Geophysical Research Abstracts
Vol. 14, EGU2012-3817-3, 2012
EGU General Assembly 2012

MESSENGER Observations of Magnetotail Dynamics at Mercury

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MESSENGER magnetic field observations taken in Mercury's magnetotail at distances of $\sim$ 2 to 4 R_M (where $R_M$is Mercury's radius or 2440 km) frequently include tail loading and unloading events, traveling compression regions (TCRs) in the lobes, and plasmoid ejection in the plasma sheet. During these loading–unloading events, the magnitude of the lobe magnetic field can increase and then decrease by up to a factor of $\sim$2, as observed during MESSENGER's third flyby. The duration of these events is usually $\sim$1–3 min, but in some case they can last for as long as $\sim$ 10 min. The transition from loading to unloading is often marked by one or more TCRs signaling the onset of magnetic reconnection in the cross-tail current sheet and the ejection of plasmoids. When MESSENGER crosses the plasma sheet at $\sim$ 3 R_M downstream of Mercury during the orbital phase of the mission, plasmoids are frequently present in the magnetic field measurements, especially when the interplanetary magnetic field has been southward. These plasmoids can occur singly, in groups of several events, or in quasi-periodic series with durations as long at $\sim$ 10 min and with individual plasmoids separated by $\sim$ 5–10 s. These phenomena at Mercury are qualitatively similar to dynamic events observed during terrestrial magnetospheric substorms and continuous dissipation events, albeit on time scales of seconds to minutes compared with tens of minutes to hours at Earth.