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The Meteorological Office Library and Museum

The centenary meeting of the British Association will bring to South Kensington scientists from all parts of the Empire, and on September 25th a party will visit the adjacent building of the Meteorological Office. The occasion seems to be opportune for a brief description of our library and museum, with references to some of the exhibits of historic interest.

The Meteorological Office was first constituted in 1855 as the "Meteorological Department of the Board of Trade" under the leadership of Admiral Fitzroy. In the early reports of the new Office no mention is made of the formation of a library, but no doubt a number of publications were received in exchange for the series of *Meteorological Papers of the Board of Trade* which began in 1857, and some of the earliest volumes in our library bear the stamp "Board of Trade, Meteorological Department." Thus the library of the Meteorological Office may be said to have been founded soon after 1855. The three-quarters of a century which has elapsed since that date covers almost the whole history of the development of meteorology as a separate science, and thanks to this early beginning our library is one of the most representative in the world.

In 1867 the control of the Meteorological Office was transferred to a Meteorological Committee appointed by the Royal Society, and the estimates for the following year contain for

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the first time provision for the purchase of books. In 1871 we find the first mention of a librarian, Mr. J. S. Harding, Junr. The number of books grew rapidly, but the arrangements for housing them were crude, until the erection of the new Meteorological Office building at South Kensington, which was completed in 1910, gave an opportunity for the provision of more adequate accommodation. The library now includes upwards of 25,000 volumes, apart from reprints and pamphlets. Two manuscript catalogues are maintained, author and subject, and in addition there is a comprehensive index, arranged geographically, to the literature of local climatology and a less complete index of upper air data. A classified list of meteorological literature is issued monthly, and forms the basis of the semi-annual *Bibliography of Meteorological Literature* published by the Royal Meteorological Society.

In addition to the library, space is provided for a small museum, permitting the display of books, diagrams and instruments of historic or scientific interest. Among the books exhibited may be mentioned part 3 of Dampier's "Voyages and Descriptions," entitled "A discourse of trade winds, breezes, storms, seasons of the year, tides and currents of the torrid zone throughout the world . . ." (London, 1700); "The general history of the air, designed and begun by the Hon. Robert Boyle" (London, 1692); "The storm," by Daniel Defoe (First edition, London, 1704); and a treatise on barometers, thermometers and hygrometers, published at Amsterdam in 1688. There is also a reproduction of the earliest known (British) journal of the weather, kept by the Rev. W. Merle from 1337 to 1344. Other exhibits include a selection illustrating the history of the *Daily Weather Report* from 1851 to date, and weather logs kept on board H.M.S. *Beagle* in 1843. Some of the instruments of historic interest are described below.

Some Instruments of Historic Interest exhibited at the Meteorological Office, London

By J. E. Belasco, B.Sc.

The 17th and 19th centuries are landmarks in the history of the science of meteorology. The 17th century saw the invention of the barometer, thermometer, hygrometer, anemometer and the earliest scientific rain-gauge. In the 19th century regular meteorological services were established in England and other countries, the first synoptic chart was produced and the first *Daily Weather Report* issued. The *Daily Weather Report* needs, as one of the foundations for its success, accurate instruments, easy to manipulate so that reliable observations can be obtained rapidly. The period between the experiment of Torri-

celli in 1643 and the publication of the first *Daily Weather Report* in 1851—a period which included the first explorations of the upper atmosphere—was marked by the appearance and improvement of a large number of instruments of ever-increasing accuracy. True it is that many of these instruments are crude and cumbersome in comparison with those we use to-day, but none the less as pioneers they are worthy of our regard and respect. Some of these in use about the middle of the 19th century have been preserved and are exhibited at the Meteorological Office, South Kensington. It is thought that it might be of some interest to our readers to bring them to their notice. Short descriptive notes, indicating the method of working, are added for the benefit of those who might wish to see the instruments.

Sunshine Recorders.—There are two main methods by which the duration of sunshine has been recorded in this country, photographically or by concentrating the sun's rays so that it scorches or chars a piece of cardboard or wood. In both cases the effect travels along by virtue of the earth's rotation, thus leaving a record of the duration of the sunshine.

The first burning type was invented by John Campbell in 1853. The instrument consisted of a hemispherical bowl of wood in the middle of which rested a spherical water or glass lens whose centre was coincident with that of the bowl. The sun's rays, focussed by the lens, burnt into the wood, the position of the burn altering from day to day with the changing declination of the sun. In this manner it was possible to obtain, between one period and another, a rough comparison of the duration and intensity of the sunshine. Later a better comparison than that made by mere inspection was obtained by rubbing wax into the grooves. The wax was then weighed after melting. Two such bowls used at Kew during the periods from December 21st, 1885, to June 21st, 1886, and from June 21st to December 21st, 1889, as well as an unused one, are exhibited.

In 1879 Stokes placed the glass lens upon a pedestal and substituted for the wooden bowl a zodiacal frame containing slots into which a strip of cardboard was placed daily to receive the focussed rays of the sun. An example of one such frame used at Dublin University from 1879 to 1914 is shown. In this instrument there is no adjustment for latitude. Such an adjustment was introduced in 1901 by Curtis, and there is a model illustrating this improvement.

When the solid glass spherical lens is exposed near the coast in sandy districts it is sometimes so pitted by sand blown about by the wind that it entirely loses its transparency and looks like ground glass. An example of a sphere exposed at Spurn Head so transformed is shown.

Hygrometers.—The humidity of the air can be determined in

various ways, and those instruments which determine it without any assumption as to the properties of materials or the laws of evaporation from wet surfaces are called " absolute " hygrometers. Such hygrometers as those named after Daniell, Dines and Alluard are well-known examples by means of which the dew point can be determined. Examples of these are exhibited.

As early as 1696 Fontana determined the increase in weight of a glass of cold water resulting from the condensation of vapour on the outside, and Soldner in 1809 noted the temperature at which dew appeared. It was in 1819 that Daniell designed his hygrometer, and this is the first instrument of its kind which can lay claim to precision. It consists, as the specimen shows, of a glass tube bent twice with a bulb at each end. One bulb is blackened and partly filled with ether, and in the limb above it is a thermometer. The other bulb is covered with muslin and is filled with ether vapour. The tube rests upon a support to which is attached a thermometer. To use the instrument a little ether is poured on the muslin until a ring of dew is formed on the black bulb, when both thermometers are quickly read. These give respectively the temperature of the air and the dew point. It was from observations of the dew point by this instrument compared with the dry and wet bulbs that James Glaisher produced his table of factors for obtaining the dew point from the readings of the wet and dry bulb thermometers and so obtained his tables of relative humidity.

G. Dines produced his hygrometer in 1871. In this instrument the dew point is determined by noting the temperature at which dew is deposited on a sheet of glass. Three specimens are shown. In two of these the sheet of glass is horizontal, in the third it is vertical. Ice-cold water is poured into the cistern, whence it flows under a thermometer to a small chamber covered by a thin black glass plate and in which rests the bulb of the thermometer. The temperature of the glass plate is lowered as the water flows out at the extremity of the hygrometer, and when lowered to the dew point a film of moisture forms on it. The temperature as indicated by the thermometer at this instant is the dew point.

Alluard's hygrometer is a modification of that used by Regnault and was brought out in 1877. A brass box containing ether is fitted with tubes to allow the passage of air through the ether. The front of the box is gilt and highly polished, and it is upon this surface that the dew is deposited.

An interesting form of psychrometer, not of great scientific value and now obsolete, is the one exhibited and made by West. It is a combination of Six's thermometer, used as the dry bulb, with a mercurial wet bulb attached. This instrument is therefore a combination of four instruments, namely, maximum,

minimum and true temperature thermometers and a hygrometer of the evaporation type.

Evaporimeters.—These instruments attempt to deal with the difficult problem of the loss of water by evaporation. The Lamont evaporimeter exhibited was designed in 1868 and in essence consists of a curved pan from the middle of which is a narrow pipe leading to a vertical cylindrical reservoir containing a close fitting piston, the position of which is adjustable by means of a screw and its height determined by a scale. The piston is screwed up so as to allow the water in the evaporation pan to run into the reservoir leaving the connecting tube full so that the water just makes the curved surface of the bottom of the pan continuous. The scale is then read and the water driven by the piston to within a little of the top of the pan and evaporation allowed to proceed. The piston is then raised so that the water sinks once more from the pan to the same point as before and the scale read. The difference of readings in scale divisions gives the depth of water evaporated.

