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Size-dependent hygroscopicity of levoglucosan and D-glucose aerosol nanoparticles

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Table

Table S1. Substances and their physical properties used in this work.

Chemical compound	Chemical formula	Molar mass [$gmol^{-1}$]	Density [$g\ cm^{-3}$]	Solubility mol/kg	Solution surface tension [$J\ m^{-2}$]	Manufacture
Levoglucosan	$C_6H_{10}O_5$	162.141	1.69	8.23[a] (20°C)	0.073[b]	Sigma-Aldrich, 99.99%
D-glucose	$C_6H_{12}O_6$	180.16	1.562	5.69[c]	0.072	Sigma-Aldrich, 99.99%

[a]Zamora et al (2011)

[b] Tuckermann and Cammenga (2004)

[c]Ruegg and Blanc (1981)

Table S2. Coefficients (a, b, c) of the fitted growth curve parameterization to measured growth factor data using Eq. (3). Measured growth factors of initial dry diameter used in Eq. (1) were firstly corrected for the Kelvin effect.

Chemical compounds	*a*	*b*	*c*
Levoglucosan	0.45602	-0.69869	0.44755
D-glucose	0.30189	-0.38796	0.30478

Table S3. Equations for KD fit water activity a_w of levoglucosan and D-glucose at 298K, respectively. Here x is the molality (mol kg^{-1})

Chemical compounds	Equations
Levoglucosan	$y = 1.97 * 10^{-9} * x^4 - 7.923 * 10^{-7} * x^3 + 0.0001469 * x^2 - 0.01649 * x + 0.9931$
D-glucose	$y = \frac{0.472*x^2+4.065*10^4*x+9.655}{x^3+884.4*x^2+4.063*10^4*x-0.5678}$

Table S4. Calculation of the ratio of gas-phase concentration to the total concentration for levoglucosan nanoparticles in the different sizes.

Levoglucosan diameter (nm)	The ratio of gas-phase concentration to the total concentration [a]
100	0.000811
60	0.000833097
20	0.023217028
15	0.177992638
10	0.328220471

[a] See S1 section below

Figure

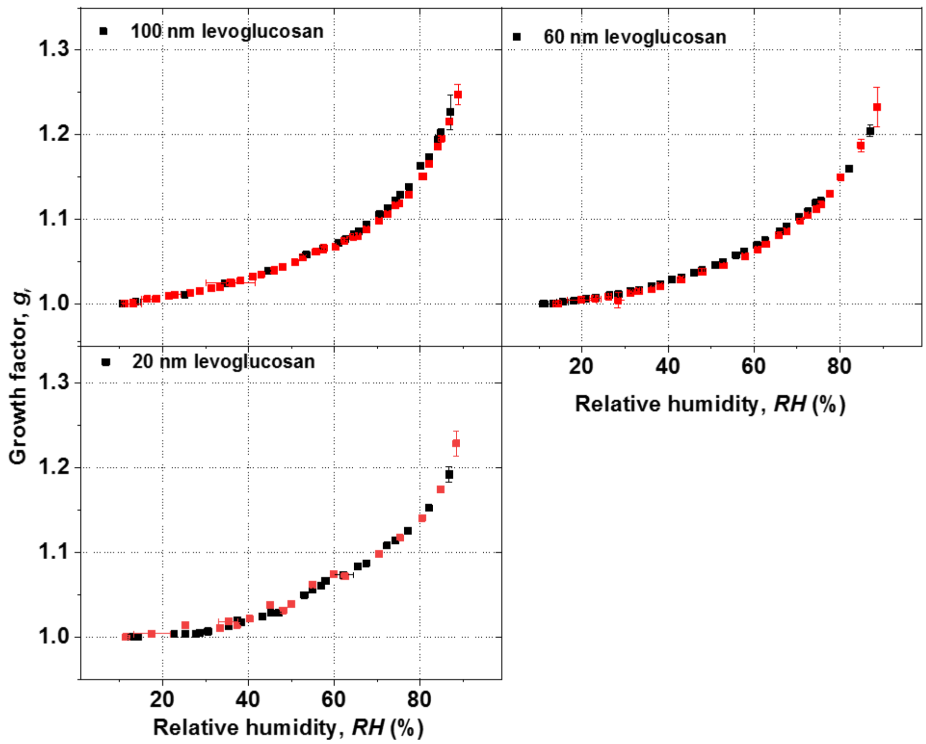

Figure S1. Mobility-diameter hygroscopic growth factors (g_f) of levoglucosan aerosol nanoparticles with dry mobility diameter from 20 to 100 nm in the deliquescence mode (black square and error bar) and the efflorescence mode (red square and error bar).

