Field Evaluation
AlphaSense OPC-N2 Sensor

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 07/10/2015 to 08/10/2015, three **AlphaSense OPC-N2** particle sensors were deployed in Rubidoux and operated side-by-side with two Federal Equivalent Method (FEM) instruments measuring the same pollutant

- AlphaSense(*3 units tested*):
  - Particulate matter sensors (optical; non-FEM)
  - Each unit measures: $PM_{1.0}$, $PM_{2.5}$ and PM_{10} ($\mu g/m^3$)
    Unit cost: ~$450
  - Time resolution: 15-sec
  - Units IDs: 216, 222, 308

- MetOne BAM (*reference method*):
  - Beta-attenuation monitor (FEM)
  - Measures $PM_{2.5}$
  - Cost: ~$20,000
  - Time resolution: 1-hr

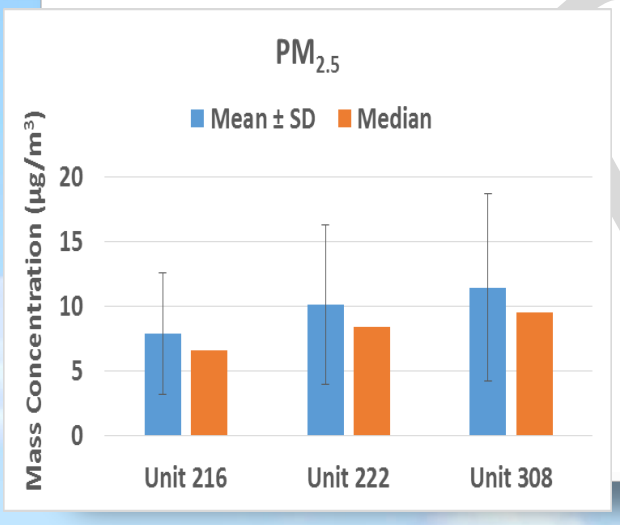
- GRIMM (*reference method*):
  - Optical particle counter (FEM)
  - Uses proprietary algorithms to calculate total $PM_{1.0}$, $PM_{2.5}$, and PM_{10} from particle number measurements
  - Cost: ~$25,000 and up
  - Time resolution: 1-min

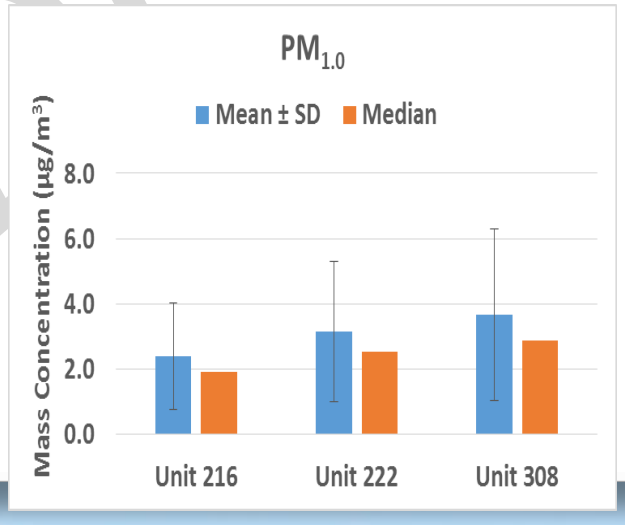
Data validation & recovery

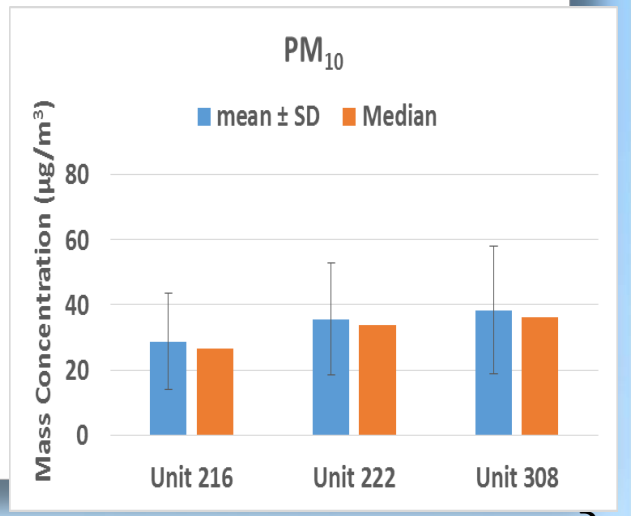
- Basic QA/QC procedures were used to validate the collected sensor data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for $PM_{1.0}$, $PM_{2.5}$ and PM_{10} from all three units was close to 100%

AlphaSense; intra-model variability

- Modest measurement variability was observed between the three AlphaSense OPC-N2 units tested



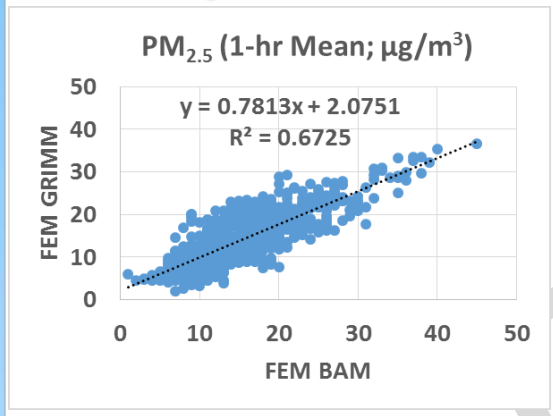


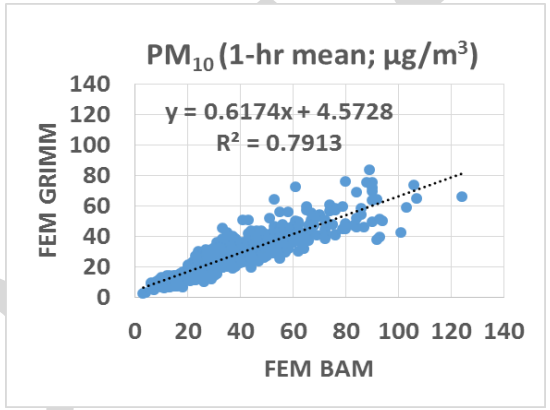


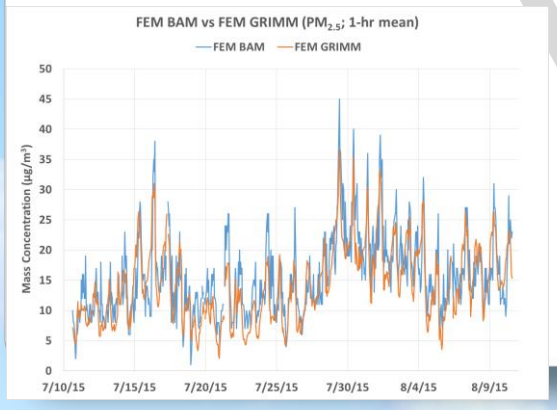
Data validation & recovery

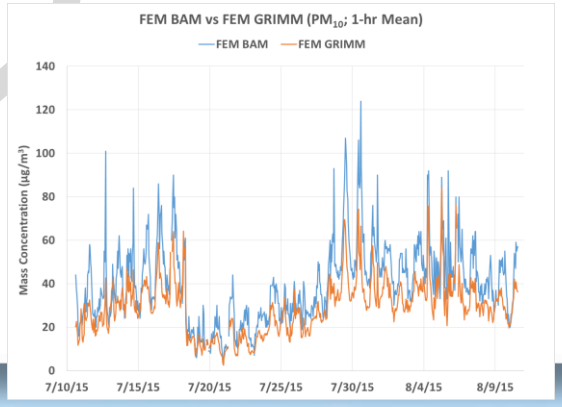
- Basic QA/QC procedures were used to validate the collected FEM data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for $PM_{1.0}$, $PM_{2.5}$ and PM_{10} from the GRIMM instrument and for $PM_{2.5}$ and PM_{10} from the BAM instrument was close to 100%.

Equivalent Methods; BAM vs GRIMM



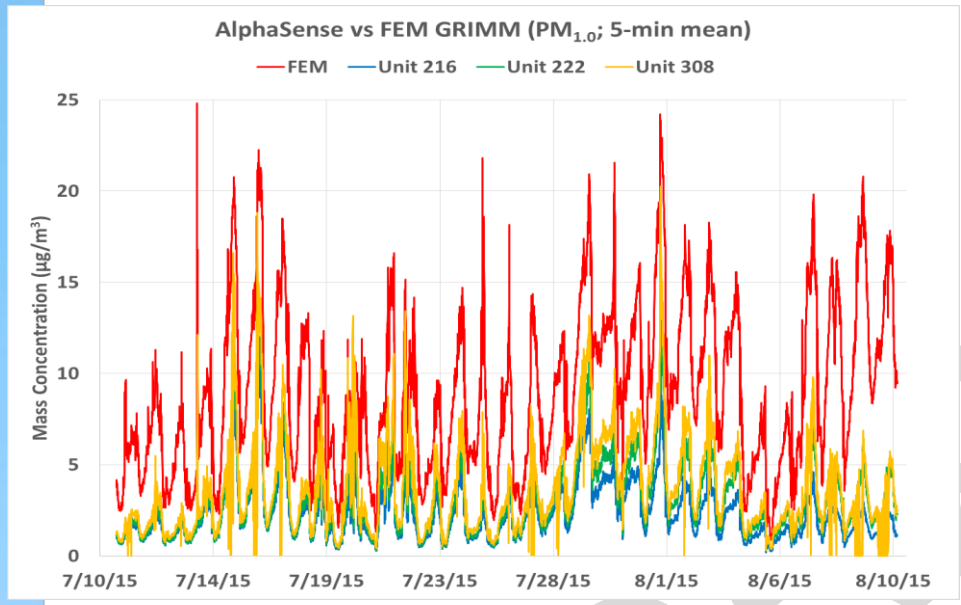




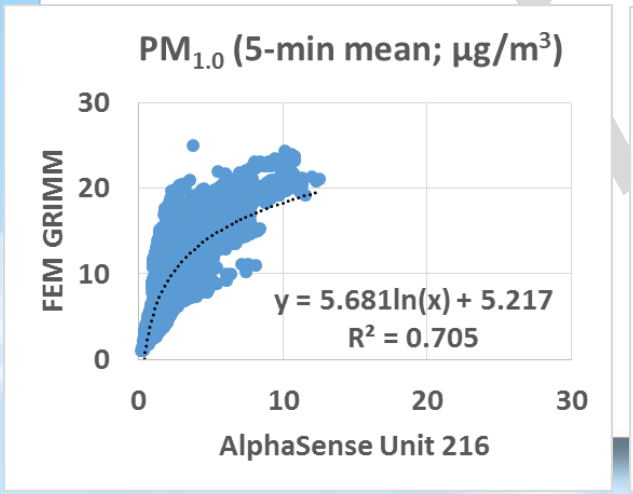


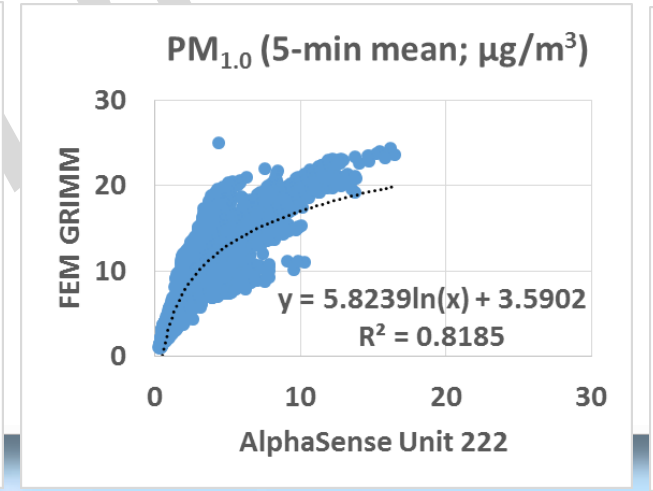
- Good correlation between the two FEM methods for both $PM_{2.5}$ & PM_{10}

