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A New Hermean Magnetic Field Model using a Modified Equivalent Source Dipole Method

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Mercury is the only terrestrial planet, besides the Earth, that has a core dynamo which generates a global magnetic field. MESSENGER orbited Mercury from 2011 to 2015 and provided magnetic measurements which convey crucial information on the magnetic field environment of the planet. We use a local method based on Equivalent Source Dipole approach to model the internal field of Mercury. The method is especially well suited when measurements cover a limited fraction of the planet's surface. Dipoles are placed deep into the planet. Note that with this modeling scheme, we do not attempt to explicitly model the external field. As the planet is in spin-orbit resonance completing three sidereal days in two years, it takes three sidereal days (one solar day) for the Sun to cover all local longitudes. We therefore consider successive periods of one solar day. A dominantly axisymmetric field is found for each solar-day model showing a significant temporal variability. This could be due to some large-scale external field that appears as internal with respect to the spacecraft orbit. The changing altitude and latitude coverage of each model may also be invoked for this variability. We finally compute a 8-solar-day model, including all solar days during the MESSENGER mission, to describe the Hermean magnetic field. Maps of the field computed at 200 km altitude show a magnetic equator at 16°N latitude, and confirm the large-scale and close-to-axisymmetry structure of the internal magnetic field of Mercury. Our model is also in agreement with the magnetic equator crossings detected before. However, our magnetic equator latitude varies with the altitude to the planet. This is indicative that the dipole-offset hypothesis is over-simplified, and that dynamo modelers have to consider alternative models when attempting to model the Hermean dynamo.