Fig. 2 is a sketch of the low-resistance combination, showing the hole into which the Thomson cell is inserted.

Fig. 3 shows the portable arrangement to prevent fracture of the silk suspension.

February 25, 1886.

Professor STOKES, D.C.L., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "On a Comparison between Apparent Inequalities of Short Period in Sun-spot Areas and in Diurnal Declination-ranges at Toronto and at Prague. By BALFOUR STEWART, M.A., LL.D., F.R.S., and WILLIAM LANT CARPENTER, B.A., B.Sc. Received February 17. Read February 25, 1886.

1. In a report to the Solar Physics Committee ("Proc. Roy. Soc.," vol. 37, p. 290, 1884) we discussed the relations between certain apparent Inequalities of short periods in sun-spot areas on the one hand and diurnal temperature-ranges at Toronto and at Kew of corresponding periods on the other.

In the present communication we proceed to discuss the connexion between the same solar Inequalities and the diurnal declination-ranges at Toronto and at Prague.

For the Toronto declination-ranges we are indebted to the kindness of the Science and Art Department, South Kensington, and of Mr. Carpmael, Director of the Toronto Observatory, through whom we have received daily values (excluding Sundays) of the diurnal range of magnetic declination at Toronto extending from 1856 to 1879 inclusive, and thus forming a series of 24 years.

Each number is the difference in scale-divisions of the declinometer between the greatest eastern and the greatest western deflection of the declination magnet on each day, as observed at the hours 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight of Toronto mean time, one scale-division of the instrument being equal to 0′·72 nearly. It is probable that such differences represent very nearly the true diurnal range.

Disturbances appear to be violent at Toronto, and we have rejected

a few of the most disturbed observations, embracing those which denote ranges above forty scale-divisions, or 28′·8. Although this rejection has been made, it must not be supposed that the remainder are entirely undisturbed, but only that they are freed from the excessive influence of the most violent disturbances.

We have extracted the Prague ranges from the published records of that Observatory, and we have not found it necessary to exclude disturbances except in one or two very marked cases. The Prague ranges are derived from observations made at 6 A.M., 10 A.M., 2 P.M., and 10 P.M., hours which are common to the whole series, and there is reason to believe that the ranges thus deduced are not greatly different from those which would have been obtained from an hourly series of observations.

2. The declination-ranges of the present paper have been reduced exactly in the same manner as the temperature-ranges of our previous report (" Proc. Roy. Soc.," May 1, 1884, vol. 37, p. 290). It is therefore unnecessary to discuss the method of reduction, this having been already done at considerable length.

We proceed consequently at once to consider—

Results of Comparison around 24 *Days.*

3. *Comparison as to Duration of Period.*—This is given in the following table, in which the sun-spot and Toronto temperature columns are transcribed from our former paper for the purpose of comparison. The sums in these columns are those of 36 years. The Prague declination columns exhibit likewise sums of 36 years, while the Toronto declination columns exhibit sums of 24 years. As in our last paper, to save space we have divided each individual sum by 100; that is to say, we have dismissed the two right hand figures.

We have inclosed in brackets the positions of all sufficiently well-defined maximum Inequalities of sun-spots, of Toronto temperature-ranges, and of Prague declination-ranges. But inasmuch as the Toronto declination-ranges only extend over 24 years, we have merely exhibited the numbers without brackets, believing these to be of inferior accuracy.

Before the table is examined it may be well for the reader to be reminded that the sun-spot areas extend from 1832 to 1867 inclusive, thus embracing 36 years; that the Toronto temperature and the Prague declination-ranges extend from 1844 to 1879 inclusive, thus embracing 36 years; while the Toronto declination-ranges extend from 1856 to 1879 inclusive, thus embracing 24 years. It thus appears that the Toronto temperature and the Prague declination-ranges are for the same 36 years, 24 of which they have in common with the sun-spot series. On the other hand, the Toronto declination

Table I.—Apparent Inequalities around 24 days (SS = Sun-spots; TT = Toronto Temperature-ranges; PD = Prague Declination-ranges; TD = Toronto Declination-ranges).

Period.	SS.	TT.	PD.	TD.	Period.	SS.	TT.	PD.	TD.	Period.	SS.	TT.	PD.	TD.
− 48	94	27	35	31	− 15	131	(76)	47	19	+ 17	241	61	80	31
− 47	98	29	32	28	− 14	162	71	50	22	+ 18	276	71	(82)	25
− 46	104	48	27	31	− 13	236	66	55	17	+ 19	(292)	78	79	17
− 45	131	(50)	41	32	− 12	228	58	53	20	+ 20	241	(81)	65	12
− 44	162	41	50	35	− 11	251	51	59	23	+ 21	227	75	55	17
− 43	214	38	(61)	39	− 10	248	48	(59)	29	+ 22	220	64	41	23
− 42	233	37	51	39	− 9	256	41	57	33	+ 23	151	48	32	35
− 41	258	38	45	38	− 8	(257)	34	56	35	+ 24	146	43	36	40
− 40	(288)	45	33	43	− 7	233	29	48	39	+ 25	141	52	41	43
− 39	255	45	33	44	− 6	232	40	43	40	+ 26	(155)	64	55	47
− 38	216	(46)	36	46	− 5	225	52	35	40	+ 27	150	(68)	62	46
− 37	175	42	36	53	− 4	117	(65)	29	50	+ 28	143	67	(63)	46
− 36	111	42	38	58	− 3	165	64	34	52	+ 29	153	61	49	46
− 35	93	48	51	63	− 2	179	45	41	53	+ 30	176	59	44	48
− 34	107	47	60	67	− 1	267	35	55	50	+ 31	223	55	37	50
− 33	149	(50)	(64)	70	0	264	37	55	52	+ 32	277	44	26	49
− 32	192	46	62	71	+ 1	272	42	57	55	+ 33	321	(48)	22	53
− 31	221	33	51	64	+ 2	(303)	42	56	47	+ 34	(332)	46	21	55
− 30	(236)	18	43	63	+ 3	259	(49)	58	49	+ 35	332	43	36	56
− 29	233	24	35	59	+ 4	225	43	(61)	50	+ 36	322	39	48	58
− 28	221	26	30	48	+ 5	208	48	44	39	+ 37	294	45	(61)	59
− 27	189	29	39	43	+ 6	203	49	46	37	+ 38	243	56	59	60
− 26	179	30	52	37	+ 7	172	57	(47)	36	+ 39	197	65	51	60
− 25	176	43	61	24	+ 8	169	(66)	35	27	+ 40	175	(68)	50	60
− 24	163	56	70	19	+ 9	189	63	36	30	+ 41	239	47	(68)	66
− 23	165	63	(75)	15	+ 10	202	55	36	31	+ 42	286	30	67	67
− 22	115	65	66	22	+ 11	204	45	39	28	+ 43	332	22	58	67
− 21	114	66	69	27	+ 12	(241)	32	41	28	+ 44	(365)	27	(63)	70
− 20	103	69	63	31	+ 13	214	19	49	27	+ 45	362	35	45	67
− 19	160	70	52	23	+ 14	178	23	63	32	+ 46	345	42	29	62
− 18	(179)	67	52	25	+ 15	174	31	71	32	+ 47	283	47	40	67
− 17	174	67	52	27	+ 16	209	42	(76)	30	+ 48	269	47	33	60
− 16	104	74	41	17	..	..	..	..	..	..	..	..	..	..

series of 24 years has its 24 years in common with the Prague series, but only 12 years in common with the sun-spot series.

