

***Interactive comment on “A new aerosol collector for on-line analysis of particulate organic matter: the Aerosol Collection Module (ACM)” by T. Hohaus et al.***

**Anonymous Referee #1**

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The manuscript entitled “A new aerosol collector for on-line analysis of particulate organic matter: the Aerosol Collection Module (ACM)” by T. Hohaus et al. describes a new aerosol collector for organic matter and its first applications during a simulation chamber experiment and ambient aerosol measurements. It presents an interesting new method that allows fast sampling and analysis of organic matter in aerosols which is important for both understanding the formation processes of aerosols and source apportionment studies of aerosols.

I recommend publication in Atmospheric Measurement Techniques after the following issues have been thoroughly addressed.

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General remarks:

- The title of the article “A new aerosol collector ...the Aerosol Collection Module (ACM)” leads to the assumption for the reader that the article would deal with a thorough characterization of the ACM. But limited effort is shown during the characterization of the measurement system to distinguish between effects / limitations / efficiencies due to the ACM part and the GC-MS / FID part. Therefore I would suggest changing the title such that it contains the entire setup consisting of ACM-GC-MS / FID.
- The ACM allows only the analyses of volatile (organic) compounds of the particle phase that evaporate in vacuum at a temperature of  $T_{\max}$  (225 deg. during SOA experiments, 260 deg. during ambient air sampling). This needs to be clearly stated in the article and in the abstract. Also a discussion of sampling artefacts of the ACM part (due to e.g. evaporation temperature) is missing in the article.
- The characterization of the particle collection, desorption and transfer efficiency with octadecane (section 4.2) has limited relevance for the performance of the system during simulation chamber or ambient aerosol measurements. Please motivate the use of octadecane in the characterisation of your instrument. To the reader it looks as it has been chosen for convenience and to obtain a good recovery rate of the system (100%). This is shown by the authors themselves quite drastically during the SOA experiments (mass fraction detected less than 12%) and stated on p1371 L10f. Therefore the article would strongly benefit from performance measurements of the ACM-GC-MS / FID system done with compounds that are more relevant for the characterization of OA or SOA than octadecane.
- Clarify throughout the article the use of GC-MS versus GC-FID. E.g. in the abstract you write about GC-MS recovery rate of 100% and in fig. 4 you describe recovery rate of GC-FID measurements. Also in the caption of figure 5, you state a ‘ACM-GC-MS FID chromatogram’, but to the reader it looks like a ACM-GC-FID chromatogram only with some auxiliary info from GC-MS.

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Specific comments and suggestions:

- p1362 L2ff: Mention source apportionment in the abstract as a field for which detailed chemical characterization of the aerosol is important.
- p1362 L10f: Rephrase and clarify, as the ACM first collects aerosols, then gasifies volatile compounds.
- p1362 L18ff: Linearity and slope have been determined with GC-FID and not GC-MS according to figure 4. Please clarify.
- p1363 L27f: What is meant with 'spatial sampling density'? Please explain what is meant and how the ACM addresses this.
- p1363 L2f: Address in a few lines AMS and PILS as you did with filter measurements. AMS and PILS seem to be equally an alternative to your method as the filter based measurements you described in the paragraph above.
- p1364 L9ff: With your description here you imply that the entire particle (of organic matter) is evaporated. This is not the case for both organic aerosols and especially inorganic aerosols, taking your maximum temperature of 225 and 260 deg. for the SOA and the ambient air experiments into account. As stated in the general comments, please clarify that only the volatile part of the OA is desorbed.
- p1365 L2ff: In the article of Liu et al., it is stated in their conclusion that the transmission efficiency of the aerodynamic lens system is "close to 100%" for (~50 nm to 1000nm). Looking into their figures, it's not even close to 100% at 50nm for any measurement. Please adopt your citations.
- p1366 L18: Please clarify what "helium 6.0" is.
- p1367 L12: Inorganic material will not be desorbed during the backflush mode. So please be more precise.
- p1369 L23ff: It is not obvious why you present the conversion of peak area (of the

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FID detector of your GC-FID) to compound concentration in such details, including table 1. It is standard procedure in analytical chemistry to calibrate the detector and a statement that your detector has been calibrated for linear response in a certain concentration range is sufficient. I would suggest removing table 1 and only state that you ensured linear response of your GC-FID detector in a concentration range.

