Response to the Reviewers

We thank the Reviewers for their critical assessment of our work, which helped us to improve the overall quality of the manuscript. In the following, we address their concerns point by point.

Reviewer 1

Note to authors: It is difficult to navigate the reviewer responses because the numbering system opted by the authors (e.g., "Reviewer Point P1.1") is different from that employed by the reviewers. In particular, where the reviewers specified different sections (e.g., Major Comments, Other Comments, Difficult Text to Understand) each beginning with the number 1, the authors have used consecutive numbering. In the future, please stick with the same numbering system used by the reviewers.

Reply: We are sorry for the confusion. Here we have followed the numbering used by the Reviewer.

General comments:

The authors have made considerable revisions in response to the reviewers' comments. In particular, the figures are more consistent and in line with AMS standards, and the introduction is considerably improved.

Reply: We thank dr. Schultz for his positive comment and, in particular, for his thorough review and very useful and appropriate comments, which greatly contributed to improving the quality of the paper.

Major Comments:

1. The abstract has only four main results (last four sentences). Is this all the results that you want to highlight from the manuscript? Abstracts at AMS journals can be up to 260 words long. The present abstract is only 218 words by my count. Can you include more results to maximize the amount of information that you make available to those who cannot or will not access the full manuscript?

Reply: The abstract has been revised to include more results, reaching the maximum length allowed by the AMS guidelines.

2. Sentences are still unusually long and difficult to read in places. I have identified some under Minor Comments, but it is incumbent on the authors to improve the manuscript further. Otherwise, they risk poor communication with their audience.

Reply: Thanks for the suggestion. The manuscript has been completely revised, paying particular attention to long sentences.

3. Three reviewers provided comments to improve the authors' manuscript, yet are unacknowledged in the manuscript.

Reply: The three reviewers are acknowledged in the new version of the manuscript.

4. In response to my original point 5 under Introduction and Literature Synthesis (now Point P 2.5), there is a whole body of literature from the Mesoscale Alpine Programme. The authors have revised the manuscript with a single sentence: "The mechanisms of intense orographic precipitation over the southern Alpine slopes have been extensively investigated in the literature, for example in studies related to the Mesoscale Alpine Programme (MAP, Bougeault et al. 2001), nicely summarized in Rotunno and Houze (2007)." Even less was said about HyMeX. This is not the level of revision required or that I requested. The authors do the body of literature that preceded their work—and themselves by extension—a disservice with this sentence. All it does is pay lip service with a passing citation to the published summary of the project. You should be discussing the results of these studies in your introduction. Was nothing learned about the mesoscale organization of precipitation from the dozens of papers published from MAP that relate to the work in this manuscript? I would be shocked if not.

Reply: The literature review related to MAP and HyMex was expanded: "The mechanisms of intense orographic precipitation over the southern Alpine slopes have been extensively investigated in the literature, for example in studies related to the Mesoscale Alpine Programme (MAP, Bougeault et al., 2001), nicely summarized in Rotunno and Houze (2007), shedding light on how the complex interaction between the Alpine orography and the impinging flow can modulate the intensity and distribution of precipitation. In this regard, Medina and Houze (2003), analyzing two intense MAP storms, proposed conceptual models for orographic precipitation in stable blocked flow and unstable unblocked flows, focusing on the Lake Maggiore area (central Italian Alps). In stable blocked flow, the lowest atmospheric layer does not experience orographic lifting and, if the rising layer of air is stable, precipitation is stratiform. On the other hand, in unstable unblocked flow, orographic lifting also affects the low-level flow, favoring the development of convective cells over the first peaks. More recently, the Hydrological cycle in the Mediterranean eXperiment (HyMeX, Ducrocq et al., 2014) focused on heavy precipitation events in different Mediterranean target areas, including the region affected by the Vaia storm, northeastern Italy, where heavy precipitation episodes are typically associated with intense low-level southeasterly flow (usually named sirocco in this geographical area) from the Adriatic Sea (Ferretti et al., 2014; Miglietta and Davolio, 2022). Coherently with Medina and Houze (2003), Davolio et al. (2016) highlighted that, in these conditions, an easterly barrier flow develops ahead of the Alps, as a consequence of the low-level flow-blocking of the incoming southeasterly wind. The dynamical characteristics of the impinging southerly flow strongly influence the location of precipitation, distinguishing between situations of persistent blocked flow, in which rainfall is concentrated over the plain due to the low-level convergence between the barrier wind and the impinging southeasterly flow upstream of the orography, and situations in which the sirocco wind progressively penetrates inland, removing the barrier wind and establishing flow-over conditions, with heavy precipitation over the Alps. In the former case, when the southeasterly wind is conditionally unstable, deep convection may develop over the plain (Manzato et al., 2015; Miglietta et al., 2016; Ricchi et al. 2021). The latter case, in which the Vaia storm can be categorized, is favored with strong southeasterly winds and a nearly moist neutral profile in the low levels. Convection is inhibited over the plain, but can develop over the Alps due to orographic lifting (Davolio et al., 2016; Stocchi and Davolio, 2017)."

