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Artificial Dissipation of Fog.

WE are glad to be allowed to publish the following letter from Sir Napier Shaw concerning the possibility of dissipating fog by artificial heating. The subject was suggested to Sir Napier by an inquirer who had seen fog disperse over a football ground as the game proceeded :—

" It is not easy to get at the actual core of the question of dissipating fog by artificial heat ; there are so few effective facts to go upon. The late Sir Norman Lockyer used to tell me of his experience of a thick fog in the Atlantic off ' the banks.' The steamer in which he was travelling was going dead slow and hearing the siren of another vessel in the neighbourhood for some time, when suddenly they came upon the other vessel stopped in the centre of a clear space free of fog. He attributed the clear space to the warmth of the vessel in the middle of it ; but I have never made out why, of all the vessels that have been adrift in fog on the Atlantic, that should be the only one to form a clear space for itself. And so with your football play. I should have thought it more likely that whenever the game stopped for a moment the players would have been shrouded in a thick mist of their own making rather than the creators of a clear space for all to see them in. On a foggy day a team of waggon horses is a sort of travelling cloud though their coats are quite as thick as a footer shirt. Are you sure that the appearance of clearing was not due to the players forming something

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definite to look at? It is very difficult to estimate the facility of seeing unless there is some definite object to be seen. Gazing into vague vacancy produces curious effects upon one's seeing. But you must know about such things better than I.

"It is, of course, within the bounds of physical possibility to dissolve the fog of a limited space by artificial heating. Colonel Moore Brabazon has talked lately of doing it on a scale suitable for an aerodrome. But air in the open is very slippery stuff and it has all sorts of ways of evading control that are very disappointing.

"For example, I do not think that in a fog air is ever 'dead calm.' I have never seen a fog that was not obviously drifting slowly if one took notice. In fact the formation of fog is dependent upon the air being in slow motion, not 'dead calm.' I think you may allow two miles an hour for the motion. It makes a good deal of difference, because when you are clearing an aerodrome the air that you are spending your money on will be going along in a very leisurely way without fluttering a flag or moving an anemometer, but at the end of an hour it will be two miles away and you will be clearing away a fresh lot of fog.

"I do not know how much the air would have to be warmed to dissipate the fog. The fog itself you say was 50 feet thick. I think you would have to calculate upon warming up to at least double that height to produce any effect, because the automatic mixing due to the slow eddies would not allow you to confine your attention to 50 feet. It is the inexorable principle of 'share and share alike' that the air acts upon in the surface layers that causes the mixing which finds expression as fog in the bottom half or quarter of the layers affected. You cannot deal exclusively with the layers in which fog is formed.

"Now for some figures. Let us suppose you allow for warming the foggy air by 5° F. in order to dissipate the fog and make things safe. A cube of air 10 yards each way weighs a ton. Take an aerodrome 400 yards wide and allow for a cross drift of 4,000 yards in an hour and an air thickness of 100 feet (30 yards) to be warmed. You have to warm about 50,000 tons of air per hour through 5°; each ton of air requires ·24 ton-units of heat for 1° rise so the air will carry off 60,000 ton-units of heat. A ton of coal gives about 10,000 ton-units, so if you can get the heat perfectly distributed without loss 6 tons of coal an hour might do that part of it. Here is another calculation that indicates a larger demand for coal. From Glossary, p. 67, we may take the amount of water in a fog as, say, 2·5 grammes per cubic yard. We are dealing with 400 × 4,000 × 15 cubic yards in

this case, *i.e.*, about 24,000,000 cubic yards, or 60,000,000 grammes, or 60 tons of water, which wants 6 tons of coal for its evaporation. Allowing for both, we may estimate 12 tons an hour as the coal consumption. Distribution by electrical heating would be much more manageable than hot-water pipes or flues, and I suppose that would mean at least five times as much fuel, say 60 tons an hour, as the amount to be devoted to clearing an aerodrome. This is a good deal, and we have assumed that the visitation only runs to 50 feet of fog. If the air outside the aerodrome goes on getting colder and the fog getting thicker we may have to reckon with 300 or 400 feet of fog; so we must think of 400 or 500 tons of coal an hour.

"You must of course arrange to have the heating on the side from which the air is drifting; it is not of much use to warm the air just as it is leaving the space you want to clear, so your installation must be four-sided.

"Having made the calculation, let me say that if it were possible to operate in this way I think we should have found more evidence for it than has hitherto come to light. A football crowd would be a very good way of trying the experiment. Arrange for a 50,000 crowd to surround a football field on the occasion of the next fog; there are always 50,000 people who have an hour or two to spare for an easy job of that kind. Has anybody ever known a ring of sightseers dissipate a fog by their mere presence? I wonder if 8,000 people are really as good as a ton of coal; they certainly ought to be.

"There must be other ways of trying the thing on the small scale. Anything of the kind must be done in the country because in fog-times the air of a place like London is full of smoke; there is a 'deck' about 300 feet up which prevents anything getting away, and the slow drift just mixes up the chimney smoke with the rest of the air *below the deck*. A deck is a layer where the temperature increases with height instead of obeying the ordinary law of getting colder with height.

"My feeling about attempting such experiments is perhaps best described by saying that the problem is about the same as trying to raise by a few degrees the temperature of the top 2 inches of the Thames between the Lots Road Power Station and Battersea Bridge when the tide has just begun to ebb. I would not like to say it is impossible with unlimited funds and coal. I do not know how much coal they burn in an hour at Lots Road, but if it is to be tried it had better be on a small brook first.

"It is much the same with the suggestion of dissipating fog by electric bursts discharge. Mr. Watson, who is working for the Committee on Atmospheric Pollution, has a contrivance which clears away tobacco smoke from a tube the size of your finger as fast as one blows it in. If you magnify the scale by 10,000,000,000, what you want is done. Multiplication by 10 will be rather an undertaking, and to do that ten times over may fairly be called impossible at this period of our history."

School of Meteorology,
Imperial College of Science and Technology,
South Kensington, S.W.7.

NAPIER SHAW.

OFFICIAL NOTICES.

Lectures on Meteorology.

THE arrangements for lectures and classes in the current term of the School of Meteorology in connection with the Aeronautical Department of the Imperial College of Science and Technology are as follows:—

1. *Mr. C. T. R. Wilson, F.R.S.*—A course of 10 lectures on Atmospheric Electricity on Wednesdays, at 2.30, beginning Wednesday, 12th January.
2. *Captain D. Brunt.*—A course of lectures on Dynamical Meteorology on Tuesdays and Thursdays, at 3.0, beginning Tuesday, 11th January. (2 terms.)
3. *Sir Napier Shaw, F.R.S.*—Continuation of the course on Instruments and Methods (weather maps, forecasts, gale-warnings, fog-warnings, and the artificial control of weather); lecture on Mondays, at 3.30, with (daily) practical work, beginning on Monday, 17th January.
4. *Sir Napier Shaw, F.R.S.*—Course of lectures for the University of London on "An Historical Review of Meteorological Theory," on Fridays, at 3.0, beginning on 21st January.

Admission to No. 4 is free, by ticket, to be obtained from the Meteorological Office; a fee is payable for Nos. 1, 2, and 3.

The Royal Institution.

ON March 10th and 17th, 1921, the Director of the Meteorological Office, Dr. G. C. Simpson, F.R.S., will deliver two lectures on "The Meteorology of the Antarctic" at the Royal Institution.

Retirement.

Mr. A. R. Simpkins, who retired on December 31st, 1920, entered the Office in September 1876 at the age of 20, being introduced by Captain Toynbee. After serving for 37 years in the Forecast Division, he joined the Statistical Division in 1913, and from that time was responsible for the compilation of the Weekly and Monthly Weather Reports. At the beginning of 1920, Mr. Simpkins succeeded Mr. Sheerman as Principal Assistant in the Statistical Division.

Climatological Stations.

OBSERVATIONS at *Wilton House, Salisbury*, a station which has been maintained by the Earls of Pembroke since about 1866, have been discontinued as from December 1920. The first Monthly Return from this station received at the Office was that for January 1903. Since March 1913, when Wilton was adopted as a District Value Station in place of Swarraton, weekly returns have been made. Mr. W. Butler, who was appointed observer in January 1916, succeeded Mr. T. Challis, who had completed 55 years' service in that capacity.

British Rainfall, 1919.

THE fifty-ninth annual volume of *British Rainfall*, and the first to be published under the authority of the Meteorological Office, was issued on December 22nd. The lateness of the date was due to the difficulty in arranging for the transfer of the printing from the old printers to the Stationery Office, which has now accepted responsibility for the work. It is hoped that a return to an earlier date will be possible in future years.

The arrangement of the volume has been kept unchanged with one exception. In order to bring together all the administrative and non-scientific sections and to obviate the awkward double pagination hitherto used, the general articles have been placed at the end of the book, forming Part IV., instead of in Part I. These include a valuable article by Mr. D. Halton Thomson, C.E., on "The Effect of Rainfall on the Saturation-level in the Chalk at Chilgrove, West Sussex, from 1836 to 1919." Mr. Thomson has carefully standardised the remarkable record of well-depth and correlated it with the monthly rainfall throughout the 84 years covered by the observations. Another article, by Mr. Salter, on "The Exposure of Rain Gauges," calls attention to some important sources of error arising from faulty rain gauge exposure, and suggests methods of detecting and obviating them.

