Field Evaluation
AS-LUNG Portable

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 10/06/2017 to 12/14/2017, three **AS-LUNG Portable** sensor were deployed at our (SCAQMD) Rubidoux station and ran side-by-side with Federal Equivalent Method (FEM) instruments measuring the same pollutants
- *AS-LUNG Portable Sensor [3 units tested]:*
  - Particle sensor (optical; non-FEM)
  - PM sensor: Plantower PMS3003
  - Each sensor reports: $PM_{1,}$ $PM_{2.5}$ and PM_{10} mass concentration ($\mu g/m^3$)
  - Unit also carries a CO_2 (ppm) sensor
  - Time resolution:15 seconds
  - Unit cost: ~$999
  - IDs: 0009, 0014, 0015

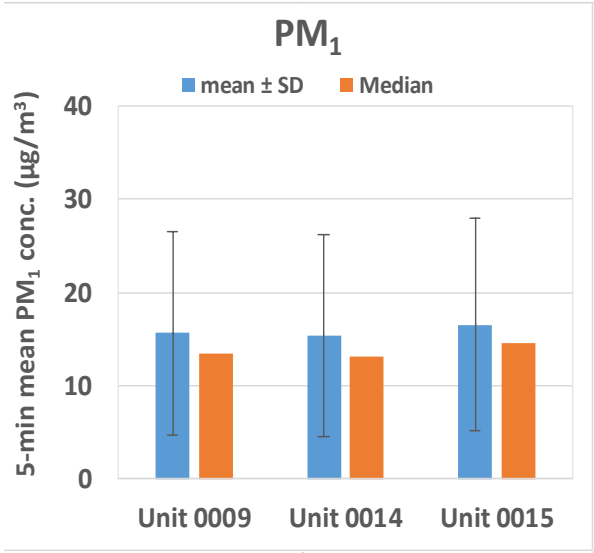
- MetOne BAM (*reference method*):
  - Beta-attenuation monitors (FEM $PM_{2.5}$, PM_{10})
  - Measures $PM_{2.5}$ & PM_{10} mass ($\mu g/m^3$)
  - Unit cost: ~$20,000
  - Time resolution: 1-hr
- GRIMM (*reference method*):
  - Optical Particle Counter (FEM $PM_{2.5}$)
  - Uses proprietary algorithms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

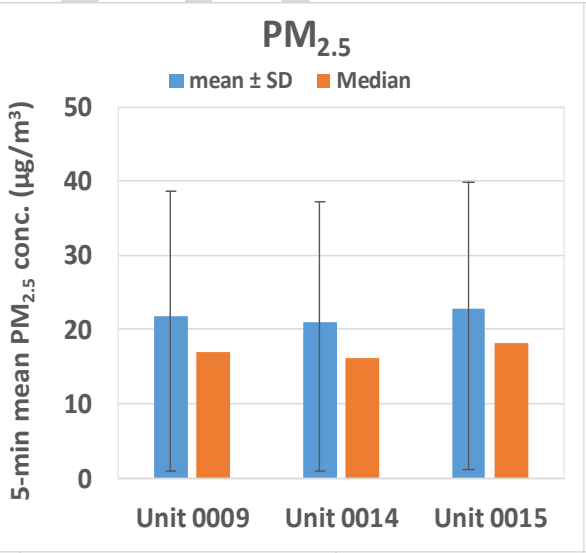
Data validation & recovery

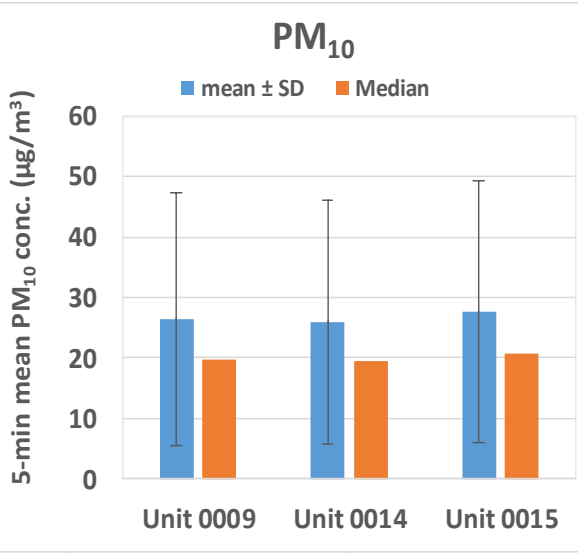
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM_1, $PM_{2.5}$ and PM_{10} mass concentrations from all AS-LUNG Portable sensors was ~82%, ~85% and ~87%, respectively.

AS-LUNG Portable; intra-model variability

- Very low intra-model variabilities (6%-8%) were observed between the different AS-LUNG Portable sensors for PM_1, $PM_{2.5}$ and PM_{10} mass concentrations ($\mu g/m^3$).

