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WATER AT UNUSUALLY LOW TEMPERATURES.

ON Monday, November 30th, the Observer at Camden Square, having finished the usual 9 a.m. Meteorological readings, reported that the water-supply for the wet bulb thermometer on the Glaisher screen (I.) was not frozen, though the air temperature was 29°·1; and examination showed that the water was absolutely free from ice, though the muslin, and the wick from the edge of the water vessel to it, were frozen. There is on the same screen another hygrometer, the water supply for which was frozen into a solid mass of ice not adhering to the vessel. This second water-vessel, (II.) though more protected from radiation, was more exposed to the wind.

The night had been clear and cold, at 9 a.m. the sky was almost cloudless and the sun shining brightly, but there was a slight accumulation of London smoke in the air, not sufficient to justify the use of the word fog or foggy. The wind was very light from E. or E.N.E. These general conditions of weather continued practically unchanged until noon.

Our immediate impression was that the water in I. remained unfrozen owing to the stillness of the air, and that rapid congelation would take place on the slightest disturbance, but stirring the surface lightly with the point of a cedar pencil produced no result. An unmounted mercurial thermometer was then obtained, and at 9.15 a.m. a series of readings commenced. The temperature of the water was ascertained by immersing the bulb and about an inch of the stem of the thermometer and stirring for 15 or 20 seconds, then reading and again stirring for 15 or 20 seconds, and again reading; if the two readings were not identical, the process was repeated. The bulb of the thermometer was not withdrawn from the water during reading.*

Time	9.0	9.15	9.45	10.0	10.15	10.30	11.0	11.30
Dry bulb ...	29°·1	29°·5	30°·9	31°·8	32°·2	33°·1	34°·6	35°·7
Water in No. I....	—	28·1	29·2	30·0	30·6	31·1	32·5	33·4

* This thermometer is by Casella, No. 19409, graduated on the stem about 15 years ago, bulb 0·23 inch diameter, taking up the true temperature in water in 15 seconds. It was compared with a Kew Standard in water, the error being at 34°·0 + 0°·6. In a drained vessel of broken ice its error was + 0°·7, and this correction has been applied to all its readings.

The minimum temperature occurred about 5.30 a.m., and was 25°·4, and there appears to be justification for assuming that the water in I. fell to very nearly this temp. without the formation of ice.

It will be seen that the temperature rose gradually, but the other conditions as before described remained unchanged, until at 9.45 a.m. it was found that the muslin and wick were thawed, the temperature of the air being 30°·9 and of the water 29°·2.

At 10.30 a.m. the ice in vessel No. II. was beginning to thaw, and moisture was visible between the ice and the glass, but there was not sufficient to flow.

By 11 a.m. the temperature of the air had risen to 34°·6, and of the water in No. I. to 32°·5, not an atom of ice having been seen in or on the water during the whole time.

Three new unused stoppered glass bottles were obtained, and at 2 p.m. all the water from vessel No. I. was bottled, the remaining ice in No. II. was melted by placing the vessel in warm water in the open air, and the whole of its contents were put into the second bottle, while the third bottle was filled with water from the store of rain water kept for replenishing the vessels I. and II.

This store is an uncorked glass bottle kept standing in the observer's office, which is filled from time to time with the rain caught in a copper rain gauge (thoroughly oxidised) with a copper receiver.

These three bottles—marked "Liquid" (vessel I.), "Frozen" (vessel II.), and "Supply"—were handed to Mr. M. J. Salter, F.I.C., F.C.S., who kindly undertook their chemical examination. From his notes we have extracted the following.

"It seemed to me that the first thing was to try to freeze the sample marked "Liquid," and notice how it behaved. I therefore took an ordinary 6 × ¾ inch test tube which had been in use for general work, and after washing it as usual, and finally with distilled water, carefully wiped it dry and polished it inside with a clean cloth. I used this same test tube throughout all the experiments. From the irregular way the water-drops adhered to the glass, I infer that it was slightly greasy. It certainly was not catharised in Tomlinson's sense (*Journ. Chem. Soc.* xxii. 125). Into this I poured enough of the water to cover the stem of the thermometer (your Casella 19409) to about 40°, but in the first freezing experiment I found it inconvenient to have so much water, and therefore for all the others I worked with the surface somewhat below 25°, which allowed me to plunge the water column almost entirely below the surface of the freezing mixture. For the freezing mixture I used ice and salt, with no special precautions as to temperature. The thermometer had a slip of wood tied across it, which just kept its bulb from touching the *bottom* of the test tube (say about ⅛ inch up). I now employed two methods of observation.

(1) As the falling temperature approached 33° I stirred the

water continuously with the thermometer, stopping every few seconds just long enough to get a reading.

(2) Leaving the thermometer hanging at rest in the water, I avoided disturbance as completely as possible, and simply watched the course of the mercury.

The following table will now speak for itself.

SAMPLE "LIQUID" (*Water from vessel No. I.*).

	Method of observation.	Lowest reading.	
	Stirring.	26°·8	At this moment spicules of ice were seen to be adhering to the thermometer, and temp. rose suddenly to 32°·0.
Warmed to 52°	,,	32°·0	Ice formed as soon as 32°·0 was reached.
,, ,, 75°	,,	24°·7	Then suddenly shot up to 32°·0, and most of the sample became solid.
,, ,, 65°	Unstirred.	28°·8	Rose suddenly to 31°·9.
,, ,, 75°	,,	28°·7	,, ,, ,, 32°·0.

SAMPLE "FROZEN" (*Water from vessel No. II.*).

	Unstirred.	31°·3	Then rose to 31°·8, and a crystal of ice seen.
Remelted.	Stirring.	26°·4	Solidified suddenly, with rise to 32°·0.
Warmed to 47°	,,	27°·7	,, ,, ,, ,, 32°·0.

SAMPLE "SUPPLY" (*Water from store*).

