

Recording and analysis of the formation of a Ball Lightning (BL), recorded in central Italy on August 15, 2022

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ABSTRACT

On August 15, 2022, there was a strong storm in central Italy, a storm that from the west side of Italy, then headed for the Italian peninsula, causing extensive damage to people and property. At that moment, the group of researchers, engaged in the electromagnetic analysis of the natural geomagnetic background, and the

visual monitoring of the sky, was able to record a rare phenomenon called "Globe Lightning" or "BL". In this study, the team of researchers presents the results.

Keywords: Ball Lightning, BL, Rare electrical phenomenon, electricity, thunderstorm.

1 – PREMISE

The study of electrical phenomena of atmospheric origin turns out to be a very difficult area of research, first of all because electrical phenomena of atmospheric origin occur randomly and without particular warnings, and then because there is a need for suitable tools to be able to capture them and then analyze. According to scientific data, 92% of the observed BLs are described as spheres, in 5% as ellipsoids [1] and this indicates that the majority of these manifestations almost always assume a round or elliptical shape. Always according to scientific indications, the BL, in 48% of the testimonies the duration of the observation of a BL (not to be confused with the life span of the BL itself, which can be higher), is less than five seconds [1], while as regards the mode of disappearance it is a slow extinction in 66%

of cases, while in 30% there is an explosion, usually without damage to things or people but there are some exceptions (fortunately not serious) [1]. Only 62% of Italian BLs were observed during thunderstorms or closely associated phenomena (Russian data, on the contrary, are on percentages of 90%), while as many as 38% are also observed in clear sky conditions (against 10% of the Russians) [1]. The annual distribution of the number of BL observed in the northern hemisphere follows that of thunderstorms, with a maximum in the months of July and August when they are more frequent. As it is possible to understand, this is an extremely rare phenomenon and at the same time interesting from a scientific point of view.

2 – METHOD AND DATA

The data considered in this study are those of satellite origin, also coming from the Roman meteorological station and of a photographic type, which document

the formation of a very large cloudy front near the Tyrrhenian Sea in Italy, these data were then analyzed temporally. by the research team.

2.1 – THE CLOUDY FACE

On 15 August 2022 the Tyrrhenian area of the Italian Peninsula was approached by a dense cloud mass (Fig. 1 and 1b), moving from the Tyrrhenian Sea to the Italian hinterland. Around 11:57 pm a lightning storm

was already underway, which the group of researchers followed optically, and photographic and video shots of the intense electrical phenomenon were recorded. This cloudy front then moved above central Italy,

favoring the observation of the storm and the emission of electrical phenomena. According to the observations made, the frequency with which the lightning appeared

was extremely high and this indicated an intense energy present at the atmospheric level, such as to produce many lightning strikes, as shown in Fig. 2.

