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Model Jerks: Insights from Observations and Synthetic Fields

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The geomagnetic field is generated by the constant motion of the fluid outer core and varies on timescales from months to millions of years. Geomagnetic jerks are rapid changes in the secular variation of Earth's magnetic field, attributed primarily to changing flows near the surface of the outer core. Various generation mechanisms have been suggested for these rapid changes but none have conclusively explained the phenomena. Jerks can be seen in magnetic observatory records over the last 170 years and in satellite data of the last 15 years. This data coverage, spatially limited and/or temporally restricted, makes it difficult to interpret the true character of jerks at the surface or their origins in the core. This leads us to investigate what further insight we can gain from synthetic magnetic fields such as those which are described by modelling stochastic processes. Such fields are not restricted by the temporal smoothing of most magnetic field models and can better represent rapid variations such as jerks.

We compare the characteristics of the synthetic fields with those of observatory and satellite data and hence, finding great similarity, study the presence of jerks in stochastic synthetic fields. Synthetic jerks are seen which resemble observed jerks, occurring frequently with regional periodic variations in amplitudes. These synthetic jerks occur without related features in the large scale secular acceleration power at the core-mantle boundary. The flexible spatial and temporal sampling of the models creates a means of validating the robustness of observed features in the real field, which suffer from limited sampling. Results suggest that the distribution of magnetic observatories is sufficient to accurately recover the large scale features of jerks. As such comparisons between jerks seen in observatory and satellite data may be drawn. We further investigate the spectral properties of jerks in the synthetic fields using spherical harmonic analysis with a view to assessing possible dynamic patterns responsible for jerk features. Such insights could help to interpret the core flows inferred from high-resolution SWARM data to understand the generation process behind jerks.