Another form of evaporimeter exhibited is De La Rue's atmidometer produced in 1879. Here water evaporates from a surface of wet parchment paper stretched over a shallow drum full of water. The water is supplied from a reservoir giving about 6 inches head. The reservoir is connected by a long narrow metal tube to a graduated glass cylinder about 6 inches high. This cylinder is filled with water and the tube which leads from it and which dips into the reservoir is perforated laterally. Hence, when by reason of evaporation, the lateral opening is exposed to the air, water flows from the glass cylinder to the reservoir so that a constant level of water is maintained in the reservoir and the amount of water evaporated is therefore indicated by the graduations in hundredths of an inch on the glass cylinder. Both the Lamont and De La Rue evaporimeters are now obsolete.

Sympiesometer.—This form of barometer was mainly used in the early half of the 19th century to obtain more satisfactory observations of pressure at sea. Its use became obsolete upon the adoption of the Kew barometer after 1856. In the sympiesometer the atmospheric pressure is balanced partly by a liquid and partly by air enclosed above this liquid. Since the indications of the instrument depend upon the temperature as well as the pressure of the air, it is also an air thermometer and is thus often called a thermo-barograph. In the log of H.M.S. *Beagle* (1843), which carried Darwin, observations with the sympiesometer are recorded three times a day.

A sympiesometer, invented by Runketti in 1839, is exhibited. This instrument consists of a U-tube, the shorter arm of which has two bulbs, one above the other, while the longer arm is closed by a screw cap. Enclosed in the sealed upper bulb is

the bulb of a thermometer, the lower bulb being filled with mercury which rises to a considerable height in the longer arm. A tap, below the lower bulb, enables one arm to be shut off from the other. On one side of the longer arm is fixed a graduated scale similar to the scale of the thermometer, and on the other side is mounted an adjustable barometer scale in which a vernier with a pointer slides. To take a reading the arrow on the barometer scale is set opposite the same scale reading as that registered by the thermometer and the height at which the mercury stands is read off on the barometer scale and vernier after bringing the pointer to the top of the mercury column.

There is also to be seen a sympiesometer on similar lines by Cox; the closed bulb at the top of the tube probably contained hydrogen, the tube itself being filled with oil or sulphuric acid. The readings obtained were set on the revolving scale at the bottom of the instrument.

Aneroids.—Very early in the history of the aneroid barometer —it was introduced by Vidie in 1843—is the metallic barometer of Bourdon which can be seen. It was invented in 1851 and consists of a thin elastic metal tube exhausted of air. The tube is bent and the ends approach or recede from each other according as the pressure increases or decreases. The motion, by suitable gearing, is communicated to a central shaft which carries an index hand moving over a dial graduated in inches. Another form of aneroid exhibited is that by Dent, introduced in 1848. Like the Vidie aneroid it consists of a shallow capsule of thin metal almost exhausted of air, the amount of air left over being used to make automatic corrections for temperature.

Barograph.—The Redier barograph exhibited is a modification by Redier in 1875 of Regnard's barometrograph of 1857. It provides a continuous record of a syphon barometer by the differential action originating from a clock, the motive force of the mercury being too small to overcome the friction of the pen on the paper.

Storm Glass.—Mention must be made of this instrument which Admiral Fitzroy attached to his barometer. It consists of a glass tube filled, it is thought, with crystals of potassium nitrate and ammonium chloride in an alcoholic solution of camphor and distilled water. Air fills the upper part of the tube. It was claimed that in stormy weather the liquid became turbid while in fine weather the liquid was clear, the crystals remaining at the bottom of the tube. Opinions differ as to the cause of these changes in the appearance of the liquid. Admiral Fitzroy regarded the changes as dependent upon the direction of the wind, Tomlinson as due to changes of light and heat. In this connexion the opinion of Faraday is of interest at this juncture. In a letter to Fitzroy in 1861, a photograph of which is exhibited, Faraday says that he regarded the instru-

ment as an old friend for it used to absorb much of his attention when he was younger. He was not quite sure of the materials used to make up the instrument, but he thought it contained alcohol, water, carbonate of potassium and hydrochlorate of ammonium. As far as he knew the changes were the effect of changes of temperature taking place with more or less rapidity, the time being important in relation to the appearance of the crystals.

Portable Anemometers.—A form of anemometer for ascertaining the strength of the wind invented by Lind in 1775 is exhibited and consists of a U-tube one end of which is closed, the other open and facing the direction of the wind. The pressure of the air is measured in terms of the altitude of a column of water at any desired instant. In other forms of Lind's anemometer both limbs were open, but a partition separated them at the top so that one mouth was protected from the wind. A modification of Lind's anemometer by Sir Snow Harris in 1858 is shown. It consists of a long bent glass tube closed at one end, the other end terminating in a bulb open to the air. The upper portion of the tube is provided with a scale. Coloured liquid is poured into the bulb until it reaches the zero of the scale. When the instrument is levelled the tube is turned so that the bulb faces the wind. The portion of the liquid column along the scale indicates the pressure and velocity of the wind, while the direction of the wind is obtained from the compass at the base of the instrument. Another modification of Lind's anemometer by Sir Snow Harris is also exhibited. Here the mouth of the limb which receives the wind has a movable cup closed at one end so that on inserting it the tube can be closed in order to record any desired gust.

The Hagemann Hand anemometer exhibited is a modification by Ellery in 1881 of Hagemann's original instrument. It consists of a U-tube mounted on a wooden frame. Alongside both limbs of the tube is a graduated scale. The shorter limb has a funnel-shaped opening and faces the direction of the wind. The longer limb is also open to the air. The difference of level of the liquid in the two limbs gives the pressure of the wind.

The *Munro Air Meter* is an early forerunner of the modern vane air meter. The specimen exhibited shows that it consists of a vane of thin aluminium of helicoid shape which is revolved by the wind. A train of wheels and a dial record the number of revolutions made in any desired interval of time.

The Rainfall of the Past Summer

The series of violent gales and rainstorms which characterised the month of August, 1931, completed one of the wettest summers experienced in England and Wales since comparable

records began. Further, when allowance is made for the usual seasonal variation by expressing the amounts as percentages of the normal for the 35 years 1881-1915, the period April to August, 1931, stands out as one of the wettest series of five consecutive months known. The comparative figures are as follows, those for earlier years being extracted from a table by Dr. J. Glasspoole*; 1927 is from the *Meteorological Magazine*:—

WET PERIODS OF 5 MONTHS, PERCENTAGE OF NORMAL.

	England and Wales	Scotland	Ireland	British Isles
1931 Apr. to Aug. ...	153	128	130	141
1927 June to Oct. ...	151	145	125	142
1924 May to Sept. ...	149	141	150	147
1911 Nov. to 1912 Mar. ...	151	121	134	139
1903 June to Oct. ...	156	144	139	150
1891 Aug. to Dec. ...	139	126	129	133
1876 Sept. to 1877 Jan. ...	157	134	168	152
1872 Sept. to 1873 Jan. ...	152	146	160	152

The percentages of normal month by month during 1931 are shown below:—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
England and Wales ...	103	124	36	173	150	148	153	143
Scotland ...	128	118	42	106	145	193	136	61
Ireland ...	88	104	101	111	162	174	121	81
British Isles	107	118	51	143	151	165	142	104

The weather of August in England and Wales was characterised by an extraordinary series of violent storms, hardly a day from the 3rd to the 20th inclusive passing without a "note worthy" fall. The following list shows the more outstanding records.

Aug. 3rd.—A violent thunderstorm occurred in London and south-east England shortly before midnight, 0·75in. of rain being recorded at Clacton between 5 p.m. on the 3rd and 9 p.m. on the 4th.

Aug. 4th.—Storms in Gloucestershire, Wiltshire and Oxfordshire. The heaviest totals recorded by the Press were 5·10in. at Wylye, 4·49in. at Steeple Langford, and 4·44in. at Salisbury, all in Wiltshire. Records communicated to the Meteorological Office include 3·03in. at Nailsworth (Glos.), and 1·89in. at Magdalen College, Oxford.

