Field Evaluation of Dylos DC1700-PM

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 8/22/2018 to 10/11/2018, three **Dylos DC1700-PM** sensor units were deployed at our (SCAQMD) Rubidoux station and ran side-by-side with reference instruments measuring the same pollutants

- **Dylos DC1700-PM (*3 units tested*):**
  - Particle sensor (optical; non-FEM)
  - Each sensor reports: $PM_{2.5}$ and PM_{10} number (number/ft^3) and mass concentration ($\mu g/m^3$)
  - Unit cost: $475
  - Time resolution: 1-min
  - Units IDs: Unit 1, Unit 2, Unit 3 (no serial IDs on units tags)
  - **DC 1700-PM** reports mass concentrations of $PM_{2.5}$ and PM_{10} in addition to number concentrations of two size ranges (i.e., >0.5 & >2.5 µm) reported by Dylos DC 1100

- **MetOne BAM (reference instrument):**
  - Beta-attenuation monitor (FEM $PM_{2.5}$, FEM PM_{10})
  - Measures $PM_{2.5}$ and PM_{10}
  - Unit cost: ~$20,000
  - Time resolution: 1-hr

- **GRIMM (reference instrument):**
  - Optical Particle Counter (FEM $PM_{2.5}$)
  - Measures $PM_{1.0}$, $PM_{2.5}$, and PM_{10}
  - Unit cost: ~$25,000 and up
  - Time resolution: 1-min

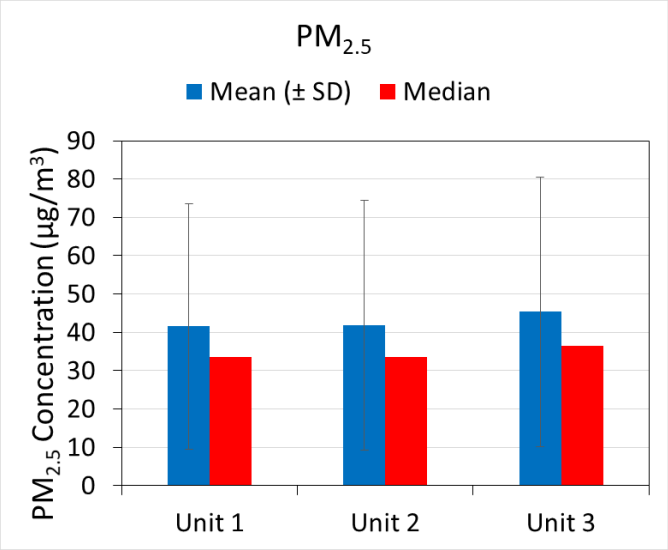
- **Teledyne T640 (reference instrument):**
  - Optical Particle Counter (FEM $PM_{2.5}$)
  - Measures $PM_{2.5}$ and PM_{10}
  - Unit cost: $21,000
  - Time resolution: 1-min

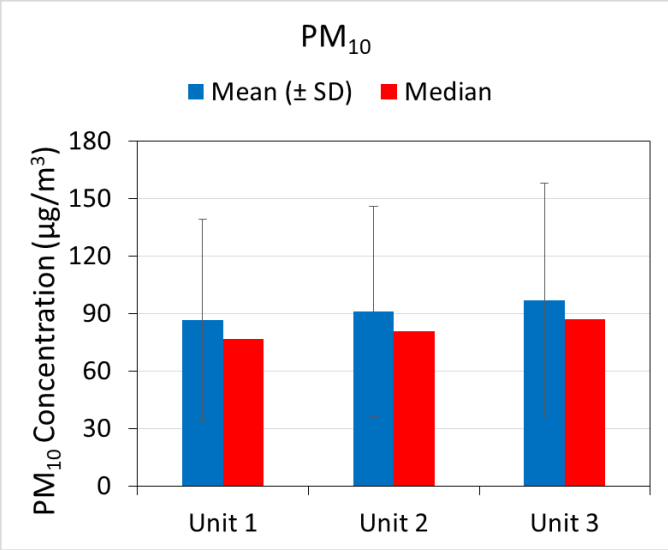
Data validation & recovery

- 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 was near 100% for all three sensor units tested and 79%, 100%, and 99%, for GRIMM, T640, and BAM, respectively.

Dylos DC1700-PM; intra-model variability

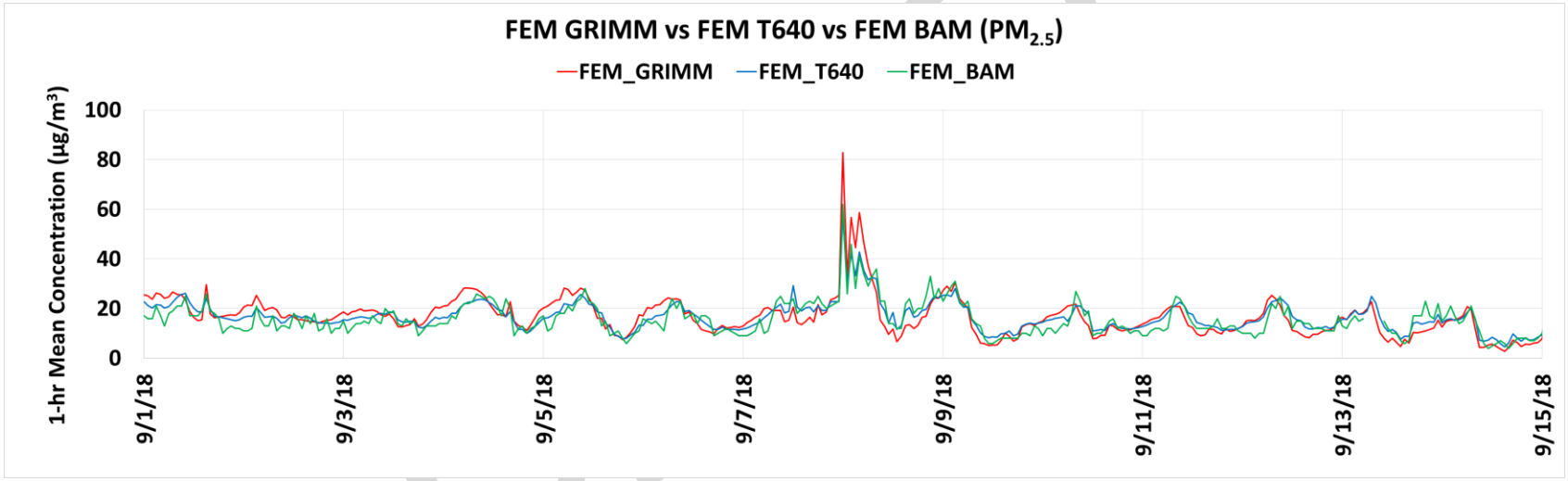
- Low intra-model variability for $PM_{2.5}$ and PM_{10} mass concentrations was observed between the three Dylos DC1700-PM units.

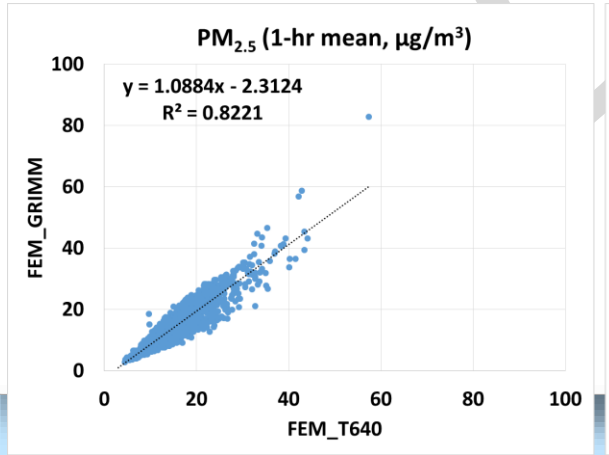


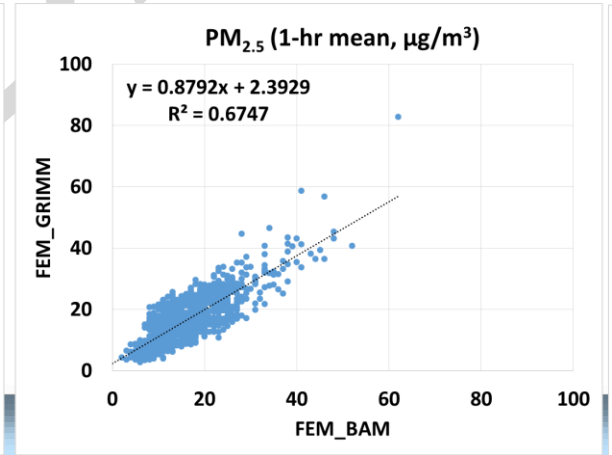


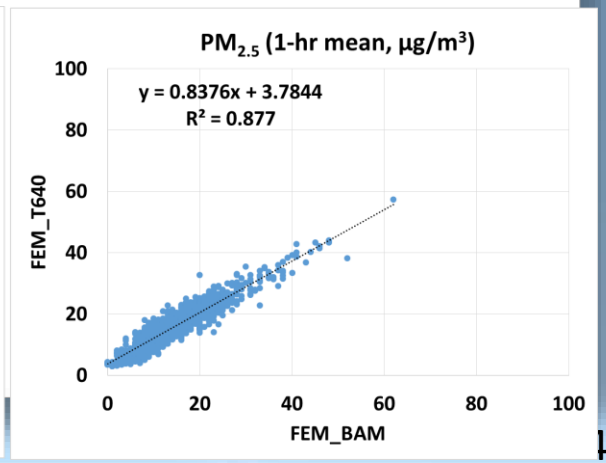
Reference Instruments
BAM vs GRIMM vs T640

- Good correlation between the three reference instruments for $PM_{2.5}$ measurements



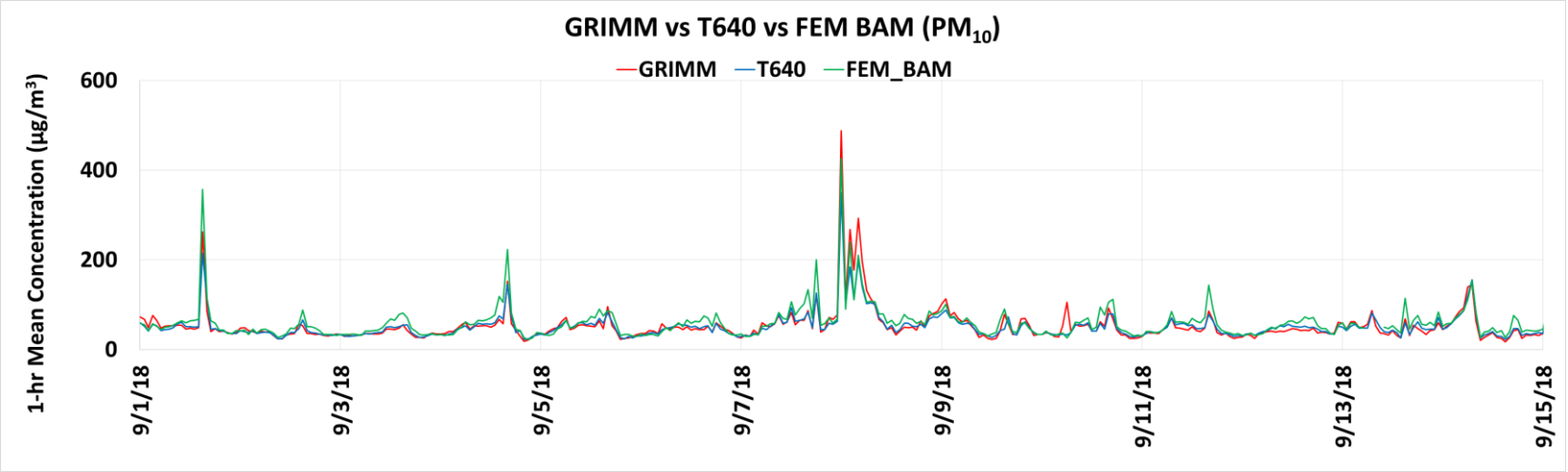


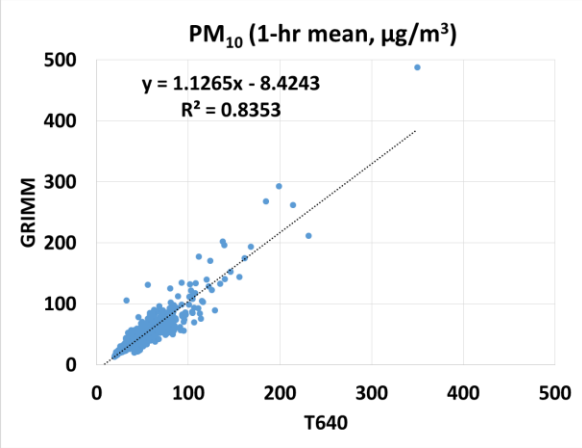


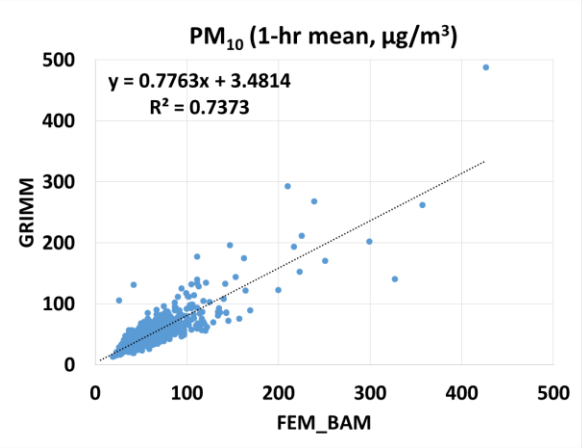


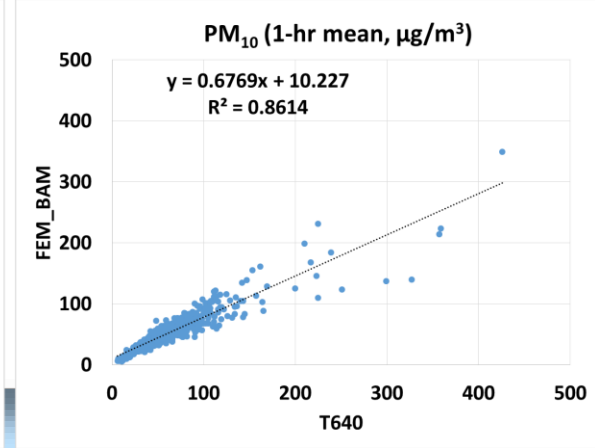
Reference Instruments
BAM vs GRIMM vs T640

