

# Field Evaluation Elitech Temtop M2000



# Background

- From 03/27/2020 to 06/04/2020, three **Elitech Temtop M2000** (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 (3 units tested):
  - Particle sensor: **optical; non-FEM (PM200, Temtop)**
  - Each unit reports:  $PM_{2.5}$  and  $PM_{10}$  ( $\mu\text{g}/\text{m}^3$ )
  - Unit also measures:  $\text{CO}_2$  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  $PM_{10}$  ( $\mu\text{g}/\text{m}^3$ )
  - **Cost: ~\$25,000 and up**
  - Time resolution: 1-min
- Teledyne API T640 (reference instrument):
  - Optical particle counter (**FEM  $PM_{2.5}$** )
  - Measures  $PM_{2.5}$  &  $PM_{10}$  ( $\mu\text{g}/\text{m}^3$ )
  - **Unit cost: ~\$21,000**
  - Time resolution: 1-min

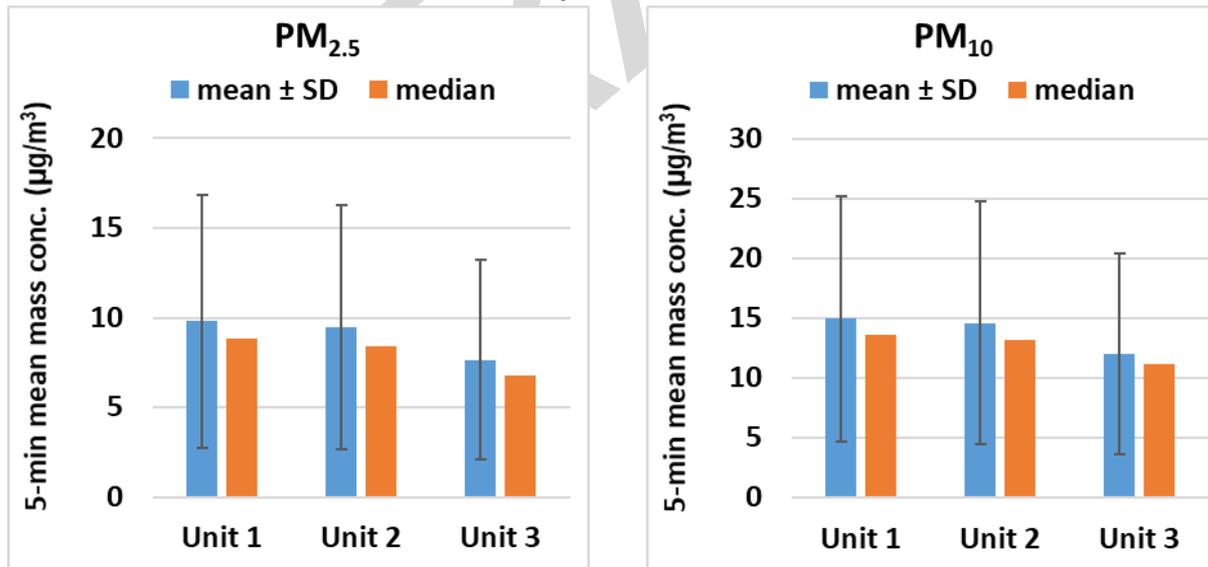


# Data validation & recovery

- 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<sub>2.5</sub> and PM<sub>10</sub> measurements

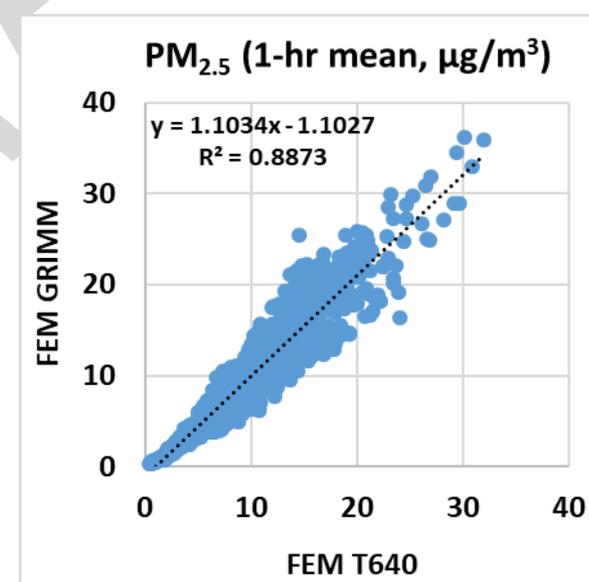
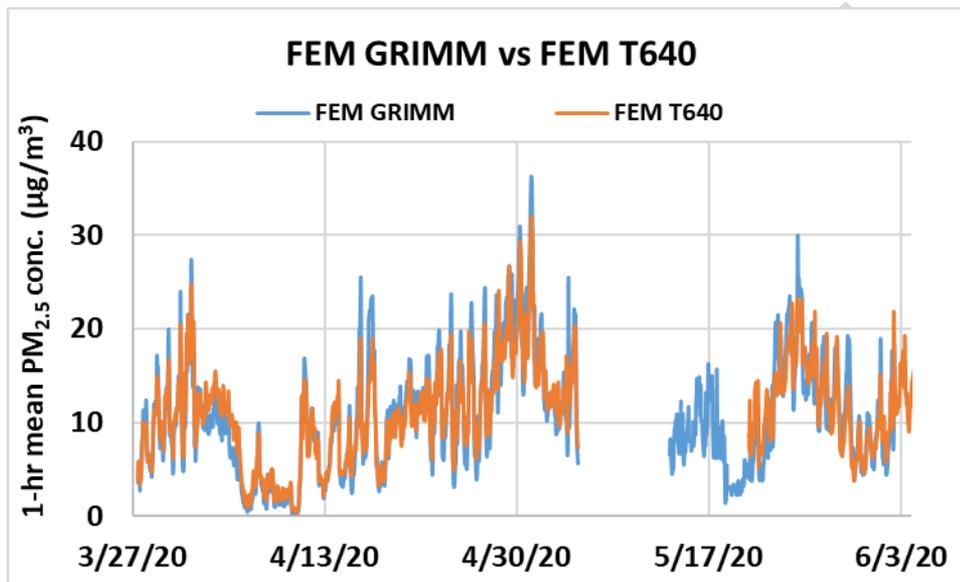
## Temtop M2000; intra-model variability

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



# Reference Instruments: PM<sub>2.5</sub> GRIMM and T640

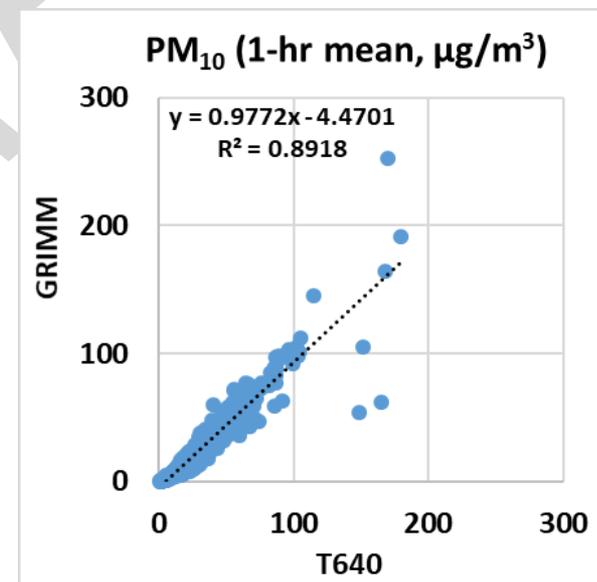
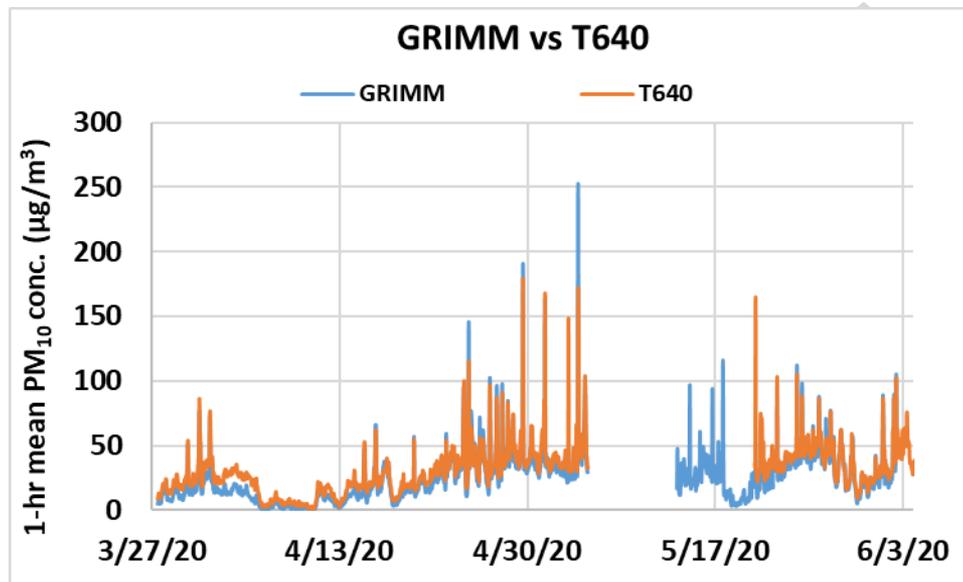
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM<sub>2.5</sub> measurements from FEM GRIMM and FEM T640 was ~ 100% and 78%, respectively
- Strong correlations between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



