

# Hygroscopicity of sub-30 nm DMA-sulfuric acid mixture particles in sub-saturated conditions – comparison of model predictions and measurements

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Hygroscopicity, i.e. the ability to take up water, regulates particles' capability to act as condensation nuclei for cloud droplets. Hygroscopicity can also rest on the water content of particles in sub-saturated conditions and thereby affect on the uptake of various vapors along the growth of secondary aerosol particles towards climate relevant sizes. Since the hygroscopic properties of the particles depend on the particle composition, hygroscopicity can offer indirect information about the composition of ambient or laboratory aerosols.

Dimethylammonium and sulfate ions have been found in the particle phase during the growth of secondary aerosol particles (e.g. Smith *et al*, 2010). Therefore, knowledge of the hygroscopicity of dimethylammonium sulfate (DMAS) nanoparticles is needed for simulating the growth of DMAS containing nanoparticles and, if hygroscopicity measurements are used, for interpreting the composition of such particles. While the thermodynamics of DMAS containing aerosol is included in thermodynamic models, the models are tested against large particles or bulk systems (e.g. Clegg *et al*, 2013). Here we test the performance of a state of the art thermodynamic model in capturing the hygroscopicity of spherical DMAS particles whose dry diameter is between 10 and 30 nm.

We used the nano-HTDMA system (i.e. Hygroscopic Tandem Differential Mobility Analyzer which is designed for sub-50 nm particles) to measure the hygroscopic growth factors (HGF, wet-to-dry particle diameter ratio) of DMAS particles in sub-saturated conditions. Measurements were performed with varying DMA and sulfuric acid molar ratios of the atomized solution. Particle dry diameters between 10 and 30 nm and RH between 20-90% were selected for the experiments. Particle composition was measured with a HR-ToF-AMS to reduce the uncertainty in experimental results due to e.g. DMA evaporation. The uncertainties of the measurements will be discussed more in detail in our presentation.

The measurements were compared to model calculations done with E-AIM (Clegg *et al*, 1998). E-AIM is a bulk thermodynamic equilibrium model of the gaseous and particulate phases which has the particle phase acid-base chemistry built in it. E-AIM represents the current state of the art thermodynamic modelling of amine containing aerosol particles.

In figure 1, we show two examples of our preliminary results where the measured and modelled HGFs are plotted as a function of the particle composition. The initial dry diameter of the particles was

15 nm in both RH. As the RH increases and the particles take up more water the difference between the modelled and measured hygroscopic growth factors increase. The model captures the HGF dependence on the RH quite well, however it does not seem to capture the composition dependence correctly. For the most acidic particles, the model overestimates the HGF, while for the least acidic particles at high RH the model underestimates the HGF.

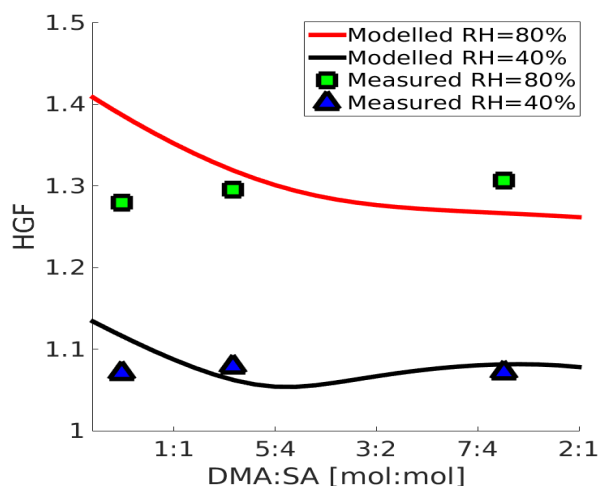


Figure 1. Preliminary results showing the measured and modelled HGF at 40% and 80% RH as a function of the particle composition. The initial dry diameters of the particles were 15 nm.

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