AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Laboratory Evaluation Report for

A.U.G. Signals Ltd – AirSENCE Standard AS400x

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Revision History

Version	Date	Note
0	02/24/2026	Original issued report

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The laboratory evaluation was conducted in an AQ-SPEC environmental chamber with simulated pollutant and interferent concentrations that were generated from nebulizer solutions, dust dispensers, and/or gas dilution calibrators. Generated environments may not be able to fully replicate the conditions that may be experienced under ambient settings. The sensor assembly, installation, and use can also impact the reliability of the products evaluated by the AQ-SPEC program.

South Coast AQMD makes no claim, warranty, or guarantee that these devices will or will not work when operated by other users for their specific applications.

South Coast AQMD's AQ-SPEC aims at providing information to and for the benefit of the public to make informed purchasing decisions on air quality sensors. In accordance with this mission, the general policy of the Governing Board of the Agency is to exclude all commercial advertising and promotional material, including links which provide exclusive private or financial benefit to commercial, non-public enterprises and which do not promote or enhance a public benefit to the general public. As a Government Agency, the South Coast AQMD neither endorses nor supports individual private commercial enterprises through testing of products by AQ-SPEC or through providing links to the sites of such commercial enterprises.

Report Role	Name	Date Completed
Tested by	Victor Rocha, Jr.	02/14/2025
Analysis by	Michelle Kuang, Ph.D.	10/16/2025
QC Review by	Wilton Mui, Ph.D.	02/21/2026
Approved by	Wilton Mui, Ph.D.	02/21/2026
Revision by	-----	-----

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Section 1: Background

Three **A.U.G. Signals Ltd. – AirSENCE Standard AS400x (hereinafter AirSENCE)** units (IDs: 0299, 0306, and 0310) were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux from 08/17/2023 to 10/12/2023. Following field-testing, the same three units were evaluated in an AQ-SPEC environmental chamber under controlled temperatures, humidities and potassium chloride particle concentrations.

A.U.G. Signals Ltd. – AirSENCE

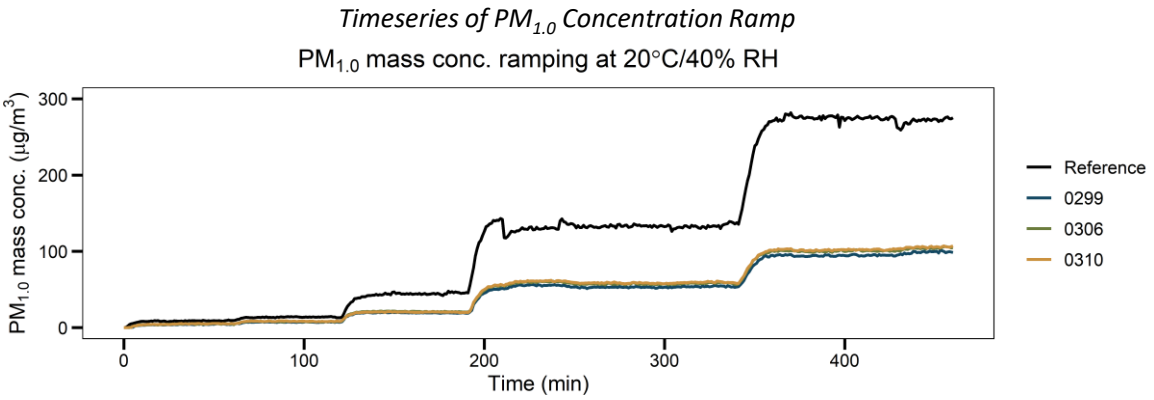
TeledyneT640x

Section 2: Manufacturer Specs

Parameter	Sensor: A.U.G. AirSENCE (raw sensor: Plantower PMS7003)	Reference Instrument: Teledyne T640x
Pollutant	$PM_{1.0}$, $PM_{2.5}$, PM_{10}	$PM_{1.0}$, $PM_{2.5}$ (FEM), PM_{10} (FEM)
Cost	$4,000 (at time of testing)	$21,000
Weight	4.8 pounds	19 pounds
Dimensions (LxWxD)	12.7 x 9.4 x 7.0 inches	7 x 17 x 14 inches
Power	9-36 VDC	100-240 VAC (360 W max)
Battery	No	No
Data transmission	Wi-Fi, Ethernet, Cellular, LoRaWAN, Serial	Ethernet, USB
Internal memory	Yes; 32 GB (5 years)	Yes; 4 GB (>1 year)
Operating temperature range	-31 – 131 degrees F	32 – 122 degrees F
Operating RH range	0%-95%	0%-100%
Product website	https://airsence.com/	https://www.teledyne-api.com/en-us/products/t640
Operating principle	Optical light scattering	Optical light scattering
Time resolution	1 minute	1 minute (as-configured)
Concentration range	0-6,000 µg/m^3	0.1-10,000 µg/m^3

Section 3: $PM_{1.0}$

Section 3.1: Data Overview



Section 3.2: Data Recovery

Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of instrument bounds as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire evaluation.

Parameter	Unit 0299	Unit 0306	Unit 0310
$PM_{1.0}$	100%	100%	100%

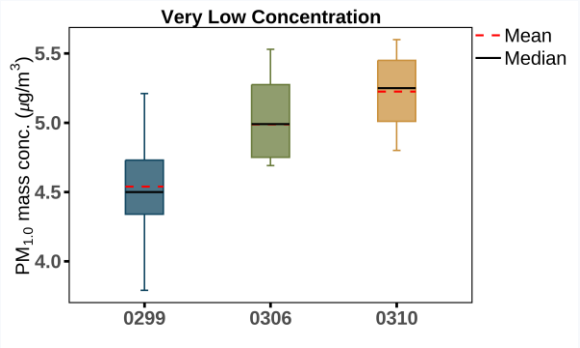
Section 3.3: Intra-Model Variability

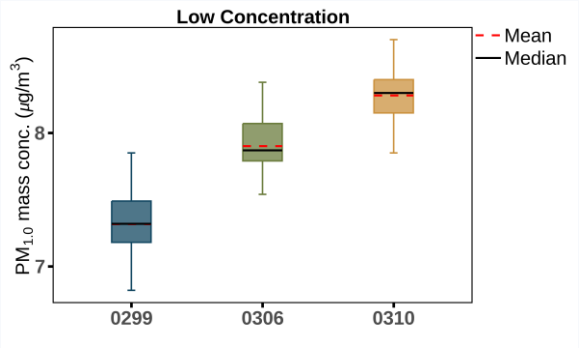
Absolute intra-model variability was calculated as the standard deviation of the mean values of the sensors. Relative intra-model variability was calculated as the absolute intra-model variability divided by the sensor grand mean. Calculations were performed using 20 measurements from each steady-state period.

