Answer to Reviewer #1 general comment

We thank the reviewer for thoroughly examining our manuscript and providing many useful comments. This answer addresses only the reviewer's general comment, while the answers to specific comments will be provided separately in the revised version of the paper.

Our study investigates weather conditions during the collapse of the Morandi Bridge in Genoa using various surface and remote sensing measurements, as well as WRF model results. While there is no clear evidence that the weather conditions played a role in the bridge collapse, which we have clearly stated in the manuscript, the reported weather conditions were characterized with strong near-surface winds and high frequency of lightning strikes, in addition to locally strong rainfall rates. These high impact weather conditions could have been a factor in the collapse and therefore it is important to document them in the scientific literature. Now, for some natural phenomena, like landslides or earthquakes, a direct cause-effect relationship between forcing and structural failure can be proven more easily. When it comes to wind, it is more difficult to prove that the weather conditions (e.g., strong winds) triggered the collapse.

A detailed structural analysis would have to be carried out in order to determine precisely if the observed strong winds caused the bridge collapse. In principle, this would include the following analyses: (1) structural integrity of the bridge and (2) the characterization of external forces that were exerted on the bridge—i.e., wind in this particular case. While the first kind of analysis is in this moment ongoing as part of a governmental judicial inquiry, the spatiotemporal characterization of the wind field is one of the main objectives of this article. Our paper extends the analysis of weather conditions beyond wind and includes lightning and rainfall as both of these can be classified as high impact weather. In other words, a study like this one needs to be prepared in order to ever investigate if wind could have caused bridge collapse.

Therefore, in our opinion the objectives of the paper are clearly defined and scientifically sound. It is not that bridges are falling down on daily basis around the world and then this is just one more paper on that subject. This tragic event is a rare incident whose occurrence coincides with the development of a strong thunderstorm in the same area. That being said, we do not see how the investigation of that thunderstorm is not important from both meteorological (phenomenological) and, in perspective, engineering (structural) point of view.

In addition, this manuscript is submitted to the journal of *Natural Hazards and Earth System Sciences* (NHESS) and not to purely structural engineering or meteorological journals. The aims and scope of NHESS (https://www.natural-hazards-and-earth-system-sciences.net/about/aims_and_scope.html) are:

- *the study of the evolution of natural systems towards extreme conditions, and the detection and monitoring of precursors of the evolution;*
- *the detection, monitoring, and modelling of natural phenomena, and the integration of measurements and models for the understanding and forecasting of the behaviour and*

the spatial and temporal evolution of hazardous natural events as well as their consequences;

- *the design, development, experimentation, and validation of new techniques, methods, and tools for the detection, mapping, monitoring, and modelling of natural hazards and their human, environmental, and societal consequences;*
- *the design, implementation, and critical evaluation of mitigation and adaptation strategies to reduce the impact of hazardous natural events on human-made structures and infrastructure, to reduce vulnerability and to increase resilience of individuals and societies;*
- *the analysis of the impact of climatic and environmental changes on natural hazards and their consequences."*

While most of the above-listed subjects can be found in our manuscript, the second bullet point (underlined) is the most relevant for our research. Our paper presents detection, monitoring and modelling of natural phenomena (i.e., thunderstorm) through the integration of measurements (surface and remote measurements) and models (WRF) to properly understand the forecasting potential and behavior of the spatial and temporal evolution of this potentially hazardous natural event. Most of the general comments made by the reviewer suggest a purely meteorological analysis with little to no mentioning of the bridge collapse. Such an analysis, however, would not fit this journal and it would be more appropriate for meteorological journals.

While we agree with some of the reviewer's comments, we believe that the provided review is not adequately formulated keeping in mind the scope of this journal, the scope of this research and the overall objectives that the authors set for the manuscript. For example, the reviewer states: "*The link to the collapse of the bridge could of course be mentioned but should not be the motivation for the study. This could rather be the observational capturing of a gust front by Doppler lidar measurements.*" We have two main objections to this statement. Firstly, the reviewer is stating what the objective of our own research should be. We can accept that the reviewer is not satisfied with the methods, research level, presentation of results, quality of figures, etc., but the review, in principle, should not reflect on how the reviewer would formulate the study's objectives if she/he carried out this research. We can all agree that different people have different research interests and our interests in the current stage of this research project are to describe, quantify and understand the genesis and predictability of this severe weather event that took place during the bridge collapse—all within the scope of this journal.

It is true that at the end of this investigation we cannot state that for sure wind was the cause of bridge collapse, also because there are no wind measurements at the bridge site to demonstrate directly this hypothesis. However, we have shown that exactly at the time of collapse a gust front was surely passing over the bridge, as demonstrated qualitatively by Figure 1 and quantitatively by the analysis reported in Section 3.2. We think that assuming this is just a coincidence would be too superficial and therefore we cannot agree with the Reviewer's statements that "there is

no evidence that the atmospheric conditions around the time of the collapse played a role in the collapse" and "the presented analysis does not provide any new insights into this".

The Reviewer states also that "Neither maximum wind speed nor precipitation amounts were extreme". However, natural hazards are not only related to very strong or extreme events. In a broader sense of its meaning, a natural hazard can be any cause of disaster, which is not always an extreme event. In other words, many structures are nowadays old and therefore susceptible of collapse because of fatigue. Under such assumption, even not really extreme events, like the one described in our paper, can become a natural hazard when it affects a structure which is very old and not well maintained or monitored, as it was the case of Morandi Bridge.

Lastly, we would like to address the general comment on the number of figures and English. Most articles today contain between 10 and 20 figures, and we have included 18 figures in our paper. We believe that all figures are relevant because each of them shows different aspects of the research results. We also find confusing that the reviewer suggests here that the number of figures is too large, but then additional figures are recommended later in the specific comments (e.g., temperature for all stations and spatial map of wind vectors). We agree with the reviewer that there are some English language inaccuracies and these will be corrected in the revised manuscript. Thank you.