Field Evaluation
Aeroqual S500
Particulate Matter Head

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 04/17/2020 to 06/24/2020[1], three **Aeroqual S500 Particulate Matter Head (hereinafter Aeroqual S500-PM)** 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

- Aeroqual S500-PM (*3 units tested*):
  - PM Sensor – Laser Particle Counter (non-FEM)
  - Each unit measures: $PM_{2.5}$ and PM_{10} ($\mu g/m^3$)
  - Unit cost: $1490 (Series 500 base + PM head)
  - Time resolution: 5-min (1-min data optional)
  - Units IDs: 1, 2, 3

- 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

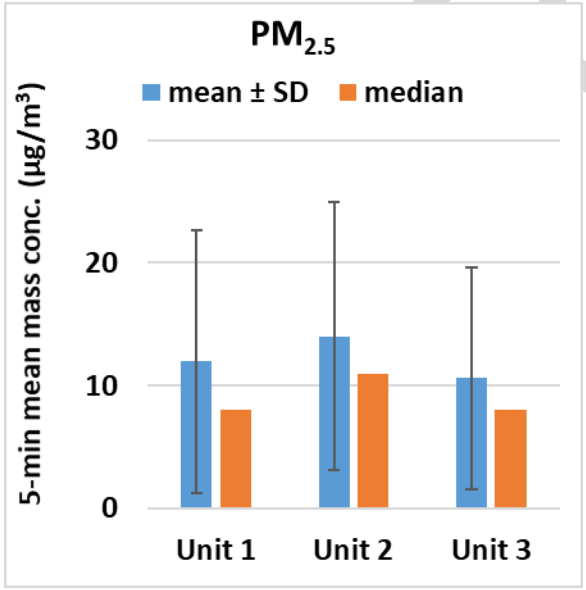
[1]*Note: sensor data were not available from 5/14/2020 to 5/20/2020 and from 6/2/2020 to 6/11/2020 due to preventive maintenance activities at the monitoring site.*

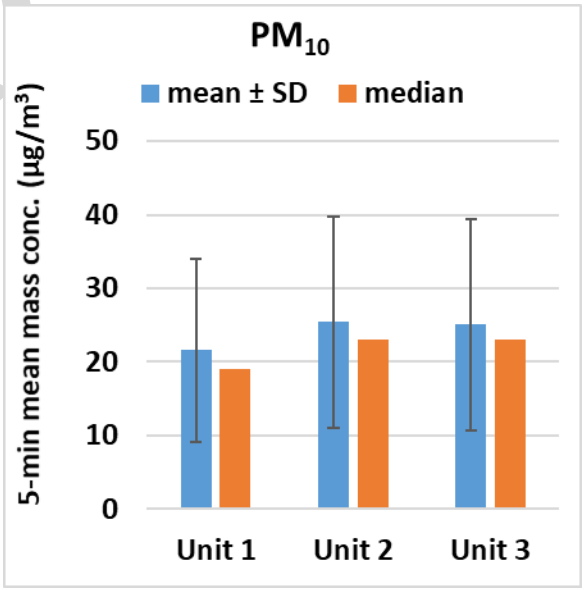
Data Validation & Recovery

- 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 1, Unit 2, and Unit 3 was ~ 100% for $PM_{2.5}$, and PM_{10} measurements

Aeroqual S500-PM; Intra-model Variability

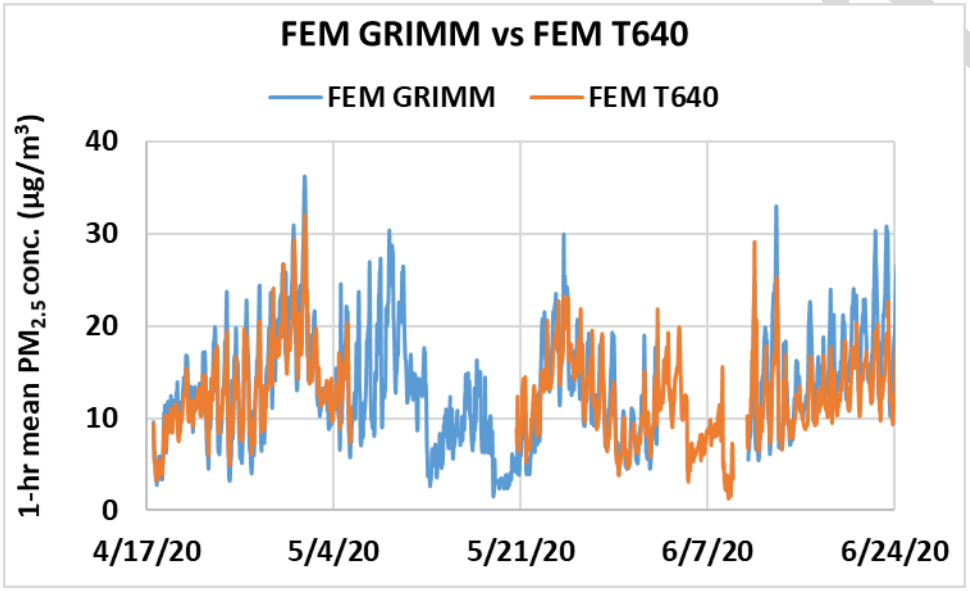
- Absolute intra-model variability was ~ 1.4 and 1.7 µg/m^3 for $PM_{2.5}$ and PM_{10} measurements, respectively (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 11 and 7% for $PM_{2.5}$ and PM_{10} measurements, respectively (calculated as the absolute intra-model variability relative to the mean of the three sensor means)

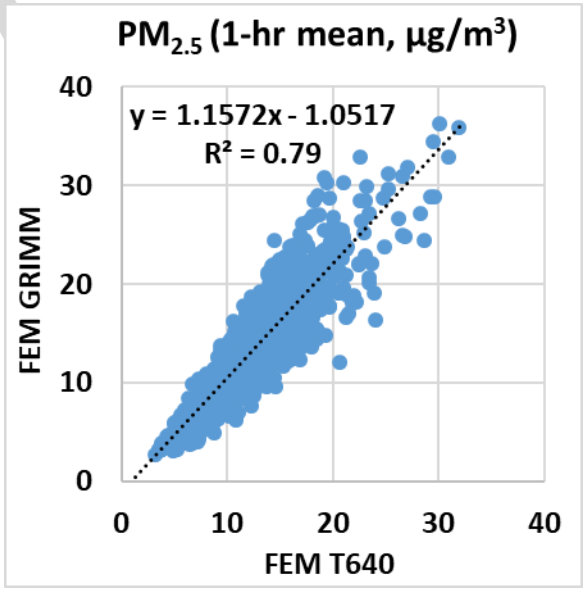




Reference Instruments: $PM_{2.5}$ FEM GRIMM & FEM T640

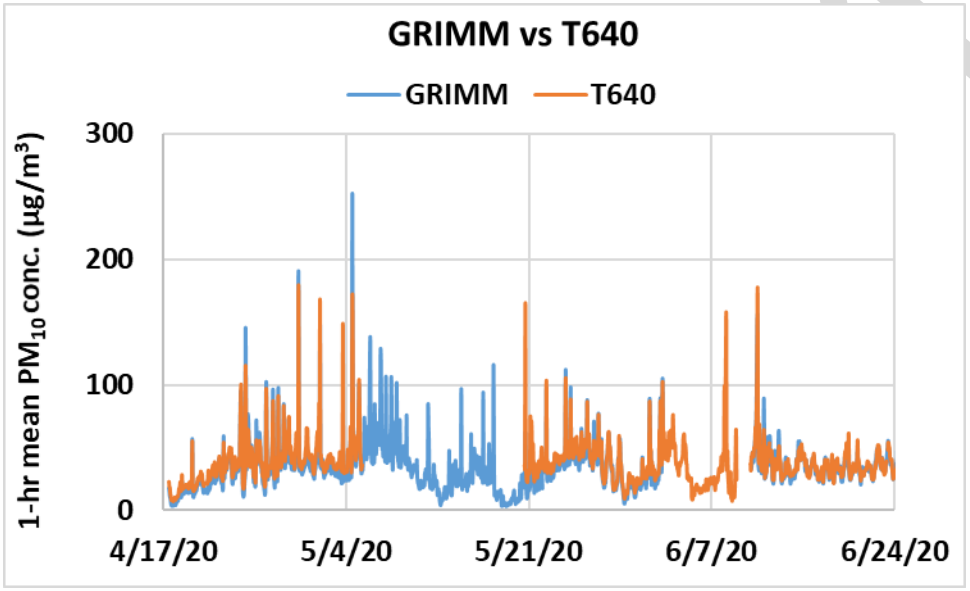
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for $PM_{2.5}$ from FEM GRIMM and FEM T640 is ~88% and 77%, respectively
- Strong correlations between FEM GRIMM and FEM T640 for $PM_{2.5}$ measurements (R^2 ~ 0.79)