Confining our comparisons in period to sun-spots, Toronto temperature, and Prague declination-ranges, it will be seen that on the whole the positions of maximum apparent Inequality for sun-spots are near those for Toronto temperature and Prague declination. It may be desirable here to repeat the remark which we made in our previous communication, that while this likeness cannot be considered as conclusively proving a connexion, it is nevertheless the sort of similarity which might be expected to exist between phenomena physically connected, but which contain so many apparent Inequalities, and these so near together, that our series of observations is not sufficiently extensive to enable us to eliminate their influence upon each other, or to allow us to ascertain their true positions.

We may likewise remark that in our opinion there is not a greater correspondence between sun-spots and declination-ranges than between sun-spots and temperature-ranges.

4. *Comparison in Phase.*—For this purpose we have treated the Toronto declination and the Prague declination Inequalities *exactly* in the way in which we treated the temperature-range Inequalities of our previous paper, so that the Inequalities of the following table (Table II) are quite comparable with those of our previous paper; they are indeed virtually the same Inequalities. The only difference is that we have in Table II set for calculation in each case from the corresponding sun-spot minimum, which seems to be the most convenient starting point when comparing together Inequalities such as those of this table, which as a rule have only one prominent maximum in their period. It thus appears that here the settings have been arranged by strictly *celestial* considerations. If, therefore, there is no connexion between these terrestrial and solar Inequalities, the declination-range maxima should be distributed impartially up and down the table without any other than chance grouping together. Their behaviour is, however, very different from this—the maxima being comparatively closely grouped together about a position a couple of days after the corresponding sun-spot maximum.

5. *Constancy of Type in the various Inequalities.*—There is a very considerable constancy of type in the declination Inequalities which, as already stated, have only one prominent maximum. Nevertheless, as will be seen both from Table II and from the diagram which accompanies this paper, there is a tendency to duplicity of phase in the terrestrial that is entirely wanting in the solar Inequalities.

Table II.—Comparison of Sun-spot and Declination Inequalities around 24 Days.*

Symbol.	Period in Days.	Date of first number (in January, 1832).
24_{-39}	23·7862	January 1 or January 25.
24_{-33}	23·8193	„ 5 „ 29.
24_{+18}	24·0985	„ 20
24_{+33}	24·1807	„ 17
24_{+40}	24·2190	„ 21

Toronto declination.						Sun-spots.						Prague declination.					
− 39	− 33	+ 18	+ 33	+ 40	Mean.	− 39	− 33	+ 18	+ 33	+ 40	Mean.	− 39	− 33	+ 18	+ 33	+ 40	Mean.
−114	−176	− 47	− 19	−131	− 97	−574	−539	−554	−421	−690	−556	− 99	− 80	−205	− 37	− 60	− 96
−101	−221	− 52	− 23	−131	−106	−526	−472	−499	−398	−639	−507	−103	− 85	−154	− 54	−128	−105
− 90	−261	− 64	− 46	−132	−119	−436	−360	−401	−372	−549	−424	− 88	− 81	−107	− 46	−178	−100
− 84	−275	− 79	− 66	−136	−128	−303	−234	−260	−340	−428	−313	− 62	− 56	− 60	− 24	−198	− 80
− 90	−221	− 29	− 69	−117	−105	−156	−111	− 94	−280	−289	−186	− 17	− 16	− 7	− 14	−190	− 49
− 87	−128	+ 36	− 31	− 78	− 58	− 9	+ 13	+ 66	−179	−139	− 50	+ 28	+ 26	+ 58	− 15	−146	− 10
− 75	− 6	+ 95	+ 20	− 25	+ 2	+125	+137	+206	− 28	+ 20	+ 92	+ 43	+ 52	+121	− 24	− 67	+ 25
− 37	+110	+108	+ 66	+ 41	+ 58	+233	+249	+314	+162	+198	+231	+ 56	+ 55	+154	− 29	+ 21	+ 52
− 1	+162	+ 71	+119	+ 88	+ 88	+331	+325	+381	+350	+365	+350	+ 49	+ 41	+159	− 31	+ 74	+ 58
+ 58	+174	+ 18	+155	+129	+107	+394	+349	+413	+505	+514	+435	+ 37	+ 19	+118	− 7	+ 98	+ 53
+121	+151	− 33	+182	+161	+116	+422	+339	+427	+606	+614	+482	+ 40	+ 30	+ 78	+ 19	+113	+ 56
+158	+111	− 32	+205	+173	+123	+412	+328	+431	+637	+643	+490	+ 35	+ 58	+ 54	+ 41	+114	+ 60
+194	+102	− 12	+217	+199	+140	+364	+330	+438	+615	+623	+474	+ 42	+109	+ 49	+ 68	+134	+ 80
+193	+110	+ 19	+184	+211	+143	+326	+350	+436	+558	+574	+449	+ 56	+153	+ 76	+ 64	+146	+ 99
+153	+139	+ 67	+115	+200	+135	+306	+354	+402	+464	+515	+408	+ 54	+143	+104	+ 57	+114	+ 94
+110	+174	+ 80	+ 49	+170	+117	+292	+330	+324	+344	+450	+348	+ 59	+ 99	+115	+ 46	+ 72	+ 78
+ 66	+176	+ 71	− 70	+ 99	+ 68	+273	+259	+196	+182	+364	+255	+ 61	+ 28	+114	+ 27	+ 2	+ 46
+ 11	+158	+ 35	−149	+ 26	+ 16	+203	+148	+ 45	− 11	+235	+124	+ 47	− 40	+ 93	+ 10	− 41	+ 14
− 10	+112	− 11	−188	− 61	− 32	+ 87	+ 21	− 98	−199	+ 61	− 26	+ 22	− 76	+ 38	− 9	− 30	− 11
− 24	+ 30	− 41	−221	−120	− 75	− 66	− 99	−225	−359	−148	−179	− 7	− 92	− 23	− 10	− 6	− 27
− 57	− 45	− 57	−179	−139	− 95	−237	−228	−330	−447	−362	−321	− 38	− 82	−110	− 13	+ 39	− 40
− 74	− 94	− 56	−136	−158	−104	−389	−351	−425	−475	−533	−435	− 65	− 72	−193	+ 3	+ 71	− 51
− 97	−135	− 52	− 85	−143	−102	−504	−461	−498	−470	−648	−516	− 70	− 68	−232	+ 4	+ 49	− 63
−123	−147	− 35	− 30	−126	− 92	−568	−536	−545	−444	−703	−559	− 80	− 65	−240	− 26	− 3	− 83

* In this table all the Inequalities are aggregated for 12 years, and have all been equalised in the same manner.

