Authors´response to the Referee 2 comments on manuscript titled " *Versatile Aerosol Concentration Enrichment System (VACES) operating as a Cloud Condensation Nuclei (CCN) concentrator. Development and laboratory characterization."* submitted to AMT 25th February 2019.

The authors would like to thank the reviewer for the helpful comments. Our responses are given in blue after each of the comments (bold characters). For a better understanding the representation of the virtual impactor in Fig. (1) was modified. In the revised MS, changes concerning the comments of the reviewers are indicated in red. Small editorial changes (such as corrections of typos, use of symbols instead of full text, etc.) are not reported here, as they are irrelevant for the scientific content of the paper.

In general, this paper does demonstrate that CCN can be concentrated fairly well within the constraints of artificially generated NaCl. Inclusion of particles other than NaCl would have added strength to the paper.

In the revised MS, results from activation curves of 100 nm and 150 nm Polystyrene Latex particles (PSL) which have a less hygroscopic behaviour are added (see Table 2 and 3; page 20). The maximum experimental enrichment factor obtained from the PSL measurements is over 16 which is very similar to the experimental enrichment factor obtained for NaCl particles. The experimental enrichment factor for 100 nm PSL particles at different ΔT is incorporated in Fig. (2) (page 16) and shows the correct performance of the new CCN-VACES performance also for less hygroscopic particles. Some recent publications were referenced that provide a detailed description of VACES operation and demonstrate its potential as particle concentrator (page 10) .

Further, the current paper employed PM over size range of 30 nm to 200 nm. It would be useful to provide discussions on the typical profile of CCN characteristics and justify the choice of experimental conditions.

More detailed characteristics of CCN have been incorporated in the manuscript (page 3, lines 14-17). The VACES modifications were performed in order to get down to the low supersaturations commonly occurring in the atmosphere. McFiggans et al. (2006) point out the complexity of ambient aerosol composition, which is relevant for CCN activation in a limited size range from ca. 30 nm up to 200 nm. Particles smaller than 30 nm are unlikely to activate and particles larger than 200 nm will activate anyway, as they normally contain enough soluble material.

Section 4.1 NaCl is used for performance testing and the text indicates that there were no changes in chemistry or physical nature of collected in PM with VACES. There are very limited discussions to cover this point.

We intentionally used NaCl for the calibration measurements, as it is a well characterized non-volatile substance. Volatile or semi-volatile material might undergo changes in the temperature range used here. A sentence to this effect was put into the MS in the introduction and also in the conclusion section. A detailed discussion of these effects, however would be far beyond the scope of this MS.

How might other hygroscopic aerosols behave in terms of size/shape impacts of growth and drying process?

Other hygroscopic aerosols would also activate according to Koehler theory at their individual critical supersaturations. Particle shape might have an influence, but Koehler theory posits spherical particles, which is usually a valid assumption, as hygroscopic particles deliquesce already at relative humidities below 100% and are spherical by the time they activate.

Section 4.2 "The order of the activation curves agrees with theory". This statement needs expansion.

An extended explanation has been incorporated in the manuscript (page 8, lines 24-29).

Further, figures seem to show quite a difference in efficiency of performance between small and larger test PM. Do the authors suggest that corrections can be made to adjust these values to account for observed differences? It also seems that at particles smaller than 30nm this could be an even larger issue. Further discussions on implications are suggested to be included.

The differences in the steepness of the slopes of the activation curves for small and larger particles is a usual feature found in many studies. As presented e.g.by Giebl et al. (2002), the activation curves (activation ratio plotted vs. dry diameter) are steeper at higher supersaturations (SS = 1.08 % and SS = 0.42%) than at lower ones. Activation curves obtained from urban aerosol (Burkart et al., 2012) show the same behaviour. An extended explanation has been incorporated in the manuscript (page 9, lines 29-30).

Section 4.3 "Further results also demonstrate that the activation curves do not depend on the inlet concentration." The concentrations of NaCl had a maximal count of 6000 /cm3 (monodisperse at 100nm). It would be useful to expand this statement to deal with what might be expected in terms of performance in real world.

In the urban background aerosol of Vienna, typical total CN concentrations lie between 1000 - 8000 #/cm^3 which corresponds to the concentrations used for the calibration, so this is the local "real world". Nevertheless higher particle number concentrations may occur in heavily polluted regions. The limiting factor here might be the available water vapour in the condenser tube(s). Earlier studies given in the experiment section, however, have not seen an effect of aerosol concentration on the enrichment factor. For example, Ntziachristos et al. (2007) used the VACES in the vicinity of the busiest US freeway in diesel truck traffic, with particle concentrations in the 30000-500000 #/cm^3 range and saw no effect in the performance of the system regarding the enrichment factor.

Ntziachristos L, Zhi N., Geller M.D., Sheesley R., Schauer J.J. and Sioutas C. "Fine, Ultrafine and Nanoparticles Trace Element and Metal Composition Near a Freeway With Heavy Duty Diesel Traffic." *Atmospheric Environment,* 41 (27): 5684 – 5696, 2007.

Conclusions can be expanded to provide recommendations for future application in real world operations and extend beyond proofs by NaCl.

As we have shown in the manuscript NaCl is a good aerosol to calibrate the CCN-VACES in terms of supersaturation. Once the CCN-VACES is set to a certain supersaturation, it will enrich CCN for further chemical analysis. A caveat has been added to the conclusions as to the possible changes of volatile particles in the temperature range of the VACES.

The closing sentences need a bit of cautionary text related to the real world applications. Especially with regards to temperature, size, chemistry issues. "Notwithstanding the strong temperature dependence, we found that the CCN VACES is a reliable instrument to activate CCN and enrich CCN concentrations at low supersaturations, provided that the temperature settings are carefully controlled."

See above.