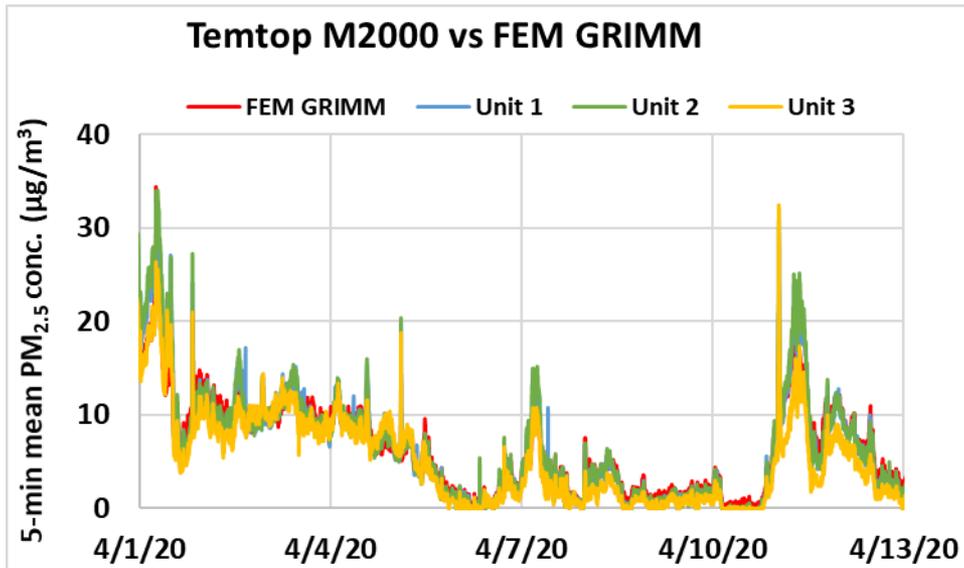
# Reference Instruments: PM<sub>10</sub>

## GRIMM and T640

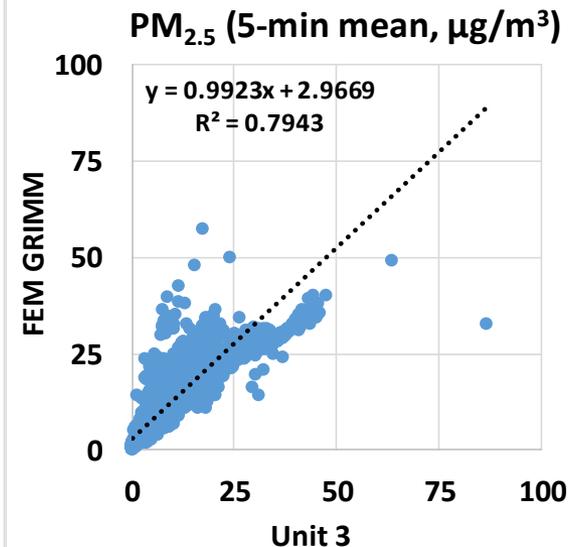
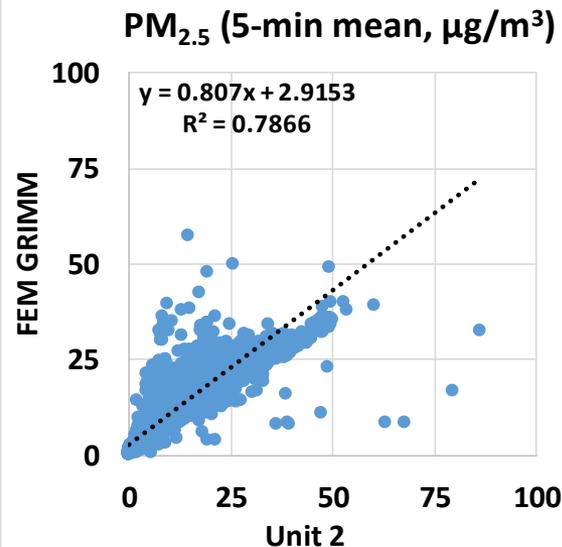
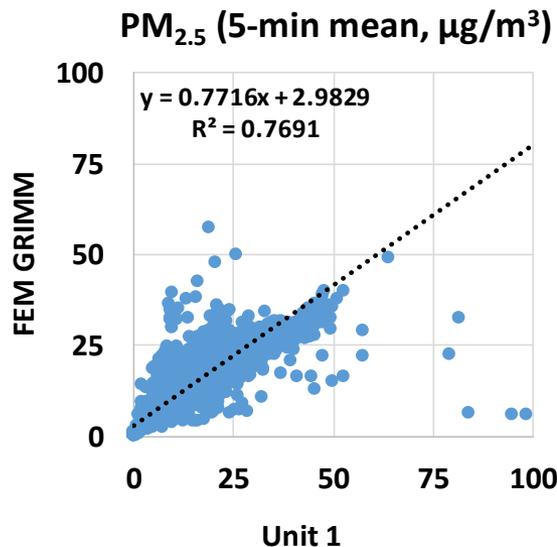
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM<sub>10</sub> measurements from GRIMM and T640 was ~ 100% and 78%, respectively.
- Strong correlations between the reference instruments for PM<sub>10</sub> measurements ( $R^2 \sim 0.89$ ) were observed.



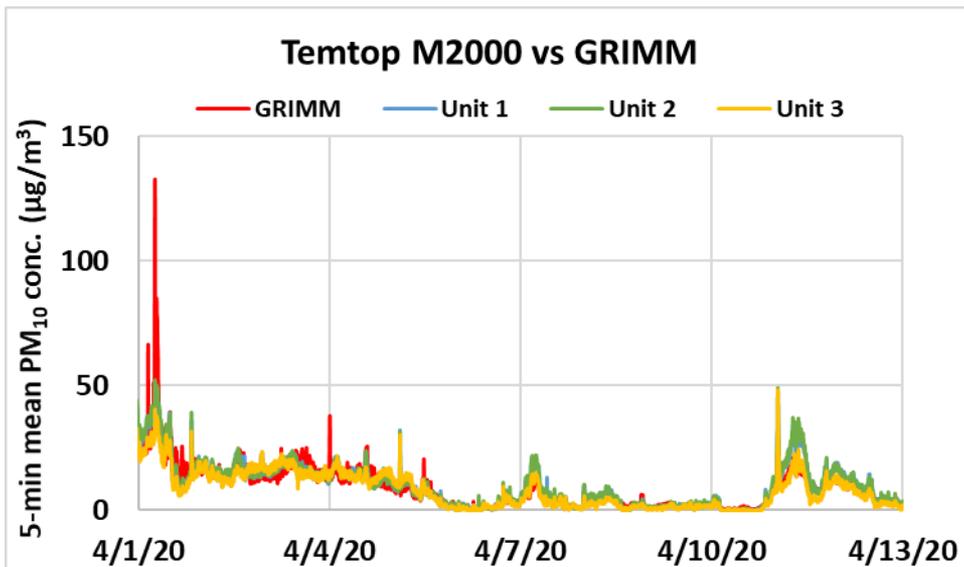
# Temtop M2000 vs FEM GRIMM (PM<sub>2.5</sub>; 5-min mean)



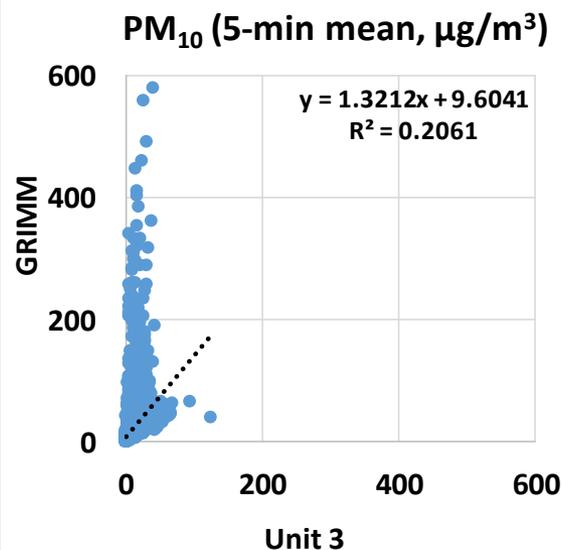
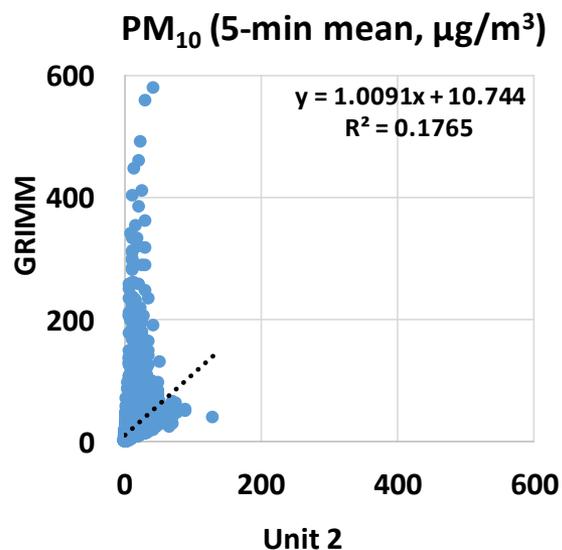
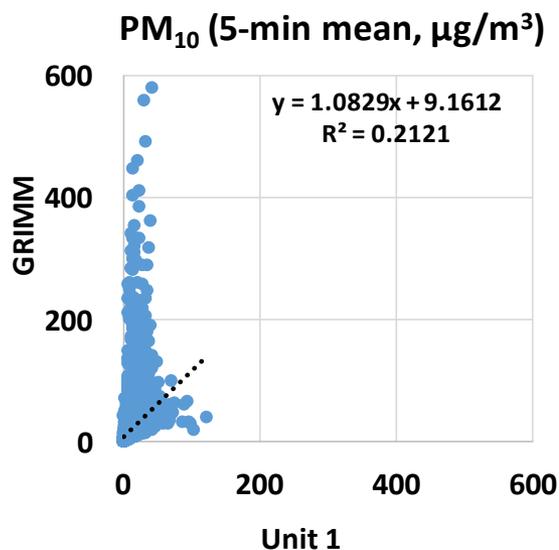
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM data ( $R^2 \sim 0.78$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>2.5</sub> mass concentrations as measured by FEM GRIMM
- The Temtop M2000 sensors seemed to track the PM<sub>2.5</sub> diurnal variations as recorded by FEM GRIMM



