AUSTRALASIAN ANTARCTIC EXPEDITION
1911-14

UNDER THE LEADERSHIP OF SIR DOUGLAS MAWSON, D.Sc., F.R.S.

SCIENTIFIC REPORTS.

SERIES B.

VOL. II.

TERRESTRIAL MAGNETISM AND RELATED OBSERVATIONS.

PART III.

MAGNETIC DISTURBANCE AT CAPE DENISON

BY

J. M. STAGG, O.B.E., M.A., D.Sc.

METEOROLOGICAL OFFICE: LONDON.

WITH FIFTY-ONE TABLES, FOUR TEXT FIGURES AND EIGHT PLATES.

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DR. J. M. STAGG.

WITH 51 TABLES, 4 TEXT FIGURES AND 8 PLATES.

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PREFATORY NOTE.

THIS part of Volume II is concerned with a variety of aspects of magnetic disturbance as registered at Cape Denison, Adelie Land, the Main Base Station of the Australasian Antarctic Expedition, 1911–14. The investigations were originally undertaken by Dr. Charles Chree. Before his death in August, 1928, the collection of the material for some of the chapters was far advanced. Dr. Chree had prepared several of the tables and the manuscript of one chapter was nearly complete. Shortly before his death Dr. Chree gave Sir Douglas Mawson a list of eight chapters, which he proposed to include in the work. These eight chapter headings have been used as a basis for the continuation of the investigations.

The photographic records, together with the manuscripts relating to researches, were forwarded to me in November, 1928. Except for the one chapter, which stands almost as Dr. Chree left it, the following pages represent my effort to complete the work.

Doubtless this final form departs very greatly from that which it was intended it should take. As far as the manuscripts could guide me, however, my endeavour has been to follow as nearly as I could the course Dr. Chree might have taken. Though I realise how feebly that aim has been accomplished, the work is submitted in the hope that it will be interpreted as having gone some way to further the utilisation of the magnetic data so arduously collected during Sir Douglas Mawson's Expedition and to relieve the loss which has befallen the Science of Terrestrial Magnetism through the contribution not coming from Dr. Chree's own hands.

J. M. STAGG.

Eskdalemuir Observatory,
Dumfriesshire, Scotland.
June, 1929.

INTRODUCTION.

In describing the results of the investigations it will be found that frequent reference is made to records of simultaneous magnetic disturbance from other stations. In particular, special interest attaches to the synchronous course of magnetic events at Cape Evans, the base station of the British Antarctic Expedition, 1910–13. For, as will be explained in the appropriate sections of the text, the variations of the component vectors of the disturbance field at Cape Denison and Cape Evans frequently differed in a pronounced manner. It was accordingly felt that side-by-side reproduction of some typical magnetograms showing simultaneous disturbance at the two stations would greatly help the reader to visualise the sequence of events. But even with the original records from both Antarctic stations available, comparison of simultaneous movements has been no easy matter. For the two sets of magnetographs did not record the same horizontal components; they were of widely different sensitivity and even for pairs of corresponding components (D and W^1, H and N^1) the same direction of movement of the trace up the sheet meant opposing sense of variation of the forces represented. Moreover, the main declination trace at Cape Denison was frequently off the sheet, so that use had to be made of the subsidiary reflected trace provided by the double mirror of the magnetograph moving system. The reduction to a common basis of all these features of difference between corresponding pairs of records was necessary before reproduction of the traces would serve any useful purpose. Unfortunately, however, I have been unable to get access to any instrument which can satisfactorily cater for such a multiplicity of requirements.

It has, therefore, been decided simply to reproduce copies of a selected number of the original magnetograms from the Cape Denison variometers.* By selecting days of disturbance for which reproductions of the Cape Evans magnetograms can be found in the volume of Terrestrial Magnetism of the British Antarctic Expedition, 1910–13, it is hoped that at least a general comparison of magnetic disturbance simultaneously recorded at two stations so uniquely situated may in that way be facilitated.

J. M. STAGG.

Lerwick Observatory, Shetland,
September, 1929.

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* In order to reduce the cost of publication, only two out of the number of magnetograms selected by Dr. Stagg have been reproduced in this volume. It should be noted that the manuscript of this Report was completed for publication in 1929.

[D. MAWSON, Ed.]

CHAPTER I.—SHORT PERIOD DISTURBANCE AT CAPE DENISON.

§1.—Selection of 355 Disturbances.

Disturbance is so persistent a feature of the magnetic registrations at stations in high latitude that even in quiet times classification of the smaller types of movement is difficult. At a station such as Cape Denison, within 600 miles of the locality of the south magnetic pole, the difficulty is much enhanced. Short period transitory oscillations constantly mask the trend in the major movements of a disturbance and, in the worst cases, entirely preclude the assignment of accurate epochs to critical stages in the variations of the main disturbing field and render amplitudes that might be attributed meaningless. Only to the boldest of the movements or those occurring at times when the locally superposed oscillations are least obtrusive can estimates of the main characteristics of the movements be given with any confidence. For measurements made even in the best conditions, a tolerance of 2 or 3 per cent. in individual cases is necessary.

Three hundred and fifty-five disturbances of short period in the records from Cape Denison have been studied, 197 in the nine months March to November of satisfactory registration in 1912, and 158 in the remaining months, January to August, 1913, for which records are available. The mean duration of all the tabulated movements was 50 minutes. One lasted 180 minutes, but that was wholly exceptional; the next longest was 120 minutes. Short, sharp oscillations of the nature of sudden commencements account for the appearance in the table of a few durations of six minutes.

In addition to the general considerations mentioned above, the qualifications for notice on the part of any disturbance were :—

1. That it should be fairly conspicuous in all three components, D, H, and Z, if all three traces were available; and
2. That is should have some feature which conformed to one of the recognised types of movement—bay, sudden commencement, or oscillation of a simple and characteristic nature.

To aid analysis, two principal lists of the selected disturbances were formed, one containing all those cases, 267, of more or less regular bays and the other comprising the more heterogeneous lot (88) of perturbations described as of wave-form (or double-bay), probable sudden commencements and movements which might be bays but which were partially obscured by superposed oscillations of very short period. Details of each member of the first class are given in Table LXXIV and those of the second in Table LXXV. Under " climax " are supplied the times to the nearest five minutes of the turning points of the chief movement in the disturbance or those of the component in which the movement was most conspicuous. The next column gives the estimate of the duration to the nearest five minutes for disturbances which lasted more than ten minutes, or to the nearest minute in the case of sharp oscillations of shorter duration. The entry is generally an average of the separate durations from the three components. In this table and all others in the chapter the times quoted are Greenwich mean times. The remaining columns give the extreme range of each element and an indication of the order and directions of change of the disturbing forces (1) transverse to the magnetic meridian, (2) along the meridian directed northwards and (3) vertically downwards. Since declination at Cape Denison was approximately 6·5° west of north, the ranges of the movement tabulated under D therefore refer to a disturbing vector component directed 6·5° south of west. Increase of the vector along the meridian to the north is denoted by + and an increase of the component perpendicular to this by W. An increase of the vertical component Z in the northern hemisphere has a numerical decrease as counterpart in the southern hemisphere. A change of the disturbing vector resulting in a decrease in the dip of the south-seeking pole is therefore denoted in the tables by +. In the actual magnetograms and with the notation adopted here, D increased to the west up the sheet, but movement up the sheet indicated a numerical decrease in H and Z.

TABLE LXXIV.

Cape Denison: Characteristics of Regular Bays.

Date.	Time of Climax.	Duration.	Ranges. D	Ranges. H	Ranges. Z	Direction of Movement. D	Direction of Movement. H	Direction of Movement. Z	Rotation or Phase.
1912.	h. m.	mins.	γ	γ	γ				
Mar. 28	17 15	60	77	41	40	WE	— +	— +	C
„ 29	16 0	75	144	117	58	WE	+ —	+ —	C
April 1	9 45	55	21	21	...	EW	— +	—	P
„	10 40	60	59	27	...	EW	— +	—	C
„ 5	12 45	30	36	38	43	EW	+ —	+ —	P
„ 6	13 10	70	69	95	160	WEW	+ —	+ —	C
„ 9	12 45	30	24	6	17	EW	+ —	+ —	P
„	13 15	30	13	4	7	EW	+ —	+ —	C
„	13 50	60	24	18	29	EW	+ —	+ —	C
„ 12	9 30	60	54	44	23	EW	— +	— +	P
„ 20	12 45	35	26	18	31	EW	+ —	+ —	P
„	13 20	70	26	54	63	EW	+ —	+ —	C
„ 23	15 50	55	35	38	21	WE	+ —	+ —	P
„ 24	10 15	55	26	31	11	EW	— +	— +	D
„ 25	13 0	65	...	101	229	...	+ —	+ —	...
„	13 45	30	...	29	57	...	+ —	+ —	...
„ 29	12 20	55	...	16	42	...	+ —	+ —	...
May 4	12 0	40	35	27	24	EW	+ —	+ —	C
„ 12	11 20	60	113	67	94	EW	+ —	+ —	P
„ 16	14 10	70	45	52	69	EW	+ —	+ —	C
„ 17	12 5	40	35	12	18	EW	+ —	+ —	P
„	12 40	55	68	62	108	EW	+ —	+ —	C
„ 19	13 45	50	28	32	40	EW	+ —	+ —	P
„ 21	12 50	40	35	21	35	EW	+ —	+ —	P
„	14 45	70	36	29	36	EW	+ —	+ —	C
„ 26	9 30	70	20	45	42	EW	— +	— +	P
„ 29	12 25	70	69	40	99	EW	+ —	+ —	P
„ 31	11 45	50	42	16	18	EW	— +	—+—	C
June 2	7 20	60	64	95	87	EW	— +	— +	AC
„ 5	14 45	40	12	19	31	EW	+ —	+ —	P
„ 10	12 45	65	30	47	82	EW	+ —	+ —	P
„ 12	10 45	30	40	16	44	EW	+ —	+ —	AC
„ 13	12 30	30	16	13	14	EW	+ —	+ —	P
„	13 40	20	13	19	14	WEW	+ —	+ —	D
„	14 20	40	42	26	32	WEW	+ —	+ —	C
„ 14	15 0	60	46	75	119	EW	+ —	+ —	C
„ 15	15 10	35	17	18	21	WEW	+ —	+ —	C
„ 17	18 0	50	45	32	43	WE	— +	— +	P
„ 23	12 30	90	86	63	91	EW	+ —	+ —	C
„ 24	12 55	45	35	31	32	EW	+ —	+ —	P
„ 26	14 0	90	43	20	48	EW	+ —	+ —	P
1912.	h. m.	mins.	γ	γ	γ				
June 30	10 40	50	53	31	23	EW	— +	+ —	C
„	11 40	55	56	23	64	EW	— +	+ —	C
July 1	13 40	60	69	54	161	EW	+ —	+ —	C
„ 8	13 20	45	43	16	30	EW	+ —	+ —	D
„ 16	21 50	20	13	16	14	WE	+ —	+ —	P
„ 17	15 0	40	26	30	47	EW	+ —	+ —	C
„	16 5	60	86	75	166	WEW	+ —	+ —	C
„ 21	10 45	30	20	18	15	EW	— +	— +	P
„	11 30	60	68	30	37	EW	— +	+ —	C
„ 22	16 45	30	19	13	24	WE	— +	— +	P
„ 23	16 15	40	26	20	26	WE	+ —	+ —	C
„ 25	13 45	70	26	24	34	EW	+ —	+ —	C
„	17 45	50	40	34	38	WE	+ —	+ —	C
„ 28	22 20	15	28	27	20	WE	+ —	+ —	AC
„ 29	10 30	45	18	5	22	EW	+ —	+ —	D
„	13 20	30	29	10	29	EW	+ —	+ —	P
„	14 50	60	22	19	33	EW	+ —	+ —	P
„ 30	12 50	55	57	35	70	EW	+ —	+ —	AC
Aug. 1	15 0	55	23	34	34	WE	+ —	+ —	C
„ 2	13 35	25	31	67	77	EW	+ —	+ —	C
„ 3	12 10	60	39	41	77	EW	+ —	+ —	C
„ 6	7 15	75	223	181	70	EW	— +	— +	C
„	18 20	100	99	30	77	WE	+ —	+ —	P
„ 7	15 30	30	10	13	13	WE	+ —	+ —	P
„ 8	14 50	30	19	26	28	WE	+ —	+ —	C
„	15 20	30	18	12	13	WE	+ —	+ —	C
„ 10	20 0	65	54	30	61	WE	— +	— +	C
„ 11	14 10	30	9	15	19	EW	+ —	+ —	C
„	14 45	40	9	12	17	EW	+ —	+ —	D
„ 16	12 40	90	37	17	39	EW	+ —	+ —	P
„ 19	9 20	25	54	62	64	EW	— +	— +	C
„	12 10	40	38	44	70	EW	+ —	+ —	P
„ 25	9 40	40	58	58	29	EW	— +	— +	C
„	13 35	45	15	27	35	EW	+ —	+ —	P
„ 26	4 25	75	33	66	77	WE	— +	— +	AC
„	12 45	60	33	21	31	EW	+ —	+ —	C
„ 28	4 30	45	45	60	51	WE	— +	— +	P
„ 31	15 15	55	27	40	52	WE	+ —	+ —	C
Sept. 1	12 40	30	14	10	25	EW	+ —	+ —	P
„	13 15	35	21	15	33	EW	+ —	+ —	P
„ 2	12 0	35	22	6	17	EW	+ —	+ —	P
„	12 45	45	16	15	30	EW	+ —	+ —	AC

TABLE LXXIV—*continued.*

Cape Denison: Characteristics of Regular Bays.

Date.		Time of Climax.	Duration.	Ranges.			Direction of Movement.			Rotation or Phase.
				D	H	Z	D	H	Z	
1912.		h. m.	mins.	γ	γ	γ				
Sept.	2	14 20	45	16	17	22	WE	+ —	+ —	D
,,	3	13 45	25	7	13	16	EW	+ —	+ —	D
,,	5	3 0	45	53	67	71	WE	— +	— +	P
,,		11 0	90	82	42	95	EW	—+—	+ —	AC
,,	7	17 40	45	32	16	30	WE	— +	— +	C
,,		18 40	75	21	20	30	WE	— +	— +	P
,,	8	6 20	45	26	28	24	WE	+ —	+ —	C
,,	9	11 30	50	42	52	59	EW	+ —	+ —	AC
,,	10	11 5	50	48	20	16	EW	— +	+ —	D
,,		11 45	50	16	13	17	EW	+ —	+ —	P
,,	11	19 15	40	23	13	16	WE	— +	— +	C
,,	12	10 50	25	71	37	48	EW	+ —	+ —	P
,,	13	13 15	60	19	34	34	EW	+ —	+ —	D
,,	14	5 15	35	35	81	59	WE	— +	— +	C
,,		9 50	40	24	30	19	EW	— +	— +	P
,,	16	11 5	70	17	40	36	EW	+ —	+ —	P
,,	22	12 0	85	61	34	63	EW	+ —	+ —	D
,,	27	11 50	35	47	16	33	EW	+ —	+ —	C
,,		16 30	40	31	13	29	WE	— +	— +	P
,,	28	13 10	45	10	13	16	EW	+ —	+ —	D
Oct.	4	13 0	90	40	44	75	EW	+ —	+ —	C
,,	5	20 30	30	17	22	14	EW	+ —	+ —	AC
,,		21 0	40	23	28	38	EW	+ —	+ —	AC
,,	6	12 20	50	44	27	48	EW	+ —	+ —	P
,,		13 15	60	32	42	65	EW	+ —	+ —	P
,,	7	11 0	40	25	11	18	EW	+ —	+ —	D
,,		12 25	70	25	17	28	EW	+ —	+ —	AC
,,		13 50	65	30	17	36	EW	+ —	+ —	D
,,		14 50	70	64	57	58	WE	+ —	+ —	C
,,	9	11 30	65	54	24	52	EW	+ —	+ —	P
,,	10	13 50	40	11	19	24	EW	+ —	+ —	D
,,	11	13 35	55	45	22	41	EW	+ —	+ —	P
,,	13	11 0	105	91	54	63	EW	+ —	+ —	C
,,	15	12 50	90	82	113	170	WEW	+ —	+ —	C
,,		14 30	80	48	54	81	EW	+ —	+ —	C
,,	16	11 50	50	48	34	74	EW	+ —	+ —	P
,,	17	11 0	25	25	37	52	EW	+ —	+ —	AC
,,		18 10	60	40	28	41	EW	+ —	+ —	C
,,	19	12 30	40	33	26	48	EW	+ —	+ —	P
,,		21 30	35	42	50	30	EW	+ —	+ —	AC
,,	21	14 15	35	23	18	28	EW	+ —	+ —	C
,,	26	8 35	50	23	27	22	EW	— +	— +	D
,,	30	3 40	45	57	117	30	EW	+ —	+ —	P
,,		13 20	65	53	54	81	EW	+ —	+ —	P
,,	31	13 0	60	31	34	55	EW	+ —	+ —	C
,,		13 50	60	26	40	52	EW	+ —	+ —	C
Nov.	3	19 20	60	31	40	47	EW	+ —	+ —	C
,,	6	1 25	20	97	84	130	EW	+ —	+ —	P
,,	7	19 15	25	34	31	34	WE	— +	— +	P
,,		19 45	40	36	34	85	WE	— +	— +	P
,,	8	11 45	30	17	24	30	EW	+ —	+ —	P
,,	17	20 15	100	124	134	159	EW	+ —	+ —	AC
,,	23	9 0	60	150	67	...	EW	— +	...	P
,,	25	11 45	25	11	12	13	EW	+ —	+ —	AC
,,		12 50	40	15	28	30	EW	+ —	+ —	P
,,	26	13 40	25	25	19	30	EW	+ —	+ —	AC
,,	27	12 20	40	26	30	34	EW	+ —	+ —	AC
,,	28	21 45	50	64	81	78	EW	+ —	+ —	AC
,,	30	13 5	50	33	26	44	EW	+ —	+ —	C
1913.										
Jan.	17	15 45	90	42	38	21	WE	+ —	+ —	C
,,	27	3 20	50	58	89	124	WE	— +	— +	C
,,	28	16 10	25	31	23	45	WE	— +	— +	P
1913.		h. m.	mins.	γ	γ	γ				
Feb.	1	9 10	55	31	28	33	EW	— +	— +	AC
,,		13 50	70	19	22	26	WE	+ —	+ —	P
,,	4	14 20	75	19	30	43	WE	+ —	+ —	C
,,	5	12 35	50	28	25	50	EW	+ —	+ —	AC
,,	7	23 45	40	66	49	61	EW	+ —	+ —	AC
,,	10	18 30	25	25	24	28	EW	+ —	+ —	AC
,,		20 40	20	13	20	19	WE	— +	— +	AC
,,		20 50	20	18	21	26	WE	— +	— +	AC
,,	11	12 55	40	17	20	35	EW	+ —	+ —	C
,,		14 50	75	13	24	33	EW	+ —	+ —	C
,,	14	13 45	75	86	192	211	WE	+ —	+ —	C
,,	21	13 40	35	15	20	35	WE	+ —	+ —	C
,,	23	14 40	75	18	27	50	WE	+ —	+ —	C
,,	25	12 0	65	51	57	85	EW	+ —	+ —	P
,,	26	14 55	75	29	57	59	WE	+ —	+ —	C
,,	28	12 20	30	10	5	7	EW	+ —	+ —	C
,,		12 45	40	20	13	20	EW	+ —	+ —	AC
,,		13 15	30	8	10	15	WE	+ —	+ —	P
,,		13 45	55	17	25	34	EW	+ —	+ —	C
Mar.	5	12 45	30	20	8	20	EW	+ —	+ —	P
,,		13 20	40	21	23	41	EW	+ —	+ —	P
,,	6	2 40	35	78	84	117	WE	— +	— +	C
,,		12 30	45	26	43	61	EW	+ —	+ —	C
,,	8	13 15	35	17	23	34	EW	+ —	+ —	P
,,	9	15 0	60	12	15	22	WE	+ —	+ —	P
,,	10	11 25	50	25	15	23	EW	+ —	+ —	C
,,	18	13 10	60	25	44	87	EW	+ —	+ —	C
,,		15 10	60	33	30	41	WE	+ —	+ —	C
,,	19	13 50	80	40	40	46	WE	+ —	+ —	C
,,		19 25	70	17	25	34	EW	+ —	+ —	C
,,	21	13 50	75	50	35	56	EW	+ —	+ —	P
,,		19 55	75	40	43	61	EW	+ —	+ —	P
,,	22	17 45	45	20	20	29	EW	+ —	+ —	C
,,	25	10 40	20	12	21	24	EW	+ —	+ —	AC
,,		16 15	60	38	44	50	WEW	+ —	+ —	C
,,	26	1 45	40	90	69	74	WE	— +	— +	C
,,	28	9 20	40	43	30	17	EW	— +	— +	C
,,		13 10	90	33	31	34	EW	+ —	+ —	P
,,	31	14 0	30	21	22	33	EW	+ —	+ —	P
,,		14 45	65	63	72	131	EW	+ —	+ —	C
,,		16 5	55	59	48	82	EW	+ —	+ —	C
April	4	14 15	55	14	29	35	WE	+ —	+ —	P
,,		16 10	45	26	15	27	EW	+ —	+ —	AC
,,	8	14 30	40	13	23	29	WEW	+ —	+ —	C
,,	13	13 15	65	26	29	53	EW	+ —	+ —	C
,,	15	9 15	70	51	29	17	EW	— +	—+—	C
,,	16	15 0	50	43	30	29	EW	+ —	+ —	C
,,		21 45	65	25	31	38	WE	— +	— +	AC
,,		23 30	25	30	52	82	EW	+ —	+ —	AC
,,	17	17 40	50	32	27	39	EW	+ —	+ —	C
,,	24	21 20	65	40	25	50	WE	— +	— +	P
,,	25	12 15	45	40	14	35	EW	+ —	+ —	P
,,	26	14 0	20	12	14	16	WE	+ —	+ —	D
,,	27	13 33	60	29	40	44	EW	+ —	+ —	C
,,		14 30	75	38	35	56	EW	+ —	+ —	C
,,	29	13 50	30	10	19	22	EW	+ —	+ —	C
May	2	11 40	50	39	19	37	EW	+ —	+ —	P
,,	3	11 15	50	50	53	109	EW	+ —	+ —	P
,,	4	13 5	50	64	58	87	EW	+ —	+ —	C
,,	5	7 30	45	91	58	46	EW	— +	— +	P
,,		23 55	115	147	115	101	WE	— +	— +	P
,,	7	1 45	60	121	83	125	WE	— +	— +	AC
,,	8	12 20	70	30	22	33	EW	+ —	+ —	C

TABLE LXXIV—*continued*.

Cape Denison: Characteristics of Regular Bays.

Date.	Time of Climax.	Duration.	Ranges. D	Ranges. H	Ranges. Z	Direction of Movement. D	Direction of Movement. H	Direction of Movement. Z	Rotation or Phase.
1913.	h. m.	mins.	γ	γ	γ				
May 8	13 30	55	17	24	46	EW	+ —	+ —	P
,, 13	3 40	30	15	24	33	WE	— +	— +	AC
,, 15	9 15	60	20	27	14	EW	— +	— +	C
,, 16	5 55	40	13	18	16	EW	— +	— +	C
,, 19	10 55	90	46	35	19	EW	— +	— +	P
,, 22	10 0	40	14	11	5	EW	— +	— +	C
,, 24	20 15	45	38	17	26	WE	— +	— +	C
,, 25	8 15	110	25	35	23	EW	— +	— +	AC
,,	13 0	35	24	12	17	EW	+ —	+ —	P
,,	13 40	40	12	30	33	EW	+ —	+ —	C
,, 26	10 30	50	36	13	16	EW	— +	+ —	C
,, 27	13 30	75	81	62	87	EW	+ - +	+ —	C
,, 29	14 30	75	74	97	80	WE	— +	+ —	P
,, 30	12 15	35	41	21	41	EW	+ —	+ —	P
June 2	13 40	35	25	23	28	WE	+ —	+ —	C
,,	14 0	50	32	42	65	WE	+ —	+ —	C
,, 3	7 15	45	51	75	45	EW	— +	— +	C
,, 6	4 0	40	18	36	33	WE	— +	— +	P
,,	20 20	30	21	27	22	EW	+ —	+-+-	P
,, 7	14 45	30	8	10	13	WE	+ —	+ —	C
,, 11	12 50	45	37	24	52	EW	+ —	+ —	P
,,	13 30	60	20	22	28	EW	+ —	+ —	C
,, 14	9 15	30	6	10	10	EW	— +	— +	C
,,	9 45	30	15	14	8	EW	— +	— +	P
,, 15	13 0	30	29	12	25	EW	+ —	+ —	P
,, 16	8 25	50	19	26	21	EW	— +	— +	P
,,	11 40	35	12	16	27	EW	+ —	+ —	P
,,	12 15	35	14	14	27	EW	+ —	+ —	P
,, 17	16 20	35	21	23	37	EW	+ —	+ —	AC
,, 19	10 45	35	11	9	4	EW	— +	— +	C
1913.	h. m.	mins.	γ	γ	γ				
June	21 25	90	104	27	80	WE	— +	— +	P
,, 20	13 35	45	12	10	12	EW	+ —	+ —	C
,, 23	12 30	100	43	14	38	EW	— +	+ —	D
,, 24	4 5	60	17	40	56	WE	— +	— +	C
,,	10 45	70	23	18	15	EW	— +	— +	P
,, 30	9 20	60	31	35	21	EW	— +	— +	C
,,	14 0	50	19	24	34	EW	+ —	+ —	D
July 1	13 10	30	21	33	52	EW	+ —	+ —	P
,, 3	9 50	30	55	37	26	EW	+ —	+ —	C
,, 5	13 40	45	12	20	27	EW	+ —	+ —	P
,, 8	13 15	80	19	11	18	EW	+ —	+ —	AC
,, 11	10 30	75	25	13	21	EW	— +	0 +	P
,, 13	12 30	50	34	26	48	EW	+ —	+ —	AC
,, 14	12 50	40	14	15	19	EW	+ —	+ —	AC
,,	13 40	50	23	17	17	EW	+ —	+ —	C
,, 17	12 30	60	41	38	...	EW	— +	...	C
,, 18	10 15	50	39	23	...	EW	— +	...	P
,,	15 25	45	15	27	36	EW	+ —	+ —	D
,, 24	16 45	80	24	27	26	WE	+ —	+ —	D
,, 26	9 20	55	19	17	13	EW	— +	— +	AC
,, 28	2 40	20	22	35	23	WE	— +	— +	C
,,	4 15	30	15	28	11	WE	— +	— +	C
,, 29	9 30	40	10	15	10	EW	— +	— +	P
,, 30	16 15	60	16	13	11	WE	+ —	+ —	C
,, 31	20 15	30	20	18	16	EW	+ —	+ —	AC
,,	20 45	30	18	15	11	EW	+ —	+ —	AC
Aug. 3	10 25	40	13	15	...	EW	— +	...	C
,, 6	8 10	45	15	23	21	EW	— +	— +	P
,,	9 40	30	35	18	11	EW	— +	— +	P

TABLE LXXV.

Disturbances of Short Period Other Than Regular Bays.

Date.	Climax.	Duration.	Range. D	Range. H	Range. Z	Direction of Movement. D	Direction of Movement. H	Direction of Movement. Z	Rotation or Phase.	Notes.
1912.	h. m.	mins.	γ	γ	γ					
April 9	0 5	20	102	122	112	EW	+ —	+ —	P	Oscillation.
,, 17	9 45	90	108	103	74	EW, EW	— +	— +	C	Z max. 40 mins. before H.
,, 30	11 50	90	107	45	57	EW	+ — + —	+ — + —	C	Double bay. H and Z not in phase.
May 5	11 45	75	223	—	306	EW, OSC		+ —		Bay in D at least double.
,, 6	16 0	60	—	—	—					Highly oscillatory and irregular in all elements.
,, 14	12 15	70	45	84	106	EW, EW	+ — + —	+ —	C	Bay in Z: H and Z largely unlike: central part clockwise.
,, 31	18 30	25	61	54	51	EW	+ —	+ —	P	A symmetrical bay: in disturbed time.
June 1	11 30	35	135	198	212					Irregular oscillatory bay: H and Z partly opposite.
,, 8	12 45	35	104	47	115	EW	+ —	+ —	P	A symmetrical bay followed by active disturbance.
,, 8	13 45	90	—	—	—					Highly oscillatory: irregular: very large.
,, 9	12 20	60	—	—	—					Highly oscillatory: irregular.
,, 12	12 15	6	41	60	47	WE	— +	— +	P	Sharp oscillation.
,, 18	15 30	70	35	56	93	WEW, OSC	+ —	+ —		Regular bay in H and Z: D oscillatory.
,, 23	19 40	90	35	5	57	EW	+ —	+ —	AC	Bay.

TABLE LXXV—*continued.*

Disturbances of Short Period Other Than Regular Bays.

Date.	Climax.	Duration.	Range. D	Range. H	Range. Z	Direction of Movement. D	Direction of Movement. H	Direction of Movement. Z	Rotation or Phase.	Notes.
1912.	h. m.	mins.	γ	γ	γ					
July 4	13 15	75	112	86	199	EW	+ —	+ —	C	H irregular: ends indefinite in storm.
,, 5	21 30	45	157	62	124	WE	— +	— +	C	Bay during larger disturbance.
,, 6	0 40	30	87	74	90	WE	— +	— +	AC	Bay during large disturbance.
,, 6	12 0	120	—	—	—					Irregular, large, oscillatory: some trace lost.
,, 8	14 10	60	78	146	232	EW, OSC	+ — + —	+ —	P	Double bay in H, single in Z. D and H oscillatory.
,, 12	3 30	15	—	47	39	—	+ —	+ —		Short bay: H and Z in phase.
,, 12	3 45	15	—	40	11		+ —	+ —		Short bay: H and Z in phase.
,, 12	13 30	35	—	26	25		+ —	+ —		Short bay: H and Z in phase.
,, 15	3 20	25	18	28	11	EW	+ —	+ —	C	Short bay.
,, 27	16 0	70	39	48	70	EW	— +	+ —	P	Irregular bay: part of larger disturbance: H and Z mainly opposite.
Aug. 2	15 0	40	—	188	—	OSC	— +	OSC		Very oscillatory: D and Z hard to follow.
,, 3	0 55	15	96	108	109	WE	— +	— +	P	Two sharp oscillations in sequence.
,, 3	1 10	15	103	111	86	WE	— +	— +	P	Closely in phase.
,, 22	15 40	60	91	128	220	WE	OSC	+ —		Bay in Z but oscillatory in all elements especially D and Z.
,, 23	14 40	60		416						Highly oscillatory: ranges large but hard to measure.
Sept. 3	21 15	8	12	94	59	EW	— +	— +	D	Suspected S.C.: double oscillation in D.
,, 4	4 10	30	54	65	126	WE	— +	— +	C	Bay nearly in phase: during disturbed time.
,, 4	10 30	60	99	29	75	EW	+ —	+ —	D	Double bay in D and Z.
,, 4	11 20	90	101	34	46	EW	— +	+ —	C	H irregular.
,, 7	0 5	10	89	81	89	EW	+ —	+ —		Conspicuous oscillation.
,, 8	1 15	18		113	93		— +	— +		D too faint: prominent oscillation: H and Z in phase.
,, 17	13 45	30	42	40	44	WE	— +	— +	P	Three bays in immediate sequence: H and Z remain remarkably alike for some 10 bay-like changes.
,, 17	14 35	55	68	48	53	WE	— +	— +	C	
,, 17	15 30	50	74	60	70	WE	— +	— +	C	
,, 18	12 0	60	117	269	229	OSC	OSC	+ —	D	All very oscillatory near 12h: Z bay-like.
,, 23	2 10	8	61	97	74	EW	+ —	+ —	P	Prominent oscillation: disturbed time.
,, 30	11 45	75	33	21	45	EW	+ —	+ —	D	Bay slight in H: ends poorly defined.
,, 30	21 40	10	40	94	81	EW	— +	— +	P	S.C.: second movement the larger in H and Z.
Oct. 14	10 15	100	64	27	38	EW	+ —	+ —	D	
,, 14	11 45	60	50	40	62	EW	+ —	+ —	D	Series of bays superposed on gradual changes, especially in D: ends rather indefinite.
,, 14	13 10	50	78	39	74	EW	+ —	+ —	P	
,, 14	14 15	55	69	50	81	EW	+ —	+ —	C	
,, 15	5 45	6	66	60	47	WE	— +	— +	P	Sharp oscillation, especially prominent in D.
,, 16	10 10	20	104	77	117	EW	+ —	+ —	P	Bay in D and Z rather part of a bay.
,,	10 30	45	79	47	85	EW	+ —	+ —	D	Bay D and Z part of a bay: H irregular.
,, 18	9 55	40	13	19	30	EW	+ —	+ —	P	Small bay.
,, 20	17 20	10	10	27	19	WE	— +	— +	P	S.C.: first movement the smaller in H and Z but larger in D.
Nov. 8	12 45	100	36	58	67	EW	+ —	+ —	D	Bay.
,,	20 10	40	35	31	89	WE	— +	— +	AC	Bay: D not quite in phase.
,, 11	12 15	70	76	57	98	EW	+ —	+ —	P	Bay: ends in D arbitrary.
,, 25	23 45	7	68	65	74	EW	— +	— +	P	Sharp oscillation: 2nd movement the larger.
1913.										
Jan. 13	23 50	10	99	60	139	WEW	+ — +	+ — +	D	Three successive swings: second movement largest.
,, 27	24 0	10	55	32	76	WE	+ —	+ —	P	Like S.C.: D movement continued 1 1/2 mins. longer.
,, 29	23 30	9	41	44	55	EW	— +	— +	P	Like S.C. (9-minute range taken in all elements).
Feb. 11	20 20	12	19	30	44	EW	+ —	+ —	P	Oscillation: D shorter time.
Mar. 10	23 35	12	47	30	71	WE	+ —	+ —	P	Double oscillation.
,,	23 45	12	26	26	49	WE	+ —	+ —	P	
,, 14	4 30	6	39	52	34	WE	— +	— +	D	Oscillation during disturbance.
,, 20	20 30	20	36	35	42	EW	+ —	+ —	AC	Oscillation.
,, 23	16 0	85	68	69	126	WEW	+ —	+ —	C	Bay in H and Z: D irregular.
April 1	14 30	90	41	44	53	WE	+ —	+ —	D	Bay. Part of larger movements: D irregular.
,, 10	10 0	55	117	66	109	EW	+ — + —	+ —		Deep bay in D and Z: H irregular: complex.

TABLE LXXV—*continued.*

Disturbances of Short Period Other Than Regular Bays.

Date.	Climax.	Duration.	Range. D	Range. H	Range. Z	Direction of Movement. D	Direction of Movement. H	Direction of Movement. Z	Rotation or Phase.	Notes.
1913.	h. m.	mins.	γ	γ	γ					
April 16	13 0	140	97	67	120	EW	+ —	+ —	C	Bay: H irregular: in D only part of larger disturbance.
,, 29	2 5	6	58	44	82	EW	— +	+ —	P	Oscillation like S.C.: H and Z opposite.
May 6	8 50	30								Oscillatory.
,,	13 0	45							D	Highly oscillatory.
,,	16 15	60							D	Highly oscillatory.
June 9	0 0	15	52	32	49	EWE	+ — +	+ — +		Oscillations fairly in phase.
,, 14	9 45	30	15	14	—	EW	— +		P	Bay D and H in phase but poorly defined.
,, 19	13 30	90	50	92	111	EW, OSC	+ —, OSC	+ —		Bay: H and Z not like: large oscillations in D and H.
,, 21	15 0	60	34	108	66	OSC	— +	OSC		Bay in H: D and Z irregular.
,, 25	13 40	60	24	8	22	EW	OSC	+ —	D	Bay in D: H hardly disturbed.
,, 26	14 0	180	71	91	127	OSC	— +	+ —	D	Oscillation in D and H: H and Z dissimilar.
,, 29	10 45	50	31	20	16	EW	— +	— +	P	Bay: Z movement trifling.
July 3	3·15	15	54	84	70	WE	— +	— +	P	Sharp oscillation.
,, 7	13 50	50	26	44	52	EW, EW	— +	+ —		Irregular movement: H and Z opposite.
,, 12	13 30	120	112	110	109	EW	+ — +	+ —		Bay: Z very faint: H and Z partly unlike.
,, 13	13 30	60	82	203	—	WE	— +	OSC	D	Confused. Active oscillation: slight bay in H and D.
,, 15	14 40	45	$\nless$102	$\nless$199	$\nless$172	WE	— +	— +		Bay in H but highly oscillatory.
,, 16	14 35 15 20	} 60	$\nless$74	$\nless$164	—	EW	— + — +	+ —		Two bays in H, first very short: highly oscillatory.
,, 20	6 30	10	41	27	—	WE	+ —		C	Oscillation like S.C.: D in advance of H.
Aug. 4	22 20	25	38	41	37	EWE	+ — +	+ — +		Three movements approximately in phase.
,, 7	14 15	100	68	62	120	EW	+ — +	+ —	C	Bay in D and Z and fairly in phase: H not in phase.

§2.—TYPES OF SHORT PERIOD DISTURBANCE.

Of the numerous generic types to which short period disturbance may conform that characterised as the "special type" in the discussions of the magnetic results from the two British Antarctic Expeditions of 1901–04 and 1910–13 was singularly absent in the records from Cape Denison. In good cases of the special type of disturbance declination (or east force), and horizontal force usually took a bay-like form increasing and decreasing roughly in phase and symmetrical in the to-and-fro movements. At the same time the vertical component vector increased slightly at first, decreased at the same rate as the change in D or H, and then returned to normal by a more prolonged and gradual rise. No distinct case of such a disturbance was detected in the records from Cape Denison (see also Chapter II, §8).

On the other hand, bays were more than usually frequent, as Table LXXIV shows. In marked contrast to the customary poorer definition of the bay movement in the vertical component of the disturbing field at other stations, the Z trace at Cape Denison usually approached most nearly the ideal increase to a maximum and symmetrically executed decrease to the normal undeviated position. Because of their frequency and, in a large percentage of all occurrences, their approach to regularity, a special study has been made of bays using as basis the data from a fresh examination of the magnetograms made in every case of a regular bay.

The characteristics of bay disturbances at Cape Denison are most conveniently studied under four heads :—

1. Type of bay, direction of changes of the components in the disturbing field to which the bay is attributable.
2. Relative intensity of the vector components in the various bay types.
3. Distribution of occurrence of bays in time.
4. Direction of rotation of the disturbing vector responsible for some bays.

§3.—Bay Types.

It will assist in brevity of description if the directions of movements are characterised with the force components always in the same order, D, H, and Z, and without specification of the element on each occasion. For example : EW, + —, + — stands for that type of bay in which the vector component transverse to the meridian has increased first to the east, reached a maximum in that direction and then been reversed to bring the field finally to its normal value; the component in the meridian has been directed northward in the first phase then withdrawn and the component in the vertical direction acting on the north pole of the magnet has increased, then decreased, *i.e.*, the dip at Cape Denison has decreased then returned to normal. Using similar representations for the other varieties of component changes in the disturbances, examination of Table LXXIV shows that :—

1. The type of bay EW, + —, + — is the commonest type. 54 per cent. of all tabulated bays have their movements so described.
2. 89 per cent. of the 267 bays belong to one of the four classes, EW, + —, + —, EW, — +, — +, WE, + —, + —, WE — +, — +, that is, with the adopted significance of + and — for H and Z changes, the two components in the meridian plane change together in the two phases of the bay movement and, in general, they are fairly in phase.
3. No bay of type EW (or WE) + —, — + was detected.
4. Only six cases of the type EW, — +, + —, and one case of WE, — +, + —, were sufficiently clear for tabulation.

Hence, combining the results in 3 and 4, out of the 244 (= 267 — 23) most regular bays which are complete in all three components and which have not been described as having a double movement in any component, only seven unquestionably had H and Z simultaneously changing in opposite directions in each of the two phases. The 23 bays which are excluded from this classification are lacking in registration of either D or Z or have a compound movement in one component.

§4.—Relative Intensity of the Vector Components.

(*a*) That there are systematic changes in the relative intensity of the components of the disturbance vector from type to type is made clear by Table LXXVI which summarises the results of an analysis of the 267 bay movements of Table LXXIV. The Table gives the mean range in each component for the various classes of bays. Results for 1912 and 1913 are given separately as well as a general mean for all tabulated bays of each class. The number of bays contributing to each set of means is shown separately.

Table LXXVI.

Mean Range of Disturbing Force Components in Different Classes of Bay.

	Class I.				Class II.				Class III.				Class IV.			
	D	H	Z	No. of Bays.	D	H	Z	No. of Bays.	D	H	Z	No. of Bays.	D	H	Z	No. of Bays.
Direction of Change	EW	+ —	+ —		EW	— +	— +		WE	+ —	+ —		WE	— +	— +	
Mean Range 1912 ...	36	32	49	84	55	55	36	11	39	34	33	15	38	37	46	14
1913 ...	27	26	40	59	27	26	19	19	25	35	41	18	50	45	58	17
Both Years	33	30	45	143	38	37	25	30	32	35	38	33	45	41	53	31

	Class V.				Class VI.				Unclassed.	No. of Bays.
	D	H	Z	No. of Bays.	D	H	Z	No. of Bays.		
Direction of Change	6 EW + 1 WE	— +	+ —		EW or WE	+ —	— +			
Mean Range 1912 ...	56	26	35	4				—		
1913 ...	51	41	45	3				—		
Both Years	54	32	39	7				—		23

In the type EW, + —, + —, the range in Z is 43 per cent. greater than the mean of the ranges in the horizontal components and the excess is conspicuous in both contributing years. By contrast, the range in the vertical component in the type EW, — +, — + is only two-thirds of the mean of the other components, and the deficit is equally marked in both years. In the aggregate, bays in which the transverse vector increased first to W also had the vertical component stronger than either of the horizontal components, this feature being common to the two years separately in the class WE, — +, — +, but shown in 1913 alone, when the direction of change in the first phase was an increase in H and Z. In those cases in which H and Z were in opposite phase, EW (or WE) — +, + —, the noticeable feature is the relative smallness of the component along the meridian.

(*b*) It has been remarked elsewhere (vide *e.g.*, Chapter IX, Part II, Vol. I) that the decrease in magnetic activity from 1912 to 1913 at Cape Denison, as shown by the range of the inequalities or absolute daily range much exceeded the decrease to be anticipated from the mean Wulf-Wulfer sunspot numbers and, indeed, much exceeded the decrease in the magnetic activity of lower latitudes. This is borne out by the mean ranges for the three vector components derived from the two years separately in bay types EW + —, + —, EW — +, — +, and WE + —, + —, which, together, comprise 206 bays. Taking the average of the three component means as criterion, the mean bay range in these three types for the two years 1912 and 1913 are 39 γ and 31 γ, 49 γ and 24 γ, 35 γ and 34 γ respectively. An inferior development of bays, therefore, accompanied the diminished general activity.

§ 5.—Distribution of Bays in Time.

(a) *Annual Variation in Occurrence Frequency.*

In addition to the approximate regularity and definiteness of movement in all components, the absence of large superposed perturbations and approach to coincidence of times of culmination in the components, and the criterion used in selecting the bays for Table LXXIV was the absence of appreciable disturbance in the hours immediately before and after the bay. An ideal bay is produced in an otherwise quiet time and suggests (simply) the approach and withdrawal of a current circuit accompanied, it may be, with a rotation of the current system about a vertical axis or the growth and decay of a current in a fixed or rotating direction. During periods of general disturbance, however, movements frequently developed which, if not produced by a similar mechanism to that of bays superposed on top of the general disturbance of the time, simulated the quiet time bay in its characteristic features. Hence, in order to maintain as impartial a selection as possible, those bay-like constituents of longer period disturbance were tabulated which conformed to the other criteria cited above and had not their symmetry seriously upset by superposed perturbations. In considering the reality of a seasonal or daily period in the frequency of occurrence of bays, it is necessary to know that such a procedure was adopted.

Any final decision as to a seasonal variation in the incidence of the bays of Table LXXIV is hard to come by. Since magnetic registration did not properly begin till April, 1912, March contributed only a few satisfactory traces and during December of the same year and part of January, 1913, the H and Z variometers worked indifferently well. Registration ceased early in August, 1913. There were also isolated occasions of partial failure of the magnetograph system at times when the remaining components indicated that bays were in progress. Therefore, although the largest number of bays are contributed by the months April to July, taking both years together, this apparent winter maximum owed its origin simply to the increased number of available days during the winter season. Judged by the percentage occurrence of bays on available days the increase from September to October and decrease to February suggests that a more complete and satisfactory registration during summer would have revealed a maximum then.

(b) *Diurnal Variation.*

On the assumption that the restricted definition of regular bays used in the selection did not overweight the contribution from that part of the day in which disturbance at Cape Denison is normally least conspicuous, an analysis of the times of climax of the selected bays of Table LXXIV should show up any tendency to a diurnal variation that may exist. On the ground that the resulting distribution in frequency and relative intensity of the component ranges justified the classification into types, the same mode of classification is also used in the analysis of their distribution in time. But since 237 of the bays belong to the first four types discussed above in which the vector change in H and Z is in the same direction in each of the two phases of the main movement and only seven bays have their changes described by EW (or WE), — +, + —, the second pair of algebraic signs representing the changes in the vertical force will be dispensed with, being merged with those representing the changes in H. Hence EW, + — stands for that class of bay in which the first phase is characterised by an increase of east force and an increase of both H and Z, and in the second phase these changes are reversed. Table LXXVII, in which the class of bay is specified by a Roman numeral and is that adopted in Table LXXVI, provides the results of the analysis.

TABLE LXXVII.

Frequency of Occurrence of Bays of Various Classes in Parts of the Day.

Class of Bay.	I			II			III			IV			V			VI		
Day Interval	h. h. 7–11	h. h. 11–15	h. h. 15–7	h. h. 7–11	h. h. 11–15	h. h. 15–7	h. h. 7–11	h. h. 11–15	h. h. 15–7	h. h. 7–11	h. h. 11–15	h. h. 15–7	h. h. 7–11	h. h. 11–15	h. h. 15–7	h. h. 7–11	h. h. 11–15	h. h. 15–7
Frequency, 1912	3	72	9	10	1	0	0	4	11	0	0	14	1	3	0			
1913	2	44	13	18	0	1	0	14	4	0	0	17	1	2	0			
Both Years	5	116	22	28	1	1	0	18	15	0	0	31	2	5	0	—	—	—

That most of the bays of type EW, + — tended to occur within a limited period centred about 22h. L.M.T. was already obvious during the process of tabulation. The division of the day into the three periods of Table LXXVII was designed to emphasise the tendency to concentration of this and the other types within limited intervals.

One hundred and sixteen out of 143 bays of the type EW, + — reached their climax within two hours of 13h. G.M.T. (22½h. L.M.T.); only 5 developed between 7h. and 11h. G.M.T. Of the remaining 22 occurring in the 16 hours, 15h.–7h. G.M.T., 18 had occurred before 23h. and of these 10 between 20h. and 22h. In contrast to this result, 28 of the 30 tabulated occurrences of bays of the type EW, — + culminated between 7h. and 11h. G.M.T. and only one of the 30 in the interval of four hours during which type EW, + — was especially prominent. Hence these two classes of bays not only differ (1) in the development of their vertical vector components and simultaneous directions of change of the components of force along the meridian and vertically downwards, and (2) their relative frequencies of occurrence, but also (3) in respect of their distributions throughout the day.

Bays of that class in which the initial change of transverse field is directed westward and is accompanied by a decrease of the forces directed along the meridian and vertically downwards are notable for their occurrence in precisely that part of the day when the previous two types are least common, viz., 15h.–7h. Within this period they show a preference for two sub-periods centred at 21h. and 4h. G.M.T.

Eighteen out of the 33 examples of class WE, + — reached a climax between 11h. and 15h. and of the remaining 15 in the interval between 15h. and 7h., 10 had occurred not later than 17h. G.M.T. Hence since the 18 between 11h. and 15h. were really restricted to the two hours preceding 15h. a better division of the day for the class WE, + — would be 13h.–17h. G.M.T., comprising as it does 28 of the 33 cases detected.

A comprehensive deduction is that bays in general show a distinct preference for the three G.M.T. hours centred at 13h. 30m., corresponding with the period of three hours centred at 23h. L.M.T. This preference is strongest for those bays in which the first phase in both H and Z is an increase and though more pronounced when the vector tranverse to the meridian is first directed to E, holds with a lag of $1\frac{1}{2}$ hours for the reverse direction. The mean time of maximum incidence corresponds with the time of most frequent occurrence of bright aurora at Cape Denison.

The two classes in which H and Z first decrease, on the other hand, are totally unrepresented during this period. For a first increase to E in declination the maximum incidence is within the hour ending 10h. G.M.T. ($19\frac{1}{2}$h. L.M.T.) and for the class in which the increase to west accompanies the decrease in H and Z there is a more diffuse scatter with possible maxima from 2h. to 5h. G.M.T. and 19h. to 22h. G.M.T. This latter interval corresponding with a time centred at 6h. L.M.T. is synchronous with the maximum frequency of zenithal aurorae at Cape Denison.

§6.—Direction of Rotation of Disturbance Vectors in Bays.

At the same time at which the direction of change of the disturbance force components was noted, information was sought as to the simultaneity or otherwise of the turning points in the two horizontal components. From this combined information it could be decided whether the disturbing vector had rotated while producing the bay. For example, on March 28, 1912, centring about 17h. 15m. there was a bay movement in which the vector increased to the west and decreased along the meridian. The change from a decrease to increase in H set in before the reversal of D to the east, so that the disturbing force rotated in a clockwise direction. On the day following and culminating about 16h. another bay developed with the same sequence of change in D but with H first increasing then decreasing because the change from westerly to easterly increase in the transverse vector had taken place while H was yet increasing, the direction of rotation remained clockwise. In this way each of the 267 "regular" bays of Table LXXIV were examined. The letters in the final column of the table indicate whether the bay is to be ascribed to a disturbing vector rotating clockwise (C) or anti-clockwise (AC); whether the horizontal components are approximately in phase (P) or, through some irregularity about the turning point, whether no decision as to the phase could be reached (D = doubtful). Owing to lack of declination trace three bays in April, 1912, could not be assigned to any class. Table LXXVIII summarises the results of the analysis.

Table LXXVIII.

Monthly Analysis of Direction of Rotation or Phase Relations of Horizontal Components of Disturbing Force in Regular Bays.

	In Phase.		Direction of Rotation. Clockwise.		Direction of Rotation. Anti-Clockwise.		Doubtful.		Others.	
	1912.	1913.	1912.	1913.	1912.	1913.	1912.	1913.	1912.	1913.
January		1		2						
February		4		8		7				
March		8	2	13		1				
April	6	3	5	8		3	1	1	3	
May	6	9	5	9		3				
June	6	10	6	10	2	1	1	2		
July	5	5	7	6	2	6	2	2		
August	6	2	12	1	1		1			
September	11		5		3		5			
October	8		9		5		4			
November	6		2		5					
Totals...	54	42	53	57	18	21	14	5	3	—
Both Years	96		110		39		19		3	

A decision about the phase was reached in 245 out of the 264 possible cases; 19 were doubtful. After making allowance for parallactic errors between the components arising from the arrangement of the magnetographs, 96 of the 245 classified bays had the two horizontal components in phase. Of the remainder only one bay in every four, approximately, could be ascribed to a disturbing force system which rotated in an anti-clockwise direction. There is a slight tendency for the clockwise type of bay to appear most frequently in the Antarctic winter and for the anti-clockwise bays to be more common in the local summer but the material available makes such a deduction hazardous.

§ 7.—The Eighty-eight Short Disturbances of Table LXXV.

Though the 88 short disturbances listed in Table LXXV are necessarily of a much more heterogeneous character than those in Table LXXIV, they may be roughly grouped as (1) bays, irregular, poorly defined or complex, (2) oscillations of the nature of sudden commencements, or (3) sharp oscillatory movements.

Many of the disturbances of the table might be assigned to any of these classes according to the component given special attention and therefore no attempt has been made to consider possible generic characteristics as in the case of regular bays. The brief descriptive notes against each occurrence sufficiently indicate the uncertainties which would accompany any such attempt.

