Symons's
Meteorological Magazine.

No. 630. JULY, 1918. Vol. LIII.

SIR NAPIER SHAW ON REVOLVING FLUID IN THE ATMOSPHERE.

In a recent memoir communicated to the Royal Society* Sir Napier Shaw gives an extremely interesting and important summary of his views on the subject of "revolving fluid in the atmosphere" following Lord Rayleigh's contribution to the dynamics of this subject based on the paper by Dr. John Aitken, F.R.S. on "The Dynamics of Cyclones and Anticyclones." Lord Rayleigh in the introduction to his paper remarked that "so much of meteorology depends ultimately upon the dynamics of revolving fluid that it is desirable to formulate as clearly as possible such simple conclusions as are within our reach," with the object of finding their application in the phenomena shown by cyclones and anticyclones. At the beginning of the paper Sir Napier Shaw states that in the twenty years during which he has been practically concerned with the progress of dynamical meteorology and the explanation of the observed phenomena of cyclones and anticyclones he has deliberately avoided the discussion of the theory of revolving fluid because he could not find it in the weather maps which form the starting point for such an investigation. In several previous investigations, of which the most exhaustive was the well known memoir dealing with "The Life-History of Surface Air Currents," it was clearly shown that in our latitudes cyclones and anticyclones are not examples of revolving fluid in the special sense referred to, and for that reason cannot be explained on the hypothesis that they are. The situation is summed up by the statement that "if the motion of the air had really been motion of a revolving fluid symmetrical with regard to a vertical axis it would not have appeared in circular form on the map. If it looks circular it is not a case of revolving fluid." This apparent paradox is explained thus, that the rate

* *Royal Soc. Proc.*; A, Vol. 94, pp. 34-52.

at which all the depressions of well marked circular form in our latitudes travel is much the same as that of the wind velocity of which they are composed. Stationary depressions are of irregular form and do not show the characteristic features of strong winds with a definite centre." But when the motion of translation is of the same order of magnitude as the winds the instantaneous motion is round a moving centre, and the actual motion with reference to the centre is the apparent uniform motion round the centre shown on the map combined vectorially with a velocity equal and opposite to that of the translation of the cyclone. Consequently the appearance of uniform and symmetrical instantaneous motion in a cyclone is in itself proof that we have not in that case symmetrical motion, about a centre, of a mass which travels as a whole. In other words the motion of air in cyclones is not the motion of revolving fluid in the special sense referred to." In "The Life History of Surface Air Currents," this conclusion was amply confirmed for all classes and forms of depressions. Cyclonic motion is, therefore, not analogous to that of a vortex ring travelling in air, but on the other hand the trajectories of a moving cyclonic disturbance show that the air flows through the depression. The vortex, therefore, does not actually breathe or pulsate. Visible examples of revolving fluid whose existence cannot be denied are are to be found in the eddy of dry leaves in a gusty wind at a street corner, the "dust-devil" of Eastern deserts, the water spout, the whirlwind, and the tropical cyclone, which is universally treated in text books of meteorology as a gigantic eddy typically analagous to the vortex ring. These, Sir Napier Shaw says, *may* (the italics are ours) be cases of revolving fluid, but they do not correspond with the phenomena of the cyclonic depressions of middle latitudes such as those experienced in the British Isles, where, during the ten years ending with 1916, a new cyclonic depression was shown on the weather maps on the average every third day. It is pointed out that a cyclonic disturbance which began as revolving fluid in the tropics is gradually transposed in higher latitudes into an ordinary cyclonic depression "and yet we have to deny the identity of the two types of phenomenon." Here a short digression containing a mathematical proof is given to show how the revolving tropical cyclone passes into the depression of our own latitudes, and how it is quite possible that in the end "the conditions necessary for maintaining a core of revolving fluid disappear and the whole system degenerates (if that is the correct expression) into cyclonic motion without a core of revolving fluid." There is nothing in the weather maps to contradict such a suggestion, although it is pointed out that owing to the destruction of buildings, instruments and sometimes the human beings who attend to them, the tropical revolving storm is a very unsatisfactory example of revolving fluid for scientific purposes. It is thus impossible to ascertain whether the behaviour

