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Magnetic-Coriolis waves in convection-driven dynamos: Implications for geomagnetic westward drift

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A prominent feature of the geomagnetic secular variation is the westward motion of the non-dipole part of the field, which is significant in the Atlantic hemisphere with timescales of a few hundred years. Potential mechanisms to account for longitudinal geomagnetic drifts are advection due to large-scale zonal flows in the Earth's core as well as propagation of rotating magnetohydrodynamic (MHD) waves, particularly of slow Magnetic-Coriolis (MC) Rossby waves. More commonly the westward motion is thought to reflect zonal flow advection, an assumption that is used when inverting the secular variation signal for the flow at the top of the core. However, recent geodynamo simulations have successfully reproduced longitudinal magnetic drifts and some authors reported that the drift is at least partly a wave propagation.

To assess to what extent waves could play a role in geomagnetic drift, we explore nonlinear simulations of convection-driven MHD dynamos in rotating spherical shells. By performing a tempo-spatial spectral analysis of simulation data, we identify a slow MC-Rossby mode, that follows the dispersion curve predicted by a quasi-geostrophic linear theory. The result indicates that such waves can be excited in the planetary fluid core and that wave propagation may indeed play a role in the magnetic drifts. This gives a framework for further exploration of different wave types, which can provide valuable information about the physical properties in the deep interior fluid core.