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Plasmaspheric Total Electron Content Variations obtained from GPS Total Electron Content Data

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The International Reference Ionosphere (IRI) model provides Total Electron Content (TEC) in the ionosphere. Recently, Global Navigation Satellite System (GNSS) is widely used to estimate TEC. However, the TEC measured from the GNSS data contain the inter-frequency biases inherent with the satellites and receivers as well as the TEC in the plasmasphere. Otsuka et al. (2002) [1] have developed a method to obtain the ionospheric TEC by subtracting the inter-frequency biases. TEC in the plasmasphere is not considered in this method, but it is known that the plasmaspheric TEC (PTEC) can be 10-50% of the ionospheric TEC. Considering the satellite zenith angle dependence on slant factor that is a factor to convert the slant to vertical TEC, PTEC could be included in the estimated inter-frequency bias. In this study, we have estimated the PTEC variations by using the obtained inter-frequency biases of more than 7,000 GNSS receivers over the world. We have found that the inter-frequency biases of the GNSS receivers at low- and mid-latitudes decrease by 2.9 TECU on average during a magnetic storm on September 8, 2017 with a Dst minimum of -122 nT. The inter-frequency bias decrease could indicate decreases in PTEC during the magnetic storm. In order to validate this hypothesis, we have analyzed PTEC obtained from an integration of the electron density obtained from the plasma wave dynamic spectrum data obtained from High Frequency Analyzer (HFA) [2] on the Arase satellite, and found that the PTEC obtained from Arase satellite shows decreases by approximately 1.1 TECU around 17 UT on September 8. Both the inter-frequency biases and PTEC from Arase satellite show recover during the recovery phase of magnetic storm. These results indicate that by using the inter-frequency biases of GNSS data, we can study the PTEC variations.

References

[1] Otsuka, Y., T. Ogawa, A. Saito, T. Tsugawa, S. Fukao, and S. Miyazaki, A new technique for mapping of total electron content using GPS network in Japan, *Earth, Planets, and Space*, 2002, 54, 63-70, https://doi.org/10.1186/BF03352422

[2] Kumamoto, A., Tsuchiya, F., Kasahara, Y., Kasaba, Y., Kojima, H., Yagitani, S., et al., High Frequency Analyzer (HFA) of Plasma Wave Experiment (PWE) onboard the Arase spacecraft, *Earth Planets and Space*, 2018, 70, 82. https://doi.org/10.1186/s40623-018-0854-0