A POSSIBLE RADIO ANOMALY OBSERVED ON THE OCCASION OF THE M_W=6.0 EARTHQUAKE OCCURRED IN DODECANESE ISLANDS AT THE END OF JANUARY 2020

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INTRODUCTION

In the last 20 years, a research into the interaction between seismic activity and disturbances in radiobroadcasts has been carried out and *radio precursors* of earthquakes have been proposed. Variations of parameters in the ground, atmosphere and ionosphere generate variations in the propagation medium of the radio-waves and so disturbances in their propagation can occur. The main results have been obtained with VLF-LF radio signals.

The VLF signals lie in the 20-80 kHz frequency band. These radio signals are used for worldwide navigation support, time signals and for military purposes. The LF signals lie in 150-300 kHz frequency band and are used for long way broadcasting by few (this type of broadcasting is going into disuse) transmitters located all over the world.

The radio precursors confirm the existence of a lithosphere-atmosphere-ionosphere coupling.

THE INFREP RADIO NETWORK

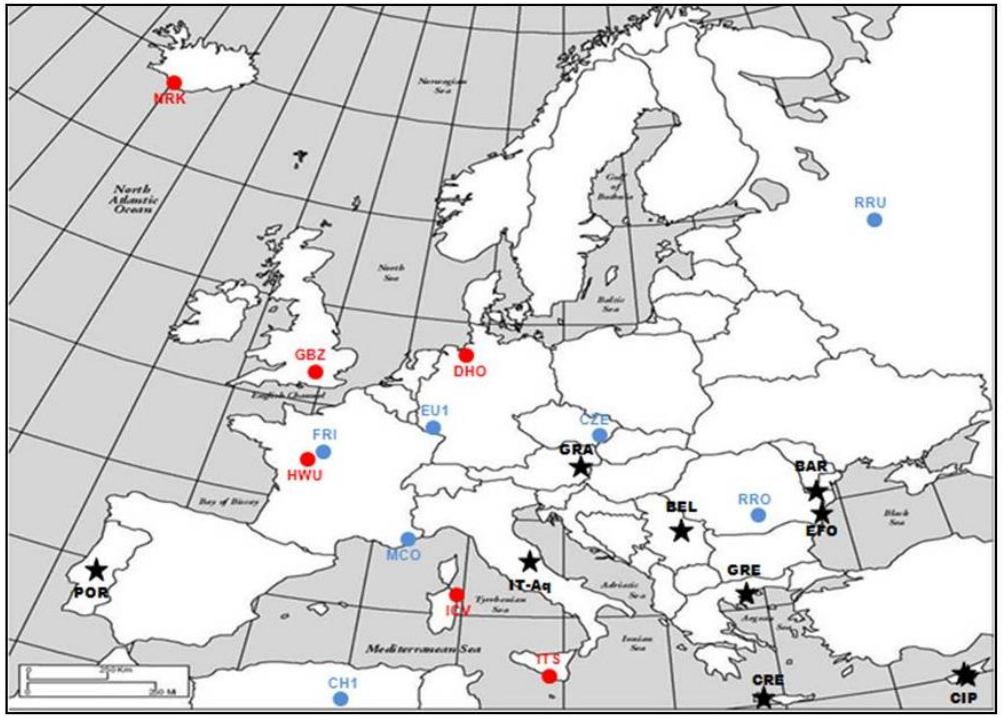
In January 2009 a network of radio receivers able to measure the electric field intensity from various broadcasting stations existing in Europe, was installed. The network currently consists of nine receivers located as follows: two in Romania and Greece; one in Italy, Serbia, Austria, Portugal and Cyprus.

The radio receivers were manufactured by an Italian factory and measure the intensity of 10 radio signals in the VLF and LF bands with 1 minute sampling rate.

The signals radiated by VLF-LF broadcasting stations located in Europe are used. Generally, each receiver collects 5 VLF and 5 LF signals; in any case, the selection of the signals to collect is based on the quality of local reception.

