Editor

Thank you for submitting your manuscript "Severe convective weather in Italy: Current understanding and Research Priorities in the TIM campaign" to NHESS.

Two reviewers have now provided their assessments, and I am pleased to inform you that both found the manuscript to be of high quality, well-structured, and scientifically sound. The paper makes a valuable contribution as a community white paper positioning Italian participation in the TIM campaign. Accordingly, I invite you to submit a minor revised version addressing the reviewers' comments and a small number of additional editorial concerns outlined below.

We would like to thank the Editor and both Reviewers for the very positive evaluation of the paper.

Additional editorial requests

Beyond the reviewer comments, I would ask the authors to consider the following points, which I believe would strengthen the manuscript:

North-south balance. The current manuscript, as Reviewer 1 implicitly signals and as is apparent from the structure, dedicates substantially more depth to northern Italy than to central and southern regions. We recognize this reflects the genuine asymmetry in the existing literature, and that is a legitimate scientific observation. However, we ask the authors to make this asymmetry more explicit and deliberate in the framing, so that readers do not interpret the imbalance as an editorial choice rather than a reflection of research gaps.

We added the following sentence at the end of the Introduction: “The northern regions are the most studied in Italy, as they are affected by the most intense convective phenomena, so this article focuses on these regions (and partly also on the central regions).”

Separation of "state of the art" from "open issues". There is currently some overlap between Sections 2 and 3, most notably for aerosols and hail. We would ask the authors to review these sections and ensure a cleaner separation: Section 2 should describe what is known, and Section 3 what remains unresolved. This need not require major restructuring as in several places a single sentence clarifying the transition would suffice.

To fulfill this request, several paragraphs have been moved from Section 2 to Section 3 and vice versa. Now we think the separation of “state of the art” from “open issues” is more effective.

Campaign coordination challenges. The manuscript advocates persuasively for the TIM campaign and describes the tools and scientific priorities well, but it does not address the practical and coordination challenges that such a multi-institutional, multi-platform campaign entails. A brief discussion acknowledging challenges such as instrument interoperability, data-sharing protocols, real-time decision-making during IOPs, and the logistical complexity of deploying airborne platforms alongside ground networks would add credibility and be useful to the wider community planning similar efforts.

Section 4.5 “Campaign coordination challenges” has been added to address some practical and coordination challenges

“A multi-institutional, multi-platform field campaign entails practical and coordination challenges, which require rigorous operational frameworks, such as instrument interoperability, data-sharing protocols, real-time decision-making during IOPs, and the logistical complexity of deploying airborne platforms alongside ground networks. In fact, different institutions bring instruments with different hardware, data format, and calibration standards, which will require establishing compliance profiles and creating centralized preprocessing scripts to align all outputs, while centralising multiple observations requires the transition to federated, cloud-based data repositories that enforce interoperable formatting like netCDF for sharing. In addition, mission-planning

strategies to rapidly evolving conditions will be required to ensure multi-aircraft coordination and to allow simultaneous data collection in the same atmospheric column from fixed-point ground networks and fast-moving airborne platforms."

A small note is the distinction between available and aspirational tools (Section 4). In places, Section 4 blends descriptions of instruments and capabilities that are already operational with those that are planned or hoped for. Clearer signposting of this distinction would help readers assess Italy's current readiness for TIM versus what would need to be secured or funded.

Section 4 has been rearranged to clarify the distinction between instruments and capabilities that are already operational from those that are planned or hoped for.

Submission of revisions

Please submit a revised manuscript together with: (i) a point-by-point authors' reply addressing both reviewer comments and the editorial requests above, and (ii) a tracked-changes version of the manuscript.

Based on your revisions I will make a decision between sending the revisions to the reviewers or have an editorial review.

I look forward to receiving your revision and thank you again for your contribution.

Kind regards,
Timothy Tiggeloven
NHESS Editor

Anonymous Referee #1

It was a pleasure reviewing this paper. The quality of the paper is high. Not only the scientific content is sound, also the structure, clarity and language are very well readable.

