Inverted SC in the Low Latitude Regions

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Abstract

In the low and middle latitudes, the horizontal component of the main impulse of SC's usually increases. But, from some observatories, SC's of the decreasing horizontal component (inverted SC) are reported, though their frequencies are very small. In this paper, the two inverted SC, observed at rather more observatories in the low and middle latitudes are examined somewhat in details. The results show that one at 04h 59m, April 2nd, 1958 is a s. f. e. and the other at 07h 18m, Jan. 10th, 1960 would be better classified as Si (magnetic sudden impulse).

The suitable classification of the rapid variations is often difficult, based on the record of only one station and this examination is made by means of the world wide data. It is suggested that the horizontal component of the main impulse of SC may always increase in the low latitude regions near Kakioka.

§ 1. Introduction

Ignoring a preliminary reverse impulse, the horizontal component of main impulse of a SC increases usually in the low and middle latitude regions and decrea-

Table 1. The occurrence frequency of the inverted SC and/or inverted SC*

Observatory	Geographic		Geomagnetic		Examined period	Frequency	Author
	Lat.	Long.	Lat.	Long.			
Cheltenham	N38°44′	W076°50′	50.1°	350.5°	1922—1946	1	V. C. A. Ferraro
Tucson	N32 15	W110 50	40.4	312.2	1910—1946	1	〃
San Juan	N18 23	W066 07	29.9	3.2	1926—1946	0	〃
Kakioka	N36 14	E140 11	26.0	206.1	1924—1963	4	Y. Yokouchi & Kakioka Mag. Obs.
Honolulu	N21 18	W158 06	21.1	266.5	1902—1946	2	V. C. A. Ferraro
Alibag	N18 38	E072 52	09.5	143.6	1905—1944	28	S. K. Chakrabarty
Huancayo	S12 02	W075 19	−00.6	353.8	1922—1946	1	V. C. A. Ferraro
Watheroo	S30 19	E115 53	−41.8	185.6	1919—1946	8	〃

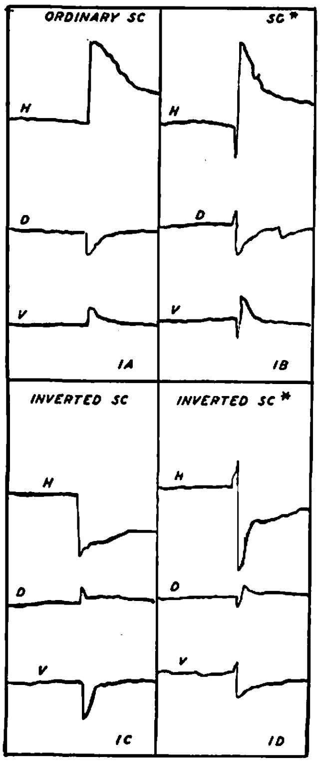


Fig. 1. Four types of SC, shown schematically (after V.C.A. Ferraro).

ses in the high latitude regions, depending upon the local time. Some authorities classified SC into the four types SC, SC*, inverted SC and inverted SC* and examined the geographical distribution and the dependency on the local time of their occurrence frequency and magnitude [1], [2], [3], [4]. After then, the above mentioned facts have been ascertained by many workers and well known, though some workers used other classifications and notations. However, the frequency of decreasing of the horizontal component of the main impulse of is very small in the low and middle latitude regions and seems to be interesting and not yet completely examined. V. C. A. Ferraro [3] and S. K. Chakrabarty [4] actually showed that the inverted SC (including the inverted SC*) at some low and middle latitude observatories could be certainly observed, although the frequency is very small.

On the other hand, T. Obayashi examined much world-wide data of SC and obtained the equivalent current system of average SC, suggesting the explanation of the various types of SC by the superposition of the different ratio of Dst and DS field [5].

He wrote "As mentioned above, in the outer auroral zone, currents in both the D^c_{st} and D^c_s parts flows towards the east in the afternoon. In the forenoon, however, the D^c_s current flows westwards against the eastwards D^c_{st} current. Consequently the amplitude of SC's is usually small at this region, and occasionally inverted SC's may take place". From the standpoint of the view, the occurrence of the inverted SC and/or inverted SC* may be limited within the forenoon side of the earth. At the same time, the occurrence of them in the low and middle latitude region means the considerably wide covering by DS field, over the earth, in spite of its comparatively weak intensity.

While, magnetic sudden impulses (Si), which have many similar characters to SC, occur often with the decreasing horizontal component even in the low latitude regions [6]. Thus, from the standpoint of the comparison of SC and Si, the examination of the inverted SC and/or SC* may be also very important.

In this paper, the author analysed the inverted SC at Kakioka Magnetic

Table 2. The inverted SC at Kakioka Magnetic Observatory during 1924-1963

Greenwich Date	Storm Time		Sudden Commencement Amplitudes			Maximal Activity on K scale 0 to 9			Ranges		
	GMT of Begin.	GMT of Ending	D	H	Z	Gr. Day	Gr. 3-hr period	K-index	D	H	Z
1930 May 30d	15h02m	04d24h	′ −1.0	γ −18	γ −12				′ 16.5	γ 101	γ 67
1944 Mar. 18d	07 00	19 24	′ −0.2	γ −14	γ −9				′ 7.2	γ 116	γ 72
1958 April 2d	04 59	03 10	γ −11	γ −4	γ −1	2	3, 4, 5	4	γ 81	γ 71	γ 38
1960 Jan. 10d	07 17	11 22	γ +2* −18	γ +5* −45	γ +4* −24	10	3, 4	6	γ 54	γ 175	γ 59

* : preliminary reverse impulse

Data for 1924-1951 : "Principal Magnetic Disturbances at Kakioka, 1924-1951" by Y. Yokouchi, Memoirs of the Kakioka Magnetic Observatory Vol. 6, No. 2

1958 April 2 : Manuscript at Kakioka Magnetic Observatory to "IAGA Bulletin No. 12m 2"

1960 Jan. 10 : Report of the Geomagnetic and Geoelectric Observations 1950-60 Kakioka Mag.

Observatory as the first step of the examination. According to Y. Yokouchi and others [7] [8] [9] [10] [11], the four cases of such SC have been recorded at Kakioka, since 1924. They are tabulated in Table 2. The first two out of them belong to the period in which we have not enough data to examine their characters.

Fortunately, the last two occurred during and after the IGY, in which we have a rather plentiful data of geomagnetism and other geophysical data. Thus our main forces of analysis are put on the last two.

§ 2.1 SSC at 04 59 April 2, 1958

The descriptions of this SSC given in IAGA Bulletin No. 12 m2 are reproduced in Table 3. Based on the same table, the geographical distribution of the observatories which reported the event is shown on Fig. 2, with the reported qualities. Glancing at the figure, we can know the phenomenon is the local one, contrary to most of SC. The high qualities are observed at the observatories near

Table 3a STORM SUDDEN COMMENCEMENTS (S. S. C. 'S) 1958

Sudden commencements followed by a magnetic storm or period of storminess.

April

02d 04h 59m A : Tk Mu Ku Wa-B : Ir Qu Hn-C : Pr Ty Mb IK SM Ka Ky Tn Am AI-X : SF Ct-(Si : Sr Kn Kr-sfe : To)-D : 48

Table 3b SOLAR-FLARE EFFECTS (S. F. E. 'S) and DOUBTFUL SOLAR-FLARE EFFECTS 1958

April

none

Note 1 In Table 3a, the time is mean values. Observatories which checked the sudden commencements and agreed with the term ssc are classified in six groups under the letters A, B, C, D, E, X, as follows :

A) when the phenomenon in their magnetograms is a very distinct ssc
B) when it is a fair, ordinary but unmistakable ssc
C) when it is a doubtful ssc
D) when in the magnetograms the ssc was decidedly not recorded, although the records were satisfactory
E) when the phenomenon cannot be discerned because of heavy disturbance
X) when the recording is missing

The checking observatories were : So Co Sr Nu Le Si Kn Mo St Wn Wi Ir Sw Ni VI Cm Ha Kv Ma Db Pr Bu Fu CF Ty Od Mb Ag Lg Aq Tf Tk Md IK Eb Ci Tl Fr Ak SM SF Ka Ks Tu Ky Qu Ta Ho SJ MB Mu Gu Kr Pa Mc Lr Hn Ku Lu PM Ap Tn Wa Hr To Am MI AI Wk Du Mw Ct Ht SB LA BS.

Note 2 A check for the solar flare effects was made by 75 observatories, the same as for the phenomenon in Table 3a, but for So, Mo, SF ; in the contrary Es and AA have checked the sfe's.

(IAGA Bulletin No. 12m 2)

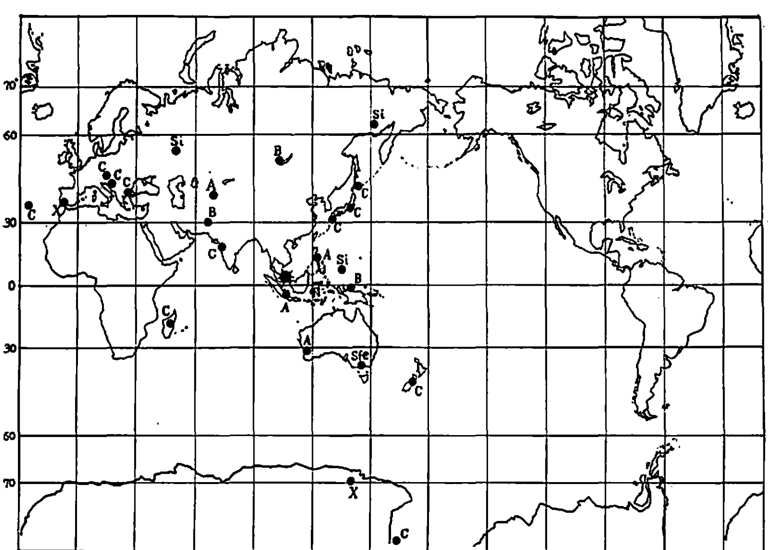


Fig. 2. The geographical distribution of observatories which reported the rapid variation. ✱ : sub-solar point ; Si : sudden impulse ; sfe : solar flare effect ; A, B, C, D, E, X : defined in Table 3, Note 1.