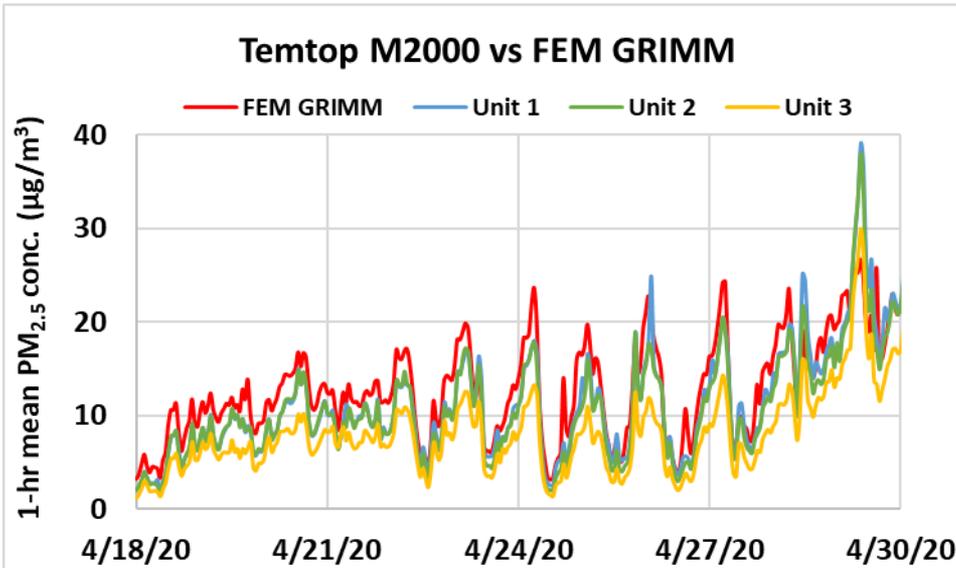
# Temtop M2000 vs GRIMM (PM<sub>10</sub>; 5-min mean)



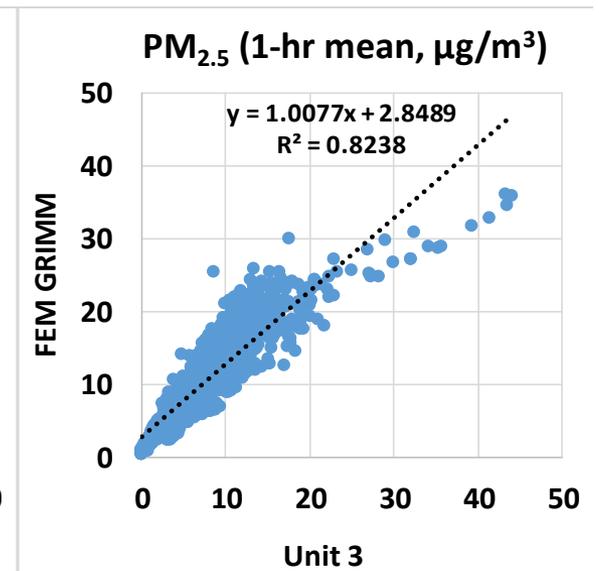
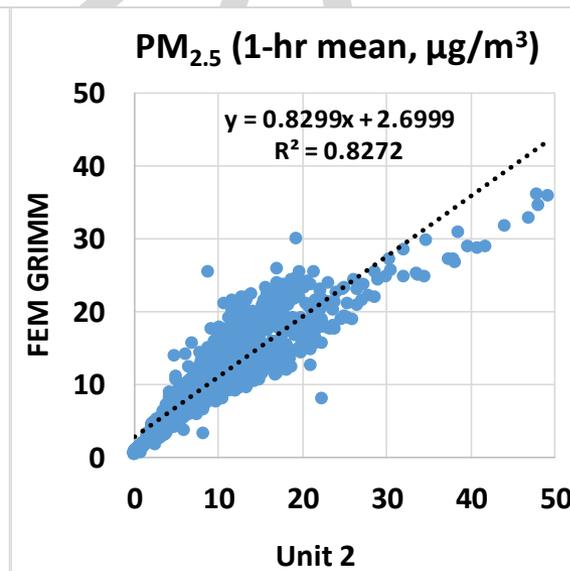
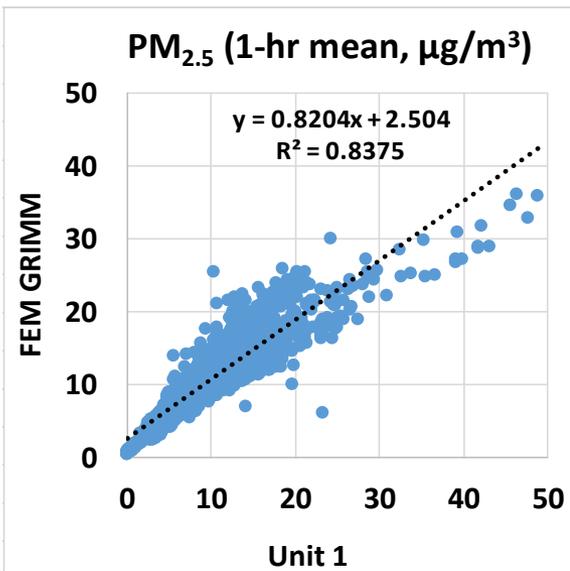
- The Temtop M2000 sensors showed very weak correlations with the corresponding GRIMM data ( $R^2 \sim 0.20$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>10</sub> mass concentrations measured by GRIMM
- The Temtop M2000 sensors did not seem to track the PM<sub>10</sub> diurnal variations as recorded by GRIMM



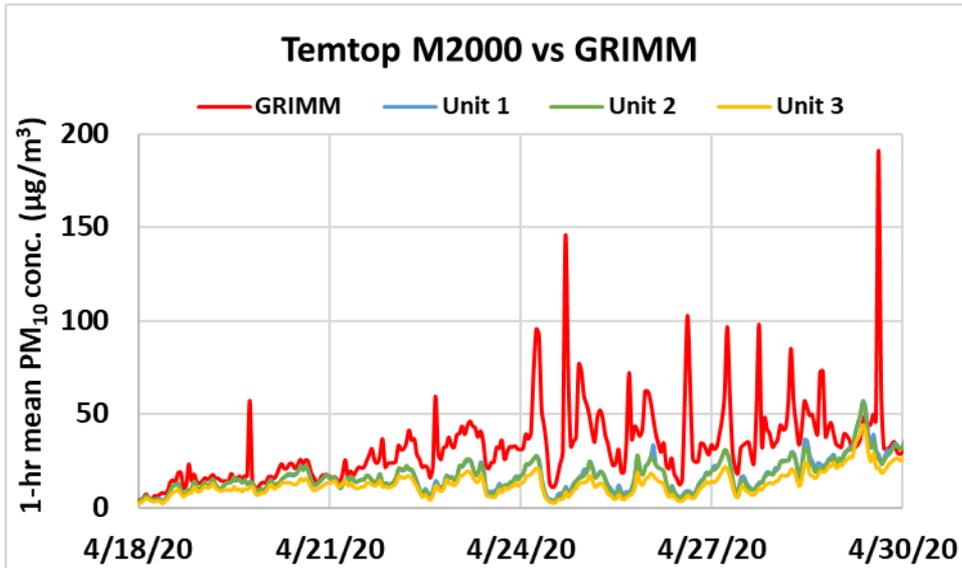
# Temtop M2000 vs FEM GRIMM (PM<sub>2.5</sub>; 1-hr mean)



