

Interactive comment on “Performance of diethylene glycol based particle counters in the sub 3 nm size range” by D. Wimmer et al.

Anonymous Referee #2

Received and published: 11 March 2013

Review of the AMT manuscript amtd-6-2151-2013 “Performance of diethylene glycol based particle counters in the sub 3 nm size range” by D. Wimmer et al., 2013

The above manuscript deals with the laboratory calibration of two types of condensation particle counters for very small particles (below 3 nm diameter). As new particle formation is still a paramount topic in atmospheric aerosol research (cf. Kulmala et al., Science, 2013, which, by the way could be cited in the introduction), in particular because of the recent technical developments, the presented work is of interest for atmospheric researchers and should be published after minor revision. Generally, the manuscript looks like there where several independent calibration efforts done, which were combined afterwards to one manuscript. I’m missing the thread, making clear, why which calibration was done. However, I know from own experience that such a

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patchwork is often forced by limited time, hence I don't blame the authors too much for that. Nevertheless, they could provide some reasons.

Specific issues are:

- p 2152 | 17: if you speak about a higher mixing ratio, please provide at least two flows here, e.g., the saturator flow and the aerosol flow.
- p 2154 | 3: "exiting the capillary" is true for the specific CPC type used in the present study, however, Eqn. 1 is of more general nature and holds true for other CPCs without capillary too. So please remove the "capillary".
- p 2154 | 5: usually, the term "counting efficiency" is used for the overall efficiency of a CPC, not only for the detection efficiency.
- p 2154 | 8: please remove "i.e." because for instance the chemical composition of a particle is not automatically determined by the particle size.
- p 2154 | 19: here I miss a paragraph describing the contents of the manuscript. This paragraph follows later at the end of Sec. 2. It should be moved from Sec. 2 to the end of the Introduction (Sec. 1).
- p 2155 | 9: I'm not a native speaker, but "after" feels for me more related to time, I suggest to use "downstream" or something similar instead.
- p 2155 | 17: please replace "Thus" with "Usually,".
- p 2155 | 24: please remove "aim to", because you characterized the CPCs.
- p 2156 | 5: please add "diameter" behind "3 nm".
- p 2156 | 3: publication year is missing for the "Iida et al." reference.
- p 2156 | 15: experimental work performed by you should be described in past time not in perfect time, please replace "have been" with "were". This is of course relevant for the rest of the manuscript too.

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- p 2157 | 12: please replace “set-up” with “DEG CPC” because this is more specific.
- p 2158 | 7: the scanning mode of the PSM, how fast is it? Please provide numbers and a reference.
- p 2158 | 18: please don't use “various” or similar expression, be more specific, in this case e.g. “three” or “four” gives detailed information.
- p 2158 Sec 3.3: you used four different generators and two different DMAs to calibrate four, more or less, different CPCs. The reader is quickly lost in knowing which instrument was calibrated with which set-up. Please provide a matrix-type table indicating to the reader which set-up was used for which CPC. This would help a lot when reading the results section later on. Furthermore, it is not clear why you did they not use only one or two generators with one DMA? Please provide some arguments/reasons, why you used different instruments, what are the advantages, what are the disadvantages of the used generators and the DMAs?
- p 2159 | 2: the air from the laboratory likely contains traces of ammonia which would quickly react with your sulfuric acid particles. Please comment on that (to the reader, not to me).
- p 2160 | 3: the whole description of the electrometers is not a “result”; please move to the “experimental” section.
- p 2160 | 5: “inter-comparison showed that . . .” should be rephrased, what you likely meant is that the two instruments agreed within 0.5-1%, but this is not what the current sentence says.
- p 2160 | 13: the reference for the fitting curve: please cite the original article, not the one citing the one citing the original article, i.e. Wehner et al., 2011 should be replaced by Stolzenburg and McMurry, 1991 (which was cited by Wiedensohler et al., 1997 which then was cited by Wehner et al., 2011). Same on page 2161.
- p 2160 | 13: please replace “error” with “uncertainty”.

- p 2160 | 15: what does “the high resolution DMA has a (size? time?) resolution of about 20” mean? 20% or 20 nm or ...? Please specify.
- p 2161 | 1: Fig. 5 shows the overall “counting efficiency”, not only the “detection” efficiency.
- p 2161 | 6: Fig. 5 and 6 show two data sets for the counting efficiency of the DEG CPC1 for negatively charged sulfuric acid particles using the nano-DMA. What’s the difference in the data? And why are they displayed in two separate figures? Please clarify and combine the data into one figure.
- p 2161 | 24: please provide a reason why the lower cut-off diameter of the DEG CPC1 is shifted towards smaller particle sizes in Fig. 7a.
- p 2161 | 27: where are the data for the DEG CPC1 in Fig. 7b?
- p 2162 | 12 : what does “cleaned carefully” mean? Heating the tubes for several hours? Or purging? What did you try to do and how successful was it? Please let the reader know this important information.
- p 2162 | 22: please replace “being activated” with “activate”
- p 2162 | 22: I don’t understand the sentence “Therefore clusters with higher organic impurity ...”. Please rephrase it to make it clearer.
- p 2162 | 28: please remove “Whereby”.
- p 2163 | 5: the last sentence of this paragraph is too long, please make it two sentences.
- p 2163 | 15: please replace “ at smaller sizes earlier than the” with “already at smaller sizes compared to the” or something similar.
- p 2163 | 17: the argument starting with “Another effect might be ...”. I don’t think that an inhomogeneous saturation ratio profile in the condenser is of much importance

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for the differences between the used DEG CPC and the PSMs. First, the used DEG CPCs have a capillary and a sheath flow around the aerosol flow leading to a relatively flat supersaturation profile experienced by the particles (cf. Stolzenburg and McMurry, 1991). Secondly, you have shown that accounting for the diffusive particle losses inside your DEG CPC leads to a similar steepness in the counting efficiency curve as for the PSM. Hence you don't need a second effect. I suggest to remove this argument.

- p 2164 | 2: please replace “to the CPC” with “by the CPC”.
- p 2164 | 23: first sentence in this paragraph (“As the internal ...”) is incomplete, please check.
- p 2166 | 4: please be more specific and replace “variety”.
- p 2166 | 9: please replace “efficiencies” with “efficiency diameters”.
- p 2166 | 10: please make it “differ” because the given statement is still valid.
- p 2166 | 15: “corrections ... are considerably reduced”. First, it is not a problem if a correction is small or large, as long as you know it exactly. What you probably meant is that the “uncertainties associated with the corrections ... are considerably reduced”. Secondly, what does “considerably” mean? By a factor of two? Or even ten?
- p 2166 | 25: please add the new Kulmala et al., 2013 reference.

Figures:

Fig. 3: these sketches are too small, please make them larger.

Fig. 4: please provide error bars for the particle diameter (x-axis), e.g., the DMA transfer window width.

Fig. 5: why did you stop the W_O_x measurements at 4 nm? It seems to me that the W_O_x data points lead to a curve with a maximum counting efficiency clearly below 100%. Please comment and let the reader know it too.

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Fig. 7: please enlarge the three graphs, the curves are hard to see.

Fig. 8: figure caption: please specify the CPC type in the last sentence, the curve is not valid for every CPC.

Fig. 10: for very high concentrations the blue data points in the insert deviate from the one to one line. Could a different coincidence behavior be the reason for this? Are the values corrected for coincidence. Please give a statement in the text.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 2151, 2013.

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