Field Evaluation
Elitech Temtop
M2000 2nd Generation

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 03/27/2020 to 06/04/2020, three **Elitech Temtop M2000 2nd Generation (hereinafter Temtop M2000)** sensors 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

- Temtop M2000 2nd Generation (*3 units tested*):
  - Particle sensor: optical; non-FEM (PM200, Temtop)
  - Each unit reports: $PM_{2.5}$ and PM_{10} (µg/m^3)
  - Unit also measures: CO_2 and formaldehyde
  - Unit also displays: Temperature and Relative Humidity
  - Unit cost: ~$100
  - Time resolution: 1-min
  - Units IDs: Unit 1, Unit 2 and Unit 3

- GRIMM (*reference instrument*):
  - Optical particle counter (FEM $PM_{2.5}$)
  - Measures $PM_{1.0}$, $PM_{2.5}$, and PM_{10} (µg/m^3)
  - Cost: ~$25,000 and up
  - Time resolution: 1-min

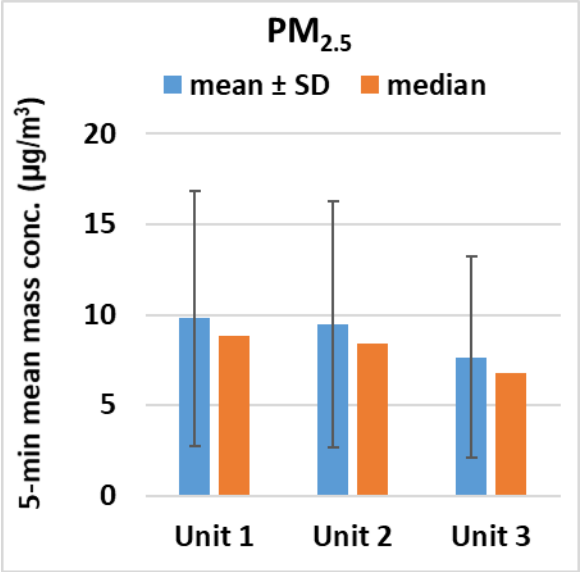
- Teledyne API T640 (*reference instrument*):
  - Optical particle counter (FEM $PM_{2.5}$)
  - Measures $PM_{2.5}$ & PM_{10} (µg/m^3)
  - Unit cost: ~$21,000
  - Time resolution: 1-min

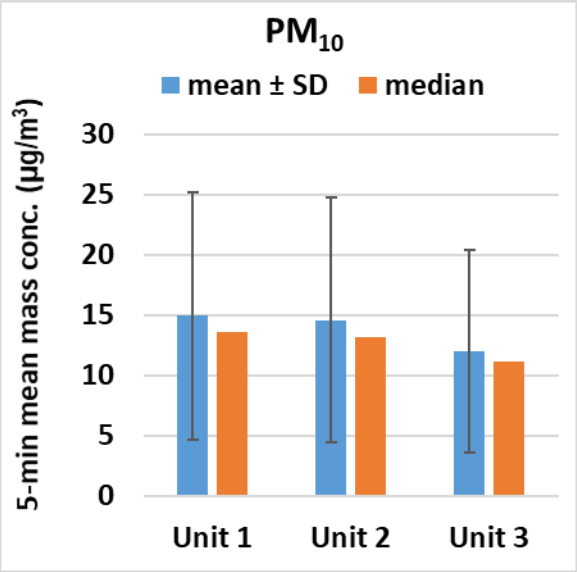
Data validation & recovery

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

Temtop M2000; intra-model variability

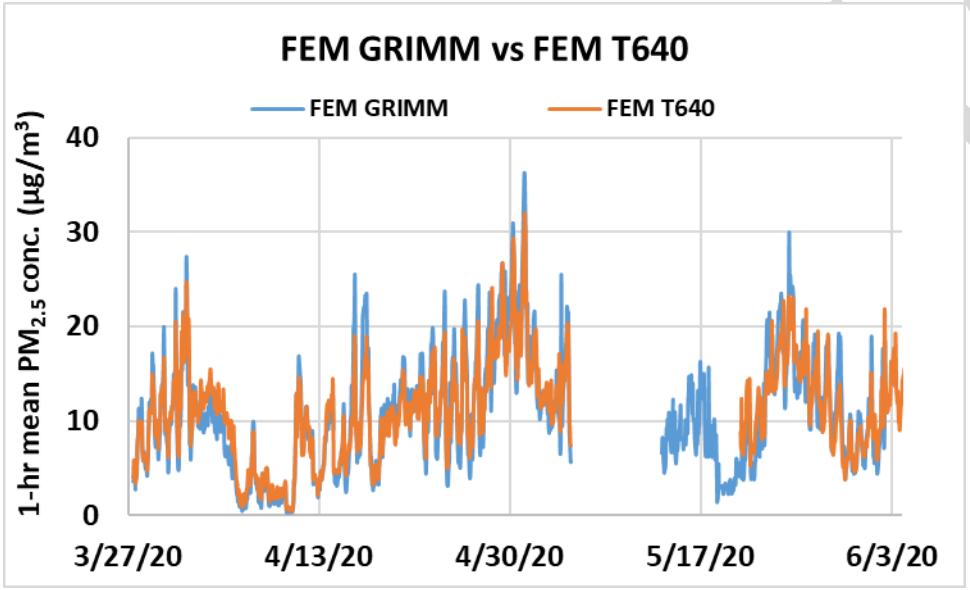
- Absolute intra-model variability was ~ 1.16 and 1.59 µg/m^3 for $PM_{2.5}$ and $PM_{10,}$ respectively (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 12.9% and 11.5 % for $PM_{2.5}$ and $PM_{10,}$ respectively (calculated as the absolute intra-model variability relative to the mean of the three sensor means)

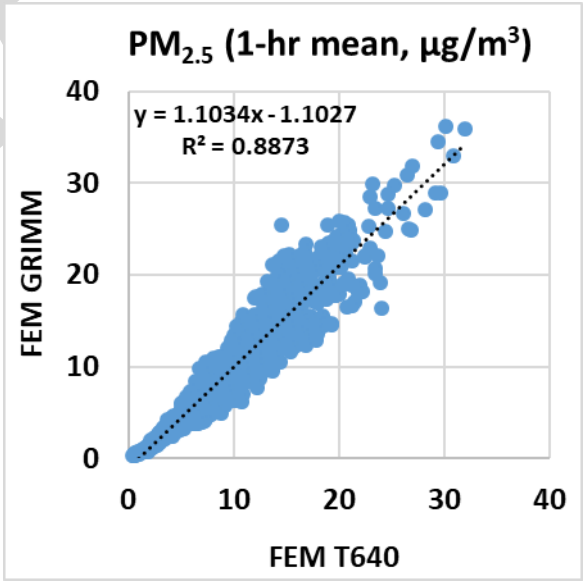




Reference Instruments: $PM_{2.5}$ GRIMM and T640

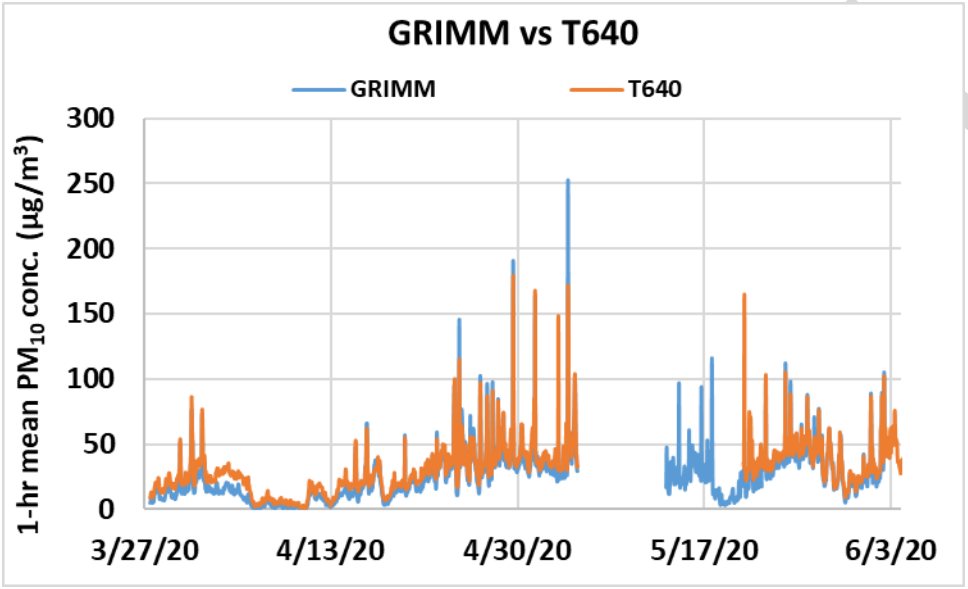
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for $PM_{2.5}$ measurements from FEM GRIMM and FEM T640 was ~ 100% and 78%, respectively
- Strong correlations between the reference instruments for $PM_{2.5}$ measurements (R^2 ~ 0.89)