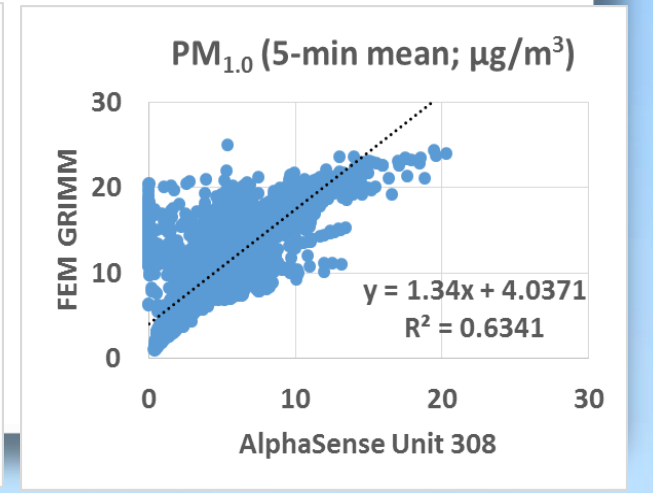
AlphaSense vs FEM GRIMM ($PM_{1.0}$; 5-min mean)



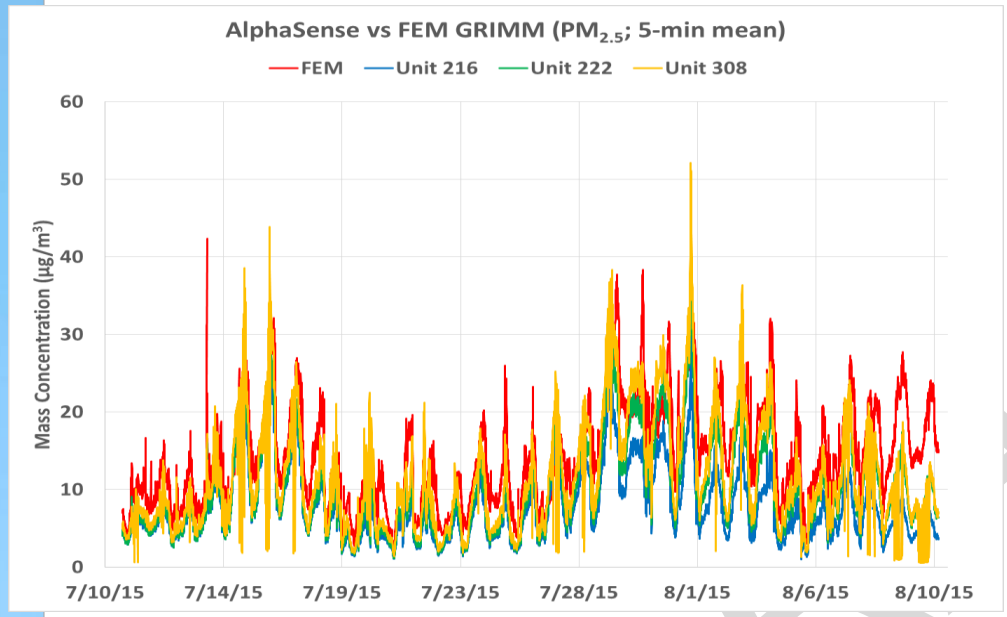
- $PM_{1.0}$ measurements from the three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.63 < R^2 < 0.82$)
- Data recorded by unit 308 (yellow line) include an unusually large number of zero values which contribute to lower the correlation between this sensor and the GRIMM ($R^2 = 0.63$)
- AlphaSense sensor measurements seem to track well the typical $PM_{1.0}$ diurnal variations recorded by the FEM instrument
- Sensor measurements largely underestimated the data recorded concurrently by the GRIMM instrument



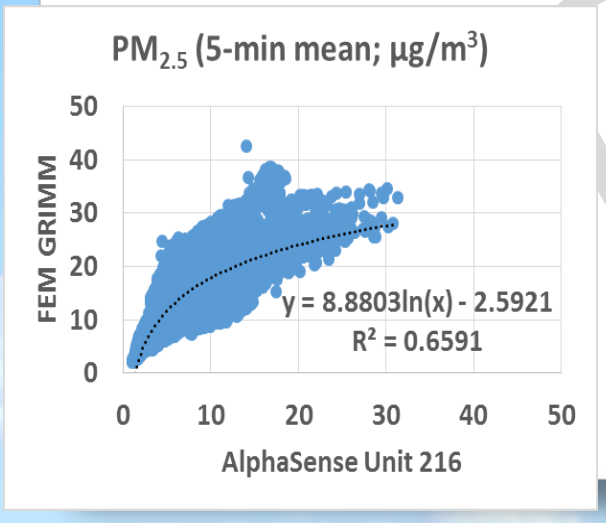


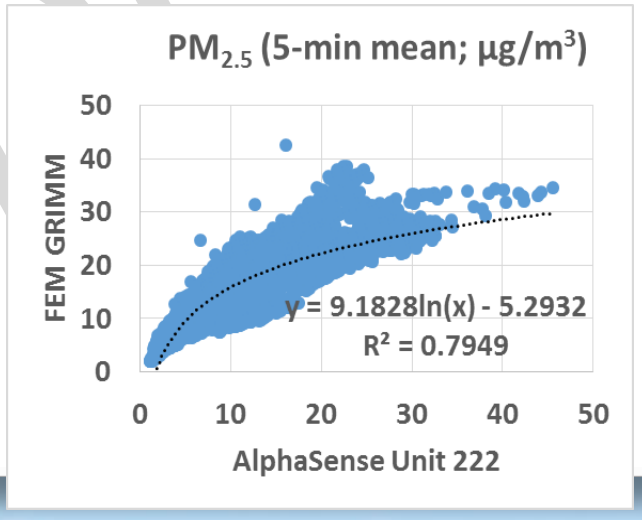


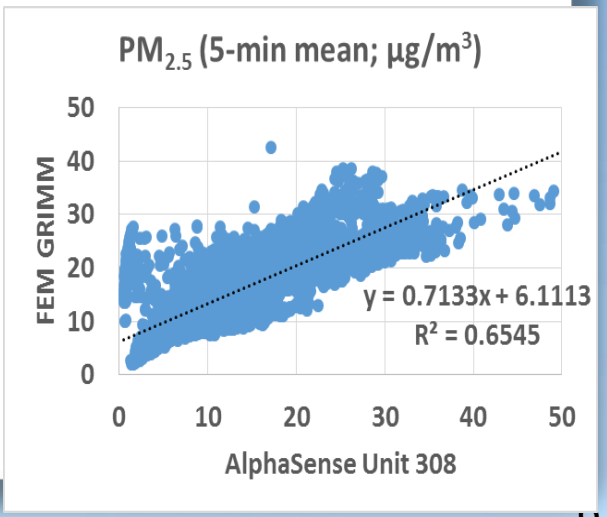
AlphaSense vs FEM GRIMM ($PM_{2.5}$; 5-min mean)



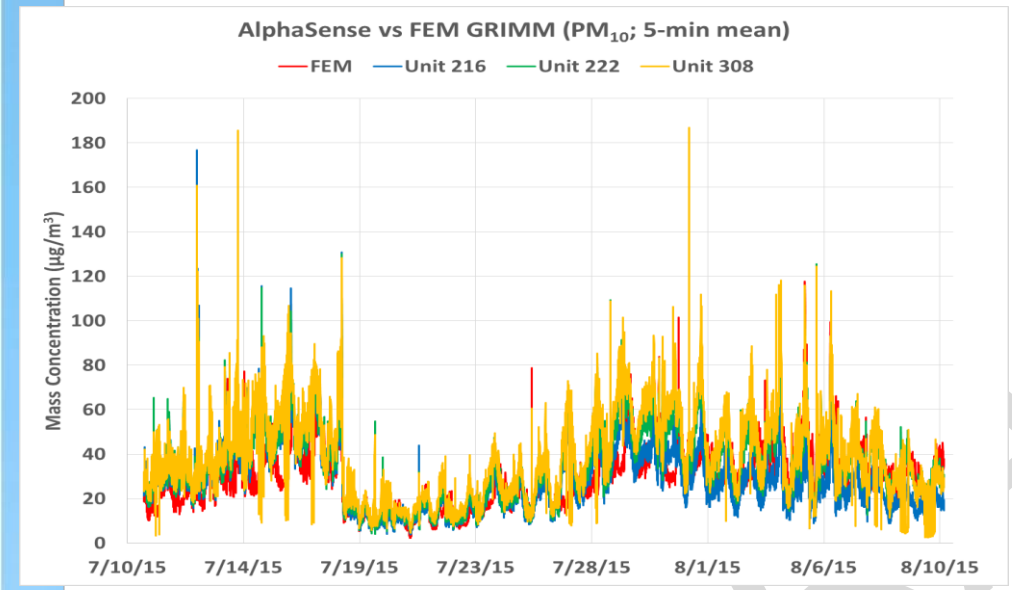
- $PM_{2.5}$ measurements from all three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.65 < R^2 < 0.79$)
- Data recorded by unit 308 (yellow line) include an unusually large number of zero or near-zero values which contribute to lower the correlation between this sensor and the GRIMM ($R^2 = 0.65$)
- AlphaSense measurements seem to track well the typical $PM_{2.5}$ diurnal variations recorded by the FEM instrument



