Electromagnetic signals that preceded the M4.8 magnitude earthquake that occurred between New Jersey and New York on April 5, 2024

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Abstract

This study presents the electromagnetic data, detected in Italy with the Radio Direction Finding system, which preceded the earthquake of 5 April 2024. At 14:23:00 UTC a medium energy earthquake of M4 occurred. .8, in the United States, in New Jersey, Whitehouse station, a few kilometers from New York. The data discussed in this research are the result of continuous 24/7 monitoring and were considered to verify whether the direction of arrival of the electromagnetic signals can be associated with the direction of the future epicentral area, despite the considerable distance between the Rome station and New York. In particular, during the monitoring, low frequencies were recorded with the azimuth coming from the future epicentral area, already ten days before the earthquake occurred. Similar frequencies appeared, respectively, nine and four days before the earthquake.

1 – Introduction

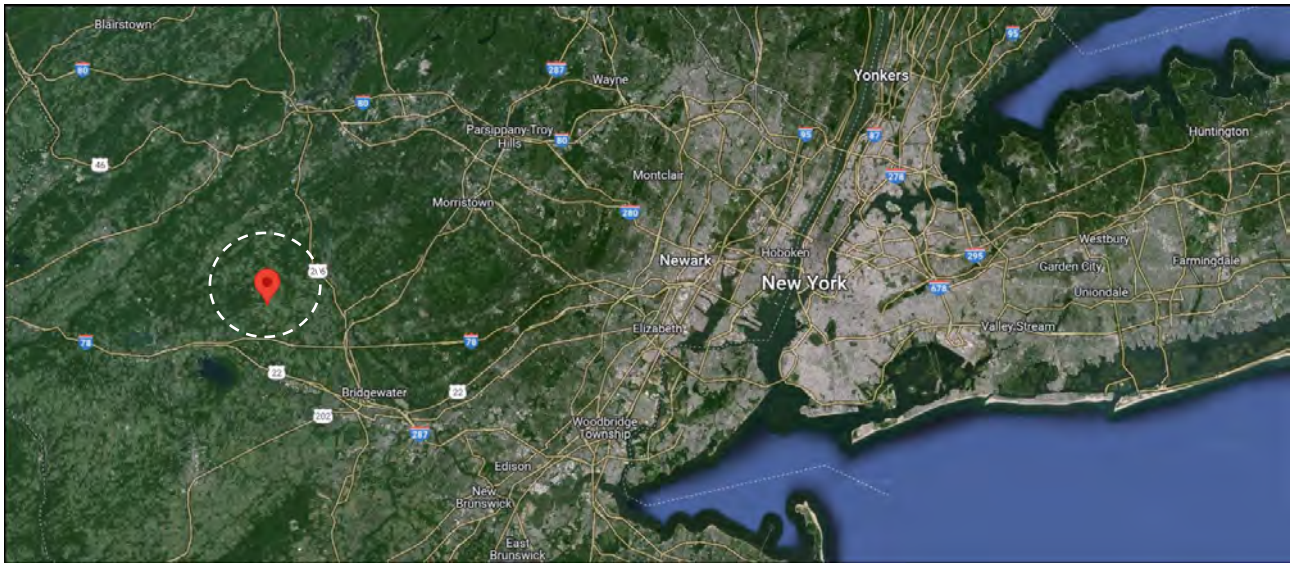


Fig. 1 - Satellite map of the position of the seismic epicenter only 70 km away from one of the largest metropolises in the United States: New York. Credits: Google Maps, USGS Data.

The recent 4.8 magnitude earthquake that affected the New Jersey area, with its epicenter located 70 kilometers from New York, has reopened the debate on the safety of large urban centers and metropolises, threatened by strong and potentially destructive earthquakes. For several years, experiments have been underway in different parts of the world to try to identify reliable seismic signals which, in the future, can contribute to carrying out preventive assessments to counteract the effects of a potentially strong earthquake. At the current state of research on seismic precursors, despite some successes, the results fall within the scope of crustal diagnoses for a better understanding

of the trigger mechanism of earthquakes. The Radio Direction Finding (RDF) network, based on the interception of electromagnetic signals coming from the future epicentral area and detectable instrumentally, stands as a candidate for a broader application on a global scale. This study presents the results of the RDF experiment relating to the signals that preceded the New Jersey earthquake. Signals detectable from a few kilometers to thousands of kilometers away, in a time window of ten days and more usually five days before the seismic event.

