Item 72

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FIELD OF SUDDEN STARTS' MAIN IMPULSES NEAR THE LOCAL ABSORPTION REGION OF COSMIC RADIO-NOISE IN THE IONOSPHERE

It would seem expedient to find some particular aspects in the distribution field of sudden starts of magnetic storms near the region of local absorption of cosmic radio-noise in the ionosphere.

Such investigations would help reveal the effect of the local increase in conductivity of the ionosphere upon the field of sudden starts of magnetic storms. For investigations of this type it is expedient to study the sudden starts not preceded by an absorption either in the polar region or in the "lights" region, as those types of phenomena are the simplest and, therefore, easier for subsequent interpretation.

Twelve such cases were revealed during the IGY - MGS (Tab. 1) (no absorption data have been recorded for the territory of the USSR); at that, the sudden starts of September 30 and December 4, 1958, are less favorable for investigations due to the fact that prior to the sudden start of September 30 the field was turbulent due to the geomagnetic effect of the preceeding solar flare to such an extent that even at the most involved magnetic observatories the effect of the sudden start was concealed to a large degree by this flare, while for the December 4 perturbation, data on absorption over Canada are absent.

Magnetograms of all these sudden starts have been studied (table 1) and for the sudden starts of July 21, August 31 and October 22, 1958, distribution of complete horizontal components **(ΔH_0)** of the main impulse field were built according to data of observations by magnetic stations in the northern as well as in the southern hemispheres of the Earth (table 2).

a Дата	f		
	b Канада	c Аляска	d Скандинавия
21/VII—1958	20	7	12
31/VII	5	0	0
30/IX	0	6	3
22/X	0	12	1
4/XII	C	6	2
11/II—1959	0	8	0
11/II (7—8^h)	0	4	0
24/II	4	0	0
9/IV	0	0	11
11/VI	0	3	4
27/II	2	7	5
5/XII	0	0	8

1 f — поглощение в десятых децибелла.
2 C— данные отсутствуют.

a = date
b = Canada
c = Alaska
d = Skandinavia

1 =absorption in tenths of decibels
2 = no data

$$\Delta H_{\theta} = (\Delta H^2 + H^2 \Delta D^2 Sin^2 I')^{1/2}.$$

The building of such charts require the knowledge of amplitudes of the main impulse in the horizontal component **(ΔH)** and the inclination **(ΔD)** as well as of the absolute value of the horizontal component (H), inclination (D) and of the angle created between the geomagnetic and the magnetic meridians (a) for each magnetic observatory (table 2).

$$\alpha = -\psi + D, \qquad (2)$$

where ψ **is** the angle between the geomagnetic and the geographic meridians of each given point on the Earth surface.

The methodology followed ensured the determination of amplitudes of the main impulse of sudden starts with a five to ten % precision.

In the first approximation of these investigations it is sufficient to limit ourselves to drawing on the map of the vectors of the main impulse of sudden starts and to a subsequent study of these curves (Fig. 1 - 6).

On July 31 in the region of local absorption of cosmic radio-noise was located over Canada (Fig. 1). The two magnetic observatories Baker Lake and Yellowknife located quite close (data from Fort Churchill are not available) had very large amplitudes of sudden starts, which equalled 220 and 300 gammas respectively; this figure is one order higher than the amplitudes of sudden starts at low and mean-latitude observatories and several times larger than the amplitudes at other high-latitude observatories in the northern hemisphere.

According to data (1) the region of local absorption of cosmic radio-noise was located on October 22 over Alaska and Scandinavia. It would seem natural to assume that this region extended from Alaska to Scandinavia over the territory of the the USSR. (Fig. 3).

The sudden starts amplitudes were similarly, quite large and equal to 240 and 250 gammas, at the magnetic observatories of Point Barrow and the Island of Haighs, located close to this region; these figures exceed the amplitude of the sudden starts on low and mean latitude observatories by one order and are several times the amplitude of a sudden start on the remaining polar magnetic observatories in the northern hemisphere. July 21 the region of additional absorption of cosmic radio-noise was located over Alaska, Canada and Scandinavia, while the absorption magnitude was larger than July 31 and October 22 (table 1).

Magnetic observatories close to this region (fig. 5) show the amplitude of the main impulse as extremely large (Barrow- 700 gammas, Churchill - 360 gammas, Keerouna - 320 gammas) and exceeding several times the magnitude of the main impulse amplitude in other magnetic observatories.