On the night of the 4th 1·14in. fell at Cleethorpes, Lincs., between 5 p.m. and 9 a.m., with a further 0·47in. during the following day.

Aug. 5th.—Storms in south-east England and in Cornwall. London was again affected, more than 1in. being recorded on the Air Ministry roof in 30 minutes. Other totals were 2·90in. at Petersfield (in less than an hour); 2·39in. at Heathfield, Barklye, Sussex; 2·05in. at Surbiton, 1·67in. at Bury St. Edmunds and 2·21in. at the Royal Observatory, Greenwich. At Kew Observatory an inch fell in 33 minutes and at Mostyn Road, Merton Park, 0·88in. in 25 minutes. At Launceston in Cornwall, Mr. R. B. Rogers recorded 2·05in. between noon and 5.30 p.m., including

* *London, Q.J.R. Meteor. Soc.*, 52, 1926, *p.* 367.

0·98in. in less than 25 minutes, while there had been a further fall of 0·85in. on the preceding night.

Aug. 7th.—2·00in. fell at Penrhyn Quarries, Carnarvon.

Aug. 8th.—Violent storm and severe floods at Boston. Mr. F. H. Tomes, A.M.Inst.C.E., writes that at Black Sluice, at the south end end of the borough of Boston, 6·10in. fell between 10 a.m. on the 8th and 1 a.m. on the 9th. The time between 10 a.m. and 1.45 p.m. accounted for 4·96in. The total between 6 a.m. on the 8th and 1 a.m. on the 9th was 6·55in. At Grand Sluice, the north end of the borough, the amount measured at 9 a.m. was 5·72in. Other falls in the 24 hours were :—

Bourne, 21 miles south-west of Boston	... ...	1·24in.
Bardney, 22 miles north-west of Boston	... ...	1·33in.
Lade Bank Engine. 8 miles north of Boston	...	2·01in.

Mr. Tomes continues : " The point of maximum rainfall appears to have been immediately south of Boston and the worst flooding occurred in the borough and the parishes of Skirbeck Quarter, Wyberton, Frampton and Kirton. Unfortunately I have no records for these latter areas."

It was unfortunate that the heaviest rain came at the time of high water. As the land is below sea-level the sewer outlets were closed and in one part, the streets were flooded to a depth of four feet. On the same day 3·63in. fell in 24 hours at Sheringham, Norfolk. The storm was associated with the rapid passage of a deep depression directly across England from the Bristol Channel to East Anglia.

Aug. 14th.—London was again visited by a severe thunderstorm. The records so far available include : 2·34in. at Worcester Park, 2·15in. at Streatham, 1·72in. at Catford, 1·17in. at the Royal Observatory, Greenwich, and 1·12in. at Kew Observatory. Flooding occurred in the London district. Falls exceeding an inch were also recorded at places in the west Midlands, and a short storm at Eastbourne gave 0·74in. in 20 minutes.

Aug. 17th.—A heavy fall at South Shields gave a total of 2·38in. in 24 hours, of which 1·95in. fell in 2 hours 20 minutes between 11.45 a.m. and 2.5 p.m.

Aug. 19th.—Lt.-Col. the Lord Wynford, D.S.O., recorded 2·28in. at Maiden Newton, Dorchester, between 2 and 4.30 a.m. on the 19th. The greater part fell between 3.45 and 4.30 a.m. At Ipplepin Vicarage, Devon, 1·93in. fell in the 24 hours ending at 9 a.m. on the 19th, and at Torquay 1·77in. fell between 5 p.m. on the 18th and 9 a.m. on the 19th. Later on the 19th falls of more than an inch occurred at many points along the south coast, including the Channel Islands. There was also a severe thunderstorm in Lancashire, and a total of 1·42in. was recorded at Leuchars, in Fife.

Aug. 20th.—Heavy rains fell in south and central Scotland, the record at Inchkeith being 1·38in. Heavy rains also fell in the Midlands of England, while a small whirlwind of unusual force passed over Chislehurst and Foot's Cray, doing some damage.

Aug. 24th.—Heavy rains fell in the Channel Islands. At St. Peter Port, Guernsey, the fall between 7 a.m. on the 24th and 7 a.m. on the 25th amounted to 2·72in., and at Jersey from 10 a.m. on the 24th to 10 a.m. on the 25th to 3·23in. In Jersey in the 40 hours from 6 p.m. on the 23rd to 10 a.m. on the 25th the total amount was no less than 4·53in.

In striking contrast to the heavy rains in the south of England, northern Scotland enjoyed the finest weather. The total rainfall of the whole of August at Lerwick, in the Shetland Isles, was only 0·25in. By the end of the month, the rivers and streams in the western Highlands were unusually low.

OFFICIAL NOTICE

Discussions at the Meteorological Office

The series of meetings for the discussion of recent contributions to meteorological literature, especially in foreign and colonial journals, will be resumed at the Meteorological Office, South Kensington, during the session 1931-2. The meetings will be held on alternate Mondays at 5 p.m., beginning on Monday, October 19th, 1931, when Dr. G. C. Simpson, C.B., F.R.S., will open the discussion.

The dates for subsequent meetings are as follows:—

November 2nd, 16th and 30th; December 14th, 1931; January 18th; February 1st, 15th and 29th; and March 14th, 1932.

The Director of the Meteorological Office wishes it to be known that visitors are welcomed at these meetings.

OFFICIAL PUBLICATION

The following publication has recently been issued:—

Annual Report *of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the year ended March 31, 1931.*

The work of the Meteorological Office during the year has shown a steady increase resulting from the greater use of meteorology which is made in many different spheres. The Office was especially occupied in carrying into effect the decisions made at three important conferences held in 1929, namely, the International Conference on Safety of Life at Sea, the Conference of Empire Meteorologists and the International Conference of Directors of Meteorological Services.

These have involved certain changes in the collection of meteorological data both from land stations and from ships at sea. Owing chiefly to the growing requirements of aviation, the system by which each country broadcast data for its own stations tended to become unworkable because of interference, and arrangements have been made for the issue of grouped reports from powerful stations by the Meteorological Offices of France, Germany, Great Britain, Russia and the United States. The changes in the collection of reports from ships at sea are less fundamental because the conferences accepted in the main the practices which had already been developed by the British Meteorological Office.

During the summer of 1930 the organisation for the supply of meteorological information to airships was brought into action during the successful flight of R.100 to Canada and back, but on October 5th, the Office suffered a great loss in the death of Mr. M. A. Giblett, Superintendent of the Airship Services Division, in the disaster to the R.101 on the flight to India.

An important investigation into the strucure of wind, on which Mr. Giblett was engaged prior to these flights, was completed by his colleagues during the year.

Correspondence

To the Editor, *The Meteorological Magazine.*

Infra-lateral Arc of Contact

I was fortunate enough to observe on August 28th last the somewhat rare infra-lateral arc of contact to the solar halo of 22°. The halo was present nearly all day, and the arc appeared at 8h. 4m. for a few minutes and reappeared a little while after. It was a brilliant white, the intensity being about the same as that of the halo itself.

S. E. ASHMORE.

Windwhistle Cottage, Grayshott, Hindhead, Surrey. September 2nd, 1931.

Alto-cumulus Castellatus and Mammato-cumulus Clouds

I am much interested to read Capt. Douglas's notes on the turret cloud, and also Mr. Pick's letter on the subject of mammato-cumulus. It struck me with regard to the latter that Mr. Humphrey's remarks apply to England also more than Mr. Pick suggested, because there are three distinct types of mammato-cumulus—

1. That associated with stratified cumulus.
2. The mammillated appearance immediately behind the edge in a trough-squall cloud and a northerly shower cloud.
3. Mammato-cumulus proper; the festooned under-side of a hybrid cirrus sheet. It seems likely that it is only this last that Mr. Humphreys referred to, and it must be admitted that generally only those cumulo-nimbus clouds which are sufficiently developed to produce slight thunder assume this form, though I have never seen it with a severe thunderstorm.

With regard to Capt. Douglas's observations of turret-cloud, I am surprised at the great preponderance of the south-west upper current. In most cases I have observed, the south-west upper current generally backs to south or to south-south-east before the actual occurrence of the storm, and practically all the severe turret-cloud storms I have noticed, such as those of May and July, 1925, have come with an upper current well in the south-east quadrant, and on three occasions the turret-clouds finally appeared moving from a point north of east.

