

Coherent Analysis of Intense Geomagnetic Disturbances Using Dusheti Observatory Data

Luka Tsulukidze^{a,b}, Oleg Kharshiladze^{a,b}, Aleksandre Gurchumelia^b,

Luca Sorriso-Valvo^{c,d}, Khatuna Elbakidze^{b,e}, Tamaz Matiashvili^b

e-mail: luka.tsulukidze617@ens.tsu.edu.ge

^a Ivane Javakhishvili Tbilisi State University, Faculty of Exact and Natural Sciences 0128, I. Chavchavadze Avenue 1, Tbilisi, Georgia

^b Mikheil Nodia Institute of Geophysics, Aleksidze str.1 Tbilisi, Georgia

^c CNR - Istituto per la Scienza e la Tecnologia dei Plasmi, Bari, Italy

^d KTH - Space and Plasma Physics, Stockholm, Sweden

^e Business and Technology University, Tbilisi, Georgia

Geomagnetic storms are intense disturbances in Earth's magnetosphere that can disrupt technological systems and impact human health. This study investigates the dynamics of solar-terrestrial interactions using data from the Dusheti Observatory and global geomagnetic indices. We examined the relationships between the interplanetary magnetic field (IMF), sunspot numbers, and the H-component of the geomagnetic field during the period from 2023 to 2024, focusing on the unprecedented geomagnetic storm of May 11, 2024. Through wavelet coherence and cross-correlation analyses, we identified significant interactions between solar and geomagnetic activity, with coherence patterns emerging well before the storm onset. The analysis of six solar cycles (1964–2024) revealed correlation at lag of 5 days, highlighting the potential predictive utility of sunspot numbers. This study also validated the reliability of local geomagnetic data, emphasizing its importance for understanding the regional manifestations of global geomagnetic events in Georgia. The findings contribute to the development of improved predictive models for geomagnetic disturbances and underscore the need for localized studies to better mitigate the risks associated with space weather.

References

- [1] Tsulukidze, L. K., Kharshiladze, O. A., Ghurchumelia, A. P., Sorriso-Valvo, L., Elbakidze, K. Z., & Matiashvili, T. G. (2024). Coherent Analysis of Intense Geomagnetic Disturbances Using Dusheti Observatory Data and the DST Index. *Journals of Georgian Geophysical Society*, 27(2).
- [2] Diaz, Jordi. "Monitoring March 2024 solar and geomagnetic storm using broad-band seismometers." 2024
- [3] Breus T. K., Halberg F., Cornelissen G. Biological effects of solar activity. *Biofizika*. 1995. 40, 737—749
- [4] Torrence C. Compo G.P. A practical guide to wavelet analysis, *Bulletin of the American Meteorological Society*, 1998. vol. 79, no. 1, pp. 61–78