Propagation and evolution of electric fields associated with solar wind pressure pulses based on spacecraft and ground-based observations

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We investigate spatial and temporal evolution of large-scale electric fields in the magnetosphere and ionosphere associated with sudden commencements (SCs) using multi-point equatorial magnetospheric (THEMIS, RBSP, GOES) and ionospheric (C/NOFS) satellites with radars (SuperDARN). A distinct SC event on March 17, 2013 and a statistical analysis of 130 SC events show that the magnetospheric electric field in the equatorial plane propagates from dayside toward nightside as a compressional wave. Estimated tailward propagation speed is about 1000–1100 km/s, which can be explained by a fast mode wave. The ionospheric electric field responds ~41 s after the onset of dayside magnetospheric electric field, which can be explained by the Alfvén wave speed. Tailward and downgoing field-aligned Poynting fluxes evaluated from THEMIS and RBSP data support these propagations. We also statistically derive a spatial distribution and time evolution of the magnetospheric electric field in the dawn-dusk direction (E_y). Our result shows that negative E_y (dawnward) propagates from noon toward the magnetotail, followed by positive E_y (duskward). At noon, negative E_y lasts for about 1 min, and positive E_y becomes dominant about 2 min after the SC onset. Negative E_y soon attenuates in the nightside region, while the positive E_y propagates fairly well to the pre-midnight or post-midnight regions while maintaining a certain amplitude. The enhancement of duskward electric field is affected by the evolution of the current system associated with the main impulse of SCs.

