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Geoscientific Model Development Discussions
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Interactive comment on "Sensitivity of aerosol extinction to new mixing rules in the AEROPT submodel of the ECHAM5/MESSy1.9 atmospheric chemistry (EMAC) model" *by* K. Klingmüller et al.

Anonymous Referee #1

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This manuscript presents a very nice and important case study on how different aerosol mixing (external, internal, core-shell) affect aerosol optics and radiative forcing. This is important progress compared to most aerosol modeling. However, reality is much more complicated (non-spherical particles) and inhomogeneous mixing beyond concentric core-shell) and the authors fail to discuss this. I recommend publication in GMD after the following comments are taken into account.

1. The title does not do a good job in conveying the message of the manuscript. "Sensitivity of aerosol extinction"; the manuscript goes far beyond aerosol extinction discussing SSA and radiative forcing. "New mixing rules", nothing new here, only the inclusion into AEROPT is new. How about starting the title with "Sensitivity of aerosol

optics and radiative forcing to different mixing scenarios in the AEROPT..."?

2. P. 3369, L. 26-28: This sentence is unclear. Please specify what kind of "absorption efficiency" you are talking about, e.g. absorption cross section per mass or per geometric cross section?

3. P. 3371, L. 6: "asymmetry factor gamma" is virtually everywhere else referred to as "asymmetry parameter g"; please use that common notation to avoid confusion.

4. P. 3373 Mixing Rules: Please give a general reference about mixing rules, for example (Chylek et al. 1988).

5. P. 3374, L. 6-9: Yes, adding the concentric core-shell model is a step forward from exclusively using externally or internally mixed homogeneous spheres. However, this is still far away from reality, where most (by mass) particles are not spherical and we are not sure about concentricity. For example mineral dust particles are generally irregularly shaped and BC particles are generally fractal-like chain aggregates. While the mixing scenarios discussed here represent progress over previous work, limitations must be discussed in detail.

6. P. 3374, L. 19: "lensing" is a geometric optics concept that only applies to large particles (size parameter x»1); this is not the case for sub-micron BC particles in the visible unless the coating is very thick. I suggest to replace "lensing" here and elsewhere by "amplification".

7. P. 3376, L. 16: "analytical approximation" of Bohren and Huffman (2007). Please mention here that this analytical equation does not apply to very small particles. For particle diameters approaching zero and a non-zero imaginary part of the refractive index, SSA goes toward zero as can be seen in the exact calculation in fig. 2; however the analytical approximation keeps increasing. The correct behavior compared to approximations has been depicted in fig. 1 of Moosmuller and Arnott (2009). Please mention this shortcoming of the analytical approximation.

8. P. 3379, L. 22-23: “have been complemented by data from I>N. Sokolik (unpublished data, 2005). At this point, the work presented here becomes un-reproducible by others. You must include the unpublished data in the supplement and discuss how they have been merged with the other data. There is already enough confusion about what refractive indices to use.

REFERENCES

Chylek, P., V. Srivastava, R. G. Pinnick, and R. T. Wang (1988). Scattering of Electromagnetic Waves by Composite Spherical Particles: Experiment and Effective Medium Approximations. Appl. Opt., 27, 2396-2404.

Moosmuller, H., and W. P. Arnott (2009). Particle Optics in the Rayleigh Regime. J. Air & Waste Manage. Assoc., 59, 1028-1031.

Interactive comment on Geosci. Model Dev. Discuss., 7, 3367, 2014.