Electromagnetic signals that preceded the destructive earthquakes that occurred in Taiwan between April 2 and 3, 2024

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Abstract

Between 2 and 3 April 2024, two strong earthquakes occurred in Taiwan, resulting in a significant number of deaths and millions of euros in damage. The primary event also resulted in a tsunami that overwhelmed the population and infrastructure. In this study, the natural electromagnetic spectrum is analyzed a few days before these earthquakes occurred, with the aim of investigating any electromagnetic signals as possible candidates for physical phenomena in the preparatory phases of earthquakes. The signals detected are characterized by very low frequencies, already noted during other potentially destructive earthquakes, and by RDF signals attributable to candidate pre-seismic signals.

1 – Premise

A magnitude M7.4 earthquake occurred on April 2, 2024 on the east coast of Taiwan at 23:58:11 (UTC), located on a reverse fault near the boundary between the Eurasian and Philippine Sea plates. The earthquake was followed by a magnitude M6.4 aftershock 13 minutes later, at 00:11:25 (UTC). This tectonically complex region has historically produced many other large M 7+ earthquakes. Over the past 50 years, another six earthquakes of magnitude M7+ have occurred within 250 km of the April 2, 2024 earthquake. The largest of these was a magnitude M7.7 earthquake in September 1999 (the Chichi earthquake) that triggered at least 2,297 fatalities, caused an estimated $14 billion in damage, and occurred 59 km east of the April 2, 2024 event. In 1920, a magnitude M8.2 earthquake, potentially associated with the subduction zone interface between the Philippine Sea and the Eurasian plates, occurred immediately to the east of the April 2 earthquake. [1] This is an area with high seismic risk where many people live. Taiwan is in fact known for its dynamic economic development, especially in the field of technology. It is one of the world's largest manufacturers of semiconductors and electronic components. Taiwan's economy is one of the most advanced in Asia, with leading sectors including electronics, petrochemicals, and precision engineering.

2 – Method and Data

The study of these two seismic events was approached starting from the verification of the presence of relevant electromagnetic signals, recorded by the RDF (Radio Direction Finding) and SELF Monitor network developed by the Radio Emissions Project since 2017 [2]. These detection stations are able to identify and record radio emissions of natural origin and provide information on their intensity, frequency, duration over time, and behavior, as well as the azimuth of origin [2] [3]. These data are able to identify the source (natural emitter) where these signals are generated with a certain error rate [4]. In the case of the study of the two Taiwanese earthquakes of magnitude M7.4 and M6.4, the first electromagnetic signals were recorded by the RDF station of Lariano, Rome, Italy, starting from March 29, 2024, at 01:05 UTC, and 08:00 UTC as visible in Fig. 1. And those of Pontedera, Pisa, Italy, from the SELF Monitor station (developed by the Radio Emissions Project), starting from 2 April 2024. While for the seismic data the researchers considered the USGS archive.