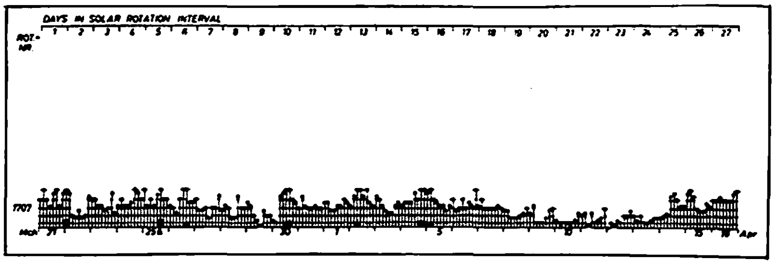
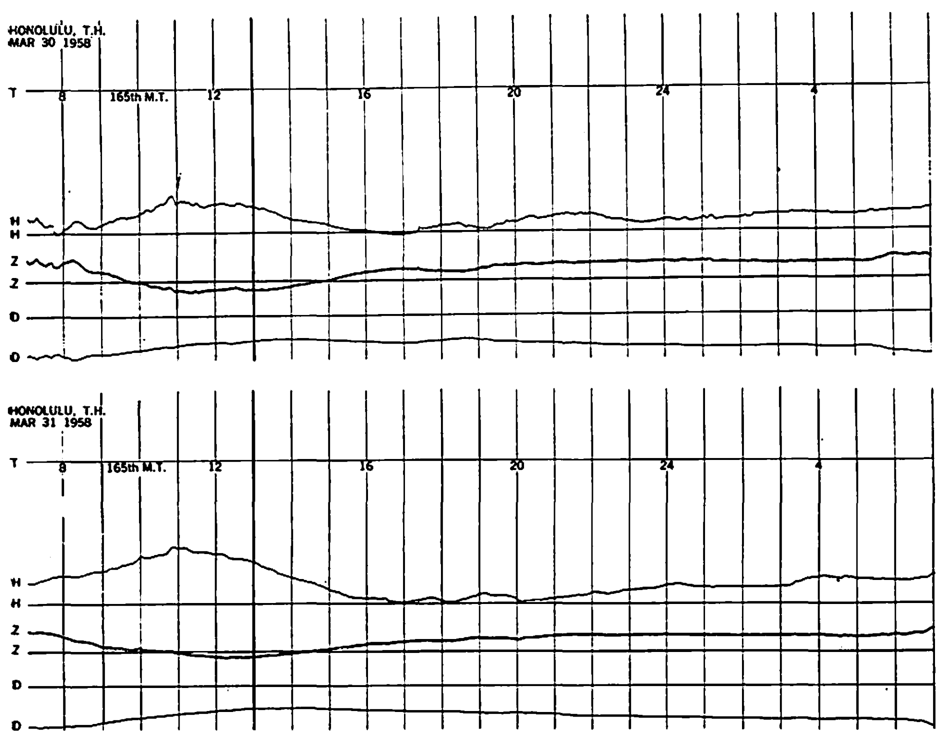


Fig. 3(a). The general aspects of the geomagnetic field around April 2nd, 1958.
Kp-diagram

the sub-solar point. The facts seem to suggest the phenomenon may not be SC, but the solar flare effect (s. f. e.). In order to show the aspects of magnetic activity in the middle latitudes around April 2nd Kp-diagram and the magnetograms at Honolulu, where the rapid variation is not reported, are given in Fig. 3. The phenomenon occurred at about 04h 59m (U. T.). But the trace of each component falls on the time mark on the ordinary magnetogram. The circumstances are similar at Kakioka, Memambetsu and Kanoya as shown in Fig. 4.



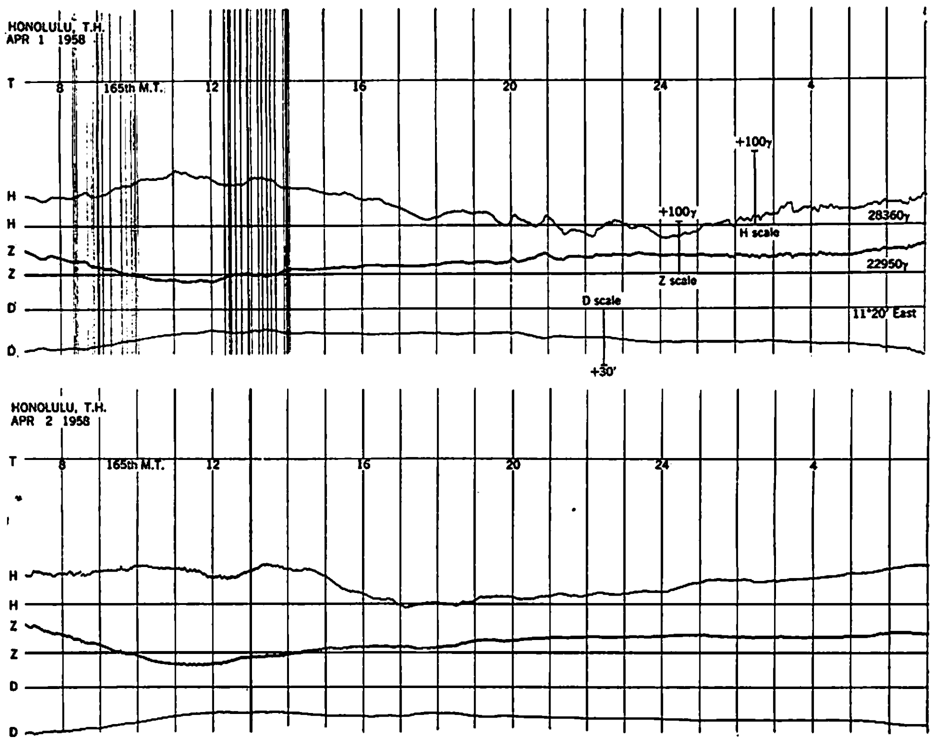


Fig. 3(b). The general aspects of the geomagnetic field around April 2nd, 1958
Magnetograms at Honolulu(geog. lat. : N21° 18′, geog. long.: W158° 06′ ; geom. lat. : 21. 1°, geom. long. : 266.5°)
Mar. 30, 1958~Apr. 2, 1958 (165th M. T.)

Thus the occurrence time and the time of maximum deviation are somewhat vague. The irregular variations before and after the concerned variation may be also a factor which makes the phenomenon indistinct. But, for the period the various rapid run recorders were operated at our observatories. Only the rapid run magnetograms at Kakioka and Memambetsu are reproduced in Fig. 5. Beside these, we could use the copies of the rapid run magnetograms at Guam, Koror and Watheroo. From them, the beginning time, the time of the maximum deviation, the ending time etc. are taken and tabulated in Table 4. Although the times of occurrence, the maximum deviation and especially the ending are very difficult to be exactly read, owing to the superposition of other phenomena and/or the flatness of the curves, we can take the nearly same beginning time. While the times of the maximum deviation are more or less different from an observatory to another. Some s. f. e's during the IGY analysed by M. Ohshio, N. Fukushima and

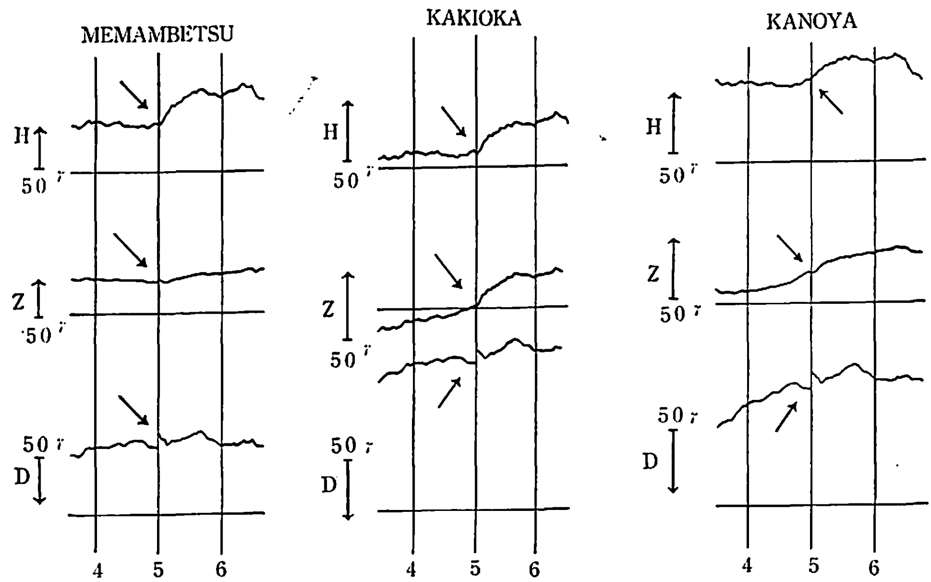
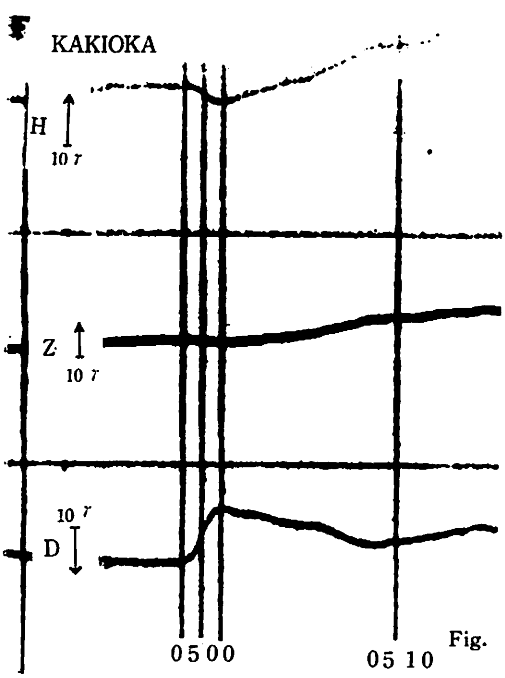


