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The Regular Diurnal Variation

OF

Magnetic Declination at Kew Observatory

FROM SELECTED YEARS OF

Many and Few Sunspots

1859-1894

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The manuscript of this Memoir was received in April of the current year, and the first proof was supplied by the printer at the beginning of August. Unfortunately the state of Dr. Chree's health was then such that he was unable to attempt the task of revision. Dr. Chree died on August 12th. The proof has been read in the Office, but only editorial corrections of a minor nature have been made.

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THE REGULAR DIURNAL VARIATION OF MAGNETIC DECLINATION AT KEW OBSERVATORY FROM SELECTED YEARS OF MANY AND FEW SUNSPOTS, 1859–1894

ABSTRACT

Magnetographs began recording at Kew Observatory in 1858, but there was no systematic tabulation of the magnetic curves until 1891. The present paper deals with the regular diurnal variation of declination in a selected number of the earlier years.

Sunspot minimum is represented by the pairs of years 1866 and 1867, 1878 and 1879, 1888 and 1889. Sunspot maximum is represented by 1859, 1860, 1870, 1871, 1872, 1883 and 1884. With these are combined for certain purposes the three later years 1892, 1893 and 1894. The mean epoch for these ten years of sunspot maximum, 1877·8 is the same as that of the six years of sunspot minimum.

Inequalities derived from the two groups of years are employed in the discussion of the systematic differences between the regular diurnal variation in years of sunspot maximum and minimum. Use is also made in the same connection of Fourier coefficients, which are calculated from the diurnal inequalities for the whole year and for the seasons of individual years. A topic receiving considerable attention is the question whether the regular diurnal variation is altering. The evidence is on the whole favourable to a slow secular change in the hours of maximum and minimum.

Three partly overlapping sub-periods are considered, viz., 1859–72, 1870–84, and 1883–94, each composed of a central two years of sunspot minimum flanked by two groups of sunspot maximum years. Values for the a and b constants in Wolf's formula $R = a + bS$ are calculated for the sub-periods, as well as for the entire period 1859–94. The differences between the values obtained for a and b for different epochs derived from the inequality ranges are much less than those found in the case of the absolute ranges. This seems due to the fact that disturbance exerts a much larger influence on the absolute than on the inequality range. In many years the value of S has little relation to disturbance in individual months. In particular some months of 1866 were more disturbed than the corresponding months of 1859 and 1870 which had immensely higher values of S.

§ 1—Previous discussions of Kew Observatory Magnetic Data

Regular tabulation of the Kew magnetic curves did not commence until 1890, and was then limited to 5 quiet days a month. This was done originally for declination (D), horizontal force (H), and vertical force (V). Measurement of V curves ceased in 1902, but that of D and H curves was continued until the end of 1924, and during the last seven years of the period the measurement of D curves embraced all days. Originally the quiet days were selected by the Astronomer Royal, but from 1906 use was made of the international quiet days selected at De Bilt.

The quiet day results from the 11 years 1890 to 1900 were discussed in *Phil. Trans. R. Soc.* A. 202, p. 235 (reprinted in *Collected Researches* National Physical Laboratory Vol. I, p. 1). This was supplemented by a discussion of D results from "ordinary" days of the same period, *Phil. Trans. R. Soc.* A. 208, p. 205 (reprinted in *Collected Researches* National Physical Laboratory Vol. 5, p. 1, with additional matter in an Appendix, p. 45). By "ordinary" days was meant all days of the 11 years with the exception of 209 highly disturbed days.

The early practice at Kew was to take instantaneous readings exactly at the hour G.M.T., and if the curve were markedly irregular it was replaced by a pencil line drawn free-hand with the object of smoothing out irregularities. The free-hand curve was drawn with an eye to the curve as a whole, not to individual hours. Thus hourly measurements from the free-hand curve would not necessarily supply for each hour values closely corresponding with 60-minute means from the original curves. The 209 days omitted were really the days when the smoothing process appeared too arbitrary.

The D, H and V results from the 209 highly disturbed days were discussed in *Phil. Trans. R. Soc.* A 210, p. 271 (reprinted in *Collected Researches* National Physical Laboratory Vol. VII, p. 1). Lastly the "ordinary" day H and V results for 1890-1900 were discussed in *Phil. Trans. R. Soc.* A 216, p. 187. These papers may be regarded as giving a fairly complete discussion of Kew magnetic data from one 11-year period 1890-1900.

§ 2—The Scope of the present Work

Subsequent to 1900 the curves, especially the *V* curves, suffered increasingly from artificial electric tram and train currents. So far as can be judged, this did not have a serious influence on the *D* and *H* regular diurnal variations, which continued to be published until 1924. But admittedly the data subsequent to 1900 are exposed to a source of uncertainty from which earlier data are free. Thus the discussion of the earlier data has long appeared a desirable object.

For defraying the expenses involved in the measurement of the curves, and the calculation of hourly means, I am indebted to grants from the Government Grant Committee. Only one element, *D*, has been dealt with. This was selected because *D* curves require no temperature correction and have an invariable scale value, and thus the data have a certainty which cannot be claimed for the other elements. The first step taken was the measurement of the daily maximum and minimum, and hence of their difference the absolute daily range. This was done, except for 1874 when registration was suspended, for every day from the start in 1858 to the end of 1900, with the exception of a few days when the trace was missing or too faint for measurement. The results were discussed in Meteorological Office, *Geophysical Memoirs* No. 22.

The regular diurnal variation had been discussed by General Sabine for a few of the earlier years. But his views as to disturbed values and their treatment differ much from those now current, and the original tabulations seemed to be lost. Thus the re-measurement of the curves was unavoidable. In all 31 years of *D* curves prior to 1890 were available. The measurement of the complete series appearing too arduous, hourly measurements were confined to certain years representative of sunspot maximum and minimum. These years and the corresponding sunspot frequencies were as follows :—

Sunspot maximum.		Sunspot minimum.	
Year.	*S*	Year.	*S*
1859	93·8	1866	16·3
1860	95·7	1867	7·3
1870	130·1	1878	3·4
1871	111·2	1879	6·0
1872	101·7	1888	6·8
1883	63·7	1889	6·3
1884	63·5		

S is the Wolf-Wolfer sunspot frequency.

In its earlier months 1866 was not a very good representative of sunspot minimum. It is desirable, however, to have each sunspot maximum or minimum represented by at least two years, and 1866 was a much better representative of sunspot minimum than 1868. The three sunspot maxima were of very different types. 1870 had the largest spot frequency of the nineteenth century, and the rise to the maximum was very rapid. The rise to the maximum in 1860 and the subsequent decline were both rather slow. The maximum reached in 1883 was low and rounded. *S* was really lower in 1883 than in several years omitted above, including 1861, 1869 and 1873.

§ 3—The Selection of Curves for Tabulation

The object being to secure results strictly comparable with those from the ordinary days of the 11 years 1890 to 1900, the same procedure was followed. Hourly measurements were taken exactly at the hour, the curves when noticeably irregular being smoothed in the old way. Days when the smoothing process appeared too arbitrary were omitted. The number of days omitted in each month is given in Table I. The total omitted for the thirteen years, 458, appears high as compared with the total 209 for the eleven years 1890-1900. This may partly represent a change of standard, as no year between 1890 and 1900 had more than 39 days omitted, and two years had each less than 10. But the average year now considered was

probably more disturbed than the average year between 1890 and 1900. Also days had to be omitted for causes other than disturbance. Minor gaps between 1890 and 1900 could be filled by reference to Falmouth curves, but this resource

TABLE I—NUMBER OF DAYS OMITTED FROM DIURNAL INEQUALITIES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1859	3	3	0	6	1	?	2	4	4	7	2	6	40
1860 ..	2	3	6	3	0	2	7	7	3	1	2	3	39
1866	3	6	3	4	1	0	0	2	5	6	4	0	34
1867	6	7	5	2	0	3	2	0	8	3	1	0	37
1870	9	4	2	5	3	5	1	8	9	5	3	4	58
1871	4	6	1	6	3	1	1	4	2	2	4	0	34
1872	5	5	2	4	0	0	6	7	2	5	4	6	46
1878	4	0	0	3	3	6	0	2	0	0	2	2	22
1879	5	2	0	2	1	0	2	0	1	1	1	1	16
1883	2	9	7	4	3	0	3	3	2	4	6	2	45
1884	3	5	3	2	0	1	3	4	2	2	2	4	31
1888	8	0	5	4	2	2	0	6	1	4	3	1	36
1889	2	0	3	0	0	0	1	1	4	3	6	0	20
Total ..	56	50	37	45	17	22	28	48	43	43	40	29	458

was not available prior to 1890. The curves of some of the earlier years had faded, occasionally to such an extent that measurement was impossible. Another cause of loss was the procedure adopted at the annual scale-value determination, usually made in January. Broun's method was followed, deflections being made of the *D* curves, as well as of the *H* and *V* curves. Photographic registration was stopped, sometimes for several hours, and the positions of the light answering to deflected positions of the magnet were marked in pencil on a temporary sheet. This led in some cases to uncertainties such that the total omission of the day seemed the lesser evil. In short, Table I includes a substantial number of days omitted not because the day was disturbed, but because the trace was defective.

§ 4—NON-CYCLIC CHANGES

Table II gives particulars of the non-cyclic (n. c.) changes[1] in the diurnal variation, determined in the usual way. Corrections were calculated and applied on the usual hypothesis that the n. c. change takes place at a uniform rate throughout the 24 hours. While the n. c. changes in some individual months are by no means negligible, there is no single year, nor any single month of the twelve, for which the mean value is not trifling. The final mean −0′·014 from the whole 156 months accords closely with the secular change in *D* during the period.

TABLE II—NON-CYCLIC CHANGES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
	′	′	′	′	′	′	′	′	′	′	′	′	′
1859 ..	+0·01	+0·23	−0·12	−0·19	+0·01	0·00	+0·24	+0·25	+0·19	+0·07	−0·49	+0·26	+0·04
1860	+0·03	+0·28	−0·48	−0·36	+0·07	+0·10	+0·40	+0·38	+0·01	+0·10	+0·43	+0·20	+0·10
1866	−0·09	+0·19	+0·23	+0·13	+0·05	+0·04	+0·17	−0·08	−0·29	+0·09	−0·33	0·00	+0·01
1867	+0·21	−0·12	−0·04	+0·21	+0·33	−0·12	+0·08	+0·16	−0·20	+0·06	−0·27	+0·02	+0·03
1870	−0·48	−0·38	−0·09	+0·26	−0·48	+0·12	−0·03	+0·17	−0·60	−0·06	−0·14	−0·21	−0·16
1871	−0·07	−0·41	+0·02	+0·26	−0·39	−0·03	−0·23	−0·08	−0·23	+0·44	+0·23	−0·14	−0·05
1872	+0·60	−0·25	−0·22	+0·12	0·00	−0·10	−0·16	−0·59	−0·18	−0·20	+0·03	+0·51	−0·04
1878	+0·01	0·00	+0·03	+0·10	+0·03	+0·04	−0·04	−0·03	0·00	+0·02	−0·07	+0·05	+0·01
1879	−0·05	−0·05	−0·07	+0·14	+0·12	−0·02	+0·04	+0·10	−0·05	+0·05	−0·03	+0·04	+0·02
1883	+0·13	−0·39	−0·46	+0·24	−0·12	−0·30	+0·34	+0·22	−0·14	+0·02	−0·23	−0·17	−0·07
1884	−0·09	+0·05	+0·16	+0·28	−0·10	−0·08	−0·04	−0·39	+0·25	−0·09	+0·07	−0·12	−0·01
1888	−0·17	0·00	−0·17	+0·01	+0·02	−0·21	+0·03	−0·14	+0·15	+0·10	−0·05	−0·01	−0·04
1889	−0·04	−0·05	−0·02	+0·02	−0·03	−0·01	0·00	−0·02	−0·05	−0·04	+0·02	−0·01	−0·02
Mean ..	0·00	−0·07	−0·09	+0·09	−0·04	−0·04	+0·06	0·00	−0·09	+0·04	−0·06	+0·03	−0·01

[1] The non-cyclic change is the algebraic excess of the value of the element at 24h. above that at oh.

§ 5—Diurnal Inequalities

Tables III to XV contain the diurnal inequalities for the several years, the maxima and minima—*i.e.*, the extreme westerly and easterly hourly values—being in heavy type. Inequalities are given for each month of the twelve, for the year,

Table III—Diurnal

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January	−1·37	−1·28	−1·25	−1·14	−1·47	−1·36	−1·27	−1·51	−0·93	+0·75	+2·60	+3·73
February ..	−2·02	−1·73	−1·18	−1·11	−1·69	−1·89	−2·04	−2·84	**−3·01**	−1·37	+1·84	+4·68
March ..	−2·88	−2·63	−2·49	−2·30	−2·52	−2·56	−2·87	**−3·84**	−3·43	−1·20	+3·57	+6·94
April ..	−1·19	−1·38	−1·59	−1·58	−1·89	−3·56	−5·88	**−6·89**	−5·45	−1·63	+3·30	+7·84
May ..	−0·85	−1·03	−1·64	−2·31	−3·34	−4·20	−4·92	**−5·01**	−3·46	−0·26	+3·65	+6·37
June ..	−1·01	−1·29	−1·91	−2·89	−4·79	−6·28	**−6·65**	−5·72	−3·73	−0·48	+3·43	+5·99
July ..	−1·14	−1·81	−2·29	−3·12	−4·42	−5·56	**−5·80**	−5·04	−3·10	−0·75	+2·62	+5·51
August ..	−1·79	−2·02	**−2·41**	−2·50	−3·96	−5·00	**−5·82**	−5·69	−3·58	−0·30	+3·99	+7·26
September	−2·44	−2·50	−2·62	−2·34	−2·42	−2·96	−3·60	**−3·83**	−2·46	+0·50	+4·59	+8·07
October ..	−2·18	−2·02	−1·83	−1·51	−1·63	−1·87	−2·64	**−3·71**	−3·43	−0·54	+3·24	+6·06
November ..	−1·25	−1·18	−1·12	−1·21	−1·44	−1·33	−1·64	−2·45	**−2·51**	−0·83	+2·17	+4·49
December ..	−2·12	−2·15	−1·37	−0·88	−0·75	−0·66	−1·09	−1·26	−1·38	+0·06	+2·18	+3·43
Year ..	−1·69	−1·75	−1·81	−1·91	−2·53	−3·10	−3·68	**−3·98**	−3·04	−0·50	+3·10	+5·86
Winter ..	−1·69	−1·58	−1·23	−1·08	−1·34	−1·31	−1·51	−2·01	−1·96	−0·35	+2·20	+4·08
Equinox ..	−2·17	**−2·13**	−2·13	−1·93	−2·12	−2·74	−3·75	**−4·57**	−3·69	−0·72	+3·68	+7·23
Summer ..	−1·20	−1·54	−2·06	−2·76	−4·13	−5·26	**−5·80**	−5·36	−3·47	−0·45	+3·42	+6·28

Table IV—Diurnal

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−2·06	−1·45	−1·37	−1·26	−1·25	−1·14	−1·05	−1·24	−1·61	+0·07	+1·97	+3·47
February	−1·62	−1·18	−1·29	−1·51	−1·34	−1·56	−2·11	−2·90	**−3·23**	−1·50	+1·60	+3·66
March ..	−2·57	−2·13	−1·65	−2·16	−2·37	−2·52	−3·15	**−4·15**	−3·62	−0·65	+3·66	+7·00
April ..	−2·20	−1·71	−1·34	−1·47	−2·17	−3·46	−4·61	**−5·26**	−4·07	−0·85	+3·66	+7·27
May ..	−1·43	−2·03	−2·52	−3·27	−4·50	−5·36	**−5·78**	−5·16	−3·30	+0·16	+4·08	+7·12
June ..	−1·01	−1·36	−1·85	−3·22	−5·25	−6·64	**−7·53**	−6·51	−4·25	−0·84	+3·46	+6·71
July ..	−1·36	−1·79	−1·97	−3·03	−4·80	−5·91	**−6·12**	−5·71	−4·15	−1·17	+2·85	+6·35
August ..	−2·07	−2·47	−2·93	−3·89	−4·65	−5·70	**−6·02**	−5·45	−3·06	+0·79	+5·17	+8·41
September	−2·03	−2·09	−2·71	**−2·77**	−3·09	−3·45	−4·11	**−4·37**	−2·80	+0·54	+4·54	+7·31
October ..	−2·45	−2·01	−1·98	−1·92	−2·13	**−2·43**	−3·00	**−3·79**	−3·39	−0·46	+3·75	+6·64
November	−1·43	−1·08	−1·19	−1·33	−1·12	−1·44	−1·65	−1·99	**−2·13**	−0·52	+2·19	+4·04
December ..	−1·29	−1·13	−0·78	−0·76	−0·65	−0·74	−0·87	−0·80	−0·76	+0·44	+1·84	+2·76
Year	−1·79	−1·70	−1·80	−2·22	−2·78	−3·36	−3·83	**−3·94**	−3·03	−0·33	+3·23	+5·90
Winter ..	−1·60	−1·21	−1·16	−1·21	−1·09	−1·22	−1·42	−1·73	−1·93	−0·38	+1·90	+3·48
Equinox ..	−2·31	−1·98	−1·92	−2·08	**−2·44**	−2·96	−3·72	**−4·39**	−3·47	−0·35	+3·90	+7·06
Summer ..	−1·47	−1·91	−2·32	−3·35	−4·80	−5·90	**−6·36**	−5·71	−3·69	−0·26	+3·89	+7·15

i.e., the 12 months combined, and for three 4-month seasons, viz., winter composed of January, February, November and December, equinox composed of March, April, September and October, and summer composed of May to August.

