to the ground is explained by the fact that in the hours during which the ground is being warmed pollution diffuses to considerable heights. The high potential of the K.H. layer is attributable to the action of thunderstorms.

There is a well-known difficulty in evaluating the magnitude of the air-earth current. The vertical current in the free atmosphere is regarded as a pure conduction current, positive and negative ions moving in opposite directions. At the surface of the ground only the positive current is effective. The negative current is thought to be counterbalanced by the transport of space-charge by eddy diffusion. Such observations as are available for testing this hypothesis are considered in the paper but the need for more observations is stressed.

On Friday, September 25th, Sir Napier Shaw described "Meteorology after the century" in which he set out the development of the physical aspect of the science, especially at early meetings of the Association. He then passed to the development of the geographical aspect, culminating in the introduction of the weather map with forecasts and storm warnings. Sir Francis Galton endeavoured, as General Secretary to the Association in 1885, to combine the physical and geographical aspects in the solution of the problem of weather, and Sir Arthur Schuster appealed to the 71st meeting for the deliberate co-ordination of meteorological observations with definite scientific purposes, the specification of the probability of inferences and the extension of knowledge by the exploration of the upper air in respect of pressure and motion, heat, water-vapour, light and sound. Sir Napier concluded with accounts of the uncertainties of forecasting, including the reconsideration of the principles of weather-sequence by the Norwegian School and others, and of

the distribution of entropy, acting through gravity, and of kinetic energy, with the aid of the conservation of angular momentum, as the controlling factors of weather.

Dr. B. F. J. Schönland, in a paper on "Lightning," gave an account of recent investigations upon thunderstorms in South Africa and their bearing upon the question of lightning discharges between the cloud and the ground. He presented evidence against the view that the branches in a lightning flash fork away from the positive pole of the discharge.

The last paper at this session was by Mr. R. A. Watson Watt and Mr. O. F. Brown on "Radio research in the British Empire," and discussed among other points the propagation of electro-magnetic waves and the nature and origin of atmospherics.

In the section of Archæology, Miss E. W. Gardner and Miss G. Caton-Thompson described "Preliminary work on the geology and archæology of the Kharga Depression, Egypt," which is of great importance in the study of climatic changes, and Mr. L. A. Cammiade and Mr. F. J. Richards described "Climatic changes in Palæolithic India."

On Monday, September 28th, the first part of the meeting of the Sub-section of Cosmical Physics of Section A was devoted to a discussion on magnetic storms and the ionization of the upper atmosphere. Professor S. Chapman opened the discussion with a brief summary of the main facts concerning storms, and proceeded to an account of his present theoretical views on their origin and causation. He regarded the only likely cause to be a neutral ionized stream of corpuscles from the sun, a suggestion first made by Lindemann in 1919. No progress in working out the effects of such a stream upon the earth had been made, however, until the recent publication of a sketch of a new theory by Chapman and Ferraro.* The main points of this theory were described. Professor E. V. Appleton continued the discussion with an account of his measures of upper-atmospheric ionization. Two distinct ionized layers are found to exist, and the ionization of the lower one is usually increased several-fold during magnetic storms. Mr. A. H. R. Goldie then proceeded to describe his recent studies on the electric current systems to which magnetic storms can be referred. He regarded magnetic storms as in the main due to an intensification of the quiet-day electric current system, the change in the system being most notable on the night side of the earth. He favoured an atmospheric dynamic theory of storms. Mr. W. M. H. Greaves next reviewed the evidence pointing to the sun, and, in particular, to corpuscular emissions from the sun, as the cause of magnetic storms. Professor J. C. McLennan spoke briefly on the help that laboratory experiments can afford in the elucidation of the

Terr. Mag. Washington, D.C., June 1931 and later issues.

difficult questions concerning atmospheric ionization, auroræ and magnetic storms. Professor A. E. Kennelly, Professor Lindemann, and Father Rowland, also contributed to the discussion.

After this discussion Dr. G. M. B. Dobson read a paper on "Recent researches on atmospheric ozone." He said that the atmosphere includes among other gases a small amount of ozone, the exact quantity being of special interest because of its connexion with weather conditions, its distribution over the world and its annual variation. Dr. Dobson next described the latest photoelectric instrument for measuring the amount of ozone. This is characterised by ease of manipulation; observations are possible on clear or cloudy days. Its object is to enable daily observations to be made regularly, and a programme has been arranged of systematic observations over northern Europe. The photoelectric instrument, having great sensitivity, allows observations to be taken either in direct sunlight or in the light of a clear zenith sky until the sun is nearly setting. Such observations enable us to deduce the height and distribution of ozone through the atmosphere. The average height is probably about 40Km., distributed between the surface and 100Km., but further observations are necessary. He next described the effect of ozone in raising the temperature of the atmosphere at great heights. This high temperature causes bending down of sound waves and gives rise to audibility of explosions at great distances. The temperatures of the upper air calculated from the absorption of sunlight by ozone and from observations of sound waves show general agreement.

Professor S. Chapman, F.R.S., then read a paper on "Atmospheric absorption of solar radiations, and some associated phenomena." He discussed the absorption of solar radiation in the upper atmosphere of the earth, taking account of the curvature of the level surface. Diagrams illustrated the degree of absorption at noon in high latitudes in winter, and in other latitudes during the hour before the sun has become visible at ground level. The results bear on the annual variation of ozone in high latitudes, the daily variation of ionization and the emission of light by excited atoms in the upper atmosphere.

On the same day a discussion of the greatest interest took place in Section E, Geography, on "Geographical problems of the earth's crust." The discussion was opened by Mr. A. R. Hinks, and was carried on by Dr. G. C. Simpson, Dr. J. H. J. Poole, Dr. H. Jeffreys, Prof. J. W. Gregory and others. The points at issue were mainly the reality of continental drift on the lines postulated by the late Dr. A. Wegener, the nature of local departures from normal gravity and the mechanism by which continental drift could possibly be effected and anomalies of gravity maintained. Especial importance was attached to a long belt of markedly deficient gravity discovered by the sub-

marine investigations of F. A. Vening-Meinesz, which follows Wallace's line in the East Indies.

No meteorological papers were read on September 29th, which was devoted to the important discussion on " The evolution of the universe," but on September 30th Dr. G. C. Simpson described to Section A the plans for the second international polar year, 1932-3. During the first polar year in 1882-3, twelve countries sent fourteen expeditions to north polar regions and two to south polar regions. The plans for next year include the re-occupation of all these stations, and in addition the establishment of sixteen new stations. The work to be undertaken includes the investigation of the atmosphere at all levels as well as studies of terrestrial magnetism, atmospheric electricity and the aurora. The organised observations will include those which require simultaneous observations over a large area, such as the movements of air masses and the manufacture and outflow of polar air in high latitudes. All stations will be equipped with self-recording instruments, and upper air observations will be undertaken as far as possible to determine the lapse rate and the height and temperature of the stratosphere. The natural difficulties and the high cost of the new wireless transmitting meteorograph will limit the upper air investigation, however, and this will be supplemented by observations at mountain stations which rise above the level of the stagnant surface air. In spite of the present financial difficulties the International Commission which had just met at Innsbruck, after reviewing the offers of help, felt justified in going ahead with the plans. The British station will be at Fort Rae in Canada, and will consist of a party of five under the leadership of Mr. J. M. Stagg.

