Evolution of convection vortices associated with sudden impulses observed by SuperDARN

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Spatial evolution of transient ionospheric convection induced by sudden impulses (SIs) recorded by ground magnetometers is studied statistically by using SuperDARN (SD) data. An advantage of using SD data instead of ground magnetic fields is that ionospheric flows measured by the radars are not virtually biased by the spatially-varying ionospheric conductance or the magnetospheric currents. First we surveyed the Sym-H index for Jan., 2007 to Dec., 2012 to identify SI events with a peak amplitude |dSym-H|greater than 10 nT. Next we searched all SD data over the northern hemisphere during the SI events for ionospheric backscatters which give us the light-of-sight velocity of horizontal ionospheric flows. For each SI event, the collected ionospheric flow data were sorted into the four periods: the pre-SI period, defined as 10 to 4 min prior to the start time of SI, and the pre-Main Impulse (MI), middle-MI, and post-MI periods defined as, respectively, Tp-dTr to Tp-dTr/3, Tp-dTr/3 to Tp+dTr/3, and Tp+dTr/3 to Tp+dTr, where Tp is the time of SI peak and dTr is the rise time (from the start to peak) of SI. The four groups of data were then averaged over the magnetic local time (MLT) - magnetic latitude (Mlat) bins each of which has a size of 2 hours in MLT times 3 degrees in Mlat. In the present study, we examine the differences in flow velocity between the pre-SI period and the three MI periods to clarify how ionospheric flows change in association with SIs. As a result, the ionospheric flow shifts eastward on the dusk side and westward on the dawn side at the higher latitudes during positive SIs (SI+), while it shows a roughly westward/eastward shift on the dusk/dawn side, respectively, during negative SIs (SI-). These polarities of flow shifts are basically consistent with the higher latitude portions of DP currents for the MI phase as shown by Araki [1994] and Araki and Nagano [1988]. In addition, the present radar observations show that the SI-induced flow shifts are extended nearly through the midnight sector, although the peaks in flow shift stay in the pre-noon and post-noon sectors. Regarding their lower latitude portions, however, a clear westward flow shift appears on dusk but the counterpart eastward shift on dawn is very weak during SI+, showing a dawn-dusk asymmetry of the induced flow vortices. In terms of temporal evolutions, the SI-induced flows last slightly longer for SI- than for SI+. These findings suggest that the compression and expansion of the magnetosphere affect in different manners the magnetosphere-ionosphere coupled convection system.