Effect of altitude-dependent times of sunrise and sunset in ionospheric modelling

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1 Extended Abstract

It is well known that the sunrise and sunset periods are of particular importance to ionospheric research and modelling because of the rapid changes in the ionospheric plasma density, temperature, and dynamics. The sharp increase in the ionisation following sunrise results in a quick increase in the ionospheric peak density, N_mF_2, and a decrease in the peak height, h_mF_2. During sunset, the reverse processes happen. Changes in plasma temperature, scale height and transport processes add further complexity which makes it difficult to investigate and model the ionospheric behaviour during this transitional period from night to day. One of the aspects contributing to this difficulty is that not all ionospheric altitudes are exposed to the first sunlight of the day at the same time. During sunrise, the upper part of the ionosphere is illuminated prior to the lower part which is still in the dark. The boundary between sunlit and dark regions moves downwards until it reaches the surface of the Earth, which is commonly taken as the moment of sunrise at certain geographical coordinates. This means that the civil sunrise does not occur until after the entire ionosphere has been illuminated.

The LIEDR (Local Ionospheric Electron Density Reconstruction) model uses ionosonde-derived characteristics (such as the ionospheric E- and F- layers' critical frequencies and peak heights) and GNNS-based TEC to reconstruct the local electron density profile up to around 1000 km [1]. An important part of the algorithm is the possibility to choose an appropriate profiler for the topside ionosphere, depending on time of day, season, geomagnetic conditions, etc [2]. If an abrupt change between the day-time and night-time profilers is implemented for all heights at the same time, artefacts appear in the model (see Figure 1). We address the problem of including the the time dependency of the irradiation as a function of altitude, and report on the improvements in the LIEDR model.

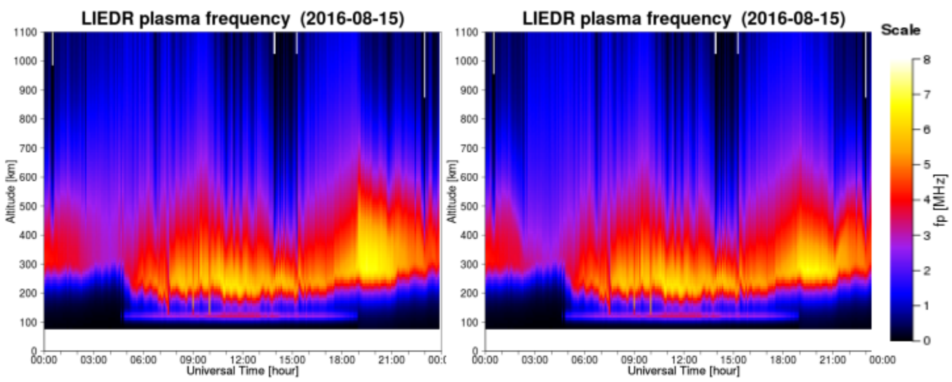

Figure 1. The old LIEDR model (left), showing artefact (highlighted by the rectangle) due to the sudden switch from day-time too night-time topside profiler. In the new version (right), the situation is rectified.

References

[1] Stankov, S. M., K. Stegen, P. Muhtarov, and R. Warnant, "Local ionospheric electron density profile reconstruction in real time from simultaneous ground-based GNSS and ionosonde measurements" *Advances in Space Research*, **47**, 2012, 1172–1180, 10.1016/j.asr.2010.11.039.

[2] Verhulst, T. and S.M. Stankov, "Ionospheric specification with analytical profilers: Evidences of non-Chapman electron density distribution in the upper ionosphere", *Advances in Space Research*, **55**, 2016, 2058–2069, 10.1016/j.asr.2014.10.017.