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Realtime three-dimensional tomography of the ionosphere over Japan based on GEONET GPS-TEC

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ABSTRACT

Measurement of ionospheric total electron content (TEC) by using the ground-based GPS receivers is now widely used. We refer to it as GPS-TEC. As there are always several GPS satellites available for the measurement, it is a very good tool for constant monitoring of the ionosphere. One of the most dense and wide network of the GPS network is GEONET (GNSS Earth observation network system) operated by Geospatial Information Authority of Japan (GSI). This is the network of more than 1300 stations over Japan. We have been developing 3D tomography of the ionospheric plasma density from the GEONET data [1]. This tomography technique uses a constrained least squares fit to reconstruct the electron density distributions. Advantage of this technique is that we do not need to refer to the ionospheric density model like IRI before starting the tomography analysis. There is a report that this tomography technique can resolve ionospheric perturbations of 200 km wavelength [2].

Recently we further develop the software system to conduct the tomography analysis in the real-time basis. GEONET real-time data of every second are available at Electronic Navigation Research Institute (ENRI) in Tokyo. The data has been used to show horizontal distribution of TEC fluctuations since 2013. This system aimed detection of medium-scale TID. So the system just concentrated on TEC fluctuations, and the 2D TEC mapping was generated about 3 minutes after the data acquisition. (We should note that real-time data are limited from 200 stations.) Our new system depends on this 2D real-time monitoring, and designed as shown in Figure 1. We acquire the real-time GPS-TEC data through data server at every 30 s, and generate 2D mapping of absolute and fluctuation of TEC. Estimation of satellite and receiver biases for the true TEC measurement are done at every one hour. The 3D tomography reconstruction of the ionosphere is then conducted at every 15 minutes, and the results are obtained with latency of 10 minutes or less. The software system is implemented on a LINUX PC by using Python language with popular modules. We tested all

functions of the software, and the results are reasonably good. We will start the real-time monitoring by the end of March 2016. In the presentation, we will report design, performance of the software system. Also we will show earlier experience from this real-time 3D monitoring of the ionosphere.

Key words: GPS-TEC. 3D tomography, GEONET, Real-time monitor of ionosphere

References:

[1] Gopi K. Seemala, Mamoru Yamamoto, Akinori Saito and Chia-Hung Chen (2014) Three-dimensional GPS ionospheric tomography over Japan using constrained least squares, J. Geophys. Res. Space Phys., 119, 3044-3052, doi:10.1002/2013JA019582.

[2] C. H. Chen, A. Saito, C. H. Lin, M. Yamamoto, S. Suzuki and G. K. Seemala (2016) Medium-scale traveling ionospheric disturbances by three?dimensional ionospheric GPS tomography, Earth Planets and Space, 68:32, doi:10.1186/s40623-016-0412-6.

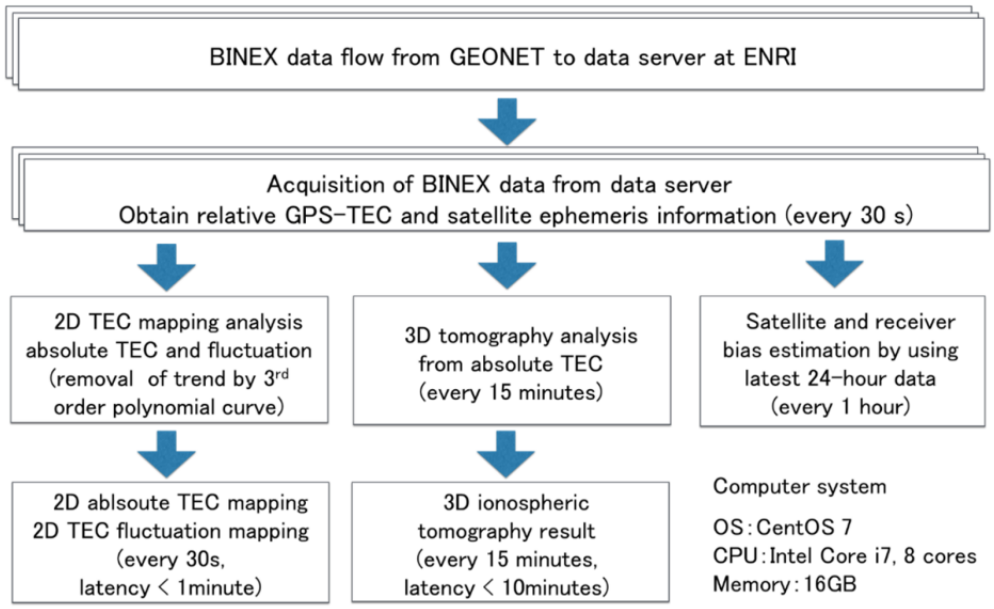

Figure 1: Design of real-time 3D ionosphere monitoring system with GEONET GPS-TEC.