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Microseism and Mediane Apollo: a new approach to investigate the Mediterranean extreme weather events

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Microseism is the most continuous and ubiquitous seismic signal on the Earth and is caused by the interaction between the atmosphere, the hydrosphere and the Solid Earth. In literature, there are several studies that deal with the relationship between microseism and cyclonic activity considering in particular hurricanes, tropical cyclones and typhoons. However, the relationships between microseism and the small-scale tropical cyclones that occur in the Mediterranean Sea, called Medicanes, have never been analysed. For this reason, we considered the Mediane Apollo, which developed in the Ionian Sea and impacted the eastern part of Sicily during the period 25th October to 5th November 2021 causing heavy rainfall (> 400 mm/48h), strong wind gusts (104 km/h) and violent sea waves (significant wave height > 3.5 m). Furthermore, the heavy rainfall induced by the presence of Apollo, caused damage to infrastructure and agriculture forcing the Sicilian regional government to declare a state of emergency for 32 municipalities (in the provinces of Catania, Messina, Siracusa and Ragusa) that were mostly affected by the Mediane Apollo.

In this work, we analysed the microseism signal recorded by 78 seismic stations installed in South Italy, Malta and Greece coastline during the period under investigation. To obtain information about the significant wave heights, we consider the data obtained by hindcast maps and four wavemeters buoys. The spectral and amplitude analysis allowed us to obtain information about the space-time variations of the microseism amplitude and in addition, we were able both to differentiate the seismic stations that perceive Apollo (stations installed close to the Ionian Sea), the seismic stations that do not perceive the medicane (stations installed close to the Tyrrhenian sea) and the microseism bands influenced by the presence of the Mediane Apollo. Moreover, we tracked the position of the Apollo by using two different methods: i) grid search method based on the seismic amplitude decay using the 78 seismic stations first mentioned and ii) array technique by 15 seismic stations installed on Etna which may be considered an array thanks to their spatial

distribution and geometry. We obtain a good match between the real positions of the Mediane Apollo derived from satellite images and the positions computed by the two analysis methods. This work shows that it is possible to extract information about the Mediterranean extreme meteor-marine events from microseism, a seismic signal that until not long ago was considered as noise, both for monitoring and research purposes.