The contents of Part II. include a discussion of the relation of the evaporation records at Camden Square from 1905 to

1918 to other meteorological elements, based upon the five-day means. This article summarises and brings to a close the series of annual articles on the subject. In the section dealing with "The Distribution of Rainfall in Time" an account is given of a tentative experiment in the revision of the units hitherto used in the computation of rainfall frequency. This was suggested by the great difficulty experienced in studying the frequency of "rain days" owing to the smallness of the unit. Together with the data for rain days, droughts and rain spells based on the unit ·01 in. are given parallel tables based on ·04 in. or 1·0 mm. No definite step is suggested in the direction of abandoning the older definitions for the present, and it is proposed to examine the relative advantages of the new method for some years before coming to any decision on the point.

An important improvement is the introduction into the volume for the first time of maps showing the distribution of annual rainfall and a description based upon them. This is a step which had been in the minds of the Editors for many years but had never been found practicable.

The observational basis of the volume was provided by 4,896 complete records—103 fewer than in 1918. The shrinkage in numbers, which represents 2 per cent. of the whole body of observers, was almost entirely confined to England and does not in any way impair the representative value of the records. In respect of distribution there is a continued tendency to improvement.

The general tables have unfortunately been set in a much smaller type than formerly, making their perusal very trying to the eyesight. This is one of the least desirable forms of economy, and it is to be hoped that a return to the more readable type of former volumes will be possible in the next issue.

Discussion at the Meteorological Office.

THE subject for discussion on December 13th, 1920, was the paper entitled "Étude préliminaire sur les vitesses du vent et les températures dans l'air libre à des hauteurs différentes," by H. H. Hildebrandsson (Stockholm, *Geog. Ann.*, 1920, No. 2, pp. 97–118).

This paper, which was brought to the notice of the meeting by Dr. H. Jeffreys, contains a useful summary of observations in various parts of the world, but not much that is novel. A striking result is arrived at in the comparison of the upper air temperatures in the quadrants of a cyclone; for the winter it is found that whilst the southern and eastern quadrants are warmer than the north and west near the ground, from 1,500 metres upwards this relation is reversed.

It will be remembered that, according to Mr. W. H. Dines, it is only in the lowest levels that any appreciable difference in temperature distribution is to be found between the quadrants; Hildebrandsson's results are based on very few observations, however. In this case of winter cyclones there are eight observations in the north and west quadrants, 23 in the sout and east quadrants. There is no evidence as to how far these refer to the same locality.

It is well known that observations of clouds and of pilot balloons do not give concordant values for the mean speed of the air currents at specified heights. Hildebrandsson's explanation is that the pilot balloon ascents are only practicable in clear weather. A more important consideration is probably that when the wind is strong balloons are lost to sight before reaching any great height. In support of this view it was mentioned by Captain Douglas that observations of shell-bursts had given some very high speeds.

With regard to the absence of information concerning the temperature of the upper air over India, Dr. Simpson explained the difficulties which had delayed the organisation of observations. He mentioned the ingenious system devised by Mr. Field to secure the return of balloon meteorographs intact. To counter the possibility that the record should be damaged through curiosity, mechanism was devised which made the record spring out of harm's way between two metal plates directly the instrument touched the ground.

The Royal Meteorological Society.

A MEETING of the Society was held on December 15th, the President, Mr. R. H. Hooker, in the chair. Captain C. K. M. Douglas presented a paper on *Temperature variation in the lowest four kilometres*. The chief object of this paper is to emphasise the importance of the source of air-supply in causing variations of the upper air temperature, and to discuss the bearing of these variations and the accompanying weather changes on the theories of Professor V. Bjerknes.

The material utilised by Captain Douglas was derived from the observations made in aeroplanes during the last year of the war in Northern France, and his vivid portrayal of the circumstances gave a special interest to his exposition. Mr. W. H. Dines' investigations have shown that temperature at such a height as 4 km. is closely correlated with the pressure, and that for a given locality the temperature at such a height is not determined by the direction of the local wind. The evidence adduced by Captain Douglas is hardly consistent with the latter conclusion, and the question will evidently require further examination.

Mr. A. P. Wainwright showed drawings of a suggested form of sunshine recorder.

A paper by Lieut.-Colonel J. E. E. Craster, entitled "An investigation of river-flow, rainfall and evaporation records," was also read. The paper is devoted to a discussion of the economy of the water supply of the Shannon Basin. The average outflow of the river month by month is known from gaugings, and the author has set out to estimate the rainfall and evaporation over the Basin, in spite of being handicapped by the entire absence of Irish observations of the latter element. The method by which the conclusions were reached received a good deal of adverse criticism in the discussion, but the general result that the difference between rainfall and river-flow is accounted for by evaporation comparable with that measured at Rothamsted, appears to be substantiated.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

A Midday Rainbow.

IN the November issue of the *Meteorological Magazine* Dr. Cholmeley states "surely a practically midday rainbow is a very rare phenomenon," and he instances a brilliant double one witnessed on October 2nd.

At Putney Bridge Station on December 1st, from 11 h. 47 m. to 11 h. 50 m., the north-western portion of a rainbow was clearly visible.

I did not think there was anything exceptional in seeing a bow so near midday. What puzzled me was that it appeared on a beautifully fine winter's day, when there was nothing in the dry, crisp feeling of the air or in the aspect of the sky to suggest that there were showers anywhere in the neighbourhood.

On referring to the *Daily Weather Report* I find that while Greenwich and Camden Square give "b" and Kensington Palace "bc, b" for the morning of the 1st, Kew Observatory gives, for 7 h. 13 h., "w2fpbbc." H. HARRIES.

Fulham, 6th December 1920.

A RAINBOW was observed here by several members of the staff on December 1st at 11 h. 40 m. A very light shower, not shown on the Beckley trace, occurred at the time. The electrogram also showed some negative potential. The amount of cloud at the time was about 3/10. It was cirro-stratus with a suspicion of light fracto-nimbus below. There was a light SW. wind. The phenomena would naturally occur a little earlier here than at Putney Bridge.

Kew Observatory, Richmond, 16th December 1920. C. CHREE.

MR. HARRIES' letter reminds me of an experience of my own at Parkstone, Dorset, one Christmas a few years ago. At about 12 h. 30 m. heavy clouds came up on a strong wind from the north, and there was a little rain. About 13 h. the cloud had passed to the south, leaving the whole of the northern half of the sky free, and against the blue sky a brilliant rainbow stood out. The bow lasted for at least five minutes.

It is an interesting question whether the rain in such a case could have fallen from the cloud before it passed over the observer's head. The drops fall from the fast moving cloud into strata where the air is travelling comparatively slowly and then get left behind, but it is remarkable that they should get so far behind as they appear to have done on this occasion. F. J. W. W.

The Sun through Black Fog.

I HAPPENED to notice some rather interesting kaleidoscopic effects in the black fog on December 8th in London, which I thought might be of some interest. At about 14 h. the blackness was intense over London, but gradually it became lighter until the sun's disc appeared as a bright red orb and shone faintly for a few minutes. Again gloom settled down, but this time it was deep yellow in colour, which gradually changed to a lurid red and gave the impression of a large conflagration. Later the colour changed again to pale yellow, and finally the intense blackness re-asserted itself as in the morning. I witnessed these changes from Piccadilly.

J. E. COWPER, Captain.

9th December 1920.

Meteorology and Private Bill Legislation.

I SEE on page 228 of the *Meteorological Magazine*, under the heading "News in Brief," reference to the Folkestone Corporation Bill, 1920, which you say is "probably unique in the annals of private Bill legislation," and would like to call your attention to the fact that the Nottingham Improvement Act, 1874, section 64, reads:—

> "The Corporation may, from time to time, establish and maintain such meteorological apparatus as they think expedient."

You will see, therefore, that the Nottingham Corporation obtained similar powers to the Folkestone Corporation 46 years ago.

ARTHUR BROWN, City Engineer.

Guildhall, Nottingham, 6th December, 1920.

Simultaneous Halo and Corona.

A LUNAR halo and corona were visible simultaneously from Hampstead soon after 9 p.m. on December 25th. The sky was covered with a thin cirro-nebula, and no definite clouds could be seen drifting over the moon's disc. Cirro-nebula normally consists of thinly scattered ice-cystals in a layer some thousands of feet thick, not always at a great height. On this occasion the lower part of the layer evidently consisted of super-cooled water drops. I witnessed this phenomenon once before from an aeroplane. On that occasion a solar corona was caused by a thin layer of ordinary water-drop cloud in the middle of finely scattered ice-crystals which caused a halo. C. K. M. DOUGLAS.

False Cirrus and Optical Phenomena.

MENTION has been made recently of halo phenomena in false cirrus. An aeroplane observer flying in the top of a shower can usually find a region where minute ice-crystals cause a fine series of coloured phenomena at close quarters, with complete halos, arcs of contact, sun pillars, and mock suns. Most of the false cirrus, however, consists of snow flakes without optical phenomena. It may therefore be expected that a ground observer would only occasionally observe optical phenomena, and very rarely a complete halo. C. K. M. DOUGLAS.

The Word "Forecast."

