Region 2 current system measured by spacecraft and ground magnetometers during substorms

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During the February 23, 1991 substorm, the CRRES satellite was located in the postmidnight inner magnetosphere. A quick response of large-scale electric fields is identified outside the plasmapause. It indicates the quick development of subauroral polarization streams. On the other hand, electric fields in the plasmasphere are directed dusk-dawn in the plasmasphere; the plasmasphere in this local time sector is in the overshielding state. An examination of simultaneous measurements of ground magnetometer chain data in the midnight sector reveals an enhancement of an eastward Hall current flowing in the subauroral ionosphere. It cannot be explained by the substorm wedge current system, but ionospheric currents flowing below 60 deg MLAT are required to change the direction of the Z component at these latitudes. The eastward current would be connected to the region 2 FAC. It is closed by the partial ring current enhanced by the pressure gradient due to particle injections into the inner magnetosphere. This study clarifies that the eastward current flowing in the subauroral ionosphere, which indicates an enhancement of the region 2 current system, can be detected by ground magnetometers. Detailed examinations of midlatitude magnetic perturbations will allow detecting the location and time evolution of the region 2 current system.

Manifestations of the region 2 dynamo are presented using coordinated measurements of electric fields and ground magnetic fields. Overshielding electric fields directed from dusk to dawn simultaneous with enhancements of subauroral ionospheric currents are direct indications of the existence of the region 2 dynamo. The overshielding state, which has been deduced from ground magnetometer data, is justified by the direct measurement of electric fields and FACs. Moreover, ionospheric Hall currents associated with the region 2 current system are identified from the analysis of subauroral ground magnetometers. Detailed time variations in the current will serve as a remote-sensing tool to deduce spatial and temporal evolutions of the region 2 current system.