CSTEP

Annexures

Performance Evaluation of Multi-pollutant Air Quality Sensors at Indi-SET, Bengaluru, India – First Edition

A Short- and Medium-Term Evaluation

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A Short- and Medium-Term Evaluation

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Annexure A: Instrument Specifications and Operation and Maintenance Protocol of Reference-Grade Instruments

This sub-section provides the specifications of the reference-grade instruments used in the *Performance evaluation of multi-pollutant air quality sensors at Indi-SET, Bengaluru, India, First Edition, A short- and medium-term evaluation*, as well as the criteria for their operation and maintenance.

***Table A1**: Specifications of reference-grade instruments used in Indi-SET for monitoring pollutant gases and PM*

Specification	O_3	NO_x	CO	SO_2	PM
Measurement method	Ultraviolet (UV) photometry	Chemiluminescence	Non-dispersive infrared (NDIR) analysis	UV fluorescence	β-ray attenuation
Measurement range	0–0.5 ppm	0–0.5 ppm	0–50 ppm, 0–100 ppm (selectable)	0–0.5 ppm (designated), 0–1 ppm (selectable)	0–1 mg/m^3, 0–5 mg/m^3 (optional), 0–10 mg/m^3 (optional)
Lower detection limit	< 0.5 ppb	< 0.5 ppb	< 0.4 ppm	< 0.5 ppb	3–4 µg/m^3
Repeatability	Within ±0.5% of the span gas concentration	Within ±0.5% of the span gas concentration	Within ± 0.5% of the span gas concentration	Within ± 0.5% of the span gas concentration	<±3%
Rise/fall time (95%)	Within 50 sec (T95)	Within 60 sec (T95)	Within 60 sec (T95)	Within 120 sec (T95)	-
Sample flow rate	800 cc/min ±10%	800 cc/min ±10%	800 cc/min ±10%	800 cc/min ±10%	16.67 litres/ min

***Table A2**: Maintenance schedule of the air quality monitoring station (AQMS; adapted from manuals of Vasthi Vair-9009 and Kentek Mezus 110, 210, 310, and 410 series)*

Parameter	Item	Schedule	Calibration Check
SO_2 analyser	Warning	Daily	No
	Dust filter	Every week or as necessary	No
	Test value check	Every week or after the repair	Yes
	Flow check	Less than normal values of flow and pressure	Yes, when abnormal
	Pneumatic line check	As necessary	Yes, when replacing the pneumatic system
	Fan filter check	As necessary	No
NO_x analyser	Warning	Daily	No
	Cleaning	As necessary	No
	Dust filter	Every week or as necessary	No
	Test value check	Every week or after the repair	Yes
	Flow check	Less than normal values of flow and pressure	Yes, when abnormal
	Pneumatic line check	As necessary	Yes, when replacing the pneumatic system
CO analyser	Warning	Daily	No
	Fan filter check	As necessary	No
	Cleaning	As necessary	No
	Dust filter	Every week or as necessary	No
	Test value check	Every week or after the repair	Yes
	Flow check	Less than normal values of flow and pressure	Yes, when abnormal
O_3 analyser	Warning	Daily	No
	Pneumatic line check	As necessary	Yes, when replacing the pneumatic system
	Warning	Daily	No

Parameter	Item	Schedule	Calibration Check
O_3 analyser	Fan filter check	As necessary	No
	Cleaning	As necessary	No
	Dust filter	Every week or as necessary	No
PM sampler	Test value check	Every week or after the repair	Yes
	Flow check	Less than normal values of flow and pressure	Yes, when abnormal
	Pneumatic line check	As necessary	Yes, when replacing the pneumatic system
	Fan filter check	As necessary	No
	Cleaning	As necessary	No
	Vacuum pump maintenance	Monthly	-
	PM_{10} inlet maintenance	Monthly	-
	Periodic flow-rate verification	Monthly	-
	Conduct a leak check monthly	Monthly	-
	Clean the nozzle and vane	Monthly	-
	Clean the rollers	2 months	-
	Check the error log	Monthly	-
	Download the digital data log	Monthly	-
	Compare PM_{10} data to the external data logger	Monthly	-
	Replace filter tape	2 months	-
	Conduct an audit for ambient sensors	6 months	-
	Test smart heater	6 months	-
	Filter tape status	Daily	-
	System alarms	Daily	-
	Cleanliness	Weekly	-
	Air flow rate	Weekly	-

