Field Evaluation
Air Quality Egg 2018 Model

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 04/25/2018 to 06/26/2018, three **Air Quality Egg 2018 Model** (hereinafter AQ Egg 2018 Model) sensors were deployed at our (SCAQMD) Rubidoux station and ran side-by-side with Federal Equivalent Method (FEM) instruments measuring the same pollutants

- Air Quality Egg 2018 Model *[3 units tested]:*
  - Particle sensor (optical; non-FEM)
  - PM sensor: Dual Plantower PMS5003
  - Each sensor reports: $PM_{1,}$ $PM_{2.5}$ and PM_{10} mass concentration ($\mu g/m^3$)
  - Time resolution:1-min
  - Unit cost: ~$249
  - IDs: 0111, 0121, 0122

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

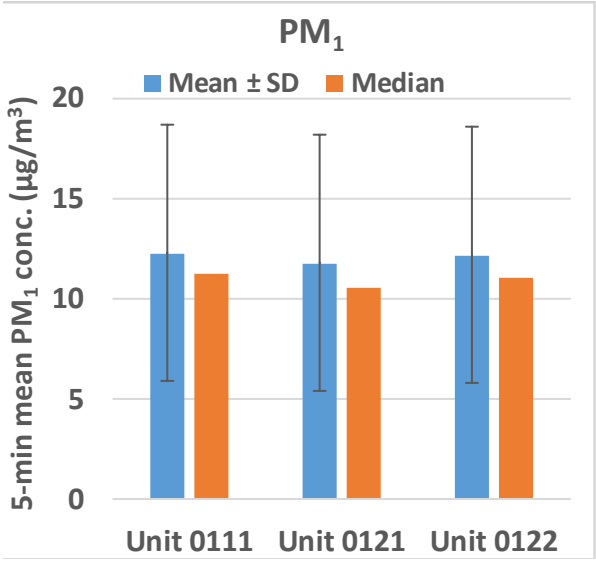
- GRIMM (*reference method*):
  - Optical Particle Counter (FEM $PM_{2.5}$)
  - Uses proprietary algorithms to calculate total $PM_{1.0}$, $PM_{2.5}$, PM_{10} mass from particle number measurements
  - Unit cost: ~$25,000 and up
  - Time resolution: 1-min

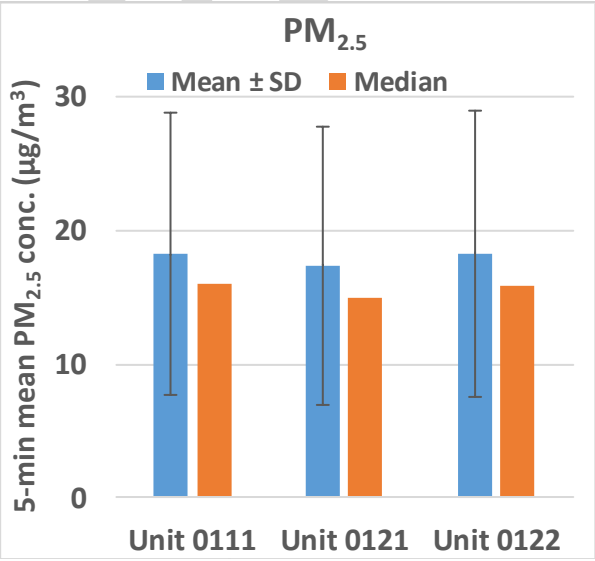
Data validation & recovery

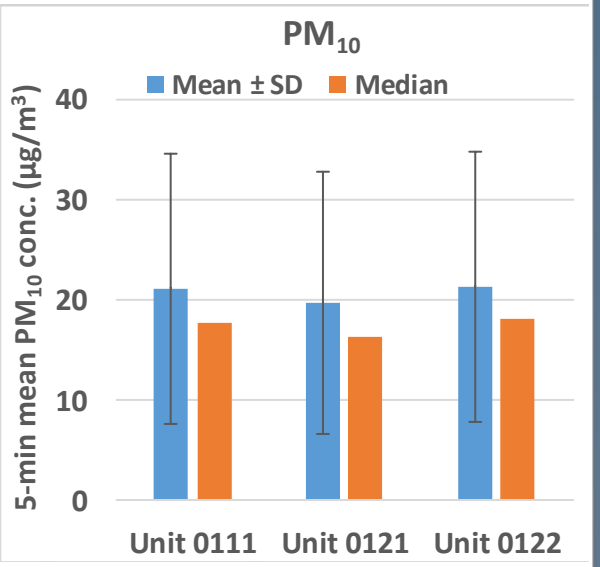
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM_1, $PM_{2.5}$ and PM_{10} mass concentrations from all AQ Egg 2018 Model was > 99.8%

AQ Egg 2018 Model; intra-model variability

- Very low intra-model variabilities (4%-8%) were observed between the different AQ Egg 2018 Model sensors for PM_1, $PM_{2.5}$ and PM_{10} mass concentrations ($\mu g/m^3$).

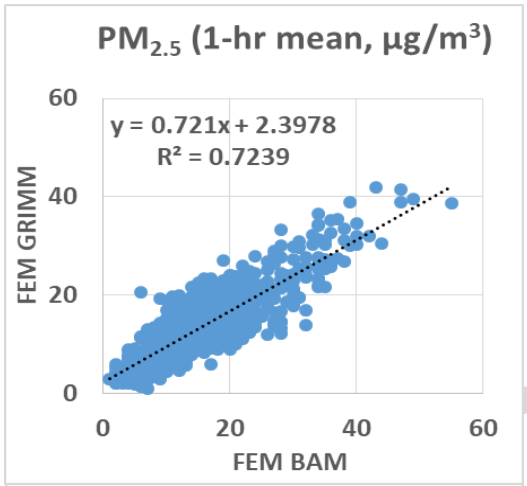


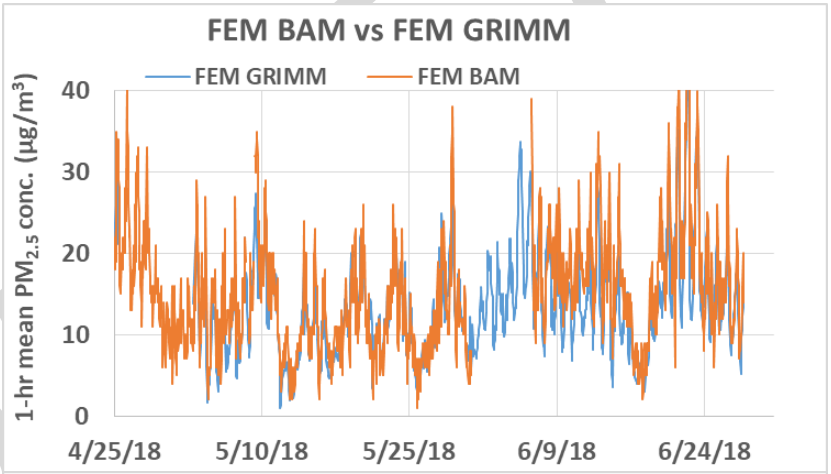


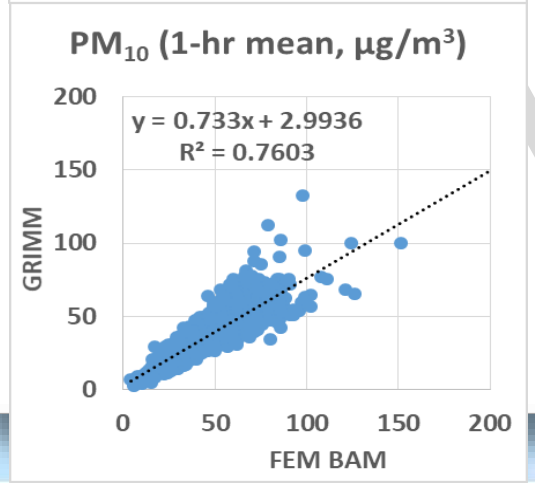


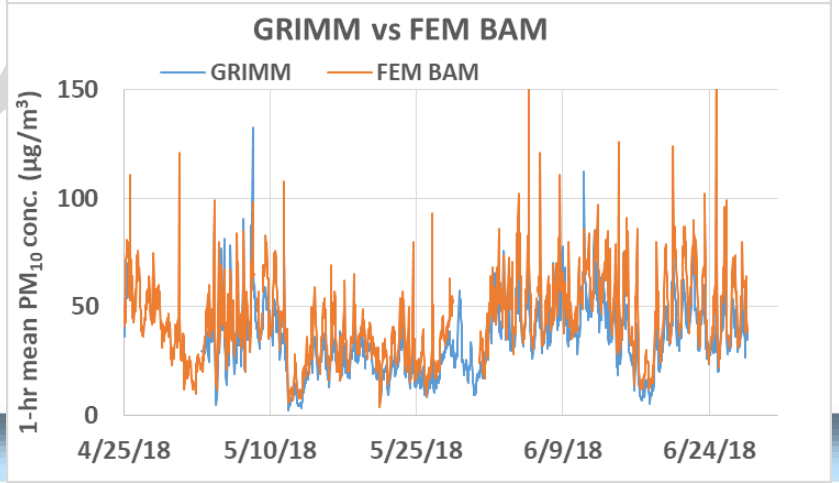
Equivalent Methods: GRIMM vs BAM

- Data recovery for $PM_{2.5}$ and PM_{10} was both 100% for GRIMM and 95% and 90% for BAM, respectively
- $PM_{2.5}$ and PM_{10} mass concentrations measured by the equivalent methods (GRIMM and BAM) show good correlation (1-hr mean, $R^2 > 0.72$)
- Overall, PM mass concentrations measured by BAM are higher than the PM mass concentrations measured by GRIMM

