Field Evaluation
Edimax AirBox

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 05/04/2018 to 07/03/2018, three **Edimax AirBox (Model AI–1001 W)** sensors were deployed at our (SCAQMD) Rubidoux station and ran side-by-side with Federal Equivalent Method (FEM) instruments measuring the same pollutants

- Edimax AirBox *[3 units tested]:*
  - ➤ Particle sensor (optical; non-FEM) (Model PMS5003)
  - ➤ Each sensor reports: $PM_{2.5}$ mass concentration ($\mu g/m^3$)
  - ➤ Time resolution: 380 seconds
  - ➤ Unit cost: ~$ 249
  - ➤ IDs: FE8A, FE90, FE88

- MetOne BAM (*reference method*):
  - ➤ Beta-attenuation monitors (FEM $PM_{2.5}$, FEM PM_{10})
  - ➤ Measures $PM_{2.5}$ & PM_{10} mass ($\mu g/m^3$)
  - ➤ Unit cost: ~$20,000
  - ➤ Time resolution: 1-hr

- GRIMM (*reference method*):
  - ➤ Optical Particle Counter (FEM $PM_{2.5}$)
  - ➤ Uses proprietary algorithms to calculate total $PM_{1.0}$, $PM_{2.5}$, PM_{10} mass from particle number measurements
  - ➤ Unit cost: ~$25,000 and up
 - ➤ Time resolution: 1-min

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 $PM_{2.5}$ mass concentrations from all Edimax AirBox was > 99.6%

Edimax AirBox;
intra-model variability

- Very low intra-model variability (4.3%) was observed between the different Edimax AirBox sensors for $PM_{2.5}$ mass concentrations (µg/m^3).
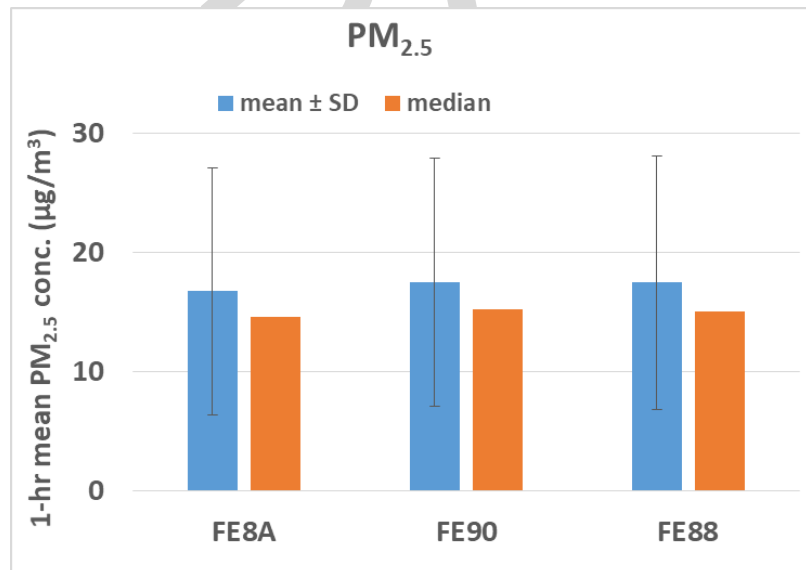
Equivalent Methods: GRIMM vs BAM

