

Field Evaluation CairPol Cairsens CO Sensor

DRAFT



South Coast
AQMD

AQ-SPEC

Air Quality Sensor Performance Evaluation Center

Background

- From 11/22/2018 to 01/17/2019, three **CairPol Cairsens CO** 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 CO (3 units tested):**
 - Each unit reports: Carbon monoxide (ppb), Temperature (°C), Relative Humidity (%)
 - **Unit cost: \$1243**
 - Time resolution: 1 min
 - Units IDs: 4569, 4570, 4571
- **SCAQMD Reference instruments:**
 - CO 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

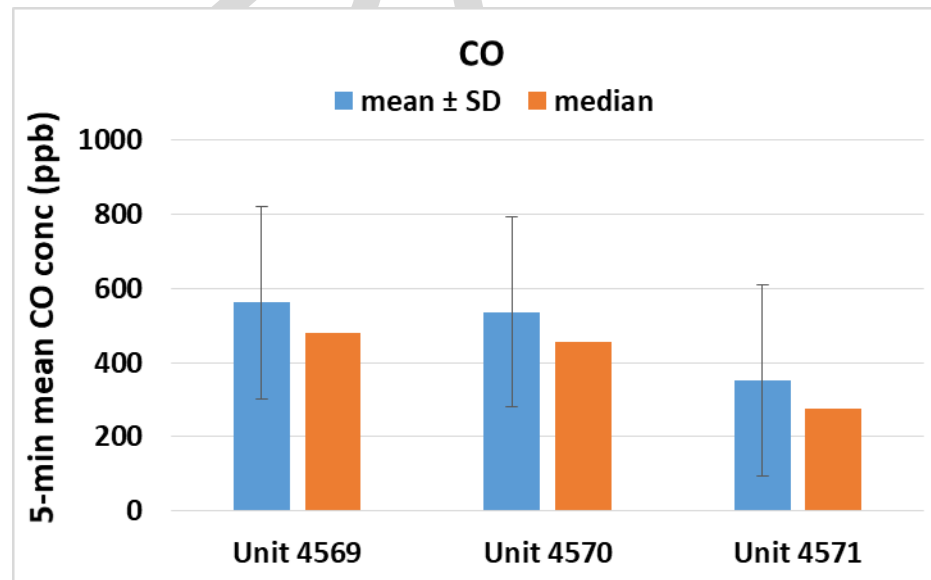


Data validation & recovery

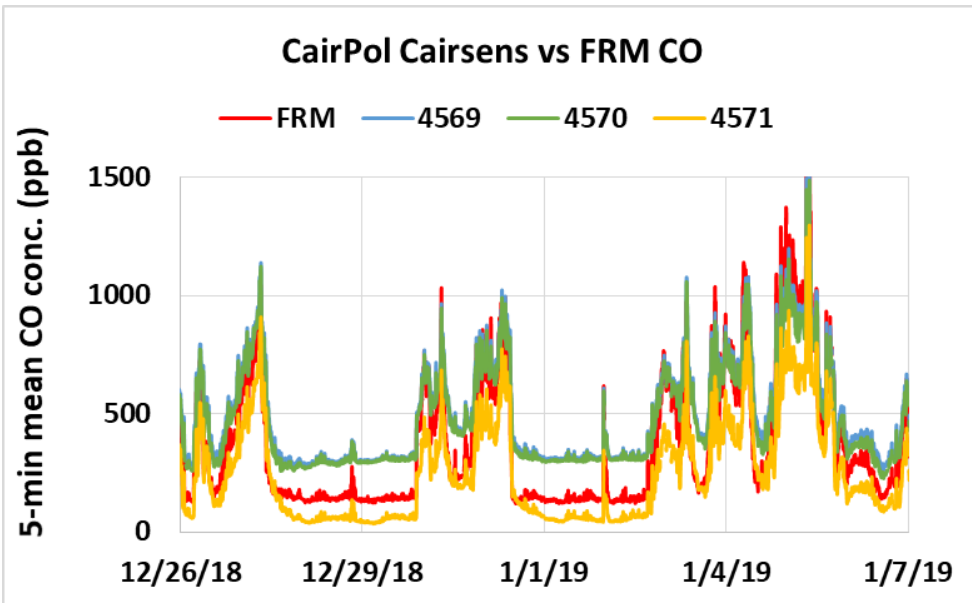
- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery from all units was 92% for CO measurements. Data recovery is calculated based on the 5-min averages FRM CO measurements due to the fact that the sensors have a limit of quantification of 100 ppb as specified by the manufacturer; all values below 100 ppb as measured by the FRM CO instrument were excluded from the data set for further analysis

