Multi-site transfer function approach for real-time simulations of the ground electric field induced by laterally-nonuniform ionospheric source.

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SUMMARY

We propose a novel approach to model the ground electric field (GEF) induced by laterally-nonuniform ionospheric sources in real-time. It exploits a) the concept of multi-site transfer function that relates the GEF at any location with horizontal magnetic field at (fixed) multiple locations with observations, b) synchronous magnetic field measurements at multiple sites in the region of interest, c) conductivity model of the region of interest, and d) spatial modes describing the equivalent source behavior. The use of only the horizontal components of the observed magnetic field and avoidance of the source determination allow us to improve the simulations' accuracy in comparison with our previous studies, where source was also described by some spatial modes. At the same time, the computational costs are identical and allow to perform real-time simulations for GEF and/or GICs.

Using Fennoscandia as an example region, we perform simulations for 4 space weather events in 2000, 2001, 2003, and 2005 and compare the available observed time series of the GEF and/or GICs for the corresponding events with simulated time series. Good agreement (the correlation coefficient is 0.9 and larger, coefficient of determination is 0.8 and larger) between observed and modeled results validates the methodology.

Keywords: Numerical simulations, 3-D conductivity, Non-uniform source, Ground electric field, Geomagnetically induced currents