Parameter	Item	Schedule	Calibration Check
PM inlet	Calibration checks	Monthly	-
	Exterior inspections	Monthly	-
	Comprehensive inspection	Annual	-
	Record-keeping	Annual	-
	Software updates	Annual	-
	Visual inspection	Daily	Only trained technicians should perform maintenance tasks, especially those that require disassembling parts of the inlet
	Clean exterior	Weekly	
	Check for signs of corrosion	Monthly	
	Inlet tube cleaning	Quarterly	
	Filter - Inspect and replace	Quarterly	
	Calibration after cleaning	Quarterly	
	Seals and gaskets	Quarterly	
	Thorough cleaning	Yearly	
	Calibration	Yearly	
Weather station	Direction of the north arrow	Weekly	-
	Alignment of the sensor	Weekly	-

Annexure B: Intra-model Precision of Sensors – Correlation

This subsection presents the correlation of multi-pollutant sensors from six Indian manufacturers: Aeron, Airveda, Airvoice, Aurassure, Respirer, and Sensit. The evaluation involved 3 to 25 sensor nodes from each manufacturer and was conducted at the Indi-SET facility. The pollutants assessed include $PM_{2.5}$, PM_{10}, NO_2, CO, and O_3. The precision among the devices for raw and manufacturer-reported (factory-calibrated) values is presented here.

