Field Evaluation
Air Quality Egg 2024 Model

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 10/09/2024 to 12/10/2024, three **Air Quality Egg 2024 Model** multi-sensor units were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux and were run side-by-side with Federal Equivalent Method (FEM) and Federal Reference Method (FRM) instruments measuring the same pollutants.

- Air Quality Egg 2024 Model (*3 units tested*):
  - Gas Sensors: Electrochemical (Winsen ZE-12A, non-FEM)
  - PM: Optical (Dual Plantower PMS5003, non-FEM)
  - Each unit measures: CO (ppb), O_3 (ppb), NO_2 (ppb), $PM_{1.0}$ (µg/m^3), $PM_{2.5}$ (µg/m^3), PM_{10} (µg/m^3), T (°C), RH (%)
  - Unit cost: $1914 (as-configured in this test; price depends on selected pollutants in configuration)
  - Time resolution: 1-min
  - Units IDs: 37eb, 57b6, and 4f80

- **South Coast AQMD Reference instruments:**
  - O_3 instrument (Teledyne T400, hereinafter FEM T400); cost: ~$7,000
    - Time resolution; 1-min
  - CO instrument (Horiba APMA 370, hereinafter FRM Horiba); cost: ~$10,000
    - Time resolution; 1-min
  - NO/NO_2 instrument (Teledyne T200, hereinafter FRM T200); cost: ~$11,000
    - Time resolution: 1-min
  - PM instrument (Teledyne API T640; FEM $PM_{2.5}$, hereinafter FEM T640); cost: $21,000
    - Time resolution: 1-min
    - Measures $PM_{1.0}$, $PM_{2.5}$, PM_{10} (µg/m^3)
  - PM instrument (MetOne BAM; FEM $PM_{2.5}$ & PM_{10}); cost: $20,000
    - Time resolution: 1-hr
    - Measures $PM_{2.5}$, PM_{10} (µg/m^3)
  - Met station (T, RH, P, WS, WD); cost: ~$5,000
    - Time resolution: 1-min

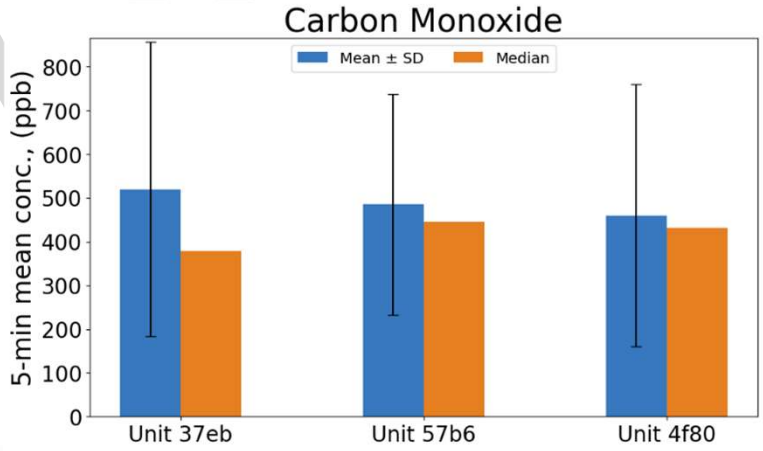
Carbon Monoxide (CO) in Air Quality Egg 2024 Model

Data validation & recovery

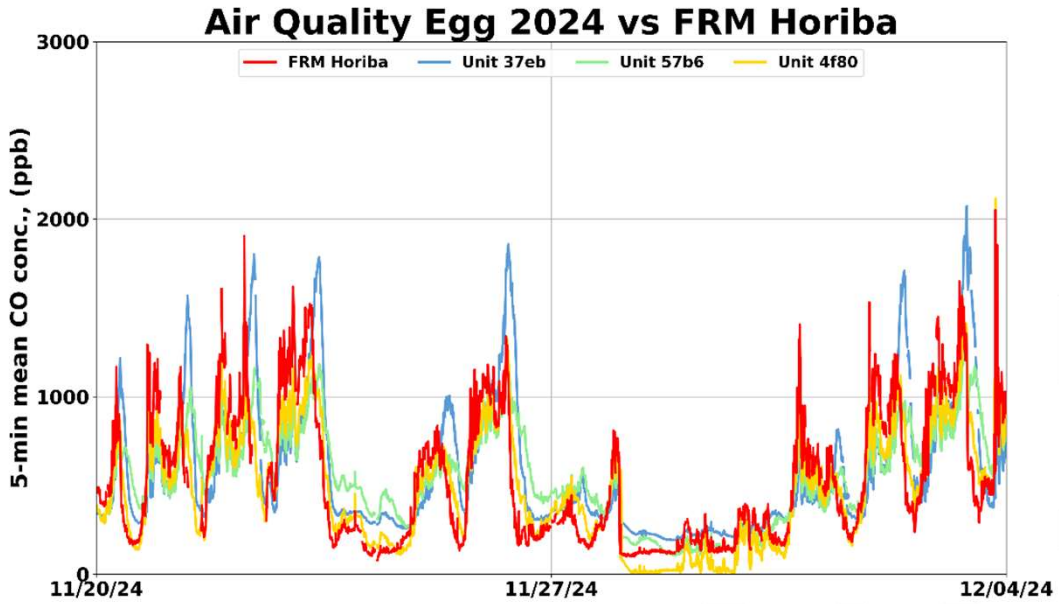
- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for CO from Unit 37eb, Unit 57b6 and Unit 4f80 was ~ 99.2%, ~97.1% and ~99.9%, respectively

Air Quality Egg 2024 Model; Intra-model variability

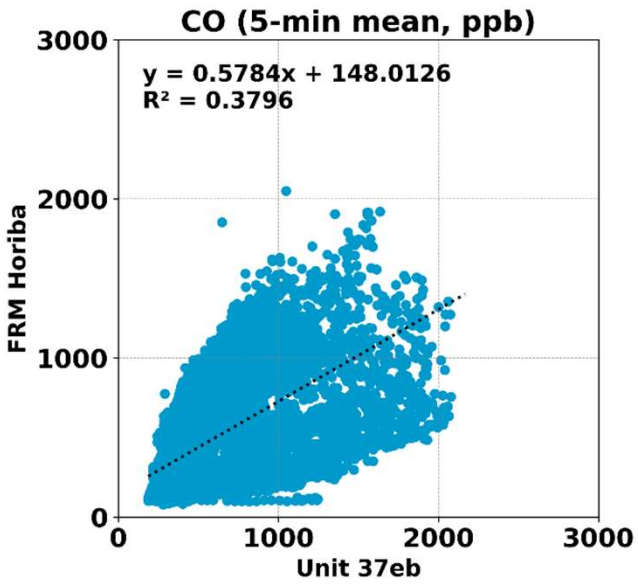
- Absolute intra-model variability was ~30.1 ppb for the CO measurements (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~6.2% for the CO measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)

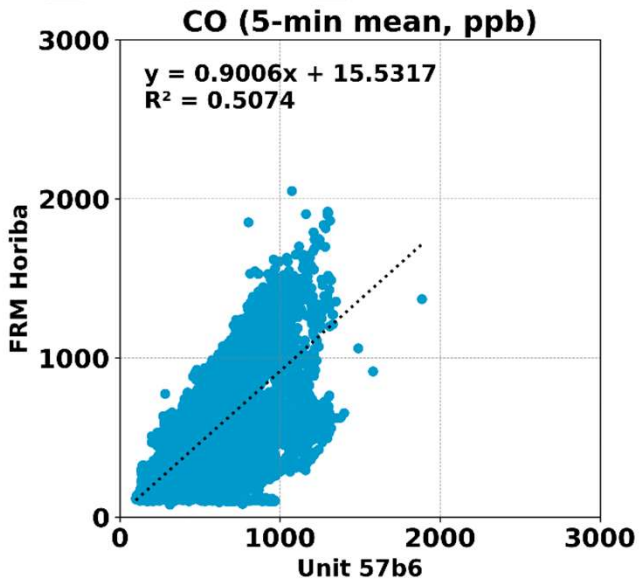


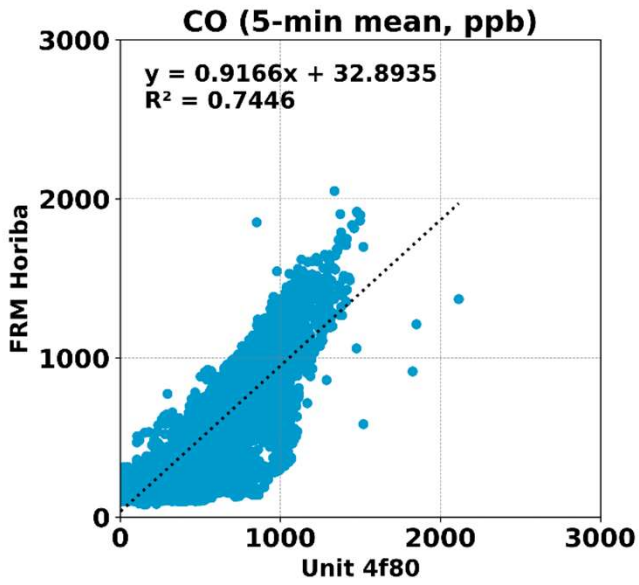
Air Quality Egg 2024 Model vs FRM Horiba (CO; 5-min mean)



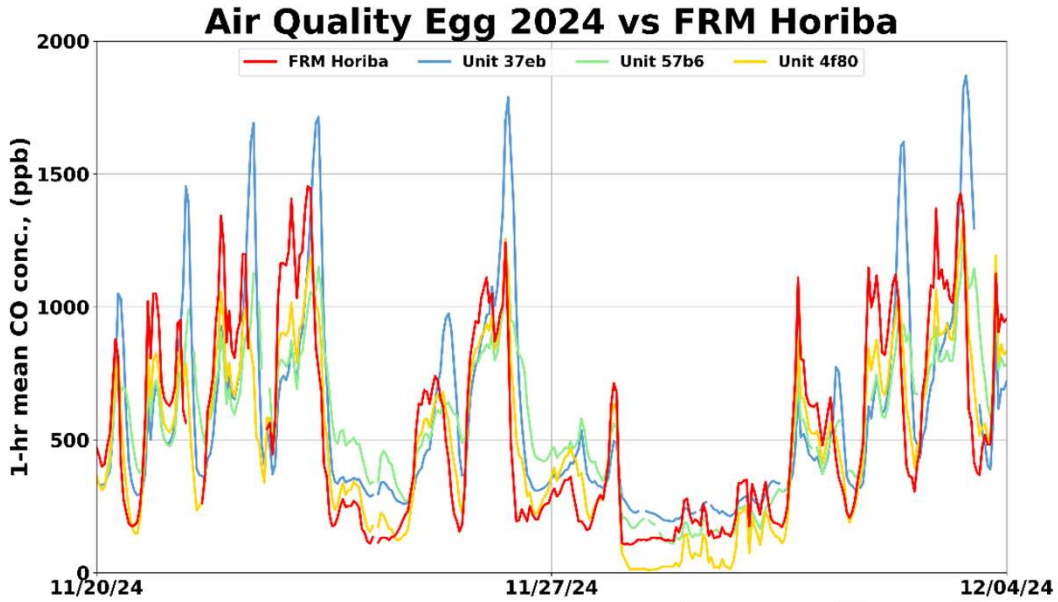
- The Air Quality Egg 2024 Model sensors showed weak to strong correlations with the corresponding FRM Horiba CO data ($0.37 < R^2 < 0.75$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the CO concentrations as measured by the FRM Horiba CO instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal CO variations as recorded by the FRM Horiba instrument



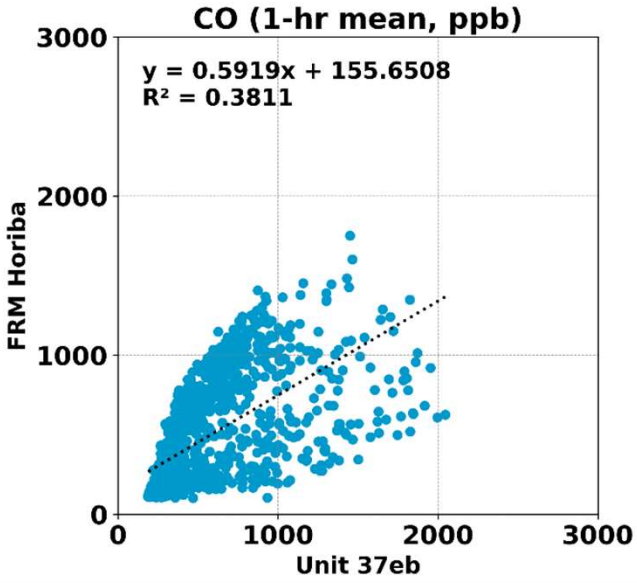


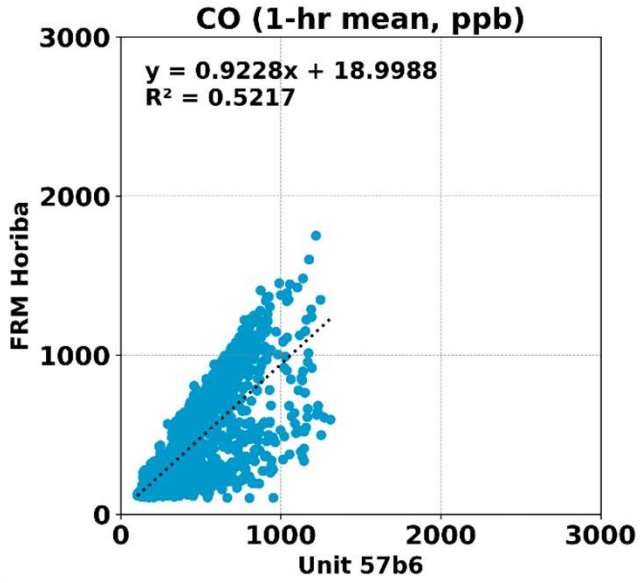


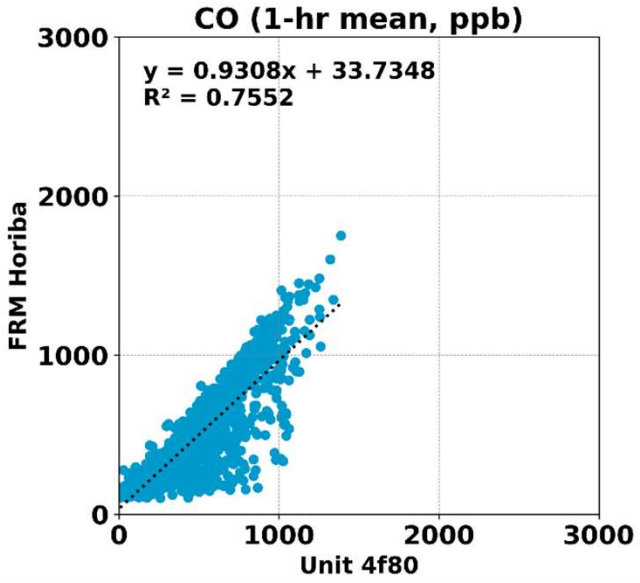
Air Quality Egg 2024 Model vs FRM Horiba (CO; 1-hr mean)



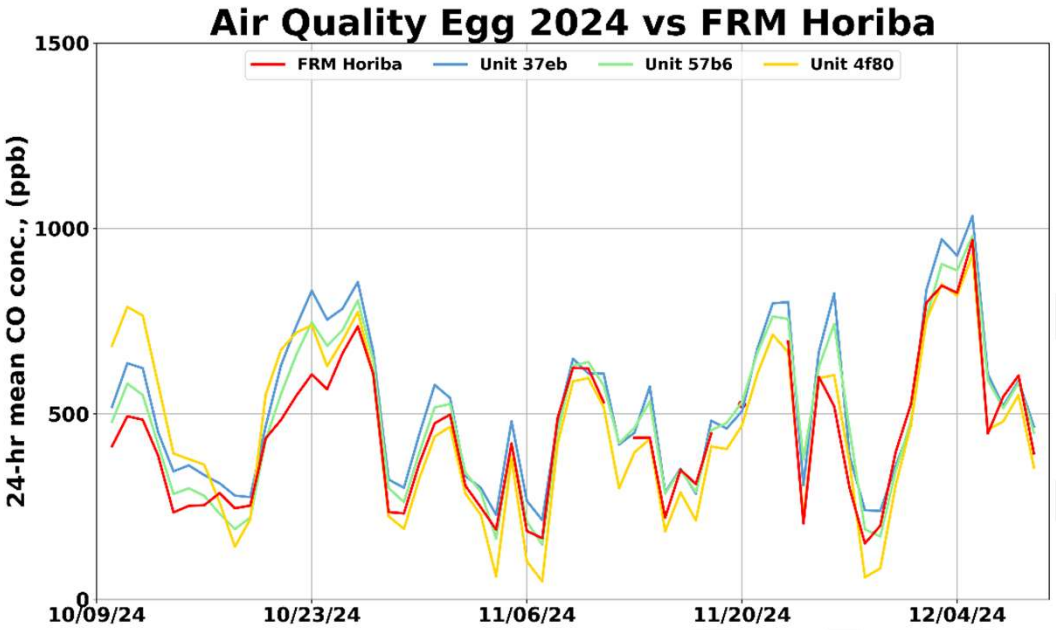
- The Air Quality Egg 2024 Model sensors showed weak to strong correlations with the corresponding FRM Horiba CO data ($0.38 < R^2 < 0.76$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the CO concentrations as measured by the FRM Horiba CO instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal CO variations as recorded by the FRM Horiba instrument



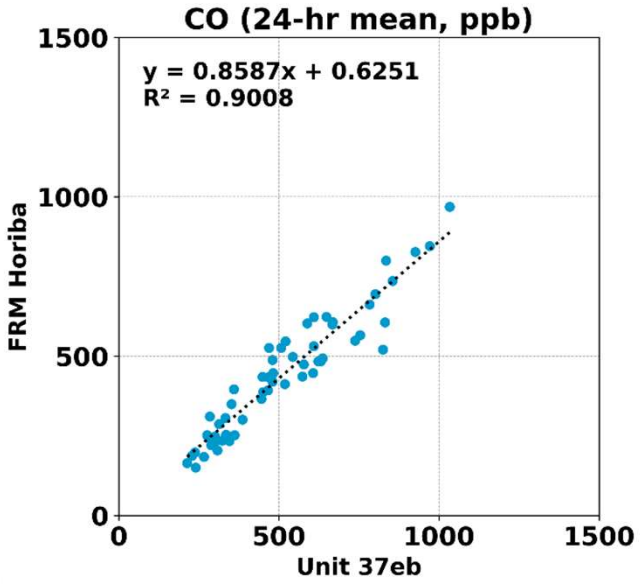


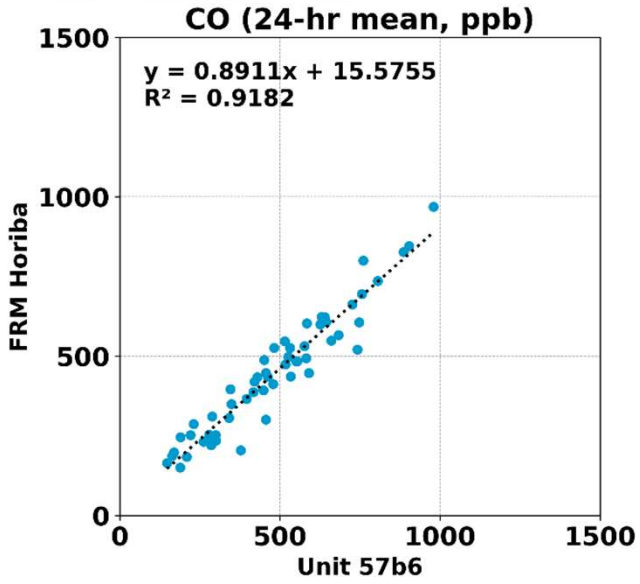


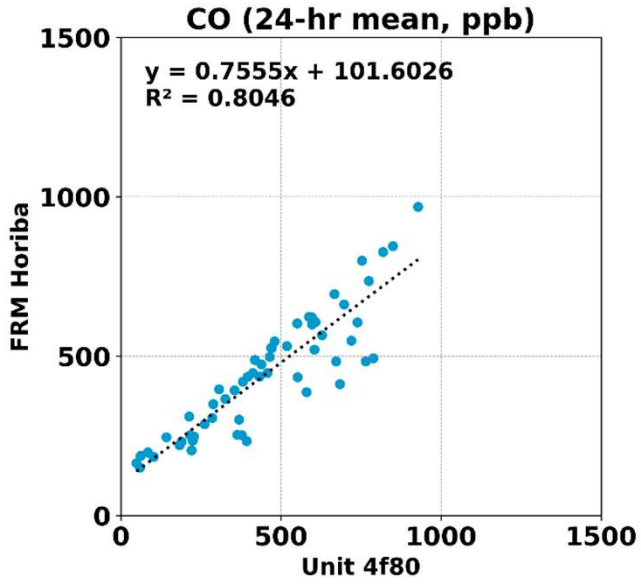
Air Quality Egg 2024 Model vs FRM Horiba (CO; 24-hr mean)



- The Air Quality Egg 2024 Model sensors showed strong to very strong correlations with the corresponding FRM Horiba CO data ($0.80 < R^2 < 0.92$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the CO concentration as measured by the FRM Horiba CO instrument
- The Air Quality Egg 2024 Model sensors seemed to track the daily CO variations as recorded by the FRM Horiba instrument







Summary: CO

	Average of 3 Sensors, CO		Air Quality Egg 2024 Model vs FRM Horiba, CO						FRM Horiba, CO (ppb)		
	Average (ppb)	SD (ppb)	R^2	Slope	Intercept	MBE[1] (ppb)	MAE[2] (ppb)	RMSE[3] (ppb)	FRM Horiba Average	FRM Horiba SD	Range during the field evaluation
5-min	486.1	295.3	0.38 to 0.74	0.58 to 0.92	15.5 to 148.0	4.9 to 72.3	125.3 to 207.4	163.8 to 299.6	448.5	319.9	78.5 to 2050.6
1-hr	486.6	292.1	0.38 to 0.76	0.59 to 0.93	19.0 to 155.7	-2.1 to 55.6	122.3 to 201.2	157.8 to 288.6	459.2	316.1	102.2 to 1750.5
24-hr	487.8	211.5	0.8 to 0.92	0.76 to 0.89	0.6 to 101.6	9.1 to 72.3	53.0 to 79.3	69.0 to 100.4	443.5	190.8	150.7 to 968.6

[1] Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).
[2] Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.
[3] Root Mean Square Error (RMSE): another metric to calculate measurement errors.

