Space Weather services based on operational radio systems

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During the past decades a growing number of observations are available, which significantly improve monitoring and modelling of the ionosphere. This is important since radio signals transmitted by modern communication, navigation and Earth observation systems suffer from ionospheric impact due to refraction, diffraction and scattering caused by the ionospheric plasma, depending on the used frequency. Our knowledge on the ionosphere is primarily based on electromagnetic radio waves impacted by the ionospheric plasma. The growing number of GNSS receivers and associated networks supports establishing high precision monitoring of ionospheric weather including perturbation tracking and forecasts usable in space weather services. Other ground based techniques like vertical sounding (VS), Incoherent Scatter Radar (ISR), Very Low Frequency (VLF) [2] or Radio Beacon measurements together with powerful space-based methods, like the Radio Occultation technique provide complementary information (see Figure 1).

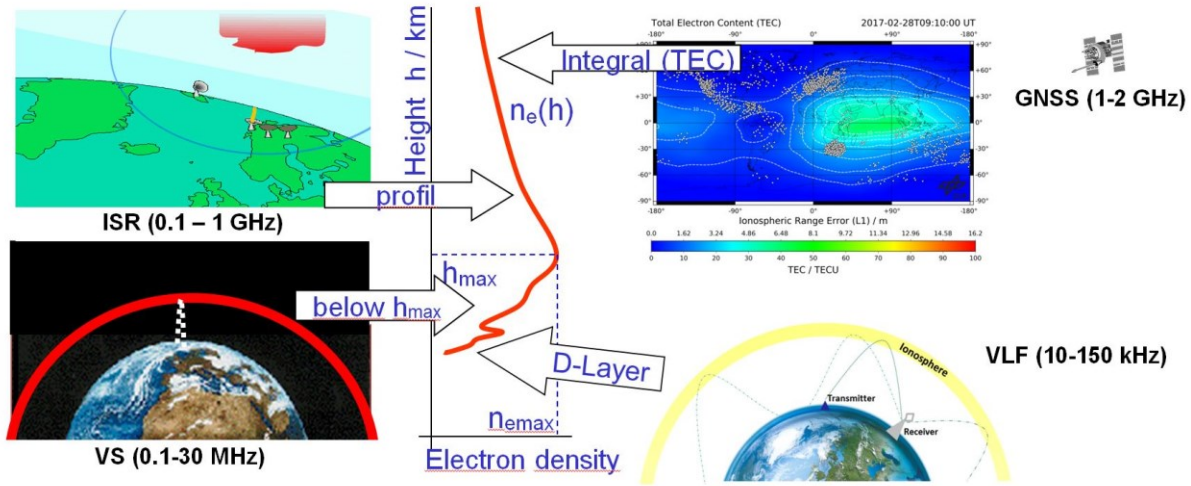

Figure 1. Sounding of the ionosphere with various ground based measurement infrastructures operating at different radio wave frequency bands. The combined ground based measurements supplemented by space based data can provide comprehensive information of the ionospheric profile.

Therefore, the combination of ground- and space-based radio observation data together with appropriate models can provide unique information about the ionosphere [2] and help to mitigate space weather effects on radio systems used in communication, navigation, aviation, satellite operations and earth observation. We like to discuss how well-established and new ionospheric measuring and observation methods might help to improve our understanding of the ionosphere and its impact on operational radio systems.

References

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[2] T. Gerzen, V. Wilken, D. Minkwitz, M. M. Hoque, S. Schlüter, "Three-dimensional data assimilation for ionospheric reference scenarios", *Annales Geophysicae,* **35**, 2017, pp. 203-215, doi:10.5194/angeo-35-203-2017