Aeron

***Figure A1**: Intra-device correlation for manufacturer-reported data of Tera Sensor $PM_{2.5}$ from the Aeron sensor*

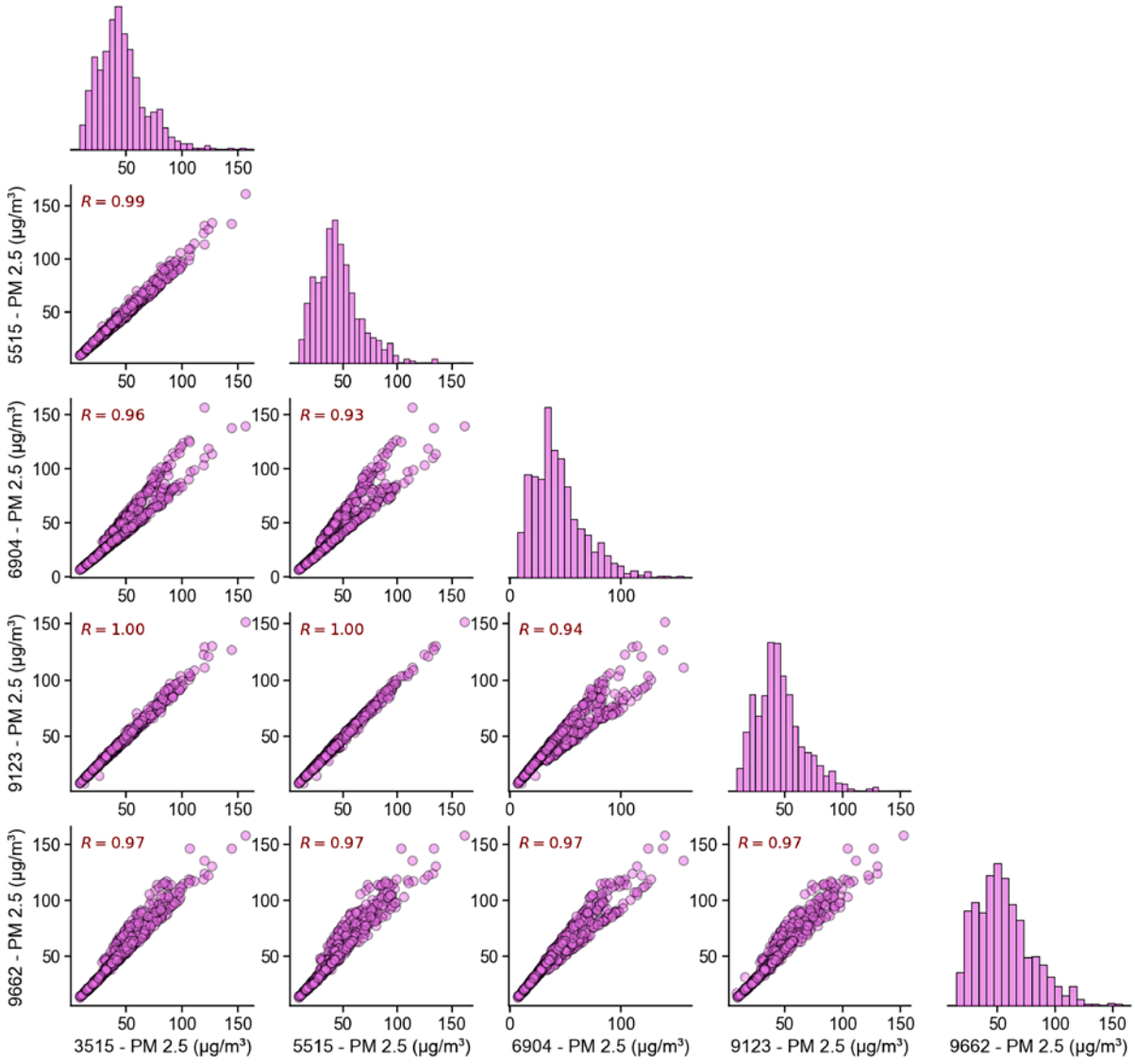


***Figure A2**: Intra-device correlation for manufacturer-reported data of Alphasense OPC $PM_{2.5}$ from the Aeron sensor*