Where the abbreviation " osc " appears in the column " Direction of movement " it may be assumed that no one movement in the rapid succession of oscillations in the element concerned during the interval specified under " duration " has been outstanding. The letters in the column " direction of rotation or phase " have the same significance as in Table LXXIV. In most of the cases where no letter appears the form of the disturbance has been too complex to permit of any decision as to phase differences between the horizontal components.

CHAPTER II.—COMPARISON OF SHORT PERIOD DISTURBANCES AT CAPE DENISON AND CAPE EVANS.

§ 8.—General Features of Magnetic Registration at the Two Stations.

Table LXXIX is intended to serve as a basis of comparison for short period disturbances at Cape Denison and Cape Evans, excluding, however, solitary oscillations of a few minutes duration. Some of the disturbances considered occurred during long storms but in all cases there was something distinctive and suggestive of individuality at least at one of the stations. The Cape Denison curves formed the original basis for compiling the list, but the Cape Evans curves were also consulted and in many cases it was really their appearance which suggested the disturbance. In some cases altering the starting or ending time by 10 or 15 minutes would make a considerable difference to the relative disturbance as measured by the ranges at the two stations. The times were carefully chosen in all cases with a view to making the comparison as fair as possible. Still as the Cape Denison curves were the first considered it is not unlikely that more than a due share of occasions have been included in which the Cape Denison disturbance was the larger.

In practically all cases the disturbance was mainly of the " bay " type, in which the element increases continuously to a maximum or decreases to a minimum and then returns approximately to its original value. But in the Antarctic shorter period oscillations were nearly always superposed, and in some of the cases in the table, the shorter period oscillations largely obscured the bay movement in one or more of the elements. This was true more especially of D at Cape Denison but sometimes it was still more true of H. As regards vertical force there was a curious difference between the stations. At Cape Evans Z^1 (to distinguish it from Z at Cape Denison) was seldom in step with the horizontal components. These latter, E^1 and N^1, often showed fairly regular bay movements with turning points simultaneous or nearly so in the two elements, and with the first and return movements approximately equal. But the changes in Z^1 were conspicuously unsymmetrical. Sometimes there was a short small initial fall of Z^1 during the commencing movement in E^1 and N^1, but long before the commencing movement in E^1 and N^1 ended the movement in Z^1 had become a rise. This rise usually continued after the reverse movements in E^1 and N^1 had set in. The final return of Z^1 to its original value was usually more deliberate than the return movements in E^1 and N^1 and at the time when the bay movements in E^1 and N^1 had terminated Z^1 remained decidedly enhanced. At Cape Denison on the other hand, as indicated in the preceding chapter, Z behaved like the horizontal components. In fact on the whole it showed the closest approach to the ideal form of bay movement. Shorter period perturbations were seldom wholly absent but they were less in evidence than in H. When H gave a close approach to the ideal bay movement, the movements in H and Z were usually closely alike, sometimes extraordinarily alike.

Table LXXIX.

Short Period Disturbances at Cape Denison and Cape Evans.

Notation used: **A** = like. O = Bay with oscillation.
B = rather like. p = in phase.
C = rather opposite. c = clockwise.
D = opposite. ac = anticlockwise.
E = uncertain.

Date. 1912.	Time. From	Time. To	D γ	H γ	Z γ	E^1 γ	N^1 γ	Z^1 γ	D and E^1	H and N^1	Z and Z^1	H and Z	D	H	Phase at C.D.	Phase at C.E.	Bay at C.D.	Bay at C.E.
	h. m.	h. m.																
April 1 ...	9 30	10 20	21	21	—	25	34	15	**A**	**D**	—	—	EW	— +	p	p	R	R
„ 1 ...	10 20	11 25	59	27	—	26	55	10	**A**	**D**	—	—	EW	— +	p	c	R	R
„ 5 ...	15 10	17 0	105	61	63	82	63	18	**B**	**B**	**E**	**A**	WE	— +	c		I	I
„ 6 ...	12 40	14 0	81	95	160	60	48	16	**D**	**A**	**E**	**A**	EW	+ —	c	c	R	R
„ 7 ...	8 50	9 25	29	21	22	52	41	29	**A**	**D**	**B**	**B**	EW	— +	p	c	I	R
„ 7 ...	9 25	10 35	106	64	53	109	123	44	**A**	**D**	**B**	**E**	EW	— +	p	c	R	R
„ 10 ...	7 35	11 0	206	103	110	161	211	123	**A**	**D**	**B**	**C**	EW	— +		p	I	I
„ 12 ...	9 0	10 0	54	44	23	25	61	18	**A**	**D**	**A**	**A**	EW	— +	p	c	R	R
„ 15 ...	10 15	12 30	166	100	286	110	147	44	**E**	**A**	**E**	**E**	EW, O	O			I	I
„ 17 ...	8 30	10 30	108	109	74	150	91	107	**A**	**D**	**D**	**B**	EW	— +	c	p	I	R
„ 18 ...	9 30	11 0	113	126	114	105	144	79	**A**	**E**	**B**	**B**	EW	+ — +	c	c	I	R
„ 20 ...	12 30	13 10	27	18	34	20	8	4	**D**	**E**	**E**	**A**	EW	+ —	p		R	I
„ 20 ...	13 10	14 30	26	54	63	32	20	10	**D**	**E**	**E**	**A**	EW	+ —	c		R	I
„ 25 ...	12 20	13 30	—	106	231	81	65	16	—	**A**	**E**	**A**	—	+ —		c	R	R
„ 29 ...	12 0	13 15	—	16	44	23	27	12	—	**A**	**E**	**A**	—	+ —		c	R	R
„ 30 ...	11 20	12 40	104	44	62	54	66	20	**D**	**D**	**B**	**E**	EW	+ — +	c	c	I	R
May 4 ...	11 30	12 30	45	28	27	11	14	8	**E**	**E**	**E**	**A**	EW	+ —	c		I	I
„ 5 ...	11 0	12 25	223	—	306	258	396	250	**E**	—	**B**	—	EW, O				I	I
„ 6 ...	15 0	17 0	115	274	218	105	50	48	**A**	**E**	**C**	**E**	WE	O			I	I
„ 7 ...	1 0	2 0	127	68	151	48	55	16	**B**	**E**	**E**	**E**	EW			c	I	I
„ 7 ...	10 30	13 0	132	146	215	56	90	40	**E**	**C**	**A**	**E**	EW, O	O			I	I
„ 10 ...	11 0	12 0	31	9	11	20	21	5	**D**	**E**	**E**	**E**	EW			c	I	R
„ 12 ...	7 0	9 0	171	109	47	173	106	58	**A**	**D**	**E**	**E**	EW	— +		p	I	I
„ 12 ...	11 0	12 0	113	67	194	84	95	22	**D**	**A**	**B**	**A**	EW	+ —	p	c	R	R
„ 12 ...	21 0	23 0	163	86	169	174	90	35	**A**	**A**	**D**	**A**	WE	— +	p	p	I	R
„ 13 ...	0 0	3 0	193	171	230	187	222	82	**D**	**A**	**D**	**A**	WE	— +	p	c	I	R
„ 13 ...	7 30	11 30	213	167	245	217	147	236	**A**	**D**	**A**	**E**	EW	— +			I	I
„ 14 ...	11 30	13 0	48	84	109	39	21	22	**E**	**E**	**D**	**C**	EW, O	— +			I	I
„ 15 ...	10 0	12 0	61	113	130	46	58	31	**B**	**C**	**D**	**C**	EW, O	— +, O			I	I
„ 16 ...	13 20	14 50	45	52	69	47	31	16	**D**	**B**	**E**	**A**	EW	+ —	c		R	I
„ 17 ...	12 20	13 30	74	62	108	40	43	9	**D**	**A**	**A**	**A**	EW	+ —	p	p	R	R
„ 19 ...	13 20	14 20	28	32	40	25	14	7	**D**	**B**	**E**	**A**	EW	+ —	p	c	R	I
„ 19 ...	23 0	24 0	95	28	60	53	61	30	**A**	**B**	**B**	**A**	WE				I	I
„ 21 ...	12 30	13 15	35	21	35	18	14	4	**C**	**B**	**E**	**A**	EW	+ —	p	c	R	I
„ 21 ...	14 0	15 35	36	32	44	21	27	10	**D**	**B**	**A**	**A**	EW	+ —			I	I
„ 26 ...	8 40	9 40	20	45	28	50	49	37	**A**	**D**	**B**	**A**	EW	— +	p	p	I	R
„ 28 ...	4 20	5 30	15	20	21	53	29	25	**B**	**A**	**C**	**A**	—	— +		c	I	R
„ 29 ...	11 50	13 0	69	40	99	38	55	17	**A**	**A**	**B**	**A**	EW	+ —	p	c	R	R
„ 30 ...	19 30	21 30	84	47	127	78	34	38	**A**	**A**	**A**	**A**	WE	— +			I	I
June 1 ...	7 30	10 30	78	65	63	165	78	95	**A**	**E**	**E**	**B**	EW				I	I
„ 1 ...	10 30	12 30	145	202	296	120	92	49	**D**	**B**	**E**	**E**	EW, O	+ —, O			I	I
„ 2 ...	6 50	8 0	64	95	87	176	103	150	**B**	**C**	**D**	**A**	EW	— +	p	p	I	R
„ 3 ...	5 0	8 0	92	156	134	195	79	112	**A**	**A**	**E**	**A**	EW	— +	c	c	I	I

TABLE LXXIX—*continued.*

Short Period Disturbances at Cape Denison and Cape Evans.

Date. 1912.	Time. From	Time. To	D γ	H γ	Z γ	E' γ	N' γ	Z' γ	D and E'	H and N'	Z and Z'	H and Z	D	H	Phase at C.D.	Phase at C.E.	Bay at C.D.	Bay at C.E.
	h. m.	h. m.																
June 8 ...	6 30	8 0	46	60	54	162	78	87	A	C	B	A	EW	— +	p	c	I	R
,, 8 ...	12 30	14 30	122	342	405	124	196	125	E	E	B	E	EW, O	O			I	I
,, 8 ...	19 0	22 0	169	80	122	155	60	36	A	A	E	A	WE	— +	p		I	I
,, 9 ...	2 0	3 0	67	77	94	97	150	138	A	A	D	A	WE	— +		c	I	R
,, 9 ...	11 30	13 0	178	311	387	90	87	40	C	E	B	E	EW, O	O		c	I	R
,, 9 ...	14 30	16 0	142	206	272	76	72	53	E	E	E	E	EW, O	— +, O			I	I
,, 10 ...	17 0	18 30	158	44	194	145	61	22	A	B	E	E	WE				I	I
,, 10 ...	22 0	23 0	102	83	120	78	72	48	A	D	B	A	WE	+ —		c	I	R
,, 13 ...	6 0	7 0	17	16	19	47	19	28	B	B	D	B	EW	— +		c	I	R
,, 13 ...	14 0	15 0	42	26	32	17	13	7	A	A	C	A	WE	+ —	c		I	I
,, 14 ...	4 0	6 0	30	40	34	58	27	27	C	A	C	A		— +		c	I	I
,, 14 ...	14 40	16 0	53	75	119	48	31	12	C	B	B	A	EW	+ —	c	c	R	R
,, 15 ...	7 0	8 0	10	9	10	26	12	10	E	B	B	A		— +		c	I	R
,, 17 ...	17 20	18 20	45	32	43	16	10	6	A	E	E	A	WE	— +	p		R	I
,, 18 ...	15 10	16 20	35	56	93	32	23	8	E	A	E	A	O	+ —		c	I	R
,, 21 ...	6 0	7 0	8	16	10	31	15	13	E	B	E	B		— +		c	I	I
,, 23 ...	11 40	13 30	97	63	91	36	55	10	C	A	E	A	EW	+ —	c	c	R	I
,, 24 ...	5 10	6 40	26	38	27	38	66	22	B	A	C	A		— +		c	I	R
,, 24 ...	12 15	14 20	48	49	55	37	55	32	D	E	E	A	EW	+ — +	c	c	I	I
,, 26 ...	13 0	15 0	43	20	48	23	25	10	C	A	B	B	EW	+ —		c	I	R
,, 27 ...	7 0	11 0	—	119	84	124	153	148	—	C	B	B		+ —			I	I
,, 27–28 ...	22 0	2 0	—	88	119	98	92	18	—	D	B	A		+ —		p	I	R
,, 29 ...	0 55	2 0	—	121	164	41	89	14	—	A	D	A	—	— +		c	I	I
,, 29 ...	11 30	13 0	55	80	151	48	61	17	B	D	E	A	WE	— +			I	I
,, 30 ...	10 30	11 30	56	39	72	74	42	25	B	A	E	C	WE	— +	c	c	R	I
July 1 ...	4 0	7 30	45	86	59	88	84	66	E	A	E	B		— +		c	I	R
,, 1 ...	13 20	14 30	69	54	161	52	35	9	D	A	B	B	EW	+ —	c	c	R	I
,, 5 ...	3 30	6 0	73	115	91	187	101	269	B	A	C	B	WE	— +			I	I
,, 5 ...	21 0	22 0	165	62	124	120	58	21	A	A	E	A	WE	— +	c	p	R	I
,, 5 ...	22 30	23 30	165	82	70	68	90	28	A	C	C	B	WE			c	I	I
,, 6 ...	11 0	13 0	†167	498	288	67	127	78	E	D	A	D	EW, O	— +, O			I	I
,, 8 ...	13 40	14 40	78	146	232	99	82	23	D	C	E	E	EW, O	+ —, O		c	I	I
,, 9 ...	11 30	13 0	48	39	83	20	34	13	C	E	E	E	EW				I	I
,, 16 ...	21 30	22 0	13	16	14	26	14	17	A	D	A	A	WE	+ —	p	p	R	R
,, 17 ...	8 30	9 30	12	16	15	39	26	20	A	D	B	A	EW	— +		p	I	R
,, 17 ...	15 20	16 40	86	75	166	80	49	25	B	E	E	A	WE	+ —	c	c	R	R
,, 20 ...	6 30	8 30	16	34	40	86	43	59	B	B	E	A		— +		c	I	I
,, 21 ...	11 10	12 10	68	30	37	22	41	11	D	D	B	D	EW	— +	c	c	R	I
,, 23 ...	6 0	8 0	20	24	33	58	14	33	E	B	E	A	WE	— +	c		I	I
,, 25 ...	17 0	19 0	41	39	54	50	20	16	A	C	E	A	WE	+ —		c	I	I
,, 25 ...	22 20	23 20	60	63	30	63	38	22	A	E	B	B	WE	— +	ac	c	I	R
,, 26 ...	15 0	17 40	52	50	66	56	59	34	A	A	B	A	WE	+ —	p	c	R	I
,, 27 ...	14 20	16 20	39	74	111	45	56	35	B	A	B	E	WE	+ — +			I	I
,, 28 ...	22 0	22 30	28	27	20	19	20	10	E	C	E	A	WE	+ —	ac	c	R	I
,, 29 ...	14 20	15 30	22	19	33	14	14	8	D	A	E	A	EW	+ —	p	c	I	I
,, 31 ...	9 0	11 30	97	36	51	48	59	22	E	C	E	E	EW	— +			I	I
August 1 ...	2 55	5 55	102	203	170	245	143	257	A	A	B	B		— +		c	I	I
,, 1 ...	14 30	15 40	23	34	34	33	29	11	B	B	E	A	WE	+ —	c		I	I
,, 1 ...	21 0	22 0	37	59	35	32	23	16	B	E	E	E	EW, EW	+ — +			I	I
,, 2 ...	4 10	5 50	32	37	56	43	26	19	A	A	E	A	EW	— +	c		I	I
,, 2 ...	13 0	14 0	31	74	83	27	32	12	E	B	E	A	EW	+ —	c		R	I
,, 2 ...	14 0	16 0	112	203	176	71	57	30	E	E	E	E	O	— +, O			I	I
,, 2 ...	22 0	23 0	20	36	32	28	34	30	B	D	D	A	WE	+ —		p	I	R
,, 3 ...	11 0	13 0	43	58	92	34	35	7	E	A	E	A	EW	+ —	c		I	I
,, 8 ...	14 30	15 10	19	26	28	14	5	4	B	E	E	A	WE	+ —	c		R	I
,, 8 ...	15 10	15 40	18	12	13	8	8	4	B	E	E	A	WE	+ —	c		R	I
,, 10 ...	19 30	21 10	54	32	61	50	19	15	A	E	E	A	WE	— + —			I	I
,, 16 ...	12 0	13 30	37	17	39	25	16	6	C	B	E	B	EW	+ —			I	I
,, 17 ...	1 0	2 45	181	108	275	165	116	34	A	B	A	E	EW			c	I	I
,, 17 ...	2 45	3 45	137	126	173	59	87	16	B	A	E	A	EW	+ —	c	c	I	I
,, 17 ...	9 30	13 0	168	56	113	63	119	35	E	D	B	E	EW	— +			I	I
,, 18 ...	11 0	13 0	59	14	42	15	29	7	E	E	E	E	EW				I	I
,, 18-19 ...	23 20	1 20	141	97	125	155	109	29	A	A	B	A	WE	— +	c	p	I	R
,, 19 ...	9 0	10 0	54	62	64	86	101	63	A	D	A	A	EW	— +		p	I	R
,, 20 ...	8 0	9 0	21	19	25	33	33	16	B	D	B	A		— +		p	I	R
,, 22 ...	7 0	8 0	31	46	25	62	55	52	A	D	B	B	EW	— +	c	p	I	R

TABLE LXXIX—*continued.*

Short Period Disturbances at Cape Denison and Cape Evans.

Date. 1912.	Time. From	Time. To	D γ	H γ	Z γ	E¹ γ	N¹ γ	Z¹ γ	D and E¹	H and N¹	Z and Z¹	H and Z	D	H	Phase at C.D.	Phase at C.E.	Bay at C.D.	Bay at C.E.
	h. m.	h. m.																
August 22 ...	15 0	16 30	96	128	220	116	95	67	A	C	E	E	WE, O	O			I	I
,, 23 ...	14 0	15 30	86	417	442	66	68	19	B	B	E	E	WE, O	O		p	I	I
,, 23 ...	21 0	23 0	103	79	76	70	34	36	A	C	E	B	WE	— +	ac		I	I
,, 24 ...	7 0	8 0	33	40	53	97	17	48	B	D	B	A	EW	— +	ac		I	I
,, 24 ...	8 0	9 0	50	46	18	61	77	40	A	D	B	A	EW	— +	p	p	I	R
,, 25 ...	8 50	10 30	78	71	29	52	73	24	A	D	E	B	EW	— +	p	c	R	I
,, 25 ...	13 0	14 0	17	27	35	38	27	23	B	B	C	A	EW	+ —		p	I	I
,, 26 ...	3 50	5 30	33	66	77	40	38	25	C	A	E	A	WE	— +			I	I
,, 26 ...	12 30	13 30	33	21	31	13	8	3	C	B	E	A	EW	+ —			I	I
,, 27 ...	4 30	5 30	32	60	70	39	21	14	A	A	B	B	WE				I	I
,, 27 ...	10 0	12 30	94	40	86	66	99	63	B	C	B	E	EW				I	I
,, 28 ...	3 0	4 0	35	60	84	41	16	13	B	E	E	E	EW				I	I
,, 28 ...	4 0	5 0	55	76	51	21	28	8	A	A	B	A	WE	— +	p		R	I
,, 28 ...	14 0	15 0	17	40	54	26	27	11	C	E	E	A	EW	+ —			I	I
,, 28 ...	15 30	16 30	46	52	71	65	53	23	E	A	B	A		+ —			I	I
,, 29 ...	2 0	3 0	51	62	104	25	35	8	D	B	E	B	WE				I	I
,, 29 ...	3 0	4 0	27	52	60	39	20	16	E	C	E	C					I	I
,, 31 ...	14 30	16 0	29	42	59	30	15	7	A	E	E	A	WE	+ —			I	I
Sept. 1 ...	12 30	13 0	14	10	25	10	8	4	C	A	E	A	EW	+ —	p		R	I
,, 1 ...	13 0	13 30	16	15	33	8	9	2	C	A	E	A	EW	+ —	p		R	I
,, 1 ...	13 30	15 0	22	34	44	27	14	6	A	A	E	A	WEW	+ —		c	I	I
,, 2 ...	8 20	9 0	9	21	24	27	30	14	A	D	E	A	EW	— +	p	p	I	R
,, 2 ...	11 40	12 20	22	6	17	10	7	2	D	E	E	E	EW				I	I
,, 2 ...	12 20	13 20	16	17	30	12	6	6	C	E	E	A	EW	+ —	p		R	I
,, 2 ...	14 0	15 0	16	17	22	11	8	4	A	B	E	A	WE	+ —	c		I	I
,, 4 ...	3 0	4 0	87	69	148	73	72	19	B	A	B	B	EW	+ —	p		I	I
,, 4 ...	6 30	7 30	46	34	24	31	20	7	A	A	E	B	EW	— +	p	c	I	R
,, 4 ...	10 0	12 40	109	46	78	51	91	36	C	B	B	E	EW				I	I
,, 5 ...	2 30	3 30	53	67	71	20	14	6	B	B	E	A	WE	— +	p		R	I
,, 5 ...	10 0	12 0	89	41	95	67	92	39	A	E	B	B	EW	— +	ac	c	I	I
,, 7 ...	3 0	4 0	29	47	37	14	14	6	E	A	E	A	EW	+ —			I	I
,, 7 ...	9 25	11 0	28	25	21	26	34	7	A	D	E	B	EW	— +	p	c	R	R
,, 8 ...	1 0	1 30		111	97	27	20	9	—	B	E	A	—	— +				I
,, 8 ...	7 30	8 40	26	44	27	68	46	44	A	D	B	A	EW	— +	p	p	I	R
,, 8 ...	23 0	23 30	79	108	74	66	61	37	A	E	B	A	EW				I	I
,, 9 ...	11 0	12 30	53	59	64	23	39	9	E	A	E	A	EW	+ —	ac		I	I
,, 10 ...	10 30	11 30	48	20	16	21	42	6	D	D	E	D	EW	— +	p	c	R	R
,, 10 ...	22 30	23 30	58	50	67	69	40	36	E	E	B	B					I	I
,, 12 ...	10 30	12 0	78	48	67	78	54	19	D	A	B	A	EW	+ —	p	p	I	I
,, 13 ...	12 40	13 50	19	34	34	17	12	10	E	B	E	A	EW	+ —			I	I
,, 13 ...	20 0	22 0	69	85	102	126	50	87	A	B	A	C	EWE	— +			I	I
,, 14 ...	5 0	6 0	52	94	84	23	29	17	B	B	B	A	WE	— +	c		I	I
,, 14 ...	9 30	10 30	24	34	21	29	48	19	B	D	A	A	EW	— +	p	p	I	I
,, 14 ...	11 0	12 0	25	12	10	54	32	21	A	B	E	E	EW	— +		p	I	R
,, 16 ...	10 45	12 0	17	40	36	19	16	6	E	A	E	A	EW	+ —			I	I
,, 18 ...	11 20	12 50	117	269	229	156	126	40	C	E	E	E	EW, O	O		c	I	R
,, 19 ...	20 0	22 0	87	67	96	155	53	67	A	E	E	A	WE				I	I
,, 20 ...	14 0	15 30	26	34	36	33	61	30	B	A	D	A	EW	+ —	c	p	I	I
,, 22 ...	11 30	12 30	49	34	53	25	35	6	E	A	E	A	EW	+ —	p		I	I
,, 23 ...	9 30	10 30	42	14	31	59	14	16	A	B	C	B	EW				I	I
,, 23 ...	13 0	14 0	39	28	46	56	48	15	A	A	B	A	EW	+ —	p	ac	I	R
,, 23 ...	17 0	18 30	114	58	88	68	41	16	A	C	A	A	WE	+ —	c		I	I
,, 24 ...	8 0	12 0	227	148	130	236	150	86	A	E	A	E	EW				I	I
,, 25 ...	22 0	23 0	43	47	87	41	26	62	C	B	D	A	WE	+ — +			I	I
,, 27 ...	11 20	12 20	47	16	33	34	22	6	D	C	B	A	EW	+ —	p	c	R	I
,, 27 ...	16 0	17 0	36	13	29	21	20	13	B	B	E	A	WE				I	I
,, 28 ...	22 30	23 30	38	47	63	29	26	30	A	D	E	B	WE	+ —		c	I	I
,, 30 ...	10 40	12 40	45	21	45	26	35	10	E	E	B	B	EW				I	I
October 3 ...	0 45	2 30	150	108	86	74	78	24	A	A	D	A	WE	— +		ac	I	I
,, 6 ...	12 0	12 50	44	27	48	25	14	4	D	A	E	A	EW	+ —	p		R	I
,, 6 ...	12 50	13 50	32	42	65	25	16	6	D	A	E	A	EW	+ —	p	p	R	I
,, 7 ...	13 20	14 35	31	17	36	65	54	31	A	A	B	B	EW	+ —	p	p	I	I
,, 7 ...	14 35	15 30	64	57	58	45	17	21	A	E	B	A	WE	+ —	c		I	I
,, 7 ...	20 30	22 0	31	54	66	78	31	51	E	E	C	B	WE				I	I
,, 7 ...	22 0	23 30	72	79	93	105	47	52	A	E	E	B	WE	— +			I	I
,, 9 ...	11 0	12 0	50	21	47	45	27	12	D	A	B	A	EW	+ —	p	c	R	R
,, 11 ...	13 0	14 0	46	22	41	78	31	57	A	A	E	A	EW	+ —	p	ac	R	R

TABLE LXXIX—*continued.*

Short Period Disturbances at Cape Denison and Cape Evans.

Date. 1912.	Time. From	Time. To	D	H	Z	E^1	N^1	Z^1	D and E^1	H and N^1	Z and Z^1	H and Z	D	H	Phase at C.D.	Phase at C.E.	Bay at C.D.	Bay at C.E.
	h. m.	h. m.	γ	γ	γ	γ	γ	γ										
Oct. 11 ...	15 0	16 0	63	67	81	74	20	17	A	C	C	A	WE, O	+ —	c		I	I
,, 11 ...	17 0	18 30	63	46	80	58	34	61	C	B	B	A	WE	— +	p		I	I
,, 12 ...	8 30	9 30	90	19	70	12	16	9	E	E	E	E	EW				I	I
,, 13 ...	5 30	6 0	84	108	63	90	17	17	A	E	A	A	EW	— +	p		I	I
,, 13 ...	10 0	12 0	82	54	68	70	82	46	B	B	B	B	EW	+ —	c		R	I
,, 15 ...	12 0	13 30	82	113	170	120	77	24	A	A	E	A	WEW	+ —	c	c	I	I
,, 16 ...	9 45	11 20	132	77	117	90	114	32	B	E	E	E	EW, O	+ — +		c	I	I
,, 16 ...	14 30	16 0	85	22	30	53	53	40	B	E	B	C	WE	+ —	ac		I	I
,, 17 ...	21 30	22 40	115	62	70	69	44	55	E	C	B	B	WE	— +			I	I
,, 19 ...	0 15	0 50	81	37	74	14	27	9	B	E	B	B	WE	+ —		p	I	I
,, 19 ...	12 20	13 0	33	26	48	16	14	5	D	A	E	A	EW	+ —	p	p	R	I
,, 19 ...	21 0	22 0	42	50	30	26	14	17	B	E	C	A	EW	+ —	ac		R	I
,, 20-21 ...	23 0	1 0	134	360	326	89	87	120	A	C	C	A		+ —			I	I
,, 21 ...	13 55	14 35	23	18	28	34	40	15	B	B	B	A	EW	+ —		p	I	I
,, 21 ...	19 0	19 30	26	32	24	55	48	31	D	D	B	B	WE	— +	ac		I	I
,, 22 ...	8 30	9 0	28	8	30	30	8	9	A	E	E	E	EW			p	I	I
,, 25 ...	6 50	7 20	18	13	18	19	27	6	A	B	A	A	WE			c	I	R
,, 25 ...	22 0	22 30	24	34	57	45	34	40	E	B	C	B	WE	+ —		p	I	R
,, 25 ...	22 30	23 0	38	15	43	46	21	19	B	B	B	E	WE			p	I	R
,, 26 ...	0 30	1 0	101	65	96	51	28	13	A	B	B	A	WE	— +			I	I
,, 26-27 ...	23 15	0 30	109	60	60	54	43	19	A	E	C	B	WE			p	I	I
,, 28 ...	19 20	20 20	45	58	52	34	63	40	E	B	D	A	EW	+ —			I	I
,, 30 ...	3 20	4 10	57	117	30	59	28	16	A	A	B	A	EW	+ —	p	ac	R	I
,, 30 ...	13 0	14 0	47	54	81	40	29	9	C	A	E	A	EW	+ —	p		R	I
,, 31 ...	12 30	13 30	27	34	55	17	20	6	C	E	E	A	EW	+ —	p		R	I
,, 31 ...	13 30	14 30	26	38	50	42	32	14	B	B	E	A	EW	+ —	p	c	R	I
Nov. 2 ...	3 10	4 30	50	66	55	70	92	22	C	B	B	E	WE	— +	c	p	I	I
,, 3 ...	18 45	19 50	31	40	47	39	44	33	C	B	C	A	EW	+ —			I	I
,, 5 ...	16 0	17 20	76	109	133	116	61	49	A	A	E	A	WE	+ —	c	c	I	I
,, 7 ...	0 40	2 20	59	79	178	68	79	38	B	B	C	B	EW	+ —			I	I
,, 7 ...	11 30	15 0	102	33	70	99	76	82	B	B	B	B	EW	+ —			I	I
,, 7 ...	19 15	19 40	32	30	33	56	46	36	C	B	E	A	EW	+ —	p		R	I
,, 7 ...	19 40	20 30	49	40	92	100	55	59	C	E	C	A	EW	+ —	p		R	I
,, 7 ...	22 0	23 10	81	55	111	89	72	59	B	C	E	B	EW	— +		p	I	I
,, 8 ...	11 30	12 0	17	24	30	27	5	15	E	E	B	A	EW	+ —	p		I	I
,, 8 ...	12 0	13 0	32	48	66	36	55	9	C	B	B	A	EW	+ —			I	I
,, 10 ...	8 50	11 15	176	64	61	223	78	52	B	B	E	E	EW				I	I
,, 10 ...	11 15	14 20	137	112	202	156	181	150	B	A	E	A	EW	+ —	p		I	I
,, 10 ...	14 20	15 30	52	28	37	73	95	45	B	B	B	A	EW	+ —			I	I
,, 11 ...	5 30	9 15	181	77	106	140	194	74	A	E	E	B	EW				I	I
,, 11 ...	11 30	13 35	115	57	98	112	113	95	E	A	C	A	EW	+ —	p	c	I	I
,, 16 ...	21 0	23 0	118	89	44	181	58	87	A	E	E	E	WE	— +	c		I	I
,, 17-18 ...	22 0	1 30	107	249	233	158	61	150	E	E	D	B		+ —			I	I

§ 9.—BASIS OF COMPARISON: DESCRIPTION OF TABLE LXXIX.

(*a*) *Difference of Components Registered at the Two Stations.*

All the times in Table LXXIX are Greenwich times. The range is in all cases the difference between the two extreme positions shown on the trace, but in a few cases the limits of registration were exceeded, and the range in the table is then an under-estimate. The D ranges at Cape Denison were converted into their force equivalents. The curves at the two stations were inter-compared with a view to recognizing resemblances or differences. H referred to a meridian approximately 6·7° west of the geographical meridian at Cape Denison, N^1 to a direction approximately 7·6° east of the geographical meridian at Cape Evans. Remembering the difference in longitude of the two stations, it was apparent that the most natural course was to compare D with E^1, and H with N^1. But occasionally the D curve resembled the N^1 curve rather than the E^1 curve. For brevity, the letters A, B, C, D and E are used to express the degree of resemblance or opposition between pairs of curves at the two stations. A implies close, B less close resemblance, D marked, C less marked opposition. Thus in the case of D and E^1, A signifies that declination change to east (or west) was associated with rise (or fall) in E^1; while D signifies that declination change to east (or west) was associated with fall (or rise) in E^1. In the case of H and N^1, or of Z and Z^1, A signifies simultaneous increase or simultaneous decrease in the two elements compared. The letter E signifies that the curves compared at the two stations differed so much in type that no decision could be reached as to their resemblance or opposition. This usually means that shorter period perturbations were overwhelmingly in evidence at one of the stations. But it sometimes means that the letter B was suggested by one part of the disturbance and the letter C by the other. The analysis of resemblance on opposition was extended to H and Z at Cape Denison, because the extraordinary resemblance visible at times between the two traces invited special inquiry.

(*b*) *Estimation of Times of Critical Epochs in the Disturbances.*

In the ordinary bay the change of magnetic force near the turning point is slow, the curve resembling a semi-circle and not two sides of a triangle. Thus the turning point or climax is difficult to fix with precision. In the Antarctic where shorter period perturbations were prevalent, it was not infrequently one of these which determined the exact time of the turning point (maximum or minimum of force). If we may judge from the phenomena at the two stations, these shorter period oscillations are much more local in their incidence than the bay movements. Occasionally, as in the case of sudden commencements, there were striking short period movements at both stations, which might have been synchronous, but usually there was no recognisable correspondence between the short period movements at Cape Denison and Cape Evans.

There were other reasons for not attempting to determine the precise degree of accordance in time between the turning points at the two stations. At both, judging by the positions of the breaks at the beginning and end of the day, there was usually, if not indeed always, a differential parallactic error between the traces from the different elements. It was thus clear that the hourly lines shown on the sheets required different corrections for the different elements, and the means did not exist of determining exactly what these corrections should be. While time was not known with the accuracy enabling us to say that the turning points for two different elements at the same station were ever absolutely identical, it was clear that on many if not most occasions the turning points were certainly not synchronous. This taken in conjunction with the fact that except in the case of Z the elements recorded at the two stations were different, precluded any really precise comparison of times.

(c) *Directions of Vector Changes: Phase Relations.*

The letters E and W indicate the directions of the D movements, and + and — show the directions of the H movements at Cape Denison. For example, on April 1, between 9h.30m. and 10h.20m., the movement was first easterly, then westerly, while H first fell, then rose. The letter A in the column headed D and E^1 implies that the corresponding change in E^1 at Cape Evans was a rise followed by a fall; while the letter D in the column headed H and N^1 implies that while H fell and rose at Cape Denison, N^1 rose and fell at Cape Evans. The occurrence of the letter O implies that the short period oscillations usually present were specially conspicuous, as for example in D between 11h. 30m. and 13h. on May 14, and in both D and H between 10h. and 12h. on May 15.

Sometimes the movements in the two horizontal components at one station kept step, the turning points being synchronous or nearly so. This is indicated by the letter p (signifying in phase). In other cases there was a fairly regular lag in the one element as compared with the other. This is indicated by the letters c or a.c., according as the rotation of the disturbing force vector was clockwise or anti-clockwise. Suppose for instance, we have at Cape Denison an EW bay in D, synchronous with a — + bay in H and that the turning point comes first in D. Then the vector is going round in the direction east, south, west, north, i.e. clockwise. The curves were often not regular enough to warrant a decision at one or other or at both stations.

The letters R and I in the last two columns denote that the bay was regular or irregular in outline. But R does not signify perfect regularity. It only means that the to and fro movements both stood out in each of the horizontal components, with no serious uncertainty as to the turning point. In some cases where I is attached, the bay movement in one of the elements would have justified an R.

Assuming disturbance to represent irregularities in the electric currents always flowing overhead, it seems not improbable that a bay movement represents a fairly regular change in progress in a definite volume of space while the irregular shorter perturbations may have a quite different origin or origins. The irregularities may be much less favourable to the existence of a regular bay at one station than at another.

The disturbances in Table LXXIX vary much in duration, and how best to use the data was not obvious. Eventually it was decided to divide the days into two 4-hour intervals 7h.–11h. and 11h.–15h. and a 16-hour interval, containing the rest of the day. The reasons for this choice will appear presently.

§10.—Relation of Disturbance Ranges to Regular Diurnal Variation.

To get an idea of what disturbance amounted to, we have to consider the size of the normal changes. Taking the regular diurnal inequality for the year for all days, and dividing the range within the interval by the number of hours contained, we get the following results :—

	At Cape Denison.			At Cape Evans.		
	D	H	Z	E^1	N^1	Z^1
Interval.	γ	γ	γ	γ	γ	γ
7h.–11h.	0·4	3·5	5·5	5·9	8·0	4·3
11h.–15h.	4·9	3·5	3·1	6·3	1·5	1·3
15h.–7h.	3·4	1·8	3·7	4·8	4·4	2·6

From these we see that 7h.–11h. was a time at which the regular changes in the horizontal components, especially D, at Cape Denison were slow as compared with those at Cape Evans, and even the vertical force changes at Cape Denison showed less than their usual excess. On the other hand, 11h.–15h. was a time when the regular changes in N^1 and Z^1 at Cape Evans were exceptionally small. These differences in the average rates of change of the forces governing the regular diurnal variation at the two stations are illustrated by Plate VII based on the inequalities of Table XCVII for all complete days in the seven months of synchronous records, April to October, 1912.

7h.–11h. was normally a quiet time at both stations. 11h.–15h. was also a relatively quiet time in the average day, but it included hours of brightest aurora, when some of the most notable short storms occurred.

§11.—Intensity of Disturbance at the Two Stations in Three Subdivisions of the Greenwich Day.

A good many of the disturbances were not wholly confined to any one of these three intervals. For example, on April 1, a disturbance lasted from 10h. 20m. to 11h. 25m. As 40 minutes of this occurred between 7h. and 11h., as against 25 minutes occurring between 11h. and 15h., it is included in the class "7h.–11h., mainly." Similarly, a disturbance between 10h.15m. and 12h.30m. on April 15 is included in the class "11h.–15h., mainly," and a disturbance covering 14h.30m. to 16h. on June 9 is included in the class "15h.–7h., mainly." Lastly, there were a few disturbances of which half appeared in each of two intervals, as for example the disturbance from

6h. to 8h. on July 23. These were relegated to the group termed "Miscellaneous." The range for each element in the average disturbance of each class is given in Table LXXX. Results are also given for the "wholly" and "mainly" group and combined.

TABLE LXXX.

Shorter Disturbances: Summary of Average Ranges at Cape Denison and at Cape Evans.

	Number.	Cape Denison.			Cape Evans.		
		D	H	Z	E^1	N^1	Z^1
		γ	γ	γ	γ	γ	γ
7h.–11h. Wholly	24	59	48	42	71	62	41
Mainly...	10	117	77	91	140	99	80
All	34	76	57	56	91	73	52
11h.–15h. Wholly	61	54	62	84	44	42	21
Mainly...	15	80	84	123	54	68	28
All	76	59	66	92	46	47	22
15h.– 7h. Wholly	83	73	72	89	72	50	39
Mainly...	9	64	84	97	68	48	40
All	92	72	73	90	72	50	39
Miscellaneous	8	64	66	77	55	51	27
All	210	67	68	85	65	53	35
Winter (May to August)	107	70	77	98	67	54	37
April, September, October and November ...	103	65	57	71	63	51	33

Considering first the mean results from the whole 210 disturbances of which there were complete records at both stations, we see that the ranges in D and H at Cape Denison and in E^1 at Cape Evans are nearly equal, and are sensibly greater than the range in N^1. The ranges of the horizontal components are much in excess of the range in Z^1 at Cape Evans, but are considerably exceeded by the range in Z at Cape Denison. The deficiency in the Z^1 range is greater than might have been expected from a consideration of the daily ranges of Z and Z^1.

As indicated above, 7h.–11h. was the time when the regular changes at Cape Evans were largest relative to those at Cape Denison, and Table LXXX shows that the same was true of the disturbances. In this interval the average E^1 range exceeds the average D range, the average N^1 range exceeds the average H range and the average Z^1 range is only 1γ less than the average Z range. Between 11h. and 15h., on the other hand, disturbance at Cape Evans, relatively considered, appears to be at a minimum; in particular the average range in Z^1 is only about a quarter of the average range in Z.

The last two lines in Table LXXX contrast the results from the winter months with those from the other months, three out of the four being equinoctial months. The daily ranges, whether regular or extreme, are least in winter at both stations; but the ranges of the short period disturbances included in Table LXXIX are slightly greater in the winter season, expecially in the case of H and V at Cape Denison.

Table LXXXI.

Short Period Disturbances at Cape Denison and Cape Evans.

Analysis of Form of Movements.

	No.	Like.				Rather Like.				Rather Opposite.				Opposite.				Uncertain.			
		D & E′	H & N′	Z & Z′	H & Z	D & E′	H & N′	Z & Z′	H & Z	D & E′	H & N′	Z & Z′	H & Z	D & E′	H & N′	Z & Z′	H & Z	D & E′	H & N′	Z & Z′	H & Z
7h.–11h. Wholly	24	19	0	3	11	3	2	12	8	0	0	1	1	0	18	1	0	2	4	7	4
Mainly	10	5	0	3	4	4	3	1	1	0	3	0	0	0	1	1	0	1	3	5	5
All	34	24	0	6	15	7	5	13	9	0	3	1	1	0	19	2	0	3	7	12	9
11h.–15h. Wholly	61	9	25	2	43	6	14	16	5	15	2	3	1	19	4	1	2	12	16	39	10
Mainly	15	0	5	2	7	5	5	6	1	1	2	0	0	4	1	1	0	5	2	6	7
All	76	9	30	4	50	11	19	22	6	16	4	3	1	23	5	2	2	17	18	45	17
15h.– 7h. Wholly	83	39	25	6	49	21	22	21	22	8	11	16	2	3	4	9	0	12	21	31	10
Mainly	9	3	3	0	5	3	2	4	1	1	0	0	1	0	0	0	0	2	4	5	2
All	92	42	28	6	54	24	24	25	23	9	11	16	3	3	4	9	0	14	25	36	12
Miscellaneous	8	2	2	0	1	3	2	3	3	0	1	0	2	1	1	0	1	2	2	5	1
All	210	77	60	16	120	45	50	63	41	25	19	20	7	27	29	13	3	36	52	98	39

§12.—Analysis of Synchronous Movements.

Table LXXXI contains an analysis of the results as to resemblance or otherwise of the changes in the contrasted elements D and E^1, H and N^1, and Z and Z^1 at the two stations also the results as regards H and Z at Cape Denison. The 210 disturbances of which records were complete are grouped, as in Table LXXX, according to the hour of their occurrence. The terms like, rather like, rather opposite, opposite and uncertain are the equivalents of the letters A, B, C, D, and E of Table LXXIX.

Considering first the 210 disturbances combined, we see that the movements in each of the contrasted pairs of elements are more often like than opposite. But Z and Z^1 show a much smaller number of cases of close resemblance than either pair of horizontal components, and a much larger number of cases when difference of type prevented the drawing of any conclusion. This is all the more noteworthy since Z and Z^1 were the only pair of elements which can claim to be strictly analogous. There were in particular many fairly conspicuous bay movements in Z during which there was little if any trace of disturbance in Z^1.

The relative behaviour of the pairs D and E^1, H and N^1 is quite different in the different time intervals. Between 7h. and 11h. we have a marked tendency to resemblance between the D and E^1 movements, and an equally marked tendency to opposition between the H and N^1 movements. Whereas between 11h. and 15h. there is a conspicuous tendency to resemblance between the H and N^1 movements and an equally marked tendency to opposition between the D and E^1 movements. Between 15h. and 7h. the tendency to resemblance prevails in both pairs of elements, but this is the time when Z and Z^1 movements show the greatest tendency to be opposite.

If we had at our disposal strictly synchronous changes of the magnetic elements at a number of stations it would be possible to assign, if not with absolute certainty, at least with considerable probability the position and amplitude of the corresponding disturbing electrical currents. But with data from only two stations success can hardly be hoped for in any attempt to draw general conclusions. Attention may, however, be called to one or two points which can be readily grasped on considering the accompanying Figures 16 and 17.

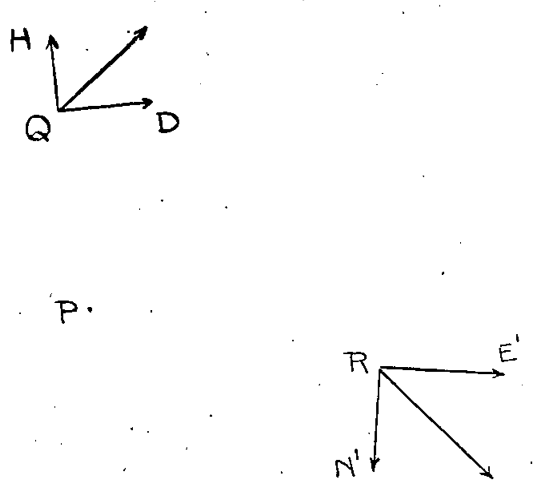

Fig. 16. 7^h-11^h

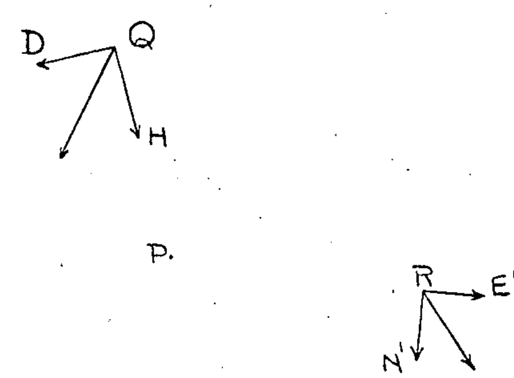

Fig. 17. 11^h-15^h

In both figures P, Q and R represent diagrammatically the position of the south magnetic pole, Cape Denison and Cape Evans. Figure 16 represents the average set of conditions between 7h. and 11h. when the D and E^1 movements are similar, while the H and N^1 movements are opposite. D is supposed somewhat larger than H, and E^1 somewhat larger than N^1 as suggested by Table LXXX. Figure 17 represents the average set of conditions between 11h. and 15h. when the H and N^1 movements are similar, while the D and E^1 movements are opposite. In accordance with Table LXXX H is supposed slightly greater than D while E^1 and N^1 are approximately equal.

If we supposed these forces all in one horizontal plane—a considerable departure from realities—the simplest explanation of the forces in Figure 16, would be an isolated magnetic pole to the west of P, it might be at a considerable height; while the simplest explanation of the forces in Figure 2 would be a vertical electrical current situated to the east of P. A magnetic pole might be the equivalent of horizontal electrical currents circling round an area. The direction of the resultant vectors in Figure 16 and the fact that the resultant force according to Table LXXX is rather larger at R than at Q suggest that the area within the horizontal currents is a large one including at least Q and possibly R. Other more plausible explanations than these may suggest themselves, but they will at least indicate the amount of information that would be required to test any explanation adequately.

One of the most remarkable results in Table LXXXI is the large number of cases in which resemblances, often close resemblances, existed between the changes shown by the H and Z traces at Cape Denison. Cases in which the changes in the two elements were decidedly opposite, *i.e.*, bay movements in which H rose while Z fell, or H fell while Z rose were exceedingly rare. This was true of all hours of the day. It should be remembered in this connection that the regular diurnal variations of H and Z at Cape Denison presented very similar features.

§13.—Phase Relations: Rotation of Disturbing Vectors.

Conclusions as to the phase were reached on only 104 occasions at Cape Denison and 106 occasions at Cape Evans or roughly in one case of two at each station. At Cape Denison D and H appeared in phase, or approximately so, on 56 occasions; on 39 occasions the force vector showed a clockwise and on 9 occasions an anti-clockwise rotation. At Cape Evans E^1 and N^1 appeared in phase on 37 occasions; on 65 occasions the force vector showed a clockwise and on only 4 occasions an anti-clockwise rotation. Of the 9 occasions of anti-clockwise rotation at Cape Denison 5 occurred between 19h. and 23h.30m.

There was no suggestion of any close relationship between the phase phenomena at the two stations. There were 14 occasions on which the horizontal components were in phase at both stations, and also 14 occasions on which the force vector rotation was clockwise at both stations. There were 20 occasions of clockwise rotation and 3 of anti-clockwise rotation at Cape Evans when the elements at Cape Denison were in phase, and there were 6 occasions of clockwise rotation at Cape Denison when elements at Cape Evans were in phase. There were 3 occasions when rotation was clockwise at Cape Evans while anti-clockwise at Cape Denison but no occasion of the converse. The occasions on which a decision was reached as to the agreement or otherwise of the phase with two pairs of elements at both stations were fewer than the occasions when no decision was reached at either station.

§ 14.—DISTURBANCES OTHER THAN BAYS.

Table LXXXII contains further particulars of corresponding ranges at Cape Denison and Cape Evans. They refer either to individual oscillations of shorter period than those usually regarded as bay disturbances, or else to intervals when there was a succession of short period perturbations difficult to sift out. In some cases of successive oscillations, including October 2 and November 5, the oscillations appeared distinct units, the correspondence of which at the two stations could hardly be doubted. But whether the movements were exactly synchronous with synchronous turning points, it is impossible to say owing to the time uncertainties already. The great majority of the occasions fall into the third period 15h. to 7h. of Tables LXXX and LXXXI.

TABLE LXXXII.

Short period Disturbances at Cape Denison and Cape Evans of a mainly oscillatory character.

Date.	Time.	D	H	Z	E¹	N¹	Z¹
	h m - h m	γ	γ	γ	γ	γ	γ
April 8–9	23 58 to 0 20	102	122	112	85	50	48
,, 13	23 0 23 15	44	58	54	39	35	24
May 29	Near 4 0	26	54	36	9	14	4
July 12	3 0 to 4 0	...	47	45	25	16	8
August 3	0 30 1 30	103	111	109	50	46	14
	23 30 24 0	38	89	59	32	18	17
,, 4	2 20 2 40	59	38	31	32	14	9
,, 8	4 0 22 10	56	61	36	32	41	21
,, 11	4 30 5 30	40	65	51	43	14	15
,, 16	0 0 0 30	41	26	35	21	31	17
September 6–7	23 50 0 10	90	81	105	36	41	10
,, 10	Near 5 50	34	27	21	32	14	10
	Near 6 45	51	20	18	39	19	13
,, 11	Near 13 30	6	8	7	17	14	7
	Near 14 50	7	9	9	27	34	14
,, 30	S.C. Near 21 40	40	94	81	96	55	57
October 2	Near 15 50	18	13	18	14	20	5
,, 3	Near 23 0	62	77	115	72	27	36
	Near 23 15	82	47	90	71	21	48
	Near 23 45	120	112	141	107	54	55
,, 7	Near 0 15	61	47	78	39	14	20
	Near 0 30	77	60	83	19	42	13
,, 8	Near 0 0	75	124	111	41	42	17
,, 13	Near 0 40	108	42	22	39	61	17
,, 15	Near 5 45	66	60	47	28	23	11
,, 16	Near 21 10	38	28	36	43	14	19
,, 17	13 25 to 13 50	16	10	9	46	33	25
,, 19	23 20 23 50	66	50	68	47	42	25
,, 20	0 40 1 0	39	57	83	32	27	14
	S.C. Near 17 25	12	8	8	28	30	12
	,, ,, ,,	5	27	19	26	48	24
,, 22	2 30 3 0	58	111	100	16	15	6
,, 24	Near 7 30	32	10	12	27	13	9
	Near 8 25	25	14	21	26	18	6
,, 28	0 10 to 0 30	103	51	56	54	44	28
November 5	Near 13 25	10	9	10	45	20	16
	Near 13 35	14	8	14	48	10	24
	Near 13 45	19	12	16	65	17	23
,, 8	Near 5 30	38	42	41	23	22	6
,, 9	22 0 to 22 30	96	87	89	116	69	67
,, 10	1 0 2 20	156	208	70	66	55	32
Means 41 complete disturbances.		53	54	53	43	30	21

As in Table LXXX the mean values of D and H are nearly equal. The mean value of Z though not as in Table LXXX larger than the mean values of D and H, is as large as before relative to the mean value of Z. While the disturbances are on the average considerably larger at Cape Denison than at Cape Evans—a phenomenon due possibly, at least in part, to the mode of selection—there are several cases, as for example the oscillations of September 11 and November 5, when the amplitude at Cape Evans is much the larger. There are even seven cases when the amplitude is greater in Z^1 than in Z.

