



Comparative Analysis of Differential Code Bias Estimation Techniques for LEO GNSS receivers: Inter-Center Assessment and Methodological Insights

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Low Earth Orbit (LEO) satellites equipped with a GNSS receiver for POD, GNSS-Radio Occultation or GNSS-Reflectometry purposes can be used to monitor ionospheric Total Electron Content (TEC). Depending on the observation geometry, dual frequency GNSS observations can be processed to derive the TEC along the paths followed by the signals from the transmitters to the receiver. This path will be above the LEO or along the limb/nadir direction. TEC products can then be assimilated into ionosphere/space weather numerical models.

One critical factor influencing the accuracy of the inferred absolute TEC is the estimation of transmitter and receiver Differential Code Biases (DCBs), which arise from the different hardware delays experienced by the signals upon transmission and reception. Transmitter DCBs for a wide variety of signal combinations are normally estimated using ground-based GNSS measurements and then distributed operationally by different centres like those belonging to the International GNSS Service (CODE, JPL, CAS, DLR etc). Receiver DCBs, however, must be characterized as part of the TEC estimation process, and several methods and approaches can be adopted for this purpose.

In the framework of NOAA's Space Weather (SpWx) Data Pilot Project on GNSS RO Measurements for Ionospheric products, several months of ionospheric observations performed by commercial Radio Occultation data providers (Spire Global and PlanetiQ) were made available to the SpWx team. The aim of this pilot project was to assess the quality of the observations and the possibility of using them to derive ionospheric products (mainly TECs and scintillations indices) that meet current and anticipated needs of operational space weather models and applications. In the framework of this pilot project, we estimated receivers DCBs and slant TECs from a wide variety of LEO GNSS receivers (flying on-board commercial but also CGMS-coordinated satellites like the EUMETSAT Metops) using different approaches and methodologies and compared the results.

This contribution presents an overview of such comparisons, highlighting the pros and cons of the various approaches, and shows how sensitive to different assumptions the estimation of the receiver DCB can be.