Geophysical Research Abstracts
Vol. 19, EGU2017-10106, 2017
EGU General Assembly 2017

Diamagnetic drift and field aligned current at Earth's dayside magnetopause: Magnetospheric Multiscale observations and global simulations

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We present Magnetospheric Multiscale (MMS) observations of electron and ion diamagnetic drift and associated field-aligned currents at Earth's dayside magnetopause under northward and southward interplanetary magnetic field (IMF) conditions. We focus on two events: 1) the southward IMF electron diffusion region (EDR) event reported by Burch et al. [Science, 2016], and 2) a steady northward IMF event far from the predicted reconnection site. In both cases, we observe Hall electric fields, strong bi-polar field-aligned current structures, and strong perpendicular current carried by non-gyrotropic electron and ion velocity distributions. Comparing observed MMS crossings with those predicted by the global simulations, we find that MMS crossed the predicted thin current sheet for both events, suggesting that sub-ion scale current thin current sheets extend thousands of ion inertial lengths away from the magnetic separator. In both cases the deviation of the electron perpendicular bulk velocity from ExB drift can be accounted for by the electron diamagnetic drift (supported by the perpendicular gradient of the perpendicular electron pressure). In the southward case, the diamagnetic drift manifests itself as the crescent shaped distributions reported by Burch et al. [2016]. In the northward case, the electron velocity distributions are non-gyrotropic but no clear crescent features appear. In both cases, we find significant parallel electric fields supported by the parallel gradient of the parallel electron pressure. The parallel electric fields inferred from the observed pressure gradients are associated with bipolar parallel current structures and are much larger than the reconnection electric fields predicted by two-dimensional theory. Our results suggest that the sub-ion scale structure observed by MMS close to the magnetic separator is a generic feature of the global Chapman-Ferraro current sheet.