At 1 p.m. members of the Sub-section of Cosmical Physics and their friends met at the Hotel Rembrandt, the occasion being the customary Meteorological Luncheon, which this year was held under the auspices of the Royal Meteorological Society. A large and distinguished gathering was present, Mr. R. G. K. Lempfert, C.B.E., M.A., President of the Society, occupying the chair. In proposing the toast of " The Guests, coupled with the name of Dr. Abbot," Mr. Lempfert referred to the influence of the British Association on the work of meteorologists in the past. After Dr. Abbot had responded, " Meteorology and the allied sciences," was proposed by Sir Richard Gregory and replied to by Dr. G. C. Simpson. Finally, Sir John Russell proposed " The British Association, coupled with the name of Dr. Ferguson, Recorder to Section A," and Dr. Ferguson replied. Those present included :—

Mr. R. G. K. Lempfert, O.B.E. (in the chair); Dr. C. G. Abbot and Mrs. Abbot; Dr. E. Kidson and Mrs. Kidson; Abbé G. Lemaitre; Prof. W. de Sitter and Mrs. de Sitter; Prof. Griffith Taylor; Mr. C. Anthony; Mr. E. C. Barton; Mr. M. G.

Bennett; Mr. E. G. Bilham; Mr. E. W. Bliss and Miss E. G. Bliss; Mr. L. C. W. Bonacina; Air-Marshal Sir Robert Brooke-Popham, K.C.B., C.M.G.; Dr. C. E. P. Brooks; Mr. A. Hampton Brown; Capt. D. Brunt; Dr. L. J. Comrie; Mr. R. Corless, O.B.E.; Mr. H. W. Davis; Mr. R. M. Deeley; Dr. H. Dingle; Mr. F. Druce; Capt. F. Entwistle and Mr. W. M. H. Greaves, Secretaries of Section A, and Mrs. Greaves; Dr. A. Ferguson, Recorder of Section A, and Mrs. Ferguson; Prof. A. Fowler, F.R.S., and Mrs. Fowler; Col. E. Gold, D.S.O., F.R.S., and Mrs. Gold; Sir Richard Gregory and Lady Gregory; Dr. Ezer Griffiths, F.R.S.; Dr. Wilfred Hall; Mr. E. L. Hawke and Mrs. Hawke; Dr. J. O. Irwin; Dr. H. Jeffreys, F.R.S.; Mr. A. Pearse Jenkin, J.P.; Prof. J. Joly, F.R.S.; Dr. L. Keffler; Miss I. Lehmann; Dr. W. J. S. Lockyer; Mr. G. W. Lord; Mr. Gordon Manley; Dr. G. Merton and Mrs. Merton; Prof. E. V. Neville; the Reverend Father O'Connor, S.J.; Mr. R. S. Read; Rev. J. P. Rowland; Sir John Russell, O.B.E., F.R.S.; Mr. D. H. Sadler; Dr. B. J. F. Schönland, O.B.E.; Lady Schuster; Mr. F. J. Scrase; Sir Napier Shaw, F.R.S.; Dr. G. C. Simpson, C.B., F.R.S., and Mrs. Simpson; Mrs. H. H. Turner; Dr. K. W. Wagner; Sir Gilbert Walker, C.S.I., F.R.S.; Mr. R. A. Watson Watt; Dr. F. J. W. Whipple; Mr. R. S. Whipple and Mr. W. M. Witchell.

Among the numerous visits and excursions arranged by the local Committee were several of special interest to meteorologists. On the afternoon of September 24th a very large party visited the National Physical Laboratory, Teddington. Other excursions were: The Royal Observatory, Greenwich, on the 25th, Kew Observatory on the 28th, the Air Port of London, Croydon, on the 29th and 30th, and the Radio Research Station, Slough, on the 29th.

A party of some 30 members of Section E (Geography), visited the Meteorological Office, South Kensington, on Friday, September 25th. As the visit occupied only one hour in a crowded day, the exhibits had been designed to illustrate prominent features of some of the more obvious activities of a meteorological service, rather than to give a detailed picture. The visitors were received by Dr. G. C. Simpson, C.B., F.R.S., Director of the Meteorological Office, who gave a short account of the history of the South Kensington Office and an outline of the programme of the visit, after which parties of visitors were conducted round the various exhibits by members of the staff.

In the British Climatology Division, the methods of constructing rainfall charts was illustrated by an index map of rainfall stations and by the "charting table," designed for rapid plotting of data on a series of charts. Photographs and charts of noteworthy falls of rain and snow were also shown.

In the General Climatology Division were shown methods by which information regarding climates of different parts of the

world can be rapidly obtained, varying from the latest map of Köppen's climatic regions to special bibliographies and the card index. Mr. G. A. Clarke's excellent series of cloud photographs, as well as a display of stereographic cloud photographs from aeroplanes, attracted considerable interest.

A set of "working charts," by means of which daily forecasts are made, was exhibited by the Forecast Division as well as *Daily Weather Reports* and other reports for supplying current data to the public.

The display of instruments included a modern set such as are used at telegraphic reporting stations of the Office, and for comparison a number of historic instruments, some of which were described in the *Meteorological Magazine* for September.

The Noteworthy Depression of August 8th, 1931

On August 8th last a depression, deepening considerably as it travelled, moved eastward across southern England giving heavy rain and boisterous winds in many parts of the British Isles.

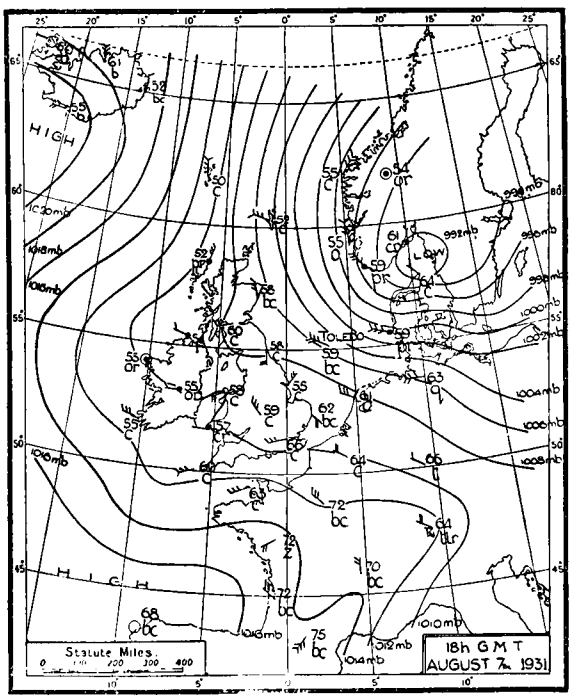

FIG. 1.

This depression was a remarkable one in view of its sudden and unexpected development and of its rapid growth. That this is so is revealed by a study of the synoptic charts. At 18h. G.M.T. on Friday, the 7th, the chart, reproduced as Fig. 1, revealed little indication of anything very untoward to come, the main features being a primary depression over Scandinavia, a secondary "kink" across southern Scotland and northern Ireland, and an anticyclone over mid-Atlantic. The 1h. chart on the 8th, however, revealed a striking change, a fully developed secondary then being centred over the Bristol Channel, the inner isobar of the secondary having a value of 1,004mb., while rain

was falling over Ireland, southern Scotland, and most of Wales and southern England. The chart for 7h. on the same morning, reproduced as Fig. 2, showed a further striking development, the secondary now being centred approximately over Salisbury and the inner isobar having the value of 998mb., while rain was more or less general over the British Isles. At 13h. the depression had travelled to a position centred off Yarmouth with a further deepening of 2mb. and winds generally boisterous over the whole country, while at 18h. there was little change except for a slight eastward movement of the centre. By 1h., however, on the following morning, the centre had passed to the Netherlands.

