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Comment on acp-2021-693

Toshi Matsui (Referee)

Referee comment on "Weakening of tropical sea breeze convective systems through interactions of aerosol, radiation, and soil moisture" by J. Minnie Park and Susan C. van den Heever, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-693-RC1, 2021

Summary:

This study conducted hundreds of sensitivity experiments of idealized cloud-resolving simulations in order to understand the effect of environmental parameters upon aerosol-sea-breeze convection interactions in tropics. Overall, set up of comprehensive sensitivity experiments, and statistical analysis (statistical emulation and variance-based analysis) are appealing aspects of this manuscript. However, the problem of this manuscript is that the figures are not summarizing and highlighting the physics very well. Although physics explanations are all reasonable, it's hard to extract essence from the figures. More specific major comments are described below. This paper has quite potential if revision goes well. So, I request "major revision" at this point.

Major Comments:

Parameter ranges (Table 2): I understand that some of them are derived from previous studies (Igel et al. 2018, Park et al. 2020). Are these perturbations in a realistic range? What do these perturbed ranges statistically mean? For example, soil saturation fraction between 0.1 and 0.9 are ranges from Savannah to tropical rainforest. Is this range typically happening in the real world of tropical coast regions? This question is also related to analysis of Fig 9a and 9b. When you compare different environmental factors, you should understand the natural ranges of these parameters, and should normalize/standardize them. Otherwise, you cannot state soil moisture has the largest impact on aerosol-cloud interactions.

Following one is my old paper that compared aerosol and thermodynamic impacts on low clouds by measuring 95%-frequency ranges of aerosol index and lower-tropospheric stability (Fig 3) in order to discuss relative importance.

Matsui, T., H. Masunaga, S.M.Kreidenweis, R.A.Pielke, Sr, W.-K. Tao, M. Chin, Y. Kaufman (2006), Satellite-based assessment of global warm cloud properties associated with aerosols, atmospheric stability, and diurnal cycle, *Journal of Geophysical Research–Aerosol and Clouds*. 111, D17204, doi:10.1029/2005JD006097.

You don't need to re-set new ranges of parameters for another hundreds of simulations, because you can just use a statistical emulator to estimate the relative impact of different parameters in standardized range. But, you have to understand statistical distributions of these parameters in the real world to understand "typical (one/two standard deviation)" ranges. With the standardized ranges of environmental parameters, you can state which parameters are important or not.

Section 5.1 and 5.2 (Figures 5-7): I don't quite understand why you plot clean-polluted differences in zig-zag form, because simulation ID in X-axis does not represent physics at all. There should be a more effective way to represent this statistical representation. For example, histograms (clean, polluted, and clean-polluted) would be better to represent statistical differences, distributions, and significance of these sensitivity overall. Same issue also applies to Fig 10, too.

Section 5.2.1 (Figure 8): You mentioned that "It is clear from this figure that….", but these scatter diagrams are not clear to me for comparison reasons. You may create a probability density grid scatter diagram (instead of dots), and you may plot clean-polluted. Or, at least, you may overlay scatter plots of clean and polluted like Fig 9e-f, and conduct some statistical process to mention "significant" or "clear" differences between clean and polluted cases.

Fig 11: Fig 11 does not summarize physics very well. It pretty much displays all cases. For example, if you compute clean-polluted differences in auto-conversion profiles, and you can create CFAD to summarize all cases in one plot for each microphysical process (melting of ice, ice-to-rain, rain-to-ice, cloud-to-rain, etc..), it would be nice, because Test ID does not show any information of environmental factors anyway. So far, it's too numerous and mechanical test ID. So, it's difficult to extract physics from this plot.

Minor Comments:

Resolution: Simulations are conducted with 1km grid spacing, and discussion of shallow-to-deep convection transition can be limited. I understand this is purely because of computational limitations with the many ensemble simulations. At least, you should mention this limitation somewhere in the manuscript.

Line 37: I suggest ditch following sentence of this paper's topic "*Such organised tropical convection also plays an essential role in global climates via its impacts on planetary circulations such as the Walker circulation or the Madden-Julian Oscillation (Hendon and Woodberry, 1993; Zhang, 2005)*." This paper is not dealing with organized tropical convection.

Line 63: "convectively" -> "convective"

Line 68: Suggest ditch "in the interest of focusing specifically on aerosol indirect effects". Sounds repetitive.

Line 70: "size and composition" -> "sizes and compositions"

Line 88: "theories" -> "hypothesis" Also apply the following sentences.

Line 139: Table 1 is not refered from sentences.

Line 243: Add "and less surface turbulent heat flux" after "With less surface upwelling longwave radiation,".

Line 245-246: Remove parenthesis.

Line 247: "longwave radiation" -> "longwave radiation and surface turbulent heat flux"

Figures 3 and 4 (and related discussion) might be combined, since these are all surface impact and feedback.

For any question/discussion, contact to me (Toshihisa.Matsui-1@nasa.gov)