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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Examination of effects of aerosols on a pyroCb and their dependence on fire intensity and aerosol perturbation using a cloud-system resolving model" *by* Seoung Soo Lee et al.

Anonymous Referee #2

Received and published: 17 August 2019

Review of: "Examination of effects of aerosol on a pyroCb and their dependence on fire intensity and aerosol perturbation using a cloud-system resolving model"

Authors: Seoung Soo Lee, George Kablick III Zhanqing Li

Recommend major revisions.

General comment:

This manuscript examines the impacts of fire intensity and aerosol concentration on the strength of convection, microphysics processes, and upper level moisture through

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simulations using spectral-bin microphysics. I find that much of the paper is not particularly novel since it's fairly well known as this point that aerosol effects tend to be muted with increasing strength of convection. However, details regarding the impacts on microphysics processes are insightful. I found the most novel portion of the paper to be the final result regarding the fact that when a weak fire produces weaker aerosol emissions, the results tend to be muted. I think the paper needs to focus more heavily on the more novel aspects of the work.

In general, the paper needs to be greatly shortened. It is far longer than a typical journal article and needs to be made more concise, particular since it's a follow-on study. There are many places in the paper where the language is too "wordy". Many sentences and statements are written in a way that is difficult to read and can get in the way of representing the scientific results. Examples are given below in the specific comments section of this review.

Specific comments:

Title: The title is too long. You could remove "using a cloud-system resolving model".

1.Lines 63-64: The changes in cirrus clouds altering the radiation budget has become a true but very common motivating factor for cloud microphysics related research as it applies to climate change. Your main motivation here is that pyroCbs with high aerosol loading can change climate. However, pycoCbs are a subcategory of deep convection that comprises a very small percentage of actual deep convective storms and cirrus anvils. As such, I think you need to improve your motivating statements for this work.

2.Line 114: Here you state that using a CSRM allows you to have "confident information" on aerosol effects. I think this assumption is a bit premature given that you have not yet discussed the model you are using or the microphysics parameterization and its capabilities. Some microphysics schemes do not necessarily provide "confident information". Perhaps you should first offer some assessment of your choice of model schemes being used.

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3.Introduction: The introduction appears quite short on references. Other work has been done on pyroCbs and several additional relevant papers should be referenced.

4.Line 160: What is your size distribution of IN? You discuss this here but there's no other mention of heterogeneous ice nucleation in the paper that I recall seeing.

5.Line 199: At 150/cm3 this seems overly clean for representing a continental type case. Can you justify your choice here?

6.Section 2: Please provide more description of how aerosols are treated in the model. Are they transported around the domain after initialization? Is there nucleation scavenging and precipitation scavenging? Does the fire continue to act as an aerosol source after initialization or do the initial aerosols just get depleted? Each of these effects can impact the interpretation of the results. A fire continually producing aerosols over time.

7.Section 2: What data was used to initialize and nudge the simulations?

8.Line 235: Your assessment of "good agreement" between the model and satellite image is based on very little comparison. Can you provide more convincing evidence that these simulations are well representing this pyroCb event?

9.Lines 341-342: Experience has shown that what you choose as your lower threshold for averaging cloud water or LWP impacts the interpretation of the results. What do you consider the lower threshold given that models can provide very small numbers of LWP that are non-zero? Including tiny values of LWP in an average can impact trends in results.

10.Lines 386-389: It seems to me that these two sentences about cloud-ice mass density are just stating that there is cloud-ice in the pyroCb and no cloud-ice outside of it. It seems unnecessary to state this since non-cloudy areas imply a lack of cloud/ice. Perhaps you can be clearer on what the intent is for these sentences.

11.Lines 390-391: What about considering homogeneous freezing? This process

should be a major contributor to anvil ice mass and number concentration. I would expect ice numbers to be huge if a large portion of your aerosols are nucleated and transported aloft.

12.Section 4: This section should probably contain some discussion of changes to cirrus cloud ice crystal number concentration. There could be quite an enhancement in cirrus crystal sizes and number which can strongly impact cloud top albedo. Given your motivation factor regarding radiation and climate change, this would seem relevant.

13.Line 439: You state "percentage increase in updrafts"? Are you referring to the number of updrafts or the updraft speed?

14.Lines 462-467: This couple of sentences is an example where the main point could be made more concise.

15.Section 4.1.2: This entire section needs to be re-written or removed. The discussion of (LWC/CNDC) is overtly long and could be greatly condensed. To this same point, figures 13 and 14 are not necessary. The discussion here refers to basic algebra that goes into unnecessary description for the anticipated audience. Further, the section on equilibrium supersaturation is also unnecessary; a very short refresher regarding supersaturation could be useful, but most of the potential readers do not need a full review of this. Referring to Rogers and Yao (1991) is adequate.

16.Lines 743-746: This is an example that shows up numerous times where the lengthy wording interferes with reading the paper in a concise manner. Here you state, "are higher in the low-aerosol run than in the control run for strong fire intensity, in the medium-low run than in the medium run for medium fire intensity, and in the weak-low run than in the weak run for weak fire intensity. . ." This is very cumbersome to read and needs to be written in a concise way. When you see this type of monotonic behavior, you can simply state. This type of writing shows up many times in the paper and this represents just one example. Please examine the full paper for areas that can be written more concisely.

17.Lines 743-760: It seems here that you're stating that larger Rv = more autoconversion in lower aerosol runs, and then in the next sentence it seems to state reduced Rv = less autoconversion in higher aerosol runs. You don't need to state both of these. One of them implies that the other must be true.

18.Line 960: The use of "enhancing difference" seems awkward. Directly state what the difference is (increase? decrease?)

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