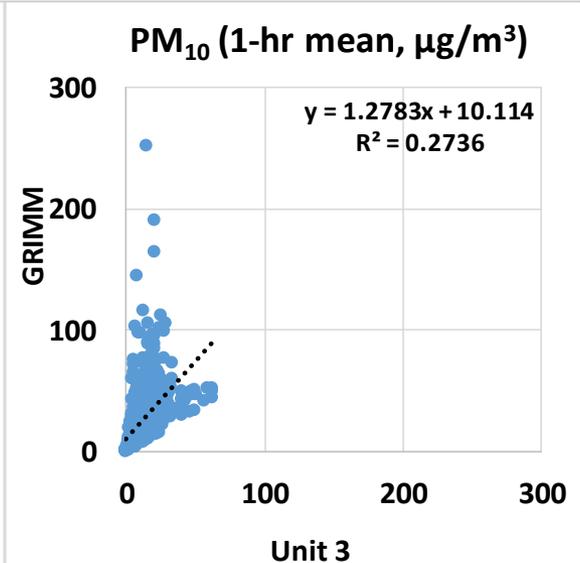
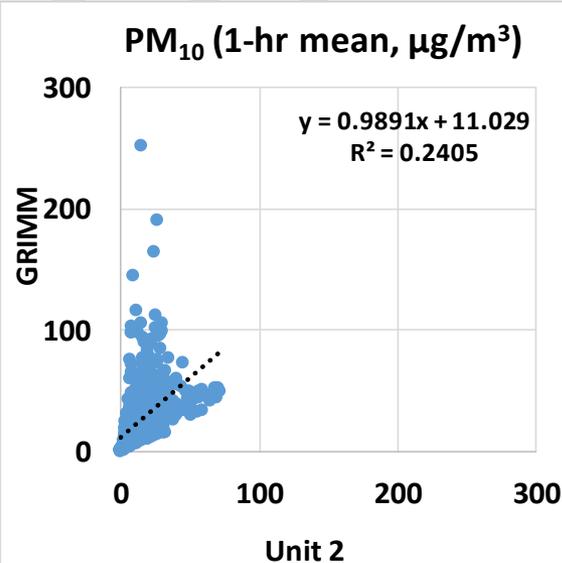
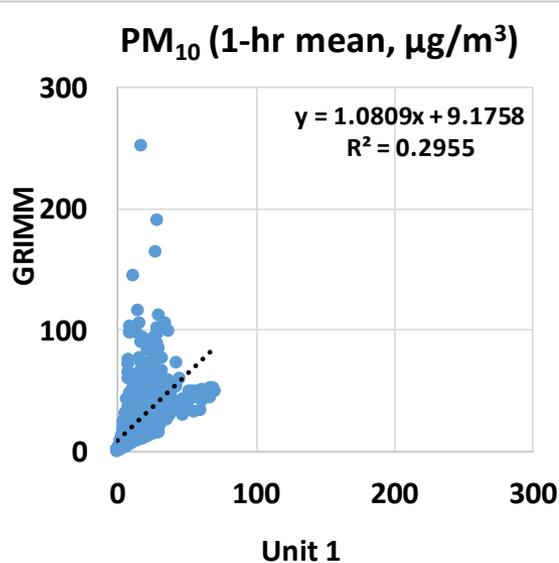
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM data ( $R^2 \sim 0.83$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>2.5</sub> mass concentrations as measured by FEM GRIMM
- The Temtop M2000 sensors seemed to track the PM<sub>2.5</sub> diurnal variations as recorded by FEM GRIMM



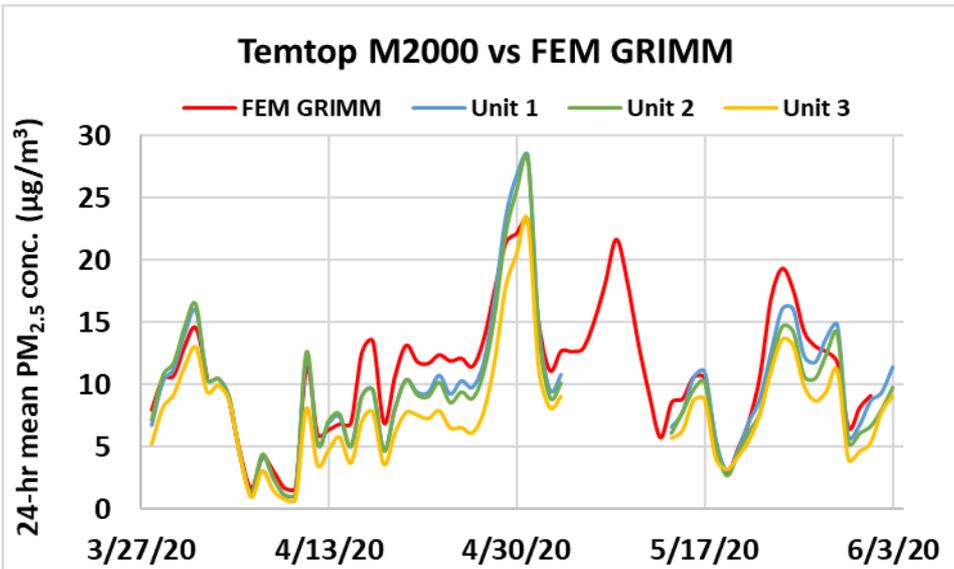
# Temtop M2000 vs GRIMM (PM<sub>10</sub>; 1-hr mean)



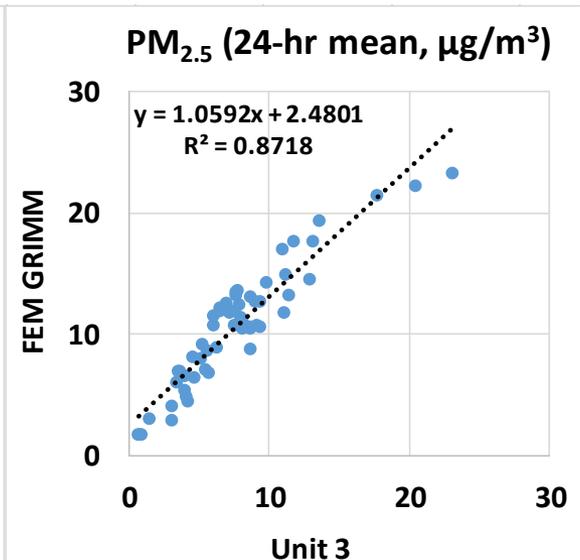
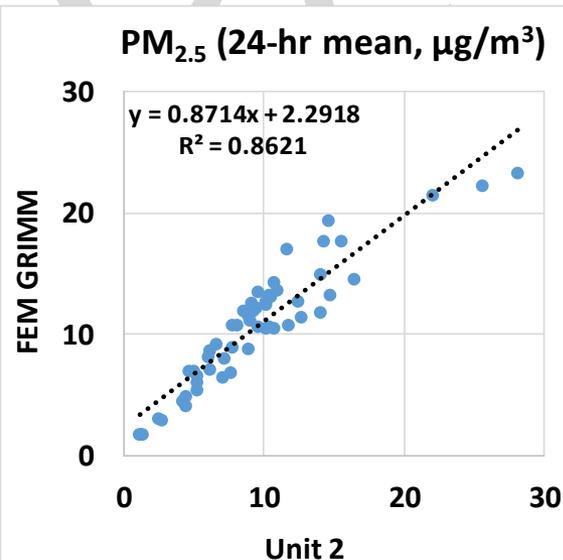
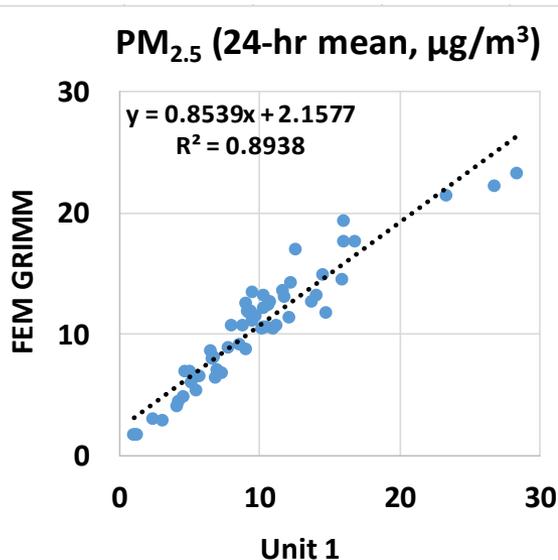
- The Temtop M2000 sensors showed very weak with the corresponding GRIMM data ( $R^2 \sim 0.27$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>10</sub> mass concentrations measured by GRIMM
- The Temtop M2000 sensors did not seem to track the PM<sub>10</sub> diurnal variations as recorded by GRIMM



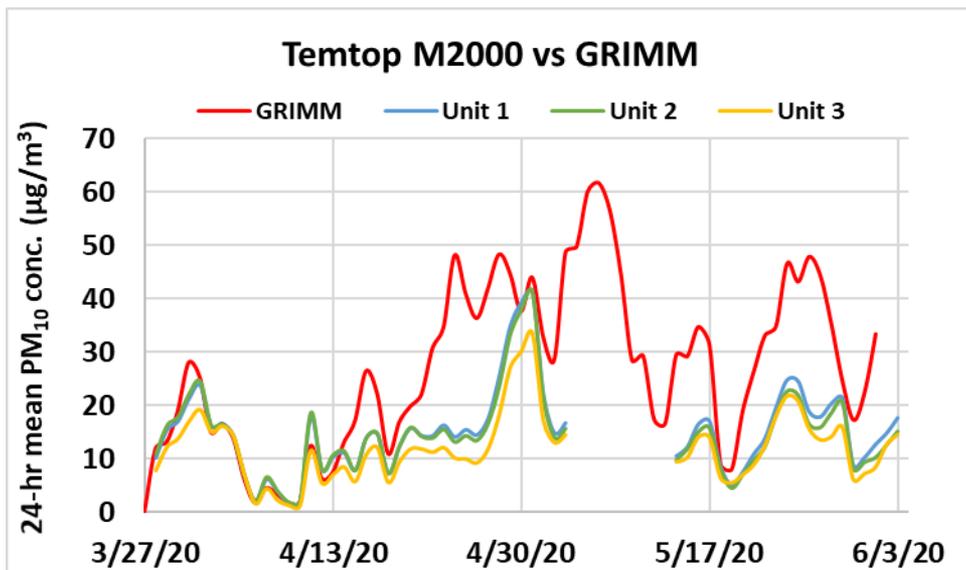
# Temtop M2000 vs FEM GRIMM (PM<sub>2.5</sub>; 24-hr mean)