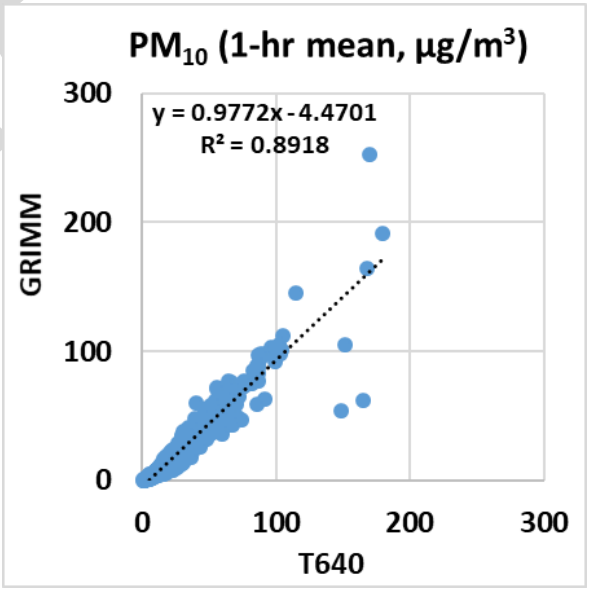




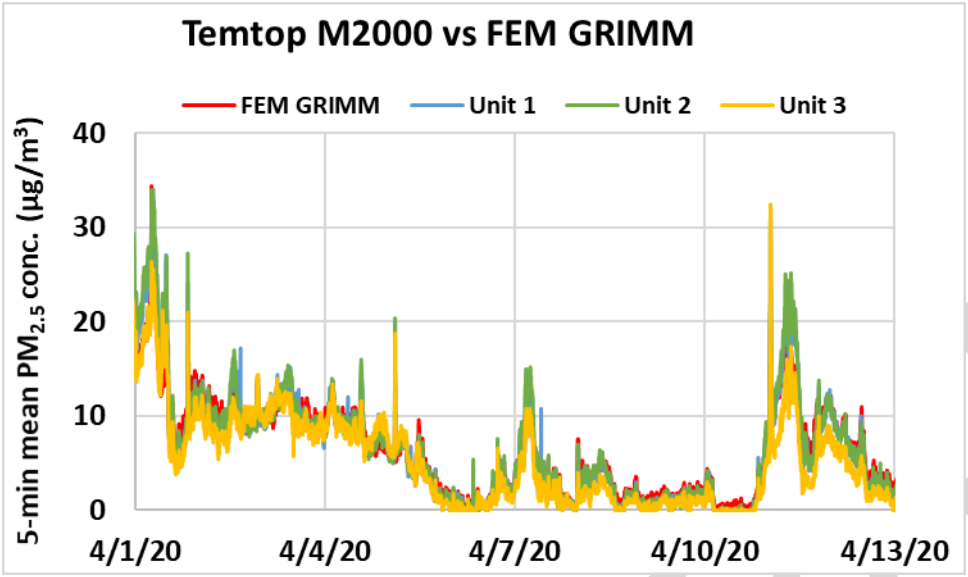
Reference Instruments: PM_{10} GRIMM and T640

- 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} measurements from GRIMM and T640 was ~ 100% and 78%, respectively.
- Strong correlations between the reference instruments for PM_{10} measurements (R^2 ~ 0.89) were observed.

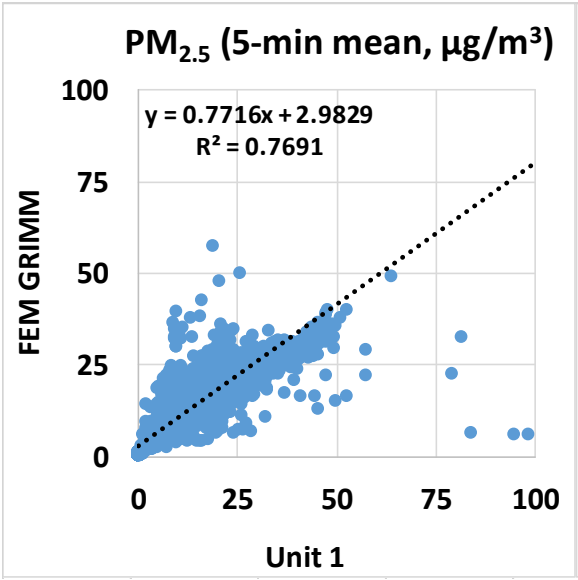


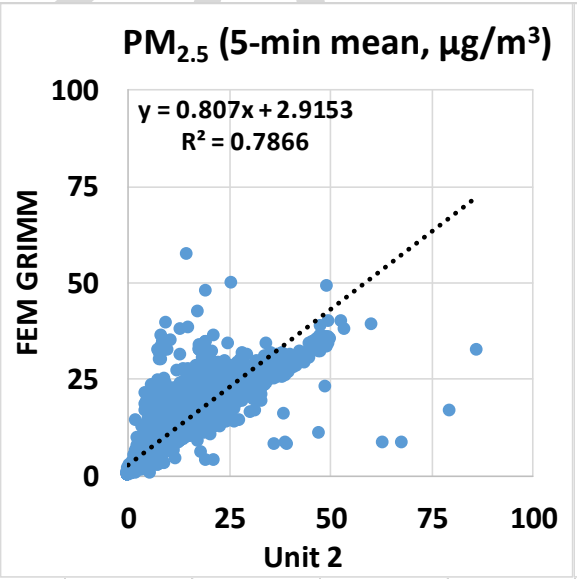


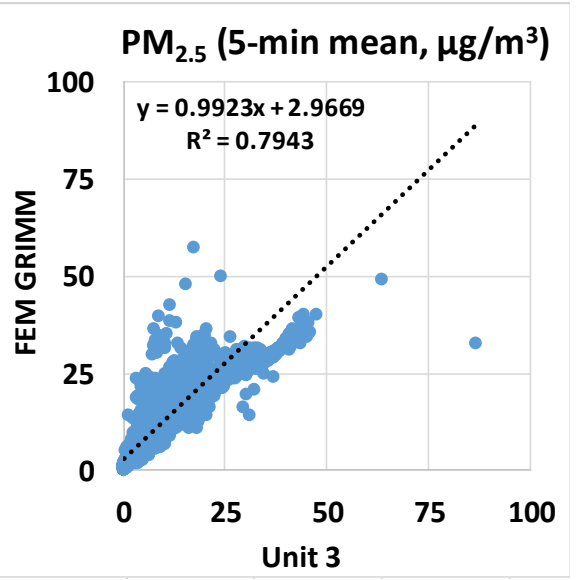
Temtop M2000 vs FEM GRIMM ($PM_{2.5}$; 5-min mean)



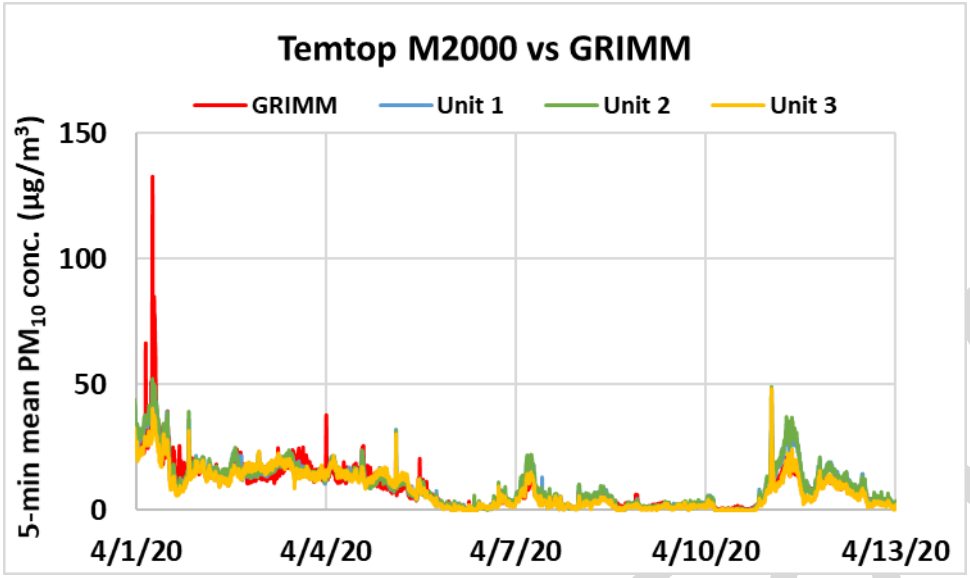
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM data (R^2 ~ 0.78)
- Overall, the Temtop M2000 sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM GRIMM
- The Temtop M2000 sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM GRIMM



