

***Interactive comment on* “Investigating the role of dust in ice nucleation within clouds and further effects on the regional weather system over East Asia – Part II: modification of the weather system” by Lin Su and Jimmy C. H. Fung**

Lin Su and Jimmy C. H. Fung

lsu@connect.ust.hk

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We deeply thank the anonymous referee for the valuable comments and suggestions, which help us improve the quality of the manuscript. Most of the referee’s concerns have been addressed, and the detailed responses to each comment are shown as following. We are still working on the rewriting of some sections suggested by the referee (specific points #4 and #9) at this moment. The revised manuscript will be submitted later, with a final version of our response to all the comments by the referees.

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General points: Several sections in the paper are too long and descriptive. Condensing these areas would improve the paper. There are several statements within the text that require references for validation and the authors should pay attention to this. Response: Please see the responses to the specific points.

Whilst the model has been validated against observational climate data and radiation data, the results would benefit from comparison to any cloud microphysical data that is available from satellite or observational studies that could provide some context and comparison for the changes in cloud ice and cloud liquid that occur when the semi-direct and indirect effects are included in the model. Response: In the first part of this paper (also in discussion, available at <https://www.atmos-chem-phys-discuss.net/acp-2017-754/>), a new treatment for online calculating the ice nucleation process involving dust particles has been implemented in to WRF-Chem. The validation for the simulated ice water content has been described in that manuscript by applying satellite observations (CALIPSO and MODIS), so it is not included in this manuscript. It turned out that the inclusion of the ice nucleation process involving dust particles improved the simulation of the atmospheric ice water content.

Following on from the above point, please could you address the following point: How sure can you be that using a different microphysics scheme would give you the same results given the uncertainty in mixed phase cloud microphysics. Response: Currently, there is no other microphysics scheme in WRF-Chem that contains an ice nucleation process involving dust particle, so we cannot say that the same results can be produced by using other microphysics schemes, especially during dust events. However, introducing a treatment for calculating ice nucleation process involving dust, which is what we have done in the first part of this paper, is essential to accurately evaluating the effects of dust particles, and the comparison with the observations has demonstrated that the simulation of the atmospheric ice water content is improved by taking this process into account. Based on the validation of the newly-implemented treatment, the effects of dust on the weather system over East Asia can be evaluated and shown

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in this manuscript.

Specific points: L42 - 43 – ‘Dust particles are recognized as effective ice nuclei...’: please add some relevant references here. Response: The references have been added.

L47 – assessing its replace with assessing the Response: Revised.

L48 – ‘Many observational and modeling studies...’: Without any specific references this sentence (and others like it) are not necessary and just detract from the point of the section. Response: The sentence has been deleted.

L47 – L62 – The writing and flow of this section could be improved. Response: We are rewriting the section.

L53 – ‘Recently...’: This word is superfluous, start the sentence with Several studies... Response: Revised.

Table 1 – Any variable component that is the same in all 4 four experiments does not need to be included in the table, the lines from Soil dataset to Chemistry mechanism could all be removed from the table and this information given in the caption of the table, or a footnote or in the main text. The table is excessively long with this information and would be more informative with just the relevant information. Response: The redundant content in Table 1 has been deleted.

L94 - L95 ‘... the Shao’s dust emission scheme...’: This should read ‘Shao’. Also please provide a reference for reproduction of the dust emissions over East Asia. Response: Revised.

L104 – ‘The configurations...were mostly the same as ...’: Not appropriate language. Perhaps abbreviate to: Because no dust is simulated in NO-AER/NO-CLOUD and NO-AER/CLOUD these simulations do not include a dust emission scheme, etc Response: Revised.

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Section 3 – Model Validation. This section was overly descriptive and felt repetitive towards the end. Please consider rewriting this. Response: The section will be rewritten to make it more precise and conclusive.

Figures 1- 4 (but specifically Figures 1 & 2): It is hard to visually compare the simulation output with the observational data because the observational data does not include ocean data but the simulations do. Outlining the region where observational data is available on the simulation output would make this clearer. Response: We have replotted these figures to make it clearer for reading.

