SYMONS'S

MONTHLY

METEOROLOGICAL MAGAZINE.

LII.] MAY, 1870. [PRICE FOURPENCE, or5s. per ann post free.

ON THE RAINFALL OF SOUTH-WESTERN EUROPE AND ALGERIA.

(Continued from page 36.)

WE resume our notice of this subject by inserting the following *résumé* of Prof. Raulin's memoir on the rainfall of Algeria, which appeared in the "*Atlas Météorologiques de l'Observatoire Impérial*, 1868."

After a brief record of all the gauges hitherto used in Algeria, 37 in number, and many of them only recently started, Prof. Raulin proceeds to say—"My rainfall investigations in the south-west of France have caused me to recognise that the most important and the most characteristic feature in the fall of rain on the surface of a country is not the absolute quantity of water which falls upon the ground during the year, but the distribution between the seasons, and especially during the several months.

"In fact, even when the annual totals are alike, there is in respect of monthly distribution complete opposition between the Mediterranean district, and Central and Northern Europe, and also in Siberia from other parts of Asia.

"In the vast district which extends from the western coasts of France, of England, and of Scandinavia, even to Kamtchatka, the summer rains are more pronounced than they are further east, although in the Mediterranean district there is almost total absence of rain during that season.

"The physical configuration of the district, although all-important as affecting the total fall of rain, has very little influence over its seasonal distribution. Thus, the rainfall at Bordeaux, although very considerable (32 in.), is not much more than half that which falls at Bayonne (56 in.), and especially at the mouth of the Bidassoa (70 in.), but the seasonal distribution remains the same.

"So also on the coast of Algeria, the rainfall at Bougie (52 in.) is almost double that at Algiers (31 and 35 in.), and three times that at Oran (19 in.), but the seasonal distribution remains the same, and June, July, and August are always extremely dry."

Prof. Raulin then proceeds to point out that only the records from Algiers, Constantine, and Mostaganem are of sufficient length to afford reliable data of seasonal distribution. Then he gives the following table, the importance of which has induced us to convert all the values and print it *in extenso*:—

Comparison Table of the Rainfall in Algeria, 1838-1867.

STATIONS ON THE COAST.

	Oran.	Mostaganem.	Algiers P. et Chaus	Algiers Hardy.	Bougie.	Djedjeli.	Phillipeville.	La Calle.
Altitude.	164 ft.	262 ft.	131 ft.	16 ft	98 ft.	131 ft.	197 ft.	82 ft.
	in.	in.	in.	in.	in.	in.	in.	in.
1838	...	...	34·03	...	...	...	...	...
9	...	...	28·38	...	..	...	...	...
1840	...	...	31·68	...	...	...	...	...
1	14·49	...	35·28	..	...	...	...	...
2	23·04	..	35·46	...	...	...	...	...
3	10·87	..	30·13	...	...	...	...	...
4	20·77	...	41·23	...	...	..	...	...
5	24·37	...	41·22	...	...	...	...	...
6	15·75	...	41·23	...	...	...	...	...
7	18·38	...	51·42	..	...	...	...	...
8	23·07	...	40·51	...	...	...	...	...
9	12·56	11·81	21·97	...	..	...	...	...
1850	12·04	11·02	29·91	...	...	..	...	...
1	13·93	12·66	31·54	...	...	...	...	...
2	16·22	21·01	29·58	...	...	...	...	...
3	28·05	22·01	35·93	...	...	...	...	...
4	16·27	19·76	42·32	...	...	...	44·30	...
5	21·54	23·39	21·54	20·86	...	...	18·76	...
6	20·47	15·73	28·66	27·35	...	...	13·50	...
7	35·71	27·68	35·36	39·11	...	...	30·25	...
8	13·07	15·85	24·75	34·21	59·59	...	41·19	...
9	15·31	16·91	35·28	40·60	57·42	..	35·51	...
1860	18·40	17·21	26·49	40·35	65·72	33·52	31·62	...
1	13·90	14·47	21·44	32·21	29·98	29·83	20·55	...
2	16·58	22·91	24·32	47·16	38·51	71·11	21·12	30·60
3	21·97	13·66	24·37	40·85	35·63	37·14	29·44	39·99
4	29·80	27 84	27·50	43·50	32·44	40·59	24·54	44·10
5	26 10	21·31	38·47	42·75	66·13	62·42	37·70	39·17
6	17·20	13·48	17·01	24·02	74·22	24·52	17·22	20·72
7	12·79	9·84	20·83	...	...	...	37·24	38·51
Mean*	19·02	17·91	31·12	35·06	51·82	42·15	30·36	34·32
Max..	35·71	27·84	51·42	47·16	74·22	71·11	44·30	44·18
Min..	10·87	9·84	17·01	20·86	29·98	24·52	13·50	20·72

* These are conversions of the means given by Prof. Raulin; they differ slightly from the true means of the yearly values as given, owing, we presume, to misprints in the "Atlas."

STATIONS INLAND.

	Tlemcen.	Sidi-Bel-Abbès.	St. Denis du-Sig.	Mascara.	Jemmapes	Constantine.	Sétif.	Batna.
Altitude.	2690 ft.	1542 ft.	180 ft.	1903 ft.	295 ft.	2116 ft.	3533 ft.	3448 ft.
	in.	in.	in.	in.	in.	in.	in.	in
1838	...	...	...	...	...	36·57	...	...
9	...	...	..	...	...	29·07	...	...
1840	...	...	...	...	...	20·32	...	..
1	...	..	...	...	...	19·99	...	...
2	...	...	...	...	...	21·63	...	...
3	...	...	..	...	...	39·27	...	...
4	...	...	...	...	..	25·55	. .	..
5	...	..	...	...	...	26·83	...	...
6	...	...	...	...	...	31·00	...	...
7	...	...	...	...	...	39·97	...	...
8	...	...	...	...	...	...	...	...
9	...	...	...	...	...	...	...	...
1850	...	...	...	...	...	..	...	...
1	...	...	...	..	...	...	...	...
2	...	...	...	...	. .	..	...	...
3	19·80	...	...	...	...	...	...	...
4	16·28	...	...	...	...	42·53	...	...
5	31·61	..	...	...	...	16·13	20·28	...
6	25·10	...	..	...	...	15·37	...	...
7	29·81	...	24·47	...	...	24·65	25·67	...
8	21·93	...	10·87	...	..	25·81	17·31	...
9	16·81	26·10	12·60	8·76	31·37	31·50	15·67	..
1860	24·82	15·95	12·13	14·23	23·17	22·95	15·19	...
1	16·02	7·92	9·72	10·47	21·87	14·93	8·17	9·93
2	22·36	13·56	15·81	20·71	31·36	22·28	13·65	16·54
3	26·01	14·24	17·28	19·56	36·57	30·20	23·19	25·26
4	34·41	19·25	21·79	30·28	28·59	20·74	13·80	15·48
5	40·99	18·71	21·42	23·93	36·08	32·58	19·84	10·14
6	20·95	11·77	13·31	10·83	13·59	14·61	10·67	7·59
7	11·58	7·83	9·03	8·53	26·26	23·52	10·47	14·07
Mean	23·91	15·06	15·28	16 52	29·21	26·94	16·66	16·40
Max..	40·99	26·10	24·47	30·28	36·57	42·53	25·67	25·26
Min...	11·58	7·83	9·03	8·53	13·59	14·61	8·17	7·59