THE "Meteorological Glossary" gives the following definition of "Forecast":—"The name given by Admiral R. Fitzroy to a statement of the weather to be anticipated in the near future from a study of a synoptic chart or 'weather map.'" A casual reader is not perhaps altogether to be blamed for forming the impression that the word was *coined* by Fitzroy in order to avoid the objection which might reasonably have been taken to the use of such a word as "prophecy" or "prediction." With such an impression in my own mind I was a little surprised to come across the word in the following sentence of de Quincey:—

> "I never once admitted them to my thoughts in *forecasting* the eventual consequences," etc. ("Opium Eater," 1821).

A reference to the New English Dictionary shows that the word was in use as a verb as early as 1388. Among numerous examples of its use since that date the following are culled:—

> "Oure forecastes are but uncertayne" (Coverdale, 1535).
>
> "A shypmaster forecasteth and is in gret thought and feare of tempests and stormes to come" (Ld. Berners, 1533).
>
> "A good *forecaster* is better than a bad worker" (J. Clarke, 1639).
>
> "Give me a wise *forecast*, that the subtelty of the devil may not entrap me" (Quarles, 1644).
>
> "No skill . . . could *forecast*
> The approach of this destructive blast" (Falconer, 1762).

The following are examples of the use of the word in the sense of pre-arrangement of details, rather than foreseeing of events which it is impossible to alter:—

"(He) to whome a Soveraign hath entrusted the command of an Army should well *forecast* his measures before he go into the Field" (Gaya, 1678).

"At the first sight the thing which was *forecast* by good order, seemeth to happen by adventure" (Golding, 1587).

"On some day *forecast* in Heaven" (Rossetti, 1871).

Should it ever be possible to obtain control of the weather, it would hardly be necessary to make any change in our terminology.

The exact date of the introduction of the word by Fitzroy appears to be 1861 (ninth number of *Meteorological Papers published by the Board of Trade*). The addition of "ed" to form the præterite and past participle is largely a modern innovation. As, however, this modification has been accepted by lexicographers and poets, except when forbidden by the the requirements of scansion, meteorologists would hardly seem to be called upon to go back to such a form as "fine weather was forecast!"

E. G. BILHAM.

19th November, 1920.

A Good Example of Mammato-Cumulus Cloud.

DURING the afternoon of December 28th two heavy showers occurred during the passage of a V-shaped secondary which was moving in a northerly direction. The wind at the time was south-west. At 16 h. the sky broke up in the SW. and it soon became apparent that the lower surface of the rain cloud was deeply festooned near the horizon. Quite suddenly three of the festoons began to extend downwards and, catching the sunlight, turned a brilliant yellow. They soon assumed remarkable proportions, hanging like elongated thimbles; they must have been very transparent, since as the sun was behind and low on the horizon the whole of the festoon was brilliantly lit up with transmitted rather than reflected light. The lower part of the festoons soon began to move forward and assume a curved shape, they appeared to join together and looked exactly like a well-developed cumulus inverted in the sky. There was a further development of mammato-cumulus in the zenith which, owing to perspective, was not so pronounced. In this case the festoons were not individual pockets, but appeared to be deep waves curved downwards in the centre. A curtain of rain hung between me and the mammato-cumulus on the horizon, but no precipitation appeared to reach the ground.

I have often been sceptical about the illustration of this phenomenon in the Meteorological Office publication, "Cloud

Forms," but I must say that, far from being an exaggeration, I should consider that it barely does justice to this cloud-formation. To produce the deep pockets I saw on this occasion I should imagine some vertical motion would take place: they looked rather like the top part of a water-spout, except that they were cylindrical rather than conical. The mere cessation of ascending currents could hardly account for them. I may add that the cloud they hung from was cumulo-nimbus with no visible false cirrus: thunder and lightning occurred about 17 h. R. FRANCIS GRANGER.

Denton Fields, Nottingham, 29th December, 1920.

NOTES AND QUERIES.

The Effect of Rainfall on River Fisheries.

A MEMORANDUM prepared by a Joint Committee of the Ministry of Agriculture and Fisheries and the Ministry of Transport has recently been issued under the title "Damage to Fisheries by Pollution." Allegations made from time to time of damage to fisheries by washings from tarred and other roads have led to the formation of the Committee and to the establishment of a special station for experimental investigations. The observations which are now asked for include notes on the behaviour of fish affected by pollution and the collection of samples of water and of mud. Instructions are given that when heavy rainfall occurs after a period of drought a sample should be taken of the rain-water (preferably at the height of the storm) from a clean roof or surface. Its temperature should be noted at once and the sample forwarded to an analyst, who should be asked to examine it for ammonia and nitrous and nitric acids. Presumably the flushing of the roof in the earlier part of a storm is relied on to give a sufficiently clean surface.

One difficulty in ascertaining how far any bad effects of a downpour of rain may be due to the pollution of the river is, that fish are extremely sensitive to sudden changes of water temperature, and the pamphlet recommends that temperature readings should be taken immediately after a storm for comparison with the pre-rainfall temperature. It will be noted that the organisation of regular readings of thermometers is pre-supposed by this recommendation. At present the only river temperatures which are published regularly in this country are those made by Mr. Hunter of the Derwent at Belper. These have appeared in the Monthly Weather Report for some years (up to September 1920 in a footnote to Table III, from October 1920 in Table IIIB). Much valuable information bearing on the subject of river pollution can be

derived from the regular observations of the impurities, both organic and inorganic, of the water of the Thames, the Lea and the New River, carried on by Sir Alexander Houston for the Metropolitan Water Board, in connection with the water supply of London; whilst the work of the Atmospheric Pollution Committee of the Meteorological Office shows to what extent pollution can be traced back to the fouling of the air by smoke.

Many rainfall observers are also keen fishermen, and it is hoped that such as have opportunities for making the required observations will communicate with the *Fisheries Secretary, Ministry of Agriculture and Fisheries*, 43 *Parliament Street, London, S.W.*1.

Official Publications.

The Rainfall of 1920.

ANY preliminary survey of the rainfall of the year must of necessity be incomplete and provisional, but it is useful at as early a date as possible to ascertain the broad outlines of the distribution in relation to the average.

In dealing with the returns for 1920, use has been made for the first time of a new set of rainfall averages prepared during the past few months. These are for the 35 years 1881–1915, the period selected for the standard climatological normals in the *Monthly Weather Report*. The number of averages available is greater than was the case formerly.

The rainfall of 1920 falls into two well-marked periods, the first seven months being generally wet, the latter five months generally dry. The general values for the months show, however, no striking departures from the average. The most unusual month was October when the distribution of rainfall was extremely abnormal.

MONTHLY GENERAL RAINFALL AS PERCENTAGE OF AVERAGE.

1920.	England and Wales.	Scotland.	Ireland.	British Isles.
January	150	142	151	147
February	77	164	89	112
March	150	137	129	139
April	204	100	146	153
May	117	164	145	141
June	99	65	78	82
July	170	104	153	143
August	59	85	62	68
September	95	87	85	89
October	58	67	127	79
November	49	106	110	87
December	101	91	97	96

The total rainfall of the year was above the average in the west, but a strip with slightly defective fall extended almost unbroken along the east coast of Great Britain. The deficiency in this strip was most marked in the extreme north and in the extreme south, less than 80 per cent. of the average falling at Dunrobin and at Dungeness. The only westerly areas with a defective fall were patches in the centre and north of Ireland and in the neighbourhood of Sidmouth.

In the wet districts excesses of more than 10 per cent. were widespread occurring over nearly the whole of the west of Great Britain, and in Ireland principally in the east and south. The areas of greatest excess were in Wales where the total rose in places to 30 per cent. above the average.

The general rainfall for the greater divisions of the British Isles was as follows :—

England, South	-	102 per cent. of the average.
„ North	-	110 „ „ „
Wales	-	121 „ „ „
England and Wales	-	109 „ „ „
Scotland	-	108 „ „ „
Ireland	-	113 „ „ „

For the British Isles as a whole the percentage is estimated as 109.

Winter Weather in Calypso Bay, Spitsbergen.

A FEW observations taken in Calypso Bay, Spitzbergen (1919–20), probably on board ship, by Colonel Boston, of the Northern Exploration Company, have been received from the Hydrographer.

The following short table summarises the results of the temperature observations :—

Temperature.	1919.	1920.				
	Dec.	Jan.	Feb.	Mar.	Apr.	May.
	° F.	° F.	° F.	° F.	° F.	° F
Highest - - - -	32	37	34	32	34	41
Lowest - - - -	−15	−20	−29	−29	−4	12
Mean of weekly extremes - -	15	12	4	12	12	29

It is noteworthy that rain was recorded on two occasions, on one of which the temperature did not rise above 23° F. A hurricane was experienced in January and a blizzard in February. The greatest frequency of snow was in March, when it occurred on 14 days. The ice in the bay broke up in April, and in May a rapid thaw set in.

A Mechanical Forecaster.

A SIMPLE mechanical forecaster has been put on the market by Messrs. Negretti and Zambra. Given a certain pressure and a certain wind direction, there must be a certain sequence of weather which is the most probable, and it should be possible to construct tables showing this probable sequence. It would be expected that the tables would be of enhanced value if separate ones were provided for summer and winter, for rising, falling or steady barometer.

Such tables are virtually combined in Messrs. Negretti and Zambra's mechanical contrivance, but there is nothing on the instrument to show on what statistics they are based.

