

***Dear Editors and Reviewer;***

*Thank you for your comments on our manuscript titled “Integration of microseism, wavemeter buoy, HF Radar and hindcast data to analyze the Mediterranean cyclone Helios”. We have taken great care to address all the comments. The main changes concerned:*

- *Estimating errors in latitude and longitude for the locations of the cyclone using the grid search methods based on seismic amplitude decay ( we added a new Supplementary Figure 5 that shows the inversely proportional relationship between the errors and the  $R^2$ );*
- *A correlation analysis between microseism amplitude and significant wave heights (we added Figure 5 shows the correlation maps derived from this analysis).*

*The detailed one-by-one response to the comments is included below (the review itself is in black, and our responses are in blue). Please note that the line numbers refer to the manuscript with the tracked revisions.*

## Editor

How to use the characterization of the seismic signature to identify the cyclonic process is an open question. It may be helpful to monitor or improve the cyclone center location or strength estimation. So I expect the article “Integration of microseism, wavemeter buoy, HF Radar and hindcast data to analyze the Mediterranean cyclone Helios” to archive more quantitative relationships between and the uncertainty analysis. It will be beneficial to the related communities fully understand this approach.

0. As explained below in greater detail, we performed further analyses to quantify the relationship between microseism amplitude and significant wave height, as well as estimated errors associated with the microseism centroid locations.

However, I suggest the authors make some improvements based on the current version.

1. Social media should avoid becoming one of the references because it has not been peer-reviewed.

1. We are aware that it would be better to avoid social media as a reference but, since this Mediterranean cyclone is very recent, many peer-reviewed papers were not available. It is worth noting that we used these references only to describe the cyclone’s features and position. In addition, the social media profile, from which we extracted information, is linked to the “European network for Mediterranean cyclones in weather and climate” and it is reliable. In any case, we now added a new reference (D’Adderio et al., 2023), published in August 2023.

2. How about the dependence of the input ocean statements or data when using seism observations to track the location result in Section 3?

2. Excuse us but we did not understand the question, could you explain it again?

3. And is it possible to be quantitative about the errors of the location result in these two analysis approaches in Section 3.4?

3. We implemented a bootstrap approach to retrieve the errors in latitude and longitude associated with the locations for the grid search approach. We added some sentences about the applied method and the results in Section 3.4.5 in lines 303-309. As for the array analysis, since the results are represented in a rose-diagram, the errors can be deduced from the dispersion of the diagram. We calculated them and reported them in the manuscript on lines 305-307.

4. Figure 8 is quite interesting in exploring microseism information's advantages and disadvantages. It clearly shows the overestimations of both the microseism and SWH-Hind after 10/2/2023, if compared to SWH-HF. The more quantitative explanations will be innovative for the reader.

4. We think that what you indicate is not an overestimation but the different SWH values between SWH-Hind and SWH-Hf and the high RMS values for the microseism are linked to the fact that these three datasets see different things. In particular, as explained in the text at lines 186-191, SWH-HF indicates the values recorded by the HF Radar that focuses on a small area, while SWH-Hind has been calculated as the median value of the SWH data within a wider area of the Sicily Channel. The cyclone passes, at first, near the HF Radar and after in the area that we used to calculate the SWH-Hind, where it stays for a longer time. Since the microseism amplitude, as explained in the literature (e.g. Ardhuin et al., 2012; Bromirski et al., 1999; Bromirski et al., 2005; Cutroneo et al., 2021; Ferretti et al., 2013, 2018), depends on a wide sea area, the pattern of the RMS amplitude time series turns out to be more similar to that of the SWH-Hind rather than that of the SWH-HF (see section 4.3 lines 468-505). In addition, to obtain more quantitative information on the similarity of such patterns, we performed a correlation analysis between microseism amplitude and significant wave height by drawing maps showing the spatial distribution of the correlation coefficient (see section 3.4 lines 262-273 for the method explanation and section 4.3 lines 474-476, 479-482 and 501-505 for the results).

### ***Reviewer 1***

I read the paper “Integration of microseism, wavemeter buoy, HF Radar and hindcast data to analyze the Mediterranean cyclone Helios” with great interest. The authors studied the features of the Mediterranean cyclone Helios by a multiparametric approach combining microseism results with sea state and meteorological data provided by wavemeter buoy, HF Radar, hindcast maps and satellite SEVIRI images. My general impression is that the article is rather well written, indeed only specific parts of the manuscript need to be revised. As highlighted by the authors, the analysis of the Mediterranean cyclone Helios was very important because it has caused heavy rainfall, strong wind gusts and violent storm surge although not able to reach the fully Medicanne characteristics, remaining a rather weak sub-tropical system. The authors aim at studying and monitoring the Mediterranean cyclones through microseism and its integration with sea state data. The paper presents scientific novelties and then it can be published. However, it needs a minor revision before being accepted.

[We thank the reviewer for the positive comment.](#)

Substantive comments – In the revised manuscript, the parts that need to be rephrased are underlined in blue and highlighted in orange.

