

Equatorial counter-electrojets during substorms

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The equatorial counter-electrojet (CEJ) events are analyzed in association with changes in the interplanetary magnetic field (IMF), the polar cap potential (PCP), and the electric field measured in the equatorial ionosphere. In one event on July 16, 1995, the equatorial CEJ was observed at the afternoon dip equator during the recovery phase of a substorm when the IMF turned northward. Rapid decreases in the PCP and in the auroral electrojet occurred simultaneously with the equatorial CEJ, suggesting the equatorward penetration of the rapid decrease in the Region-1 field-aligned currents (R1 FACs) under the condition of well-developed shielding electric field due to the R2 FACs. In the other event on April 8, 1993, the equatorial CEJ associated with the northward turning of the IMF was directly related to a rapid decrease in the equatorial electric field measured by the Jicamarca incoherent scatter radar as well as to a decrease in the PCP. We propose a scenario for the equatorial CEJ as caused by the dominant R2 FACs, when the R1 FACs decreased abruptly because of the northward turning of the IMF. We also suggest that the DP1 current system associated with the substorm primarily consists of the Hall currents surrounding the R2 FACs and the equatorial CEJ that closes with the R2 FACs, overwhelming the DP2 currents caused by the R1 FACs. The coherent occurrence of the electric field in the F-region with the current system in the E-region at the equator matches the TM0 mode in the Earth-ionosphere waveguide proposed by Kikuchi et al. (Nature, 1978, p.650). All the conditions for the equatorial CEJ most likely occur during the substorm, but the northward turning of the IMF and the resultant decrease in the PCP plays a crucial role under the condition of the well-developed R2 FACs.