Inequality 1859

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+4·22	+3·77	+2·20	+1·19	+0·76	+0·36	−0·25	−1·16	−1·33	−1·65	**−1·92**	−1·65	January.
+5·97	**+6·03**	+4·63	+3·26	+1·81	+1·01	−0·02	−1·07	−1·88	−2·49	−2·59	−2·34	February.
+8·65	+8·45	+6·87	+4·18	+1·35	−0·42	−1·18	−1·49	−1·83	−2·40	−2·83	−3·09	March.
+9·91	+9·44	+6·61	+3·71	+0·84	−0·87	−1·24	−1·38	−1·69	−1·75	−1·98	−1·78	April.
+7·28	+6·32	+4·64	+2·67	+0·68	−0·23	−0·65	−0·62	−0·53	−0·59	−0·94	−1·11	May.
+7·13	+7·01	+5·77	+3·85	+1·60	+0·64	+0·05	+0·19	−0·07	−0·08	−0·15	−0·66	June.
+7·02	+7·00	+5·71	+4·04	+1·85	+0·85	+0·38	+0·10	−0·33	−0·42	−0·40	−0·88	July.
+9·10	+8·38	+6·26	+3·51	+0·92	−0·29	−0·38	−0·70	−0·86	−1·32	−1·18	−1·66	August.
+9·09	+7·92	+5·82	+3·17	+1·03	−0·26	−1·44	−2·00	−2·51	−3·06	−3·03	−2·67	September.
+7·36	+6·95	+4·88	+2·86	+1·28	+0·22	−0·37	−1·37	−2·06	−2·27	−2·79	−2·68	October.
+5·27	+4·87	+3·53	+2·40	+1·31	+0·52	−0·12	−1·11	−1·96	−2·09	−2·36	−2·07	November.
+4·37	+4·36	+3·25	+2·60	+1·80	+1·16	+0·49	−0·69	−1·99	−2·92	**−3·56**	−2·96	December.
+7·11	+6·71	+5·01	+3·12	+1·27	+0·22	−0·39	−0·94	−1·42	−1·75	−1·98	−1·96	Year.
+4·96	+4·76	+3·40	+2·36	+1·42	+0·76	+0·03	−1·01	−1·79	−2·29	**−2·61**	−2·25	Winter.
+8·75	+8·19	+6·04	+3·48	+1·13	−0·33	−1·06	−1·56	−2·02	−2·37	−2·66	−2·55	Equinox.
+7·63	+7·18	+5·60	+3·52	+1·26	+0·24	−0·15	−0·26	−0·45	−0·60	−0·67	−1·08	Summer.

Inequality 1860

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+4·38	+4·06	+3·20	+3·03	+1·55	+1·32	+0·57	−1·26	−2·11	−2·55	**−2·70**	−2·61	January.
+5·16	**+5·78**	+4·69	+2·89	+1·63	+0·87	+0·39	−0·52	−1·45	−2·18	−2·15	−2·20	February.
+8·87	+8·36	+6·23	+3·31	+1·34	−0·06	−1·08	−1·74	−2·21	−2·83	**−3·09**	−2·83	March.
+8·82	+7·87	+5·29	+3·01	+0·96	−0·26	−0·68	−1·06	−1·02	−1·79	−2·59	−2·45	April.
+7·66	+7·05	+5·25	+3·21	+1·40	−0·21	−0·57	−0·27	+0·30	−0·07	−0·67	−1·14	May.
+8·14	+7·77	+6·22	+4·00	+2·09	+0·53	+0·03	+0·29	+0·09	−0·03	−0·12	−0·77	June.
+8·10	+8·06	+6·39	+4·17	+2·03	+0·46	+0·27	+0·23	+0·14	−0·42	−0·97	−1·54	July.
+9·71	+8·77	+6·38	+3·22	+0·43	−0·63	−0·58	−0·77	−0·72	−1·01	−1·27	−1·73	August.
+8·23	+6·74	+4·60	+2·34	+0·66	+0·09	−0·27	−0·83	−1·25	−1·77	−1·72	−1·85	September.
+7·45	+6·69	+4·91	+2·79	+1·36	+0·28	−0·60	−1·25	−1·95	−2·14	−2·30	−2·12	October.
+4·97	+4·53	+3·65	+2·23	+1·24	+0·11	−0·53	−1·13	−1·68	−1·97	−1·93	−1·78	November.
+3·16	+2·85	+1·95	+1·32	+0·66	+0·20	−0·58	−1·22	−1·30	**−1·48**	−1·44	−1·39	December.
+7·05	+6·54	+4·90	+2·96	+1·28	+0·23	−0·30	−0·79	−1·10	−1·52	−1·75	−1·87	Year.
+4·42	+4·31	+3·37	+2·37	+1·27	+0·63	−0·04	−1·03	−1·04	−2·04	**−2·05**	−2·00	Winter.
+8·34	+7·42	+5·26	+2·86	+1·08	+0·01	−0·66	−1·22	−1·61	−2·13	−2·42	−2·31	Equinox.
+8·40	+7·91	+6·06	+3·65	+1·49	+0·04	−0·21	−0·13	−0·05	−0·38	−0·76	−1·29	Summer.

TABLE V—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−1·84	−1·28	−0·63	−0·18	−0·14	−0·17	−0·24	−0·43	−0·31	+0·54	+2·35	+3·32
February ..	−1·62	−1·02	−0·67	−0·13	−0·30	−0·59	−0·91	−1·57	−1·64	−0·51	+1·82	+3·62
March ..	−1·88	−1·65	−1·48	−1·50	−1·42	−1·31	−1·63	−1·57	−0·78	+0·75	+3·57	+5·19
April ..	−1·86	−1·70	−1·89	−1·98	−2·30	−2·72	−3·59	**−3·87**	−2·73	−0·42	+2·71	+5·72
May ..	−1·43	−1·27	−1·59	−2·16	−3·07	−3·49	−3·96	**−3·97**	−2·88	−0·52	+2·56	+4·70
June ..	−1·54	−1·48	−1·65	−2·32	−3·43	−4·01	**−4·47**	−4·16	−2·88	−0·78	+2·38	+4·33
July ..	−1·32	−1·46	−2·05	−2·42	−3·16	−3·63	**−3·92**	−3·62	−2·31	−0·37	+2·18	+4·63
August ..	−1·58	−1·74	−2·28	−1·97	−2·31	**−2·77**	**−2·77**	−2·54	−1·54	+0·38	+2·85	+5·07
September ..	−0·51	−0·63	−1·40	−1·41	−1·12	−1·30	−1·55	−1·51	−0·45	+0·93	+3·50	+4·85
October ..	−0·91	−0·79	−0·64	−0·65	−0·59	−0·36	−0·36	−0·58	−0·59	+0·73	+3·27	+4·71
November ..	−0·81	−0·01	+0·38	−0·54	+0·67	+0·36	+0·27	−0·11	+0·09	+1·11	+3·13	**+3·83**
December ..	−0·84	−0·30	−0·20	−0·08	−0·23	−0·31	−0·35	−0·11	−0·10	+0·59	+1·90	+2·57
Year ..	−1·35	−1·11	−1·17	−1·19	−1·45	−1·69	−1·96	−2·00	−1·34	+0·20	+2·68	+4·38
Winter ..	−1·28	−0·65	−0·28	+0·04	0·00	−0·18	−0·31	−0·56	−0·49	+0·43	+2·30	+3·33
Equinox ..	−1·29	−1·19	−1·35	−1·39	−1·36	−1·42	−1·78	−1·88	−1·14	+0·50	+3·26	+5·12
Summer ..	−1·47	−1·49	−1·89	−2·22	−2·99	−3·47	**−3·78**	−3·57	−2·40	−0·32	+2·49	+4·68

TABLE VI—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−0·41	−0·02	−0·27	−0·09	−0·23	−0·28	−0·53	−0·89	−0·68	+0·36	+1·72	+2·87
February ..	−0·81	−0·55	−0·35	−0·44	−0·48	−0·80	−1·06	−1·61	−1·84	−0·63	+1·50	+3·40
March ..	−0·82	−0·73	−0·62	−0·82	−1·27	−1·40	−2·09	**−2·80**	−2·46	−0·62	+2·02	+4·40
April ..	−1·24	−1·17	−1·45	−1·68	−2·17	−2·84	−3·50	**−3·86**	−2·92	−0·57	+2·57	+5·00
May ..	−1·02	−1·91	−1·03	−2·20	−2·98	−3·54	**−3·79**	−3·27	−1·88	+0·41	+3·30	+5·01
June ..	−1·47	−1·51	−1·68	−2·51	−3·30	−3·55	−3·73	**−3·95**	−2·90	−0·63	+2·63	+4·58
July ..	−1·40	−1·13	−1·50	−2·46	−3·52	−3·92	**−3·96**	−3·70	−2·40	−0·16	+2·57	+4·43
August ..	−1·64	−1·49	−1·63	−2·25	−2·60	−3·13	**−3·17**	−2·71	−1·45	+0·29	+3·50	+5·97
September	−1·13	−1·08	−1·23	−0·92	−0·61	−1·12	−1·89	−2·16	−1·16	+0·39	+3·58	+5·43
October ..	−1·60	−1·56	−1·10	−0·93	−0·63	−0·17	−0·30	−0·48	−0·14	+1·29	+3·73	**+5·09**
November ..	−0·69	−0·21	−0·11	−0·21	−0·32	−0·36	−0·39	−0·54	−0·33	+0·66	+2·49	**+3·71**
December ..	−0·62	−0·17	−0·03	+0·01	−0·28	−0·51	−0·45	−0·24	−0·20	+0·34	+1·57	+2·43
Year ..	−1·15	−0·96	−0·99	−1·21	−1·53	−1·80	−2·07	**−2·18**	−1·53	+0·09	+2·60	+4·36
Winter ..	−0·63	−0·24	−0·19	−0·18	−0·33	−0·49	−0·61	−0·82	−0·76	+0·18	+1·82	+3·10
Equinox ..	−1·20	−1·14	−1·10	−1·09	−1·17	−1·38	−1·95	**−2·33**	−1·67	+0·12	+2·98	+4·98
Summer ..	−1·61	−1·51	−1·68	−2·35	−3·10	−3·53	**−3·66**	−3·41	−2·16	−0·02	+3·00	+5·00

Inequality 1866

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+3·88	+3·30	+1·91	+0·75	+0·36	−0·14	−0·66	−1·38	−1·97	−2·29	**−2·43**	−2·34	January.
+4·98	**+5·09**	+4·16	+2·39	+1·10	+0·24	−0·49	−1·59	−2·74	−3·18	**−3·44**	−2·94	February.
+5·88	+5·40	+3·96	+2·12	+0·17	−0·85	−1·64	−2·21	**−2·47**	−2·42	−2·23	−1·95	March.
+7·21	+6·61	+5·00	+3·39	+1·60	+0·02	−0·78	−1·15	−1·54	−1·78	−1·87	−1·98	April.
+5·67	**+5·67**	+5·00	+3·82	+2·38	+0·93	−0·02	−0·61	−1·08	−1·51	−1·61	−1·66	May.
+5·27	**+5·50**	+4·91	+3·82	+2·55	+1·29	+0·38	−0·02	−0·48	−0·69	−1·07	−1·42	June.
+5·64	+5·61	+4·58	+3·22	+1·96	+1·22	+0·61	−0·13	−0·87	−1·46	−1·58	−1·41	July.
+6·12	+5·49	+3·93	+2·38	+0·95	+0·16	−0·59	−0·97	−1·33	−1·60	−1·57	−1·73	August.
+5·28	+4·10	+2·35	+1·29	+0·10	−1·04	−2·04	**−2·48**	−2·23	−1·97	−1·77	−0·98	September.
+4·89	+4·42	+2·45	+0·60	−0·76	−1·84	−2·27	−2·58	**−2·65**	−2·36	−1·94	−1·13	October.
+3·73	+2·95	+1·76	+0·38	+0·04	−1·02	−1·92	−2·86	−3·65	**−3·96**	−3·08	−1·81	November.
+2·93	+2·48	+1·76	+1·22	+0·49	−0·28	−1·39	−2·00	**−2·25**	−2·18	−1·86	−1·37	December.
+5·12	+4·72	+3·48	+2·11	+0·91	−0·11	−0·90	−1·50	−1·94	**−2·12**	−2·04	−1·73	Year.
+3·88	+3·45	+2·40	+1·18	+0·50	−0·30	−1·12	−1·96	−2·65	**−2·90**	−2·70	−2·12	Winter.
+5·81	+5·13	+3·44	+1·85	+0·28	−0·93	−1·68	−2·11	**−2·22**	−2·13	−1·95	−1·51	Equinox.
+5·68	+5·57	+4·61	+3·31	+1·96	+0·90	+0·10	−0·43	−0·94	−1·32	−1·46	−1·55	Summer.

Inequality 1867

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+3·07	+2·18	+1·06	+0·57	+0·29	+0·16	−0·64	−1·57	**−1·89**	−1·69	−1·70	−1·28	January.
+3·99	+3·79	+2·52	+0·89	+0·32	+0·31	−0·21	−1·11	−1·75	**−1·92**	−1·73	−1·39	February.
+5·84	+5·45	+4·27	+2·62	+0·98	−0·75	−1·70	−1·81	−1·98	−2·23	−1·95	−1·45	March.
+6·39	+6·00	+4·28	+2·70	+1·24	+0·24	−0·24	−0·66	−1·32	−1·44	−1·76	−1·59	April.
+5·74	+5·16	+3·97	+2·90	+1·91	+1·00	−0·08	−0·63	−0·60	−0·92	−1·67	−2·13	May.
+5·44	+5·30	+4·31	+3·05	+2·08	+1·21	+0·48	−0·23	−0·53	−0·94	−0·97	−1·18	June.
+5·50	**+5·69**	+4·79	+3·46	+2·19	+1·08	+0·41	+0·03	−0·80	−1·50	−1·84	−1·86	July.
+6·86	+5·79	+4·12	+2·66	+1·03	−0·08	−1·28	−2·09	−1·79	−1·69	−1·62	−1·66	August.
+5·96	+4·75	+3·53	+1·69	+0·07	−1·24	−1·89	−2·30	**−2·48**	−2·40	−2·04	−1·72	September.
+4·95	+3·74	+1·96	+0·69	−0·06	−1·03	−1·87	−2·20	−2·42	**−2·51**	−2·51	−2·04	October.
+3·66	+2·80	+1·68	+0·78	+0·31	−0·26	−1·32	−2·46	**−2·79**	−2·56	−2·11	−1·53	November.
+2·49	+1·72	+1·10	+0·58	+0·23	−0·22	−0·43	−1·14	−1·67	**−1·88**	−1·55	−1·17	December.
+4·99	+4·36	+3·13	+1·88	+0·88	+0·04	−0·73	−1·35	−1·67	−1·81	−1·79	−1·58	Year.
+3·30	+2·62	+1·59	+0·71	+0·29	0·00	−0·65	−1·57	**−2·02**	−2·01	−1·77	−1·34	Winter.
+5·79	+4·99	+3·51	+1·93	+0·56	−0·70	−1·43	−1·74	−2·05	−2·15	−2·06	−1·70	Equinox.
+5·89	+5·49	+4·30	+3·02	+1·80	+0·80	−0·12	−0·73	−0·93	−1·26	−1·52	−1·71	Summer.