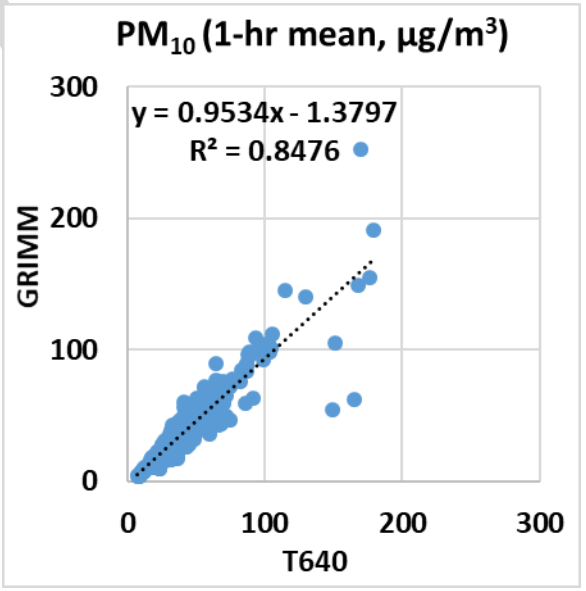




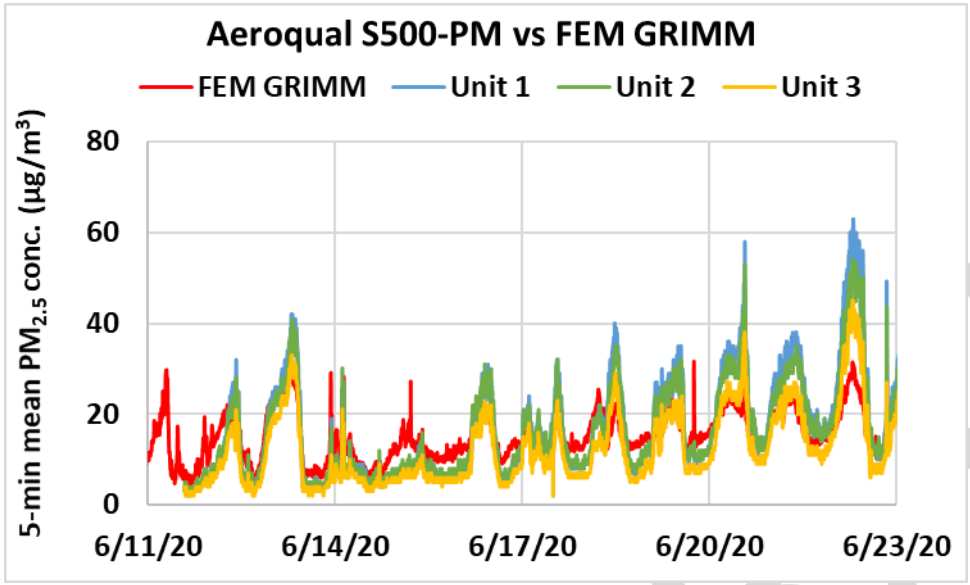
Reference Instruments: PM_{10} GRIMM & T640

- 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 PM_{10} from GRIMM and T640 is ~88% and 77%, respectively
- Strong correlations between GRIMM and T640 for PM_{10} measurements (R^2 ~ 0.85)

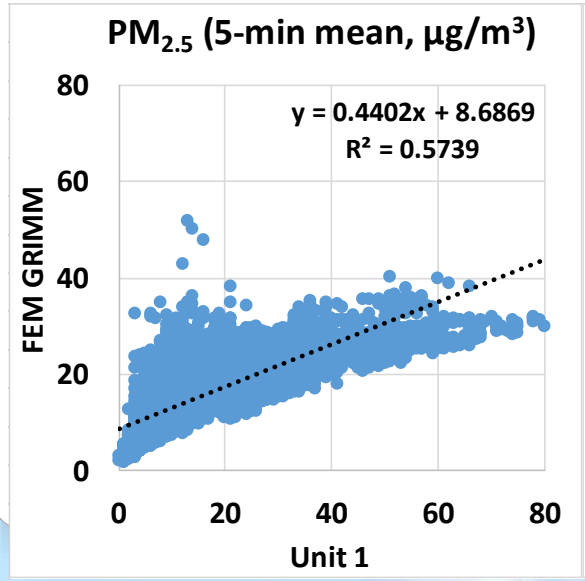


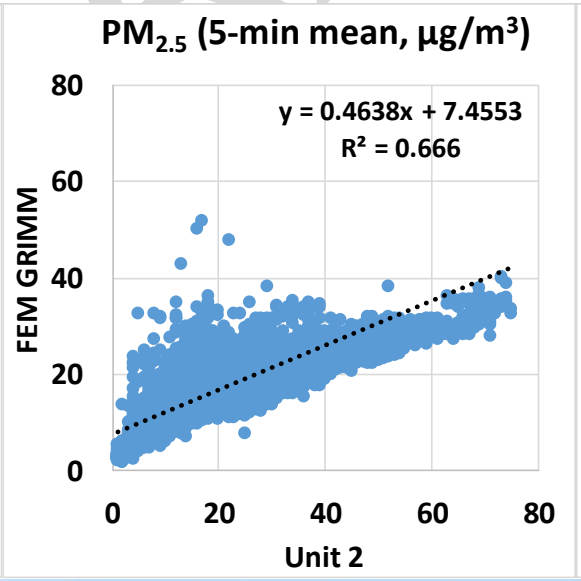


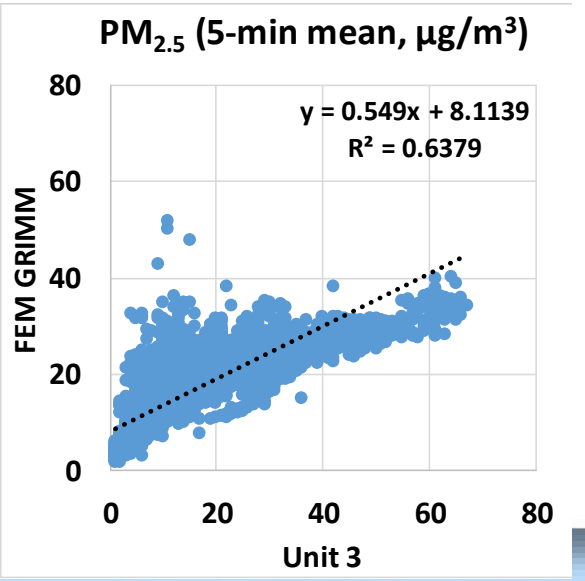
Aeroqual S500-PM vs FEM GRIMM ($PM_{2.5}$; 5-min mean)



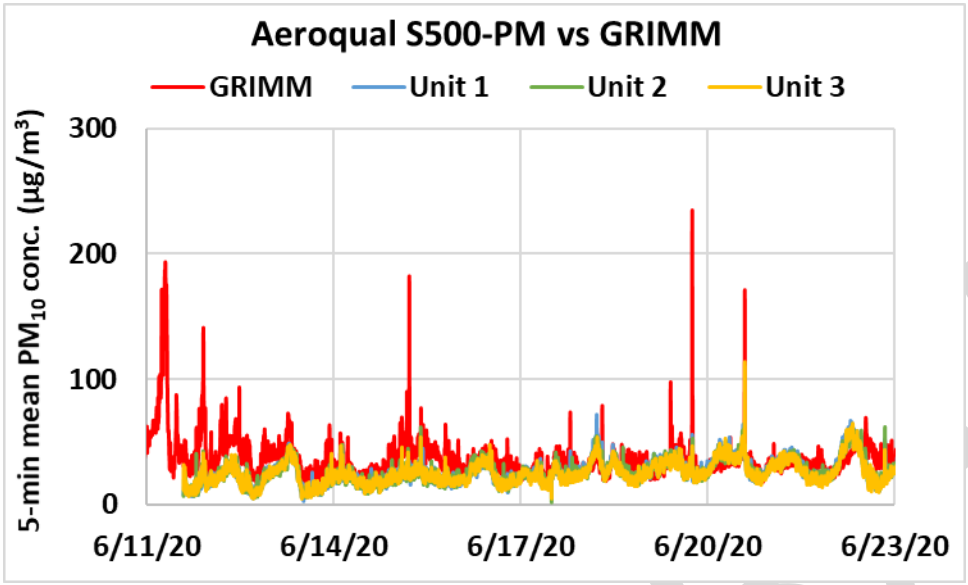
- The Aeroqual S500-PM sensors showed moderate correlations with the corresponding FEM GRIMM data (R^2 ~ 0.63)
- Overall, the Aeroqual S500-PM sensors underestimated the $PM_{2.5}$ mass concentrations as measured by the FEM GRIMM
- The Aeroqual S500-PM sensors seemed to track the diurnal $PM_{2.5}$ variations as recorded by the FEM GRIMM



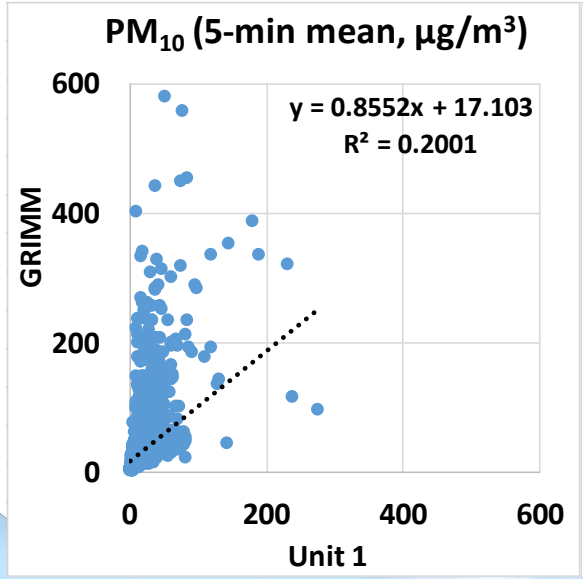


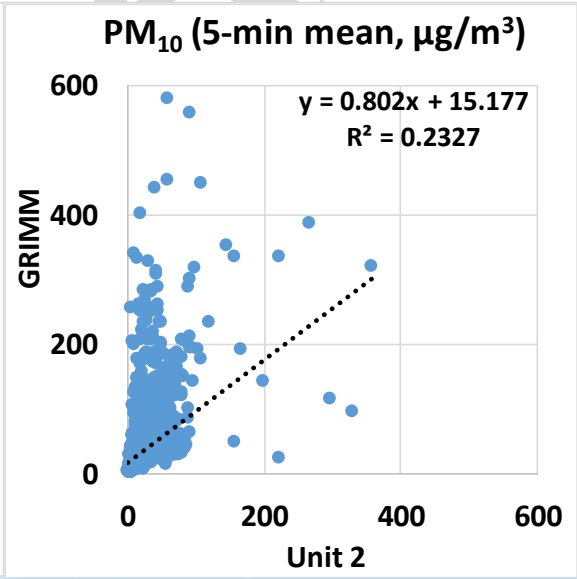


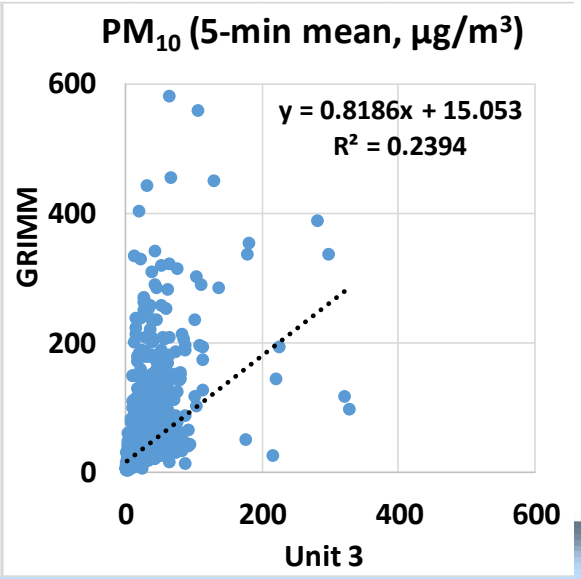
Aeroqual S500-PM vs GRIMM (PM_{10}; 5-min mean)



