Review of “Typhoon rainstorm simulation with radar data assimilation in southeast coast of China” by Tian J., Liu R., Ding L., Guo L. and Zhang B. (Manuscript ID: NHESS-2020-146)

Overall:

This study exploits radar data assimilation into the Weather Research and Forecasting (WRF) model in order to improve the model’s performance during typhoon rainfall simulations over a medium-scale catchment in southeast China. Nine different assimilation modes are examined based on the data and time intervals applied. Many previous studies have already examined the impact of assimilating different kind of radar data (i.e., radar reflectivity, radial velocity, radar reflectivity+radial velocity, as in this case) into NWP systems (e.g., Liu et al., 2018; Sugimoto et al., 2009). The novelty of the present study seems to lies on the investigation of three different assimilation time intervals (1h, 3h and 6h). However, this novelty is not highlighted sufficiently in the manuscript. Also, the paper lacks a concrete structure and an adequate methodological framework, while there are quite some occasions where the English could be improved. Detailed comments on the manuscript are provided below.

Major:

Novelty: Please elaborate more to demonstrate the novelty of the current study. Why the assimilation time intervals are important? How they affect the performance of the data assimilation? Why previous studies (for instance those you refer in the introduction; Page 2, L. 28-32 and Page 3, L. 1-2) follow different approaches (i.e., 1h, 3h, 6h)? How these time intervals have been set so far in the literature (more referenced are needed)? Based on experience? Is this the first study examining different assimilation time intervals?

Structure: The structure in Sections 1-3 is confusing for the reader. Firstly, in several parts of Sections 2-3 (e.g., Page 5, L. 12-14 and Page 6, L. 3-4), the motivation of conducting the study is mentioned. However, a comprehensive description of the background of the study (including the choice of the study area) should be given in Section 1 (Introduction). Secondly, the various information are mixed, as the model description (sub-sections 2.1, 2.2, 2.3) is presented with the evaluation process (sub-section 2.4) and then, the study area and storm events (sub-section 3.1), and numerical experiments (sub-sections 3.2. and 3.3) are presented. I strongly suggest, revising the above structure following a more appropriate set-up (for example: study area and case studies -> model description and numerical experiments -> evaluation process).

Methodology:

a) The authors highlight the need of accurate rainfall forecasts in the study area. Thus, I would expect examining the radar data assimilation options under an operational forecasting model configuration. However, they use the global analysis FNL data, which are not maintained in real-time, to drive the model instead of an operational real-time global dataset (e.g., NCEP GFS). Also concerning the model set-up, what do you mean by “considering the application effect and frequency in southeast coast of China?” (Page 3. L. 29-30)? How does it affect the selection of physics options? Please provide a more clear and sufficient background for justifying the applied model configuration.

b) Please justify the use of the Control Variable option 3 (CV3) of the WRF-3Dvar system for the model background errors covariance matrix (B matrix). As the authors acknowledge (e.g., Page 4, L. 10-11 and Page 10, L. 10-13), the B matrix has a strong impact on data assimilation process. Using domain-specific model background errors (i.e., CV5 option), instead of global (i.e., CV3 option), could lead to different results and conclusions. Since CV5 is a more appropriate option compared to CV3 option, and it is a common practice in data assimilation literature (e.g., radar data: Mazarella et al., 2019, conventional observations: Yang et al., 2014, and satellite and GNSS data: Giannaros et al., 2020; Lagasio et al., 2019), I strongly suggest conducting the study using the CV5 B matrix option.

