Reply to the Comments by Referee #2 for Manuscript gmd-2021-143 "A micro-genetic algorithm for combinatorial optimization of physics parameterizations in Weather Research and Forecasting model for quantitative precipitation forecast in Korea"

General Comment:

This study used the micro-genetic algorithm and performed a combinatorial optimization of cumulus, microphysics, and planetary boundary layer schemes from the WRF model to improve the quantitative precipitation forecast of a heavy rainfall event in Korea. Five different fitness functions are chosen in terms of Equitable Threat Score to obtain the corresponding best combination of physics schemes for each fitness function. The methodology adopted in this study is explained in great detail, and this method could be very useful to obtain the best combination of physics parameterization schemes with a minimal number of model runs instead of performing an exhaustive search. The manuscript is well written in general, and the results are presented with clarity.
Having said this, I have a few comments on the manuscript.

⇒ We appreciate the referee's positive and detailed review. We have revised the manuscript in accordance to specific comments provided by the referee, which significantly enhance the quality of the manuscript. An item-by-item response to the comments is provided below.

Specific comments:

1. *The main concern with this work is that the results obtained from this study are very specific to the heavy rainfall event that was considered. Recent studies on parameter estimation, such as Duan et al. (2017) and Di et al. (2018), have performed simulations over multiple heavy rainfall events to obtain a set of optimal parameters to improve the precipitation prediction. Since only a single event was considered in this study, the robustness of the results obtained could not be ascertained. It would be good if the authors could repeat this exercise for a few more heavy rainfall events and present a comprehensive result. The authors should at least try to check how the optimum schemes (OPT-EXP1) are performing for other heavy rainfall events compared to REF and CTL.*

⇒ We appreciate the referee pointing this out. As recommended by the reviewer, we have conducted new simulations using the optimum schemes (i.e., OPT-EXP1) for other heavy rainfall events to verify the performance compared to REF and CTL.

⇒ Figure R1 below for another heavy rainfall event shows the spatial distribution of 24-hr accumulated precipitation from 0100 UTC 3 to 0000 UTC 4 July 2014 for RAR, OPT-EXP1, CTL, and REF. All simulations underestimated the precipitation intensity along the coastline, whereas overestimated over the inland. However, OPT-EXP1 captured rain cells (i.e., C1 and C2) well compared to REF and CTL.

Figure R2, for the other heavy rainfall event, shows the spatial distribution of the 24-hr accumulated precipitation from 0100 UTC 25 to 0000 UTC 26 August 2015. Generally, REF shows the best performance rather than OPT-EXP1 and CTL, though it overestimated the precipitation compared to RAR. However, the rain cells were well captured along the coastal line for all

simulations. The OPT-EXP1 predicted slightly better the region of precipitation than REF. Although OPT-EXP1 overestimated precipitation over the sea on the east side, it would not have significant impact on the accuracy of prediction over the inland.

⇒ We agree with the reviewer's opinion that the robustness of the optimized physics schemes cannot be confirmed by a specific heavy rainfall event. The main focus of this study was to emphasize the importance of the optimization of physics scheme sets as well as physical parameters, and to introduce the automatic optimization method (i.e., the μ-GA-WRF interface system) as a potential tool to improve precipitation forecast. The scope of this study did not include finding the robust optimal physics scheme sets for forecasting well all the precipitation cases in Korea: it is because there are several different categories of heavy rainfall cases that depends on different mechanisms of initiation and development in Korea. Therefore, we have not included the verification results from the other events in the revised manuscript. However, we have added the discussions on the limitation and the robustness of the optimum scheme set, and the relevant references suggested by the reviewer — Duan et al. (2017) and Di et al. (2018) — in the revised manuscript as follows:

In recent studies, optimization experiments for parameter estimation for multiple heavy rainfall events have been conducted to obtain a set of optimal parameters to improve the precipitation prediction (e.g., Duan et al., 2017; Di et al., 2018). We address that the optimized scheme set obtained in this study is specific to the selected rainfall case or at the best to the rainfall systems that occur under similar synoptic and geographical environment; thus, it is not robust to all the precipitation cases in Korea, which depend on different mechanisms of initiation and development. As a future study, we plan to perform the combinatorial optimization of physical parameterization schemes for several heavy rainfall cases under the same category in terms of location and synoptic environment, expecting to find an optimal scheme set robust to the heavy rainfall systems in that category.

2. *In Figures 6 and 9, the Correlation coefficient, R, was mentioned in the scatter plots. But some values of R were more than 1. As the values of the correlation coefficient must lie between -1 and +1, the authors should check the calculation of the correlation coefficient*

⇒ We appreciate the reviewer's comment. We are sorry to cause a confusion. In fact, *R* is the 'regression coefficient' that represents the slope in the scatter plot, not the 'correlation coefficient'. We have changed the word 'correlation coefficient' to 'regression coefficient' in explaining the scatter plots in the revised manuscript.