The area where this earthquake occurred is Whitehouse Station, New Jersey, a community located in Hunterdon County with a population that has shown significant growth over the years. According to census data, the population was 2,089 people in 2010 and reached 3,152 residents in 2020, showing an increase of 50.9% in a decade [1]. The most recent data indicates a population of approximately 3,129 residents in 2023, with a population density of 1,242 people per square mile. This area is characterized by a high population density compared to other rural areas, but still remains lower than large metropolitan areas [1]. The area between Whitehouse Station, New Jersey, and New York City is characterized by a rich variety of critical infrastructure and a dense population.

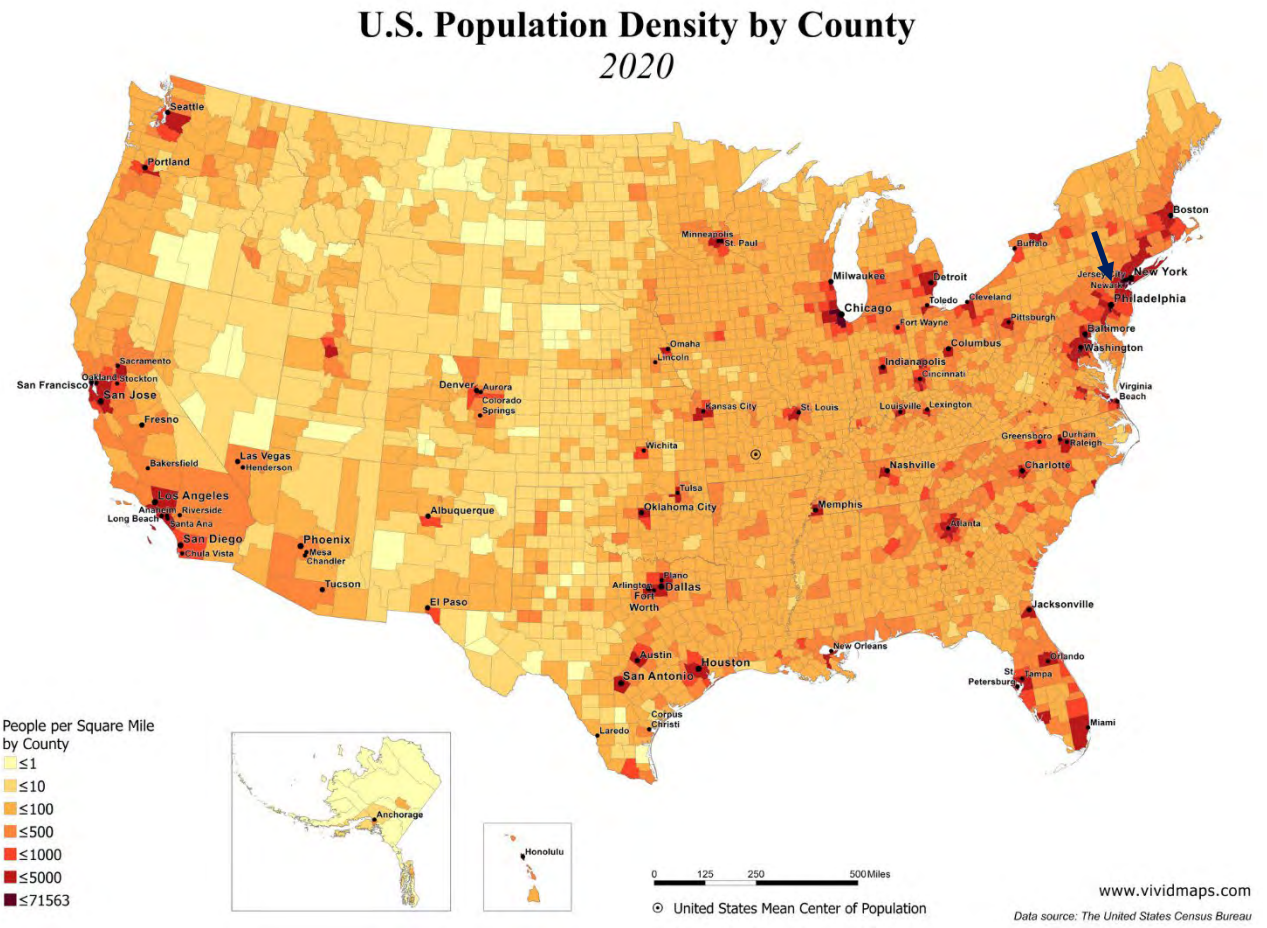


Fig. 2 – Population density of the United States by county in 2020. As you can see, the area in which the earthquake considered in this study occurred has a high population density (dark arrow). Credits: United States Census Bureau.