Would it not be a good thing to designate the turret-cloud cumulo-nimbus, alto-cumulo-nimbus, as the behaviour and structure of the cloud both differ substantially from that of the ordinary cumulo-nimbus?

P. PETROCOKINO.

Jack Straw's Castle, Hampstead. July 11th, 1931.

Funnel-Cloud near Newquay, Cornwall

On August 22nd, 1931, at 13h. 45m. G.M.T. while attending motor-cycle races in a field 1·3 miles east of Newquay with the surface wind NW., force 3, we observed, to the south, a "funnel-cloud" projecting from the lower horizontal edge of a large dark cumulo-nimbus cloud. There was a sky line about a mile to the south, so that it was difficult to estimate the distance and position; but we judged it to be over somewhere near Summercourt to Newlyn Downs about four miles away. The cloud was drifting slowly from the left or east and rain was falling from it to the right or south-south-west. The sky was clear of heavy cloud from about east-south-east through north to south-west and in the zenith.

The conical funnel had mostly well-defined edges; the lower portion was roughly cylindrical and crooked and indistinct and hardly joined to the conical part and lasted only about a minute. The conical part lasted for 8 minutes from time of being first observed, and moved slowly, with the cloud, to the right.

C. C. Vigurs.
John T. C. Vigurs.

St. Michael's House, Newquay. August 26th, 1931.

"Cold-front" Cloud

At about 4 p.m. on Wednesday, August 5th, 1931, I was flying towards Calais along the coast from Ostend and encountered a thunderstorm over the town. After an unsuccessful attempt to fly round it inland to the aerodrome at St. Inglevert, I returned to the eastern side of the town and commenced the Channel crossing.

I then observed that a small, detached, white cloud which I had seen about 10 or 15 minutes before floating low down over the water had apparently grown out across the Channel until, within the time stated, it was many miles in length and joined a narrow promontory of white cloud, not more than a hundred feet or so wide, lying within a few feet of the water and receiving frequent lightning discharges from above. I was flying from Calais on a true bearing of 311° and my course was parallel to and about half a mile east of this cloud, which I watched with considerable interest, feeling that it would be highly dangerous to cross over it.

After flying about eight miles out to sea I encountered rain and deemed it desirable to turn back and land at Ostend, which I did. The top of the cloud was similar in appearance to that of any harmless cumulus cloud. The under side was striated, as though rain were falling from it.

I regret that owing to lack of experience in these matters I

cannot give a more accurate account of what I regarded as a very curious meteorological phenomenon.

R. P. J. DENMAN.

Kester, Kemsing, Kent. August 7th, 1931.

When forwarding the above letter from Mr. Denman, Mr. R. A. Watson remarks that:—

"It appears probable that Mr. Denman was flying along a 'cold front' in which the cold air above had over-run the cold air below, such as that described by Sutcliffe.* Probably the line of cumulo-nimbus above was the ordinary line-squall cloud, but below this a tongue of warm air protruded into the cold wedge forming another line-squall cloud immediately beneath. The point which impressed Mr. Denman was the extraordinary speed with which the lower "promontory" of cloud rushed out to sea . . . It is apparent, however, that an unstable shape might be propagated along a cold front (with all its attendant phenomena) at a speed far exceeding any which we ordinarily observe in meteorological elements."

The Splashing of Rain

Referring to Colonel Gold's interesting article on the splashing of rain in your August number, some data regarding the height to which water drops may splash was recently obtained by noting dirt marks on the glass side of a verandah. A leak in the roof permitted drops to fall through the verandah in one spot on to the ground below, which consisted of loose earth. A puddle formed here. Splashes of dirty water from this puddle left marks on the glass side of the verandah about a foot away. The highest mark was 2ft. 8in. above the floor and marks at 2ft. 6in. were fairly numerous. The dried splash marks consisted of crescents of dirt, not mere points; the splashes had, therefore, been of considerable size. At the time when the observation was made no rain was falling, so that the size of the falling drops which gave rise to the splashing could not be determined, but there can be little doubt that they would be fairly large drops. The distance through which they fell from the verandah roof was about 9 feet.

J. S. DINES.

Frost in August

The unusual occurrence of a screen minimum of 32°F. during August was recorded here at 6h. on August 26th. Thermometers exposed one inch and two feet above short grass fell to 26°F. and 30°F. respectively.

Heavy hoar-frost had developed by 22h. on the 25th, and at 6h. on the 26th the whole countryside was white. Ice about 1 mm. thick formed on shallow pools in the neighbourhood.

*London, Meteorological Office, Professional Notes, No. 62.

Valley mist from 22h. to 24h. on the 25th was followed by moderate fog until 6h.

E. L. HAWKE.

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

May and September Maximum Temperatures

On setting down the mean maximum temperatures at Kew for May and September for each of the three twenty-year periods from 1871 to 1930, as is done in the accompanying table, a curious result becomes apparent:—

Period	Mean Maximum Temperature May	September
1871-1890	61·1°F.	64·3°F.
1891-1910	61·4°F.	65·0°F.
1911-1930	63·7°F.	65·2°F.

The result is that there appears to have been a progressive rise in the temperature of each of the two months considered. It would be interesting to know whether this increase can be supported by other evidence and whether it is to be regarded as a real climatic fact.

WILLIAM H. PICK.

33, *Brunswick Square, London, W.C.*1. *August 5th*, 1931.

[The increase in the mean maximum temperatures of May and September is presumably connected with the increase in the average daily temperature of the winter half-year, which has been traced over a wide area in Europe*, reaching a maximum in Hungary. Examination of average curves of temperature at Kew for 1871-1900 and 1901-1929† shows that the second period was markedly warmer than the first in January, February, March, May, October and December, slightly warmer in July and September, and about the same in the other months.

It is open to discussion for how long a change of this nature must continue before it can be regarded as a real change of climate instead of a temporary fluctuation, but one would hesitate to say that the change pointed out by Mr. Pick has reached the former status as yet.—ED., *M.M.*]

NOTES AND QUERIES

Transparent Hail

Although hail showers are frequently observed in air currents of polar origin the occurrence of transparent hail is much less common, and the occasion of a rain and hail shower at Holyhead at 14h. G.M.T. on April 1st, 1931, is worthy of note.

The observations below were made by Mr. H. L. Pace. He states that the hail pellets were small and of no definite shape

* *Meteorological Magazine*, 57, 1922, *p.* 203.

† *London, Q.J.R. Meteor. Soc.*, 56, 1930, *p.* 377.

and melted a few seconds after reaching the ground. The sky was covered with stratus and alto-stratus clouds, the base of the stratus cloud being estimated at 4,000 to 5,000 feet. No cumulo-nimbus or similar cloud was observed. Measurements obtained during a pilot balloon ascent at 12h. G.M.T. gave a surface wind E. by S., 23 m.p.h., which veered to S. by E., 45 m.p.h. at 5,000 feet. Vertical velocities obtained by the tail method amounted to 160 ft./min. upwards in the 7th minute (3,000 to 3,500 feet) and to 180 ft./min. downwards in the succeeding minute, while at lower levels the vertical velocities were less than half these values. At the time of the hail shower the surface temperature was 45°F. and the relative humidity 50 per cent.

In attempting to provide an explanation of the formation of the transparent hail one cannot use any direct measurement of upper air temperatures. At Duxford on the morning of April 1st the air mass, at least in the lower levels, was quite different in origin from that at Holyhead. If, however, one assumes a temperature lapse rate at Holyhead of 3°F. per 1,000 feet, this would give a temperature of 33°F. at 4,000 feet or approximately freezing point at or near the cloud base. The lowest layers of the cloud would then form the supercooled region. The transparent nature of the hail and the small size of the pellets indicate the formation of drops in the supercooled region and a relatively short distance of fall in the cloud. For a drop of diameter 1mm. a vertical velocity of 196 ft./min. would be sufficient to keep the drop stationary, and this velocity is of the order measured just below the cloud.

The drops could have been formed only a short distance above the cloud base, and in falling would not increase in size very much. If locally the vertical currents were strong the drops would acquire various ellipsoidal shapes and solidify in these forms. Further, if the vertical currents did not extend into the region of snow in the cloud the drops observed would remain quite clear.

