Geophysical Research Abstracts
Vol. 12, EGU2010-15509, 2010
EGU General Assembly 2010

Gravitational driving of inner core super-rotation

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The traditional driving mechanism invoked to explain the super-rotation of the inner core, whether steady or time-dependent, involves visco-electromagnetic stresses by core flows at the inner core boundary (ICB). Gravitational coupling of the inner core with the mantle then acts to impede the rate of inner core rotation. However, gravitational coupling can act as the driving mechanism for a super-rotating inner core if there are azimuthal variations in heat flux at the ICB. In this scenario, inner core growth would not be axially symmetric and, provided the resulting inner core topography is misaligned with the mantle gravitational potential, a gravitational torque would drive a rotation of the inner core. A steady pattern of heat flux at the ICB would result in a steady rate of inner core rotation, whereas time-dependent variations in the amplitude and pattern of heat flux would lead to inner core oscillations. In this work, we explore the possible rates of inner core rotation that can be achieved in such a dynamical scenario. We show that for typical growth rates, maximum rotation rates smaller than 0.0001 deg/yr are expected. This is clearly too small to explain some of the inner core rotation rates inferred seismically. However, an inner core steadily rotating at such rate would complete a full rotation in 3 million years. Thus, the inner core would not remain aligned with the mantle over geologically long timescales. This may pose a problem for explaining the hemispherical differences in seismic anisotropy of the inner core on the basis of a steady but axially varying heat flux at the ICB.