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Time-evolving model for the exosphere of Mercury with rotating surface

A. Mura, S Orsini, A Milillo, and V Mangano
IAPS, INAF, Rome, Italy (alessandro.mura@ifsi-roma.inaf.it)

Here we study the short-time and yearly variations of the sodium exosphere of Mercury. Exospheric sodium comes from release processes occurring at the planetary surface, such as thermal- or photonstimulated desorption. The amount of surface sodium which is available for release, however, is limited. Such loss processes deplete the surface concentration of sodium, which is continuously refilled by diffusion from the interior of regolith grains or by chemical sputtering. Ejected sodium particles may either escape the gravity, also thanks to the radiation pressure acceleration, or be photoionized, or fall back onto the surface. Falling particles may either stick to the surface or bounce. A Montecarlo model, simulating all these processes, is used to obtain the exosphere densities, the global lossrates at different true anomaly angles, and typical timescales for small-term variations, taking into account planet's orbit and rotation speed. We compare this model with either ground- and spacebased observations of the sodium exosphere and tail to evaluate the effectiveness of each source process. We focus on the recent MESSENGER observation of the Sodium and Calcium tail. We find that including a source process which effectiveness is proportional to the precipitation of solar wind protons, such as chemical sputtering, is necessary to explain most of the available observations in both qualitative and quantitative way. We find that, to reproduce dawndusk asymmetries, we need to include the rotation of Mercury's surface in the model. After finding the correct model parameter by calibrating the model with observation, we simulate the short-term and yearly variations of sodium.