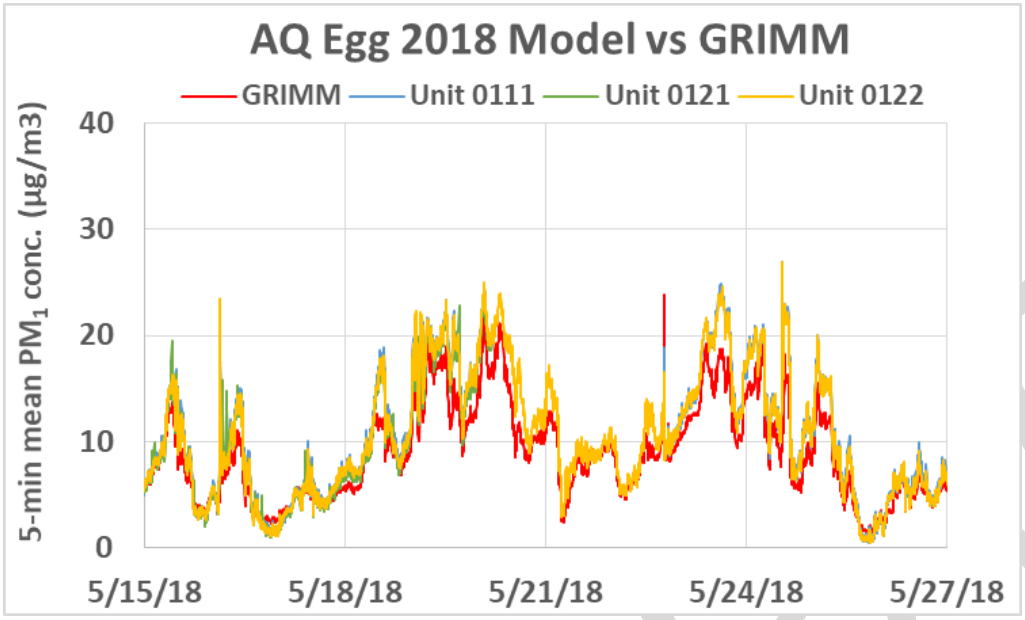




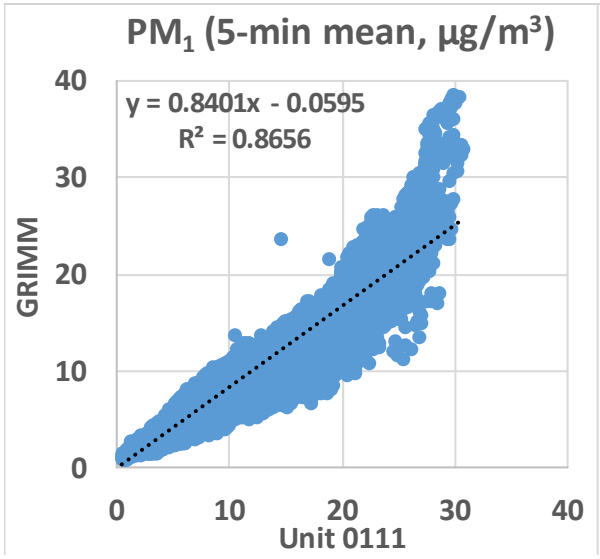


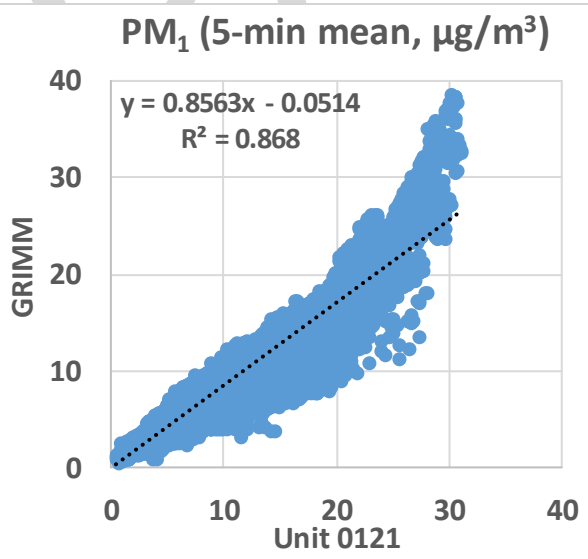


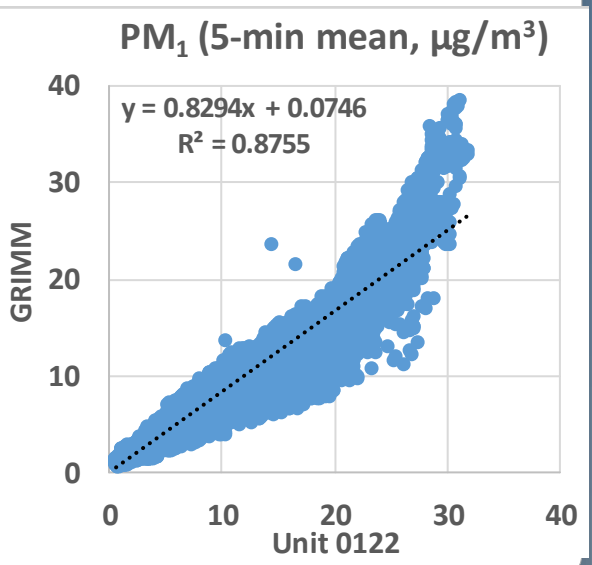
AQ Egg 2018 Model vs GRIMM (PM_1; 5-min mean)



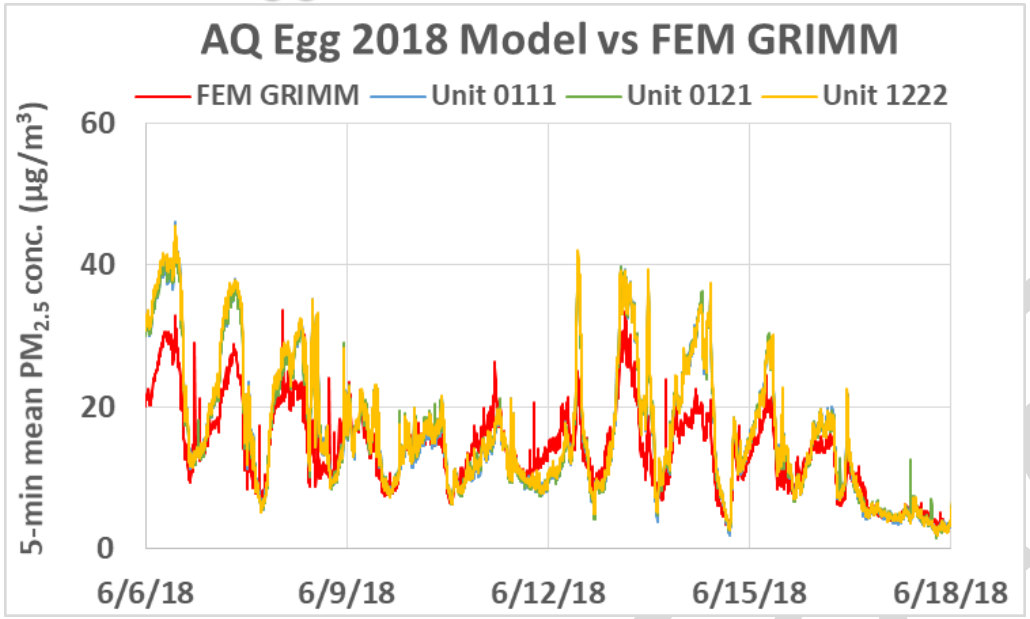
- AQ Egg 2018 Model PM_1 mass measurements show good correlations with the corresponding GRIMM data (R^2 > 0.86)
- Overall, the AQ Egg 2018 Model sensors overestimate PM_1 mass concentrations measured by GRIMM
- The AQ Egg 2018 Model sensors track well the PM_1 diurnal variation recorded by GRIMM



