Interactive comment on "The influence of the baseline drift on the resulting extinction values of a CAPS PMex" by Sascha Pfeifer et al. - Final Response

S. Pfeifer et al.

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We would like to thank the Referees for the constructive comments. Please find our response to each of the comments below:

Referee comments are denoted with RC. Author replies/comments are in blue and denoted with AC. Changes in the manuscript are in blue and italicized.

1 Anonymous Referee #1

RC: Figure 1: I suggest revising this plot to show extinction readings at three wavelengths in one panel, under the same y-axis scale, so that it's clearer to the readers the magnitude of the baseline variation at these different wavelengths. It will help determine whether the shift in CAPS-green in the second week is "significant", as stated in Page 3 Line 24.
It is complicated to implement this, because all three devices have different basic loss signals (blue 580, green 380, red 480). With a second or third y-axis this could be manageable. However, we think that this is even more difficult for the reader to understand. Alternatively you can leave the multi-plot as it is and only adjust the scaling. but this results in an almost horizontal line for red. Not very informative.
So we leave the plot as it is.

RC: Page 3 Line 23: does the difference between CAPS-blue and CAPS-green extinction readings scale with the difference in NO2 absorption cross-sections at 450 and 530 nm? That analysis can help determine the source of the variation in the extinction signals.
Unfortunately, no new facts can be derived from the existing database. Only that the increase is not due to NO2 or particle contamination of the mirrors.

RC: Page 4 Line 1: To be precise, the variations in the baseline is not caused by "changes in the gas composition", but rather the rapid change in the abundance of the absorbing gases, such as NO2, in the ambient air.
Perhaps the expression "change of gas composition" sounds very wide-ranging and exaggerated. We have therefore reformulated the term: *rapid change in the concentration of absorbing gases.*

RC: Figure 3 Caption: the caption does not mention that the results are from CAPS-blue.
we have specified the caption:
*Time series of lastbaseline (top) and the resulting extinction values (bottom) for the uncorrected (blue) and corrected method (red) for CAPS-blue (*450 nm*) measuring particle free ambient air.*

2 Anonymous Referee #4

RC: For the results of the comparison with the nephelometer, the authors described that "The factors represent a correction of internal calibration, which primarily consider the influence of the purge air variability.". This sentence seems unclear. Do you mean the flow rates of purge air or their mixing situations with sample air were different for the three different CAPS PMex?
We mean variability of the flow rate, to be more precise the ratio of the flow rates of purge air and sample air.
we have specified this in the text:
The factors represent a correction of internal calibration, which primarily consider the influence of the variable ratio of purge air and sample air flow rate.

RC: In addition, information on the calibrations of nephelometers and the corrections of the nephelometer data to adjust to those at the wavelengths of CAPS PMex should be added.
The nephelometer is calibrated with particle free air and CO_2. The wavelengths were interpolated using the scattering Angström exponent, although this is not necessary for blue 450nm. For the other two wavelengths the deviation is very small with 5nm (nephelometer: 525nm or 635nm).
We have added:
using CO_2 as high span gas

and:
The values were adjusted adjusted to the wavelength of the respective CAPS PMex (450, 530 and 630 nm*) by using scattering Angström exponent.*

RC: Also, the maximum values of extinction coefficients at wavelengths 450, 530, and

630 nm look similar. The results may be strange, because relatively large extinction Angstrom exponents are expected for small particles with diameters of about 50 nm. The referee is absolutely right. The extinction Angstrom exponents are relatively large. As an explanation: For the devices, the manufacturer states that they have a linear behavior for values smaller than $500\,\mathrm{Mm}^{-1}$. Therefore, only values smaller than $500\,\mathrm{Mm}{-1}$ were used for the quality checks, to ensure comparability of the results of all the devices. We have added:
In order to reduce the influence of potential non-linear effects of CAPS PMex, only values less than $500\,\mathrm{Mm}^{-1}$ *were used for this analysis.*

RC: For baseline corrections of this kind of instruments, the linear interpolation method is widely (normally) used. The comparison of results of the linear interpolation method and cubic spline method should be added.
As already pointed out in the text, there are many methods of interpolation, with all their advantages and disadvantages. Linear interpolation is one of them In contrast to various other requests, this request is within the scope of this work and would not shift the focus of the work. Nevertheless, this requires a major change in many sections of the text as well as some plots.