Table III.—Apparent Inequalities around 26 days (SS = Sun-spots; TT = Toronto Temperature-ranges; PD = Prague Declination-ranges; TD = Toronto Declination-ranges).

N.B.—In this table two or three more numbers of SS and TT are bracketed than in the corresponding tables of our previous paper.

Period.	SS.	TT.	PD.	TD.	Period.	SS.	TT.	PD.	TD.	Period.	SS.	TT.	PD.	TD.
− 48	(456)	53	58	50	− 16	327	31	59	51	+ 16	496	57	(90)	28
− 47	453	60	(60)	55	− 15	394	40	66	48	+ 17	280	63	75	40
− 46	451	59	56	53	− 14	456	54	68	46	+ 18	345	54	70	45
− 45	407	56	56	55	− 13	429	50	80	45	+ 19	280	41	66	48
− 44	321	61	55	57	− 12	459	68	93	51	+ 20	234	42	60	53
− 43	273	68	44	44	− 11	(472)	(80)	101	58	+ 21	247	47	55	50
− 42	271	63	54	45	− 10	345	68	(105)	63	+ 22	234	48	50	44
− 41	259	69	61	44	− 9	320	63	103	68	+ 23	290	58	41	47
− 40	180	48	70	53	− 8	266	68	105	69	+ 24	304	57	39	45
− 39	168	39	75	52	− 7	124	67	(117)	78	+ 25	(340)	51	38	40
− 38	167	60	86	54	− 6	128	63	114	78	+ 26	322	37	36	48
− 37	149	59	106	47	− 5	159	(68)	106	73	+ 27	321	47	35	48
− 36	168	(60)	118	43	− 4	231	55	95	76	+ 28	315	73	38	50
− 35	205	51	(124)	47	− 3	284	49	79	73	+ 29	230	(88)	47	49
− 34	276	48	119	47	− 2	(340)	37	60	68	+ 30	218	61	55	48
− 33	296	43	111	51	− 1	304	44	49	66	+ 31	179	52	60	48
− 32	317	28	105	49	0	319	44	47	62	+ 32	140	(70)	70	48
− 31	384	58	101	33	+ 1	320	43	56	63	+ 33	115	68	(71)	45
− 30	382	60	85	41	+ 2	213	49	58	50	+ 34	168	55	66	42
− 29	(410)	(62)	65	49	+ 3	218	(51)	(67)	48	+ 35	211	43	66	41
− 28	387	58	57	56	+ 4	(232)	48	66	46	+ 36	269	44	56	40
− 27	373	50	59	58	+ 5	137	45	59	40	+ 37	320	55	45	37
− 26	350	40	63	54	+ 6	181	44	54	43	+ 38	411	66	50	44
− 25	351	44	67	55	+ 7	212	43	51	47	+ 39	493	69	45	46
− 24	332	53	72	51	+ 8	200	57	38	36	+ 40	552	62	45	46
− 23	287	51	68	53	+ 9	238	78	34	38	+ 41	619	73	43	50
− 22	(337)	(72)	(77)	60	+ 10	308	(84)	44	40	+ 42	632	(73)	49	45
− 21	297	71	69	56	+ 11	358	70	59	31	+ 43	(637)	70	(56)	41
− 20	240	59	64	49	+ 12	425	(80)	66	33	+ 44	596	47	43	41
− 19	297	56	62	53	+ 13	478	74	74	34	+ 45	559	42	42	41
− 18	264	43	55	55	+ 14	481	69	80	29	+ 46	510	..	39	39
− 17	292	36	52	54	+ 15	(503)	58	87	28	+ 47	374	..	47	41
..	..	..	..	..	..	..	..	..	..	+ 48	..	..	57	44

Results of Comparison around 26 Days.

6. *Comparison as to Duration of Period.*—This is exhibited in Table III, which is precisely analogous to Table I. The same remarks, too, are applicable to both tables, and it will be observed that here, as in the former table, the positions of maximum Inequality for sun-spots, are, on the whole, near those for Toronto temperature and Prague declination. Nor is there, in our opinion, a greater correspondence between sun-spots and declination-ranges than between sun-spots and temperature-ranges.

7. *Comparison in Phase.*—This comparison is exhibited in Table IV, which is precisely analogous to Table VI of our previous communication, except that here we have introduced the Inequality −52, which we had omitted from Table VI, because the Toronto Inequality was not sufficiently near the type. It will be noticed from Table IV, that at least as far as regards the Toronto declination, the constancy of phase is not so evident as for the Inequalities around 24 days. It will likewise be remarked, that while the chief Toronto declination maximum, like that for Inequalities around 24 days, follows a little after the sun-spot maximum, the chief Prague declination maximum decidedly precedes the other two. It thus appears that the similarity in time of maximum between the two declination stations which holds for Inequalities around 24 days (Table II) does not hold for Inequalities around 26 days.

Broadly speaking, in both cases there are appearances of duplicity of phase, but in the case of Toronto the same maximum has remained the predominant one in both tables, while in the case of Prague the predominant maximum for the 24-day Inequalities has become the subsidiary maximum for those around 26 days.

8. In attempted explanation of this we would in the first place desire to repeat the remark we made in our previous communication, namely, that there are two possible kinds of periodicity with regard to sun-spots, and that it is not necessary to regard the Inequalities around 24 days and those around 26 days as perfectly similar phenomena. Again, as regards the evidence we gave in a footnote to that communication, tending to show that the Inequalities around 26 days might denote the synodic periods with respect to the earth of those around 24 days, this evidence is, we find, borne out by the declination results. We prefer, however, to wait until we have accumulated more information before we venture to discuss this important subject. Meanwhile we shall content ourselves with remarking that the similarity between the two stations, Toronto and Prague, for the one set of magnetic Inequalities, and their dissimilarity for the other, is at first sight in favour of the theory of a physical difference of some sort between the two. We

Table IV.—Comparison of Sun-spot and Declination Inequalities around 26 Days.*

Symbol.	Period in days.	Date of first number (in January, 1832).
26_{-52}	25·6915	January 22.
26_{-29}	25·8279	,, 16.
26_{-11}	25·9347	,, 7.
26_{+10}	26·0593	,, 17.
26_{+42}	26·2492	,, 7.