CairPol Cairsens CO ; intra-model variability

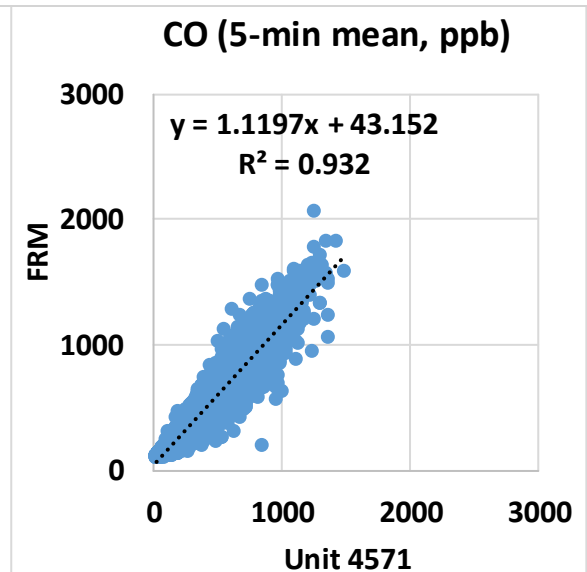
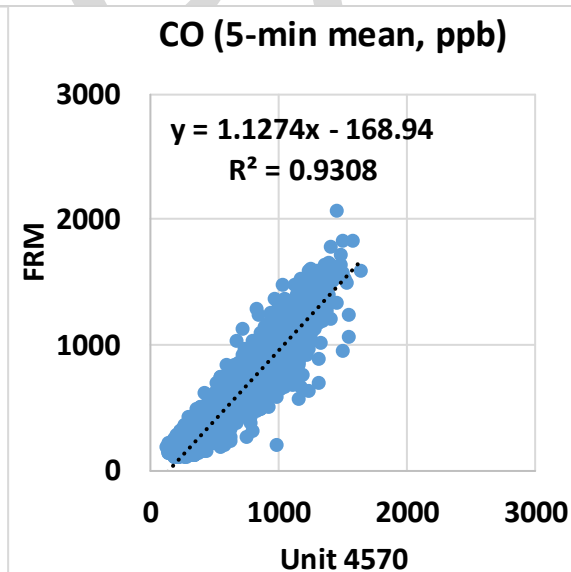
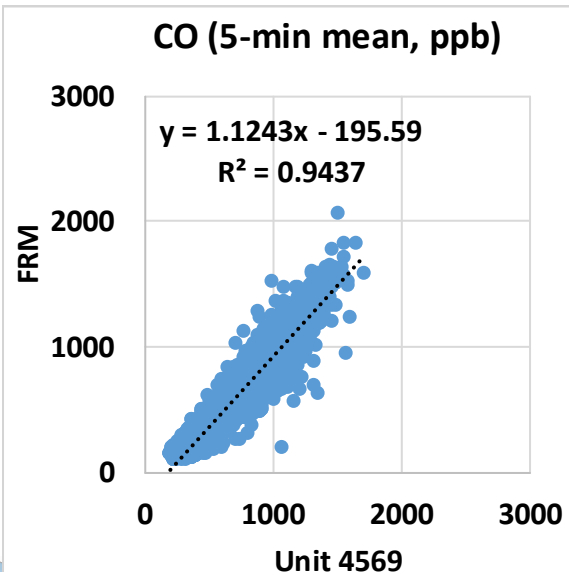
- High measurement variability (43%) was observed between the three CairPol Cairsens CO units



