Combination of high rate ionosonde measurements with COSMIC-2 radio occultation observations: first results and future developments.

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The knowledge about ionospheric plasma density vertical distribution within an altitudinal range of 100–500 km is critically important for the profile-based models widely used for the applications related to the trans-ionospheric radio wave propagations, satellite communication, and global navigation systems operational tasks.

The high frequency sounding radars - ionosondes provide unbiased benchmark measurements of ionospheric plasma density due to direct relationship between sounding wave reflection and plasma frequency at a particular altitude. But due to this fact, the ground-based ionosonde operation is limited from the ionosphere lower boundary up to the F2 layer peak and does not cover the topside part of the F2 layer. The radio occultation (RO) observations from GNSS receivers onboard low-Earth-orbiting (LEO) satellites provide measurements of electron density vertical distribution also from lower boundary of ionosphere and can cover an altitudinal range up to the height of the orbit where satellites operate (about 500-700 km).

Within the framework of the PITHIA-NRF Trans-National Access program, we investigated an opportunity to obtain the observational-based dependances of ionospheric plasma density distributions (electron density profiles, EDPs) by combining advantages of both the ionosondes and LEO RO measurements. For this task, we use high rate observations from Ebro and El Arenosillo ionosondes and COSMIC-2 RO EDPs collocated within area of these ionosonde observations in space and time.

Based on analysis of high sampling rate ionosonde observations s with collocated RO measurements we demonstrated how combined EDPs based only on real high-quality observations can be constructed. Such electron density profiles can be considered as analogy of incoherent scatter radar derived "full profiles" as the reference for altitudinal distribution of ionosphere plasma density.

Using the obtained reference EDPs, we estimated the accuracy of empirical profile-based models of ionosphere - International Reference Ionosphere (IRI) and NeQuick, to demonstrate model-data discrepancies, which can be improved in the future.

Results of this work are inspired the Observatori de l'Ebre and UCAR COSMIC teams to carry out in the future high sampling rate ionosonde observations with COSMIC-2 RO measurement combinations for synoptical measurements campaigns during the solstice and equinox periods of 2025 in order to collect new dataset of reference EDPs based only on real measurements. One of important application of such reference profiles is a validation of empirical models of ionosphere and source for their future improvements.