Such a scheme could account for the small size, irregular shapes and the clearness of the hail stones observed.

R. S. READ.

Mammato-cumulus at Amesbury, Wilts.

Very well-developed mammato-cumulus was observed at 18h. 40m. G.M.T. at Amesbury on April 17th, 1931. A heavy shower of rain and hail commenced about 18h. 15m. and continued until 18h. 40m. After the shower had ceased, looking towards the south-east, nearly the whole sky up to the zenith was filled with heavy mammato-cumulus. There was a clearance to the north-west. The " festoons " were well developed and very large. It was estimated that in some cases the bottom of the " festoons "

were about 300 feet below the main cloud level. The mammato-cumulus occurred in polar air whose origin was to the north of the Arctic Circle.

It is of interest to examine the pressure distribution existing at the time. A depression over the North Sea was moving south-south-east, while a cold air current behind it had spread southwards over the British Isles. The main cold front associated with the depression over the North Sea passed Larkhill at 7h. 45m. on the 17th. An aeroplane ascent at Duxford at 9h. 15m. showed a steep lapse rate up to about 6,000 feet with a stable lapse-rate above. Another ascent at 13h. on the same day, when the front had moved southwards to north France, gave a lapse-rate almost equal to the dry adiabatic up to 14,000 feet. Rain and hail showers had developed by this time and " anvils " were numerous. At 13,000 feet there had been a drop in temperature of 12°F. since the morning ascent.

The heavy shower at 18h. 15m., after which the mammato-cumulus was observed, probably occurred at a secondary cold front. At Larkhill, two miles away, a gust of 54 m.p.h. was experienced at the passage of the front, temperature fell 7·5°F. without any recovery, while the barograph showed an upward " kick " of about 1mb.

L. DODS.

Reviews

Metropolitan Water Board. Twenty-fifth Annual Report on the results of the chemical and bacteriological examination of the London waters for the twelve months ended 31st December, 1930. By Sir Alexander Houston, Director of Water Examination. Size $13\frac{1}{4} \times 8\frac{1}{4}$, pp. 73, *Illus.* London: P. S. King and Son, Ltd., 1931. Price 21s.

This report worthily maintains the high standard of scientific worth, literary elegance and humour that we have come to associate with the name of Sir Alexander Houston. Seeing that this is the official report of the chemical and bacteriological department of so august a body as the Metropolitan Water Board, the mention of " humour " may appear surprising. To readers who have not seen the forerunners of this volume, it is necessary to explain that Sir Alexander Houston has for some years past achieved the rather surprising feat of producing a report in which the facts and statistics are presented in such a way as to afford considerable entertainment even to readers not professionally interested in the chemical problems associated with water supply. The whole report bears the impress of a most vivid and engaging personality.

Section IX (Meteorological Notes) gives a summary of the year's weather at home and abroad " extracted for the most

part," as the author says in a footnote, " from the *Meteorological Magazine*, a journal of immense interest and importance." The style of the report may be judged by the following samples :—

July.— . . . It has been said of our climate that we never have two consecutive fine days. It was fine enough, at all events, on July 11th and 12th at Leeds to allow Don Bradman to complete his record Test Match score of 334 runs.

December.— . . It is remarkable, however, that double gilt-edged securities, War-savings certificates, and the funds of first-class building societies rode triumphantly through the crisis as if they had cornered the sunshine and security of the world. Their sunshine and safety will be ours when the tide turns, and meanwhile we are thankful that on Christmas Day, locally, at all events, and on the Sunday following, the temporary charms of the weather lured us back to the cheerful outlook which the Yuletide has planted imperishably in the hearts of all true Britishers.

Enough has been said to show that Sir Alexander's reports are veritable oases in the arid ground of official publications. The reader should on no account miss the article on the Kempton Park Works beginning on p. 57. The wealth of literary allusion in this section, ranging from *Punch* to the Holy Scriptures, is truly remarkable. It is impossible to refrain from one or two more quotations :—

" After the Exhibition was opened the story goes that a ' bright young thing ' was asked if she were going to the Persian Exhibition, and her reply was : ' No. I simply loathe cats ! ' "

" Millions of passengers cross the Thames by these bridges every year, alas, they seldom, it is to be feared, give the river a thought, yet it is speaking to them all the time in the silent language of great rivers carrying messages full of history and romance to the sea. Those gifted with imagination can happily hear where there is no sound and see where there is no vision."

In reviewing the twenty-second volume of this series for the *Meteorological Magazine*, Mr. R. Corless suggested that the author might consider the question of altering the wording of the title-pages, making it indicate to a casual reader that something more than dry-as-dust statistics lay behind the cover. I am not sure that I agree. Delights are enhanced by being unexpected, and here is a case where the assiduous and dutiful delver into official records reaps a rich reward !

E. G. BILHAM.

Social and Economic Geography. By L. Brettle, M.A.(Oxon.), B.Litt., F.R.G.S. Size 8½ × 6, pp. xvii + 459, *Illus.* London, Sir Isaac Pitman and Sons Ltd. 10s. 6d. net.

The " jacket " of this useful book describes it as " a concise treatment of the more important relationships existing between man and his environment in different characteristic parts of the world." This description is justified, for the author has the knack of stating his arguments clearly and driving them home with a few well-chosen details. The important part of

"environment" which results from climate and weather receives ample treatment, far different from the perfunctory descriptions of climatic zones, which are only too often regarded as sufficient for books of this type. In fact, the whole arrangement of the first part of the book is climatic, successive chapters dealing with the equatorial rain-forest region; tropical transitional regions; sub-tropical regions; cool temperate regions having cyclonic weather; hot and warm deserts; taiga, tundra and polar ice-cap regions; and highland regions. Each section opens with a table showing the average temperature and precipitation of typical places in the region, followed by a brief summary of the main climatic characteristics, to which the economic peculiarities are related. It is in connexion with these tables that we must make one of our few criticisms, for though in general they appear to be sufficiently accurate, in some cases they depart rather widely from the latest published statistics. Thus on page 46 the rainfall of Singapore is shown as ranging from 2·2in. in April to 16·0in. in December, while the latest averages show only a variation from 6·6in. in February to 10·6in. in December, which accords better with the characteristic description of the equatorial rain-forest region.

The book is lavishly illustrated with photographs and maps. The diagram of the inter-relationships of temperature, wind and rainfall in fig. 14 would have been more useful if it had been less ideal, but the series of world maps in figs. 15 to 26 form a most remarkable testimony to the importance of climatic environment. For example, the map of "principal occupations" on land closely resembles those of temperature (not reduced to mean sea level) and precipitation, while at sea the meeting places of warm and cold currents faithfully mark the main fishing areas. Another interesting point is the general similarity, as regards the tropical regions, of the rainfall chart with that showing the extra premiums charged by a British Insurance Company for foreign residence. The changeable climate of western Europe is attributed to its position near the "polar front," the modern theory of which is described and illustrated by full-page reproductions of charts from two daily weather reports, though it is to be feared that the uninitiated will find difficulty in recognising on these the boundaries of the polar and equatorial air currents.

Another important feature is the series of questions at the end of each chapter, and here again the importance of climatology is fully recognised. The very numerous photographs are of great interest, and the general appearance of the book is excellent, especially when the moderate price is considered. The index is generous.

C. E. P. Brooks.

The Weather of August, 1931

Pressure was below normal in a belt covering southern Canada and north-western United States, over the southern North Atlantic, Spitsbergen, Jan Mayen and most of Europe, with the exception of south-western Norway, Scotland and southern Spain; the greatest deficits were 4·8mb. at Spitsbergen and 4·7mb. at Brest. Pressure was above normal over northern Canada and the southern and north-eastern United States, Bermuda, northern North Atlantic to Norway, Iceland and in a belt from the Canary Islands across southern Spain, to the western Mediterranean and over the Kara Sea, the greatest excess being 4·9mb. at Reykjavik. Temperature was above normal over Spitsbergen, about normal in Scandinavia but below normal over central and southern Europe. Rainfall was below normal at Spitsbergen, northern Norway, south-east Sweden and Switzerland and above normal over Norrland, Sweden.

