

## ***Interactive comment on “The ToF-ACSM: a portable aerosol chemical speciation monitor with TOFMS detection” by R. Fröhlich et al.***

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Reply to:

Interactive comment on “The ToF-ACSM: a portable aerosol chemical speciation monitor with TOFMS detection” by R. Fröhlich et al.

Anonymous Referee 2

1. Reorder the figures so that they are presented in the text sequentially.

*revised*

2. Page 6772, Line 24, an aerodynamic lens with larger size cutoff is mentioned, has it

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been tested on the ToF-ACSM?

*No, the lens with larger cutoff was not tested with the ToF-ACSM. It has been tested extensively on the AMS and Q-ACSM by Aerodyne, but these results are beyond the scope of this paper.*

3. Page 6774, line 3, give a bit more information about the flange.

*Changed sentence to: “It is noted that a specially-designed flange, which bolts directly onto the end of the vacuum chamber is used to hold the detector mount, providing unconstrained access and allowing for fast [...] of interest. This is in contrast to the Q-ACSM system where the quadrupole head has to be disassembled to replace the detector or the AMS where the entire mass analyser must be removed.”*

4. Page 6774, Line 22-23, check the grammar of this sentence.

*Sentence changed to “To ignore transients in the inlet, the first 20 s of data after a valve switch must be discarded.”*

5. Page 6778, line 8-9, the quoted variations in the RIEs of  $\text{NH}_4$  and  $\text{SO}_4$  are quite large for the same instrument. Is there information about why they change so much? From a practical point of view, if large variations were observed between two calibrations, how were RIEs applied to determine  $\text{NH}_4$  and  $\text{SO}_4$ ?

*The quoted variations in the text give the range of RIEs measured with instruments utilizing the same ionization scheme. The RIE variations of a stable instrument during a continuous deployment are much smaller. The mean values and standard deviations on the mean measured during the 14 months of measurement at the Jungfraujoch, were  $3.23 \pm 0.42$  and  $0.65 \pm 0.05$  for  $\text{NH}_4$  and  $\text{SO}_4$ , respectively. The manuscript is thus altered to report these values, which more accurately reflect the performance of the instrument. Removed page 6778 line 8 and added: “Typically they lie between 2.5-5 and 0.6-1.2, respectively. During the long-term measurement at the Jungfraujoch the ToF-ACSM RIEs were  $\text{RIE}_{\text{NH}_4} = 3.23 \pm 0.42$  and  $\text{RIE}_{\text{SO}_4} = 0.65 \pm 0.05$ .”*

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6. Page 6778, line 10 -11, the purpose of analyzing  $(\text{NH}_4)_2\text{SO}_4$  particles is to determine the RIE for sulfate. It is unclear why one should know the size and concentration of  $(\text{NH}_4)_2\text{SO}_4$  particles to determine the RIE for sulfate?

It is correct that in general, with the RIE of  $\text{NH}_4$  already known from the  $\text{NH}_4\text{NO}_3$  calibration, the mass of  $\text{SO}_4$  particles which are introduced into the instrument can be determined directly without knowing size and concentration of the original  $(\text{NH}_4)_2\text{SO}_4$  particles and in this way also the RIE of  $\text{SO}_4$  could be determined. The incorrect parts were removed from the text. Sentence changed to: "For the mIE calibrations ammonium nitrate ( $\text{NH}_4\text{NO}_3$ ) particles of known size and concentration are needed, similar to the calibrations of the Q-ACSM (Ng et al., 2011). Hence, the same calibration equipment is required.  $\text{NH}_4\text{NO}_3$  is mainly used because it is easily accessible and atomised, vaporises with 100 % efficiency to ions from the ammonium and nitrate species.  $\text{NH}_4\text{NO}_3$  is also well focused by the aerodynamic lens and does not experience particle bounce at the vaporiser. Particles of  $\text{NH}_4\text{NO}_3$  can be produced from an aqueous solution by a nebuliser, size selected with a DMA after being dried by e.g. a silica gel drier and then fed simultaneously to the ToF-ACSM and a CPC for counting." We remove the word "[...] calibration [...]" in Page 6779 line 20