- Data recovery for $PM_{2.5}$ was 100% and 82% for GRIMM and BAM, respectively
- $PM_{2.5}$ mass concentrations measured by the equivalent methods (GRIMM and BAM) show a good correlation (1-hr mean, $R^2 > 0.71$)
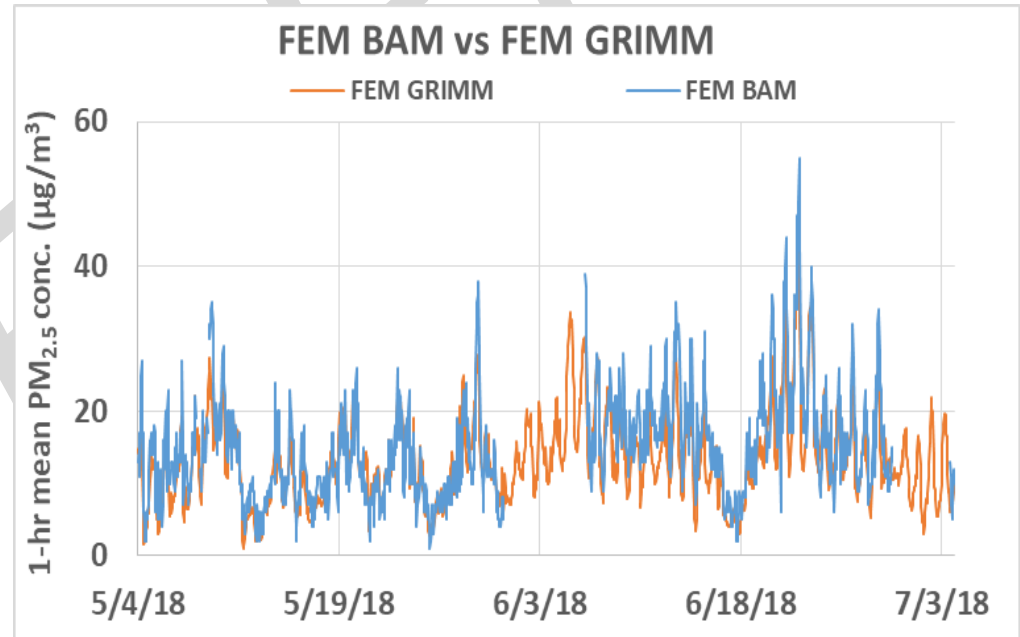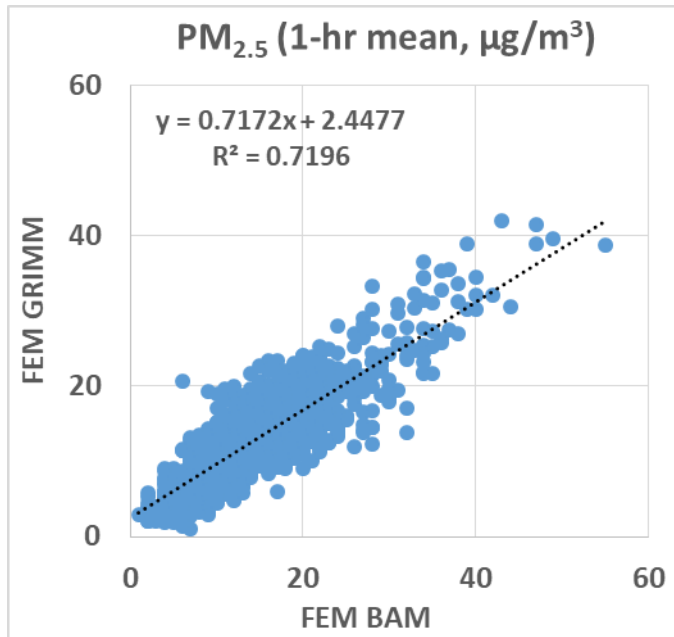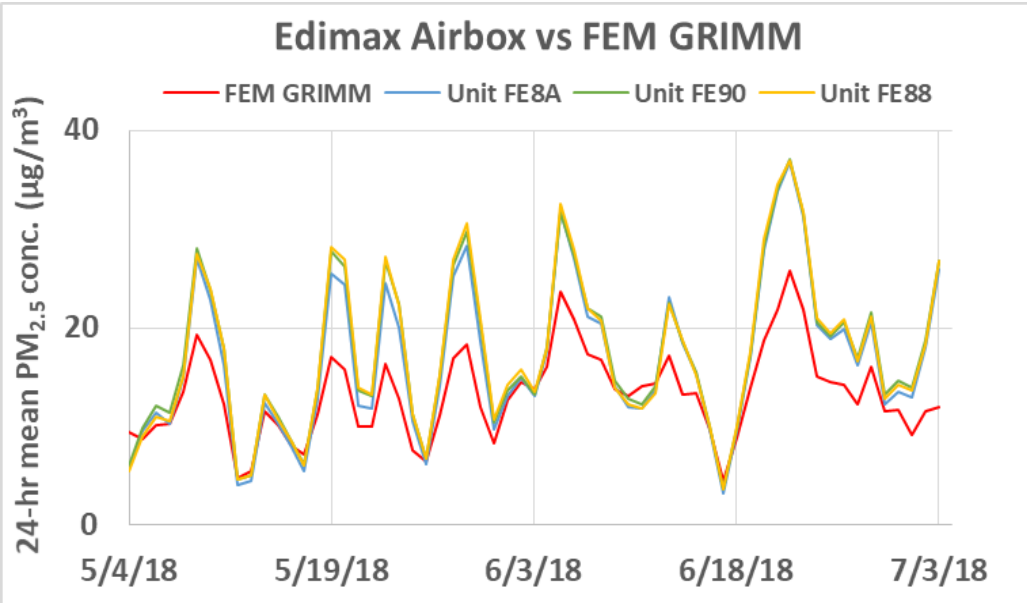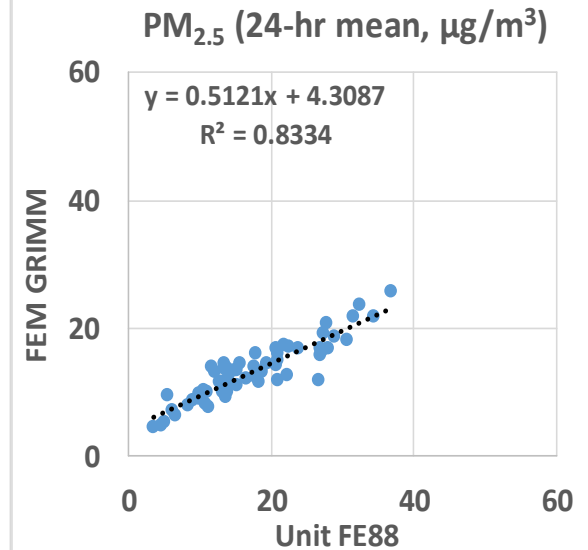
