Field Evaluation
Aeroqual AQY (v0.5)
From 12/22/2017 to 03/27/2018, three Aeroqual AQY (Version 0.5) multi-sensor units were deployed in Rubidoux and run side-by-side SCAQMD Federal Equivalent Method (FEM) and Federal Reference Method (FRM) instruments measuring the same pollutants.

**Aeroqual AQY (3 units tested):**
- Sensors: Ozone – Gas Sensitive Semiconductor (GSS); NO₂ – Gas Sensitive Electrochemical (GSE) (non-FEM/non-FRM); PM\(_{2.5}\) – Laser Particle Counter (LPC) (non-FEM), (model SDS011 by Nova Fitness)
- Each unit measures: \(O_3\) (ppb), NO₂ (ppb), PM\(_{2.5}\) (\(\mu g/m^3\)), T (degrees C), RH (%)
- Unit cost: \$3,000 (includes 2-yr tech support + cloud data software license)
- Time resolution: 1-min
- Units IDs: AQY 130, AQY 131 (AQY 134), AQY 132 (On 2/15/2018, entire unit AQY 131 was replaced by unit AQY 134 due to faulty NO₂ sensor)

**SCAQMD Reference instruments:**
- \(O_3\) instrument (FEM); cost: \$7,000
- Time resolution: 1-min
- NO\(_X\) instrument (FRM); cost: \$11,000
- Time resolution: 1-min
- GRIMM (FEM PM\(_{2.5}\)); cost: \$25,000 and up
- Time resolution: 1-min
- MetOne BAM (FEM PM\(_{2.5}\)); cost: \$20,000
- Time resolution: 1-hr
- Met station (T, RH, P, WS, WD); cost: \$5,000
- Time resolution: 1-min
Ozone ($O_3$) in AQY
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 ozone in the four AQYs was high (i.e., 92% for AQY 130; 76% for AQY 131; 97% for AQY 132 and 100% for AQY 134).

Aeroqual AQY; Intra-model variability

• Low measurement variability was observed between the two AQY units (130, 132) for ozone during the entire deployment period.
Aeroqual AQY vs FEM (Ozone; 5-min mean)

- AQY Ozone measurements show an excellent correlation with the corresponding FEM data ($R^2 \sim 0.96$)
- The AQYs seem to track well the diurnal ozone variations recorded by the FEM instrument
Aeroqual AQY vs FEM (Ozone; 1-hr mean)

- AQY Ozone measurements show an excellent correlation with the corresponding FEM data ($R^2 \sim 0.96$)
- The AQYs seem to track well the diurnal ozone variations recorded by the FEM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs FEM (Ozone; 8-hr mean)

• AQY Ozone measurements show an excellent correlation with the corresponding FEM data ($R^2 \sim 0.96$)
• The AQYs seem to track well the diurnal ozone variations recorded by the FEM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Nitrogen Dioxide (NO₂) in AQY
During this AQ-SPEC field evaluation, Aeroqual corrected and calculated NO$_2$ in all four units, using two different approaches:

1$^{\text{st}}$ approach (in this report, pollutant referred to as NO$_2$):
- NO$_2$ with correction for O$_3$ bias using AQY ozone data in real-time
- Calculation by on-instrument Aeroqual algorithm

2$^{\text{nd}}$ approach (in this report, pollutant referred to as NO$_2$ V2):
- NO$_2$ with correction for O$_3$ and RH bias using AQY ozone and AQY RH data in real-time
- Calculation by new on-instrument Aeroqual algorithm

To better assist in understanding the procedures mentioned above, Aeroqual has shared all related proprietary information with AQ-SPEC.
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 NO$_2$ in the four AQYs was high (i.e., 98% for AQY 130; 95% for AQY 131; 85% for AQY 132 and 92% for AQY 134).

Aeroqual AQY; Intra-model variability

- Substantial measurement variability was observed between the two AQY units (130, 132) for nitrogen dioxide during the entire deployment period.
Aeroqual AQY vs FRM (NO$_2$; 5-min mean)

- AQY NO$_2$ measurements show a moderate correlation with the corresponding FRM data ($R^2 \sim 0.50$)
- The AQYs seem to track the diurnal NO$_2$ variations recorded by the FRM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
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 NO$_2$ V2 in the four AQYs was high (i.e., 98% for AQY 130; 99% for AQY 131; 97% for AQY 132 and 99% for AQY 134).

