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Imaging of ionospheric irregularities by using ground-based and space-borne instruments

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It is known that space weather events such as intense geomagnetic storms and/or solar flares produce significant disturbances in the ionosphere. The disturbances can be of different spatial scales, can occur anywhere in the world. Small-scale disturbances represent a significant threat to radio-based communication, since they cause strong scintillations of radio-signals, and can, in the worst scenarios, lead to long-lasting radio blackouts. Therefore, it is crucially important to be able to track such irregular structures in the ionosphere.

In this work, we use a set of ground-based and space-borne instruments to study the occurrence and evolution of ionospheric irregularities during the 25-26 August 2018 geomagnetic storm. With the minimum SYM-H excursion of -205 nT, this storm has become the third largest storm in the 24th solar cycle. The irregularities are tracked by calculating the rate-of-TEC index (ROTI) from data of ground-based GNSS-receivers, space-ROTI (from Swarm A and Swarm B satellites), as well as rate-of-density index RODI (for Ne measurements by SWA, SWB and CSES – the China Seismo-Electromagnetic Satellite). We show that the storm produced quite intensive ionospheric irregularities at high-latitudes, around the auroral oval. However, the strongest fluctuations in the electron density and the TEC were observed over the Pacific Ocean at low and middle latitudes. We confirm that, although satellite data depict irregularities in the topside ionosphere, they can be successfully used in regions with poor GNSS-coverage, e.g., over the polar and auroral regions in the SH or/and over the Oceans. For better global imagery of irregularities, ionospheric parameters along with fluctuation indices (ROTI/S-ROTI/RODI) should be analysed.

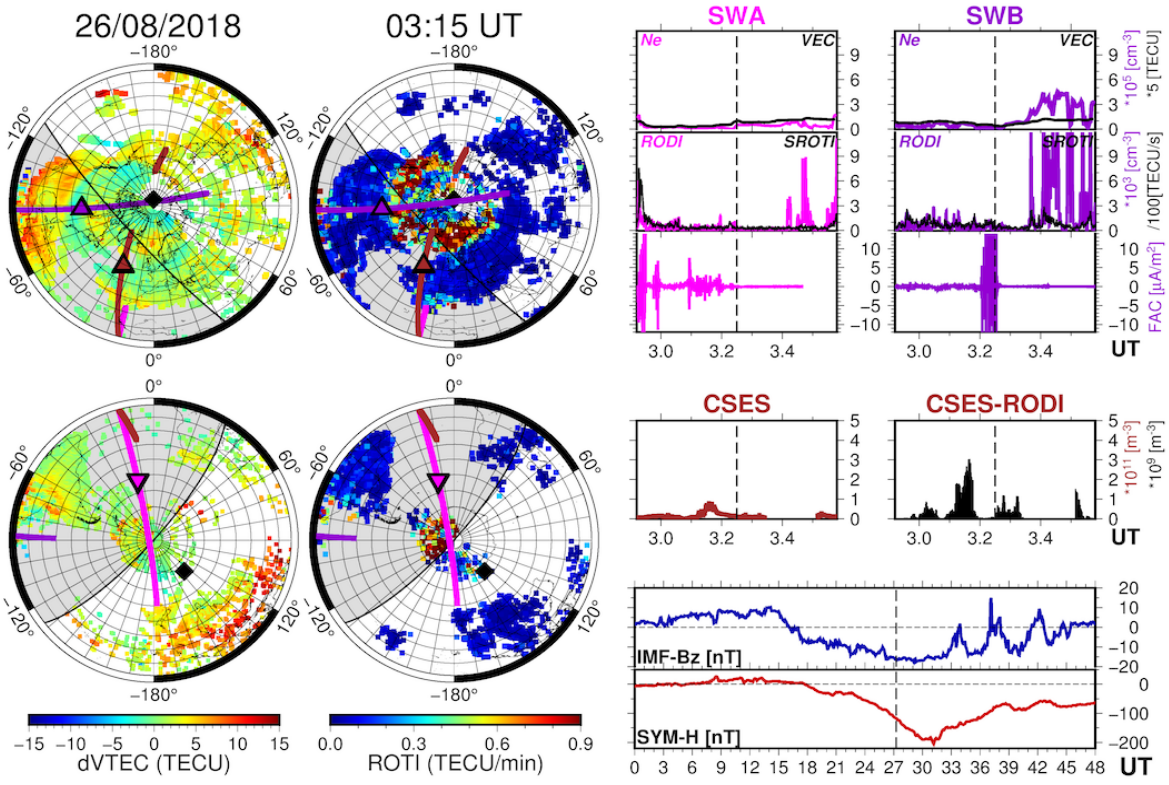

Figure 1. Ionospheric disturbances and irregularities observed during the main phase of the August 2018 storm by a combination of ground-based and space-borne instruments.