TABLE VII—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−2·20	−1·91	−1·89	−1·78	−1·70	−1·52	−1·22	−1·15	−0·84	+0·32	+1·94	+3·32
February ..	−1·90	−1·79	−1·82	−2·13	−2·13	−1·96	−2·05	−2·49	−1·93	−0·01	+2·87	+4·81
March ..	−3·24	−3·69	−3·12	−3·05	−3·18	−3·19	−3·80	**−4·12**	−3·17	−0·20	+4·24	+7·48
April ..	−2·58	−2·06	−2·66	−2·91	−3·35	−4·12	−5·70	**−6·26**	−4·75	−1·58	+3·62	+7·96
May ..	−1·70	−1·99	−2·42	−3·35	−4·99	−6·39	**−6·96**	−6·51	−4·36	−0·63	+3·81	+7·31
June ..	−1·35	−1·55	−2·09	−3·20	−5·05	−6·67	**−7·15**	−6·92	−5·02	−1·09	+3·61	+6·71
July ..	−1·40	−1·89	−2·21	−3·42	−5·48	−6·90	**−7·36**	−6·88	−4·66	−1·01	+3·31	+6·83
August ..	−2·50	−2·49	−3·00	−3·78	−5·09	−6·28	**−6·59**	−5·41	−2·96	+0·62	+4·87	+8·44
September ..	−2·47	−2·41	−2·76	−3·13	−3·41	−3·76	−4·62	**−4·65**	−2·89	+0·58	+5·25	+8·43
October ..	−2·04	−2·03	−2·14	−2·00	−1·93	−2·12	−3·13	−4·52	**−4·54**	−2·11	+2·87	+6·29
November ..	−2·74	−2·48	−2·49	−2·03	−1·89	−2·09	−2·47	−3·00	−2·69	−0·31	+2·76	+5·52
December ..	−1·87	−1·66	−1·54	−1·56	−1·54	−1·40	−1·17	−1·30	−1·20	+0·11	+1·69	+3·05
Year ..	−2·17	−2·16	−2·35	−2·70	−3·31	−3·87	−4·35	**−4·44**	−3·25	−0·44	+3·40	+6·35
Winter ..	−2·18	−1·96	−1·94	−1·88	−1·81	−1·74	−1·73	−2·01	−1·66	+0·03	+2·31	+4·18
Equinox ..	−2·58	−2·55	−2·67	−2·77	−2·97	−3·30	−4·31	**−4·89**	−3·84	−0·83	+3·99	+7·54
Summer ..	−1·74	−1·98	−2·43	−3·44	−5·15	−6·56	**−7·01**	−6·43	−4·25	−0·53	+3·90	+7·32

TABLE VIII—DIURNAL

	1h.	2h.	3h	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−1·82	−1·56	−1·31	−1·22	−1·16	−1·01	−1·22	−1·82	−1·70	+0·10	+2·01	+3·58
February ..	−2·78	−2·59	−2·22	−1·95	−1·84	−2·00	−2·29	**−2·92**	−2·65	−0·99	+1·56	+4·33
March ..	−3·96	−3·97	−3·52	−2·95	−2·46	−2·81	−4·01	**−4·95**	−4·37	−1·12	+3·49	+7·32
April ..	−2·68	−3·03	−3·11	−3·51	−3·86	−4·81	−6·34	**−6·75**	−5·27	−1·42	+3·79	+8·34
May ..	−1·09	−1·06	−2·44	−3·53	−4·47	−5·51	−6·43	**−6·65**	−4·97	−1·67	+2·97	+6·74
June ..	−1·01	−1·61	−2·35	−3·66	−5·09	−6·20	**−7·20**	−7·19	−5·17	−1·43	+3·40	+6·46
July ..	−1·40	−1·99	−3·01	−4·07	−5·28	−6·30	**−6·53**	−5·91	−4·32	−1·18	+3·01	+6·48
August ..	−2·17	−2·48	−2·74	−3·56	−4·84	−6·21	**−6·66**	−5·95	−3·53	−0·26	+4·04	+7·91
September ..	−3·30	−3·29	−3·19	−3·22	−2·92	−3·32	−4·07	**−4·20**	−2·72	+0·80	+4·95	+8·07
October ..	−2·50	−2·35	−2·20	−2·18	−2·06	−2·08	−2·72	**−3·73**	−2·94	+0·09	+3·25	+6·39
November ..	−2·30	−1·37	−1·07	−1·19	−0·86	−0·89	−0·92	−1·55	−1·54	+0·39	+2·99	+5·03
December ..	−2·12	−1·85	−1·70	−1·57	−1·24	−1·18	−0·90	−1·06	−1·16	+0·07	+2·39	+4·07
Year ..	−2·26	−2·26	−2·42	−2·72	−3·01	−3·53	−4·11	**−4·39**	−3·30	−0·55	+3·15	+6·23
Winter ..	−2·26	−1·84	−1·58	−1·48	−1·28	−1·27	−1·33	−1·84	−1·76	−0·11	+2·24	+4·25
Equinox ..	−3·11	−3·16	−3·00	−2·97	−2·83	−3·26	−4·28	**−4·91**	−3·83	−0·41	+3·87	+7·53
Summer ..	−1·42	−1·79	−2·63	−3·70	−4·92	−6·07	**−6·70**	−6·42	−4·50	−1·13	+3·36	+6·90

Inequality 1870

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+ **4·31**	+4·11	+3·37	+2·67	+2·04	+1·06	+0·08	−0·66	−1·54	−2·14	−2·36	**−2·43**	January.
+ **5·93**	+5·75	+4·39	+2·44	+1·63	+0·79	+0·13	−0·85	−2·12	**−2·77**	−2·68	−2·09	February.
+ **8·89**	+8·49	+6·54	+3·78	+1·70	+0·91	+0·04	−0·49	−1·56	−2·30	−3·12	−3·73	March.
+10·13	+9·48	+6·90	+4·07	+1·83	+0·10	−0·13	−0·26	−0·56	−1·38	−2·58	−3·15	April.
+ **8·82**	+8·58	+6·67	+4·30	+2·17	+0·53	+0·08	−0·09	−0·24	−0·49	−0·87	−1·25	May
+ **7·90**	+7·89	+6·59	+4·36	+2·57	+1·12	+0·53	+0·22	+0·13	−0·07	−0·55	−0·92	June.
+ **8·43**	+8·40	+6·67	+4·54	+2·43	+0·83	+0·16	+0·20	+0·33	+0·17	−0·21	−0·78	July.
+ **9·90**	+9·38	+6·85	+3·85	+1·46	−0·21	−0·30	−0·61	−1·04	−1·31	−1·72	−1·99	August.
+ **9·18**	+7·72	+5·01	+2·47	+0·66	−0·13	−0·53	−0·57	−1·27	−2·03	−2·29	−2·50	September.
+ **7·56**	+7·21	+5·54	+3·30	+1·81	+0·58	−0·29	−1·04	−1·31	−1·71	−1·95	−2·35	October.
+ **6·23**	+5·67	+4·65	+3·53	+2·75	+1·85	+0·90	−0·41	−1·87	−2·95	**−3·29**	−3·04	November.
+ 4·10	**+4·11**	+3·23	+2·41	+2·06	+1·75	+0·66	−0·59	−1·78	−2·47	**−2·62**	−2·32	December.
+ **7·61**	+7·23	+5·53	+3·48	+1·93	+0·76	+0·11	−0·43	−1·07	−1·62	−2·02	−2·21	Year.
+ **5·14**	+4·91	+3·91	+2·76	+2·12	+1·36	+0·44	−0·63	−1·83	−2·58	**−2·74**	−2·47	Winter.
+ **8·94**	+8·22	+6·00	+3·41	+1·50	+0·36	−0·23	−0·59	−1·17	−1·85	−2·48	−2·93	Equinox.
+ **8·76**	+8·56	+6·69	+4·26	+2·16	+0·57	+0·12	−0·07	−0·21	−0·43	−0·84	−1·23	Summer.

Inequality 1871

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+ 4·40	**+4·44**	+3·20	+2·08	+1·58	+1·15	+0·35	−0·55	−1·59	−2·53	**−2·92**	−2·41	January.
+ 5·97	**+6·33**	+5·38	+3·65	+2·50	+1·61	+0·52	−0·53	−1·44	−2·14	−2·51	−2·91	February.
+ **9·22**	+8·91	+6·95	+4·54	+2·27	+1·21	+0·27	−0·57	−1·31	−2·14	−2·63	−3·48	March.
+10·56	+9·79	+7·72	+5·00	+2·42	+0·71	−0·46	−1·09	−1·42	−1·27	−1·08	−2·16	April.
+ **8·28**	+7·77	+6·21	+4·09	+2·15	+0·73	+0·16	+0·23	+0·11	−0·40	−0·56	−0·74	May.
+ **8·22**	+8·20	+6·71	+4·86	+2·96	+1·25	+0·26	+0·11	+0·15	−0·39	−0·59	−0·80	June.
+ 7·90	**+7·93**	+6·92	+5·21	+3·33	+1·62	+0·25	+0·08	−0·38	−0·43	−0·67	−1·09	July.
+ **9·83**	+9·59	+7·35	+4·79	+2·35	+0·28	−0·54	−0·95	−1·38	−1·53	−1·55	−1·86	August.
+ **8·79**	+7·73	+5·83	+3·61	+1·77	+0·18	−0·79	−1·25	−1·59	−2·22	−2·60	−2·99	September.
+ **7·64**	+7·07	+5·50	+3·38	+1·86	+0·78	−0·54	−1·49	−2·47	−3·18	−2·92	−2·56	October.
+ **5·98**	+5·48	+4·00	+2·53	+1·43	+0·37	−0·63	−1·77	−3·10	−3·74	**−3·79**	−3·38	November.
+ **4·79**	+4·36	+3·64	+2·15	+1·49	+0·96	+0·20	−1·03	−2·17	**−2·77**	−2·70	−2·63	December.
+ **7·63**	+7·30	+5·78	+3·82	+2·18	+0·90	−0·08	−0·73	−1·38	−1·90	−2·04	−2·25	Year.
+ **5·28**	+5·15	+4·05	+2·60	+1·75	+1·02	+0·11	−0·97	−2·08	−2·80	**−2·98**	−2·83	Winter.
+ **9·05**	+8·37	+6·50	+4·13	+2·08	+0·72	−0·38	−1·10	−1·70	−2·20	−2·31	−2·80	Equinox.
+ **8·56**	+8·37	+6·80	+4·74	+2·70	+0·97	+0·03	−0·03	−0·37	−0·69	−0·84	−1·12	Summer.

TABLE IX—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−2·19	−1·79	−1·60	−1·49	−1·53	−1·26	−1·14	−1·40	−1·57	−0·61	+1·65	+4·08
February ..	−2·60	−2·26	−1·81	−1·38	−1·23	−1·26	−1·61	−2·16	−2·28	−0·87	+1·84	+4·23
March ..	−3·07	−3·11	−3·40	−2·70	−2·84	−3·44	**−4·37**	−4·28	−2·84	+0·61	+4·66	+7·61
April ..	−2·01	−2·05	−2·50	−2·45	−2·85	−3·86	−5·35	**−5·91**	−4·71	−1·11	+3·29	+7·51
May ..	−1·48	−1·84	−2·45	−3·28	−4·51	−5·53	**−5·85**	−5·47	−3·92	−0·63	+3·35	+6·52
June ..	−1·84	−2·03	−2·39	−2·91	−4·29	−5·67	**−6·67**	−6·36	−4·45	−0·85	+3·24	+6·61
July ..	−1·77	−1·96	−2·61	−3·30	−4·26	−5·38	**−5·68**	−5·52	−4·04	−1·09	+2·65	+5·99
August ..	−1·79	−2·12	−2·78	−3·40	−4·54	−5·78	**−6·19**	−5·56	−3·35	+0·52	+4·24	+7·80
September ..	−2·03	−1·97	−2·38	−2·42	−2·21	−3·12	−4·30	**−4·81**	−3·40	+0·08	+4·32	+7·33
October ..	−3·19	−3·10	−2·29	−1·54	−1·07	−1·57	−2·24	**−3·24**	−2·75	−0·51	+3·52	+6·35
November ..	−2·25	−1·90	−1·50	−1·08	−0·74	−0·85	−0·88	−1·27	−1·11	+0·65	+3·13	+4·85
December ..	−2·06	−1·55	−1·37	−0·94	−0·62	−0·38	−0·50	−0·27	+0·22	+1·46	+2·35	+3·21
Year ..	−2·19	−2·14	−2·26	−2·24	−2·56	−3·17	−3·73	**−3·85**	−2·85	−0·20	+3·19	+6·01
Winter ..	−2·27	−1·87	−1·57	−1·22	−1·03	−0·94	−1·03	−1·27	−1·18	+0·16	+2·24	+4·09
Equinox ..	−2·57	−2·56	−2·64	−2·28	−2·24	−3·00	−4·06	**−4·56**	−3·42	−0·23	+3·95	+7·20
Summer ..	−1·72	−1·99	−2·56	−3·22	−4·40	−5·59	**−6·10**	−5·73	−3·94	−0·51	+3·37	+6·73

TABLE X—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−0·68	−0·40	−0·31	−0·33	−0·49	−0·52	−0·65	−0·63	−0·04	+0·65	+1·60	+2·23
February ..	−0·48	−0·38	−0·52	−0·47	−0·63	−0·80	−1·01	−1·03	−0·59	+0·34	+1·81	+2·05
March ..	−0·71	−0·64	−0·71	−0·80	−0·93	−1·27	−1·79	**−2·66**	−2·24	−0·48	+1·81	+3·73
April ..	−0·83	−0·98	−1·18	−1·41	−1·64	−2·21	−3·08	**−3·75**	−3·13	−1·09	+1·37	+3·78
May ..	−0·80	−0·83	−0·95	−1·31	−2·29	−3·03	**−3·45**	−3·41	−2·66	−0·32	+2·12	+3·76
June ..	−0·75	−1·09	−1·33	−2·03	−3·15	−4·03	**−4·47**	−4·30	−2·96	−0·56	+2·39	+4·47
July ..	−0·96	−0·98	−1·25	−1·81	−2·76	−3·01	−3·44	**−3·65**	−3·05	−1·19	1·70	3·97
August ..	−1·46	−1·51	−1·60	−1·85	−2·48	−2·89	**−3·43**	−3·20	−1·78	+0·52	+3·23	+5·11
September ..	−1·21	−1·19	−1·49	−1·30	−1·59	−2·09	−2·76	**−2·85**	−1·74	+0·46	+3·30	+5·35
October ..	−0·93	−0·89	−0·94	−0·89	−0·82	−0·98	−1·33	**−1·71**	−1·29	+0·28	+2·56	+3·98
November ..	−0·69	−0·33	−0·29	−0·40	−0·43	−0·58	−0·60	−0·76	−0·62	+0·37	1·51	**2·22**
December ..	−0·50	−0·06	0·00	−0·11	−0·21	−0·28	−0·30	−0·10	+0·46	+1·22	+1·48	+1·91
Year ..	−0·83	−0·77	−0·88	−1·06	−1·45	−1·81	−2·19	**−2·34**	−1·64	+0·02	+2·07	+3·00
Winter ..	−0·59	−0·29	−0·28	−0·33	−0·44	−0·55	−0·64	−0·63	−0·20	+0·65	+1·60	+2·33
Equinox ..	−0·92	−0·92	−1·08	−1·10	−1·24	−1·64	−2·24	**−2·71**	−2·10	−0·21	+2·26	+4·14
Summer ..	−0·99	−1·10	−1·28	−1·75	−2·67	−3·24	**−3·70**	−3·64	−2·61	−0·30	+2·36	+4·33

INEQUALITY 1872

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+5·18	**+5·77**	+4·15	+2·75	+1·82	+1·19	+0·14	−1·29	−2·43	**−2·97**	−2·91	−2·65	January.
+5·80	**+5·99**	+4·61	+2·77	+1·71	+1·14	+0·40	−0·57	−1·81	−2·61	**−3·10**	−3·02	February.
+8·94	+8·35	+6·30	+3·93	+2·04	+0·61	−0·52	−1·40	−2·22	−2·77	−3·13	−2·97	March.
+9·40	+8·94	+6·76	+4·43	+2·00	+0·37	−0·88	−1·67	−1·84	−1·66	−1·85	−1·98	April.
+7·59	+7·49	+6·46	+4·51	+2·34	+0·67	−0·17	−0·27	−0·35	−0·70	−1·13	−1·40	May.
+8·11	+8·10	+6·89	+5·28	+2·95	+1·21	−0·13	−0·53	−0·64	−0·87	−1·09	−1·56	June.
+7·67	+7·87	+6·51	+4·77	+2·63	+0·91	+0·07	−0·19	−0·46	−0·45	−0·86	−1·54	July.
+8·88	+8·27	+6·08	+3·51	+1·24	+0·14	−0·13	−0·22	−0·64	−1·10	−1·55	−1·60	August.
+8·71	+7·88	+5·51	+3·19	+1·33	+0·14	−0·99	−1·47	−2·17	−2·39	−2·51	−2·40	September.
+7·14	+6·74	+4·83	+2·94	+1·41	+0·65	+0·11	−1·03	−2·19	−2·90	−3·18	−2·88	October.
+5·46	+5·13	+3·73	+2·65	+1·14	+0·20	−1·44	−2·18	−3·23	**−3·30**	−2·88	−2·35	November.
+3·52	+3·42	+2·55	+1·97	+1·09	+0·53	−0·24	−1·19	−2·41	**−3·06**	−3·03	−2·70	December.
+7·20	+7·00	+5·37	+3·56	+1·81	+0·65	−0·32	−1·00	−1·70	−2·06	−2·27	−2·25	Year.
+4·99	**+5·08**	+3·76	+2·54	+1·44	+0·77	−0·28	−1·31	−2·47	**−2·98**	**−2·98**	−2·68	Winter.
+8·55	+7·98	+5·85	+3·62	+1·69	+0·44	−0·57	−1·39	−2·10	−2·43	−2·67	−2·56	Equinox.
+8·06	+7·93	+6·49	+4·52	+2·29	+0·73	−0·09	−0·30	−0·52	−0·78	−1·16	−1·52	Summer.