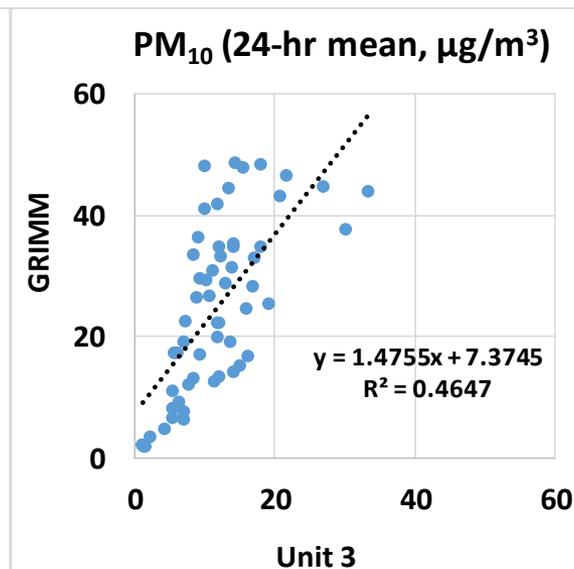
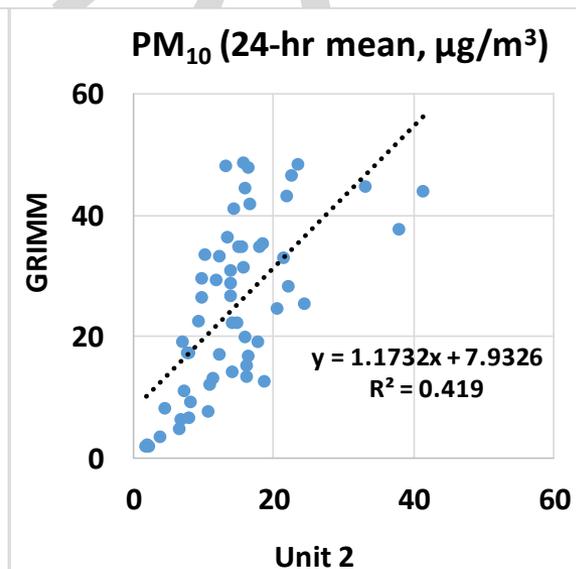
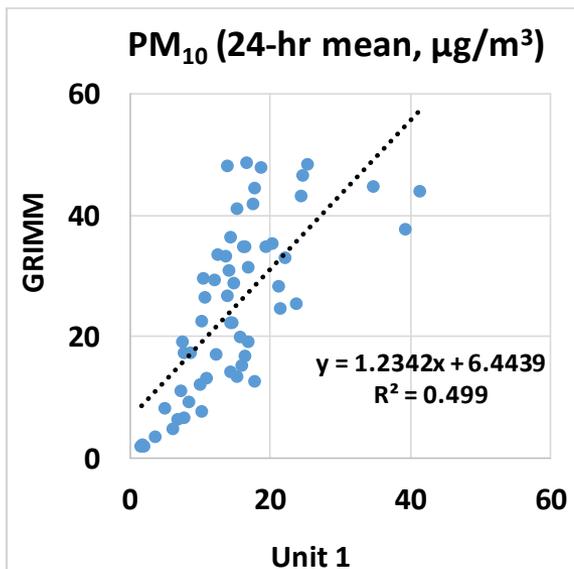
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM data ( $R^2 \sim 0.88$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>2.5</sub> mass concentrations as measured by FEM GRIMM
- The Temtop M2000 sensors seemed to track the PM<sub>2.5</sub> diurnal variations as recorded by FEM GRIMM



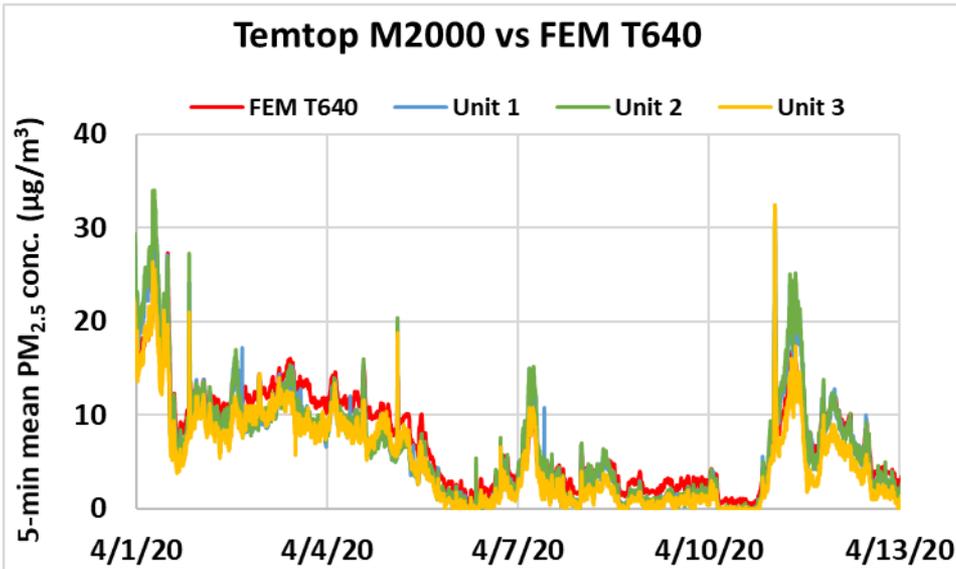
# Temtop M2000 vs GRIMM (PM<sub>10</sub>; 24-hr mean)



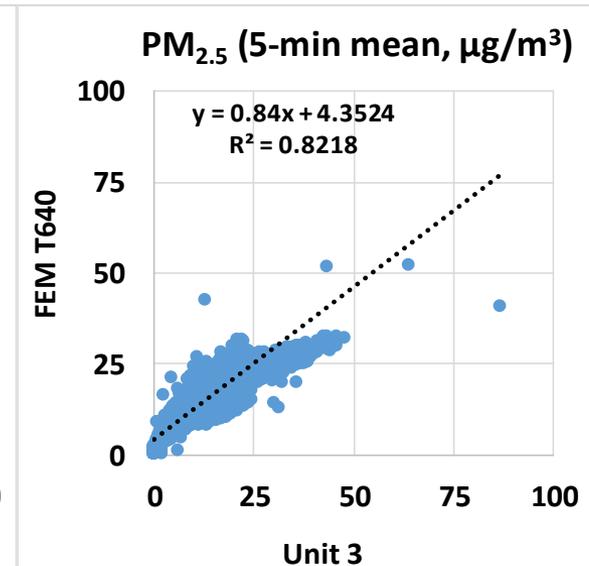
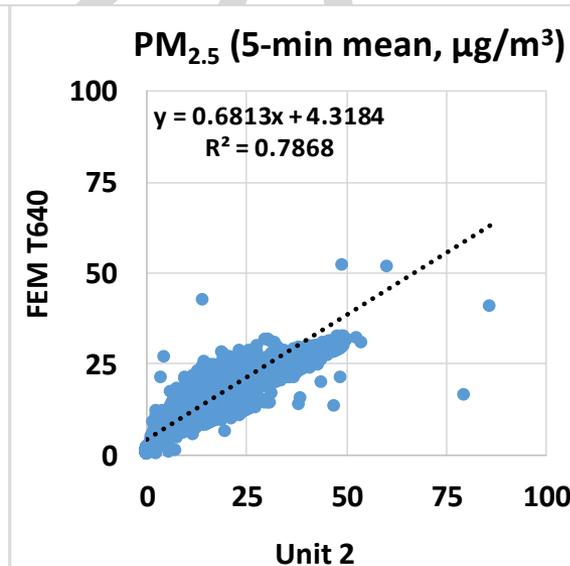
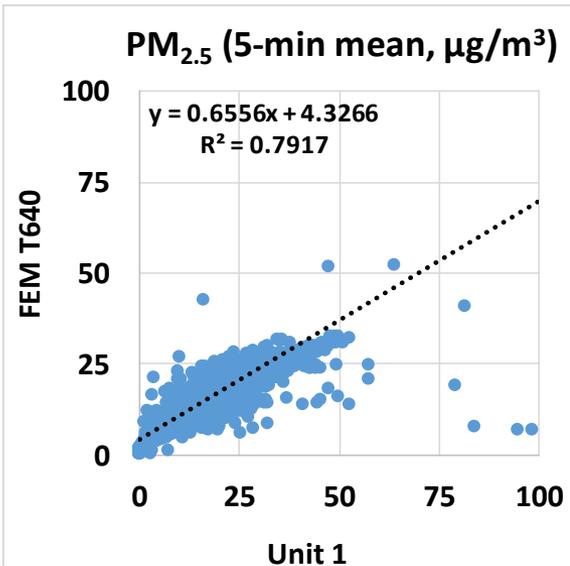
- The Temtop M2000 sensors showed weak correlations with the corresponding GRIMM data ( $R^2 \sim 0.46$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>10</sub> mass concentrations measured by GRIMM
- The Temtop M2000 sensors did not seem to track the PM<sub>10</sub> diurnal variations as recorded by GRIMM



