Hydrology and Earth System Sciences

Discussions

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Interactive comment on "Characterising patterns of heavy precipitation events in the eastern Mediterranean using a weather radar and convection-permitting WRF simulations" *by* Moshe Armon et al.

Anonymous Referee #3

Received and published: 14 November 2019

General comments:

The paper summarizes a comprehensive compilation of heavy precipitation events (HPEs) in the Eastern Mediterranean (EM) based on high-resolution radar data and WRF simulations. This set of events can be representative of the climatology in this area, and is used to quantify the spatio-temporal characteristics of HPE, and the ability to numerically predict the patterns of HPEs. A collection of four diagnostics are used to typify and contrast the radar-based and WRF spatio-temporal precipitation patterns. The events are further classified according to the synoptic situation responsible for the

HPEs: namely, Mediterranean cyclone (MC) and active Red Sea trough (ARST). This topic is important as it serves as a benchmark for using numerical weather prediction for flood forecasts, as well as for downscaling of future climate projections. Overall, the presentation is very good, although some excessive text can still be made easier to read, as I suggest in the following. Two major weaknesses of the results and their organization should be fully addressed before the paper can be considered for publication, as detailed in the first two Specific Comments below. Other specific comments should also be clarified.

Specific comments:

1. An important distinction is made between HPE under ARST and MC. However, the classification is not maintained throughout the results, having in mind the double goal of the paper: (i) characterize HPE patterns and (ii) evaluate WRF performance. In its current form, the classification is merely mentioned, while referring to previous works on the different spatio-temporal patterns under MC/ARST, but this is not directly shown here, with an exception of Fig. 11a-f. As mentioned in the text, HPE related to ARST is harder for prediction because of the local characteristic convection which dominates the patterns. On the other hand, HPE under MC is characterized by a cold front structure. To enhance the presentation of the results in light of the MC/ARST classification, and to make the discussion and conclusions robust, I suggest to (i) show the spatio-temporal patterns separately for each group (ii) compare the radar/WRF bias between HPE-ARST and HPE-MC. The two aspects can be achieved by reorganization of the presentation of the results, and showing figures such as Fig. 2, 3, 6, 7, 11g and 12 in light of the classification. By doing this, it will be interesting to see if there are consistent differences in the model performance, and substantiate the discussion in Lines 449-458.

2. Two individual HPE events are shown in more detail. They are important to get a better grasp of the patterns and the model/radar biases and the diagnostics used. It is, however, remaining unclear if the reader should take these results as representative,

and if so, of what. It is mentioned that HPE #1 is of MC type, while HPE #5 is ARST-type. Are they representative of the two types? Since both cases perform badly in terms of the SAL diagnostic, why do you focus on them? As the message of the work is to demonstrate the overall good performance of WRF, I find this confusing, and suggest to also illustrate the point with a case where WRF performs representatively well. I suggest to clarify this issue by explaining the rationale behind choosing to focus on these events. Further, it will make an easier reading to mark the chosen events onto Figs. 6,7,10,11.

3. Table S1 and Fig. 8: How is HPE duration calculated, and what does it mean if an HPE has a 48-h duration but no shorter durations (e.g., HPE #6)? This is confusing and should be clarified. Consequently, the results in Fig. 8 are confusing, and it is not very clear to me what we can learn from this figure.

4. Section 3.5.4 is difficult to understand, and the description of the 2D autocorrelation field, its ellipticity and orientation in Lines 379-392 is not also not clear when not referring to a figure. Please enhance or clarify these parts, possibly with an illustrative figure, such that the analysis can be standalone without referring to the references.

5. I suggest to move the spatio-temporal characteristics in Fig. 9 and 10 to earlier on in the text, even to when presenting the list of events in Sec. 3.4. This seems more natural to understand the events characteristics before assessing the model performance.

Technical corrections:

1. Line 10: add 'spatio-temporal' before 'patterns', and elaborate on what you mean by 'effects'.

2. Line 78: replace 'getting a' by 'receiving'.

3. Line 101: Add the coordinates of Ben-Gurion airport.

4. Line 130: replace 'Other' by 'Additional'.

5. Section 3.1: add more details about the radar such as: wavelength (The authors mentioned about the C band), radar parameters (reflectivity, doppler, etc). What is the maximum range of the radar observations? We see it very clearly in Fig. 1b, but number will further clarify.

6. Fig. 2: Are the white areas on the eastern side of the circle domain masked out according to the black line in Fig. 3c? If so, this should be mentioned.

7. Fig. 3: There is no legend of (a), (b), (c) and (d) as mentioned in the caption and text.

8. Figs. 3,4,5: a normalized difference (e.g., (WRF-radar)/radar) would make more sense than a ratio WRF/radar, such that the red areas will not distract the attention from more important biases.

9. Line 210: Section 3.5.3 please add a sentence to motivate the use of the DAD curve.

10. Fig. 4e: replace the scatter plot by a density plot, to see the details inside the black area.

11. Fig. 5: add the equivalent Fig. 4d-f to this case.

12. Line 165: the synoptic classification is based on semi-objective classification by Alpert (2004). This classification is based on parameters such as T, P, U and V at 1000 hPa once per day based on NCEP-NCAR reanalysis with coarse resolution ãĂŰ2.5ãĂŮˆ°. The model (WRF) was analyzed with six hourly ERA-Interim reanalysis with 80km horizontal resolution. It is worth mentioning this.

13. Line 266: greater than 99% of pixels': do you mean to write 'corresponding to less than 1% of the pixels in this HPE'?

14. Line 278: which bias to you refer to in the square brackets? 15. Line 336: missing 'a' after 'are'.

16. Line 437: remove 'a' before 'catchments'.

17.Line 490: replace 'weather' by 'numerical weather prediction'.

18. Fig. 11a-f: make the green and blue colors more distinguishable.

19. Fig. 12: would 'temporal lag' be more suitable than 'temporal distance'?

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-500, 2019.