Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1367-RC1, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of particle number and mass size distributions of major chemical components on particle mass scattering efficiency in urban Guangzhou of South China" *by* Jun Tao et al.

Anonymous Referee #1

Received and published: 15 March 2019

The authors investigate key factors affecting mass scattering efficiencies by using particle size distribution data, PM2.5 and PM10 bulk data, and measured light scattering coefficients. Measurements were made at an urban site in China. The authors characterized the size, composition, and mass scattering efficiencies of the major aerosol modes and determined the major species contributions to mass and scattering for each mode. They used this information to calculate particulate mass scattering efficiencies for each mode. The study provides useful information on mass scattering efficiencies–parameters needed for visibility estimates and to relate mass to scattering for satellite

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Discussion paper

or modeling applications. The paper is fairly well organized and written but is in need of many clarifications, as described in the comments below.

Line 7: I'm concerned about reporting the condensation mode MMAD of 0.21 um. This just reflects the midpoint of the diameter bin. If this is the case, why not just report the midpoint of diameter bins for all the modes? Reporting it like data is meaningless.

Line 19: How is "fine" defined here?

Line 42: Define "IMPROVE" on first usage.

Line 45: MSE are important parameters not just for the IMPROVE equation, but for any application relating mass to optical properties.

Line 49: Include "based on an assumed size distribution" after "formula. . ."

Line 60: Yes, the second IMPROVE algorithm was developed for rural (very clean) areas, so it isn't a surprise that it doesn't perform well in urban areas.

Line 69: I think the reference here should be "Malm and Hand, 2007". Also, the efficiencies used in the second IMPROVE algorithm are based on an assumed size distribution and composition.

Line 73: Consider removing "According to Mie theory" because Mie theory doesn't specifically speak to the factors hindering the IMPROVE formulas. Line 75: Also, what about assumed hygroscopic growth curves in the IMPROVE algorithm?

Line 81: I think the authors mean "inline" when they say "online" data?

Line 88: Especially in urban areas.

Line 116: It would also help to include the other measurements in Table 1, such as the size distributions and nephelometer measurements.

Line 123: Do the authors mean "blank" instead of "background"?

Line 136: What is the expected size cut of the nephelometer? Are there expected

size-resolved losses from the tubing from the inlets that affect the size distribution and nephelometer measurements?

Line 140: Define “RH” at first usage (unless I missed it earlier).

Line 141: Were RH and temperature monitored? What were typical values?

Line 179: How were field blanks obtained?

Line 179: Why was OP so low from the 81mm filters?

Line 201-205: I am not sure of the rationale behind defining the condensation mode as the midpoint diameter of the smallest bin? If the MMAD of the mode is just assigned the midpoint diameter of the bin, what point is there in measuring any size distributions? The MMAD would just be the midpoint diameter of each bin which is meaningless. I don’t think you can report the MMAD of the condensation mode if this is how you derive it.

Line 209: I assume this discussion is with respect to the technique by Dong et al. (2004)? It might be helpful to provide more detail here regarding this method, since many of the results depend on it. For example, how were collection efficiencies incorporated into this inversion?

Line 215: Is this size resolved mass from the thermodynamic model on the binned data or the fit data?

Line 217: A section on the DMA and APS size distribution analysis is needed. How was the APS calibrated? How was aerodynamic diameter converted to mobility diameter (or vice versa)? What is the response of the APS to particles of different density? How was density calculated?

Line 225: Is PM10 here the bulk gravimetric PM10 or the summed data from the impactor? Does this include water at the RH of the PM10 gravimetric measurement? Particle bound water can still exist for 40% RH.

Line 226-227: Units for MMAD?

Line 226: How were MMADs calculated for the ‘continuous’ lognormal data?

Line 226: Again, reporting an MMAD for the condensation mode is meaningless.

Line 229: Define PRD.

Line 237: Close to what?

Line 289: What about K+ in the fine mode?