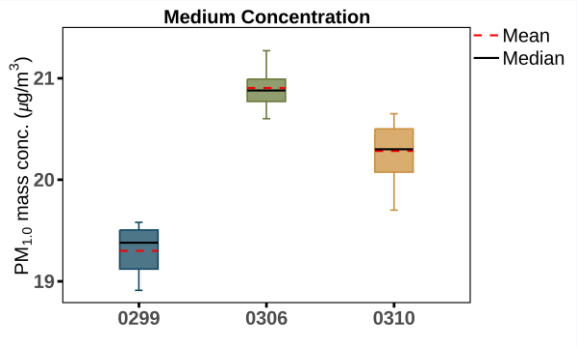
$PM_{1.0}$ Concentration (µg/m³)	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
Very Low (9.2)	0.3	7.0
Low (13.9)	0.5	6.2
Medium (45.2)	0.8	4.0
High (134.5)	2.9	5.1
Very High (273.0)	3.4	3.3

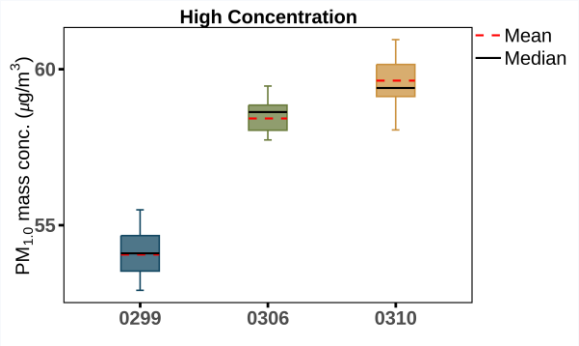
Section 3: $PM_{1.0}$

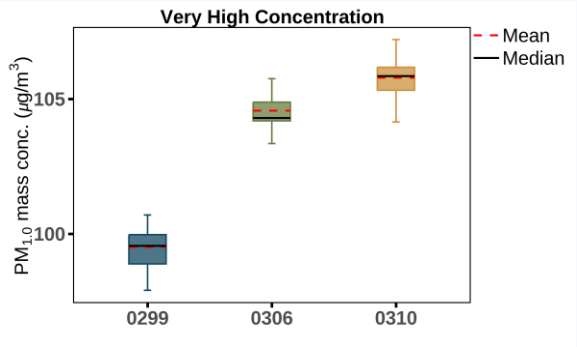
Section 3.3: Intra-Model Variability – Box Plots











Interpretation: The AirSENCE sensors had different distributions at all concentrations.

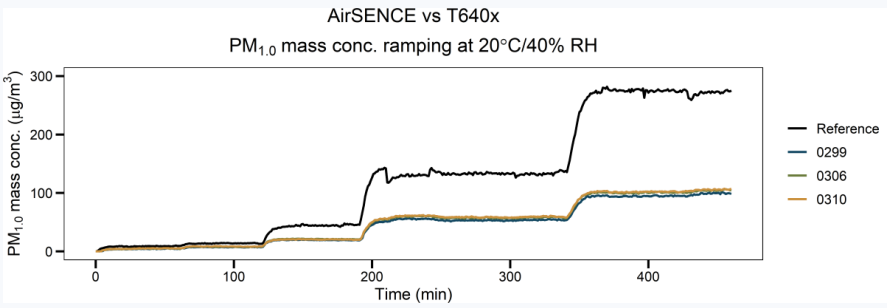
Section 3: $PM_{1.0}$

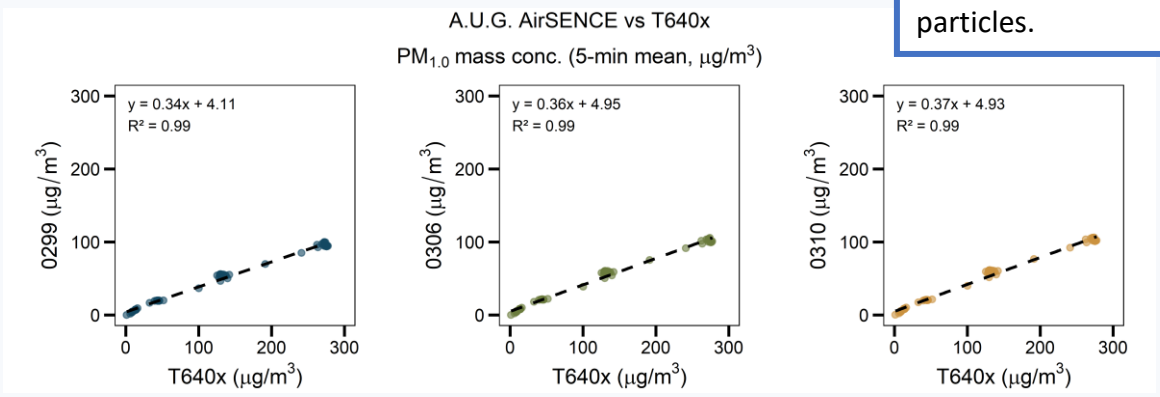
Section 3.4: Linearity (R^2)

Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data points were eliminated from the data-set.

A summary of the mean R^2 between the sensor and T640x across all units tested.

