3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

TEC enhancements over tectonic plate boundaries occurring more often than large earthquakes

Wojciech Jarmołowski* (1), Paweł Wielgosz (1), Anna Krypiak-Gregorczyk (1), Beata Milanowska (1)
(1) University of Warmia and Mazury in Olsztyn, ul. Oczapowskiego 2, 10-719 Olsztyn, Poland, e-mail: wojciech.jarmolowski@uwm.edu.pl

The responses of the atmosphere to the earthquakes or volcanic eruptions became an interesting observation and can contribute in near future to the forecasts of these events. The researchers investigate small-scale ionospheric perturbations related with gravity waves after larger earthquakes or larger-scale local changes of Total Electron Content (TEC) called TEC enhancements. TEC anomalies called enhancements are most often linked with geomagnetic storms or Earth-dependent phenomena, like earthquakes, volcanic eruptions or nuclear explosions. This study reveals a very frequent occurrence of TEC enhancements not exclusively linked with specific seismic phenomena, but located over tectonic plate boundaries (see: Fig. 1). This work applies kriging-based UQRG global ionosphere maps (GIMs), from the Polytechnic University of Catalonia (UPC) IonSAT group, to the detection of relative TEC changes. More flexibility and speed coming from the use of good GIMs instead of raw GNSS data is an advantage of this study. This work focuses on global relative and normalized TEC variations [1], which have spatial and temporal behavior strongly indicating their relation both with geomagnetic changes and tectonic plate system. This study extends rarely discussed, but a very frequent interaction between tectonic plate edges and ionosphere. The seismic origin of TEC enhancements and their link with tectonic plate edges is suspected from their duration, shape and location. The observed spatial co-location of TEC enhancements and depletions with tectonic plate boundaries strongly suggest the relation of TEC with general seismic activity, but not necessarily with the strongest earthquakes. The expected correlation of TEC variations with enhanced geomagnetic activity and geomagnetic storms can be also easily observed and distinguished. Additionally, the influence of geomagnetic changes, although merged with the influence of tectonic boundaries, can be separated from each other to some extent. This research shows that differential and regularized TEC can be especially interesting for permanent observation of global lithosphere-ionosphere coupling, also in time free from strong earthquakes. Hence this study adds to the observation of Earth-atmosphere system and encourages to the continuous observation of TEC enhancements and their extended analysis. UQRG implementation of GIMs - based on the stochastic modeling, appears as particularly useful in the studies of continuous global TEC changes over seismically active regions and research on earthquake forecasting.

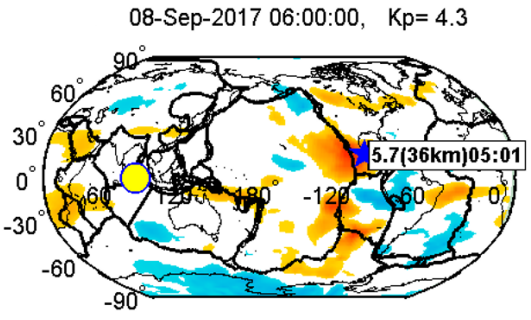

Figure 1. Example of normalized TEC enhancements occurring in the places, where no earthquakes with magnitude at least 4.5 are observable. Most of these places are over tectonic plate edges. Blue star denotes earthquake occurred within 1.5 h interval from the map time. The label includes its magnitude, depth and time. Yellow circle denotes respective Sun position at the time of the map.

1. A. Shinbori, Y. Otsuka, T. Sori, T. Tsugawa, and M. Nishioka, Temporal and spatial variations of total electron content enhancements during a geomagnetic storm on 27 and 28 September 2017. Journal of Geophysical Research: Space Physics 2020, 125, e2019JA026873. https://doi.org/10.1029/2019JA026873