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Study of potential ionospheric signatures associated to 2022 Tonga Volcano Eruption and Tsunami from LEO- and ground-based GNSS data

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Abstract

In this work, we characterized the significant ionospheric disturbances regarding the 2022 Tonga volcano eruption and its resulting tsunami. This is done by analysing the LEO- and ground-based GNSS data, thanks to the new PIES approach (POD GNSS LEO Detrended Ionospheric Electron Content Significant Deviations [1]). The LEO observation of POD GNSS is capable of recording almost all the wavefront information of the travelling ionospheric disturbances (TIDs), due to the tens of times faster velocity of the LEO satellites than TIDs. The topside ionosphere occurred the obvious disturbances during the event, in particular when the largest eruption caused the tsunami, which happened to be recorded by LEO Swarm and KOMPSAT-5 satellites. The parameters are compatible with the ones of ground-based GNSS observation, which may come from the same origin and be recorded at different heights, such as the atmospheric acoustic waves or gravity waves released. The topside ionospheric disturbances are confirmed with the independent ionospheric observation data, i.e. the in-situ electron density measurements of the Langmuir Probe (LP) on board Swarm LEOs. This study confirmed the PIES tool in monitoring ionospheric disturbances above LEO satellites. In the future, a potential monitoring system for the ionospheric disturbances would be established, on the basis of hundreds of CubeSats with POD GNSS receivers and other appropriate sensors.

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Reference:

1. Heng Yang, Manuel Hernandez-Pajares, et al. Systematic detection of anomalous ionospheric perturbations above LEOs from GNSS POD data including possible tsunami signatures (2022), Transactions on Geoscience and Remote Sensing, under review.