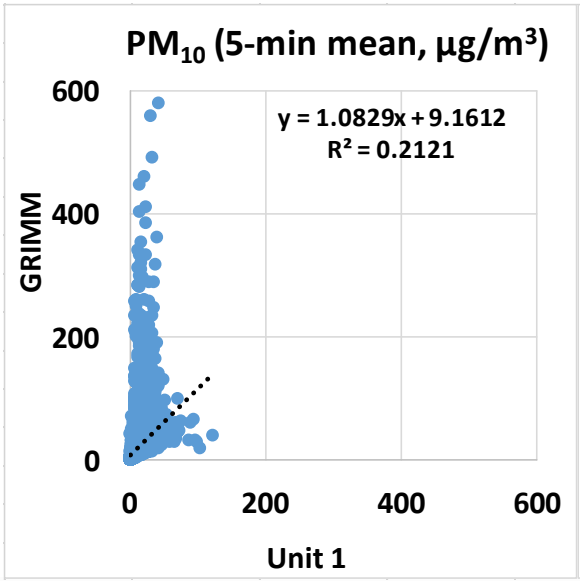


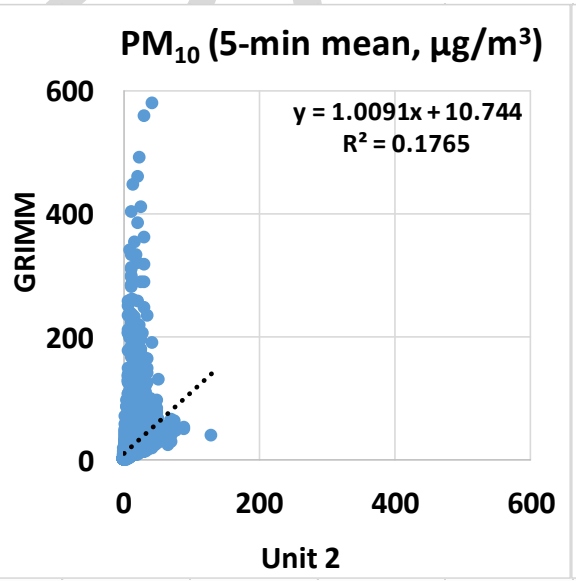


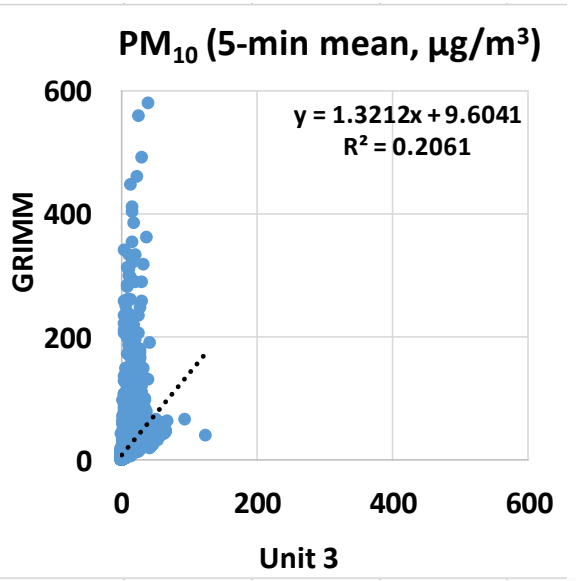
Temtop M2000 vs GRIMM (PM_{10}; 5-min mean)



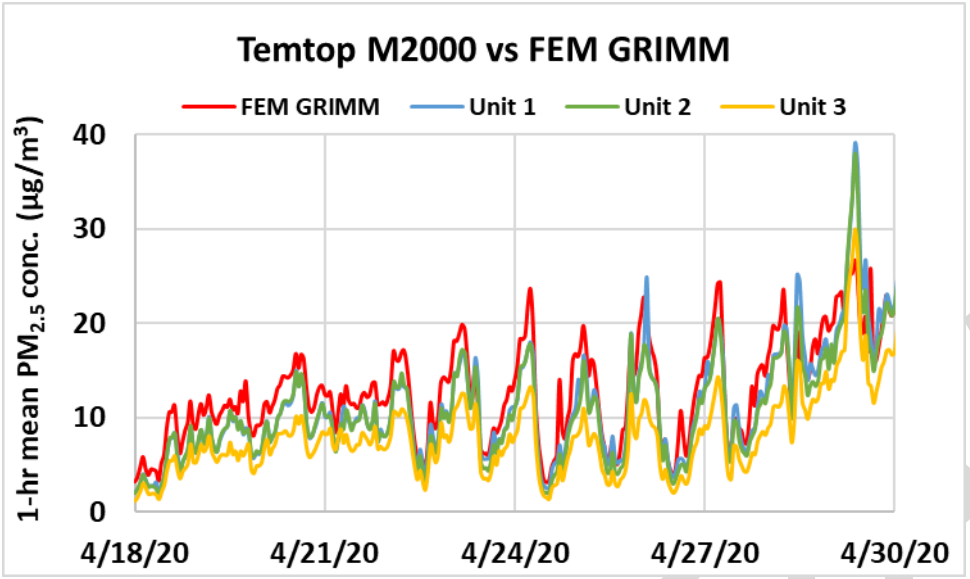
- The Temtop M2000 sensors showed very weak correlations with the corresponding GRIMM data (R^2 ~ 0.20)
- Overall, the Temtop M2000 sensors underestimated the PM_{10} mass concentrations measured by GRIMM
- The Temtop M2000 sensors did not seem to track the PM_{10} diurnal variations as recorded by GRIMM



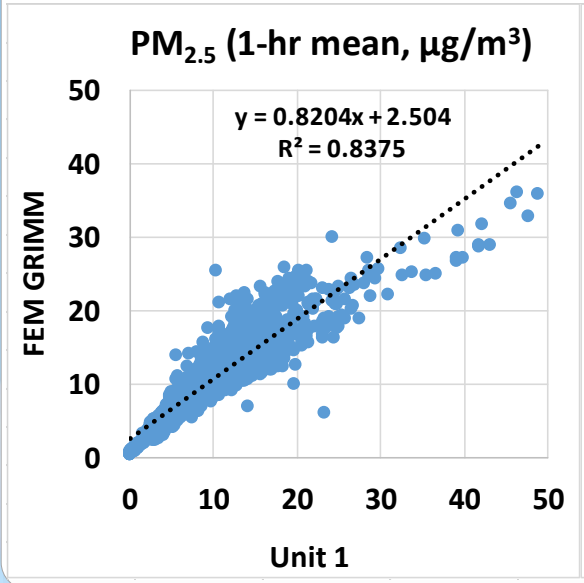


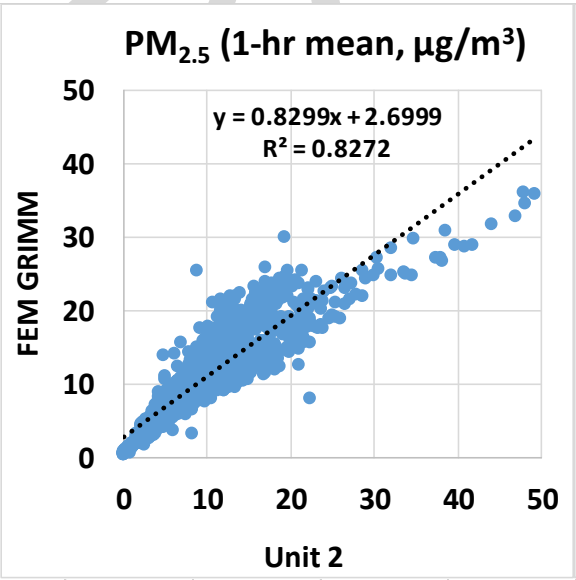


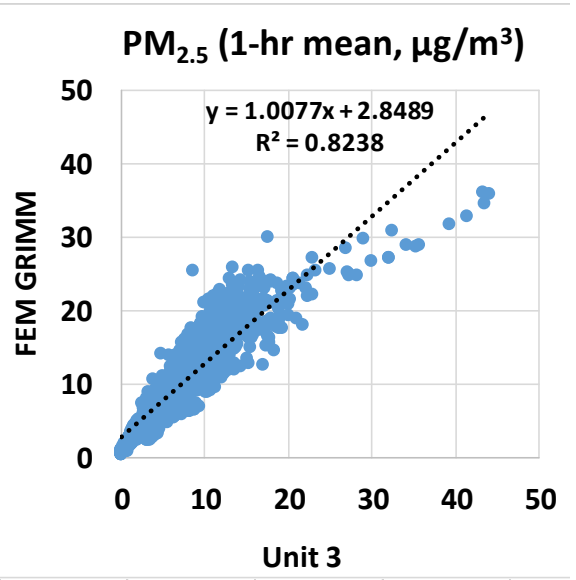
Temtop M2000 vs FEM GRIMM ($PM_{2.5}$; 1-hr mean)



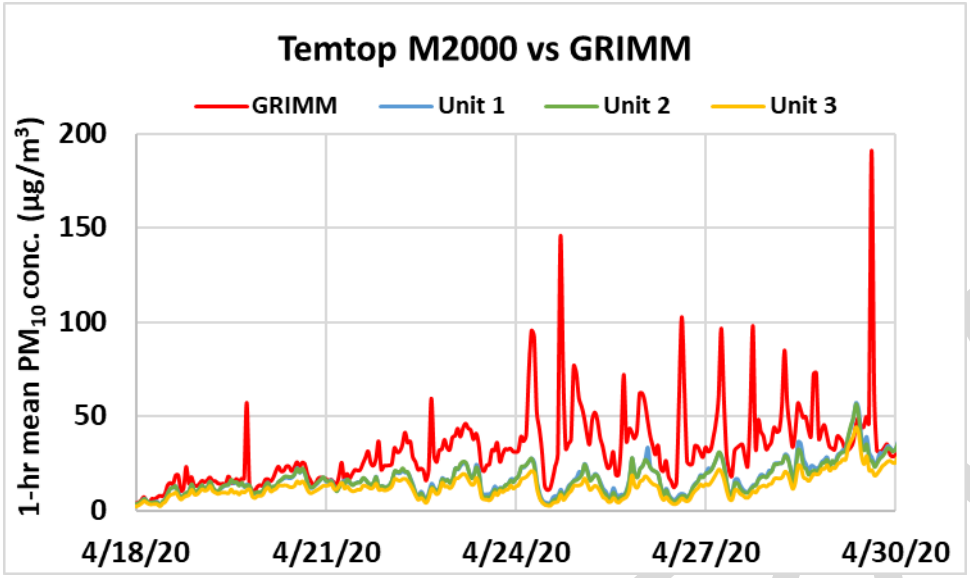
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM data (R^2 ~ 0.83)
- Overall, the Temtop M2000 sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM GRIMM
- The Temtop M2000 sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM GRIMM



