ACP-2022-377

Reply to Reviewer 2

Date: 7 Oct 2022

Title: A modelling study of an extreme rainfall event along the northern coast of Taiwan on 2 June 2017

Authors: Chung-Chieh Wang *et al.*

Reviewer's Comments:

Summary:

Authors designed 5 cloud model runs to simulate and discuss an extreme rainfall event along the northern coast of Taiwan on 2 June 2017. The 24-h rainfall maximum along the northern coast is well simulated (541 mm) in the F1 experiment (1-km run) as compared with the rain gauge observation (645 mm). Analyses on mei-yu frontal movement and the roles of frontal disturbance are valuable. There are some major comments about the model experiments. I would suggest authors to modify the paper according to my comments to make the manuscript more complete and solid. The paper could be publishable in Atmospheric Chemistry and Physics with major revisions.

Reply: The constructive comments from this reviewer (Reviewer 2) are very much appreciated. Following the instruction from the journal editor, herein we respond to all referee comments (RCs) and describe how the revision is to be performed. The actual revision will start immediately after we receive the go ahead from the editor. Below, the point-by-point responses to each of the comments from this reviewer are given, following the original comments.

Major comments:

In the S3 experiment (3-km experiment), the surface front arrived at northern Taiwan too early, by about 9 h. Authors state that this situation is acceptable for the third day simulation. However, the arrival time error of surface front is too large (~ 9h). It means that model failed to simulate the large-scale/mesoscale weather patterns in real atmosphere (including circulations, radiation, thermodynamic processes and etc.). Thus, it is not acceptable to use the simulation of S3 to analyze the frontal characteristics. Also, one important question is that: if the authors know that there are great errors for the third-day simulation, why do author use the third-day simulation to analyze the front/frontal rainband characteristics? I strongly suggest that authors compare model simulated 24-h rainfall accumulation and rain gauge observation from CWB by presenting the same time period during 1600 UTC 1 June to 1600 UTC 2 June (0000-2400 LST 2 June) [Figs. 6 and 9b].

Reply: Thank you for your comment. We agree with this reviewer that the sensitivity tests on the topography should be based on an experiment that has a better overall agreement with the

observation, if possible. Therefore, in the revision, we use the M18 experiment (and rename it to F3, meaning 3-km forecast) as the 3-km control run and analyze the characteristics of the front and frontal rainbands in this run as suggested, rather than the S3 experiment. As for the 24-h accumulation, the reason for the CWB to produce its routine rainfall maps from 1600 UTC is because it is 0000 LST in Taiwan, so Fig. 6a shows the daily rainfall. In other words, it was not based on any reason linked to this case per se. In this case, it just so happens that 1600 UTC was about one hour before the rain started in the northern coast, where the episode lasted for about 10 h as shown in Fig. 5. So we simply took the CWB plot and used it directly, without making another plot using a selected 24-h window. In Figs. 9 and 10, the rainfall in two 1-km experiments (F1 and S1) are compared. In F1, the rainfall starts right after 1600 UTC so it is spot on in the timing of rainband arrival (see Fig. 12), but we chose 1300-1300 UTC in order to show the whole event (lasting for about 12 h) to the readers clearly, with a few hours of lead time. A similar 24-h time frame was selected for S1 based on the same reason. The comparison between the two runs and with the observation is fair as long as the same length (24 h) is used and the whole rainfall episode in northern Taiwan is covered in a similar way, as in Figs. 9 and 10. In addition, the S1 experiment is used to illustrate why it had less total rainfall (or, equivalently, why F1 had more rainfall) in the model, so it is OK to exhibit larger errors including timing errors, as long as the evolution is a realistic one. In the revision, we also state that the larger timing error in S1 could be a factor of its lower rainfall accumulation along the northern coast in Taiwan, and the above points are also better clarified, along the lines as suggested.

