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Global evolution of the Earth's magnetic field during the Holocene

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Archaeomagnetic and palaeomagnetic data suggest significant variations of the geomagnetic field during the Holocene. The field intensity exhibits particularly strong changes including its decrease of about 30% during the last 300 years. Archaeomagnetic jerks, characterized by intensity peaks and changes to the sense of secular variation appear to be contemporaneous with global climatic changes. The structure and dynamics of the underlying processes in the Earth's core, however, remain elusive so far.

We present an analysis of archaeomagnetic, palaeomagnetic, and historic field data in order to obtain a spherical harmonic geomagnetic field model up to degree five for the Holocene period. This is accomplished by a Bayesian inversion technique, which minimizes the total variational power at the core-mantle boundary under data constraints. The inversion equation is linear, easy to apply and very stable with respect to changes in the input parameters. Furthermore, since our inversion method leads to a unique solution and is very fast, it allows for a detailed statistical investigation of the influence of data uncertainties by using a bootstrap type statistical analysis. Data sets comprising full vector, directional, but also pure intensity data are used. It is shown that data selection significantly affects the resulting characteristics of the model. In particular lake sedimentary data appear to contribute significant bias. As the inversion works reliably even on a smaller base of good data, we carefully selected the input data to include only the most trustworthy. The obtained model of field morphology indicates that most significant changes of the magnetic field vector, in particular archaeomagnetic jerks, are related to the dynamics of equatorial magnetic flux patches

at the core mantle boundary. The predictive character of a global field model allows reconstruction of field evolutions of direction and intensity in time for any location and thus provides a powerful aid for archaeomagnetic dating.