Field Evaluation
Clarity Node PM Sensor

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

- From 2/15/2018 to 04/25/2018, three **Clarity Movement Co.** sensor nodes were deployed at our (SCAQMD) Rubidoux station and ran side-by-side with Federal Equivalent Method (FEM) instruments measuring the same pollutant

- *Clarity Movement Co. Sensor node [3 nodes tested]:*
  - Particle sensor (optical; non-FEM)
  - Each sensor reports:
    - $PM_{2.5}$ mass concentration ($\mu g/m^3$)
    - NO_2, CO_2 and TVOC (Under Development)
  - Time resolution: 2-4 minutes
  - Unit cost: ~$1,300 (includes 1-yr of cloud data access, cellular connectivity, and tech support)

  Node #1 (N5L7);
  Node #2 (Y3GK); Node #3 (5KGG)

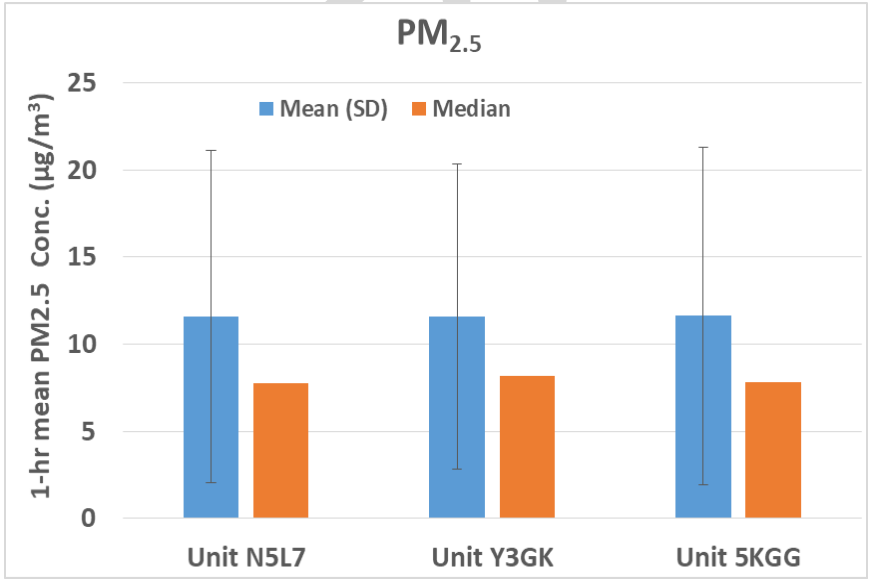
- MetOne BAM (*reference method*):
  - Beta-attenuation monitors (FEM)
  - Measures $PM_{2.5}$ & PM_{10} mass ($\mu g/m^3$)
  - Unit cost: ~$20,000
  - Time resolution: 1-hr

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 $PM_{2.5}$ mass concentration from all three Clarity Node sensors was between 97 and 100%.

Clarity Node; intra-model variability

- Very low measurement variations were observed between the different Clarity Node sensors for $PM_{2.5}$ mass concentrations ($\mu g/m^3$).



$PM_{2.5}$ Data Handling

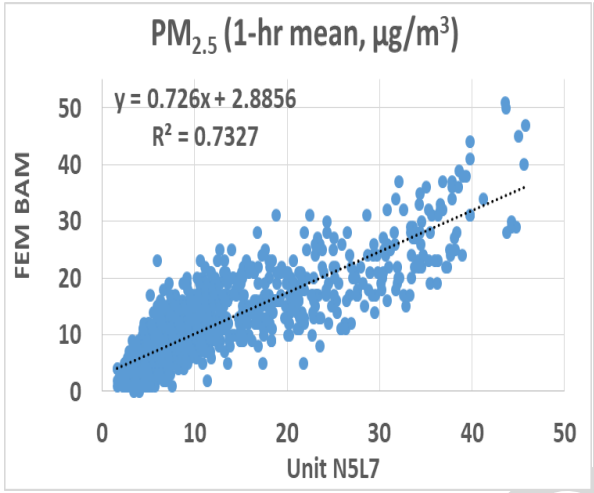
- On 01/24/18, Clarity released updated default temperature and relative humidity correction factors. All prior $PM_{2.5}$ readings from Clarity Node deployments were retroactively re-calculated with the new correction factors.

