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Interactive Comment

Interactive comment on "A size-composition resolved aerosol model for simulating the dynamics of externally mixed particles: SCRAM (v 1.0)" *by* S. Zhu et al.

Anonymous Referee #2

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The manuscript by Zhu et al. presents the simulation results from a size-composition resolved aerosol box model SCRAM. After providing the detailed description regarding the model treatments, the authors conduct a couple of ideal case studies to demonstrate the ability of this box model in reproducing the reference results of Zhang et al. (199). Finally additional case simulations are conducted by using a real case of model inputs from previous 3-D simulation results to show the impacts of different aerosol dynamic processes, mixing states (i.e., internal vs external mixing), and different assumptions for condensation/evaporation approaches on simulated aerosol mass and number distribution. This manuscript is generally well written with many interesting analyses. It's definitely of scientific interest to the atmospheric science community and

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I would recommend it to be accepted after a minor revision.

Specific comments:

One of the main reasons for majority of current 3-D atmospheric chemical transport or air quality models to use the assumption of internally-mixed aerosol treatment is the large computational cost, which could even make 3-D simulations impossible without sacrificing accuracy of aerosol representation (e.g., without reducing the number of aerosol species and size bins). The past studies have also found the overall aerosol mass and number concentrations could be very comparable for different aerosol size distributions between internal- and external-mixing. This point has also been verified in many occasions (in both text and figures) in Section 3 and 4 by this study. So I would really like to see some discussions in the conclusion section on how the current 3-D models can take advantage of and benefit from the treatment of external-mixing aerosols (such as the ability to predict the mixed states of aerosols) in SCRAM to compensate the loss of computational efficiency.

Page 7938, line 12: "thresholds of 12"; this is for primary aerosol only. There is another standard for secondary aerosol. May need to explicitly mention it here.

Page 7940, lines 9-18: I don't suggest putting such detailed information in the introduction. If it's essential information that authors would like to deliver, they should move it into somewhere else such as the methodology section.

Page 7942, line 19: How do you select values of accommodation coefficient?

Page 7943, line 6: which version of ISORROPIA here?

Page 7956, lines 11-12: I wouldn't say it's a perfect match since there is a little difference for the peak values of number distribution.

Page 7957, Section 4: It seems the SOA formation is not included in SCRAM and it has to rely on the other SOA modules if incorporated into 3-D models? It should be indicated in the manuscript.

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Page 7957, line 25: deposition is also ignored here and should be mentioned.

Page 7958, line 8: why choose 7 sections? Many existing aerosol modules typically use 4/8/12-bin structures.

Page 7958, line 12: When you grouped them, does the model still be able to track the concentrations of individual species (this is very important!). How do you treat individual species within each group for mass fraction sections? Such information is expected here.

Page 7959, line 3: change all the scenario names to upper cases (e.g., a to A and b to B).

Page 7960, lines 13-15: this seems to be conflicted with our general understanding that fine-mode particles are much easier internally-mixed than coarse-mode particles.

Page 7961, line 14: I didn't see that Figures 9 and 10 were mentioned before this. Please don't jump the figure numbers.

Page 7963, line 8: The information provided in this table indicates that the CUP time required by the external-mixing for the current box model could significantly slow down the simulation. I would expect some discussion on how this box model could be incorporate in a feasible way into 3-D models without reducing the number of size bins and mass fraction sections (which are keys for accurate simulations of externally-mixed aerosol processes). Are there any rooms for authors to optimize the code to further reduce the computational time, because I am not sure if the current performance in terms of CPU time is acceptable for the 3-D implementation?

Page 7963, line 11: C/E; this acronym should be defined much earlier in Section 4.2.

Page 7963, lines 24-25: I was looking for this information when I read Section 2. I would suggest adding this information where it is appropriate.

Page 7964, lines 23-24: Again I am really not sure how feasible it could be to incorporate the current box model into 3-D considering the huge increase of computation cost between the internal- and external-mixed results.

Figure 2: Can you replace the lines for reference and internal cases with markers? Figure 6: Is it UTC or local time?

Technical notes:

Page 7939, line 25: i.e.

Page 7939, line29: number of particle species

Page 7952, line 13: should Qij be Qijafter builk eq.?

Page 7953, lines 22 and 23: the highest

Page 7957, line 17: on 1 July 2009

Page 7957, line 18: 2.28âŮę E, 48.88âŮę N

Page 7962, line 19: Fig. 7c and 9a?

Page 7962, line 21: 0.0398

Page 7963, line 9: the lowest

Page 7963, line 16: 15% faster

Page 7964, line 5: typical emissions

Interactive comment on Geosci. Model Dev. Discuss., 7, 7937, 2014.