There were numerous instances of a prominent oscillation of some minutes duration at one of the stations to which there was certainly no corresponding counterpart at all prominent at the other station. More than this it is impossible to say, owing to the almost continuous persistence of small oscillations.

CHAPTER III.—DISTURBANCE AT CAPE DENISON RELATED TO DISTURBANCE AT ESKDALEMUIR.

§15.—Records Available for Comparison.

After considering the relationships between simultaneous disturbances at the two Antarctic Stations interest is naturally stimulated to compare corresponding disturbances recorded at either of these stations and at some remote station. For this purpose Eskdalemuir has been selected chiefly because the actual magnetograms covering an extended period were readily available for first hand examination but also because previous investigations have shown that magnetic changes at Eskdalemuir are thoroughly representative of moderate latitudes. Indeed, Eskdalemuir was more highly disturbed than most stations providing autographic records at that time. It has the further merit of being entirely free from artificially produced disturbance.

Unfortunately the vertical force variometer at Eskdalemuir behaved unsatisfactorily in 1912—the Observatory was officially opened only the previous year—and the early part of 1913. Therefore no Z data are available until the end of March of that year. During April and the first half of June, vertical force records with a high degree of sensitiveness (0·82 γ and 0·91 γ per mm) were obtained, but their practical usefulness was still questionable till July 1. During December 1912 and the first half of January 1913 the H and Z records at Cape Denison were unsatisfactory. For such reasons, therefore, the comparison between disturbances at Cape Denison and Eskdalemuir has been limited to the $6\frac{1}{2}$ months from the middle of January to the end of July, 1913, and even for these months the magnitude of the vertical force changes at Eskdalemuir is specified only for July and on six isolated occasions in the early part of June.

§16.—Classification of Disturbances.

With disturbance, the rule rather than the exception in the Antarctic, the natural procedure to adopt in the comparison, was to compare Cape Denison with Eskdalemuir. All those occasions on which the Eskdalemuir curves showed prominent isolated perturbations with some individuality were therefore listed. Hours of beginning and ending were allotted so as to include only the main part of the movements; ranges, and directions of force change were measured and the essential features shortly described. With the majority of the disturbances of the bay type, but not necessarily of the bay simplicity of form the most frequent durations were one and two hours. In cases of sharp, shorter period oscillations of sudden commencement type the duration was estimated to a minute *quam proxime.* The simultaneous events as registered at Cape Denison were then examined for the time intervals specified for the Eskdalemuir disturbance.

A comprehensive table was prepared summarising the results from the two stations. It contained details of 156 disturbances in 144 of which the force changes were of a slow nature with average duration about $1\frac{1}{2}$ hours. The remaining dozen comprised five sudden commencements, four suspected sudden commencements and three sharp oscillations which were definitely not sudden commencements.

On the basis of the nature of the changes in the horizontal components of the disturbance field at Eskdalemuir each tabulated disturbance was allotted to one of five classes according as the force changes appeared to be :—

1. Simple and regular both in N and W.
2. Simple and regular either in N or W, the simultaneous perturbations in one of these being irregular, indefinite or small.
3. Multiple but regular in one or both of N. or W.
4. Of a sharp oscillatory character, including sudden commencements.
5. Conformable to no obvious type, miscellaneous.

These separate classes of disturbances are given in Tables LXXXIII to XCV, which, but for the additional descriptive notes on each disturbance, together contain all the information of the parent table. The table heading indicates the class of disturbance referred to; so that Tables LXXXIII to LXXXIV relate to movements which in the horizontal components are, as *e.g.*, in Table LXXXIII, fairly simple and regular and so can be described as NS, EW (implying that the increases in vector components were, in the first place, directed towards the north and towards the east, followed, in the second place, by increases in the reverse directions) or as in Table LXXXIV, NS, WE in which the changes in the meridian vector component were in the same order while those across the meridian were reversed and finally for Tables LXXXV and LXXXVI, SN, EW and SN, WE. The other headings are similarly self-explanatory. All refer to the appearance of the disturbance as recorded at Eskdalemuir.

In all the tables LXXXIII to XCV the direction of change in the remaining component(s) at Eskdalemuir not used in specifying the group type is given in the column(s) immediately following the hours of duration of such disturbance; then follows an abbreviated summary of the nature and directions of change of the three components at Cape Denison between the times specified in the second column, and finally, three columns each Eskdalemuir and Cape Denison giving the extreme ranges of the elements in the interval. Changes in declination at Cape Denison are expressed in terms of their equivalent disturbing force.

It is to be noted that in some cases no pronounced movement in one direction has been discernible at one station or the other. The letters m ≡ mainly and r ≡ rather tabulated against the algebraic signs + ≡ rising and — ≡ falling relate to these doubtfully directed movements. As in previous chapters oscillatory is abbreviated to osc. and the significance of + for vertical force changes at Cape Denison is the same as that for stations in northern latitudes, namely, an increased pull on the north-seeking pole of the magnet, this being equivalent to a *numerical decrease* of the vertical field in the Antarctic.

TABLE LXXXIII.

Characteristics of Simultaneous Disturbance at Eskdalemuir and Cape Denison.

(*a*) Type NS, EW at Eskdalemuir.

Date.	Hour.		Esk. Z	Nature of Changes at Cape Denison.			Component Ranges.					
							Eskdalemuir.			Cape Denison.		
	From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Jan. 18 ...	20	23½		WEm	— +	— +	71	125		216	210	136
„ 19 ...	19·5	21½		WE	— +	— +	26	23		93	107	88
„ 20 ...	20	24		WEr	irreg.	irreg.	39	40		214	246	143
„ 25 ...	20	22		EW	+ —	— + —	63	26		110	64	92
Feb. 15 ...	18	21		irreg.	irreg.	irreg.	50	53		74	58	82
„ 17 ...	19	21		irreg.	irreg.	irreg.	49	40		64	50	92
„ 26 ...	20	22		WE	— +	— + m	43	37		52	48	68
Mar. 17 ...	18	22		WE	irreg.	irreg.	62	71		49	76	139
„ 31 ...	22	24		irreg.	irreg.	irreg.	38	63		76	61	57
April 1 ...	19	22	tr.	WE	irreg.	irreg.	31	38	4	37	63	41
„ 10 ...	16	18	+ —	WE	— +	— +	67	49	8	28	47	41
„ 24 ...	20	22	tr.	WE	— +	— +	26	26	4	32	43	52
June 4 ...	20	22		WE	— +	— +	42	31		30	33	52
„ 28 ...	21	24	tr.	WEm	— +	— +	44	59		53	85	52
July 14 ...	0	1	—	irreg. OSC	irreg.	irreg.	44	28	10	34	45	23

TABLE LXXXIV.

(*b*) Type NS, WE at Eskdalemuir.

Date.	Hour.		Esk. Z.	Nature of Changes at Cape Denison.			Component Ranges.					
							Eskdalemuir.			Cape Denison.		
	From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Feb. 25-26 ...	22	2		EWm	+ —	irreg.	56	40		207	122	88
April 10 ...	0	4	+ — +	irreg.	irreg.	irreg.	61	73	28	69	107	98
„ 27 ...	13	14	OSC	EW	+ —	+ —	34	22		32	30	38
June 30 ...	16	18	tr.	irreg.	irreg.	irreg.	19	12		9	23	29
„ 30 ...	20	22	tr.	WE	— + — +	— + — +	25	20		20	45	21
July 25 ...	16	17	+	irreg.	irreg.	irreg.	35	19	6	12	16	16

TABLE LXXXV.

(*c*) Type SN, EW at Eskdalemuir.

Date.		Hour.		Esk. Z.	Nature of Changes at Cape Denison.			Component Ranges.					
								Eskdalemuir.			Cape Denison.		
		From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Feb.	9 ...	15	18		WEWE	+ —	+ —	30	19		69	49	99
,,	13 ...	18	20		WE	+ r	— + r	50	54		27	74	82
,,	14 ...	12	16		WEWE	+ — m	+ — m	96	92		236	163	272
Mar.	16 ...	16	20		WEW	+ — + m	— + —	77	61		121	168	269
April	3 ...	1	3	— + — +	WEWE	+ —	irreg.	17	18	6	60	54	46
,,	12 ...	22	24	— +	WE	— r	— r	75	84	49	44	84	82
,,	15–16 ...	21	1	— +	WE m	— +	— + —	50	62	38	69	137	84
,,	16 ...	14	15	+ —	WE	— + r	— +	43	19	4	32	42	27
May	5 ...	22	24	—	EW	— m	— m	54	54	76	115	116	112
,,	6 ...	3	5½	— +	irreg.	— +	— +	43	24	13	76	36	98
,,	6 ...	20	22	+ —	WE	— +	— +	42	74	10	94	112	117
,,	15 ...	16	18	+	irreg.	irreg.	irreg.	28	18	5	14	12	13
,,	24 ...	19½	21	tr.	WE	— + —	— + —	25	24	3	17	40	26
,,	29 ...	20	22	tr.	WE	— r	— +	29	21	3	35	37	44
June	2 ...	0	2	—	EWE	— +	— +	130	54	62	116	61	101
,,	2 ...	2	4	+	irreg.	irreg.	irreg.	57	35	31	61	55	57
,,	3 ...	6½	9		EW	— +	— +	34	27		82	58	57
,,	15 ...	12	14	+	EW	tr.	irreg.	29	11	9	10	36	26
,,	21 ...	13½	15		EW	+ —	+ OSC	25	10		122	28	69
,,	21 ...	17⅓	19⅓		WE	— +	+	33	18		35	68	45
,,	23 ...	11½	13½		EW	irreg.	+ —	27	22		15	43	37
July	1 ...	19	20		WE m	— +	— +	28	27		24	46	26
,,	12 ...	16	18	+	W m	irreg.	irreg.	50	31	8	20	34	21
,,	12 ...	18	20	+ —	EW	irreg.	irreg.	64	55	7	18	45	18
,,	21 ...	4	6	+ —	E m	irreg.	irreg.	26	20	7	30	34	39
,,	25 ...	5	7	+ —	WEWE	+ — + —	+ — + —	18	24	5	33	33	42
,,	25 ...	7	9	—	E m	— m	irreg.	34	37	9	27	29	16
,,	29 ...	4	6	+ —	irreg.	irreg.	irreg.	22	20	4	33	31	39

TABLE LXXXVI.

(*d*) Type SN, WE at Eskdalemuir.

Date.		Hour.		Esk. Z.	Nature of Changes at Cape Denison.			Component Ranges.					
								Eskdalemuir.			Cape Denison.		
		From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Mar.	7 ...	2	4		OSC	+ —	— r	26	48		49	41	78
,,	21 ...	4	6		E m	irreg.	irreg.	36	40		52	76	54
,,	30 ...	2	5		WEWE	— + m	— + m	52	34		197	148	153
April	1 ...	2	5	+ —	WE m	— + m	— + m	24	33	11	94	82	125
,,	23 ...	5	7	— +	WEW	— +	— +	19	28	11	35	31	41
May	5 ...	2	4	—	WE	— +	— +	59	78	60	127	71	82
,,	13 ...	3	5	— +	E m	— +	— +	18	27	7	39	23	46
,,	21 ...	2	4	tr.	irreg.	irreg.	irreg.	12	16	3	37	41	39
June	1 ...	20	22	—	WEWE	— r	— r	48	66	35	68	86	65
July	13 ...	3	5	— +	irreg.	irreg.	irreg.	18	30	9	37	50	48

TABLE LXXXVII.

(*e*) Type NS and irregular or trifling in W or waves at Eskdalemuir.

Date.	Hour.		Esk. Z	Nature of Changes at Cape Denison.			Component Ranges.					
							Eskdalemuir.			Cape Denison.		
	From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Jan. 18–19 ...	23½	2		irreg.	irreg.	irreg.	104	40		263	236	211
Feb. 10 ...	23	24		WE	— +	irreg.	35	11		25	28	27
Mar. 11–12 ...	22	1		WE r	— +	— +	30	53		118	114	190
„ 14 ...	20	24		WEW	— + — +	— + — +	77	70		64	138	150
„ 24 ...	0	2		EWEW	— m	irreg.	38	27		125	95	68
„ 30 ...	21	23		WE m	— + —	— +	54	30		69	81	93
April 4–5 ...	23	2	— +	WE m	—	—	34	28	13	113	68	87
„ 14 ...	17	18	tr.	WE	tr.	tr.	35	16	3	12	23	11
„ 28 ...	22	23½	—	irreg.	irreg.	irreg.	19	14	5	18	17	21
May 9 ...	22	24	—	WE m	— +	—	28	13	16	39	45	35
„ 12 ...	17	18		WE	tr.	+ — +	18	11	2	6	10	10
„ 29 ...	14	16	+	WE	— +	+ —	27	9	12	97	69	60
July 12 ...	12	14	+	EW	— +	— +	48	18	13	84	106	114
„ 14 ...	18	20	— +	WE	irreg.	irreg.	44	19	9	24	33	26
„ 20 ...	12	14	+	WEW	+ m	+ m	37	33	21	62	33	60
„ 20 ...	14	16	+	W m	+ — m	+ —	45	19	21	31	36	31
„ 23 ...	1	3	— +	irreg.	irreg.	irreg.	18	33	8	21	31	23
Mar. 14 ...	4	8		irreg.	irreg.	irreg.	50	44		113	120	136

TABLE LXXXVIII.

(*f*) Type SN at Eskdalemuir.

Date.	Hour.		Nature of Changes at—					Component Ranges.					
			Eskdalemuir.		Cape Denison.			Eskdalemuir.			Cape Denison.		
	From.	To.	W	Z	D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Jan. 30	7	9	OSC		E m	irreg.	irreg.	74	47		54	139	116
Feb. 26	9	12	tr.		EW	— + r	— + r	50	28		71	91	34
Mar. 8	20	24	EWEW		irreg.	irreg.	irreg.	43	49		113	101	126
„ 15	11	13	irreg.		EW m	+ — +	+ —	56	28		135	137	167
April 10	9	11	tr.	+ —	EW m	OSC	+ —	31	17	5	67	145	117
„ 12	14	16	irreg.	+	WEWE	+ — + —	+ — + —	54	33	21	48	97	60
May 7	1	3	EWE	— +	WE m	— + m	— + m	69	54	41	83	120	125
„ 27	13	15	OSC	+	EW	+ — +	+ —	34	26	9	60	83	76
„ 28	9	13	irreg.	— +	EW	— + r	irreg.	50	53	18	37	39	46
June 26	13	15	tr.		EWEW	— +	+ —	35	14		93	71	95
„ 27	17½	18¾	tr.		irreg.	irreg.	irreg.	18	8		13	10	11
July 15	16	18	irreg.	+	W m	irreg.	irreg.	52	28	19	23	51	43

TABLE LXXXIX.

(*g*) Type EW at Eskdalemuir.

Date.	Hour.		Nature of Changes at—					Component Ranges.					
			Eskdalemuir.		Cape Denison.			Eskdalemuir.			Cape Denison.		
	From.	To.	W	Z	D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Feb. 12-13	22	2	NSNSNS		irreg.	irreg.	irreg.	49	35		167	112	163
Mar. 21	18	20	tr.		WE	+ m	— +	17	46		42	48	61
April 12	18	20	SNS m	+ —	WE	irreg.	— +	58	89	14	32	81	71
July 21	2	4	NSN	— +	WE m	irreg.	+ —	23	34	7	38	53	42
„ 31	½	2½	NSNS	— +	irreg.	irreg.	irreg.	19	24	3	31	31	26

TABLE XC.

(*h*) Type WE at Eskdalemuir.

Date.	Hour.		Nature of Changes at—					Component Ranges.					
			Eskdalemuir.		Cape Denison.			Eskdalemuir.			Cape Denison.		
	From.	To.	N	Z	D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Feb. 1	0	2	SNS		WE	irreg.	+ —	28	39		47	102	78
April 28	1	4	tr.	OSC	WE m	— + m	— + m	25	40		104	82	54
May 7	22	24	irreg.	—	irreg.	irreg.	irreg.	24	43	24	97	91	95
June 29	3	6	SNS	— +	WE	— +	— +	35	55		88	27	83

TABLE XCI.

(*i*) Type NS, NS; EW, EW at Eskdalemuir.

Date.	Hour.		Esk. Z	Nature of Changes at Cape Denison.			Component Ranges.					
							Eskdalemuir.			Cape Denison.		
	From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Mar. 15 ...	19	21		EW m	+ — m	+ — m	52	44		44	59	95
„ 17 ...	0	4		WE m	— + m	— + m	68	56		138	150	119
April 16 ...	20	23		WE m	— + m	— + m	52	54		32	40	44

TABLE XCII.

(*j*) Type SN, SN; EW, EW at Eskdalemuir.

Date.	Hour.		Esk. Z	Nature of Changes at Cape Denison.			Component Ranges.					
							Eskdalemuir.			Cape Denison.		
	From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Mar. 23 ...	14	16		WEWE	+ m	+ m	66	53		69	68	133
June 9 ...	22	24		W m	— m	— m	20	29		45	44	41
„ 13 ...	20	22	tr.	irreg.	irreg.	irreg.	20	12	3	25	20	25

TABLE XCIII.

Horizontal components at Eskdalemuir; irregular including oscillatory.

Date.	Hour.		Esk. Z	Nature of Changes at Cape Denison.			Component Ranges.					
							Eskdalemuir.			Cape Denison.		
	From.	To.		D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Feb. 14 ...	9	12		irreg.	irreg.	irreg.	90	33		76	87	126
Mar. 14 ...	8	12		irreg.	irreg.	irreg.	49	39		61	77	75
„ 14 ...	12	16		irreg.	irreg.	+ — m	72	72		335	133	371
„ 14 ...	16	20		irreg.	irreg.	+ — + —	35	62		52	73	119
„ 21 ...	12	14		E m	+	+	37	31		49	57	85
April 4 ...	16	18	+	WE	irreg.	irreg.	37	28	8	28	59	41
„ 9 ...	16	20		WE m	irreg.	—	122	163		101	153	278
„ 9 ...	20	24	— +	WE m	+ — + — +	+ — + —	84	91	84	129	97	125
„ 17 ...	22	24	—	WEWE	irreg.	irreg.	43	54	29	37	63	60
„ 27 ...	18	22		WE m	— +	— +	42	36		39	79	65
May 4 ...	8	10	—	EW m	— +	— +	44	41	7	37	48	25
„ 7 ...	18½	20½	irreg.	irreg.	irreg.	irreg.	37	35	7	44	37	41
„ 13 ...	16	18	+	irreg.	+ r	+ r	29	14	4	14	9	8
„ 18 ...	14	16	+	irreg.	irreg.	irreg.	34	20	13	8	10	11
June 1 ...	6	8	+ —	irreg.	— r	irreg.	44	55	5	41	43	27
„ 2 ...	20	23		WE	irreg.	irreg.	45	24		50	54	54
„ 29 ...	14	16	tr.	irreg.	irreg.	irreg.	26	13		10	17	16
„ 29 ...	16	18	+	irreg.	irreg.	irreg.	37	16		14	25	16
„ 29 ...	22	24	tr.	E r	irreg.	irreg.	22	11		24	33	18
July 1 ...	13	14		WEWE m	—	— + —	27	12		38	24	52
„ 10 ...	16	18	+	WE m	— m	?	40	18	10	18	21	
„ 12 ...	20	22	—	WEW	— + r	+ — r	46	19	13	46	98	73
„ 15 ...	12	14	+	WE m	irreg.	irreg.	35	19	9	18	36	21
„ 20 ...	16	18	+	WEWE	+ —	+ —	32	49	18	46	42	65
„ 24 ...	15	17	+	WE	+ —	+ —	39	11	14	27	26	29
„ 25 ...	14	15	+	W m	irreg.	irreg.	27	16	9	20	35	26
„ 25 ...	18	19	tr.	EW	+ —	+ —	19	13	2	35	42	42

TABLE XCIV.

Sharp oscillations including SC, S.

Date.	Time.	Nature of Changes at—						Component Ranges.						Description.
		Eskdalemuir.			Cape Denison.			Eskdalemuir.			Cape Denison.			
		N	W	Z	D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ	
	h. m.													
Jan. 29	23 25	N	W		EW	— +	— +	10	7		44	45	54	SC.
Feb. 14	5 21	N	W		EW	+ —	+ —	4	9		49	12	41	SC. ?
„ 26	3 17	N	W		EW	— +	— +	17	21		75	114	27	SC.
Mar. 8	23 32	N			EW	— +	— +	19	0		71	50	90	SC. ?
„ 11	14 16	NS	WE		EW	+ —	+ —	24	18		4	3	6	Oscillation not SC.
„ 11	16 0	NS	WE		EW	+ —	+ —	26	18		3	5	5	Oscillation not SC.
„ 11	17 33	N	W		WE	— +	— +	18	8		6	7	10	Sharp oscillation not SC.
„ 14	4 28	N	W		EW ?	— +	— +	23	26		52	45	37	SC.
April 8	19 52	N	W	—	EW	— +	— +	41	15	3	28	19	22	SC.
May 23	23 8	NS	WE	— +	EW	— +	— +	10	9	1	13	5	7	SC. ?
June 23	22 28	N	W		EW	— +	— +	26	9		47	15	29	SC.
July 20	6 30	?	WE		WE	+ —	— + ?	2	8	0	26	41	10	SC. ?

TABLE XCV.

Miscellaneous Disturbances at Eskdalemuir.

Date.		Hour.		Nature of changes at—						Component Ranges at—					
				Eskdalemuir.			Cape Denison.			Eskdalemuir.			Cape Denison.		
		From.	To.	N	W	Z	D	H	Z	ΔN	ΔW	ΔZ	ΔH	ΔD	ΔZ
Jan.	19–20	21½	0¼	SNS	irreg.		irreg.	irreg.	irreg.	50	33		121	114	105
Feb.	15	0	4	NSNS	WEW		OSC	OSC	OSC	57	68		243	193	299
Mar.	15–16	23	2	SNS	WEW		irreg.	irreg.	irreg.	35	54		130	198	129
,,	16	20	24	irreg.	EWEWm		irreg.	irreg.	irreg.	39	92		101	103	150
,,	23	0	2	NSN	EWEm		Em	—+—	irreg.	37	49		96	104	54
April	9	12	16	NSNSNS	W	+	irreg.	irreg.	irreg.	94	84	59	317	170	343
May	4	16	19	NSNS	WEWE	+	WEWm	+—	+	96	60	35	55	111	123
,,	25	2	4	NS	Em	—+	WE	—+	—+—	14	31	8	39	41	74
June	19	18	20	SNSNSN	?		Wm	irreg.	—	42	22		15	19	24
July	12	14	16	Nm	irreg.	+	Wm	+m	—m	87	29	9	84	54	101
,,	13	16	18	SNSN	irreg.	+	Wr	irreg.	—+	45	22	10	22	59	60
,,	20	10½	12	S	tr.	—	EW	—	+r	44	12	8	41	76	36
,,	25	10	11	NSN	irreg.	irreg.	irreg.	+m	+—	45	18	4	23	40	44

§17.—Relative Directions of the Corresponding Movements in Simpler Bay Disturbances.

Tables LXXXIII to LXXXVI together give the chief available characteristics of 59 disturbances in which the changes in both horizontal components at Eskdalemuir were fairly regular and for the most part consisted of an increase or decrease followed by a decrease or increase in the normal field strength. They were therefore most purely of the simple bay type. Table LXXXV relating to the most frequently occurring class of bay at Eskdalemuir in which the superposed field during the first phase was directed to decreasing both the north and west components of the normal field, shows that in only a quarter of the cases selected were the changes in H at Cape Denison directed similarly to those at Eskdalemuir in both phases of the movement and another six showed the initial fall only. On four occasions the direction of change of the meridian field at Cape Denison was opposed to that at Eskdalemuir. Again, corresponding with the 28 EW movements at Eskdalemuir only six were similarly directed at Cape Denison in both phases; nine of the 28 at Cape Denison were mainly opposite to those at Eskdalemuir in both phases, and another six had either the first movement to W or consisted of a series of movements directed WE, WE. Want of information about the vertical component at Eskdalemuir does not allow comparison of the field changes in that direction.

These features of the class of disturbance SN, EW at Eskdalemuir as given in Table LXXXV as summarised in the third line of Table XCVI. This latter table presents the results of a similar analysis of the changes at Cape Denison corresponding with the simpler changes in the horizontal components at Eskdalemuir as compiled in Tables LXXXIII to XC. Movements at Cape Denison characterised as trifling (tr.) or very small, or again, as irregular and oscillatory with no specified direction in these constituent tables are naturally excluded from the analysis. An entry in the column headed NS means that corresponding with the Eskdalemuir changes in the first column, the change of force component along the meridian at Cape Denison has mainly been as an increase to the north and a subsequent decrease. If the corresponding change at Cape Denison was multiple such as NSN but with the first movement directed northwards followed by a relaxation towards the original position, or again, if the changes have been just perceptible though with a net northward trend, or even simply a movement northward without apparent return within the specified interval, the column headed NS (partly) or N has been credited. A similar procedure has been adopted for the other directions.

TABLE XCVI.

Direction changes of disturbing force at Cape Denison corresponding with changes in selected disturbances at Eskdalemuir.

Changes at Eskdalemuir.	No.	Nature of changes at Cape Denison.							
		Along meridian.				Across meridian.			
		NS	NS partly NN	SN	SN partly NS	EW	EW partly or E	WE	WE partly NW
NS,EW	15	1		6	1	1		10	
NS,WE	6	2			1	2		1	
SN,EW	28	4	3	7	6	6	3	9	6
SN,WE	10	1		5	1		2	2	3
NS	18	1	1	5	4	1	1	8	4
SN	12		3	2	2	5	2	1	2
EW	5		1					3	
WE	4			2				3	

Summarising the somewhat indefinite results from this secondary analysis it turns out that :—

1. In 39 (= 15 + 6 + 18) occurrences of an NS movement at Eskdalemuir, the number of cases of movement wholly or partly NS or simply N at Cape Denison was 5 and in the opposite direction 17.
2. In 50 (= 28 + 10 + 12) occurrences of SN at Eskdalemuir there were 23 of SN or simply S at Cape Denison and 11 simultaneously directed NS.
3. In 48 cases of EW at Eskdalemuir, 10 were EW wholly or partly or simply E at Cape Denison and 28 in the opposite direction; and
4. In 20 cases of WE at Eskdalemuir, 4 were EW wholly or partly or simply E at Cape Denison and 9 were in the opposite direction.

From such results the only justifiable conclusions are :—

1. Whether the disturbing vector directed northward at Eskdalemuir tends to a decrease or an increase of the normal quiet field, the tendency at Cape Denison is for the south force to increase; and
2. With somewhat greater validity, disturbance in which the component directed eastward is most strongly developed in the first phase at Eskdalemuir tends to be associated with an oppositely directed disturbing field at Cape Denison.

§18.—Intensity of the Disturbance Vector Components in the More Regular Movements.

Mean ranges $\overline{\Delta N}$, $\overline{\Delta W}$ for the horizontal components at Eskdalemuir and $\overline{\Delta H}$, $\overline{\Delta D}$ and $\overline{\Delta Z}$ for the three components at Cape Denison for each of the groups of disturbance are collected in Table XCVII. The table also gives a weighted mean for 131 disturbances assigned to one or other of the specific classes of relatively longer period and a further general mean got by taking in the results the group 'miscellaneous.' The final lines of the table show the ranges from the two groups, first, of twelve sharp oscillations including the possible sudden commencements and, second, these last alone.

TABLE XCVII.

Mean ranges of Components of disturbing force at Eskdalemuir and Cape Denison during simultaneous disturbances.

Type of Change at Eskdalemuir.	No.	Eskdalemuir.			Cape Denison.				$\Delta N^2 + \Delta W^2$. / $\Delta H^2 + \Delta D^2$ as percentage.
		ΔN	ΔW	$\Delta N^2 + \Delta W^2$.	ΔH	ΔD	ΔZ	$\Delta H^2 + \Delta D^2$.	
NS, EW	15	46	47	4325	77	82	77	12653	34
NS, WE	6	38	31	2405	58	57	48	6613	36
SN, EW	28	44	36	3232	58	62	70	7208	45
SN, WE	10	31	40	2561	73	65	73	9554	27
NS and irregular or very small in EW or WE	18	41	27	2410	71	71	75	10082	24
SN and irregular or very small in EW or WE	12	47	32	3233	66	90	85	12456	26
EW and irregular or very small in NS or SN	5	33	46	3205	62	65	73	8069	40
WE and irregular or very small in NS or SN	4	28	44	2720	84	75	77	12681	21
NSNS, EWEW	3	57	51	5850	71	83	66	11930	49
SNSN, EWEW	3	35	31	2186	46	44	66	4052	54
Irregular and oscillatory	27	44	37	3305	52	55	72	5729	58
Mean of classified (slower) movements ...	131	42	37	3133	64	67	73	8585	36
Miscellaneous	13	52	44	4640	99	99	119	19602	24
Mean of all slower movements	144	43	38	3293	67	70	77	9389	35
Sharp oscillations including S.C.'s	12	18	12	468	35	30	28	2125	22
Possible S.C.'s alone	9	17	11	410	45	38	35	3469	12

Although the omission of vertical data for Eskdalemuir detracts from the usefulness of the table, the relative variations of intensity as between the horizontal components at the two stations separately in each of the classes of disturbances and the relative intensities as between the two stations are not without interest.

Over the 144 movements which comprise Tables LXXXIII to XCIII, the average N range at Eskdalemuir is 64% of the H range at Cape Denison and $\overline{\Delta W}$ is 54% of ΔD expressed in force units. But in individual classes the relative intensities of the corresponding components of the disturbing vectors at the two stations may be as high as 85% as in the case of N and H in the class of 27 irregular and oscillatory movements or as low as 33% for the ratio of the same components in the class described as WE at Eskdalemuir.

Variations in the relative intensity of the vector components at each station separately are naturally dependent on the class of disturbance. For example, while the expectation for all short slow period disturbances at Eskdalemuir is to have $\triangle N$ 13% greater than $\triangle W$, the excess of $\triangle N$ over $\triangle W$ is increased to 47% if the choice of the disturbance is that of Table LXXXVIII. On the other hand, $\triangle W$ at Eskdalemuir may be 33% greater than $\triangle N$ as in the class 'WE with irregularities in N.' In addition to these extreme cases which arise purely from the manner of selection, the intensity of the east-west component of disturbing force relative to that along the meridian departs seriously from the average only in the class of bay SN, WE. In this class $\triangle W$ exceeds $\triangle N$ by 29%. At Cape Denison the disturbing vector directed along the meridian is normally smaller than that transverse to it but in the class of bay disturbance SN, WE in which the customary relationship at Eskdalemuir is most affected, the relative intensities at Cape Denison are similarly affected.

Considering now the group of 12 sharp oscillations, $\triangle N$ exceeds $\triangle W$ by 50% at Eskdalemuir and $\triangle H$ exceeds $\triangle D$ (always expressed in force units) at Cape Denison by 17%. At the same time $\triangle N$ is only 51% of $\triangle H$ and $\triangle W$ 40% of $\triangle D$. If the possible sudden commencements alone are considered these last percentages are reduced to 38% and 31% respectively.

A better basis of comparison for the activity of the disturbing forces in the horizontal plane at the two stations is afforded by the data of those last three columns of Table XCVII, which give the sums of the squared ranges $\triangle N^2 + \triangle W^2$ and $\triangle H^2 + \triangle D^2$ and the ratios of these sums for each class of disturbance. If the squared ranges are taken as representative measures, the activity at Eskdalemuir for all slower movements is on the average only a little over one third of that at Cape Denison, but may be as high as 58% in irregular and oscillatory movements or as low as 21% when the basis of comparison has been a bay movement at Eskdalemuir with the principal disturbing component in the first phase directed westward. A feature of interest is the value of the ratio for the square of the resultant vector in the horizontal plane at Eskdalemuir to that at Cape Denison. The value, 45%, is higher than for any other of the first eight disturbance types of the table in which the force changes at Eskdalemuir approach regularity in at least one component. At the bottom of the list, the intensities of the forces in the disturbances described as possible sudden commencements at Eskdalemuir are seen to be very diminutive images of their Antarctic counterparts.

§19.—Variations in Relative Disturbance Intensity at Cape Denison and Eskdalemuir With Time of Day.

A further analysis of the parent table from which Tables LXXXIII to XCIV were derived was directed to an examination of the question whether disturbances occurring within particular intervals of the day at Eskdalemuir were more closely associated with corresponding disturbances in the Antarctic than at other times; and, further, what influence the time of occurrence had on the intensity of the components of the disturbing force along the three mutually perpendicular directions. The procedure was to divide the day into six intervals 0h. to 4h., 4h. to 8h.,——— 20h. to 24h. and form groups of those disturbances in the primary (unpublished) table which occurred wholly within one or other of the subdivisions of the day. Since the fewest disturbances had been noted as occurring in the Greenwich morning and forenoon intervals they were eventually combined into one group covering the period of 8 hours from 4h. to 12h. Even this combined class contained only 17 disturbances. Altogether 116 of the primary list of disturbances were classified, the remainder occurring partly in one, partly in the next interval were omitted. The mean ranges for the two horizontal components at Eskdalemuir and the three components △H, △D and △Z at Cape Denison for each of the five day-divisions are given in Table XCIX. The second column of the table contains the number of disturbances contributing to each set of means.

TABLE XCVIII.

Variation of average components of disturbing force with time of occurrence.

Disturbances Wholly Between—	No.	Eskdalemuir.			Cape Denison.				$\frac{\triangle N^2 + \triangle W^2}{\triangle H^2 + \triangle D^2}$.
		△N	△W	$\triangle N^2 + \triangle W^2$.	△H	△D	△Z	$\triangle H^2 + \triangle D^2$	
0h. and 4h....	19	42	42	3528	80	78	78	12484	28
4h. and 12h....	17	42	31	2725	52	68	60	7328	37
12h. and 16h....	22	46	30	3016	84	64	95	11152	27
16h. and 20h....	28	44	37	3305	31	50	58	3461	95
20h. and 24h....	30	43	45	3874	69	77	74	10690	36
12h. and 16h.‡.	18	40	22	2084	47	50	57	4709	44

‡ Omitting four days of largest △H.

Features in the Eskdalemuir results which attract attention are the comparative constancy of the △N means throughout the day and, by contrast, the variability of △W. For disturbances in the last four hours of the day △W is 50% than △W in disturbances occurring within four hours after noon. There is, therefore, a diurnal variation in the ratio of △N to △W, △N exceeding △W from 4h. to 20h. especially in the interval 4h. to 16h. but being approximately equalled from 20h. to 4h. Similar features at Cape Denison are not apparent from this analysis. The reversal of the customary excess of △D over △H during the first afternoon interval looks novel. In reality, however, it is explained by the circumstance that of the 22 disturbances contributing to the mean in the group occurring between 12h. and 16h., three had the outstandingly high ranges in H, 236γ, 335γ and 317γ and one of 122γ. If the disturbances with these components are eliminated from the group the means from the remaining 18 are as follows, the unit as usual being γ :—

△N	△W	△H	△D	△Z
40	22	47	50	57

Hence the usual feature of △D exceeding △H at Cape Denison is restored. As was also deducible from Table XCVII, the vertical component of the disturbing vector at Cape Denison is seen to be greater than either of the horizontal components. Table XCVIII now provides the further information that as compared with the horizontal components the prominence of Z in disturbances at Cape Denison is least from 0h. to 4h. and greatest from 12h. to 16h.

By examining the separate constituents of the tables for the five sub-divisions of the day and noting the frequency of occurrence with which $\triangle N$ exceeded $\triangle W$ or the reverse for the Eskdalemuir components and the number of occurrences of highest value of $\triangle H$, $\triangle D$ and $\triangle Z$ in each disturbance for Cape Denison Table XCIX was compiled. A half occurrence was attributed to each of two equal ranges. This analysis confirms in somewhat greater detail the conclusions already drawn from the consideration of the mean ranges of the separate groups.

TABLE XCIX.

Relative frequency of precedence of component ranges in groups of hours.

Interval.		No. of Occurrences.	No. of Days when—		No. of Days when—		
From.	To.		$\triangle N$ Greater.	$\triangle W$ Greater.	$\triangle H$ Greatest.	$\triangle D$ Greatest.	$\triangle Z$ Greatest.
h.	h.						
0	4	19	6	13	6½	8½	4
4	12	17	12	5	1	9	7
12	16	22	21½	½	3	8	11
16	20	28	22	6	2	13½	12½
20	24	30	15	15	6½	11½	12

Using squared ranges as basis, the final column of Table XCVIII shows the variation of activity of the disturbance vectors in the horizontal plane for the five intervals of the day. The period 16h. to 20h. stands out conspicuously as that part of the day when disturbance at Eskdalemuir approaches in intensity simultaneous disturbance at Cape Denison. If, as in the examination above for the group 12h. to 16h., the four days of largest $\triangle H$ at Cape Denison are excluded the values of $\triangle N^2 + \triangle W^2$ and $\triangle H^2 + \triangle D^2$ become $2084\gamma^2$ and $4709\gamma^2$ respectively with the ratio of Eskdalemuir to Cape Denison 44%. Accepting the value instead of 27% derived from all the 22 days, the conclusion is that, relative to Cape Denison, disturbance intensity at Eskdalemuir increases from 4h. to 20h. and then falls off to a minimum in the first four hours of the day.

At Cape Denison disturbance is a maximum about 11½h. L.M.T. (2h. G.M.T.), falls off to a principal minimum at 18h. L.M.T. (8½h. G.M.T.), has a rather feeble secondary maximum at 23h. L.M.T. (13½h. G.M.T.) and, after decreasing slightly at 2½h. L.M.T. (17h. G.M.T.), rises steadily again to the pre-midday maximum. Disturbance at Eskdalemuir, on the other hand, has a principal maximum at 21h. and a minimum at 10h. with no certain secondary developments. Hence the times of maximum and minimum values of the ratio disturbance intensity at Eskdalemuir. Disturbance intensity at Cape Denison using the 18 constituents from the interval 12h. to 16h. are at least partly accounted for by the combination of the two diurnal distributions with the added accidental factor of an unusually low development in disturbance at Cape Denison between 16h. and 20h. during the months examined.

CHAPTER IV.—TERM HOURS.

§20.—General Considerations: Co-operating Stations and Magnetic Character of Scheduled Hours.

Much interest attaches to a detailed comparison of simultaneous records of disturbance from a number of stations distributed over a wide range of latitude and longitude, especially, if, in the registration, arrangements have been made to ensure an open time scale for the purpose of accurate timing of corresponding movements. Unless special provision can also be made for a temporary increase of sensitivity in the magnetographs at the same time as the increase is made in the rotation period of the recording drum, identification of critical stages even in moderate disturbance is troublesome and estimates of such features as times of occurrence and lengths of ordinate at maximum and minimum values of the field are made uncertain through the flattening of the trace. Nevertheless, results from the 'term hours,' as such pre-arranged intervals are called, during which quick-run records are made, of the British Antarctic Expedition 1902–04 had been of sufficient value to prompt further trials in the British and Australian Expedition covering the years 1910–14.

It was unfortunate that the results of either of these expeditions could not have been examined before the list of term hours for the other were fixed. For though the choice in season was necessarily restricted by the arrangements of the expedition, a greater concentration of hours in those months which have now been seen to be more prolific in short period disturbances in the Antarctic could probably have been arranged. Further, with the knowledge that the diurnal incidence of this type of disturbance varies in a pronounced manner with the locality of the station relative to the magnetic pole, a slightly different distribution of the term hours throughout the day might have increased the expectancy of recording representative short period disturbances at both bases.

TABLE C.

Stations co-operating in the 1912-13 scheme of term hours.

Station.	φ	λ	Station.	φ	λ
	° ′	° ′		° ′	° ′
Stonyhurst	53 51N	2 28W	Melbourne	37 32S	145 28E
Eskdalemuir	55 19N	3 12W	Cape Denison	67 0S	140 40E
Pilar	31 41S	63 51W	Buitenzorg	6 35S	106 47E
Vieque	18 9N	65 26W	Toungoo	18 56N	96 27E
Cheltenham	38 44N	76 51W	Barrackpore	22 46N	88 22E
Agincourt	43 47N	79 16W	Dehra Dun	30 19N	78 3E
Tucson	32 15N	110 50W	Kodaikanal	10 14N	77 28E
Sitka	57 3N	135 20W	Helwan	29 52N	31 21E
Honolulu	21 19N	158 4W	De Bilt	52 6N	5 11E
Cape Evans	77 38S	166 24E	Val Joyeux	48 49N	2 1E

In addition to Cape Evans, the base station of the British Antarctic Expedition, which had already completed its own scheme of hours, 18 stations contributed to the schedule arranged in conjunction with the Australian base station at Cape Denison. Table C gives the list of stations from which data either in the form of quick-run records (copies or originals) copies of ordinary slow-run records or special eye observations were obtained. The next table (Table CI) gives details of the dates and Greenwich times of the selected hours together with the international character figure for each of the days and the character figure for the separate hours for which magnetograms from the Antarctic stations were available. In the expectation of a maximum frequency of short period disturbance in the early evening hours at Cape Denison one of the sets of term hours was fixed at 8h. to 10h. G.M.T., and in the further expectation of at least an average quota of disturbance in the early morning—as well as with a view to comparing the activities at the two periods of the day,—a second set was fixed at 17h. to 19h. G.M.T. Except for the addition of a pair of hours on January 2, 1913, these two sets were arranged, the early evening hours on one day in each month from March, 1912, to January, 1913 and the morning hours on the second day following.

TABLE CI.

Character figures for the selected term hours.

Date.	International Daily Character.	Hourly Character. 8 to 9h. C.D.	8 to 9h. C.E.	9 to 10th. C.D.	9 to 10th. C.E.	Date.	International Daily Character.	Hourly Character. 17 to 18h. C.D.	17 to 18h. C.E.	18 to 19h. C.D.	18 to 19h. C.E.
1912.						1912.					
March 19	0·0	...	...	...	...	March 21	0·9	...	1	...	2
April 16	1·0	2	2	2	2	April 18	0·6	1	1	2	2
May 14	1·0	2	2	1	1	May 16	0·1	1	1	1	1
June 11	0·6	1	1	2	1	June 13	0·1	0	0	0	0
July 16	0·5	2	2	1	1	July 18	0·2	0	0	1	0
August 13	0·0	0	0	0	0	August 15	0·4	0	0	0	0
September 10 ...	0·2	0	0	0	0	September 12 ...	0·6	0	1	1	1
October 8	0·3	1	1	2	1	October 10	0·4	1	1	0	1
November 5 ...	0·7	1	0	0	1	November 7 ...	0·1	0	1	0	2
December 3	0·7	1	...	1	...	December 5	0·0	1	...	1	...
1913.						1913.					
January 28	0·6	1	...	1	...	January 2	1·0	2	...	2	...
						January 30	1·3	1	...	2	...

The mean international character figure for all the 23 days in the list is 0·45, with the mean for the second set of 12 days containing the 17h. to 19h. periods slightly the higher of the two separate group means. There was no day for which magnetic records at both Antarctic stations are available with an international character figure exceeding 1·0, and the prevalence of 0's and 1's in the hourly characters sufficiently indicates that only slight or very moderate perturbations had characterised the majority of the hours in the Antarctic. In these circumstances the hope of being able to assign times and ranges to corresponding movements at stations distributed widely over the earth is much reduced, for locally developed perturbations, especially in higher latitudes, masks what might be truly general movements.

Much consideration has already been given to data furnished by the scheme of term hours arranged in connection with the station at Cape Evans, especially in regard to the estimation of magnetic activity within the hours. There was little likelihood that any considerable adjustments would be necessary to the deductions from that investigation from further information derived from the new material. Rather, since the average intensity of disturbance had rapidly decreased from 1911—the year to which the previous list of hours had been confined—to 1912, the uncertainties attaching to estimation of ordinates and times of singularity in quick-run traces would be exaggerated. For the more level the curve the greater are the probable errors arising from imperfect information about temperature coefficients and also the more troublesome it is to determine at which points the turning values are to be estimated.

§21.—Term Hour Ranges at 20 Stations.

Accepting the expressions adapted by Bidlingmaier from the fundamental integral of Maxwell for the energy in a magnetic field for the " activity " of the changing field of the earth's magnetism in quiet or disturbed times, it has been shown that the activity within a limited period can, with a fair degree of precision be expressed as a simple function of the range within the period. If the interval be 60 minutes and the approximate value $\Sigma\eta_n^2/n$ be taken for the true internal activity $\frac{1}{\tau}\int_{t=\tau-1}^{t=\tau}\eta^2 dt$ then $\Sigma\eta_n^2/n = CR^2$ is valid for a wide diversity of recording stations and for the range R encountered in the average hour. The value of the constant C has upper and lower limits 0·25 and 0 respectively but over a large variety of hours the average value approximates to 0·1. If the range is deduced from the values of the ordinates at the instants of maximum and minimum in the curve during the diving, *i.e.*, the extreme range, the constant is smaller than when derived from the relation by the use of the equidistant ordinates which have been used in forming the activity expression. The disparity between the values of the constant obtained in these two ways naturally increases with the intensity of the disturbance within the hour. For the individual hours in Table CI, however, a very fair estimate of the comparative activities would be obtained by squaring the extreme ranges measured within the hour at each of the recording stations. This is the object in providing Table CII.

For each of the 46 hours in the schedule the extreme ranges in the three components at the 20 stations are given when the information furnished was sufficient to allow an estimate to be assigned with confidence. In all stations except Eskdalemuir, Cape Evans and Buitenzorg the range in the column headed D is given both in minutes of arc and its equivalent in force units. At the three stations cited declination as such was not registered and the entry is really the range in the recorded force component oriented most nearly perpendicular to the meridian. It refers to W at Eskdalemuir, E′ at Cape Evans and Y (geographical east) at Buitenzorg.

TABLE CII.

Ranges during term hours at 20 Co-operating Stations.

Station.	March 19, 1912.								April 16, 1912.							
	8h. to 9h.				9h. to 10h.				8h. to 9h.				9h. to 10h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	2·0	10	11	...	4·5	23	6	...	1·6	8	29	...	1·5	7	18	...
Eskdalemuir	...	9	15	...	...	2	9	...	...	14	66	...	...	16	25	...
Pilar	0·6	5	2	1	0·3	2	3	...	0·9	7	21	3	0·3	2	11	3
Vieque	...	...	...	...	...	...	...	...	1·6	14	8	8	0·6	5	5	3
Cheltenham	...	...	...	...	...	...	...	...	6·4	37	11	13	2·1	12	7	11
Agincourt	0·4	2	1	...	0·3	1	3	...	17·3	81	26	...	4·0	19	14	...
Tucson	...	...	...	...	...	...	...	...	3·8	30	18	3	0·4	3	8	1
Sitka	...	...	...	...	...	...	...	...	10·6	48	49	103	9·2	41	45	70
Honolulu	...	...	...	...	...	...	...	...	0·8	7	20	6	0·2	2	8	2
Cape Evans	...	8	8	...	...	8	5	...	...	169	172	287	...	69	60	132
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	22	20	...	...	9	8	...	...	>187	>169	115	160	67	61	99	59
Buitenzorg	...	2	5	4	...	2	5	1	...	11	27	12	...	2	9	6
Toungoo	1·1	13	12	7	0·8	9	9	2	1·0	12	23	4	0·7	8	6	3
Barrackpore	1·1	12	9	...	1·5	17	9	...	0·9	10	19	9	0·8	9	9	5
Dehra Dun	0·7	7	4	2	1·6	16	4	8	1·3	13	26	11	0·7	7	9	4
Kodaikanal	1·0	11	30	12	0·6	7	28	10	0·7	8	31	12	0·3	3	5	9
Helwan	...	...	...	...	...	...	...	...	1·4	12	21	12	0·5	4	10	3
De Bilt...	0·3	2	15	...	2·2	12	4	...	3·0	16	41	...	4·8	25	19	...
Val Joyeux	0·5	3	18	...	1·5	8	4	...	2·6	15	36	...	2·5	15	14	...

Station.	May 14, 1912.								June 11, 1912.							
	8h. to 9h.				9h. to 10h.				8h. to 9h.				9h. to 10h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	1·5	7	11	...	1·1	6	8	...	1·6	8	5	...	3·0	15	5	...
Eskdalemuir	...	12	11	...	...	14	10	...	...	8	10	...	...	10	4	...
Pilar	0·3	2	15	1	1·0	7	3	0	...	...	...	...	...	...	...	...
Vieque	...	...	...	...	...	...	...	...	0·5	4	1	0	0·6	5	2	1
Cheltenham	2·2	13	10	7	0·5	3	4	9	1·0	6	2	1	1·0	6	3	1
Agincourt	5·2	25	13	...	1·9	9	5	...	2·6	12	5	...	2·4	11	4	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	8·1	37	15	18	2·7	12	12	2	3·7	17	8	6	2·3	11	7	2
Honolulu	0·5	4	3	2	0·2	2	6	2	0·3	3	2	3	0·3	3	1	1
Cape Evans	...	116	40	87	...	48	32	31	...	36	25	31	...	28	23	14
Melbourne	2·1	14	7	...	1·1	8	14	...	0·6	4	3	...	1·0	7	3	...
Cape Denison	72	65	58	34	25	23	42	15	2·2	20	16	86	15	14	22	94
Buitenzorg	...	4	11	2	...	9	7	2	...	5	9	11	...	13	4	9
Toungoo	0·5	6	6	1	0·3	3	3	0	0·4	5	9	2	0·3	3	16	2
Barrackpore	...	...	4	...	...	...	5	...	0·8	9	14	4	0·5	5	14	3
Dehra Dun	0·9	9	12	5	0·8	8	3	3	0·9	9	5	5	1·0	10	9	7
Kodaikanal	0·2	2	8	16	0·6	7	2	1	0·2	2	14	1	1·0	11	24	5
Helwan	1·1	10	20	6	1·0	9	8	3	1·1	10	10	...	1·5	13	7	...
De Bilt...	1·2	6	8	...	2·8	15	10	...	2·4	13	9	...	2·9	15	7	...
Val Joyeux	0·9	5	18	...	2·4	14	13	...	1·0	6	8	...	2·4	14	5	...

TABLE CII—*continued.*

Ranges during term hours at 20 Co-operating Stations.

Station.	July 16, 1912.								August 13, 1912.							
	8h. to 9h.				9h. to 10h.				8h. to 9h.				9h. to 10h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	0·7	3	16	...	0·5	2	7	...	0·9	5	6	...	1·2	6	2	...
Eskdalemuir	...	12	26	...	...	11	9	...	...	8	9	...	...	7	6	...
Pilar	0·9	7	10	1	0·9	7	3	1	0·1	1	3	1	0·4	3	2	1
Vieque	0·7	6	6	3	0·8	7	3	3	...	...	...	...	...	...	...	...
Cheltenham	1·0	6	12	...	1·4	8	5	...	...	...	...	...	...	...	...	...
Agincourt	0·9	4	14	...	4·0	19	9	...	1·3	6	2	...	1·8	8	1	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	5·5	25	8	...	2·2	10	12	...	...	...	...	...	...	...	...	...
Honolulu	0·4	3	3	1	0·6	5	8	1	...	...	...	...	...	...	...	...
Cape Evans	...	78	38	38	...	55	31	29	...	16	18	6	...	14	15	5
Melbourne	1·7	11	21	...	1·8	12	15	...	...	...	...	...	...	...	...	...
Cape Denison	70	64	47	31	30	27	40	8	12	11	13	...	11	10	11	...
Buitenzorg	...	5	5	...	...	11	7	...	...	2	14	...	...	2	3	...
Toungoo	0·9	10	6	16	0·9	10	4	1	0·8	9	6	5	0·3	3	6	1
Barrackpore	0·8	9	5	7	1·3	14	6	6	1·5	17	7	4	1·0	11	5	1
Dehra Dun	0·1	1	15	6	0·9	9	9	14	0·4	4	2	4	1·4	14	3	3
Kodaikanal	0	0	18	14	0·8	9	18	10	0	0	27	11	0·5	5	21	19
Helwan	0·9	8	19	6	0·5	4	17	3	...	...	...	...	...	...	...	...
De Bilt...	2·2	12	20	...	2·5	13	7	...	2·1	11	6	...	2·2	12	3	...
Val Joyeux	1·2	7	14	...	1·5	9	8	...	2·1	12	7	...	1·9	11	3	...

