ACP paper 2019-937 – revised version "Hectometric scale simulations of a Mediterranean heavy precipitation event during HyMeX SOP1." O. Nuissier, F. Duffourg, M. Martinet, V. Ducrocq and C. Lac

REPLY TO THE COMMENTS OF ANONYMOUS REFEREE #1

General comments:

We fully agree with this general remark. In this present study, we recognize that we are not showing any sensitivity experiments to assess the precise role played by the lateral boundary conditions and we also recognize that the conclusion presented here is too affirmative. The predictability of this heavy precipitation event, associated with offshore deep convection over the sea, is relatively low compared with more classical events anchored over the mountain range foothills. The direct orographic forcing appears less crucial while the convective systems were moving over the sea, but the neighbouring mountains are able to deflect the environmental mesoscale flow. We agree that the model physics could also have a strong impact on the simulation. As a matter of fact, Martinet et al. (2017) showed for this case study that the formulation of the mixing length impacts the simulated surface precipitation through, in some cases, greater low levels moisture advection and hydrometeor contents within the convective system. Moreover, Thévenot et al. (2016) and Rainaud et al. (2017) even showed that taking into account the wave effect or sea surface conditions in different parameterizations of the sea state is able to modify locally the spatial distribution of the precipitation, although the overall rainfall pattern is globally well reproduced.

We agree that all these aspects are important but it must be emphasized that, during IOP16a case, the location and the evolution of deep convection over the sea (in particular the split into two distinct systems CS1 and CS2) are closely controlled by the upstream conditions (i.e. low levels moisture convergence generated by a surface low pressure located between Spain and Balearic Islands) and how they propagate inside of our LES domains. This split of deep convection over the sea is a real challenge for this case study. Another numerical experiment could consider a larger LES domain encompassing these upstream conditions. Although this LES over a very large domain would suffer from expansive computing time, it would be able to address whether a higher resolution simulation of these features is crucial. All these aspects have been included and discussed in the revised version of the paper.

Specific comments:

1) Page 2, line 22: The sentence has been rewritten.

2) Page 2, line 27: The text has been corrected.

3) Page 2, line 28: The text has been corrected.

4) Page 2, line 34: The text has been corrected.

5) Page 3, line 1: The text has been corrected.

6) Page 3, line 7: The text has been corrected.

7) Page 3, line 14: The text has been corrected.

8) Page 3, line 21: The text has been changed.

9) Page 3, line 23: The text has been changed.

10) Page 4, line 15: The text has been changed.

11) Page 6, line 3: The text has been changed.

12) Page 6, line 10: The word has been corrected here and throughout the text.

13) Page 7, line 4: The sentence has been rewritten accordingly.

14) Page 7, line 13: The text has been changed.

15) Page 7. Additional parametrization schemes have been added in the model description accordingly.

16) Page 7, line 30: The word has been corrected here and throughout the text.

17) Page 8, line 8: The word has been corrected here and throughout the text.

18) Page 8, line 9: The sentence has been rewritten.

19) Page 8, line 15: The text has been corrected.

20) Page 8, line 4: The text has been changed.

21) Page 9, line 12: The sentence has been rewritten.

22) Page 9, line 14: The text has been corrected.

23) Page 10, line 2: The text has been corrected.

24) Page 10, line 11: The text has been corrected.

25) Page 10, line 11: We agree with this remark. We cannot state "essentially due to the lateral boundary conditions...''. The sentence has been rewritten (see also response to general remark).

26) Page 11, line 1: The sentence has been rewritten.

27) Page 11, line 11: The text has been corrected.

28) Page 11, line 13: The text has been corrected.

29) Page 11, line 23: The text has been corrected.

30) Page 11, line 29: The text has been corrected.

31) Page 11, line 31: The text has been corrected.

32) Page 11, line 32: The text has been corrected.

33) Page 12; line 3: The text has been corrected.

34) Page 12, line 9: The text has been corrected.

35) Page 13, line 1: The sentence has been rewritten.

36) Page 13, line 2: The text has been corrected.

37) Page 16, line 1: The text has been corrected.

