Ground-based GNSS-derived TEC data assimilation into NeQuick: a test case

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NeQuick 2 [1] is the ionosphere electron density model developed at the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy in collaboration with the University of Graz, Austria. It is a quick-run model particularly designed for trans-ionospheric propagation applications that has been conceived to reproduce the median behaviour of the ionosphere.
In order to reconstruct the 3-D ionosphere electron density for current conditions, different data ingestion techniques based on the NeQuick adaptation to GNSS-derived Total Electron Content (TEC) data have been implemented [2] and these techniques have demonstrated to improve the model performance, in particular during geomagnetically disturbed periods [3]. NeQuick has also been used as a part of very sophisticated assimilation models, which are able to incorporate (direct and) indirect measurements of the ionosphere electron density [4].
In the present work, the results related to the implementation of the Best Linear Unbiased Estimator (BLUE) [5] algorithm to assimilate ground-based GNSS-derived Total Electron Content (TEC) data into NeQuick 2, considered as a background model, are presented. TEC data for the days 15 and 16 July 2017 from about 300 receivers located in the European region have been assimilated. Manually scaled peak parameter values obtained at one-hour time interval from Julisrhuh, Fairford and Tromso ionosondes have been considered as ground-truth independent measurements for the validation of the assimilation scheme. It is noticed that the day 15 corresponds to a geomagnetically quiet period, whereas the day 16 can be considered disturbed (slightly in terms of dst index, with a minimum of -72 nT) as far as the effects on TEC and electron variations with respect to the previous day are concerned.
The analysis results, based on the relative frequency distribution of the differences between the reconstructed and the corresponding experimental peak parameter values, indicate the effectiveness of the proposed data assimilation method. As an example, it is reported that, for the two days, the average, standard deviation, maximum and minimum error in the reconstructed foF2, the critical frequency F2 ionospheric layer, are 0.02, 0.42, 1.09, -1.32 MHz respectively. For comparison purposes, the analogous errors for the NeQuick model, used as a background, are 0.04, 0.72, 2.43, -2.40 MHz.

References

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