

Laboratory Evaluation

Sensirion SPS30



Background

Three **Sensirion SPS30 Evaluation Kits** (hereinafter **Sensirion SPS30**) sensors (units IDs: 7CE8, D038, 5455) were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (03/07/2019 to 05/14/2019) 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 Sensirion SPS30 units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing).

- **Sensirion SPS30 (3 units tested):**

- Particle sensor: (optical; non-FEM)
- PM sensor: Sensirion SPS30
- Each unit reports: PM_{1.0}, PM_{2.5} and PM₁₀ (µg/m³)
- Also measures PM_{4.0} (µg/m³)
- **Unit cost: \$100**
- Time resolution: 1 second
- Units IDs: 7CE8, D038, 5455



- **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

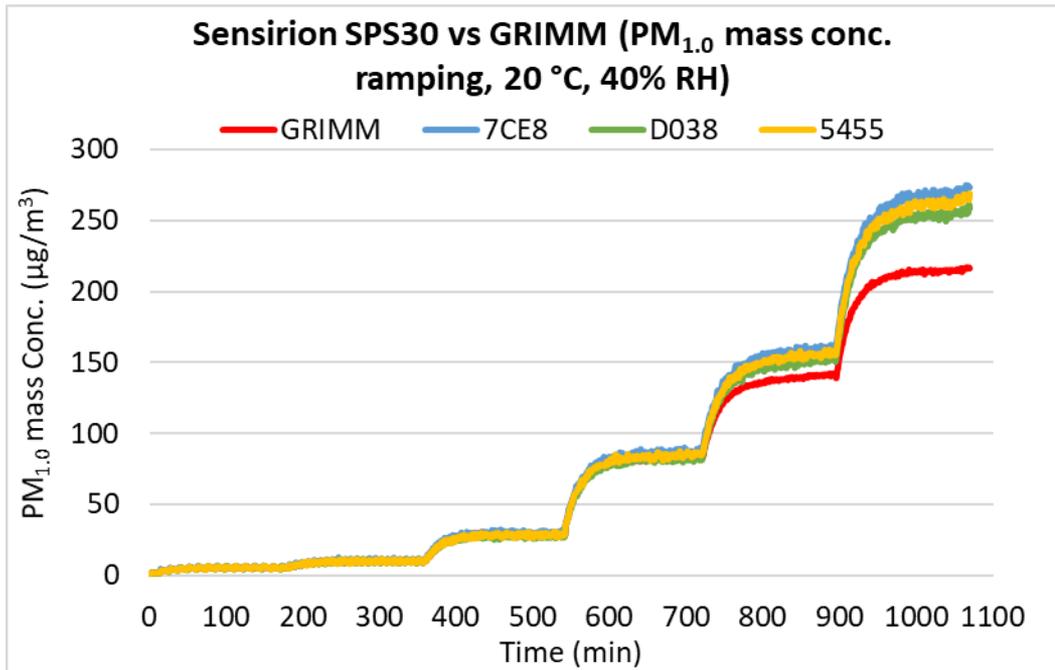


FEM GRIMM

Evaluation results for PM_{1.0} mass concentration

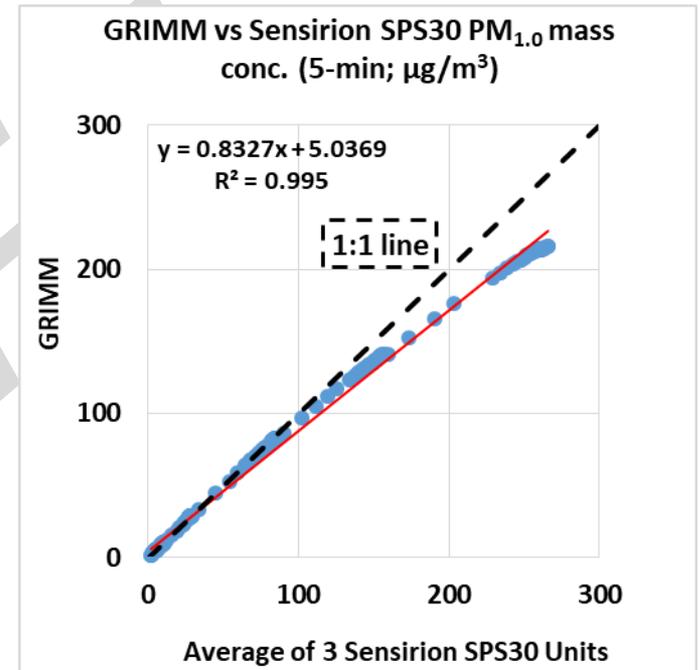
Sensirion SPS30 vs GRIMM

Sensirion SPS30 vs GRIMM (PM_{1.0} mass conc.)



- The Sensirion SPS30 sensors tracked well with the PM_{1.0} concentration variation as recorded by the GRIMM in the concentration range of 0 - ~200 µg/m³.