Before returning to the question of seasonal distribution, Prof. Raulin makes the following remarks on the above tables :—

"The comparison of these annual quantities shows that there is not entire agreement in the succession of dry and wet years at the various stations. But, as one might expect, there is more analogy between what occurs on the coast and in the interior of the same province, than between what occurs through the entire coast line of the three provinces.

"The last three lines of the table enable us to establish that the excesses of the maxima above the mean are greater than the defects of the minima below it, whence it results that the mean of the two extreme

years is above the true mean of the whole period, the only exceptions are Phillipeville and Jemmapes, stations nine miles apart."

The maxima are to the minima in the relation of $3\frac{1}{2}$ and $2\frac{1}{2}$ to 1.

Prof. Raulin's remarks on the seasonal distribution of rain in Northern Africa will be noticed in our next.

UNDERGROUND TEMPERATURE.

(Continued from page 18.)

THE following is a continuation of the Report of the Underground Temperature Committee of the British Association, read at their meeting last year at Exeter :—

"The main results of the experiments in the bore-tube are shown in the following table :—

"*Abstract of Results obtained at Kentish Town Well, Jan. 1 to June 30, 1869.*

Depth.	Date of observation	Observed temperature.	Difference for 50 feet.	Rate of increase, in degrees, per foot.	Temperature in observing-room. Max.	Temperature in observing-room. Min.	Depth of rain.	Depth to surface of water in tube.
ft.		° 49·2	° 1·8	·036	° 46·8	° 38·2	in. 1·06	ft. in.
50	Jan. 8							
100	,, 15	51·0	1·1	·022	49·2	39·5	·20	
150	,, 22	52·1	1·5	·030	46·8	36·0	·22	210 0
200	,, 29	53·6	2·4	·048	43·0	31·8	·64	
250	Feb. 5	56·0	0·1	·002	48·4	39·5	·83	208 6(*a*)
300	,, 12	56·1	0·0	·000	49·4	42·3	·89	210 6
350	,, 19	56·1	2 0	·040	48·2	39·2	·38	
400	,, 26	58·1	1·0	·020	46·5	36·8	·67	209 6
450	Mar. 5	59·1	1·1	·022	46·5	35·2	·59	210 0(*b*)
500	,, 12	60·2	0·8	·016	45·8	35·2	·10	
550	,, 19	61·0	0·2	·004	44·0	34·8	·15	
600	,, 23	61·2	0·2	·004	44·5	37·6	·95	
650	,, 27	61·4	1 4	·028	43·0	34·9	·05	? 219 0(*c*)
700	April 3	62·8	0·6	·012	43·6	36·0	·22	211 0
750	,, 12	63·4	0·8	·016	54·0	37·3	·19	
800	,, 17	64·2	0 8	·016	54·4	46·2	·38	209 0
850	,, 24	65·0	0·8	·016	52·4	40·8	·53	
900	,, 30	65·8	0·9	·018	56·2	40·6	·01	210 0
950	May 7	66·7	1·1	·022	53·8	43·5	1·00	
1000	,, 14	67·8	1·2	·024	54·2	45·4	·47	210 6
1050	,, 21	69·0	...	..	55·2	44·2	·47	210 6(*d*)
1070	,, 24	69·3	...	...				
1085*	,, 28	69·6	...	...	58·0	47·2	·75	210 6
1085*	June 4	69·8	0·7	·014	56·0	43·0	·58	
1100*	,, 11	69·7	1·0	·020	61·9	48·5	·01	210 6
1100*	,, 14	70·0	...	..				

"(*a*) First observation in the water.

"(*b*) Water becomes muddy.

"(*c*) This water-measurement seems erroneous.

"(*d*) On attempting to lower the thermometers to 1100 feet, found the mud supported them, and the cord became slack. The observations to which an asterisk is attached were obtained by leaving the cord so slack as to allow the

thermometers to bury themselves in the mud; but there is much risk in attempting to withdraw them."

"Assuming 49° as the surface-temperature, and adopting 70° as the temperature at 1100 feet, we find, for the mean rate of increase downwards, ·0191° per foot, or 1° for 52·4 feet.

"Comparing the first observation in the water (56°) with the temperature at the bottom (70°), the mean rate of increase comes out ·0165, or 1° for 60·6 feet.

"During the remainder of the present year the repetition of the observations will be continued, and it is hoped the influence of seasonal changes will be measured and eliminated. In conclusion, we have to acknowledge the liberality of the New River Company in allowing Mr. Symons unreserved access to their grounds, and permission to erect the necessary apparatus, which has been efficiently protected by their servants."

I desire to say, in reference to the foregoing Report, that the length of time which Mr. Symons found it necessary to interpose between his observations is a peculiar circumstance of which I can at present offer no sufficient explanation, and I cannot help thinking that it might be obviated by some modification of the arrangements. Mr. M'Farlane, in three different bores, has found 15 minutes amply sufficient to give the correct temperature. Can the difference be owing to the greater size and smoothness of the bore in this instance offering less resistance to vertical currents?

