PRELIMINARY ANALYSIS OF THE LF NIGHT DATA COLLECTED BY THE EUROPEAN RADIO NETWORK DURING ONE YEAR

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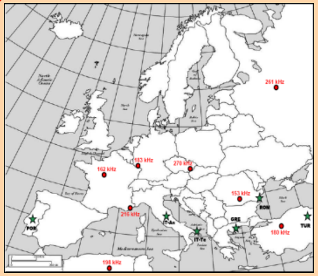

Figure 1

In last two years a LF (150-300 kHz) radio network has been put into operation in Europe. At the moment six receivers (TUR, ROM, GR, IT-An, IT-Tc, POR) are collecting the intensities (dB_m) of 4-6 LF radio signals with a sampling rate of 1 min. In Figure 1 the receivers are indicated by stars and the transmitters by circles. As an example in Figure 2 the 216 kHz signal recorded by four different receivers during February 2010 is shown.

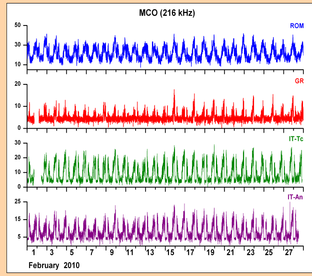

Figure 2

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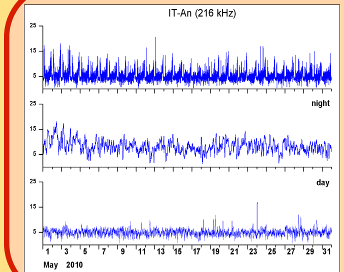

Figure 3

The LF radio signals are characterized by the ground wave (daytime) and the sky wave (nighttime). The first one is strongly affected by the troposphere conditions; the other by the ionosphere conditions. Therefore, it is usefull to separate the daytime data from the nighttime ones. As an example in Figure 3 is reported the raw 216 kHz signal collected by the IT-An receiver with the pertinent nighttime and daytime content.

Figure 4 shows the 270 kHz nighttime signal obtained from the raw data collected by the GR receiver from July 2009 up to December 2010. The top panel in the Figure represents the temperature data in the radio path area in the same period. A very clear correlation appears beetween the two long time trends proving the influence of the solar radiation on the ionosphere and consequently on the sky wave.

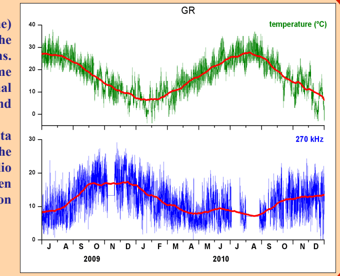

Figure 4

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In this study the nighttime data collected by the IT-An, IT-Tc, TUR and GR receivers from July 2009 up to December 2010 have been analysed. As method of analysis the Wavelet transform was applied considering the "Morlet" as base function. As it concerns the earthquakes, the European Mediterranean Seismological Centre (EMSC) catalog has been used. In the above mentioned period, we selected the events occurred with M≥5.0 inside the 5th Fresnel zone defined by each receiver and the different LF trasmitters. In the period (three months) centered on the occurrence of these earthquakes we have analised the radio data; in order to discover anomalies the spectrograms showing both the amplitude of the signal versus the Wavelet scale and the dependence between amplitude and time, have been drawn. In the cases of corespondence between radio anomaly and earthquakes the reliability of the results was verified considering other possible sources of disturbance in radio data and possible problems in the transmitters. Panel (4) shows a positive result; Panel (6) shows a negative one. Moreover the seismicity around each transmitter has been investigated in order to reveal possible disturbances in the radiated signals. Panel (5) shows an example of such an effect.

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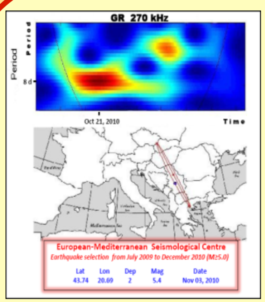