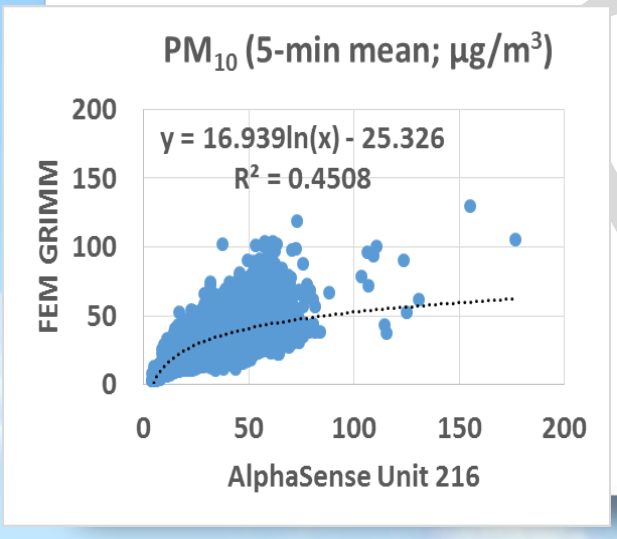


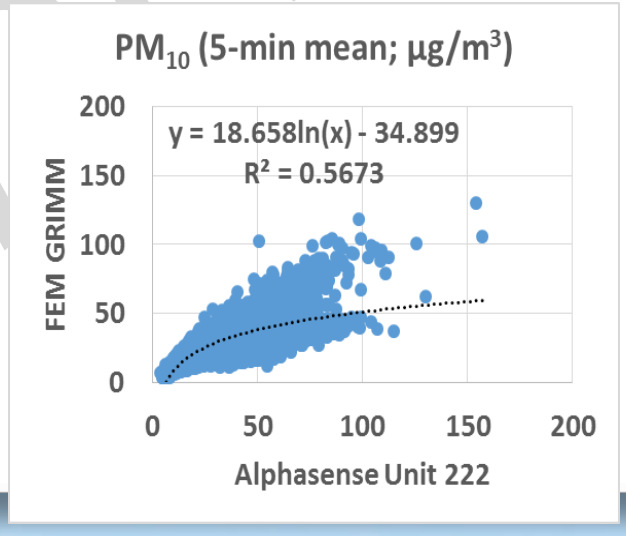


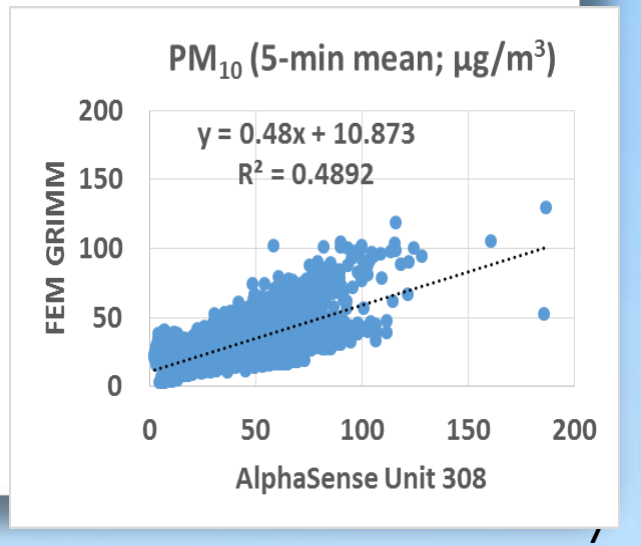
AlphaSense vs FEM GRIMM (PM_{10}; 5-min mean)



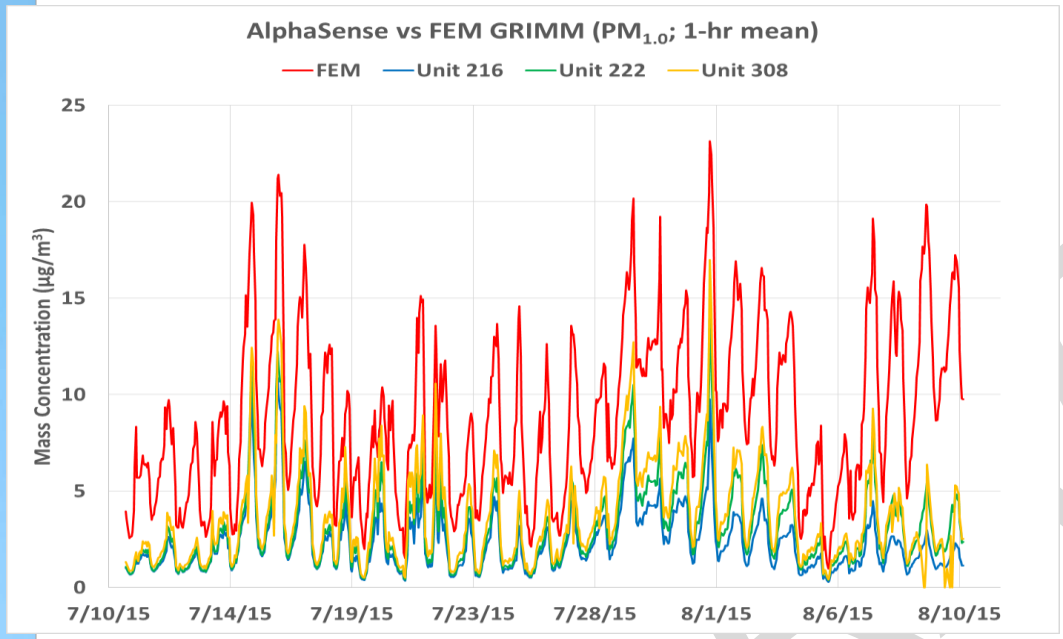
- PM_{10} measurements from the three AlphaSense sensors show a moderate correlation with the corresponding FEM GRIMM data (0.45 < R2 < 0.56)
- Data recorded by unit 308 (yellow line) include an unusually large number of low (underestimated) values which contribute to lower the correlation between this sensor and the GRIMM (R^2 = 0.49)
- AlphaSense measurements seem to track well the typical PM10 diurnal variations recorded by the FEM instrument



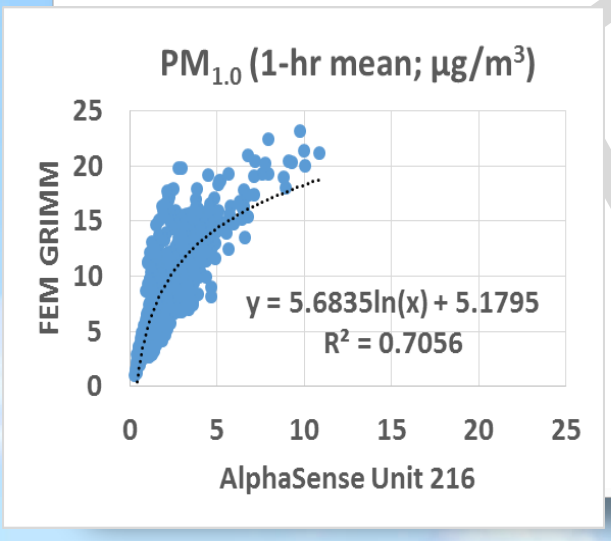


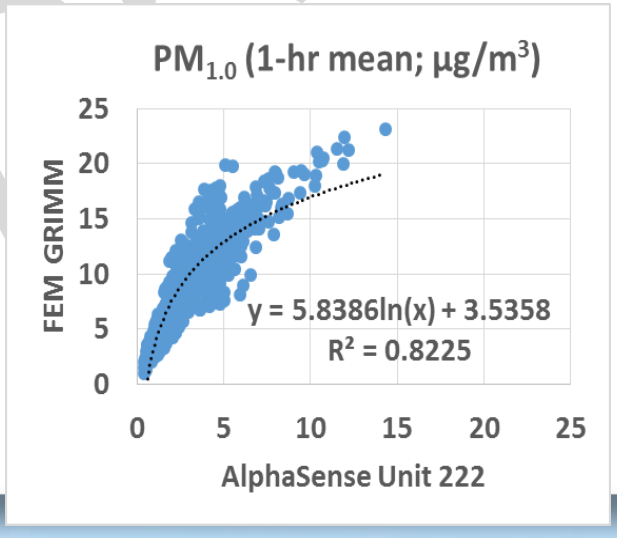


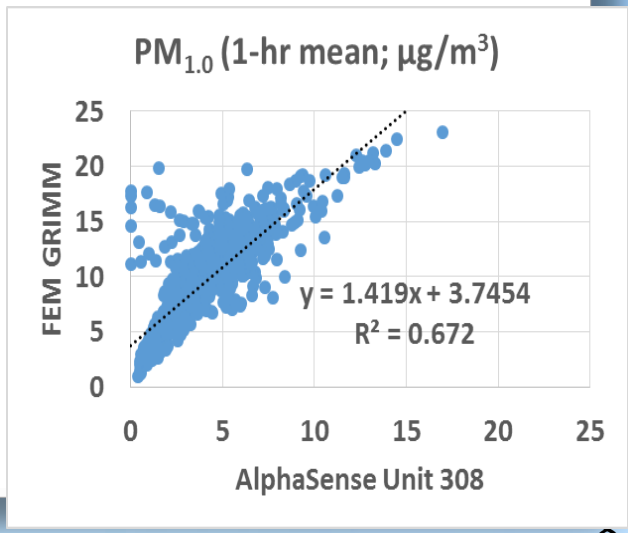
AlphaSense vs FEM GRIMM ($PM_{1.0}$; 1-hr mean)