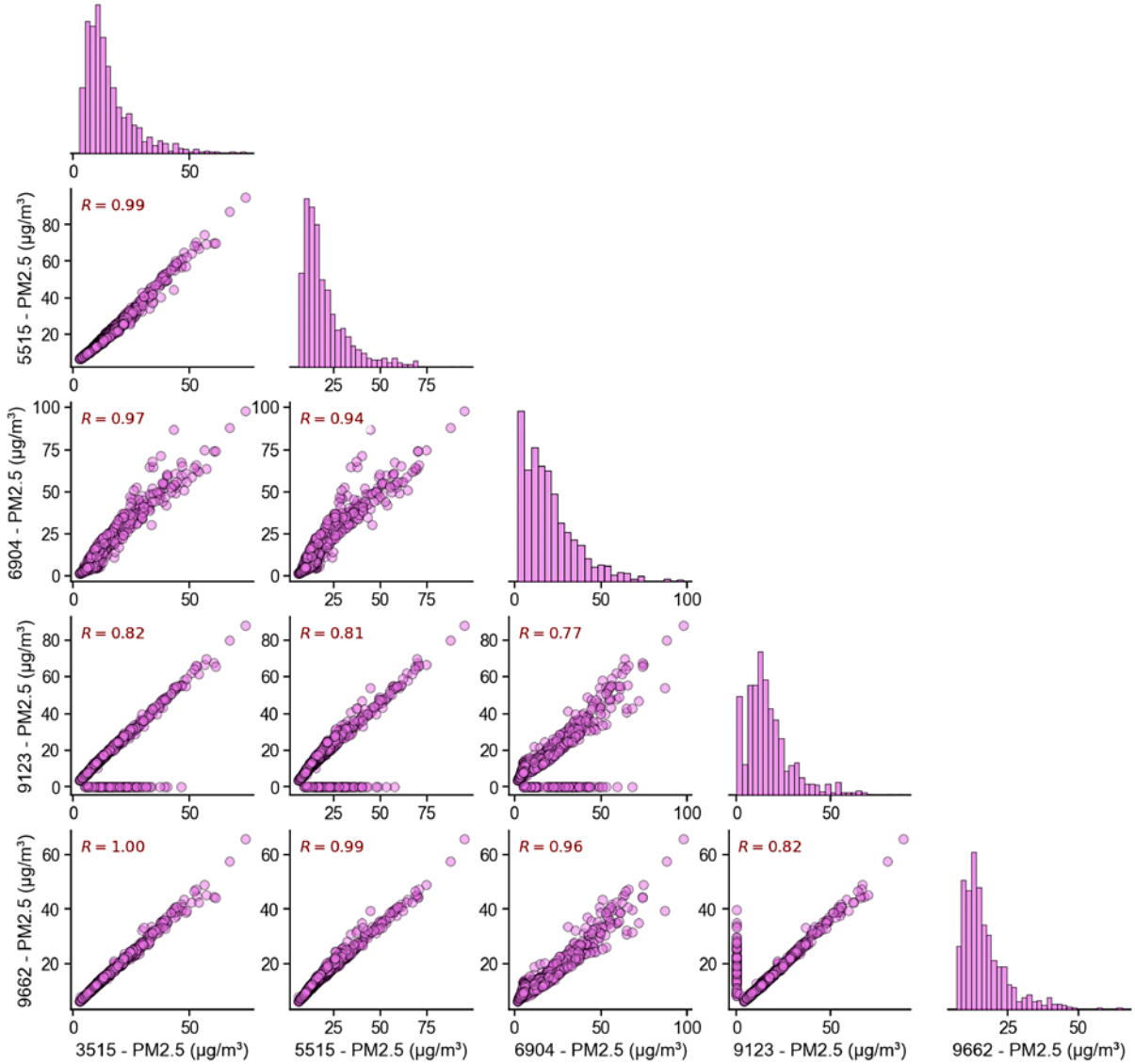


***Figure A3**: Intra-device correlation for manufacturer-reported data of Tera Sensor PM_{10} from the Aeron sensor*

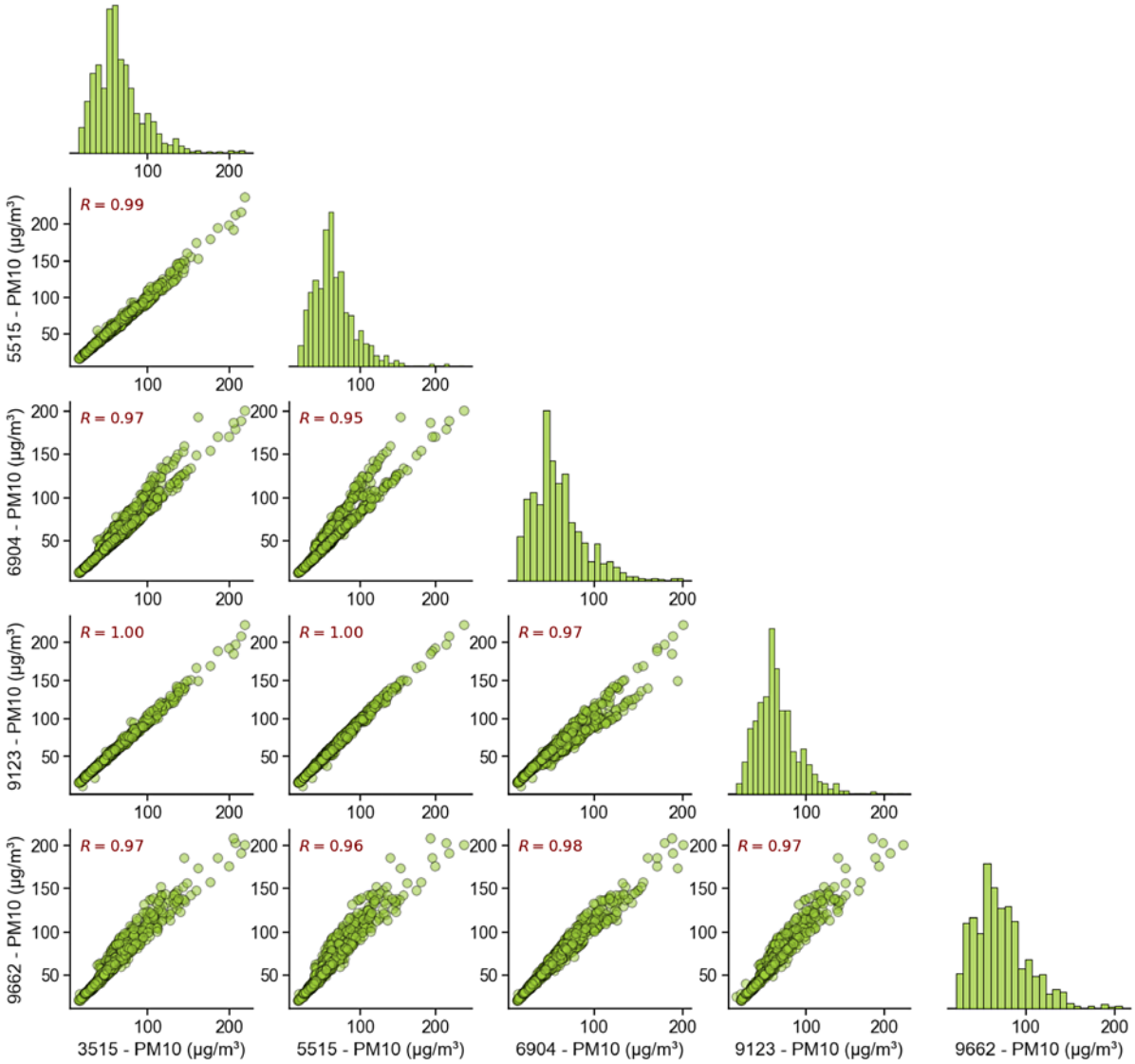


