Systematic changing and variations of GPS/GLONASS differential code biases

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Along with navigation and precise time applications, Global Navigation Satellite Systems (GNSS) are widely used nowadays to remotely sense the ionosphere in equatorial, mid-latitude and arctic regions. While estimating absolute TEC using the code and phase measurements simultaneously, a satellite and receiver dependent systematic error occurs. This error is associated with differential code biases (DCB) - the different, frequency dependent processing times of L1 and L2 signals in RF paths, both for satellites and receivers. Due to these DCBs, TEC, in some cases, can obtain even non-physical negative values. For example, a 1-ns DCB causes a ~3 TECU error in TEC estimation.

We analyze DCBs dynamics and errors in TEC estimations associated with satellites and receivers DCBs for 2000–2014. For such estimates, we used the CODE laboratory data [ftp://ftp.unibe.ch/aiub/CODE/].

The systematic variability of the TEC estimation errors associated with DCBs, which is about ~1 TECU/year for the GPS satellite and three times greater (~3 TECU/year) for the GLONASS satellite. There are significant variations in TEC errors for GLONASS with amplitude up to ~5 TECU compared to rather small variations for GPS.

Systematic DCBs change both for GLONASS and GPS frequency channels is observed significantly varying depending on station (Fig.1). For the GLONASS and GPS frequency channels, seasonal variations in estimated TEC errors (up to ~20 TECU) associated with DCBs are observed (see. Fig. 1a). Such strong variations could be associated with variations in the receiver environment, especially meteoparameters, such as temperature and humidity. It is not just receiver hardware problems because such variations are not observed for the other receivers of the same type. In Fig. 2a, we show temperature from the weather station next to IRKJ receiver [http://www.ncdc.noaa.gov/cdo-web/]. The maximum of temperature seasonal variation corresponds to the minimum of DCB seasonal variation.

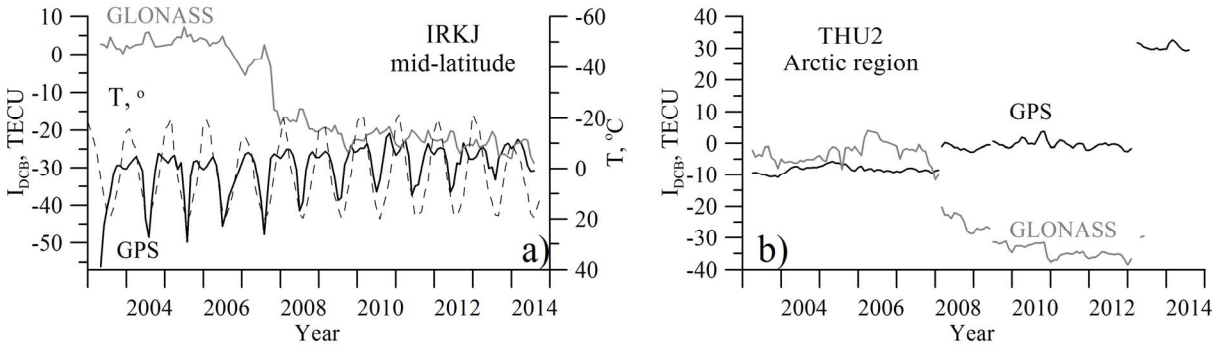

Fig. 1. Dynamics of TEC estimation error caused by DCB of receiver GLONASS (gray line) and GPS (black line) channels: a) - IRKJ station (mid-latitude); b) THU2 station (arctic region). Dashed line marks temperature (°C).