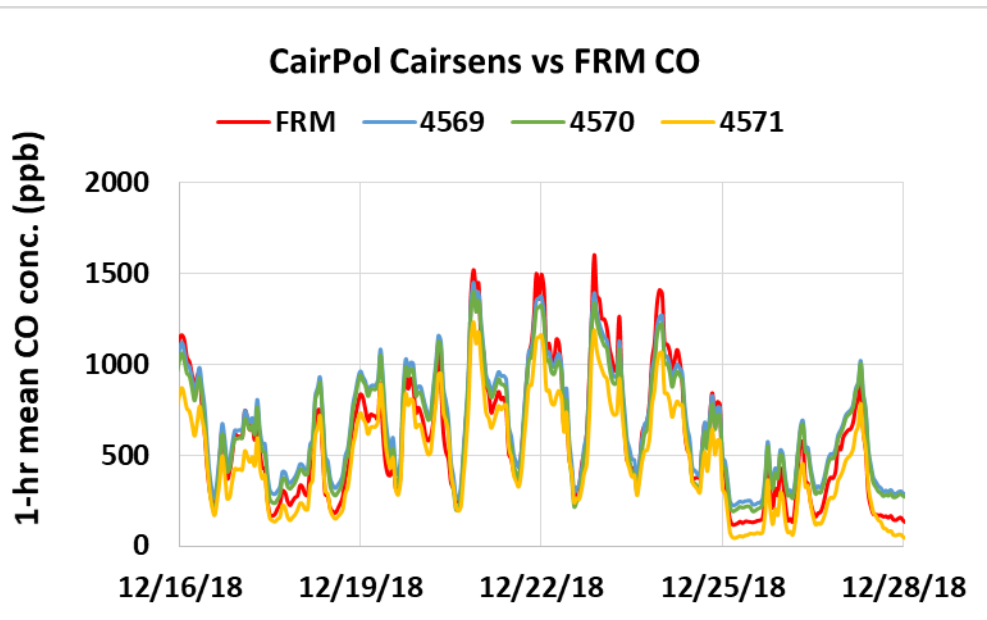
CairPol Cairsens vs FRM (CO; 5-min mean)



