

Temporal evolution of ionospheric flows around substorm onset: high time resolution SuperDARN measurements in support of THEMIS

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We have studied the temporal evolution of ionospheric plasma flows at nightside auroral latitudes, especially its possible relationship with the substorm signatures in the magnetotail, such as fast flows and dipolarization, by combining the THEMIS observations in the tail and the ionospheric convection measurements with the SuperDARN network. In support of the THEMIS mission, the SuperDARN community is using a special camping-beam mode during THEMIS tail conjunctions over North America to maximize the temporal resolution of measurements of ionospheric convection. The SuperDARN THEMIS mode (so-called `themis_scan`) provides 6-second resolution for a single camping beam while simultaneously marching through each beam of the normal 2-minute scan. This special operation mode enables us to visualize rapid variations of localized plasma flows near the footprints of the THEMIS spacecraft without losing global coverage of the SuperDARN network. In this paper, we present two substorm events which occurred in March 2008 during the first THEMIS tail season. For both substorms, expansion phase onsets were identified from the ground magnetometer and all-sky cameras of the THEMIS GBO network. The convection measurements with the SuperDARN radars in the North American sector demonstrate that the ionospheric plasma drift started increasing almost simultaneously with the onsets and decreased 3-5 minutes later. In the magnetotail, fast earthward flows were observed by the THEMIS spacecraft near the magnetic equator. We will discuss the possible association among these signatures at the magnetospheric and ionospheric altitudes. Furthermore, in both events, before the substorm expansion onsets, the all-sky cameras of THEMIS GBO and SuperDARN radars observed auroral arcs that rapidly moved equatorward in the auroral oval. We will discuss magnetospheric counterpart of this auroral signature on the basis of the THEMIS observations.