Cool, unsettled weather with frequent thunderstorms accompanied by heavy rain prevailed over the greater part of England during most of August. In many parts of Scotland and Ireland, however, the month was dry and sunny. With pressure high over Scotland and low over France a spell of warm, thundery weather was experienced in England from the 3rd to 5th.* The storms were accompanied by heavy local rain and flooding in southern England.† Meanwhile fair weather with good sunshine totals prevailed in the west and north of the British Isles; Markree Castle (Co. Sligo) had 14·3hrs. of bright sunshine on the 4th. The warmest spell of the month occurred at this time, temperature rising to 80°F. at Aberystwyth and 79°F. locally in Ireland and south-east England on the 4th. Subsequently pressure became high westward of Ireland and low over Scandinavia, with secondaries travelling southward over Great Britain. Cool, rather cloudy weather prevailed, with occasional heavy rain, though conditions continued fairer on the whole in the western districts; Ross-on-Wye had 13·5hrs. of bright sunshine on the 9th. On the 8th unusually heavy rain was reported in eastern England.† On the 11th the anticyclone off the south-west coasts extended northwards and then moved eastwards on the 13th; during these days temperature rose temporarily above 70°F. in the south. From the 14th to 23rd depressions passed eastwards across the country. Conditions continued very unsettled with frequent thunderstorms and heavy rain,† but some bright intervals. On the 18th and 19th temperature exceeded 70°F. in the south, but this was followed by a cold spell with maxima below 60°F. on the 21st-23rd. The 18th and 22nd were the sunniest days of this period with 13·0hrs. at Valentia on the 22nd and 12·7hrs. at Stonyhurst and York on the 18th. On the 24th a deep depression centred off Brest caused severe gales and heavy rain in the English Channel,† with gusts of 90 m.p.h. and 72 m.p.h. at Pendennis and

* See *Meteorological Magazine* 66, 1931, p. 158. † See p. 183.

Scilly Isles respectively. A welcome change to settled fair weather occurred in the north about the 25th and in the south about the 26th, but temperature remained low. On the 24th many maxima were below 55°F., even as far south as Dungeness and Leafield. Ground frosts were experienced on the 23rd to 27th, 26°F. being recorded on the ground at Rhayader on the 26th. Much sunshine occurred on several days at the end of the month. The total rainfall was well above the average in England but below average in Scotland and Ireland. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	178	+ 45	Liverpool	170	+ 6
Aberdeen	129	— 21	Ross-on-Wye	147	—27
Dublin	169	+ 7	Falmouth	175	—36
Birr Castle	175	+ 33	Gorleston	182	—24
Valentia	197	+ 42	Kew	136	—51

The special message from Brazil states that in the northern regions, the rainfall was irregular with 0·16in. above normal and in the central and southern regions generally scarce with 0·43in. and 0·91in. below normal respectively. Six anticyclones passed across the country. Crops generally were in good condition except in the north-east though affected by the frosts. At Rio de Janeiro pressure was 3·4mb. above normal and temperature 0·9°F. below normal.

Miscellaneous notes on weather abroad culled from various sources.

Several deaths from heat-stroke were reported from Italy at the beginning of the month owing to the high temperatures which prevailed there being accompanied by the enervating scirocco; the temperature also remained relatively high during the nights. Twelve deaths were caused by a thunderstorm of exceptional violence in northern France on the 4th, heavy thunder- and hailstorms occurred in south-west Germany on the 5th, followed by flooding, and a cloudburst was experienced in the Valle Aurina to the south-east of the Brenner Pass on the 6th. A violent storm, accompanied by hail, swept the coast near Toulon for 12 minutes on the 9th, and a waterspout was seen off La Rochelle during a thunderstorm. Bad weather was frequently experienced in Switzerland leading to several accidents. Serious forest fires broke out on the French Riviera on the 21st, but these were mastered by the 23rd, and rain fell on the 25th. Unusually heavy rain fell in Stockholm on the 23rd, and the Sahlgren Hospital was flooded. Heavy rain during the greater part of the month in Flanders and Germany caused serious losses to agriculture due to flooding. Paris had less than half the normal amount of sunshine for the month

and more than twice the rainfall. Storms were experienced on the Atlantic coast of France and in the central Mediterranean on the 24th and 23rd respectively. (*The Times*, August 6th-September 2nd.)

A typhoon, during which the wind reached 136 m.p.h. in a gust, struck Hongkong on the 1st doing minor damage. Disastrous floods were experienced in China throughout the month owing to the occurrence of abnormally heavy rains simultaneously in several Yangtze regions at a time when the rivers were already high owing to the melting snows on the Tibetan borders and the dykes were in a neglected condition. Further heavy rain occurred during the month. From the 18th-20th the level of the Yangtze at Hankow, where the floods are worst, reached the record height of 53½ft. above Bund level. Millions of people are homeless and hundreds were drowned. The flood situation, on the Hoang Ho, of sections of Honan, north Anwhei, north Kiangsu and Shantung was almost as disastrous as that of the Yangtze as regards loss of life and damage. All the lower parts of the province of Szechwan are also suffering from similar unprecedented floods. High temperatures added to the misery of the people, but fortunately these had fallen by the 27th. By the 30th the floods were declining, but there was still risk of more water coming down from the upper rivers. The floods along the Brahmaputra and Padma caused much of the paddy harvest to be lost; these continued most of the month. Many people were drowned as the result of floods caused by the monsoon in the low-lying villages in the Malvan district of Bombay. Drought was ruining the crops in the zone between Meiktila and Mandalay, while crops on the lower reaches of the Irrawaddy were being ruined by floods. (*The Times*, August 5th-31st.)

Floods on the River Murray due to the exceptionally heavy rainfall caused much damage mainly to dairy settlements in South Australia; 25 miles of levées had collapsed by the 30th. (*The Times*, August 25th-31st.)

Cool, wet weather prevailed generally in Canada during the first part of the month with drier conditions later. Temperature was mainly above normal in the United States, except along the eastern coast at the end of the month. In the Argentine the weather was generally cool and dry. A cyclone did much damage in Paraguay about the 17th. (*The Times*, August 7th-29th, and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Rainfall, August, 1931—General Distribution

England and Wales	143	per cent of the average 1881-1915.
Scotland	61	
Ireland	81	
British Isles	104	