3 - Discussions

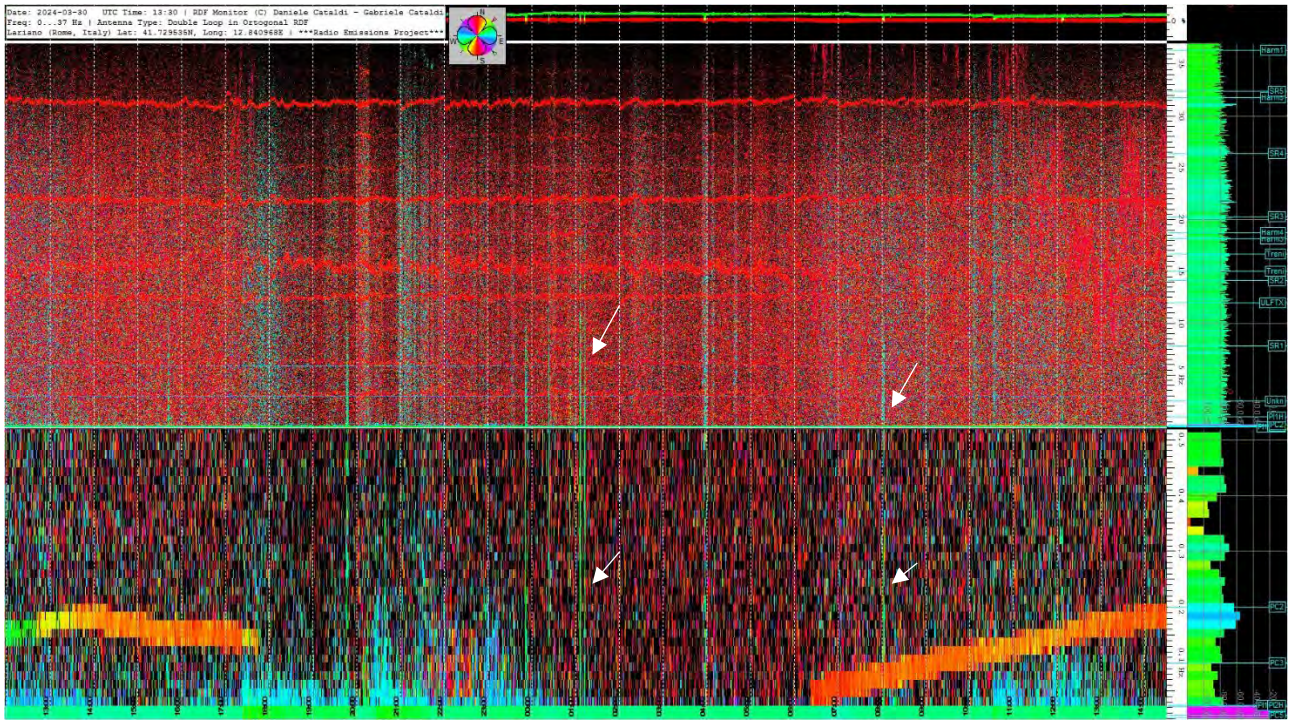

Fig. 1 – Dynamic Spectrogram recorded by the RDF station of Lariano, Rome, Italy, between 29 and 30 March 2024. The spectrogram shows the temporal context on the abscissae and on the ordinates we find the electromagnetic frequency of radio signals of natural origin. The colors of the signals are associated with their azimuth (direction) of arrival relative to the position of the RDF station. In this case, impulsive green/turquoise signals associated with the geographical area of Taiwan are highlighted. Credits: Radio Emissions Project.

As of March 29, 2024, the RDF station of Lariano, Rome, Italy, has identified electromagnetic signals which, although short-lived (3-5 minutes), occurred with a certain temporal cadence. These signals positioned at an electromagnetic frequency between: 0.0 and 15 Hz are not recordable by normal radio equipment which is not capable of detecting frequencies between the SELF (0-3 Hz) and ELF (3-30 Hz) signals. The same electromagnetic signal was then recorded at 01:00 UTC on March 31, 2024, also in this case the signal had a duration of 3-5 minutes and an electromagnetic frequency between 0.0 and 15 Hz. Shortly afterwards it occurred another emission, around 01:30 UTC on 31 March 2024, although of weaker intensity, with a duration of 3.5 minutes and an electromagnetic frequency between 0.0 and 7.5 Hz (Fig. 2). Electromagnetic signals then repeated themselves in the following hours. In this case the signals with electromagnetic frequency between 0.0 and 12 Hz appeared at the following times: 09:40 UTC (31 March 2024), 13:45 UTC (31 March 2024), 21:50 UTC (31 March 2024) , 00:05 UTC (1 April 2024). The duration of these signals is between 3 and 5 minutes, as visible in Fig. 3. And again, the analysis of the electromagnetic data highlighted a new series of electromagnetic emissions that appeared on 1 April 2024: the time is as follows : 02:00 UTC, 06:05 UTC, 10:02 UTC, 14:06 UTC. Also in this case the bandwidth of these signals was between 0.0 and 10 Hz, as visible in Fig. 4. These emissions occurred together with a whole series of increases in the natural geomagnetic background which showed a turquoise azimuth/ light blue, i.e. close to the Taiwan area but moved by a few hundred kilometers (Pacific area). In Fig. 5 we then notice a total change in azimuth of the natural geomagnetic background from red to blue/turquoise, starting from a strong emission which occurred at approximately 15:00 UTC with a bandwidth between 0.0 and over 35 Hz (at full band), as visible in Fig. 5.

