Supplementary Material for

Deriving the hygroscopicity of ambient particles using low-cost optical particle counters

by

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Table S1: The compared sensors in AQB and instruments of EPA for every species.

	AQB	EPA
T, RH	Seeed (SHT31)	Metone (083D)
CO	Alphasense (CO-B4)	HORIBA (APMA360)
NOx	Alphasense (NO-B4) for NO Alphasense (NO2-B431) for NO_2	ECOTECH (ML9841)
O_3	Alphasense (OX-B431)	ECOTECH (ML9810)
SO_2	Alphasense (SO2-B4)	ECOTECH (ML9850)
VOC	Alphasense (PID-AH2)	Horiba (APHA 360)
PM	Alphasense (OPC-N2)	METONE (BAM1020)

Table S2: The hygroscopicity, molecular weight, and density of salts used in hygroscopicity deriving.

salt	$(NH_4)_2SO_4$	$(NH_4)HSO_4$	NH_4NO_3	$NaNO_3$	$NaCl$
hygroscopicity	0.61	0.7	0.67	0.88	1.28
molecular weight (g mol^{-1})	132	115	80	85	58.5
density (g cm^{-3})	1.70	1.78	1.72	2.26	2.17

Table S3: The correlation coefficient (r) for measured parameters between two AQB systems and between AQB #1 and TW-EPA Nanzi station

r	AQB #1 vs AQB #2	AQB #1 vs TW-EPA
T	0.958	0.948
RH	0.949	0.932
CO	0.995	0.976
NO	0.976	0.624
NO_2	0.944	0.504
Ox (NO_2+O_3)	0.979	0.961
VOC	0.675	-0.373
SO_2	0.973	0.343
$PM_{2.5}$	0.978	0.689
PM_{10}	0.967	0.483

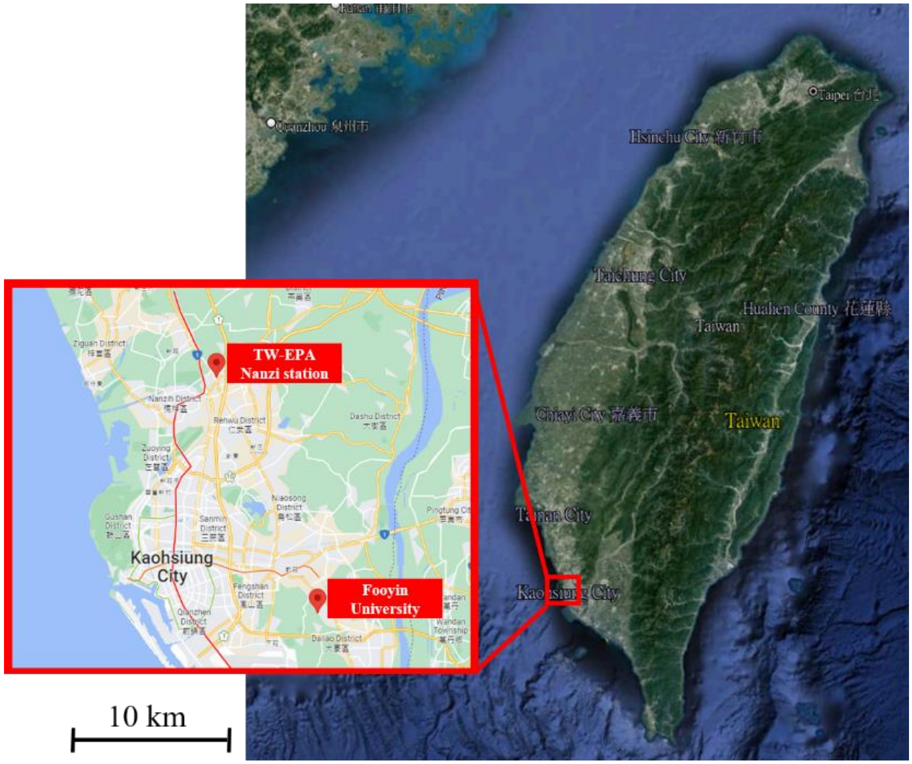

Figure S1. Location of TW-EPA Nanzi station (calibration campaign) site and Fooyin University (sampling campaign). (from © Google Earth 2024 and © Google Maps 2024)

