Reply to the Comments by Referee #1 for Manuscript gmd-2021-242 "Determining the sensitive parameters of WRF model for the simulation of tropical cyclones in the Bay of Bengal using Global Sensitivity Analysis and Machine Learning"

General comments:

This study investigated the impacts of 24 tunable parameters in the Weather Research and Forecasting model on the simulations of tropical cyclones over the Bay of Bengal region. Three global sensitivity analysis methods were employed and compared. The parameter sensitivity results were found to be consistent across three methods for all the variables, and 8 out of the 24 parameters contribute 80%−90% to the overall sensitivity scores. Compared to default parameters, applying optimal parameters produced remarkable improvements in the simulated 10m wind speed, surface air temperature, surface air pressure, and precipitation predictions. I think the manuscript is well organized and the presentation is generally good. However, there are some aspects need to be improved before considering of publication.

The authors appreciate the positive and valuable comments by the referee, which helped in improving the quality of the manuscript. The manuscript has been revised following the referee's comments. A point-by-point response to the comments is provided below.

Minor comments:

Comment 1: The word "prediction" is used in the title and in the main text extensively. Please note that the meanings of "prediction" and "simulation" are not exactly the same, and improved simulation with a better model does not always translate into increases in prediction skills. One good example was given by Liu et al. (2019), who showed that the parameters' impacts on simulation and prediction might be different. I understand that the topic of this study is

"simulation", so I suggest replacing the word "prediction" by simulation in the title and in the text.

Reply 1: *The authors thank the reviewer for pointing out. The word "prediction" has been replaced with "simulation" in the revised manuscript text as well as in the title.*

Comment 2: Several literatures that are highly related to the selection of parameters are missing in the manuscript. For example, P6 - multiplier of entrainment mass flux rate, P4 - Von Karman constant, and P3 - scaling related to surface roughness, which are found to be important for tropical cyclone simulations in this study, were primarily identified by Yang et al. (2012) and Yang et al. (2017). These papers should be cited accordingly

Reply 2: *Point well taken. The following citations have now been added in the introduction part of the revised manuscript.*

Yang et al., (2012) conducted an uncertainty quantification and tuning of five key parameters found in the new Kain-Fritsch scheme of the WRF model, using the Multiple Very Fast SImulated Annealing (MVFSA) sampling algorithm. The authors have reported that the optimal parameters reduced the model precipitation bias significantly, and the model performance is sensitive to the downdraft and entrainment related parameters. Yang et al., (2017) studied the sensitivity of 25 parameters within the Mellor-Yamada-Nakanishi-Niino (MYNN) planetary boundary layer scheme and MM5 surface layer scheme of the WRF model, for the simulations of turbine height wind speed, and reported that more than 60% of the output variance is contributed by only 6 parameters.

Yang et al. (2012): Some issues in uncertainty quantification and parameter tuning: a case study of convective parameterization schemes in the WRF regional climate model, Atmos. Chem. Phys., 12:2409-2427

Yang et al. (2017): Sensitivity of Turbine-Height Wind Speeds to Parameters in Planetary Boundary-Layer and Surface-Layer Schemes in the Weather Research and Forecasting Model, Boundary-Layer Meteorology. 162:117–142

Specific comments:

Comment 1: Line 24, ".Singh et al. (2021a)."?

Reply 1: *The punctuation mark before the author has been removed in the revised manuscript, and ".Singh et al. (2021a)." is changed to "Singh et al. (2021a)."*

Comment 2: Line 25, "Singh et al. (2019) showed that present warming climate impacts on the …", please check the grammar.

Reply 2: *The mistake has been rectified in the revised manuscript. The sentence is changed to "Singh et al.,(2019) showed that the present warming climate impacts the formation and severity of the tropical cyclones over the BoB region"*

Comment 3: Line 29, What does "VSCS" mean?

Reply 3: *VSCS is the short form of Very Severe Cyclonic Storms. The expansion has been provided in the revised manuscript.*

Comment 4: Line 50, "at once" -> "simultaneously"?

Reply 4: *At line 50,"at once" is changed to "simultaneously" in the revised manuscript.*

Comment 5: Line 108, "in question to"?

Reply 5: *At line 108, "caused by the variable in question" is changed to "caused by that variable" in the revised manuscript.*

Comment 6: Line 395-402, the definition of P6 and the analyses about its impacts largely follows that of Yang et al. (2012), which should be added here. Meanwhile, it is not clear to me why suppressed convection (i.e. weakened consumption of CAPE or instability) leads to more "stable" stratiform clouds. Have the authors checked the vertical profiles of atmosphere temperature and moisture? One explainable for the changes in stratiform precipitation is the competition for moisture between convective and stratiform processes as indicated by Liu et al. 2018.

Reply 6: *The authors thank the reviewer for his valuable suggestions. Though the vertical profiles of atmospheric temperature and moisture were not examined in the current study, the explanation to the above mentioned statement is found through the studies of Yang et al.,(2012) and Liu et al.,(2018). The citations are added in the revised manuscript as follows.*

The parameter P6 is the entrainment of mass flux rate in the Kain-Fritsch cumulus physics scheme, which has been identified as a sensitive parameter for the simulations of precipitation in the studies of Yang et al.,(2012). The entrainment of air into the updrafts indicates a detrainment of moisture from the updrafts, which is the key water source for the formation of stratiform clouds. This indicates that the formation of stratiform clouds compensates for the reduction of convective processes and leads to an increase in the stratiform precipitation (Liu et al., 2018).

Liu et al. (2018): Combined impacts of convection and microphysics parameterizations on the simulations of precipitation and cloud properties over Asia, Atmospheric Research, 212:172-185