Atmos. Chem. Phys. Discuss., 14, C2143–C2145, 2014
www.atmos-chem-phys-discuss.net/14/C2143/2014/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol and dynamic effects on the formation and evolution of pyro-clouds" *by* D. Chang et al.

Anonymous Referee #4

Received and published: 7 May 2014

This study used a 2D atmospheric model with a 2-moment microphysical scheme to simulate pyro-clouds. The effects of aerosol and convection intensity on cloud, rain, ice-phase particles, as well as surface rainfall were studied using a test matrix of 31 aerosol concentrations by 42 convection intensities. The authors also carried out process analysis for 4 individual simulations to explore mechanisms of the simulated sensitivities. Results from these process analyses essentially agreed with various previous studies, although nothing new was found. The strength of this study, in my opinion, is the large number of sensitivity simulations which afford more robust sensitivity analyses. However, the authors did not take the full advantage of their simulations. For example, they reverted back to analyzing only 4 individual members in their PA analysis, instead of studying the mean and variations of all available members. Since there

is a large room for improvement here, I would recommend publication with major revision. I hope the authors will take full advantage of their large simulation dataset and add more depth to their analyses.

Major concerns:

1. Convection is a highly non-linear process. This puts a serious constraint on individual sensitivity studies. One of the ongoing debates is how representative such an individual case study is in elucidating aerosol-cloud interactions. With >1000 simulations and independent variations in two external forcings (aerosol and fire intensity), this study may be able to shed some light on these debates. For example, if we were to conduct 2 sensitivity tests with high/low CN number (e.g., 2x or10x aerosol concentration), what is the probability that we will be able to get RS within one standard deviation from the mean? Will we be able to at least get the RS sign correctly? How robust is it to apply the mechanisms derived form an individual case with contrasting aerosol scenes to various environmental conditions, in this case, fire intensity? Statistical analysis along this direction will be very helpful in quantifying uncertainties of individual studies. It could also guide designs of future sensitivity tests.

2. There is an inconsistency in the RS analysis in the first part, which used 1302 cases, and the PA analysis in the second part, which used only 4 individual simulations. How do we know that mechanisms derived from PA analysis for an individual case are the same mechanisms that produced the mean sensitivities for hundreds of cases? If the authors can prove that the 4 individual cases are representative (see my comments in the previous paragraph), future aerosol-cloud simulations may be greatly simplified. If this cannot be proven, then PA analysis need to be done the same way as RS analysis, using all 1302 simulations.

Minor points:

1. The current simulation used pyro-cloud set up, e.g., there is a steady heat source at surface. This is fundamentally different from, e.g., a cumulus formed in the atmosphere.

The authors should limit their discussions within pyro-clouds. Certain speculative comments, e.g., P7788, L2, P7798, L1, may not be applicable. I would suggest removing them from the discussion.

2. In the sensitivity tests, CN concentration ranges from 200 to 100000 per cubic centimeter, fire intensity ranges from 1000 to 100000 W/mˆ2. Can you describe what ranges of CN and fire intensity are realistic? Does higher fire intensity also produce higher CN? Obviously 200 cmˆ-3 is not realistic in any pyro clouds. This can guide the readers to pay more attention to certain ranges of the parameter space. This information should be added explicitly in section 2.2.

3. RS values show large fluctuations for fire forcing between 2x10ˆ4 to 1x10ˆ5 (fig. 3,5,7,9). The authors could do more study on why this is the case. For example, do these fluctuations occur during the initial formation of the pyro clouds? Since the model used a steady heating at the surface, using results from the last hour may reduce these fluctuations.

4. P7783, L27, Is the fire forcing at a single point? What are the justifications for using a single point heating? Intuitively I thought forest fires spread to a large area, certainly larger than the 85 km domain size.

5. P7780, L12: “When we upscale the activation of a single aerosol. . .”, “extend” should probably replace “upscale”.

6. Fig. 11, 13, 15: The scales of y-axis are all different. The authors should point that out explicitly, instead of just tucking them discretely at the corner of each plot. If the authors decided to calculate averages instead of 4 contrasting simulations, as I suggested in my major concern, the mean values might be closer to each other. And the y-axis might be more uniform for labeling.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 7777, 2014.