AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Field Evaluation Report for

Ecomesure EcomSmart 1 (Ver. 3.1.0)

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Performance Snapshot

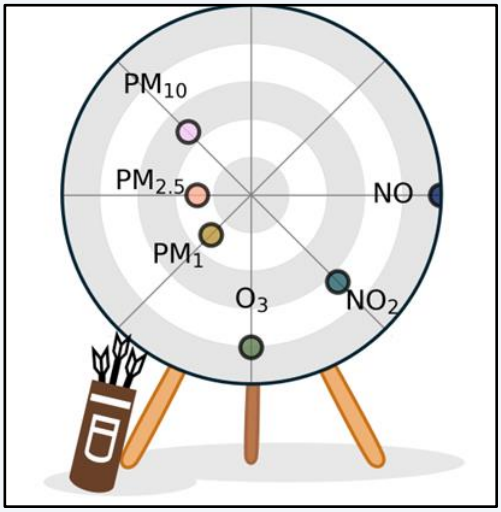
Ecomesure EcomSmart 1

Tested: 11/04/2025 to 12/30/2025

○ CO	○ SO_2
○ CO_2	○ VOC
○ CH_4	✓ PM_1
○ H_2S	✓ $PM_{2.5}$
✓ NO	○ PM_4
✓ NO_2	✓ PM_{10}
○ NO_x	○ UFP
✓ O_3	○ BC

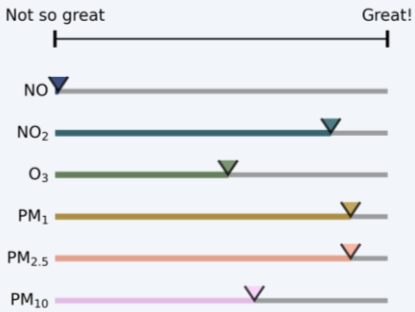
✓ Tested ● Not tested ○ Not available

Does it hit the target?



The closer the sensor lands near the center, the more accurate its readings were compared to the pollution levels.

How well does it track?



A longer bar means the sensor did a better job of tracking the real changes in air pollution levels — going up when the concentration levels went up, and down when they dropped.

$$$ Cost	$ Web portal	4.4 lbs Weight	Display	option Battery	$ Solar	Weatherproof
option Wi-Fi	option Cellular	Bluetooth	Internal memory	Serial	USB	Ethernet

F20260302.0

Performance Snapshot

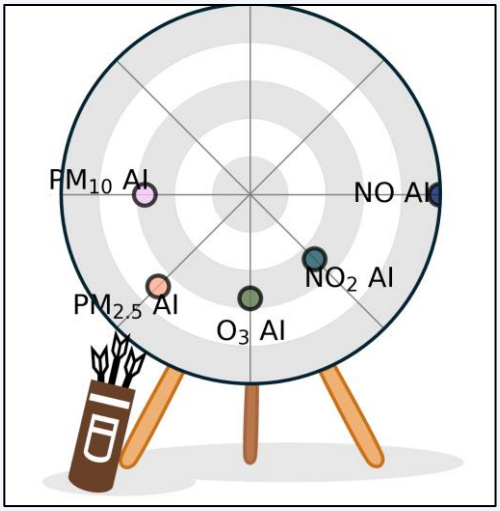
Ecomesure EcomSmart 1 – “AI” outputs

Tested: 11/04/2025 to 12/30/2025

○ CO	○ SO_2
○ CO_2	○ VOC
○ CH_4	○ PM_1
○ H_2S	✓ $PM_{2.5}$
✓ NO	○ PM_4
✓ NO_2	✓ PM_{10}
○ NO_x	○ UFP
✓ O_3	○ BC

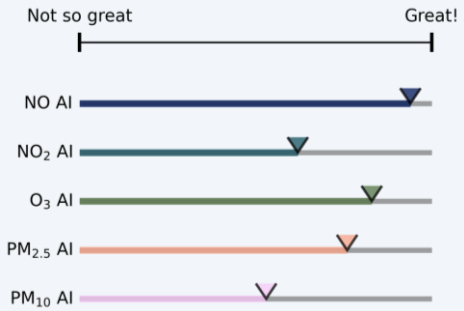
✓ Tested ● Not tested ○ Not available

Does it hit the target?



The closer the sensor lands near the center, the more accurate its readings were compared to the pollution levels.

How well does it track?

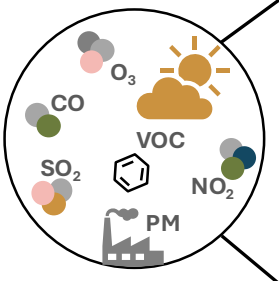


A longer bar means the sensor did a better job of tracking the real changes in air pollution levels — going up when the concentration levels went up, and down when they dropped.

$$$ Cost	$ Web portal	4.4 lbs Weight	Display	option Battery	$ Solar	Weatherproof
option Wi-Fi	option Cellular	Bluetooth	Internal memory	Serial	USB	Ethernet

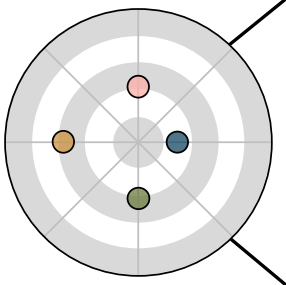
*AI refers to the “AI” output channels that are part of the “AI-Ready” product configuration

Performance Snapshot Guide



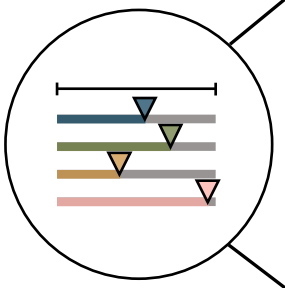
Pollutant List: This list shows the pollutants that the sensor is capable of measuring. Pollutants highlighted in blue with a check mark were tested for performance, those in gray were not tested, and those in white are not measured by the sensor.

◆ **CH_4** methane ◆ **CO** carbon monoxide ◆ **CO_2** carbon dioxide ◆ **H_2S** hydrogen sulfide ◆ **NO** nitric oxide ◆ **NO_2** nitrogen dioxide ◆ **NO_x** nitrogen oxides ◆ **O_3** ozone ◆ **SO_2** sulfur dioxide ◆ **VOC** volatile organic compounds ◆ **BC** black carbon ◆ **PM_1** mass of particles smaller than 1 micrometer ◆ **$PM_{2.5}$** mass of particles smaller than 2.5 micrometers ◆ **PM_4** mass or particles smaller than 4 micrometers ◆ **PM_{10}** mass of particles smaller than 10 micrometers ◆ **UFP** ultrafine particles, smaller than 0.1 micrometers



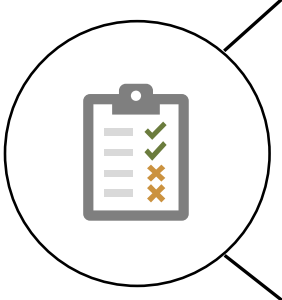
Target Graphic: The closer the sensor "hits" the center, the closer the sensor's readings were to the actual concentrations. If the sensor hit inside the center circle, its readings were within 20% of the actual concentration. Each ring going outward is another 20% further from the actual concentration. If the sensor falls off the target entirely, its readings were either zero, or more than twice the actual concentration!

More technically, the distance from the center is calculated from sensor-reference relative absolute errors, averaged across all 1-hour means, averaged across the number of sensor units tested. These distances are precise and not binned in 20% intervals.



Bar Graphic: The longer the bar, the better the sensor followed the ups-and-downs of the actual concentrations. A long bar doesn't always mean that the sensor exactly "matched" the actual concentration, but it does mean the sensor was responding when the air was clean or dirty. A long bar also means it's possible to adjust the sensor's readings to match the actual concentrations if you can gather data side-by-side with a reference monitor to make a formula to correct the readings!

More technically, the bar length ranges between 0 to 1 and is calculated from sensor-reference coefficients of determination (R^2; square of the Pearson correlation coefficient), with 1-hour means, averaged across the number of sensor units tested.



Feature Symbols: Some sensors can be configured with extra features. The price we list in the reports was the price for the product version we tested. Your price may vary from ours. If a symbol has the word option in it, it means the manufacturer offers that option at no extra cost. If a symbol has a small $ sign in it, that means it is a paid option.

The number of **$** signs used for sensor "cost" is based on the 2022 average cell phone price of $735 (https://www.wsj.com/business/telecom/how-much-is-too-much-for-a-smartphone-3a300905), adjusted for inflation for the year we tested the sensor. One **$** sign means the sensor cost less than an average cell phone; two **$$** signs means it cost less than twice an average cell phone; three **$$$** signs means it cost more than twice an average cell phone. For other options, only one $ sign is used for simplicity as it is too complicated to describe the variety of add-on costs through symbols.

Revision History

Version	Date	Note
0	03/11/2026	Original issued report

Disclaimer: This sensor was evaluated on firmware version 3.1.0. Although some sensor outputs are called “AI”, they are generated using temperature- and humidity-based corrections using data collected in France and not data from the AQ-SPEC test site. On this basis, the sensor was deemed eligible for evaluation. “AI” outputs are included in this report to fully inform consumers if they purchase the “AI-Ready” version of this device.

All documents, reports, data, and other information provided are for informational and/or educational use only.

Some sensors evaluated by AQ-SPEC were field-tested inside a custom-made aluminum enclosure to protect the sensors from windblown rain, harsh sunlight, and animals. The field evaluation reports contain data collected at an air monitoring station during a specific 30- to 60-day period and cannot be duplicated at a different location, season, or time period. As sensor performance may be affected by time- and location-specific environmental conditions at the test site, replication and/or duplication of results may not be possible to achieve. The sensor assembly, installation, and use can also impact the performance of products evaluated by AQ-SPEC. No sensor calibration was performed by South Coast AQMD staff for this evaluation. Laboratory chamber testing may be necessary to fully evaluate the performance of these sensors under controlled temperature, humidity, pollutant, and interferent concentrations.

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
Tested by	Leslie Garcia, Noel Ruiz, and Randy Lam	12/30/2025
Analysis by	Namrata Shanmukh Panji, Ph.D.	01/23/2026
Quality Control Review by	Ehsan Mosadegh, Ph.D.	02/10/2026
Approved by	Wilton Mui, Ph.D.	03/11/2026
Revision by	-----	-----

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Section 1: Background

Three Ecomesure EcomSmart 1 (hereinafter EcomSmart 1) units (IDs: 01272, 01273, 01274) were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux, CA from 11/04/2025 to 12/30/2025. The evaluation period lasted 8 weeks. The sensor units were co-located with reference grade instruments as described below.

Note: Although some outputs are called "AI", they are generated using temperature- and humidity-based corrections using data collected in France and not data from the AQ-SPEC test site. "AI" outputs are included in this report to fully inform consumers if they purchase the "AI-Ready" version of this device.

Ecomesure EcomSmart 1

Test site at Rubidoux, CA

Section 2: Manufacturer Specs

Parameter	Sensor: Ecomesure EcomSmart 1 (raw sensor is Alphasense)	Reference Instrument: Teledyne T200
Pollutant	NO, NO_2, NO "AI", NO_2 "AI"	NO, NO_2 (FRM), NOx
Cost	$5,664	~$11,000
Weight	4.41 lbs	40 lbs
Dimensions (LxWxH)	8.2 x 7.8 x 3.5 inches	7 x 17 x 23.5 inches
Power	5 VDC USB, 2 A max.	100-240 VAC
Battery	Optional (8-12 hr)	No
Data transmission	Ethernet (Wi-Fi, Cellular, LoRa optional)	Serial, Ethernet, USB
Internal memory	microSD, web storage	Yes
Operating temperature range	-22 to 104 (NO_2), -22 to 122 (NO) degrees F	41-104 degrees F
Operating RH range	15 to 85% (NO_2), 15 to 90% (NO)	Not specified
Product website	https://ecomesure.com/en/connected-systems/ecomsmart-1	https://www.teledyne-api.com/en-us/products/t200
Operating principle	Electrochemical	Chemiluminescence
Time resolution	1-minute (as-tested)	1-minute (as-configured)
Concentration range	0-20,000 ppb	0-20,000 ppb

Section 2: Manufacturer Specs

Parameter	Sensor: Ecomesure EcomSmart 1 (raw sensor is Alphasense)	Reference Instrument: Teledyne T400
Pollutant	O_3, O_3 "AI"	O_3 (FEM)
Cost	$5,664	~$7,000
Weight	4.41 lbs	31 lbs
Dimensions (LxWxH)	8.2 x 7.8 x 3.5 inches	7 x 17 x 23.5 inches
Power	5 VDC USB, 2 A max.	100-240 VAC
Battery	Optional (8-12 hr)	No
Data transmission	Ethernet (Wi-Fi, Cellular, LoRa optional)	Serial, Ethernet, USB
Internal memory	microSD, web storage	Yes
Operating temperature range	-22 to 104 degrees F	41-104 degrees F
Operating RH range	15 to 85%	Not specified
Product website	https://ecomesure.com/en/connected-systems/ecomsmart-1	https://www.teledyne-api.com/en-us/products/t400
Operating principle	Electrochemical	UV absorption
Time resolution	1-minute (as-tested)	1-minute (as-configured)
Concentration range	0-20,000 ppb	0-10,000 ppb

Section 2: Manufacturer Specs

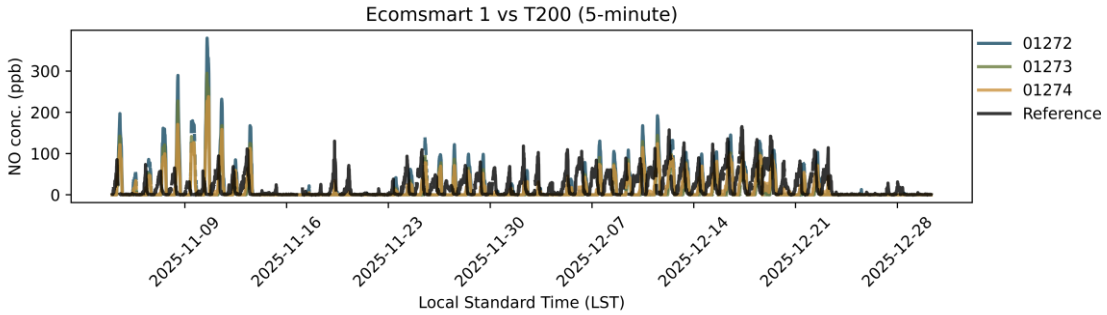
Parameter	Sensor: Ecomesure EcomSmart 1 (raw sensor is Tera Sensors NextPM)	Reference Instrument: Teledyne API T640
Pollutant	PM_1, $PM_{2.5}$, PM_{10}, $PM_{2.5}$ "AI", PM_{10} "AI"	PM_1, $PM_{2.5}$ (FEM), PM_{10}
Cost	$5,664	~$21,000
Weight	4.41 lbs	19 lbs
Dimensions (LxWxH)	8.2 x 7.8 x 3.5 inches	7 x 17 x 14 inches
Power	5 VDC USB, 2 A max.	100-240 VAC
Battery	Optional (8-12 hr)	No
Data transmission	Ethernet (Wi-Fi, Cellular, LoRa optional)	Serial, Ethernet, USB
Internal memory	microSD, web storage	Yes (with USB flash drive)
Operating temperature range	14 to 122 degrees F	32-122 degrees F
Operating RH range	0 to 95%	0%-100%
Product website	https://ecomesure.com/en/connected-systems/ecomsmart-1	https://www.teledyne-api.com/en-us/products/t640
Operating principle	Optical light scattering	Optical light scattering
Time resolution	1-minute (as-tested)	1-minute (as-configured)
Concentration range	0-1000 $\mu g/m^3$	0.1-10,000 $\mu g/m^3$

Section 3:
Evaluation of outputs

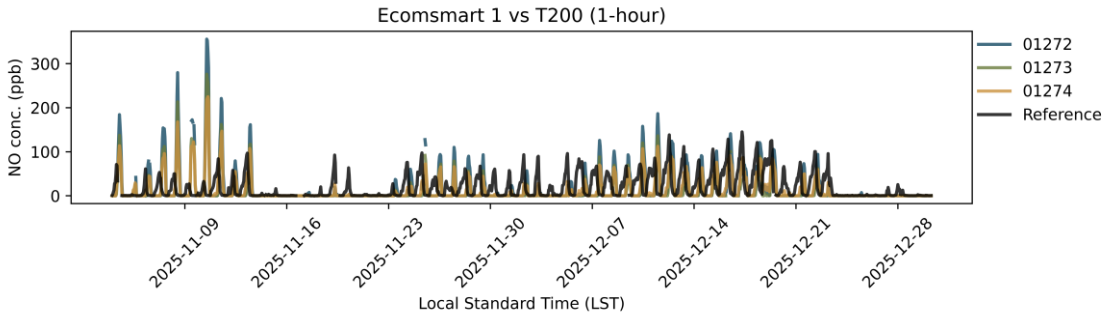
Section 3.1: NO

Section 3.1.1: Data Overview

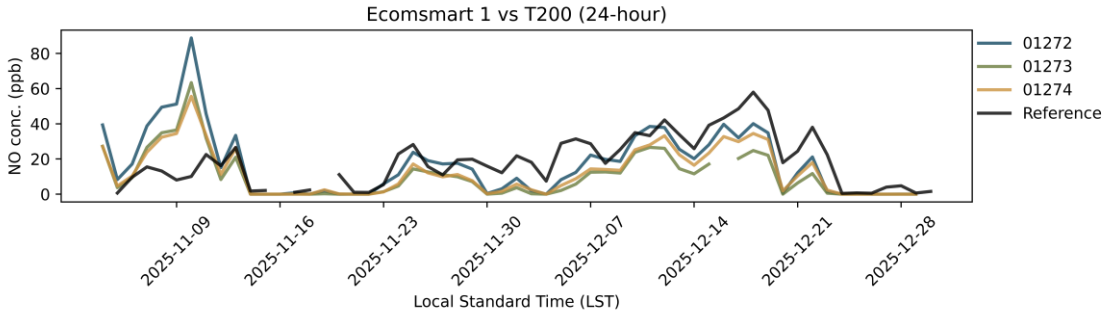
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 3: NO

Section 3.1.2: Data Recovery

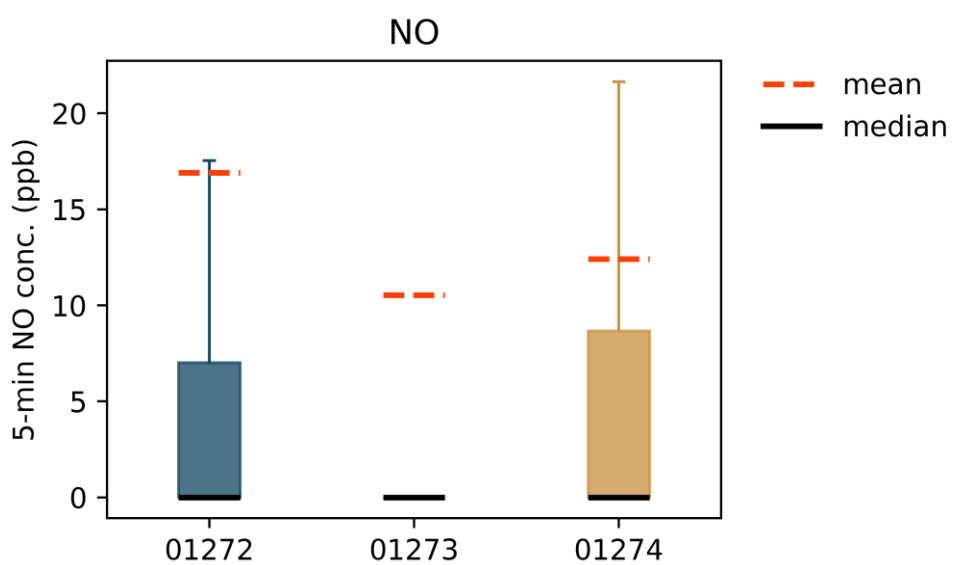
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
NO	95.1%	96.6%	98.2%

Section 3.1.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (ppb)	Relative intra-model variability (%)
NO	3.0	23.4



Interpretation: The EcomSmart 1 units had different pollutant distributions. Since the 75th percentile of observed values for Unit 01273 was zero, its box does not appear on the plot.

