

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 studied...” - 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:

“Similar to moisture, aerosol concentrations can exhibit strong spatial heterogeneity and vertical stratification depending on PBL dynamics and long-range transport. Depending on their distribution within the atmosphere, aerosols may either invigorate or suppress convective development (Stier et al., 2024). However, 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 available. We added:

“Despite the 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 the its frequent exposure to Saharan dust outbreaks (Vogel et al., 2025). Nevertheless, 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 and it has been re-written:

“Very high-resolution simulations (i.e. with a grid spacing of less than 1 km) are 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) may clarify the role of convection-relevant and not yet fully studied physical processes, such as the impact of aerosols on cloud microphysics... 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.