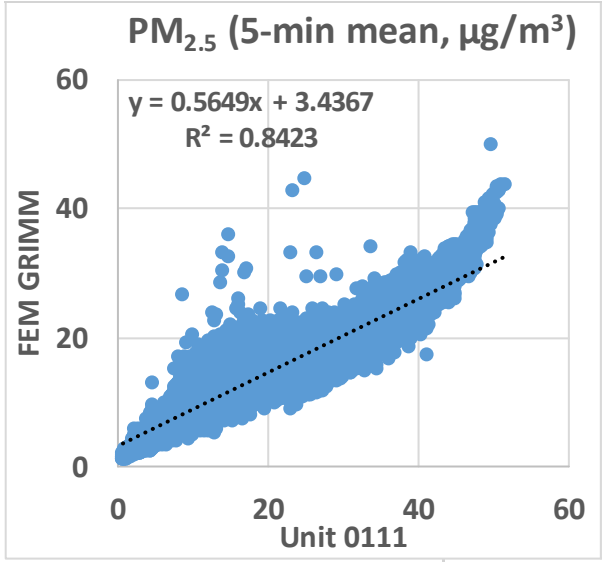


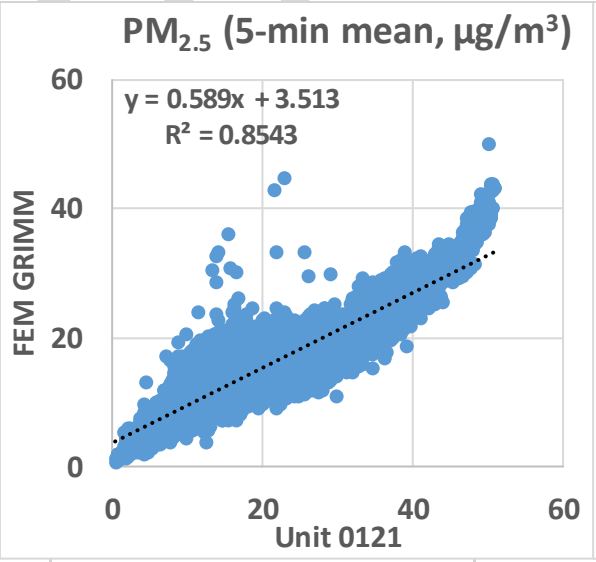


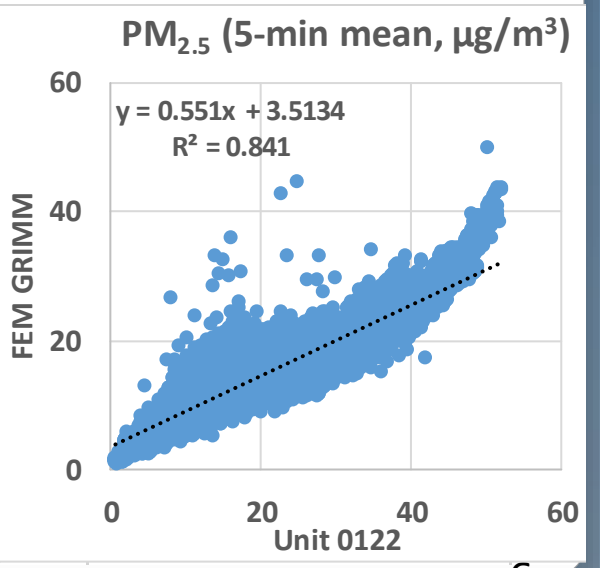
AQ Egg 2018 Model vs FEM GRIMM ($PM_{2.5}$; 5-min mean)



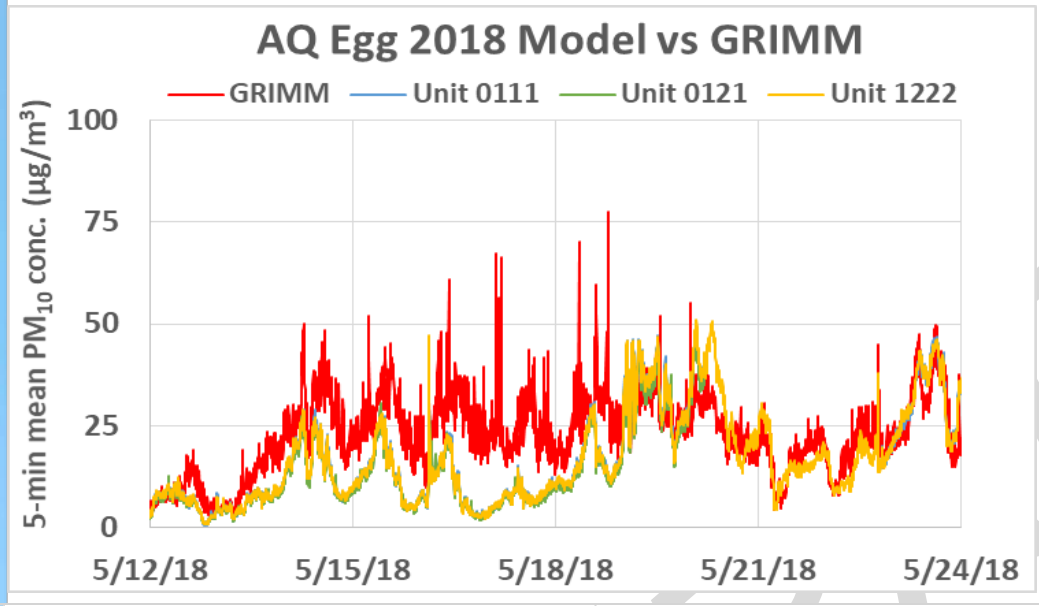
- AQ Egg 2018 Model $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data ($R^2 > 0.84$)
- Overall, the AQ Egg 2018 Model sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM GRIMM
- The AQ Egg 2018 Model sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM GRIMM



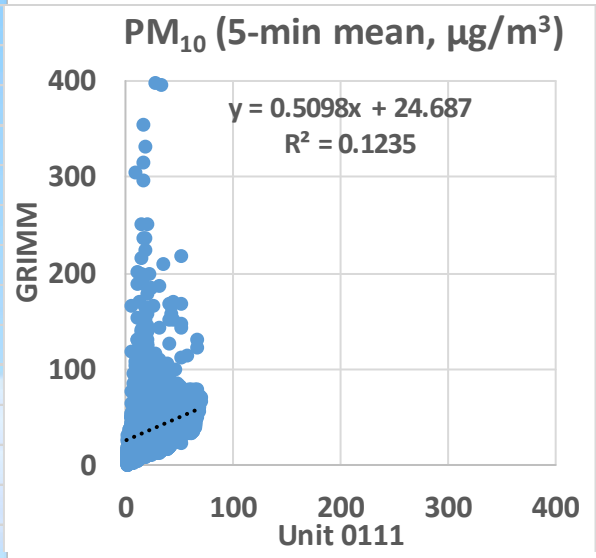


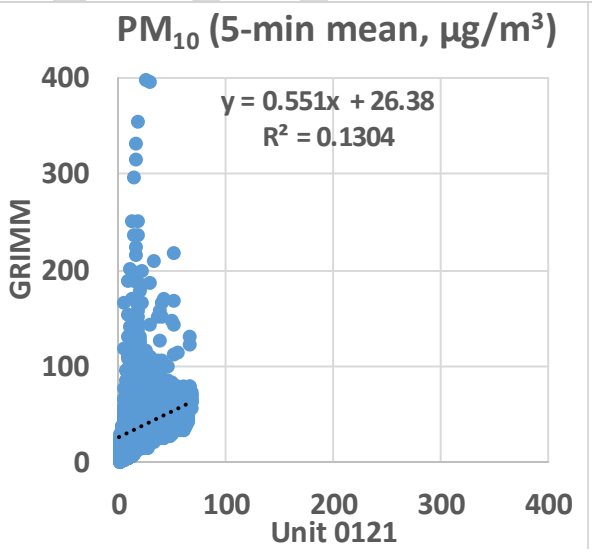


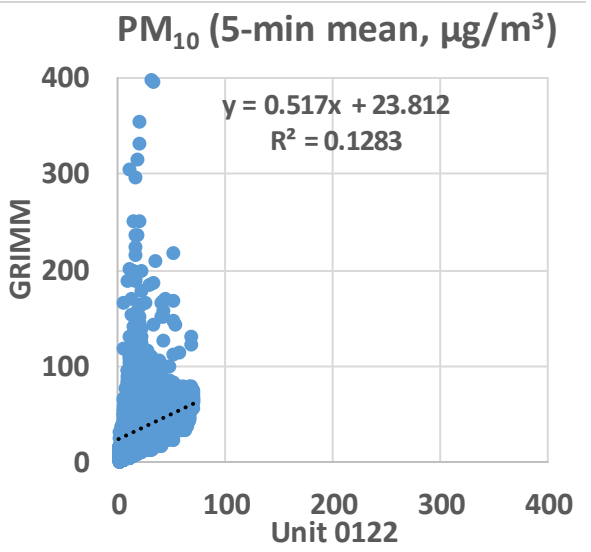
AQ Egg 2018 Model vs GRIMM (PM_{10}; 5-min mean)