Section 3.1: NO

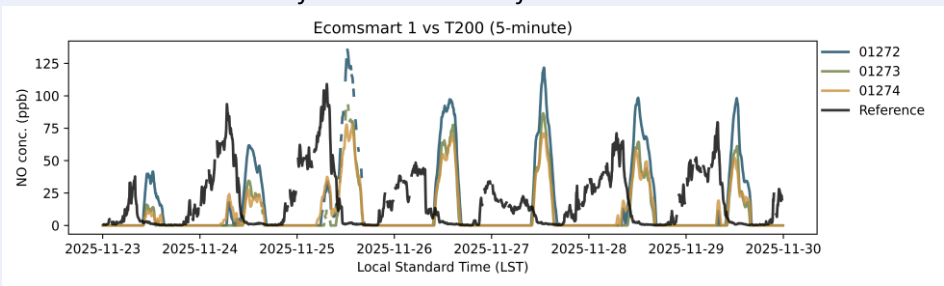
Section 3.1.4: Linearity (R^2)

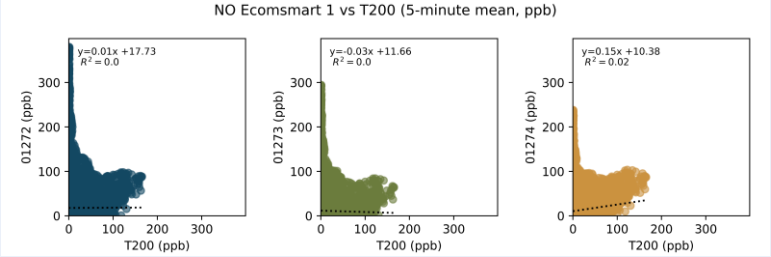
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and T200 across all units tested.

Parameter	Time Resolution	T200 (mean ± SD)
NO	5-minute	0.01 ± 0.01
	1-hour	0.01 ± 0.01
	24-hour	0.27 ± 0.09

Timeseries of a 1-week subset of the 8-week evaluation



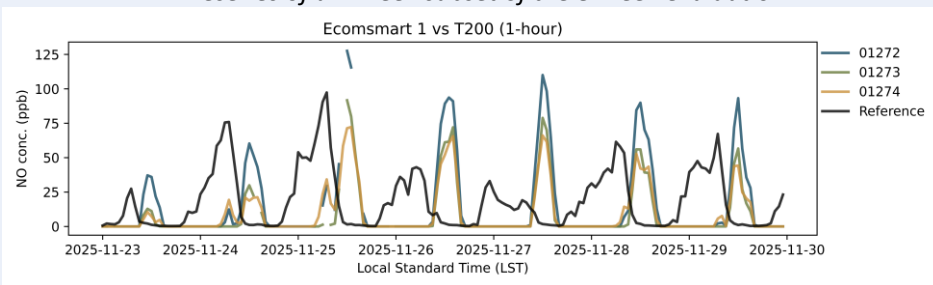


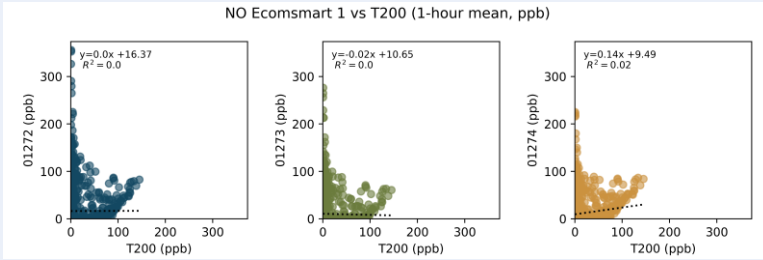
Interpretation: The EcomSmart 1 units showed no correlation with the corresponding T200 data (0.00 < R^2 < 0.02) for 5-minute averaging.

Section 3: NO

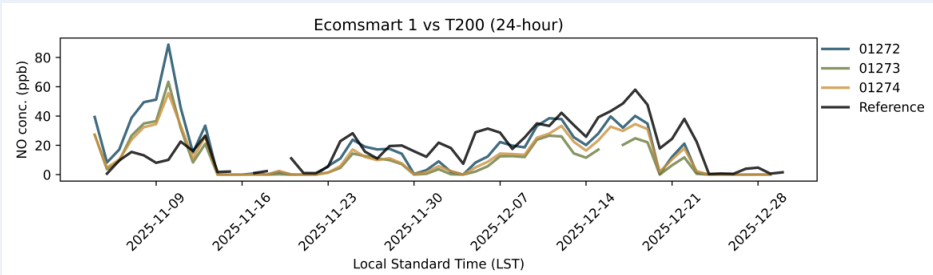
Section 3.1.4: Linearity (R^2)

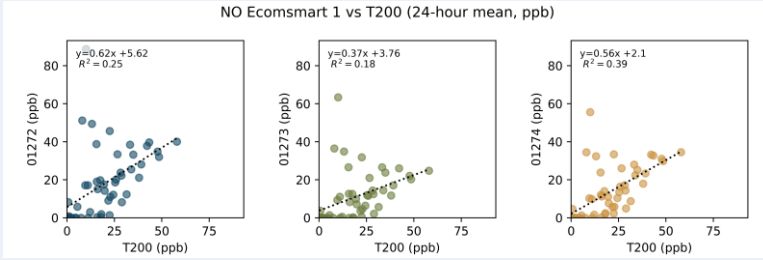
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed no correlation with the corresponding T200 data (0.00 < R^2 < 0.02) for 1-hour averaging.



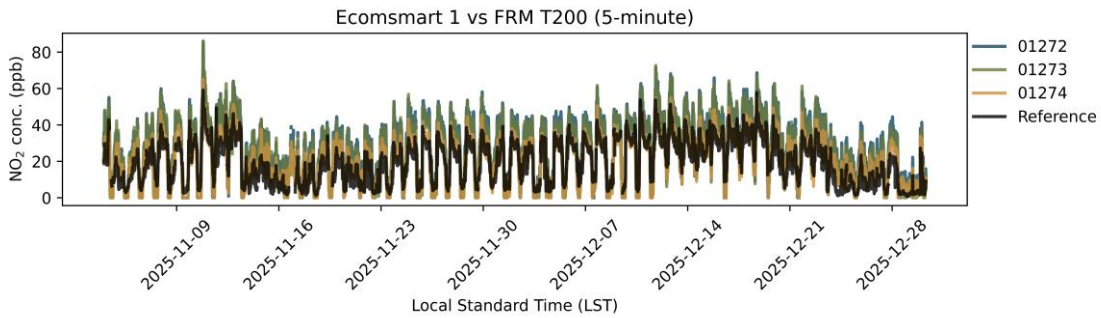


Interpretation: The EcomSmart 1 units showed very weak to weak correlation with the corresponding T200 data (0.18 < R^2 < 0.39) for 24-hour averaging.

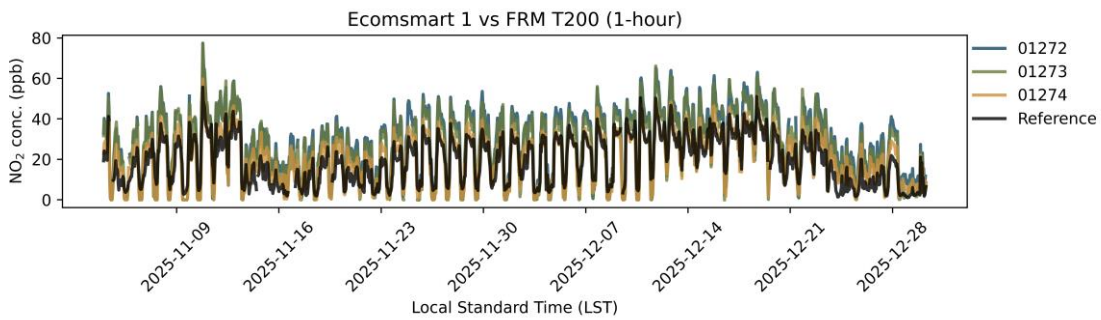
Section 3.2: NO_2

Section 3.2.1: Data Overview

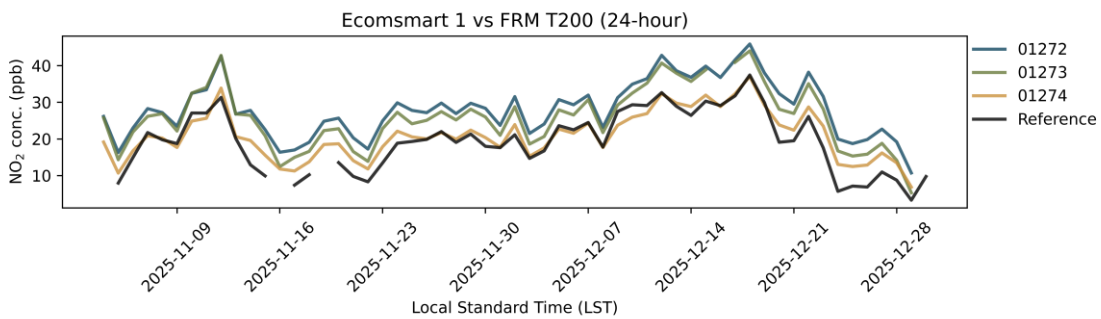
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 3.2: NO_2

Section 3.2.2: Data Recovery

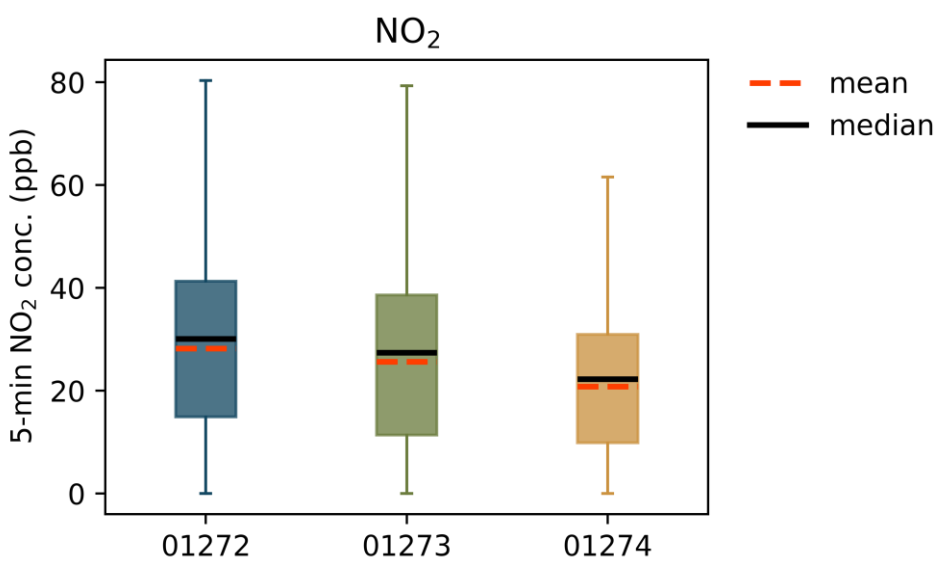
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
NO_2	95.1%	96.6%	98.2%

Section 3.2.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (ppb)	Relative intra-model variability (%)
NO_2	3.7	15.0



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 3.2: NO_2

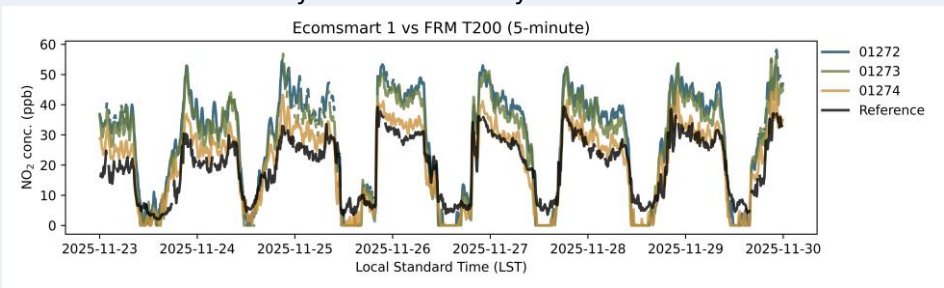
Section 3.2.4: Linearity (R^2)

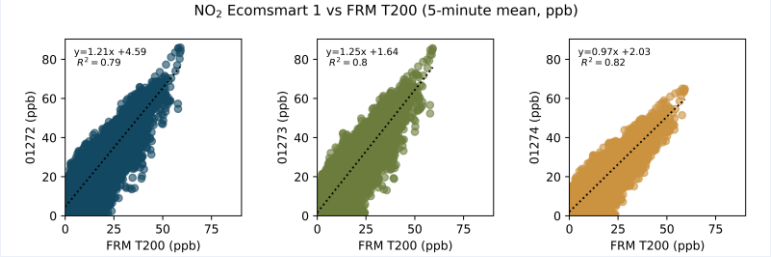
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and FRM T200 across all units tested.

Parameter	Time Resolution	FRM T200 (mean ± SD)
NO_2	5-minute	0.80 ± 0.01
	1-hour	0.83 ± 0.01
	24-hour	0.91 ± 0.01

Timeseries of a 1-week subset of the 8-week evaluation



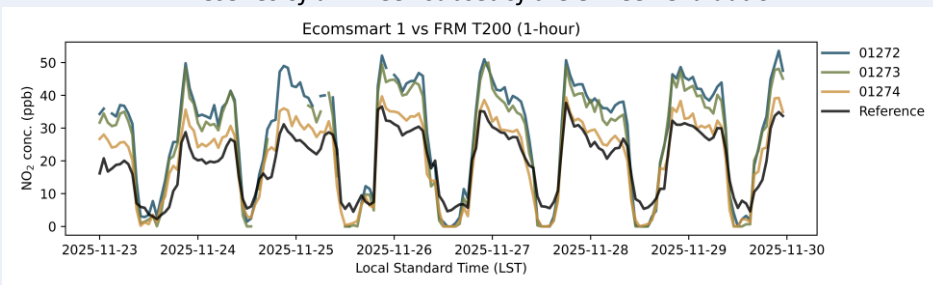


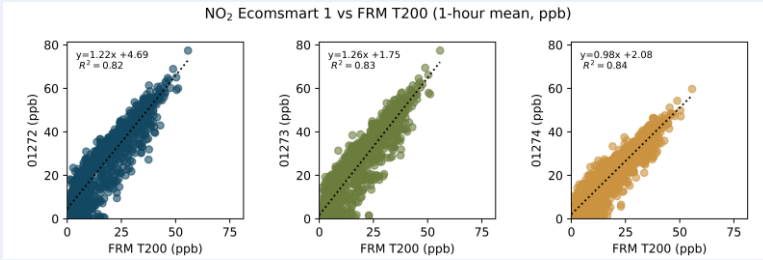
Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding FRM T200 data (0.79 < R^2 < 0.82) for 5-minute averaging.

Section 3.2: NO_2

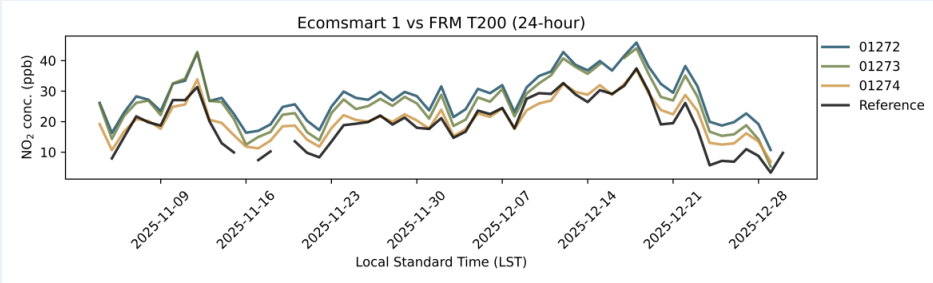
Section 3.2.4: Linearity (R^2)

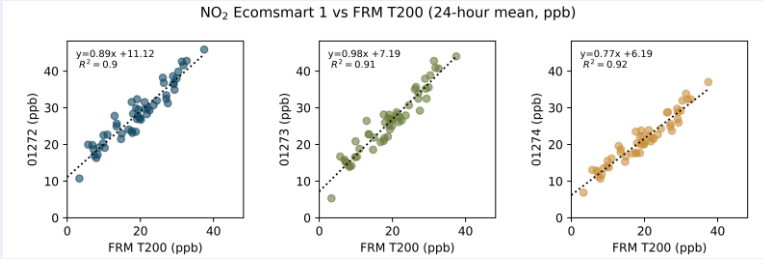
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding FRM T200 data (0.82 to 0.84) for 1-hour averaging.



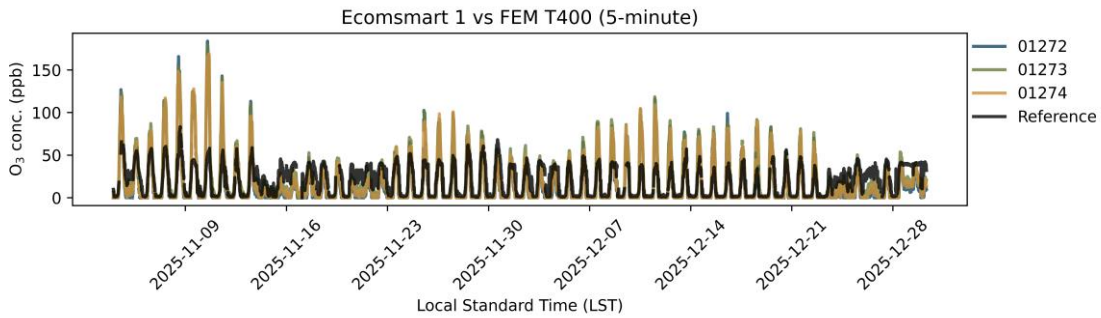


Interpretation: The EcomSmart 1 units showed very strong correlation with the corresponding FRM T200 data ($0.90 < R^2 < 0.92$) for 24-hour averaging.

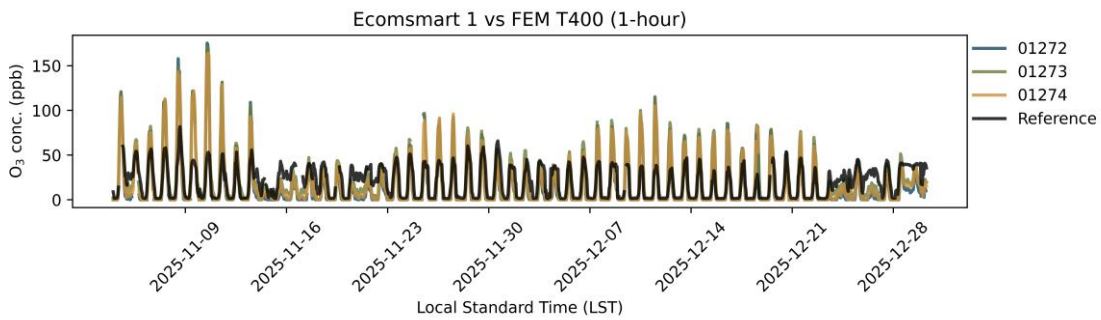
Section 3.3: O_3

Section 3.3.1: Data Overview

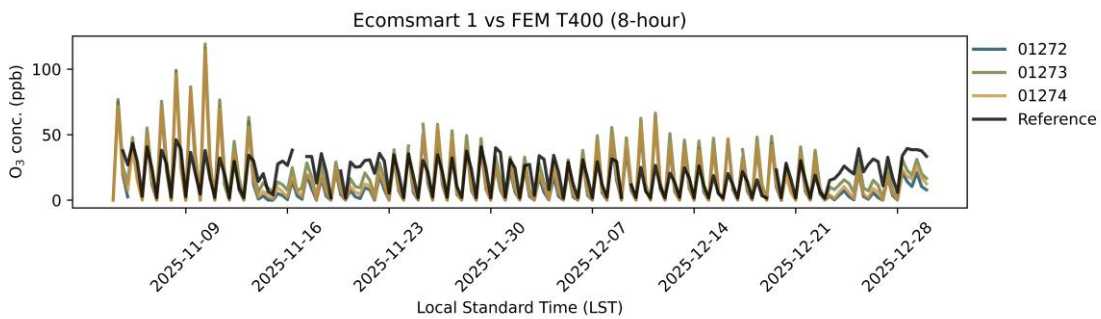
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 3.3: O_3

Section 3.3.2: Data Recovery

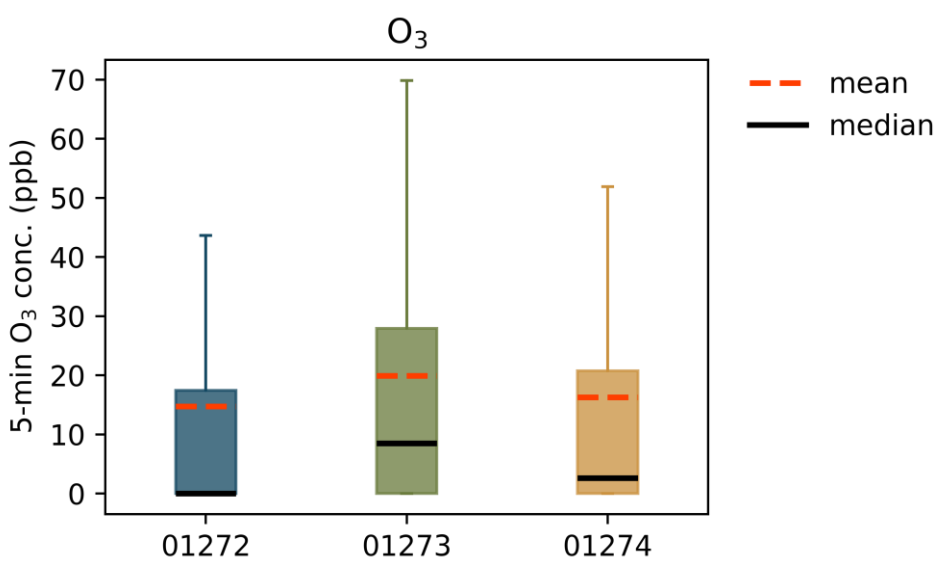
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
O_3	95.1%	96.6%	98.2%

Section 3.3.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (ppb)	Relative intra-model variability (%)
O_3	2.7	15.9



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 3.3: O_3

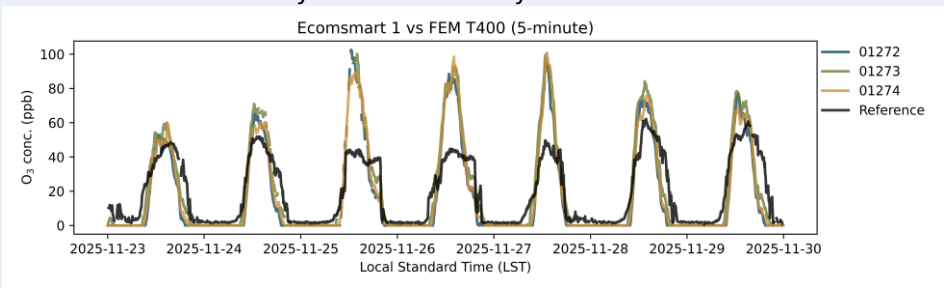
Section 3.3.4: Linearity (R^2)

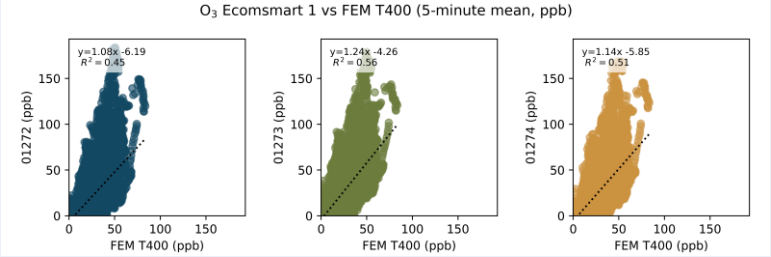
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and FEM T400 across all units tested.