- Good correlation between the three reference instruments for PM_{10} measurements

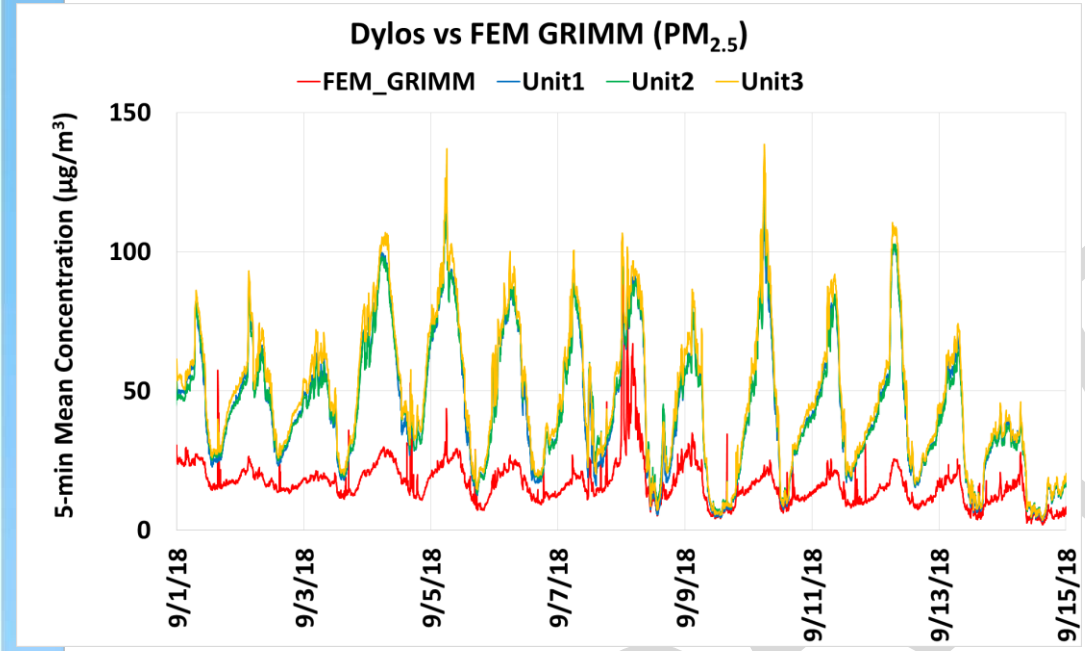




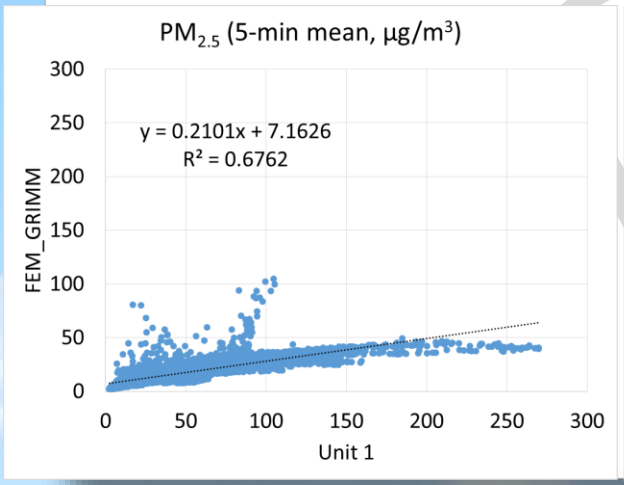


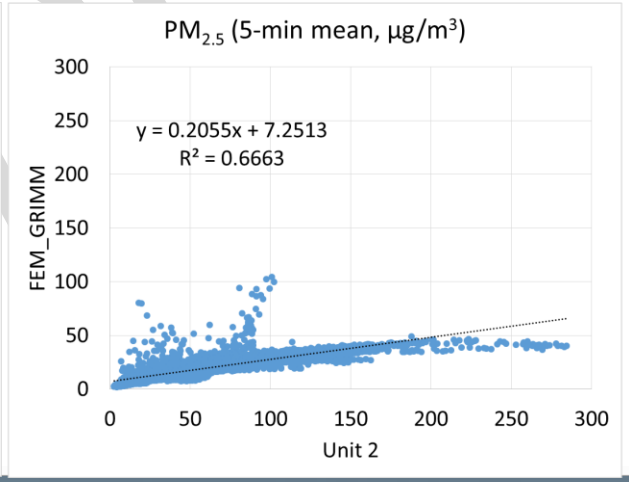


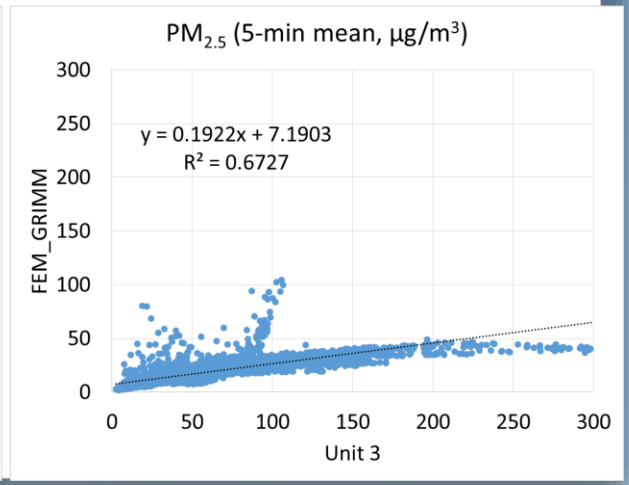
Dylos DC1700-PM vs FEM GRIMM ($PM_{2.5}$; 5-min mean)



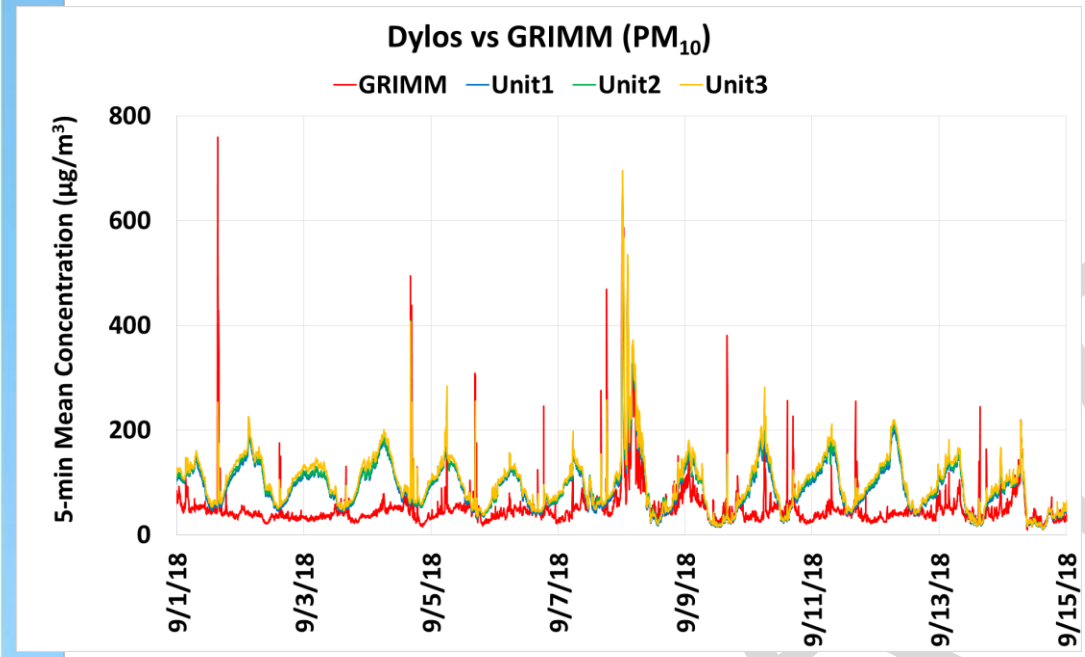
- $PM_{2.5}$ measurements from the three Dylos sensors correlate moderately with the corresponding FEM GRIMM data ($0.66 < R^2 < 0.68$).
- The three sensor units tested largely overestimate the $PM_{2.5}$ levels recorded by the FEM GRIMM instrument.



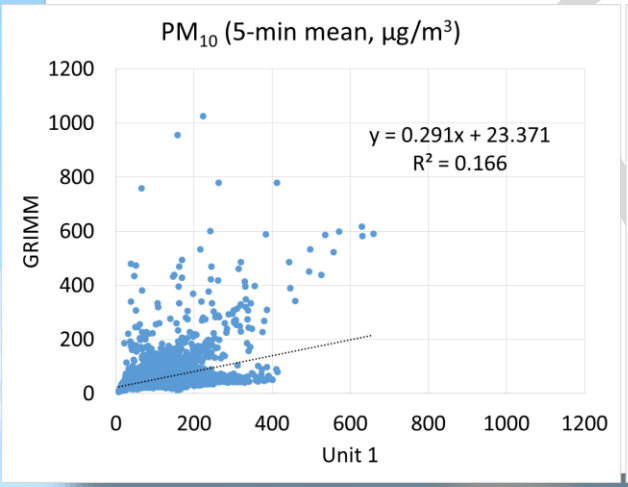


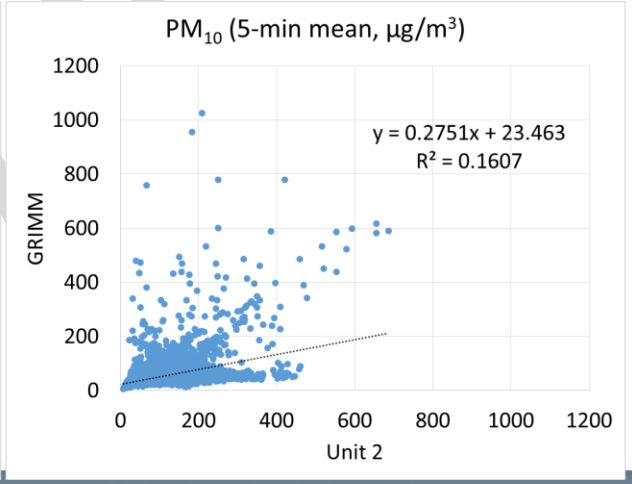


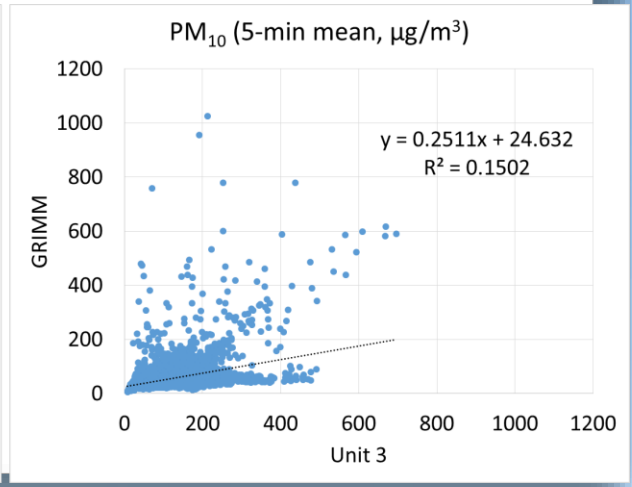
Dylos DC1700-PM vs GRIMM (PM_{10}; 5-min mean)



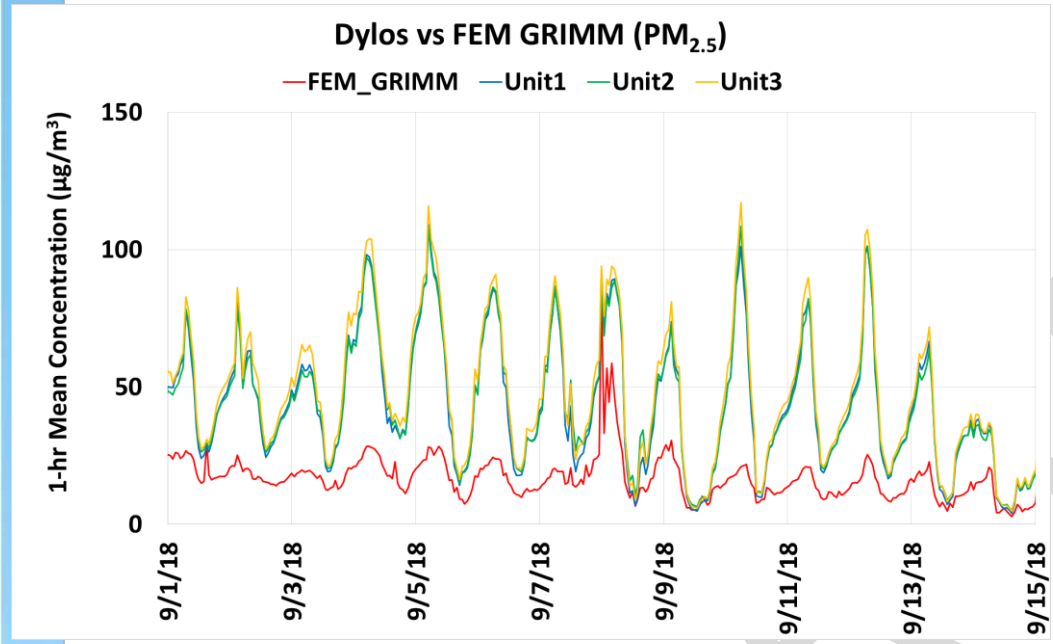
- Dylos PM_{10} measurements correlate poorly with the corresponding GRIMM PM_{10} mass concentrations ($R^2 < 0.2$).
- Dylos measurements seem to modestly track the PM_{10} diurnal variations recorded by the GRIMM instrument.



