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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Simplifying the calculation of light scattering properties for black carbon fractal aggregates" *by* A. J. A. Smith and R. G. Grainger

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This study provides a parameterization for light scattering properties of black carbon fractal aggregates (FAs). The authors used the MSTM to calculate the rigorous scattering properties of FAs with different fractal dimensions and sizes at wavelengths from 400 nm to 15 μm, and found that there is no possible spherical model that can represent those properties accurately. Then, a parameterization of the light scattering properties as a function of the monomer number is carried out to simplify the calculation, and provides accurate approximations on the extinction cross section, single-scattering albedo and asymmetry parameter of the FAs. The paper shows some useful results for applications, however, I have some concerns and comments for the authors to consider in

the revision.

1. One of the simplest and most popular algorithms for light scattering properties of the fractal aggregates is known as the Rayleigh-Debye-Gans (RDG) method, which has simple formulae and is highly efficient for calculations of any circumstance. Thus, before evaluating any parameterization on light scattering properties of the fractal aggregates, its accuracy compared with the direct approximations from the RDG should be checked. If the RDG can give similar accuracy, it becomes really meaningless to carry out any of those parameterizations. I think it is of great interest to add RDG results in the comparison, since RDG is a much more flexible and practical method. More details on the RDG can be found from the review paper by Sorensen (AST 2001; 35: 648-687) and its references.

2. Page 3540: The authors discuss the aging of BC as well as its effects. Yin and Liu (JQSRT 2010; 11: 2115-2126) and Liu et al. (AST 2012; 46: 31-43) built a simple model to study the scattering properties of coated aggregates, and can be easily adapted for this study (by also applying the effective medium approximations). From their work, the coating enhances not only the absorption but also the scattering of the aggregates, and their work should be mentioned.

3. The right panel of Fig. 5: The asymmetry parameters for most aggregates shown in the figure are less than 0.4, whereas the color bar chosen can hardly show the details of their values.

4. Page 3544: The authors try to use the scattering properties of spheres to represent those of fractal aggregates, and it should be noticed: even appropriate spheres can be found for the cross sections and asymmetry parameters, the accuracy of such approximations is significantly challenged for the phase function, which was investigated in Li et al. (JQSRT 2010; 111: 2127-2132 that is cited in the manuscript).

5. In Fig. 7, the authors show only the performance of the spherical approximation at wavelength of 550 nm, and demonstrate that the errors do not improve with increased

wavelength. However, as the wavelength increases, the size parameter of the particle decreases, and the scattering properties should be simple and close to those of Rayleigh scattering. How do the errors distribute at large wavelengths (e.g. 12 μm), and are they still over 15% for most cases or just for few special n_s or D_f? A figure similar to Fig. 7 but for large wavelength will be interesting to discuss if the spherical approximation shows difference performance.

6. Table 1 shows that coefficients 1 for SSA and g are both zero at 550 nm, and this indicates that it is not necessary to consider the linear term in Equations 3 and 4 for SSA and g. Is it true for all wavelengths or just for this single case, and this should be clarified in the paper.

7. The bottom panels of Fig. 7 have some curves, which are not explained in the paper, and the numbers listed in Fig. 9 are not well discussed. All those should be detailed in the captions or the manuscript.

8. Page 3548/Conclusions: Although the spheres cannot be used to model the optical properties of fractal aggregates accurately, there are still other approximations that are efficient enough for GCMs (such as RDG mentioned above). Furthermore, considering the uncertainties on the parameters of the fractal aggregates (e.g. k_f, D_f, and size distribution), the errors cased by the RDG or even the spherical approximations may be much smaller. Thus, the parameterization should not be the only way to consider the BC aerosol in GCMs.

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