

Field Evaluation MagnaSCI SRL uRADMonitor SMOGGIE-PM v1.101



Background

- From 04/17/2020 to 06/27/2020¹, three **MagnaSCI SRL uRADMonitor SMOGGIE-PM v1.101 (hereinafter uRADMonitor SMOGGIE)** 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) instruments measuring the same pollutants
- uRADMonitor SMOGGIE (3 units tested):
 - PM Sensor – Optical Particle Counter (**Plantower PMSA003, non-FEM**)
 - Each unit measures: PM_{1.0}, PM_{2.5} and PM₁₀ (µg/m³), T (°C), RH (%)
 - **Unit cost: \$110**
 - Time resolution: 1-min
 - Units IDs: 0032, 0033, 0034
- South Coast AQMD Reference Instruments:
 - GRIMM (**FEM PM_{2.5}**); **cost: \$25,000 and up**
 - Time resolution: 1-min
 - Teledyne API T640 (**FEM PM_{2.5}**); **cost: \$21,000**
 - Time resolution: 1-min
 - Met station (T, RH, P, WS, WD); **cost: ~\$5,000**
 - Time resolution: 1-min

¹Note: sensor data were not available between 6/4/2020 and 6/11/2020 due to preventive maintenance activities at the monitoring site

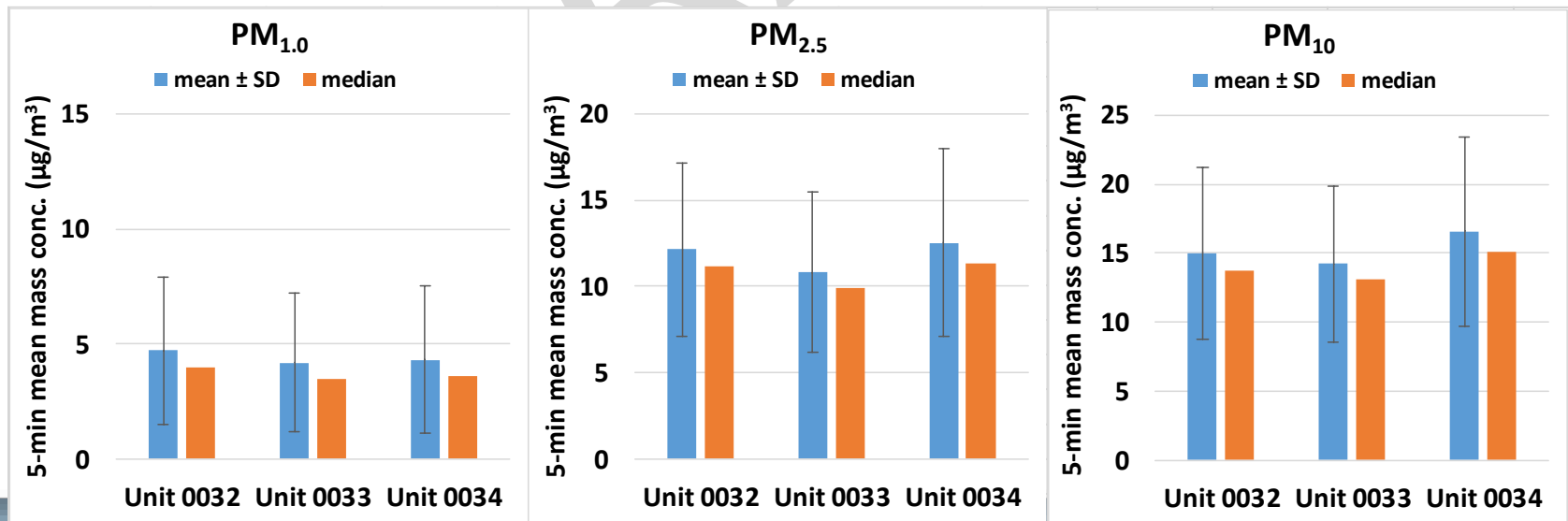


Data Validation & Recovery

- 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 0032, Unit 0033, and Unit 0034 was ~ 78%, 98%, and 96%, respectively for PM_{1.0}, PM_{2.5}, and PM₁₀ measurements

uRADMonitor SMOGGIE; Intra-model Variability

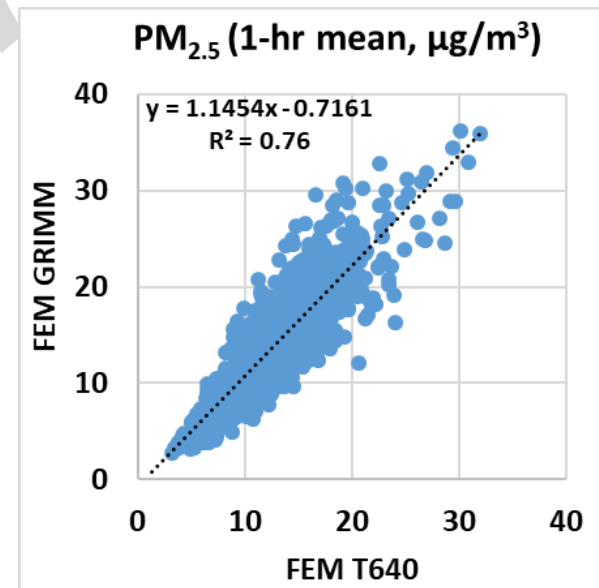
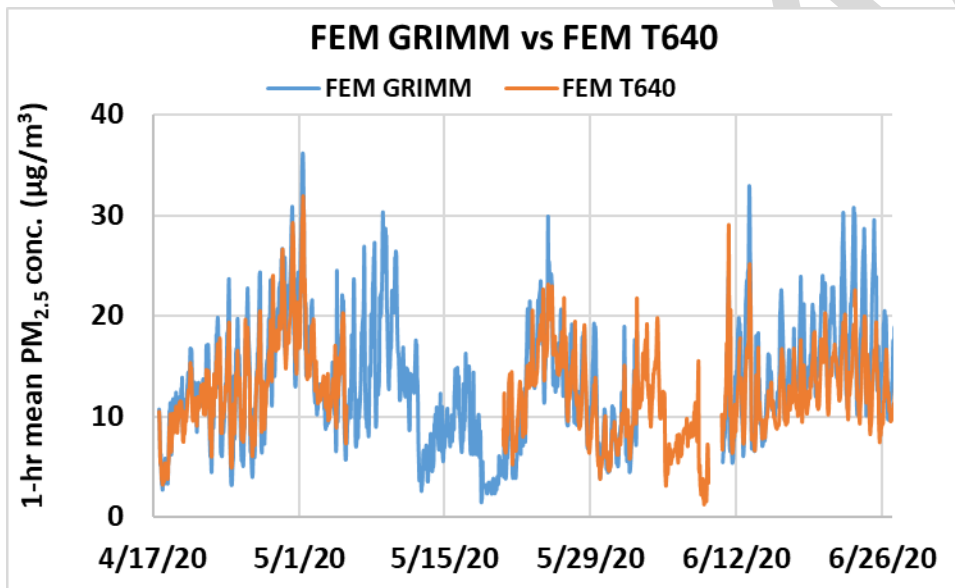
- Absolute intra-model variability was ~ 0.23, 0.73, and 0.99 $\mu\text{g}/\text{m}^3$ for the PM_{1.0}, PM_{2.5}, and PM₁₀ measurements, respectively (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 5.2, 6.2, and 6.5% for the PM_{1.0}, PM_{2.5}, and PM₁₀ measurements, respectively (calculated as the absolute intra-model variability relative to the mean of the three sensor means)



Reference Instruments: PM_{2.5}

FEM GRIMM & FEM T640

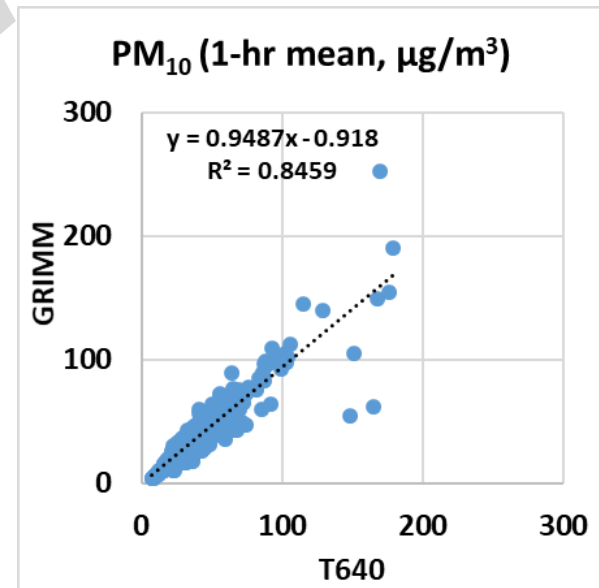
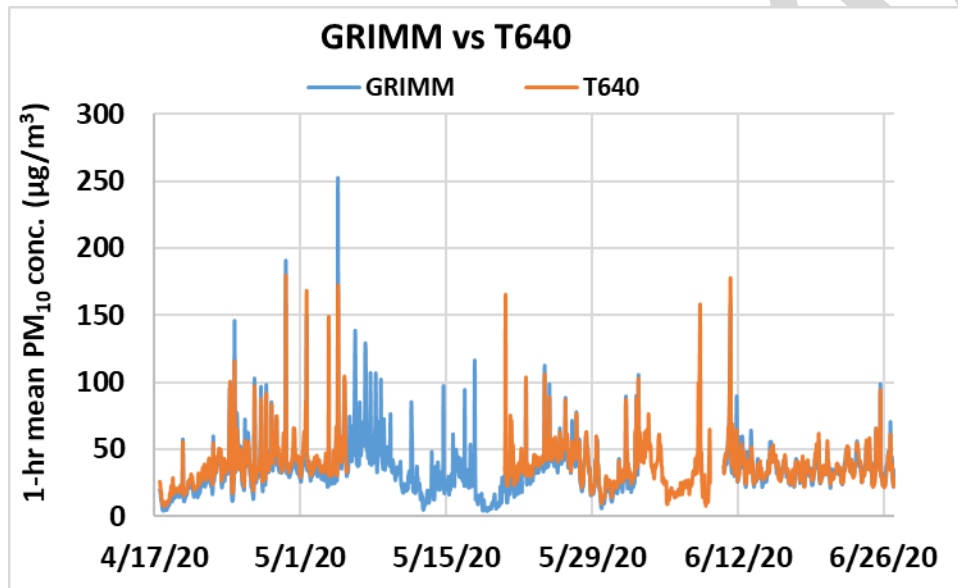
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for PM_{2.5} from FEM GRIMM and FEM T640 is ~88% and 77%, respectively
- Strong correlations between FEM GRIMM and FEM T640 for PM_{2.5} measurements ($R^2 \sim 0.76$)



