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Modeling the magnetic field of Mercury using the Time Dependent Equivalent Source Dipole method

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We introduce the Time Dependent Equivalent Source Dipole (TD-ESD) method developed with the purpose of modeling the Hermean magnetic field. It takes into account the partial orbital coverage provided by MErcury Surface, Space ENvironment, Geochemistry, and Ranging (MESSENGER) mission. The TD-ESD method is based on the Equivalent Source Dipole approach, which has been largely used to downward or upward continue to constant altitude measurements of magnetic fields of crustal origin, on local or global scale. In this present application to Mercury, for which an internal core field is expected, the dipoles are uniformly distributed at a spherical surface placed deep into the planet's interior. Both their magnitude and directions are not a priori imposed and are free to evolve with time. Using synthetic data generated at MESSENGER orbit positions we successfully recover the three components of the magnetic field. We also recover the temporal variation that we a priori imposed. We find that downward and upward continuation is possible over a certain limited region. The resulting field is within 6% of the initial field for altitudes ranging between -100km and 1500km. Here we present the first constant altitude magnetic field maps derived from MESSENGER measurements acquired during the first mercury's solar day. We identify a strong time dependent signature of the external magnetic field, even when only measurements over the northern hemisphere below $\sim$1000 km altitude are used. A future improvement of the method will consist in the simultaneous analysis of the external and internal magnetic fields.