Global evolution and propagation of electric fields during sudden commencements based on multi-point observations

Naoko Takahashi[1]; Yasumasa Kasaba[1]; Yukitoshi Nishimura[2]; Atsuki Shinbori[3]; Takashi Kikuchi[4]; Tomoaki Hori[5]; Nozomu Nishitani[5]
[1] Tohoku Univ.; [2] UCLA; [3] RISH, Kyoto Univ.; [4] ISEE, Nagoya Univ.; [5] ISEE, Nagoya Univ.

Sudden commencements (SCs) are triggered by an abrupt compression of the dayside magnetopause, which causes a fast mode wave propagating toward the Earth in the equatorial magnetosphere across the magnetic field line. The sudden compression also induces the Alfven wave propagation toward the polar ionosphere along magnetic field lines. The latter causes the global transmission of ionospheric electric field at speed of light, and can propagate the influence back to the inner and/or nightside magnetosphere. These general propagation processes have been demonstrated in previous papers using direct observations.

Motivated by these issues, we investigate global evolution and propagation of electric fields using in-situ satellites and ionospheric radars. In order to clarify the magnetospheric response, we obtain the magnetospheric electric and magnetic field data from THEMIS (5 probes) and Van Allen Probes (RBSP, 2 probes). Magnetospheric magnetic field data obtained from GOES 13 and 15 are also referred to. We identify the ionospheric response using the C/NOFS satellite and SuperDARN radar. The event selection criteria are set as follows: (1) SCs occurred from January 2013 to December 2014. (2) The amplitude of the SYM-H is more than 10 nT, and its rise time is less than 5 min. One hundred and thirty events satisfied these criteria.

An event study on 17 March 2013 shows that the magnetospheric electric field is propagated from dayside to nightside magnetosphere. At the onset time, the magnetospheric magnetic field starts to increase, which indicates that the detected electric field is associated with the compression of the magnetosphere. In the ionosphere, C/NOFS satellite and SuperDARN radar detect the dusk-to-dawn electric field about 1 min after the onset in the magnetosphere. Poynting fluxes evaluated from THEMIS and RBSP data are directed toward the ionosphere along magnetic field lines in both dayside and nightside, which indicates that the Alfven wave launches toward the polar ionosphere at the onset. We statistically derive the spatial evolution of magnetospheric electric fields. This result can be interpreted as follows: First, the fast mode wave propagates from dayside to nightside magnetosphere, and ˜105-120 s after the onset, the magnetospheric convection becomes stronger. We also find that the spatial distribution of the response time is asymmetric between dawn and dusk, which can be explained by the asymmetry of the plasmapause location.