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RAINFALL OF SPAIN AND PORTUGAL.

(Continued from page 84.*)*

BEFORE proceeding with our notes on Dr. Hellmann's memoir, we have the pleasure of inserting the following letter from Señor Capello respecting the extraordinarily large rainfall reported from Serra da Estrella. It is one of the most curious coincidences which has occurred in meteorology that just when it has been proved that Coimbra, which used to be quoted as having 119 or 224 inches per annum has really only 35 inches, another station, not 50 miles from it, is found with a rainfall of nearly 150 inches, or between two and three times as much as anywhere else in Spain or Portugal. We hope that our Portuguese friends, now that they have proved the existence of one spot beating our English Seathwaite and running even the Stye very close, will take the matter seriously in hand, and do as we have done, establish daily gauges in the surrounding villages, and monthly ones on the mountains, and give to the world full details of the rainfall of this exceptional district.

To the Editor of the Meteorological Magazine.

SIR,—I have just seen (in the notice of Dr. Gustav Hellmann's magnificent treatise on the "Rainfall of the Peninsula,") in your monthly *Meteorological Magazine*, that you have some doubts as to the accuracy of the returns from Serra da Estrella. I hasten to forward you the following values:—

	Total yearly fall. in.		Max. fall and date. in.
1882	165·67*	.....	7·99 October 27th
1883	120·81	.....	4·88 April 26th
1884	108·60	.....	10·79 January 28th
1885	170·48	.....	6·57 November 25th
1886	184·29	.....	11·50 March 4th

You will see that the fall in 1885 and 1886 was even greater than in the earlier years, and that in a single day at Serra da Estrella

* 11 months, February to December.

more rain falls than at some stations in the interior of Spain during a whole year.

The rain gauge is one of Babinet's, of the usual pattern, 8·89 in. in diameter, corresponding to an area of four decimetres. The measuring glass holds a litre, corresponding, therefore, to 25 millimetres (say one inch).

We were at first afraid that there must be some error in the observations, but all was cleared up some time since. We placed two similar gauges about two miles apart, and they were read every third day, and the quantities were practically identical at the two stations.

I can, therefore, assure you that however excessive the above figures may appear, they are accurate.—Yours truly,

J. CAPELLO.

Observatoire de Don Luiz, Lisbon, July 24th.

We pass over Dr. Hellmann's remarks on the distribution of rain during the 24 hours, because of the shortness of the period on which he has had to rely and of the paucity of the stations, only three in the whole Peninsula.

The author then proceeds to give valuable data for thirty of the longest-established stations, namely, the greatest and least monthly, and greatest and least yearly, totals at each. The monthly minimum is *nil* at almost every station; the monthly maxima are always, in the winter half-year, generally in December or January, and range from 6 in. to 25 in. (25·20 in. at Granada in November, 1858).

After giving the actual values of the wettest and driest year at each station, Dr. Hellmann gives the same values expressed as ratios of the yearly mean at each station. He does not seem to have discussed these results very fully, and his remarks are chiefly directed to the inconvenience to agriculture arising from a rainfall which at one station was, in one year, five and a half times greater than in another. This *per se* is certainly a very alarming figure; the actual values are—

	Max.			Min		Ratios.		M
	Amount.	Year.	Mean.	Amount.	Year.	Max.	min.	m
Sevilla	34·65	1881	16·14	6·30	1874	2·15	·39	5·5

But this is the only case exceeding five times; there are (counting the above) three exceeding four times, and nine exceeding three times—which is about the greatest ever found in the British Isles. Finally we offer the following conclusions which may be acceptable as approximations to the truth :—

(1). The rainfall in the wettest year is generally 60 per cent. above the mean, but may be only 14 per cent. above it, or may be 119 per cent. above it, *i.e.*, may be more than twice the mean amount.

(2). The rainfall in the driest year is generally 44 per cent. below the mean, but may be only 24 per cent. below it, or may be 64 per cent. below it, *i.e.*, may be little more than one-third of the mean amount.

(3). Generally the widest extremes are at the dry stations.

Dr. Hellmann has done all that is possible towards ascertaining the nature and amount of secular change in the rainfall of the Peninsula, but he has not data enough ; there are but four stations available, and of these the longest is but for 35 years, and one is only for 25 years.

Droughts.—Of course they get some terrible droughts in Spain and Portugal, and the author gives valuable tables of droughts of 15 days and upwards at San Fernando and at Madrid.

Max. falls in 24 hours.—This subject is treated by the author as fully as the others, but we are not certain that the data are in all cases absolutely indisputable. There are, we believe, few countries where the observers are more careful than they are in the British Isles, yet we constantly detect them in entering as the fall on one day the accumulation of two or three during which they have been absent. This makes grand values for max. fall in 24 hours, but of course the record, while quite right as part of the total for the year, is worse than useless—deceptive for a max. in 24 hours. However this may be, the values are not often remarkable ; there are only six stations at which the max. exceed 5 inches, viz. :—

Vizeu,	February 2, 1880, 5·08 in.	Tarifa,	January 28, 1881, 6·42 in.
Carcagente,	November 17, 1855, 5·43 in.	Granada,	(?) 1858, 7·91 in.
Salamanca,	September 7, 1882, 5·79* in.	Serra da Estrella	Oct. 27, 1882, 7·99 in.

As regards heavy falls in short periods, Dr. Hellmann finding himself confronted with the remarkable record of 33 in. in 26 hours at Gibraltar in November 1826, has not confined his table to Spain and Portugal, but has given all the most noteworthy reports for South Western Europe. We do not recollect ever seeing such a collection, and have not only converted the values as given in his table, but have also re-arranged the entries so that they may be readily compared with the data given annually under the heading of "Heavy rains in short periods" in *British Rainfall.* This is essential if the facts are to be thoroughly grasped, because the importance of a rainfall does not depend alone on either duration, or rate per hour—let us take two imaginary cases,

Rain, 9 a.m. to noon ... 3·20 in., rate per hour, 1·06 in.
,, 9 a.m. to 6 p.m. ... 7·32 in., ,, ,, ,, ·81 in.

the former gives the higher rate, but the latter is the more remarkable fall, because a high rate was kept up for a long period.

