

AQ-SPEC

Air Quality Sensor Performance Evaluation Center

Evaluation Summary

Sensor Description

Manufacturer/Model:
Sensirion/
Nubo

Pollutants:
PM_{1.0} and PM_{2.5}
mass concentration

Time Resolution:
1-min

Type: Optical



Additional Information

Field evaluation report:

<http://www.aqmd.gov/aq-spec/evaluations/field>

Lab evaluation report:

<http://www.aqmd.gov/aq-spec/evaluations/laboratory>

AQ-SPEC website:

<http://www.aqmd.gov/aq-spec>

- Overall, the accuracy of the Sensirion Nubo was fairly constant (86% to 98% and 81% to 94%) over the range of PM_{1.0} and PM_{2.5} mass concentration tested, respectively. Overall, the Sensirion Nubo sensors overestimated PM_{1.0} measurements when PM_{1.0} concentrations were > 100 µg/m³ and overestimated and PM_{2.5} measurements from GRIMM in the laboratory experiments at 20 °C and 40% RH.
- The Sensirion Nubo sensors exhibited high precision for all T/RH combinations and all PM concentrations.
- The Sensirion Nubo sensors (IDs: 2A3E, 1743 and 051E) showed low intra-model variability for both the field and laboratory evaluations.
- Data recovery was ~97% and 100% from all units in the field and laboratory evaluations.
- For PM_{1.0}, the Sensirion Nubo sensors showed very strong correlations with the corresponding GRIMM data; and showed strong to very strong correlations with the ref. instruments from the field for PM_{2.5} ($0.76 < R^2 < 0.92$) and very strong correlations with GRIMM in the laboratory evaluations ($R^2 > 0.99$ for PM_{1.0} and PM_{2.5}).
- The same three Sensirion Nubo units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

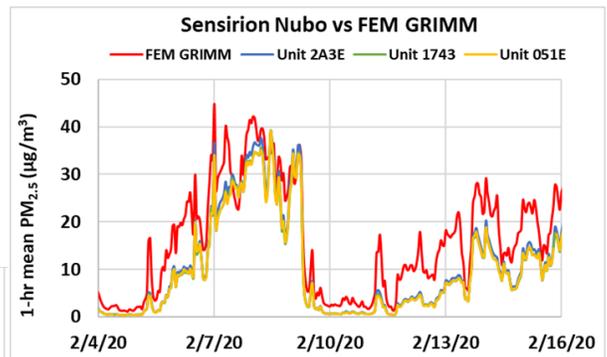
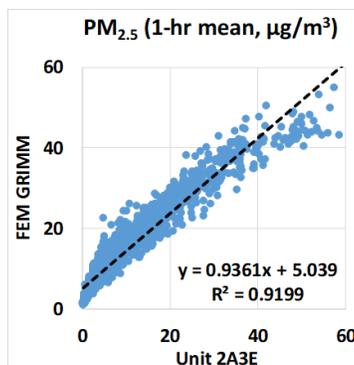
Field Evaluation Highlights

- Deployment period 12/27/2019 - 02/27/2020: the three Sensirion Nubo sensors showed very strong correlations with the corresponding GRIMM data for PM_{1.0}, and strong to very strong correlations with the corresponding FEM GRIMM and FEM BAM for PM_{2.5}.
- The units showed low intra-model variability and data recovery was ~ 97%.

1-hr mean, all ref. inst.

PM_{1.0}: ~ 0.96

PM_{2.5}: $0.76 < R^2 < 0.92$



Coefficient of Determination (R^2) quantifies how the three sensors followed the PM_{2.5} concentration change by the reference instruments.

An R^2 approaching the value of 1 reflects a near perfect agreement, whereas a value of 0 indicates a complete lack of correlation.