Parameter	Time Resolution	FEM T400 (mean ± SD)
O_3	5-minute	0.51 ± 0.04
	1-hour	0.52 ± 0.05
	8-hour	0.42 ± 0.05

Timeseries of a 1-week subset of the 8-week evaluation



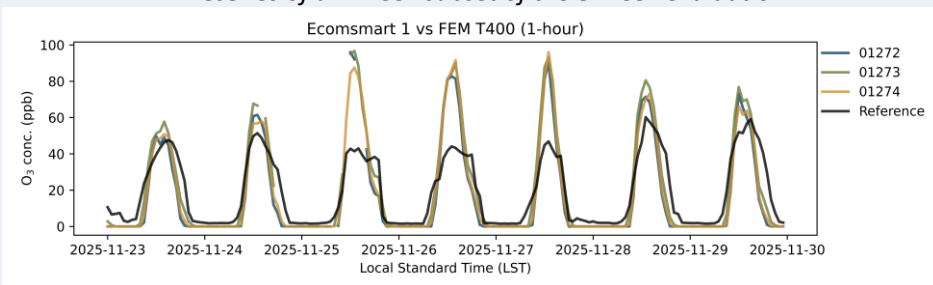


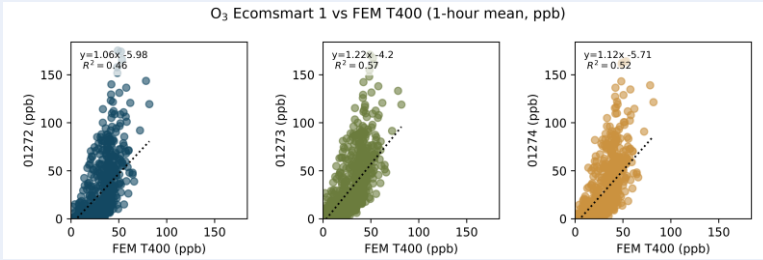
Interpretation: The EcomSmart 1 units showed weak to moderate correlation with the corresponding FEM T400 data (0.45 < R^2 < 0.56) for 5-minute averaging.

Section 3.3: O_3

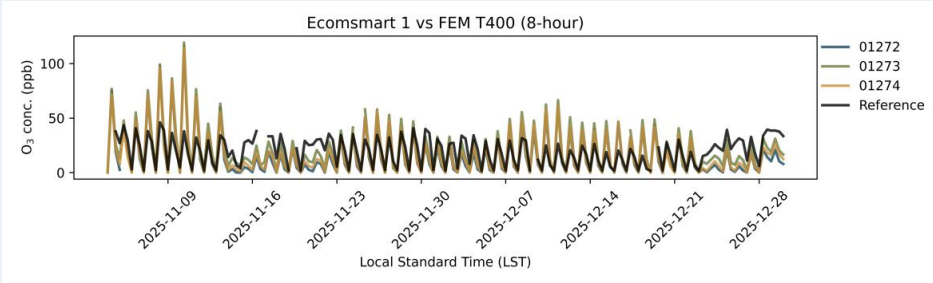
Section 3.3.4: Linearity (R^2)

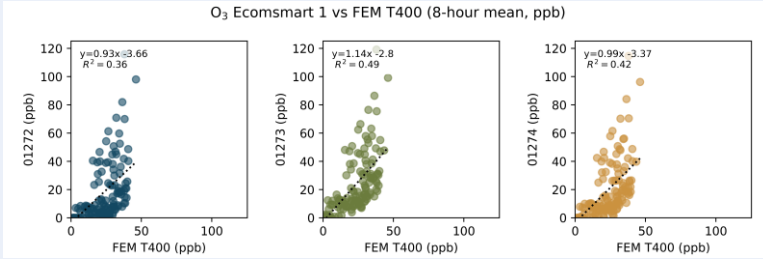
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed weak to moderate correlation with the corresponding FEM T400 data (0.46 < R^2 < 0.57) for 1-hour averaging.



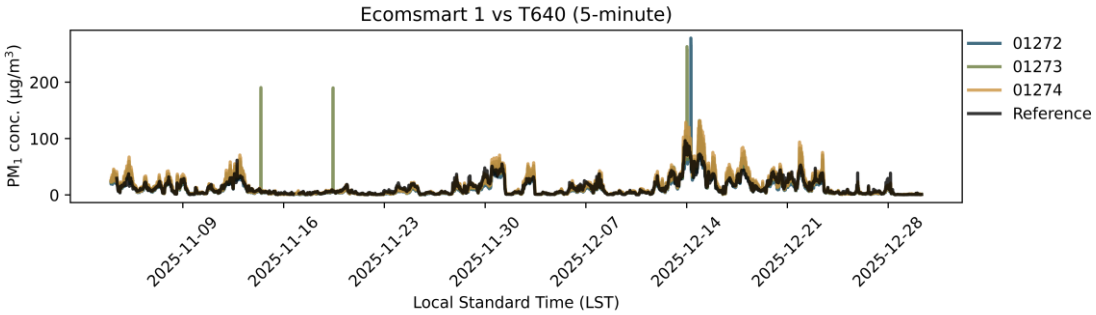


Interpretation: The EcomSmart 1 units showed weak correlation with the corresponding FEM T400 data (0.36 < R^2 < 0.49) for 8-hour averaging.

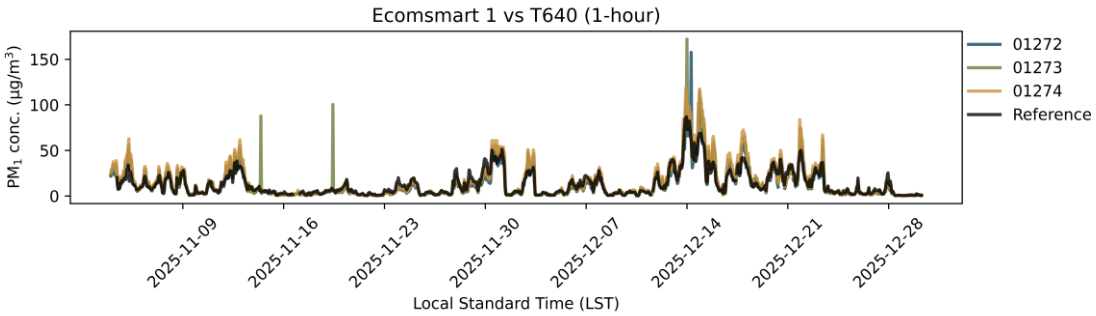
Section 3.4: PM_1

Section 3.4.1: Data Overview

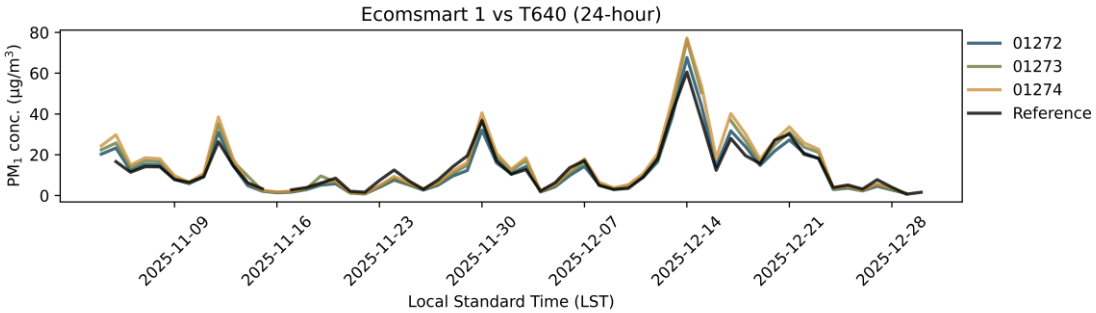
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 3.4: PM_1

Section 3.4.2: Data Recovery

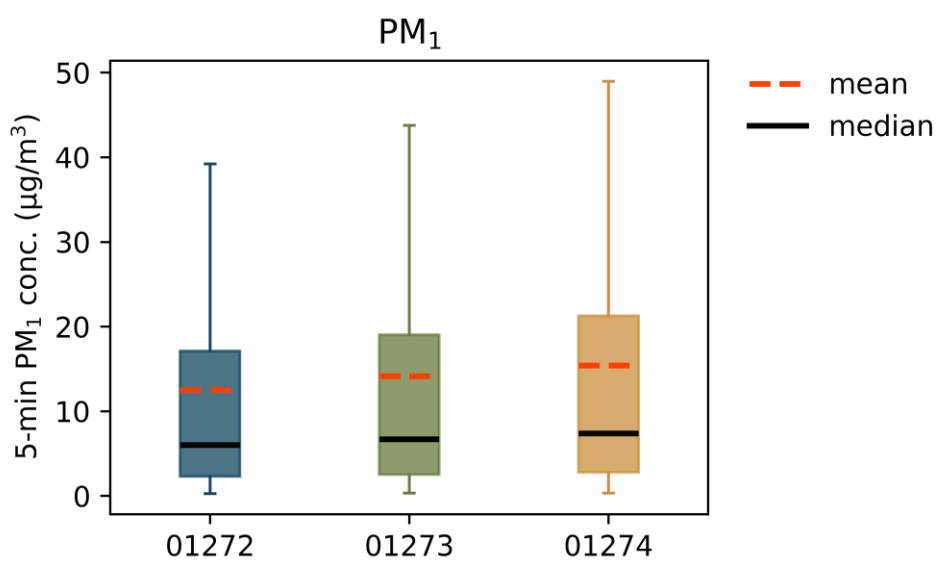
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
PM_1	95.1%	96.6%	98.2%

Section 3.4.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
PM_1	1.4	10.2



Interpretation: The EcomSmart 1 units had different pollutant distributions.

Section 3.4: PM_1

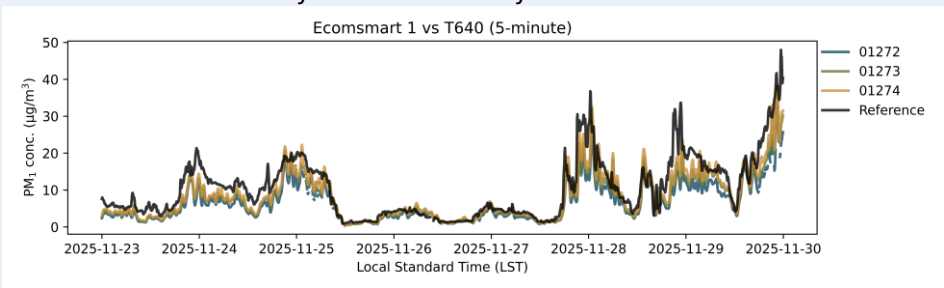
Section 3.4.4: Linearity (R^2)

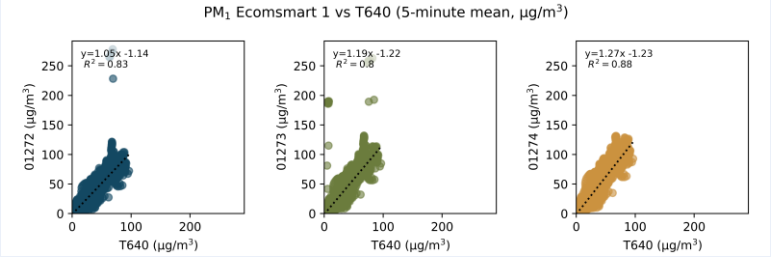
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and T640 across all units tested.

Parameter	Time Resolution	T640 (mean ± SD)
PM_1	5-minute	0.84 ± 0.04
	1-hour	0.89 ± 0.02
	24-hour	0.95 ± 0.00

Timeseries of a 1-week subset of the 8-week evaluation



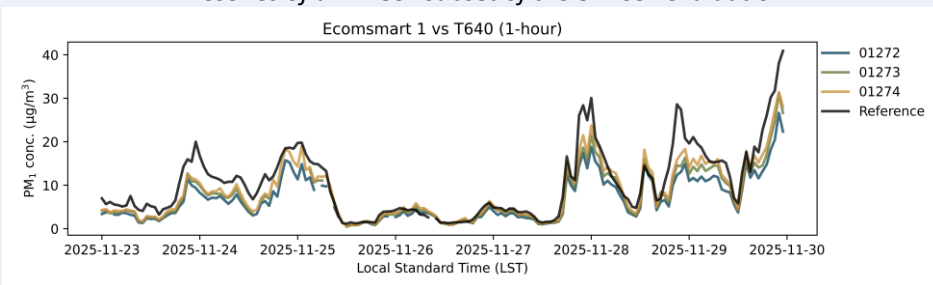


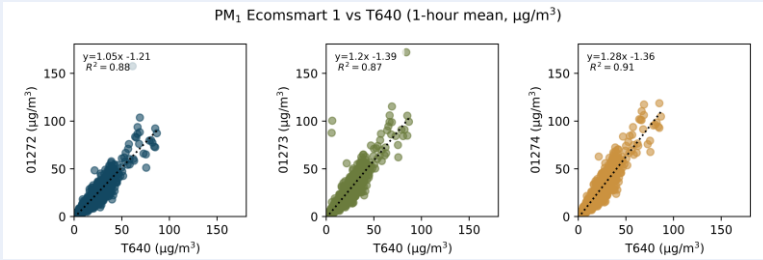
Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding T640 data ($0.80 < R^2 < 0.88$) for 5-minute averaging.

Section 3.4: PM_1

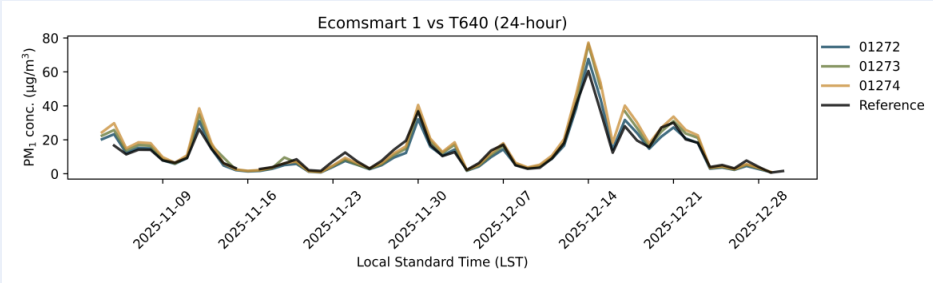
Section 3.4.4: Linearity (R^2)

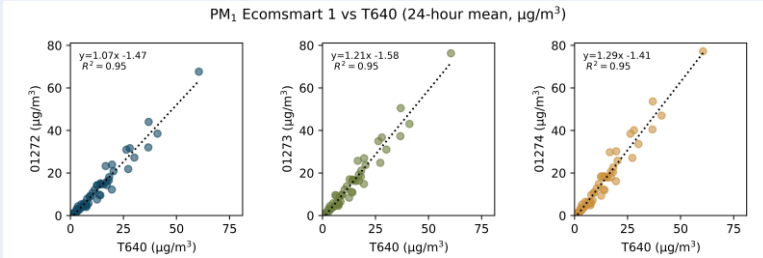
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed strong to very strong correlation with the corresponding T640 data (0.87 < R^2 < 0.91) for 1-hour averaging.



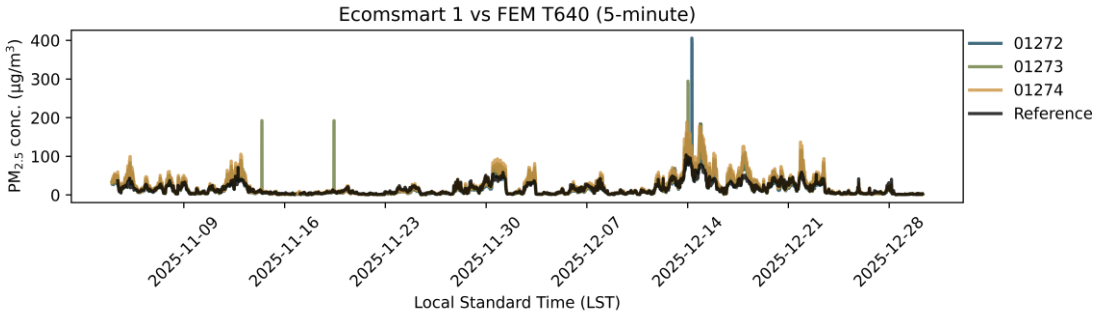


Interpretation: The EcomSmart 1 units showed very strong correlation with the corresponding T640 data (R^2 = 0.95) for 24-hour averaging.

