On short-period dynamics in the Earth's core based on ground observations of geomagnetic jerks

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Geomagnetic jerks are relatively sharp (V-shaped or Λ-shaped) changes in the rate of secular variations of one (usually eastern) or several components of the Earth's magnetic field.

When performing these studies, we used data from the registration of the geomagnetic field at the Budkov (49.08° N, 14.02° E), Belsk (51.84° N, 20.79° E), Borok (58.03° N, 38.14° E) observatories and the Geomagnetic Adolf Schmidt Observatory Niemegk (52.07° N, 12.68° E). To calculate the first derivatives of the geomagnetic field components, we used the results of instrumental observations of the geomagnetic field from 2004 to 2020.

Segmented regression analysis is used as a method for calculating the slope of the first derivative of the secular variation and its changes. To determine the location of breakpoints, i.e. change in the slope of the first derivative of the secular variation (in our case, the geomagnetic jerk), the global optimization problem was solved using the differential evolution algorithm (it is the most successful stochastic method for global optimization of functions of real variables).

The method proposed made it possible to identify the geomagnetic jerks in 2007 (June 2007), 2011 (October 2011), 2014 (January 2015), and 2017 (March 2018). Difficulties in identifying the jerks of 2011 and 2014 in the northern and vertical components of the geomagnetic field are likely due to the fact that years close to the solar maximum are more noisy due to external effects compared to the years of solar minimum.

To interpret the experimental results, which showed that jerks follow with a quasi-period of 3-4 years, a mechanism for the occurrence of rapid changes in the geomagnetic field, due to unstable processes in the Earth's core, is proposed.