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Plasma sheet-geosynchronous-ground conjugate observations of field and current oscillations during oscillatory flow braking

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Braking of earthward reconnection outflows near 10 Re down the Earth's magnetotail can produce oscillations in the magnetic fields and currents. It is important to study the regions of transient enhanced currents that are born in the plasma sheet during oscillatory flow braking (OFB) because they involve ionospheric energy losses through Ohmic heating and aurora, and may modulate particle injection into the inner magnetosphere. We use expansion substorm phase conjugate observations by MMS, GOES and ground magnetometers on 9 August 2016 to identify and track propagation of the transient enhanced current and field disturbances from the near-Earth plasma sheet. It appears that MMS was directly observing an oscillatory flow driving current and field disturbances. GOES 13-15 observations helped us track propagation of the magnetic field disturbances associated with the currents in the azimuthal direction along the geosynchronous orbit. In turn, by correlating MMS and ground current observations we were able to identify the parallel propagation of the current disturbances down to the substorm onset arc location. These observations indicate that whereas the global DC substorm currents are probably produced by pressure gradient redistribution during magnetotail dipolarization, the smaller-amplitude AC currents result from the flow rebound and further interchange oscillations of the near-Earth plasma sheet parcels. The fact that the field and current disturbances propagate both parallel and azimuthally suggest that the AC currents are channels of magnetotail energy dissipation such as through Ohmic heating in the ionosphere and through azimuthal spreading of the field oscillation energy.