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Symmetry, Zonation and Scales in the Earth-core flow and their effect on the Length-of-Day variation predictions.

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By combining direct numerical simulations and core-flow inversion from geomagnetic secular variations, we show that in order to explain length-of-day variations, a core flow inversion should not damp small scales and allow quasi-geostrophic as well as anti-symmetric flows, and finaly that a mostly zonal flow is plausible.

The secular variation of the magnetic field of the Earth is due to the flow of liquid metal advecting the magnetic field inside the Earth's core. A large number of studies has focused on inference of the core surface flow from geomagnetic field data, recorded by dedicated satellites, and by magnetic observatories scattered at the Earth surface. Recently, it has been advocated that Quasi-Geostrophic (QG) flows should give a good description of the flow in the core, and kinematic properties of this type of flows have already been used to constrain the core surface flow inferred from magnetic field data to be tangentially geostrophic, symmetric with respect to the equator and purely azimuthal at the rim of the tangent cylinder.

Still, some unclear points persist, and our study tries to shed some light on three of them :

- The QG hypothesis has been justified for asymptotically small slopes, and the question arises as to its validity in the vicinity of the equator of both inner core and core-mantle boundary. For example, the flow that crosses the equator line under the Indian ocean (southward) and Brazil (northward), referred in studies where the tangential geostrophy of flows was not imposed, could not be captured by a QG model, which imposes a purely azimuthal flow at the equator.
- Even though the global amount of equatorial symmetry of surface core flow has been gradually increasing with time during the period 1840-2010, no analysis has been made to identify which are the symmetric features that can be associated to QG dynamics.
- Recent efforts have been made to also describe small scale flows, taking into account their contribution to large-scale secular variation by advecting an unknown small scale geomagnetic field. However, these small scales seem to be too poorly constrained and no useful information has been obtained from them. A possible effect of underparametrization of core flow models due to strong regularizations is the overestimation of decade length of day variations in most studies. We investigate the possibility that this may be due to aliasing of small scales to large scales, by comparing estimations when using different regularizations.