c) The description of the evaluation process is unclear and insufficient. No information (map illustration, data temporal analysis and coverage etc.) is presented concerning the rain gauges (Page 5, L. 6-7) used for evaluating the model results. No information is presented concerning the method for pairing the model output and observations (e.g., nearest neighbor?). What do you mean by "areal rainfall observation at each rain gauge i" (Page 5, L. 15), since, the areal rainfall is calculated at the catchment scale using the observations from all 8 stations (Page 5, L. 6-7)? In overall, the terms "spatial" and "temporal" for computing the statistics CSI and RMSE are confusing. For example, to my understanding, spatial RMSE refers to the evaluation of the modeled 24-h rainfall considering all 8 stations, while temporal RMSE refers the evaluation of the basin-averaged rainfall using 24 model-observations pairs. However, both metrics consider the spatial dimension. Most studies in the literature apply the standard approach of domain-wide statistics (spatial dimension), using model-observation pairs of the examined variable (e.g., 1h or 24h rainfall) over all available stations, aggregated for certain time periods (temporal dimension). Thus, please consider revising the application of the statistics. Also, please consider computing more statistic metrics (e.g., POD, FAR etc.) to enhance the evaluation process. In the same direction, please consider evaluating the model results under different time intervals (e.g., 6h; 0, 6, 12, 18) and rain thresholds (e.g., >0.1, > 0.2 etc.). Finally, please provide information in the description of evaluation process concerning the construction and usage of Figures 4-9. For instance, do Figures 4-6 refer to the 24-h modeled and observed rainfall? Do Figures 7-9 refer to areal rainfall?

d) 2/3 typhoon events affected the study area as tropical cyclones and had a limited impact in the study area. This fact does not support the aim of the study, which focus of typhoon rainfall simulations. I suggest including more high-impact typhoon rainfall events in the study. Also, please refer in more detail to the impacts on properties, people etc. in the study catchment, as well as to the flooding mechanisms (fluvial?) in the area. This will assist the results interpretation in terms of natural hazard analysis.

Results/Discussion: Please provide evidence on how assimilating radial velocity and radar reflectivity affect the WRF model's initial and boundary conditions (ICBC), and performance during the conducted numerical experiments. For example, you could compare the ICBC wind field and water vapor transportation between the experiments. This is important to support the interpretation of the results.

Minor:

Page 2, L. 22-27, 29-31 and Page 2, L. 1-2: Please refer to models and data assimilation schemes used.

Page 4, Section 2.2.3: The description could be improved in terms of English and details provided.

Please refer to what is being shown in Figures 4-9 (24-h rainfall? Areal rainfall? See comment c) in Methodology above).

Please enhance the resolution of Figures 7-9.

Below there are some examples where the English could be improved.

Title: Please replace “simulation” by “simulations”

Page 2, L. 2 and 5: Please replace “system” by “systems”

Page 2, L. 10: Please replace “by” by “using the”

Page 2, L. 14: Please replace “WRF-LTNGA” by “the WRF-LTNGA scheme”

Page 2, L. 16-17: Please move “for hydrological applications” to the previous sentence (“...into the WRF model for hydrological applications”)

Page 2, L. 19-20: Please rephrase

Page 2, L. 21: Please replace “the” by “their”

Page 2, L. 28: Please remove “the”

Page 3, L. 5: Please change to “caused by the interaction of typhoons and the complex terrain”

Page 3, L. 6-7: Please rephrase.

Page 3, L. 11: Please rephrase “flood disasters have attacked...”

Page 3, L. 23: Please replace “can be” by “is”

Page 3, L. 28: Please add “a” (“...has a significant effect...”)

Page 5, L. 13-14: Please rephrase “... and 24 for N is the ...”

Page 6, L. 1-2: Please use past tense.

etc.

References

Giannaros, C., Kotroni, V., Lagouvardos, K., Giannaros, M.T., Pikridas, C., 2020. Assessing the Impact of GNSS ZTD Data Assimilation into the WRF Modeling System during High-Impact Rainfall Events over Greece. Remote Sens. . https://doi.org/10.3390/rs12030383

Lagasio, M., Pulvirenti, L., Parodi, A., Boni, G., Pierdicca, N., Venuti, G., Realini, E., Tagliaferro, G., Barindelli, S., Rommen, B., 2019. Effect of the ingestion in the WRF model of different Sentinel-derived and GNSS-derived products: analysis of the forecasts of a high impact weather event. Eur. J. Remote Sens. 52, 16–33. https://doi.org/10.1080/22797254.2019.1642799

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