***Figure A4**: Intra-device correlation for manufacturer-reported data of Alphasense OPC PM_{10} from the Aeron sensor*

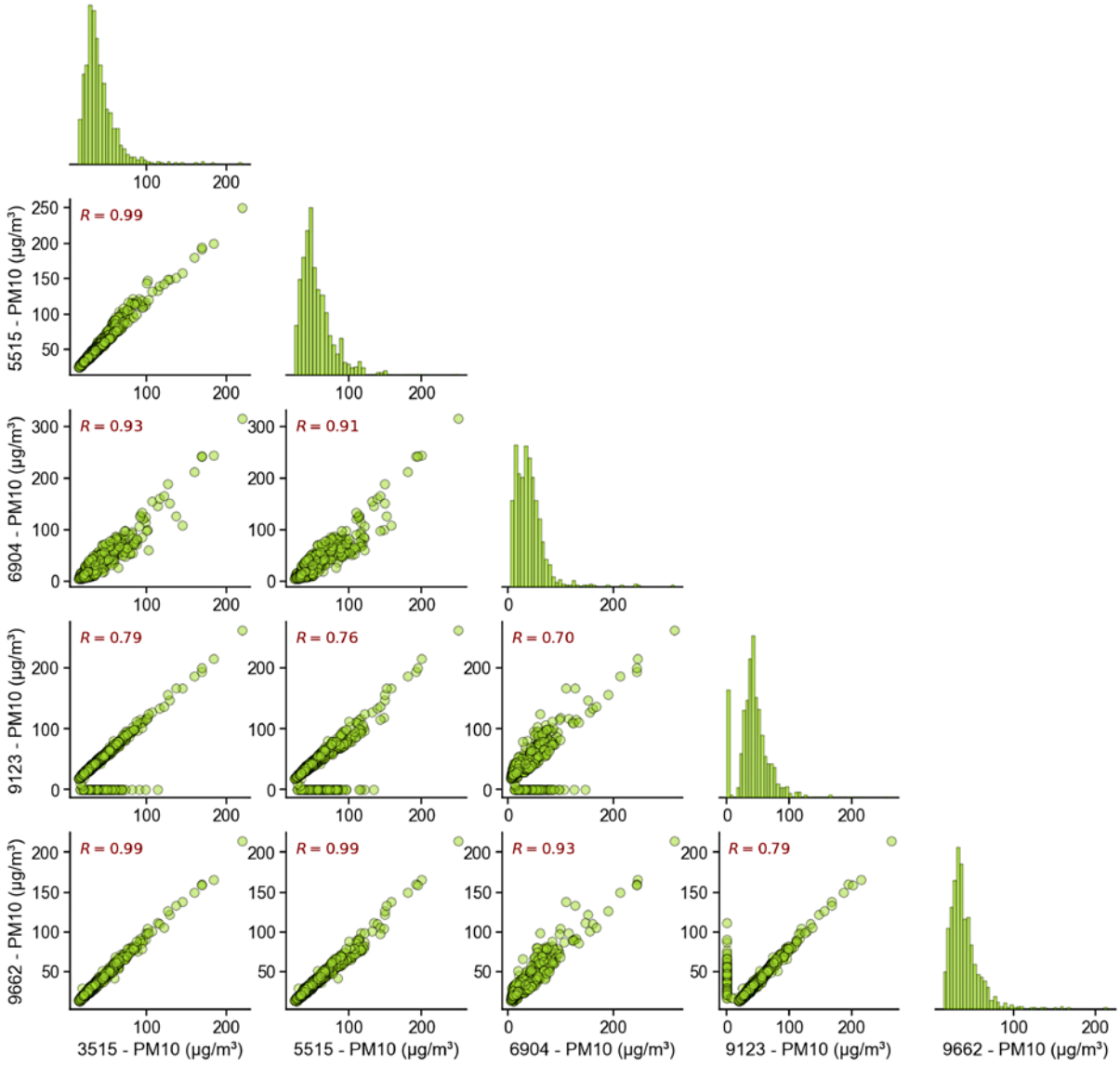


