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Amplification of induced current due to complicated resistivity structure in the earth

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Abrupt changes of geomagnetic field can make large induced electric current on the earth, and yield damages to pipelines, cables and other architectures. For understanding the phenomena and future risks, explorations of sub-surface resistivity structure are necessary because the heterogeneous resistivity structure in the crust and mantle amplifies the induced electrical current locally. The hazard prediction based on the homogeneous earth may result in the under-estimation. Here, I introduce possible cases of induced current near the coastal areas, based on two-dimensional (2D) and three-dimensional (3D) earth structure including the sea layer. My study is based on the numerical forward calculation of induced electric field in the earth. The former case comes from 2D forward simulation. In this case, the straightly elongated coastal line is assumed, and various sub-surface and sub-seafloor resistivity structures are imposed. The numerical results suggest that the amplitude of induced current becomes about 6 times larger than the homogeneous earth without the sea layer. The width of affected land zone is about 20 km from the coast line. In the second case, the 3D forward modeling is employed to express the complicated coastal line and bathymetry. As a result, the amplitude goes double at the cape zones. These phenomena come from the boundary charge along the coastal area. I conclude that electrical structure around the coast line (not only below the land, but also below the seafloor) should be focused for the huge induce current.

Keywords: Geomagnetic field, Induced current, Land-Ocean interaction, resistiivty