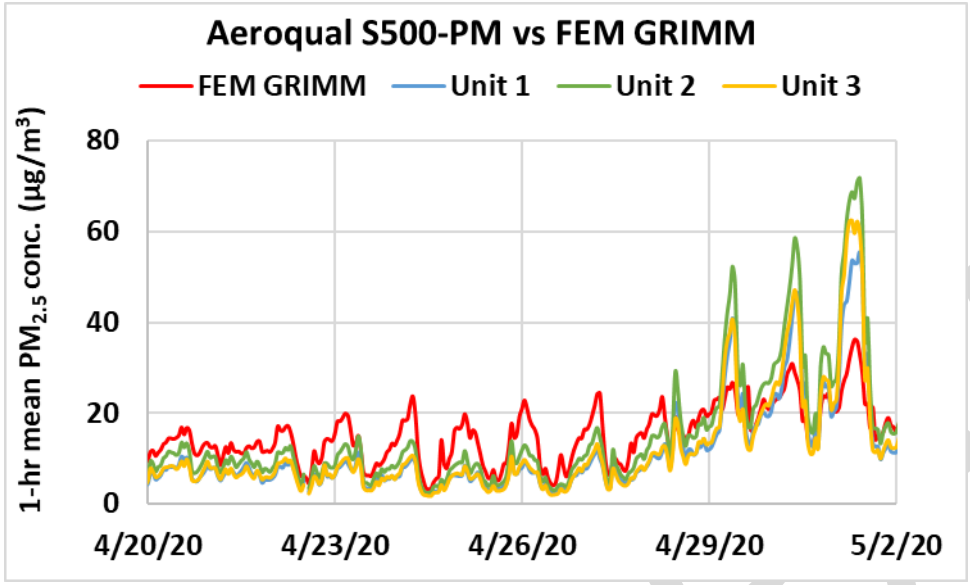
- The Aeroqual S500-PM sensors showed very weak correlations with the corresponding GRIMM data (R^2 ~ 0.22)
- Overall, the Aeroqual S500-PM sensors underestimated the PM_{10} mass concentrations as measured by the GRIMM
- The Aeroqual S500-PM sensors did not seem to track the diurnal PM_{10} variations as recorded by the GRIMM



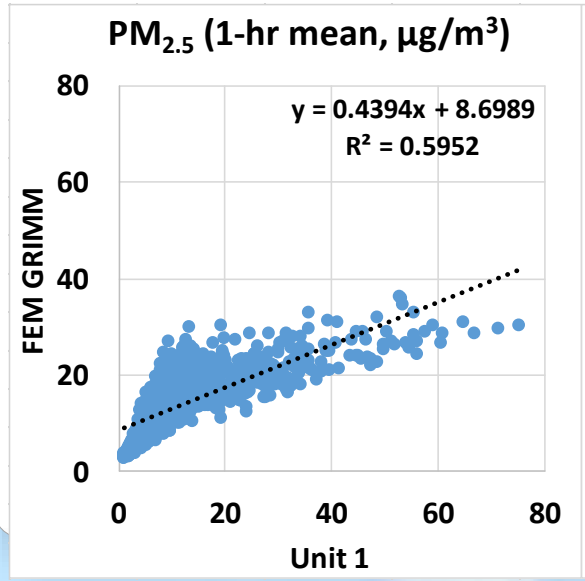


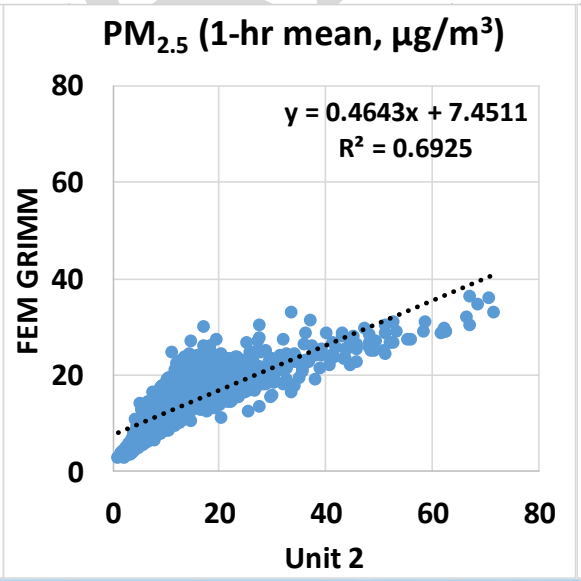


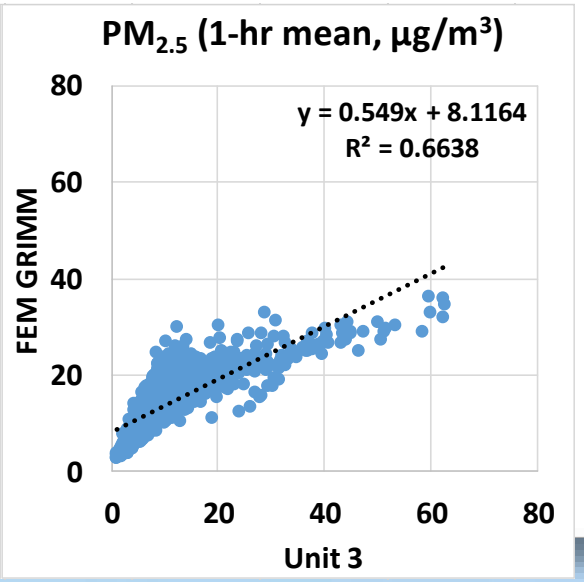
Aeroqual S500-PM vs FEM GRIMM ($PM_{2.5}$; 1-hr mean)



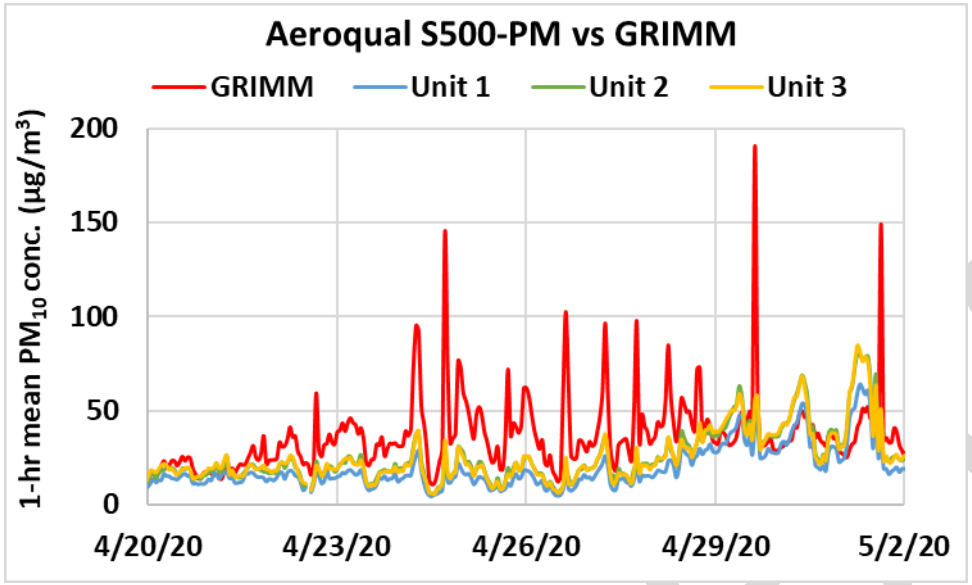
- The Aeroqual S500-PM sensors showed moderate correlations with the corresponding FEM GRIMM data (R^2 ~ 0.65)
- Overall, the Aeroqual S500-PM sensors underestimated the $PM_{2.5}$ mass concentrations as measured by the FEM GRIMM
- The Aeroqual S500-PM sensors seemed to track the diurnal $PM_{2.5}$ variations as recorded by the FEM GRIMM



