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Continent-wide R1/R2 Current System and Ohmic Losses by Broad Dipolarization-Injection Fronts

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We employ Magnetospheric Multi-Scale, Geostationary Operational Environmental and Los Alamos National Laboratory satellites, as well as the ground magnetometer networks over Greenland and North America to study a substorm on August 9, 2016 between 9 and 10 UT. We found that during the substorm two earthward flows, whose foremost dipolarization-injection fronts exceeded 6.5Re and 4Re in Ygsm, impinged and rebounded from Earth's dipolar field lines. The impingements and rebounds ended with a substorm current system of downward R1 and upward R2 currents which grew to azimuthally cover the whole North American continent. At the fronts, regions of enhanced negative j dot E prime were formed and peaked toward the end of the impingements. These regions appeared to be conjugate with eastward moving aurora (along the growth phase arc and together with eastward propagating energetic electrons at GEO), which manifests ionospheric Ohmic losses through Joule heating.