***Figure A5**: Intra-device correlation for raw data of NO_2 from the Aeron sensor*

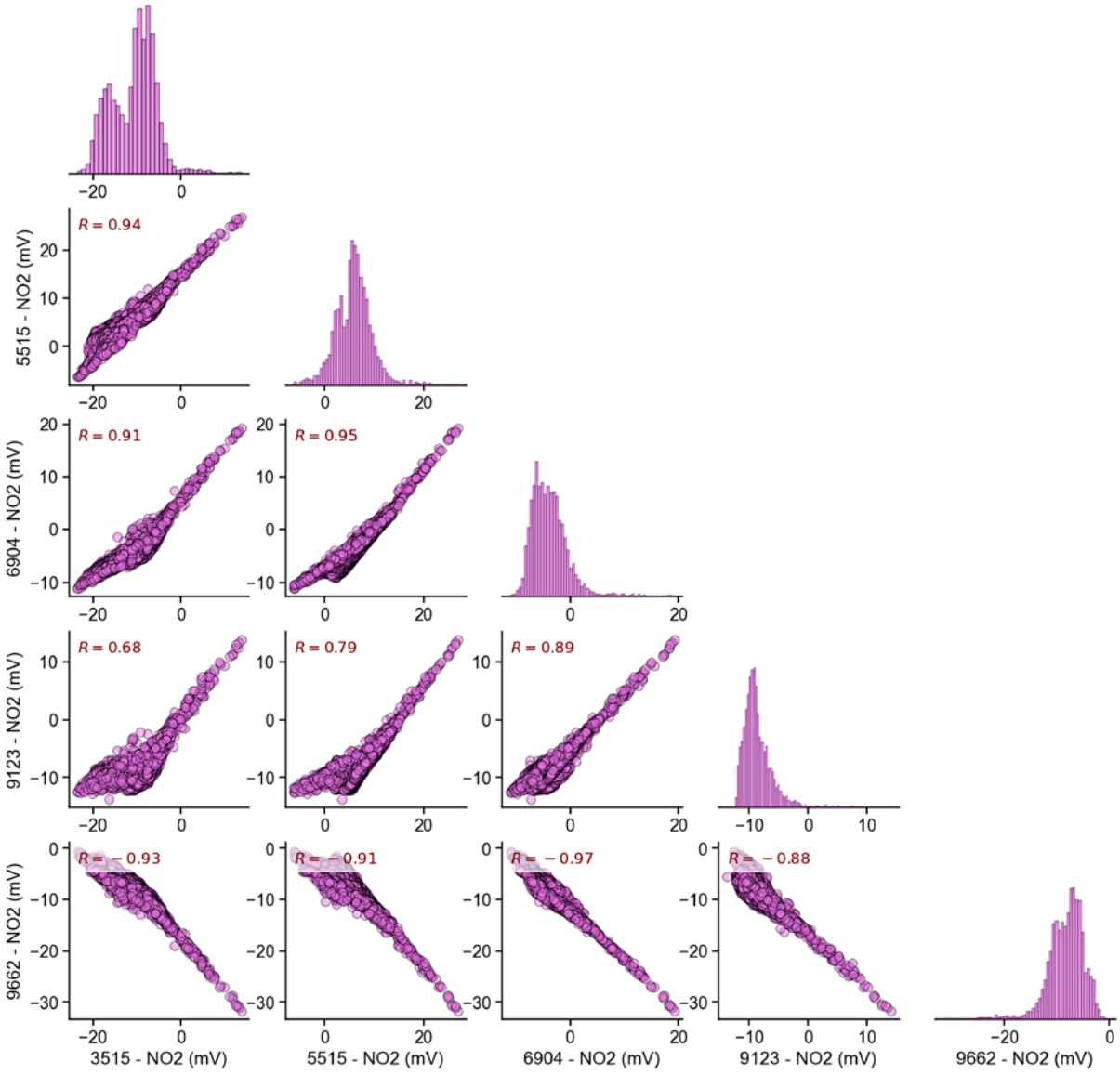


***Figure A6**: Intra-device correlation for