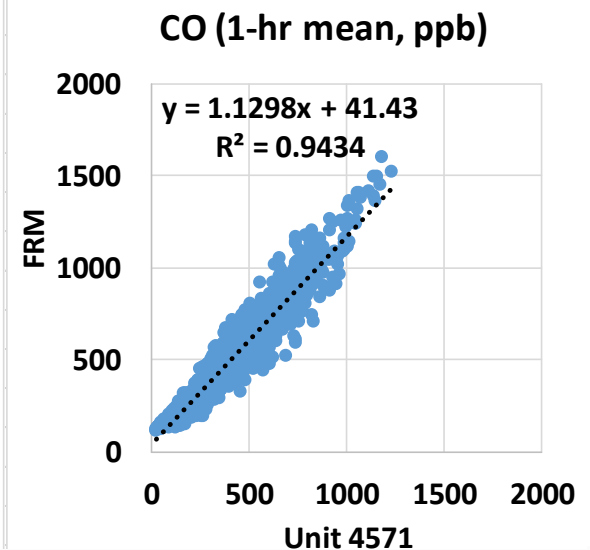
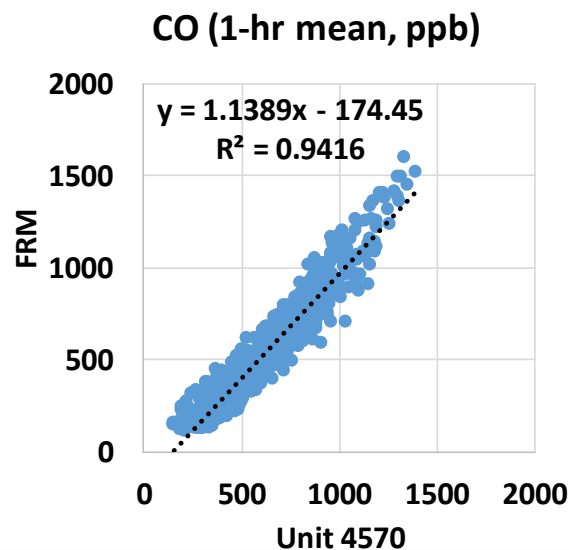
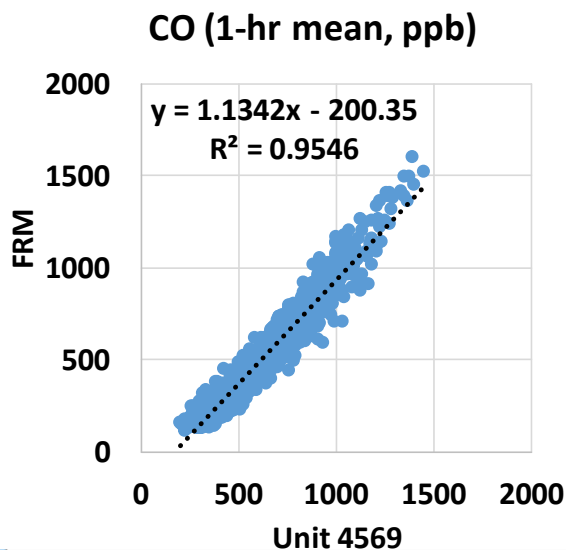
- CairPol Cairsens sensors showed excellent correlation with the corresponding FRM CO data ($R^2 \sim 0.935$)
- Overall, units 4569 and 4570 overestimate while unit 4571 underestimates CO concentration as measured by the FRM instrument
- The CairPol Cairsens sensors track well the CO diurnal variations as recorded by the FRM instrument



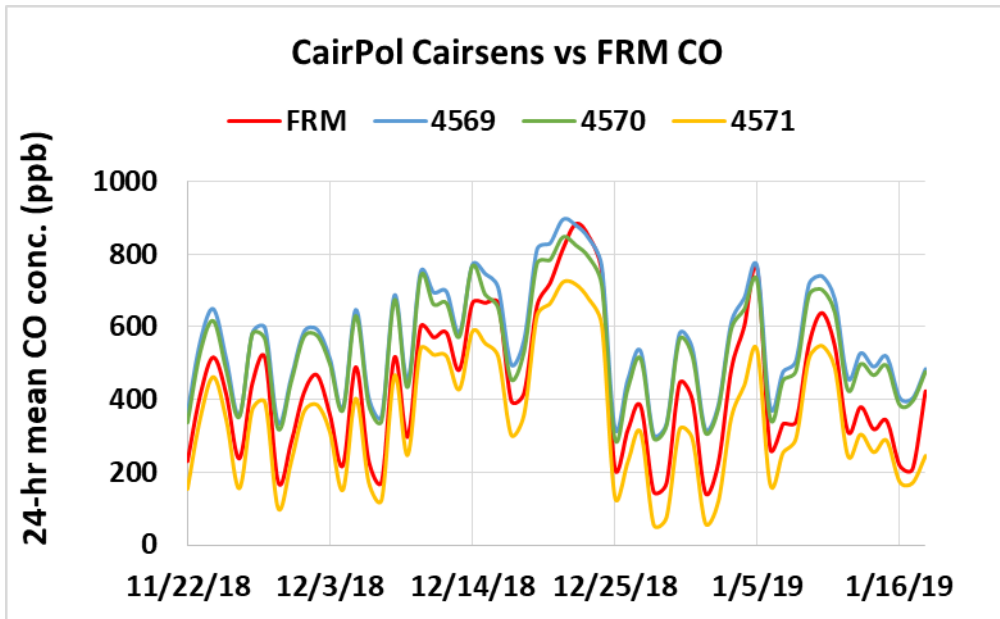
CairPol Cairsens vs FRM (CO; 1-hr mean)



