Electric Fields Estimation from the Solar Storm of May 2024 Using an Updated Lithospheric Resistivity Model of the Iberian Peninsula

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Summary

During heightened solar activity, anomalous electric fields are induced within the Earth, generating Geomagnetically Induced Currents (GICs) that affect electrical distribution networks, even in moderate latitudes.

The estimation of induced electric fields, which generate GICs, relies on a deep understanding of the region's lithospheric resistivity distribution. In our efforts to improve the electrical resistivity models of the Iberian Peninsula, we have recently gathered new long-period magnetotelluric (MT) data from areas where the previous models needed more information. We enhanced our existing prior model through three-dimensional inversion techniques including this new data, and addressed data gaps in previously underexplored areas.

For the solar storm of May 2024, we modeled the induced electric fields using the model impedances (Z) and the measured geomagnetic fields (B). In regions where, direct measurements of B were not available, we employed the Spherical Elementary Currents Systems (SECS) method. This method allowed us to estimate B by extrapolating data from magnetic observatories to the targeted areas, a crucial step in assessing the magnitude and distribution of GICs across the region. The results of our induced electric field modeling have been incorporated into preliminary hazard maps, which help classify regions based on the intensity and direction of induced electric fields during severe solar events. These maps are valuable tools for evaluating and designing infrastructure to withstand this phenomenon's impacts.

Keywords: Geomagnetically Induced Currents, lithospheric resistivity model, magnetotelluric, electric hazard map