



## **Study of the traveling large-scale ionospheric irregularities associated with earthquake precursors using GNSS**

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Recently, GPS techniques have provided a very good chance to study these seismo-ionospheric effects. In this paper, an analysis of the TEC variations obtained using GPS permanent measurements during the Baltic Sea earthquake (21 September 2004) is presented. The area around the Baltic Sea is not a region of seismic activity. Two shocks occurred on 21 September 2004. The mean magnitude obtained from five Polish seismic centers was about 5.0-5.3. This value is the threshold of the seismo effects occurrence in the ionosphere. In TEC data over the region of the earthquake, a specific ionospheric anomaly appearing one day before the seismic shock was detected. An ionospheric variability had a positive sign with an enhancement of about 4-5 TECU relative to the non-disturbed state of ionosphere. The anomaly had a duration of 4-5 hours in the day time. The spatial size of this anomaly was about 1000km. The characteristic parameters of the anomaly show that it can be associated with ionospheric precursors of an earthquake. The impact of the disturbed ionosphere, 1 day prior to the first shock of the earthquake, was also visible on the elaborated GPS vectors. The analyses relied on studying the repeatability of vectors' coordinates, connecting Lamkowko (the nearest station to the epicenter of the earthquake) with other IGS/EPN stations: Borowiec, Borowa Góra, Ryga and Wilno. The biggest impact was observed at high component on the Lamkowko-Wilno vector. It reached several millimeters. Together with the monitoring of the ionosphere, the analysis of GPS vectors during earthquakes allows to conclude that valuable information concerning future seismic events can be also obtained from routine IGS/EPN GPS vectors elaboration.