* More than in the whole year 1875, which gave only 4·88 in. Moreover, this 5·79 in. was 41 per cent. of the total for 1882.

Heavy falls of rain in less than 48 hours in South Western Europe.

Station and Country.	Date.	Duration	Total.	Rate per Hour.
		H. M.	in.	in.
Lagarde, Vaucluse, France	4 July, 1876	10	1·18	7·09
Savoillans, Vaucluse, France	10 July, 1884	15	1·69	6·77
Marseilles, France	21 Sep., 1839	25	1·60	3·82
Perpignan, Pyrenees O., France	21 May, 1859	45	2·21	2·95
Bollène, Vaucluse, France	8 Sep., 1879	1 0	4·53	4·53
Avignon, France	3 Sep., 1884	1 0	3·01	3·01
Molitg, Prades, Pyrenees O., France	20 May, 1868	1 30	12·32	8·22
Perpignan, Pyrenees O., France	29 Aug., 1855	1 30	5·32	3·54
Perpignan, Pyrenees O., France	18 Oct., 1876	1 30	4·57	3·04
Montpellier, France	26 Nov., 1868	1 30	2·56	1·70
Orange, Vaucluse, France	20 July, 1883	2 0	5·81	2·91
Montpellier, France	11 Oct., 1861	2 0	3·74	1·87
Orange, Vaucluse, France	8 Aug., 1877	4 0	4·49	1·13
Montpellier, France	26 Sep., 1857	6 0	5·12	·85
Montpellier, France	11 Oct., 1862	7 0	9·17	1·31
Reggio, Calabria, Italy	20 Oct., 1880	7 30	8·08	1·08
Malaga, Spain	17 Dec., 1876	10 0	5·28	·53
Viviers, Ardèche, France	26 Sep., 1801	18 0	13·57	·78
Joyeuse, Ardèche, France	9 Oct., 1827	22 0	31·18	1·42
Genoa, Italy	25 Oct., 1822	24 0	31·97	1·33
Le Bleymard, Lozère, France	13 Sep., 1885	(24)	15·75	·66
St. Gervais, Hérault, France	17 Oct., 1874	(24)	9·84	·41
Pont-de-Monvert, Lozère, France	13 Sep., 1885	(24)	9·45	·39
Notre Dame des Neiges, Lozère, France	8 Oct., 1878	(24)	9·13	·38
Gette, Hérault, France	13 Sep., 1885	(24)	9·06	·38
Vialas, Lozère, France	8 Oct., 1878	(24)	8·70	·36
Villefort, Lozère France	8 Oct., 1878	(24)	8·66	·36
Granada, Spain	1858	(24)	7·88	·33
Gibraltar, Spain	25 Nov., 1826	26 0	33·00	1·27
Carcagente, Valencia, Spain	21 Oct.. 1843	30 0	15·75	·52
Carcagente, Valencia, Spain	4 Nov., 1864	33 0	11·89	·36
Carcagente, Valencia, Spain	7 Dec., 1853	42 0	19·69	·47

It would be too discursive to make this table the base of a thorough consideration of the probable maximum fall of rain to be expected in extra tropical countries; but looking at the havoc constantly wrought by the so-called "bursting of a waterspout," "breaking of a cloud," &c., we see no reason why if a rain gauge were precisely at the site of greatest fall 24 to 36 in. should not be measured.

It is unfortunately very rare for engineers or surveyors to investigate these cases, in fact the only one that we remember was on Black Hambledon, in Yorkshire (*British Rainfall*, 1870); and when a surveyor does examine a case he can give us only the total fall over certain areas, not the amount at individual spots in those areas.

We hear often of holes being torn in the ground, even on the flat 10 ft. diameter, and 4 ft. or 5 ft. deep. It would require a good many inches of rain to do that. While, therefore, we are always on the look out for mistakes of decimal points, for leaks into gauges, and for other sources of error, we hesitate to refuse credence to amounts which most persons would laugh at. Perhaps we are the more ready to believe these amounts because we have ourselves measured in London the following values :—

Time	1 Min.	5 Min.	15 Min.	30 Min.
	in.	in.	in.	in.
Amount ...	0·17	0·56	1·43	2·32
Rate per hour ...	10·20	6·72	5·72	4·64
Rate per day *...	244·80	161·28	137·28	111·36

However, we must pass to Dr. Hellmann's cases. The highest rate is that reported from Molitg. We have had the pleasure of visiting that little paradise, nestled amid the mountains of the Eastern Pyrenees, and conversing with Dr. Massia, the son of the observer who measured this fall in 1868, and are sure that the observation may be accepted as perfectly correct.

We feel much more hesitation over the enormous *daily* totals in the preceding list, but it is difficult to show that any one is improbable. If we doubt Viviers, there is Bleymard to exceed it, and Bleymard itself is supported by Cette and Pont-de-Monvert. And if we say that we will accept 15 in. in a day as the maximum for Europe, how are we to upset the three accordant values from Joyeuse, Genoa, and Gibraltar.

The work concludes with tables giving the whole of the monthly values *in extenso* for 67 stations, and the best map yet prepared of the mean rainfall of Spain and Portugal.

EXCEPTIONAL PHENOMENA IN JULY 1888.