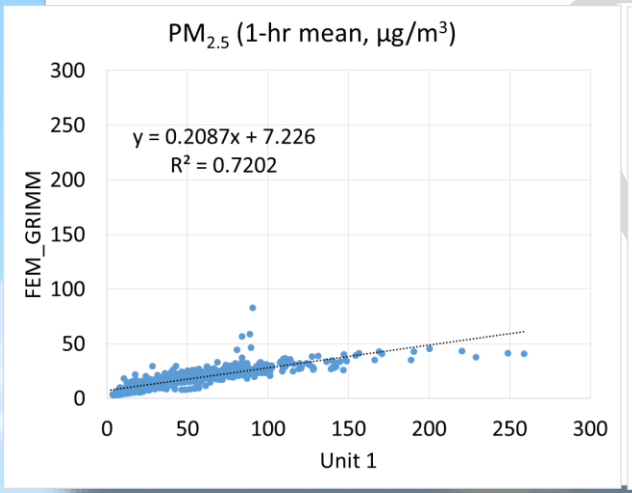


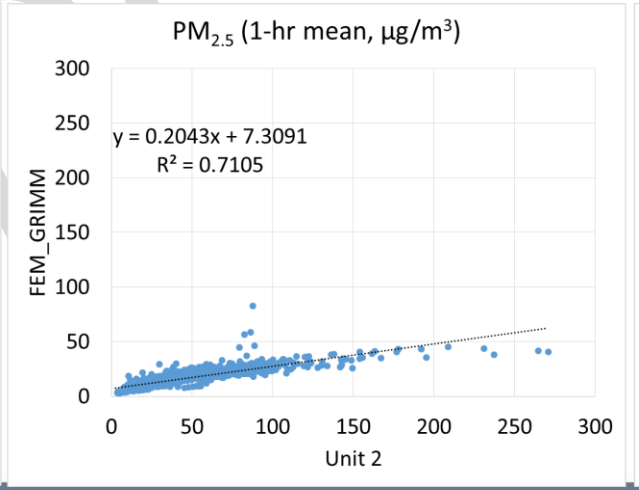


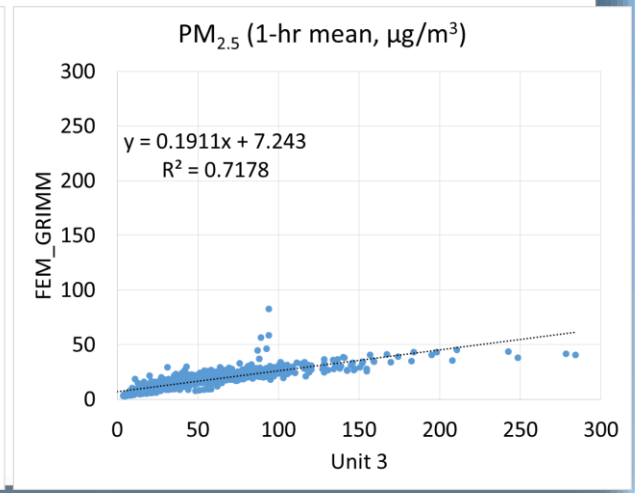
Dylos DC1700-PM vs FEM GRIMM ($PM_{2.5}$; 1-hr mean)



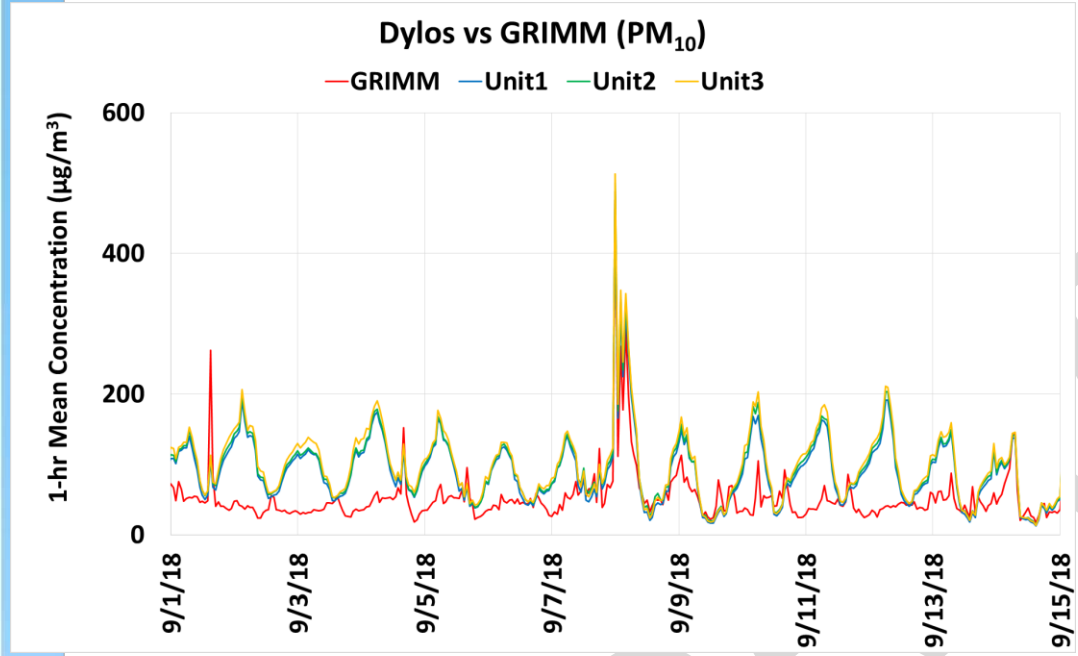
- Hourly-averaged $PM_{2.5}$ measurements form the three Dylos sensors correlate moderately with the corresponding FEM GRIMM data.
- The three sensor units tested seem to track the diurnal $PM_{2.5}$ variations recorded by the FEM GRIMM instrument well.
- The sensors $PM_{2.5}$ measurements largely overestimate the corresponding FEM GRIMM data.



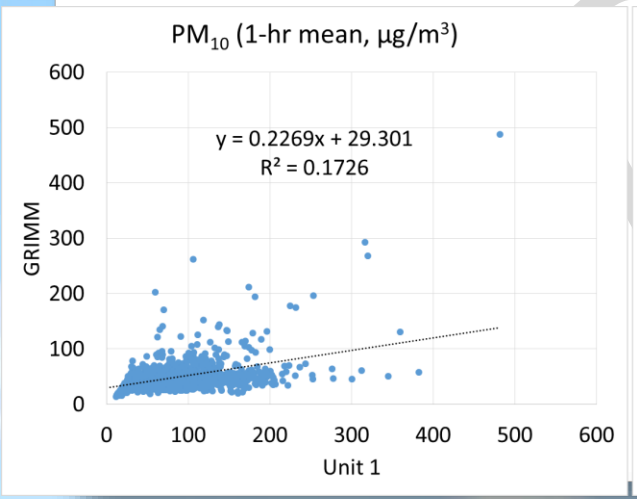


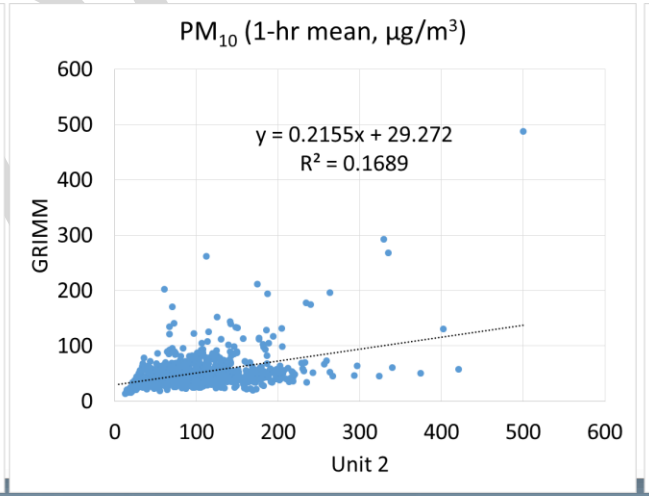


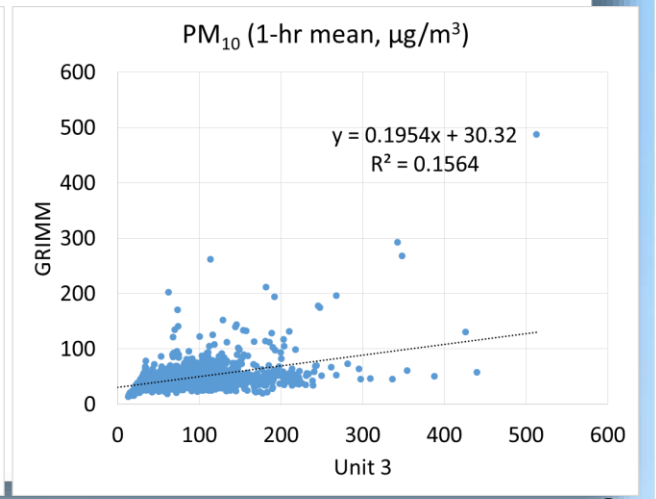
Dylos DC1700-PM vs GRIMM (PM_{10}; 1-hr mean)



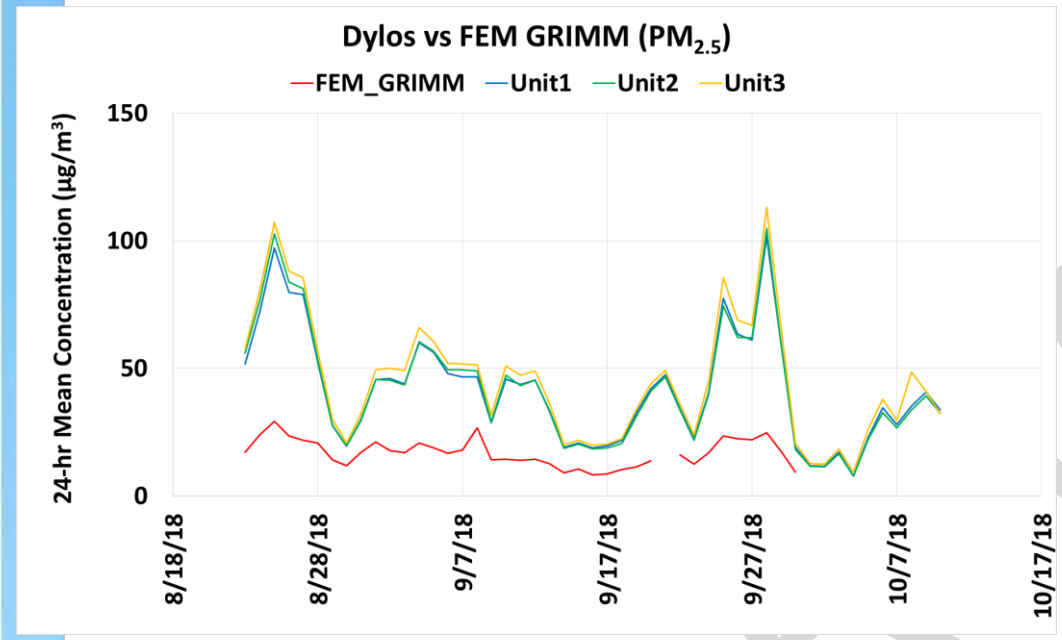
- Dylos PM_{10} measurements correlate poorly with the corresponding GRIMM PM_{10} mass concentrations
- The three sensor units track modestly the diurnal PM_{10} variations recorded by the GRIMM instrument.