5. Lines 664-690 lack quantitative information. Most sentences are general statements, especially "a certain amount of dry stability is needed in the boundary layer" and "presence of a moist

unstable environment aloft allows the development of banded convection". Without quantitative information, the conclusion lacks precision. Can more quantitative information be added to the conclusions?

Reply: This part of the Conclusions was revised to add more quantitative information.

6. Units keep jumping back and forth between m and km unnecessarily. Sometimes written as "1 km", sometimes written as "1000 m". Be consistent throughout. Using "1 km" is certainly shorter and easier to read. See for example the rapid reversal at lines 297-300. See also "6-7 km" at line 662 vs "6000-7000 m" at line 373.

Reply: km is now used consistently in the manuscript.

7. There remains tedious reading around the figure citations. For the most part, just put the figure citations in parentheses after the cited information. You don't need "as shown in" (e.g., Lines 562, 567). You don't need "The results of the simulations are shown in Fig. 17" (e.g., Line 576). You don't need "as can be seen in the y-z section in Fig. 18a" (e.g., Line 579). These are unnecessary words, phrases, and sentences. Delete. Just put the citations in parentheses. Fix throughout the entire manuscript.

Reply: Thanks for the suggestion. The manuscript has been completely revised, paying particular attention to this aspect.

Minor Comments:

1. Line 59: According to AMS style, phrases starting with "e.g.," or "i.e.," should be in parentheses. Fix here and throughout the manuscript.

Reply: This has been fixed throughout the manuscript.

2. Line 64 is a misplaced modifying phrase. "Skills of NWP models" connects to "besides being influenced...". The sentence makes no sense when written this way.

Reply: Sentence modified: "The skills of NWP models in reproducing orographic banded convection are affected not only by the terrain characteristics and their representation in the model but also by the ability of the simulation to reliably capture the characteristics of the flow impinging on the mountain range."

3. Avoid the word "significant" or "significantly" in scientific writing. Doing so avoids any inference of statistical significance (Eloquent Science, p. 362). For example, line 68. Fix throughout.

Reply: This has been fixed throughout the manuscript.

4. Line 79: Avoid the word "comprehensive". No study is truly comprehensive. Furthermore, what would constitute an endgame where the authors would claim that such a result is "comprehensive"? It's hard to define. In short, the word cannot be defended.

Reply: Sentence changed: "whereas the evaluation of the atmospheric factors affecting deep banded convection has received less attention."

5. Lines 141, 175, 543: Delete the word "clearly" (an adverb, as per Reviewer Point P 2.43; Minor Comment 4).

Reply: The word "clearly" has been deleted.

6. Lines 157-160: This sentence is too long. Unnecessary commas are not helping.

Reply: This sentence has been split: "This synoptic situation favored the development of intense and moist southeasterly wind over the Adriatic Sea, usually named Sirocco in this geographical area. Heavy precipitation and strong wind gusts characterized this phase of the storm, with consequent damage in the eastern Italian Alps."

