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Gyre-driven decay of the geomagnetic dipole

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Direct observations show that the magnitude of the Earth's magnetic dipole has steadily decayed over the past 170 years; it is now more than 10% weaker than it was 1840. Here, we explore the possibility that a planetary scale gyre in the outer core, previously revealed by core flow inversions, plays an important role in dipole decay with its meridional arms simultaneously transporting reversed flux poleward and strong normal flux equatorward. We present simple kinematic experiments that demonstrate the basic mechanism together with results from frozen-flux, quasi-geostrophic, core flow inversions that display similar characteristics. Moving to a more realistic scenario, we present initial investigations of dipole decay in a 3D, convection-driven, numerical dynamo with an Earth-like magnetic Reynolds number. This allows for the evolution of the magnetic field by both advection and diffusion processes. The numerical dynamo model studied naturally generates a planetary scale quasi-geostrophic gyre (Aubert et al., 2013) and is initialized to be in a state consistent with the observed core surface magnetic field (Aubert, 2014). We find that this system can reproduce the general characteristics of current dipole decay episode, and that advection by the planetary scale gyre plays an important role.

References

Aubert, J., Finlay, C. C., Fournier, A. (2013) Bottom-up control of geomagnetic secular variation by the Earth‘s inner core, Nature 502, 219-223, 2013, doi: 10.1038/nature12574.

Aubert, J. (2014) Earth‘s core internal dynamics 1840-2010 imaged by inverse geodynamo modelling, Geophys. J. Int. 197, 1321-1334, 2014, doi: 10.1093/gji/ggu064.