

Ionospheric space weather studies for GNSS users

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NICT has observed ionosphere using Ionosondes and GNSS receiver networks in Japan and Southeast Asia for the nowcast and forecast of the ionospheric condition. Two-dimensional ionospheric total electron content (TEC) maps have been derived from dense ground-based GNSS receiver networks and applied to studies of various ionospheric disturbances since mid-1990s. For the purpose of monitoring and researching ionospheric conditions and ionospheric space weather phenomena, we have developed TEC maps over Japan using GEONET. Currently, we are providing high-resolution two-dimensional maps of absolute TEC, detrended TEC, rate of TEC change index (ROTI), and loss-of-lock on GPS signal over Japan in real-time basis.

We have collected all the available GNSS receiver data in the world to expand the TEC observation area. To expand the two-dimensional TEC observation area with high-resolution, we have conducted Dense Regional And Worldwide International GNSS TEC observation (DRAWING-TEC) project, which consists of the three items: (1) standardizing GNSS-TEC data, (2) developing a new high-resolution TEC mapping technique, and (3) sharing the standardized TEC data or the information of GNSS receiver network. One of other effective methods to expand TEC observation area would be to use the maritime GNSS buoys.

NICT have started a new research project to validate the ionospheric effect of precise positioning technique using GNSS including quasi-zenith satellite (QZSS) since 2017. In this project, we will investigate ionospheric effects on individual positioning techniques (single frequency, DGPS, and RTK-PPP) and consider methods to mitigate and/or prevent the positioning errors under severe ionospheric conditions. We have tried to use multi-GNSS data including GPS and QZSS for routine data collection and processing. In the Southeast Asia, it is important to identify which satellite-receiver path suffers from plasma bubble structures for verifying the ionospheric effects on GNSS positioning. We have a plan to install VHF radar at Chumphon (Thailand) and multi-GNSS receivers at Chumphon, Bac Lieu (Vietnam), and Cebu (Philippines) at the magnetic equator.

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