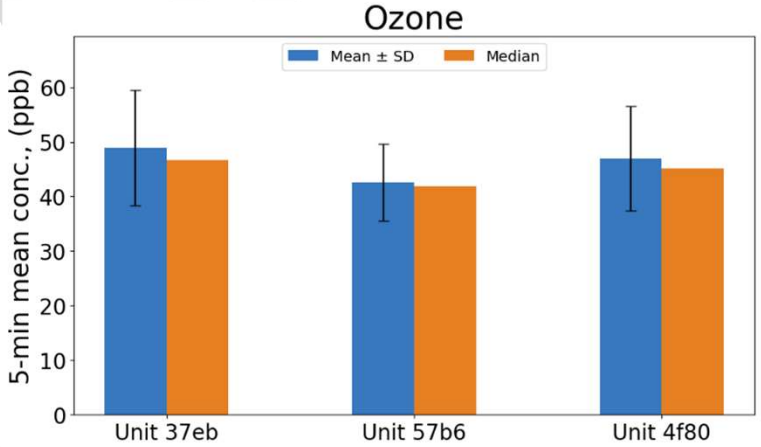
Ozone (O_3)
in Air Quality Egg 2024 Model

Data validation & recovery

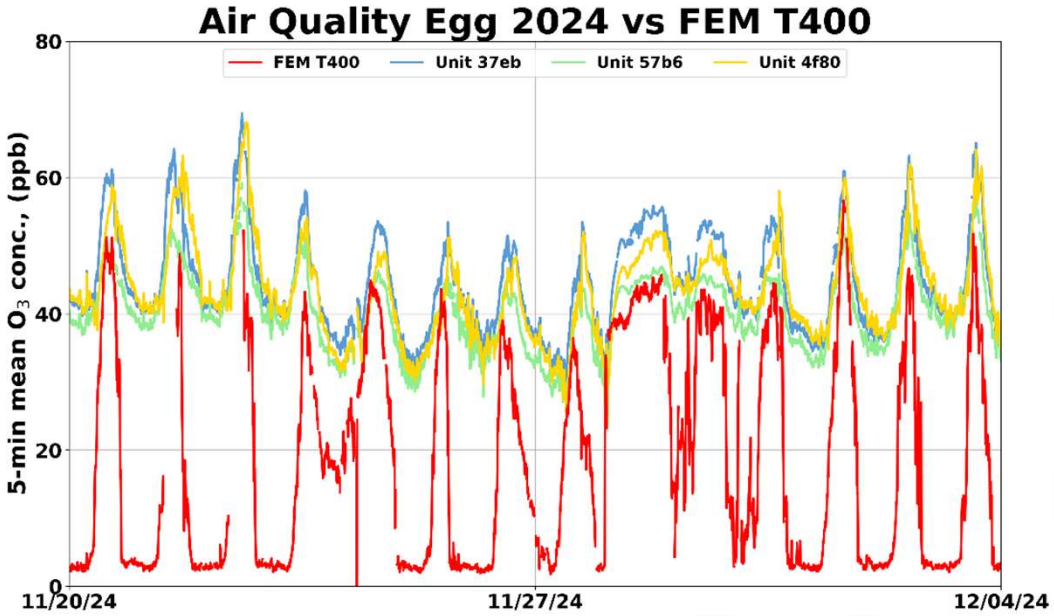
- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for O_3 from Unit 37eb, Unit 57b6 and Unit 4f80 was ~99.1%, ~97.1% and ~99.9%, respectively

Air Quality Egg 2024 Model; Intra-model variability

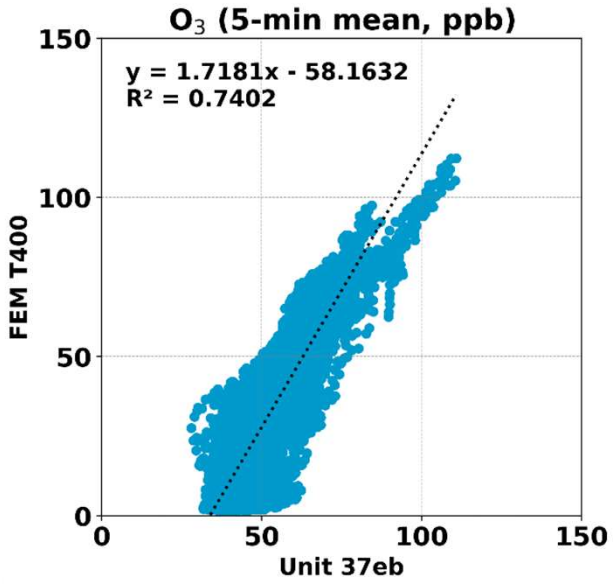
- Absolute intra-model variability was ~3.2 ppb for the ozone measurements (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~6.9% for the ozone measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)

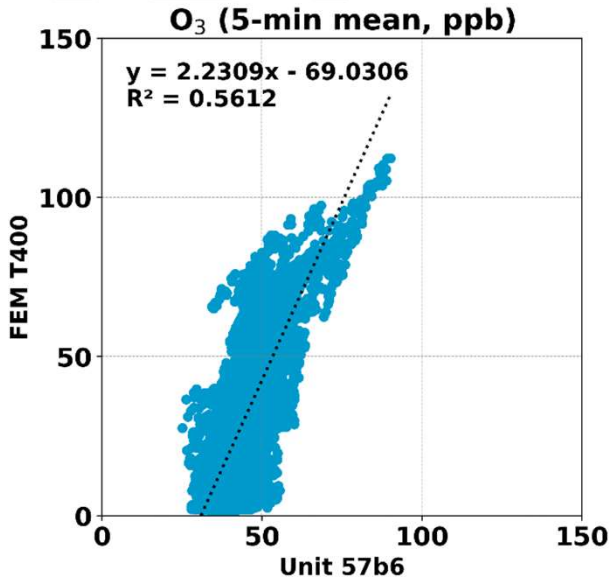


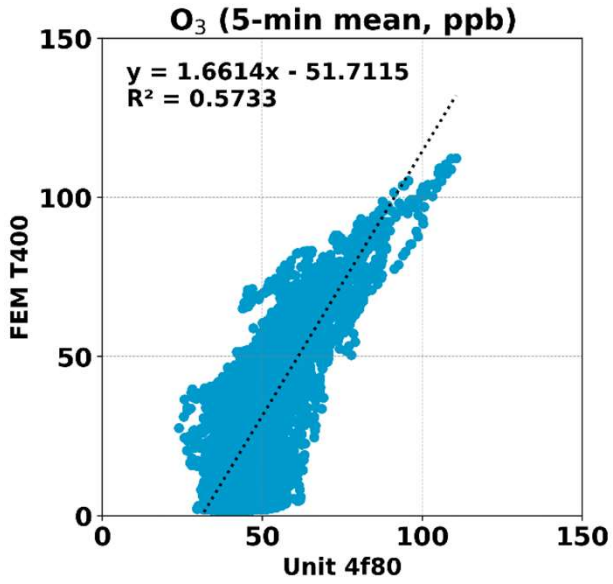
Air Quality Egg 2024 Model vs FEM T400 (Ozone; 5-min mean)



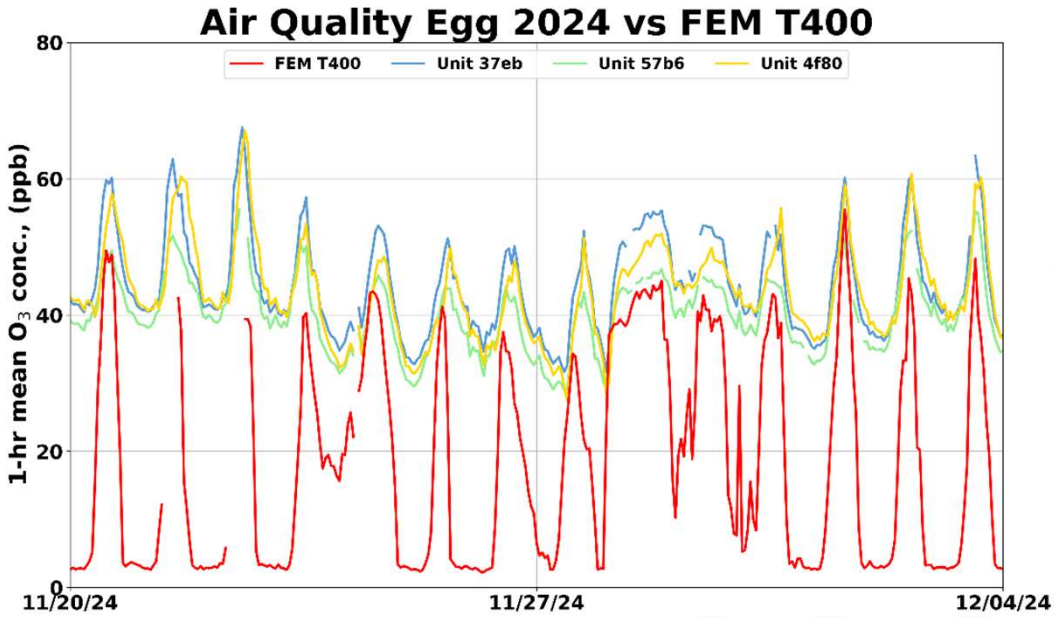
- The Air Quality Egg 2024 Model sensors showed moderate to strong correlations with the corresponding FEM T400 ozone data ($0.56 < R^2 < 0.75$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the ozone concentrations as measured by the FEM T400 ozone instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal ozone variations as recorded by the FEM T400 instrument



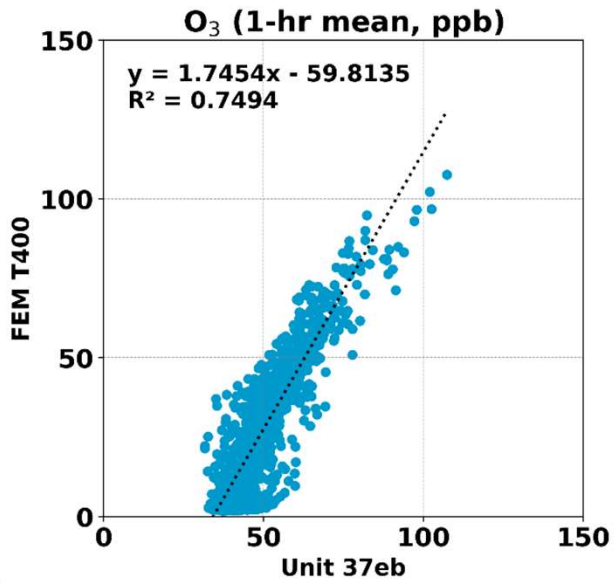


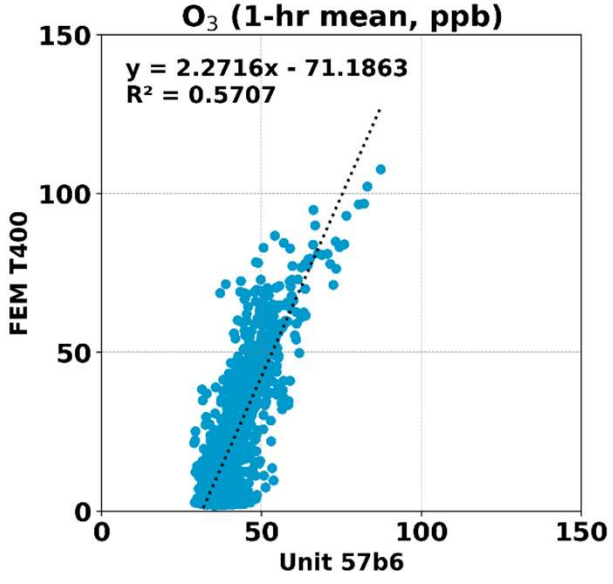


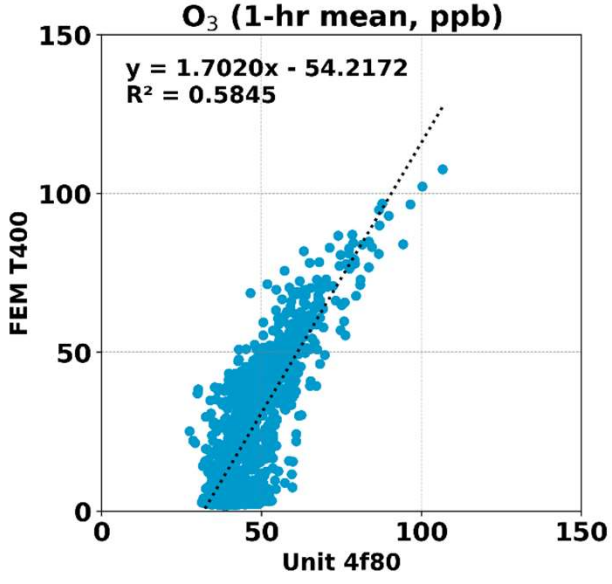
Air Quality Egg 2024 Model vs FEM T400 (Ozone; 1-hr mean)



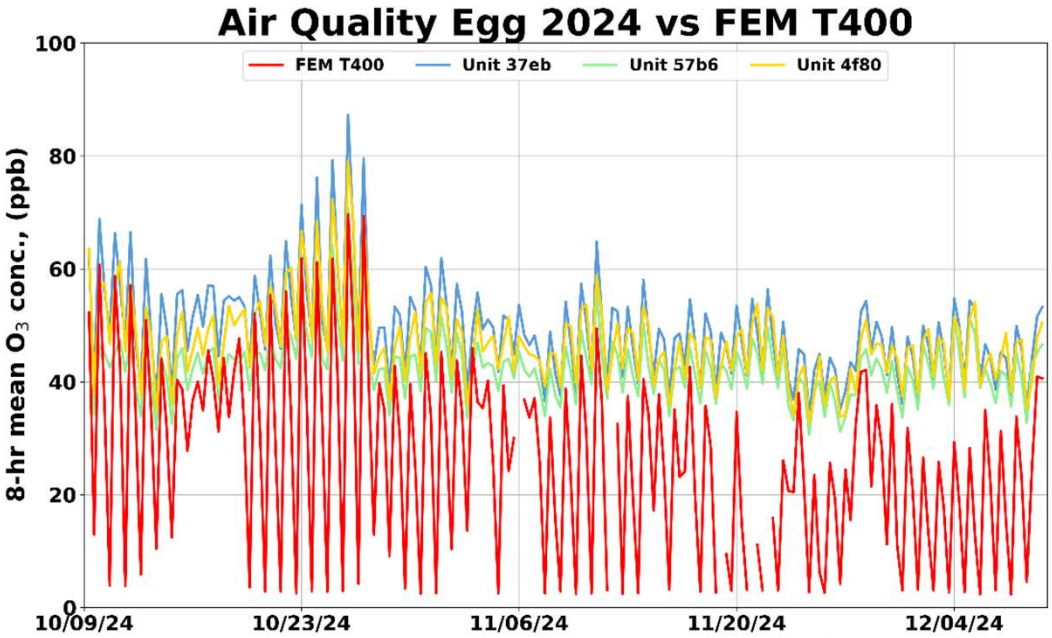
- The Air Quality Egg 2024 Model sensors showed moderate to strong correlations with the corresponding FEM T400 ozone data ($0.57 < R^2 < 0.75$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the ozone concentrations as measured by the FEM T400 ozone instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal ozone variations as recorded by the FEM T400 instrument



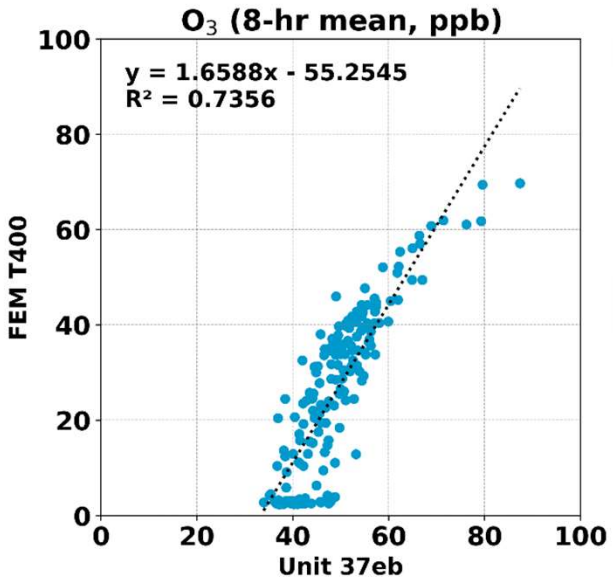


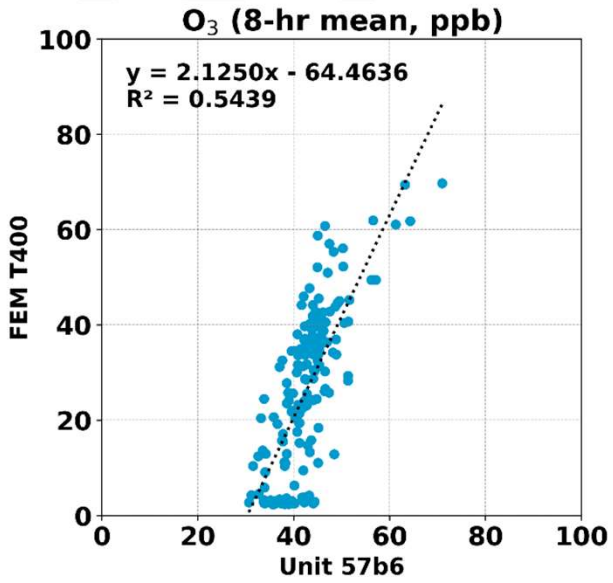


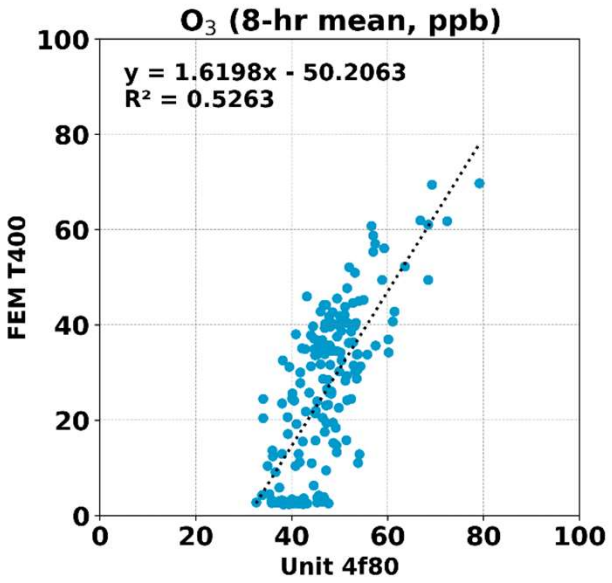
Air Quality Egg 2024 Model vs FEM T400 (Ozone; 8-hr mean)



- The Air Quality Egg 2024 Model sensors showed moderate to strong correlations with the corresponding FEM T400 ozone data ($0.52 < R^2 < 0.74$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the ozone concentrations as measured by the FEM T400 ozone instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal ozone variations as recorded by the FEM T400 instrument







Summary: Ozone

	Average of 3 Sensors, Ozone		Air Quality Egg 2024 Model vs FEM T400, Ozone						FEM T400, Ozone (ppb)		
	Average (ppb)	SD (ppb)	R^2	Slope	Intercept	MBE[1] (ppb)	MAE[2] (ppb)	RMSE[3] (ppb)	FEM T400 Average	FEM T400 SD	Range during the field evaluation
5-min	46.3	9.1	0.56 to 0.74	1.66 to 2.23	-69.0 to -51.7	16.3 to 22.5	18.9 to 22.8	23.3 to 26.2	27.2	21.5	0.0 to 112.2
1-hr	46.3	9.0	0.57 to 0.75	1.70 to 2.27	-71.2 to -54.2	17.1 to 23.2	19.5 to 23.5	23.8 to 26.7	26.0	21.3	1.7 to 107.6
8-hr	46.3	7.4	0.53 to 0.74	1.62 to 2.13	-64.5 to -50.2	16.6 to 23.0	17.5 to 23.0	21.2 to 25.3	26.0	17.1	2.3 to 69.7

[1] Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).
[2] Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.
[3] Root Mean Square Error (RMSE): another metric to calculate measurement errors.