	Unstirred.	31°·1	At moment, when this reading obtained, it was found that nearly half the water was frozen.
Warmed to 55°	,,	30°·1	Then rose to 31°·8, and most of it found to be solid.
,, ,, 50°	,,	31°·6	Then rose to 31°·8, and most of it found to be solid.

The above show that the solidification is extremely capricious and that this is not due to the presence of any substance in solution which produces an absolute lowering of the freezing point, but is rather to be attributed either to the absence of nuclei, or possibly to the presence of some substance such as tarry matter by which ordinary nuclei are rendered inert. I noticed later on that the samples showed a tendency to form films, as if there was present some substance which increased the surface tension. As far as can be judged from the somewhat negative character of the results with "Supply," it seems that the exposure to a smoky atmosphere in the open glass vessels on the Glaisher screen had increased the tendency to resist freezing.

I next took the specific gravity of the samples at 60° F., using a Sprengel sp. gr. tube, which holds 12·5575 grams of distilled water. This, having been made originally for taking the sp. gr. of oils and varnishes, has rather wide capillaries, so that it is scarcely fit for work of the highest refinement. The results I got, were, however—

"LIQUID"	1·00023.
"FROZEN"	1·00059.
"SUPPLY"	1·00013.

These numbers are quite sufficient to show that the impurities present are not in sufficient quantity to affect the freezing point, even if the rise of the thermometer to 31°·8—32°·0, as soon as ice began to form did not indicate that 32° was the true freezing point.

The question at issue being one of temperature, refined determination of impurities appeared unnecessary, but—

"LIQUID" showed—Ammonia in considerable quantity with Nessler.

" " Sulphuric acid or a sulphate with barium chloride.

" " Oxidisable organic matter (? sulphurous acid) with permanganate.

" " Non-volatile matters, both organic and mineral, when evaporated on platinum foil.

Comparative observations with distilled water were also made.

A test-tube, with no special cleaning, was employed, and distilled water, neither specially pure, nor quite free from dust.

DISTILLED WATER.

	Method of observation.	Lowest reading.	
	Unstirred.	22°·1	Then rose to 32°·0, and became solid.
Warmed to 40°.	"	25°·3	Then rose suddenly to 32°·0, and whole mass became solid.
	Fresh distilled water from same supply.		
	Unstirred.	17°·3	Thermometer touched and found to be loose, instantly rose to 32°·0, and whole solidified.
	Fresh distilled water from same supply.		
Warmed to 45°.	Unstirred.	12°·3	Then the whole froze with a sort of flash, and temp. rose to 31°·8.
	Tube wiped carefully, and fresh distilled water from same supply.		
	Stirred.	28°·3	Then rose to 32°·1, and changed to ice.

So far the report. Is it generally known that ordinary or distilled water in an open vessel can, with extreme ease, and without any precautions, be cooled nearly 20° F. below freezing point without solidifying? Is 12°·3 F. the lowest to which a mass can be cooled? We can trace no statement on the subject in any book on physics which we have consulted. Prof. Everett, in his translation of Deschanel, tells us that "Despretz has cooled water to —20° C. (—4° F.) in fine capillary tubes, without its freezing, and Dufour has obtained a similar result by suspending globules of water in a liquid of the same specific gravity, with which it would not mix, this liquid being one which had a very low freezing point."

These cases are, however, quite different, the case before us is one of a wine-glassful of water—not of water in "capillary tubes," or individual globules.

Prof. Atkinson, in his translation of Ganot, says, "The freezing point of pure water can be diminished by several degrees if the water be previously freed from air by boiling, and be then kept in a perfectly still place. In fact, it may be cooled to —15° C. (5° F.) and even lower, without freezing. But when it is slightly agitated the liquid at once solidifies."

In the case reported above, the water had not been "boiled," and far from being "still," had been repeatedly stirred with a black-lead pencil, and with a thermometer bulb.

Lastly, we referred to Larousse's *Grande Dictionnaire* with the following result:—

"A 0° C. l'eau prend l'état solide; on peut cependant, en la protégeant bien contre tout agitation, la refroidir jusq' à —12° C. (10°·4 F.) sans qu'elle se congèle. La moindre secousse détermine alors la congélation immédiate de la masse et la température remonte à 0° C. (32° F.)."

Here again it is pointed out that the least shock will produce immediate congelation; but the water in vessel I. was not merely shaken, but stirred, without freezing, when several degrees below 32° F.

ROYAL METEOROLOGICAL SOCIETY.

THE monthly Meeting of this Society was held on Wednesday evening, the 16th December, 1896 at the Institution of Civil Engineers, Mr. E. Mawley, F.R.H.S., President, in the chair.

Mr. R. H. Curtis read a paper entitled: "An Attempt to Determine the Velocity Equivalents of Wind-Forces estimated by Beaufort's Scale."

For such a comparison to be satisfactory, four conditions are essential:

(1) The observations should be made at an exposed station, where it may reasonably be expected that the full range of wind-force would be experienced.

(2) The station should be provided with an anemometer, the constants of which are known, and which should occupy a position entirely free from purely local disturbing influences.

(3) The estimations of wind-force should be made by an observer of experience, stationed in the same locality as the anemometer, but acting independently of its indications.

(4) There must be available a sufficiently long series of observations to yield reliable mean results.

Of all the records available those for Scilly appeared most nearly to fulfil the above requirements, and that station was adopted as the principal one. Fleetwood and Yarmouth being used as check stations, and also readings of the Dines's tube anemometer, at Holyhead. In all, 10,263 observations at Scilly were dealt with, and

12,098 at the other stations. The results of the Robinson Anemometers were corrected by the application of the factor appropriate to each instrument, and the readings were further checked by comparison with observations of the tube anemometer. The wind forces estimated by the observers were checked by comparison, with similar estimates made at neighbouring light-ships, or light-houses. The winds from different points of the compass being separately examined to see how far they yielded accordant results.