of a tropical storm is in harmony with Lord Rayleigh's theory or Dr. Aitken's practical illustrations. Sir Napier Shaw in his investigations starts with the assumption which meteorologists cannot deny that temporary whirls are actually visible, and cites a case described by Mr. R. H. Curtis of a whirl which carried off the sheets of music from an open-air band-stand with a spinning motion to a great height and dropped them some miles away. Here there are obviously two elements, the current which carries the whirl, and the whirl within the current. The supposition is made that we have here a mass of revolving fluid with a discontinuity of velocity at the circle bounding the revolving mass. There may be a relation at the margin of the whirl and the wind in the current which carries it, but as shown by Lord Rayleigh, and Dr. Aitken, the velocity in the whirl at any time depends upon dynamical or physical processes within the whirling mass itself. No general assumption can therefore be made of a relation between the velocity in the whirl and the rate of its translation. The difficulty of investigating small whirls is that they cannot be detected on the working weather map, if under twenty miles in diameter. The vortex that appears on such a map it is shown " must be more like a penny than a pin." A method was devised for the investigation and identification of vortices having a temporary existence in the atmosphere, but not to be found directly on the map. This is described on pp. 40-44 of Sir Napier Shaw's paper, but considerations of space render it impossible to go into the matter here with the fulness necessary for a clear understanding of the procedure. It will be sufficient to say that in addition to a large number of illustrative cases two special cases are cited, *viz.*, the destructive " secondary " depression of March 24th, 1895, which in the eastern counties of England was unattended with any rainfall either before, or during, or after the strong wind. Except for the wind it was a fine afternoon and remained so. The second case is the tornado in Devonshire and South Wales on October 27th, 1913, which did not appear on the working charts at 6 p.m. when the greatest damage was done. The first case may " be cited as a good example of revolving fluid carried along in a main current, the velocity of translation being governed by the spacing of the isobars of the main depression outside the area affected by the local rotation, and, in virtue of this, the air which formed the mass of revolving fluid over the south of Ireland at 8 a.m., was carried along bodily to Denmark by 6 p.m." As a good deal of rain fell in the west its existence is *prima facie* evidence of considerable convection in the atmosphere. It is thus reasonable to suppose that the special conditions involved in the maintenance of a column of revolving fluid are satisfied, namely that the wind velocity in the surrounding medium should be the same at all elevations. The second case cited, *viz.*, the tornado in the Taff Valley, Glamorgan, in which the barograph near the centre showed

a sudden fall and recovery of 10 mb. (·30 in.), within less than one minute, and where the localities where damage was done were those of heavy rainfall, was evidently associated with a very definite line of discontinuity marking off the area of rotational velocity from its environment. The destruction in South Wales seems to have been occasioned by the conveyance of the air within the moving column of revolving fluid, forming an excellent example of the progression of revolving fluid, although it was impossible to identify it on a map. Sir Napier Shaw sums up his conclusions in the following words, "We are thus able to draw a definite distinction between the cyclonic or anticyclonic motion as exhibited in the atmosphere and cases of revolving fluid motion. In the latter there is rotation about the vertical axis and the whole mass of revolving fluid is carried along bodily in a current of air which has a velocity corresponding with its position in the main cyclonic system and which can be related to the run and the distance apart of the isobars. There is practical discontinuity of velocity between this current and the rotating mass, and there is no relation between the velocity of wind in the whirl and the velocity of translation in which the whirl travels over the country. In the case of a cyclonic depression the travel over the country is a part of the motion of the wind in the cyclone itself. There is no discontinuity of velocity. The wind so moves that each part of it revolves about a centre which has a motion of translation. The rate of progress of the centre depends upon the curvature of the path of the air in the cyclone, and the motion of the centre is apparently due to the fact that the cyclostrophic component of the pressure is governed by the radius of curvature of the path and not by the radius of the circle of instantaneous motion. The motion in a travelling cyclonic depression is therefore of a different type from that of motion in a circle with a superposed velocity of translation." The memoir concludes with a supplementary note remarking that the terms used by the author are remarkably similar to those employed by Prof. R. de C Ward in his investigation on "Tornadoes in the United States," published last July in the *Quar. Jour. Roy. Met. Soc.* There can be little doubt that these violent manifestations are columns of revolving fluid developed locally in the southern portions of large cyclones and carried along with the ordinary wind of the cyclone in which they are formed. R. C. M.

ROYAL METEOROLOGICAL SOCIETY.

THE last monthly meeting for the 1917-18 Session was held on June 19th, at 70, Victoria Street, S.W., Sir Napier Shaw, F.R.S., President, in the Chair.

Dr. S. Chapman, F.R.A.S., read a paper entitled "The Lunar Atmospheric Tide at Greenwich, 1851-1917." The tidal forces, due to the moon, affect the aerial as well as the fluid ocean, and the lunar atmospheric tide is manifested by a periodic variation in the height of the barometer having two maxima and two minima (high and low tide) in the course of a lunar day. This variation is much smaller than the solar semi-diurnal barometric variation, which is not a simple solar tidal effect; the minute lunar variation, however, can be detected with ease in the records of tropical observatories, where the irregular fluctuations of pressure are small. Attempts to determine it in the records of European observatories have been made, but hitherto without success. By treating hourly observations of "quiet" days only, on which the barometric range did not exceed 0·1 in., and by abstracting the solar variation, the lunar atmospheric tide at Greenwich has now been ascertained. Its total amplitude is less than 0·001 in., the harmonic formula being 0·00038 sin $(2t + 114°)$ inch, where "t" represents lunar time measured, at the rate of 360° per lunar day, from the epoch of upper transit. A comparison with the variation at Batavia (lat. 6° S.), viz., 0·00256 sin $(2t + 65°)$ inch, suggests that the amplitude varies as the fourth power of the cosine of latitude, and that the phase also varies with latitude.