Parameter	Time Resolution	AirSENCE (mean ± SD)
$PM_{1.0}$	5-minute	0.99 ± 0.00

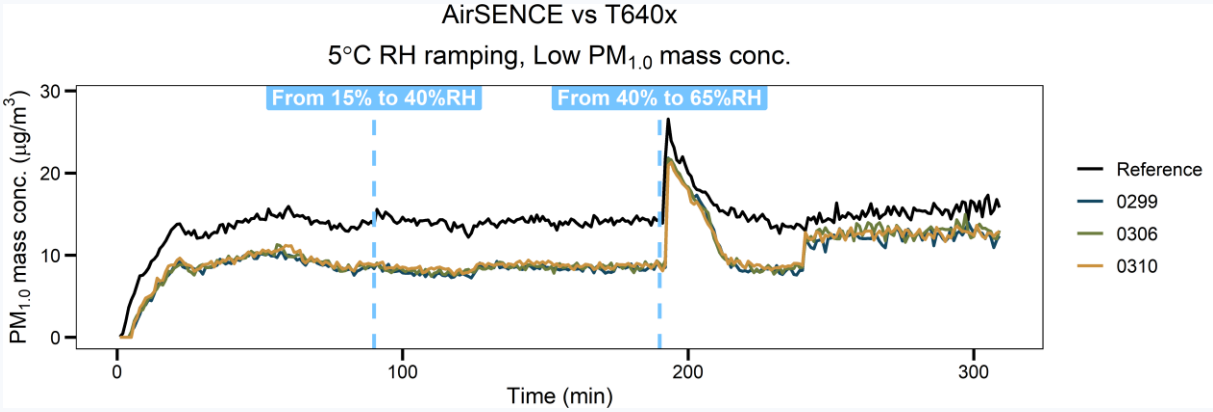


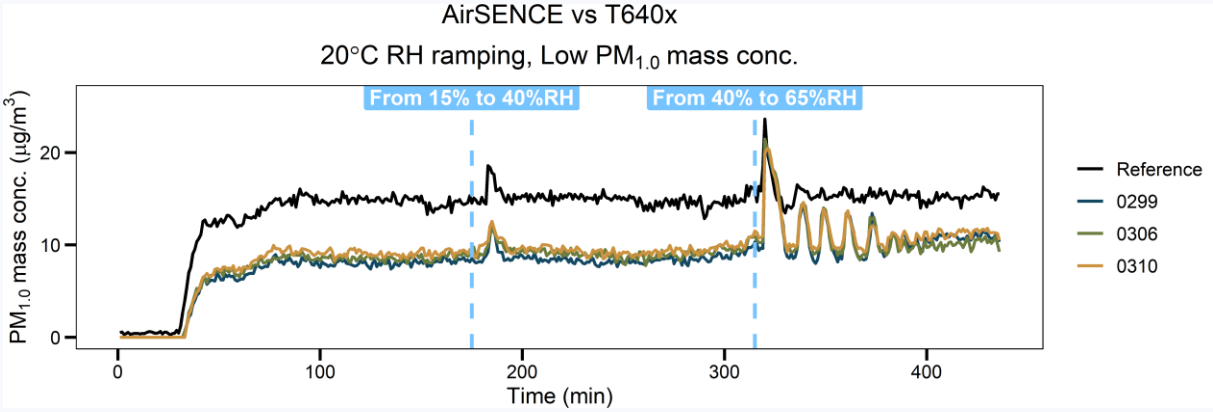


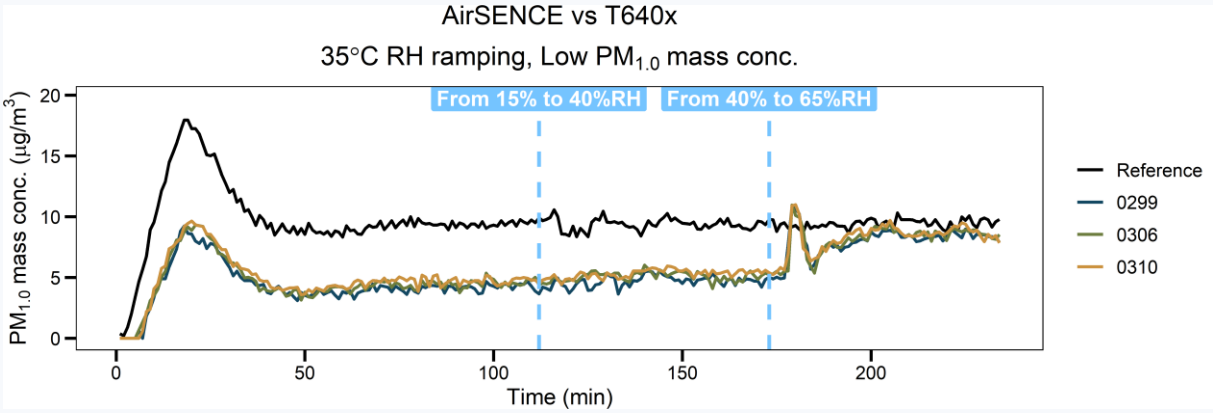
Interpretation: The AirSENCE showed very strong correlation with the corresponding T640x data (R^2 = 0.99) at 5-minute averaging, for potassium chloride particles.