The values yielded by the Scilly observations are :—

Mean Velocity Equivalents, in miles and tenths, obtained from the observations made with the Robinson Anemometer at Scilly.

Estimated Force by Beaufort's Scale	0	1	2	3	4	5	6	7	8	9	10	11	12
Equivalent Velocity	...	3·9	6·7	9·3	13·5	19·8	26·0	31·7	36·9	43·0	51·5	63·1	...

While those finally adopted by the Author as the result of the whole discussion are :—

Velocity Equivalents for Estimated Forces by Beaufort's Scale.

Beaufort's Scale	0	1	2	3	4	5	6	7	8	9	10	11	12
Equivalent Velocity in miles per hour ...	2	4	7	10	14	19	25	31	37	44	53	64	77
Metres per sec.	0·9	1·8	3·1	4·5	6·3	8·5	11·2	13·9	16·5	19·7	23·7	28·6	34·4

The President remarked that to adopt the new factor for the Robinson's cup anemometer would make a great alteration from the values we were accustomed to see : 105 miles an hour would become 77 miles ; 87 miles, 64 ; 72 miles, 53, and so on.

Mr. Chatterton thought that Mr. Curtis had treated the 1887 results of the Wind Force Committee too politely. The Committee had worked on data based on a fallacious coefficient, and they now found that the exposure of the anemometers was also bad. He hoped that the day had gone by when results of useless observations would continue to be printed at the public expense.

Mr. Dines considered the practice of continuing to use a wrong factor—one that everybody who printed and who read the results knows to be wrong—was indefensible. In early years he had been surprised that the Scilly values were far below those for Holyhead ; but he afterwards found out that the Scilly instrument was not of the standard pattern, and that for it the factor 3 was practically correct.

Mr. Charles Harding believed that the Wind Force Committee had not arrived at an absolute decision as to what is best to be done, and he suggested that no alteration should be made before 1900. If a change were made now, another might be necessary a year or two

hence. He criticised Mr. Curtis's value of 2 miles an hour for force 0, or dead calm.

Mr. Symons exhibited a diagram showing some eight or ten different determinations of the equivalents of Beaufort scale, and remarked on the wide variation between them.

Mr. Gaster suggested that Mr. Symons's diagram illustrated the necessity for Mr. Curtis's paper. In a calm, light airs from various directions would all act on the anemometer, and cause revolution of the cups. He thought it was often forgotten that the extreme estimates of velocities of 100 or 120 miles an hour, were estimates in terms of West India hurricanes, which no canvas could stand. It must be remembered that the results based on factor 3 *are* printed, and the amount of confusion that would be caused by alteration would be very great.

Mr. Sowerby Wallis considered the paper a final settlement of what the Beaufort Scale means now; but he did not feel sure that it was the same when Admiral Beaufort invented it. Mr. Curtis's values show a steadily increasing increment of velocity for each value of the scale, while some of the earlier determinations—notably Sir H. James's—show a uniform increment. Would it be possible to get, on this point, the opinion of old salts who remembered sailing ships?

Mr. Brodie believed that finality, if not reached, was very nearly approached. In the paper, the Scilly values were treated as nearly perfect; but the observer is an old man, who would probably be soon superseded, and change of observer often results in change of the forces recorded. Estimation should be abolished altogether, by the use of a portable anemometer.

Mr. Ellis found that if Mr. Curtis's figures are taken to one place of decimals they run much better, and agree very closely with a mathematical formula which he had worked out, which gives for force 0, 1·6 miles. He asked whether Mr. Curtis considered the factor as constant for all velocities?

Capt. Carpenter doubted whether officers of the present day had any idea what sail a frigate could carry; but the state of the surface of the sea was a useful aid—the beginning of the formation of "white horses" indicated a wind of force 4. Some portable anemometer would be a great improvement on the use of the Beaufort Scale.

A paper by Dr. Leigh Canney on the "Winter Climate of Egypt" was read by the Secretary. The climate of Egypt during the winter is influenced by the Libyan desert, by the Mediterranean Sea, and by the extent of cultivated land. The author gave the results of a series of observations which he had carried on during the past three winters. The observations were started with the object of arriving at a comparative knowledge respecting the climates of the various stations now considered as health resorts in Egypt, and by a strictly comparable method to arrive at the precise differences between the climates of Upper and Lower Egypt, all previous observations having

failed in this respect. The stations at which observations were made were Cairo, Helouan, Mena House Hotel, Luxor, Assouan, the Valley of the Tombs of the Kings, and the crest of the Libyan Hills. As self-recording thermometers and hair hygrometers were used at each station, valuable data have been obtained on the diurnal variation of temperature and humidity.

Dr. Marcet considered the paper a very valuable one, but there were one or two points on which he would have liked more information—the treatment of the question of rainfall, for instance, being very slight. Solar radiation temp. also is very important, but difficult to observe, as the sun max. in vacuo seems to be unsatisfactory, but the shade temperatures given in the paper were no guide to the heat to which our soldiers were exposed in the last campaign. The slight fall of temp. at sunset at Luxor was interesting, and he (the speaker) had more than once observed an almost equal rise of temperature. The sensation of chilliness was not felt in Upper Egypt till about 4 hours after sunset, while in Lower Egypt it was felt much sooner.

Dr. Theodore Williams said that the traces exhibited seemed wonderfully uniform at the different stations, and also day after day. It was surprising to see that in the desert, where there is utter absence of vegetation, there is less range of temp. than in the cultivated regions. What struck him most with regard to humidity was, not the lowness of the values, but that in the night the percentage rose at times to 80, and the wonder was where the moisture came from. As regards rainfall in Upper Egypt, there is practically none to record. The position of the instruments on roofs was contrary to English ideas, but it was necessary to get up 40 or 50 ft. to get above the rise of the Nile.

