Magnetic flux pileup and magnetic field dipolarization during substorm

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During the period from July to October in 2004, the orbit apogee of Double Star TC-1 of 13RE located in the magnetotail, which made it possible to survey some basic features of substorm processes in the magnetotail. In the present paper we make a case study of substorm occurring on Sep. 17, 2004. At about 0117 UT FUV WIC on board IMAGE observed an aurora breakup. Almost at the same time the LANL-01A and 90-085 at the geosynchronous altitude detected dispersionless injection of energetic electrons. About 2-3 minutes later a weak dipolarization was seen by NOAA geosynchronous satellite GOES 12. Interestingly, ten minutes before substorm onset, Cluster observed an earthward flow at (-15.00, 2.05, 3.50) REGSM. At 0116 UT (one min before onset) TC-1 saw a beginning of magnetic flux pile-up at its position (-10.26, -1.36, 1.01) REGSM, characterized by an increasing of Bz component with almost constant Bx and thermal pressure. At about 0126 UT (9 minutes after onset) TC-1 observed a local dipolarization of the magnetic field which was characterized by a rapid decrease of Bx component and a sharp jump in the thermal pressure, together with a continuous increase of Bz. In the literature, some authors treated the flux pile-up and dipolarization in the tail as a single process named ą°dipolarizationąś. However, as TC-1 measurements show in this event, flux pile-up and dipolarization are characterized by completely different signatures. The same feature holds for many other events. Detailed inspections of TC-1 data in this event show that the beginning of flux pile-up was ˜10 minutes preceding the dipolarization. Besides, the latter lasted only for about two minutes, whereas the former kept for almost one hour. All these aforementioned differences imply that flux pile-up and dipolarization are two different dynamical processes. Nevertheless, further studies indicate that they are ą°cause-effectąś related: The magnetic flux pileup may lead the field lines with ą°goodąś curvature to change to the ą°badąś ones, further compresses the magnetic field and yields disturbances. These can set up appropriate conditions for development of instabilities and then trigger substorm expansion onset. In summary, this case study seems consistent with the synthesis substorm model of near-Earth neutral line (NENL) and near-Earth current disruption (NECD).