Solar Activity and Electromagnetic Signals that preceded the M7.5 Earthquake of January 1, 2024, in Japan

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Abstract

On January 1, 2024, a strong earthquake occurred in Japan, causing deaths and damage to Japanese infrastructure. This study discusses the electromagnetic and solar signals that anticipated the strong earthquake. This earthquake was preceded by a series of electromagnetic signals recorded by the RDF network developed by the Radio Emissions Project in Italy and by peculiar solar activity that occurred in the days before the disastrous quake. The authors believe that there may be a relationship linking telluric activity with space weather, evidenced by electromagnetic signals detectable in the phases preceding the earthquake in a time window of about five days. The results of the experiment show that the data can be compared with other known cases in the scientific literature, in the context of a crustal diagnosis and seismic precursor candidates.

Keywords: Japan Earthquake, Electromagnetic Seismic Precursors, Earthquake Precursors, Radio Direction Finding, Solar Activity.

1 - Introduction

The issue of safety to protect communities, infrastructure, and to contain the economic damages resulting from destructive seismic events has led research to investigate physical, chemical, and biological signals, now also employing artificial satellites and AI, to mitigate the impact of earthquakes. Research on seismic precursor candidates covers an extremely broad field of study, with numerous precursor phenomena historically classified and experimented by international research teams. In recent years, the Radio Emissions Project, based in Rome, Italy, has conducted multiple studies on electromagnetic precursor phenomena that seem to be associated with endogenous, seismic, and volcanic activity. These electromagnetic precursor phenomena appear to be mediated by solar activity [1][2][3], which in this context seems to facilitate seismic triggering on a global scale. [4] [5] [6] [15] [16] [17] [18] [19] [20] [21]

Since 2017, the Radio Emissions Project has established an electromagnetic monitoring network (RDF), based on radio receiving stations that use Radio Direction Finding technology, capable of detecting the direction of arrival of electromagnetic signals and measuring their intensity and behavior over time. [7]

The experimentation of this detection network has shown that before strong earthquakes there are recurrent local emissions, emitted in a geographical area, identified as the future epicentral zone of an impending earthquake [8] [9] [10].

The same investigative methodology was applied to the Japanese earthquake, thanks to the 24/7 data detection of RDF signals from the respective network monitoring stations, and the retrieval of data from the spaceweather website to perform a real-time comparison with electromagnetic data.

2 - Method and Data

The method used to compile this study is that of comparison, while the electromagnetic detection data come from the recordings made by the Italian RDF network:

1. RDF Station in Pontedera PI, located in Northern Italy.
2. RDF Station in Lariano RM, located in Central Italy.

Both stations provided evidence of clear natural signals, originating from the geographic area where the earthquake occurred. The seismic data examined in this study are those of the USGS (https://www.usgs.gov/), updated and temporally related to the evidence of electromagnetic signals highlighted by the Italian RDF network. The space weather data were retrieved from the institutional website iSWA (https://iswa.ccmc.gsfc.nasa.gov/IswaSystemWebApp/) and from satellites.

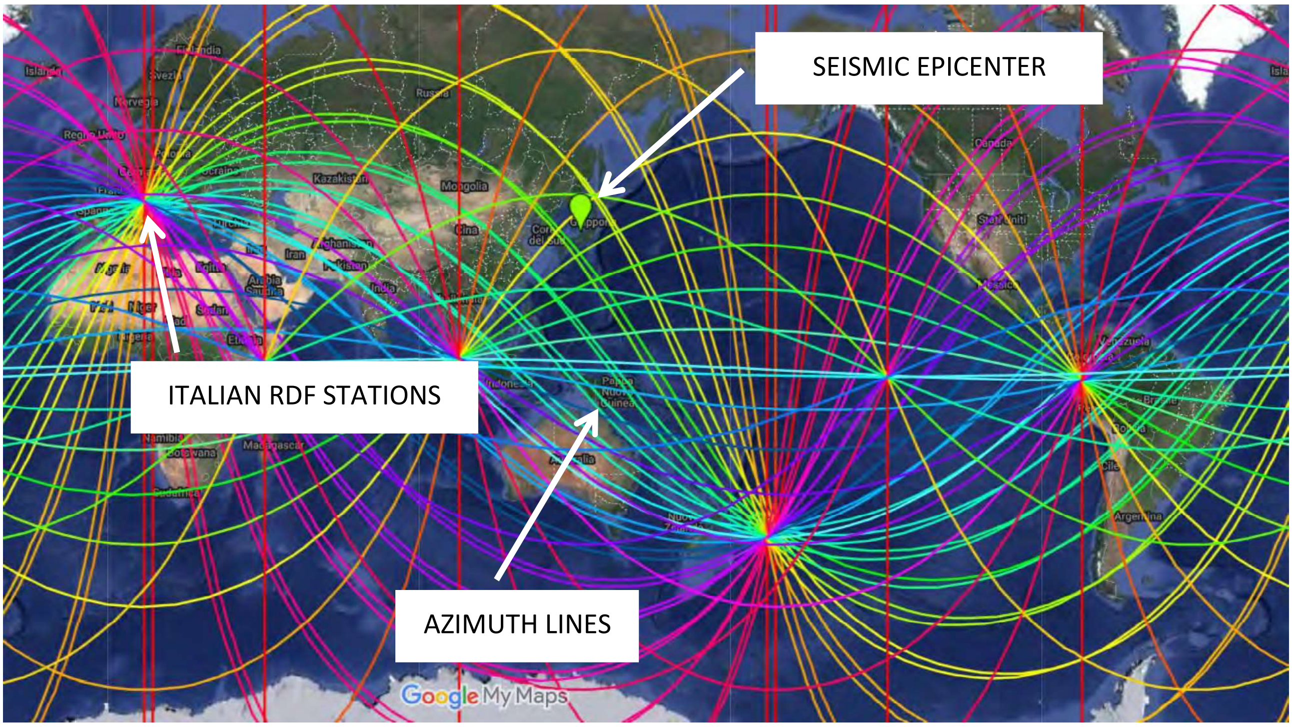

Fig. 1 - Colorimetric Map of the Global RDF Network developed by the Radio Emissions Project, which shows the presence of the Japanese seismic epicenter (in green). The colored lines represent the azimuths relative to the various RDF stations located globally, including those in Italy. Credits: Radio Emissions Project; Google My Maps.

The first electromagnetic recordings made by the Italian RDF network, related to the precursory signals of the Japanese earthquake, were registered from November 1, 2023, at around 11:00 UTC (Fig. 2) by the Pontedera PI RDF station. These signals, appearing suddenly for the first time in a period when there had been no evidence of such radio emissions, were extremely evident compared to the normal natural electromagnetic background, lasting about 2.4 hours.

The emissions reappeared around 17:30 UTC on November 1, 2023 (Fig. 3), this time lasting approximately 3.3 hours. The electromagnetic signals continued to appear for days and weeks until December 6, 2023 (Fig. 4), when an extensive electromagnetic emission, also from the azimuth in yellow relative to the Pontedera PI station, was observed. It started at 06:00 UTC and lasted until about 12:00 UTC, with a duration of a full 6 hours. This signal was again centered around 13 kHz. From this date, electromagnetic signals with a yellow azimuth became increasingly frequent. On December 14, 2023 (Fig. 5), the signals remained extremely interesting, this time a signal on the yellow azimuth from the Pontedera PI station appeared at 14:00 UTC, 18:35 UTC, lasting 4.5 continuous hours. This signal was preceded and followed by other intense electromagnetic emissions with different azimuths. The signals continued for several more days, indicating an ongoing accumulation of crustal energy in an area located on the yellow azimuth. Ten days later, specifically on December 24, 2023 (Fig. 6), a new extensive electromagnetic emission was recorded, lasting 4.1 hours, starting at 07:40 UTC, and ending around 12:00 UTC.

