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The European radio network (INFREP) for studying earthquake precursors: status and preliminary results obtained on the occasion of the Dodecanese islands earthquakes (January 30, 2020; Mw=5.6 and Mw=5.7)

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Abstract

The paper describes the current status of the European radio network INFREP developed for studying earthquake precursors and reports the preliminary results obtained on the occasion of the Dodecanese islands earthquakes (M_W=5.6 and M_W=5.7) occurred on January 30, 2020. Information for the registration of users interested to the visualization of the trends and to download of the data acquired by the VLF/LF receivers of the INFREP network are also provided.

1 Introduction

Different factors such as meteorological conditions, solar bursts and geomagnetic activity affect VLF/LF radio waves propagation. At the same time, variations of some parameters in the ground, in the atmosphere and in the ionosphere occurring during the preparatory phase of earthquakes can produce disturbances in the propagation of the previous signals along their radio paths: these disturbances are the radio precursors. Since 2009, several VLF/LF radio receivers have been installed throughout Europe in order to realize a European radio network for studying the VLF/LF radio precursors of earthquakes, called the INFREP network [1-3]. This research topic is rising a growing interested as witnessed by recent papers using data acquired also by other VLF/LF radio networks [4]. This paper describes the current status of the INFREP network and reports the preliminary results obtained on the occasion of the Dodecanese islands seismic crisis (main shocks M_W=5.6 and M_W=5.7) occurred at the end of January 2020.

2 The INFREP Network

The INFREP network currently consists of nine receivers located in different countries in southern Europe: two in Romania and Greece, one in Italy, Austria, Portugal, Cyprus and Serbia. The receivers, realized by an Italian factory, can measure with 1 min sampling rate, the intensity of 10 radio signals in the band VLF (10-50 kHz) and LF (150-300 kHz). The transmitters are standard radio broadcasting (LF) or systems used for radio-navigation, time signal and mainly for military purpose (VLF). Figure 1 display the location of receivers and VLF/LF transmitters. More information about the activity of the INFREP network is available at the URL www.infrep-network.eu where interested users can register, download data and visualize results.
The data collected by the INFREP receivers are transmitted every day to the server of the network located in Bari, Italy. Registered users can visualize the temporal trend of each of ten VLF/LF signals and download the data in order to identify possible anomalies, i.e. unusual variations of the daily regular behavior of VLF/LF signals to be considered as possible earthquake precursors. Generally, due to the different conditions of the ionosphere, the VLF/LF radio signals are less disturbed during the night than during the day. Therefore, in INFREP the analysis of the radio data is performed only on the nighttime data. The wavelet spectral analysis is a common tool used in the study of the radio precursors of earthquakes [4, 5]. A tool for the computation of the wavelet spectrum of VLF/LF signals using the Morlet function has been implemented and is available among the visualization tools on the INFREP web site. The wavelet power spectrum is visualized as a 2D image that, once properly normalized with respect to the power of the white noise, gives information on the strength and precise time occurrence of the various spectral components of the VLF/LF time series. This tool for spectral analysis is used for the identification of anomalies in the VLF/LF signals. For a given day, the wavelet spectrum is computed using a time series starting 20 days before the reference day and ending 15 days after it.

3 Preliminary report of the last radio precursor revealed by INFREP data

In this paragraph we present the preliminary results of the last successful application of the data acquired by the receivers of the INFREP network. At the end of January 2020 an intense seismic crisis occurred on Dodecanese islands; the main earthquakes (Mw= 5.6 and Mw= 5.7) happened on January 30. This seismic activity occurred in the "sensitive" zone of the INFREP receiver located in Cyprus. Figure 2 shows the Cyprus receiver and the area interested by the seismic activity (foreshocks, main shocks and aftershocks). The analysis of the raw radio data revealed clear pre-seismic anomalies on the three

VLF radio signals (19.58, 20.27, 23,40 kHz) collected by the Cyprus receiver and crossing the zone of the previous seismic activity (see Figure 2).
The temporal trend of these VLF signals, from beginning of 24 January till the end of 30 January 2020 is shown in Figure 3. The analysis of daily day/night trend of these signals points out a clear anomaly during the night of 29 January 2020, one day before the occurrence of the main shocks of the seismic crisis.

Figure 1. INFREP network: current set of the receivers and VLF/LF transmsitters overlaid to a Google© map.

