Geophysical Research Abstracts
Vol. 15, EGU2013-2282, 2013
EGU General Assembly 2013

A single spacecraft method to study the spatial profiles inside the magnetopause

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Previous magnetopause observations have revealed that the tangential magnetic field often rotates over C-shaped hodograms during the boundary crossing. Using observations of magnetopause crossings by the ESA Cluster mission and a simulation developed at LPP by Nicolas Aunai, we developed a single spacecraft method using the temporal information on the magnetic field in such crossings, complemented by the ion data. We can so obtain a 1D spatial parameter to characterize the depth in the layer and study the structure of the magnetopause as a function of this parameter. This allows using one single spacecraft magnetic data, completed by ion data at large temporal scales, to study the spatial structure of the boundary, and access scales that the particle temporal measurements of the four spacecraft do not permit. To obtain the normal direction and position, we first initialize our computations thanks to the standard MVABC method. Then we use the magnetic field data in the current layer, and suppose it is 1D, rotating in the tangential plane along an ellipse, with an angle variation essentially linear in space, with small sinusoidal perturbations. Making the assumption that the normal velocity of ions is dominated by the motion of the boundary and that the internal structure of the magnetopause is stationary over the duration of a crossing, we can compute the best normal direction and parameters of the model with CIS velocity and FGM magnetic field data, and so derive the spatial position of the spacecraft in the boundary. This method, which has been tested on the simulation data, could be applied successfully on several magnetopause crossings observed by Cluster. It directly gives a thickness and a normal direction, and permits to establish spatial profiles of all the physical quantities inside the boundary. It can be used to better understand the internal structure of the boundary, its physical properties and behavior regarding the flux conservation equations. The obtained results are compared with the results of other methods.