Nitrogen Dioxide (NO_2) in Air Quality Egg 2024 Model

Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for NO_2 from Unit 37eb, Unit 57b6 and Unit 4f80 was ~99.2%, ~97.1% and ~99.9%, respectively

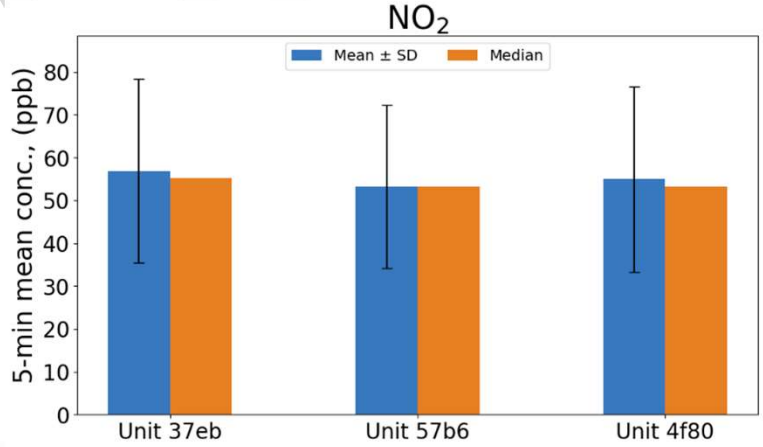
Air Quality Egg 2024 Model; Intra-model variability

- Absolute intra-model variability was ~1.8 ppb for the NO_2 measurements

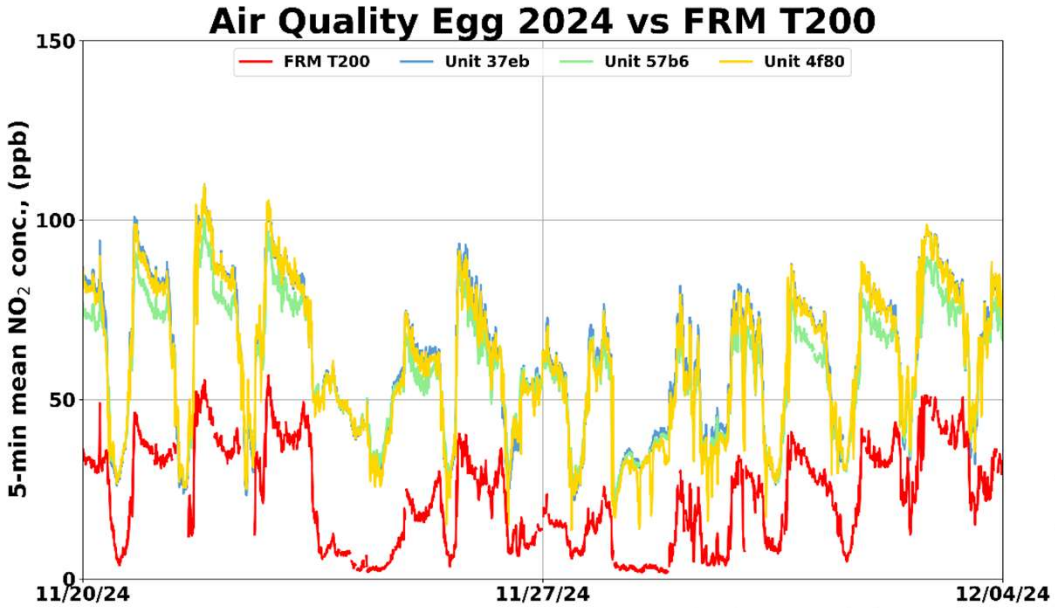
(calculated as the standard deviation of the three sensor means)

- Relative intra-model variability was ~3.3% for the NO_2 measurements

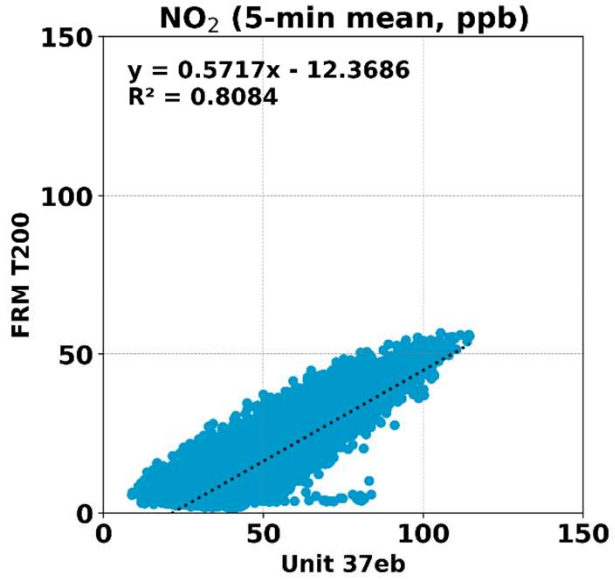
(calculated as the absolute intra-model variability relative to the mean of the three sensor means)

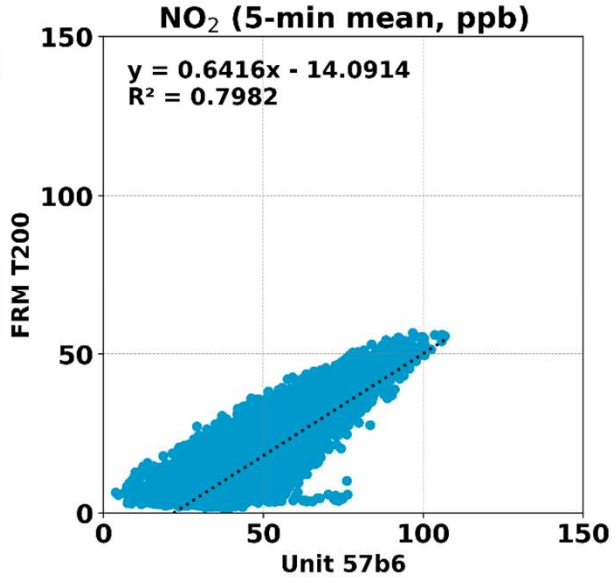


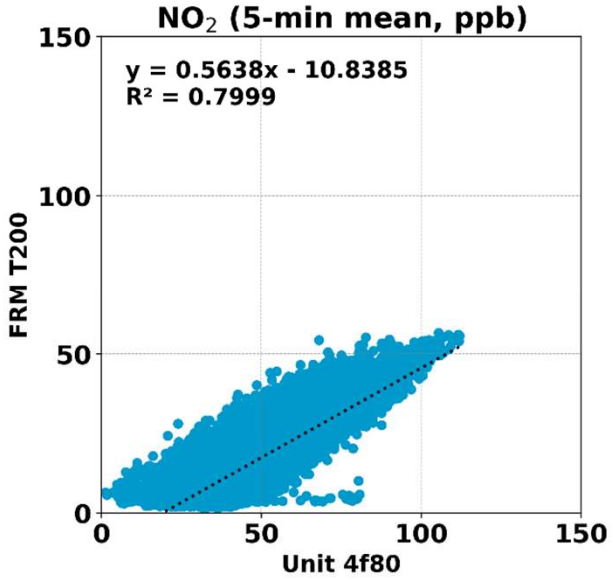
Air Quality Egg 2024 Model vs FRM T200 (NO_2; 5-min mean)



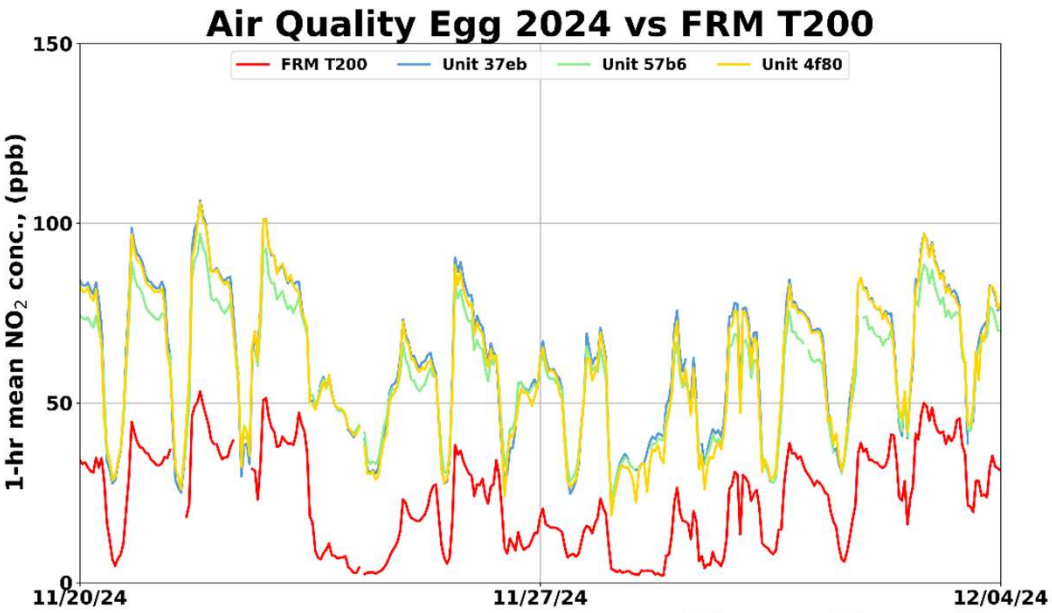
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding FRM T200 NO_2 data ($0.79 < R^2 < 0.81$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the NO_2 concentration as measured by the FRM T200 instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal NO_2 variations as recorded by the FRM T200 instrument



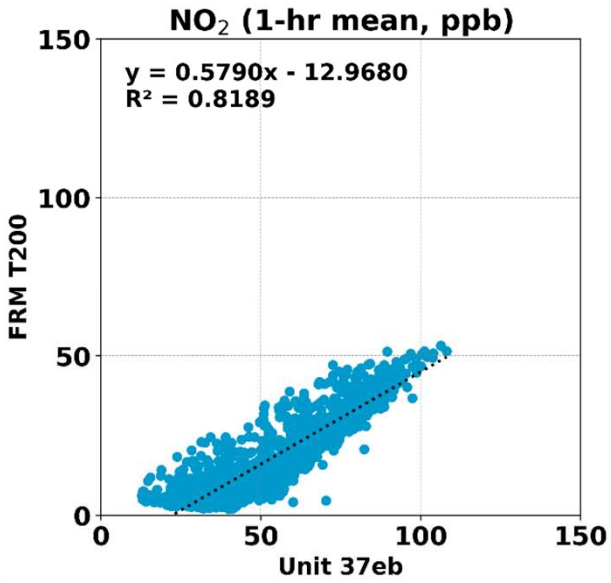


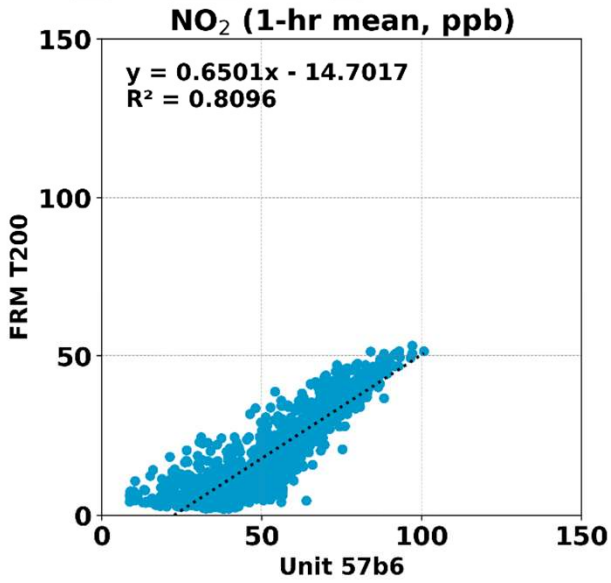


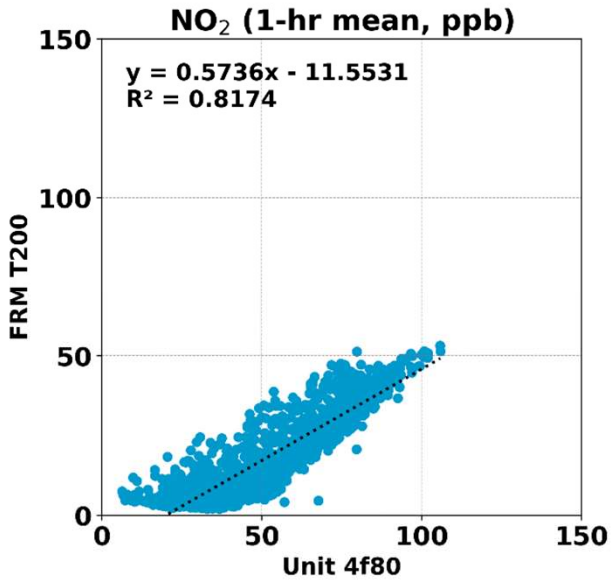
Air Quality Egg 2024 Model vs FRM T200 (NO_2; 1-hr mean)



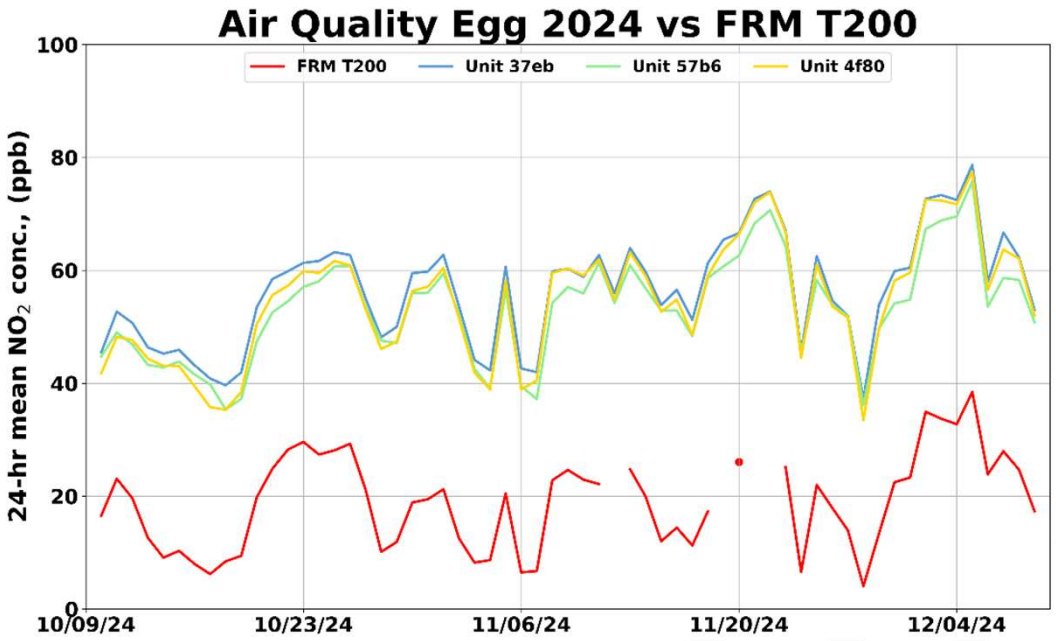
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding FRM T200 NO_2 data ($0.80 < R^2 < 0.82$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the NO_2 concentration as measured by the FRM T200 instrument
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal NO_2 variations as recorded by the FRM T200 instrument



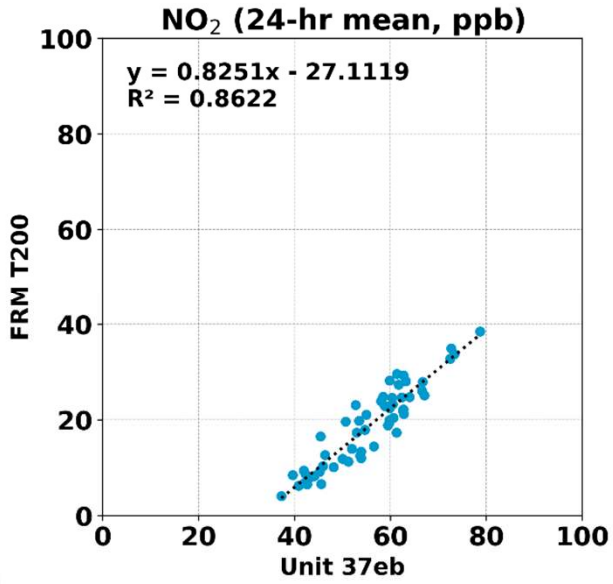


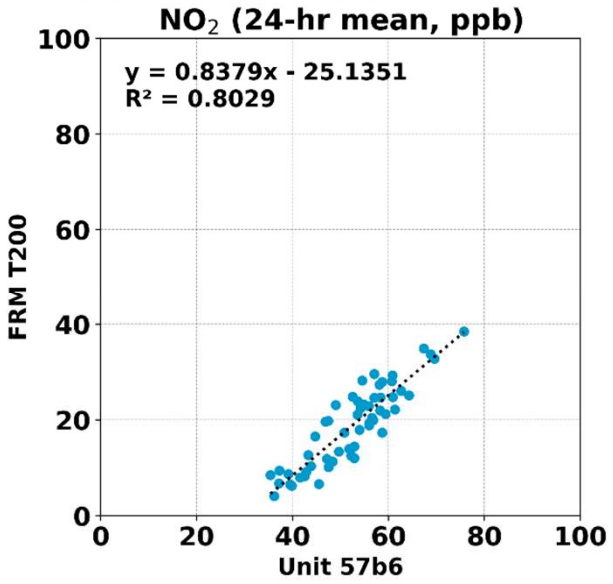


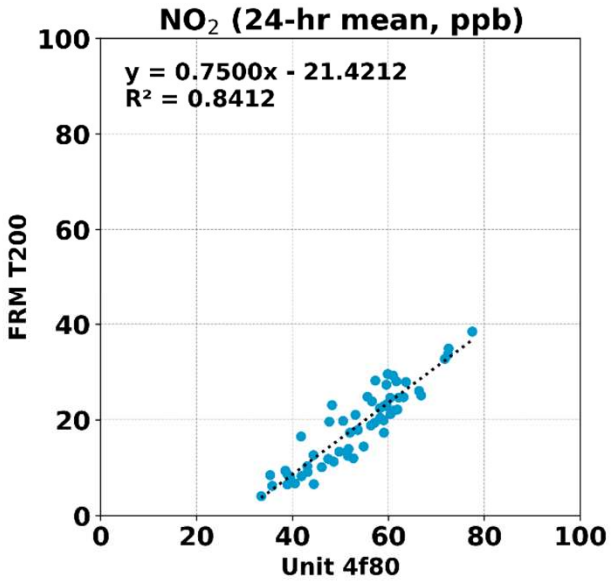
Air Quality Egg 2024 Model vs FRM T200 (NO_2; 24-hr mean)



- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding FRM T200 NO_2 data ($0.80 < R^2 < 0.87$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the NO_2 concentration as measured by the FRM T200 instrument
- The Air Quality Egg 2024 Model sensors seemed to track the daily NO_2 variations as recorded by the FRM T200 instrument







Summary: NO_2

	Average of 3 Sensors, NO_2		Air Quality Egg 2024 Model vs FRM T200, NO_2						FRM T200, NO_2 (ppb)		
	Average (ppb)	SD (ppb)	R^2	Slope	Intercept	MBE[1] (ppb)	MAE[2] (ppb)	RMSE[3] (ppb)	FRM T200 Average	FRM T200 SD	Range during the field evaluation
5-min	54.6	20.7	0.80 to 0.81	0.56 to 0.64	-14.1 to -10.8	32.9 to 36.2	32.9 to 36.2	34.2 to 37.8	19.3	13.6	1.4 to 56.7
1-hr	54.7	20.5	0.81 to 0.82	0.57 to 0.65	-14.7 to -11.6	33.4 to 36.9	33.4 to 36.9	34.6 to 38.4	19.8	13.5	2.0 to 53.2
24-hr	54.8	9.8	0.80 to 0.86	0.75 to 0.84	-27.1 to -21.4	33.7 to 36.9	33.7 to 36.9	33.9 to 37.0	18.9	8.4	4.1 to 38.5

[1] Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).
[2] Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.
[3] Root Mean Square Error (RMSE): another metric to calculate measurement errors.