In next slide the location of the receivers and of the transmitters with the indication of the relative frequency is shown.

star = receiver
circle = transmitter VLF (red)-LF (blue)



labels and frequencies of the VLF-LF transmitters

VLF	Frequency (kHz)	LF	Frequency (kHz)
GBZ	19.58	RRO	153
ICV	20.27	FRI	162
HWU	21.75	EU1	183
DHO	23.4	CH1	198
TBB	26.7	MCO	216
ICE	37.5	RRU	261
NSY	45.9	CZE	270

The data collected are transmitted by Internet, every day, to the server located at the CNR-IAC, Bari (Italy) that is the central node of the network.

INFREP web site (http://www.infrep-network.eu/)

In order to reveal possible seismic precursors, the radio data had to be analyzed for discovering "anomalies", which differs from normal variations of the data trends. Different methods of analysis as the residual dA/dP (Rozhnoi et al., 2004), the terminator time TT (Hayakawa et al., 1996), the Wavelet spectra and the Principal Component Analysis could be used (Biagi et al., 2006; 2008). Sometimes, also the visualization of the raw trend could be sufficient.

Here this last method is used.

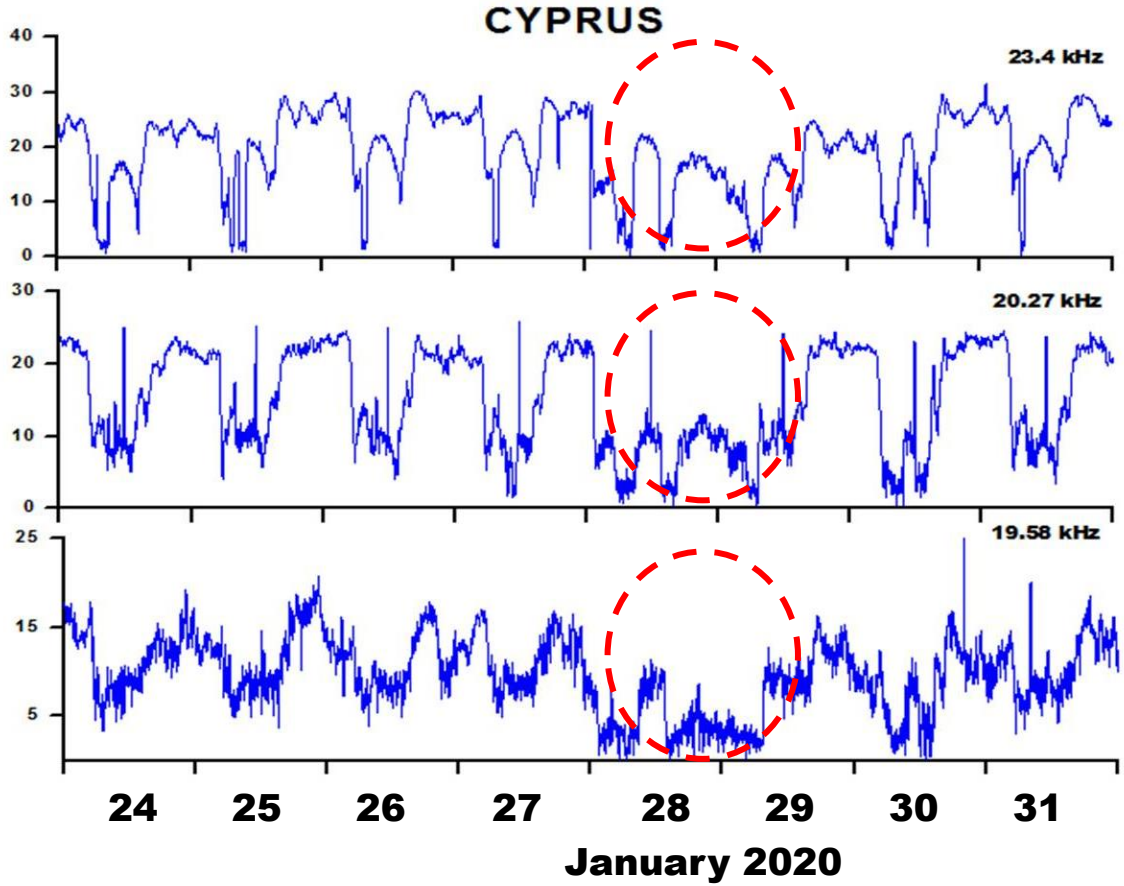
In any case the individuation of an anomaly is not sufficient to claim a radio precursor. In fact, as well as the preparatory phase of earthquakes, other causes can produce radio anomalies: solar flares, anomalous geomagnetic activity and adverse meteorological conditions mainly around the receiver location. These effects can produce radio anomalies very similar to the pre-seismic ones; so, before to claim radio precursors it is necessary to check these effects.