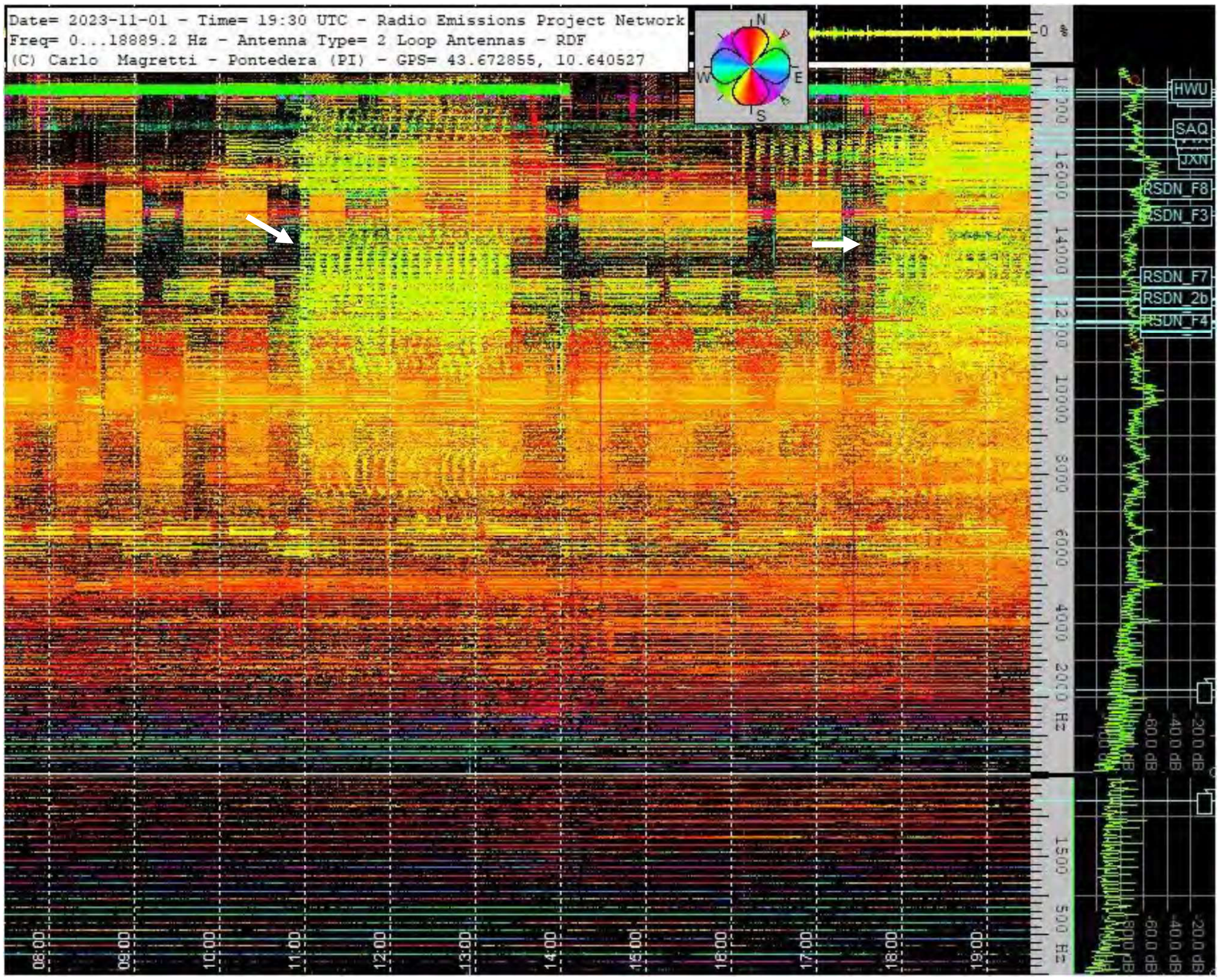

Fig. 2 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz. Credits: Radio Emissions Project; Carlo Magretti.

The electromagnetic emissions recorded by the Pontedera PI station proved to be extremely interesting to the research group, who noted the evolution of these signals that were previously invisible but now seem to increase in repetitiveness. On December 31, 2023 (Fig. 7), the electromagnetic signals recorded by the Pontedera PI RDF station reappeared at 08:00 UTC and ended around 11:10 UTC, with a total duration of the emissions of 3.1 hours. In this case, too, this radio signal was important in a predictive context, preceded by other electromagnetic appearances at the same frequency (13 kHz).

On January 1, 2024 (Fig. 8) at 07:10:09 (UTC), a strong earthquake struck Japan with a magnitude of Mw 7.5, causing deaths and the collapse of some homes. This event caused significant damage to Japanese infrastructure. In the recorded spectrogram, a faint reddish emission is visible at the moment the strong earthquake occurred, but there were no other electromagnetic emissions indicating the yellow azimuth. Only subsequently (a few hours later) were there other electromagnetic signals with the same azimuth, probably produced by the Earth's crust near the seismic hypocenter, under significant energetic increase (tectonic stress). The RDF station in Lariano RM also recorded an intense emission, not preceded and not followed by other similar emissions, which had alerted the researchers involved in this study. The emission visible in Fig. 9.

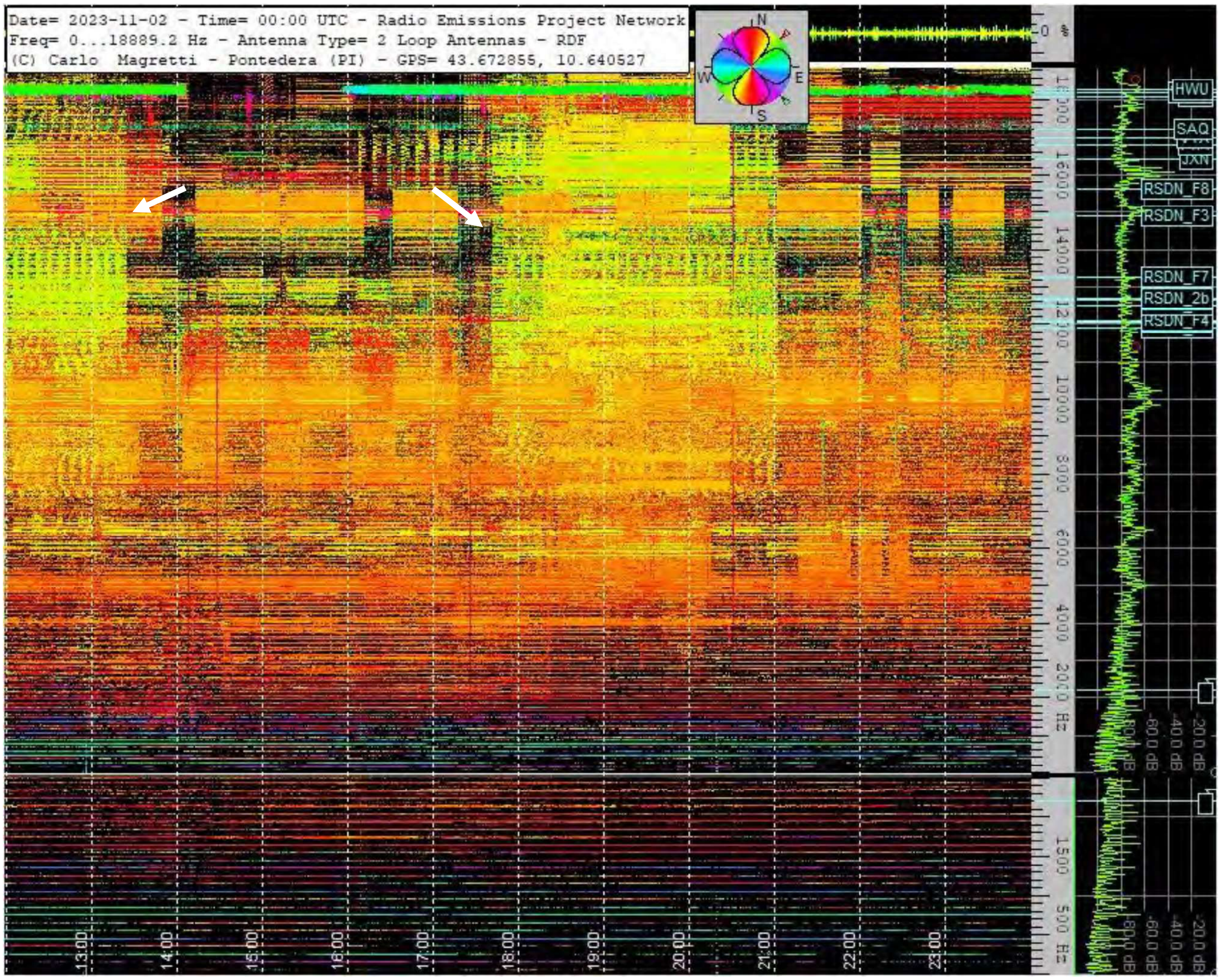

Fig. 3 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz. Credits: Radio Emissions Project; Carlo Magretti.

On December 29, 2023 (Fig. 9), the Lariano RM RDF station highlighted the presence of a strong electromagnetic emission, appearing around 18:00 UTC and lasting until approximately 20:35 UTC, with an electromagnetic frequency ranging from 0.0 Hz to 1 Hz, and repeated resonance harmonics reaching up to 4 Hz. This evidently 'anomalous' signal aroused interest among the research group involved in this study, given that the green azimuth had not appeared for weeks.