A mechanical device has certainly great advantages over a set of tables from the point of view of compactness and convenience in use, but it limits the freedom of the designer in his choice of weather anticipated under different sets of circumstances. Thus, when he has settled the weather which will follow different barometric readings from 28·0 in. to 31·0 in. with a south wind, his choice of the weather for similar pressures with west wind or north wind is somewhat circumscribed by the form of the instrument.

That the expectation of bad weather should be accounted higher when the barometer is falling is in accordance with our usual habits of thought. It is not certain, however, whether the facts bear out this idea. E. H. Chapman has shown* that the correlation between the change in pressure in 12 hours and the rainfall in the following 24 hours is slight. No doubt the period of 12 hours is too long; the barometric tendency of our weather reports, *i.e.*, the change of pressure in 3 hours, should be a more reliable guide. The amateur who is provided with the new "Forecaster" should consult his barograph to learn whether pressure is rising or falling; comparison of this morning's reading of the barometer with last night's will not help him much.

Dr. Chapman has also investigated† the association of pressure at a definite hour with rainfall in the subsequent 24 hours. His conclusions are incorporated in a "Seasonal Aneroid," which is represented in his paper and which we understand has been put on the market by Messrs. Pastorelli and Rapkin.

It should be pointed out that any such instrument can only be of service in a restricted area. The Forecaster should be the London Forecaster or the Falmouth Forecaster or what not.

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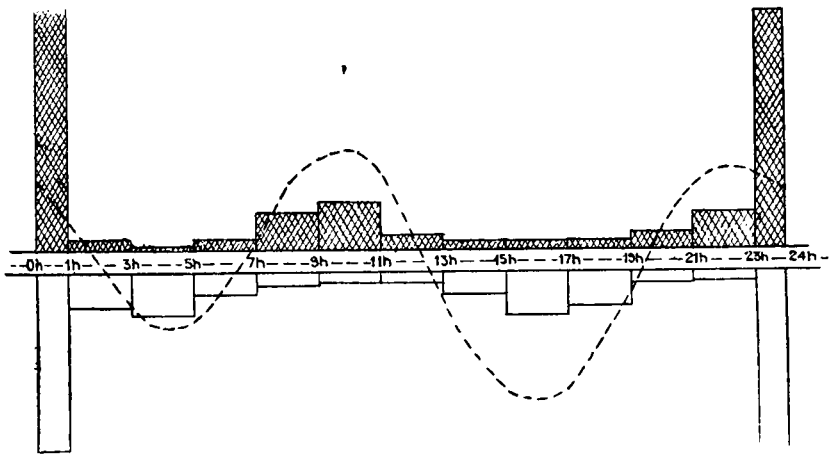
* Q.J.R. Met. Soc., Vol. XL., No. 172, October 1914.
† Q.J.R. Met. Soc., Vol. XLII., No. 180, Ootober 1916.

The Incidence of Barometric Maxima and Minima.

THE daily maxima and minima of pressure at British observatories have been published for many years in *Hourly Values from Autographic Records*, but their significance does not appear to have been closely investigated.* Dr. Arthur Turnbull, whose interest in the question is due to certain speculations about tides, has recently† examined the original tabulations of extreme pressures at Kew Observatory during five years, 1910–14, and has prepared tables showing the

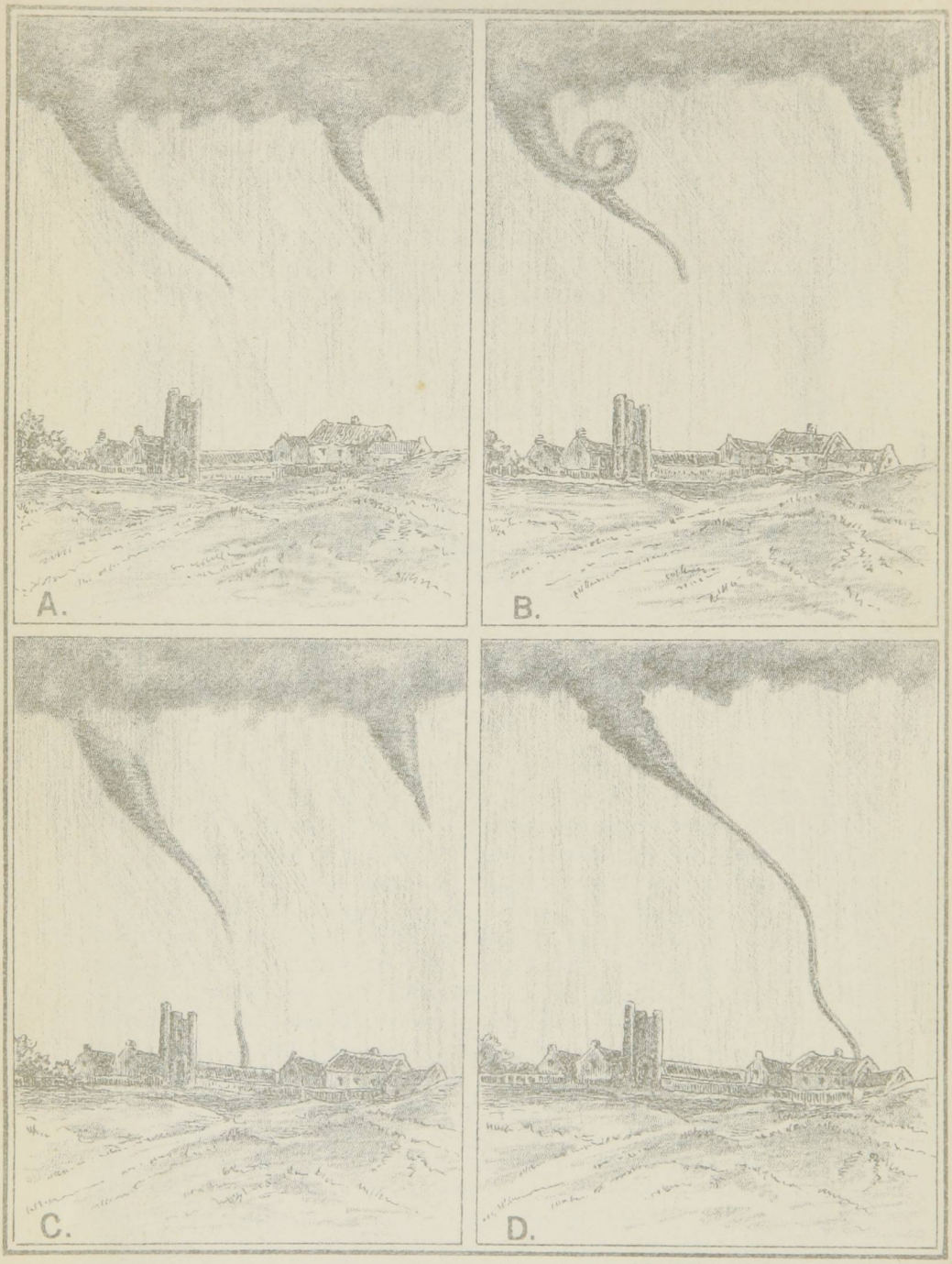


frequency with which maxima and minima of pressure occur at various times of day. Dr. Turnbull's results have been used in the preparation of the diagram reproduced herewith.

The frequency with which the maximum for the calendar day occurs between specified hours is represented by the area of the corresponding block, whilst the frequencies for the minimum are represented by the unshaded blocks. It will be noticed that, except at the beginning and end of the day, 2-hour intervals are utilised. The graph of the normal diurnal variation of pressure for Kew Observatory is superimposed on the frequency diagram. The crests and troughs of this graph are in close agreement with the greatest frequencies of the extremes of pressure. The striking excess of maxima and minima of pressure about midnight is no doubt due to the fact that when pressure is rising more or less steadily, the midnight reading is generally the maximum for the preceding 24 hours and minimum for the following 24 hours. The sum of the areas of the blocks on either flank

* An analysis of the time of occurrence of the extremes of temperature at Eskdalemuir has been published by Dr. Crichton Mitchell in the *Journal of the Scottish Meteorological Society*, Third Series Vol. XVII, No. XXXIV., 1917, p. 156.

† M.O. Letter 58,227/20.



CLOUD — PENDANTS: DUNMORE 1816.

By Robert Jacob.

H.M. Stationery Office Press, Kingsway W.C.2.

J. 201. Wt. 105. 435. 1250. 1/21.

of the diagram being about equal to the total area of the remaining blocks, it will be seen that it is about an even chance whether an extreme for the calendar day is really a turning point of the barogram or is merely incidental to the selection of midnight as the limit of the record.

Weather Lore.

IT is appropriate that "The Shepherd of Banbury's Weather Rules and Sayings"* should be reprinted by Mr. E. A. Walford, of Banbury. In his introductory remarks Mr. Walford tells us that John Claridge published his Shepherd's Legacy in 1670, but that the "Rules to Judge of Changes in the Weather" appear to have been issued earlier. Whether Claridge was actually a shepherd is not stated.

Mr. Walford mentions some of the other sources from which he has derived proverbs, but does not refer to Mr. Richard Inwards's book on Weather Lore. There is a large field for statistical investigation offered by all this proverbial wisdom. In these opening days of the year 1921 one cannot have much faith in the proverb

"In the decay of the moon, a cloudy morning bodes a fair afternoon,"

and some experiences mentioned lately in our correspondence columns do not bear out

"A rainbow at noon, rain very soon."