In addition possible malfunction of the receiver or of the transmitter must be examined.

DODECANESE ISLANDS EARTHQUAKE (JANUARY 30, 2020)

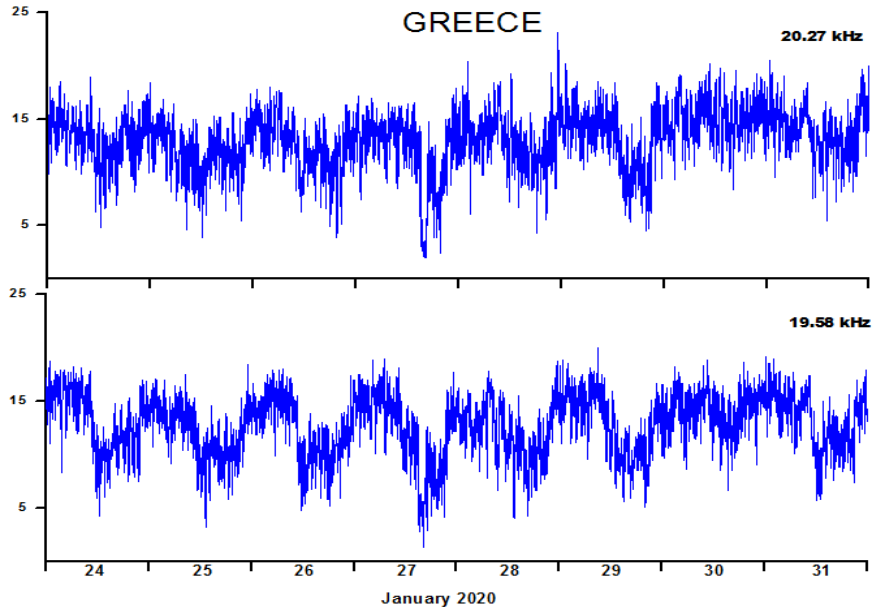
On January 30, 2020 an earthquake with Mw=6.0 occurred in Dodecanese Islands. This event occurred in the "sensitive" zone of the Cyprus receiver of INFREP network as it is shown in the map where the red symbol indicates the location of the earthquake and the ellipses represent the 5th Fresnel zones related to the Cyprus receiver of the 19.58kHz, 20.27kHz and 23.40kHz transmitters.

In this occasion clear anomalies (night time decrease of the intensity) appeared on the 28-29 nigth in the trends of the previous three VLF radio signals collected by the receiver as it is shown in the Figure. Note that the trends of the other signals collected by this receiver do not show similar decreases. So, some malfunction of the receiver is unlike.

