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DOMINATION OF GEOEFFICIENCY FOR INTERPLANETARY PLASMA ISOLATED STREAM FROM ONE OF SOLAR SOURCES IN INTERACTING STREAMS

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In [1] it was noted, that in 85% of cases, near the Earth's orbit were observed streams, stipulated by several solar sources and classification for such streams was suggested. It was shown that characteristics of interplanetary plasma average for the class of complex streams differ from corresponding characteristics for isolated streams of separate solar sources and a conclusion on essential intermixing of these streams when interacting in the interplanetary space.

The goal of this paper is to show, that in most of events with complex streams one of isolated streams was dominating and determining the type of Long Auroral Disturbance (LAD) in the magnetospheric-ionospheric system.

Fig. 1a presents temporal variation of the solar wind velocity V, proton number density N, and IMF B_z component calculated by the superposed epoch method after hourly average values of corresponding parameters for 6 events of isolated SDF-streams, during which, there were observed long auroral disturbances of the 2-d type without any visible signs of other types of LAD. Hourly values of the interplanetary space parameters were taken from the OMNI section of King catalogue on a CD-ROM. The LAD beginning time was assumed to be the zero point, when averaging results. The results given in Fig. 1a, correspond to those previously obtained for this type of streams in papers [1,2]. During the first 12 hours the LAD concentration N was $\approx$ 10 cm^{-3}, the velocity V - about 400 m/s. IMF B_z was changing the sign approximately every 6 hours. We have not carried out the detailed analysis of structure of SDF -streams, since this problem has been previously considered in detail in paper [2].

Fig. 2 a, c, e represents graphs of changes in time of the average values V, N, B_z , obtained by averaging after the 2-d type LAD events, but with complex streams, formed by interaction of isolated streams from two solar sources: SDF + CH (2a), SDF+ HCS (2c) and SDF+sf (2e). The comparison of these figures shows that although they were obtained by averaging of data for different classes of interacting streams, the mean values of characteristics and their temporal variations during the 2-d type LAD periods are similar to the ones, given in Fig. 1a for isolated SDF-streams: these are: the number density N $\geq$ 10 cm^{-3}, the velocity V $\leq$ 400 km/s, long-period variations of IMF B_z .The latter ones are manifested more distinctly in the graphs for separate events. As the alternating B_z component was averaged, the picture is somewhat distorted, because of the difference in periods and amplitudes of B_z variations in various events.

For comparison, in Figs. 2b, d, f there were given graphs V, N, B_z for the same 3 classes of complex streams, as in Figs. 2a, c, e. The graphs of Fig. 2b were obtained for 3 events with complex streams SDF+CH, when there was observed an auroral disturbance of the 1-st type on Earth, without signs of other LAD. It can be seen, that in these events with complex streams, characteristics of interplanetary space corresponded more to those of plasma for the events with isolated streams from coronal holes: N < 7 cm^{-3} , V $\approx$ 500-550 km/s. The B_z component varied within the range from -3 to -6 nT.

Of 4 events of complex streams of SDF+HCS class only in one event, there was observed auroral disturbance of the 1-st type. Temporal variations of the velocity, concentration and IMF B_z during this event are given in Fig. 2d. In this event B_z component was oriented southwards for more than 9 hours and was equal to < -5 nT. The solar wind velocity was less than average for SDF streams, which is typical for streams from Helmet Coronal Streamers [1].

The 3-d type of LAD without signs of other types has not been observed in events with complex streams of SDF+sf class. In 2 events, auroral disturbances were classified as being of the 3-d type of LAD with distinct signs of the 2-d type. The graphs of temporal variations of V, N, and B_z are given in Fig. 2f. It is seen, that in these events that an essential intermixing of isolated streams was taking place. The velocity exceeded a little bit, the average one in SDF-streams. The density during the 1-st 6 hours was amounting to about 20 cm^{-3}, then dropped to 10 cm^{-3}. The oscillations periods of B_z component were a little less, than in events with isolated SDF-streams. The carried out comparison demonstrated that the degree of intermixing of isolated streams in complex ones, is not as high as it had been assumed to be before. One of isolated streams is dominating and produces the LAD type on Earth that corresponds to its solar source. This conclusion was confirmed during the comparison of V, N, B_z temporal variation graphs for two events of the 3-d type LAD and three events of the 1-st type LAD for the class of complex streams CH+sf (figures are not presented).