Coefficient of Determination



- The Sensirion SPS30 sensors showed very strong correlations with the GRIMM PM_{1.0} mass conc. ($R^2 > 0.99$).

Sensirion SPS30 vs GRIMM PM_{1.0} Accuracy

- Accuracy (20 °C and 40% RH)

Steady state #	Sensor Mean (µg/m ³)	GRIMM (µg/m ³)	Accuracy (%)
1	5.2	5.5	95.8
2	9.6	9.9	97.6
3	28.3	29.0	97.5
4	84.7	82.8	97.7
5	156.3	141.2	89.3
6	264.5	215.6	77.3

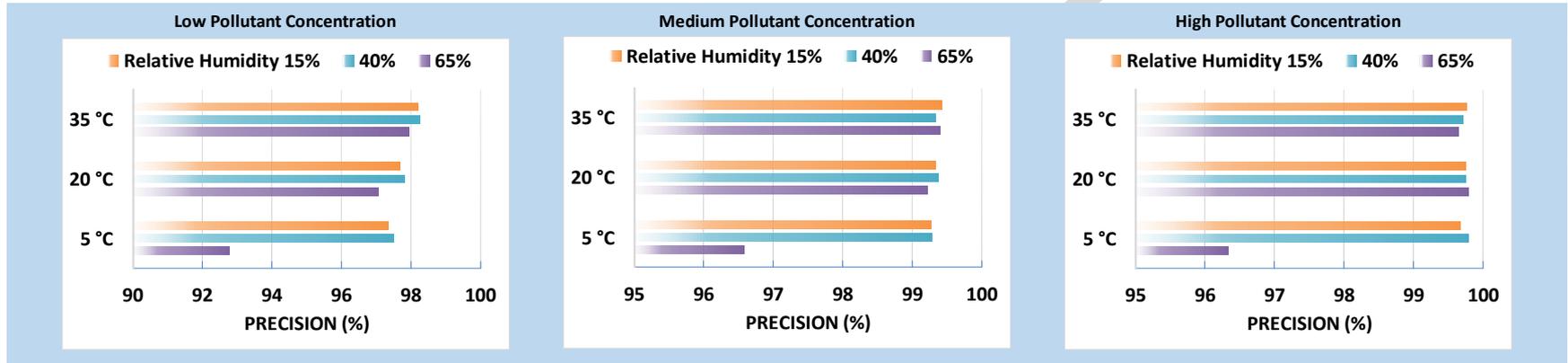
- Overall, the Sensirion SPS30 sensors overestimated GRIMM PM_{1.0} mass concentration. The accuracy of the Sensirion SPS30 sensors was > 95% when PM_{1.0} mass concentrations were < 100 µg/m³ and decreased to ~77% when PM_{1.0} mass concentrations were > 100 µg/m³ for the PM_{1.0} mass concentration range tested

Sensirion SPS30: Data Recovery and Intra-model Variability

- Data recovery for PM_{1.0} mass concentration from all units was 100%
- Low PM_{1.0} measurement variations were observed between the Sensirion SPS30 sensors