On January 1, 2024 (Fig. 10), the Lariano RM RDF station again showed the appearance of electromagnetic signals on the green azimuth. As visible in Fig. 10, around 23:00 UTC on December 31, 2023, the natural geomagnetic background shifted in color on the greenish azimuth, and around 07:05 UTC the earthquake occurred. This earthquake remained within the temporal range in which the azimuth variation indicated the color green, relative to the Lariano RM station.

Regarding the activity of space weather, namely the space phenomena generated by solar activity present during the period in which this earthquake occurred, it can certainly be considered that the Earth had just entered a stream of solar wind faster than usual, as visible in Fig. 13.

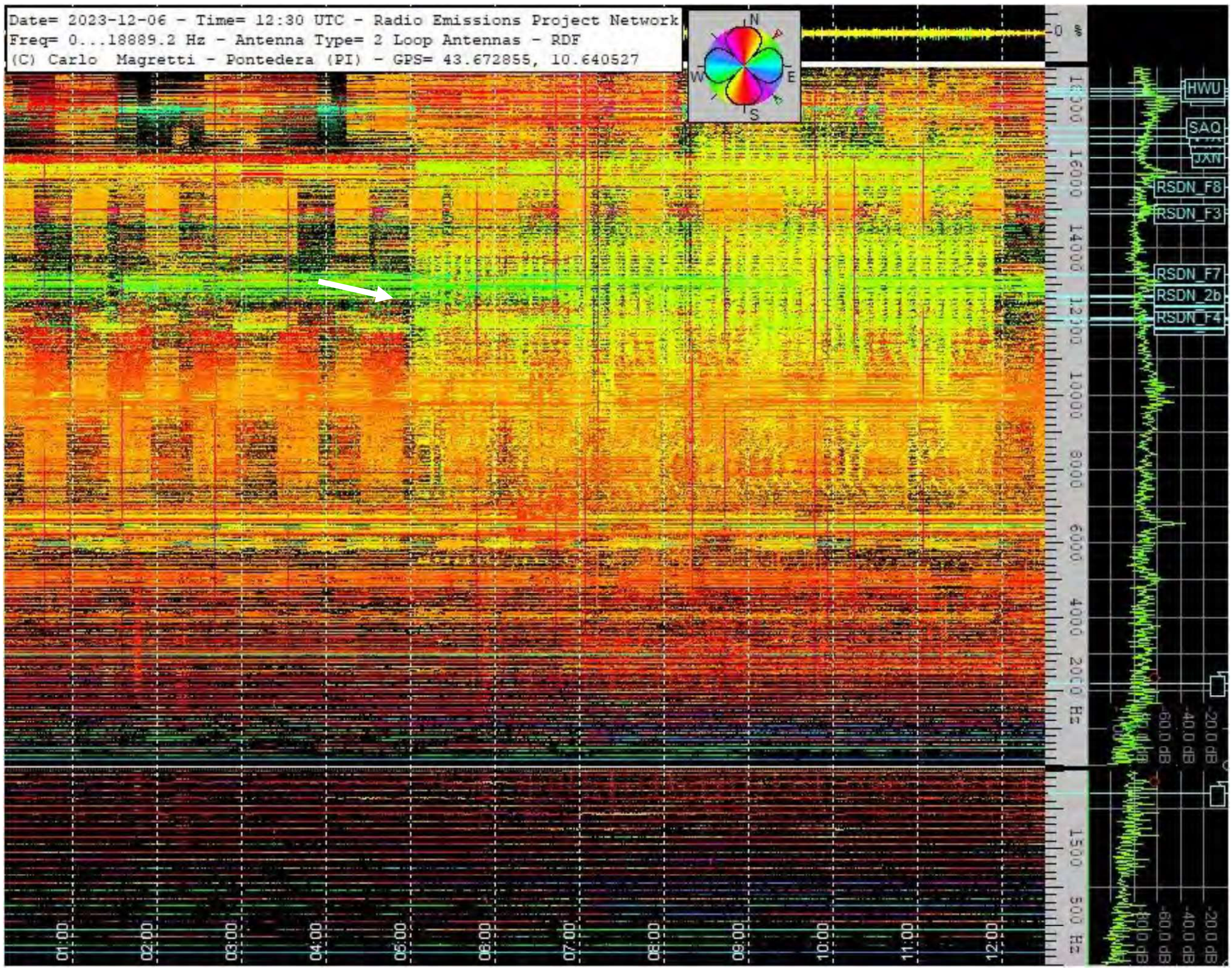

Fig. 4 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz. Credits: Radio Emissions Project; Carlo Magretti.

The measured solar activity showed clear variations in the period between December 29, 2023, and January 1, 2024. Observing Fig. 14, which displays the WINDMI (Wind Direction and Magnitude Index), a metric used in meteorology to measure space weather activity, there was a noticeable increase in nT (nanoTesla):

GOES (Geostationary Operational Environmental Satellites). The term “Primary X-Ray Flux” in relation to GOES satellites refers to their ability to measure the flux of X-rays emitted by the Sun.

The indices used are:

- WINDMI (Wind Direction and Magnitude Index).
- AL (nT): The AL index (Auroral Electrojet Index Low) measures the electromagnetic activity in the aurora, or the polar regions of the Earth. It is measured in nanotesla (nT) and is an indicator of the intensity of electric currents in the upper atmosphere, particularly those associated with the aurora borealis.
- Dst (nT): The Dst index (Disturbance Storm Time) is another geomagnetic indicator, also measured in nanotesla (nT). It reflects global variations in the Earth's geomagnetic field caused by the interaction between the solar wind and the Earth's magnetosphere.

It is evident how solar activity had led to a geomagnetic increase on our Planet several days before the Japanese earthquake. Geomagnetic and solar activities have been at the center of numerous scientific studies for years, demonstrating a direct correlation with terrestrial seismic activity. [18] [19] [20] [21] Another important data related to space weather comes from GOES data (Primary X-Ray Flux). The GOES satellites (Geostationary Operational Environmental Satellites) measure the Primary X-Ray Flux emitted by the Sun.