Table 2

Date	Φ	Λ	H	D	ψ	α	
1	2	3	4	5	6	7	8
Thule	89.0	0.0E	4150	—78.0	0.0	—78°	—
Resolute Bate	83.0	289.6	890	—88.0	45.6	—134	—
SP-7	80.0	190.0	X	y			
Godhavy	79.8	32.5	8520	—51.5	—12	—40	—
Murchison Bay	75.2	137.2	X	y			—
Baker Lake	73.8	315.2	X	y			—
Haighs	71.5	153.3	5500	24.0	—30.0	54	—
Reikyavik	70.2	71.0	12000	—28.0	—25.0	—2	+
Yellowknife	69.0	293.3	X	y			∓
Churchill	68.7	322.7	X	y			
Barrow	68.6	241.0	8870	25.0	30.0	—5	
Chelyuskin	65.9	177.5	3380	23	2	25	—
Keerouna	65.3	115.8	X	y			
College	64.5	255.4	12500	29	27	2	—
Big Delta	64.4	259.0	13050	30	28	2	
Murmansk	64.1	126.5	11540	11	—30	41	
Lervik	62.5	88.6	14510	—10	—25	15	—
Wellen	61.8	237.0	13890	15	25	—10	—
Minuk	61.8	301.0	12940	27	17	10	+
Tiksi	60.5	191.4	7370	—15	6	—21	—
Sitka	60.0	275.4	15000	30	20	10	+
Eskdalemuir	58.5	82.9	16720	—11	—18	7	—
Lovo	58.1	105.8	15250	1	—22	23	
Leningrad	56.2	117.1	15020	7	—20	27	—
Agincourt	55.0	347.0	15690	—7	4	—11	—
Vittevin	54.2	91.0	18090	—6	—19	13	—
Victoria	54.1	293.0	18760	24	18	6	+
Srednikan	53.1	210.6	16590	—10	13	—3	—
Yakustk	51.0	193.8	14720	—17	6	—23	—
Moscow	50.8	120.5	17110	8	—20	28	—
Svider	50.6	104.6	18340	0	—18	18	—
Frederisksburg	49.6	349.9	19120	—7	—6	—1	—
Kazan	49.3	130.4	16480	10	—15	25	+
Sverdlovsk	48.5	140.7	15940	14	—15	29	+
Castelachio	45.7	89.5	22340	—6	—16	10	
Irkutsk	41.0	174.4	19380	—2	—3	1	+
San Fernando	41.0	71.3	30700	—8	—15	7	—
Panagyurishche	40.9	107.4	23480	1	—10	11	—
Tucson	40.4	312.2	25870	13	10	3	+
So.Sakhalinsk	36.9	207.6	25450	—9	7	—15	+
Tbilisi	36.7	122.1	24110	5	—12	17	—
Memambetsu	34.1	208.3	26530	—8	9	—17	—
Tashkent	32.4	143.7	25750	5	—10	15	+

Table 2 (Cont'd)

1	2	3	4	5	6	7	8
Vladivostok	32.4	198.3	27010	−10	6	−16	+
Ashkhabad	30.6	133.5	27600	3	−11	14	−
San Juan	29.9	3.2	27650	7	− 1	− 6	−
Teoloukan	29.6	327.1	30230	10	8	2	+
Kakioka	26.0	206.0	30160	−7	8	15	+
Tamanrasset	25.4	79.6	28000	− 7	−13	6	−
Honolulu	21.1	266.5	28400	12	15	− 3	+
M'Boor	21.3	55.0	31590	−14	− 12	− 2	−
Canoya	20.7	198.1	32980	− 4	6	−10	+
Paramaribo	17.0	14.5	29130	−12	− 3	− 9	−
Cha-Pa	11.0	173.4	38000	− 1	− 2	1	−
Ebadan	10.6	74.6	31000	−12	−12	0	−
Bangiew	4.6	88.5					
Guam	3.9	212.8	35700	2	10	− 8	−
Mantinlupa	3.2	190.8	38970	0	4	− 4	+
Guanchaio	- 0.6	353.8	28590	5	1	4	+
Coror	−3.2	203.4	37680	2	7	− 5	+
Apia	−10.0	260.2	34860	12	12	0	−
Trelev	−31.7	3.2	22880	9	− 4	13	−
Hermanus	−33.7	81.7	13060	−24	−14	−10	−
Wateroo	−41.7	185.8	23000	− 3	1	− 4	±
Tulangi	−46.7	220.9	22690	10	10	0	+
Amberley	−47.7	252.5	22090	20	10	10	−
Argentina Isl.	−53.8	3.3	25530	17	− 2	19	−
Kerguelen	−57.2	128.0	X	У			+
Macuori Isl.	- 61.1	243.1	23300	20	18	2	−
Holly Bay	−65.8	24.3	20280	− 1	−21	22	−
Mary Byrd	−70.6	33.6	15960	69	33	36	±
Mason	−73.1	103.0	15000	−57	−33	−26	−
Little America	−74.0	312.0	11350	103	48	55	+
Dumont Durville	−75.5	230.9	X	У			
Mirny	−77.0	146.5	13780	−79	−15	−64	−
Oasis	−77.4	160.8	11990	−85	−10	−75	−
Wilkins	−77.8	110.5	9300	−82	− 5	−77	
Hallett	−78.6	278.1	6100	103	57	46	
Scott Bays	−79.0	294.4	9780	164	64	88	
Pionerskaya	−80.3	146.5	13240	−86	−15	−71	
Vostok	−90.0	171.8	12890	−117	− 5	−112	