As regards the first 210 feet, being the portion occupied by air, it is not surprising that the influence of season should here be perceptible, seeing that the well is 8 feet in diameter. The temperature of the air in an opening of this size, *even for the average of the year*, cannot be taken to represent that of the solid earth at the same depth, but will doubtless be found to be intermediate between the latter and the mean temperature of the external air.

"*Observations on the Temperature of the Strata, taken during the sinking of the Rose Bridge Colliery, Wigan, Lancashire*, 1868-69. By EDWARD HULL, M.A., F.R.S., Director of the Geological Survey of Ireland.

"In an elaborate paper by Mr. W. Hopkins, F.R.S., entitled 'Experimental Researches on the Conductive Powers of various Substances,' published in the Philosophical Transactions for 1857, an account is given of a series of experiments made under the general supervision of Mr. Hopkins himself and Mr. W. Fairbairn, F.R.S., during the sinking of the Astley Pit of Dukenfield Colliery, in Cheshire.* At the time this paper was written, the depth attained was only a little more than 1400 feet, and the rate of increase between the depths of 700 feet and 1330 feet was found to be 1° F. for about 65 feet. These observations were subsequently continued until the pits had attained their full depth of 2151 feet from the surface. The last observation made was in the shale overlying the coal-seam known as the 'Black Mine,' which it was the object of the proprietor, Mr. Astley, to reach, and the temperature was found to be 75° F. Assuming the 'stratum of constant temperature,' or, as it is also called by Humboldt—'the invariable stratum,' to be that which was reached at 16·5 feet with a temperature of 51° F., the total increase of temperature would amount to 24° F., giving as the rate of increase 1° F. for every 83·925 feet. This is much below the average rate of increase.

"During a part of the period above referred to (from 1854–56) another coal-pit was being sunk at Wigan, which reached the depth of 1800 feet, down to the celebrated 'Cannel Mine.' At this pit similar observations on the temperature of the strata were made very carefully by the manager, Mr. Bryham, which were kindly communicated to myself for publication, and will be found in my work on the 'Coalfields of Great Britain.' The ultimate temperature attained in this pit, at the depth from the surface of 1800 feet, was found to be 72° F., and assuming

* The entire series of these interesting observations were kindly supplied to me by Mr. W. Fairbairn, and are published in 'The Coalfields of Great Britain,' 2nd edition, p. 226.

the invariable stratum to be the same as that at Dukenfield Colliery, the resulting rate of increase would be 1° F. for every 61·5 feet, which accords very closely with the result obtained by Professor Phillips, F.R.S., at the Monkwearmouth Colliery.

"Since the time above referred to, the proprietor of the Rose Bridge Colliery, Mr. J. Grant Morris, determined to carry down the shafts from the 'Cannel' seam to the 'Arley' seam of coal, which was known to lie more than 600 feet below it, and, consequently, in the spring of 1868, preparations were commenced for carrying out this project. In the incredibly short time of one year and two months the Arley coal was struck, and was found to be of good thickness and quality. The total depth reached was 2,424 feet, and the ultimate temperature in the coal itself was found to be 93½° F. The manager of the colliery, Mr. Bryham, sensible of the value of observations on the temperature of the strata at such unusual depths (this being probably the deepest colliery in the world, certainly in Britain), made a series of observations with as much care as the circumstances would admit, and has entrusted them to me for publication.

"The mode of taking the observations was as follows:—On a favourable stratum, such as shale, or even coal, having been reached, a hole was drilled with water in the solid strata to depth of one yard from the bottom of the pit. A thermometer was then inserted, the hole having been sealed and made air-tight with clay. At the expiration of half-an-hour the thermometer was taken up and the reading noted.

"It might possibly be objected that the time allowed (30 minutes) was insufficient for the imbedding of the thermometer, and that the readings are liable to error from this cause. I feel sure, however, that if any error has arisen it is inappreciable, and does not in the least invalidate the general result. In fact I am assured by Mr. Bryham that, from actual testing on several occasions, he found less than this time of 30 minutes sufficient for the purpose required.

"While the temperatures of the strata were being measured, observations were also carried on *pari passu* on those of the open pit during the descent; these are given in the table annexed. By a comparison of the results in the two columns, it will be observed that as the depth increased, the difference between the corresponding temperatures in the pit and the strata tended to augment; in other words, the temperature of the strata was found to augment more rapidly than that of the open pit.

"The effects of the high temperature and pressure on the strata at the depth of 2425 feet, are, as I am informed by Mr. Bryham, making themselves felt, and cause an increase in the expense both of labour and timber for props. This colliery, in fact, will be in a position to put to the test our views and speculations on the effects of high temperature and pressure on mining operations.

"In order to obtain the average rate of increase of heat, as shown by the experiments at Rose Bridge Colliery, we may assume (in the absence of direct observation) the position and temperature of the *invariable stratum* to be 50 feet from the surface and 50° F., which is probably nearly the mean temperature of the place. With these data the increase is 1° F. for every 54·57 feet, which approximates to that obtained by Professor Phillips at Monkwearmouth of 1° F. for about every 60 feet.

"If, on the other hand, for the purpose of comparison, we adopt the measurements for the *invariable stratum* as obtained at Dukenfield, we find the rate of increase to be 1° F. for every 47·2 feet as against 1° F. for every 83·2 feet in the case of Dukenfield itself. So great a discordance in the results is remarkable, and is not, in my opinion, attributable to inaccuracy of observation in making the experiments. On the other hand, I may venture to suggest that it is due, at least in some measure, to dissimilarity in the position and inclination of the strata in each case. These I now proceed to point out.

"*Position of the Strata at Rose Bridge and Dukenfield Collieries.*—Rose Bridge Colliery occupies a position in the centre of a gently sloping trough, where the beds are nearly horizontal; they are terminated both on the west and east by large parallel faults, which throw up the strata on either side. The colliery is placed in what is known as 'the deep belt.'

