A study of plasmaspheric electron content variations during a magnetic storm using the GPS total electron content data

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By using dual-frequency Global Positioning System (GPS) data, the value of total electron content (TEC), which is an integration of the electron density along a ray path from satellite to receiver, can be measured. However, the measured TEC contains not only TEC values but also the inter-frequency biases inherent with satellites and receivers. In order to obtain absolute TEC, these biases need to be removed. Previous research (Otsuka et al., 2002) has developed a technique to estimate the absolute TEC using a least square fitting technique with an assumption of a single layer. However, the estimated absolute TEC sometimes shows negative values at equatorial region. This may be caused by the estimation error for the absolute TEC. In the current technique, the plasmasphere is not considered. The plasmaspheric electron content (PEC) could be included in the estimated biases. Therefore, in this study, we have analyzed the bias data obtained from approximately 9,000 receivers in the world to investigate PEC during a magnetic storm on March 17, 2013. The Dst index reached a minimum of -132 nT at 21 UT on March 17, 2013. Ten days' average of bias data during magnetic quiet days on March is calculated as reference value for each receiver to investigate effects of the magnetic storm. Standard deviations of biases during quiet days are used to investigate the stability of biases. The standard deviation of the biases for most of the receivers ranges 0-2 TECU, denoting that the biases are stable for day-to-day variation and that PEC variation during magnetic storm can be investigated. By subtracting reference value from the biases on the day during the magnetic storm, PEC variations at different longitudes and latitudes during the magnetic storm are investigated. The results show that during the main phase of magnetic storm, the PEC, on average, decreased by 1.69 TECU in Japan, by 0.95 TECU in Europe, by 0.77 TECU in Australia and by 0.61 TECU in North America, indicating that the PEC decrease has longitudinal dependence. Most of the PEC recovers during the period from March 18, 2013 to March 20, 2013.

Key words: total electron content; global positioning system; bias; plasmasphere