**Atmospheric
Measurement
Techniques
Discussions**

Interactive comment on "Aerosol quantification with the Aerodyne Aerosol Mass Spectrometer: detection limits and ionizer background effects" *by* F. Drewnick et al.

F. Drewnick et al.

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Thank you for these helpful comments. We addressed all comments as detailed below.

P171 L7-11: The reviewer is correct, we changed the text according to this comment and cited first the Bahreini et al., paper and then the other papers in chronological order.

P173 L3: The upper limit for negligible transmission of the aerodynamic lens was changed to 'approximately 1.5 μm'; in agreement with the reviewer's comment.

P175 L9: The statement provided here is a general statement about general analytical measurements. We completely agree with the reviewer's comment about the break-

down of the normal distribution for ion counting statistics. However, since this is a general statement we do not include such special cases in the statement and re-worded the sentence in order to make clearer that this is the typical case.

P177 Equation4: The fact that gas phase signal can influence the detection limits for certain m/z, especially during the aerosol measurements and thus the LOD definition provided here is a lower limit for the detection limit values is now mentioned in the text. In addition it is mentioned that particle counting statistics effects are not considered here and the two references provided by the reviewer are referenced here.

P180 L7: The citation was added as suggested by the reviewer.

P184 L8-9: The additional effect causing larger cross-sensitivity in the ToF-AMS compared to the Q-AMS is now also mentioned in the text.

P185 L20-30: Thank you for this comment! We added two sentences and the provided reference to the text. However, since particles that bounce off the hot vaporizer likely also bounce off other (colder) surfaces without evaporation we do not expect that this process will dominate the effect discussed further down in the manuscript. We also cited Huffman et al. (2005) as suggested by the reviewer.

P186 L2: We disagree with the comment that fitting the sum of multiple exponentials to the background concentration data would be better. This would be correct if there would be a certain (and small) number of separated processes with different individual time constants that contribute to the overall self-cleaning process. However, in the AMS ionizer the time constants of the self-cleaning process depend on the temperature of the surface where molecules are temporarily deposited. Since these temperatures have a continuous variation (from very hot near the filaments and the vaporizer to room temperature at the chamber walls) no finite number of individual processes with individual time constants can be identified. Therefore we do not change the current way of analyzing these processes and just provide this more qualitative information that shows the general processes occurring in the vaporizer.

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P188 L25: As suggested by the reviewer the similar figure for the ToF-AMS was shown as Figure 5B. Both panels of Figure 5 are now referenced in the text.

P189 L5: The word 'arbitrarily' was removed from the text and the sentence was re-worded in order to make clear that the LOD can be reduced to very low values until other effects than ion counting statistics dominate the detection limits.

P189 L7: We disagree with this comment. While for the organics detection limits the values can be recalculated without including the m/z that have air and water interfer-ences this is not possible for ammonium. Recalculation of the organics LODs without these m/z results in significantly lower detection limits, which can already be seen from Figure 2, where the major contributors to the LOD of organics is in the m/z that have contributions from air and water. Therefore these LOD values and their averaging time dependence would not be characteristic for organics. Electronic noise is definitely an important contributor to the LODs of organics that comprise a large number of m/z, as stated by the reviewer. However, also the influence of electronic noise should also be reduced with increasing averaging times. Due to these reasons we do not change the statement in the text, which we consider rather conservative.

P189 L16: This additional possibility to improve Q-AMS detection limits was added to the text.

P189 L28: The statement in the manuscript is correct. As the reviewer mentioned par-ticle counting statistics is improved by increasing the chopper open/closed ratio. This is also mentioned in the manuscript. However, the absolute mass concentration de-tection limit is reduced when the chopper open/closed ratio is increased, as correctly stated in the text. Equation 4 is not valid anymore when the chopper open/closed ratio is different from 1 since then the error curves of the two measurements are different from each other. For example by increasing the open/closed ratio to 90:10 the mea-surement time for the aerosol measurement is increased by a factor of 1.8 (resulting in a reduction of the noise by a factor of 1/1.34). However the measurement time of the

instrument background is reduced by a factor of 5, resulting in an increase of the noise by a factor of 2.24. Therefore the overall result is an increase in the noise of the total measurement and thus an increase in the detection limit. In order to make this clearer a short statement is added to the text in the manuscript.