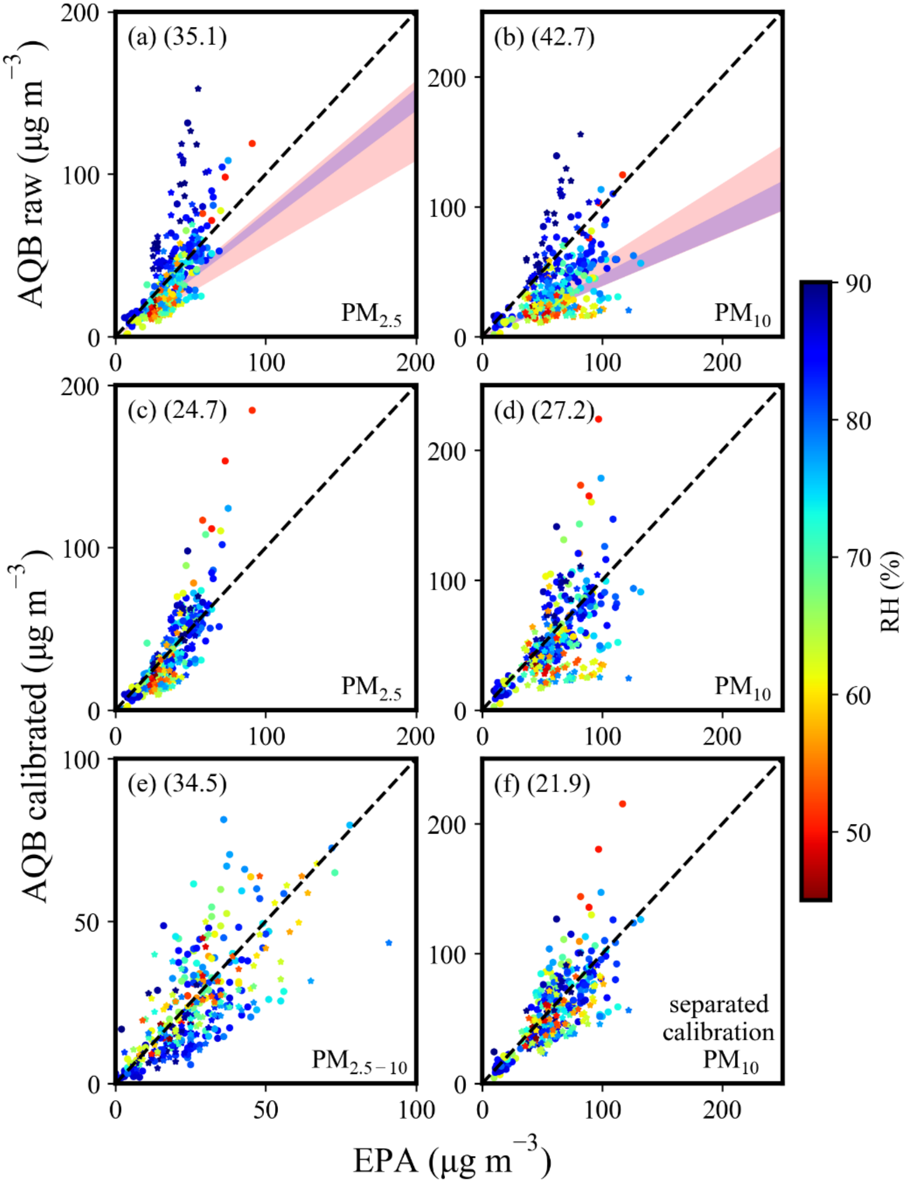

Figure S2: The correlation of mass concentration between EPA and OPC in AQB #2: (a, c) $PM_{2.5}$, (b, d) PM_{10}, (e) $PM_{2.5\text{-}10}$, and (f) separated calibration PM_{10}. (a, b) are the raw data, while (c, f) are the calibrated data. Marker color corresponds to relative humidity. The shaded region corresponds to the sensitivity coefficient ("α"). The data show the first period (red paved/circle points) and the second period (purple paved/star points). The value in parentheses is the MAPE in percentage.

