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A mutisatellite study of the large and meso-scale changes of the near-Earth plasma sheet and lobe driven by multiple substorms

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We present a detailed study of the tail dynamics during a 12h period of enhanced magnetic activity linked to a magnetic storm driven by the arrival at the Earth orbit of a small, dense and high speed cloud of solar plasma with a negative IMF Bz. The period comprises three main AE enhancements, up to 1500 nT for the most severe substorm. The tail dynamics as seen onboard Cluster, Double Star and the LANL geostationary satellites is quite similar for the three events. These data are complemented by measurements of ENA fluxes made onboard the IMAGE spacecraft. In the tail, each substorm corresponds to an energy loading period followed by a dipolarization of the magnetic field seen from 6.6 to 18 Re, both in the plasma sheet and in the lobe. Plasma sheet thinning as observed with Double Star occurs during energy loading in the tail and is enhanced at the onset of strong dissipations of magnetic energy which precedes by about two minutes particle injections at geostationary orbit. As expected from the tail current decrease, each dipolarization coincides with an increase of the electric field in the lobes, up to several mV/m, as deduced from the perpendicular velocity of ionospheric oxygen ions beams streaming here towards the far tail. The simultaneous use of the Cluster, Double Star and LANL satellites show that the onset of the magnetic energy conversion occurs between 7 and 17 Re, and that once initiated, the perturbation propagates both towards the Earth and toward the far tail. Furthermore, using the four Cluster spacecraft we are able, for one of the substorms, to study in detail the local propagation of the instability signatures into the lobe, at 18 Re from the Earth. We compare the obtained results with available models of substorms.