This area represents one of the highest population densities in the United States, also due to its proximity to greater New York. [2] [3] [4] [5] [6] In this area, in fact, statistical data indicate a very high growth in the population over the last 10 years, and in general a number of inhabitants of several tens of millions. What would happen if a strong earthquake occurred in this area? What damage would it cause, what critical issues would it raise and how many deaths would it cause if it were not possible to have a system capable of warning sufficiently in advance of the occurrence of a strong earthquake?

2 – Method and Data

The April 5, 2024 magnitude 4.8 earthquake near Whitehouse Station, New Jersey, occurred due to oblique reverse and strike-slip faulting at shallow depths in the crust. Although this event did not occur near a plate boundary, such "intraplate" earthquakes can and do occur. While this earthquake is relatively small globally, earthquakes of this magnitude are commonly felt widely across the eastern United States due to the efficient propagation of seismic waves in the region.

Earthquakes in the eastern United States are rare but not unexpected. Since 1950, another 40 earthquakes of magnitude 3 and above have occurred within 250 km of today's quake. In this time interval, the earthquake of April 5, 2024 is the largest. Within 500 km of the April 5 earthquake, 13 earthquakes of magnitude M 4.5 and above have been recorded since 1950, the largest of which was the August 23, 2011 earthquake of magnitude 5.8 which caused substantial damage and was felt in all the eastern United States. The April 5, 2024 earthquake occurred in a region where faults have previously been identified that can be reactivated at any time.

The group of researchers engaged in this study analyzed the data of electromagnetic signals of natural origin, recorded through the Italian RDF - Radio Direction Finding network, developed by the Radio Emissions Project starting from 2017 [7], an electromagnetic monitoring network capable of identifying, recording and processing all signals of natural origin included in the SELF to VLF band (i.e. from 0 to 30 kHz). [8] This network is made up of a series of radio sensors, capable of identifying the intensity of these natural signals, their electromagnetic frequency, bandwidth, time of appearance and disappearance, behavior and even their direction of arrival, and therefore understand from which geographical area these are generated. [9] [10] [11] [12] [13] [14] [15]

The group of researchers wondered whether the earthquake had been preceded by electromagnetic precursor signals which could have indicated the preparatory phase of the earthquake in time.