Rainfall: August, 1931: England and Wales

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square.....	5·03	227	*Leics* .	Belvoir Castle.....	3·30	126
Sur .	Reigate, Alvington....	5·05	206	*Rut* .	Ridlington.....	2·98	119
Kent .	Tenterden, Ashenden...	3·63	158	*Linc* .	Boston, Skirbeck.....	8·02	335
,, .	Folkestone, Boro. San..	3·89	...	,, .	Cranwell Aerodrome...	3·45	127
,, .	Margate, Cliftonville...	3·28	170	,, .	Skegness, Marine Gdns	3·14	129
,, .	Sevenoaks, Speldhurst	4·58	...	,, .	Louth, Westgate.....	3·65	130
Sus .	Patching Farm.....	3·15	125	,, .	Brigg, Wrawby St....	4·48	...
,, .	Brighton, Old Steyne..	2·41	111	*Notts* .	Worksop, Hodsock.....	4·65	190
,, .	Heathfield, Barklye....	6·13	227	*Derby*.	Derby, L. M. & S. Rly.	5·84	223
Hants.	Ventnor, Roy. Nat. Hos.	3·37	169	,, .	Buxton, Devon Hos....	6·63	151
,, .	Fordingbridge, Oaklnds	4·23	161	*Ches* .	Runcorn, Weston Pt...	5·88	163
,, .	Ovington Rectory.....	5·17	191	,, .	Nantwich, Dorfold Hall	6·05	...
,, .	Sherborne St. John.....	4·36	180	*Lancs* .	Manchester, Whit. Pk.	7·34	213
Berks .	Wellington College.....	3·31	143	,, .	Stonyhurst College....	4·86	96
,, .	Newbury, Greenham...	2·95	112	,, .	Southport, Hesketh Pk	4·58	132
Herts .	Welwyn Garden City...	4·24	...	,, .	Lancaster, Strathspey	3·56	...
Bucks.	H. Wycombe, Flackwell	5·19	...	*Yorks*.	Wath-upon-Dearne.....	4·24	177
Oxf . .	Oxford, Mag. College..	4·29	190	,. .	Bradford, Lister Pk....	3·30	122
Nor .	Pitsford, Sedgebrook...	2·70	112	,, .	Oughtershaw Hall.....	5·30	...
,, .	Oundle.....	3·02	...	,, .	Wetherby, Ribston H.	3·50	128
Beds .	Woburn, Crawley Mill	3·65	158	,, .	Hull, Pearson Park.....	4·04	139
Cam .	Cambridge, Bot. Gdns.	2·50	106	,, .	Holme-on-Spalding.....	3·50	...
Essex .	Chelmsford, County Lab	3·78	174	,, .	West Witton, Ivy Ho.	4·14	141
,, .	Lexden Hill House....	3·35	...	,, .	Felixkirk, Mt. St. John	3·40	119
Suff .	Hawkedon Rectory.....	4·66	180	,, .	Pickering, Hungate....	3·54	138
,, .	Haughley House.....	2·80	...	,. .	Scarborough.....	2·26	81
Norf .	Norwich, Eaton.....	3·24	137	,, .	Middlesbrough.....	2·15	78
,, .	Wells, Holkham Hall	3·09	129	,, .	Baldersdale, Hury Res.	...	...
,, .	Little Dunham.....	2·91	107	*Durh* .	Ushaw College.....	3·07	105
Wilts.	Devizes, Highclere.....	4·20	146	*Nor* .	Newcastle, Town Moor	3·40	116
,, .	Bishops Cannings.....	4·42	143	,, .	Bellingham. Highgreen	4·12	117
Dor .	Evershot, Melbury Ho.	3·86	123	,, .	Lilburn Tower Gdns....	2·67	95
,, .	Creech Grange.....	4·26	149	*Cumb* .	Geltsdale.....	3 55	...
,, .	Shaftesbury, Abbey Ho.	3·06	105	,, .	Carlisle, Scaleby Hall	2·72	66
Devon.	Plymouth, The Hoe....	3·84	124	,, .	Borrowdale, Seathwaite	7·20	62
,, .	Polapit Tamar.....	6·11	192	,, .	Borrowdale, Rosthwaite	5·24	...
,, .	Holne, Church Pk. Cott.	5·63	126	,, .	Keswick, High Hill.....	4·25	...
,, .	Cullompton.....	4·07	133	*West* .	Appleby, Castle Bank..	3·65	111
,, .	Sidmouth, Sidmount...	3·14	112	*Glam* .	Cardiff, Ely P. Stn....	4·24	98
,, .	Filleigh, Castle Hill....	4·86	...	,, .	Treherbert. Tynywaun	8·01	...
,, .	Barnstaple. N. Dev. Ath	3·89	118	*Carm* .	Carmarthen Friary.....	3·20	69
,, .	Dartm'r, Cranmere Pool	9·20	...	*Pemb* .	Haverfordwest, School	3·41	82
Corn .	Redruth, Trewirgie.....	4·48	131	*Card* .	Aberystwyth.....	3·39	...
,, .	Penzance, Morrab Gdn.	3·10	98	,, .	Cardigan, County Sch.	4·39	...
,, .	St. Austell, Trevarna...	4·81	133	*Brec* .	Crickhowell, Talymaes	5·70	...
Soms .	Chewton Mendip.....	5·34	119	*Rad* .	Birm W. W. Tyrmynydd	5·64	105
,, .	Long Ashton.....	3·96	113	*Mont* .	Lake Vyrnwy.....	5·64	109
,, .	Street, Millfield	4·16	152	*Denb* .	Llangynhafal.....	6·77	219
Glos. .	Cirencester, Gwynfa....	5·07	169	*Mer* .	Dolgelly, Bryntirion...	6·38	113
Here .	Ross, Birchlea.....	5·15	201	*Carn* .	Llandudno.....	4·27	141
,, .	Ledbury, Underdown..	4·78	183	,, .	Snowdon, L. Llydaw 9	15·45	...
Salop .	Church Stretton.....	6·16	189	*Ang* .	Holyhead, Salt Island	2·74	86
,, .	Shifnal, Hatton Grange	4·93	175	,, .	Lligwy.....	3·72	113
Worc .	Ombersley, Holt Lock	3·49	130	*Isle of Man*			
,, .	Blockley.....	5·88	...		Douglas, Boro' Cem....	4·07	107
War .	Birminghm, Edgbaston	4·65	172	*Guernsey*			
Leies .	Thornton Reservoir....	4·73	169		St. Peter P't. Grange Rd.	6·85	292

Rainfall: August, 1931: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per cent. of Av.
Wigt .	Pt. William, Monreith	3·74	97	*Suth* .	Melvich	1·04	...
,, .	New Luce School	2·52	56	,, .	Loch More, Achfary	1·79	31
Kirk .	Carsphairn, Shiel	2·80	42	*Caith* .	Wick	1·07	39
Dumf .	Dumfries, Crichton, R.I	2·40	...	*Ork* .	Pomona, Deerness	·51	18
,, .	Eskdalemuir Obs.	1·80	35	*Shet* .	Lerwick	·21	7
Roxb .	Branxholm	3·81	118	*Cork* .	Caheragh Rectory	3·35	...
Selk .	Ettrick Manse	2·77	53	,, .	Dunmanway Rectory	3·20	68
Peeb .	West Linton	4·28	...	,, .	Ballinacurra	3·54	95
Berk .	Marchmont House	3·34	101	,, .	Glanmire, Lota Lo	3·89	106
Hadd .	North Berwick Res.	4·46	141	*Kerry* .	Valentia Obsy.	3·62	76
Midl .	Edinburgh, Roy. Obs.	5·58	181	,, .	Gearahameen	8·60	...
Lan .	Auchtyfardle	1·91	...	,, .	Killarney Asylum	...	...
Ayr .	Kilmarnock, Agric. C.	...	...	,, .	Darrynane Abbey	4·00	92
,, .	Girvan, Pinmore	2·32	52	*Wat* .	Waterford, Brook Lo	2·73	71
Renf .	Glasgow, Queen's Pk.	2·18	62	*Tip* .	Nenagh, Cas. Lough	3·07	78
,, .	Greenock, Prospect H.	1·88	34	,, .	Roscrea, Timoney Park	2·75	...
Bute .	Rothesay, Ardencraig.	2·69	55	,, .	Cashel, Ballinamona	3·63	102
,, .	Dougarie Lodge	1·43	.	*Lim* .	Foynes, Coolnanes	2·31	60
Arg .	Ardgour House	2·63	...	,, .	Castleconnel Rec.	3·21	...
,, .	Manse of Glenorchy	..	...	*Clare* .	Inagh, Mount Callan	3·20	...
,, .	Oban	1·05	23	,, .	Broadford, Hurdlest'n.	3·94	...
,, .	Poltalloch	1·56	32	*Wexf* .	Gorey, Courtown Ho	2·52	76
,, .	Inveraray Castle	1·65	25	*Kilk* .	Kilkenny Castle	2·17	62
,, .	Islay, Eallabus	1·48	34	*Wic* .	Rathnew, Clonmannon	3·45	...
,, .	Mull, Benmore	2·40	..	*Carl* .	Hacketstown Rectory.	3·04	75
,, .	Tiree	...	...	*Leix* .	Blandsfort House	3·97	101
Kinr .	Loch Leven Sluice	...	...	,, .	Mountmellick	3·53	...
Perth .	Loch Dhu	2·65	39	*Offly* .	Birr Castle	2·55	67
,, .	Balquhidder, Stronvar	...	...	*Kild'r* .	Monasterevin	2·99	...
,, .	Crieff, Strathearn Hyd.	1·68	40	*Dubl* .	Dublin, Fitz Wm. Sq.	3·12	103
,, .	Blair Castle Gardens	1·09	32	,, .	Balbriggan, Ardgillan	3·73	109
Angus .	Kettins School	3·35	101	*Me'th* .	Beauparc, St. Cloud	3·69	...
,, .	Dundee, E. Necropolis	3·39	100	,, .	Kells, Headfort	3·60	87
,, .	Pearsie House	...	...	*W.M* .	Moate, Coolatore	2·90	...
,, .	Montrose, Sunnyside	2·04	73	,, .	Mullingar, Belvedere	3·62	87
Aber .	Braemar, Bank	3·04	89	*Long* .	Castle Forbes Gdns	2·80	68
,, .	Logie Coldstone Sch.	2·00	63	*Gal* .	Ballynahinch Castle	4·02	73
,, .	Aberdeen, King's Coll.	1·87	68	,, .	Galway, Grammar Sch.	2·65	...
,, .	Fyvie Castle	2·74	86	*Mayo* .	Mallaranny	...	...
Moray .	Gordon Castle	2·42	76	,, .	Westport House	4·23	105
,, .	Grantown-on-Spey	2·84	89	,, .	Delphi Lodge	8·32	97
Nairn .	Nairn, Delnies	1·98	82	*Sligo* .	Markree Obsy.	4·33	99
,, .	Ben Alder Lodge	2·07	...	*Cav'n* .	Belturbet, Cloverhill	3·37	91
Invs .	Kingussie, The Birches	1·51	...	*Ferm* .	Enniskillen, Portora	...	...
,, .	Loch Quoich, Loan	...	...	*Arm* .	Armagh Obsy	2·06	57
,, .	Glenquoich	2·74	33	*Down* .	Fofanny Reservoir	6·04	...
,, .	Inverness, Culduthel R.	1·74	...	,, .	Seaforde	3·63	97
,, .	Arisaig, Faire-na-Squir	2·12	...	,, .	Donaghadee, C. Stn.	3·30	99
,, .	Fort William	3·31	...	,, .	Banbridge, Milltown	3·03	...
,, .	Skye, Dunvegan	1·31	...	*Antr* .	Belfast, Cavehill Rd.	3·29	...
R & C .	Alness, Ardross Cas.	2·18	74	,, .	Glenarm Castle	3·68	...
,, .	Ullapool	·64	18	,, .	Ballymena, Harryville	3·13	73
,, .	Torridon, Beudamph	...	...	*Lon* .	Londonderry, Creggan	2·10	45
,, .	Achnashellach	1·53	...	*Tyr* .	Omagh, Edenfel	2·36	55
,, .	Stornoway	1·38		*Dn* .	Malin Head	1·41	...
Suth .	Lairg	1·22	38	,, .	Dunfanaghy	1·70	...
,, .	Tongue	1·08	34	,, .	Killybegs, Rockmount	2·19	39