"Dukenfield Colliery, on the other hand, is planted upon strata which are

highly inclined. The beds of sandstone, shale, and coal, rise and crop out to the eastward at angles varying from 30° to 35°. Now, I think we may assume that strata consisting of sandstones, shales, clays, and coal, alternating with each other, are capable of conducting heat more rapidly along the planes of bedding than across them, different kinds of rocks having, as Mr. Hopkins's experiments show, different conducting powers. If this be so, we have an evident reason for the dissimilar results in the two cases before us. Assuming a constant supply of heat from the interior of the earth, it could only escape, in the case of Rose Bridge, *across* the planes of bedding, meeting in its progress upwards the resistance offered by strata of, in each case, varying conducting powers. On the other hand, in the case of Dukenfield the internal heat could travel along the steeply-inclined strata themselves, and ultimately escape along the outcrop of the beds.

"I merely offer this as a suggestion explanatory of the results before us, and may be allowed to add that the strata at Monkwearmouth Colliery, the thermometrical observations at which correspond so closely with those obtained at Rose Bridge, are also in a position not much removed from the horizontal, which is some evidence in corroboration of the views here offered."

Thermometrical Observations at Rose Bridge Colliery.

Date.	Depth in feet.	Strata.	Temperature in open pit.	Temperature in solid strata.
			° F.	° F.
July, 1854	483	Blue shale	...	64·5
August, 1854	564	Warrant earth	...	66
May, 1858	1650	Blue shale	...	78
July, 1858	1800	Warrant earth	...	80
May 18, 1868	1890	"Raven coal"	73	83
July 24, 1868	1995	Linn and wool	75	85
April 19, 1869	2019	"Yard Coal" mine	76	86
November 18, 1868	2100	Strong blue metal	76	87
February 22, 1869	2208	Do.	76	88½
March 12, 1869	2244	Shale	77	89
April 17, 1869	2286	Linn and wool, or strong shale	78	90·5
May 3, 1869	2322	Strong shale	80	91·5
May 19, 1869	2346	Blue metal	79	92
July 8, 1869	2403	Strong blue shale	79	93
July 16, 1869	2424	Coal (Arley mine)	79	93½

Remarks.

All holes vertical in solid at bottom of pit drilled with water 1 yard deep, and thermometer remained in hole thirty minutes, and made air-tight with clay.

CLIMATE OF NEW ZEALAND.

THE Government of this distant colony have taken a wise step in fostering meteorology, by supplying observers with good instruments, good places in which to observe them, placing them under an able chief, and not crippling him for a few pages of printing.

The folio publications noticed at the foot* are principally numerical

* *Appendix to the Statistics of New Zealand (Meteorology) for* 1866, 1867, *and* 1868, *Wellington*, Folio, 28 pages.

Monthly Tables, 1868 *and* 1869 (except September, 1869). Folio, 23 pages.

Meteorological Report for 1868, *together with Abstract of all Meteorological Returns for New Zealand prior to that date.* By JAMES HECTOR, M.D., F.R.S. Wellington: G. Didsbury, Government Printer, 1869. 8vo., 21 pages.

tables, but in the octavo pamphlet Dr. Hector has wisely inaugurated his superintendence of the whole of the stations by a review of "*all* meteorological returns for New Zealand prior to that date." The word which we have italicized is a strong one to use, but we believe it to be correct.

The pamphlet commences with a brief recital of previous publications upon the subject, and of the steps taken in order to secure perfect uniformity among the observers, brief (a trifle too brief for residents at the antipodes) notes of the positions of the observatories, of the instruments and of their positions, then abstracts of the monthly mean temperature at the various stations, the result of which is epitomized in the following table and remarks :—

TABLE I.—*Mean Temperature of the Air in shade, recorded at the Chief Towns in the North and Middle Islands of New Zealand, from the earliest Observations up to the end of* 1867.

Place.	Mean Annual Temp.	Mean Temp. for (SPRING) Sept., Oct., Nov.	Mean Temp. for (SUMMER) Dec., Jan., Feb.	Mean Temp. for (AUTUMN) Mar., Apl., May.	Mean Temp. for (WINTER) June, July, August.	Period of Observations.
NORTH ISLAND.	deg.	deg.	deg.	deg.	deg.	
Auckland	60·7	58·8	68·6	62·3	53·3	15 years.
Taranaki	56·8	55·9	64·2	57·4	49·5	12 ,,
Wellington	55·7	54·6	63·6	56·7	47·9	10 ,,
Means for North Island ..	57·7	56·4	65·4	58·8	50·2	
SOUTH ISLAND.						
Nelson	54·6	53·3	62·5	56·4	46·7	16 years.
Christchurch	55·1	55·5	64·7	55·9	44·5	11 ,,
Dunedin	50·7	50·0	57·4	51·6	43·6	15 ,,
Means for South Island...	53·4	52·9	61·5	54·6	44·9	
North Island	57·7	56·4	65·4	58·8	50·2	
South Island	53·4	52·9	61·5	54·6	44·9	
Means for North and South Islands	55·6	54·6	63·5	56·7	47·5	

"From the above Table it will be observed that in the North Island the mean annual temperature for Auckland is the highest (60°·7), and that for Taranki (56°·8) the next, while Wellington is the lowest (55°·7).

"In the South or Middle Island, Christchurch and Nelson show the highest annual mean temperature (55°·1 and 54°·6); Dunedin is very much lower, viz., 50°·7.

"January and February, corresponding to July and August in England, are the two warmest months in New Zealand; and July and August, corresponding to January and February in England, the two coldest (excepting in Nelson and Wellington, at which places the mean readings are lowest for June and July).

"The climate of London is 7°·2 colder than that of the North Island, and 3°·8 colder than the Middle Island of New Zealand, and the difference between the mean annual temperature of the whole of New Zealand and that of London is 5°·7, the former being 55°·7 and the latter 50°.

"The following are the means for the two warmest and two coldest months in the year in the several localities, with their differences :—

Auckland.	Taranaki.	Wellington.	Nelson.	Christchurch.	Dunedin.
69·6	64·7	64·6	63·6	65·2	58·0
53·1	49·3	47·8	45·9	44·3	43·2
16·5	15·4	16·8	17·7	20·9	14·8

"From which we find that the average difference between the mean temperature of the warmest and coldest months of the year in New Zealand is 17°·0; at Rome it is 27°, at Montpellier 33°, at Milan 38°, and at Jersey 22°.

"The observations from these six stations have been selected to form the above Table, as they extend over a tolerably long period, and give a fair comparison of the climate of the North and South Islands."