7. Page 6778, line 20, is the size  $D_m$  or  $D_{va}$ ?

It is the mobility diameter  $d_m$ . Sentence changed to: "With the equipment described above a fixed concentration (between 300 and 1500  $\text{cm}^{-3}$ ) of  $\text{NH}_4\text{NO}_3$  calibration aerosol particles with a uniform mobility diameter in the range between  $d_m = 300$ —350 nm are selected with the DMA and sampled by the instrument.

8. Page 6880, Line 10, is t in the unit of second?

It never matters what units are used in a quantity equation. For example, with  $t = 120 \text{ s} = 2 \text{ min}$  the fraction  $60 \text{ s}/t$  is always  $\frac{1}{2}$ , independent on the units. In other words:  $60 \text{ s}/120 \text{ s} = \frac{1}{2}$  and  $60 \text{ s}/2 \text{ min} = \frac{1}{2}$ . This is because the value of a quantity includes the units. See VIM 1.21. No change made.

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9. Fig. 1. What's the broken green line?

The broken green line illustrates a linear fit to the  $\text{NO}_3$  signal (blue circles) Addition to figure description: "The dashed lines represent linear fits to the  $\text{NH}_4$  (red) and  $\text{NO}_3$  signals (green)"

10. Fig. 3, check the figure caption, some descriptions are inconsistent.

Description of graph (c) was wrong. Sentence changed to: "There is a good correlation between the scattering coefficient and the mass concentration of the ToF-ACSM ( $R^2 = 0.87$ )..."

11. Figure 8, the correlations between the two ACSM are systematically better than those between ToF-ACSM and CToF. Is there some fundamental reason for this? Could it be due to difference in instrument designs between ACSM and a regular AMS?

We believe that, rather than fundamental reasons, the slightly worse correlation between ToF-ACSM and CToF-AMS has the two following main reasons:

1. The comparison with the CToF-AMS was made in winter during a period with very low concentrations resulting in a much higher noise influence and less dynamic range
2. The Q- and ToF-ACSM sampled from exactly the same inlet during their intercomparison. Due to logistical reasons that unfortunately was not possible during the CToF-AMS and ToF-ACSM intercomparison. The inlet line of the CToF-AMS was significantly longer, resulting in variable inlet line losses depending on the ambient particle size distribution In response to the reviewer's comment regarding ACSM design differing from that of the AMS, we note that the ToF-ACSM as described in this work is not simply a Q-ACSM where the Quad is replaced with a ToF mass spectrometer, e.g. also the vacuum chamber and the vacuum pumping scheme were redesigned in the ToF-ACSM. Thus we would not expect that the ACSMs should intercompare better with each other than with a ToF-AMS. Hence we propose the reasons listed above.

12. Fig. 9, I am not convinced that the separation of  $\text{C}_2\text{H}_3\text{O}$  and  $\text{C}_3\text{H}_7$  is quantitative.

C2977

*Can the authors show the diagnostic time series of mass accuracy and resolution?*

*The fitting procedure utilised is actually very constrained and does not allow the mass position of the peaks or the peak width (resolution) to vary. Thus time-series of mass-accuracy and resolution are not available, as only the amplitude of the peaks is fitted. The constrained nature of the fits is described on page 6791 line 26. Clearly it is difficult to assign quantitative error bars to such fitted amplitudes. Assessing these errors has been the focus of a recent study by one of the authors and the predictions of uncertainty from this are in agreement with the amplitude variation owing to mass calibration perturbations as described page 6793 line 7. There are many ions in the spectrum for which the ETOF resolving power is insufficient for successful deconvolution of the overlapping peaks; however for the example in the text a basic high-resolution analysis is possible. It is therefore conservatively concluded that "we demonstrate the possibility" to apply HR fitting, which we argue is an appropriate and not over-stated claim.*

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