Aeroqual AQY; Intra-model variability

• Very low measurement variability was observed between the two AQY units (130, 132) for nitrogen dioxide (V2) during the entire deployment period.
Aeroqual AQY vs FRM (NO$_2$; 5-min mean)

- AQY NO$_2$ measurements in AQYs 130 and 132 correlate well with the corresponding FRM data ($R^2 \approx 0.77$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal NO$_2$ variations recorded by the FRM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs FRM (NO$_2$; 1-hr mean)

- AQY NO$_2$ measurements in AQYs 130 and 132 correlate well with the corresponding FRM data ($R^2 \approx 0.79$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal NO$_2$ variations recorded by the FRM instrument
Aeroqual AQY vs FRM (NO$_2$; 24-hr mean)

- AQY NO$_2$ measurements in AQYs 130 and 132 correlate very well with the corresponding FRM data ($R^2 \sim 0.83$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal NO$_2$ variations recorded by the FRM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
PM$_{2.5}$ in AQY
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).
- AQY PM$_{2.5}$ was corrected based on AQY RH data in real-time.
- Data recovery for PM$_{2.5}$ in the four AQYs was excellent (i.e., 99% for AQY 130; 100% for AQY 131, AQY 132 and AQY 134).

Aeroqual AQY; Intra-model variability

- Very low measurement variability was observed between the two AQY units (130, 132) for PM$_{2.5}$ during the entire deployment period.
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 data-set)
- PM$_{2.5}$ data recovery was 68 % for the GRIMM and 88 % for the BAM.

Equivalent methods: BAM vs GRIMM

- Excellent agreement between the two equivalent methods for PM$_{2.5}$
Aeroqual AQY vs FEM (GRIMM PM$_{2.5}$; 5-min mean)

- AQY PM$_{2.5}$ measurements in AQYs 130 and 132 correlate very well with the corresponding FEM GRIMM data ($R^2 \sim 0.86$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track well the diurnal PM$_{2.5}$ variations recorded by the FEM GRIMM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
• AQY PM$_{2.5}$ measurements in AQYs 130 and 132 correlate very well with the corresponding FEM GRIMM data ($R^2 \sim 0.86$)
• The two AQYs seem to be highly accurate
• The two AQYs seem to track well the diurnal PM$_{2.5}$ variations recorded by the FEM GRIMM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs FEM (GRIMM PM$_{2.5}$; 24-hr mean)

- AQY PM$_{2.5}$ measurements in AQYs 130 and 132 correlate very well with the corresponding FEM GRIMM data ($R^2 \approx 0.92$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track well the diurnal PM$_{2.5}$ variations recorded by the FEM GRIMM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs FEM (BAM PM$_{2.5}$; 1-hr mean)

- AQY PM$_{2.5}$ measurements in AQYs 130 and 132 correlate very well with the corresponding FEM BAM data ($R^2 \sim 0.84$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal PM$_{2.5}$ variations recorded by the FEM BAM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs FEM (BAM PM$_{2.5}$; 24-hr mean)

- AQY PM$_{2.5}$ measurements in AQYs 130 and 132 correlate very well with the corresponding FEM BAM data ($R^2 \approx 0.90$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal PM$_{2.5}$ variations recorded by the FEM BAM instrument

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs SCAQMD Met Station (Temp; 5-min mean)

- AQY Temp measurements in AQYs 130 and 132 correlate very well with the corresponding SCAQMD Met Station sensor (R² ~ 0.93)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal Temp variations recorded by the SCAQMD Met station sensor

On 2/15/18, AQY 131 was replaced by AQY 134
Aeroqual AQY vs SCAQMD Met Station (RH; 5-min mean)

- AQY RH measurements in AQYs 130 and 132 correlate very well with the corresponding SCAQMD Met Station sensor ($R^2 \sim 0.96$)
- The two AQYs seem to be highly accurate
- The two AQYs seem to track the diurnal RH variations recorded by the SCAQMD Met station sensor

On 2/15/18, AQY 131 was replaced by AQY 134
Discussion

• With the exception of a faulty NO$_2$ sensor in one of the three units (AQY 131), the Aeroqual AQY v0.5 multi-sensor units (AQY 130 and 132) performed very well and showed:
  ➢ Minimal down-time: data recovery from each unit was higher than 90%
  ➢ Low intra-model variability for all measured pollutants

• During the entire field deployment testing period:
  ➢ Ozone sensors showed excellent correlation with a more expensive FEM instrument ($R^2 > 0.95$)
  ➢ NO$_2$ V2 sensors showed very good correlation with a more expensive FRM instrument ($R^2 > 0.74$) and high accuracy
  ➢ PM$_{2.5}$ sensors showed very good correlation with more expensive FEM instruments (GRIMM: $R^2 > 0.84$ and BAM: $R^2 > 0.83$) and high accuracy
  ➢ Temperature and relative humidity sensors showed excellent correlation with the SCAQMD Met Station sensors (T: $R^2 > 0.91$ and RH: $R^2 > 0.94$)

• No sensor calibration was performed by AQ-SPEC prior to the beginning of this field testing
• Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under controlled T and RH conditions, and known target and interferent pollutants concentrations.

• These results are still preliminary