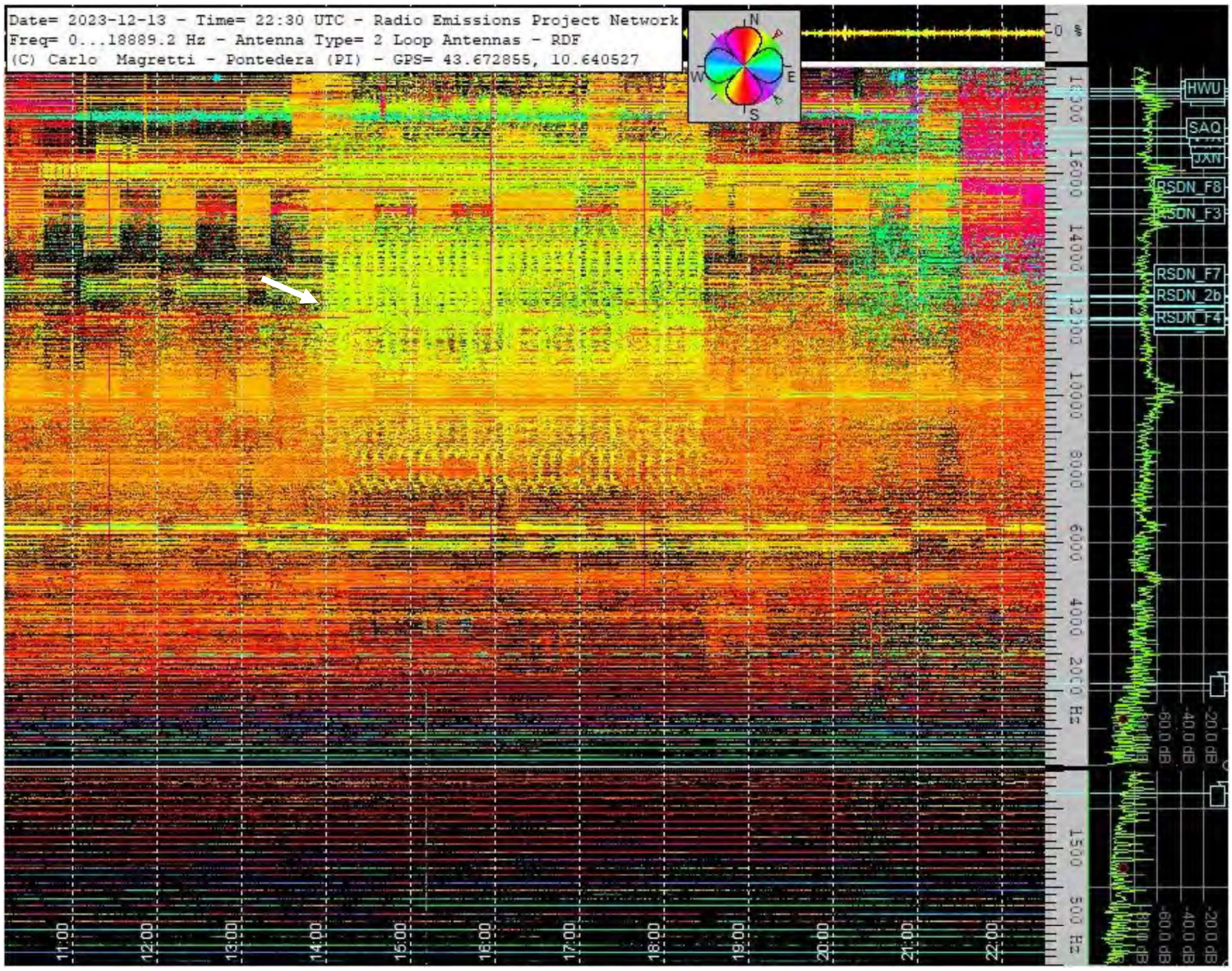

Fig. 5 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz. Credits: Radio Emissions Project; Carlo Magretti.

X-rays from the Sun are an important indicator of solar activity, particularly of solar flares and other energetic events that occur on the Sun's surface. Fig. 15 clearly shows the significant connection between the activity of the Sun and the Japanese earthquake, which followed an intense increase in 'X' emissions starting from December 31, 2023, at 11:40 UTC.

On this date, the preparatory phase of the earthquake was still underway. Another notable data point is the speed of the solar wind, recorded by the ACE satellite. The ACE satellite (Advanced Composition Explorer), launched in 1997, is primarily focused on the study of space weather and energetic particles coming from the Sun and interplanetary space.

The recording from the ACE satellite highlights a sudden increase in the speed of the solar wind, just a few hours before the earthquake (Fig. 16).

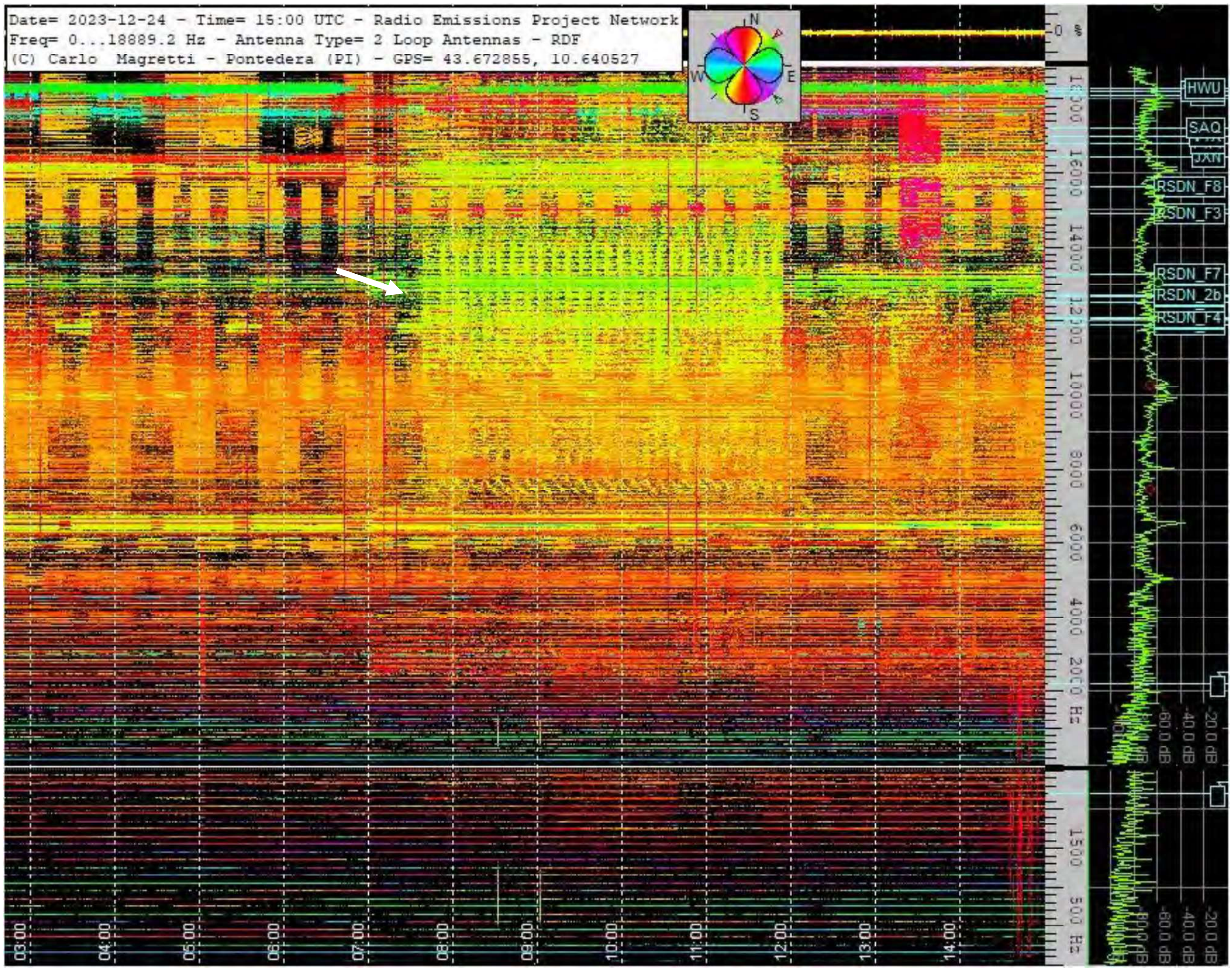

Fig. 6 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz. Credits: Radio Emissions Project; Carlo Magretti.

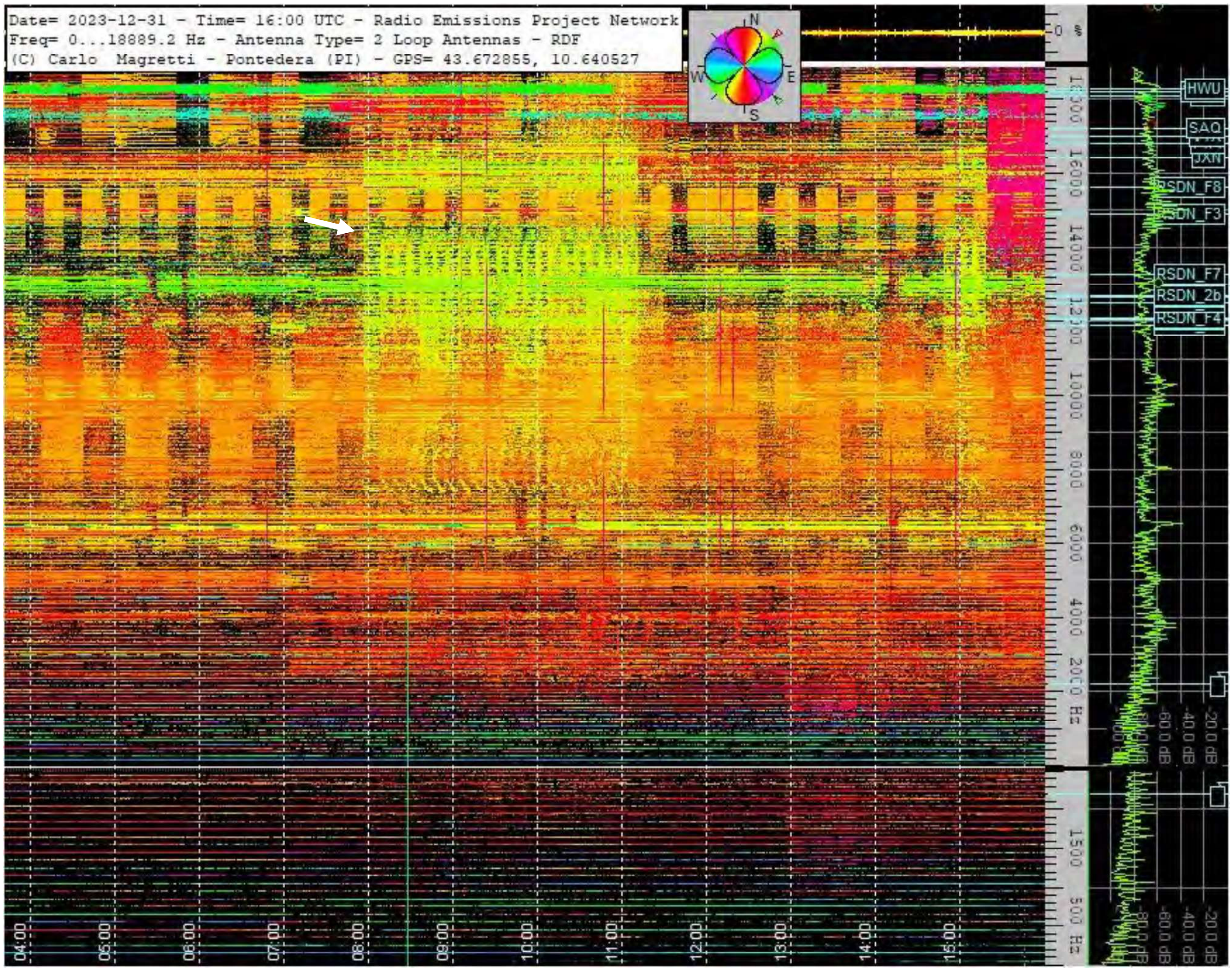

Fig. 7 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz. Credits: Radio Emissions Project; Carlo Magretti.

