

Laboratory Evaluation

IQAir AirVisual Pro PM_{2.5} Sensor



Background

Three **IQAir AirVisual Pro PM_{2.5}** sensors (units IDs: 4VW9, WLL6, and X44P), previously field tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (08/02/2017 to 10/05/2017) under ambient environmental conditions, have now been evaluated in the South Coast AQMD Chemistry Laboratory under controlled artificial aerosol concentration/size range, temperature, and relative humidity conditions.

IQAir AirVisual Pro Sensor (3 units tested):

- PM_{2.5} (μg/m³) (optical; non-FEM)
- PM₁₀ (μg/m³) (optical; non-FEM)
- CO₂ (ppm)
- VOC (ppb)
- **Unit cost: \$269 USD**
- Time resolution: 10 seconds
- Units IDs: 4VW9, WLL6, X44P



IQAir AirVisual Pro

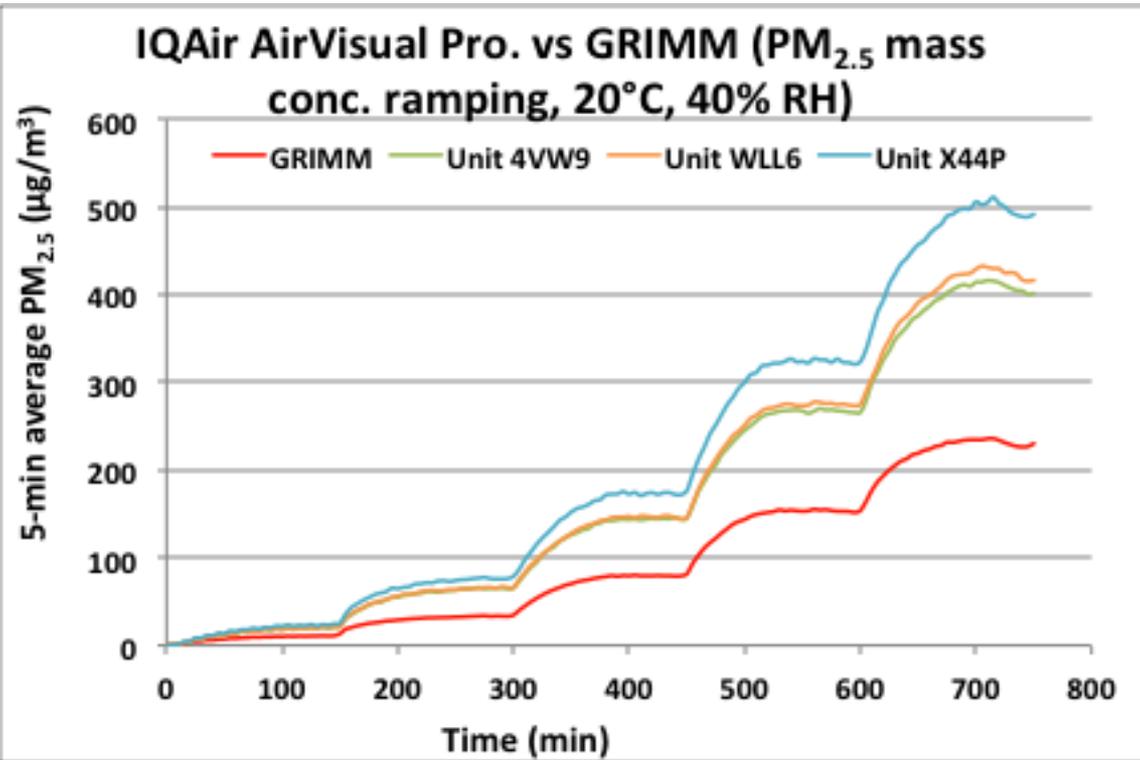
GRIMM (reference method):

- Optical particle counter
- **FEM PM_{2.5}**
- Uses proprietary algorithms to calculate total PM, PM_{2.5}, and PM₁ mass conc. from particle number measurements
- **Cost: ~\$25,000**
- Time resolution: 1-min