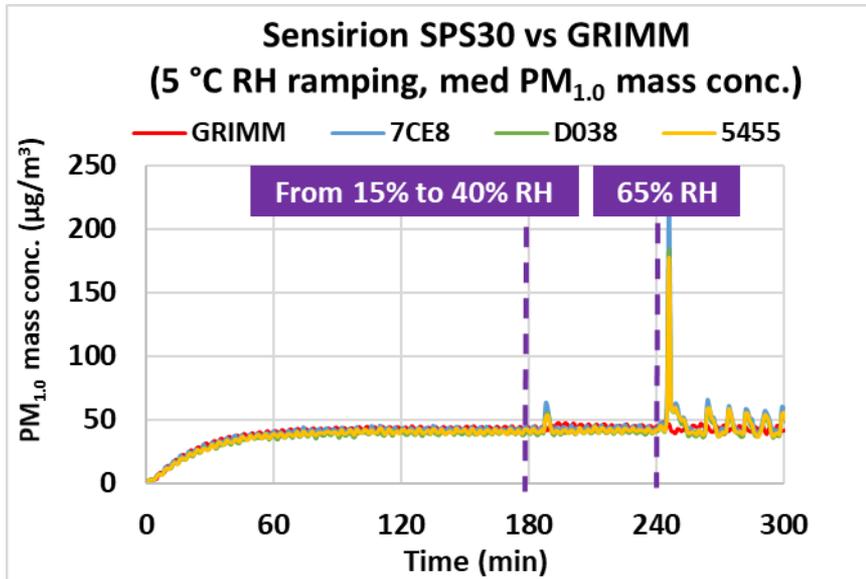
Sensirion SPS30 PM_{1.0} : Precision

- Precision (Effect of PM_{1.0} conc., Temperature and Relative Humidity)



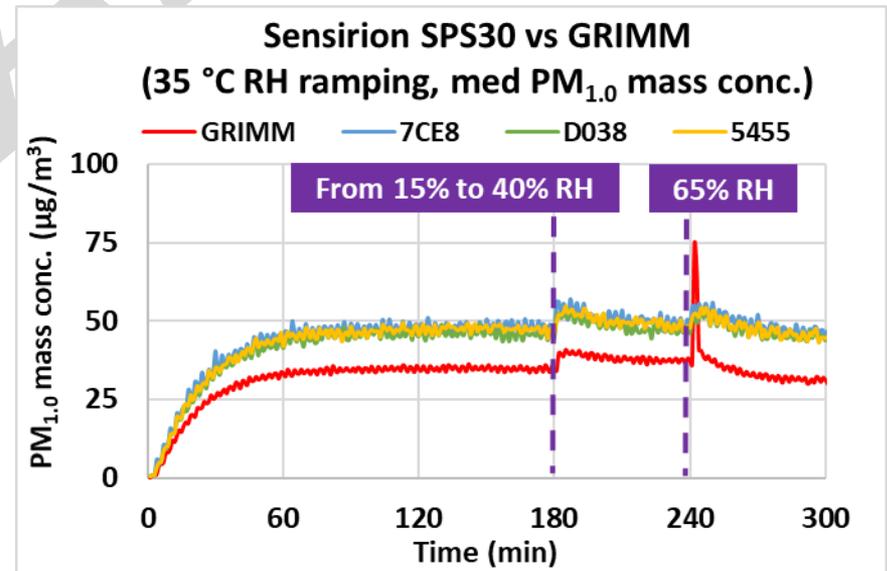
- Overall, the Sensirion SPS30 sensors showed high precision for all of the combinations of low, medium and high PM_{1.0} conc., T, and RH.
- Precision was relatively lower for 5 °C/65% RH at all PM_{1.0} levels; precision increased as PM_{1.0} concentrations increased.

Sensirion SPS30 PM_{1.0}: Climate Susceptibility



Low Temp – RH ramping
(medium conc.)

