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Quasi-geostrophic thermal convection and zonal flows in the outer core.

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Highly developped regimes of thermal convection in a rapidly rotating sphere are still very difficult to compute and analyse. Most of the numerical dynamos models of the geodynamo are based on convective flows but the Rayleigh number is generally kept not very far from the onset of convection according to available computational resources as fully developped regimes of thermal convection need very fine grids and small time steps. Here, we develop a new numerical model where the velocity field is computed on the equatorial plane using a quasi geostrophic approximation while the heat equation (and the induction equation) is solved in the spherical domain. This approach is particularly powerful to compute thermal convection for low (magnetic) Prandtl number and our results agree with 3D numerical calculation of Jones et al (2000) and Zhang et al (1994) at the onset.

We have perfomed calculations for $E = 10^{-8}$, Pr = 0.01 and Ra = 50 Ra_c. The flow is then made of Rossby waves interacting with vortices and large azymuthal flows. Non linear mixing of potential vorticity lead to strong zonal flows which dissipate the kinetic energy of the flow in the Ekman layers. We observe many jets (until 5) with prograde zonal jets at the center of the sphere (where the convection is less active) and in the outer part (with a necklace of spiralling Rossby waves). Some prelimanry kinematic dynamo calculations have also been performed.

Keywords: thermal convection, dynamos, zonal flows