INEQUALITY 1878

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+2·32	+1·35	+0·40	+0·32	+0·18	−0·01	−0·27	−0·65	**−1·10**	−1·08	−1·01	−6·90	January.
+3·45	+2·95	+1·46	+0·38	+0·03	−0·24	−0·67	−1·29	**−1·61**	−1·44	−1·26	−0·87	February.
+4·76	+4·23	+2·72	+0·98	+0·03	−0·30	−0·72	−0·89	−0·95	−0·76	−1·28	−1·04	March.
+5·34	+5·23	+3·95	+2·70	+1·49	+0·35	−0·47	−0·66	−0·65	−1·01	−1·21	−0·99	April.
+4·50	+4·44	+3·41	+2·30	+1·17	+0·39	−0·16	−0·32	−0·49	−0·74	−0·69	−0·76	May.
+5·44	**+5·79**	+4·73	+2·96	+1·29	+0·19	−0·34	−0·41	−0·36	−0·38	−0·51	−0·66	June.
+5·18	+5·03	+3·87	+2·56	+1·27	+·078	+0·18	−0·10	−0·39	−0·51	−0·55	−0·82	July.
+5·92	+5·29	+3·82	+2·10	+0·76	−0·27	−0·52	−0·84	−1·11	−1·19	−1·22	−1·31	August.
+5·45	+4·25	+2·37	+1·20	+0·55	+0·35	−0·30	−1·10	−1·47	−1·65	−1·34	−1·31	September.
+3·82	+3·17	+1·66	+0·45	+0·28	−0·06	−0·55	−0·67	−1·13	−1·28	−1·27	−1·14	October.
+2·21	+1·67	+1·03	+0·91	+0·72	+0·05	−0·44	−0·79	−1·04	**−1·39**	−1·30	−1·05	November.
+1·92	+1·25	+0·67	+0·43	−0·09	−0·48	−1·04	−1·38	**−1·48**	−1·36	−1·13	−0·81	December.
+4·19	+3·72	+2·51	+1·44	+0·64	+0·06	−0·44	−0·76	−0·98	−1·07	−1·06	−0·97	Year.
+2·47	+1·80	+0·89	+0·51	+0·21	−0·17	−0·60	−1·03	−1·31	**−1·32**	−1·17	−0·91	Winter.
+4·84	+4·22	+2·68	+1·33	+0·59	+0·09	−0·51	−0·83	−1·05	−1·18	−1·27	−1·12	Equinox.
+5·26	+5·14	+3·96	+2·48	+1·12	+0·27	−0·21	−0·42	−0·59	−0·70	−0·74	−0·89	Summer.

TABLE XI—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−0·81	−0·60	−0·30	−0·20	−0·29	−0·40	−0·42	−0·72	−0·52	+0·40	+1·30	+2·22
February ..	−0·62	−0·54	−0·64	−0·61	−0·70	−0·76	−1·00	−1·39	−1·23	−0·34	+1·44	+2·75
March ..	−0·97	−0·93	−0·88	−0·88	−0·99	−1·35	−1·86	**−2·47**	−2·20	−0·79	+1·68	+3·97
April ..	−0·46	−0·56	−0·87	−1·12	−1·63	−2·09	−3·24	**−3·75**	−2·62	−0·67	+1·95	+4·22
May ..	−0·88	−1·02	−1·05	−1·60	−2·34	−2·84	**−3·78**	−3·74	−2·56	−0·46	+2·25	+4·40
June ..	−0·70	−0·93	−1·25	−2·28	−3·15	−3·77	**−4·16**	−4·09	−2·77	−0·66	+2·17	+4·27
July ..	−0·66	−0·87	−1·01	−1·77	−3·00	−3·54	**−3·81**	−3·72	−2·84	−0·90	+1·85	+4·28
August ..	−1·14	−1·38	−1·54	−1·83	−2·66	−3·41	**−3·97**	−3·76	−2·11	+0·24	+3·20	+5·52
September ..	−1·35	−1·52	−1·68	−1·76	−1·71	−1·97	−2·48	**−2·57**	−1·56	+0·54	+2·83	+4·63
October ..	−0·93	−0·80	−0·91	−0·92	−0·87	−0·96	−1·51	**−2·15**	−1·93	−0·23	+2·49	+4·01
November	−0·77	−0·42	−0·17	−0·22	−0·36	−0·47	−0·69	−0·93	−0·89	+0·01	+1·73	+2·71
December ..	−0·79	−0·33	−0·11	0·00	−0·01	−0·17	−0·31	−0·46	−0·48	+0·10	+1·13	+1·81
Year ..	−0·84	−0·82	−0·87	−1·10	**−1·48**	−1·81	−2·27	**−2·48**	−1·81	−0·23	+2·00	+3·73
Winter ..	−0·75	−0·47	−0·30	−0·26	−0·34	−0·45	−0·60	−0·87	−0·78	+0·04	+1·40	+2·37
Equinox ..	−0·93	−0·95	−1·09	−1·17	−1·30	−1·59	−2·27	**−2·74**	−2·08	−0·29	+2·24	+4·21
Summer ..	−0·85	−1·05	−1·21	−1·87	−2·79	−3·39	**−3·93**	−3·83	−2·57	−0·45	+2·37	+4·62

TABLE XII—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−1·03	−0·94	−0·44	−0·56	−0·81	−0·94	−1·11	−1·19	−0·69	+0·58	+1·68	+2·69
February ..	−1·33	−1·12	−0·78	−0·86	−1·05	−1·21	−1·38	−1·69	−1·99	−0·92	+0·91	+2·75
March ..	−1·49	−1·12	−2·31	−1·89	−1·19	−1·26	−1·37	−2·88	**−3·31**	−1·77	+1·20	+4·10
April ..	−0·74	−0·88	−1·35	−1·61	−2·23	−2·49	−3·57	**−4·77**	−4·38	−2·04	+1·32	+4·87
May ..	−1·21	−1·53	−1·24	−1·86	−2·83	−3·88	**−4·31**	**−4·31**	−3·15	−0·36	+2·70	+5·22
June ..	−0·96	−1·30	−1·51	−2·94	−4·46	−5·04	**−5·13**	−4·89	−3·40	−0·68	+2·67	+5·23
July ..	−1·59	−1·83	−2·62	−2·87	−3·73	−4·97	**−5·01**	−4·67	−3·54	−1·16	+1·98	+4·85
August ..	−1·01	−1·03	−1·37	−2·12	−2·80	−3·65	**−4·27**	−4·23	−2·87	−0·74	+2·39	+5·06
September ..	−1·74	−1·62	−1·59	−1·87	−2·48	−2·83	−3·61	**−4·05**	−3·36	−0·57	+2·97	+6·03
October ..	−1·37	−1·18	−0·94	−1·01	−0·96	−1·36	−2·37	−3·96	**−3·99**	−1·72	+2·26	+5·03
November ..	−1·38	−0·95	−0·80	−0·72	−0·74	−1·07	−1·47	**−2·13**	−2·10	−0·31	+2·07	+3·54
December ..	−1·57	−1·16	−0·99	−1·03	−0·71	−0·56	−0·64	−0·93	−0·69	+0·43	+1·69	+2·75
Year ..	−1·29	−1·22	−1·33	−1·61	−2·00	−2·44	−2·85	**−3·31**	−2·79	−0·77	+1·99	+4·34
Winter ..	−1·33	−1·04	−0·75	−0·79	−0·83	−0·94	−1·15	−1·48	−1·37	−0·06	+1·59	+2·93
Equinox ..	−1·33	−1·20	−1·55	−1·60	−1·71	−1·98	−2·73	**−3·91**	−3·76	−1·52	+1·94	+5·01
Summer ..	−1·19	−1·42	−1·69	−2·45	−3·45	−4·39	**−4·68**	−4·52	−3·26	−0·73	+2·44	+5·09

Inequality 1879

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+2·59	+2·05	+0·91	+0·45	+0·38	+0·11	−0·29	−0·88	−1·25	**−1·31**	−1·30	−1·19	January.
+3·39	+3·08	+1·77	+0·55	+0·30	+0·12	−0·37	−0·79	−1·21	**−1·40**	−1·06	−0·78	February.
+5·18	+4·70	+3·24	+1·78	+0·71	+0·05	−0·72	−1·32	−1·44	−1·75	−1·59	−1·15	March.
+5·24	+4·43	+2·66	+1·40	+0·57	−0·07	−0·31	−0·48	−0·55	−0·66	−0·71	−0·66	April.
+4·93	+4·53	+3·37	+2·16	+1·00	+0·26	−0·19	−0·44	−0·32	−0·48	−0·55	−0·74	May.
+5·15	+5·09	+4·32	+3·06	+1·56	+0·51	−0·09	−0·43	−0·47	−0·49	−0·33	−0·49	June.
+5·18	+4·91	+3·59	+1·92	+0·99	+0·26	0·00	−0·09	−0·01	−0·13	−0·14	−0·50	July.
+6·37	+5·54	+3·64	+1·86	+0·48	−0·18	−0·12	−0·38	−0·67	−1·15	−1·26	−1·22	August.
+5·26	+4·39	+2·65	+1·13	+0·54	+0·08	−0·25	−0·59	−0·95	−1·19	−1·11	−1·29	September.
+4·30	+3·59	+2·22	+1·08	+0·56	−0·07	−0·71	−1·00	−1·26	−1·51	−1·25	−1·14	October.
+2·81	+2·01	+1·10	+0·69	+0·51	−0·01	−0·41	−1·04	**−1·45**	−1·40	−1·29	−1·11	November.
+2·15	+1·60	+0·94	+0·84	+0·74	+0·38	−0·36	−0·93	−1·41	**−1·64**	−1·51	−1·20	December.
+4·38	+3·83	+2·53	+1·41	+0·70	+0·12	−0·32	−0·70	−0·92	−1·09	−1·01	−0·96	Year.
+2·74	+2·19	+1·18	+0·63	+0·48	+0·15	−0·36	−0·91	−1·33	**−1·44**	−1·29	−1·07	Winter.
+4·99	+4·28	+2·69	+1·35	+0·59	0·00	−0·50	−0·85	−1·05	−1·28	−1·17	−1·06	Equinox.
+5·41	+5·02	+3·73	+2·25	+1·01	+0·21	−0·10	−0·34	−0·37	−0·56	−0·57	−0·74	Summer.

Inequality 1883

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+3·27	+3·11	+2·11	+0·68	+1·24	+0·88	−0·64	−0·81	−1·84	**−2·11**	−1·67	−1·58	January.
+4·37	**+4·58**	+3·59	+2·30	+0·65	+0·62	+0·79	+0·20	−1·18	**−2·56**	−2·48	−2·30	February.
+5·93	**+6·26**	+5·12	+2·99	+1·86	+0·10	−0·52	−1·52	−1·09	−1·83	−2·00	−1·90	March.
+6·77	**+6·97**	+5·17	+3·68	+1·65	+0·49	−0·93	−0·90	−0·89	−1·21	−1·66	−1·39	April.
+6·10	+5·56	+4·30	+2·73	+1·26	+0·03	−0·29	−0·69	−0·39	−0·39	−0·95	−0·58	May.
+6·25	**+6·42**	+5·62	+4·31	+2·52	+1·09	+0·12	−0·57	−0·78	−0·76	−0·69	−0·96	June.
+7·27	**+7·64**	+6·54	+3·76	+2·56	+0·92	−0·05	−0·32	−0·50	−0·45	−0·85	−1·32	July.
+6·62	+6·07	+4·87	+2·78	+1·27	+0·28	+0·07	−0·29	−1·03	−1·26	−1·15	−1·67	August.
+7·49	+6·86	+4·85	+2·40	+0·81	+0·18	−0·29	−1·52	−1·66	−1·88	−1·43	**−1·19**	September.
+6·16	+5·74	+4·18	+1·78	+0·75	+0·25	−0·47	−1·20	−1·34	−1·56	−1·32	−1·39	October.
+3·86	+3·32	+2·38	+1·50	+0·88	+0·27	−0·03	−0·40	−0·96	−1·48	−1·63	−1·55	November.
+3·28	+3·06	+2·01	+1·06	+0·81	+0·44	+0·11	−0·74	−1·42	**−1·92**	−1·63	−1·63	December.
+5·61	+5·47	+4·23	+2·50	+1·36	+0·46	−0·18	−0·73	−1·09	−1·45	−1·45	−1·45	Year.
+3·70	+3·52	+2·52	+1·39	+0·90	+0·55	+0·06	−0·44	−1·35	**−2·02**	−1·85	−1·76	Winter.
+6·59	+6·46	+4·83	+2·71	+1·27	+0·26	−0·55	−1·29	−1·25	−1·62	−1·60	−1·47	Equinox.
+6·56	+6·42	+5·33	+3·40	+1·90	+0·58	−0·04	−0·47	−0·67	−0·72	−0·91	−1·13	Summer.

TABLE XIII—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−1·83	−1·27	−1·06	−0·97	−0·84	−1·10	−1·20	−1·82	−2·03	−0·41	+1·86	+3·48
February ..	−1·18	−0·87	−0·74	−0·83	−0·86	−1·36	−1·69	−2·77	**−3·37**	−2·16	+1·08	+3·14
March ..	−2·22	−1·68	−1·37	−1·40	−1·48	−1·98	−3·06	**−4·50**	−4·25	−1·68	+2·67	+5·93
April ..	−1·59	−1·55	−1·72	−1·98	−2·30	−3·51	−4·75	**−5·21**	−4·11	−1·64	+2·60	+6·80
May ..	−1·28	−1·43	−1·82	−2·43	−3·43	−4·13	**−4·72**	−4·42	−2·50	−0·21	+2·97	+5·90
June ..	−1·81	−1·94	−2·54	−3·44	−4·40	**−5·27**	−5·22	−4·95	−3·53	−0·56	+2·83	+5·72
July ..	−1·85	−2·20	−2·35	−2·97	−3·89	**−4·73**	−4·61	−3·97	−2·25	+0·14	+3·10	+5·32
August ..	−1·82	−1·99	−2·35	−2·91	−3·14	**−3·73**	−3·60	−3·61	−2·15	+0·30	+3·53	+6·00
September ..	−1·82	−2·15	−2·09	−2·18	−2·20	−2·67	−3·58	**−3·84**	−2·55	+0·06	+3·31	+6·52
October ..	−1·54	−1·58	−1·45	−1·46	−1·31	−1·48	−2·21	**−3·46**	**−3·46**	−1·32	+2·39	+5·21
November ..	−1·13	−0·82	−0·65	−0·47	−0·54	−0·72	−0·78	−1·51	−1·85	−0·67	+1·67	+3·68
December ..	−1·42	−0·77	−0·39	−0·16	+0·06	−0·16	−0·28	−0·96	−1·25	−0·40	+1·19	+2·44
Year ..	−1·62	−1·52	−1·54	−1·77	−2·03	−2·57	−2·98	**−3·42**	−2·78	−0·71	+2·43	+5·01
Winter ..	−1·39	−0·93	−0·71	−0·61	−0·54	−0·84	−0·99	−1·76	**−2·13**	−0·91	+1·45	+3·18
Equinox ..	−1·79	−1·74	−1·66	−1·76	−1·82	−2·41	−3·40	**−4·25**	−3·59	−1·15	+2·74	+6·11
Summer ..	−1·69	−1·89	−2·27	−2·94	−3·72	−4·47	**−4·54**	−4·24	−2·61	−0·08	+3·11	+5·73

TABLE XIV—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−0·86	−0·52	−0·23	−0·24	−0·18	−0·30	−0·47	−0·83	−0·81	+0·04	+1·33	+2·65
February ..	−1·50	−1·20	−1·18	−0·89	−0·82	−0·62	−0·29	−0·21	−0·13	+0·63	+2·17	+3·10
March ..	−1·26	−1·11	−0·93	−0·94	−0·89	−0·96	−1·22	−2·21	**−2·77**	−1·47	+1·07	+3·78
April ..	−1·04	−1·15	−1·10	−1·51	−1·92	−1·90	−2·07	**−2·49**	−1·95	−0·41	+1·75	+3·99
May ..	−1·40	−1·34	−1·48	−1·91	−2·68	−3·03	**−3·36**	−3·08	−2·12	−0·05	+2·50	+4·46
June ..	−1·05	−1·18	−1·46	−2·14	−3·36	**−3·96**	−3·91	−3·79	−2·84	−0·81	+1·92	+4·20
July ..	−1·42	−1·29	−1·57	−2·24	−3·15	−3·75	**−3·81**	−3·68	−2·59	−0·82	+1·90	+4·33
August ..	−1·19	−1·19	−1·34	−1·69	−2·66	−3·33	**−3·75**	−3·52	−2·35	−0·36	+2·25	+4·67
September ..	−1·77	−1·60	−1·81	−1·79	−1·66	−1·76	−1·96	**−2·15**	−1·21	+0·82	+3·27	+5·14
October ..	−1·03	−0·92	−0·91	−0·79	−0·81	−1·00	−1·30	−1·96	**−2·04**	−0·55	+2·23	+4·14
November ..	−0·91	−0·49	−0·53	−0·34	−0·30	−0·27	−0·18	−0·24	−0·14	+1·54	+2·26	**+3·10**
December ..	−0·87	−0·41	+0·02	+0·04	+0·07	−0·01	−0·09	−0·27	−0·18	+0·50	+1·48	+1·90
Year ..	−1·19	−1·03	−1·04	−1·20	−1·53	−1·74	−1·87	**−2·04**	−1·59	−0·08	+2·01	+3·79
Winter ..	−1·03	−0·65	−0·48	−0·36	−0·31	−0·30	−0·26	−0·39	−0·31	+0·68	+1·81	+2·69
Equinox ..	−1·28	−1·20	−1·19	−1·26	−1·32	−1·40	−1·64	**−2·20**	−1·99	−0·40	+2·08	+4·26
Summer ..	−1·27	−1·25	−1·46	−2·00	−2·96	−3·52	**−3·71**	−3·52	−2·47	−0·51	+2·14	+4·42