The extremes of temperature are not abstracted, but running cursorily over the folio returns and some others in our possession, we notice no shade temperature above 98°, or below 9°, the range is therefore less than in this country.

We regret that Dr. Hector has not given the rainfall in each year from the commencement of observations, but only the averages up to 1867. Arranging the stations from south to north, they are as follows:—

			Mean Annual Fall. in.	No. of years.
Middle Island.—	S.	Southland	43·63	9
	E.	Dunedin	32·74	15
	E.	Christchurch	31·64	11
	C.	Bealey	126·02	1
	W.	Hokitika	119·40	3
	E.	Blenheim	26·10	5
	N.	Nelson	53·30*	16
North Island.—	W.	Wellington	50·52	10
	E.	Napier	39·60	2
	W.	Taranaki	59·39	12
	E.	Auckland	44·68	15
	W.	Mongonui	57·70	3

In the absence of the yearly fall at the older stations, it is impossible for us to reduce the above to anything like true averages, and we need not in these pages point out how delusive are averages of only a few years. Mr. Martens, the observer at Southland, in a paper printed in 1866, gave the details for his own station up to that date; completing it from Dr. Hector's tables, we have the yearly fall at Southland as follows; side by side therewith we give the ratio of the fall in each year to the mean of the whole period (10 years) of observation.

	Total Depth. in.	Ratio.
1859	22·71	53
1860	29·32	68
1861	27·51	64
1862	47·27	110
1863	53·03	123
1864	51·16	119
1865	63·69	148
1866	47·24	110
1867	41·62	97
1868	46·35	108
Mean	42·990	100

* Rain gauge 27 feet above ground.

Mr. Martens is careful to state that his observations were taken near the surface of the ground, and hence the most obvious explanation of the small values in the first three years—viz, that until 1862 the gauge was on some building—is untenable. Are we then to consider that during the three years 1859, 1860, and 1861, the fall was less than two-thirds of the mean of ten years, including those years of drought? There is no evidence to disprove this view, and if we are to accept it, we must also acknowledge that if at Southland the fall had only been observed during 1859, 60, and 61, the mean would have been taken as 26·51 in., and if during 1863, 64, and 65, as 55·96 in., that is to say, in one case as rather more than twice as great as in the other. As, however, it will be noticed that the later years are more uniform than the earlier ones, we doubt if any of the means assigned to the various stations are more than 25 per cent. in error. This uncertainty might have been greatly lessened by the adoption of the mode of discussion pursued in *British Rainfall*, 1867, p. 19. We hope that in a future publication Dr. Hector will either adopt this method himself, or at any rate supply the yearly totals from the commencement of observations at each station, so that others may do so if they desire it.

A short note on barometric results is followed by a table of radiation temperatures 1865—67, indicating very similar values to those in this country.

The next table contrasts the climates of the E. and W. coasts (which we have roughly indicated on page 00, by prefixing letters indicating the positions of the rainfall stations), Christchurch and Hokitika being selected. If our readers will for Christchurch read Scarborough, and for Hokitika read Portree, in each case raising the mean temperature three degrees, they will at once understand the two climates.

We have no desire to disparage meteorological progress in our own country, but if our colonies continue as liberal to meteorology and the observers and directors as zealous as they now are, we shall soon have them setting us an example.

SNELL'S ANEROID HYGROMETER.

To the Editor of the Meteorological Magazine.

SIR,—In describing this instrument in your February number, have you not made a slight mistake? You say, "a piece of whipcord, fastened at one end, is wound two or three times round the axle, it then passes upwards over a pulley, and has a leaden weight attached at the other end to keep the string tight." Should it not be that the piece of whipcord being fastened at one end, passes upwards over a pulley, and on its return downwards is wound two or three times round the axle, and has a weight attached to the end?

According to your description, the needle would be affected only by the expansion and contraction of the cord between the place of fastening and the axle (a very small length), whereas, according to the

latter, the expansion and contraction of nearly the whole length of cord would be brought to bear.

A self-constituted instrument, of a similar kind, may be seen by anybody visiting the Charing Cross Hotel, on going up in the "lift," which is regulated by a thick rope passing up the whole length of the "lift." The porter in charge will tell you any day what the weather is going to be, by the slackness or tightness of the rope.

I am, yours truly,

Avon Lodge, near Rugby, 6th April, 1870. FREDERICK FULLER.

[Quite true; in our description the course of the cord was incorrectly stated.—Ed.]

THUNDERSTORM IN YORKSHIRE.

To the Editor of the Meteorological Magazine.

Sir,—I beg to enclose you particulars relating to the damage done by the sharp but short thunderstorm which occurred near here at 4.30 p.m. Greenwich mean time, last Saturday.—Yours truly,

LOUIS J. CROSSLEY.

Willow Hall Observatory, April 11th, 1870.

"A heavy thunderstorm passed over Halifax and neighbourhood on Saturday afternoon (9th), its effects being particularly felt at Ovenden, where the residence of Mr. Johnson, cotton spinner, was struck. The lightning went down one of the chimneys, and, with two exceptions, entered every room in the building, smashing all the windows and destroying the principal staircase. The lightning passed through the back kitchen window, which was instantly demolished, and entered the yard, where it tore up the flags, after which it entered the wash kitchen, destroyed the pump, and tore up the flags. Considerable damage was done to the house internally. Mr. Johnson, his wife, and the servant were in the house, but fortunately none were at all injured. There was an immense fall of hailstones"

HEIGHT OF GAUGES.

To the Editor of the Meteorological Magazine.

Sir,—As you invite remarks upon Rule IV., I venture to say a word on the subject.

Your correspondent, "R.," argues, that the excess of rain at 1 foot above that registered at greater heights is caused by the wind gathering water from (1) the sea, (2) lakes and ponds, (3) trees and hedgerows.

With regard to (1), I find that the fall here, one mile inland, is nearly always greater in storms from the sea-ward than on the cliff edge, even when the gauge on the cliff is quite whitened outside with a deposit of salt. Probably, if the spray is light enough to be blown up the cliffs, it is light enough not to fall in any appreciable quantity into the gauge.

(2) The water of ponds and lakes is seldom enough agitated to be raised by the wind. I would venture to draw your correspondent's attention to the fact, that the gauge on Derwent Island catches no more, but rather less, than other gauges at Keswick.