Laboratory Evaluation Highlights

Accuracy (PM_{2.5})

$$A (\%) = 100 - \frac{|\bar{X} - \bar{R}|}{\bar{R}} * 100$$

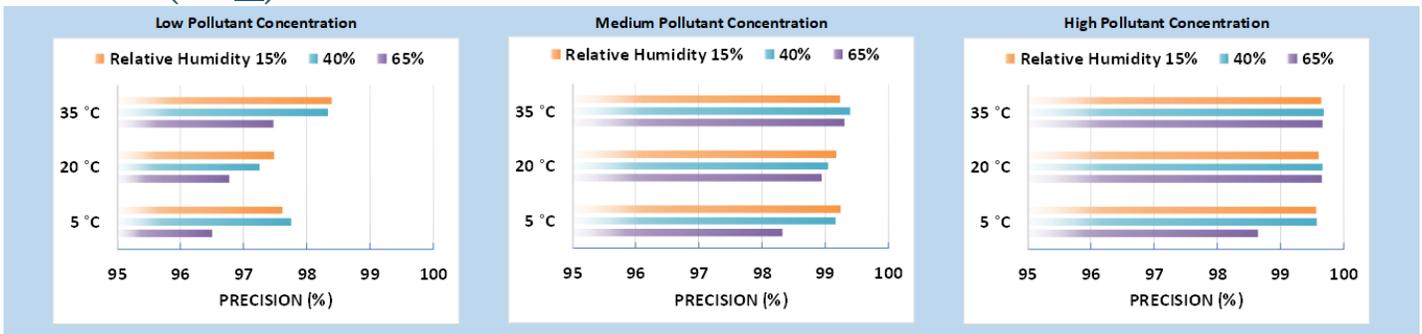
Steady state #	Sensor Mean (µg/m ³)	FEM GRIMM (µg/m ³)	Accuracy (%)
1	8.9	8.4	93.9
2	16.4	13.7	80.9
3	52.3	45.3	84.5
4	131.5	117.7	88.3
5	308.5	261.5	82.0

Accuracy was evaluated by a concentration ramping experiment at 20 °C and 40%. The sensor's readings at each ramping steady state are compared to the reference instrument.

A negative % means sensors' overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor's accuracy.

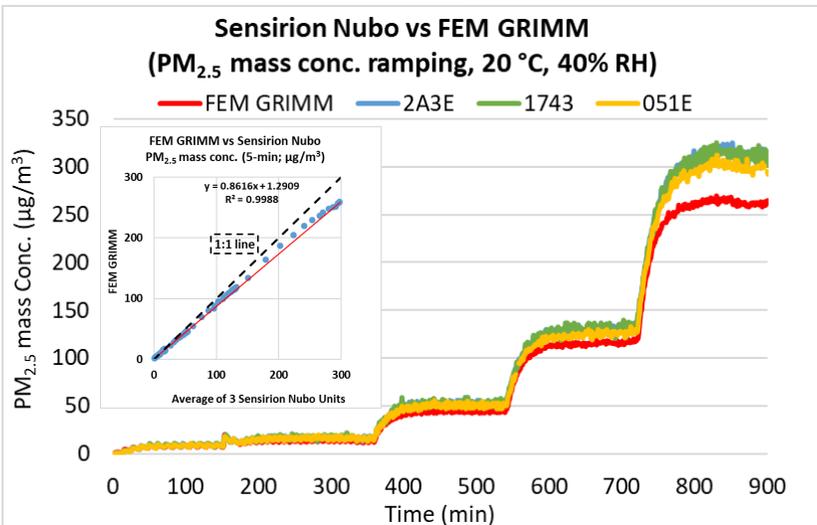


Precision (PM_{2.5})



Sensor's ability to generate precise measurements of PM_{2.5} concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and dry (5 °C and 15%) cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), or hot and dry (35 °C and 15%).

Coefficient of Determination



The Sensirion Nubos sensors showed very strong correlations with the corresponding FEM PM_{2.5} data ($R^2 > 0.99$) at 20 °C/40% RH. For conc. ramping experiments of PM_{1.0}, please see the lab report.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the Sensirion Nubos sensor precision. At the set-points of RH changes, the sensors reported spiked changes in concentration for all PM levels at 5 °C.

Observed Interferents

N/A



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