The annual general meeting of this society was held on Wednesday January 20th, at the Institution of Civil Engineers, Great George-street, Westminster, Mr. E. Mawley, President, in the chair. The president delivered an address on "Shade Temperatures," in which he stated that of all meteorological observations there were none approaching in importance those made of the temperature of the air—generally known as shade temperature. Mr. Mawley traced the history of the different methods of exposing thermometers since the time that regular observations of the weather had been made in this country. For many years open screens were most favoured by meteorologists, that devised by Mr. J. Glaisher, F.R.S., and the late Astronomer Royal (Sir G. B. Airy, F.R.S.) being the pattern principally used. In 1864 Mr. T. Stevenson, C.E. invented an admirable form of closed screen with louvred sides, which was considered preferable to the open type of screen, and has now almost entirely superseded the Glaisher stand. In 1883 the Stevenson screen was considerably improved by a committee of the Royal Meteorological Society. Mr. Mawley then described his own experiments at Croydon and Berk-

hamstead with this improved screen, known as the Royal Meteorological Society's pattern. He advised the general adoption of this form of thermometer exposure, both in this country and on the Continent. He had recently made observations in the Stevenson screen, and also in the screens used in France and Germany, and the conclusion he had come to was that the results obtained in the Stevenson screen were not only the nearest to the true air temperatures, but also more likely to be independent of surrounding conditions than other patterns.

A TORNADO AT ESTE'S PARK, COLORADO.

WE have been favoured with the following description, and insert it with the object of ascertaining what foundation there is for the impression that tornadoes are creatures of the plains. Este's Park is (we see by Dr. Theodore Williams's Presidential Address to the Royal Meteorological Society, where it is fully described) 7,500 feet above sea level, so that the average reading of the barometer there must be about 22½ inches or only three-quarters of that in the plains; evidently therefore to produce equal structural damage the velocity of the wind must be much greater. Hence we have three points on which information is desirable, (1) Is it a fact that Tornadoes rarely occur at high altitudes; or (2) Is their force less, and do they thereby escape notice? (3) Are they more rare because the conditions of heat and moisture necessary for their formation do not exist?

Extract from letter by Mr. H. C. Rogers, dated Este's Park, Colorado, Nov. 4th, 1896:—

The place where I am staying is in summer run as an hotel; now another man and I are the only visitors. During the last ten days the weather has not only been cold but made objectionable by a cold west wind. About 4 p.m. to-day a friend, Dr. James, called, and we three were sitting in a room which opens on to a verandah. Suddenly we heard the sound of a terrific rushing wind and the rattle of gravel and debris, the house swayed, the windows were darkened and then suddenly the room was more light than usual. The front of the house consists of two sides of a square, and it is firmly built with a verandah 8 feet deep all round the two sides. On going out we found that about 55 feet of the verandah had been carried away—a few yards, severed from the portion carried away, lay on the ground a heap of splinters, but by far the larger portion had been lifted over the wing of the house and deposited by the river 85 yards away. We have also heard that timbers were seen flying over the Post Office, distant about a quarter-of-a-mile, and they may have been part of our verandah. In seven windows facing the verandah not a pane of glass was broken. The outer door (a sort of door with wire gauze instead of panel) was ripped off its hinges, and is a mass of splinters. The whole performance, from the first sound of the whirl

until the business was over, could not have been more than five seconds. Just before this a strong blast of wind started up from the east, the opposite direction to that of the strong wind that has prevailed during the last few days—they apparently met near here and took the form of a cyclone. I do not think that it came from any considerable distance, nor do we think that it travelled far, for we could see no trees down or other signs of destruction. This is an extremely rare occurrence at an altitude where the atmosphere is so rarified, and nobody seems to have heard of such a tornado in these mountains before—although of course it is nothing to be compared to what happens at lower elevations out in the plains east of this place, such as occurred at St. Louis not many months ago.

REVIEWS.

Neudrucke von Schriften und Karten . . . . herausg. von Prof. Dr. HELLMANN. Berlin: A. Asher & Co. 4to. 1896.

No. 7.—EVANGELISTA TORRICELLI. *Esperienza dell'Argento Vivo. Accademia del Cimento. Istrumenti per conoscer l'Alterazioni dell'Aria.*

THIS may be described as an essay on the invention and early history of the barometer, thermometer and hygrometer, and is perhaps the most important of this valuable series of works; not on account of the rarity of the works reproduced, for as we have ourselves five or six editions of the "Saggi" of the Accademia, including those of 1666 and of 1841, we can hardly regard it as very rare,* but because of the mass of information which Dr. Hellmann has inserted in the notes. Nothing but careful perusal can do justice to it; but, to take a very low indication of the information concentrated in it, we may mention that we find Dr. Hellmann quoting Greek, Latin, Dutch, English, French, German and Italian.

It is impossible within any ordinary limit to give a fair idea of the research epitomized in this book, the only conceivable complaint seems to us to be that it somewhat breaks down under its own wealth of confirmatory evidence, and gives the feeling of ones having been reading a dictionary rather than a book. No one without thoroughly mastering it must pretend to write the early history of the three instruments we have named, but we think that the "Einleitung" might with advantage have been relieved by some portions being transferred to the "Anmerkungen." As to these Remarks which occupy eight quarto pages, we know no other eight pages which contain so much useful information. Dr. Hellmann on

* A reference to the superb glass work of the Florentines in the middle of the 17th century, and an engraving of one of their thermometers, will be found on p. 91 of Vol. XI. (1876) of the *Met. Mag.*

p. 20 points out the desirability of an accurate comparison of the Florentine thermometer at the Royal Institution, with a standard; and we trust that that may soon be done.

No. 8.—E. HALLEY, A. VON HUMBOLDT, E. LOOMIS, U. J. LE VERRIER, E. RENOU. *Meteorologische Karten*, 1688, 1817, 1846, 1863, 1864.

