SEPARATION OF CORE AND CRUSTAL MAGNETIC FIELD SOURCES

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Fluid motions in the electrically conducting core and magnetized crustal rocks are the two major sources of the magnetic field observed on or slightly above the Earth's surface. The exact separation of these two contributions is not possible without imnposing a priori assumptions about the internal source distribution. Nonetheless models like these have been developed for hundreds of years (Halley, 1692; Gauss, 1838). Gauss' method, least-squares analysis with a truncated spherical harmonic expansion, has been the method of choice for more than 100 years although he did not address separation of core and crustal sources, but rather internal versus external ones. Using some arbitrary criterion for appropriate truncation level, we now extrapolate downward core field models through the (approximately) insulating mantle. Unfortunately our view can change dramatically depending on the degree of truncation for describing core sources.

Core sources cannot be uniquely determined even if we have error-free data everywhere and know all we need about the crust. There is still an infinite collection of electric currents consistent with the observations. One way to by-pass this inherent ambiguity, both for such idealized data or more realistic measurements, is to ask for the model which is, in some well-defined sense, the most simple one. It might be smallest or perhaps most like some other model which we favor.

The harmonic spline technique for constructing some kinds of smoothest models has already been discussed (Shure, Parker and Backus, 1982; Parker and Shure, 1982). We present here a preliminary harmonic spline model for 1980 based on a 4180-data subset of quiet Magsat vector measurements and compare this model to GSFC 9/80, a model representative of many produced by more traditional methods using the Magsat data. The spline model represents the core sources and is chosen so that the rms radial magnetic field at the core surface is nearly minimized. Several criteria are used to compare these two models mentioned including power spectra at both the core and surface, the distribution of null-flux curves at the core-mantle boundary (places where the radial field is zero) and the flux through these patches. We find there are 9 patches for the spline model while there are 11 for GSFC 9/80 which also appear more contorted. Finally the patch fluxes for the spline model are smaller than for the equivalent regions for GSFC 9/80 in spite of both models fitting the data equally well. These null-flux curves and patch integrals are used for making inferences about convection in the core and it is therefore important to estimate them and their associated errors correctly.

References

Gauss, C.F., 1838. Allgemeine Theorie des Erdmagnetismus, In: Resultate magn. Verein.

Halley, E., 1692, An account of the cause of the change of the variation of the magnetic needle, with an hypothesis of the structure of the earth, Phil. Trans., 563ff.

Parker, R.L. and L. Shure, 1982. Efficient modeling of the Earth's magnetic field with harmonic splines, Geophys. Res. Lettrs. 9, 812-815.

Shure, L., R.L. Parker and G.E. Backus, 1982. Harmonic splines for geomagnetic modeling, PEPI 28, 215-229.