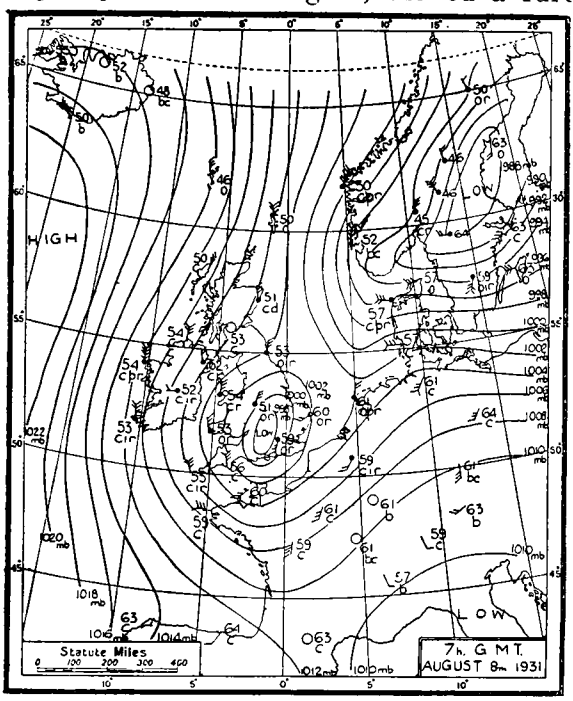

FIG. 2

Some noteworthy phenomena were associated with the passage of the disturbance. Amongst the more spectacular was a remarkable hailstorm at Hatfield on the afternoon of Saturday, the 8th, which resulted, to quote *The Daily Mirror* of the 10th, in conditions " like a scene from the Arctic regions," ice holding up traffic over a considerable distance on the Barnet by-pass road. Temperature readings over the country presented abnormal features for August, the temperature at Birmingham at 13h. on the Saturday being only 50°F., while Glasgow during Saturday night experienced appreciable ground frost. It may only be a coincidence but it is to be remarked that these shivery conditions fell within Buchan's fifth cold spell, which stretches from August 6th to 11th. There were also some heavy rainfall amounts to record in connexion with the depression.* Wind conditions were generally blustery, and the Norfolk coast especially, according to newspaper reports, had a particularly boisterous experience on the Saturday night.

WILLIAM H. PICK.

*See *Meteorological Magazine*, 66, 1931, p. 185.

Memorial Tablet to the late M. A. Giblett, M.Sc.

On Monday, October 5th, 1931, the anniversary of the loss of H.M. Airshop R 101, a tablet was placed in the Library of the Meteorological Office, South Kensington, bearing the following inscription :—

IN MEMORY OF
MAURICE ALFRED GIBLETT
SUPERINTENDENT
OF THE
AIRSHIP SERVICES DIVISION
OF THE
METEOROLOGICAL OFFICE
WHO PERISHED IN THE DISASTER TO
H.M. AIRSHIP R 101
NEAR BEAUVAIS, FRANCE
ON
5TH OCTOBER, 1930

Discussions at the Meteorological Office

November 2nd, 1931.—*The mistral in the plains of the middle Rhône, between Bas-Dauphiné and Provence.* By E. Rougetet (Météorologie, Paris, 6, 1930, pp. 341-85) (in French). *Opener*—Mr. C. S. Durst, B.A.

November 16th, 1931.—*Historical note on the catch of rain-gauges.* By H. R. Puri (India Meteor. Dept. Sci. Notes, Calcutta III, No. 23, 1931). *Opener*—Mr. J. Glasspoole, Ph.D.

Correspondence

To the Editor, *The Meteorological Magazine.*

Remarkable Coloured Halos

A remarkable system of solar halos was seen at Armagh Observatory on September 4th. At 15h. 45m. G.M.T., the sky was partly covered with flocculi of alto-cumulus, and in the intervals between these patches the blue was seen through a very delicate and uniform veil of cirro-nebula. In this, a brilliant parhelion shone vertically above the sun, associated with a fragment of halo concave upwards, but tailing off to the north into one curving downwards, so that the whole resembled an elongated letter S, or an italic f. I fancy this appearance was due to a bit of the usual 22½° halo, asociated with a tangent arc at the point vertically above the sun. The alto-cumulus gradually dissolved, and at 17h. 25m. the sun was shining in a sky clear but for the cirro-nebula, an all but imperceptible veil; and now a magnificent circle of pure rainbow spectrum was visible at 45° from the sun. The parhelion was brighter, and was now seen to be on the circumference of a 22½° halo, a good deal fainter

than that at 45°, and with less vivid colours. The bright patch was rather hyperbolic than circular in shape, and there were faint traces of a sun pillar extending from the sun upwards to it. The halo system lasted nearly 3 hours, only disappearing shortly before sunset.

I have seen many halos and combinations of halos, but I have never before seen anything like the large rainbow coloured halo. It was in every respect like a rainbow except in position, and the colours were, if possible, purer and clearer than those of a rainbow. Though not as bright as a primary rainbow, it was brighter than I have ever seen a secondary bow, though it was narrower, and the repetition of the colours on the violet edge was absent. The red was on the inside of the circle, whereas in a rainbow it is on the outside.

WM. F. A. ELLISON.

The Observatory, Armagh. September 7th, 1931.

St. Elmo's Fire

Mr. G. H. Brown, Parkstone Avenue, Horfield, Bristol, reports the occurrence of St. Elmo's Fire at 19h. 15m. G.M.T., on Sunday, July 12th, which he describes as follows:—"Upon looking up I saw a decided blue light not unlike the new daylight-tinted electric bulbs on the arrow of the indicating vane arm pointing true north. On closer inspection from the front gate it was still there, and several passers-by also looked up mystified. This was then 19h. 20m., and thunder occurred several times within a few minutes, and it seems that a rather severe thunderstorm which had taken place at Weston-super-Mare was nearing us. I cannot quite understand why the light was not on the very top of the vane itself, unless the copper tip of the direction pointer was selected as the better conductor, for I may mention that the metal tubing is 50ft. from the ground running up the side of the house, and is earthed, with copper bed plate."

Alto-cumulus Castellatus Clouds and Thunderstorms

I agree with Mr. Petrocokino that severe thunderstorms of the turret cloud type sometimes come with upper currents on the east side of south. For example, on the evening of July 9th, 1923, the wind was SE. at 5,000 feet and S. by E. at 18,000 feet, and on the afternoon of July 22nd, 1925, the wind was 50 m.p.h. from SSE. at 10,000 feet. On July 20th, 1929, and August 29th, 1930, there were also severe storms preceded by turret clouds, but on these occasions the upper current was slightly west of south. The preponderance of south-west upper currents is due largely to comparatively high turret clouds, often associated with moderate or slight storms, and sometimes with none at all.

Thunderstorms associated with large easterly components in

the upper wind are by no means rare, especially in the early summer, and in some cases there is something of the turret cloud structure, though not necessarily alto-cumulus castellatus proper. I think the cloud structure in question requires an absence of convection from near the ground, and the necessary conditions are sometimes present at quite moderate heights (say 5,000 feet) even in the daytime, as, for example, when there is a cool shallow north-east wind from the North Sea, and a warm unstable current above it, either from east or south, or occasionally south-west. I agree that the turret cloud cumulo-nimbus differs substantially in its method of development from ordinary cumulo-nimbus, and that it ought to have some designation, but I do not much like the suggested term "Alto-cumulus nimbus." Comparatively low and heavy turret clouds have little in common with alto-cumulus.

C. K. M. DOUGLAS.

September 24th, 1931.

May and September Maximum Temperatures

Evaluation of the decadal means of maximum temperature for May and September at Greenwich Observatory since 1841 indicates that the progressive rise noted by Mr. Pick in the three sets of 20-year means (1871-1890, 1891-1910, 1911-1930) for these two months at Kew should be interpreted as a temporary fluctuation rather than as a real climatic change. The Greenwich means are as follows:—

	Mean Maximum Temperature.		
Period.	*May.*	*September.*	*January.*
1841-1850	65·6°F.	67·2°F.	41·8°F.
1851-1860	62·9°F.	67·7°F.	44·7°F.
1861-1870	65·1°F.	68·3°F.	43·0°F.
1871-1880	62·7°F.	67·1°F.	43·4°F.
1881-1890	64·3°F.	66·3°F.	42·7°F.
1891-1900	63·8°F.	68·1°F.	42·2°F.
1901-1910	62·9°F.	66·1°F.	43·9°F.
1911-1920	66·6°F.	67·0°F.	44·2°F.
1921-1930	64·8°F.	67·6°F.	46·1°F.