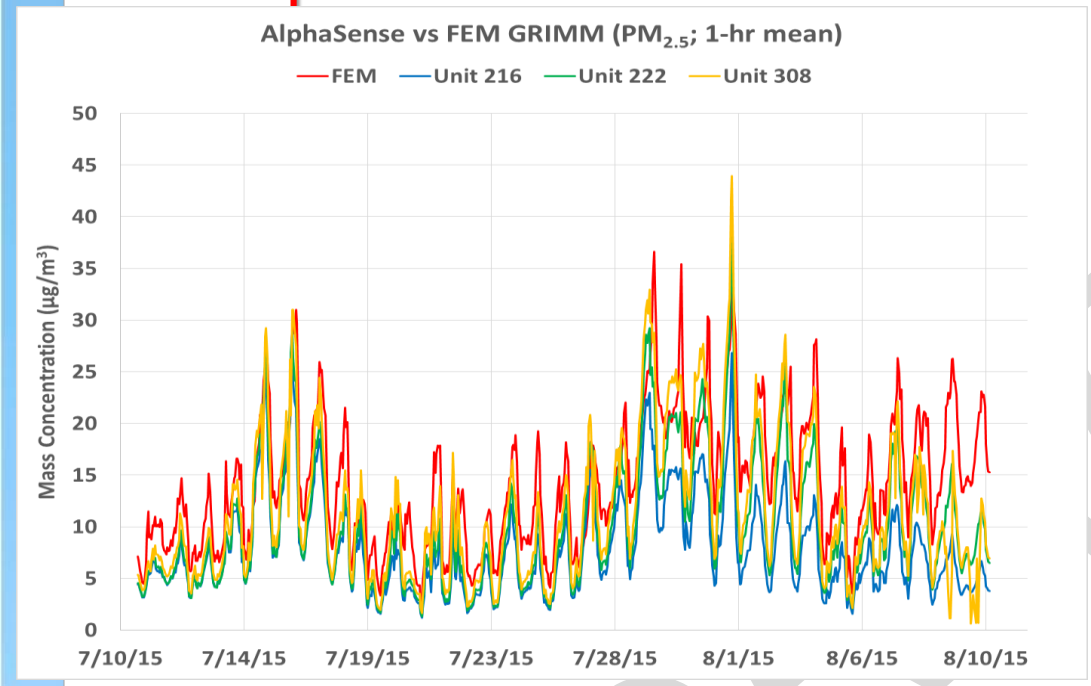
- $PM_{1.0}$ measurements from all three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.67 < R^2 < 0.82$)
- AlphaSense measurements seem to track well the typical $PM_{1.0}$ diurnal variations recorded by the FEM instrument
- The sensors measurements largely underestimated the corresponding GRIMM data



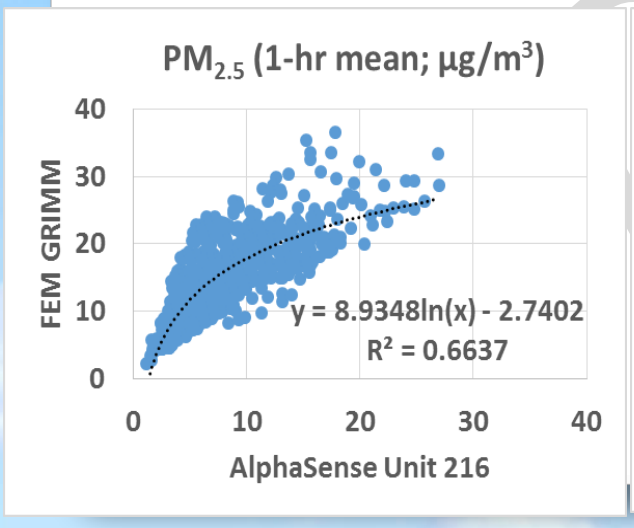


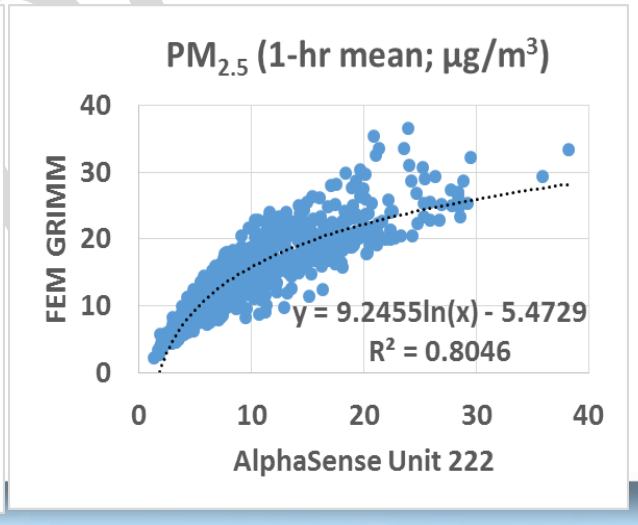


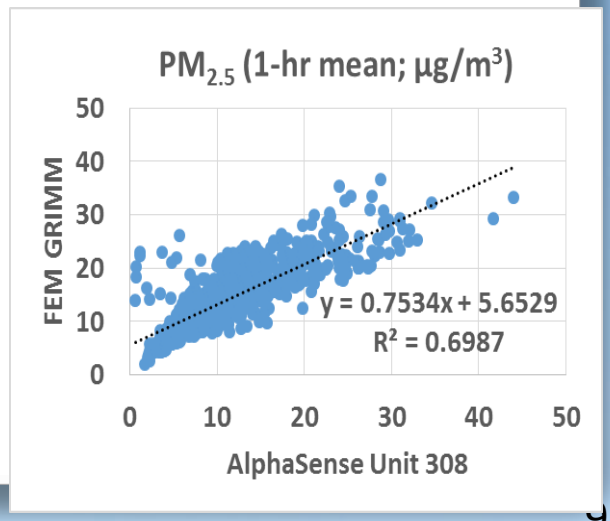
AlphaSense vs FEM GRIMM ($PM_{2.5}$; 1-hr mean)



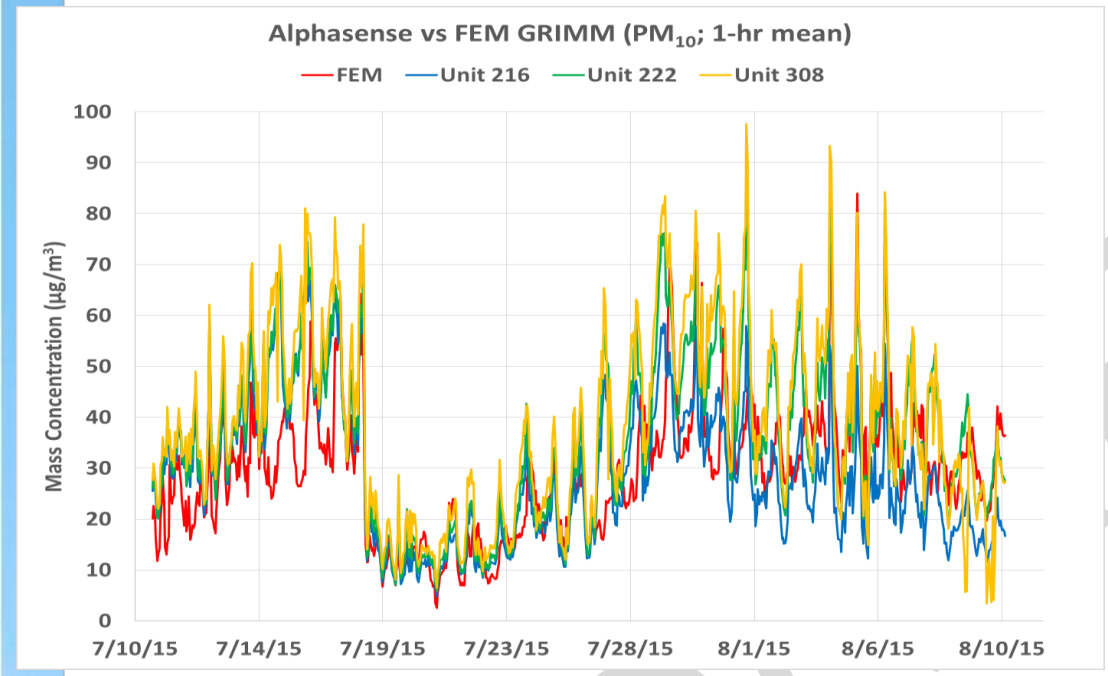
- $PM_{2.5}$ measurements from all three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.66 < R^2 < 0.80$)
- AlphaSense measurements seem to track well the typical $PM_{2.5}$ diurnal variations recorded by the FEM instrument



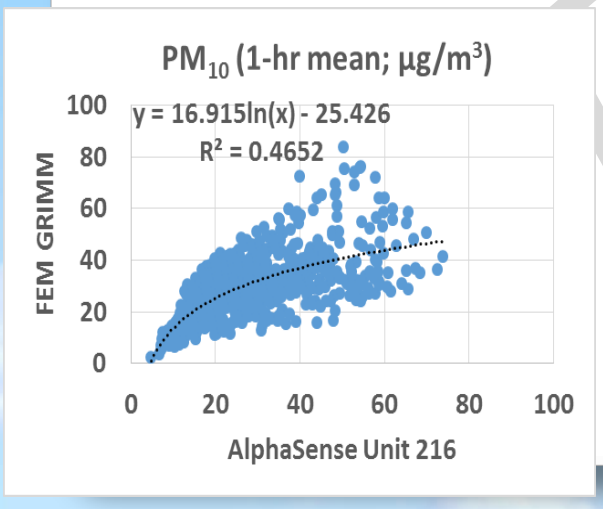


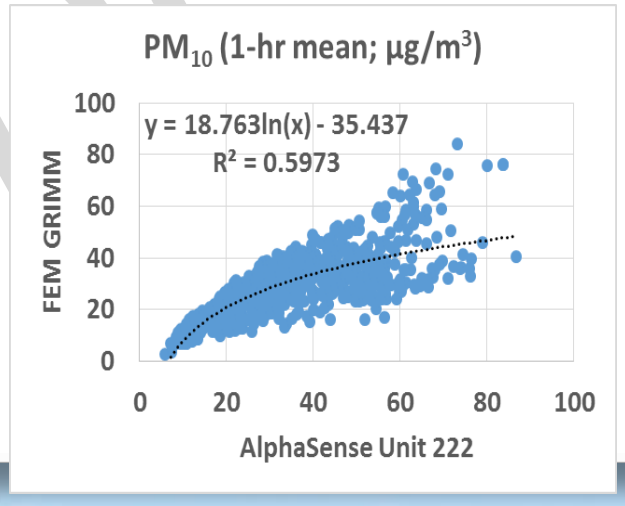


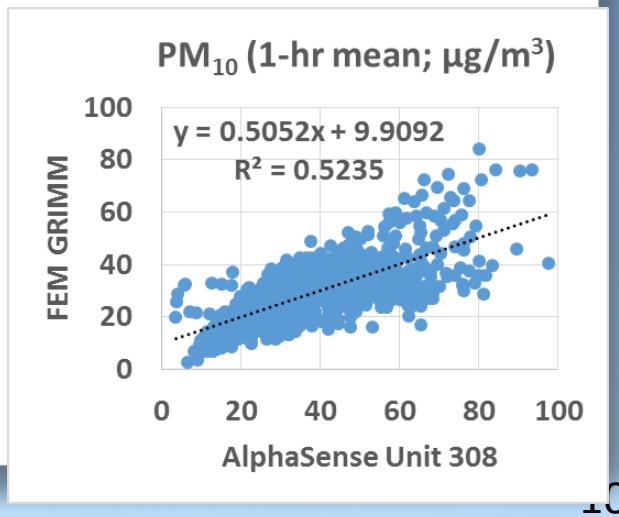
AlphaSense vs FEM GRIMM (PM_{10}; 1-hr mean)