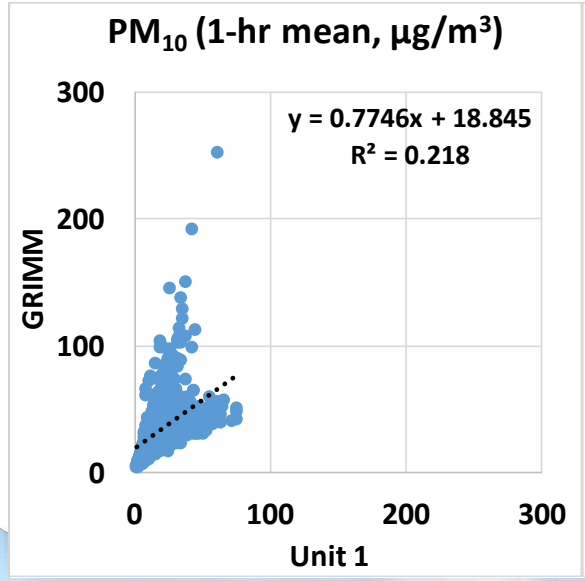


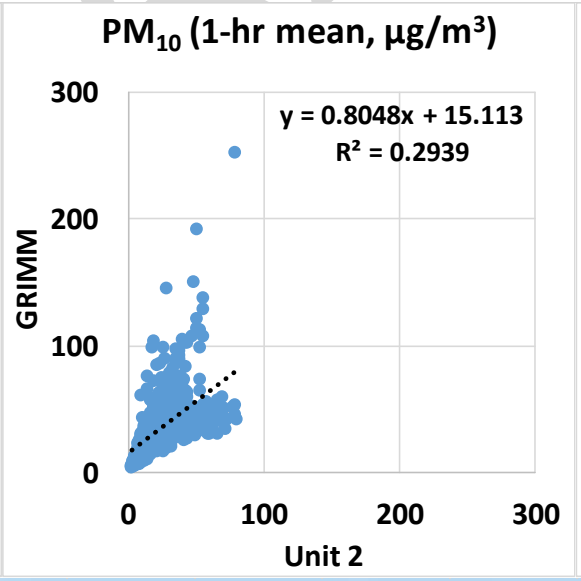


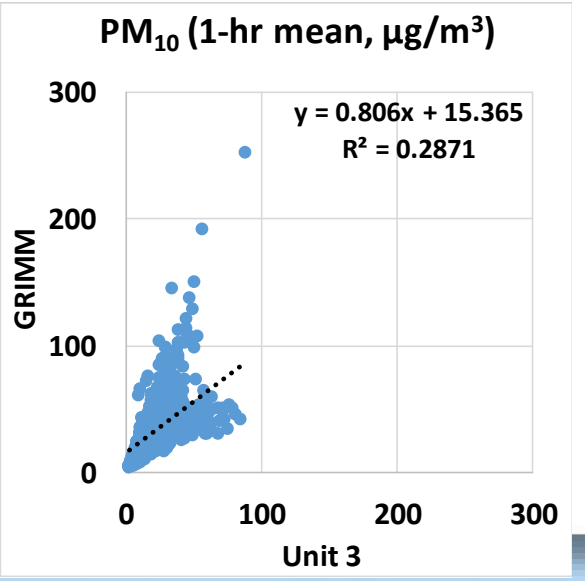
Aeroqual S500-PM vs GRIMM (PM_{10}; 1-hr mean)



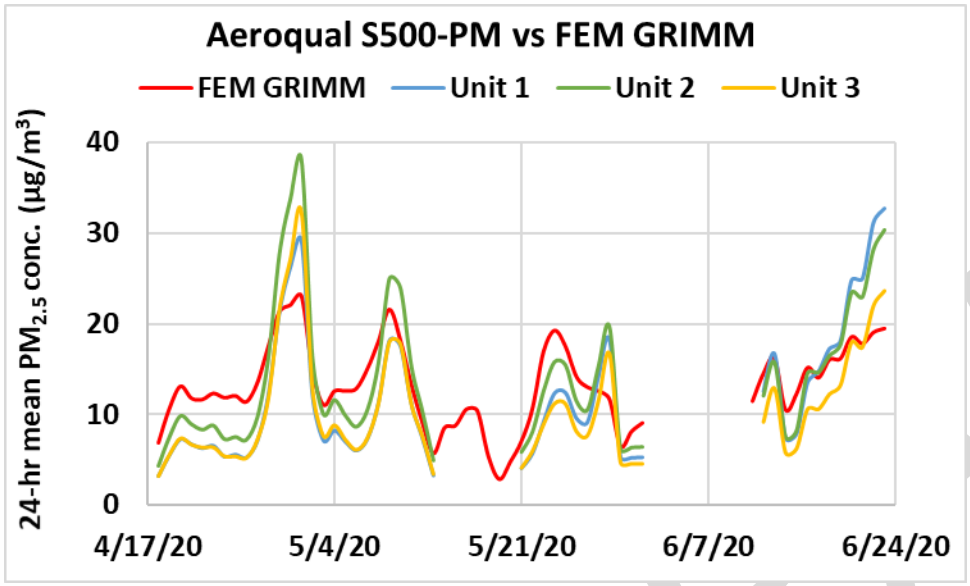
- The Aeroqual S500-PM sensors showed very weak correlations with the corresponding GRIMM data (R^2 ~ 0.27)
- Overall, the Aeroqual S500-PM sensors underestimated the PM_{10} mass concentration as measured by the GRIMM
- The Aeroqual S500-PM sensors did not seem to track the diurnal PM_{10} variations as recorded by the GRIMM



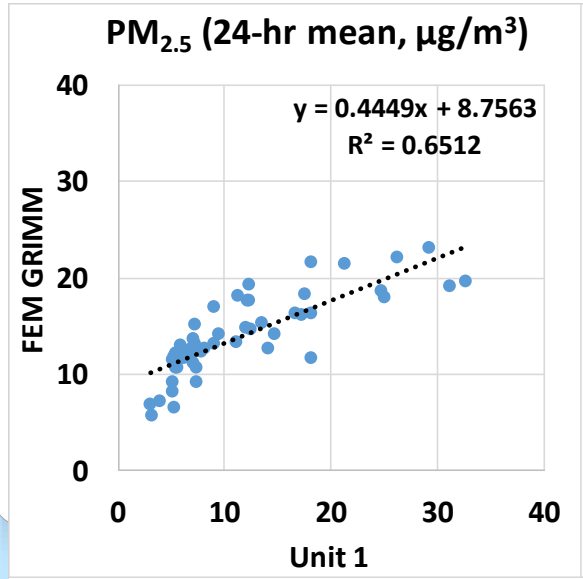


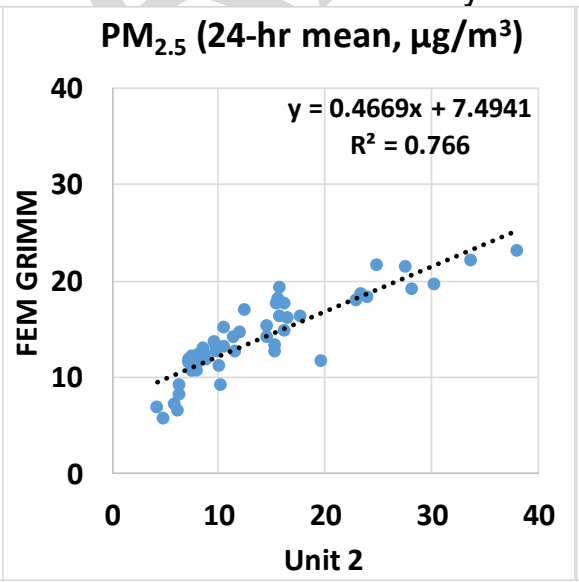


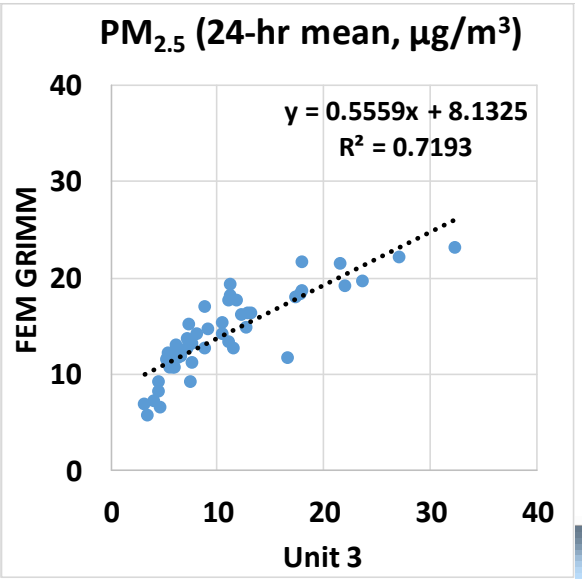
Aeroqual S500-PM vs FEM GRIMM ($PM_{2.5}$; 24-hr mean)



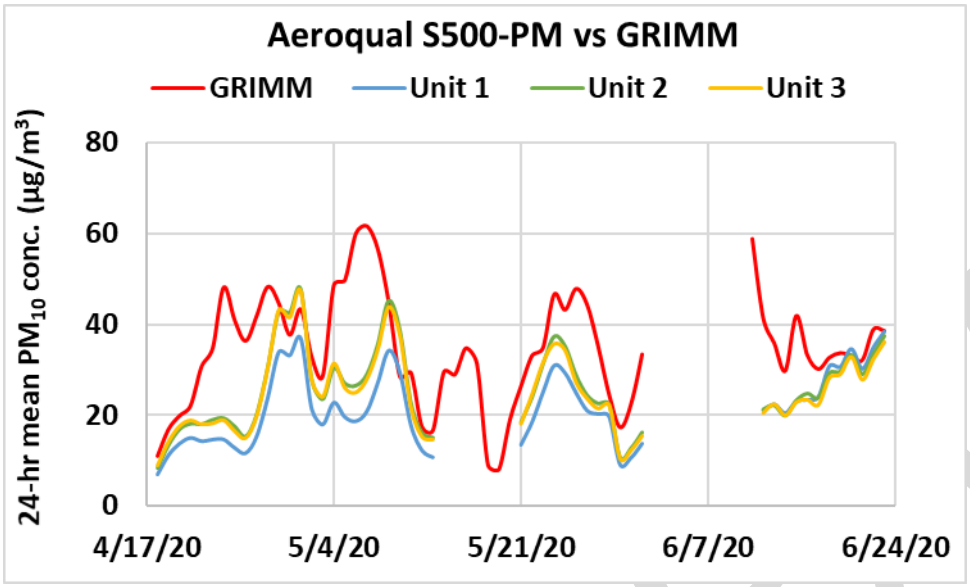
- The Aeroqual S500-PM sensors showed moderate to strong correlations with the corresponding FEM GRIMM data ($0.65 < R^2 < 0.77$)
- Overall, the Aeroqual S500-PM sensors underestimated the $PM_{2.5}$ mass concentrations as measured by the FEM GRIMM
- The Aeroqual S500-PM sensors seemed to track the diurnal $PM_{2.5}$ variations as recorded by the FEM GRIMM



