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Reply on RC1

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Author comment on "Sensitivity of the Weather Research and Forecasting (WRF) model to downscaling extreme events over Northern Tunisia" by Saoussen Dhib et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2020-376-AC1, 2021

Response to reviewers' comments

Title: Sensitivity of the Weather Research and Forecasting model (WRF) to downscaling extreme events over Northern Tunisia Authors: Saoussen Dhib, Víctor Homar, Zoubeida Bargaoui, Mariadelmar Vich

We thank the reviewers for their time and helpful comments. We have addressed each point below. Reviewer comments are shown in bold, while author responses are shown in unformatted text.

The aim of this study is to examine the sensitivity of WRF rainfall estimates for different Planetary Boundary Layer (PBL) and Cumulus Physics (Cu) schemes. Sensitivity studies have shown that there is no best common combination scheme (PBL and Cu) for all events. The average of the 10 best combinations for each event is used to map the ensemble. The authors conclude that some schemes are more sensitive and others less sensitive.

Response: We thank the reviewer for this feedback. We have ensured that the revised manuscript addresses the main issues that were brought up in the review.

The abstract lacks important information. A few sentences about the setup, time simulation, and significant results are desirable. Provide the readers with this information here so they can decide if the paper is useful to their needs and so they can determine where to find the information they need within the main text.

Response: Thank you for critical feedback. We have ensured that the overall purpose of the study is more clearly defined in the revised abstract. These paragraphs will be added.

The period January 2007- August 2009 is investigated based on a daily rainfall network composed by 318 rain gauges covering 36000 km². We focus on heavy rainfall situations composed by days when a threshold of 50 mm/day is exceeded at least one recording location. Thus, a total of 77 heavy rainfall days are identified. Inverse distance is adopted to elaborate rain maps which are compared with maps obtained using WRF estimations (10 km resolution). The calibrated power coefficient is found 1.2 using cross-validation approach. MSGMPE failed to detect as rainy 11 days out of 77. So we propose to use WRF too to predict them. To run the comparison only 4 representative days out 11 are studied because the important time of simulations: the day with highest average spatial rainfall, the day with highest spatial standard deviation, one typical day with spatial average and standard deviations represented the most common situation and the day ranked 2 with respect to spatial average.

For each studied day, we begin the simulation at 12pm the day before that means 6 hours to attend some stability of the model before the studied day beginning. The end of the simulation is one day after. As a first test of the performance of the various parameters schemes, we did a quantile quantile comparison for the 12/01/2009 using the 3 parameters (PBL, Cu, Mp) schemes. The results show that there is not an important variability in the performance of the various Mp schemes. Then, we decided to continue the sensitivity study only with PBL and Cu parameters. Using WRF, simulation of 10 combination takes in average 4 days. It depends on the UIB department server availability. Also, usually we should run again about 20% of the simulations each time because of WRF crash or internet interruption. Then, for the 99 simulations of the different Cu and PBL for all the rainy days take about 190 days.

The introduction also lacks the study purpose. In addition, the scientific contributions are not clear in the current form of the manuscript and should be further elaborated. What the gap will be filled?

Response: WRF has many parametrizations the most common in the literature sensitive parametrizations for rainfall localization and intensity, are Cu, and much less PBL and Mp (Hewitson et al.2004; Tadross et al.2006). In this study, for each day, we will need to do 792 simulations (Cu with 11 schemes, PBL with 9 schemes and Mp with 8 schemes) to get a satisfactory configurations which can be find only with testing numerous physical parameterizations. 10 simulations takes in average 4 days which depends on the UIB department server availability. Also, usually we should run again about 20% of the simulations each time because of WRF crash or internet interruption. Then, for the 792 simulations we will need 380 days for each event. It is clear that the simulations duration is very long and it should be reduced with conservation of the performance of the WRF rainfall estimation. The aim of this study is to choose the best representing schemes of extreme rainfall by WRF over Northern Tunisia which will make the use of WRF more efficient for users in short time.

From the description of the methods given, it is not clear what advancements have been made over other designs already described in the literature. Has there been any previous research using this method? What are the superior methods used in this study?

Response: All previous mentioned research, examine few schemes for each parameter and aim to choose one best combination which is not representative for the different climate variability and the rainfall intensity. It is the first sensitivity study for rainfall estimation over Tunisia. The originality of this research appear in two components. Firstly, we will test all the schemes of each parameter. Secondly, we will choose not one best combination but the 10 best combinations which will be averaged later to give an ensemble map. This ensemble map will give the best estimation in comparison with all the other individual combinations. Secondly, based on the sensitivity study we selected 3 best schemes for each parameter (PBL, Cu) which have the ability to give a good results for the various extreme event types.