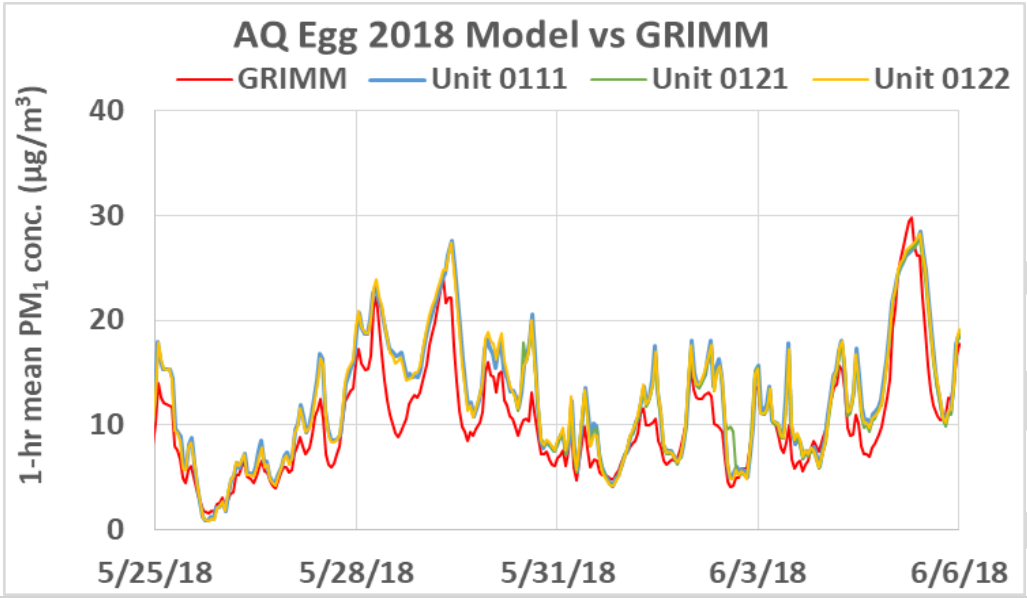
- AQ Egg 2018 Model PM_{10} mass measurements do not correlate with the corresponding GRIMM data ($R^2 < 0.14$)
- Overall, the AQ Egg 2018 Model sensors overestimate PM_{10} mass concentrations measured by GRIMM
- The AQ Egg 2018 Model sensors do not track the PM_{10} diurnal variation recorded by GRIMM



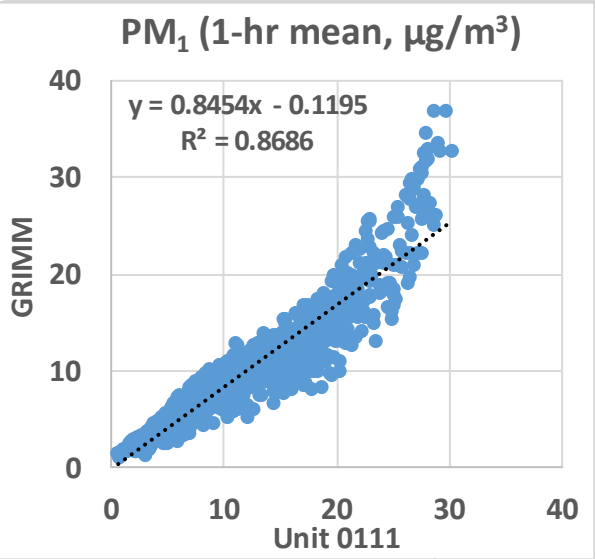


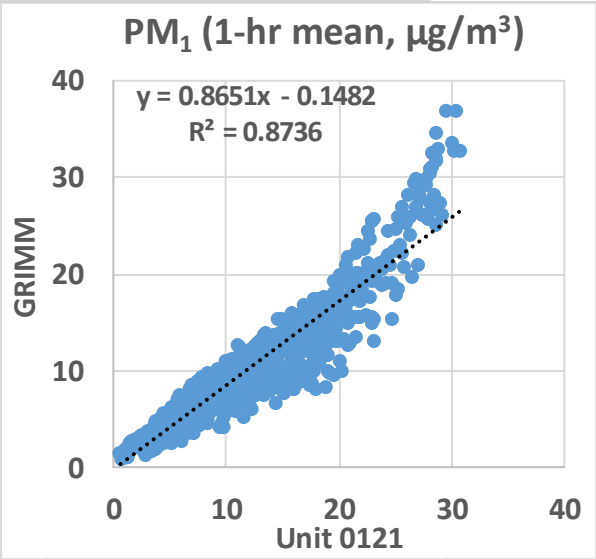


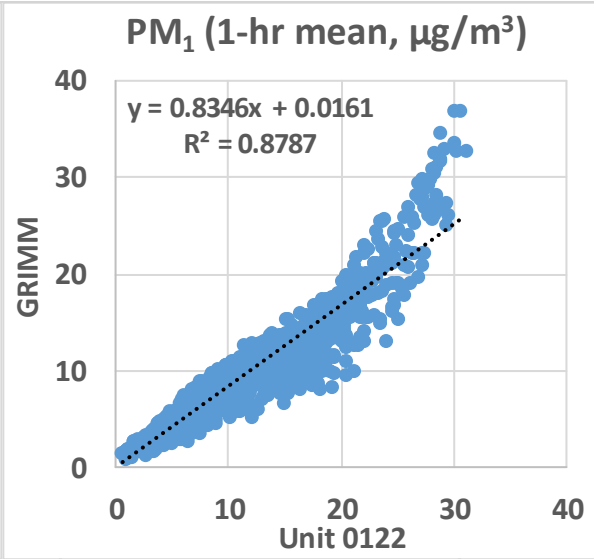
AQ Egg 2018 Model vs GRIMM (PM_1; 1-hr mean)



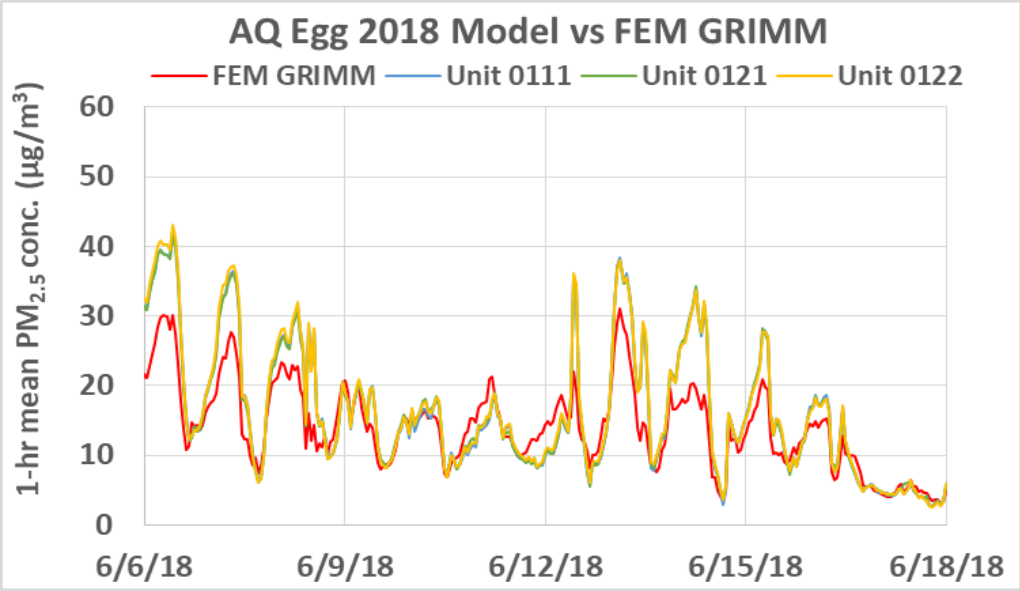
- AQ Egg 2018 Model PM_1 mass measurements show good correlations with the corresponding GRIMM data (R^2 > 0.86)
- Overall, the AQ Egg 2018 Model sensors overestimate PM_1 mass concentrations measured by GRIMM
- The AQ Egg 2018 Model sensors track well the PM_1 diurnal variation recorded by GRIMM



