Magnetospheric dynamics under northward IMF conditions surveyed by concurrent observations of TPA and omega-band aurora

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Nightside magnetospheric processes (dynamics) directly reflect to auroral morphology and type. By investing type of auroras and the auroral morphological changes, we can expect to understand what physical processes would take place in the magnetotail. Under northward Interplanetary Magnetic Field (IMF) conditions, transpolar arcs (TPAs) and omega-band aurora can be observed. A source of TPA is considered as field-aligned currents induced by the plasma flow shear (including the plasma flow vortices) between the fast plasma flows generated by magnetotail magnetic reconnection and slower background magnetospheric plasma flows. On the other hand, it is well-known that omega-band aurora is also likely to be formed by the field-aligned current induced by the flow shear in the magnetotail, such as the Kelvin-Helmholtz instabilities. Based on the contemporaneous observations of TPA and omega-band aurora, we try to investigate (diagnose) how the plasma and its energy are transported in the nightside magnetosphere toward ionosphere under northward IMF conditions. On January 10th, 1997, transpolar arc (TPA) and omega-band aurora contemporaneously occurred for about 5.5 hours between 17:58 UT and 22:23 UT even when Interplanetary Magnetic Field (IMF) orientation changed from weakly southward to northward at ~21:00 UT. Because no in-situ magnetotail observations were unfortunately found in this day, we performed global MHD simulations based on the Open Geospace General Circulation Model (Open GGCM) distributed in the Community Coordinated Modeling Center (CCMC), and discussed the physical relation between two different auroral appearances and nightside magnetospheric processes. In this simulation, after the IMF-B_z orientation turned from weakly southward to northward, clear flow shear between fast earthward plasma flows triggered by magnetotail reconnection and slower tailward background magnetospheric flows was seen around X_{gsm} ~ -40 Re in the dawn sector, being consistent with the TPA and omega-band auroral brightening. These flow shears may be a “source” of field-aligned currents to form the TPA. Furthermore, they bifurcated toward dawn and dusk, and showed stronger vortices in the dusk region than those in the dawnward sector. These vortex(-like) structures, bifurcated duskward, and associated field-aligned currents would be linked to the formation of the omega-band aurora. In this presentation, we will discuss further the relation between the variations of these flow shear (vortex) structures, TPA and omega-band auroral formations under northward IMF conditions, followed by weak southward IMF intervals.

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