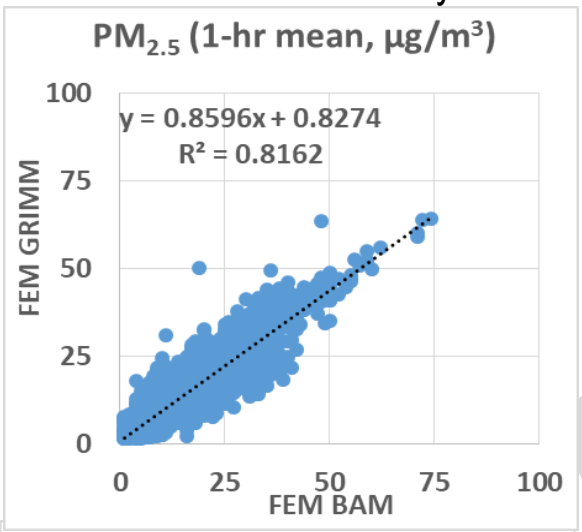


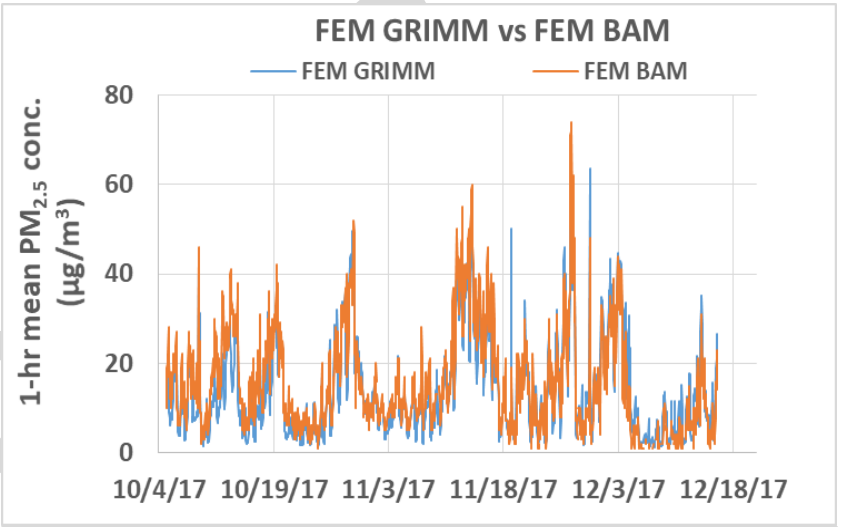


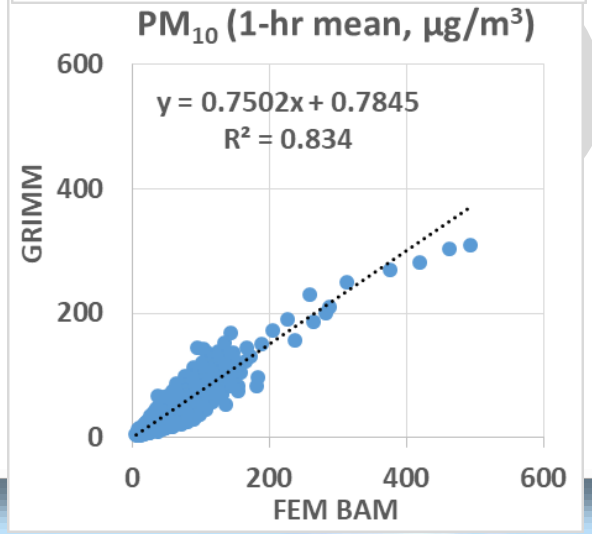


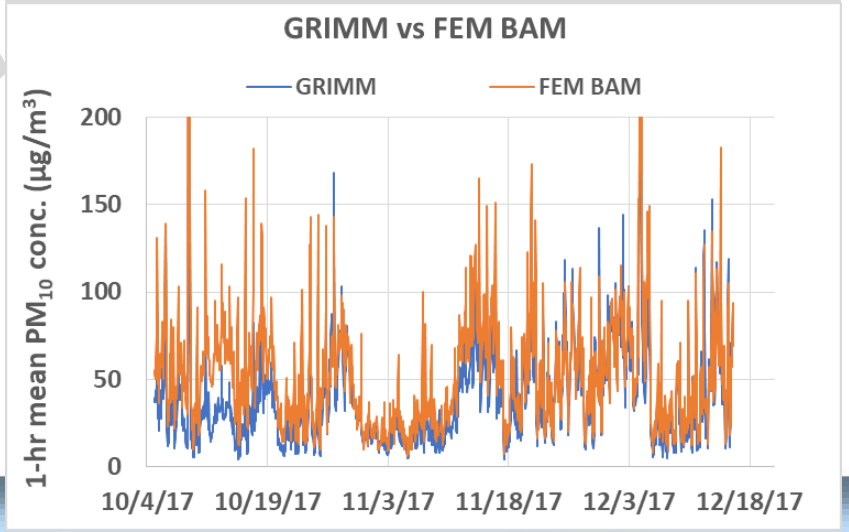
Equivalent Methods: GRIMM vs BAM

- PM mass concentrations measured the equivalent methods correlate well for 1-hr mean concentrations ($R^2 > 0.81$)
- Overall, PM mass concentrations measured by FEM BAM are slightly higher than the PM mass concentrations measured by GRIMM

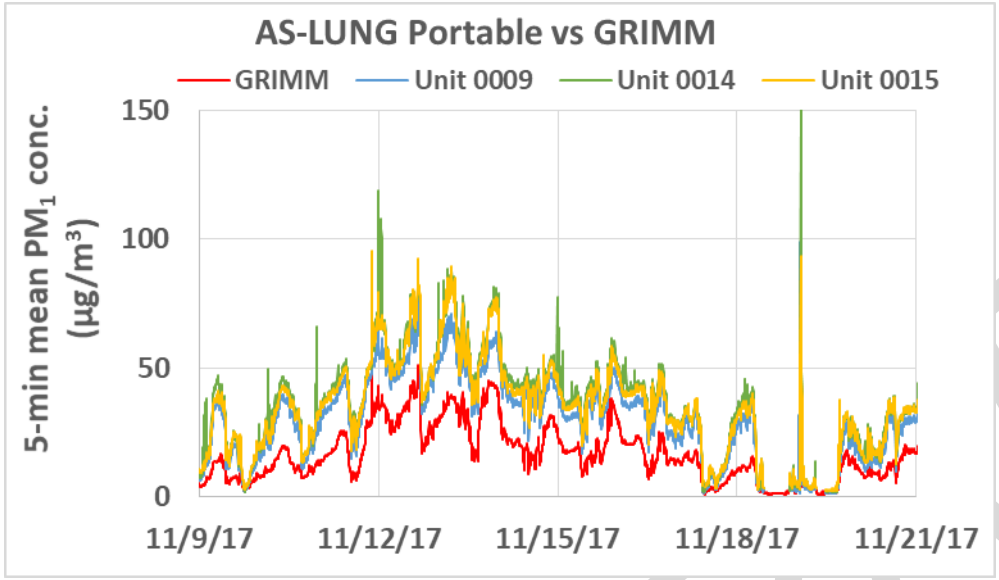




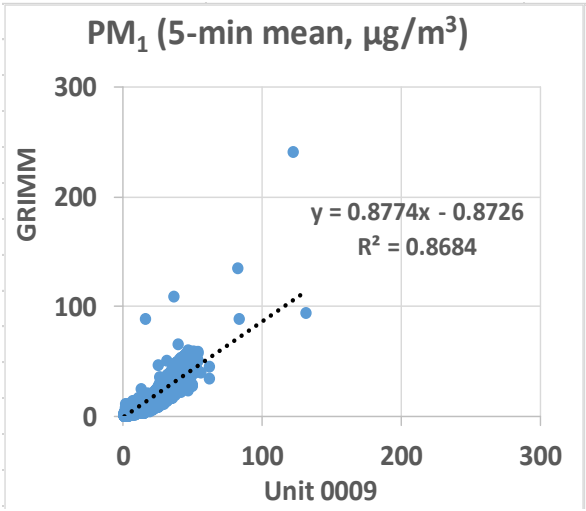


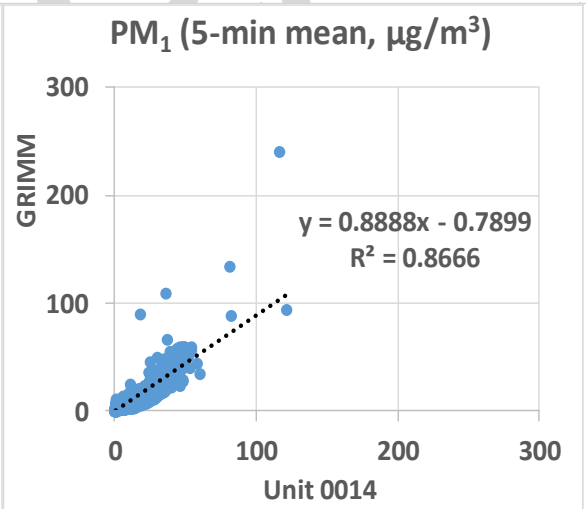


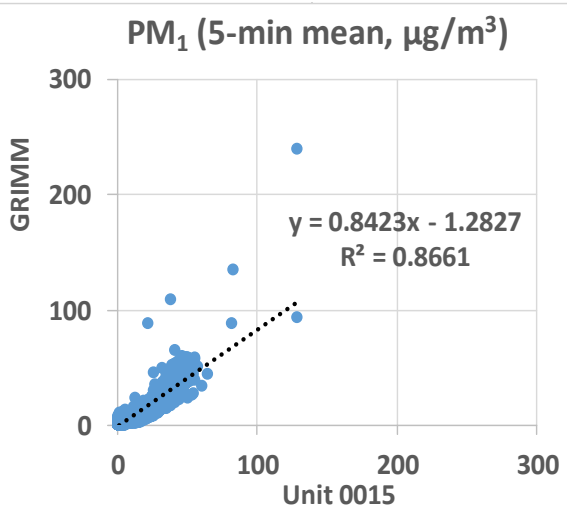
AS-LUNG Portable vs GRIMM (PM_1; 5-min mean)



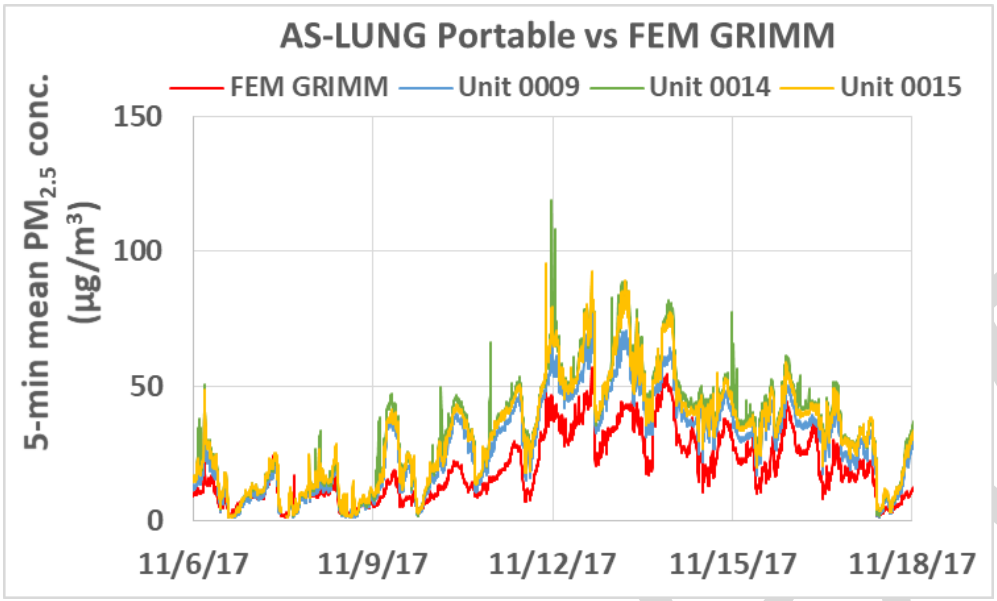
- AS-LUNG Portable PM_1 mass measurements correlate well with the corresponding GRIMM data ($R^2 > 0.86$)
- Overall, the AS-LUNG Portable sensors overestimate PM_1 mass concentrations measured by GRIMM
- The AS-LUNG Portable sensors track well the PM_1 diurnal variation recorded by GRIMM