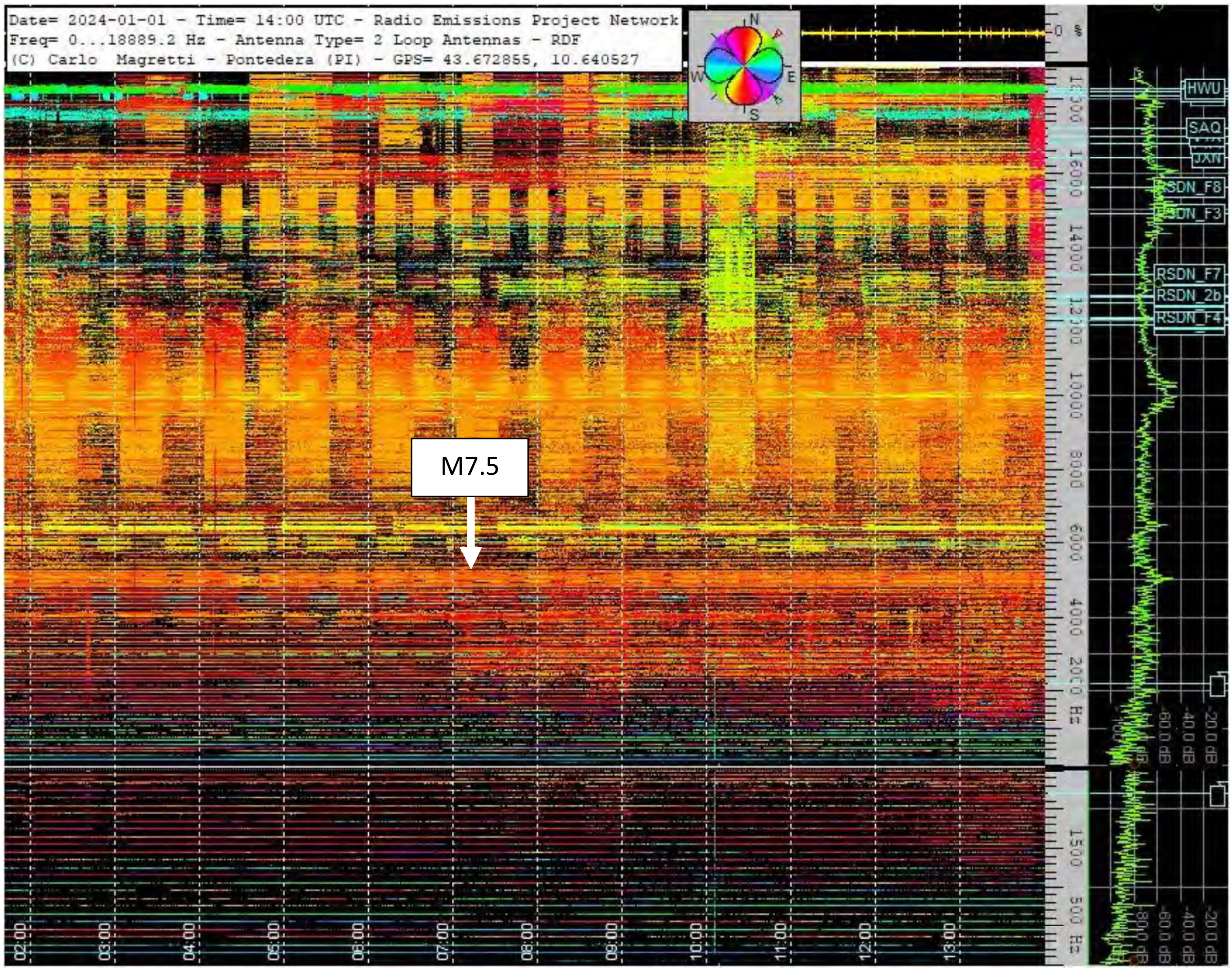

Fig. 8 – Dynamic Spectrogram recorded by the Pontedera PI RDF station, managed by Carlo Magretti, which highlights the presence of strong electromagnetic signals on the yellow azimuth, appearing at an average electromagnetic frequency of 13 kHz, as well as the temporal position of the earthquake. Credits: Radio Emissions Project; Carlo Magretti.

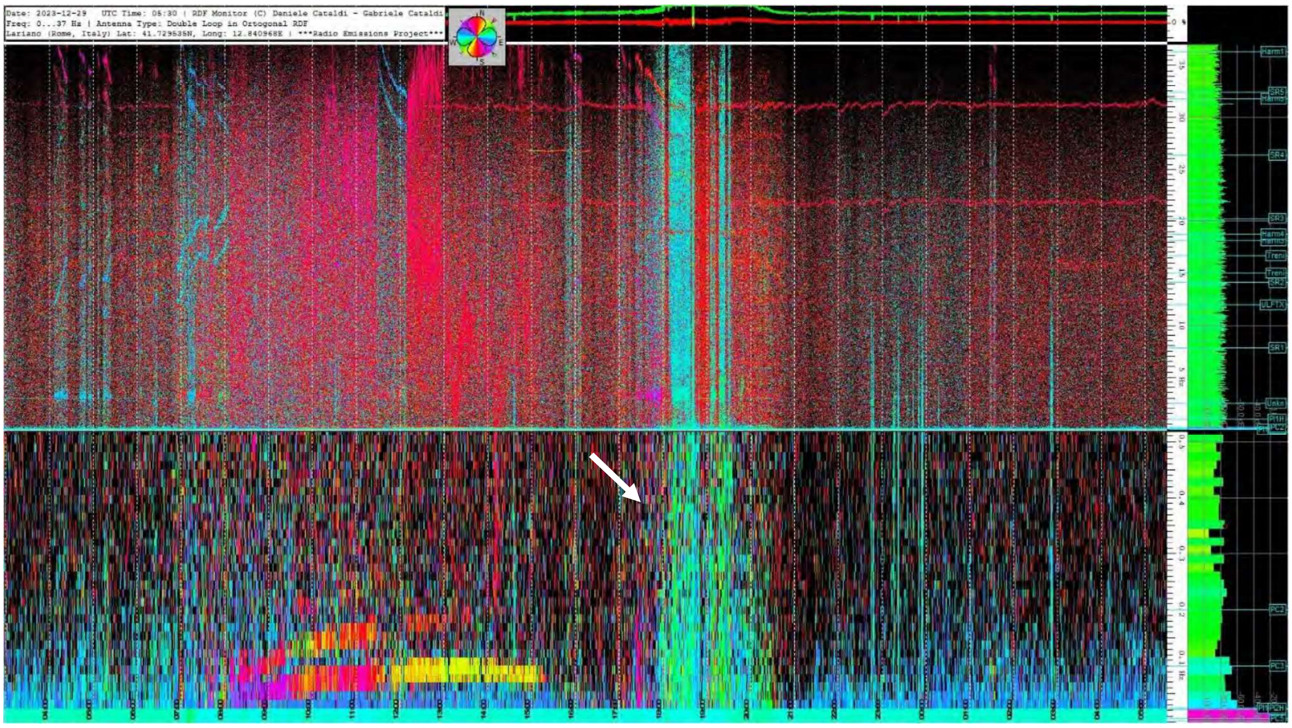

Fig. 9 – Dynamic Spectrogram recorded by the Lariano RM RDF station, showing the electromagnetic emission with a green azimuth. Credits: Radio Emissions Project, Daniele Cataldi.

