# Real-time 3-D Ionospheric Tomography and Its Validation by the MU Radar

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Ionospheric tomography is a technique to reconstruct ionospheric density profiles from various measurements. We have developed a real-time 3-D ionospheric tomography system over Japan by using total electron contents (TECs) derived from dual-frequency Global Navigation Satellite System (GNSS) signals measured by 200 receivers of GEONET over Japan [1]. The algorithm of the tomography is a constrained least-squares [2, 3]. The real-time 3-D tomography system has been running since March 2016 and produces 3-D ionospheric density profiles over Japan every 15 minutes with a latency of 6 minutes.

The reconstructed ionospheric density profiles are shown to be generally in agreement with the foF2 values measured by ionosondes. However, we also see that the foF2 values estimated by the 3-D tomography are not always in good agreement with those observed by ionosondes depending on season, local time, and location. Furthermore, foF2 represents the ionospheric peak density, which is just one of the values to characterize the ionospheric density profile.

The Middle-and-Upper (MU) radar located at Shigaraki (34.85ºN, 136.1ºE), Japan is an MST radar operating at 46.5 MHz with a peak power of 1 MW. It is also capable of incoherent scatter (IS) measurements to derive electron density profiles. To evaluate the performance of the 3-D tomography in terms of the F region peak height and shapes of the electron density profile, the 3-D tomography results are compared with the MU radar IS measurements. 127 electron density profiles (with an integration period of 1 hour) of the MU radar IS measurements from May 2016 to September 2017 are used.

Temporal variations of the electron density measured by the MU radar are well followed by the 3-D tomography. Top-side and bottom-side profiles tend to be well represented by the 3-D tomography when the peak density and heights are well represented. However, the F region peak heights are sometimes overestimated, especially when the peak height is low. For seasonal variation, better agreement is obtained in the data in May, but more discrepancies in the data in November. These are possibly due to the constraint conditions used in the tomographic reconstruction, and is under investigation by examining the constraint conditions, which will also be reported at the meeting.

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