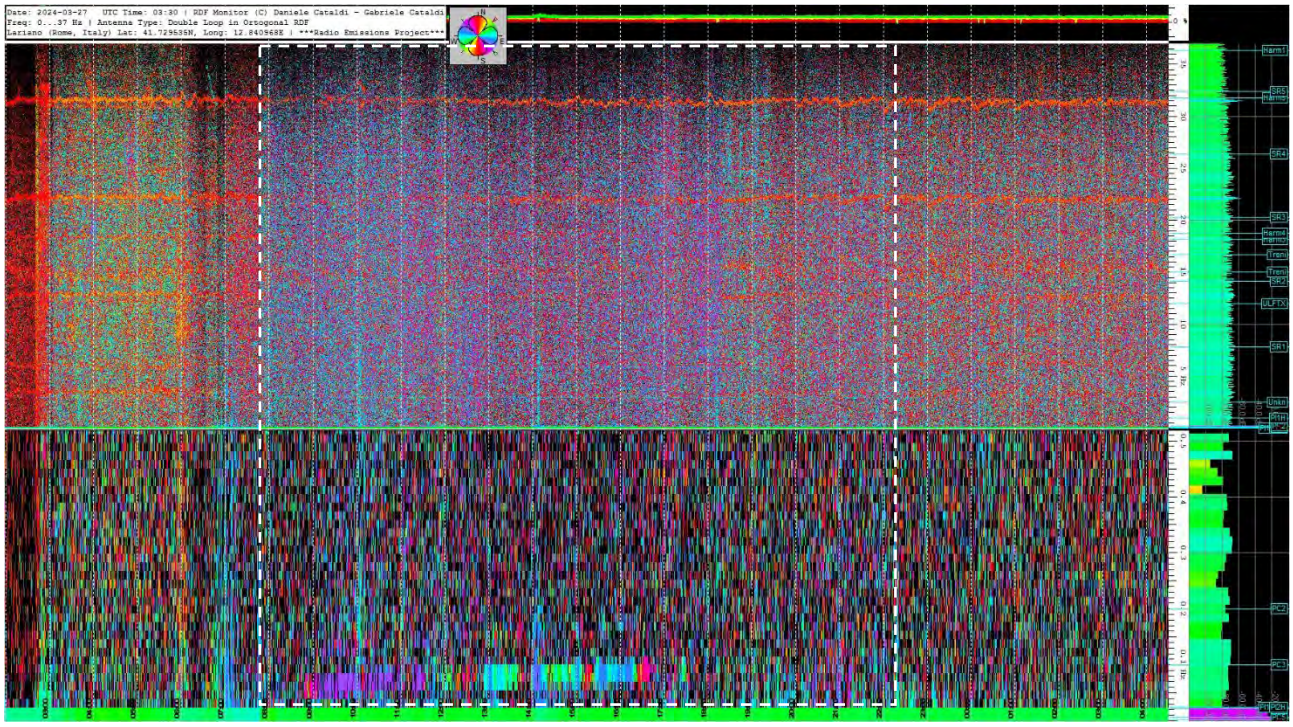


Fig. 3 – Dynamic spectrogram recorded between 26 and 27 March 2024 from the Lariano station, Rome, Italy, it shows the natural electromagnetic background. On the abscissas the UTC time, on the ordinates the electromagnetic frequency of radio signals. Credits: Radio Emissions Project.

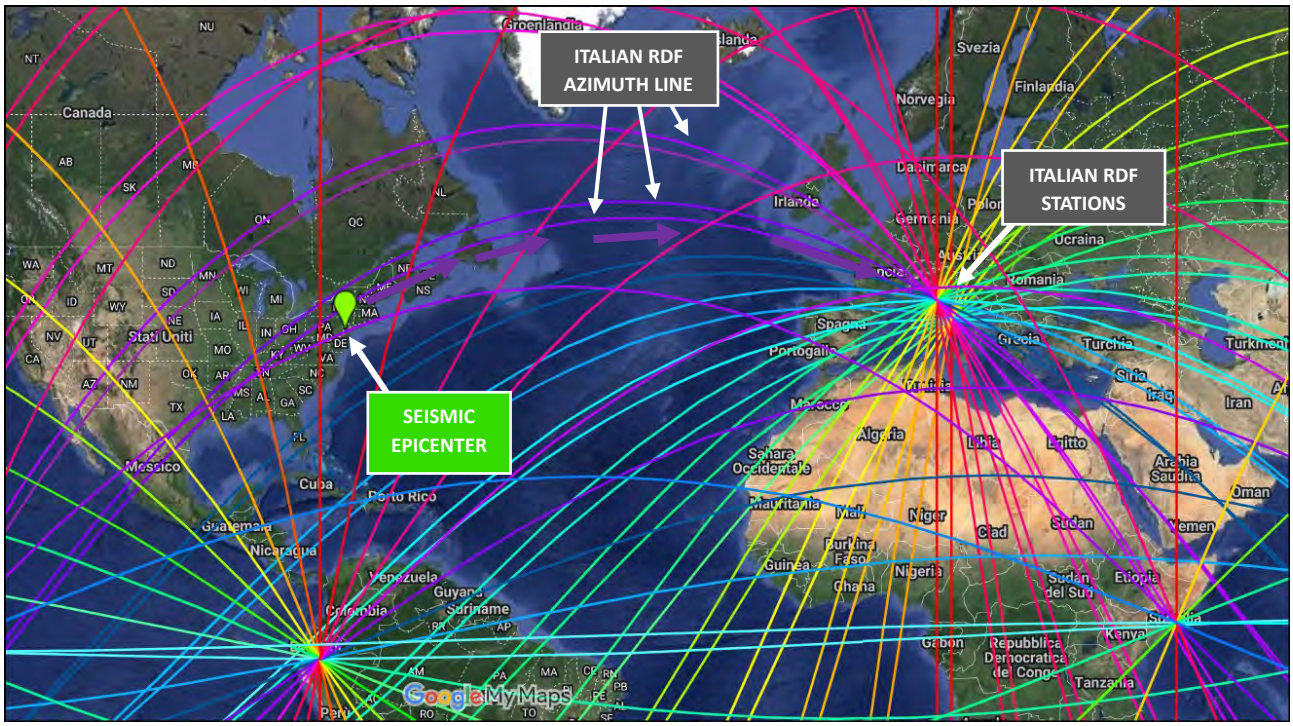


Fig. 4 – World colorimetric map, of the RDF network. In this case, the position of the seismic epicenter and the various azimuths departing from Italy are highlighted (Italian RDF stations). It is clear that the azimuth of origin of the radio signals is blue/violet, recorded from the RDF station in Lariano Rome, Italy, (in the direction of the local NNW). Credits: Radio Emissions Project; Google My Maps.