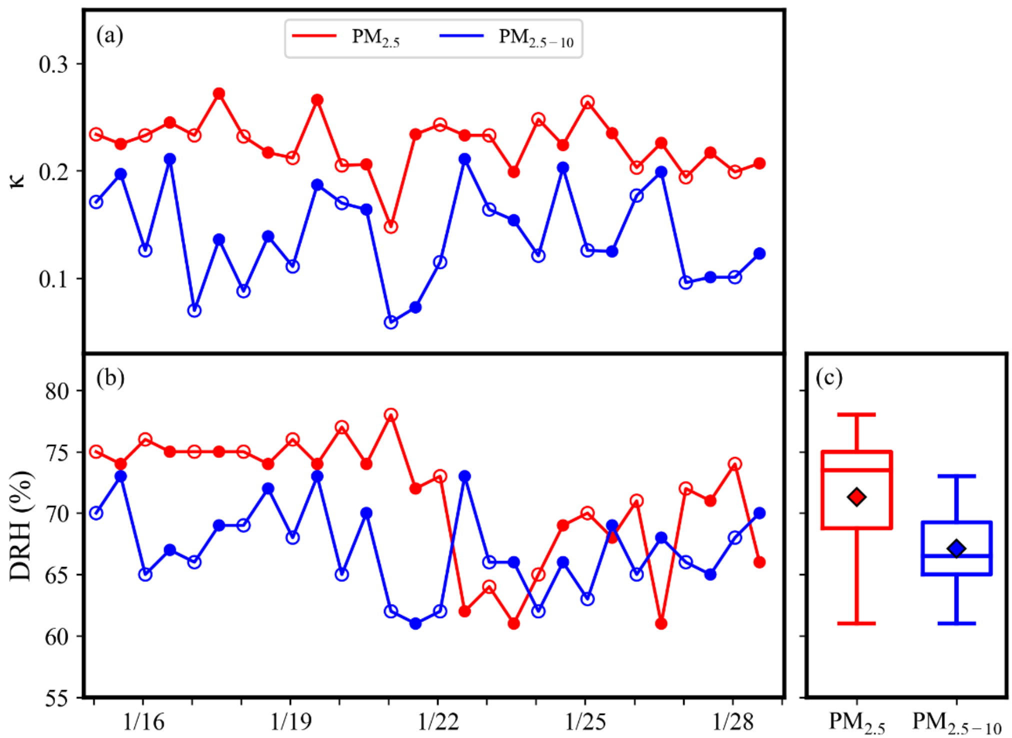

Figure S3: The temporal profiles of (a) derived κ by ion chromatography and (b) DRH determined from E-AIM and (c) box-plot distribution for the 2013 winter campaign period. (hollow circle: daytime samples; solid circle: nighttime samples; diamond: mean value; outliers: < 1st quartile Q1-1.5 interquartile range (IQR) or > 3rd quartile Q3+1.5 IQR).

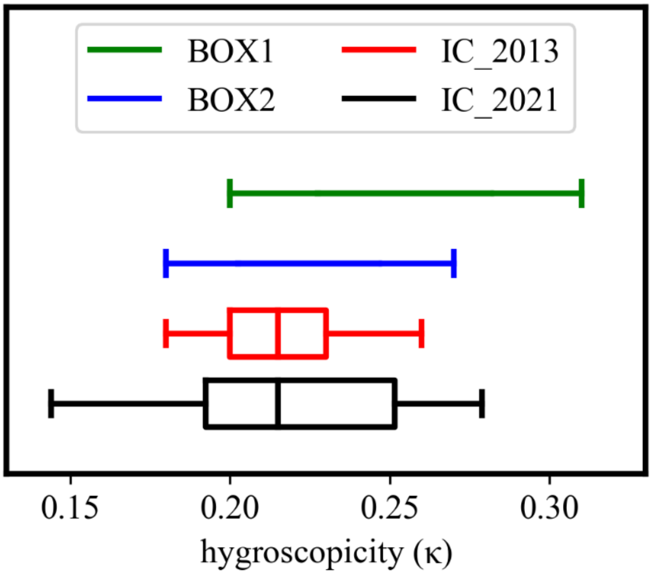

Figure S4: The hygroscopicity of $PM_{2.5}$ derived by AQBs and ion chromatography with the assumption particle density of 1.2 g cm^{-3}. The samples of year 2021 were collected at the National Kaohsiung University of Science and Technology (22°46'22.4" N 120°24'03.4" E) in Kaohsiung for the period of 8 – 18 December 2021.