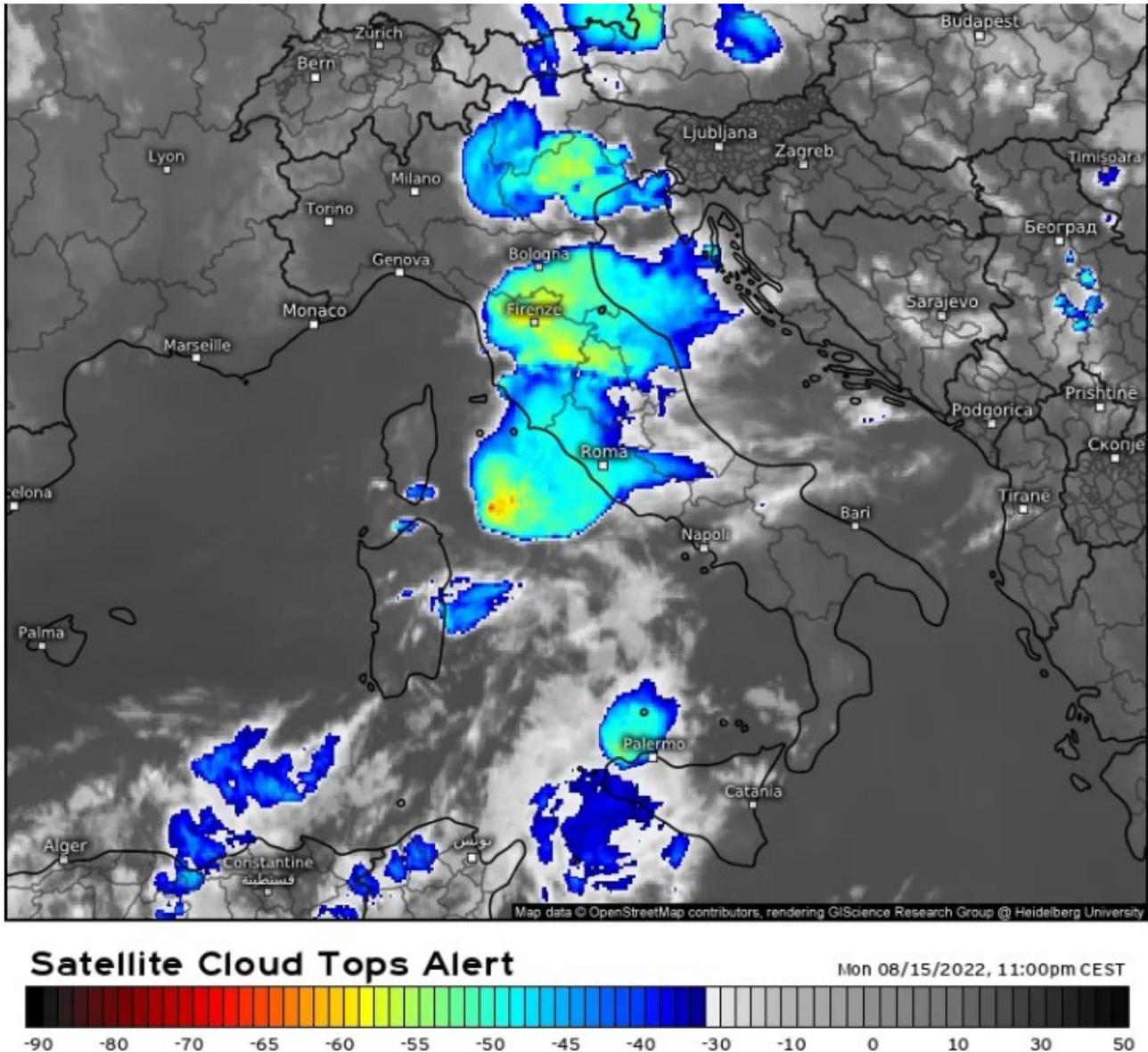


Fig. 1 – Satellite photo of August 15, 2022, 23:00 UTC. It shows the Italian territory and the presence of a dense cloud mass that approaches the Italian Peninsula from the Tyrrhenian side (West). Credits: meteologia.com; © OpenStreetMap contributors, rendering GIScience Research Group @ Heidelberg University - Satellite data: EUMETSAT.