Inequality 1884

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+4·48	+4·00	+2·55	+1·54	+1·21	+0·80	+0·14	−0·33	−1·07	−1·98	**−2·12**	−2·06	January.
+4·50	**+4·88**	+4·15	+2·46	+1·35	+0·42	+0·07	−0·72	−1·30	−1·47	−1·35	−1·26	February.
+7·18	+6·85	+5·08	+2·72	+1·09	+0·46	−0·25	−1·03	−1·20	−2·02	−1·84	−2·03	March.
+8·57	+8·26	+5·89	+3·43	+1·14	−0·44	−1·06	−1·19	−1·23	−1·43	−1·33	−1·54	April.
+6·73	+6·47	+4·68	+2·95	+1·29	+0·15	−0·60	−0·79	−0·63	−0·98	−0·68	−1·02	May
+7·01	**+7·15**	+6·22	+4·59	+2·56	+0·99	+0·02	−0·43	−0·19	−0·49	−0·80	−1·43	June.
+6·57	+6·32	+4·56	+2·93	+1·59	+0·58	+0·51	+0·10	−0·09	−0·44	−1·04	−1·34	July.
+6·81	+6·05	+4·13	+2·21	+0·71	+0·03	+0·11	−0·25	−0·62	−0·92	−1·23	−1·59	August.
+7·61	+6·78	+4·29	+2·01	+0·95	−0·03	−0·54	−1·11	−1·52	−1·67	−1·76	−1·75	September.
+6·24	+5·76	+4·11	+2·27	+1·06	+0·23	−0·42	−1·08	−1·52	−1·76	−1·65	−1·60	October.
+4·50	+4·03	+2·57	+1·41	+0·71	+0·05	−0·46	−1·27	−1·81	**−2·19**	−2·14	−1·67	November.
+3·32	+2·81	+1·94	+1·21	+0·79	+0·36	−0·38	−0·64	−1·46	−1·63	**−2·26**	−1·98	December.
+6·13	+5·78	+4·18	+2·48	+1·20	+0·30	−0·24	−0·73	−1·05	−1·42	−1·52	−1·61	Year.
+4·20	+3·93	+2·80	+1·66	+1·02	+0·41	−0·16	−0·74	−1·41	−1·82	−1·97	−1·74	Winter.
+7·40	+6·91	+4·84	+2·61	+1·06	+0·05	−0·57	−1·10	−1·37	−1·72	−1·65	−1·73	Equinox.
+6·78	+6·50	+4·90	+3·17	+1·54	+0·44	+0·01	−0·34	−0·38	−0·71	−0·94	−1·35	Summer.

Inequality 1888

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+3·30	+2·44	+1·39	+0·47	+0·14	−0·03	−0·46	−1·02	−1·54	−1·60	**−1·61**	−1·11	January.
+3·61	+3·19	+2·00	+0·91	+0·35	−0·02	−0·66	−1·23	−1·49	−1·76	**−2·02**	−1·95	February.
+5·20	+5·14	+3·82	+2·11	+0·78	−0·02	−0·67	−1·15	−1·62	−1·53	−1·74	−1·51	March.
+5·39	+5·12	+3·31	+1·83	+0·63	−0·19	−0·80	−0·67	−0·92	−1·21	−1·43	−1·17	April.
+5·55	+5·01	+4·00	+2·55	+1·88	+0·55	−0·39	−0·79	−1·07	−1·04	−1·25	−1·44	May.
+5·50	+5·42	+4·67	+3·17	+1·57	+0·65	+0·24	−0·25	−0·53	−0·60	−0·52	−0·92	June.
+5·68	+5·57	+4·61	+3·35	+1·89	+0·79	+0·32	0·00	−0·52	−0·99	−1·27	−1·39	July.
+5·93	+5·52	+4·08	+2·41	+0·90	+0·02	−0·09	−0·40	−0·49	−0·77	−1·11	−1·52	August.
+5·88	+4·88	+3·23	+1·45	+0·35	−0·31	−0·81	−1·24	−1·47	−1·65	−1·87	−1·92	September.
+4·64	+3·97	+2·56	+1·04	+0·20	−0·14	−0·65	−1·12	−1·22	−1·61	−1·45	−1·32	October.
+2·80	+2·04	+0·88	+0·39	+0·19	−0·19	−0·66	−1·20	−2·01	**−2·26**	−1·90	−1·46	November.
+2·26	+1·97	+1·33	+0·89	+0·25	−0·24	−0·65	−1·30	−1·83	**−2·02**	−1·70	−1·25	December.
+4·64	+4·19	+2·99	+1·71	+0·76	+0·07	−0·44	−0·86	−1·23	−1·42	−1·49	−1·41	Year.
+2·99	+2·41	+1·40	+0·67	+0·23	−0·12	−0·61	−1·19	−1·72	**−1·91**	−1·81	−1·44	Winter.
+5·28	+4·78	+3·23	+1·61	+0·49	−0·17	−0·73	−1·04	−1·31	−1·50	−1·62	−1·48	Equinox.
+5·66	+5·38	+4·34	+2·87	+1·56	+0·50	+0·02	−0·36	−0·65	−0·85	−1·04	−1·32	Summer.

TABLE XV—DIURNAL

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
	′	′	′	′	′	′	′	′	′	′	′	′
January ..	−0·53	−0·25	−0·09	−0·20	−0·15	−0·12	−0·29	−0·39	−0·02	+0·55	+0·98	+1·68
February ..	−1·30	−0·97	−0·81	−0·67	−0·43	−0·57	−0·59	−0·70	−0·86	−0·23	+1·03	+2·54
March ..	−1·11	−1·27	−1·42	**−1·64**	−1·41	−1·28	−1·14	−1·44	−1·39	−0·41	+1·51	+3·58
April ..	−0·91	−0·91	−1·33	−1·73	−2·06	−2·49	−2·87	**−3·22**	−2·50	−0·79	+1·56	+4·22
May ..	−0·75	−1·00	−1·26	−1·68	−2·59	−3·31	**−3·45**	−3·20	−2·15	−0·07	+2·89	+4·91
June ..	−1·40	−1·51	−1·83	−2·66	−3·49	**−4·28**	−3·67	−3·30	−2·31	−0·22	+2·38	+4·37
July ..	−1·55	−1·61	−1·56	−1·76	−2·63	−3·14	−3·35	**−3·42**	−2·66	−0·94	+1·60	+3·89
August ..	−1·07	−1·14	−1·54	−1·96	−2·50	−3·22	**−3·63**	−3·38	−2·01	+0·44	+3·04	+5·14
September	−1·27	−1·28	−1·32	−1·39	−1·59	−1·86	−2·43	**−2·49**	−1·53	+0·62	+2·92	+4·95
October ..	−1·09	−0·78	−0·48	−0·54	−0·68	−0·88	−1·35	**−2·06**	−2·03	−0·22	+2·51	+4·40
November ..	−1·05	−0·43	−0·22	−0·17	−0·25	−0·29	−0·16	−0·40	−0·52	+0·17	+1·69	+2·68
December ..	−0·71	−0·37	−0·07	−0·26	−0·27	−0·17	−0·25	−0·37	−0·04	+0·65	+1·43	+2·31
Year ..	−1·06	−0·96	−0·99	−1·22	−1·50	−1·80	−1·93	**−2·03**	−1·50	−0·04	+1·96	+3·72
Winter ..	−0·90	−0·50	−0·30	−0·33	−0·28	−0·29	−0·32	−0·46	−0·36	+0·29	+1·28	+2·30
Equinox ..	−1·10	−1·06	−1·14	−1·32	−1·44	−1·63	−1·95	**−2·30**	−1·86	−0 20	+2·12	+4·29
Summer ..	−1·19	−1·32	−1·55	−2·02	−2·80	−3·49	**−3·53**	−3·33	−2·28	−0·20	+2·48	+4·58

§ 6—COMPARISON OF INEQUALITIES FROM YEARS OF SUNSPOT MAXIMA AND MINIMA

Before proceeding further, it is desirable to consider the differences between typical years of many and few sunspots. The mean epochs from the seven years of sunspot maximum and the six years of sunspot minimum dealt with in Tables III to XV differ rather largely, being 1873·3 for the former group, and 1877·8 for the latter. To get rid of this difference, it was decided to include in the group of sunspot maximum years the three later years 1892, 1893 and 1894, though these had been already dealt with when considering the period 1890 to 1900. This gives us a total of 10 sunspot maximum years, with a mean epoch 1877·8, identical with that of the sunspot minimum group. Table XVI and Plate I contrast the diurnal inequalities from these sunspot maximum and sunspot minimum groups. Individual months are not considered, but only the year and the three seasons.

Apart from the difference in amplitude, which is much larger at all seasons in the sunspot maximum than in the sunspot minimum years, the most conspicuous difference is the greater development of the morning minimum in the sunspot

TABLE XVI—DIURNAL INEQUALITY FROM

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
Sunspot Maximum.	′	′	′	′	′	′	′	′	′	′	′	′
Year ..	−1·86	−1·86	−1·97	−2·19	−2·60	−3·10	−3·55	**−3·76**	−2·93	−0·52	+2·76	+5·47
Winter ..	−1·83	−1·52	−1·31	−1·20	−1·15	−1·18	−1·28	−1·63	−1·63	−0·24	+1·88	+3·63
Equinox ..	−2·21	−2·20	−2·26	−2·27	−2·36	−2·80	−3·64	**−4·32**	−3·53	−0·77	+3·21	+6·51
Summer ..	−1·53	−1·85	−2·32	−3·09	−4·29	−5·33	**−5·73**	−5·33	−3·62	−0·56	+3·17	+6·28
Sunspot Minimum.												
Year ..	−1·07	−0·94	−0·99	−1·16	−1·49	−1·78	−2·05	**−2·18**	−1·57	−0·01	+2·22	+3·93
Winter ..	−0·86	−0·47	−0·30	−0·25	−0·28	−0·38	−0·46	−0·62	−0·48	+0·38	+1·70	+2·69
Equinox ..	−1·12	−1·08	−1·16	−1·22	−1·31	−1·51	**−1·97**	−2·37	−1·81	−0·08	+2·49	+4·50
Summer ..	−1·23	−1·29	−1·51	−2·04	−2·88	−3·44	**−3·72**	−3·55	−2·41	−0·32	+2·47	+4·61

Inequality 1889

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	
′	′	′	′	′	′	′	′	′	′	′	′	
+2·27	+1·63	+0·90	+1·03	+0·24	−0·13	−0·62	−1·18	−1·47	**−1·50**	−1·33	−0·95	January.
+3·25	+2·94	+2·15	+1·08	+0·54	+0·13	−0·34	−0·82	−1·21	−1·39	**−1·45**	−1·40	February.
+4·32	**+4·32**	+3·27	+1·76	+0·50	−0·06	−0·59	−0·98	−1·27	−1·22	−1·27	−1·37	March.
+5·80	+5·25	+3·74	+2·49	+1·31	+0·52	−0·12	−0·64	−1·27	−1·39	−1·44	−1·26	April.
+5·33	+4·65	+3·43	+1·92	+0·86	+0·08	−0·39	−0·75	−0·99	−0·96	−0·79	−0·80	May.
+5·43	+5·42	+4·25	+3·21	+1·57	+0·42	+0·13	−0·13	−0·21	−0·43	−0·75	−0·94	June.
+5·04	**+5·10**	+4·24	+3·15	+1·87	+1·17	+0·43	−0·02	−0·43	−0·76	−1·12	−1·43	July.
+6·15	+5·40	+3·77	+2·10	+0·69	−0·23	−0·60	−0·73	−0·96	−1·09	−1·23	−1·35	August.
+5·49	+4·39	+2·86	+1·28	+0·23	−0·28	−0·50	−0·86	−1·07	−1·46	−1·68	−1·61	September.
+4·61	+3·91	+2·56	+1·13	+0·21	−0·39	−1·05	−1·34	−1·67	−1·75	−1·62	−1·44	October.
+3·09	+2·34	+1·58	+1·04	+0·37	−0·11	−0·87	−1·47	**−1·92**	−1·90	−1·65	−1·52	November.
+2·67	+1·78	+1·22	+0·82	+0·22	−0·26	−0·74	−1·31	−1·53	**−1·76**	−1·70	−1·26	December.
+4·45	+3·93	+2·83	+1·75	+0·72	+0·07	−0·44	−0·85	−1·17	−1·30	−1·34	−1·28	Year.
+2·82	+2·17	+1·46	+0·99	+0·34	−0·09	−0·64	−1·20	−1·53	**−1·64**	−1·53	−1·28	Winter.
+5·06	+4·47	+3·11	+1·66	+0·56	−0·05	−0·57	−0·96	−1·32	−1·45	−1·50	−1·42	Equinox.
+5·49	+5·14	+3·92	+2·59	+1·25	+0·36	−0·11	−0·41	−0·65	−0·81	−0·97	−1·13	Summer.

maximum years. In winter there are two well marked minima, both for the sunspot maximum and the sunspot minimum years, the evening minimum being the more pronounced, especially in the sunspot minimum years. In equinox and in the year the evening minimum continues to be clearly shown in the sunspot minimum years, but is hardly represented in the sunspot maximum years. In summer the evening minimum is doubtfully represented even in the sunspot minimum years; as in the other seasons, the depression towards the morning minimum is much more pronounced in the sunspot maximum years.

It is easy to see, either in Table XVI or in Plate I, that the crossing of the zero declination line in either direction occurs earlier in the sunspot minimum than in the sunspot maximum years, the difference between the two groups of years being greatest in winter and least in summer.

In winter it is clear, either from Table XVI, or Plate I, that the principal maximum in the early afternoon occurs somewhat earlier in the sunspot minimum than in the sunspot maximum years. As regards the other seasons, mere inspection of the table or curves hardly leads to a definite conclusion.

Years of Sunspot Maximum and Minimum

13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	Range.	A.D.
′	′	′	′	′	′	′	′	′	′	′	′	′	′
+6·70	+6·41	+4·92	+3·13	+1·60	+0·56	−0·14	−0·70	−1·17	−1·56	−1·77	−1·88	10·46	2·63
+4·53	+4·38	+3·33	+2·21	+1·38	+0·76	+0·01	−0·84	−1·67	−2·18	**−2·30**	−2·17	6·83	1·84
+7·95	+7·44	+5·51	+3·27	+1·46	+0·31	−0·48	−1·06	−1·49	−1·91	−2·13	−2·23	12·27	2·97
+7·63	+7·42	+5·92	+3·90	+1·97	+0·61	+0·03	−0·20	−0·36	−0·60	−0·87	−1·24	13·36	3·08
+4·63	+4·13	+2·91	+1·72	+0·77	+0·04	−0·55	−1·00	−1·32	−1·47	−1·45	−1·32	6·81	1·70
+3·03	+2·44	+1·49	+0·78	+0·34	−0·09	−0·66	−1·31	−1·76	**−1·87**	−1·71	−1·36	4·90	1·07
+5·30	+4·65	+3·11	+1·62	+0·51	−0·29	−0·90	−1·26	−1·50	−1·62	−1·60	−1·38	7·67	1·85
+5·57	+5·29	+4·14	+2·75	+1·45	+0·51	−0·07	−0·45	−0·69	−0·92	−1·05	−1·22	9·29	2·23

§ 7—Possible gradual changes in the Diurnal Inequality

One of the chief possibilities kept in view was a gradual change in the diurnal inequality. From the previous results it is fairly obvious that there is no chance of substantiating a small gradual change unless we consider the sunspot maximum and sunspot minimum years separately. As the time of the principal daily minimum varies considerably with the season, the most promising single feature in the diurnal inequality is the time of the principal maximum. The exact time of maximum will naturally not coincide with an exact hour G.M.T., and as the diurnal inequalities contain figures only for exact hours, they cannot without some subsidiary hypothesis supply exact information as to the time of maximum. If there were any large change it would, of course, show up clearly, but that obviously is not the case. It will be found that 13 h. supplies the largest hourly mean in the diurnal inequality for the year in every single year, whether of sunspot maximum or sunspot minimum, and even in every single season, with the solitary exception of winter 1872. In 1872 the maximum in January and February was at 14 h., and in the winter season the value for 14 h. slightly exceeded that for 13 h. As 1872 was not one of the earliest sunspot maximum years, the incident has no clear bearing on the present point. If we consider the hour of occurrence of the largest value in individual months, we obtain the following results :—

Number of Occurrences of Principal Maximum

Seven sunspot maximum years			Six sunspot minimum years			
Year	13h.	14h.	Year	12h.	13h.	14h.
1859	11	1	1866	1	8½	2½
1860	11	1	1867	2	9	1
1870	11	1	1878	1	10	1
1871	9	3	1879	—	12	—
1872	9	3	1888	1	11	—
1883	7	5	1889	—	10½	1½
1884	10	2				
Total	68	16	Total	5	61	6

The occurrence of ½ signifies equality between the hourly values for 13h. and 14h.

