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EXCESSIVE FROST IN NOVEMBER.

IN our last number we had to record an October frost unapproached for at least half a century. We now have to notice a more exceptional frost in November.

This November frost was an extremely remarkable one ; (1) because it occurred in the daytime ; (2) because it was so local.

As will be seen further on, the temperature fell much lower at other places than it did at Greenwich, or at Camden Square, but as long records are available at those places, it will be well first to examine what occurred at them.

Greenwich.—November 23rd was quite exceptionally warm ; the average was $54^{\circ}\cdot 9$, which was higher than on any day in the third decade of November during the 60 years, 1814 to 1873. Then a rapid fall of temperature set in, and on the 28th the maximum was $26^{\circ}\cdot 9$, the minimum was $18^{\circ}\cdot 3$, and the mean $21^{\circ}\cdot 8$, which is nearly 2 degrees colder than any other day in November during the above-named long period of 60 years.

Camden Square.—Out of the 32 Novembers ending with that of 1889 there has been one (1888) in which there was no frost, there have been 14 in which the temperature fell below 27° , and four in which it fell below 23° , these cases being as follows :—

AIR TEMPERATURES IN NOVEMBER BELOW 23° .

1858..... $20^{\circ}\cdot 1$ on the 24th		1871..... $21^{\circ}\cdot 0$ on the 19th
1861..... $21^{\circ}\cdot 8$ on the 19th		1887..... $22^{\circ}\cdot 1$ on the 17th

In 1890 it fell below all these, excepting 1858—viz., to $20^{\circ}\cdot 8$ on the 29th.

It is necessary to explain why the minimum at Greenwich is stated to be on the 28th and at Camden Square on the 29th. The minimum (as will be further explained subsequently) occurred nearly at the same time, 4—5 p.m. on the 28th, at both places, but at Greenwich for many years it has been the custom to record the temperatures as they would have been if read off at midnight. We believe that no readings are now really taken at that hour, but the theory has survived the practice. This minimum was therefore on the Greenwich system correctly set down to the 28th. The rule, however, for

climatological stations is that the maximum read on any morning is to be entered to the day before, but the minimum to the day on which it is read, because in an overwhelming majority of cases the minimum occurs in the early morning hours, and therefore belongs to the day on which (at 9 a.m.) it is read. Hence, in accordance with rule, the entry at Camden Square is for November 29th.

It will probably be most convenient if we reduce the many letters and notes with which we have been favoured, into the form of paragraphs, and sort them into counties, taking the usual "Rainfall" order, and taking the stations in each county as nearly as may be in the order of increasing latitude, *i.e.*, from south to north. The exceptional phenomena of the afternoon and evening of November 28th having been confined to the S. and S.E. of England, records from other parts are not generally quoted. Sharp weather prevailed in most parts of the country, and in the eastern counties it was much colder on the 30th than on the 28th. In those cases in which we are aware of the pattern of thermometer stand, we shall use the abbreviations *Stev.* for Stevenson's, and *Gla.* for Glaisher's.

MIDDLESEX.

Edith Road, Kensington.—Min. in *Stev.* $22^{\circ}\cdot 2$.—G. VON U. SEARLE.

Royal Botanic Gardens, Regent's Park.—Temp. in *Stev.* on November 28th, max. $25^{\circ}\cdot 0$; min. $20^{\circ}\cdot 5$; 3 p.m. $22^{\circ}\cdot 5$; 9 p.m. $23^{\circ}\cdot 0$.—W. SOWERBY.

Camden Square, London.—The lowest temp. was $20^{\circ}\cdot 8$ on *Gla.* and $21^{\circ}\cdot 6$ in *Stev.* The Richard thermograph sheet shows that the temperature fell steadily from noon to 5.5 p.m. on the 28th, when the above-mentioned minimum occurred; and it did not rise 1° until about 1 a.m. on the 29th, after which it rose steadily.—G. J. SYMONS.

Pinner Hill.—Min. on 28th, 21° .—H. E. SELLWOOD.

SURREY.

Hall Place, Cranleigh, Guildford.—This house faces S., and is 233 ft. above sea level; at 8 p.m. on 28th a ther. outside a S. window 15 ft. above ground, read 12° , at 11 p.m. 20° , and at 4 a.m. on 29th 22° .—E. S. ROWCLIFFE.

Abinger Hall, Dorking.—The 28th was bitterly cold, our ther. standing at 20° to 22° all day, and going down to 1° for a short time in the evening.—G. PAYNE.

Brockham, Betchworth.—Minimum in *Stev.*, $4^{\circ}\cdot 5$.—A. CHEALES.

Holmfels, Reigate.—Min. on 29th, 2° .—F. T. BAKER.

Emlyn House, Leatherhead.—The ther. in my garden, 3 ft. above ground and about 40 ft. above the river Mole, fell until 7 p.m. of 28th, when it registered 5° ; there was very little wind.—A. T. MILLER.

Caterham.—In the valley between Caterham and Purley two persons had thermometers which fell to 2° .—CECIL E. BYRON.

Coulsdon.—This village is 520 ft. above sea-level, and here the temperature fell to 4° .—CECIL E. BYRON.

Ingleside, Kenley.—The temperature here fell to 9° in the stand and to 3° on the snow.—HAROLD SMITH.

Purley.—A thermometer outside a greenhouse read 5° at 6 p.m. on the 28th; the severity lasted only about two hours, say 5 to 7 p.m. The fingers of my left hand were so chilled in driving up from the station that on the fifth subsequent day I had recovered feeling in only two of them.—CECIL E. BYRON.

Wallington.—Min. in Stev. on 28th, 10°·3.—F. C. BAYARD.

Ormesby House, Grange Road, Sutton.—Temperature on snow on 28th, at 4.30 p.m., 4°; at 6.30 p.m., 7°; at 7 p.m., 12°; at 9 p.m., 15°·5; and at 11.45 p.m. it had again fallen, and stood at 4°·5, although no apparent change had taken place in the sky, which was uniformly clouded over.—W. THURTELL.

Addiscombe, Croydon.—Minimum in Stev., 10°·3.—E. MAWLEY.

Kew Observatory.—On November 28th, the max. was 25°·5 at 0.35 p.m., from which it fell steadily until 4.8 p.m., when the min. of 21°·5 was reached, and it remained within 1° of that point until after midnight.—G. M. WHIPPLE.

