Field-aligned currents generated by a long-period oscillation in the solar wind dynamic pressure: MHD simulation results

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Responses in the magnetosphere-ionosphere system to a long-period oscillation (period of 10 min) in the solar wind dynamic pressure (Psw) have been investigated using the global magnetohydrodynamic (MHD) numerical simulation [Tanaka, JGR, p12057, 1995]. The dayside magnetopause moves outward/inward following the Psw oscillation under the condition of northward interplanetary magnetic field. In response to the expanded (compressed) state of the magnetosphere, the field-aligned currents (FACs) flowing downward (upward) on the duskside and upward (downward) on the dawnside appear in the northern hemisphere. The oscillatory FAC systems are necessarily accompanied by twin-vortex convection flows in the ionosphere, responsible for quasi-periodic magnetic field perturbations at high latitudes. The polarity of the dual FAC system and ground magnetic signatures deduced from the numerical simulation are consistent with observational results of Motoba et al. [submitted to JGR]. Furthermore, the MHD modeling results show that the ionospheric convection appears correspondent to dynamical magnetospheric convection originating well inside the closed field lines.

We further focus on driving mechanisms of the Psw-induced FAC for the time interval when the magnetospheric state just shifts from contraction to expansion. During this interval, we have found that there are two current generator regions in the magnetosphere: the major current generator connecting to FACs are formed in the high-latitude cusp region and the minor one in the equatorial plane at L values ranging from about 8 to 12 Re. Around the current generators, disturbances in the magnetic field and pressure have a diamagnetic property (the pressure change is anti-correlated with the magnetic field strength change). The results in the simulation suggest that the perpendicular diamagnetic currents play an important role in the generation of FACs in response to the Psw oscillation.