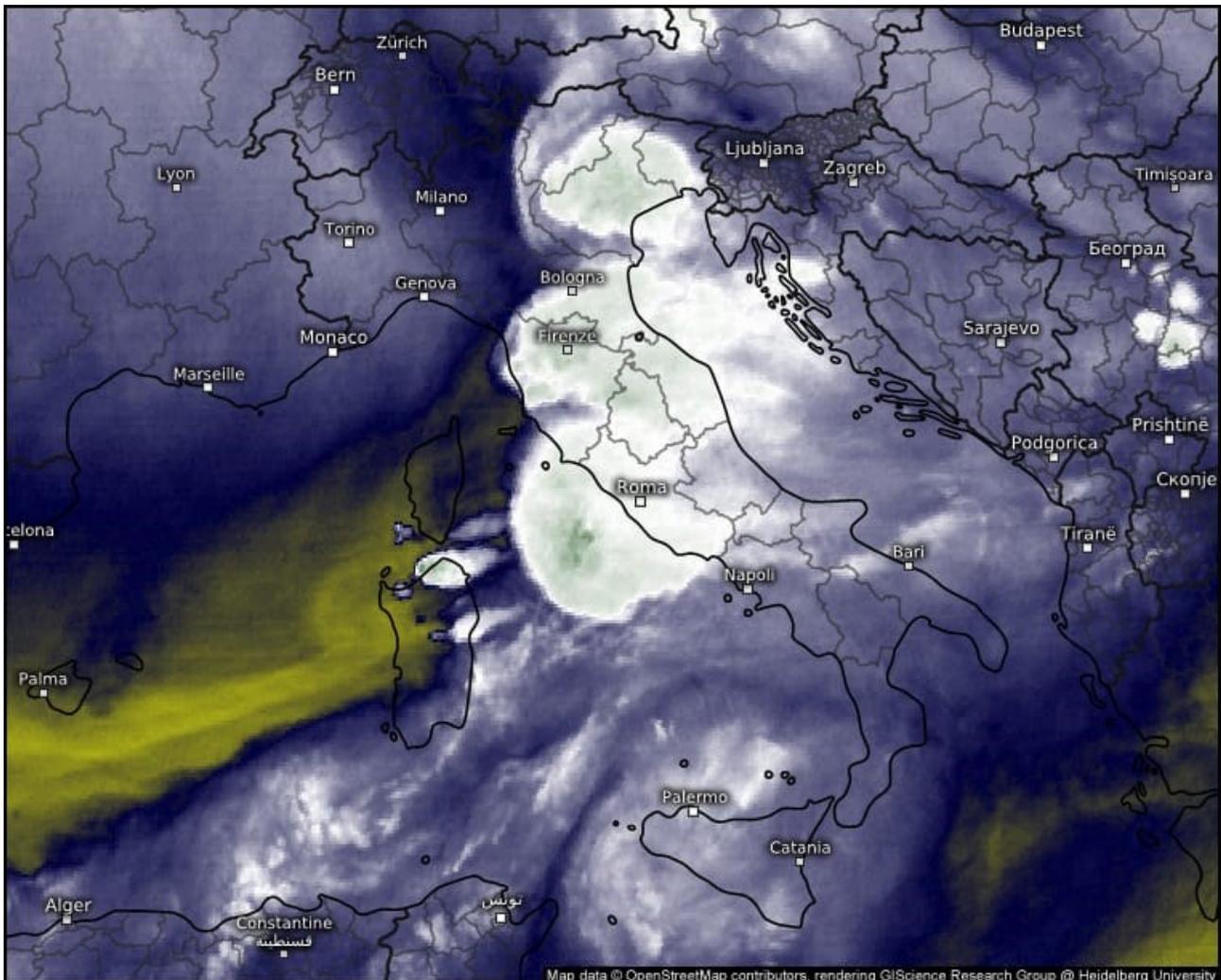
2.2 - DATA OF THE URBAN WEATHER STATION

The data relating to the urban weather station located in Rome, in the GPS position: Lat: 41.891 ° N, Long. 12.567 °, and called: Centocelle Amateur Weather Network - Weather Underground (IROME7860). It is located at an elevation of 46 meters above sea level, has been active since 2020, and has the following characteristics:

1. Electric sensor, external positioned on the roof of the building (39 meters) while the sensor is positioned at 46 meters. This all in one 7.1 sensor includes:
 - Thermo-hygrometer.
 - Rain gauge.
 - Wind speed sensor.

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- Wind direction sensor.
 - UV solar radiation sensor.
2. Solar panel.
 3. The communication between the console and the external sensor is RF 868 Mhz.
 4. A second Ecowitt GW 1100 Weather station gateway completes the configuration.
 5. An Ecowitt WH57 outdoor lightning sensor with solar radiation shield.