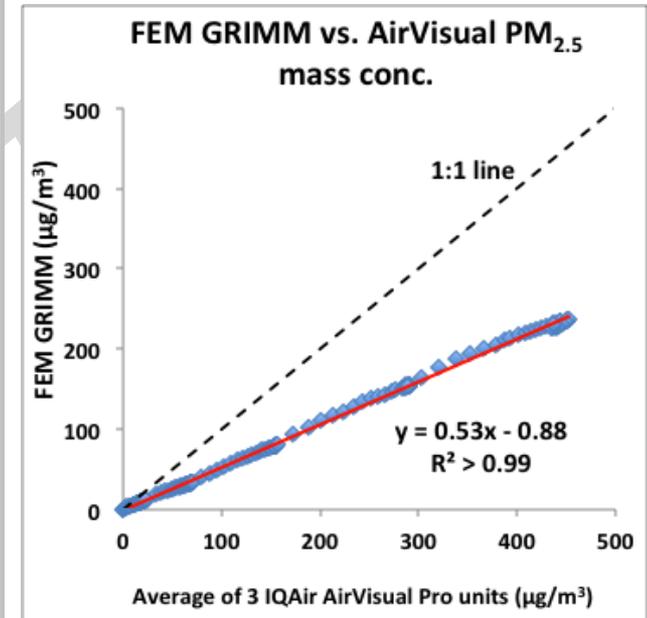


FEM GRIMM

IQAir AirVisual Pro vs FEM GRIMM (PM_{2.5} mass; 5-min mean)



- The three IQAir AirVisual Pro tracked well with the concentration variation recorded by FEM GRIMM in the concentration range of 0-250 $\mu\text{g}/\text{m}^3$.



- Three IQAir AirVisual Pro sensors showed very strong correlations with GRIMM PM_{2.5} mass conc. ($R^2 > 0.99$).
- IQAir AirVisual Pro sensors overestimated the GRIMM PM_{2.5} mass conc.;, with a slope of 0.53.

PM_{2.5} Accuracy: IQAir AirVisual Pro vs. GRIMM

- Accuracy (20 °C and 40% RH)

Steady State (#)	Sensor mean (µg/m ³)	GRIMM (µg/m ³)	Accuracy (%)
1	21.3	10.9	5.2
2	69.0	33.5	-6.2
3	154.6	79.3	5.0
4	288.6	153.0	11.4
5	440.0	228.5	7.4

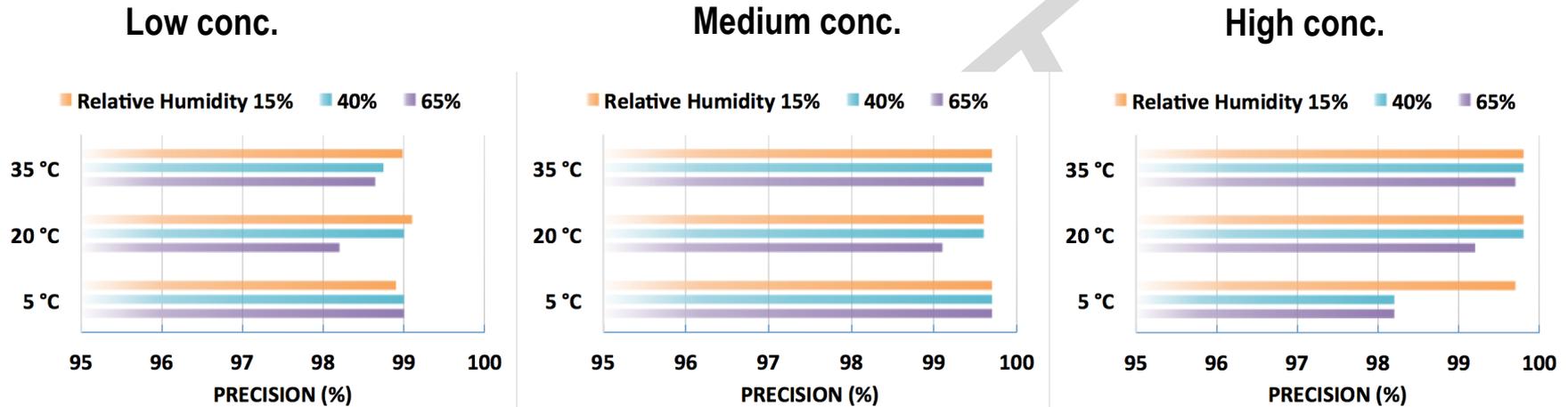
- The three IQAir AirVisual Pro sensors overestimated FEM GRIMM PM_{2.5} mass concentration over the concentration range of 0-250 µg/m³. Therefore, according to the calculation below, IQAir AirVisual Pro sensors have low accuracy compared to FEM GRIMM.

IQAir AirVisual Pro Data Recovery and Intra-model variability

- Data recovery for PM_{2.5} mass concentration from Unit 4VW9, Unit WLL6, and Unit X44P was 100%.
- Low PM_{2.5} measurement variations were observed among the three IQAir AirVisual Pro units.