Station.	September 10, 1912.								October 8, 1912.							
	8h. to 9h.				9h. to 10h.				8h. to 9h.				9h. to 10h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	3·8	19	5	...	3·8	19	6	...	1·9	10	13	...	2·8	14	5	...
Eskdalemuir	...	9	9	...	...	11	10	...	...	13	13	...	...	10	15	...
Pilar	0·5	4	3	6	0·4	3	1	5	...	...	...	...	0·3	2	5	1
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	0·3	1	3	...	1·4	7	3	...	1·3	6	7	...	1·3	6	4	...
Tucson	...	...	...	...	...	...	...	...	0·9	7	5	0	1·0	8	2	0
Sitka	...	...	...	...	...	...	...	...	3·0	14	9	8	5·8	27	16	13
Honolulu	...	...	...	...	...	...	...	...	0·1	1	3	1	0·1	1	4	1
Cape Evans	...	10	7	4	...	17	10	6	...	29	38	9	...	23	23	4
Melbourne	...	...	...	...	...	...	...	...	1·8	12	6	...	2·4	16	14	...
Cape Denison	7	6	9	24	13	12	9	15	40	36	23	33	45	41	33	54
Buitenzorg	...	2	9	5	...	3	5	4	...	6	11	...	...	6	6	...
Toungoo	1·0	11	3	2	0·7	7	5	1	0·5	6	10	0	0·4	5	6	0
Barrackpore	1·2	13	6	1	0·7	8	7	0	1·0	11	10	4	0·8	9	8	0
Dehra Dun	1·1	11	5	4	1·1	11	5	1	0·8	8	8	5	1·1	11	9	1
Kodaikanal	1·0	11	12	0	0·1	1	12	0	0·4	4	24	5	0·3	3	23	10
Helwan	...	...	...	...	...	...	...	...	1·5	13	10	3	1·4	12	4	6
De Bilt...	2·5	13	7	...	2·3	12	9	...	1·7	9	13	...	3·9	21	6	...
Val Joyeux	1·9	11	3	...	3·1	18	6	...	0·8	5	13	...	2·5	14	5	...

TABLE CII—*continued.*

Ranges during term hours at 20 Co-operating Stations.

Station.	November 5, 1912.								December 3, 1912.							
	8h. to 9h.				9h. to 10h.				8h. to 9h.				9h. to 10h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eskdalemuir	...	3	8	...	...	5	4	...	...	4	7	...	...	5	10	...
Pilar	...	...	...	...	...	...	...	...	0·2	1	10	1	0·4	3	4	1
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	0·1	1	0	...	0·3	1	1	...	0·8	4	6	...	0·8	4	3	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Honolulu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Evans	...	9	12	17	...	20	13	12	...	...	...	...	...	...	...	...
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	19	17	9	15	8	7	15	13	33	30	...	...	44	40	...	29
Buitenzorg	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toungoo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Barrackpore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dehra Dun	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kodaikanal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Helwan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
De Bilt...	0·8	4	8	...	2·1	11	3	...	0·8	4	7	...	1·1	6	10	...
Val Joyeux	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Station.	December 31, 1912.								January 28, 1913.							
	8h. to 9h.				9h. to 10h.				8h. to 9h.				9h. to 10h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eskdalemuir	...	4	7	...	...	3	3	...	...	4	4	...	...	5	8	...
Pilar	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	0·5	2	1	...	0·6	3	4	...	1·7	8	2	...	1·3	6	2	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Honolulu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Evans	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	...	...	...	...	...	...	...	...	1·7	15	9	18	22	20	17	9
Buitenzorg	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toungoo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Barrackpore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dehra Dun	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kodaikanal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Helwan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
De Bilt...	0·2	1	12	...	1·6	8	2	...	1·0	5	5	...	1·1	6	4	...
Val Joyeux	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE CII—*continued.*

Ranges during term hours at 20 Co-operating Stations.

Station.	March 21, 1912.								April 18, 1912.							
	17h. to 18h.				18h. to 19h.				17h. to 18h.				18h. to 19h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	0·8	4	4	...	4·7	24	5	...	0·3	2	3	...	0·7	3	5	...
Eskdalemuir	...	2	6	...	...	4	4	...	...	5	12	...	...	5	10	...
Pilar	0·8	6	6	8	1·0	7	2	7	0·3	2	1	4	0·8	6	7	9
Vieque	...	...	...	...	...	...	...	...	0·7	6	1	0	0·2	2	3	1
Cheltenham	...	...	...	...	...	...	...	...	0·3	2	10	1	0·5	3	9	6
Agincourt	1·9	9	11	...	0·6	3	11	...	0·9	4	16	...	0·4	2	13	...
Tucson	...	...	...	...	...	...	...	...	2·2	18	2	3	1·9	15	2	2
Sitka	...	...	...	...	...	...	...	...	1·8	8	7	4	1·5	7	9	4
Honolulu	...	...	...	...	...	...	...	...	0·8	7	1	2	0·7	6	1	2
Cape Evans	...	19	8	4	...	15	18	5	...	36	25	18	...	83	38	31
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	14	13	...	...	21	19	...	...	27	24	20	41	35	31	48	66
Buitenzorg	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	1
Toungoo	0·0	0	5	0	0·0	0	4	0	0·0	0	4	1	0·0	0	1	0
Barrackpore	0·2	2	6	1	0·1	1	8	2	...	...	5	...	...	...	5	...
Dehra Dun	0·1	1	5	1	0·2	2	4	0	0·1	1	6	1	0·1	1	2	1
Kodaikanal	0·1	1	1	1	0·1	1	5	3	0·0	0	6	2	0·0	0	0	2
Helwan	...	...	...	...	...	...	...	...	0·4	4	7	2	0·4	4	4	1
De Bilt...	0·4	2	3	...	0·2	1	6	...	1·0	5	6	...	0·8	4	7	...
Val Joyeux	0·5	3	4	...	0·5	3	5	...	0·8	5	4	...	0·7	4	6	...

Station.	May 16, 1912.								June 13, 1912.							
	17h. to 18h.				18h. to 19h.				17h. to 18h.				18h. to 19h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	0·7	3	10	...	0·9	5	7	...	0·8	4	4	...	1·1	6	8	...
Eskdalemuir	...	7	16	...	...	8	10	...	...	4	9	...	...	5	13	...
Pilar	1·0	7	4	7	1·4	11	4	7	0·8	6	7	2	0·7	5	5	1
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	0·6	3	12	...	1·3	6	5	...	2·4	11	7	...	1·0	5	14	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Honolulu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Evans	...	21	23	12	...	21	20	13	...	17	8	6	...	19	7	9
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	19	18	13	9	20	18	9	17	12	11	11	10	21	19	14	8
Buitenzorg	...	...	...	...	...	3	2	2	...	...	...	...	...	2	4	0
Toungoo	0·1	1	4	0	0·4	5	2	0	0·1	1	1	0	0·1	1	2	1
Barrackpore	...	...	6	...	...	...	3	...	0·2	2	1	4	0·1	1	4	1
Dehra Dun	0·1	1	4	1	0·5	5	3	1	0·2	2	2	0	0·1	1	4	0
Kodaikanal	0·2	2	0	1	0·5	6	0	1	0·1	1	2	0	0·1	1	5	0
Helwan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
De Bilt...	1·3	7	10	...	1·1	6	7	...	0·7	4	6	...	0·8	4	12	...
Val Joyeux	0·5	3	7	...	0·7	4	5	...	0·8	5	5	...	0·7	4	10	...

TABLE CII—*continued.*

Ranges during term hours at 20 Co-operating Stations.

Station.	July 18, 1912.								August 15, 1912.							
	17h. to 18h.				18h. to 19h.				17h. to 18h.				18h. to 19h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	...	...	...	...	...	...	...	...	0·9	5	3	...	0·6	3	3	...
Eskdalemuir	...	9	9	...	...	3	7	...	...	3	3	...	...	2	3	...
Pilar	1·4	11	7	6	0·9	7	3	8	0·5	4	10	12	1·7	13	4	6
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	1·3	6	1	...	1·2	5	12	...	0·8	4	10	...	1·0	5	7	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Honolulu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Evans	...	6	7	4	...	10	5	4	...	2	3	2	...	6	8	2
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	5	5	7	6	11	10	4	7	4	3	5	13	7	7	5	8
Buitenzorg	...	...	...	...	...	1	4	5	...	...	...	...	...	0	2	...
Toungoo	0·3	3	2	1	0·5	5	5	1	0·1	1	4	2	0·2	2	1	0
Barrackpore	0·1	1	3	...	0·2	2	3	...	0·4	4	2	1	0·1	1	1	0
Dehra Dun	0·2	2	1	1	0·2	2	1	1	0·4	4	4	0	0·1	1	1	0
Kodaikanal	0·3	3	2	0	0·4	4	1	1	0·0	0	0	0	0·0	0	4	0
Helwan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
De Bilt...	1·6	8	3	...	0·4	2	5	...	0·5	3	3	...	0·8	4	4	...
Val Joyeux	...	...	...	...	...	...	...	...	0·8	4	3	...	0·3	2	4	...

Station.	September 12, 1912.								October 10, 1912.							
	17h. to 18h.				18h. to 19h.				17h. to 18h.				18h. to 19h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	1·4	7	5	...	2·0	10	5	...	3·6	18	5	...	1·5	7	4	...
Eskdalemuir	...	4	13	...	...	2	10	...	...	8	8	...	...	3	7	...
Pilar	0·3	2	3	9	0·2	1	8	20	0·8	6	3	11	1·1	8	2	13
Vieque	...	...	...	...	...	...	...	...	0·3	3	5	4	0·1	1	1	4
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	0·5	2	7	...	1·2	5	4	...	1·4	7	15	...	0·8	4	7	...
Tucson	...	...	...	...	...	...	...	...	1·1	9	5	1	0·8	6	3	2
Sitka	...	...	...	...	...	...	...	...	1·0	5	5	8	0·9	4	6	1
Honolulu	...	...	...	...	...	...	...	...	1·0	9	1	2	0·2	2	4	4
Cape Evans	...	20	20	10	...	38	10	9	...	21	27	26	...	44	38	28
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	0·6	4	0	...
Cape Denison	9	8	4	13	13	12	23	22	34	31	48	19	20	18	19	16
Buitenzorg	...	...	...	...	...	1	3	2	...	...	...	...	...	0	4	...
Toungoo	0·3	3	3	1	0·4	5	2	0	0·3	3	5	1	0·1	1	5	1
Barrackpore	0·1	1	5	0	0·3	3	4	0	0·2	2	5	0	0·2	2	5	0
Dehra Dun	0·4	4	5	1	0·5	5	6	1	0·3	3	5	1	0·1	1	4	1
Kodaikanal	0·1	1	1	1	0·0	0	5	0	0·0	0	1	0	0·0	0	0	5
Helwan	...	...	...	...	...	...	...	...	0·2	2	2	2	0·1	1	3	2
De Bilt...	0·8	4	8	...	1·0	5	7	...	1·7	9	4	...	0·8	4	8	...
Val Joyeux	0·7	4	6	...	0·7	4	5	...	2·0	11	6	...	0·8	5	7	...

TABLE CII—*continued.*

Ranges during term hours at 20 Co-operating Stations.

Station.	November 7, 1912.								December 5, 1912.							
	17h. to 18h.				18h. to 19h.				17h. to 18h.				18h. to 19h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eskdalemuir	...	1	3	...	...	2	3	...	...	3	4	...	...	3	3	...
Pilar	...	...	...	...	...	...	...	...	0·8	6	15	10	0·7	5	14	2
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Agincourt	0·5	2	4	...	0·5	2	7	...	0·4	2	7	...	1·3	5	9	...
Tucson	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sitka	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Honolulu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Evans	...	13	14	12	...	55	78	31	...	...	...	...	...	...	...	...
Melbourne	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cape Denison	7	6	5	7	23	20	14	29	39	35	...	6	60	55	...	...
Buitenzorg	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toungoo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Barrackpore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dehra Dun	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kodaikanal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Helwan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
De Bilt...	0·2	1	1	...	0·2	1	3	...	0·8	4	4	...	0·5	3	3	...
Val Joyeux	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Station.	January 2, 1913.								January 30, 1913.							
	17h. to 18h.				18h. to 19h.				17h. to 18h.				18h. to 19h.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
Stonyhurst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eskdalemuir	...	9	18	...	...	30	55	...	...	4	6	...	...	4	5	...
Pilar	...	...	...	...	...	...	...	...	0·5	4	6	3	0·7	5	13	4
Vieque	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cheltenham	1·8	10	10	11	1·4	8	25	6	...	...	...	...	...	...	...	...
Agincourt	1·9	9	7	...	1·9	9	20	...	1·9	9	8	...	0·4	2	11	...
Tucson	1·1	9	32	4	2·1	17	27	4	...	...	...	...	...	...	...	...
Sitka	4·4	20	10	3	7·7	35	32	5	...	...	...	...	...	...	...	...
Honolulu	0·9	8	6	5	0·9	8	8	4	...	...	...	...	...	...	...	...
Cape Evans	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Melbourne	2·3	15	7	...	3·4	23	15	...	...	...	...	...	...	...	...	...
Cape Denison	81	73	...	54	153	139	...	95	12	11	11	16	32	29	12	27
Buitenzorg	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Toungoo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Barrackpore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dehra Dun	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kodaikanal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Helwan	0·5	4	14	5	2·0	18	14	6	...	...	...	...	...	...	...	...
De Bilt...	1·3	7	16	...	7·0	38	45	...	0·5	3	4	...	1·1	6	6	...
Val Joyeux	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

§22.—The Disturbed Term Hour, April 16, 8h. to 10h.

The term hours 8h. to 10h. on April 16, 1912, formed one of the successes of the scheme, for the whole day was one of continuous disturbance in the Antarctic and, with an international character figure of 1·0 it could reasonably be assumed that the disturbance was widespread. A fairly regular bay movement culminating about 8h.30m. G.M.T. was the chief feature within the prearranged interval and was most conspicuous in declination or the equivalent force vector across the meridian. Locally superposed perturbations were present in all the curves from moderate and higher latitudes. Data were available from all the co-operating stations except Melbourne, and 14 of the remaining 19 stations supplied curves or readings from which ranges could be estimated for all three components. The high sensitivity of the declination magnetograph at Cape Denison resulted in loss of trace near the culmination of the bay movement. The range quoted for that component and all dependent entries of the table are therefore considerably underestimated.

Using the squares of the range as the index of activity, Table CIII provides a survey of this quantity for the two constituent hours 8h. to 9h. and 9h. to 10h., April 16, 1912, for all the 19 stations. The measures of resultant activity in the horizontal field are given for each station and, when possible, values for the resultant vectors in three-dimensions.

TABLE CIII.

Squares of extreme ranges in a disturbed term hour.

Station.	April 16, 1912. 8h. to 9h. D	H	V	$\bar{H}$	T	9h. to 10h. D	H	Z	$\bar{H}$	T	8h. to 10h. $\bar{H}$
	γ^2	γ^2	γ^2	γ^2	γ^2	γ^2	γ^2	γ^2	γ^2	γ^2	γ^2
Stonyhurst	64	841	...	905	...	49	324	...	373	...	1,278
Eskdalemuir ...	196	4,356	...	4,552	...	256	625	...	881	...	5,433
Pilar...	49	441	9	490	499	4	121	9	125	134	615
Vieque	196	64	64	260	324	25	25	9	50	59	310
Cheltenham ...	1,369	121	169	1,490	1,659	144	49	121	193	314	1,683
Agincourt	6,561	676	...	7,237	...	361	196	...	557	...	7,794
Tucson	900	324	9	1,224	1,233	9	64	1	73	74	1,297
Sitka	2,304	2,401	10,609	4,705	15,314	1,681	2,025	4,900	3,706	8,606	8,411
Honolulu	49	400	36	449	485	4	64	4	68	72	517
Cape Evans ...	28,561	29,584	82,369	58,145	140,514	4,761	3,600	17,424	8,361	25,785	66,516
Cape Denison ...	>28,561	13,225	25,600	>41,786	>67,386	3,721	9,801	3,481	13,522	17,003	>55,308
Buitenzorg	121	729	144	850	994	4	81	36	85	121	935
Toungoo	144	529	16	673	689	64	36	9	100	109	773
Barrackpore ...	100	361	81	461	542	81	81	25	162	187	623
Dehra Dun	169	676	121	845	966	49	81	16	130	146	975
Kodaikanal... ...	64	961	144	1,025	1,169	9	25	81	34	115	1,059
Helwan	144	441	144	585	729	16	100	9	116	125	701
De Bilt	256	1,681	...	1,937	...	625	361	...	986	...	2,923
Val Joyeux... ...	225	1296	...	1,521	...	225	196	...	421	...	1,942

The squared ranges differ enormously from station to station. The Antarctic stations are in a special class with activity of a different order of magnitude from all others. Except at Cape Evans and Cape Denison and the two other stations of moderately high latitude, Sitka and Agincourt, the contribution to the total space activity from the vertical component is small compared with the contributions from the components in the horizontal plane.

As a summary of events in the horizontal plane we may consider the entries under $\overline{H}$ in the final column of Table CIII. They refer to the complete interval of two hours and are obtained by simply adding the entries under $\overline{H}$ for the two separate hours. Excluding the contributions from the Antarctic bases the mean $\overline{H}$ in the column is $2191\gamma^2$. Of the 17 stations contributing to the mean Sitka, 3·84 times the mean, Agincourt, 3·56 times, and Eskdalemuir, 2·48 times, are in order with the highest values and Vieque, 0·14 times the mean, is the lowest. So that even outside polar latitudes magnetic activity can vary in the ratio 30 to 1 for synchronous disturbance. Relative to the same mean Cape Evans has activity 303·6 times and Cape Denison 252·4 times as great. Were it not for the loss of trace at the latter station these two estimates would be more nearly equal.

§23.—Ordinates at 5-minute Intervals at Cape Denison and Cape Evans: "Magnetic Activity" in Term Hours.

Though the validity of the relation $\Sigma\eta_n^2/n = CR^2$ is unquestionable for stations in moderate and low latitudes the quantity of quick-run material available from previous Antarctic expeditions was insufficient to make it certain that the same relation could be extended to high latitudes. For further insight into this question all the quick-run records at both Cape Evans and Cape Denison have therefore been examined in detail. Ordinates at equidistant 5-minute intervals beginning at the exact hour were tabulated for the three components and, since the examination was to be restricted to activity within the two-hourly intervals, the lowest value of the ordinates in the interval was taken as the standard of reference. Differences from this standard were converted into force units and minutes of arc for D at Cape Denison. The results are supplied by Tables CIV, (*a*) and (*b*). Data for declination only can be given for the hours in March, 1912, at Cape Denison because the magnetographs were not properly in operation till later in that month. The absence of entries for H and Z for December 5 and for H alone on December 3, 1912, and January 3, 1913, is due to unsatisfactory records of these components at those times. Magnetic registration at Cape Evans ceased in November, 1912. To be comparable with the positive direction of change of E^1 at Cape Evans, declination changes at Cape Denison have been considered as increasing to the east. The entries under D for this station for the times 8h.25m., 8h.30m. and 8h.35m., April 16, 1912, are underestimates, due, as mentioned earlier, to loss of trace through excessive sensitivity of the variometer.

TABLE CIV.

Term Hours:—Differences from lowest values during two hours at Cape Denison and Cape Evans.

Cape Denison.

	March 19, 1912.				April 16, 1912.				May 14, 1912.				June 11, 1912.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
h. m.	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
8 0	18	16	...	...	57	52	114	23	80	72	0	4	9	8	8	2
8 5	21	19	...	...	28	25	101	6	53	48	1	0	20	18	5	6
8 10	16	14	...	...	68	61	87	5	37	34	9	4	8	7	4	0
8 15	8	8	...	...	93	84	68	0	23	21	20	3	9	8	12	20
8 20	11	10	...	...	172	155	73	46	26	24	28	7	15	14	10	29
8 25	5	5	...	...	>201	>182	53	85	51	46	40	26	12	11	5	25
8 30	6	5	...	...	>201	>182	33	112	59	53	41	28	9	9	3	23
8 35	5	5	...	...	>201	>182	9	128	70	63	35	28	2	2	0	15
8 40	9	8	...	...	191	172	0	157	40	57	30	7	17	15	5	59
8 45	5	4	...	...	149	134	22	140	35	32	32	5	17	15	3	54
8 50	1	1	...	...	121	109	24	128	20	18	33	8	13	12	0	37
8 55	0	0	...	...	104	94	25	117	12	11	43	9	14	12	8	57
9 0	2	2	...	...	66	60	38	104	8	8	53	11	8	7	10	82
9 5	3	3	...	...	21	19	45	73	0	0	59	10	6	6	13	75
9 10	3	3	...	...	28	25	68	81	2	2	63	9	2	2	10	60
9 15	4	4	...	...	19	17	65	61	0	0	76	15	12	11	14	72
9 20	2	2	...	...	34	31	77	76	11	10	81	19	4	3	7	48
9 25	2	2	...	...	16	14	94	81	8	7	78	21	7	6	5	62
9 30	8	7	...	...	19	17	102	85	3	2	81	18	0	0	15	80
9 35	4	4	...	...	15	14	104	84	4	3	89	19	6	5	18	85
9 40	6	5	...	...	5	5	110	86	7	6	89	16	12	11	23	117
9 45	10	9	...	...	0	0	124	97	8	7	88	13	12	11	19	97
9 50	5	5	...	...	17	15	135	113	8	8	89	11	10	9	16	91
9 55	6	6	...	...	20	18	131	117	15	14	92	15	11	10	12	74
10 0	6	5	...	...	21	19	130	113	23	21	95	24	13	12	14	87

Cape Denison.

	July 16, 1912.				August 13, 1912.				September 10, 1912.				October 8, 1912.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
h. m.	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
8 0	69	62	16	17	6	5	13	...	0	0	6	15	21	19	3	6
8 5	61	55	11	16	12	11	3	...	3	2	8	24	9	8	0	0
8 10	64	58	11	17	12	11	0	...	3	2	6	23	6	6	7	1
8 15	64	58	7	15	13	11	3	...	2	2	10	16	2	1	17	20
8 20	62	57	0	7	7	7	9	...	0	0	6	4	0	0	17	23
8 25	38	34	1	3	10	9	8	...	0	0	4	0	8	7	21	30
8 30	24	22	7	0	16	15	2	...	0	0	3	1	13	12	19	30
8 35	19	17	19	7	11	10	4	...	2	2	3	8	7	6	15	24
8 40	12	11	27	10	10	9	8	...	3	3	3	14	2	2	12	20
8 45	0	0	36	11	11	10	6	...	3	2	3	15	13	11	11	24
8 50	21	19	40	17	8	7	9	...	4	4	3	16	8	7	9	27
8 55	38	35	44	27	6	5	10	...	1	1	3	15	27	25	7	26
9 0	43	39	45	28	8	8	8	...	1	1	9	16	32	29	1	24
9 5	39	36	49	28	11	10	4	...	4	4	9	20	58	53	3	37
9 10	35	32	52	25	9	8	3	...	8	7	9	23	52	47	7	38
9 15	25	23	57	24	10	9	4	...	9	8	9	22	45	41	14	44
9 20	18	16	61	20	8	7	7	...	12	11	10	22	69	63	27	64
9 25	19	17	69	22	9	9	7	...	7	7	9	16	65	59	28	70
9 30	26	24	77	28	8	8	9	...	8	8	6	11	49	44	26	60
9 35	25	22	75	23	7	7	7	...	2	2	1	6	33	30	18	46
9 40	29	26	81	25	7	6	10	...	1	0	0	6	42	38	15	40
9 45	39	35	81	28	3	3	15	...	1	1	3	8	42	38	13	43
9 50	36	32	83	25	0	0	14	...	1	1	3	9	47	43	13	47
9 55	40	36	81	25	2	2	12	...	4	4	5	10	35	32	13	42
10 0	45	41	82	28	6	5	14	...	4	3	4	12	42	38	13	44

TABLE CIV—*continued.*

Term Hours:—Differences from lowest values during two hours at Cape Denison and Cape Evans.

Cape Denison.

	November 5, 1912.				December 3, 1912.				January 28, 1913.			
	D		H	Z	D		H	Z	D		H	Z
h. m.	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
8 0	15	13	8	0	0	0	...	54	20	18	3	6
8 5	17	16	15	8	26	23	...	53	20	18	0	10
8 10	16	15	15	10	21	19	...	45	19	17	0	6
8 15	19	17	11	9	24	22	...	41	12	11	2	3
8 20	18	16	9	10	17	16	...	40	14	12	5	3
8 25	14	13	9	12	24	22	...	30	14	12	6	3
8 30	10	9	8	13	23	21	...	23	15	13	3	0
8 35	6	5	9	16	20	18	...	9	20	18	4	5
8 40	2	2	15	16	41	37	...	0	21	19	2	5
8 45	1	1	14	15	38	35	...	4	25	22	0	5
8 50	1	0	14	13	20	18	...	21	27	25	2	12
8 55	4	4	14	11	31	29	...	35	25	22	5	17
9 0	5	5	14	5	41	37	...	34	24	21	8	20
9 5	2	2	13	1	25	23	...	30	20	18	12	20
9 10	0	0	8	0	19	17	...	25	16	15	18	21
9 15	4	4	4	1	12	11	...	38	17	16	18	24
9 20	5	4	3	8	11	10	...	38	11	10	18	24
9 25	3	3	2	8	6	5	...	27	3	2	20	27
9 30	6	6	2	8	4	4	...	30	0	0	18	25
9 35	2	2	0	7	0	0	...	26	1	1	19	24
9 40	4	3	1	12	1	0	...	24	13	12	20	26
9 45	2	2	1	10	6	6	...	20	13	12	19	27
9 50	6	5	1	7	7	6	...	21	11	10	21	28
9 55	6	5	3	8	9	8	...	16	12	11	22	25
10 0	3	3	2	4	9	8	...	16	10	9	27	30

Cape Evans.

	March 19, 1912.			April 16, 1912.			May 14, 1912.			June 11, 1912.			July 16, 1912.		
	E^1	N^1	Z	E^1	N^1	Z	E^1	N^1	Z	E^1	N^1	Z	E^1	N^1	Z
h. m.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
8 0	13	0	...	76	31	4	116	39	108	25	0	0	92	31	17
8 5	12	0	...	57	19	16	83	22	110	26	3	2	101	26	18
8 10	13	0	...	66	38	6	71	0	95	30	1	2	92	15	25
8 15	13	1	...	115	85	0	54	10	74	25	10	7	103	21	25
8 20	12	3	...	132	121	10	57	12	63	28	10	12	100	25	32
8 25	12	6	...	161	177	9	65	23	53	37	11	10	89	9	45
8 30	10	6	...	145	173	48	75	29	43	16	10	25	67	0	52
8 35	11	10	...	165	164	76	71	20	44	17	14	26	54	4	52
8 40	10	8	...	167	125	126	47	9	48	45	15	18	38	2	51
8 45	10	8	...	72	53	230	37	20	42	21	5	29	28	3	44
8 50	7	7	...	59	54	228	14	16	42	25	14	21	37	20	36
8 55	5	6	...	89	76	196	8	29	32	19	2	22	48	33	28
9 0	5	8	...	60	57	190	0	36	26	9	6	18	49	37	28
9 5	3	7	...	59	34	166	3	44	18	10	3	14	48	35	25
9 10	3	10	...	59	25	154	7	51	13	5	7	13	34	40	25
9 15	3	10	...	34	10	140	9	57	10	6	20	11	18	39	24
9 20	1	9	...	34	18	109	15	63	5	14	24	7	10	41	19
9 25	0	10	...	17	0	102	23	61	2	22	24	10	0	44	20
9 30	5	12	...	5	3	93	23	61	2	0	20	17	9	52	10
9 35	6	12	...	14	16	78	33	63	2	11	25	11	13	55	8
9 40	3	10	...	0	22	76	20	56	5	13	18	13	12	55	7
9 45	5	10	...	1	23	71	25	60	1	9	22	12	26	61	1
9 50	3	11	...	10	24	67	43	53	3	7	14	14	29	59	1
9 55	8	12	...	17	30	63	28	50	1	9	12	14	28	62	2
10 0	5	10	...	25	33	59	24	50	0	8	8	12	35	64	0

TABLE CIV—*continued.*

Term Hours :—Differences from lowest values during two hours at Cape Denison and Cape Evans.

Cape Evans.

	August 13, 1912.			September 10, 1912.			October 8, 1912.			November 5, 1912.		
	E¹	N¹	Z	E¹	N¹	Z	E¹	N¹	Z	E¹	N¹	Z
h. m.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
8 0	9	10	0	5	5	3	26	0	0	16	12	0
8 5	10	17	0	4	5	2	20	0	3	20	11	1
8 10	19	23	2	3	8	2	4	7	6	21	8	4
8 15	22	18	2	1	8	2	7	18	3	19	8	5
8 20	17	14	4	3	11	3	10	26	0	18	8	6
8 25	16	12	5	0	5	3	1	23	7	18	2	7
8 30	15	14	2	1	6	1	8	28	1	17	0	9
8 35	15	12	4	3	8	2	16	29	0	14	1	11
8 40	6	10	6	4	7	2	11	22	5	15	1	11
8 45	12	12	3	6	5	3	10	21	6	16	7	13
8 50	13	9	4	1	5	3	15	33	5	17	6	16
8 55	10	5	6	3	7	2	12	34	6	17	7	17
9 0	10	11	6	1	10	1	10	38	7	19	4	17
9 5	13	10	6	3	9	0	8	52	8	17	12	21
9 10	13	14	7	8	8	1	3	53	13	10	14	25
9 15	9	11	10	12	6	2	8	52	11	7	14	25
9 20	12	9	9	14	5	2	3	55	13	6	10	20
9 25	10	8	10	17	5	2	0	57	14	6	8	21
9 30	6	7	10	19	4	2	5	52	11	6	8	21
9 35	5	8	10	14	0	6	5	46	12	5	10	25
9 40	5	4	10	6	2	6	5	47	10	2	12	25
9 45	3	3	10	3	5	6	10	44	11	2	8	25
9 50	1	0	9	5	6	6	12	45	11	0	15	28
9 55	2	3	8	5	5	6	17	42	13	4	17	25
10 0	0	3	7	5	6	6	18	52	13	3	15	22

Cape Denison.

	March 21, 1912.				April 18, 1912.				May 16, 1912.				June 13, 1912.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
h. m.	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
17 0	...	...	...	...	12	10	18	30	2	2	7	4	10	9	8	7
17 5	3	3	...	...	18	17	17	34	4	3	8	7	11	10	9	7
17 10	5	5	...	...	7	6	14	34	2	2	7	7	9	8	8	5
17 15	5	4	...	...	2	2	8	41	5	4	8	7	5	5	5	1
17 20	7	6	...	...	7	6	8	40	9	8	7	7	9	8	5	0
17 25	6	5	...	...	8	7	0	24	8	7	7	7	8	8	4	0
17 30	3	2	...	...	0	0	1	17	9	9	8	5	3	3	9	0
17 35	2	2	...	...	1	1	1	8	9	8	8	7	6	5	12	5
17 40	3	3	...	...	8	7	0	2	6	5	5	5	9	8	14	8
17 45	13	12	...	...	13	12	0	0	2	2	3	1	14	13	8	6
17 50	13	12	...	...	20	18	8	4	0	0	0	0	15	13	7	6
17 55	7	7	...	...	19	17	8	20	13	12	11	7	9	8	9	8
18 0	3	3	...	...	19	17	8	29	18	17	11	7	7	7	11	7
18 5	5	5	...	...	6	5	4	38	17	16	9	8	11	10	8	3
18 10	1	1	...	...	5	4	6	38	14	13	6	5	9	8	9	8
18 15	0	0	...	...	19	17	6	29	12	11	11	6	5	5	5	5
18 20	6	5	...	...	11	10	3	23	16	15	13	10	0	0	3	3
18 25	6	5	...	...	15	13	0	20	19	18	13	15	1	1	5	7
18 30	9	8	...	...	9	8	5	31	19	17	9	15	4	4	4	8
18 35	13	12	...	...	11	10	16	42	15	13	13	16	5	5	5	5
18 40	19	17	...	...	17	15	15	47	7	7	7	5	13	12	5	2
18 45	10	9	...	...	11	10	21	39	1	1	5	1	18	16	6	3
18 50	2	2	...	...	21	19	28	63	3	2	10	5	18	16	7	5
18 55	1	1	...	...	27	25	44	86	3	2	11	8	17	16	1	8
19 0	0	0	...	...	8	7	46	85	3	2	5	5	12	11	0	10

TABLE CIV—*continued.*

Term Hours :—Differences from lowest values during two hours at Cape Denison and Cape Evans.

Cape Denison.

	July 18, 1912.				August 15, 1912.				September 12, 1912.				October 10, 1912.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
h. m.	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
17 0	9	8	0	0	2	2	3	3	8	7	3	10	0	0	50	7
17 5	11	10	0	2	5	5	5	6	9	8	3	10	3	2	56	19
17 10	11	10	4	6	3	3	3	12	7	7	3	12	19	17	47	16
17 15	10	9	3	4	4	4	0	3	7	7	3	13	27	24	40	18
17 20	10	9	3	0	5	4	3	3	7	6	3	11	32	29	36	21
17 25	12	11	5	2	5	5	3	0	5	5	1	8	30	27	28	16
17 30	13	12	5	3	6	5	5	1	8	7	2	10	27	25	23	10
17 35	11	10	5	2	6	5	5	4	8	7	0	7	26	24	22	12
17 40	10	9	3	1	5	5	5	8	2	2	3	6	26	24	21	12
17 45	10	9	3	2	7	6	5	10	5	5	1	4	27	25	17	9
17 50	9	8	3	2	6	6	6	15	9	9	3	1	32	29	17	11
17 55	8	8	3	4	4	4	5	12	6	6	3	2	30	27	12	6
18 0	9	8	3	5	3	3	3	13	5	5	3	0	32	29	9	4
18 5	9	8	3	3	2	2	3	13	0	0	5	2	31	29	13	6
18 10	11	10	7	5	2	1	3	13	9	8	16	10	36	32	13	9
18 15	11	10	3	5	2	2	4	15	12	11	18	12	34	31	13	10
18 20	10	9	3	4	5	4	5	13	9	9	20	14	29	26	10	9
18 25	9	9	3	4	4	4	6	15	10	9	23	19	35	31	9	10
18 30	9	8	3	7	4	4	5	15	10	9	19	24	25	23	2	6
18 35	6	5	3	4	3	3	3	13	10	9	16	21	21	19	0	1
18 40	4	4	3	3	3	3	3	1	10	9	16	21	21	19	2	2
18 45	0	0	3	0	1	1	3	12	10	9	13	18	23	20	2	0
18 50	3	3	3	0	0	0	2	9	8	7	11	18	28	25	3	4
18 55	4	4	7	4	1	1	3	12	12	11	10	21	33	30	10	8
19 0	3	3	7	4	7	6	5	12	10	9	10	25	40	37	14	12

Cape Denison.

	November 7, 1912.				December 5, 1912.				January 2, 1913.				January 30, 1913.			
	D		H	Z	D		H	Z	D		H	Z	D		H	Z
h. m.	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ	′	γ	γ	γ
17 0	0	0	0	1	38	35	...	...	52	47	...	16	23	21	11	20
17 5	4	3	1	7	40	36	...	...	44	40	...	13	18	17	6	20
17 10	3	3	3	4	35	32	...	...	48	43	...	18	18	16	7	16
17 15	2	2	3	0	24	32	...	...	39	35	...	14	16	14	5	12
17 20	3	2	0	1	32	29	...	...	46	42	...	21	14	13	4	10
17 25	4	4	2	2	36	33	...	...	40	36	...	9	14	13	3	6
17 30	6	5	3	4	44	40	...	...	32	29	...	0	13	12	5	9
17 35	6	6	2	3	42	38	...	...	62	56	...	24	12	11	5	3
17 40	2	2	1	4	37	34	...	...	42	38	...	9	18	16	5	5
17 45	0	0	0	4	52	47	...	...	53	48	...	22	21	19	8	8
17 50	1	1	1	4	58	52	...	...	67	61	...	30	13	12	2	3
17 55	3	3	2	2	63	57	...	...	108	98	...	53	21	19	9	8
18 0	3	2	1	0	59	54	...	...	102	92	...	47	24	21	2	6
18 5	4	4	3	2	52	47	...	...	127	115	...	73	23	21	8	16
18 10	7	6	3	3	48	44	...	...	119	108	...	99	23	21	5	15
18 15	9	8	1	4	45	41	...	...	58	53	...	54	30	27	8	20
18 20	11	10	3	5	43	39	...	...	29	27	...	43	23	21	3	20
18 25	12	11	3	5	37	33	...	...	11	10	...	43	11	10	0	13
18 30	15	13	3	12	35	31	...	...	7	7	...	55	2	2	0	7
18 35	11	10	2	9	30	27	...	...	3	2	...	50	0	0	0	5
18 40	7	6	1	7	17	16	...	...	0	0	...	38	12	11	5	4
18 45	11	10	3	15	19	17	...	...	21	19	...	26	8	8	0	0
18 50	13	12	7	16	16	14	...	...	20	18	...	16	17	15	5	10
18 55	24	22	13	29	9	8	...	...	22	20	...	13	23	21	9	15
19 0	24	22	10	38	0	0	...	...	7	7	...	1	15	14	8	27

TABLE CIV—*continued.*

Term Hours:—Differences from lowest values during two hours at Cape Denison and Cape Evans.

Cape Evans.

	March 21, 1912.			April 18, 1912.			May 16, 1912.			June 13, 1912.			July 18, 1912.		
	E[1]	N[1]	Z	E[1]	N[1]	Z	E[1]	N[1]	Z	E[1]	N[1]	Z	E[1]	N[1]	Z
h. m.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
17 0	...	...	...	32	29	21	16	8	17	17	6	11	...	...	...
17 5	0	0	12	28	20	24	16	10	15	17	14	9	11	0	2
17 10	2	3	12	30	20	22	19	9	11	11	17	9	11	7	0
17 15	8	2	10	34	21	17	17	8	11	7	14	10	10	7	2
17 20	12	3	8	37	19	14	17	8	10	8	8	10	8	2	2
17 25	17	7	6	54	24	9	17	4	10	14	13	7	12	5	1
17 30	18	8	5	62	13	5	17	8	8	8	11	6	10	5	2
17 35	12	6	8	40	20	15	16	8	10	3	11	9	10	5	0
17 40	8	3	8	41	9	13	16	7	10	4	17	5	10	1	2
17 45	9	0	8	43	12	13	21	0	7	5	14	6	12	5	1
17 50	14	0	5	39	14	13	21	1	9	1	13	9	8	5	2
17 55	15	1	4	37	6	12	12	24	5	1	11	9	10	4	0
18 0	14	1	4	41	5	10	17	20	6	4	8	5	6	4	2
18 5	13	3	4	44	12	8	15	17	10	8	4	5	9	1	2
18 10	14	0	4	39	13	8	18	12	8	0	4	7	9	5	1
18 15	15	0	3	52	18	0	6	5	10	5	4	6	3	4	2
18 20	17	2	3	42	17	3	7	18	6	5	5	7	10	5	0
18 25	14	5	3	43	14	5	13	19	4	11	3	6	6	5	2
18 30	27	15	0	42	16	5	17	13	6	13	3	3	8	3	1
18 35	21	16	4	36	12	8	11	10	8	15	0	3	6	2	2
18 40	17	10	4	19	29	11	21	6	5	17	3	2	3	5	0
18 45	16	3	4	39	27	5	9	4	7	17	4	2	1	3	1
18 50	19	6	3	13	0	13	0	17	5	14	1	1	2	3	0
18 55	20	6	2	0	26	4	10	12	0	14	3	0	0	...	...
19 0	17	6	5	1	26	2	13	9	3	17	3	0	...	...	...

Cape Evans.

	August 15, 1912.			September 12, 1912.			October 10, 1912.			November 7, 1912.		
	E[1]	N[1]	Z	E[1]	N[1]	Z	E[1]	N[1]	Z	E[1]	N[1]	Z
h. m.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
17 0	3	3	1	31	0	11	...	...	...	51	23	18
17 5	3	2	2	36	11	8	...	...	...	47	23	17
17 10	2	2	2	42	8	4	19	33	26	51	24	13
17 15	3	2	1	42	5	4	19	33	30	53	25	12
17 20	3	3	2	35	1	7	19	37	30	53	24	13
17 25	3	4	2	41	1	4	25	37	34	50	23	15
17 30	1	1	2	42	2	4	22	36	34	44	24	16
17 35	2	1	2	41	3	3	20	28	41	48	23	0
17 40	1	3	2	37	1	3	28	27	33	48	17	9
17 45	2	2	2	41	7	2	25	16	32	47	17	7
17 50	2	1	1	45	10	0	25	23	24	44	17	7
17 55	2	2	1	26	15	6	23	20	26	44	11	6
18 0	2	1	2	28	17	5	30	16	21	44	10	4
18 5	1	3	1	26	22	7	28	27	13	44	10	4
18 10	1	2	2	30	21	6	8	25	23	50	10	2
18 15	1	5	2	13	20	10	19	24	23	45	10	5
18 20	0	5	1	8	20	7	16	17	26	46	7	2
18 25	0	1	0	14	11	4	14	16	10	48	10	1
18 30	5	0	1	6	17	3	32	13	6	54	11	0
18 35	3	4	2	0	17	6	45	0	12	50	3	4
18 40	1	3	2	12	19	5	41	3	5	37	0	6
18 45	0	1	2	13	14	7	34	10	0	41	14	4
18 50	3	3	1	14	16	9	38	2	7	28	34	13
18 55	3	1	2	14	18	8	30	12	12	25	75	13
19 0	0	4	1	19	12	6	0	35	13	0	51	31

The values of the difference-ordinates in Tables CIV (*a*) and CIV (*b*) would allow reconstruction of the variation of the components at the two Antarctic bases to be made but their primary use in this investigation is to determine values of the magnetic activity for all the separate hourly intervals. For this purpose further differences $\eta_0\ \eta_1\ \eta_2$ —— η_{12} from the means of the 13 difference-ordinates in each 60-minute interval of the tables were squared. In this way the quantities $\frac{1}{12}\{\frac{1}{2}(\eta_0^2 + \eta_{12}^2) + \eta_1^2 + \ldots\ldots\ldots \eta_{11}^2\}$ were formed. They will be written shortly as $\frac{1}{12}\,\Sigma\eta^2$. Tables CV and CVI contain the values of this quantity for the two pairs of separate hours both for the three components at each station separately and for the combination $\overline{\text{H}}$, for the horizontal plane, and $\overline{\text{T}}$ for the total field. The 7-day means in the first of these tables (CV) relating to the hours 8h. to 9h. and 9h. to 10h. refer to the days April 16, May 14, June 11, July 16, September 10, October 8, and November 5 for which complete registrations in all three components were provided by both stations. Likewise the 8-day means in Table CVI for the other pair of hours omit the days in March, December and January for which data are incomplete. Each set of means therefore answers to precisely corresponding events at the two Antarctic base stations.

TABLE CV.

$\frac{1}{12}\Sigma\eta^2$ within hours 8h. to 9h. and 9h. to 10h. at Cape Denison and Cape Evans.

Hour.	Date.	Cape Denison.					Cape Evans.				
		D	H	V	$\overline{\text{H}}$	T	E[1]	N[1]	V	$\overline{\text{H}}$	T
8h. to 9h.	1912.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
	March 19	30·3	—	—	—	—	6·8	11·4	—	18·2	—
	April 16	2864·0	1121·8	3088·5	3985·8	7074·3	1801·7	2903·0	7942·2	4704·7	12646·9
	May 14	303·4	207·6	95·3	511·0	606·3	785·0	97·7	652·3	882·7	1535·0
	June 11	17·9	13·3	484·4	31·2	515·6	75·3	24·6	88·7	99·9	188·6
	July 16	405·5	238·6	59·7	644·1	703·8	739·5	138·3	145·1	877·8	1022·9
	August 13	6·9	11·9	—	18·8	—	18·8	20·2	2·9	39·0	41·9
	Sept. 10	1·8	5·8	56·2	7·6	63·8	3·0	3·6	0·5	6·6	7·1
	October 8	61·7	41·0	99·4	102·7	202·1	34·3	121·9	6·6	156·2	162·8
	Nov. 5	38·8	7·8	14·1	46·6	60·7	4·0	13·4	27·3	17·4	44·7
	Dec. 3	54·8	—	285·4	—	—	—	—	—	—	—
	1913.										
	January 28	18·4	5·1	27·4	23·5	50·9	—	—	—	—	—
	7-Day Mean	527·6	233·7	556·8	761·3	1318·1	491·8	471·8	1266·1	963·6	2229·7
9h. to 10h.	1912.										
	March 19	4·4	—	—	—	—	4·4	2·1	—	6·5	—
	April 16	132·3	898·6	267·3	1030·9	1298·2	429·9	160·0	1508·3	589·9	2098·2
	May 14	23·8	140·0	17·3	163·8	181·1	134·8	49·1	44·7	183·9	228·6
	June 11	14·2	23·3	307·3	37·5	344·8	27·1	52·7	7·2	79·8	87·0
	July 16	58·3	166·5	6·3	224·8	231·1	197·0	95·4	97·5	292·4	389·9
	August 13	9·0	15·2	—	24·2	—	18·7	15·5	2·3	34·2	36·5
	Sept. 10	11·7	11·6	38·9	23·3	62·2	31·4	6·3	5·7	37·7	43·4
	October 8	102·3	63·7	128·1	166·0	294·1	24·5	25·9	3·5	50·4	53·9
	Nov. 5	2·8	16·8	13·3	19·6	32·9	25·0	11·2	7·4	36·2	43·6
	Dec. 3	73·3	—	47·1	—	—	—	—	—	—	—
	1913.										
	January 28	32·3	13·4	7·3	45·7	53·0	—	—	—	—	—
	7-Day Mean	49·3	188·6	111·2	238·0	349·2	124·2	57·2	239·2	181·5	420·7

TABLE CVI.

$\frac{1}{12}\Sigma\eta^2$ within hours 17h. to 18h., and 18h. to 19h. at Cape Denison and Cape Evans.

Hour.	Date.	Cape Denison.					Cape Evans.				
		D	H	V	$\bar{H}$	T	E¹	N¹	V	$\bar{H}$	T
17h. to 18h.	1912.										
	March 21	11·2	—	—	—	—	24·1	7·2	7·5	31·3	38·8
	April 18	39·3	36·1	204·8	75·4	280·2	85·2	39·1	26·7	124·3	151·0
	May 16	17·1	8·1	6·0	25·2	31·2	5·4	38·6	8·3	44·0	52·3
	June 13	8·2	7·9	9·8	16·1	25·9	26·9	9·1	3·3	36·0	39·3
	July 18	1·6	2·3	3·0	3·9	6·9	2·4	4·0	0·8	6·4	7·2
	August 15	1·3	2·5	23·1	3·8	26·9	0·6	0·8	0·3	1·4	1·7
	Sept. 12	3·0	1·2	16·3	4·2	20·5	29·7	25·6	6·3	55·3	61·6
	October 10	72·5	197·6	23·5	270·1	293·6	11·2	57·0	26·2	68·2	94·4
	Nov. 7	2·9	1·4	3·6	4·3	7·9	10·5	21·9	16·4	32·4	48·8
	Dec. 5	99·0	—	—	—	—					
	1913.										
	January 2	380·9	—	192·8	—	—					
	January 30	9·8	5·6	28·7	15·4	34·1					
	8-Day Mean	18·2	32·1	36·3	50·4	86·6	21·5	24·5	11·0	46·0	57·0
18h. to 19h.	1912.										
	March 21	24·8	—	—	—	—	14·4	25·3	1·5	39·7	41·2
	April 18	34·9	192·0	381·8	226·9	608·7	254·5	67·0	12·8	321·5	334·3
	May 16	39·0	7·8	20·9	46·8	67·7	32·0	27·2	7·3	59·2	66·5
	June 13	30·3	6·8	5·6	37·1	42·7	29·6	2·8	5·9	32·4	38·3
	July 18	9·9	2·7	3·8	12·6	16·4	9·3	2·0	0·7	11·3	12·0
	August 15	2·5	1·6	2·6	4·1	6·7	2·5	2·8	0·7	5·3	6·0
	Sept. 12	7·8	28·8	48·1	36·6	84·7	67·8	10·2	3·9	78·0	81·9
	October 10	26·7	24·8	12·9	51·5	64·4	150·7	92·3	60·8	243·0	303·8
	Nov. 7	27·8	11·8	89·8	39·6	129·4	143·0	422·7	43·3	565·7	609·0
	Dec. 5	210·8	—	—	—	—					
	1913.										
	January 2	1551·8	—	596·6	—	—					
	January 30	65·9	11·3	48·3	77·2	125·5					
	8-Day Mean	22·4	34·5	70·7	56·9	127·6	86·2	78·4	16·9	164·5	181·5

§24.—" Activity " at Cape Denison and Cape Evans in Term Hours Compared.

As the comparisons in Chapters V and VII show, Cape Denison on the average was more highly disturbed than Cape Evans. But judged by the mean values of activity in the column T of Tables CV and CVII for the four term hours, Cape Evans would appear to be the more magnetically active station. Only in the interval 17h. to 18h. which was the least disturbed of the four hours separately, does the mean value T of the activity for total field at Cape Denison exceed that at Cape Evans. Further, though a casual inspection of several magnetograms for the two stations would suffice to leave the impression that the vertical component of the vector in the average disturbance was more subject to large fluctuations at Cape Denison than at Cape Evans, the tables for the two pairs of term hours show that only in the averages of the hours 17h. to 18h. and 18h. to 19h. for which corresponding data existed, were the values of vertical component activity at Cape Denison in excess of those for Cape Evans.

In the main this result is probably an accident of the selection of hours for comparison. Occasions in which the vertical component was more active at Cape Evans than at Cape Denison were noticed and there may have been an unrepresentative number of such occasions in the list of selected hours. In addition the difference of local time at the two stations was a not insignificant factor in introducing differences into the activity as at present measured on the average day. For though Cape Evans was only 1 hour 43 minutes ahead of Cape Denison it happened that the two sets of term hours were chosen at times when this difference in local time made itself most conspicuous in the ordinary diurnal variation. For partial information on this point reference may be made to Table CVII which gives the diurnal inequalities at the two stations for three pairs of approximately corresponding components, the inequalities being derived from all days of complete record in the months April to October, 1912, over which interval simultaneous registration was in progress. Plate VII is intended to represent the inequalities of Table CVII (or their nearest force equivalents). From these it will be seen that both in the earlier and later intervals of the day covered by the term hours, the rates of change in all components, but especially in the horizontal components at Cape Evans, were decidedly larger than the corresponding rates at Cape Denison. Since comparative quiet rather than disturbed conditions characterised the majority of the hours in the scheme, this difference between the two stations would make its maximum contribution to the difference in the values of the activities. That even on those days when $\frac{1}{12}\Sigma\eta^2$ is large, the values for Cape Evans mainly exceed those for Cape Denison is to be explained, first, on the circumstances of the choice of hours as indicated above; secondly, on the basis of the increase in amplitude of the regular diurnal variation on disturbed days, thus increasing the rate of change of field in the specified hours at one station (Cape Evans) more than at the other; and thirdly, to the known differences in the diurnal variation of disturbance at the two stations.

TABLE CVII.

Mean diurnal inequalities from all complete days April to October, 1912, at Cape Denison and Cape Evans.