Fig. 4. Ordinary magnetograms at Memambetsu, Kakioka and Kanoya on April 2nd, 1958.
Memambetsu : geog. lat. N43°55′, geog. long. E144°12′; geom. lat. 34.0°, geom. long. 208.5°
Kakioka : geog. lat. N36°14′, geog. long. E140° 11′ ; geom. lat. 26.0°, geom. long. 206.1°
Kanoya : geog. lat. N31°25′, geog. long. E130° 53′ ; geom. lat. 20.5°, geom. long. 198.2°



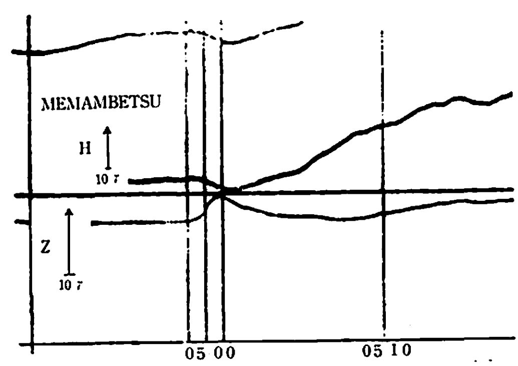


Fig. 5(a) Rapid run magnetogram at Memambetsu around 05h April 2nd, 1958

Fig. 5(b). Rapid run magnetogrom at Kakioka around 05h April 2nd, 1958

Table 4. Some elements on the rapid run magnetograms

Observatory	GMT of					Sense and Max. amplitude		
	Beginning	Maximum deviation			Ending	H	D	Z
		H	D	Z				
	h m	h m	h m	h m	h m	γ	γ	γ
Memambetsu	4 59.0	5 01.6	5 00.9	5 01.6	5 9	− 2	−16	− 4
Kakioka	4 59.0	5 01.0	5 01.0	5 ?	5 9	− 3	−11	+ 1
Guam	5 00.0	5 01.7	5 00.5	5 01.1	5 10	+ 9	− 7	+ 1
Koror	4 59.0	5 03.5	5 01.0	5 03.5	5 9	+14	+ 1	+19
Watheroo	4 59.0	5 00.3	5 00.9	5 00.9	5 10	−13	−29	+14

T. Nagata show such a tendency, as cited in the next section [12].

Therefore, the discrepancy between the time of the maximum deviation at any observatories may not be able to offer evidence in disproof of the statement that the phenomenon is a s. f. e.

§ 2.2 Brief reviews of morphology of s. f. e.

Since J. A. Fleming described a magnetic variation following a short wave fadeout was 1936 [13], A. G. McNish (1937 a, b, c) [14] [15] [16], S. Imamiti (1938, 1940, 1943) [17] [18] [19] and others examined the variation. And they concluded s. f. e. was a momentary augmentation of Sq, owing to the ionization enhancement in the ionosphere caused by the ultra-violet radiation. In 1958, H. Volland & J. Taubenheim [20] stated that s. f. e. was not a mere augmentation of Sq and the regular difference between the both current systems was due to the different heights of the current layers. They concluded that a half of the current for s. f. e. flows in the E-layer and another half of it flows in the D-layer. J. Veldkamp & D. van Sabben (1960) [21], M. Yasuhara & H. Maeda (1961) [22] and D. van Sabben (1961) [23] examined the s. f. e. during the IGY. While, T. Rikitake (1950) [24] and T. Nagata (1952) [25] treated s. f. e. as a transient phenomenon and examined the electromagnetic induction within the earth and the ionosphere. Recently T. Rikitake & T. Yukutake (1962) [26] treated in detail the electromagnetic induction in the ionosphere. M. Oshio. N. Fukushima and T. Nagata analysed s. f. e. 's during the IGY (1963) [12] and concluded that s. f. e. occurs in the dark hemisphere as well as in the sunlit hemisphere and the difference of the time of the maximum deviation on the world amounts to 10-15 minutes and s. f. e. can be explained by the combination of the enhancement of electron contents due to solar X rays and the electromagnetic induction in the ionosphere.

§ 2.3 Equivalent Current

The geographical distribution of the horizontal vector of the concerned variation is drawn in Fig. 6. The observatories, of which records are examined in this research, are listed in Table 5.

As stated before, there are some differences of the time of maximum deviation between observatories. But, most of the available data are the ordinary magnetograms and so, we adopted the difference between the extreme values at about 04h 59m and 05h 01m, as the magnitude of the variation. The inaccuracy of time mark and/or the error of scaling the curves may be inavoidable to some extent in the analysis of this kind. However, those may not introduce much error, judged from the examination of the curve of rapid run magnetograms at the observatories as given in Table 4. At least, the current pattern in the sunlit hemisphere may be hardly changed. In the same figure, the current arrows of Sq at the corresponding time are drawn. As Sq, we took the variation of March 28, which was one of five international quiet days.

Table 5. The observatories of which data are used

CSAGI No.	Station	Geographic		Geomagnetic		Ψ
		Lat.	Long.	Lat.	Long.	
A 020	C. Chelyuskin	N77° 43′	E104°17′	65.°9	177.°5	−03.°2
A 030	Resolute Bay	N74 41	W094 50	83.0	289.6	45.8
A 033	Dixon Is.	N73 32	E080 33	63.0	161.4	−12.9
A 037	Tixie Bay	N71 34	E128 54	60.1	191.1	07.0
A 049	Godhavn	N69 14	W053 31	79.9	032.5	−17.6
A 050	Murmansk	N68 57	E033 03	64.1	126.5	−26.3
A 070	Kotzebue	N66 53	W162 38	63.6	242.3	26.5
A 099	Baker Lake	N64 20	W096 02	73.9	314.8	25.9
A 101	Reykjavik	N64 11	W021 41	70.2	071.0	−25.4
A 102	Big Delta	N64 00	W145 44	64.3	259.3	26.3
A 107	Healy	N63 51	W148 58	63.6	256.6	25.9
A 121	Srednikan	N62 26	E152 19	53.2	210.6	12.5
A 124	Yakutsk	N62 01	E129 40	51.0	193.8	07.8
A 134	Nurmijarve	N60 30	E024 39	57.8	112.5	−22.0
A 140	Lerwick	N60 08	W001 11	62.5	088.6	−23.6
A 145	Churchill	N58 45	W094 06	68.8	322.5	21.4
B 009	Lovö	N59 21	E017 50	58.1	105.8	−22.1
B 019	Sverdlovsk	N56 44	E061 04	48.5	140.7	−13.0
B 035	Moscow	N55 29	E037 19	50.8	120.5	−17.5
B 119	Hartland	N51 00	W004 29	54.6	079.0	−18.1

CSAGI. No.	Station	Geographic		Geomagnetic		Ψ
		Lat.	Long.	Lat.	Long.	
B 143	Pruhonice	N49° 59′	E014°33′	49.9°	097.3°	−17.9°
B 145	Lvov	N49 54	E023 44	48.0	105.1	−17.2
B 168	Chambon la F.	N48 01	E002 16	50.4	083.9	−17.2
B 191	Tihany	N46 54	E017 54	46.3	099.1	−16.7
B 349	Stonyhurst	N53 51	W002 28	56.9	082.7	−19.6
C 001	Petropavlovsk	N53 06	E158 38	44.6	126.0	12.1
C 018	Odessa	N46 47	E030 54	43.8	111.1	−15.6
C 051	Vladivostock	N43 41	E132 10	32.8	198.3	04.8
C 076	Tashkent	N41 25	E069 12	32.5	143.8	−09.0
C 098	Toledo	N39 53	W004 03	43.9	074.7	−14.4
C 143	San Fernando	N36 28	W006 12	41.0	071.4	−13.5
C 147	Kakioka	N36 14	E140 11	26.0	206.1	06.3
C 236	Tucson	N32 15	W110 50	40.4	312.2	10.0
C 245	Kanoya	N31 25	E130 50	20.5	198.2	04.2
C 273	Tamanrasset	N22 47	E005 31	26.0	081.3	−12.2
C 277	Honolulu	N21 18	W158 06	21.1	266.5	12.2
C 287	Teoloyucan	N18 45	W099 11	28.6	328.3	06.3
C 300	San Juan	N18 23	W066 07	29.9	003.2	−00.7
C 311	M' Bour	N14 24	W016 58	21.3	055.0	−09.6
C 362	Irkutsk	N52 28	E104 02	40.8	174.5	−01.8
C 364	Tbilisi	N42 05	E044 42	36.7	122.1	−13.1
E 538	Alibag	N18 38	E072 52	09.5	143.6	−07.2
E 553	Muntinlupa	N14 22	E121 01	03.0	189.7	02.0
E 556	Guam	N13 35	E144 52	04.0	212.9	06.3
E 562	Annamalainagar	N11 24	E079 41	01.5	149.4	−05.9
E 575	Paramaribo	N05 50	W055 10	17.0	014.5	−02.9
E 583	Bangui	N04 36	E018 35	05.0	088.6	−11.4
E 585	Fanning Is.	N03 54	W159 23	03.8	268.8	11.4
E 603	Trivandrum	N08 29	E076 57	−01.1	146.4	−06.4
E 606	Koror	N07 20	E134 30	−03.2	203.4	04.5
E 625	Hollandia	S02 34	E140 31	−12.6	210.3	05.7
E 634	Kuyper	S06 02	E106 44	−17.4	183.9	00.8
E 646	Huncayo	S12 02	W075 19	−00.6	353.8	01.3
E 653	Apia	S13 48	W171 46	−16.0	260.2	11.6
E 672	Tahiti	S17 33	W149 37	−15.2	283.8	11.6
C 925	Watheroo	S30 19	E115 53	−41.8	185.6	01.3
C 957	Hermanus	S34 26	E119 14	−33.4	080.5	−13.8
B 966	Toolangi	S37 32	E145 28	−46.7	220.8	09.3
B 979	Amberley	S43 09	E172 43	−47.7	252.5	15.1
B 998	Aux Francais	S49 21	E070 12	−56.5	127.8	−13.9
A 959	Pionerskaya	S69 44	E095 30	−80.3	146.5	24.2
A 961	Macquarie Is.	S54 30	E158 57	−65.7	243.0	17.7
A 977	Wilkes	S66 15	E110 32	−77.8	179.1	−00.4
A 985	Charcot	S69 22	E139 01	−78.3	234.5	27.2
A 988	Cape Hallett	S72 18	E170 18	−78.6	278.1	40.1
A 989	Halley Bay	S75 31	W026 37	−65.6	024.2	−19.0
A 991	Scott Base	S77 51	E166 47	−79.0	294.4	58.7
A 995	Little America	S78 11	W162 12	−74.0	312.0	45.9
A 997	Byrd Station	S79 59	W120 00	−70.6	336.0	27.6