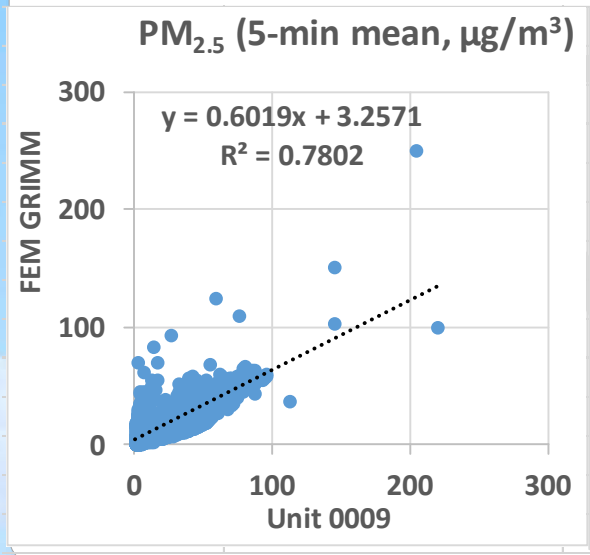


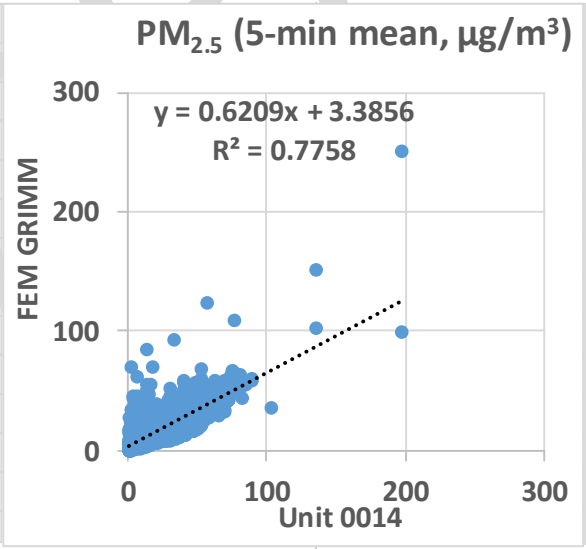


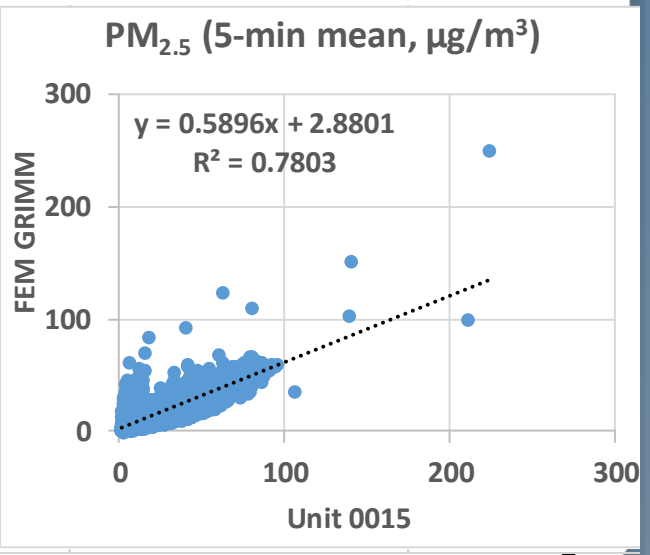
AS-LUNG Portable vs FEM GRIMM ($PM_{2.5}$; 5-min mean)



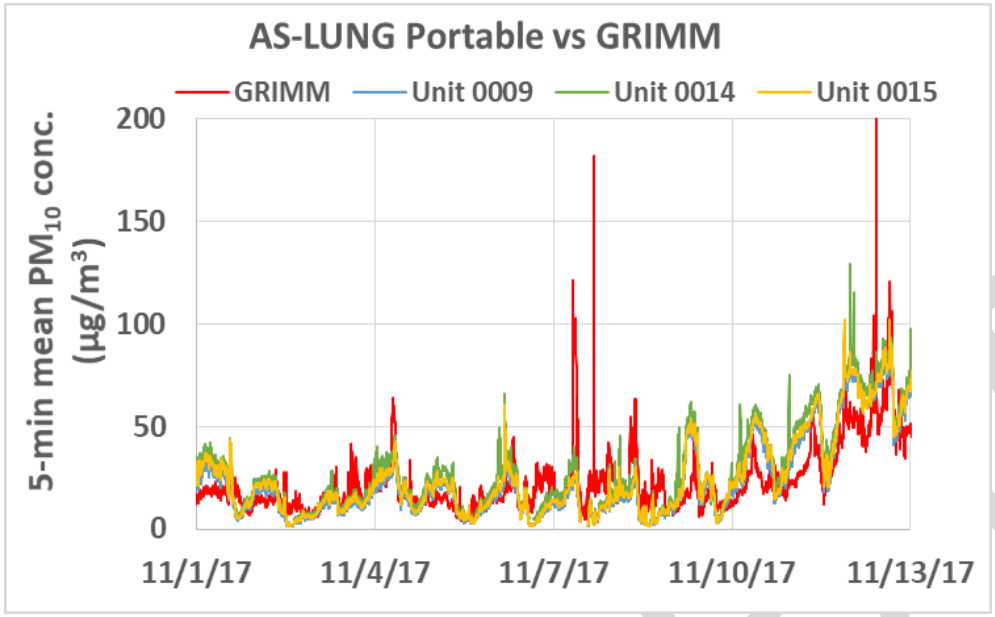
- AS-LUNG Portable $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data ($R^2 > 0.77$)
- Overall, the AS-LUNG Portable sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM GRIMM
- The AS-LUNG Portable sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM GRIMM



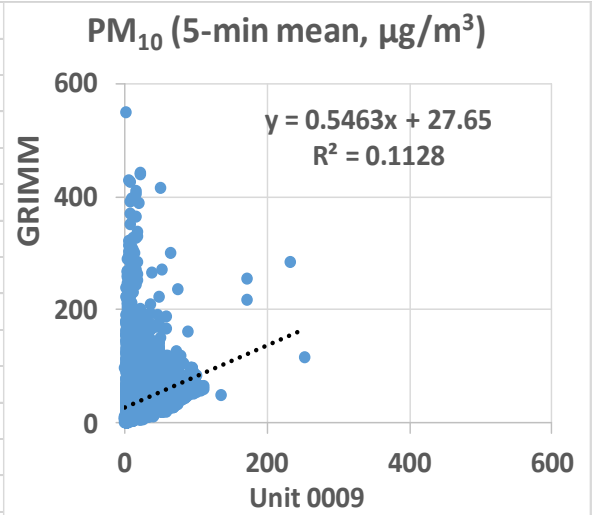


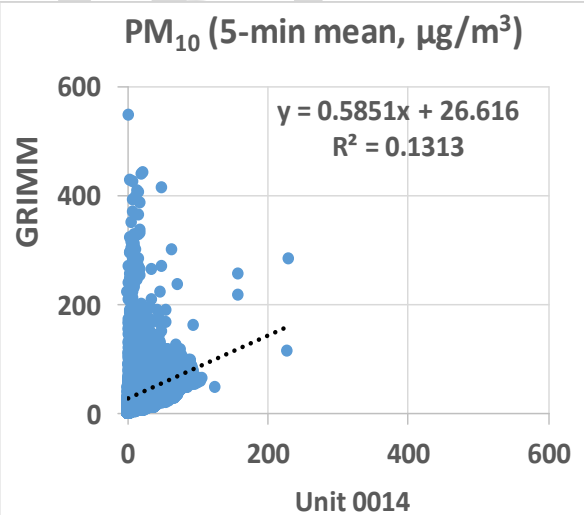


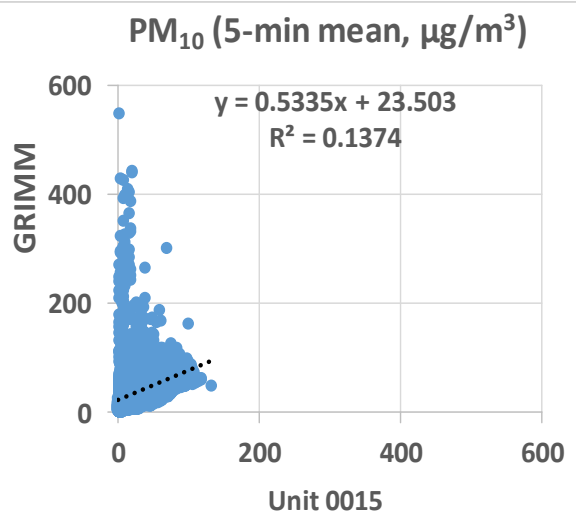
AS-LUNG Portable vs GRIMM (PM_{10}; 5-min mean)



