Geophysical Research Abstracts
Vol. 18, EGU2016-14264, 2016
EGU General Assembly 2016

Ion flow ripples in the Earth's plasma sheet

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For a long time, magnetotail flows were considered rather smooth and laminar, and primarily dominated by a simple convection flow pattern. However, in the early 90's, high speed bursty bulk flows (BBFs) were discovered and found to commonly perturb the underlying convection flows. In addition, there are other disturbances complicating the magnetotail flow pattern. Instabilities such as the Kelvin-Helmholz instability and the kink instability can cause different types of magnetic field oscillations, such as field line resonances. It is expected that ions will follow these oscillations if the typical time and length scales are larger than the gyroperiod and gyroradius of the ions. Though low-velocity sloshing and ripple disturbances of the average magnetotail convection flows have been observed, their connection with magnetic field oscillations is not fully understood. Furthermore, when studying BFFs, these "Ion Flow Ripples" (IFRs) are often neglected, dismissed as noise or can even erroneously be identified as BBFs. It is therefore of utter importance to find out and understand the role of IFRs in magnetotail dynamics. In a statistical investigation, we use several years of Cluster plasma sheet data to study the low-speed flows in the magnetotail. We investigate different types of IFRs, study their occurrence, and discuss their possible causes.