XXIX. *First Analysis of One Hundred and Seventy-seven Magnetic Storms, registered by the Magnetic Instruments in the Royal Observatory, Greenwich, from* 1841 *to* 1857.

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1. IN a paper which the Royal Society have printed in their Philosophical Transactions for 1862, I gave a series of curves exhibiting to the eye the diurnal inequalities of Terrestrial Magnetism in the three directions of Westerly Force, Northerly Force, and Nadir Force, as inferred from eye-observations and photographic registers at the Royal Observatory from 1841 to 1857. The paper, or the works to which it refers, exhibits also the secular change and the annual inequality through that period, and the lunar inequalities as inferred from the period 1848 to 1857. These results were obtained by excluding the observations of certain days (of which a list was given) on which the motions of the magnetometers were so violent that it was difficult to draw a mean curve through the magnetic curve of the day. In the present paper I propose to give the principal results deducible from the days omitted in the former paper. But before entering into the details of the numerical investigations, I think it desirable to explain the principles upon which both parts of the investigations have been conducted.

2. The methods commonly employed in late years for measuring and classifying the effects of magnetic disturbance have been, in my judgment, very valuable to the science, especially in its earlier stages. But familiarity through many past years with magnetic photograms has strongly impressed me with the feeling that a different method ought now to be employed, taking account of relations of disturbances which perhaps could not be known at the introduction of the ancient method. I may thus describe the general ideas which have guided me:—First, that there is no such thing as a day really free from disturbance, and no reason in the nature of things for separating one or more days from the general series. There is abundant reason for such separation on the ground of convenience of reduction; but when the reduction has been effected by suitable process, the results of the separated days ought to be combined with those of the unseparated days in the formation of general means (the numerical necessity for which I propose to consider in the close of this paper),—the reduction of the separated days serving also to throw great light upon the nature of the acting forces on those days, which forces in all probability are acting, though in different degrees, on other days. Second, that, with our present knowledge of the character of magnetic disturbances, I cannot think myself justified in separating any single magnetic indication, or any series of indications defined only by their magnitude; nor do I entertain the belief that any

special value could attach to the results which I might derive from observations from which such indications have been removed. The study of the photograms shows clearly that the successive indications at successive moments of the same day are a connected series; there is no such thing as a sudden display of force in any element; the sharpest salience which is exhibited on a generally smooth curve occupies at least an hour in its development (I believe, never less, although the individual saliences in a continued storm are of shorter duration), and during this time the force has been gradually increasing and gradually diminishing. Under these circumstances, I cannot think it right that I should cut off a part of that salience, with the belief of obtaining results, that can possess any philosophical value, from the part which is left. And I come to the conclusion that each disturbed day must be considered in its entirety, and that our attention ought to be given in the first instance to the devising of methods by which the complicated registers of each of those days, separately considered, can be rendered manageable, and in the next place to the discussion of the laws of disturbance which they may aid to reveal to us, and to the ascertaining of their effects on the general means in which they ought to be included.

3. The discrimination of the classes of days which (on the one hand) are treated by the general process in the "Results of Magnetical Observations, 1859," and of those which (on the other hand) are to be treated by the methods of this Memoir, has been effected entirely by the judgment of the Superintendent of Computations as to the certainty and accuracy with which he could draw a mean line through the disturbed curves. I do however entirely recognize the propriety of defining the "disturbed days" by some numerical limit, when it can be conveniently done: but, the day being defined, I then think that the entire disturbed day or storm ought to be treated as a coherent whole; and that the laws of disturbance and the amalgamation with general means ought to be deduced from it, as already mentioned, without reference to any numerical limit.

4. The records of disturbances from 1848 to 1857 are taken from the photograms; and the value of these, I believe, is unimpeachable. The instruments appear to have been in the highest state of efficiency; I do not think that there is the least doubt on the indications of any disturbed day. And (as the effect of adjustments made expressly for that purpose) the traces of the most violent motions are in general perfectly preserved—an advantage which is possessed, I believe in a peculiar degree, by the photograms of the Royal Observatory. Some sheets may be lost from defects in the paper, defects in the chemical process, &c.; but none, I believe, from rapidity and violence of motion of the magnets. The indications for every salient point of the curves have been translated into numbers which are printed in the "Results of Magnetical Observations" for each year; and those numbers are used as the basis of the following calculations. For the years 1841–1847, in which observations were made by eye, it will be seen in the printed Observations that no opportunity was lost, on the slightest appearance of disturbance, of following most carefully the indications of all the magnetometers: and in fact, as regards both the number of days of such observations and the number of

observations on each day, the observations taken are far more numerous than was necessary. The judgment of the Superintendent has been exercised in making such a selection of days and such a limitation of records for each day as should make the adopted register for the period 1841–1847 harmonize well with that for the period 1848–1857.

In the following investigations, whenever one instrument has exhibited such signs of disturbance that its indications were thought unfit for treatment in the former Reductions and are therefore included in this Analysis, the indications of the two other instruments are also included in this Analysis.

5. In deciding on the method of making the disturbed curves more manageable, the following was my train of ideas. As the photographic curve usually consists of a series of lines (very little curved) highly inclined to the time-abscissa and leading alternately upwards and downwards, if each of these lines be bisected and the bisecting points be joined, the joining lines will form a polygon of much less violent character than the original. If these joining lines be bisected and the bisecting points joined, we shall have a polygon of still smoother character, with angles sensibly corresponding to the original times, excepting only the first and the last. If the double process be repeated, the polygon will be still smoother, but wanting points corresponding to the two first and two last observations. And thus we shall have a mean curve containing all the long waves of the original curve, and freed from the irregularities of short period, whose values, however, can be measured. Numerically, each step of the process is represented by taking, for the numerical value of a new ordinate, the arithmetical mean of the numerical values of adjacent ordinates, or, still more easily, by adding the adjacent ordinates, adding the adjacent sums thus formed, and dividing by 4, and repeating this operation. An instance will make this process clear.

Readings for Northerly Force (corrected for temperature) in the Magnetic Storm of 1854, March 6.

Göttingen Time.	Reading.	1st Sum.	2nd Sum.	¼th.	3rd Sum.	4th Sum.	¼th or Adopted.
h m							
0 0	·1153						
		·2306					
1 8	1153		·4628	·1157			
		2322			·2314		
1 32	1169		4630	1157		·4622	·1155
		2308			2308		
1 50	1139		4603	1151		4609	1152
		2295			2301		
2 7	1156		4601	1150		4605	1151
		2306			2304		
2 30	1150		4615	1154		4613	1153
		2309			2309		
2 44	1159		4621	1155		4619	1155
		2312			2310		
2 58	1153		4622	1155		4621	1155
		2310			2311		
3 30	1157		4624	1156		4626	1157
		2314			2315		
4 5	1157		4634	1159		4635	1159
		2320			2320		
4 12	1163		4643	1161		4643	1161
		2323			2323		
4 45	1160		4648	1162		4646	1161
		2325			2323		
5 23	1165		4645	1161		4636	1159
		2320			2313		
6 15	1155		4606	1152		4611	1153
		2286			2298		
6 39	1131		4585	1146		4601	1150
		2299			2303		
7 6	1168		4628	1157		4623	1156
		2329			2320		
7 15	1161		4653	1163		4641	1160
		2324			2321		
7 24	1163		4633	1158		4631	1158
		2309			2310		
7 32	1146		4608	1152		4608	1152
		2299			2298		
7 45	1153		4583	1146		4587	1147
		2284			2289		
8 25	1131		4571	1143		4581	1145
		2287			2292		
9 17	1156		4595	1149		4597	1149
		2308			2305		
9 45	1152		4624	1156		4620	1155
		2316			2315		
10 40	1164		4634	1159		4639	1160
		2318			2324		
11 23	1154		4659	1165		4664	1166
		2341			2340		
11 50	1187		4699	1175		4690	1172
		2358			2350		
12 8	1171		4701	1175		4694	1174
		2343			2344		
12 20	1172		4674	1169		4677	1169
		2331			2333		
12 39	1159		4656	1164		4660	1165
		2325			2327		
13 8	1166		4653	1163		4652	1163
		2328			2325		
13 17	1162		4648	1162		4651	1163
		2320			2326		
13 45	1158		4655	1164		4660	1165
		2335			2334		
20 0	1177		4680	1170		4674	1169
		2345			2340		
21 0	1168		4680	1170		4676	1169
		2335			2336		
22 3	1167		4663	1166		4664	1166
		2328			2328		
22 25	1161		4649	1162		4647	1162
		2321			2319		
22 46	1160		4629	1157		4627	1157
		2308			2308		
22 55	1148		4604	1151		4599	1150
		2296			2291		
23 4	1148		4561	1140		4563	1141
		2265			2272		
23 30	1117		4526	1132			
		2261					
23 59	1144						

The Adopted Numbers are those to be compared with the Original Reading, in order to ascertain what portion of the Original Reading is to be ascribed to Irregularities: and the Adopted Numbers are also to be compared with the Monthly Means deduced from the days of easy reduction, in order to ascertain what portion is to be considered as Wave-Disturbance. Thus we finally obtain the following separation of numbers, whose aggregate represents the Original Reading:—

Component parts of Northerly Force in the Magnetic Storm of 1854, March 6.

Göttingen Time.	Monthly Mean.	Wave-Disturbance.	Irregularities.
h m			
1 32	·1158	−·0003	+·0014
1 50	1158	− 6	−·0013
2 7	1158	− 7	+ 5
2 30	1160	− 7	− 3
2 44	1160	− 5	+ 4
2 58	1161	− 6	− 2
3 30	1162	− 5	0
4 5	1162	− 3	− 2
4 12	1162	− 1	+ 2
4 45	1162	− 1	− 1
5 23	1162	− 3	+ 6
6 15	1162	− 9	+ 2
6 39	1163	− 13	− 19
7 6	1163	− 7	+ 12
7 15	1163	− 3	+ 1
7 24	1163	− 5	+ 5
7 32	1163	− 11	− 6
7 45	1163	− 16	+ 6
8 25	1163	− 18	− 14
9 17	1163	− 14	+ 7
9 45	1164	− 9	− 3
10 40	1164	− 4	+ 4
11 23	1164	+·0002	− 12
11 50	1165	+ 7	+ 15
12 8	1165	+ 9	− 3
12 20	1165	+ 4	+ 3
12 39	1164	+ 1	− 6
13 8	1164	− 1	+ 3
13 17	1164	− 1	− 1
13 45	1164	+ 1	− 7
20 0	1168	+ 1	+ 8
21 0	1161	+ 8	− 1
22 3	1156	+ 10	+ 1
22 25	1156	+ 6	− 1
22 46	1155	+ 2	+ 3
22 55	1155	− 5	− 2
23 4	1155	− 14	+ 7

The disturbance of Horizontal Force is thus separated into two well-distinguished parts. One part consists of five long waves, alternately − and +. The other part consists of irregularities of short period, which do not show the least symptom of disappearing at the disappearance of the waves, and appear to have nothing in common with them except the connexion of both with the same general Magnetic Storm.

6. For fully understanding the import of these numbers, it will perhaps be necessary to study the succession of numbers in each individual instance. In this First Analysis, I have proceeded, as the first step, to take the means that appear to be most valuable. As regards the Waves, I have taken separately the mean of the wave-disturbances through each wave. But as this quantity gives little information unless taken in conjunction with the time through which it acts, I have multiplied it by the length of the wave in hours; and this product I have distinguished by the technical term *Fluctuation*. The

following is now an Epitome of the Magnetic Storm which we have had under consideration.

Epitome of Disturbances of Northerly Force in the Magnetic Storm of 1854, March 6.

Times of beginning and end of wave.		Length of wave in hours.	Mean Wave-disturbance.	Fluctuation.	Aggregate Fluctuation.	Sum of Hours.	Mean Disturbance.	Number of Irregularities.	Mean Period of Irregularity.	Mean value of Irregularity.
h m	h m	h							h	
0 0	11 1	11·02	−·0007	−·0077				22	0·50	±·0006
11 1	12 54	1·88	+ 5	+ 9		h		5	0·38	8
12 54	13 31	0·62	− 1	− 1	−·0033	23·98	−·0001	2	0·31	2
13 31	22 51	9·33	+ 5	+ 47				6	1·56	4
22 51	23 59	1·13	− 10	− 11				2	0·57	4

The disturbances of Westerly Force and Nadir Force are treated in the same way—the values of disturbance, &c. being converted, at convenient stages, into values expressed in terms of whole Northerly Force.

The numbers contained in these Epitomes serve as bases for the investigations which follow. The Epitomes themselves, though greatly reduced from the voluminous calculations on which they are founded, are far too extensive to be included in this Memoir: they will probably be printed in the Greenwich Observations.