38) Page 16, line 2: The text has been corrected.

39) Page 16, line 4: The sentence has been rewritten.

40) Page 16, line 5: The text has been corrected.

41) Page 16, line 11: The text has been corrected.

42) Figure 10: We agree with this remark. It is not obvious to compare all simulations against observations as the simulation domains are different initially. However former Figure 10 has been redrawn zooming over the region of interest on the observations and including a grid on each panel.

43) Page 16, line 26: The text has been corrected.

44) Page 16, line 33: The sentence has been rewritten.

45) Page 17, line 3: The sentence has been rewritten.

46) Figure 12: In the revised version former Figure 12 has been improved adding the horizontal and vertical scale.

47) Page 8, line 1: The text has been corrected.

48) Page 20, line 18: The text has been corrected.

49) Page 20, line 18: The text has been corrected.

50) Page 20, line 29: The text has been corrected.

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REPLY TO THE COMMENTS OF ANONYMOUS REFEREE #2

General comments:

1) **More comparison against observations:**

We agree that a deeper analysis comparing the simulations and the available observations should improve the paper. However, it must be emphasized that such analysis has been performed previously in the studies of Duffourg et al, 2016 or Martinet et al, 2017, for which the numerical design was similar. Although the goal of the present study is to focus more on comparing the 150 m simulation with the 450 m simulation, additional observations have been added in the revised Figure 6 and 7, as it is done in Figure 4. On the other hand we did not modify former Figure 5 since it is more difficult to compare the simulations to a radar quantitative surface precipitation estimate strongly impacted by large uncertainties over the sea.

2) **Compare the results with other similar studies:**

We agree that compare the results with other similar studies using LES should improve the paper. Furthermore we are grateful to the referee #2 for providing a list of references which has been included in the revised version of the paper.

Specific comments:

1) Page 2, line 14: The text has been corrected.

2) Page 2, line 27: This problem has been corrected throughout the text in order to be consistent.

3) Page 3, line 19: The year of the reference has been added.

4) Page 3, line 20: We meant plural. The text has been modified accordingly.

5) Page 3, line 21: The text has been corrected.

6) Page 4, figure caption 1: The IR channel used here is 9 (10.8 µm). The figure caption has been modified accordingly.

7) Page 6, line 5: The text has been corrected.

8) Page 6, line 10: The text has been corrected.

9) Page 7, line 5: The sentence has been rewritten.

10) Page 7, line 30: The text has been corrected.

11) Page 7, line 30 (and elsewhere): The word has been corrected here and throughout the text.

12) Page 8, line 1 (and elsewhere): The word has been corrected here and throughout the text.

13) Page 8, line 15: The text has been corrected.

14) Page 9, Figure 5b: The y-axis title has been modified accordingly. Regarding the remark of including a surface precipitation estimation from radar observations see please response to general comments above.

15) Page 9, line 14: The text has been corrected.

16) Page 10, Figure 6: Figure 6 has been redrawn adding another column with the observed radar reflectivities.

17) Page 11, line 8: The text has been corrected.

18) Page 11, line 10: The text has been corrected.

19) Page 12, Figure 7: Figure 7 has been redrawn adding another column with the observed infrared satellite observations.

20) Page 12, line 3 (and elsewhere): The word has been corrected here and throughout the text.

21) Page 12, line 9: The text has been corrected.

22) Page 13, line 10: The text has been corrected.

23) Page 15, Figure 10: We agree with this remark. It is not obvious to compare all simulations against observations as the simulation domains are different initially. However former Figure 10 has been redrawn zooming over the region of interest for the observations and including a grid on each panel.

24) Page 17, Figure 11: The caption has been corrected.

25) Page 18, Figure 12: All the hydrometeor contents are represented (rain water, cloud water, graupel, snow aggregate and ice water contents). The caption has been modified accordingly.

26) Page 20, line 18: The text has been corrected.

27) Page 20, line 30: The text has been corrected.

28) Page 20, line 32: We meant that we need to consider more convective case studies and use more statistical approaches. The sentence has been rewritten.

29) Page 24: The reference has been corrected.