Estimation of the ionospheric TEC using a single-frequency consumer receiver

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Ionospheric total electron contents (TEC) have been observed using high-density networks of GNSS ground stations. Most of the networks are built in mid latitude regions and it is important to expand them in low latitudes for the global TEC observation. The purpose of this study is to expand TEC observation networks in low latitude regions at low costs using not multi-frequency receivers but single frequency ones.

An estimation method of the ionospheric TEC using single frequency GPS signals was proposed in the former study and its validity was demonstrated by using GEONET data. In the present study, we applied the method to the data acquired by a single frequency receiver for consumer use (u-blox, NEO-7P) and examined estimation accuracy. In the TEC estimation by single frequency signals, a spatial variation model with 1^{st} order polynomial functions is adopted to represent latitudinal and longitudinal TEC distribution. Unknown parameters of the TEC distribution and receiver clock error are estimated by a least squares method from pseudorange observations which are obtained by a GPS receiver at a known position.

Clock oscillator installed in the consumer receiver has a relatively large error compared with that in high-performance receivers. The clock errors can be actually estimated as one of the unknown parameters in the TEC estimation model. In the former studies, only the data from receivers which continuously calibrate their own clock errors were used because the method cannot be applicable to the data from receivers which calibrate their clock errors with their specific intervals. Most of the consumer products are, unfortunately, the latter type. In this study, we have made the TEC estimation method applicable to both data types by calibrating accurate reception time from the receiver clock error with feedback processing. TECs derived from the u-blox data are evaluated by comparing with those from the GEONET data. As a result, there are random time variation with an accuracy of around 10 TECU. These random errors are considered to be removed by a filtering.

Keywords: Ionospheric TEC, Single Frequency Receiver