The obtained result allowed to determine the average characteristics of streams near the Earth's orbit from coronal holes, Helmet of Coronal Streamers and subflares (fig. 1 b, c, and d correspondingly), as regards events with complex streams.

For determination of average parameters of coronal holes streams, there were selected 7 events of complex streams (which did not included isolated HCS-streams), during which there were observed easily to classify the 1-st type LADs. Graphs of temporal variations V, N, and IMF B_z , made up using the superposed epoch method, are given in Fig. 1b and they give idea about the dynamics of parameters of the interplanetary plasma, coming towards the Earth from coronal holes. The average velocity of such streams amounts to about 550 km/s and does not vary much during a

disturbance period, and its average concentration is less 10 cm^{-3}, whereas the IMF B_z component is southwards oriented for a long period and the absolute value of B_z is >5 nT.

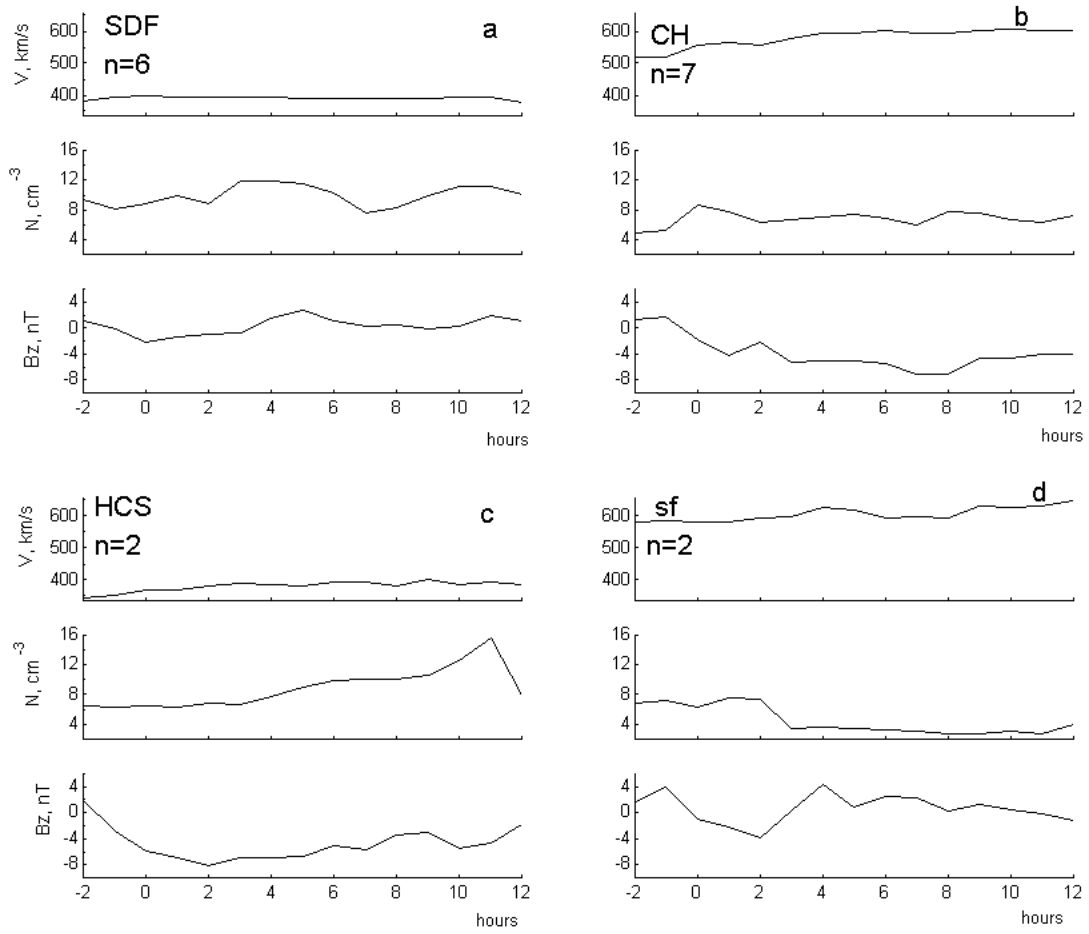

Fig. 1. The estimations of mean parameters of interplanetary plasma streams for solar sources: SDF (a), CH (b), HCS (c), sf (d). n is the number of events.

