

Ionospheric-Plasmaspheric Tomography over Japan with Constrained Least-squares Method for GPS-TEC data

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An Ionospheric-plasmaspheric tomography algorithm using the GPS Total Electron Content (TEC) data was developed to reconstruct the plasma density distribution over Japan. The ionosphere is the region from 80km altitude to 1,000km altitude, and the plasmasphere is the region from 1,000km to 20,000km. They contain plasma that made by ionization of the Earth's atmosphere. GPS is a satellite-based navigation system that measures the traveling time of the radio wave between the GPS satellites and the GPS receivers. The propagation of the GPS radio wave makes delay caused by the plasma in the ionosphere and the plasmasphere. GPS can measure the delay and estimate the total amount of the plasma along the radio wave propagation path can be estimated from the GPS data. This total electron content data can provide the information of the plasma density distribution between the GPS satellite and the receiver. The altitude of the GPS satellite orbit is almost the outer edge of the plasmasphere. Therefore the GPS data is suitable to study the plasma distribution in the plasmasphere and the ionosphere. We developed an algorithm to derive the three dimensional distribution of the plasma density over Japan. The GPS data used in this study was measured by a GPS receiver network in Japan, GEONET, which is operated by Geographical Survey Institute, Japan. The density of the GPS receiver is high, and its coverage is wide enough to reconstruct the plasma density with high resolution. GPS receivers are also installed on low-earth orbit (LEO) satellite. The GPS data from the satellite-borne receiver provide TEC between the GPS satellite and LEO satellite. The developed tomography algorithm can include these satellite-satellite TEC data. The plasma density was reconstructed for the case when the equatorial ionization anomaly was enhanced. The reconstructed density structure of the meso-scale plasma density structure was also studied in comparison to the observational data obtained by ionosondes and the MU radar.