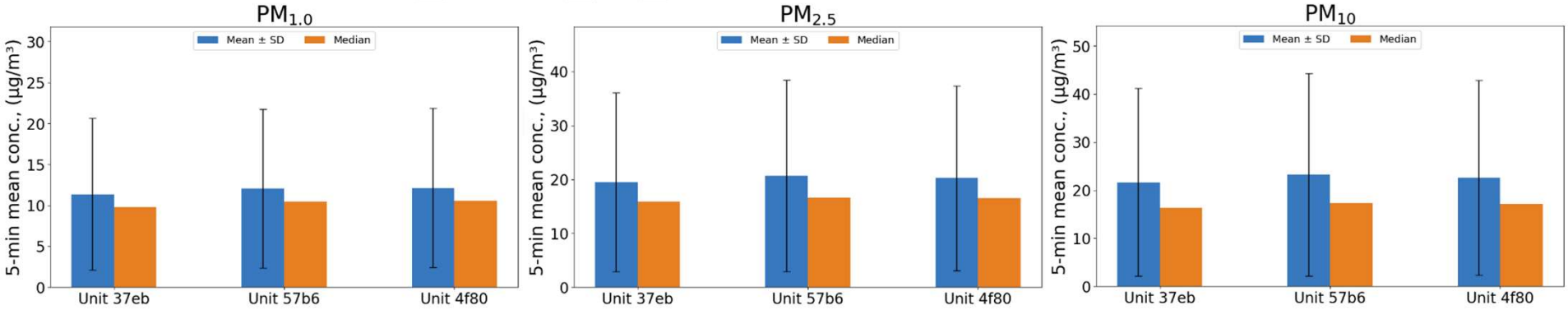
Particulate Matter (PM) in Air Quality Egg 2024 Model

Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery from Unit 37eb, Unit 57b6 and Unit 4f80 were ~99.2%, ~97.1%, and ~99.9% for each sensor unit and for all $PM_{1.0}$, $PM_{2.5}$ and PM_{10} measurements, respectively.

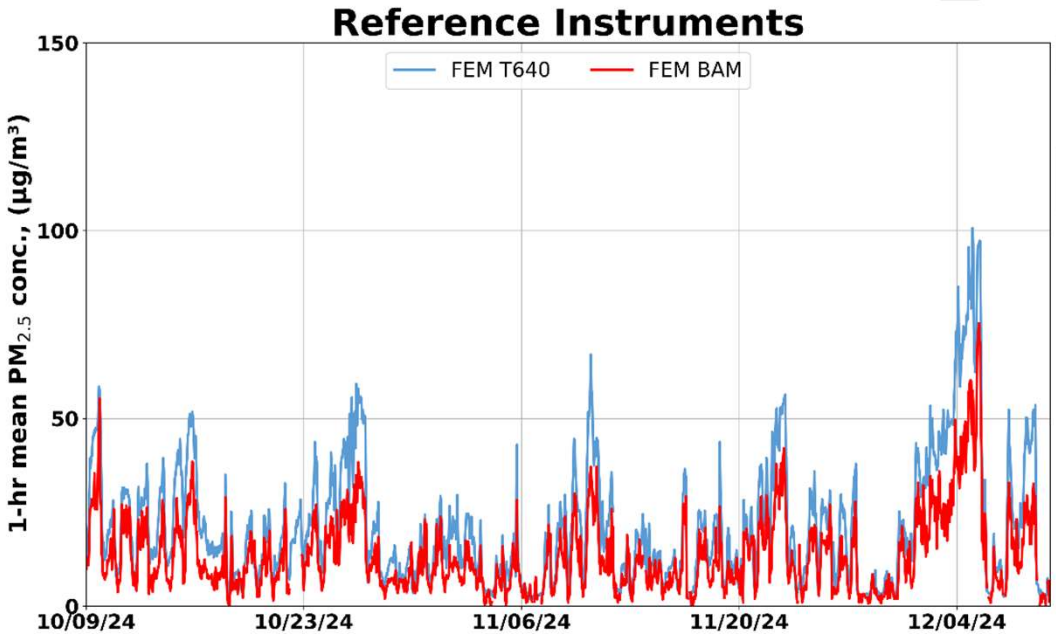
Air Quality Egg 2024 Model; intra-model variability

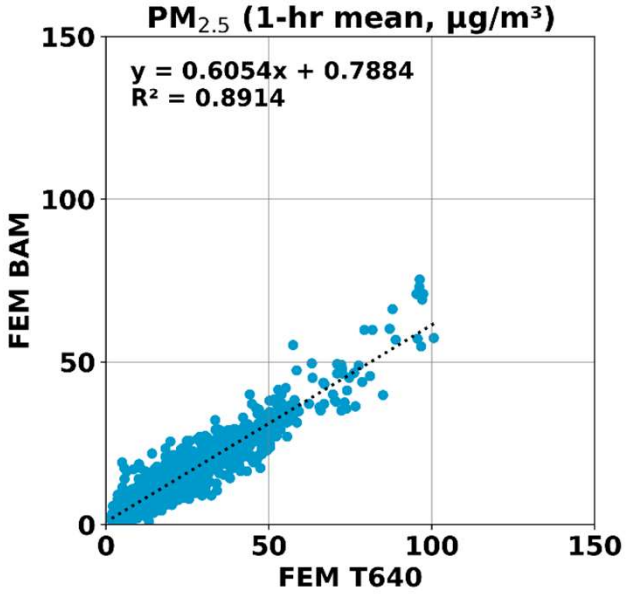
- Absolute intra-model variability was ~0.4, ~0.6, and ~0.8 µg/m^3 for $PM_{1.0}$, $PM_{2.5}$ and PM_{10}, respectively (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~3.5%, ~3.0% and ~3.6% for $PM_{1.0}$, $PM_{2.5}$ and PM_{10}, respectively (calculated as the absolute intra-model variability relative to the mean of the three sensor means)



Reference Instruments: $PM_{2.5}$ FEM BAM and FEM T640

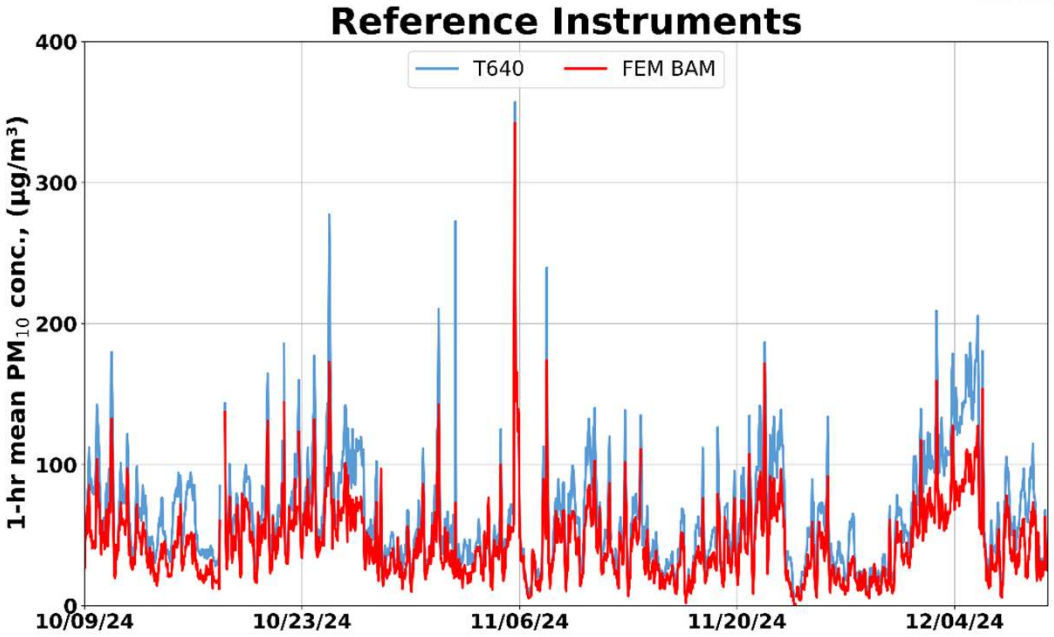
- Data recovery for $PM_{2.5}$ from FEM BAM and FEM T640 was ~97.6% and ~99.8%, respectively.
- Strong correlations between the reference instruments for $PM_{2.5}$ measurements (R^2 ~0.89) were observed.

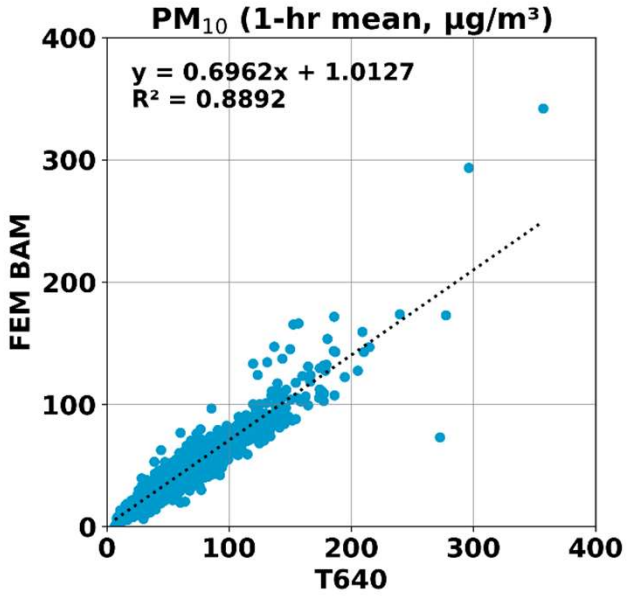




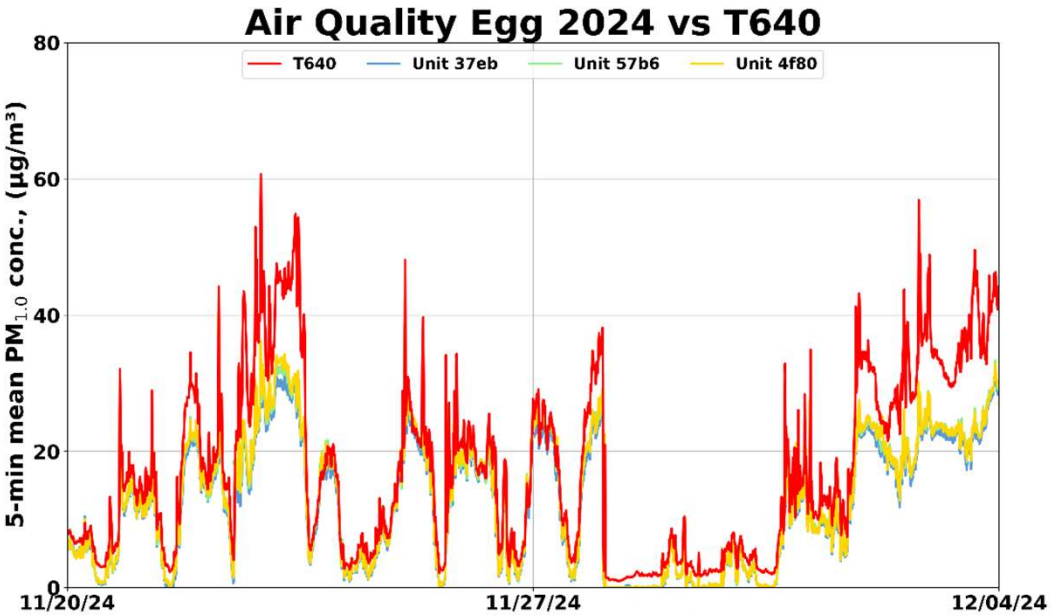
Reference Instruments: PM_{10} FEM BAM and T640

- Data recovery for PM_{10} from FEM BAM and T640 was ~100% and ~99.4%, respectively.
- Strong correlations between the reference instruments for PM_{10} measurements (R^2 ~0.89) were observed.

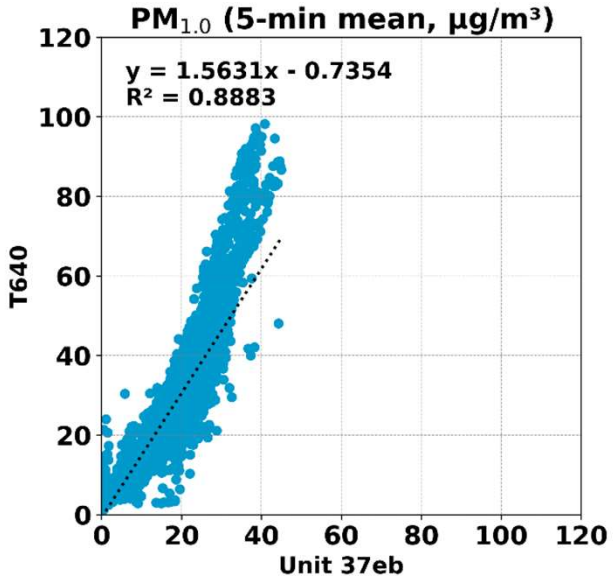


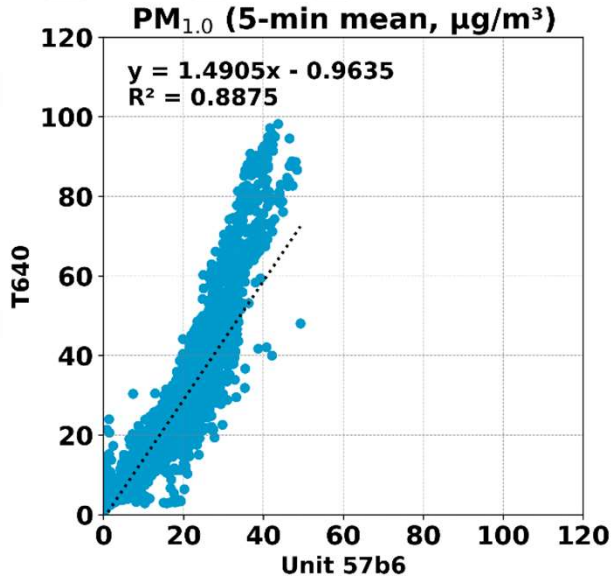


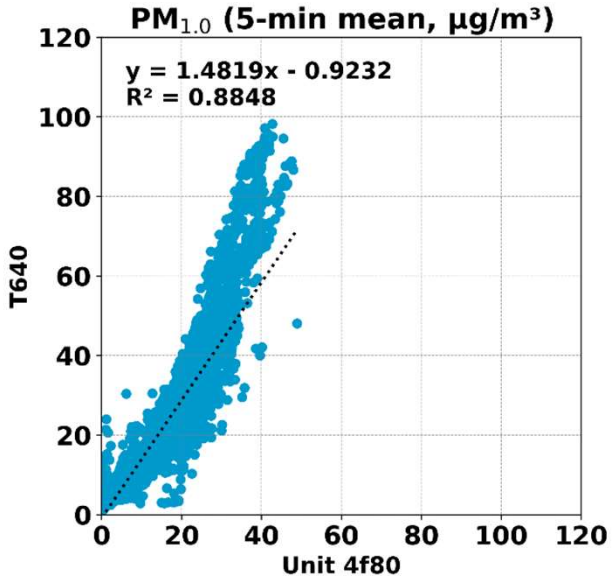
Air Quality Egg 2024 Model vs T640 ($PM_{1.0}$; 5-min mean)



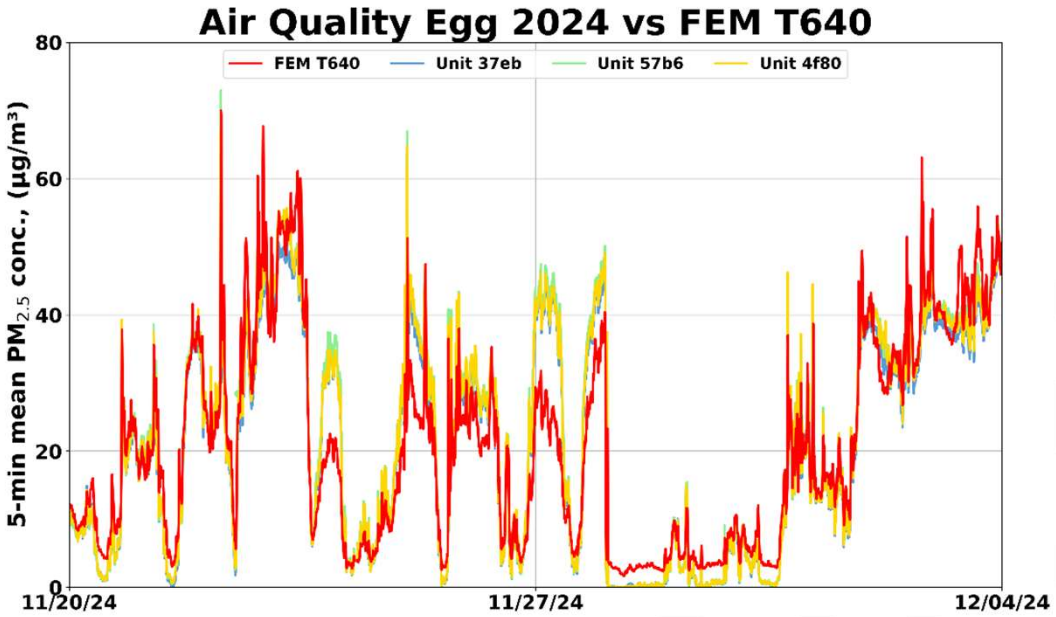
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding T640 data ($0.88 < R^2 < 0.89$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the $PM_{1.0}$ mass concentrations as measured by T640
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{1.0}$ diurnal variations as recorded by T640



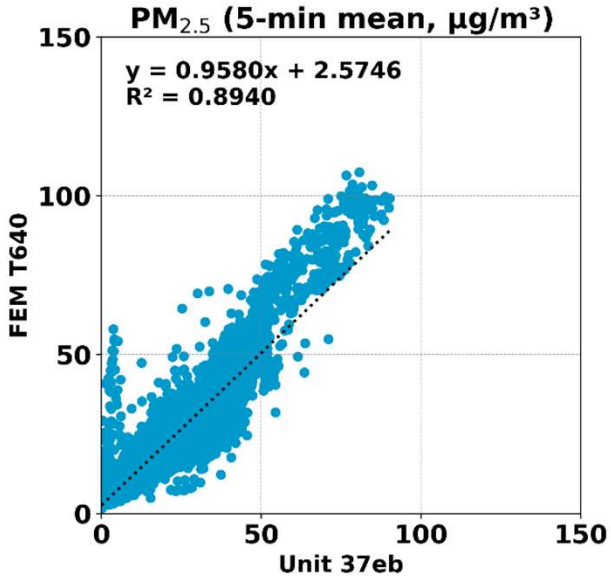


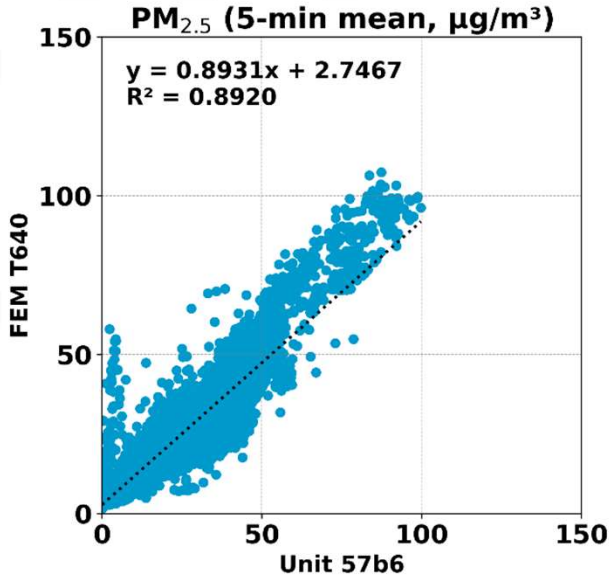


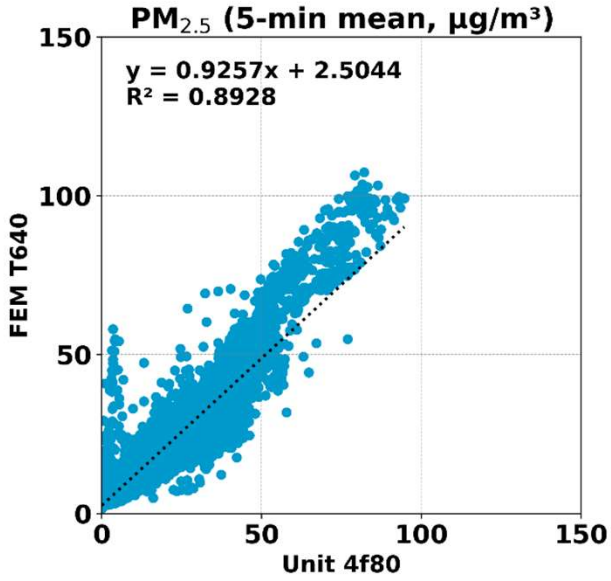
Air Quality Egg 2024 Model vs FEM T640 ($PM_{2.5}$; 5-min mean)



