

Characteristics of ionospheric electric field oscillations associated with Sudden Commencement observed by SuperDARN radars and ground magnetometers

Kohei Iida¹, *Nozomu Nishitani¹, Tomoaki Hori¹

1. Institute for Space-Earth Environmental Research, Nagoya University

Sudden Commencement (SC) is observed mainly as a sudden increase of the H-component of geomagnetic field at low latitudes. Similarly, it is also observed as a rapid increase of SYM-H index. Past studies showed that it is caused by a sudden compression of the magnetosphere associated with rapid increases of the solar wind dynamic pressure. At middle and high latitudes, SCs cause perturbations associated with twin vortex type ionospheric currents [Araki, 1994]. It was reported that the disturbances of the ionospheric current and the electric field at high latitude associated with SC consists typically of the Preliminary Impulse (PI) and the Main Impulse (MI). Sometimes they are accompanied by damped oscillations lasting for about several tens of minutes to an hour with periods of several minutes. Previous studies report that the oscillations associated with SC are seen by geomagnetic observations [e.g. Saito and Matsushita, 1967; Fukunishi, 1979] and satellites [e.g. Nagano and Araki, 1985]. In recent years they are also observed by SuperDARN radars in the ionosphere [e.g., Thorolfsson et al., 2001; Hori et al., 2012; Liu et al., 2013]. The reason why both types of SC-associated disturbances can occur, however, have not yet been understood well. We examine the cause of the difference between the two kinds of SC events, using SuperDARN radars in the northern hemisphere covering ~40 to 90 degree geomagnetic latitudes. For the analyzed period from January 2011 to June 2017, 309 SC events were identified and 74 events out of them were accompanied by the ionospheric electric field oscillations immediately following MIs, as observed by at least one SuperDARN radar. We contrast 235 events (only PI and MI) with 74 events (oscillation following MIs) and find that the magnitude of solar wind dynamic pressure and speed change does not seem to be the cause of the difference between the two types of disturbance associated with SC events. On the other hand, the larger the variation of them per one minute is, the higher the occurrence rate of electric field oscillations is. Regarding the magnetic local time (MLT) dependence of the ionospheric electric field oscillations, the occurrence rate is low in 9-15 MLT. The seasonal variation of the occurrence rate tends to be low in summer. Judging from the comparison with the theoretical analysis of MHD waves by Newton et al. (1978), the cause of this tendency is not Joule heating in the ionosphere. Instead we suggest that the occurrence rate in the ionosphere reflects the occurrence frequency distribution in the magnetosphere, as reported by Nagano and Araki (1985).

Keywords: SuperDARN, sudden change in solar wind dynamic pressure, Sudden Commencement (SC), ionospheric electric field oscillation