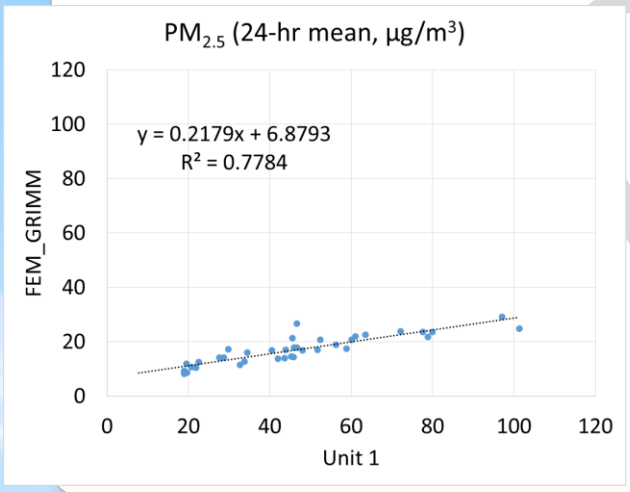


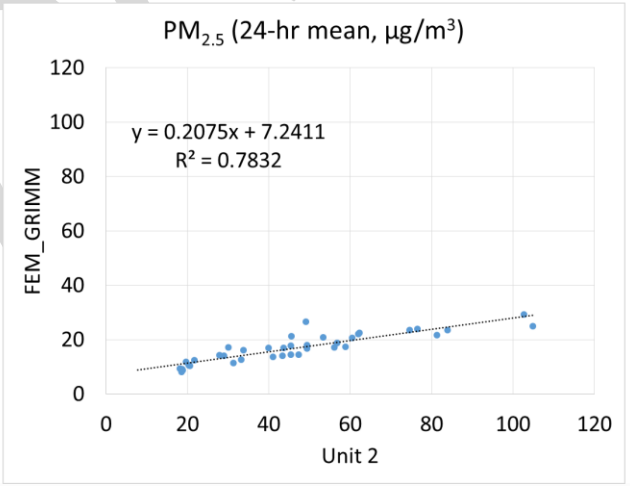


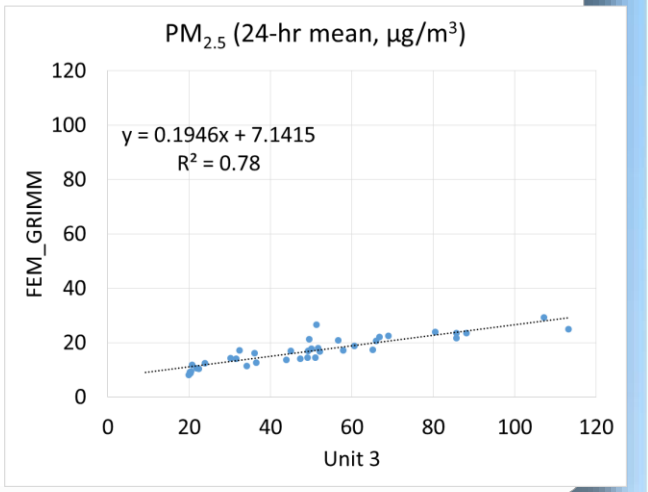
Dylos DC1700-PM vs FEM GRIMM ($PM_{2.5}$; 24-hr mean)



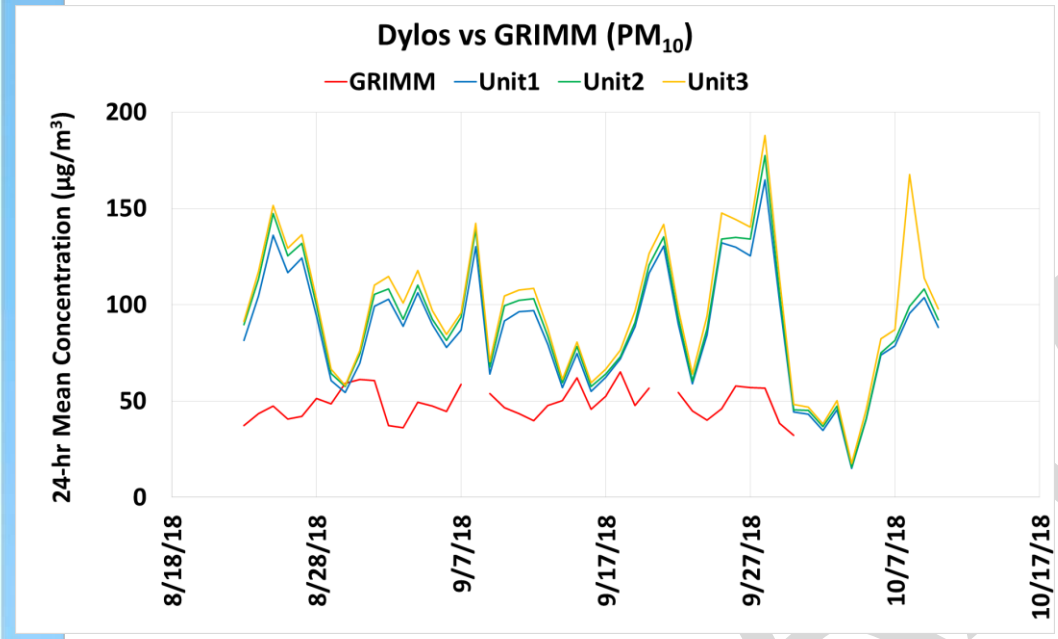
- Daily-averaged $PM_{2.5}$ measurements from Dylos sensors correlate well with the corresponding FEM GRIMM data ($0.77 < R^2 < 0.79$)
- The three sensor units tested largely overestimate $PM_{2.5}$ levels recorded by the FEM GRIMM instrument.



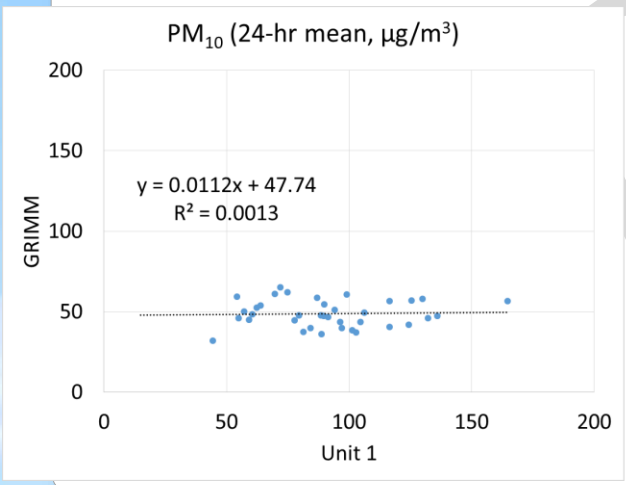


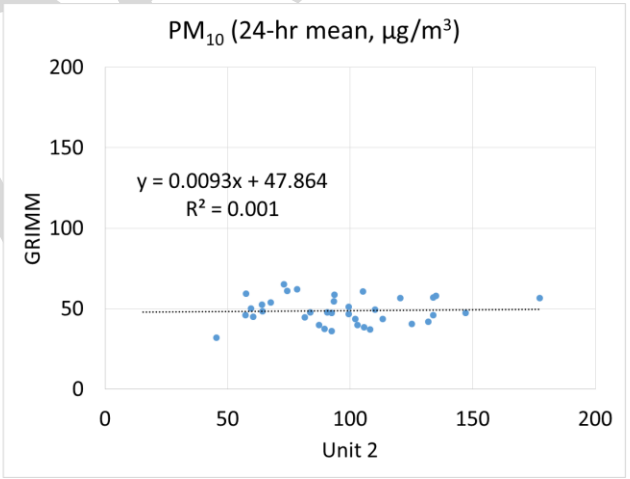


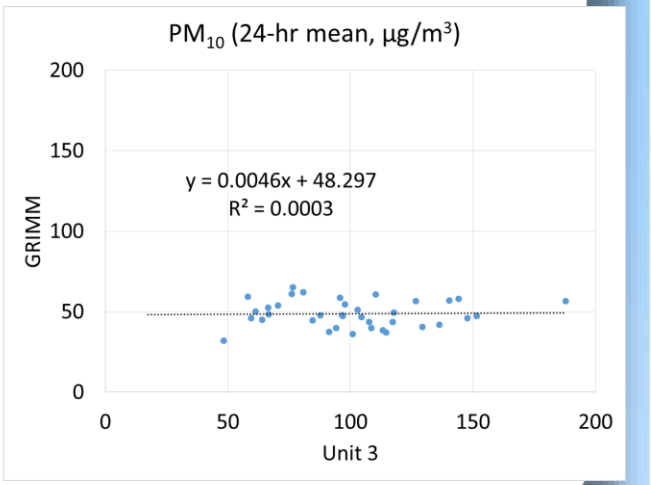
Dylos DC1700-PM vs GRIMM (PM_{10}; 24-hr mean)



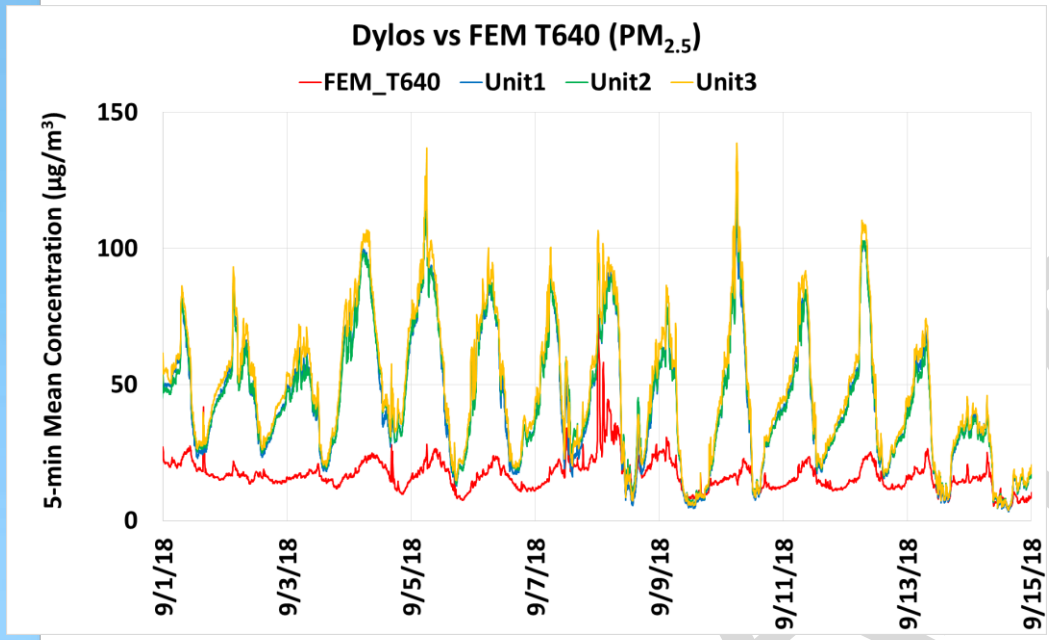
- Daily-averaged PM_{10} measurements from Dylos sensors do not correlate with the corresponding GRIMM PM_{10} mass concentrations (R^2 <0.01).
- The sensors PM_{10} measurements largely overestimate the corresponding GRIMM data.



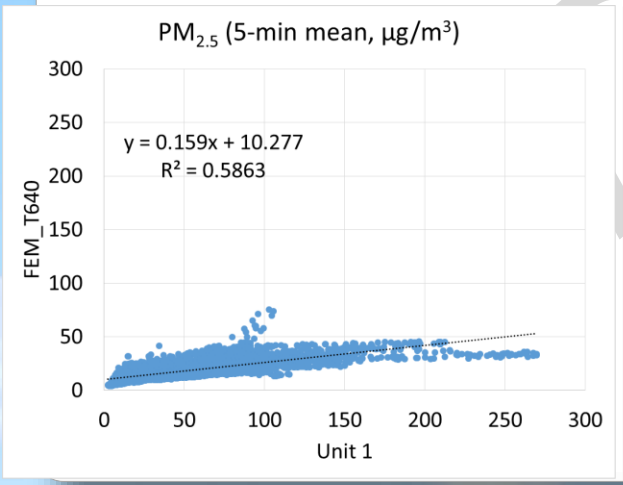


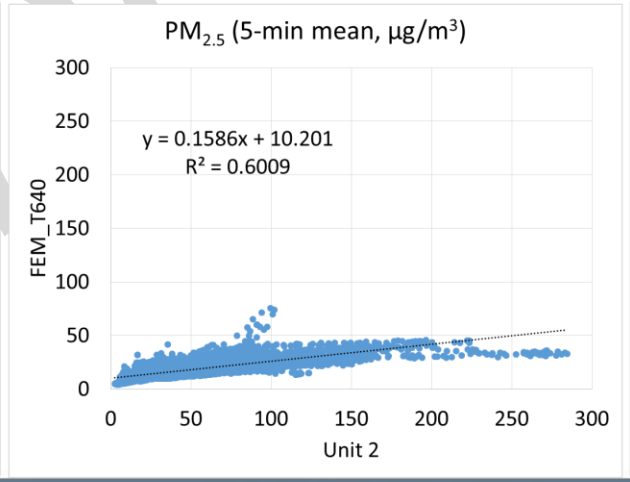


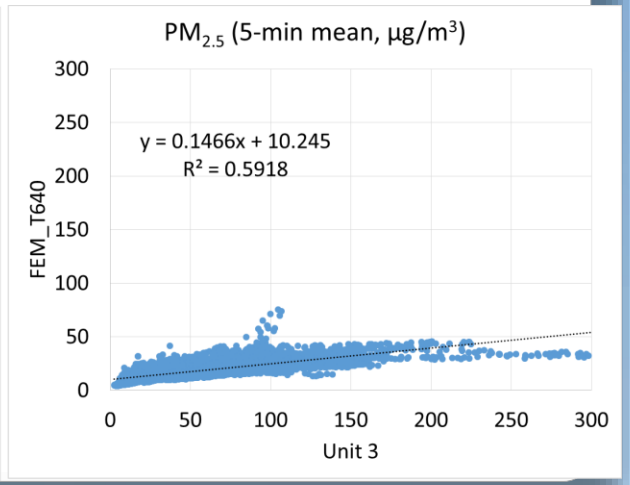
Dylos DC1700-PM vs FEM T640 ($PM_{2.5}$; 5-min mean)