(3) As far as I have observed, hedgerows and trees arrest the flying drops of rain, and allow it to fall directly to the ground in larger drops, so that a gauge on the lee side of them catches less and not more than the correct fall.

I am obliged, therefore, to conclude, that the reasons alleged against Rule IV. are insufficient. Besides, if the object of a rain gauge is to find how much rain falls to the ground, it should be put *as near the ground as possible, provided that insplashing be avoided.* The amount of condensation of vapour in the atmosphere above any place is a different thing from the rainfall.—I am, Sir, your obedient servant,

F. W. STOW.

Hawsker, Whitby, April 26th.

To the Editor of the Meteorological Magazine.

SIR,—With reference to a letter signed "R.," in your last number, upon Rule IV. of *British Rainfall*, 1869, in which he advocates 6 ft. above the ground as a better mean, I would beg to call his attention to Rule II., "Old-established gauges should not be removed," and on looking over the elaborate tabular exposition of last year, I find that there are only 12 gauges situated at an elevation of six feet above the ground, whilst there are upwards of 1300 below that height—a good reason for their retaining their present position, which many have occupied for years, others are not suited for mounting.

Some fourteen years ago, when I first began to need instructions on meteorological instruments, the books on this subject were not easily obtainable, I went into a stationer's shop and asked for a work on meteorological instruments and their use, or practical meteorology, and was told I might perhaps get what I wanted at the ironmonger's over the road. I fixed my solar radiation thermometer at 6 ft above the ground; after two years I was told that near the ground was the proper place, and was adopted by the generality of observers, and of course placed it so; now, after ten years, it is hoped I shall put it back from where it was removed; so that the present rules only stand good until the next magazine arrives.

As the remarkably close agreement of my inclined gauges at 6 feet and 30 feet has called forth a few remarks from your editorial pen, and also from "R.," I may add that I did not append any to my table, not having sufficient data, and nothing should be done in a hurry, except catching flies; I cannot say that a tilted gauge near the ground would yield the same results, but I think there would be a close approximation. I recollect, some years ago, before I knew anything about tilted gauges, placing pads of bibulous paper at an angle of 45° and others flat, from heights near the ground to 30 feet, on several wet days; and after a short exposure, on being re-weighed, the results were, that those which had been placed at an angle were of the same weight, whilst those laid flat differed in the same proportion as ordinary gauges do with elevation.

I should like to try a tilted gauge near the ground, but pecuniary circumstances will not admit of it at present. It would require to be worked by a vane at some distance.

I am, Sir, your obedient servant,

April 30th. J. ARNOLD, F.M.S.

APRIL, 1870.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Date.	Min. Deg.	Date.	No. of Nights below 32°. In shade	On grass
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	·47	— ·66	·12	9, 29	6	79·4	20	26·7	2	6	10
II.		Maidstone (Linton Park)	·43	— ·79	·16	9	4	80·0	20	28·0	1§	8	...
,,		Selborne (The Wakes)	·35	— 1·15	·22	9	4	73·0	20	20·8	2	10	14
III.		Hitchen	·43	— ·57	·18	29	8	72·0	20	25·0	1, 3	5	...
,,		Banbury	·66	— ·50	·22	9	7	74·5	20	28·0	5	7	...
IV.		Bury St. Edmunds (Culford)	·78	+ ·03	·21	10	8	74·0	20	23·0	5	6	11
V.		Bridport	·53	— ·95	·30	9	4	70·0	20	22·5	6	11	...
,,		Barnstaple	·58	— 1·43	·11	30	9	75·3	21	31·0	7	..	..
,,		Bodmin	·31	— 1·39	·14	29	7	65·0	13	31·0	6	3	...
VI.		Cirencester	·68	— ·61	·35	9	5	...	...	...	...	...	...
,,		Shifnall (Haughton Hall)	1·09	— ·06	·35	29	8	71·0	20	26·5	5	4	...
,,		Tenbury (Orleton)	·79	— ·75	·23	29	9	76·0	20	25·2	5	4	12
VII.		Leicester (Wigston)	·55	— ·75	·20	29	5	82·0	20	25·0	4	5	...
,,		Boston	·73	— ·24	·16	9	7	78·9	20	28·1	4	3	16
,,		Grimsby (Killingholme)	·64	..	·18	29	7	71·0	20	31·0	5	2	...
,,		Derby	·75	— ·68	·31	9	7	77·0	20	28 0	5	4	...
VIII.		Manchester	2·22	+ ·46	·76	29	10	76·3	20	31·0	3, 5	2	6
IX.		York	·66	— ·44	·32	9	6	79·0	20	32·0	6	0	...
,,		Skipton (Arncliffe)	2·46	— ·58	·40	8	10	...	...	...	...	..	..
X.		North Shields	·78	— ·53	·52	9	9	64·2	20	32·5	5, 6	0	...
,,		Borrowdale (Seathwaite)	...	...	...	.	...	...	...	...	...	...	...
XI.	WALES.	Cardiff (Town Hall)	...	...	...	...	...	...	...	...	...	...	...
,,		Haverfordwest	·71	— 1·15	·41	8	6	67·5	18	27·1	4	4	6
,,		Rhayader (Cefnfaes)	·89	— 1·00	·30	30	7	72·0	...	26·0	...	6	...
,,		Llandudno	2·08	+ ·58	·61	13	9	72·8	19	35·7	3	0	...
XII.	SCOTLAND.	Dumfries	·69	— ·98	·25	22	9	72·5	18	30·0	5	3	10
,,		Hawick (Silverbut Hall)	·96	...	·28	29	11	...	...	...	...	...	...
XIV.		Ayr (Auchendrane House)	2·11	— ·11	·47	12	18	73·0	21	28·0	3	2	9
XV.		Castle Toward	2·48	— ·02	·57	23	18	66·0	18	30·0	3	5	9
XVI.		Leven (Nookton)	·50	— ·75	·14	8	10	64·0	16*	31·0	5, 6	2	15
,,		Stirling (Deanston)	1·22	— ·53	·32	23	15	71·5	18	25·0	10	10	...
,,		Logierait	·79	...	·21	20	11	...	...	...	...	..	...
XVII.		Ballater	·77	...	·15	28	8	70·5	20	28·0	4	5	...
,,		Aberdeen	1·29	...	·46	9	13	66·5	25	33·3	4	...	...
XVIII		Inverness (Culloden)	·93	...	·20	14	12	69·1	20	36·0	9	0	10
,,		Portree	7·80	+ 2·53	1·14	23	22	...	...	...	...	...	...
,,		Loch Broom	6·44	...	·85	27	20	...	...	...	...	...	...
XIX.		Helmsdale	2·22	...	·44	30	18	...	...	...	...	...	...
,,		Sandwick	2·77	+ 1·03	·49	25	20	60·9	17	34·7	28	0	1
XX.	IRELAND.	Cork	1·14	...	·40	20	8	...	...	...	...	...	...
,,		Waterford	·82	— 1·41	·28	8	8	50·0	15†	30·0	...	4	...
,,		Killaloe	2·07	— ·06	·53	20	15	68·0	16‡	27·0	5	4	...
XXI.		Portarlington	·93	— 1·09	·24	22	16	66·0	19	34·0	4	0	0
,,		Monkstown	·61	— 1·03	·52	13	3	...	...	...	...	...	...
XXII.		Galway	2·61	...	·68	20	18	67·0	19	37·0	8	0	...
,,		Bunninadden (Doo Castle)	1·72	...	·57	20	12	59·0	25	25·0	5	2	...
XXIII		Bawnboy (Owendoon)	2·01	...	·49	20	17	70·0	19	33·0	8	0	3
,,		Waringstown	1·62	...	·58	8	15	69·0	17	30·0	1, 2	3	10
,,		Strabane (Leckpatrick)	2·32	..	·50	20	18	69·0	17‡	26·0	7	6	8

