Review of ACP manuscript “Modeling the influences of aerosols on pre-monsoon circulation and rainfall over Southeast Asia” by Lee et al.

This study examines the effect of biomass burning in Southeast (SE) Asia on regional climate during the pre-monsoon period using a climate model with very coarse resolution. It shows significant impact of aerosol radiative effects on precipitation spatial distribution and circulation pattern, similar to many other studies. Aerosol indirect effect is only briefly demonstrated with radiative forcing. To me, the paper is not completed yet. How aerosol indirect effect changes circulation, water vapor, and precipitation patterns is of more interest and larger uncertainty, which should be in-depth examined and compared with aerosol radiative effect. In addition, there are many arbitrary assumptions for explaining the model results. Many of them can be validated by a little in-depth data analysis. See examples provided in the detailed comments below. This study seems to lack goals. It does not appear to link the modeling study with any observational phenomena/hypothesis. It also does not have some necessary introduction for the recent understanding/progress of this area.
Much of information about model and experiment design is missing or not clearly described. For example, is GOES-AGCM is a regional model of GOES or still a global climate model? What is used for cumulus parameterization? Does the cumulus parameterization consider any aerosol impacts? Also, I would like to understand if there are any new model developments for this study. Please describe as a separate paragraph and label clearly if there is.
Therefore, the paper needs to go through very significant revisions to reach a form that can be published. Hope these comments are helpful to shape the study.

Specific comments:

Too many acronyms in this paper and it is very hard to follow. In addition, it would be much easier for readers if the authors follow terminology symbols that are generally used in literature. For example, liquid cloud effective radius can be represented as $re_l$ instead of LCER. Use cloud, ice and total number concentrations are generally represented with $N_c$, $N_i$ and $N_{tot}$ (not the long acronyms used in this study)

Section 1, Introduction does not include information about what are aerosol radiative and indirect effects. There is also no brief introduction of the current understanding of aerosol impacts on deep convective clouds and straticumuli/stratiform clouds since these clouds are the study objects. There are significant progresses that have been made recent years based on process-level modeling studies and observational studies in this field. Please conduct literature search.

Section 3.1: The purpose of the section should be validation of model simulations. I do not see this goal from the text and figure 2. Does climatology

data include high BB cases? I suppose it should be. Then what is the meaning of comparing with climatology? Why not compare with the observations of the corresponding model time period?

Figure 3: why is droplet effective radius increased a little over the ocean near coast? It is unusual. Clouds should be shallow generally and the place is the downwind of the BB sources. Droplet size should be significant decreased. There are some observational studies that have shown it.

P32895, Line 6-9, what is your justification for preexisting clouds? What Figure 4 shows is that cloud water peaks around 800 mb, where strongest condensation probably occurs. It does not say anything if clouds occur first or BB aerosols first.

P32896, Line 11, change “May aerosol concentrations” to “Aerosol concentrations in May”. There are a few these kinds of statements that should not appear in a scientific paper.

P32896, Line 15-20, since you attribute the negative CDNC and LWP to reduced cloud fraction and RH. Please present these figures. In addition, what is the reason for the larger stability of the lower atmosphere? Semi-direct effects? If so, there are many such studies, which could be cited.

P32896, Line 21, now you use Nc and Lc (you used CDNC and LWC before). Please clarify and use the consistent symbols. In addition, you did not show the increase of CCN also. So, please add CCN to Figure 4. I’d like to see if and how much CCN is increased with high BB emissions. This is important to examine the contribution from aerosol radiative effect and indirect effect.

Figure 5, I do not understand the figure caption. What is COSP? This figure should be from the model simulations.

Since cloud fractions at higher level and lower level have very different radiative effect. Please break cloud fraction into the lower level and high-level cloud fraction to give in-depth insight about how they contribute to the radiative forcing at TOA, atmosphere and surface shown in Figure 5.

P32896, Line 26-28, since the precipitation anomaly pattern is different in each month, which month have you chosen to compare with the satellite observations? Therefore, you should provide figures for the observations accordingly in each month. Otherwise, you should not make such comparison.

P32898, Line 1, you can not arbitrarily say that the atmospheric heating is totally from aerosol absorption without looking into it. Increase clouds in the higher levels can cause atmospheric heating also. You need to break into clear-sky and cloudy-sky to get idea how much direct heating from aerosol light-absorption.

Figure 8, I am surprised that BB in the south impact the surface temperature in the far north so much. How do you explain it?

P32899, please explain a strong LW warming at 700 mb (but not a SW warming)?

P32900, line 20, it is not clear where the downwind is since precipitation in many places are reduced. Suggest plotting wind field to show wind directions and circulation.

P32900, Line 24, there is no such process called “rain re-evaporation”. Please change to “rain evaporation”. Also, this assumption can be examined by plotting the changes of the below-cloud RH.

P32901, last paragraph, smaller IE could also be due to the cloud fraction parameterization does not consider much aerosol impact. So, your results here does not mean that IE effect is smaller than direct effect in reality or detailed process models. This limitation needs to be discussed. Also, IE can be warming (higher –level clouds) or cooling (lower-level clouds). The cancellation can make the sum is small. This can be examined in my previous suggestion.
If your cumulus parameterization does not include aerosol impacts, then it may explain why you only see reduced precipitation by IE because your IE effect here only limits to the large-scale stratiform clouds (many CRM studies have showed increased precipitation for deep cumulus clouds). This discussion should be added too. Therefore, I suggest a discussion section.
Please also provide what cloud fraction assumption is used in Model Description.

Section 3.4, to more clearly examine the circulation change, besides Figure 10, spatial distribution of wind field should be shown.

Section 3.5, this section is way too simple and does not provide much information. Only the radiative forcing is provided for the two sensitivity runs for the indirect effects. It is worth analyzing how precipitation, water vapor, and circulation are changed by considering only aerosol indirect effects and what the differences are compared with the runs with the combined effects.

BBA and BB effects are used for the same thing (sometimes it is said as BBA effect and sometimes said as BB effect. It is very confusing. Please clarify to be consistent.