Toronto declination.						Sun-spots.						Prague declination.					
− 52	− 29	− 11	+ 10	+ 42	Mean.	− 52	− 29	− 11	+ 10	+ 42	Mean.	− 52	− 29	− 11	+ 10	+ 42	Mean.
−125	+ 50	−176	+138	− 82	−39	− 977	−818	−887	− 852	−1036	−914	−175	−143	−176	+ 62	+ 4	− 86
−123	0	−121	+131	− 15	−26	−1103	−763	−855	− 862	− 996	−916	−152	−146	−132	+100	+ 55	− 55
− 82	− 58	− 49	+111	+ 41	− 7	− 805	−659	−779	− 789	− 926	−792	−107	−155	− 27	+124	+102	− 12
− 31	−100	+ 10	+ 46	+ 53	− 4	− 507	−502	−603	− 665	− 791	−614	− 47	−121	+138	+111	+131	+ 42
− 32	−141	+ 62	− 40	+ 22	−26	− 229	−308	−361	− 499	− 555	−390	+ 35	− 36	+266	+ 73	+101	+ 88
− 35	−170	+108	−129	− 27	−51	+ 51	−101	− 81	− 282	− 273	−137	+140	+ 73	+332	+ 48	+ 64	+131
− 34	−143	+167	−153	− 69	−46	+ 334	+ 91	+141	− 28	− 11	+105	+194	+121	+298	+ 12	− 16	+122
+ 1	− 74	+186	−123	−120	−26	+ 310	+286	+294	+ 253	+ 208	+270	+186	+103	+212	+ 21	− 58	+ 93
− 4	+ 31	+156	− 51	−170	− 8	+ 383	+463	+372	+ 537	+ 427	+436	+158	+ 54	+126	+ 25	−102	+ 52
+ 12	+117	+ 66	− 21	−163	+ 2	+ 389	+599	+414	+ 806	+ 699	+581	+157	+ 53	+ 85	+ 66	− 55	+ 61
+ 46	+166	− 28	− 4	−107	+15	+ 486	+661	+441	+1007	+ 981	+715	+148	+ 79	+ 87	+ 51	− 13	+ 71
+119	+153	− 85	− 14	− 32	+28	+ 604	+659	+466	+1107	+1248	+817	+107	+114	+ 67	+ 5	+ 21	+ 63
+177	+100	− 96	− 6	− 35	+28	+ 721	+637	+512	+1097	+1404	+874	+ 59	+105	+ 15	− 63	− 33	+ 17
+209	+ 38	− 58	+ 6	− 60	+27	+ 796	+586	+588	+1015	+1412	+879	+ 21	+ 67	− 33	− 71	− 59	− 15
+203	+ 11	− 27	+ 35	− 50	+34	+ 560	+560	+687	+ 868	+1258	+787	+ 14	+ 37	− 35	− 38	− 11	− 7
+158	− 6	+ 11	+ 71	+ 22	+51	+ 384	+514	+771	+ 662	+1013	+669	− 22	+ 32	− 27	− 20	+ 68	+ 6
+ 97	− 23	+ 54	+ 72	+122	+64	+ 558	+475	+767	+ 381	+ 752	+587	− 24	+ 68	− 57	− 25	+109	+ 14
+ 26	− 76	+110	+ 18	+160	+48	+ 491	+383	+645	+ 85	+ 486	+418	− 71	+ 60	−126	− 49	+ 64	− 24
− 35	− 90	+140	− 47	+190	+32	+ 551	+273	+422	− 159	+ 197	+257	− 81	+ 45	−145	− 37	+ 18	− 40
− 66	− 85	+119	− 95	+165	+ 8	+ 365	+116	+188	− 313	− 123	+ 47	−106	+ 2	−109	− 19	− 21	− 51
− 73	− 29	+ 60	− 87	+153	+ 5	+ 169	− 68	− 28	− 408	− 455	−158	− 48	− 2	− 60	− 23	− 51	− 37
− 53	+ 16	− 8	− 58	+104	+ 0	− 131	−296	−238	− 473	− 748	−377	− 21	− 14	− 75	− 65	− 74	− 50
− 78	+ 54	− 84	− 6	+ 52	−12	− 526	−504	−469	− 517	− 960	−595	− 3	− 37	−136	−102	− 85	− 73
− 81	+ 77	−140	+ 29	+ 2	−23	− 867	−679	−687	− 562	−1062	−771	− 68	− 87	−161	−112	− 72	−100
− 98	+ 87	−184	+ 74	− 66	−37	− 931	−778	−833	− 644	−1084	−854	−118	−129	−167	− 61	− 52	−105
− 98	+ 95	−193	+103	− 90	−37	−1076	−827	−887	− 765	−1065	−924	−176	−143	−160	− 13	− 35	−105

* In this Table all the Inequalities are aggregates for 12 years, and have all been equalised in the same manner.

have used the words *at first sight*, because, apart altogether from the comparatively small number of the Inequalities discussed, there is a strictly terrestrial consideration which we must not lose sight of.

It is well known to all magneticians that we have not as yet arrived at any wholly satisfactory method of separating between the disturbed and the undisturbed magnetic observations, and the results now exhibited have unquestionably been deduced from observations which include a good many disturbances. Now under these circumstances the effects of disturbances would only disappear from our results on the hypothesis that such effects have no reference whatever to the periodicities of which we have been treating—that they are, in fact, non-periodic—so that they will become eliminated in a sufficiently extensive series of observations. But we have much reason to suppose that this is not the case, for the observations of Professor Loomis and of Mr. John Allan Broun would seem to indicate that short-period Inequalities of sun-spots occasion terrestrial magnetic disturbances, which follow closely on the celestial phenomena, so that a maximum of sun-spots is quickly followed by a maximum of disturbance. Now in the preceding tables we have discussed some of the most prominent solar Inequalities in connexion with their magnetic effects, and doubtless the result we have obtained is a composite one, its components being an Inequality of solar diurnal declination-range (undisturbed), and an Inequality of disturbance declination-range. We may add that Toronto is a station where the disturbance is great, and also that the sun-spot Inequalities around 26 days are greater than those around 24 days.