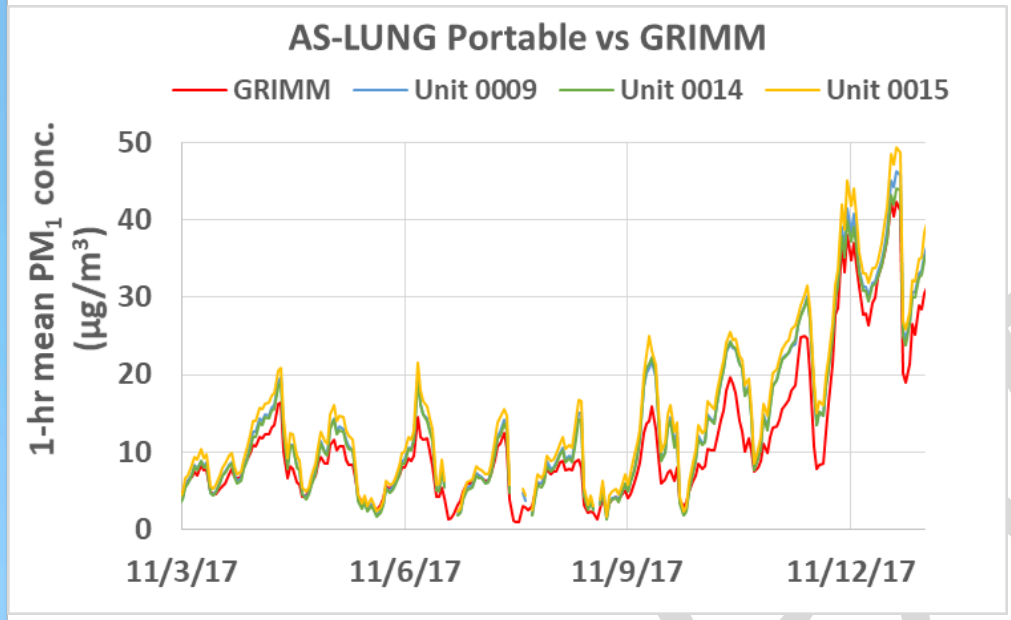
- AS-LUNG Portable PM_{10} mass measurements do not correlate with the corresponding GRIMM data ($0.11 < R^2 < 0.14$)
- Overall, the AS-LUNG Portable sensors overestimate PM_{10} mass concentrations measured by GRIMM
- The AS-LUNG Portable sensors do not track well the PM_{10} diurnal variation recorded by GRIMM



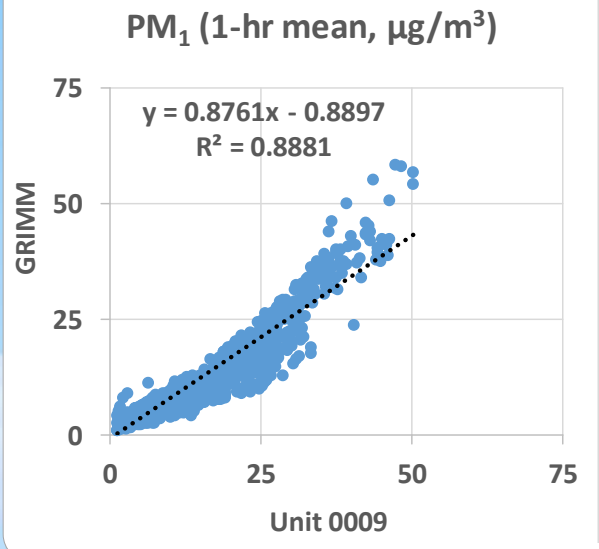


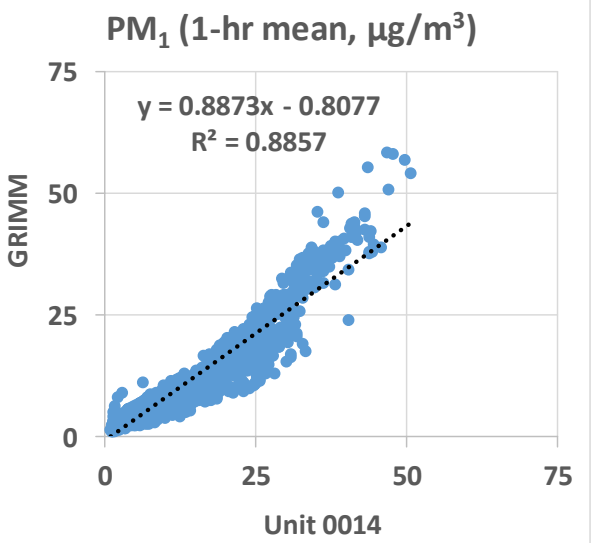


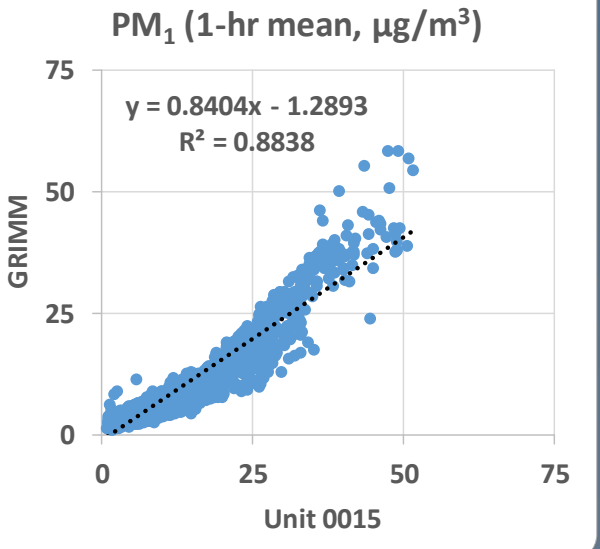
AS-LUNG Portable vs GRIMM (PM_1; 1-hr mean)



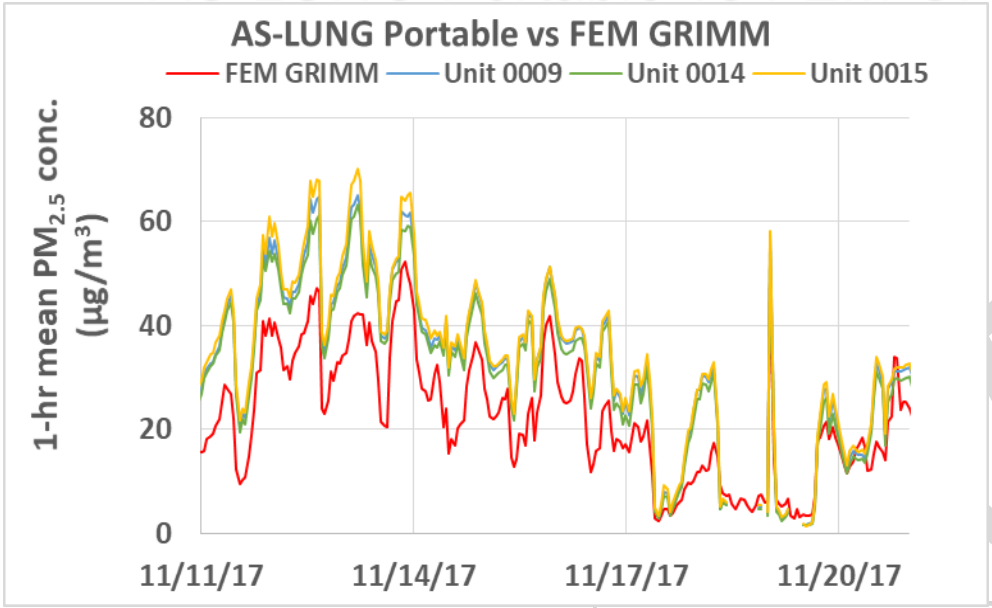
- AS-LUNG Portable PM_1 mass measurements correlate well with the corresponding GRIMM data ($R^2 > 0.88$)
- Overall, the AS-LUNG Portable sensors slightly overestimate PM_1 mass concentrations measured by GRIMM
- The AS-LUNG sensors track well the PM_1 diurnal variation recorded by GRIMM