In the sunspot maximum group there is a slight suggestion of a tendency in the time of maximum to get later. Also the position of 1883 and 1884 as compared with 1859 and 1860 cannot be ascribed to the relatively poor development of sunspots in 1883 and 1884, because that would naturally tend to make the hour of maximum earlier and not later. In the sunspot minimum group the evidence, apart from 1866, is, on the whole, rather in the same direction. As regards 1866, the months which put the maximum value at 14h. came from the first half of the year, which had the characteristics of a time of moderate rather than low sunspot frequency. In particular, February, which put the maximum most decidedly at 14h., had 38·4 for its value of S. We shall return to this question presently, in connection with the analysis of the diurnal inequality in Fourier waves.

§ 8—Variations in the Scale of the Diurnal Inequality

Meantime a glance is desirable at Tables XVII and XVIII, which give respectively the ranges and the A.D.'s from the diurnal inequality of each month, season and year, as well as the arithmetic means from the 12 monthly values. The

Plate I.

KEW OBSERVATORY, 1859-94.

To face p. 20.

DIURNAL VARIATION OF MAGNETIC DECLINATION

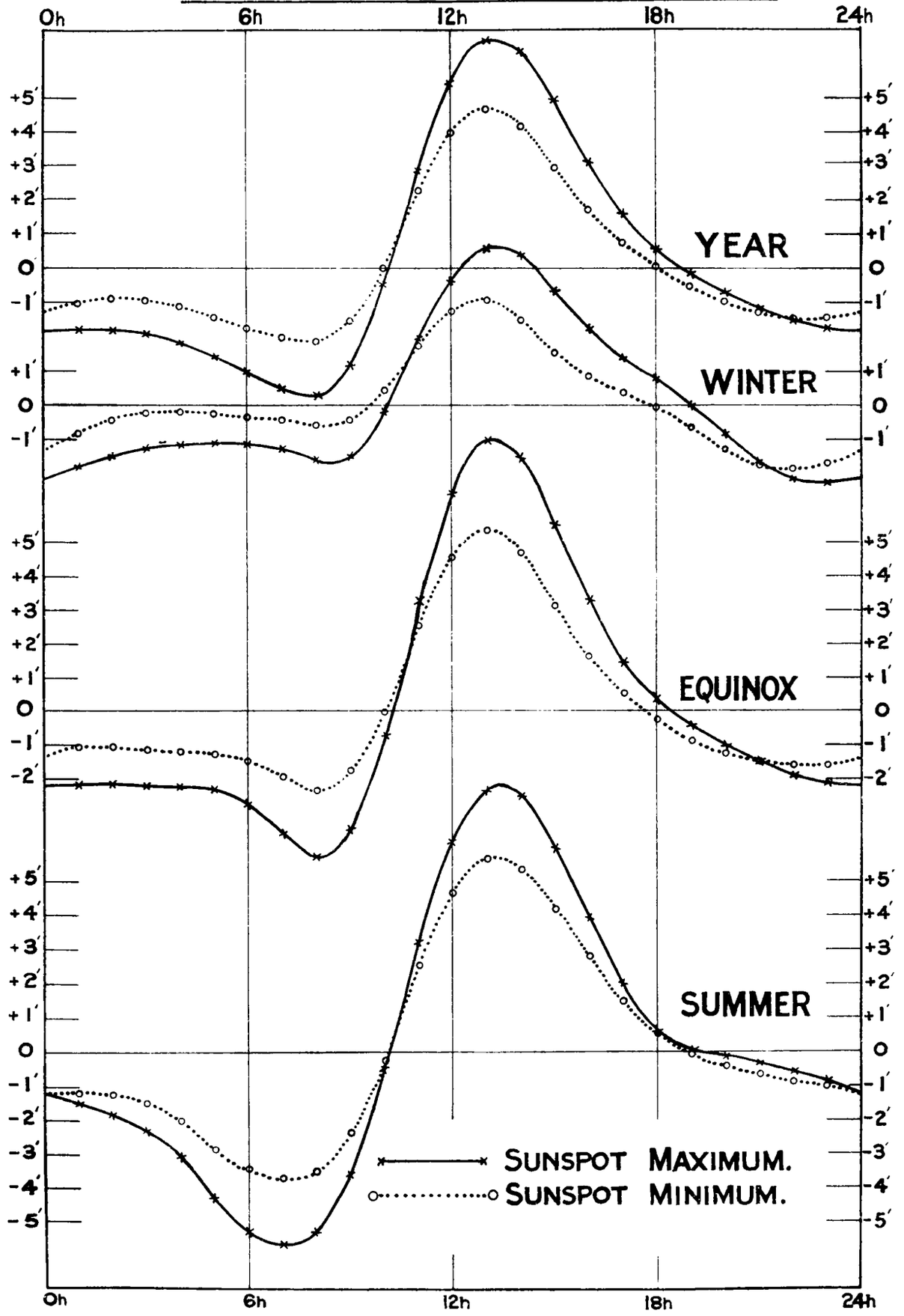

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TABLE XVII—RANGE OF DIURNAL INEQUALITY

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	A.M.	Year	W.	E.	S.
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1859	6·14	9·04	12·49	16·80	12·29	13·78	12·82	14·92	12·92	11·07	7·78	7·93	11·50	11·09	7·57	13·32	13·43
1860	7·08	9·01	13·02	14·08	13·44	15·67	14·22	15·73	12·60	11·24	7·10	4·64	11·49	10·99	6·47	12·73	14·76
1866	6·31	8·53	8·35	11·08	9·64	9·97	9·56	8·89	7·76	7·54	7·79	5·18	8·38	7·24	6·78	8·03	9·46
1867	4·96	5·91	8·64	10·25	9·53	9·39	9·65	10·03	8·44	7·60	6·50	4·37	7·94	7·17	5·32	8·12	9·55
1870	6·74	8·70	13·01	16·39	15·78	15·05	15·79	16·49	13·83	12·10	9·52	6·73	12·51	12·05	7·88	13·83	15·77
1871	7·36	9·25	14·17	17·31	14·93	15·42	14·46	16·49	12·99	11·37	9·77	7·56	12·59	12·02	8·26	13·96	15·26
1872	8·74	9·09	13·31	15·31	13·44	14·78	13·55	15·07	13·52	10·38	8·76	6·58	11·88	11·05	8·06	13·11	14·16
1878	3·42	5·06	7·42	9·09	7·95	10·26	8·84	9·35	8·30	5·53	3·61	3·40	6·85	6·53	3·79	7·58	8·96
1879	3·90	4·79	7·65	8·99	8·71	9·31	8·99	10·34	7·83	6·45	4·26	3·79	7·08	6·86	4·18	7·73	9·34
1883	5·38	7·14	9·57	11·74	10·41	11·55	12·65	10·89	11·54	10·15	5·99	5·20	9·35	8·92	5·72	10·50	11·24
1884	6·60	8·25	11·68	13·78	11·45	12·42	11·30	10·54	11·45	9·70	6·69	5·58	9·95	9·55	6·33	11·65	11·32
1888	4·91	5·63	7·97	7·88	8·91	9·46	9·49	9·68	8·03	6·68	5·36	4·28	7·36	6·68	4·90	7·48	9·37
1889	3·77	4·70	5·96	9·02	8·78	9·71	8·52	9·78	7·98	6·67	5·01	4·43	7·03	6·48	4·46	7·36	9·02
1892	6·02	8·09	10·79	11·88	11·96	12·15	11·92	12·67	10·60	9·99	6·01	6·10	9·85	9·36	6·42	10·73	12·04
1893	5·90	7·99	11·84	14·40	13·31	13·87	13·05	14·36	12·09	9·97	6·66	5·39	10·74	10·34	6·34	12·04	13·51
1894	5·70	7·67	10·47	12·97	12·43	11·92	12·11	12·90	11·22	8·87	6·26	5·06	9·80	9·35	5·96	10·82	12·22
Means—																	
10 years sunspot maximum.	6·57	8·42	12·04	14·47	12·94	13·66	13·19	14·01	12·28	10·48	7·45	6·08	10·97	10·47	6·90	12·27	13·37
7 years sunspot maximum.	6·86	8·64	12·46	15·06	13·11	14·10	13·54	14·30	12·69	10·86	7·94	6·32	11·32	10·81	7·18	12·73	13·71
6 years sunspot minimum.	4·55	5·77	7·67	9·39	8·92	9·69	9·18	9·68	8·06	6·75	5·42	4·24	7·44	6·83	4·90	7·72	9·28

TABLE XVIII—A.D. (AVERAGE DEPARTURE) OF DIURNAL INEQUALITY

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	A.M.	Year.	W.	E.	S.
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1859	1·63	2·44	3·33	3·47	2·64	2·97	2·92	3·29	3·35	2·74	2·05	1·98	2·73	2·70	2·00	3·21	2·93
1860	1·97	2·23	3·23	3·08	3·02	3·28	3·25	3·58	2·92	2·82	1·91	1·27	2·71	2·68	1·81	3·00	3·22
1866	1·37	1·95	2·25	2·68	2·56	2·53	2·47	2·28	1·87	1·75	1·60	1·16	2·04	1·97	1·46	2·11	2·44
1867	1·02	1·39	2·13	2·37	2·45	2·42	2·51	2·52	2·12	1·79	1·35	0·88	1·91	1·86	1·13	2·07	2·44
1870	1·94	2·39	3·50	3·67	3·52	3·47	3·52	3·78	3·28	2·93	2·82	1·93	3·06	3·03	2·26	3·33	3·53
1871	1·90	2·65	3·68	4·02	3·29	3·55	3·56	3·85	3·48	3·00	2·35	2·01	3·11	3·08	2·20	3·52	3·54
1872	2·23	2·38	3·59	3·56	3·25	3·53	3·26	3·39	3·21	2·81	2·25	1·69	2·93	2·90	2·09	3·27	3·34
1878	0·76	1·11	1·52	2·02	1·85	2·27	2·04	2·23	1·94	1·32	0·89	0·78	1·56	1·52	0·87	1·68	2·08
1879	0·87	1·12	1·77	1·71	1·91	2·17	1·92	2·23	1·83	1·52	0·97	0·81	1·57	1·56	0·93	1·69	2·05
1883	1·36	1·73	2·29	2·58	2·33	2·85	2·96	2·45	2·64	2·18	1·48	1·30	2·18	2·16	1·43	2·42	2·64
1884	1·67	1·83	2·67	3·05	2·59	3·09	2·64	2·49	2·62	2·27	1·55	1·18	2·30	2·29	1·55	2·64	2·68
1888	0·98	1·33	1·83	1·83	2·21	2·28	2·37	2·15	2·08	1·57	1·10	0·90	1·72	1·68	1·07	1·81	2·24
1889	0·77	1·14	1·61	2·08	2·01	2·26	2·20	2·22	1·89	1·61	1·08	0·92	1·65	1·62	0·97	1·77	2·15
1892	—	—	—	—	—	—	—	—	—	—	—	—	—	2·45	1·73	2·76	2·90
1893	—	—	—	—	—	—	—	—	—	—	—	—	—	2·59	1·77	2·93	3·06
1894	—	—	—	—	—	—	—	—	—	—	—	—	—	2·44	1·67	2·66	2·99
Means—																	
10 years sunspot maximum.	—	—	—	—	—	—	—	—	—	—	—	—	—	2·63	1·85	2·97	3·08
7 years sunspot maximum.	1·81	2·24	3·33	3·35	2·95	3·25	3·16	3·26	3·07	2·68	2·06	1·62	2·72	2·69	1·91	3·06	3·13
6 years sunspot minimum.	0·96	1·34	1·85	2·12	2·17	2·32	2·25	2·27	1·96	1·59	1·17	0·91	1·74	1·70	1·07	1·86	2·23

A. D.—*i.e.*, the numerical mean of the 24 hourly departures from the mean of the day—is probably a better measure than the range of the activity of the forces to which the regular diurnal variation is due. It is less dependent on the accident of whether the time of a principal maximum or minimum happens to coincide closely with an hour G.M.T.

As use is made subsequently of the monthly ranges[2] for 1892, 1893 and 1894, these are included in Table XVII. But in Table XVIII data from these three years are confined to the yearly and seasonal inequalities.

As we should expect, the arithmetic mean of the 12 monthly ranges or A.D.'s is invariably larger than the range or A.D. from the inequality for the year, but in the case of the A.D. the excess is always very small.

Mean results are given for the sunspot maximum and sunspot minimum groups of years separately, and two sets of sunspot maximum results are given in Table XVII, one including the other omitting 1892, 1893 and 1894.

The most consistent tendency in the different years is towards a minimum of amplitude in December. This is the month of least amplitude in the sunspot maximum and sunspot minimum groups of years in both Tables XVII. and XVIII. The sunspot maximum years 1859 and 1871 have the minimum amplitude in January in both the tables, but the same is true of the sunspot minimum year 1889. The only other exceptions to the rule are 1878, when the A. D. has its minimum in January, and 1892 when the range has its minimum in November. There seems no certain difference as between sunspot maximum and sunspot minimum.

The means from the 11 years 1890 to 1900 agreed in showing a marked minimum of amplitude in December, January coming next.

There is much less consistency as regards the month of maximum amplitude. In both Tables XVII and XVIII the groups of sunspot maximum years place the maximum amplitude in April. In Table XVII the excess of the April value over the next highest, that for August, is fairly substantial ; but the maximum occurs in August in six individual years, and in two other years it occurs in June or July ; only eight of the sixteen years have the maximum actually in April. In Table XVIII the maximum is found in April in only three individual years, one 1866, a year of sunspot minimum. As against this, there are three occurrences of the maximum in June, two in July, four in August and one in March. In the group of sunspot minimum years the maximum amplitude appears in June in both tables, but the excess of the June over the August value is very trifling especially in Table XVII. In the case of the 11 years 1890-1900 August came first, April occupying only the second place. On the whole, what the figures suggest is a tendency to a secondary minimum amplitude towards midsummer in a good many years, especially sunspot maximum years, while in other years there is a very rounded maximum towards midsummer.

In the case of the absolute daily range, a secondary minimum towards midsummer is clearly shown[3] both in the sunspot maximum group and in the average year 1858 to 1900, and even in the sunspot minimum group of years. Taking a mean from all the years, the maximum absolute range occurred in April, but in the sunspot minimum group of years the April value was slightly exceeded by the March and September values.

If we take the seasonal data in Tables XVII and XVIII, we find the winter value invariably much the lowest. The summer value exceeds the equinoctial in the groups of years in both Tables XVII and XVIII, the excess being best marked in the sunspot minimum group of years. The excess of the summer value is more decided for the range than for the A.D. In either table there is only one year—1884 in Table XVII, 1859 in Table XVIII—when the equinoctial exceeds the summer value. The depression in the amplitude at midwinter is considerably more conspicuous

[2] *London, Phil. Trans. R. Soc.* A, **208** (1908) p. 215 ; *N.P.L. Collected Researches* V (1908) p. 13.
[3] *Geophysical Memoirs* No 22 (1923). Table III.

for the inequality range than for the absolute range. The difference between the phenomena in the inequality and absolute ranges seems due to the larger influence exercised by disturbance on the latter. Disturbance is notably large in the equinoctial months and notably small near midsummer.

If we take the monthly mean values from the sunspot maximum and sunspot minimum groups of years, employing the 7-year mean for the former, we find that in the sunspot maximum group the ratio borne by the range to the A.D. varies from 3·74 in March to 4·50 in April, the value derived from the arithmetic means of the monthly values being 4·16; while in the sunspot minimum group the ratio varies from 4·08 in July to 4·74 in January, the value derived from the arithmetic means of the monthly values being 4·28. In the sunspot maximum group the ratio is least in the winter months, whereas in the sunspot minimum group it is then largest.

If we take the seasonal data for the ranges and A.D.'s, we find the same phenomenon. The winter value of the ratio of the range to the A.D. is decidedly the least in the sunspot maximum group of years, but the largest in the sunspot minimum group. This suggests that in drawing conclusions as to the relative effectiveness of the sunspot influence in winter and summer a good deal may depend on whether we base our comparison on ranges or on A.D.'s.

