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Earthward convected flux ropes/magnetic islands triggering field dipolarization/substorm expansion: Comparison between observations and simulations

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We present simultaneous observations from various instruments onboard the THEMIS spacecraft during substorm events on February 2008. In order to shed light on the mechanism triggering near-Earth dipolarization/substorm expansion we examine the associated earthward high speed plasma flows and intense wave activity accompanied by clear dipolarization signatures. We present evidence that flux ropes in the late stage of their life are embedded within the high-speed earthward convective plasma sheet flows. This fact has important implications since the leading edge of the flux rope having south polarity can impulsively merge with the north polarity field of the stretched magnetotail leading to mutual erosion of both magnetic structures. The merging of the vertically oriented oppositely-directed field lines can lead to local cross-tail current reduction and flux rope dissipation. The observations are combined with two-dimensional full-particle simulations. Although the simulation results do not thoroughly reproduce our observations (i.e. 2-dimensionality in the simulation), they can help us understand the observations and emphasize the fact that flux rope/magnetic island merging process can trigger substorm expansion.