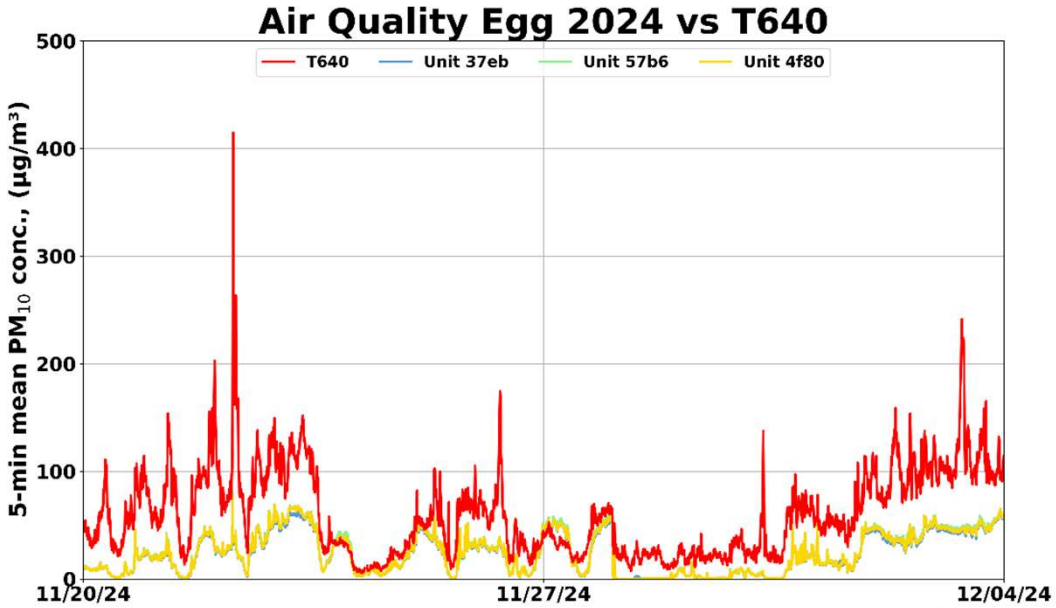
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding FEM T640 data ($0.89 < R^2 < 0.90$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM T640
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM T640



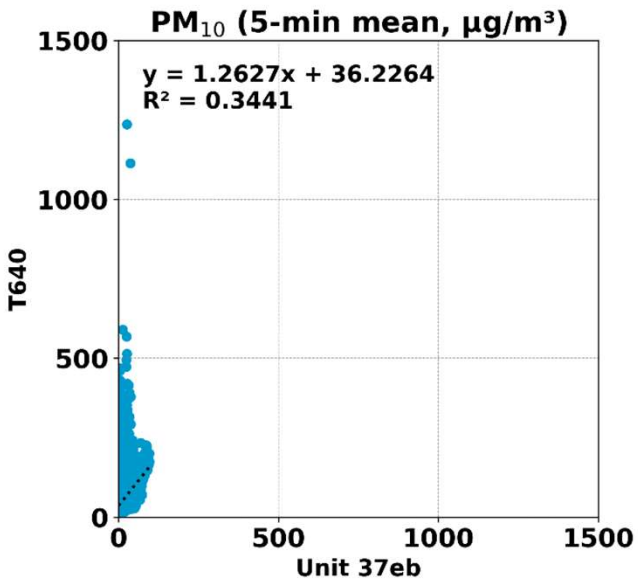


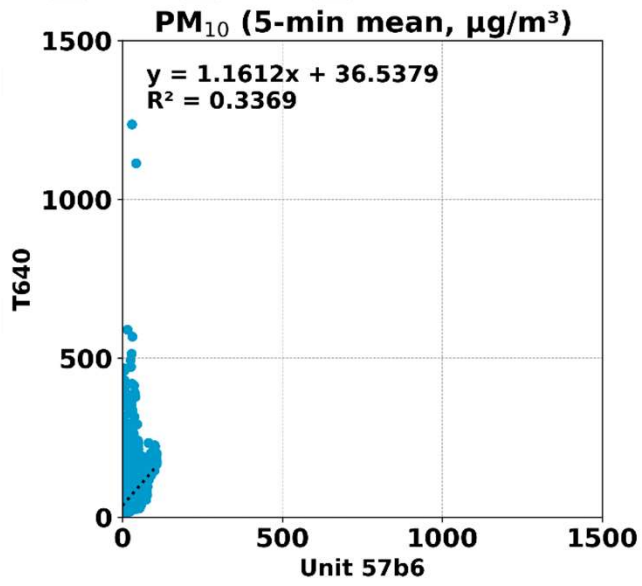


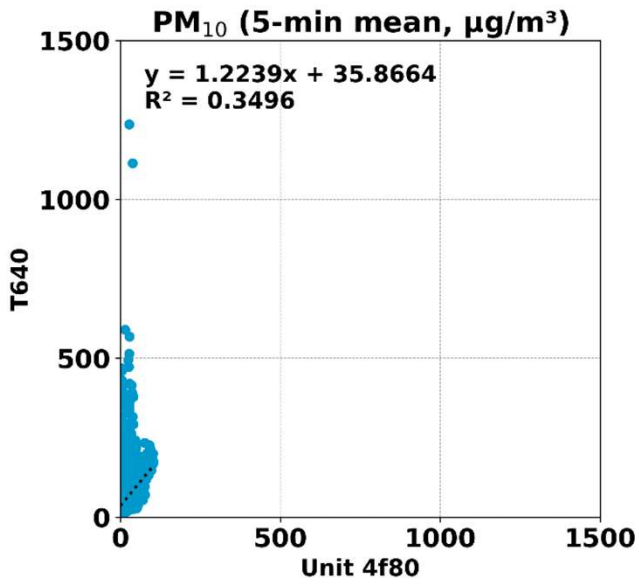
Air Quality Egg 2024 Model vs T640 (PM_{10}; 5-min mean)



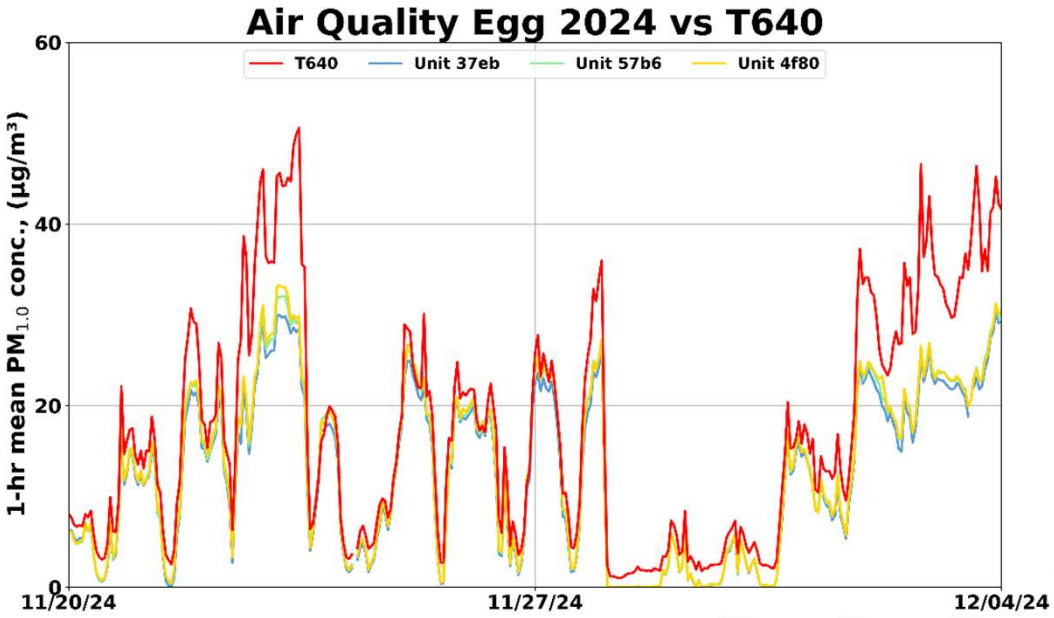
- The Air Quality Egg 2024 Model sensors showed weak correlations with the corresponding T640 data ($0.33 < R^2 < 0.35$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the PM_{10} mass concentrations as measured by T640
- The Air Quality Egg 2024 Model sensors did not seem to track the PM_{10} diurnal variations as recorded by T640



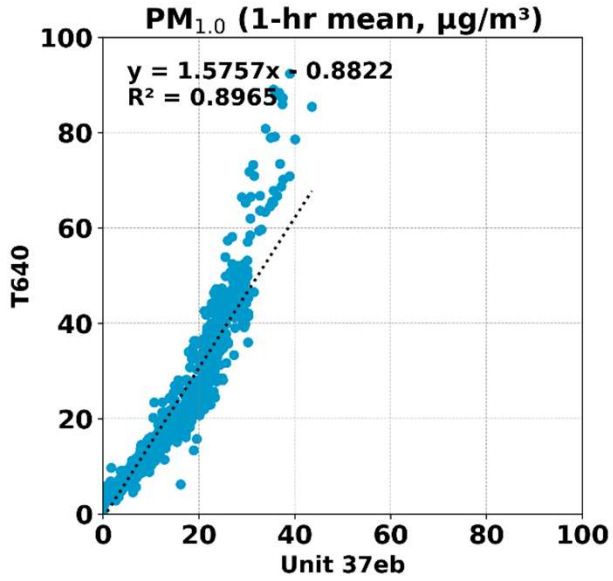


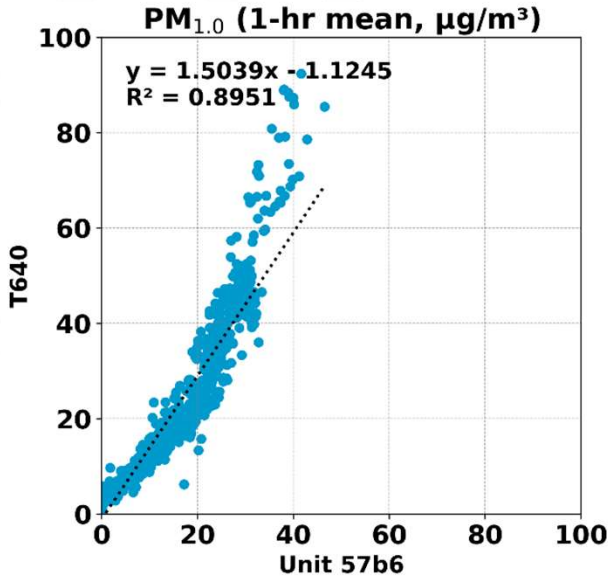


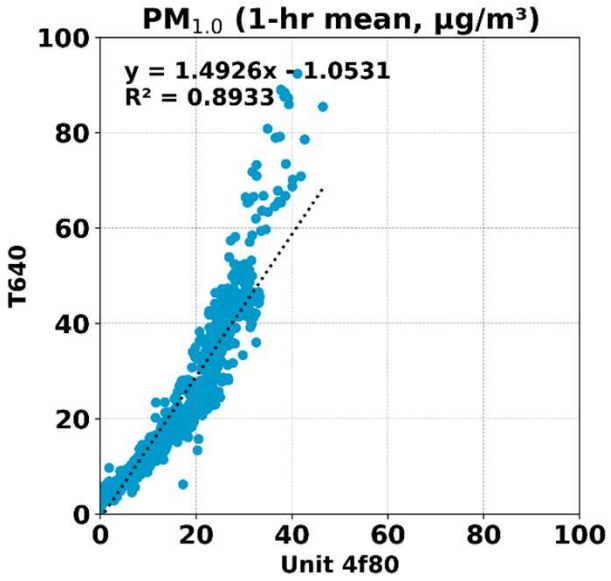
Air Quality Egg 2024 Model vs T640 ($PM_{1.0}$; 1-hr mean)



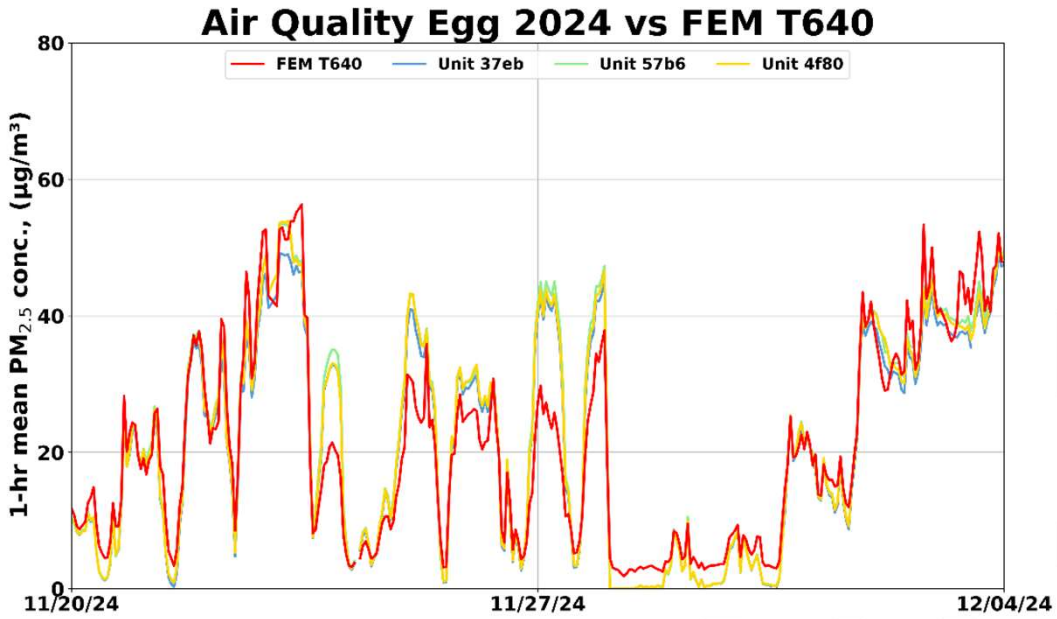
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding T640 data ($0.89 < R^2 < 0.90$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the $PM_{1.0}$ mass concentrations as measured by T640
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{1.0}$ diurnal variations as recorded by T640



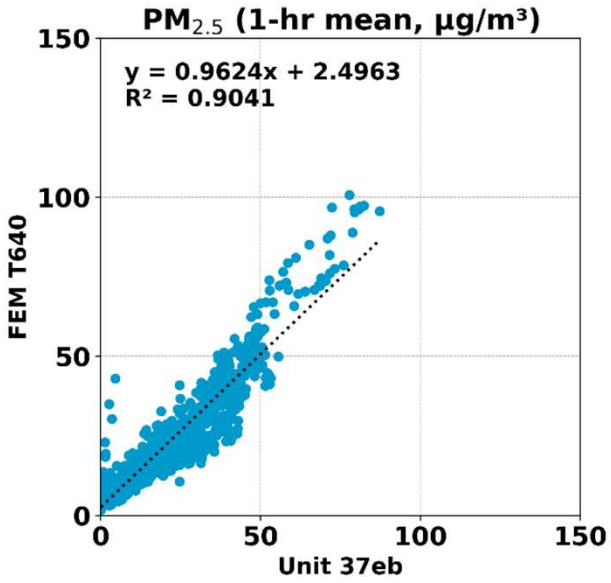


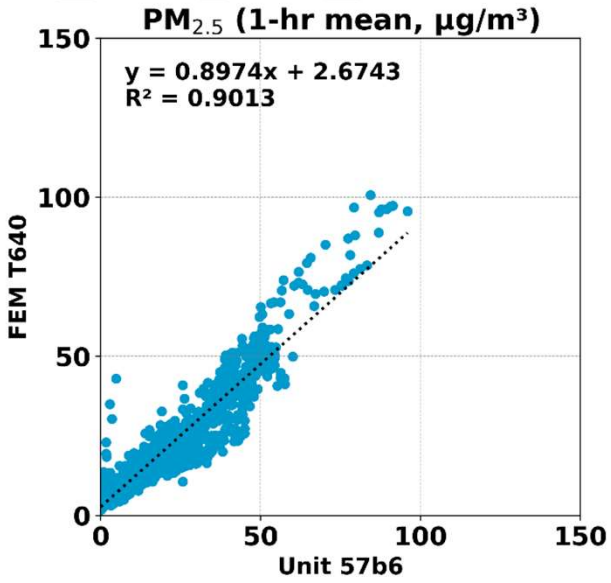


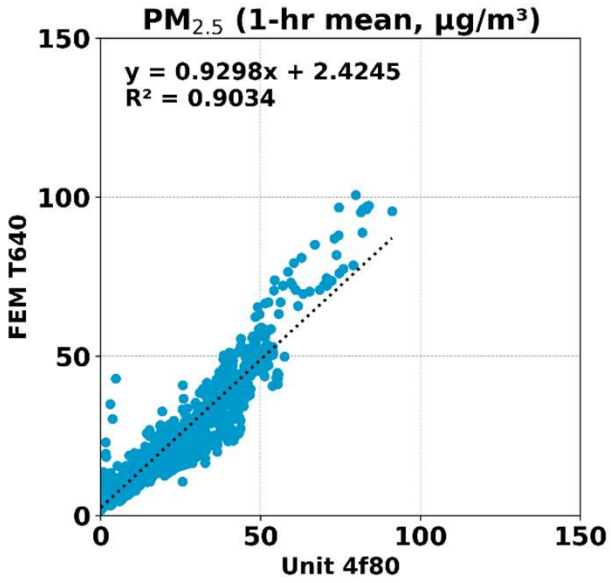
Air Quality Egg 2024 Model vs FEM T640 ($PM_{2.5}$; 1-hr mean)



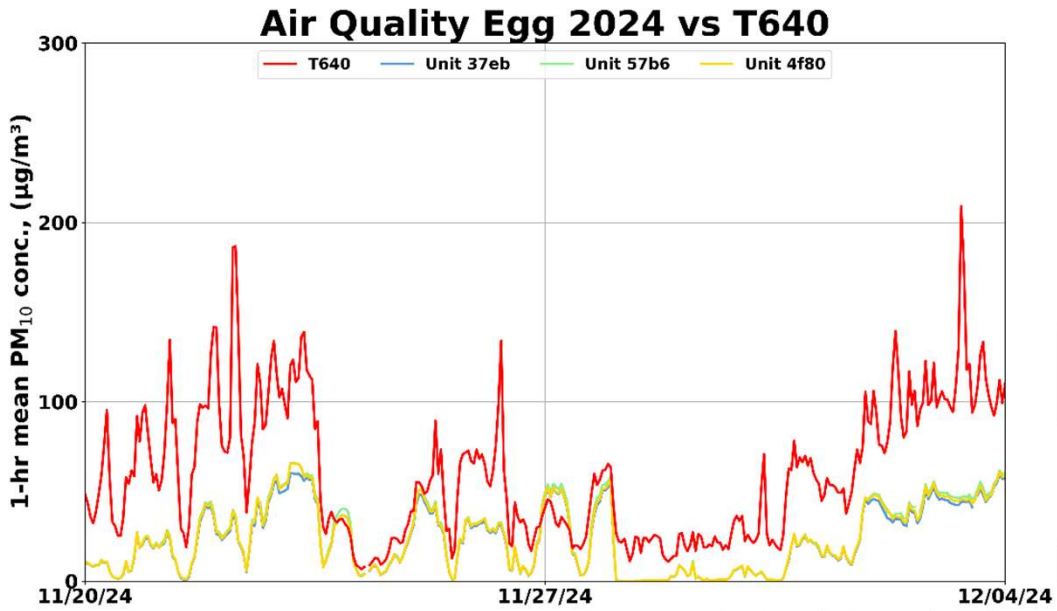
- The Air Quality Egg 2024 Model sensors showed very strong correlations with the corresponding FEM T640 data ($0.90 < R^2 < 0.91$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM T640
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM T640



