



Progress towards the adjoint dynamo problem

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Data assimilation is a powerful tool for understanding the evolution of a time-varying physical system. For example, it can be used to determine properties of control parameters or initial conditions. This method is widely applied in environmental science, meteorology and seismology. A most important aspect of the analysis involves deriving and computing the adjoint model.

In the geodynamo problem, governing the evolution of the Earth's magnetic field, the material properties of the core are assumed homogeneous and known, and therefore our interest is in determining the initial 3-D magnetic field configuration. In this system, constraints are provided by a wide spectrum of observations, from very accurate satellite data recorded over the last few decades, to archeomagnetic observations over the last ten thousand years.

As an initial study, we created a mathematical framework and the corresponding numerical algorithm for computing the adjoint of the magnetic induction equation and applied it to the inversions of a kinematic dynamo model and a 3-D nonlinear toy model. We analyse the dependency of the results on factors such as the magnetic Reynolds number and the length of the assimilated observational time window.