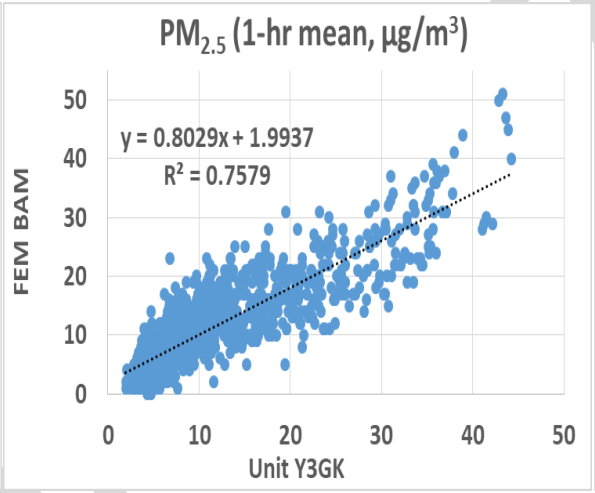
- Due to the correction factor release on 01/24/18, the start date for the AQ-SPEC field evaluation was set for 02/15/18.

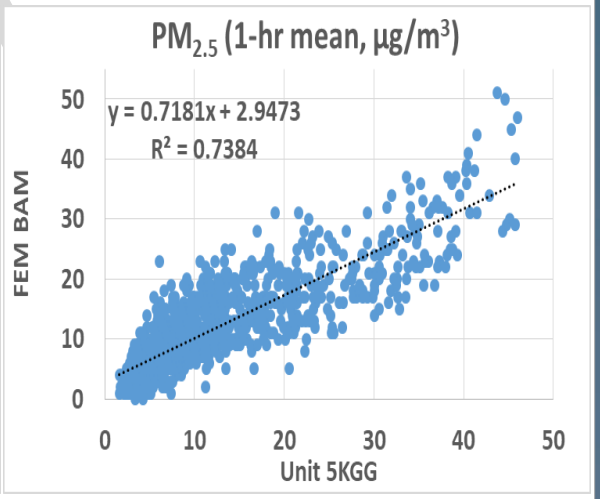
- Data handling: sensor readings are uploaded by the Clarity Node to Clarity Cloud. In the Clarity Cloud, a "Smart Calibration" can be applied to $PM_{2.5}$ readings with correction factors for bias, offset, temperature, and humidity. The resulting calibrated measurements are made available to the user.

- In the AQ-SPEC field evaluation, only default temperature and humidity correction factors were applied from the 01/24/18 release. These factors were not changed during the evaluation time period.