Satellite Water Vapor

Mon 08/15/2022, 11:45pm CEST

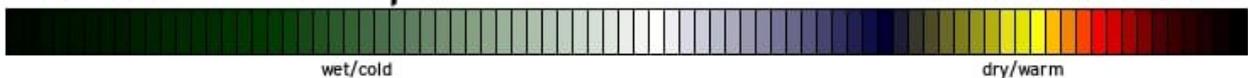


Fig. 1b – Satellite photo of August 15, 2022, 23:45 UTC. It shows the Italian territory and the presence of a dense cloud mass that approaches the Italian Peninsula from the Tyrrhenian side (West). Credits: meteologia.com; © OpenStreetMap contributors, rendering GIScience Research Group @ Heidelberg University - Satellite data: EUMETSAT.

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The weather station has followed the evolution of the storm phenomena that occurred right above the Italian capital. In this context it was immediately evident that there was a lightning storm in progress, hundreds of lightning strikes in a few minutes, as shown in Fig. 2. The data indicate the presence of strong gusts of wind just behind the formation of the Lightning Globular (BL), as visible in the graph, this means that the storm had completely approached the geographical area, with winds up to 7.2 km / h, compared to the normality encountered during the morning with light winds and gusts of wind within the limits. (Fig. 4). Interesting data are, for example, those of the temperature recorded during the lightning storm, which appears to have increased (Fig. 4), while there has been a marked decrease in atmospheric pressure (Fig. 5). During the

formation of the BL the Dew Point dropped quickly (Fig. 4).

1. If we are going to check what are the data recorded when the ball lightning was formed, these are the following: Wind speed: 3.9 km / h.
2. Wind gust: 7.2 km / h.
3. Temperature: 26.8 ° C.
4. Dew Point: 17.8 km / h.
5. Relative atmospheric pressure: 1008.7 hPa.
6. Absolute atmospheric pressure: 1006.4 hPa.

2.3 - VIDEO AND PHOTOGRAPHIC DOCUMENTATION

When the lightning storm was close to the capital, around 11:55 pm, the researcher Franco Menenti documented the electrical activity of the strong storm, managing to resume the formation of the rare electrical phenomenon, called: BL , lasting about 0.5 seconds, as shown in the photographic sequence (Fig. 3). The electrical phenomenon is extremely rare in nature, and in this case it was generated by an electric discharge intensity (lightning), which spread across the sky below the cloudy front for several km.

- In photo A: you can see an intense lightning "explode" under the cloud, and generate branches.
- In photo B: the ramifications of the lightning disappear and an unusual bright flash of clear elliptical shape is highlighted that persists in the sky.

- In Photo C: the luminous oval remains imprinted in the sky and tends to a more rounded shape, while the presence of some branches originating from the main lightning persists.
- In photo D: the clear spherical shape of Ball Lightning (BL) is visible, which is located inside the spherical luminous globe, this formation will last for about 0.5 seconds.

Between photo A and photo C, the duration of the recovery is almost one second, while the terminal phase of the formation of the BL, visible in photo D, lasted about 0.5 seconds. In total, the phenomenon lasted approximately 1.5 seconds. Suddenly appearing and disappearing (Fig. 3).