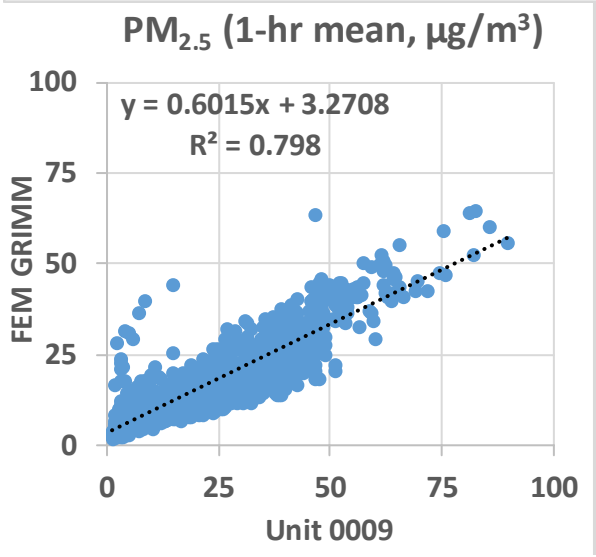


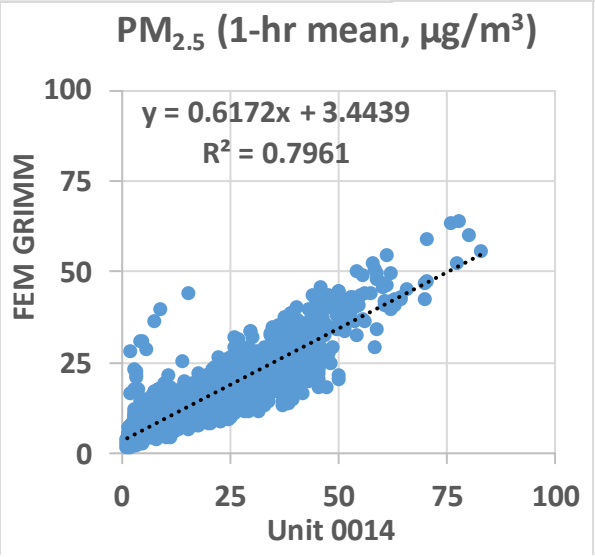


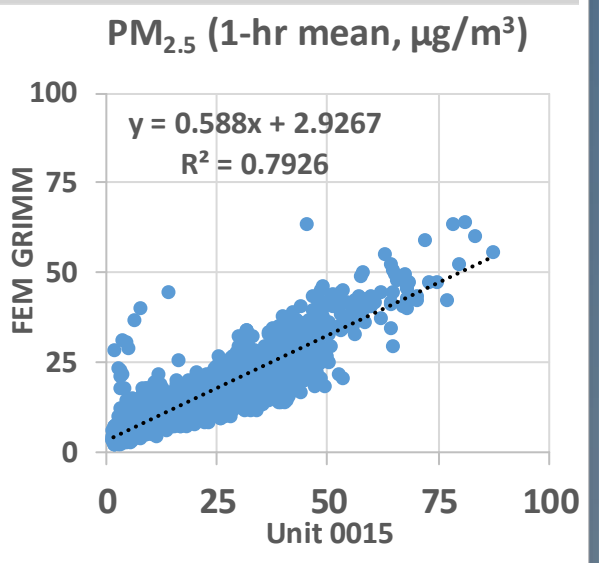
AS-LUNG Portable vs FEM GRIMM ($PM_{2.5}$; 1-hr mean)



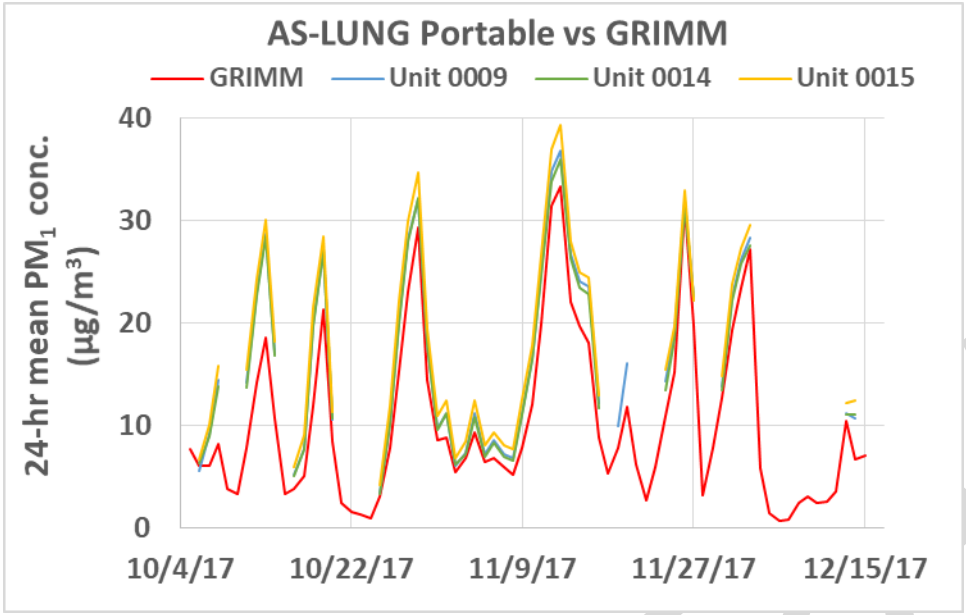
- AS-LUNG Portable $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM GRIMM data ($R^2 > 0.79$)
- Overall, the AS-LUNG Portable sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM GRIMM
- The AS-LUNG sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM GRIMM



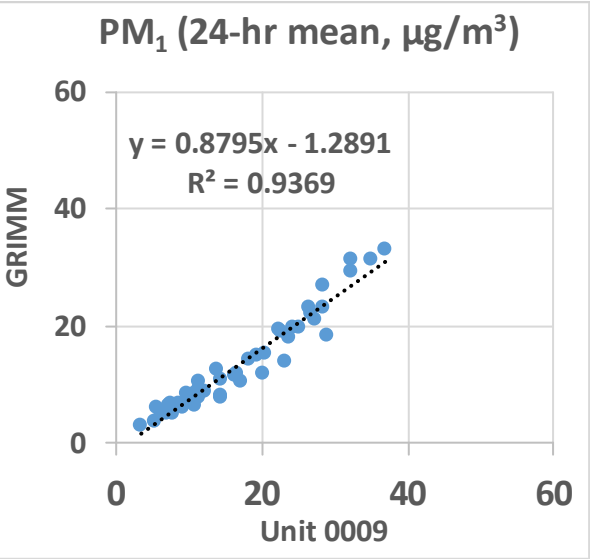


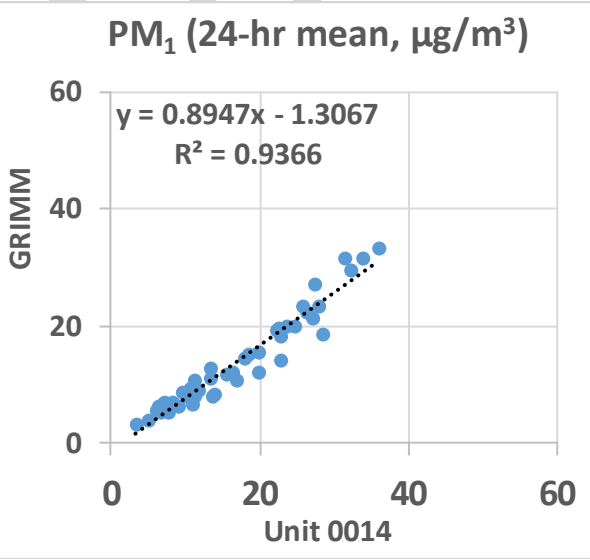


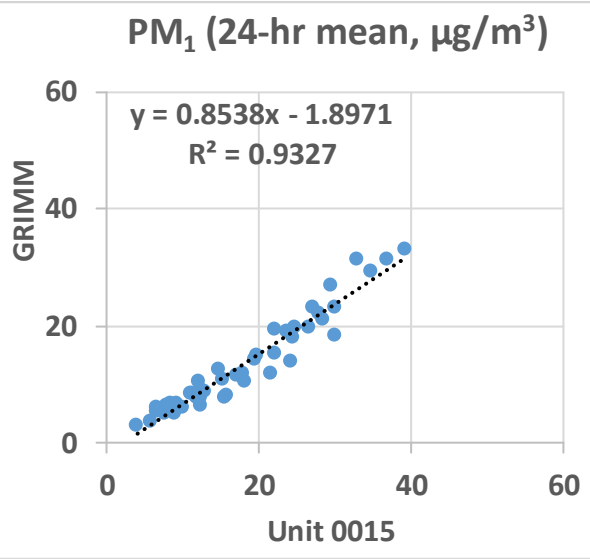
AS-LUNG Portable vs GRIMM (PM_1; 24-hr mean)



