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Validation of Ionospheric Models using COSMIC TEC Measurements

Abstract:
We report the results of a model validation study that was recently carried out to assess the accuracy of the slant total electron content (TEC) produced by ionospheric models. Most model assessments rely on validation against near vertical TEC measurements made by ground based receivers or in some cases against JASON radar altimeter vertical TEC measurements. The goal of our study was to assess the how well the models captured the horizontal and vertical electron density gradients, especially at low latitudes near the Equatorial Ionization Anomaly, where vertical TEC measurements are not readily available because there are few land masses to house the GPS receivers. We used the slant total electron content measurements made by the COSMIC constellation during the spring of 2012 for this study. The total electron content along each COSMIC line-of-sight was calculated through the models and compared to the measurements.

We assessed the following ionospheric models: NeQuick, IRI-2007 and 2011, SAMI-3, and the Utah State University version of the Global Assimilation of Ionospheric Measurements (GAIM) model. We found that the GAIM model performed best overall, showing low biases.

One area of concern with all of the models was that the mean percentage difference between the COSMIC measurements and the TEC calculated along the line-of-sight showed significant scatter, _15% at the 1-sigma level. This was traced in part to the spatial resolution of the models, which was fixed at the native GAIM resolution to better inter-compare the results.

However, the deviations between the models and the COSMIC TECs was more significant at higher altitudes, where all of the models showed lower TEC values than were observed by COSMIC.

This suggests that the topside scale-heights in all the models should be increased. Since the models are normally validated using near vertical TEC measurements and good agreement is usually shown in these studies and to first order the vertical TEC is proportional to the product of the electron density at the F-region peak and the top-side scale height, our results suggest that the peak density values in the models is also in error and is likely to be too high.