Edimax AirBox vs FEM GRIMM (PM$_{2.5}$; 1-hr mean)
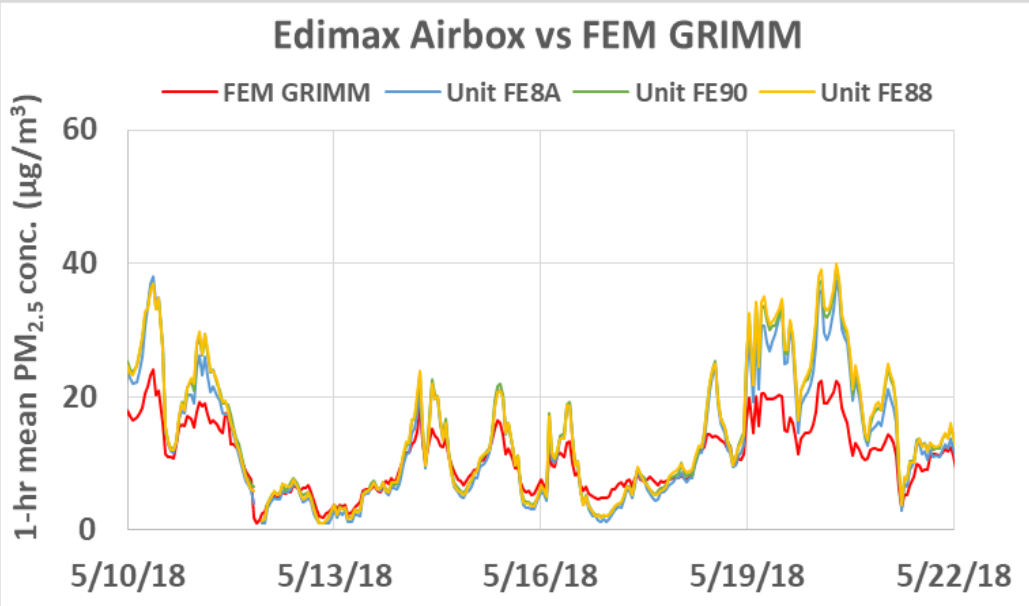
- Edimax AirBox PM$_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data (R^2 > 0.85)
- Overall, the Edimax AirBox sensors overestimate PM$_{2.5}$ mass concentrations measured by FEM GRIMM
- The Edimax AirBox sensors track well the PM$_{2.5}$ diurnal variation measured by FEM GRIMM