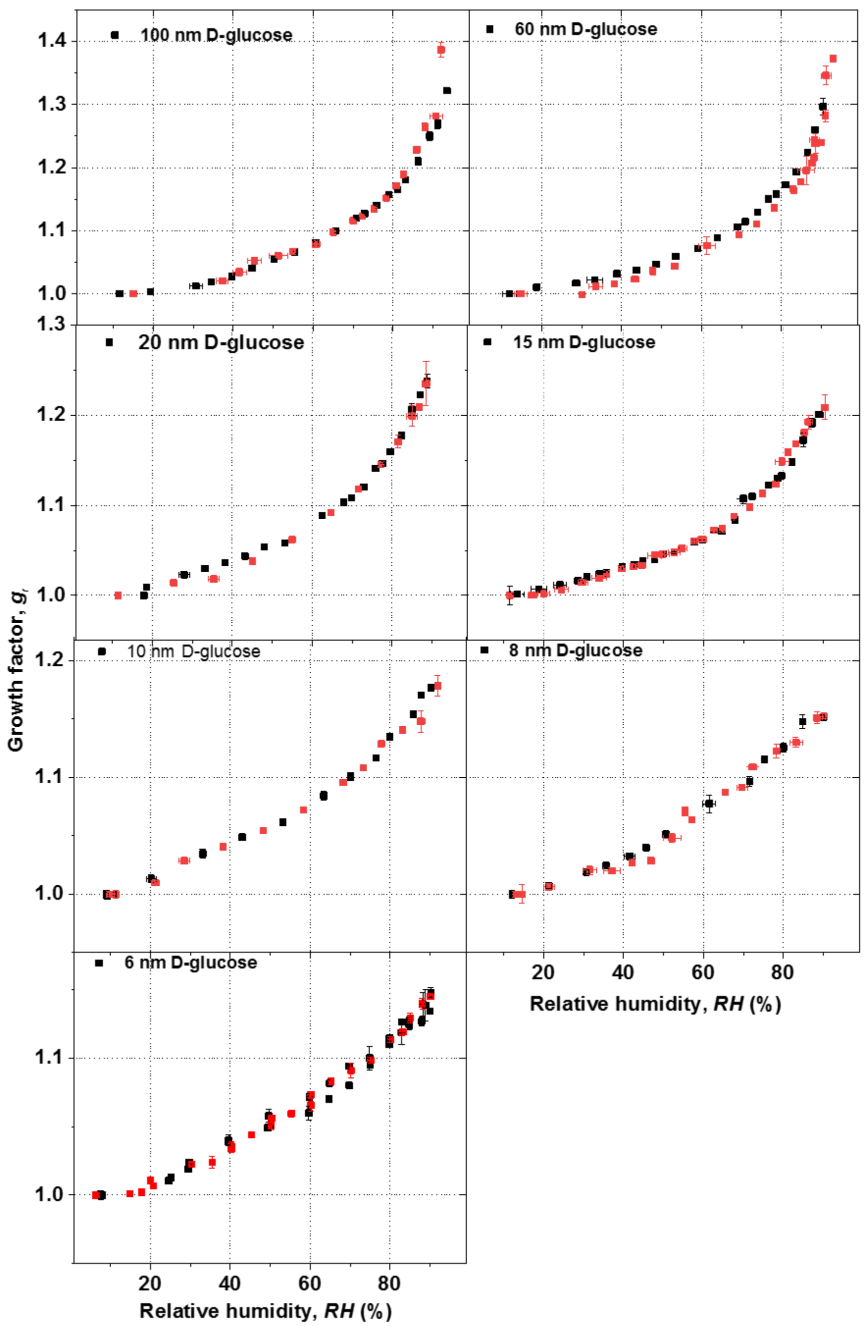

Figure S2. Mobility-diameter hygroscopic growth factors (g_f) of D-glucose aerosol nanoparticles with dry mobility diameter from 6 to 100 nm in the deliquescence mode (black square and error bar) and the efflorescence mode (red square and error bar).

