Geophysical Research Abstracts
Vol. 14, EGU2012-2134, 2012
EGU General Assembly 2012

Application of Self Adaptive Unsupervised Neural Networks for Processing of VLF-LF signals to detect Seismic-Ionospheric Precursor Phenomena.

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This paper investigates the development and application of artificial neural networks (ANN) based on Predictive Modular Neural Networks (PREMONNs) to provide a self adaptive unsupervised method for detecting disturbances that can be attributed to seismic-ionospheric precursor phenomena using VLF radio signals. As such, the neural network is applied to bring forth and adaptively discriminate different characteristics in the received signals, in real time, in order to provide data segments of interest that can be correlated to subsequent seismic phenomena.

PREMONNs have been developed for time series prediction and through that for source switching detection in a time series; they are constituted by two modules. The first tier is a module consisting of a dynamic array of neural networks following the data stream in order to predict the next value of a time series whereas the second is a decision one utilizing a Bayes probability equation to decide on source switching. That module is responsible for electing and appropriately training the closest fitting NN or switching to a new NN if a source switch is apparent.

For the purpose of this paper, VLF signals transmitted by a number of European VLF transmitters are monitored for over a year in Thessaloniki (40.69N 22.78E) and the data from December 2010 to December 2011 are used. The received signals are sampled and stored for off line processing. The receiver was developed by Elettronika Srl, and is part of the International Network for Frontier Research on Earthquake Precursors (INFREP). Signals received from the 20.27KHz ICV station in Tavolara, Italy (Lat 40.923,Lon. 9.731) were used. The received VLF signal was normalized and then processed using the Empirical Mode Decomposition Method (EMD). The resulting data are used to train the unsupervised ANN and the performance of the developed network is then evaluated. The efficacy of different layouts of the PREMONN is evaluated and the application of a self-organizing classifier is then discussed. It classifies disturbances and provides the basis of a preliminary system for the analysis and objective correlation of the perceived disturbances.

Therefore, it may be concluded that an automated system based on the PREMONN paired with an unsupervised classifier may provide a real-time method for correlating seismic activity with the observed disturbances.