Estimation of electrical conducitivity in the mantle transition zone by using the Sq source model GAIA

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We've tried to estimate the electrical conductivity of the mantle structure by using the Sq variation derived from the GAIA (Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy). From the late 19th century, many paper have reported the vertical structure of the electrical conductivity in the Earth by using magnetic field data, and recently, some paper also reported the three-dimensional structure of the conductivity in the subsurface or the global Earth. MT methods suppose the plane-wave assumption and it can be adapted
in the period below about 10,000 sec. On the other hand, the Dst or ring current source in the magnetosphere is notable in the period over 100,000 sec, and geomagnetic P10 source assumption may be valid. Between 10,000 and 100,000 sec, however, it is well known that Sq field is dominant, and that has complex source distribution and we must consider the complexity of the spatial pattern of the source as well as the electrical conductivity in the Earth. In order to detect the details of the source field, we need a lot of observation on the Earth. We, however, have only a couple of hundreds geomagnetic stations at the most so far, and thus we can know geomagnetic components in a long spatial length, which is only up to spherical harmonic degree, say, 10-15 at the most. Very recently, some paper reported trial of the usability of the satellite data, but they are not well done to estimate the electrical conductivity so far. Therefore we try another approach. We use the well-modelled Sq field as the inducing field, GAIA, which is developed by upper atmosphere researchers in Japan. GAIA is based on fluid dynamics, photo-chemistry
and electromagnetics, combining atmospherere model, ionosphere model, and electro daynamics model which are developed separatedly.
First we executed spherical harmonic expansion of GAIA magnetic field
of GAIA for 3 day time series up to 20, which correspond to three sequent solar quiet days. And then, three-dimensional forward modeling in the spherical coordinate was executed in the frequency domain. Now, we
suppose the 1-D structure in the Earth under the ocean-land lateral contrast. As the results, the calculated geomagnetic data inversely converted to the time domain could be closer to the observed data, compared to the GAIA Sq field itself, that is, total of RMS data misfit at 71 stations decreases by 40%.
Next, we try to find the best fit 1-D model in the mantle. We suppose the basic 1-D model as the standard model by Baba (2017) in the northwest Pacific. We also try other models which are more conductive and less
conductive, and as the results, the original model by Baba (2017) is almost the best to explain the vertical magnetic field data of Sq, and slightly more conductive model may be the very best.

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