Section 3: $PM_{1.0}$

Section 3.5: Climate Susceptibility – Low Concentrations

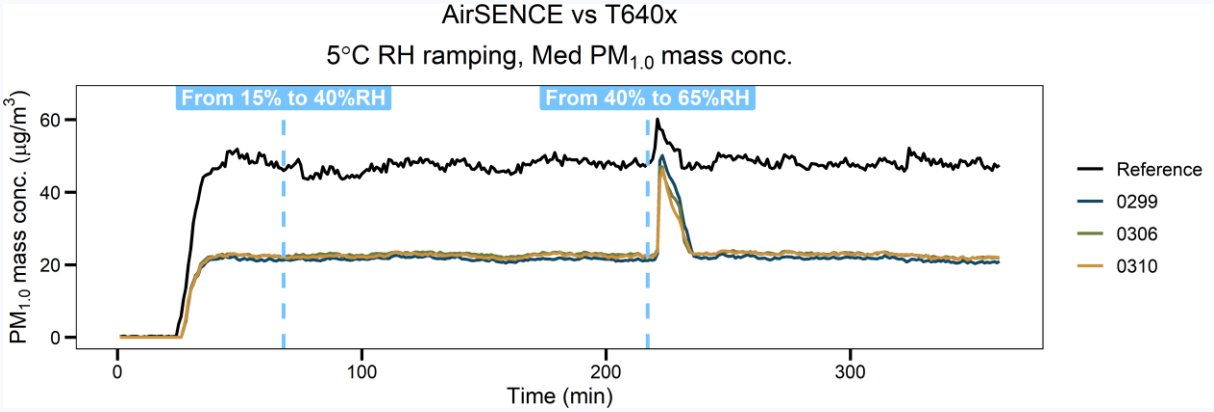


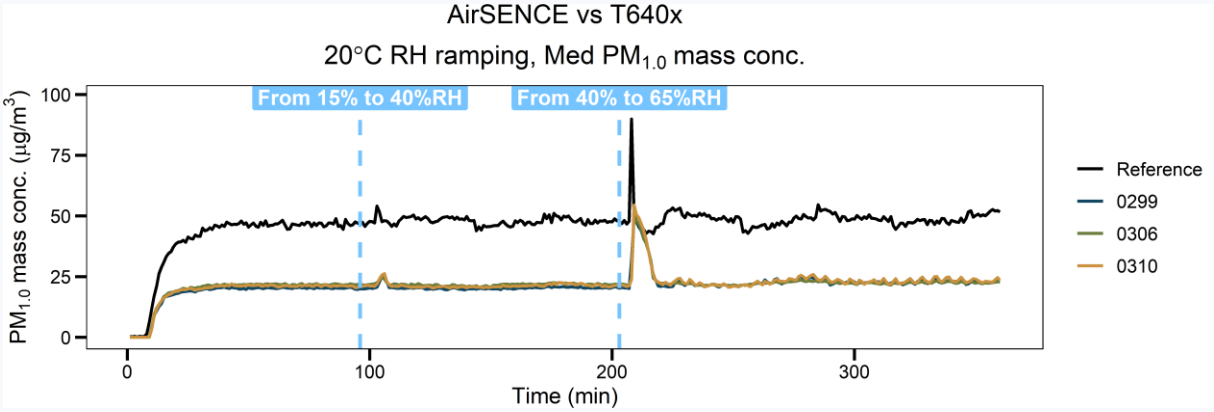


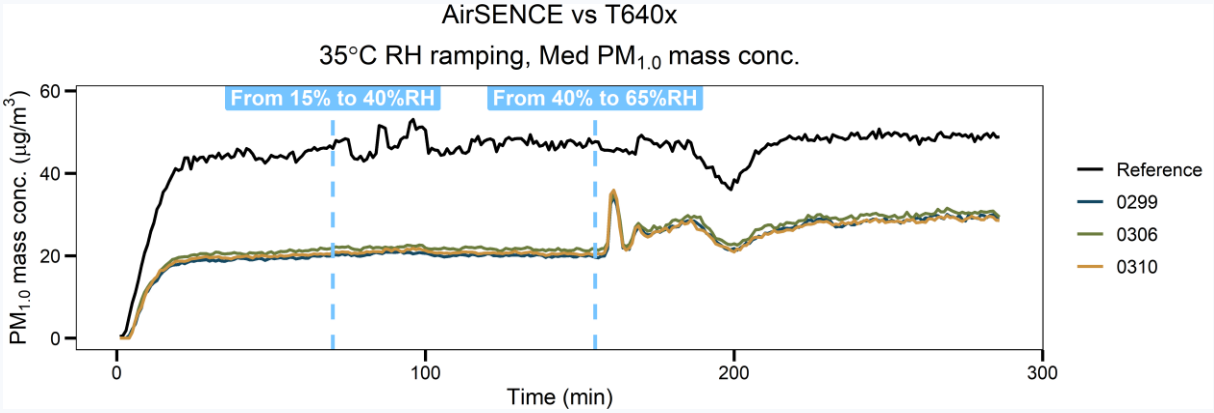


Section 3: $PM_{1.0}$

Section 3.5: Climate Susceptibility – Med. Concentrations

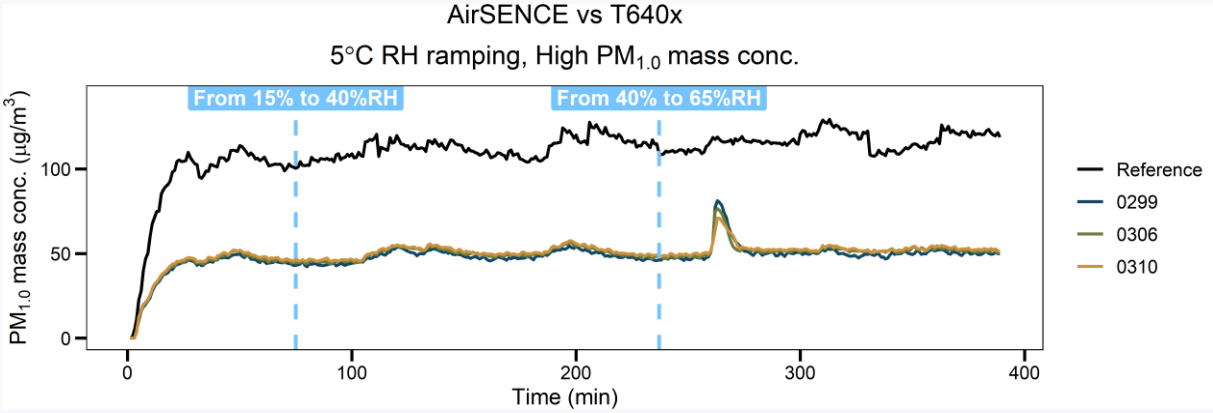


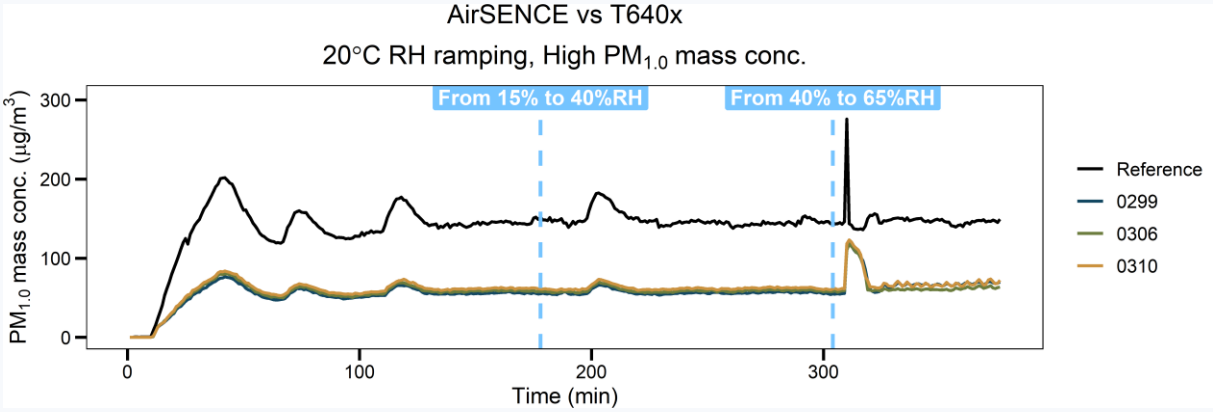


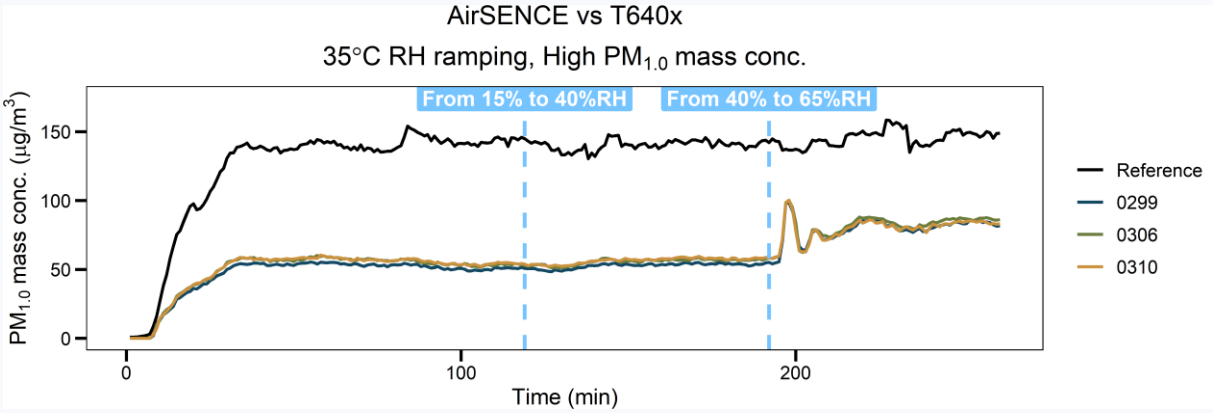


Section 3: $PM_{1.0}$

Section 3.5: Climate Susceptibility – High Concentrations



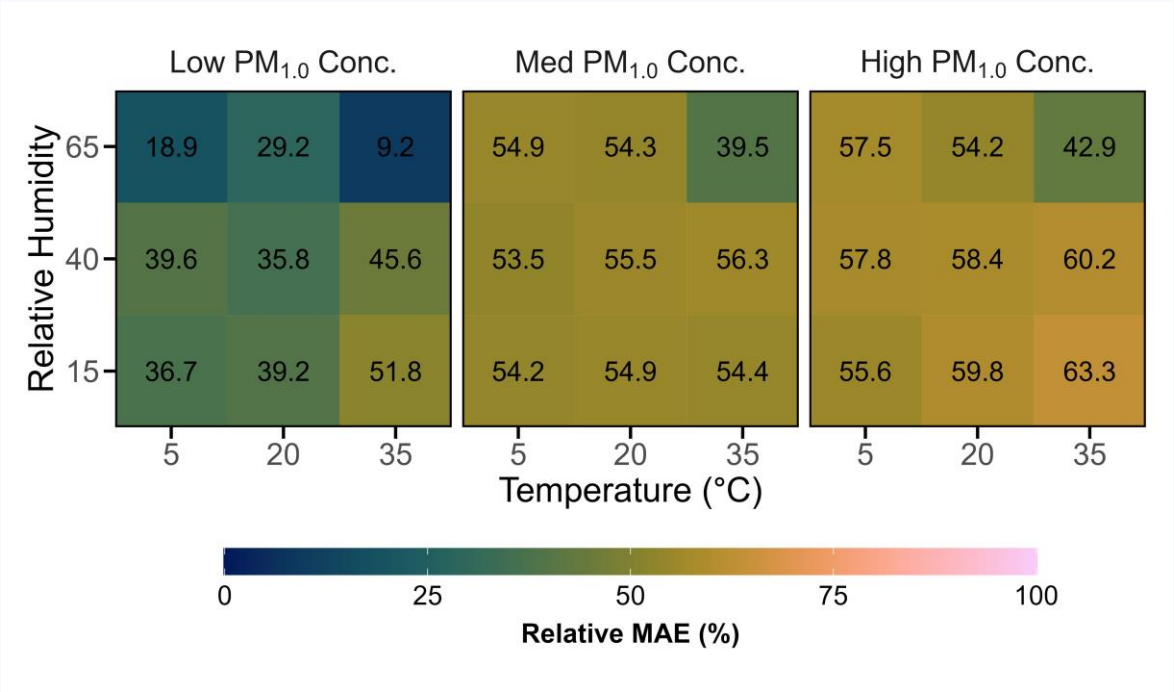




Section 3: $PM_{1.0}$

Section 3.5: Climate Susceptibility – Heat Maps

Relative MAE: effect of $PM_{1.0}$ concentration, temperature and RH

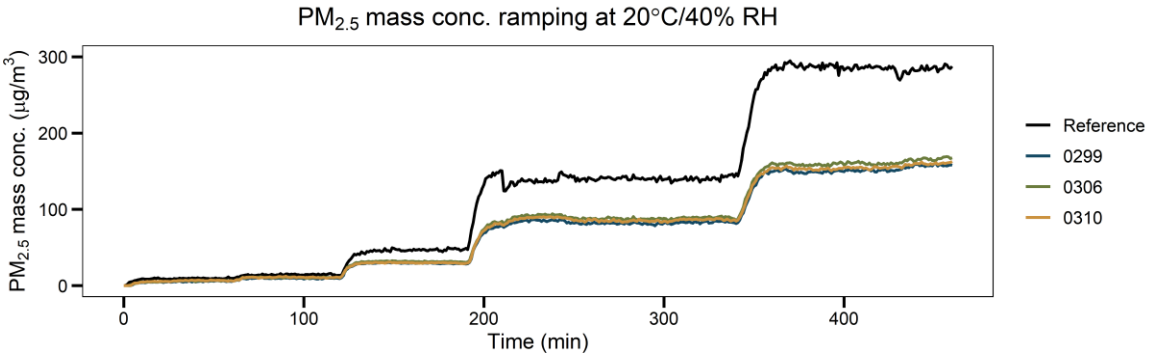


Interpretation: The AirSENCE generally showed higher relative MAE values at medium and high $PM_{1.0}$ concentrations, at lower RH, and at higher T, for potassium chloride particles.