CAMDEN SQUARE, LONDON.—The loss and discomfort which have resulted from our having had in London only 11 days without rain since June 4th will probably render an authoritative statement of the facts generally acceptable. I purpose in this letter dealing with the facts at this station only, reserving comments upon what has occurred over the country generally until I possess fuller information. One reason why such exceptional notice has been taken of this wet summer is its contrast to that of 1887. From June 4th to July 31st, 1887, rain fell on 10 days; during the corresponding period this year it has fallen on 46 days. In 1887 the total depth during that period was 1·12 in.; this year it has been 7·22 in, so that rain has been nearly five times as frequent and nearly seven times as heavy. No wonder that such a contrast attracts attention. My record now goes

* Of course we do not suggest that it is possible for rain to continue to fall so heavily for so long a period as 24 hours.

back here for 30 years, and there is only one July wetter than the one just passed—viz., July, 1880. Then the fall was 5·11 in., against 4·91 in. in this year. It may be well to give a list of summer months in which the fall has been greater than in the past July; they are as follows:—1860, June, 5·47 in.; 1878, June, 6·71 in.; 1878, August, 6·72 in.; 1879, August, 5·11 in.; 1880, July, 5·11 in. This shows that a fall of 4·91 in., though unusual, and about double the average, is by no means unprecedented. We must look into details if we wish to know why it has been so uncomfortable. Much depends upon how the rain falls, whether in continuous drizzle or in torrential rains. Now, though we have had several short torrential storm rains, we have not once had an inch in 24 hours, but it has fallen day after day, so that in July it rained on 26 out of the 31 days.

Another and very important consideration is the temperature, and this has been far more remarkable for lowness than the rain for excess of quantity. There are five different features with respect to temperature, and I will briefly compare each with the records kept by myself since 1857, with verified instruments, similarly mounted throughout.

Mean temperature at 9 *a.m.*—Mean for 30 years, 64°·5; 1888, 59°·2; in 1879 the value was also 59°·2; in 1860 it was 59°·9, and in every other year above 60°.

Absolute maximum *temperature during the month.*—Mean for 30 years, 86°·0; in 1888, 75°·9; in 1860 also the *maximum* was 75°·9, and there is no other year with so low a *maximum*.

Average maximum *for the month.*—Mean for 30 years, 74°·7; in 1888, 67°·3. There is no other so low, the only three below 70° being—1860, 69°·9; 1875, 69°·8; and 1879, 67°·7.

Average minimum *for the month.*—Mean for 30 years, 54°·0. The lowest was 50°·2 in 1863, and there are nine instances lower than 1888, which was 52°·3.

Absolute minimum *for the month.*—Mean for 30 years, 45°·2; the lowest, 40°·3 in 1863, and there are five instances lower than 1888, which was 42°·8.

Hence we see that although the *minima* have not been excessively low, the *maxima* have been low beyond all precedent for 30 years, and it is to that, coupled with continuous and heavy, though not unprecedented, rain, that all the discomfort and loss is due.—G. J. SYMONS.

ROYAL OBSERVATORY, GREENWICH.—Violent rain in afternoon and evening of 30th, more especially during the thunderstorm between 5 p.m. and 7 p.m. Hail also fell at times; total fall, 2·49 in.—W. H. M. CHRISTIE.

FORDINGBRIDGE, HANTS.—This has been a very exceptional month—wet sunless, cold, and cheerless. Rain fell on a greater

number of days (22) than ever recorded here but once, viz., September, 1885, when it fell on 24 days. Only one day is entered 'fine sunshine.' The total fall for the month has been 3·93 inches. This, however, has been exceeded on four occasions in the 13 previous years, viz., 4·33 in 1875; 4·03 in 1877; 5·38 in 1879; and 4·83 in 1880. The fall in July varies very much, and 0·63, 0·17, and 0·54 are entered during the same period. 0·17 inches is the least in any one month for the 13 years. The average of the last 10 years for July is 2·39 inches. The quantity of rain since January 1st has been 15·86, and the average of the same period 16·59 inches, so that we are still slightly in arrear. This is chiefly caused by the very dry February in this year, which was only 0·73, while the average is 3·19 in. The barometer has been low, above 30 inches on only nine days; the variation has been only from 30·19 to 29·46 inches. The thermometer has been very low for July, and twice registered 40° at night; it was 40°, 42°, and 44° on three nights in January. During the day the highest was 72° on the 6th, and it was 70° and above on four days only, and once only 58°. The rain has been a great boon to the water supply of the country, the deficiency of which was becoming very serious; also has been highly advantageous to the grass and root crops, and the straw of corn crops; but the hay has been sadly spoiled, and much injury done to heavy crops of wheat and barley from laying. A fine August and September would tend much, however, to put matters straight, and is devoutly to be desired.—T. WESTLAKE.

ABINGDON, BERKS, *Monday, July 30th.*—I emptied the gauge at 9 a.m. The weather looked heavy all the morning until about noon, when for an hour or so there was sunshine, but with heavy, dark clouds towards the east, and constant distant thunder. About 2.30 there was a short, heavy shower for about ten minutes; at three a sudden downpour began, and the old people in this village say that they never witnessed such rain. The road is completely washed, and is nothing but bare stone. This continued till a little after 5 p.m., about two hours and twenty minutes. I then emptied the rain gauge, and found it contained 2·95 in. The storm appeared to come from the east. Just above the Rectory is a field of potatoes on the slope, and about an acre is completely washed away, right over a clover field for about 150 yards, and against the hedge at the bottom are at least 50 cart loads of earth and stones. I witnessed nine labourers who had been all day gathering up the potatoes washed away. The storm seems to have gone due west, and I fancy was very heavy towards Didcot and on towards Swindon.—PERCY BURD, *The Rectory, Little Wittenham, Abingdon, July 31st*, 1888.

AYLSHAM NORFOLK.—On the evening of the 30th I measured an extraordinary fall, which reached 3·09 inches between 5.20 p.m. and

7 p.m. My pond, which measures 2¼ acres, and in which the water was eight inches below the bank, overflowed in less than an hour.—R. J. PURDY.

