

Field Evaluation Foobot Sensor



Background

- From 07/14/2016 to 09/15/2016, three **Foobot PM Sensors** were deployed in Rubidoux and ran side-by-side with a Federal Equivalent Method (FEM) instrument measuring the same pollutants.
- Foobot Sensor (3 units tested):
 - Includes Particle sensor (**optical; non-FEM**)
 - Each unit reports: Fine particles ($\mu\text{g}/\text{m}^3$), total VOC, CO (ppm), CO_2 (ppm), Temp and RH; only evaluated for $\text{PM}_{2.5}$ during this study
 - **Unit cost: ~\$200**
 - Time resolution: 5-min
 - Units IDs: Foobot 1, Foobot 2, Foobot 3
- MetOne BAM (reference method):
 - Beta-attenuation monitors (**FEM**)
 - Measures $\text{PM}_{2.5}$ & PM_{10} mass ($\mu\text{g}/\text{m}^3$)
 - **Unit cost: ~\$20,000**
 - Time resolution: 1-hr

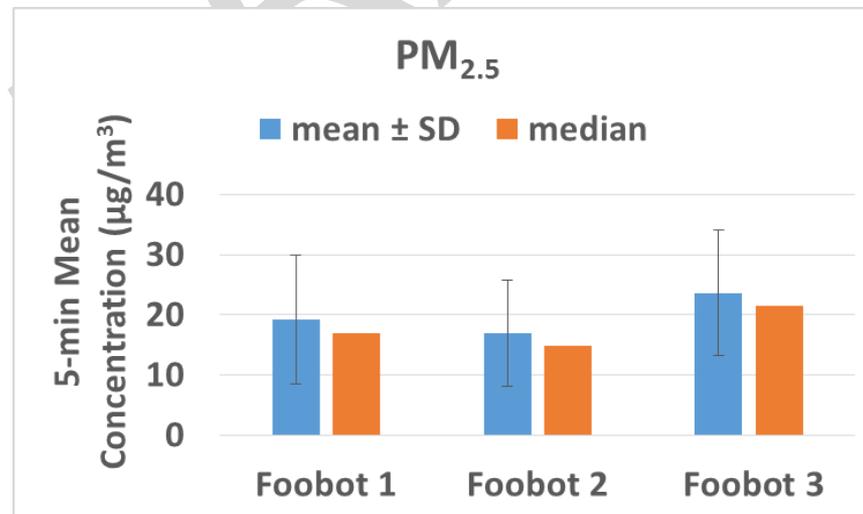


Data validation & recovery

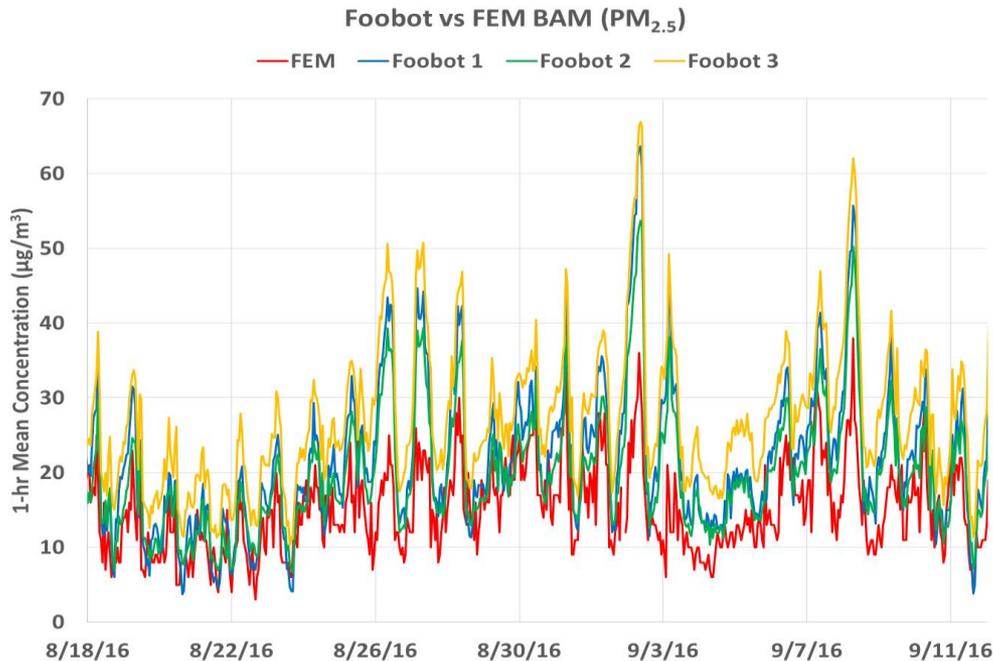
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM_{2.5} from Foobot 1, Foobot 2 and Foobot 3 was ~99 %.

