

Laboratory Evaluation

IQAir AirVisual Pro v1.1683



Background

Three **IQAir AirVisual Pro FW 1.1683** (hereafter **IQAir AirVisual Pro**) sensors (units IDs: TP7S, YCYL, MXC7) were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (08/15/2018 to 10/11/2018) under ambient environmental conditions and have been evaluated in the South Coast AQMD Chemistry Laboratory under controlled artificial aerosol concentration/size range, temperature, and relative humidity. The same three IQAir AirVisual Pro units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

IQAir AirVisual Pro (3 units tested):

- Particle sensors (**optical; non-FEM**)
- Each unit measures: PM_{2.5} mass concentration ($\mu\text{g}/\text{m}^3$), Temperature ($F/^\circ\text{C}$), Relative Humidity (%)
- **Unit cost: ~\$270**
- Time resolution: 1-min
- Units IDs: TP7S, YCYL, MXC7
- Difference from 1st generation: Improved PM_{2.5} sensor with a further enhanced calibration process

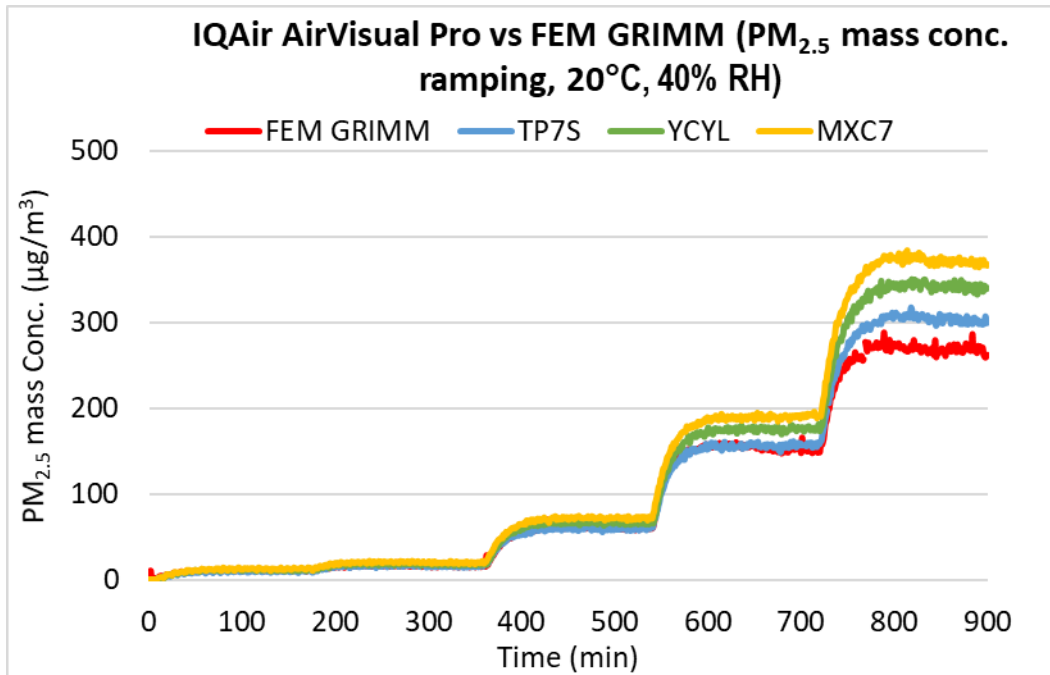


GRIMM (reference method):

- 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

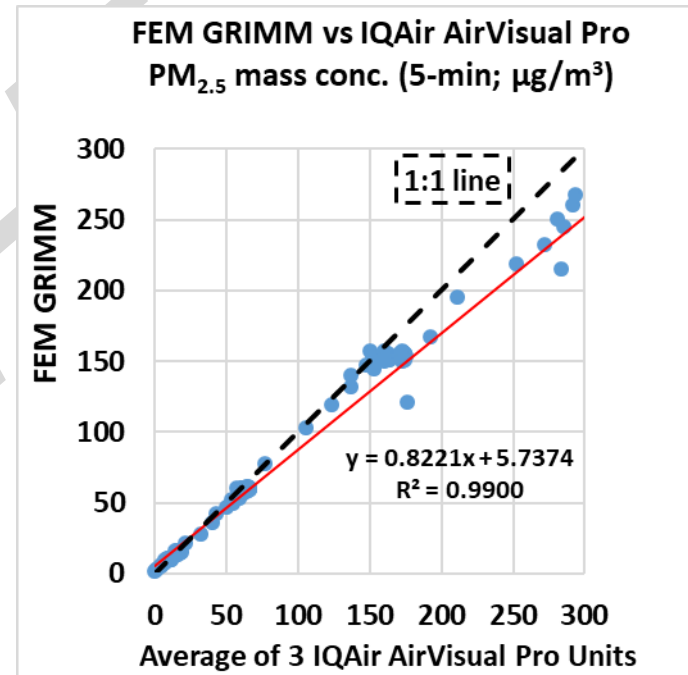


IQAir AirVisual Pro vs FEM GRIMM (PM_{2.5} mass conc.)