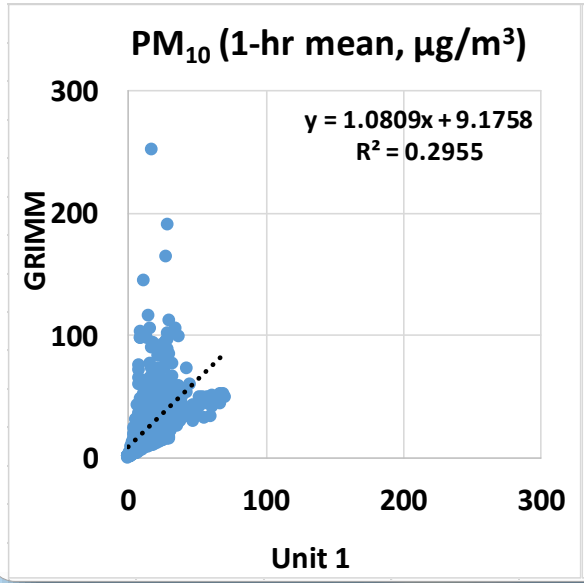


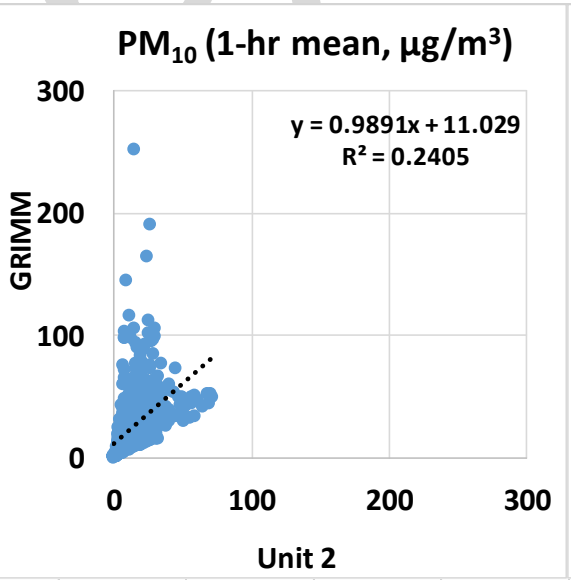


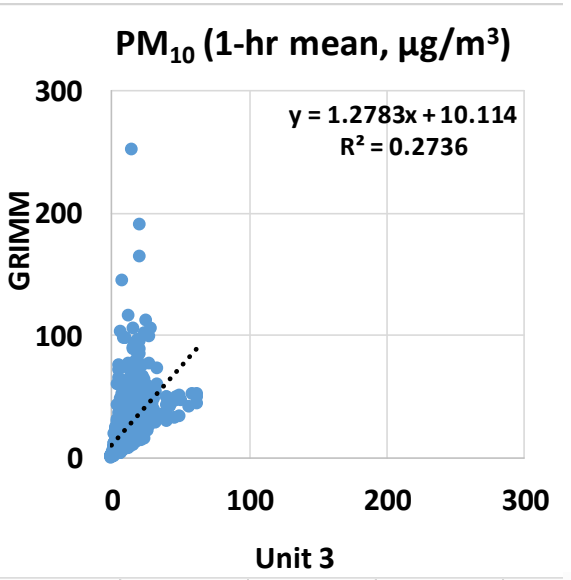
Temtop M2000 vs GRIMM (PM_{10}; 1-hr mean)



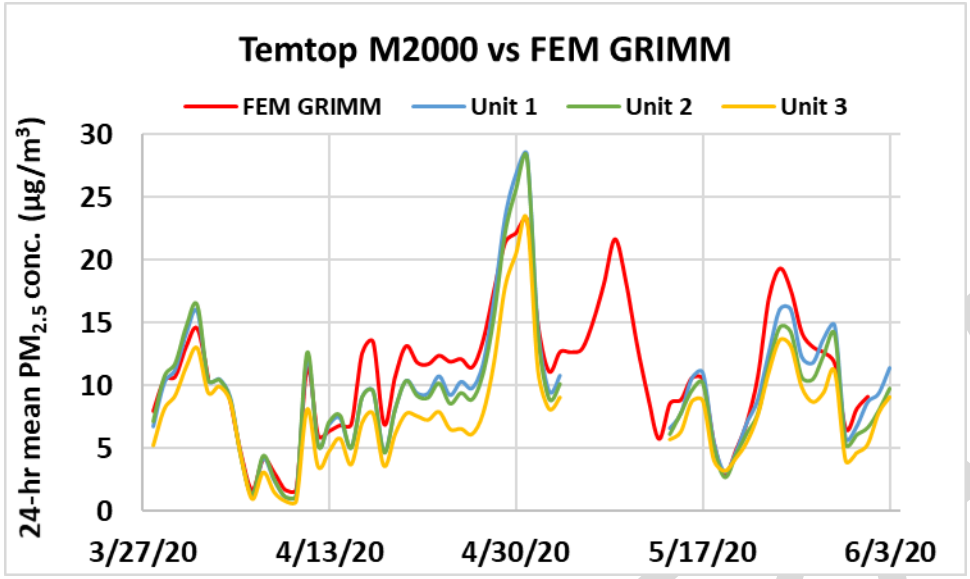
- The Temtop M2000 sensors showed very weak with the corresponding GRIMM data (R^2 ~ 0.27)
- Overall, the Temtop M2000 sensors underestimated the PM_{10} mass concentrations measured by GRIMM
- The Temtop M2000 sensors did not seem to track the PM_{10} diurnal variations as recorded by GRIMM



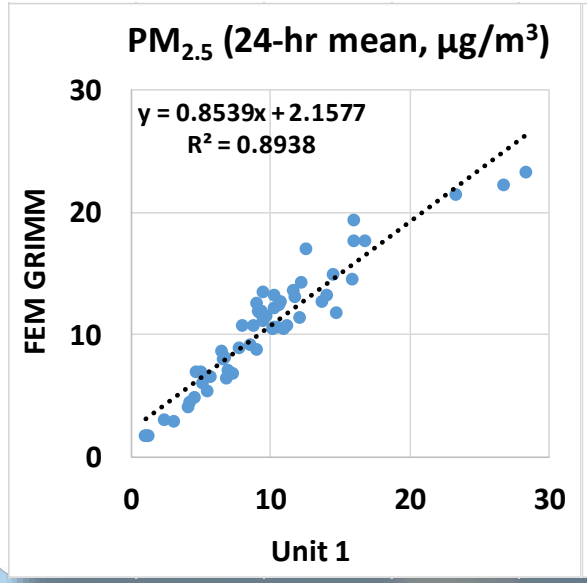


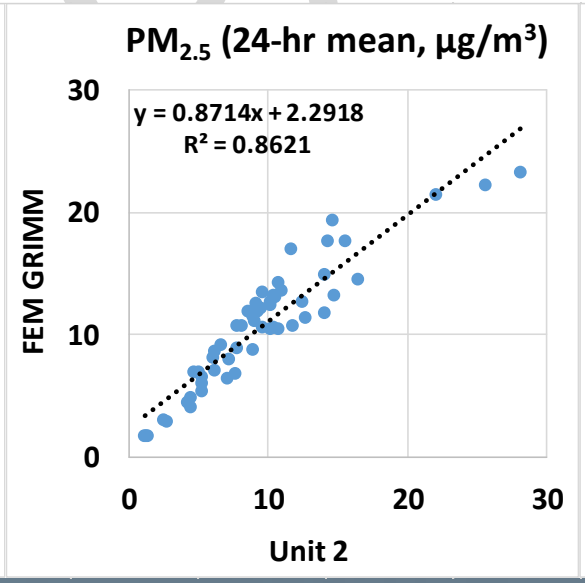


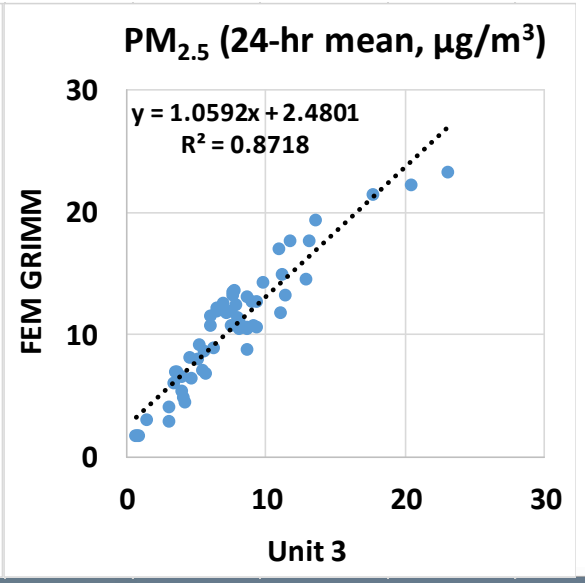
Temtop M2000 vs FEM GRIMM ($PM_{2.5}$; 24-hr mean)