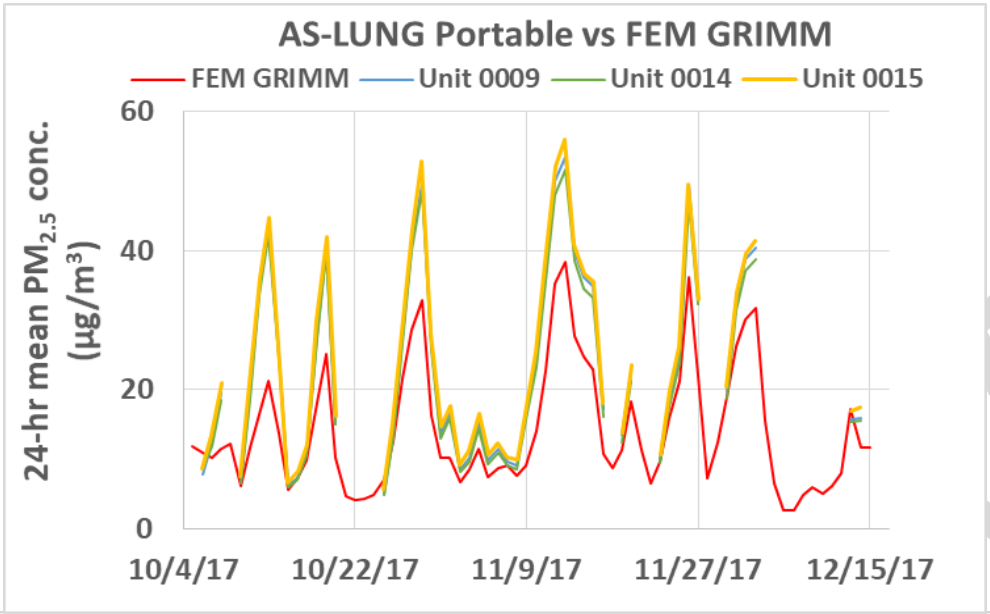
- AS-LUNG Portable PM_1 mass measurements correlate well with the corresponding GRIMM data ($R^2 > 0.93$)
- Overall, the AS-LUNG Portable sensors slightly overestimate PM_1 mass concentrations measured by GRIMM
- The AS-LUNG portable sensors track well the PM_1 diurnal variation recorded by GRIMM



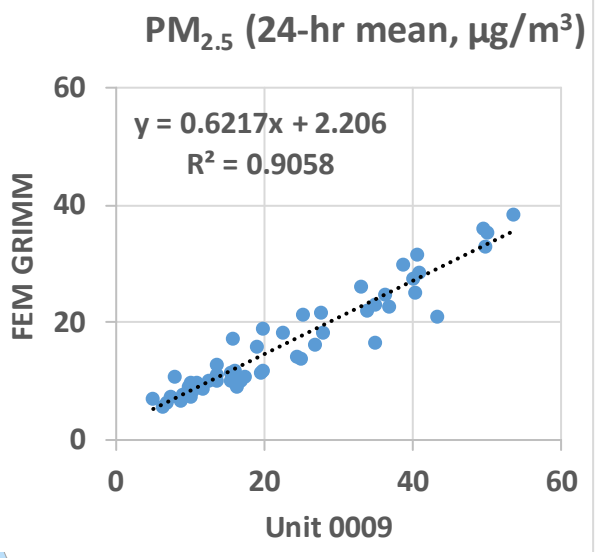


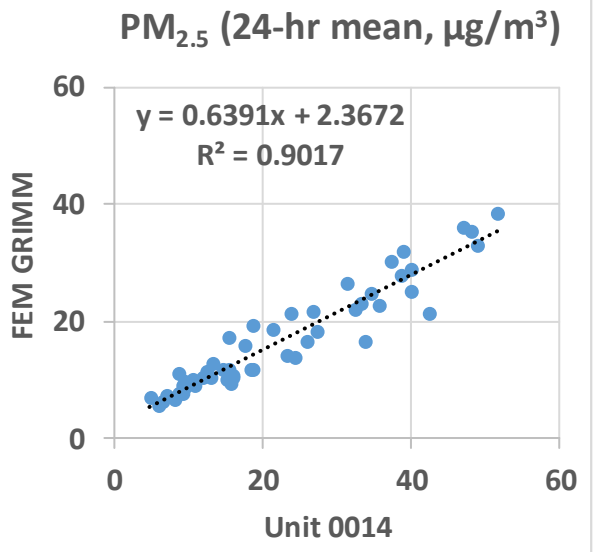


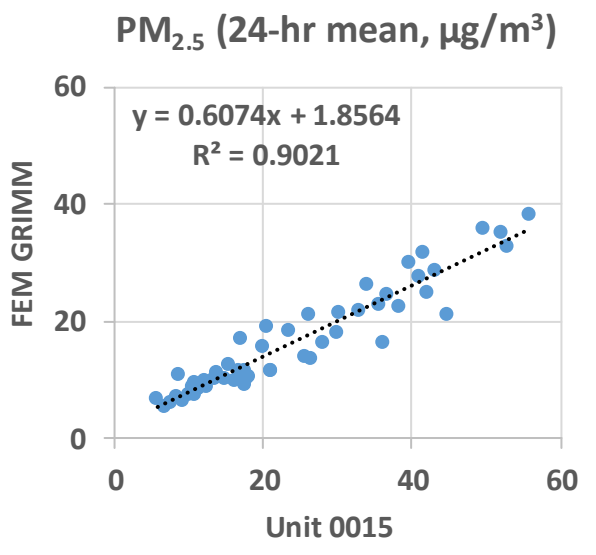
AS-LUNG Portable vs FEM GRIMM ($PM_{2.5}$; 24-hr mean)



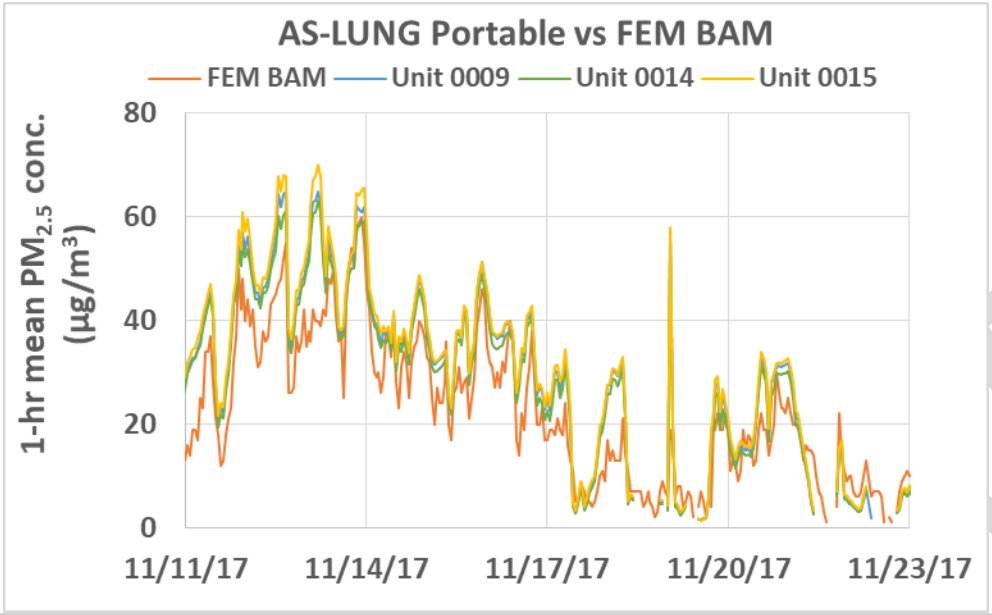
- AS-LUNG Portable $PM_{2.5}$ mass measurements correlate well with the corresponding FEM GRIMM data (R^2 > 0.90)
- Overall, the AS-LUNG Portable sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM GRIMM
- The AS-LUNG Portable sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM GRIMM



