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Magnetotail energy dissipation during an auroral substorm

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Violent releases of space plasma energy from the Earth's magnetotail during substorms produce strong electric currents and bright aurora. But what modulates these currents and aurora and controls dissipation of the energy released in the ionosphere? Using data from the THEMIS fleet of satellites and ground-based imagers and magnetometers, we show that plasma energy dissipation is controlled by field-aligned currents (FACs) produced and modulated during magnetotail topology change and oscillatory braking of fast plasma jets at 10–14 Earth radii in the nightside magnetosphere. FACs appear in regions where plasma sheet pressure and flux tube volume gradients are non-collinear. Faster tailward expansion of magnetotail dipolarization and subsequent slower inner plasma sheet restretching during substorm expansion and recovery phases cause faster poleward then slower equatorward movement of the substorm aurora. Anharmonic radial plasma oscillations build up displaced current filaments and are responsible for discrete longitudinal auroral arcs that move equatorward at a velocity of about 1 km s^{-1}. This observed auroral activity appears sufficient to dissipate the released energy.