		1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.
		′	′	′	′	′	′	′	′	′	′	′	′
Cape Denison...	D	+ 25·3	+ 20·1	+ 9·5	− 2·5	− 13·7	− 21·3	− 24·6	− 24·5	− 25·7	− 26·4	− 26·8	− 25·3
		γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
	H	− 8·7	− 12·9	− 15·8	− 20·4	− 20·3	− 18·0	− 16·2	− 16·5	− 9·2	− 4·9	+ 0·6	+ 5·5
	Z	− 18·1	− 30·0	− 37·5	− 36·1	− 32·2	− 20·9	− 10·3	− 5·7	+ 1·3	+ 4·9	+ 12·5	+ 18.0
Cape Evans ...	E	− 13·5	− 4·8	+ 5·0	+ 14·8	+ 20·9	+ 25·2	+ 27·9	+ 27·3	+ 24·0	+ 18·6	+ 12·2	+ 6·2
	N	− 21·5	− 25·8	− 26·5	− 25·5	− 21·1	− 13·5	− 6·7	+ 1·9	+ 8·7	+ 14·9	+ 18·1	+ 19·4
	Z	− 15·5	− 14·2	− 12·0	− 7·7	− 2·7	+ 0·9	+ 4·9	+ 8·3	+ 12·1	+ 13·7	+ 13·7	+ 14·2

		13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.
		′	′	′	′	′	′	′	′	′	′	′	′
Cape Denison...	D	− 16·6	− 10·3	− 2·5	+ 1·9	+ 5·1	+ 9·8	+ 11·3	+ 17·9	+ 25·5	+ 29·1	+ 31·4	+ 32·9
		γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
	H	+ 11·7	+ 12·6	+ 14·3	+ 13·8	+ 13·7	+ 13·5	+ 14·0	+ 12·7	+ 11·5	+ 9·0	+ 5·3	− 0·5
	Z	+ 18·0	+ 18·1	+ 17·3	+ 18·1	+ 13·7	+ 14·2	+ 17·7	+ 15·8	+ 15·7	+ 11·9	+ 2·4	− 8·7
Cape Evans ...	E	+ 2·7	+ 0·1	− 3·0	− 7·2	− 11·5	− 16·1	− 17·3	− 22·2	− 24·5	− 22·7	− 21·3	− 21·2
	N	+ 17·1	+ 16·7	+ 17·1	+ 17·2	+ 17·1	+ 13·9	+ 9·7	+ 3·9	− 1·0	− 5·3	− 11·0	− 18·0
	Z	+ 11·9	+ 11·5	+ 9·5	+ 5·7	+ 2·1	− 1·5	− 3·7	− 5·3	− 7·3	− 10·7	− 12·7	− 15·2

§25.—RANGES IN TERM HOURS: FROM 5-MINUTE AND EXTREME ORDINATES.

With the measurements of ordinates at 5-minute intervals now available, it was an immediate step to deduce the ranges within each hour based on these 5-minute readings. These ranges R_5 are given in Table CVIII. Then by measuring the ordinates afresh at the instants of maximum and minimum value in each hour, the extreme ranges Re supplied by Table CIX were obtained.

TABLE CVIII.

Term Hours: Ranges from 5-minute Readings.

	8h. to 9h.						9h. to 10h.					
	Cape Denison.			Cape Evans.			Cape Denison.			Cape Evans.		
	D	H	Z	E[1]	N[1]	Z	D	H	Z	E[1]	N[1]	Z
1912.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
March 19 ...	19	—	—	8	10	—	7	—	—	8	5	—
April 16 ...	157	114	157	110	158	230	60	97	56	60	57	131
May 14 ...	64	53	28	116	39	82	21	42	15	43	27	26
June 11 ...	16	12	82	36	15	29	12	18	69	22	22	11
July 16 ...	62	45	28	75	37	35	25	38	8	49	29	28
August 13 ...	10	13	—	16	18	6	10	12	—	13	14	4
September 10 ...	4	7	24	6	6	2	11	10	17	18	10	6
October 8 ...	29	21	30	25	38	7	34	27	46	18	19	7
November 5 ...	17	7	16	7	12	17	6	14	12	19	13	11
December 3 ...	21	—	54	—	—	—	37	—	22	—	—	—
1913.												
January 28 ...	14	8	20	—	—	—	21	19	10	—	—	—
7-day mean ...	50	37	52	54	44	57	24	35	32	33	25	31

	17h. to 18h.						18h. to 19h.					
	Cape Denison.			Cape Evans.			Cape Denison.			Cape Evans.		
	D	H	Z	E[1]	N[1]	Z	D	H	Z	E[1]	N[1]	Z
1912.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	
March 21 ...	10	—	—	18	8	8	17	—	—	14	16	5
April 18 ...	18	18	41	34	24	19	21	46	66	52	29	13
May 16 ...	17	11	7	9	24	12	17	8	15	21	16	10
June 13 ...	10	10	8	16	11	6	16	11	8	17	8	7
July 18 ...	4	5	6	6	7	2	10	4	7	10	4	2
August 15 ...	4	6	15	2	3	1	6	4	6	5	5	2
September 12 ...	7	3	13	19	17	11	11	20	25	30	11	7
October 10 ...	29	47	17	11	21	20	18	14	12	45	35	26
November 7 ...	6	3	7	9	15	14	20	12	38	54	75	31
December 5 ...	35	—	—	—	—	—	54	—	—	—	—	—
1913.												
January 2 ...	69	—	53	—	—	—	115	—	98	—	—	—
January 30 ...	10	9	17	—	—	—	27	9	27	—	—	—
8-day mean ...	12	13	14	16	15	10	15	15	22	29	23	12

TABLE CIX.

Term Hours : Extreme Hourly Ranges.

	8h. to 9h.						9h. to 10h.					
	Cape Denison.			Cape Evans.			Cape Denison.			Cape Evans.		
	D	H	Z	E^1	N^1	Z	D	H	Z	E^1	N^1	Z
1912.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
March 19 ...	20	—	—	8	10	—	8	—	—	8	5	—
April 16 ...	169	115	160	169	172	287	61	99	59	69	60	132
May 14 ...	65	58	34	116	40	87	23	42	15	48	32	31
June 11 ...	20	16	86	36	25	31	14	22	94	28	23	14
July 16 ...	64	47	31	78	38	38	27	40	8	55	31	29
August 13 ...	11	13	—	16	18	6	10	12	—	14	15	5
September 10 ...	6	9	24	10	7	4	12	10	17	18	10	6
October 8 ...	36	23	33	29	38	9	41	33	54	23	23	7
November 5 ...	17	9	16	9	12	17	7	15	13	20	13	12
December 3 ...	30	—	—	—	—	—	40	—	29	—	—	—
1913.												
January 28 ...	15	9	20	—	—	—	21	19	10	—	—	—
7-day mean ...	54	40	55	64	47	68	26	37	37	37	27	33

	17h. to 18h.						18h. to 19h.					
	Cape Denison.			Cape Evans.			Cape Denison.			Cape Evans.		
	D	H	Z	D	H	Z	D	H	Z	D	H	Z
1912.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
March 21 ...	13	—	—	19	8	8	19	—	—	15	18	5
April 18 ...	24	20	41	36	25	19	31	48	66	83	38	31
May 16 ...	18	13	9	21	24	12	18	9	17	21	20	13
June 13 ...	11	11	10	17	11	6	19	14	8	19	8	9
July 18 ...	5	7	6	6	7	4	10	4	7	10	5	4
August 15 ...	3	6	15	2	3	2	7	5	8	6	8	2
September 12 ...	8	4	13	20	20	11	12	23	25	38	11	9
October 10 ...	31	48	19	21	27	26	18	19	16	45	38	28
November 7 ...	6	5	7	13	15	14	20	14	38	55	78	31
December 5 ...	35	—	6	—	—	—	55	—	—	—	—	—
1913.												
January 2 ...	73	—	54	—	—	—	139	—	98	—	—	—
January 30 ...	11	11	17	—	—	—	29	12	27	—	—	—
8-day mean ...	13	14	15	17	16	12	17	17	23	35	26	16

Comparison of the two sets of ranges after conversion to force units showed some discrepancies in the sense that on a few occasions the directly measured extreme range Re was less than that derived from the 5-minute ordinates. The difference which seldom exceeded 2γ, and was more usually 1γ, was due to the difficulty of determining the real maximum and minimum ordinates on a trace run at an increased rate but with the usual sensitivity. For with a sensitivity of 8γ/mm. the setting of the scale at an instant when the ordinate differed from the true maximum or minimum ordinate by 0·25 mm. sufficed to underestimate the range by 2γ. Except with a laborious routine of trial and error, 0·2 mm. on a long slow curve is readily overlooked. All necessary adjustments were made so that in no case is the tabulated Re now less than the corresponding R_5. In both sets of tables of ranges a similar significance attaches to the 7-day and 8-day means as in the tables supplying the values of $\frac{1}{12}\Sigma\eta^2$.

It is obvious from a comparison of the means for Re and R_5 that the true (extreme) range at an Antarctic station may be very decidedly larger than the range derived from the ordinates even at the comparatively short interval of five minutes. In a particular hour the difference $Re-R_5$ may amount to 54% of R_5 as in the component E^1 at Cape Evans during the hour 8h.–9h. on April 16, 1912, when a short quick movement almost entirely between 8h.45m. and 8h.50m. was completely missed by the equidistant five-minute ordinates at these times. With a predominance of sharp oscillations so typical of Antarctic curves during really disturbed intervals such a difference between Re and R_5 might well be doubled.

§26.—The Constant C in the Relation $\frac{1}{12}\Sigma\eta^2 = CR^2$.

With the information of Tables CV–CVI and CVIII–CIX now available we are in a position to compute values of the constant C in the relation connecting activity and squared ranges on the basis of the two types of range, considering the diversity of magnitude of the constituents in the relation from hour to hour, it was not practicable to use averages even for the same groups of hours. Each of the hours and each component was, therefore, worked separately and then means derived for the four separate term hours and for the three components. These final means of the constants Ce and C_5 obtained respectively by using the extreme and 5-minute ranges are given in Table CX. All available pairs of estimates of activity and range have been utilised in forming the table, so that the number of individual values of the constants which have contributed to the separate entries for each hour and component are not the same for Cape Evans as for Cape Denison. Rejection of activities and ranges other than those for the seven common and complete days for the hours 8h. to 10h. and the eight days for the hours 17h. to 19h. would, however, leave the tabulated values of the constants practically unchanged.

TABLE CX.

Mean Values of C in the Relation $\frac{1}{12}\Sigma\eta^2 = CR^2$.

(Ce refers to extreme range: C_5 refers to range from 5-min. ordinates.)

Ce.	Cape Denison.				Cape Evans.			
	D	H	V	Mean three components.	E^1	N^1	V	Mean three components.
8h to 9h ...	·0748	·0761	·0804	·0771	·0679	·0802	·0829	·0770
9h to 10h ...	·0645	·0795	·0748	·0729	·0687	·0692	·0824	·0734
17h to 18h ...	·0749	·0648	·0880	·0759	·0685	·0808	·0711	·0735
18h to 19h ...	·0745	·0788	·0684	·0739	·0652	·0642	·0643	·0646
Means	·0722	·0748	·0779	·0750	·0676	·0736	·0752	·0721
C5.	Cape Denison.				Cape Evans.			
8h to 9h ...	·0975	·0990	·0908	·0952	·0896	·0938	·1132	·0989
9h to 10h ...	·0775	·0882	·0870	·0842	·0835	·0781	·0966	·0861
17h to 18h ...	·0869	·0962	·1002	·0944	·0935	·0898	·1157	·0997
18h to 19h ...	·0903	·1064	·0775	·0914	·0816	·0889	·0993	·0899
Means	·0876	·0975	·0889	·0913	·0871	·0876	·1062	·0936

Results that emerge from an examination of Table CX are :—

1. The comprehensive mean Ce for all hours and all three components is only 80% of the mean value for C_5 taking both stations together.
2. These mean values of the constants in the activity-range relation are substantially higher than the values derived from the quick-run records at Cape Evans during 1911. Compared with the values ·072 for Ce and ·094 for C_5 in Table CX, the corresponding values in 1911 were ·059 and ·077. Since it is unlikely that the evaluation of the ratio $\frac{1}{12}\Sigma\eta^2/R^2$ from all the stations co-operating in the schedule of hours for 1912–13 would result in a value appreciably greater than that derived for the previous year, ·094, the result suggests that the apparent fall in the value of the ratio with increasing latitude shown by the earlier data was fortuitous. Results from a more extensive series of term hours would probably confirm that a single value of the ratio $\frac{1}{12}\Sigma\eta^2/R^2_5$ is universally valid provided magnetographs of comparable sensitivity are used in the registration.
3. With the exception of the decrease in the value of C_5 from H to Z at Cape Denison, the means for all four hours for both types of constant are related $C_D < C_H < C_Z$ or the equivalent $C_{E^1} < C_{N^1} < C_Z$ at Cape Evans.
4. The means for all three components both for Ce and C_5 are highest for the individual hour 8h. to 9h. at Cape Denison. At Cape Evans the hour 17h. to 18h. is greatest for C_5.

CHAPTER V.—LONGER DISTURBANCES.

§27.—Summary of Prominent Features.

Some 24 disturbances of longer duration than those discussed in Chapter I have been selected from the Adelie Land records for description of the major features of interest and comparison with the simultaneous records of the disturbances at Cape Evans. For the latter purpose the selection was necessarily confined to the seven months, April to October, 1912. Dates and, when the disturbance did not continue over the entire day, times for each disturbance are provided by the first section of Table CXI. Other details relating to the extreme range within the disturbance and the times of occurrence of highest and lowest value of each component are furnished by the same table. The average duration of the disturbances was about 10½ hours.

The following sections contain brief résumés of the chief movements in each of the listed intervals.

(*a*) April 5, 18h., to April 6, 5h.

Irregular movements in the earlier hours of April 5 had left the azimuth of the horizontal field west of the normal orientation (6°5′ west of north) for that epoch, and though large fluctuations were superposed on the general trend from time to time, that direction of the field persisted throughout the disturbance. The largest deflection from the mean position occurred between 18h.40m. and 20h.45m. when the disturbing vector produced a westward rotation exceeding 6° of the whole field. During the same interval and in contrast to the activity in the E–W direction the component vectors in the meridian and vertically downward remained practically steady. In both these components the striking features were long period increases and decreases of field strength roughly in phase, the longest with maxima at 21h.10m. and 3h.12m. and with an intervening minimum at 0h. being synchronous with a similar variation in N′ (the component directed 7°36′ east of true north) at Cape Evans.

As opposed to the parallelism between the H and Z vector changes at Cape Denison, the Z trace at Cape Evans showed no characteristic oscillations similar to those in the prime meridian plane on the other side of the south magnetic pole. A comparatively featureless slow rise of field strength to 21½h. and a subsequent slow fall to 4h. on April 6 has no parallel in the vertical component changes at Cape Denison.

(*b*) April 10, 6h. to 12h.

This disturbance chiefly affected the field transverse to the meridian. Though an underestimate due to loss of trace in a major fluctuation, the extreme range in D was 264 minutes of arc equivalent to 238 force units, while the range in the meridian vector was only 106γ. After an interval of highly oscillatory movements near the opening of the disturbance, the charges in D were such as resulted from an eastward directed disturbing vector, increasing then relaxing with constant superposed fluctuations. The average resultant azimuth in the horizontal plane was well to the east of the normal magnetic meridian.

The variation in Z had points of resemblance to those in D as well as H. A badly formed bay movement from 9h. to 10h.5m. was approximately simultaneous with the epoch of extreme easterly elongation in D.

(*c*) April 15, 1h. to 14h.

Except for minor perturbations of moderate amplitude from 18h. to midnight on April 14, conditions prior to the outbreak of this disturbance had been fairly quiet. From 0h. to 4h.46m. on April 15 the field strength in the meridian decreased with the usual superposed fluctuations; followed a period of increase to a maximum at 11h.16m. after which time it fell steadily to normal at 14h.

In declination the cause of the disturbance was more irregular. From the outset the tendency was for the vector to rotate in a westerly direction, reaching a maximum in that direction at 2h.23m. and returning approximately to the original orientation at 8h.10m. The easterly trend of this last phase of the movement continued to 11h.10m., 4 minutes before the maximum value of the meridian disturbance vector was attained. A final return swing to west occupied the remainder of the line of the disturbance. During the entire interval, the declination trace was so highly oscillatory that identification of turning points was made with difficulty.

Not only did many of the shorter period perturbations in the vertical field closely resemble simultaneous changes in H, but the slower movements in the general trend of the two fields was similar. Only from 3h.30m. to 6h. when, indeed the parallelism in the minor changes was most close, was there any noticeable tendency to opposition in the major variations. While H continued to decrease till 5h., Z had already reached a well defined minimum at 3h.36m.

The main changes in the horizontal field components at Cape Denison compared closely with the synchronous changes at Cape Evans. But the slow decrease in Z at this latter station from beginning to end of the disturbance with no distinctive oscillations superposed is entirely different from the vertical field changes at Cape Denison. There is only a feeble analogue in the Cape Evans traces for the succession of three well marked oscillations in Z and H between 5h. and 6h. at Cape Denison.

High sensitivity in the declination variometer as well as the persistence of short period oscillations throughout the disturbance make a detailed intercomparison between the movements in D at Cape Denison and E[1] at Cape Evans difficult, but a general sympathy of movement seems to be the prominent feature.

(*d*) May 12, 0h. to 14h.

As on April 15, the disturbance beginning about midnight on May 11 was preceded by an interval of comparative quiet. The vector along the meridian in the horizontal plane was at first directed northward and continued increasing in this direction till 3h.40m. when a gradual decrease lasting for $7\frac{1}{2}$ hours set in. Between 11h.10m. and 11h.20m. there was an accelerated decrease of H amounting to 120γ in that interval followed by a rise, partly sudden, to an approximately normal value at the time of completion of the disturbance. Except during the almost stationary period in H preparatory to the sudden decrease at 11h.10m., when the meridian disturbing vector simply fell away gradually, the vertical field changes showed a remarkable parallelism to those in H. Even of the smaller fluctuation in the latter very few were not clearly mirrored in the Z trace.

Soon after the opening of the disturbance (1h.33m.) the disturbing field across the meridian and directed westward reached its maximum and thereafter the direction was mainly east of the normal meridian. During the latter interval there were two large oscillatory excursions of almost equal amplitude to the east, the extreme positions being attained at 7h.35m. and 11h.17m. The latter was approximately synchronous with the sudden changes answering to increasing field strength in the prime meridian components. The changes in the movement are summarised thus :—

Component.	Time.	Magnitude.	Direction.
D	11h.5m. to 11h.17m.	123′·8 ≡ 112 γ	Eastward.
H	11h.7m. to 11h.19m.	123 γ	Increase.
Z	11h.8m. to 18h.18m.	97 γ	Increase.

(*e*) May 12, 21h. to 24h.

This disturbance was one of the shorter among the twenty-four selected for description and consisted essentially of a double oscillation regularly described by all three components superposed on a slow uniform change of field along the three orthogonal directions. The oscillation was best developed in the vertical field component. Though the duration (1h.12m.) of the first half of the oscillation there exceeded the second (55m.) and the amplitude of the second (35·4γ) exceeded that of the first (19·3γ) the mean trend of the Z trace at the end of the oscillation was in continuation with that at the beginning, implying a progressively decreasing main field during the operation of the deflecting vector.

In D and H the first of the movements answering to increasing west declination and decreasing meridian field strength had the longer duration and greater amplitude; the second movement of the oscillation was only just observable in H but prominent in D.

A single bay disturbance attributable to EW then WE superposed vectors transverse to the meridian and a component directed first to S then to N in the direction of the meridian, both phases being effected in the interval 21h.20m. to 23h.10m. were the chief features of the later part of the disturbance.

(*f*) May 13, 0h. to 14h.

Only a short interval relatively free from large perturbations separated the disturbance of May 13 from that just described, otherwise the two outbreaks might have been treated together. See Fig. 18.

Following on the continued rise in the value of H and increase in westerly deflexion in D during the last hour of May 12, both these elements proceeded to vary in phase till 8h.3m. on May 13. Two bay-like movements of long period, the earlier 50% longer in duration than the second, occupied the time till 5h.15m., after which there was an interval of comparative quiet. Beginning at 7h. a third oscillation of decidedly smaller range lasted till 8h.3m. Up to 6h. the changes in H and Z were mainly in step with those in declination, increasing values of the field strength in these components corresponding with increasing easterly D. The third of the oscillations in the two force components coincided with a westerly movement in D.

Between 8h.20m. and 8h.42m. two rapid oscillations in declination directed east-west-east synchronised with rapid rises in both the vertical and meridian field strengths. In the former a rise of 224γ occurred between 8h.20m. and 8h.37m. and in the latter a rise of 82γ occurred between 8h.35m. and 8h.42m. A further slow increase in H and a decrease to normal strength in Z from 9h. to 14h. answered to a progressive westward movement in D. All components were frequently interrupted by minor oscillations of brief period.

Remarkable differences and similarities in the progress of the elements at Cape Denison and Cape Evans during the disturbance of May 13 are to be noted. The parallelism between the H and Z traces during the bay-like movement centred about 1h.30m. at Cape Denison, has no counterpart at Cape Evans in the behaviour of either of the corresponding components N^1 and Z. There is, on the other hand, considerable similarity in the variations of declination at Cape Denison and E^1 at Cape Evans. Attention is most strikingly attracted, however, by the absence of any analogue at Cape Denison to the sharp movement between 5h.50m. and 6h.30m. in all three components at Cape Evans, and conversely to the absence at this latter station of any movements of dimensions and characteristics similar to those which are prominent in the Cape Denison magnetograms about 8h.30m.

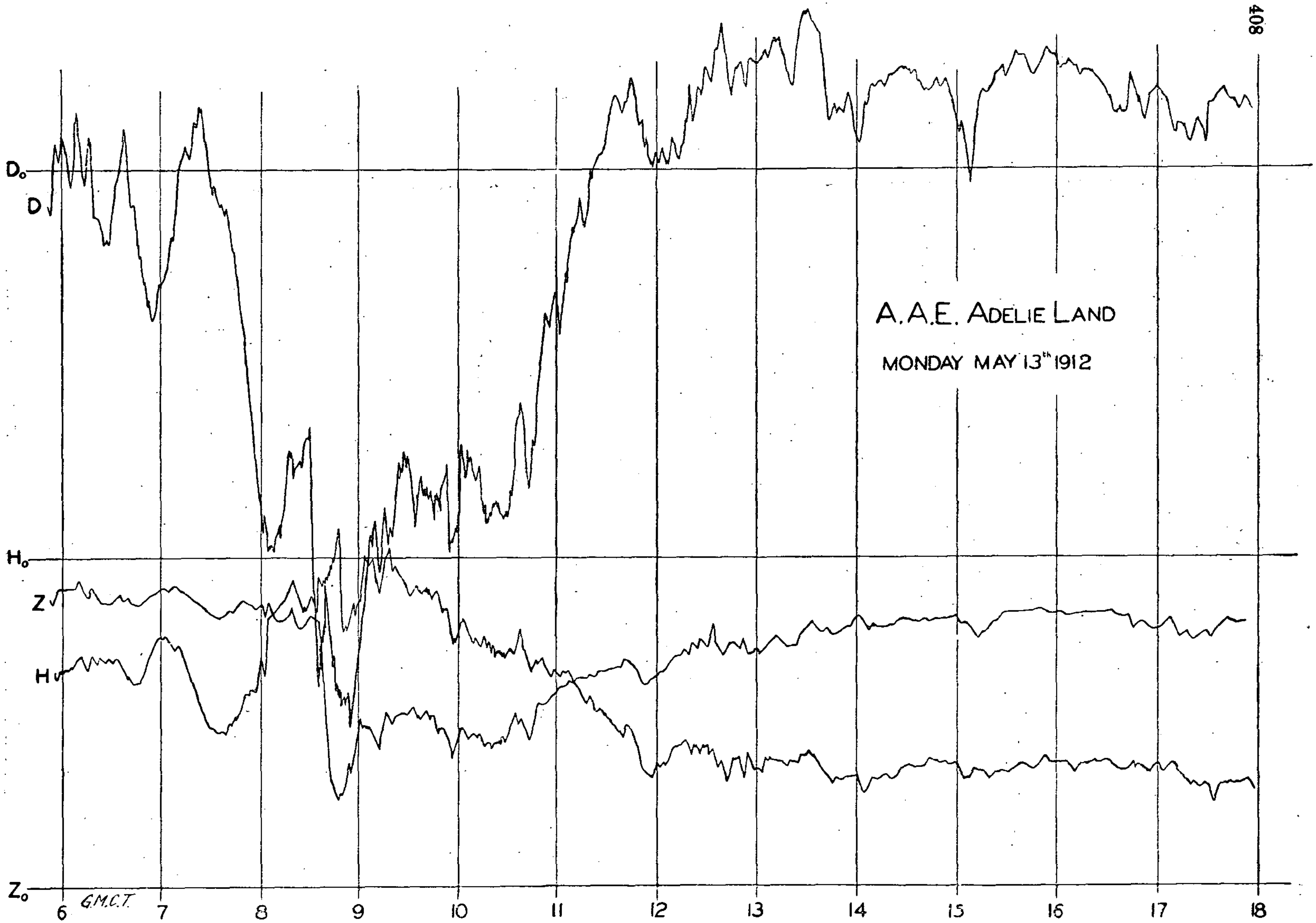

Fig. 18—A tracing of the Magnetograph curve of May 13th, 1912; Cape Denison.

(*g*) June 8.

The subdivision of the disturbance on June 8 and 9 does not mean that four separate and independent outbreaks of disturbance were discernible in the records from Cape Denison. On the contrary, from 21h. on June 7 till the early hours of June 9 there was no interval undisturbed in at least one component. The subdivisions had been resorted to in the investigation on the basis of the records from Cape Evans (*vide* Brit. Ant. Expedition, 1910–13, Terrestrial Magnetism, Section 120), simply to allow comparison with curves for various parts of the disturbance contributed by other stations. The adoption of the same subdivisions in the present examination therefore facilitates comparison between events in the same limited intervals at these other stations.

2h. to 5h.

The main movements in H and Z executed with remarkable parallelism of variation and closeness of phase were two bays, the first a "negative" bay answering to a rise followed by a fall in the value of the two fields (always considering a rise in Z in the Antarctic as the equivalent of a decrease of dip indicating a numerical decrease in the vertical field strength there), and the second, following after about 16 minutes, a bay of the usual type. These movements occupied the time from 3h.15m. to 4h. 35m. They were preceded by two smaller perturbations of shorter period and smaller amplitude. Two major eastward deflexions in D corresponding to the bays in the force traces were interrupted by oscillations of range not less than that of the bays.

6h. to 8h.

In place of the well developed "disturbance of special type" shown on the Cape Evans magnetograms from 6h.55m. to 7h.50m., disturbances in H and Z Adelie Land in the interval between 5h.40m. and 8h.10m. took the form of a succession of two bays of inconspicuous range. Simultaneously, declination was highly variable in short period movements and, except for an eastward increase approximately synchronous with the second bay in the force components, showed no obvious correspondence.

10h. to 16h.

During this part of the disturbance also, magnetic events at Cape Denison and Cape Evans differed markedly. From 10h. to 12h.36m. there was nothing of prominence. But at 12h.36m. a rapid increase in H and Z coincided with a rotation of the disturbance vector to the east, and, after reaching simultaneous turning points at 12h.45m., a reverse tendency continued in all components till 13h.12m. when the fall abruptly ceased. A short interval of renewed increase in the horizontal and vertical field strengths was followed about 13h.25m. by a period of unusual oscillation in all three components. Rapid changes of large amplitude and extremely short period (a small number of minutes) made a certain scrutiny of the progress of events from 13h.25m. to 14h.15m. impossible. On the whole, however, the mean-value of Z was well above its normal value, with H slightly below and D to the east of the normal meridian azimuth.

19h. TO 22h.

During these hours the form of the disturbance was primarily a bay of long period, the disturbing vectors deflecting D first east then west and, both in the horizontal meridian and vertical fields, answering in the first phase to a decrease and in the second phase an increase of the average field strengths.

(*h*) JUNE 9, 0h. TO 5h.

Another shallow bay of long period in which H and Z were subjected to forces tending to decrease the fields in the first part of the disturbance and then restore them to normal strength in the second part characterised the early hours of June 9. The fall in the force vectors of the prime meridian had ceased by 2h.30m. Simultaneously declination increased in a slow drift to west then east. These changes in the three components were frequently interrupted by minor perturbations of considerable amplitude in the horizontal meridian and vertical fields. Centred at 0h. and with a duration of two minutes a sudden west movement in D was equivalent to a disturbing field from east to west increasing at the rate of 40γ per minute.

(*i*) JUNE 27, 6h. TO 12h.

Interrupted by a slight inverted bay between 6h.15m. and 6h.58m., the disturbing vector along the magnetic meridian increased gradually from 6h. to 8h.37m. when an accelerated increase forming the first phase of a larger movement like an inverted bay set in. The subsequent decrease in value of the component from 9h.10m. to 10h.30m. was more gradual. Between 6h.15m. and 7h. the vertical component of the field also increased and decreased; then, after remaining steady except for minor oscillations till 8h.40m., the main bay in H was echoed in Z though on a reduced scale. No declination record was available for the disturbance.

(*j*) JUNE 27, 22h., TO JUNE 28, 2h.

This a further example of an inverted bay (increase then decrease) in the two recorded force components. The traces were much interrupted by minor oscillations. There was no D trace.

(*k*) JULY 31, 14h., TO AUGUST 1, 8h.

A large movement of bay type beginning at 3h.10m. on August 1 and continuing for three hours was superposed on the progressive decrease in the horizontal and vertical fields which had set in at the commencement of the storm. The form of the bay in Z remained flat from the end of the first (decreasing field strength) movement at 3h.42m. till 4h.30m. when the return rise to the original normal value set in. D meanwhile was highly oscillatory about a mean azimuth which was westward of the undisturbed meridian.

(*l*) AUGUST 18, 14h., TO AUGUST 19, 6h.

Within the main part of this disturbance, which was comprised between 18h. on August 18 and 5h. on August 19, the chief movement occurred from 20h. to 21h.30m. Between 20h.7m. and 20h.35m. the change in declination was equivalent to an east to west deflecting vector of 203γ and was followed by an eastward directed vector, interrupted by the usual minor oscillations, of 250γ between 20h.54m. and 21h.32m. Corresponding with these, the changes in the vertical field were more spectacular than those along the meridian in the horizontal plane. For Z increased by 390γ between 20h.36m. and 21h.13m. and the subsequent fall, though not completed till midnight of August 18 was of equal range. Until 23h.30m. H was mildly perturbed by minor oscillations, then followed two comparatively shallow bay movements, the earlier of which synchronized with a westerly change in D and a slight bay superposed on the gradual decrease which was proceeding in Z.

(*m*) AUGUST 19, 9h. TO 10h.

This movement has been selected in the discussion of the Cape Evans records because of its isolation and as exemplifying a typical "disturbance of special type." Somewhat similar characteristics to those at Cape Evans are present in the Cape Denison traces, though as usual, the real generic features of the special type are not well defined.

In both H and Z a simple oscillation, the direction of change of whose first phase answered to a decrease in field strength, took place simultaneously with an easterly change in declination. The duration of the latter, as was frequently the case, exceeded the duration of the oscillation in H or Z. As shown by the ranges for the hour given in Table CII, the movements were of similar amplitude in all three components. This disturbance is reproduced as Plate XIII.

(*n*) SEPTEMBER 17, 11h. TO 23h.

A detailed account of this disturbance is given in Chapter VI.

(*o*) SEPTEMBER 18, 0h. TO 14h.

The disturbance of the previous day continued spasmodically till about 14h. on September 18, the only intervals of comparative quiet—though always interrupted by minor fluctuations—being most evident in the force vectors of the meridian plane. From 0h. to 2h. a bay movement characterised all components with ranges of 181γ in H, 133γ in Z and 227·5 minutes of arc in D, the last being equivalent to an east to west disturbing force of 206γ. As in all direct bays the commencing movements in H and Z corresponded to a diminution of the normal field strength with the return movement not so complete or deliberate as the first.

Further subsidiary perturbations centred at 4h. and 6h.25m. occurred in H and Z with a smaller one mainly in H at 7h.35m.; movements of considerable irregularity and not in phase with those in the force components were proceeding in D during the same period. Then after 3½ hours of moderate quiet a sharp movement in all three components set in at 11h.29m., and in the subsequent 11 minutes H increased by 77γ, Z by 104γ and the exchange in declination, 85·5 minutes of arc, was equivalent to an east force of 78γ. Subsequent movements in all components were highly oscillatory, Z about a mean position at the culmination of an inverted bay initiated by the movement just described, H after a rapid rise and fall superposed on the major outline of a bay synchronous with that in Z and D during a similar rapid reversed excursion to west.

(*p*) September 24, 0h. to 14h.

All the disturbances hitherto described have had their main trend frequently interrupted by the additional perturbations of very local origin which are conspicuous on the records for most days at Antarctic stations. Such perturbations were singularly absent during the earlier part of the disturbance on September 24. Except for a temporary arrest of the major variation between 2h.20m. and 3h.10m., the strength of the horizontal field along the meridian fell continuously from 1h.45m. to 3h.56m. Between 3h.5m. and 3h.56m. the decrease was 175 γ; the total decrease from the opening of the disturbance was 336 γ. After 4h. H increased systematically till the end of the disturbed period. The trend in Z was similar. A fall of 229 γ from 0h. to 3h.35m. was succeeded by a continuous rise of 359γ to 9h.50m. with a subsequent fall of 140γ to a normal level at 12h.17m. In the main rise therefore, the variations in these components of the disturbance field were attributable simply to a much enhanced development of the regular disturbed day variation. Though additional perturbations were more evident than in H and Z, the same is true of the tranverse disturbing field. The greatest westerly elongation at 3h.26m. was attained after two hours of rapid oscillation, culminating in an E to W movement of range 2° 6′ executed within 27 minutes. A further bay movement equivalent to the super position of an east-divided disturbing force of 355γ and a return movement to W of 266γ brought the meridian to normal azimuth by 12h. 14m.

About 10h. some small oscillations were visible in all three components, the largest in H was of range 42γ, in Z 51γ, and D 61′ or 55γ in west force.

(*q*) September 24, 14h., to September 25, 2h.

Remarkably steady general conditions persisted from 14h. to 19h. with the only interruptions a succession of fairly regular oscillations in D and H, which were only partially recognisable in Z. Just after 19h. a larger bay movement began in D, reached a westerly elongation at 20h.58m. and remained in an oscillatory state there till 23h.14m. when the reverse eastward movement interrupted by further oscillations brought the trace to a normal position by 2h. The mean range in D during the day was 3°. H and Z were also affected by the disturbance field but the changes were not in phase with those in the EW component or with each other. The period of the oscillation was shorter in H and Z than in D and the mean minimum position reached later. Further, though the fall of 185γ in Z was almost equal to the rise, as in D, the main fall in H was partially counterbalanced by an immediately preceding rise; the oscillation in H was rather of the nature of a double oscillation about the mean. All three components were considerably affected by minor perturbations till 6h. on the 25th. This disturbance is reproduced as Plate XIV.

(*r*) SEPTEMBER 30, 21h., TO OCTOBER 1, 8h.

A clear sudden commencement (impetus) beginning at 21h.34m. on the 30th September after an exceptionally quiet period of 10 hours opened a moderate disturbance which continued for 20 hours.

The direction and magnitude of the constituent movements in the S.C. were as follows :—H fall 32γ, then rise 93γ.

Z fall 52γ, then rise 81γ.

D to east 44′ then west 44′ (≡ 40γ E then W force). The turning points in the oscillation were partially masked by minor movements. The S.C. was equally clearly recorded at Cape Evans, and there the directions of change of N[1] and Z in the two parts of the movement were the reverse of those at Adelie Land. In the EW direction the vector component was in the same sense at the two stations.

After the S.C., H strengthened slightly to 24h., and, after a short decrease rose 309γ between 2h.46m. and 3h.35m., when followed an almost linear fall of 437γ to 5h.48m. with a subsequent slow rise of 269γ to 15h. The only additional perturbation of note occurred between 23h.45m. and 0h.50m. Z was decidedly more affected by superposed oscillations than H, but, on the whole, its value fell after the S.C. to 4h.28m., most of the fall (266γ) taking place in the $2\frac{1}{2}$ hours preceding the minimum. A recovery of 244γ had been made by 7h.50m., and thereafter it continued a slow rise to slightly beyond its normal value at 11h.50m. Declination showed the usual oscillations at all phases of the disturbance. Slightly west of normal at the outset, γ made a series of rapid excursions to E, of which one between 0h.25m. and 0h.47m. ranged through 160′. A slower return movement to W with incessant minor interruptions preceded a further large eastward drift from 3h.12m. to 8h.12m. and a reverse change from east to west through 6° 9′ lasting till 14h.47m.

(*s*) OCTOBER 12, 20h., TO OCTOBER 13, 13h.

With continuous minor perturbations of no great amplitude, H fell from 21h. 35m. to 3h.10m., then increased to 10h.30m. Between 5h.42m. and 5h.52m. there was a rise of 107γ in a sharp oscillation. Z was similarly affected, except that after the initial period of fall the rise was more gradual. A quick rise of 59γ in the 12 minutes preceding the maximum at 10h. was synchronous with a smaller rise of 40γ in H. In both these components the epochs of maxima and minima were again roughly those of the regular disturbance variation. The same is true of D. As H and Z fell, D increased to west with much oscillatoriness. Near the turning point at 0h.35m., a sudden E then W movement had a range of 2° 6 ′(≡ 106γ).

(*t*) OCTOBER 14, 6h., TO OCTOBER 15, 6h.

A succession of oscillatory perturbations of nearly equal amplitude superposed on the usual disturbance variation in all three components was the chief feature of this disturbance. Though specially conspicuous in D, the oscillations were mainly prominent in H and Z, and in these components were almost, if not quite, in phase.

The starting time of D most frequently was earlier than that for the two force components and the completion of the swing later. Details of some of the movements are as follows, using — to indicate a fall, + a rise, and E and W to indicate movements to east and to west in declination.

	7h. 40m to 9h.	11h. 20m. to 12h. 20m.	12h. 42m. to 13h. 30m.	13h. 46m. to 14h. 45m.	16h. 22m. to 16h. 40m.	18h. 30m. to 20h. 10m.	12h. 0m to 12h. 18m.
H ...	— 60γ, + 90γ	+ 40γ, — 20γ	+ 34γ, — 38γ	+ 50γ, — 47γ	+ 46γ	+ 48γ, —36γ, + 34γ, — 64γ	+ 60γ
Z ...	....	+ 52γ, — 59γ	+ 55γ, — 74γ	+ 52γ, — 78γ	+ 70γ	+ 81γ,— 37γ, + 48γ, — 85γ	+ 140γ
D ...	E 105′, W 80′	E 40′, W 45′	E 45′, W 85′	E 37′, W 74′	....	E 65′, W 48′, E 40′, W 46′.	E 58′

Between 0h. and 20m. and 0h.45m., D increased E 5° 40′; in the same interval Z first increased 141γ, then decreased 47γ; H showed minor oscillations of unimportant magnitude.

Overlapping the time of sudden increase of 94γ in H, and 274γ in Z during a period of 25 minutes centred at 2h., D increased E by 106′ equivalent to an east directed force of 96γ. This was really the first movement of a succession of four from 0h.48m. to 5h.33m., all being easily recognisable in the three components and with the major turning points approximately synchronous in H and Z though not always in D.

A small but conspicuous oscillation of the sudden commencement type appeared about 5h.45m. The chief changes were H + 67γ, Z + 47γ, D W 74′ (≡ 67γ).

(*u*) October 20, 17h., to October 21, 1h.

Another period of freedom from considerable disturbance was broken by a poorly developed S.C. at 17h.22m. on October 20. The chief movements in the subsequent activity were completed by 1h. 30m. on the 21st.

In the " commencement " itself, the superposed field lowered the values of H and Z while D increased to W, the magnitudes being H and Z=7γ and D=13′ (≡ 12γ). Only four (or five) perturbations of bay type were superposed on the general trend which again took the form of a simple enhancement of the regular variation in all three components. The most prominent of these additional perturbations occurred between 23h.15m. on the 20th and 0h.28m. on the 21st, the three components varying in phase. From 23h.15m. to 0h., H and Z rose 151γ and 263γ respectively; the equivalent increase in E force was only 58γ. Over the 45 minutes to 0h.30m. (*i.e.*, including the preceding movement), H increased by 289γ and Z by 321γ. An eastward movement in D between 23h.46m. and 0h.1m. had a range of 142′, being only 4′ short of the extreme range for the whole disturbance.

§28.—Extreme Ranges in Disturbed Intervals at Cape Denison and Cape Evans.

The preceding descriptions of the broad outlines of force changes in 24 selected disturbances at Cape Denison provide no basis for a numerical comparison with disturbance recorded at other stations. But such a comparison with the other recording station in the Antarctic, Cape Evans, is of more than usual interest, more especially when it has been found that records covering the same disturbed period at the two stations differ so conspicuously in many of the major movements. While it is realised that the ideal foundation for comparison must be on the lines proposed by Bidlingmaier, even the next best substitute for the "activity integral" in the form of squares of ranges of force variations within small time intervals is associated with an expense of labour incommensurate with the value of the results to be derived. This is especially the case with such records as those from Cape Denison in which loss of trace from an extremely high oscillatoriness in one or more of the traces was partly overcome by the use of a double mirror so that part of the trace was frequently continued from off the top on to the bottom of the sheet.

With as many as 24 disturbances for comparison the average value of the extreme range of force variation encountered during each disturbed period will provide at least a rough comparative measure of the force changes and if current theory is well founded the squares of these extreme ranges should roughly measure the "activity" of the disturbing vectors. It is to be noted, however, that such measures will refer only to the major and more widely acting forces and can take little or no account of the local perturbing fields which impress short period fluctuations on the large scale field changes. A further consideration of such period activity is made in Chapter VIII.

The extreme ranges of the components D, H and Z at Cape Denison, together with the lines of occurrence of the maximum and minimum values, have been measured for the 24 disturbances whose main characteristics have already been summarised. The corresponding extreme values and times recorded in the same intervals at Cape Evans have been similarly measured. Both sets of data are supplied by Table CXI. The range in D is given in terms of its equivalent in force units as well as in minutes of arc. Since declination at Cape Denison during 1912 was 6°·5 west of north the equivalent force ranges relate to a disturbing vector component directed along a line 6°·5 south of west. No D record is available for the disturbances on June 27 and part of June 28.

N′ at Cape Evans, it will be remembered, is the component directed 7°36′ east of north and E′, 7°36′ south of true east. Z, the component directed radially downwards is, therefore, the only element providing strictly comparable data for the two stations. It may also be recalled that the average values of the horizontal meridian fields at Cape Denison and Cape Evans during the period covering the common disturbances were roughly proportional to the distances, 575 miles and 795 miles respectively, separating the two stations from the supposed locality of the south magnetic pole (71°10′ S, 15°45′ E). The horizontal field strength towards the pole at Cape Denison was ·030 gauss and at Cape Evans ·043 gauss. The stations were approximately 900 miles apart.

TABLE CXI.

Longer Disturbances: Ranges at Cape Denison and Cape Evans.

From.		T		Cape Denison.						Ranges.						
				D		H		Z		Cape Denison.				Cape Evans.		
				Max.	Min.	Max.	Min.	Max.	Min.	D		H	Z	N′	E′	Z
	h.		h.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	′	γ	γ	γ	γ	γ	γ
April 5	18	April 6	5	3 12	20 45	3 9	0 2	3 28	0 8	403	363	233	224	208	311	101
„ 10	6	„ 10	12	9 30	6 12	10 35	9 0	9 36	6 3	<264	<238	106	134	228	162	131
„ 15	1	„ 15	14	11 10	2 23	11 16	4 46	11 30	3 36	338	304	261	490	207	248	139
May 12	0	May 12	14	7 35	1 33	11 24	3 40	11 22	3 39	315	284	214	350	300	226	116
„ 12	21	„ 12	24	21 19	22 13	23 20	22 35	23 5	22 10	182	164	98	184	106	180	36
„ 13	0	„ 13	14	8 40	1 30	13 54	8 33	8 37	1 25	407	366	209	369	382	247	306
June 8	2	June 8	5	4 5	2 15	2 25	4 20	5 0	4 10	100	90	171	129	116	101	55
„ 8	6	„ 8	8	6 10	6 27	6 42	7 20	8 0	6 18	61	55	60	62	78	163	86
„ 8	10	„ 8	16	14 0	14 52	13 45	13 52	13 35	12 15	464	418	337	416	197	151	124
„ 8	19	„ 8	22	19 5	20 35	19 42	20 30	21 48	20 13	187	168	80	124	59	152	38
„ 9	0	„ 9	5	4 40	0 5	0 2	2 18	0 1	2.18	139	125	147	124	215	164	150
„ 27	6	„ 27	12	No record.		6 15	9 10	10 35	6 32	—	—	131	91	153	140	95
„ 27	22	„ 28	2	No record.		22 20	3 57	1 40	23 57	—	—	88	119	93	101	23
July 31	14	Aug. 1	8	4 44	23 0	17 44	4 30	17 46	3 44	209	188	310	207	196	323	324
Aug. 18	14	„ 19	6	3 15	20 35	22 25	4 5	21 12	3 58	364	328	173	394	188	302	82
„ 19	9	„ 19	10							60	54	64	64	102	87	63
Sept. 17	11	Sept. 17	23	12 55	20 35	17 40	22 20	19 0	20 25	372	335	181	165	256	302	119
„ 18	0	„ 18	14	11 40	1 2	11 40	11 58	11 50	0 49	303	273	215	330	260	227	87
„ 24	0	„ 24	14	9 52	3 25	1 45	3 58	9 54	3 32	360	324	339	351	351	244	210
„ 24	14	„ 25	2	1 43	21 12	23 52	23 10	1 0	23 36	206	185	156	215	265	200	103
„ 30	21	Oct. 1	18	8 10	0 26	3 33	5 48	11 43	4 30	284	256	445	333	226	288	180
Oct. 12	20	„ 13	12	11 15	0 35	21 34	2 15	10 30	5 42	301	271	171	185	216	246	109
„ 14	6	„ 15	6	8 15	23 52	16 42	4 15	21 54	4 17	470	423	257	364	336	477	162
„ 20	17	„ 21	1	23 25	23 46	23 42	0 40	23 31	0 29	146	131	360	324	180	110	122
Means of 24 ranges (except for D at C.D.)											243 (22)	200	239	205	211	123

Since both stations were well within the auroral zone whose limits are critical for the definition of the primary features of disturbance in polar regions, it might have been anticipated that the effects of disturbance on the component of the horizontal field directed along the meridian would be approximately equally pronounced at both the Antarctic stations; while from the very sensibly smaller controlling field at Cape Denison, force variations in an EW direction would produce much larger ranges in the component along this direction at Cape Denison than at Cape Evans. There would have been little foundation either in fact or theory for a forecast of the average behaviour of the vertical disturbing vectors.

The expectations as regards the horizontal components are generally confirmed by the mean values of the range over the 24 disturbances. Only 5γ in a range of 200γ differentiate the mean ranges of the vector component along the meridian, that at Cape Evans being the higher, but the corresponding ranges for D and E′ are 243γ and 219γ, the latter being the mean from 22 common disturbances. There can, however, be only surprise at the result that the range of the vertical component at Cape Evans is no more than 51% of that at Cape Denison. In individual disturbances the Z range at the latter station exceeds that at Cape Evans in 20 of the total number of 24 tabulated ranges.

§29.—SQUARES OF EXTREME RANGES COMPARED.

Consequent upon the earlier consideration the squares of the ranges for separate components, for the combined vectors in the horizontal plane and for the resultant vectors in three dimensions are supplied by Table CXII. Two sets of mean values of the squares are appended; one set derived from the use of all available constituents of the table, the number in parenthesis after each mean denoting the number contributing to its formation, and a second set relating to the two disturbances for which complete data are available for both stations. Rounding to the unit of $100\gamma^2$ of the table accounts for any discrepancy between the added values for the surface or total activities and the sums of the squares of ranges for individual components.

Though mean the squared range for E′ at Cape Evans in the last line of the table exceeds that for D at Cape Denison, the excess in the value for the field component along the meridian at Cape Denison over that at Cape Evans more than counterbalances the deficit in the transverse field changes. The net result, therefore, is that both in the horizontal plane $\overline{H}$ and the three-dimensional field $\overline{T}$, Cape Denison has precedence over Cape Evans. In the vertical field alone the square of the disturbing force range at Cape Evans is only 28% of that at Cape Denison. For the resultant in the horizontal plane $\overline{H}$ the percentage is 83% and for the total resultant of all three components $\overline{T}$ barely 61%. These figures refer to the second set of means derived from the 22 disturbances for which ranges are complete in all components.

TABLE CXII.

Longer Disturbances at Capes Denison and Evans: Squares of Ranges. (Unit $100\gamma^2$.)

Date of Disturbance.	Cape Denison.			Cape Evans.			Cape Denison.	Cape Evans.	Cape Denison.	Cape Evans.
	D^2	H^2	Z^2	N'^2	E'^2	Z^2	$\overline{H}_D$	$\overline{H}_E$	$\overline{T}_D$	$\overline{T}_E$
April 5–6	1,318	543	502	433	967	102	1,861	1,400	2,362	1,502
April 10	566	112	180	520	262	172	679	782	858	954
April 15	924	681	2,401	428	615	193	1,605	1,044	4,006	1,237
May 12, 0h.–14h.	807	458	1,225	900	511	135	1,265	1,411	2,490	1,545
May 12, 21h.–24h.	269	96	339	112	324	13	365	436	704	449
May 13	1,340	437	1,362	1,459	610	936	1,776	2,069	3,138	3,006
June 8, 2h.–5h.	81	292	166	135	102	30	373	237	540	267
June 8, 6h.–8h.	30	36	38	61	266	74	66	327	105	400
June 8, 10h.–16h.	1,747	1,136	1,731	388	228	154	2,883	616	4,613	770
June 8, 19h.–22h.	282	64	1,538	35	231	14	346	266	500	280
June 9	156	216	1,538	462	269	225	372	731	526	956
June 27, 6h.–12h.	—	172	83	234	196	90	—	430	—	520
June 27, 22h.–28, 2h.	—	77	142	86	102	5	—	189	—	194
July 31, 14h.–Aug. 1, 8h.	353	961	428	384	1,043	1,050	1,314	1,427	1,743	2,477
August 18 14h.–19, 6h.	1,076	299	1,552	353	912	67	1,375	1,265	2,927	1,333
August 19	29	41	41	104	76	40	70	180	111	219
September 17	1,122	328	272	655	912	142	1,450	1,567	1,722	1,709
September 18	745	462	1,089	676	515	76	1,208	1,191	2,297	1,267
September 24, 0h.–14h.	1,050	1,149	1,232	1,232	595	441	2,199	1,827	3,431	2,268
September 24, 14h.–25, 2h.	342	243	462	702	400	106	586	1,102	1,048	1,208
September 30	655	1,980	1,109	511	829	324	2,636	1,340	3,745	1,664
October 12	734	292	342	467	605	119	1,027	1,072	1,369	1,191
October 14	1,789	660	1,325	1,129	2,275	262	2,450	3,404	3,775	3,667
October 20	172	1,296	1,050	324	121	149	1,468	445	2,517	594
Means—										
(1) Days in parenthesis	7'9 (22)	536 (22)	724 (24)	491 (24)	540 (24)	205 (24)	1244 (22)	1032 (24)	2044 (22)	1237 (24)
(2) 22 Common days	709	536	779	521	576	219	1,244	1,097	2,044	1,317

$\overline{T}$ for Cape Evans exceeds $\overline{T}$ for Cape Denison in only 5 of the 22 complete disturbances but $\overline{H}$ at Cape Evans exceeds $\overline{H}$ at Cape Denison in 12 of the disturbances. Therefore, though the average activity in all three components during disturbance at Cape Denison does greatly exceed that at Cape Evans, the pre-eminence of Cape Denison is essentially a result of the behaviour of the vertical disturbance vector there.

In the discussion of the instrumental side of the magnetic work of the Expedition (Scientific Reports, Series B, Vol. I) it was pointed out that the behaviour of the vertical force variometer was not always completely satisfactory. But the main troubles were encountered in 1913 after the period of simultaneous records which are at present under discussion was past. In addition, the observer in charge of the magnetograph installation decided that the anomalous records obtained in 1913 and, therefore, presumably in 1912—if the source of imperfection was present to an unnoticed degree then—were to be attributed to friction in the balance system. Such a defect would, however, tend to diminish the range of the recorded vertical force changes rather than enhance them. The accuracy of the scale values used in reducing the measured ordinates on the traces to force units was verified. It must, therefore, be concluded that the differences between the recorded ranges of the vertical component of the disturbance vectors at the two stations are real.

