Simulation of Geomagnetically Induced Electric Field Originating from Field-Aligned Current

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Solar wind has a large impact on the Earth's magnetosphere. When the solar wind with southward Interplanetary Magnetic Fields (IMF) comes, magnetic storms and substorms occur in the near-Earth space. Due to this change in the space environment, field-aligned current (FAC) generated in the magnetosphere flows into the ionosphere. In addition to FAC, the magnetspheric and ionospheric currents induce geomagnetically induced electric field (GIE) on the surface of the Earth. GIE generates geomagnetically induced current (GIC) flowing in the conducting electrical wires. GIC causes severe damages on our life. In 1989, for example, large amplitude GIC flowed in the province of Quebec, Canada, and interrupted electric services over nine hours. The purpose of our study is to understand the relationship between the ionospheric current and GIE. Here, We focused on GIE in the polar region, and conducted finite-difference time-domain (FDTD) simulations. We used the 3-dimensional model that contains the ionosphere, the atmosphere, land and/or sea. We set FAC and Pedersen current as current sources. In order to evaluate the validity of our simulation, we used the Häkkinen method. This method calculates the electromagnetic field induced on the surface in frequency domain. We compared the electromagnetic field calculated by FDTD simulation with the one by the Häkkinen method. We will investigate the simulation results in future for a better understanding and modeling of GIC.

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