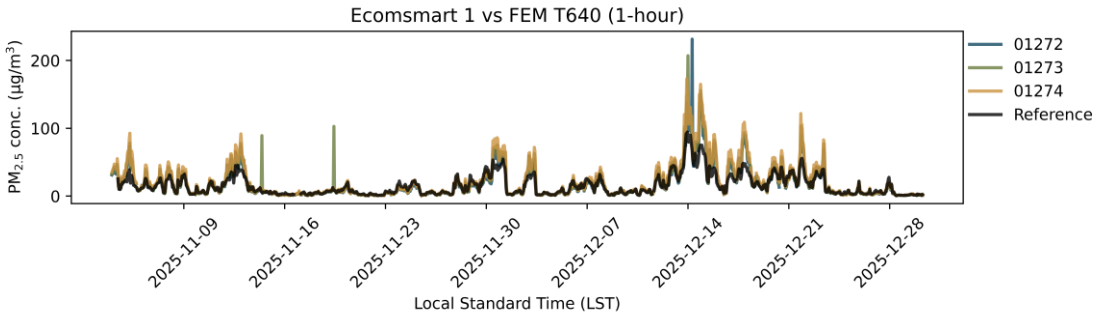
Section 3.5: $PM_{2.5}$

Section 3.5.1: Data Overview

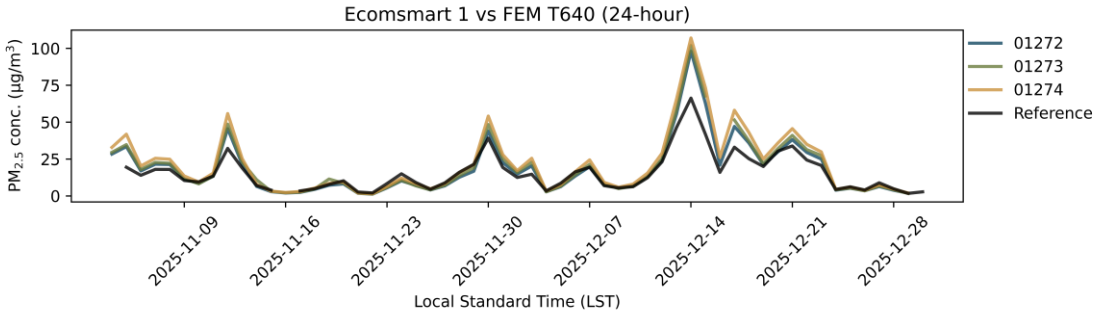
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 3.5: $PM_{2.5}$

Section 3.5.2: Data Recovery

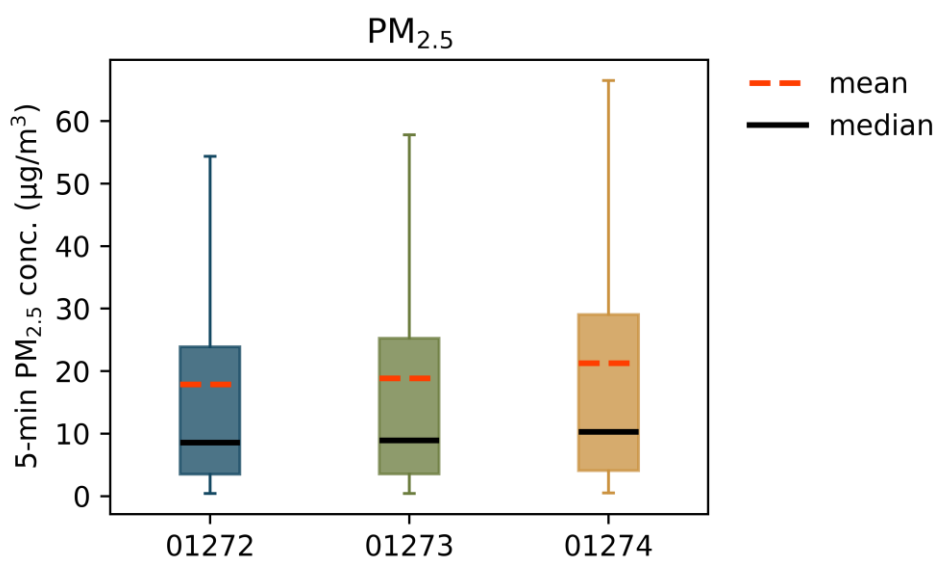
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
$PM_{2.5}$	95.1%	96.6%	98.2%

Section 3.5.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
$PM_{2.5}$	1.6	8.7



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 3.5: $PM_{2.5}$

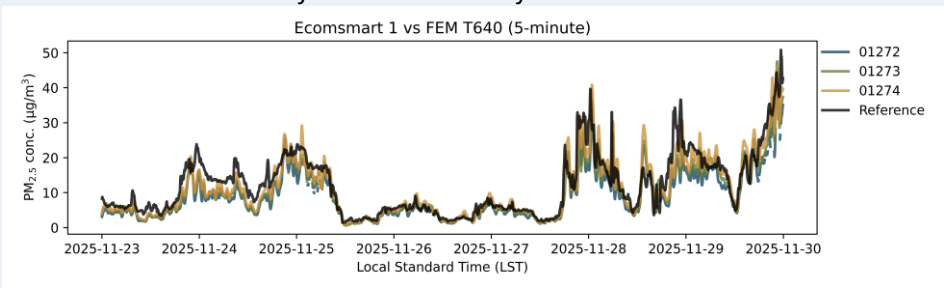
Section 3.5.4: Linearity (R^2)

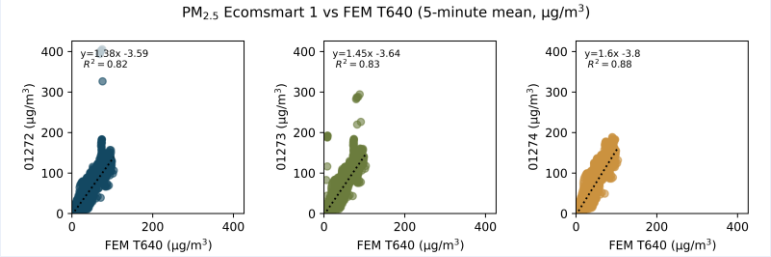
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and FEM T640 across all units tested.

Parameter	Time Resolution	FEM T640 (mean ± SD)
$PM_{2.5}$	5-minute	0.84 ± 0.02
	1-hour	0.89 ± 0.01
	24-hour	0.95 ± 0.00

Timeseries of a 1-week subset of the 8-week evaluation



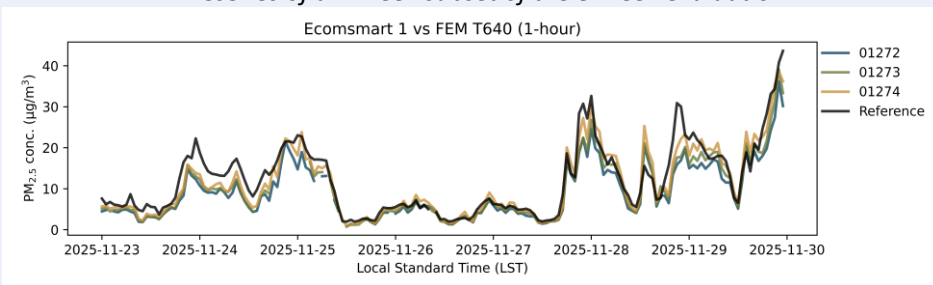


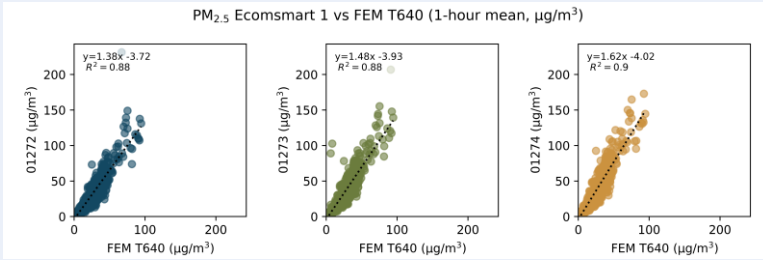
Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding FEM T640 data ($0.82 < R^2 < 0.88$) for 5-minute averaging.

Section 3.5: $PM_{2.5}$

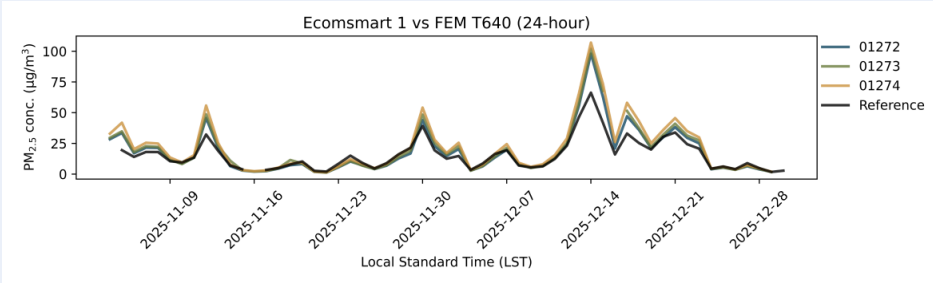
Section 3.5.4: Linearity (R^2)

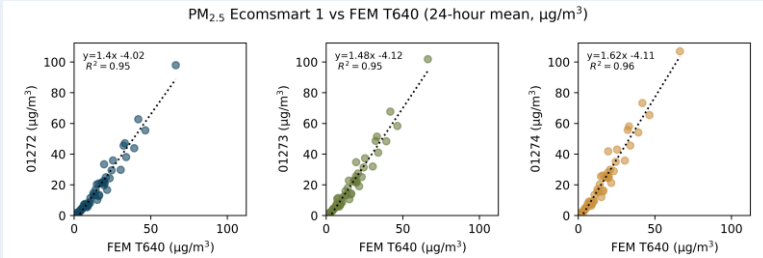
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed strong to very strong correlation with the corresponding FEM T640 data (0.88 < R^2 < 0.90) for 1-hour averaging.



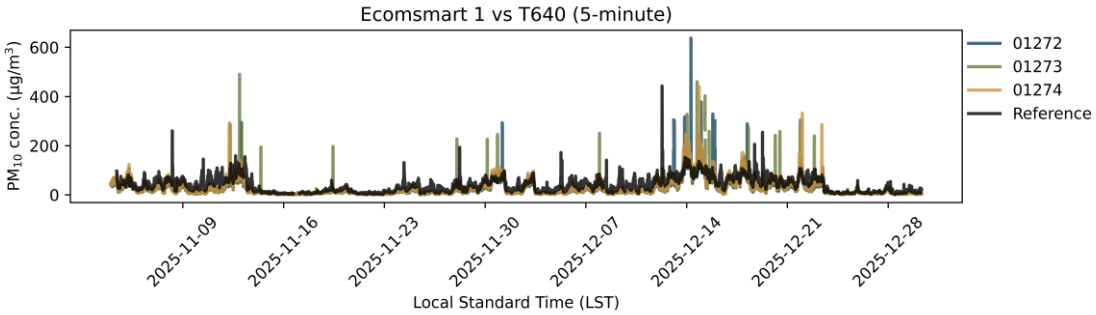


Interpretation: The EcomSmart 1 units showed very strong correlation with the corresponding FEM T640 data (0.95 < R^2 < 0.96) for 24-hour averaging.

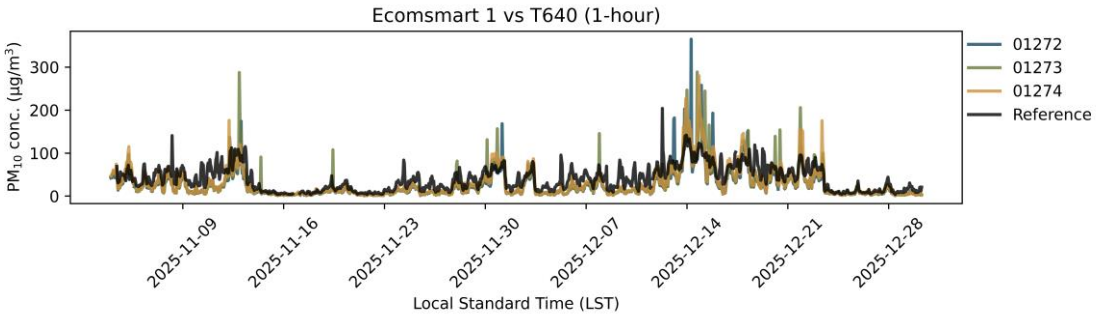
Section 3.6: PM_{10}

Section 3.6.1: Data Overview

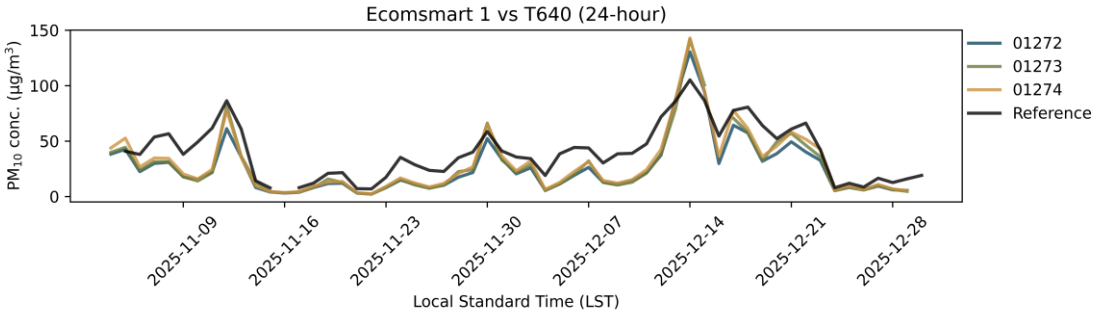
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 3.6: PM_{10}

Section 3.6.2: Data Recovery

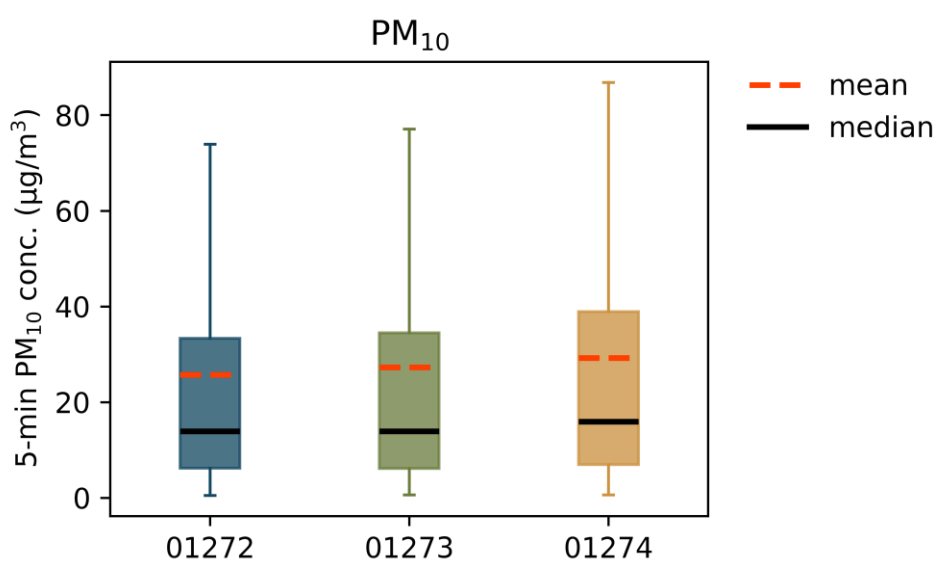
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
PM_{10}	95.1%	96.6%	98.2%

Section 3.6.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
PM_{10}	1.7	6.3



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 3.6: PM_{10}

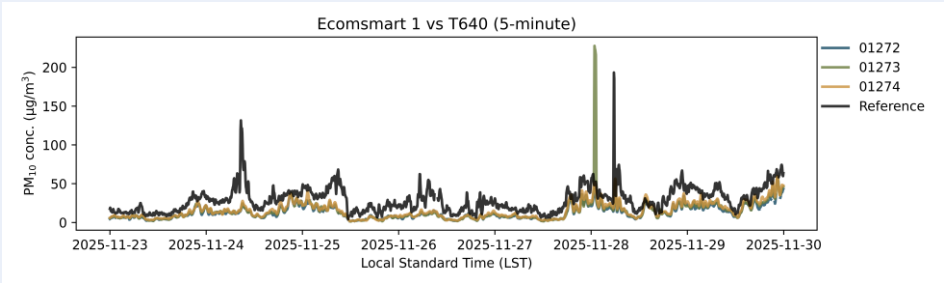
Section 3.6.4: Linearity (R^2)

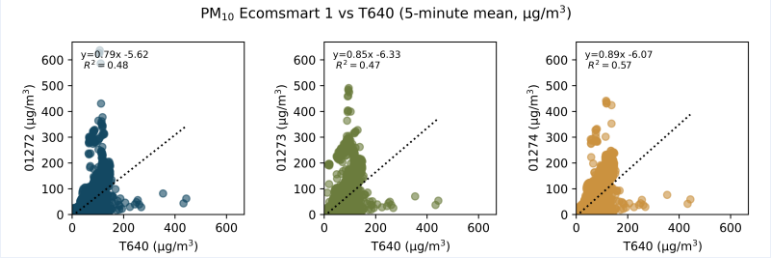
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and T640 across all units tested.

Parameter	Time Resolution	T640 (mean ± SD)
PM_{10}	5-minute	0.51 ± 0.04
	1-hour	0.60 ± 0.03
	24-hour	0.79 ± 0.01

Timeseries of a 1-week subset of the 8-week evaluation



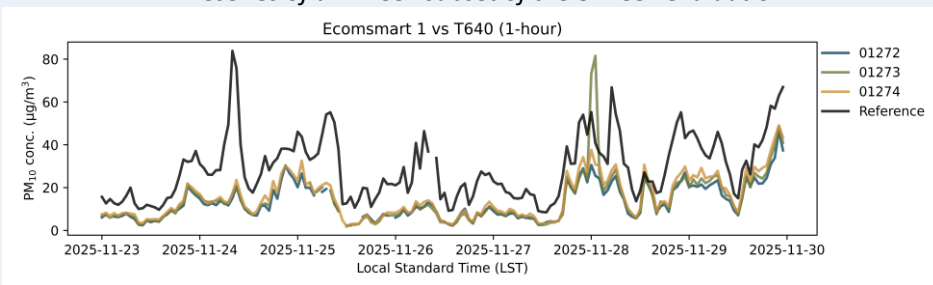


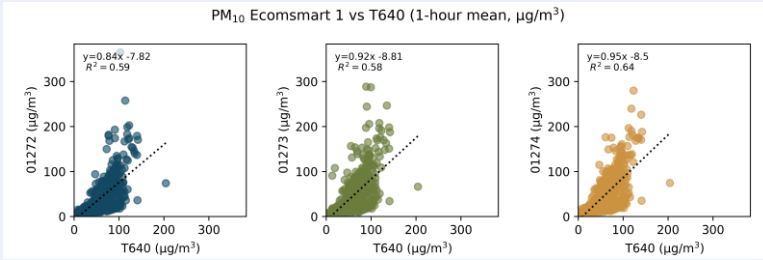
Interpretation: The EcomSmart 1 units showed weak to moderate correlation with the corresponding T640 data (0.47 < R^2 < 0.57) for 5-minute averaging.

Section 3.6: PM_{10}

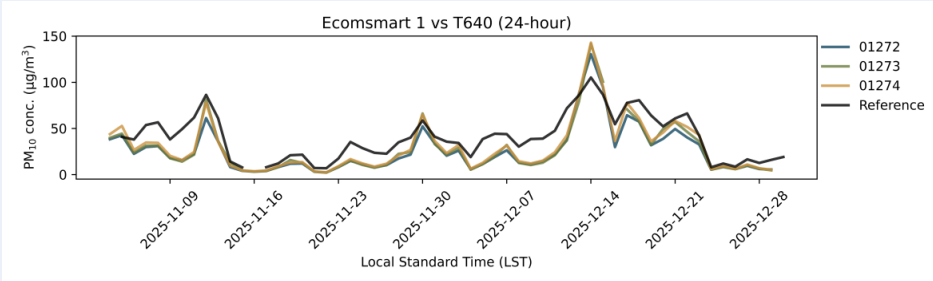
Section 3.6.4: Linearity (R^2)

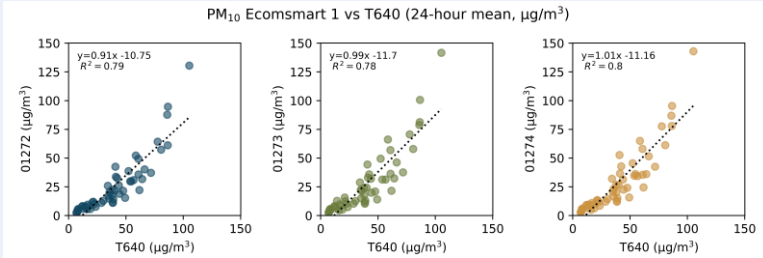
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed moderate correlation with the corresponding T640 data ($0.58 < R^2 < 0.64$) for 1-hour averaging.





Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding T640 data ($0.78 < R^2 < 0.80$) for 24-hour averaging.