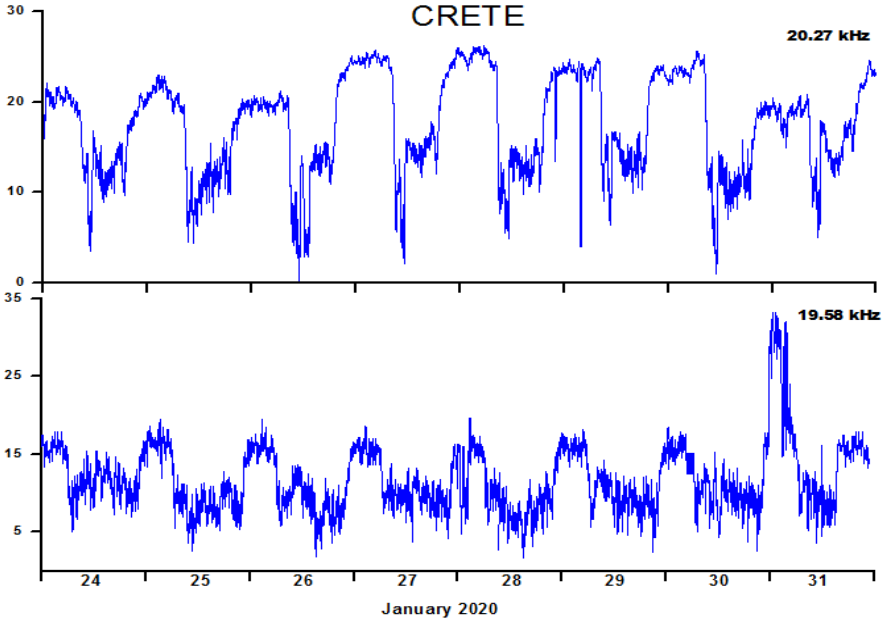


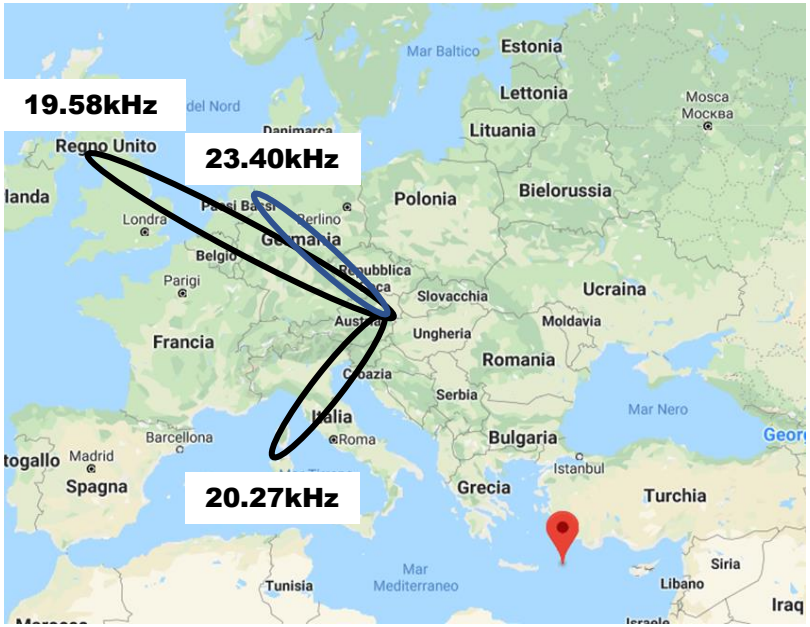
In order to corroborate the possibility that the previous decreases could be preseismic anomalies related to the Dodecanese earthquake , the data collected in the same period by the GRE, CRE, GRA and BAR (see map in slide 4) receiver have been examined. The trends are shown in next two slides.
Clearly, it appears that none anomaly stand up in these trends at the end of January.
So, at first a possible malfunction of the 19.58kHz, 20.27kHz, 23.40kHz transmitters should be excluded. Then, the appearence of some disturbance in the atmosphere of the epicentral area of earthquake as cause of the previous decreases appears very realistic.