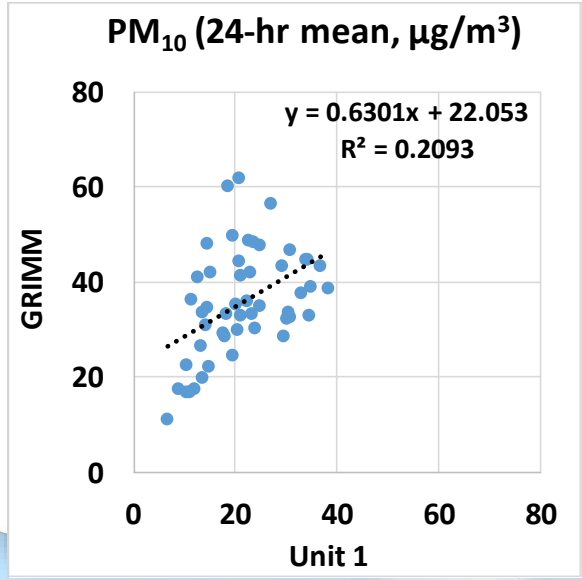


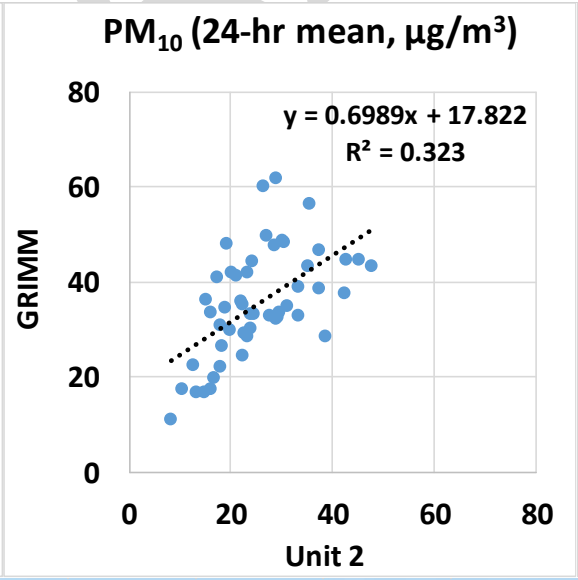


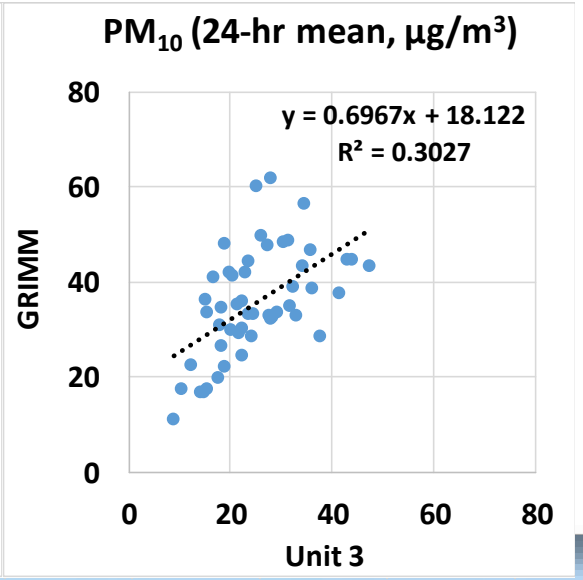
Aeroqual S500-PM vs GRIMM (PM_{10}; 24-hr mean)



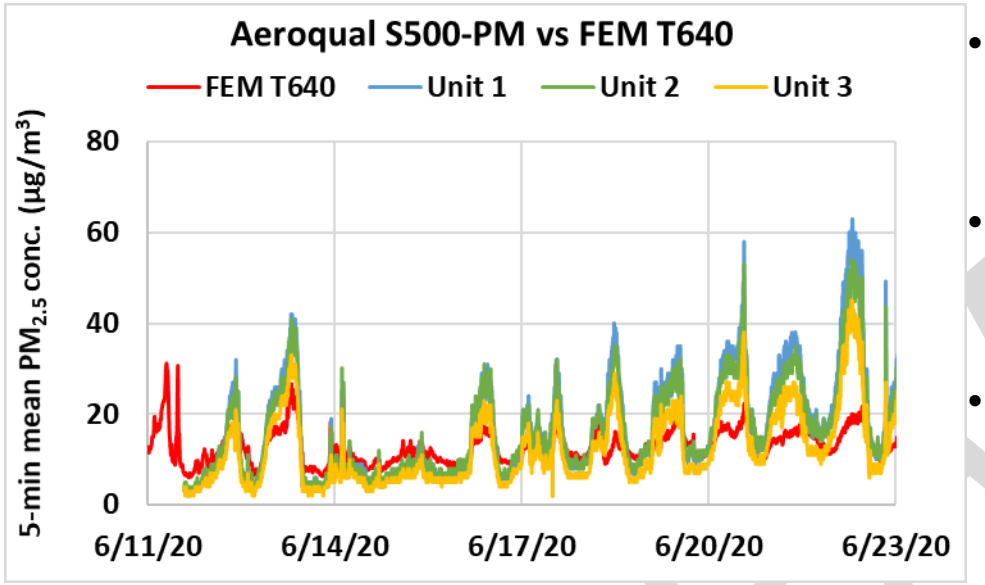
- The Aeroqual S500-PM sensors showed very weak to weak correlations with the corresponding GRIMM data ($0.20 < R^2 < 0.33$)
- Overall, the Aeroqual S500-PM sensors underestimated the PM_{10} mass concentration as measured by the GRIMM
- The Aeroqual S500-PM sensors did not seem to track the diurnal PM_{10} variations as recorded by the GRIMM



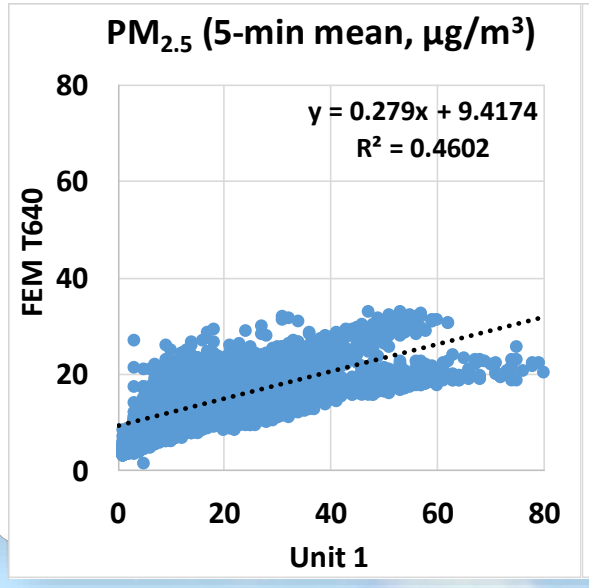


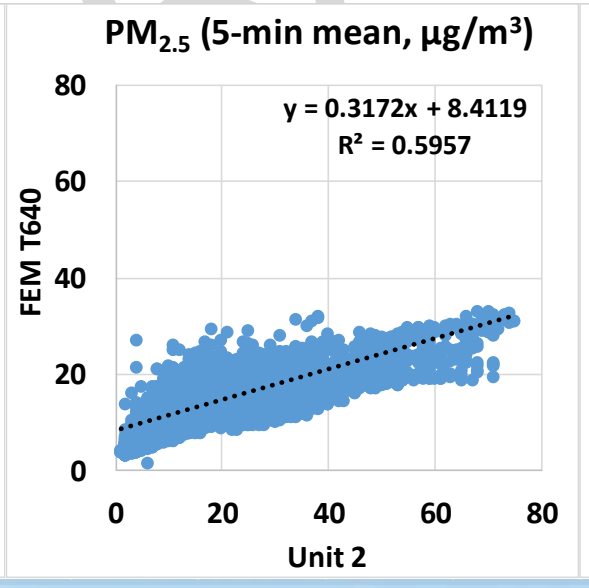


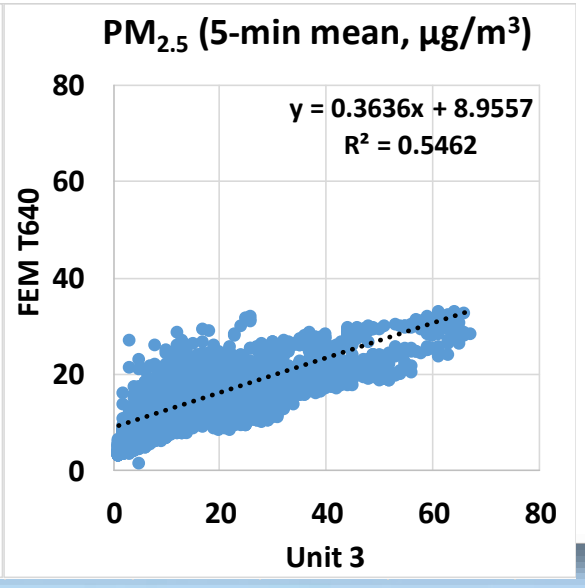
Aeroqual S500-PM vs FEM T640 ($PM_{2.5}$; 5-min mean)