It is true that differences in the vertical field changes even within such a limited area of the pole were to some extent to be anticipated, but the differences actually found seem out of proportion to the difference in the distances between either station and the region of the magnetic pole. The result can only mean that within the auroral zone there is an inner zone of discontinuity in the vertical force changes which normally arise from the overhead current system in disturbance.

CHAPTER VI.—THE DISTURBANCE OF SEPTEMBER 17, 1912.

§30.—Description of the Chief Features as Registered at Cape Denison.

After 48 hours of comparatively quiet conditions a disturbance began just before noon on September 17. For reasons which will become plain in the ensuing discussion, the subsequent movements in the magnetic field at Cape Denison have been made the subject of special study. A tracing of the magnetogram of this occasion is reproduced in Fig. 19.

Declination alone showed much variation during the first hour, but after 13h. the variations in all three components took the form of a succession of waves, the earlier members of which were remarkably regular. These waves continued till after 19h. Then at 19h.30m. a much larger movement, well developed in all components set in. The phase relationships in the horizontal components of the disturbing force vectors during this movement were rendered specially conspicuous by their approximate regularity and made it obvious that the influencing forces had been rotatory in character, swinging from east to west through north, *i.e.*, anti-clockwise. Similar peculiarities had also been evident in the same interval of the synchronously recorded disturbance at Cape Evans and had been examined with reference to the records at other magnetic observatories (*vide* Brit. Ant. Expedition, 1910–13, Terr. Mag. Sections 125–7).

Plate VIII reproduces an attempt to illustrate the main features of the Adelie Land and Cape Evans magnetograms for the interval covering the disturbed hours. In the original magnetograms the sense of direction for increasing force or its equivalent in declination at Cape Denison was opposite to that at Cape Evans in both horizontal components. Further, the high sensitivity of the declination magnetograph at the former station—the scale value was such that 1 millimetre of ordinate on the trace meant a change of $1{\cdot}65\gamma$ in the vector transverse to the meridian—was such as to require almost continuous use of the reserve trace which was made available by the wide angle mirror of the Eschenhagen instrument used. Direct reproduction of the original magnetograms would, therefore, have assisted little in a comparison of the two Antarctic records. An attempt has therefore been made to reduce systematically the ordinates of the D trace after drawing a continuous trace by piecing together the primary record and the discontinuous excursions from the second trace at the other side of the sheet. The reproduced record is therefore a composite production and as such is intended merely to represent the main features in the variations of the disturbing force vectors at Cape Denison for comparison with those at Cape Evans. The measurements of times and changes of force quoted in the following tables and discussion are based on the actual magnetograms.

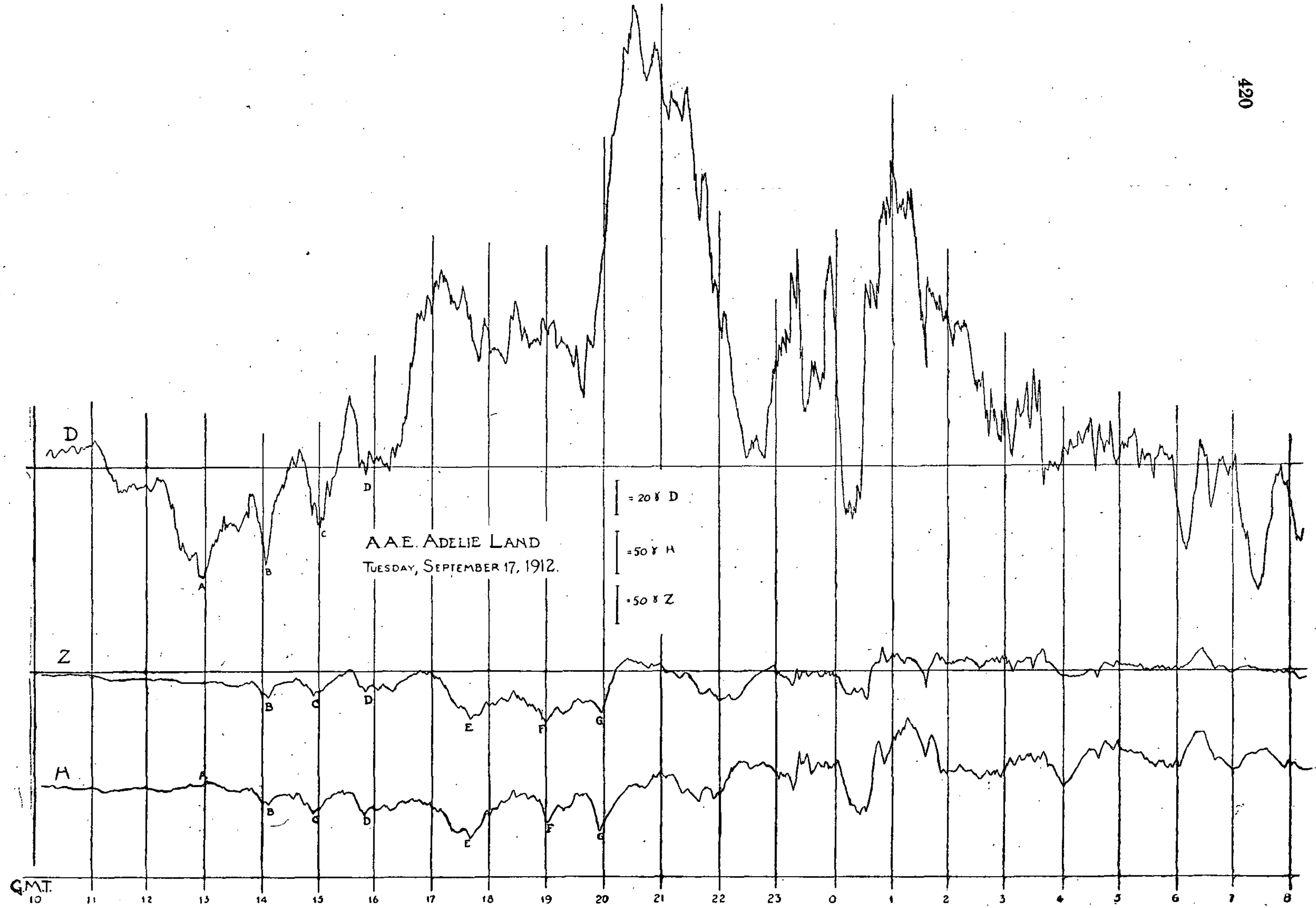

Fig. 19—Tracing of the Magnetograph Record for September 17th, 1912, at Cape Denison.

Table CXIII summarises the main characteristics of the constituent movements of the disturbance from 12h.15m. to 19h.30m., changes in declination being expressed in terms of their equivalents in force units.

TABLE CXIII.

Cape Denison : September 17, 1912. Field changes during succession of waves.

Movement of Series.	H				D (to East).				Z			
	Time.		Direction of Field Change.	Magnitude of Field Change.	Time.		Direction of Field Change.	Magnitude of Field Change.	Time.		Direction of Field Change.	Magnitude of Field Change.
	From.	To.			From.	To.			From.	To.		
	h. m.	h. m.			h. m.	h. m.			h. m.	h. m.		
A	12 15	13 0	Decrease	20	12 15	12 55	Increase	59	...	...	None appreciable	...
	13 0	13 47	Increase (mainly).	23	12 55	13 47	Decrease	49	...	...		...
B	13 47	14 5	Increase	38	13 47	14 5	Increase	41	13 47	14 7	Increase	43
	14 5	14 37	Decrease	27	14 5	14 39	Decrease	68	14 7	14 37	Decrease	52
C	14 37	14 55	Increase	50	14 39	15 1*	Increase	62	14 37	14 55	Increase	48
	14 55	15 35	Decrease	56	15 1	15 33	Decrease	74	14 55	15 35	Decrease	67
D	15 35	15 50	Increase	54	15 33	15 50	Increase	45	15 35	15 50	Increase	56
	15 50	16 45	Decrease	35	15 50	17 12†	Decrease	120	15 50	16 45	Decrease	52
E	16 45	17 40	Increase	93	17 12	17 50	Increase	54	16 45	17 40	Increase	127
	17 40	18 25	Decrease	114	...	...	...	...	17 40	18 25	Decrease	77
F	18 25	19 3	Increase	64	...	...	...	...	18 25	19 0	Increase	81
	...	...	...	...	...	...	...	...	19 0	19 32	Decrease	58

* Previons spur 14h.50m. † Out of step.

In the first of the succession of waves A, unrepresented in the vertical disturbing field, the change in declination answers to a force increasing first to east and reaches its maximum some five minutes before the less well developed minimum of an oscillation in H which started almost simultaneously. In the three subsequent waves B, C and D represented by all three components, turning points are attained almost simultaneously or only differ by times which are within the margin of error in the estimation of time allowable on account of superposed perturbations of short period or from errors of parallax inherent in the mode of registration. Only at the completion of the return movement from east to west after 15h.50m. does declination take a course different from the meridian and radial force components. Further, if Z be regarded as increasing positively when the dip of the south end of the magnet is decreased, and declination be considered as changing positively, under the influence of an east-directed force, all three components are completely in phase throughout these early movements. Indeed the parallelism between the vectors in the meridian plane throughout the disturbance is one of the remarkable features.

Towards the completion of the fourth wave, the disturbance field, as indicated by the independent variation of declination, began to assume a rotatory motion out of phase with the synchronous variations in H and Z. From that stage up to 19h.30m. when the largest of the constituent movements of the disturbance begins, declination changes are only slightly related to those of the two force components. These latter, however, continue to vary in step throughout the remainder of the disturbance. After a short interval of hesitation about 16h. H and Z execute two further movements of longer period when the principal movement of the day begins.

This culminating oscillation exceeded its precursors both in duration and amplitude. From a preliminary maximum value in an easterly direction at 19h.37m. declination changed through 4° 11′ to its extreme westward position at 20h.35m. then swung back through 4° 52′ in the next 115 minutes. These changes in declination were equivalent to the superposition, first of a west force of 227γ, followed by a force in the opposite direction of 265γ. The maximum in H and in Z was not attained till 19h.55m. after which the values of both these components decreased, then rose to complete the movement about 22h.

§31.—The Interval 19h.30m. to 22h. in Detail: 5-minute Ordinates.

Undulatory variations in the disturbance field similar to those just described were experienced throughout the earth, and, in particular, the bay-like movement between 19h.30m. and 22h. as registered at Cape Denison was found to be prominent in the disturbance at almost all the other observatories from which records were obtained. Since this part of the disturbance had received special attention in the discussion of the records from Cape Evans, a detailed analysis has been extended to Cape Denison.

TABLE CXIV.

Cape Denison: 1912 September, 17th: Departures from Mean at 5-minute Intervals and Squares.

Time.	ΔD (to west).	ΔH	ΔZ	ΔN	ΔW	ΔN^2	ΔW^2	ΔZ^2
h. m.	γ	γ	γ	γ	γ			
19 30	−115	+ 2	+ 52	+ 16	−114	256	12,996	2,704
19 35	−120	+ 9	+ 52	+ 23	−118	529	13,924	2,704
19 40	−120	+ 2	+ 56	+ 16	−119	256	14,161	3,136
19 45	−101	+ 19	+ 52	+ 31	− 98	961	9,604	2,704
19 50	−106	+ 59	+ 60	+ 71	− 98	5,041	9,604	3,600
19 55	− 80	+ 90	+ 82	+ 99	− 69	9,801	4,761	6,724
20 0	− 55	+ 69	+ 56	+ 75	− 46	5,625	2,116	3,136
20 5	− 29	+ 49	+ 15	+ 52	− 23	2,704	529	225
20 10	+ 19	+ 22	− 25	+ 20	+ 21	400	441	625
20 15	+ 26	+ 5	− 40	+ 2	+ 26	4	676	1,600
20 20	+ 47	− 8	− 51	− 13	+ 46	169	2,116	2,601
20 25	+ 72	− 21	− 59	− 29	+ 69	841	4,761	3,481
20 30	+ 79	− 21	− 51	− 30	+ 76	900	5,776	2,601
20 35	+ 97	− 18	− 48	− 29	+ 94	841	8,836	2,304
20 40	+ 82	− 18	− 48	− 28	+ 79	784	6,241	2,304
20 45	+ 54	− 18	− 37	− 24	+ 52	576	2,704	1,369
20 50	+ 55	− 45	− 48	− 51	+ 49	2,601	2,401	2,304
20 55	+ 65	− 38	− 40	− 45	+ 60	2,025	3,600	1,600
21 0	+ 70	− 48	− 44	− 56	+ 64	3,136	4,096	1,936
21 5	+ 41	− 38	− 25	− 43	+ 36	1,849	1,296	625
21 10	+ 31	− 42	− 25	− 45	+ 26	2,025	676	625
21 15	+ 42	− 25	− 18	− 30	+ 39	900	1,521	324
21 20	+ 39	− 5	− 7	− 10	+ 38	100	1,444	49
21 25	+ 34	− 8	− 22	− 12	+ 33	144	1,089	484
21 30	+ 47	− 1	− 11	− 6	+ 47	36	2,209	121
21 35	+ 1	+ 16	+ 8	+ 16	+ 3	256	9	64
21 40	− 19	+ 9	+ 30	+ 11	− 18	121	324	900
21 45	− 6	− 11	+ 30	− 10	− 7	100	49	900
21 50	− 14	− 11	+ 19	− 9	− 15	81	225	361
21 55	− 65	+ 12	+ 34	+ 20	− 63	400	3,969	1,156
22 0	− 81	+ 9	+ 52	+ 18	− 79	324	6,241	2,704

Thirty-one ordinates at 5-minute intervals over the period 19h.30m. to 22h. were tabulated for the three components and expressed in terms of force units, considering declination as increasing positively when the change in disturbing force across the meridian was directed eastward. Then taking the average ordinate over the interval as the standard of reference, 5-minute departures of each vector component from the standard were obtained and from these the departures for the true geographical components N, E and Z were deduced. The results are given in Table CXIV and graphically represented in Plate VIII. This figure also shows the changes in the three geographical components in the same interval at Cape Evans and, to illustrate simultaneous magnetic events at stations distributed over northern latitudes, at Honolulu, Sitka Helwan and Eskdalemuir. The data for these stations were furnished by Table CLXXVI, p. 369 Brit. Ant. Expedition Terr. Mag.

Since the rotation of the disturbing vector in the movement now being considered had commenced before the previous disturbance in the meridian force components H and Z had completely disappeared, the values of field strengths of these components continue to rise till 19h.55m. then fall steadily in sympathy with the rotation. Though the maximum easterly elongation in D was reached by 20h.35m., H (N) did not begin to increase till 21h. It is this phase difference between force components in and across the meridian which establishes the anti-clockwise rotation of the vector in the horizontal plane.

§32.—Vector Changes at Cape Denison and Other Stations.

Attention has already been directed to the fact that in most disturbances as registered at Cape Denison a prominent feature was the parallelism, sometimes remarkably close, in the major variations of the two disturbing vector components in the meridian plane. In contrast to the usual state of affairs at Cape Evans this was especially noticeable, and could be attributed only to the position of the current systems responsible for the magnetic field changes relative to the two stations. If the amplitudes of corresponding movements in the H and Z traces at Cape Denison had been exactly equal—and there were many examples of a fair approach to this condition—then the current system would be approximately just as many kilometres to the north or south of the station as it was high above the surface. At Cape Evans, on the other hand, the system would be sufficiently distant relative to its height that the vertical component of the associated field was reduced and distorted by secondary perturbing fields. To a minor degree a similar difference in behaviour between the horizontal meridian and vertical field components of disturbance have been noted at two stations in lower latitudes in the northern hemisphere. There are many more cases of approximation to parallelism between the H and Z traces in disturbance at Lerwick, Shetland (60° 8′ N, 1° 11′ W) than at Eskdalemuir (55° 19′, 3° 12′ W) only some 360 miles further south.

TABLE CXV.

September 17, 1912, 19h.30m. to 22h.: Magnetic "Activity."

(Unit: 1×10^{-10} Erg/cc.)

	N	E	Z	Horizontal Plane.	Complete Field.
Cape Denison	56·2	164·8	71·8	221·0	292·8
Cape Evans	42·7	175·3	19·0	218·2	237·3
Honolulu	4·8	3·0	0·3	7·8	8·0
Helwan	43·3	2·6	6·4	46·1	52·5
Sitka	35·4	14·3	10·2	49·7	59·9
Eskdalemuir	154·5	80·2	12·7	234·7	247·4

Table CXV and Plate VIII show that the part of the disturbance of September 17, 1912, between 19h.30m. and 22h. was no exception to the difference between the two Antarctic stations. For though the horizontal vector components along the meridian took the same course, the vertically directed component showed no parallelism. The changes in H both at Honolulu and at Sitka were similar to those at the Antarctic stations; in the group of stations Mauritius, Helwan, Falmouth and Eskdalemuir, on the other hand, the field strengths to north and east in the horizontal plane increased while the decrease was in progress in the Antarctic, and also, if Honolulu and Sitka are representative, in the hemisphere to the west of a line joining Agincourt to the region of the south magnetic pole.

The rotatory character of the disturbance field is further shown in vector diagrams of Plate IX, the co-ordinates of the diagrams being the departures entered in Table CXIV, smoothed by the formula $(a + 26 + c) / 4$ to facilitate comparison with Plate LVII of the Brit. Ant. Expedition Terr. Mag. Volume. As in the case of the horizontal plane vectors at Cape Evans, the direction of rotation at Cape Denison is anti-clockwise and though a general NW–SE trend characterises the diagrams for both stations, the superposed perturbations between 20h.30m. and 21h.30m. result in a much less regular description in the south-easterly quadrant at Cape Denison than at Cape Evans. On the other hand while a meridian vector diagram for the latter station would have little regularity and small development owing to the behaviour of the vertical force component, that for Cape Denison is a fairly regular figure with major axis directed approximately 45° from the vertical and is described in an anti-clockwise direction.

§33.—The "Activity" of the Disturbance Between 19h.30m. and 22h.

The "activity" of the disturbance field as computed from the approximate form of Bidlingmaier's activity integral for short intervals of time $\Sigma\triangle^2/8\pi n$. Where $\triangle$ is the departure of the element from an assumed normal or standard of reference at each of a number n of small submultiples of the interval, had been considered for that part of the disturbance between 19h.30m. and 22h. on September 17, 1912, and Cape Evans and ten other stations (vide Table CLXXVII, p. 373, Brit. Ant. Exp. Terr. Mag., 1910–13). Using the data of Table CXV an estimate of "activity" has been made for the disturbance at Cape Denison during the same interval.

Though it is true that the mean of the 31 five-minute ordinates for the 2½ hours was far from representing the undisturbed level for the interval, the preceding disturbance made the choice of the value of the field at 19h.30m. equally unacceptable. The activity has therefore been calculated on the basis of the mean ordinate. Activities for N and E separately are given in Table CXV and are therefore immediately comparable with those for N^1 and E^1 at Cape Evans, and for N and E at Honolulu, Sitka, Helwan and Eskdalemuir extracted from Table CLXXVII cited above. Combined activities for the resultants in the horizontal plane and in all three dimensions are also supplied by the table.

The prominent features of the table are :—

1. Of the two Antarctic stations the activity of the disturbance vector either in the horizontal field alone or when extended to three dimensions is greater for Cape Denison than for Cape Evans. The activity of the east directed component alone at this latter station is greater than the activity of the corresponding component at Cape Denison.
2. The main difference between the two stations lies in the contribution to the total activity made by the vertical field component. At Cape Evans this is only 8%; at Cape Denison it is nearly 25% of the activity of the total resultant in space.
3. Eskdalemuir is the only other station of the table with an activity of a similar order of magnitude to that in the Antarctic. Indeed the disturbance field in the horizontal plane at that station was more active when judged by the criterion at present employed than at either of the Antarctic stations.
4. The relative insignificance of the disturbance at stations in an intermediate zone between the Antarctic stations and Eskdalemuir or even Sitka is well represented by the entries for Honolulu. The activities at Buitenzorg and Alibag are of similar magnitude.

§34.—Relation of "Activity" to Squares of Ranges During the Disturbance.

It is convenient to examine here the relations between the mean square of the departures of the disturbing forces from the "normal" field with the mean square of the range of the forces. For Bidlingmaier in considering the estimation of activity in small intervals of time, had proposed the use of the square of the range in an interval of the order of an hour to replace the computation of $\Sigma\triangle^2/12$ from five-minute departures as a means of approximating to the activity integral. If R represents the range for an hour or for an interval comprising a small number of hours covered by a disturbance (2½ in the present case) and $\triangle$ is the departure at each of n sub-multiples of the interval then the ratio $\Sigma\triangle^2/nR^2$ should be constant.

From the data obtained from Cape Evans and two other stations for the period 19h.30m. to 22h., September 17, 1912, the value of the constant has been found to be approximately 0·09 (vide Brit. Ant. Exp. Terr. Mag. p., 375).

Taking as the range the difference between the largest and smallest ordinates in Table CXIV, the values of the ratio for the horizontal plane and derived from all three components are:—

	$\frac{1}{31}\frac{\Sigma\triangle_N^2 + \Sigma\triangle_E^2}{R_N^2 + R_E^2}$	$\frac{1}{31}\frac{\Sigma\triangle_N^2 + \Sigma\triangle_E^2 + \Sigma\triangle_Z^2}{R_N^2 + R_E^2 + R_Z^2}$
Cape Denison	0·080	0·082
Cape Evans	0·082	0·080

These values of the ratio are intermediate between the two sets of values derived from the Term Hour data (see Table C, Chapter IV). Though not computed in the same way as those given above, the average value of the ratio for the three components was somewhat less (·075 for Cape Denison and ·072 for Cape Evans) when the extreme range was used and somewhat higher (·091 for Cape Denison and ·094 for Cape Evans) when the range from the five-minute ordinates was substituted for R. As explained in the discussion of these results conditions were comparatively quiet during the intervals covered by the Term Hour data.

CHAPTER VII.—DISTURBANCE AT CAPE DENISON AND CAPE EVANS REFERRED TO SIMULTANEOUS DISTURBANCE AT CHRISTCHURCH, NEW ZEALAND.

§35.—The Basis and Limited Scope of the Comparison.

Unless it be referred to and compared with the record of simultaneous disturbance at some station in more moderate latitudes, the real magnitude of disturbance in the Antarctic is apt to be grossly underestimated. At the time of the expeditions there were few stations in the Southern Hemisphere providing continuous records for such a purpose and the employment of data from stations on the other side of the earth weakens deductions which might be drawn from a comparison. The nearest continuously recording station was at Christchurch, New Zealand (43° 32′ S, 172° 37′ E). By the courtesy of the Director, H. F. Skey, of the Observatory there, reprints of magnetograms were made available for a number of days within the period of synchronous registration at the two Antarctic bases, and on which there had been a fair degree of disturbance. The ultimate selection of disturbed periods to be used for the comparison was determined primarily by the appearance of the Christchurch records. In the general magnetic quiet of the months concerned, 1912, April to October, with a paucity of first class disturbance, the final list was very limited and certainly not representative of the relative intensities under conditions of really well developed disturbance.

For reasons which have been discussed elsewhere the hourly range and its square have been taken as the basis of comparison of the relative magnetic activities at the three stations. The range within each hour, in groups of hours varying from one to twenty-four, were measured for all available components at the two Antarctic bases and at Christchurch, and the material finally retained and tabulated referred to 153 disturbed hours. For these all the Cape Denison records are complete for D, H and Z, though on two days, 8 June 13h. to 14h. and 4 July 14h. to 15h., the ranges quoted are under-estimated through the trace going beyond the limits of registration; the curve covering the disturbing hours on 6 August at Cape Evans was missing. Uncertainties arising from local artificial disturbance in the vicinity of the Christchurch Observatory made the estimates of hourly range for the vertical component unreliable in all but a few hours each night. Ranges for that station are, therefore, published only for the two horizontal components.

The hourly ranges r_D relating to declination at Cape Denison and Christchurch have been converted into the equivalent force units, and as leading to the most appropriate comparison the ranges for Cape Evans have been tabulated for E^1, N^1 and Z in that order. In addition to the estimates of range for each of the 153 hours, Table CXVI gives the squares of these ranges for each component separately and for the resultant vector in the horizontal plane. For the two Antarctic stations the squared range of the complete resultant in space is given in the final columns of the two relevant sections of the table.

TABLE CXVI.

Hourly Ranges at Cape Denison, Cape Evans and Christchurch during Selected Disturbed Periods.

Date.	Hour Ending G.M.T.	Cape Denison.								Cape Evans.								Christchurch.				
		r_D	r_H	r_Z	r_D^2	r_H^2	r_Z^2	$r_D^2+r_H^2$	$r_D^2+r_H^2+r_Z^2$	$r_{E'}$	$r_{N'}$	r_Z	$r_{E'}^2$	$r_{N'}^2$	r_Z^2	$r_{E'}^2+r_{N'}^2$	$r_{E'}^2+r_{N'}^2+r_Z^2$	r_D	r_H	r_D^2	r_H^2	$r_D^2+r_H^2$
1912—		γ	γ	γ	$γ^2$	$γ^2$	$γ^2$	$γ^2$	$γ^2$	γ	γ	γ	$γ^2$	$γ^2$	$γ^2$	$γ^2$	$γ^2$	γ	γ	$γ^2$	$γ^2$	$γ^2$
May 12	1	69	43	48	4,761	1,849	2,304	6,610	8,914	43	46	8	1,849	2,116	64	3,965	4,029	12	7	144	49	193
	2	113	56	84	12,769	3,136	7,056	15,905	22,961	30	77	14	900	5,929	196	6,829	7,025	15	7	225	49	274
	3	69	39	57	4,761	1,521	3,249	6,282	9,531	61	75	26	3,721	5,625	676	9,346	10,022	6	11	36	121	157
	4	141	93	129	19,881	8,649	16,641	28,530	45,171	66	93	16	4,356	8,649	256	13,005	13,261	13	18	169	324	493
	5	68	63	70	4,624	3,969	4,900	8,593	13,493	48	32	17	2,304	1,024	289	3,328	3,617	7	13	49	169	218
	6	36	54	39	1,296	2,916	1,521	4,212	5,733	35	39	22	1,225	1,521	484	2,746	3,230	11	29	121	841	962
	7	37	43	41	1,369	1,849	1,681	3,218	4,899	62	80	15	3,844	6,400	225	10,244	10,469	17	17	289	289	578
	8	101	51	31	10,201	2,601	961	12,802	13,763	65	90	49	4,225	8,100	2,401	12,325	14,726	50	33	2,500	1,089	3,589
	9	84	88	41	7,056	7,744	1,681	14,800	16,481	86	48	51	7,396	2,304	2,601	9,700	12,301	23	18	529	324	853
	10	37	25	23	1,369	625	529	1,994	2,523	41	30	14	1,681	900	196	2,581	2,777	1	10	1	100	101
	11	23	18	13	529	324	169	853	1,022	39	24	15	1,521	576	225	2,097	2,322	3	18	9	324	333
	12	112	67	192	12,544	4,489	36,864	17,033	53,897	85	97	21	7,225	9,409	441	16,634	17,075	19	24	361	576	937
	13	44	42	44	1,936	1,764	1,936	3,700	5,636	43	50	13	1,849	2,500	169	4,349	4,518	11	11	121	121	242
	14	62	33	74	3,844	1,089	5,476	4,933	10,409	32	50	25	1,024	2,500	625	3,524	4,149	9	5	81	25	106
May 13	1	31	66	53	961	4,356	2,809	5,317	8,126	44	78	19	1,936	6,084	361	8,020	8,381	12	17	144	289	433
	2	152	88	123	23,104	7,744	15,129	30,848	45,977	162	129	73	26,244	16,641	5,329	42,825	48,214	30	30	900	900	1,800
	3	46	96	103	2,116	9,216	10,609	11,332	21,941	53	98	39	2,809	9,604	1,521	12,413	13,934	18	24	324	576	900
	4	62	84	119	3,844	7,056	14,161	10,900	25,061	54	39	11	2,916	1,521	121	4,437	4,558	4	8	16	64	80
	5	85	70	71	7,225	4,900	5,041	12,125	17,166	50	26	14	2,500	676	196	3,176	3,372	11	10	121	100	221
	6	53	61	54	2,809	3,721	2,916	6,530	9,446	60	58	100	3,600	3,364	10,000	6,964	16,964	29	19	841	361	1,202
	7	68	37	34	4,624	1,369	1,156	5,993	7,149	129	73	177	16,641	5,329	31,329	21,970	53,299	32	15	1,024	225	1,249
	8	147	100	42	21,609	10,000	1,764	31,609	33,373	151	184	45	22,801	33,856	2,025	56,657	58,682	47	49	2,209	2,401	4,610
	9	103	81	227	10,609	6,561	51,529	17,170	68,699	99	56	138	9,801	3,136	19,044	12,937	31,981	26	19	676	361	1,037
	10	50	70	63	2,500	4,900	3,969	7,400	11,369	74	57	85	5,476	3,249	7,225	8,725	15,950	19	27	361	729	1,090
	11	98	40	81	9,604	1,600	6,561	11,204	17,765	155	107	81	24,025	11,449	6,561	35,474	42,035	34	12	1,156	144	1,300
	12	48	73	34	2,304	5,329	1,156	7,633	8,789	78	61	74	6,084	3,721	5,476	9,805	15,281	14	13	196	169	365
	13	45	32	37	2,025	1,024	1,369	3,049	4,418	52	28	78	2,704	784	6,084	3,488	9,572	7	7	49	49	98
	14	45	29	38	2,025	841	1,444	2,866	4,310	50	32	27	2,500	1,024	729	3,524	4,253	3	4	9	16	25

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TABLE CXVI.—*continued.*

Hourly Ranges at Cape Denison, Cape Evans and Christchurch during Selected Disturbed Periods.

Date.	Hour Ending G.M.T.	Cape Denison.								Cape Evans.								Christchurch.				
		r_D	r_H	r_Z	r_D^2	r_H^2	r_Z^2	$r_D^2+r_H^2$	$r_D^2+r_H^2+r_Z^2$	$r_{E'}$	$r_{H'}$	r_Z	$r_{E'}^2$	$r_{H'}^2$	r_Z^2	$r_{E'}^2+r_{H'}^2$	$r_{E'}^2+r_{H'}^2+r_{Z'}^2$	r_D	r_H	r_D^2	r_H^2	$r_D^2+r_H^2$
1912.		γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ²	γ²	γ²
June 8	3	79	84	97	6,241	7,056	9,409	13,297	22,706	27	48	8	729	2,304	64	3,033	3,097	9	10	81	100	181
	4	55	72	85	3,025	5,184	7,225	8,209	15,434	57	72	26	3,249	5,184	676	8,433	9,109	5	20	25	400	425
	5	56	98	126	3,136	9,604	15,876	12,740	28,616	80	79	43	6,400	6,241	1,849	12,641	14,490	7	23	49	529	578
	6	82	50	37	6,724	2,500	1,369	9,224	10,593	57	51	40	3,249	2,601	1,600	5,850	7,450	6	7	36	49	85
	7	56	40	44	3,136	1,600	1,936	4,736	6,672	89	64	18	7,921	4,096	324	12,017	12,341	29	31	841	961	1,802
	8	42	56	58	1,764	3,136	3,364	4,900	8,264	159	79	89	25,281	6,241	7,921	31,522	39,443	24	25	576	625	1,201
	9	64	30	36	4,096	900	1,296	4,996	6,292	50	69	17	2,500	4,761	289	7,261	7,550	15	13	225	169	394
	10	59	46	54	3,481	2,116	2,916	5,597	8,513	92	56	31	8,464	3,136	961	11,600	12,561	13	10	169	100	269
	11	28	44	26	784	1,936	676	2,720	3,396	55	30	27	3,025	900	729	3,925	4,654	4	5	16	25	41
	12	50	19	39	2,500	361	1,521	2,861	4,382	71	46	25	5,041	2,116	625	7,157	7,782	7	7	49	49	98
	13	107	64	129	11,449	4,096	16,641	15,545	32,186	47	86	17	2,209	7,396	289	9,605	9,894	18	30	324	900	1,224
	14	>122	338	>358	>14,884	114,244	>128,164	>129,128	>257,292	110	120	60	12,100	14,400	3,600	26,500	30,100	30	14	900	196	1,096
	15	148	66	303	21,904	4,356	91,809	26,260	118,069	57	185	105	3,249	34,225	11,025	37,474	48,499	16	23	256	529	785
	16	48	45	115	2,304	2,025	13,225	4,329	17,554	37	33	37	1,369	1,089	1,369	2,458	3,827	1	8	1	64	65
	17	42	24	57	1,764	576	3,249	2,340	5,589	23	47	23	529	2,209	529	2,738	3,267	7	2	49	4	53
	18	14	16	38	196	256	1,444	452	1,896	25	28	8	625	784	64	1,409	1,473	4	2	16	4	20
	19	17	19	16	289	361	256	650	906	28	18	17	784	324	289	1,108	1,397	2	4	4	16	20
	20	64	37	45	4,096	1,369	2,025	5,465	7,490	69	28	21	4,761	784	441	5,545	5,986	11	8	121	64	185
	21	104	43	57	10,816	1,849	3,249	12,665	15,914	110	55	18	12,100	3,025	324	15.125	15,449	7	15	49	225	274
	22	116	71	51	13,456	5,041	2,601	18,497	21,098	81	49	33	6,561	2,401	1,089	8,962	10,051	11	13	121	169	290
	23	70	48	74	4,900	2,304	5,476	7,204	12,680	26	33	14	676	1,089	196	1,765	1,961	6	6	36	36	72
	24	64	42	32	4,096	1,764	1,024	5,860	6,884	26	51	19	676	2,601	361	3,277	3,638	1	1	1	1	2
July 3	18	27	13	27	729	169	729	898	1,627	17	24	11	289	576	121	865	986	4	12	16	144	160
	19	14	31	54	196	961	2,916	1,157	4,073	55	21	15	3,025	441	225	3,466	3,691	4	6	16	36	52
	20	15	34	44	225	1,156	1,936	1,381	3,317	40	24	34	1,600	576	1,156	2,176	3,332	2	7	4	49	53
	21	46	76	87	2,116	5,776	7,569	7,892	15,461	74	42	56	5,476	1,764	3,136	7,240	10,376	3	5	9	25	34
	22	53	58	69	2,809	3,364	4,761	6,173	10,934	63	32	40	3,969	1,024	1,600	4,993	6,593	2	7	4	49	53
	23	85	75	62	7,225	5,625	3,844	12,850	16,694	71	71	32	5,041	5,041	1,024	10,082	11,106	2	7	4	49	53
	24	36	29	16	1,296	361	256	1,657	1,913	25	19	14	625	361	196	986	1,182	3	24	9	256	265

TABLE CXVI—*continued.*

Hourly Ranges at Cape Denison, Cape Evans and Christchurch during Selected Disturbed Periods.

Date.	Hour Ending G.M.T.	Cape Denison.								Cape Evans.								Christchurch.				
		r_D	r_H	r_Z	r_D^2	r_H^2	r_Z^2	$r_D+r_H^2$	$r_D^2+r_H^2+r_Z^2$	$r_{E'}$	$r_{H'}$	$r_{Z'}$	$r_{E'}^2$	$r_{H'}^2$	$r_{Z'}^2$	$r_{E'}^2+r_{H'}^2$	$r_{E'}^2+r_{H'}^2+r_{Z'}^2$	r_D	r_H	r_D^2	r_H^2	$r_D^2+r_H^2$
		γ	γ	γ	γ^2	γ^2	γ^2	γ^2	γ^2	γ	γ	γ	γ^2	γ^2	γ^2	γ^2	γ^2	γ	γ	γ^2	γ^2	γ^2
1912. July 4	1	68	42	32	4,624	1,764	1,024	6,388	7,412	45	41	14	2,025	1,681	196	3,706	3,902	3	15	9	225	234
	2	94	74	82	8,836	5,476	6,724	14,312	21,036	54	79	9	2,916	6,241	81	9,157	9,238	15	8	225	64	289
	3	88	111	84	7,744	12,321	7,056	20,065	27,121	37	49	18	1,369	2,401	324	3,770	4,094	12	3	144	9	153
	4	51	61	45	2,601	3,721	2,025	6,322	8,347	76	29	22	5,776	841	484	6,617	7,101	7	13	49	169	218
	5	96	56	48	9,216	3,136	2,304	12,352	14,656	90	73	14	8,100	5,329	196	13,429	13,625	22	13	484	169	653
	6	58	42	41	3,364	1,764	1,681	5,128	6,809	67	61	87	4,489	3,721	7,569	8,210	15,779	10	21	100	441	541
	7	72	67	29	5,184	4,489	841	9,673	10,514	84	62	64	7,056	3,844	4,096	10,900	14,996	3	10	9	100	109
	8	52	67	32	2,704	4,489	1,024	7,193	8,217	78	55	24	6,084	3,025	576	9,109	9,685	26	40	676	1,600	2,276
	9	64	47	52	4,096	2,209	2,704	6,305	10,009	147	45	45	21,609	2,025	2,025	23,634	25,659	18	36	324	1,296	1,620
	10	27	26	32	729	676	1,024	1,405	2,429	33	43	25	1,089	1,849	625	2,938	3,563	7	10	49	100	149
	11	51	37	45	2,601	1,369	2,025	3,970	5,995	39	22	21	1,521	484	441	2,005	2,446	5	7	25	49	74
	12	66	32	98	4,356	1,024	9,604	5,380	14,984	45	51	17	2,025	2,601	289	4,626	4,915	9	13	81	169	250
	13	81	81	217	6,561	6,561	47,089	13,122	60,211	97	58	19	9,409	3,364	361	12,773	13,134	24	22	576	484	1,060
	14	117	86	181	13,689	7,396	32,761	21,085	53,846	50	69	35	2,500	4,761	1,225	7,261	8,486	29	28	841	784	1,625
	15	118	199	>261	13,924	39,601	>68,121	53,525	>121,646	80	103	17	6,561	10,609	289	17,170	17,459	19	29	361	841	1,202
	16	105	47	235	11,025	2,209	55,225	13,234	68,459	48	123	31	2,304	15,129	961	17,433	18,394	17	18	289	324	613
	17	59	29	49	3,841	841	2,401	4,322	6,723	50	44	35	2,500	1,936	1,225	4,436	5,661	6	7	36	49	85
	18	48	33	58	2,304	1,089	3,364	3,393	6,757	16	30	13	256	900	169	1,156	1,325	7	5	49	25	74
	19	71	51	74	5,041	2,601	5,476	7,642	13,118	78	62	17	6,084	3,844	289	9,928	10,217	8	7	64	49	113
	20	35	43	70	1,225	1,849	4,900	3,074	7,974	31	54	10	961	2,916	100	3,877	3,977	2	4	4	16	20
	21	34	64	60	1,156	4,096	3,600	5,252	8,852	56	34	20	3,136	1,156	400	4,292	4,692	7	8	49	64	113
	22	62	75	68	3,844	5,625	4,624	9,469	14,093	63	42	24	3,969	1,764	576	5,733	6,309	5	6	25	36	61
	23	119	74	88	14,161	5,476	7,744	19,537	27,281	65	73	35	4,225	5,329	1,225	9,554	10,779	6	3	36	9	45
	24	46	118	66	2,116	13,924	4,356	16,040	20,396	56	123	31	3,136	15,129	961	18,265	19,226	7	27	49	729	778

TABLE CXVI—*continued.*

Hourly Ranges at Cape Denison, Cape Evans and Christchurch during Selected Disturbed Periods.

Cape Denison.

Date.	Hour Ending G.M.T.	r_D	r_H	r_Z	r_D^2	r_H^2	r_Z^2	$r_D^2+r_H^2$	$r_D^2+r_H^2+r_Z^2$
1912.		γ	γ	γ	γ²	γ²	γ²	γ²	γ²
July 5	1	97	73	43	9,409	5,329	1,849	14,738	16,587
	2	208	129	191	43,264	16,641	36,481	59,905	96,386
	3	78	119	156	6,084	14,161	24,336	20,245	44,581
	4	47	68	76	2,209	4,624	5,776	6,833	12,609
	5	60	43	73	3,600	1,849	5,329	5,449	10,778
	6	44	68	42	1,936	4,624	1,764	6,560	8,324
	7	31	18	22	961	324	484	1,285	1,769
	8	48	27	37	2,304	729	1,369	3,033	4,402
	9	34	47	39	1,156	2,209	1,521	3,365	4,886
	10	38	55	47	1,444	3,025	2,209	4,469	6,678
	11	86	169	174	7,396	28,561	30,276	35,957	66,233
	12	136	140	59	18,496	19,600	3,481	38,096	41,577
	13	102	144	94	10,404	20,736	8,836	31,140	39,976
	14	63	88	191	3,969	7,744	36,481	11,713	48,194
	15	54	99	151	2,916	9,801	22,801	12,717	35,518
	16	32	64	72	1,024	4,096	5,184	5,120	10,304
	17	43	20	62	1,849	400	3,844	2,249	6,093
	18	47	39	108	2,209	1,521	11,664	2,730	15,394
	19	45	57	109	2,025	3,249	11,881	5,274	17,155
	20	68	60	48	4,624	3,600	2,304	8,224	10,528
	21	69	53	57	4,761	2,809	3,249	7,570	10,819
	22	170	62	124	28,900	3,844	15,376	32,744	48,120
	23	132	51	82	17,424	2,601	6,724	20,025	26,749
	24	66	45	31	4,356	2,025	961	6,381	7,342

Cape Evans.

Date.	Hour Ending G.M.T.	$r_{E'}$	$r_{H'}$	r_Z	$r_{E'}^2$	$r_{H'}^2$	r_Z^2	$r_{E'}^2+r_{H'}^2$	$r_{E'}^2+r_{H'}^2+r_{Z'}^2$
1912.		γ	γ	γ	γ²	γ²	γ²	γ²	γ²
July 5	1	171	95	94	29,241	9,025	8,836	38,266	47,102
	2	168	104	50	28,224	10,816	2,500	39,040	41,540
	3	45	82	17	2,025	6,724	289	8,749	9,038
	4	55	74	24	3,025	5,476	576	8,501	9,077
	5	129	65	175	16,641	4,225	30,625	20,866	51,491
	6	160	141	216	25,600	19,881	46,656	45,481	92,137
	7	45	56	24	2,025	3,136	576	5,161	5,737
	8	39	50	13	1,521	2,500	169	4,021	4,190
	9	58	28	60	3,364	784	3,600	4,148	7,748
	10	100	65	87	10,000	4,225	7,569	14,225	21,794
	11	105	89	65	11,025	7,921	4,225	18,946	23,171
	12	54	38	24	2,916	1,444	576	4,360	4,936
	13	62	70	31	3,844	4,900	961	8,744	9,705
	14	85	32	16	7,225	1,024	256	8,249	8,505
	15	69	65	35	4,761	4,225	1,225	8,986	10,211
	16	46	30	28	2,116	900	784	3,016	3,800
	17	41	39	12	1,681	1,521	144	3,202	3,346
	18	39	31	16	1,521	961	256	2,482	2,738
	19	71	40	13	5,041	1,600	169	6,641	6,810
	20	44	26	14	1,936	676	196	2,612	2,808
	21	56	41	9	3,136	1,681	81	4,817	4,898
	22	120	56	20	14,400	3,136	400	17,536	17,936
	23	52	73	29	2,704	5,329	841	8,033	8,874
	24	39	49	24	1,521	2,401	576	3,922	4,498

Christchurch.

Date.	Hour Ending G.M.T.	r_D	r_H	r_D^2	r_H^2	$r_D^2+r_H^2$
1912.		γ	γ	γ²	γ²	γ²
July 5	1	7	22	49	484	533
	2	4	18	16	324	340
	3	6	6	36	36	72
	4	11	13	121	169	290
	5	8	27	64	729	793
	6	8	10	64	100	164
	7	15	15	225	225	450
	8	13	10	169	100	269
	9	22	5	484	25	509
	10	15	10	225	100	325
	11	38	33	1,444	1,089	2,533
	12	8	15	64	225	289
	13	18	5	324	25	349
	14	10	17	100	289	389
	15	5	12	25	144	169
	16	4	5	16	25	41
	17	6	3	36	9	45
	18	4	9	16	81	97
	19	4	3	16	9	25
	20	6	3	36	9	45
	21	9	5	81	25	106
	22	7	16	49	256	305
	23	4	3	16	9	25
	24	4	3	16	9	25

TABLE CXVI—*continued.*

Hourly Ranges at Cape Denison, Cape Evans and Christchurch during Selected Disturbed Periods.

		Cape Denison.								Cape Evans.								Christchurch.				
Date.	Hour Ending G.M.T.	r_D	r_H	r_Z	r_D^2	r_H^2	r_Z^2	$r_D^2+r_H^2$	$r_D^2+r_H^2+r_Z^2$	$r_{E'}$	$r_{H'}$	r_Z	$r_{E'}^2$	$r_{H'}^2$	r_Z^2	$r_{E'}^2+r_{H'}^2$	$r_{E'}^2+r_{H'}^2+r_{Z'}^2$	r_D	r_H	r_D^2	r_H^2	$r_D^2+r_H^2$
1912.		γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ	γ²	γ²	γ²	γ²	γ³	γ	γ	γ²	γ²	γ²
July 6	1	87	71	87	7,569	5,041	7,569	12,610	20,179	35	34	8	1,225	1,156	64	2,381	2,445	9	0	81	0	81
	2	65	61	84	4,225	3,721	7,056	7,946	15,002	33	40	9	1,024	1,600	81	2,624	2,705	5	2	25	4	29
	3	25	31	33	625	961	1,089	1,586	2,675	21	19	7	441	361	49	802	851	4	1	16	1	17
	4	46	52	35	2,116	2,704	1,225	4,820	6,045	18	11	7	324	121	49	445	494	4	3	16	9	25
	5	39	44	25	1,521	1,936	625	3,457	4,082	30	10	7	900	100	49	1,000	1,049	4	5	16	25	41
	6	33	46	20	1,089	2,116	400	3,205	3,605	23	15	20	529	225	400	754	1,154	4	2	16	4	20
	7	25	28	26	625	784	676	1,409	2,085	9	13	6	81	169	36	250	286	4	3	16	9	25
	8	14	12	6	196	144	36	340	376	10	8	6	100	64	36	164	200	2	2	4	4	8
	9	10	17	11	100	289	121	389	510	16	11	6	256	121	36	377	413	1	4	1	16	17
	10	15	18	15	225	324	225	549	774	25	20	10	625	400	100	1,025	1,125	1	7	1	49	50
	11	24	12	15	576	144	225	720	945	36	23	12	1,296	529	144	1,825	1,969	7	7	49	49	98
	12	289	498	295	83,521	248,004	87,025	331,525	418,550	40	98	70	1,600	9,604	4,900	11,204	16,104	10	32	100	1,024	1,124
	13	149	500	117	22,201	250,000	13,689	272,201	285,890	65	73	40	4,225	5,329	1,600	9,554	11,154	14	8	196	64	260
	14	20	22	111	400	484	12,321	884	13,205	25	24	17	625	576	289	1,201	1,490	3	4	9	16	25
	15	28	22	39	784	484	1,521	1,268	2,789	18	25	27	324	625	729	949	1,678	4	3	16	9	25
	16	25	17	16	625	289	256	914	1,170	32	41	16	1,024	1,681	256	2,705	2,961	2	4	4	16	20
	17	72	21	33	5,184	441	1,089	5,625	6,714	45	20	13	2,025	400	169	2,425	2,594	12	1	144	1	145
	18	41	29	27	1,681	841	729	2,522	3,251	24	21	6	576	441	36	1,017	1,053	6	3	36	9	45
	19	61	67	59	3,721	4,489	3,481	8,210	11,691	79	25	20	6,241	625	400	6,866	7,266	4	5	16	25	41
	20	63	48	91	3,969	2,304	8,281	6,273	14,554	54	28	13	2,916	784	169	3,700	3,869	1	4	1	16	17
	21	50	31	31	2,500	961	961	3,461	4,422	35	27	15	1,225	729	225	1,954	2,179	2	3	4	9	13
	22	58	58	62	3,364	3,364	3,844	6,728	10,572	29	30	8	841	900	64	1,741	1,805	1	1	1	1	2
	23	46	41	63	2,116	1,681	3,969	3,797	7,766	41	31	8	1,681	961	64	2,642	2,706	8	12	64	144	208
	24	40	29	32	1,600	841	1,024	2,441	3,465	45	29	7	2,025	841	49	2,866	2,915	7	6	49	36	85
July 8	13	31	7	21	961	49	441	1,010	1,451	17	21	6	289	441	36	730	766	4	7	16	49	65
	14	50	73	148	2,500	5,329	21,904	7,829	29,733	75	24	13	5,625	576	169	6,201	6,370	14	14	196	196	392
	15	88	108	211	7,744	11,664	44,521	19,408	63,929	90	87	24	8,100	7,569	576	15,669	16,245	10	14	100	196	296
	16	34	30	28	1,156	900	784	2,056	2,840	39	45	15	1,521	2,025	225	3,546	3,771	1	4	1	16	17

TABLE CXVI—*continued.*

Hourly Ranges at Cape Denison, Cape Evans and Christchurch during Selected Disturbed Periods.

Date.	Hour Ending G.M.T.	Cape Denison.								Cape Evans.								Christchurch.				
		r_D	r_H	r_Z	r_D^2	r_H^2	r_Z^2	$r_D+r_H^2$	$r_D^2+r_H^2+r_Z^2$	$r_{E'}$	$r_{H'}$	r_Z	$r_{E'}^2$	$r_{H'}^2$	r_Z^2	$r_{E'}^2+r_{H'}^2$	$r_{E'}^2+r_{N'}^2+r_{Z'}^2$	r_D	r_H	r_D^2	r_H^2	$r_D^2+r_H^2$
		γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ²	γ²	γ²
July 21	11	21	18	13	441	324	169	765	934	10	23	6	100	529	36	629	665	12	7	144	49	193
	12	62	30	38	3,844	900	1,444	4,744	6,188	22	36	10	484	1,296	100	1,780	1,880	4	16	16	256	272
	13	17	26	25	289	676	625	965	1,590	19	6	14	361	36	196	397	593	4	2	16	4	20
Aug. 6	17	19	15	33	361	225	1,089	586	1,675									5	5	25	25	50
	18	69	12	30	4,761	144	90	4,905	4,995									18	3	324	9	333
	19	84	17	74	7,056	289	5,476	7,345	12,821									13	10	169	100	269
	20	14	29	36	196	841	1,296	1,037	2,333									1	4	1	16	17
	21	16	8	11	256	64	121	320	441									4	6	16	36	52
Aug. 21	10	52	20	23	2,704	400	529	3,104	3,633	60	14	8	3,600	196	64	3,796	3,860	2	9	4	81	85
	11	63	15	45	3,969	225	2,025	4,194	6,219	42	82	16	1,764	6,724	256	8,488	8,744	17	24	289	576	865
	12	54	19	19	2,916	361	361	3,277	3,638	73	55	31	5,329	3,025	961	8,354	9,315	8	12	64	144	208
	13	35	31	19	1,225	961	361	2,186	2,547	19	24	8	361	576	64	937	1,001	7	7	49	49	98
	14	50	36	49	2,500	1,296	2,401	3,796	6,197	41	45	9	1,681	2,025	81	3,706	3,787	11	6	121	36	157
Aug. 23	8	111	32	69	12,321	1,024	4,761	13,345	18,106	30	63	9	900	3,969	81	4,869	4,950	15	35	225	1,225	1,450
Aug. 24	8	33	43	52	1,089	1,849	2,704	2,938	5,642	95	18	47	9,025	324	2,209	9,349	11,558	16	7	256	49	305
	9	50	47	22	2,500	2,209	484	4,709	5,193	62	72	39	3,844	5,184	1,521	9,028	10,549	8	18	64	324	388
Aug. 24	15	22	35	52	484	1,225	2,704	1,709	4,413	28	18	7	784	324	49	1,108	1,157	7	13	49	169	218
	16	20	27	38	400	729	1,444	1,129	2,573	31	27	14	961	729	196	1,690	1,886	6	11	36	121	157

§36.—Some Aspects of Table CXVI Containing Parallel Data.

