

Atmos. Meas. Tech. Discuss., author comment AC2
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Reply on RC1

Kevin B. Fischer and Giuseppe A. Petrucci

Author comment on "Utilizing an electrical low-pressure impactor to indirectly probe water uptake via particle bounce measurements" by Kevin B. Fischer and Giuseppe A. Petrucci, Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-35-AC2>, 2021

We thank RC1 for taking their time to carefully review our manuscript and provide detailed feedback.

It is not very clear to me whether this method is proposed to measure particle hygroscopicity or particle phase state. If it is the former, then more detailed comparison with hygroscopic growth behaviors (e.g., curves) for those well studied species should be made. If it is the latter, parameters that are more closely related to phase state (e.g., viscosity or water uptake/evaporation kinetics that is related to diffusivity of water molecules in viscous particles) should be provided.

This manuscript is not intended to present a new method. It is intended to highlight potential artefacts observed for the ELPI sampling from humid environments. The work presented herein using is based off the bounce factor method previously developed. Particle hygroscopicity and particle phase state are not measured. Instead, particle bounce under dry and humid conditions is qualitatively measured, which relates to the hygroscopicity and phase state.

It is assumed that all particles that bounce from any preceding stage will end up in the last (filter) stage. How valid is this assumption? As seen from Fig. 1, the DRH and ERH of AS were not very sharp, as different from normally reported abrupt changes of either mass or diameter during deliquescence and efflorescence for this crystalline species. Does it reflect a possibility that some "residual" particles might end up in earlier stages even if the AS particles are known to be solid crystalline?

We agree that there is a possibility that some residual particles may not bounce fully to reach the filter stage. This can occur more often if the aluminum surfaces of the impaction stages are not regularly cleaned and changed. In our instance, the surfaces were regularly cleaned and changed to allow for optimal particle bounce conditions (should the particles be of more solid character).

The RH drop at the lower stages of ELPI was said to have a negligible effect on the drying of AS particles (P8/L188), but can lead to sufficiently fast drying of sucrose particles (P11/L239). This looks a bit contradicting to me. Please clarify.

We agree that this result was peculiar, which led to the writing of this manuscript to highlight potential artefacts observed when utilizing an ELPI and sampling from high relative humidity environments. We believe that the different properties (including but not limited to drying kinetics, hygroscopicity, solubility) of the two aerosols, due to the different compositions of the two aerosol standards used, AS (ammonium sulfate) and sucrose, may explain the results. At this point further work is needed to understand the reasons for these observations. At this time, we wanted to highlight this apparent artefact and urge caution for the ELPI and sampling from high relative humidity environments.

I think Figures 4 and 5 can be combined into one figure for easy comparison of the same species of two diameters.

We feel it is more appropriate to keep these separate to more easily highlight the electrical currents observed for each impactor stage within one type (diameter) of sucrose aerosol population.

Why 190-nm particles can reach equilibrium in water uptake and show much less particle bounce than 70-nm particles? The former should take a longer time to complete the water uptake than the latter. Furthermore, what is the residence time of those particles in the 775-L chamber?

We cannot comment on the equilibrium water uptake time, as this was never measured here. Both 70 nm sucrose particles and 190 nm sucrose particles were injected into the chamber that was already humidified to >90% relative humidity. We show that particle bounce for the 190 nm particles is shut down, but not for the 70 nm particles, because of the local relative humidity values experienced at each individual impactor stage. For 190 nm, initial impaction occurs on stages with relative humidity negligibly changed from chamber relative humidity, while for 70 nm, initial impaction occurs on stages with relative humidity significantly lower than that of chamber relative humidity. Following injection into the chamber (which itself took 30 minutes), particles were allowed to "sit" for 10 minutes.

Table 2: why are the residence times for different stages differ so dramatically? Is it related to the physical distance between consecutive stages?

Particles experience acceleration in the lower stages, and the pressure is decreased, leading to shorter residence times. The physical distance between consecutive stages is the same.

Section 3.5: what new insights does this work, using atmospherically relevant small particles, contribute to the understanding of aerosol drying? Or alternatively, does aerosol drying process help explain some observations here (as stated in the last sentence in the abstract). For the latter point, I believe the interpretation is a little bit contradicting as stated in the last general comment above. Either way, I find Section 3.5 not fitting well in the manuscript.

This manuscript is not intended to provide a new understanding of aerosol drying; rather, it is suggested as a possible explanation for the observed artefact. We do not find this necessarily contradicting, as two different aerosol standards were used: ammonium sulfate (inorganic salt), and sucrose (organic sugar), both with vastly different properties and molecular level composition.

P3/L65: suggest to use "775-L" here and some other places

775L is mentioned in L66. We would be happy to clarify this in other locations that are specified.

Figure 7: what can the inflection point RH for the SOA data set tell us?

The approximate inflection point relative humidity serves as an indicator as to when a significant change in relative particle bounce was observed.