Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
https://doi.org/10.5194/amt-2021-90-RC2, 2021

Comment on amt-2021-90

Anonymous Referee #2

Referee comment on "Rapid measurement of RH-dependent aerosol hygroscopic growth using a humidity-controlled fast integrated mobility spectrometer (HFIMS)" by Jiaoshi Zhang et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-90-RC2, 2021

The manuscript by Zhang et al. entitled as 'Rapid measurement of RH-dependent aerosol hygroscopic growth using a humidity-controlled fast integrated mobility spectrometer (HFMIS)' introduces a novel technique to measure hygroscopic growth of atmospheric aerosol particles with high time resolution. The instrument is developed using the humidity-controlled fast integrated mobility spectrometer, which the authors have previously developed. The developed instrument is capable to measure hygroscopic growth of aerosol particles with the high time resolution, which is difficult to be achieved by other techniques such as the HTDMA. The performance of the instrument was validated using ammonium sulfate and ambient particles in an urban area. The manuscript is well written. The topic is within a scope of the journal. The reviewer suggests accepting this manuscript after addressing the following minor comments.

L57: 'hygroscopic growth measurements to a wide range of RH conditions (20% to 85%).
'

HFIMS is capable to measure hygrscopicity of aerosol particles for the range of 20% ≤ RH ≤ 85%. I was wondering if the instrument can be operated at RH > 85%, as higher RH is generally more important for investigating water uptake properties. It will be useful if there is a detailed information about limiting factors for conducting measurement at elevated RH. Such information will help readers to think about future approaches in improving hygroscopicity measurements.

L70: ‘Lopez-Yglesias et al. (2014) used a “membrane-less” diffusion-based humidifier to accelerate the transition between sample RH setpoints. In their HTDMA, it takes about 4 min for the system to stabilize for a 5% - 20% (absolute value) change in the RH setpoint.’

The idea of using two nafion tubing for rapid RH control is great. At the same time, I wondered the reason why the authors did not use the membrane-less diffusion-based humidifier if it is capable to change RH rapidly.

L73: ‘In the HFIMS, the sample aerosol is first dried to below 20% RH by a Nafion dryer’

Some organic aerosol particles that do not experience efflorescence might still retain measurable amount of water at the corresponding RH. It would be good if the authors could provide the reason why the criteria of ‘below 20%’ has been chosen.

L91: ‘The dynamic range of WFIMS is roughly a factor of 10 in mobility, which enables it to detect growth factors from 0.8 to 2.4 at a single separator voltage.’

I was wondering how the ‘factor of 10 in mobility’ in dynamic range could be translated to the variability in growth factor of 0.8 to 2.4 (probably because of large slip correction factors for smaller particles?). It would be better if this sentence could be rewritten in a clearer way.

L95: ‘The total flow rate of the humid and dry air flows is 18.0 LPM, slightly above the WFIMS sheath flow rate of 14.9 LPM, and the excess is exhausted.’

Is there a reason why 18.0 Lpm of humidified flow needs to be prepared? I wondered why this approach was selected, rather than generating 14.9 lpm of humidified air directly

using the mass flow controllers.

L98: ‘The sample flow rate is monitored and maintained at 0.3 LPM through adjusting the sheath flow rate using a proportional solenoid valve (0248A, MKS Instruments) driven by a PID controller.’

Could particle loss occur in the proportional valve?

L122: ‘which are controlled by mass flow meters’

Did the authors use mass flow controllers or mass flow meters?

L123: ‘This approach leads to a faster control and stabilization of RH than in the Nafion exchanger.’

It was not clear why this approach provides faster response. Please clarify.

L160: ‘At an RH of 85% or lower, the maximum range of growth factor (i.e., the ratio of humidified particle diameter to that of dry particles) for atmospheric aerosols is 0.8-2.0 (Gysel et al., 2007). For example, for dry particles of 35 nm, the diameter of humidified particles ranges from 28 to 105 nm. For the next dry size of 165 nm in the sequence, the possible size range of humidified particles is between 132 and 495 nm.’

The range of 28 to 105 nm corresponds to hygroscopic growth factor of 0.8~3.0. similarly, the measurable range of hygroscopic growth for 165 nm (132 – 495 nm) corresponds to growth factor of 0.8~3.0. It would be better to explicitly mention the range of hygroscopic growth factors (rather than showing diameters) so that the readers can easily compare the measurement range for the present study with Gysel et al. (2007).

L239: 'The variation of GF-PDF suggests that the pre-existing aerosol changed from one that was dominated by aged particles with large contribution of inorganics (e.g., sulfate) to a mixture of both aged particles and freshly emitted ones that consisted mostly of organics with low hygroscopicity'

I wondered if the authors have any evidence to support the idea that freshly emitted less hygroscopic particles are mostly composed of organic species. There might have been some contributions of soot (or elemental/black carbon) particles (McMurry et al., 1996)

Figure 6: Figure captions are overlapping with data for panels (d1 – d3).

References

McMurry, P. H., Litchy, M., Huang, P.-F., Cai, X., Turpin, B. J., Dick, W. D., & Hanson, A. (1996). Elemental composition and morphology of individual particles separated by size and hygroscopicity with the TDMA. *Atmospheric Environment, 30*(1), 101-108.