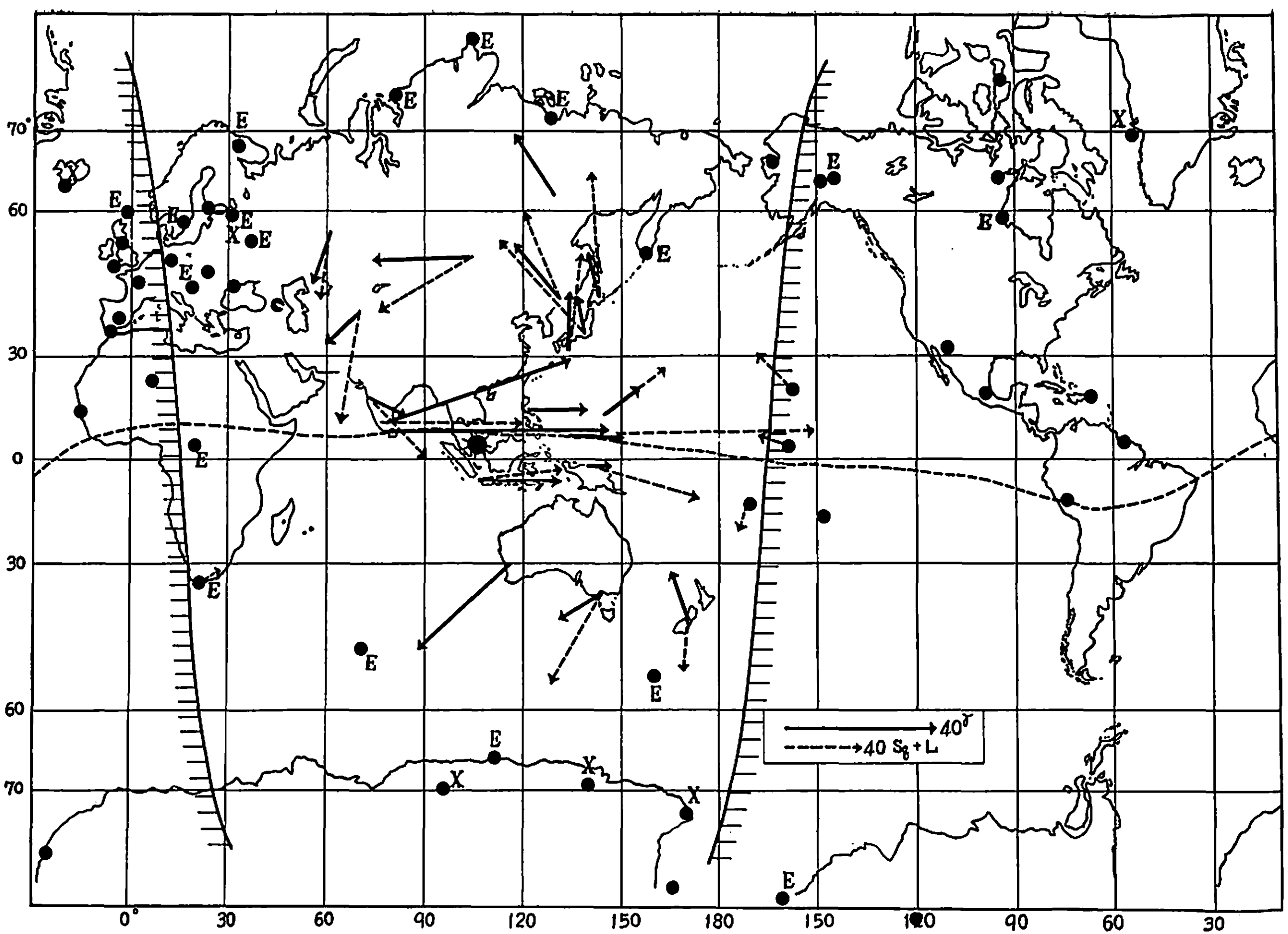


Fig. 6. The current arrows of the concerned variation and Sq.
X : record missing
E : Because of other disturbance, the phenomenon can not be discerned
✱ : sub-solar point

Both the current arrows at most stations fairly well coincide to each other, except ones at Amberley where the current arrow of the concerned variation takes nearly the opposite direction to that of Sq. But, such a case can be seen near the sun set and/or sun rise zones in the cases of many positive s. f. e. 's, as shown in the

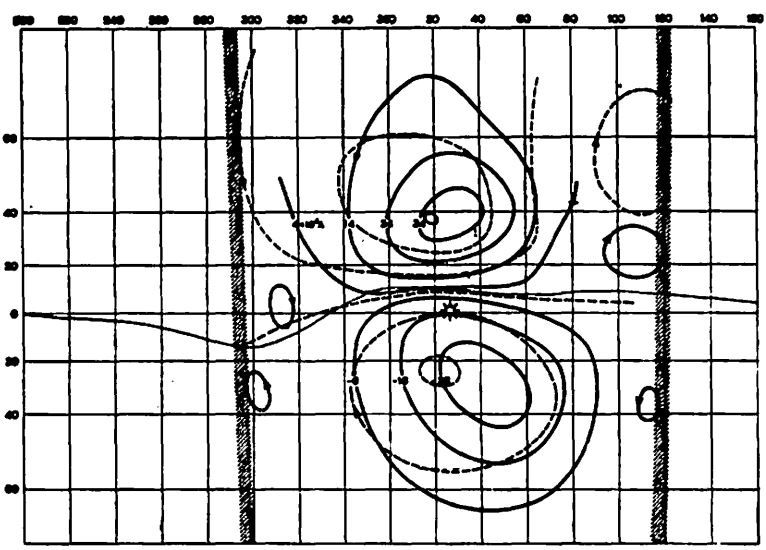


Fig. 7. An example of the current system of the positive s. f. e.'s. (after D. van Sabben) Currents systems of solar flare effects and daily variation, 23 March 1958, 1015 UT. The full lines show the current system of the s. f. e. at the time of its maximum; the stream lines are provided with numbers which give the total current in units of 10^4A, flowing in between these lines and a zero line in the center of the diagram. The dashed lines represent the current system of the daily variation at the time of the maximum s.f.e. The sub-solar point, the twilight zones and the magnetic equator are also indicated. The geographic coordinates are used.

Table 6 (a) SOLAR
April

Observatory	Date Apr. 1958	Observed Universal Time			Location			Duration Minutes
					Approx.		McMath Plage Region	
		Start	End	Max.	Lat.	Mer. Phase		
Tashkent	02	0430E	0450	0434	S 15	W61	4476	20D
Nizamiah	02	0427	0441	0433	S 15	W58	4476	14
Kodaikanal	02	0502E	0507D		S 26	W34	4478	5D
Nizamiah	02	0505E	0515		S 23	W34	4478	10D

results by some authorities. And this facts may rather secure the opinion that s. f. e. is not merely an augmentation of Sq. Furthermore, the sudden change at Srednikan is abnormally large. This may be perhaps attributed to a superposition of a variation due to other causes and/or an accidental error. Thus on the map, the current arrow at Srednikan is excluded.

Fig. 6 is a preliminary one and both of the concerned variation and Sq are not corrected by the electromagnetic induction within the earth.

But, even if we take into consideration the effect of the induction, the relation between the two kinds of the current arrows will not be considerably changed

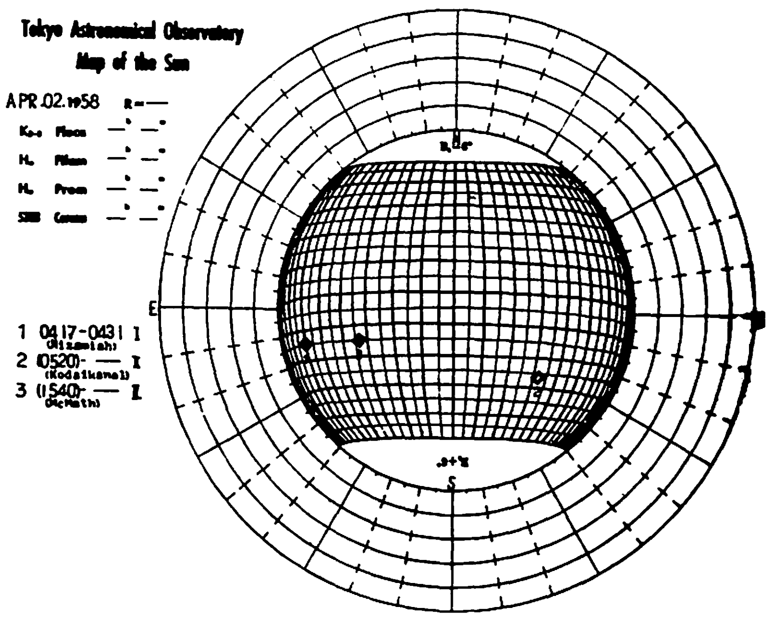


Fig. 8. Heliographic data

FLARES
1958

Importance	Obs. Cond.	Measurements					Provisional Ionospheric Effect
		Time UT	Meas. Area Sq. Deg.	Corr. Area Sq. Deg.	Max. Width Hα	Max. Int. %	
1	1		1.94	4.00			Slow S-SWF
1	3	0433	1.22	2.23	2.00		Slow S-SWF
2	2	0505			4.80		S-SWF
1	3	0505	3.65	4.52	2.30		

