Supplementary Material

A. NMASS CPC dimensions

Table S1: Key dimensions of the NMASS CPC unit

Component	Length (mm)	Inner Diameter (mm)	Outer Diameter (mm)
Sample inlet	31.6	11.0	15.9
Saturator (post capillary)	22.9	14.8	31.8
Condenser	59.5	13.4	31.8
Optics nozzle	24.1	18.9	34.2
Aerosol Injector Tube 1	49.2	3.8	3.0
Aerosol Injector Tube 2	43.0	6.0	7.0
Capillary tube	19.1	0.83	1.07

B. Kelvin Diameter Calculations

The saturation vapour pressure at the saturator and condenser temperatures (T_{sat} and T_{cond}) is given either by Eq. S1 in the case of diethylene-glycol and Fluorinert, or Eq. A2 in the case of n-butanol, where T in both cases is the temperature in Kelvin:

$$log_{10}P_s = a - \frac{b}{T-c} \quad \text{(S1)}$$

$$log_{10}P_s = \frac{-52.3b}{T} + c, \quad \text{(S2)}$$

where a, b, and c are empirical coefficients (Table S1). Following Baron and Willeke (2001) Baron and Willeke (2001), the surface tension, γ, and molar volume, ν, (Table S1) are used to relate the saturation vapour pressure on a droplet surface to D^*, as given by equation 3 (Hinds, 1999):.

$$D^* = \frac{4\nu\gamma}{RTln\left(\frac{P_S(T_{sat})}{P_S(T_{cond})}\right)}. \quad \text{(S3)}$$

Table S2. Material properties of n-butanol, diethylene glycol and Flourinert FC-43 for calculating the Kelvin diameter.

	Surface Tension mN m^{-1} at 25°C	Molar Mass g mol^{-1}	Mass Density g cm^{-3} at 20-25 °C	a	b	c
Butanol	24.2[1]	74.12[1]	0.81[2]	-	46.78[3]	11.26[3]
Diethylene-Glycol	55.1[5]	106.12[4]	1.114[5]	7.7007954[6]	2019.25[6]	-99.494[6]
Flourinert, FC-45	16[7]	670[8]	1.860[8]	10.511[8]	2453[8]	0[8]

1.The Dow Chemical Company (2012), 2. National Center for Biotechnology Information 3. Baron and Willeke (2001), 4. Macdonald and Lide (2003), 5. Yaws (2008), 6.MEGlobal (2005), 7. 3M Electronics (2009), 8. 3M Performance Materials (2000)