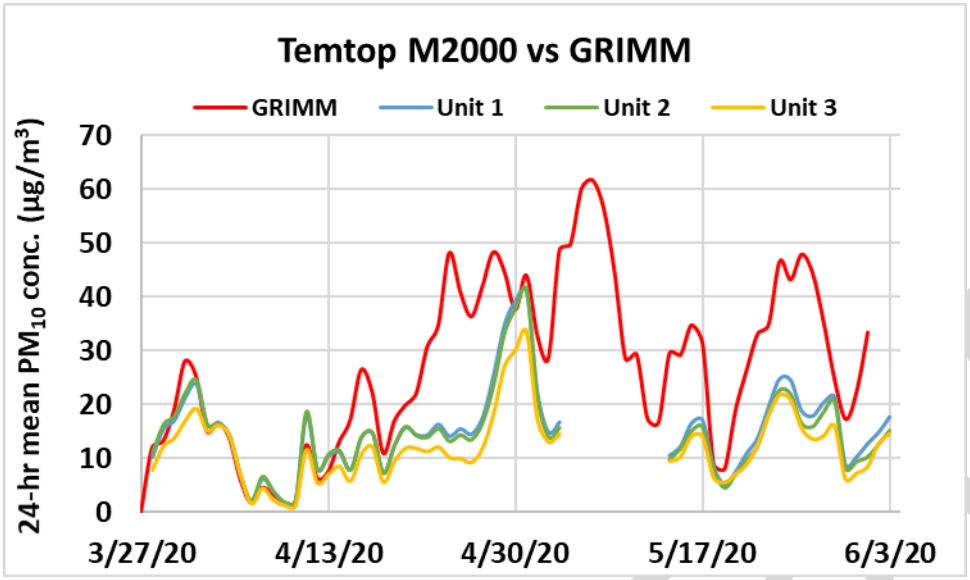
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM data (R^2 ~ 0.88)
- Overall, the Temtop M2000 sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM GRIMM
- The Temtop M2000 sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM GRIMM



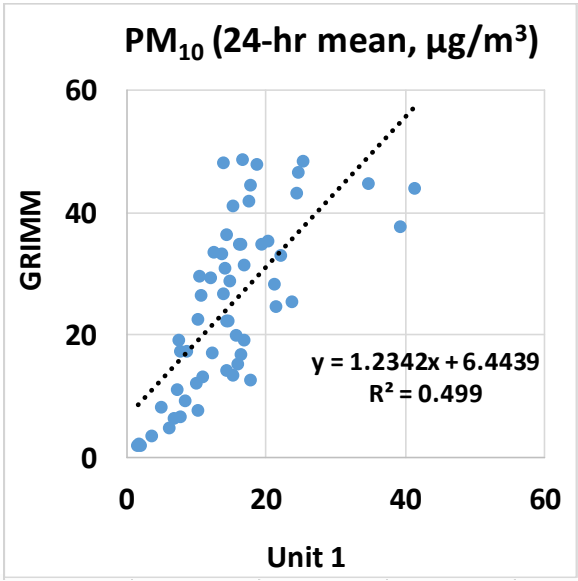


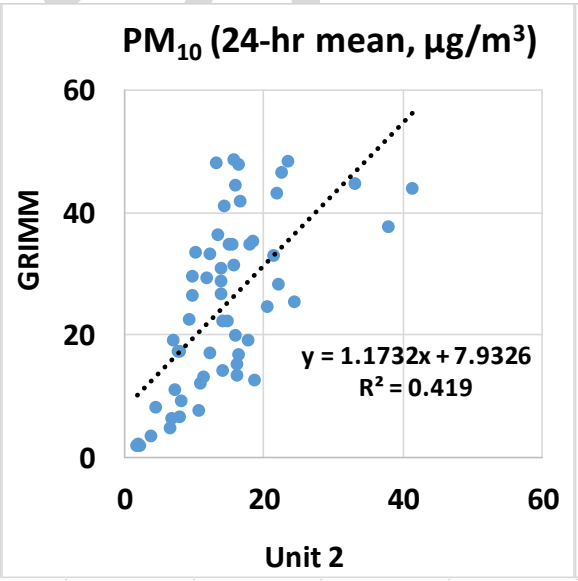


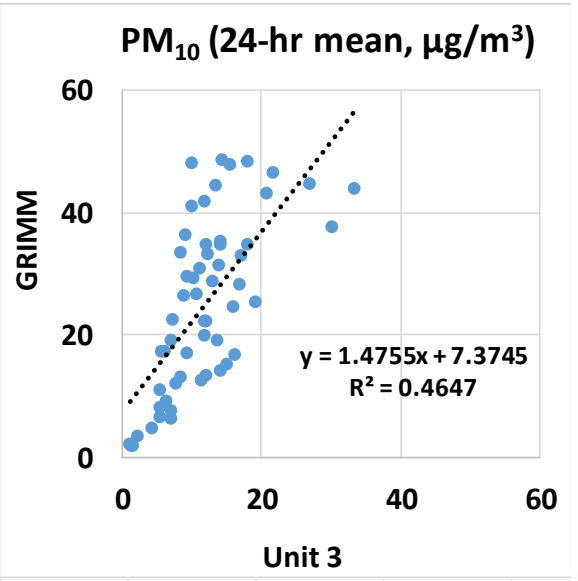
Temtop M2000 vs GRIMM (PM_{10}; 24-hr mean)



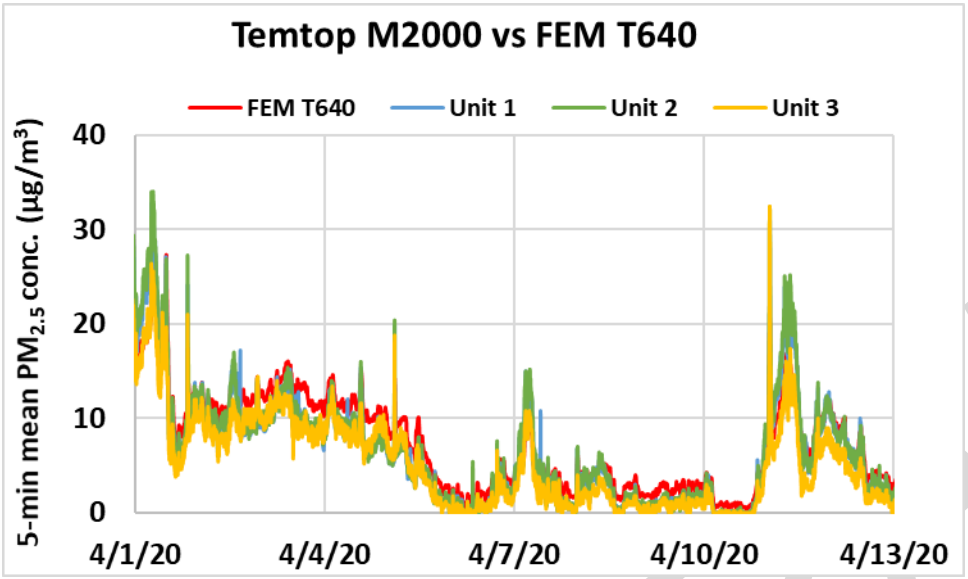
- The Temtop M2000 sensors showed weak correlations with the corresponding GRIMM data (R^2 ~ 0.46)
- Overall, the Temtop M2000 sensors underestimated the PM_{10} mass concentrations measured by GRIMM
- The Temtop M2000 sensors did not seem to track the PM_{10} diurnal variations as recorded by GRIMM



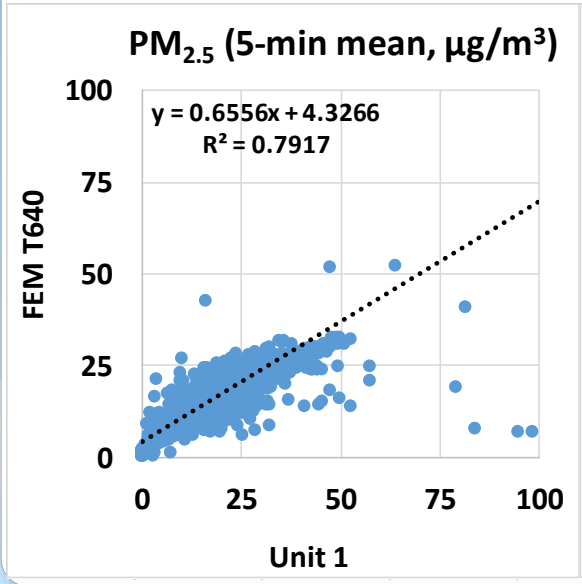


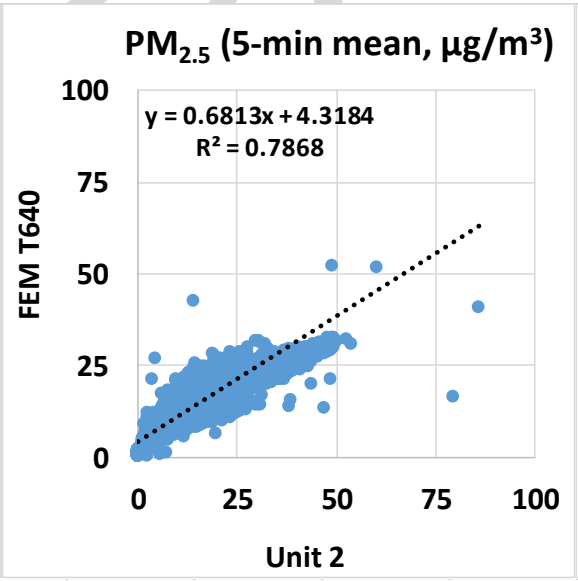


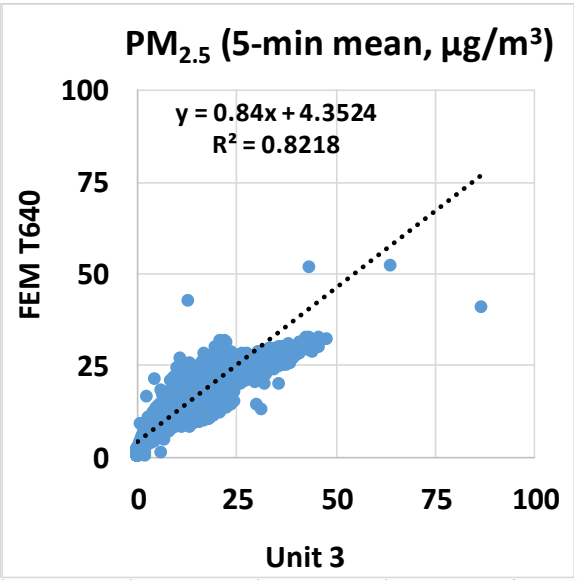
Temtop M2000 vs FEM T640 ($PM_{2.5}$; 5-min mean)