Section 3.7: Summary Metrics

		NO		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	13.29	13.29	13.40
	SD*	32.51	32.25	14.89
	Range*	0.00 to 379.80	0.00 to 355.78	0.00 to 88.77
	Abs. IMV*	3.0	3.0	3.2
	Rel. IMV (%)	23.4	23.3	24.4
	CV (RSD, %)	247.12	245.00	112.16
T200	Average*	18.44	18.79	18.43
	SD*	27.39	26.80	14.75
	Range*	0.01 to 165.30	0.10 to 145.08	0.43 to 57.98
	CV (RSD, %)	148.53	142.61	80.07
EcomSmart 1 vs. T200	Pearson R^2	0.00 to 0.02	0.00 to 0.02	0.18 to 0.39
	Spearman ρ	0.14 to 0.33	0.14 to 0.34	0.65 to 0.74
	Kendall τ	0.11 to 0.26	0.11 to 0.26	0.48 to 0.57
	Slope	-0.03 to 0.15	-0.02 to 0.14	0.37 to 0.62
	Intercept*	10.38 to 17.73	9.49 to 16.37	2.10 to 5.62
	MBE*	-6.74 to -0.86	-8.19 to -2.63	-7.67 to -1.41
	$nMBE_{mean}$	-0.38 to -0.05	-0.44 to -0.14	-0.42 to -0.08
	$nMBE_{range}$	-0.04 to -0.01	-0.06 to -0.02	-0.13 to -0.02
	MAE*	22.78 to 28.88	22.53 to 28.21	10.40 to 12.55
	$nMAE_{mean}$	1.24 to 1.55	1.20 to 1.48	0.56 to 0.69
	$nMAE_{range}$	0.14 to 0.17	0.16 to 0.19	0.18 to 0.22
	RMSE*	36.84 to 49.80	35.85 to 48.07	13.59 to 16.79
	$nRMSE_{mean}$	2.00 to 2.67	1.91 to 2.52	0.73 to 0.91
	$nRMSE_{range}$	0.22 to 0.30	0.25 to 0.33	0.24 to 0.29

*Units in: ppb

Section 3.7: Summary Metrics

		NO_2		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	24.90	24.96	24.95
	SD*	15.09	14.79	7.57
	Range*	0.00 to 86.07	0.00 to 77.44	5.33 to 45.90
	CV (RSD, %)	60.72	59.37	30.50
	Abs. IMV*	3.7	3.7	3.7
	Rel. IMV (%)	15.0	14.9	14.9
FRM T200	Average*	19.09	19.38	19.24
	SD*	11.85	11.62	8.26
	Range*	0.82 to 59.22	1.02 to 55.68	3.31 to 37.44
	CV (RSD, %)	62.11	59.96	42.94
EcomSmart 1 vs. FRM T200	Pearson R^2	0.79 to 0.82	0.82 to 0.84	0.90 to 0.92
	Spearman ρ	0.89 to 0.90	0.91 to 0.92	0.93 to 0.95
	Kendall τ	0.71 to 0.72	0.74 to 0.75	0.79 to 0.82
	Slope	0.97 to 1.25	0.98 to 1.26	0.77 to 0.98
	Intercept*	1.65 to 4.59	1.75 to 4.69	6.19 to 11.12
	MBE*	1.52 to 8.70	1.71 to 9.08	1.76 to 9.06
	$nMBE_{mean}$	0.08 to 0.45	0.09 to 0.46	0.09 to 0.47
	$nMBE_{range}$	0.03 to 0.15	0.03 to 0.17	0.05 to 0.27
	MAE*	4.66 to 10.44	4.35 to 10.50	2.48 to 9.06
	$nMAE_{mean}$	0.24 to 0.54	0.23 to 0.54	0.13 to 0.47
	$nMAE_{range}$	0.08 to 0.18	0.08 to 0.19	0.07 to 0.27
	RMSE*	5.67 to 11.71	5.17 to 11.61	3.16 to 9.41
	$nRMSE_{mean}$	0.30 to 0.61	0.27 to 0.59	0.16 to 0.48
	$nRMSE_{range}$	0.10 to 0.20	0.09 to 0.21	0.09 to 0.28

*Units in: ppb

Section 3.7: Summary Metrics

		O_3		
		5-minute averages	1-hour averages	8-hour averages
EcomSmart 1	Average*	16.98	16.94	17.16
	SD*	27.24	27.05	20.97
	Range*	0.00 to 183.83	0.00 to 175.29	0.00 to 119.23
	CV (RSD, %)	162.63	161.83	123.83
	Abs. IMV*	2.7	2.7	2.7
	Rel. IMV (%)	15.9	15.9	15.5
FEM T400	Average*	20.05	19.23	19.36
	SD*	17.13	16.93	13.15
	Range*	0.00 to 83.44	1.21 to 81.81	1.43 to 46.07
	CV (RSD, %)	85.41	88.02	67.94
EcomSmart 1 vs. FEM T400	Pearson R^2	0.45 to 0.56	0.46 to 0.57	0.36 to 0.49
	Spearman ρ	0.83 to 0.87	0.85 to 0.89	0.80 to 0.83
	Kendall τ	0.65 to 0.69	0.68 to 0.71	0.60 to 0.64
	Slope	1.08 to 1.24	1.06 to 1.22	0.93 to 1.14
	Intercept*	-6.19 to -4.26	-5.98 to -4.20	-3.66 to -2.80
	MBE*	-4.56 to 0.63	-4.85 to 0.09	-4.94 to -0.11
	$nMBE_{mean}$	-0.23 to 0.03	-0.25 to 0.00	-0.26 to -0.01
	$nMBE_{range}$	-0.06 to 0.01	-0.06 to 0.00	-0.11 to -0.00
	MAE*	11.89 to 14.15	11.18 to 13.54	10.46 to 12.64
	$nMAE_{mean}$	0.59 to 0.71	0.58 to 0.71	0.53 to 0.65
	$nMAE_{range}$	0.14 to 0.17	0.14 to 0.17	0.23 to 0.28
	RMSE*	19.29 to 20.86	18.29 to 20.04	15.44 to 16.97
	$nRMSE_{mean}$	0.95 to 1.04	0.95 to 1.05	0.78 to 0.88
	$nRMSE_{range}$	0.23 to 0.25	0.23 to 0.25	0.35 to 0.38

*Units in: ppb

Section 3.7: Summary Metrics

		PM_1		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	14.03	14.06	14.22
	SD*	17.72	17.31	14.11
	Range*	0.26 to 278.20	0.33 to 172.15	0.80 to 77.27
	CV (RSD, %)	126.53	123.18	99.29
	Abs. IMV*	1.4	1.4	1.5
	Rel. IMV (%)	10.2	10.2	10.2
T640	Average*	13.10	13.11	13.06
	SD*	13.92	13.84	11.64
	Range*	0.23 to 96.37	0.25 to 86.78	0.68 to 60.55
	CV (RSD, %)	106.31	105.60	89.11
EcomSmart 1 vs. T640	Pearson R^2	0.80 to 0.88	0.87 to 0.91	0.95
	Spearman ρ	0.96	0.97	0.97
	Kendall τ	0.82 to 0.83	0.84 to 0.85	0.86 to 0.87
	Slope	1.05 to 1.27	1.05 to 1.28	1.07 to 1.29
	Intercept*	-1.23 to -1.14	-1.39 to -1.21	-1.58 to -1.41
	MBE*	-0.51 to 2.32	-0.54 to 2.32	-0.54 to 2.38
	$nMBE_{mean}$	-0.04 to 0.18	-0.04 to 0.18	-0.04 to 0.18
	$nMBE_{range}$	-0.01 to 0.02	-0.01 to 0.03	-0.01 to 0.04
	MAE*	3.30 to 4.18	2.94 to 3.90	2.12 to 3.29
	$nMAE_{mean}$	0.25 to 0.32	0.23 to 0.30	0.16 to 0.25
	$nMAE_{range}$	0.03 to 0.04	0.03 to 0.05	0.04 to 0.06
	RMSE*	6.69 to 8.76	5.41 to 7.18	2.91 to 5.23
	$nRMSE_{mean}$	0.51 to 0.68	0.41 to 0.55	0.22 to 0.39
	$nRMSE_{range}$	0.07 to 0.09	0.06 to 0.08	0.05 to 0.09

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

Section 3.7: Summary Metrics

		$PM_{2.5}$		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	19.35	19.40	19.61
	SD*	24.41	23.92	19.57
	Range*	0.41 to 405.77	0.52 to 231.42	1.23 to 107.04
	CV (RSD, %)	126.38	123.48	99.89
	Abs. IMV*	1.6	1.7	1.7
	Rel. IMV (%)	8.7	8.6	8.7
	PM_c Conc.*	7.87 to 8.41	7.82 to 8.50	7.88 to 8.57
	Fine Fraction	0.65 to 0.67	0.64 to 0.67	0.66 to 0.69
FEM T640	Average*	15.66	15.67	15.62
	SD*	15.21	15.11	12.80
	Range*	0.64 to 103.50	0.81 to 94.42	1.76 to 66.29
	CV (RSD, %)	97.11	96.42	81.93
	PM_c Conc.*	24.20	24.21	24.33
	Fine Fraction	0.38	0.38	0.38
EcomSmart 1 vs. FEM T640	Pearson R^2	0.82 to 0.88	0.88 to 0.90	0.95 to 0.96
	Spearman ρ	0.96 to 0.97	0.97 to 0.98	0.97 to 0.98
	Kendall τ	0.83 to 0.85	0.85 to 0.87	0.89
	Slope	1.38 to 1.60	1.38 to 1.62	1.40 to 1.62
	Intercept*	-3.80 to -3.59	-4.02 to -3.72	-4.12 to -4.02
	MBE*	2.28 to 5.64	2.26 to 5.64	2.32 to 5.77
	$nMBE_{mean}$	0.15 to 0.36	0.14 to 0.36	0.15 to 0.36
	$nMBE_{range}$	0.02 to 0.05	0.02 to 0.06	0.04 to 0.09
	MAE*	5.18 to 7.11	4.80 to 6.81	3.84 to 6.25
	$nMAE_{mean}$	0.33 to 0.45	0.31 to 0.43	0.24 to 0.39
	$nMAE_{range}$	0.05 to 0.07	0.05 to 0.07	0.06 to 0.10
	RMSE*	11.64 to 14.15	10.06 to 13.55	6.82 to 10.75
	$nRMSE_{mean}$	0.75 to 0.90	0.64 to 0.87	0.43 to 0.68
	$nRMSE_{range}$	0.11 to 0.14	0.11 to 0.14	0.11 to 0.17

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

Section 3.7: Summary Metrics

		PM_{10}		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	27.43	27.49	27.76
	SD*	35.30	33.46	26.64
	Range*	0.49 to 637.47	0.79 to 365.21	2.12 to 143.00
	CV (RSD, %)	128.96	121.88	96.02
	Abs. IMV*	1.7	1.7	1.8
	Rel. IMV (%)	6.3	6.4	6.4
	PM_c Conc.*	7.87 to 8.41	7.82 to 8.50	7.88 to 8.57
	Fine Fraction	0.65 to 0.67	0.64 to 0.67	0.66 to 0.69
T640	Average*	39.86	39.88	39.96
	SD*	29.80	28.79	24.39
	Range*	1.35 to 443.23	3.23 to 204.08	6.86 to 105.19
	CV (RSD, %)	74.77	72.19	61.04
	PM_c Conc.*	24.20	24.21	24.33
	Fine Fraction	0.38	0.38	0.38
EcomSmart 1 vs. T640	Pearson R^2	0.47 to 0.57	0.58 to 0.64	0.78 to 0.80
	Spearman ρ	0.89 to 0.90	0.90 to 0.92	0.91 to 0.93
	Kendall τ	0.71 to 0.72	0.73 to 0.75	0.76 to 0.79
	Slope	0.79 to 0.89	0.84 to 0.95	0.91 to 1.01
	Intercept*	-6.33 to -5.62	-8.81 to -7.82	-11.70 to -10.75
	MBE*	-14.13 to -10.48	-14.23 to -10.49	-14.20 to -10.61
	$nMBE_{mean}$	-0.35 to -0.26	-0.36 to -0.26	-0.35 to -0.26
	$nMBE_{range}$	-0.03 to -0.02	-0.07 to -0.05	-0.14 to -0.11
	MAE*	16.62 to 18.50	16.13 to 17.97	13.07 to 15.57
	$nMAE_{mean}$	0.42 to 0.47	0.41 to 0.45	0.32 to 0.39
	$nMAE_{range}$	0.04	0.08 to 0.09	0.13 to 0.16
	RMSE*	25.57 to 29.89	22.93 to 25.87	16.30 to 18.37
	$nRMSE_{mean}$	0.64 to 0.76	0.58 to 0.65	0.40 to 0.46
	$nRMSE_{range}$	0.06 to 0.07	0.11 to 0.13	0.17 to 0.19

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

Summary Metrics Guide

Average:	mean of individual sensor means; the grand mean
SD:	mean of individual sensor standard deviations (σ; measure of variation of the values about its mean)
Range:	the highest and the lowest values observed
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)
Abs. IMV:	intra-model variability expressed in absolute terms; standard deviation of individual sensor means
Rel. IMV:	intra-model variability expressed in relative terms; the ratio of the Absolute IMV to the Average
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)
Spearman ρ:	Spearman's rank correlation coefficient; a measure of how well the reference and sensor measurements follow a monotonic relationship, based on their ranked values (a value from -1 to 1)
Kendall τ:	Kendall's rank correlation coefficient; a measure of the agreement in ordering between paired reference and sensor measurements, based on how often the pairs are in the same vs. opposite order (a value from -1 to 1)
Slope:	change in the sensor's value per unit increase in the reference monitor's value
Intercept:	the sensor's value when the reference monitor observes zero
MBE:	mean bias error; mean of the differences between reference and sensor measurements
$nMBE_{mean}$:	mean bias error normalized with respect to the reference mean value
$nMBE_{range}$:	mean bias error normalized with respect to the difference of the highest and lowest reference values
MAE:	mean absolute error; mean of the absolute differences between reference and sensor measurements
$nMAE_{mean}$:	mean absolute error normalized with respect to the reference mean value
$nMAE_{range}$:	mean absolute error normalized with respect to the difference of the highest and lowest reference values
RMSE:	root mean square error; the square root of the average squared differences between reference and sensor measurements
$nRMSE_{mean}$:	root mean square error normalized with respect to the reference mean value
$nRMSE_{range}$:	root mean square error normalized with respect to the difference of the highest and lowest reference values

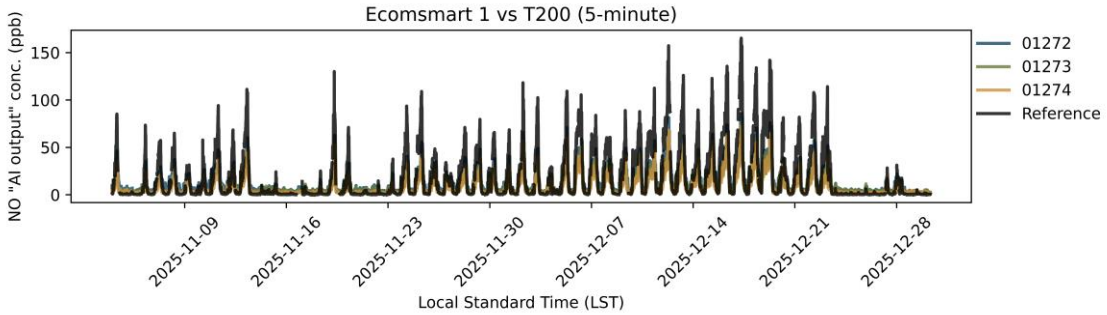
Section 4:
Evaluation of “AI” outputs*

*Although some outputs are called “AI”, they are generated using temperature- and humidity-based corrections using data collected in France and not data from the AQ-SPEC test site. “AI” outputs are included in this report to fully inform consumers if they purchase the “AI-Ready” version of this device.

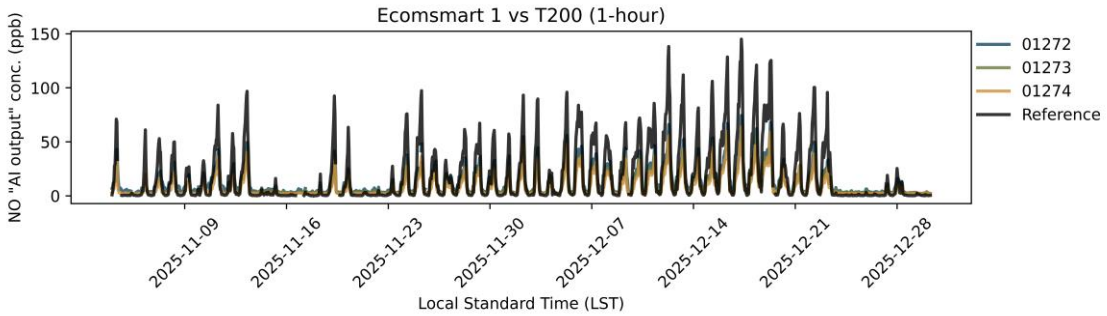
Section 4.1: NO “AI” output

Section 4.1.1: Data Overview

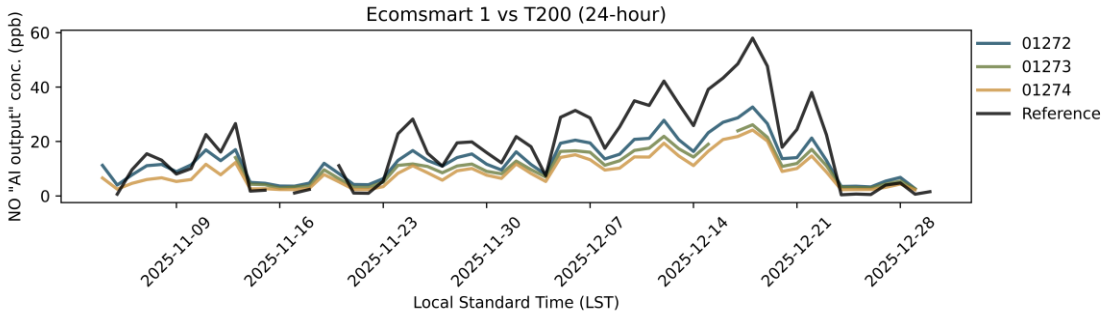
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 4.1: NO “AI” output

Section 4.1.2: Data Recovery

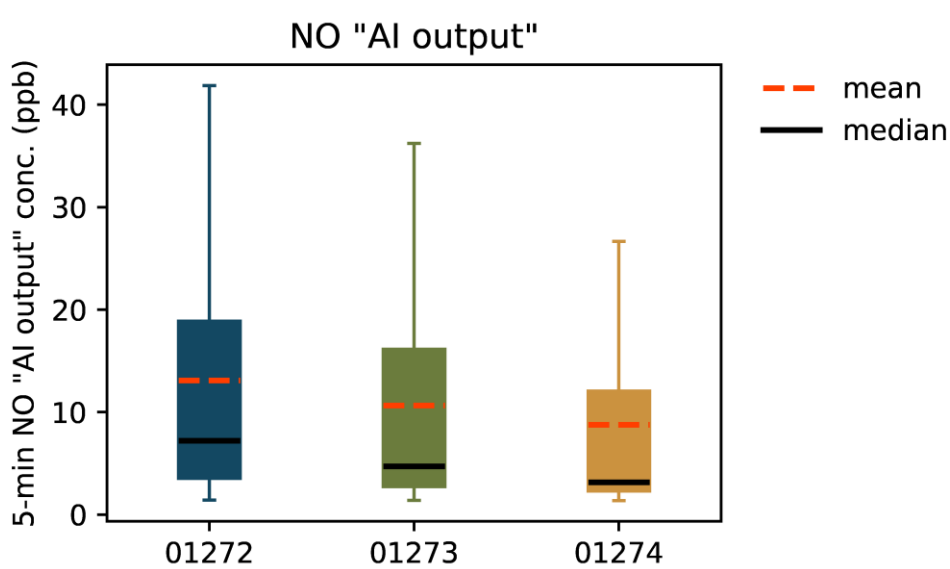
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
NO “AI”	95.0%	84.4%	98.1%

Section 4.1.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (ppb)	Relative intra-model variability (%)
NO “AI”	2.0	18.7



Interpretation: The EcomSmart 1 units had different pollutant distributions.

Section 4.1: NO "AI" output

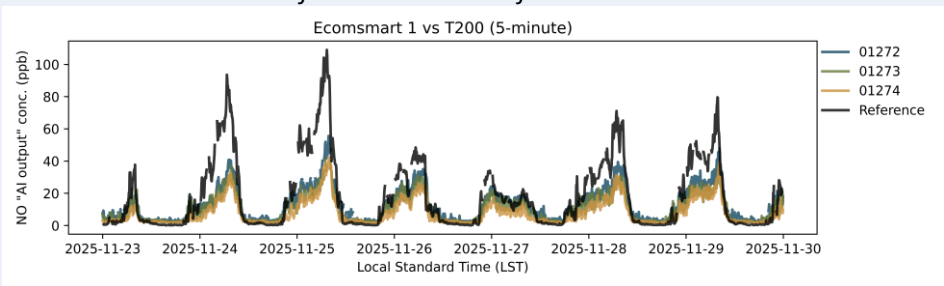
Section 4.1.4: Linearity (R^2)

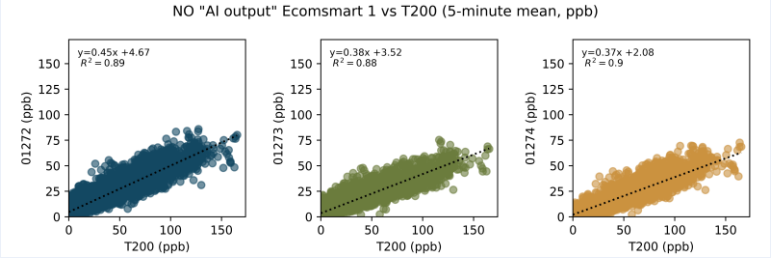
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and T200 across all units tested.