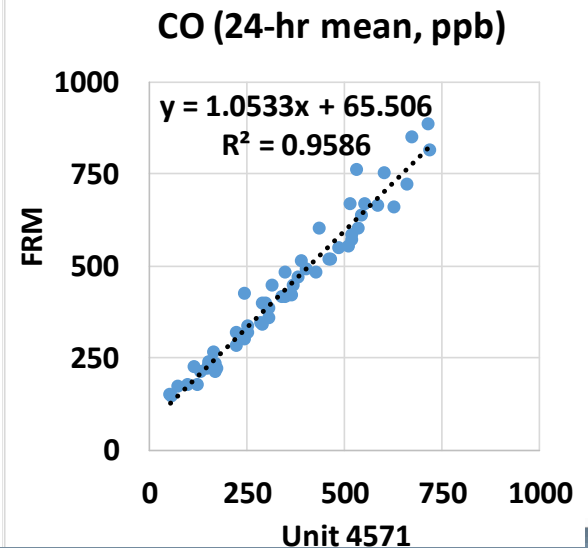
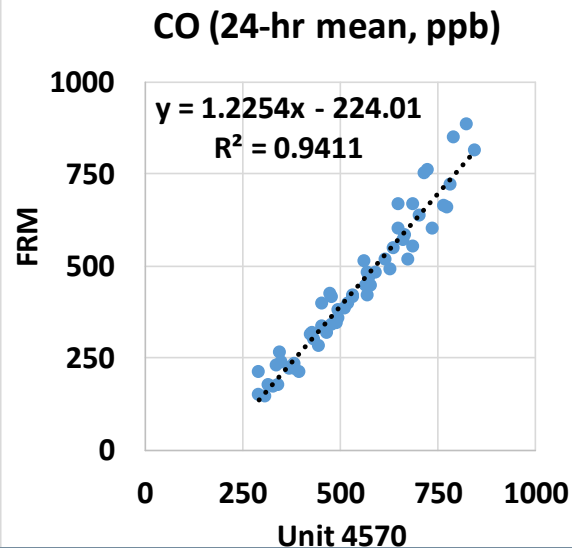
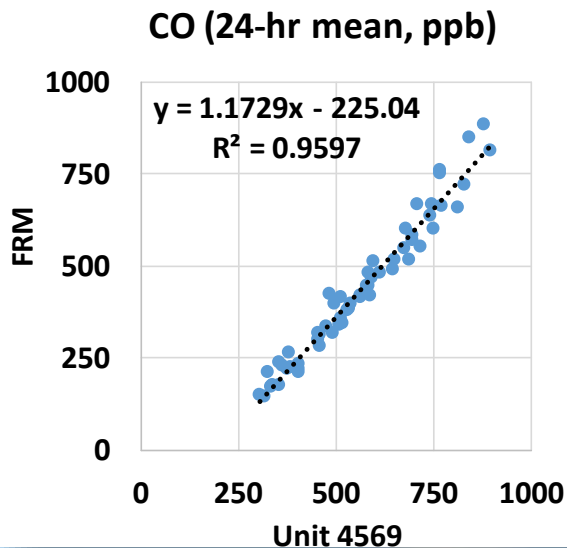
- CairPol Cairsens CO sensors showed excellent correlation with the corresponding FRM CO data ($R^2 \sim 0.946$)
- Overall, units 4569 and 4570 overestimate while unit 4571 underestimates CO concentration as measured by the FRM instrument
- The CairPol Cairsens CO sensors track well the CO diurnal variations as recorded by the FRM instrument