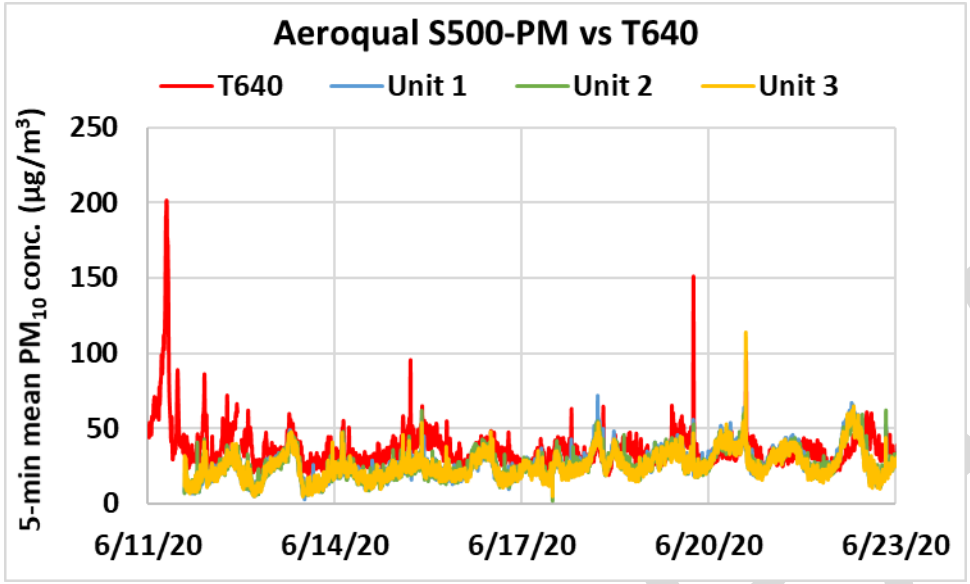
- The Aeroqual S500-PM sensors showed weak to moderate correlations with the corresponding FEM T640 data ($0.46 < R^2 < 0.60$)
- Overall, the Aeroqual S500-PM sensors underestimated the $PM_{2.5}$ mass concentrations as measured by the FEM T640
- The Aeroqual S500-PM sensors seemed to track the diurnal $PM_{2.5}$ variations as recorded by the FEM T640



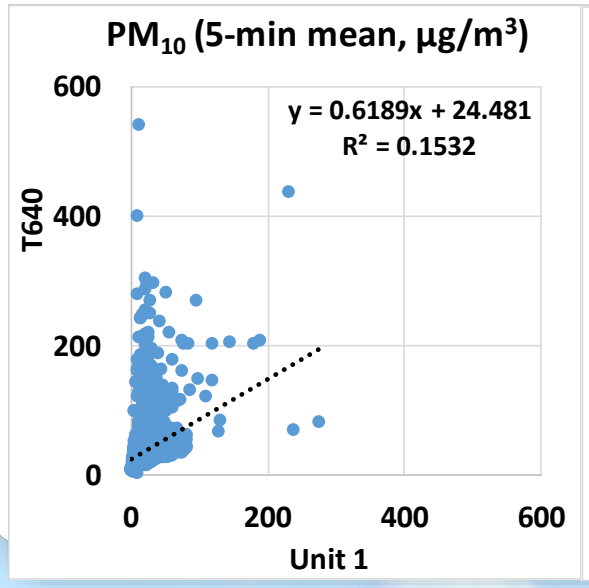


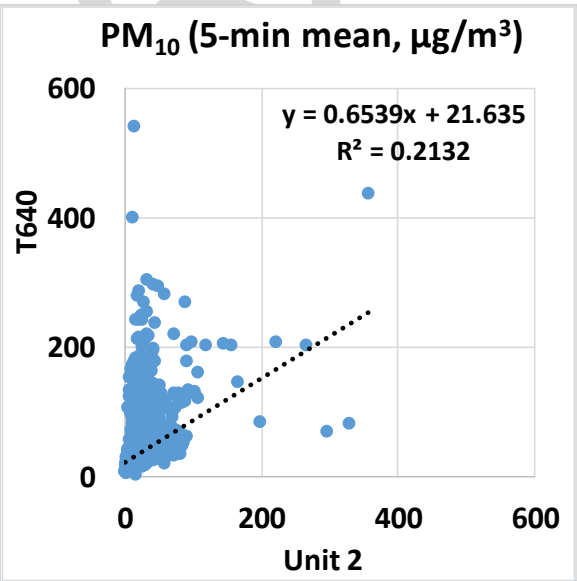


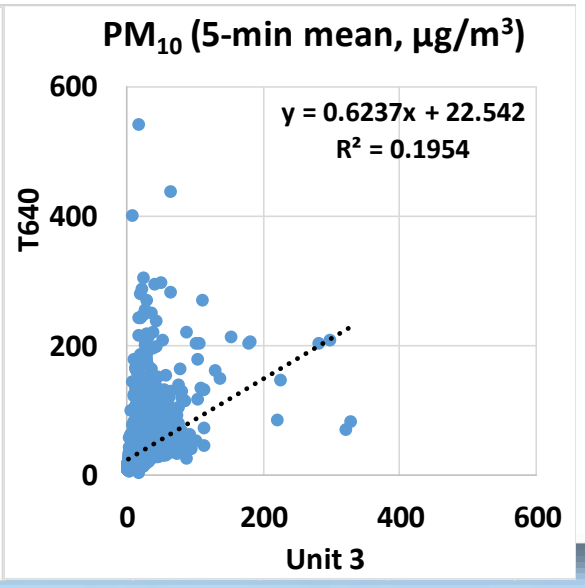
Aeroqual S500-PM vs T640 (PM_{10}; 5-min mean)



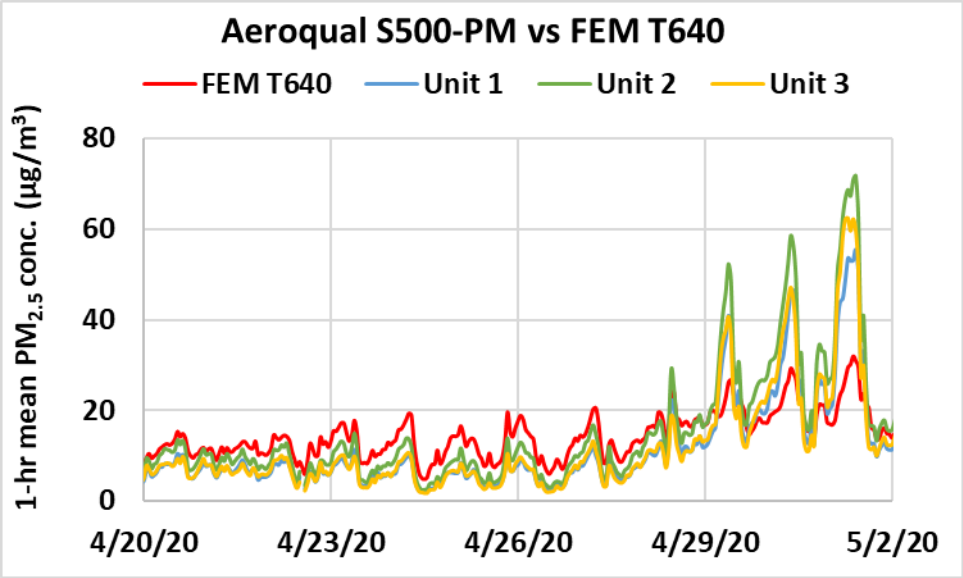
- The Aeroqual S500-PM sensors showed very weak correlations with the corresponding T640 data (R^2 ~ 0.19)
- Overall, the Aeroqual S500-PM sensors underestimated the PM_{10} mass concentration as measured by the T640
- The Aeroqual S500-PM sensors did not seem to track the diurnal PM_{10} variations as recorded by the T640