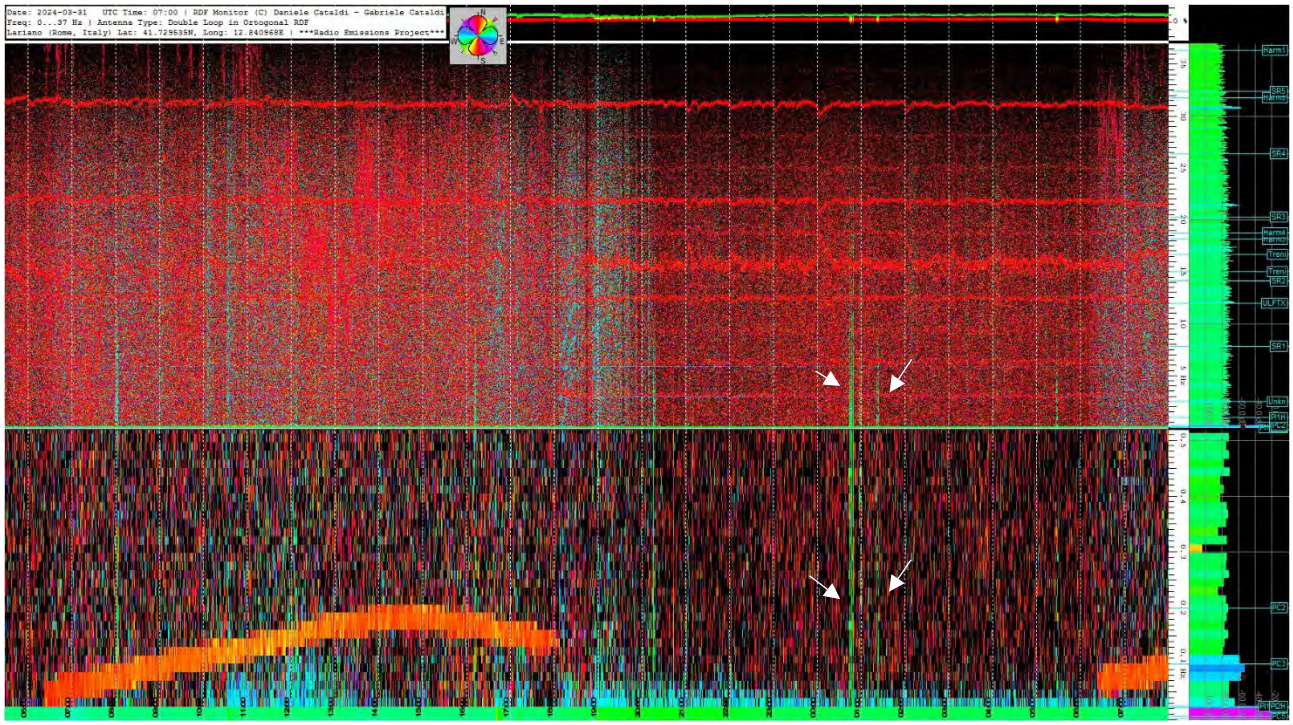

Fig. 2 – Dynamic spectrogram recorded by the RDF station of Lariano, Rome, Italy, between 30 and 31 March 2024. The spectrogram shows the temporal context on the abscissae and on the ordinates we find the electromagnetic frequency of radio signals of natural origin. The colors of the signals are associated with their azimuth (direction) of arrival relative to the position of the RDF station. In this case, impulsive green/turquoise signals associated with the geographical area of Taiwan are highlighted. Credits: Radio Emissions Project.

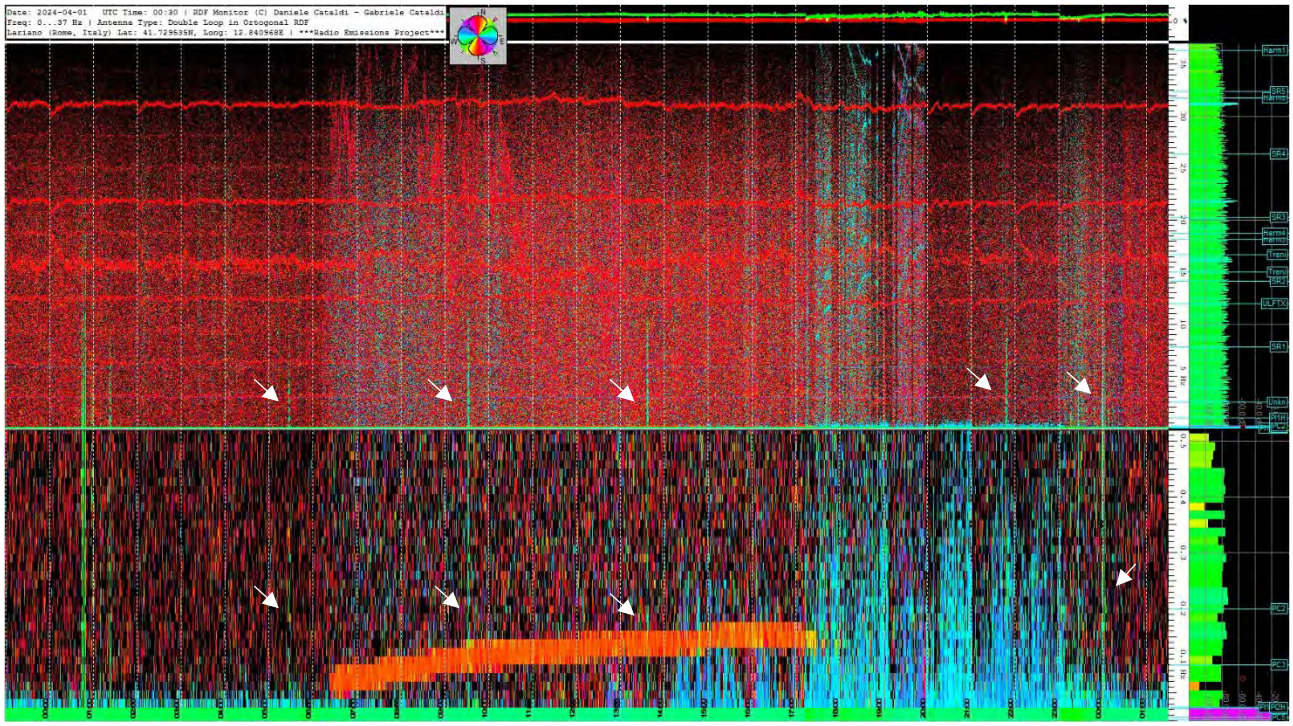

Fig. 3 – Dynamic spectrogram recorded by the RDF station of Lariano, Rome, Italy, between 31 March 2024 and 1 April 2024. The spectrogram shows the temporal context on the abscissae and on the ordinates we find the electromagnetic frequency of radio signals of natural origin. The colors of the signals are associated with their azimuth (direction) of arrival relative to the position of the RDF station. In this case, impulsive green/turquoise signals associated with the geographical area of Taiwan are highlighted. Credits: Radio Emissions Project.