(CRPL-F PART B SOLAR-GEOPHYSICAL DATA)

Table 6 (b) Ionospheric Effects of Solar Flares
(Short-Wave Radio Fadeouts)
April 1958

April 1958	Start UT	End UT	Type	Wide Spread Index	Impor-tance	Observation Stations	Known Flare, UT
2	0421	0455	Slow-S-SWF	5	2	CA, KO, OK, TO	0427
2	0459	0613	S-SWF	5	2+	AN, CA, KO, NE, OK, TO	0502E

CA=Canberra, Australia
DA=Darmstadt, G. F. R.
JU =Juhlesruh, G. D. R.
KO=Kodaikanal
KU=Kuhlungsborn
MA=Madrid, Spain
NE=Nederhorst den Berg, Netherlands.
PU=Prague. Czech.
SW=Enköping, Sweden
TO=Hiraiso Radio Wave Observatory, Japan
CW* =Cable and Wireless, Barbadoes
CW** =Cable and Wireless, Somerton, England
CW***=Cable and Wireless, Brentwood, England
CW+ =Cable and Wireless, Hong Kong
RCA* =RCA Communications Inc., Riverhead, N. Y.

(CRPL-F PART B SOLAR-GEOPHYSICAL DATA)

and may show the secured relations about other positive s. f. e's. For the purpose of reference, the equivalent current system of a s. f. e. is reproduced in Fig. 7.

§ 2.4 Solar phenomena and Ionospheric effects

In order to examine the solar phenomena and the ionospheric effects at the concerned time, we refered to the followings; Daily Maps of the Sun during the International Geophysical Year, July 1, 1957–December 31, 1958, prepared by the Tokyo Astronomical Observatory July 1959 and CRPL-F series, part B Solar-Geophysical Data. Furthermore, we consulted the Hiraiso Radio Wave Observatory. The results are reproduced in Fig. 8 and Table 6.

§ 3. SSC at 07 18 Jan. 10, 1960

IAGA Bulletin for the year 1960 is not yet published, but the preliminary report on sudden commencements by Dr. A. Romaña, described that 56 observatories reported the rapid variation at 07h 18m, being the mean of the occurrence times reported. The 44 observatories out of 56 reported SSC and other 12 observatories did Si. Judging from the circumstances, the rapid change seems to be world-wide. Also the aspects of the magnetic activity after the concerned phenomenon are those of ususl magnetic storms, as shown in Fig. 9. Therefore, it may be all right in a sense that the observers adopt the phenomenon as SSC. It seems necessary, however, to pay attention to the magnetic condition about an hour

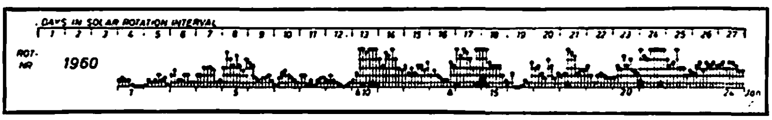


Fig. 9(a). The general aspects of the magnetic activity around Jan. 10th 1960 Kp-diagram

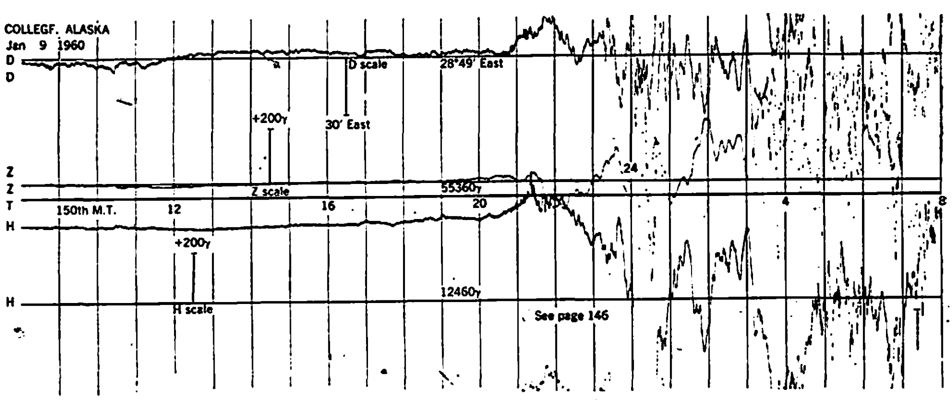


Fig. 9(b). Magnetogram at College (geog. lat. N64° 52′, geog. long. W147°50′ ; geom. lat. 64. 6°, geom. long. 256.6°).

before the phenomenon. The magnetograms around the concerned phenomenon at Kakioka, Memambetsu and Kanoya are reproduced in Fig. 10. As shown in the magnetograms, the horizontal component begins to unusually increase from about 6h U. T. and at a few minutes before 7h U. T., a small but rapid increasing of the horizontal component is recorded, in common with three observatories. On the magnetograms, the occurrence time of the rapid increasing is 6h 56m. The variation is not distinguished on the magnetograms, but some stations recorded a remarkable one at the same time. Such magnetograms are reproduced in Fig. 11. The variation at Kakioka is distinguished rather more clearly on the tellurigram than on the magnetogram. It will be perhaps due to that the tellurigram responses sensitively to the short period magnetic variations.

We now classify the magnetic rapid variations, based on the definition resoluted by the the Committee of IAGA. But, it will be often difficult to apply it strictly to the practical example and the magnetogram at only one station will be sometimes insufficient to define SSC.

The number of the magnetograms in this research may be also insufficient, but it may be able to say at least the disturbance began before 7 hour. Thus, it may be reasonable to take the concerned variation as Si, though whether the beginning of this disturbance is the rapid variation at 06h 56m or the gradual increaing at about 6h, is not established.

Next we examined the magnetograms at Honolulu during 1947–1960, in order to understand the back ground field on which Si's occur. They seem to appear rather freely from the back ground field and a variety of cases occur, so that it seems difficult to classify them into some appropriate groups. We are now concerned in the sudden impulse of the decreasing horizontal component and if we say only

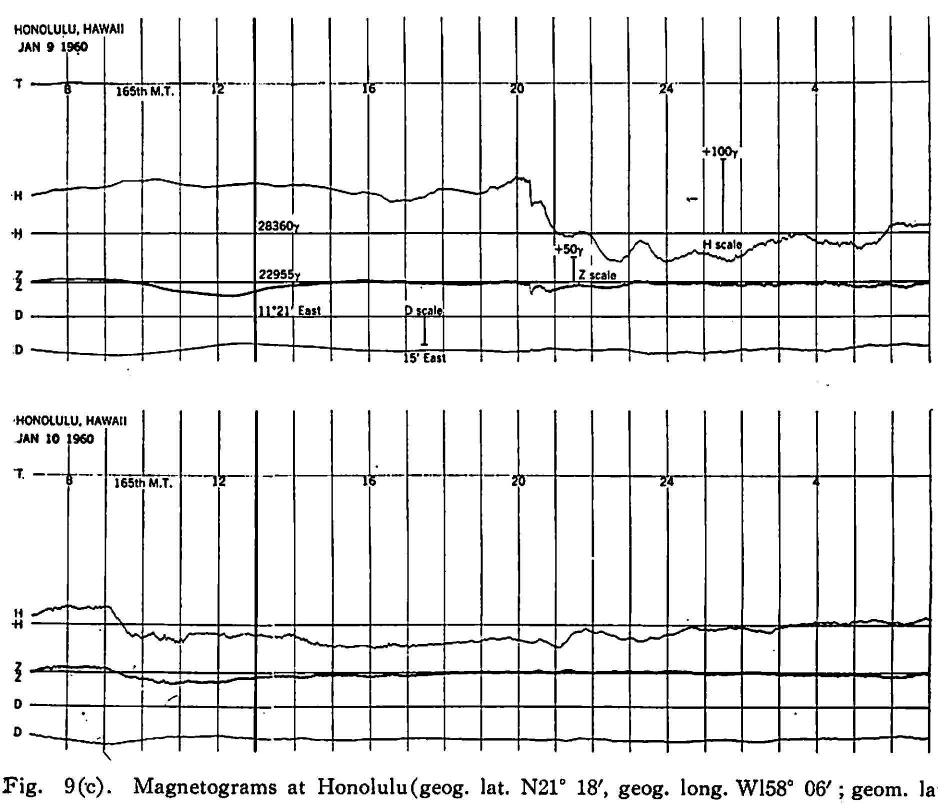


Fig. 9(c). Magnetograms at Honolulu (geog. lat. N21° 18′, geog. long. W158° 06′ ; geom. lat. 21.1°, geom. long. 266.5°).