For making up graphs V, N, B_z, corresponding to streams from the helmet coronal streamers, there were selected 2 events of complex streams, formed without any influence by coronal holes, during which a LAD of the 1-st type (Fig. 1c) was developing in the auroral zone. For HCS streams, low velocity V < 380 km/s, density of interplanetary plasma N ≈ 6-10 cm^{-3} and long periods of southwards orientation of IMF B_z < -5 nT, are typical.

Characteristics of interplanetary plasma near the Earth's orbit from flare streams were estimated by 2 events with complex streams, when there were observed on Earth the 3-d type LAD without signs of other types disturbances (Fig. 1d). According to results by other authors, flare streams had the maximum velocity (about 600 km/s) and the lowest density (~5 cm^{-3}) and alternating IMF B_z component with variations about every 3 hours. During the first hours of LAD, there were observed the largest values of N concentration and IMF B_z absolute value, which was, probably, due to the Earth's passing through the shock wave.

IMF B_z variations, during the events with complex streams were studied more in detail. For the 10 events of the 1, 2 and 3 types LAD there were made up graphs of the IMF B_z average values and determined periods of temporal variations of this parameter. For the first type of LAD, the B_z (t) for over 10 hours was equal to < -5 nT and did not vary much. The B_z (t) for the 2-d and the 3-d types of LADs were alternating and varied with periods of 5,5 and 2,4 hours correspondingly.