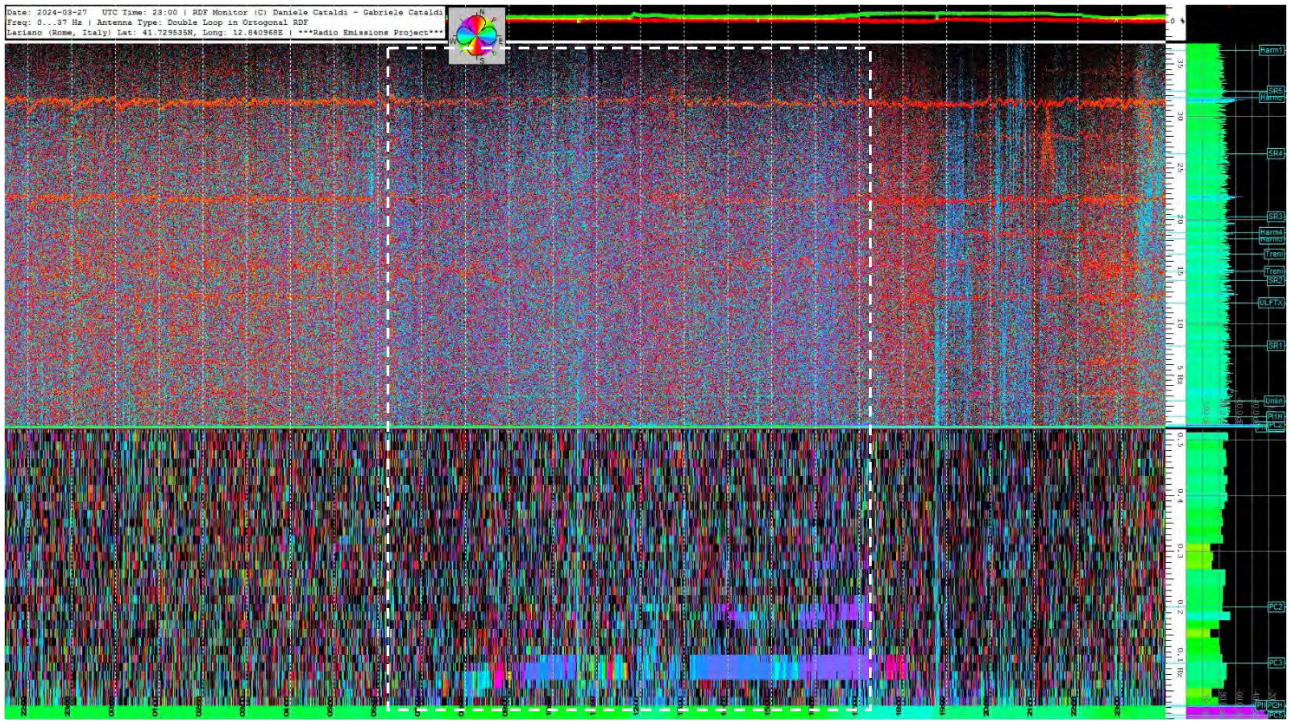


Fig. 5 – Dynamic spectrogram recorded between 26 and 27 March 2024 from the Lariano station, Rome, Italy, it shows the natural electromagnetic background. On the abscissas the UTC time, on the ordinates the electromagnetic frequency of radio signals. Credits: Radio Emissions Project.

Around 08:00 UTC on March 26, 2024, the natural geomagnetic background presented a variation in azimuth from red to blue/purple, as visible in Fig. 3. This variation included the entire electromagnetic band analyzed by the Italian RDF network. 0-35 Hz. The blue-purple color indicates signals coming

from the NNW direction (as visible in the colorimetric map Fig. 4) with respect to the geographical position of the RDF station of Lariano, Rome, Italy. This azimuth variation, blue/purple in colour, had its maximum intensity until approximately 19:00 UTC, subsequently lasting for other hours.