A paper by Mr. Miller Christy was also read, entitled, "The Audibility of Gunfire on the Continent at Chignal St. James, near Chelmsford, during 1917," in which the author continued his series of observations of the sound of gunfire commenced in 1915 and published by the Society in 1916. In the present paper the record is confined entirely to Mr. Christy's observations at Chignal St. James. The most interesting point in connection with the observations is that there is apparently (1) a regular and well-defined season or period during which the gunfire is usually audible with ease, and that this is followed by (2) a longer season or period during which the gunfire is seldom or never heard. The following are the earliest and latest dates of the sound of the gunfire on the Continent as heard at Chignal St. James during the three years 1915-1917 :—

1915—From about	**1st May**	**to about**	**31st August**	**=**	**17**	**weeks**	**3**	**days**
1916—	**„**	**„**	**1st May**	**„**	**15th August**	**=**	**15**	**„**	**1**	**„**
1917—	**„**	**„**	**22nd April**	**„**	**6th Sept.**	**=**	**19**	**„**	**4**	**„**

Mr. F. J. W. Whipple, F.R.Met.Soc., contributed a paper entitled, "Seasonal Variation in the Audibility of Gunfire." Mr. Christy's

observations indicate that in Essex continental gunfire is only heard during the summer months. On the other hand, evidence collected by W. Brand and published in the *Meteorologische Zeitschrift*, in February, 1917, indicates that in Germany at places 100 km. or more from the firing line, such sounds are only heard during the winter. Thus it appears that in summer the outer zone of audibility lies to the west of the source of sound, in winter to the east. No theory hitherto put forward in explanation of the existence of the outer zone of audibility is in accord with this generalization.

The following gentlemen were elected Fellows of the Society :—Messrs. F. G. Bales, J. Hooley, H. E. Richards, F. L. Watkins, Rev. T. E. R. Phillips, Lieut. W. H. Pick, R.E. and Ensigns P. J. Barnes, J. C. Boyd, A. Gardner, H. le G. Goodspeed and W. S. Vanderbilt, of the U.S. Naval Reserve Force.

Correspondence.

To the Editor of Symons's Meteorological Magazine.

DRY AIR AT TOTLAND BAY.

THE mean humidity for the month of June at 9 a.m. (Greenwich time) amounted to only 69·4 per cent. This is the driest June atmosphere during all the thirty-two Junes I have taken readings at Totland Bay. The nearest approach to it was in June, 1911, with a relative humidity of 71·3 per cent. The boundary line of Totland parish measures eight miles; six of these miles are washed by the sea.

An absolute drought of 17 days ended on June 8th, showing a deficiency of 97 tons of rain water to the acre, and a partial drought of 33 days terminated on June 14th, giving a deficiency of 157 tons of water to the acre.

On June 15th, we had the unusual scene for half an hour of fields all white with large hailstones in the late afternoon; distant thunder, but no lightning accompanied the hail.

Many places have had ground frosts this June, but the nearest approach to it here was a temperature of 35·9 F. by the exposed thermometer on the grass on June 26th. JOHN DOVER.

Aston House, Totland Bay, Isle of Wight.

BLACK RAIN.

In case it is of any interest I am reporting to you that in a very heavy rainfall, on Monday afternoon, June 17th, here (about 6 p.m. summer-time) the rain was black as if full of soot, not only close to buildings but in the rain gauge. I was not at home at the time, but my daughter kept the contents. I understand the wind was northerly. Could the storm have brought London smoke in suspension? We are about twenty-nine miles from the City, but it is the only solution I can think of. T. H. W. BUCKLEY.

The Grange, Crawley Down, June 19th, 1918.

WARM MAYS.

During recent years there has been a remarkable predominance of warm Mays According to the Meteorological Office Calendar, the mean temperature for May in the Midlands, as derived from observations made in the period 1881-1905, is 51°·1, F.

This value has been exceeded here in nine out of the past eleven years. The mean temperature of May for the decade 1908-17 was 52°·9, and, according to the law of averages, a cold May was certainly due in 1918. Yet the May just passed was warmer than any in the preceding ten years. The mean temperature was as high as 55°·9, with " summer heat " on six days, and a maximum reading of 84°—the highest temperature recorded here in May during the past quarter century. DAVID HILL OWEN.

Sparkhill, Birmingham, June 7th, 1918.

DIURNAL VARIATION OF PRESSURE AND WIND VELOCITY.

It is well known that at exposed places like the top of Ben Nevis, and probably also at other stormy spots on our western coasts, the barometric pressure is reduced appreciably with winds above a certain force. This effect increases with each augmentation in wind velocity and is due to the suck-out of air from the room in which the barometer is hung. As wind velocity has a well-marked diurnal range, the hourly values of pressure must be modified accordingly, especially at places where the wind velocity is high, and its daily range considerable. Has this factor ever been taken into account in discussing the diurnal range of pressure in exposed situations?

R. C. MOSSMAN.

Edinburgh, June 4th, 1918.

LOCAL WHIRLWIND.

My gardener has told me of a curious little whirlwind he witnessed some days ago. Two men were digging a piece of ground in the middle of the orchard where the apple trees are far apart, sloping towards south-east, they heard a noise like distant thunder; as it continued they looked up and saw dead leaves being swept up from the ground and whirled to a height of 40 feet. This whirlwind moved in an irregular direction, and when it passed near them seemed to be icy cold. I believe it was a sunny afternoon, with north-east wind.

R. B. ROGERS.

Hexworthy, Launceston, Cornwall, April 26th, 1918.

GOVERNMENT COMMITTEE ON WATER POWER.

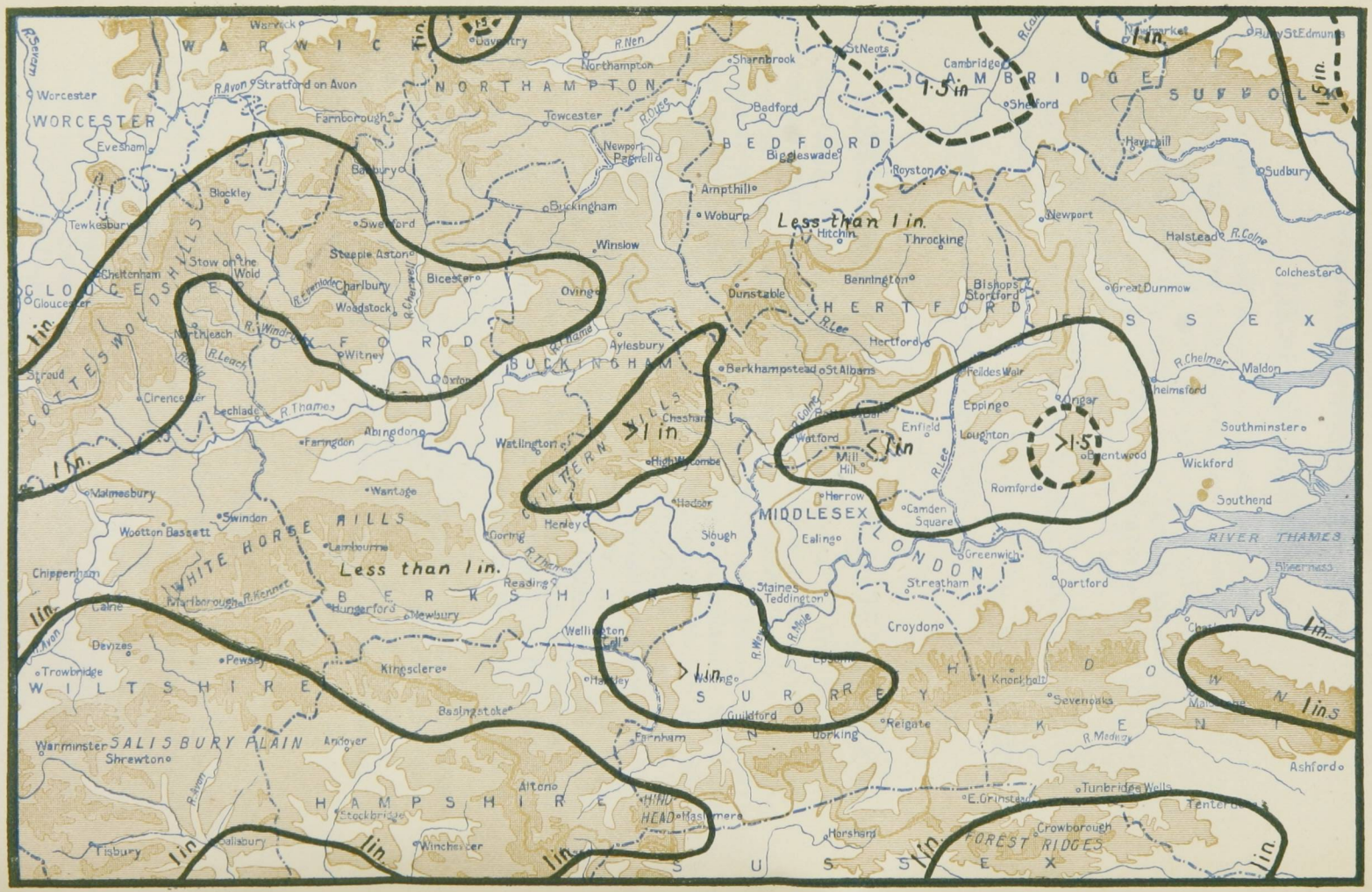
The Board of Trade, with the concurrence of the Ministry of Reconstruction, have appointed a Committee to examine and report upon the Water Power resources of the United Kingdom, and the extent to which they can be made available for industrial purposes. The following are the members of this Committee :—Sir John F. C. Snell, C.E., Chairman; Mr. G. S. Albright, Mr. H. F. Carlill (Board of Trade), Sir Dugald Clerk, F.R.S., Dr. J. F. Crowley, Mr. Philip Dawson, Professor Gibson of University College, Dundee, Mr. Vernon Hartshorn, Dr. H. R. Mill, Mr. A. Newlands, C.E., Mr. G. C. Vyle (Associated Chambers of Commerce), Mr. A. J. Walter, K.C., Mr. Ralph Walter (Ministry of Reconstruction) and Mr. D. J. Williams. Mr. R. T. G. French is the Secretary of the Committee, the address of which is 10, Princes Street, Westminster, London, S.W. 1.