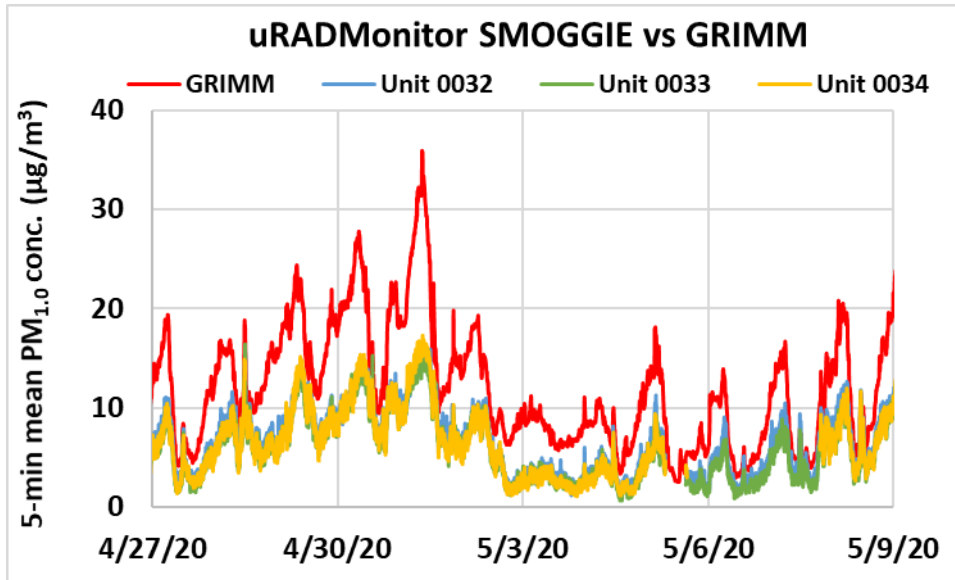
Reference Instruments: PM₁₀

GRIMM & T640

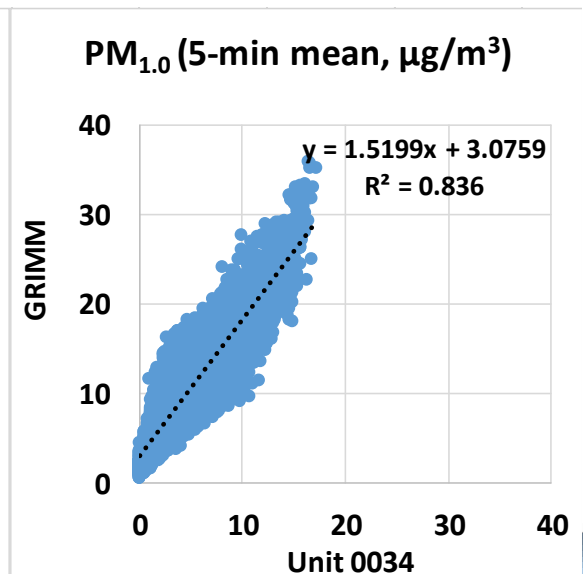
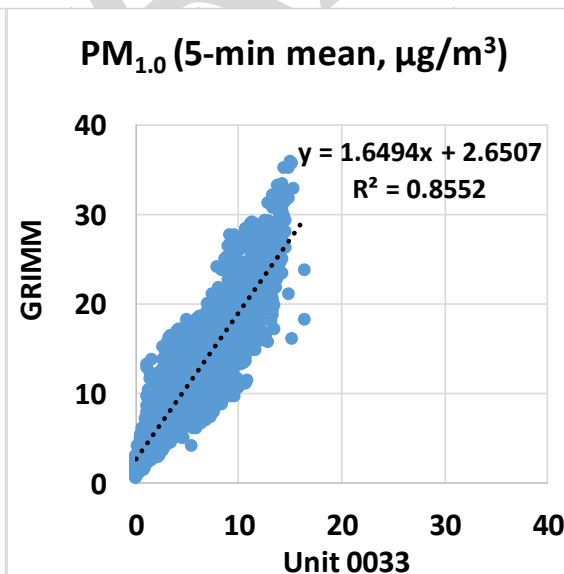
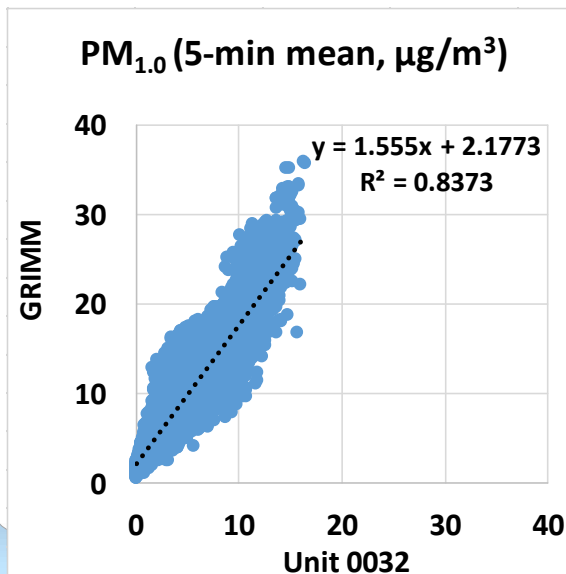
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM₁₀ from GRIMM and T640 is ~88% and 77%, respectively
- Strong correlations between GRIMM and T640 for PM₁₀ measurements ($R^2 \sim 0.85$)



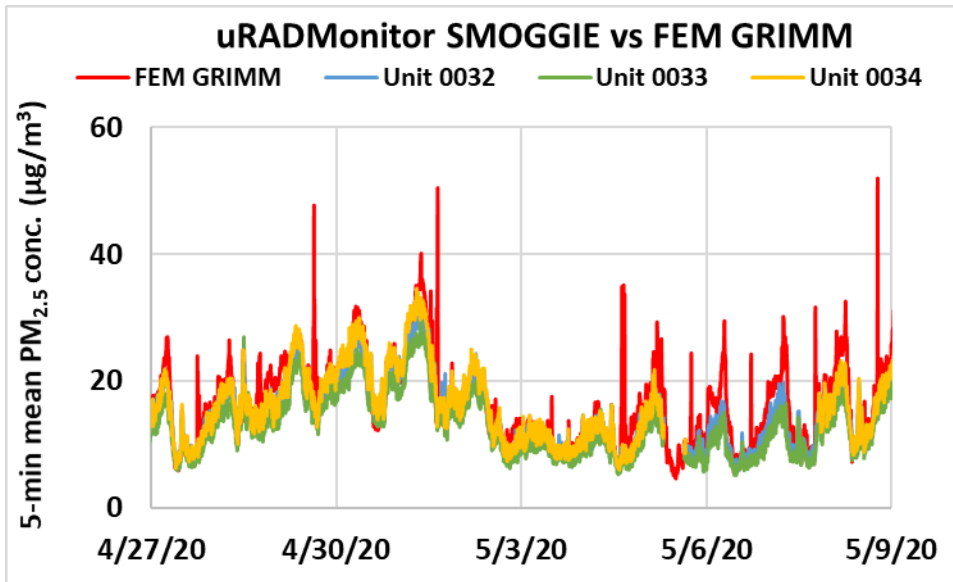
uRADMonitor SMOGGIE vs GRIMM (PM_{1.0}; 5-min mean)



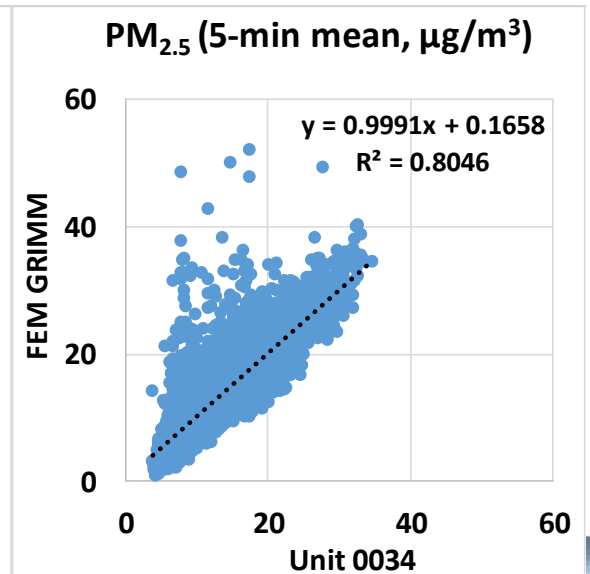
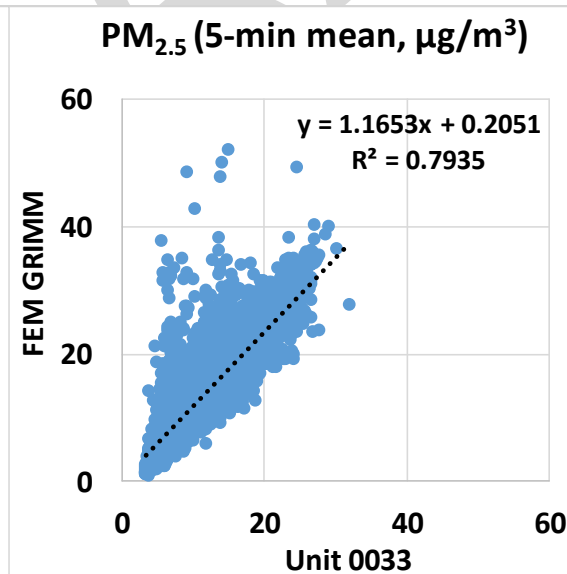
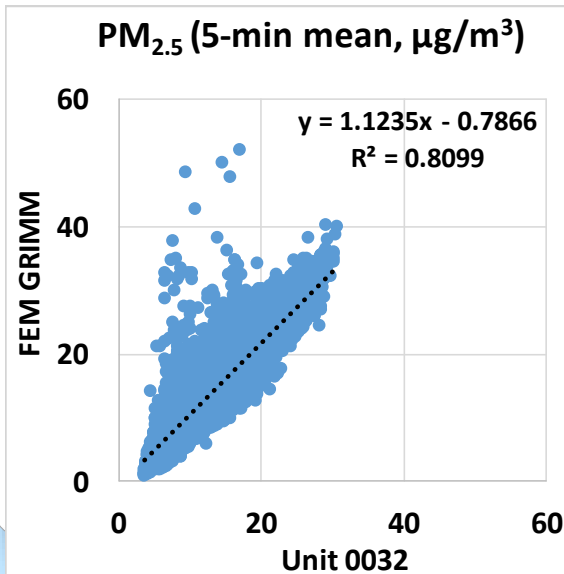
- The uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding GRIMM data ($R^2 \sim 0.84$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{1.0} mass concentrations as measured by the GRIMM
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{1.0} variations as recorded by the GRIMM



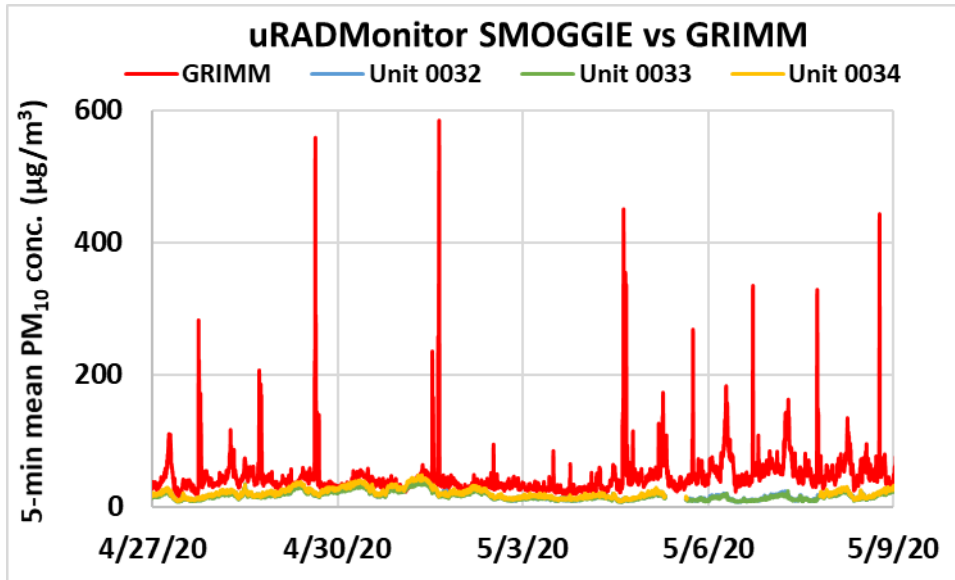
uRADMonitor SMOGGIE vs FEM GRIMM (PM_{2.5}; 5-min mean)



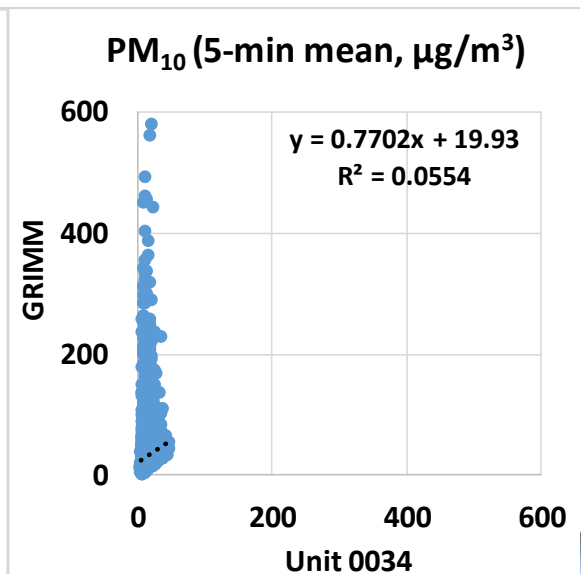
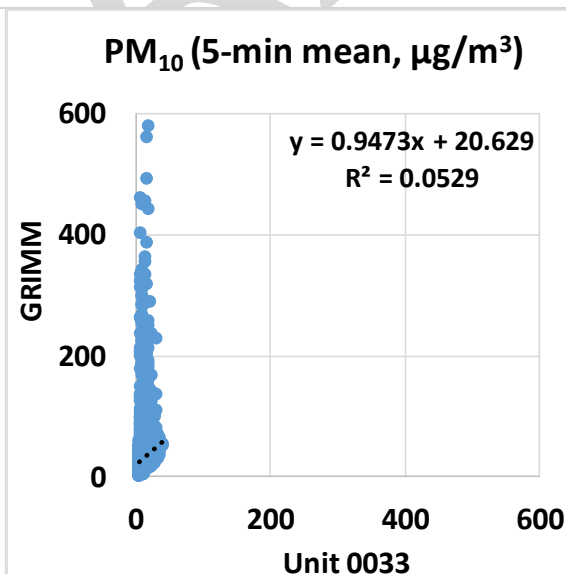
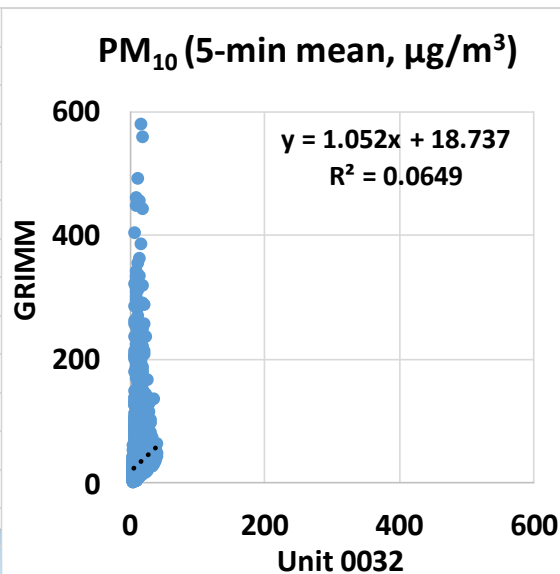
- The uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding FEM GRIMM data ($R^2 \sim 0.80$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{2.5} mass concentrations as measured by the FEM GRIMM
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{2.5} variations as recorded by the FEM GRIMM