BABBACOMBE, TORQUAY.—Yesterday the heaviest storm of rain, hail, thunder and lightning ever known here passed over us, the storm clouds coming from W.N.W. and going off to E. It began at 1.4 p.m., was very severe from 1.30 to 2.15 p.m., and ceased at 4.10 p.m., though showers fell till 8.15 p.m., accompanied by thunder from 6.1 to 6.3 p.m. The total rainfall was 1·98 inches; 1·47 inches of which fell in the 30 minutes from 1.30 to 2 p.m. Great damage was done to vegetation and glass, and chicken were killed by the tremendous hail which fell from 1.33 to 1.58 p.m., many of the stones measuring ¾ in. by ½ in. in diameter. The ground was covered an inch deep with them for about an hour, and they were still lying several inches deep in the drifts this afternoon. Numerous houses were flooded by rain rushing through them from the higher grounds. The lightning and thunder were simultaneous at 2.6 p.m. The surface wind varied from a light S.E. breeze at 1.15 p.m. to N.N.E. in a squall at 1.49 p.m., then to a light breeze from N.N.W. at 2 p.m. (when the barometer, at 32° and the sea level read 29·748, and the dry bulb thermometer 51°·8, and wet ditto 50°·9); and was generally light from N.N.E. to E. till 4.15 p.m. The barometer rose slowly, with a few slight retrogressions, during the storm. The temperature fell from its maximum (for the day) of 66°·4 before 1 p.m. to its minimum 51°·7 at 2.15 p.m., but rose again to 57°·4 at 5 p.m. The rainfall in Torquay was much less than here, the following amounts having been registered there (for the 6th): viz., at Lamorna, 0·82 in.; Strand, 0·61 in.; Grey's Lodge, 0·56 in.; Castle College, 0·48 in.; and Devon Rosary, 0·37 in. At Livermead (1 mile S.W. of Torquay) no rain fell up to 6 p.m. My observations here quite confirm the partiality of the storm over this peninsula, as I saw blue sky from S.W. to S.E. from 1 to 3.30 p.m., and also in the N.E. quarter from 1 to 2.30 p.m. The day's rainfall (1·98 in.) has been only twice exceeded since observations were commenced here in August, 1876; viz., on October 4th, 1880, when 2·44 in. fell; and on December 26th, 1886, when 2·57 in. fell.—EDWIN E. GLYDE, F.R.Met.Soc., *Kirkham, Babbacombe, Torquay, July 7th*, 1888.

STREET, SOMERSET.—The accompanying returns were collected to show how peculiarly *local* many of the heavy rains were in Somerset, specially round Street in the early part of July. Thunderstorms occurred in the district every day from the 1st to 8th, often two or three; they were frequent all through the month. July 3rd to 5th I was at Bridport, Dorset, and little rain fell, hay being carried by the sea on the 5th, much hurt by previous rain. It was pretty constantly clear at and off the coast; cloudy, with slight showers at Bridport, two miles inland; heavy showers three or four miles in-

land. July 4th, most of the rain fell in an hour, about 2 p.m., at Street—three chief storms. July 8th, the falls at Street (9.45 to 10.45), Langport district and Mendip district (both about 1 p.m.), were separate thunderstorms. At Langport occurred a terrific, but very local, hail fall. Messrs. Kelway's extensive gardens, to the E.N.E., escaped; Mr. Vincent Stuckey's grounds, to the E.S.E. and barely half-a-mile off, were ruined; "our flower-garden destroyed, peas and beans looked as if a gun had been shot down their ranks." The hail lay 3 to 4 inches deep, lasting in places till next noon. The hail barely extended beyond the small town itself. July 16th, waterspout broke near North Petherton. Rain fell in sheets, washing away soil and all in a turnip-field on the west side of the Quantocks, at Colthurst. Being near Edington, S. and D.R., 10 miles or so away, I noticed from the train, about 11.20 a.m., a peculiar cloud, and suggested that there must be a waterspout in that direction. July 30th, at Baltonsborough, three miles E.S.E. of Street, terrific TS, 2 inches of rain; great floods; horses swimming on the high road; only slight rain at Street; still less near King Weston; 2½ miles S.S.W. of Baltonsborough, which had only the "fringe" of the storm.—J. E. CLARK.

[The table would require a whole page, we must, therefore, epitomize the facts in a few lines. Mr. Clark has obtained records from 15 out of the 44 stations quoted in *Brit. Rain.*, 1887, and from one of which we were not previously aware. The results are shortly as follows:—1st. Rain general—between 0·17 and 0·46 at all stations except Willett Ho., where none was recorded. 2nd. Variable from none at S. Petherton to 0·98 at Chewton Mendip. 3rd. Variable and small except at Glastonbury, 0·58. 4th. Very variable; only 0·11 at Weston-super-Mare, more than an inch at most eastern stations, and 1·75 in. at Street. 5th. Small generally. 6th. Gradually increasing W. to E.; 0·01 at Exford, 0·93 at Chewton Mendip. 7th. Generally small; max. 0·56 at Yeovil. 8th. Inappreciable in the W. but 1·16 in. at Langport. From 9th to 15th there is nothing noteworthy. On 16th there was a heavy local fall in the vicinity of Taunton and Bridgewater; 1·60 fell at Lydeard House between 1 and 2.30 p.m., and smaller amounts at surrounding stations.—Ed. *Met. Mag.*]

THE GRAIG, ROSS.—The rainfall for last month at this station corresponds very closely with that of July, 1880.

	Total amount.	No. days.		TEMPERATURE. Mean max.	Mean min.	Absolute max.	Absolute Min.	Cloud.
July 1880	5·96	24	...	69·8	50·5	75·0	45·8	7·9
,, 1888	6·06	27	...	65·4	53·7	74·9	39·5	8·5
56 days ending July 31, 1880	8·78	43	...					
,, ,, ,, ,, 29, 1888	8·77	45	...					
Lowest max., or coldest day	1880	62·0	...	Highest min., or warmest night		1880	59·0	
Ditto.....	1888	56·8	...	Ditto		1888	57·0	

The amount and continuity of rain has, therefore, been equally great in both years, but 1888 has had a much greater number of cold days, for whereas in 1880 the lowest maximum was 62°·0, in 1888 there were no less than seven days when it was below 60°. The mean maximum (65°·4) is the lowest I have recorded in July; 1879, 1883, and 1875 coming next with 65°·6, 67°·2, and 67°·5 respectively. The number of rainy days also beats record, 1882 with 25 days being the next below. The total amount has been twice exceeded in my 30 years' observations, viz., in 1872, 7·54 in.; 1875, 6·76 in.; but in each of these years there were very heavy falls—in 1872 the following was registered: July 6—7, 2·77 in; 24—25, 1·09 in.; 29—30, 2·29 in., or a total of 6·15 in. in three storms. In 1875 rain commenced at 7 a.m. on July 14th, and in 36 hours 3·63 in. fell. In 1888 the most in any two consecutive days was 1·08 in. Rain fell every day from the 14th to the 30th inclusive, 4·85 in. in 17 days. This year there have been scarcely any fine intervals for the haymakers. Let us hope that the next five weeks may be as fine and dry as they were in 1880.—Yours, &c., H. SOUTHALL, *August 2nd*, 1888.