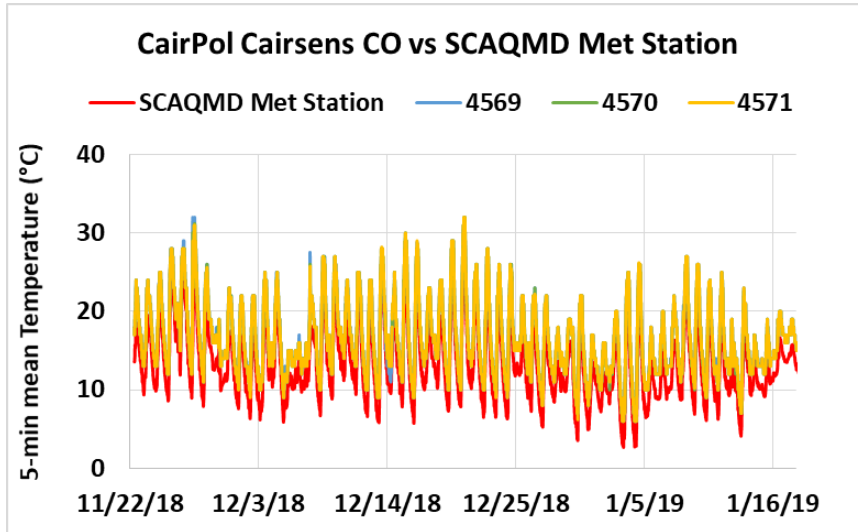
CairPol Cairsens vs FRM (CO; 24-hr mean)



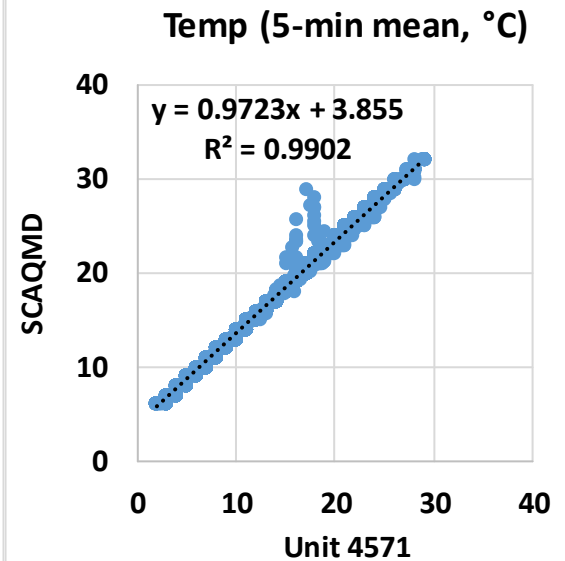
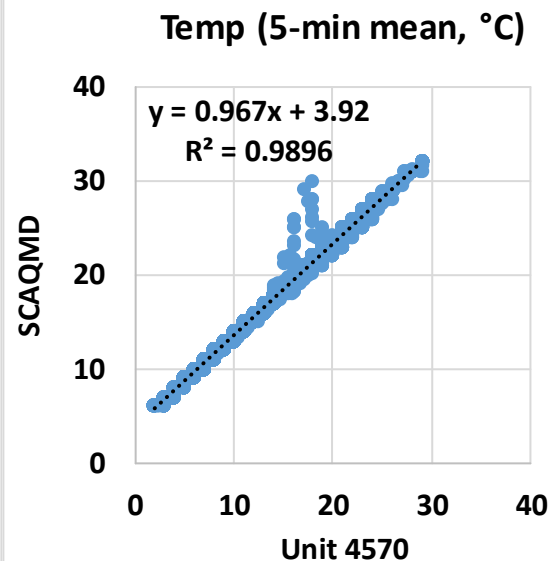
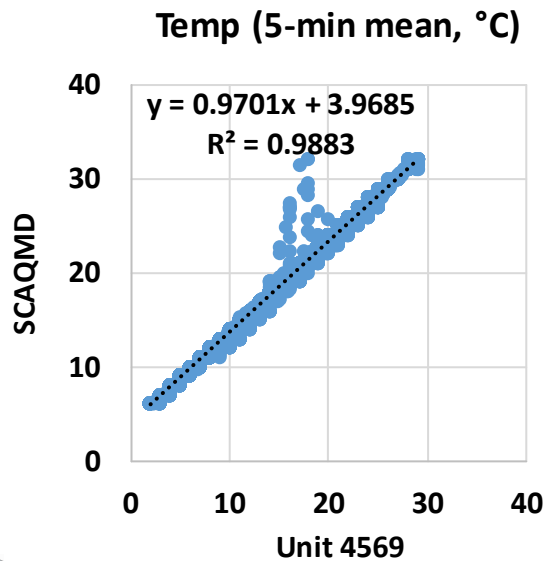
- CairPol Cairsens CO sensors showed excellent correlation with the corresponding FRM CO data ($R^2 \sim 0.953$)
- Overall, units 4569 and 4570 overestimate while unit 4571 underestimates CO concentration as measured by the FRM instrument
- The CairPol Cairsens CO sensors track well the CO diurnal variations as recorded by the FRM instrument



