

ON THE RELATION BETWEEN THE SYM-H AND Dst- INDICES DURING THE DEVELOPMENT OF MAGNETIC STORM

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1. Introduction

The Dst-index obtained by hourly average values of the magnetic field at four stations located in various longitudinal sectors at latitudes $\Phi' \approx 20-30^\circ$ is the index of magnetic field depression at low latitudes during the magnetic storm periods. Recently for the characteristics of magnetic field depression the SYM-H index has been used. It is obtained from 1 min data of the magnetic field at ~ 10 stations, located mainly at latitudes $\Phi' \approx 40-50^\circ$ [1]. It is considered in [2-4] that the SYM-H index is an analog of Dst but with a better temporal resolution. As shown in [5], during super magnetic storms with Dst variation ≥ 400 nT, the SYM-H variations can considerably differ from Dst behavior and thus the SYM-H index is not always an analog of Dst. In this paper the relation between the Dst and SYM-H variations for magnetic storms of different intensity, with Dst varying from ~ -50 nT to -450 nT is investigated.

2. Observations

For the analysis, we use the hourly values of Dst, 1-min values of SYM-H, data on the low-latitude geomagnetic disturbances ($\Phi' \sim 10-50^\circ$) for the events of 1991-2003 and global geomagnetic observations at the auroral station chain (IMAGE, CANOPUS, MACCS, Greenland Coast and CPMN with 1-20 s for October 29-31, 2003).

Fig.1 (a,b,c) presents the Dst and SYM-H variations with the amplitudes of Dst ≤ 150 nT (a), $\leq 200-250$ nT (b) and $\geq 300-400$ nT (c).

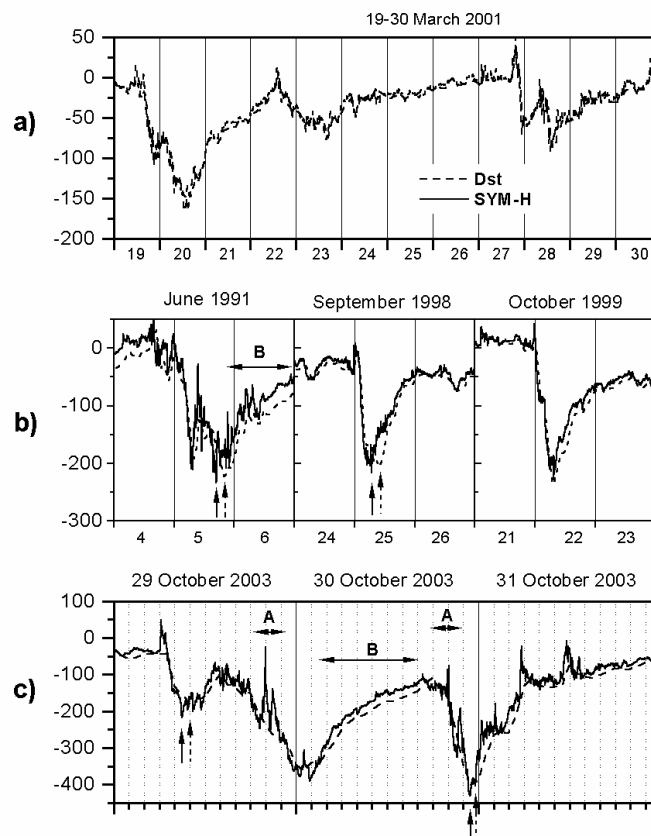


Fig.1. Variations of the Dst and SYM-H indices with the amplitudes of Dst ≤ 150 nT (a), $\leq 200-250$ nT (b) and $\geq 300-400$ nT (c)

In Fig.1 one can see that Dst and SYM-H vary in a similar way for Dst amplitude ≤ 150 nT (Fig.1a). However, there are some distinctions in the SYM-H and Dst variations for Dst amplitude ≥ 200 nT (Fig.1b and c). First, the

maximum amplitudes of the SYM-H index in some events (the solid arrows) are registered 2-3 hours earlier than those of the Dst index (the dotted arrows in Fig. 1b and c). Second, for $Dst < -200$ nT, the SYM-H index sometimes exhibits sharp excursions during Dst decreasing (the intervals A in Fig. 1c). Third, during Dst recovery phase, SYM-H is by ~ 50 nT less in amplitude as compared to Dst (the intervals B in Fig. 1b and c).

To study the peculiarities in the variations of the SYM-H and Dst indices, the longitudinal variations of the H-components at latitudes $\Phi' \sim 40-55^\circ$ (Fig.2b) and $\Phi' \sim 10-30^\circ$ (Fig.2c) have been analyzed.