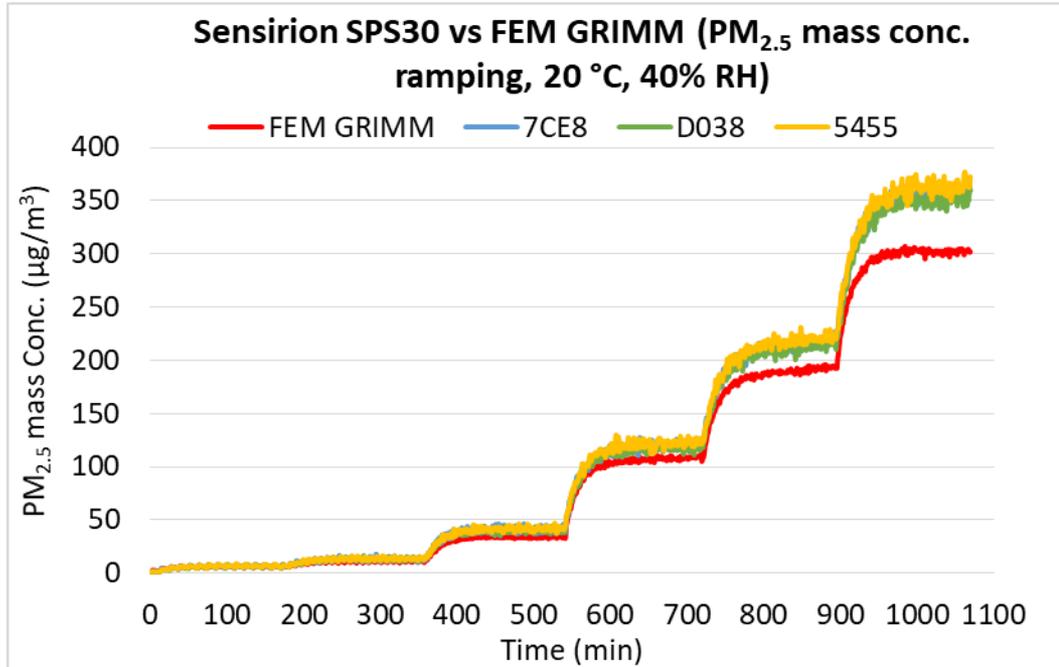
High Temp – RH ramping
(medium conc.)



Evaluation results for PM_{2.5} mass concentration

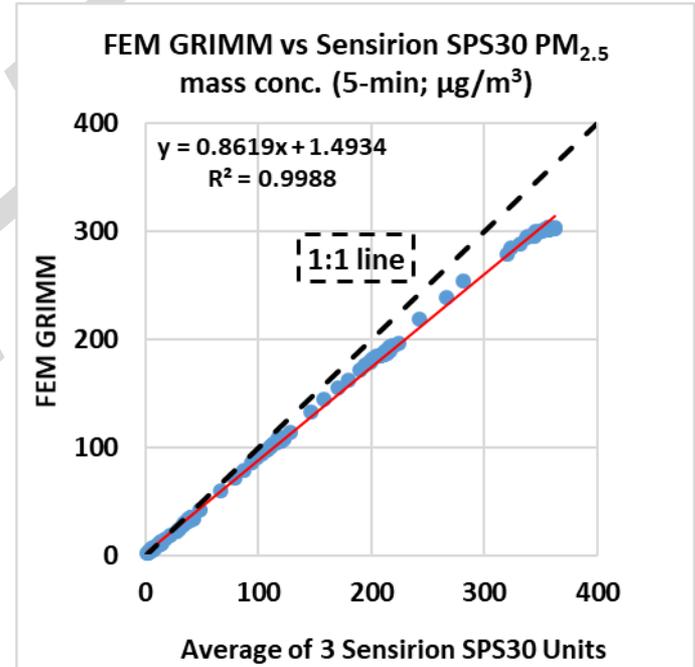
Sensirion SPS30 vs FEM GRIMM

Sensirion SPS30 vs FEM GRIMM (PM_{2.5} mass conc.)



- The Sensirion SPS30 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 Sensirion SPS30 sensors showed very strong correlations with the FEM GRIMM PM_{2.5} mass conc. ($R^2 > 0.99$).