N.W. YORKSHIRE.—ON the night of July 25th, one of the most destructive summer floods ever known swept down Swaledale. Hundreds of people went round the Castle walks anxious to witness the numerous articles of furniture, huge trees, and sheep and pigs floating down the rapid stream. In Upper Swaledale considerable destruction has been wrought. Gunnerside Bridge was swept down, and other bridges were seriously damaged. Most of the walls on the flatts were forced down, and great injury was done to the meadows which were completely under water. Whaw Bridge in Arkengarthdale has been nearly totally washed away, its foundations having been very dangerously undermined. The wooden bridges at Punchard, Seel Houses, and Escliffe were also washed away. The houses at the low end of Reeth were flooded, the wall at the high side of Reeth Bridge was washed down, and the great concrete wall at the low side of Fremington Mill and used as a backwater, was also washed down. At Hawes Junction the very large amount of 3·18 in. of rain was measured.

WIND VELOCITY.

IT may be an old story, but everybody does not at all times recollect how little anemometers tell us of the real motion of air currents. No one would think of quoting, as the velocity of a river, measurement of its motion within 4 or 6 inches of its bottom, where, of course, it is greatly retarded by friction against the river bed. So with anemometers, their records (even putting aside the question of whether the observations are reduced on the scale of 3 to 1 or of 2·2 to 1) are largely influenced by the friction of the air against the

earth's surface. Here are two facts which, for convenience, we put in parallel column.

BALLOON ASCENT.

The first of a series of balloon ascents was made from the Anglo-Danish Exhibition on Saturday afternoon, by Mr. Simmons, who descended at Ingatestone, near Chelmsford, a distance of 26 miles from London, just half-an-hour after leaving the Exhibition, *i.e.*, travelled 52 miles in an hour.

ROYAL OBSERVATORY, GREENWICH.

"The total horizontal motion of the wind on July 14th was 126 miles, the max. pressure 0·9 lb." The former gives a mean velocity of 5 miles an hour, the latter shows that not even for an instant did the velocity exceed 14 miles an hour.

THE CLIMATE OF THE BRITISH EMPIRE DURING 1887.

The Climatological Summary for 1887 shows the same general characteristics as those for former years, the stations which record the extremes—enviable or otherwise—set out in the summary being much the same as usual.

Comparing with the summary for 1886, Stanley, Falkland Isles takes the place of London as the dampest station, and of Auckland as the most cloudy station. At Adelaide, 1887 was exceptionally wet, and Malta reappears with the smallest rainfall.

The Australian stations again outdo the East Indian with their extremely high maximum shade temperatures, though the average maxima at the latter far exceed those of Australia, and the Canadian stations of course maintain their—we had almost said—pre-eminence at the bottom of the temperature scale, and perhaps the word is justified by the fact that the readings would be high but for *the minus* sign in front of them.

SUMMARY.

Highest temperature in shade: 111°·2 at Adelaide, on January 9th.
Lowest temperature in shade: —42°·7 at Winnipeg, on January 7th.
Greatest range in year: 135°·9 at Winnipeg.
Least range in year: 22°·0 at Barbados.
Greatest mean daily range: 24°·5 at Winnipeg.
Least mean daily range: 9°·6 at Barbados.
Highest mean daily temperature: 80°·2 at Colombo, Ceylon.
Lowest mean daily temperature: 31°·0 at Winnipeg.
Driest station: Adelaide, mean humidity, 60.
Dampest station: Stanley, Falkland Isles, mean humidity, 86.
Highest temperature in sun: 164°·0 at Adelaide.
Lowest temperature on grass: —21°·0 at Toronto.*
Greatest rainfall: 94·95 inches at Bombay.
Least rainfall: 17·23 inches at Malta.
Most cloudy station: Stanley, Falkland Isles, average amount 7·0.
Least cloudy station: Malta, average amount 3·7.

* There being no grass mim. thermometer at any other Canadian station.

CLIMATOLOGICAL TABLE FOR THE BRITISH EMPIRE FOR 1887.