Parameter	Time Resolution	T200 (mean ± SD)
NO "AI"	5-minute	0.89 ± 0.00
	1-hour	0.94 ± 0.00
	24-hour	0.98 ± 0.00

Timeseries of a 1-week subset of the 8-week evaluation



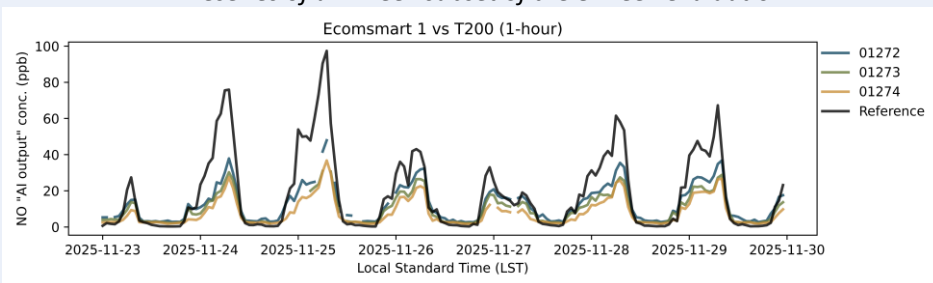


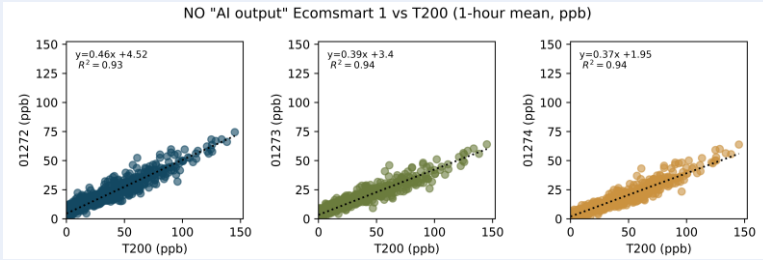
Interpretation: The EcomSmart 1 units showed strong to very strong correlation with the corresponding T200 data (0.88 < R^2 < 0.90) for 5-minute averaging.

Section 4.1: NO "AI" output

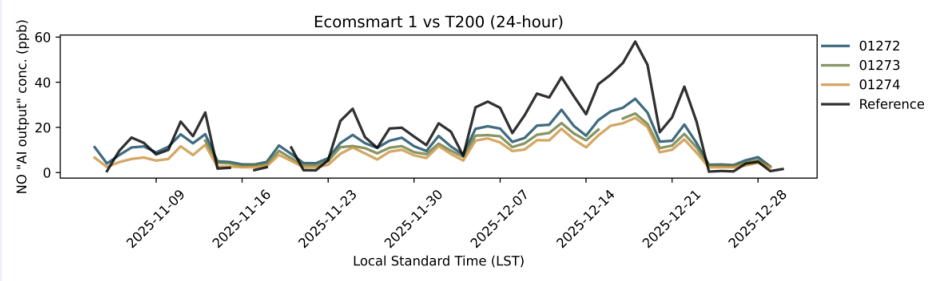
Section 4.1.4: Linearity (R^2)

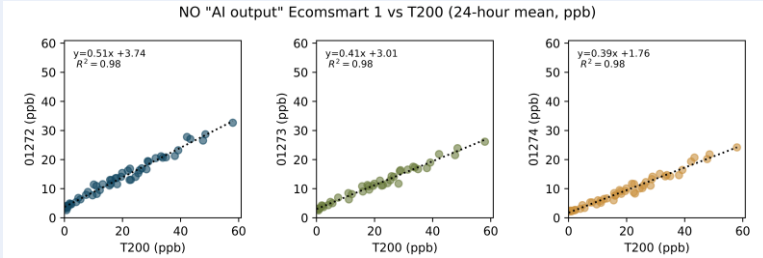
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed very strong correlation with the corresponding T200 data (0.93 < R^2 < 0.94) for 1-hour averaging.



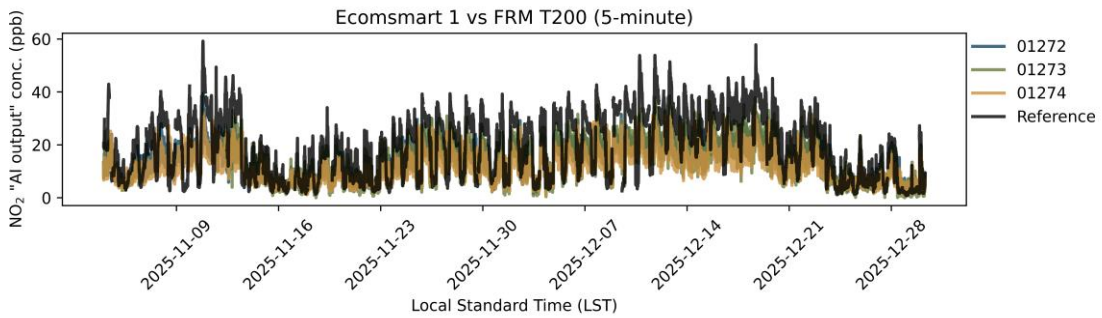


Interpretation: The EcomSmart 1 units showed very strong correlation with the corresponding T200 data (R^2 = 0.98) for 24-hour averaging.

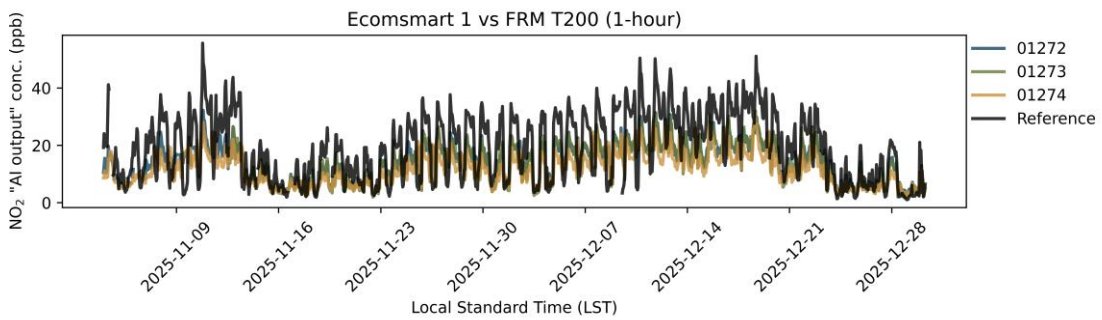
Section 4.2: NO_2 "AI" output

Section 4.2.1: Data Overview

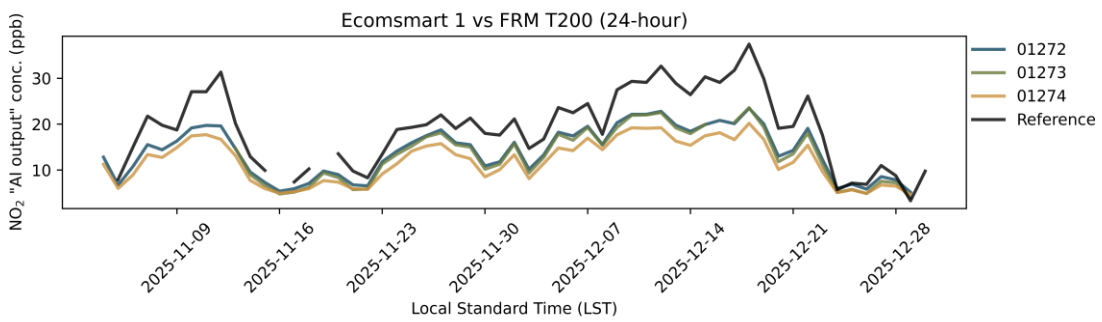
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 4.2: NO_2 "AI" output

Section 4.2.2: Data Recovery

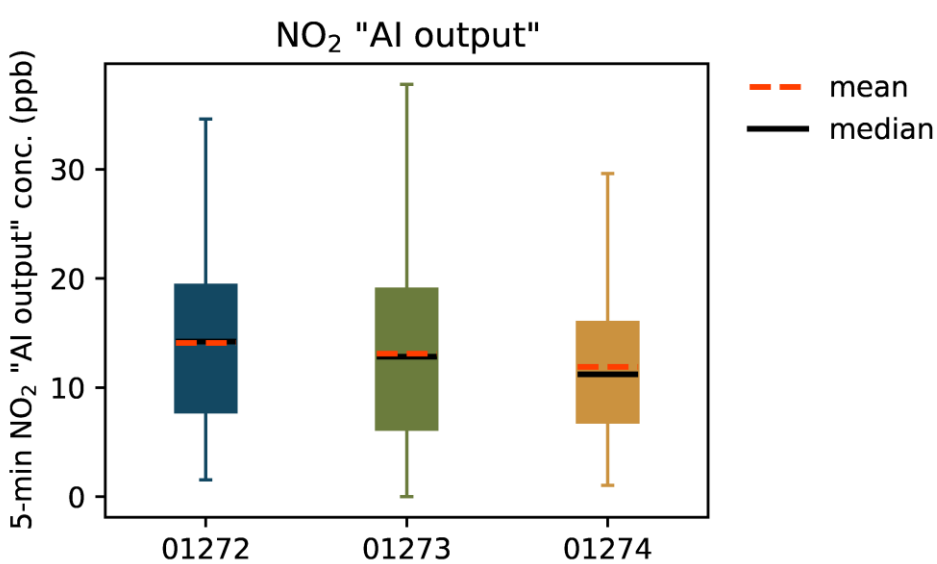
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
NO_2 "AI"	95.0%	84.4%	98.1%

Section 4.2.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (ppb)	Relative intra-model variability (%)
NO_2 "AI"	1.1	8.8



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 4.2: NO_2 "AI" output

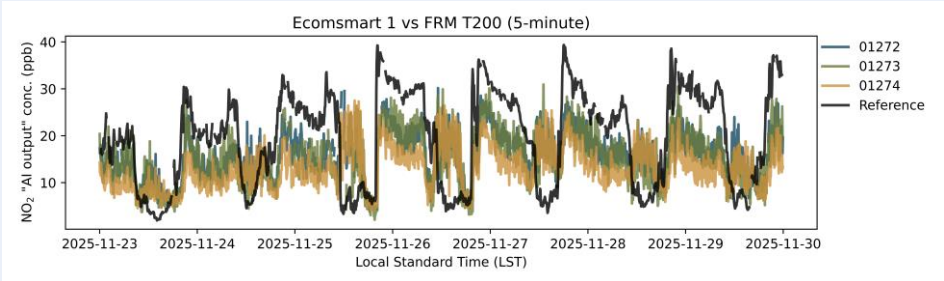
Section 4.2.4: Linearity (R^2)

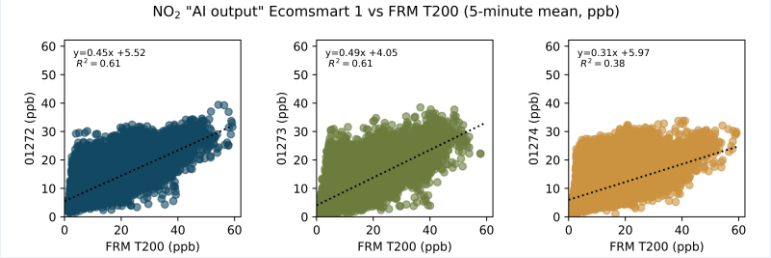
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and FRM T200 across all units tested.

Parameter	Time Resolution	FRM T200 (mean ± SD)
NO_2 "AI"	5-minute	0.53 ± 0.11
	1-hour	0.62 ± 0.12
	24-hour	0.93 ± 0.01

Timeseries of a 1-week subset of the 8-week evaluation



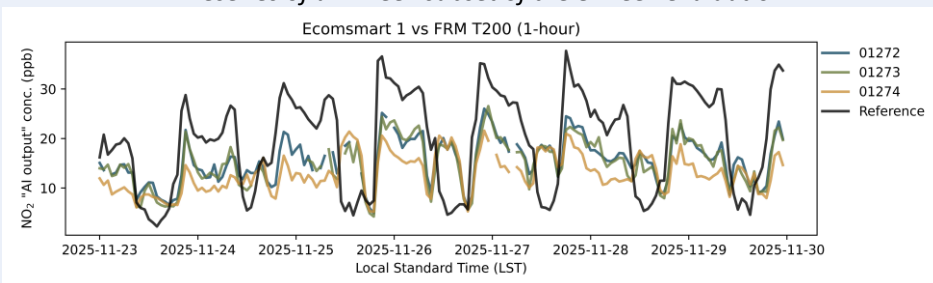


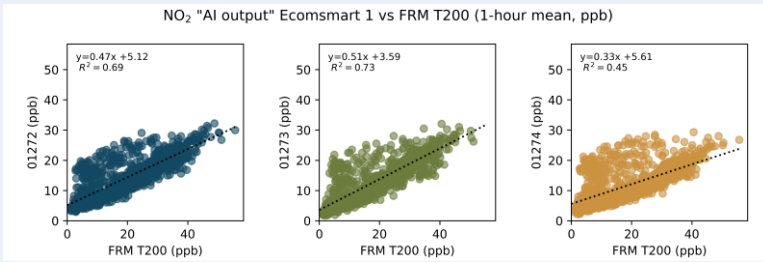
Interpretation: The EcomSmart 1 units showed weak to moderate correlation with the corresponding FRM T200 data (0.38 < R^2 < 0.61) for 5-minute averaging.

Section 4.2: NO_2 "AI" output

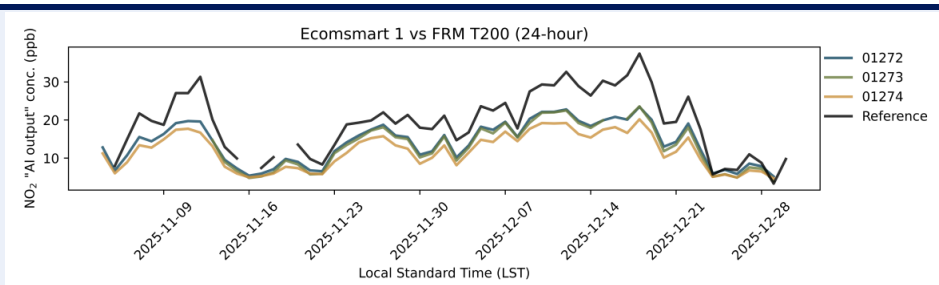
Section 4.2.4: Linearity (R^2)

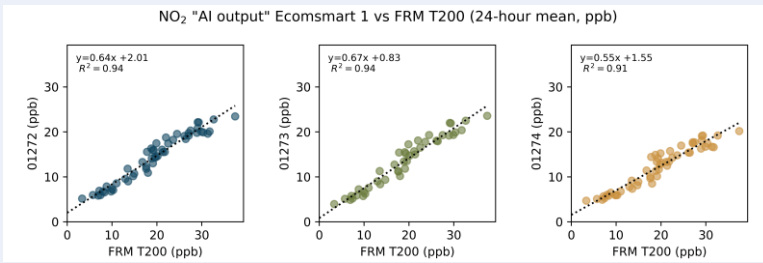
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed weak to strong correlation with the corresponding FRM T200 data (0.45 to 0.73) for 1-hour averaging.



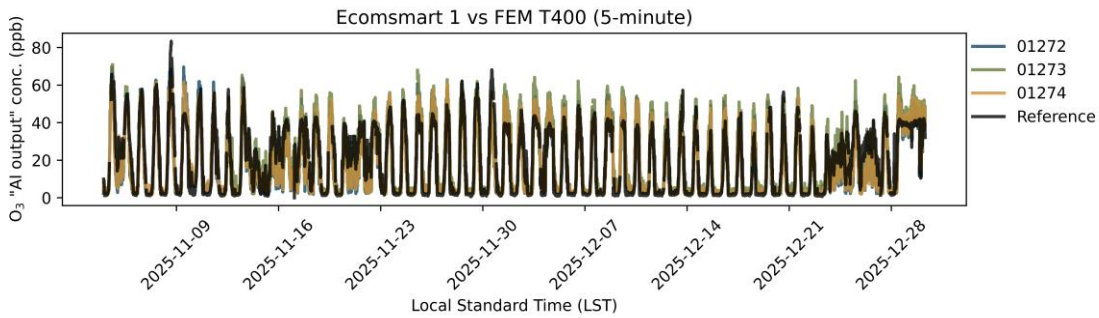


Interpretation: The EcomSmart 1 units showed very strong correlation with the corresponding FRM T200 data (0.91 < R^2 < 0.94) for 24-hour averaging.

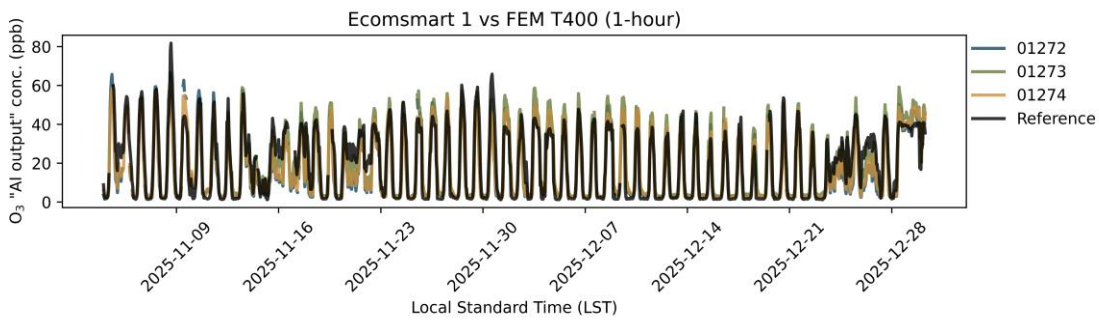
Section 4.3: O_3 "AI" output

Section 4.3.1: Data Overview

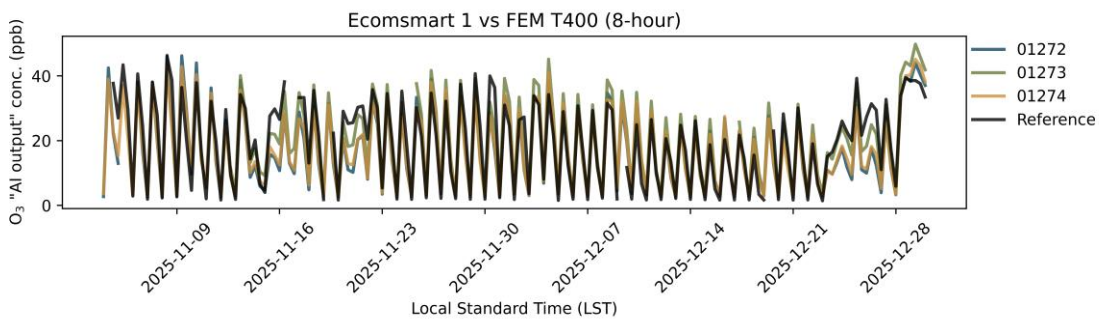
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 4.3: O_3 "AI" output

Section 4.3.2: Data Recovery

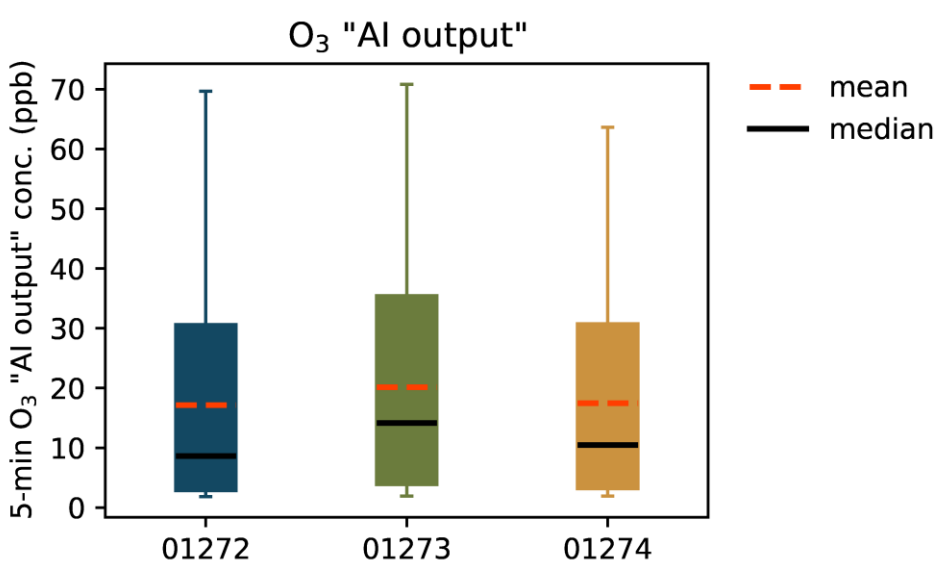
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
O_3 "AI"	95.0%	84.4%	98.1%

Section 4.3.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (ppb)	Relative intra-model variability (%)
O_3 "AI"	1.9	10.8



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 4.3: O_3 "AI" output

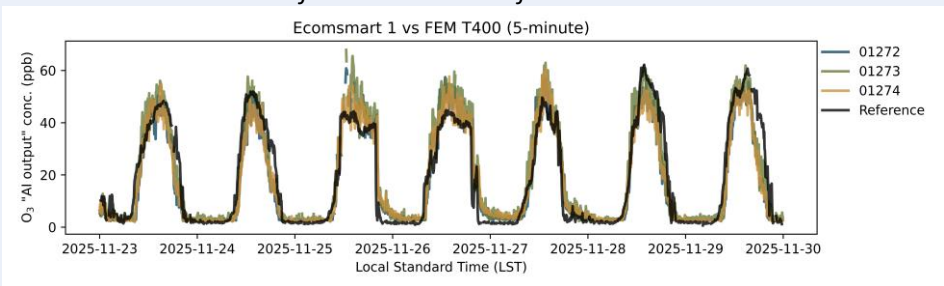
Section 4.3.4: Linearity (R^2)

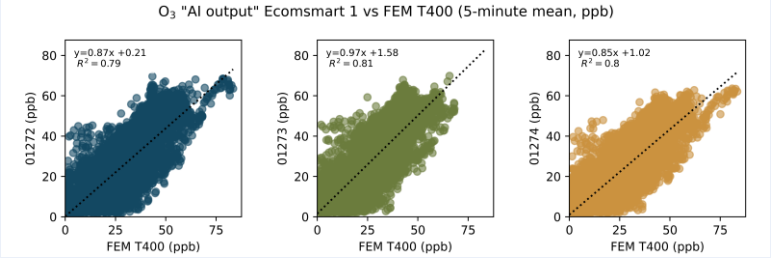
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and FEM T400 across all units tested.