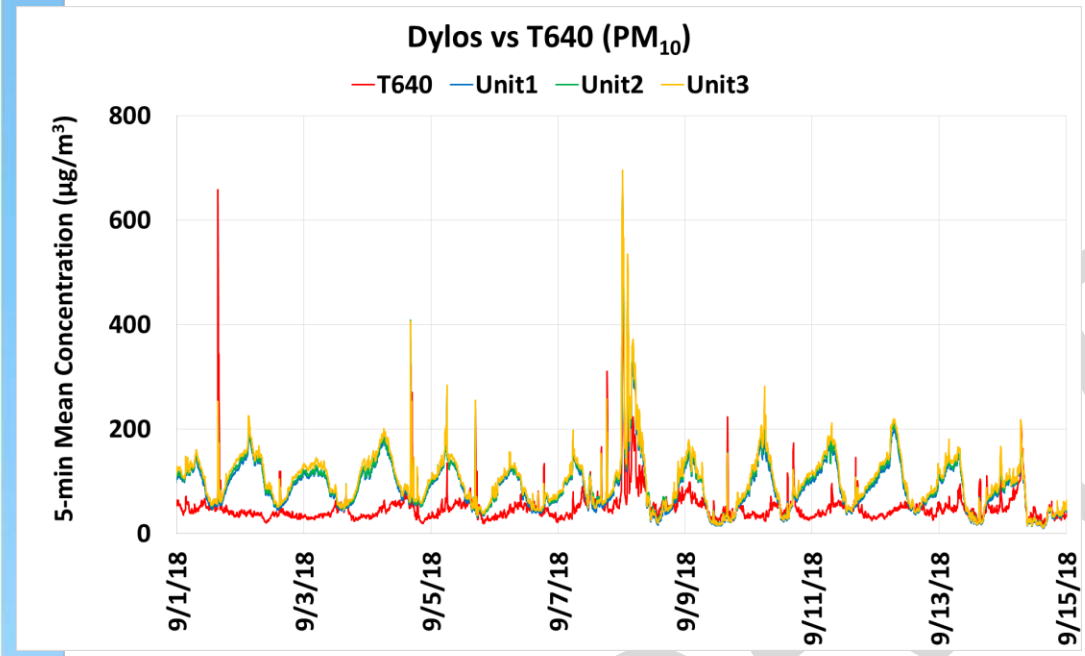
- $PM_{2.5}$ measurements from the three Dylos sensors correlate moderately with the corresponding FEM T640 data ($0.58 < R^2 < 0.61$).
- The three sensor units tested largely overestimate $PM_{2.5}$ variations recorded by the FEM T640 instrument.



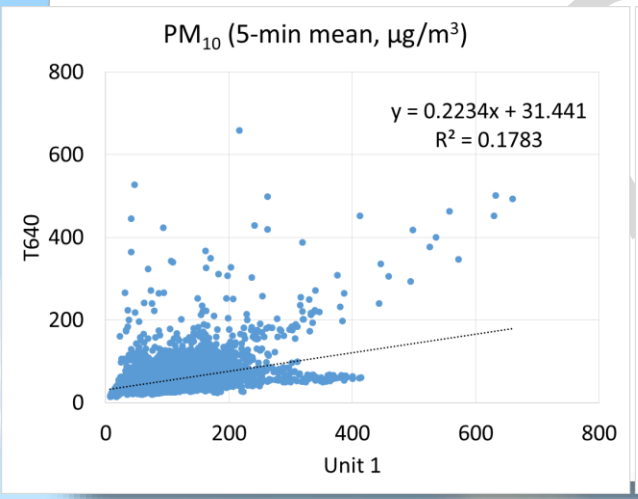


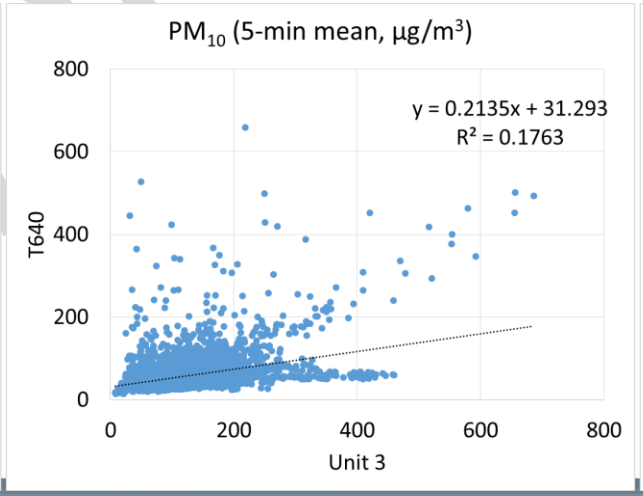


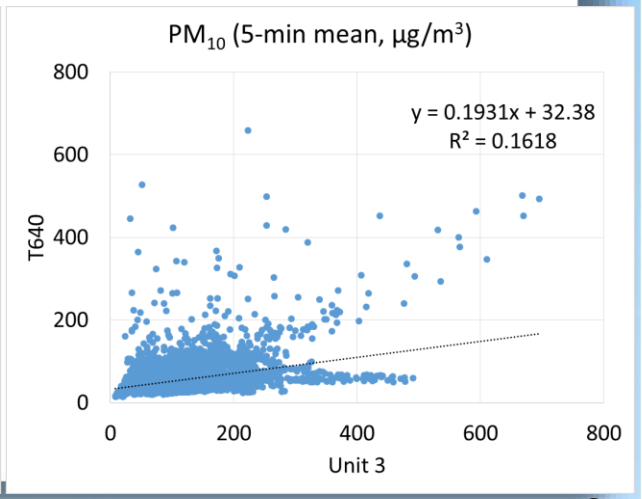
Dylos DC1700-PM vs T640 (PM_{10}; 5-min mean)



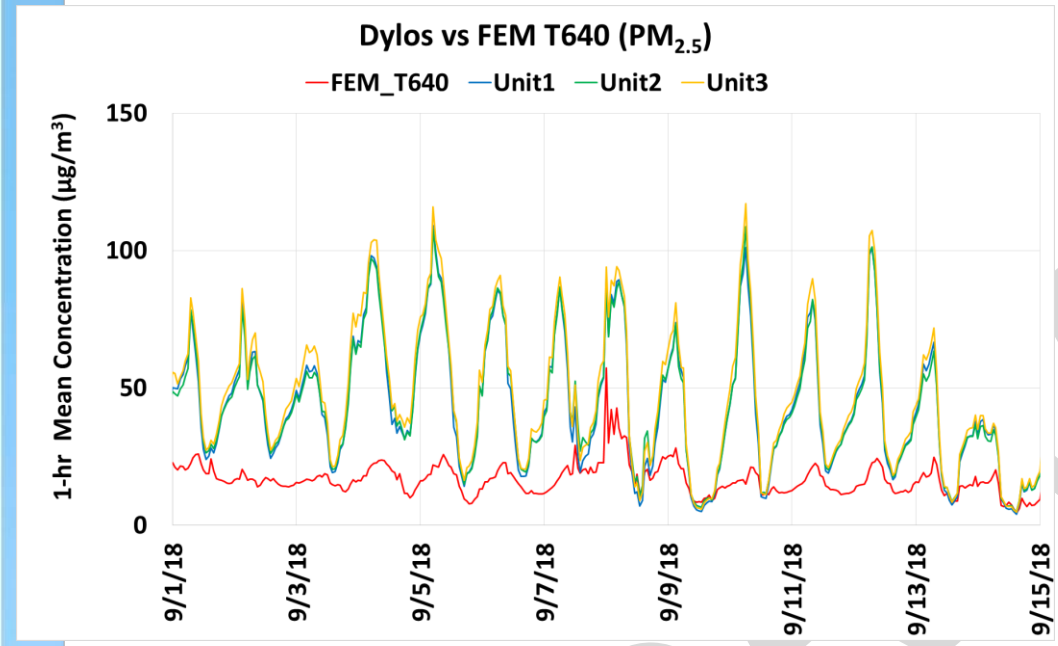
- Dylos PM_{10} measurements correlate poorly with the corresponding T640 PM_{10} mass concentrations ($R^2 < 0.2$).
- Dylos PM_{10} measurements largely overestimate PM_{10} levels recorded by T640.



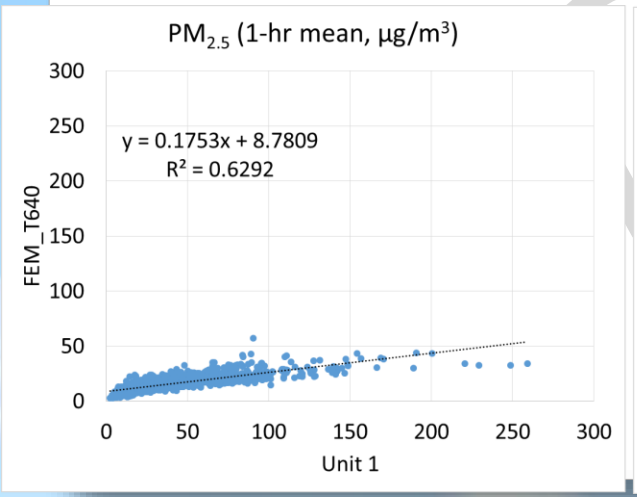


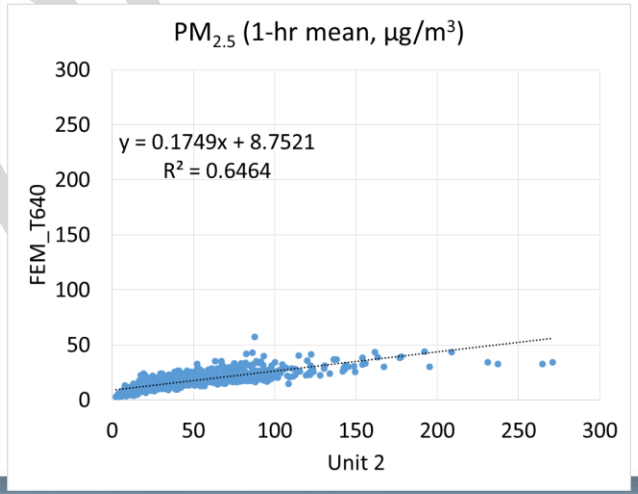


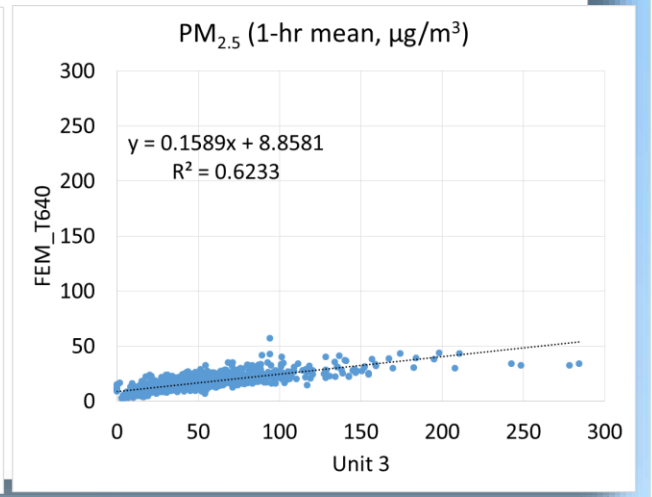
Dylos DC1700-PM vs FEM T640 ($PM_{2.5}$; 1-hr mean)



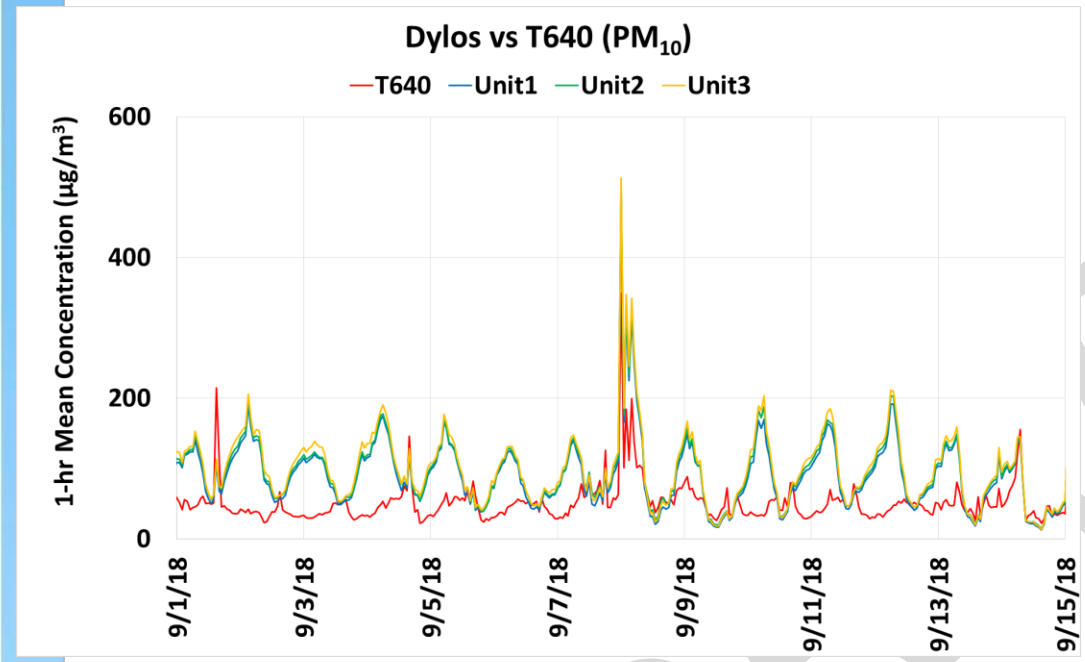
- $PM_{2.5}$ measurements form the three Dylos sensors correlate moderately with the corresponding FEM T640 data.
- The three sensor units tested seem to track well the diurnal $PM_{2.5}$ variations recorded by the FEM T640 instrument.
- The sensors $PM_{2.5}$ measurements largely overestimate the corresponding FEM T640 data.



