Detection of jerk-like magnetic field variation in a numerical dynamo model using wavelet analysis

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Geomagnetic jerk is known as a sudden change in the trend of geomagnetic secular variation, which typically occurs in annual timescale. A conventional and direct way to identify jerks is by looking for V- or \Lambda-shaped changes in the slope of the secular variation of a field component at observatories. Instead, to find geomagnetic jerks, Alexandrescu et al. (1995) applied wavelet analysis to geomagnetic field data obtained at ground observatories in Europe. They detected geomagnetic jerks in 1901, 1913, 1925, 1969 and 1978, and showed that regularity of the magnetic field variation is about 1.5 rather than 2.

Although dynamo action in the Earth’s core should generate such a singular variation, physical mechanisms responsible for jerks are still unknown. In this respect, numerical dynamo modeling could be useful, because all information within the core relating magnetic field variations can be obtained. However, magnetic field variation in dynamo models occurs more slowly compared with the geomagnetic secular variation probably due to assumed values of the fluid viscosity very far from that in the Earth’s core. Therefore, it is not evident that any jerk-like fast magnetic field variation can be observed in numerical dynamo models. In this study, we report results of our attempt to detect jerk-like magnetic field variation in a numerical dynamo model using wavelet analysis. The Ekman number of the model is 3×10^{-5}, which is not the state-of-the-art but comparatively small, giving a good starting point.

Brief summary of the results is as follows: (1) Jerk-like magnetic field variation is detected in all of the three components; (2) Regularity of such variations is typically larger than 2; (3) Jerk-like variation occurs both globally and locally. Relevance of the present results to the geomagnetic jerk and relation to the internal dynamics are discussed based on these findings.

Keywords: Geomagnetic jerk, Dynamo, Wavelet analysis