Temporal and spatial variability of space weather driven telluric fields in Northwestern Russia

D. Epishkin1, V. Pilipenko2,3, E. Sokolova2, Ya. Sakharov4, N. Yagova2, and V. Selivanov4

1”Nord-West” Ltd, Moscow, Russia, dmitri\_epishkin@mail.ru

2 Institute of Physics of the Earth, Moscow, Russia

3 Geophysical Center, Moscow, Russia

4 Polar Geophysical Institute, Apatity, Russia

Magnetic storms and substorms have a potential to cause serious failures of space and ground technological systems. The investigations of space weather effects at high latitude are of great importance for mitigation possible risks connected with threats to electric power supply infrastructure caused by geomagnetically induced currents (GICs). The potential difference due to telluric fields is responsible for GICs in grounded electric power systems. Monitoring of the geomagnetic field variations are carried out by world-wide array of magnetometers, while regular long-term observations of GICs and telluric electric fields still are not so common and need more consolidated efforts.

We present the first results of the analyses of temporal and spatial variability of telluric electric fields in the eastern Fennoscandia and their comparison with available GIC measurement in electric power grids. We calculated “synthetic” telluric fields from the IMAGE geomagnetic records via the impedance relationship (plane wave approximation of the external field). The information on impedance tensors is provided by the deep electromagnetic array BEAR performed over the Shield. We also use some magnetotelluric data from sites in the North-western Russia.

The elaborated algorithm of telluric E(t) field synthesis for a geomagnetic field variations H(t) uses standard frequency domain relationship between electric and magnetic fields via the complex impedance tensor Z(f). The Fourier transform is applied for magnetic records in a running time window W(Ƭ) to produce a set of spectral estimates of H(f) and corresponding spectral estimates of telluric field E(f)= Z(f)\*H(f). Inverse Fourier transform performed for each running window results in estimation of E(Ƭ+dt(i), i=0,n), where dt(i) is a time shift from the beginning of the record. Thus for a specific moment of time we have several electric field estimates, which are averaged to get final synthetic electric field time series E(t). The program was successfully tested on the synthetic magnetic and electric fields of COMDAT project. The preliminary results include:

(a) the analyses of E-field variations (intensity and polarization) at several sites for selected space weather events: magnetic storm, substorm, and Pi3 pulsations.

(b) analyses of induced telluric field dependence on the local geoelecrical structure: comparison of E-field disturbances for several sites with contrasting geoelectric parameters in Eastern Fennoscandian Shield with its complicated deep conductivity pattern: from resistive Archaean domains to conductive Palaeoproterozoic mobile belt (Lake Ladoga conductivity anomaly);

(c) The modelling results have been compared with observations of the system to monitor GIC in electric power lines deployed at Kola Peninsula and Karelia by the Polar Geophysical Institute and Center for Physical and Technical Problems of North's Energetic. The E-fields synthesized from data of IMAGE stations via local impedances have been compared with GIC measurements at nearest sites.

**Keywords:** synthesis of telluric fields, Eastern Fennoscandian Shield, GIC, space weather

**Acknowledgements:** We acknowledge the data from IMAGE array, BEAR project, and support by grant № 16-17-00121 from the Russian Science Foundation and grant №16-05-00543 from the Russian Foundation for Basic Research.

DOI: 10.13140/RG.2.2.19665.38242