Atmos. Chem. Phys. Discuss.,
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric energy budget response to idealized aerosol perturbation in tropical cloud systems" *by* Guy Dagan et al.

Anonymous Referee #1

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The authors have run some fairly large-domain cloud resolving simulations over the tropical Atlantic, in order to investigate how aerosol indirect effects contribute to the radiative impact of aerosols. They note a non-negligible contribution that depends on the cloud regime being examined. The regime and location dependence of aerosol forcing is something that is not well captured in climate models, since most don't include aerosol effects on convection. This study is straightforward and worthwhile, as it begins to break down these differences in the radiation budgets. I believe it is a good contribution and have only a few suggestions to help improve the manuscript.

Comments:

Changing CDNC is, you even admit, a rather simplistic way to approach aerosol effects. In addition to neglecting the activation and scavenging effects that you mention,

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another missing piece is the direct effect. This can be especially important in the eastern Atlantic where you are looking since a lot of the aerosols that would be present in this region are dust. Have you considered how the direct effect would fit into this?

You held SST constant in these simulations. Do you have a sense for how much this might have affected the overall energy budgets? I would suspect at least the sensible heat flux might show some differences.

Your 'residual' term is rather large, especially in the deep convective case. You make the point earlier that this term would become negligible on longer time and spatial scales, however an important point in this paper is how large the differences can be on smaller scales. Do you have thoughts on what is largely making up this residual term? How much of it is physical processes that you are not considering, versus the fact that the model simulations are not going to be perfectly balanced, considering the scales and the boundary forcing.

Your mass flux in Fig 11 - how is this calculated? Is this just a total over the whole domain? Or only in updrafts? If this is domain-wide, I imagine the largest reason for the increase is simply the larger amount of deep convection.

The paper is a bit long and I think you could consider getting rid of a few of the figures that tell a redundant story. The inclusion of the 2nd, deep convective case is important because of this point you make on page 32 "Our results demonstrate that regional atmospheric energy budgets can be significantly perturbed by changes in CDNC and that the magnitude of the effect is cloud regime dependent (even for a given geographical region and given time of the year as the two cases are separated by less than a week)." However, the physical mechanisms for the changes in cloud amount and radiative fluxes are consistent between the two cases, so some of the figures and discussion here are a bit repetitive.

In general this could use some copy-editing. Nothing that prevents understanding, but there are a number of small typos and verb agreement issues.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-813, 2019.

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