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

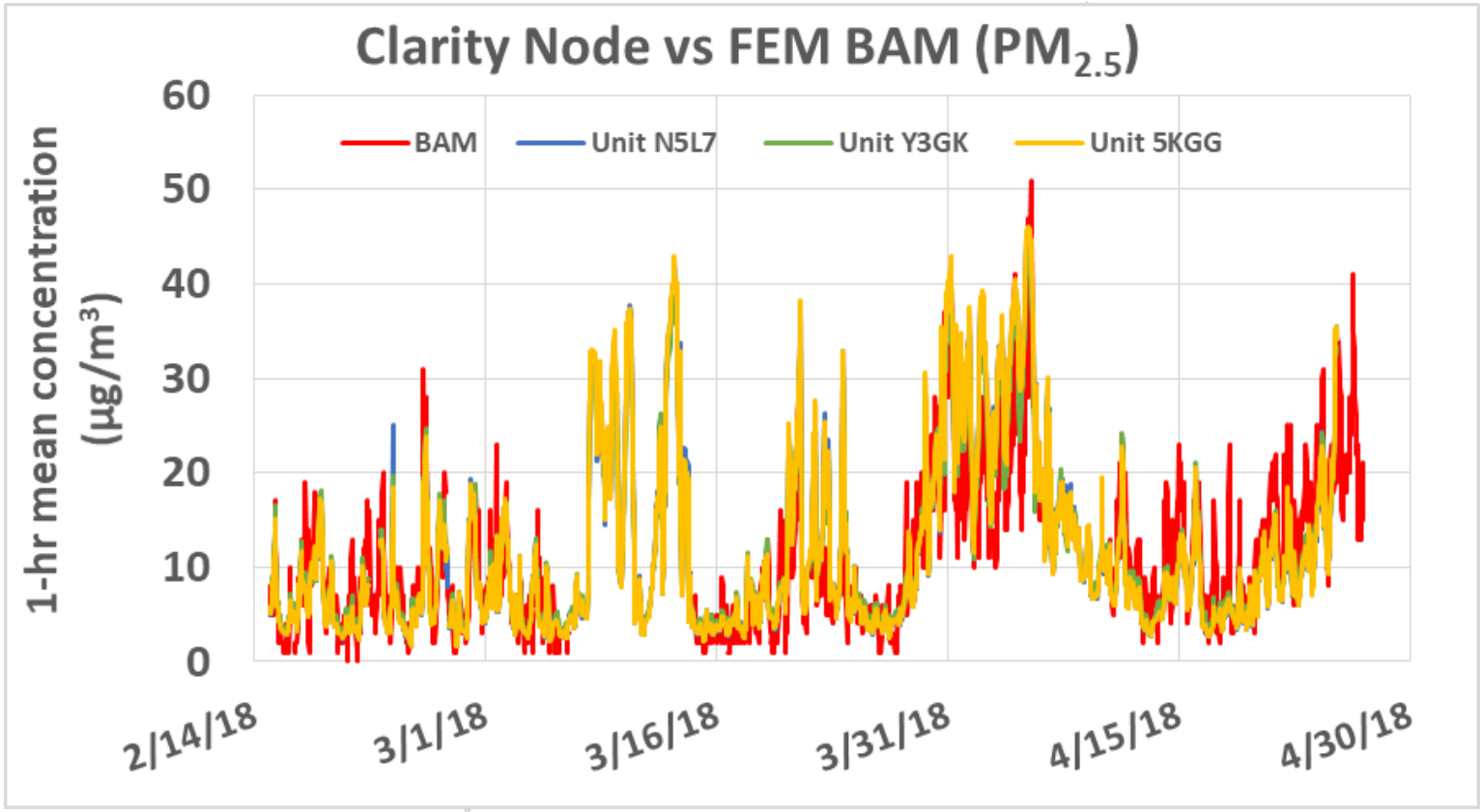






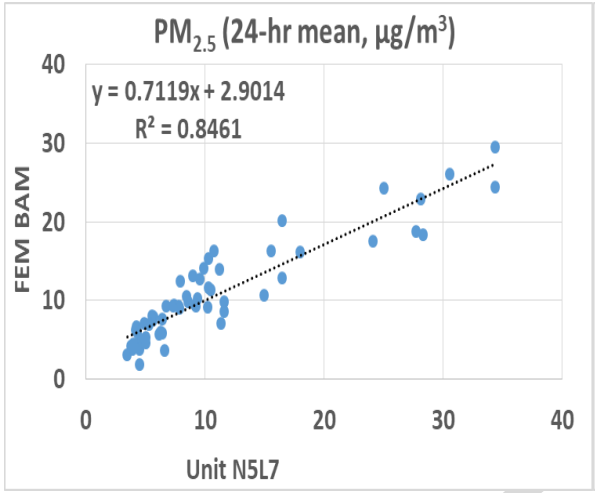
- Clarity Node $PM_{2.5}$ mass measurements correlate well with the corresponding FEM BAM data ($R^2 > 0.73$)

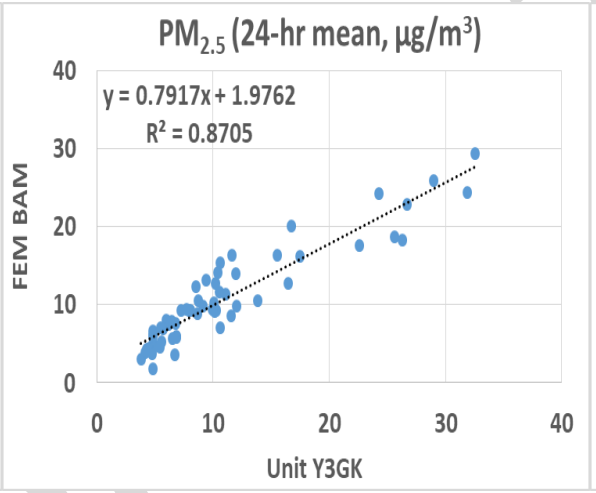
Clarity Node vs FEM BAM ($PM_{2.5}$; 1-hr mean)

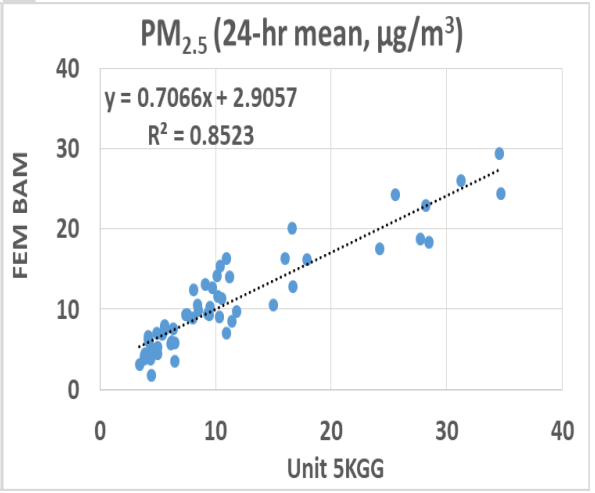


- Clarity Node sensors track well the diurnal $PM_{2.5}$ variations recorded by the FEM BAM instrument

