A study on the fluctuation of the terrestrial ionosphere for the radio occultation measurements of planetary ionospheres

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We are preparing for the radio occultation measurements of the Martian atmosphere and the lunar ionosphere by using the spacecrafts Nozomi and Selene, respectively. We study the feasibility to detect these planetary ionospheres with the knowledge of the fluctuation of the terrestrial ionosphere. For this purpose, the characteristics of the fluctuation of the terrestrial ionosphere was investigated by using the TEC data obtained by the GPS network. The result indicates that the Martian nightside ionosphere and the lunar ionosphere can be measured if we choose suitable conditions of the terrestrial ionosphere for the measurement and monitor the fluctuation of the terrestrial ionosphere along the ray path of the radio occultation by using the GPS network.

We focus on the fluctuation of the terrestrial ionosphere, which is a serious error source when we try to obtain the information on planetary ionospheres by the radio occultation measurement. We are preparing for the radio occultation measurements of the Martian atmosphere and the lunar ionosphere by using the spacecrafts Nozomi and Selene, respectively. By using the radio occultation method, we can measure the electron densities in planetary ionospheres. The phase of the radio wave transmitted from the spacecraft to the Earth is perturbed when the radio wave passes through the planetary ionosphere. The electron density profile can be derived from the phase perturbation.

The information on the nightside ionosphere of Mars is based on the observations by the Mars 4 and 5 and the Viking orbiter. The detection of the lunar ionosphere by radio occultation technique was reported in the Luna 22 mission. Since the phase shift caused by the fluctuation of the terrestrial ionosphere is comparable with those by the Martian nightside ionosphere and the lunar ionosphere, the detection of these ionospheres is difficult in general. The fluctuation of the terrestrial Total Electron Content (TEC) along the ray path between the spacecraft and the receiving station will be estimated from two coherent signals transmitted from several Global Positioning System (GPS) satellites. We can obtain the TEC information over Japan from the GPS network of the Geographical Survey Institute (GSI) in Japan, GPS Earth Observation Network (GEONET).

The possibility of the detection of the Martian nightside ionosphere and the lunar ionosphere at each local time is investigated for the summer and winter cases by using the TEC data obtained by the GPS network. The result indicates that the Martian nightside ionosphere and the lunar ionosphere can be measured if we choose suitable conditions of the terrestrial ionosphere for the measurement and monitor the fluctuation of the terrestrial ionosphere along the ray path of the radio occultation by using the GPS network.

There are several ways to estimate the TEC fluctuation of the terrestrial ionosphere by using the GPS network. In general, it is difficult to find a GPS satellite-ground receiver pair whose ray path is close to the ray path of the radio occultation measurement of the planetary atmosphere. Therefore, we develop a method to estimate the TEC fluctuation of the terrestrial ionosphere along the ray path of the radio occultation by many GPS satellite-ground receiver pairs. The feasibility of this method is tested by regarding one GPS satellite as the Nozomi or Selene spacecraft. A qualitatively good agreement between the true TEC and the estimated TEC was obtained by this method.