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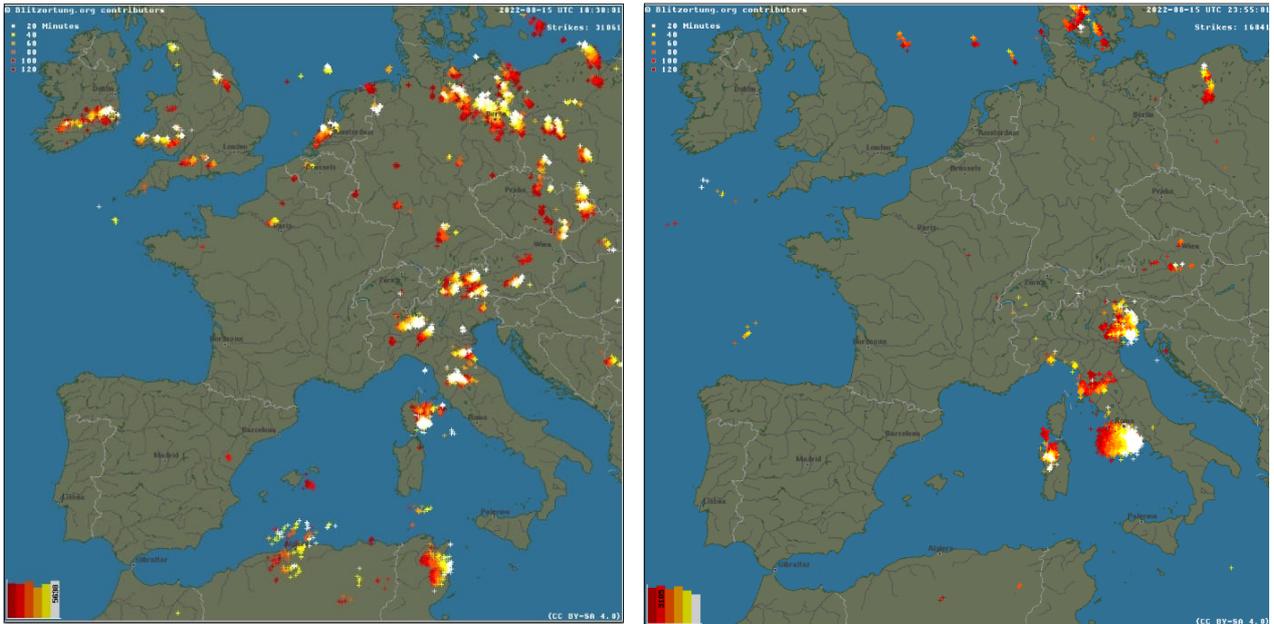


Fig. 2 – Satellite images in sequence, showing the presence of electrical lightning strikes of natural origin, at 18:30 UTC and 23:55 UTC on August 15, 2022. It is possible to note the presence of a concentration of lightning strikes near central Italy whose origin was mediated by a series of thunderstorms located on Corsica. Credits: Blitzortung.org.



Fig. 3 – Photographic sequence made by Franco Menenti, in Rome in Italy, on August 15th 2022 at about 23:55 UTC. Credits: Franco Menenti.

The amount of energy present inside the storm front was enormous, and in fact capable of causing the formation of hundreds of lightning strikes within a few

minutes (Fig. 2). The graphs provided by the Roman meteorological station are eloquent in this regard (Fig. 4).