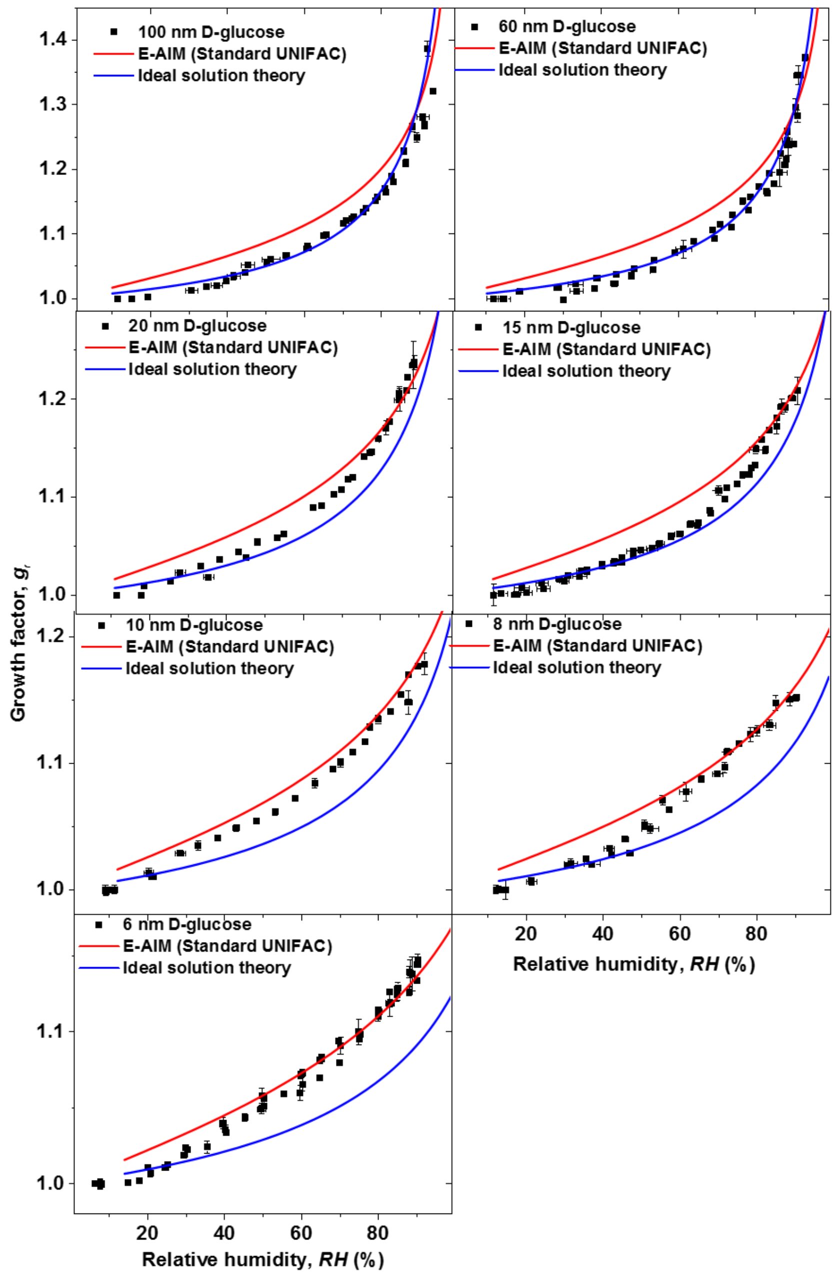

Figure S3. Mobility-diameter hygroscopic growth factors (g_f, black squares) of D-glucose aerosol nanoparticles with dry mobility diameter from 100 down to 6nm in both deliquescence and efflorescence modes. In comparison, E-AIM (Standard UNIFAC) (red line) and Ideal solution theory (blue line) predict growth factors of D-glucose aerosol nanoparticles.