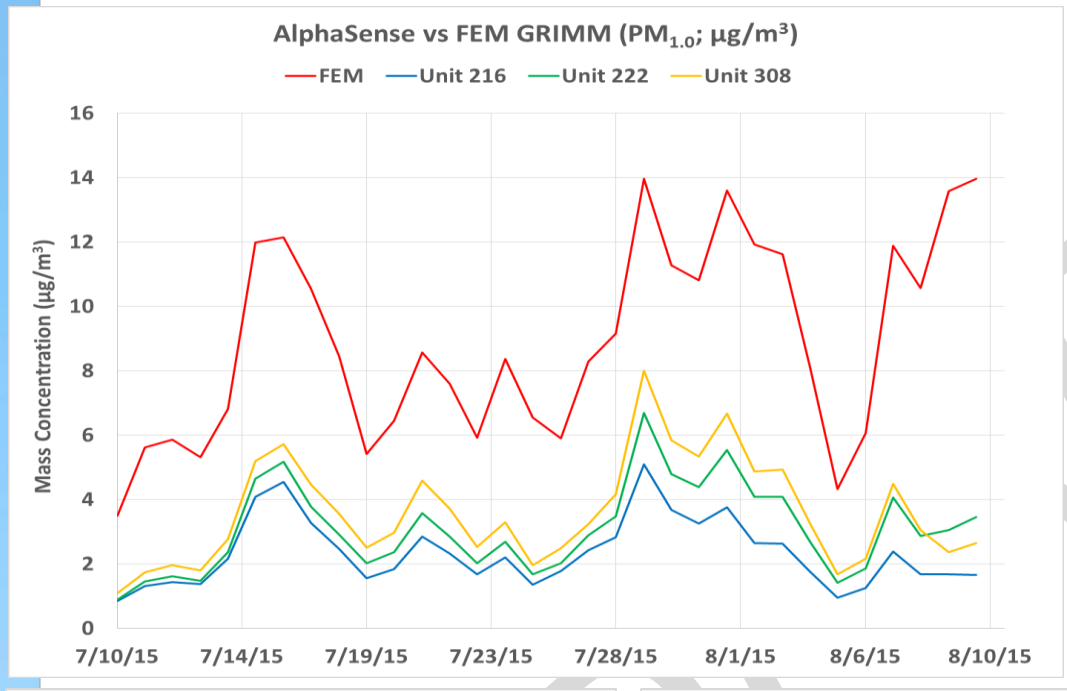
- PM_{10} measurements from all three AlphaSense sensors show a moderate correlation with the corresponding FEM GRIMM data ($0.46 < R^2 < 0.60$)
- AlphaSense measurements seem to track well the typical PM_{10} diurnal variations recorded by the FEM instrument



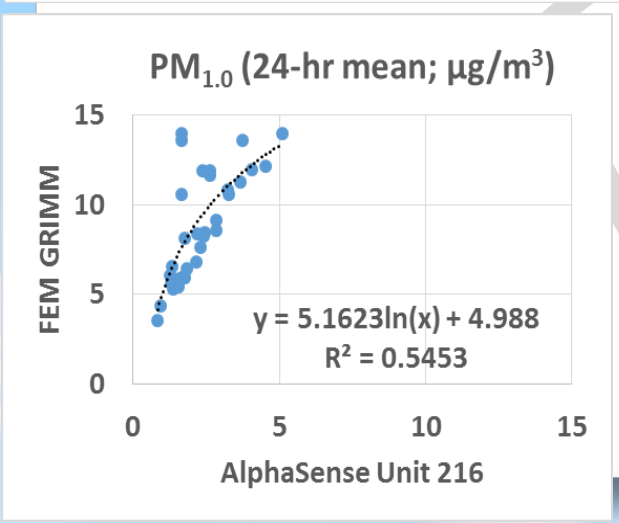


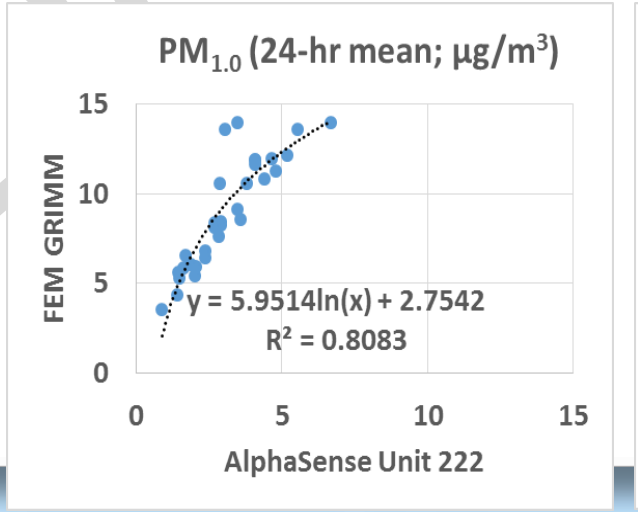


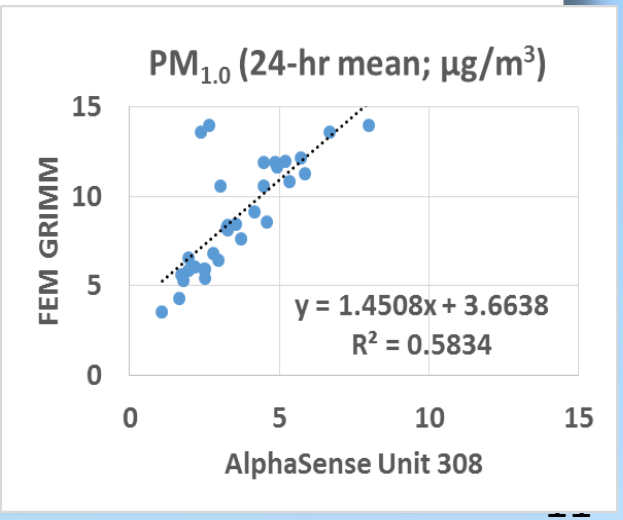
AlphaSense vs FEM GRIMM ($PM_{1.0}$; 24-hr mean)



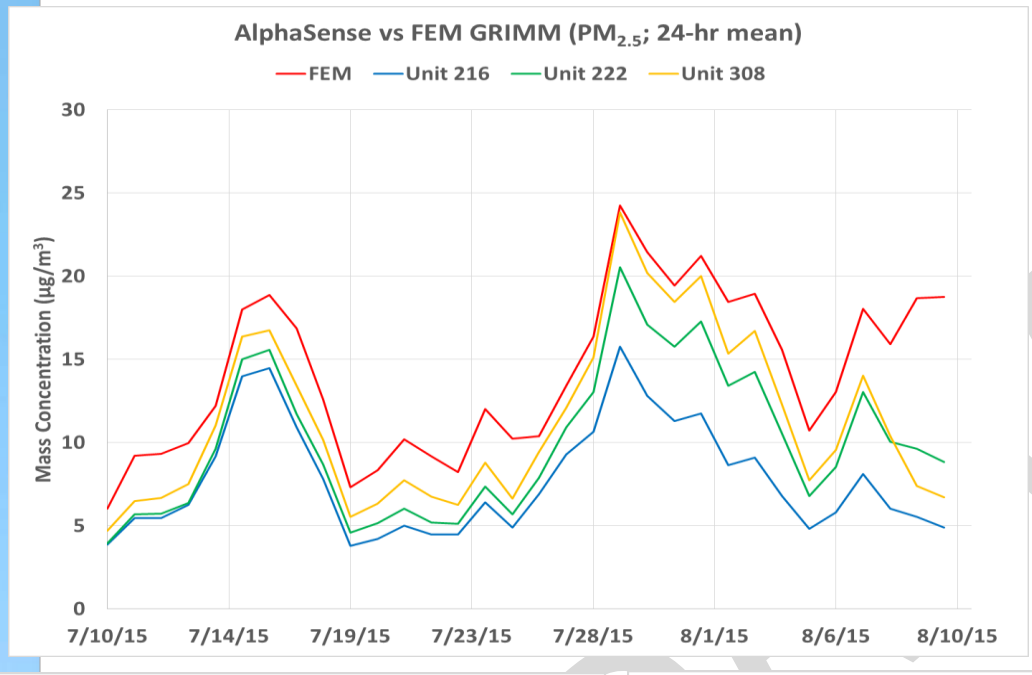
- $PM_{1.0}$ measurements from all three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.54 < R^2 < 0.81$)
- AlphaSense measurements track the typical $PM_{1.0}$ diurnal variations recorded by the FEM instrument
- The sensors measurements largely underestimated the GRIMM data



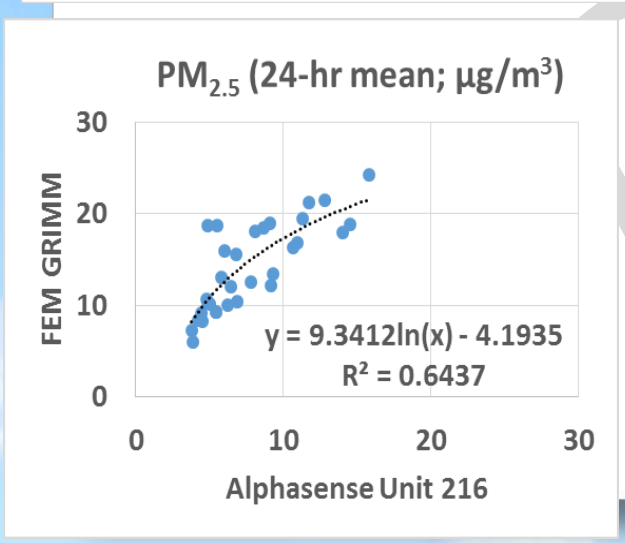


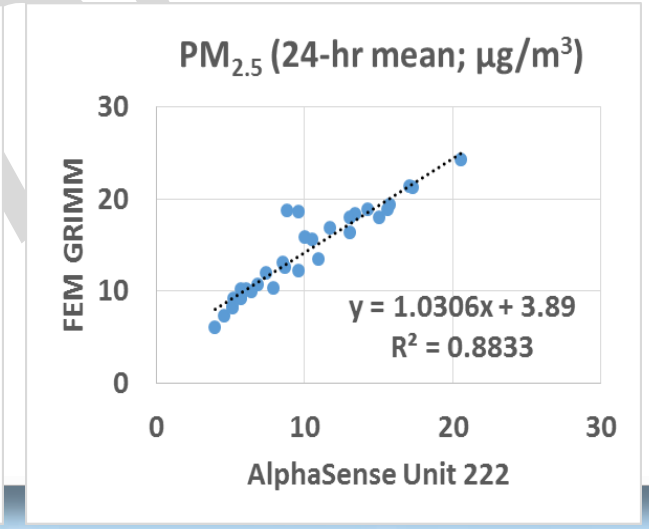


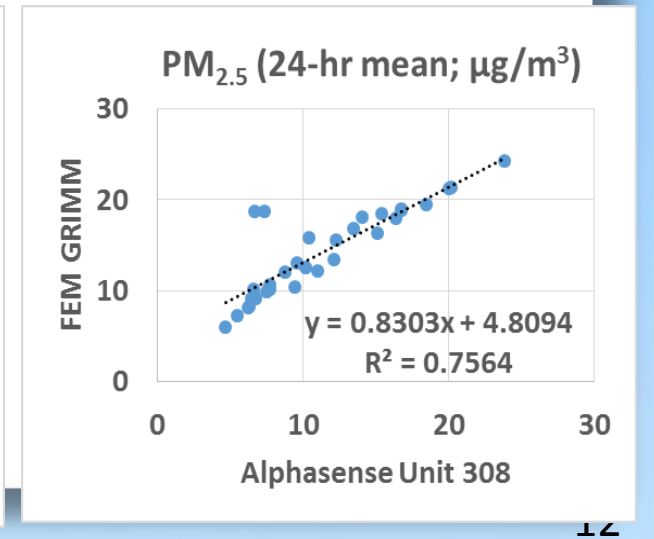
AlphaSense vs FEM GRIMM ($PM_{2.5}$; 24-hr mean)