7. Treating the Waves as the first subject, I take in the first instance the algebraical aggregate of the Fluctuations for each separate Magnetic Storm. In Table I., the first or longest of the three Tables which follow, every recorded storm is included; and in the second, or Table II., these are all collected to form annual aggregates. But as the days of record do not strictly coincide for the three instruments, partly from accidents in the chemical preparation of the photographic paper, &c., but more particularly from the experimental state of the Vertical-Force Instrument during a part of the year 1848, I have thought it desirable to form Table III. from the observations which are strictly comparable. In regard to the last columns of each department of Table I., and the last lines of Tables II. and III., it will be remarked that the "Fluctuation" is a product of number of hours by Magnetic Disturbance, and therefore, for the Mean Disturbance, the Aggregate of Fluctuations must be divided by the Sum of Hours.

TABLE I.—Algebraic Sums of Magnetic Fluctuations (in terms of Horizontal Force) on Days of Great Magnetic Disturbance.

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.
1841.									
Sept. 24	13·9	−0·0022	− 2	12·0	−0·0456	−38	14·0	−0·0392	− 28
25	22·0	− ·0200	− 9	12·9	− ·0054	− 4	11·3	+ ·2580	+229
27	8·2	− ·0270	−33	8·2	− ·0097	−12	8·2	+ ·0670	+ 82
Oct. 25	22·0	− ·0417	−19	22·0	− ·0484	−22	20·2	+ ·0226	+ 11
Nov. 18	17·9	− ·0735	−41	17·9	− ·0125	− 7	18·0	− ·0323	− 18
19	22·8	+ ·0016	+ 1	24·0	− ·0276	−12	23·7	− ·0379	− 16
Dec. 3	12·7	+ ·0088	+ 7	12·7	− ·0205	−16	10·9	+ ·0424	+ 39
14	10·0	− ·0296	−30	10·0	− ·0130	−13	10·0	+ ·0621	+ 62
1842.									
Jan. 1	6·7	−0·0240	−36	6·7	+0·0387	+58	6·1	+0·0061	+ 10
Feb. 24	8·0	− ·0090	−11	8·0	− ·0400	−50	8·0	+ ·0014	+ 2
April 14	7·6	+ ·0214	+28	7·4	− ·0423	−57	8·0	− ·0784	− 98
15	23·1	+ ·0087	+ 4	24·0	− ·1416	−59	22·2	− ·0061	− 3
July 1	7·7	+ ·0008	+ 1	7·7	− ·0178	−23	8·0	+ ·0135	+ 17
2	13·6	− ·0523	−39	13·4	− ·0138	−10	13·2	+ ·0608	+ 46
3	9·7	− ·0003	0	10·0	− ·0650	−65	10·0	− ·0289	− 29
Nov. 10	14·2	− ·0340	−24	14·2	− ·0710	−50	14·2	+ ·0185	+ 13
21	12·0	− ·0054	− 5	12·0	− ·0132	−11	12·0	− ·0312	− 26
Dec. 9	10·0	− ·0220	−22	10·0	− ·0187	−19	10·0	+ ·0311	+ 31
1843.									
Jan. 2	10·0	+0·0180	+18	10·0	−0·0180	−18	10·0	−0·0261	− 26
Feb. 6	6·0	+ ·0002	0	.....	.....	.....	.....	.....	.....
16	4·0	− ·0044	−11	4·0	− ·0048	−12	.....	.....	.....
24	11·6	− ·0129	−11	11·6	− ·0189	−16	11·6	+ ·0031	+ 3
May 6	4·4	− ·0216	−49	4·1	− ·0226	−55	4·2	− ·0064	− 16
July 24	13·7	+ ·0145	+11	13·7	− ·0227	−17	14·0	+ ·0140	+ 10
25	6·0	+ ·0210	+35	6·0	+ ·0002	0	5·6	+ ·0329	+ 59
1844.									
Mar. 29	15·7	−0·0140	− 9	15·7	−0·0305	−19	16·0	−0·0448	− 28
30	12·0	− ·0097	− 8	12·0	− ·0126	−11	11·6	+ ·0017	+ 2
Oct. 1	6·0	− ·0156	−26	6·0	− ·0198	−33	6·0	+ ·0018	+ 3
20	.....	.....	.....	8·0	− ·0224	−28	8·0	− ·0904	−113
Nov. 16	10·0	+ ·0112	+11	10·0	− ·0280	−28	9·7	+ ·0398	+ 41
22	8·0	+ ·0248	+31	8·0	− ·0196	−25	8·0	− ·0052	− 7
1845.									
Jan. 9	10·0	−0·0290	−29	10·0	−0·0440	−44	10·0	+0·080	+ 8
Feb. 24	15·7	− ·0198	−13	16·2	− ·0177	−11	16·2	− ·0211	− 13
Mar. 26	14·0	− ·0210	−15	14·0	− ·0090	− 6	14·0	− ·0070	− 5
Aug. 29	6·2	− ·0037	− 6	6·1	− ·0024	− 4	6·2	− ·0062	− 10
Dec. 3	14·1	− ·0022	− 2	14·2	− ·0667	−47	14·2	+ ·0439	+ 31
1846.									
May 12	10·0	−0·0009	− 1	10·0	−0·0044	− 4	10·0	−0·0040	− 4
July 11	.....	.....	.....	10·0	− ·0092	− 9	3·4	− ·0044	− 13
Aug. 6	11·9	+ ·0099	+ 8	11·9	− ·0037	− 3	12·0	− ·0015	− 1
7	22·0	+ ·0286	+13	22·0	− ·0013	− 1	21·9	+ ·0051	+ 2
24	14·0	− ·0107	− 8	12·0	− ·0036	− 3	16·0	− ·0160	− 10
25	16·0	− ·0096	− 6	16·0	+ ·0050	+ 3	14·2	− ·0071	− 5

TABLE I. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.
1846 (cont^{d}).									
Aug. 28	8·8	−0·0058	− 7	8·7	−0·0075	− 9	8·8	−0·0114	− 13
Sept. 4	15·9	+ ·0091	+ 6	15·8	− ·0116	− 7	16·0	+ ·0208	+ 13
5	13·0	+ ·0056	+ 4	12·9	− ·0062	− 5	12·3	+ ·0274	+ 22
10	13·9	+ ·0005	0	13·8	+ ·0029	+ 2	14·0	+ ·0140	+ 10
11	23·8	− ·0030	− 1	23·8	− ·0148	− 6	23·7	+ ·0292	+ 12
21	19·9	− ·0286	−14	19·8	− ·0183	− 9	20·0	− ·0100	− 5
22	14·0	− ·0158	−11	14·0	− ·0305	−22	13·9	+ ·0225	+ 16
Oct. 2	6·0	− ·0156	−26	6·0	− ·0102	−17	6·0	+ ·0060	+ 10
7	17·7	− ·0073	− 4	17·7	− ·0509	−29	18·0	− ·0378	− 21
8	12·0	+ ·0059	+ 5	11·8	− ·0227	−19	11·8	+ ·0905	+ 77
Nov. 26	16·2	− ·0069	− 4	14·6	− ·0279	−19	16·2	− ·0002	0
Dec. 23	10·0	− ·0160	−16	10·0	+ ·0170	+17	10·0	+ ·0074	+ 7
1847.									
Feb. 24	10·0	−0·0167	−17	10·0	−0·0110	−11	9·9	−0·0030	− 3
Mar. 1	8·0	+ ·0082	+10	8·0	− ·0047	− 6	8·0	+ ·0616	+ 78
19	20·0	− ·0121	− 6	20·0	− ·0846	−42	18·2	− ·0783	− 43
April 3	8·0	− ·0240	−30	8·0	− ·0061	− 8	8·0	+ ·0264	+ 33
7	16·0	− ·0046	− 3	16·0	− ·0493	−31	16·0	− ·0171	− 11
21	6·0	+ ·0004	+ 1	5·5	− ·0120	−22	6·0	+ ·0156	+ 26
May 7	8·0	+ ·0344	+43	8·0	− ·0032	− 4	10·0	− ·0100	− 10
June 24	4·0	+ ·0109	+27	.....	.....	.....	.....	.....	.....
July 9	.....	.....	.....	4·0	− ·0352	−88	4·0	− ·0464	−116
Sept. 24	18·0	+ ·0082	+ 5	18·0	+ ·0332	+18	17·0	+ ·0435	+ 26
26	9·8	− ·0159	−16	9·8	− ·0401	−41	10·0	− ·0260	− 26
27	10·0	+ ·0008	+ 1	10·0	− ·0300	−30	9·7	+ ·0603	+ 62
Oct. 22	5·8	+ ·0033	+ 6	5·8	− ·0403	−70	6·0	− ·0108	− 18
23*(1st)	12·0	+ ·0091	+ 8	12·0	− ·0132	−11	11·6	+ ·0988	+ 85
23 (2nd)	2·0	− ·0025	−13	1·9	− ·0030	−16	2·0	+ ·0016	+ 8
24	23·3	+ ·0137	+ 6	23·3	− ·2088	−90	23·7	+ ·0538	+ 23
25	10·0	− ·0093	− 9	10·0	− ·0150	−15	9·5	+ ·0654	+ 69
Nov. 22	14·0	+ ·0120	+ 9	14·0	− ·0304	−22	15·2	− ·0421	− 28
Dec. 17	22·0	+ ·0157	+ 7	22·0	− ·0268	−12	14·0	+ ·1260	+ 90
18	12·0	− ·0120	−10	12·0	− ·0193	−16	.....	.....	.....
19	10·0	+ ·0175	+17	10·0	− ·0910	−91	.....	.....	.....
20	18·0	− ·0132	− 7	18·0	− ·0581	−32	.....	.....	.....
1848.									
Jan. 16	14·2	−0·0047	− 3	10·3	−0·0340	−33	.....	.....	.....
28	14·0	− ·0210	−15	19·1	+ ·0217	+11	.....	.....	.....
Feb. 20	22·5	− ·0192	− 9	9·1	− ·0335	−37	.....	.....	.....
21	16·9	+ ·0047	+ 3	22·8	− ·0742	−33	.....	.....	.....
22	4·0	− ·0043	−10	4·0	− ·0125	−31	.....	.....	.....
23	18·0	− ·0113	− 6	8·6	− ·0024	− 3	.....	.....	.....
24	20·8	+ ·0335	+16	22·8	− ·0503	−22	.....	.....	.....
Mar. 17	3·3	+ ·0077	+23	5·2	− ·0067	−13	.....	.....	.....
20	14·2	− ·0126	− 9	11·5	− ·0309	−27	.....	.....	.....
April 7	11·4	+ ·0045	+ 4	4·1	− ·0074	−18	.....	.....	.....
May 18	9·1	− ·0016	− 2	8·4	+ ·0105	+12	.....	.....	.....
July 11	16·4	− ·0054	− 3	19·4	− ·0415	−21	.....	.....	.....
Oct. 18	11·5	+ ·0024	+ 2	10·6	− ·0271	−26	7·1	−0·0970	−136

* On October 23, 1847, all the observations were interrupted during 10 hours.