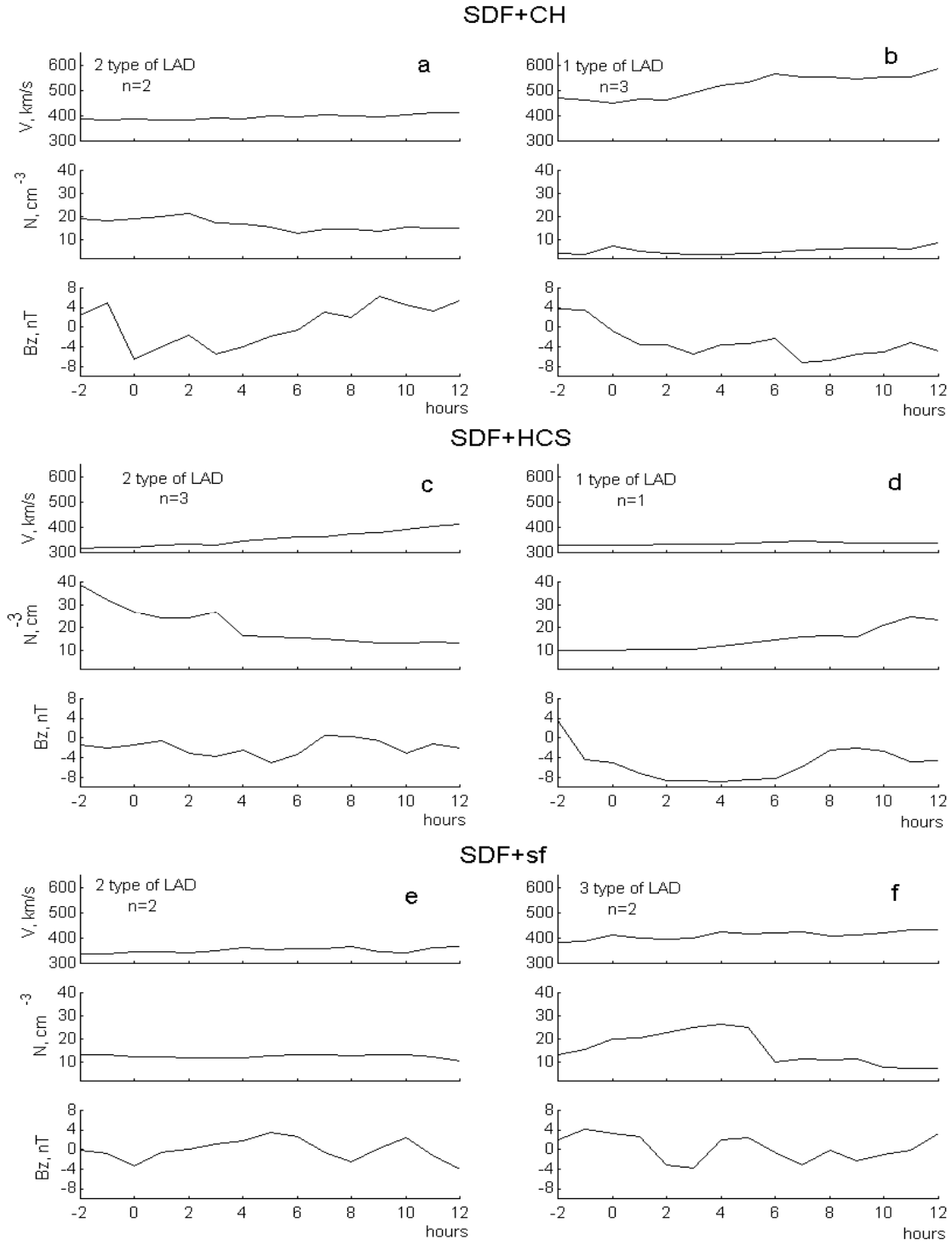

Fig.2. The temporary variations of the velosity (V), concentrations (N) and B_z IMF in the classes of the complicated streams: SDF+CH (a, b), SDF+HCS (c,d), SDF+sf (e,f) during different types of LAD: the first type (b, d), the second type (a, c, e), the third type (f). n is the number of events.

In [3], it is shown that SDF-streams were producing the 2-d type LAD, flares were causing the LADs of the 3-d type and coronal holes and helmet coronal streamers - LADs of the 1-st type. From the number of events with complex streams, indicated in table [3], those were picked up, during which the 2-d type LAD was observed without signs of other types. For each of them, average periods of B_z variations were determined, as well as probabilities of their distinctions from the 5,5 and 2,4 hours' P_1 and P_2 correspondingly were determined too. The maximal value of P_1 was below 0,75 and the minimal one of $P_2 > 0,95$. In a similar way the comparison of average periods of B_z variations, during events with complex streams and the third type of LAD: $P_1 > 0,95$, $P_2 < 0,8$ was carried out. For events with

complex streams and auroral disturbances of the 1-st type (given in table [3]), IMF B_z for more than 10 hours was southwards oriented and was equal to < -5 nT. These results show, that if in the auroral zone, an easy to classify (without other types signs) LAD of a certain type is observed, then, the IMF B_z variations should be about the same as in the events with isolated streams, defining this type of LAD.

Thus, the estimation of the geoefficiency of interplanetary plasma complex streams averaged parameters showed that intermixing of isolated streams is not absolute. More often a stream of one solar source was dominating. Temporal variations of IMF B_z corresponded to B_z (t) during LADs, produced by a dominating solar source.

For sources of disturbed streams of the solar wind, considered in [1, 3], there were obtained estimates of the dominating rating, determined as the ratio of Σ_1 sum, given in [3] at the end of table, to the total number of events, in which a stream from this source had been observed. The largest dominating rating 0,529 was the one of filament streams, the least one belonged to flare and HCS streams (0,362 and 0,359 correspondingly). The dominating rating of streams from coronal holes had an intermediary value of 0,462.

Conclusion

There was no total intermixing of isolated streams from different solar sources in the interacting streams of interplanetary plasma. Most often, the domination of one of the isolated streams was observed and during these periods the LAD type, corresponding to the dominating solar source was observed. This allowed us to estimate temporal variations of streams from coronal holes, helmet coronal streamers and flare streams after events with complex streams. The domination rate of isolated streams under their interaction in the interplanetary space was various. The filament streams had the maximal domination rating - 0,529. Coronal hole streams had 0,462. The estimates of HCS and sf streams domination rating coincided: 0,359, and 0,362 correspondingly.

References

K.G. Ivanov, Solar sources of interplanetary plasma at the Earth orbit// Geomagnetism and aeronomy, 1996, V.36, N 2, P.19.

K.G.Ivanov, Geomagnetic disturbances during the Earth passing through the filament solar wind// Geomagnetism and aeronomy, 1998, V.38, N 5, P.1

M.G. Gelberg, S.Z.Gershengolts, S.V.Saraeva, Relationship between the solar sources of interplanetary plasma streams and types of long auroral disturbances// In this issue.