The results from the study are scientifically interesting and may represent a good examination to get the benefits of processing the entire simulations processes. However, there are several important concerns with the manuscript, such as the presence of a large number of vague descriptions, questionable arguments, and the lack of in-depth discussions. To resolve the fundamental flaws, an essential re-work on discussions is believed to be required, and the resultant manuscript would be so different from this one that it would be considered a new piece of research work.

Response

Thank you for the remarks about the discussion. We are working, now, to make it deeper and to highlight the influence of schemes with the location (topographic area, coastal area,…). Also, we are trying to highlight the influence of convective cumulus schemes in rainfall amounts within the different type of the studied rainy days.

The conclusion does not have significant finding according to the important results. Which scheme should be recommendation by authors?

Response: Thank you for the encouragement. Actually in the conclusion, we summarized the main useful tools of the sensitivity study which are: using different evaluation coefficients performance, the ensemble map of the best 10 combinations of each studied day, and the identification of three best schemes of each parameter (Cu and PBL) for the whole study area. However, we didn’t mentioned the real names of these schemes. In the revised manuscript, we will add the names of the best schemes. Furthermore, we will highlight the amount of wined time by using the 9 combinations of the best 3 selected schemes of each parameter (Cu and PBL) at the place of using an ensemble map of the combination of all the schemes (99 combinations).

Line 32: Please check the correct format of abbreviation! It should be …blab la bla (MSG MPE) …

Response: We corrected it. Meteosat Second Generation Multi-sensor Precipitation Estimate (MSG MPE) **Line 68: … Radar Topography Mission (SRTM)… Is this correct abbreviation? Response:** We corrected it. Shuttle Radar Topography Mission **Line 73: What is mean ‘Heavy event’? Please elaborated it! Response:** Heavy events are defined as those rainy days exceeding 50 mm/day for at least one station. **Line 78: Why the authors select 2 stations? Where is this location? Please explain it more clearly!**

Response: The heavy days evaluated by MSGMPE are selected based on a threshold of 50 mm/day for at least one station out of 318 stations. For this study we selected the rainy days with a threshold of at least 2 stations surpassing 50 mm/day which avoid very spatial localized extreme events. There is not a specified location of these stations. They can be in urban zone, forest, orographic area,... **Figure 4 is not clear information! The authors employ both outer and inner domains, where is the boundaries? Give the clear information in your figure!**

Response: We will change Figure 4 with another figure containing the two domains with all the coordinates information. **Line 159: It is difficult to understand this sentence.**

Response: For the PBL schemes simulation, the Cu scheme was fixed to 2 and Mp scheme to 6 (Fig.5a). **Line 162 – 164: Please give the clear explanation for quantile quantile comparison?**

Response:

In statistics, a quantile-quantile (Q-Q) plot is a probability plot which associates the frequency of non-overshoot. It is a robust estimator, which doesn't compare pixel by pixel but compares the shapes of two probability distributions by plotting their quantiles against each other. If the two distributions being compared are similar, the points in the Q–Q plot will approximately lie on the line $y = x$. We compared the quantile distrubition of WRF estimation (spatial resolution of 10 km) against the quantile distribution of the correspondent ground map. Firstly The Q-Q graph shows if there is an overestimation or an underestimation by WRF. Figure 5 plots have WRF as abscissa and ground rainfall as ordinate. If WRF curve is over the X=Y line that means WRF underestimate rainfall and if WRF curve is below x=y line that means WRF overestimate rainfall. Secondly, Q-Q plot highlight the capacity of WRF estimation of the different type of rainfall: low (less than 20 mm/day/pixel), medium (between 20 and 60 mm/day/pixel) and maximum values (more than 60 mm/day/pixel).

Line 173: Why the authors are choosing a threshold of 0.1 mm? What is the reason?

Response: A threshold of 0.1 mm/pixel is used in SAL and FSS verification to distinguish between rainy and no rainy pixels. We chose 0.1 threshold to detect the rainy pixels. **Line 182: The blank space should be removed!**

Response: We corrected it. Thank you.

Thank you for the feedback. In the updated manuscript, we will ameliorate the redaction quality of the whole paper, add deeper discussion, compare our results with many previous finds as suggested.

We would again like to thank the reviewers for their time and helpful comments.