TABLE I. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.
1848 (cont^{d}.)									
Oct. 23	10·6	−0·0060	− 6	9·9	−0·0066	− 7	.....	.....	.....
25	17·5	− ·0034	− 2	18·5	+ ·0025	+ 1	.....	.....	.....
29	16·1	− ·0041	− 2	4·4	·0000	0	.....	.....	.....
Nov. 17	20·0	− ·0003	− 0	19·3	− ·1955	−101	18·9	+0·0601	+ 32
18	14·2	− ·0266	−19	10·3	− ·0201	− 20	4·2	+ ·0208	+ 50
Dec. 17	9·5	+ ·0011	+ 1	5·5	− ·0194	− 35	10·3	− ·0744	− 72
1849.									
Oct. 30	22·9	−0·0129	− 6	22·8	−0·0160	− 7	22·9	−0·3484	−152
Nov. 27	23·1	+ ·0291	+13	22·4	− ·0258	− 12	.....	.....	.....
1850.									
Feb. 22	23·7	−0·0076	− 3	23·5	−0·0088	− 4	23·3	+0·2030	+ 87
23	23·6	+ ·0034	+ 1	23·3	− ·0327	− 14	23·5	− ·0279	− 12
Mar. 31	23·9	− ·0104	− 4	23·5	− ·0375	− 16	23·3	·0000	0
May 7	.....	.....	.....	23·9	− ·0021	− 1	.....	.....	.....
June 13	24·0	− ·0249	−10	23·4	− ·0062	− 3	23·7	− ·3882	−164
Oct. 1	23·2	+ ·0487	+21	22·7	− ·0522	− 23	22·0	− ·1188	− 54
2	23·5	+ ·0401	+17	23·6	− ·0495	− 21	22·6	− ·0098	− 4
1851.									
Jan. 16	23·6	−0·0244	−10	23·4	+0·0125	+ 5	22·9	−0·1009	− 44
19	24·0	+ ·0175	+ 7	24·0	+ ·0328	+ 14	23·2	− ·1367	− 59
Feb. 18	23·1	+ ·0082	+ 4	23·1	− ·0287	− 12	23·4	+ ·1382	+ 59
Sept. 3	18·6	+ ·0451	+24	23·4	− ·0426	− 18	23·3	+ ·1004	+ 43
4	23·4	+ ·0168	+ 6	23·9	− ·0232	− 9	23·0	+ ·1769	+ 77
6	24·0	− ·0465	−19	23·8	− ·0238	− 10	23·4	− ·0508	− 22
7	23·0	− ·0052	− 2	23·9	− ·0576	− 24	23·8	− ·0481	− 20
29	22·7	− ·0550	−24	23·9	− ·0474	− 20	22·4	− ·3838	−171
Oct. 2	23·7	+ ·0037	+ 2	24·0	− ·0632	− 26	23·6	− ·1364	− 58
28	23·1	+ ·0152	+ 7	22·7	− ·0244	− 11	22·9	− ·1834	− 80
Dec. 6	23·3	− ·0307	−13	23·4	− ·1264	− 54	22·6	+ ·0815	+ 36
28	23·2	+ ·0083	+ 4	23·9	− ·0217	− 9	23·2	− ·0950	− 41
29	18·5	− ·0360	−20	22·4	− ·0627	− 28	21·4	+ ·0191	+ 9
1852.									
Jan. 4	23·8	+0·0245	+10	22·0	+0·0968	+ 44	23·5	−0·0137	− 6
19	22·6	+ ·0073	+ 3	23·2	− ·0336	− 14	22·3	− ·1206	− 54
Feb. 14	22·3	− ·0073	− 3	23·2	+ ·0771	+ 33	22·1	− ·0229	− 10
15	23·7	+ ·0006	0	23·7	− ·0150	− 6	23·4	− ·1763	− 75
17	23·3	− ·0021	− 1	23·5	− ·0449	− 19	23·0	+ ·2517	+109
18	23·9	+ ·0031	+ 1	23·7	− ·0587	− 25	23·9	+ ·4422	+185
19	21·0	− ·0261	−12	23·5	− ·0492	− 21	23·0	− ·2596	−113
20	22·9	− ·0078	− 3	23·7	− ·0371	− 16	23·1	− ·1594	− 69
21	20·0	− ·0186	− 9	23·8	− ·0604	− 25	22·5	− ·1735	− 77
April 20	23·9	+ ·0226	+ 9	24·0	− ·0790	− 33	22·5	− ·1508	− 67
May 19	16·0	− ·0485	−30	23·5	+ ·0047	+ 2	21·3	+ ·0595	+ 28
20	6·8	− ·0068	−10	23·4	− ·0068	− 3	13·8	+ ·0605	+ 44
June 11	22·5	− ·0030	− 1	23·5	− ·0310	− 13	22·3	− ·4354	−195
16	23·3	− ·0126	− 5	23·5	+ ·0177	+ 8	.....	.....	.....
July 10	21·1	− ·0362	−17	21·3	+ ·0042	+ 2	22·3	− ·0302	− 14
Nov. 11	23·9	+ ·0057	+ 2	23·2	− ·0235	− 10	23·0	− ·3236	−141
13	23·7	+ ·0114	+ 5	23·3	− ·0352	− 15	21·3	− ·1638	− 77

TABLE I. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.
1853.									
Jan. 10	22·7	−0·0063	− 3	22·6	−0·0200	− 9	.....	.....	.....
Mar. 7	23·8	− ·0171	− 7	23·9	− ·0224	− 9	23·8	+0·3353	+141
8	23·0	− ·0073	− 3	23·9	− ·0072	− 3	22·5	+ ·5298	+236
11	.....	.....	.....	23·9	− ·0253	−11	23·2	+ ·3529	+152
May 2	22·0	− ·0101	− 5	23·5	− ·0657	−28	22·9	+ ·3595	+157
3	23·7	− ·0074	− 3	23·7	− ·0552	−23	23·0	+ ·3424	+149
24	23·3	+ ·0092	+ 4	23·6	+ ·0300	+13	23·7	+ ·2269	+ 96
June 22	23·8	− ·0157	− 7	23·7	− ·0029	− 1	23·2	− ·1487	− 64
July 12	23·8	− ·0019	− 1	24·0	− ·0090	− 4	23·4	+ ·0097	+ 4
Aug. 21	.....	.....	.....	.....	.....	.....	23·7	− ·0617	− 26
Sept. 1	23·5	+ ·0220	+ 9	22·8	− ·0032	− 1	23·5	− ·0550	− 23
2	23·6	+ ·0037	+ 2	23·9	− ·0616	−26	23·7	+ ·0331	+ 14
Oct. 1	.....	.....	.....	24·0	− ·0312	−13	.....	.....	.....
2	.....	.....	.....	24·0	− ·0336	−14	.....	.....	.....
25	23·5	− ·0119	− 5	24·0	− ·0092	− 4	24·0	+ ·3093	+129
Nov. 9	23·5	+ ·0037	+ 2	23·7	− ·0474	−20	23·5	− ·0578	− 25
Dec. 6	23·5	+ ·0134	+ 6	24·0	− ·1079	−45	23·3	+ ·0183	+ 8
21	23·4	+ ·0044	+ 2	23·0	− ·0071	− 3	23·3	− ·1790	− 77
1854.									
Jan. 8	23·8	+0·0029	+ 1	23·4	+0·0246	+11	23·7	−0·1089	− 46
20*	23·9	− ·0043	− 2	23·5	− ·0096	− 4	7·0	− ·0104	− 15
(resumed) 20	.....	.....	.....	.....	.....	.....	14·1	− ·0550	− 39
Feb. 16	23·8	− ·0209	− 9	24·0	− ·0337	−14	23·8	− ·1165	− 49
24	23·9	− ·0145	− 6	23·3	+ ·0020	+ 1	23·7	− ·1414	− 60
25	23·9	+ ·0049	+ 2	23·9	+ ·0119	+ 5	23·7	+ ·0812	+ 34
Mar. 6	23·9	− ·0084	− 4	24·0	− ·0033	− 1	23·9	− ·1049	− 44
15	23·7	− ·0099	− 4	24·0	− ·0261	−11	23·3	− ·0030	− 1
16	23·5	− ·0034	− 1	24·0	− ·0408	−17	23·7	+ ·0498	+ 21
28	23·8	− ·0114	− 5	24·0	− ·1271	−53	22·7	+ ·1451	+ 64
April 10	23·9	− ·0076	− 3	23·9	− ·0123	− 5	22·6	− ·0851	− 38
23	23·6	+ ·0103	+ 4	24·0	− ·0196	− 8	23·7	+ ·0207	+ 9
May 25	23·6	+ ·0004	0	24·0	+ ·0176	+ 7	23·9	− ·0653	− 27
1855.									
Mar. 12	24·0	−0·0117	− 5	23·4	−0·0506	−22	23·5	−0·2111	− 90
April 4	23·6	− ·0028	− 1	23·6	− ·0108	− 5	20·3	− ·0018	− 1
July 19	.....	.....	.....	22·8	− ·0263	−12	23·5	− ·0101	− 4
Oct. 18 ..... †	23·7	− ·0052	− 2	24·0	− ·0477	−20	23·8	+ ·1049	+ 44
1857.									
Feb. 26	22·6	+0·0014	+ 1	22·6	−0·0086	− 4	23·2	−0·1368	− 59
Mar. 13	23·2	+ ·0052	+ 2	.....	.....	.....	.....	.....	.....
May 7	24·0	+ ·0207	+ 9	24·0	− ·0418	−17	22·6	− ·3191	−141
10	23·8	+ ·0056	+ 2	22·1	+ ·0270	+12	24·0	− ·0147	− 6
Sept. 3	24·0	− ·0124	− 5	24·0	− ·0259	−11	24·0	− ·4177	−174
Nov. 12	23·3	+ ·0163	+ 7	23·3	− ·0006	0	.....	.....	.....
16	21·3	− ·0073	− 3	23·3	− ·0036	− 2	.....	.....	.....
17	22·8	− ·0049	− 2	22·5	− ·0277	−12	.....	.....	.....
Dec. 16	24·0	− ·0021	− 1	24·0	− ·0304	−13	24·0	− ·2230	− 93
17	22·8	− ·0086	− 4	22·6	− ·0881	−39	24·0	+ ·0427	+ 18

* On Jan. 20, 1854, the observations of the Vertical-Force Instrument were interrupted during 3 hours.

† In 1856 there were no days of Great Magnetic Disturbance throughout the year.

The last figure in the "Algebraic Mean of Disturbance" is in the fourth decimal place of Horizontal Force.

TABLE II.—Algebraic Sums of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including all days of Record of Great Magnetical Disturbance.

Year.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.
1841	129·47	−·1836	−14	119·63	− ·1827	−15	116·19	+ ·3427	+ 29
1842	112·57	−·1161	−10	113·34	− ·3847	−34	111·74	− ·0132	− 1
1843	55·72	+·0148	+ 3	49·39	− ·0868	−18	45·40	+ ·0175	+ 4
1844	51·74	−·0033	− 1	59·70	− ·1329	−22	59·29	− ·0971	− 16
1845	60·00	−·0757	−13	60·41	− ·1398	−23	60·52	+ ·0176	+ 3
1846	244·86	−·0606	− 2	250·89	− ·1979	− 8	247·99	+ ·1305	+ 5
1847	246·75	+·0239	+ 1	246·29	− ·7489	−30	198·75	+ ·3193	+ 16
1848	264·18	−·0666	− 3	223·83	− ·5274	−24	40·65	− ·0905	− 22
1849	46·00	+·0162	+ 4	45·25	− ·0418	− 9	22·92	− ·3484	−152
1850	141·79	+·0493	+ 3	163·80	− ·1890	−12	138·34	− ·3417	− 25
1851	294·04	−·0830	− 3	305·70	− ·4764	−16	299·17	− ·6190	− 21
1852	364·65	−·0938	− 3	395·76	− ·2739	− 7	353·07	−1·2159	− 34
1853	327·14	−·0213	− 1	402·06	− ·4789	−12	350·67	+2·0150	+ 57
1854	285·10	−·0619	− 2	285·82	− ·2164	− 8	279·75	− ·3937	− 14
1855	71·37	−·0197	− 3	93·75	− ·1354	−14	91·03	− ·1181	− 13
1856	0·00	·0000	.....	0·00	·0000	.....	0·00	·0000	.....
1857	231·53	+·0139	+ 1	208·37	− ·1997	−10	141·73	−1·0686	− 75
Sum	2926·91	−·6675		3023·99	−4·4126		2557·21	−1·4636	
Mean Disturbance		−·00023			− ·00146			− ·00057	

TABLE III.—Algebraic Sums of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including only those days of Great Magnetic Disturbance in which Records were made by the three Instruments.

Year.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.	Number of Hours.	Algebraic Aggregate of Fluctuations.	Algebraic Mean of Disturbance.
1841	129·47	−·1836	−14	119·63	− ·1827	−15	116·19	+ ·3427	+ 29
1842	112·57	−·1161	−10	113·34	− ·3847	−34	111·74	− ·0132	− 1
1843	45·72	+·0190	+ 4	45·39	− ·0820	−18	45·40	+ ·0175	+ 4
1844	51·74	−·0033	− 1	51·70	− ·1105	−22	51·29	− ·0067	− 1
1845	60·00	−·0757	−13	60·41	− ·1398	−23	60·52	+ ·0176	+ 3
1846	244·86	−·0606	− 2	240·89	− ·1887	− 8	244·61	+ ·1349	+ 5
1847	202·69	+·0207	+ 1	202·19	− ·5453	−27	194·75	+ ·3657	+ 19
1848	55·17	−·0234	− 4	45·74	− ·2621	−58	40·65	− ·0905	− 22
1849	22·92	−·0129	− 6	22·84	− ·0160	− 7	22·92	− ·3484	−152
1850	141·79	+·0493	+ 3	139·88	− ·1869	−13	138·34	− ·3417	− 25
1851	294·04	−·0830	− 3	305·70	− ·4764	−16	299·17	− ·6190	− 21
1852	341·34	−·0812	− 2	372·27	− ·2612	− 7	353·07	−1·2159	− 34
1853	304·41	−·0150	− 1	308·40	− ·3688	−12	303·72	+1·7238	+ 57
1854	285·10	−·0619	− 2	285·82	− ·2164	− 8	279·75	− ·3937	− 14
1855	71·37	−·0197	− 3	70·97	− ·1091	−14	67·58	− ·1080	− 16
1856	0·00	·0000	0	0·00	·0000	0	0·00	·0000	0
1857	141·04	+·0046	0	139·26	− ·1678	−12	141·73	−1·0686	− 75
Sum	2504·23	−·6428		2524·42	−3·6984		2471·43	−1·6035	
Mean Disturbance		−·00026			− ·00147			− ·00065	

8. The most remarkable of the results of these Tables is, not only that upon the whole the Algebraic Aggregate of Fluctuations for the Northerly Force is negative (which has been previously recognized), but that it is negative in every separate year. It will be seen in Table I. that on some separate days the Aggregate of Fluctuations is positive, but the number of days is only 22, in opposition to 155 with negative Aggregates.