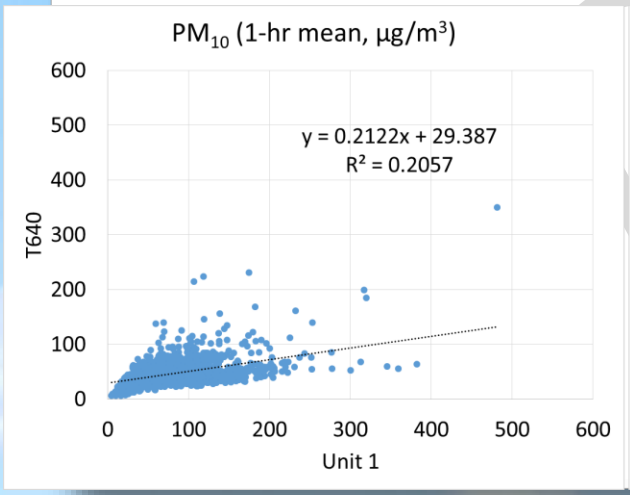


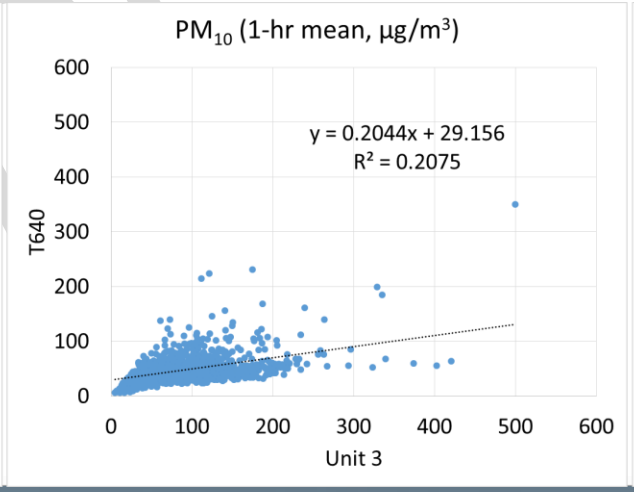


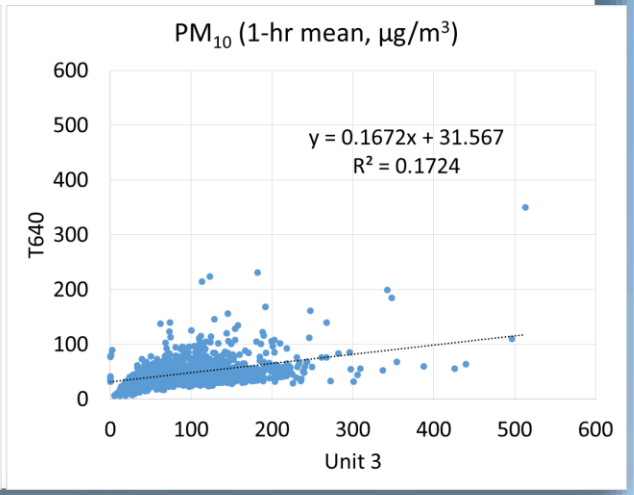
Dylos DC1700-PM vs T640 (PM_{10}; 1-hr mean)



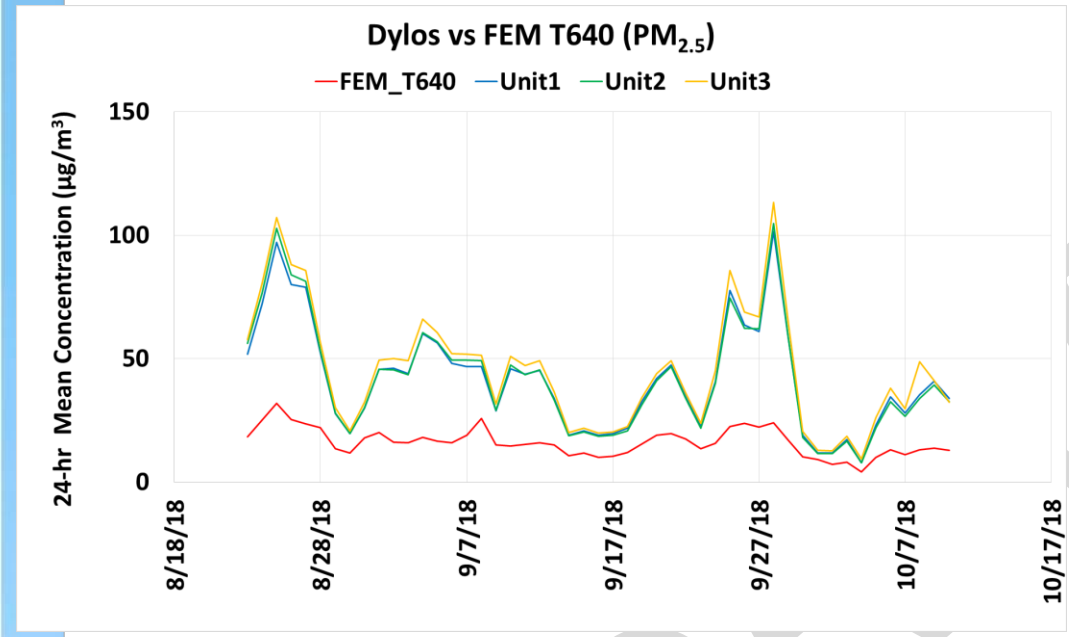
- Hourly-averaged Dylos PM_{10} measurements correlate poorly with the corresponding T640 PM_{10} mass concentrations ($R^2 < 0.21$).
- The three sensor units seem to track modestly the diurnal PM_{10} variations recorded by the T640 instrument.



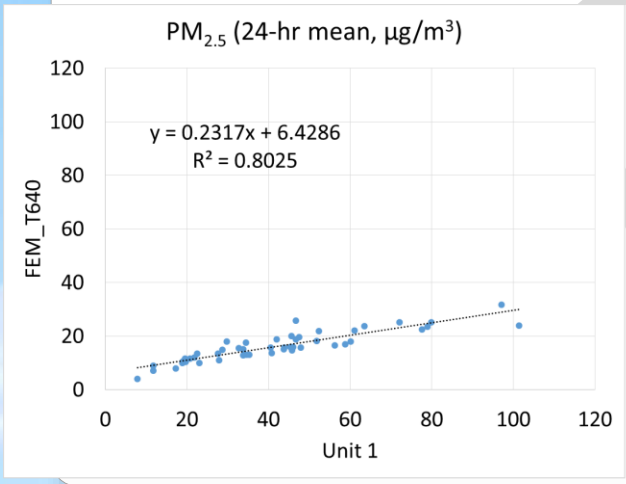


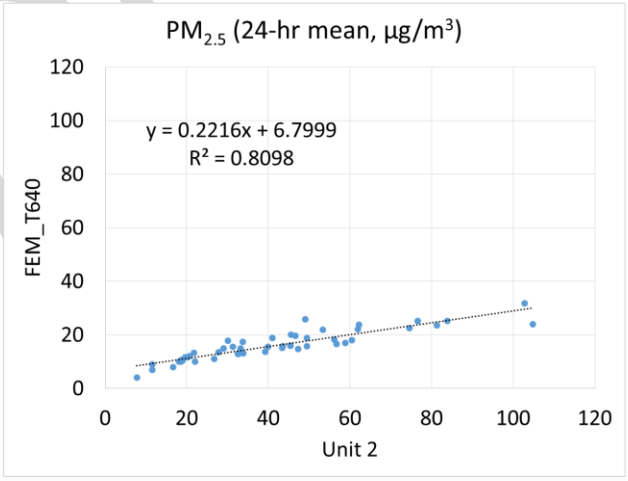


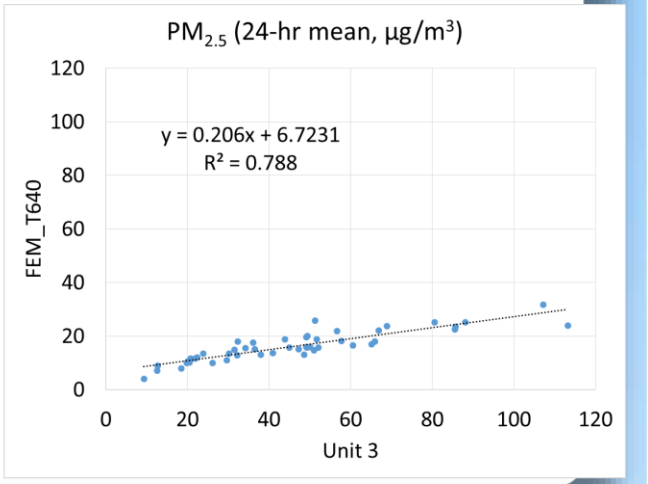
Dylos DC1700-PM vs FEM T640 ($PM_{2.5}$; 24-hr mean)



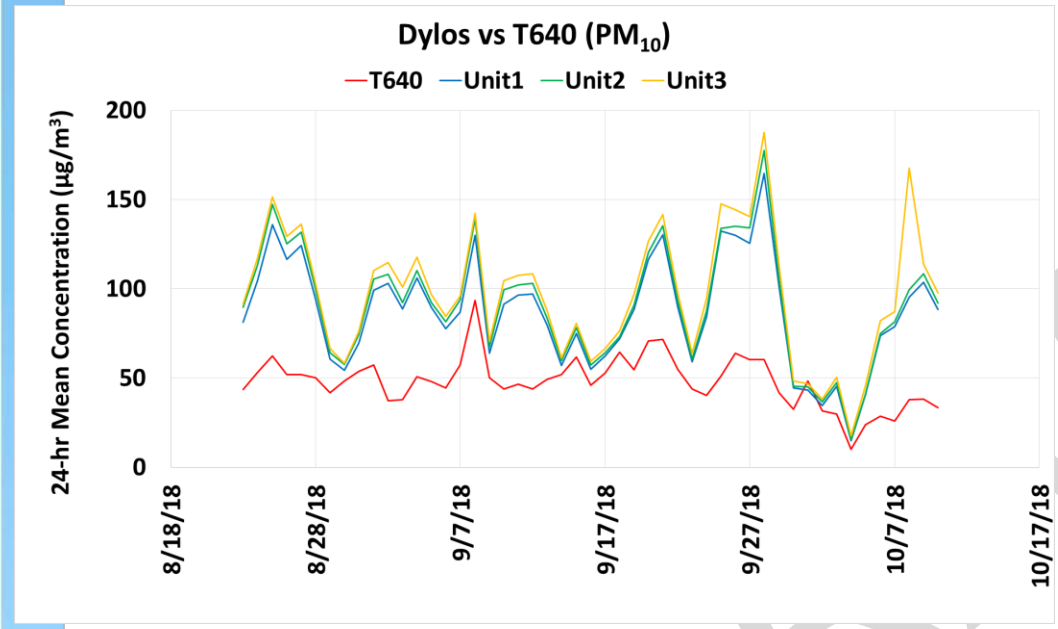
- Daily-averaged $PM_{2.5}$ measurements from Dylos sensors correlate well with the corresponding FEM T640 data ($0.78 < R^2 < 0.81$)
- The three sensor units tested seem to track well the day-today $PM_{2.5}$ variations recorded by the FEM T640 instrument.
- Dylos sensors largely overestimate $PM_{2.5}$ levels measured by FEM T640.