Fig. 5 shows the trend of electromagnetic emissions in the following hours, in which new increases in the natural geomagnetic background are observed between approximately 05:00 UTC and approximately 17:00 UTC on March 27, 2024, with emissions that have presented an electromagnetic frequency between 0.0 and 35 Hz. In these 10 hours, the natural electromagnetic background varied intensely towards a precise azimuth, i.e. the one coming from the NNW of Italy, in the direction of New Jersey and New York, just as happened some hours before (spectrogram visible in Fig. 3).

In the following hours the geomagnetic background resumed its "normal" color, i.e. between light blue and red, demonstrating that the emissions in the direction of New Jersey and New York had ended.

However, they recurred again, with a new colorimetric variation of the geomagnetic background between 16:00 UTC on 1 April 2024 and 03:00 UTC on 2 April 2024. This colorimetric change appeared suddenly and also in this case the signals electromagnetic waves highlighted with blue/purple color from the RDF station of Lariano, Rome, Italy, indicated the direction of New Jersey and New York (Fig. 6), with electromagnetic frequency between 0.0 and 35 Hz. In particular in Fig. 6 observe a further appearance of electromagnetic signals, this time in the SELF band (0-3 Hz), between 18:30 UTC and 21:00 UTC on 1 April 2024, with an electromagnetic frequency (bandwidth) between 0.0 Hz and 0.5 Hz.

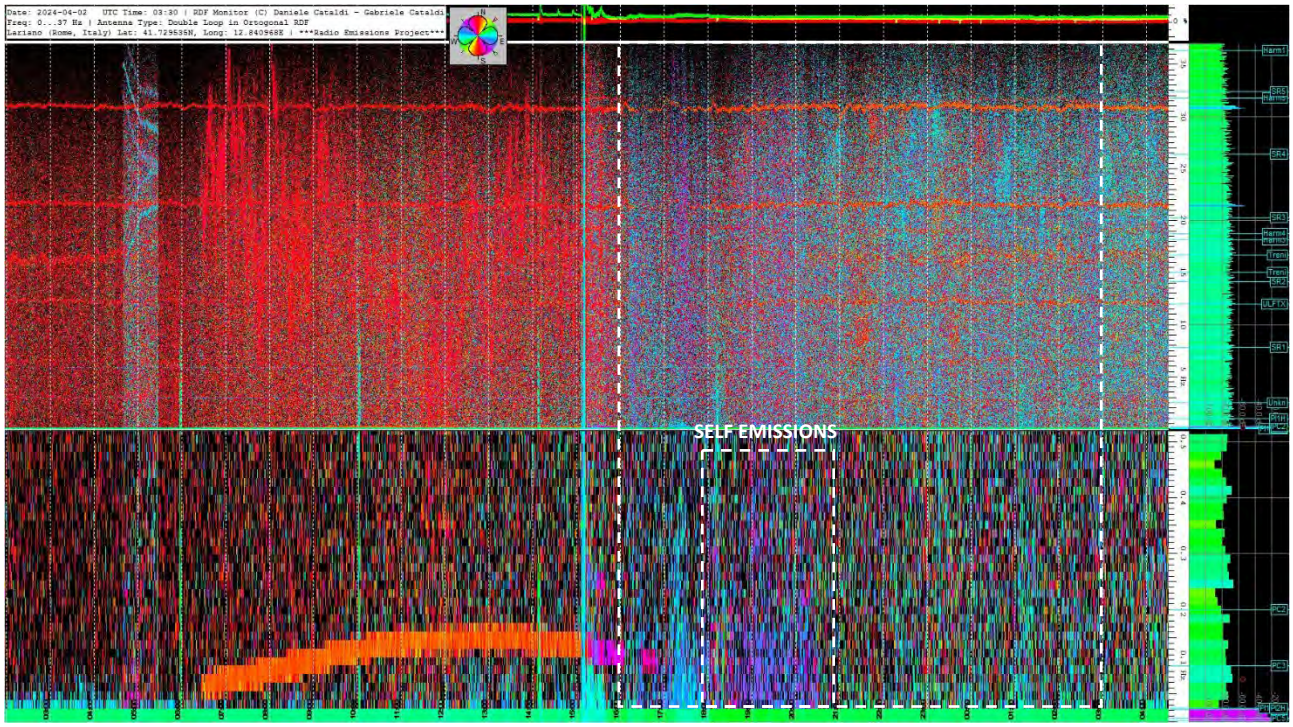


Fig. 6 – Dynamic spectrogram recorded between 1 and 2 April 2024 from the Lariano station, Rome, Italy, it shows the natural electromagnetic background. On the abscissas the UTC time, on the ordinates the electromagnetic frequency of radio signals. Credits: Radio Emissions Project.

