Geophysical Research Abstracts
Vol. 12, EGU2010-12394, 2010
EGU General Assembly 2010

Insolation and Resulting Surface Temperatures of Study Regions on the Moon and Implications for Mercury

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The imaging spectrometer MERTIS (Mercury Radiometer and Thermal Infrared Spectrometer) is part of the payload of ESA's BepiColombo mission, which is scheduled for launch in 2014 (Hiesinger et al., 2010). The instrument consists of an IR-spectrometer and radiometer, which observe the surface in the wavelength range of 7-14 and 7-40μm, respectively. The four scientific objectives are to a) study Mercury's surface composition, b) identify rock-forming minerals, c) globally map the surface mineralogy and d) study surface temperature and thermal inertia (Hiesinger et al., 2010; Helbert et al., 2005).

Previous studies of the lunar surface have shown that thermal emission contributes to the observed signal from the surface and can influence the spectral characteristics, e.g. the depth of absorption bands (e.g. Clark, 2009; Pieters et al., 2009; Sunshine et al., 2009). Therefore accurate knowledge of the solar insolation and resulting thermal variations is needed. In order to calculate insolation and surface temperatures, we use a numerical model which has been described by Bauch et al. (2009). Surface temperatures are depending on the surface and subsurface bulk thermophysical properties, such as bulk density, heat capacity, thermal conductivity, emissivity, and albedo. Topography also influences surface temperatures, as it changes the angle of solar incidence, but also leads to shadowed areas, e.g. the floors of polar craters. The model solves the one-dimensional heat transfer equation, based on a depth and temperature dependent thermal inertia. The surface boundary condition is based on the energy balance relation; the energy entering a surface equals the energy leaving the surface. In addition to the direct solar insolation, reflectance and scattering from adjacent surface regions also influence the surface temperatures.

In preparation of the MERTIS experiment, we performed detailed thermal models of the lunar surface, which we extrapolated to Mercury. For our simulation, we use topography data from the Moon and transfer them as model regions to the surface of Mercury. When calculated with lunar parameters, this allows us to compare the results to lunar temperature measurements of the Apollo, Clementine and Chandrayaan missions (e.g. Keihm and Langseth (1973), Lawson et al. (2000), Pieters et al. (2009)). It also allows a direct comparison of the insolation and thermal variation between craters on the lunar and mercurian surface.

Hiesinger, H. et al. (2010), PSS 58, 144-165; Helbert, J. et al. (2005), LPSC XXXVI, Abstract #1753; Clark, R.N. (2009), Science 326, 562-564; Pieters, C.M. et al. (2009), Science 326, 568-572; Sunshine, J.M. et al. (2009), Science 326, 565-568; Bauch, K.E. et al. (2009) LPSC XL, Abstract #1789; Keihm, S.J. and Langseth, M.G. (1973), Proc. Lunar Sci. Conf. 4th, 2503-2513; Lawson, S.L. et al. (2000), JGR 105, E5, 4273-4290