SEVERE FROST IN SURREY.—The weather here on the 28th ult. was phenomenal with regard to the severe frost. We registered at four o'clock on the above date 24° frost Fahr. [*i.e.*, 8° F.], and at six o'clock the mercury showed 6° below zero. After that time it gradually rose above zero. In the Rev. W. Wilks' garden at Shirley, two miles from here, the thermometer registered 2° below zero; at Warmington, four miles, 5½° below, and at Riverhead, near Sevenoaks, 1° below zero. The shrubs here are turned quite black, the Aucubas especially seem ruined. I may mention that our thermometer registered the above at 6 inches from the ground. Enclosed herewith are a few leaves of shrubs and ivy to show the result.—R. H. COPPIN, *Addington, Croydon*. [The temperatures recorded are extremely low, but the thermometer is too near the ground. The leaves sent are blackened, and evidently the injury is severe.]—*Journal of Horticulture*.

We reprint this paragraph without assuming any responsibility for the accuracy of the thermometers. On the one hand, the records support each other, while on the other hand, one cannot but suspect that there must have been spirit at the top of the tubes or errors in the thermometers themselves.

KENT.

Dungeness.—Min. in air between 8 a.m. 28th and 8 a.m. 29th, 18°.—MET OFF. WEATHER REPORT.

Hythe.—Min. in air on 28th, 15°.—H. B. MACKESON.

Cranbrook.—Min. temp. lower than for 25 years, viz., 10°.—G. PILE.

Goudhurst.—Min. 11°; lowest ever recorded in November.—J. S. CLARKE.

Colebrook Park, Tonbridge.—This house is half-way between Ton-

bridge and Tonbridge Wells, and 350 ft. above sea level; I have usually two Rutherford min. thermometers in use, each about 2 ft. above the ground, and about 300 yards apart; one is an ordinary one by Negretti & Zambra, the other divided on its stem by Beck; each recorded 8° for the evening of the 28th. Finding it very cold, I, in the afternoon of the 28th, put out a third thermometer—a mercurial one. It read as follows:—4.30 p.m., 15° ; 5 p.m., 11° ; 6.15 p.m., $9^{\circ}5$; 11 p.m., 14° ; but the indices of each of the Rutherford's showed 8° , to which it must have fallen some time between 6.15 and 11 p.m. The night was intensely bright and still.—W. A. SMITH.

East Malling, Maidstone.—A Six's thermometer here fell to 8° .—W. A. SMITH.

Tower Fields, Keston, Farnborough.—The following are the temperatures during the afternoon and evening of 28th:—2 p.m., 21° ; 4 p.m., 17° ; 6.30 p.m., 14° ; 8 p.m., 17° ; 10 p.m., 22° ; 11 p.m., 23° .—G. BUCHANAN, M.I.C.E.

Foxgrove Road, Beckenham.—On returning from town I felt it very cold; I looked at the thermometer, it was then (6.30 p.m.) 15° , but had been down to 8° ; at 10.30 p.m. it had risen to 19° . Thermometer by Browning, 4 ft. from ground, facing N. It is most remarkable that this low temperature should have occurred during the daytime. I am told that there was a gleam of sunshine just before sunset. Was the sudden clearing of the sky the cause of the intense cold?—C. S. PRINGLE.

Foxgrove, Beckenham.—Temp. on Gla. stand on November 28th, 9 a.m., $23^{\circ}4$; about 5 p.m., minimum 10° ; 6.30 p.m., 17° ; 10.30 p.m., 19° ; max. of day, $27^{\circ}5$.—P. BICKNELL.

Royal Observatory, Greenwich.—Max. on Gla. stand, November 28th, $26^{\circ}9$; min., $18^{\circ}3$; min. in Stev. $18^{\circ}0$; min. on grass, $18^{\circ}1$. The temperature fell quite steadily to the min. at 4.20 p.m., and then rose with equal steadiness, rising $0^{\circ}8$ by 5.5 p.m.—W. ELLIS.

SUSSEX.

Church House, Heene, Worthing.—Min. in Stev. $14^{\circ}9$, the lowest that I remember recording during 22 years.—W. J. HARRIS.

Prestonville Road, Brighton.—Min. $16^{\circ}2$; on grass $14^{\circ}5$.—F. H. PHILLIPS.

South Park, Bodiam, Hawkhurst.—The thermometer here fell to 13° before midnight on 28th, the lowest I have recorded for ten years.—L. M. JACKSON.

Observatory, Crouborough Cross.—Min. in Stev. $11^{\circ}3$; exposed at 4 ft., $8^{\circ}6$; on snow, $3^{\circ}2$. Unprecedented in November during the present century.—C. L. PRINCE.

HAMPSHIRE.

East Tisted Rectory, Alton.—I wonder whether you have received record of any frost equal to that in this notoriously cold valley. My thermometer, 4 ft. above ground, and under its little penthouse

board as usual, stood at 1°, and so did another which had been verified at Kew.—F. HOWLETT.

Ashdell, Alton.—Min. in air on 29th, 14°.—F. CROWLEY.

Strathfield Turgiss.—Min. on 29th in Stev., 17°·6; on grass, 14°·5.—C. H. GRIFFITH.

HERTFORDSHIRE.

Broxbourne.—Min. 17°·0 on 29th.—G. J. NEWBERY.

The Grange, St. Albans.—Min. in Stev., 19°·0.—J. HOPKINSON.

Rosebank, Berkhamstead.—Min. in Stev. 21°·6, and on grass 20°·8 for 29th, but lower for 30th, viz., 20°·0, and 9°·0 on grass.—E. MAWLEY.

Hamel's Park, Buntingford.—Min. for 29th 16°.—E. WALLIS.

Hitchen.—Min. 18° on 28th.—W. LUCAS.

BUCKINGHAMSHIRE.

Addington, Winslow.—Min. in Stev., 22° on 28th, 22° on 29th, and 20° on 30th.—J. MATHISON.

OXFORDSHIRE.

Magdalen College, Oxford.—Min. in air on 28th, 22°·5.—E. CHAPMAN.

NORTHAMPTONSHIRE.

Castle Ashby.—Min. 21°·0 on 28th.—R. G. SCRIVEN.

CAMBRIDGESHIRE.