It is interesting to note the large range of May variation (3·9°F.) among the nine decades as compared with that of September (2·2°F.). In the matter of diurnal warmth spring apparently tends to be more inconstant than autumn not only day by day and year by year, but decade by decade. To apportion the analysis evenly through the twelve months, the Greenwich mean maximum values for January in each ten-year period are appended. In this instance the inter-decadal range of variation is still greater—4·3°F., of which as much as 3·9°F. figures in the remarkable increase shown since 1891-1900.

E. L. HAWKE.

Caenwood, Rickmansworth, Herts. October 5th, 1931.

NOTES AND QUERIES

New Meteorological Station at Tonga, Friendly Islands

Since January 1st, 1931, meteorological observations have been carried out by the Director of Agriculture at the Government Experimental Station, Nukualofa, Tonga (22°S., 175°W.). The hour of observation is 9h. Tonga time. Observations for the first four months have now been received and have already brought out a striking contrast between two successive months. February was dry, receiving only 0·41in. of rain, but March was rather rainy, the month's total amounting to 20·14in. on 25 days of which 6·72in. fell on the 24th. There were corresponding differences of temperature and humidity, as shown by the following short table:—

	Temperature			Relative Humidity
	Mean Maximum	Mean Minimum	Daily Range	9h.
	°F	°F	°F	%
February	86·8	69·0	17·8	66
March	83·2	71·7	11·5	80

Canadian Auroral Expedition

A scientific expedition has just proceeded by the Canadian National Railways to Churchill, on Hudson Bay, for the purpose of photographing the Aurora Borealis.

The expedition, which is composed of three explorers and three scientists, is equipped with a camera possessing an ultra high speed lens and with panchromatic films. Churchill has been selected because, at this time of the year, it offers the best position for observation, being situated on a direct line between the auroral pole and the magnetic pole and in the belt of maximum frequency of the aurora.

The expedition will stay in the north for six weeks and, besides photographing the aurora, will measure the height of the display by means of photography and triangulation and by making astronomical transits. The expedition also hopes to discover if the auroral phenomenon is connected with static electricity and terrestrial magnetism.

In order to obtain the complete range of colour in the aurora, a double negative back to back in the camera will be used, each negative sensitive to one-half of the spectrum. Cinematograph films will also be taken.

Heavy Rainfall in a Tropical Storm

Reports of the storms which occurred in Fiji during the period February 17th to March 2nd, 1931, show that although not un-

precedented as regards force of wind, they were accompanied by the most extensive and disastrous floods ever experienced in Fiji. Over two hundred persons lost their lives, much structural damage was done and serious loss was caused to the various crops.

There appears to be some doubt whether two storm centres were concerned or whether a single storm centre hovered close to northward of the group for several days, but the main damage was caused by a period of continuous heavy rain, culminating on February 21st, on the night of which the floods on the island of Viti Levu reached their peak. No district in Viti Levu escaped serious loss, but the other islands of the group were little affected.

In the district of Colo North remarkable falls of rain were measured at the Government Station, Nadarivatu, 2,500 feet above sea level, a total of 91½ inches of rain being experienced in nine days. The daily totals were as follows:—

	in.			in.			in.
17th	1·66	...	20th	11·65	...	23rd	2·92
18th	5·94	...	21st	20·40	...	24th	4·50
19th	8·55	...	22nd	24·20	...	25th	11·70

Heavy falls were also recorded in other places, Tavua having 30 inches on the 21st and 22nd, whilst in the Ra district it was reported that "the rainfall from 17th to 26th February was approximately 50 inches, the gauge frequently overflowing."

S. T. A. MIRRLEES.

The Thermal Conductivity of Snow

The *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo*, vol. 12, 1929-30, contains a paper by Masao Kuroda on the "Thermal Conductivity of Snow," which is of interest to meteorologists. The readings were made by the members of the Alpine Club of Waseda University, Japan, who measured the temperature of the snow daily every three hours from March 12th to April 7th, 1928, at the surface and at depths of 5, 10 and 20cm. In the calculations only the data for fine days were employed and these were divided into two groups, I, those on which the maximum temperature did not reach 0°C., and II, those on which temperature remained near 0°C. for some time and melting occurred.

The averages of the first group were analysed harmonically at the surface and at 5cm. depth, and values of the diffusivity calculated from the first two terms of the series. These showed a rather wide dispersion but gave an average figure of 0·0086. This was checked by comparing the calculated and observed temperatures at 10 and 20cm. depth, and gave good results after allowing for the upward transfer of heat from the earth. The thermal conductivity of snow of specific gravity 0·125 was

calculated as 0·000516, a rather higher value than those previously obtained in the laboratory.

The temperatures calculated from this conductivity were compared with the observed temperatures at all depths. In the morning the former were too low, in the later afternoon and evening too high, the departures being greatest at 10cm. The author accounts for this discrepancy by the convection of air through the pores in the snow; in the morning the air heated with the snow is replaced by cold air from above, hindering the downward conduction, while the air in the deeper snow does not move; later, when the surface begins to cool, cold air penetrates downwards and assists conduction. It appears that in field measurements conduction and convection cannot be separated. Since the mean temperature increases downwards, the result is a measure of conductivity higher than those found in laboratory experiments.

The diurnal variations on days accompanied by melting cannot be employed for calculating the thermal conductivity but are applied to calculate approximately the heat consumed in melting. The results agree reasonably well with the rate of lowering of the snow surface.

Reviews

Weather dominated by solar changes. By C. G. Abbot, Smiths. Misc. Coll. 85, No. 1. Hodgkins Fund and Roebling Fund, Washington, D.C.

In this paper Dr. C. G. Abbot shows that the changes of pressure and temperature at Washington following increases of solar radiation are on the whole opposite to those following decreases, suggesting a real connexion between short period solar fluctuations and terrestrial weather. The changes are complex and irregular, and differ greatly from one month to another, while the temperature effects are too large to be explained by local heating. The author thinks they may be of value in forecasting, if the changes of the solar constant can be forecast, and he accordingly investigates periodicities in the latter by a graphical method. Five periodicities are found, with lengths of 68, 45, 25, 11 and 8 months. The monthly mean temperatures at Washington are analysed for similar periodicities, and the results, with the addition of a "terrestrial" period of 18 months, are employed to construct a curve of calculated temperatures which resembles fairly well the curve of observed readings, corrected for the annual variation.

Climate and migrations. By J. C. Curry. Smiths. Ann. Rep. for 1929, Washington, D.C., pp. 423-35.

In this historical study, reprinted from "Antiquity," the racial movements in Eurasia are employed to construct a curve

showing alternating periods of migration and rest. The migrations agree fairly well with the periods of drought in Eurasia according to Brooks (" Climate through the Ages "), but the author also finds in them a periodicity of about 640 years.

The thermal structure of the free atmosphere over Agra. By G. Chatterjee and N. K. Sur. Reprinted from Gerlands Beiträge zur Geophysik, Leipzig, 25, 1930, pp. 266-78.

Upper air investigation in India by means of sounding balloons, after being in abeyance for some time subsequent to the war, has been revived with great and commendable vigour during the last few years. The above paper presents a summary of the results obtained by the Agra Aerological Observatory since the year 1925. It opens with a brief but most instructive account of the instrumental methods employed, followed by tables and graphs showing monthly and seasonal mean values of temperature over Agra up to about 20 geodynamic kilometres. Further graphs show the variation of temperature at the tropopause throughout the year and indicate the various types or tropopause commonly found.

It is evident that upper air investigation at Agra is very much alive at the present time. An example of the enterprise of the staff may be given in the fact that they make their own balloons, and that the heights reached therewith now exceed those obtained by sounding balloons in England with the best balloons which can be purchased.

L. H. G. DINES.

Wanderers Wetterbuch. By Dr. Otto Myrbach. Size $6\frac{3}{4} \times 4\frac{3}{4}$in., pp. 184, *Illus.* Leipzig, Berg. and Buch, 1931. 2 marks.

