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Mercury's exospheric model for SPIDER

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The propagation of Solar events and the response of planetary environment is a fundamental area of interest in the study of the solar system, object of several models and tools for data analysis. In the framework of the starting Europlanet-2024 program, the Virtual Activity (VA) SPIDER (Sun-Planet Interactions Digital Environment on Request) aims a publicly available and sophisticated services, in order to model planetary environments and solar wind interactions. One of these services is focused on the prototype for the model of the Mercury exosphere, in particular to study its exospheric density and the solar wind precipitation to the surface. Mercury is a unique case in the solar system: absence of an atmosphere and the weakness of the intrinsic magnetic field. The Hermean exosphere is continuously eroded and refilled by interactions with plasma and surface, so the environment is considered as a single, unified system – surface- exosphere-magnetosphere. The study of the generation mechanisms, the compositions and the configuration of the Hermean exosphere will provide crucial insight in the planet status and evolution.

The MESSENGER/NASA mission visited Mercury in the period 2008-2015, adding a consistent amount of data but a global description of planet's exosphere is still not available; the ESA BepiColombo mission will study Mercury orbiting around the planet from 2025. For this reason, it is important to have a modelling tool ready for interpreting observational data and testing different hypothesis on release mechanism. Considering different generation and loss mechanisms, we present a Monte Carlo three-dimensional model of the Hermean exosphere, that considers all the major sources and loss mechanisms. In fact, this numerical model includes among the processes responsible of the formation of such an exosphere the ion sputtering (IS), the thermal desorption (TD), the photon-stimulated desorption (PSD) and micro-meteoroids impact vaporization (MMIV) from the planetary surface. The model calculates the trajectories of ejected particles from which we obtain the spatial and energy distributions of atmospheric particles. Furthermore, an analytical model is obtained by fitting the numerical data with parametric functions. In this way, it is possible to model the exosphere of Mercury for each source separately and we can investigate the role of each physical source independently of the others.

Here we present the web-based interface of the model and the functionalities of this infrastructure that is being implemented in SPIDER. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149.