Supplementary Material

Derivation of Equation (1)

The vapor pressure of water over an aqueous solution droplet is given by the following expression of the Köhler equation (Köhler, 1936):

$$s = a_w \exp\left(\frac{4\sigma V_{m,w}}{RTD_{aq}}\right), \qquad \text{(S1)}$$

where s is the saturation ratio relative to a flat surface of liquid water, a_w is the water activity of the solution, σ is the solution-vapor surface tension, $V_{m,w}$ is the molar volume (M/ρ where M is molecular weight and ρ is density) of pure water, R is the universal gas constant, T is the solution temperature, and D_{aq} is the aqueous particle diameter.

The water activity for a multi-component solution following Raoult's law is given by:

$$a_w = \frac{n_w}{n_w + \sum\limits_{k \in \{\text{AS},\text{ORG}\}} i_k n_k}, \qquad \text{(S2)}$$

where n_w is the number of moles of water, n_k is the number of moles of species k in solution, and i_k is the corresponding van't Hoff factor. Species k = "AS" refers to the ammonium sulfate seed, and species k = "ORG" refers to the organic component of the particle. Semi-ideality of the solution is assumed such that the solutes may interact with the solvent but not with each other (Stokes and Robinson, 1966). Moreover, the van't Hoff factor of the organic component (i_{ORG}) is taken as unity, implying that the organic component does not interact with water.

Assuming fully soluble behavior at activation, which is an appropriate assumption following results from King et al. (2007), n_k is calculated as:

$$n_k = \frac{\pi D_{geo,dry}^3 \varepsilon_k V_{m,k}^{-1}}{6}, \qquad \text{(S3)}$$

where ε_k is the volume fraction of species k in the dry particle, $V_{m,k}$ is the molar volume of species k in the dry particle, and $D_{geo,dry}$ is the dry geometric diameter of the particle. Replacing n_k in Eq. (S2) with Eq. (S3), we obtain:

$$a_w = n_w \left(n_w + \frac{\pi D_{geo,dry}^3}{6} \sum_{k \in \{\mathrm{AS,ORG}\}} i_k \varepsilon_k V_{m,k}^{-1} \right)^{-1} . \tag{S4}$$

Substitution of Eq. (S4) into Eq. (S1) leads to Eq. (1) of the paper, for which n_w and D_{aq} are related assuming an additivity of volumes, i.e., $(\pi/6) D_{aq}^3 = (\pi/6) D_{geo,dry}^3 + n_w V_{m,w}$.

Table S1. Observed activated fractions (F_a) at each CCNC supersaturation (%), for all measured organic mass loadings (μg m^{-3}). Uncertainties in supersaturations are ±4.6% of the base values (King et al., 2007).

Organic mass loading (μg m^{-3})	Diameter (nm) DMA$_2$	Supersaturation (%)	Activated fraction, F_a
≥ 95.2	80	0.081	0.000
		0.130	0.007
		0.178	0.046
		0.226	0.180
		0.275	0.343
		0.323	0.480
		0.372	0.811
		0.420	1.008
		0.468	1.003
		0.565	0.989
	100	0.081	0.017
		0.130	0.061
		0.178	0.246
		0.226	0.397
		0.275	0.610
		0.323	0.929
		0.372	1.009
		0.420	0.975
		0.468	1.000
		0.565	1.016
15.4	80	0.081	0.000
		0.130	0.005
		0.178	0.046
		0.226	0.174
		0.275	0.329
		0.323	0.482
		0.372	0.821
		0.420	0.998
		0.468	0.997

		0.565	1.005
	100	0.081	0.004
		0.130	0.044
		0.178	0.170
		0.226	0.338
		0.275	0.625
		0.323	0.957
		0.372	1.000
		0.420	1.009
		0.468	0.977
		0.565	1.014
6.97	80	0.081	0.000
		0.130	0.003
		0.178	0.027
		0.226	0.150
		0.275	0.321
		0.323	0.464
		0.372	0.807
		0.420	0.983
		0.468	1.000
		0.565	0.998
	100	0.081	0.001
		0.130	0.021
		0.178	0.114
		0.226	0.319
		0.275	0.611
		0.323	0.917
		0.372	1.005
		0.420	1.010
		0.468	0.991
		0.565	0.994
5.01	80	0.081	0.000
		0.130	0.004
		0.178	0.040
		0.226	0.151
		0.275	0.293
		0.323	0.560

