

EGU21-5154, updated on 11 Mar 2021

<https://doi.org/10.5194/egusphere-egu21-5154>

EGU General Assembly 2021

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Wavelet analysis applied on temporal data sets in order to reveal possible pre-seismic radio anomalies and comparison with the trend of the raw data

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Since 2009, several radio receivers have been installed throughout Europe in order to realize the INFREP European radio network for studying the VLF (10-50 kHz) and LF (150-300 kHz) radio precursors of earthquakes. Precursors can be related to “anomalies” in the night-time behavior of VLF signals. A suitable method of analysis is the use of the Wavelet spectra. Using the “Morlet function”, the Wavelet transform of a time signal is a complex series that can be usefully represented by its square amplitude, i.e. considering the so-called Wavelet power spectrum.

The power spectrum is a 2D diagram that, once properly normalized with respect to the power of the white noise, gives information on the strength and precise time of occurrence of the various Fourier components, which are present in the original time series. The main difference between the Wavelet power spectra and the Fourier power spectra for the time series is that the former identifies the frequency content along the operational time, which cannot be done with the latter. Anomalies are identified as regions of the Wavelet spectrogram characterized by a sudden increase in the power strength.

On January 30, 2020 an earthquake with $M_w = 6.0$ occurred in Dodecanese Islands. The results of the Wavelet analysis carried out on data collected some INFREP receivers is compared with the trends of the raw data. The time series from January 24, 2020 till January 31, 2000 was analyzed. The Wavelet spectrogram shows a peak corresponding to a period of 1 day on the days before January 30. This anomaly was found for signals transmitted at the frequencies 19,58 kHz, 20, 27 kHz, 23,40 kHz with an energy in the peak increasing from 19,58 kHz to 23,40 kHz. In particular, the

signal at the frequency 19,58 kHz, shows a peak on January 29, while the frequencies 20,27 kHz and 23,40 kHz are characterized by a peak starting on January 28 and continuing to January 29. The results presented in this work shows the perspective use of the Wavelet spectrum analysis as an operational tool for the detection of anomalies in VLF and LF signal potentially related to EQ precursors.