Geophysical Research Abstracts
Vol. 15, EGU2013-14246-1, 2013
EGU General Assembly 2013

High frequency variations of the main magnetic field: convergence of observations and theory (Petrus Peregrinus Medal Lecture)

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Understanding the main magnetic field variations has been hindered by the discrepancy between the periods (from months to years) of the simplest linear wave phenomena and the relatively long time intervals (10 to 100 years) over which magnetic field changes can be confidently monitored.

A theoretical description of short-period waves within the Earth's fluid core is at hand. Quasi-geostrophic inertial waves (akin to Rossby waves in the atmosphere) are slightly modified in the presence of magnetic fields and torsional oscillations consist of differential motion between coaxial rigid cylindrical annuli. Torsional oscillations are sensitive to the whole magnetic field that they shear in the course of their propagation. From their modelling, we have thus gained an estimate for the magnetic field strength in the core interior.

There is now ongoing work to extend the theoretical framework to longer times. Furthermore, data collected from the Swarm constellation of three satellites to be launched this year by ESA will permit to better separate the internal and external magnetic signals. We may thus dream to detect quasi-geostrophic inertial waves. As the spectral ranges of theoretical models and observations begin to overlap, we can now go beyond the understanding of the magnetic field variations as the juxtaposition of partial models, arranged as a set of nested Matryoshka dolls. This talk will give illustrations for this statement, among which the question of induction in the lower mantle.