Edimax AirBox vs FEM GRIMM (PM$_{2.5}$; 24-hr mean)

Edimax Airbox vs FEM GRIMM

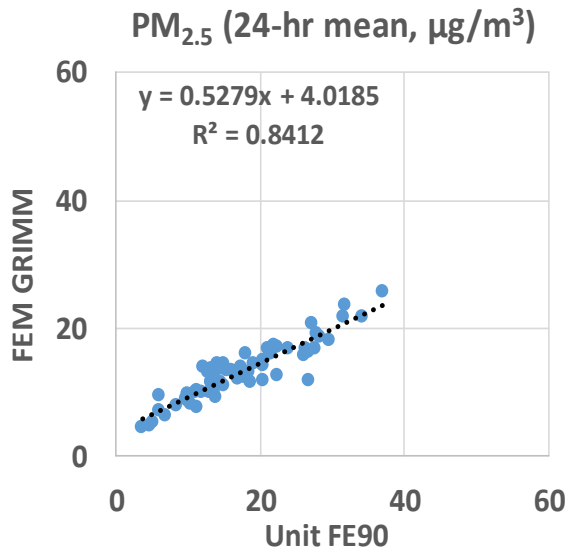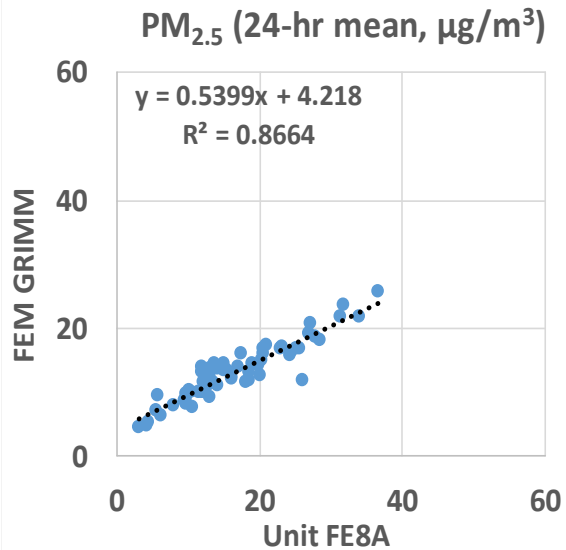Legend: FEM GRIMM — Unit FE8A — Unit FE90 — Unit FE88
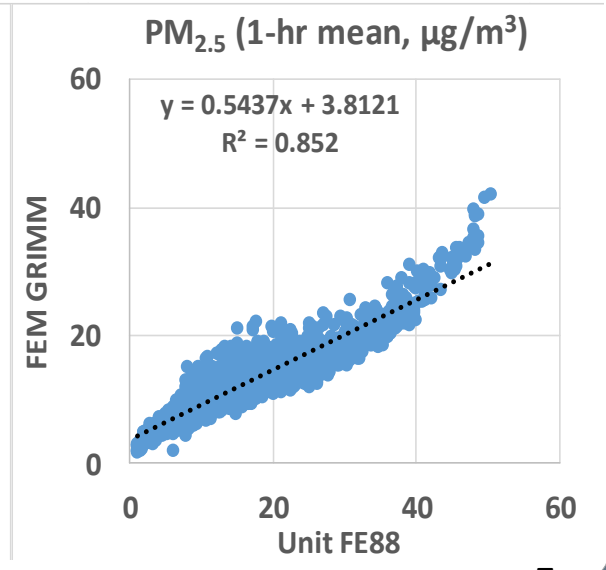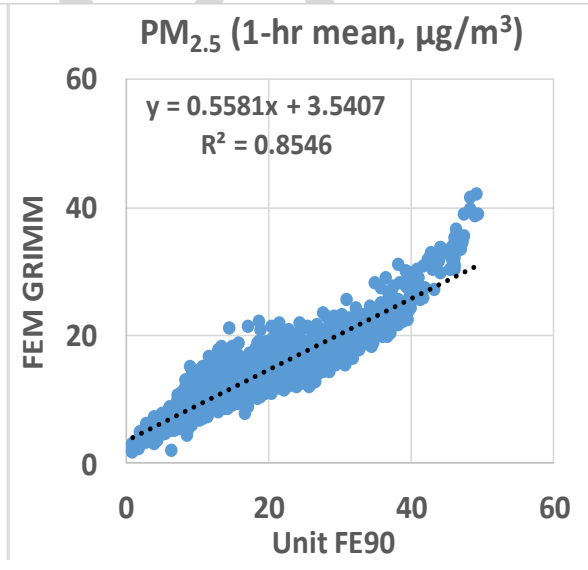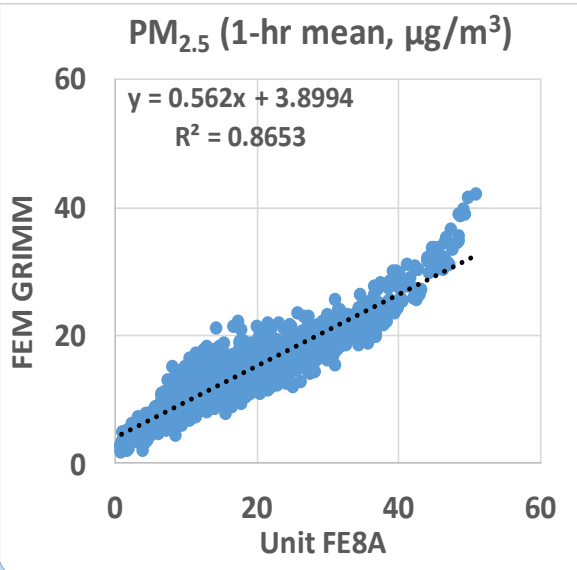
- Edimax AirBox PM$_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data (R^2 > 0.83)
- Overall, the Edimax AirBox sensors overestimate PM$_{2.5}$ mass concentrations measured by FEM GRIMM
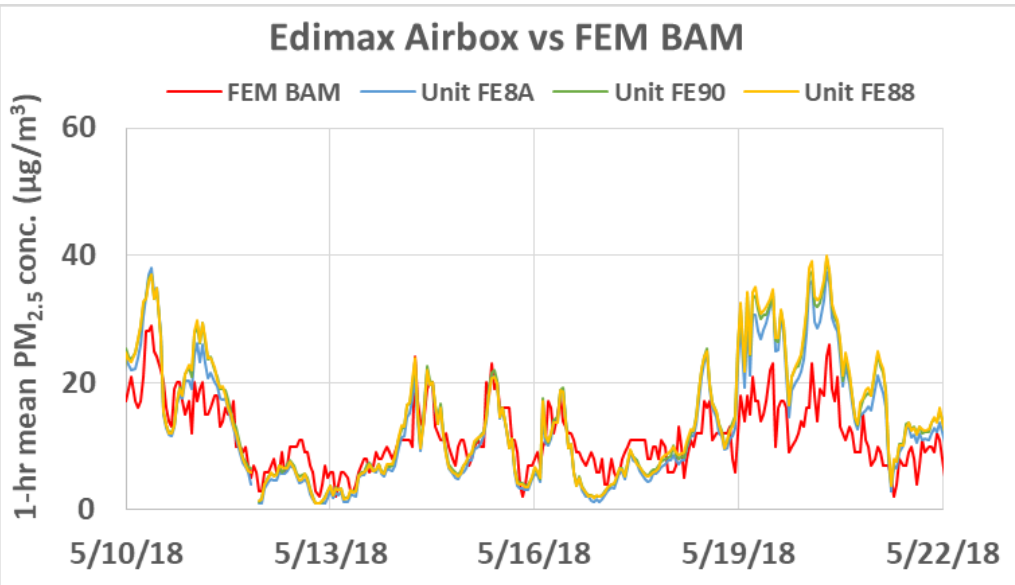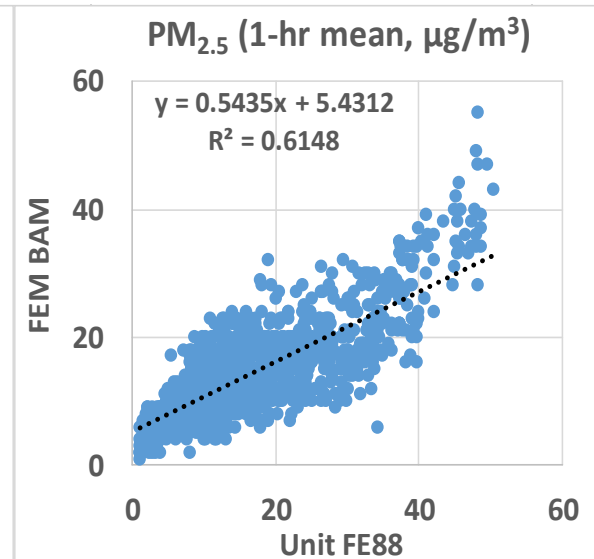- The Edimax AirBox sensors track well the PM$_{2.5}$ diurnal variation measured by FEM GRIMM