Observatory, Cambridge.—Min. in air between 8 a.m. on 28th and 8 a.m. on 29th, 20°.—MET. OFF. WEATHER REPORT.

ESSEX.

Sheering, Harlow.—Min. in air on 29th and on 30th, 16°.—E. HILL.

SUFFOLK.

Bishops Hill, Ipswich.—Min. 17° on 29th and on 30th.—G. A. BIDDELL.

Rendlesham Hall, Woodbridge.—Min. in air on 30th, 17°.—RENDLESHAM.

NORFOLK.

Denver Rectory, Downham.—Unprecedentedly low minima for November. Ther. has no spirit at the top of the tube, and is in Stev. Min. on 27th, 23°·7; 28th, 22°·5 (lowest since 1862); 29th, 26°; 30th, 17° (record of 28th further beaten).—J. M. DU PORT.

Cossey, Norwich.—Min. 5° on 30th.—ALBERT J. CULLEY.

East Dereham.—Min. at 4 ft. above ground, 17° on 29th.—G. H. COOPER.

WILTSHIRE.

Alderbury, Salisbury.—Min. in air on 28th, 11°.—R. S. HUTCHINGS.

Bishops Cannings.—Min. in air on 29th, 10°.—C. W. HONY.

DORSET.

Heatherlands, Parkstone, Poole.—About 5 p.m. on 28th temp. fell to 20°, and it continued to fall until just before 9 p.m. on that day,

when it reached the very low point of $16^{\circ}2$ in the air and (some time during the evening or night), $7^{\circ}9$ on the grass.—R. H. BARNES.

Langton Herring, Weymouth.—Min. 17° , being 4° lower than has been recorded in November during 19 years; on the grass the min. was 12° .—CLEMENT H. GOSSET.

DEVONSHIRE.

Babbacombe, Torquay.—Min. on 29th, $22^{\circ}3$ in Stev., and $21^{\circ}8$ on grass.—E. E. GLYDE.

Druid, Ashburton.—Min. on 29th, $19^{\circ}7$.—FABYAN AMERY.

Woodway, Teignmouth.—Min. on 29th, $21^{\circ}6$ in Stev., and $17^{\circ}0$ on grass, the lowest since commencing observations in 1879.—G. W. ORMEROD.

Barnstaple.—Min. 20° on 29th.

SOMERSETSHIRE.

Wells.—Min. on 29th in air, 22° , and on grass, 16° .—R. J. MANNING.

LEICESTERSHIRE.

Barkby, Leicester.—Min. $16^{\circ}0$ on 29th.—E. N. POCHIN.

RUTLANDSHIRE.

Ketton Hall [Stamford].—Min. on 29th, 25° ; on 30th, 11° .—F. COVENTRY.

LINCOLNSHIRE.

Boston.—Min. 13° on 30th.—W. H. WHEELER.

Hemingby, Horncastle.—Min. on 30th, in air, $8^{\circ}6$.—E. S. BENGOUGH.

JERSEY.

Hastings Terrace, St. Heliers.—Min. $20^{\circ}0$.—W. J. LANCASTER.

Noirmont, St. Aubins.—Min. in air between 8 a.m., 28th, and 8 a.m., 29th, 16° .—MET. OFF. WEATHER REPORT.

We may now epitomize the facts—as regards intensity and time. It is noteworthy that of all the records from verified thermometers in Stevenson's screens, only one is below 10° , viz., that at Brockham, near Dorking, where $4^{\circ}5$ was recorded.

The temperatures below even that are, in the order of intensity, the following :—*

Coulsdon, Surrey.....	4°	East Tisted, Alton, Hants ...	1°
Holmfels, Reigate, Surrey...	2°	Riverhead, Sevenoaks, Kent	-1°
Caterham Valley, ,, ...	2°	Shirley, Surrey.....	-2°
Abinger Hall, Dorking ,, ...	1°	Warmington, Surrey	$-5\frac{1}{2}^{\circ}$

Nearly all these stations are in the district of which the Meteorological Committee of the Croydon Microscopical Society is representative. We shall be glad to hear that they have investigated these and other records in their district and ascertained which are correct, which errors are due to spirit being lodged in the top of the tubes, which to faulty instruments, and which to bad exposure.

* We have omitted the records of 4° at Sutton, and of -6° at Addington, because in each case the thermometer was on, or close to, the snow.

Apparently, however, it can hardly be doubted that in the air the temp. on November 28th fell nearly to zero, and on snow below it.

The examination of the precise time of the phenomenon, which has necessitated plotting a large number of observations, tends to confirm our impression that it was a very local one—a down-rush of cold air, with probably a clear sky, allowing radiation for a short time in the vicinity of Caterham—and occurring between 4 and 6 p.m. In proof of its local character, it may be sufficient to give the temperature at four hours at Greenwich, Kew, and Camden Square :—

	3 p.m.	4 p.m.	5 p.m.	6 p.m.	Min.
Greenwich	20·8	19·5	19·0	21·0	18·3
Kew	23·0	22·1	22·0	22·4	21·5
Camden Square	22·8	22·5	21·7	21·0	20·8
Kew warmer than Greenwich...	+2·2	+2·6	+3·0	+1·4	+3·2
Camden Sq. warmer than ,, ...	+2·0	+3·0	+2·7	+0·0	+2·5

This shows plainly that the intensity of cold was increasing in directions S. and E. of Kew and of Camden, and beyond Greenwich, in that direction, is the district of Kent and Surrey, whence the lowest records have been sent. So few hourly records have been received that we can say only that there is some indication that the minimum occurred later at stations furthest towards S. and E., but nowhere later than 7 p.m.

BAROMETRIC DEPRESSIONS.

To the Editor of the Meteorological Magazine.

SIR,—Professor Hazen appears to have misunderstood the object of my letter. I understood him to say that the liberation of latent heat by the condensation of vapour could be shown to be physically incapable of supplying the energy of the cyclone, and I made the calculation (which he now implies to be inapplicable) simply with the view of combating his statement.

It is not probable that the axis of the cyclone is vertical, at least in temperate latitudes, neither does Ferrel's theory require that it should be so, but it is not at all clear how the upper part is to travel twice as fast as the lower, and the whole to remain one single storm for several days. Might we not as well say that the locomotive of a train travels twice as fast as the carriages? There can be little doubt about the ascensional current in the central parts of a cyclone—it follows inevitably from the fact of the inclination of the wind direction to the isobars, for there is no other possible direction in which the air, moving towards the centre, can escape. Also, the central parts of a cyclone are those in which the rain chiefly falls.

