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## **Investigation of earthquake signatures on the Ionosphere over Europe**

Abstract:

The link between seismic activity and ionospheric perturbations related to earthquake preparation has acquired significant attention in the last two decades. That was possible mostly through technological developments such as ground based techniques to study the bottomside ionosphere (ionosondes, VLF receivers), satellite based instruments to conduct investigations of the topside ionosphere as well as dense networks of GNSS receivers that enabled monitoring of the full extent of the ionospheric plasma via Total Electron Content (TEC) and ionospheric tomography techniques. These have enabled the systematic and effective monitoring of the spatial modification of the ionosphere with a high temporal resolution.

In this study we present the framework and preliminary results of a research project that concerns the investigation of the lithosphere-atmosphere-ionosphere interaction with respect to earthquake events by exploiting a multi-instrument approach facilitated by existing ionospheric monitoring networks in Europe. The main goal of this project is to study the ionospheric phenomena associated with earthquakes and to identify their main types, features and peculiarities of manifestation for different earthquake magnitudes and epicenter locations and depths.

For this purpose, earthquake catalogs for the period 1998-2013 were created and maps which depict the preparation area corresponding to each selected event were assembled. With the aid of these maps, VLF/LF data (amplitude and phase) from INFREP VLF/LF (International Network for Frontier Research on Earthquake Precursors) and AWESOME VLF (Atmospheric Weather Electromagnetic System for Observation, Modeling, and Education) networks were collected for several paths crossing the preparation area.

After specification of amplitude and phase data corresponding to each event several techniques in search of ionospheric signatures were applied. Furthermore, an effort was undertaken to identify earthquake signatures on TEC (Total Electron Content) data by exploiting GNSS networks over Europe.

Finally, possible earthquake signatures on various ionosonde-derived ionospheric characteristics and features expressed in terms of ionograms and time-series of ionospheric characteristics were investigated.