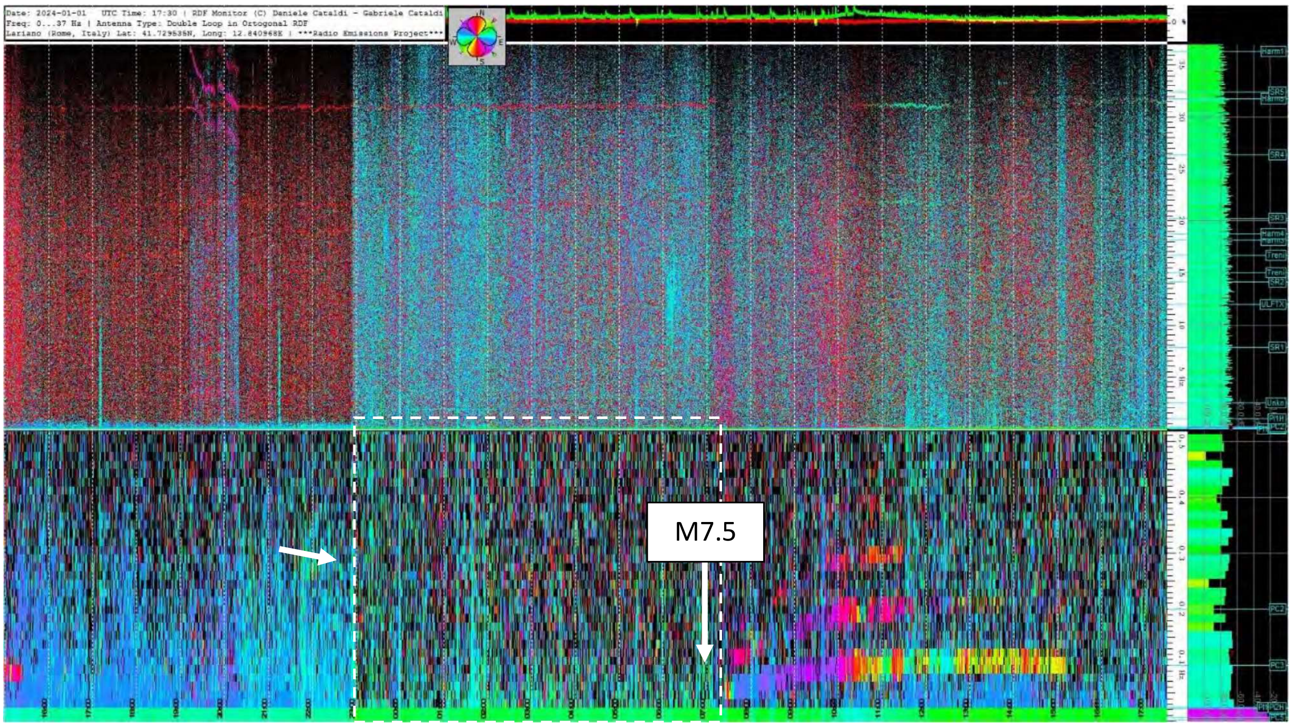

Fig. 10 – Dynamic Spectrogram recorded by the Lariano RM RDF station, showing the electromagnetic emission with a green azimuth and the presence of the earthquake's time. Credits: Radio Emissions Project, Daniele Cataldi.

3 - Temporal Scanning of Signals

The initial electromagnetic recordings made by the Italian RDF network, related to the precursor signals of the Japanese earthquake, were registered starting from November 1, 2023, around 11:00 UTC (Fig. 2) by the Pontedera PI RDF station. These signals appeared suddenly for the first time in a period when there had been no evidence of such radio emissions. They were extremely evident compared to the normal natural electromagnetic background, lasting about 2.4 hours.

The emissions reappeared around 17:30 UTC on November 1, 2023 (Fig. 3), this time lasting approximately 3.3 hours. The electromagnetic signals continued to appear for days and weeks until December 6, 2023 (Fig. 4), when an extensive electromagnetic emission was observed, also emanating from the yellow azimuth relative to the Pontedera PI station, starting at 06:00 UTC until about 12:00 UTC, lasting a full 6 uninterrupted hours. This signal was again centered around 13 kHz. From this date, electromagnetic signals with the yellow azimuth became increasingly frequent. On December 14, 2023 (Fig. 5), the signals remained extremely interesting, with a signal appearing on the yellow azimuth from the Pontedera PI station at 14:00 UTC, 18:35 UTC, lasting 4.5 continuous hours. This signal was preceded and followed by other intense electromagnetic emissions with different azimuths. The signals continued for several more days, indicating an ongoing accumulation of crustal energy in an area located on the yellow azimuth. Ten days later, precisely on December 24, 2023 (Fig. 6), a new extensive electromagnetic emission was recorded, lasting 4.1 hours, starting at 07:40 UTC, ending around 12:00 UTC.

On December 31, 2023 (Fig. 7), the electromagnetic signals recorded by the Pontedera PI RDF station reappeared at 08:00 UTC, ending around 11:10 UTC, with a total duration of the emissions of 3.1 hours. In this case, too, this radio signal was important in a predictive context, preceded by other electromagnetic appearances at the same frequency (13 kHz).

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Only subsequently (a few hours later) were there other electromagnetic signals with the same azimuth, probably produced by the Earth's crust near the seismic hypocenter, under significant energetic increase (tectonic stress).

The Lariano RM RDF station also recorded an intense emission, not preceded and not followed by other similar emissions detected previously (Fig. 9).

On December 29, 2023 (Fig. 9), the Lariano RM RDF station highlighted the presence of a strong electromagnetic emission, appearing around 18:00 UTC and lasting until about 20:35 UTC, with an electromagnetic frequency ranging from 0.0 Hz to 1 Hz, and repeated resonance harmonics up to 4 Hz.

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On this date, the preparatory phase of the earthquake was still underway. Another notable data point is the speed of the solar wind, recorded by the ACE satellite. The ACE satellite (Advanced Composition Explorer), launched in 1997, is primarily focused on the study of space weather and energetic particles coming from the Sun and interplanetary space.

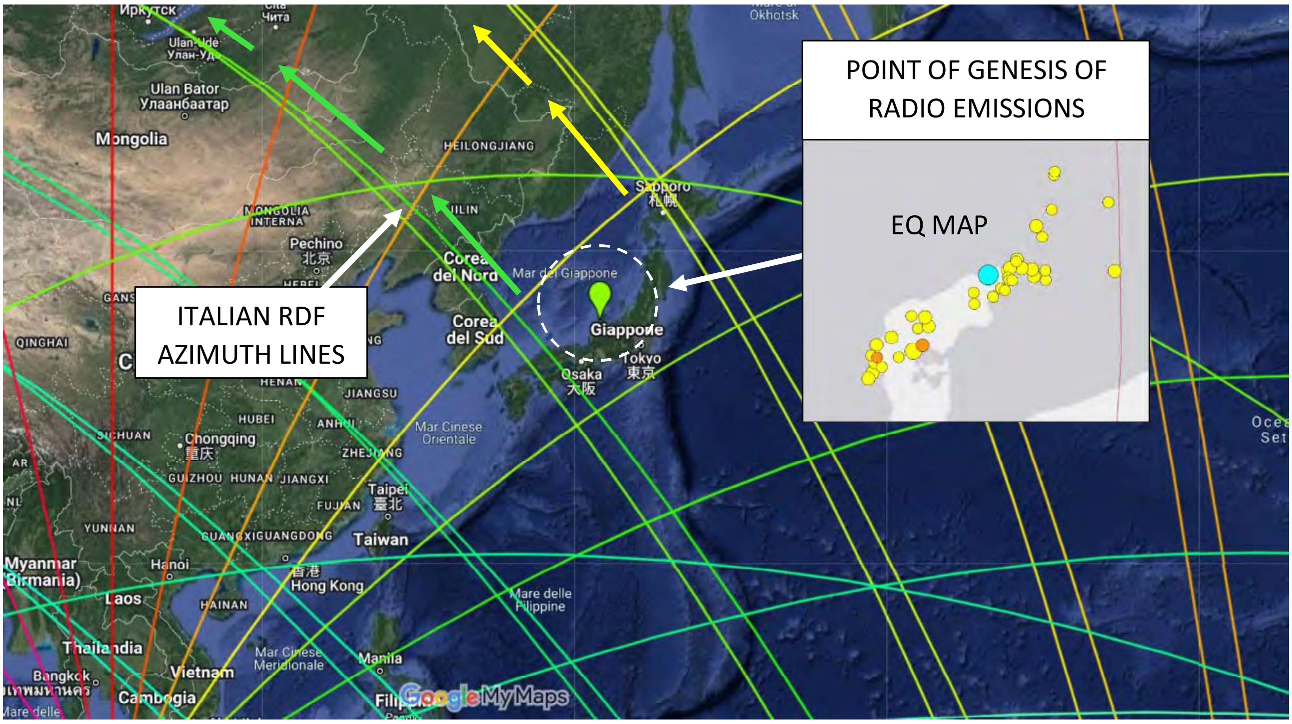

Fig. 11 – Colorimetric map developed by the Radio Emissions Project, highlighting the geographical area of the earthquake (Japan) and its epicenter. The colored lines represent the azimuths relative to the various RDF stations located globally, including those in Italy. It is evident how the signals (azimuths) green and yellow delineate the geographical area of Japan, where the earthquake subsequently occurred. Credits: Daniele Cataldi; Radio Emissions Project; USGS.