The paper covers important aspects of lack of data and scientific understanding that should be tackled by a large European field campaign on severe thunderstorms, while the Italian foci are highlighted specifically. Those Italian foci are well in line with the general idea of the field campaign, as evident from the cited main TIM whitepaper by Fischer et al., and the present paper provides important further details.

We would like to thank the reviewer for the very positive evaluation of the paper.

The introduction nicely covers the context. The State of the Art chapter allows for a good overview on current knowledge and warning practice. The sections on Atmospheric Rivers and Aerosols provide important further motivation for the field campaign. A technical note: One fresh paper that only appeared this year (formally not in 2025, as stated in the References section) could be added to the hail section, as it specifically discusses hail trends for northern Italy: https://doi.org/10.1038/s41561-025-01868-0

The reference has been updated and it is now mentioned in the hail section in two sentences.

"… Northern Italy has shown the largest global increase in very-large hail frequency (up to +0.03 events per decade; Battaglioli et al., 2026), … A record of US$6 billion loss has been experienced in Northern Italy in 2023 (Battaglioli et al., 2026)."

Another technical remark: At some instances (Fig. 3, for example) the F-Scale is used for the rating of tornado intensities, at other instances the EF-Scale is used. As the EF-Scale is defined mostly for building codes and building practices in the USA (and specifically defined by the purpose of US buildings instead of generic stability properties), it usually cannot be applied to European buildings. In other words, it is not defined for many European Damage Indicators (DIs). For this reason, it would be correct to consistantly refer to the F-Scale throughout the paper (for historical ratings, or to the IF-Scale for recent or freshly rerated events).

F-scale and IF-scale are now used throughout the paper.

The Open Issues section is well written too. The paragraph starting with line 411 is a very important one. Same for chapter 3.3. The paragraph starting with line 496 provides an important motivation, chapter 3.8 too. Chapter 4.2 mentions the relationship to civil protection aspects and highlights the importance of analyzing the ground impact of severe convective storms. In the Conclusions section, the paragraph starting with line 616 is again a quite important one.

To summarize, this paper seems to be a good scientific basis integrating inter-connected disciplins in a well-designed multi-disciplinary approach for the described and planned field campaign activities in Italy. I congratulate the authors.

Again, thanks for your appreciation of the paper.

Anonymous Referee #2

This article provides an excellent overview about currently pressing research topics on severe convective storms with a focus on Italy as the European hotspot for these events. The authors advocate for field measurements to tackle this research.

The structure of the manuscript is good to follow, the Figures are appropriate, and the writing is of high quality. Scientifically, I agree with most of the article. I only have a few optional minor comments that could improve certain aspects in my opinion.

We would like to thank the reviewer for the very positive evaluation of the paper.

specific comments:

L. 47: “While northern Italy is most studies,…” - to the unfamiliar reader this may sound like there are no open questions for N Italy. Consider adding something like "...flash flood, there are many open questions. The southern regions are even less explored..."

Changed as requested.

L. 151: Perhaps verify, my status was that 2028-2030 is more likely.

Right. Changed.

L. 163: consider including a map or adding the relevant regions to Fig. 2. I think this would help the readers who are not familiar with Italy.

The names of Northern Italian regions have been added to Fig. 2.

Section 2.5: I agree with the importance of Aerosols. You could add a bit more perspective specifically for convective storms. For example, are Aerosols, like moisture, distributed heterogeneously in severe storm situations like in the triple point scenario you mention above (deMartin et al 2024)?

We provide additional detail on the distribution of aerosols in severe-storm environments and within clouds. Observational evidence remains very limited, representing one of the major gaps in our understanding of the role of aerosols in convective storm development. We added in Section 3.2:

"…; in fact, depending on their distribution within the atmosphere, aerosols may either invigorate or suppress convective development (Stier et al., 2024). Unfortunately, direct observations in convective environments remain scarce. Limited airborne measurements reveal substantial variability in aerosol concentrations and properties throughout the cloud column, suggesting that aerosol–cloud interactions are highly sensitive to local microphysical, dynamical and thermodynamic conditions (e.g. Zanatta et al., 2023)."
Reference: Zanatta, M., Mertes, S., Jourdan, O., Dupuy, R., Järvinen, E., Schnaiter, M., Eppers, O., Schneider, J., Jurányi, Z., and Herber, A.: Airborne investigation of black carbon interaction with low-level, persistent, mixed-phase clouds in the Arctic summer, Atmospheric Chemistry and Physics, 23, 7955–7973, https://doi.org/10.5194/acp-23-7955-2023, 2023.

