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 (μg/m³), total VOC, CO (ppm), CO₂ (ppm), Temp and RH; only evaluated for PM₂.₅ 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 PM₂.₅ & PM₁₀ mass (μg/m³)
  ➢ 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 $\mu$g/m$^3$. 

[Graph showing PM$_{2.5}$ concentrations for Foobot 1, Foobot 2, and Foobot 3 with mean ± SD and median values.]
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