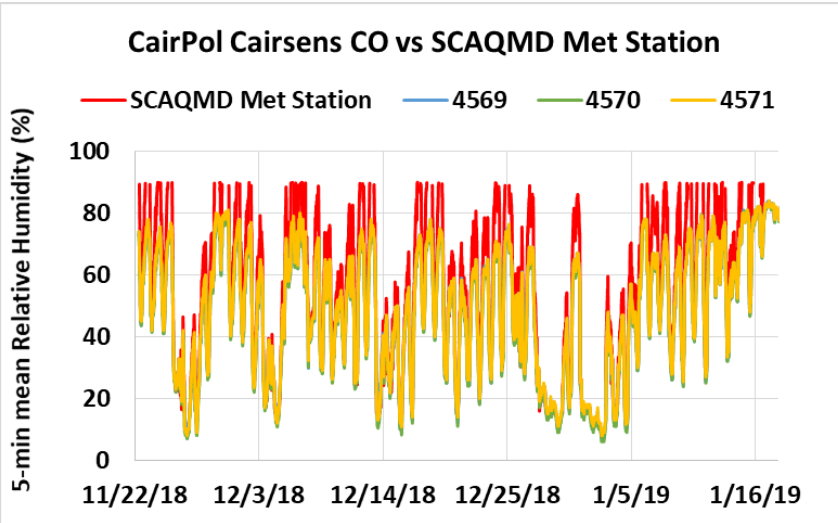
CairPol Cairsens CO vs SCAQMD Met Station (Temp; 5-min mean)



- CairPol Cairsens CO temperature measurements correlate very well with the corresponding SCAQMD Met Station data ($R^2 \sim 0.99$)
- Overall, the CairPol Cairsens CO sensors overestimate temperature measurements as recorded by SCAQMD Met Station
- The CairPol Cairsens CO sensors seem to track well the temperature diurnal variations as recorded by SCAQMD Met Station