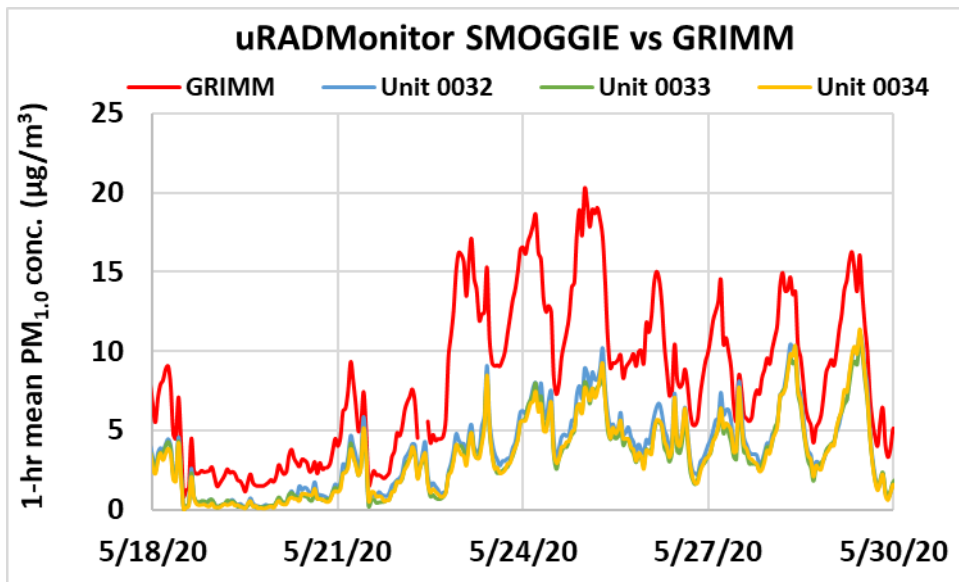
uRADMonitor SMOGGIE vs GRIMM (PM₁₀; 5-min mean)



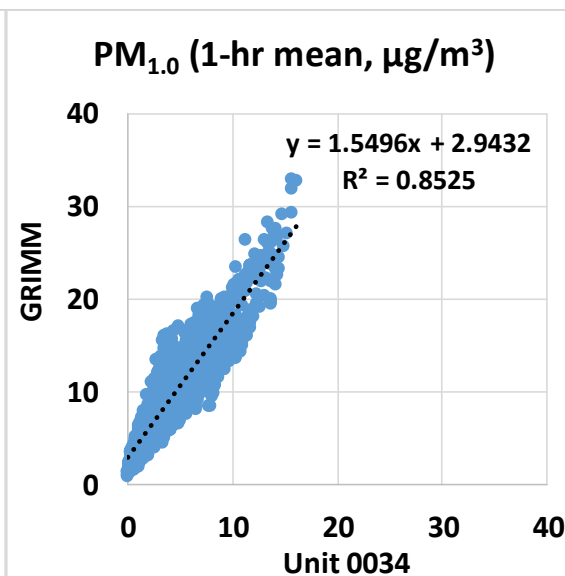
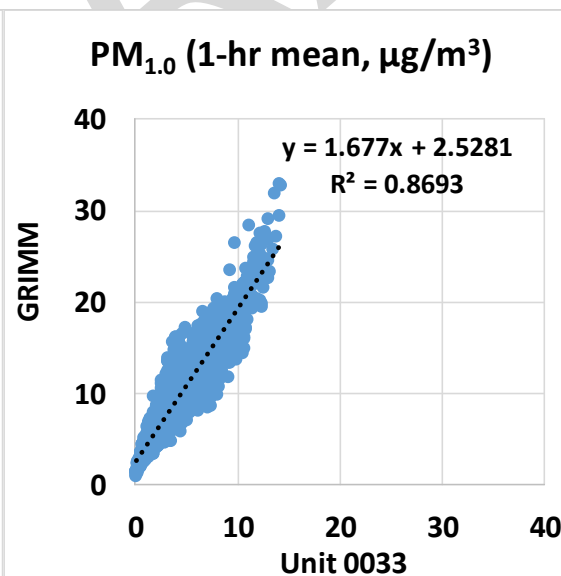
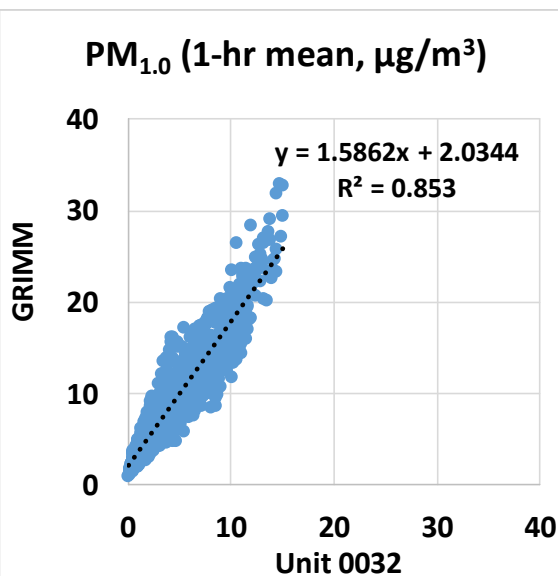
- The uRADMonitor SMOGGIE sensors did not correlate with the corresponding GRIMM data ($R^2 \sim 0.06$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM₁₀ mass concentrations as measured by the GRIMM
- The uRADMonitor SMOGGIE sensors did not seem to track the diurnal PM₁₀ variations as recorded by the GRIMM



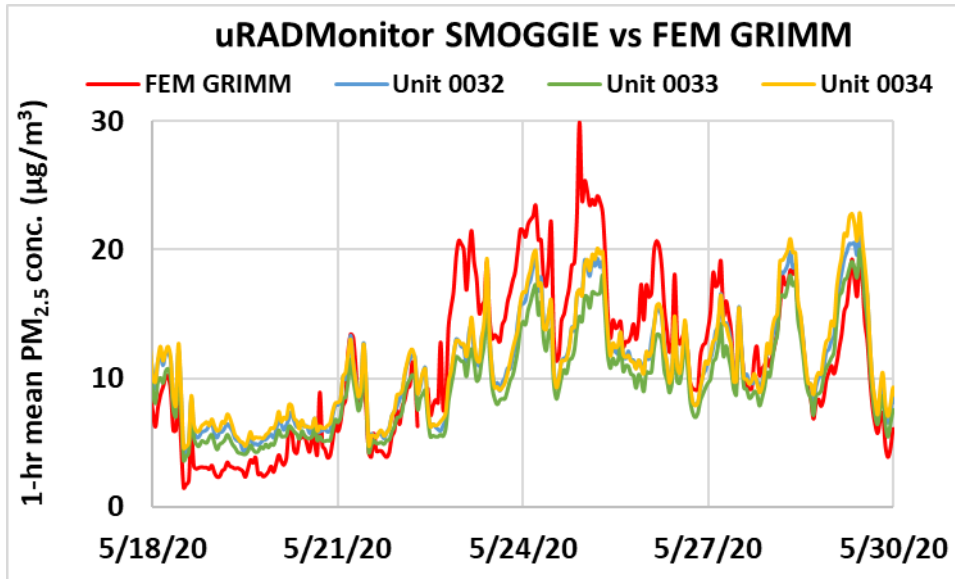
uRADMonitor SMOGGIE vs GRIMM (PM_{1.0}; 1-hr mean)



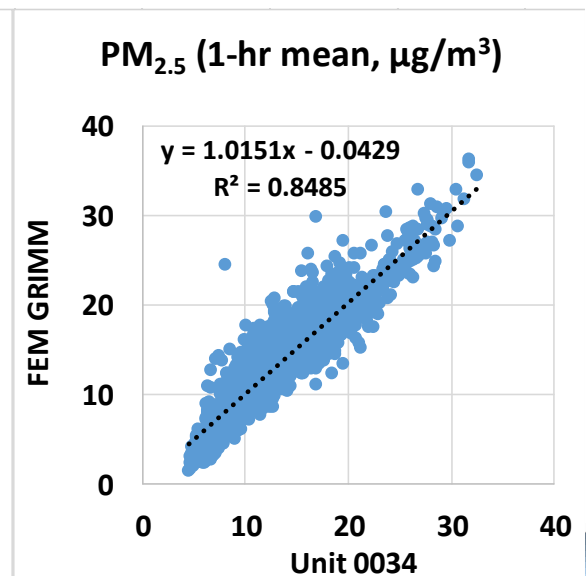
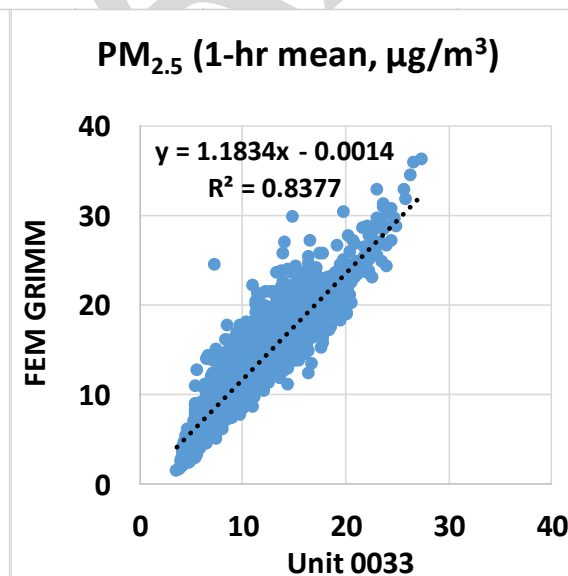
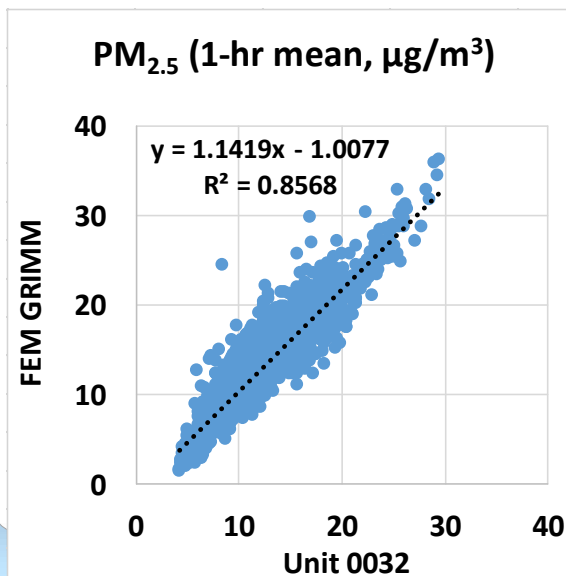
- The uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding GRIMM data ($R^2 \sim 0.86$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{1.0} mass concentrations as measured by the GRIMM
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{1.0} variations as recorded by the GRIMM



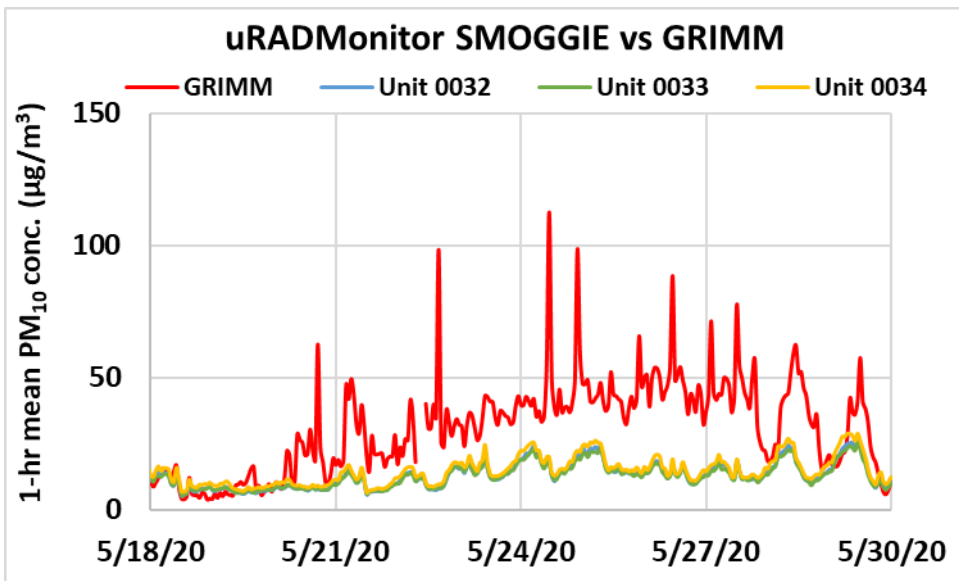
uRADMonitor SMOGGIE vs FEM GRIMM (PM_{2.5}; 1-hr mean)