Few proverbs are quoted more frequently than

"Red at night is the shepherd's delight,
Red in the morning the shepherd's warning."

The first half of this couplet is plausible enough; but does experience bear out the second line? There should be observational evidence, but where is it to be found? If there had been an international symbol for a red sky our climatological summaries would have provided the information. The only summary we can recall is Lieut. Silvester's,† covering the single month of March 1917, which gives five "pink" sunrises, two of which were followed by gales with rain or snow.

Some Old Sketches of Cloud-Pendants.

IN connection with Mr. R. W. Smith's letter on cloud-pendants, published in the *Meteorological Magazine*, November, 1920, p. 224, Mr. J. Ernest Grubb, of Seskin, Carrick-on-Suir, has forwarded some interesting sketches of similar phenomena observed at Dunmore in 1816 by Robert Jacob. The sketches represent the aspect presented to an observer looking north towards Killea Hill. The following is Jacob's account of what he saw:—

* "The Shepherd of Banbury's Weather Rules and some Rhymes and Sayings," Edwin A. Walford, Bookseller, 71, High Street, Banbury.

† Q.J.R. Met. Soc., Vol. XLVI., No. 195, p. 268.

"Towards the latter end of summer 1816, while walking in the fields near the village of Dunmore at the entrance of Waterford Harbour, about 2 o'clock in the afternoon, I observed a gloomy appearance towards the north, which was evidently a heavy and partial shower of rain; the cloud from which it proceeded was of that form known by the name of nimbus, at no great distance, approaching me, being borne along by a gentle breeze. I had not long observed it when the margin next me, which was well defined, presented an unusual appearance in two places, as represented in the sketch marked A. These appendices had a very rapid spiral motion, and repeatedly increased and decreased; that to the left extended downwards and soon became much longer; it again contracted and in contracting assumed a very remarkable form which was indescribably beautiful and interesting. No sooner had it taken this peculiar shape, delineated in the sketch marked B, than it increased to a considerable length, every part still preserving the rapid spiral motion as at first. It continued to play in the air and extend itself towards the earth, and after some time it suddenly assumed the form represented in the sketch marked C. The second one disappeared, having retained the rapid spiral motion to the last. The other seemed for a short time to detach itself from the margin of the cloud, and something of a similar nature made its appearance near the earth; they approached, united, and formed the waterspout delineated in the sketch marked D. By this time it was not far from me, the spiral motion extremely beautiful from the margin of the cloud to the earth. The shower soon reached me, but ere I felt the falling drops of rain this curious phenomenon had disappeared.

"The rain was very heavy in that part of the country over which the cloud had passed. I had no instruments near me to ascertain the temperature of the atmosphere, height of the barometric column or quantity of rain which fell. The shower passed on to the wide extended ocean and nature resumed her smiling aspect."

Sunshine and Seed Culture.

WITH reference to the utility of the Book of Normals, Mr. J. L. North, of the Royal Botanic Society of London, writes: "I have long wanted to know what it was that made Essex and Suffolk and part of Norfolk the super counties for seed growers, and now I can see it is the excess of sunshine in July and August—the seed-maturing months. I had an idea it was some difference in the light itself—some actinic difference to which plants are sensitive, though we are not."

Messrs. Pastorelli & Rapkin, Ltd., of 46, Hatton Garden, E.C., send an attractive list of self-recording barometers, thermometers, and hygrometers, showing a number of handsome models at prices which, in these days, one can regard as moderate.

A BOOKLET recently issued by Messrs. Negretti and Zambra, under the title "Meteorological Data and other Facts," contains much out-of-the-way information, from the date of the Krakatoa Eruption to the weight of Cleopatra's Needle and the heaviest and lightest rainfall in the world. The quoting of authorities for the information is an excellent feature of the work, though it may not avert the criticism that in some cases the records have not been brought up to date.

Review.

Meteorology. By R. G. K. Lempfert, M.A., C.B.E., Assistant Director of the Meteorological Office. London: Methuen & Co., price 7*s.* 6*d.* net.

This little book contains an extensive but by no means an exhaustive account of meteorological phenomena. It is essentially the work of an experienced meteorologist; a physicist possessed of Mr. Lempfert's knowledge would have been tempted to treat the matter differently. A physicist is prone to regard meteorology as a storehouse of phenomena upon which he may draw to illustrate his laboratory experiments or his mathematical deductions; a meteorologist untiringly collects his data before venturing upon an explanation, and if he has a fault it is that he hesitates a little too long before attempting to introduce a physical theory. This, fortunately, cannot be strongly urged against the author, because, though the strength of Mr. Lempfert's book undoubtedly lies in its adherence to accredited meteorological facts, he has not hesitated to give *résumés* of modern theories designed to account for the phenomena he describes; this is indeed a valuable feature of his book. A wealth of material has become available since the publication of Mr. Lempfert's earlier booklet on "Weather Science," particularly with respect to upper air investigations, and it is because a most discriminating selection has been made from this material that the reader into whose hands the work falls will gain an excellent survey over recent meteorological work and will welcome it as an important addition to his library.

The author begins with a description of the weather map, and in presenting the salient features of the anticyclone and

the depression he does well not to overwhelm his reader with too large a variety of isobaric distributions. The rainfall in a depression is treated at some length, and in a later chapter we have an interesting account of his own and Sir Napier Shaw's work upon air trajectories in a travelling depression.

In a chapter upon Pressure, attention is drawn to the assumption regarding air temperature upon which continental observers base their barometric reductions to sea level, and it is subsequently pointed out that over elevated land the winds are nowhere blowing in accordance with the distributions of isobars drawn on the usual weather map. A relative error possessed by aneroids used as altimeters on aircraft receives attention, and it is evident that the correction involved may be large compared with the "lag" error, which these instruments usually possess.

Taken in conjunction with the account of the physical processes in the atmosphere, the three chapters in which the thermal structure of the atmosphere are discussed provide an excellent review of our present state of knowledge of this important branch of the subject. We find adiabatic lapse rate simply explained, and brief accounts are given of G. I. Taylor's work upon eddy motion and its influence upon fog formation, of Gold's explanation of the temperature conditions in the stratosphere, and of W. H. Dines' remarkable observations of temperature and pressure at different levels in cyclonic and anticyclonic distributions.

The phenomena associated with winds are first discussed from the point of view of the measurement of their velocities, their gustiness and their relation to the pressure distribution. In this we learn the trick of steering a wind across a track of country or ocean by applying a suitable pressure gradient at right angles to the direction which it is desired that the flow shall take, and we find also accounts of the distribution of average pressure at ground level and at 4,000 metres. The stimulating effect of the war is shown by the development of Bjerknes' schematic representation of the flow of air in a cyclonic disturbance, which was used by the Norwegian meteorologists when deprived of weather telegrams; and it is also shown by the method suggested for estimating the wind at considerable altitudes.

The diurnal variation of the wind and its variations with altitude is treated in the light of the researches of Taylor, the Eiffel Tower observers, and J. S. Dines, and one is glad to find a diagrammatic summary of G. M. Dobson's work upon the winds in the neighbourhood of the troposphere. Some rearrangement of material would have assisted the reader

here, and we miss a reference to Cave's work at Ditcham Park.

The investigation of the correlation coefficients between pressure and temperature at heights up to 13 kilometres by W. H. Dines leads to the conclusion that the pressure at the surface is mainly governed by the pressure at 9 kilometres, and on this point Mr. Lempfert subscribes to the view that it is probable that the main features of the distribution of pressure are dictated from above.

As has already been indicated, there are subjects which have not been fully treated: little will be found on thunderstorms or upon insolation; the suggestive results of Abbott's investigation into the variation of the solar constant surely deserve recognition in a work upon meteorology, and more upon the subject of forecasting from so experienced a meteorologist would have been welcome.

The book comes at a time when public interest in meteorology is greater than it has ever been before, thanks largely to the war, in which, as the author points out, the subject played a notable part, and thanks also to the development of aviation. It is no credit to us that before the war our agricultural and pastoral industries were so little alive to the value of meteorological studies that public opinion did not demand the widespread publication of weather maps in the daily press—elsewhere, notably in some of the Colonies, the usefulness of this knowledge has long been recognised. One is inclined to regret that Mr. Lempfert has missed the opportunity of insisting upon the benefits which a more extended knowledge of meteorological conditions may confer upon farming and allied industries. Something has already been done—I find around me a dairy bacteriologist keeping daily records of sunshine, a wheat expert correlating his crop with rainfall, a dairy farmer who looks askance at the approach of a thunderstorm, and many whose interest in weather forecasting only requires quickening. In his own book Sir Napier Shaw, by appealing to the agriculturalist, sets an example which might, I think, be followed with advantage. But the scope of the book before us is necessarily limited by its size, and it undoubtedly serves as an admirable text-book. It is well printed, and the illustrations are both numerous and clear; it should prove of interest both to the official meteorologist and to those whose work only touches the fringe of the subject.

W. G. DUFFIELD.

Reading, Jan., 1921.

Weather in the British Isles: December 1920.

OUTSTANDING features of the weather in the British Isles during Deecmber were the wintry spell which occurred during the second week, and the unusual warmth which set in just before Christmas. Other notable events were the gales which were experienced all over the kingdom on the 3rd, and the fogs which were very general between the 6th and 9th.