Stations. *Those in Italics are South of the Equator.*	Absolute. Maximum. Temp.	Absolute. Maximum. Date.	Absolute. Minimum. Temp.	Absolute. Minimum. Date.	Average. Max.	Average. Min	Average. Mean.	Average. Dew Point.	Average. Humidity	Absolute. Max. in Sun.	Absolute. Min. on grass.	Total Rain. Depth.	Total Rain. Days.	Average Cloud
	°		°		°	°	°	°		°	°	°	in.	0—10
England, London	88·8	July 3	14·5	January 2	56·5	41·0	48·8	41·0	79	133·4	11·0	19·21	140	6·1
Malta	100·2	July 24	43·0	January 11	73·3	59·7	66·5	56·6	75	158·4	36·0	17·23	82	3·7
Mauritius	85·0	January 11	54·6	August 18	77·7	67·9	72·8	63·7	75	138·7	42·1	46·64	209	5·7
Calcutta	102·0	April 21, 22	47·1	January 24	85·5	70·1	77·8	68·3	70	159·5	35·4	58·07	116	4·3
Bombay	93·5	April 14	55·9	February 9	84·9	74·0	79·5	70·9	76	149·2	41·9	94·95	112	4·1
Ceylon, Colombo	94·2	February 19	66·8	February 1	86·2	74·2	80·2	70·0	74	151·2	56·0	84·15	182	6·0
Melbourne	104·9	January 10	33·0	June 27	66·4	50·1	58·3	49·3	74	154·2	26·7	32·39	153	6·0
Adelaide	111·2	January 9	36·5	July 12	71·7	53·4	62·6	47·9	60	164·0	29·9	25·69	164	4·8
Wellington	83·0	January 26	31·0	August 25	61·6	48·4	55·0	48·3	80	150·0	23·0	55·97	175	4·2
Auckland	81·5	January 17	35·0	August 13	65·9	53·3	59·6	52·8	78	147·0	26·0	37·71	181	6·7
Falkland Isles, Stanley		...	17·0	June 7	..	36·6	...	39·4	86	133·0	17·5	28·04	234	7·0
Jamaica, Kingston	93·3	July 21	56·7	December 4	88·3	69·3	78·8	69·8	75	...	...	37·60	...	...
Barbados	88·0	October 10	66·0	Feb. 13,15,21 / Mar. 3, 4, 8	80·8	71·2	76·0	70·0	79	...	...	73·59	181	6·1
Toronto	97·2	July 16	—16·6	January 3	52·5	35·4	44·0	37·5	75	...	—21·0	25·72	160	6·3
New Brunswick, **Fredericton**	91·7	June 30 / July 2	—34·1	January 9	49·2	29·3	39·3	33·7	73	...	...	45·31	168	5·5
Manitoba, Winnipeg	93·2	July 6	—42·7	January 7	43·2	18·7	31·0	27·2	79	...	...	17·98	137	4·9
British Columbia, Victoria	86·0	June 21	6·0	February 2, 5	55·3	39·5	47·4	...	...	...	...	39·06	127	...

SUPPLEMENTARY TABLE OF RAINFALL, JULY, 1888.

[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	5·33	XI.	Castle Malgwyn	6·45
,,	Margate, Birchington...	3·58	,,	Rhayader, Nantgwillt..	8·78
,,	Littlehampton	5·45	,,	Carno, Tybrith	7·95
,,	Hailsham	4·82	,,	Corwen, Rhug	6·18
,,	Ryde, Thornbrough	5·79	,,	Port Madoc	7·21
,,	Alton, Ashdell.....	4·85	,,	I. of Man, Douglas	6·53
III.	Oxford, Magdalen Col...	4·44	XII.	Stoneykirk, Ardwell Ho.	4·17
,,	Banbury, Bloxham	5·81	,,	New Galloway, Glenlee	5·69
,,	Northampton	4·20	,,	Melrose, Abbey Gate...	4·54
,,	Cambridge, Beech Ho...	3·45	XIII.	N. Esk Res. [Penicuick]	6·25
,,	Wisbech, Bank House..	3·73	XIV.	Ballantrae, Glendrishaig	4·58
IV.	Southend	4·56	,,	Glasgow, Queen's Park.	4·52
,,	Harlow, Sheering	3·61	XV.	Islay, Gruinart School..	3·09
,,	Rendlesham Hall	4·82	XVI.	St. Andrews, Pilmour Cot	5·55
,,	Diss	5·85	,,	Balquhidder, Stronvar..	6·77
,,	Swaffham	4·32	,,	Dunkeld, Inver Braan..	5·46
V.	Salisbury, Alderbury...	5·45	,,	Dalnaspidal H.R.S. ...	6·66
,,	Warminster	5·48	XVII.	Keith H.R.S.	3·66
,,	Bishop's Cannings	4·72	,,	Forres H.R.S.	3·06
,,	Ashburton, Holne Vic....	9·44	XVIII.	Strome Ferry H.R.S....	3·37
,,	Hatherleigh, Winsford.	5·11	,,	Fearn, Lower Pitkerrie.	3·38
,,	Lynmouth, Glenthorne.	6·22	,,	Loch Shiel, Glenaladale	5·52
,,	Probus, Lamellyn	9·13	,,	S. Uist. Ardkenneth ...	2·92
,,	Launceston, S. Petherwin	7·74	,,	Invergarry	5·04
,,	Wincanton, Stowell Rec.	6·68	XIX.	Lairg H.R.S.	...
,,	Taunton, Lydeard Ho...	6·28	,,	Forsinard H.R.S.	1·78
,,	Wells, Westbury.....	8·76	,,	Watten H.R.S.	2·02
VI.	Bristol, Clifton	6·22	XX.	Dunmanway, Coolkelure	5·87
,,	Ross	6·06	,,	Fermoy, Gas Works ...	5·68
,,	Wem, Clive Vicarage ...	5·55	,,	Tipperary, Henry Street	4·75
,,	Cheadle, The Heath Ho.	5·28	,,	Limerick, Kilcornan ...	3·07
,,	Worcester, Diglis Lock	5·44	,,	Miltown Malbay.....	4·50
,,	Coventry, Coundon	6·66	XXI.	Gorey, Courtown House	6·82
VII.	Melton, Coston	5·19	,,	Navan, Balrath	5·25
,,	Ketton Hall [Stamford]	4·14	,,	Mullingar, Belvedere...	5·94
,,	Horncastle, Bucknall ...	4·75	,,	Athlone, Twyford	5·14
,,	Mansfield, St. John's St.	5·50	,,	Longford, Currygrane...	4·99
VIII.	Knutsford, Heathside ...	4·92	XXII.	Galway, Queen's Coll...	4·03
,,	Walton-on-the-Hill.....	5·09	,,	Clifden, Kylemore	5·42
,,	Lancaster, South Road.	6·72	,,	Crossmolina, Enniscoe..	4·82
,,	Broughton-in-Furness ..	8·87	,,	Collooney, Markree Obs.	4·68
IX.	Shipley, Esholt Vic. ..	4·37	XXIII.	Rockcorry.....	3·54
,,	Ripon, Mickley	4·16	,,	Warrenpoint	4·64
,,	Scarborough, West Bank	6·50	,,	Seaforde	6·63
,,	East Layton [Darlington]	4·46	,,	Belfast, New Barnsley .	6·02
,,	Middleton, Mickleton ..	5·18	,,	Cushendun	8·06
X.	Haltwhistle, Unthank..	4·77	,,	Bushmills	6·08
,,	Shap, Copy Hill	6·60	,,	Stewartstown	5·50
XI.	Llanfrechfa Grange	7·62	,,	Buncrana	7·53
,,	Llandovery	6·26			