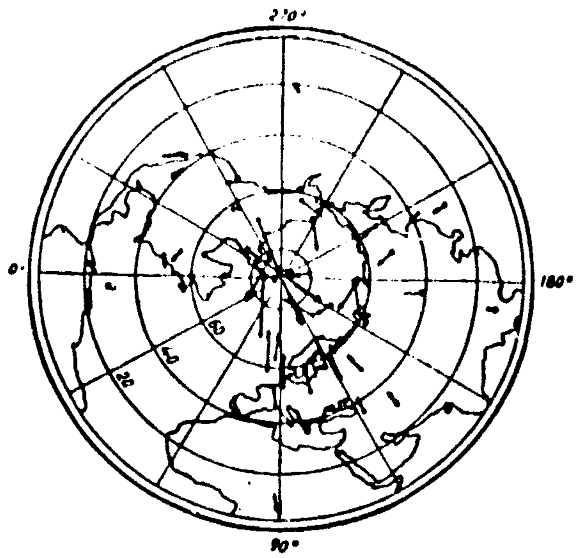

Fig. 1. Main impulse field of sudden start July 31,1958 at 13 o'clock 34 min. GMT (northern hemisphere)

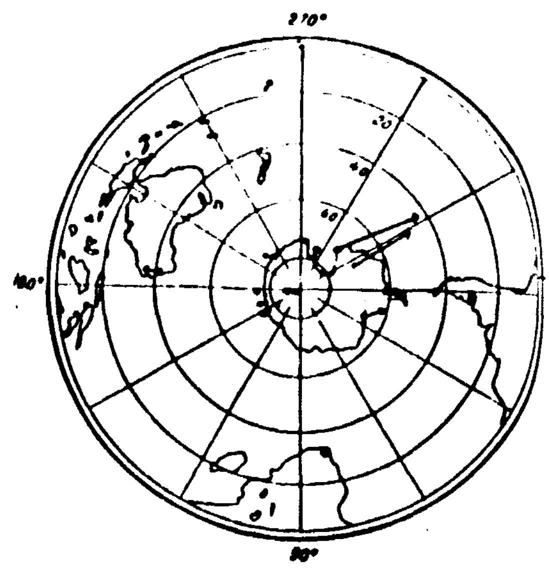

Fig. 2. Main impulse field of sudden start July 31, 1958 15 h 34 min. GMT (southern hemisphere)

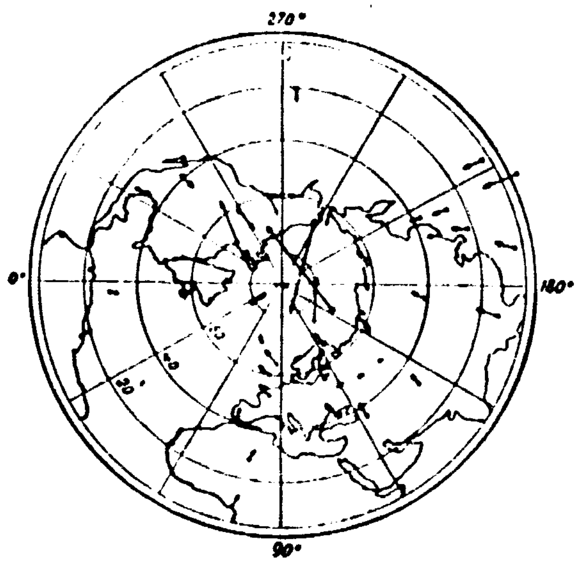

Fig. 3. Main impulse field of sudden start October 22,1958 at 3 h 19 min. GMT (northern hemisphere)