Section 2.5: the interplay of hail to the previous sections could be mentioned and perhaps discussed here. For example the role of aerosols (e.g., Brennan and Wilhelm 2025) or of mediterranean moisture and local boundaries (de Martin 2025).

We thank the reviewer for this suggestion. We have added a brief discussion on the potential role of aerosols in hail formation. In particular, we highlight recent studies suggesting a link between coarse aerosol particles, especially Saharan dust, and hail occurrence through their ability to act as ice-nucleating particles. We also note that the available evidence remains limited and is largely based on satellite observations, reanalyses and modelling studies, with relatively few in-situ observations. We added in Section 2.5:

"Despite limited observational evidence, coarse-mode aerosol particles, particularly mineral dust, have recently been linked to hail formation through their ability to act as efficient ice-nucleating particles. Several studies reported positive associations between hail occurrence and enhanced Saharan dust loadings (Brennan and Wilhelm, 2025), which is extremely important for Italy, given its frequent exposure to Saharan dust outbreaks (Vogel et al., 2025)."
and in Section 3.2
"Lastly, aerosol-mediated effects on hail development remain a potentially important but poorly constrained process."

Line 358: "advancing the physics of the model" - this is quite general and no details are given. Do you mean improving microphysics schemes (again a link to aerosols), model resolution, fluxes over orography (TeamX), etc.? Are there any plans on these topics for TIM over Italy?

What models are currently used and will be tried to improve?

We agree that this point was quite general, so it has been re-written. Following editor's suggestion, it has been moved to Section 3.8

"very high-resolution simulations (i.e. with a grid spacing of less than 1 km) will be necessary to study local low-level circulations (e.g., up-valley and down-valley flows, mountain-valley breeze, …) that are relevant for the initiation of convection. Furthermore, the sensitivity of the model to parameterization schemes (e.g., convection, turbulence, microphysics) should clarify the role of convection-relevant and not yet fully studied physical processes, such as the impact of aerosols on cloud microphysics."
And in Section 2.7:
"… applied to different models used in Italy (e.g., WRF, MOLOCH, COSMO)."

L. 587: I agree that resolving aerosol concentrations in 3D is crucial. This point could be supported more by the fact that convective storms source their inflow differently, depending on their mode (supercell, MCS, etc.) and if they are elevated or surface-based. For Supercells, different flanks of the storm even have different inflow origins, which has implications for hail growth (e.g., Lin et al. 2022). Of course near orography, inflows might be even more complex and changing over time. Thus, 3D monitoring of aerosols, moisture, and winds would be a unique and impactful observation set.

Lin, Y., & Kumjian, M. R. (2022). Influences of CAPE on Hail Production in Simulated Supercell Storms. Journal of the Atmospheric Sciences, 79(1), 179–204. https://doi.org/10.1175/JAS-D-21-0054.1

Thanks for the important comment. We added some sentences in Section 4.4. and the reference:

“Resolving aerosol concentrations in 3D is crucial considering that convective storms source their inflow differently, depending on their mode (supercell, MCS, etc.) and on the fact they are elevated or surface based. For supercells, different flanks of the storm even have different inflow origins, which has implications for hail growth (e.g., Lin and Kumjian, 2022). Near the orography, inflows might be even more complex and changing over time. Thus, monitoring of aerosols, moisture, and winds would be a unique and impactful observation set, …”

Typos:

L. 105: “unique“ instead of “peculiar“?

Changed.

L. 272: “have“ instead of “has“ ?

Changed.

L. 290: extra space

Added.

L. 510: "…to investigate severe convective weather features at unprecedented resolution." ?

Changed.