Substorm-associated, large-scale magnetic field changes in the magnetotail- 2

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The authors examined sudden decreases in the lobe magnetic field accompanied by magnetic field dipolarizations and substorm expansions to search for a critical condition to initiate large-scale magnetic field changes in the lobe. In this study, such events were designated as the magnetotail deflation (MD). The magnetic field component parallel to the equatorial plane was normalized to a fixed geocentric distance (R = 15 Re), and was corrected for the compression effect of the solar wind dynamic pressure. It was shown that the normalized, corrected value, B_enc, just prior to a magnetotail deflation correlates well with the Dst index. The regression function appeared to delineate the upper limit of data points in the B_enc-Dst scattering plot. On the basis of this finding, we suggested that the MD event occurs when the B_enc value reaches its upper limit, determined by the solar wind pressure and the Dst index [Nakai and Kamide, Joint Meeting, 2000]. However, one of researchers declared the following counter argument:

(1) The lobe magnetic field usually reaches a peak before substorm-associated decrease, as is known as the final stage of so-called a loading process.

(2) Because the authors use such a peak as the beginning of MD events, it is natural that the MD events should appear near the upper limit of the lobe intensity.

(3) B_enc has a rough correlation with Dst, and so MD events, which appear near the upper limit in the B_enc plot, naturally show a crude correlation with Dst.

(4) Hence, the Dst correlation of MD events is a natural consequence of the lobe field Dst dependence, and cannot suggest the existence of a prerequisite condition for MD event.

The purpose of this paper is to discuss the validity of this argument, and to reinforce our conclusion. The item (1) is a well established fact. It is, however, also well known that the lobe field intensity can take various values just prior to the onset of MDs. In our data set, for example, B_enc values before MDs are scattered between 38 and 56 nT. Thus, [it is natural that the MD events should appear near the upper limit of the lobe intensity] in the item (2) is wrong. If one accepts a dripping faucet analogy for the loading/unloading process in the magnetotail, it may be natural to consider that the plasmoid is ejected when the lobe field magnitude reaches some critical value. The B_enc value, however, can take various values just before the MD event, as we mentioned above. This discrepancy is in fact the issue that the authors proposed in there earlier presentation.

As stated in the item (3), the B_enc value correlates with the Dst index with a regression function, B_enc = 32.1 - 0.148 Dst (c.c. = 0.56). However, since the data points of B_enc values just prior MD events are much less than those in the whole data set, B_enc values just prior to MD events do not necessarily correlate with the Dst index. Based on the item (3), the item (4) has no sense.

The result of our analyses that B_enc values just prior to MD events appear near the upper limit for fixed Dst values is not a natural consequence. It is important to note that the B_enc value varies more rapidly than the Dst index. According to the above regression equation, a decrease of 10 nT in the Dst index increases the B_enc value by 1.5 nT. However, in each MD event the B_enc value often changes by more than 10 nT, accompanied by a variation of 2-3 nT in the Dst index. What the Dst index determines is the range of variations in B_enc. This suggests that the MD event preferably occurs when the B_enc value reaches the upper limit determined by the Dst index.