		0.372	0.909
		0.420	1.001
		0.468	1.007
		0.565	0.992
	100	0.081	0.001
		0.130	0.015
		0.178	0.109
		0.226	0.361
		0.275	0.713
		0.323	0.972
		0.372	1.018
		0.420	1.002
		0.468	0.982
		0.565	0.998
2.90	80	0.081	0.000
		0.130	0.003
		0.178	0.023
		0.226	0.139
		0.275	0.309
		0.323	0.455
		0.372	0.824
		0.420	0.994
		0.468	1.005
		0.565	1.001
	100	0.081	0.004
		0.130	0.021
		0.178	0.144
		0.226	0.386
		0.275	0.678
		0.323	0.955
		0.372	1.023
		0.420	0.996
		0.468	0.987
		0.565	0.994
1.74	80	0.081	0.000
		0.130	0.005
		0.178	0.028

		0.226	0.169
		0.275	0.414
		0.323	0.608
		0.372	0.908
		0.420	1.012
		0.468	1.002
		0.565	0.986
	100	0.081	0.003
		0.130	0.027
		0.178	0.176
		0.226	0.540
		0.275	0.790
		0.323	0.994
		0.372	1.006
		0.420	1.004
		0.468	0.983
		0.565	1.008
1.24	80	0.081	0.000
		0.130	0.003
		0.178	0.027
		0.226	0.158
		0.275	0.406
		0.323	0.696
		0.372	0.945
		0.420	1.007
		0.468	1.001
		0.565	0.992
	100	0.081	0.003
		0.130	0.024
		0.178	0.270
		0.226	0.682
		0.275	0.912
		0.323	0.995
		0.372	1.007
		0.420	1.006
		0.468	0.980
		0.565	1.006

0.95	80	0.081	0.000
		0.130	0.009
		0.178	0.046
		0.226	0.284
		0.275	0.621
		0.323	0.872
		0.372	0.992
		0.420	1.015
		0.468	0.997
		0.565	0.988
	100	0.081	0.006
		0.130	0.032
		0.178	0.377
		0.226	0.833
		0.275	1.000
		0.323	1.012
		0.372	1.009
		0.420	0.990
		0.468	0.983
		0.565	1.007

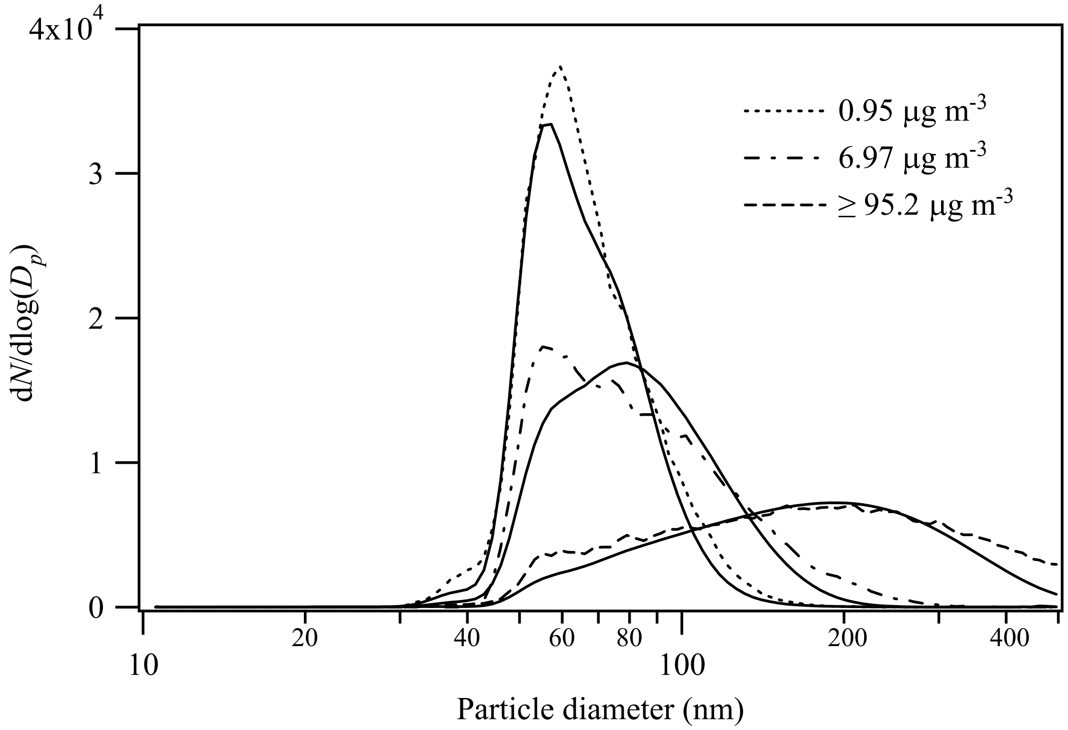

Figure S1. Comparison between observed steady-state size distributions (dashed and dotted lines) and those modeled using the approach of Seinfeld et al. (2003) as described in Eqs. (7) and (8) (solid lines). The distributions shown are for three different mass loadings that represent the range of those used in this study and are the same as those in Fig. 4.

Literature Cited

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