ELECTROMAGNETIC COUPLING BETWEEN THE REGION-1 AND -2 FIELD-ALIGNED CURRENTS AND THE EQUATORIAL IONOSPHERE

TAKASHI KIKUCHI 1, Yusuke Ebihara 2, Kumiko K. Hashimoto 3, Tomoaki Hori 1, Ryuho Kataoka 4, Shin-Ichi Watari 5, and Nozomu Nishitani 1

1. Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Aichi 464-8601, Japan, e-mail:kikuchi@stelab.nagoya-u.ac.jp
2. Advanced Research Institute, Nagoya University, Nagoya, Aichi 464-8601, Japan
3. Kyushu University of Health and Welfare, Nobeoka, Miyazaki 882-8508, Japan
4. Computational Astrophysics Laboratory, Institute of Physics and Chemical Research (RIKEN), Wako, Saitama 351-0198, Japan
5. National Institute of Information and Communications Technology, Koganei, Tokyo 184-8795, Japan

The convection electric field penetrates to the equatorial ionosphere with no significant shielding during DP2 fluctuation events with periods of 30-60 min (Nishida, JGR, 1968; Kikuchi et al., JGR, 1996; Kobea et al., AG, 1998) and even during storm main phase continuing for several hours (Huang et al., JGR, 2005; JASTP, 2007). On the other hand, shielding becomes effective in 17–20 min during substorm growth phase (Somayajulu et al., GRL, 1987; Kikuchi et al., JGR, 2000), and 1 h during storm main phase (Kikuchi et al., JGR, 2008). Overshielding occurs when the IMF turns northward or the southward IMF decreases during substorms (Kikuchi et al., JGR, 2003) and during storm recovery phase (Kikuchi et al., JGR, 2008). To clarify relative contributions of the convection and shielding electric fields in the low latitude ionosphere, we analyzed equatorial DP2 fluctuation events of 30-60 min periods using magnetometer data, SuperDARN convection maps and electric potentials calculated with the comprehensive ring current model (CRCM) (Fok et al., JGR, 2001). The equatorial DP2 fluctuation was found to be caused by alternating eastward (e-EJ) and westward electrojets (w-EJ) in the equatorial ionosphere, which were caused by the southward and northward IMF, respectively. Using SuperDARN convection maps, we further show that the e-EJ was associated with large-scale two-cell convection vortices, while the w-EJ accompanied reverse flow vortices equatorward of the two-cell vortices. With the aid of the CRCM, we suggest that the reverse flow vortices were associated with the Region-2 field-aligned currents (R2 FACs) that caused overshielding at the equator. Thus, we suggest that the R1 and R2 FACs are connected with the e-EJ and w-EJ, respectively. As a result, the overshielding electric field and current can appear at mid-equatorial latitudes irrespective of the period of fluctuations, when the R1 FAC decreases its intensity. This scenario well explains the disturbances in equatorial electric and magnetic fields: DP2 fluctuations with periods of 30-60 min (Nishida, JGR, 1968), penetration electric fields continuing for several hours during storm main phase (Huang et al., JGR, 2005), and the equatorial counterelectrojet during storm/substorm recovery phase (Kikuchi et al., JGR, 2000, 2003, 2008).

magnetosphere-ionosphere current system, equatorial electrojet, overshielding

Takashi Kikuchi, Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Aichi 464-8601, Japan, e-mail:kikuchi@stelab.nagoya-u.ac.jp