SIX facsimile maps which Dr. Hellmann happily describes as milestones on the road of meteorological progress. Halley's Map of the Winds, Humboldt's first Isothermal Chart, Loomis's Storm Map, Early Isobaric Charts by Le Verrier (or possibly by Marié Davy?) and Renou's Map of the Mean Isobars for France—this is the interesting set reproduced in No. 8. And there is of course the usual introduction and bibliography by Dr. Hellmann of a quality which no living man can equal, and from which one always learns something. For instance, we recently reproduced the first weather map, sold in the 1851 Exhibition; Dr. Hellmann gives us a paragraph in Dutch from a work by Dr. Buijs Ballot which shows that it was through seeing these maps that he was led to publish analogous ones in the Nederlandsch Meteorol. Jaarboek für 1852.

On another page Dr. Hellmann mentions that he possesses the first of a series of a sort of synoptic weather maps for November, 1725, by an unknown author residing at an unknown place, which bear the title "Erster Entwurf einer Witterungs-Charte darinne die Witterung wie man sie an verschiedenen Oerthern Teutschlandes in einem District von etlichen 80 Meilen lang und 60 Meilen breit, im Monath Novembr., 1725, beobachtet, vorgestellet wird."

No. 9.—HENRY GELLIBRAND. *A Discourse Mathematical on the Variation of the Magneticall Needle. London*, 1635.

A FACSIMILE reproduction of the copy of the above rare tract belonging to Mr. Latimer Clark, F.R.S. The first comparisons between the true terrestrial meridian and the magnetic meridian were made by Burrowes at Limehouse, Oct. 16, 1580, when he found it about 11° 16′ E. On June 13, 1622, Mr. Gunter at the same place found it to be about 5° 56′ E., but it does not seem to have occurred to him that this difference showed any secular change, and therein lies the merit of Gellibrand's paper in that he not merely determined the variation at Deptford on June 12, 1634, to be only 4° 4′ E., but pointed out the decrease of about 7° in 54 years.

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE, AUGUST, 1896.

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.	TotalRain. Depth.	Days.	Aver. Cloud.
	°		°		°	°	°	0-100	°	°	inches		
England, London	77·1	13	45·4	27	69·9	51·6	54·0	83	123·9	40·1	1·92	14	5·8
Malta	104·8	11	59·4	31	86·6	71·0	66·2	68	152·0	52·9	·00	0	2·2
Mauritius	75·0	7	58·6	8	72·6	63·2	57·2	71	121·9	47·3	2·08	16	5·0
Calcutta	89·8	28	75·6	3	87·6	78·7	78·2	87	157·7	75·1	11·02	21	7·7
Bombay	86·1	25	75·0	11	83·6	76·6	75·4	86	142·8	72·3	20·77	29	8·8
Ceylon, Colombo	88·0	15	73·3	4	85·4	77·3	73·2	80	145·0	70·0	6·35	15	6·1
Melbourne	67·2	22	35·8	2	56·6	42·4	43·1	74	118·0	24·8	2·75	14	6·8
Adelaide	71·7	22	37·7	3	61·3	44·1	42·5	72	130·1	29·3	1·23	15	6·3
Sydney	67·7	23	40·5	1	59·2	45·7	43·9	81	117·7	29·8	1·78	12	3·4
Wellington	60·0	25	34·0	5*b*	53·7	42·0	40·0	75	116·0	21·0	3·63	17	4·6
Auckland	64·0	31	38·0	11	57·2	46·3	42·8	73	121·0	32·0	3·65	...	5·4
Jamaica, Kingston	91·8	19*a*	70·4	22	90·7	74·1	70·7	71	...	...	·40	5	...
Trinidad	91·0	19	68·0	9	88·4	71·7	74·2	84	176·0	67·0	7·66	20	...
Grenada	86·2	8	72·2	15	83·3	74·7	70·7	73	148·4	...	8·81	23	3·9
Toronto	89·9	4	42·3	20	79·2	56·6	57·9	70	107·0	37·0	1·13	9	4·7
New Brunswick, Fredericton	92·7	11	40·3	31	76·6	51·4	54·0	66	...	...	1·10	11	4·1
Manitoba, Winnipeg	84·6	7	32·0	31	74·8	48·0	...	...	...	...	1·51	11	4·7
British Columbia, Esquimalt	73·7	6	46·2	11	68·3	50·9	53·5	85	...	...	·57	5	6·3

a—and 23. *b*—and 6, 10.

REMARKS.

MALTA.—Adopted mean temp. 77°·7, or 0°·5 below the average. Mean hourly velocity of wind 9·4 miles. Average temp. of sea 79°·0. TS on 28th. Absolute max. the highest reading recorded in 13 years, while the absolute min. is the lowest for August. J. F. DOBSON.

Mauritius.—Mean temp. of air 1°·3, dew point 2°·0, and rainfall ·19 in., below, their respective averages. Mean hourly velocity of wind 12·5 miles, or 0·2 above average; extremes, 28°·6 on 1st, and 2·3 on 10th and 11th; prevailing direction, E.S.E. T. F. CLAXTON.

CEYLON, COLOMBO.—Lightning was seen on the 18th, 19th and 26th. F. W. GRIMLINTON.

Adelaide.—Mean temp. 1°·3, and rainfall 1·14 in., below the average for 39 years. The winter throughout South Australia has been very dry. C. TODD, F.R.S.

Sydney.—Rainfall 1·04 in. below, humidity 7°·7 above, and temperature 2°·5 below, their respective averages. This month was remarkable for the number of cloudless nights, hence dew was measured on 13 days amounting to ·065 in. The average max. is the lowest since 1861. H. C. RUSSELL, F.R.S.

Wellington.—The first part of the month was generally fine, with occasional showers and light winds, the middle showery, then fine weather until the end, when it was showery and unsettled. S on the hills during the latter part of the month. H on 8th and 17th. Fog on 6th. R. B. GORE.

Auckland.—Weather warm and mild during the greater portion of the month. Barometrical pressure and mean temp. both considerably above the average. Rainfall considerably below. T. F. CHEESEMAN.

TRINIDAD.—Rainfall 2·66 in. below the 30 years average. J. H. HART.