PM$_{2.5}$ (24-hr mean, μg/m^3)

$y = 0.5399x + 4.218$
$R^2 = 0.8664$

PM$_{2.5}$ (24-hr mean, μg/m^3)

$y = 0.5279x + 4.0185$
$R^2 = 0.8412$

PM$_{2.5}$ (24-hr mean, μg/m^3)

$y = 0.5121x + 4.3087$
$R^2 = 0.8334$

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Edimax AirBox vs FEM BAM (PM$_{2.5}$; 1-hr mean)

Edimax Airbox vs FEM BAM

Legend: FEM BAM — Unit FE8A — Unit FE90 — Unit FE88

- Edimax AirBox PM$_{2.5}$ mass measurements show moderate correlations with the corresponding FEM BAM data (0.61< R^2 < 0.68)
- Overall, the Edimax AirBox sensors overestimate PM$_{2.5}$ mass concentrations measured by FEM BAM
- The Edimax AirBox sensors track moderately well the PM$_{2.5}$ diurnal variation measured by FEM BAM

PM$_{2.5}$ (1-hr mean, µg/m^3)

$y = 0.5867x + 5.122$
$R^2 = 0.6783$

PM$_{2.5}$ (1-hr mean, µg/m^3)

$y = 0.5666x + 4.9922$
$R^2 = 0.6366$

PM$_{2.5}$ (1-hr mean, µg/m^3)

$y = 0.5435x + 5.4312$
$R^2 = 0.6148$

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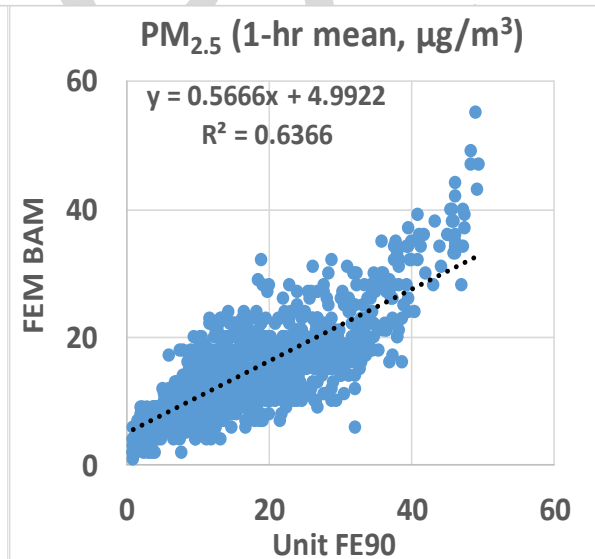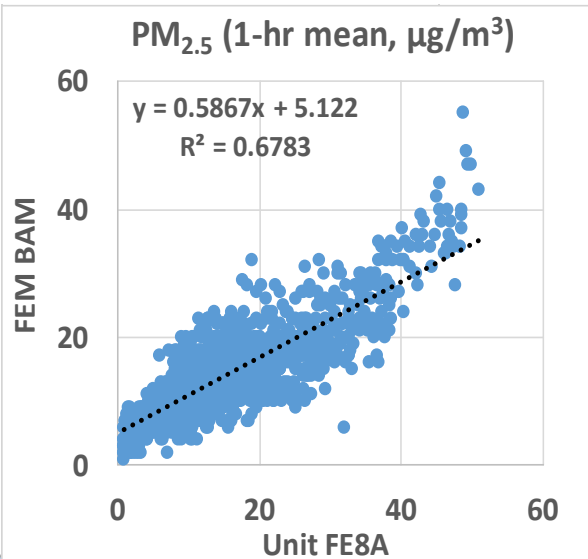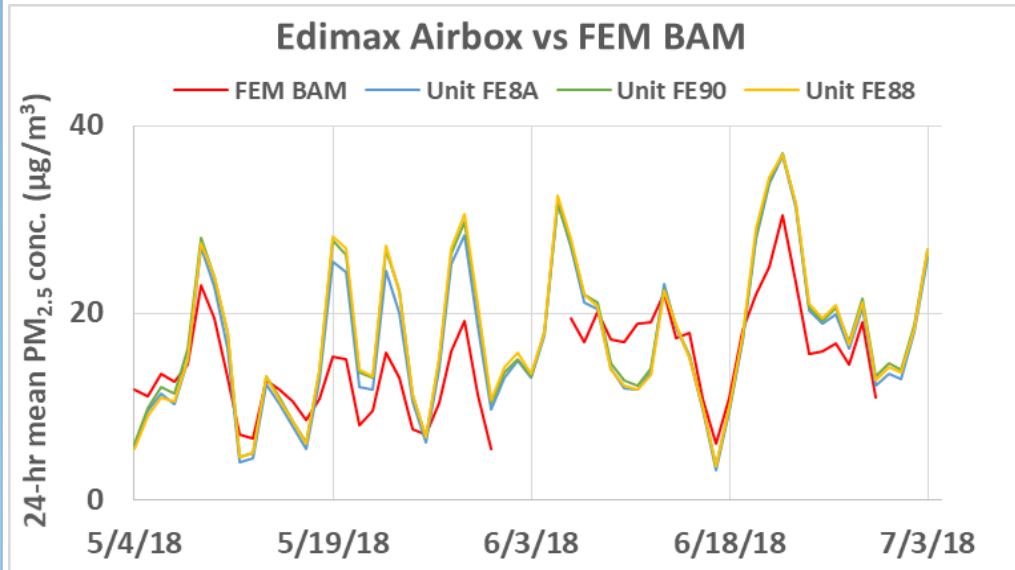# Edimax AirBox vs FEM BAM (PM$_{2.5}$; 24-hr mean)
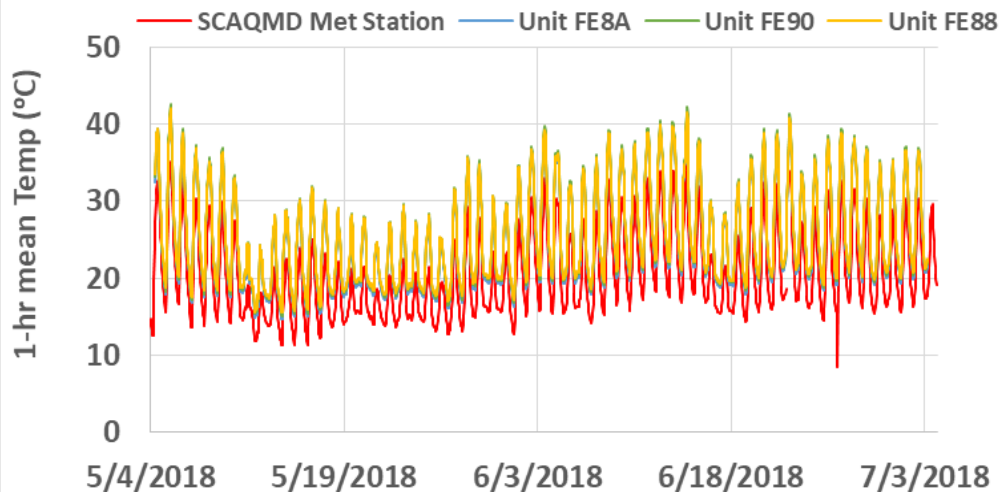

