4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

Low Earth orbit COSMIC-2 and geostationary GOES observations for International Reference Ionosphere model validation and improvement.

Iurii. Cherniak[(1)]*, Irina Zakharenkova[(1)], John Braun[(1)], Jan Peter Weiss[(1)], Qian Wu[1,2]
(1) COSMIC Program Office, University Corporation for Atmospheric Research, Boulder, Colorado, USA
(2) HAO, University Corporation for Atmospheric Research, Boulder, Colorado, USA

The International Reference Ionosphere (IRI) is an empirical model based on ground-based and of space-born ionospheric observations. The IRI model is widely used for scientific and application tasks and it is recognized as the international standard for the Earth's ionosphere specification. Taking into account that the model is based on the past datasets, there are conducted actual efforts for comparison of the IRI-derived parameters with new measurements to assess the potential improvements of the model.

The equatorial and low latitudes represent one of the most complicated regions of the ionosphere with large variability and with sparse coverage by observation facilities. The COSMIC-2 mission launched in 2019 provides the substantial data source for that particular region. The actual COSMIC-2 constellation focuses on low-latitudinal region and operates at 24° inclination orbit with ~550 km altitude. COSMIC-2 provides GNSS radio occultation (RO) monitoring of ionosphere, but at the same time this mission hosts in-situ plasma density probe - Ion Velocity Meter (IVM) payload that can complement RO observations. Six satellites provide unprecedently dense coverage by both GNSS RO and in-situ observation of ionospheric plasma density.

Using the COSMIC-2 derived ionospheric F2 layer peak parameters and IVM in situ plasma density measurements, we investigate the IRI performance for the equatorial ionosphere representation at low, mid, and high solar activity levels of the present 25th solar cycle and report the derived data-model discrepancies when COSMIC-2 was used as independent reference measurements.

Another challenge for empirical profile-based models of ionosphere is representation of the topside part of the ionosphere and plasmasphere, which is definitively related with lack of measurements of vertical plasma density distribution above 800-1000 km in altitude. We introduce a new observational data source to evaluate and improve topside part of empirical models' plasma density specification - RO electron density profiles retrieved for the first time from a geostationary orbit. The UCAR team demonstrates that GPS signals propagated through the Earth's atmosphere and tracked by the geostationary GOES-16 and GOES-17 satellites GPS receivers can be used to retrieve the ionosphere electron density profiles by RO technique. We developed a novel approach which enabled us to retrieve more than 10K electron density profiles with a maximum altitude up to 2000 km, much higher than any existing LEO RO mission. The performance of geostationary RO measurements for specifying the vertical distribution of ionospheric plasma density and results of comparisons with IRI derived electron density profiles are discussed.

The new direction of IRI is a specification of the ionospheric irregularities occurrence and actual versions of IRI contain formulations for spread-F occurrence probabilities. For extension of the IRI model in this direction we proposed new datasets which can describe climatology of the ionospheric irregularities occurrence at equatorial latitudes using COSMIC-2 IVM observations and ground-based GNSS measurements.