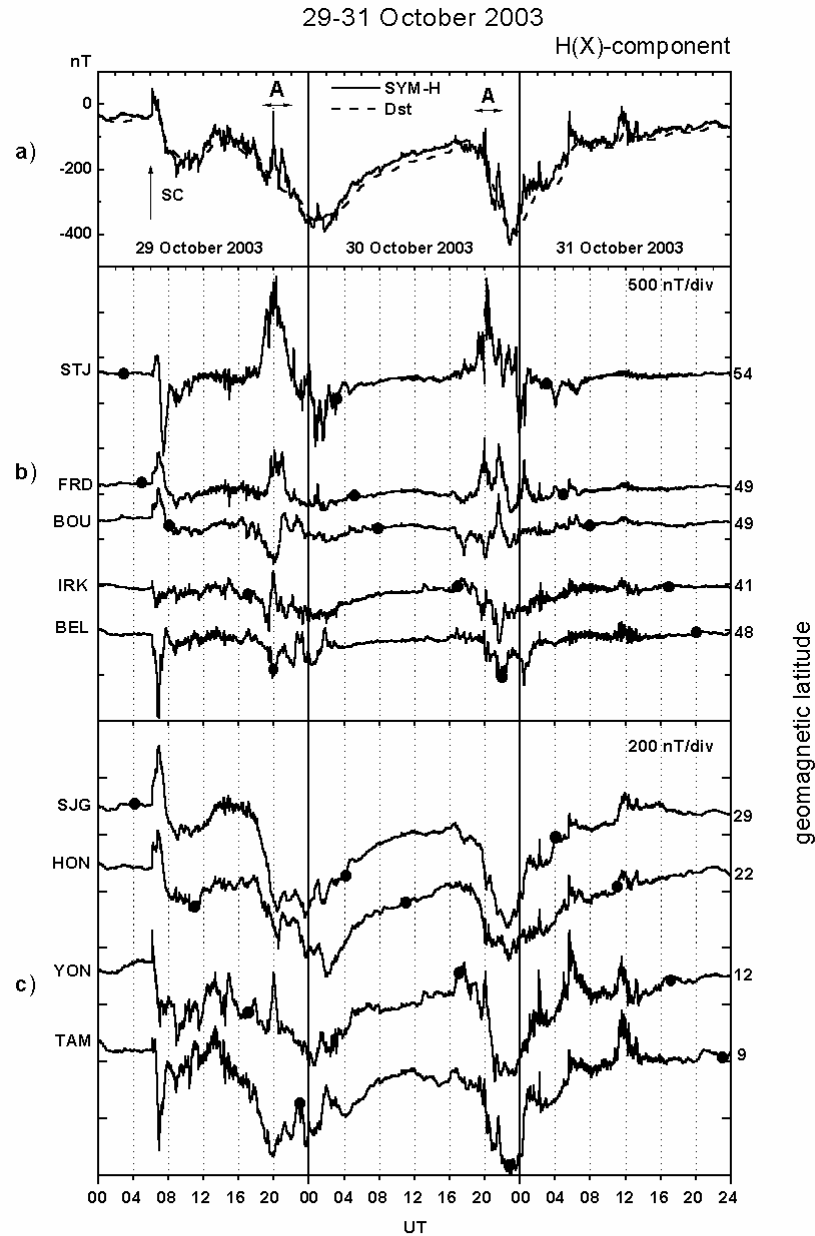


Fig.2. Variations of the SYM-H and Dst indices (a) and geomagnetic field H-component at various times at latitudes $\Phi' \approx 40-54^\circ$ (b) and $\Phi' \approx 10-30^\circ$ (c) during a magnetic storm on October 29-31, 2003

As seen from Fig.2, a sharp decrease of SYM-H on October 29-30, 2003 about 20 UT (intervals A), as opposed to the smooth growth of Dst, corresponds to positive pulses of the H-components at the latitudes $\Phi' \sim 40-55^\circ$ in the post-noon-to-evening sector, but is accompanied by negative disturbances of ΔH in all time sectors at the latitudes $\Phi' \sim 10-30^\circ$ correlating with the Dst variations.

In Fig.3 the H-component variations at the stations around the same meridian but at different latitudes $\Phi' \sim 50^\circ$ and $\Phi' \sim 10-30^\circ$ for the period of October 19-21, 2001 with $Dst \geq -150$ nT are shown. From Fig.3 it follows that, in

contrast to Fig.2, for the period of smaller Dst amplitude, the variations of ΔH at low and middle latitudes in the pre-noon-to-evening sector correlate better both in sign and in intensity than in the case of large negative Dst (Fig. 2).