The same rule applies to thunderstorms, which are well known to be small secondary depressions, and that they chiefly occur in the south-eastern quadrant of the cyclone is often brought forward in support of Ferrel's theory.

W. H. DINES

ROYAL METEOROLOGICAL SOCIETY.

The opening meeting of the session of the Royal Meteorological Society was held on Wednesday evening, November 19th, at the Institution of Civil Engineers, when the President, Mr. Baldwin Latham, M.Inst.C.E., delivered an address on "The Relation of Ground Water to Disease."

The pages of history show that when the ground waters of our own or of other countries have arrived at a considerable degree of lowness, as evidenced by the failure of springs and the drying up of rivers, such periods have always been accompanied or followed by epidemic disease. In all probability, ground water in itself, except under conditions where it is liable to pollution, has no material effect in producing or spreading disease. As a rule, it is only in those places in which there has been a considerable amount of impurity stored in the soil that diseases become manifest, and the most common modes by which diseases are, in all probability, disseminated, are by means of the water supplies drawn from the ground, or by the elimination of ground air, into the habitations of the people. It is found that the periods of low and of high water mark those epochs when certain organic changes are taking place in the impurities stored in the ground, which ultimately become the cause, and lead to the spread, of disease. Mr. Latham defines "ground water" as all water found in the surface soil of the earth's crust, except such as may be in combination with the materials forming the crust of the earth. It is usually derived from rainfall by percolation, and it is also produced by condensation. In dry countries ground water is principally supplied by the infiltration from rivers, as for example, in the Delta of the Nile.

If but little water passes into the ground for a long period it naturally leads to the lowering of the water line, and to the drying of the ground above the water-line; and it is curious to note with reference to smallpox, that this disease generally occurs after there has been a long absence of percolation, and a consequent drying of the ground. On the other hand, smallpox is unknown when the ground has long been wet, or is receiving moisture by condensation or capillarity.

The study of the level of underground water shows that certain diseases are more rife when the water is high in the ground, and others when the water is low. The conditions that bring about and accompany low water, however, have by far the most potent influence on health, as low water years are, without exception, unhealthy. As a rule, the years of high water are extremely healthy, except, as often happens, when high water follows immediately upon markedly low water; on the rise of the water an unhealthy period invariably follows.

Mr. Latham has found those districts for which the water is drawn from springs are usually more subject to epidemics and disease

than districts supplied from rivers or extended areas, or from sources not liable to underground pollution. In the case of Croydon, one portion of the district (under three-fourths) is supplied with water taken direct from the ground, whilst the remaining portion is supplied with water from the river Thames. It is curious to note that even so recently as 1885, the zymotic death-rate in the district supplied with underground water was twice as great as in that part of the district supplied from the Thames; and in that year 41 deaths from smallpox occurred in Croydon, every one of which occurred in the district supplied by the underground water.

Mr. Latham, in his address, dealt largely with zymotic diseases as affected by ground water, and showed that cholera ordinarily breaks out when there is least ground water; a high air and earth temperature is also necessary for its development, and, as a rule, the low-lying districts are favourable to the production of these high temperatures. Smallpox is almost always preceded by a long period of dryness of the ground, as measured by the absence of percolation. Typhoid fever is most prevalent after a dry period, on the first wetting of the ground or percolation from any cause. The condition essential to the development of diphtheria is a damp state of the ground, marked by extreme sensitiveness to percolation of rain. Scarlet fever follows the state of dryness of the ground, which is essential for its development, and occurs in the percolation period. The conditions that precede smallpox are those favourable for the development of scarlet fever, and, like smallpox, the dampness of the ground for any considerable period in any particular locality may check its development or render it less virulent, and it is most rife in low water years. Measles are least prevalent at the low water periods, and mostly rife at and near high water periods. Whooping cough follows the percolation period in its incidence, increasing with percolation and diminishing as the waters in the ground subside. Diarrhoea is generally more prevalent in a low water year than in other years; that is, with a very much colder temperature in a low water year there is a very much higher death-rate from this disease.

METEOROLOGICAL PHOTOGRAPHY.

As stated in the October number of this Magazine, a Committee of the British Association was appointed at Leeds to assist, foster, and systematize the application of photography to meteorology. The Committee has already commenced work, and prepared blank forms and instructions, copies of which will with pleasure be supplied by the Secretary, to whom, of course, all communications and offers of co-operation should be forwarded. It is most desirable that our readers, whether themselves photographers or not, should bring this effort to the knowledge of all their photographic friends, both in this country and abroad. The Committee consists of G. J. Symons, F.R.S. (Chairman), Professor R. Meldola, F.R.S., John Hopkinson, F.L.S., F.G.S., Arthur W. Clayden, M.A., F.C.S., F.G.S. (secretary), "Warleigh," Palace Road, Tulse Hill Park, London, S.W.

REVIEW.

Klimaschwankungen seit 1700 nebst Bemerkungen über die Klimaschwankungen der Diluvialzeit. Von Dr. EDUARD BRÜCKNER, a.o., Professor der Geographie an der Universität zu Bern. [*Geographische Abhandlungen herausgegeben von Prof. Dr. ALBRECHT PENCK, Band IV., Heft 2.*] Wien, E. Hölzel, 1890. 8vo. viii.—324 pages, 13 diagrams, and one plate.

THIS work is essentially one for thoughtful persons. It is one of the compilation of which would frighten most men, by the vastness of the subject, and by the mass of material to be dealt with. It is an attempt to ascertain the existence, and, if any, the amount of climatic variation which our earth has undergone, both in remote and in historic times, and to this end Dr. Brückner has employed chiefly six varieties of data.

- (1) The dates of the opening and closing of navigation on Russian rivers.
- (2) Records of severe winters.
- (3) The dates of the vintages in France. (These have been recorded for more than three centuries.)
- (4) Details of annual rainfall.
- (5) " " " temperature.
- (6) Sunspot frequency.

One fact will sufficiently indicate the labour compressed into this work—it contains returns from 804 stations for an aggregate of more than 36,000 years; another will illustrate the thoroughness with which it has been executed, the foot-notes, chiefly references to other writers upon the subjects, must number considerably over 500.