In addition to the comparatively numerous publications dealing with general meteorology, climatology, aeronautical meteorology, &c., there appears now and again some little book which appeals to the nature-loving side of man. A few years ago Mr. C. J. P. Cave published his " Clouds and weather phenomena for artists and other lovers of nature," which dealt with the colour of the sky, optical phenomena and clouds. This year we have by an official forecaster at the headquarters of the meteorological service in Vienna, a weather-book for wanderers. In Austria it is easy to understand that a wanderer is naturally in some degree a mountain climber, so that the mention of mountains on the first and last pages and throughout the work is scarcely surprising.

Presupposing no knowledge beyond that obtained in a general school education, the author builds up his structure gradually and carefully, urging the reader to read the book through from beginning to end before using it for reference purposes. Perhaps this is the reason why no index is included. There is a fairly

full table of contents, but the reviewer experienced difficulty at times in re-finding some passages, *e.g.*, the paragraphs dealing with waterspouts, tornadoes, &c., which are to be found under "hail." There are also some riddles which may be due to printers' errors, but apart from such minor defects, the author has succeeded in presenting in less than 200 small pages a great deal of information in a very pleasant and readable form. He has intentionally avoided technical discussions of instruments, &c., which are not essential to the tourist, and climate is barely touched upon since he argues that mean values are of less importance to the Alpine wanderer than weather.

After a simple explanation of the meteorological elements and some principles of thermodynamics, the greater part of the book is devoted to air-masses, the formation of various kinds of cloud and precipitation, "fine" weather processes (which receive unusual though scarcely undue respect in 20 pages of this small book!), forecasting and lastly, definite examples chosen from recent years. The differences between highland and lowland conditions are emphasised and the tables accompanying the weather maps have been specially arranged to show vertical variations on different sides of the Alps and calculated temperature gradients. The author discusses the uses and also the limitations of official forecasts and stresses the duty of the leader of a party with respect to weather. Incidentally the candid manner in which he explains the forecasters' standpoint should help to foster a sympathetic understanding on the part of the reader.

The language is clear and should be easily understood by anyone with a moderate knowledge of German, while simplicity of style adds a charm to this little book which should be of particular interest and value to visitors to the Austrian Alps. It contains many good illustrations and photographs, and concludes with a nine-page weather drama in four acts described by Dr. Peter Lautner of Munich under the title of "A February storm on the Zugspitze."

L. D. SAWYER.

Deutsches Meteorologisch Jahrbuch für Bayern, 1929.

(*a*) *Die Münchener Registrierballonfahrten im Jahre*, 1929. By P. Zistler and H. Zierl.

Contains complete data, also "tephigrams."

(*b*) *Zum Mikroklima isolierter Standorte.* By K. Hummel.

Deals with measurements of temperature at various heights and exposures among vegetation.

(*c*) *Zur Methodik der Untersuchung der mechanischen Windstruktur.* By M. J. Holtzmann.

Deals mainly with the instrumental factors involved in measuring gustiness.

(*d*) *Harmonische Analyse des Luftdruckes von München und Zugspitze im Mai*, 1926. By L. Egersdörfer.

(*e*) *Die Zugspitzbahn-Versuche.* By A. Büdel.

Autographic records have been obtained from instruments fitted outside the cars on the funicular railway up the Zugspitze. There is an observatory at the top (9,724 feet), and also observing stations at the bottom and a little below the summit, and two other stations in the valley at no great distance. Aeroplane flights were also made in the neighbourhood so as to compare the conditions in the free air with those on the mountain. The paper deals mainly with the observation work, but some examples are reproduced. This work should be of great value as an investigation of mountain meteorology.

(*f*) *Schwankungen der Niederschlagsbereitschaft über West- und Mitteleuropa.* By A. Schmauss.

A large number of diagrams and charts showing the day to day variation of rainfall over Europe, averaged for period 1891 to 1910, are given. Deductions are made therefrom, of doubtful validity.

Books Received

Jaarboek, Koninklijk Nederlandsch Meteorologisch Instituut, 1929. A. Meteorologie, B. Aard-Magnetisme (Nos. 97 and 98). Utrecht, 1930.

Ergebnisse Aerologischer Beobachtungen, 1929. K. Ned. Meteor. Inst. (No. 106 A). Utrecht, 1930.

Onweders, optische verschijnselen, enz. in Nederland. Naar vrijwillige waarnemingen in 1928. Deel xlix, Amsterdam, 1930.

Obituary

We regret to learn of the death on September 25th at the age of 69 of M. Emile Schaer, founder of the Jungfraujoch Observatory and since 1898 assistant at the Geneva Observatory.

News in Brief

The retirement is announced of Mr. H. A. Hunt from the position of Commonwealth Meteorologist of Australia on February 6th, 1931. He is succeeded by Mr. William Shand Watt.

We learn from the *Morning Post* that a new type of aeroplane specially designed for flights into the stratosphere is now ready for its first ascent at the Junkers works at Dessau. It has been ordered by the Aeronautical Research Institute of Berlin, which proposes to carry out the first flight within a few weeks. It is the Institute's aim to explore and study the higher regions with the idea that future air services will use the stratosphere.

Errata

September, 1931, p. 184, fourth line from bottom of page, *for* "1·67in. at Bury St. Edmunds" *read* "1·67in. at Westley, 2 miles from Bury St. Edmunds." The rainfall in the town of Bury St. Edmunds itself was much smaller; Canon E. Hill has kindly supplied the following figures: 0·92in. at Whiting Street, 0·66in. at Southbridge House, and 0·62in. at Northgate Street.

September, 1931, p. 195, last line, *for* "with gusts of 90 m.p.h. and 72 m.p.h." *read* "with gusts of 79 m.p.h. and 72 m.p.h."

The Weather of September, 1931

Pressure was above normal over western Europe (including Switzerland), the northern North Atlantic and the extreme north-west of Africa, the greatest excess being 9·0mb. at Thorshavn. Pressure was below normal over Spitsbergen, north-east Norway, east Sweden, Russia, eastern Germany and south-east Europe and Madeira, the greatest deficit being 6·1mb. at Moscow. Temperature was below normal over the whole of western Europe—as much as 6·5°F. below normal at Zurich—but above normal at Spitsbergen. The rainfall distribution was irregular, in excess at Spitsbergen and in eastern Svealand, Sweden, deficient in northern Norway, most of Sweden and in Switzerland.

The weather of September over the British Isles was generally cold and dull, but after the heavy local rain at the beginning mainly dry. The opening days were very unsettled. A complex depression off south-west Ireland moved slowly eastward across England giving heavy rain in many places, 4·97in. at Kildale (Yorks.) and 3·11in. at Pickering (Yorks.) on the 4th, and 3·20in. at Dalgany (co. Wicklow), and 2·43in. at Mansfield (Notts.) on the 3rd were among the heavier falls. Floods occurred locally. Thunderstorms were widespread on the 2nd and 3rd and local on the 4th, 5th and 7th. Temperature was high at the beginning of the month, especially in north England and the Midlands, where it rose to 73°F. at Huddersfield on the 1st. In the rear of the depression cold northerly winds, approaching gale force locally at times, prevailed over the British Isles and day temperatures were low; one of the lowest maxima reported was 49°F. at Leafield on the 5th. Sunshine records were good in south-east England on the 3rd, and in Ireland on the 5th. Thereafter the character of the month completely changed, quiet anticyclonic weather prevailing with only occasional short breaks. On the 6th an anticyclone situated westward of Ireland with a tongue of high pressure extending over France moved a little eastwards. A period of cool, mainly fair weather ensued apart from scattered showers. Ground frost occurred generally and sunshine records were good, the 6th, 7th and 8th were very fine days in Ireland and north-west England. This distribution persisted with little change until the evening of