* And 17, 18. † And 16, 25. ‡ And 19. § And 2, 29.

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

METEOROLOGICAL NOTES ON APRIL.

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.

CAMDEN TOWN.—T and H at 2.10 p.m. on 10th; S in forenoon of the 28th.

LINTON PARK.—A dry, warm, and sunny month, with frosts only on six days and R on four days; winds changeable, but not high; bar. high and steady from the 11th to the 29th. Great progress in vegetation during the month, yet things are not, at the end of it, as forward as they were last year at the same time. Cuckoo heard on the 16th.

SELBORNE.—A most ungenial month; all vegetation retarded to an almost unprecedented degree; the drought and low temp. injurious to crops of almost every kind. Dense fog on the 5th, H at 2 p.m. 10th; min. temp. 20° higher on the 8th than on the 6th; bright aurora with coruscations on the 5th. Martin first seen on 12th; cuckoo heard on 17th.

HITCHIN.—The greatest heat (72° on 20th) recorded so early during 20 years' observations.

BANBURY.—H on 9th and 10th.

CULFORD.—T and H on 10th, and H on 27th; mean temp. of month 48°·1.

BRIDPORT.—Very fine calm month; ther. fell below 32° on the first seven nights, the frost of the 6th being very severe (22°5·), but doing no damage, whilst on the 29th, when the ther. registered 29°, the potatoes were cut severely; cherry in blossom on the 20th, horse chesnut in leaf on 21st; cuckoo made its appearance on the 20th, swallows on the 21st.

BODMIN.—Great evaporation on 19th and 23rd. The drought, which lasted 38 days, has been severely felt, ·37 in. only having fallen, and, during 21 years, I have never registered so small a quantity in that number of days.

CIRENCESTER.—A dry and cold month, with two short fits of S. and S.W. winds and warmth; a little R and H, but increasing warmth and much sunshine have moved the sap and burst the buds of early trees, and the moderate night frosts have not destroyed the blossoms.

SHIFNALL.—A seasonable month on the whole, rainfall about the average; vegetation, though very backward, made rapid progress towards the end of the month, when the temperature rose greatly (71° on 20th). Prevailing winds throughout were N. and N.W. Willow in blossom on 4th, celandine in flower on 5th, gooseberries in blossom on 10th, hawthorn in leaf on 18th, asparagus cut on 19th, blackthorn in blossom on 20th, wild cherry on 21st, and pear tree on 26th; white butterfly first seen on 5th; golden plovers in a flock on passage on 11th; swallow (H. rustica) first seen on 16th; cuckoo first heard on 19th.

ORLETON.—Thick fog at 9.30 a.m. on 16th; cuckoo frequently heard and seen on that day.

WIGSTON.—An unusually dry month; the range of ther. excessive; the reading (82°) on the 20th was higher than I have any record of in April for more than 40 years. The warmth of the weather between the 16th and 22nd stimulated vegetation very much.

BOSTON.—The month was, on the whole, dull and cold, and the changes in temp. very sudden and remarkable; lunar halos seen on 8th, 14th, and 15th; H fell on the 9th; T heard on 10th; horse chesnut in leaf on 18th, hawthorn on 23rd, field elm and lime on 24th.

GRIMSBY.—Grass very scarce till the close of the month; very few swallows (first seen on the 9th); much of the wheat has been destroyed by the wire-worm; very little R fell until the last two days of the month. On 23 days the wind was W. or compounds of W. A little H on 28th; large lunar halo on 14th; peewits inland on 1st; willow warbler heard on 14th, and cuckoo on 24th. Coltsfoot flowered on 1st, ribes on 5th, pilewort on 7th, yew and wych elm on 8th.

DERBY.—April has passed, and, until the last day, without April showers; the weather has been fine, but generally cold; spring backward; N.E. wind only once recorded.

YORK.—Dew point for the month 39°·9.

NORTH SHIELDS.—Lunar halo on 13th; auroræ on 24th, 26th, and 28th; H

on 27th ; cherry in blossom on 17th, pear on 26th, violets on 1st, and, before the end, auriculas, hyacinths, primroses, anemones, early tulips, polyanthus, &c.

WALES.

HAVERFORDWEST.—A dry cold month; some warm weather about the middle ; very little frost. Vegetation backward, and water becoming rather scarce ; every indication of a dry summer. Scarlatina prevailing in a severe form, many deaths.

CEFNFAES.—A dry cold month ; frosty nights and sunny days; wind N.E. and N.W. ; vegetation backward.