JULY, 1888.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average. 1870–9	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 Night below 32°. In shade.	No. of Night below 32°. On grass.
			inches	inches.	in.								
I.	ENGLAND.	London (Camden Square) ...	4·91	+ 2·44	·90	17	26	75·9	1	55·7	11	0	0
II.		Maidstone (Hunton Court)...	5·26	+ 3·22	·99	31	23	...	...	...	...	...	...
,,		Strathfield Turgiss	5·23	+ 2·93	·89	5	23	72·6	19	40·6	11	0	1
III.		Hitchin	2·92	+ ·22	·44	2 *e*	25	71·0	22	44·0	10	0	...
,,		Winslow (Addington)	4·57	+ 1·97	·82	2	23	70·0	17 *b*	39·0	1 *f*	0	...
IV.		Bury St. Edmunds (Culford)	4·49	+ 1·52	·54	16	19	68·0	17 *c*	33·0	13	0	...
,,		Norwich (Cossey)	3·78	+ 1·03	·70	27	18	...	...	...	...	...	...
V.		Weymouth(LangtonHerring)	3·23	...	·85	2	22	71·0	19	43·0	11	0	...
,,		Barnstaple	3·94	+ ·39	·53	1	22	69·0	15	41·0	1	0	...
,,		Bodmin	10·16	+ 6·72	2·88	30	26	67·0	20	53·0	28	0	0
VI.		Stroud (Upfield)	5·91	+ 3·07	·71	14 *a*	27	75·0	13	44·0	12	0	...
,,		ChurchStretton(Woolstaston)	4·75	+ 1·72	·69	15	27	72·0	19	38·0	11	0	0
,,		Tenbury (Orleton)	5·44	+ 2·53	·71	27	28	73·0	19	36·7	13	0	0
VII.		Leicester (Barkby)	5·59	+ 2·85	·92	15	23	78·0	17	38·0	10	0	...
,,		Boston	4·77	+ 2·24	·78	4	22	80·0	19	41·0	12	0	...
,,		Hesley Hall [Tickhill].....	5·04	...	·62	17	24	75·0	19	39·0	1	0	...
VIII.		Manchester (Ardwick).....	6·25	+ 2·44	1·80	2	20	71·0	24	41·0	2	0	0
IX.		Wetherby (Ribston Hall) ...	5·56	+ 2·95	·84	18	16	...	...	...	...	...	...
,,		Skipton (Arncliffe)	5·51	+ ·56	·59	14	24	72·0	26	37·0	31	0	...
,,		Hull (People's Park)	5·75	+ 2·93	·90	15	23	...	...	...	...	...	...
X.		North Shields	5·45	+ 2·90	1·44	25	20	71·0	21 *d*	40·0	7	0	0
,,		Borrowdale (Seathwaite).....	11·21	+ 2·44	1·32	22	21	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely).....	7·52	+ 3·70	1·50	7	27	...	...	...	...	...	...
,,		Haverfordwest	7·78	+ 3·85	1·30	1	26	70·5	19	41·5	12	0	...
,,		Plinlimmon (Cwmsymlog) ...	7·72	...	·95	1	20	...	...	...	...	...	...
,,		Llandudno.....	4·60	+ 1·89	·70	2	24	67·0	21	42·0	11	0	...
XII.	SCOTLAND.	Cargen [Dumfries]	4·82	+ 1·69	1·28	22	21	73·8	19	36·8	1	0	...
,,		Jedburgh (Sunnyside).....	4·83	+ 1·90	·80	16	25	73·0	20	37·0	1	0	...
XIV.		Old Cumnock	4·31	+ 1·21	·66	2	23	80·0	19	32·0	7 *g*	3	...
XV.		Lochgilphead (Kilmory)	5·94	+ 1·40	1·57	2	20	...	...	...	...	...	...
,,		Oban (Craigvarren)	6·21	...	1·27	2	25	69·3	19	43·6	10	0	...
,,		Mull (Quinish).....	3·93	...	·72	20	19	...	...	...	...	...	...
XVI.		Loch Leven Sluices	3·70	+ ·65	·90	23	13	...	...	...	...	...	...
,,		Dundee (Eastern Necropolis)	5·30	+ 2·51	1·00	16	17	75·4	19	37·8	1	0	...
XVII.		Braemar	5·64	+ 2·78	2·00	2	23	71·3	20	36·8	8	0	3
,,		Aberdeen	4·59	...	1·37	3	17	71·0	20	41·0	7	0	...
XVIII		Lochbroom	2·04	...	·45	9	13	...	...	...	...	...	...
,,		Culloden	3·56	+ ·78	...	...	...	74·0	19	39·0	7	0	0
XIX.		Dunrobin	2·65	...	·65	2	13	66·5	19	39·0	7	0	...
,,		Kirkwall (Swanbister)..... ..	...	...	...	...	...	...	...	...	...	...	...
XX.	IRELAND.	Cork (Blackrock)	6·31	+ 3·47	1·02	31	19	72·0	6 *e*	42·0	10	0	..
,,		Dromore Castle	5·63	...	·77	1	21	72·0	16	40·0	19	0	...
,,		Waterford (Brook Lodge) ...	5·24	...	1·04	1	19	70·0	19	41·0	1	0	...
,,		O'Briensbridge (Ross)	3·26	...	·54	2	21	74·0	20	47·0	2 *h*	0	...
XXI.		Carlow (Browne's Hill)	5·57	+ 3·01	1·07	27	22	...	...	...	...	...	...
,,		Dublin (FitzWilliam Square)	3·88	+ 1·46	·51	27	22	68·7	21	42·9	11	0	0
XXII.		Ballinasloe	4·91	+ 2·03	·95	23	20	70·0	13	40·0	27	0	...
XXIII		Waringstown	5·21	+ 1·63	1·15	27	23	76·0	19	36·0	31	0	...
,,		Londonderry (Creggan Res.).	6·25	...	1·66	27	27	...	...	...	...	...	...
,,		Omagh (Edenfel)	5·02	+ 1·77	1·55	27	23	71·0	19	40·0	10 *i*	0	...

a And 16. *b* And 19, 23. *c* And 26, 29. *d* And 23. *e* And 15. *f* And 13. *g* And 30, 31. *h* And 13. *i* And 31.