the 10th, when a secondary depression south of Iceland moved south-east and gave rain locally on the 11th and 12th. Thunderstorms occurred in the west on the 10th. About the 13th an anticyclone centred near the Azores moved north-east over the British Isles and warmer but mainly cloudy conditions with light south-west to west winds prevailed for some days, with much mist or fog and local drizzle. Temperature rose above 70°F. at many places on the 15th, 16th and 18th, and reached 72°F. at York and Hull on the 15th. Good sunshine records were obtained along the south coast on the 16th. Although the anticyclone persisted, a change to cooler conditions occurred about the 20th, when the winds became northerly. The weather for the next two or three days was sunny and bright but cool; sunshine records of over 10hrs. were registered at many places on the 20th, 22nd and 23rd; Valentia (co. Cork) had 11·0hrs. on the 20th, 10·7hrs. on the 22nd and again on the 23rd. Slight rain occurred in eastern England on the 22nd or 23rd. After this the weather became increasingly overcast, the anticyclone diminished in intensity and moved eastwards. It was followed by a depression from the Atlantic which brought rain to the west on the 29th and to other districts on the 30h, with warmer conditions in the south. Temperature was below normal for the month, the mean being as much as 2·9°F. below normal at Kew. The distribution of bright sunshine was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	93	— 22	Liverpool	93	—35
Aberdeen	110	— 14	Ross-on-Wye	95	—41
Dublin	97	— 42	Falmouth	131	—32
Birr Castle	111	— 15	Gorleston	127	—35
Valentia	127	— 6	Kew	117	—28

The special message from Brazil states that the rainfall was irregular in the northern regions with an average 0·47in. above normal and generally scarce in the central and southern regions with averages 0·35in. and 0·87in. below normal respectively. The crops were generally in good condition, especially the cane and cotton crops. The coffee blossom was affected in some places by strong winds. Four anticyclones crossed the country. At Rio de Janeiro pressure was 1·3mb. above normal and temperature 1·3°F. below normal.

Miscellaneous notes on weather abroad culled from various sources.

High winds were experienced along the Atlantic and Channel coasts of France on the 6th and 7th, and cold weather accompanied by heavy snowfall was reported from the Alps and the Auvergne. On the 7th the snow had descended to a level of 3,000ft. in the Alps. Heavy snow fell in upper Bavaria and in the Taunus hills a few miles to the north-west of Frankfurt on the 22nd and 23rd. This is the first time snow has been

recorded in September in Munich since 1830 and near Frankfurt since 1859. Cold weather was also experienced in France, and snow was recorded in the central and southern districts about the 24th. (*The Times*, September 7th-8th, 24th-26th.)

The Chinese floods continued throughout September. At Hankow the river was 51ft. above bund level on the 4th, but the floods were gradually subsiding, the river being down to 48ft. on the 22nd when some streets were nearly dry. A small typhoon struck Hongkong on the 12th doing much damage to the fishing fleets—200 Chinese were drowned. Floods were still reported from several districts of Burma on the 8th, but in others the monsoon partially failed. A typhoon in Japan on the night of the 26th caused the heaviest rainfall recorded in Tokyo for 17 years (*The Times*, September 5th-28th).

Several miles of the Canadian Pacific main railway line have been swept away by the flooding of the Columbia river in the Rocky Mountains. A heat wave, unusually severe for September, with temperatures of over 90°F., passed over central and eastern Canada round about the 9th; a maximum temperature of 100°F. was recorded at Ottawa on the 11th. At the same time in Alberta the temperature was below freezing point and snow fell on the 9th. Two hundred people were reported on the 4th to have been drowned by the floods in Porto Rico. A hurricane struck Belize, British Honduras, at 11.30 a.m. on the 10th and lasted 4 hours, during which the velocity of the wind reached 90 m.p.h. After this there was dead calm for half-an-hour with a very low barometer and high temperature. Then came the second blast, which lasted 5 hours and during which the wind reached 120 m.p.h. An inrush of the sea followed which inundated the town in places to a depth of 16ft. The number of deaths was estimated at 1,000 and most of the town was destroyed. A much less severe hurricane passed over Jamaica on the 12th, destroying many banana trees. A hurricane passed over Santa Rosalie, lower California, on the 12th and 13th, killing some 50 people, and a hurricane also swept Vera Cruz on the 16th wrecking a number of small ships in the harbour. Temperature was considerably above the normal over the United States during the month, except along the Pacific Coast, where it was about normal, while rainfall was generally deficient at the beginning and end of the month though in excess locally in the middle. (*The Times*, September 4th-22nd, *Toronto Weather Map*, September 12th, and *Washington, D.C., U.S., Dept. Agric., Weekly Weather and Crop Bulletin.*)

Rainfall, September, 1931—General Distribution

England and Wales	123	per cent of the average 1881-1915.
Scotland	55	
Ireland	101	
British Isles	102	