Lines 71 → 73: The sentence “This method, called cyclone phase space analysis, relies on a large spectrum of different cyclone types in a way to form a continuum between tropical and extratropical cyclones.” needs to be specified more clearly. Please rewrite it.

[We rewrote this sentence and added more details about the method used to classify the transition from extra-tropical to tropical cyclones \(see lines 69-75\).](#)

Lines 102 → 105: The sentence “primary microseism (PM), that shows the same period as the oceanic waves (13 - 20 s) and low amplitudes, and is generated by the energy transfer of oceanic waves breaking against the shoreline (Ardhuin et al., 2015; Hasselmann, 1963).” should be supported by more references, as Lepore and Grad (2018).

[Fixed \(see line 114\).](#)

Lines 240 → 242: In the sentence “Each dot, in Figure 4, represents a seismic station and the color of the dot relates to the corresponding RMS amplitude at that location, as specified in the color bar.”, you should widen the description of Figure 4, otherwise it is difficult to understand its connection with the rest of the paragraph.

In section 3 (Data and methods) we present only the data and methods used in our study; a detailed description of all the figures cited in this section is given in section 4 (Result and discussion). We rewrote a part of the sentence to connect this to the rest of the paragraph (see lines 250-260).

Line 333 → 334: I believe it is very important adding something concerning the innovative features of the i-waveNET at this point of the manuscript.

We added a paragraph in Section 3.1 (Seismic Data; see lines 175-181).

Lines 393 → 397: The sentence “In particular, during the Medicane Apollo, the analysis did not show a significant amplitude increase in the PM band, while during the subtropical system Helios, the RMS amplitude time series for the PM (Supplementary Figure 2), although with two orders of magnitude smaller, showed a trend similar to the SM (Figure 3) and SPSM (Supplementary Figure 1) ones.” lacks of clarity in the comparison between Apollo and Helios. Please rewrite that part.

Fixed (see lines 424-437).

Lines 463 → 465: The sentence “Concerning the array techniques, we chose to focus on the SM band since, according to the information from the ARF, we expect reliable localizations only on the PM and SM bands, while for the SPSM band appears spatial aliasing.” does not specify why the authors chose to focus only on the SM bands notwithstanding also the PM band gives reliable localization. Please specify better.

Fixed (see 510-512).

Lines 568 → 570: The sentence “In particular, the HF radar and the hindcast maps exhibit an SWH of about 6 meters while the wavemeter buoy shows an SWH of about 3 meters” is not clearly discussed in the rest of the manuscript.

The differences between the values recorded by the two instruments are only linked to the position where wave buoys and HF Radar are installed. We discussed this in the Sea State section (4.1; see lines 371-393).

Technical corrections – In the revised manuscript, the parts needing corrections are marked in purple; furthermore, the parts that should be deleted are crossed out in blue. Corrections are reported in the shape of pop-up yellow notes. In the following, the lines are listed needing modifications.

ABSTRACT, line 29.

Fixed.

INTRODUCTION, lines 58, 69 and 122.

Fixed.

SUB-TROPICAL SYSTEM “HELIOS”, line 143.

Fixed.

CONCLUSIONS, lines 572, 576, 577 and 578.

Fixed.

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*Thank you for your comments on our manuscript titled “**Integration of microseism, wavemeter buoy, HF Radar and hindcast data to analyze the Mediterranean cyclone Helios**”. We have taken great care to address all the comments. The detailed one-by-one response to the comments is included below (the review itself is in black, and our responses are in blue). Please note that the line numbers refer to the manuscript with the tracked revisions.*

**Reviewer 2**

1. There are too many references in the paper, so it is suggested that the author focus more on the relevant references of the research content and delete irrelevant parts.

Since in this work we deal with both seismology and meteorology, considering in particular Medicanes, it is essential to introduce these two aspects by analyzing and citing the existent literature. Also the performed analysis requires a citation of the existing literature. The number of our references is in line with the limit imposed by several journals (70-80). For these reasons, we think that the number of references is appropriate for our research.

2. It is recommended to describe the data and then give the main purpose of the data.

We provide a detailed description of the data used in this study in section 3. In particular, we described the seismic data in section 3.1 and the analysis performed using this data in lines: 173-174, 182. Similarly, Sea state data are described in sections: 3.2 (overview of the sea state data used in this study), 3.2.1 (Hindcast maps), 3.2.2 (wavemeter buoy), 3.2.3 (HF Radar) and 3.2.4 (Satellite data).

3. Part 3.3 only introduces what the figure shows, and does not specifically analyze the details and possible reasons of the figure pattern.

In section 3 (Data and methods) we present only the data and methods used in our study; a detailed description of all the figures cited in this section is given in section 4 (Result and discussion). In particular, the figures cited in section 3.3 are discussed in section 4.2.

4. The black solid line in Figure 3 is not only indicated in the text, but also suggested in the figure illustration.

Fixed. We added what the black lines represent both in the text (lines 249 and 393) and in Figure 3.