On the first day of the month an anticyclone extended over the Baltic and Central Europe, and at the same time a large cyclonic system, the main centre of which lay near Iceland, affected the British Isles, to which it brought gales and rainy weather, 24 mm. of rain falling at Blacksod Point and 19 mm. at Portland Bill. During the night of the 1st–2nd a depression over the English Channel moved across France, and filled up, and another depression crossed the north of Ireland, the cyclonic area being characterised by strong gales and unsettled weather with maximum temperatures as high as 55° F. on the 2nd over a large area in England and Ireland. On the 3rd a large depression over the British Isles moved first in a north-easterly direction to the North Sea, and then southwards towards Holland; and within the affected area there were further gales from the west or north-west, with unsettled weather generally. Gusts exceeding 30 metres per second were recorded on the 3rd at places as far apart as Dyce (near Aberdeen) and Falmouth, and at Southport 37 metres per second (84 miles per hour) was attained. Much damage was done to shipping, and at Halifax a tramcar was blown over and people injured. The weather map for this date records some very interesting changes in wind direction and in temperature, the latter being especially striking, the readings at Baldonnel (Dublin), for example, falling from 54° F. at 1 h. to 45° F. at 7 h., whereas at Lympne (Kent) during the same period there was a rise from 44° F. to 52° F.

An anticyclone which spread over the British Isles from the south-west in the rear of this depression reached Scandinavia by the 5th and remained the dominant feature on the weather map until the 18th. During this period the weather of the British Isles was also affected by depressions moving across the Icelandic region, but for the greater part the temperature was low, and although some of the days were sunny, fog occurred from time to time, and there were also occasional falls of snow and sleet. During the 5th sunshine was abundant in the south-west parts of the British Isles, and 7·4 hours were recorded at Penzance and 6·4 hours at Valencia Observatory. Fog was widely experienced on the 6th, 7th, and 9th; on the 6th, at Renfrew, and on the 9th, at Manchester, it persisted all day; during the night of the 7th there was fog over practically the whole of England. On the 10th there was slight snow in east and south-east England, and there was more over a wide area on the 11th, when it fell to a depth of 14 inches at Clacton. Mr. F. L. Bland, the observer at Copdock (Ipswich), reports that the heavy snowstorm on the night of the 11th ranks among the memorable falls of the last half-century, for it is extremely rare to find a uniform covering of 8 ins. without any drifting at all. The snow fell light and dry, so that the yield of water (17 mm.) is not large compared with some other snowstorms of recent years. Snow also fell at many places on the 12th, 13th, 15th and 16th, the melted snow yielding 15 mm. at Jersey on the 12th and 22 mm. at Plymouth on the 13th, the latter figure being in notable contrast to the fall which occurred at Princetown (9 mm.) and at Sheepstor (3 mm.). Some very low temperatures were associated with this wintry spell, and readings below 15° F. were recorded at many stations and were below 20° F. in parts of the London area on the 13th. The lowest reading reported was −1° F. at Raunds (Northants), other low minima in the shade being 4° F. at Cambridge and 3° F. at Oundle.

In striking contrast with these conditions was the abnormally mild weather which set in on the 18th and continued until the end of the year, the distribution of pressure over the British Isles during this period under the

THAMES VALLEY RAINFALL.——DECEMBER, 1920.

Meteorological Magazine

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

Isohyetals.

influence of Atlantic depressions being persistently cyclonic. At Christmas the weather was conspicuously abnormal. During the night of the 23rd a warm current from the south developed; the warm air had reached a line extending from the Thames Estuary to the north-west of Ireland by 7 h. on the 24th, on which day maximum temperatures of 55° F. were recorded at many southern stations. On Christmas Day, although there was a general deficiency of sunshine, maxima of 56° F. were reached at many places and 59° F. at Bude and at Llandudno. The minimum was 50° F. at Pembroke, Roche's Point, and Scilly, and only 49° F. at Kensington Palace—readings which may be compared with 32° F. at Nairn and 34° at Stornoway, Renfrew, and Eskdalemuir. Rain was general on Boxing Day, but the temperature remained high and maxima of 55° F. were common, and, except in the northern parts of the kingdom, these abnormally mild conditions were maintained until the close of the month.

The month was on the whole unfavourable for flying, being characterised by much low cloud and generally poor visibility. Conditions were very unsettled early in the month, with a south-west gale on the 3rd and a northerly gale next day. Afterwards there was a long spell of north-east winds and generally overcast weather, the clouds being usually very low, though occasionally above 2,000 feet. In the south-east of England conditions were rendered very unfavourable by fog on the 8th, snow on the 11th, and low clouds, rain and drizzle from the 17th and 19th. In the last ten days there was a change to a south-west type and rather better conditions, with some fine days of good visibility. In the south-east and east conditions were more favourable than elsewhere in this period, but low clouds and rain caused very bad flying weather on the 21st, 24th, 28th and 31st.

The total rainfall for the month was in excess of the average in nearly all parts of England and Wales, but the excess was extremely moderate. In Scotland and Ireland there was a slight deficiency except in parts of the east. Less than 75 mm. fell over the greater part of the English midlands and in the north-east of Scotland, but practically all westerly districts had more than 100 mm.

The areas with 250 mm. were apparently smaller than usual. The general values for the countries were England and Wales, 101; Scotland, 91; Ireland, 97; British Isles, 96.

In London (Camden Square) the mean temperature was 40·7° F., or ·6° F above the average. The duration of rainfall was 78·9 hours, and the evaporation, ·4 in.

Weather Abroad: December 1920.

At the beginning of the month unsettled weather was general over the Continent. A depression, moving in from the Atlantic, crossed England on the 3rd to the northern North Sea, whence it moved south over France to the Mediterranean, causing gales in the North Sea and heavy rain in the area affected by its passage. Paris recorded 55 mm. of rain in the 24 hours ending 7 h. on the 5th.

An anticyclone, moving from SW., covered the British Isles by the 5th, and then moved across to Scandinavia, where it remained until the 17th. Under the influence of a deep depression which had developed over the North Cape by the 18th, this anticyclone moved in a southerly direction and remained over Central Europe until the 20th.

During this fortnight, easterly wind, and very cold weather, with falls of snow, were prevalent over many parts of the Continent. In Germany, Central Europe and parts of France maximum temperatures remained below freezing point on several days. For example, on the 9th the

(*Continued on* p. 292.)

Rainfall Table for December 1920.

STATION.	COUNTY.	Aver. 1875–1909.	1920.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	2·13	2·36	60	111	·41	23	23
Tenterden (View Tower)	*Kent*	2·77	3·25	82	117	·34	1	26
Arundel (Patching)	*Sussex*	2·91	3·69	94	127	·74	23	14
Fordingbridge (Oaklands)	*Hampshire*	3·35	3·25	82	97	·42	1	19
Oxford (Magdalen College)	*Oxfordshire*	2·06	2·23	57	108	·32	23	22
Wellingborough (Swanspool)	*Northampton*	2·13	2·05	52	96	·62	29	16
Hawkedon Rectory	*Suffolk*	2·06	2·89	73	140	·49	4	24
Norwich (Eaton)	*Norfolk*	2·39	3·22	82	135	·31	5	28
Launceston (Polapit Tamar)	*Devon*	4·46	3·99	101	90	·57	30	18
Lyme Regis (Rousdon)	„	3·68	4·08	104	111	1·14	1	17
Ross (Birchlea)	*Herefordshire*	2·71	2·98	76	110	·57	1	23
Church Stretton (Wolstaston)	*Shropshire*	2·99	3·22	82	108	·68	29	20
Boston (Black Sluice)	*Lincoln*	1·88	2·39	61	127	·30	29	25
Worksop (Hodsock Priory)	*Nottingham*	2·17	2·35	60	108	·54	29	21
Mickleover Manor	*Derbyshire*	2·38	3·06	78	129	·68	29	19
Southport (Hesketh Park)	*Lancashire*	3·10	2·53	64	82	·54	24	17
Wetherby (Ribston Hall)	*York, W. R.*	2·27	3·08	78	136	·60	17	13
Hull (Pearson Park)	„ *E. R.*	2·32	2·69	68	116	·35	29	26
Newcastle (Town Moor)	*North'land.*	2·46	4·11	104	167	·81	29	21
Borrowdale (Seathwaite)	*Cumberland*	15·14	10·75	273	71	..	..	..
Cardiff (Ely)	*Glamorgan*	4·70	5·14	131	109	·95	30	22
Haverfordwest (Portfield)	*Pembroke*	5·18	5·00	127	97	·81	30	14
Aberystwyth (Gogerddan)	*Cardigan*	4·66	3·06	78	66	1·00	24	8
Llandudno	*Carnarvon*	2·84	2·21	56	78	·61	29	20
Dumfries (Cargen)	*Kirkcudbrt.*	4·84	6·15	156	127	1·06	29	19
Marchmont House	*Berwick*	2·83	4·48	114	158	1·00	29	19
Girvan (Pinmore)	*Ayr*	5·48	4·89	124	89	·88	1	19
Glasgow (Queen's Park)	*Renfrew*	3·95	3·28	83	83	·46	29*	19
Islay (Eallabus)	*Argyll*	5·73	4·47	114	78	·98	2	21
Mull (Quinish)	„	6·59	5·81	148	88	1·25	1	18
Loch Dhu	*Perth*	9·48	8·00	203	84	1·10	30†	17
Dundee (Eastern Necropolis)	*Forfar*	2·67	3·31	84	124	·39	21	21
Braemar	*Aberdeen*	3·13	4·96	126	158	1·09	3	17
Aberdeen (Cranford)	„	3·43	4·09	104	119	1·05	3	24
Gordon Castle	*Moray*	2·72	1·32	34	49	·37	3	13
Drumnadrochit	*Inverness*	3·76	2·69	68	72	·80	22	9
Fort William	„	9·41	6·57	167	70	1·12	25	19
Loch Torridon (Bendamph)	*Ross*	9·71	7·47	190	77	1·31	1	17
Stornoway	„	5·95	4·99	127	84	·88	20	20
Dunrobin Castle	*Sutherland*	3·09	2·08	53	67	·37	2	10
Wick	*Caithness*	3·11	2·39	61	77	·72	3	20
Glanmire (Lota Lodge)	*Cork*	5·29	5·41	137	102	·91	30	18
Killarney (District Asylum)	*Kerry*	6·92	5·84	148	84	·87	30	19
Waterford (Brook Lodge)	*Waterford*	4·32	4·42	112	102	·70	30	19
Nenagh (Castle Lough)	*Tipperary*	4·34	3·77	96	87	·58	28	20
Ennistymon House	*Clare*	5·03	3·68	94	73	·43	1	18
Gorey (Courtown House)	*Wexford*	3·42	4·48	114	131	·68	1	18
Abbey Leix (Blandsfort)	*Queen's Co.*	3·41	3·19	81	94	·62	29	17
Dublin (FitzWilliam Square)	*Dublin*	2·27	1·98	50	87	·49	29	18
Mullingar (Belvedere)	*Westmeath*	3·39	2·97	75	88	·55	24	15
Woodlawn	*Galway*	4·27	2·68	68	63	·42	23	17
Crossmolina (Enniscoe)	*Mayo*	6·11	5·76	146	94	·89	2	20
Collooney (Markree Obsy.)	*Sligo*	4·34	3·76	96	87	·53	3	18
Seaforde	*Down*	3·77	6·08	154	161	1·18	30	21
Ballymena (Harryville)	*Antrim*	3·97	4·79	122	121	1·02	30	22
Omagh (Edenfel)	*Tyrone*	3·91	3·86	98	99	·71	29	22