Attempted Elimination of Disturbances.

9. All these considerations point to the necessity of eliminating as much as possible the effect of disturbances before we venture to discuss our results. We have attempted to do this in the following manner :—

First of all, we would remind the reader that the Inequalities around 24 and 26 days that we have been dealing with are most probably not *all* the Inequalities around these periods, but only the larger specimens of them.

We remarked in our previous communication that observations founded on sun-spots might present the same variety of period, when treated as we have treated them, which they presented when treated in another way by Carrington, who found that the spots in one solar latitude had a different period of rotation from those in another. If there be any truth in this remark, we might expect that the few solar Inequalities which we have exhibited are only the most prominent members of a comparatively large series, packed, it may be, so

closely together that we cannot disentangle them completely by our limited series of observations. Now it is probable that magnetic disturbances would limit themselves in great measure to the especially large solar Inequalities, so that if we could find some method of treating not merely the *larger* but *all* the Inequalities, we might probably rid ourselves to a considerable extent of the influence of disturbance. But by our method we have the means of doing this. We possess for each element, for each period altogether over 100 series, representing Inequalities extending from -52 to $+52$ of our notation.

Furthermore, we have the same series of 24 years common to Toronto declination, Kew temperature, and Prague declination, and it is with this common series that we have made a comparison as follows. The Kew temperature Inequalities have virtually only one maximum and one minimum, and we have selected all those in which it is possible to ascertain accurately the position of the maximum, that is to say, all those which are according to type. Now let the Toronto and Prague declination Inequalities be set in all cases so as to start from the maximum of the corresponding Kew temperature Inequality, using of course for this purpose not the whole 36 years of Prague observations, but only 24 of these. We are thus comparing 24 years of simultaneous declination records at Toronto and at Prague, the setting being in each case from the maximum of the corresponding Kew temperature record for the same 24 years.

In this comparison all the Inequalities, great and small, may be imagined as made use of, and the influence of disturbance eliminated at least to a great extent.

10. The results of this process are exhibited in the following table, and they may be at once compared with those given in Tables II and IV. For the purpose of this comparison we have transferred the starting points of the modified Inequalities to the solar minimum, so as to make them comparable with those of the previous tables. We can easily make the change from the knowledge derived from our previous paper that the Kew temperature maximum is about 2 days before the solar maximum.

The Toronto declination Inequality for 24 days is not greatly altered by the modified process.

In the Prague declination Inequality for 24 days the modification produced causes the two maxima to be more clearly separated from one another.

In both of these Inequalities as modified, the great maximum is not long after the solar maximum.

If we turn next to the Inequalities around 26 days, we find that for Toronto the subsidiary maximum of Table IV becomes when modified the predominant one, and the prominent maximum of Table IV the

subsidiary one, while there is no striking alteration in the Prague Inequality.

Table V.—Modified Values with Disturbances supposed to be Reduced.

Toronto declination, 24 days.	Prague declination, 24 days.	Toronto declination, 26 days.	Prague declination, 26 days.
−31	− 7	+38	+60
−29	− 9	+37	+64
−22	−11	+39	+63
−12	−12	+37	+71
− 7	− 9	+36	+61
+ 1	− 1	+23	+50
+ 9	+ 3	+ 5	+30
+17	+ 5	−10	+28
+29	+ 5	−19	+32
+36	− 4	−19	+30
+41	− 9	−26	+16
+44	−12	−31	−15
+40	−13	−43	−40
+37	+ 1	−41	−59
+29	+17	−29	−55
+14	+29	−12	−38
− 1	+36	+ 3	−16
−17	+33	+ 7	− 6
−30	+18	+ 1	− 8
−32	+ 1	−17	−36
−31	−12	−29	−67
−27	−20	−24	−98
−27	−18	− 4	−84
−31	−11	+16	−44
..	..	+29	+10
..	..	+33	+51

Thus the result has been to do away with that want of similarity between the Toronto and Prague 26-day Inequalities which appeared in Table IV, and to substitute two series in which the predominant maximum of the one is near in position to that of the other, and the subsidiary maximum of the one near in position to that of the other.

Nevertheless, the predominant maxima of the 24-day Inequalities agree most nearly in position with the subsidiary maxima of the 26-day Inequalities. In fine, the Inequalities around 26 days are different from those around 24 days in much the same way for both stations.

11. It appears to us that these results are in favour of there being some physical difference between the Inequalities around 24 days and those around 26 days, or at least we may use this as a working hypothesis. Professor Stokes has suggested that an outbreak of solar

activity would probably alter the quality as well as the quantity of the solar rays, so as to bring in a greater proportion of those which are absorbed in the upper regions of the atmosphere. We might probably thus expect a set of terrestrial actions following promptly after the solar outbreak. This is similar to what we have more especially in the magnetic Inequalities around 24 days.

On the other hand, if the Inequalities around 26 days are due to the earth's being placed in a favourable position for receiving the solar influence, we shall have a state of things physically different from that which we imagine to characterise the Inequalities around 24 days, and in our ignorance of the exact way in which the sun influences the magnetism of the earth, we cannot assert that the Inequality produced in the one case will be necessarily the same as that produced in the other.

Apparent Progress of Magnetic Weather.

12. In order to prevent ambiguity, it is desirable to define what we mean by the apparent progress of magnetic weather. If a particular state of declination diurnal range—a maximum for instance—be found to occur at Prague four days after it occurs at Toronto, and if there is reason to believe that this difference in time depends upon the distance between the stations, we should characterise the phenomenon by terming it an apparent progress of magnetic weather from west to east. But this phrase must not be regarded as implying any theoretical explanation of the observed fact, or as asserting that it is an actual progress of matter in the direction from west to east which gives rise to the phenomenon.

It is obvious that if such a progression exists it will be most readily seen in the undisturbed observations, for it is one of the characteristics of a disturbance to occur simultaneously or nearly so at stations far apart, while it is another characteristic to exalt the daily range. Hence if disturbances possess periodicity, the maxima of their periods might be expected to occur simultaneously or nearly so at stations far apart. Magnetical weather is, however, something different from disturbances, and denotes, as we have used the term, a particular state or value of undisturbed diurnal magnetic range, just as a particular state or value of diurnal temperature-range may be said to denote a particular kind of meteorological weather. Again, in certain preliminary investigations evidence has been given by one of us tending to show that there is possibly a progress of magnetic weather from west to east. But it is clear that in making a comparison of this nature not only must we get rid of disturbances as much as possible, but we must likewise limit our comparison to Inequalities of the same type or nearly so. Now both of these conditions are possessed by the eries of Table V, for in the first place we may imagine that they are

nearly freed from disturbance, and in the next place the two series are very much alike in type.