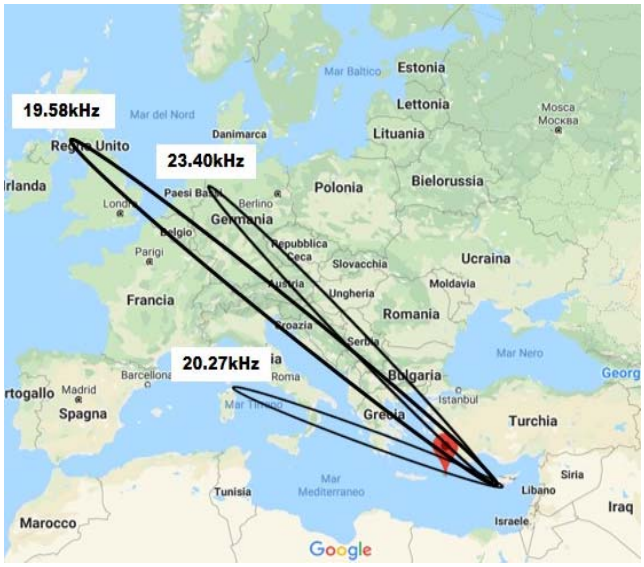
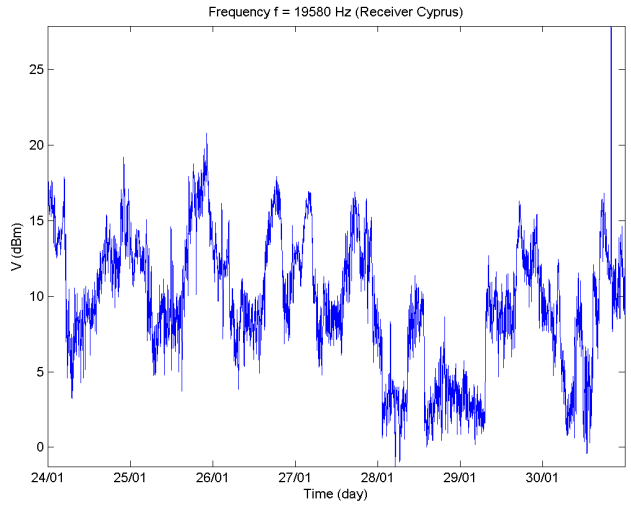
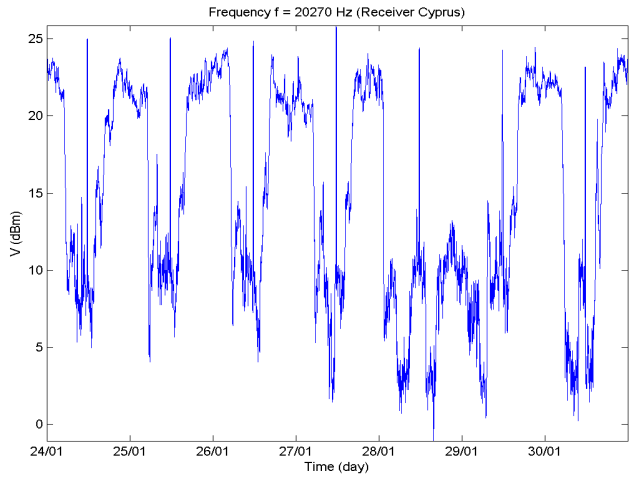


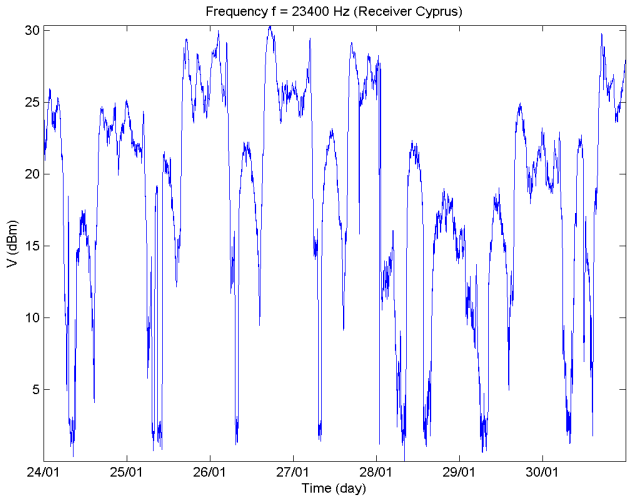
Figure 2. Cyprus receiver and VLF transmitters used to detect anomaly. The red area indicate the location of Dodecanese Islands (36°N, 27°E) seismic crisis occurred at the end of January 2020



a)



(b)



(c)

Figure 3. VLF signals collected by the Cyprus receiver from 24 to 30 January 2020: (a) 19.58 kHz, (b) 20.27 kHz and (c) 23.40 kHz. An anomalous decrease appears on 29 January.

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