The recording from the ACE satellite highlights a sudden increase in the speed of the solar wind, just a few hours before the earthquake (Fig. 16).

Electromagnetic recordings show that there were electromagnetic emissions coming from the area of the strong Japanese earthquake, weeks and days before it occurred.

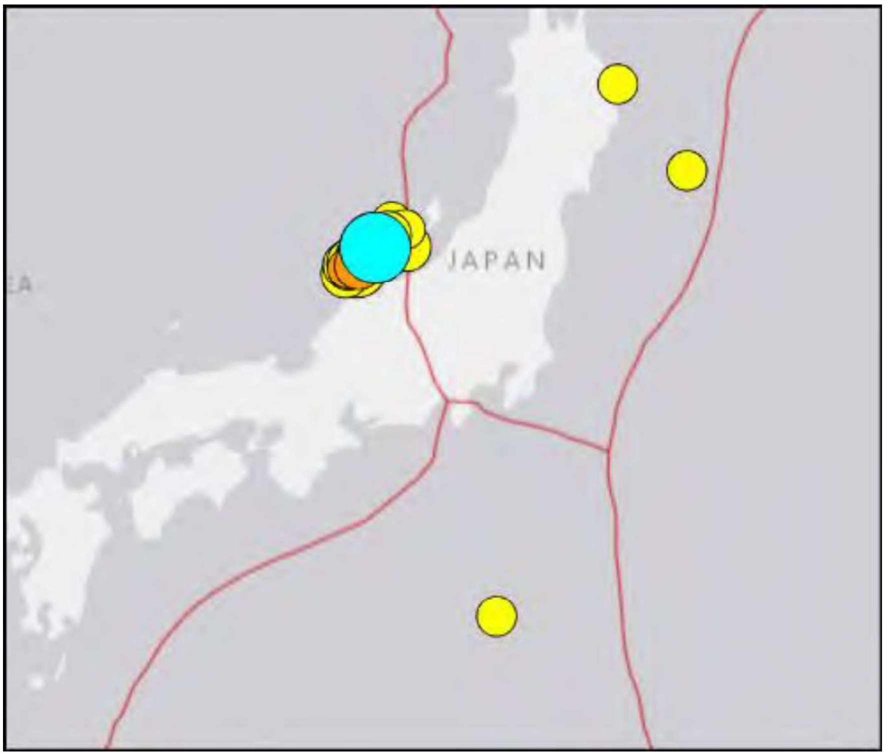

Fig. 12 – Mapping of the earthquakes that occurred in Japan with the Main Shock of Mw7.5 and subsequent seismic events that characterized the Japanese area from January 1, 2024, to January 6, 2024 (M4.5+). Credits: USGS

The RDF network map (Fig. 11) shows the Japanese zone with the respective azimuths of signal origin, delimited by the yellow and green azimuths, the same colors that the RDF system highlighted in relation to the appeared signals, indicating, without a doubt, the Japanese area.

It is evident that the area within which the Japanese earthquake occurred emitted electromagnetic emissions detectable from a distance, in this case around 9,500 km.

An emission of this kind must have had a power of thousands of Watts to reach Italy and be detected, justifying the fact that such electromagnetic signals were emitted by an extremely extensive and wide fault, where a lot of energy accumulates (tectonic stress). Indeed, if we observe the Japanese area, it shows numerous subsequent earthquakes to the main shock of magnitude Mw7.5 that occurred between January 1, 2024, and January 6, 2024 (M4.5+), as visible in Fig. 12.

Japan is located in a highly seismic region, where several tectonic plates meet, including the Pacific Plate, the Philippine Plate, the North American Plate, and the Eurasian Plate. This positioning leads to high seismic and volcanic activity. The faults in Japan are numerous and complex, with some of the most notable including the Nankai Fault and the Sagami Fault. These faults have the capability to generate very powerful and destructive earthquakes.

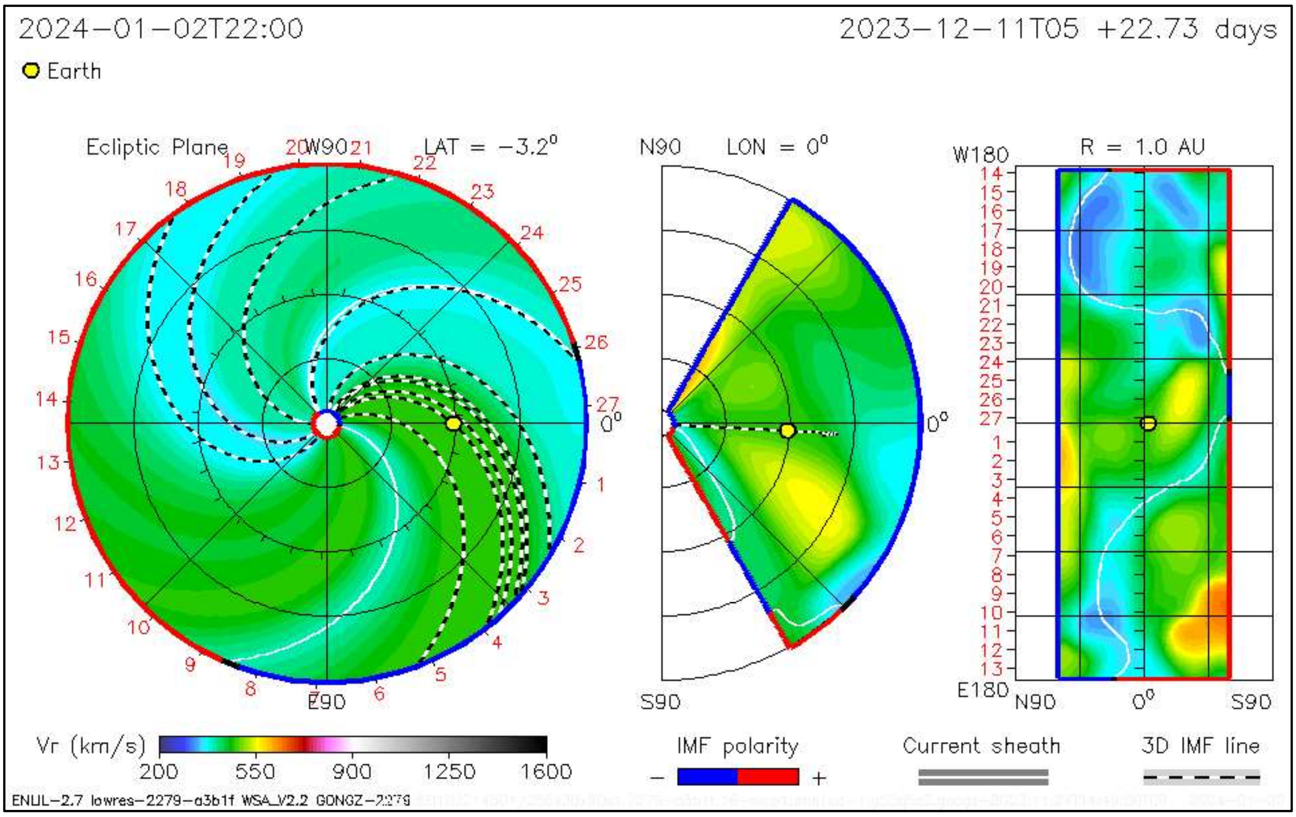

Fig. 13 – Solar Wind Speed measured at Earth's orbit. It is evident that around January 1, 2024, the Earth had entered a stream of solar wind with a higher velocity. Credits: iSWA.