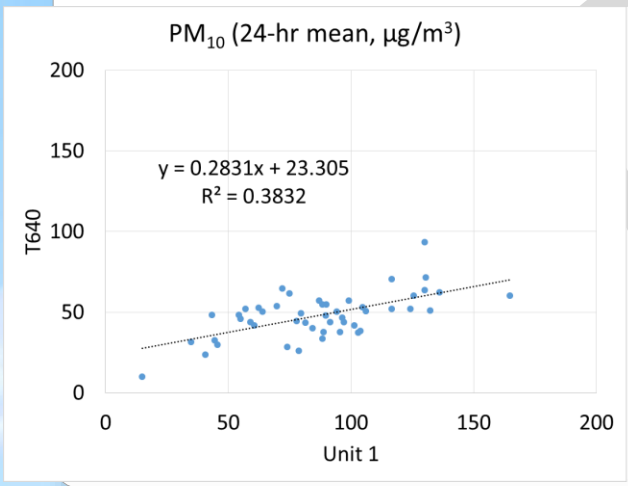


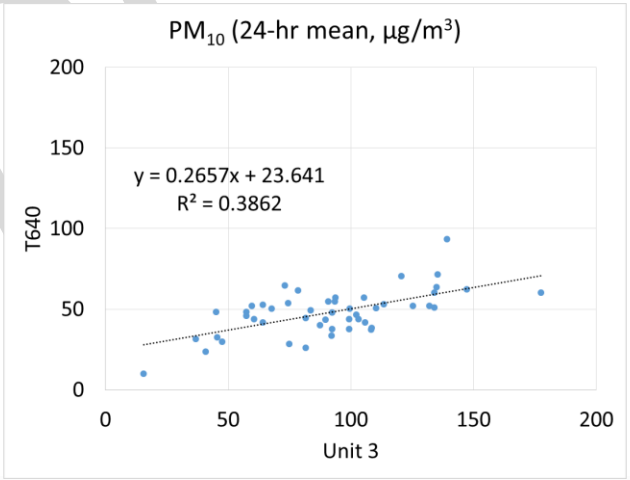


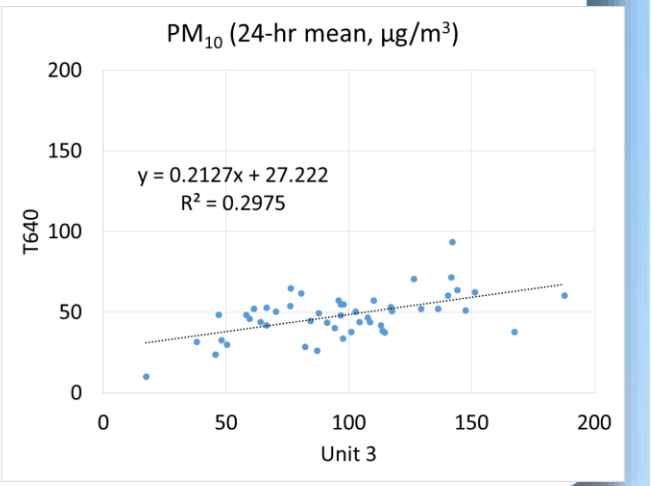
Dylos DC1700-PM vs T640 (PM_{10}; 24-hr mean)



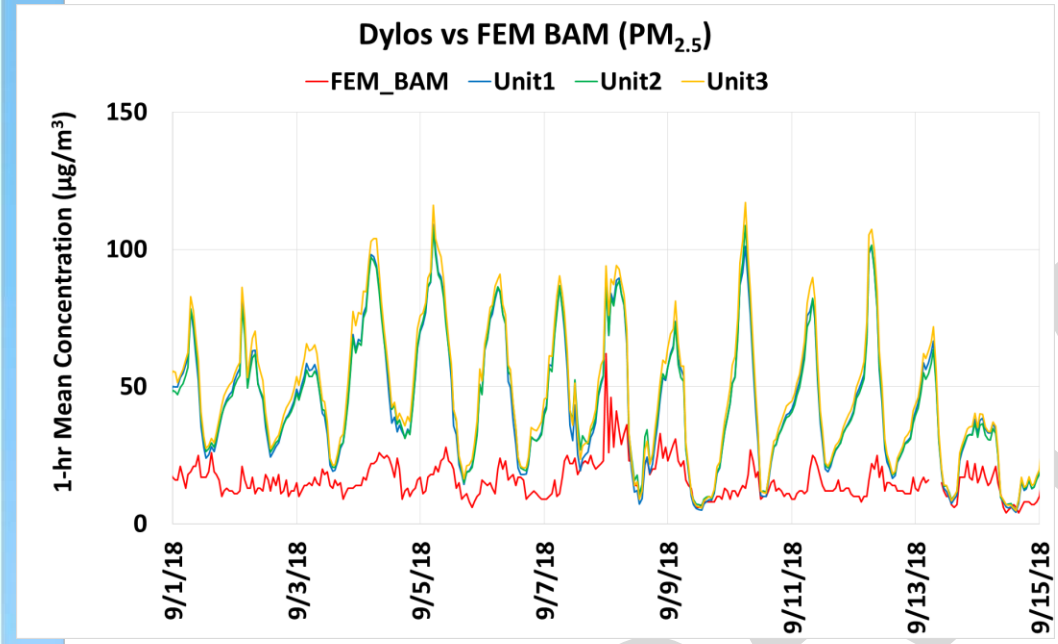
- Daily-averaged Dylos PM_{10} measurements show low correlation with the corresponding T640 PM_{10} mass concentrations.
- The three sensor units tested seem to track modestly the day-to-day PM_{10} variations recorded by the T640 instrument.
- The sensors PM_{10} measurements largely overestimate the corresponding T640 data.



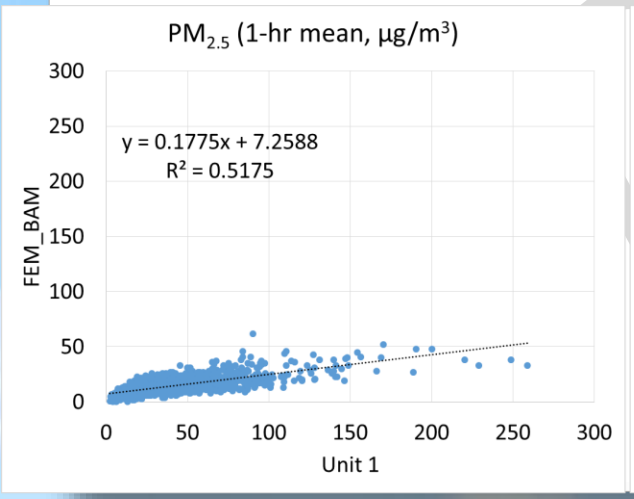


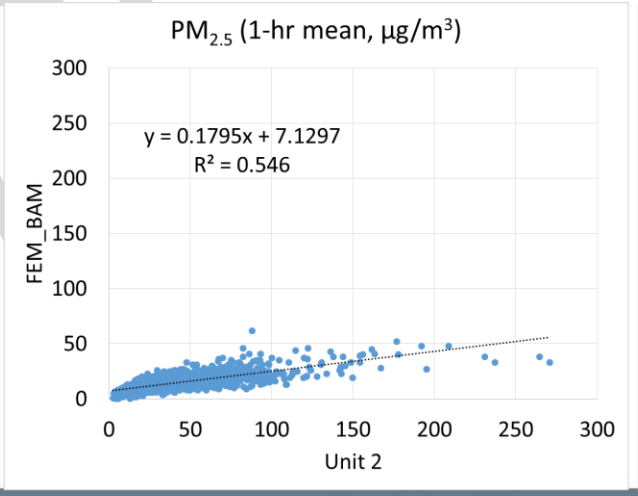


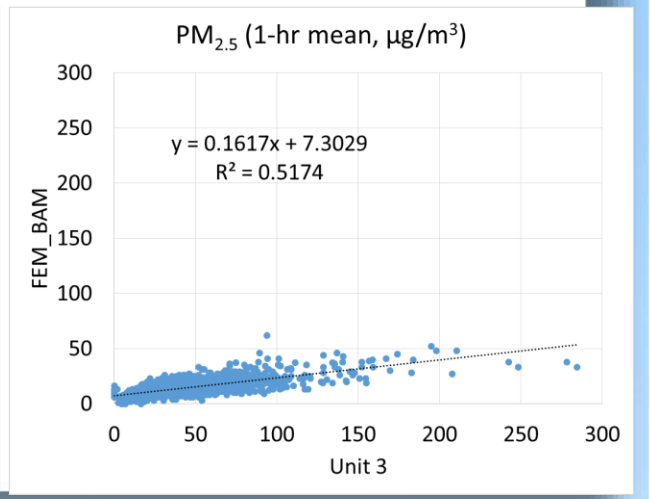
Dylos DC1700-PM vs FEM BAM ($PM_{2.5}$; 1-hr mean)



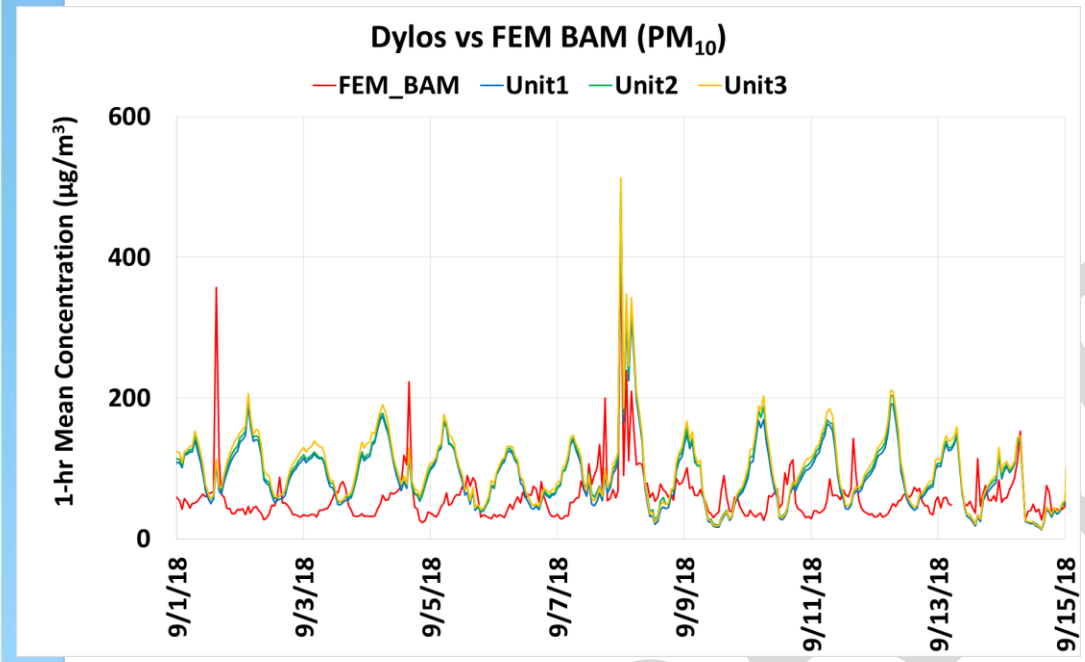
- $PM_{2.5}$ measurements from the three Dylos sensors correlate moderately with the corresponding FEM BAM data.
- The three sensor units tested seem to track well the diurnal $PM_{2.5}$ variations recorded by the FEM BAM instrument.
- The sensors $PM_{2.5}$ measurements largely overestimate the corresponding FEM BAM data.



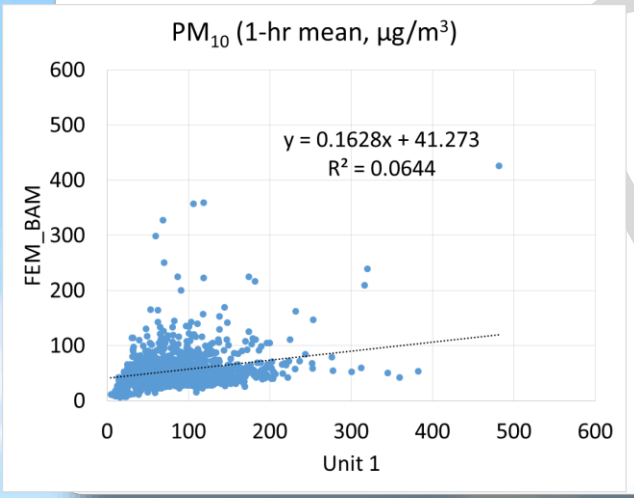


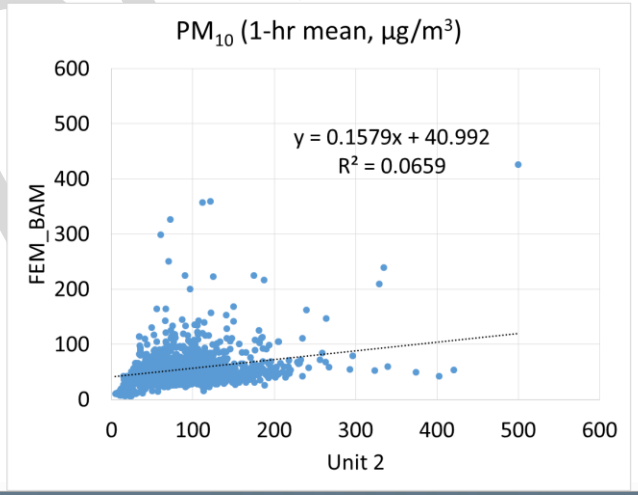


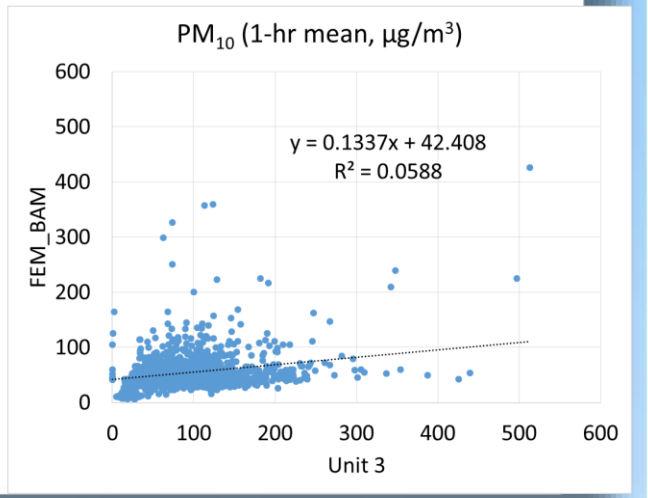
Dylos DC1700-PM vs FEM BAM (PM_{10}; 1-hr mean)



