Abstracts

Comparison of three approaches for the simulation of the geoelectric field induced by space weather events in Fennoscandia

Elena Marshalko (1,2,3), Mikhail Kruglyakov (1, 4), Alexey Kuvshinov (1), Liisa Juusola (5)

(1) Institute of Geophysics, ETH Zürich, Switzerland; (2) Institute of Physics of the Earth, Moscow, Russia; (3) Geophysical Center, Moscow, Russia; (4) Geoelectromagnetic Research Center, Institute of Physics of the Earth, Moscow, Russia; (5) Finnish Meteorological Institute, Finland

Large eruptions from the solar corona release massive amounts of plasma, which flow into interplanetary space at a high speed. The interaction of the plasma flow with the Earth's magnetosphere leads to the intensification of the geomagnetic field. According to the principle of electromagnetic induction, this field induces the so-called geomagnetically induced currents in the earth and ground-based technological systems (power grids, pipelines, railway systems, etc.).

To estimate the potential hazard to these systems from the space weather events, it is necessary to understand the spatiotemporal evolution of the geoelectric field. Once the geoelectric field is quantitively estimated, the geomagnetically induced currents can be calculated from the geometry of transmission lines and system design parameters.

In this work we present the first-ever comparison of three approaches to the geoelectric field simulation in Fennoscandia. In the first two approaches the source is represented by a laterally varying sheet current flowing above the Earth. Specifically, within the first approach the the source is computed on the basis of a 3-D magnetohydrodynamic simulation of the geospace; the source in the second approach is constructed by applying the SECS method to magnetic field data from the IMAGE observatories. The third approach is the impedance-based one, in which the local plane wave concept is used. We perform these simulations for the Fennoscandian region by using a realistic 3-D conductivity model (SMAP). The geoelectric field induced by these three sources is computed using a 3-D EM forward modelling code PGIEM2G which is based on a contracting integral equation method. We compare modelling results to EM field observations and discuss advantages and disadvantages of the considered approaches.