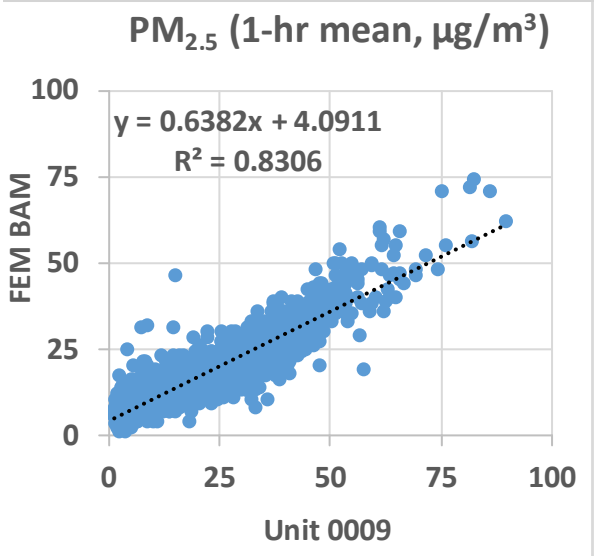


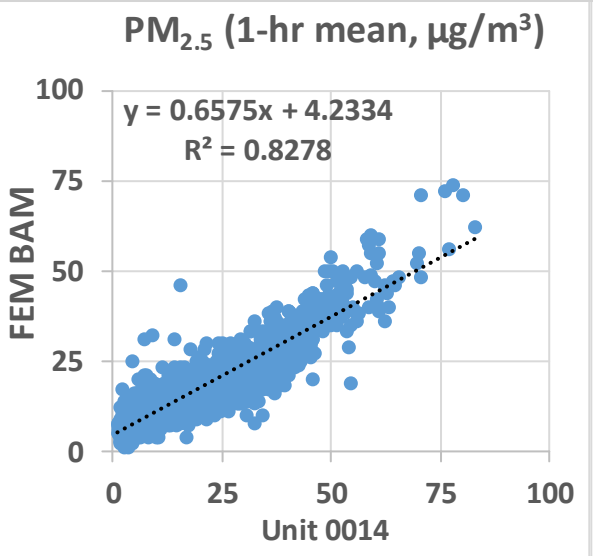


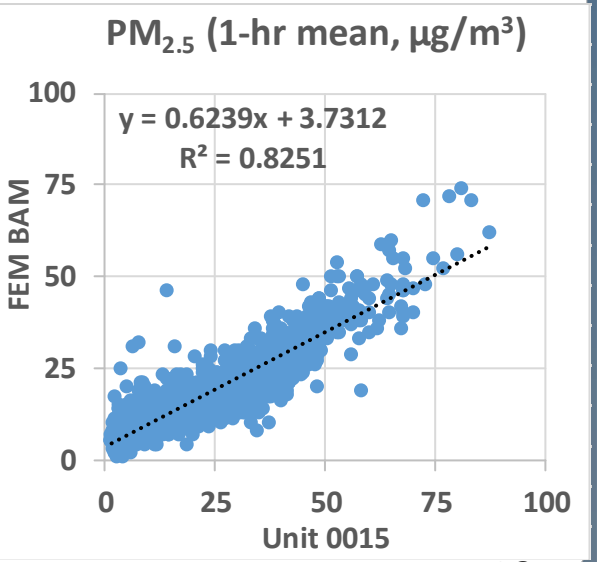
AS-LUNG Portable vs FEM BAM ($PM_{2.5}$; 1-hr mean)



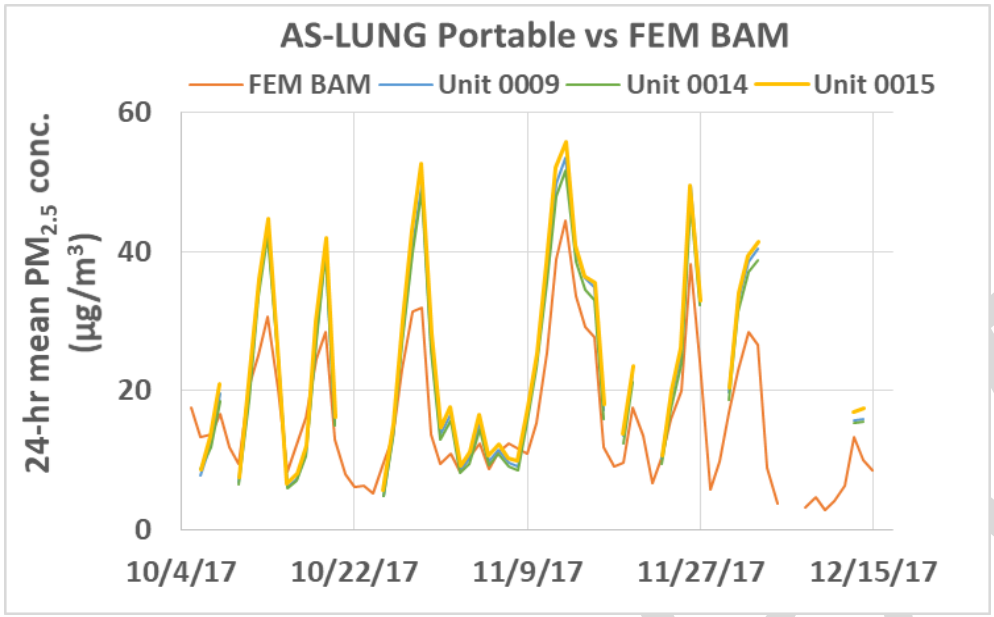
- AS-LUNG Portable $PM_{2.5}$ mass measurements show good correlations with the corresponding FEM BAM data ($R^2 > 0.82$)
- Overall, the AS-LUNG Portable sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM BAM
- The AS-LUNG sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM BAM



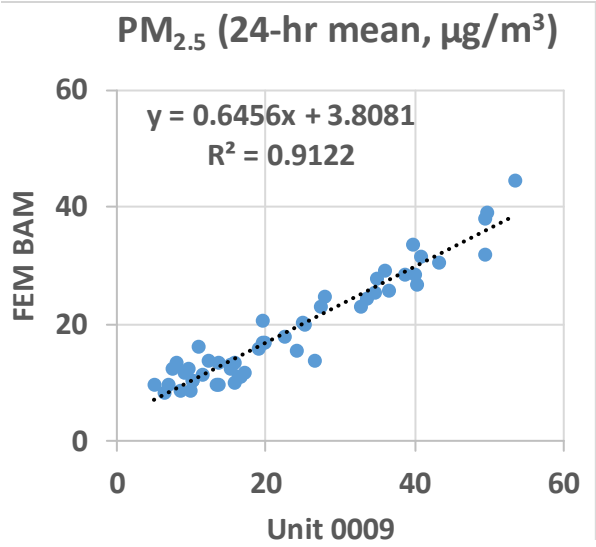


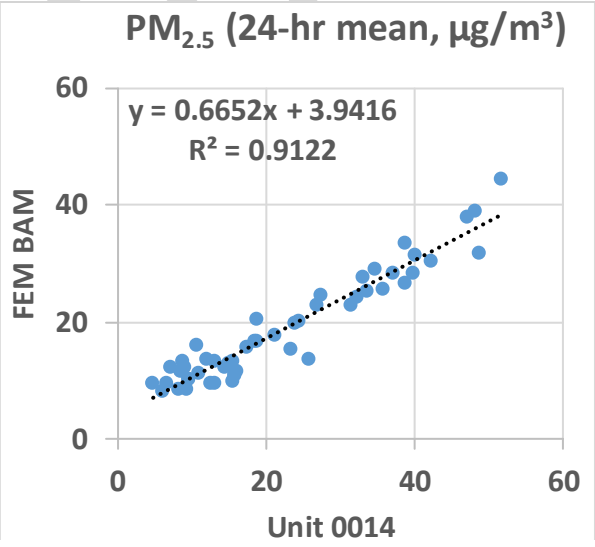


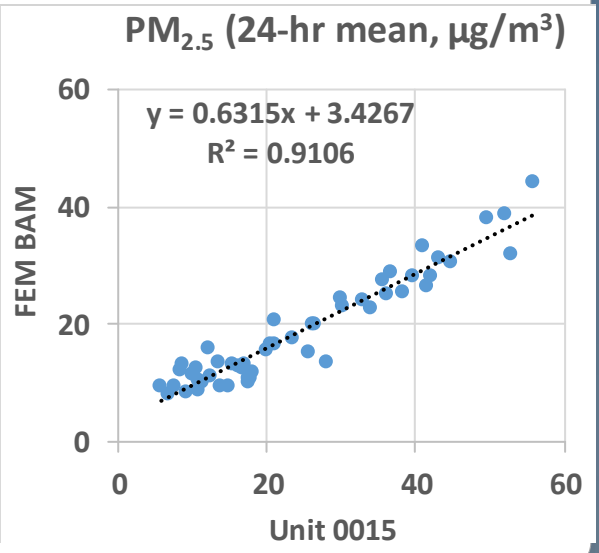
AS-LUNG Portable vs FEM BAM ($PM_{2.5}$; 24-hr mean)



