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Analysis of the magnetic storms and variations of the geomagnetic field components at the Pleshchenitsy Observatory, Republic of Belarus

Ihar A. Saladukhin[1] , Genady A. Aronov , Arkady G. Aronov , Valiantsina M. Laziuk , Larisa L. Pustoshilo

[1] Центр геофизического мониторинга Национальной академии наук Беларуси, Беларусь

saladukhin@cgm.by

The effects of the coronal mass ejections and high-speed solar wind streams mostly manifested during magnetic storms can give rise to several negative consequences for the realization of the space and land technologies [1, 2]. In the first case, these may be an influence upon the ionosphere resulting in the short-wave radio blackout, malfunctions of the radio communication systems, navigation system errors, as well as a direct impact upon satellites (surface charges and currents, electronic system failures, etc.) In the second case, these are the induction effects developed in the power lines, products pipe lines, communication cables that cause a risk of the power and communication systems damage. In this context, the study of the causes, periodicity and nature of magnetic storms is considered to be an actual problem.

The Pleshchenitsy Geophysical Observatory was created in 1958 at a specially equipped site 65 km distant from Minsk for research on the state of the geomagnetic field and seismic activity. The observatory is currently a part of the Center of Geophysical Monitoring of the National Academy of Sciences of Belarus. Continuous observations of the geomagnetic field elements such as the magnetic declination D, horizontal H and vertical Z components, as well as the full geomagnetic field vector modulus F, have been carried out since 1960. Starting from 1970 the data obtained at the Pleshchenitsy Observatory have been used to analyze the magnetic storms and to divide them into 4 classes in accordance with an established scale.

50 magnetic storms were recorded and processed in 2023, which is 11 storms less than their number recorded in 2022 (61). Nevertheless, this is 1.5 times more than the average long-term value (33.3) for the previous 53 years (1970-2022) which is indicative of a remaining high degree of the geomagnetic field perturbation in the last year. An analysis of the number of magnetic storms is compared with the solar activity in four adjacent 11-year cycles. Long-term variations in the magnetic storm number show that the periods of their reduction are replaced by the periods of their increase. At the same time, the maxima of their number do not coincide with the maxima of the Wolf numbers W, but are shifted towards a drop in the solar activity, which is consistent with the reference data [3, 4].

The data of observations of the average annual values of the magnetic field components in 2023 were as follow: D = 9.395°, H = 17742 nT, Z = 48395 nT, F = 51545 nT. The paper presents an analysis of the nature of change of the Earth's magnetic field elements D, H, Z, F in Belarus for the period from 1960 to 2023. So, a significant increase in the magnetic declination D was revealed: the average secular variation is 4′14″ per year, while it averaged 8′36″ per year over the past 10 years. The average annual value F of the total geomagnetic field vector modulus also showed a clear tendency to increase (from 49621 to 51545 nT) for the specified period. This may be due to the continuing displacement of the Earth's magnetic poles [5, 6].

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