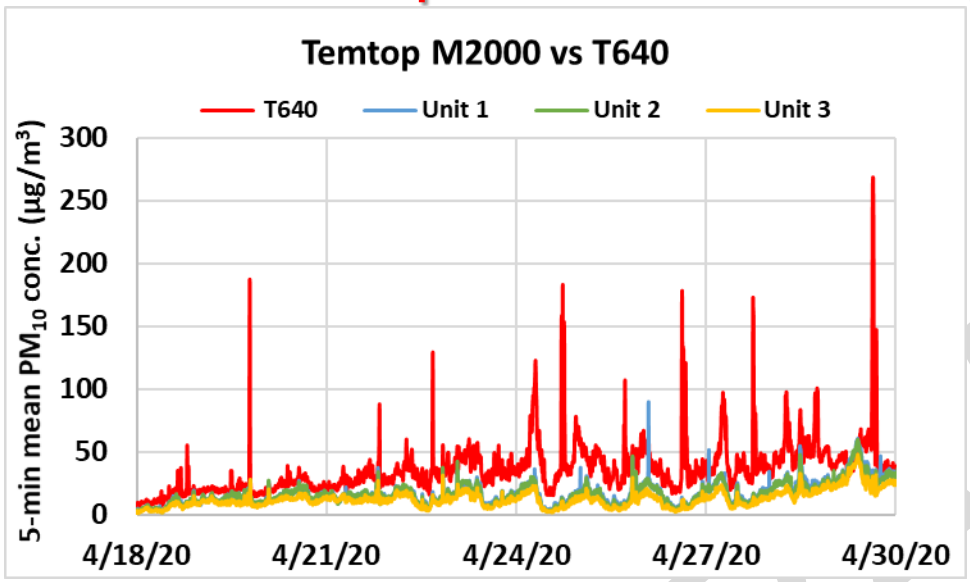
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM T640 data (R^2 ~ 0.80)
- Overall, the Temtop M2000 sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM T640
- The Temtop M2000 sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM T640



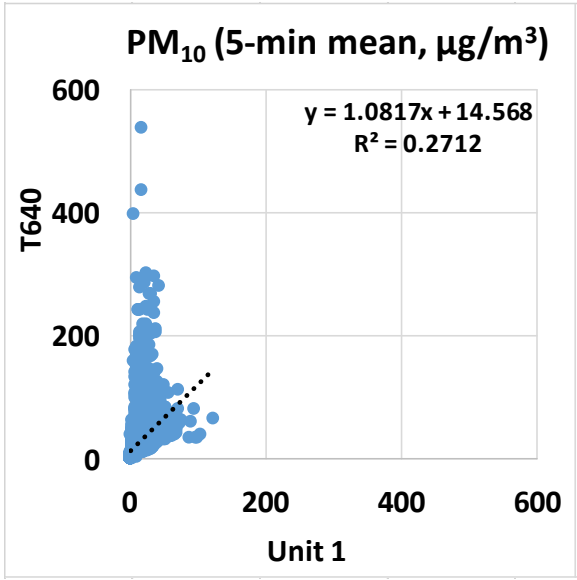


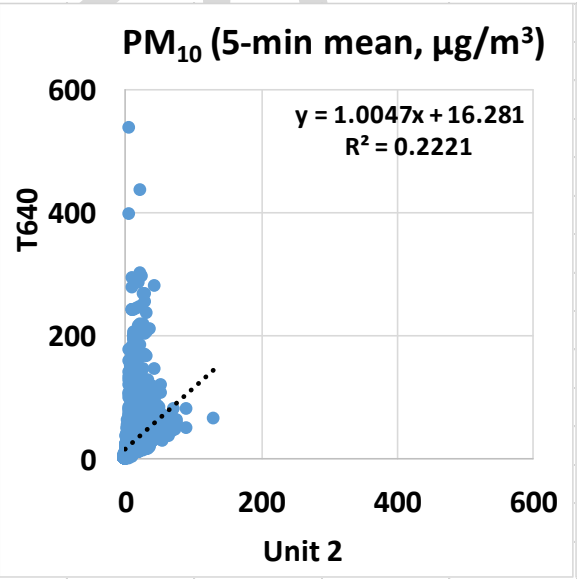


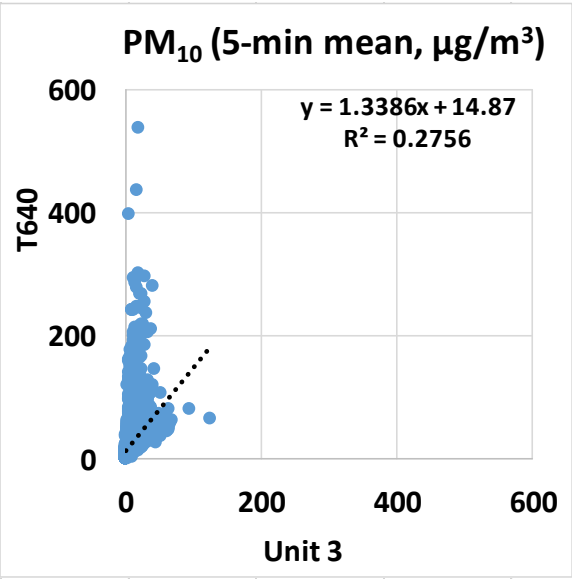
Temtop M2000 vs T640 (PM_{10}; 5-min mean)



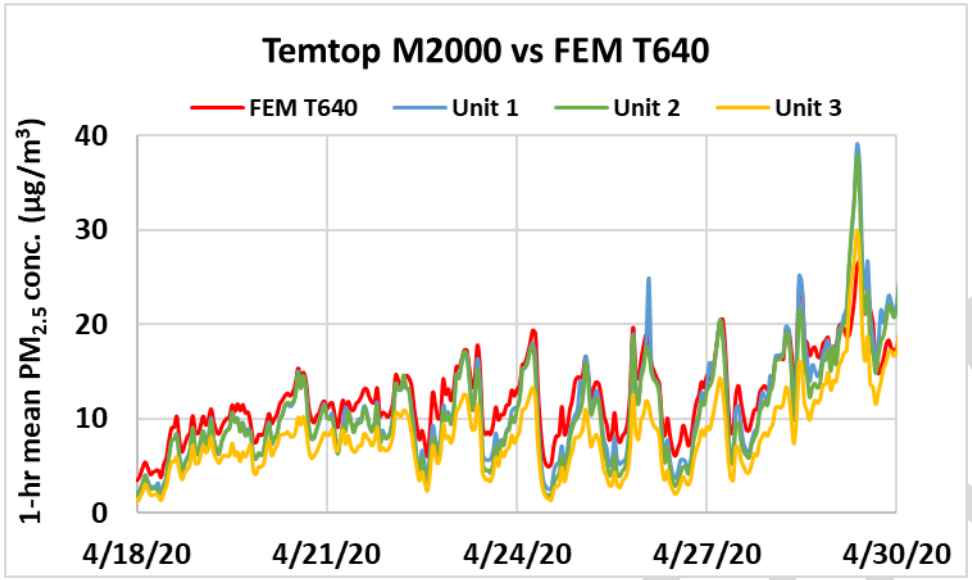
- The Temtop M2000 sensors showed very weak correlations with the corresponding T640 data (R^2 ~ 0.26)
- Overall, the Temtop M2000 sensors underestimated the PM_{10} mass concentrations as measured by T640
- The Temtop M2000 sensors did not seem to track the PM_{10} diurnal variations as recorded by T640