* and 30. † and 31.

Supplementary Rainfall, December 1920.

Div.	STATION.	RAIN.		Div.	STATION.	RAIN.	
		in.	mm.			in.	mm.
II.	Ramsgate	2·62	66	XII.	Langholm, Drove Rd.	5·73	146
,,	Sevenoaks, Speldhurst	2·91	74	XIII.	Selkirk, Hangingshaw	4·83	123
,,	Hailsham Vicarage	3·94	100	,,	North Berwick Res.	2·38	60
,,	Totland Bay, Aston	2·81	71	,,	Edinburgh, Royal Ob.	2·19	56
,,	Ashley, Old Manor Ho.	3·01	76	XIV.	Biggar	3·08	78
,,	Grayshott	3·86	98	,,	Leadhills	7·38	188
,,	Ufton Nervet	2·59	66	,,	Maybole, Knockdon	2·96	75
III.	Harrow Weald, Hill Ho.	2·39	61	XV.	Rothesay	5·16	131
,,	Pitsford, Sedgebrook	1·98	50	,,	Ardgour House	8·44	214
,,	Chatteris, The Priory.	1·93	49	,,	Inveraray Castle	5·56	141
IV.	Elsenham, Gaunts End	2·37	60	,,	Holy Loch, Ardnadam	7·61	193
,,	Lexden, Hill House	2·57	65	XVI.	Loch Venachar	5·30	135
,,	Aylsham, Rippon Hall	3·23	82	,,	Glenquey Reservoir	5·60	142
,,	Swaffham	2·59	66	,,	Loch Rannoch, Dall	5·22	133
V.	Devizes, Highclere	2·41	61	,,	Coupar Angus	3·69	94
,,	Weymouth	3·40	86	,,	Montrose Asylum	3·25	82
,,	Ashburton, Druid Ho.	8·79	223	XVII.	Balmoral Castle	3·86	98
,,	Cullompton	3·31	84	,,	Fyvie Castle	2·70	69
,,	Hartland Abbey	3·12	79	,,	Keith Station	2·11	54
,,	St. Austell, Trevarna	5·25	133	,,	Grantown-on-Spey	1·13	29
,,	North Cadbury Rec.	2·24	57	XVIII.	Cluny Castle	3·50	89
,,	Cutcombe, Wheddon Cr.	6·73	171	,,	Loch Quoich, Loan	12·70	323
VI.	Clifton, Stoke Bishop.	3·47	88	,,	Skye, Dunvegan	6·27	159
,,	Ledbury, Underdown.	2·59	66	,,	Fortrose	·85	22
,,	Shifnal, Hatton Grange	2·48	63	,,	Ardross Castle	3·31	·84
,,	Ashbourne, Mayfield	3·17	80	,,	Glencarron Lodge	7·01	178
,,	Barnt Green, Upwood	1·99	50	XIX.	Tongue Manse	2·24	57
,,	Blockley, Upton Wold	2·89	73	,,	Melvich Schoolhouse	1·58	40
VII.	Grantham, Saltersford	2·25	57	,,	Loch More, Achfary	3·77	96
,,	Louth, Westgate	3·12	79	XX.	Dunmanway Rectory	8·45	215
,,	Mansfield, West Bank	2·90	74	,,	Mitchelstown Castle	5·22	133
VIII.	Nantwich, Dorfold Hall	2·37	60	,,	Gearahameen	10·00	254
,,	Bolton, Queen's Park.	3·74	95	,,	Darrynane Abbey	5·62	143
,,	Lancaster, Strathspey.	3·19	81	,,	Clonmel, Bruce Villa	3·77	96
IX.	Wath-upon-Dearne	2·22	56	,,	Cashel, Ballinamona	3·70	94
,,	Bradford, Lister Park.	3·74	95	,,	Roscrea, Timoney Pk.	2·98	76
,,	West Witton	3·71	94	,,	Foynes	2·65	67
,,	Scarborough, Scalby	3·96	101	,,	Broadford, Hurdlesto'n	3·48	88
,,	Ingleby Greenhow	3·21	82	XXI.	Kilkenny Castle	3·26	83
,,	Mickleton	4·20	107	,,	Rathnew, Clonmannon	3·82	97
X.	Bellingham	5·32	135	,,	Hacketstown Rectory	3·76	96
,,	Ilderton, Lilburn	4·40	112	,,	Tullamore, Rathrobin	2·56	65
,,	Orton	6·42	163	,,	Balbriggan, Ardgillan	2·89	73
XI.	Llanfrechfa Grange	6·08	154	,,	Drogheda	3·30	84
,,	Treherbert, Tyn-y-waun	14·75	375	,,	Athlone, Twyford	2·75	70
,,	Carmarthen Friary	5·31	135	,,	Castle Forbes Gdns.	3·28	83
,,	Fishguard	4·22	107	XXII.	Ballynahinch Castle	6·31	160
,,	Lampeter, Falcondale	4·09	104	,,	Westport House	4·33	110
,,	Abergwngy	4·90	124	XXIII.	Enniskillen, Portora	4·24	108
,,	Cray Station	10·50	267	,,	Armagh Observatory	3·05	77
,,	B'ham W.W., Tyrmynydd	5·93	151	,,	Warrenpoint	5·17	131
,,	Lake Vyrnwy	6·73	171	,,	Banbridge, Milltown	3·23	82
,,	Llangynhafal, P. Dràw	2·18	55	,,	Belfast, Cave Hill Rd.	5·71	145
,,	Dolgelly, Bryntirion	4·79	122	,,	Glenarm Castle	6·01	153
,,	Lligwy	3·37	86	,,	Londonderry, Creggan.	3·30	84
XII.	Stoneykirk, Ardwell Ho.	4·68	119	,,	Sion Mills	3·37	86
,,	Whithorn, Cutroach	3·32	84	,,	Milford, The Manse	3·51	89
,,	Carsphairn. Shiel	7·83	199	,,	Killybegs, Rockmount	4·53	115