Section 4: $PM_{2.5}$

Section 4.1: Data Overview

Timeseries of $PM_{2.5}$ Concentration Ramp



Section 4.2: Data Recovery

Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of instrument bounds as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire evaluation.

Parameter	Unit 0299	Unit 0306	Unit 0310
$PM_{2.5}$	100%	100%	100%

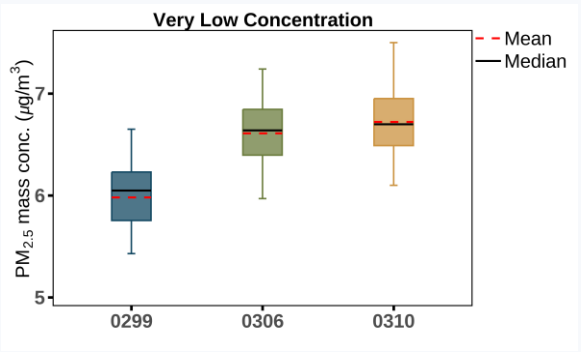
Section 4.3: Intra-Model Variability

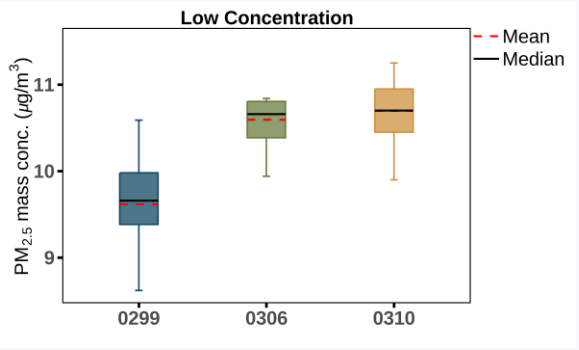
Absolute intra-model variability was calculated as the standard deviation of the mean values of the sensors. Relative intra-model variability was calculated as the absolute intra-model variability divided by the sensor grand mean. Calculations were performed using 20 measurements from each steady-state period.

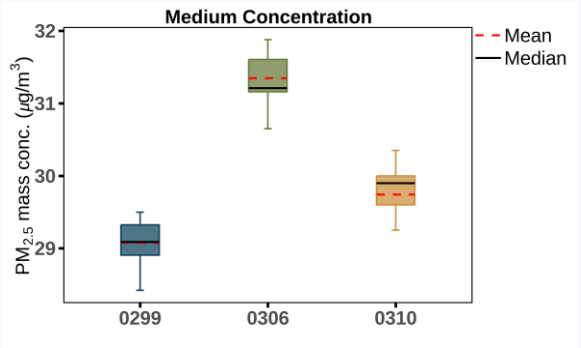
$PM_{2.5}$ Concentration (µg/m³)	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
Very Low (9.6)	0.4	6.1
Low (14.6)	0.6	5.8
Medium (47.5)	1.2	3.9
High (142.1)	2.9	3.3
Very High (285.3)	4.6	2.8

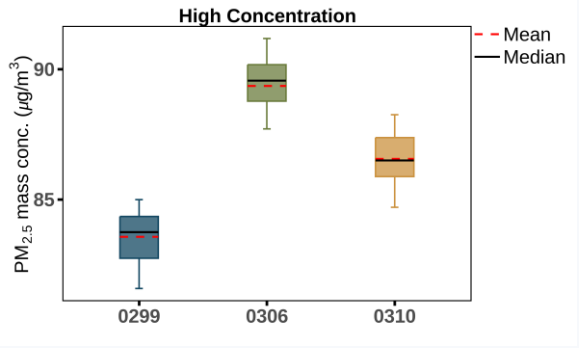
Section 4: $PM_{2.5}$

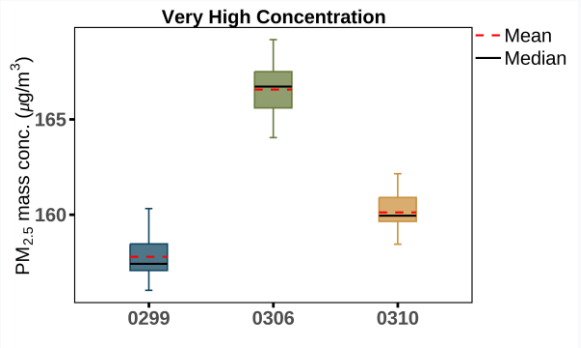
Section 4.3: Intra-Model Variability











Interpretation: The AirSENCE sensors had different distributions at all concentrations.

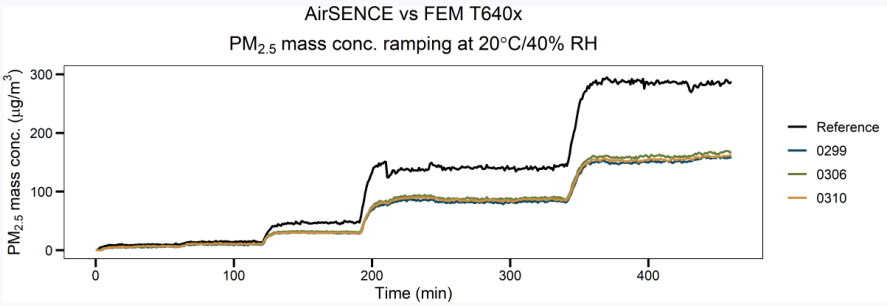
Section 4: $PM_{2.5}$

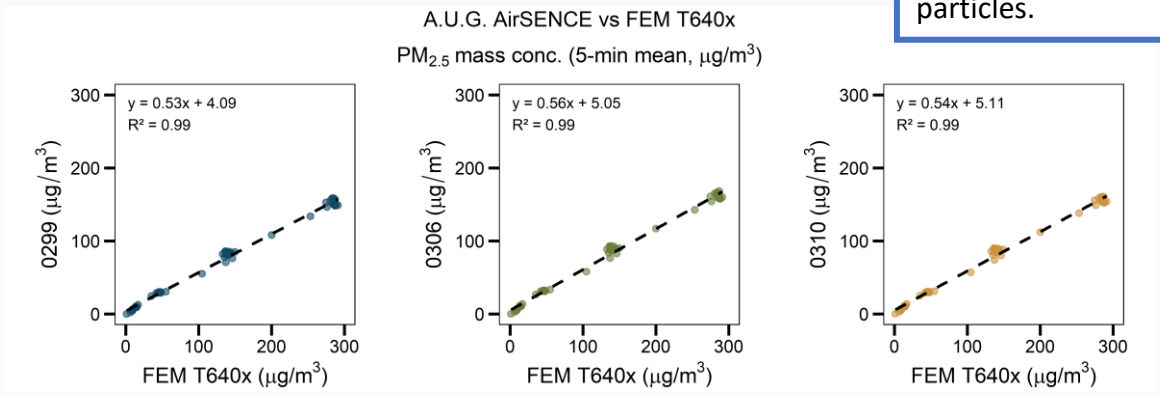
Section 4.4: Linearity (R^2)

Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data points were eliminated from the data-set.

A summary of the mean R^2 between the sensor and T640x across all units tested.