The Sub-Committee of the Conjoint Board of Scientific Societies for enquiring into the Water Power of the British Empire, under the chairmanship of Sir Dugald Clerk, has, as the result of its investigations drawn up a preliminary report for presentation to the Conjoint Board.

NEW POSTAL RATES.

Rainfall observers who send in monthly postcards (British Rainfall, Form C.) can continue to do so at the ½d. rate of postage, provided that when completed in hand-writing the latter refers solely to the subject matter. This would exclude any remark other than one relating to the weather of the month. Until a new edition of cards can be printed, the words " Post Card " should be struck out and the words " Printed Paper " substituted.

THAMES VALLEY RAINFALL JUNE, 1918



THE WEATHER OF JUNE.

A SPELL of fine warm weather, which had commenced about the third week in May, continued throughout the early days of June. On the 2nd, which proved by far the hottest day of the month, the thermometer rose slightly above 80° in many parts of England and Ireland, and reached 83° at Camden Square and 84° at Killarney. In the eastern, central and south-eastern districts the nights were, however, cold, and between the 3rd and 5th, a sharp ground frost occurred in many places, the exposed thermometer falling to 19° at Raunds (Northants), 26° at Greenwich, and 27° at Wisley.

Towards the close of the first week an absolute drought (which had, however, only just exceeded the prescribed limits) came to an end, and for more than a fortnight the weather was generally cool and showery. The wind was usually from some point between W. and N., and on the 9th and 10th, when small depressions moved south-eastwards across the country, a gale was experienced in many of the western and northern districts, the velocity of the wind in gusts being as high as 76 miles per hour at Aberdeen. Between the 12th and 15th, a large cyclonic disturbance passed slowly eastwards from Iceland to Scandinavia, while further secondaries moved directly across the United Kingdom. Thunderstorms were experienced in many isolated parts of Great Britain on the 15th, and in the south-east of England on the 16th and 17th, while on the 18th and 19th, when a well marked depression moved eastwards across our southern districts, a heavy fall of rain occurred in some parts of Devonshire and South Wales. The day temperatures recorded about this time were extremely low for the time of year, the thermometer in many places failing to reach 55°, and the nights were also very cold. One of the most striking features in the weather of June was in fact the general prevalence of ground frosts. In addition to the cases already quoted (between the 3rd and 5th) the phenomenon was observed on the nights of the 14th the 16th-17th, and between the 23rd and 25th. At Benson (Oxon.) ground frost occurred during the month on as many as eight nights, three of which were consecutive. Strong N.W. winds, which prevailed on the 22nd, again reached gale force in many places, the gusts blowing with a velocity of 60 miles an hour, at Southport, and 54 miles at Paisley, Eskdalemuir and Holyhead. In the closing week the weather became more settled, and although the nights remained cold, the day temperatures gradually rose to a point slightly in excess of the June average.

The total amount of bright sunshine for the month was in excess of the normal. In most districts the departure was slight, but in England S.W. the mean daily duration was an hour and a half more than the average.

The rainfall was practically everywhere below the average, most so in England, where only a few districts had as much as 50 per cent. In the east of Scotland also less than half the average fell. The total fall was less than an inch in the east generally and very few stations in England had as much as 2 inches. In Wales and the west of Scotland considerable areas had more than three inches, but this amount was experienced only very locally in the west of Ireland.

In London (Camden Square), the mean temperature was 59°·3, or 0·8 below the average. The duration of bright sunshine was 188·2 hours, and of rainfall, 18·6 hours. The total evaporation from a free water surface was 3·01 in.

RAINFALL TABLE FOR JUNE, 1918.