Figure 5a

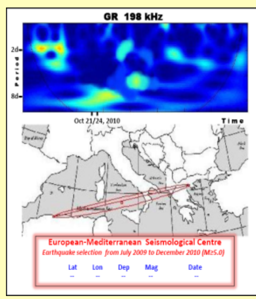

Figure 6

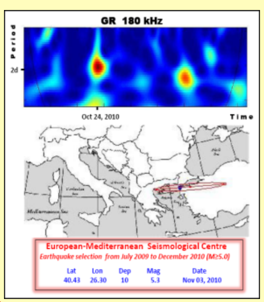

Figure 5b

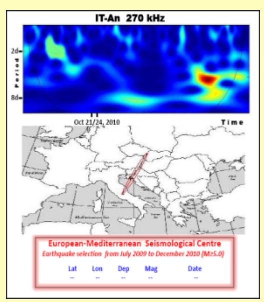

Figure 7

On November 03, 2010 two earthquakes with M=5.4 and M=5.3 occurred in Serbia and in Western Turkey, respectively. Both these events are inside the 5th Fresnel zone of the GR receiver related to the 270 kHz (Figure 5a) and the 180 kHz (Figure 5b) transmitters, respectively and they were the unique events with M ≥5.0 occurred inside these zones from July 2009 to December 2010.

As shown in the Figures 5a, b the Wavelet analysis of the nighttime two signals pointed out clear anomalies on October 21 and October 24, respectively.

The metereological conditions and the geomagnetic activity are not able to justify these anomalies. At the same time: (1) Figure 6 is an example showing that the previous anomalies are not present in the other LF radio signals collected by the GR receiver; (2) Figure 7 indicates that the anomaly shown in Figure 5a cannot be ascribed to the transmitters. A similar result can be obtained for the anomaly shown in Figure 5b.

THE PREVIOUS CONSIDERATIONS VALIDATE THE ANOMALIES SHOW IN FIGURE 5a,b AS PRECURSORS OF THE MENTIONED EARTHQUAKES.

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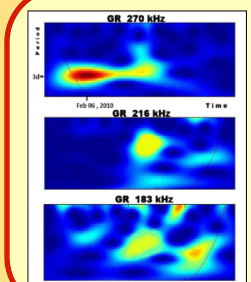

Figure 8

Figure 8 shows the spectrograms related to the GR receiver for the 270 kHz, 216 kHz and 183 kHz signals. A very clear anomaly appears in the 270 kHz signal on February 06, 2010; a similar anomaly is not present in the other two radio signals. The two spectrograms in Figure 9 related to IT-An and IT-Tc receivers show the same anomaly in the same period. These results indicate some disturbance in the trasmitter (270 kHz) zone. The EMSC catalog reveals the occurrence of an earthquake with M=4.9 located at about 200 km from the transmitter. The situation is shown in the map of Figure 9. None Fresnel zone in this case can be considered.

ON THE BASIS OF THE PREVIOUS CONSIDERATIONS THE ANOMALY REVEALED AT THE DIFFERENT RECEIVERS IN THE 270 kHz SIGNAL COULD BE A CO-SEISMIC EFFECT PRODUCED BY THE MENTIONED EARTHQUAKE.

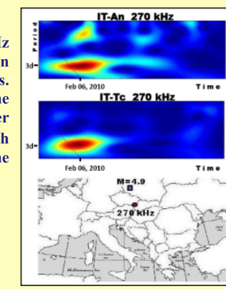

Figure 9

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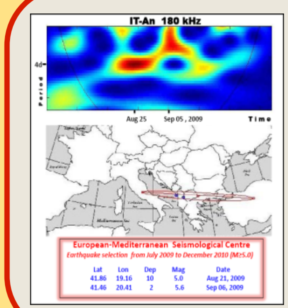

Figure 10

On August 21 and September 06, 2009 two earthquakes with M=5.0 and M=5.6 occurred in Albania. Both these events are inside the 5th Fresnel zone of the IT-An receiver related to the 180 kHz (Figure 10) transmitter and they were the unique events with M ≥5.0 occurred inside this zone from July 2009 to December 2010.

As shown in the Figures 10 the Wavelet analysis of the 180 kHz nighttime signal pointed out clear anomalies during the previous period.

The metereological conditions and the geomagnetic activity are not able to justify this anomaly. But, the spectograms shown in Figure 11 indicate that the previous anomaly is present also in radio signals collected by the same IT-An receiver from other transmitters located in different directions. In such a way, it is consistent the possibility of some man-made, local (receiver site) disturbance occurred in that period as cause of this anomaly.

THE PREVIOUS CONSIDERATION DOES NOT ALLOW TO VALIDATE THE POSSIBILITY THAT THE ANOMALY SHOWN IN FIGURE 10 COULD BE RELATED TO THE MENTIONED EARTHQUAKES.

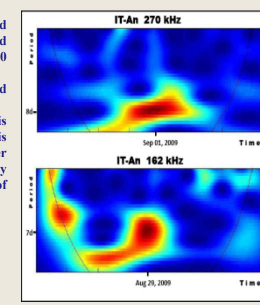

Figure 11