



## **Application of differential analysis of VLF signals for seismic-ionospheric precursor detection from multiple receivers**

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This study investigates the application of differential analysis on VLF signals emitted from a single transmitter and received by multiple stations in order to filter and detect disturbances that can be attributed to seismic-ionospheric precursor phenomena. The cross-correlation analysis applied on multiple VLF signals provides a way of discerning the nature of a given disturbance and accounts for more widespread geomagnetic interferences compared to local precursor phenomena.

For the purpose of this paper, data acquired in Thessaloniki (40.59N, 22.78E) and in Heraklion (35.31N, 25.10E) from the VLF station in Tavolara, Italy (ICV station Lat. 40.923, Lon. 9.731) for a period of four months (September 2014 - December 2014) are used. The receivers have been developed by Elettronika Srl and are part of the International Network for Frontier Research on Earthquake Precursors (INFREP).

A normalization process and an improved variant of the Hilbert-Huang transform are initially applied to the received VLF signals. The signals derived from the first two Intrinsic Mode Functions (IMF1 and IMF2) undergo a cross-correlation analysis and, in this way, time series from the two receivers can be compared. The efficacy of the processing method and the results produced by the proposed process are then discussed. Finally, results are presented along with an evaluation of the discrimination and detection capabilities of the method on disturbances of the received signals.

Based upon the results, the merits of such a processing method are discussed to further improve the current method by using differential analysis to better classify between different disturbances but, more importantly, discriminate between points of interest in the provided spectra. This could provide an improved method of detecting disturbances attributed to seismic-ionospheric precursor phenomena and also contribute to a real-time method for correlating seismic activity with the observed disturbances.