The Aggregate for the Westerly Force is also negative: and though the different years do not consent in the same way as for the Northerly Force, yet their discordance is not so great as to justify us in setting aside this indication, although there may be greater doubt upon the accuracy of its value. This Aggregate (taken in comparison with that for the Northerly Force) appears to show that, on the whole, the direction of Disturbing Force is 10° to the East of South.

The Aggregate for the Nadir Force appears greater, but it is very uncertain; it might be nearly destroyed by the omission of a single year.

9. These characteristics of the directions of the disturbing forces will appear also in the following enumeration of the instances in which the first and last waves of each Magnetic Storm are affected in different ways. In comparing the numbers it must be borne in mind that, when there is only one wave, that wave is considered, in different places, both as the first and the last.

	Westerly Force.	Northerly Force.	Nadir Force.
Whole number of positive fluctuations	340	177	118
of negative fluctuations	302	277	120
Number of instances in which the first wave is + ...	106	58	81
in which the first wave is −	62	114	64
in which the last wave is + ...	100	15	63
in which the last wave is −	68	157	82

Number of Storms beginning with Westerly Force+ and Northerly Force + . . 35
beginning with Westerly Force+ and Northerly Force − . . 68
beginning with Westerly Force− and Northerly Force + . . 21
beginning with Westerly Force− and Northerly Force − . . 40
ending with Westerly Force+ and Northerly Force + . . 7
ending with Westerly Force+ and Northerly Force − . . 90
ending with Westerly Force− and Northerly Force + . . 8
ending with Westerly Force− and Northerly Force − . . 58

Number of Storms beginning with Northerly Force+and Nadir Force + . . . 26
beginning with Northerly Force+and Nadir Force − . . . 21
beginning with Northerly Force−and Nadir Force + . . . 55
beginning with Northerly Force−and Nadir Force − . . . 42
ending with Northerly Force+and Nadir Force + . . . 6
ending with Northerly Force+and Nadir Force − . . . 7
ending with Northerly Force−and Nadir Force + . . . 57
ending with Northerly Force−and Nadir Force − . . . 74

10. The following Tables, Tables IV., V., and VI., exhibit the Aggregates of Fluctuations without regard of sign. They are required in order to give information on the Mean Value of Disturbance by Wave in each of the three directions.

TABLE IV.—Absolute Sums, without regard of sign, of Magnetic Fluctuations (in terms of Horizontal Force) on Days of Great Magnetic Disturbance.

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.
1841.									
Sept. 24	2	0·0292	21	1	0·0456	38	1	0·0392	28
25	6	·0608	28	2	·0846	66	1	·2580	228
27	1	·0270	33	3	·0101	12	1	·0670	82
Oct. 25	4	·0427	19	1	·0484	22	2	·0434	21
Nov. 18	2	·0961	54	1	·0125	7	3	·0517	29
19	5	·0214	9	3	·0292	12	2	·0505	21
Dec. 3	3	·0152	12	3	·0207	16	1	·0424	39
14	2	·0312	31	1	·0130	13	1	·0621	62
1842.									
Jan. 1	1	0·0240	36	1	0·0387	58	1	0·0061	10
Feb. 24	3	·0148	19	1	·0400	50	2	·0044	5
April 14	1	·0214	28	1	·0423	57	1	·0784	98
15	3	·0311	13	1	·1416	59	2	·0465	21
July 1	4	·0100	13	1	·0178	23	3	·0137	17
2	1	·0523	31	5	·0292	22	1	·0608	46
3	2	·0283	29	1	·0650	65	2	·0545	55
Nov. 10	1	·0340	24	1	·0710	50	1	·0185	13
21	2	·0320	27	3	·0248	21	1	·0312	26
Dec. 9	1	·0220	22	3	·0189	19	1	·0311	31
1843.									
Jan. 2	1	0·0180	18	1	0·0180	18	1	0·0261	26
Feb. 6	2	·0060	10	...	.....	...	...	.....	...
16	1	·0044	11	1	·0048	12	...	.....	...
24	3	·0131	11	3	·0201	17	2	·0093	8
May 6	1	·0216	49	1	·0226	55	2	·0110	26
July 24	2	·0149	11	2	·0247	18	1	·0140	10
25	1	·0210	35	5	·0026	4	1	·0329	59
1844.									
Mar. 29	2	0·0314	20	3	0·0309	20	1	0·0448	28
30	4	·0169	14	3	·0126	10	2	·0161	14
Oct. 1	1	·0156	26	1	·0198	33	1	·0018	3
20	...	.....	...	1	·0224	28	1	·0904	113
Nov. 16	2	·0200	20	1	·0280	28	1	·0398	41
22	1	·0248	31	3	·0220	28	2	·0092	11
1845.									
Jan. 9	1	0·0290	29	1	0·0440	44	1	0·0080	8
Feb. 24	2	·0200	13	3	·0185	11	1	·0211	13
Mar. 26	1	·0210	15	3	·0104	7	1	·0070	5
Aug. 29	3	·0053	9	1	·0024	4	1	·0062	10
Dec. 3	4	·0310	22	1	·0667	47	1	·0439	31
1846.									
May 12	3	0·0073	7	2	0·0100	10	2	0·0118	12
July 11	...	.....	...	2	·0118	12	1	·0044	13
Aug. 6	3	·0209	18	2	·0133	11	2	·0147	12
7	1	·0286	13	7	·0089	4	3	·0123	6
24	3	·0109	8	1	·0036	3	1	·0160	10
25	1	·0096	6	3	·0070	4	1	·0071	5
28	3	·0122	14	3	·0075	9	1	·0114	13

TABLE IV. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.
1846 (cont^{d}).									
Sept. 4	2	0·0201	13	2	0·0156	10	1	0·0208	13
5	4	·0148	12	3	·0226	17	2	·0304	23
10	2	·0187	14	3	·0047	3	1	·0140	10
11	5	·0342	14	5	·0226	10	3	·0316	13
21	2	·0474	24	3	·0201	10	1	·0100	5
22	6	·0352	25	3	·0425	30	2	·0645	46
Oct. 2	1	·0156	26	1	·0102	17	1	·0060	10
7	2	·0295	17	3	·0523	29	1	·0378	21
8	5	·0185	15	3	·0235	20	1	·0905	77
Nov. 26	2	·0237	14	3	·0281	19	2	·0210	13
Dec. 23	1	·0160	16	1	·0170	17	2	·0112	11
1847.									
Feb. 24	2	0·0223	22	1	0·0110	11	1	0·0030	3
Mar. 1	4	·0152	19	2	·0167	21	1	·0616	77
19	9	·0339	17	2	·0960	48	2	·1269	70
April 3	1	·0240	30	3	·0067	8	1	·0264	33
7	2	·0224	14	2	·0515	32	2	·0205	13
21	3	·0028	5	1	·0120	22	1	·0156	26
May 7	1	·0344	43	2	·0114	14	1	·0100	10
June 24	1	·0109	27	...	.....	...	...	.....	.....
July 9	...	.....	...	1	·0352	88	1	·0464	116
Sept. 24	10	·0550	31	5	·1912	106	2	·1277	75
26	3	·0163	17	1	·0401	41	2	·0338	34
27	3	·0056	6	1	·0300	30	1	·0603	62
Oct. 22	4	0·0043	7	2	·0409	71	1	·0108	18
23*(1st)	10	·0235	20	3	·0564	47	2	·1158	100
23(2nd)	1	·0025	13	1	·0030	16	1	·0016	8
24	7	·0845	36	5	·2554	110	7	·1144	48
25	5	·0103	10	1	·0150	15	1	·0654	69
Nov. 22	6	·0226	16	2	·0572	41	2	·1057	70
Dec. 17	12	·0315	14	2	·0552	25	1	·1260	90
18	4	·0162	13	1	·0193	16	...	.....	.....
19	2	·0433	43	1	·0910	91	...	.....	.....
20	10	·0434	24	6	·1277	70	...	.....	.....
1848.									
Jan. 16	2	0·0179	12	1	0·0340	33	...	.....	.....
28	2	·0306	22	4	·0375	20	...	.....	.....
Feb. 20	6	·0380	17	1	·0335	37	...	.....	.....
21	4	·0267	16	3	·0962	42	...	.....	.....
22	2	·0045	11	1	·0125	31	...	.....	.....
23	2	·0235	13	3	·0028	3	...	.....	.....
24	3	·0375	18	3	·0525	23	...	.....	.....
Mar. 17	1	·0077	23	2	·0093	18	...	.....	.....
20	4	·0208	15	1	·0309	27	...	.....	.....
Apr. 7	3	·0109	10	2	·0084	21	...	.....	.....
May 18	4	·0096	11	2	·0123	14	...	.....	.....
July 11	6	·0184	11	2	·0689	36	...	.....	.....
Oct. 18	4	·0288	25	3	·0323	30	1	0·0970	136
23	4	·0200	19	3	·0234	24	...	.....	.....
25	3	·0158	9	4	·0157	9	...	.....	.....
29	2	·0129	8	1	·0000	0	...	.....	.....

* On October 23, 1847, all the observations were interrupted during 10 hours.

TABLE IV. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.
1848 (cont^{d}).									
Nov. 17	7	0·0683	34	3	0·1961	103	7	0·0769	41
18	3	·0276	19	3	·0271	26	1	·0208	50
Dec. 17	2	·0161	17	1	·0194	35	1	·0744	72
1849.									
Oct. 30	3	0·0209	9	2	0·0228	10	1	0·3484	152
Nov. 27	3	·0295	13	3	·0280	12	.....	.....	.....
1850.									
Feb. 22	4	0·0172	7	4	0·0244	10	1	0·2030	87
23	6	·0186	8	2	·0333	14	2	·0303	13
Mar. 31	4	·0214	9	1	·0375	16	1	·0000	0
May 7	.....	.....	.....	3	·0249	10	.....	.....	.....
June 13	2	·0285	12	2	·0534	23	1	·3882	164
Oct. 1	1	·0487	21	1	·0522	23	1	·1188	54
2	3	·0421	18	1	·0495	21	2	·0212	9
1851.									
Jan. 16	3	0·0432	19	2	0·0517	22	1	0·1009	44
19	4	·0293	12	2	·0468	19	1	·1367	59
Feb. 18	5	·0252	11	2	·0505	22	1	·1382	59
Sept. 3	5	·0473	25	3	·0522	22	3	·1114	48
4	7	·0218	9	5	·0444	19	1	·1769	77
6	2	·0595	25	3	·0378	15	3	·0648	28
7	7	·0462	20	7	·1108	46	3	·1805	76
29	6	·0720	32	3	·0972	41	2	·3864	172
Oct. 2	5	·0343	14	5	·0636	27	3	·1370	58
28	2	·0772	33	4	·0506	22	1	·1834	80
Dec. 6	4	·0465	20	1	·1264	54	1	·0815	36
28	5	·0247	11	3	·0243	10	1	·0950	41
29	4	·0420	23	1	·0627	28	3	·0233	11
1852.									
Jan. 4	3	0·0357	15	1	0·0968	44	3	0·0523	22
19	7	·0183	8	5	·0462	20	1	·1206	54
Feb. 14	4	·0217	10	3	·0823	37	4	·0585	26
15	7	·0412	17	3	·0712	30	3	·1879	80
17	6	·0283	12	4	·0475	20	3	·2525	110
18	7	·0277	12	4	·1041	43	1	·4422	185
19	3	·0919	43	5	·1042	44	1	·2596	113
20	7	·0186	8	3	·0441	18	1	·1594	69
21	3	·0370	18	3	·0660	28	1	·1735	77
April 20	7	·0570	24	3	·0796	33	1	·1508	67
May 19	3	·0487	30	4	·0289	12	1	·0595	28
20	1	·0068	10	3	·0140	6	1	·0605	44
June 11	3	·0514	23	2	·0606	26	1	·4354	195
16	4	·0310	13	5	·0275	12	.....	.....	.....
July 10	2	·0490	23	2	·0336	15	3	·0660	29
Nov. 11	3	·0393	17	2	·0367	16	1	·3236	141
13	3	·0386	16	3	·0352	15	1	·1638	77

