A New Magnetic Field Model for Core-Motion Studies

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We report on the construction of a new time-dependent model of the field at the core-mantle boundary constructed from past measurements of the magnetic field from the global network of magnetic observatories, satellite data and land and marine survey measurements. The model is specifically designed for use in studies of the fluid motion at the top of the core under the idealisation of the core of the earth as a perfect conductor, commonly termed the "frozen-flux" approximation. This approximation leads to several constraints on allowable changes in the morphology of the radial field at the CMB. Null-flux patches, namely areas of flux of the same sign, must retain their topology over time, and the total flux linked by the patch must be invariant. Additionally, under the approximation of an insulating mantle and magnetostrophic force balance at the top of the core, the radial planetary vorticity must be conserved by the patches. We have succeeded in constructing a new time-dependent model of the core magnetic field based on global historical measurements, which has the same topology of null-flux patches as a model for 2000, and which conserves the above invariants. The methodology employs a spherical triangle tesselation of the sphere, with nodes derived from the bi- and trisections of the regular icosahedron inscribed in the sphere. The model is expanded in linear B-splines in time. Solutions are sought using an iterative Newton-type method, with bounds placed on the parameters in order to ensure the correct topology is retained. We expect the model we find to be useful for the self-consistent derivation of models of core motions under the frozen-flux approximation.