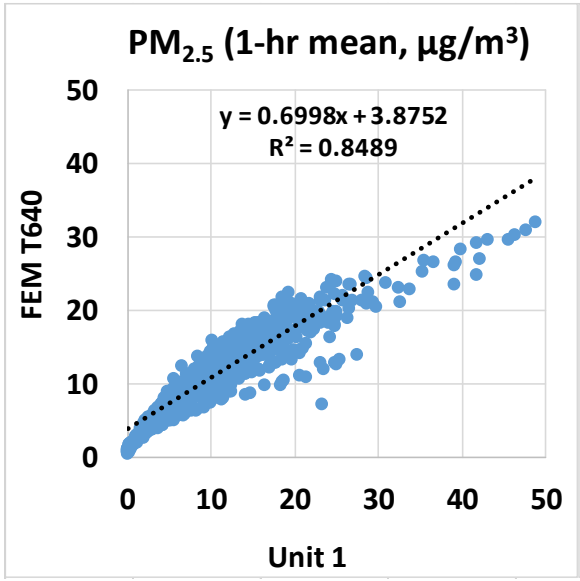


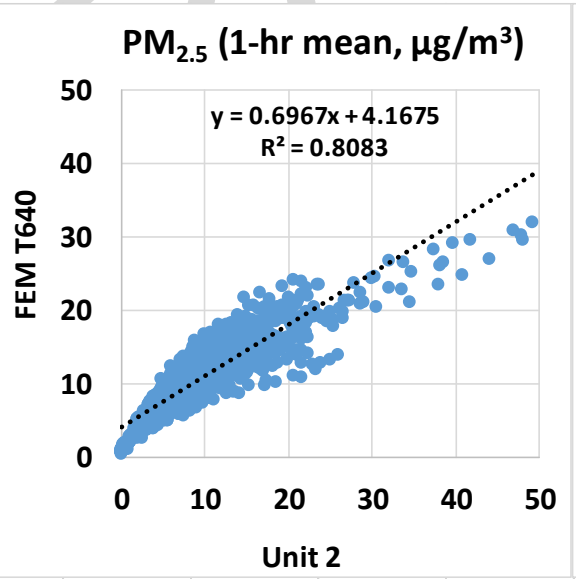


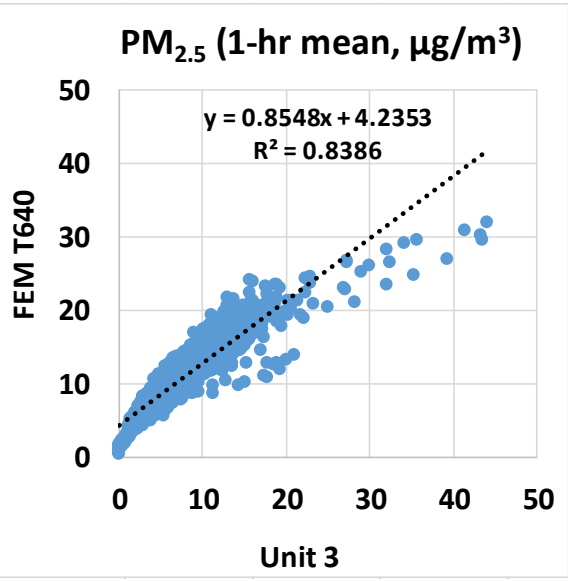
Temtop M2000 vs FEM T640 ($PM_{2.5}$; 1-hr mean)



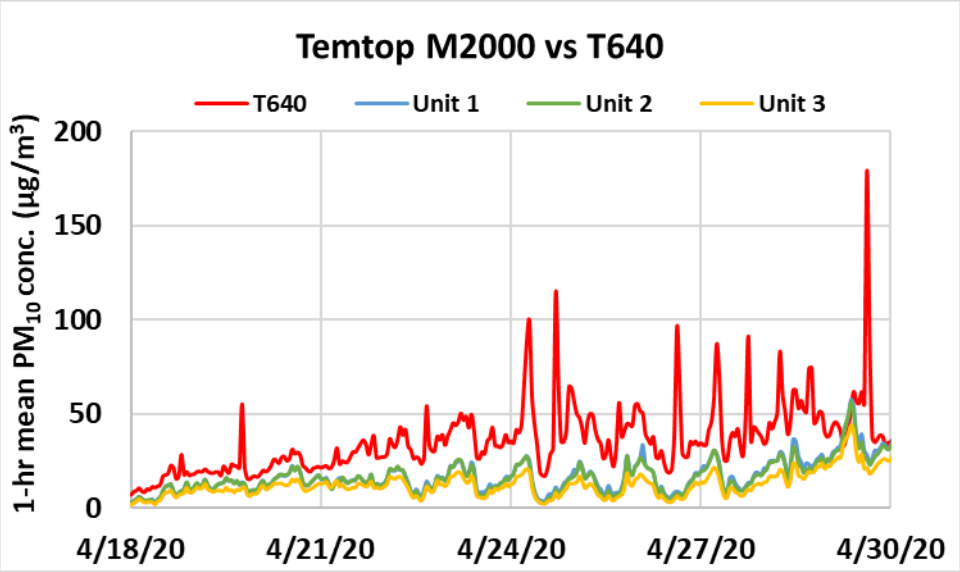
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM T640 data (R^2 ~ 0.83)
- Overall, the Temtop M2000 sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM T640
- The Temtop M2000 sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM T640



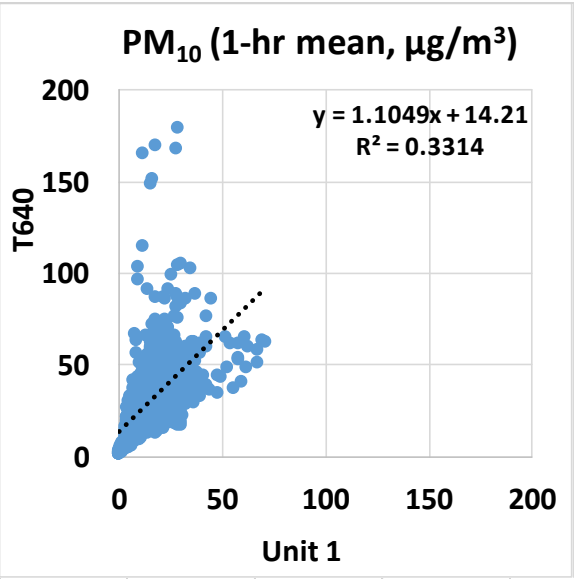


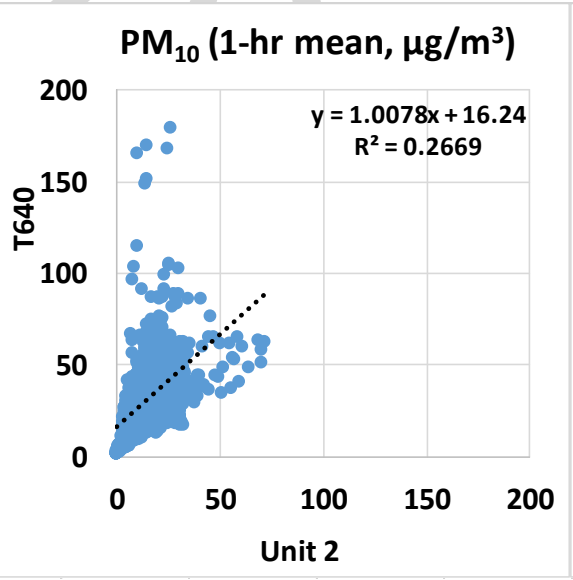


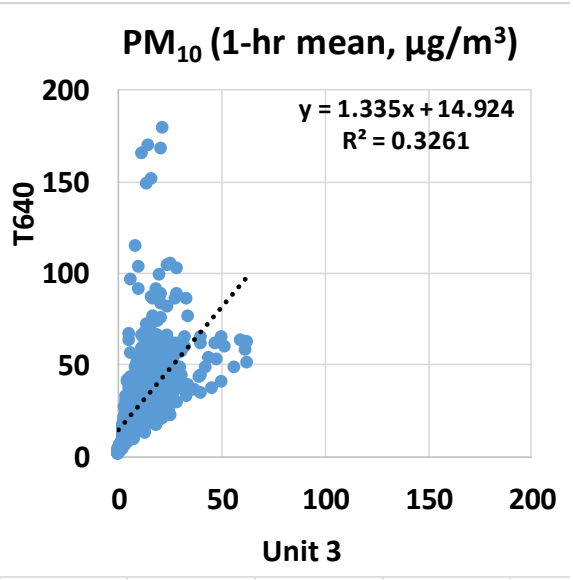
Temtop M2000 vs T640 (PM_{10}; 1-hr mean)



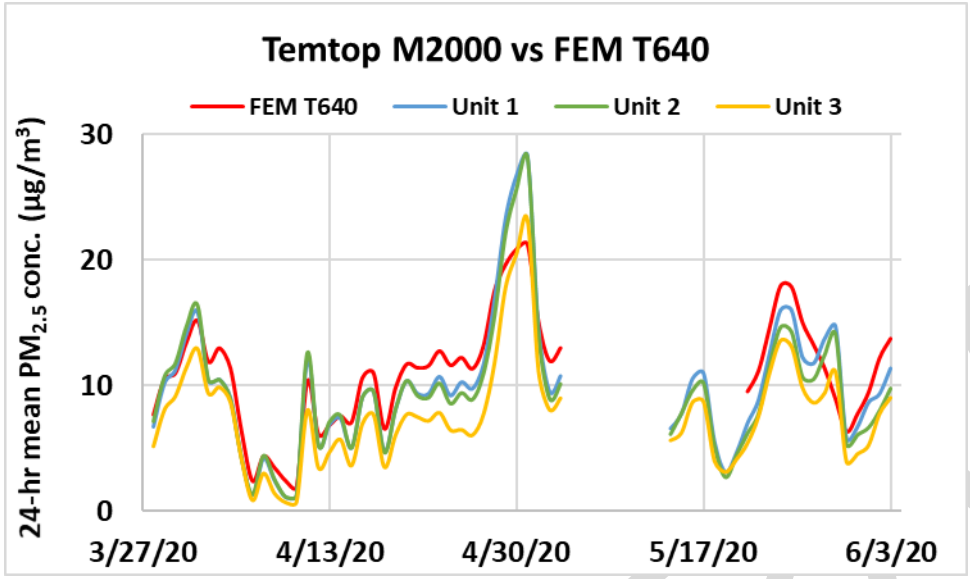
- The Temtop M2000 sensors showed weak correlations with the corresponding T640 data (R^2 ~ 0.31)
- Overall, the Temtop M2000 sensors underestimated the PM_{10} mass concentrations as measured by T640
- The Temtop M2000 sensors did not seem to track the PM_{10} diurnal variations as recorded by T640