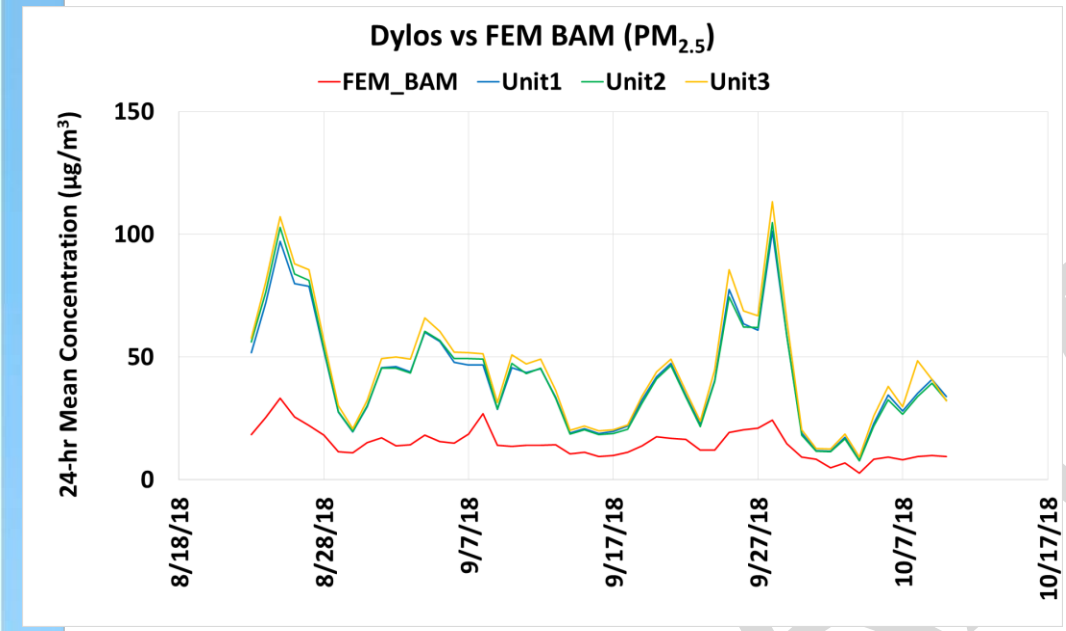
- Dylos PM_{10} measurements do not correlate with the corresponding FEM BAM PM_{10} mass concentrations (R^2 ~ 0.0)
- The three sensor units tested seem to track modestly the diurnal PM_{10} variations recorded by the FEM BAM instrument.



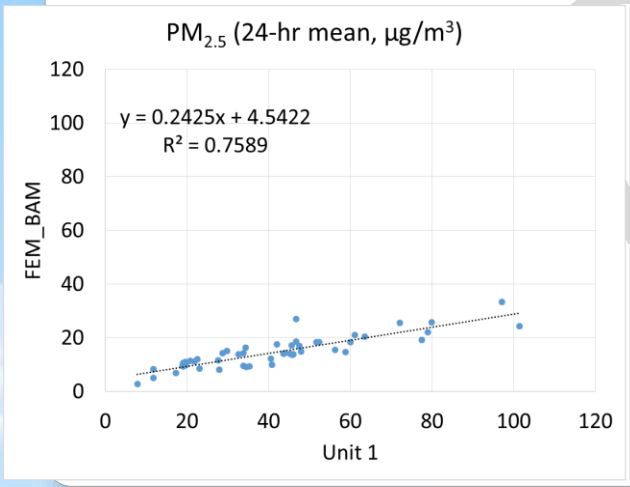


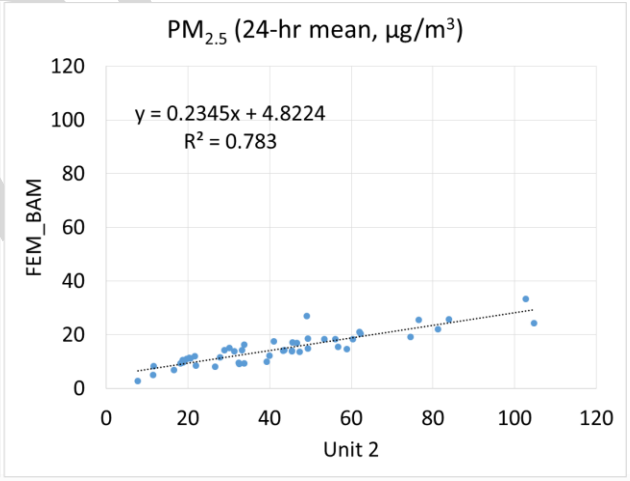


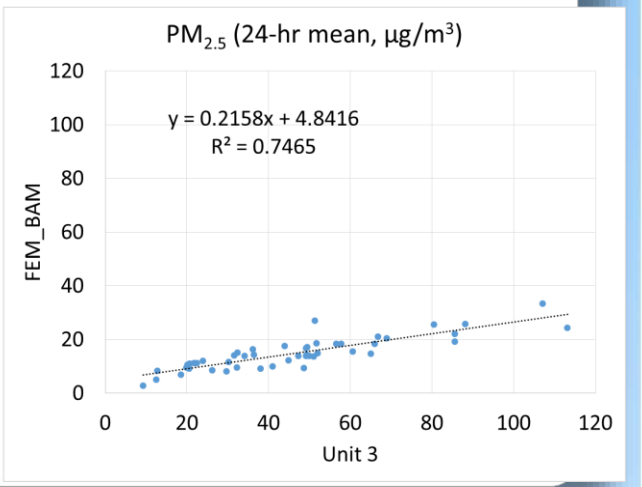
Dylos DC1700-PM vs FEM BAM ($PM_{2.5}$; 24-hr mean)



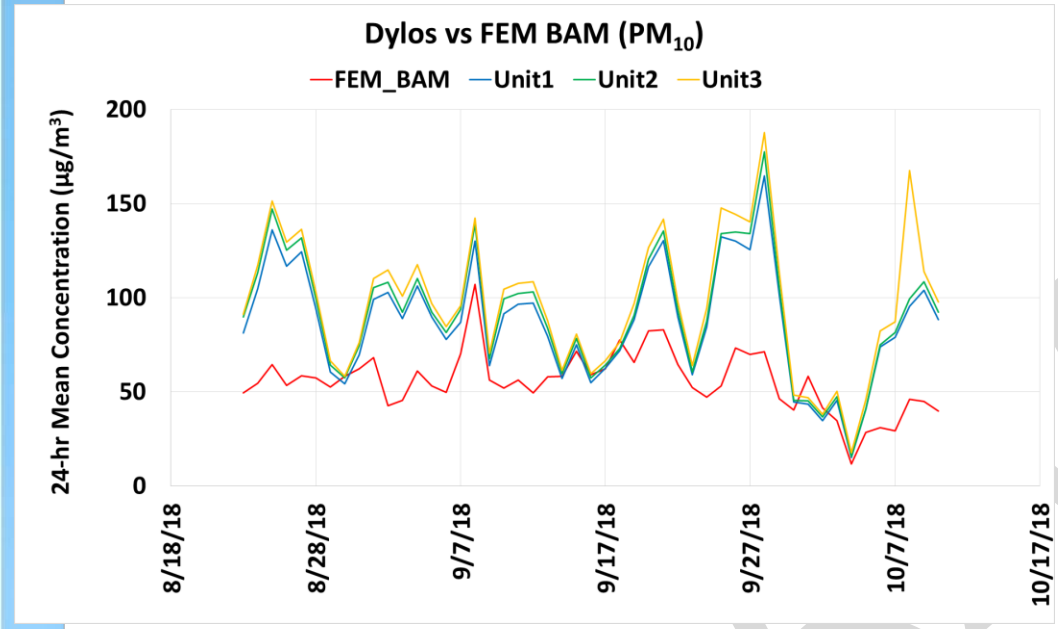
- Daily-averaged $PM_{2.5}$ measurements from Dylos sensors correlate well with the corresponding FEM BAM data ($0.74 < R^2 < 0.79$)
- The three sensor units tested seem to track well the day-to-day $PM_{2.5}$ variations recorded by the FEM BAM instrument.
- The sensors $PM_{2.5}$ measurements largely overestimate the corresponding FEM BAM data.



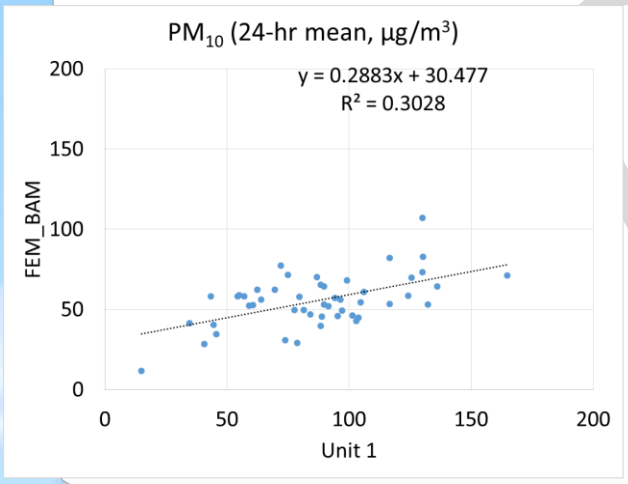


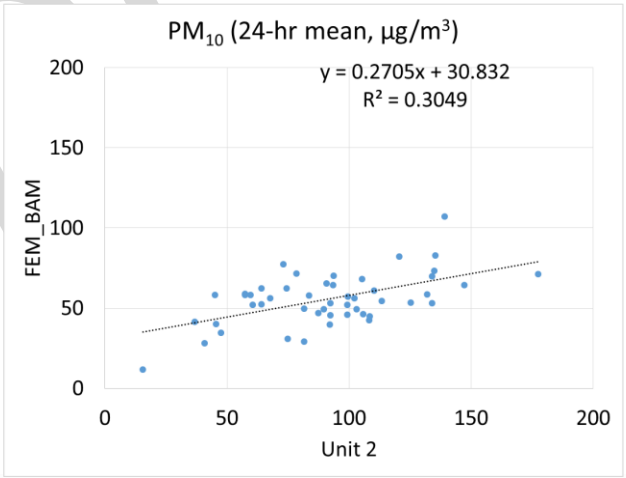


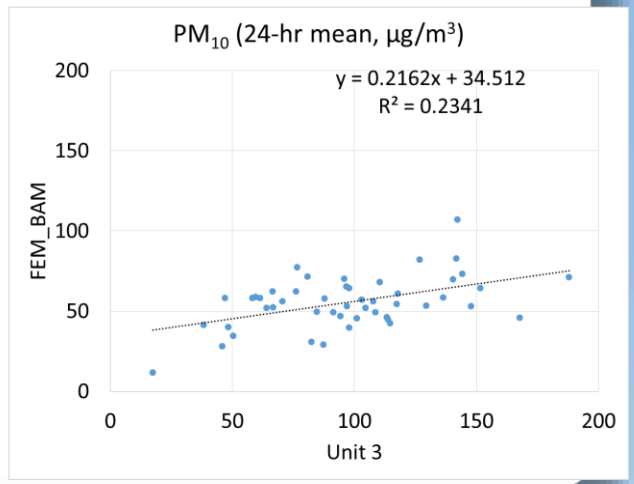
Dylos DC1700-PM vs FEM BAM (PM_{10}; 24-hr mean)



- Daily-averaged Dylos PM_{10} measurements correlate poorly (R^2 <0.31) with the corresponding FEM BAM measurements
- The three sensor units tested seem to track the day-to-day PM_{10} variations recorded by the FEM BAM instrument.
- The sensors PM_{10} measurements largely overestimate the corresponding FEM BAM data.







Discussion

- Overall, the **Dylos DC1700-PM** sensor units were very reliable with high data recovery (~100%)
- The three units tested showed low intra-model variability for the mass concentrations of $PM_{2.5}$ and PM_{10}
- Dylos $PM_{2.5}$ data correlated moderately with the corresponding 5-min values from FEM GRIMM ($0.66 < R^2 < 0.68$) and FEM T640 ($0.58 < R^2 < 0.61$)
- Hourly-averaged Dylos $PM_{2.5}$ mass concentrations showed moderate correlations ($0.51 < R^2 < 0.55$) with hourly FEM BAM $PM_{2.5}$ measurements
- Dylos PM_{10} mass concentrations correlated poorly ($R^2 < 0.2$) with the corresponding PM_{10} mass measurements from reference monitors (GRIMM, T640, and FEM BAM)
- Dylos $PM_{2.5}$ and PM_{10} measurements largely overestimated the corresponding values measured by GRIMM, T640, and BAM
- **DC 1700-PM** reports mass concentrations of $PM_{2.5}$ and PM_{10} in addition to number concentrations of two size ranges (i.e., >0.5 & >2.5 µm) reported by Dylos DC 1100
- It should be noted that no sensor calibration had been performed by SCAQMD Staff prior to the beginning of this field testing
- Laboratory chamber testing may be necessary to fully evaluate the performance of these sensors over different / more extreme environmental conditions

- All results are still preliminary