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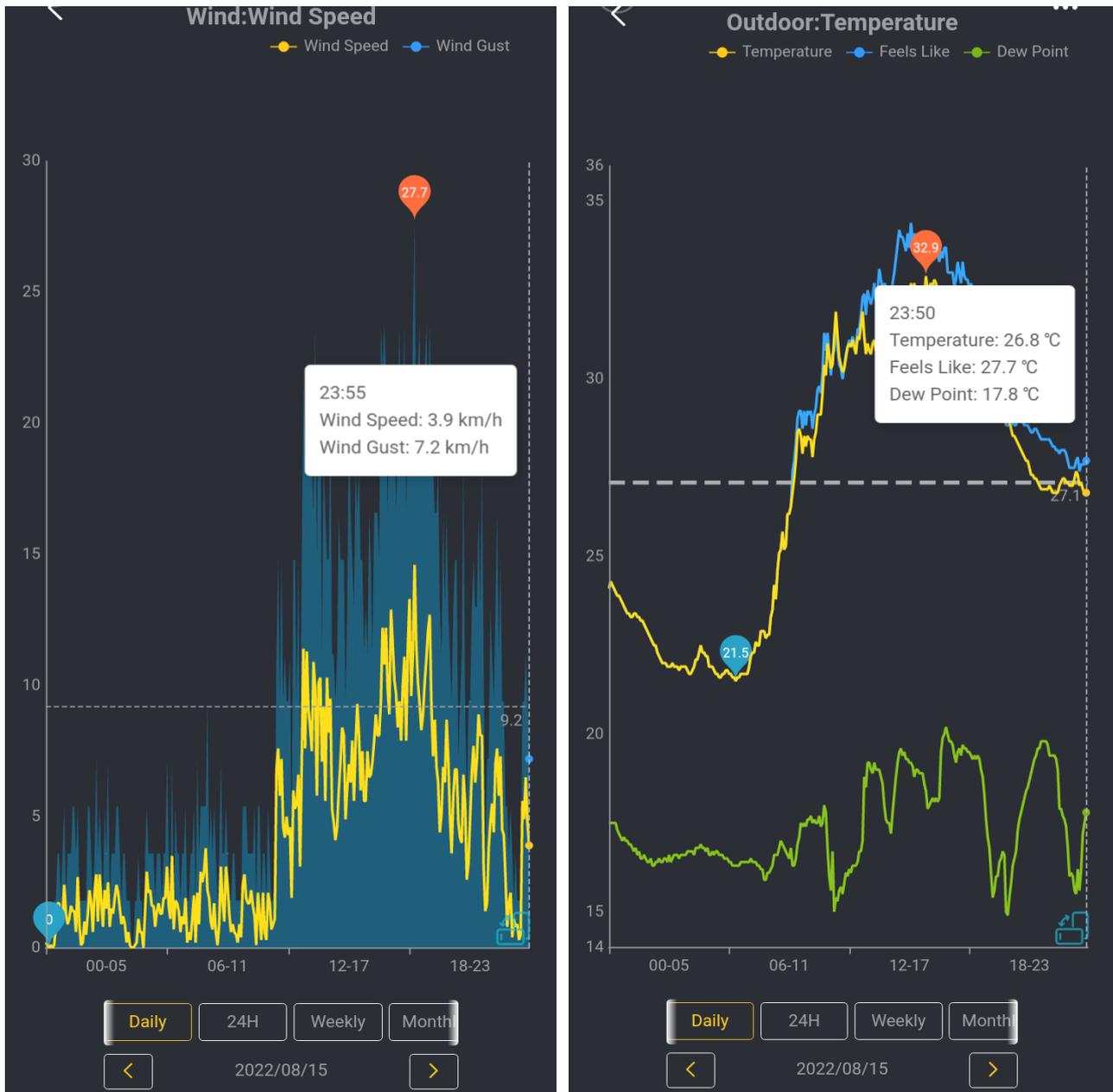


Fig. 4 – Data from the weather station in Rome, which refer to the time of the appearance of the ball lightning and the previous hours. The graphs show real-time readings of wind speed, Dew Point and Feels Like weather conditions. Credits: Franco Menenti; Rete Meteo Amatori.

Fig. 6, shows a time sequence lasting 0.5 seconds, inherent in the moment just following the disappearance of the Globular Lightning (BL). It shows three frames, in which some electrical “nodes” are visible, still active and perhaps a source of genesis

of the BL. The hypothesis is that these nodes are also determined by the action of magnetic fields as well as by the presence of suspended electrical charges below the storm cloud [4].

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Fig. 5 – Data from the weather station in Rome, which refer to the time of the appearance of the Globe Lightning and the previous hours. The graphs show real-time (relative and absolute) barometric pressure readings. Credits: Franco Menenti; Rete Meteo Amatori.

