

Overview of the first HyMeX Special Observation Period over Italy: observations and model results

R. Ferretti¹, E. Pichelli¹, S. Gentile¹, I. Maiello¹, D. Cimini^{2,1}, S. Davolio³, M. M. Miglietta⁴, G. Panegrossi⁵, L. Baldini⁵, F. Pasi⁶, F. S. Marzano^{7,1}, A. Zinzi⁸, S. Mariani⁹, M. Casaioli⁹, G. Bartolini¹⁰, N. Loglisci¹¹, A. Montani¹², C. Marsigli¹², A. Manzato¹³, A. Pucillo¹³, M. E. Ferrario¹⁴, V. Colaiuda¹ and R. Rotunno¹⁵

Answer to referee #1

Following the reviewer suggestion two areas have been improved: NAO and PV. As first the definition of the NAO index and the link to the southern Mediterranean area events are described. Hence, specifically the interaction of the large scale pattern for each event presented in the paper is illustrated. For what concerns PV the acronym definition has been added and, also the link with heavy precipitation in the southern side of the Alpine ridge is specifically addressed.

Major issues:

- 1. P 11653 It says that "40 vertical levels are used." Need to know more about the vertical resolution of these models: spacing, how well it resolves boundary layer processes. These kinds of facts are important for the simulation of episodes of intense convection.*

For each model, information on the vertical distribution of the levels is added; specifically the high of the first level and the density in the PBL is specified.
- 2. P11654 L2 Should state that no convective parameterization is used for the inner domain just to be clear. I only inferred this from previous sentences in the paragraph, but the authors need to make this clear if this is indeed the case.*

It is stated for each model if the convective scheme is used. This is also stated clearly in table 4.
- 3. NAO index is mentioned several times, but I don't think that the authors make clear the implications for the meteorological events that are subsequently described. Also, is the acronym defined? In section 3 a negative NAO index is said to make "the weather regime favorable for precipitating systems". Is this for generating the system? Maintaining what is already there? What does a negative NAO index even mean? Is an index close to zero (P11657 L22) a neutral NAO or an extreme one? I think that the general reader could use a nice basic explanation of the NAO. Later on when NAO index values are given, another sentence should explain how that number is relevant to the meteorology on that day.*

We agree with the referee, NAO index explanation is added in section 3 as follow: 'The permanent Icelandic Low and Azores High control the direction and strength of westerly winds into Europe. The relative strengths and positions of these systems vary from year to year and this variation is known as the NAO. The station-based index of the NAO is based on the difference of normalized sea level pressure (SLP) between Lisbon, Portugal (or Ponta Delgada, Azores) and Stykkisholmur/Reykjavik, Iceland since 1864. A more complex definition is based on the principal empirical orthogonal function (EOF) of surface pressure. Through east-west oscillation motions of the Icelandic low and the Azores high, it controls

the strength and direction of westerly winds and storm tracks across the North Atlantic. A large difference in the pressure at the two stations (NAO+) leads to increased westerlies and, consequently, cool summers and mild and wet winters in Central Europe and its surrounding Atlantic area. If the index is low (NAO-), westerlies are suppressed. Hence, the two previous areas suffer from cold winters and storms tracks are shifted southerly toward the Mediterranean Sea increasing storm activity and rainfall in southern Europe and North Africa.'

Moreover, for each event a sentence to clarify the relevance of the NAO value is added.

4. *P11661 L 24-26 The relationship between the cyclone and the PV anomaly is unclear. Are the authors implying that the PV anomaly caused the cyclone or that the presence of the cyclone enhanced an existing PV anomaly? Also, is PV defined as Potential Vorticity in the text?*

The acronym definition of Potential Vorticity is added in this paragraph. Moreover the link between PV anomalies and cyclone/occurrence of heavy rainfall has been clarified. The following sentence is added: 'It is well known that the lateral translation of an elongated north-south aligned PV streamer produces favorable conditions for heavy precipitation in the south side of the Alpine ridge (Massacand et al., 1998).'

5. *P11670 L18 What processes are these high resolution models representing well in order to simulate these characteristics? Is it the numerical grid spacing in the horizontal? vertical? orography? Is it the fact that the innermost models are non-hydrostatic?*

A sentence will be added to clarify the role of each of these parameters, the increase of the horizontal and vertical resolution allows for improving the model orography, and of the associated vertical motion. Because of most of the events were characterized by orographic precipitations, we can speculate that these parameters are playing a major role for attaining a correct forecast. Of course, a high horizontal resolution model (below 6km) requires the non-hydrostatic assumption.

6. *P 11672 L1-8 Observed intensities appear more similar to WRF model experiments. Can the authors comment on why this might be? Is different orography important? or the microphysical schemes?*

A sentence to explain these results will be added.

Minor issues:

1. Ok, done
2. Ok, done
3. Ok, done
4. Ok, we change the sentence accordingly
5. Ok, thanks
6. Ok, thanks
7. Ok, we changed this sentence
8. Ok, we changed the sentence
9. Ok, we changed the word with strength
10. Ok, done
11. We changed the sentence with parent domain
12. We changed this sentence with: 'five different hydrometeors: cloud water, cloud ice, rain, snow, graupel'
13. Ok, changed
14. Ok, done
15. Ok we changed this sentence

16. Ok we changed the sentence as follow: ‘Conversely, in Rome at "Sapienza" University, the NASA 2D video disdrometer recorded a total amount of 25 mm. A hourly rain rate of 20 mm was recorded between 1740LST and 1840LST, being 114 mm/h the highest rain rate estimated in 1 minute.’
17. Ok, done
18. We changed this sentence as follow: ‘The presence of a convection core at 4 km (Fig. 12b) is confirmed by large, positive values of differential reflectivity co-located with high reflectivity values that are typically associated to heavy rain with (or formed from) melting graupel or small hail (Meischner et al., 1991). The trailing part of the convective systems exhibits a quite thick and not well defined bright band signature (Fig. 12c,d).’
19. We checked, the figures are correct. We mean Figure 12.
20. We changed this sentence as follow: ‘Figure 12 shows an RHI collected by Polar 55C during the F20 flight (position of F20 red circle in Figure 12c). Both sensors detected a stratiform structure of precipitation. Differential reflectivity shows an increase around at 6km height and at 10 km distance from the radar, indicating the formation of oblate ice particles.’
21. Ok, done
22. Ok done.
23. To clarify we changed the sentence as follow: ‘The correct forecast of the PV anomaly contributed to increase the skill of the rainfall forecast.’
24. Ok, done
25. Ok, thanks
26. Ok thank you very much.
27. Ok, we added the acronym definition, and correct the errors.
28. Ok, done
29. Ok, we changed the sentence and we defined HPE and LT.
30. We added a sentence to clarify what it can be investigated next based on the HyMeX campaign preliminary results.

Figures and Tables

1. Ok, done
2. Ok, done
3. Ok, done
4. Ok, we are working on it
5. Ok we added in the caption the area definition and the color bar.
6. Ok, done
7. Ok, we are working on it
8. We are removing the wind vectors
9. Ok, done
10. Ok, done
11. We try to do it.
12. We are trying to improve the figure.