Does field-aligned acceleration control substorm onsets?

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Abrupt particle acceleration along auroral field lines is essential to complete the substorm onset process. However, recent substorm-triggering scenarios (such as NENL and CD models) do not necessarily contain a self-consistent field-aligned acceleration process; instead, it is a consequence of the process. In these substorm onset arguments, a question arises: Can the ionosphere at any time accept the onset demand from the magnetosphere and instantly build up a parallel electric field in the M-I coupling region? There might be cases in which the ionosphere is not ready for a substorm, not ready to establish a substorm current closure between the magnetosphere and ionosphere and field-aligned acceleration. To answer this question, we need detailed observations of the dynamical behavior (vertical development) of the field-aligned acceleration region around substorm onset times as well as information on the latitudinal and longitudinal expansion of the auroral arcs (horizontal development).]

We have recently derived information on the dynamical behavior of the field-aligned acceleration during substorms using AKR spectra from high-time resolution electric-field observations (Morioka et al. 2007; 2008]. In the present paper, we investigate the evolution of the field aligned acceleration in relation to the substorm onset using data from POLAR, GEOTAIL and CLUSTER satellites, and report some substorms which do not show simultaneous onset between southern and northern auroral regions. This may indicate that the substorm onset is ignited at the M-I coupling region in each hemisphere.