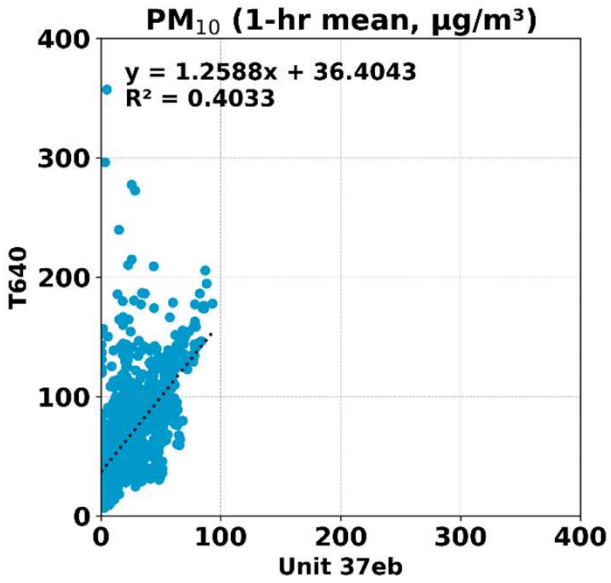


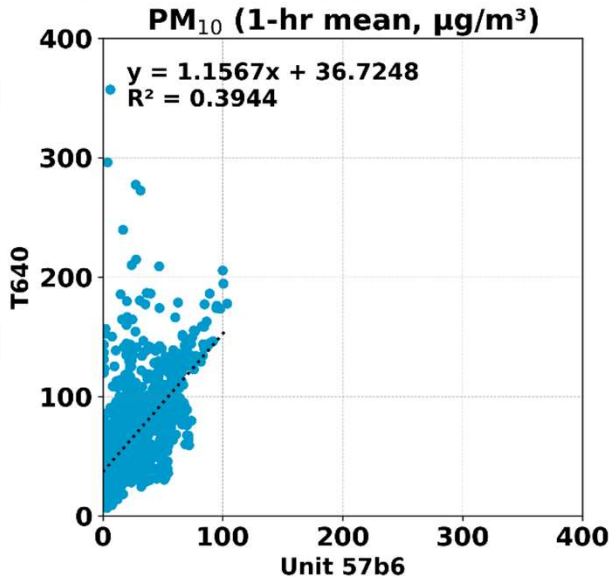


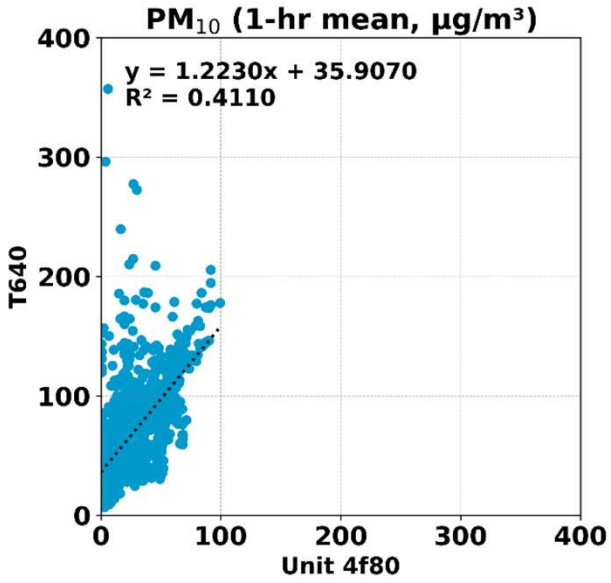
Air Quality Egg 2024 Model vs T640 (PM_{10}; 1-hr mean)



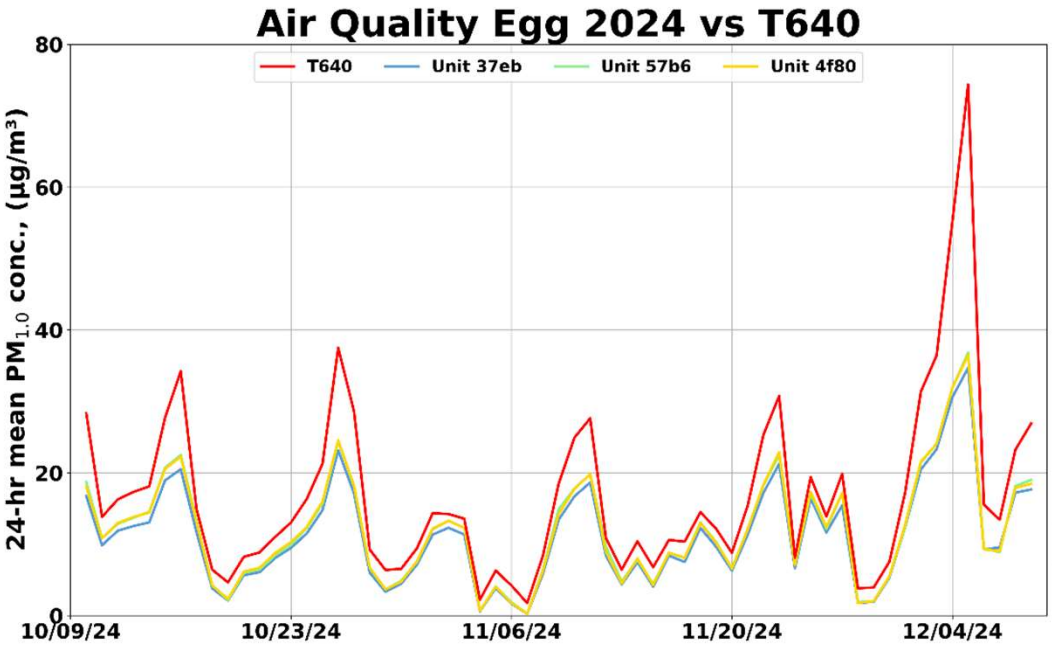
- The Air Quality Egg 2024 Model sensors showed weak correlations with the corresponding T640 data ($0.39 < R^2 < 0.42$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the PM_{10} mass concentrations as measured by T640
- The Air Quality Egg 2024 Model sensors seemed to track the PM_{10} diurnal variations as recorded by T640



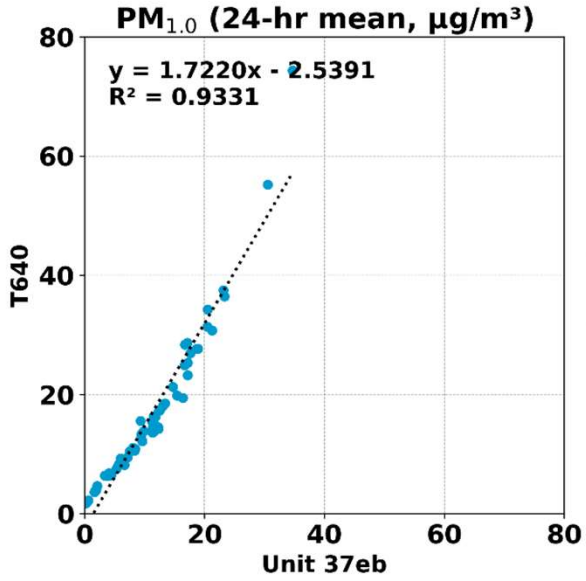


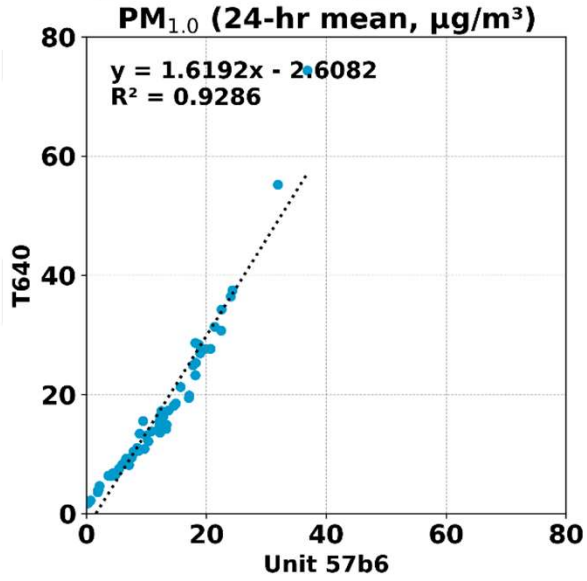


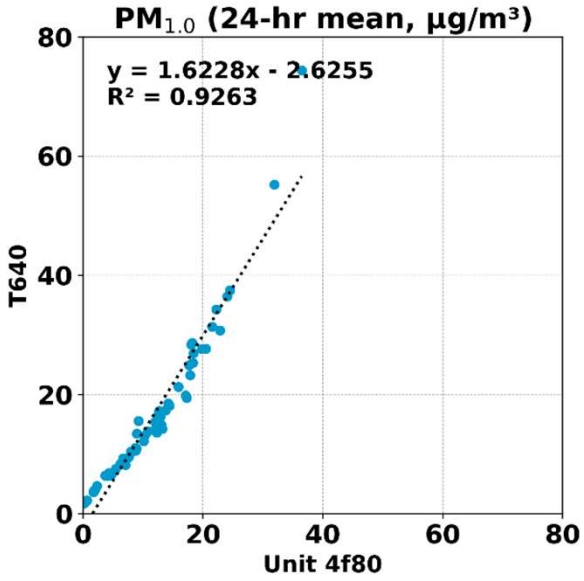
Air Quality Egg 2024 Model vs T640 ($PM_{1.0}$; 24-hr mean)



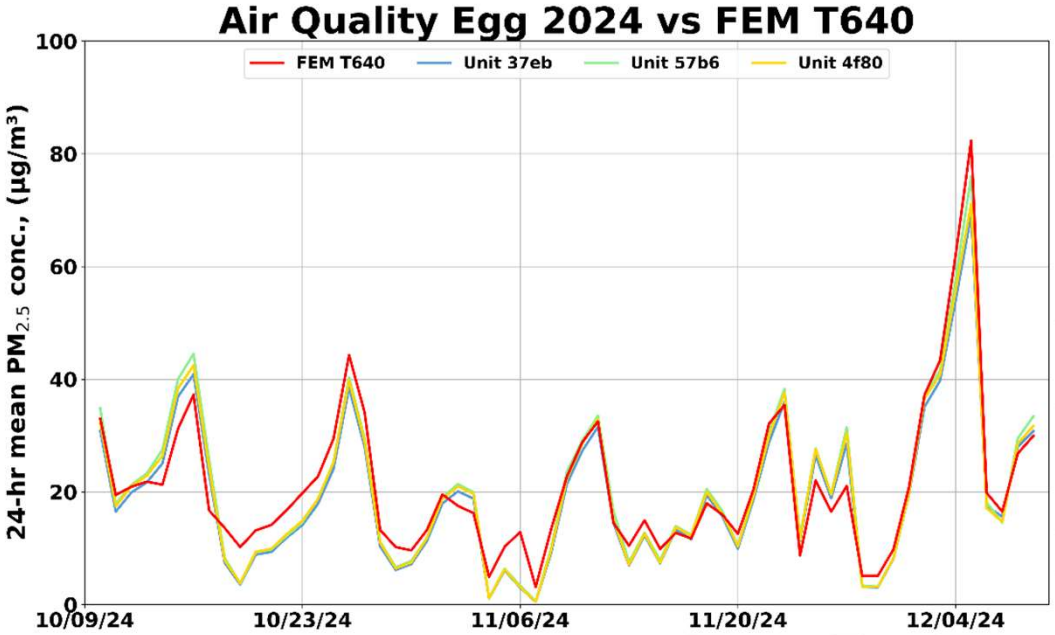
- The Air Quality Egg 2024 Model sensors showed very strong correlations with the corresponding T640 data ($0.92 < R^2 < 0.94$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the $PM_{1.0}$ mass concentrations as measured by T640
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{1.0}$ daily variations as recorded by T640



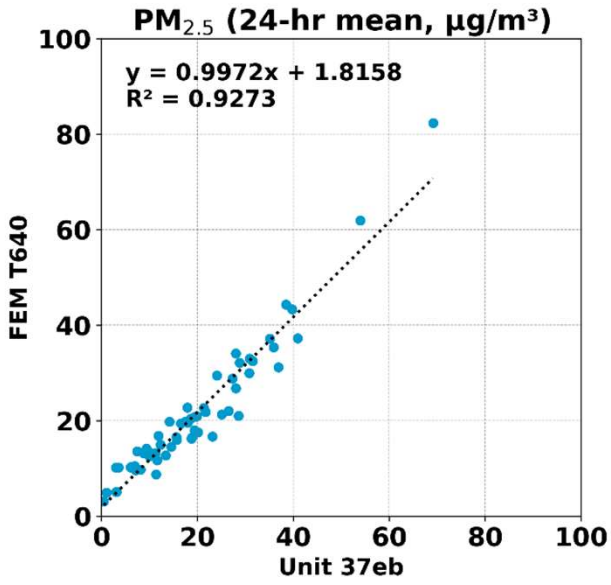


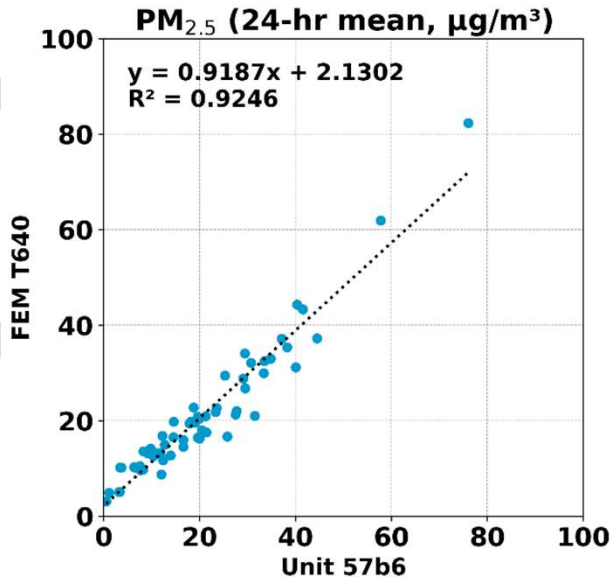


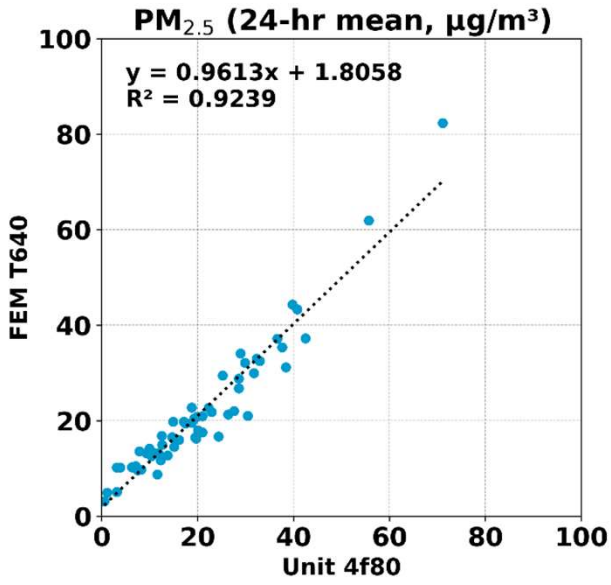
Air Quality Egg 2024 Model vs FEM T640 ($PM_{2.5}$; 24-hr mean)



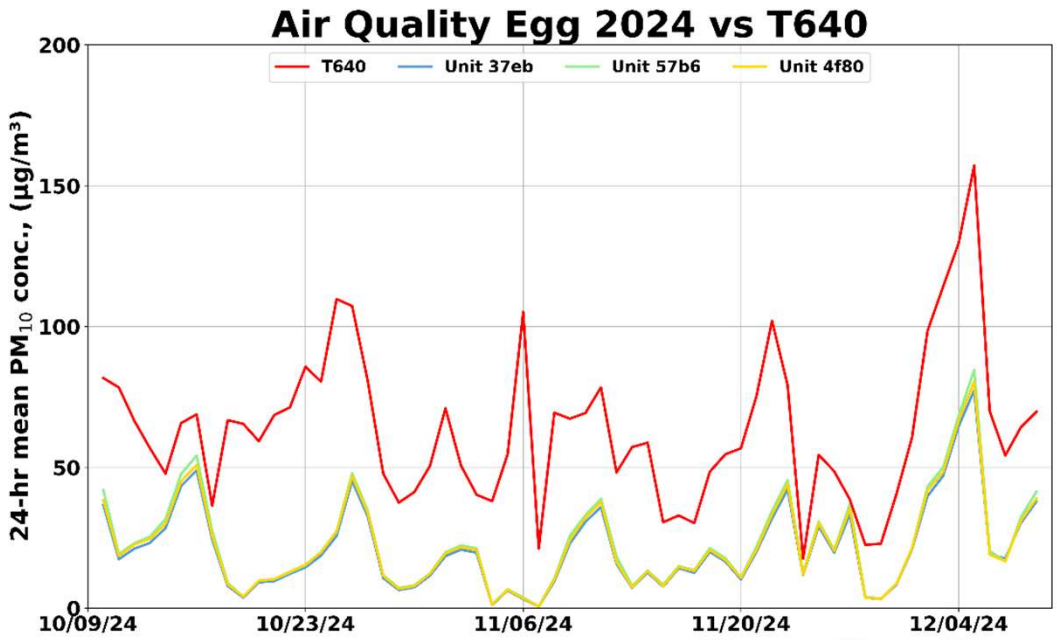
- The Air Quality Egg 2024 Model sensors showed very strong correlations with the corresponding FEM T640 data ($0.92 < R^2 < 0.93$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM T640
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{2.5}$ daily variations as recorded by FEM T640



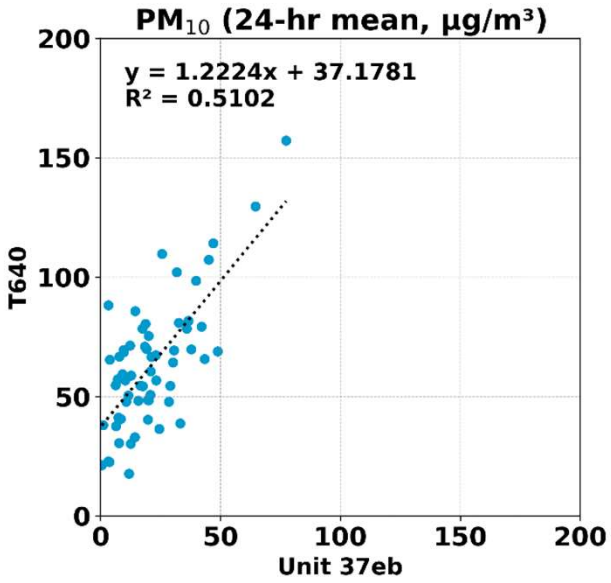


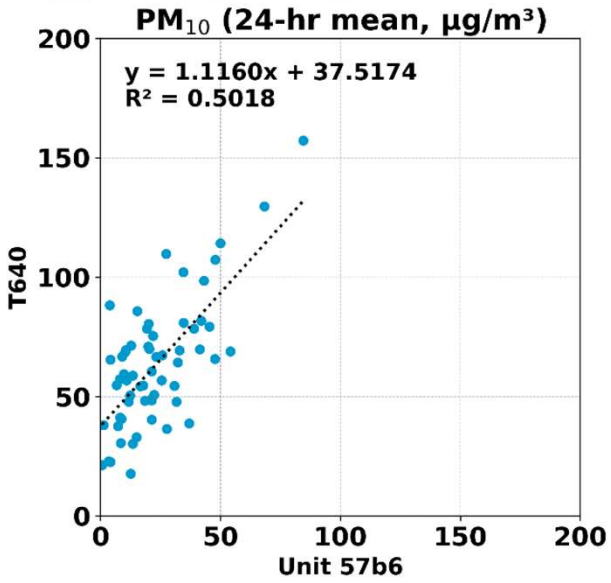


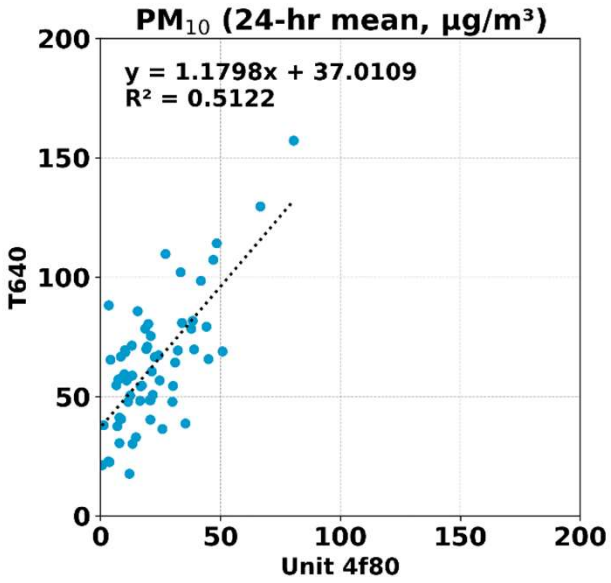
Air Quality Egg 2024 Model vs T640 (PM_{10}; 24-hr mean)