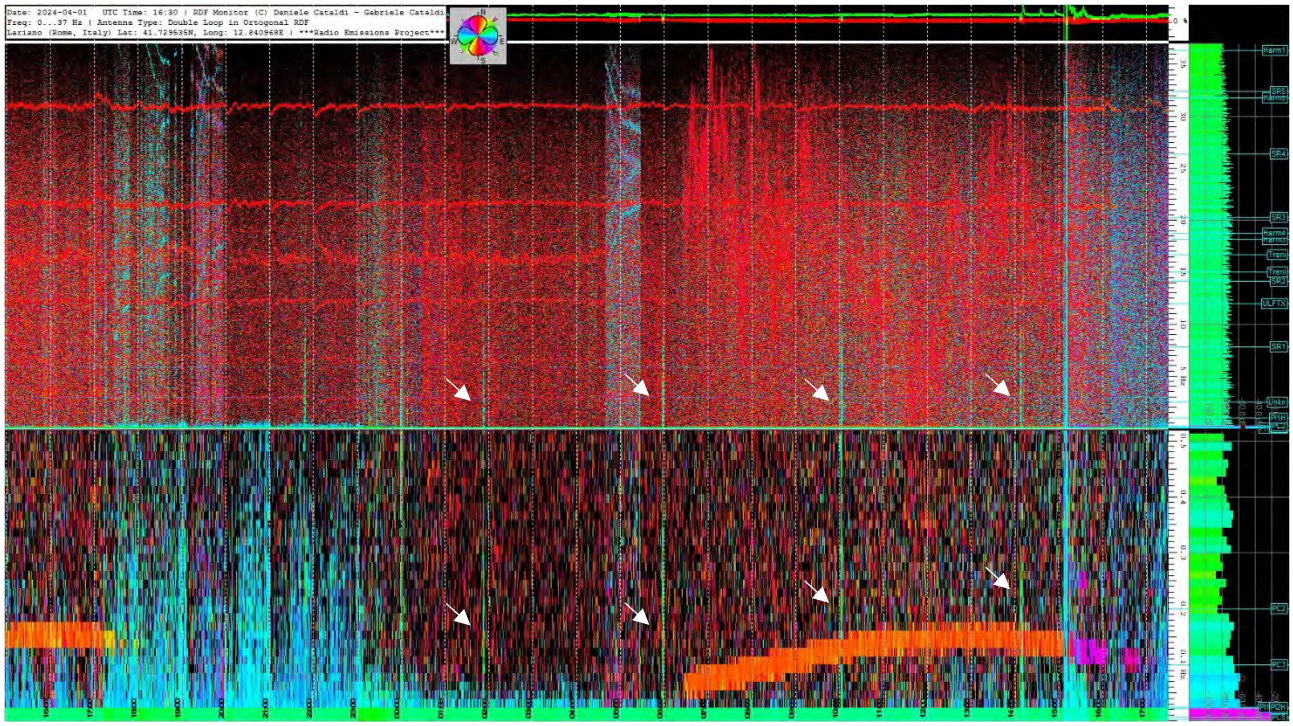

Fig. 4 – Dynamic spectrogram recorded by the RDF station of Lariano, Rome, Italy, between 31 March 2024 and 1 April 2024. The spectrogram shows the temporal context on the abscissae and on the ordinates we find the electromagnetic frequency of radio signals of natural origin. The colors of the signals are associated with their azimuth (direction) of arrival relative to the position of the RDF station. In this case, impulsive green/turquoise signals associated with the geographical area of Taiwan are highlighted. Credits: Radio Emissions Project.