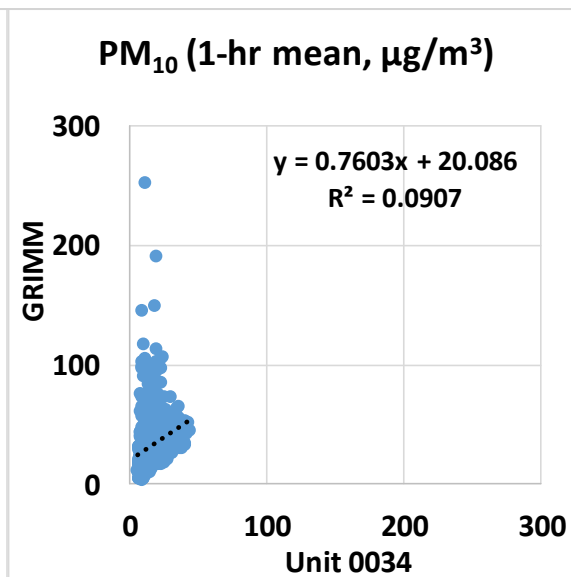
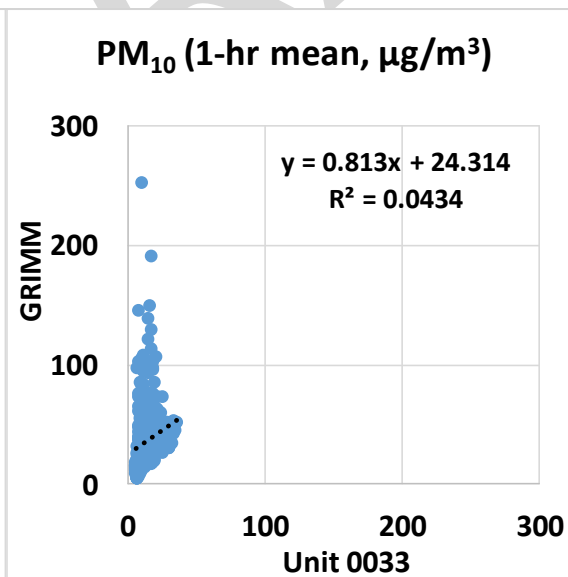
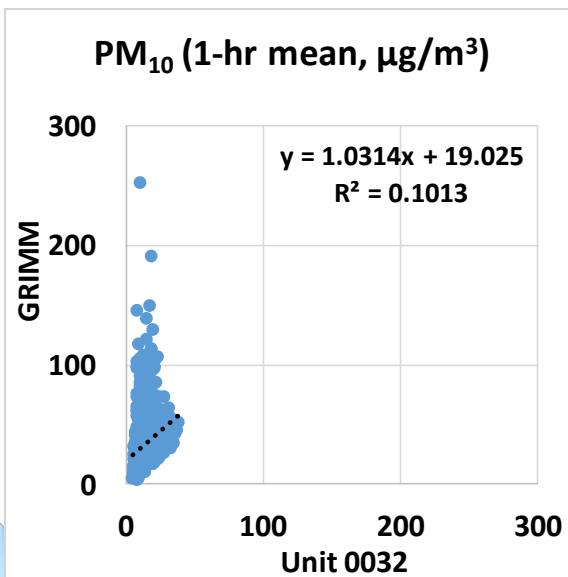
- The uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding FEM GRIMM data ($R^2 \sim 0.85$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{2.5} mass concentrations as measured by the FEM GRIMM
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{2.5} variations as recorded by the FEM GRIMM



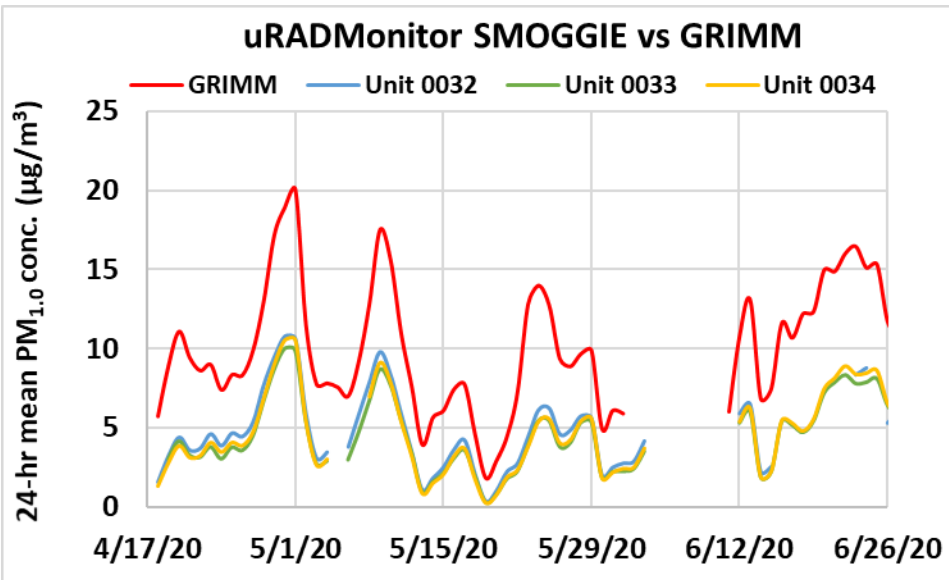
uRADMonitor SMOGGIE vs GRIMM (PM₁₀; 1-hr mean)



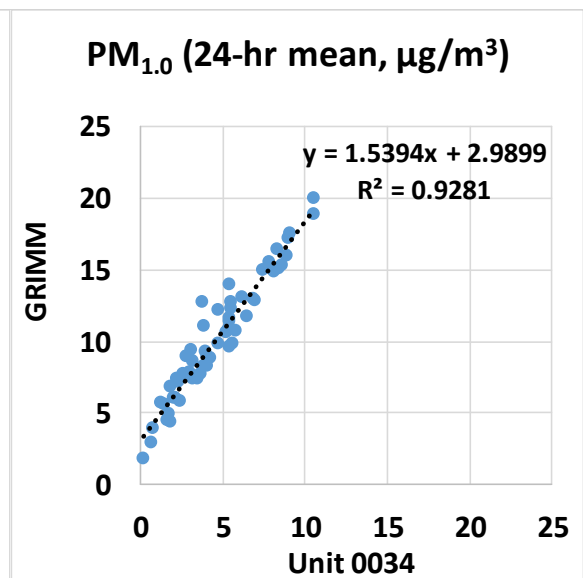
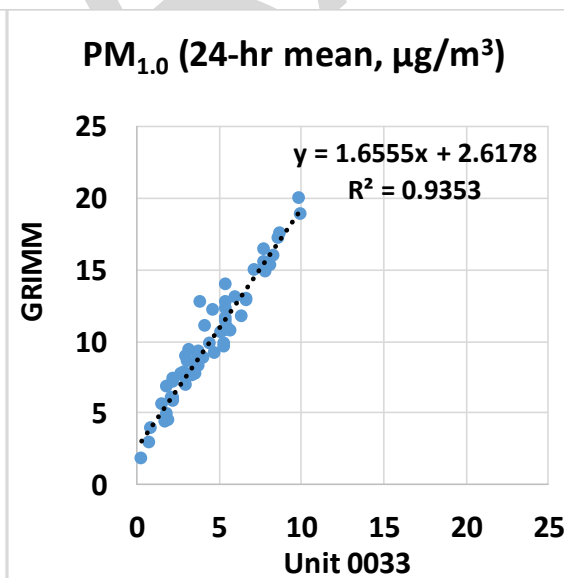
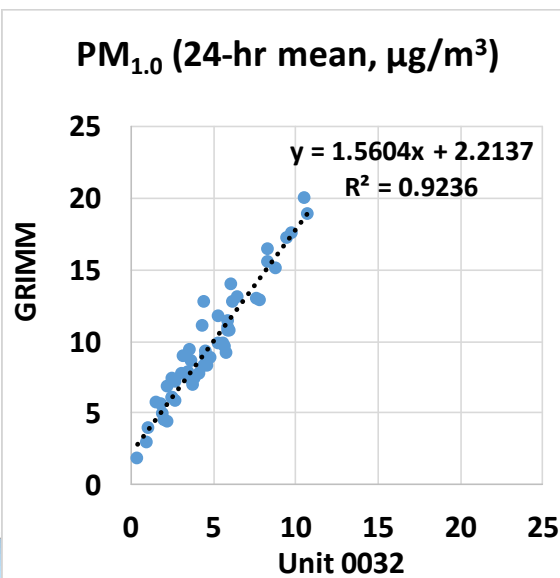
- The uRADMonitor SMOGGIE sensors showed no to very weak correlations with the corresponding GRIMM data ($0.04 < R^2 < 0.11$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM₁₀ mass concentration as measured by the GRIMM
- The uRADMonitor SMOGGIE sensors did not seem to track the diurnal PM₁₀ variations as recorded by the GRIMM



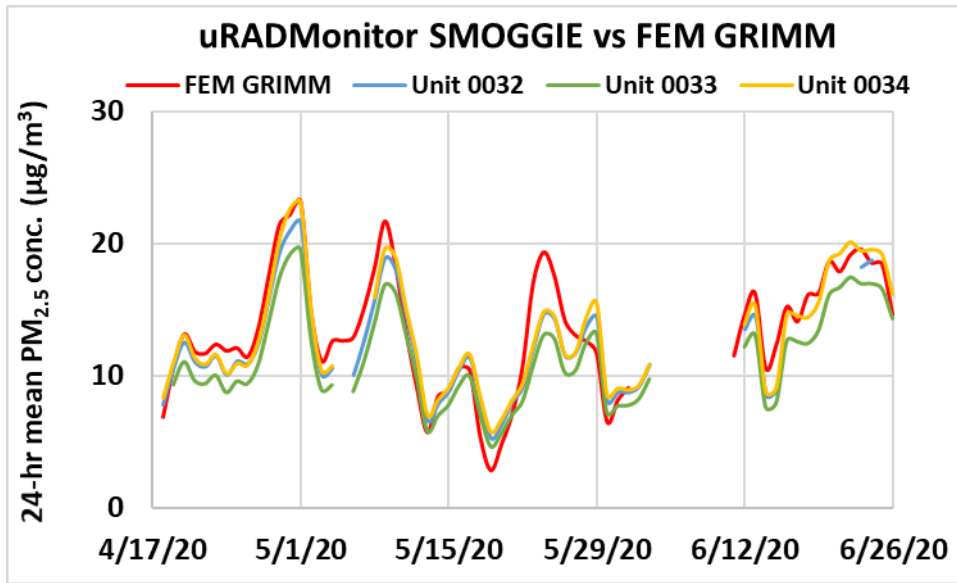
uRADMonitor SMOGGIE vs GRIMM (PM_{1.0}; 24-hr mean)



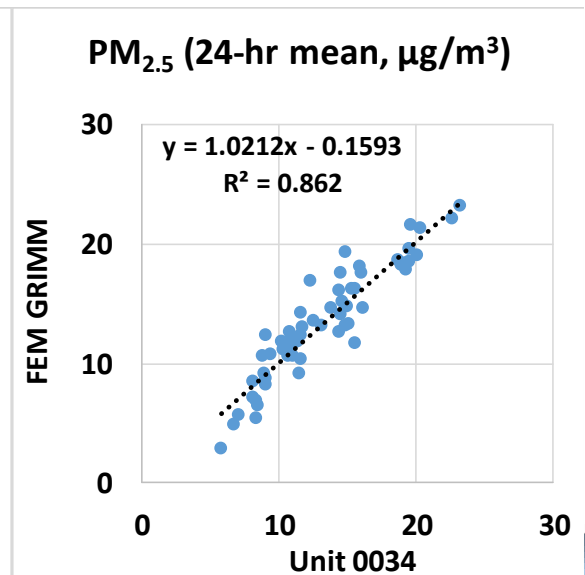
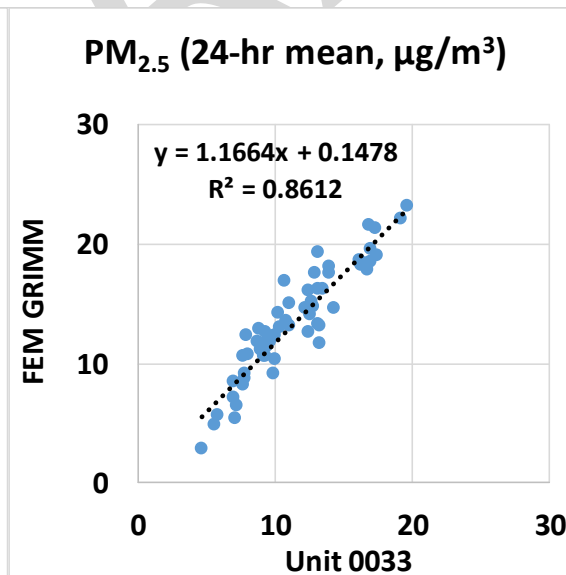
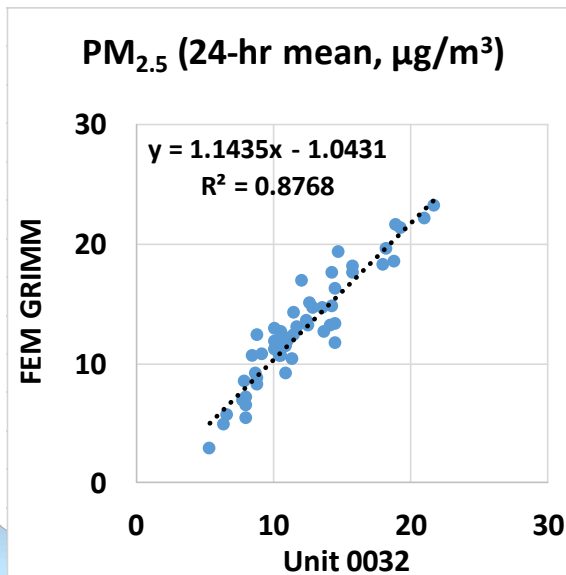
- The uRADMonitor SMOGGIE sensors showed very strong correlations with the corresponding GRIMM data ($R^2 \sim 0.93$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{1.0} mass concentrations as measured by the GRIMM
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{1.0} variations as recorded by the GRIMM