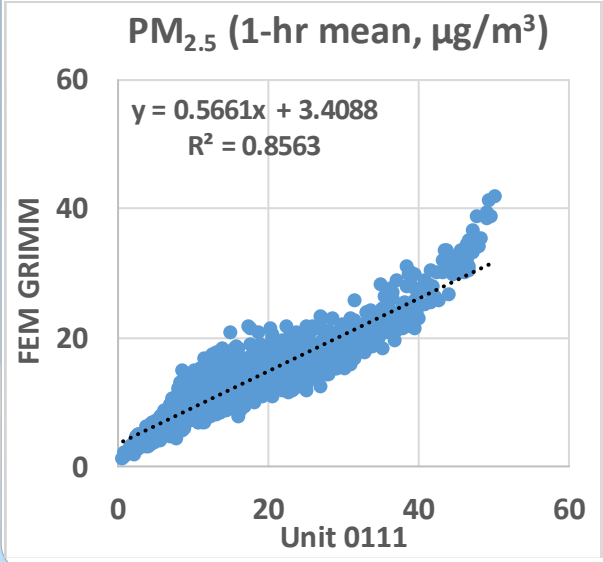


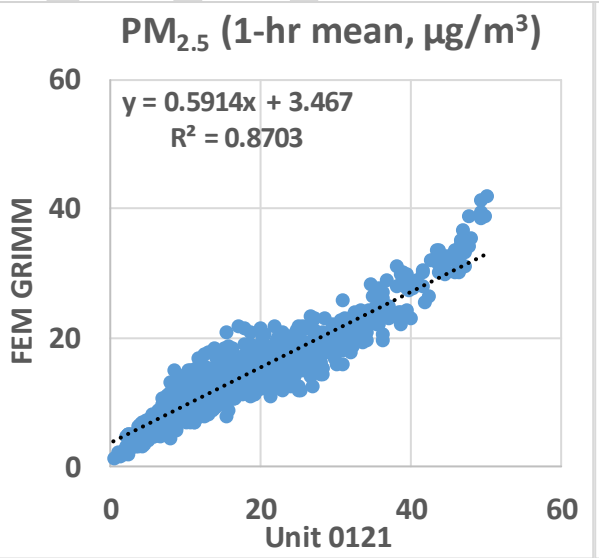


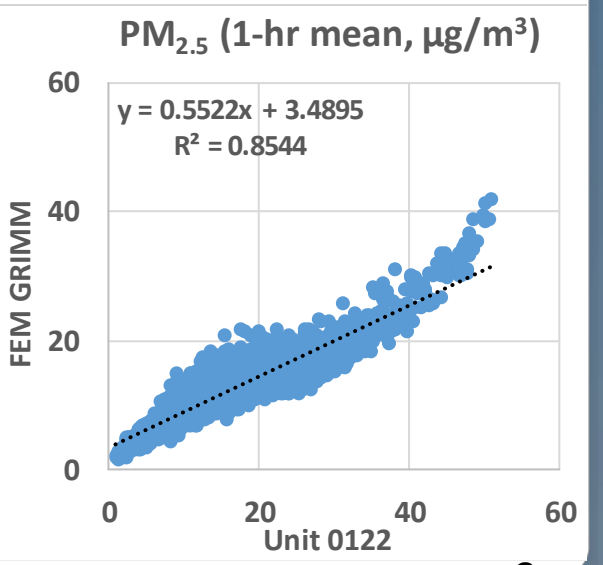
AQ Egg 2018 Model vs FEM GRIMM ($PM_{2.5}$; 1-hr mean)



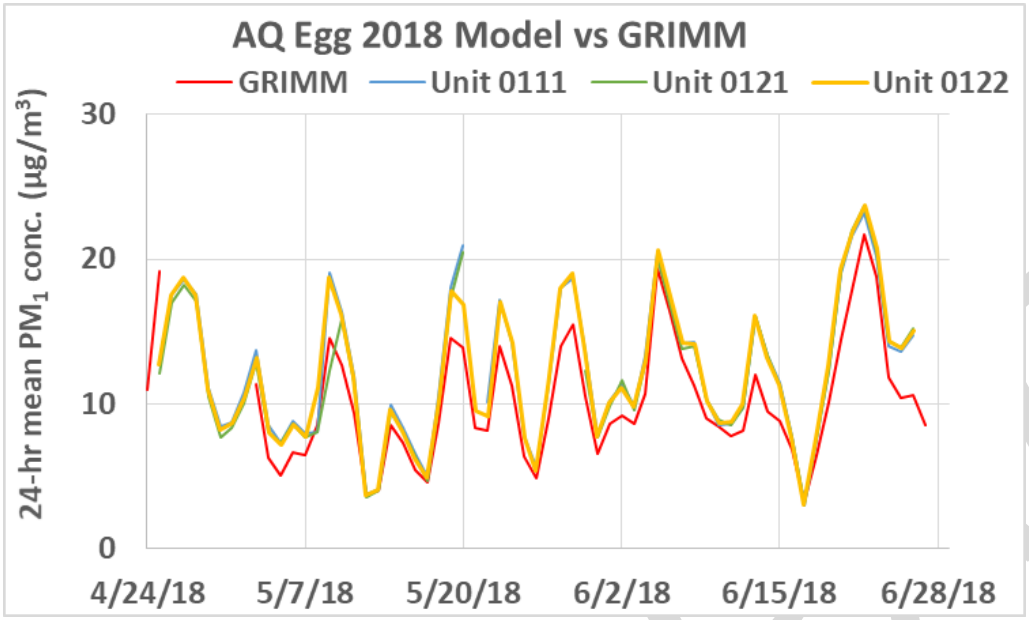
- AQ Egg 2018 Model $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data ($R^2 > 0.85$)
- Overall, the AQ Egg 2018 Model sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM GRIMM
- The AQ Egg 2018 Model sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM GRIMM



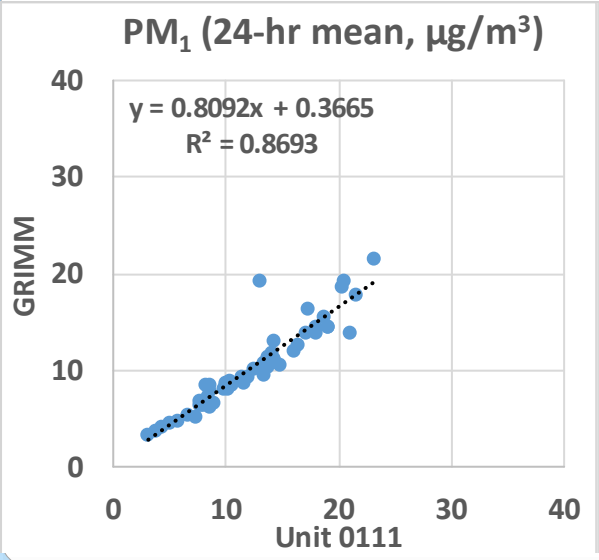


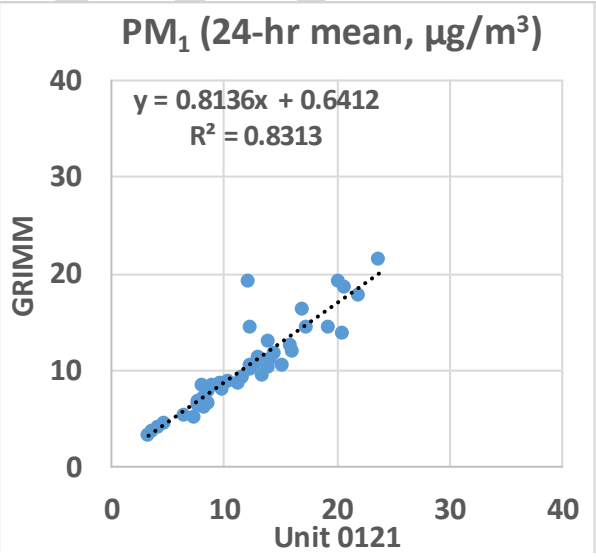


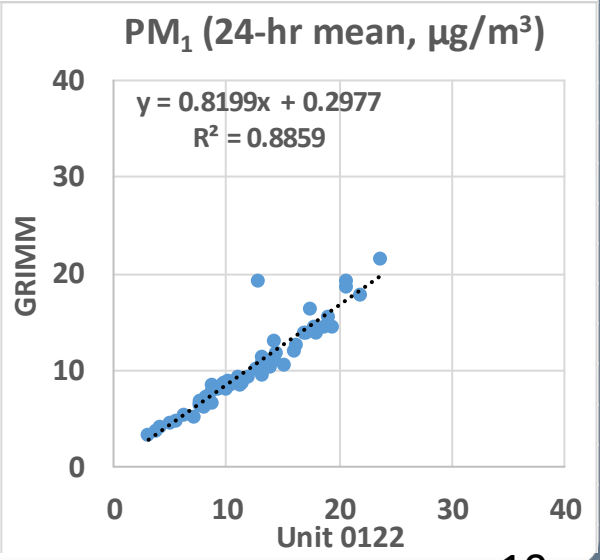
AQ Egg 2018 Model vs GRIMM (PM_1; 24-hr mean)