Parameter	Time Resolution	AirSENCE (mean ± SD)
$PM_{2.5}$	5-minute	0.99 ± 0.00

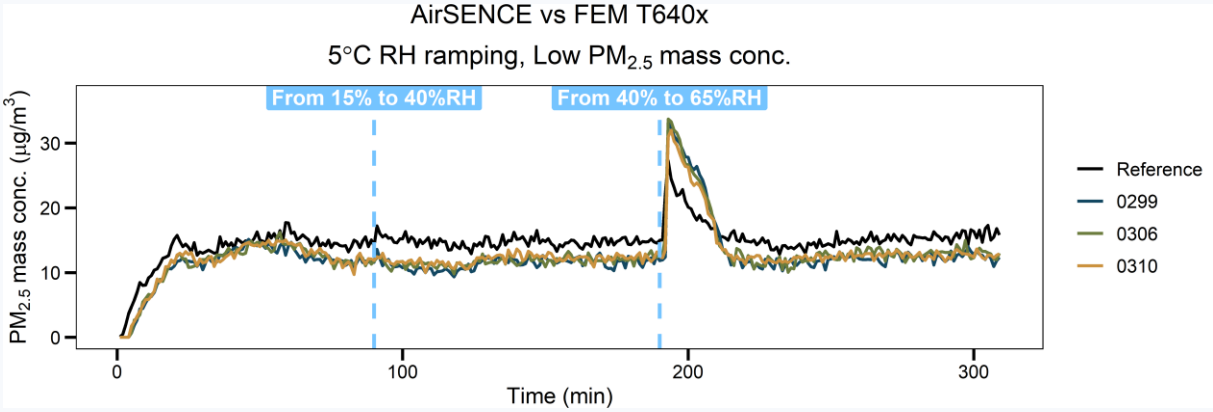


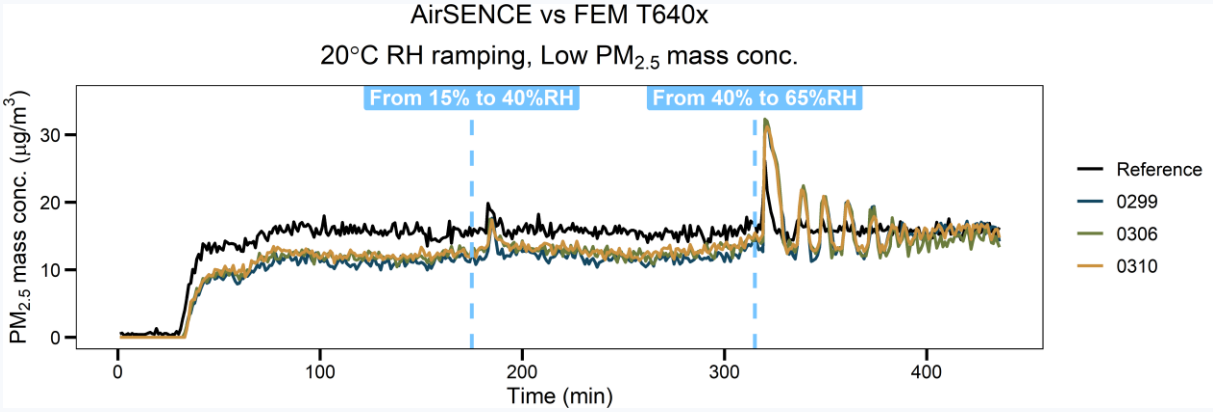


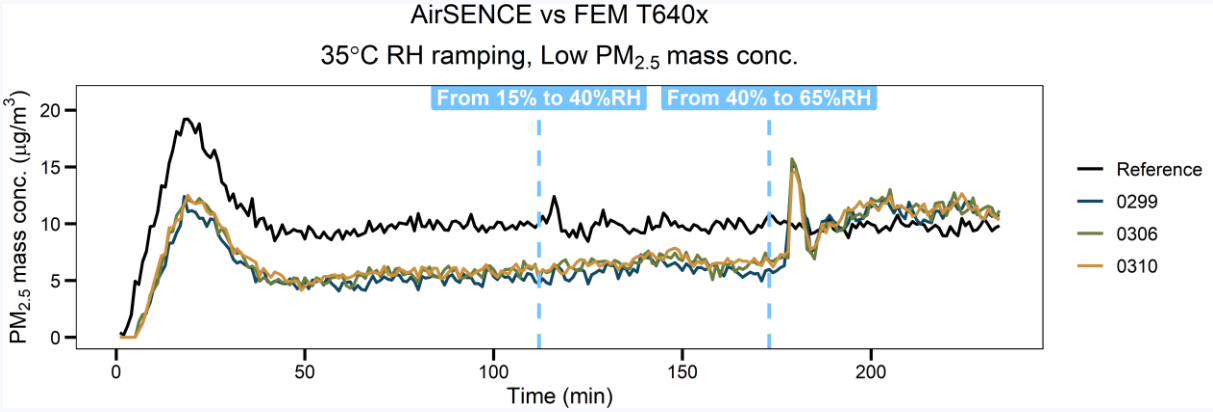
Interpretation: The AirSENCE showed very strong correlation with the corresponding FEM T640x data (R^2 = 0.99) at 5-minute averaging, for potassium chloride particles.

