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Temporal and spatial developments of overshielding current system at middle latitudes and the equator during storms

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During the strong southward interplanetary magnetic field (IMF), the convection electric field originating from the region-1 field-aligned currents (R1 FACs) causes a two-cell ionospheric current at high latitudes. The convection electric field penetrates to the magnetic equator, and drives the eastward equatorial electrojet (EEJ). Subsequently, when the southward IMF weakens, the reversed ionospheric current, equatorial counter electrojet (CEJ), is driven by the developed shielding electric field originating from the region-2 field-aligned currents (R2 FACs). Its condition is called a 'overshielding' because the shielding electric field relatively overcomes the reduced convection field in lower latitudes of the R2 FACs [e.g., Kelley et al., 1979]. However, the temporal and spatial relationship of ionospheric currents between middle latitudes and the equator hasn't been yet established during the overshielding. In this paper, we investigated magnetic field variations in high-low latitudes in the 21 CEJ events (overshielding events) during storms occurred during the period from 2001 to 2002. In high-middle latitudes during the period, the developed auroral electrojet (AEJ) moved poleward with ~3-8 degrees in the unit of magnetic latitude, maintaining the strength. This indicates a contraction of the auroral oval. Subsequently, the strength rapidly decreased without such a poleward shift. This result supports that the overshielding electric field is strengthened by the poleward shift of the R1 FACs [Kikuchi et al., 20 08]. Moreover, in the 7 of 21 CEJ events, the magnetic field variation in lower latitudes than the above AEJ region showed a reversed direction with 10 % magnitude, comparing with the AEJ. This variation was generated by the ionospheric Hall currents associated with the overshielding electric field. Here, it is also found that the observed life time of CEJ, about 75-320 min, was about 1.5-3.0 times longer than that of the overshielding current at the middle latitudes (about 40-90 min). This fact implies that the CEJ at the equator is driven by the ionospheric disturbance dynamo with the life time of several to dozen hours [Blanc and Richmond, 1980] as well as the overshielding electric field with that of several tens of minute [e.g., Peymirat et al., 2000]. Thus, it is possible that we indentify the life time of overshielding and derive that of the disturbance dynamo, using the characteristic magnetic field variation observed at middle latitudes associated with the overshielding.