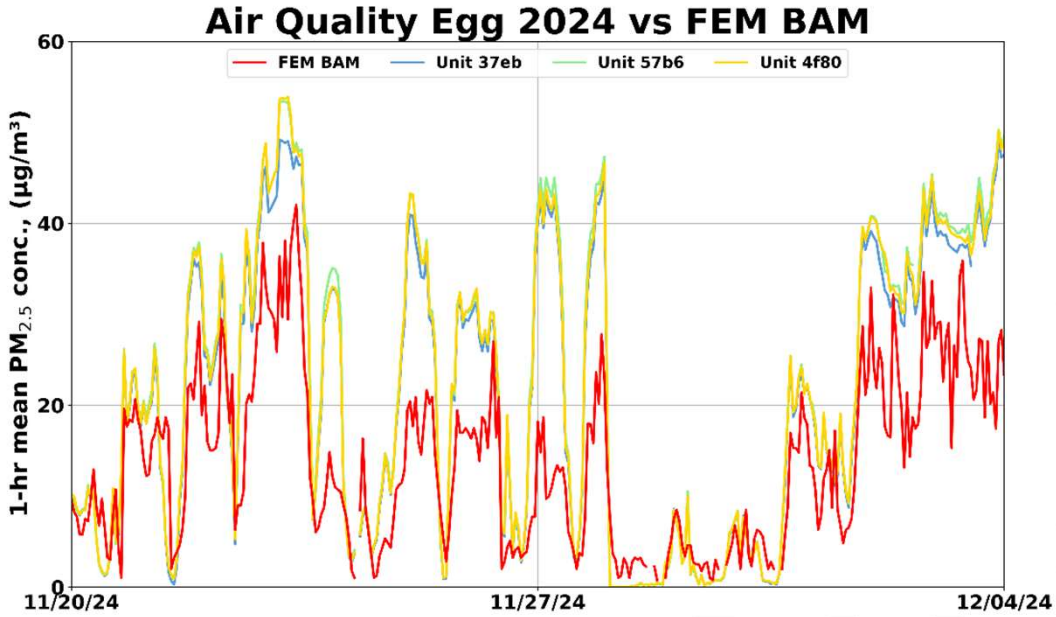
- The Air Quality Egg 2024 Model sensors showed moderate correlations with the corresponding T640 data ($0.50 < R^2 < 0.52$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the PM_{10} mass concentrations as measured by T640
- The Air Quality Egg 2024 Model sensors seemed to track the PM_{10} daily variations as recorded by T640



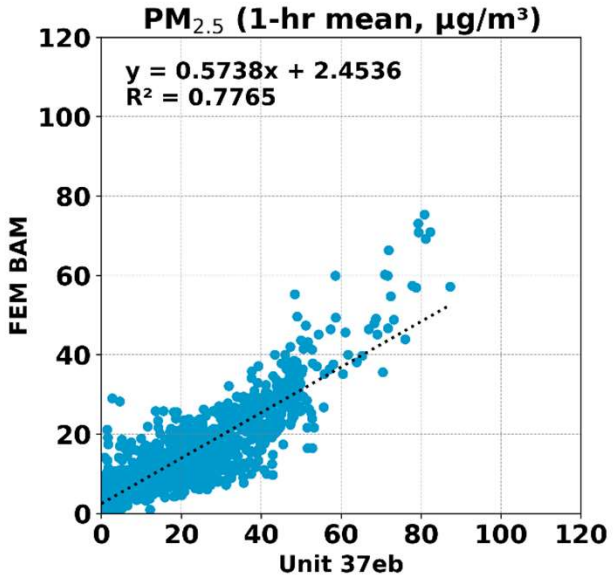


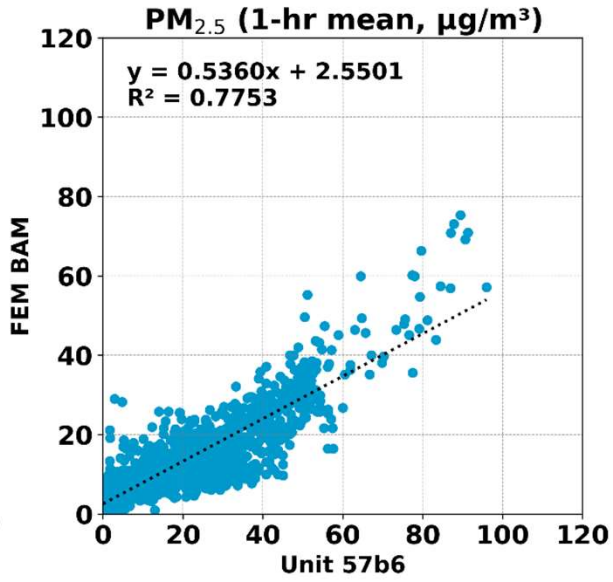


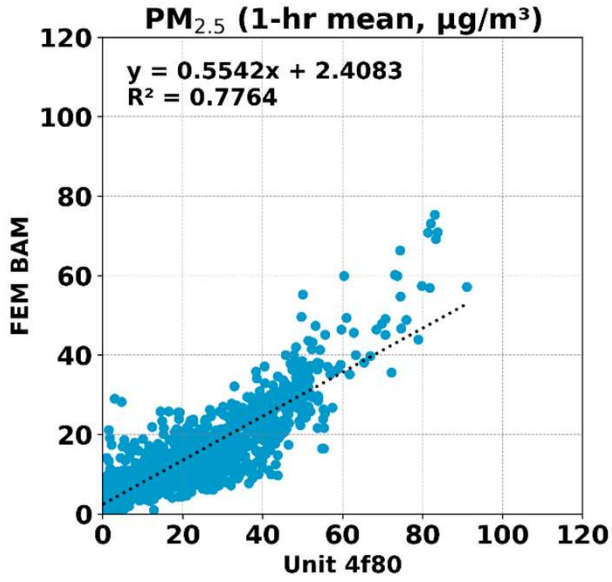
Air Quality Egg 2024 Model vs FEM BAM ($PM_{2.5}$; 1-hr mean)



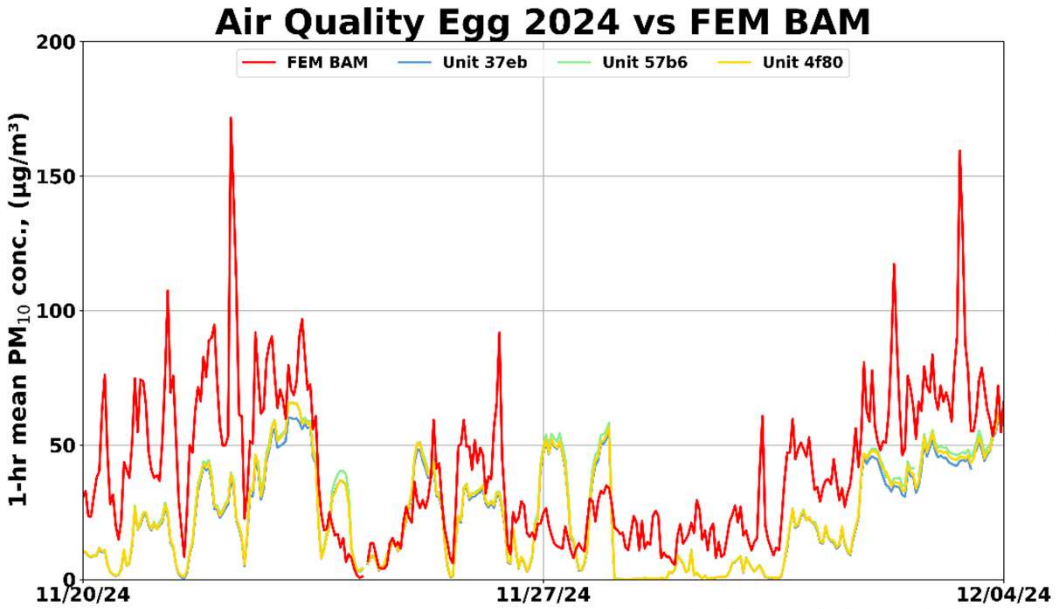
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding FEM BAM data ($0.77 < R^2 < 0.78$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the $PM_{2.5}$ mass concentrations as measured by FEM BAM
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM BAM



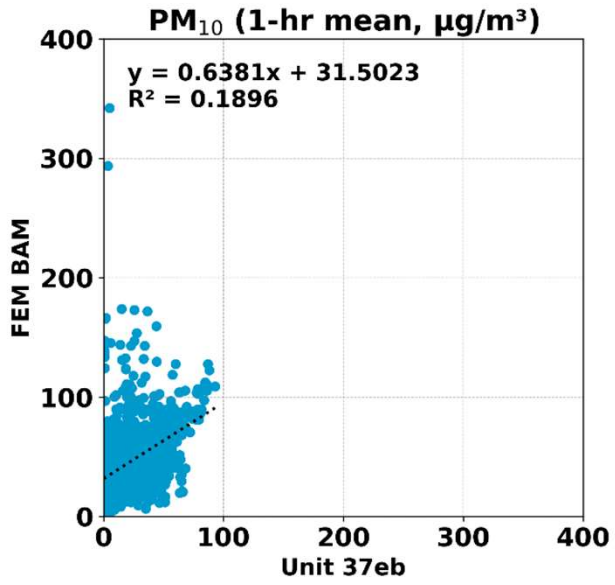


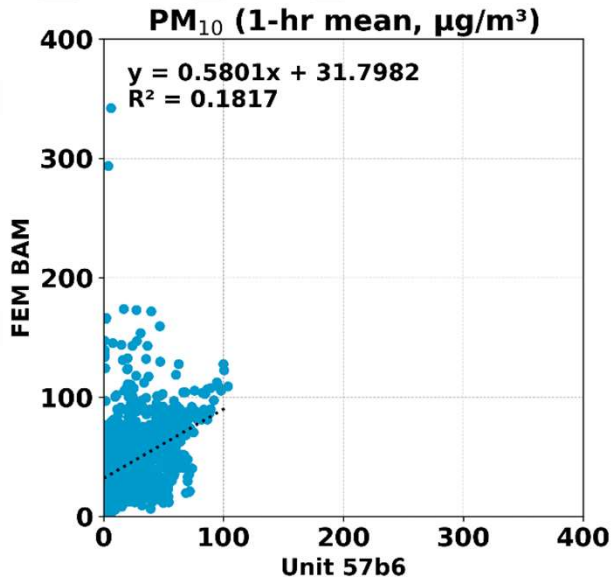


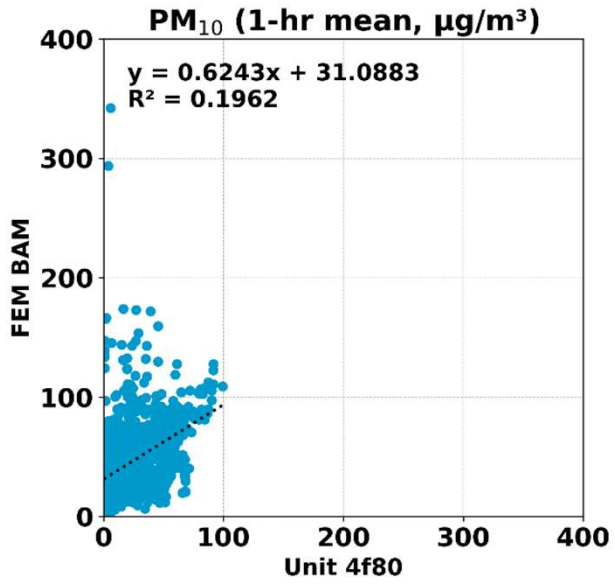
Air Quality Egg 2024 Model vs FEM BAM (PM_{10}; 1-hr mean)



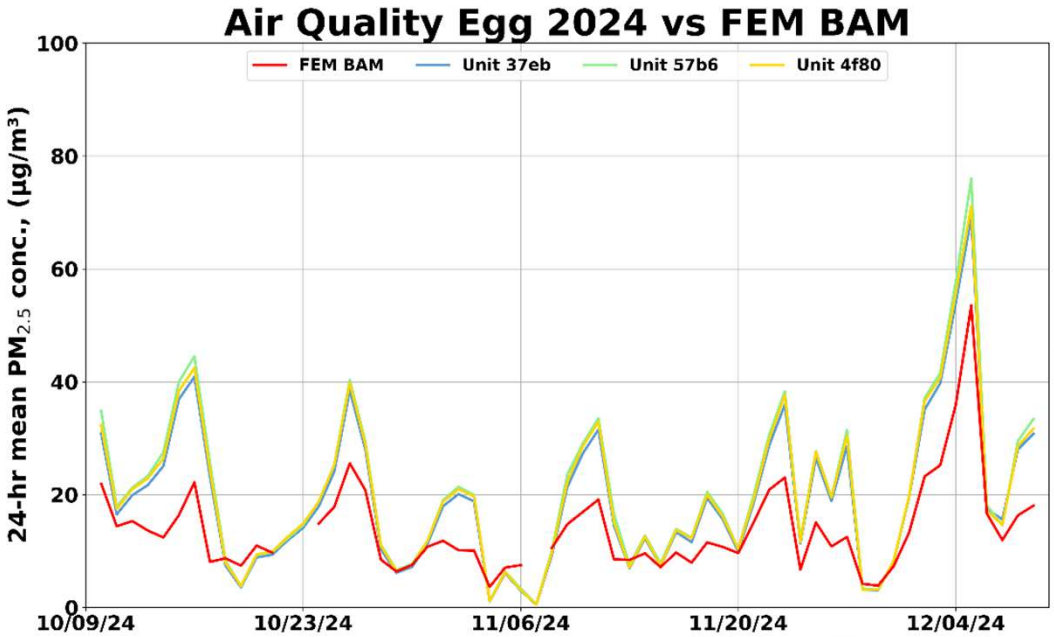
- The Air Quality Egg 2024 Model sensors showed very weak correlations with the corresponding FEM BAM data ($0.18 < R^2 < 0.20$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the PM_{10} mass concentrations as measured by FEM BAM
- The Air Quality Egg 2024 Model sensors did not seem to track the PM_{10} diurnal variations as recorded by FEM BAM



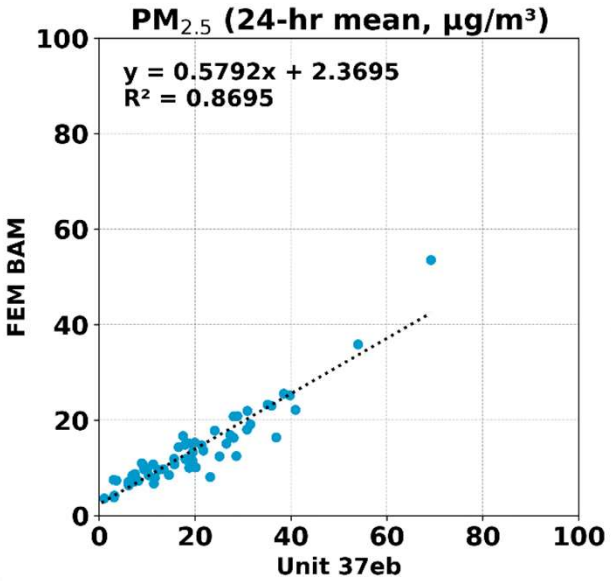


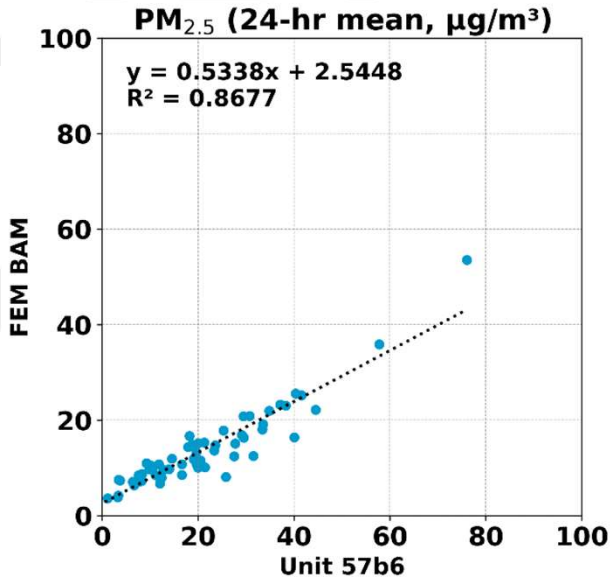


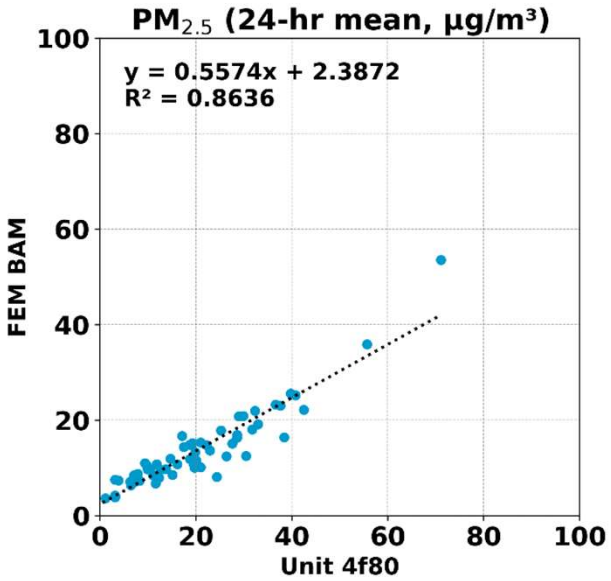
Air Quality Egg 2024 Model vs FEM BAM ($PM_{2.5}$; 24-hr mean)



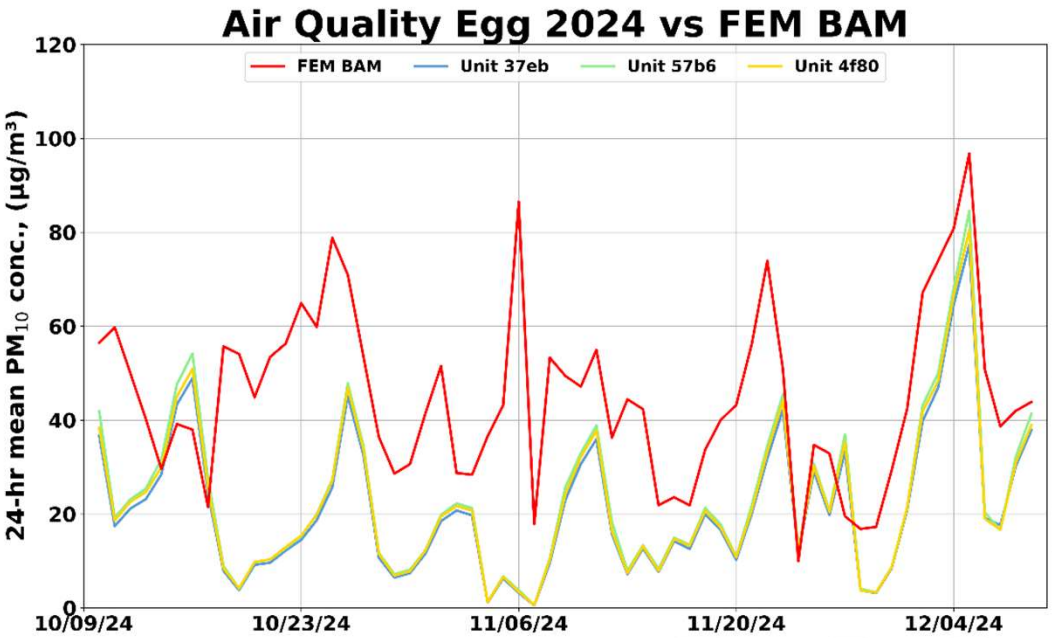
- The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding FEM BAM data ($0.86 < R^2 < 0.87$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the $PM_{2.5}$ mass concentrations as measured by FEM BAM
- The Air Quality Egg 2024 Model sensors seemed to track the $PM_{2.5}$ daily variations as recorded by FEM BAM