In all figures the individual color scales could be replaced by 1 large vertical scale bar for more clarity. Response: We have replaced the small legend with a general larger one in Fig. 1–6, and Fig. 12, a sample for Fig. 1 is attached at the end of this response. But as the plots in other figures (Fig. 7-8, Fig. 13) do not share the same color legend, we cannot replace them with a general color scale.

L150, L167 and other places: ‘a significant improvement’ ‘not so significant’. Throughout the text phrases like this are misnomers, you have not included any evidence of significance testing and so these statements are not appropriate as the comparisons are subjective. Either consider calculating significance, include what significance testing was carried out or change the language. Response: We have modified the statement to exclude the description of significance.

L197 – Figure 6 is mentioned before Figure 5, this is confusing, reorder the figures. Response: It was a mistake to mention Figure 6 before Figure 5 at the start of section 4 (“...within the atmosphere over East Asia during the simulation period are shown in Figures 6 and 7...”, it should be “...Figure 5 and 6”), we have revised it in the updated manuscript.

Section 4 – Please start this section with a sentence similar to used for the caption in Table 2. Response: Revised.

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L235 – L236 – Could the size fraction of dust play a role here? With coarse dust near the source responsible for more LW absorption? Response: Yes, we have revised the sentence to be “. . .due to the absorption of LW radiation by the thick dust layer with large fraction of coarse particles in the atmosphere.”

L290 – typo in downwelling all-sky Response: Revised.

L291 – L292 – within the atmosphere (remove in). Response: Revised.

L337 – Are there any observational records that could be compared against the cloud liquid water and cloud ice water path values in the models? Response: Yes. The comparison has been done in the first part of this paper for validating the performance of the model in simulating the atmospheric ice water content.

L350 – Similarly here is there any observational data for cloud droplet number? Response: We cannot find any kind of observational data for cloud droplet number.

L360 - The peak at 6 km doesn't look like a peak. It's an increase that is sustained for several km. Response: Revised.

Figure 13 – Consider showing the precipitation anomalies as a percentage change in precipitation to better convey the data. Response: It can be done but the figures will be messy. As there are many areas where there is zero precipitation in the CTRL run, while there is precipitation in the DUST run. The percentage cannot be calculated for these areas.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2017-755>, 2017.

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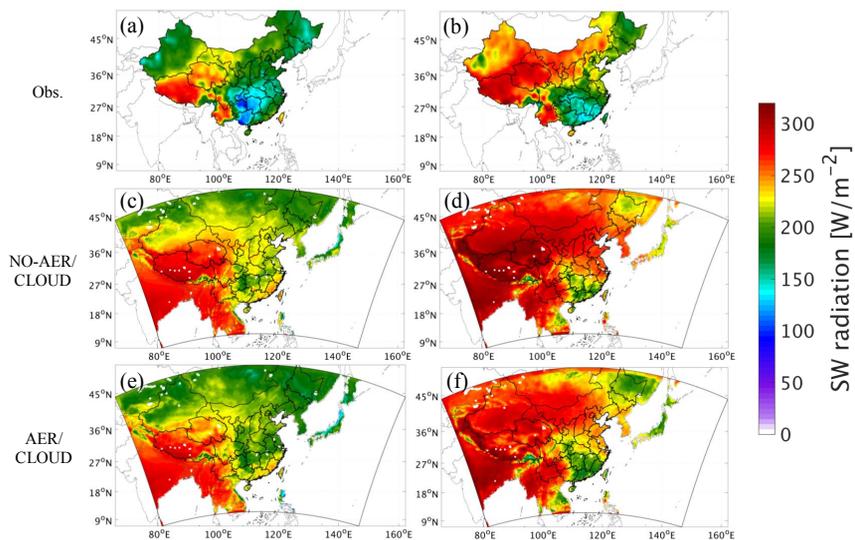


Fig. 1. Spatial distributions of the average downward SW radiation at surface from observations (a, b), from NO-AER/CLOUD (c, d), and from AER-CLOUD (e, f) during March (left panel) and April (right panel) 20