- Edimax AirBox PM$_{2.5}$ mass measurements show good correlations with the corresponding FEM BAM data (R^2 > 0.58)
- Overall, the Edimax AirBox sensors overestimate PM$_{2.5}$ mass concentrations measured by FEM BAM
- The Edimax AirBox sensors track moderately well the PM$_{2.5}$ diurnal variation measured by FEM BAM

PM$_{2.5}$ (24-hr mean, µg/m^3)

$y = 0.5359x + 5.6678$
$R^2 = 0.6503$

PM$_{2.5}$ (24-hr mean, µg/m^3)

$y = 0.5131x + 5.638$
$R^2 = 0.6096$

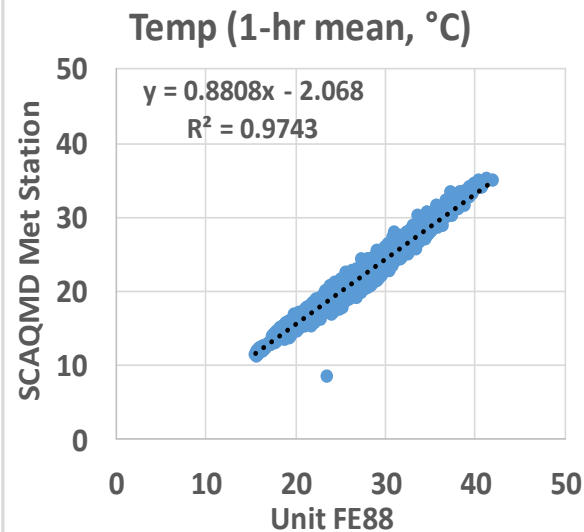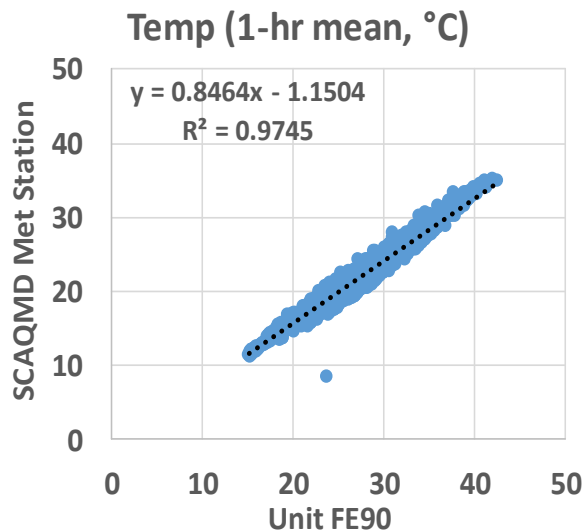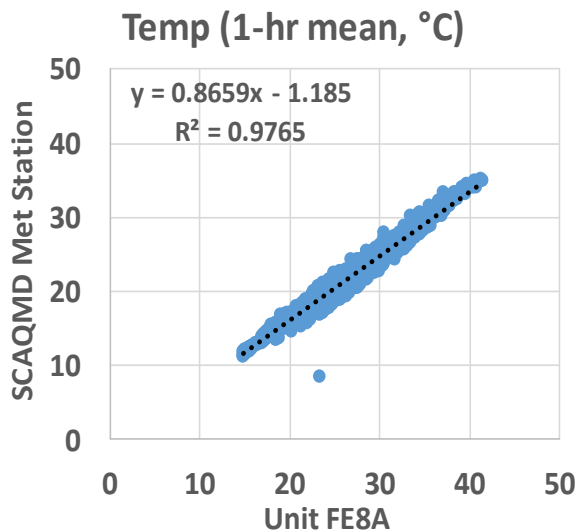PM$_{2.5}$ (24-hr mean, µg/m^3)