Foobot sensors; intra-model variability

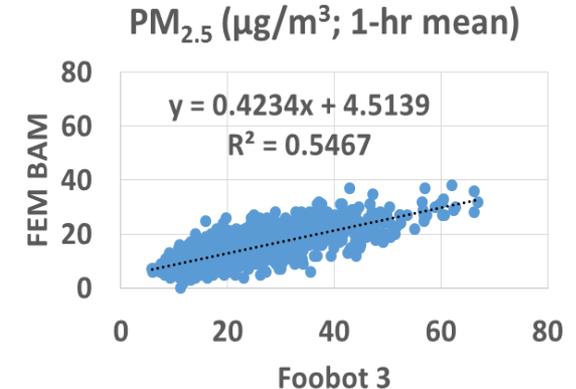
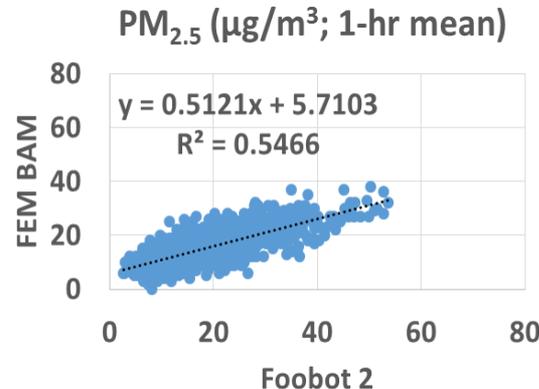
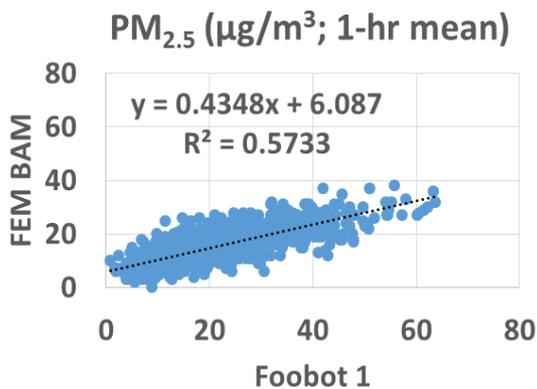
- Modest measurement variations were observed between the three Foobot devices tested for PM_{2.5} mass concentrations in $\mu\text{g}/\text{m}^3$.



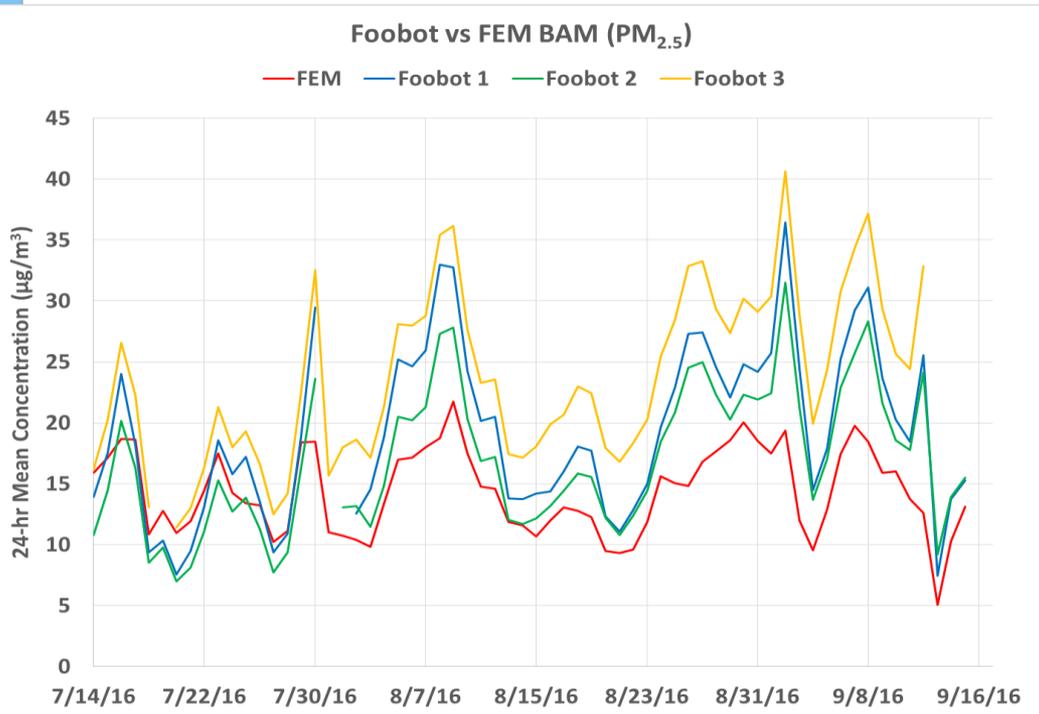
Foobot Sensor vs FEM BAM (PM_{2.5} Mass; 1-hr mean)



