Geophysical Research Abstracts
Vol. 15, EGU2013-407-1, 2013
EGU General Assembly 2013

Electromagnetic 2D/3D Particle-in-Cell simulations of the solar wind interaction with lunar crustal anomalies.

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We present the first 2D/3D fully kinetic Particle-in-Cell simulations of the solar wind interaction with lunar crustal magnetic anomalies. The simulations are performed using the implicit electromagnetic Particle-in-Cell code iPIC3D [Markidis, Lapenta & Rizwan-uddin, 2010]. Multiscale physics is resolved for all plasma components (heavy ions, protons and electrons) in the code, recently updated with a set of open boundary conditions designed for solar wind-body interactions. We use a dipole to model the crustal anomaly. The dipole center is located outside the computational domain and the boundary representing the lunar surface is modeled as a particle-absorbing plane. Photo-emission from the lunar surface is at this point not included, but will be in future work. We study the behaviour of the dipole model with variable surface magnetic field strength under changing solar wind conditions and confirm that lunar crustal magnetic fields may indeed be strong enough to stand off the solar wind and form a mini-magnetosphere, as suggested by MHD simulations [Harnett & Winglee, 2000, 2002, 2003] and spacecraft observations [Kurata et al., 2005; Halekas et al., 2008; Wieser et al., 2010]. 3D-PIC simulations reveal to be very helpful to analyze the diversion/braking of the particle flux and the characteristics of the resulting particles accumulation. The particle flux to the surface is significantly reduced at the magnetic anomaly, surrounded by a region of enhanced density due to the magnetic mirror effect. Finally we will present preliminary results on the interaction of the solar wind with weaker magnetic anomalies in which highly non-adiabatic interactions are expected.