TABLE IV. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.	Number of Waves.	Absolute Aggregate of Fluctuations.	Absolute Mean of Disturbance.
1853.									
Jan. 10	3	0·0229	10	3	0·0208	9	.....	.....	.....
Mar. 7	8	·0269	11	6	·0302	13	1	0·3353	141
8	6	·0293	13	5	·0242	10	1	·5298	236
11	.....	.....	.....	5	·0279	12	1	·3529	152
May 2	3	·0359	16	1	·0657	28	1	·3595	157
3	6	·0210	9	3	·0552	23	1	·3424	149
24	7	·0280	12	5	·0886	38	3	·2273	96
June 22	3	·0253	11	3	·0259	11	1	·1487	64
July 12	8	·0299	13	3	·0646	27	4	·0777	33
Aug. 21	.....	.....	.....	.....	.....	.....	1	·0617	26
Sept. 1	7	·0264	11	4	·0838	37	2	·0648	28
2	5	·0299	13	5	·0738	31	2	·0717	30
Oct. 1	.....	.....	.....	1	·0312	13	.....	.....	.....
2	.....	.....	.....	1	·0336	14	.....	.....	.....
25	4	·0153	6	3	·0160	7	1	·3093	129
Nov. 9	5	·0503	21	1	·0474	20	2	·0766	33
Dec. 6	5	·0354	15	1	·1079	45	2	·0633	27
21	5	·0176	8	3	·0097	42	1	·1790	77
1854.									
Jan. 8	3	0·0249	10	2	0·0374	16	1	0·1089	46
20*	8	·0245	10	3	·0108	4	1	·0104	15
20	.....	.....	.....	.....	.....	.....	1	·0550	39
Feb. 16	5	·0219	9	5	·0383	16	1	·1165	49
24	6	·0335	14	4	·0230	10	3	·1460	62
25	3	·0135	5	6	·0235	10	2	·1310	55
Mar. 6	4	·0228	10	5	·0145	6	1	·1049	44
15	9	·0265	11	2	·0407	17	4	·0514	22
16	7	·0294	12	1	·0408	17	1	·0498	21
28	4	·0284	12	1	·1271	53	1	·1451	64
April 10	6	·0458	19	4	·0687	29	3	·0855	38
23	3	·0233	10	4	·0334	14	2	·0897	38
May 25	6	·0112	5	3	·0188	8	4	·0759	32
1855.									
Mar. 12	5	0·0395	16	2	0·0574	25	1	0·2111	90
April 4	3	·0248	10	7	·0154	7	2	·0282	14
July 19	.....	.....	.....	2	·0653	29	2	·0719	31
Oct. 18 †	3	·0234	10	2	·0499	21	1	·1049	44
1857.									
Feb. 26	3	0·0204	9	2	0·0180	8	1	0·1368	59
Mar. 13	3	·0194	8	.....	.....	.....	.....	.....	.....
May 7	3	·0689	29	4	·0726	30	1	·3191	141
10	9	·0118	5	4	·0388	18	2	·0893	37
Sept. 3	6	·0372	15	4	·0515	21	2	·4199	175
Nov. 12	3	·0353	15	4	·0162	7	.....	.....	.....
16	2	·0271	12	4	·0216	9	.....	.....	.....
17	3	·0605	26	3	·0339	15	.....	.....	.....
Dec. 16	5	·0405	17	3	·0768	32	1	·2230	93
17	11	·0134	6	1	·0881	39	2	·0543	23

* 1854, Jan. 20. The Vertical-Force observations were interrupted during 3 hours.

† In 1856 there were no days of Great Magnetic Disturbance throughout the year.

The last figure in the "Absolute Mean of Disturbance" is in the fourth decimal place of Horizontal Force.

TABLE V.—Sums, without regard of sign, of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including all days of Record of Great Magnetical Disturbance.

Year.	Number of Storms.	Westerly Force.			Northerly Force.			Nadir Force.		
		Number of Waves.	Number of Hours.	Absolute Sum of Fluctuations.	Number of Waves.	Number of Hours.	Absolute Sum of Fluctuations.	Number of Waves.	Number of Hours.	Absolute Sum of Fluctuations.
1841	8	25	129·47	·3236	15	119·63	·2641	12	116·19	·6143
1842	10	19	112·57	·2699	18	113·34	·4893	15	111·74	·3452
1843	7	11	55·72	·0990	13	49·39	·0928	7	45·40	·0933
1844	6	10	51·74	·1087	12	59·70	·1357	8	59·29	·2021
1845	5	11	60·00	·1063	9	60·41	·1420	5	60·52	·0862
1846	18	46	244·86	·3632	50	250·89	·3213	28	247·99	·4155
1847	21	100	246·75	·5249	45	246·29	1·2229	30	198·75	1·0719
1848	19	64	264·18	·4356	43	223·83	·7128	10	40·65	·2691
1849	2	6	46·00	·0504	5	45·25	·0508	1	22·92	·3484
1850	7	20	141·79	·1765	14	163·80	·2752	8	138·34	·7615
1851	13	59	294·04	·5692	41	305·70	·8190	24	299·17	1·8160
1852	17	73	364·65	·6422	55	395·76	·9785	27	353·07	2·9661
1853	18	75	327·14	·3941	53	402·06	·8065	24	350·67	3·2000
1854	12	64	285·10	·3057	40	285·82	·4770	25	279·75	1·1701
1855	4	11	71·37	·0877	13	93·75	·1880	6	91·03	·4161
1856	0	0	0·00	·0000	0	0·00	0000	0	0·00	·0000
1857	10	48	231·53	·3345	29	208·37	·4175	9	141·73	1·2424
Sums	177	642	2926·91	4·7915	455	3023·99	7·3934	239	2557·21	15·0182
Means of Absolute Disturbances ...				·00164			·00244			·00587

TABLE VI.—Sums, without regard of sign, of Magnetic Fluctuations (in terms of Horizontal Force) for each Year from 1841 to 1857, including only those days of Great Magnetic Disturbance in which Records were made by the three Instruments.

Year.	Number of Storms.	Westerly Force.			Northerly Force.			Nadir Force.		
		Number of Waves.	Number of Hours.	Absolute Sum of Fluctuations.	Number of Waves.	Number of Hours.	Absolute Sum of Fluctuations.	Number of Waves.	Number of Hours.	Absolute Sum of Fluctuations.
1841	8	25	129·47	·3236	15	119·63	·2641	12	116·19	·6143
1842	10	19	112·57	·2699	18	113·34	·4893	15	111·74	·3452
1843	5	8	45·72	·0886	12	45·39	·0880	7	45·40	·0933
1844	5	10	51·74	·1087	11	51·70	·1133	7	51·29	·1117
1845	5	11	60·00	·1063	9	60·41	·1420	5	60·52	·0862
1846	17	46	244·86	·3632	48	240·89	·3095	27	244·61	·4111
1847	16	83	202·69	·4111	36	202·19	·9497	29	194·75	1·0255
1848	4	16	55·17	·1408	10	45·74	·2749	10	40·65	·2691
1849	1	3	22·92	·0209	2	22·84	·0228	1	22·92	·3484
1850	6	20	141·79	·1765	11	139·88	·2503	8	138·34	·7615
1851	13	59	294·04	·5692	41	305·70	·8190	24	299·17	1·8160
1852	16	69	341·34	·6112	50	372·27	·9510	27	353·07	2·9661
1853	13	72	304·41	·3712	43	308·40	·6930	22	303·72	2·7854
1854	12	64	285·10	·3057	40	285·82	·4770	25	279·75	1·1701
1855	3	11	71·37	·0877	11	70·97	·1227	4	67·58	·3442
1856	0	0	0·00	·0000	0	0·00	·0000	0	0·00	·0000
1857	6	37	141·04	·1922	18	139·25	·3458	9	141·73	1·2424
Sums	140	553	2504·23	4·1468	375	2524·42	6·3124	232	2471·43	14·3905
Means of Absolute Disturbances ...				·00166			·00250			·00582

11. In examining the last line of these Tables, it must be borne in mind that the numbers are affected by the constant part of the Disturbance which appears as "Mean Disturbance" at the end of Table III. The value of mean disturbance for Nadir Force (as has been remarked) is uncertain, and that for Westerly Force is small; but that for Northerly Force is important. A constant term $-\cdot00147$, combined with variable quantities whose mean value is $\pm\cdot00250$, and whose actual value even at the maximum of its wave will very frequently be far less, will destroy some waves entirely. It will also increase the apparent Mean of Absolute Disturbances, even when the number of waves is not diminished. Thus: suppose, as a simple case, that the pure disturbance is represented by $a \sin\theta$, but that, when affected with a constant term, it is $a \sin\theta - b$. (As has been stated, when a is smaller than b, the addition of $-b$ will make every value $-$, and will destroy the alternation of $+$ waves and $-$ waves, and thus the just number of waves will be apparently diminished.) When a is greater than b, if Θ be the first value of θ which makes $a \sin\theta - b = 0$, the positive Fluctuation will be found by integrating from $\theta = \Theta$ to $\theta = \pi - \Theta$, and the negative Fluctuation by integrating from $\theta = \pi - \Theta$ to $\theta = 2\pi + \Theta$. The general value of the integral is $-a\cos\theta - b\theta$; the first limited integral is $2a\cos\Theta - b(\pi - 2\Theta)$: the second is $-2a\cos\Theta - b(\pi + 2\Theta)$, or (with sign changed, to make it positive) $+2a\cos\Theta - b(-\pi - 2\Theta)$; and the sum of these, or aggregate of absolute fluctuations, is $4a\cos\Theta + 4b\,.\,\Theta$. Now Θ is determined by the condition $a\sin\Theta - b = 0$, or $\sin\Theta = \frac{b}{a}$. If b be small, $\Theta = \frac{b}{a}$ nearly, $\cos\Theta = 1 - \frac{b^2}{2a^2}$ nearly, and the aggregate of absolute fluctuations $= 4a + \frac{2b^2}{a}$. The second term is the increase of the aggregate arising from the introduction of the term b.

If then we conceive the numbers in the last line of Table VI. to be affected with the correction which ought to be introduced in order to neutralize the effect of the large constant term in Northerly Force, it is certain that the number 375 would be considerably increased, and that the number 6·3124 would be considerably diminished. A very extensive examination of details would be necessary to enable us to say what would be the exact proportion of the changes: but it appears to me extremely probable (though at present far from certain) that the corrected Numbers of Waves are sensibly equal, the corrected Absolute Sums of Fluctuations are sensibly equal, and the corrected Means of Absolute Disturbances are sensibly equal, for Westerly Force and for Northerly Force.

The Number of Waves for Nadir Force is less than half that for the other forces; and the Absolute Sum of Fluctuations is about three times as great as that for the others.

12. It would be very important to ascertain any correspondence in the times of the waves in the different directions. I have not yet succeeded in discovering any satisfactory or certain relation.

First, in comparison of the Waves of Westerly and Northerly Forces, the coincidences of times of wave are so rare that it seems evident that nothing can be inferred from the few which can be found. From 1849 to 1857, when the photographic apparatus recorded equally the disturbances at all hours, I do not find one. In a less rigorous examination of the storms from 1841 to 1847, I find that on Nov. 19, 1841, there

were contemporaneous waves from $12^h\ 17^m$ to $13^h\ 17^m$, W. F.+, No. F.+; and on Jan. 1, 1842, when the storm consisted of a single wave, $6^h\ 0^m$ to $12^h\ 41^m$, the forces were W. F.—, No. F.+. And the second W. F.— on Jan. 16, 1848, corresponds nearly with the sole No. F.—. Sometimes two waves in one direction correspond nearly with one in the other direction: thus in the beginning of the storm 1854, April 10, the W. F.+ from $0^h\ 7^m$ to $5^h\ 21^m$ and — from $5^h\ 21^m$ to $13^h\ 16^m$ occupy the same time as No. F.+ from $0^h\ 5^m$ to $13^h\ 9^m$: but this relation is not supported in the remainder of the same storm. A more frequent relation appears to be, that the evanescence of one wave corresponds with the maximum of the other: thus on February 21, 1852, and March 7, 1853, the waves stand in this order:

	Westerly Force.		Northerly Force.	
	Limits of Waves.	Character of Waves.	Limits of Waves.	Character of Waves.
1852. Feb. 21.....	0·27		0·12	—
	4· 9	+	3·14	+
	15·15	—	5·16	—
			23·59	
1853. Mar. 7.....	0·10	—	3·13	—
	4· 5	+	5·32	+
	6·25	—	7·19	
	12·20			

which relation, however, in the latter instance, is not maintained through the storm. And, generally, this relation does not appear to hold through the whole of any one storm consisting of numerous waves.

13. As the number of Nadir Waves approximates to half the number of Westerly Waves, it might seem worthy of inquiry whether the maximum of Nadir Wave corresponds to a change of Westerly Wave. The following instances have been remarked.

