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Analysis of structure causal sources of the Main Earth's Magnetic Field and its secular variations according to The World Magnetic Model

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Models of the Main Earth's magnetic field and its secular variations are constructed by decomposition of the magnetic potential into a series of spherical functions based on the compilation of observational data of the world network observatories, orbital, aeromagnetic, surface and hydro-magnetic surveys, for example: the world magnetic model (WDM, 12 degree), international geomagnetic field (IGRF, 13 degree), enhanced magnetic model (EMM, 790 degree).

However, spherical harmonic analysis itself is not a good tool for analyzing the structure of sources of global magnetic anomalies. In this work a set of 14 magnetic dipoles with seven unknown parameters (magnetic moment, the three coordinates of the center of the dipole and three guides of the cosine of the vector the axis of the dipole) was used as approximation model of the main Earth's magnetic field. The world Magnetic Model (WDM) developed jointly by the National center for environmental information (NCEI, USA) and the British geological survey (BGS) was used as reference data for global magnetic anomalies. The search for a solution was carried out by minimizing the composed function

$$\mu(m_{d_1},..,m_{d_m},\vec{r}_1,..,\vec{r}_m,\vec{p}_1,..,\vec{p}_m)=\sum_{k=1}^{n}\left|\vec{w}_k^{\text{ext}}-\sum_{j}^{m}\vec{w}_{k,j}^{\text{int}}\right|^2, \quad (1)$$

where:

m_{d_i} – magnetic moments of dipoles;

$\vec{p}_{ß}$ – direction vectors of the axes of the dipoles;

$\vec{w}_k^{\text{ext}}$ – the gradient of the magnetic potential according to WMM;

$\vec{w}_{k,j}^{\text{int}}$ – the gradient of the magnetic potential of the j-th dipole at the k-th observation point;

Search for solutions was carried out for three magnetic epochs separated by a 50-year time interval (1918, 1968 and 2018). As a result, the character of the variations of each dipole for 100 years was obtained, and some sources demonstrate stability and can be explained by several current systems in the outer core of the Earth.

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