STATION.	COUNTY.	RAINFALL.						
		Aver. 1875–1909. in.	1918. in.	Diff. from Av. in.	Per cent. of Av.	Max. in 24 hours. in.	Max. in 24 hours. Date.	No. of Days
Camden Square	*London*	2·28	1·30	— ·98	57	·42	14	11
Tenterden	*Kent*	2·03	·96	—1·07	47	·31	19	11
Arundel (Patching)	*Sussex*	2·13	·85	—1·28	40	·40	18	8
Fordingbridge (Oaklands)	*Hampshire*	1·93	·96	— ·97	50	·54	18	7
Oxford (Magdalen College)	*Oxfordshire*	2·27	1·07	—1·20	47	·32	18	13
Wellingborough (Swanspool)	*Northampn*	2·14	·49	—1·65	23	·09	18	14
Bury St. Edmunds (Westley)	*Suffolk*	2·21	·95	—1·26	43	·33	19	10
Geldeston [Beccles]	*Norfolk*	1·77	1·90	+ ·13	108	·88	17	12
Polapit Tamar [Launceston]	*Devon*	2·18	1·93	— ·25	88	·62	18	12
Rousdon [Lyme Regis]	,,	2·18	1·02	—1·16	47	·64	18	8
Stroud (Field Place)	*Gloucester*	2·43	·96	—1·47	40	·45	18	11
Church Stretton (Wolstaston)	*Shropshire*	2·59	1·03	—1·56	40	·26	18	9
Boston	*Lincoln*	1·95	·81	—1·14	42	·35	25	10
Worksop (Hodsock Priory)	*Nottingham*	2·06	·80	—1·26	39	·29	25	9
Mickleover Manor	*Derbyshire*	2·55	·81	—1·74	32	·18	9	11
Congleton (Buglawton Vic.)	*Cheshire*	2·69	1·93	— ·76	72	·39	9	17
Southport (Hesketh Park)	*Lancashire*	2·26	1·66	— ·60	73	·50	6	12
Wetherby (Ribston Hall)	*York, W.R.*	2·17	·72	—1·45	33	·35	16	4
Hull (Pearson Park)	,, *E.R.*	2·09	·40	—1·69	19	·11	6	9
Newcastle (Town Moor)	*North'land*	2·04	·71	—1·33	35	·30	6	7
Borrowdale (Seathwaite)	*Cumberland*	6·94	...	...	...	...	...	...
Cardiff (Ely)	*Glamorgan*	2·55	1·87	— ·68	73	1·01	18	14
Haverfordwest	*Pembroke*	2·74	1·63	—1·11	59	·59	18	9
Aberystwyth (Gogerddan)	*Cardigan*	2·97	2·18	— ·79	73	·67	9	12
Llandudno	*Carnarvon*	1·97	1·26	— ·71	64	·41	9	12
Cargen [Dumfries]	*Kirkcudbrt.*	2·84	1·42	—1·42	50	·33	6	14
Marchmont House	*Berwick*	2·38	·47	—1·91	20	·16	15,20	7
Girvan (Pinmore)	*Ayr*	3·04	2·19	— ·85	72	·44	9	15
Glasgow (Queen's Park)	*Renfrew*	2·41	1·11	—1·30	46	·21	7·22	12
Islay (Eallabus)	*Argyll*	2·80	2·14	— ·66	77	·33	15	21
Mull (Quinish)	,,	3·30	2·96	— ·34	90	·57	6	19
Balquhidder (Stronvar)	*Perth*	4·07	...	...	...	...	...	...
Dundee (Eastern Necropolis)	*Forfar*	2·06	·81	—1·25	39	·33	15	10
Braemar	*Aberdeen*	2·18	·91	—1·27	42	·16	15	11
Aberdeen (Cranford)	,,	2·02	1·57	— ·45	77	·28	20	15
Gordon Castle	*Moray*	2·13	1·89	— ·24	89	·47	15	15
Drumnadrochit	*Inverness*	2·26	2·14	— ·12	95	·50	15	18
Fort William	,,	3·77	3·83	+ ·06	102	1·21	13	16
Loch Torridon (Bendamph)	*Ross*	4·07	4·10	+ ·03	100	·73	6	17
Dunrobin Castle	*Sutherland*	2·10	1·46	— ·64	70	·52	22	10
Glanmire (Lota Lodge)	*Cork*	2·91	·97	—1·94	34	·43	8	9
Killarney (District Asylum)	*Kerry*	2·92	2·54	— ·38	87	·52	8	13
Waterford (Brook Lodge)	*Waterford*	2·79	1·80	— ·99	65	·39	8	10
Nenagh (Castle Lough)	*Tipperary*	2·70	1·69	—1·01	63	·46	8	15
Ennistymon House	*Clare*	3·18	1·77	—1·41	56	·33	8	14
Gorey (Courtown House)	*Wexford*	2·59	1·29	—1·30	50	·29	8	11
Abbey Leix (Blandsfort)	*Queen's Co.*	2·58	1·70	— ·88	66	·43	8	16
Dublin (Fitz William Square)	*Dublin*	2·00	·91	—1·09	45	·19	9	13
Mullingar (Belvedere)	*Westmeath*	2·72	1·89	— ·83	69	·38	9	11
Crossmolina (Enniscoe)	*Mayo*	3·17	1·74	—1·43	55	·29	17	14
Cong (The Glebe)	,,	3·18	1·38	—1·80	43	·33	16	13
Collooney (Markree Obsy.)	*Sligo*	3·11	2·79	— ·32	90	·76	8	18
Seaforde	*Down*	2·88	1·43	—1·45	50	·36	18	12
Ballymena (Harryville)	*Antrim*	2·89	2·14	— ·75	74	·37	9	17
Omagh (Edenfel)	*Tyrone*	2·82	1·92	— ·90	68	·60	9	15

SUPPLEMENTARY RAINFALL, JUNE, 1918.