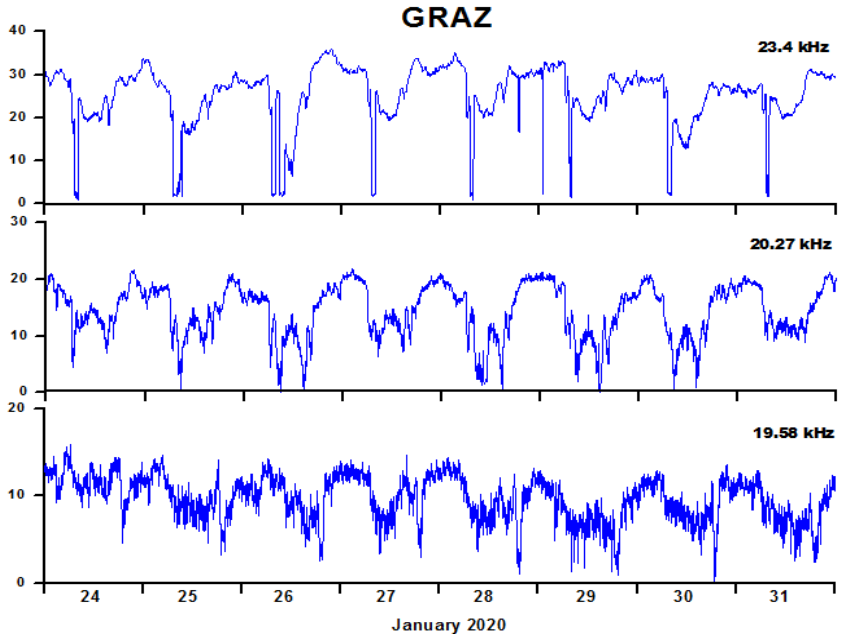

19.58kHz
20.27kHz
Mar Baltico
Estonia
Lettonia
Lituania
Mosca
Москва
Danimarca
Paesi Bassi
Berlino
Polonia
Bielorussia
Germania
Repubblica Ceca
Slovacchia
Ucraina
Austria
Ungheria
Moldavia
Francia
Romania
Serbia
Mar Nero
Bulgaria
Istanbul
Madrid
Spagna
Turchia
Mar Mediterraneo
Tunisia
Siria
Libano
Iraq

