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Ionospheric seismology: what can learn about natural hazards from the ionosphere?

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It is known that Natural Hazards (NH) events, such as earthquakes, tsunamis, volcanic eruptions, and severe tropospheric weather events can generate perturbations in the atmosphere and ionosphere. The branch of Geophysics that studies NH-associated ionospheric disturbances is often called "Ionospheric Seismology". Since the first detection of co-seismic ionospheric disturbances (CSID) in 1964, nowadays, NH-associated perturbations are regularly detected in ionosphere [1-2].

The modern Ionospheric Seismology includes not only detection of NH-driven ionospheric perturbations and analysis of their main features, but also the development of methods of localization of the NH source from the ionosphere. For instance, CSID first occur just above the seismic source. Therefore, knowing the time and the coordinates of the first CSID arrivals it is possible to obtain the position and the structure of the source [3; Figure 1]. To detect the source location from ionospheric total electron content (TEC) measurements, we assume that the perturbation propagates from a point source as a spherical wave, with constant velocity. Then, by solving a system of equations, we determine the position of the source and the time onset of the source. This method allowed, for the first time, to detect an eruptive volcano from the ionosphere [4].

In this contribution, we will present an overview of the recent developments in the area of the ionospheric detection of earthquakes, tsunamis and volcanic eruptions, and we will explore future perspectives for this novel discipline. Namely, we will discuss future possibilities for real-time seismo- ionospheric methods and their application for NH mitigation.

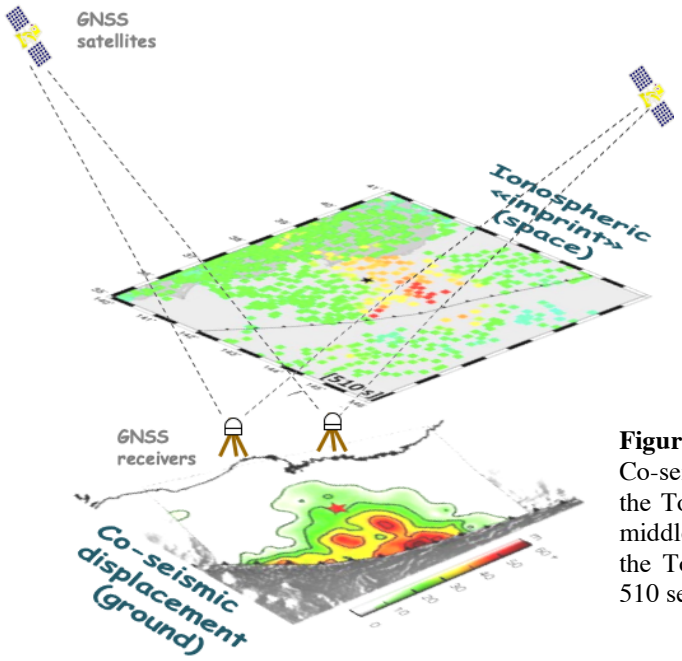

Figure 1. Scheme of GNSS-ionospheric seismology. (bottom) Co-seismic displacements of the water column occurred due to the Tohoku-oki earthquake of 11 March 2011 [6]; (image in the middle) TEC perturbations above the near-epicentral region of the Tohoku-oki earthquake, a snapshot of the TEC obtained at 510 sec after the earthquake [5].

References

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