Div.	STATION.	Rain inches.	Div.	STATION.	Rain inches.
II.	Warlingham, Redvers Road..	·91	XI.	Lligwy	1·62
,,	Ramsgate.....	·87	,,	Douglas, Isle of Man	1·90
,,	Hailsham	·99	XII.	Stoneykirk, Ardwell House...	1·95
,,	Totland Bay, Aston House...	1·02	,,	Carsphairn, Shiel.....	2·85
,,	Stockbridge, Ashley..	·99	,,	Langholm, Drove Road	1·08
,,	Grayshott.....	1·14	XIII.	Selkirk, The Hangingshaw..	·44
III.	Harrow Weald, Hill House...	·97	,,	North Berwick Reservoir.....	·14
,,	Pitsford, Sedgebrook...	·48	,,	Edinburgh, Royal Observaty.	·42
,,	Woburn, Milton Bryant.....	·46	XIV.	Biggar.....	·95
,,	Chatteris, The Priory..... ...	·25	,,	Maybole, Knockdon Farm ...	1·41
IV.	Elsenham, Gaunts End	·79	XV.	Buchlyvie, The Manse.....	1·58
,,	Shoeburyness	·67	,,	Ardgour House	6·63
,,	Colchester, Hill Ho., Lexden	·58	,,	Oban.....	2·59
,,	Ipswich, Rookwood,Copdock	1·54	,,	Campbeltown, Witchburn ..	...
,,	Aylsham, Rippon Hall.... ..	1·43	,,	Holy Loch, Ardnadam.....	2·49
,,	Swaffham	·55	,,	Tiree, Cornaigmore	...
V.	Bishops Cannings	1·47	XVI.	Glenquey	1·70
,,	Weymouth.....	·62	,,	Loch Rannoch Dall.....	1·87
,,	Ashburton, Druid House	1·70	,,	Blair Atholl	·64
,,	Cullompton	1·11	,,	Coupar Angus	·82
,,	Lynmouth, Rock House	1·49	,,	Montrose, Sunnyside Asylum.	1·51
,,	Okehampton, Oaklands.....	1·47	XVII.	Balmoral	1·02
,,	Hartland Abbey.....	1·53	,,	Fyvie Castle	...
,,	St. Austell, Trevarna	1·46	,,	Keith Station	2·93
,,	North Cadbury Rectory.....	·84	XVIII.	Rothiemurchus	·91
VI.	Clifton, Stoke Bishop	1·21	,,	Loch Quoich, Loan	12·20
,,	Ledbury, Underdown..... ...	·71	,,	Skye, Dunvegan	4·16
,,	Shifnal, Hatton Grange.....	1·02	,,	Fortrose.....	1·83
,,	Droitwich.....	·72	,,	Glencarron Lodge	5·29
,,	Blockley, Upton Wold.....	1·27	XIX.	Tongue Manse	3·00
VII.	Grantham, Saltersford.....	·16	,,	Melvich	2·95
,,	Louth Westgate	·51	,,	Loch More, Achfary	6·35
,,	Bawtry, Hesley Hall	·88	XX.	Dunmanway, The Rectory ..	1·58
,,	Whaley Bridge, Mosley Hall	2·50	,,	Mitchelstown Castle.....	1·12
,,	Derby, Midland Railway.....	·56	,,	Gap of Dunloe Gearahameen	4·20
VIII.	Nantwich, Dorfold Hall	1·16	,,	Darrynane Abbey.....	1·85
,,	Bolton, Queen's Park	2·39	,,	Clonmel, Bruce Villa	1·31
,,	Lancaster, Strathspey	2·08	,,	Broadford, Hurdlestown.....	1·83
IX.	Langsett Moor, Up. Midhope	1·23	XXI.	Enniscorthy, Ballyhyland...	1·63
,,	Scarborough, Scalby	·59	,,	Rathnew, Clonmannon	1·09
,,	Ingleby Greenhow	·82	,,	Ballycumber, Moorock Lodge	2·31
,,	Mickleton	·60	,,	Balbriggan, Ardgillan	1·47
X.	Bellingham, High Green Manor	·65	,,	Castle Forbes Gardens.....	1·69
,,	Ilderton, Lilburn Cottage ...	·44	XXII.	Ballynahinch Castle.....	2·60
,,	Keswick, The Bank.....	1·85	,,	Woodlawn	1·16
XI.	Llanfrechfa Grange	...	,,	Westport, St. Helens	1·73
,,	Treherbert, Tyn-y-waun	4·09	,,	Dugort, Slievemore Hotel ...	2·14
,,	Carmarthen, The Friary	1·32	XXIII.	Enniskillen, Portora.....	2·09
,,	Fishguard, Goodwick Station.	1·15	,,	Dartrey [Cootehill]	2·61
,,	Crickhowell, Tal-y-maes.....	1·50	,,	Warrenpoint, Manor House ..	1·85
,,	Gwernargllwydd	4·50	,,	Belfast, Cave Hill Road	1·66
,,	Birmingham WW., Tyrmynydd	2·55	,,	Glenarm Castle	2·30
,,	Lake Vyrnwy	...	,,	Londonderry, Creggan Res ..	3·84
,,	Llangynhafal, Plas Drâw.....	1·72	,,	Milford, The Manse.....	2·61
,,	Rhwibryfdir	4·88	,,	Killybegs	3·49
,,	Dolgelly, Bryntirion.....	4·49			

Climatological Table for the British Empire, January, 1918.