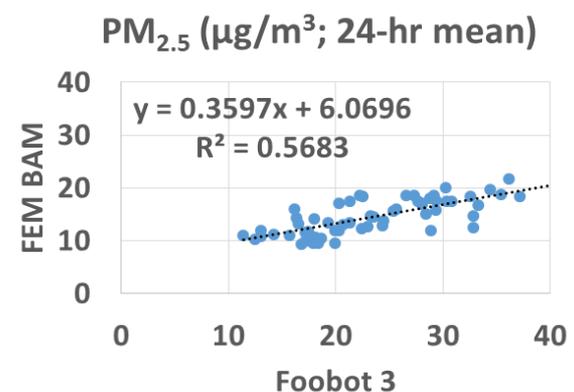
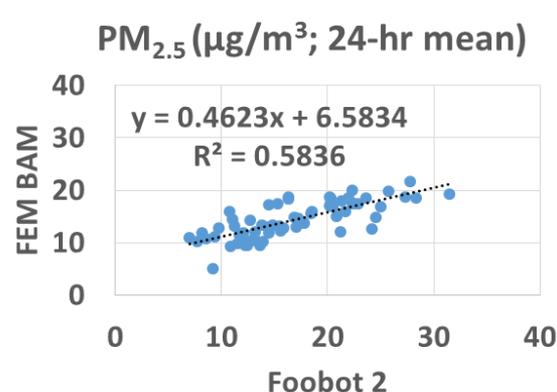
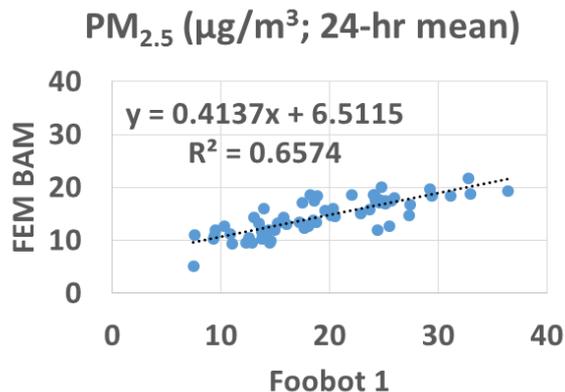
- Foobot PM_{2.5} mass measurements correlate well with the corresponding FEM BAM data ($R^2 > 0.54$).
- The three sensors seem to track well the diurnal variations as recorded by the FEM BAM instrument.
- Foobot devices moderately overestimate the FEM measurement data.
- Data recovery for FEM BAM PM_{2.5} was 96.3%



Foobot Sensor vs FEM BAM (PM_{2.5} Mass; 24-hr mean)



- Foobot PM_{2.5} mass measurements correlate well with the corresponding FEM BAM data ($R^2 > 0.56$)
- The three sensors track well the diurnal variations as recorded by the FEM BAM instrument.
- Foobot devices moderately overestimate the FEM measurement data.



Discussion

- Overall, the three **Foobot PM Sensors** were reliable (data recovery was between ~99 % across the three sensor devices) and were characterized by modest intra-model measurement variability.
- The Foobot sensors demonstrated a modest correlation ($R^2 \sim 0.55$) with the FEM instrument and moderately overestimated the FEM (BAM) measurement data.
- The sensors tracked well the $PM_{2.5}$ diurnal variations as recoded by the FEM instrument.
- It should be noted that no sensor calibration had been performed by SCAQMD Staff prior to the beginning of the field testing.
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors over different / more extreme environmental conditions.
- All results are still preliminary