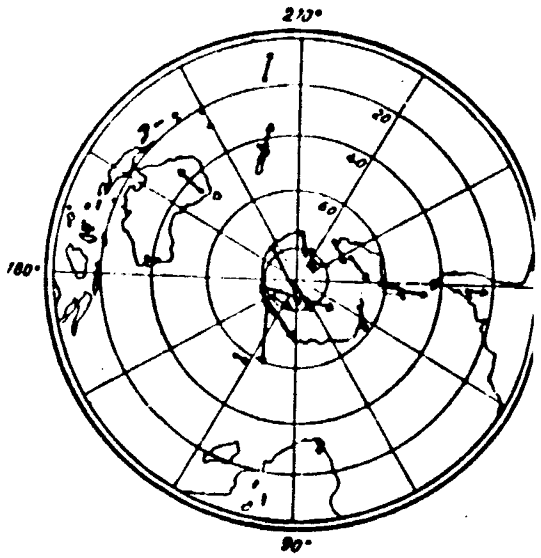

Fig. 4. Main impulse field of sudden start October 22, 1958 at 3 h 19 min. GMT (southern hemisphere)

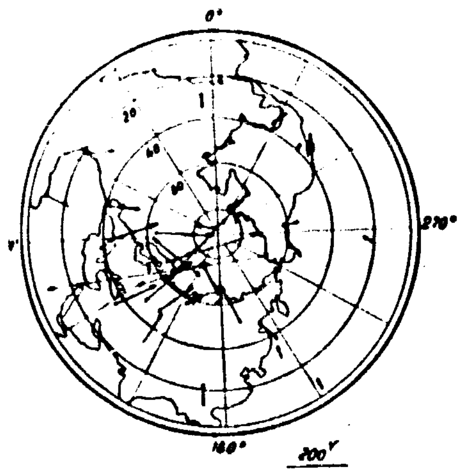

Fig..5. Main impulse filed of sudden start July 21, 1958 at 6 h 40 min. GMT (northern hemisphere)

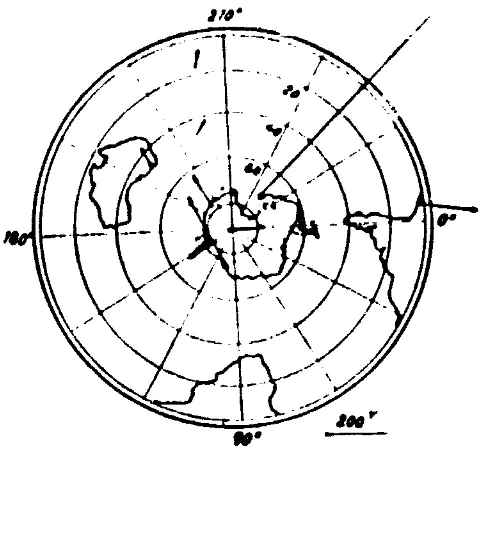

Fig. 6. Main impulse field of sudden start July 21, 1958 at 16 h 40 min. GMT (southern hemisphere)

The study of magnetograms of other SSC (Table 1) revealed that during these sudden starts the same effect took place: an extremely strong increase of the field of the main impulse near the region of local absorption of cosmic radio-noises.

Data on radio-noise absorption in the southern hemisphere are lacking. It is noted that in the southern hemisphere (Fig. 2,4,6) as well, stations located in regions which are magnetically conjugated with regions of local absorption of cosmic radio-noise in the northern hemisphere - the amplitudes of sudden starts are very large and exceed considerably the amplitudes of sudden starts in other points of the southern hemisphere. Thus, July 31 in the southern hemisphere the stations Little America and Byrd (Fig. 2) revealed amplitudes of sudden starts equalling 210 and 160 gammas, respectively, whereas on October 22 the Dumont Durville, Wilkings, Mirny and Oasis stations displayed the same characteristics, with amplitudes of sudden starts equalling 150 -180 gammas (Fig. 4).