§ 9—Harmonic Analysis

Tables XIX and XX contain the results derived from the Fourier analysis of the diurnal inequality. Previous experience had shown that the "accidental" element is large in results derived from individual months. It was also known

TABLE XIX—FOURIER COEFFICIENTS FROM MEAN DIURNAL INEQUALITY FOR THE YEAR

	c_1	c_2	c_3	c_4	α_1	α_2	α_3	α_4
					° ′	° ′	° ′	° ′
1859	3·683	2·540	1·150	0·337	231 12	41 41	237 12	56 44
1860	3·699	2·500	1·137	0·309	229 36	45 40	239 31	56 22
1866	2·689	1·797	0·626	0·270	245 46	38 14	241 16	58 58
1867	2·512	1·762	0·661	0·302	242 41	40 50	247 58	64 32
1870	4·297	2·570	1·194	0·337	227 0	44 24	241 10	55 2
1871	4·326	2·583	1·126	0·381	228 5	39 52	234 52	65 39
1872	4·047	2·402	1·052	0·334	232 19	39 11	236 38	67 49
1878	2·026	1·548	0·653	0·241	234 20	46 23	247 24	71 38
1879	2·064	1·587	0·717	0·296	232 20	45 31	245 41	67 20
1883	2·913	2·058	0·878	0·331	227 39	36 57	232 27	50 9
1884	3·121	2·119	1·050	0·364	229 45	40 55	233 45	57 1
1888	2·311	1·546	0·670	0·276	238 15	41 2	238 37	46 11
1889	2·217	1·518	0·617	0·245	237 19	42 44	240 37	52 17
†1892	3·545	1·959	0·857	0·279	230 10	46 24	232 18	54 29
†1893	3·603	2·292	1·013	0·294	225 3	40 5	229 29	59 30
†1894	3·441	1·989	0·919	0·299	225 40	37 44	227 28	50 59
Sunspot Max. years								
Means all 10 years	3·667	2·301	1·038	0·327	228 39	41 17	234 29	57 22
,, 1859 & 1860	3·691	2·520	1·144	0·323	230 24	43 40	238 22	56 33
,, 1870 to 1872	4·223	2·518	1·124	0·351	229 8	41 9	237 33	62 50
,, 1883 & 1884	3·017	2·088	0·964	0·347	228 42	38 56	233 6	53 35
,, 1892 to 1894	3·530	2·080	0·930	0·291	226 58	41 24	229 45	54 59
Sunspot min. years.								
Means all 6 years	2·303	1·626	0·657	0·272	238 27	42 27	243 35	60 9
,, 1866 & 1867	2·600	1·780	0·643	0·286	244 14	39 32	244 37	61 45
,, 1878 & 1879	2·045	1·568	0·685	0·268	233 20	45 57	246 33	69 29
,, 1888 & 1889	2·264	1·532	0·643	0·260	237 47	41 53	239 37	49 14

† Apparently not published previously.—*Editor.*

that in addition to a large annual variation in phase in most of the Fourier "waves," there was also a considerable difference between the phase in years of many and few sunspots. It is pretty obvious from these considerations that, so far as the question of a progressive change in the diurnal inequality is concerned, the data from the whole year in Table XIX are the most likely to be serviceable. Considering first the results from the groups of years in Table XIX.

We see that α_1 and α_3 are very decidedly smaller in years of many than in years of few sunspots. In the case of α_1 the difference observed, 9° 48′, is equivalent to a time difference of 39·2 minutes; in the case of α_3 the difference observed, 9° 6′, represents only 12·8 minutes of time. α_2 and α_4 are also larger for the sunspot minimum than for the sunspot maximum group of years, but the difference is small and might be accidental.

A reduction in the phase angle means a later occurrence of the hour or hours of maximum. Thus the time of the maximum is later in the years of sunspot maximum, at least in the case of the 24-hour and 8-hour waves. Also the difference is so large in the case of the 24-hour wave as greatly to increase the difficulty of reaching a decision as to a progressive change in the diurnal inequality.

In view of the irregularities apparent in the shorter Fourier waves in Table XIX, Table XX was confined to the 24-hour and 12-hour waves in the seasonal diurnal irregularities. Considering the results from the sunspot maximum and sunspot minimum groups in Table XX, we see that α_1 and α_2 both exhibit a large seasonal variation. In every year without exception α_1 is largest in winter and least in summer, while α_2 is largest in summer and least in winter. But, whereas

TABLE XX—FOURIER COEFFICIENTS FROM SEASONAL DIURNAL INEQUALITIES

	c_1			c_2			a_1			a_2		
	W	E	S	W	E	S	W	E	S	W	E	S
							°	°	°	°	°	°
1859	2·78	4·26	4·17	1·56	3·08	3·15	241·1	236·9	218·7	22·6	38·7	53·9
1860	2·50	4·07	4·66	1·46	2·81	3·41	239·9	235·5	218·9	22·2	43·2	57·3
1866	2·23	2·83	3·47	1·36	2·05	2·08	269·7	253·3	224·1	18·6	46·5	42·8
1867	1·61	2·72	3·46	1·18	2·06	2·10	264·2	249·6	227·3	29·5	40·8	47·3
1870	3·27	4·65	5·12	1·41	2·85	3·61	237·7	230·9	216·6	21·5	43·4	53·9
1871	3·18	4·94	5·10	1·55	2·86	3·52	242·9	231·9	215·1	16·7	40·3	49·5
1872	3·09	4·51	4·81	1·48	2·85	3·22	248·9	235·3	218·8	16·0	39·3	49·5
1878	1·24	2·20	2·88	0·79	1·71	2·15	263·8	235·4	221·3	43·9	44·6	48·8
1879	1·29	2·22	2·86	0·86	1·74	2·21	255·8	235·4	219·6	28·9	45·0	52·3
1883	2·02	3·10	3·74	1·13	2·49	2·64	242·6	229·0	218·6	22·3	33·4	46·5
1884	2·04	3·47	3·92	1·42	2·63	2·50	240·8	231·5	222·4	18·1	39·4	55·2
1888	1·66	2·43	3·18	0·83	1·71	2·11	266·4	241·0	221·8	30·7	40·2	45·8
1889	1·44	2·39	3·05	0·85	1·71	2·06	263·3	239·1	223·9	24·8	42·3	50·6
1892	2·57	3·95	4·27	1·08	2·27	2·60	243·4	233·0	219·6	30·0	46·1	53·4
1893	2·54	4·02	4·39	1·23	2·62	3·12	239·6	226·4	215·5	24·0	37·2	48·8
1894	2·34	3·67	4·41	1·25	2·28	2·59	236·6	229·0	217·1	15·1	36·9	49·2
Sunspot maximum years—												
Means all 10 years ..	2·63	4·06	4·46	1·36	2·67	3·03	241·4	231·9	218·1	20·9	39·8	51·7
1859 & 1860 ..	2·64	4·16	4·42	1·51	2·95	3·28	240·5	236·2	218·8	22·4	40·9	55·6
1870 to 1872 ..	3·18	4·70	5·01	1·48	2·85	3·45	243·2	232·7	216·8	18·1	41·0	51·0
1883 & 1884 ..	2·03	3·29	3·83	1·27	2·56	2·57	241·7	230·2	220·5	20·2	36·4	50·8
1892 to 1894 ..	2·48	3·88	4·35	1·19	2·39	2·77	239·9	229·5	217·4	23·0	40·1	50·4
Sunspot minimum years—												
Means all 6 years ..	1·58	2·47	3·15	0·98	1·83	2·12	263·9	242·3	223·0	29·4	43·2	47·9
1866 & 1867 ..	1·92	2·78	3·46	1·27	2·05	2·09	266·9	251·4	225·7	24·0	43·7	45·1
1878 & 1879 ..	1·27	2·21	2·87	0·83	1·73	2·18	259·8	235·4	220·4	36·4	44·8	50·5
1888 & 1889 ..	1·55	2·41	3·11	0·84	1·71	2·08	264·9	240·0	222·8	27·8	41·2	48·2

the excess in the winter value of α_1 is greatest for the sunspot minimum years, the excess in the summer value of α_2 is greatest for the sunspot maximum years. Examining Table XX more minutely, we see that the values of α_1 and α_2 in adjacent years, each of many or of few sunspots, present rather large differences especially in winter.

As we have already remarked, α_1, α_2, α_3 and α_4 all show a fall as S increases, but the significance of the falls in α_2 and α_4 seemed open to doubt. A similar inquiry both for ordinary and for quiet days had been made for the 11 years 1890 to 1900, employing 1892-95 (mean S 72·65) as sunspot maximum years and 1890, 1899 and 1900 (mean S 11·40) as years of sunspot minimum. In this case, as S increased, α_1, α_2 and α_3 all fell, alike on quiet and on ordinary days. But while α_4 also fell on quiet days, it showed a slight increase on ordinary days. The falls in α_1 and α_3 were more decided than that in α_2. But while Table XIX suggests a fall of 0°·118 in α_1, for a rise of 1 in S, the result derived from 1890 to 1900 was a fall of only 0°·053 for a rise of 1 in S. In 1890 to 1900, α_1, α_2, α_3 and α_4 were also calculated from the disturbed day inequalities, and it was found that α_1 and α_4 increased markedly with disturbance, while α_2 and α_3 fell.

The results for α_1 claim special attention. Taking the whole eleven years 1890-1900, α_1 was 222° 27′ for quiet days, 230° 21′ for ordinary days and 257° 52′ for highly disturbed days. The sunspot minimum value was 224° 14′ for quiet days, and 232° 6′ for ordinary days ; while the sunspot maximum value was 221° 1′ for quiet days, and 228° 12′ (printed in error 238° 12′) for ordinary days. Thus we have the somewhat curious result that α_1 increases markedly with disturbance, but yet falls as S increases. This tends to explain some of the differences observed between successive years in Table XIX. In years with similar values for S we may regard the amplitude of the absolute daily range as a pretty sound criterion of disturbance. Accepting it, 1859 was more disturbed than 1860, 1866 than 1867, 1872 than 1871, 1888 than 1889, 1892 than 1894, and 1894 than 1893. In each of these cases the more disturbed year gives the larger value of α_1 in Table XIX. There is in fact only one case which goes the opposite way ; 1883 had a larger absolute range than 1884, but its value of α_1 is the smaller.

§ 10—Progressive changes in the Phases of the Fourier Terms

If the sunspot maximum groups of years in Table XIX could be regarded as representing identical conditions, the evidence for a progressive fall in α_1 would be overwhelming. Each group of years shows a sensible fall as compared with the previous group. The difference between the groups centring at 1860·0 and at 1893·5 is 3° 26′, representing a time difference of 13·7 minutes in 33½ years. If, however, we allow for the differences between the mean values of S in the separate groups, at the rate of 0°·118 per 1 S, then reduce to a common value of 90·5 of S, we find the successive values of α_1 to be 230° 54′, 232° 18′, 225° 31′ and 225° 33′. The difference between the earliest and latest values of α_1 is enhanced, but the progression looks less convincing. If we employed the results of 1890-1900 giving a reduced influence of S, we should obtain, of course, a smoother progression.

In the case of the sunspot minimum years α_1 is notably smaller for the third group than for the first, but the lowest value is supplied by the intermediate group. The differences between the values of S for the three groups are relatively small; judging by the size of the absolute daily range, the first group was the most, and the intermediate group the least disturbed. If this difference in disturbance had not existed, we should presumably have had a larger value of α_1 for 1878-9, and a smaller excess in α_1 from 1866-7 over α_1 from 1888-9. On the whole, the sunspot minimum groups of years, like the sunspot maximum, favour a progressive fall in α_1.

According to the results from 1890 to 1900, α_2 diminishes markedly as disturbance increases. This accords with the differences between the values of α_2 for the following pairs of years; 1859 and 1860, 1866 and 1867, 1871 and 1872, 1888 and 1889, and 1893 and 1894; but the large value of α_2 in 1892 as compared with 1894 and 1893 is an exception to the rule.

The difference between the mean values of α_2 for the groups of 10 sunspot maximum and 6 sunspot minimum years suggests that a rise of 1 in S produces a very small fall, only 0°·014, in α_2. If we use this, and reduce to a common value of S, the mean values of α_2 for the successive sunspot maximum groups of years become 43° 43′, 41° 31′, 38° 33′ and 41° 14′ respectively. This would increase the excess of α_2 for 1859-60 over that for 1892-4 from 2° 16′ to 2° 29′. The time equivalents are respectively 4·5 minutes and 5·0 minutes. Thus we have again a suggestion of a progressive lag in the hour of maximum, but the progression is not at all smooth, the value of α_2 for 1883-4 being outstandingly low.

The sunspot minimum groups of years give erratic results. The low value of α_2 for 1866-7 and the high value for 1878-9 probably owe something to the fact that disturbance was high in 1866-7 and low in 1878-9 as compared with 1888-9.

The wave amplitudes c_3 and c_4 are so much smaller than c_1 and c_2 that changes in α_3 and α_4 are of minor importance. α_3 falls with increase in S or in disturbance. Taking the uncorrected values from the sunspot maximum groups of years in Table XIX we have a progressive fall in α_3. The difference, 8° 37′, between the mean values for 1859-60 and 1892-4 represents a time difference of 11·5 minutes. The results from the sunspot minimum groups of years are again irregular. The difference in disturbance would naturally lower the value of α_3 for 1866-7 and raise that for 1878-9 as compared with that for 1888-9. Thus, on the whole, the evidence from α_3 is in favour of a progressive lag in the time of maximum.

The results from α_4 seem too irregular to carry weight.

§ 11—The Significance of the Progressive Retardation of the Hour of Maximum Declination

A short glance at the seasonal values of α_1 and α_2 in Table XX will suffice. As already pointed out, the winter values for the different groups of years vary erratically. In equinox the sunspot maximum and sunspot minimum values of α_1, especially the former, suggest a progressive fall. In the case of α_2 the equinoctial results point in the same direction, but not at all conclusively.

In summer, both in the sunspot maximum and sunspot minimum groups, the evidence on the whole is slightly in favour of a progressive fall of α_1. The same is true of α_2 in the sunspot maximum groups of years; but in the sunspot minimum groups α_2 is greater for the third than for the first group of years.

The question of a possible retardation in the time of maximum was first considered in connection with the hour of occurrence of the absolute daily maximum.[4] The evidence was on the whole decidedly favourable to a retardation at the rate of about 5 minutes in 30 years. This, of course, strengthens the case now presented in favour of a retardation.

As explained in the *Geophysical Memoir*,[4] we should expect a retardation to arise through the secular change of declination, unless that has been accompanied by a neutralising change in the system of forces to which is due the diurnal variation

[4] *Meteorological Office, Geophysical Memoirs*, No. 22, p. 42.

in the horizontal magnetic components. The maximum declination occurs when the radius vector of the vector diagram for the magnetic forces in the horizontal plane is normal to the magnetic meridian. Between 1860·0 and 1893·5, the mid-epochs of the first and last sunspot maximum groups of years, westerly declination diminished about 4° 10′. Taking the average rate of rotation of the radius vector, 15° per hour, the time equivalent would be about 16·7 minutes. As a matter of fact, the rate of rotation of the radius vector near noon is a little above its average. For example, in the quiet day vector diagram for 1890 to 1900 the average hourly rate between 11 h. and 15 h. was 16¾°, and at this rate the time equivalent of 4° 10′ would be about 15 minutes. This is only a little greater than the time lag derived from the values of α_1 for the earliest and latest groups of sunspot maximum years in Table XIX, but is decidedly in excess of what we should find for the real change if we took account of sunspot minimum as well as sunspot maximum years and of α_2, α_3 and α_4 as well as α_1.

§ 12—The Amplitude of the Fourier Terms in years of Sunspot Maxima and Minima

Tables XXI and XXII contain information as to the relative amplitudes of the different Fourier waves in years of many and few sunspots. The values employed for c_1, c_2, c_3 and c_4 were the arithmetic means from the individual ten years comprising the sunspot maximum group, and from the individual six years comprising the sunspot minimum group. The seasonal values used went one decimal place beyond the figures given in Table XX. Table XXI gives the result obtained by dividing each sunspot maximum mean value by the corresponding sunspot minimum mean value. The amplitude of each of the four waves increases with S, but the increase is decidedly less for c_2 and c_4, especially for c_4, than it is for c_1.

Table XXI—Ratios from Diurnal Inequalities for the Year and the Seasons. Sunspot Maximum Value : Sunspot Minimum Value

	Year	Winter	Equinox	Summer
c_1	1·59	1·67	1·65	1·42
c_2	1·42	1·39	1·46	1·43
c_3	1·58	—	—	—
c_4	1·20	—	—	—

Table XXII—Ratios from Sunspot Maximum and Sunspot Minimum Years

	Inequality for year			c_2/c_1 seasonal inequalities		
	c_2/c_1	c_3/c_1	c_4/c_1	Winter	Equinox	Summer
Sunspot maximum ..	0·628	0·283	0·089	0·515	0·658	0·680
Sunspot minimum ..	0·706	0·286	0·118	0·620	0·742	0·673

This agrees with the results obtained from the 11 years 1890-1900, but that period made the increases for c_3 and c_4 relatively less than according to Table XXI.

According to Table XXII the relative importance of the shorter period Fourier waves in general diminishes as S increases. This is especially true of winter; in summer c_2/c_1 shows little dependence on S. Here again, there is a general agreement with the conclusions of 1890-1900, but in that case the summer value of c_2/c_1 appeared decidedly reduced in the sunspot maximum years.

§ 13—Wolf's Formula applied to the Diurnal Inequality for the year

When dealing with results from all years the best way of determining the constants a and b in Wolf's formula

$$R = a + b\,S$$

is by the method of least squares. But when data are available only from the years of most and fewest sunspots another method must be adopted. The simplest is to arrange the years in two groups representative respectively of sunspot maximum and minimum and to assume that the mean range for each group is given exactly by Wolf's formula, when S is assigned the mean sunspot frequency from the group of years included. Results obtained in this way for the year as a whole are given in Table XXIII for the whole period 1859-94 and for three sub-periods. Wolf's formula was applied to the inequality range and A. D., also to c_1, c_2, c_3 and c_4 as calculated from the mean diurnal inequalities of the several years. In the case of the whole period 1859-94 equal weights were given to the ten years of sunspot maximum, the arithmetic means of the quantities from these ten years being the sunspot maximum data, and the arithmetic means of the corresponding quantities from the six years of sunspot minimum being the sunspot minimum data.