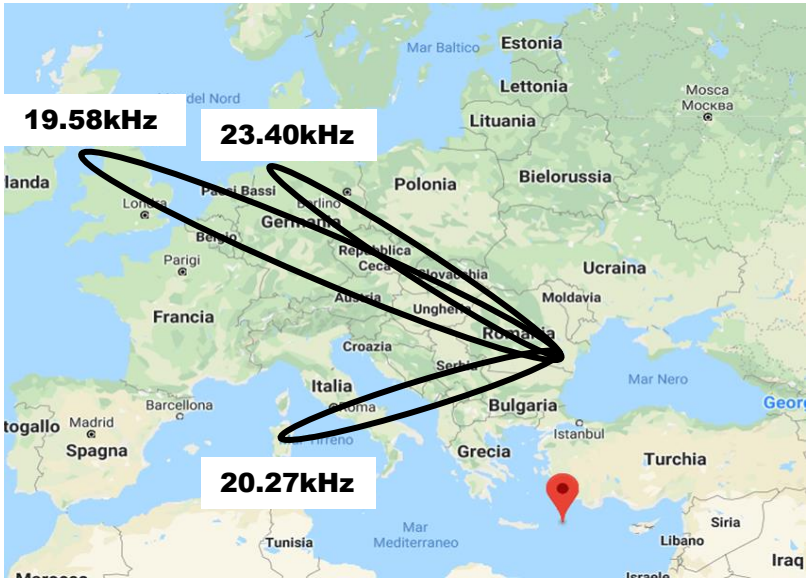

GREECE
20.27 kHz
19.58 kHz
25
15
5
24
25
26
27
28
29
30
31
January 2020

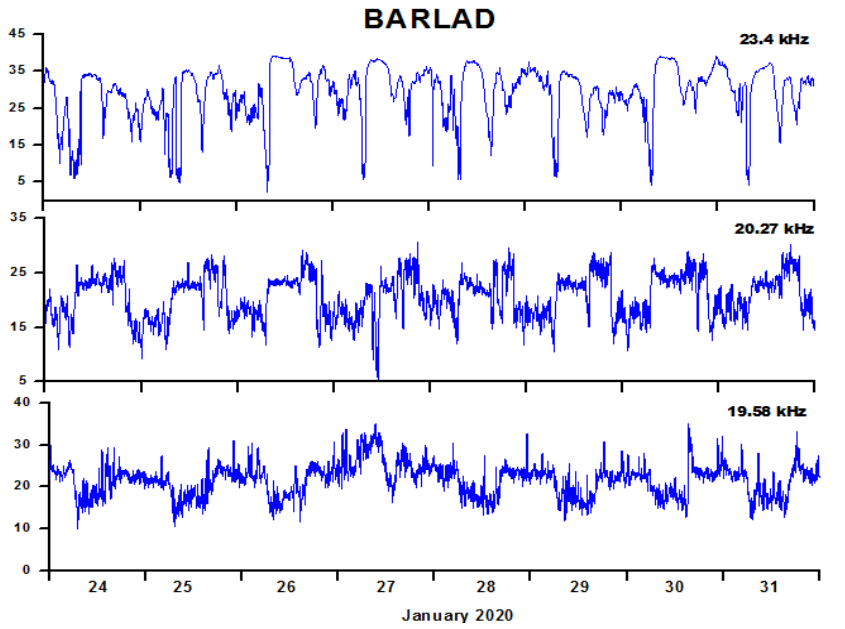

19.58kHz
20.27kHz
Mar Baltico
Estonia
Lettonia
Lituania
Mosca
Москва
Danimarca
Paesi Bassi
Berlino
Polonia
Bielorussia
Germania
Repubblica Ceca
Slovacchia
Ucraina
Austria
Ungheria
Moldavia
Francia
Romania
Serbia
Mar Nero
Bulgaria
Istanbul
Madrid
Spagna
Grecia
Turchia
Mar Mediterraneo
Tunisia
Siria
Libano
Iraq


CRETE
20.27 kHz
19.58 kHz
30
20
10
0
35
25
15
5
24
25
26
27
28
29
30
31
January 2020


19.58kHz
23.40kHz
20.27kHz
Mar Baltico
Estonia
Lettonia
Lituania
Mosca
Москва
Regno Unito
Polonia
Bielorussia
Londra
Berlino
Belgio
Parigi
Slovacchia
Ucraina
Francia
Ungheria
Moldavia
Romania
Serbia
Mar Nero
Barcellona
Roma
Bulgaria
Madrid
Spagna
Istanbul
Grecia
Turchia
Tunisia
Mar Mediterraneo
Siria
Libano
Iraq


GRAZ
23.4 kHz
20.27 kHz
19.58 kHz
24
25
26
27
28
29
30
31
January 2020


19.58kHz
23.40kHz
20.27kHz
Mar Baltico
Estonia
Lettonia
Lituania
Mosca
Москва
Polonia
Bielorussia
Parigi
Ucraina
Francia
Moldavia
Croazia
Italia
Mar Nero
Barcellona
Bulgaria
Madrid
Spagna
Istanbul
Grecia
Turchia
Tunisia
Mar Mediterraneo
Siria
Libano
Iraq


BARLAD
23.4 kHz
20.27 kHz
19.58 kHz
24
25
26
27
28
29
30
31
January 2020

No anomalous geomagnetic activity or adverse meteorological conditions appeared at the end of January 2020, so the possibility that the anomaly revealed in the radio signals collected by the Cyprus receiver is a precursor of the Dodecannese earthquake is convincing.

Note that this anomaly is by the standards pointed out for the radio precursors, i.e:
a) a precursor time within ten days
b) a value of M_w equal or greater than 6.0
c) the epicentre located inside the 5th Fresnel zone of the radio signal near the receiver (most sensitive zone).

CONCLUSIONS

The radio signals confirm their validity as earthquakes precursors.

The importance of using the data of a radio network clearly stands out from this presentation.

In any case in order to produce an earthquake forecast statistically significant one parameter is not sufficient. Only the simultaneous use of several different parameters could produce a success.