This increase, the one recorded on 18:00 UTC and 21:00 UTC on 1 April 2024, was the last electromagnetic increase recorded by the RDF station of Lariano, Rome, Italy, which had North America as its azimuth of origin , while the earthquake occurred on April 5, 2024 at 14:23 UTC, almost 4 days later.

3 – Conclusions

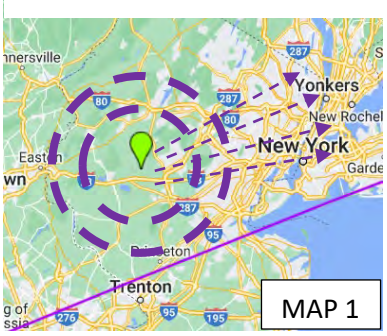
The recordings of the RDF network processed by the electromagnetic reception system between March 26, 2024 and April 2, 2024, highlighted a series of electromagnetic signals that showed an azimuth of origin of the electromagnetic signals from the geographical area of New Jersey and New York, an area with a high concentration of population and technological infrastructure, where a medium-magnitude earthquake occurred, putting them at risk.

In this context, the time gap between the first recorded signals and the occurrence of the M4.8 magnitude earthquake was approximately 10 days, with particular electromagnetic emissions recorded 4 days before.

The possibility of recording pre-seismic electromagnetic signals 10 days before a seismic event would make it possible to mitigate the problems of seismic risk in a specific area of the globe.

We know well, for example, what the timescales are for the safety of millions of people, in a large city, it would take a few days, other days would be needed to organize and prepare for the post-earthquake.

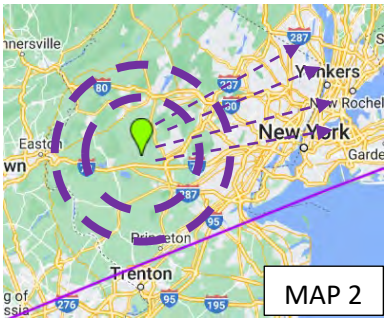
10 days before the earthquake



Map of the New Jersey and New York area, March 26-27, 2024: pre-seismic electromagnetic signals present emissions at a full-band frequency.

0.0 – 35 Hz.

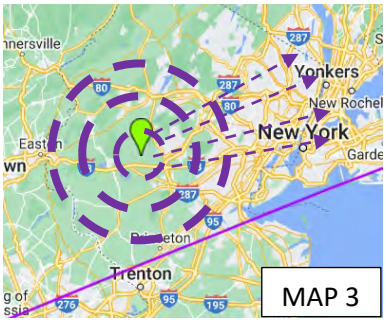
9 days before the earthquake



Map of the New Jersey and New York area, March 27, 2024: pre-seismic electromagnetic signals present emissions at a full-band frequency.

0.0 – 35 Hz.

4 days before the earthquake



Map of the New Jersey and New York area, April 1, 2024: pre-seismic electromagnetic signals present emissions at a very low frequency, together with the normal increase in the natural electromagnetic background.

0.0 – 0.5 Hz and 0.0 – 35 Hz.

Map 1 and 2 show the (circular) electromagnetic emissions that start from the center of the future seismic epicenter (green markers) and also propagate in the direction of New York, to reach Italy, where the RDF network will identify them.

In Map 3, these (circular) emissions become denser, due to the emission of further radio anomalies which are also distributed at lower frequencies and do not only include the natural geomagnetic background.