$y = 0.4909x + 6.055$
$R^2 = 0.5862$
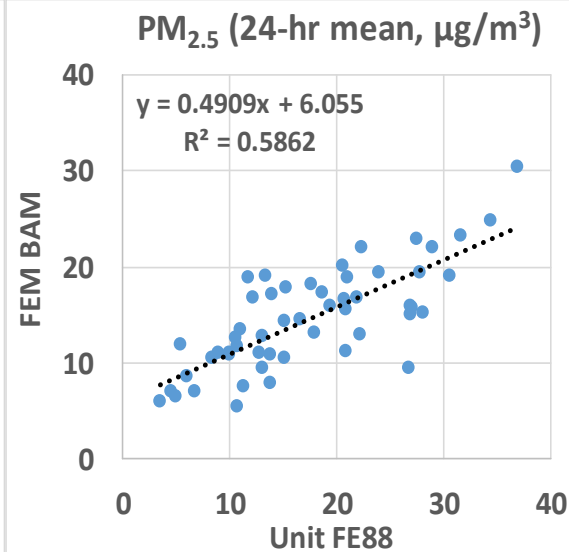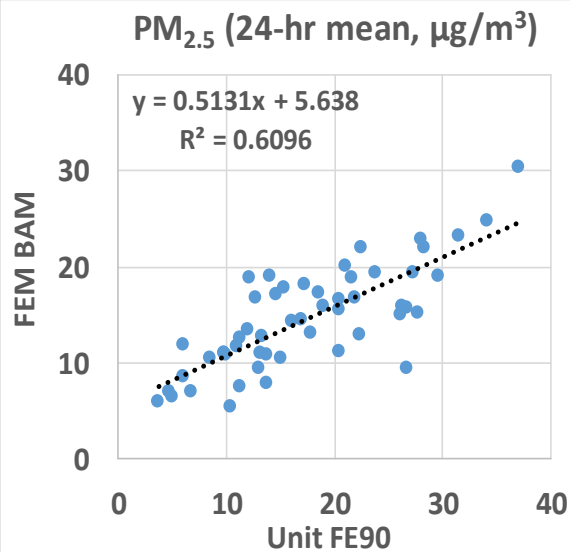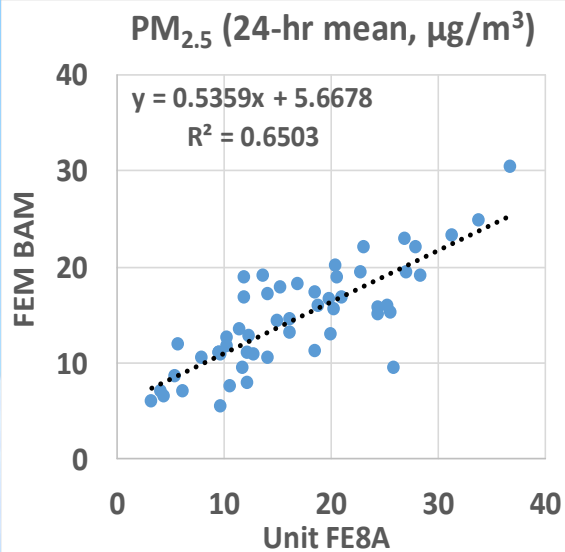
Edimax AirBox vs SCAQMD Met Station (Temp; 1-hr mean)

Edimax Airbox vs SCAQMD Met Station

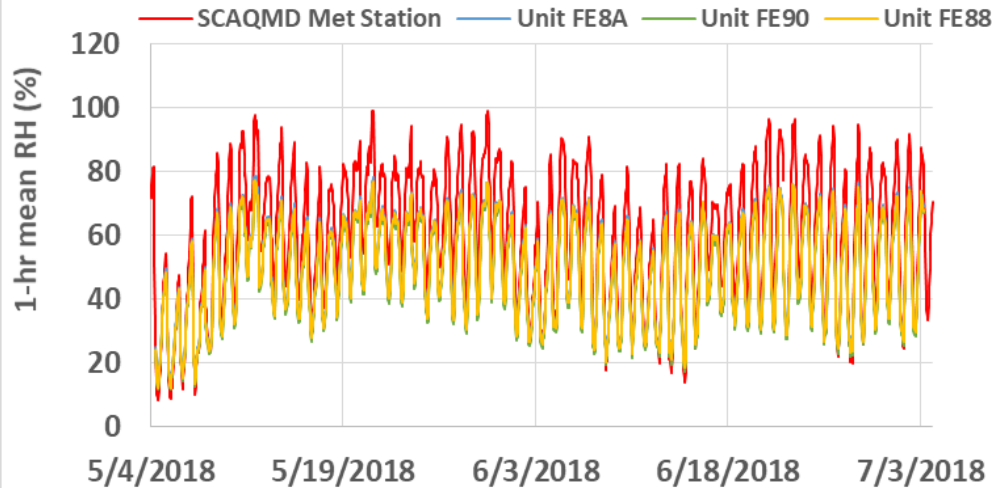Legend: SCAQMD Met Station — Unit FE8A — Unit FE90 — Unit FE88