Rainfall: September, 1931: England and Wales

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square.....	2·70	148	*Leics* .	Belvoir Castle.....	2·69	144
Sur .	Reigate, Alvington.....	2·09	100	*Rut* .	Ridlington.....	3·72	194
Kent .	Tenterden, Ashenden...	2·25	105	*Linc* .	Boston, Skirbeck.....	2·67	152
,, .	Folkestone, Boro. San..	1·32	...	,, .	Cranwell Aerodrome...	2·58	145
,, .	Margate, Cliftonville...	1·16	59	,, .	Skegness, Marine Gdns	2·92	161
,, .	Sevenoaks, Speldhurst	2·27	...	,, .	Louth, Westgate.....	1·82	90
Sus .	Patching Farm.....	2·05	85	,, .	Brigg, Wrawby St....	2·68	...
,, .	Brighton, Old Steyne..	2·02	97	*Notts* .	Worksop, Hodsock.....	3·07	202
,, .	Heathfield, Barklye....	2·19	89	*Derby*.	Derby, L. M. & S. Rly.	2·09	127
Hants.	Ventnor, Roy. Nat. Hos.	2·20	89	,, .	Buxton, Devon Hos....	4·02	124
,, .	Fordingbridge, Oaklnds	1·92	89	*Ches* .	Runcorn, Weston Pt...	3·41	128
,, .	Ovington Rectory.....	2·48	108	,, .	Nantwich, Dorfold Hall	5·34	...
,, .	Sherborne St. John.....	1·51	74	*Lancs* .	Manchester, Whit. Pk.	3·08	129
Berks .	Wellington College.....	2·02	110	,, .	Stonyhurst College.....	2·99	78
,, .	Newbury, Greenham...	2·17	107	,, .	Southport, Hesketh Pk	3·58	138
Herts .	Welwyn Garden City...	2·38	...	,, .	Lancaster, Strathspey	3·23	...
Bucks.	H. Wycombe, Flackwell	2·08	...	*Yorks*.	Wath-upon-Dearne.....	3·88	246
Oxf . .	Oxford, Mag. College..	2·62	156	,, .	Bradford, Lister Pk....	3·81	184
Nor .	Pitsford, Sedgebrook...	3·73	207	,, .	Oughtershaw Hall.....	2·82	...
,, .	Oundle.....	2·37	...	,, .	Wetherby, Ribston H.	4·46	276
Beds .	Woburn, Crawley Mill	2·44	136	,, .	Hull, Pearson Park.....	3·50	204
Cam .	Cambridge, Bot. Gdns.	2·87	178	,, .	Holme-on-Spalding.....	2·65	...
Essex .	Chelmsford, County Lab	1·72	100	,, .	West Witton, Ivy Ho.	3·82	178
,, .	Lexden Hill House....	1·55	...	,, .	Felixkirk, Mt. St. John	4·54	250
Suff .	Hawkedon Rectory.....	2·38	123	,, .	Pickering, Hungate....	5·35	280
,, .	Haughley House.....	1·97	...	,, .	Scarborough.....	4·04	226
Norf .	Norwich, Eaton..... ...	2·36	110	,, .	Middlesbrough.....	4·62	278
,, .	Wells, Holkham Hall	3·73	196	,, .	Baldersdale, Hury Res.	1·93	...
,, .	Little Dunham.....	2·32	101	*Durh* .	Ushaw College.....	3·61	180
Wilts.	Devizes, Highclere.....	2·65	130	*Nor* .	Newcastle, Town Moor	2·03	100
,, .	Bishops Cannings.....	2·20	100	,, .	Bellingham, Highgreen	1·32	55
Dor .	Evershot, Melbury Ho.	1·90	71	,, .	Lilburn Tower Gdns....	2·58	109
,, .	Creech Grange.....	2·07	75	*Cumb* .	Geltsdale.....	1·50	...
,, .	Shaftesbury, Abbey Ho.	1·72	71	,, .	Carlisle, Scaleby Hall	1·43	52
Devon.	Plymouth, The Hoe...	1·64	64	,, .	Borrowdale, Seathwaite	7·95	80
,, .	Polapit Tamar.....	...	...	,, .	Borrowdale, Rosthwaite	3·53	...
,, .	Holne, Church Pk. Cott.	1·82	51	,, .	Keswick, High Hill.....	2·16	...
,, .	Cullompton	1·36	60	*West* .	Appleby, Castle Bank..	1·32	52
,, .	Sidmouth, Sidmount...	1·56	68	*Glam* .	Cardiff, Ely P. Stn.....	1·93	62
,, .	Filleigh, Castle Hill....	2·48	...	,, .	Treherbert. Tynywaun	3·46	...
,, .	Barnstaple. N. Dev. Ath	1·94	72	*Carm* .	Carmarthen Friary.....	2·92	84
,, .	Dartm'r, Cranmere Pool	3·80	...	*Pemb* .	Haverfordwest, School	4·43	125
Corn .	Redruth, Trewirgie.....	3·48	111	*Card* .	Aberystwyth.....	3·79	...
,, .	Penzance, Morrab Gdn.	3·05	104	,, .	Cardigan, County Sch.	3·14	...
,, .	St. Austell, Trevarna...	3·23	101	*Brec* .	Crickhowell, Talymaes	3·20	...
Soms .	Chewton Mendip.....	1·48	48	*Rad* .	Birm W. W. Tyrmynydd	2·87	74
,, .	Long Ashton.....	2·95	123	*Mont* .	Lake Vyrnwy.....	3·21	91
,, .	Street, Millfield	1·54	68	*Denb* .	Llangynhafal.....	5·46	246
Glos. .	Cirencester, Gwynfa....	2·19	100	*Mer* .	Dolgelly, Bryntirion...	4·72	111
Here .	Ross, Birchlea.....	1·86	97	*Carn* .	Llandudno.....	3·92	172
,, .	Ledbury, Underdown..	2·02	106	,, .	Snowdon, L. Llydaw 9	10·15	...
Salop .	Church Stretton.....	2·30	113	*Ang* .	Holyhead, Salt Island	3·08	115
,, .	Shifnal, Hatton Grange	2·38	123	,, .	Lligwy.....	2·98	108
Worc .	Ombersley, Holt Lock	2·36	133	*Isle of Man*			
,, ..	Blockley.....	2·35	...		Douglas, Boro' Cem....	4·14	127
War .	Birminghm, Edgbaston	2·41	135	*Guernsey*			
Leics .	Thornton Reservoir....	2·36	130		St. Peter P't. Grange Rd.	2·41	93

Rainfall: September, 1931: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per cent of Av.
Wigt .	Pt. William, Monreith	3·60	123	*Suth* .	Melvich	1·13	...
,, .	New Luce School.....	2·55	71	,, .	Loch More, Achfary ...	3·65	63
Kirk .	Carsphairn, Shiel	2·19	41	*Caith* .	Wick.....	·94	38
Dumf .	Dumfries, Crichton, R.I	1·49	...	*Ork* .	Pomona, Deerness.....	·81	28
,, .	Eskdalemuir Obs.....	1·46	39	*Shet* .	Lerwick.....	1·11	37
Roxb .	Branxholm.....	1·79	80	*Cork* .	Caheragh Rectory.....	1·52	...
Selk .	Ettrick Manse	1·73	48	,, .	Dunmanway Rectory...	1·31	32
Peeb .	West Linton	1·34	...	,, .	Ballinacurra.....	1·50	59
Berk .	Marchmont House.....	1·87	78	,, .	Glanmire, Lota Lo.....	1·16	41
Hadd .	North Berwick Res....	1·34	64	*Kerry* .	Valentia Obsy.....	2·61	63
Midl .	Edinburgh, Roy. Obs.	1·98	105	,, .	Gearahameen.....	5·20	...
Lan .	Auchtyfardle	1·04	...	,, .	Killarney Asylum.....	2·56	67
Ayr .	Kilmarnock, Agric. C.	...	...	,, .	Darrynane Abbey.....	2·52	71
,, .	Girvan, Pinmore	1·73	45	*Wat* .	Waterford, Brook Lo...	3·35	121
Renf .	Glasgow, Queen's Pk..	1·35	49	*Tip* .	Nenagh, Cas. Lough ...	3·13	111
,, .	Greenock, Prospect H.	1·64	35	,, .	Roscrea, Timoney Park	2·20	...
Bute .	Rothesay, Ardencraig.	2·51	62	,, .	Cashel, Ballinamona ...	2·68	109
,, .	Dougarie Lodge.....	2·06		*Lim* .	Foynes, Coolnanes	1·78	62
Arg .	Ardgour House	3·06	...	,, .	Castleconnel Rec.....	1·82	...
,, .	Manse of Glenorchy...	...	...	*Clare* .	Inagh, Mount Callan...	3·80	...
,, .	Oban.....	1·85	42	,, .	Broadford, Hurdlest'n.	2·24	...
,, .	Poltalloch	2·15	47	*Wexf* .	Gorey, Courtown Ho...	4·70	190
,, .	Inveraray Castle.....	2·19	34	*Kilk* .	Kilkenny Castle	2·33	101
,, .	Islay, Eallabus	2·76	66	*Wic* .	Rathnew, Clonmannon	5·74	...
,, .	Mull, Benmore	...	..	*Carl* .	Hacketstown Rectory..	2·96	106
,, .	Tiree.....	2·30	...	*Leix* .	Blandsfort House.....	4·36	160
Kinr .	Loch Leven Sluice.....	1·59	...	,, .	Mountmellick.....	2·93	...
Perth .	Loch Dhu.....	2·50	44	*Off'ly* .	Birr Castle	2·50	109
,, .	Balquhidder, Stronvar	...	...	*Kild'r.*	Monasterevin	3·15	...
,, .	Crieff, Strathearn Hyd.	1·39	49	*Dubl* .	Dublin, Fitz Wm. Sq....	4·84	252
,, .	Blair Castle Gardens...	1·27	54	,, .	Balbriggan, Ardgillan.	3·95	194
Angus.	Kettins School.....	1·24	62	*Me'th* .	Beauparc, St. Cloud...	3·28	...
,, .	Dundee, E. Necropolis	1·04	50	,, .	Kells, Headfort.....	3·52	132
,, .	Pearsie House.....	1·06	...	*W.M.* .	Moate, Coolatore.....	2·31	...
,, .	Montrose, Sunnyside...	1·74	53	,, .	Mullingar, Belvedere...	3·74	140
Aber .	Braemar, Bank.....	1·22	49	*Long* .	Castle Forbes Gdns.....	2·44	85
,, .	Logie Coldstone Sch....	1·60	69	*Gal* .	Ballynahinch Castle...	3·91	82
,, .	Aberdeen, King's Coll.	·89	40	,, .	Galway, Grammar Sch.	1·88	...
,, .	Fyvie Castle	1·78	68	*Mayo* .	Mallaranny..... ...	5·23	...
Moray.	Gordon Castle.....	1·63	65	,, .	Westport House.....	2·75	77
,, .	Grantown-on-Spey.....	1·69	68	,, .	Delphi Lodge.....	8·31	109
Nairn.	Nairn, Delnies	1·27	58	*Sligo* .	Markree Obsy..... ...	2·70	81
Invs .	Ben Alder Lodge	1·85	...	*Cav'n* .	Belturbet, Cloverhill...	1·84	74
,, .	Kingussie, The Birches	1·10	...	*Ferm* .	Enniskillen, Portora...	3·31	...
,, .	Loch Quoich, Loan.....	1·27	...	*Arm* .	Armagh Obsy	1·96	80
,, .	Glenquoich	2·63	30	*Down* .	Fofanny Reservoir	5·13	...
,, .	Inverness, Culduthel R.	1·20	...	,, .	Seaforde	3·87	141
,, .	Arisaig, Faire-na-Squir	1·32	...	,, .	Donaghadee, C. Stn....	2·32	97
,, .	Fort William.....	1·58	...	,, .	Banbridge, Milltown...	2·07	...
,, .	Skye, Dunvegan.....	1·80	...	*Antr* .	Belfast, Cavehill Rd...	2·93	...
R & C.	Alness, Ardross Cas....	1·50	...	,, .	Glenarm Castle.....	2·15	...
,, .	Ullapool	1·15	31	,, .	Ballymena, Harryville	2·30	74
,, .	Torridon, Bendamph...	...	...	*Lon* .	Londonderry, Creggan	3·27	99
,, .	Achnashellach	1·57	..	*Tyr* .	Omagh, Edenfel.....	1·87	61
,, .	Stornoway	1·66	...	*D.n* .	Malin Head.....	3·01	...
Suth .	Lairg.....	1·03	59	,, .	Dunfanaghy.....	2·69	...
,, .	Tongue	1·78	56	,, .	Killybegs. Rockmount .	3.11	68