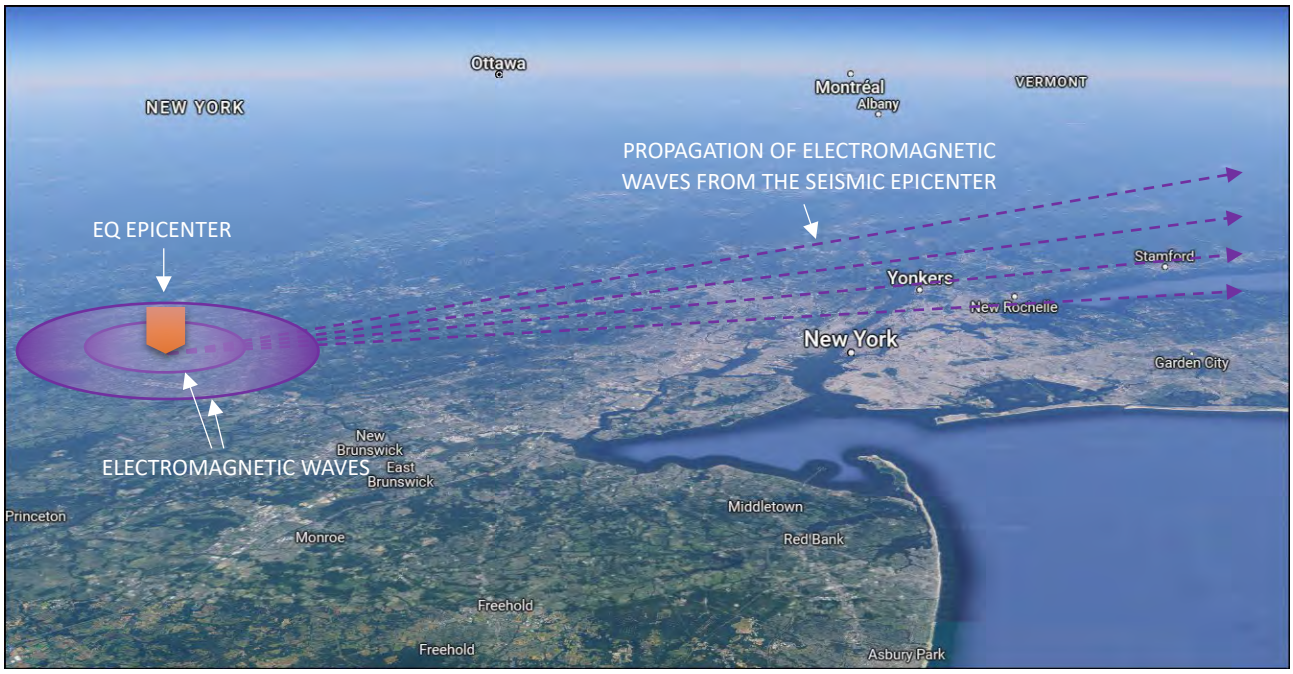


Fig. 7 – Satellite map of the area where the M4.8 magnitude earthquake occurred, between New Jersey and New York. Specifically, the reconstruction of the electromagnetic emissions emitted and propagated from the area of the seismic epicentre. Credits: Google Maps.

In Fig. 7, the future seismic epicenter of the New Jersey M4.8 earthquake, in which the electromagnetic emissions that reach Italy propagate starting from 10 days before the earthquake, up to approximately 4 days before the seismic event (as also described in Maps 1, 2 and 3). In this case the preparatory phenomena of the earthquake, of the electromagnetic type, are induced by piezoelectricity phenomena. Piezoelectricity is a physical phenomenon in which some crystalline materials (such as quartz) generate an electrical voltage in response to an applied mechanical pressure. This property allows mechanical energy to be converted into electrical energy and vice versa. In the seismic context, the concept of piezoelectricity takes on a significant role in two main areas of interest: the generation of warning signals of earthquakes and the analysis of the mechanisms that contribute to their genesis. [16]

In this context, the group of researchers identified and analyzed electromagnetic signals resulting from the piezoelectricity phenomena that occurred in the area affected by the earthquake. It is no coincidence, in fact, that the Italian RDF network identified these signals, having the azimuth originating from New Jersey in a fairly narrow time frame compared to the date and time in which the earthquake occurred.

The usefulness of the methodology used by the researchers engaged in this study could facilitate mitigating the issue of seismic risk on a global scale, if a global-scale RDF monitoring network were deployed.

References:

[1] Database: Geographic Names Information System (GNIS). A database of name and location information on more than two million physical and cultural features throughout the United States and its territories; the associated states of the Marshall Islands, the Federated States of Micronesia and Palau; and Antarctica. It's a type of dictionary. It was developed by United

States Geological Survey (USGS) in collaboration with the United States Board on Geographic Names (BGN) to promote standardization of feature names.

[2] U.S. Census Bureau: For up-to-date data on the population of metropolitan areas, including New York: census.gov.

[3] Port Authority of New York and New Jersey: Provides information on airports, bridges, tunnels, and other critical infrastructure projects in the region: panynj.gov.

[4] NJ Transit: For details on public transportation services in New Jersey, including trains and buses that connect to New York City: njtransit.com.

[5] Metropolitan Transportation Authority (MTA): Offers information on public transportation services within New York City, including the subway and commuter rail: mta.info.

[6] U.S. Department of Energy: For information on energy infrastructure in the United States: energy.gov.

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