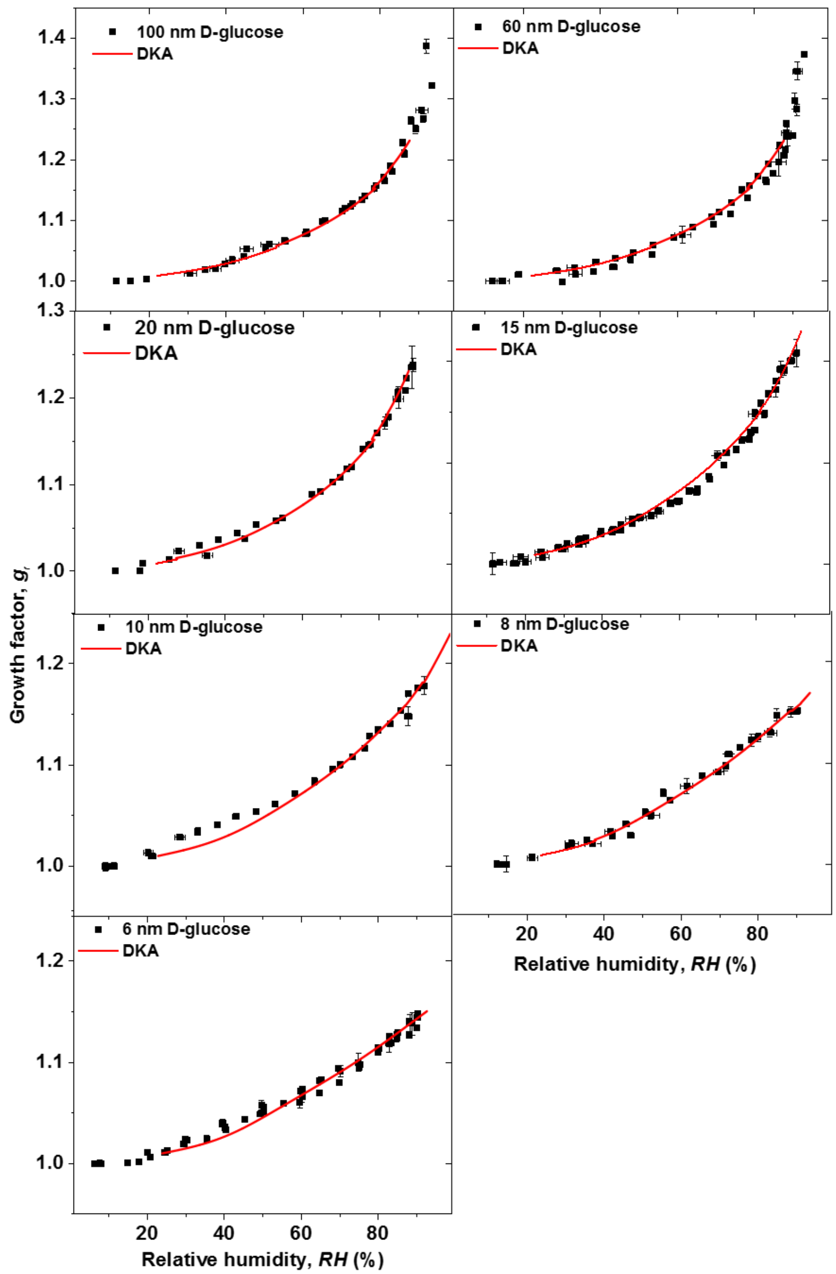

Figure S4. Mobility-diameter hygroscopic growth factors (g_f, black squares) of D-glucose aerosol nanoparticles with dry mobility diameter from 100 down to 6nm in both deliquescence and efflorescence modes. In comparison, DKA model (red line) predict growth factors of D-glucose aerosol nanoparticles.

S1. Calculation of ratio of gas-phase concentration to the total concentration

S1.1 Calculation of gas-phase concentration (g/cm^3)

$$P_A = P_A^0 exp\left(\frac{2\sigma M}{RT\rho_l R_p}\right) \quad \text{(S1)}$$

$$m_{gas} = \frac{PVM}{RT} \quad \text{(S2)}$$

where P_A and P_A^0 are vapor pressure, equilibrium vapor pressure, respectively. σ, M , $\rho_l, and\ R_p$ mean surface tension, molecular weight of the substance, liquid-phase density, and a droplet of radius, respectively. This equation (Eq. 8) shows a relationship between mass in gas phase (m_{gas}) and pressure (*P*), volume (*V*), mole mass (*M*), the ideal gas constant (*R*), and temperature. Here, Vapor pressure *(P*) is equal to saturated ratio of levoglucosan vapor multiplied saturated levoglucosan vapor pressure at 293.15 K.

S1.2 Calculation of total concentration of generated particles (g/cm^3)

$$m_{total} = \frac{dN}{dlogD_p} \times dlogD_p \times \frac{\pi}{6} D_p^3 \times \rho \quad \text{(S3)}$$

where dN is particle concentration, D_p is the particle diameter, and ρ is the density of particles.

S1.3 Ratio of the gas-phase concentration to the total concentration of generated particles

$$Ratio = \frac{m_{gas}}{m_{total}} \quad \text{(S4)}$$