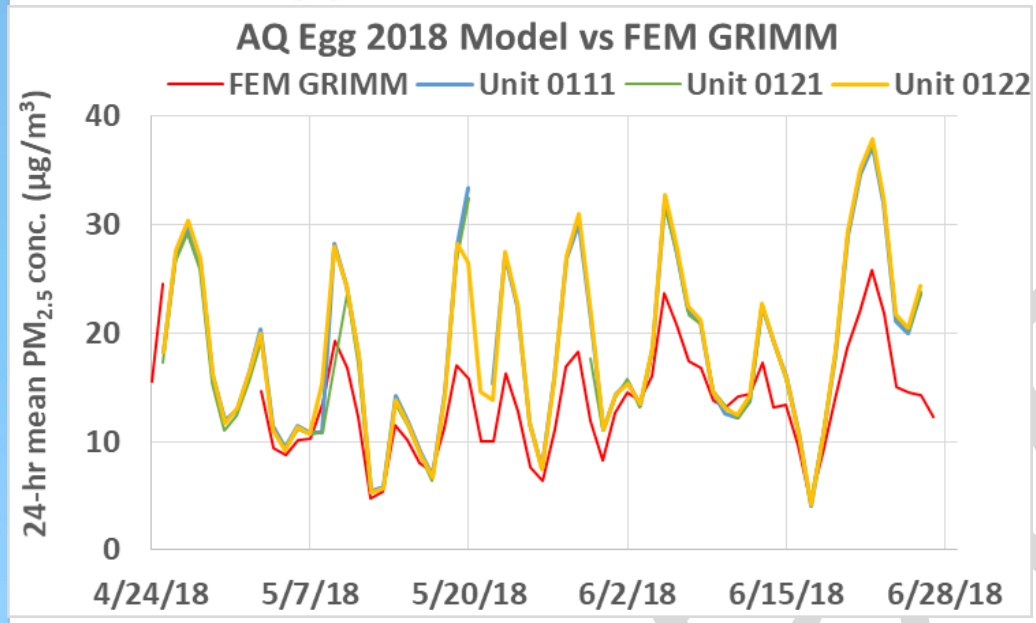
- AQ Egg 2018 Model PM_1 mass measurements show good correlations with the corresponding GRIMM data ($0.83 < R^2 < 0.89$)
- Overall, the AQ Egg 2018 Model sensors overestimate PM_1 mass concentrations measured by GRIMM
- The AQ Egg 2018 Model sensors track well the PM_1 diurnal variation recorded by GRIMM



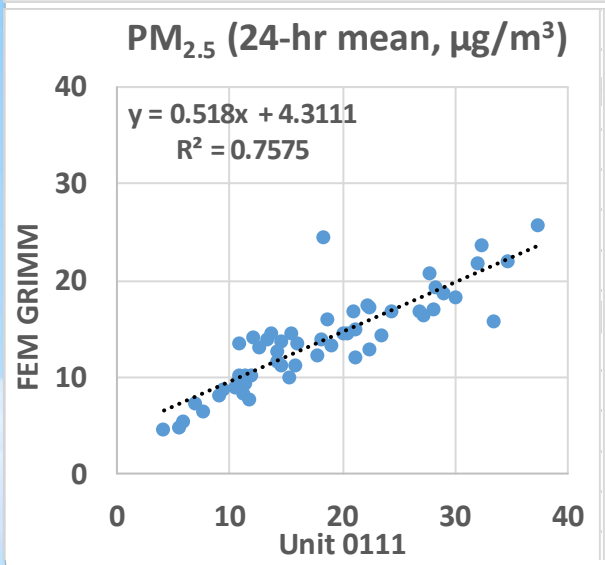


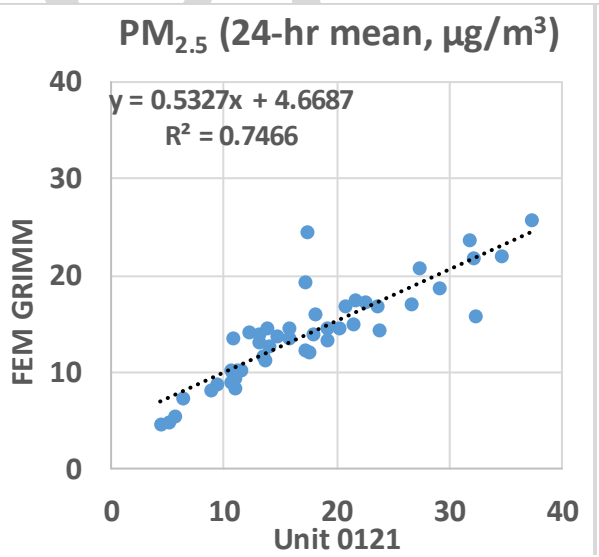


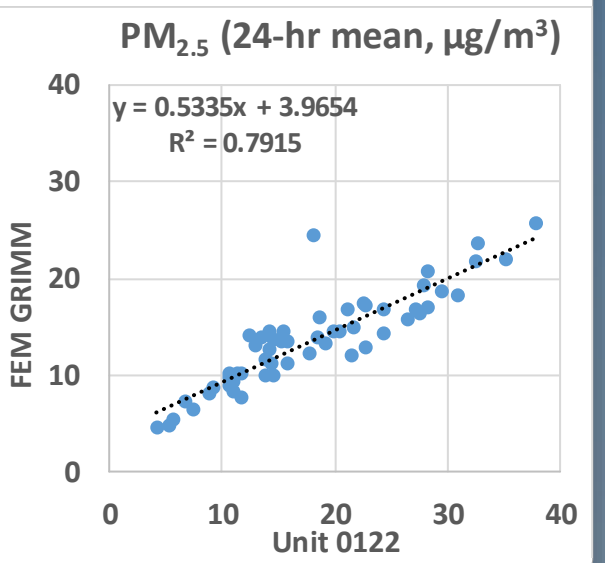
AQ Egg 2018 Model vs FEM GRIMM ($PM_{2.5}$; 24-hr mean)



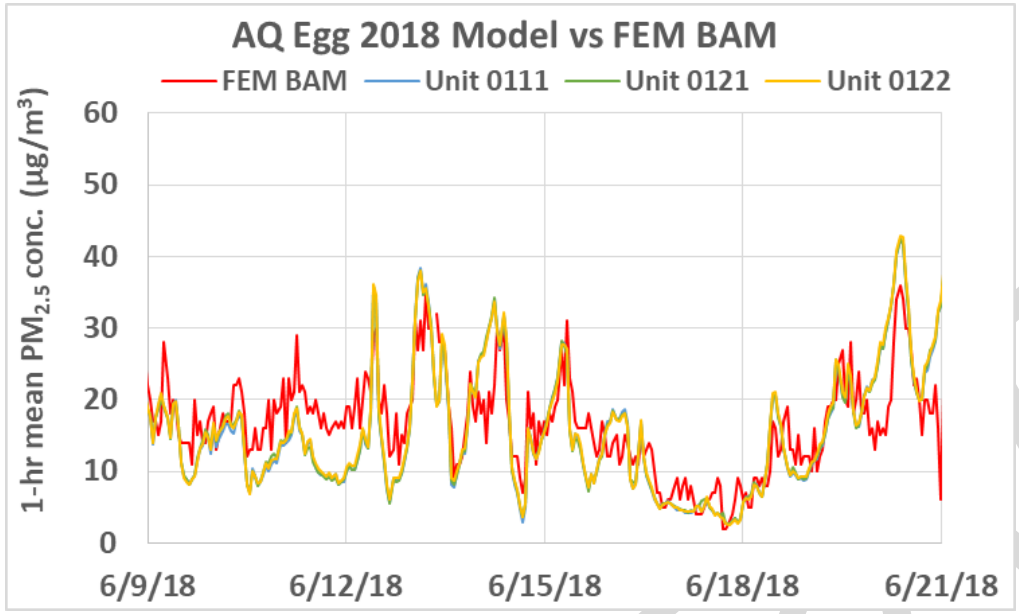
- AQ Egg 2018 Model $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data ($R^2 > 0.74$)
- Overall, the AQ Egg 2018 Model sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM GRIMM
- The AQ Egg 2018 Model sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM GRIMM