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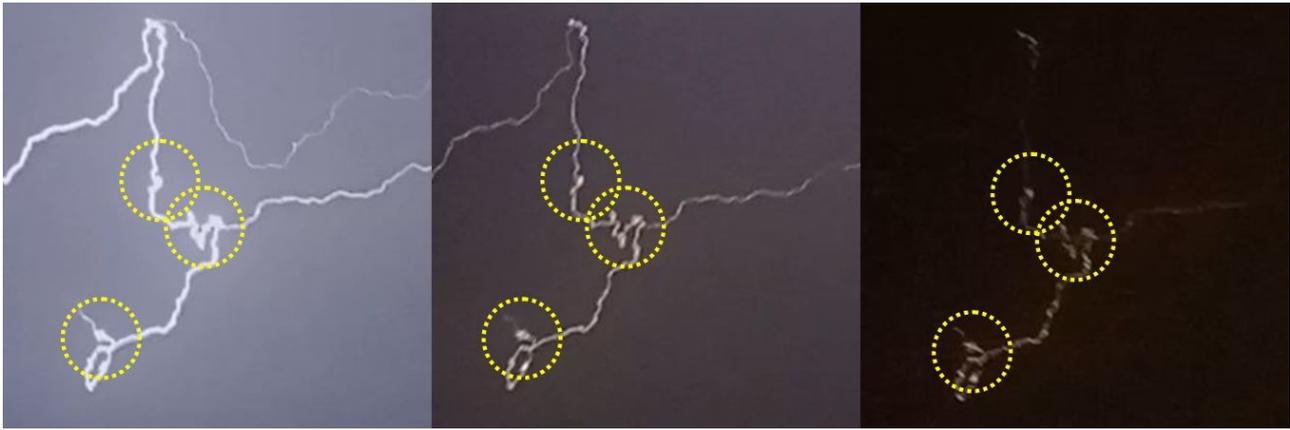


Fig. 6 – Terminal photographic sequence, where the presence of the globular lightning is no longer observed, but of the main lightning that generated it. If you look carefully at the sequence of photographs, you can see the presence of electrical "nodes" where it is probably possible to expect the formation of this kind of rare electrical phenomena (BL). Credits: Franco Menenti.

3 – DISCUSSION

There have been for countless time, many testimonies of the phenomenon of BL [3], a phenomenon that is still controversial today and worthy of serious studies. Some groups of researchers try to explain the nature of the genesis of this electrical phenomenon [2] by providing multiple hypotheses that can justify and explain, in part, the formation, within the earth's atmosphere, of this electrical phenomenon.

The data recorded at satellite level and by the weather station in Rome, provide information on some weather parameters that could suggest the conditions within which it is possible to expect the formation of a BL? Difficult to say with certainty, also because we are talking about data from a single weather station. We would also need many other data, such as electrical and chemical data. But that there is the presence, in the Roman sky, of a rare electrical phenomenon, characterized by a spherical shape, is clear. An important fact is reported by the witness who made the video and photographic shots of the BL who declared that the appearance and disappearance of the light phenomenon was not anticipated by any roar or noise, as is the case for a classic lightning bolt.

The photographic evidence relating to the presence of electrical "nodes" in the sky, demonstrates how at the basis of the genesis of the BL, there may be complex mechanisms, in which probably not only the electric

particles in suspension are involved, but even local magnetic fields, which they allow these "nodes" to appear, calling them a greater presence of flowing electrical charges. In the literature, in fact, it is stated that to obtain a spherical electric field in air, the presence of a magnetic field is required [4].

The hypothesis is anything but strange and certainly deserves further study. This photographic documentation probably shows precisely the possible signs of the interaction between some weak magnetic fields and the concentration of flowing electrical charges.

It should be noted that there is no exhaustive technical documentation in the scientific literature as there are several ongoing experiments that attempt to replicate the formation of this electrical phenomenon. In this case we are faced with a research area that is still too young, which should be implemented and deepened in a better way. This study has the main purpose of providing further data for the understanding of this rare electrical phenomenon.

However, this is one of the few cases of BL documented in the city of Rome and in central Italy in general.

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