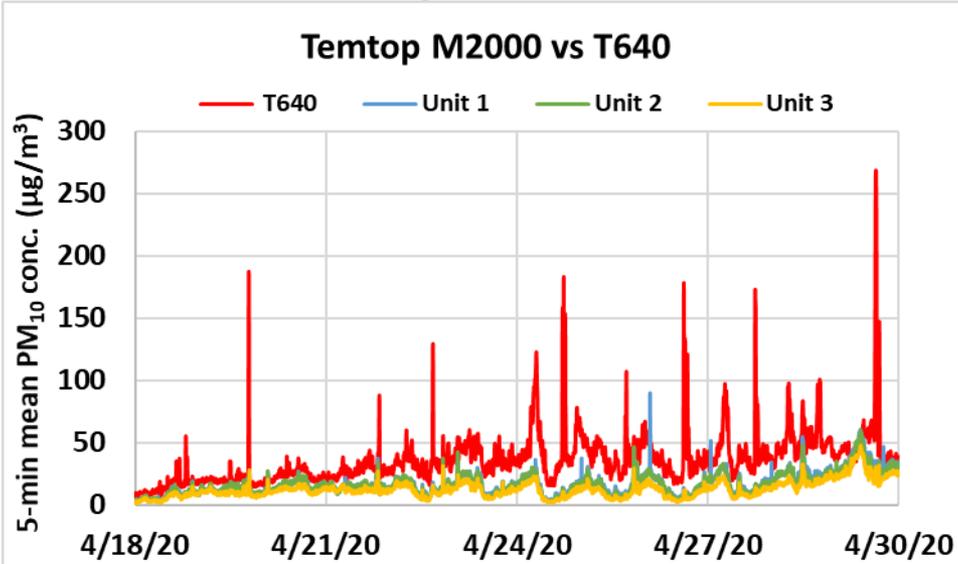
# Temtop M2000 vs FEM T640 (PM<sub>2.5</sub>; 5-min mean)



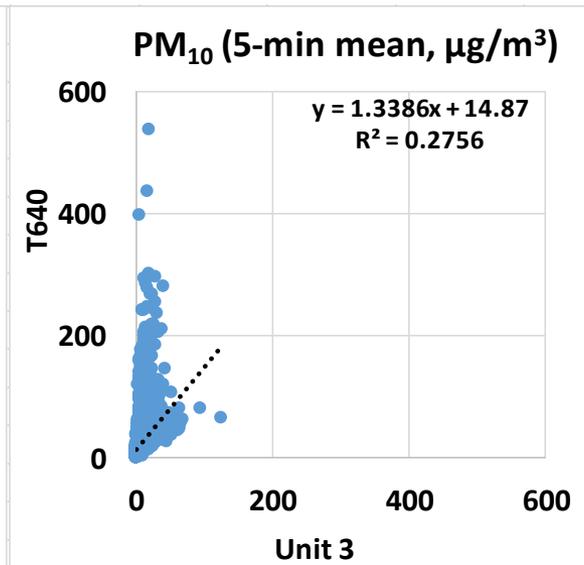
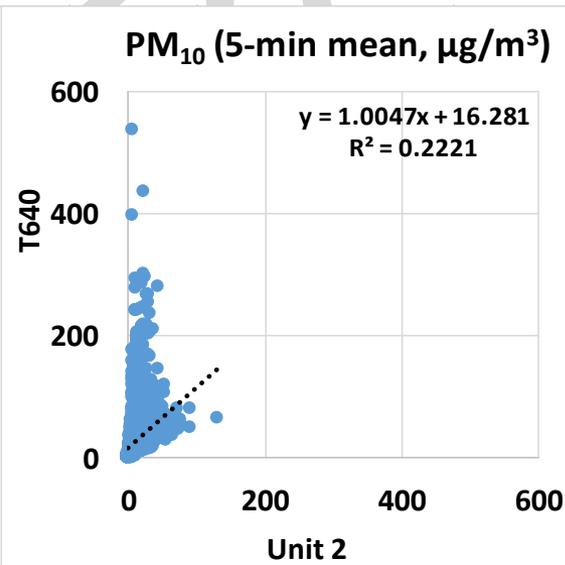
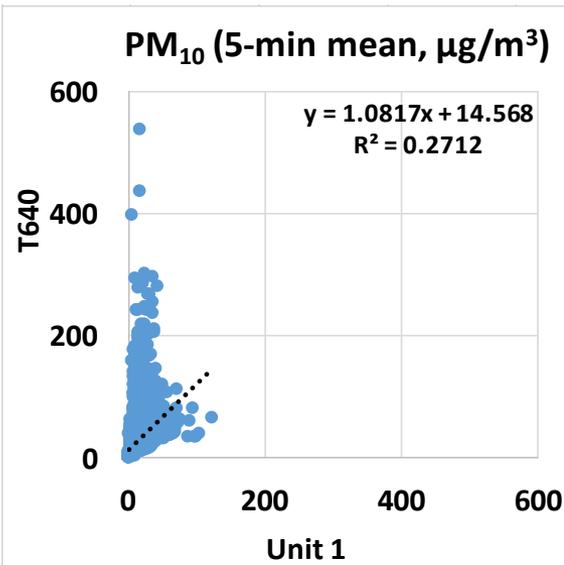
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM T640 data ( $R^2 \sim 0.80$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>2.5</sub> mass concentrations as measured by FEM T640
- The Temtop M2000 sensors seemed to track the PM<sub>2.5</sub> diurnal variations as recorded by FEM T640



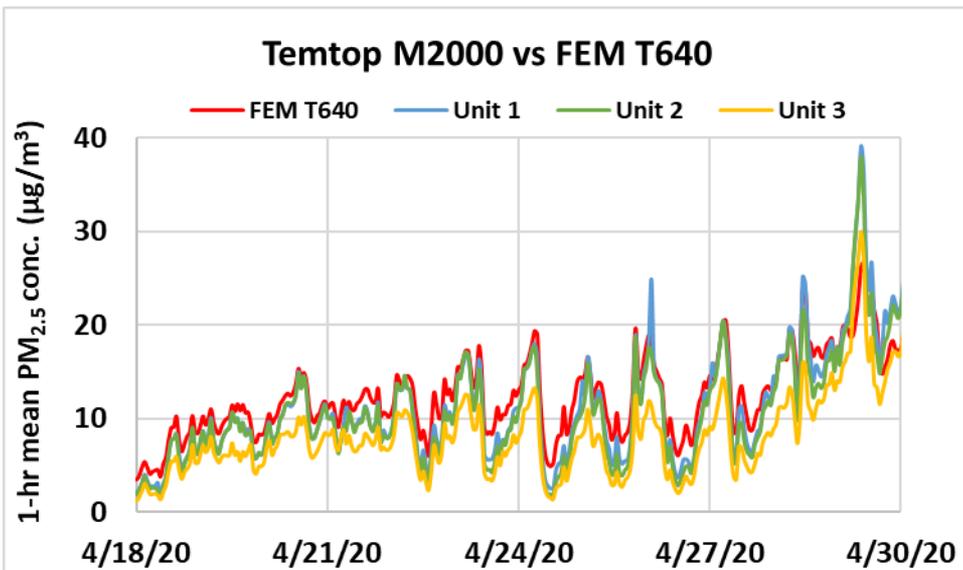
# Temtop M2000 vs T640 (PM<sub>10</sub>; 5-min mean)



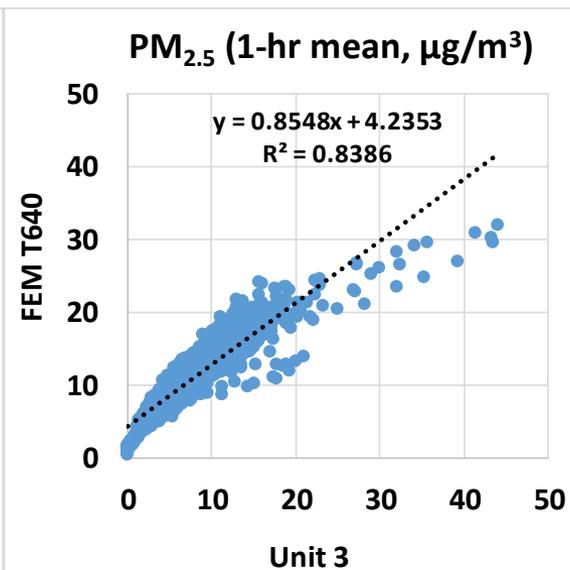
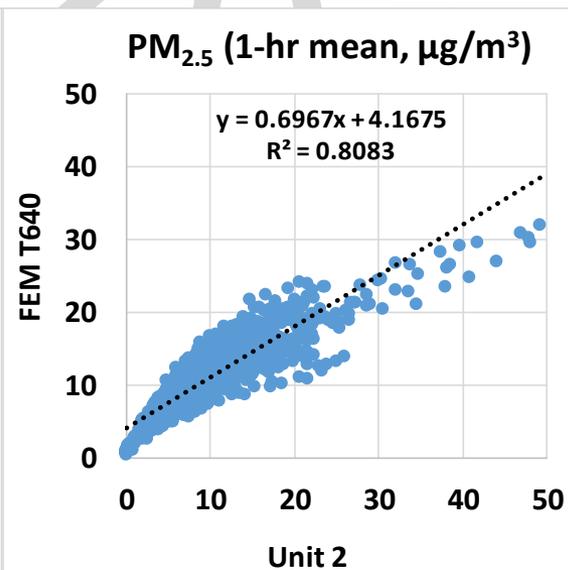
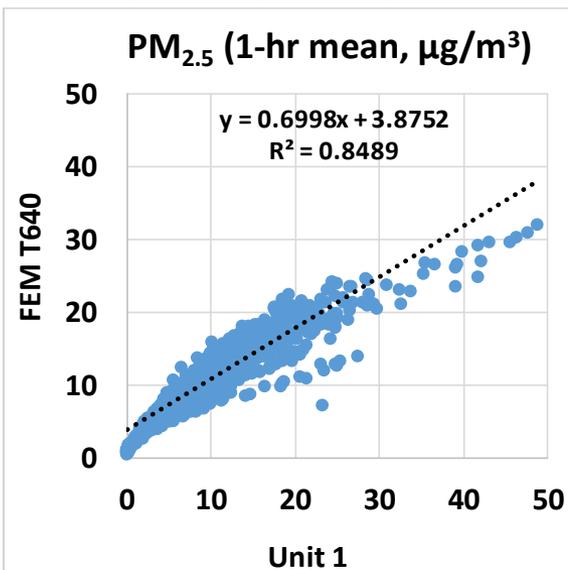
- The Temtop M2000 sensors showed very weak correlations with the corresponding T640 data ( $R^2 \sim 0.26$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>10</sub> mass concentrations as measured by T640
- The Temtop M2000 sensors did not seem to track the PM<sub>10</sub> diurnal variations as recorded by T640