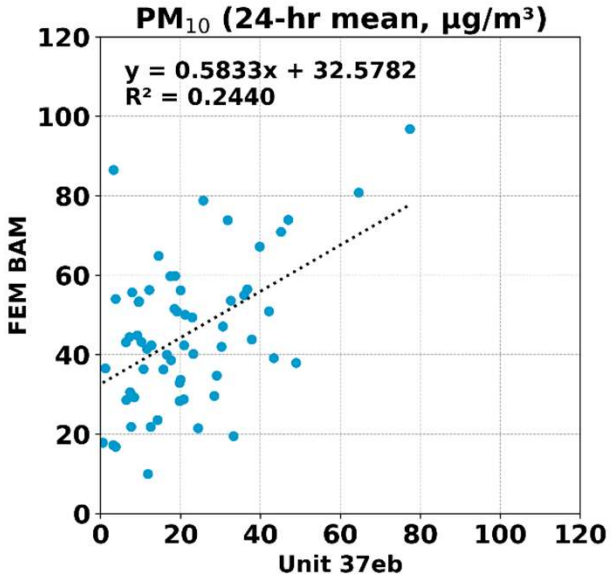


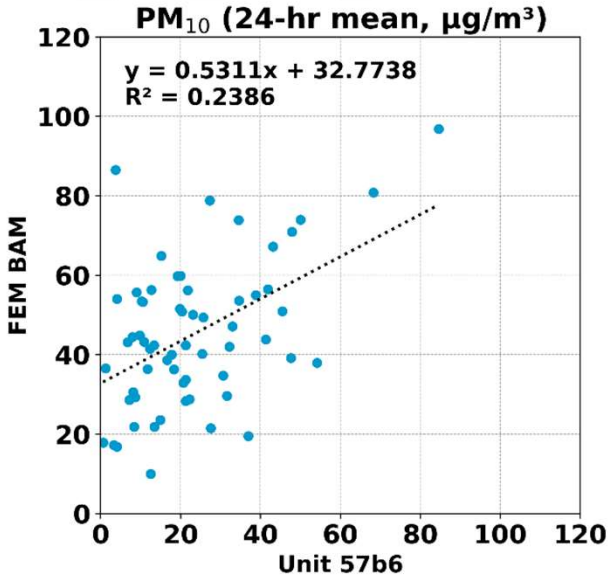


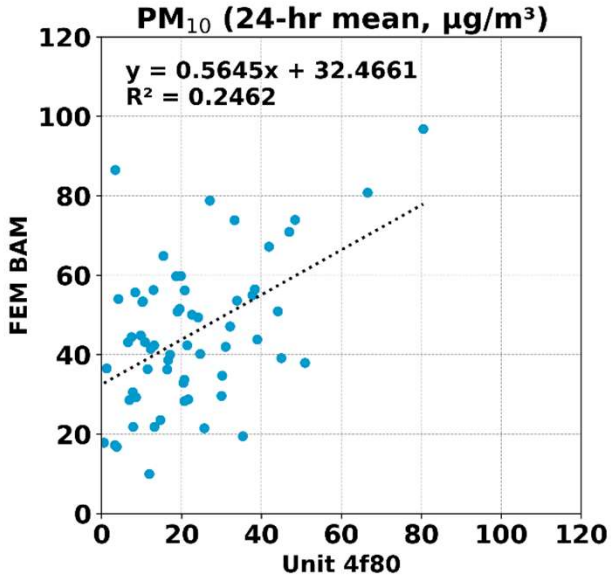
Air Quality Egg 2024 Model vs FEM BAM (PM_{10}; 24-hr mean)



- The Air Quality Egg 2024 Model sensors showed very weak correlations with the corresponding FEM BAM data ($0.23 < R^2 < 0.25$)
- Overall, the Air Quality Egg 2024 Model sensors underestimated the PM_{10} mass concentrations as measured by FEM BAM
- The Air Quality Egg 2024 Model sensors did not seem to track the PM_{10} daily variations as recorded by FEM BAM







Summary: PM

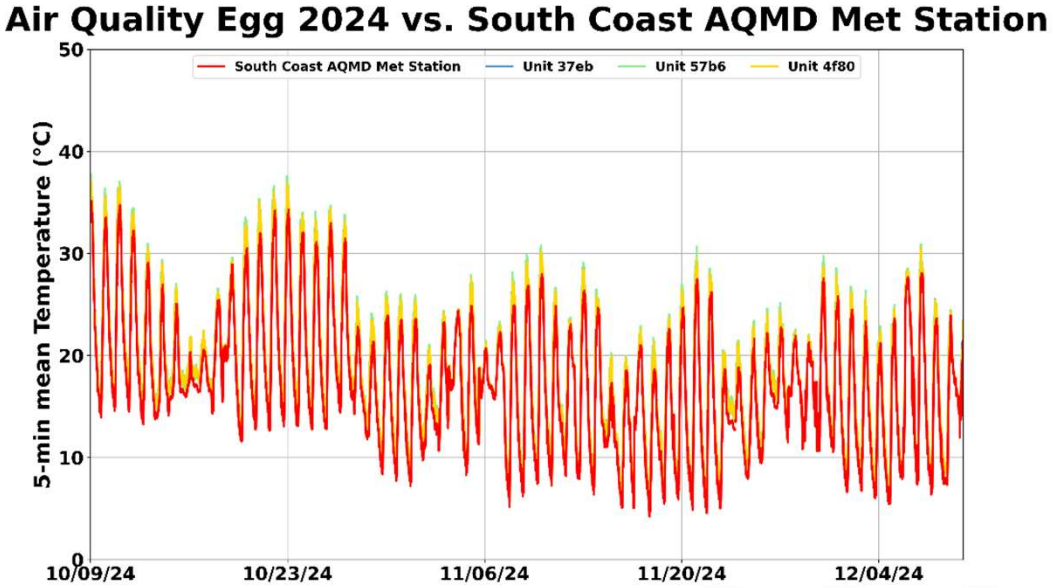
	Average of 3 Sensors, $PM_{1.0}$		Air Quality Egg 2024 Model vs T640, $PM_{1.0}$						T640 ($PM_{1.0}$, $\mu g/m^3$)		
	Average ($\mu g/m^3$)	SD ($\mu g/m^3$)	R^2	Slope	Intercept	MBE[1] ($\mu g/m^3$)	MAE[2] ($\mu g/m^3$)	RMSE[3] ($\mu g/m^3$)	Ref. Average	Ref. SD	Range during the field evaluation
5-min	11.7	9.6	0.88 to 0.89	1.48 to 1.56	-1.0 to -0.7	-5.6 to -4.8	4.9 to 5.7	8.5 to 9.2	16.8	15.3	0.5 to 98.2
1-hr	11.7	9.5	0.89 to 0.90	1.49 to 1.58	-1.1 to -0.9	-5.6 to -4.8	4.9 to 5.6	8.4 to 9.1	16.8	15.2	0.6 to 92.4
24-hr	11.7	7.4	0.93	1.62 to 1.72	-2.6 to -2.5	-5.6 to -4.8	4.8 to 5.6	7.5 to 8.2	16.8	12.7	1.7 to 74.4
	Average of 3 Sensors, $PM_{2.5}$		Air Quality Egg 2024 Model vs FEM BAM & FEM T640, $PM_{2.5}$						FEM BAM & FEM T640 ($PM_{2.5}$, $\mu g/m^3$)		
	Average ($\mu g/m^3$)	SD ($\mu g/m^3$)	R^2	Slope	Intercept	MBE[1] ($\mu g/m^3$)	MAE[2] ($\mu g/m^3$)	RMSE[3] ($\mu g/m^3$)	Ref. Average	Ref. SD	Range during the field evaluation
5-min	19.9	17.1	0.89	0.89 to 0.96	2.5 to 2.7	-1.8 to -0.5	4.2 to 4.3	5.7 to 5.9	21.0	16.8	1.6 to 107.4
1-hr	19.9	17.0	0.78 to 0.90	0.54 to 0.96	2.4 to 2.7	-1.8 to 7.3	4.0 to 9.0	5.4 to 12.1	13.7 to 21.0	10.7 to 16.6	0.0 to 100.6
24-hr	19.9	13.7	0.86 to 0.93	0.53 to 1.00	1.8 to 2.5	-1.8 to 7.3	3.1 to 7.9	3.9 to 10.3	13.8 to 21.0	8.2 to 13.6	3.1 to 82.3
	Average of 3 Sensors, PM_{10}		Air Quality Egg 2024 Model vs FEM BAM & T640, PM_{10}						FEM BAM & T640 (PM_{10}, $\mu g/m^3$)		
	Average ($\mu g/m^3$)	SD ($\mu g/m^3$)	R^2	Slope	Intercept	MBE[1] ($\mu g/m^3$)	MAE[2] ($\mu g/m^3$)	RMSE[3] ($\mu g/m^3$)	Ref. Average	Ref. SD	Range during the field evaluation
5-min	22.2	20.3	0.34 to 0.35	1.16 to 1.26	35.9 to 36.5	-41.8 to -40.3	40.7 to 42.1	53.0 to 54.1	63.1	41.9	5.1 to 1236.2
1-hr	22.3	20.1	0.18 to 0.41	0.58 to 1.26	31.1 to 36.7	-42.0 to -22.0	25.7 to 42.2	34.9 to 51.6	45.0 to 63.1	28.3 to 38.2	0.6 to 357.0
24-hr	22.2	16.2	0.24 to 0.51	0.53 to 1.22	32.5 to 37.5	-41.9 to -22.0	23.7 to 41.9	28.2 to 45.9	45.0 to 63.3	18.3 to 26.5	10.0 to 157.1

[1] Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).

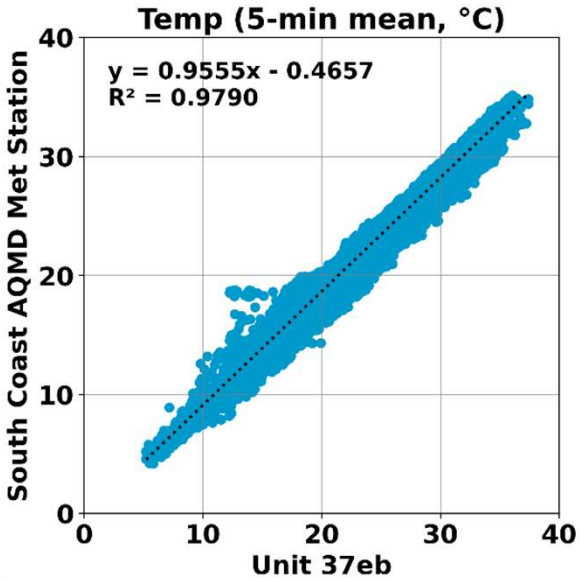
[2] Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.

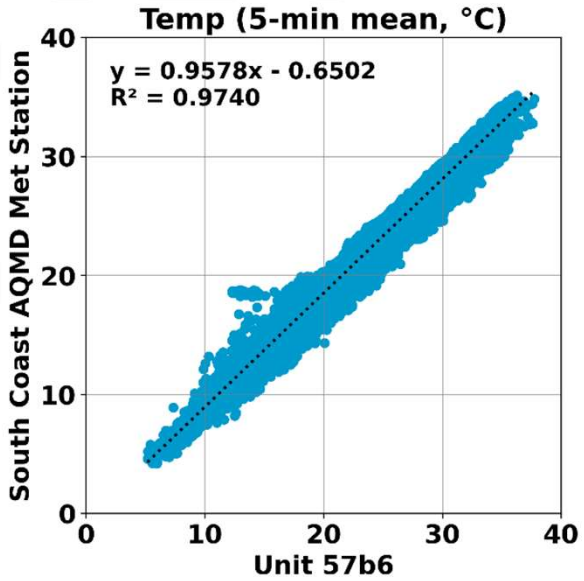
[3] Root Mean Square Error (RMSE): another metric to calculate measurement errors.

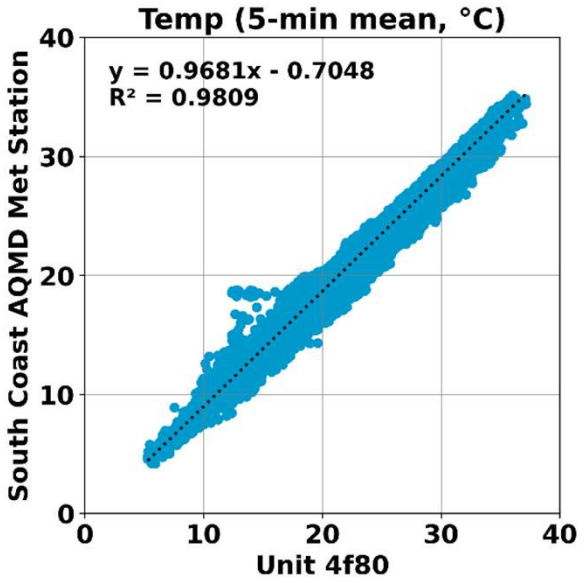
Air Quality Egg 2024 Model vs South Coast AQMD Met Station (Temp; 5-min mean)



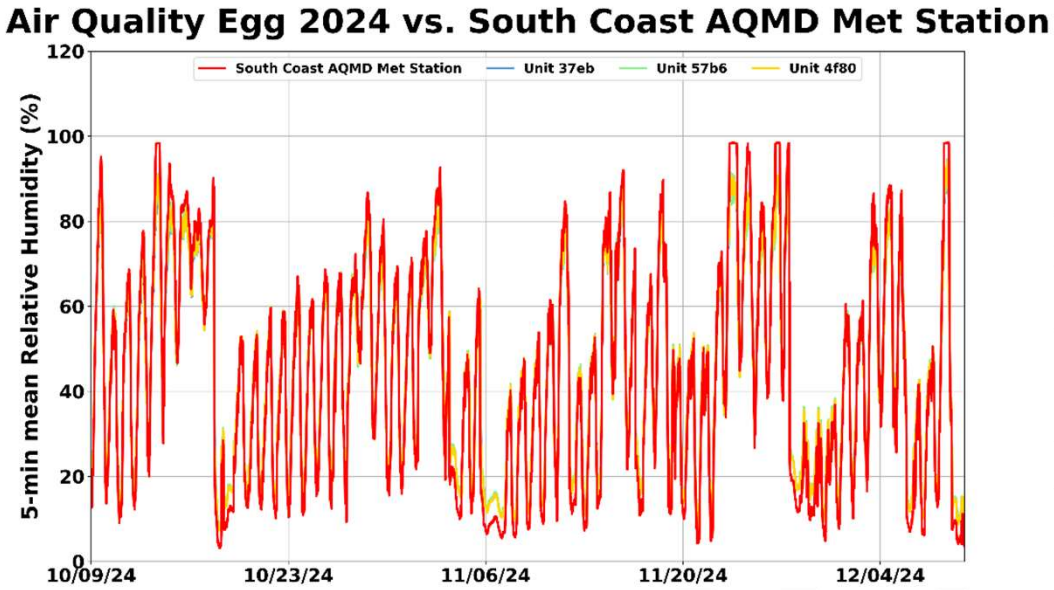
- The Air Quality Egg 2024 Model sensors showed very strong correlations with the corresponding South Coast AQMD Met Station data ($0.97 < R^2 < 0.99$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the temperature measurement as recorded by South Coast AQMD Met Station
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal temperature variations as recorded by South Coast AQMD Met Station



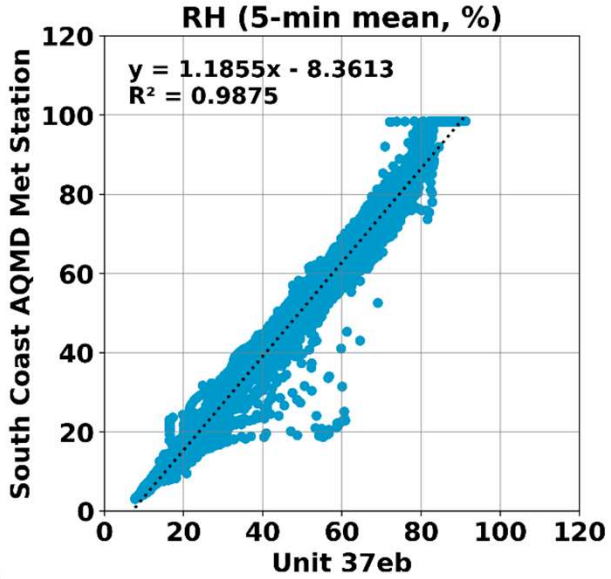


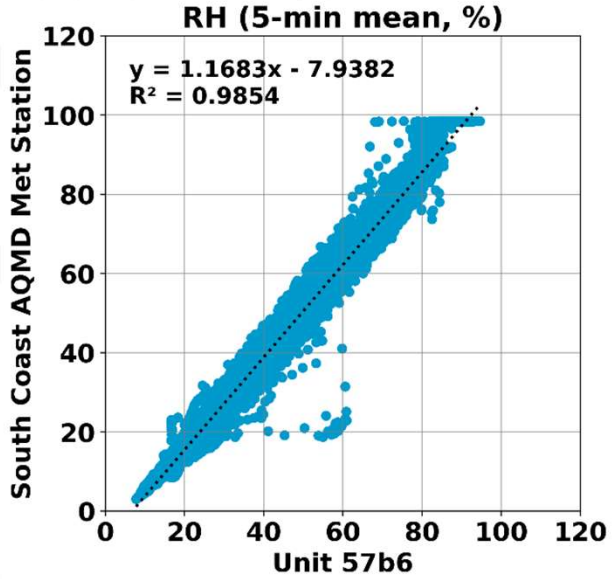


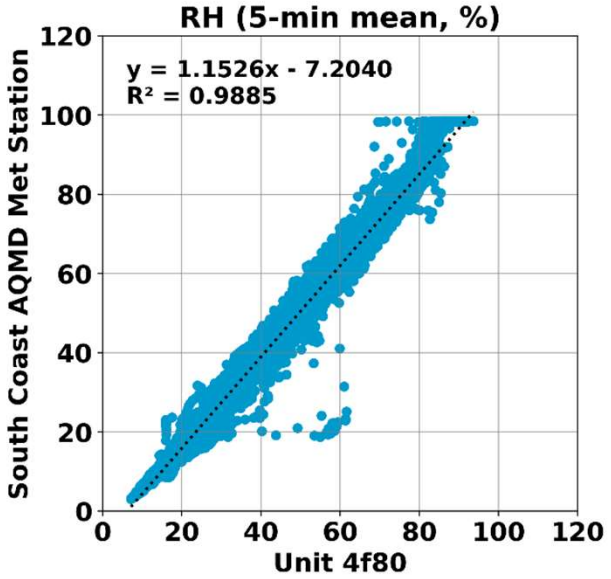
Air Quality Egg 2024 Model vs South Coast AQMD Met Station (RH; 5-min mean)



- Air Quality Egg 2024 Model sensors showed very strong correlations with the corresponding South Coast AQMD Met Station data ($0.98 < R^2 < 0.99$)
- Overall, the Air Quality Egg 2024 Model sensors overestimated the RH measurement as recorded by South Coast AQMD Met Station
- The Air Quality Egg 2024 Model sensors seemed to track the diurnal RH variations as recorded by South Coast AQMD Met Station







Discussion

- The three **Air Quality Egg 2024 Model** sensors' data recovery for CO, O_3, NO_2, and all PM fractions was ~98.7%, ~98.7%, ~98.7% and ~98.7%, respectively.
- The absolute intra-model variability for CO, O_3, NO_2 was ~30.1, ~3.2, and ~1.8 ppb respectively. Absolute intra-model variability was ~0.4, ~0.6, and ~0.8 µg/m^3 for $PM_{1.0}$, $PM_{2.5}$ and PM_{10}, respectively
- Reference instruments: strong correlations between FEM BAM and FEM T640 for $PM_{2.5}$ (R^2 ~ 0.89, 1-hr mean) and strong correlations between FEM BAM and T640 for PM_{10} (R^2 ~ 0.89, 1-hr mean) mass concentration measurements
- During the entire field deployment testing period:
  - CO sensors showed weak to strong correlation with the FRM Horiba instrument ($0.37 < R^2 < 0.75$, 5-min mean) and generally overestimated the corresponding FRM Horiba data
  - Ozone sensors showed moderate to strong correlation with the FEM T400 instrument ($0.56 < R^2 < 0.75$, 5-min mean) and generally overestimated the corresponding FEM T400 data
  - NO_2 sensors showed strong correlations with the FRM T200 instrument ($0.79 < R^2 < 0.81$, 5-min mean) and overestimated the corresponding FRM T200 data
  - The Air Quality Egg 2024 Model sensors showed strong correlations with the corresponding T640 $PM_{1.0}$ data ($0.89 < R^2 < 0.90$, 1-hr mean), strong correlations with the corresponding FEM BAM and FEM T640 $PM_{2.5}$ data ($0.77 < R^2 < 0.91$, 1-hr mean) and very weak to weak correlations with the corresponding FEM BAM and T640 reference PM_{10} data ($0.18 < R^2 < 0.42$; 1-hr mean). The sensors underestimated $PM_{1.0}$, $PM_{2.5}$ and PM_{10} mass concentrations as measured by T640; The sensors overestimated $PM_{2.5}$ and underestimated PM_{10} mass concentrations as measured by FEM BAM.
  - Temperature and relative humidity sensors showed very strong correlations with the South Coast AQMD Met Station T and RH data, respectively (R^2 ~ 0.98 and ~0.99) and overestimated the T and RH data as recorded by the South Coast AQMD Met Station
- No sensor calibration was performed by South Coast AQMD staff for this evaluation.
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under controlled T and RH conditions, and known target and interferent pollutants concentrations.
- These results are still preliminary