- The IQAir AirVisual Pro sensors tracked well with the concentration variation as recorded by the FEM GRIMM in the concentration range of 0 - ~300 µg/m³.

Coefficient of Determination



- The IQAir AirVisual Pro sensors showed very strong correlations with the FEM GRIMM PM_{2.5} mass conc. ($R^2 = 0.99$)

IQAir AirVisual Pro vs FEM GRIMM PM_{2.5} Accuracy

- Accuracy (20°C and 40% RH)

Steady state #	Sensor Mean (µg/m ³)	FEM GRIMM (µg/m ³)	Accuracy (%)
1	11.2	10.18	89.7
2	17.5	15.20	84.9
3	64.6	59.62	91.7
4	172.4	153.11	87.4
5	338.2	270.07	74.8

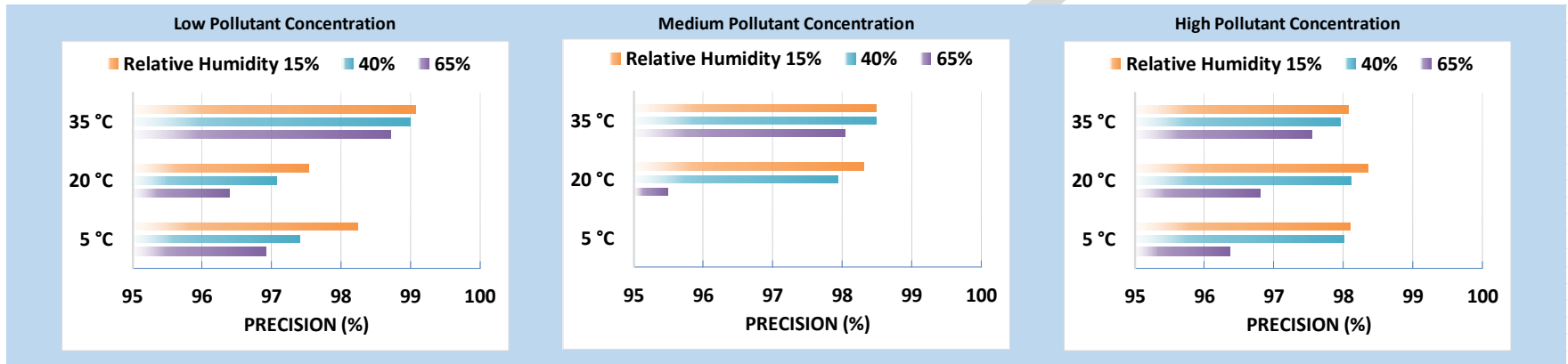
- The IQAir AirVisual Pro sensors overestimated FEM GRIMM PM_{2.5} mass concentration at 20°C and 40% RH. The IQAir AirVisual Pro sensors showed good accuracy for all PM_{2.5} levels except for ~300 µg/m³.

IQAir AirVisual Pro: Data Recovery and intra-model variability

- Data recovery for PM_{2.5} mass concentration from all units was 100% except for Unit YCYL in several experiments
- PM_{2.5} measurement variations were observed between the three units: 36.4%, 23.6% and 24.6% for low, medium and high PM_{2.5} mass concentrations, respectively

