Temporary shrinkage of the near-equatorial tail after the substorm expansion onset

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Kawano et al. (2000) presented a case of three recurring substorms, in which the GEOTAIL spacecraft, located in the magnetotail near the equatorial part of the tail magnetopause, temporarily exited the tail and then returned to the tail after the expansion onset for all of the three substorms. The position of GEOTAIL was near (-42, -22, 0) [Re].

They suggested that this phenomenon was caused by the temporary shrinkage of the mid-tail equatorial magnetosphere after the expansion onset, and that the shrinkage was likely to have been caused by the near-Earth neutral line (NENL). That is, as the NENL ejected plasma in the radial direction away from the NENL, it drew in plasma along the line including the NENL toward the NENL, and thus the magnetopause near that line moved inward.

In this paper, we have constructed a database of this kind of events observed by GEOTAIL between Oct. 5, 1993 and Dec. 31, 2002, and examined if the above-stated interpretation is valid. In more detail, we have first identified magnetopause crossings of GEOTAIL based on its observation of the plasma density, temperature, and tailward velocity. We have then selected crossing pairs, i.e., entry-exit pairs and exit-entry pairs, by using the following two criteria: (1) an entry and its paired exit were separated in time by less than three hours; (2) during the four hours consisting of two hours preceding the pair-event start time and two hours following the event end time, GEOTAIL was in the same region (i.e., inside or outside the magnetosphere). We have also identified, as an independent procedure, substorm expansion onsets by using the AL index, and compiled them into another database. Then, for each of the above-identified crossing pairs, we have selected a corresponding substorm onset if the former started less than three hours before or after the latter.

After the above-stated event-selection procedure, we have first compared the starting times of the exit-entry pairs and the substorm expansion onset times. As a result, we have found that the majority of them started after (i.e., not before) the substorm expansion onset, consistent with the temporary-shrinkage interpretation by Kawano et al.

We have also compared the ending times of the entry-exit pairs (which were not studied by Kawano et al.) and the substorm expansion onset times. As a result, we have found that the majority of them ended near the substorm expansion onset time.

More details, including the position dependence of the event occurrence frequency and the time separation between the substorm onset and the event, will be presented at the meeting.

