Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2015-935-RC2, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluating Model Parameterizations of Submicron Aerosol Scattering and Absorption with In Situ Data from ARCTAS 2008" *by* M. J. Alvarado et al.

Anonymous Referee #3

Received and published: 15 April 2016

This paper presents a closure study using in situ observations of aerosol composition and size as well as aerosol optical properties during the ARCTAS campaign to validate five aerosol optical properties modules. During this campaign there was a large abundance of biomass burning aerosol, so the focus of this closure study is on absorption. Four of those modules have in common that they prescribe the aerosol size distribution parameters, so the aerosol mass concentrations are the only inputs. These modules are used in current global models. The fifth optical properties module is used as part of the more detailed aerosol process model ASP and can make use of size distribution information.

I regard this paper as a valuable contribution to isolate and quantify errors in optical

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properties calculations that are part of state-of-the art models. I have some questions and suggestions that would make the presentation of this paper clearer. I recommend this paper for publication after these are addressed.

General comments

1. Closure studies of optical properties have a long history. I encourage the authors to shift the emphasis in the introduction from describing the importance of LAC to reviewing some of the closure studies in the literature to provide context for the work under review. A few examples are Cai et al., 2011, Highwood et al., 2012, Esteve et al., 2014, Quinn and Coffman, 1998, Sciare et al., 2005, Wex et al., 2002, but there are many more.

Cai et al., Journal of Geophysical Research, 116 (2011), D02202

Highwood et al., Atmospheric Chemistry and Physics, 12 (2012), 7251–7267

Esteve et al., Atmospheric Environment, 89 (2014), 517- 524

Quinn and Coffman, Journal of Geophysical Research, 103 (1998), 16575–16596

Sciare et al., Atmospheric Chemistry and Physics, 5 (2005), 2253–2265

Wex et al., Journal of Geophysical Research, 107 (2002), 8122

2. The description of the models/ aerosol optical property modules is somewhat confusing. I recommend referring consistently to the actual optical property module in each case, since the full chemical transport models are not used for this study. For example, in section 2.2, what is actually evaluated is a portion of the FAST-JX model, correct? Similarly, large parts of section 2.5 seem to be not relevant for this paper, as there are no model runs using the full ASP model, but only the optical properties module is used. If that's indeed the case, I recommend eliminating or substantially shortening section 2.5.1, except for the description about the assumptions how aerosol composition is represented over the different size bins.

Specific comments

1. Replace the phrase “to get” with “to obtain” (e.g. line 5)

2. page 4, line 9: replace “intensity” with “burden” or similar

3. page 5, line 2: should read “result”

4. page 6, line 7: suggest to rephrase: “six types of water clouds, three types of ice clouds and ten aerosol types”

5. page 6, line 12: The list of different components is confusing. Is water-insoluble aerosol everything insoluble except for soot and mineral dust (which are a separate class), and is water-soluble aerosol everything soluble except for sea salt and sulfate? Please clarify.

6. page 6, line 30: should read “based on Mie theory calculations” (remove “the”).

7. page 7, line 1: How is dependence of refractive indices on relative humidity parameterized?

8. page 8, line 24: suggest to rephrase: “all particles in a size bin are assumed to have the same composition”.

9. Page 8, line 26: suggest to rephrase: “one bin each for particles smaller than 10 nm or larger than 20 μm.”

10. page 8, line 28: This sentence says that the mass fractions of different aerosol components are the same for all the bins. Does this mean that the aerosol is assumed to be fully internally mixed? In other words, it’s not only assumed that the particles within one bin have the same composition as stated two lines above, but all particles have the same composition?

11. page 10, line 27: Regarding the Maxwell Garnett mixing rule, are there assumptions necessary how many BC inclusions there are, if so, what is assumed in this

study?

12. page 11, line 22: The SP2 instrument only covers a range above 90 nm, but a fraction of BC particles will have smaller cores, which will be missing from the mass concentration, but their absorption will be captured. Can you estimate how big of a problem this is for the closure?

13. page 13, line 13: replace slower with lower.

14. page 13, line 19: should read 7.75 ?

15. Section 4.1: Since size distribution measurements are available, can you include some information of how close/how different the observed size distributions were from the assumed distributions?

16. page 15, line 16: add “volume” to “extinction coefficient”

17. page 16, line 26: here the authors talk about modes as inputs for ASP, which is in contradiction to the information on page 8, which talked about size bins. Please clarify.

18. page 19, line 2: delete “the shows”

19. Section 6: the term mixing state is used when it should be mixing rule.

20. Conclusions: The four fixed-size-distribution models are all rather similar. Can you comment on why the GMI leads to the best results?

21. page 24, line 13: What improvements might this be?

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