Parameter	Time Resolution	FEM T400 (mean ± SD)
O_3 "AI"	5-minute	0.80 ± 0.01
	1-hour	0.83 ± 0.02
	8-hour	0.82 ± 0.03

Timeseries of a 1-week subset of the 8-week evaluation



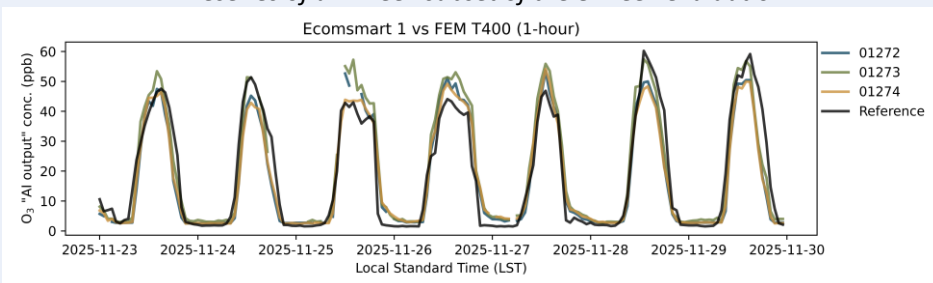


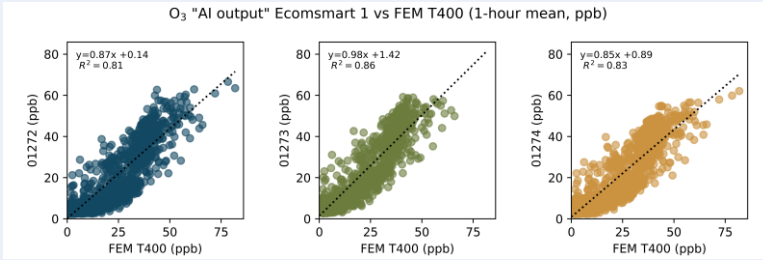
Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding FEM T400 data (0.79 < R^2 < 0.81) for 5-minute averaging.

Section 4.3: O_3 "AI" output

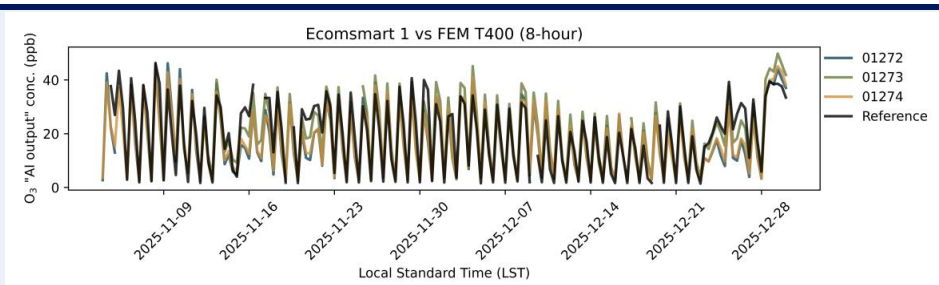
Section 4.3.4: Linearity (R^2)

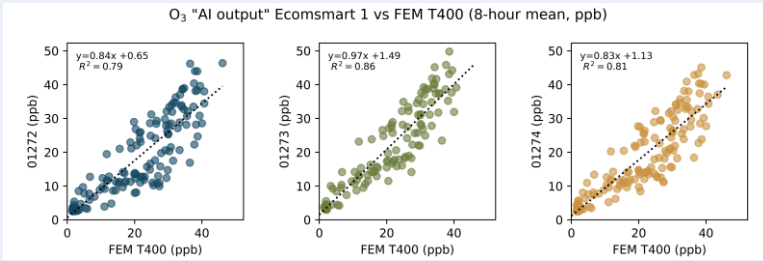
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding FEM T400 data (0.81 < R^2 < 0.86) for 1-hour averaging.



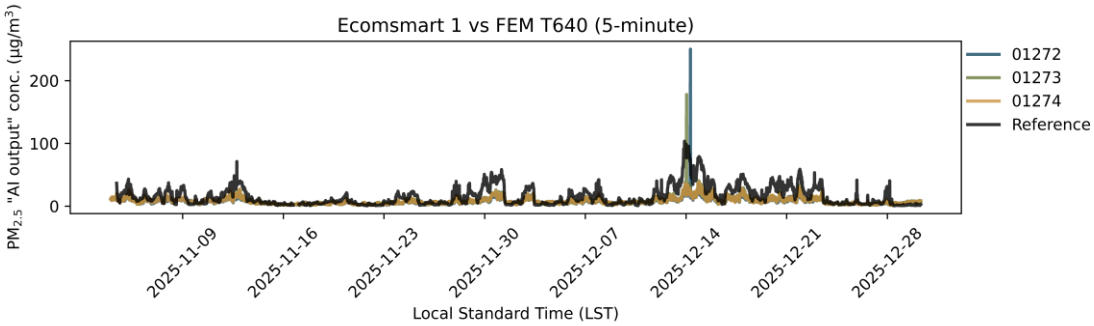


Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding FEM T400 data (0.79 < R^2 < 0.86) for 8-hour averaging.

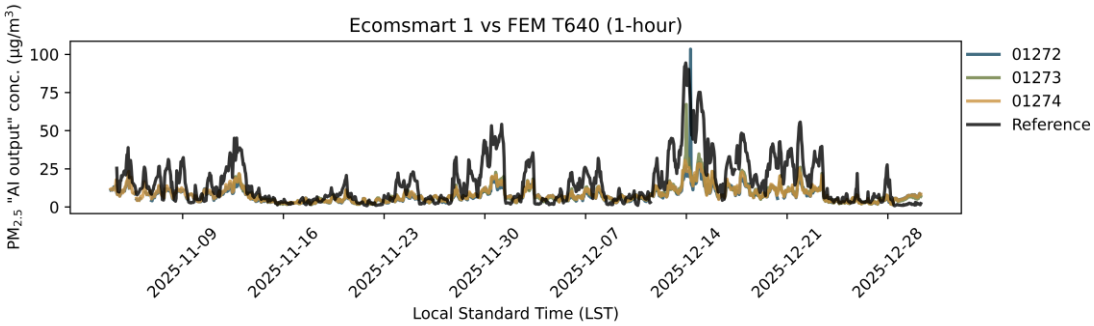
Section 4.4: $PM_{2.5}$ "AI" output

Section 4.4.1: Data Overview

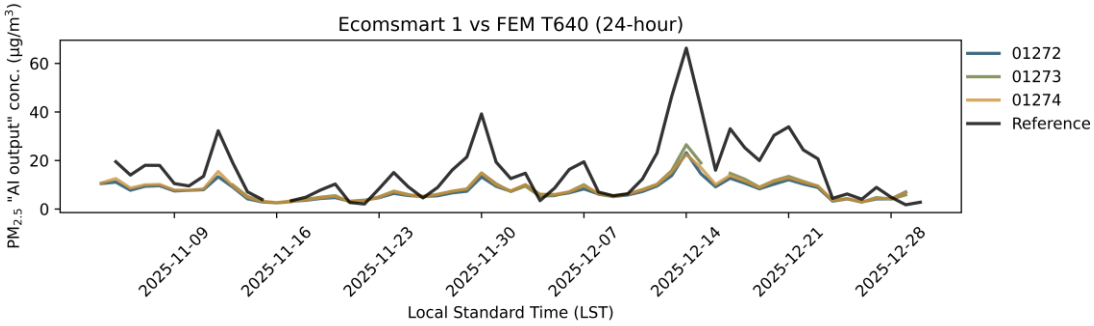
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 4.4: $PM_{2.5}$ "AI" output

Section 4.4.2: Data Recovery

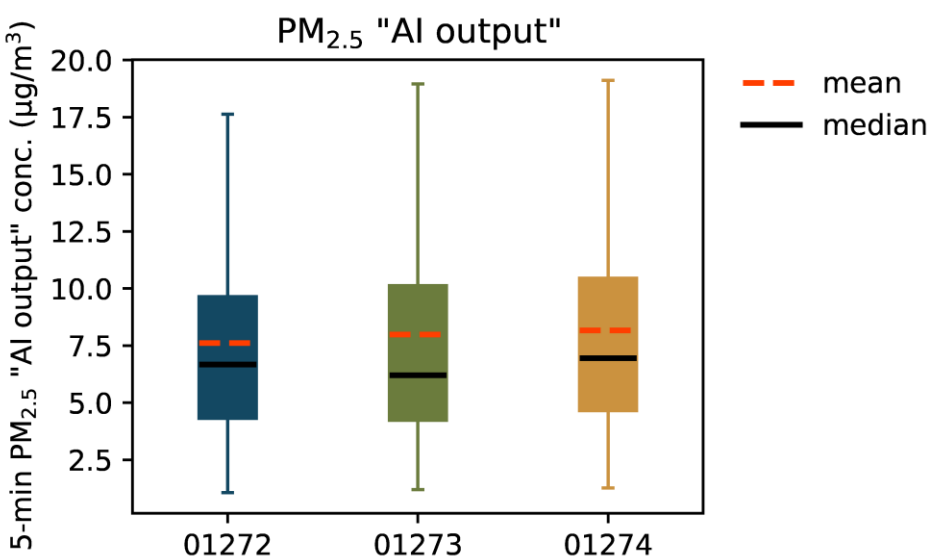
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
$PM_{2.5}$ "AI"	95.0%	84.4%	98.1%

Section 4.4.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
$PM_{2.5}$ "AI"	0.3	4.3



Interpretation: The EcomSmart 1 units had similar pollutant distributions.

Section 4.4: $PM_{2.5}$ "AI" output

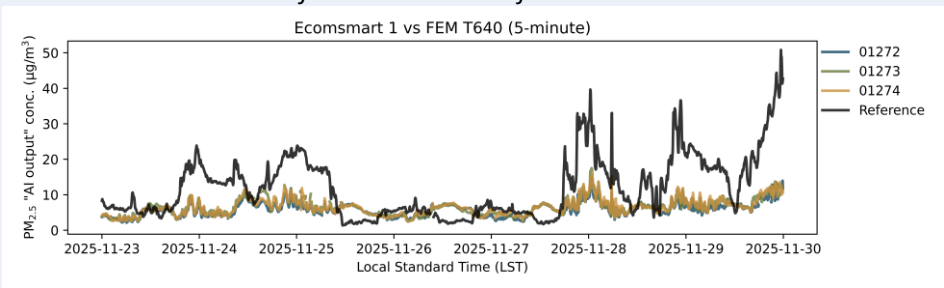
Section 4.4.4: Linearity (R^2)

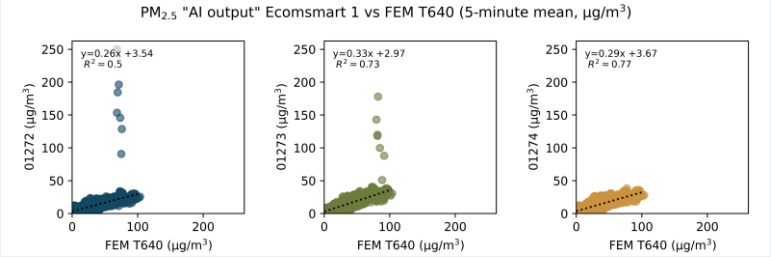
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and FEM T640 across all units tested.

Parameter	Time Resolution	FEM T640 (mean ± SD)
$PM_{2.5}$ "AI"	5-minute	0.67 ± 0.12
	1-hour	0.76 ± 0.10
	24-hour	0.92 ± 0.02

Timeseries of a 1-week subset of the 8-week evaluation



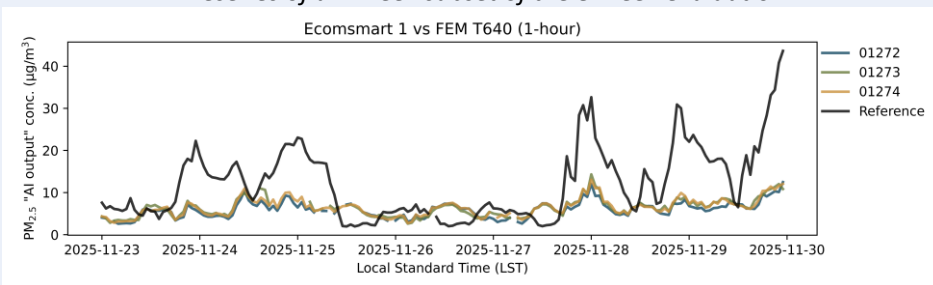


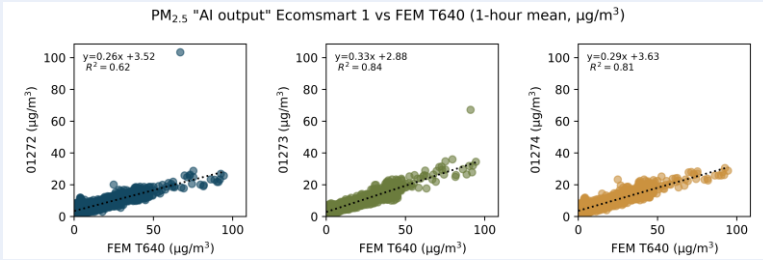
Interpretation: The EcomSmart 1 units showed moderate to strong correlation with the corresponding FEM T640 data (0.50 < R^2 < 0.77) for 5-minute averaging.

Section 4.4: $PM_{2.5}$ "AI" output

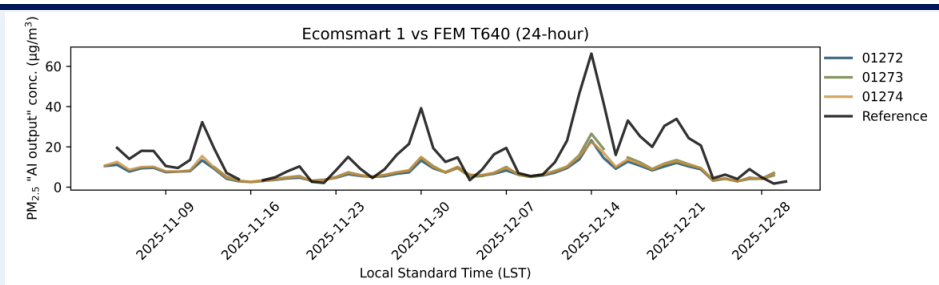
Section 4.4.4: Linearity (R^2)

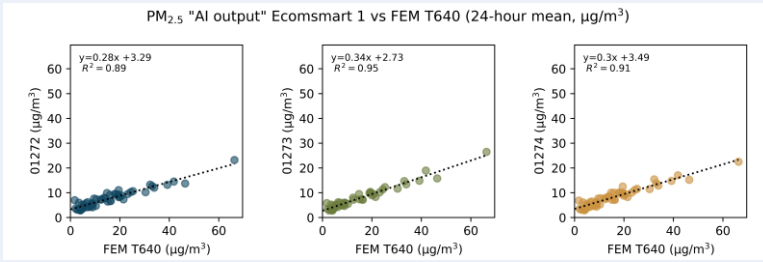
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed moderate to strong correlation with the corresponding FEM T640 data (0.62 < R^2 < 0.84) for 1-hour averaging.



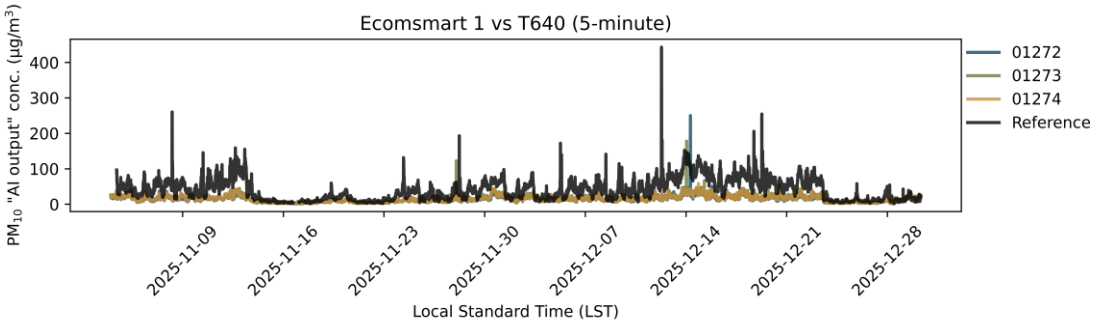


Interpretation: The EcomSmart 1 units showed strong to very strong correlation with the corresponding FEM T640 data (0.89 < R^2 < 0.95) for 24-hour averaging.

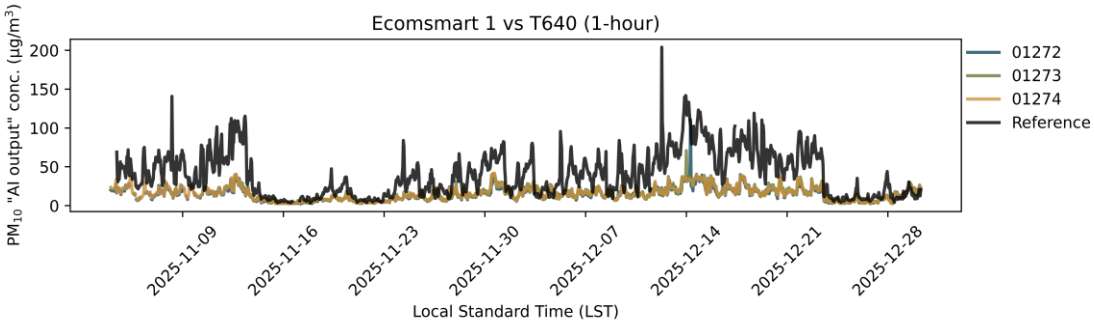
Section 4.5: PM_{10} "AI" output

Section 4.5.1: Data Overview

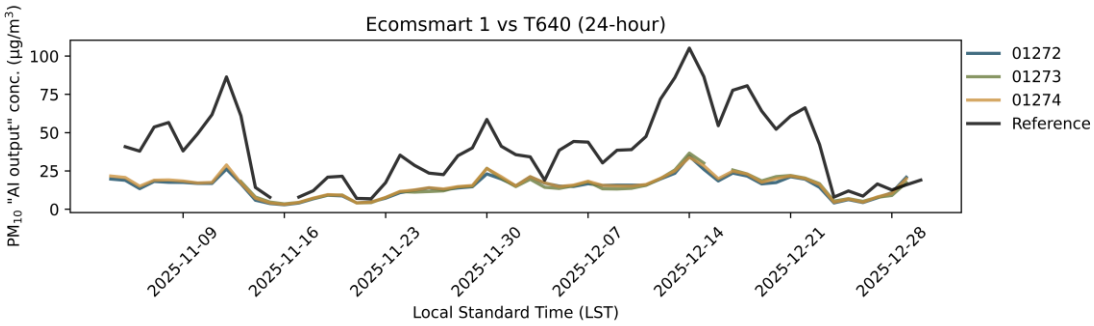
Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Timeseries of the 8-week evaluation



Section 4.5: PM_{10} "AI" output

Section 4.5.2: Data Recovery

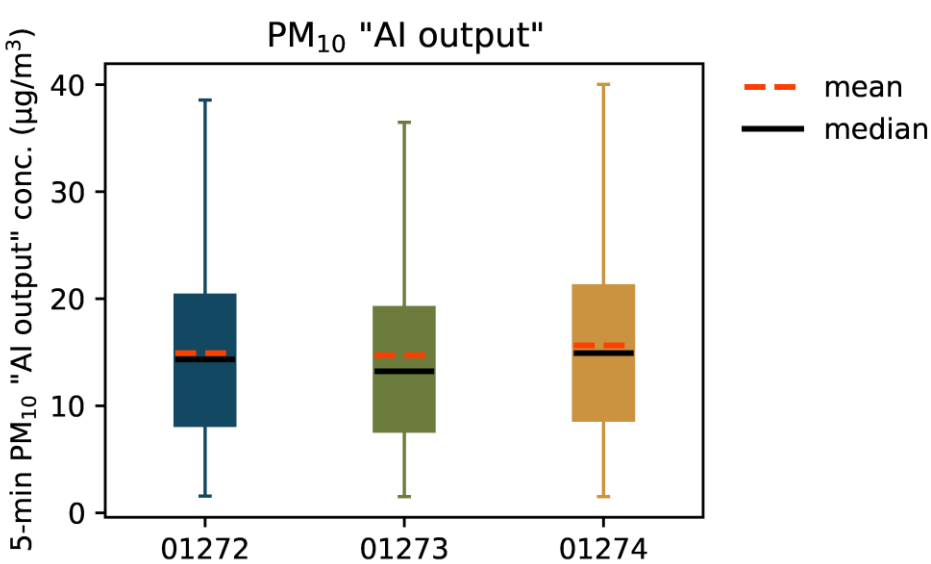
Basic QA/QC procedures such as removal of duplicate records was performed. Nulls, negatives, out of range concentrations as specified by the manufacturer, and values flagged as invalid by the sensor were considered invalid. Data recovery was calculated as the percent of valid readings through the entire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

Parameter	01272	01273	01274
PM_{10} "AI"	95.0%	84.4%	98.1%

Section 4.5.3: 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 data resampled to 5-minute averages.