P192 L11: The reviewer is correct; it is not likely that elemental iodine will be a very sticky component. The text was changed here to reflect that not I2 but iodine-containing salts are responsible for long-term instrument contamination. This species was already mentioned in the section on long-term instrument contamination (3.2.3; P187); also here 'iodine' is converted into 'iodine-containing species'.

P197, Table 1: The detection limit values were converted into ng/m^3 as suggested by the reviewer.

P198, Table 2: The time constants are those for the decay of the excess detection limits above the standard level. This was clarified in the text.

General Comment: PAH detection limits: We agree with the reviewer's suggestion that including detection limit values for PAH would be an interesting addition to the paper. However, as the reviewer correctly stated several of the authors are also active in this area. Within this activity an improved identification procedure of PAH within the mass spectra is in the process of development. The current identification procedure for PAH makes relatively crude assumptions in order to extract the PAH information from the spectra. This results in large uncertainties in PAH concentrations, especially at low concentrations. Therefore we do not attempt to provide DL values for this species and plan to add this information in a publication about an improved PAH identification scheme.

General Comment - Literature comparison: Thank you for this suggestion. We completely agree with the suggestion to compare the detection limits measured in this study with those reported in the literature. For this purpose we added a table (new Table 2) providing an overview over previously reported AMS detection limits and a discussion

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of our results in the context of these values in chapter 3.1

Minor Items:

P170 L23-24: The acronyms are now spelled out for the two versions of the AMS

P171 L1: 'its' was changed to 'their' as suggested.

P171 L29: 'procedures' was replaced by 'processes' as suggested.

P172 L7: This sentence was changed as suggested.

P172 L14-15: The two sentences were combined to avoid the repetition of information.

P173 L10: The sentence was changed and only the typical operation temperature (600 °C) is provided now.

P173 L13 (not 18): 'includes' was replaced by 'contains' as suggested.

P173 L22: The wording was changed from 'quantitatively reach the vaporizer' to 'quantitatively pass the chopper' in order to avoid confusion.

P174 L3-4: The sentence was changed according to the reviewer's suggestion.

P174, Equation 1: The collection efficiency (CE) was included into equation 1 as suggested.

P175, L26: The citations were re-ordered to appear in chronological order.

P175 L23: '(under the Gaussian assumption)' was added to the text as suggested by the reviewer.

P176 L11: 'of' was replaced by 'to' as suggested.

P176 L21: The 'lower' is correct here. If during the flight the background and therefore the LOD values are decreasing measurements of detection limits after the flight will provide lower values than those actually present during the flight.

P177 L22: 'background ion' was replaced by 'background species' as suggested by the reviewer.

P178 L25: 'control' was replaced by 'monitor' as suggested.

P179 L5: 'in the present configuration' was added to the sentence to account for improvements by future configuration changes to the instruments.

P180 L10: Since the actual value of the duty cycle loss due to dead time effects after movement of the chopper depends on the frequency of chopper movements we did not add a certain number for this effect (as suggested by the reviewer) but added a note about this effect to the text.

P181 L24: 'then' was replaced by 'than' as suggested.

P182 L5: A note was added to the text that the LODs for these m/z can be improved by using filaments not containing tungsten.

P185 L15: Here it was our intention to provide a short but complete description of the processes occurring in the vaporizer when aerosol particles are measured and how these processes affect the dynamics of the instrument background and thus the measurement of aerosol mass concentrations. In order to keep this section consistent we hesitate removing information from this paragraph that was in part mentioned before.

P190 L17: 'semi-urban' was replaced by 'suburban' as suggested by the reviewer.

P191 L3-6: In order to improve clarity the sentence was changed similar to what was suggested by the reviewer.

P201, caption of Figure 3; caption of Figure 6: All detection limits besides those calculated for increased averaging times (Figure 5) are for 30s averaging times. This information was added to the captions of both figures and to the caption of Table 1.

P203 Figure 5: As suggested by the reviewer also the data for the ToF-AMS were included into this Figure. Therefore in order to avoid confusion the scale of the nitrate,

sulfate and chloride DLs was not changed. However, to improve the visibility of the evolution of the detection limits of these species zero lines were added to the two panels in the figure.

P204 Figure 6: The jumps in the DL for very small number of m/z used are likely due to different contributions to the overall noise and to the overall signal of total organics by the individual m/z. A short note about this was added to the Figure caption.

Interactive comment on Atmos. Meas. Tech. Discuss., 1, 169, 2008.

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