Climatological Table for the British Empire, March, 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. ..	1014·3	+ 0·9	66	18	47·8	34·2	41·0	— 1·4	34·7	81	8·4	0·32	— 1·37	5	4·0	34
Gibraltar	1013·2	— 3·8	74	49	66·2	53·6	59·9	+ 2·4	53·7	87	6·5	8·09	+ 3·30	16	..	..
Malta	1013·7	— 0·5	79	47	65·0	54·1	59·5	+ 2·4	54·0	73	6·1	0·38	— 1·10	6	6·8	57
St. Helena	1013·8	+ 1·5	72	61	69·4	62·1	65·7	— 0·6	62·7	93	9·2	3·09	..	18	..	..
Sierra Leone	1009·7	— 1·0	93	67	89·0	74·0	81·5	-- 0·9	76·3	75	4·8	1·82	+ 0·66	2	..	..
Lagos, Nigeria	..	..	96	71	90·9	78·8	84·9	+ 1·6	79·8	79	7·4	5·89	+ 2·15	7	..	..
Kaduna, Nigeria	1013·0	+ 1·1	102	..	97·5	..	..	..	75·5	74	..	0·12	— 0·32	1	..	..
Zomba, Nyasaland ..	1009·9	+ 0·2	87	62	80·4	65·6	73·0	+ 1·7	..	75	6·5	2·48	— 6·60	10	..	..
Salisbury, Rhodesia ..	1010·0	+ 0·9	89	51	81·6	59·1	70·3	+ 2·1	61·9	66	3·9	0·72	— 3·98	9	7·4	61
Cape Town	1015·6	+ 1·1	97	53	82·0	62·0	72·0	+ 3·9	62·6	77	3·7	0·00	— 0·88	0	..	..
Johannesburg	1014·1	+ 1·5	84	49	75·7	54·7	65·2	+ 1·8	56·1	68	4·2	1·71	— 2·73	10	7·8	63
Mauritius	1009·9	— 2·1	87	67	84·4	73·4	78·9	+ 0·9	74·3	71	5·6	25·12	+ 15·75	15	8·1	66
Calcutta, Alipore Obsy.	1011·3	+ 1·4	99	62	91·7	70·6	81·1	+ 0·9	70·6	80	2·9	1·31	— 0·07	3*	..	..
Bombay	1011·5	+ 0·6	91	65	85·8	71·4	78·6	— 0·9	70·2	74	2·5	0·00	— 0·02	0*	..	..
Madras	1011·6	+ 0·7	93	69	89·6	72·6	81·1	0·0	75·2	78	1·9	0·00	— 0·34	0*	..	..
Colombo, Ceylon	1011·6	+ 1·5	92	72	89·4	75·0	82·2	+ 0·4	77·8	72	4·7	1·86	— 2·42	9	9·4	78
Singapore	1010·4	..	94	73	89·9	74·7	82·3	+ 1·5	..	..	..	5·18	— 2·22	17	6·3	52
Hongkong	1015·9	0·0	80	55	67·7	60·5	64·1	+ 0·8	59·9	79	8·0	3·17	+ 0·49	12	2·5	21
Sandakan	..	..	89	73	87·7	75·4	81·5	+ 0.5	77·5	81	..	4·39	— 4·08	7	..	..
Sydney, N.S.W.	1017·8	+ 1·5	91	56	76·4	64·4	70·4	+ 1·1	66·5	79	7·5	7·39	+ 2·41	20	4·9	40
Melbourne	1017·8	+ 0·9	96	44	72·8	53·6	63·2	— 1·3	58·0	69	6·1	5·50	+ 3·32	11	5·8	47
Adelaide	1018·6	+ 1·5	101	48	79·5	57·2	68·3	— 1·5	57·1	43	5·5	1·32	+ 0·29	6	7·7	63
Perth, W. Australia ..	1015·5	+ 0·2	99	55	83·5	62·0	72·7	+ 1·5	61·6	53	3·5	0·90	+ 0·09	4	9·2	75
Coolgardie	1015·7	+ 0·9	99	47	83·4	58·7	71·1	— 0·8	59·1	44	3·5	0·59	— 0·35	3	..	..
Brisbane	1017·9	+ 3·5	89	62	81·3	67·7	74·5	+ 0·2	69·8	77	6·6	14·92	+ 9·14	24	6·7	54
Hobart, Tasmania	1016·7	+ 2·5	84	43	66·0	51·5	58·7	— 0·6	53·1	71	6·8	4·16	+ 2·46	17	5·6	45
Wellington, N.Z.	1021·9	+ 4·7	70	44	62·8	51·5	57·1	— 3·5	53·8	75	6·5	0·64	— 2·69	10	6·4	52
Suva, Fiji	1010·4	+ 2·0	87	71	83·1	74·2	78·7	— 1·4	74·9	81	7·1	20·02	+ 5·53	28	4·6	38
Apia, Samoa	1009·9	+ 0·7	89	73	86·3	75·6	80·9	+ 1·6	78·2	82	6·4	10·26	— 3·72	22	5·3	43
Kingston, Jamaica ..	1013·1	— 1·8	90	64	86·7	70·2	78·5	+ 1·4	67·6	79	4·8	0·95	— 0·07	5	9·2	77
Grenada, W.I.	1013·8	+ 0·8	91	72	88·0	74·6	81·3	+ 3·5	74·0	75	3·2	0·74	— 1·92	12	..	..
Toronto	1014·8	— 2·5	48	19	38·8	28·1	33·5	+ 3·9	29·2	78	8·5	2·81	+ 0·40	12	4·1	34
Winnipeg	1024·5	+ 5·3	42	— 9	27·8	12·0	19·9	+ 4·9	..	..	5·0	0·89	— 0·27	8	..	..
St. John, N.B.	1012·9	— 1·2	53	20	38·7	28·2	33·5	+ 5·1	28·9	82	8 0	3·01	— 1·53	12	2·9	24
Victoria, B.C.	1018·1	+ 2·2	57	34	50·3	34·0	42·1	— 1·4	42·7	83	7·3	2·40	— 0·03	18	3·9	33

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