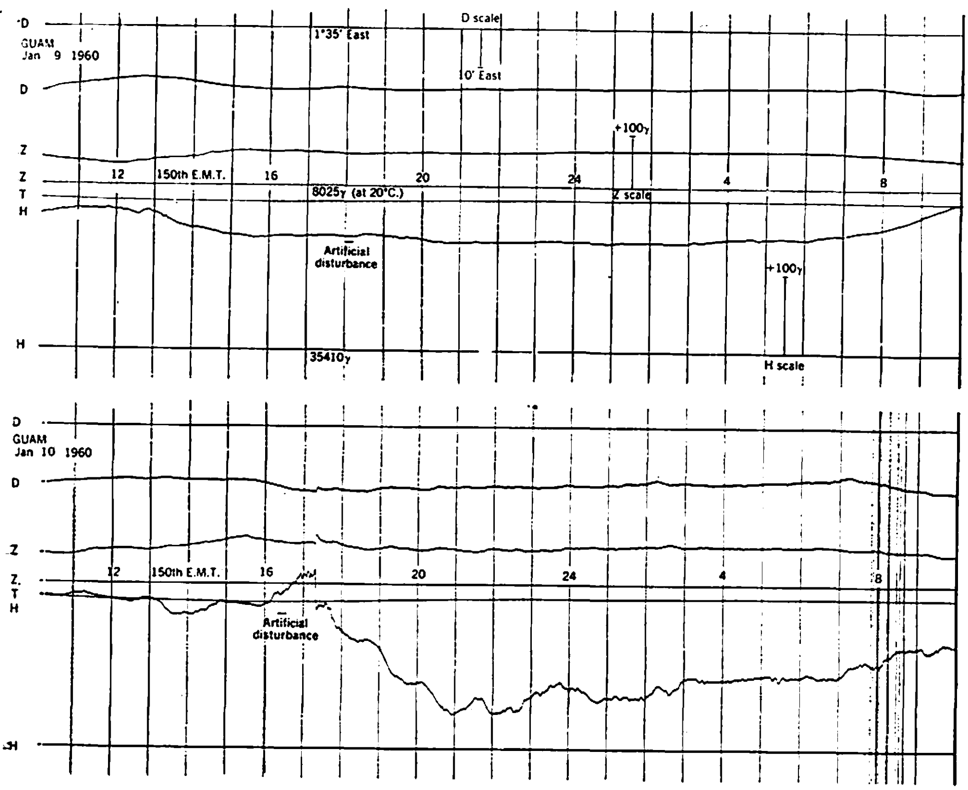


Fig. 9(d). Magnetograms at Guam(geog. lat. N13° 35′, geog. long. E144° 52′ ; geom. lat. 04.0°, geom. long. 212.9°).

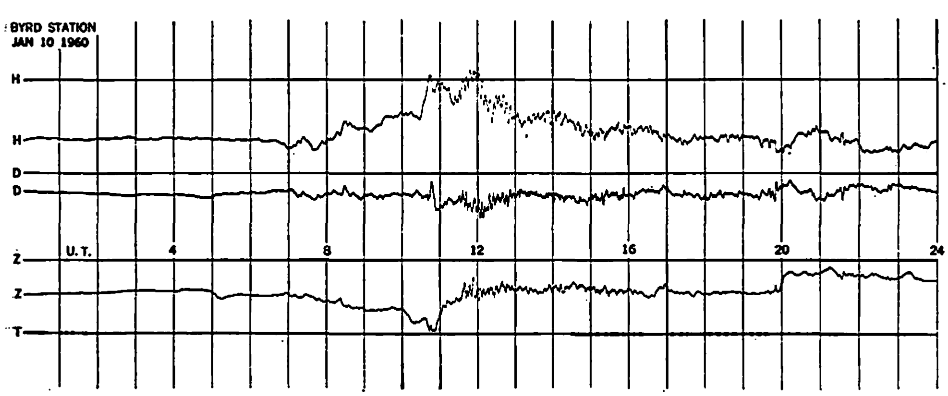


Fig. 9(e). Magnetogram at Byrd(geog. lat. S79° 59′, geog. long. W120°00′ ; geom. lat. -70.6, geom. long. 336.0°).

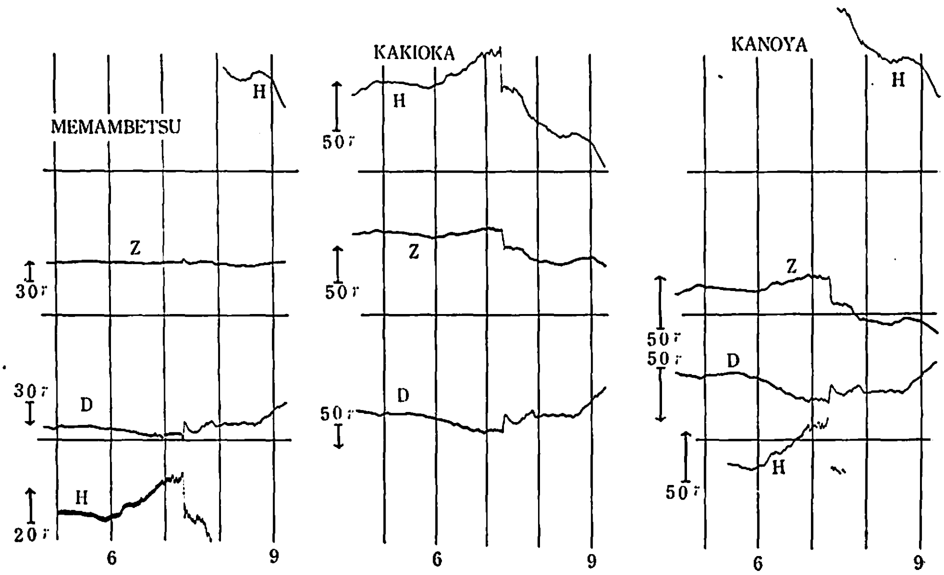


Fig. 10. Magnetograms at Kakioka, Memambetsu and Kanoya, 07h Jan. 10d 1960.

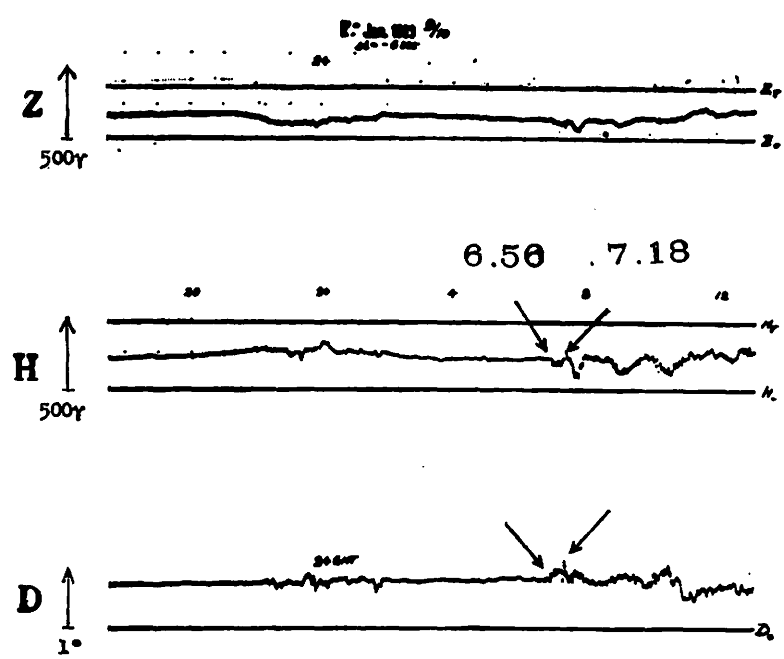


Fig. 11(a). Magnetogram at Reykjavik (geog. lat. N64° 11′, geog. long. W 021°41′; geom. lat. 70. 2°, geom. long. 071.0°), showing the comparatively distinguished disturbance at 06 h 56m.

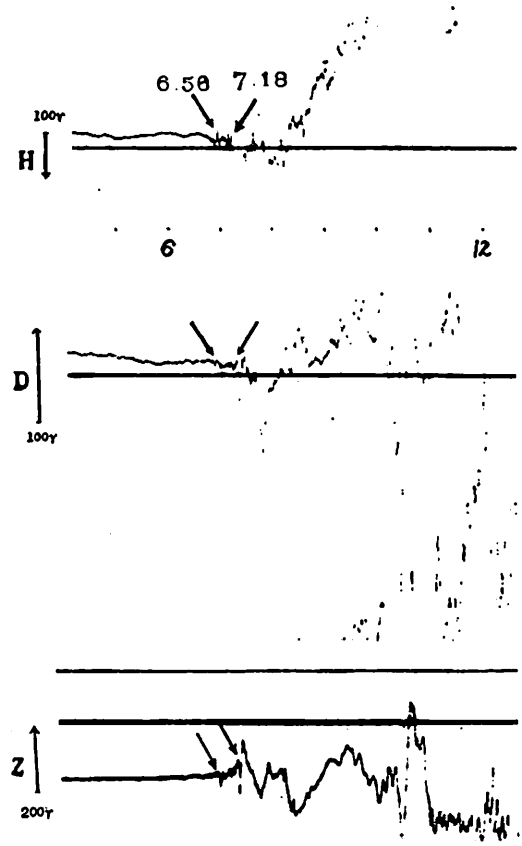


Fig. 11(b). Magnetogram at Meanook (geog. lat. N54° 37′, geog. long. W113° 20′ ; geom. lat. 61.9°, geom. long. 301.0°), showing the comparatively distinguished disturbance at 06h 56m.