Section 4: $PM_{2.5}$

Section 4.5: Climate Susceptibility – Low Concentrations

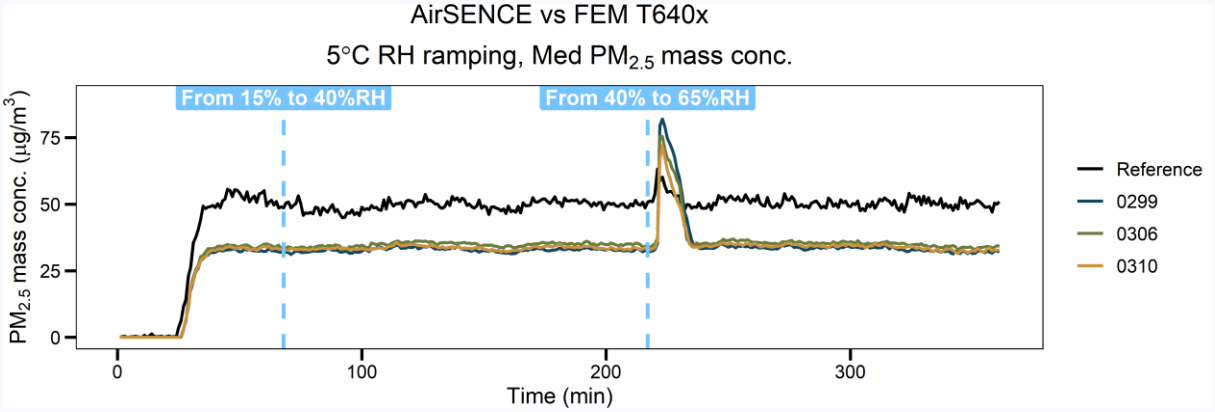


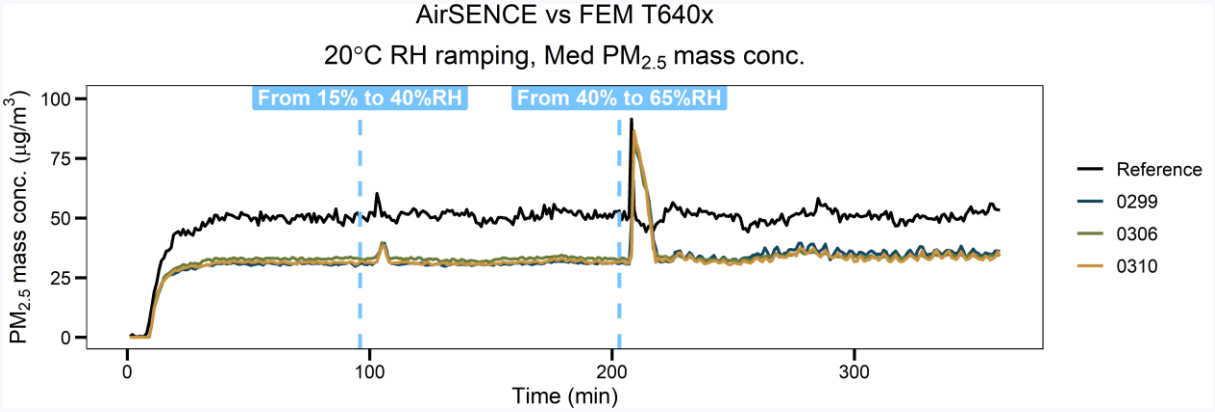


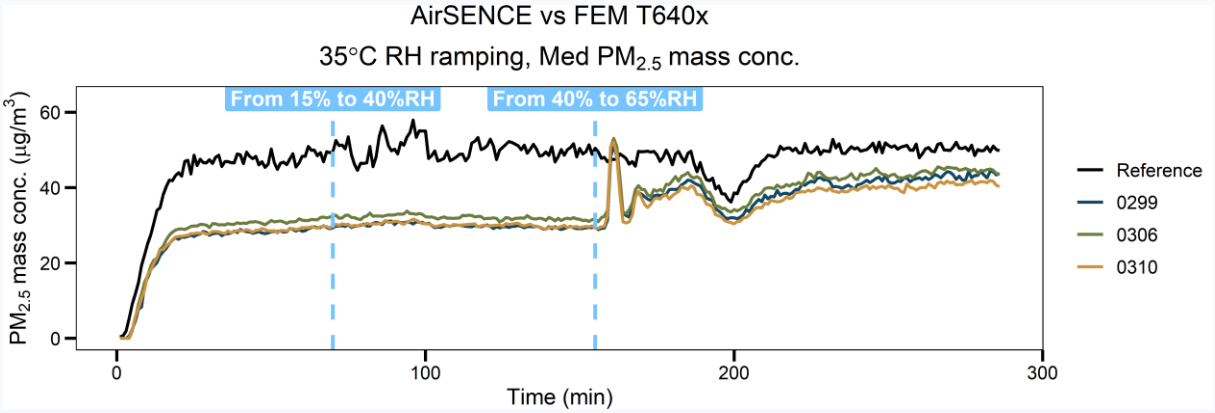


Section 4: $PM_{2.5}$

Section 4.5: Climate Susceptibility – Med. Concentrations

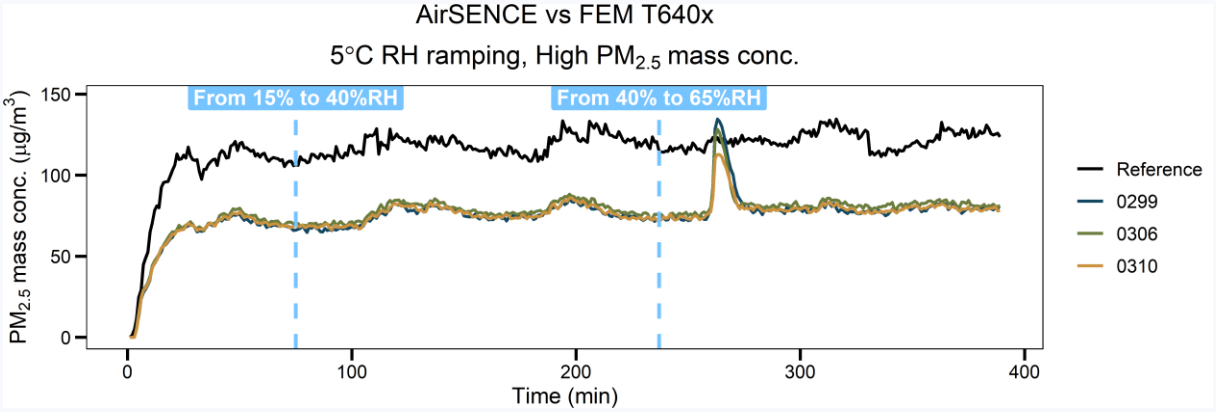


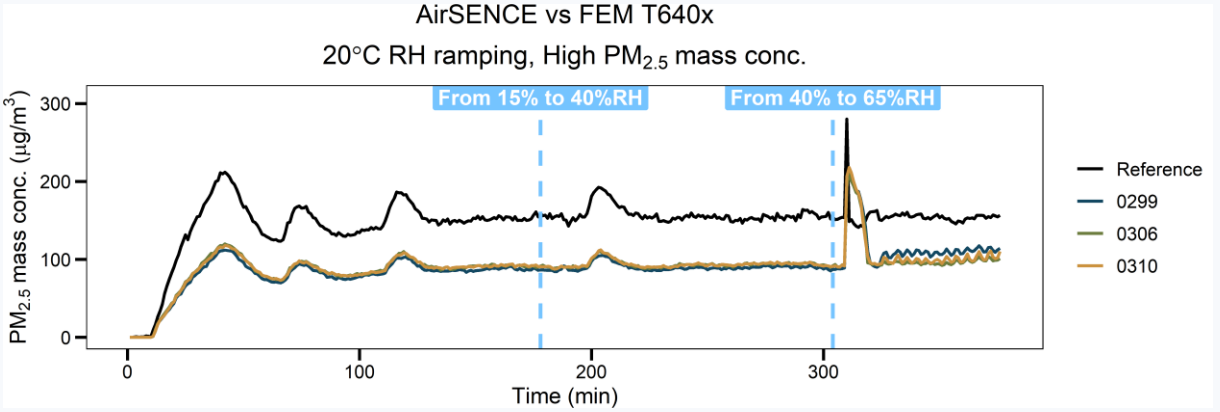


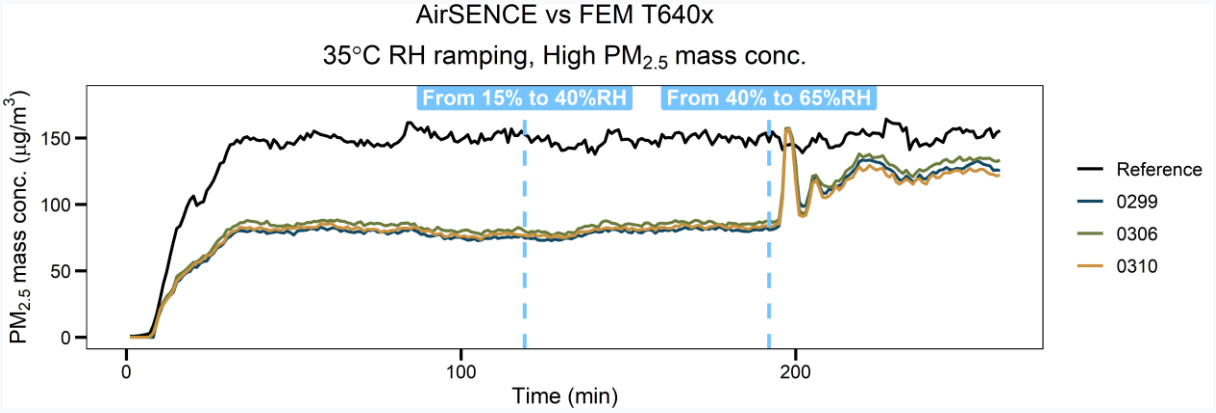


Section 4: $PM_{2.5}$

Section 4.5: Climate Susceptibility – High Concentrations



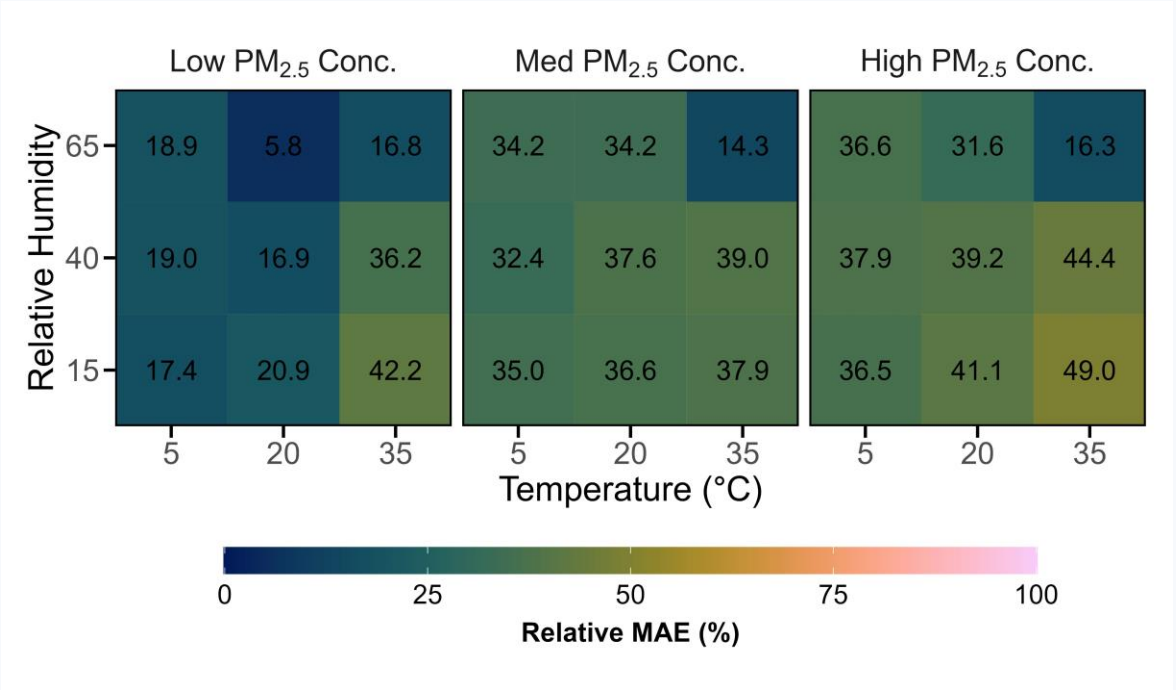




Section 4: $PM_{2.5}$

Section 4.5: Climate Susceptibility – Heat Maps

Relative MAE: effect of $PM_{2.5}$ concentration, temperature and RH



Interpretation: The AirSENCE generally showed higher relative MAE values at medium and high $PM_{2.5}$ concentrations, at lower RH, and at higher T, for potassium chloride particles.

Section 5: Summary Metrics

		$PM_{1.0}$				
		Very low	Low	Medium	High	Very High
AirSENCE	Average*	4.9	7.8	20.1	57.3	103.3
	SD*	0.3	0.3	0.2	0.8	0.8
	CV (RSD, %)	6.7	3.3	1.2	1.4	0.8
	Absolute IMV*	0.3	0.5	0.8	2.9	3.4
	Relative IMV (%)	7.0	6.2	4.0	5.1	3.3
T640x	Average*	9.2	13.9	45.2	134.5	273.0
	SD*	0.4	0.4	1.4	2.6	1.6
	CV (RSD, %)	4.3	3.2	3.0	2.0	0.6
AirSENCE vs. T640x	Pearson R^2	0.99				
	Slope	0.34 to 0.37				
	Intercept	4.11 to 4.95				
	MBE*	-4.6 to -3.9	-6.6 to -5.6	-25.9 to -24.3	-80.5 to -75.0	-173.5 to -167.1
	$nMBE_{mean}$	-0.5 to -0.4	-0.5 to -0.4	-0.6 to -0.5	-0.6 to -0.6	-0.6 to -0.6
	MAE*	3.9 to 4.6	5.6 to 6.6	24.3 to 25.9	75.0 to 80.5	167.1 to 173.5
	$nMAE_{mean}$	0.4 to 0.5	0.4 to 0.5	0.5 to 0.6	0.6 to 0.6	0.6 to 0.6
	RMSE*	4.0 to 4.6	5.6 to 6.6	24.4 to 26.0	75.0 to 80.5	167.1 to 173.5
	$nRMSE_{mean}$	0.4 to 0.5	0.4 to 0.5	0.5 to 0.6	0.6 to 0.6	0.6 to 0.6

*Units in $\mu g/m^3$

Section 5: Summary Metrics

		$PM_{2.5}$				
		Very low	Low	Medium	High	Very High
AirSENCE	Average*	6.5	10.3	30.0	86.4	161.6
	SD*	0.4	0.4	0.4	1.1	1.3
	CV (RSD, %)	6.0	4.4	1.2	1.3	0.8
	Absolute IMV*	0.4	0.6	1.2	2.9	4.6
	Relative IMV (%)	6.1	5.8	3.9	3.3	2.8
FEM T640x	Average*	9.6	14.6	47.5	142.1	285.3
	SD*	0.6	0.7	1.4	2.9	2.8
	CV (RSD, %)	6.0	5.1	3.0	2.0	1.0
AirSENCE vs. FEM T640x	Pearson R^2	0.99				
	Slope	0.53 to 0.56				
	Intercept	4.09 to 5.11				
	MBE*	-3.6 to -2.9	-5.0 to -3.9	-18.4 to -16.1	-58.5 to -52.8	-127.5 to -118.7
