

Development of real-time three-dimensional GPS-TEC tomography

SUZUKI, Shota^{1*} ; YAMAMOTO, Mamoru¹ ; CHEN, Chieh-hung⁴ ; SAITO, Susumu² ; SEEMALA, Gopi¹ ; SAITO, Akinori³

¹Research Institute for Sustainable Humanosphere, Kyoto University, ²Department of Geophysics, Graduate School of Science, Kyoto University, ³Navigation Systems Department, Electronic Navigation Research Institute, ⁴Department of Earth and Environmental Sciences, National Chung Cheng University, Taiwan

Recently, a new three-dimensional GPS ionospheric tomography technique is developed which uses total electron content (TEC) data from the dense GPS receiver network, GPS Earth Observation Network (GEONET) in Japan. It uses the least squares fitting method constrained by the spatial gradient, and does not require an ionospheric model as the initial guess that could bias the reconstruction of electron density. But it refers to the NeQuick model to determine constrained parameters. The purpose of this study is to develop this technique and incorporate into the real-time GPS-TEC monitoring system. First we increase the computation speed by using a sparse matrix algorithm when solving the least squares fitting method. Programmed with Python, it takes less than 5 minutes to calculate a tomography by using 1.7GHz Intel Core i7. We could also improve the stability of the calculation. Furthermore we try to find a new method for determining the constrained parameters by analyzing a large amount data. As the tomography uses absolute TEC, it is necessarily to estimate instrumental delay bias which is originated in the hardware of the GPS satellite and receiver. We develop the bias estimation procedure that uses RINEX-OBS data of the previous day. Organizing these parts, we develop a system to conduct three-dimensional tomography analysis in the real-time basis.

Keywords: GEONET, TEC, tomography, sparse matrix, real-time system