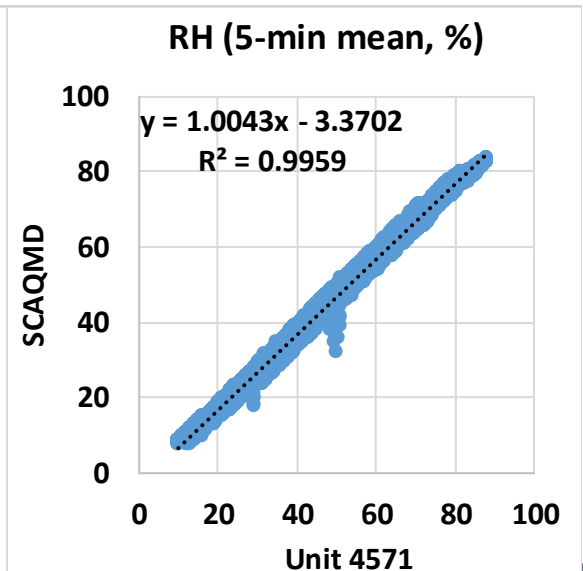
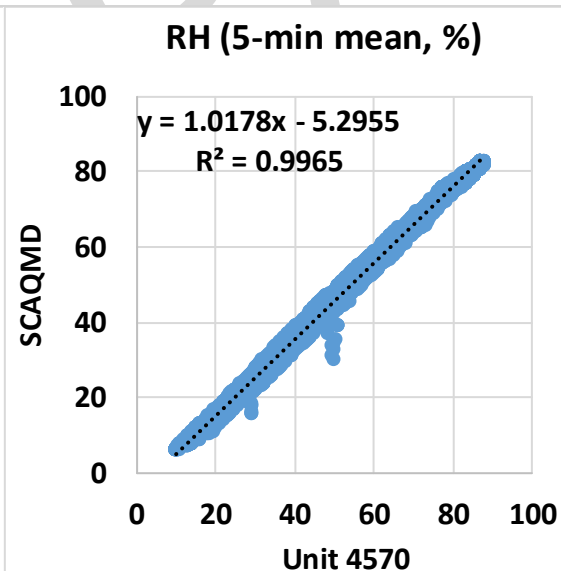
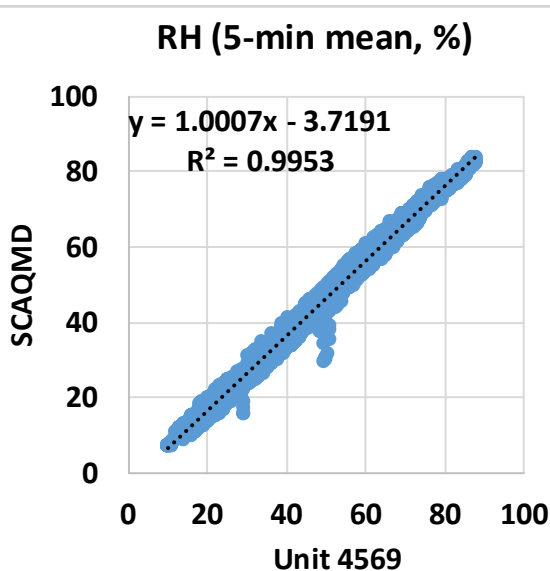


CairPol Cairsens CO vs SCAQMD Met Station (RH; 5-min mean)



- CairPol Cairsens CO RH measurements correlate very well with the corresponding SCAQMD Met Station data ($R^2 \sim 0.99$)
- Overall, the CairPol Cairsens CO sensors underestimate RH measurements as recorded by SCAQMD Met Station
- The CairPol Cairsens CO sensors seem to track well the RH diurnal variations as recorded by SCAQMD Met Station

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



Discussion

- The three **CairPol Cairsens CO** sensors' data recovery from each unit was ~92%, Data recovery is calculated based on the 5-min averages FRM CO measurements due to the fact that the sensors have a limit of quantification of 100 ppb as specified by the manufacturer, all values below 100 ppb measured by the FRM CO instrument were excluded from the data set for further analysis
- The three sensors showed high intra-model variability (43%) for CO measurements
- The CairPol Cairsens CO sensors showed excellent correlations with the FRM instrument ($R^2 \sim 0.93$) and track well the CO 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