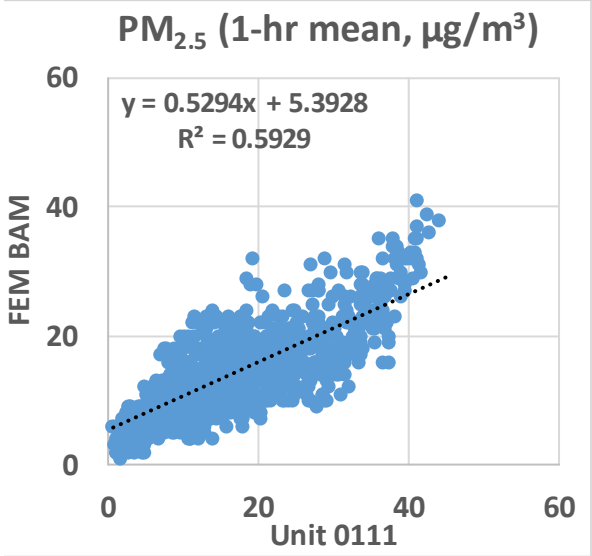


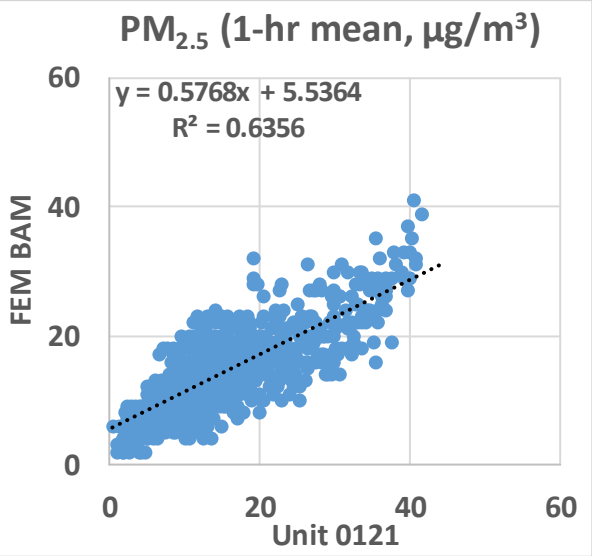


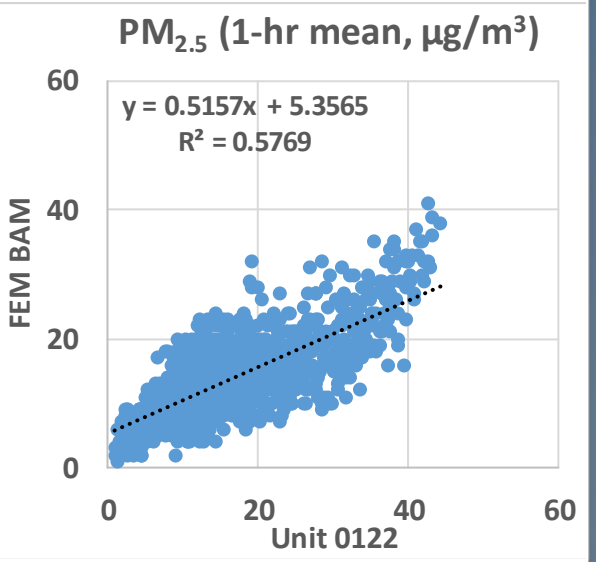
AQ Egg 2018 Model vs FEM BAM ($PM_{2.5}$; 1-hr mean)



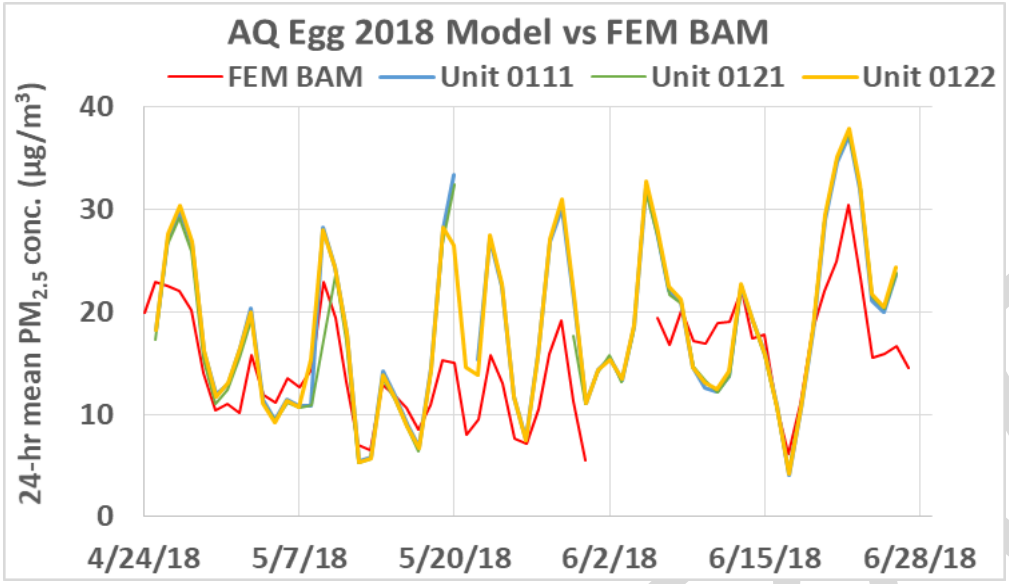
- AQ Egg 2018 Model $PM_{2.5}$ mass measurements show moderate correlations with the corresponding FEM BAM data ($0.57 < R^2 < 0.64$)
- Overall, the AQ Egg 2018 Model sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM BAM
- The AQ Egg 2018 Model sensors track moderately well the $PM_{2.5}$ diurnal variation recorded by FEM BAM



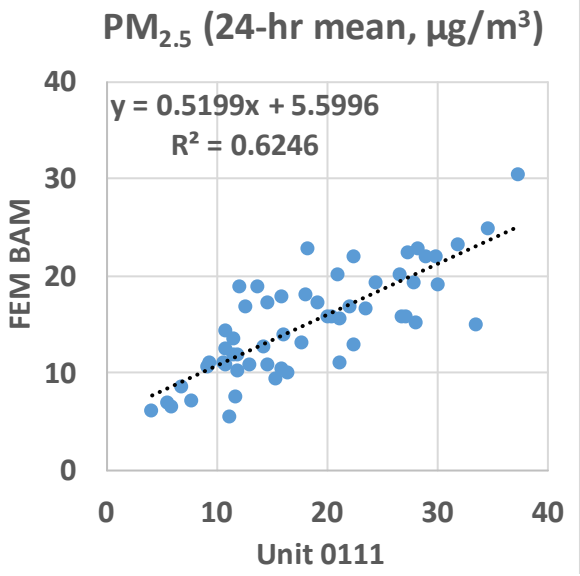


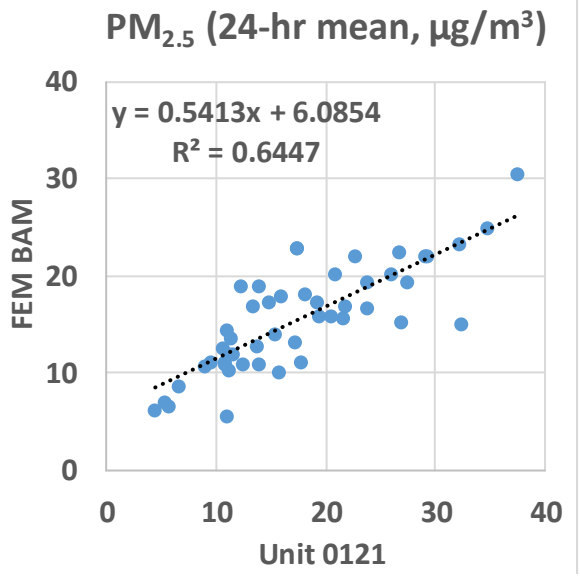


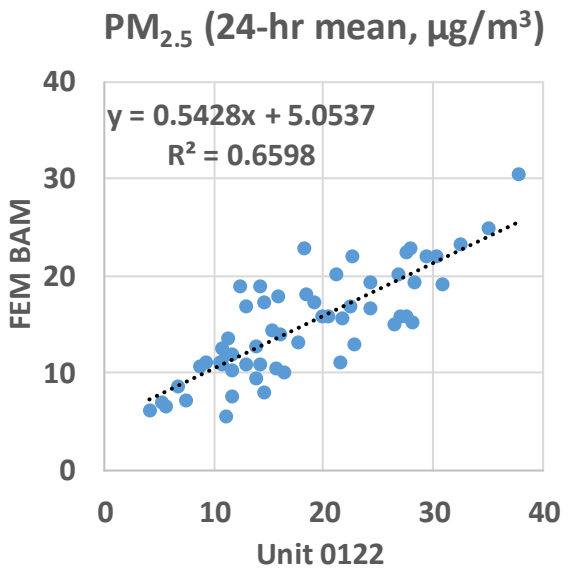
AQ Egg 2018 Model vs FEM BAM ($PM_{2.5}$; 24-hr mean)



