Geophysical Research Abstracts, Vol. 8, 04012, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04012

Dynamics of planetary ions in the Mercury's magnetosphere: Comparison between ion trajectories in MHD fields and a rescaled analytical model

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A recent study of ion dynamics in the Mercury's magnetosphere, which uses a rescaled analytical model of the geoelectric and geomagnetic fields for Mercury, shows that non-adiabatic motion of ions in the magnetotail can cause a narrow band of energetic (several keV) Na^+ precipitation in each hemisphere [*Delcourt et al.*, *Ann. Geophys.*, p1723, 2003]. Since these precipitation bands extend over several degrees in latitude and a wide range of longitude, it may lead to additional sputtering of planetary material at the surface. On the other hand, it is not evident that the magnetospheric configuration and global convection pattern in the Mercury's magnetosphere can be described with the rescaled geomagnetospheric model.

In order to investigate whether the ion dynamics in the self-consistent field configuration differs from that in the rescaled model, we conducted systematic trajectory tracings of Na^+ ions in the electric and magnetic fields obtained from a MHD simulation of the Mercury-solar wind interaction. For comparison with the previous study under the empirical field model, the southward IMF condition is selected in the MHD simulation. While the empirical model assumes the existence of the distant neutral line (DNL) in the Mercury's magnetotail, the MHD result shows the formation of the near-Mercury neutral line (NMNL) at a position closer to the planet than the rescaled location of DNL.

The existence of the NMNL alters trajectories of Na^+ ions and changes the ratio of ions that can precipitate back onto the planet surface. The ions reached to the region of the tailward flow in the plasma sheet do not return to the planet regardless of whether their motion is adiabatic or not. The calculation also shows that the global convection pattern and location of the reconnection line in the magnetotail depend on the conductivity at the surface of the planet as well as on the strength of IMF Bz. In the Earth's magnetosphere, the near-Earth neutral line is often formed associated with substorms. These results thus suggest that the precipitation pattern of planetary ions onto Mercury's surface changes significantly with the activity level of the Hermian magnetosphere.