SUPPLEMENTARY TABLE OF RAINFALL, JANUARY, 1897.

[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 .	2·96	XI.	Lake Vyrnwy	1·81
,,	Birchington, Thor	2·34	,,	Corwen, Rhug	1·78
,,	Hailsham	2·68	,,	Criceith, Talarvor.....	1·60
,,	Ryde, Thornbrough	2·87	,,	I. of Man, Douglas	2·53
,,	Emsworth, Redlands ...	2·87	XII.	Stoneykirk, Ardwell Ho.	1·65
,,	Alton, Ashdell	2·28	,,	New Galloway, Glenlee	2·99
III.	Oxford, Magdalen Col..	1·79	,,	Lilliesleaf, Riddell	1·38
,,	Banbury, Bloxham	2·00	XIII.	N. Esk Res. [Penicuick]	2·35
,,	Northampton, Sedgebrook	2·49	,,	Edinburgh, Blacket Pl..	·80
,,	Duddington [Stanford]..	2·21	XIV.	Glasgow, Queen's Park..	1·22
,,	Alconbury	1·94	XV.	Inverary, Newtown	1·48
,,	Wisbech, Bank House...	1·76	,,	Oban, The Corran	1·15
IV.	Southend	2·29	,,	Islay, Gruinart School...	1·09
,,	Harlow, Sheering..... ...	2·27	XVI.	Dollar.....	1·88
,,	Colchester, Lexden	2·09	,,	Balquhidder, Stronvar...	2·54
,,	Rendlesham Hall	2·34	,,	Ballinluig	1·68
,,	Rushall Vicarage	1·87	,,	Dalnaspidal H.R.S.....	3·03
,,	Swaffham	1·62	XVII.	Keith H.R.S.....	·64
V.	Salisbury, Alderbury ...	2·42	,,	Forres H.R.S.	1·22
,,	Bishop's Cannings	2·18	XVIII.	Fearn, Lower Pitkerrie..	·96
,,	Blandford, Whatcombe .	2·49	,,	N. Uist, Loch Maddy ...	2·18
,,	Ashburton, Holne Vic...	4·09	,,	Invergarry.....	1·35
,,	Okehampton, Oaklands.	3·27	,,	Aviemore H.R.S.	1·72
,,	Hartland Abbey	2·08	,,	Loch Ness, Drumnadrochit	1·66
,,	Lynmouth, Glenthorne.	2·78	XIX.	Invershin	1·66
,,	Probus, Lamellyn	4·15	,,	Scourie	1·78
,,	Wellington, The Avenue	2·22	,,	Watten H.R.S.....	1·45
,,	Wincanton.....	1·99	XX.	Dunmanway, Coolkelure	5·73
VI.	Clifton, Pembroke Road	1·90	,,	Cork, Wellesley Terrace	4·00
,,	Ross, The Graig	2·42	,,	Killarney, Woodlawn ...	3·72
,,	Wem, Clive Vicarage ...	2·27	,,	Caher, Duneske	2·67
,,	Cheadle, The Heath Ho.	1·85	,,	Ballingarry, Hazelfort...	2·04
,,	Worcester, Diglis Lock	1·93	,,	Limerick, Kilcornan ...	1·74
,,	Coventry, Kingswood ...	2·43	,,	Broadford, Hurdlestown	1·50
VII.	Grantham, Stainby	2·66	,,	Miltown Malbay	2·57
,,	Horncastle, Bucknall ...	2·25	XXI.	Gorey, Courtown House	2·93
,,	Worksop, Hodsck Priory	2·37	,,	Athlone, Twyford	1·92
,,	Neston, Hinderton	1·25	,,	Mullingar, Belvedere ...	2·40
VIII.	Southport, Hesketh Park	·97	,,	Longford, Currygrane...	1·85
,,	Broughton-in-Furness ...	1·54	XXII.	Woodlawn	2·19
IX.	Ripon, Mickley.....	1·73	,,	Crossmolina, Enniscoe ..	2·70
,,	Melmerby, Baldersby ...	1·75	,,	Collooney, Markree Obs.	2·12
,,	Scarborough, Obs.	2·66	,,	Ballinamore, Lawderdale	2·03
,,	Middleton, Mickleton ...	1·31	XXIII.	Lough Sheelin, Arley...	1·60
X.	Haltwhistle, Unthank...	1·11	,,	Warrenpoint.....	2·79
,,	Bamburgh	1·86	,,	Seaforde.....	2·22
,,	Keswick, The Bank.....	1·20	,,	Belfast, Springfield	2·11
XI.	Llanfrechfa Grange	2·53	,,	Bushmills, Dundarave..	1·86
,,	Llandovery	2·24	,,	Stewartstown	1·38
,,	Castle Malgwyn	3·03	,,	Killybegs	2·43
,,	Builth, Abergwesyn Vic.	2·66	,,	Lough Swilly, Carrablagh	1·21
,,	Rhayader, Nantgwillt...	2·70			

