Field Evaluation
CairPol Cairsens NO$_2$ Sensor
Background

- From 11/22/2018 to 01/18/2019, three CairPol Cairsens NO\textsubscript{2} sensors were deployed at a SCAQMD stationary ambient monitoring site in Rubidoux and were run side-by-side with a reference instrument measuring the same pollutant.

- **CairPol Cairsens NO\textsubscript{2} (3 units tested):**
  - Each unit reports: NO\textsubscript{2} (ppb), Temperature (°C), Relative Humidity (%)
  - Unit cost: $1198
  - Time resolution: 1 - min
  - Units IDs: 4541, 4542, 4543

- **SCAQMD Reference instruments:**
  - NO\textsubscript{x} instrument: FRM
    - cost: ~$10,000
    - Time resolution: 1 - min
  - Met station (Temperature, Relative Humidity, Pressure, Wind Speed, Wind Direction)
    - cost: ~$5,000
    - Time resolution: 1 - min
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 from all units was 4.3% for NO\textsubscript{2} measurements. Data recovery is calculated based on the 5-min averages FRM NO\textsubscript{2} measurements due to the fact that the sensors have a limit of quantification of 40 ppb as specified by the manufacturer, all values below 40 ppb as measured by the FRM NO\textsubscript{2} instrument were excluded from the data set for further analysis

CairPol Cairsens NO\textsubscript{2} ; intra-model variability

• High measurement variability (64%) was observed between the three CairPol Cairsens NO\textsubscript{2} units
CairPol Cairsens vs FRM (NO₂; 5-min mean)

- CairPol Cairsens sensors do not correlate with the corresponding FRM NO₂ data ($R^2 \approx 0.12$)
- Overall, the CairPol Cairsens sensors underestimates NO₂ concentration as measured by the FRM instrument
- The CairPol Cairsens sensors do not track the NO₂ diurnal variations as recorded by the FRM instrument
- Due to the lack of data points, further analyses on 1 and 24-hr averages are not reported

\[
y = 0.2225x + 34.922
\]
\[
R^2 = 0.1636
\]

\[
y = 0.2113x + 38.996
\]
\[
R^2 = 0.1593
\]

\[
y = -0.0344x + 43.639
\]
\[
R^2 = 0.0458
\]
CairPol CairSens NO\textsubscript{2} temperature measurements correlate very well with the corresponding SCAQMD Met Station data ($R^2 \approx 0.96$)

• Overall, the CairPol CairSens NO\textsubscript{2} sensors overestimate temperature measurements as recorded by SCAQMD Met Station

• The CairPol CairSens NO\textsubscript{2} sensors seem to track well the temperature diurnal variations as recorded by SCAQMD Met Station
CairPol Cairsens NO$_2$ vs SCAQMD Met Station (RH; 5-min mean)

- CairPol Cairsens NO$_2$ RH measurements correlate very well with the corresponding SCAQMD Met Station data ($R^2 \sim 0.96$)
- Overall, the CairPol Cairsens NO$_2$ sensors underestimate RH measurements as recorded by SCAQMD Met Station
- The CairPol Cairsens NO$_2$ sensors seem to track well the RH diurnal variations as recorded by SCAQMD Met Station

Note: the CairPol Ciarsense RH sensor has an operational range between 10 and 90%, all values below 10% and over 90% are excluded
Discussion

• The three CairPol Cairsens NO$_2$ sensors’ data recovery from each unit was 4.3%, Data recovery is calculated based on the 5-min averages FRM NO$_2$ measurements due to the fact that the sensors have a limit of quantification of 40 ppb as specified by the manufacturer, all values below 40 ppb as measured by the FRM NO$_2$ instrument were excluded from the data set for further analysis

• The three sensors showed high intra-model variability (64%) for NO$_2$ measurements

• The CairPol Cairsens NO$_2$ sensors do not correlate with the FRM instrument ($R^2 \sim 0.12$) and do not track the NO$_2$ diurnal variations as measured by the FRM instrument

• 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

• All results are still preliminary