It will probably afford the best general idea of the scope of the work if we give the titles of each of the ten chapters, and say a few words on each.

The first deals with the present state of the question as to climatic changes, begins by defining climate, and then notices successively the changes during prehistoric (geologic) times, discusses briefly the question of alterations during historic times—(a) as regards rainfall, (b) as regards temperature—and ends by criticising somewhat severely sunspot and other cycles.

The second chapter is devoted wholly to the variations in the level of the Caspian Sea, which are shown to be almost entirely dependent upon, and synchronous with, climatic changes, and that though very uncertain, they seem to be of long period.

In Chapter III. Dr. Brückner deals with the variations in other seas and lakes which have no outlet, taking not merely those of Europe, but also illustrations from Asia, America, Africa, and Australia, Mr. H. C. Russell's observations on Lake George being especially useful.

In Chapter IV. he passes on to the question of the discharges of

rivers, and records of their levels, and concludes that his researches thus far have shown that there are considerable oscillations of climate, that they are approximately, but not strictly, synchronous over the globe, but that it is not clear whether they are produced by rainfall or by temperature, or a mixture of the two, nor what is the primary cause.

In Chapter V. Dr. Brückner attacks, in a very thorough and able way, the problem of the secular variation of rainfall. He has collected returns from nearly all parts of the world, reduced the values to their equivalent percentages, and given the results in considerable detail. But he has allowed himself such free scope in filling up missing years, in order to increase the number of records available for discussion, that, while we accept the tables as probably correct, and certainly representing what Dr. Brückner believes to be so, all the values must not be accepted as the arithmetical results of perfect records. Considering this fact, it is rather amusing that twice over he brings up English records in order to condemn them. It would take too much space to deal with both cases, but the examination of one has led us to notice that the Paris observations partly corroborate the great drought indicated by the Lyndon observations from about 1728 to 1767, to which attention has often been directed. Quoting from Mr. Symons's table,* Dr. Brückner

* "Report of the British Association, 1866," p. 286.

finds two records for part of that time, which run on long afterwards; he compares their mean ratios thus :—

Lyndon—Chatsworth	1761-69	.....	-6·8
" "	1770-98	.....	+4·9
			11·7
	Difference	.....

and adds, "therefore are the amounts of rain before 1770 about 11 or 12 per cent. too small." We do not see the reason for the "therefore;" it would have been equally fair to say "therefore are the amounts of rain [at Chatsworth] too large." But Dr. Brückner proceeds to say that a similar indication is afforded by the following values :—

		mm.	inches
Lyndon (Rutland), 1737-69 (23 years)	.....	mean 538	= 21·18
" " 1770-98 (29 " )	.....	" 637	= 25·08

And on the strength of the above, he has cut the record into two portions. He may be right; it is very difficult to say whether he is or is not; but the existence or non-existence of that great drought cannot be so easily disposed of, and it is droll in the extreme to find that on page 136 Dr. Brückner charges the Paris records with being *wrong in the same direction as the Lyndon ones, and at about the same date*, and on p. 191 he gives that very year 1770 as closing a dry period, "eine Trockenperiode 1756-70."

(To be continued.)

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, MAY, 1890.

STATIONS. <i>(Those in italics are South of the Equator.)</i>	Absolute.				Average.				Absolute.		Total Rain.		Aver. Cloud.
	Maximum.		Minimum.		Max.	Min.	Dew Point.	Humidity.	Max. in Sun.	Min. on Grass.	Depth.	Days.	
	Temp.	Date.	Temp.	Date.									
England, London	77·6	25	39·1	31	65·5	45·8	44·1	68	120·2	34·0	inches	13	4·9
Malta.....	80·4	6	53·0	4	73·3	58·8	56·8	76	139·4	47·8	·61	4	3·5
<i>Cape of Good Hope</i> ...	84·8	1	41·0	19	64·7	50·0	...	...	...	...	5·93	...	5·9
<i>Mauritius</i>	79·5	1	59·8	25	76·4	65·3	62·2	76	132·7	52·3	·82	7	4·2
Calcutta.....	105·4	8	67·2	16	95·3	77·1	76·8	74	157·8	66·8	5·34	15	4·2
Bombay.....	92·2	2	78 0	10	89·7	80·0	75·2	73	142·8	69·8	·06	2	2·5
Ceylon, Colombo .....	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Melbourne</i>	73·5	14	37·7	9	62·9	46·5	48·6	81	122·1	30·2	2·35	11	7·0
<i>Adelaide</i> .....	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Wellington</i>	68·0	2,3	37·0	12	58·3	46·4	...	...	110·0	28·0	3·86	18	4·0
<i>Auckland</i>	68·0	22	40·0	13	63·3	51·1	49·2	74	125·0	30·0	4·33	20	5·8
Jamaica, Kingston.....	89·2	15	67·5	2	87·2	71·0	69·7	73	...	...	1·22	...	...
Trinidad	89·5	19	65·0	20	85·9	69·5	70·1	79	158·5	62·0	5·14	15	...
Toronto	77·0	31	28·1	8	59·0	41·1	42·2	74	...	20·0	2·62	23	6·6
New Brunswick, } Fredericton	70·8	20	30·0	12	60·4	41·0	43·7	70	...	...	9·08	20	7·2
Manitoba, Winnipeg } British Columbia, } Victoria	78·6	29	17·3	1	55·2	30·4	34·0	68	...	...	1·15	10	5·6
	71·0	5,25	38·0	1,18 29	63·8	43·3	...	...	...	...	·98	7	...

REMARKS.

MALTA.—Mean temp. 64°·5 ; mean hourly velocity of wind 10·4 miles. Sea temp. rose from 62°·9 to 72°·0 TSS on 1st, 27th, and 31st. J. SCOLES.

Mauritius.—Mean temp. of air 2°·0, of dew point 1°·9, and R 3·52 in. below, their respective averages. Mean hourly velocity of wind 8·5 miles, or 1·6 below average ; extremes 27·9 on 3rd, and 1·6 on 2nd ; prevailing direction S.E. by E. to E.S.E. Unusually intense skyglows before sunrise and after sunset throughout the month. C. MELDRUM, F.R.S.