	$nMBE_{mean}$	-0.4 to -0.3	-0.3 to -0.3	-0.4 to -0.3	-0.4 to -0.4	-0.4 to -0.4
	MAE*	2.9 to 3.6	3.9 to 5.0	16.1 to 18.4	52.8 to 58.5	118.7 to 127.5
	$nMAE_{mean}$	0.3 to 0.4	0.3 to 0.3	0.3 to 0.4	0.4 to 0.4	0.4 to 0.4
	RMSE*	3.0 to 3.7	4.0 to 5.1	16.2 to 18.5	52.9 to 58.6	118.7 to 127.5
	$nRMSE_{mean}$	0.3 to 0.4	0.3 to 0.3	0.3 to 0.4	0.4 to 0.4	0.4 to 0.4

*Units in $\mu g/m^3$

Summary Metrics Guide

Average:	mean of individual sensor means at a given steady-state concentration; the grand mean
SD:	mean of individual sensor standard deviations (σ; measure of variation of the values about its mean) at a given steady-state concentration
CV (RSD):	mean of individual sensor coefficient of variations (relative standard deviation; the ratio of the standard deviation to the mean, expressed as a percentage) at a given steady-state concentration
Absolute IMV	intra-model variability expressed in absolute terms; standard deviation of individual sensor means at a given steady-state concentration
Relative IMV	intra-model variability expressed in relative terms; the ratio of the *Absolute IMV* to the *Average* at a given-steady-state concentration
Pearson R^2:	the squared value of the Pearson correlation coefficient; the square of the covariance of the reference and sensor measurements divided by the product of their standard deviations (a value from 0 to 1)
Slope:	change in the sensor's value per unit increase in the reference monitor's value
Intercept:	the sensor's predicted value when the reference monitor observes zero
MBE:	mean bias error; mean of the differences between reference and sensor measurements at a given steady-state concentration
$nMBE_{mean}$:	mean bias error normalized with respect to the reference mean value at a given steady-state concentration
MAE:	mean absolute error; mean of the absolute differences between reference and sensor measurements at a given steady-state concentration
$nMAE_{mean}$:	mean absolute error normalized with respect to the reference mean value at a given steady-state concentration
RMSE:	root mean square error; the square root of the average squared differences between reference and sensor measurements at a given steady-state concentration
$nRMSE_{mean}$:	root mean square error normalized with respect to the reference mean value at a given steady-state concentration