

Interactive comment on “Investigation of water adsorption and hygroscopicity of atmospheric particles using a commercial vapor sorption analyzer” by Wenjun Gu et al.

Anonymous Referee #3

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This manuscript describes a technique for determining the mass growth factor (MGF) and deliquescence relative humidity (DRH) of compounds using a commercial vapour sorption analyser.

The authors present the methodology for determining the DRH and the MGF, followed by measurements of DRHs for different compounds/temperatures intended to confirm the RH calibration of the instrument. They then present measurements of the mass hygroscopic growth of ammonium sulphate and sodium chloride at two different temperatures, followed by calcium sulphate dihydrate which is used as a mimic for a low hygroscopicity species.

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In Lines 94-97, the authors note that two groups have already reported measurements using a similar technique, but that the novelty of their manuscript lies in the fact that it systematically evaluates the performance of the technique which has not been done before. I believe the manuscript is suitable for publication in AMT only after the concerns regarding the rigour of this validation included in the list below are adequately addressed.

(Line 1-2) The title of the manuscript is factually incorrect. The paper reports water adsorption and hygroscopicity of atmospherically relevant compounds, not of atmospheric particles (ie. sampled directly from the atmosphere). This should be changed.

(Lines 67-72) The authors say the strength of the technique is the ability to make measurements on non spherical particles, which can be problematic for some of the more commonly used techniques which make measurements on species in the aerosol phase. However, the authors do not mention any of the drawbacks of looking at the hygroscopic behaviour of particles on a hydrophilic surface, in that they will not be able to access supersaturated solute states or determine the efflorescence RH.

(Line 155-156) The authors state that the RH can be varied between 0 and 98% with an absolute accuracy of $\pm 1\%$ as measured by a probe. Can the authors provide any details on the type of probe used here? Capacitance probes typically used for RH determination can be expected to have an accuracy of $\pm 2\%$ at RHs below 80%, but the error can climb to $\pm 3\%$ at RHs above this. These are obviously significantly larger than the quoted value.

(Line 177-181) If the authors are measuring the DRH why does the experimental method involve setting the RH higher than the DRH and then lowering it slowly? If there is no lag between slowly changing the desired RH in the software and this value equilibrating in the chamber (the authors do not mention one), why can the measurement not be performed by increasing the RH slowly from a value below the DRH? This way you would get a lot more data which would actually visualise the step change in

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mass as the particle deliquesced.

Figure 2. Error bars in the RH (from the absolute accuracy of the probe stated in line 156) need adding to this plot.

Table 1 and Table 2. DRH values determined from this work need an associated error originating from the probe accuracy.

Figure 3. Errors bars in RH are included for the DRH reference data but not for the DRH values determined in this work. These need adding to the plot. Also, the authors should comment on the systematic disagreement between the data as a function of temperature which can be seen in panel b).

Figure 4. There are not enough data points on the graphs here to use them as a validation of the technique. In each panel all but one of the data points are on the flat region of the hygroscopic curve and there are no data at all either side of the deliquescence event, which is actually the region of interest. Further data points need adding to each plot which show a clear tracing out of the deliquescence region and more data points should also be added at high RH as this is the region most relevant to activation of aerosol in the atmosphere. Error bars in the RH (from the probe) should be included. The authors should also comment on the fact that the ammonium sulphate data at both temperatures deviates from E-AIM at high RH.

Figure 5 panel b) The raw mass data shows frequent dips and spikes. What is the origin of this?

(Line 314) Is this number supposed to be 0.025%?

(General comment) The authors say the greatest advantage of this technique is the ability to look at non-spherical particles, however they report no measurements (even preliminary ones) of non spherical particles here. The impact of this manuscript would be much higher if some were to be included.

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