In Fig. 3 und 4 the results for the linear interpolation were added. The graphics have been slightly changed and the captions have been modified.

In the abstract we changed the last section:
Two methods are shown to minimize this effect. Modified continuous baseline values are calculated in a post-processing step using simple linear interpolation and cubic smoothing splines. Both methods are useful to reduce artefacts, although the use of cubic smoothing splines gives slightly better results. The extinction artefacts are diminished and the effective scattering of the resulting extinction values is reduced by about 50 %.
In chapter 3.2, P. 4 L. 18:
It is possible to reduce these artefacts by using interpolation methods. Two different procedures were considered. The first one is a simple and often used linear interpolation method. A potentially better alternative is the use of cubic smoothing splines.

In chapter 3.2, P. 4 L. 32:
It should be emphasized that the use of any interpolation method to recalculate the baseline has its limits. Only trends that can be estimated from the baseline data can be reproduced for lastbaseline. It is impossible to reproduce any faster fluctuations that are not covered by the selected baseline period and duration. Furthermore, when using the cubic smoothing splines there is the possibility that under extreme conditions with strongly fluctuating baseline trends the method can lead to erroneous overshot structures. In these cases, the first step should be the readjustment the baseline settings.
If the requirements are fulfilled, these approaches result in a continuous time series of current baseline values, without phase-shift relative to the loss signal (see Fig. **??***). As expected, the result is slightly better when cubic smoothing splines are used, as this is*

a continuously differentiable function. Another important difference is that with cubic smoothing splines trends during a baseline measurement are considered and are therefore reproducible. In contrast to this, the linear interpolation method uses only one average value per baseline measurement, analogous to the internal procedure. As a result, there are individual cases where the linear interpolation does not lead to any improvement of the extinction values, but there are also cases where the improvement corresponds to that of the cubic smoothing spline. However, in both case the resulting extinction values improve significantly. In Fig. **??** *the resulting histograms and statistical parameters for particle extinction for all instruments and the entire time series are shown. As expected, the mean value remains almost unchanged at values close to zero. But the distribution becomes narrower and more symmetrical. For the CAPS-blue the standard deviation is reduced by* 43 % *using the linear interpolation and* 50 % *using cubic smoothing splines. For CAPS-green the reduction is* 19 % *with both methods. The skewness for CAPS-blue is reduced from* 2.909 *to a value of* 0.756 *using the linear interpolation and* 0.104 *for cubic smoothing splines. The results for the CAPS-red remain almost unchanged.*

In chapter 3.2, P. 5 L. 24:
For instance, at 450 nm, *the precision is improved by a factor of approximately 2.8 using the linear interpolation method and 3.7 using cubic smoothing splines.*

In chapter 4, P. 5 L. 31:
The use of linear interpolation or cubic smoothing splines to calculate the current baseline values are more adequate methods for a variable background. Both procedures lead to improved values, although the result for cubic smoothing splines is slightly better. Artefacts for particle extinction almost disappear and variability decreases.

In chapter 4, P. 5 L. 34:
If the change of the background signal is relatively slow, these methods allows to reduce the frequency of baseline periods and thus reduce number of position changes of the built-in ball valve extending its lifetime. On the other hand, in the majority of cases, the background variability is unknown and the ambient aerosol and the composition of the carrier gases may be closely coupled (e.g. near traffic emission). From this it follows that the measuring and baseline period should be equally weighted, if one considers the background signal as equivalent. The use of a gas monitor in parallel operation can serve as a reference to adjust the baseline period. However, these interpolation methods, in particular cubic smoothing splines, can be used to take into account the continuous change of the background signal and improve the quality of the resulting extinction values.