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Zonal flow accelerations in a quasi-geostrophic model of magneto-convection

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Combined magnetic field and length-of-day observations have confirmed the presence of rigid azimuthal oscillations of co-axial cylindrical surfaces at decadal timescale in the Earth's core. It remains unclear whether these motions are the signature of free modes (i.e. torsional oscillations), or rigid accelerations forced by the underlying convective dynamics in the core, or a combination of the two. If they are forced accelerations, they must result from an evolving torque balance on cylinders in the core. The driving torque can be of two origins: either from Reynolds or Magnetic stresses. In this work, we investigate the role of these two processes in a numerical model of magneto-convection. Convective core flows are modeled on a two-dimensional equatorial-plane grid following the assumption of quasi-geostrophy. These flows are powered by thermal forcing, also
specified on a 2D grid. We impose a background magnetic field
(representing the dynamo generated field) on which the flow acts,
leading to a Lorentz force feeding back on the flow. We follow the evolution of the magnetic field on a 3D spherical grid. This set up allows us to reach a small Ekman number and small magnetic Prandtl number regime. The goal of this study is to determine whether convective eddies participate in the zonal flow accelerations directly through the mean Reynolds stresses they generate, or only through the shearing and advective action they have on the magnetic field and which then leads to a Lorentz torque.