Melbourne.—Mean temp. of air 1°·2, of dew point 2°·5, humidity 3, amount of cloud 0·4, and R ·25 in. above their respective averages. Prevailing winds N.E. and N., strong on 18th and 28th. Heavy dew on 11 days. Fog on 8 days. R. L. J. ELLERY, F.R.S.

Wellington.—On the whole a showery month, although the total R was nearly an inch below the average. Strong wind from S. on 11th and 31st, and from N.W. on 28th and 29th, otherwise moderate in force. H on 11th and 12th. Temp. very near the average. R. B. GORE.

Auckland.—Showery and unsettled almost throughout. Mean temp. and pressure close to the average. R slightly above the average. T. F. CHEESEMAN.

SUPPLEMENTARY TABLE OF RAINFALL,
NOVEMBER, 1890.

[For the Counties, Latitudes, and Longitudes of most of these Stations,
see *Met. Mag.*, Vol. XIV., pp. 10 & 11.]

Div.	STATION.	Total Rain.	Div.	STATION.	Total Rain.
		in			in.
II.	Dorking, Abinger Hall.	3·03	XI.	Castle Malgwyn	6·74
„	Margate, Birchington...	2·60	„	Builth(LlanwrtydWells)	8·31
„	Littlehampton	2·71	„	Rhayader, Nantgwillt..	10·26
„	Hailsham	3·47	„	Carno, Tybrith	9·58
„	Ryde, Thornbrough	2·84	„	Corwen, Rhug	7·41
„	Alton, Ashdell.....	2·11	„	I. of Man, Douglas	9·81
III.	Oxford, Magdalen Col...	1·51	XII.	Stoneykirk, ArdwellHo.	9·74
„	Banbury, Bloxham	2·25	„	New Galloway, Glenlee	13·09
„	Northampton	2·68	„	Melrose, Abbey Gate...	4·47
„	Cambridge, Fulbourne..	2·06	XIII.	N. Esk Res. [Penicuick]	8·25
„	Wisbech, Bank House..	2·58	XIV.	Ballantrae, Glendrishaig	8·60
IV.	Southend	2·74	„	Glasgow, Queen's Park.	6·42
„	Harlow, Sheering	2·11	XV.	Islay, Gruinart School..	10·23
„	Rendlesham Hall	3·28	XVI.	Dollar.....	6·80
„	Diss	5·06	„	Balquhider, Stronvar..	11·80
„	Swaffham	3·42	„	Coupar Angus Station..	6·52
V.	Salisbury, Alderbury ...	1·76	„	Dunkeld, Inver Braan..	6·39
„	Warminster	2·30	„	Dalnaspidal H.R.S. ...	8·28
„	Bishop's Cannings	2·31	XVII.	Keith H.R.S.	4·68
„	Ashburton, Holne Vic....	7·03	„	Forres H.R.S.	2·83
„	Hatherleigh, Winsford.	2·83	XVIII.	Fearn, Lower Pitkerrie.	2·78
„	Lynmouth, Glenthorne.	4·45	„	Loch Shiel, Glenaladale	...
„	Probus, Lamellyn	5·47	„	N. Uist, Loch Maddy ...	9·14
„	Launceston, S. Petherwin	4·75	„	Invergarry	8·64
„	Wincanton, Stowell Rec.	2·55	„	Aviemore H.R.S.	3·20
„	Taunton, Lydeard Ho... ..	...	„	Loch Ness, Drumna drochit	3·10
„	Wells, Westbury	3·07	XIX.	Lairg H.R.S.	5·18
VI.	Bristol, Clifton	2·55	„	Scourie	5·39
„	Ross	2·05	„	Watten H.R.S.	3·80
„	Wem, Clive Vicarage ...	4·16	XX.	Dunmanway, Coolkelure	11·27
„	Cheadle, The Heath Ho.	5·97	„	Fermoy, Gas Works ...	5·08
„	Worcester, Diglis Lock	2·14	„	Tipperary, Henry Street	4·71
„	Coventry, Coundon	3·53	„	Limerick, Kilcornan ...	4·44
VII.	Ketton Hall [Stamford]	3·90	„	Miltown Malbay.....	6·69
„	Grantham, Stainby	3·64	XXI.	Gorey, Courtown House	4·37
„	Horncastle, Bucknall ...	2·45	„	Navan, Balrath .....	...
„	Worksop, Hodsock Priory	3·23	„	Mullingar, Belvedere ...	6·76
VIII.	Neston, Hinderton	5·72	„	Athlone, Twyford	6·72
„	Knutsford, Heathside ...	6·04	„	Longford, Currygrane...	6·54
„	Lancaster, South Road.	6·48	XXII.	Galway, Queen's Coll...	7·15
„	Broughton-in-Furness ..	13·78	„	Clifden, Kylemore	15·66
IX.	Wakefield Prison	2·71	„	Crossmolina, Enniscoe..	9·98
„	Ripon, Mickley	3·80	„	Collooney, Markree Obs.	7·35
„	Scarborough, West Bank	2·91	„	Ballinamore, Lawderdale	8·83
„	East Layton [Darlington]	4·26	XXIII.	Warrenpoint	5·50
„	Middleton, Mickleton..	3·73	„	Seaforde	8·64
X.	Haltwhistle, Unthank..	5·01	„	Belfast, New Barnsley..	9·58
„	Shap, Copy Hill	8·16	„	Bushmills, Dundarave...	7·89
XI.	Llanfrechfa Grange	4·35	„	Stewartstown	7·52
„	Llandovery	7·30	„	Buncrana	7·79

