Atmospheric
Chemistry
and Physics
Discussions

Open Access

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

Anonymous Referee #2

Received and published: 11 April 2014

The paper from Smith and Grainger is a short paper addressing the scope of ACP. They carry an investigation on the light interaction with uncoated black carbon aggregates using different models, and therefore different approximations in shape (aggregates of spheres vs. spheres). They assess the capability of Mie theory to mimic reference values obtained by T-matrix computations (also refered in the text as Multiple Spheres T-matix fortran code – MSTM), which are considered as reference values. In particular, they investigate on the applicability of spherical approximation to match reference values by using any particle size and any refractive index. They found black carbon aggregates light interaction cannot be appropriately represented by simplified spherical

models at any size and any refractive index in the vis and near thermal infrared, and they propose a new parameterization as a function of number of aggregate sphere that could be potentially used in GCM.

General comments: 1. There is a general inconsistency of how an aggregate of black carbon spheres is referred in the text (BC, BCFAs or soot).

2. In a subsection of the introduction, section 1.1, the authors present a physical description of aerosol formation and ageing. The authors mention the absorption enhancement due to coating and refer to few papers (Fuller 1999, Jacobson 2001, Bond 2006). Absorption properties of black carbon and appropriate parameterization are a major topic, due to climatological relevance and there could be cited more recent literature, i.e. Liu et al., 2012; Kahnert et al., 2012; Adachi et al., 2010. Also, it has been found both in field campaign and using numerical computations that, when black carbon aggregates are not fully embedded in the transparent coating there is no or little absorption enhancement, please add in the text, as well, Cappa et al, (2012, 2013) and Scarnato et al., (2013), as references.

It would have been interesting a discussion of the author's numerical computations of absorptions properties of BC aggregates, which are not specifically addressed in the paper.

3. I, personally, would find more "clear" having the equations that are currently in sec 3.3 and 3.4, instead presented in the method section, in this way there would be more space for discussion of results.

4 In my opinion, generally, the results could be discussed more in the details and compared, where possible, with relevant literature. For example, results in fig, 2 and 3 could be compared with the work of Liu et al., 2008, Kahnert, 2010a,b; Kahnert and Devasthale, 2011; Wu et al., 2012, Scarnato et al, 2013.

An increase in the font size in the plot would help in reading figures. Figures results

are not discussed in detail in the text (for example Fig. 7).

Suggested corrections in the text and other comments:

Introduction section 1.2 page 3541: Line 3: Please, consider to rewrite the sentence "Particles are defined by equation" with "Fractal aggregates can be described in terms of "

Line 7: Please, consider to rewrite the sentence with the following: "The fractal dimension gives a measure of the compactness of the aggregate, a Df value of 1 describe an open chain structure, while a Df value of 3 describe a compact aggregate "

Line 22: instead of "correct" write "considered as reference values ". Remove quotations.

Method Please, explain the author choice to use different set of refractive indexes for different wavelengths ranges. Chang and Charalapopolous refractive index are provided, as well, in the 400 nm to 1um wavelength region.

Results: The scattering cross section increase with increase of fractal dimension has also been found and discussed by Scarnato et al., (2013) and Liu et al. (2008), please add references.

Reference Adachi, K., Chung, S., and Buseck, P. R.: Shapes of soot aerosol particles and implications for their effects on climate, J. Geophys. Res., 115, D15206, doi:10.1029/2009JD012868, 2010.

Cappa, C. D., et al., Radiative absorption enhancements due to the mixing state of atmospheric black carbon, Science, 337 (6098), 1078{1081, DOI: 10.1126/science.1223447, 2012.

Cappa, C. D., et al., Response to comment on "radiative absorption enhancements due to the mixing state of atmospheric black carbon", Science, 339 (6118), 393, DOI: 10.1126/science.1230260, 2013 Kahnert, M.: On the discrepancy between modeled

and mea- sured mass absorption cross sections of light absorbing carbon aerosols, Aerosol Sci. Tech., 44, 453–460, doi:10.1080/02786821003733834, 2010a. Kahnert, M.: Numerically exact computation of the optical prop- erties of light absorbing carbon aggregates for wavelength of 200 nm-12.2 μm, Atmos. Chem. Phys., 10, 8319–8329, doi:10.5194/acp-10-8319-2010, 2010b.

Liu, L., Michael, I., Mishchenko, W., and Arnott, P.: A study of radiative properties of fractal soot aggregates using the superpo- sition T-matrix method, J. Quant. Spectrosc. Ra., 109, 2656–663, 2008.

Liu, C., Panetta, R. L., and Yang, P.: The influence of water coating on the optical scattering properties of fractal soot aggregates, Aerosol Sci. Tech., 46, 31–43, doi:10.1080/02786826.2011.605401, 2012.

Scarnato, B. V., Vahidinia, S., Richard, D. T., and Kirchstetter, T. W.: Effects of internal mixing and aggregate morphology on optical properties of black carbon using a discrete dipole approximation model, Atmos. Chem. Phys., 13, 5089-5101, doi:10.5194/acp-13-5089-2013, 2013.

Wu, Y., Gu, X., Cheng, T., Xie, D., Yu, T., Chen, H., and Guo, J.: The single scattering properties of the aerosol particles as aggregated spheres, J. Quant. Spectrosc. Ra., 113, 1454–1466, doi:10.1016/j.jqsrt.2012.03.015, 2012.