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高解像度 GPS 全電子数観測による電離圏擾乱の研究
Ionospheric disturbances studied by high-resolution GPS total electron content observations

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The Global Positioning System (GPS) is a worldwide precise radio-navigation system formed from a constellation of at least 24 satellites at 20,200 km altitude, 4.2 R_E from the center of the Earth. GPS orbit configuration ensures that 5-10 satellites are visible from any single point on the Earth. The dual-frequency signals from the GPS satellites pass through the ionosphere to reach ground-based GPS stations. The phase and group velocities of radio waves vary in the ionosphere depending on the integrated electron density, that is total electron content (TEC), along the ray path and on the frequency of the radio waves. Using these characteristics, the TEC integrated along the ray path between a GPS satellite and a receiver can be accurately measured using two GPS signals in different frequencies. The TEC strongly reflects variations in the ionosphere at an altitude of about 300 km, where is the peak height of ionospheric electron density.

We have developed high-resolution TEC maps using dense GPS receiver networks. We have been collecting all the available GNSS receiver data in the world to expand the TEC observation area. These GNSS data are provided by IGS, UNAVCO, SOPAC, and other regional data centers. Currently, we are providing global and regional maps of absolute TEC, detrended TEC, and rate of TEC change index (ROTI). These data and quick-look maps are archived and available in DRAWING-TEC website (http://seg-web.nict.go.jp/GPS/DRAWING-TEC/).

These high-resolution GPS-TEC maps have been applied to studies of various ionospheric disturbances. Sudden increase in TEC caused by solar flares were studied using global TEC observations. Regional TEC observations have revealed new characteristics of large- and medium-scale traveling ionospheric disturbances (LSTIDs and MSTIDs). Recently, clear concentric waves and short-period oscillations were observed after huge earthquakes/tsunamis and massive tornadoes, indicating that acoustic and/or gravity waves propagate upward from the lower atmosphere and reach the ionosphere.

In this presentation, we will introduce recent studies of ionospheric disturbances using high-resolution GPS-TEC observations.

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