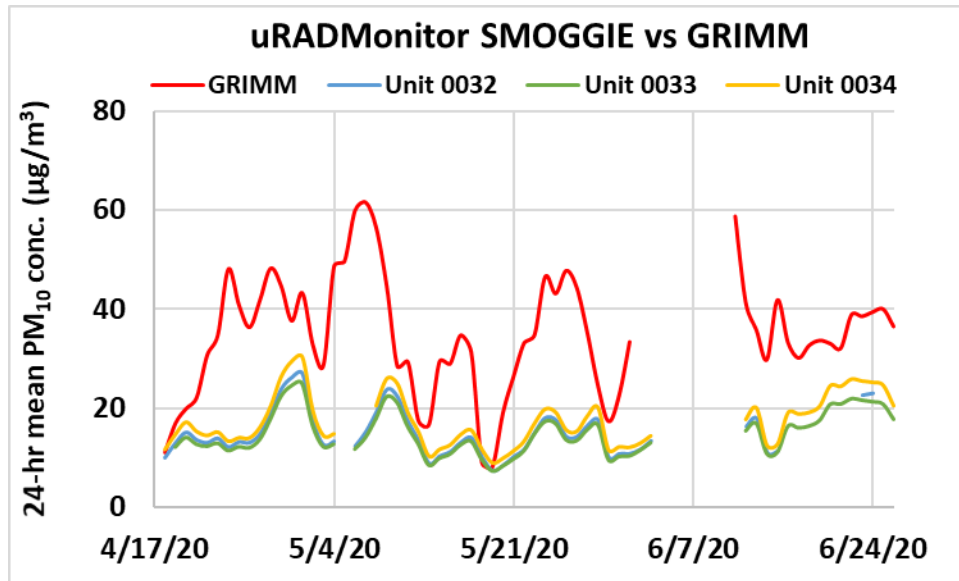
uRADMonitor SMOGGIE vs FEM GRIMM (PM_{2.5}; 24-hr mean)



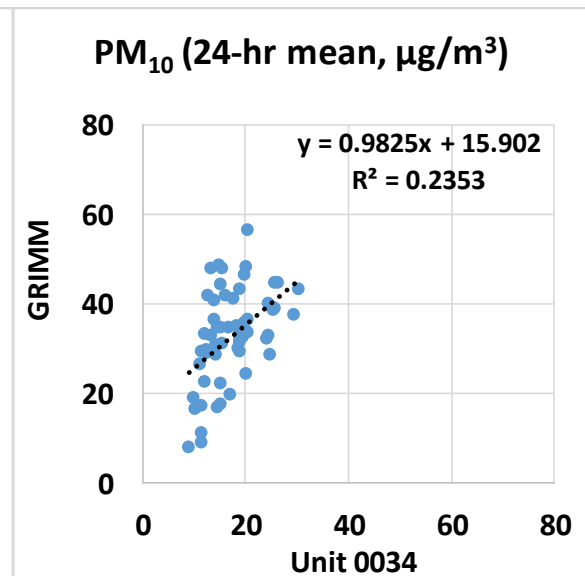
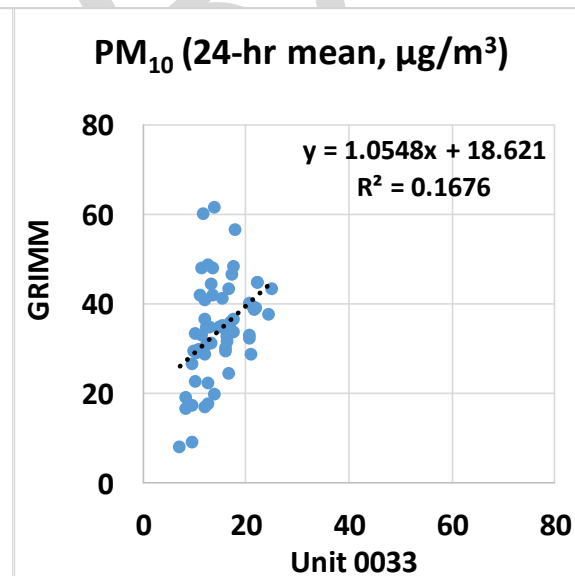
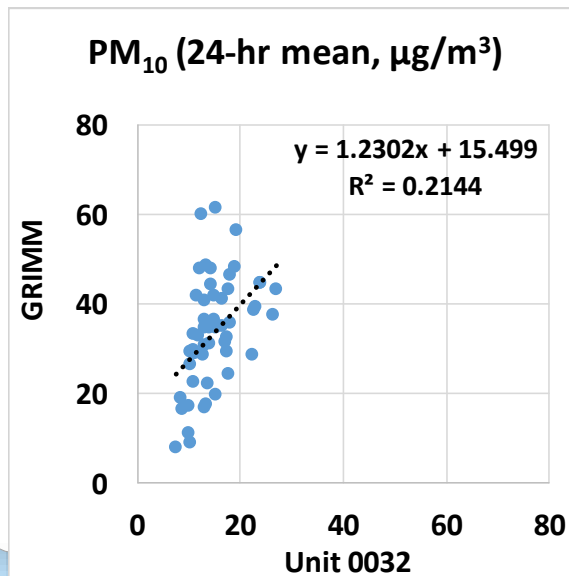
- The uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding FEM GRIMM data ($R^2 \sim 0.87$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{2.5} mass concentrations as measured by the FEM GRIMM
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{2.5} variations as recorded by the FEM GRIMM



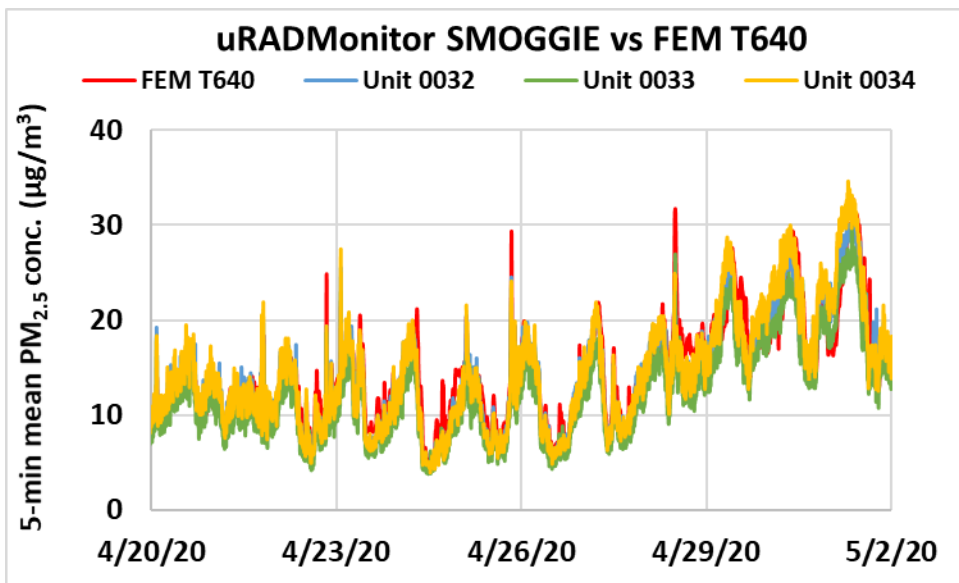
uRADMonitor SMOGGIE vs GRIMM (PM₁₀; 24-hr mean)



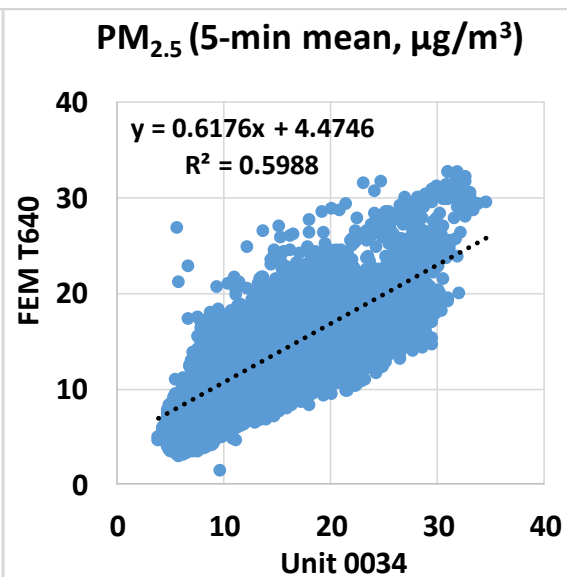
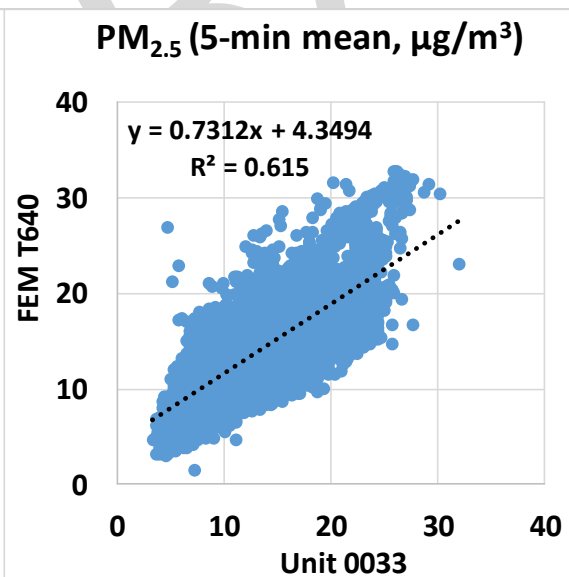
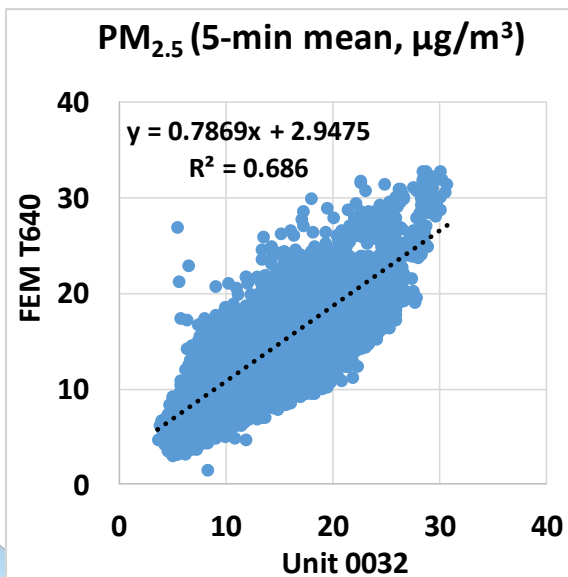
- The uRADMonitor SMOGGIE sensors showed very weak correlations with the corresponding GRIMM data ($R^2 \sim 0.21$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM₁₀ mass concentration as measured by the GRIMM
- The uRADMonitor SMOGGIE sensors did not seem to track the diurnal PM₁₀ variations as recorded by the GRIMM



