

Atmos. Chem. Phys. Discuss., referee comment RC2
<https://doi.org/10.5194/acp-2021-597-RC2>, 2021
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Comment on acp-2021-597

Anonymous Referee #2

Referee comment on "Sensitivity of Summertime Convection to Aerosol Loading and Properties in the United Arab Emirates" by Ricardo Fonseca et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-597-RC2>, 2021

This manuscript attempts to use the WRF model to assess the convection-aerosol interactions over the UAE in summer. Unfortunately, there are some major flaws with the manuscript in its present form, and I have to recommend that the manuscript be rejected.

There are three critical issues with the paper. The first is a lack of clear scientific question and focus. The title states that the topic of the paper is convection-aerosol interaction, but which part of that interaction is the key scientific question here? The introduction very broadly touched upon the impacts of ARI and ACI on the lifetimes and precipitations of MCS, but no key scientific question is brought forth. The abstract even mentions the impacts of nudging in the outer model domains, which further confuses the reader. Also, there are way too many sensitivity experiments. What is the purpose of testing (very) different aerosol composition assumptions in the model, if the point was to assess ACI in a particular case?

Secondly, the methodology used in this study is not appropriate for the question it appears to want to address. If the purpose is to investigate the 'interaction of convection and aerosol', then in the model, aerosols and cloud microphysics and dynamics should be allowed to 'interact' in a physically-realistic or reasonable way. Instead, the authors used a WRF model and implemented an 'aerosol-aware' cloud microphysics, which really does not allow aerosol and convection to 'interact' with each other. The use of assumed aerosol loading as initial condition and then allow them to be advected in no way physically represent the locations and strengths of the aerosols relative to the convective systems, as evidenced in Figs 2 and 5. Many of the assumptions (e.g., 30% dust in the radiation calculation; conversion of Ns to PM10; etc) are simply wrong.

Thirdly, because the manuscript is lacking focus, it is also extremely long, without apparent need to be that way. For example, the verification diagnostics presented in section 2.4 are fairly standard; there is probably no need to elaborate. The discussion on the effects of nudging and the effects of assuming much of the aerosols to be carbonaceous is very confusing and not related to the topic at hand.

Specific comments:

Lines 12-13: "Both an idealised and ... are considered": This sentence is unclear. Please revise.

Lines 24-28: "In particular, ... 51 W/m²." This sentence is extremely long and unclear. Please revise.

Line 28: Not sure what "the former" and "the latter" refer to.

Lines 51-52: The increased number of smaller cloud droplets mostly lead to more scattering (hence higher albedo and optical depth). This is not the same as 'reducing the radiative window'. Also, this statement is missing reference.

Line 54: Albrecht effect: missing reference.

Line 248: "Nwfa and Nifa ... evolve during the course of the model integration": How is this achieved? Do you simulate the emission/transport/deposition of the Ns? Or do you prescribe how N changes with time? If the latter, how do you ensure that this correctly represents the response of N to meteorology. More importantly, how do you know that you are not forcing the cloud microphysics to do things that you wish to see?

Lines 249-250: "...dataset on a monthly time-scale ... downloaded from the model's website": What is this dataset based on? Is it based on a model calculation or some kind of satellite data inversion?

Line 252: So Nwfa and Nifa are first set with initial conditions and then allowed to advect and diffuse? How do you ensure that the transported Ns are realistic? Also, the scavenging of Ns (both hygroscopic and non-hygroscopic) by precipitation are not considered?

Lines 249-255: The description of the aerosol settings in the sensitivity experiments is unclear. I have a hard time following what assumptions are made. Please consider revising.

Line 257: Does the number of non-hygroscopic aerosol affect the number of ice nuclei? This is not a default option in WRF. What parameterization is used to describe this sensitivity?

Lines 264-265: "...assumes a mixture of 70% water soluble and 30% dust-like aerosols": Is this a reasonable assumption for this case, where most of the aerosols were dust? More importantly, is this assumption consistent with the prescribed hygroscopic/non-hygroscopic aerosol numbers?

Lines 278-281: Is the effect of nudging in the outer domains one of the scientific questions you want to address in this study? If not, and if nudging is necessary to capture the large-scale atmospheric dynamics, then it should be included in all the key experiments. Otherwise there are simply too many experiments without a clear, key scientific question.

Lines 312-314: Why use MERRA-2 aerosol product for this study? Has the AOD in MERRA-2 been evaluated over this part of the world, particular since the surface is bright?

Lines 351-358: In fig2a-c, it appears that the dusts are mostly in the Northeastern part of the domain, but the MERRA-2 AODs are mostly in the central/southern part of the domain. Which one is more accurate and how do you reconcile the discrepancy? More importantly, which one is more consistent with the assumed Ns in the simulation?

Fig 2a-c: How are these figures colored? If this is indeed 'RGB' (i.e., real color) images, why would the dust be pink and the clouds orange/brown/black? Clearly, some other type of processing has been applied.

Section 4.1: The aerosol loading simulated here are neither consistent with the RGB plots or the MERRA-2 AOD shown in Fig 2.

Figure 5: The labeling is extremely confusing. Some subplots are not labeled, and which ones are (c) and (d)? The caption says: "The aerosol concentration in panels (c) and (d) is scaled as in panels (a) and (b)", which I do not understand.

Section 4.1: The conversion of WRF 'simulated' aerosol loading to PM10 is inappropriate. The Ns here are not realistic aerosol loading. They are first prescribed as initial condition and then allowed to be transported. In no way were the Ns physically related to dust in the model.