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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Size distribution and mixing state of black carbon particles during a heavy air pollution episode in Shanghai" *by* X. Gong et al.

Anonymous Referee #1

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Review of Gong et al.

The manuscript presents a short collection of data from two single-particle instruments measured during a pollution episode in Shanghai, China. A single particle soot photometer (SP2) measured refractory black carbon (rBC) number and mass distributions as well as optical size. A single particle aerosol mass spectrometer (SPAMS) measured mass spectra of individual particles in parallel. Together the instruments provided information on the abundance and composition of BC-containing particles. To my knowledge this is the first direct comparison and analysis of single-particle data from the two approaches, and while the manuscript does not exploit the advantages of

the two techniques as much as might be possible, it still represents a valuable contribution and presents information from a unique and important region (Chinese megacities). I recommend it for publication in ACP once the following comments have been addressed:

General comments

There are a few places where I think more could be done with the co-located single particle instruments. For example, was there much consistency in results between SPAMS "mixed" particle clusters and SP-derived coating thickness? In addition, more details should be provided on the comparisons between the two instruments:

+ were the number concentrations calculated for the same diameter range for both instruments?

+ was the reduced detection efficiency (about half) for the SPAMS accounted for in the comparison?

+ what is considered "internally mixed" for both instruments? Were all rBC particles measured by the SP2 included, or only those with a coating thickness above some value. If so, why?

The most appropriate comparison would be a best estimate of number concentration reported by both instruments for a size range both instruments measure well.

Related point: I am not aware of any studies that directly compare single-particle MS results to a co-located SP2, so think the scatter plot in the supplementary material is worth including in the main paper. If there are some recent papers comparing SP2 to single-particle MS suggest including a short comparison of the results here to those.

Specific comments

35384 – 6: The term "refractory black carbon (rBC)" should be used when presenting any results specifically from the SP2. Recommend changing text here and through-

out the manuscript. The distinction will also help distinguish results from the mass spectrometer versus SP2.

35384 – 9: Add “in diameter” after 60-400 nm (assuming results are reported as diameters).

35387 – 28: It might be beneficial to add a small note to clarify that the “SPAMS” here is NOT the same as the SP-AMS (Soot Particle-AMS), which shares the laser system of the SP2 and therefore might lead to a little confusion.

35389 – 14/15: Change “laser power” to “laser current”. Note that a constant laser current does not necessarily mean a constant cavity laser power. Ideally PSL could be used to verify the laser power before and after the study period, however considering the data are reported for a five-day period I do not think this is especially important in this case.

36390 – 7: suggest changing/adding “. . .was calculated as (Dp-Dc)/2, which assumes a concentric core-shell morphology.”

35390 – 17: Is the SPAMS a laboratory-built instrument or the commercial instrument available from Livermore Instruments (SPAMS 3.0). Please specify here in addition to citing the reference.

35391 – 8: Are the final number concentrations corrected for this factor when comparing to SP2? Please clarify.

35391 – 28: Please state if there was a sizecut (cyclone, impactor) used on the main inlet, or if the instruments sampled all transmitted particles (with their response limited by upper size limit of the instruments).

35392 – 1: Suggest renaming this section because it focuses more on the trace gas measurements then meteorology. Also, according to the caption for Figure 1 data were taken from the Hongkou Station. This information should be provided in the main text as well.

35392 – 25: The data shown in Figure 2 are study averages? Please state.

33393 – 8: All comparisons are to SP2-measured values, correct? Should be stated if so.

35396 – 5: Should be stressed here that the results discussed here are from the LEO-fitting of SP2 data and not BC cores but the total, mixed diameter particle.

35396 – 12: The paragraphs in this section move back and forth between SP2 and SPAMS data, so it would be a little more clear to state when SPAMS data is being discussed and when we are back to SP2 data.

35397 – 4: The condensation and droplet modes are defined in terms of vacuum aerodynamic diameter in the manuscript, but I did not see what value was used to distinguish the modes for the SP2. I assume to make the two plots shown in Figure 5c the data was split for some mixed particle diameter. It would be useful to show that as a line on both figures, because by definition you cannot have any particles above it for the condensation mode or below for the droplet mode. It would be good to shade this region of Figure 5c either black or weight since it is an invalid data region for both plots. Finally, it is not stated if this analysis was performed for all particles measured during the study or only during specific time periods.

35397 – 26: This is a nice example of using both instruments to better understand what is happening, though there should be some care in treating the correlation as direct evidence (how well do the large, thickly coated particles correlate with other BC particle categories identified by the SPAMS?). I do think the figure (S5) should be moved out of supplementary material into the main text. Also, the text discusses the number fraction of BC from biomass burning, but not mass fraction (which could be estimated from the SP2 data). A 20% contribution (or higher, for mass) from biomass burning seems high for an urban region, but can the authors discuss more. Do they expect significant residential burning near their site?

35397 – 13: Do either of these studies report PM? Values in Shanghai were probably much higher than in the other locations mentioned, so you might have much more rapid mixing with BC acquiring thicker coatings faster.

35398 – 16: There should be a note here that the choice of BC core diameter (60-80 nm) means that you will only obtain optical sizing for the most thickly coated particles due to the scattering detector sensitivity (minimum optical diameter of about 170 nm). Do the larger BC cores display a similar rapid coating behavior?

35398 – 26: “incensement”?

Figure 4: Please add label for color scale including units (dN/dlogDp)? Caption for (b) states the red lines shows number concentration but axis label gives particle number.

Figure 6: Information for color scale should be provided.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 35383, 2015.