THE MERCURY PLASMA ENVIRONMENT: MHD PREDICTIONS AND MERCURY PICKUP IONS.

T. H. Zurbuchen 1,2, P. L. Koehn 2, L. A. Fisk 2, G. Gloeckler 3, and K. Kabin 4, 1thomasz@umich.edu, 2University of Michigan, Atmospheric, Oceanic and Space Sciences Department, Ann Arbor, MI 48109-2143, 3University of Maryland, Physics Department, Space Research Group, College Park MD, 20742, 4University of Alberta, Department of Physics, Edmonton, AL T6G 2J1, Canada.

Abstract: The Mercury environment is dominated by two particle populations: the solar wind and ions originating from Mercury. The absence of any significant ionosphere and atmosphere creates a magnetosphere that differs from the Earth’s and may affect the transfer of energy from the solar wind to magnetospheric plasma. We use three-dimensional MHD simulations from Kabin et al. [1] to model fundamental magnetospheric processes in the planet’s vicinity.

Due to its close vicinity to the Sun, the solar wind momentum flux is ~ 10 times larger than the momentum flux at Earth [see, e.g., Russell et al. [1988] [2]. At the same time, Mercury’s intrinsic magnetic field is relatively weak. Under normal solar wind conditions, this magnetic field is able to hold off the solar wind, preventing it from striking the planet’s surface. This is not always the case, however. For example, during fast coronal mass ejections the solar wind ram pressure can be sufficient to compress the magnetopause to the surface. This direct interaction gives rise to sputtered particles that provide a direct probe of the surface composition. Most of these particles are released in a neutral state and are eventually ionized. The resulting pickup ions move through Mercury’s magnetosphere.

We apply the results of recently modeled three-dimensional MHD interactions of the solar wind and Mercury’s magnetosphere to predict the plasma and composition measurements on MESSENGER, a Mercury orbiter scheduled for launch in 2004. We then use this simulated MHD structure of the magnetosphere to record the trajectories of newly created magnetospheric and near-surface pickup ions. During certain parts of the MESSENGER orbit, these ions are observed during their first gyration. The observed particles therefore provide a good measure for the neutral particle environment near Mercury. During other, more distant parts of the MESSENGER orbit, the spatial distribution of particles depends on the large-scale structure of the Mercury magnetosphere. Detailed pickup ion measurements therefore provide direct information about the Mercury surface composition, and the structure of the Mercury magnetosphere.

We will present the simulated trajectories and spatial distributions of these pickup ions, as well as predictions of particle fluxes measured by the Fast Imaging Plasma Spectrometer (FIPS), one of the mass spectrometers on board the MESSENGER spacecraft.

References: