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Use of RO-derived electron density profiles to assess the NeQuick model topside

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NeQuick 2 [1] is an ionosphere electron density model developed at the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy with the collaboration of the University of Graz, Austria. It is a quick-run model particularly suitable for trans-ionospheric propagation applications that has been designed to represent the climatological behavior of the ionosphere. To provide "weather-like" specification of the 3-D electron density, different data ingestion techniques have been developed on the basis of NeQuick adaptation to GNSS-derived Total Electron Content (TEC) data and ionosonde measured peak parameters values [2].

In the present work a specific ingestion method has been implemented to assess the NeQuick model topside using, as "ground truth", selected Radio Occultation (RO)-derived electron density profiles obtained from COSMIC satellites. As a first step, the model has been adapted only to peak electron density (NmF2) and height (hmF2) of the RO-derived experimental profiles. Then, the mismodeling in the reconstruction of the topside ionosphere electron density (after data ingestion and up to the COSMIC satellite height, at about 800 km) has been estimated as the integrated (absolute) difference between the experimental and the corresponding modelled electron density as a function of height.

Subsequently, in addition to NmF2 and hmF2, the NeQuick has been forced to match, in RMS sense, also the electron density in the first 200 km above hmF2. For this purpose the model has been modified and a modulating factor has been introduced to allow for the assimilation of the experimental topside slab thickness.

The topside mismodeling error has been computed as in the previous case and, as expected, the statistical results indicate that the full assimilation scheme provides a better description of the topside ionosphere.

Nevertheless, an analysis has been carried out on the modulating factor values that allowed the best matching of the topside electron density profiles.

In particular the first results based on the assimilation of about 400 profiles indicated that the NeQuick model tends to overestimate the topside scale height in the first few hundred kilometres above hmF2. Indeed the global mean value of the mentioned modulating factor of ~0.83, compared to the default value of 1.00, indicates that a reduction of the model topside thickness parameter has to be applied in order to match the experimental topside profiles at the locations and epochs where the data are available.

It has to be noted that, in order to select RO-derived (through Abel inversion) profiles less affected by the spherical symmetry assumption for the ionosphere electro density, the criteria expressed in [3] have been applied. In particular RO profiles collocated with an ionosonde, and having the corresponding hmF2 and foF2 values matching at 5% level, have been considered. The collocation distance between the RO-derived profile at F peak and the ionosonde location was limited up to 1 degree in latitude and longitude within a time interval for the occultation occurrence of 15 min.

Only data during geomagnetically quiet periods (Kp <2) were considered for the comparisons.

References

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