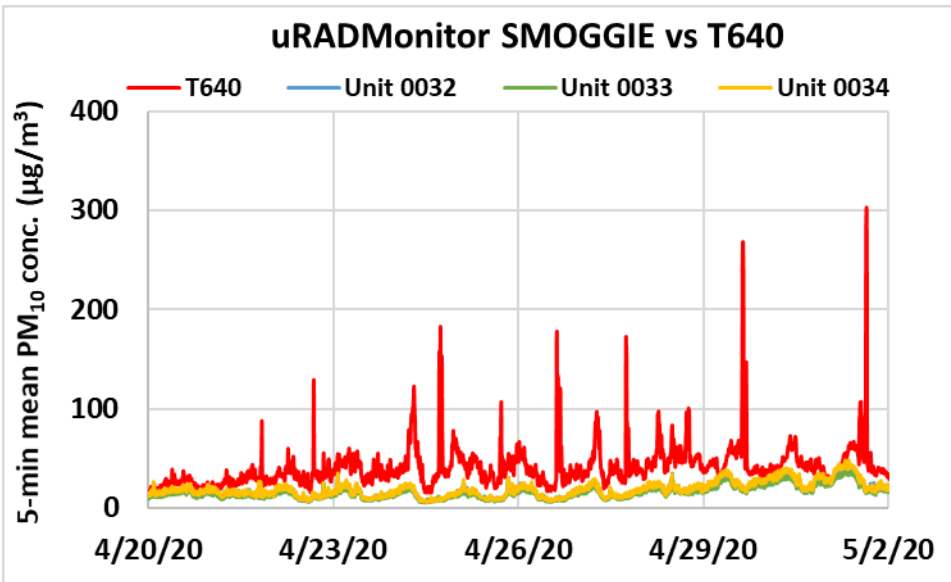
uRADMonitor SMOGGIE vs FEM T640 (PM_{2.5}; 5-min mean)



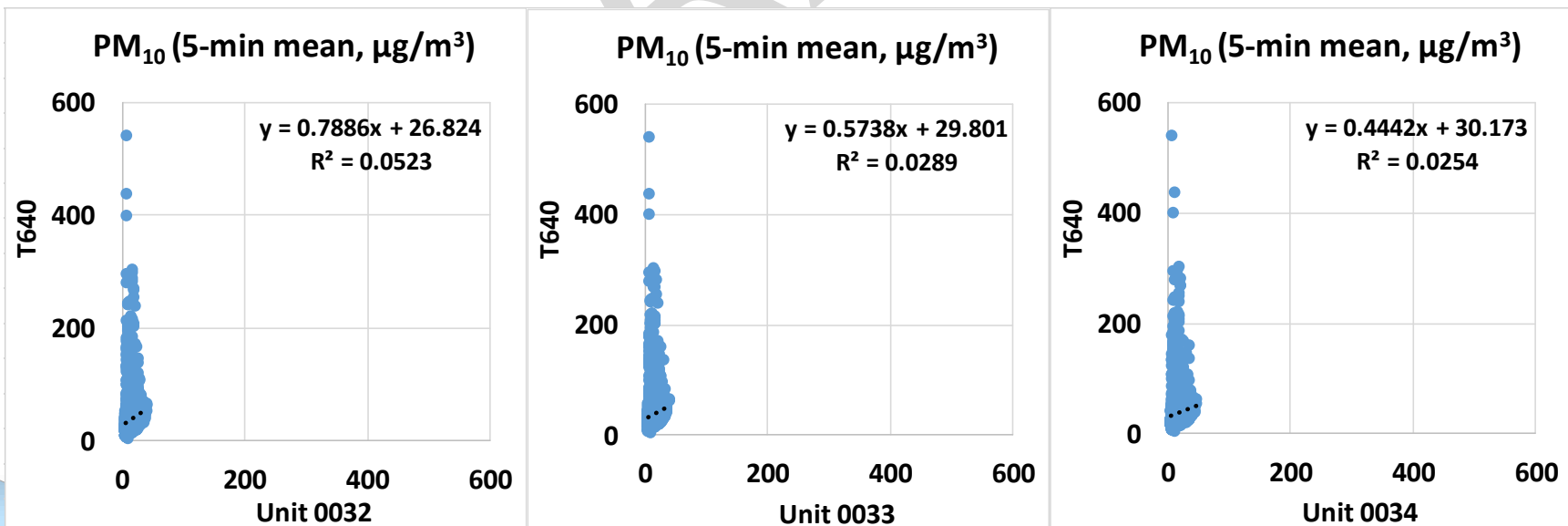
- The uRADMonitor SMOGGIE sensors showed moderate correlations with the corresponding FEM T640 data ($R^2 \sim 0.63$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{2.5} mass concentration as measured by the FEM T640
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{2.5} variations as recorded by the FEM T640



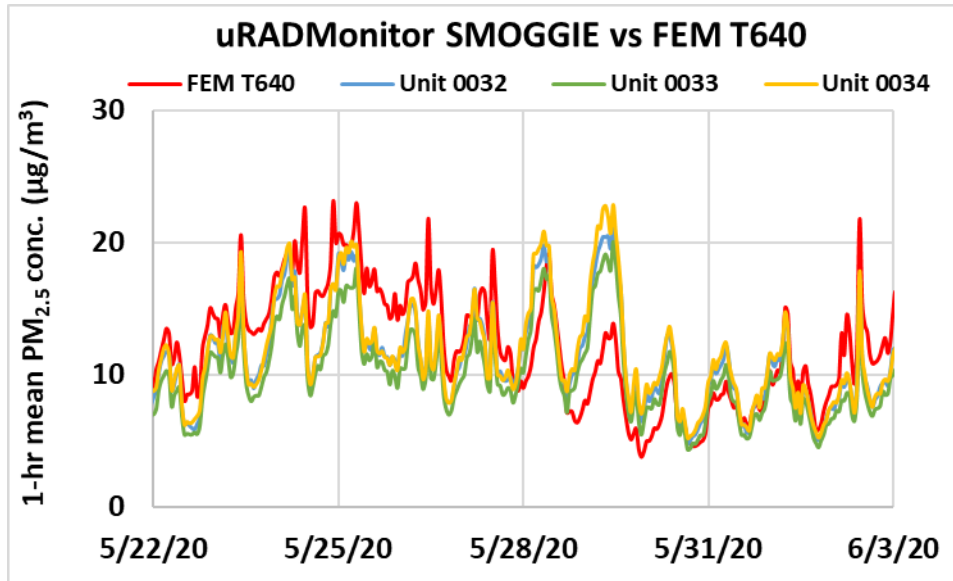
uRADMonitor SMOGGIE vs T640 (PM₁₀; 5-min mean)



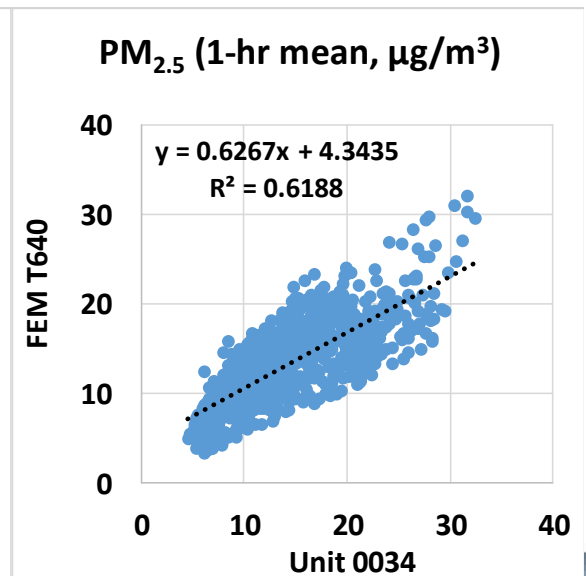
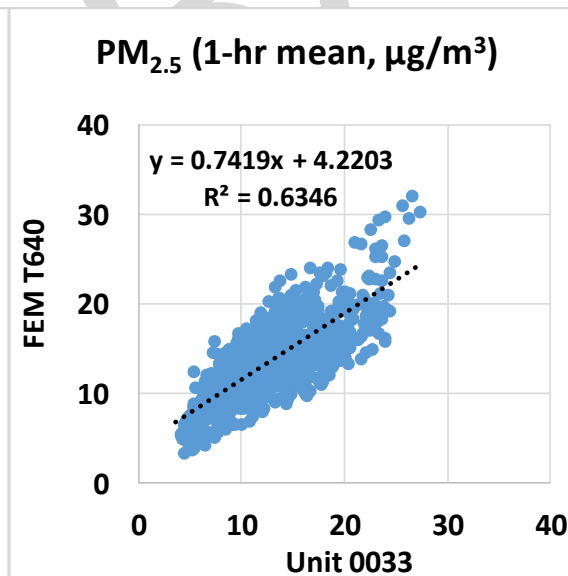
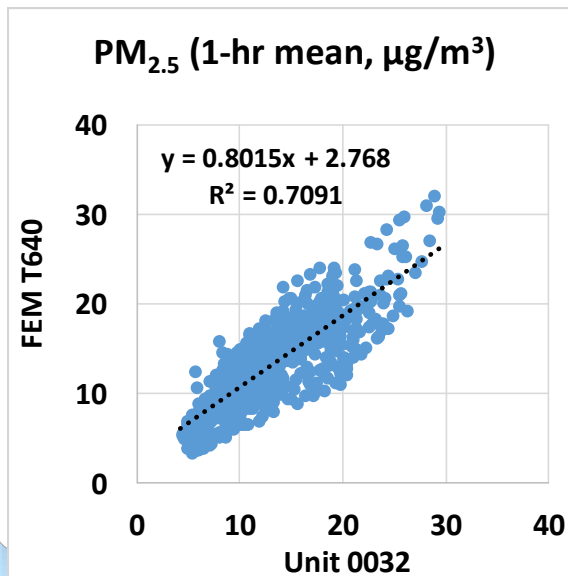
- The uRADMonitor SMOGGIE sensors did not correlate with the corresponding T640 data ($R^2 \sim 0.04$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM₁₀ mass concentration as measured by the T640
- The uRADMonitor SMOGGIE sensors did not seem to track the diurnal PM₁₀ variations as recorded by the T640



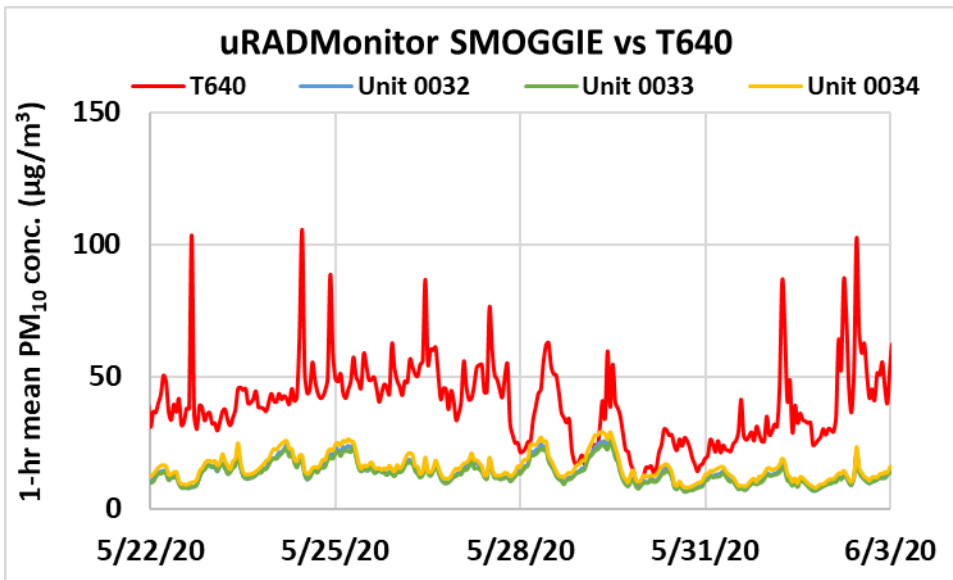
uRADMonitor SMOGGIE vs FEM T640 (PM_{2.5}; 1-hr mean)