JANUARY, 1897.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1880-9.	Greatest Fall in 24 hours. Dpth	Greatest Fall in 24 hours. Date	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Max. Date	Min. Deg.	Min. Date.	No. of Nights below 32°. In shade.	No. of Nights below 32°. On grass
		inches.	inches.	in.								
I.	London (Camden Square) ...	2·05	+ ·43	·83	8	20	47·0	10	23·4	18	15	22
II.	Maidstone (Hunton Court)...	2·22	+ ·67	·50	7	12	...	...	...	...	...	...
,,	Strathfieldsaye	2·44	...	·57	8	12	...	...	...	...	...	...
III.	Hitchin	2·25	+ ·71	·78	8	18	44·0	6	23·0	23*c*	25	...
,,	Winslow (Addington)	2·04	+ ·23	·57	8	20	48·0	7	17·0	18	21	25
IV.	Bury St. Edmunds (Westley)	1 99	+ ·52	·43	16	16	47·0	1	22·0	24	...	...
,,	Norwich (Brundall)	2·44	...	·49	16	26	45·0	1,10	22·0	26	21	24
V.	Weymouth(LangtonHerring)	1·95	— ·39	·54	7	15	49·0	10	22·5	24	15	...
,,	Torquay (Cary Green)	2·48	...	·73	7	16	50·1	11	24·0	24	11	19
,,	Polapit Tamar [Launceston]..	3·06	+ ·04	·67	29	15	51·3	10	18·5	18	18	20
VI.	Stroud (Upfield)	2·40	+ ·20	·43	8	15	47·0	7	21·0	23	21	...
,,	ChurchStretton(Woolstaston)	2·29	+ ·13	·41	8	20	43·5	7	21·0	23*d*	24	30
,,	Tenbury (Orleton)	2·15	+ ·01	·47	8	18	47·5	7	21·3	18	15	24
VII.	Leicester (Barkby)	1·44	— ·32	·26	7	20	44·0	1	12·0	17	24	30
,,	Boston	1·91	+ ·52	·43	8	18	47·0	6	22·0	26	20	...
,,	Hesley Hall [Tickhill].....	2·39	+ ·62	·66	7	21	43·0	1	20·0	24	24	...
VIII.	Manchester(PlymouthGrove)	1·00	— 1·46	·30	4	10	43·0	5, 6	18·0	23	21	22
IX.	Wetherby (Ribston Hall) ...	·87	— 1·02	·32	8	8	...	...	...	...	...	...
,,	Skipton (Arncliffe)	2·40	— 3·24	·47	4	15	...	...	...	...	...	...
,,	Hull (Pearson Park).	1·85	+ ·08	·30	7, 14	19	49·0	1	21·0	26	22	24
X.	Newcastle (Town Moor)	2·09	+ ·28	·63	7	20	...	...	...	...	...	...
,,	Borrowdale (Seathwaite).....	2·20	— 9·98	·55	3	11	...	...	...	...	...	...
XI.	Cardiff (Ely).....	2·26	— 1·03	·45	31	15	...	...	...	...	...	...
,,	Haverfordwest	3·40	— 1·02	·67	3	19	50·9	1	19·6	17	12	18
,,	Aberystwith (Gogerddan) ...	1·38	— 2·15	·25	26*a*	10	48·0	7	11·0	16*e*	25	...
,,	Llandudno.....	1·45	— ·83	·32	30	16	50·2	1	24·4	22	...	...
XII.	Cargen [Dumfries]	1·24	— 2·53	·36	7	8	47·4	1	16·0	18*f*	19	...
,,	Jedburgh (Sunnyside).....	...	...	...	...	...	...	...	...	...	...	...
XIV.	Colmonell	1·70	...	·45	29	9	48 0	3	18 0	23	...	...
XV.	Lochgilphead (Kilmory).....	1·80	— 4·34	·30	25	12	...	...	20·0	14	21	...
,,	Mull (Quinish).....	1·56	— 4·11	·80	4	10	...	...	...	...	...	...
XVI.	Loch Leven Sluices	1·90	— 1·00	·50	8	9	...	...	...	...	...	...
,,	Dundee (Eastern Necropolis)	1·75	— ·22	·40	30	16	48·1	1	22·3	25	21	...
XVII.	Braemar	1·76	— ·93	·22	9	20	48·3	7	13·4	23	24	30
,,	Aberdeen (Cranford)	3·18	...	·94	30	27	44·0	1, 2	20·0	16	21	...
,,	Cawdor (Budgate)	1·58	— ·59	·65	30	11	...	...	...	...	...	...
XVIII	Strathconan [Beauly]	1·70	— 3·18	·65	8	5	...	...	...	...	...	...
,,	Glencarron Lodge.....	2·05	...	·40	24	17	49·3	2	19·1	17	24	...
XIX.	Dunrobin	1·36	— 1·10	·50	30	8	48·8	3	23·8	25	20	...
,,	S. Ronaldsay (Roeberry).....	1·43	— 1·52	·21	26	22	46·0	2	24·0	25	20	...
XX.	Darrynane Abbey.....	3·17	...	·56	29	22	...	...	...	...	...	...
,,	Waterford (Brook Lodge) ...	3·44	— ·12	·60	6	16	50·0	3	20·0	18	16	...
,,	O'Briensbridge (Ross)	1·74	...	·57	31	13	...	...	...	...	...	...
XXI.	Carlow (Browne's Hill)	2·55	— ·35	·46	5	18	...	...	...	...	...	...
,,	Dublin (FitzWilliam Square)	2·69	+ ·83	·58	6	17	51·3	3	25·0	17	13	21
XXII.	Ballinasloe	2·01	— 1·07	·41	29*b*	16	48·0	2	23·0	16	15	...
,,	Clifden (Kylemore)	4·64	...	1·18	29	17	...	...	...	...	...	...
XXIII	Waringstown	2·26	— ·39	·57	29	15	48·0	2	16·0	16	23	26
,,	Londonderry (Creggan Res.).	1·61	— 1·81	·41	29	19	...	...	...	...	...	...
,,	Omagh (Edenfel)	1·55	— 1·47	·44	29	15	48·0	2	17·0	16	18	27

ENGLAND. WALES. SCOTLAND. IRELAND.

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

a—and 31. *b*—and 31. *c*—and 26. *d*—and 24. *e*—and 17. *f*—and 24.

METEOROLOGICAL NOTES ON JANUARY, 1897.

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.

HITCHIN.—A very cold month. There have not been such S drifts, or so many roads blocked, since April, 1876.

ADDINGTON.—Rain and S on a good many days. The 23rd was a very wild day, a high wind blowing the S of the previous night into great drifts, blocking some of the roads in the district. From the 16th to the end the temp. was low, the average max. being only 35°, and the average min. of the same time 25°. Foggy on three days.