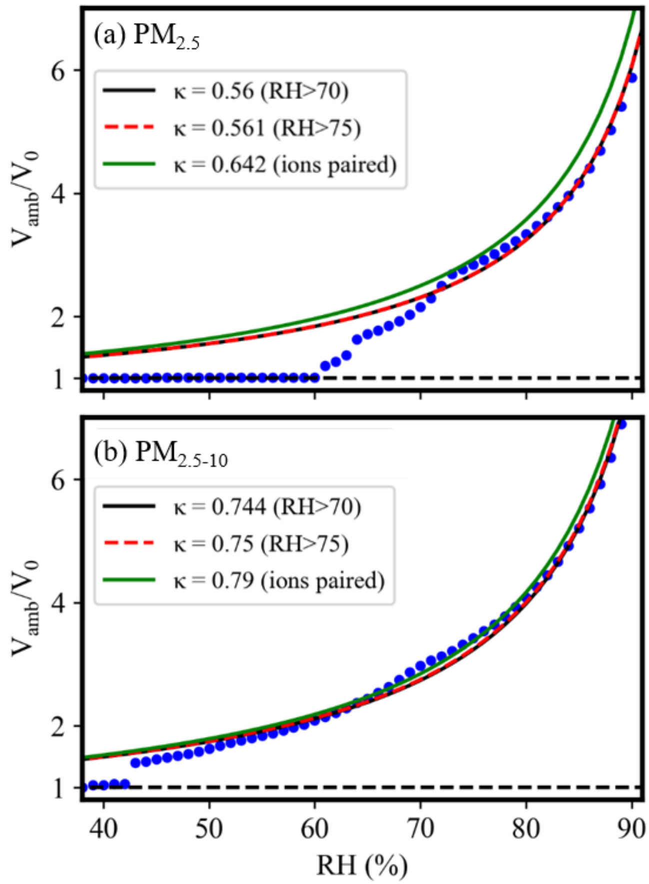

Figure S5: The volume ratio (ambient state compared to dry state) as a function of RH for (a) integrated fine particles and (b) coarse particles using E-AIM and the fitting lines using κ-Köhler equation (Eq. 2) with data points above the threshold as indicated in the legend. (sample mean composition, the molarity ratio of Na^+:NH_4^+:Cl^-:SO_4^{2-}:NO_3^- is 14:458:0:142:6 and 65:59:16:19:70 for $PM_{2.5}$ and $PM_{2.5\text{-}10}$, respectively. There is no insoluable composition taken into account in the caculation)

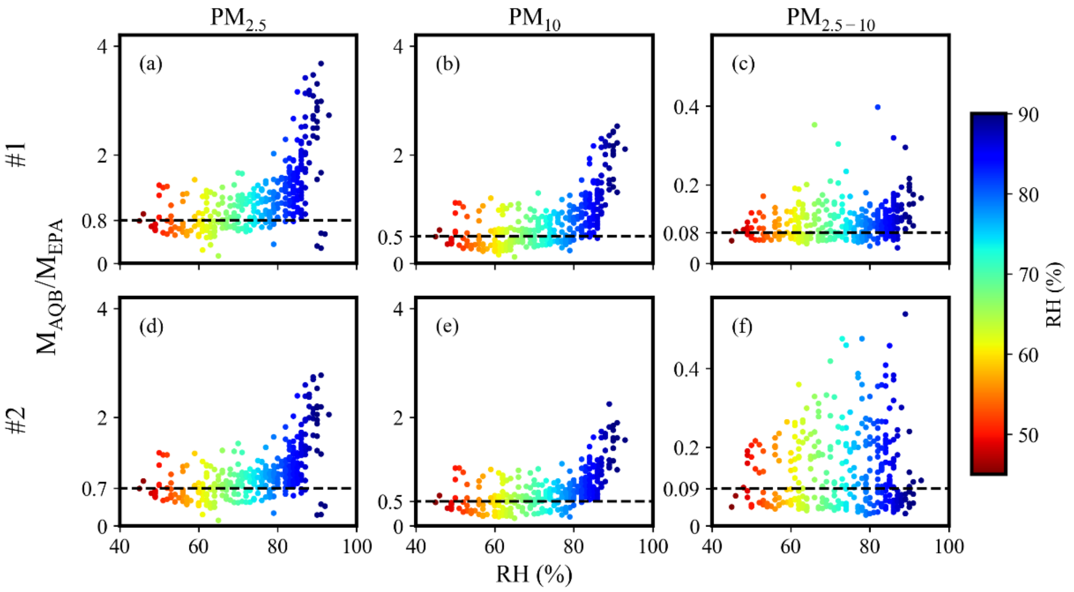

Figure S6: The mass ratio (ambient state compared to dry state) as a function of RH for (a, d) $PM_{2.5}$, (b, d) PM_{10}, (c, f) $PM_{2.5\text{-}10}$ using AQB#1 and #2 data compared. Marker color corresponds to relative humidity. The dashed lines indicate the inverse of the sensitivity coefficient (α) obtained from data at RH < 50 %.