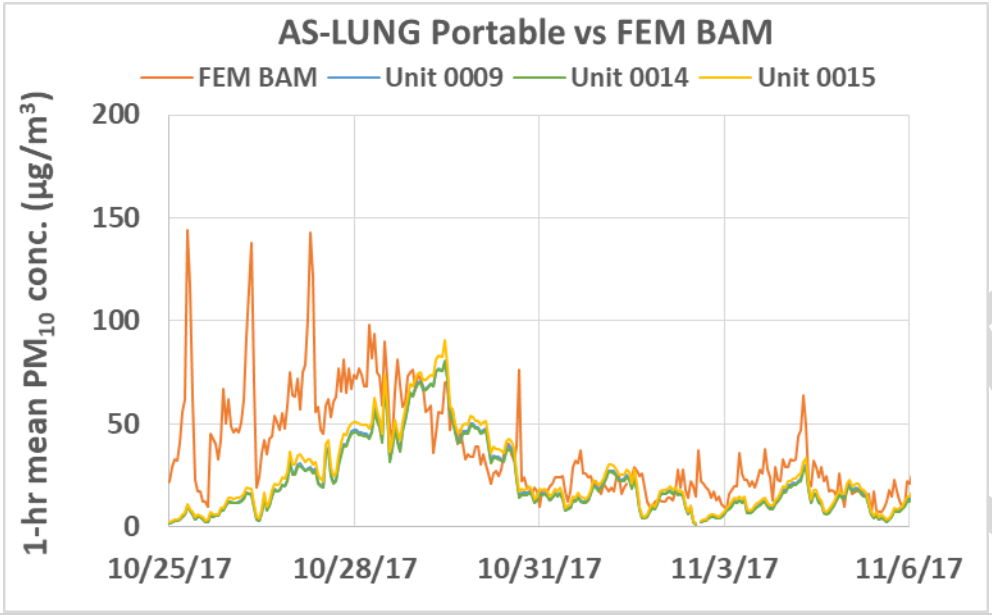
- AS-LUNG Portable $PM_{2.5}$ mass measurements correlate well with the corresponding FEM BAM data ($R^2 > 0.91$)
- Overall, the AS-LUNG Portable sensors overestimate $PM_{2.5}$ mass concentrations measured by FEM BAM
- The AS-LUNG Portable sensors track well the $PM_{2.5}$ diurnal variation recorded by FEM BAM



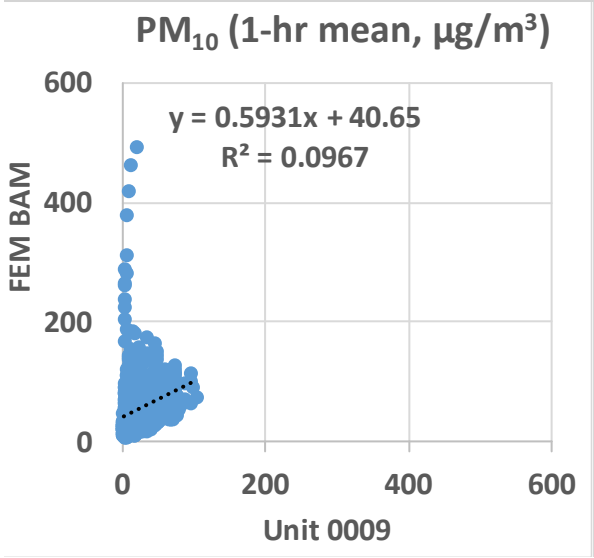


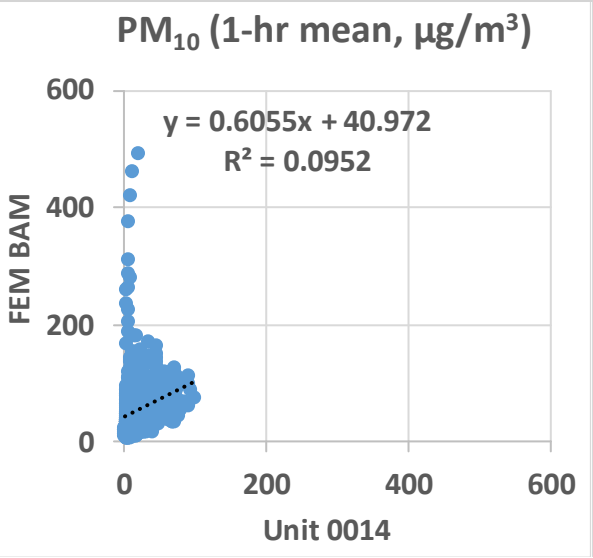


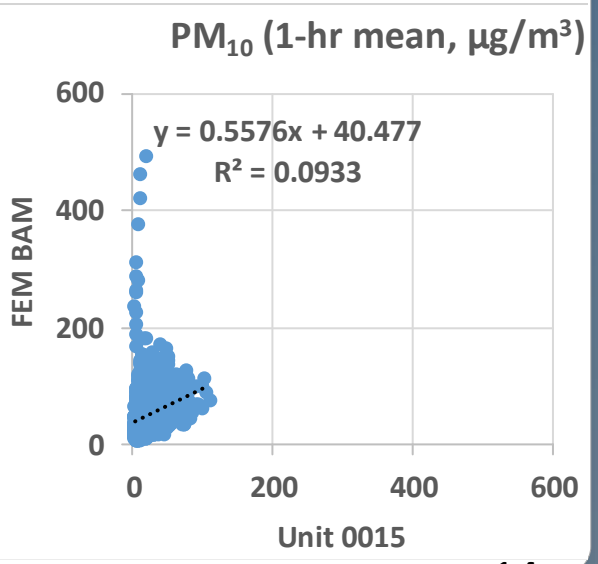
AS-LUNG Portable vs FEM BAM (PM_{10}; 1-hr mean)



- AS-LUNG Portable PM_{10} mass measurements do not correlate with the corresponding FEM BAM data ($0.09 < R^2 < 0.10$)
- Overall, the AS-LUNG Portable sensors overestimate PM_{10} mass concentrations measured by FEM BAM
- The AS-LUNG Portable sensors do not track well the PM_{10} diurnal variation recorded by FEM BAM







Discussion

- The three **AS-LUNG Portable** sensors had a data recovery of > 82% with low intra-model variability (6% to 8%)
- The equivalent methods (GRIMM and BAM) correlate well with each other for both $PM_{2.5}$ (R^2 > 0.81) and PM_{10} (R^2 > 0.83) mass concentration measurements (1-hr mean)
- PM_1 mass concentration measurements measured by AS-LUNG Portable correlate well with the corresponding GRIMM values (R^2 > 0.88, 1-hr mean) and overestimate PM_1 mass concentration measurements measured by GRIMM
- $PM_{2.5}$ mass concentration measurements measured by AS-LUNG Portable correlate well with the corresponding FEM GRIMM and FEM BAM (0.79 < R^2 <0.83), 1-hr mean) and overestimate $PM_{2.5}$ mass concentration measurements measured by FEM GRIMM and FEM BAM
- PM_{10} mass concentration measurements measured by AS-LUNG Portable do not correlate with the corresponding FEM BAM (R^2 < 0.11, 1-hr mean) and GRIMM values (R^2 < 0.11,1-hr mean) and overestimate PM_{10} mass concentration measurements measured by the FEM BAM and GRIMM
- 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