BURY ST. EDMUNDS, WESTLEY.—The month was mild till the 16th, then much S and winterly weather till the end. The snow was heavily drifted in some places, and a snow plough was very useful. S on 8 days.

NORWICH, BRUNDALL.—A rough, winterly month, with much snow during the second half. Strong gales with blinding S storms occurred on the 22nd and 23rd, and the drifts exceeded any in these parts since January, 1881. Mean temp. about 3° below average. Range of temp. unusually small. Winter aconite in flower on 1st, snowdrop on 9th, and crocus on 14th; all unusually early. Aurora on 2nd; fog on 5th; H on 14th. S on the ground from 17th to 31st inclusive.

WEYMOUTH, LANGTON HERRING.—With the exception of the 2nd, the first fourteen days were mild. From the 4th to the 12th there was a good deal of wet and fog. On the 15th the weather became much colder, and remained cold to the end of the month. The mean temp. at 9 a.m. (35°·8) is 2°·8 below the average of 25 years. Very little snow fell, and it never quite covered the ground. Fogs on 4 days.

TORQUAY, CARY GREEN.—Rainfall ·76 in. below the average. Mean temp. 39°·0, or 2°·6 below the average. Duration of sunshine 59 hours 55 minutes, being 7 hours 35 minutes below the average; twelve sunless days.

POLAPIT TAMAR [LAUNCESTON].—A cold, seasonable month, and, though rather wet during the first week and the last four days, the total rainfall is less than the average. Thick fog till 10.30 a.m. on 11th. Squally, with S, about 4.30 p.m. on 22nd, and S for 20 minutes at 2.30 p.m. on 23rd.

STROUD, UPFIELD.—Severe S storm from N.W. on 22nd, when about three-quarters of an inch fell; S also on 9th, 21st, 25th, 27th, 30th, and 31st.

WOOLSTASTON.—A severe month, with continued frost. S fell lightly on 9 days, but there was no heavy fall. Mean temp. 32°·7.

TENBURY, ORLETON.—A very cold, dismal month, with a mean temp. more than 3°·5 below the average of 36 years. No intense cold, but a succession of slight night frosts, with cloudy days. From the 4th to the 13th neither sun, moon, nor stars were ever visible. S on 9 days.

LEICESTER, BARKBY.—A cold month, especially so during the latter half. Very little sunshine. About 4 inches of S. Mean temp. 33°·1.

MANCHESTER, PLYMOUTH GROVE.—Mean temp. 34°·0—the lowest for January since observations commenced in 1868, with the exception of 1871, 1879, and 1881; and the driest January since 1868, with the exception of 1880, 1881, and 1896. Slight falls of S on the 9th and 19th; S storm on the 22nd; and S on 24th, 25th, 26th, and 29th. Dense fog on the 11th, 18th, and 19th. The last ten days very winterly.

WALES.

HAVERFORDWEST.—January commenced fine, but on the 3rd it became gloomy, wet, and stormy, and continued so until the 13th, when the sky cleared, the wind veered to N.E., and a fine, bright, frosty period set in, which lasted until the 22nd, when S fell, and again on 25th, covering the Precelly range. Afterwards the wind shifted to N.W., with heavy S and H showers, and cold, precarious weather prevailed to the end.

ABERYSTWITH, GOGERDDAN.—S fell on the 26th, 27th, and 28th to a depth of about three inches.

SCOTLAND.

CARGEN [DUMFRIES].—Although no very sudden fluctuations of temp. occurred during the month, which was uniformly cold, there was considerable difference in the mean temp. of the last 19, as compared with the first 12, days. From 1st to 12th, when the thermometer was only once below freezing point, the mean temp. was 38°·4; from 13th to 31st, when frost was registered on every day except 20th, the mean was 31°·8. The mean for the month is 3°·5 below the average of 38 years. The rainfall (of which upwards of ·50 in. fell in the form of S) shews a great deficiency from the average, and is one of the lowest on record; only in the years 1880 and 1881 was less recorded. Owing to the continued frost, curlers had a merry time, but little progress was possible with farm work. S on 16th, 2½ inches deep; on the 24th, 2 inches; and on the 29th, 2½ inches.

COLMONELL.—Rainfall 2·99 in. below the average of 20 years. Mean temp. 1°·4 below the average.

BRAEMAR.—A month of dreary, unsettled weather.

ABERDEEN, CRANFORD.—Gale of wind from the N. and a heavy snowstorm on the 26th, 27th, and 28th.

S. RONALDSAY, ROEBERRY.—A very good month, although cold, until the 24th, when a very severe S storm came on, which continued to the end of the month. Mean temp. 35°·5; 2°·5 below the average of 7 years.

IRELAND.

DARRYNANE ABBEY.—Rainfall below the average. Sharp frosts during the third week, with H, and a few flakes of S on 26th.

WATERFORD, BROOK LODGE.—S on 15th, 17th, 22nd and 23rd. Mean temp. 37°·9.

O'BRIENSBRIDGE, ROSS.—R much under the average. Many fine and bright days in the middle of the month, with slight frosts.

DUBLIN.—Opening with a brilliantly fine day, January, 1897, proved a cold, changeable month. Between the 3rd and the 10th, inclusive, there was an abundant rainfall, with S.E. winds; the weather was open at this time, but after the 14th, frequent frosts occurred, and S fell from time to time. Mean temp. 38°·1, or 3°·3 below the average. Foggy on 9 days. High winds on 11 days, reaching the force of a gale on 4 days. S or sleet fell on 5 days, and H on 5 days.

CLIFDEN, KYLEMORE.—Stormy weather on 1st, 5th, 7th and 29th; strong east gale on 6th. S showers on 26th.

OMAGH, EDENFEL.—The polar, or easterly winds, which prevailed almost without intermission during the month, resulted in weather which may be called of sub-acute severity, for although it froze on 27 nights, sometimes severely, on no day was a temperature of freezing maintained throughout. There was a deficient rainfall, and little or no snow.