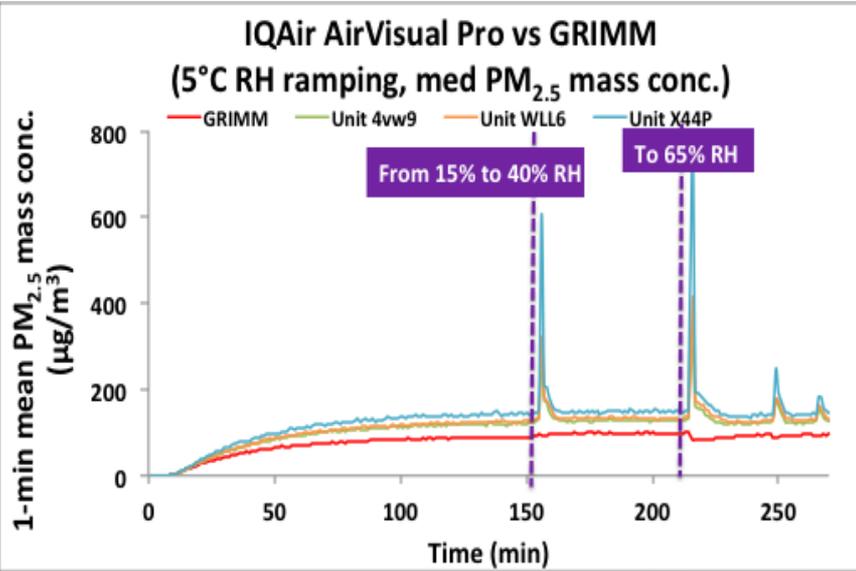
PM_{2.5} Precision: IQAir AirVisual Pro

- Precision (Effect of PM_{2.5} conc., Temperature and Relative Humidity)

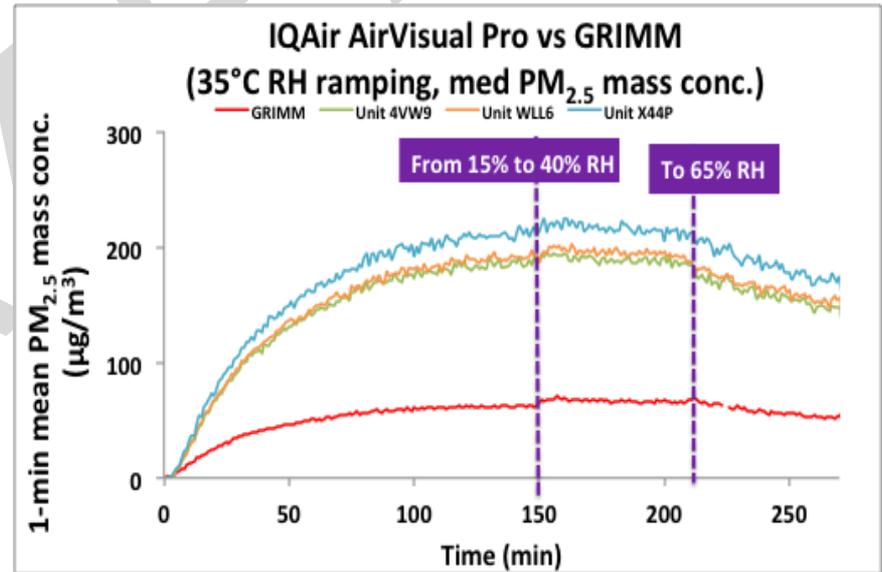


- Overall, the three IQAir AirVisual Pro sensors showed high precision for all combinations of low, medium and high PM_{2.5} conc., T, and RH over a FEM GRIMM PM_{2.5} conc. range of 0-250 µg/m³.

IQAir AirVisual Pro Climate Susceptibility



Low Temp - RH ramping
(medium conc.)



High Temp - RH ramping
(medium conc.)

Discussion

- **Accuracy:** Overall, the three IQAir AirVisual Pro sensors showed low accuracy, compared to the FEM GRIMM for PM_{2.5}. IQAir AirVisual Pro sensors overestimated FEM GRIMM PM_{2.5} readings in the laboratory experiments.
- **Precision:** The IQAir AirVisual Pro sensors showed high precision for all test combinations (PM_{2.5} concentrations, T and RH).
- **Intra-model variability:** Low intra-model variability was observed among the IQAir AirVisual Pro sensors.
- **Data Recovery:** Data recovery for PM_{2.5} mass concentration was 100% for all units tested.
- **Coefficient of Determination:** The three IQAir AirVisual Pro sensors showed very strong correlation/linear response with the corresponding FEM GRIMM PM_{2.5} measurement data ($R^2 > 0.99$) for mass concentration range between 0 and 250 $\mu\text{g}/\text{m}^3$.
- **Climate susceptibility:** For all temperature and relative humidity combinations, the climate conditions had minimal effect on the IQAir AirVisual Pro's precision. IQAir AirVisual Pro exhibited huge spikes at the set-points of RH changes at low temperature (5°C) for all PM concentrations, smaller or no spikes were observed at higher temperatures.