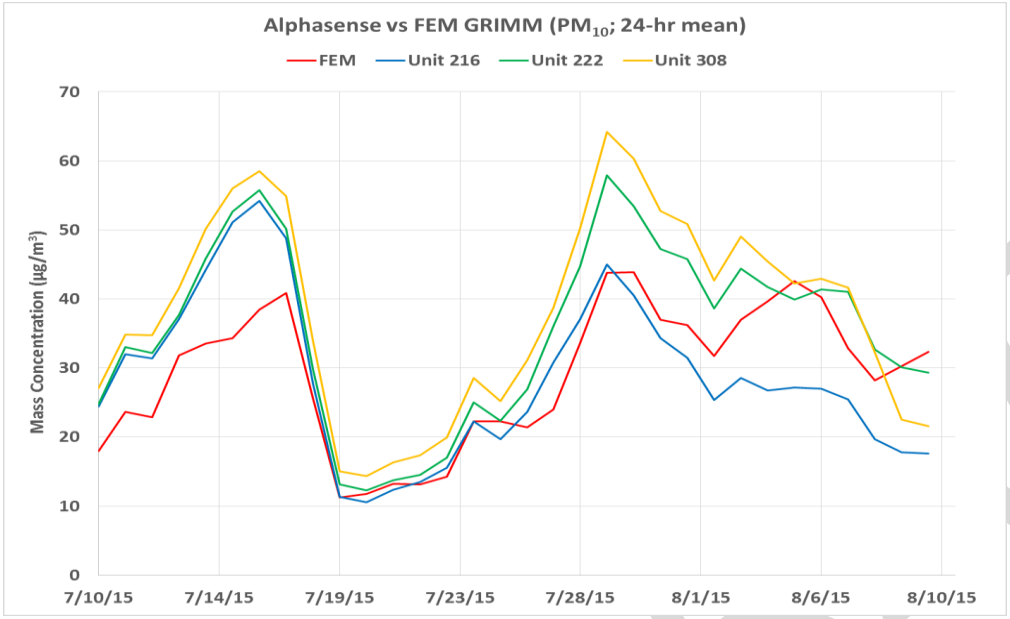
- $PM_{2.5}$ measurements from all three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.64 < R^2 < 0.88$)
- AlphaSense measurements track the typical $PM_{2.5}$ diurnal variations as recorded by the FEM instrument



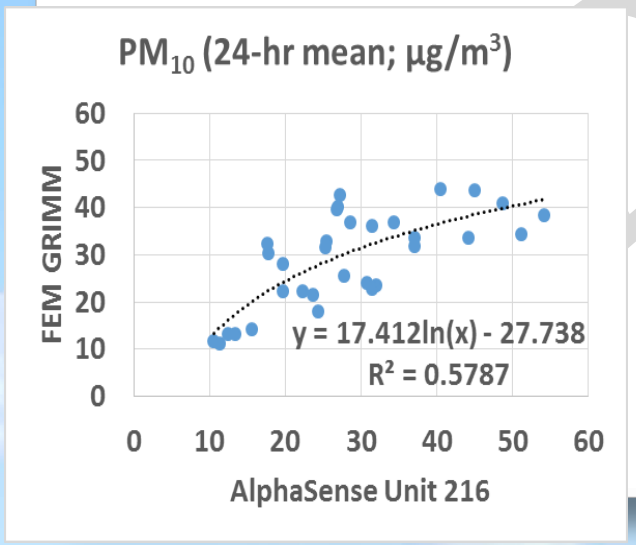


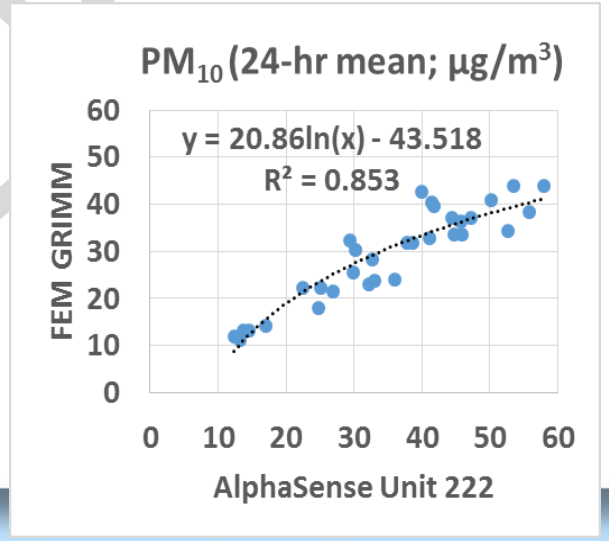


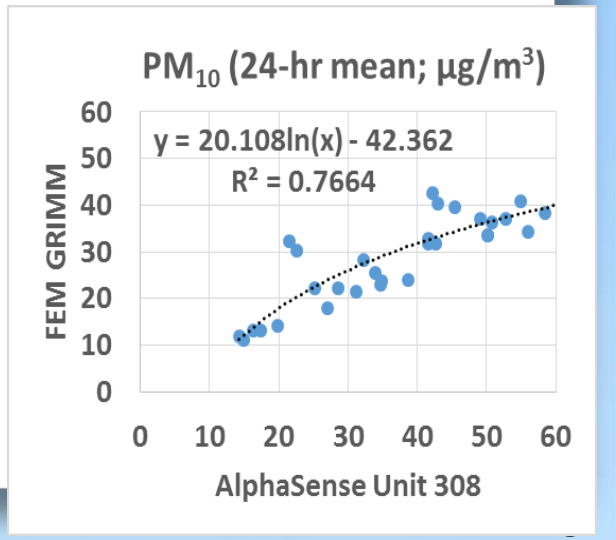
AlphaSense vs FEM GRIMM (PM_{10}; 24-hr mean)



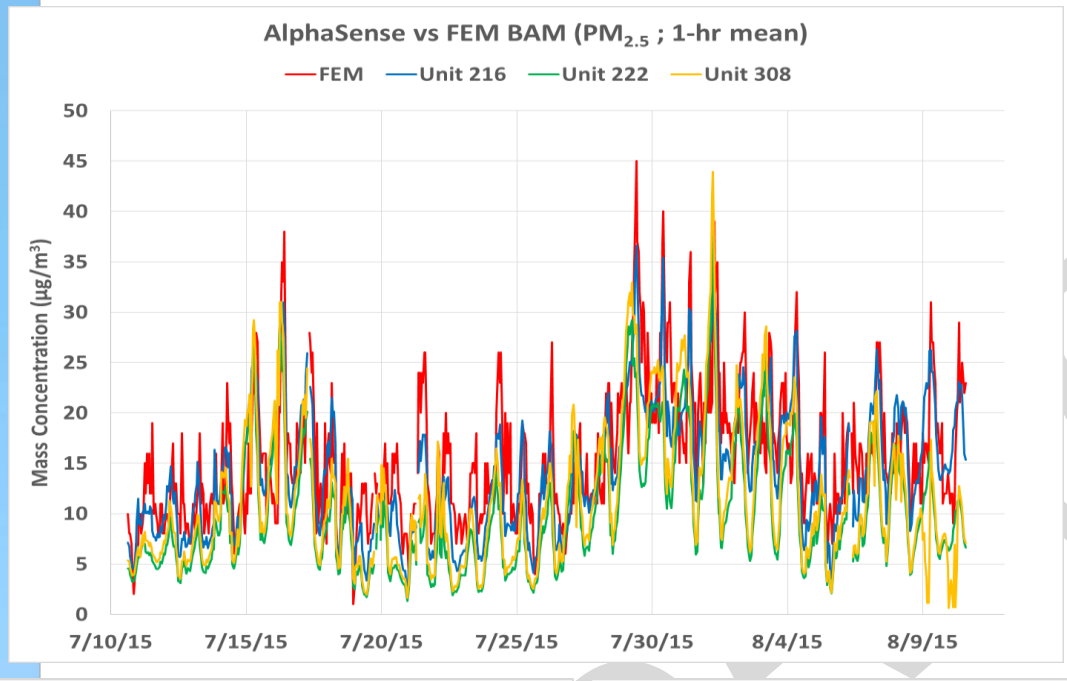
- PM_{10} measurements from all three AlphaSense sensors correlate well with the corresponding FEM GRIMM data ($0.57 < R^2 < 0.85$)
- AlphaSense measurements track the typical PM_{10} diurnal variations recorded by the FEM instrument