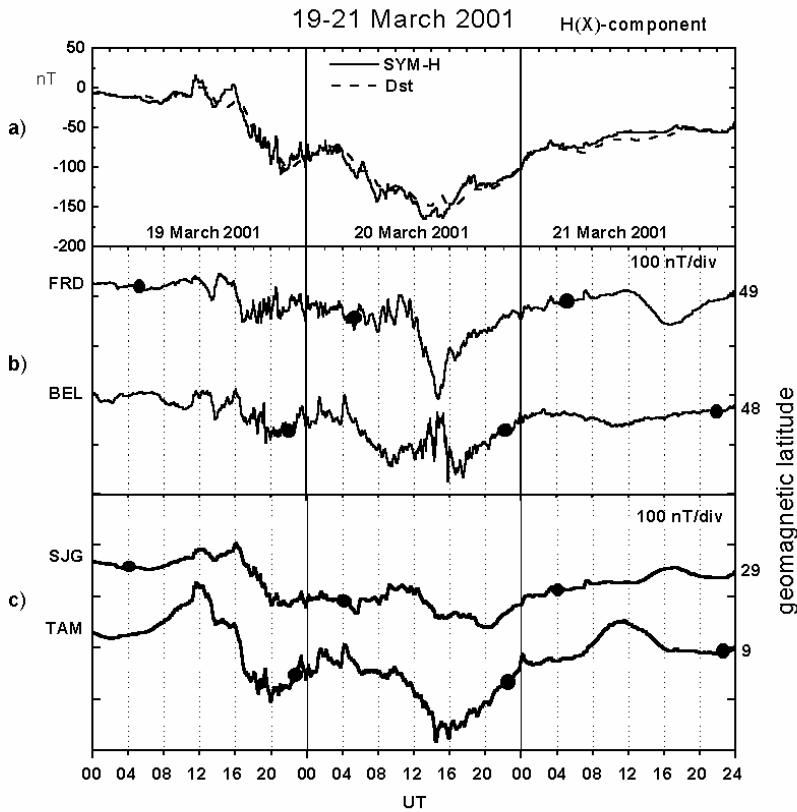


Fig.3. Variations of the SYM-H and Dst indices (a), and geomagnetic H-component around the same meridian at latitudes $\Phi' \approx 40-54^\circ$ (b) and $\Phi' \approx 10-30^\circ$ (c) during a magnetic storm on March 19-21, 2001

3. Discussion and conclusions

The data presented above show that the variations of the SYM-H and Dst-indices are determined by the character of field changes at latitudes $\Phi' \sim 40-50^\circ$ and $\Phi' \sim 10-30^\circ$, respectively, which have a number of peculiarities, being more pronounced under large Dst amplitudes ($\geq 200-300$ nT). This probably indicates that the sources of ΔH variation at middle and low latitudes can be both of general and of special nature. The comparison of the behavior of SYM-H and Dst with the dynamics of the auroral electrojets in [6] has shown that the sharp bursts of SYM-H both on October 29, 2003 and on October 30, 2003 were caused by repeatable substorm activity. This activity manifested in the enhancement of the westward electrojet and its poleward expansion (starting from $\Phi' \sim 55^\circ$) near midnight, as well as in the strengthening of the eastward electrojet in the post-noon-to-evening sector at lower latitudes. Therefore, the most probable reason for the positive variations of ΔH at $\Phi' \sim 40-50^\circ$ in Fig. 2b and of the bursts of the SYM-H index is the influence of the eastward electrojet located at these latitudes. At the same time, at lower latitudes the westward currents with the maximum intensity in the evening sector (Fig.2c) are registered, which, probably, contribute to the variations of the Dst index. The source of the westward current at these latitudes is most likely the ring current, which is enhanced for some time after substorm activations. The delay of Dst maximum amplitude moment relative to that of SYM-H (Fig.1) can be related to the time of particle convection to lower latitudes and the time of gradient drift of hot ions from the midnight sector to the evening sector.

At the recovery phase, there is a decay of the ring current, formed during the main phase of magnetic storm, which results in the gradual decrease of the Dst and SYM-H indices (Fig.1). Smaller negative values of SYM-H in comparison with Dst in this period (Fig.1, the interval B) obviously mean that the ring current located at latitudes $\Phi' \sim 20-30^\circ$ is not shifted in meridian in the course of magnetic storm recovery phase.

Thus, frequent using of the SYM-H index instead of the Dst-index [2,3,7] for characteristic of magnetic field depression in the inner magnetosphere is not always correct. Especially this is true for the analysis of intense magnetic storms with the amplitude of Dst $> 200-250$ nT.

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