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Positioning performance of the Neustrelitz Total Electron Content Model (NTCM) driven by Galileo ionization coefficients

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GNSS single-frequency applications are affected by the interaction of the radio signals with the free electrons of the ionosphere, introducing range errors of up to 100 m in the L-band. Besides the GPS Klobuchar and the Galileo NeQuick ionospheric models, also the Neustrelitz Total Electron Content Model (NTCM) has been proposed as a practicable solution to mitigate such propagation errors.

In this investigation we present a global statistical validation of the NTCM version driven by Galileo ionization coefficients (NTCM-GlAzpar) by comparing its performance with the performance achieved by the NeQuickG and Klobuchar models in the position domain. For this aim, we used the ESA analysis tool "gLAB" in the Standard Point Positioning (SPP) mode and GNSS data over two different time periods. The first period covers one month of perturbed solar activity (December 2014) and the second period corresponds to a month of quiet conditions (December 2019). We achieved a worldwide coverage with data from up to 73 receivers of the International GNSS Service (IGS).

Our statistical analysis allows us to conclude that the NTCM-GlAzpar model clearly outperforms the results achieved with the Klobuchar model and is slightly better, or at least comparable, to the performance shown by NeQuickG. Indeed, the root mean squared (RMS) values of the hourly mean 3D position errors obtained for the global dataset are 4.36, 4.61 and 6.71 meters for perturbed conditions and 2.32, 2.35 and 2.75 meters for the quiet period, respectively for the NTCM-GlAzpar, NeQuickG and Klobuchar models. Nevertheless, through a geographic- and diurnal-specific analysis, we identify also that the performance of NTCM-GlAzpar slightly decreases for conditions of reduced solar activity – at night time, higher latitudes and low perturbations.

We further discuss the applicability of the NTCM-GlAzpar ionospheric model in GNSS single-frequency applications motivated by its simple software adaptations and low computational cost.