Sensirion SPS30 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	6.7	6.5	96.2
2	13.3	11.4	83.4
3	41.1	34.8	81.8
4	120.8	108.8	89.0
5	218.8	193.5	86.9
6	359.4	302.7	81.3

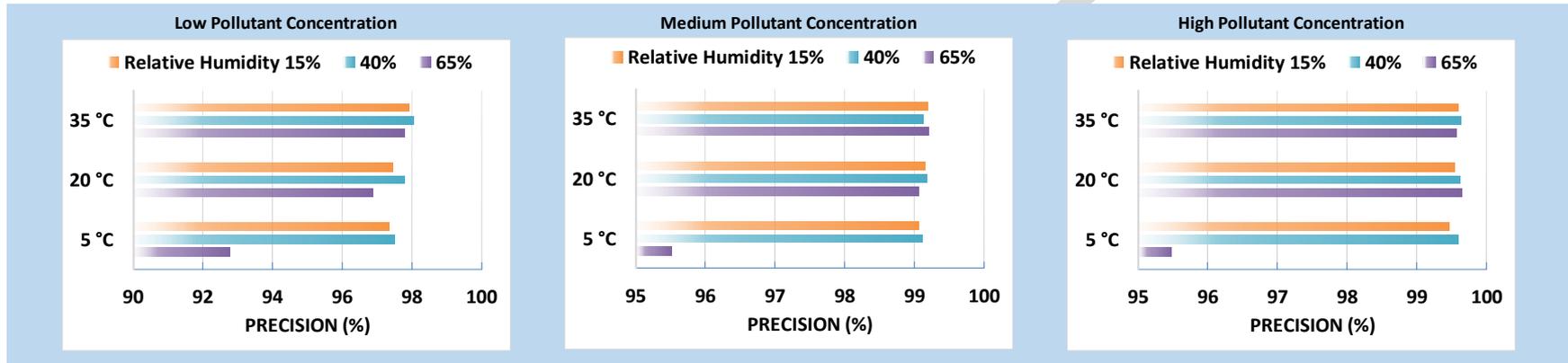
- The Sensirion SPS30 sensors overestimated FEM GRIMM PM_{2.5} mass concentration at 20 °C and 40% RH. The accuracy of the Sensirion SPS30 sensors was fairly constant (81% to 96%) for the PM_{2.5} mass concentration range tested.

Sensirion SPS30: Data Recovery and Intra-model Variability

- Data recovery for PM_{2.5} mass concentration from all units was 100%
- Low PM_{2.5} measurement variations were observed between the Sensirion SPS30 sensors