Table XXIII—Values of the Constants in Wolf's Formula; Diurnal Inequality for Whole Year

	a				100b				100b/a			
	1859–72	1870–84	1883–94	1859–94	1859–72	1870–84	1883–94	1859–94	1859–72	1870–84	1883–94	1859–94
Range	6·683	6·488	6·288	6·490	4·426	4·403	4·459	4·403	0·662	0·679	0·709	0·678
A.D.	1·798	1·481	1·579	1·616	0·989	1·252	1·098	1·123	0·550	0·845	0·696	0·695
c_1	2·430	1·958	2·162	2·176	1·441	1·837	1·564	1·648	0·593	0·938	0·724	0·757
c_2	1·686	1·527	1·476	1·559	0·786	0·858	0·855	0·815	0·466	0·562	0·579	0·523
c_3	0·582	0·665	0·612	0·622	0·520	0·419	0·470	0·460	0·893	0·630	0·768	0·740
c_4	0·280	0·265	0·255	0·267	0·054	0·094	0·091	0·066	0·193	0·355	0·357	0·248

The procedure for the sub-periods was a little different. Take, for example, the period 1859-72, consisting of a central group of years 1866 and 1867 representing sunspot minimum and two flanking groups of sunspot maximum years 1859-60 and 1870-72. The mean values of S and of the magnetic quantity, *e.g.* the range, from 1866 and 1867 were taken as representing sunspot minimum. The corresponding values for sunspot maximum were calculated, however, by allowing equal weights to two means, one from the two years 1859 and 1860, the other from the three years 1870, 1871 and 1872. In short, equal weight was attached to the two groups of sunspot maximum years respectively beginning and ending the sub-period, irrespective of whether they included two years or three.

In the case of the range the differences between the sub-periods in Table XXIII are remarkably small, especially as regards the values of b. In the case of the A.D. there is a very sensible difference between the first and second sub-periods, a being high in the former and low in the latter, while the contrary is true of b and of 100 b/a. The behaviour of c_1 is similar to that of the A.D., but c_3 goes the opposite way. The values of 100 b/a are smaller for c_2 and very much smaller for c_4 than those for c_1, c_3, the range or the A.D. The value of 100 b/a for c_4 in the first sub-period is outstandingly small.

§ 14—Wolf's Formula applied to Diurnal Inequalities for Seasons

Table XXIV presents results analogous to Table XXIII, but based on the three seasonal diurnal inequalities. By A.M. is meant the arithmetic mean of the three seasonal values, whether of a, b, or 100 b/a from the three sub-periods. It will be seen that the differences between the results obtained in this way and those in the next column derived by a method which allows equal weight to each year are mostly very small.

As regards a it will be seen that without exception there is a large rise as we pass from winter to equinox, and a further rise, usually fairly substantial, as we pass from equinox to summer. According to Wolf's formula, a represents the value of the magnetic quantity concerned in the ideal year of no sunspots. In this ideal state summer is conspicuously the season when the diurnal inequality is largest.

Table XXIV—Values of Wolf's Formula Constants. Seasonal Diurnal Inequalities

		a					100b					100b/a				
		1859–72	1870–84	1883–94	A.M.	1859–94	1859–72	1870–84	1883–94	A.M.	1859–94	1859–72	1870–84	1883–94	A.M.	1859–94
Range	Winter ..	5·790	3·819	4·525	4·711	4·684	1·795	3·737	2·288	2·607	2·602	0·310	0·979	0·506	0·598	0·556
	Equinox.	7·380	7·403	7·095	7·293	7·292	5·473	5·204	5·917	5·531	5·518	0·742	0·703	0·834	0·760	0·757
	Summer	9·103	8·928	8·896	8·976	8·972	4·898	4·720	4·071	4·563	4·583	0·538	0·529	0·458	0·508	0·511
A.D.	Winter ..	1·165	0·849	0·958	0·991	0·985	0·900	1·143	0·924	0·989	1·016	0·775	1·347	0·965	1·029	1·031
	Equinox	1·938	1·617	1·714	1·756	1·751	1·197	1·403	1·380	1·327	1·356	0·618	0·867	0·805	0·763	0·775
	Summer .	2·374	2·010	2·127	2·170	2·168	0·804	1·174	0·931	0·970	0·953	0·338	0·584	0·438	0·453	0·439
c_1	Winter ..	1·745	1·193	1·477	1·472	1·462	1·195	1·636	1·110	1·314	1·375	0·684	1·371	0.751	0·935	0·941
	Equinox.	2·559	2·115	2·309	2·328	2·318	1·722	1·973	1·865	1·853	1·935	0·673	0·933	0·808	0·805	0·835
	Summer	3·366	2·781	3·007	3·051	3·048	1·206	1·823	1·454	1·494	1·469	0·358	0·656	0·484	0·499	0·482
c_2	Winter ..	1·230	0·796	0·799	0·942	0·937	0·272	0·672	0·612	0·519	0·493	0·221	0·845	0·766	0·611	0·526
	Equinox.	1·942	1·673	1·645	1·753	1·752	0·881	1·085	1·215	1·060	1·022	0·454	0·648	0·739	0·614	0·584
	Summer	1·989	2·132	2·021	2·047	2·048	1·229	0·974	0·867	1·023	1·027	0·618	0·457	0·429	0·501	0·502

When however we pass to b—representing the increase in the magnetic element concerned due to a rise of one in S—we find the equinoctial value invariably the largest, except in the case of c_2 where the summer value exceeds it in the first sub-period and even slightly in the complete period. Except in the case of c_2, the excess of the equinoctial value of b is very substantial. The consequence is that in years of many sunspots equinox comes to the front as the season of large amplitudes.

S generally sensibly exceeds zero at sunspot minimum, and usually falls short of 100 at sunspot maximum. But 100 b/a gives a good idea of the ratio borne by the sunspot influence on the magnetic element at sunspot maximum to the value of the element at sunspot minimum. The values of 100 b/a show more irregularity than those of a or b. In the case of the whole period, the two last columns of Table XXIV agree in making the summer value invariably the least. The same is true of the second and third sub-periods. But in the first sub-period the winter value is the lowest for the range and for c_2, and the summer value for c_2 even exceeds the equinoctial. There is rather a remarkable difference between the range and the A.D. In the case of the range, equinox supplies the largest value of 100 b/a in 4 instances out of 5, while in the case of the A.D. the winter value is invariably the largest.

§ 15—Wolf's Formula applied to Diurnal Inequalities for months

Table XXV gives results for the 12 months of the year obtained in the same way as those for the whole period in Table XXIII. For example, the sunspot maximum data for January were arithmetic means of the ranges and of the values of S from the ten Januarys of the sunspot maximum group of years, while the sunspot minimum data for January were arithmetic means from the six Januarys of the sunspot minimum group of years. The data in the last four lines are simply arithmetic means of the values of a, b, etc., from the twelve or four months of the year included.

Table XXV—Constants of Wolf's Formula and S Statistics

	Range			S. data			
				mean values			
	a	$100b$	$100b/a$	S. Max.	S. Min.	½ (Max. + Min.)	Max. —Min.
January	4·310	2·856	0·663	79·0	8·2	43·6	70·8
February	5·432	3·313	0·610	90·3	10·2	50·2	80·1
March	7·141	5·576	0·781	87·8	9·4	48·6	78·4
April	9·029	5·552	0·615	97·9	6·4	52·1	91·5
May	8·680	4·301	0·495	99·1	5·6	52·3	93·6
June	9·351	4·665	0·499	92·4	7·1	49·8	85·3
July	8·917	4·456	0·500	95·8	5·8	50·8	90·0
August	9·254	4·917	0·531	96·6	8·6	52·6	88·0
September	7·661	5·430	0·709	85·0	7·3	46·1	77·7
October	6·404	4·529	0·707	90·1	7·5	48·8	82·6
November	5·227	2·536	0·485	87·8	7·7	47·8	80·1
December	4·049	2·425	0·599	83·6	8·0	45·8	75·7
Arithmetic means							
12 months	7·121	4·213	0·599	90·5	7·7	49·1	82·8
Winter	4·755	2·783	0·589	85·2	8·5	46·8	76·7
Equinox	7·559	5·272	0·703	90·2	7·7	48·9	82·5
Summer	9·050	4·585	0·506	96·0	6·8	51·4	89·2

The tendency to a minimum in a and in b near midwinter is well shown. In the case of b there is a well marked secondary minimum in summer flanked by maxima in the equinoctial months. In the case of b/a there are again two decided maxima in the equinoctial months with minima in summer and in winter, the former decidedly the more pronounced. The values of b/a for May, June and July are remarkably alike.

The information supplied as to S is partly intended to meet the possibility that the range is affected by the values of S in adjacent months as well as in the current month. If that were the case, the values of b/a would tend to be low or high according as the S differences in the last column of Table XXV were large or small. The S difference is notably low, 70·8, for January, and notably high, 93·6, for May. Now May shows the lowest value of b/a, and the value of b/a for January exceeds the values for the two adjacent months. Thus the figures do rather support the view that the value of S in adjacent months is not wholly immaterial. The difference between the values of b/a for March and April rather points in the same direction.

§ 16—Wolf's Formula applied to Ranges

Table XXVI compares results obtained by applying identical methods to the inequality range I and the absolute range A. In the case of the absolute range each month is of necessity treated separately. The magnetic quantity taken as representing sunspot minimum is the arithmetic mean value of the quantity from the individual months included in the season. The only difference in the case of the magnetic quantity representing sunspot maximum is that equal weight was allowed to the two groups of sunspot maximum years included in the sub-period, irrespective of whether they consisted of two years or three. To get absolutely parallel results for I, the ranges employed were arithmetic means from the included months, not the ranges from seasonal inequalities.

Table XXVI—Inequality Range and Absolute Range of the Constants in Wolf's Formula

	sub-period	Year		Winter		Equinox		Summer	
		I	A	I	A	I	A	I	A
a	1859–72	7·69	14·52	5·92	13·05	8·09	17·22	9·18	13·44
	1870–84	6·75	9·11	3·85	6·76	7·40	9·87	9·00	10·71
	1883–94	6·92	11·19	4·59	9·67	7·20	12·10	8·99	11·81
$100\frac{b}{a}$	1859–72	3·98	4·53	1·92	2·84	4·82	4·52	4·85	5·91
	1870–84	4·69	9·10	3·99	9·65	5·28	10·17	4·73	7·43
	1883–94	4·17	6·19	2·55	5·51	5·90	7·37	4·12	5·72
$100\frac{b}{a}$	1859–72	0·518	0·312	0·324	0·217	0·596	0·263	0·528	0·440
	1870–84	0·695	0·999	1·035	1·427	0·713	1·030	0·526	0·694
	1883–94	0·603	0·553	0·555	0·570	0·820	0·609	0·458	0·484

Absolute ranges are much larger than inequality ranges in disturbed months. This does not, however, necessarily imply that the value of a for the absolute range should be large compared with that for the inequality range, because large absolute ranges might occur only in years of many sunspots. As a matter of fact, however, in Table XXVI the values of a in the A columns are invariably substantially larger, and usually very much larger, than those in the I columns. This is especially true of the first sub-period, for both winter and equinox. In general b is also substantially higher in the A than in the I column, but in one case, equinox 1859-72 the I value is the larger.

In the case of b/a there is rather a marked difference between the two earlier sub-periods. In the first the inequality range invariably supplies the larger value of b/a, whereas in the second the absolute range value is invariably the larger. In the case of the absolute range the values of b/a for the first sub-period all appear abnormally low as compared with those for the later periods. Whereas in the case of the inequality range the summer value of b/a for the first sub-period is actually slightly the largest ; it is only the winter value for the first sub-period, that appears outstandingly low. The differences between the three sub-periods are very much less in the I than in the A columns.

There seems little doubt that magnetic disturbance is the ultimate cause of the difference between the phenomena from the inequality and absolute ranges. When we deal with whole years or even 4-month seasons we have less to fear from the possible influence of S in adjacent months. According to Table XXVII the differences between the seasonal values of the S quantities involved are mostly small. The largest is between the summer and winter values of the S maximum—S minimum difference for 1859-72, the former being outstandingly large and the latter outstandingly small. But as Table XXVI shows, it is the winter value of b/a that stands out, and it is exceptionally *small.*

TABLE XXVII—MEAN VALUES OF S DATA

	1859–72				1870–84				1883–94			
	S.max.	S. min.	mean	Diff.	S.max.	S. min.	mean	Diff.	S.max.	S. min.	mean	Diff.
Winter	97·7	14·5	56·1	83·2	86·3	4·4	45·4	81·9	70·2	6·7	38·5	63·5
Equinox	108·7	12·7	60·7	96·0	95·2	4·9	50·0	90·3	68·3	5·5	36·9	62·8
Summer	111·8	8·2	60·0	103·6	89·9	4·7	47·3	85·2	74·7	7·4	41·0	67·3

The precise way in which high values are obtained for a and low values for b in winter 1859-92 is easily followed. Here are the corresponding data from 1859-60 and 1866-67.

	January		February		November		December	
	1859–60	1866–67	1859–60	1866–67	1859–60	1866–67	1859–60	1866–67
Value of S	82·6	15·8	87·8	19·6	97·5	9·2	88·3	13·4
Absolute Range ..	12′·28	12′·09	16′·39	17′·64	13′·56	14′·68	14′·02	9′·42
Inequality Range ..	6·61	5·63	9·03	7·22	7·44	7·15	6·28	4·78

In two of the four months the absolute range is actually larger for the sunspot minimum than the sunspot maximum years, in spite of the large excess in the value of S for the latter ; and in a third month, January, the excess of the sunspot maximum absolute range is trifling. While the phenomena are not so anomalous in the case of the inequality range, the excesses of the sunspot maximum over the sunspot minimum ranges are small, in view of the large excesses of S, especially in November.

The most outstanding month was February, 1866. S having the value 38·4—high, of course, for a sunspot minimum year, but still below the average—the absolute range was 21′·52, as compared with 17′·17 in February 1859, when S was 87·6, and 21′·24 in February 1870, when S was 114·9. In February 1866 the absolute range exceeded 20′ on 13 days, as against 10 days in February 1870, the year of largest sunspot frequency of the century.

In short, the value of S is in no way a trustworthy indication of contemporaneous disturbance. Contemporaneously with a very moderate value of S we may have a very large amount of disturbance, and the disturbance runs up the daily range, especially the absolute daily range.

In *Geophysical Memoirs* No. 22 where values were calculated for a and b from absolute ranges, the value obtained for b/a from the earliest of the four sub-periods then taken, which was comprised of the years 1858 to 1867, was outstandingly low. Judging by the results of the present paper, that phenomenon must be ascribed mainly to the fact that for sunspot minimum years 1866 and 1867 were unusually disturbed. It is instructive in this connection to compare the values calculated for ideal state $S = 0$ from the absolute and inequality ranges of the six sunspot minimum years, employing the appropriate values obtained for b from the whole period 1859-72.

	1866	1867	1878	1879	1888	1889
	′	′	′	′	′	′
Arithmetic mean of all day absolute ranges ..	14·85	13·68	9·23	9·16	11·74	10·57
Arithmetic mean of 12 monthly inequality ranges	7·68	7·63	6·70	6·82	7·07	6·76
Range of mean diurnal inequality for the year ..	6·52	6·85	6·38	6·60	6·38	6·20

The figures in the last line show a very much closer approach to equality than those in the first line

APPENDIX

In the *Scientific Papers* of Henry Cavendish, Vol. II, p. 489, a table, No. XVI, compares certain results bearing on the diurnal variation of declination given by Cavendish with results from 1890 and 1893. The principal object was to show the large amplitude of the diurnal variation in the early years, especially in two years of large sunspot frequency 1778 ($S = 154{\cdot}4$) and 1788 ($S = 130{\cdot}9$). The results for 1788 were based on readings at hourly or two-hourly intervals on every day of June, at some station apparently in London. They were described by Cavendish as taken with "Mr. Gilpin's obs(erving) needle." The data in the Cavendish volume commence at 7h., but the Cavendish MS. contained complete data also for 6h. Taking the 6-hour value as the point of departure 0′·0, we have the following results for 1788 and for 1870, which according to Wolf and Wolfer was a year of fairly similar sunspot frequency.

	6h.	7h.	8h.	10h.	12h.	13h.	14h.	16h.	18h.	20h.	22h.	23h.
1788	0′·0	+0′·1	+0′·7	+8′·4	+17′·4	+19′·3	+19′·3	+13′·4	+7′·5	+6′·3	+5′·9	+5′·8
1870	0·0	−0·5	−0·2	+5·6	+13·4	+14·6	+14·5	+11·0	+7·8	+6·9	+6·6	+6·1

No data for hours earlier than 6h. are given in the Cavendish MS., but it is clear from the above that the principal minimum (easterly extreme) occurred decidedly earlier in 1788 than in 1870. In all the years of sunspot maximum from 1859 onwards, the minimum appeared as early as 6h. in only one, 1884 (when D was lower by 0′·05 at 6h. than at 7h.), and for a sunspot maximum year 1884 had a very low value of S. Even amongst the sunspot minimum years—when, as we have seen, maxima and minima occur earlier than in sunspot maximum years—only two had the minimum as early as 6h. Thus the above result affords support to the view that a secular retardation has occurred.

A possible explanation is given in the Cavendish volume of the relatively large size of the regular diurnal variation of declination near the end of the 18th century as compared with the present day.

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