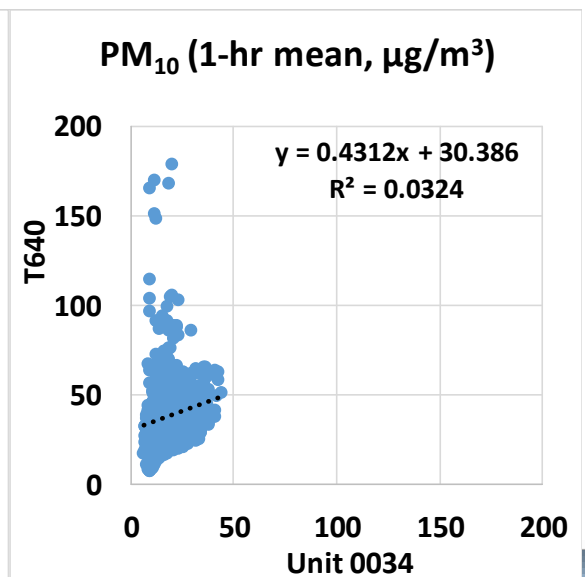
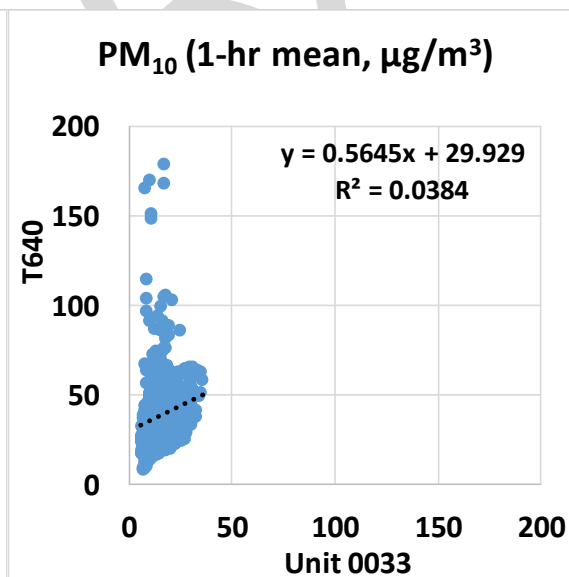
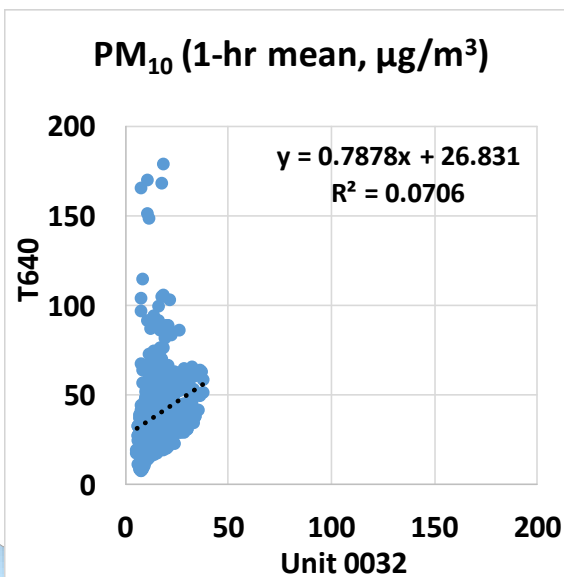
- The uRADMonitor SMOGGIE sensors showed moderate to strong correlations with the corresponding FEM T640 data ($0.61 < R^2 < 0.71$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{2.5} mass concentration as measured by the FEM T640
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{2.5} variations as recorded by the FEM T640



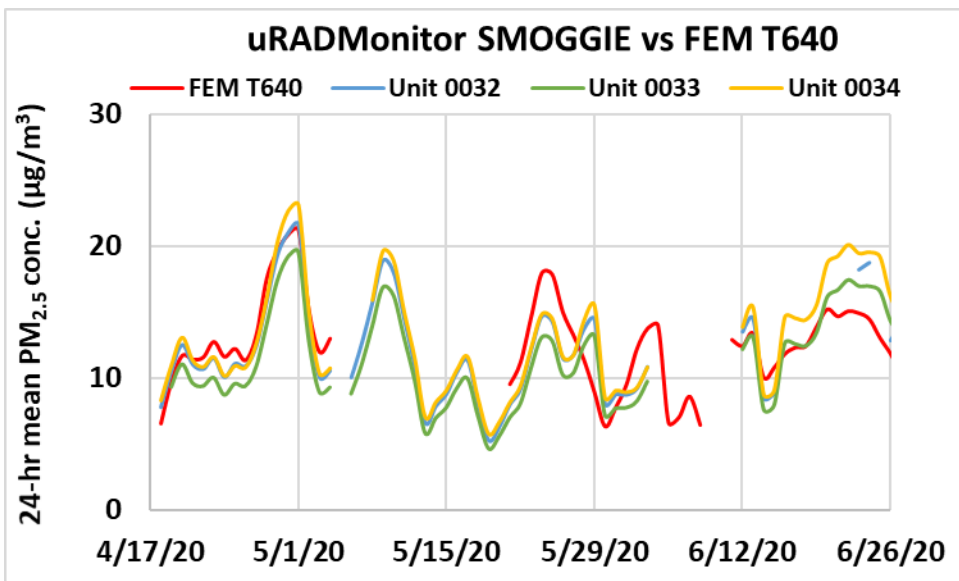
uRADMonitor SMOGGIE vs T640 (PM₁₀; 1-hr mean)



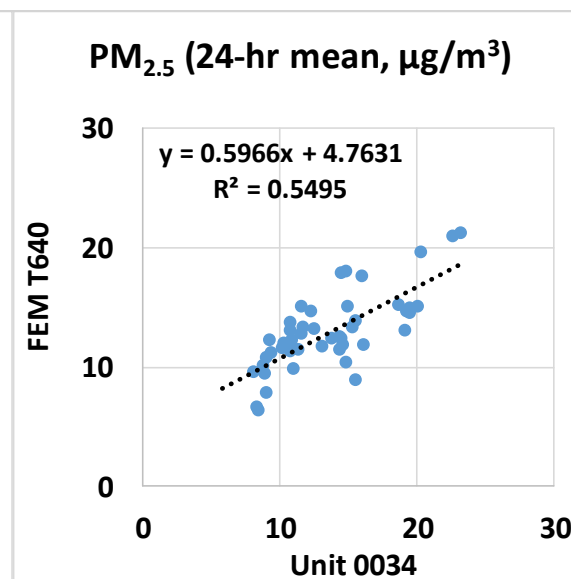
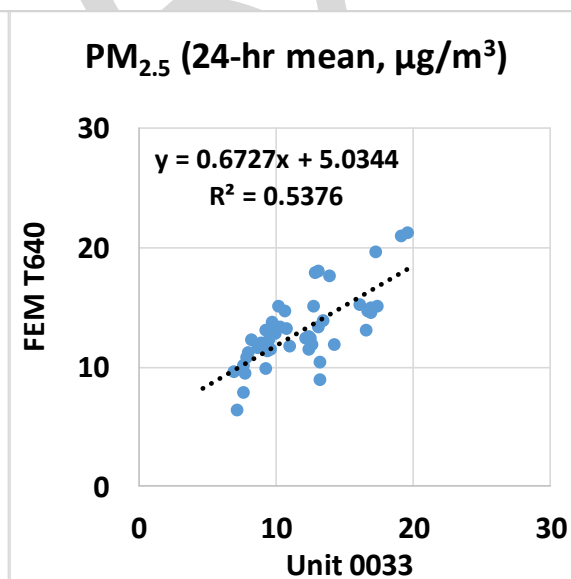
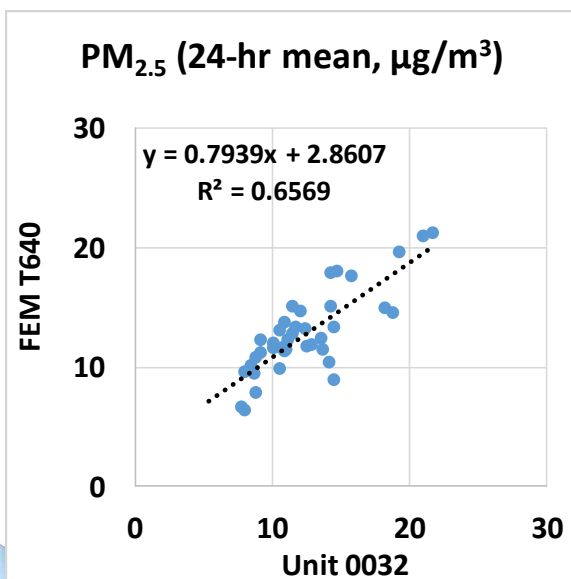
- The uRADMonitor SMOGGIE sensors did not correlate with the corresponding T640 data ($R^2 \sim 0.05$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM₁₀ mass concentrations as measured by the T640
- The uRADMonitor SMOGGIE sensors did not seem to track the diurnal PM₁₀ variations as recorded by the T640



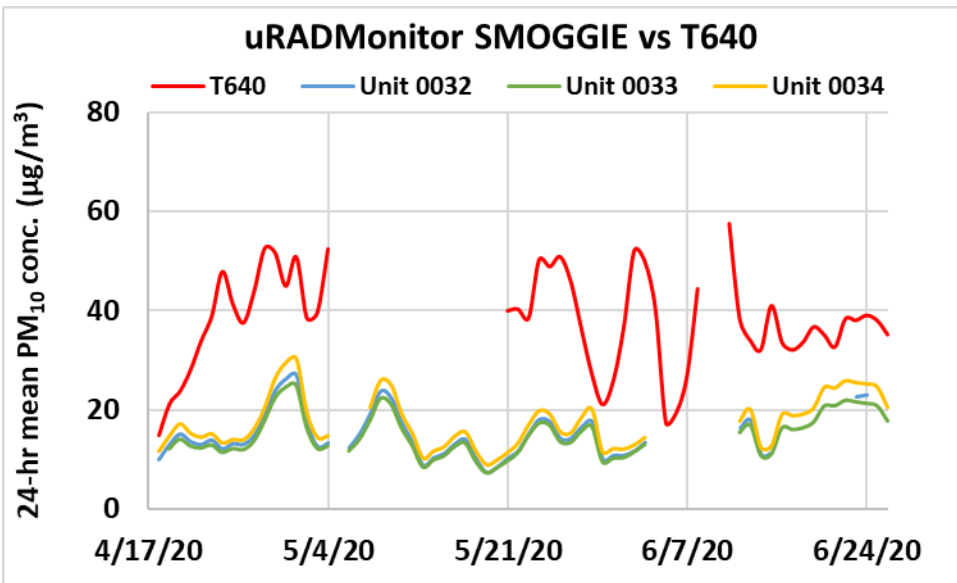
uRADMonitor SMOGGIE vs FEM T640 (PM_{2.5}; 24-hr mean)



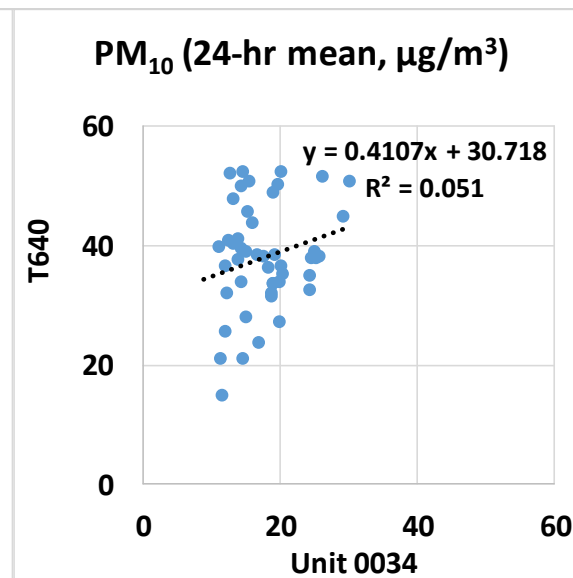
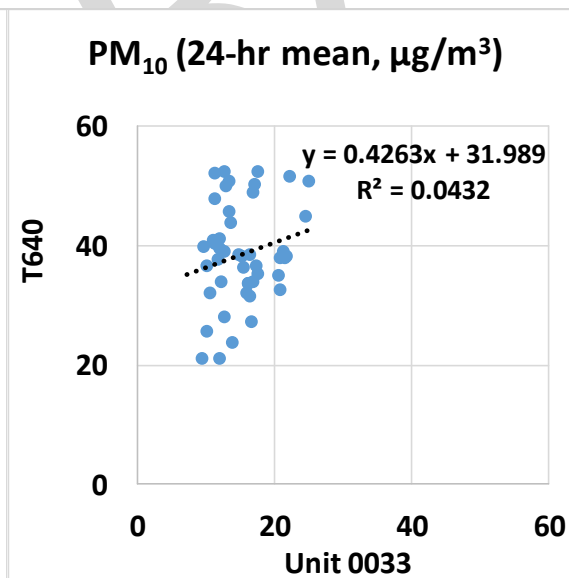
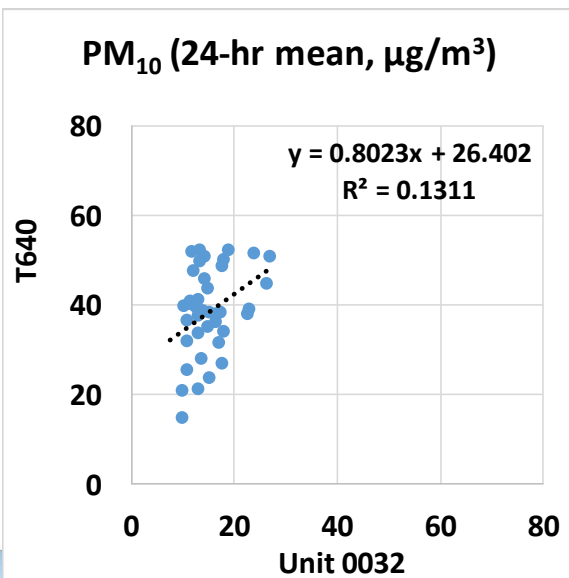
- The uRADMonitor SMOGGIE sensors showed moderate correlations with the corresponding FEM T640 data ($R^2 \sim 0.58$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM_{2.5} mass concentration as measured by the FEM T640
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal PM_{2.5} variations as recorded by the FEM T640