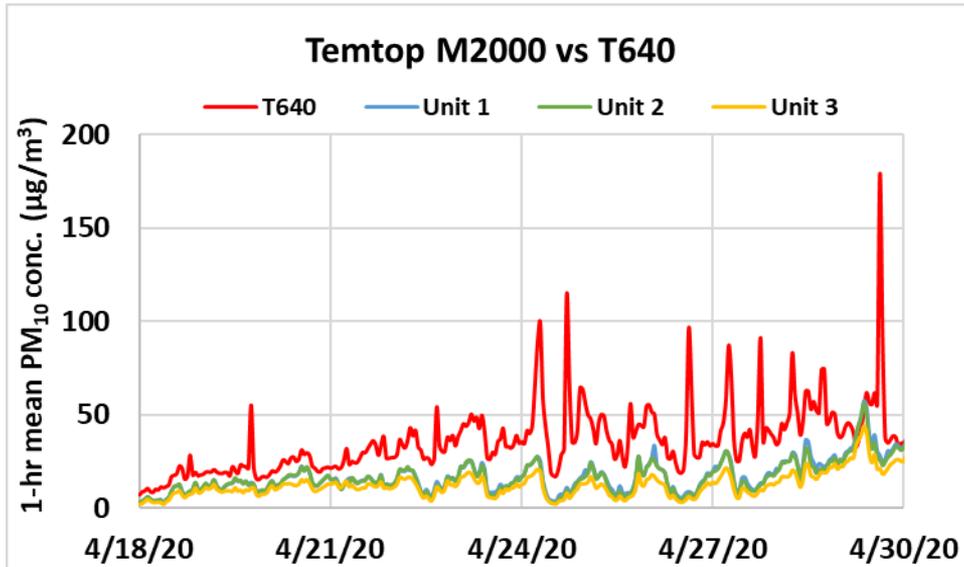
# Temtop M2000 vs FEM T640 (PM<sub>2.5</sub>; 1-hr mean)



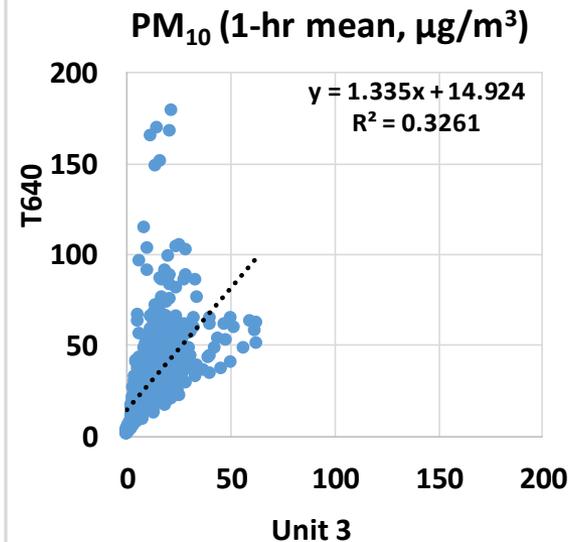
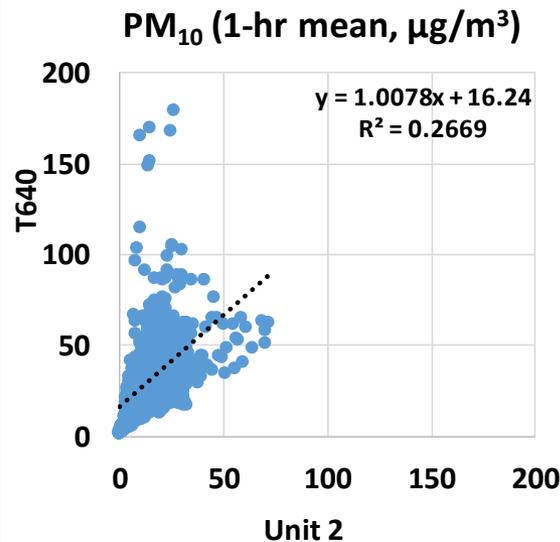
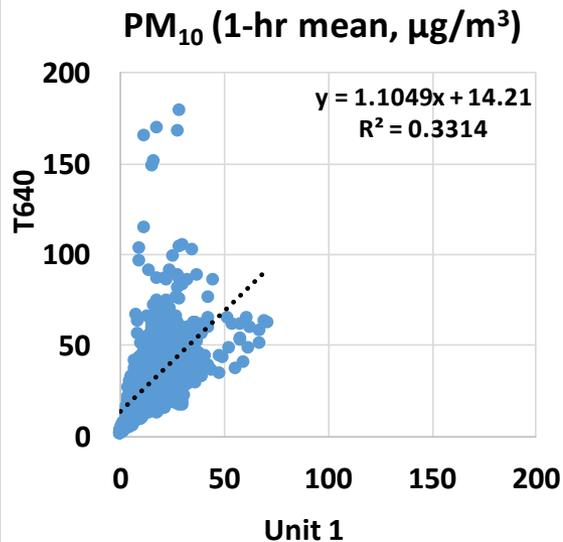
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM T640 data ( $R^2 \sim 0.83$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>2.5</sub> mass concentrations as measured by FEM T640
- The Temtop M2000 sensors seemed to track the PM<sub>2.5</sub> diurnal variations as recorded by FEM T640



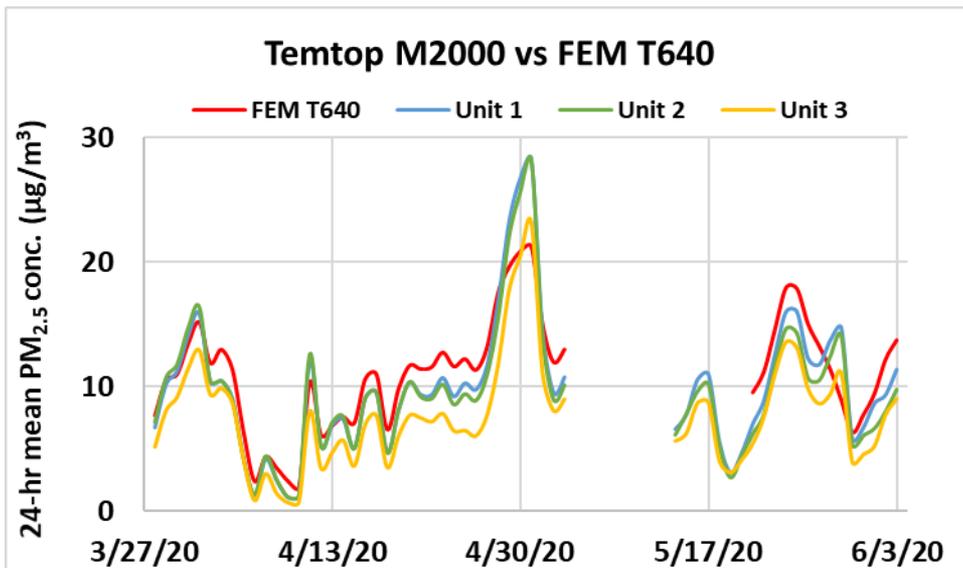
# Temtop M2000 vs T640 (PM<sub>10</sub>; 1-hr mean)