NOVEMBER, 1890.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL.				Days on which -01 or more fell.	TEMPERATURE				No. of Nights below 32°		
		Total Fall.	Differ- ence from average. 1880-9	Greatest Fall in 24 hours.			Max.		Min.			In shade.	On grass.
				Dpth	Date.		Deg	Date	Deg.	Date			
I.	London (Camden Square) ...	1.62	- 1.04	.34	6	17	58.1	23	20.8	29	617		
II.	Maidstone (Hunton Court)...	3.69	+ .76	.90	25	21	...	...	...	...	...
III.	Strathfield Turgiss	1.62	- 1.10	.43	6	18	58.3	23	17.6	29	1017		
IV.	Hitchin	1.89	- .79	.42	6	21	57.0	23	18.0	28	8...		
V.	Winslow (Addington)	2.16	- .77	.43	6	21	58.0	23	20.0	30	1217		
VI.	Bury St. Edmunds (Westley)	2.93	+ .38	.65	23	17	53.0	23	15.0	29	...		
VII.	Norwich (Cossey)	3.34	+ .77	.70	23	16	...	...	5.0	30	2.8
VIII.	Weymouth (Langton Herring)	2.63	- 1.03	.42	9	21	57.0	1a	17.0	29	7...		
IX.	Barnstaple	3.83	- .78	.57	6	18	59.0	9, 14	20.0	29	...		
X.	Bodmin (Fore Street)	6.67	+ 1.20	.75	4	28	...	...	...	...	...
XI.	Stroud (Upfield)	2.10	- 1.23	.37	6	21	58.0	16b	22.0	29	7...		
XII.	Churchstretton (Woolstaston)	4.96	+ 1.44	1.33	8	23	59.5	19	21.0	27	716		
XIII.	Tenbury (Orleton)	2.95	- .19	.82	6	22	60.6	23	21.8	30	1012		
XIV.	Leicester (Barkby)	3.07	+ .78	.52	23	21	59.0	23	16.0	29	1625		
XV.	Boston	2.85	+ .66	.72	23	19	60.0	1	13.0	30	10...		
XVI.	Hesley Hall [Tickhill].....	2.95	+ .93	.51	6h	23	59.0	19	21.0	27f	13...		
XVII.	Manchester (Plymouth Grove)	5.02	+ 2.02	1.02	22	23	58.0	19	26.0	26	718		
XVIII.	Wetherby (Ribston Hall) ..	2.72	+ .65	.61	7	11	...	...	...	...	...
XIX.	Skipton (Arneliffe)	9.71	+ 2.96	1.71	6	27	55.0	19	...	...	7...
XX.	Hull (Pearson Park)	3.03	+ 1.02	.65	23	19	...	...	...	...	...
XXI.	North Shields	3.28	+ 1.25	.99	23	19	57.0	19	...	...	...
XXII.	Borrowdale (Seathwaite)....	25.48	+ 10.69	2.69	6	23	...	...	...	...	...
XXIII.	Cardiff (Ely)	4.42	- .49	.67	6	24	...	...	...	...	...
XXIV.	Haverfordwest	6.95	+ 1.09	.85	6	22	59.0	22	22.0	29	5.9		
XXV.	Plinlimmon (Cwmsymlog) ...	...	...	...	...	...	...	...	...	...	...
XXVI.	Llandudno	5.81	+ 2.72	.99	6	21	58.0	2	29.1	30	3...		
XXVII.	Cargen [Dumfries]	9.28	+ 4.72	2.32	6	20	56.4	19	22.0	27	9...		
XXVIII.	Jedburgh (Sunnyside).....	4.16	+ 1.66	1.30	8	17	56.0	19e	20.0	29	14...		
XXIX.	Old Cumnock	8.11	+ 3.14	1.20	6	22	57.0	19	14.0	26	13...		
XXX.	Lochgilhead (Kilmory)	11.91	+ 4.62	2.37	6	25	...	...	...	...	...
XXXI.	Oban (Craigvarren)	10.49	- .19	1.30	29	25	58.6	20	23.9	27	3...		
XXXII.	Mull (Quinish)	10.06	+ 3.07	1.66	29	26	...	...	...	...	...
XXXIII.	Loch Leven Sluices	6.70	+ 2.74	2.00	7	15	...	...	...	...	...
XXXIV.	Dundee (Eastern Neropolis)	4.65	+ 1.95	1.45	6	17	55.9	19	23.5	29	8...		
XXXV.	Braemar	5.03	+ .45	1.32	6	18	54.0	19	10.0	27	1225		
XXXVI.	Aberdeen (Cranford)	5.56	...	1.35	6	25	60.0	19	21.0	27g	8...		
XXXVII.	Strome Ferry	7.81	- .07	.83	6	27	...	...	...	...	...
XXXVIII.	Inverness (Culloden)	1.93	- .56	...	...	...	55.0	19	23.0	27	623
XXXIX.	Dunrobin	3.47	+ .64	.97	6	14	57.5	19	24.8	27	8...		
XL.	S. Ronaldsay (Roeberry).....	5.29	+ 1.87	.83	1	24	52.0	30	32.0	26h	2...		
XLI.	Cork (Blackrock)	5.21	+ .58	.82	8	19	61.0	22d	23.0	28	8...		
XLII.	Dromore Castle	12.38	+ 6.70	1.70	2	23	57.0	11	22.0	28	...		
XLIII.	Waterford (Brook Lodge) ...	4.53	+ .86	.73	6	23	59.0	22a	26.5	9	9...		
XLIV.	O'Briensbridge (Ross)	6.99	...	1.16	1	25	55.0	20	25.0	28i	...		
XLV.	Carlow (Browne's Hill)	4.35	+ 1.29	.73	6	26	...	...	...	...	...
XLVI.	Dublin (Fitz William Square)	4.21	+ 1.38	.63	10	27	63.0	19	26.3	29	316		
XLVII.	Ballinasloe	6.50	+ 2.59	1.15	6	25	56.0	2	19.0	29	11...		
XLVIII.	Waringstown	8.11	+ 5.01	1.42	6	25	58.0	19	20.0	26	914		
XLIX.	Londonderry (Creggan Res.) ..	8.01	+ 3.49	1.47	6	28	...	...	...	...	...
L.	Omagh (Edenfel)	7.23	+ 3.36	1.23	6	26	55.0	14e	22.0	27g	611		

a And 19, 23. b And 19. c And 20. d And 23. e And 18, 19, 22, 23. f And 30. g And 28. h And 27. i And 29.

+ Shows that the fall was above the average; - that it was below it.

METEOROLOGICAL NOTES ON NOVEMBER, 1890.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; T S for Thunderstorm; R for Rain; H for Hail; S for Snow.

ENGLAND.

STRATHFIELD TURGIS.—The first three weeks were mild and uniform in temp.; a very decided change occurred on the 23rd, when severe weather set in, and continued to the end. The grass min. thermometer registered 14°·5 on the morning of the 29th. A short, sharp squall occurred at 6.45 p.m. on the 21st, accompanied by heavy R.