Parameter	Absolute intra-model variability (µg/m³)	Relative intra-model variability (%)
PM_{10} "AI"	0.3	2.1



Interpretation: Two out of three EcomSmart 1 units had similar pollutant distributions.

Section 4.5: PM_{10} "AI" output

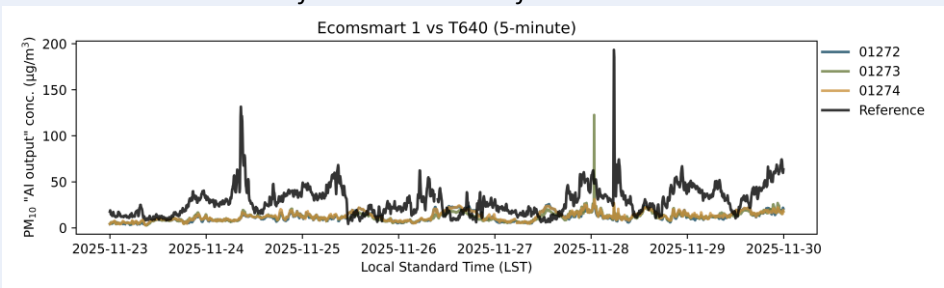
Section 4.5.4: Linearity (R^2)

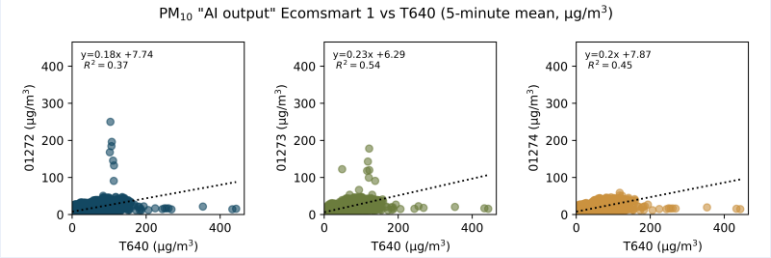
Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, readings flagged by the sensor, and invalid data-points were eliminated from the data-set).

A summary of the mean R^2 between the sensor and T640 across all units tested.

Parameter	Time Resolution	T640 (mean ± SD)
PM_{10} "AI"	5-minute	0.46 ± 0.07
	1-hour	0.53 ± 0.08
	24-hour	0.81 ± 0.04

Timeseries of a 1-week subset of the 8-week evaluation



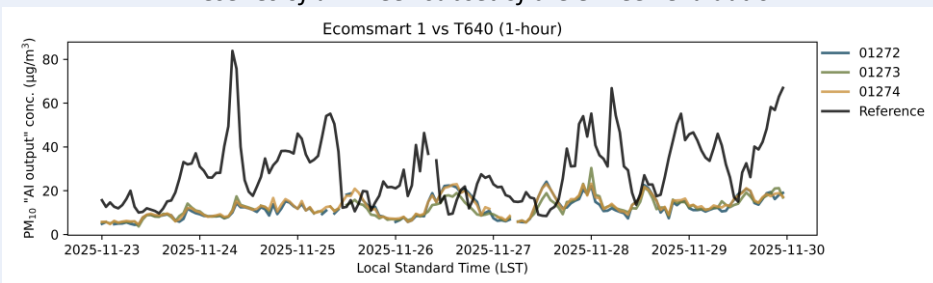


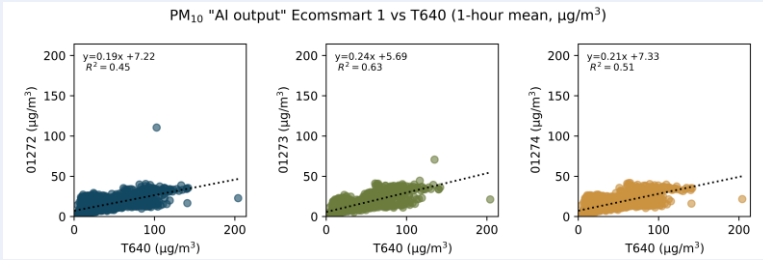
Interpretation: The EcomSmart 1 units showed weak to moderate correlation with the corresponding T640 data (0.37 < R^2 < 0.54) for 5-minute averaging.

Section 4.5: PM_{10} "AI" output

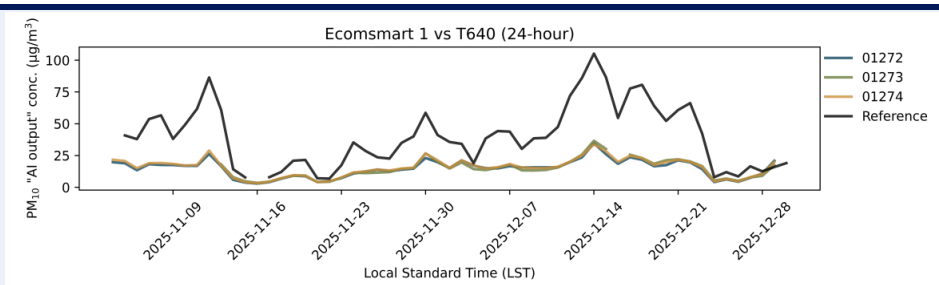
Section 4.5.4: Linearity (R^2)

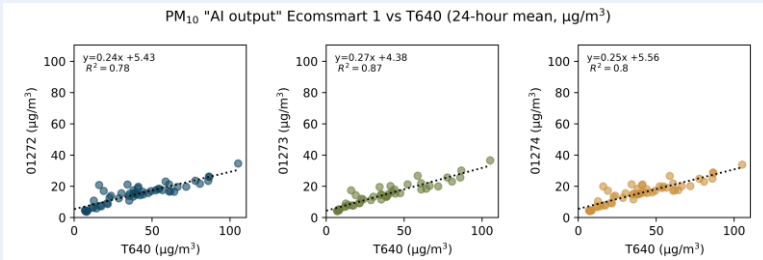
Timeseries of a 1-week subset of the 8-week evaluation





Interpretation: The EcomSmart 1 units showed weak to moderate correlation with the corresponding T640 data ($0.45 < R^2 < 0.63$) for 1-hour averaging.





Interpretation: The EcomSmart 1 units showed strong correlation with the corresponding T640 data ($0.78 < R^2 < 0.87$) for 24-hour averaging.

Section 4.6: Summary Metrics

		NO "AI"		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	10.85	10.89	10.89
	SD*	11.52	11.32	6.49
	Range*	1.37 to 85.92	1.59 to 74.50	2.25 to 32.68
	Abs. IMV*	2.0	2.0	2.1
	Rel. IMV (%)	18.7	18.7	18.9
	CV (RSD, %)	107.47	105.15	60.01
T200	Average*	18.44	18.79	18.43
	SD*	27.39	26.80	14.75
	Range*	0.01 to 165.30	0.10 to 145.08	0.43 to 57.98
	CV (RSD, %)	148.53	142.61	80.07
EcomSmart 1 vs. T200	Pearson R^2	0.88 to 0.90	0.93 to 0.94	0.98
	Spearman ρ	0.86 to 0.89	0.91 to 0.92	0.99
	Kendall τ	0.68 to 0.71	0.75 to 0.77	0.91 to 0.92
	Slope	0.37 to 0.45	0.37 to 0.46	0.39 to 0.51
	Intercept*	2.08 to 4.67	1.95 to 4.52	1.76 to 3.74
	MBE*	-9.56 to -5.53	-9.80 to -5.76	-9.72 to -5.47
	$nMBE_{mean}$	-0.52 to -0.30	-0.52 to -0.30	-0.52 to -0.29
	$nMBE_{range}$	-0.06 to -0.03	-0.07 to -0.04	-0.17 to -0.10
	MAE*	9.97 to 11.34	9.80 to 11.42	6.91 to 10.27
	$nMAE_{mean}$	0.53 to 0.62	0.51 to 0.61	0.37 to 0.55
	$nMAE_{range}$	0.06 to 0.07	0.07 to 0.08	0.12 to 0.18
	RMSE*	16.69 to 20.05	16.04 to 19.57	9.08 to 13.23
	$nRMSE_{mean}$	0.89 to 1.09	0.84 to 1.05	0.48 to 0.71
	$nRMSE_{range}$	0.10 to 0.12	0.11 to 0.14	0.16 to 0.23

*Units in: ppb

Section 4.6: Summary Metrics

		NO_2 "AI"		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	13.04	13.07	13.06
	SD*	6.75	6.41	5.31
	Range*	0.00 to 39.40	1.76 to 32.23	3.96 to 23.58
	CV (RSD, %)	51.81	49.03	40.64
	Abs. IMV*	1.1	1.1	1.1
	Rel. IMV (%)	8.8	8.8	8.9
FRM T200	Average*	19.09	19.38	19.24
	SD*	11.85	11.62	8.26
	Range*	0.82 to 59.22	1.02 to 55.68	3.31 to 37.44
	CV (RSD, %)	62.11	59.96	42.94
EcomSmart 1 vs. FRM T200	Pearson R^2	0.38 to 0.61	0.45 to 0.73	0.91 to 0.94
	Spearman ρ	0.66 to 0.79	0.70 to 0.86	0.96 to 0.98
	Kendall τ	0.51 to 0.60	0.57 to 0.69	0.84 to 0.88
	Slope	0.31 to 0.49	0.33 to 0.51	0.55 to 0.67
	Intercept*	4.05 to 5.97	3.59 to 5.61	0.83 to 2.01
	MBE*	-7.09 to -5.09	-7.41 to -5.33	-7.24 to -5.06
	$nMBE_{mean}$	-0.37 to -0.27	-0.38 to -0.27	-0.37 to -0.26
	$nMBE_{range}$	-0.12 to -0.09	-0.14 to -0.10	-0.21 to -0.15
	MAE*	7.54 to 9.68	7.32 to 9.64	5.14 to 7.30
	$nMAE_{mean}$	0.40 to 0.51	0.38 to 0.50	0.26 to 0.38
	$nMAE_{range}$	0.13 to 0.17	0.14 to 0.18	0.15 to 0.21
	RMSE*	9.37 to 11.78	8.89 to 11.54	6.01 to 8.25
	$nRMSE_{mean}$	0.49 to 0.62	0.46 to 0.60	0.31 to 0.42
	$nRMSE_{range}$	0.16 to 0.20	0.16 to 0.21	0.18 to 0.24

*Units in: ppb

Section 4.6: Summary Metrics

		O_3 "AI"		
		5-minute averages	1-hour averages	8-hour averages
EcomSmart 1	Average*	18.27	18.23	18.35
	SD*	16.81	16.48	12.58
	Range*	1.81 to 70.84	2.36 to 66.58	2.54 to 49.82
	CV (RSD, %)	92.26	90.71	68.80
	Abs. IMV*	1.9	1.9	1.9
	Rel. IMV (%)	10.8	10.8	10.7
FEM T400	Average*	20.05	19.23	19.36
	SD*	17.13	16.93	13.15
	Range*	0.00 to 83.44	1.21 to 81.81	1.43 to 46.07
	CV (RSD, %)	85.41	88.02	67.94
EcomSmart 1 vs. FEM T400	Pearson R^2	0.79 to 0.81	0.81 to 0.86	0.79 to 0.86
	Spearman ρ	0.88 to 0.89	0.90 to 0.91	0.91 to 0.94
	Kendall τ	0.68 to 0.69	0.71 to 0.73	0.73 to 0.78
	Slope	0.85 to 0.97	0.85 to 0.98	0.83 to 0.97
	Intercept*	0.21 to 1.58	0.14 to 1.42	0.65 to 1.49
	MBE*	-2.31 to 1.06	-2.29 to 1.05	-2.35 to 0.87
	$nMBE_{mean}$	-0.12 to 0.05	-0.12 to 0.06	-0.12 to 0.05
	$nMBE_{range}$	-0.03 to 0.02	-0.03 to 0.02	-0.05 to 0.02
	MAE*	5.64 to 5.93	4.91 to 5.47	4.04 to 4.73
	$nMAE_{mean}$	0.28 to 0.30	0.26 to 0.29	0.21 to 0.24
	$nMAE_{range}$	0.07 to 0.08	0.06 to 0.08	0.10 to 0.11
	RMSE*	7.71 to 8.41	6.52 to 7.71	4.98 to 6.53
	$nRMSE_{mean}$	0.39 to 0.42	0.35 to 0.40	0.26 to 0.34
	$nRMSE_{range}$	0.10 to 0.11	0.09 to 0.10	0.13 to 0.15

*Units in: ppb

Section 4.6: Summary Metrics

		$PM_{2.5}$ "AI"		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	7.92	7.91	7.91
	SD*	5.56	5.24	4.19
	Range*	1.06 to 250.18	1.46 to 103.45	2.55 to 26.50
	CV (RSD, %)	70.30	66.21	53.00
	Abs. IMV*	0.3	0.3	0.3
	Rel. IMV (%)	4.3	4.4	4.4
	PM_c Conc.*	6.75 to 7.48	6.70 to 7.48	6.59 to 7.46
	Fine Fraction	0.55 to 0.56	0.55 to 0.56	0.54 to 0.55
FEM T640	Average*	15.66	15.67	15.62
	SD*	15.21	15.11	12.80
	Range*	0.64 to 103.50	0.81 to 94.42	1.76 to 66.29
	CV (RSD, %)	97.11	96.42	81.93
	PM_c Conc.*	24.20	24.21	24.33
	Fine Fraction	0.38	0.38	0.38
EcomSmart 1 vs. FEM T640	Pearson R^2	0.50 to 0.77	0.62 to 0.84	0.89 to 0.95
	Spearman ρ	0.72 to 0.78	0.74 to 0.79	0.90 to 0.93
	Kendall τ	0.54 to 0.60	0.56 to 0.61	0.74 to 0.79
	Slope	0.26 to 0.33	0.26 to 0.33	0.28 to 0.34
	Intercept*	2.97 to 3.67	2.88 to 3.63	2.73 to 3.49
	MBE*	-7.96 to -7.44	-8.01 to -7.50	-8.18 to -7.62
	$nMBE_{mean}$	-0.51 to -0.48	-0.51 to -0.48	-0.52 to -0.48
	$nMBE_{range}$	-0.08 to -0.07	-0.09 to -0.08	-0.13 to -0.12
	MAE*	8.69 to 9.45	8.70 to 9.41	7.99 to 8.57
	$nMAE_{mean}$	0.56 to 0.61	0.56 to 0.60	0.51 to 0.54
	$nMAE_{range}$	0.08 to 0.09	0.09 to 0.10	0.12 to 0.13
	RMSE*	13.41 to 14.35	13.28 to 14.14	11.77 to 12.34
	$nRMSE_{mean}$	0.86 to 0.92	0.85 to 0.90	0.74 to 0.78
	$nRMSE_{range}$	0.13 to 0.14	0.14 to 0.15	0.18 to 0.19

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

Section 4.6: Summary Metrics

		PM_{10} "AI"		
		5-minute averages	1-hour averages	24-hour averages
EcomSmart 1	Average*	15.10	15.07	15.01
	SD*	8.98	8.65	7.10
	Range*	1.51 to 250.18	2.34 to 110.59	2.92 to 36.62
	CV (RSD, %)	59.57	57.44	47.37
	Abs. IMV*	0.3	0.3	0.3
	Rel. IMV (%)	2.1	2.0	2.1
	PM_c Conc.*	6.75 to 7.48	6.70 to 7.48	6.59 to 7.46
	Fine Fraction	0.55 to 0.56	0.55 to 0.56	0.54 to 0.55
T640	Average*	39.86	39.88	39.96
	SD*	29.80	28.79	24.39
	Range*	1.35 to 443.23	3.23 to 204.08	6.86 to 105.19
	CV (RSD, %)	74.77	72.19	61.04
	PM_c Conc.*	24.20	24.21	24.33
	Fine Fraction	0.38	0.38	0.38
EcomSmart 1 vs. T640	Pearson R^2	0.37 to 0.54	0.45 to 0.63	0.78 to 0.87
	Spearman ρ	0.67 to 0.79	0.69 to 0.81	0.85 to 0.93
	Kendall τ	0.50 to 0.60	0.52 to 0.62	0.71 to 0.81
	Slope	0.18 to 0.23	0.19 to 0.24	0.24 to 0.27
	Intercept*	6.29 to 7.87	5.69 to 7.33	4.38 to 5.56
	MBE*	-24.93 to -22.81	-25.02 to -22.99	-25.31 to -23.03
	$nMBE_{mean}$	-0.63 to -0.61	-0.63 to -0.61	-0.63 to -0.61
	$nMBE_{range}$	-0.06 to -0.05	-0.12 to -0.11	-0.26 to -0.23
	MAE*	23.54 to 26.24	23.58 to 26.15	23.10 to 25.49
	$nMAE_{mean}$	0.63 to 0.66	0.62 to 0.65	0.61 to 0.63
	$nMAE_{range}$	0.05 to 0.06	0.12 to 0.13	0.23 to 0.26
	RMSE*	33.43 to 35.78	32.74 to 34.90	29.44 to 31.47
	$nRMSE_{mean}$	0.87 to 0.90	0.84 to 0.87	0.76 to 0.78
	$nRMSE_{range}$	0.08	0.16 to 0.17	0.30 to 0.32

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

Summary Metrics Guide

Average:	mean of individual sensor means; the grand mean
SD:	mean of individual sensor standard deviations (σ; measure of variation of the values about its mean)
Range:	the highest and the lowest values observed
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)
Abs. IMV:	intra-model variability expressed in absolute terms; standard deviation of individual sensor means
Rel. IMV:	intra-model variability expressed in relative terms; the ratio of the Absolute IMV to the Average
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)
Spearman ρ:	Spearman's rank correlation coefficient; a measure of how well the reference and sensor measurements follow a monotonic relationship, based on their ranked values (a value from -1 to 1)
Kendall τ:	Kendall's rank correlation coefficient; a measure of the agreement in ordering between paired reference and sensor measurements, based on how often the pairs are in the same vs. opposite order (a value from -1 to 1)
Slope:	change in the sensor's value per unit increase in the reference monitor's value
Intercept:	the sensor's value when the reference monitor observes zero
MBE:	mean bias error; mean of the differences between reference and sensor measurements
$nMBE_{mean}$:	mean bias error normalized with respect to the reference mean value
$nMBE_{range}$:	mean bias error normalized with respect to the difference of the highest and lowest reference values
MAE:	mean absolute error; mean of the absolute differences between reference and sensor measurements
$nMAE_{mean}$:	mean absolute error normalized with respect to the reference mean value
$nMAE_{range}$:	mean absolute error normalized with respect to the difference of the highest and lowest reference values
RMSE:	root mean square error; the square root of the average squared differences between reference and sensor measurements
$nRMSE_{mean}$:	root mean square error normalized with respect to the reference mean value
$nRMSE_{range}$:	root mean square error normalized with respect to the difference of the highest and lowest reference values