13. In order to compare the Inequalities of Table V we may consider the Prague series as stationary and the Toronto as movable, and take the algebraic addition of the two series in various relative positions. For instance, Toronto pulled backwards one or two divisions (days) to the left; both together; Toronto pushed forward 1, 2, 3, 4, 5, &c., divisions to the right. The algebraic sum of the two will give the greatest range when the corresponding phases of the two Inequalities are most nearly together.

The following is the result obtained by this method of comparison :—

Table VI.

24-day Inequalities.	Joint area of both.	26-day Inequalities.	Joint area of both.
Toronto 2 to left	594	Toronto 2 to left	1322
,, 1 ,,	676	,, 1 ,,	1448
Together	738	Together	1560
Toronto 1 to right	776	Toronto 1 to right	1628
,, 2 ,,	804 }	,, 2 ,,	1658
,, 3 ,,	796 }	,, 3 ,,	1670
,, 4 ,,	794 }	,, 4 ,,	1642
,, 5 ,,	794 }	,, 5 ,,	1574
,, 6 ,,	792 }	,, 6 ,,	1532
,, 7 ,,	770	,, 7 ,,	1500
,, 8 ,,	742		
,, 9 ,,	726		
,, 10 ,,	694		

For the 24-day Inequalities the position of maximum area is somewhat undecided, the numbers bracketed being practically the same. On the whole we may consider that the middle point of this region, which denotes "Toronto 4 to the right," expresses the nearest coincidence in phase.

For the 26-day Inequalities the maximum is when Toronto is pushed three divisions to the right. We may therefore state that as far as this comparison is concerned, a given phase occurs at Toronto three or four days before it occurs at Prague. In this preliminary investigation no account has been taken of the difference in longitude between the two stations as affecting the strict simultaneity of the diurnal ranges.

Comparison between Temperature-ranges and Declination-ranges.

14. The Toronto temperature-ranges and the Prague declination-ranges are for the same series of 36 years, and if we compare together the corresponding Inequalities of these ranges as given in Tables I and III, we obtain the following result by taking the sums :—

Toronto Temperature-range, 24 days.	Prague Declination-range, 24 days.	Toronto Temperature-range, 26 days.	Prague Declination-range, 26 days.
4735	4795	5293	6316

We may conclude from this comparison that, as treated by our method, the declination-ranges and temperature-ranges exhibit Inequalities pretty much of the same magnitude. There is a slight excess of the declination over the temperature for the 26-day Inequalities, but these, being larger, may possibly be influenced by the results of disturbance to a greater extent than those around 24 days. Disturbance would doubtless increase the range.

Again, while both kinds of Inequalities are very much of the same size, the results of this and of our previous paper lead us to conclude that the one set of Inequalities does not exhibit a closer correspondence with sun-spots than the other, so that as far as our experience goes there is no reason for saying that for short-period solar Inequalities the terrestrial result is more marked in magnetism than in meteorology.

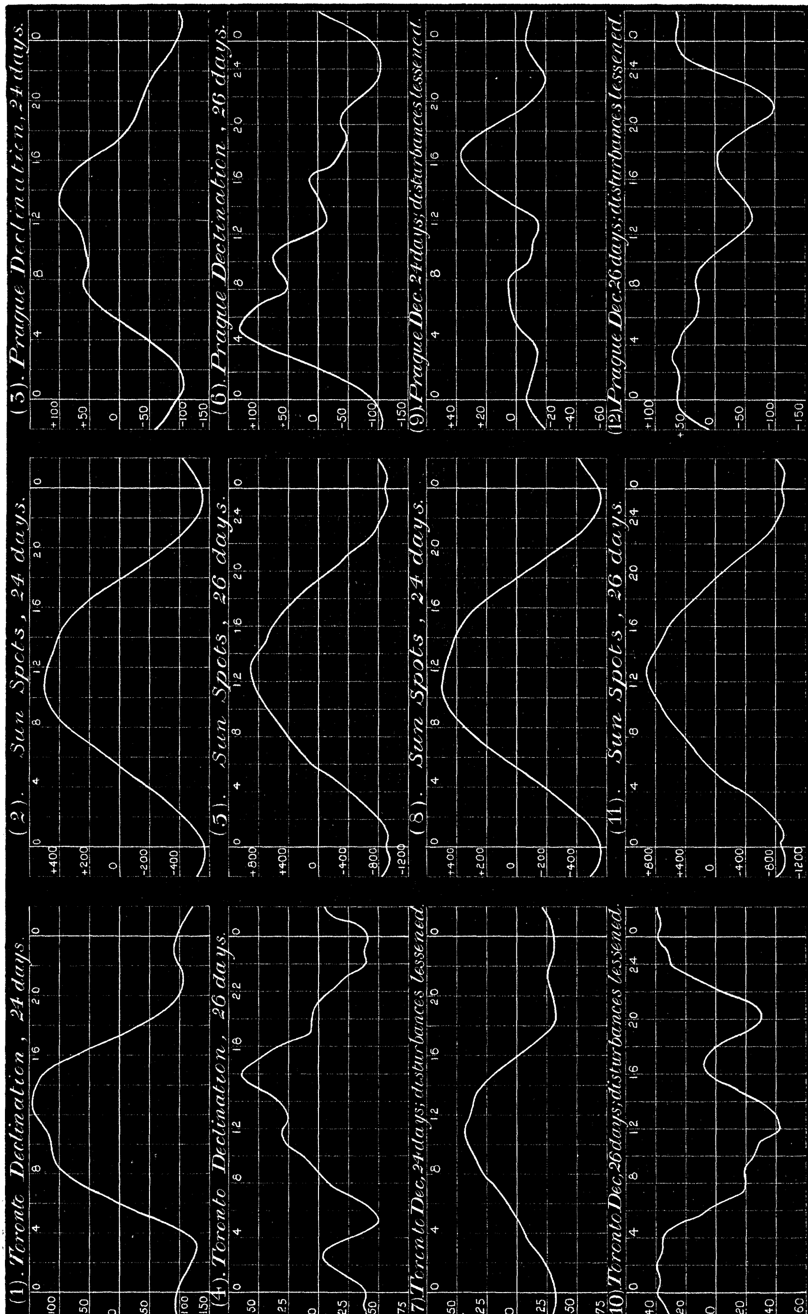
15. It is perhaps worth while to exhibit the connexion between the temperature-range and the declination-range Inequalities in the following manner (p. 234).