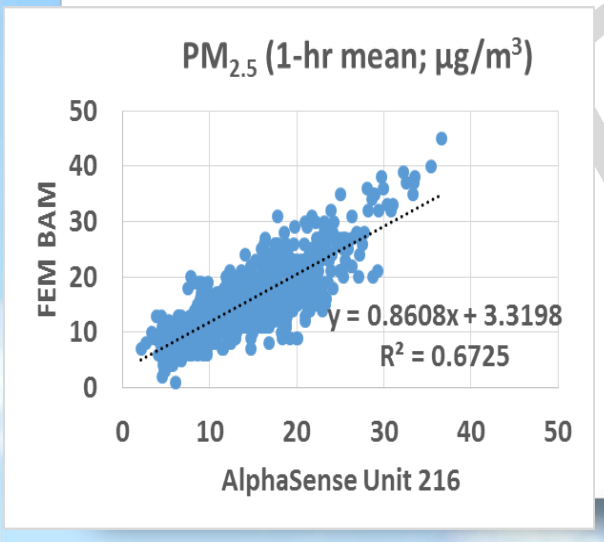


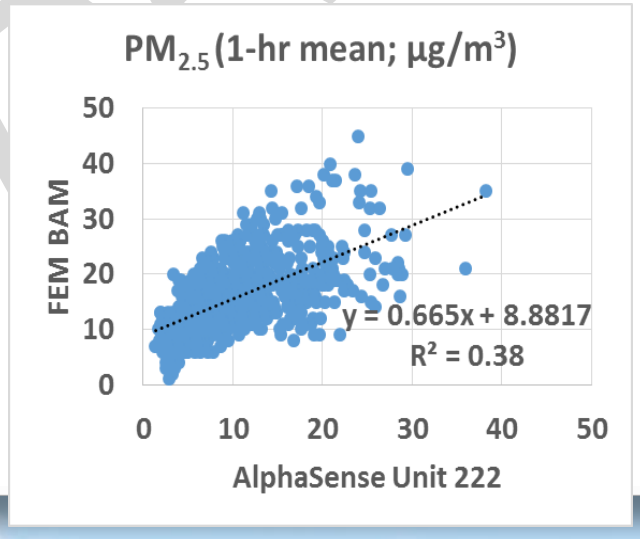


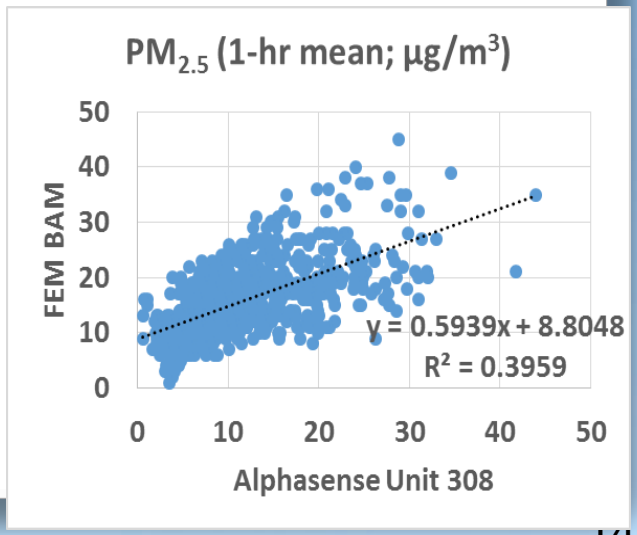
AlphaSense vs FEM BAM ($PM_{2.5}$; 1-hr mean)



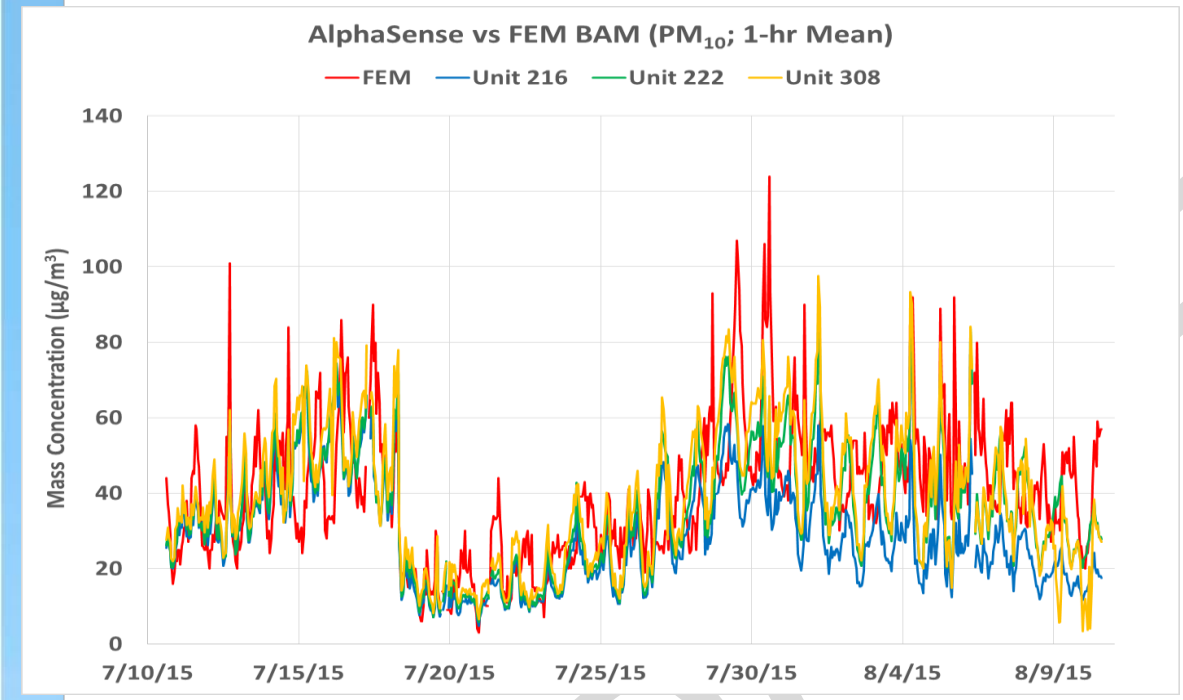
- $PM_{2.5}$ measurements from all three AlphaSense sensors show a moderate correlation with the corresponding FEM BAM data ($0.38 < R^2 < 0.67$)
- Alphasense measurements seem to track well the typical $PM_{2.5}$ diurnal variations recorded by the FEM BAM instrument



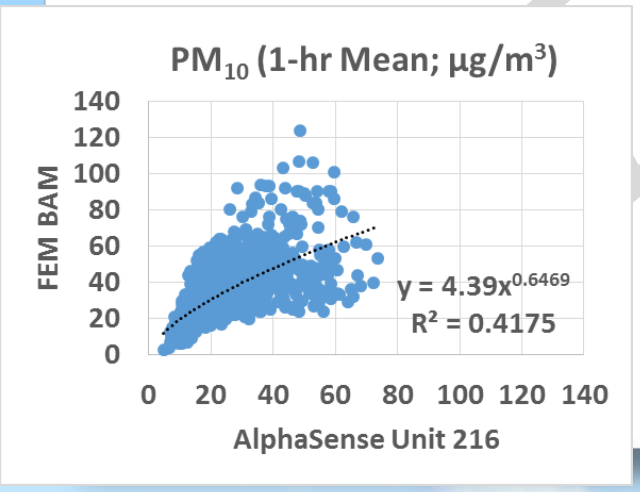


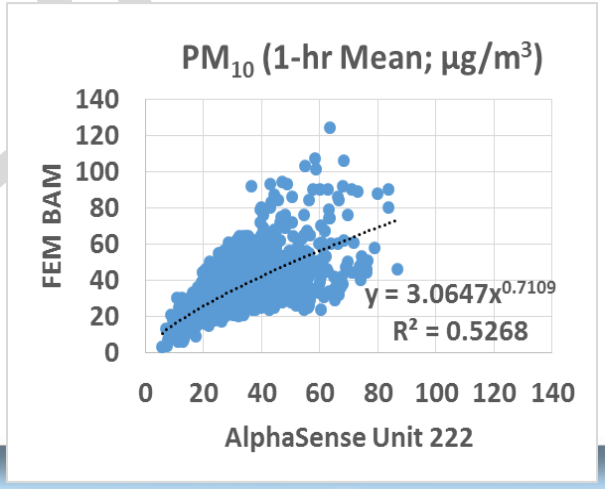


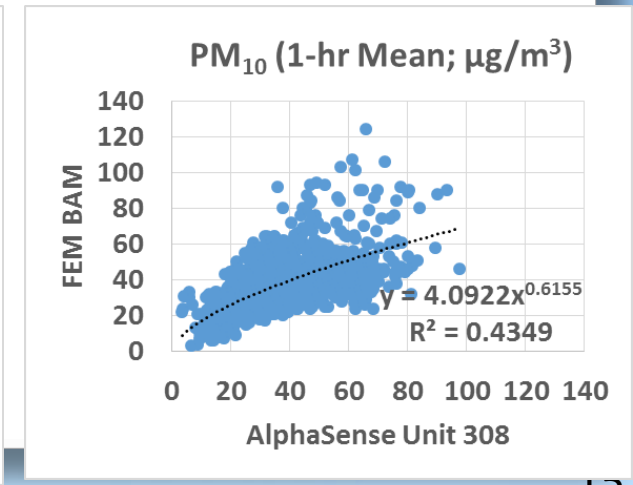
AlphaSense vs FEM BAM (PM_{10}; 1-hr mean)



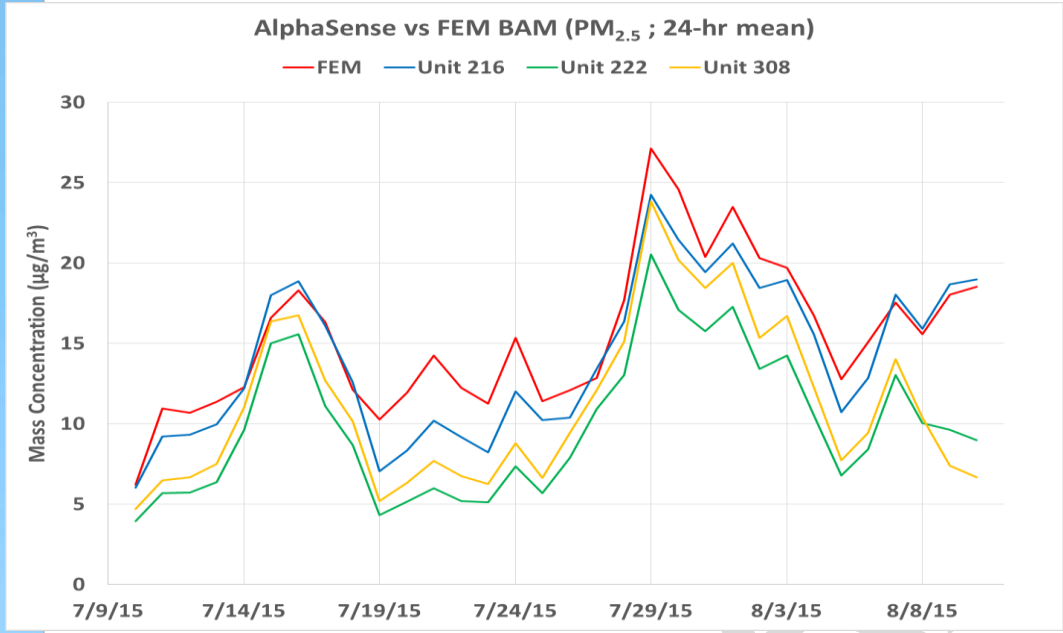
- PM_{10} measurements from all three AlphaSense sensors show a moderate correlation with the corresponding FEM BAM data ($0.41 < R^2 < 0.53$)
- Alphasense measurements seem to track well the typical PM_{10} diurnal variations recorded by the FEM BAM instrument