Time of Maximum of Nadir Wave.	Sign of Nadir Wave.	Change of Westerly Wave.	Time of Maximum of Nadir Wave.	Sign of Nadir Wave.	Change of Westerly Wave.
h m			h m		
1841. Sept. 25. 3 35	+	+ to —	1852. Feb. 18. 4 37	+	+ to —
4 17	+	— to +	June 11. 14 28	—	— to +
6 19	+	+ to —	Nov. 11. 8 18	+	+ to —
1847. Sept. 24. 5 51	+	+ to —	1853. Mar. 8. 6 28	+	+ to —
10 21	—	— to +	14 24	+	+ to —
Oct. 23. 5 27	+	+ to —	May 2. 17 35	+	— to +
7 1	+	+ to —	3. 3 33	+	+ to —
Oct. 24. 13 4	—	— to +	24. 10 10	+	— to +
Dec. 17. 6 15	+	— to +	July 12. 11 37	—	+ to —
8 13	+	— to +	15 57	+	— to +
1851. Sept. 4. 7 19	+	— to +	Sept. 1. 15 37	—	+ to —
7. 4 14	+	+ to —	2. 5 18	+	+ to —
6 30	+	— to +	Oct. 25. 13 47	+	+ to —
7 34	—	+ to —	1854. Apr. 10. 17 56	—	— to +
10 19	—	+ to —	1857. Dec. 17. 6 10	+	+ to —
1852. Feb. 18. 2 56	+	+ to —			

I am unable to draw any inference from these.

14. The classification in Article 9 appears to lead to no result as to the effect of connexion of special signs of the first or last waves of the different forces. The inequalities shown in the first Table of Article 9 (of which the difference of numbers of last wave + and numbers of last wave − for the Northerly Force is the most remarkable) are quite sufficient to explain the inequalities in the combinations exhibited in the latter part of Article 9. And, on the whole, the principal conclusions which can be deduced from the examination of the Waves appear to me to be the following:—

That, while on the whole the Westerly Force is −, yet the number of + waves is the greater; and at the beginnings and ends of storms the number of + waves is greater than the number of − waves in a proportion exceeding 3 : 2.

That, the Northerly Force being on the whole −, in two instances out of three the first Northerly wave is −, and in ten instances out of eleven the last Northerly wave is −.

That, due regard being had to the effect of the constant − Northerly Force, it appears probable that the number of waves and the mean value of wave-disturbance are nearly the same for Westerly Force and for Northerly Force; but

That for the Nadir Force the number of waves is less than one-half the number for the other forces, while the mean value of disturbance is more than double that for the other forces.

15. I now proceed with the Irregularities. The following Tables (VII., VIII., IX.) exhibit their aggregates under the same divisions as those for the Waves. It will be remarked that, from the nature of the process by which the Irregularities are found, their algebraic sum in each storm is sensibly $=0$; and therefore they are treated here only as numbers without sign.

TABLE VII.—Absolute Sums, without regard of sign, of Coefficients of Magnetic Irregularity (in terms of Horizontal Force), on Days of Great Magnetic Disturbance.

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.
1841.									
Sept. 24	10	0·0133	13	6	0·0060	10	2	0·0031	15
25	70	·1417	20	73	·1226	17	61	·1760	29
27	6	·0086	14	12	·0090	8	3	·0021	7
Oct. 25	33	·0437	13	36	·0354	10	14	·0157	11
Nov. 18	25	·0329	13	28	·0325	12	18	·0208	12
19	19	·0252	13	26	·0213	8	13	·0139	11
Dec. 3	7	·0134	19	13	·0127	10	3	·0018	6
14	8	·0145	18	9	·0146	16	6	·0072	12
1842.									
Jan. 1	6	0·0068	11	8	0·0038	5	5	0·0021	4
Feb. 24	7	·0132	19	9	·0162	18	3	·0013	4
April 14	12	·0152	13	11	·0168	15	6	·0090	15
15	20	·0291	15	35	·0373	11	15	·0134	9
July 1	9	·0137	15	15	·0198	13	10	·0113	11
2	23	·0349	15	35	·0502	14	10	·0134	13
3	29	·0437	15	42	·0502	12	20	·0236	12
Nov. 10	11	·0197	18	14	·0139	10	4	·0021	5
21	14	·0132	9	15	·0204	14	1	·0008	8
Dec. 9	19	·0209	11	36	·0176	5	6	·0036	6
1843.									
Jan. 2	5	0·0059	12	6	0·0056	9	2	0·0005	3
Feb. 6	3	·0024	8	...	.....	...	...	.....	...
16	7	·0008	1	6	·0015	3	...	.....	...
24	12	·0118	10	37	·0166	4	6	·0041	7
May 6	17	·0206	12	22	·0196	9	9	·0105	12
July 24	4	·0047	12	6	·0058	10	5	·0013	3
25	14	·0151	11	13	·0141	11	5	·0015	3
1844.									
Mar. 29	21	0·0230	11	24	0·0159	7	9	0·0046	5
30	18	·0246	14	29	·0335	12	7	·0041	6
Oct. 1	9	·0056	6	9	·0070	8	1	·0005	5
20	...	.....	...	11	·0113	10	3	·0046	15
Nov. 16	28	·0290	10	19	·0190	10	9	·0049	5
22	22	·0234	11	31	·0300	10	9	·0072	8
1845.									
Jan. 9	15	0·0167	11	9	0·0105	12	4	0·0033	8
Feb. 24	16	·0163	10	26	·0123	5	13	·0072	6
Mar. 26	12	·0125	10	16	·0124	8	4	·0028	7
Aug. 29	19	·0065	3	11	·0087	8	5	·0015	3
Dec. 3	57	·0698	12	61	·0708	12	27	·0242	9
1846.									
May 12	13	0·0161	12	15	0·0130	9	4	0·0044	11
July 11	...	.....	...	14	·0178	13	7	·0057	8
Aug. 6	26	·0172	7	35	·0172	5	7	·0036	5
7	64	·0207	3	55	·0308	6	15	·0090	6
24	9	·0075	8	9	·0055	6	5	·0015	3
25	5	·0033	7	5	·0059	12	2	·0015	8
28	28	·0150	5	24	·0178	7	3	·0023	8

TABLE VII. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.
1846 (cont^{d}).									
Sept. 4	26	0·0178	7	29	0·0156	5	5	0·0028	6
5	32	·0255	8	36	·0285	8	7	·0093	13
10	6	·0049	8	6	·0056	9	3	·0008	3
11	28	·0311	11	31	·0378	12	12	·0123	10
21	23	·0162	7	18	·0158	9	7	·0041	6
22	68	·0771	11	59	·0692	12	28	·0244	9
Oct. 2	8	·0089	11	11	·0100	9	3	·0018	6
7	25	·0343	14	28	·0295	11	3	·0049	16
8	29	·0213	8	29	·0245	9	5	·0031	6
Nov. 26	28	·0253	9	29	·0235	9	7	·0080	11
Dec. 23	12	·0163	14	9	·0133	17	7	·0039	6
1847.									
Feb. 24	20	0·0132	7	15	0·0107	7	4	0·0026	7
Mar. 1	42	·0416	10	43	·0384	9	16	·0126	8
19	49	·0835	17	36	·0518	14	24	·0283	12
April 3	15	·0214	14	18	·0232	13	3	·0039	13
7	19	·0225	12	22	·0306	14	4	·0044	11
21	12	·0142	12	8	·0095	12	2	·0018	9
May 7	6	·0088	15	4	·0047	12	2	·0010	5
June 24	3	·0046	15	...	.....	...	...	.....	...
July 9	...	.....	...	8	·0134	17	5	·0075	15
Sept. 24	148	·2666	18	128	·3262	26	119	·2192	18
26	12	·0128	11	15	·0142	9	9	·0087	10
27	16	·0167	10	12	·0124	10	10	·0201	20
Oct. 22	29	·0232	8	30	·0406	14	24	·0157	6
23*(1st)	86	·1132	13	73	·1332	18	58	·0882	15
23(2nd)	3	·0016	5	1	·0021	21	2	·0088	44
24	113	·2034	18	128	·3134	24	94	·1722	18
25	20	·0225	11	17	·0184	11	7	·0121	17
Nov. 22	34	·0428	13	46	·0462	10	15	·0375	25
Dec. 17	86	·1400	16	39	·0577	15	33	·0540	16
18	29	·0297	10	21	·0236	11	...	.....	...
19	66	·0937	14	44	·0963	22	...	.....	...
20	97	·2546	26	64	·2191	34	...	.....	...
1848.									
Jan. 16	21	0·0570	27	21	0·0381	18	...	.....	...
28	18	·0361	20	19	·0422	22	...	.....	...
Feb. 20	35	·0573	16	16	·0329	21	...	.....	...
21	35	·1182	34	49	·1857	38	...	.....	...
22	4	·0099	25	5	·0087	17	...	.....	...
23	16	·0283	18	12	·0248	21	...	.....	...
24	24	·0431	18	21	·0407	19	...	.....	...
Mar. 17	4	·0036	9	7	·0141	20	...	.....	...
20	28	·0553	20	20	·0470	23	...	.....	...
April 7	21	·0390	19	9	·0241	27	...	.....	...
May 18	20	·0233	12	12	·0252	21	...	.....	...
July 11	33	·0544	16	25	·0608	24	...	.....	...
Oct. 18	21	·0675	32	18	·0666	37	14	0·0524	37
23	23	·0518	23	19	·0396	21	...	.....	...
25	20	·0284	14	22	·0300	14	...	.....	...
29	11	·0185	17	1	·0018	18	...	.....	...

* On Oct. 23, 1847, all the observations were interrupted during 10 hours.

TABLE VII. (continued).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.
1848 (cont^{d}).									
Nov. 17	38	0·1225	32	77	0·2394	31	41	0·2362	58
18	17	·0272	16	17	·0306	18	1	·0008	8
Dec. 17	19	·0396	21	12	·0213	18	14	·0167	12
1849.									
Oct. 30	19	0·0232	...	8	0·0192	...	4	0·0046	12
Nov. 27	11	·0158	...	7	·0166	...	...	.....	...
1850.									
Feb. 22	27	0·0219	8	26	0·0356	14	5	0·0113	23
23	35	·0506	15	28	·0612	22	3	·0129	43
Mar. 31	29	·0249	9	17	·0249	15	1	·0072	72
May 7	...	.....	...	13	·0174	13	...	.....	...
June 13	13	·0180	14	14	·0202	14	4	·0123	31
Oct. 1	34	·0384	11	30	·0405	14	8	·0123	15
2	25	·0390	16	25	·0400	16	7	·0087	12
1851.									
Jan. 16	43	0·0544	13	36	0·0429	12	4	0·0090	23
19	37	·0341	9	35	·0420	12	6	·0077	13
Feb. 18	22	·0297	13	39	·0410	11	20	·0165	8
Sept. 3	19	·0311	16	28	·0231	8	40	·0355	9
4	29	·0512	18	63	·0843	13	42	·0460	11
6	18	·0320	18	40	·0558	14	47	·0388	8
7	89	·1659	19	106	·1899	18	86	·1367	16
29	63	·1426	23	122	·1828	15	67	·1115	17
Oct. 2	33	·0489	15	43	·0602	14	29	·0414	14
28	24	·0448	19	46	·0509	11	20	·0180	9
Dec. 6	40	·0697	17	51	·0615	12	30	·0404	13
28	36	·0381	11	37	·0313	9	15	·0144	10
29	47	·0463	10	52	·0452	9	12	·0098	8
1852.									
Jan. 4	38	0·0343	9	22	0·0208	9	18	0·0087	5
19	31	·0358	12	59	·0540	9	31	·0177	6
Feb. 14	20	·0255	13	19	·0562	30	17	·0195	11
15	101	·0987	10	62	·0888	14	53	·0398	7
17	90	·1440	16	92	·1924	21	124	·1354	11
18	73	·0965	13	66	·1295	20	54	·0576	11
19	73	·1630	22	71	·1397	20	100	·1789	18
20	45	·0457	10	60	·0641	11	17	·0198	12
21	50	·0739	15	70	·0785	11	23	·0226	10
April 20	52	·0690	13	52	·1515	29	41	·0440	11
May 19	25	·0207	8	36	·0322	9	12	·0121	10
20	3	·0031	10	37	·0466	13	14	·0077	6
June 11	31	·0573	18	37	·0586	16	32	·0352	11
16	41	·0373	9	39	·0464	12	...	.....	...
July 10	29	·0352	12	25	·0411	16	15	·0111	7
Nov. 11	37	·0483	13	38	·0435	11	20	·0224	11
13	43	·0506	12	25	·0301	12	12	·0080	7
1853.									
Jan. 10	19	0·0195	10	16	0·0146	9	...	.....	...
Mar. 7	66	·0423	6	63	·0423	7	11	0·0201	18
8	72	·0621	9	57	·0415	7	11	·0147	13

TABLE VII. (concluded).