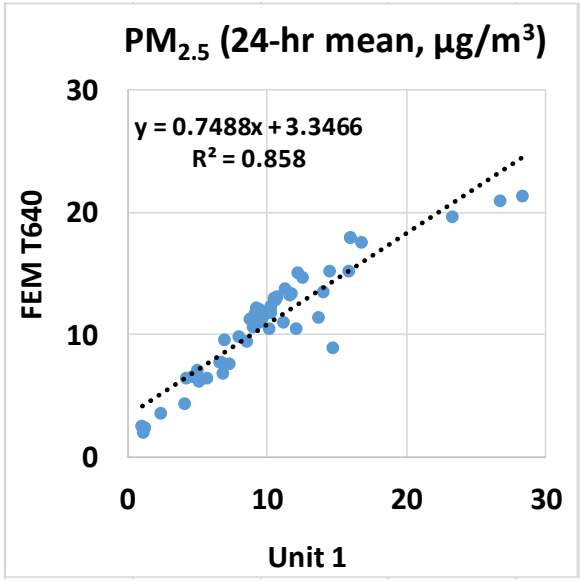


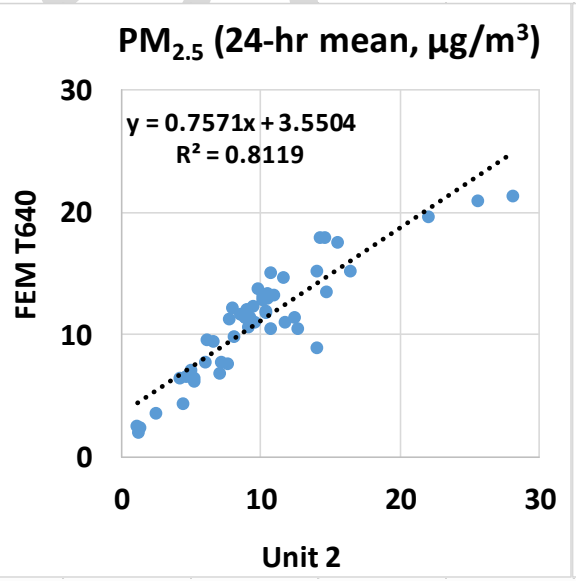


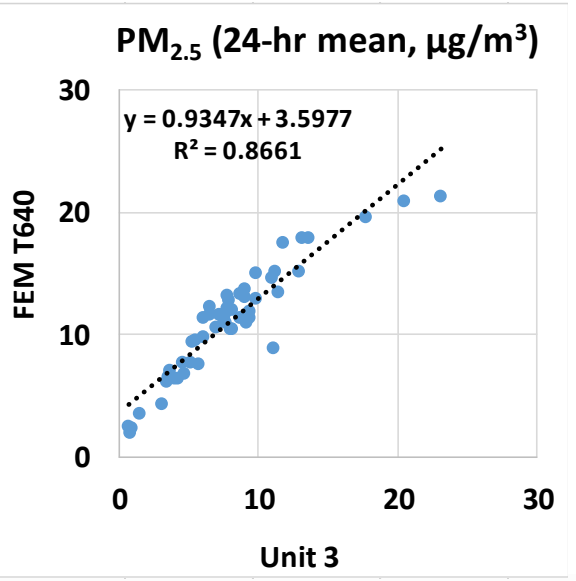
Temtop M2000 vs FEM T640 ($PM_{2.5}$; 24-hr mean)



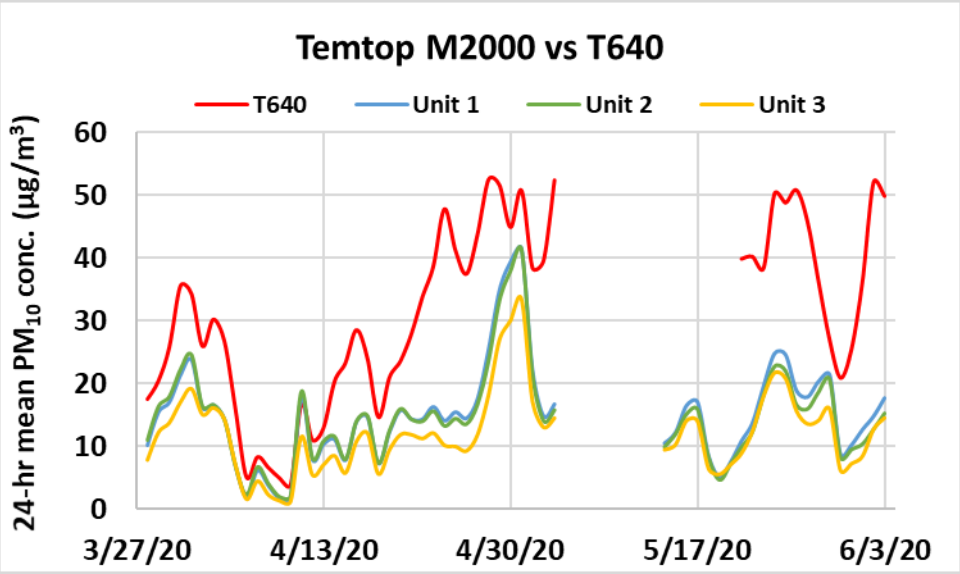
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM T640 data (R^2 ~ 0.84)
- Overall, the Temtop M2000 sensors underestimated the $PM_{2.5}$ mass concentrations as measured by FEM T640
- The Temtop M2000 sensors seemed to track the $PM_{2.5}$ diurnal variations as recorded by FEM T640



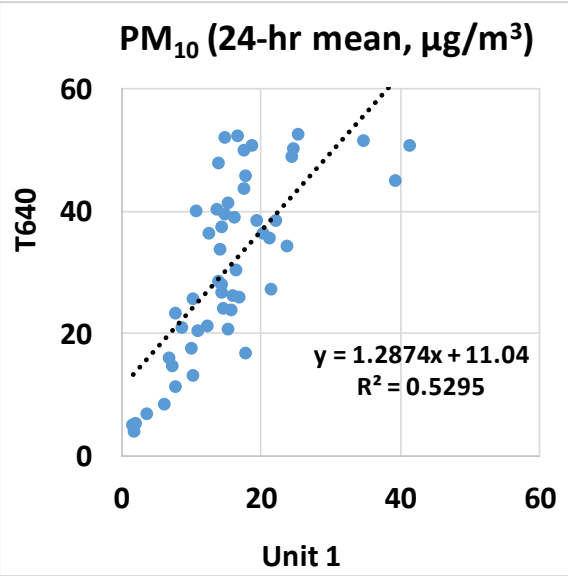


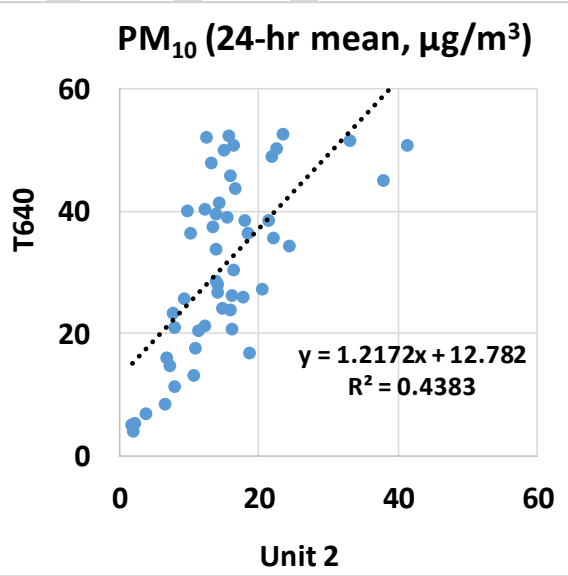


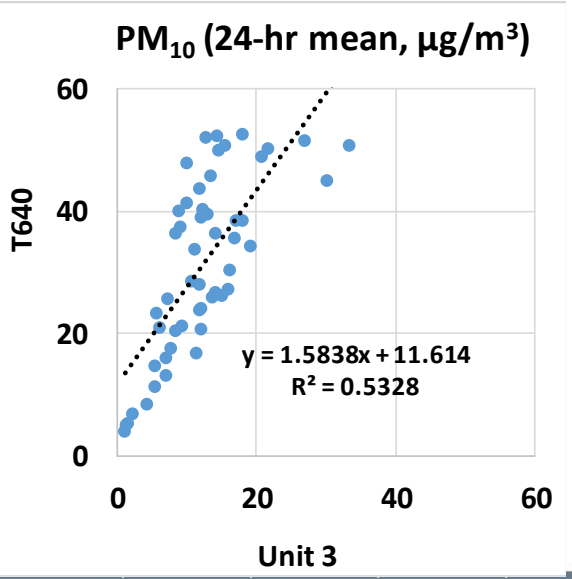
Temtop M2000 vs T640 (PM_{10}; 24-hr mean)



- The Temtop M2000 sensors showed moderate correlations with the corresponding T640 data (R^2 ~ 0.50)
- Overall, the Temtop M2000 sensors underestimated the PM_{10} mass concentrations as measured by T640
- The Temtop M2000 sensors did not seem to track the PM_{10} diurnal variations as recorded by T640







Discussion

- The three **Temtop M2000** sensors' data recovery from units Unit 1, Unit 2 and Unit 3 ~ 100% for both $PM_{2.5}$ and PM_{10} measurements
- The absolute intra-model variability was ~ 1.16 and 1.59 µg/m^3 for $PM_{2.5}$ and $PM_{10,}$ respectively
- Strong correlations between FEM GRIMM and FEM T640 for $PM_{2.5}$ (R^2 ~ 0.89, 1-hr mean) and PM_{10} (R^2 ~ 0.89, 1-hr mean) mass concentration measurements
- $PM_{2.5}$ mass concentrations measured by Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM and FEM T640 data (R^2 ~ 0.83 and 0.83, respectively, 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 Temtop M2000 sensors showed very weak to weak correlations with the GRIMM and T640 data (R^2 ~ 0.27 and 0.31, respectively; 1-hr mean) and underestimated PM_{10} mass concentrations measured by GRIMM and T640
- No sensor calibration was performed by South Coast AQMD 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