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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigating the Impacts of Saharan Dust on Tropical Deep Convection Using Spectral Bin Microphysics" *by* Matthew Gibbons et al.

Anonymous Referee #1

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Review of: Investigating the Impacts of Saharan Dust on Tropical Deep Convection Using Spectral Bin Microphysics. This is an interesting paper which examine the role of dust particles on deep convective clouds by acting as IN. To do so, the authors used the WRF model in a "real case" configuration coupled with bin microphysics scheme. The topic is of great importance and the tools used here are appropriate for making progress in understanding of it. However, I do have questions and suggestions for the authors: General comments I fill that more details are need in order for the reader to be able to fully evaluate the methodology:

Do you consider removal of IN by precipitation? Dry deposition? Do you consider

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Discussion paper

regeneration upon evaporation? Is the domain mean IN concentration constant with time? In addition, I guess that you don't divide the INs to bins, so how do you consider their sizes? What is their fall velocity?

The same goes for the CCN concentration, do you consider wet deposition? Regeneration upon evaporation? During 33 h of simulation with strong rain rates I guess the CCN concentration could change dramatically.

Regarding the model resolution, many previous studies have shown sensitivity to the resolution in respect to cloud resolving simulations. For example, Lebo and Morrison (2015) showed that only in $\geq$250m resolution the deep convective clouds' cores are well resolved. I suspect that 3km resolution for the inner domain is too coarse. Do you really need the outer domain to cover such a large area? I suggest to compromise on the total area covered by the simulation and go to higher resolution. Maintaining the same number of grid point but for smaller area won't increase the computation cost.

In many parts of the paper you repeat yourself (I listed a few examples blow but there are many more). Moreover, I think that with a bit of editing work this paper can become shorter and clearer, maintain its main results.

Specific comments

P2 L17 and 30: you say that dust particles are effective CCNs but later you describe totally different effect of dust on deep convective cloud than reported previously. How can it be integrated?

P3 L15-19: This sentence is unclear to me. What is the contradiction here? Since the 50's people attributed aerosol effect to changes in droplet size distribution.

P6 L7: How do you determine the rate of IN resupply?

P8 L1: Isn't it also proportional to the IN size?

P8 L23: How accurate those assumptions?

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P13 L6: Here you declare stronger outflows from the core to the anvil, but in the abstract you wrote: “fewer particles form within and/or are transported into the anvil regime.” Isn’t it contradiction?

P13 L12: Suggest replacing “dynamical intensity” by “meteorological/environmental conditions” since dynamics and microphysics could be coupled.

P13 L14-16: It is an exact repetition. Pleas delete it.

P13 L29-31: Do you refer to the dusty case here? If yes, it will be nicer to spell this out.

P14 L12: I suggest referring here to two resent papers discussing the effect of aerosol on the vertical transport of hydrometers: How do changes in warm-phase microphysics affect deep convective clouds? Chen et al., 2017, ACP; Aerosol effect on the mobility of cloud dropletsâĂŔ. Koren et al., 2015, ERL.

End of P14 and beginning of P15: It is repetition from above.

P16 L3: Suggest mentioning hear that the aerosol effect on clouds also depends on the environmental conditions and on the range of aerosol concentration examined.

P17 L29: It is repetition from above.

P18 L15: How do you define rain drops in the bin scheme?

P19 L14-17: Repetition from above.

Figure 11 c and f: Why not presenting super saturation (or saturation deficit) instead of water vapor concentrations? Since the temperature varies as well (different latent heat fluxes) the water vapor does not provide all necessary information.

P20 L6 and L10: Here some measure of the variance is needed to evaluate if order of 100m change in mean cloud top is significant.

P20 L21: Isn’t it also because of the reduction in the available liquid water for freezing?

P21 L15, and L16-17: Repetition.

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P22 L17: Is ∼1% change in precipitation significant compare to the simulations noise? In some cases different realizations of the same conditions could have higher different than that.

P22 L19: How do you determine that it is “significantly”?

P23 L4: “In the first of a two part study”. This is the first time you mention another part of this study. What is the second part about?

P23 L18-19: The reasoning here is not clear to me. Is the stronger evaporation of the smaller hydrometers results in cooling and stronger downdrafts or vice versa (stronger downdrafts drive stronger evaporation)?

Technical comments

P8 L6: correct (m-3)

I suggest to have continues counting to the equations to avoid confusions.

P10 L20, L27, L29 and many other places: change “number” to “number concentration”.

P12 L34: What does “1.e2 um” stand for?

P13 L28: Please correct: “th is”.

I suggest organizing the figures in the order they are mentioned in the paper.

P19 L16: since only one case study is simulated here change “case studies” to “case study”.

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