- p1370 L8f: "SMPS distribution" is laboratory slang. Change to e.g. number size distribution.
- p1370 L20: "a conversion factor", please rephrase to something more instructive.
- p1370 L21ff: Please clarify in this chapter that the GC-FID detector was used (and not integration over all mass peaks in the GC-MS mass spectra).
- p1371 L8: It would be instructive for the aerosol community to translate the measurement range (10 to 100 ng) to an aerosol mass concentration using your flow rate into the ACM.
- p1373 L14: Please verify that TSI 3687 model number is correct.
- p1376 L16ff: The reported 'recovery rate' of the ACM-GC-MS system for the SOA experiment ranged from 11% to 6%. These values are strikingly different from the recovery rate of 100% for the optimum test compound of octadecane reported in chapter 4.2. A part of the difference is attributed to the losses in the GC-MS detector due to higher oxygenated products and compounds with a high molecular weight. It would strengthen the paper if the authors could provide a quantification of the estimated losses due to the ACM part for the SOA experiment.
- p1377 L20ff: It would be instructive to give numbers to your corrections (BF, PVD, ND) for the filter measurements.
- p1377 L24ff: In the conclusion of Liu et al. 2007, it is stated that "For typical accumulation mode particles (~50 to 1,000 nm diameter), the EL is close to 100%" (EL = lens transmission efficiency). Please explain the why your lens assembly behaves dif-

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ferent at diameters > 500nm. Also, as you have simultaneously measured the particle number size distribution with a SMPS, it would be instructive to have a figure with the measured size distribution in the paper.

- p1378 L11f. The time behaviour of the relative nopinone abundance during the SOA experiment is already shown in figure 6. Therefore figure 7, as it stands, is redundant. To get a better view on the comparability of filter vs. ACM-GC-MS measurements, I suggest to replace the timeline with a scatter plot of filter vs. ACM-GC-MS data and insert a liner fit on these data. This could also support your statement that both methods agree reasonable well. Looking at the timeline plot, ACM-GC-MS consistently underestimates the filter based values and agrees well only for a few data points taken on the last day of the experiment.

- p1378 L18ff: Please explain better why the agreement of the two measurement methods should improve on the second and third day. Your statement that the “system is in steady state with the chamber walls” does not explain any improvement in the agreement of the two measurement systems (filter and ACM-GC-MS)!

- p1379 L5: It might be instructive to compare the areas under the aerosol and background lines in fig. 8 to get an estimate of the contribution of the gas phase to the aerosol phase measurement.

- p1379 L7: 2nd word, replace “in” with “is”.

- p1379 L20: Clarify in the sentence that the ACM-GC-MS is capably of measuring ambient organic aerosol mass loadings. It obviously cannot measure “ambient aerosol mass loadings”. Also, you clearly showed with the octadecane and SOA experiments that the efficiency of your system strongly depends on the chemical composition of the organic part of the aerosol. And you state in chapter 5.4 that the GC-MS detector does not measure well “higher oxygenated products” and “high molecular weight compounds”. Therefore the capability of the ACM-GC-MS regarding both being linear and quantitative strongly depends on the composition of your particles! This absolutely

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needs to be clarified within the paper!

- p1379 L26 & P1380 L24: Why 70 nm as lower limit? Throughout the article you state 50 nm.

- p1380 L22: Looking at fig. 7, the agreement for nopinone is at most reasonable for the first two days. Actually, the ACM-GC-MS clearly underestimates the filter values. Please revise.

- p1380 L23ff: The statement “... with quantitatively reproducible results” is not backed up by data from the SOA experiment. The nopinone comparison to filter measurements is neither reproducible nor quantitative (ratio changes from day 1 to day 3 of the experiment, see fig. 7). Also, the total organic mass fraction detected by ACM-GC-MS varies from 11% to 6% (fig. 6). Therefore either drop this statement or back it up with results.

- p1380 L26ff: The ACM-GC-MS can not provide ambient aerosol mass loadings (see above), but at most ambient organic aerosol mass loadings. Also, as it has been shown throughout the paper, the collection / detection efficiency strongly depends on the composition of the organic aerosols (100% for octadecane, less for nopinone and close to zero for high molecular weight compounds and highly oxygenated organics, chapter 5.4). Therefore the ACM-GC-MS can not be capable of measuring linearly and quantitatively ambient organic aerosols. Linearity and efficiency depend on the aerosol composition under investigation.

Tables & Figures:

- Table 3: Please add dimension to the retention time (minutes).

- Figure 3: The CPC comes after the electrostatic classifier in the setup of an SMPS. Please change in your figure. A DMA is nothing else than an ‘electrostatic classifier’, so no need for different naming. Also please add the FID in parallel to the MS in your GC-MS/FID system.

- Figure 5: Add dimension to y-axis (e.g. [a.u.])

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- Figure 7: Does not add additional information compared to figure 6. I suggest replacing it with a scatter plot of filter vs. ACM-GC-MS measurements to assess the comparability of the two methods.
- Figure 8: Can you extend the x-axis (retention time) to values such that the entire peak of the chromatogram is on the plot? The signal is not back to its zero value at 43 minutes.

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