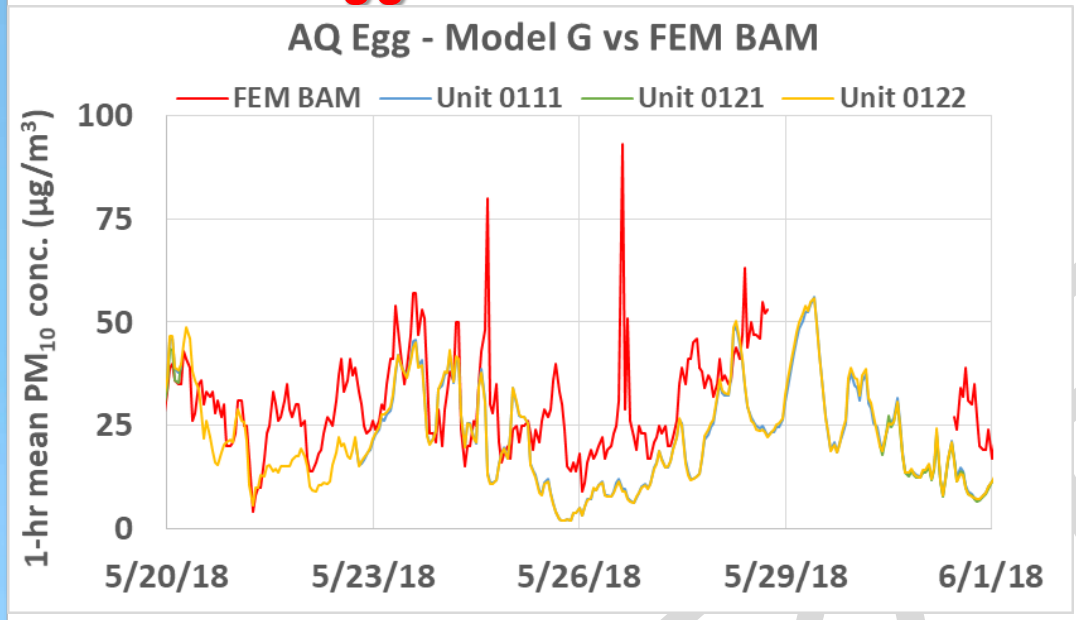
- AQ Egg 2018 Model $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM BAM data ($R^2 > 0.62$)
- Overall, the AQ Egg 2018 Model sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM BAM
- The AQ Egg 2018 Model sensors track moderately well the $PM_{2.5}$ diurnal variation recorded by FEM BAM



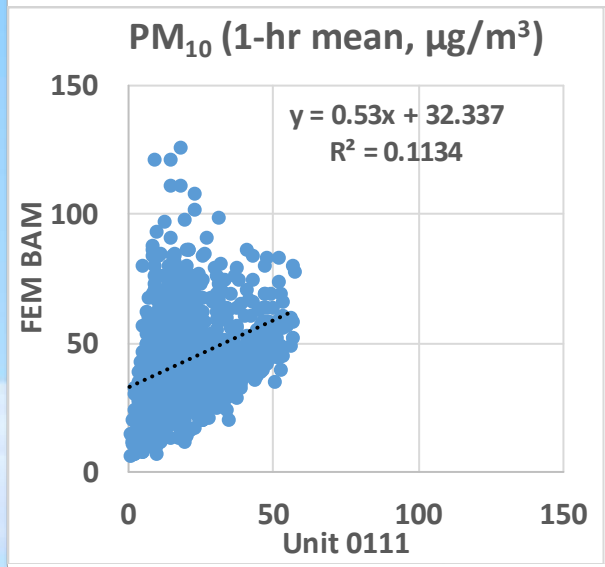


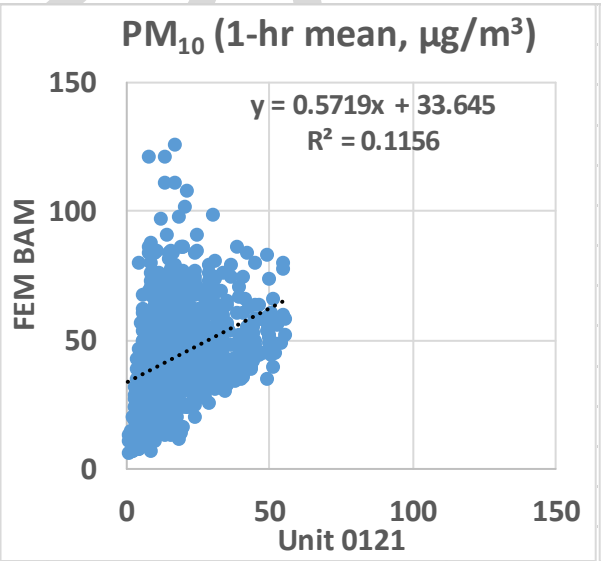


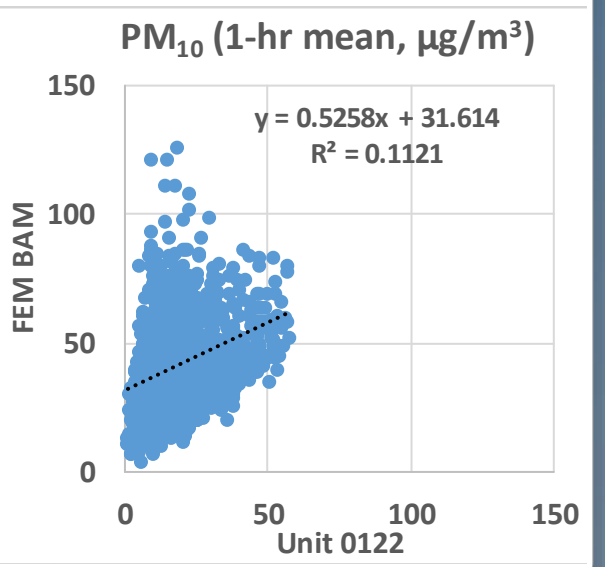
AQ Egg 2018 Model vs FEM BAM (PM_{10}; 1-hr mean)



- AQ Egg 2018 Model PM_{10} mass measurements do not correlate with the corresponding FEM BAM data (R^2 < 0.12)
- Overall, the AQ Egg 2018 Model sensors overestimate PM_{10} mass concentrations measured by FEM BAM
- The AQ Egg 2018 Model sensors do not track the PM_{10} diurnal variation recorded by FEM BAM







Discussion

- The three **Air Quality Egg 2018 Model** sensors had a data recovery of 99.8% with low intra-model variability (4% to 8%)
- The equivalent methods (GRIMM and BAM) correlate well with each other for both $PM_{2.5}$ ($R^2 > 0.72$) and PM_{10} ($R^2 > 0.76$) mass concentration measurements (1-hr mean)
- PM_1 mass concentration measurements measured by Air Quality Egg 2018 Model correlate well with the corresponding GRIMM values ($R^2 > 0.86$, 1-hr mean) and overestimate PM_1 mass concentration measured by GRIMM
- $PM_{2.5}$ mass concentration measurements measured by Air Quality Egg 2018 Model correlate well with the corresponding FEM GRIMM ($R^2 > 0.85$, 1-hr mean) and moderately correlated with FEM BAM ($R^2 > 0.57$, 1-hr mean) and overestimate $PM_{2.5}$ mass concentration measured by FEM GRIMM and FEM BAM
- PM_{10} mass concentration measurements measured by Air Quality Egg 2018 Model do not correlate with the corresponding GRIMM values ($R^2 < 0.18$,1-hr mean) and FEM BAM ($R^2 < 0.12$, 1-hr mean) and overestimate PM_{10} mass concentration measured by GRIMM and FEM BAM
- 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
- All results are still preliminary