J O U R N A L C L U B

Substorm Expansion Dynamics and Storm Ring Current Intensifications

by

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ABSTRACT

We propose a new cause-and-effect sequence of processes leading from the brightening of the equatorward-most auroral arc at substorm onset to the ring current intensifications during major storms under southward interplanetary magnetic field (IMF). The equatorward-most auroral arc brightens when the enhanced northward E-field overlaps with the southward conductance gradient in the auroral oval. The brightness of the auroral arc increases with increasing upward field-aligned current as the convection reversal layer moves into the auroral oval. Blockage of the northward Hall current in the enhanced auroral arc conductance produces southward polarization E-field, leading to intensification of the westward electrojet. The westward electrojet closes in the near-Earth plasma sheet (NEPS). It is the closure of the intensified westward electrojet current which disrupts the cross-tail current to cause dipolarization earthward and thinning tailward of the current disruption region. Intense thinning tailward of the current disruption region leads to the formation of near-Earth neutral line (NENL). Energy released by the NENL causes the ongoing dipolarizing region to expand tailward, leading to poleward expansions of auroral bulge, i.e., auroral breakups. Localized dipolarization E-fields energizes plasma in the dipolarizing region. Earthward convection drives the plasma in the NEPS into the inner magnetosphere to intensify the ring currents in major storms. The NENL is proposed to be responsible for powering the penetration of sunward convection into the inner magnetosphere to intensify ring currents of major storms. The more intense the substorms, the closer the NENL forms to the Earth, leading to deeper penetration of convection into the inner magnetosphere and greater intensifications of the ring current.

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