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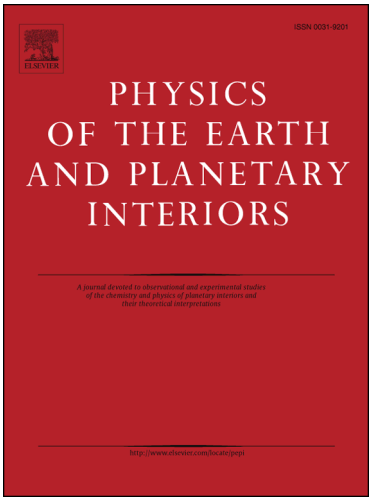

The reversed and normal flux contributions to axial dipole decay for 1880-2015

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The reversed and normal flux contributions to axial dipole decay for 1880-2015

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Abstract

The axial dipole component of Earth's internal magnetic field has been weakening since at least 1840, an effect widely believed to be attributed to the evolution of reversed flux patches (RFPs). These are regions on the core-mantle boundary (CMB) where the sign of radial flux deviates from that of the dominant sign of hemispheric radial flux. We study dipole change over the past 135 years using the field models gufm1, COV-OBS.x1 and CHAOS-6; we examine the impact of the choice of magnetic equator on the identification of reversed flux, the contribution of reversed and normal flux to axial dipole decay, and how reversed and normal field evolution has influenced the axial dipole. We show that a magnetic equator defined as a null-flux curve of the magnetic field truncated at spherical harmonic degree 3 allows us to robustly identify reversed flux, which we demonstrate is a feature of at least degree 4 or 5. Additionally, our results indicate that the evolution of reversed flux accounts for approximately two-thirds of the decay of the axial dipole, while one third of the decay is attributed to the evolution of the normal field. We find that the decay of the axial dipole over the 20th century is associated with both the expansion and poleward migration of reversed flux. In contrast to this centennial evolution, changes in the structure of secular variation since epoch 2000 indicate that poleward migration currently plays a much reduced role in the ongoing dipole decay.

Keywords: geomagnetism, axial dipole, reversed flux patches, secular variation, magnetic equator

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