LLANDUDNO.—Cuckoo first heard on 15th and swallows first seen on 16th ; dense fog from 1.30 to 7 p.m. on 16th ; a lilac in flower on the 23rd in a sheltered spot : gathered honeysuckle in full flower on the 25th.

SCOTLAND.

DUMFRIES.—This month has been very dry and cold, with frequent frosts; four days, from the 17th to the 20th, very hot : the ther. in shade at 72°·5 on 18th ; during the third week the temp. at night high, which, with the few days' heat, caused vegetation to make great progress for a few days, when checked by northerly winds ; S on the 9th ; swallows seen on the 19th ; cuckoo heard on 21st.

HAWICK.—Rather a cold dry month, with slight frosts on 13 nights, on six nights the drinking troughs sheeted over with ice ; the rainfall of this and last month has amounted to 2 ins. only, and R is now very much wanted. Apricots are well set on the open walls, and, owing no doubt to the well-ripened wood of last season, there is a fine appearance of a bounteous crop of fruit ; swallows first seen on the 26th ; some H fell on the 30th.

AUCHENDRANE.—Bar. pressure, mean temp., elastic force of vapour, and dew point above the mean for April ; below the mean were the bar. range, rainfall, mean force of wind, cloud, evaporation, and the difference between the mean dew point and the mean temp. ; the humidity agreed with the April mean, but fell once so low as 61° ; this dryness of the air and small amount of cloud caused a great range between the day and night temp., and was accompanied by most seasonable weather for sowing the seed and cleaning the arable land.

CASTLE TOWARD.—A month of good spring-like weather of showers and sunshine, with only a few slight frosty nights, so that although vegetation has only progressed slowly, it has met with no check ; very warm from the 16th to the 21st, which burst many of the deciduous trees into full leaf in a few days ; apricots well set with fruit ; other stove fruit and early pears have been in full flower since the 15th, and as there has not been any frost during that time we expect a full crop ; gale on the 22nd ; foggy on morning of 19th.

NOOKTON.—High wind on night of 19th.

DEANSTON.—Month generally cold and frosty ; high cold winds, especially during the last ten days ; some mild days ; only two days in succession (the 22nd and 23rd) with any R worth mentioning ; vegetation very backward, few trees having any green about them at the end of the month.

LOGIERAIT.—First part of the month dry, with a high temp. ; on 23rd a change occurred—cold north winds, a measure of frost which continued to the end of the month ; swallows first seen on the 1st of May.

BALLATER.—One of the finest spring months known, and seed got put into the ground in excellent order. Rainfall below the mean ; temp. high for the season ; the last week experienced a marked decrease in temp., N.E. winds prevailing, with an unusual amount of cloud.

ABERDEEN.—Mean bar. and temp. above the mean of 13 years ; rainfall below the mean ; winds chiefly S.W., S., and N.W. ; a fine dry month till the 26th, after which it was boisterous and cold ; H on the 10th, 26th, 27th, and 28th ; S on the 27th ; L at night on 6th and 8th ; dense fog all day on 18th, and till 8 p.m. on 19th. Auroræ on 6 nights.

SANDWICK.—April was mild and dry till the latter part, but the last ten days were wet and the last five days boisterous, N.W. winds prevailing. Auroræ on 2nd, 16th, 17th, 18th, 19th, 21st and 28th, coruscating to the zenith on the 18th and 28th ; large lunar halos on 9th and 14th ; a gale of 43 miles an hour from 8 to 10 a.m. on 7th, of 54 miles from 3 to 4 a.m. on 23rd, of 50 miles from 7 p.m. 26th, and continued till 8 a.m. on 27th, 55 miles from 12 till 2 a.m. Solar halos on 10th and 15th.

IRELAND.

DOO CASTLE.—Fine month for farming operations, spring work in a forward state in consequence; cold wind blowing strong from N. and N.W. the greater part of the month retarded vegetation and blanched braird; swallows seen in the middle of the month; cuckoo heard on the 30th.

WARINGSTOWN.—Fine and very favourable for labour, though not warm; spring, in some respects, backward, but crops looking well; the ground unusually dry and easily handled.

LECKPATRICK.—Fine month, latter half very cold; on 18th the wind veered round to S.E., followed by a gale and R; the last week very cold, constant northerly wind; swallows first seen on 22nd.

A TAX ON OBSERVERS.

To the Editor of the Meteorological Magazine.

SIR,—May I trouble you with a word or two relative to a letter ("A Tax on Observers") I have recently seen in the April number of your periodical? When observations are undertaken, and continued for many years with care and patience, it is scarcely to be supposed that the observer is willing to waste his meritorious labours by concealing their results from every eye but his own. There are certain localities (such as Devon, Cornwall, and the Isle of Wight), the meteorology of which will always be pre-eminently interesting; and observers who are fortunate (or unfortunate) enough to reside in them, must expect to be applied to occasionally. If the task set them be beyond their powers a courteous statement to that effect would, I am sure, satisfy the applicants. I have met with great kindness from meteorologists in general (one of whom, a "perfect stranger," has more than once sent me his registers, at the risk of loss or damage in transit), and I am slow to believe that any gentleman would discontinue observations in preference to following the course I have ventured to recommend. I am also slow to believe that the good feeling characteristic of meteorologists is on the decrease—an obtuseness engendered by the fact, that in four out of five cases I have received the information asked for, with kindly professions of friendship.—I remain, faithfully yours,

April 22nd, 1870. CIT.

AURORA BOREALIS.

To the Editor of the Meteorological Magazine.

SIR,—A most beautiful display of aurora borealis was observed here last night. About 7.30 p m. a bank of light of a deep red colour appeared in N.N.E., with waves passing across the sky to W.S.W. When first seen, the light was taken for the reflection of a large fire. At 8 p.m. it suddenly faded away At 8.10 p.m. a great number of pale white streamers rose from a dark line on the northern horizon, and as they neared the zenith became tinged with red; they continued very bright till 8.35, when they became much dimmer, and at 9 p.m. had almost disappeared. The idea of a storm following within three days of a display of aurora does not seem to hold good, as it was observed on several occasions last month without any change in the weather.—Yours truly, THOS. PAULIN.

Winchmore Hill, April 6th, 1870.

[Two valued communications on evaporation and several other notes unavoidably postponed.—ED.]