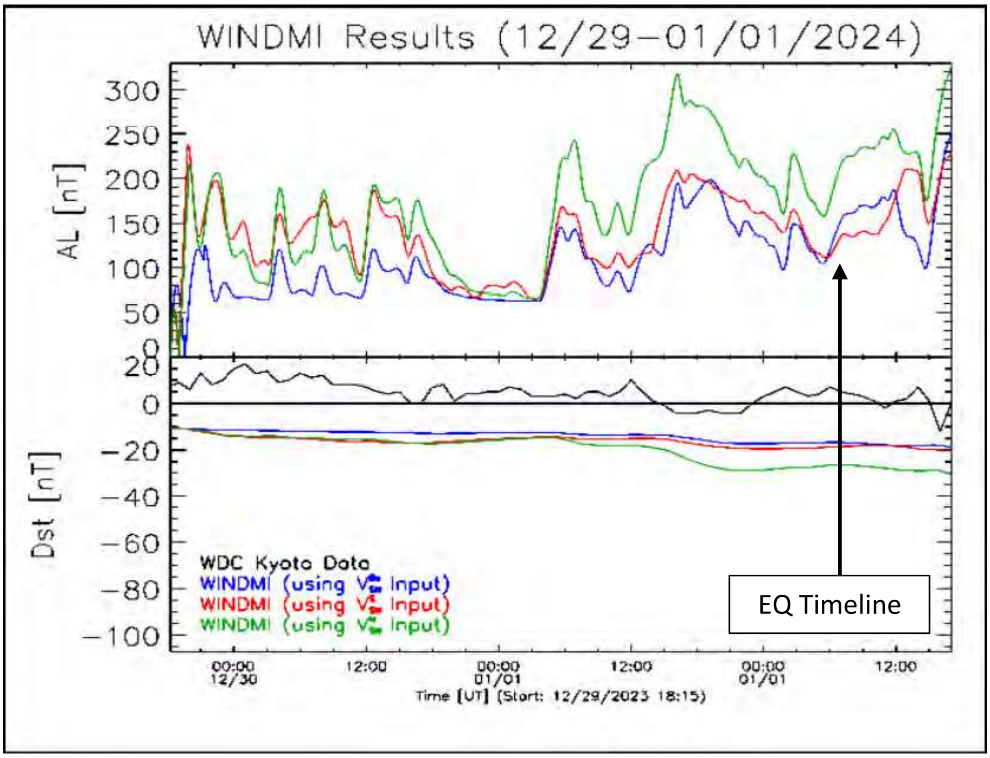

Fig. 14 – The WINDMI chart shows the presence of interesting geomagnetic variations in the period from December 29, 2023, to January 1, 2024. Credits: iSWA.

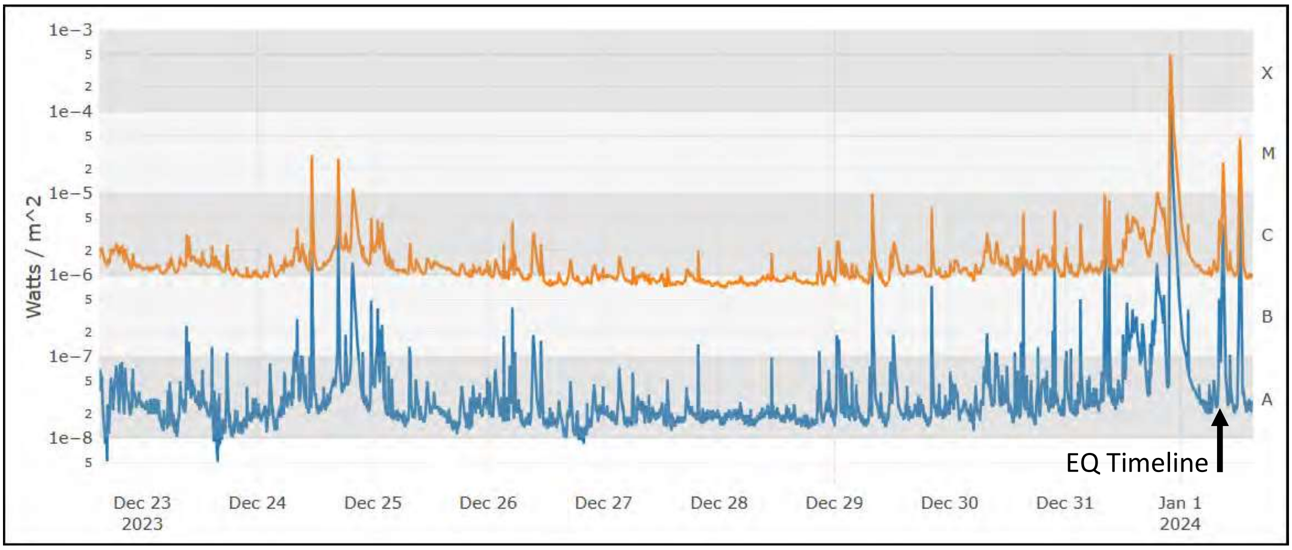

Fig. 15 – Chart showing the solar 'X' radiation (X-Rays) recorded by GOES satellites, 10 days prior to the earthquake that occurred in Japan, highlighting the Time-Line of the earthquake that followed a series of increases. Credis: iSWA.

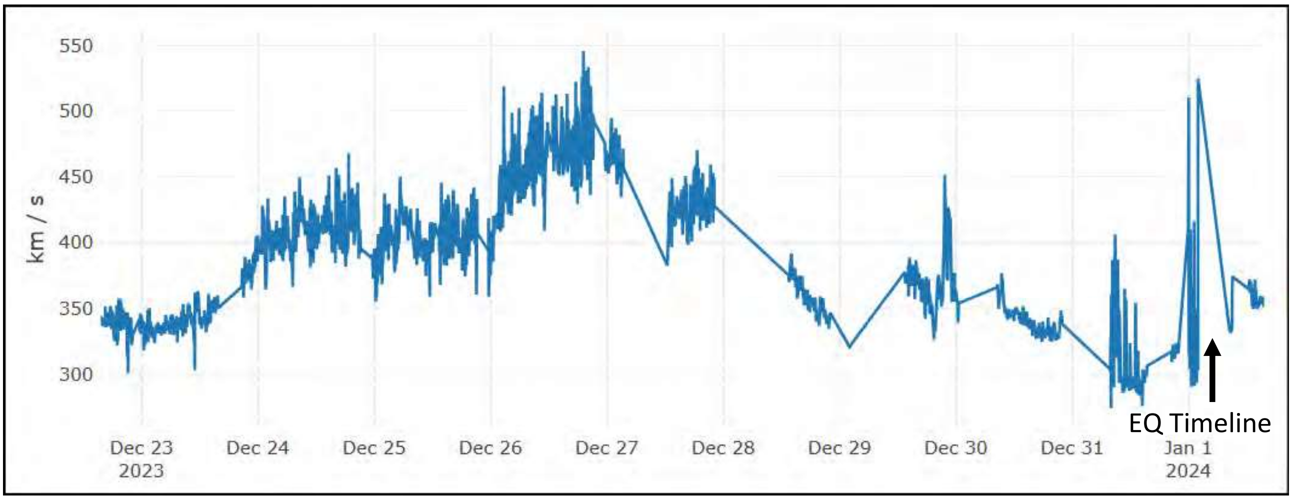

Fig. 16 – Chart of the solar wind speed, recorded by the ACE satellite, showing an intense increase in speed just a few hours before the Japanese earthquake. Credits: iSWA.

4 - Conclusion

This study has gathered enough information to conclude that the Japanese earthquake, which occurred on January 1, 2024, with a magnitude of Mw7.5, was preceded by electromagnetic signals generated many days before the violent earthquake.

In this phase, energy accumulates before being released, mechanical stress produces high pressure on rocks which, due to the pressure, produce free ions (moving electrical charges) [13], resulting in the phenomenon of piezoelectricity, through which they can emit radiofrequency [11][12][14], especially over a very extensive fault surface, like the Japanese one.

Such signals emitted from the 'local' lithosphere can be received and recorded by one or more radio receiving stations at a distance. Multiple radio stations can also triangulate the signal, understanding the exact position where such a natural emitter is located.

The two Italian RDF stations (separated by a distance of 300 km) provided data on the angle of arrival of the radio signals (Angular or Directional Triangulation), relative to their GPS position, and therefore it was possible to understand where such signals were coming from.

In this case, the signals preceded the strong and destructive earthquake by 61 days.

Another important data emerged from this study is that of solar activity, which is directly correlatable to the preparatory phase of the earthquake in question:

- Increase in the speed of the solar wind a few hours before the earthquake occurred.
- Increase in Earth's geomagnetic activity, beginning several days before the earthquake.
- Increase in X-ray activity from the Sun several hours before the earthquake occurred.

In light of these results, it is evident that solar activity seems to be again associated with terrestrial seismic activity and in this case with the strong Japanese earthquake.

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