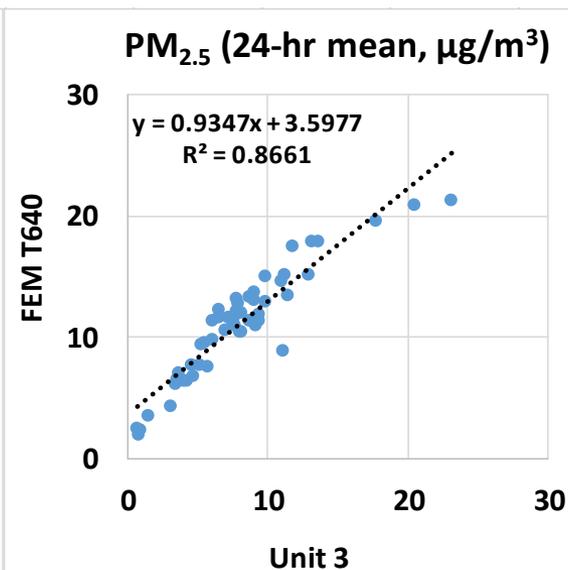
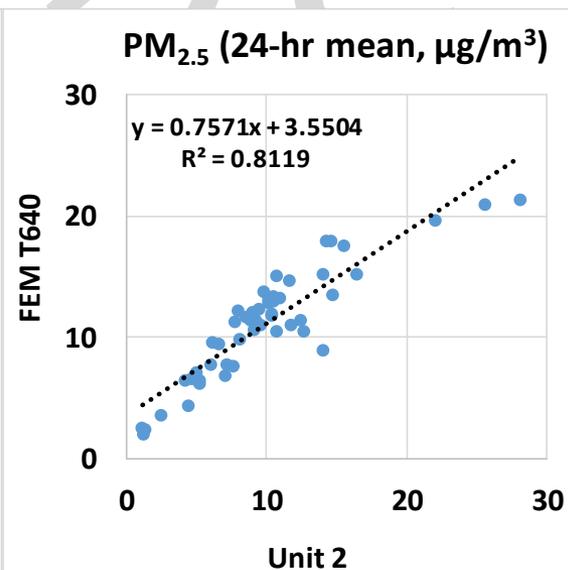
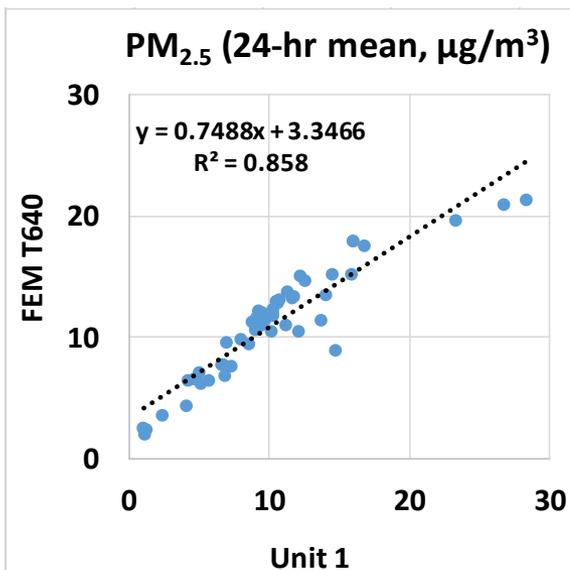
- The Temtop M2000 sensors showed weak correlations with the corresponding T640 data ( $R^2 \sim 0.31$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>10</sub> mass concentrations as measured by T640
- The Temtop M2000 sensors did not seem to track the PM<sub>10</sub> diurnal variations as recorded by T640



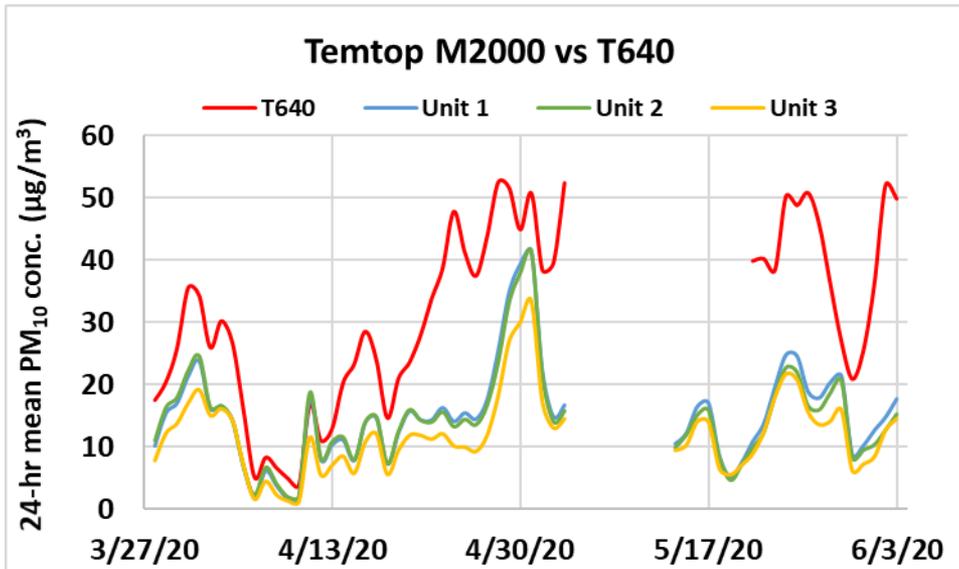
# Temtop M2000 vs FEM T640 (PM<sub>2.5</sub>; 24-hr mean)



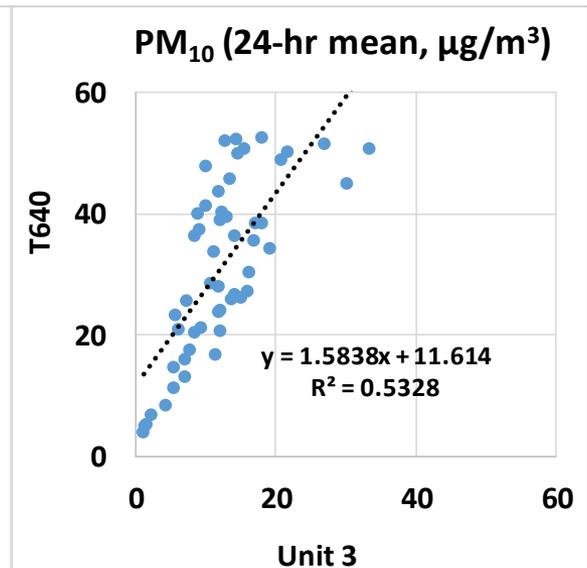
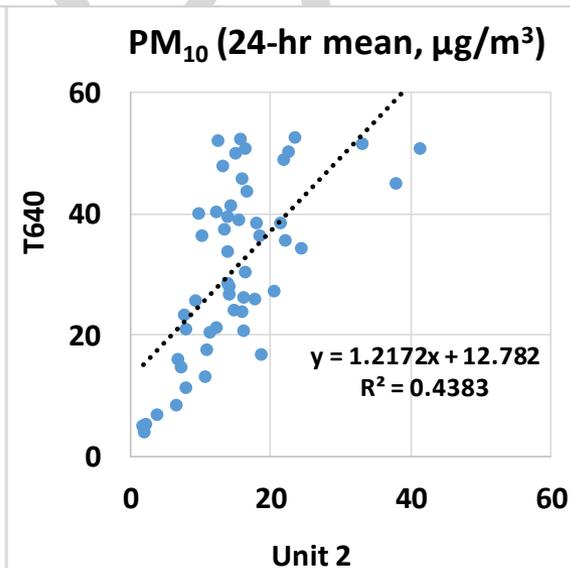
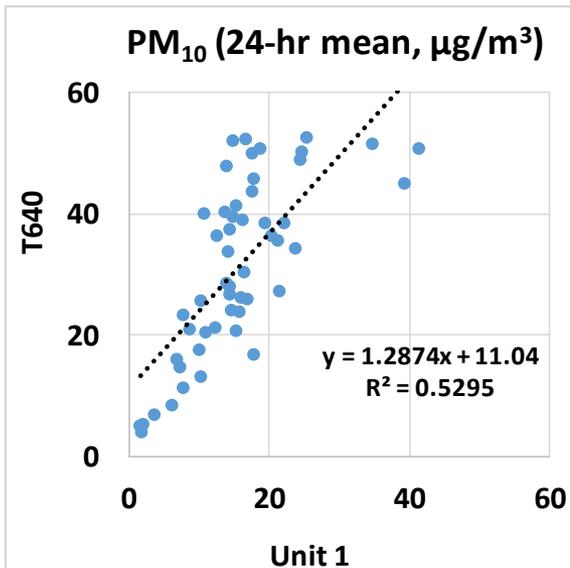
- The Temtop M2000 sensors showed strong correlations with the corresponding FEM T640 data ( $R^2 \sim 0.84$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>2.5</sub> mass concentrations as measured by FEM T640
- The Temtop M2000 sensors seemed to track the PM<sub>2.5</sub> diurnal variations as recorded by FEM T640



# Temtop M2000 vs T640 (PM<sub>10</sub>; 24-hr mean)



- The Temtop M2000 sensors showed moderate correlations with the corresponding T640 data ( $R^2 \sim 0.50$ )
- Overall, the Temtop M2000 sensors underestimated the PM<sub>10</sub> mass concentrations as measured by T640
- The Temtop M2000 sensors did not seem to track the PM<sub>10</sub> 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<sub>2.5</sub> and PM<sub>10</sub> measurements
- The absolute intra-model variability was ~ 1.16 and 1.59 µg/m<sup>3</sup> for PM<sub>2.5</sub> and PM<sub>10</sub>, respectively
- Strong correlations between FEM GRIMM and FEM T640 for PM<sub>2.5</sub> ( $R^2 \sim 0.89$ , 1-hr mean) and PM<sub>10</sub> ( $R^2 \sim 0.89$ , 1-hr mean) mass concentration measurements
- PM<sub>2.5</sub> mass concentrations measured by Temtop M2000 sensors showed strong correlations with the corresponding FEM GRIMM and FEM T640 data ( $R^2 \sim 0.83$  and  $0.83$ , respectively, 1-hr mean). The sensors underestimated PM<sub>2.5</sub> mass concentrations as measured by FEM GRIMM and FEM T640
- PM<sub>10</sub> mass concentrations measured by Temtop M2000 sensors showed very weak to weak correlations with the GRIMM and T640 data ( $R^2 \sim 0.27$  and  $0.31$ , respectively; 1-hr mean) and underestimated PM<sub>10</sub> 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