Reconnection, Global Flux Transport and Energy Conversion at Earth's Magnetotail

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It has been known that convection in Earth's magnetosphere is reconnection-driven. However, magnetotail reconnection, required to complete flux circulation to the dayside, is theoretically prohibited in the presence of a magnetic field component, Bz, normal to the sheet with two exceptions: One is driven reconnection by external (solar wind) impulses or high dynamic pressure that reduce the field locally; the other is spontaneous reconnection in quasi-static equilibria that gradually develop a positive Bz gradient away from the planet. Recent observations suggest that both scenarios can operate and both result in inherently transient, localized reconnection bearing all the hallmarks of reconnection in the absence of Bz (such as peak reconnection rates, Hall current system, parallel electric fields, and particle heating up to a small fraction of the available magnetic energy). Under substorm conditions the reconnection site is initiated near Earth where the low lobe density generates flux tubes with low entropy, able to penetrate to the inner magnetosphere and around the Earth to replenish the flux. It moves down-tail as convection near Earth is gradually prohibited by the dipolarized (low entropy) flux there. This tailward motion fosters the growth of another substorm cycle when reconnection is choked by the inability of the outflows to move Earthward by interchange motions. Under storm conditions reconnection starts even closer to Earth despite the strong Earth dipole. This is enabled by the solar wind dynamic pressure that leads to a local minimum in Bz there. Despite the favorable conditions, though, it appears reconnection there too is transient and does not fully convert the magnetic energy to heat. In all cases it is evident that reconnection is not the location of dominant magnetic energy conversion but a facilitator of energy conversion further downstream by field-line contraction.