The Distant Tail Behavior During High Speed Solar Wind Streams and Magnetic Storms

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We. have examined the ISEE-3 distant tail data during three intense (Dst < -100 nT) magnetic storms and have identified the tail response to high speed solar wind streams, interplanetary magnetic clou ds, and near-earth storms. The three storms have a peak Dst ranging from -150 to -220 nT, and occur on Jan. 9, Feb. 4 and Aug. 8, 1983. During the storm onsets, the fast solar wind and magnetic field dynamic pressure ($B^2/8X$ -t $\sum n_i kT_i$) fluctuations moved the tail across the. spacecraft multiple times. The magnetotail is strongly compressed by the outside sheath pressure. The lobe field strength can usually be predicted by the pressure balance. The strongest lobe field magnitude detected is 37 nT during storm main phase on Jan. 10, which is higher than the sheath field by 5 - 10 nT. The sheath plasma pressure accounts for the. higher lobe field strengths. However, for the Feb. 4 storm, wc find that 3 tail lobe encounters arc not in static balance with sheath pressure. During the storm times, [he. field magnitudes of the lobe and plasmasheet increase by a factor of 3-5 relative to the quiet time. The temperature and density in both regions also increase by factors of 2-3, but with little plasma β changes, as onc would expect. Under the assumption of tail flux conservation, increased sheath pressure implies a reduced tail size. Besides the tail size changes, the location of the nominal tail axis is controlled by solar wind flow orientation. This study shows that more than 7070 of tail in-and-out events arc predicted by either of these external mechanisms (changes of tail size duc to the external pressure and the solar wind directional changes). Many tail plasmasheet jettings and slow-mode shocks have been detected in both the storm main and recovery phases. One remarkable feat ure of the jet t i ngs is very strong earthward flow (up to 1200 km/s) and tailward flow (up to 1500 km/s). The solar wind speed for these events was only -900 km/s. Both tail flow events have the highest speeds found to date. The preponderance. of such a strong earthward flow indicates that during magnetic storms, magnetic reconnection occurs at locations well beyond the distance of ISEE-3. Through the interface of slow-mode shocks between the tail lobe and the plasmasheet/boundary layer, magnetic energy is being converted into plasma thermal and kinetic energy by the magnetic merging process. The predicted downstream plasma jetting speed (978 Ire/s) is consistent with the observations (1 000 km/s) in the boundary layer. One surprising feature is that this reconnection process seems to be quite prominent during the storm recovery phase. One possible suggestion is that the dynamics of the distant tail arc not at all related to magnetic storms and substorms, but is an afkr-effect, re.leasing extra magnetic tail energy by field sloughing via these reconnection events.

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