Geophysical Research Abstracts
Vol. 17, EGU2015-4120, 2015
EGU General Assembly 2015

Torsional waves operating in geodynamo and magnetoconvection simulations

Robert Teed (1), Chris Jones (2), and Steve Tobias (2)

(1) DAMTP, University of Cambridge, Cambridge, United Kingdom (R.J.Teed@damtp.cam.ac.uk), (2) Dept. of Applied Mathematics, University of Leeds, Leeds, United Kingdom

Torsional waves are a principal feature of the dynamics of the fluid outer core where the Earth's magnetic field is generated. These oscillations are Alfvén waves operating about an equilibrium known as a Taylor state (Taylor, 1963) and they propagate in the cylindrical radial direction. The change in core angular momentum inferred from geomagnetic observations has a measurable impact on the length of the day, and the small decadal variations in the length-of-day signal confirm the existence of torsional oscillations (Holme & de Viron, 2013). Many questions remain unanswered about the exact nature of these waves and this presentation will attempt to address some of these.

In order to gain insight we perform three-dimensional spherical dynamo and magnetoconvection simulations in parameter regimes where Earth-like magnetic fields are produced. Many of our simulations produce the desired torsional oscillations, identified by their movement at the correct Alfvén speed, and several show Earth-like core travel times of around 4 years.

Our dynamo simulations (Teed et al., 2014) show torsional waves within the tangent cylinder region that also have the ability to pass through this theoretical cylinder. By calculating the driving terms for these waves we find that both the Reynolds force and ageostrophic convection acting through the Lorentz force can be important in driving torsional oscillations.

Driven by a desire to reach smaller Ekman numbers and larger magnetic field strengths, which are computationally unattainable in dynamo simulations, we perform, in our follow up work, magnetoconvection simulations (Teed et al., 2015) by imposing a dipolar field on the core-mantle boundary. Under this configuration we find a transition, at low Ekman numbers, to regimes where excitation is found only at the tangent cylinder, is delivered by the Lorentz force and gives rise to a periodic Earth-like wave pattern. This pattern is approximately operating on a 4 to 5 year timescale, similar to the 6 year period expected of the waves in the Earth.

References

Holme, R. & de Viron, O., 2013. Characterization and implications of intradecadal variations in length of day. *Nature* **499** (7457), 202–204.

Taylor, J., 1963. The magneto-hydrodynamics of a rotating fluid and the Earth's dynamo problem. *Proc. Roy. Soc. A* **274**, 274–283.

Teed, R., Jones, C., Tobias, S., 2014. The dynamics and excitation of torsional waves in geodynamo simulations. *Geophys. J. Int.* **196** (2), 724–735.

Teed, R., Jones, C., Tobias, S., 2015. The transition to Earth-like torsional oscillations in magnetoconvection simulations. *Submitted*