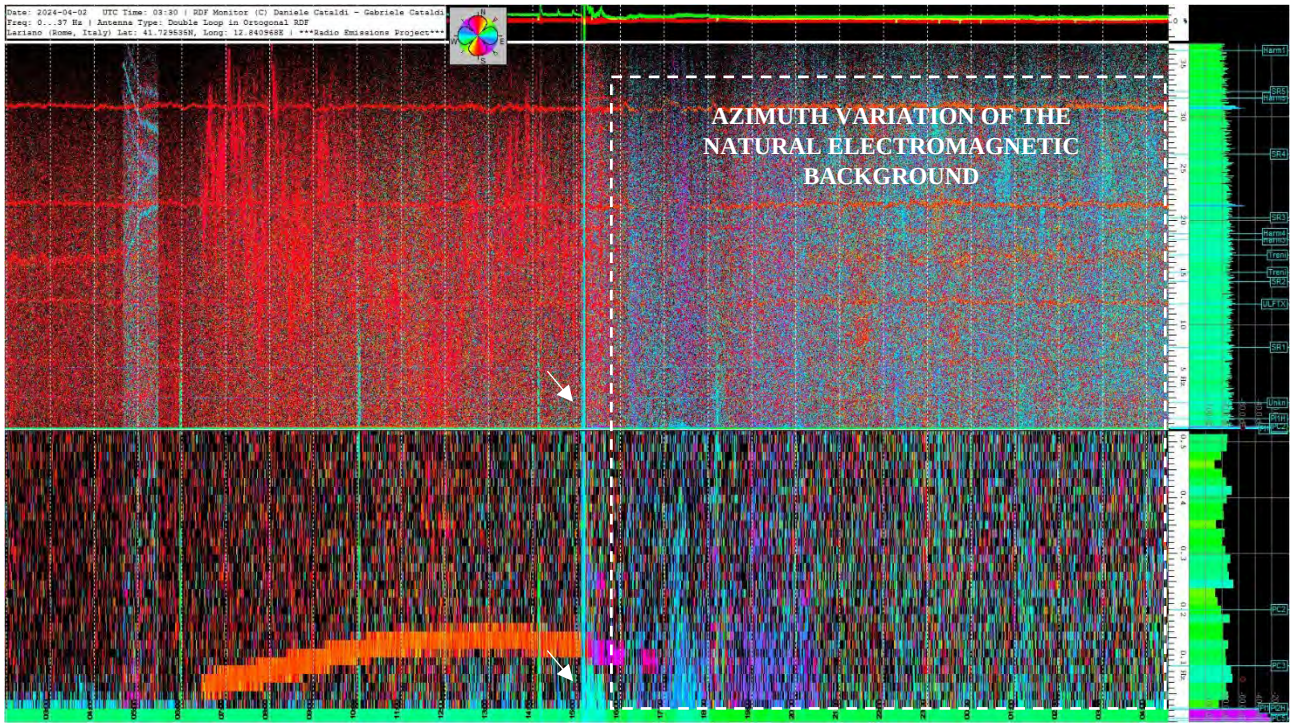

Fig. 5 – Dynamic spectrogram recorded by the RDF station of Lariano, Rome, Italy, between 1 April 2024 and 2 April 2024. The spectrogram shows the temporal context on the abscissae and on the ordinates we find the electromagnetic frequency of radio signals of natural origin. The colors of the signals are associated with their azimuth (direction) of arrival relative to the position of the RDF station. In this case, impulsive green/turquoise signals associated with the geographical area of Taiwan are highlighted. Credits: Radio Emissions Project.

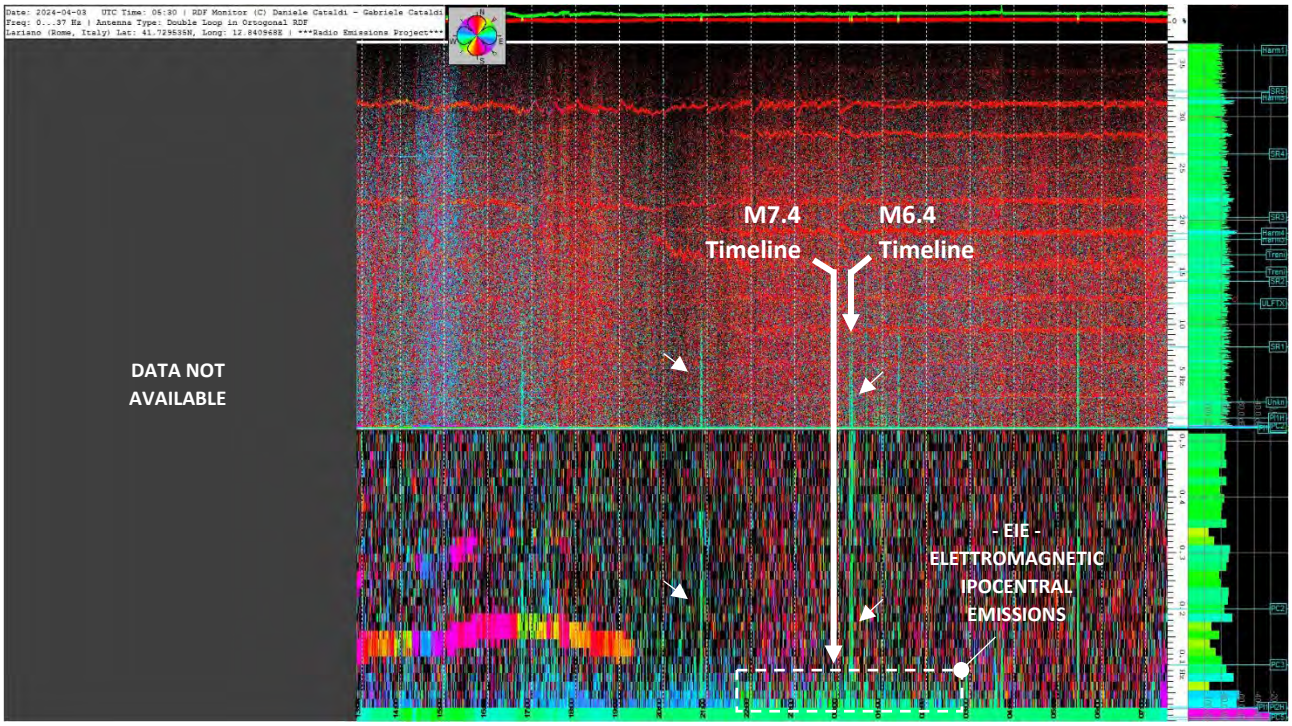

Fig. 6 – Dynamic spectrogram recorded by the RDF station of Lariano, Rome, Italy, between 2 April 2024 and 3 April 2024. The spectrogram shows the temporal context on the abscissae and on the ordinates we find the electromagnetic frequency of radio signals of natural origin. The colors of the signals are associated with their azimuth (direction) of arrival relative to the position of the RDF station. In this case, impulsive green/turquoise signals associated with the geographical area of Taiwan are highlighted. Credits: Radio Emissions Project.

Finally, the latest spectrogram recorded by the RDF station of Lariano, Rome, Italy, which shows emissions close to the time of the two earthquakes: 21:00 UTC on 2 April 2024, and one at 00:11 UTC on 3 April 2024, precisely on the time of the M6.4 aftershock, as visible in Fig. 6. In this case the electromagnetic emissions had the following duration. The first around 21:00 UTC lasted 3-5 minutes, the second and stronger emission lasted about 5-7 minutes. (Fig. 6).