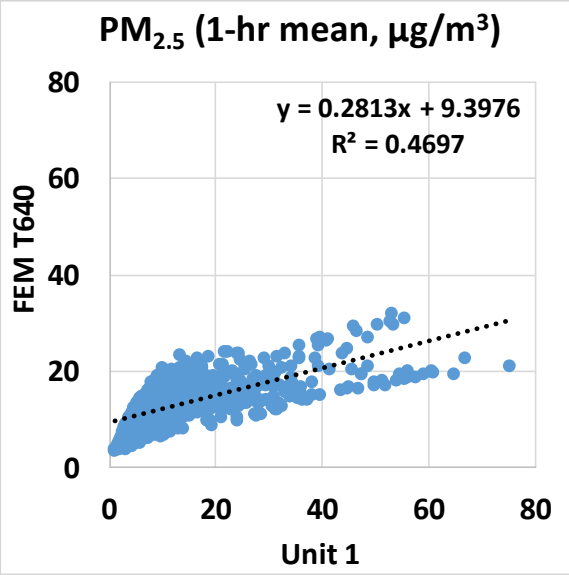


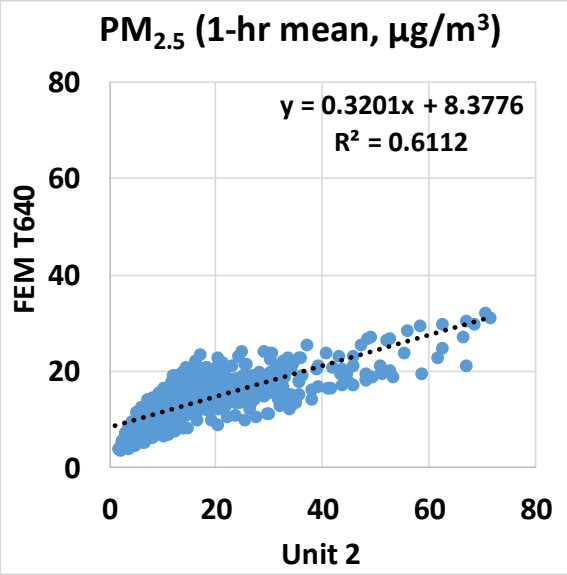


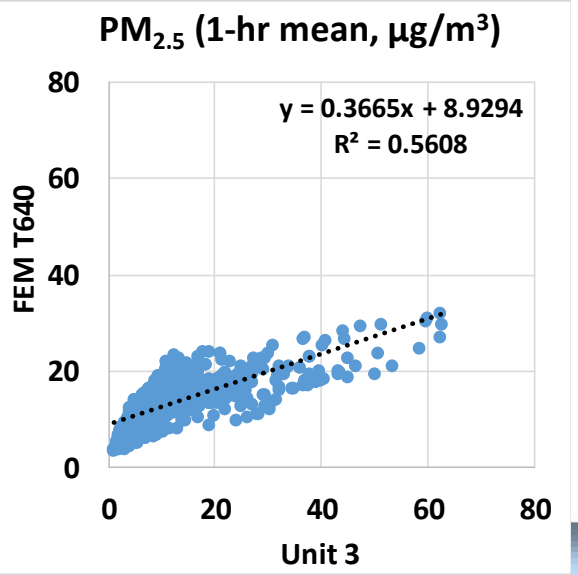
Aeroqual S500-PM vs FEM T640 ($PM_{2.5}$; 1-hr mean)



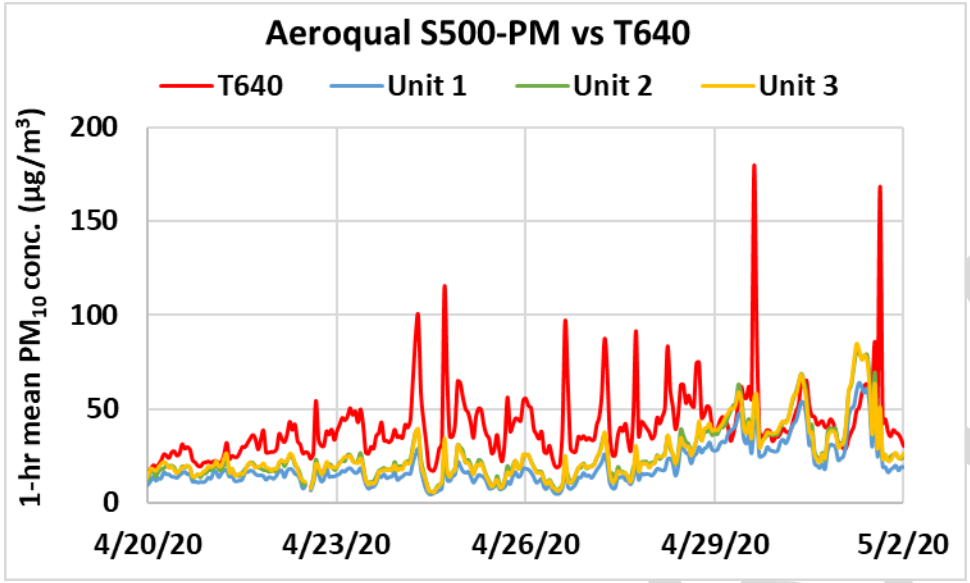
- Aeroqual S500-PM sensors showed weak to moderate correlations with the corresponding FEM T640 data ($0.46 < R^2 < 0.62$)
- Overall, the Aeroqual S500-PM sensors underestimated the $PM_{2.5}$ mass concentrations as measured by the FEM T640
- The Aeroqual S500-PM sensors seemed to track the diurnal $PM_{2.5}$ variations as recorded by the FEM T640



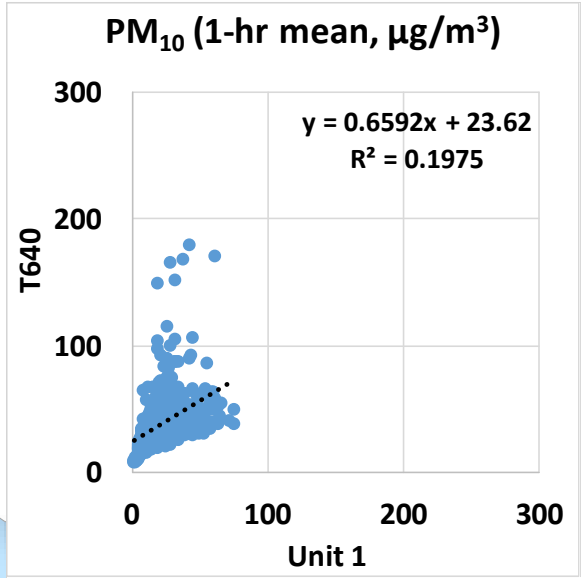


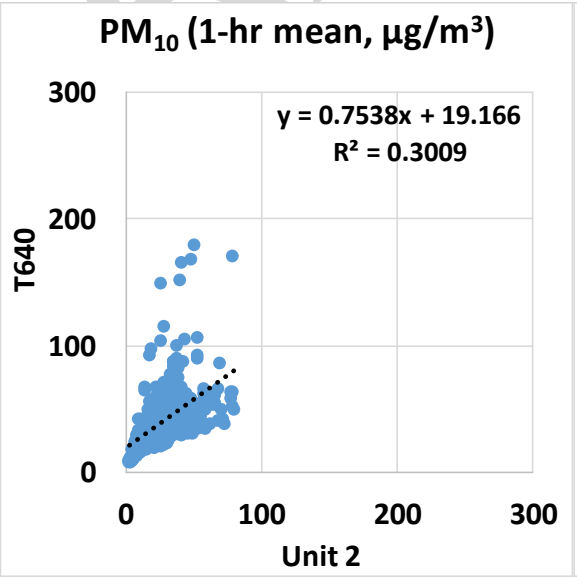


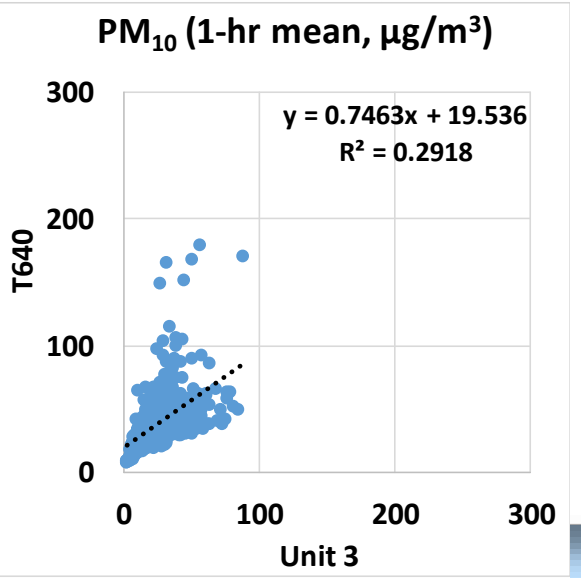
Aeroqual S500-PM vs T640 (PM_{10}; 1-hr mean)



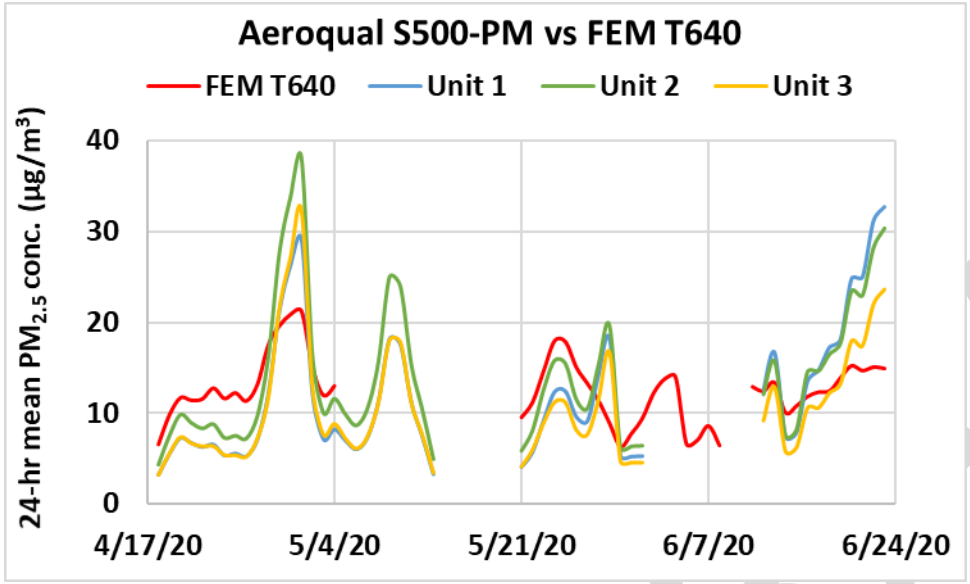
- The Aeroqual S500-PM sensors very weak to weak correlations with the corresponding T640 data ($0.19 < R^2 < 0.31$)
- Overall, the Aeroqual S500-PM sensors underestimated the PM_{10} mass concentrations as measured by the T640
- The Aeroqual S500-PM sensors did not seem to track the diurnal PM_{10} variations as recorded by the T640