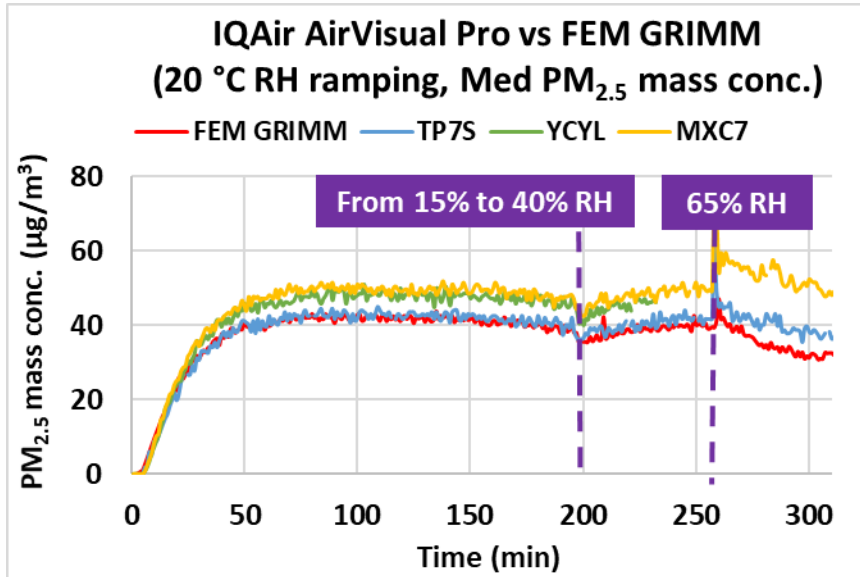
IQAir AirVisual Pro: Precision

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



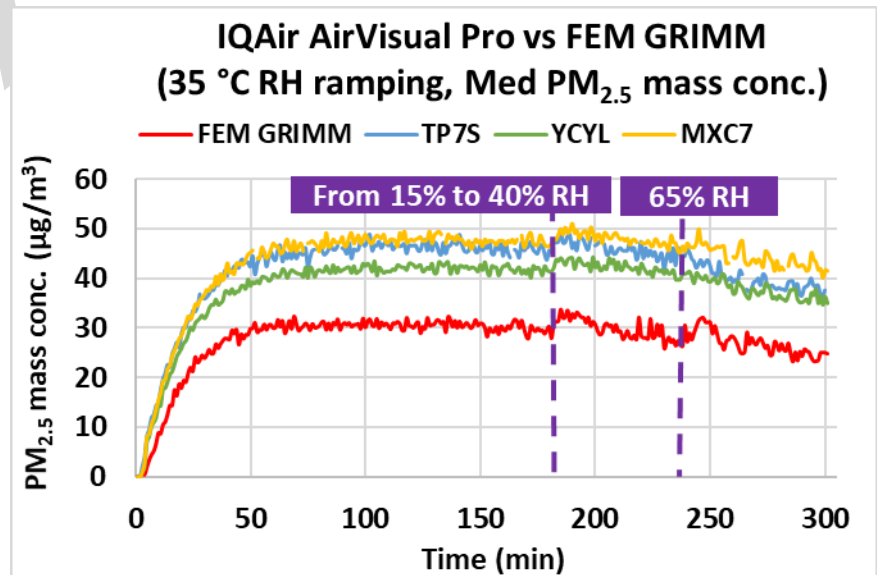
- Overall, the IQAir AirVisual Pro sensors showed high precision for all of the combinations of low, medium and high PM_{2.5} conc., T, and RH.
- No results presented for the Medium PM_{2.5} RH ramping at 5°C due to low data recovery from all units

IQAir AirVisual Pro: Climate Susceptibility



**Med Temp – RH ramping
(medium conc.)**

**High Temp – RH ramping
(medium conc.)**



Discussion

- **Accuracy:** Overall, the IQAir AirVisual Pro sensors showed good accuracy for all PM_{2.5} levels except for ~300 µg/m³. The IQAir AirVisual Pro sensors overestimated PM_{2.5} measurements from FEM GRIMM in the laboratory experiments at 20°C and 40% RH.
- **Precision:** The IQAir AirVisual Pro sensors have high precision for all test combinations (PM concentrations, T and RH) for PM_{2.5} mass concentrations
- **Intra-model variability:** Intra-model variability was observed among the IQAir AirVisual Pro sensors was 36.4%, 23.6% and 24.6% for low, medium and high PM_{2.5} mass concentrations, respectively.
- **Data Recovery:** Data recovery for PM_{2.5} mass concentration from all units was ~100% except for Unit YCYL not able to report data in several experiments.
- **Coefficient of Determination:** The IQAir AirVisual Pro sensors showed very strong correlation/linear response with the corresponding FEM GRIMM PM_{2.5} measurement data ($R^2 = 0.99$).
- **Climate susceptibility:** For most of the temperature and relative humidity combination, the IQAir AirVisual Pro sensors showed variations in PM_{2.5} concentrations at 65% RH, especially at low temperature.