7. Line 172: Follow proper format for "skew T-logp". Fix throughout.
https://www.ametsoc.org/index.cfm/ams/publications/author-information/formatting-and-manuscript-components/ams-style-for-common-meteorological-terms/

Reply: Fixed throughout the manuscript.

8. Figure 2. The wind barbs are too small to read. Vertically stack panels so each panel is larger and the wind barbs are more easily read.

Reply: Done.

9. Line 207: Insert comma after "MSL".

Reply: Done.

10. Line 215: Change "aiming" to "aimed"?

Reply: "aiming" changed to "aimed".

11. Line 219: Insert comma after "direction"

Reply: Comma inserted.

12. Line 231: No comma.

Reply: Comma deleted.

13. Line 241: Monin–Obukhov should have an en dash, not a hyphen.

Reply: Hyphen replaced with en dash.

14. Figure 4: Resolution does not equal grid spacing. Change the word to "grid spacing" or "grid interval".

Reply: Done.

15. Lines 348-349: Remove top/bottom panel and replace with figure panel letters.

Reply: Done.

16. Line 352: "cf." means compare, so which specific figure panels in Fig. 6 are being compared to which specific panels in Fig. 4? Write it as something like "(cf. Figs. 4x,y and Fig. 6z)".

Reply: Changed to: "(cf. Figs. 4a,b and Fig. 6a)".

17. Line 417: Insert comma before "the".

Reply: Done.

18. Line 470: Do not start the sentence with a numeral.

Reply: Sentence modified: "The same wind profile as CTRL (thus with a constant wind direction), but rotated clockwise by 30°, is used in 210°."

19. Line 537: "Concerning layer 1 static stability" is an awkward start to this sentence.

Reply: Sentence modified: "Three different simulations were performed to analyze the influence of layer 1 static stability, varying exclusively the Brunt-Väisäla frequency N_1 of the first layer (Fig. 15a)."

20. Line 569: cite the CTRL figure.

Reply: Done.

21. Line 587: Delete "it is interesting to notice". Unnecessary.

Reply: Done.

22. Line 633: RH is not a variable; it is an acronym, so it should not be italicized as per AMS style.
https://www.ametsoc.org/index.cfm/ams/publications/author-information/formatting-and-manuscript-components/list-of-acronyms-and-abbreviations/

Reply: Changed throughout the manuscript.

23. There is a tendency to start a sentence with "This <verb>", such as "This suggests" (e.g., Lines 635, 688). The problem is that it is often unclear what "this" means. The whole previous sentence? A specific noun in the previous sentence? A part of the previous sentence? It is unclear. Revise these sentences for clarity. Fix here and elsewhere in the manuscript.

Reply: Fixed throughout the manuscript.

24. Lines 638-640: This sentence is unclear. The unusual word "disturbance" is part of the problem, but there are also difficulties in understanding the whole sentence the way it is worded.

Reply: Sentence modified: "The presence of a near-saturated layer at mid-troposphere allows parcels to condense also with small vertical velocity perturbations, thus explaining the development of convection also upstream of the ridge, which completely inhibits the organization of orographic rainbands."

25. Line 645: is "grasped" the right word?

Reply: "grasped" substituted with "taken".

26. Multiple citations within parentheses should be separated with semicolons, as per AMS style. An example is line 666. Also at line 666, space needed after "2000".

Reply: Fixed throughout the manuscript.

27. Line 669: What does "it" refer to?

Reply: Sentence modified: "However, weakly organized bands developed even in simulations with vertically-constant approaching wind, provided that wind speed is sufficiently intense to guarantee a flow-over regime".

28. Please ensure that you have used commas correctly throughout. Some sentences are challenging to read because commas are not used correctly. Please search "proper comma use" in your browser.

Reply: The manuscript has been completely revised, paying particular attention to the proper comma use.