Climatological Table for the British Empire, April, 1931.

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F	°F.	%	0—10	in.	in.			
London, Kew Obsy. ..	1011·8	— 2·6	62	33	52·1	40·6	46·3	— 1·0	42·1	84	7·9	3·66	+ 2·21	16	3·8	27
Gibraltar.....	1013·8	— 2·7	78	47	69·3	53·2	61·3	+ 0·3	53·3	85	4·3	5·48	+ 2·80	11	..	..
Malta	1012·9	— 0·5	73	47	64·3	54·9	59·6	— 1·3	55·4	78	5·6	0·09	— 0·77	4	8·3	63
St. Helena	1014·2	+ 0·9	71	58	67·9	60·6	64·3	— 1·0	61·9	93	9·3	4·37	..	26	..	..
Sierra Leone	1009·2	— 1·6	94	70	89·3	73·9	81·6	— 0·8	76·9	75	5·2	1·94	— 2·12	5	..	..
Lagos, Nigeria	1009·8	0·0	92	71	88·9	77·5	83·2	+ 0·7	78·8	80	8·5	7·16	+ 1·41	14	..	..
Kaduna, Nigeria	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zomba, Nyasaland ..	1012·5	0·0	82	54	76·4	62·9	69·7	+ 0·4	..	77	6·2	6·16	+ 2·50	11	..	..
Salisbury, Rhodesia ..	1012·6	+ 0·1	86	45	77·6	55·9	66·7	+ 1·0	58·3	65	4·0	0·52	— 0·47	4	8·3	71
Cape Town.....	1018·5	+ 2·1	84	44	70·0	53·9	61·9	— 1·3	54·6	83	5·2	3·83	+ 1·96	11	..	..
Johannesburg	1017·6	+ 0·3	78	34	67·4	49·2	58·3	— 1·7	50·3	69	3·3	3·92	+ 2·18	11	8·3	72
Mauritius	1015·6	+ 1·6	85	66	82·4	71·2	76·8	+ 1·0	73·4	77	5·4	7·15	+ 2·68	15	6·8	59
Calcutta, Alipore Obsy.	1006·1	— 0·2	103	68	97·2	78·6	87·9	+ 2·3	78·5	81	4·2	1·08	— 1·10	1*	..	..
Bombay	1008·7	— 0·1	94	73	91·1	78·0	84·5	+ 1·4	77·1	75	1·7	0·01	— 0·04	0*	..	..
Madras	1008·4	0·0	98	74	92·7	78·6	85·7	+ 0·4	78·7	75	5·1	1·51	+ 0·88	2*	..	..
Colombo, Ceylon	1009·9	+ 1·2	91	73	88·6	75·8	82·2	— 0·5	78·6	78	7·5	9·40	— 0·33	22	7·7	63
Singapore	1009·4	+ 0·5	94	72	89·0	75·7	82·3	+ 0·6	78·6	80	6·2	6·80	— 0·84	19	6·0	49
Hongkong	1012·5	— 0·1	86	59	75·0	67·8	71·4	+ 0·6	68·7	87	9·3	8·93	+ 3·62	15	2·6	21
Sandakan	..	..	92	74	89·8	76·0	82·9	+ 0·7	78·0	79	..	1·90	— 2·59	4	..	..
Sydney, N.S.W.	1018·7	+ 0·3	81	49	70·4	58·4	64·4	— 0·3	60·1	81	6·6	7·24	+ 1·72	18	5·4	48
Melbourne	1020·9	+ 1·4	77	43	65·7	48·2	56·9	— 2·6	52·7	81	6·3	2·82	+ 0·65	11	5·6	50
Adelaide	1020·6	+ 0·7	91	47	73·5	52·6	63·1	— 0·8	54·7	51	4·4	0·90	— 0·83	11	7·6	68
Perth, W. Australia ..	1017·2	— 1·2	89	42	74·4	57·1	65·7	— 1·1	59·0	65	5·0	3·96	+ 2·31	10	7·2	64
Coolgardie	1017·5	— 1·1	93	42	76·1	52·5	64·3	— 0·7	55·4	59	4·5	0·48	— 0·48	7	..	..
Brisbane	1016·5	— 1·1	90	56	78·5	60·9	69·7	— 0·6	63·6	69	4·1	3·61	+ 0·07	8	7·7	67
Hobart, Tasmania....	1019·8	+ 5·0	72	38	61·4	47·1	54·3	— 0·9	49·4	75	5·8	1·80	— 0·05	10	5·2	48
Wellington, N.Z.	1018·7	+ 0·6	66	41	59·4	50·0	54·7	— 2·4	52·0	79	7·5	5·59	+ 1·71	14	5·0	45
Suva, Fiji	1011·4	+ 0·8	89	72	84·7	74·7	79·7	+ 1·1	76·1	83	6·7	8·33	— 3·88	21	6·1	52
Apia, Samoa	1010·0	+ 0·1	89	72	86·3	74·1	80·2	+ 1·3	77·5	77	5·1	15·94	+ 5·79	13	6·8	58
Kingston, Jamaica ..	1012·2	— 1·9	91	70	88·2	73·2	80·7	+ 2·3	72·1	79	3·4	0·85	— 0·39	6	5·7	46
Grenada, W.I.	1013·6	+ 1·1	92	71	87·7	73·8	80·7	+ 1·8	73·7	75	3·9	2·49	+ 0·33	15	..	..
Toronto	1016·4	+ 0·3	78	28	53·5	36·1	44·8	+ 2·7	38·3	64	4·7	1·90	— 0·39	8	6·6	49
Winnipeg	1017·0	+ 0·3	75	11	52·4	31·0	41·7	+ 4·0	..	..	4·1	0·34	— 1·06	5	..	..
St. John, N.B.	1014·6	+ 1·2	65	26	49·6	34·6	42·1	+ 3·1	37·5	69	5·7	3·89	+ 0·38	12	5·4	40
Victoria, B.C.	1017·6	+ 0·1	75	37	58·3	44·4	51·3	+ 3·4	46·7	70	4·4	1·11	— 0·41	12	7·8	57

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