In this spectrogram the signals highlighted the green/turquoise azimuth, as also in the other spectrograms, which refers to the Taiwan area.

Close to the two earthquakes, an increase in radio signals (natural electromagnetic background) at an electromagnetic frequency between 0.0 and 0.08 Hz was also observed. In this particular electromagnetic band, electromagnetic emissions are associated with those relating to local hypocentral emissions, i.e. electromagnetic emissions determined by the massive fracturing of the rock (lithosphere) at the surfaces of the faults. This emission appeared between 22:00 UTC on 2 April 2024 and 04:00 UTC on 3 April 2024, as visible in Fig. 6.

In the same time period, the electromagnetic station of the Radio Emissions Project located near Pontedera, Pisa, Italy, in the SELF band (0-3 Hz), recorded a truly notable electromagnetic increase (Fig. 7).

This radio anomaly appeared at 08:35 UTC, lasting until 10:30 UTC. The greatest intensity of the signal is visible in red, precisely at an electromagnetic frequency of 0.0 Hz (geomagnetic background), and then rises in frequency up to 1.3 Hz. This radio emission is in close temporal relation with the seismic events in Taiwan considered in this study, as visible in Fig. 7.

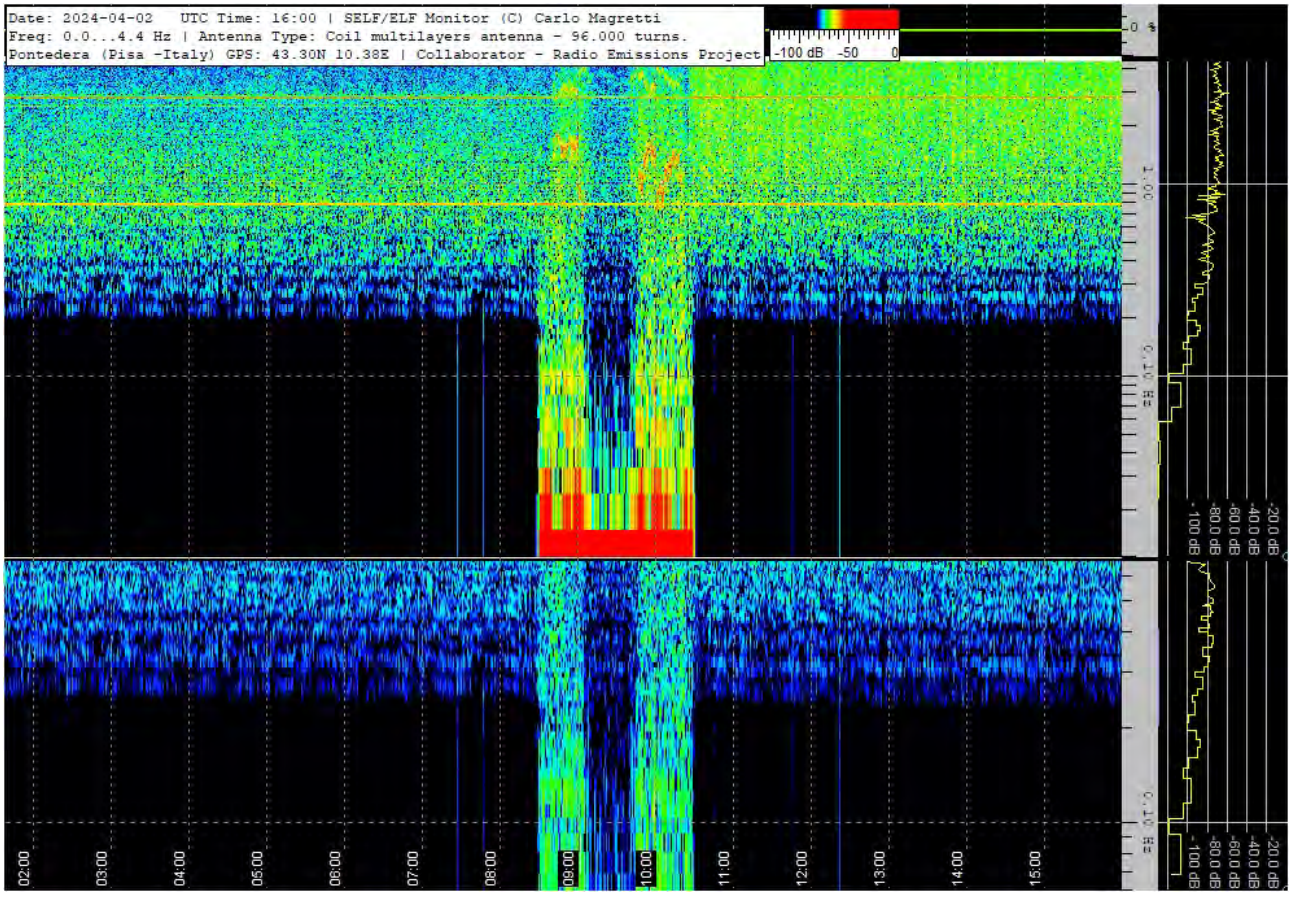

Fig. 7 – Dynamic spectrogram of the SELF Monitor station of Pontedera, Pisa, Italy, recorded on 2 April 2024, showing a particular recorded radio anomaly of natural origin. The electromagnetic frequency of radio signals is visible on the ordinates, and the UTC time on the abscissas. Credits: Radio Emissions Project, Carlo Magretti.

