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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Using a coupled LES-aerosol radiation model to investigate urban haze: Sensitivity to aerosol loading and meteorological conditions" *by* Jessica Slater et al.

Anonymous Referee #2

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This study set up a coupled LES-aerosol radiation model to simulate an urban environment and investigate the interaction between aerosols and PBL dynamics. The coupled LES-aerosol model made it possible to get more information for the sensitivity of PBL dynamics to aerosols. This paper was well written, especially with a very informative description of the novel coupled model. The model results showed its ability to simulate the interaction between aerosol, meteorological condition, and PBL dynamics. However, I would suggest adding more discussion on the processes and mechanisms of the interaction between aerosol, meteorological condition, and PBL dynamics using this novel model. I recommend further expand the discussion section to help us understand deeper in the effect of aerosol on the PBL and the effect of interaction on the

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Discussion paper

development of haze episode.

Specific comments:

1. Why did you only simulate daytime but not the full day including night?

2. Figure 2(b): Why did all cases underestimate the latent heat flux to a large extent?

3. Line 203: Why did you assume SO4 strongly scattering but ignore NO3? As measured in SALSA, nitrate is much more than sulfate during this haze episode (in a factor of $\sim$2), which is made up 21% of aerosols as you list in Table 2. I don't think the effect of NO3 can be ignored in this case. As well as NH4, which is as important as SO4 for the fraction of aerosols. As a result, your model result may underestimate the scattering of all aerosols.

4. Line 230: Although it is clear that aerosols have an effect on the decrease in the PBL height, the inclusion of high and low aerosol concentration has a different effect on the temperature in the lower and upper boundary layer as shown in Figure 4. For example, a low concentration of aerosol causes cooling in the upper layer, while the high concentration of aerosol causes warming there on 24/11; low concentration of aerosol causes slight cooling in the lower layer on 25/11, while cause slight warming on 26/11. I suggest adding some more detailed discussion instead of giving a rough conclusion as "inclusion of aerosols causes cooling in the lower boundary layer and warming in the upper layers".

5. Table 3: Could you add some discussion on the difference in the percentage of decrease in PBL height between high and low aerosol cases? The high concentration of aerosol causes a much larger decrease in PBL height on 26/11 than that on 24/11 and 25/11. This discussion would help to understand more about the effect of aerosol on PBL height and its influence factors. I saw you gave some explanation in Section 5.2, but I think those were still not enough. First, why high aerosols will cause >1âĎČ cooling on 26/11, while only 0.3âĎČ on 24/11? Second, it looks like the high aerosols

decrease the potential temperature ∼1âĎČ in the lower layers on 25/11, but why PBL height was only decreased by 20%, which was much smaller than that on 26/11.

6. Line 252: Varied aerosol vertical profiles minimize the increase in vertical velocity close to the model top, while they also increase the vertical velocity in the lower layers. This section (4.3) was talking about the effect of aerosol vertical profiles, but this paragraph only mentioned it with a half-sentence. The comparison in the vertical velocity is interesting and informative as shown in Figure 8. Please give more results about the effect of aerosol vertical profiles. Maybe separate the effects of high aerosol concentration and aerosol vertical profiles on vertical velocity into two sections.

7. Line 273: Could you state more detail on how aerosol-radiation interactions of the previous night affect the meteorological condition on 25/11? Else, I suggest discussing more the sensitivity of boundary layer dynamics to meteorological conditions and its detail processes, instead of talking much about the variation of observed aerosols during these days.

8. Figure 7: Does the turquoise line mean the aerosol profile does not change (significantly) in the case with the constant aerosol profile? If yes, why not?

9. Line 317: This result was enough to prove the ability of your model to simulate the interaction between aerosol and meteorological conditions, but I would recommend adding more discussion on the detailed process of the interaction between aerosol and meteorological condition within the PBL using your model.

10. In this study, you mixed all kinds of aerosols and showed comprehensive results. Since the absorbing aerosol and scattering aerosol have a totally different effect on PBL dynamics, I would suggest conducting more sensitivity experiments to investigate the separate effect of absorbing aerosol and scattering aerosol. This would further improve our understanding of the interaction of aerosol and PBL during haze.

Technical comments:

1. Line 23: It will be better to add some references for these observation results.

2. Line 32: Change distribution to diffusion?

3. Line 125: what are the refractive indexes you used in the model? Please add a table or reference.

4. Line 158: What is “the first simulation”? Case A?

5. Figure 2: The potential temperatures at 8 pm are shown on the left, but you did not simulate anything at 8 pm. As you stated, the model ends at 6 pm each day. Why did you show the temperature at 8 pm here?

6. Line 178: What are some features you mentioned here? Please clarify them.

7. Line 201-202: SO4, NO3, NH4 are not very correct to stand for sulfate, nitrate, and ammonium.

8. Line 203: A period was missing after “these case”.

9. Line 228: It is better to mention figures in order. Figure 5 was discussed in figure 4.

10. Figure 5: The color in the legend is wrong.

11. Figure 5: Why did not use a unit of mixing ratio in Figure 5 like Figure 6&7? Making them the same will be better to understand.

12. Figure 6: where are dashed red lines? Could you make them more obvious? Or give some explanation in the legend.

13. Figure 6&7: I suggest to change A and B to case 2 and case 3.

14. Figure 7: where is the blue solid line?

15. Figure 8: I suggest adding a short subtitle (like date & case) for each subplot to make readers easy to understand.

16. Line 284: Did you mean Figure 4?

17. Line 294: A period was missing after “aloft”.

18. Line 303: same aerosol as high concentration case?

19. Line 315: What do a) and b) stand for here? I didn’t find a subplot in Figure 7.

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