- Edimax AirBox temperature measurements show good correlations with the corresponding SCAQMD Met Station data ($R^2 > 0.97$)
- Overall, the Edimax AirBox sensors slightly overestimate temperature measured by SCAQMD Met Station
- The Edimax AirBox sensors track well the temperature diurnal variation measured by SCAQMD Met Station
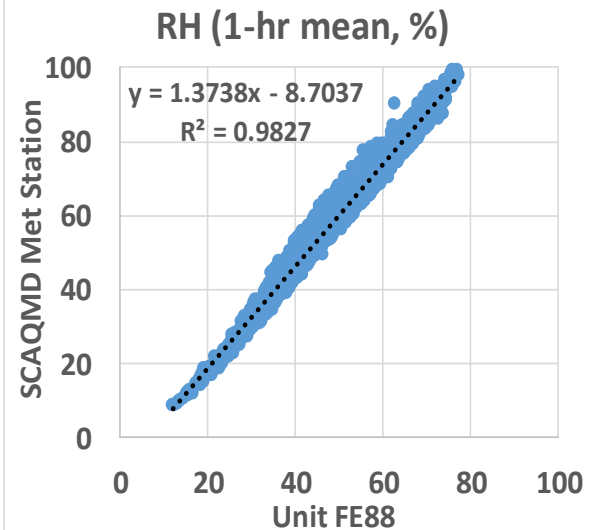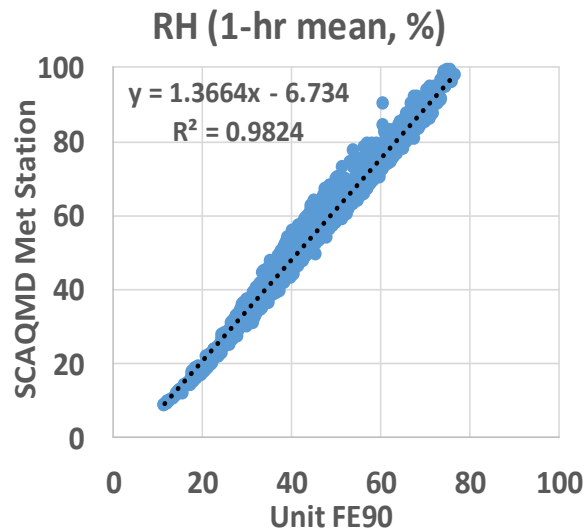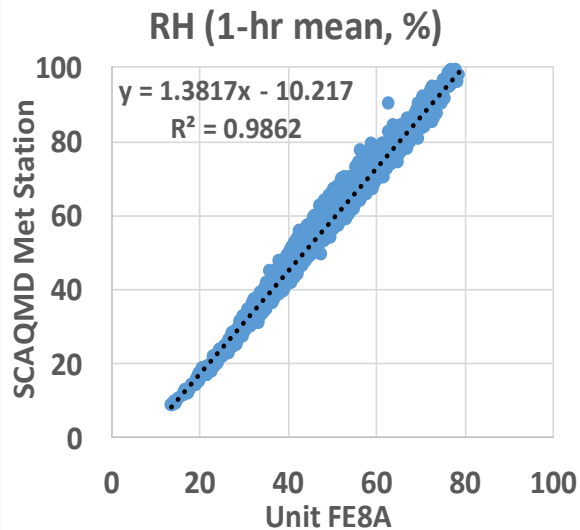
Temp (1-hr mean, °C)

$y = 0.8659x - 1.185$
$R^2 = 0.9765$

Unit FE8A

Temp (1-hr mean, °C)

$y = 0.8464x - 1.1504$
$R^2 = 0.9745$

Unit FE90

Temp (1-hr mean, °C)

$y = 0.8808x - 2.068$
$R^2 = 0.9743$

Unit FE88

Edimax AirBox vs SCAQMD Met Station (RH; 1-hr mean)

Edimax Airbox vs SCAQMD Met Station

- Edimax AirBox RH measurements show good correlations with the corresponding SCAQMD Met Station data ($R^2 > 0.98$)
- Overall, the Edimax AirBox sensors underestimate RH measured by SCAQMD Met Station
- The Edimax AirBox sensors track well the RH diurnal variation measured by SCAQMD Met Station

RH (1-hr mean, %)

y = 1.3817x - 10.217
R^2 = 0.9862

RH (1-hr mean, %)

y = 1.3664x - 6.734
R^2 = 0.9824

RH (1-hr mean, %)

y = 1.3738x - 8.7037
R^2 = 0.9827

Discussion

- The three **Edimax AirBox (Model AI–1001W)** sensors had a data recovery of 99.6% with low intra-model variability (4.3%)
- $PM_{2.5}$ mass concentration measurements measured by Edimax AirBox correlate well with the corresponding FEM GRIMM ($R^2 > 0.85$, 1-hr mean) and moderately correlated with FEM BAM ($R^2 > 0.61$, 1-hr mean) and overestimate $PM_{2.5}$ mass concentration measured by FEM GRIMM and FEM BAM
- The raw sensor used in Edimax EdiGreen Home is Plantower PMS5003
- No sensor calibration was performed by SCAQMD Staff prior to the beginning of this test
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under known aerosol concentrations and controlled temperature and relative humidity conditions
- <u>All results are still preliminary</u>