HITCHIN.—The 23rd was the hottest day so late in November ever recorded here, and the 28th was the coldest since 1858.

ADDINGTON.—From the 14th to 23rd the max. temp. in shade was rather high, but from thence to the end it was very cold, the min. shade temp. on the 27th, 28th, 29th, and 30th being 23°, 22°, 22°, and 20°; on the evening of the 30th it began to thaw, the wind changing to S.W. The month was very free from fogs. Snow on 3 days.

BURY ST. EDMUNDS, WESTLEY.—The month was mild and favourable for agriculture till the 25th, when great cold set in, and continued till the end, with a considerable fall of S.

LANGTON HERRING.—From the 1st to the 18th the weather was wet and mild; the last five days were unprecedentedly cold. On the night of the 28th the temp. fell to 17° in shade, and on the grass to 12°. Taking the whole month, the temp. was very slightly below the average. The range of temp. was the greatest in any month for the last 19 years, being 40°. A solar halo was observed on the 15th, L on the 2nd, T and L on the 9th.

BODMIN, FORE STREET.—A very stormy, wet, and cold month. The first 10 days very wet and stormy, and it continued showery until the 25th, when H fell with very high wind; hard frost from the 26th to the end of the month, and bitterly cold wind; S on the 27th and 28th. The coldest November for many years.

STROUD, UPFIELD.—A fine, warm month, till the last few days. Gales on the 1st and 6th, L on the 9th, S on the 25th, 28th, 29th, and 30th.

WOOLSTASTON.—The first half of the month was wet, cold, and stormy, strong gales with very heavy R occurring from 6th to 8th. The weather then became quite genial, and the 18th, 19th, and 20th were warm summer days. Another gale occurred on the 23rd, and after this it became extremely cold, S falling on 27th and 28th. Mean temp., 42°·1.

ORLETON.—Temp. a little above the average. Heavy R on 5th, accompanied by a great gale of wind, the worst for several years. On the 20th the temp. was 60°, and on the 23rd 60°·6, the latter being the highest so late in the year for 30 years, though on November 18th, 1875, the temp. rose to 61°·3. From the 25th to the end of the month the weather was very cold, the maxima on the 27th and 28th being 33°·4 and 33°·2 respectively. S on the 27th and 28th.

BOSTON.—S on the 26th and 27th, eight inches deep.

MANCHESTER, PLYMOUTH GROVE.—Fine autumn weather on 1st, 5th, and 10th. Wet mist on 13th, 17th, and 18th; many damp and foggy days up to the 17th, but no dense fogs during the month. Heavy fall of S on 27th. On 26th and 28th the min. on grass fell to 20°. Mean temp. 42°·8.

HULL, PEARSON PARK.—From the 1st to the 12th the weather was generally showery; then mist or fog prevailed until the 21st; this was followed by stormy weather, often with heavy falls of S and H nearly to the end of the month.

WALES.

HAVERFORDWEST.—One of the most remarkable Novembers that I have observed. The first six days were very stormy, especially on the night of

the 6th; the wind exceeded in force in this gale any gale since the memorable one of December 8th, 1886 (lowest bar. 28.927 in.). The R was continuous, and greatly above the average. The temp. was, up to the 23rd, greatly above the mean; a sudden and abrupt change took place on the 24th, the wind shifted to N.N.E., and the mean temp. of the six days from the 24th to the 29th inclusive was 30°·8. I never registered such continuous cold in any previous November. The month ended mild and wet. Prevailing winds, W. and S.W.

SCOTLAND.

CARGEN.—The first half of the month was extremely wet and stormy; 6·73 in. of R fell during the first 14 days, 2·32 in. falling on the 6th. During 31 years this fall has only been exceeded once, viz., 8th February, 1869, when 2·34 in. fell. Sharp frost prevailed from 26th to 29th, the minimum temp. ranging from 26°·4 to 22°. TS on the 10th.

JEDBURGH.—Winter manifested its appearance by S and frost, but to no great extent. Out-door work was not stayed in any way. Great stillness prevailed in the atmosphere, and there was almost no fog.

OBAN.—R almost constant throughout the month, and in great quantity. Crops still remain exposed to the weather, and farming operations were at a standstill. There were no heavy gales. At the close, a sharp frost occurred with some S. So continuous a rain for nearly six months is without previous record in this district. Most of the crops are lost, but potatoes on elevated gravel beds are of fine quality, quite superior to those of the dry season of 1889.

CULLODEN.—The weather was very changeable; much R fell at intervals, with occasional high winds from W. and N.W. A slight earthquake occurred on 15th, at 10 minutes before 6 p.m.

ROEBERRY.—A very coarse, wet month; the wettest since 1882.

IRELAND.

CORK.—Almost incessant R to the 17th, then mostly fine to the 23rd, and heavy squalls on the 24th. The last week fair and frosty, except the 29th and 30th, which were wet and foggy. Mean temp. 44°·1.

DROMORE.—Very wet, with a very severe frost during the last week.

WATERFORD, BROOK LODGE.—Gales on 2nd and 7th; fogs on 18th, 19th, and 20th; S on 26th and 27th. Ripe strawberries gathered on the 8th.

O BRIENSBRIDGE, ROSS.—The heaviest November R since 1883; much L and heavy gales in the first half of the month, sharp frosts on 27th, 28th, and 29th, and the month closed with a return of misty and mild weather.

DUBLIN.—A wet, stormy, cheerless month, reminding one of November, 1888, which was the wettest and most stormy for more than a quarter of a century. The weather remained open until the 24th, when a spell of snow-storms and bitter cold set in with peculiar suddenness. The S storm on the night of the 26th was the heaviest experienced since the memorable storm of January, 17th, 1881. High winds on 12 days, attaining the force of a gale on five. Fogs on four days, H on five days, sleet and S on 26th, 27th, and 28th. On the 30th the S rapidly disappeared, under the influence of a S.W. gale and warm R.

BALLINASLOE.—Very wet and cold; floods very high in both Shannon and Suck.

OMAGH, EDENFEL.—During the first 25 days R was almost incessant, with occasional strong winds, and on the 6th a gale, but generally with mild humid air and extreme dampness. On the 25th a slight fall of snow was followed by three days of dry, clear, keen frost, and on the 29th by a return to R and humidity. The wettest November in at least 26 years.