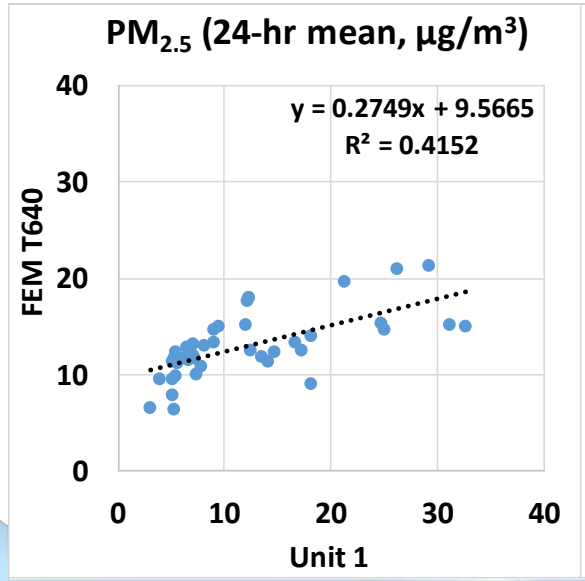


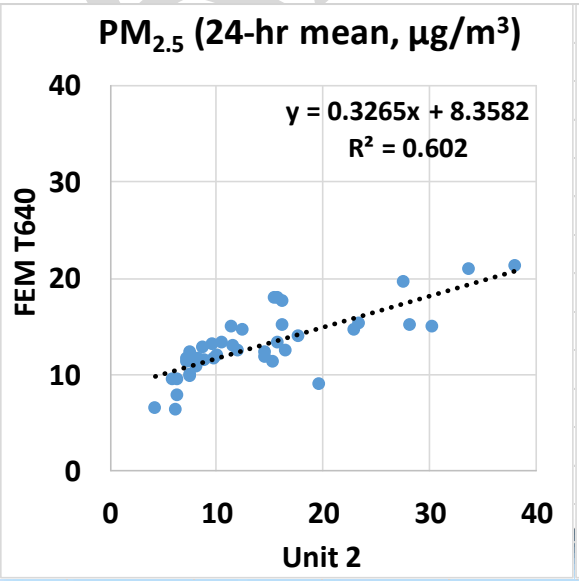


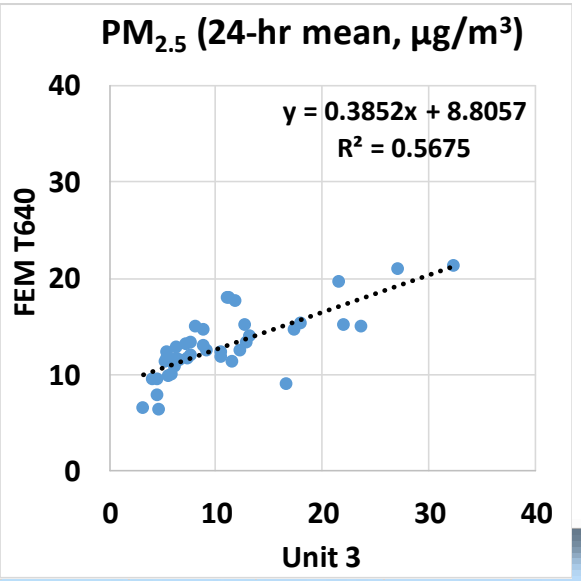
Aeroqual S500-PM vs FEM T640 ($PM_{2.5}$; 24-hr mean)



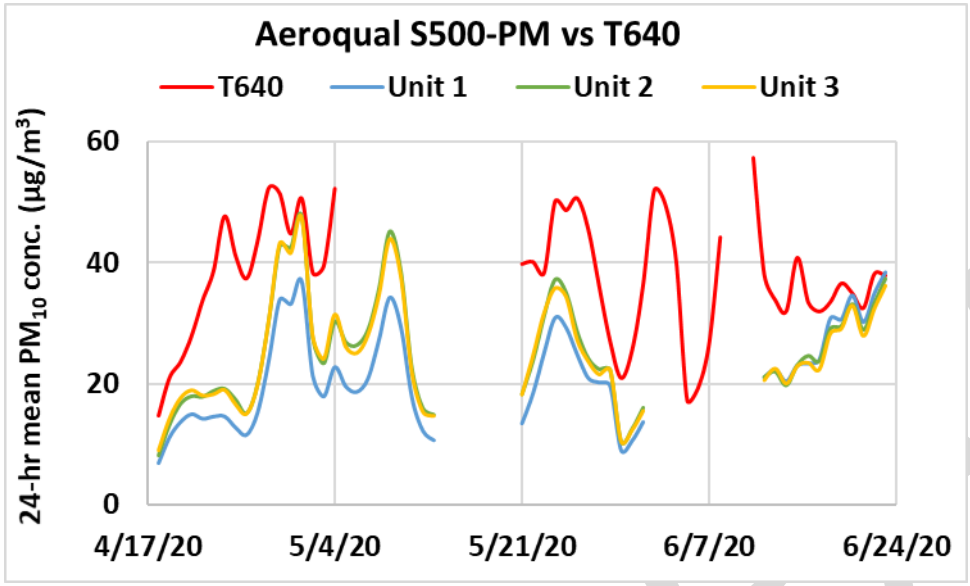
- The Aeroqual S500-PM sensors showed weak to moderate correlations with the corresponding FEM T640 data ($0.41 < R^2 < 0.61$)
- Overall, the Aeroqual S500-PM sensors underestimated the $PM_{2.5}$ mass concentration as measured by the FEM T640
- The Aeroqual S500-PM sensors seemed to track the diurnal $PM_{2.5}$ variations as recorded by the FEM T640



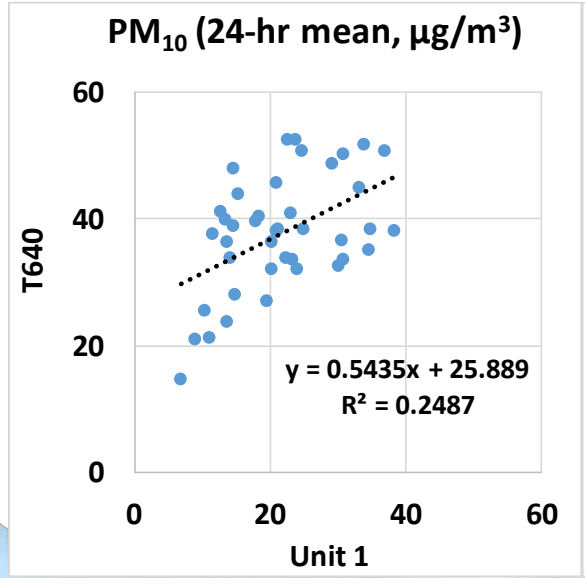


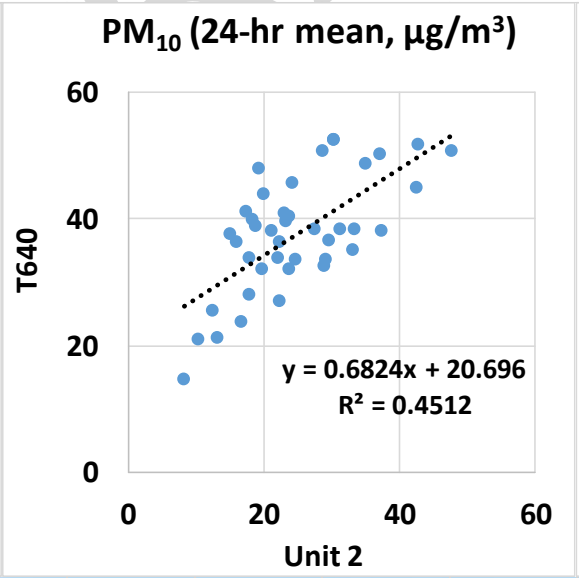


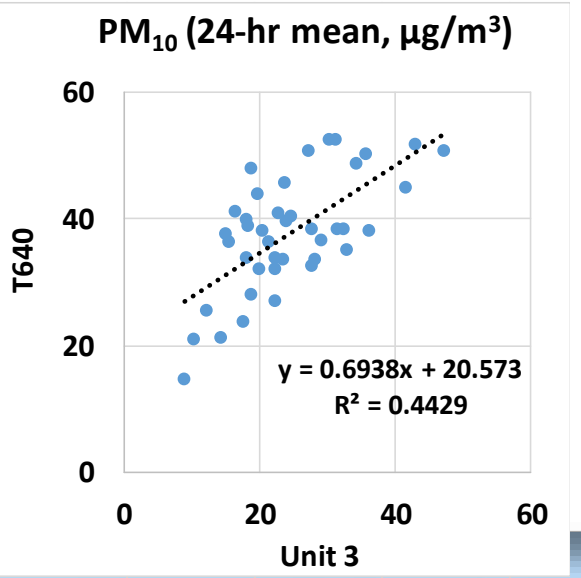
Aeroqual S500-PM vs T640 (PM_{10}; 24-hr mean)



- The Aeroqual S500-PM sensors showed very weak to weak correlations with the corresponding T640 data ($0.24 < R^2 < 0.46$)
- Overall, the Aeroqual S500-PM sensors underestimated the PM_{10} mass concentrations as measured by the T640
- The Aeroqual S500-PM sensors did not seem to track the diurnal PM_{10} variations as recorded by the T640







Discussion

- The three **Aeroqual S500-PM** sensors' data recovery from Unit 1, Unit 2 and Unit 3 was ~ 100% for $PM_{2.5}$ and PM_{10} measurements.
- Absolute intra-model variability was ~ 1.4 and 1.7 µg/m^3 for $PM_{2.5}$, 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 ~ 0.79, 1-hr mean) and PM_{10} mass concentration measurements (R^2 ~ 0.85, 1-hr mean).
- $PM_{2.5}$ mass concentrations measured by Aeroqual S500-PM sensor showed moderate correlations with the corresponding FEM GRIMM (R^2 ~ 0.65; 1-hr mean) and weak to moderate correlations with the corresponding FEM T640 data ($0.46 < R^2 < 0.62$; 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 Aeroqual S500-PM sensors showed very weak correlations with the GRIMM (R^2 ~ 0.27; 1-hr mean) and very weak to weak correlations with the T640 data ($0.19 < R^2 < 0.31$; 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