Institut für Geophysik

Geophysikalisches Kolloquium
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Dynamo constraints on the long-term evolution of Earth's magnetic field strength

Elucidating the processes in the liquid core that have produced observed changes in geomagnetic field intensity over the last 3.5 billion years is crucial for understanding the dynamics and evolution of Earth's deep interior. Here we combine geodynamo simulations with theoretical scaling laws and thermal history models of long-term (Gyr) core evolution to investigate the variation of Earth's magnetic field strength over geological time. We first compare the field strength within the dynamo region and on the outer boundary (considered as the core-mantle boundary, CMB) between a suite of 314 dynamo simulations and two power-based theoretical scaling laws. The scaling laws are both based on a Quasi-Geostropic (QG) force balance at leading-order and a Magnetic, Archimedian, and Coriolis (MAC) balance at first order and differ in treating the characteristic lengthscale of the convection as fixed (QG-MAC-fixed) or determined as part of the solution (QG-MAC-free). When the dataset is filtered to retain only simulations with magnetic to kinetic energy ratios greater than at least two we find that the internal field, RMS CMB field and dipole CMB field exhibit power-law behaviour that is compatible with both scalings within uncertainties arising from different heating modes and boundary conditions. However, while the extrapolated intensity based on the QG-MAC-free scaling matches Earth's modern CMB field, the QG-MAC-fixed prediction is too high and significantly overestimates paleointensities over the last 3.5 Gyrs.

We combine the QG-MAC-free scaling with outputs from 275 thermal history models (selected to span uncertainties in the main input parameters) to construct synthetic true dipole moment (TDM) curves spanning the last 3.5 Gyrs. Best-fitting TDMs reproduce binned data from the PINT database during the Bruhnes and before inner core nucleation within observational uncertainties, but PINT does not contain the predicted strong increase and subsequent high TDMs during the early stages of inner core growth. The best-fitting models are obtained for a present-day CMB heat flow of 11-16 TW, increasing to 17-22 TW 4 billion years ago, and predict a minimum TDM at inner core nucleation.

Das Kolloquium findet um **16Uhrc.t.** als Zoom-Videokonferenz statt. Der Link dazu wird auf der Homepage und per eMail rechtzeitig mitgeteilt.
Alle an dem Thema Interessierten sind hierzu herzlich eingeladen.

Die Dozenten des Instituts für Geophysik