DP2 variations observed by King Salmon HF radar and RapidMag

Tomoaki Hori[1]; Takashi Kikuchi[2]; Yuji Tsuji[3]; Atsuki Shinbori[4]; Kazuhiro Ohtaka[5]; Manabu Kunitake[5]; Shinichi Watari[5]
[1] Solar-Terrestrial Environment Laboratory, Nagoya Univ.; [2] STELab; [3] Particle and Astrophysical Sci.,Nagoya Univ; [4] Solar-Terrestrial Environment Laboratory, Nagoya Univ.; [5] NICT

The present paper examines in detail the evolution of the DP2-type ionospheric current/convection cell associated with alternate northward/southward turnings of the IMF. We focus on a case study with excellent coordination of SuperDARN King Salmon (KSR) HF radar and the Realtime auroral and polar ionosphere disturbance Magnetometers (RapidMag) covering the auroral latitudes from the evening to afternoon local time sector. The IMF had a weak but persistent southward component (~-1 to -3 nT) mostly in the course of the event with two short (~10 to 15 min) intervals of IMF-Bz ~0 or even northward IMF. The ground magnetograms show gradual increases (abrupt declines) of the H-component in association with the increases (decreases) of the merging electric field, respectively, derived from the simultaneous solar wind-IMF observations. The fairly coherent variations in the wide range of local time indicate that the geomagnetic field variations reflect typical evolution of the large-scale DP2 current system, which is known to be closely associated with the variation of the merging electric field or the IMF-Bz component. This feature is consistent with the simultaneous observation of ionospheric drift velocity by KSR. The radar observation further provides us with the 2-D convection structure near the lower latitude edge of the dusk convection cell. The result is that the ionospheric plasma generally flows westward there and has a larger speed with increasing latitude in association with increases in the merging electric field. However, once the southward IMF ceases or even shifts to northward and thereby the merging electric field goes down, the region of westward flow moves toward higher latitudes and instead an eastward flow emerges there, forming a sheared flow of the counterclockwise sense. This indicates that a downward field-aligned current (FAC), which is the region-2 (R2) sense on the dusk side, flows into the sheared flow region. Subsequently the convection returns to a westward flow again upon the increase of the merging electric field due to the southward turning of IMF. A likely interpretation of these observations would be as follows: The R2 convection cell associated with a downward FAC is overwhelmed by the DP2 convection under the southward IMF. As the DP2 cell weakens rapidly, however, the R2 cell is still driven for a while by the partial ring current with a slowly decaying nature, resulting in the emergence of the R2 sense flow shear in the ionosphere. In other words, the ionospheric convection structure is controlled by the dynamic balance between those driven by the region-1 FAC (the dusk DP2 cell in this case) and those by the R2 FAC. The radar observation also reveals that those changes of convection structure take place rather quickly (~several min), very sensitive even to small variations of the merging electric field.