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The geomagnetic secular-variation timescale in observations and numerical dynamo models

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The knowledge of the spatial power spectra R_n of the main geomagnetic field and Q_n of its secular variation makes it possible to define typical timescales $\tau_n = (R_n/Q_n)^{1/2}$ for each spherical harmonic degree n. Investigating both observations and numerical dynamo models, we test the relevance of a one-parameter law of the form $\tau_n = \tau_{\mathrm{SV}}/n$ in contrast to a two-parameter law of the form $\tau_n = \alpha \times n^{\gamma}$. We show that the one-parameter law is satisfied for the non-dipole field, given the statistical way the observed τ_n are expected to fluctuate, and moreover well-suited to describe the intrinsic behaviour of a dynamo. For recent satellite field models, we thus find a value $\tau_{\mathrm{SV}} \approx 470 \pm^{90}_{65}$ yr, when considering degrees $n = 3$ to 10. Given the agreement found between instantaneous and time-averaged estimates of τ_{SV} in numerical dynamos, we expect the above figure to be appropriate to describe the dynamics of the geomagnetic field on timescales much longer than that of the historical record. The secular-variation timescale τ_{SV} has already been used in systematic studies to estimate typical quantities of the Earth's dynamo. In the broader context of geomagnetic data assimilation, and under the assumption that the Earth and a given numerical dynamo share the same asymptotic behaviour as regards the secular-variation timescales, τ_{SV} could provide a sensible and convenient means to rescale the time axis of dynamo simulations.