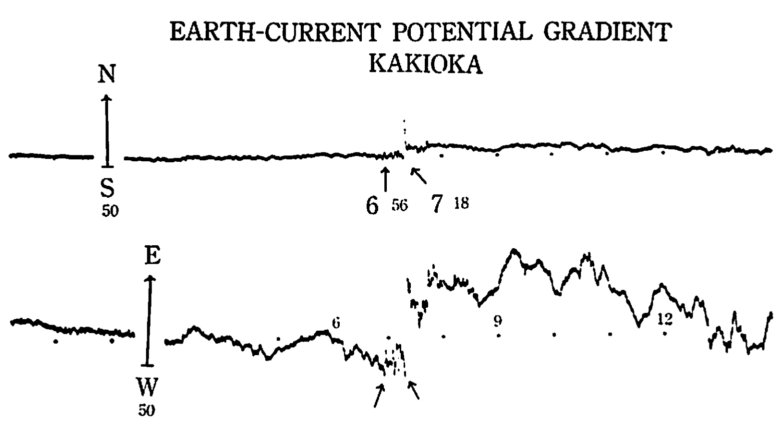


Fig. 12(a). Tellurigram at Kakioka (1960 Jan. 10)

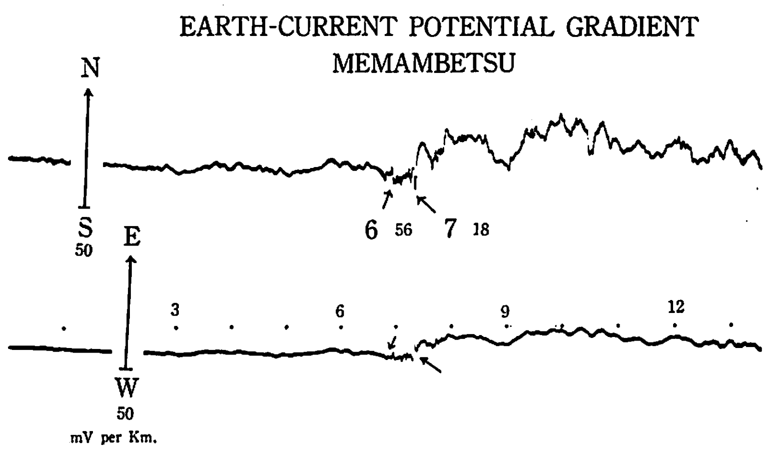


Fig. 12(b). Tellurigram at Memambetsu (1960 Jan. 10)

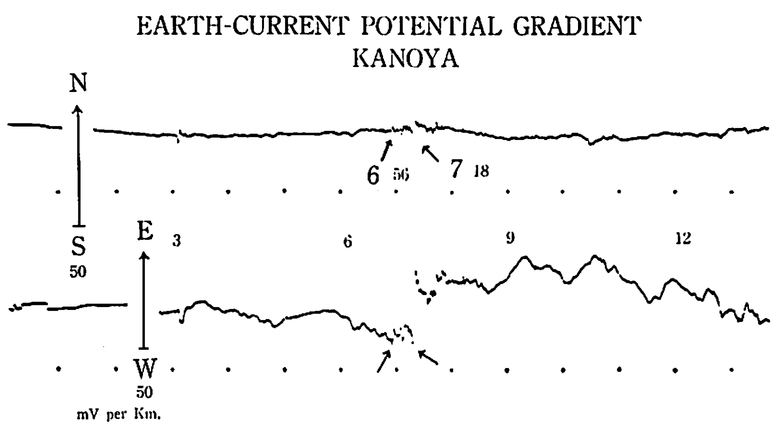


Fig. 12(c). Tellurigram at Kanoya (1960 Jan. 10)

about them, the following cases are often observed.

I. Lonely in the calm state.

II. Lonely in the various stage of the disturbance. Especial remarks to the case that the disturbances end with them may be necessary.

III. Preceded or followed by the sudden increasings of the horizontal component, which this author took as one of the four classes of Si and notated Si (+−i) or Si (−+i) in the previous paper [6]. These occur in the disturbance and also in the calm state. And SC's are sometimes regarded as such sudden increasings, combining with the sudden decreasings at about the beginning of the main phase. While, there are some cases that the SC's are not distinguished and only the sudden decreasings remain distinctly.

The discussed case seems to belong to III. The typical examples for each are reproduced in Fig. 13.

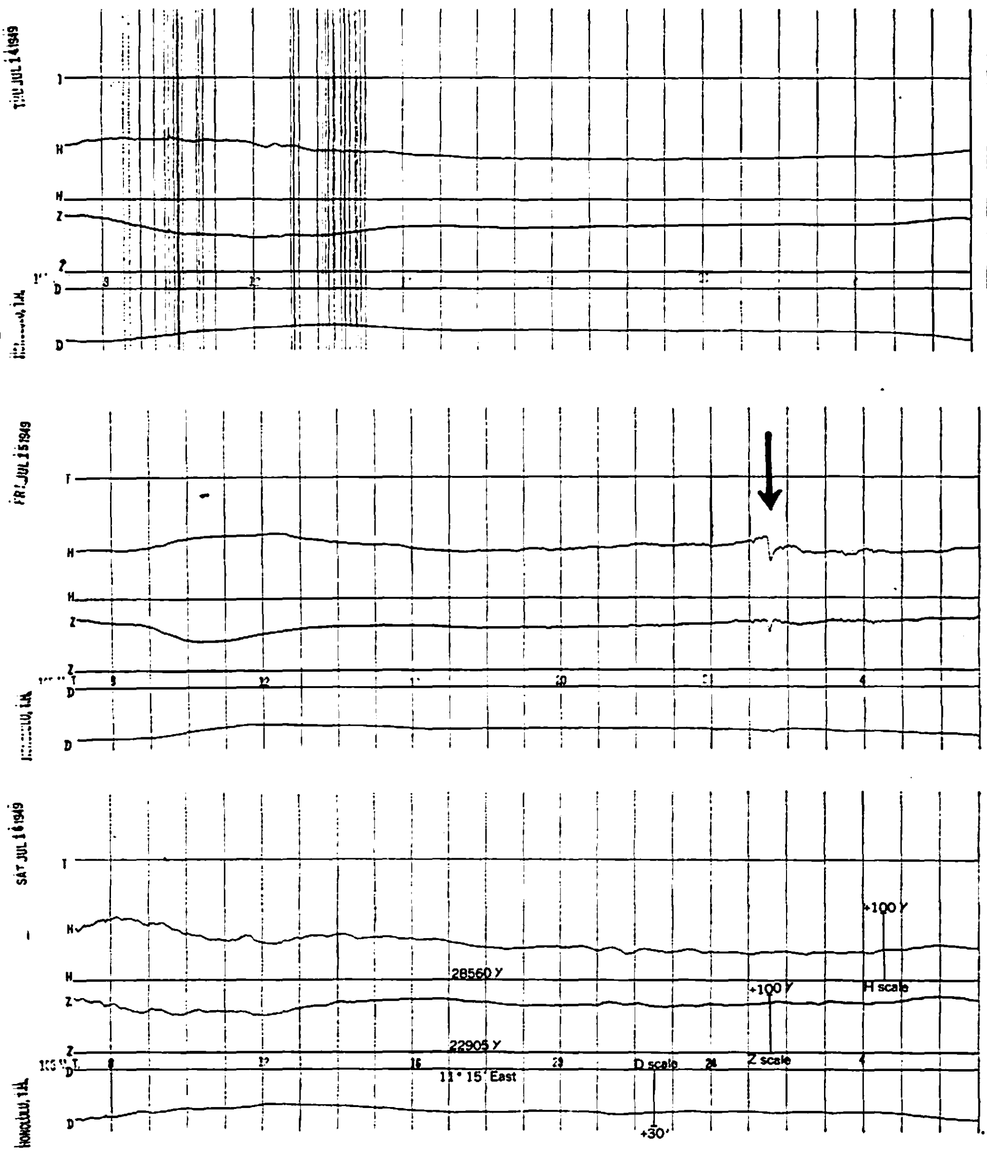


Fig. 13(a). Example of Si of the decreasing horizontal component, which occurred lonely in the calm state. July 15, 1949 (165th. M. T.)

Among the typical examples, the magnetogram of May 17, 1952 is noteworthy. This is very similar to the disturbance of Jan. 10, 1960. The sudden decreasing of the horizontal component at 23h 59m is classified into Si, according to IAGA Bulletin. This may support the concerned phenomenon should be taken as Si. Although the mechanisms of Si are not yet established, this kind of Si may suggest qualitatively a mechanism that the contraction of the magnetosphere at the stage of increasing and the expansion of it at the stage of the decreasing are caused by the solar wind. The obscure increasing may be the same as the beginning of a gradually commenced storm.

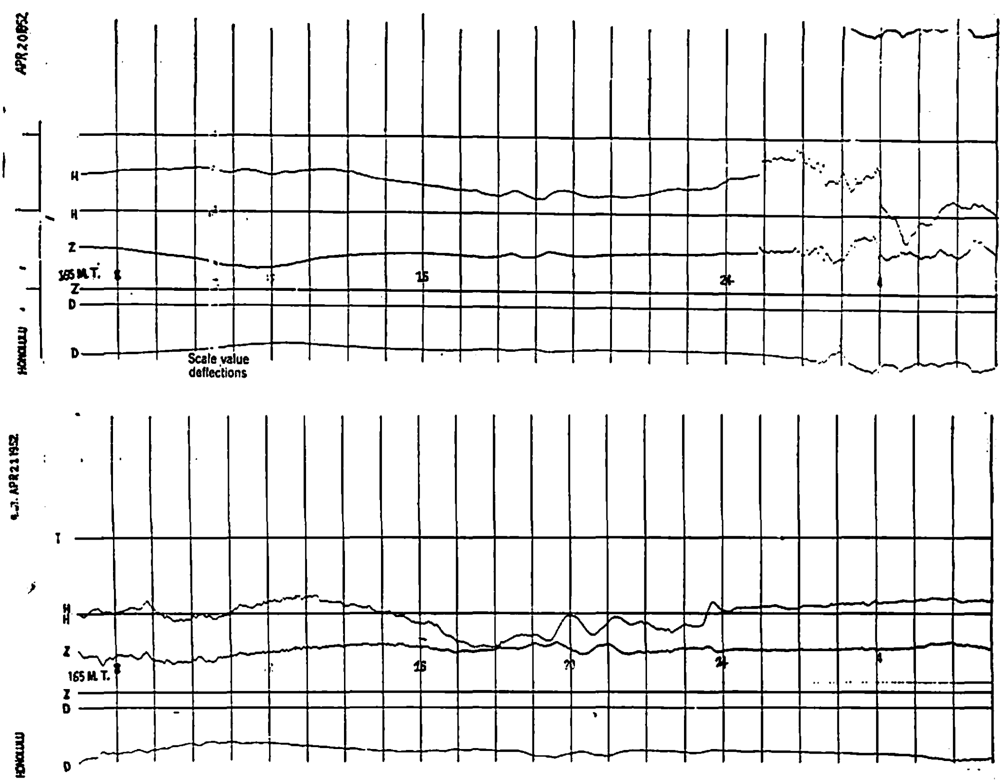


Fig. 13(b). Example of Si of the decreasing horizontal component, which occurred, preceded by SC and seemed to be classified into III. Apr. 21, 1950 (165th M.T.)