To test and clarify the role played by the topography on the mei-yu front, authors remove topography of Taiwan (and northern Taiwan) in S3 experiment, referring to S3-NT and S3-NNT experiments. Since the frontal arrival time error is about 9 h, it is not appropriate to use S3, S3-NT, and S3-NNT experiments (3-km experiments) to discuss the interactions between mei-yu frontal system and topography over Taiwan. Instead, authors should use F1 experiment (1-km experiment; the best simulation of frontal arrival time and propagation speed in this manuscript) as the CTRL run and design the sensitivity tests of topography based on F1 experiment (e.g., F1-NT and F1-NNT).

Reply: Thank you for this comment. As stated above, we agree with this reviewer that the sensitivity tests on the topography should be based on the M18 experiment (which is called F3 now), and two new terrain-removal experiments (F3-NT and F3-NNT, respectively) had been performed for sensitivity tests. The differences are similar to what we had in our previous draft (among S3, S3-NT, and S3-NNT), as shown below in Fig. B1. In F3-NNT, the northern coast does not receive less total rainfall (compared to F3) when the northern terrain is removed.

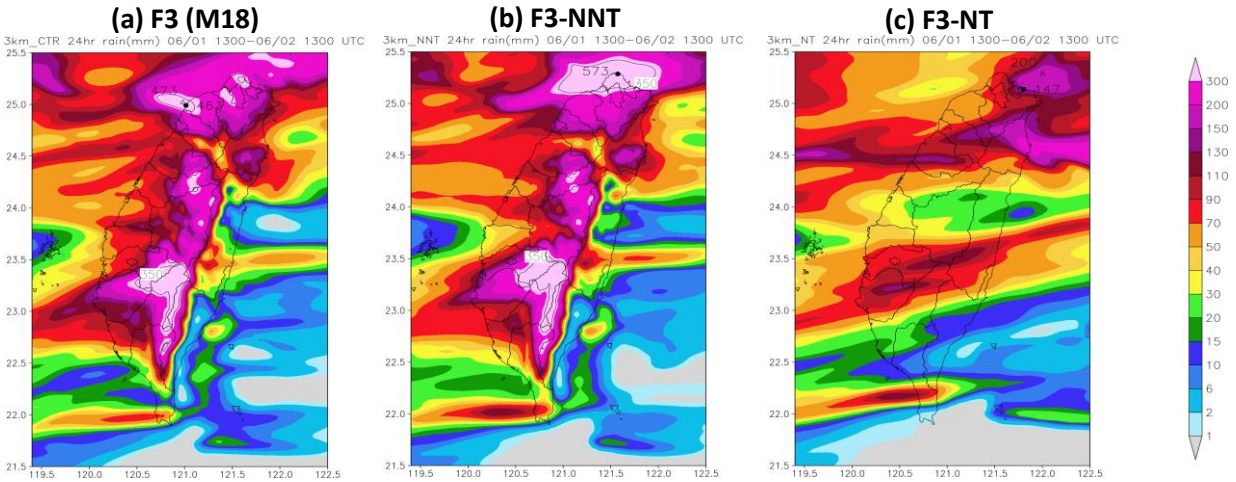

Fig. B1. Total 24-h accumulated rainfall (mm) surrounding Taiwan in (a) F3, (b) F3-NNT, and (c) F3-NT experiments, respectively.

Right now, we are also running F1-NT and F1-NNT experiments driven by F3-NT and F3-NNT, respectively to confirm our results on topography, as suggested by this reviewer. We expect them to give similar results as F3-NT and F3-NNT. Once these experiments are finished, we will use them in the revision, as suggested. We may still show the 3-km tests in our revision for comparison, as this is the model resolution comparable to Tu et al. (2022) in their tests (their Fig. 18).

Minor comments:

1. Line 219-221: "This is because without the terrain, the near-surface (and low-level) southwesterly winds can blow across the flattened island without the blocking effect (Figs. 7g-i)," should be "… (Figs. 7g-i)."

Reply: Suggestion accepted.

2. Line 275: delete "say,"

Reply: Suggestion accepted.

3. Section 7 (Line 380-383) and Figure 1b: For the "NNT" (remove northern Taiwan) run, do authors remove Datun Mountain only in the model or both Datun Mountain and Linkou Plateau? Please specify.

Reply: Both of them are removed. In the revision, this will be better clarified as suggested.