C. Orifice Changer for Pressure Control System

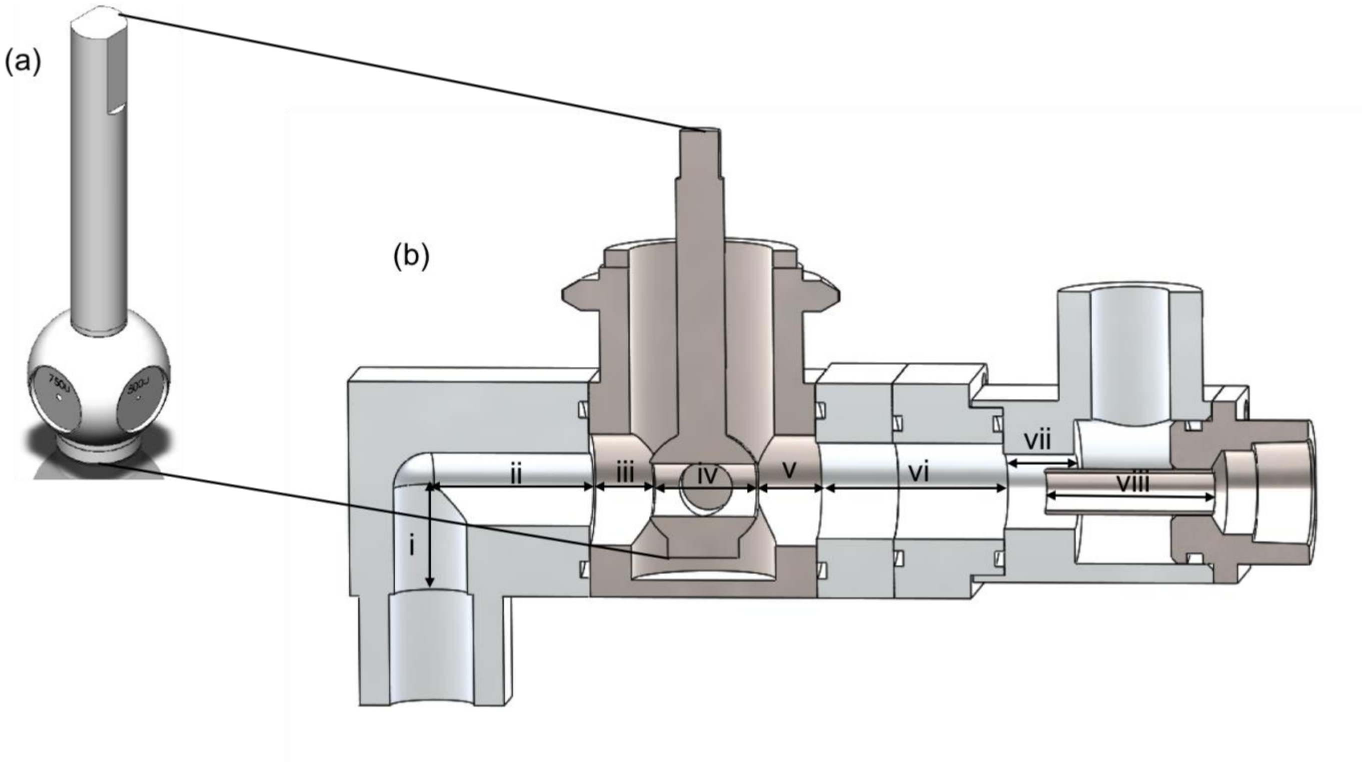

Fig.S1 Schematic of the orifice changer system used to keep internal pressure of the NMASS at 120 hPa while ambient pressure varies between 200 and 1034 hPa. Two orifices are brazed onto a drilled-out ball valve (a), which is turned by a Hanbay actuator depending on the upstream pressure. A pressure reducing inlet (b) based on the University of Minnesota design (Lee et al., 1993) (right) joins onto the orifice system to bring sample flow to the CPCs with minimised particle losses. Key dimensions are given in table S3.

Table S3. Key dimensions of the orifice changer for pressure control system

Part	Length (mm)	Inner Diameter (mm)
i	14.0	9.7
ii	21.1	9.7
iii	8.3	14.7
iv*	30.0	9.7
v	8.3	14.7
vi	24.8	12.7
vii	9.4	9.9
viii	22.2	5.0

*these are the dimensions of the path of the flow through the ball valve

D. Nano-DMA sizing uncertainties

Table S4. Nano-DMA parameters and uncertainties used to calculate calibration diameter uncertainties for the NMASS calibrations.

Parameter	Mean	Uncertainty
Sheath Flow (lpm)	5.1	0.1
Aerosol Pressure (mb)	917	1
DMA voltage (V)	200	0.5%
DMA column outer diameter (m)	0.03613	2.54e-5
DMA column inner diameter (m)	0.0312	2.54e-5
DMA column length (m)	0.34054	2.54e-5

E. Monte Carlo simulations

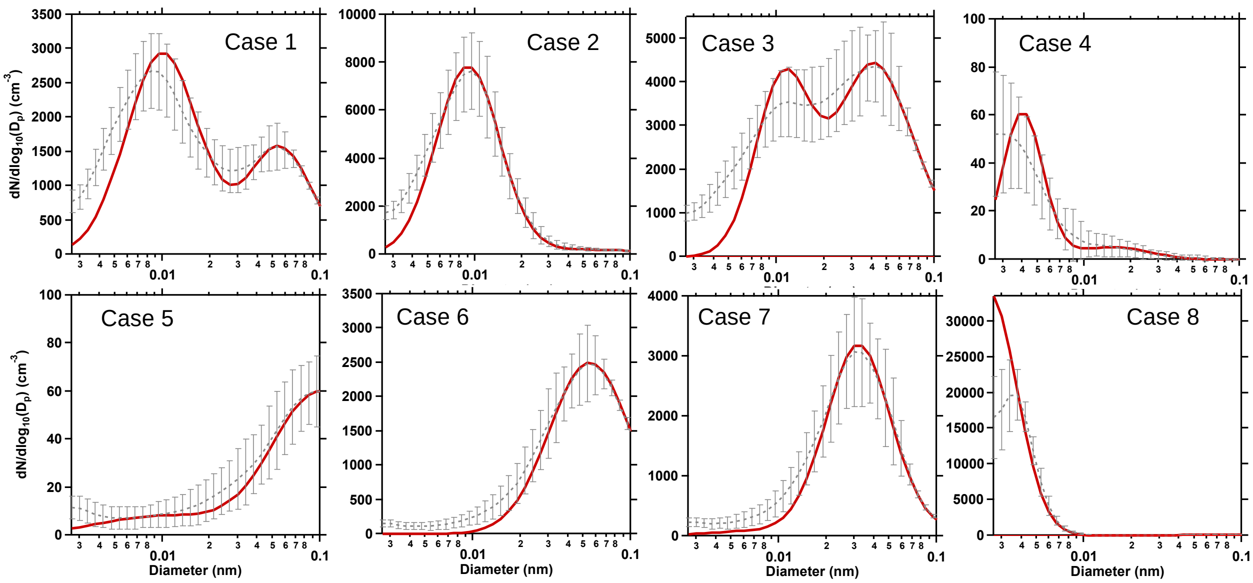

Fig. S2. Lognormal size distributions described by parameters in Table 2 of main text (solid red line), and mean and standard deviation from 1000 Monte Carlo simulations of inversion of instrument response calculated from the lognormal size distribution. Noise was added to each of the simulated instrument responses (CPC concentrations) to represent counting and concentration uncertainties. The instrument response curves (Fig. 5 in the main text) were also independently shifted in diameter by an amount equal to the observed variation during multiple calibrations.

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