Year, Month, and Day.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.	Number of Irregularities.	Absolute Sum of Coefficients of Irregularity.	Mean Coefficient of Irregularity.
1853 (cont[d]).									
Mar. 11	.....	.....	.....	54	0·0411	8	11	0·0175	16
May 2	59	0·0367	6	80	·0528	7	15	·0165	11
3	63	·0391	6	61	·0556	9	21	·0157	7
24	77	·0646	8	97	·1206	12	37	·0555	15
June 22	50	·0361	7	51	·0454	9	17	·0170	10
July 12	123	·1097	9	129	·1231	10	34	·0524	15
Aug. 21	.....	.....	.....	.....	.....	.....	8	·0118	15
Sept. 1	42	·0260	6	46	·0418	9	13	·0190	15
2	70	·0665	9	90	·0959	11	36	·0391	11
Oct. 1	.....	.....	.....	12	·0036	3	.....	.....	.....
2	.....	.....	.....	9	·0037	4	.....	.....	.....
25	22	·0187	9	27	·0156	6	10	·0105	10
Nov. 9	49	·0407	9	49	·0376	8	19	·0118	6
Dec. 6	60	·0489	8	41	·0461	11	26	·0321	12
21	35	·0298	8	28	·0221	8	8	·0067	8
1854.									
Jan. 8	33	0·0207	6	24	0·0218	9	13	0·0090	7
20*.....	49	·0279	6	35	·0206	6	4	·0023	6
20	.....	.....	.....	.....	.....	.....	4	·0059	15
Feb. 16	56	·0460	8	67	·0527	8	26	·0170	7
24	53	·0460	9	67	·0481	7	21	·0175	8
25	56	·0405	7	63	·0487	8	22	·0208	9
Mar. 6	33	·0178	5	37	·0204	6	16	·0216	14
15	59	·0463	8	65	·0425	7	28	·0229	8
16	58	·0556	10	69	·0513	7	24	·0188	8
28	62	·0591	9	77	·0549	7	49	·0249	5
April 10	49	·0527	11	79	·0688	9	52	·0357	7
23	38	·0206	6	49	·0322	7	21	·0108	5
May 25	38	·0229	6	52	·0342	6	32	·0301	9
1855.									
Mar. 12	55	0·0361	6	59	0·0320	5	23	0·0157	7
April 4	55	·0355	6	53	·0390	7	19	·0111	6
July 19	.....	.....	.....	80	·0451	6	21	·0152	7
Oct. 18 ..... †	40	·0267	7	60	·0311	5	13	·0111	8
1857.									
Feb. 26	41	0·0128	3	21	0·0119	6	10	0·0126	13
Mar. 13	37	·0155	4	.....	.....	.....	.....	.....	.....
May 7	90	·0778	9	102	·0883	9	58	·0504	9
10	60	·0196	3	65	·0309	5	13	·0129	10
Sept. 3	55	·0501	9	92	·0629	7	37	·0296	8
Nov. 12	47	·0256	5	58	·0292	5	.....	.....	.....
16	41	·0265	6	56	·0191	3	.....	.....	.....
17	42	·0329	8	68	·0307	4	.....	.....	.....
Dec. 16	66	·0847	13	82	·1496	18	19	·0147	8
17	78	·0626	8	93	·0771	8	30	·0221	7

In the column "Mean Coefficient of Irregularity," the last figures correspond to the fourth decimal place of Horizontal Force.

* In 1854, Jan. 20, the Vertical Force observations were interrupted during 3 hours.

† In 1856 there were no days of Great Magnetic Disturbance throughout the year.

TABLE VIII.—Sums, without regard of sign, of Coefficients of Magnetic Irregularity (in terms of Horizontal Force), for each Year from 1841 to 1857, including all days of Record of Great Magnetical Disturbance.

Year.	Westerly Force.			Northerly Force.			Nadir Force.		
	Number of Storms.	Number of Irregularities.	Sum of Coefficients.	Number of Storms.	Number of Irregularities.	Sum of Coefficients.	Number of Storms.	Number of Irregularities.	Sum of Coefficients.
1841	8	178	·2933	8	203	·2541	8	120	·2406
1842	10	150	·2104	10	220	·2462	10	80	·0806
1843	7	62	·0613	6	90	·0632	5	27	·0179
1844	5	98	·1056	6	123	·1167	6	38	·0259
1845	5	119	·1218	5	123	·1147	5	53	·0390
1846	17	430	·3585	18	442	·3813	18	130	·1034
1847	20	905	1·4306	20	772	1·4857	17	431	·6986
1848	19	408	·8810	19	382	·9736	4	70	·3061
1849	2	30	·0390	2	15	·0358	1	4	·0046
1850	6	163	·1928	7	153	·2398	6	28	·0647
1851	13	500	·7888	13	698	·9109	13	418	·5257
1852	17	782	1·0389	17	810	1·2740	16	583	·6405
1853	14	807	·6407	17	910	·8034	15	277	·3404
1854	12	584	·4561	12	684	·4962	12	312	·2373
1855	3	150	·0983	4	252	·1472	4	76	·0531
1856	0	0	·0000	0	0	·0000	0	0	·0000
1857	10	557	·4081	9	637	·4997	6	167	·1423
Sums	168	5923	7·1252	173	6514	8·0425	146	2814	3·5207
Mean Coefficient ...			·00120			·00123			·00125

TABLE IX.—Sums, without regard of sign, of Coefficients of Magnetic Irregularity (in terms of Horizontal Force), for each Year from 1841 to 1857, including only those days of Great Magnetic Disturbance in which Records were made by the three Instruments.

Year.	Number of Storms.	Westerly Force.		Northerly Force.		Nadir Force.	
		Number of Irregularities.	Sum of Coefficients.	Number of Irregularities.	Sum of Coefficients.	Number of Irregularities.	Sum of Coefficients.
1841	8	178	·2933	203	·2541	120	·2406
1842	10	150	·2104	220	·2462	80	·0806
1843	5	52	·0581	84	·0617	27	·0179
1844	5	98	·1056	112	·1054	35	·0213
1845	5	119	·1218	123	·1147	53	·0390
1846	17	430	·3585	428	·3635	123	·0977
1847	16	710	1·0480	635	1·1333	426	·6911
1848	4	95	·2568	124	·3579	70	·3061
1849	1	19	·0232	8	·0192	4	·0046
1850	6	163	·1928	140	·2224	28	·0647
1851	13	500	·7888	698	·9109	418	·5257
1852	16	741	1·0016	771	1·2276	583	·6405
1853	13	788	·6212	819	·7404	258	·3111
1854	12	584	·4561	684	·4962	312	·2373
1855	3	150	·0983	172	·1021	55	·0379
1856	0	0	·0000	0	·0000	0	·0000
1857	6	390	·3076	455	·4207	167	·1423
Sums ...	140	5167	5·9421	5676	6·7763½	2759	3·4584
Mean Coefficient...			·00115		·00119		·00125

16. The most striking particulars in the last line of these Tables are the following: First, the almost exact equality of the Mean Coefficients of Irregularity in the three

elements. And this remarkable agreement proves that the Irregularities as measured here are real objective facts. For they are measured from photographic sheets in which the scales are very different: on the Westerly and Northerly records, 0·01 of Horizontal Force is represented by 2·87 inches and 2·55 inches, while on the Nadir record 0·01 of Horizontal Force is represented by 0·88 inch. Yet the eye of the Reader of the Photographs has caught the Irregularities when shown on this small scale as certainly as when shown on the larger scale. With reference to their physical import, I think it likely that the equality of Coefficients of Irregularity may hereafter prove to be one of the most important of the facts of observation.

Second, the near agreement in the number of Irregularities for Westerly Force and for Northerly Force.

Third, the near agreement in the number of Irregularities for Nadir Force with half the number of Irregularities for Westerly or for Northerly Force.

17. I have not succeeded in discovering any clear relation between the times of occurrence of Irregularities of Westerly Force and of Northerly Force. They certainly do not coincide. In their intermixture, I cannot assert that an Irregularity of one element always occurs between two of the other element, though there is a general appearance of that law.

18. It appeared to me possible that an Irregularity of Nadir Force might occur at the change between + and − Irregularities of Westerly Force; and the following examination seems to show a certain degree of plausibility in the supposition:—

Day.	Total Number of Nadir Irregularities.	Number of Nadir Irregularities corresponding to changes of sign for Westerly Irregularities.
1841. Sept. 25	61	52
1847. Sept. 24	119	76
Oct. 23	60	36
24	94	66
Dec. 17	36	20
1851. Sept. 4	42	26
7	86	68
29	67	50
1852. Feb. 15	53	42
17	124	101
18	54	42
19	100	68
June 11	32	22
Dec. 11	20	14
1853. Mar. 8	11	8
May 2	15	12
3	21	13
24	37	25
July 12	34	25
Sept. 1	13	9
2	36	25
Oct. 25	10	9
Dec. 6	26	23
1854. Feb. 24	21	16
April 10	52	35
1855. Mar. 12	23	16
1857. May 7	58	39
Sept. 3	37	31
Dec. 17	30	21
Total	1372	990

19. The investigations which I had proposed to myself as more peculiarly the object of this paper are now terminated, in so far as their results can be comprehended in tables of numerical values and remarks on the relations between the numbers. But I think it desirable to subjoin Tables tending to exhibit the laws of frequency of the great wave-disturbances and the irregularities, with respect to the months of the year and with respect to the hours of the day.

20. First, for the months of the year. The following numbers are formed by simply collecting from Tables I., IV., and VII. all the numbers arranged in groups under each nominal month. It will be seen at once that the distribution of magnetic storms through the year is so irregular that, even in the long period of seventeen years, no inference can be drawn connecting the Magnetic Storms with the Seasons.

TABLE X.—Aggregates of Fluctuations and Inequalities, arranged by Months, in terms of the Horizontal Force.

Month.	Westerly Force.			Northerly Force.			Nadir Force.		
	Algebraical Aggregate of Fluctuations.	Absolute Aggregate of Fluctuations.	Sum of Irregularities.	Algebraical Aggregate of Fluctuations.	Absolute Aggregate of Fluctuations.	Sum of Irregularities.	Algebraical Aggregate of Fluctuations.	Absolute Aggregate of Fluctuations.	Sum of Irregularities.
January	− ·0435	·3183	·3492	+ ·0679	·4827	·3169	− ·5582	·6250	·0662
February ...	− ·1425	·6275	1·2093	− ·5521	1·0223	1·3985	− ·1176	2·4732	·5974
March	− ·1279	·3905	·6038	− ·5193	·6071	·5640	+1·0271	2·0367	·2158
April	+ ·0289	·2635	·3192	− ·4074	·4596	·4330	− ·2766	·5416	·1341
May	− ·0266	·3052	·3533	− ·0554	·4638	·5411	+ ·6293	1·9545	·2291
June	− ·0453	·1471	·1533	− ·0224	·1674	·1706	− ·9723	·5841	·0522
July	− ·0598	·2238	·3114	− ·2361	·4187	·4414	+ ·0109	·4423	·1430
August	+ ·0087	·0875	·0702	− ·0135	·0427	·0859	− ·0988	·1294	·0312
September...	− ·1198	·7046	1·1977	− ·4614	1·0812	1·3994	− ·1785	2·2337	·9391
October	+ ·0066	·5864	·8836	− ·8129	·9881	1·0282	− ·2781	1·8979	·4866
November ...	− ·0431	·6511	·6016	− ·6096	·7150	·6836	− ·5549	·9893	·3744
December ...	− ·1032	·4860	1·0726	− ·7603	·9448	·9799	− ·0969	1·1105	·2516

The disproportion of Irregularities to Fluctuations in the Nadir Force, as compared to those in the other Forces, is very remarkable.

21. Secondly, for the hours of the day. For each hour, on a day of storm, the nearest value of wave-disturbance (not of fluctuation) and the nearest value of irregularity were taken from the sheets in which the reductions described in Article 5 were made; and all the numbers thus found were collected for each hour, the + and − values of wave-disturbance being placed in separate columns. Thus the following Table is formed.

TABLE XI.—Sums of Wave-disturbances and of Irregularities, arranged by hours of Göttingen Solar Time, in terms of Horizontal Force.

Hour of Göttingen Time.	Westerly Force.				Northerly Force.				Nadir Force.			
	Number of Measures.	Sums of Wave-disturbance.		Sums of Irregularities.	Number of Measures.	Sums of Wave-disturbance.		Sums of Irregularities.	Number of Measures.	Sums of Wave-disturbance.		Sums of Irregularities.
		+	−			+	−			+	−	
0	25	·0201	·0103	·0213	29	·0136	·0717	·0323	5	·0285	·0000	·0090
1	56	·0558	·0106	·0416	57	·0339	·0726	·0674	19	·0681	·0306	·0236
2	77	·0658	·0203	·0658	82	·0617	·0900	·0954	33	·1434	·0455	·0370
3	76	·0881	·0224	·0725	92	·1060	·0807	·1060	40	·1773	·1131	·0563
4	98	·1051	·0334	·1144	108	·1201	·0823	·1462	63	·3094	·1187	·0774
5	95	·0831	·0437	·1179	103	·1407	·1019	·1233	60	·2832	·1113	·0681
6	105	·0752	·0713	·1327	114	·1276	·1291	·1290	74	·3701	·0856	·0794
7	104	·0593	·1079	·1353	108	·0806	·1422	·1344	77	·3976	·0974	·0915
8	122	·0331	·1759	·1746	136	·0570	·2171	·1754	79	·3092	·1280	·0853
9	126	·0276	·1848	·1743	119	·0479	·2393	·1439	80	·2866	·1575	·1169
10	123	·0165	·2191	·1976	130	·0553	·2612	·1750	86	·2529	·2061	·1241
11	116	·0267	·1841	·1531	111	·0544	·2747	·1524	77	·2110	·2837	·0889
12	121	·0278	·2070	·1429	122	·0449	·2917	·1422	74	·1629	·2716	·1007
13	111	·0277	·2036	·1606	108	·0307	·2470	·1429	63	·1097	·2830	·0799
14	112	·0442	·1574	·1442	109	·0308	·2897	·1260	74	·1768	·3133	·0941
15	99	·0601	·1324	·1604	100	·0362	·2194	·1443	59	·1329	·2598	·0717
16	102	·0537	·0951	·1359	97	·0160	·2428	·1287	59	·0966	·2881	·0825
17	84	·0695	·0508	·0926	86	·0120	·2137	·1117	54	·0910	·2963	·0619
18	87	·1016	·0315	·0970	93	·0101	·2043	·1169	46	·1010	·2038	·0532
19	76	·1008	·0193	·0793	85	·0112	·2531	·0990	44	·0830	·1889	·0470
20	75	·1170	·0107	·0826	81	·0076	·2646	·0713	39	·0614	·1295	·0427
21	58	·0613	·0083	·0527	65	·0087	·1919	·0694	29	·0619	·0740	·0306
22	59	·0647	·0179	·0520	69	·0038	·2241	·0694	26	·0355	·0460	·0270
23	51	·0460	·0214	·0346	57	·0052	·1463	·0441	24	·0491	·0396	·0177

It must be remarked here that the number of measures at 0^h is made in this Table unfairly small. This arises partly from the interruptions which are almost unavoidable in the operation of changing the photographic sheets at 0^h, and partly from the manner in which the measured quantities have been treated in the discussion of Storms. When a storm has evidently occupied a part of a day, it has been usual to treat by rule the measures of the entire sheet of that day, from 0^h to 24^h; and in that process, as is described in the beginning of Article 5, the two first and two last measures are lost; and some of these ought, in a great number of cases, to be referred to 0^h. The best value that can be taken for 0^h will be the mean of the values for 23^h and for 1^h.

22. It will be seen that, at the same hour, the mean value of Irregularity is nearly the same for the three Forces, but that, from hour to hour, the mean Irregularities are largest where the number of measures is greatest, that is, where storms are most frequent. In regard to the Wave-disturbance; for Westerly Force, the aggregate is + from 17^h to 6^h, − from 7^h to 16^h; for Northerly Force, the aggregate is + from 3^h to 5^h, − from 6^h to 2^h; and for Nadir Force, the aggregate is + from 23^h to 10^h, − from 11^h to 22^h. In regard to the modification which these Wave-disturbances might be supposed to produce on the laws of Diurnal Inequality, when it is remarked that each

of the hours 0^h, 1^h, 2^h, &c. has been repeated 17×365 times, it will be seen that the introduction of these Storm Days into the general mass of observations will in no instance alter the mean Diurnal Inequality by a unit in the fourth decimal place. In a year of very great disturbance, as 1853, they may possibly introduce a correction of one unit, or perhaps two units, in the fourth decimal of some of the Diurnal numbers.

23. The import of the numbers of the last Table will be best seen by the following treatment. If for either of the three directions of force, at any one hour, we form the Algebraic sum of the + and − sums of wave-disturbances, and divide by the number of measures, we obtain the mean wave-disturbance whenever a storm occurs at that hour. If we form the Absolute sum, and divide it similarly, we obtain the double average departure from that mean whenever a storm occurs at that hour. The mean Irregularity is obtained by simple division.

TABLE XII.—Frequency of Storms, mean Wave-disturbance, average departure from the mean, and mean Irregularity, in terms of the Horizontal Force, at each hour of Göttingen Solar Time.

Hour of Göttingen Time.	Westerly Force.				Northerly Force.				Nadir Force.			
	Frequency of Storms.	Mean Wave-disturbance.	Average departure from Mean. ±	Mean Irregularity. ±	Frequency of Storms.	Mean Wave-disturbance.	Average departure from Mean. ±	Mean Irregularity. ±	Frequency of Storms.	Mean Wave-disturbance.	Average departure from Mean. ±	Mean Irregularity. ±
0	54	+ ·00039	·00061	·00085	57	− ·00200	·00147	·00112	22	+ ·00570	·00285	·00180
1	56	+ 81	59	74	57	− 68	93	118	19	+ 197	260	124
2	77	+ 59	56	86	82	− 35	93	116	33	+ 297	286	112
3	76	+ 86	73	95	92	+ 28	101	115	40	+ 161	363	140
4	98	+ 73	71	117	108	+ 35	94	135	63	+ 303	340	123
5	95	+ 42	67	124	103	+ 38	118	120	60	+ 287	329	114
6	105	+ 4	70	126	114	− 1	113	113	74	+ 385	308	107
7	104	− 47	80	130	108	− 57	103	124	77	+ 390	321	119
8	122	− 117	86	143	136	− 118	101	129	79	+ 229	276	108
9	126	− 125	84	138	119	− 161	121	121	80	+ 161	278	146
10	123	− 165	96	161	130	− 158	122	135	86	+ 54	267	144
11	116	− 136	91	132	111	− 198	148	137	77	− 94	321	116
12	121	− 148	97	118	122	− 202	138	117	74	− 147	294	136
13	111	− 159	104	145	108	− 200	129	132	63	− 275	312	127
14	112	− 101	90	129	109	− 238	147	116	74	− 185	331	127
15	99	− 73	97	162	100	− 183	128	144	59	− 215	333	122
16	102	− 41	73	133	97	− 234	133	133	59	− 325	326	140
17	84	+ 22	72	110	86	− 235	131	130	54	− 380	359	115
18	87	+ 81	77	112	93	− 209	115	126	46	− 224	331	116
19	76	+ 107	79	104	85	− 285	155	117	44	− 241	309	107
20	75	+ 142	85	110	81	− 317	168	88	39	− 175	245	110
21	58	+ 91	60	91	65	− 281	154	107	29	− 42	234	106
22	59	+ 79	70	88	69	− 319	165	101	26	− 40	157	104
23	51	+ 48	66	68	57	− 248	133	77	24	+ 40	185	74

The Soli-tidal character of the principal characteristics of the occasional Magnetic Storms, as to frequency, magnitude, inequalities of wave-disturbance, and Irregularities, is seen clearly in this Table.

24. I now come to the consideration of the physical inference from these numerical conclusions. And first I would remark that I do not think that they can be reconciled with the supposition of definite galvanic currents or definite magnets, suddenly produced, in any locality whatever, as sufficient to explain the disturbances observed here. On that hypothesis, it would seem necessary to believe that such sudden currents or magnets would produce simultaneous disturbances in the three co-ordinate directions, that, if the long period of a wave permitted some deviation from this rule, yet the short period of an inequality would admit of no such deviation, and that, on any supposition, the number of disturbances in the three directions would be approximately equal. Yet in fact we find that neither in Waves nor in Irregularities is there the least appearance of simultaneity, and that, though there is close equality of numbers between the Westerly and Northerly Forces, yet the Nadir Force (in which the Irregularities are as strongly marked as in the Westerly and Northerly, and the Wave-disturbances much more strongly marked) exhibits less than half the number. These considerations appear to me quite conclusive as showing that the observed disturbances cannot be produced by the forces of any suddenly created galvanic current or polar magnet.

25. To suggest instead of this an imperfect conjecture, based upon grounds so inadequate as those which we can at present use for its foundation, must be a delicate and dangerous, I may almost say an invidious enterprise. Yet the impression of an explanation of broad character, partly definite but generally indefinite, has, in the course of this investigation, forced itself so strongly on my mind, that I should think it wrong to omit to describe it. Its fundamental idea is, that there may be in proximity to the earth something which (to avoid unnecessary words) I shall call a Magnetic Ether; that under circumstances generally, but not always, having reference to the solar hour, and therefore probably depending on the sun's radiation or on its suppression, a current from N.N.W. to S.S.E., approximately, or from S.S.E. to N.N.W. (according to the boreal or austral nature of the ether) is formed in this Ether; that this current is liable to interruptions or perversions of the same kind as those which we are able to observe in currents of air and water; and that their effect is generally similar, producing eddies and whirls, of violence sometimes far exceeding that of the general current from which they are derived.

26. Our powers of observing the two elements to which I have referred for analogy are somewhat different, but both imperfect. We know that in a gale of wind, the direction of the wind is continually changing; the horizontal pressure and the barometric pressure also are continually changing; but the changes are so rapid that we cannot easily determine whether there is any correspondence between them. But, in the storms on a large scale, there is reason to think that some winds are radial, but far more are cyclonic; that in some instances the barometer rises in the centre, but in more it is depressed; and in many instances the disturbance of vertical pressure is enormous (for 1 inch of barometer corresponds to a pressure of about 70 lbs. per square foot). Of water, perhaps the best study is to be found in disturbed tidal currents, as those of the

Western Islands of Scotland; here, in some places, approximately circular spaces are to be seen which are quiet, but which appear to the eye to be elevated above the rest; in some disturbed places the water is thrown upwards; in other places the sea is whirling round with great speed, in a good circular form, and with a funnel of considerable depth in the centre; in other places, boiling currents are running very fast in opposite directions, though separated by no great space; the general impression however is that of circularity*; great circles and small circles coexisting. Though these circular forms may be more prevalent in one part of the sea than another, they are not fixed, but wander irregularly, sometimes suddenly disappearing, and sometimes as suddenly created anew. In like manner, in the course of a river, travelling funnels may be seen, whose depth sometimes exceeds their breadth.

27. Now it appears to me that if a sentient and reasoning being were immersed either in the air or in the water through which these circles are wandering, he would perceive actions nearly similar to those which we have found to exist in the magnetic storms. The large and slowly-displaced circles would produce Wave-disturbances, slowly changing their direction, and thus having different times of evanescence in the N. and S. direction (on the one hand) and in the E. and W. direction (on the other hand); the smaller circles, in like manner, would produce the rapid Irregularities. And in the relation between E. and W. disturbances and vertical disturbances, there is a point which well deserves attention. When a water-funnel passed nearly over the observer, travelling (suppose) in a N. direction, he would first experience a strong current to the E., afterwards a strong current to the W. (or *vice versâ*), and between these there would be a very strong vertical pressure in one direction, not accompanied by one in the opposite direction; thus he would have half as many vertical as horizontal impulses. This state of things corresponds to the proportion which we have found throughout for the magnetic disturbances, and to the relation found in Article 18. I may also add that the rule at which we have arrived, that the waves of vertical force are few, but that their power, when they do occur, is very great, seems to correspond to what is reported of the whirlwinds of great atmospheric storms; which, violent and even frequent as they may be, occur very rarely at any assigned place.

28. It seems to me that there is so much plausibility in these suppositions as to justify me in expressing a wish that some effort might be made to verify them. The immediate object of observations would be, to ascertain through a locality of considerable extent the times and magnitudes of Wave-disturbances and of Irregularities on the same days throughout, with the view of discovering whether they could be collectively represented as the effects of such travelling vortices as I have suggested. In regard to the extent of the locality, I should think that a portion of the Continent of Europe would suffice, and that five or six magnetic observatories would decide the points under inquiry. In regard to the mode of observation, though eye-observation is, for a limited time, the most accurate, yet self-registering record is the only method which can insure the

* I have been upon these currents, and in close proximity to these whirlpools.

observation of all that is required; only, I would specially observe, it is indispensable that eye-observations be used to check the zeros of time and of measure, and that the photographic traces be so strong that they will not be lost in rapid motions of the magnet. In regard to the mode of primary reduction, I imagine that the method followed in this Memoir (with such small alterations as experience may suggest) will be found best.

*** The computations for the "Diurnal Inequalities" were performed by computers under the immediate superintendence of Mr. JOHN LUCAS; some portions of them were revised and corrected by JAMES GLAISHER, Esq., F.R.S., Superintendent of the Magnetical and Meteorological Department of the Royal Observatory. The curves were drawn under Mr. GLAISHER's superintendence by Mr. W. C. NASH, and reduced to scale by Mr. JAMES CARPENTER, Assistant in the Astronomical Department of the Royal Observatory. The computations of the present Memoir were made under the superintendence of Mr. GLAISHER, by Mr. NASH and junior computers.