Verification of ionospheric electron density estimation technique using C/NOFS satellite and EISCAT data

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Abstract

Ionospheric empirical model such as NeQuick 2 depends on F2 peak and topside ionosphere parameters that can be estimated using ground-based ionosonde and topside sounders. However, the uneven distribution of ground-based instruments and the very limited topside sounders have been barriers for the development of a reliable empirical model that can specify the ionosphere, especially in a region where there are very few ground-based instruments available. This paper investigates the performance of NeQuick 2 model in estimating ionospheric density structure in low- and high-latitude regions, by assisting the model with the total electron content (TEC) obtained from a ground-based GPS receiver, which is referred to as data ingestion. First, we drive the model with various ionization parameters, deviating from daily solar radio flux (F10.7) parameter, until the model provides slant TEC (sTEC) that best fits the measurements obtained from a GPS receiver located in Nazret (Ethiopia). Then we have used the optimized ionization parameter (effective ionization level) and run the model at different locations nearby the reference station and produce the spatial distribution of the density profiles of the ionosphere in the East African region. Finally, we investigate the performance of NeQuick 2 model, both before and after data ingestion in estimating the topside ionosphere density profiles. This has been carried out by extracting in-situ density from the model output density profiles at the corresponding location of C/NOFS (Communication/ Navigation Outage Forecast System) satellite orbit and compared it with the in-situ ion density observed by Planar Langmuir Probe (PLP) onboard C/NOFS. It is shown that the performance of the model after data ingestion reproduces the topside ionosphere better up to about 824 km away from the reference station than that before adaptation. In addition, NeQuick 2 has been adapted to sTEC obtained

from high-latitude (TromsØ in Norway) GPS receiver and the model has been used to reproduce ionospheric parameters measured by VHF Incoherent Scatter Radar (EISCAT). It is shown that the model after data ingestion reproduces both electron density full profile and F region peak height measurements (over the VHF radar station) better than that before adaptation.

Keywords: Ionosphere, NeQuick, TEC ingestion, GPS, C/NOFS, topside electron density, EISCAT