STATIONS. (*Those in italics are South of the Equator.*)	Absolute. Maximum. Temp.	Date.	Absolute. Minimum. Temp.	Date.	Average. Max.	Min.	Dew Point.	Humidity.	Absolute. Max. in Sun.	Min. on Grass.	Total Rain Depth.	Days.	Aver. Cloud.
	°		°		°	°	°	0-100	°	°	inches		
London, Camden Square	54·9	21	16·1	9	44·6	34·2	36·2	88	87·6	16·5	2·86	18	8·2
Malta	64·6	25	40·5	7	59·0	50·9	...	80	117·0	31·6	·44	4	2·3
Lagos	90·2	30*a*	67·2	17	87·7	72·3	69·0	69	145·0	61·0	·00	0	6·5
Cape Town	97·0	27	53·1	26	81·6	60·1	55·0	58	...	...	·05	1	1·8
Johannesburg	84·3	27	42·0	25	72·2	53·0	54·3	83	...	41·5	4·96	18	7·2
Bloemfontein	90·2	28	48·3	5	80·7	57·5	55·2	63	...	...	4·67	11	4·1
Calcutta...	77·8	24	47·8	6	75·6	53·2	50·4	62	..	37·1	·00	0	2·0
Bombay...	86·8	30	62·8	25	83·3	68·2	63·3	67	136·0	54·1	·00	0	1·5
Madras	88·0	26	64·9	6	81·8	69·9	68·5	81	152·6	63·3	8·05	10	5·2
Colombo, Ceylon ...	88·1	28	66·9	19	84·2	70·7	69·0	80	159·0	59·0	4·25	10	6·2
Hongkong	66·7	12	42·1	9	59·2	49·8	33·8	46	...	...	·01	2	3·0
Sydney	81·2	27	59·2	3	76·0	64·7	61·5	70	153·2	55·4	13·18	19	5·8
Melbourne	98·7	25	52·7	2	79·9	60·7	56·7	63	151·0	44·0	2·44	9	4·4
Adelaide	104·6	21	51·7	1, 17	87·9	64·2	55·0	45	161·0	43·8	·38	3	2·3
Perth	107·0	9	52·8	3	89·1	66·7	59·3	55	171·6	47·3	·43	4	2·9
Coolgardie	108·6	25	51·0	14	92·0	63·2	50·5	36	174·2	48·0	·01	1	2·4
Brisbane	94·1	14	61·8	6	82·9	67·0	64·8	73	156·7	55·9	7·70	21	7·2
Hobart, Tasmania ..	95·1	21	46·0	17	70·2	54·2	50·6	65	148·8	39·2	·99	10	6·3
Wellington ...	78·5	17	46·7	30	70·2	58·0	55·2	73	154·0	34·4	1·73	11	5·9
Jamaica, Kingston ...	91·5	26	56·9	2	84·5	67·1	64·4	74	...	...	·58	3	2·8
Grenada	87·0	3	69·0	16	82·0	71·0	...	77	138·0	...	6·16	21	4·0
Toronto	33·1	7	—8·0	27	20·4	6·0	6·6	81	95·5	—10·5	2·30	13	5·6
Fredericton	36·0	7	—28·0	3	18·8	—1·4	4·0	86	...	...	3·11	12	5·0
St. John, N.B. ...	38·0	13	—13·5	3	22·1	6·4	7·3	73	103·5	—13·7	3·71	17	5·4
Victoria, B.C.	56·0	3	23·2	30	45·8	38·3	38·0	86	105·0	16·6	...	...	...

a—31.

Johannesburg.—Bright sunshine 189·9 hours.

COLOMBO, CEYLON.—Mean temp. 77°·5, or 1°·2 below, dew point 0°·4 below, and R 1·06 in. above, averages. Mean hourly velocity of wind 5·0 miles.

HONGKONG.—Mean temp. 54°·0. Bright sunshine 241·9 hours. Mean hourly velocity of wind 10·8 miles.

Sydney.—Very heavy R on the 11th when 6·53 in. fell in 24 hours.

Melbourne.—Mean temp. 2°·9 above, and R ·58 in. above, averages.

Adelaide.—Mean temp. 1°·9 above, and R ·34 in. below, averages.

Perth.—The hottest January since 1896, the temperature on 17 days being over 90°.

Coolgardie.—Rainfall about half an inch below average.

Brisbane.—Mean temp. 2°·7 below average. Rainfall slightly above average.

Wellington.—Bright sunshine, 206·4 hours. Mean temp. 1°·7 above average.