Consequences of severe Space Weather events

ROMAN LEONHARDT AND RACHEL BAILEY

Organisation(en):

Zentralanstalt für Meteorlogie und Geodynamik, Hohe Warte 38, 1190 Wien

Abstract

«Space weather" refers to the state of near-Earth space and the upper atmosphere of the Earth. Space weather events are mainly related to solar activity. Solar coronal mass ejections, high-speed solar wind streams and solar energetic particles result in most geo-effective space weather phenomena. Examples are induced density variations in the thermosphere, which lead to drops in spacecraft orbits and accelerated particles that increase radiation levels at commercial flight altitudes. Coronal mass ejections strongly affect the Earth's magnetic field and cause rapid field variations, termed «geomagnetic storms". This is followed by a chain of electromagnetic induction processes in the surface and atmosphere that induce direct currents in the electrically conductive networks at the surface, such as the power transmission networks. Larger currents can damage individual transformers and cause large-scale transmission problems in the network.

These geomagnetic storms are permanently monitored at several stations in Austria. The Zentralanstalt für Meteorologie und Geodynamik (ZAMG) maintains the Conrad Observatory, which covers all geophysical disciplines. The geomagnetic part of the observatory is certified by the international INTERMAGNET network for global geomagnetic observation. They provide high quality real-time geomagnetic data to the World Data Centers. In close collaboration with the Austrian Power Grid (APG) operators, the expected geomagnetically-induced currents within the power lines are determined in real-time and the hazard potential is quantified. A major aim is to better protect power transmission systems and enhanced prediction time for expected disturbances.

Space weather events have only been intensively researched for around 30 years. It was shown that, in the past, solar storms that would have had a devastating impact on today's technical infrastructure have occurred. The repetition rate of such events is largely unknown. Due to the impact of space weather on the steadily increasing air traffic and on more widespread critical infrastructure such as power grids or satellite navigation, the importance of space weather is still underestimated.

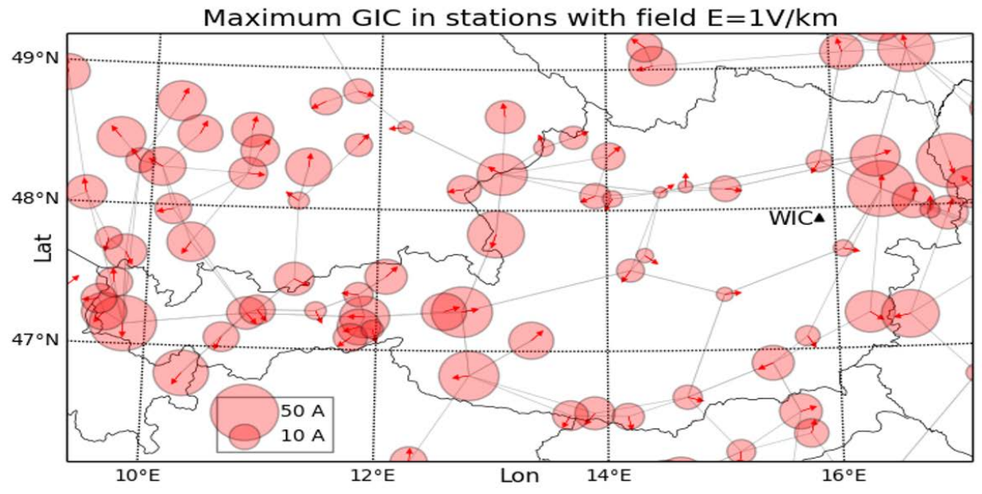

Fig. 1: Expected maximum geomagnetically induced currents (GIC) within the Austrian power transmission network during a severe geomagetic storm. All orientations of a geoelectric field with magnitude 1 V km –1 were investigated. Each circle represents a node, and the line connections between nodes are shown in grey. The size of the circle represents the magnitude of GICs, while the arrows depict the geoelectric field orientation that leads to a maximum at that node. The position of the Conrad Observatory (WIC) is marked by the black triangle (Bailey et al., 2017).