We have already (Art. 9) mentioned how the Kew temperature-ranges were used by us for setting the Inequalities whose mean result is given in Table V. Now if there be no perceptible physical relation between temperature-range and declination-range, the declination-range Inequalities set by this method should have their corresponding phases distributed at random impartially up and down the paper. In Table VII we have exhibited the individual series representing Prague declination-ranges around 26 days that have been set by this method, only in order to save space we have grouped them into threes (with due regard to phase). It will, we think, be seen from this table that, with comparatively few exceptions, *minus* numbers are grouped together in the upper part of the table, and *plus* numbers in the lower.

The result is thus, in our opinion, in favour of that hypothesis which asserts a physical relationship between the two Inequalities.

Table VII.—Individual Prague Declination Inequalities (26 Days) set by Kew Temperature Maxima.

−51	−48	−42	−36	−27	−24	−21	−18	−15	−12	+0	+3	+6	+9	+12	+15	+18	+21	+24	+36	+42	+45	Sum.
+ 51	− 14	+ 148	−2503	− 738	+ 74	− 616	− 419	− 337	+ 36	−1759	−1101	− 777	+ 109	+1055	+ 207	+ 662	+ 966	+ 992	+ 897	+728	+300	− 2039
− 135	− 219	+ 447	−2255	− 927	− 72	− 715	− 746	− 356	+ 97	−1613	−1086	− 668	+ 144	+ 448	− 254	+ 281	+ 777	+ 388	+ 428	+641	+ 18	− 5377
− 565	− 314	+ 531	−1946	− 949	− 407	− 891	− 988	− 139	− 165	− 917	− 829	− 170	+ 824	+ 28	− 175	− 240	+ 414	− 467	− 79	+ 89	−445	− 7800
− 385	− 186	+ 833	−1130	− 185	− 651	− 985	−1304	− 267	− 686	− 710	− 638	+ 462	+1028	− 75	− 219	− 600	+ 30	− 709	+ 47	−348	−675	− 7353
− 553	− 49	+1003	− 324	+ 43	− 785	− 942	−1494	− 692	− 762	− 666	− 186	+1057	+ 951	+ 45	+ 47	− 411	− 246	− 380	+ 649	−843	−505	− 5039
− 619	+ 320	+ 974	+ 400	+ 210	− 388	− 694	−1564	−1553	− 619	− 559	+ 241	+1312	+ 298	+ 99	+ 88	− 155	− 457	+ 31	+1005	−565	+ 2	− 2183
−1107	+ 444	+1086	+ 731	− 296	− 23	− 431	−1306	−1944	− 286	+ 6	+ 692	+1054	− 72	+ 146	− 83	− 78	− 401	+ 83	+ 579	− 47	+548	− 705
−1168	+ 284	+1193	+1079	− 317	+ 373	− 150	− 933	−2024	− 498	+ 494	+ 889	+ 511	− 170	+ 218	− 607	− 787	− 260	+ 59	− 464	+521	+719	− 1038
−1293	− 297	+1104	+1574	− 430	+ 215	− 444	− 684	−1451	− 808	+ 478	+ 813	− 21	− 302	− 198	−1366	−1610	− 199	+ 321	−1006	+322	+445	− 4837
−1077	− 924	+ 635	+1880	− 370	− 16	− 375	− 572	− 827	−1123	+ 243	+ 809	− 312	− 368	− 674	−1791	−2272	− 678	+ 179	−1287	+ 40	− 20	− 8900
− 919	−1394	− 76	+1585	− 648	− 307	− 326	− 201	− 340	−1355	− 2	+ 431	− 379	− 603	−1393	−2116	−2132	−1162	− 263	−1146	+ 10	−112	−12848
− 605	−1660	− 155	+ 915	− 367	− 158	+ 477	+ 517	− 129	−1425	+ 405	+ 357	− 227	− 539	−1372	−1899	−1491	−1750	−1063	−1149	+153	+ 40	−11125
− 178	−1427	+ 59	+ 842	+ 258	+ 50	+ 673	+1422	+ 119	−1505	+ 693	+ 71	− 22	− 599	−1341	−1304	− 734	−1325	− 944	−1001	+243	+257	− 5694
+ 376	−1115	+ 629	+1011	+ 563	+ 292	+ 964	+1700	+ 590	−1156	+1201	+ 290	− 83	− 606	− 934	− 482	− 7	− 878	− 447	− 714	+138	+150	+ 1472