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean of Day M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	°F.		°F.		°F.	°F.	°F.	°F.
London, Kew Observatory	1013·9	−1·6	73	19	46	25, 28	66·9	53·2	60·1	−2·6
Gibraltar	1016·9	+1·6	90	25	62	15	81·3	67·0	74·1	−0·6
Malta	1015·0	+1·0	92	23	70	31	86·1	76·2	81·1	+3·6
Sierra Leone	1015·4	+2·9	88	10	69	8	82·2	72·0	77·1	−1·8
Lagos, Nigeria	1015·3	+1·5	87	21	72	8	81·5	74·2	77·9	+0·6
Kaduna, Nigeria	1016·1	+4·3	85	14,17,18	61	2	81·1	66·5	73·8	−0·8
Zomba, Nyasaland	1020·8	+2·9	78	18	48	14	71·7	53·3	62·5	+0·8
Salisbury, Rhodesia	1023·3	−0·7	76	17, 18	38	31	70·3	43·0	56·7	+0·8
Cape Town	1021·8	+0·5	77	12	39	4	62·8	48·7	55·7	+0·8
Johannesburg	1030·0	+0·5	71	21	36	12	62·1	42·1	52·1	+1·5
Mauritius	1022·2	+1·8	76	7	52	28	73·4	60·8	67·1	−1·2
Bloemfontein	..	..	71	20	23	18	63·8	32·8	48·3	+1·0
Calcutta, Alipore Obsy.	996·7	−2·5	95	1	77	27	88·5	79·6	84·1	+0·6
Bombay	..	..	89	1	75	7	84·3	78·3	81·3	+0·2
Madras	..	..	103	19	76	13	99·5	80·6	90·1	+2·8
Colombo, Ceylon	1010·2	+2·1	85	20, 23	74	24	84·4	77·0	80·7	−0·6
Hong Kong	1001·1	−3·8	93	25	76	20	87·0	79·1	83·1	+0·6
Sydney	1018·9	+0·4	68	1	40	13	61·6	47·1	54·3	+1·9
Melbourne	1017·6	−1·3	67	28	34	17	57·3	42·0	49·7	+1·1
Adelaide	1018·1	−2·3	65	20	39	15	59·3	44·6	51·9	+0·3
Perth, West Australia	1018·0	−1·1	71	22	35	30	62·2	46·1	54·1	−0·9
Coolgardie	1018·7	−1·2	71	23	29	1	60·7	38·2	49·5	−1·7
Brisbane	1018·4	+0·2	74	1, 28	41	13	68·1	51·1	59·6	+1·3
Hobart, Tasmania	1014·6	+0·9	59	1	36	18	54·4	40·8	47·6	+2·2
Wellington, N.Z.	1021·1	+8·2	61	9	29	25	54·3	41·5	47·9	+0·4
Suva, Fiji	1012·8	−1·4	85	24	55	3	78·4	66·0	72·2	−1·4
Kingston, Jamaica	1015·5	+0·8	95	15	71	12	90·8	74·2	82·5	+0·8
Grenada, W.I.	1014·5	+1·2	87	7	71	11	83·5	74·2	78·9	0·0
Toronto	1014·0	−0·1	87	30	44	16	76·7	56·1	66·4	−1·8
Winnipeg	1015·0	+2·3	89	26	39	15	79·6	53·3	66·5	+0·3
St. John, N.B.	1013·1	−0·6	83	9	50	18	68·1	53·1	60·6	+0·2
Victoria, B.C.	1018·8	+2·1	91	7	49	3	68·1	51·5	59·8	−0·5

LONDON, KEW OBSERVATORY.—Mean speed of wind 7·7 mi/hr ; 3 days with thunder heard, 1 day with fog.

GIBRALTAR.—1 day with fog.

MALTA.—Prevailing wind direction NW ; mean speed 5·9 mi/hr.

SIERRA LEONE.—Prevailing wind direction SW.

SALISBURY.—Prevailing wind direction Easterly.

MAURITIUS.—Prevailing wind direction NW ; mean speed 9·6 mi/hr.

British Empire, July 1920.

TEMPERATURE		Relative Humidity	Mean Cloud Am'nt	PRECIPITATION				BRIGHT SUNSHINE		STATIONS
Absolute				Amount		Diff. from Normal	Days	Hours per day	Percentage of possible	
Max. in Sun ° F.	Min. on Grass ° F.	%	0–10	in.	mm.	mm.				
138	34	74	8·0	4·40	112	+ 57	20	4·3	27	London, Kew Observatory.
151	58	73	2·1	0·00	0	− 1	0	..	..	Gibraltar.
147	..	76	0·7	0·00	0	− 1	0	11·6	81	Malta.
..	..	85	8·3	40·03	1017	+144	27	..	..	Sierra Leone.
158	70	88	6·6	9·55	243	− 26	21	..	..	Lagos, Nigeria.
..	..	93	..	6·78	172	− 60	22	..	..	Kaduna, Nigeria.
..	..	85	6·7	0·48	12	+ 5	4	..	..	Zomba, Nyasaland.
135	31	56	3·4	0·00	0	0	0	..	..	Salisbury, Rhodesia.
..	..	77	4·8	5·18	132	+ 42	13	..	..	Cape Town.
..	30	56	2·7	0·04	1	− 5	1	9·0	85	Johannesburg.
..	45	75	6·2	2·23	57	− 6	24	6·7	61	Mauritius.
..	..	57	2·1	0·00	0	− 10	0	..	..	Bloemfontein.
..	76	80	9·6	14·47	368	+ 41	18	..	..	Calcutta, Alipore Obsy
135	72	85	9·3	22·60	574	− 65	30	..	..	Bombay.
161	75	60	7·5	2·19	56	− 48	14	..	..	Madras.
157	72	76	8·2	2·54	65	− 65	15	..	..	Colombo, Ceylon.
..	..	81	7·4	24·04	611	+292	18	6·5	49	Hong Kong.
112	33	74	4·7	5·87	149	+ 27	16	..	..	Sydney.
109	30	76	4·9	1·53	39	− 7	17	..	..	Melbourne.
122	29	73	5·8	2·89	73	+ 6	16	..	..	Adelaide.
119	25	75	5·4	5·86	149	− 18	19	..	..	Perth, West Australia.
136	25	56	3·5	0·72	18	− 5	5	..	..	Coolgardie.
127	34	68	4·3	2·19	56	− 2	14	..	..	Brisbane.
105	28	72	5·1	0·77	20	− 34	16	5·3	57	Hobart, Tasmania.
111	18	82	5·7	2·42	61	− 83	11	4·1	44	Wellington, N.Z.
..	..	85	3·1	3·95	100	− 17	15	..	..	Suva, Fiji.
..	..	65	5·3	0·53	13	− 29	1	..	..	Kingston, Jamaica.
138	..	79	7·0	11·39	289	+ 40	28	..	..	Grenada, W.I.
147	38	73	4·5	3·64	92	+ 15	13	..	..	Toronto.
..	..	72	3·0	0·76	19	− 58	6	..	..	Winnipeg.
139	43	85	5·7	2·98	76	− 16	13	..	..	St. John, N.B.
145	43	75	3·3	1·00	25	+ 16	5	..	..	Victoria, B.C.

COLOMBO, CEYLON.—Prevailing wind direction WSW; mean speed 5·8 mi/hr.

HONG KONG.—Prevailing wind direction SE; mean speed 12·6 mi/hr.; 3 days with thunder heard.

PERTH.—Prevailing wind direction N; mean speed 10 mi/hr; 1 day with fog, 3 gales.

WELLINGTON, N.Z.—1 day with fog.

SUVA, FIJI.—3 days with thunder heard.

GRENADA.—Prevailing wind direction E.

maximum temperature was 23° F. at Neufahrwasser and Memel. Maxima of 19° F. at Aachen and 21° F. at Flushing and Brussels occurred on the 16th; at Lyons and Belfort, on the 17th, the temperature failed to reach 20° F.

After this period, low-pressure areas moved from Iceland to Scandinavia and pressure remained low in the Eastern Atlantic over a very large area until the end of the month. Temperatures rose generally over Western and Central Europe, and for the last week of December mild weather predominated on the Continent, except in Northern Scandinavia where severe frosts occurred. The 7 h. temperature at Saerna on the 28th was − 13° F., while at Haparanda on the 29th there was a reading of 6° F.

In the Western Mediterranean region low-pressure areas caused rather unsettled weather for about the first three weeks of the month, but on the 22nd an anticyclone, which had moved eastward from the Azores, began to spread over the Western Mediterranean. By the 25th it covered this area, and persisted until the end of the month, causing a spell of rainless weather. The winter rain has so far been scanty in India.

At Cairo and Alexandria the weather, except for an unsettled period at the end of the month, was mostly fine with temperature maxima round about 70° F.

At the beginning of the month beneficial rain fell in New South Wales generally, but in the second week abnormally heavy rain fell over an extensive area round Sydney, doing great damage to the wheat harvest. The storm was the worst that has been experienced in the State for 70 years; 10 in. of rain was recorded in three days, the average December rainfall being 2·6 in. The rain was particularly disastrous, coming after a three years' drought.

Near the middle of the month a heavy storm occurred at the Japanese naval station at Kure, in which 29 vessels laden with iron and coal sank and several heavy guns were plunged into the sea by a landslide.

Geostrophic Wind over London; February, 1881–1915.

FREQUENCY OF STRENGTH AND DIRECTION.

Estimates based on the D.W.R. charts (8 *h.*, 1881–1908; 7 *h.*, 1909–1915).

Direction.	5 m/s. 11 mi/hr.	10 m/s. 22 mi/hr.	15 m/s. 33 mi/hr.	20 m/s. 44 mi/hr.	Over 20 m/s. Over 44 mi/hr.	Total Frequency of Direction.
N.	14	12	17	7	4	54
NE.	12	21	13	9	3	58
E.	9	19	16	11	3	58
SE.	27	14	7	6	3	57
S.	16	20	13	9	10	68
SW.	19	59	44	31	48	201
W.	11	50	56	39	41	197
NW.	16	25	36	23	13	113
Total Frequency of strength	124	220	202	135	125	806*

* Indeterminate—181.