Further interesting details on these electromagnetic emissions also derive from the SELF station of Pontedera, Pisa Italy, which show, at the time of the two earthquakes in Taiwan, a clear lowering of the natural geomagnetic background between 10.30pm UTC on 2 April 2024 and 01:50 UTC on April 3, 2024, as visible in Fig. 8. Such a decrease in the natural electromagnetic background can be determined by the preparatory phenomena of the earthquake [5] [6] [7] [8] which can interact with the propagation of radio waves especially if coming from the hypocentral area at different electromagnetic frequencies [9] . In this case it could be a Destructive Interference that happens when two waves meet out of phase, i.e. the peaks of one wave align with the valleys of the other. This type of interference can reduce or completely cancel the amplitude of the resulting wave, attenuating or eliminating the signal [10].

4 – Conclusion

The electromagnetic detection system highlighted a series of emissions, which consist of decreases in the signals of the natural geomagnetic background or increases of the same geomagnetic background, which occurred temporally close to the seismic events in Taiwan of magnitude M7.4 and M6. 4 occurred between 2 and 3 April 2024. These radio emissions, considered radio anomalies, originated from the geographical area of Taiwan, as indicated by the RDF station of Lariano, Rome, Italy. This leads us to think that these electromagnetic emissions were generated by earthquake preparation phenomena, from a few days before to a few hours before the occurrence of the two earthquakes considered there. This is certainly not accidental, given that over the years, other emissions of this type have been found thanks to the use of the Italian RDF network by the same group of researchers and in seismic events of destructive magnitude. [11][12][13][14] [15][16][17]