Even with the lack of ranges for the vertical component of the disturbing field at Christchurch, many features of interest are provided by individual hourly estimates for the remaining components at the three stations. In particular the intensely localised nature of many of the superposed perturbations of period under an hour becomes manifest. The first hours of the disturbance of 12 May may be taken as typical. Whereas the range of the disturbing force in the meridian at Christchurch remained steady in the first two hours it increased from 43γ to 56γ at Cape Denison and from 46γ to 77γ at Cape Evans. In the same interval, though the force transverse to this direction only increased its range of variation from 12γ to 15γ at Christchurch, it rose from 69γ to 113γ at Cape Denison, but at Cape Evans, only some 900 miles distant, it fell from 43γ to 30γ. The change in behaviour of the vertical force within these hours was similar at the two Antarctic stations but the magnitude of the range at Cape Denison was exactly six times that at Cape Evans in both hours. Such a difference between scales of change of the disturbing field in the vertical at the expedition bases were frequent. In the hour 3h. to 4h. on 13 May the change in Z at Cape Evans was only 11γ, little more than the average expected from the diurnal variation appropriate to that epoch. But at Cape Denison in the same hour the range was about eleven times as great. Other illustrations of this feature are given by the hour 13h. to 14h., 4 July, when the comparable Z ranges were 217γ at Cape Denison and 19γ at Cape Evans, and again for the hour 13h.–14h., 5 July with 191γ as against 16γ. Examples of the opposite tendency are much more limited and the relative difference much reduced. 5 July 4h. to 5h. when the Z range at Cape Denison was 73γ and that at Cape Evans 175γ is one of the few.

Almost without exception the ranges and squares quoted for Christchurch are of a different order of magnitude from those for the Antarctic stations. Both in the meridian and transverse disturbing forces, but especially in the latter, the ratios of the Antarctic to the Christchurch range are commonly above 10. On some of the larger movements recorded at Christchurch, when presumably the current system responsible for the disturbance has been much further north than usual, the range of one or other horizontal component at that station approximates to that at Cape Evans and less frequently to that at Cape Denison. 12 May, 7h. to 8h. is a case in point. On occasions of really large disturbance in the Antarctic, on the other hand, as on 8 June, 13h. to 14h. the range of the force in the meridian at Cape Denison may exceed 24 times the range for the same hour at Christchurch.

§37.—Examples of Extreme Ranges and Times of Occurrence at the Three Stations.

As exemplifying further details of the disturbances selected for comparison, the following Table CXVII contains the extreme ranges with times of occurrence of maximum and minimum values at the three stations for the disturbance of 12 and 13 May and 8 June.

TABLE CXVII.

Typical extreme ranges and times of extreme in disturbed intervals.

Date.	Interval.	Cape Denison.								
		R_D	Max.	Min.	R_H	Max.	Min.	R_Z	Max.	Min.
1912.		γ	h. m.	h. m.	γ	h. m.	h. m.	γ	h. m.	h. m.
May 12	0h. to 14h.	287	7 35	1 35	207	11 25	3 40	342	11 20	3 35
„ 13	0h. to 14h.	370	8 40	1 30	210	13 50	8 35	368	8 40	1 25
June 8	2h. to 5h.	88	4 15	2 15	170	2 25	4 25	126	5 0	4 10
„ 8	6h. to 8h.	56	6 10	6 25	60	6 40	7 20	65	8 0	6 20
„ 8	10h. to 16h.	148	14 0	14 50	331	13 40	13 50	>393	13 30 to 14 5	12 15
„ 8	19h. to 22h.	168	19 5	20 35	78	19 45	20 30	123	21 50	20 15

Date.	Interval.	Cape Evans.									Christchurch.					
		R_{E^1}	Max.	Min.	R_{N^1}	Max.	Min.	R_Z	Max.	Min.	R_D	Max.	Min.	R_H	Max.	Min.
1912.		γ	h. m.	h. m.	γ	h. m.	h. m.	γ	h. m.	h. m.	γ	h. m.	h. m.	γ	h. m.	h.m.
May 12	0h. to 14h.	226	7 37	11 12	300	11 25	3 33	116	2 10	8 5	96	3 35	7 40	74	11 30	6 0
„ 13	0h. to 14h.	247	8 15	0 5	382	7 50	1 23	306	0 20	9 10	84	1 10	10 25	91	7 50	1 32
June 8	2h. to 5h.	101	4 20	2 45	116	2 5	4 13	55	2 30	4 30	15	4 5	2 0	46	2 5	4 30
„ 8	6h. to 8h.	163	7 14	6 35	78	7 3	7 40	86	7 5	7 30	52	6 10	7 20	38	6 0	7 10
„ 8	10h. to 16h.	151	11 15	13 40	197	13 57	14 30	124	12 35	14 12	30	13 25	13 5	37	13 35	11 35
„ 8	19h. to 22h.	152	19 0	20 30	59	19 30	20 31	38	21 40	19 15	22	20 20	22 0	22	19 45	20 20

Two features of the table are noteworthy. Approximate coincidence of times of attainment of highest and lowest values of the disturbing forces at the three stations is not uncommon. For example, in the component of the disturbing force in the direction of the meridian the maxima on 12 May at Cape Denison and Cape Evans were synchronous and the minima occurred within seven minutes of each other; in the component across the meridian in the same disturbance two minutes separated the maximum turning points. As between Cape Evans and Christchurch the maximum in N^1 on 12 May occurred only 5 minutes before the maximum in H and on the following day the maxima occurred simultaneously while the minimum values were attained within nine minutes of each other.

Such results indicate that the major influences in the disturbance were operating approximately simultaneously over the area covered by the three stations and that the resultant movements in the resulting magnetic field were sufficiently developed to transcend the phase differences in the ordinary diurnal variations arising from the local time differences between the stations. For Cape Evans and Christchurch this was only about half an hour, and Cape Denison and Christchurch about two and one-quarter hours.

Secondly, instead of the almost systematic supremacy of the Cape Denison hourly ranges over those for Cape Evans in all components, and instead of the differences between either of these and the ranges for Christchurch amounting to several multiples of the latter, the differences between the extreme ranges over sets of hours are not so consistently large and unidirected except in the case of vertical force. On 12 May the extreme range R_D for Cape Denison exceeds R_{E^1}, but in the same interval of fourteen hours R_H is only 69% of R_{N^1}. A similar change as between the superiority of the extreme ranges in these two components is noticeable on the following day. At the same time the corresponding ranges for Christchurch increase from the average of about one-fifth those in the Antarctic, which is the ratio for the hourly ranges (*vide infra*) to one-third.

§38.—Average Hourly Ranges for each Disturbance.

Such changes are best considered with reference to the summarised values of average hourly ranges $\bar{r}$ and their squares for each of the groups of disturbed hours of Table CXVI. These averages are supplied by Table CXVIII. That the direct addition of the mean squared ranges in this table does not always lead to the entry in the column of combined squared ranges for the vector in the horizontal plane and for the total vector is accounted for by the fact that these latter are derived from the addition of the separate squared resultants for each tabulated hour. Where a difference does exist it should not exceed one unit.

In addition to the means for each group of disturbed hours, the table contains three sets of general means; the first set relates to the seven days comprising 12, 13 May, 8 June, and 3, 4, 5 and 6 July of the upper half of the table and therefore has as its basis 131 of the total number (153) of selected disturbed hours; the second relates to the further group of seven periods of disturbances (except in the case of Cape Evans, where only six days are available); and the third comprises all the constituent groups. In each of the three sets of general means the contributing groups are equally weighted irrespective of the number of constituent hours of each group.

Representing most favourably the average relative state of affairs in longer disturbance, the first of these sets of means shows that in all components, but most prominently in the vertical component, the disturbing field at Cape Denison is more highly active than at Cape Evans and almost incomparably more so than at Christchurch. If the squared ranges be regarded as a measure of the activity of the disturbance vector, disturbance activity in the horizontal plane at Cape Evans is on the average only 66% of that at Cape Denison, and at Christchurch only 5%. When all three components are combined the activity at Cape Evans for this set of 131 hours is only 50% of the activity at Cape Denison.

When the comparison is extended to the whole number of tabulated disturbances, the mean range for the forces along the meridian is the same for the two Antarctic stations; but the mean squared range for this component at Cape Denison is nearly 50% greater than that for Cape Evans, the difference arising from the greater variability of the constituent hourly ranges about the mean at the former station. 57γ and 52γ represent the average ranges per hour at Capes Denison and Evans respectively for the disturbing force directed across the meridian, but the difference between the corresponding ranges for the vertical field 61γ and 26γ is relatively much greater. In comparison with the horizontal field ranges at either of these stations the corresponding means for Christchurch are only between one-quarter and one-fifth of the Antarctic values, with a resulting activity for the combined components in the horizontal plane about one-twentieth of that at Cape Evans.

That the differences in mean range and deduced magnetic activity between the Antarctic stations on the one hand and such a station as Christchurch on the other is not alone due to a difference in scale (arising, say, from concentration of the responsible current system) of the same system of acting forces, is clear both from the differences which are manifest between the two Antarctic stations themselves and also from the changes in the relative values of the range of variation of the disturbing forces as between these stations and between either and Christchurch, when for the average range within the hour is substituted the extreme range over the complete group of hours for each selected disturbance.

As noted in connexion with Table CXVII, Cape Denison does not maintain such a constant supremacy over Cape Evans in the case of extreme range as for the average hourly, and the ratio 1 to 5 for Christchurch to the Antarctic for the mean hourly range is much reduced when the extreme range is the basis of comparison. Such results make it clear that though the scale of magnitude of the disturbing force vectors is really enormously increased with increasing proximity to the polar cap, superposed short period fluctuations arising from local perturbing forces contribute in large measure to the total activity of the magnetic field during even average disturbance in the Antarctic.

TABLE CXVIII.

Summary of Mean Hourly Ranges and Squares for Disturbed Periods at Cape Denison, Cape Evans and Christchurch.

Date.	Number of Hours.	Cape Denison.								Cape Evans.								Christchurch.				
		$\bar{r}_D$	$\bar{r}_H$	$\bar{r}_Z$	$\bar{r}_D^2$	$\bar{r}_H^2$	$\bar{r}_Z^2$	$\bar{r}_D^2+\bar{r}_H^2$	$\bar{r}_D^2+\bar{r}_H^2+\bar{r}_Z^2$	$\bar{r}_{E'}$	$\bar{r}_{N'}$	$\bar{r}_Z$	$\bar{r}_{E'}^2$	$\bar{r}_{N'}^2$	$\bar{r}_Z^2$	$\bar{r}_{E'}^2+\bar{r}_{N'}^2$	$\bar{r}_{E'}^2+\bar{r}_{N'}^2+\bar{r}_{Z'}^2$	$\bar{r}_D$	$\bar{r}_H$	$\bar{r}_D^2$	$\bar{r}_H^2$	$\bar{r}_D^2+\bar{r}_H^2$
1912.		γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ	γ²	γ²	γ²	γ²	γ²	γ	γ	γ²	γ²	γ²
May 12	14	71	51	63	6,210	3,038	6,069	9,247	15,317	53	59	22	3,080	4,111	632	7,191	7,823	14	16	331	314	645
,, 13	14	74	66	77	6,811	4,901	8,544	11,713	20,256	87	73	69	9,288	7,174	6,857	16,463	23,320	20	18	573	456	1,029
June 8	22	68	61	85	5,684	7,847	14,307	13,531	27,838	63	60	32	5,068	4,905	1,573	9,973	11,546	11	13	179	237	416
July 3	7	39	45	51	2,085	2,487	3,144	4,573	7,717	49	33	29	2,861	1,398	1,065	4,258	5,324	3	10	9	87	96
,, 4	24	70	65	85	5,608	5,571	11,571	11,179	22,749	62	59	27	4,546	4,203	1,028	8,749	9,778	11	15	189	325	515
,, 5	24	75	72	87	7,613	6,837	10,174	14,451	24,625	77	60	46	7,729	4,355	4,670	12,084	16,754	10	11	154	187	341
,, 6	24	55	74	56	6,272	22,181	6,572	28,453	35,026	33	28	15	1,339	1,181	416	2,520	2,936	5	5	37	64	101
,, 8	4	51	55	102	3,090	4,485	16,912	7,576	24,488	55	44	15	3,884	2,653	251	6,537	6,788	10	11	114	123	237
,, 21	3	33	25	25	1,525	633	746	2,158	2,904	17	22	10	315	620	111	935	1,046	7	8	59	103	162
Aug. 6	5	40	16	37	2,526	313	1,614	2,839	4,453	—	—	—						8	6	107	37	144
,, 21	5	51	24	31	2,663	649	1,135	3,311	4,447	47	44	14	2,547	2,509	285	5,056	5,341	9	12	105	177	283
,, 23	1	111	32	69	2,321	1,024	4,761	13,345	18,106	30	63	9	900	3,969	81	4,869	4,950	15	35	225	1,225	1,450
,, 24	2	41	45	37	1,795	2,029	1,594	3,823	5,417	78	45	43	6,435	2,754	1,865	9,189	11,053	12	12	160	187	347
,, 24	2	21	31	45	441	977	2,074	1,419	3,493	29	23	11	873	527	123	1,399	1,521	6	12	43	145	187
Means.																						
1st 7 periods	131	65	62	72	5,755	7,552	8,626	13,309	21,933	61	53	34	4,844	3,904	2,320	8,748	11,069	11	13	210	239	449
2nd 7 periods	22	50	33	49	3,480	1,444	4,119	4,924	9,044	43	40	17	2,492	2,172	453	4,664	5,117	10	14	116	285	401
All	153	57	47	61	4,617	4,498	6,373	9,116	15,488	52	47	26	3,759	3,105	1,458	6,863	8,322	10	13	163	262	425

CHAPTER VIII.

SOME GENERAL FEATURES OF DISTURBANCE.

§39. INEQUALITIES FOR DAYS GROUPED ACCORDING TO THE INTERNATIONAL CHARACTER FIGURE.

Preceding chapters have been concerned with special features of magnetic disturbance as registered at Cape Denison. It remains to consider such of the more general features as may be deduced from a study of the diurnal inequalities representative of disturbed conditions of varying degrees of intensity. Although almost entirely based on the magnetic records of stations in the northern hemisphere, the international scheme for the characterisation of individual Greenwich days according to the intensity and duration of disturbance has been shown to be applicable to world wide conditions in a way not at first anticipated. Almost all the days of available record from the Adelie Land base have therefore been grouped according to the international character figure. The groups comprised :—

1. The five days per month selected as international quiet days.
2. Days of character figure 0·1 and 0·2.
3. Days of character figure 0·3 and 0·4.
4. Days of character figure 0·5, 0·6, 0·7 and 0·8.
5. The five days per month of largest character figure.

In many months there was a residue of more than five days of complete data after the five groups had been formed; the average number per month in excess of the required five was, however, only two, not enough to justify the formation of an additional group of days between that for characters 0·5 to 0·8 and that representing the most disturbed conditions.

Seasonal mean inequalities for each of the five types of day were formed, grouping together the contributions from the months May to August, 1912 and May to July, 1913 for winter, April, September and October, 1912 and March and April, 1913 as equinox and November, 1912, to February, 1913, as summer. By suitable combination of the mean inequalities for D and H, N and W inequalities were deduced, using in the transformation, a mean value of declination and horizontal force appropriate to the months constituting each season. The annual mean inequalities for each element, both primary and derived and for each group of days, have been formed as the means of the three corresponding seasonal inequalities.

Both the range (the algebraic difference between the largest and least of the inequality ordinates) and the average departure (the mean of the 24 constituents of the inequality regardless of sign) are given for each inequality. For moderate latitudes and in average conditions the former will serve as a measure of the magnitude of the forces producing the inequality but in the conditions of the present investigation with the almost constant presence of additional and highly localised perturbing forces, the average departure is a safer criterion of comparison.

TABLE CXIX.

Mean Diurnal Inequalities for Days Grouped according to International Character Figure : Year : G.M.T.

Element.	International Character Figure.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	Range.	Average Departure.
		′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
D	0·04	+18·2	+ 9·8	+ 0·2	— 8·7	—15·8	—15·2	*—17·2*	—13·5	—13·4	—13·5	—12·4	—13·0	— 9·9	— 5·9	— 1·0	— 0·1	+ 1·2	+ 3·4	+ 5·5	+11·5	+15·7	+20·8	*+28·2*	+25·2	45·4	11·6
	0·15	+23·1	+18·4	+ 7·5	— 5·2	—11·8	—16·2	—15·8	—16·2	*—17·1*	*—17·1*	—15·3	—15·5	—13·6	— 7·4	— 2·9	+ 0·6	+ 1·0	+ 2·3	+ 4·6	+ 8·2	+14·4	+21·6	+26·0	*+26·4*	43·5	12·8
	0·34	+24·0	+18·6	+ 7·4	— 6·0	—17·1	—20·9	*—22·7*	—21·3	—20·7	—21·2	—20·1	—19·5	—13·9	—10·1	— 2·1	+ 2·3	+ 3·5	+ 9·5	+ 8·6	+12·3	+21·6	+25·7	*+28·8*	+26·7	51·5	16·0
	0·64	+25·8	+17·2	+ 7·8	— 0·9	—12·8	—20·8	—26·4	—23·8	*—28·6*	—26·9	—28·5	—25·1	—19·5	—10·7	— 1·4	+ 1·4	+ 6·8	+ 8·7	+13·6	+20·9	+28·5	+31·6	*+33·4*	+29·5	62·0	18·8
	1·15	+38·0	+33·2	+23·6	+ 5·7	—10·9	—27·4	—43·9	—49·7	—54·0	*—55·9*	—53·2	—53·1	—41·7	—25·8	—10·5	+ 1·2	+13·2	+23·1	+26·0	+41·0	+56·7	+57·2	*+58·9*	+48·4	114·8	35·5
		γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
H	0·04	— 6·4	— 6·9	— 5·0	— 3·0	— 1·9	— 4·7	*— 7·0*	— 5·0	— 5·3	— 4·3	— 3·1	— 2·0	+ 1·9	+ 4·1	+ 7·0	+ 5·2	+ 5·9	+ 6·6	+ 7·6	*+ 7·8*	+ 6·5	+ 5·4	+ 0·1	— 3·6	14·8	4·8
	0·15	— 4·1	— 3·4	+ 0·5	*—10·1*	— 7·3	— 9·2	— 9·3	— 6·9	— 9·0	— 6·9	— 4·3	+ 0·5	+ 3·9	+ 4·1	+ 6·4	+ 5·8	+ 5·6	+ 6·4	+ 6·1	+ 8·1	*+10·2*	+ 9·5	+ 2·9	+ 0·6	20·3	5·9
	0·34	— 2·2	— 7·0	—10·0	—10·8	—12·5	*—13·3*	—11·3	— 8·7	— 7·1	— 6·4	— 3·0	— 0·2	+ 7·0	+ 7·8	*+10·3*	+ 9·7	+ 9·3	+ 7·6	+ 7·4	+ 8·7	+ 9·5	+ 8·3	+ 6·4	+ 0·6	23·6	7·7
	0·64	— 3·7	— 9·7	—16·6	*—21·9*	—18·8	—14·2	—16·2	—10·0	— 9·7	— 5·7	— 1·4	+ 4·1	+ 8·0	+ 9·3	+11·8	+13·1	*+13·9*	+10·9	+11·7	+13·0	+12·5	+ 9·4	+ 9·1	+ 1·4	35·8	10·7
	1·15	— 7·5	—23·8	—30·2	—34·6	—34·6	*—35·7*	—29·9	—29·1	—24·3	—11·0	+ 1·5	+11·2	+20·1	+25·7	*+28·3*	+25·1	+23·8	+21·0	+20·7	+23·0	+21·8	+18·8	+10·2	+ 9·7	64·0	21·7
Z	0·04	— 7·5	—17·3	—27·9	*—29·7*	—28·1	—20·1	—13·1	— 5·6	— 1·9	+ 0·9	+ 3·0	+ 5·9	+10·3	+12·6	+10·5	+10·1	+11·3	+13·4	+15·3	*+16·0*	+14·2	+14·7	+10·4	— 1·0	45·7	12·5
	0·15	— 3·1	—22·1	—31·7	*—32·8*	—32·5	—24·1	—12·4	— 8·8	— 3·1	+ 0·9	+ 3·5	+ 8·3	+12·4	+12·7	+11·0	+11·9	+11·1	+13·8	+17·2	*+19·9*	+19·1	+18·9	+ 9·1	+ 0·9	52·7	14·2
	0·34	—12·3	—27·5	—35·8	*—38·8*	—33·1	—25·3	—15·8	—11·0	— 5·1	— 0·3	+ 6·2	+11·3	+12·3	+17·4	+17·0	+15·4	+14·5	+12·9	+20·0	*+21·4*	+20·2	+19·2	+10·6	+ 2·9	60·2	16·9
	0·64	— 8·7	—26·9	—40·7	*—41·6*	—34·8	—24·4	—15·3	—10·6	— 3·7	— 0·1	+ 7·5	+13·8	+13·9	+14·7	+12·3	+17·4	+18·6	+19·5	*+23·1*	+20·8	+19·3	+16·8	+ 8·7	+ 0·3	64·7	17·2
	1·15	—29·3	—50·1	*—57·3*	—52·6	—45·8	—35·1	—19·8	—15·2	+ 0·1	+ 9·2	+15·7	+27·3	+33·6	*+40·3*	+30·9	+32·1	+21·4	+23·5	+24·1	+23·6	+17·8	+18·3	+ 0·1	—13·0	97·6	26·5
N	0·04	*— 8·3*	— 7·8	— 4·9	— 2·1	— 0·2	— 3·1	— 5·1	— 3·5	— 3·9	— 2·9	— 1·9	— 0·8	+ 3·0	+ 4·6	*+ 7·0*	+ 5·2	+ 5·7	+ 6·1	*+ 7·0*	+ 6·7	+ 4·9	+ 3·2	— 2·8	— 6·3	15·3	4·5
	0·15	— 6·5	— 5·3	— 0·3	*— 9·4*	— 6·0	— 7·4	— 7·6	— 5·1	— 7·1	— 5·0	— 2·6	+ 2·1	+ 5·3	+ 4·8	+ 6·7	+ 5·7	+ 5·5	+ 6·1	+ 5·6	+ 7·2	*+ 8·7*	+ 7·1	+ 0·1	— 2·2	18·1	5·4
	0·34	— 4·8	— 9·0	—10·7	—10·1	—10·6	*—11·0*	— 8·8	— 6·3	— 4·9	— 4·1	— 0·8	+ 1·9	+ 8·4	+ 8·8	*+10·4*	+ 9·3	+ 8·8	+ 6·6	+ 6·4	+ 7·0	+ 7·1	+ 5·5	+ 3·3	— 2·6	21·4	7·0
	0·64	— 6·5	—11·5	—17·4	*—21·6*	—14·0	—11·9	—13·3	— 7·3	— 6·6	— 2·7	+ 1·6	+ 6·8	+10·1	+10·4	+11·8	+12·8	*+13·1*	+ 9·9	+10·1	+10·6	+ 9·3	+ 5·9	+ 5·8	— 1·7	34·7	9·7
	1·15	—11·5	—27·4	—33·0	*—35·3*	—33·6	—32·8	—35·1	—23·6	—18·3	— 5·0	+ 7·2	+16·8	+24·5	+28·3	*+29·2*	+24·6	+21·9	+18·3	+17·8	+18·7	+15·9	+13·0	+ 4·5	+ 5·0	64·5	20·9
W	0·04	+15·3	+ 7·0	— 0·9	— 8·1	—14·1	—13·2	*—16·0*	—12·6	—12·4	—11·9	—10·4	—10·6	— 8·4	— 4·6	+ 0·2	+ 0·6	+ 1·9	+ 4·1	+ 5·2	+10·0	+13·9	+18·8	*+24·4*	+21·8	40·4	10·3
	0·15	+20·2	+16·1	+ 6·7	— 5·8	—11·5	—15·7	—15·3	—15·3	*—16·4*	—16·1	—14·2	—13·9	—11·7	— 6·1	— 1·8	+ 1·2	+ 1·6	+ 2·9	+ 4·8	+ 8·3	+14·1	+20·4	+23·6	*+23·8*	40·2	12·0
	0·34	+21·3	+15·9	+ 5·4	— 6·7	—16·9	—20·3	*—21·7*	—20·1	—19·4	—19·8	—18·4	—17·5	—11·6	— 8·2	— 0·7	+ 3·3	+ 4·3	+ 9·4	+ 8·6	+15·1	+20·5	+24·0	+26·6	*+27·0*	48·7	15·1
	0·64	+22·7	+14·3	+ 5·0	— 3·4	—13·7	—20·3	—25·6	—22·5	*—26·8*	—24·7	—25·5	—22·0	—16·5	— 8·5	+ 0·2	+ 2·8	+ 7·9	+ 9·1	+13·5	+20·3	+27·0	+29·4	*+31·0*	+26·6	57·8	17·5
	1·15	+33·0	+28·3	+22·2	+ 4·6	—11·2	—26·1	—41·9	—47·6	*—51·4*	—51·3	—47·5	—46·5	—36·2	—20·2	— 5·6	+ 5·8	+17·4	+23·9	+24·9	+37·4	*+50·6*	+49·6	+44·4	+39·9	102·0	32·0

TABLE CXX.

Mean Diurnal Inequalities for Days Grouped according to International Character Figure: Winter: G.M.T.

Element.	International Character Figure.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	Range.	Average Departure.
		′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
D	0·05	+10·1	+ 4·8	+ 1·5	− 5·5	− 8·8	−8·8	− *9·2*	− 6·7	− 5·9	− 6·3	− 5·3	− 7·2	− 6·7	− 2·9	− 0·2	+ 1·8	+ 3·2	+ 2·5	+ 4·0	+ 7·2	+ 7·1	+ 9·3	+*11·4*	+10·7	20·6	6·1
	0·17	+13·2	+ 7·9	+ 1·6	− 5·8	− 9·1	−*11·0*	−10·4	− 9·3	− 9·1	− 9·0	−10·3	−10·1	− 8·7	− 3·9	− 1·7	+ 2·7	+ 5·1	+ 4·3	+ 5·5	+ 6·9	+ 9·6	+12·5	+*14·7*	+14·4	25·7	8·2
	0·35	+15·0	+10·9	+ 5·6	− 2·8	−10·7	−10·0	−10·9	−11·0	−10·5	−11·3	−*13·6*	−13·3	−12·5	− 8·6	− 0·4	+ 2·3	+ 2·8	+ 6·5	+ 6·5	+10·8	+11·1	+11·3	+15·4	+*17·4*	31·0	9·6
	0·62	+16·2	+11·0	+ 8·8	+ 1·9	− 4·4	− 9·8	−11·8	−10·1	−12·7	−16·9	−*21·6*	−19·5	−19·5	− 9·0	− 2·8	+ 2·2	+ 4·4	+ 4·2	+ 6·6	+ 9·8	+15·9	+18·8	+*20·2*	+18·1	41·8	11·5
	1·09	+33·5	+32·3	+12·0	− 0·8	−13·6	−23·2	−35·8	−38·2	−37·2	−39·5	−38·6	−*41·4*	−32·0	−23·7	− 9·1	− 3·0	+ 3·9	+13·5	+17·5	+36·3	+44·4	+47·0	+*48·3*	+47·4	89·7	28·0
		γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
H	0·05	− 2·5	− 2·6	− 4·4	− 3·7	− 2·4	− 3·3	− *5·1*	− 3·2	− 2·1	− 1·5	− 1·1	− 0·3	+ 2·3	+ *4·5*	+ 4·0	+ 3·9	+ 2·3	+ 3·0	+ 3·1	+ 3·5	+ 2·6	+ 3·2	0·0	− 0·2	9·6	2·7
	0·17	− 5·1	− *8·3*	− 7·5	− 7·4	− 7·1	− 6·8	− 6·2	− 3·3	− 1·7	− 0·4	− 0·5	+ 3·4	+ 3·0	+ 6·5	+ *6·9*	+ 6·1	+ 5·9	+ 4·3	+ 3·8	+ 5·3	+ 4·4	+ 3·9	+ 2·1	− 1·3	15·2	4·6
	0·35	− 4·5	− 8·1	− 9·8	−*11·3*	−10·2	− 8·0	− 6·1	− 5·8	− 5·0	− 3·0	− 2·5	+ 1·2	+ 6·8	+*10·1*	+ 9·7	+ 7·3	+ 5·6	+ 7·5	+ 6·9	+ 5·0	+ 4·2	+ 5·8	+ 3·2	+ 1·0	21·4	6·2
	0·62	− 5·3	− 8·7	−12·5	−*14·9*	−13·8	−11·2	−12·6	− 7·9	− 6·4	− 3·9	− 1·2	+ 3·9	+ 7·3	+ 8·7	+10·3	+*12·9*	+10·4	+ 8·3	+ 8·7	+ 9·3	+ 8·1	+ 6·9	+ 4·5	− 0·9	27·8	8·3
	1·09	−18·6	−28·1	−25·9	−*36·3*	−31·2	−20·9	−19·3	−21·9	−17·6	− 7·2	+ 3·0	+ 9·1	+14·3	+19·7	+25·7	+20·8	+25·3	+26·2	+*26·5*	+26·2	+18·0	+10·7	+10·4	− 8·9	62·8	19·7
Z	0·05	− 6·8	−13·8	−16·8	−*17·1*	−13·6	− 7·8	− 3·0	− 1·8	− 0·3	+ 1·6	+ 2·0	+ 3·5	+ 8·6	+ 8·2	+ *9·4*	+ 8·0	+ 6·4	+ 6·2	+ 6·3	+ 7·0	+ 6·8	+ 5·9	+ 2·3	− 1·9	26·5	6·9
	0·17	−11·5	−18·4	−*21·4*	−20·5	−16·9	−10·4	− 6·9	− 1·3	− 0·9	+ 1·9	+ 3·5	+ 5·4	+ 9·2	+ 9·8	+*12·2*	+11·3	+ 8·9	+ 9·0	+10·1	+ 9·7	+ 9·1	+ 7·9	+ 3·2	− 3·0	33·6	9·3
	0·35	−16·8	−21·7	−19·9	−*22·1*	−17·8	−12·8	− 8·0	− 6·9	− 3·3	− 0·6	+ 6·1	+11·8	+12·3	+*17·5*	+16·0	+11·3	+10·5	+12·2	+12·0	+ 9·8	+12·1	+ 7·3	+ 0·1	− 9·0	39.6	11·6
	0·62	−14·1	−19·3	−*27·0*	−26·8	−19·7	−14·5	−11·5	− 6·6	− 1·0	− 1·8	+ 4·4	+10·5	+11·6	+14·6	+15·8	+*17·8*	+12·5	+11·8	+11·7	+10·6	+14·3	+11·9	+ 2·7	− 7·9	44·8	12·5
	1·09	−29·6	−38·3	−*38·9*	−38·8	−32·7	−20·7	−17·3	−13·2	− 2·1	+ 6·2	+15·6	+22·0	+30·8	+36·6	+33·0	+*39·0*	+22·1	+19·2	+19·7	+15·3	+ 9·1	+ 2·6	−11·2	−28·4	77·9	22·6
N	0·05	− 3·6	− 3·1	− *4·6*	− 3·1	− 1·5	− 2·4	− 4·1	− 2·5	− 1·5	− 0·8	− 0·5	+ 0·5	+ 3·0	+ *4·8*	+ 4·0	+ 3·7	+ 2·0	+ 2·7	+ 2·7	+ 2·7	+ 1·8	+ 2·2	− 1·2	− 1·3	9·4	2·5
	0·17	− 6·5	− *9·0*	− 7·6	− 6·7	− 6·1	− 5·6	− 5·1	− 2·3	− 0·7	+ 0·6	+ 0·6	+ 4·5	+ 3·9	+ 6·9	+ *7·1*	+ 5·8	+ 5·4	+ 3·8	+ 3·2	+ 4·6	+ 3·4	+ 2·6	+ 0·5	− 2·8	16·1	4·4
	0·35	− 6·1	− 9·2	−10·3	−*10·9*	− 9·0	− 6·8	− 4·9	− 4·6	− 3·9	− 1·8	− 1·1	+ 2·6	+ 8·1	+*10·9*	+ 9·6	+ 7·0	+ 5·3	+ 6·7	+ 6·2	+ 3·9	+ 3·0	+ 4·6	+ 1·6	− 0·8	21·8	5·8
	0·62	− 7·0	− 9·8	−13·3	−*15·0*	−13·2	−10·1	−11·2	− 6·7	− 5·1	− 2·1	+ 1·1	+ 6·0	+ 9·3	+ 9·6	+10·5	+*12·6*	+ 9·8	+ 7·8	+ 7·9	+ 8·2	+ 6·3	+ 4·9	+ 2·4	− 2·8	27·6	8·0
	1·09	−22·1	−31·3	−27·0	−*35·9*	−29·6	−18·3	−15·4	−17·7	−13·6	− 2·9	+ 7·1	+13·4	+*17·6*	+22·1	+*26·5*	+21·0	+24·7	+24·6	+24·4	+22·2	+13·2	+ 5·6	+ 5·2	−13·8	62·4	19·0
W	0·05	+ 8·7	+ 4·0	+ 0·8	− 5·3	− 8·2	− 8·3	− *8·8*	− 6·4	− 5·5	− 5·8	− 4·8	− 6·5	− 5·7	− 2·1	+ 0·3	+ 2·1	+ 3·2	+ 2·6	+ 4·0	+ 6·9	+ 6·7	+ 8·7	+*10·2*	+ 9·6	19·0	5·6
	0·17	+11·2	+ 6·1	+ 0·5	− 6·1	− 9·0	−*10·7*	−10·0	− 8·7	− 8·4	− 8·1	− 9·3	− 8·6	− 7·4	− 2·7	− 0·7	+ 3·1	+ 5·3	+ 4·4	+ 5·3	+ 6·8	+ 9·1	+11·6	+*13·4*	+12·7	24·1	7·5
	0·35	+12·9	+ 8·8	+ 3·8	− 3·8	−10·8	− 9·9	−10·5	−10·6	−10·0	−10·5	−*12·5*	−11·8	−10·4	− 6·5	+ 0·7	+ 3·0	+ 3·2	+ 6·7	+ 6·6	+10·3	+10·4	+10·8	+14·2	+*15·7*	28·2	8·9
	0·62	+13·9	+ 8·9	+ 6·4	− 0·1	− 5·5	−10·1	−12·1	− 9·9	−12·2	−15·6	−*19·5*	−17·0	−16·6	− 7·1	− 1·3	+ 3·5	+ 5·1	+ 4·8	+ 6·9	+ 9·9	+15·2	+17·6	+*18·6*	+16·1	38·1	10·6
	1·09	+27·8	+25·6	+ 7·7	− 5·0	−15·9	−23·3	−34·4	−*36·8*	−35·4	−36·2	−34·2	−36·0	−27·0	−18·9	− 5·2	− 0·2	+ 6·5	+15·2	+18·8	+35·6	+41·9	+43·4	+*44·5*	+41·4	81·3	25·7

TABLE CXXI.

Mean Diurnal Inequalities for Days Grouped according to International Character Figure : Equinox : G.M.T.

Element.	International Character Figure.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	Range.	Average Departure.
		′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
D	0·05	+21·4	+13·0	−1·0	−7·0	−14·0	*−16·8*	*−16·8*	−13·0	−11·5	−13·5	−11·5	−14·0	−9·2	−5·0	+0·9	+2·9	+1·4	+5·0	+5·7	+6·1	+11·2	+16·1	+23·5	*+26·0*	42·8	11·1
	0·14	+21·3	+14·6	+10·0	−6·3	−12·4	−18·3	−14·3	−14·5	−14·7	−18·0	−15·9	*−18·5*	−16·7	−10·4	−2·9	+0·8	+2·1	+6·7	+7·5	+10·5	+13·9	+20·6	+25·9	*+29·0*	47·5	13·6
	0·33	+20·0	+12·7	+5·0	−7·5	−16·5	−22·2	*−22·6*	−21·7	−21·1	−20·3	−19·1	−19·2	−11·4	−5·8	+1·9	+3·9	+7·8	+7·2	+10·2	+14·9	+23·8	*+27·1*	+26·5	+26·4	49·7	15·6
	0·65	+22·5	+21·1	+8·9	+2·3	−13·7	−23·2	−30·7	−27·1	−31·6	*−36·3*	−33·1	−28·0	−17·9	−9·2	−0·8	+4·2	+9·6	+12·8	+17·2	+26·1	+30·1	+32·6	*+34·9*	+29·3	71·2	21·0
	1·21	+30·3	+25·2	+20·1	+5·0	−10·5	−33·6	−49·8	−47·1	−59·1	*−61·7*	−53·6	−48·7	−38·9	−19·3	−7·4	+1·6	+17·9	+27·2	+31·1	+41·1	*+65·1*	+62·9	+54·3	+47·9	126·8	35·8
		γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
H	0·05	−0·2	−3·3	−3·3	−8·1	−4·7	−7·4	*−9·9*	−6·4	−7·0	−5·0	−0·7	+1·4	+6·4	*+7·9*	+7·2	+4·0	+6·3	+4·1	+4·9	+4·7	+5·6	+4·5	+2·3	−3·5	17·8	4·9
	0·14	−0·5	−1·7	*−9·8*	−5·2	−6·3	−8·3	−6·2	−6·3	−5·3	−6·1	−2·1	+2·9	+7·6	*+9·5*	+8·3	+7·5	+6·0	+6·3	+5·0	+4·1	+4·8	+1·6	−2·9	−2·6	19·3	5·3
	0·33	−3·4	−5·8	−9·6	−13·7	*−19·9*	−18·0	−12·9	−7·5	−4·2	−1·4	+0·7	+1·0	+7·2	+7·7	+9·1	+8·3	+8·0	+6·9	+7·7	*+10·9*	+9·4	+9·2	+6·3	+4·0	30·8	8·0
	0·65	−6·0	−10·0	−18·6	*−28·6*	−24·7	−20·0	−17·8	−9·2	−5·2	−3·7	+1·7	+6·4	+10·3	+12·3	+12·4	+11·5	+13·3	+12·6	+13·5	+12·3	*+15·1*	+9·1	+11·4	+1·9	43·7	12·0
	1·21	−8·4	−16·6	−28·0	−40·7	*−44·3*	−39·2	−38·0	−29·5	−24·6	−9·2	+5·8	+10·6	+24·2	+26·6	+30·0	+31·2	*+31·4*	+28·3	+26·7	+22·3	+17·8	+11·0	+4·4	+8·2	75·7	23·2
Z	0·05	−7·0	−19·3	−29·3	*−30·9*	−26·5	−16·6	−6·9	−0·8	+2·5	+3·7	+6·9	+9·3	+11·7	+11·9	+8·5	+8·5	+9·6	+9·3	+9·3	+10·8	*+13·4*	+11·0	+9·7	+1·2	44·3	11·4
	0·14	−9·3	−23·9	*−35·4*	−29·6	−32·0	−25·7	−11·3	−5·1	+2·0	+2·6	+6·1	+11·9	*+18·6*	+18·3	+14·0	+13·1	+12·0	+12·4	+12·6	+15·7	+17·0	+12·9	+7·1	−4·0	54·0	14·7
	0·33	−10·5	−25·1	−35·1	*−39·0*	−37·1	−23·7	−11·6	−6·9	+0·3	+0·5	+8·1	+11·2	+13·4	+15·1	+12·4	+12·7	+14·0	+15·4	+17·0	*+21·3*	+18·7	+16·5	+10·4	+2·0	60·3	15·8
	0·65	−17·2	−30·6	*−45·1*	−44·9	−33·6	−20·5	−9·5	−7·0	−1·9	+6·7	+16·6	+18·9	+17·5	+16·6	+13·5	+13·9	+18·0	+21·9	*+28·0*	+18·1	+17·2	+9·9	+0·2	−6·7	73·1	18·1
	1·21	−29·4	−40·5	−57·1	*−59·7*	−57·5	−40·8	−29·4	−17·5	+4·6	+18·4	+22·7	+30·9	+28·6	*+33·8*	+25·8	+30·1	+25·3	+30·6	+31·4	+23·3	+14·2	+19·6	+5·6	−13·4	93·5	28·8
N	0·05	−2·5	−4·7	−3·2	−7·2	−3·2	−5·5	*−8·0*	−5·0	−5·7	−3·5	+0·6	+2·9	+7·4	*+8·3*	+7·0	+3·7	+6·1	+3·6	+4·3	+4·0	+4·4	+2·7	−0·3	−6·3	16·3	4·6
	0·14	−2·8	−3·3	*−10·8*	−4·5	−4·9	−6·2	−4·6	−4·7	−3·7	−4·1	−0·4	+4·9	+9·3	*+10·5*	+8·5	+7·3	+5·8	+5·6	+4·2	+3·0	+3·3	−0·6	−5·7	−5·8	21·3	5·2
	0·33	−5·6	−7·2	−10·0	−12·8	*−18·0*	−15·5	−10·3	−5·0	−1·9	+0·8	+2·8	+3·1	+8·3	+8·2	+8·8	+7·8	+7·0	+6·1	+6·5	*+9·2*	+6·7	+6·1	+3·4	+1·1	27·2	7·2
	0·65	−8·5	−12·2	−19·5	*−28·7*	−23·0	−17·4	−14·4	−6·1	−1·8	+0·3	+5·3	+9·5	+12·2	*+13·2*	+12·4	+10·9	+12·2	+11·1	+11·5	+9·4	+11·7	+5·4	+7·5	−1·3	41·9	11·1
	1·21	−11·6	−19·2	−30·0	−40·9	*−42·9*	−35·2	−32·3	−24·2	−18·0	−2·4	+11·6	+15·8	+28·2	+28·5	+30·6	*+30·8*	+29·2	+25·1	+23·1	+17·6	+10·6	+4·0	−1·5	+2·9	73·7	21·5
W	0·05	+19·1	+11·2	−1·3	−7·3	−13·1	−15·9	*−16·2*	−12·4	−11·1	−12·7	−10·4	−12·3	−7·4	−3·6	+1·7	+3·1	+2·1	+5·0	+5·7	+6·1	+10·7	+14·7	+21·3	*+22·8*	39·0	10·3
	0·14	+18·9	+12·9	+7·7	−6·2	−11·9	*−17·4*	−13·5	−13·8	−13·7	−16·8	−14·5	−16·2	−14·0	−8·2	−1·6	+1·6	+2·6	+6·8	+7·3	+9·9	+13·0	+18·6	+22·9	*+25·6*	43·0	12·3
	0·33	+17·5	+10·7	+3·2	−8·3	−17·2	*−22·0*	−21·7	−20·3	−19·4	−18·3	−17·0	−17·1	−9·3	−4·3	+2·8	+4·5	+8·0	+7·2	+10·0	+14·6	+22·4	*+25·3*	+24·5	+24·1	47·3	14·6
	0·65	+19·4	+17·7	+5·8	−1·3	−15·2	−23·1	−29·5	−25·3	−28·9	*−32·9*	−29·4	−24·2	−14·8	−6·7	+0·8	+5·2	+10·2	+12·9	+17·0	+24·8	+28·7	+30·2	*+32·6*	+26·4	65·5	19·3
	1·21	+26·1	+20·5	+14·6	−0·4	−14·7	−34·7	−49·1	−45·6	−55·8	*−56·3*	−47·2	−42·2	−31·9	−14·1	−3·0	+5·1	+19·8	+27·7	+31·0	+39·4	*+60·3*	+57·5	+49·0	+43·8	116·6	32·9

TABLE CXXII.

Mean Diurnal Inequalities for Days Grouped according to International Character Figure : Summer : G.M.T.

Element.	International Character Figure.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	Range.	Average Departure.
														γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
D	0·02	+23·2	+11·6	0·0	−13·6	−24·7	−20·1	*−25·6*	−20·8	−22·7	−20·6	−20·3	−17·8	−13·9	− 9·8	− 3·8	− 5·1	− 1·0	+ 2·7	+ 6·9	+21·0	+28·9	+36·9	*+49·8*	+38·8	75·4	18·3
	0·15	+34·7	+32·6	+10·8	− 3·4	−14·0	−19·3	−22·8	−24·7	*−27·5*	−24·3	−19·7	−18·0	−15·3	− 7·8	− 4·0	− 1·6	− 4·1	− 4·0	+ 0·7	+ 7·1	+19·7	+31·7	*+37·3*	+35·9	64·8	17·5
	0·35	+37·0	+32·1	+11·6	− 7·8	−24·2	−30·5	*−34·6*	−31·1	−30·6	−32·0	−27·7	−26·0	−17·7	−16·0	− 7·8	+ 0·8	0·0	+14·7	+ 9·1	+21·3	+30·0	+38·7	+44·5	*+46·2*	80·8	23·8
	0·66	+38·8	+19·5	+ 5·6	− 6·8	−20·3	−29·3	−36·7	−34·3	*−41·6*	−27·4	−30·7	−27·7	−21·1	−13·9	− 0·6	− 2·3	+ 6·4	+ 9·0	+16·9	+26·8	+39·4	+43·5	*+45·0*	+41·2	86·6	24·3
	1·15	+50·1	+42·1	+38·8	+13·0	− 8·5	−25·5	−46·1	−63·9	−65·7	−66·6	−67·4	*−69·3*	−54·2	−34·4	−15·1	+ 5·0	+17·7	+28·5	+29·3	+45·6	+60·7	+61·6	*+74·1*	+49·9	143·4	43·1
H	0·03	*−16·6*	−14·8	− 7·2	+ 2·7	+ 1·5	− 3·5	− 6·0	− 5·3	− 6·9	− 6·4	− 7·5	− 7·2	− 2·9	− 0·2	+ 9·8	+ 7·7	+ 9·1	+12·6	+14·7	*+15·3*	+11·3	+ 8·5	− 1·9	− 7·2	31·9	7·8
	0·15	− 6·6	− 0·2	+18·8	−17·6	− 8·6	−12·6	−15·6	−11·0	*−20·0*	−14·3	−10·3	− 4·9	+ 1·0	− 3·7	+ 4·0	+ 3·7	+ 4·9	+ 8·6	+ 9·6	+14·9	+21·6	*+22·9*	+ 9·6	+ 5·8	42·9	10·5
	0·35	+ 1·2	− 7·1	−10·7	− 7·4	− 7·4	−14·0	*−14·9*	−12·7	−12·1	−14·7	− 7·2	− 2·7	+ 7·0	+ 5·5	+12·2	+13·4	+14·3	+ 8·5	+ 7·6	+10·1	*+14·8*	+ 9·9	+ 9·6	− 3·2	29·7	9·5
	0·66	+ 0·1	−10·5	−18·8	*−22·1*	−18·0	−11·3	−18·3	−12·9	−17·5	− 9·4	− 4·7	+ 1·9	+ 6·5	+ 6·8	+12·6	+14·8	*+18·0*	+11·7	+12·8	+17·3	+14·2	+12·2	+11·3	+ 3·3	40·1	12·0
	1·15	+ 4·4	−26·8	−36·6	−26·7	−28·4	*−47·1*	−32·5	−35·8	−30·6	−16·7	− 4·2	+14·0	+21·8	+30·9	+29·3	+23·3	+14·7	+ 8·7	+ 8·9	+20·4	+29·5	*+34·7*	+15·7	+29·8	81·8	23·8
Z	0·03	− 8·7	−18·7	−37·7	−41·1	*−44·3*	−36·0	−29·3	−14·1	− 8·0	− 2·7	+ 0·1	+ 4·9	+10·7	+17·7	+13·7	+13·7	+18·0	+24·8	+30·2	+30·2	*+32·4*	+27·1	+19·1	− 2·4	76·7	20·2
	0·15	+11·4	−24·1	−38·3	−48·4	*−48·7*	−36·3	−19·1	−20·0	−10·4	− 1·7	+ 1·0	+ 7·6	+ 9·4	+ 9·9	+ 6·9	+11·4	+12·3	+20·0	+28·9	+34·4	+31·3	*+36·0*	+16·9	+ 9·6	84·7	20·6
	0·35	− 9·6	−35·8	−52·3	*−54·4*	−44·3	−39·4	−27·9	−19·1	−12·2	− 0·7	+ 4·5	+10·9	+11·2	+19·7	+22·5	+22·1	+18·9	+21·1	+30·9	+33·1	+29·9	*+33·8*	+21·3	+15·8	88·2	24·6
	0·66	+ 5·3	−30·9	−49·9	*−53·1*	−51·1	−38·1	−24·9	−18·2	− 8·2	− 5·2	+ 1·6	+11·9	+12·7	+12·8	+ 7·5	+20·5	+25·2	+24·8	+29·7	*+33·7*	+26·5	+28·5	+23·3	+15·6	86·8	23·3
	1·15	−28·9	−71·5	*−76·0*	−59·3	−47·1	−43·9	−12·6	−14·9	− 2·3	+ 2·9	+ 8·8	+28·9	+41·3	*+50·5*	+33·9	+27·3	+16·8	+20·8	+21·3	+32·1	+30·1	+32·8	+ 5·9	+ 2·7	126·5	29·7
N	0·03	*−18·9*	−15·6	− 7·0	+ 4·1	+ 4·0	− 1·7	− 3·3	− 3·1	− 4·5	− 4·4	− 5·7	− 5·7	− 1·5	+ 0·7	+10·0	+ 8·2	+ 9·1	+12·1	*+14·1*	+13·4	+ 8·5	+ 4·7	− 6·9	−11·2	33·0	7·4
	0·15	−10·2	− 3·6	+17·6	−17·1	− 7·0	−10·5	−13·1	− 8·3	*−17·0*	−11·6	− 8·1	− 3·0	+ 2·6	− 2·9	+ 4·4	+ 3·9	+ 5·3	+ 8·9	+ 9·4	+14·1	+19·3	*+19·4*	+ 5·6	+ 2·0	36·4	9·4
	0·35	− 2·7	−10·5	*−11·8*	− 6·5	− 4·8	−10·7	−11·2	− 9·3	− 8·8	−11·2	− 4·2	0·0	+ 8·9	+ 7·2	+12·9	+13·2	*+14·2*	+ 6·9	+ 6·5	+ 7·8	+11·5	+ 5·7	+ 4·8	− 8·1	26·0	8·3
	0·66	− 4·1	−12·4	−19·3	*−21·2*	−15·8	− 8·1	−14·3	− 9·2	−13·0	− 6·4	− 1·5	+ 4·8	+ 8·7	+ 8·3	+12·6	+14·9	*+17·2*	+10·7	+10·9	+14·4	+10·0	+ 7·5	+ 7·5	− 1·0	38·4	10·6
	1·15	− 0·9	−31·6	−42·1	−29·2	−28·2	*−45·0*	−27·7	−28·9	−23·4	− 9·6	+ 3·0	+21·3	+27·8	*+34·4*	+30·5	+22·0	+11·8	+ 5·3	+ 6·0	+16·2	+23·8	+29·3	+ 9·9	+25·9	79·4	22·2
W	0·03	+18·2	+ 5·9	− 2·1	−11·8	−20·9	−15·5	*−23·1*	−19·1	−20·5	−17·2	−15·9	−12·9	−12·1	− 8·0	− 1·4	− 3·5	+ 0·4	+ 4·6	+ 5·8	+17·1	+24·2	+33·0	*+41·8*	+32·9	64·9	15·3
	0·15	+30·4	+29·3	+11·9	− 5·1	−13·6	−18·9	−22·3	−23·5	*−27·0*	−23·4	−18·9	−16·8	−13·7	− 7·4	− 3·1	− 1·0	− 3·1	− 2·6	+ 1·7	+ 8·1	+20·2	+31·1	*+34·6*	+33·0	61·6	16·7
	0·35	+33·4	+28·1	+ 9·2	− 7·9	−22·7	−29·0	*−32·8*	−29·5	−28·9	−30·5	−25·7	−23·7	−15·1	−13·8	− 5·6	+ 2·3	+ 1·7	+14·2	+ 9·1	+20·3	+28·7	+35·9	*+41·1*	*+41·1*	73·9	22·1
	0·66	+34·9	+16·3	+ 2·8	− 8·7	−20·3	−27·6	−35·1	−32·3	*−39·4*	−25·7	−27·6	−24·7	−18·2	−11·7	+ 1·0	− 0·4	+ 7·9	+ 9·5	+16·7	+26·1	+37·0	+40·5	*+41·8*	+37·4	81·2	22·6
	1·15	+45·0	+38·8	+44·2	+19·3	− 3·0	−20·3	−42·1	−60·4	*−62·9*	−61·3	−61·2	−61·2	−49·8	−27·7	− 8·6	+12·4	+25·8	+28·9	+24·9	+37·1	+49·6	+47·9	*+49·8*	+34·4	112·7	38·2

TABLE CXXIII.