3. *In Fig.1, The positions of Yes and No seem to have been swapped in the outer loop. As mentioned in Section 3.2, if the maximum number of generations is exceeded, the algorithm should stop.*

⇒ Corrected. We appreciate the reviewer pointing out this.

4. *Line 194, "...referred to as OTP." I think the authors meant OPT.*

⇒ Corrected.

5. *The language of the manuscript needs to be improved. There are some small spelling and grammatical mistakes in some places. Some of them are: Line 196; "grid" is written as "gird", Lines 235 and 345; "12th" is written as "12nd", Line 236; "4th" is written as "4rd", Line 238; "physics" is written as "physic"*

⇒ Corrected. We appreciate the reviewer for checking out these typos.

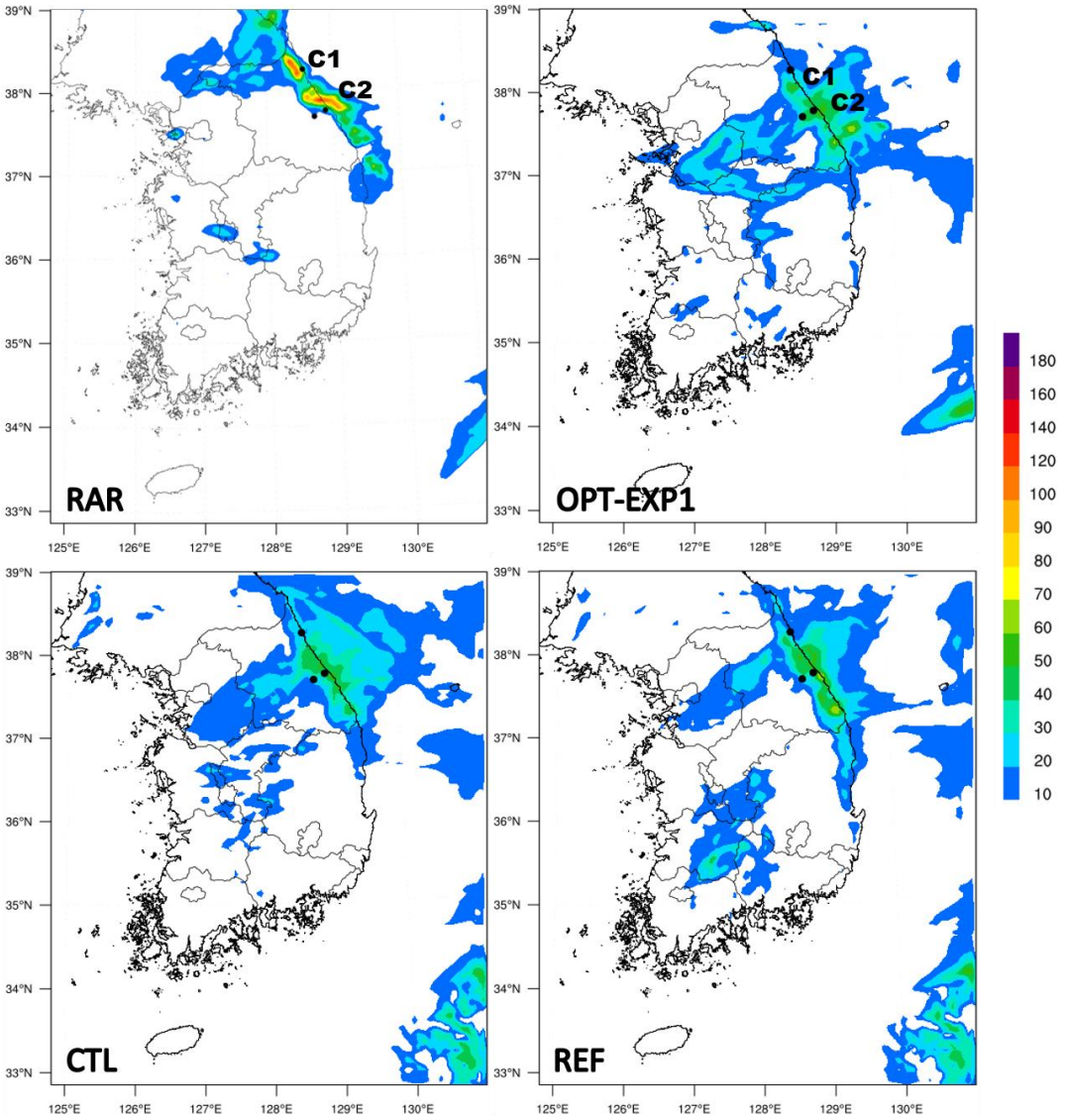

Figure R1. The spatial distribution of 24-hr accumulated precipitation from 0100 UTC 3 to 0000 UTC 4 July 2014 for RAR, OPT-EXP1, CTL and REF. Black dots depict locations of weather stations: Sokcho, Gangneung, and Daegwallyeong. C1 and C2 represent rain cells.