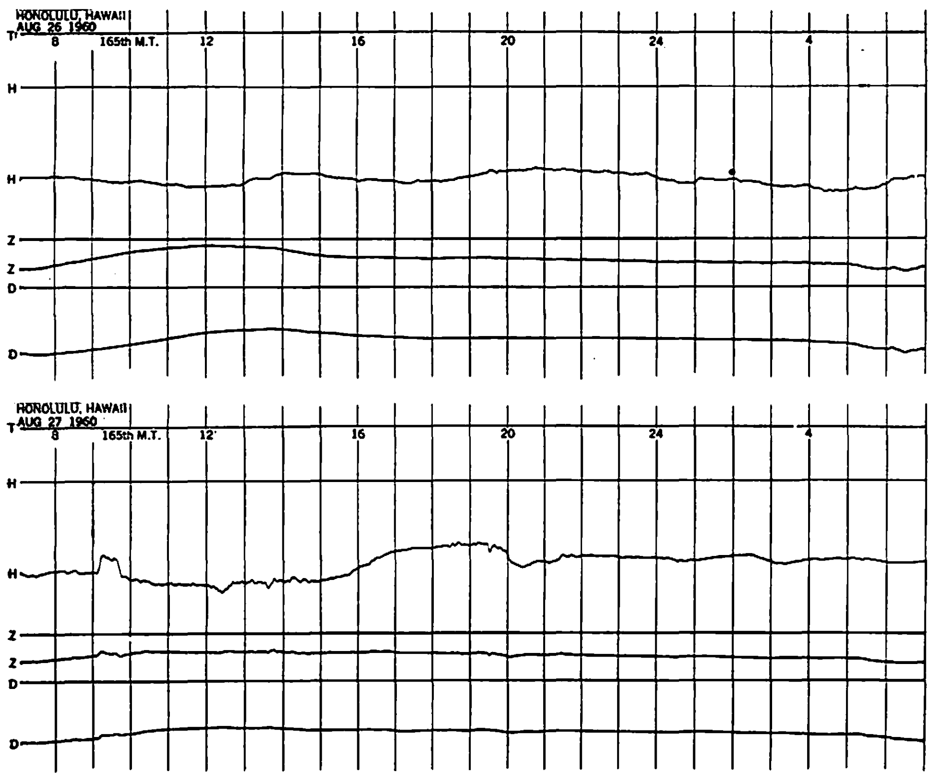


Fig. 13(c). Example of Si of the decreasing horizontal component, which is followed by the increasing horizontal component. Aug. 27, 1960 (165th M. T.) On these magnetograms, the horizontal component decreases toward the top of the sheet.

We may be, of course, able to explain the phenomena in any other way and should think any other mechanisms for other types of Si. In this paper, we would avoid to refer them and emphasize only from the morphological standpoint the conclusion that the sudden variation at 07h 18m, classified into SSC would better be taken as Si.

§ 4. Conclusions

We indicated two of the four inverted SC's at Kakioka since 1924 mentioned above will be possibly classified into other categories of the rapid variation and although the other two remain without the examination of world-wide scale, it seems to suggest that the inverted SC may not occur at Kakioka. S. K. Chakrabarty,

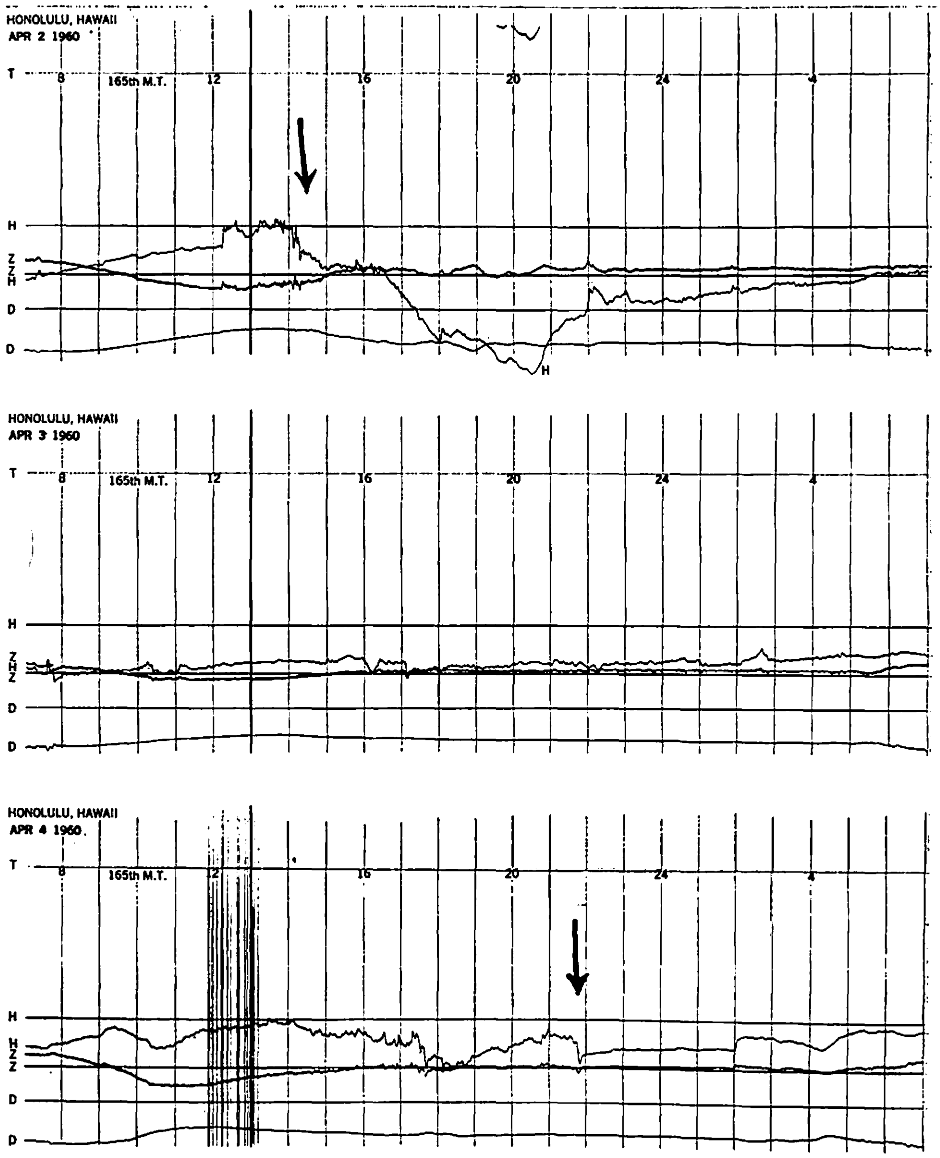


Fig. 13(d). Examples of Si of the decreasing horizontal component. Si on April 2nd, 1960 occurred at about the beginning of the main phase of the suddenly commenced storm and one on 4th, at about the end of the storm. (165th M. T.)

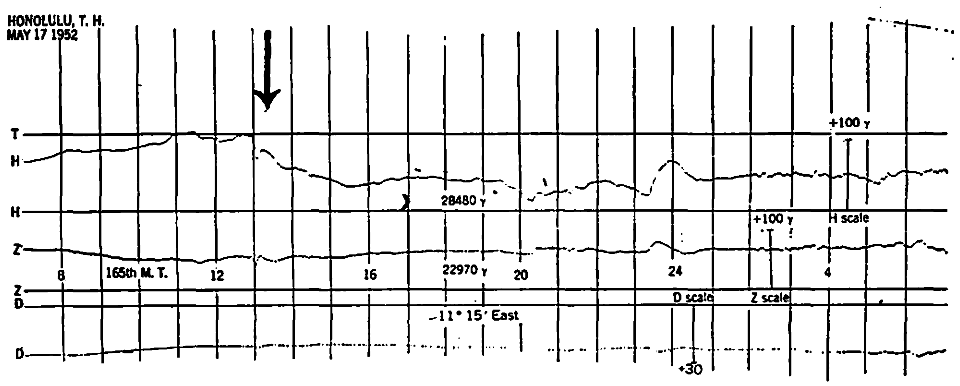


Fig. 13(e). Examle of Si of the decreasing horizontal component, which occurred at about the beginning of the main phase of the gradually commenced storm. May 17, 1952 (165th M.T.)

who examined the magnetograms at Alibag for the period 1905–1944, wrote "The third type, called the inverted S. C.'s does occur at Alibag, but their frequency is small. It is quite possible that they are not really S. C. s', but form part of normal fluctuations. Altogether, about 800 S. C.'s were recorded during the period under review, of which only 28 can be classified as inverted S. C.'s."

Thus, at any other low and middle latitude observatories, the inverted SC may need to be reexamined.

Acknowledgements

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低緯度地方における Inverted SC

山 口 又 新

概 要

SC メーンインパルスの水平分力は，中低緯度では増加し，高緯度では地方時に依存して，増加したり減少したりするのが普通である。しかし，中低緯度観測所からも頻度は，極めて少ないが水平分力の減少する *SC* が報告されている。柿岡には，1923～1951に2個，1958年に1個，1960年に1個，合計4個がある。

SC 等の地磁気急変化を，一観測所のみの観測記録によって決定することは，困難な場合が多く，1924～1951中の2例についての調査は未了であるが，後の2例について汎世界的資料を検討した。この2例は，かなり多くの観測所が *SC* と報じているが，調査の結果，1958年4月2日4時59分の急変化は，*s.f.e.* であり，1960年1月10日7時18分の急変化は，*Si*(−*C*)（水平分力の急減するサドンインパルス）と見た方がよいことがわかった。このことは，柿岡程度に緯度が低い処では，水平分力の減少する *SC* は起らないことを示唆する。又他の中低緯度観測所から報告された例についても，詳細に検討する必要があるように思われる。