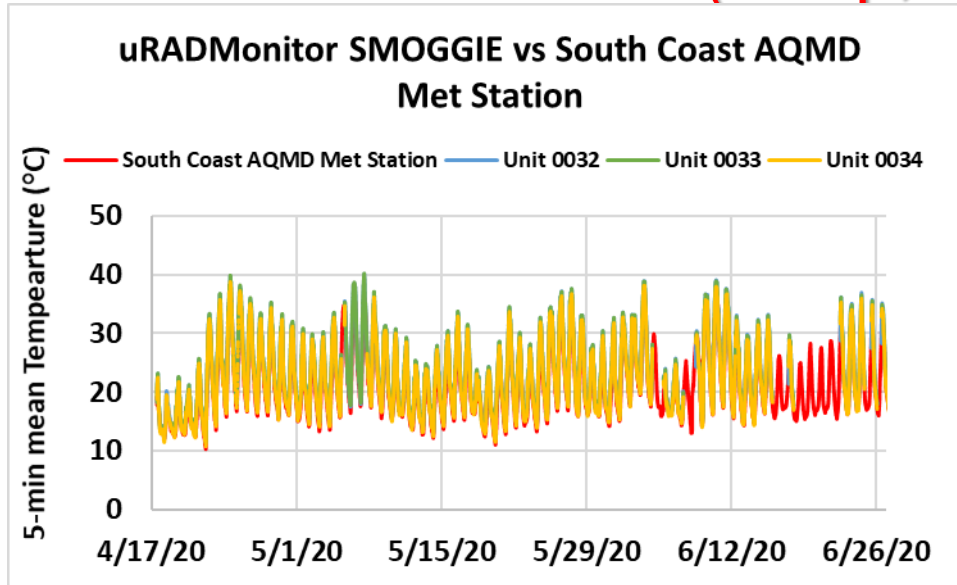
uRADMonitor SMOGGIE vs T640 (PM₁₀; 24-hr mean)



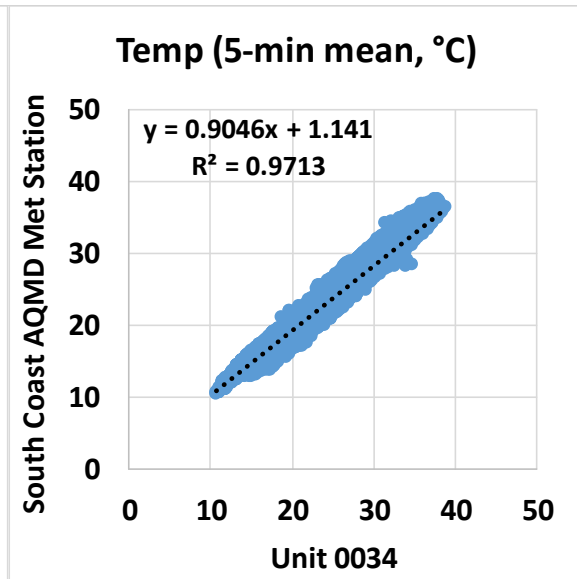
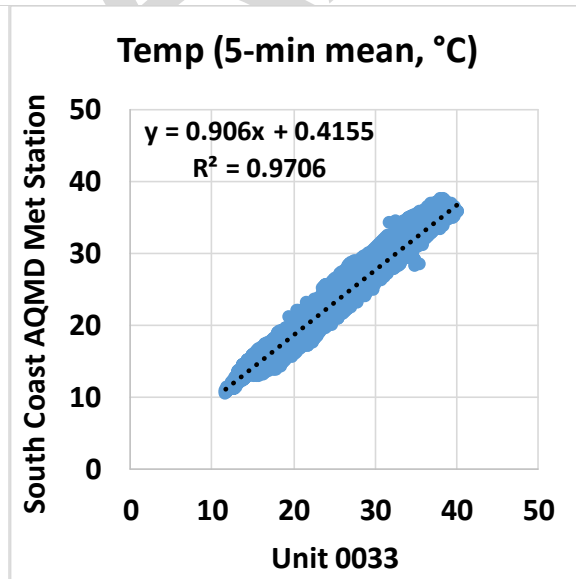
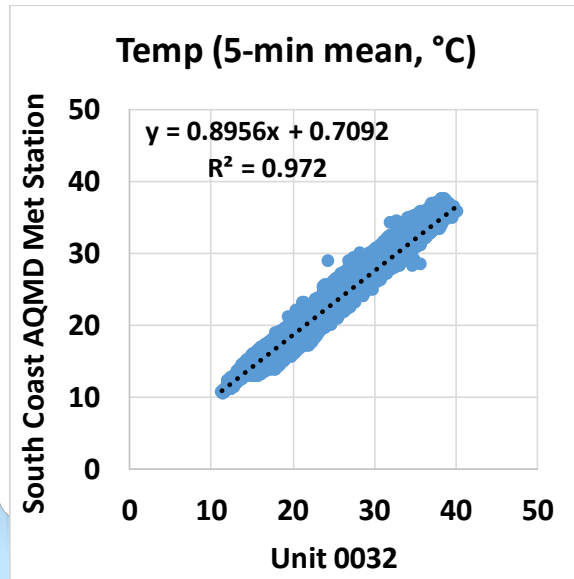
- The uRADMonitor SMOGGIE sensors showed no to very weak correlations with the corresponding T640 data ($0.04 < R^2 < 0.14$)
- Overall, the uRADMonitor SMOGGIE sensors underestimated the PM₁₀ mass concentrations as measured by the T640
- The uRADMonitor SMOGGIE sensors did not seem to track the diurnal PM₁₀ variations as recorded by the T640



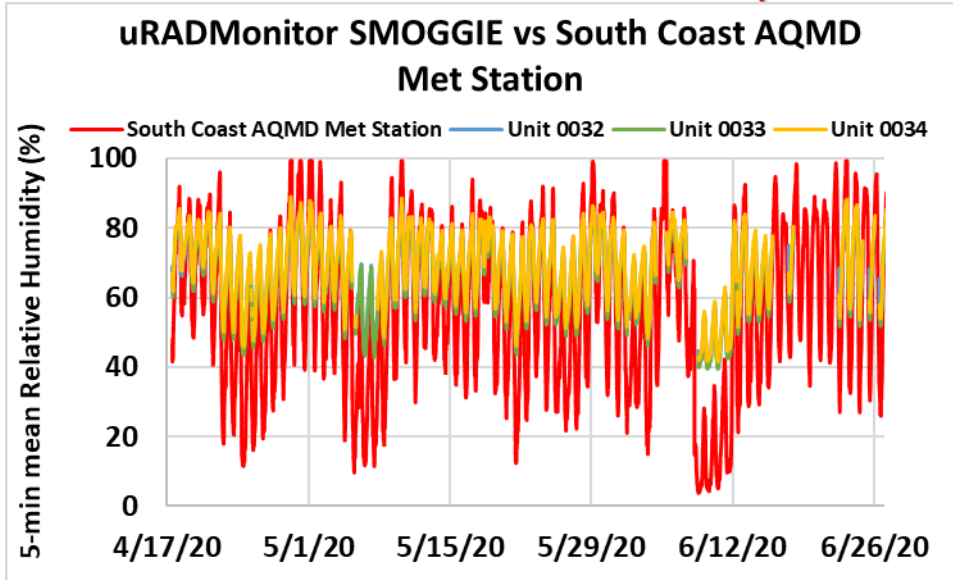
uRADMonitor SMOGGIE vs South Coast AQMD Met Station (Temp; 5-min mean)



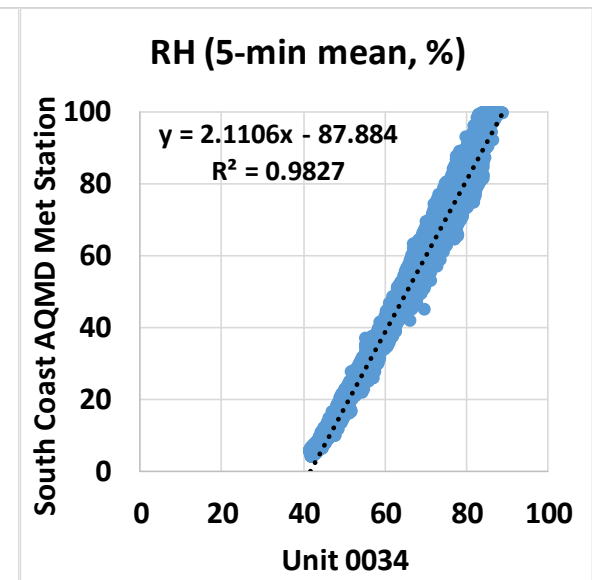
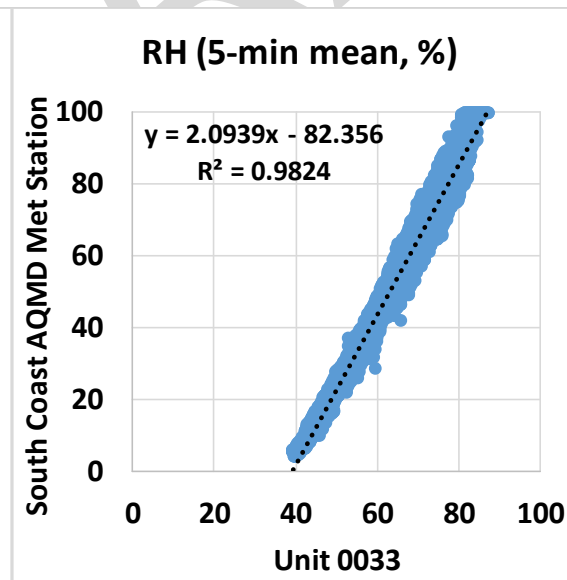
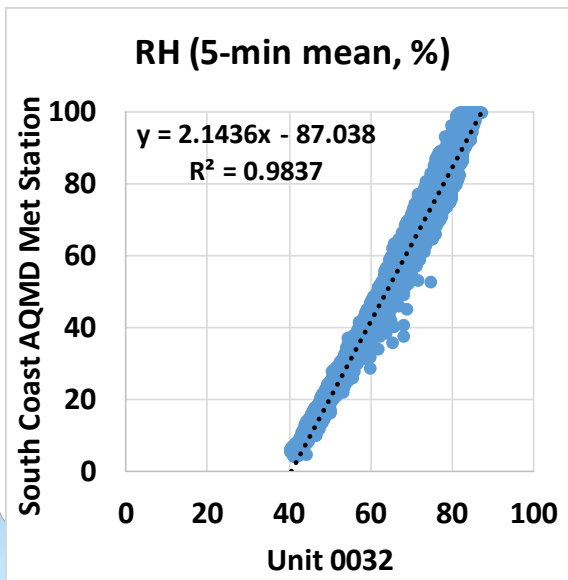
- uRADMonitor SMOGGIE sensors showed very strong correlations with the corresponding South Coast AQMD Met Station data ($R^2 \sim 0.97$)
- Overall, the uRADMonitor SMOGGIE sensors overestimated the temperature measurement as recorded by South Coast AQMD Met Station
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal temperature variations as recorded by South Coast AQMD Met Station



uRADMonitor SMOGGIE vs South Coast AQMD Met Station (RH; 5-min mean)



- uRADMonitor SMOGGIE sensors showed very strong correlations with the corresponding South Coast AQMD Met Station data ($R^2 \sim 0.98$)
- Overall, the uRADMonitor SMOGGIE sensors overestimated the RH measurement as recorded by South Coast AQMD Met Station
- The uRADMonitor SMOGGIE sensors seemed to track the diurnal RH variations as recorded by South Coast AQMD Met Station



Discussion

- The three **uRADMonitor SMOGGIE** sensors' data recovery from Unit 0032, Unit 0033 and Unit 0034 was ~ 78%, 98%, and 96%, respectively for $PM_{1.0}$, $PM_{2.5}$, and PM_{10} measurements.
- Absolute intra-model variability was ~ 0.23, 0.73, and 0.99 $\mu\text{g}/\text{m}^3$ for the $PM_{1.0}$, $PM_{2.5}$, and PM_{10} measurements, respectively.
- The reference instruments (GRIMM and T640) showed strong correlations with each other for $PM_{2.5}$ mass concentration measurements ($R^2 \sim 0.76$, 1-hr mean) and PM_{10} mass concentration measurements ($R^2 \sim 0.85$, 1-hr mean).
- $PM_{1.0}$ mass concentrations measured by uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding GRIMM data ($R^2 \sim 0.86$, 1-hr mean). The sensors underestimated $PM_{1.0}$ mass concentrations as measured by GRIMM.
- $PM_{2.5}$ mass concentrations measured by uRADMonitor SMOGGIE sensors showed strong correlations with the corresponding FEM GRIMM data ($R^2 \sim 0.85$; 1-hr mean) and moderate to strong correlations with the corresponding FEM T640 data ($0.61 < R^2 < 0.71$; 1-hr mean). The sensors underestimated $PM_{2.5}$ mass concentrations as measured by FEM GRIMM and FEM T640.
- PM_{10} mass concentrations measured by uRADMonitor SMOGGIE sensors showed no to very weak correlations with the corresponding GRIMM data ($0.04 < R^2 \sim 0.11$; 1-hr mean) and did not correlate with the corresponding T640 data ($R^2 \sim 0.05$; 1-hr mean). The sensors underestimated PM_{10} mass concentrations measured by GRIMM and T640.
- No sensor calibration was performed by AQ-SPEC prior to the beginning of this field testing.
- 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