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Combining archeomagnetic and historical data to create a global magnetic field model of the Earth over the last 1000 years

Robin Senftleben[1], Monika Korte[1], Chris Finlay[2]

[1] Helmholtz Zentrum Potsdam, Deutsches GeoForschungsZentrum GFZ, Telegrafenberg, 14473 Potsdam, Germany

[2] DTU SPACE, National Space Institute, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark

Global geomagnetic field models on different time scales are useful tools to study the field evolution and gain insights into underlying processes in the Earth's outer core. However, historical full vector field data are only available from 1840 on, and millennial scale field models based on archeo- and paleomagnetic data in general have rather low temporal and spatial resolution.

This study aims to complement the high resolution data of historical sources with archeomagnetic data to first expand the time range back to 1000 AD and second add total magnetic field informations in the times from 1590 AD to 1840 AD. This makes it possible to constrain the first Gauss coefficient, which represents the axial dipol moment, with actual observations and not with a linear extrapolation, like in the gufm1 model spanning the past 400 years (Jackson et al. 2000). The resulting model will be used to study details of the decaying behaviour of the dipol moment and the development of the South Atlantic Anomaly.

In order to deal with the very uneven data distribution and to take account of uncertainties in the data we apply regularizations, which allow for a smooth and simple model that still represents the data. In other words, we try to fit the data just within their uncertainty estimates, or trade off a good fit to the data against a smooth model that does not show artificial structure. Consistent weighting of all considered data is crucial to obtain a reliable model this way. Taking data uncertainties and data distribution as they are published and available, the resulting model shows unrealistic characteristics. This concerns, e.g., the dipole moment between 1590 and 1840 because of the high amount of directional historical data and the comparatively much higher error of the low number of archeomagnetic intensity data in that time interval. The effect can be compensated by increasing the weighting of the intensity data.

Moreover, because of big differences in data count throughout the whole timespan of the model, time dependent damping parameters, which control the strength of the regularizations, are needed to get a reasonable result. This also can be achieved by adjusting the weighting of different data subsets. The weighting was chosen so that the spatial complexity of the model would be similar to the gufm1 model.

Here, we present strategies to adequately address the weighting of the all parts of the highly inhomogeneous data set in order to derive a reliable model of past field evolution. We present a preliminary preferred model and discuss differences seen in comparison to other available models like gufm1 or published millennial scale field models.