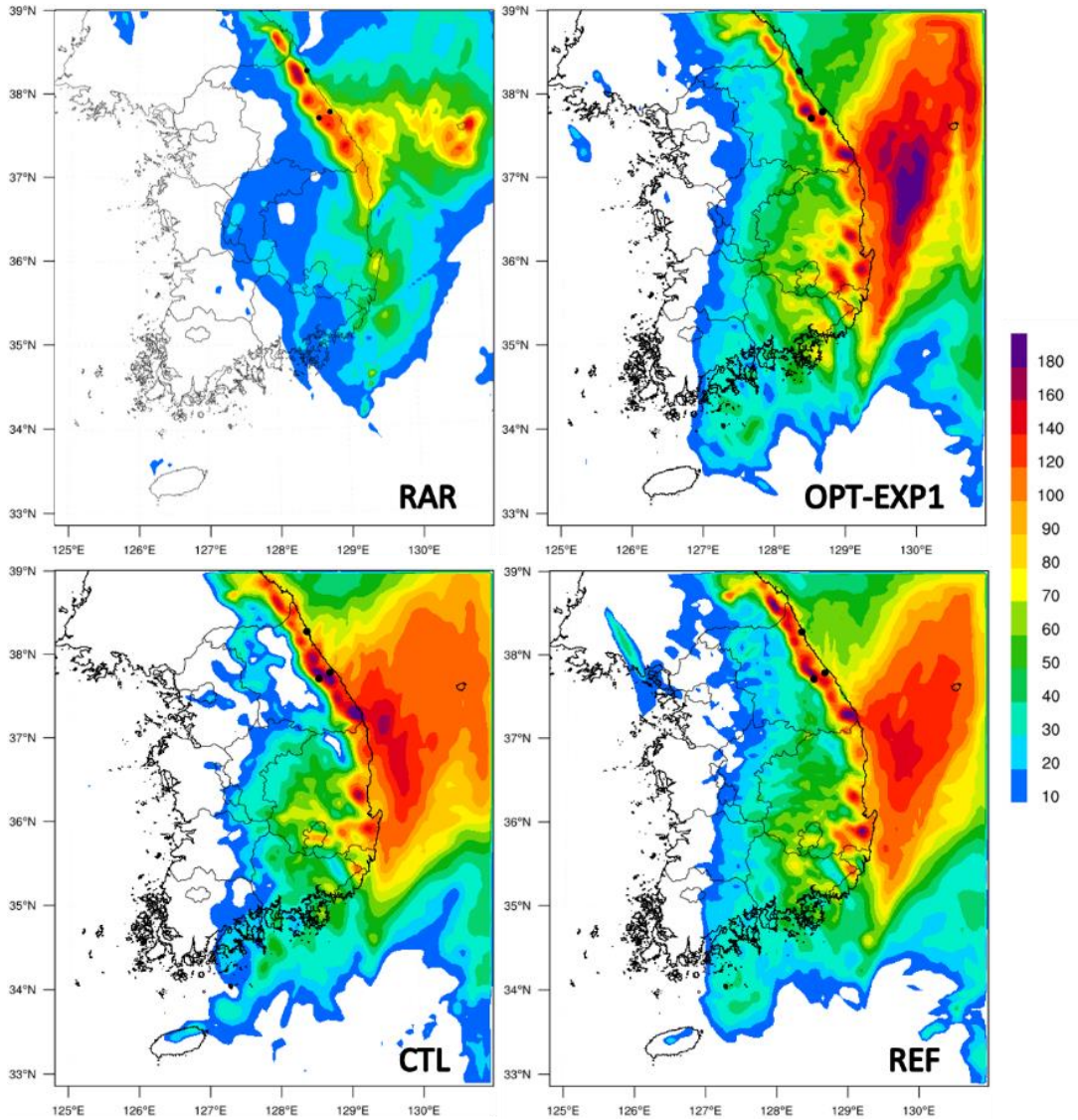

Figure R2. Same as Fig. R1 but for 24-hr accumulated precipitation from 0100 UTC 25 to 0000 UTC 26 August 2015.