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Development of Ionospheric Tomography Using Neural Network

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In order to investigate the dynamics of ionospheric phenomena, an estimation of three-dimensional ionospheric electron density distribution is effective. Recently, GPS occultation observations by satellites can provide a global profile of ionosphere. However, satellite observations have an essential difficulty in discrimination in time and space. Therefore, in addition to the occultation observation, continuous ground-based GPS observation will be required to investigate ionospheric physics. In the past, various algorithms for ionospheric tomography have been proposed. In this paper, the Residual Minimization Training Neural Network (RMTNN) tomographic approach is selected (Ma et al., 2005). TEC data with location and altitude derived by ground based GPS receivers and ionosonde are used for the developed method. This approach has an advantage in reconstruction with sparse data.

However, Ma et al., (2005) have demonstrated few results in specific conditions and they did not provide the general performance. Therefore, we validate the performance of reconstruction in the case of disturbed period and sparse data by the simulation and/or real data in this paper.

At first, in order to examine the effectiveness of the method for disturbed conditions, a simple plasma bubble model is investigated. The reconstructed image agrees well with plasma bubble model, and it suggests the high capability of RMTNN method for the disturbed ionosphere.

Then, we checked the RMTNN method for the Sumatra region, Indonesia as a sparse data case. It is found that the reconstruction indicates a good agreement with the model data except below 250 km altitudes. In order to improve these difficulties, information on electron density at the lower ionosphere (100 km altitude) by NeQuick model for restriction is used. As a result, the proposed method shows a great improvement in estimation of densities at lower altitudes below 250 km.