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Potential Effect of Sodium Atoms Diffusion Inside the Regolith on Mercury's Sodium Exosphere

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A Mercury's thermal model has been developed, in order to describe the temperature of the surface exposed to solar radiation. This model describes the surface temperature and the first meters below during a whole diurnal cycle. Such a model has been tested with respect to known measurements of Mercury's surface temperature (Chase et al. 1976) and previous models (Hapke and Hale 2002).

This model is being coupled to a model for the diffusion of sodium atoms inside the regolith. The sodium concentration vertical profile in the first meters below the surface, and its evolution during a whole diurnal period, are estimated. The sodium concentration depends on the subsurface temperature (estimated by the thermal model), and on porosity and tortuosity of the regolith. Diffusion of sodium atoms into the regolith is limited by adsorption and by the incident flux of Na at the surface. This latter is a function of Mercury's heliocentric position and of the latitude/longitude at Mercury's surface. Sodium atoms reimpacting the surface on the nightside stick most probably to it and are desorbed into the exosphere when the Sun rises on Mercury's surface.

Leblanc and Johnson (2003) neglected any diffusion inside the regolith of the newly reabsorbed population of Na atoms on the nightside and therefore supposed that process of evaporation in the morning was only dependent on the surface temperature. We are now investigating the potential role of the diffusion inside the regolith at sunset and sunrise. At sunset, surface temperature is cooler than subsurface temperature, therefore sodium atoms diffuse downward. At sunrise, the surface temperature is warmer than the temperature below the surface and therefore sodium atoms diffuse upward. Diffusion can induce a delay of the release to exosphere of sodium trapped in the subsurface and can therefore modify the dynamics of Mercury's sodium exosphere.

References: Chase et al. Icarus, 28:655, 1976 - Hale and Hapke, Icarus, 156, 318, 2002 - Leblanc and Johnson, Icarus, 164, 261, 2003.