(*a*) Inequalities for Q Days, Winter, 1913. (*b*) Difference Inequalities for Year and Seasons.

	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	Range.	Average Departure.
(*a*) Q days, Winter, 1913.																										
	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
D	+ 5·6	+ 2·1	+ 0·7	− 4·3	− 5·5	− 6·3	− 4·5	− 3·9	− 3·3	− 3·7	− 3·9	− 8·9	− 6·9	− 2·7	− 4·6	+ 3·1	+ 2·5	+ 1·3	+ 3·5	+ 4·1	+ 5·8	+ 7·7	+ 9·9	+ 8·9	18·8	4·6
H	− 3·7	− 3·3	− 3·2	− 3·9	− 1·6	− 2·0	− 2·1	− 3·2	− 1·4	− 0·7	+ 0·7	− 0·7	+ 1·3	+ 4·3	+ 3·5	+ 5·0	+ 2·0	+ 2·2	+ 1·7	+ 2·2	+ 2·9	+ 1·5	+ 0·9	− 1·1	8·2	2·2
Z	− 7·0	−10·9	−11·0	− 9·8	− 7·1	− 3·0	− 1·7	0·0	0·0	+ 0·6	+ 0·4	+ 3·4	+ 7·6	+ 6·6	+ 6·5	+ 5·2	+ 4·3	+ 3·8	+ 4·0	+ 4·7	+ 3·5	+ 2·6	− 0·4	− 3·6	18·6	4·5
N	− 4·3	− 3·5	− 3·2	− 3·4	− 1·0	− 1·3	− 1·6	− 2·8	− 1·0	− 0·3	+ 1·1	+ 0·2	+ 2·0	+ 4·6	+ 3·6	+ 2·7	+ 1·7	+ 2·0	+ 1·3	+ 1·8	+ 2·3	+ 0·7	− 0·2	− 2·0	8·9	2·0
W	+ 4·6	+ 1·5	+ 0·2	− 4·3	− 5·1	− 5·9	− 4·3	− 3·9	− 3·1	− 3·4	− 3·4	− 8·0	− 6·0	− 1·9	− 0·2	+ 3·1	+ 2·5	+ 1·4	+ 3·3	+ 3·9	+ 5·5	+ 7·1	+ 9·0	+ 7·8	17·0	4·1
(*b*) Difference inequalities.																										
Year ... N	− 3·2	−19·6	−28·1	−33·2	−33·4	−29·7	−30·0	−20·1	−14·4	− 2·1	+ 9·1	+17·6	+21·5	+23·7	+22·2	+19·4	+16·2	+12·2	+10·8	+12·0	+11·0	+ 9·8	+ 7·3	+11·3	57·1	17·4
W	+17·7	+21·3	+23·1	+12·7	+ 2·9	−12·9	−25·9	−35·0	−39·0	−39·4	−37·1	−35·9	−27·8	−15·6	− 5·8	+ 5·2	+15·5	+19·8	+19·7	+27·4	+36·7	+30·8	+20·0	+18·1	76·1	22·7
Z	−21·8	−32·8	−29·4	−22·9	−17·7	−15·0	− 6·7	− 9·6	+ 2·0	+ 8·3	+12·7	+21·4	+23·3	+27·7	+20·4	+22·0	+10·1	+10·1	+ 8·8	+ 7·6	+ 3·6	+ 3·6	−10·3	−12·0	60·5	15·0
Winter N	−18·5	−28·2	−22·4	−32·8	−28·1	−15·9	−11·3	−15·2	−12·1	− 2·1	+ 7·6	+12·9	+14·6	+17·3	+22·5	+17·3	+22·7	+21·9	+21·7	+19·5	+11·4	+ 3·4	+ 6·4	−12·5	55·5	16·6
W	+19·1	+21·6	+ 6·9	+ 0·3	− 7·7	−15·0	−25·6	−30·4	−29·9	−30·4	−29·4	−29·5	−21·3	−16·8	− 5·5	− 2·3	+ 3·3	+12·6	+14·8	+28·7	+35·2	+34·7	+34·3	+31·5	65·6	20·3
Z	−22·8	−24·5	−22·1	−21·7	−19·1	−12·9	−14·3	−11·4	− 1·8	+ 4·6	+13·6	+18·5	+22·2	+28·4	+23·6	+31·0	+15·7	+13·0	+13·4	+ 8·3	+ 2·3	− 3·3	−13·5	−26·5	54·9	16·2
Equinox N	− 9·1	−14·5	−26·8	−33·7	−39·7	−29·7	−24·3	−19·2	−12·3	+ 1·1	+11·0	+12·9	+20·8	+20·2	+23·6	+27·1	+23·1	+21·5	+18·8	+13·6	+ 6·2	+ 1·3	− 1·2	+ 9·2	66·8	17·5
W	+ 7·0	+ 9·3	+15·9	+ 6·9	− 1·6	−18·8	−32·9	−33·2	−44·7	−43·6	−36·8	−29·9	−24·5	−10·5	− 4·7	+ 2·0	+17·7	+22·7	+25·3	+33·3	+49·6	+42·8	+27·7	+21·0	94·3	23·4
Z	−22·4	−21·2	−27·8	−28·8	−31·0	−24·2	−22·5	−16·7	+ 2·1	+14·7	+15·8	+21·6	+16·9	+21·9	+17·3	+21·6	+15·7	+21·3	+22·1	+12·5	+ 0·8	+ 8·6	− 4·1	−14·6	53·1	17·8
Summer N	+18·0	−16·0	−35·1	−33·3	−32·2	−43·3	−24·4	−25·8	−18·9	− 5·2	+ 8·7	+27·0	+29·3	+33·7	+20·5	+13·8	+ 2·7	− 6·8	− 8·1	+ 2·8	+15·3	+24·6	+16·8	+37·1	80·4	20·8
W	+26·8	+32·9	+46·3	+31·1	+17·9	− 4·8	−19·0	−41·3	−42·4	−44·1	−45·3	−48·3	−37·7	−19·7	− 7·2	+15·9	+25·4	+24·3	+19·1	+20·0	+25·4	+14·9	+ 8·0	+ 1·5	94·6	25·8
Z	−20·2	−52·8	−38·3	−18·2	− 2·8	− 7·9	+16·7	− 0·8	+ 5·7	+ 5·6	+ 8·7	+24·0	+30·6	+32·8	+20·2	+13·6	− 1·2	− 4·0	− 8·9	+ 1·9	− 2·3	+ 5·7	−13·2	+ 5·1	85·6	14·2

TABLE CXXIV.

Mean Hourly Values of H after commencement of 28 Disturbances.

Means.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.	24h.	25h.
	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
A	120·1	119·4	115·8	108·0	98·0	92·5	81·4	65·0	55·1	55·8	68·0	70·9	86·1	83·0	96·2	96·5	108·9	111·3	112·5	120·4	124·3	124·4	119·6	116·9	115·5
B	+ 7	+10	+ 7	+ 8	+ 5	+ 3	+ 5	− 9	−16	−14	− 8	− 6	− 1	−16	− 5	−11	− 4	− 6	− 6	+ 2	+10	+12	+ 5	+ 8	+11
C	+ 7	+ 6	− 6	0	− 1	+ 6	+15	− 2	− 6	− 5	0	+ 2	− 1	−25	−16	−13	− 8	−20	−14	− 2	+15	+25	+12	+15	+22
D	+ 8	+14	+21	+16	+11	0	− 5	−16	−25	−22	−16	−15	− 1	− 8	+ 5	− 9	+ 1	+ 8	+ 2	+ 5	+ 5	0	− 3	+ 1	− 1

In drawing conclusions from the results supplied by Tables CXIX to CXXII regard must be had to several points.

1. Though the winter and equinoctial inequalities are means from two separate sets of inequalities for 1912 and 1913 respectively, the constituent months are not symmetrically distributed about mid-summer. The mean epoch for winter is near the end of December, 1912, whereas that for equinox is more nearly the beginning. Since, therefore, general magnetic activity in the Antarctic was declining from 1912 to 1913 at a greater rate than would have been deduced from any criterion of solar activity or even from magnetic conditions in moderate latitudes, the differences in corresponding inequalities from the two seasons though mainly are not purely attributable to differences in magnetic conditions as between Antarctic winter and equinoctial conditions. Relative to the winter conditions, the mean activity of the months contributing to the tabulated equinoctial inequalities is slightly exaggerated. This effect is small and, as will be seen, the amplitude only and not the type of the inequality can be affected.

2. These considerations are even more cogently applicable to the table of summer data in all elements but D. For during December, 1912; the H and Z variometers were functioning so indifferently that that month has contributed no data to the seasonal mean in these elements, and, therefore, in N and W. The implication of this is that the summer inequalities of Table CXXII are also reduced in amplitude but not affected in form for all elements except declination.

3. Since the reduction in scale of the summer and equinoctial inequalities will not be compensated by the enhanced winter inequality relative to an epoch at 31st December, 1912, the annual mean inequalities will have suffered a slight net reduction.

§40.—The Effects of Increasing Disturbance on the Diurnal Inequalities.

The material of Table CXIX for the year may be first considered. The results are partially illustrated in Plate X. The mean character figure entered in the final column for each group of days after the second is approximately double that of the preceding group. Though it is only after the third group that successive differences are really large, yet there is no element in which the average departure of the inequality does not systematically increase from the first to the fifth groups. Even in the case of the range, D and W, which are largely inter-dependent, are the only elements which fail to show a progressive increase with the increasing character figure. International character figures, therefore, even when restricted to a limited number of months, are thoroughly representative of magnetic conditions far beyond the area covering the stations contributing to the scheme. And, further, not only do the figures provide an adequate means of differentiating between quiet and disturbed conditions even to within small distances of the magnetic pole, but they are also a sensitive means of discriminating between days of relatively poor magnetic dispersion in such localities.

According to current hypotheses there should be a difference in type as well as in amplitude between inequalities representative of quiet and of disturbed conditions. Between groups of days whose mean character figures differ by over one unit such a difference, if it exists in Antarctic regions, might be expected to be evident, and to accompany the increased disturbance associated with the increasing character figures of successive group inequalities of Table CXIX a corresponding increasing distortion of the quiet day variation due to superposition of the disturbance variation would be anticipated. Plate X shows that there is no evidence of such an effect in any one of the elements. Increase of international character has associated with it a progressive increase in amplitude on the variation but the type remains essentially the same.

§41.—The Regular Variation on Days of Least Range.

1913 was a year of very low sunspot activity; it was the minimum year of the cycle. Not only so, but magnetically it was phenomenally quiet in all moderate latitudes. Even in Adelie Land there were isolated days during which no sensible perturbations interrupted the smooth run of the traces. Hence, if any quiet day variation exist, its characteristics should become evident by forming a mean inequality from days of 1913 which are at the same time of low international character figure and free from obvious local disturbance. Such conditions are approximately obtained by considering the inequalities from the selected quiet days of the winter of 1913 alone. Combing material derived from the fifteen selected quiet days of the three months May, June and July having a mean character figure, 0·04, the inequalities for this season reproduced from the appropriate tables in Part II, Volume I, are seen (Table CXXIII (*a*)) to have exactly the same form as for the days of just slightly character figure or for the days of higher general disturbance (in both years).

Hence, through a series of inequalities in which the average departure increases from 4·58 (quiet days winter 1913) to 43·1 (disturbed days summer) in D, from 2·21 to 23·8 in H and 4·49 to 29·7 in Z, for corresponding groups of days and seasons, the type of the inequality remains invariable. It can therefore be concluded either that the quiet day variation, if it exists, is vanishingly small and can only be detected on occasions of special Antarctic quiet, or that the regular quiet and disturbance variations, essentially different in type for stations outside a limited area surrounding the poles, become identical within this region. On the evidence here presented, the latter conclusion is the more acceptable.

§42.—Seasonal Change in the Effects of Disturbance on the Inequalities.

The effectiveness of the forces producing the inequalities on either quiet or disturbed days increases substantially from the Antarctic winter to the Antarctic summer, the seasonal change being most conspicuous on quiet days. In all components the average departure for the selected quiet days of summer is about three times as great as for winter but in the groups of days of highest character figure the increase from winter to summer is only 54% in D, 21% in H and 31% in Z. The state of affairs in the equinoctial months is representative of the year as a whole.

§43.—Difference Inequalities and Vector Diagrams.

The nature of the time variation of the disturbing forces which, superposed on the normal quiet day variation, produces the composite inequality representative of disturbed days can be further examined by subtracting each hourly value in the quiet day inequality from the corresponding value in that for disturbed conditions. The resulting ' difference ' inequality specifies the additional disturbing force at each hour of the day. When such inequalities are combined for geographical force components in pairs, diagrams representing the space and time variations of the resulting vectors in three orthogonal planes can be constructed. Table CXXIII (*b*) contains the difference inequalities in the three rectangular components for the year and three seasons, and Plate X supplies their graphical representation as vector diagrams.

At stations in latitudes well on the equatorial side of the auroral zone in the northern hemisphere the vector diagram for the forces in the horizontal plane is elongated in a direction transverse to the magnetic meridian, but the direction of elongation changes to be along the meridian for stations on or just outside the zone. There is also evidence that that for at least some stations in the former category the elongation is along the meridian at one season of the year and transverse to the meridian at another. This latter fact means :—

1. That at such stations the changes in sense of the predominating uniquely directed disturbing force are abrupt; and
2. That the direction of the predominating force changes from being almost wholly in the plane of the meridian at one season to being perpendicular to it at another.*

The corresponding events as presented by Plate XI are largely different from those just described. In the horizontal and prime vertical planes the only indication of a tendency to abruptness in change of vector direction is in the latter in summer, and might well arise from the paucity of material available. With this exception the vector diagrams for those two planes are fairly smooth and roughly oval with the longer axis in the east-west direction in both cases. In all three seasons the area swept by the vector in the night hours (18h. to 6h. L.M.T. or 9h. to 21h. G.M.T.) is not substantially less than that described in the daylight hours.

* 64550—I

In the case of the N V components the diagrams are distinctly elongated in the direction of increasing north and vertical force. On the average of the three seasons, there being no radical change of form of diagram from winter to summer, the times of quickest changes are 14h. to 16h. G.M.T. in the one direction and less quickly at about 4h. G.M.T. in the opposite direction. Such a form of diagram is a result of the approximate coincidence of phase of the two constituent components. If N and V increased and decreased systematically together the diagram would, of course, take the form of a right line.

§44.—The "Storm-time" Variation.

In the Antarctic the effect of disturbance is to depress the mean value of the horizontal force throughout the disturbed hours by about 10γ and to enhance the vertically downward force (regarded as in the northern hemisphere as acting on the north pole of the suspended magnet) by at least double the amount. But no information is available as to the general form of the variation which is superposed on the regular disturbance variation while these net changes in the magnetic field around the pole are in progress. An attempt has been made to deduce the form of this variation (which, because of its supposed independence of local time and because of its dependence entirely on the time of commencement of the disturbance, supposed large and world wide, is called the "storm-time" variation) from the data collected at the Adelie Land base. Though unsuccessful in producing a variation differing from the Antarctic regular disturbance variation so conspicuously as the storm-time variation in low and moderate latitudes differs from the corresponding regular disturbance variation, it is of interest to record the procedure and results of the attempt.

Two methods were tried :—

1. On the assumption that days which were likely to furnish contributions to a synthetic storm-time variation must be internationally disturbed, a list of all days in the period April, 1912, to July, 1913, of character figure $\nless$ 1·0 was formed. From this list were eliminated all days which had not been assigned a character-figure 2 on the basis of the Cape Denison magnetograms alone. 28 days remained. The magnetograms for these days were then examined to determine that hour on which each disturbance seemed to have begun. In some cases the initial hour was fixed by a movement of sudden commencement type but, in the absence of any such movement and more usually, the first sharp movement was noted which looked distinctively different from any preceding smaller and presumably local perturbations. The twenty-five hourly values of horizontal force following on each of these 28 initial hours were then tabulated arranging all the initial hours below each other independently of the actual Greenwich time. The average variation formed from the array is given as A in Table CXXIV and depicted in Plate XII.

The form of the variation is a single wave with minimum eight hours and maximum 21 hours after the initial hour. It is evident, on comparison with the ordinary disturbance variation of H with 21h. as first ordinate reproduced below, the storm-time variation, that the variation obtained by this procedure is simply the ordinary variation commencing about 21h. G.M.T. That such a result might have been anticipated is obvious from the distribution of the 28 initial hours throughout the 24 hours of the day shown below.

Hour of day (G.M.T.) ...	3h.	5h.	7h.	12h.	16h.	17h.	19h.	20h.	21h.	22h.	23h.	24h.
Frequency of initial hour	1	1	2	1	2	2	3	4	5	4	1	2

The three hours 20h., 21h. and 22h. contributed 13 of the total 28 of selected initial hours, so that the centre of gravity of the distribution is not far from 21h. A resulting variation from such a distribution, therefore, necessarily had the ordinary disturbance variation with 21h. as commencing epoch as its chief ingredient. Since further there was a decided tendency for disturbance commencing in the Greenwich evening at Adelie Land to be more highly developed than disturbance commencing at other hours of the day, even a smaller contribution of initial hours for the part of the day would have produced a similar result.

The further remark is relevant, that the type of disturbance in which the storm-time variation might be expected to be most prominent should be sufficiently unique to have a commencing epoch independent of local time. That the disturbances resulting from the method of selection adopted were grouped around a certain hour therefore, indicates that they were not of the rare, first magnitude type; that, indeed the period covered by the available material was too restricted to furnish examples of disturbance of the calibre required.

A second attempt was, however, made by grouping those sequences of 25 hourly values, which were used in the first investigation, with the same initial hour, and forming a mean variation appropriate to each of the twelve hours of the day (see the distribution above), to which had been assigned an initial disturbed hour. Then from each of these twelve mean variations there was subtracted the regular disturbance variation (identified, because of the absence of evidence for a quiet day variation differing in type, with the variation for disturbed days) appropriate to the mean dates of the groups of days on which the selected disturbances had occurred and displaced so that its epoch coincided with the initial hour of the group. For example, July 3rd and August 22nd, 1912, were the two days on which 16h. G.M.T. was considered to be the initial hour of the disturbance. From the mean variation appropriate to these times and days was, therefore, deducted the disturbed variation for winter 1912, setting down the value for 16h. G.M.T. below the first hour of the variation and so on. The twelve residual variations thus found were set down with initial hours in the same vertical column and the resulting set of means derived for each of the 25 columns is given as B in Table CXXIV. That table also contains two auxiliary mean variations, (C) and (D), derived the one (C) from those six constituent groups which had their initial hour in the part of the day 24h. to 16h. G.M.T., and the other (D) from the six constituents with the initial hour in the remaining seven hours 17h. to 23h. G.M.T. These three variations are represented in Plate XII.

In spite of the precautions taken to reduce the influence of the regular variation, the latter is still the conspicuous feature except in the case of the part-day variation for the set of contributing hours 0h. to 16h. G.M.T., when the form is too irregular for identification. The greater the disturbance on any one day or group of days the larger is the amplitude of the disturbance variation, so that the usefulness of a mean variation derived from a more extended set of days of lower average disturbance as a method of eliminating the regular variation is reduced. There still remains a considerable residual variation of the regular type and of sufficient amplitude to mask any storm-time changes which might be present.

It is, therefore, obvious that the prime essential in obtaining the sequence of storm-time changes is to have such a sufficiently extended set of magnetograph data that a considerable number of storms of first-class magnitude are represented; and, further, that these storms have clean cut starting movements (preferably of sudden commencements type) distributed as nearly as possible uniformly throughout the 24 hours of the day.

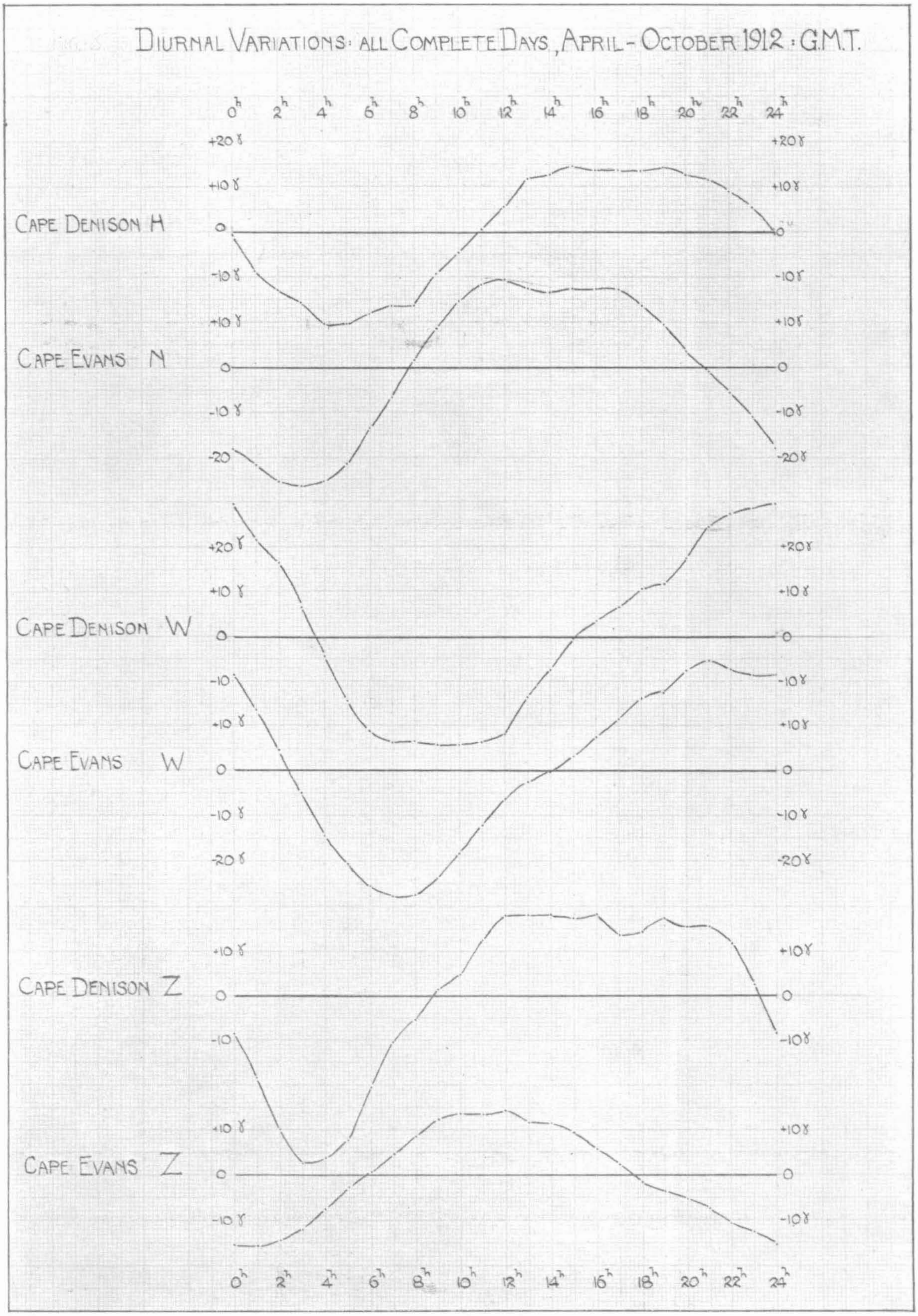
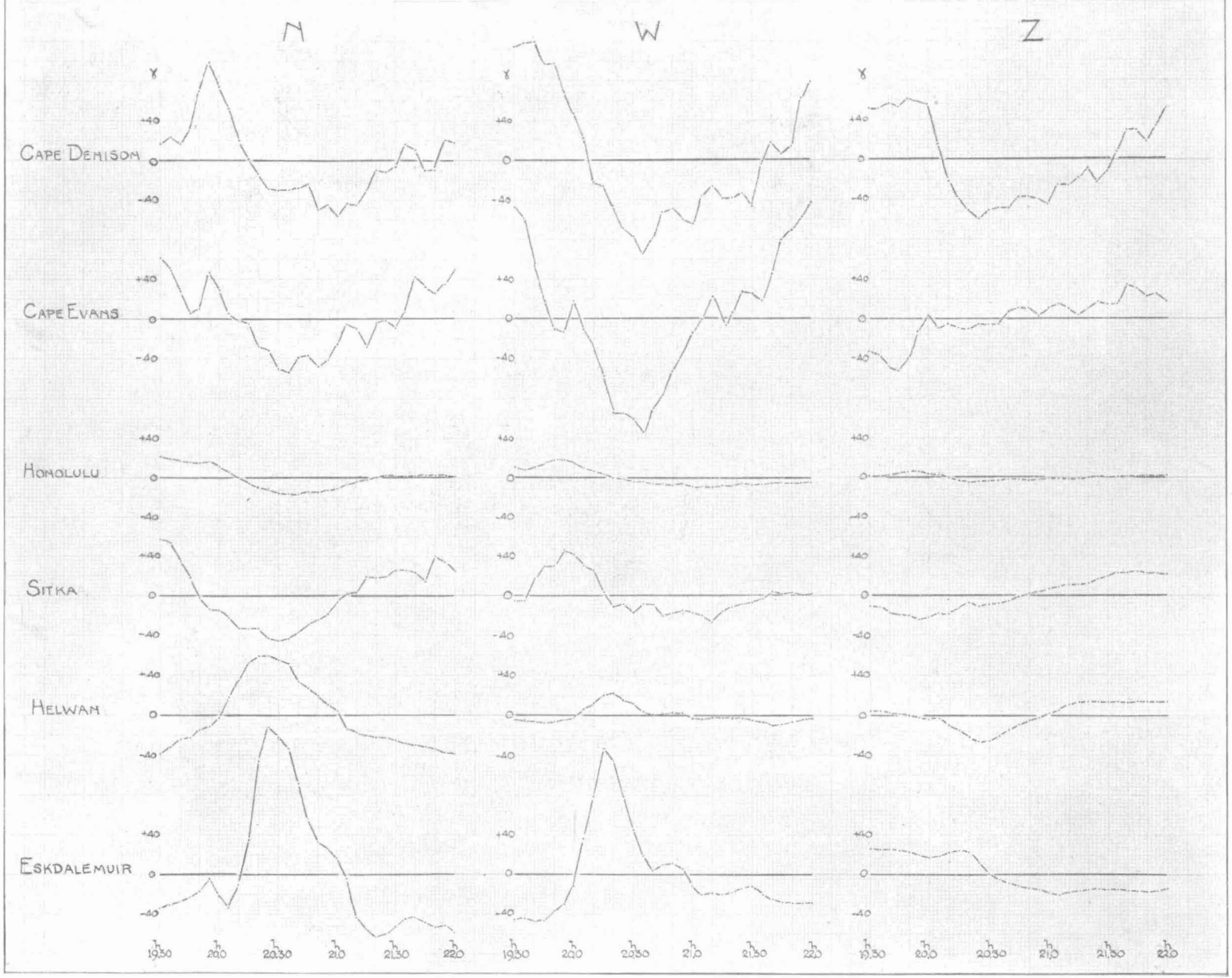
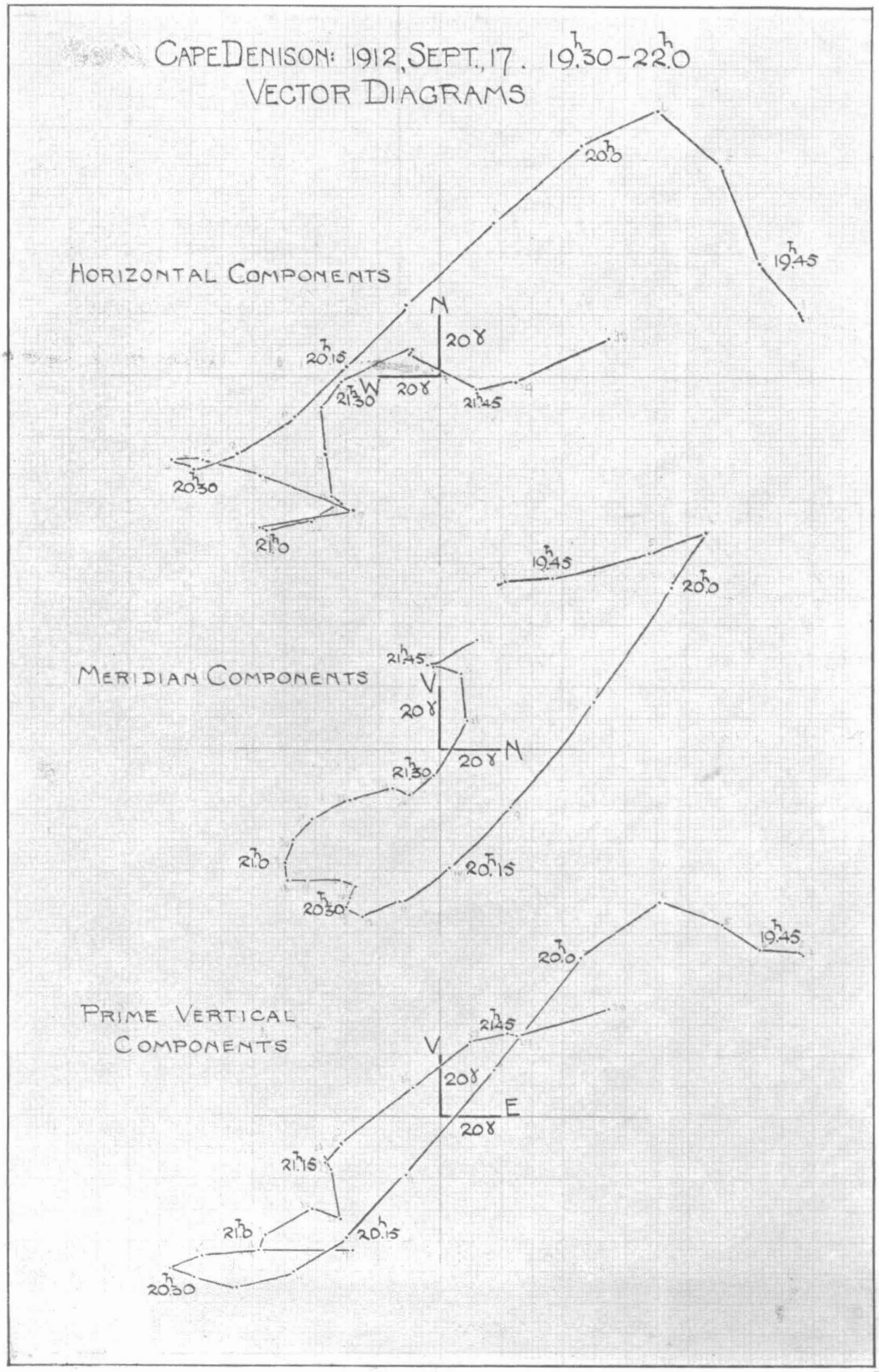
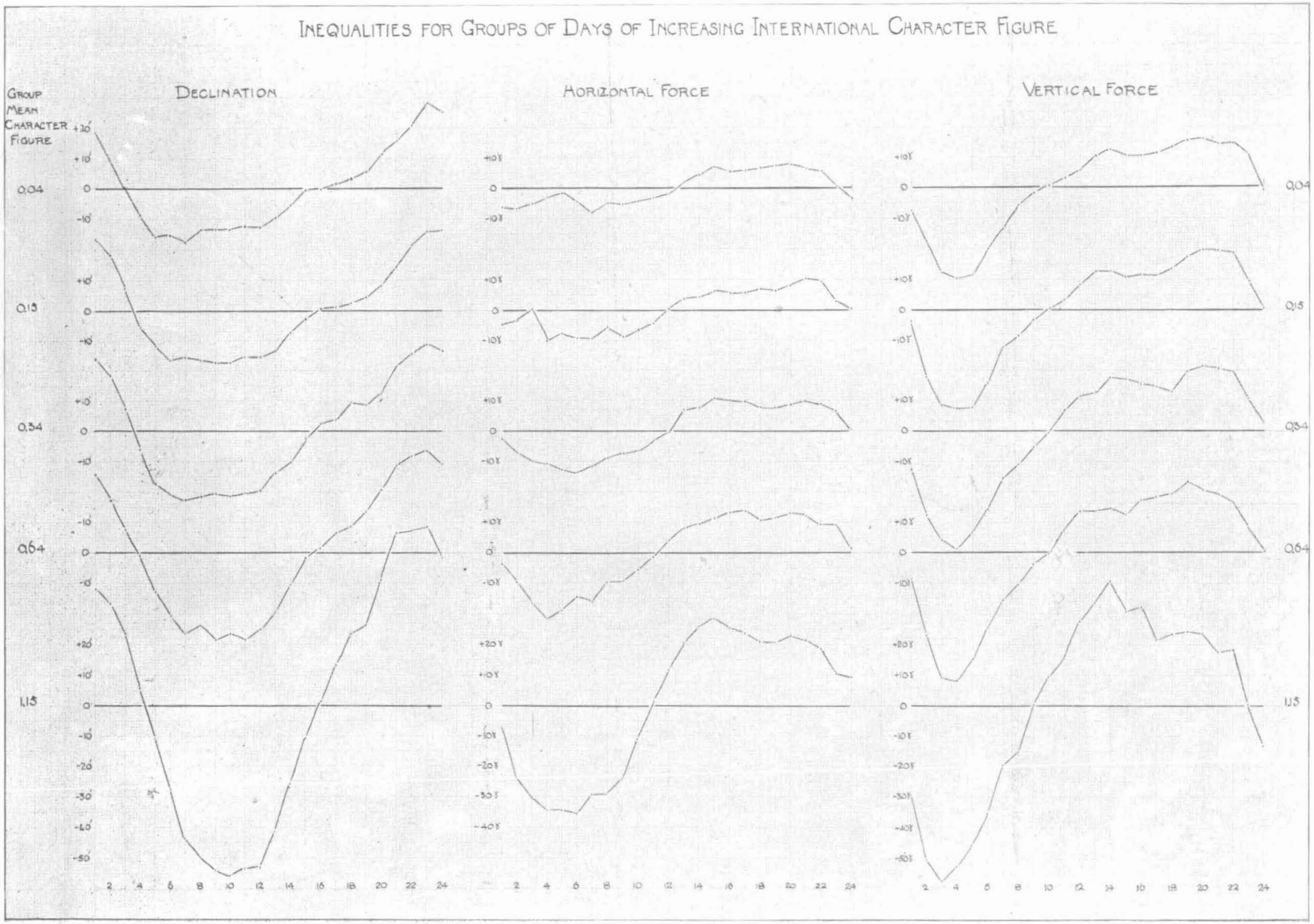
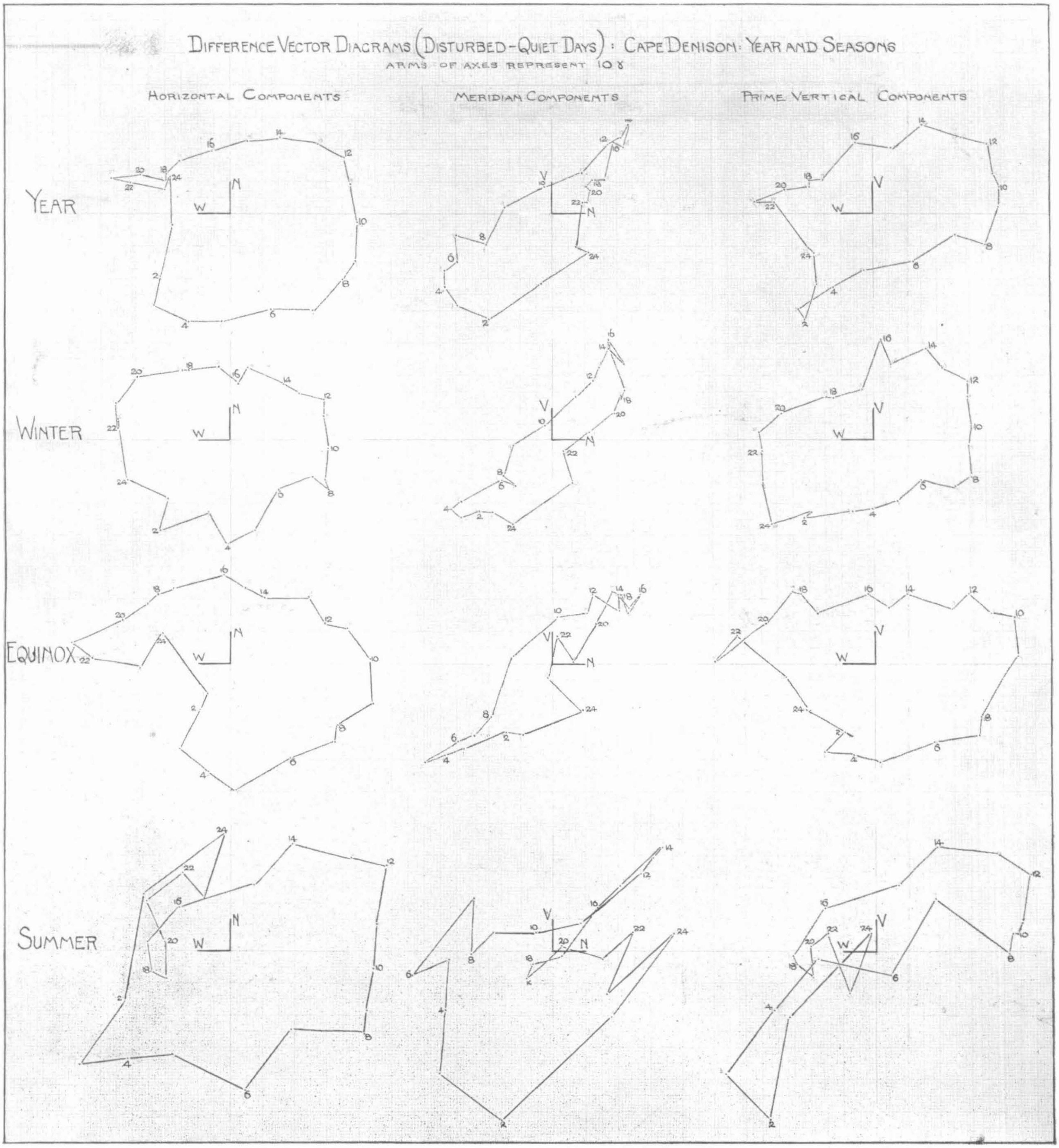

DIURNAL VARIATIONS: ALL COMPLETE DAYS, APRIL - OCTOBER 1912 : G.M.T.
0h 2h 4h 6h 8h 10h 12h 14h 16h 18h 20h 22h 24h
CAPE DENISON H
CAPE EVANS N
CAPE DENISON W
CAPE EVANS W
CAPE DENISON Z
CAPE EVANS Z
+20γ
+10γ
0
-10γ
-20γ

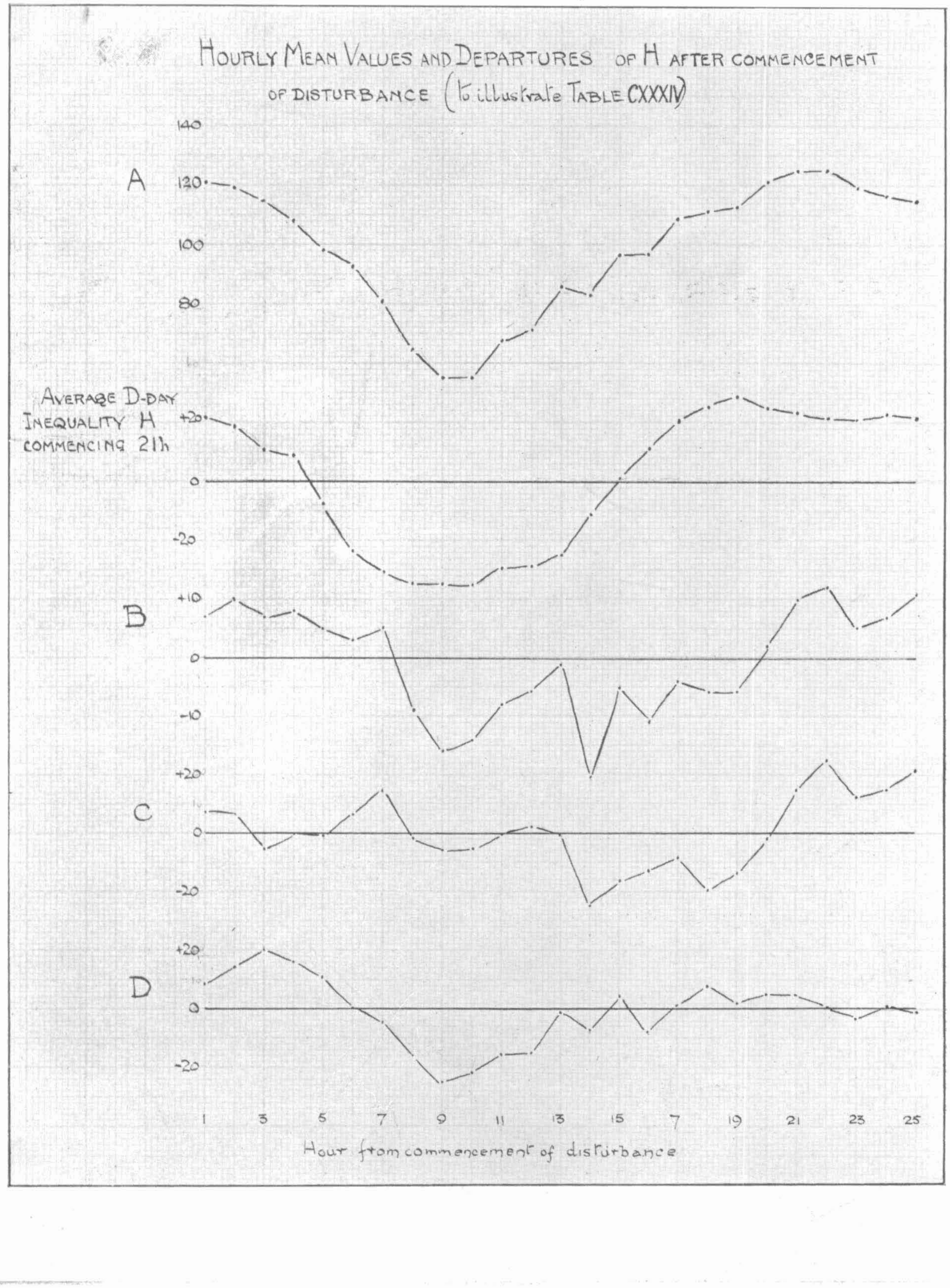
Plate VIII - 1912, September 17, 19h30 to 22h0 Changes in Magnetic Force at 5-Minute Intervals

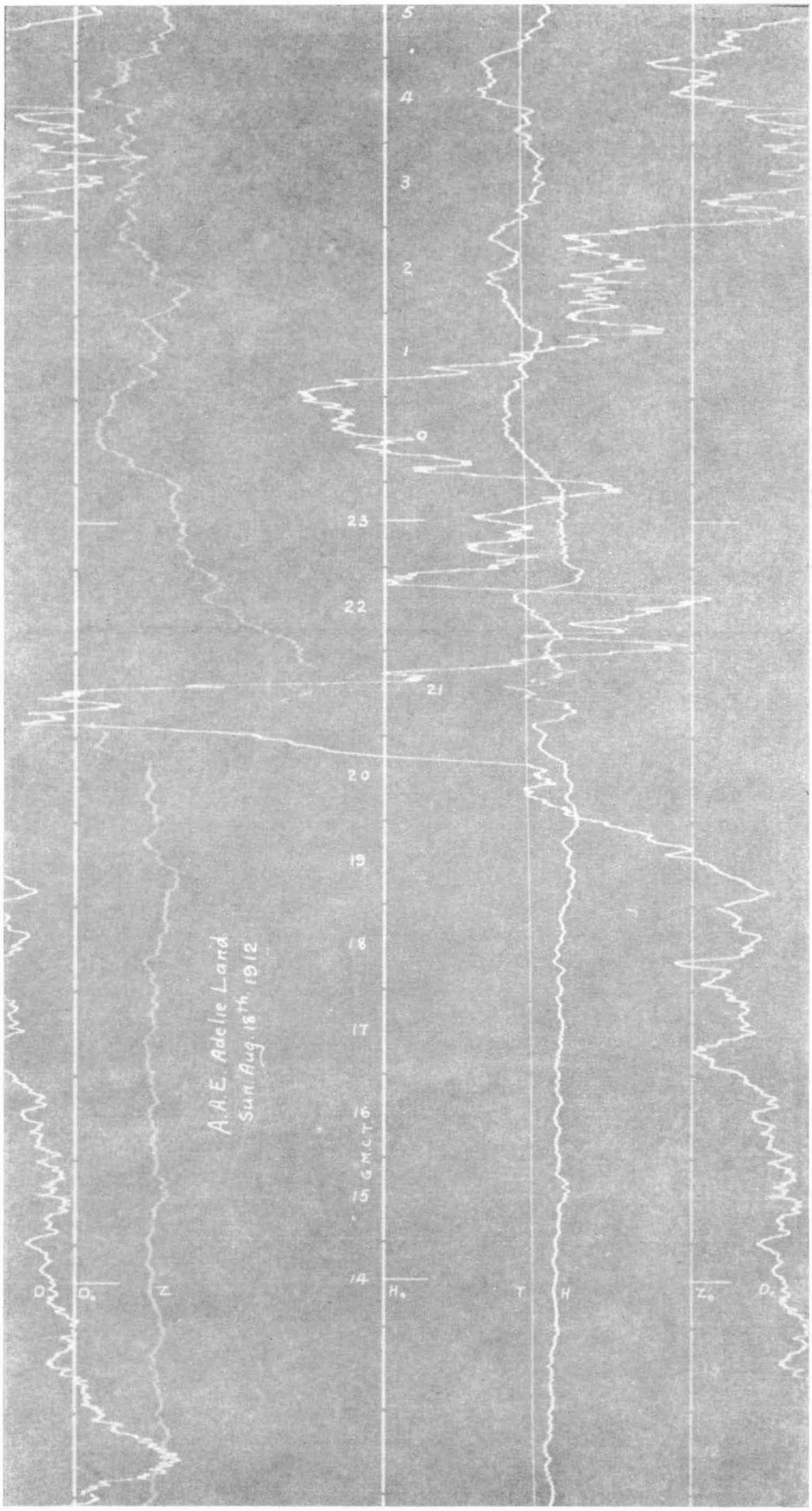



CAPE DENISON: 1912, SEPT. 17. 19h30–22h0
VECTOR DIAGRAMS
HORIZONTAL COMPONENTS
N
20γ
W
20γ
20h0
19h45
20h15
21h30
21h45
20h30
21h0
MERIDIAN COMPONENTS
V
20γ
N
20γ
19h45
20h0
21h45
21h30
21h0
20h15
20h30
PRIME VERTICAL COMPONENTS
V
20γ
E
20γ
20h0
19h45
21h45
21h15
21h0
20h15
20h30

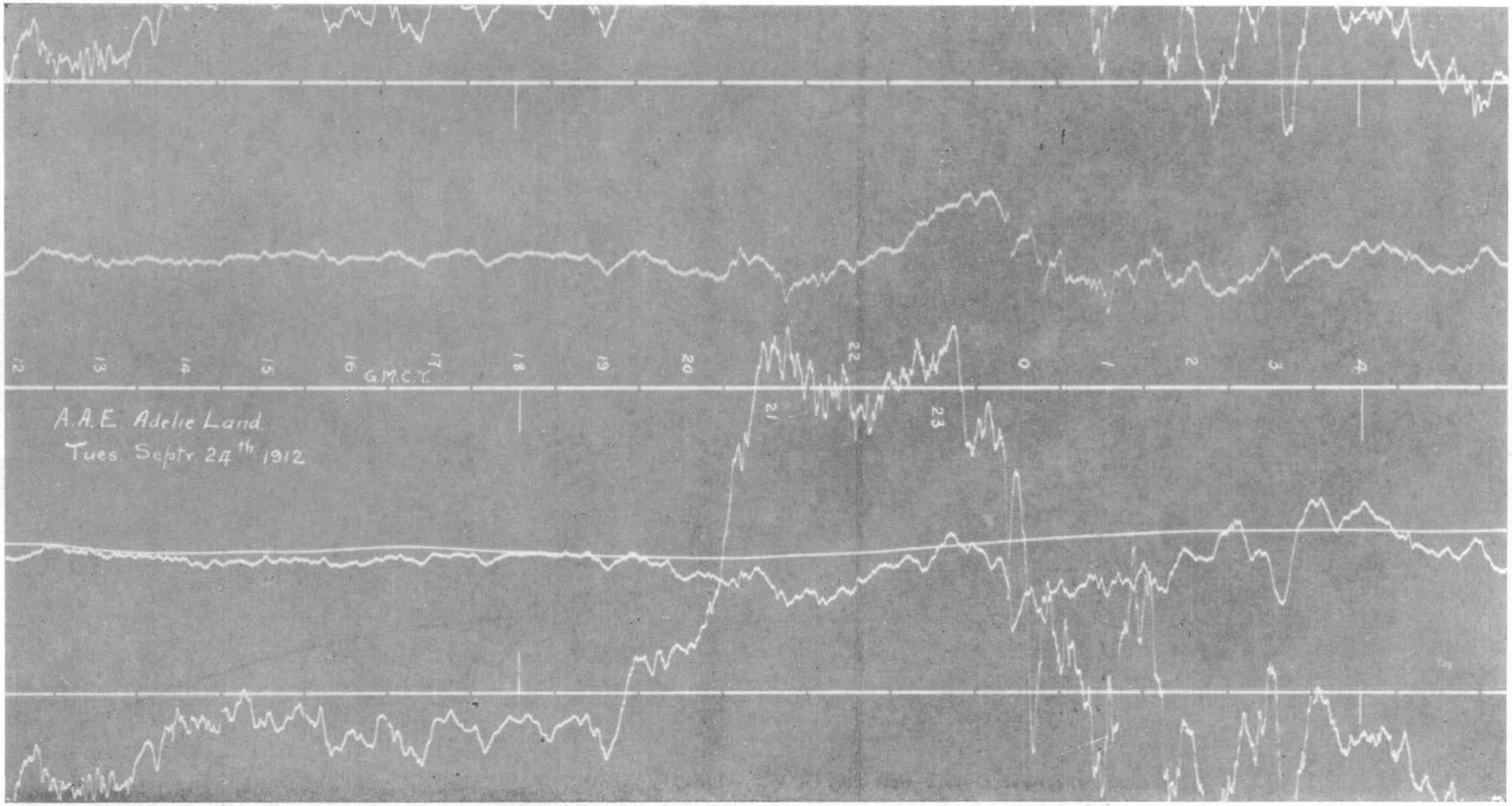

INEQUALITIES FOR GROUPS OF DAYS OF INCREASING INTERNATIONAL CHARACTER FIGURE
DECLINATION
HORIZONTAL FORCE
VERTICAL FORCE
GROUP MEAN CHARACTER FIGURE
0.04
0.15
0.34
0.64
1.15
2 4 6 8 10 12 14 16 18 20 22 24


DIFFERENCE VECTOR DIAGRAMS (DISTURBED - QUIET DAYS): CAPE DENISON: YEAR AND SEASONS
ARMS OF AXES REPRESENT 10γ
HORIZONTAL COMPONENTS
MERIDIAN COMPONENTS
PRIME VERTICAL COMPONENTS
YEAR
WINTER
EQUINOX
SUMMER


Hourly Mean Values and Departures of H after commencement of disturbance (to illustrate Table CXXXIV)
140
120
100
80
A
Average D-day Inequality H commencing 21h
+20
0
-20
+10
B
0
-10
+20
C
0
-20
+20
D
0
-20
1
3
5
7
9
11
13
15
17
19
21
23
25
Hour from commencement of disturbance



REPRODUCTION OF A DISTURBED SECTION OF THE MAGNETOGRAM OF AUGUST 18, 1912: CAPE DENISON.



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