Line 336: Coarse mode mass fractions also depend on other species. Do the authors mean their absolute concentrations rather than relative concentrations?

Line 339: Change title to “Closure of particle mass, number concentration, and bsp”

Line 345: Was sulfate fully neutralized for the duration of the study?

Line 355: Was 5% used here?

Line 362: I am not sure what is meant here by the “total”? How was “total” derived in this context?

Line 371: Same comment as the previous.

Line 382: Please provide more details regarding this method.

Line 384: This would be expected because of the diameter-cubed dependence between number and mass.

Line 386: What is the difference in the definition of the estimated NMAD of the number concentrations of individual species and the NAMD of particle number concentrations? (individual versus particle?). I think an issue here is that the constant 0.21 μm value is meaningless.

Line 392: What densities were used?

Line 397: The reasoning here isn't clear. The size segregated chemical mass species concentrations should be dry. Unless the authors mean that particle bound water was associated with a gravimetric measurement, the individual species mass do not include water.

Line 418-420: I am unclear as to why scattering efficiencies are being discussed here?

Line 421-423: This is the first discussion of these design flaws – are the authors referring to the single bin for the condensation mode?

Line 426: How much higher?

Line 429: How do the authors know that EC was internally mixed with OM or inorganic salts during this study?

Line 433-434: The reasoning here is unclear. What are the estimation errors and models?

Line 448: The authors need to provide more details on how they derived bsp. What refractive indices did they use, how did they calculate them, which number size distributions did they use, etc.

Line 455: Why "especially the inversion technique method"?

Line 460: What do the authors mean that OC was underestimated by the OC/EC protocol?

Line 468, 472: Do the authors mean "inline" data?

Line 502: What did the authors use for refractive indices for the "unidentified fraction"?

Line 517, 521: I am not sure what is meant by "particle and chemical species". What is the distinction?

Line 540: This points back to the previous comments as well. Was "particle MSE" estimated by summed bsp from individual species divided by summed particle mass,

or was bsp calculated for “particle”, which then would require a “particle” refractive index? It would help if the authors provided details for how these things are calculated (see comment for line 448).

Line 577: Define MMGD

Line 626-627: Sentence is unclear.

Line 630: How were sigma values calculated?

Line 653: What does “bulk particle” mean?

Line 670: Sea salt in the IMPROVE formula is assumed to have a mass mean diameter of 2.5 um, so it is assumed to be in the coarse mode with the tail extending into the PM2.5 mode.

Figures and Tables: Table 2: Define size range of condensation, droplet and coarse modes. Again, reporting 0.21 um for all condensation mode MMAD is meaningless. Define “MMAD” in the caption.

Table 3: Define size range of condensation and droplet modes. Again, reporting 0.21 um for all condensation mode MMAD is meaningless. Define “MSE” and “MMAD” in the caption. Include wavelength and relative humidity (Dry = ?%) in the caption or subtitle.

Figure 1: Define “PRD” in the caption.

Figure 2: Was CaSO4 and Ca(NO3)2 subtracted out of the soil formula when using Ca to calculate soil? These figures suggest that EC mass size distributions are larger than OM distributions? Are these stacked? If so EC » SO4 but mass concentrations in Table 2 suggests this is not the case. The presentation is somewhat confusing. Keep the y-axis the same for all seasons for easier comparisons.

Figure 3: Similar comments as previous caption.

Figure 4: It would help to plot the APS data in terms of mass or volume instead of

number based on the size range- the larger modes would be more visible.

Figure 6: Include wavelength, relative humidity conditions, and size range. Is this total bsp?

Figure 7: Similar comments to figure 2. I don't understand how the mass of sulfate can be so much higher than EC yet the EC scattering is greater?

Figure 8: Define "MSE", "fine", wavelength, and relative humidity conditions in the caption.

Figure 9: Caption doesn't include any information on MSE. Also include wavelength, and relative humidity conditions in the caption.

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