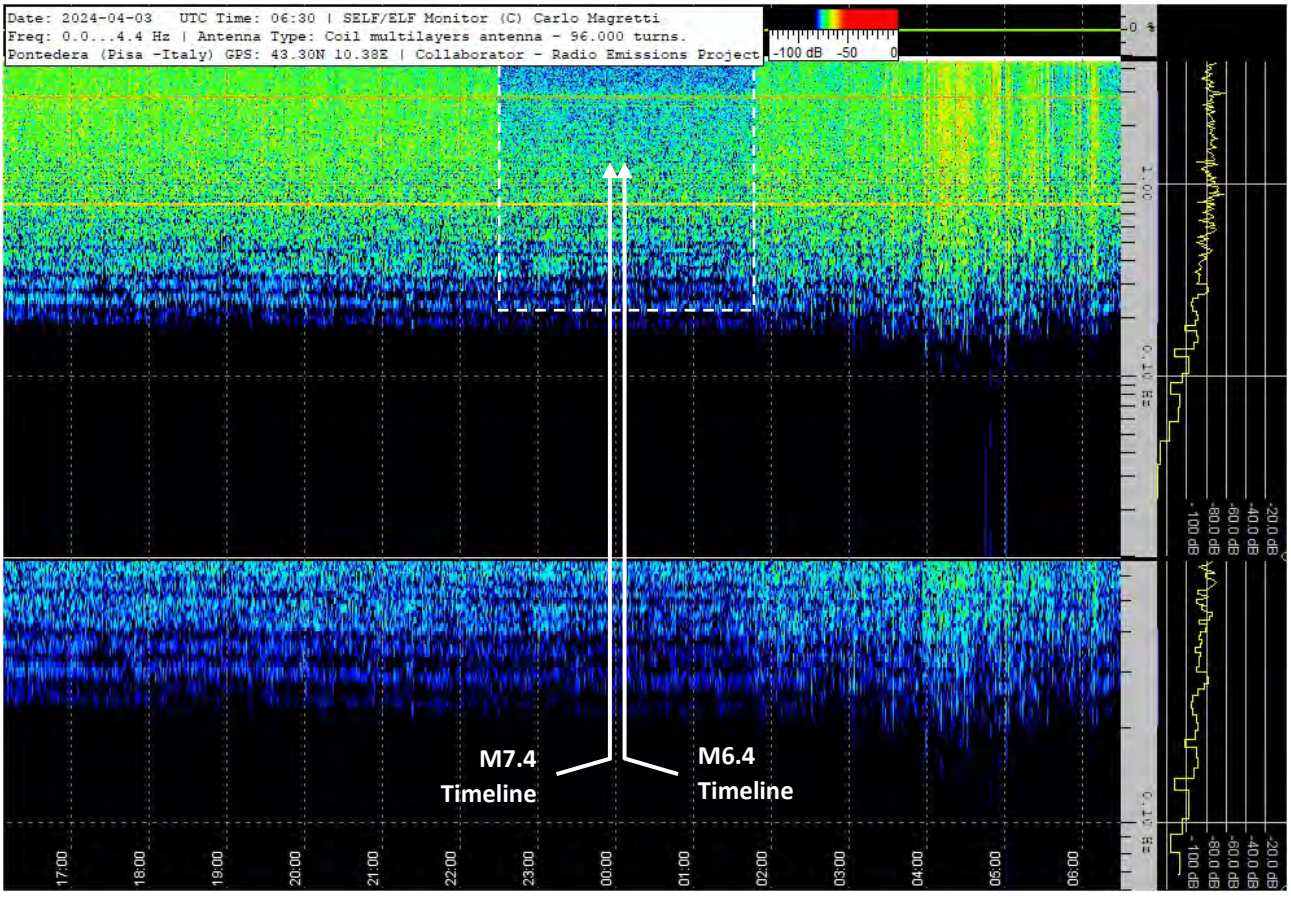

Figura 8 – Dynamic spectrogram of the SELF station in Pontedera, Pisa, Italy, recorded between April 2024 and 3 April 2024, showing a decrease in radio emissions from the natural geomagnetic background. The electromagnetic frequency of radio signals is visible on the ordinates, while the UTC time is visible on the abscissas. Credits: Radio Emissions Project, Carlo Magretti.

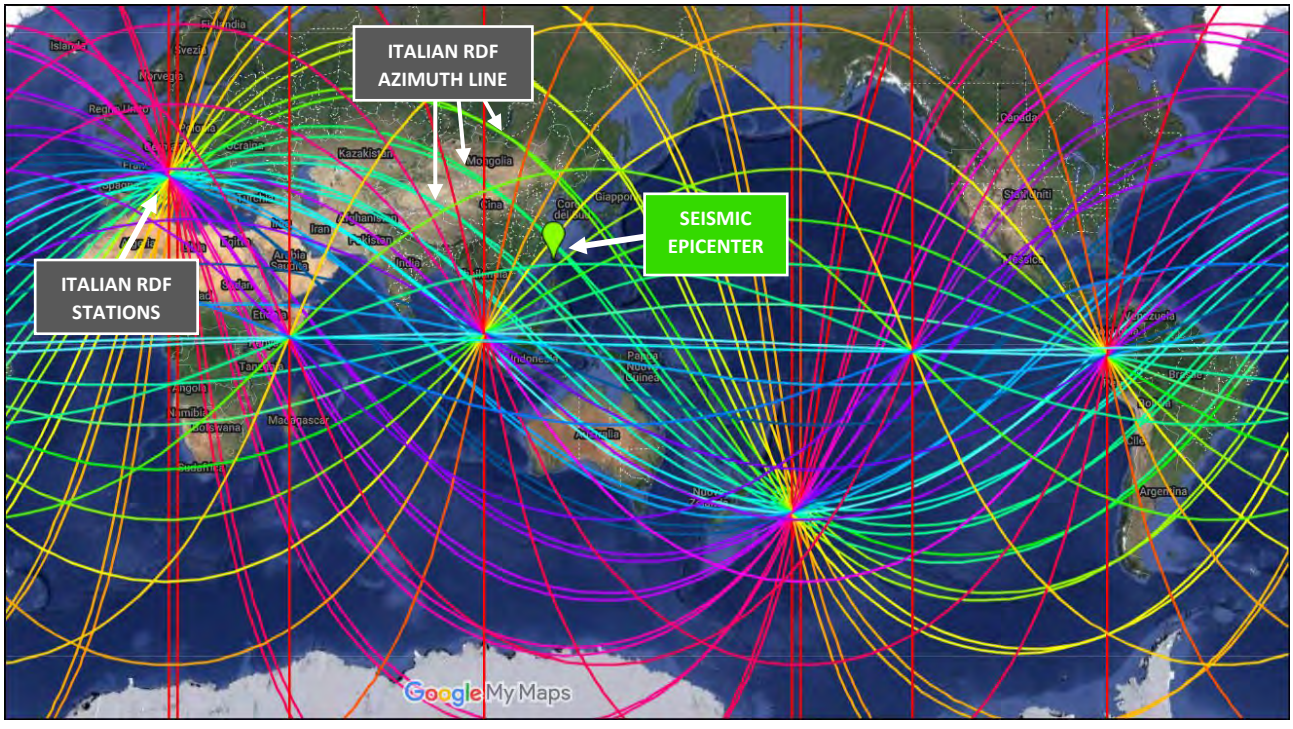

Fig. 9 – Global mapping of the RDF network, developed by the Radio Emissions Project. It highlights, among other things, the position of the Italian RDF stations and the point of the seismic epicenter. Credits: Radio Emissions Project, Google My Maps.

It can therefore be hypothesized that seismic events of this type are associated with physical phenomena capable of generating electromagnetic emissions (piezoelectricity) [18][19][20] and that such radio emissions (radio anomalies) can be generated with great power and propagated along the earth-ionosphere cavity, to be received even at great distances. In this case the distance that separates Taiwan from the Italian radio receiving stations is over 9,700 km. [21][22][23]

The colors of the azimuth lines of the RDF diagram, visible in Fig. 9 which depart from the Italian RDF stations, indicate that the detection system interprets the identified radio signals, giving them respective indications on their geographical origin (angle of origin). It is evident that the color of the radio signals visible on the dynamic spectrograms recorded by the RDF station of Lariano, Rome, Italy (from Fig. 1 to Fig. 6), geographically intercept the seismic epicenter of Taiwan, located over 9,700 km away. This indicates that such signals come from future epicentral areas. Other increases were observed from a radio reception system centered on the SELF band (0-3 Hz) which, again, shortly preceded the Taiwan earthquakes.

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