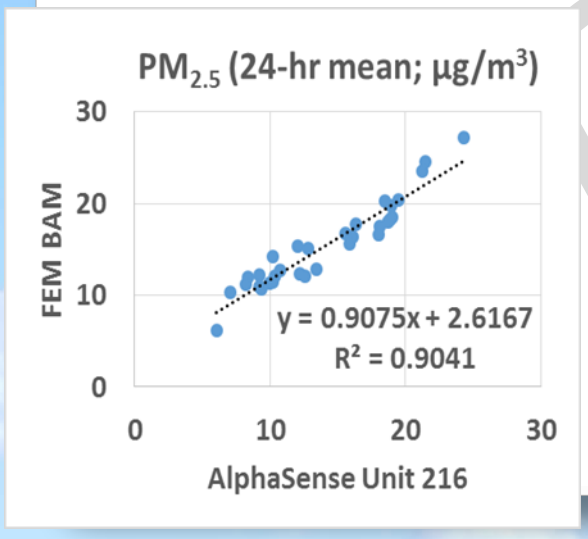


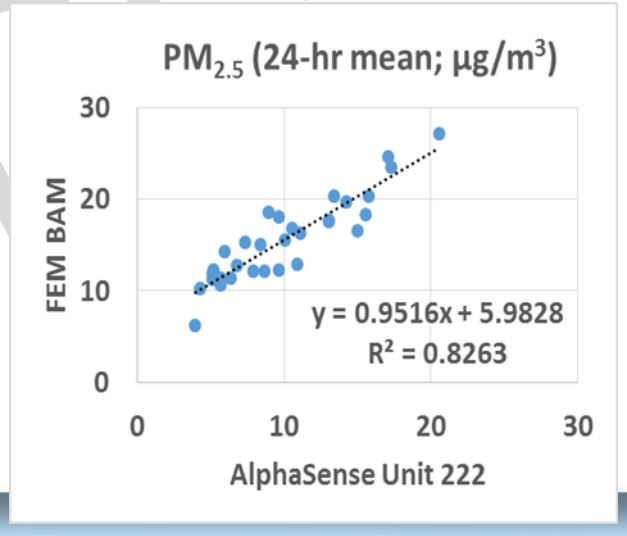


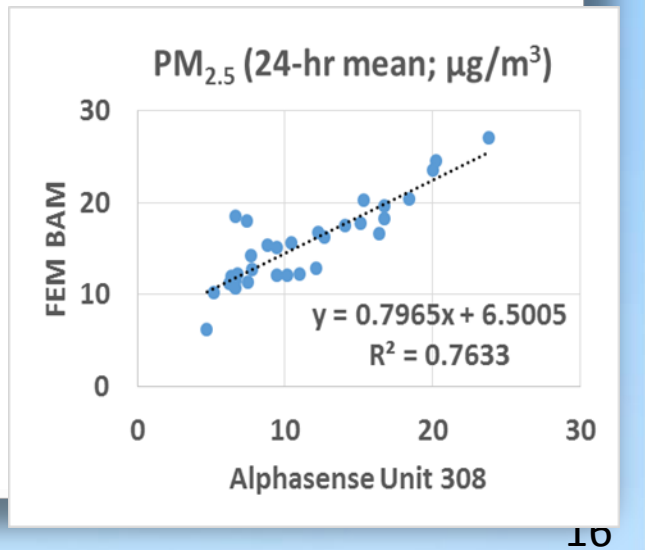
AlphaSense vs FEM BAM ($PM_{2.5}$; 24-hr mean)



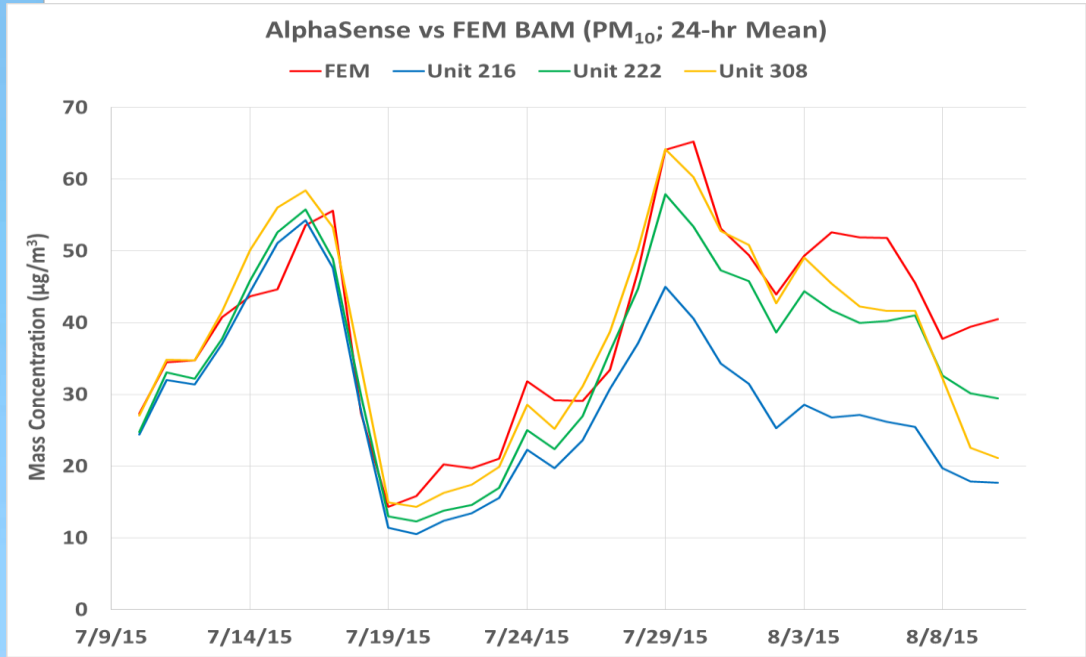
- $PM_{2.5}$ measurements from all three AlphaSense sensors correlate well with the corresponding FEM BAM data ($0.76 < R^2 < 0.91$)
- AlphaSense measurements track the typical $PM_{2.5}$ diurnal variations recorded by the FEM instrument



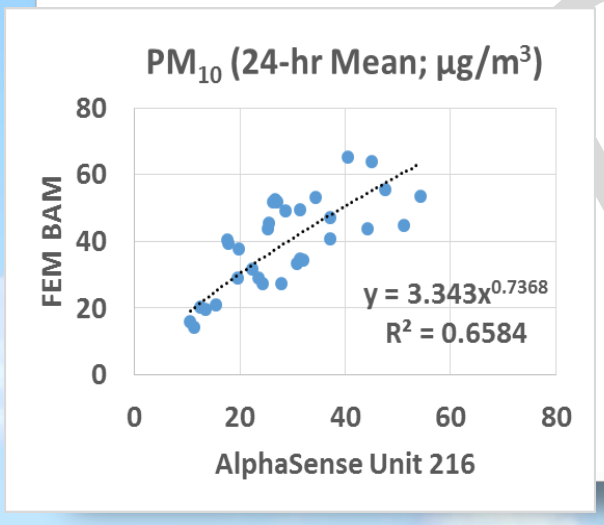


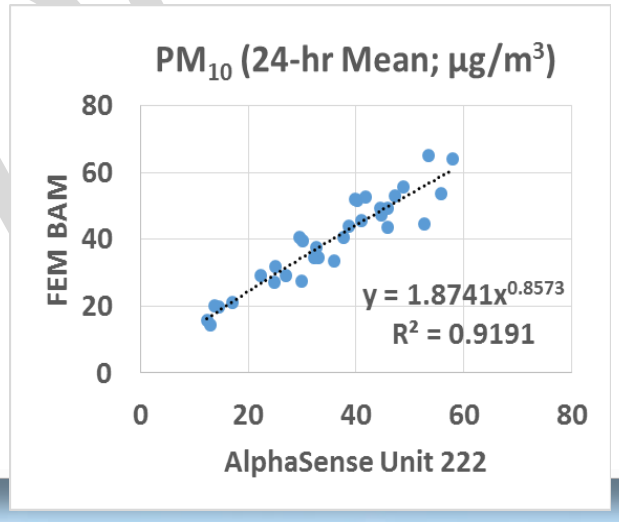


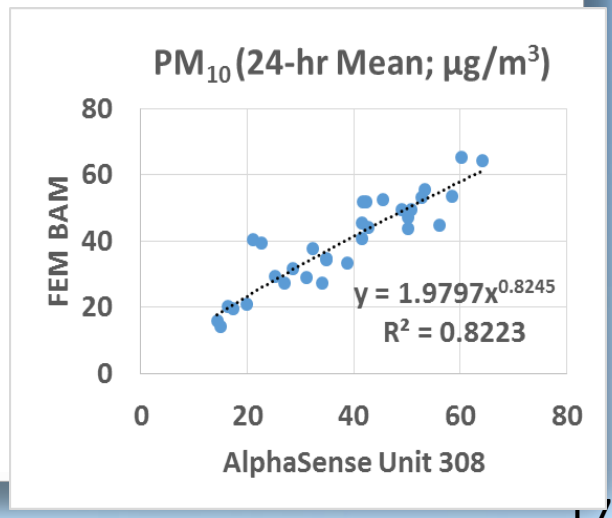
AlphaSense vs FEM BAM (PM_{10}; 24-hr mean)



- PM_{10} measurements from all three AlphaSense sensors correlate well with the corresponding FEM BAM data ($0.66 < R^2 < 0.92$)
- AlphaSense measurements track the typical PM_{10} diurnal variations recorded by the FEM instrument







Discussion

- Overall, the three **AlphaSense OPC-N2** particle sensors performed well during this field testing and showed:
  - Minimal down time over a period of about one month
  - Modest intra-model variability
  - Overall good correlation with substantially more expensive instruments (GRIMM and BAM; EPA-approved FEM Methods)
- AlphaSense measurements seem to track the $PM_{1.0}$, $PM_{2.5}$ and PM_{10} diurnal variations recorded by the FEM GRIMM and BAM instruments
- AlphaSense OPC-N2 $PM_{1.0}$ data was usually largely underestimated, while AlphaSense $PM_{2.5}$ and PM_{10} data were closer to the corresponding FEM values. However, no sensor calibration was performed prior to the beginning of this field testing
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under known aerosol concentrations and controlled temperature and relative humidity conditions

➢ These results are still preliminary