An exceptionally large increase in the main impulse of the sudden start was observed in the magnetically conjugated region of the southern hemisphere on July 21, 1958 (Fig. 6). In Little America the ΔH_0 was equal to about 1000 gammas, in

Mason it was 250 gammas, while several stations operating at normal sensitivity (Byrd, Hallet) were unable to record the SSC, due to the extremely fast changes of the field.

Similar phenomena took place in all SSC listed in table 1.

If we consider that regions of local absorption of cosmic radio noise at the time of sudden starts are created due to the appearance, in the ionosphere, of energy particles (2,3), and that these latter appear simultaneously in the magnetically-conjugated regions(4) of the northern and southern hemispheres, it is only natural to assume that the Little America and Byrd stations on July 31 and the Dumont Durville, Mirny, Wilkings, Oasis stations on October 22, etc., were located close to the regions of local absorption of cosmic radio-noise in the southern hemisphere.

A further investigation of this phenomenon is required, to be based on data (already known) from the IGY and especially on data of the MGSS (International Year on Aurora Borealis) as we may hope that data on cosmic radio noise absorption lacking at present may be obtained for this period for the territory of the Soviet Union and the southern hemisphere. However, the results quoted above would seem to indicate that close to the region of local absorption of cosmic radionoise there exists a particularity in the field of the main impulse of the sudden start which consists in the fact that the amplitude of the main impulse is revealed by stations located close to this region, as being quite large and considerably larger than at the other magnetic observatories. We may even consider the possibility that between the local absorption of cosmic radio-noise and the increase in the amplitude of sudden starts near the region of this absorption there exists a definite physical connection.

It is natural to assume that the increase of the amplitude has been caused by the perturbation of the magnetic field of the Earth by the local increase in electric conductivity of the ionosphere in the absorption area. Thus, July 31 the absorption of cosmic radio-noise equalled five tenth of a decibel, which corresponds to an increase in ionization density E - ionosphere layer - of about 5.10^4 cu cm (1) and a Hall conductivity (σ_2) approximately 50% of daily non-perturbation value equal (5) to about 10^{-8} units CGSM, in other words - about 5.10^{-9} units of CGSM. The corresponding current force in the ionosphere each second centimeter of the meridian (i_o) in the order of magnitude equals (6):

$$i_0 \approx \frac{f \cdot \Delta H_0}{2\pi}, \qquad (3)$$

where f is the part of the external sources in a perturbation field $(f \approx 0.6)$; in order to have this current exist - an electric field E with a tension of the following order is required:

$$E \approx \frac{f \Delta H_0}{2\pi \Delta \sigma_2} . \qquad (4)$$

The sudden start of July 31 with a ΔH_0 about 260 gammas and the $\Delta\sigma_2$ of about 5.10^{-9} CGSM required, thus, an electric field equal to the order of magnitude of 5.10^{-9} CGSM required, thus, an electric field equal to the order of magnitude of 5.10^{4} of CGSM.

On October 22 the ionization density increased approximately about 10^{5} cu cm and the Hall conductivity by 100%, in other words by 10^{-8} units of CGSM, which requires, for the perturbation of the field of the order of 250 gammas the existence of an electric field with a tension of about 2.10^{4} CGSM, etc. The modern concepts of the electric field of a polar magnetic perturbation (7-8) allow for the possibility of the existence of electric field tension values close to these orders of magnitude.

However, there is still the undertainty - in the information available - as to the magnitude of the electric field in the region of local absorption of cosmic radio-noise in the ionosphere at the time of sudden starts; the problem which also remains to be solved is that of the nature of the extremely large increase in the amplitude of sudden starts near the region of local absorption of cosmic radi-noise in the ionosphere.

In the final consideration, the idea not to be excluded is that the region of local absorption of cosmic radio-noise is the cause of the large amplitudes of the sudden starts; on the other hand, the extremely strong changes of the field may be the cause of the settling of charged particles and the formation of a region of local absorption of cosmic radio-noise in the ionosphere.

This could take effect in the case where the electric field in the ionosphere during sudden starts was found to be considerably smaller than it is required by the theory of perturbation of the magnetic field, effected by a local increase in the conductivity of the ionosphere. However, such possibility seems to be less realistic than the former.

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