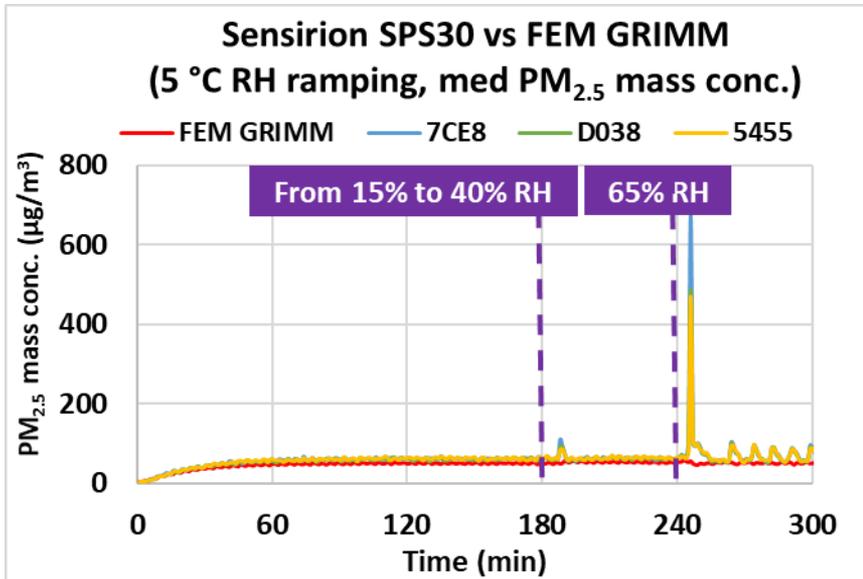
Sensirion SPS30 PM_{2.5}: Precision

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



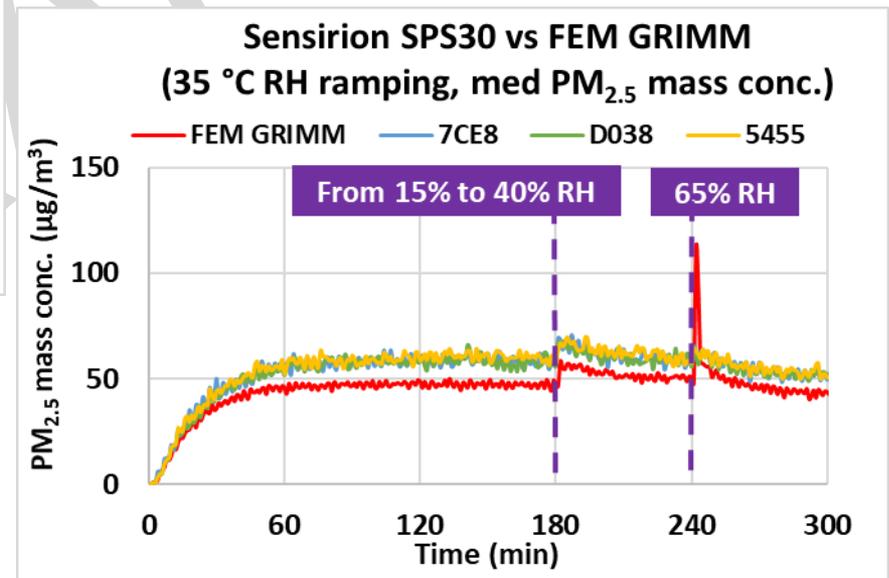
- Overall, the Sensirion SPS30 sensors showed high precision for all of the combinations of low, medium and high PM_{2.5} conc., T, and RH.
- Precision was relatively lower for 5 °C/65% RH at all PM_{2.5} levels; precision increased as PM_{2.5} concentrations increased.

Sensirion SPS30 PM_{2.5} : Climate Susceptibility



Low Temp – RH ramping
(medium conc.)

High Temp – RH ramping
(medium conc.)



Discussion

- **Accuracy:** Overall, the accuracy of the Sensirion SPS30 was > 95% when PM_{1.0} mass concentrations were < 100 µg/m³ and decreased to ~77% when PM_{1.0} mass concentrations were > 100 µg/m³ for the PM_{1.0} mass concentration range tested and was fairly constant (81% to 96%) for the PM_{2.5} mass concentration range tested. Overall, the Sensirion SPS30 sensors overestimated PM_{1.0} and PM_{2.5} measurements from GRIMM in the laboratory experiments at 20 °C and 40% RH.
- **Precision:** The Sensirion SPS30 sensors showed high precision for all test combinations (PM concentrations, T and RH) for both PM_{1.0} and PM_{2.5} mass concentrations except at 5 °C/65% RH.
- **Intra-model variability:** low intra-model variability was observed among the Sensirion SPS30 sensors.
- **Data Recovery:** Data recovery for PM_{1.0} and PM_{2.5} mass concentration from all units was 100%.
- **Coefficient of Determination:** The Sensirion SPS30 sensors showed very strong correlation/linear response with the corresponding GRIMM PM_{1.0} and FEM GRIMM PM_{2.5} measurement data ($R^2 > 0.99$).
- **Climate susceptibility:** For most of the temperature and relative humidity combination, the climate condition had minimal effect on the Sensirion SPS30's precision. At the set-points of RH changes, the Sensirion SPS30 sensors reported spiked changes in concentration and showed significant variation in concentration at 5 °C/65% RH.