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

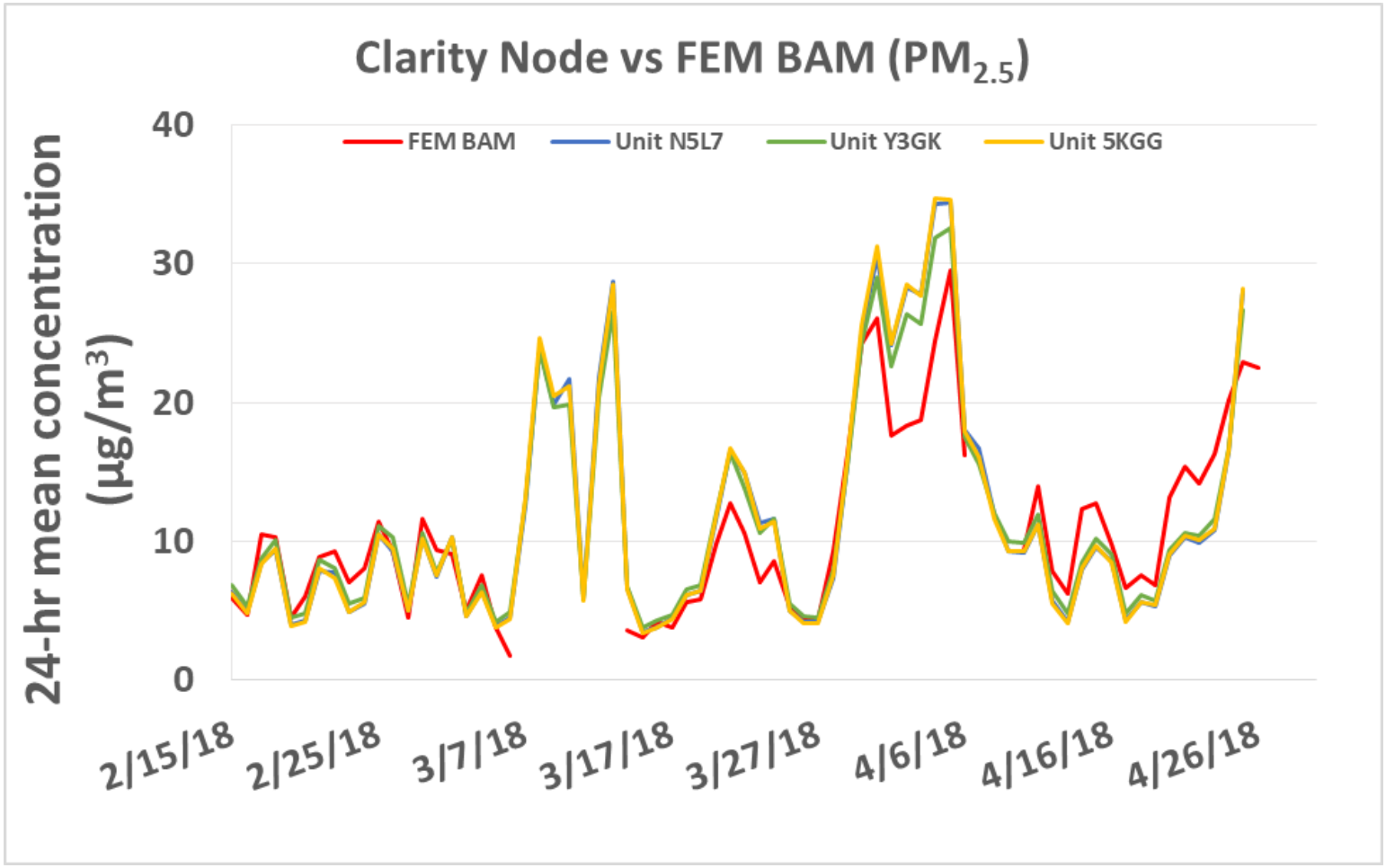






- Clarity Node $PM_{2.5}$ mass measurements correlate well with the corresponding FEM BAM data ($R^2 > 0.84$)

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



- Clarity Node sensors track well the diurnal $PM_{2.5}$ variations recorded by the FEM BAM instrument

Discussion

- The three **Clarity Movement Co** Nodes performed well and showed:
  - Minimal down-time: data recovery from each unit was higher than 97%
  - Low intra-model variability for $PM_{2.5}$ measurements between Nodes
- During the field deployment testing period:
  - $PM_{2.5}$ sensors correlated well with a more expensive FEM instrument ($R^2 > 0.73$, 1-hr mean)
  - Clarity Node sensors track the diurnal $PM_{2.5}$ variations recorded by the BAM instruments

- No sensor calibration was performed by SCAQMD 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

- These results are still preliminary