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Development of neural network based ionospheric tomography and application to actual data under several conditions

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Three-dimensional ionospheric tomography is effective for investigation of the dynamics of ionospheric phenomena. Especially, to understand the anomalous and/or irregular ionospheric structure, model-free and robust tomographic technique is important. However, it is an ill posed problem in the context of sparse data, and accurate electron density reconstruction is difficult. The Residual Minimization Training Neural Network (RMTNN) tomographic approach, a multilayer neural network trained by minimizing an objective function, allows reconstruction of sparse data. Moreover, the method is not required the initial ionospheric distributions (in other words, model-free method).

In this study, we validate the reconstruction performance of the developed algorithm using numerical simulation and actual data under various ionospheric conditions. Then we apply it to the practical data observed in March 2011, Japan (before the 2011 off the Pacific coast of Tohoku earthquake, Mw 9.0). As for the Tohoku earthquake, the significant enhancements are found in Total Electron Content (TEC) investigation, 1, 3-4 days prior to the earthquake. Especially, TEC increase of 3 days prior to the earthquake was remarkable. As a result, the reconstructed distribution of electron density was enhanced in sub-ionosphere to over F-region in comparison with 15 days backward median distribution. Moreover the enhanced area is seems to be developed to upper ionosphere from sub-ionosphere with time. The tomographic results suggest the existence of some energy influx from the surface associated with seismic activity. Details will be shown in the presentation.

Keywords: Ionospheric tomography, Neural network, GPS