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

METEOROLOGICAL NOTES ON JULY, 1888.

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 TURGISS.—The wettest July recorded in nearly 30 years. "July sloppy, August croppy," says the old adage. The sloppy part of the programme has been fully carried out. Vegetation suffered from a deficiency of accumulated heat; hot brilliant weather was much wanted to save the hay and to mature the corn crops. The month came to an end with continued R and local TSS; the temp. being quite autumnal. TSS on 5th and 30th; T on 4th, 17th, and 23rd; fog on 14th.

ADDINGTON.—A remarkably cold and wet July; R falling on so many days damaged some of the crops very much, particularly hay. The total R has been exceeded only three times, viz., 1871, 4·65 in.; 1875, 4·72 in.; 1880, 8·24 in. T on 4th, 5th, 18th, 26th, and 27th.

CULFORD.—Unusually wet all through the month, with much T.

LANGTON HERRING.—An abnormally cold month. R 1·02 in. above the average, the fall from Jan. 1st still showing a deficiency of 1·93 in. Mean temp. at 9 a.m. (60°·2), 3°·1 below the average. There was a remarkable absence of sunshine, and the corn fields were quite green at the close. Some hay was spoilt by the continuous wet. Pressure low.

BODMIN.—A cold ungenial month, with the heaviest R recorded for many years on 30th. Mean temp. 59°·8.

STROUD.—S fell at Birdlip, between Stroud and Cheltenham, on 11th; ·28 in. of R fell in half an hour on 20th. T and L on 23rd.

WOOLSTASTON.—The coldest and most cheerless July remembered, with only four rainless days, and an almost entire absence of sunshine. Mean temp. 55°·8. Strong gale on 2nd. Most of the hay crop ruined.

ORLETON.—A very cold, wet, and cloudy month. Mean temp. nearly 10° below that of 1887, and 5°·5 below the average of 27 years; the mean of the first 15 days was about 7° below the average, and the lowest for 60 years; the max. reached 70° on only six days, and was below 60° on six days. Distant T was frequent, but no storm came near, and there was no heavy R. Heavier rainfall occurred in July 1834, 1855, 1861, and 1875. Pressure generally low and steady, with little high wind.

BARKBY.—A very wet, cold and cloudy month. Very trying for haymaking; crops mostly injured; scarcely 30 consecutive hours without R. T on six days, and a church and tall chimney struck by L at Leicester. S on 11th between Barkby and Leicester.

BOSTON.—Mean temp. 3°·6 below the average. T and L on 5 days.

MANCHESTER.—Abnormally wet and cold for July.

HULL.—Generally wet and cold.

NORTH SHIELDS.—S on 10th; TSS on 25th.

WALES.

HAVERFORDWEST.—One of the most disastrously wet Julys for many years, and cold withal, the temp. reaching 70° on only one day. On the evening of the 1st misty R commenced falling, and from 4 a.m. on the 2nd till 2.30 p.m. it fell in torrents, the total being 1·94 in. From the 14th to the end of the month, there was not a single dry day, and vast quantities of hay were damaged, and the corn was beaten down in many places.

LLANDUDNO.—TS on 2nd, 11th

SCOTLAND.

CARGEN.—The coldest July recorded during the 28 years observed, the mean

temp being 4°·5 below the average. Duration of sunshine 133 hours, 110 hours less than the average, which, combined with the very low temp., greatly retarded vegetation. Easterly winds on 17 days ; T and L on 26th ; T on 24th and 31st.

JEDBURGH.—The month was abnormally cold and ungenial, with almost daily rain. Cereal crops fairly good but very late ; roots very fair ; hay not much damaged.

OBAN.—A cool month with excessive rainfall.

LOCHBROOM.—On the whole a fine month, dry and cold, but with at times scorching sunshine. Vegetation made little progress, and was very stunted at the close. H storm and S on hills on 9th.

CULLODEN.—Cold throughout with little sunshine ; very unsettled after the 20th with frequent R and much T. Crops look well.

DUNROBIN.—A cold and sunless month.

IRELAND.

CORK.—Unusually cold and wet with T on 3 days. The wettest July during 23 years.

DROMORE.—Rather too much R.

WATERFORD.—Rainfall 2·24 in. above the average, the latter half being very wet and bad for haymaking. Mean temp. 57°·0. T on 2nd and 7th.

O'BRIENSBRIDGE.—An unsatisfactory month for haymaking ; temp. low and many wet days ; T and L frequent.

DUBLIN.—A wet, cloudy, cold month, almost as wet and cold as July, 1879, with which month it had many features in common. Mean temp. 57°·3, being the lowest in 23 years, with the exception of 1879 (57°·2). Mean humidity 85 ; amount of cloud 7·4 ; L on two days ; T on two days.

BALLINASLOE.—TS on 31st ; T on 21st, 22nd, and 23rd ; ·25 in. of R fell in 10 minutes on 22nd, and ·38 in. in 30 minutes on 29th.

EDENFEL.—A month of low temp. and almost constant R, culminating in a fall of 1·55 in. on 27th ; worse for haymaking than even 1879. On the 10th and 31st potato tops were blackened by frost in low-lying damp situations.

GREAT RAIN STORMS ON AUGUST 1ST.

WE purpose dealing with these in our next number, and shall be obliged by any observers, who measured upwards of 2 inches for that day, sending particulars. We know of one station at which more than 4½ inches fell.