+1034	− 447	+ 478	+1287	+ 345	+ 463	+ 708	+1498	+1082	− 459	+ 853	− 2	− 295	− 687	− 815	+ 121	+ 754	+ 204	+ 225	− 347	+327	+323	+ 6650
+1199	− 158	+ 50	+ 651	− 341	+ 833	+ 686	+ 813	+1353	+ 546	+ 869	+ 49	− 552	− 760	− 789	+ 349	+1454	+ 645	+ 224	+ 138	+429	+263	+ 7951
+1048	+ 194	− 643	+ 173	− 307	+1285	+ 343	+ 633	+1326	+1391	+ 839	+ 133	− 456	− 804	− 765	+ 432	+1703	+1124	+ 68	+ 327	+177	+282	+ 8503
+ 808	+ 320	− 809	− 146	+ 50	+1211	+ 367	+ 605	+1085	+1895	+1238	+ 678	− 332	− 711	− 595	+ 594	+1313	+ 988	+ 83	+ 439	−401	−331	+ 8349
+ 954	+ 690	− 802	+ 213	+ 482	+ 424	+ 590	+ 700	+ 940	+1865	+1284	+ 754	− 2	− 497	− 99	+ 843	+ 749	+ 955	+ 151	+ 449	−821	−510	+ 9312
+ 829	+ 969	− 833	+ 608	+ 372	− 701	+ 996	+ 561	+ 917	+1542	+ 667	+ 374	+ 220	+ 104	+ 158	+1059	+ 59	+ 716	+ 164	+ 822	−830	−633	+ 8140
+ 458	+1044	− 947	+ 739	+ 60	−1152	+1135	+ 485	+ 888	+1079	+ 70	− 248	+ 482	+ 694	+ 580	+1159	− 148	+ 343	− 195	− 750	−611	−163	+ 6502
+ 124	+ 917	−1207	+ 386	+ 165	− 836	+ 773	+ 562	+ 722	+ 824	− 435	− 404	+ 382	+1010	+ 780	+1119	− 15	− 225	− 340	+ 272	−466	− 79	+ 4029
+ 146	+ 835	−1274	− 428	+ 725	− 75	+ 306	+ 527	+ 482	+ 691	− 307	− 402	+ 180	+ 852	+1274	+1215	+ 596	− 580	− 273	− 384	−251	− 15	+ 3840
+ 528	+ 893	−1295	−1192	+1279	+ 160	− 269	+ 342	+ 410	+ 581	− 344	− 278	− 227	+ 430	+1364	+1224	+1047	− 254	+ 238	− 341	+109	−144	+ 4261
+ 490	+ 795	− 895	−1913	+1021	+ 178	− 539	+ 55	+ 212	+ 248	− 632	− 560	− 423	+ 280	+1513	+1166	+1117	+ 341	+ 742	+ 282	+449	+ 29	+ 3956
+ 559	+ 499	− 234	−2237	+ 302	+ 13	− 641	− 209	− 67	+ 52	−1396	− 847	− 714	− 6	+1342	+ 673	+ 945	+ 912	+1133	+ 834	+807	+256	+ 1973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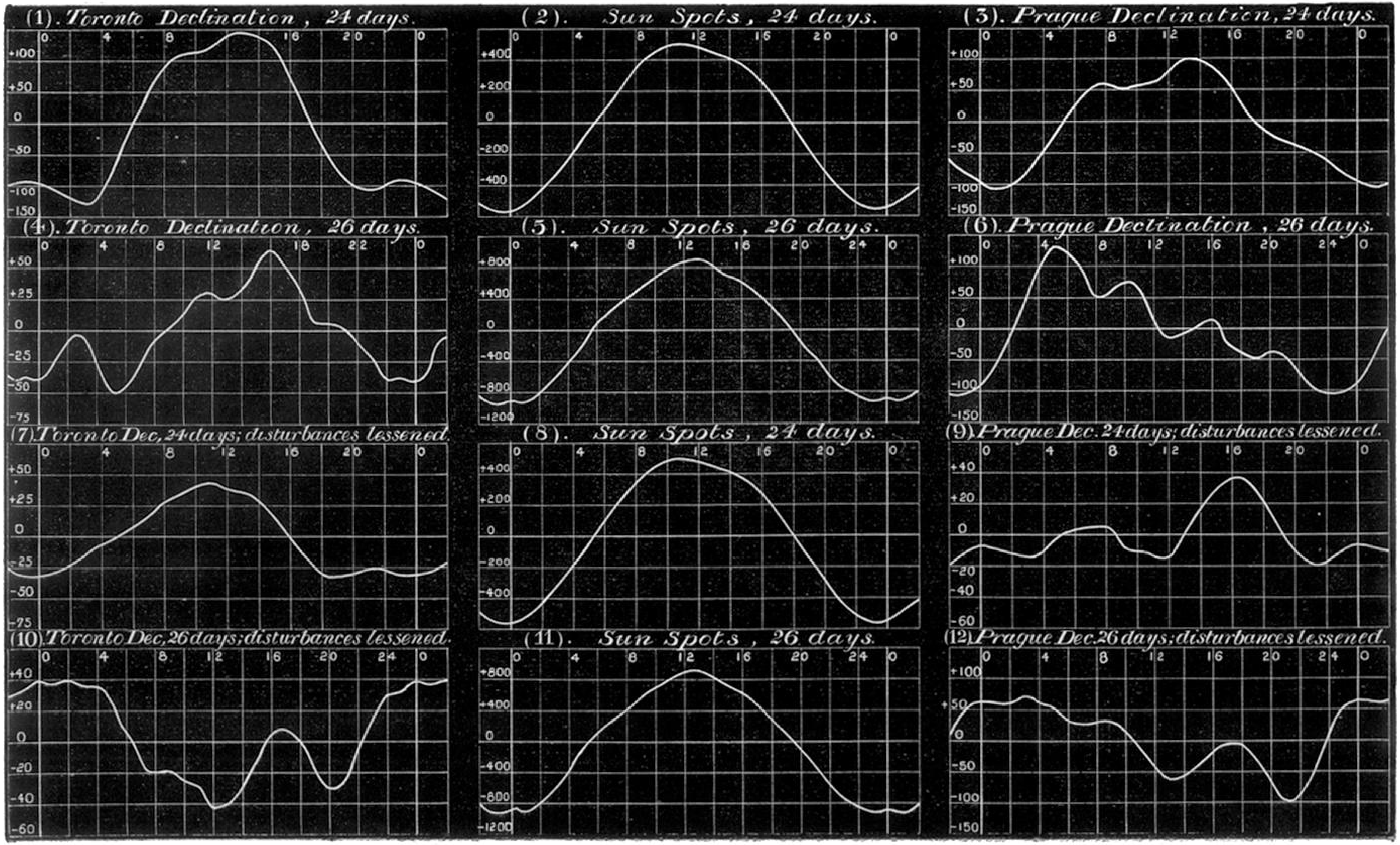
(2). Sun Spots, 24 days.
(3). Prague Declination, 24 days.
(4). Toronto Declination, 26 days.
(5). Sun Spots, 26 days.
(6). Prague Declination, 26 days.
(7). Toronto Dec. 24 days; disturbances lessened.
(8). Sun Spots, 24 days.
(9). Prague Dec. 24 days; disturbances lessened.
(10) Toronto Dec. 26 days; disturbances lessened.
(11). Sun Spots, 26 days.
(12) Prague Dec. 26 days; disturbances lessened.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+100 +50 0 -50 -100 -150
(2). Sun Spots, 24 days.
0 4 8 12 16 20 0
+400 +200 0 -200 -400
(3). Prague Declination, 24 days.
0 4 8 12 16 20 0
+100 +50 0 -50 -100 -150
(4). Toronto Declination, 26 days.
0 4 8 12 18 22 0
+50 +25 0 -25 -50 -75
(5). Sun Spots, 26 days.
0 4 8 12 16 20 24 0
+800 +400 0 -400 -800 -1200
(6). Prague Declination, 26 days.
0 4 8 12 16 20 24 0
+100 +50 0 -50 -100 -150
(7) Toronto Dec, 24 days; disturbances lessened.
0 4 8 12 16 20 0
+50 +25 0 -25 -50 -75
(8). Sun Spots, 24 days.
0 4 8 12 16 20 0
+400 +200 0 -200 -400
(9) Prague Dec. 24 days; disturbances lessened.
0 4 8 12 16 20 0
+40 +20 0 -20 -40 -60
(10) Toronto Dec, 26 days; disturbances lessened.
0 4 8 12 16 20 24 0
+40 +20 0 -20 -40 -60
(11). Sun Spots, 26 days.
0 4 8 12 16 20 24 0
+800 +400 0 -400 -800 -1200
(12) Prague Dec. 26 days; disturbances lessened.
0 4 8 12 16 20 24 0
+100 +50 0 -50 -100 -150