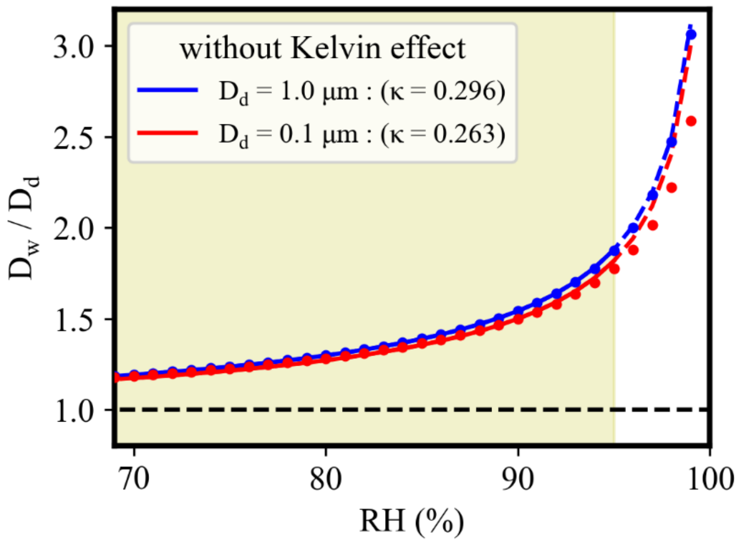

Figure S7: The particle growth diameter ratio as a function of RH for particle sizes of 0.1 (red) and 1.0 (blue) µm. Points are diameter ratio with Kelvin effect at κ = 0.3 for 70-95 % of RH using Eq. 2, and solid lines are the fitting results without Kelvin effect.

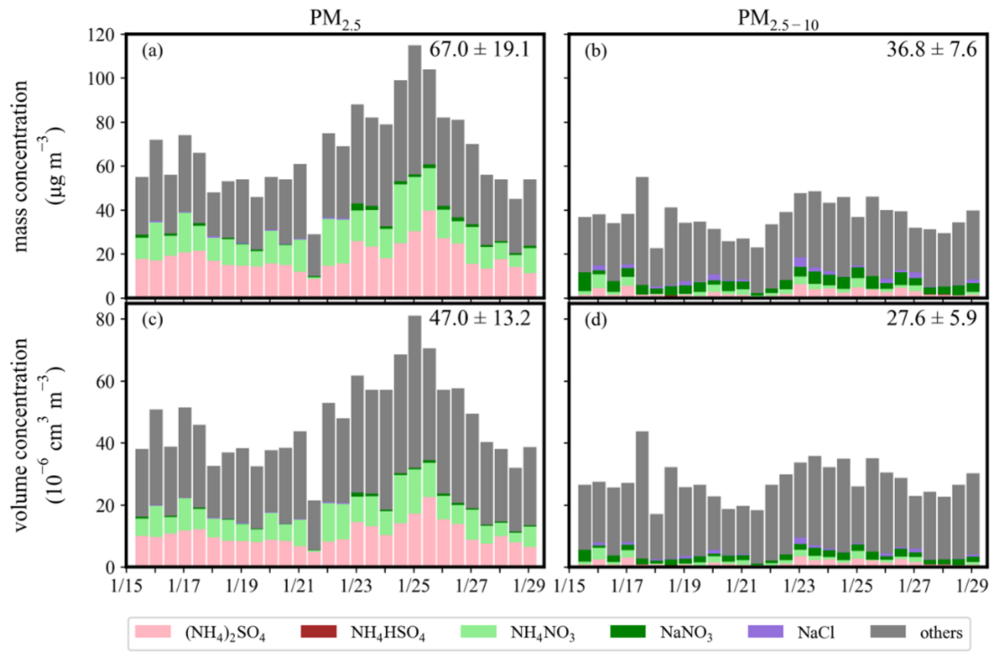

Figure S8: The temporal profiles of mass and volume concentration for (a, c) $PM_{2.5}$ and (b, d) $PM_{2.5\text{-}10}$. Column color corresponds to the contribution of different components. (others are characterized as secondary organic compositions having a density of 1.2 g cm^{-3}). The number on the upper right corner is the mean ± 1 SD.