manufacturer-reported data of NO_2 from the Aeron sensor*

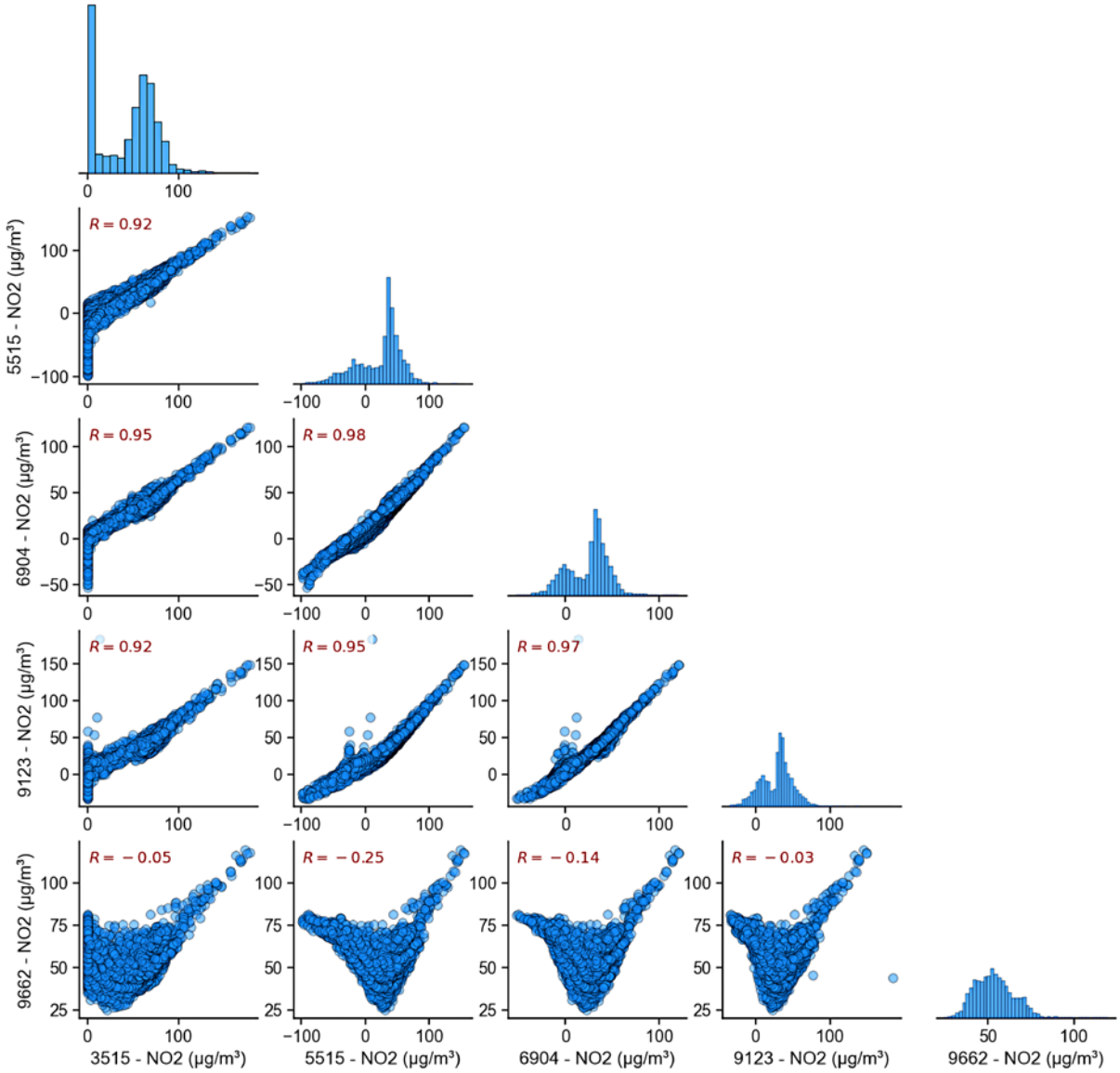


***Figure A7**: Intra-device correlation for raw data of O_3 from the Aeron sensor*

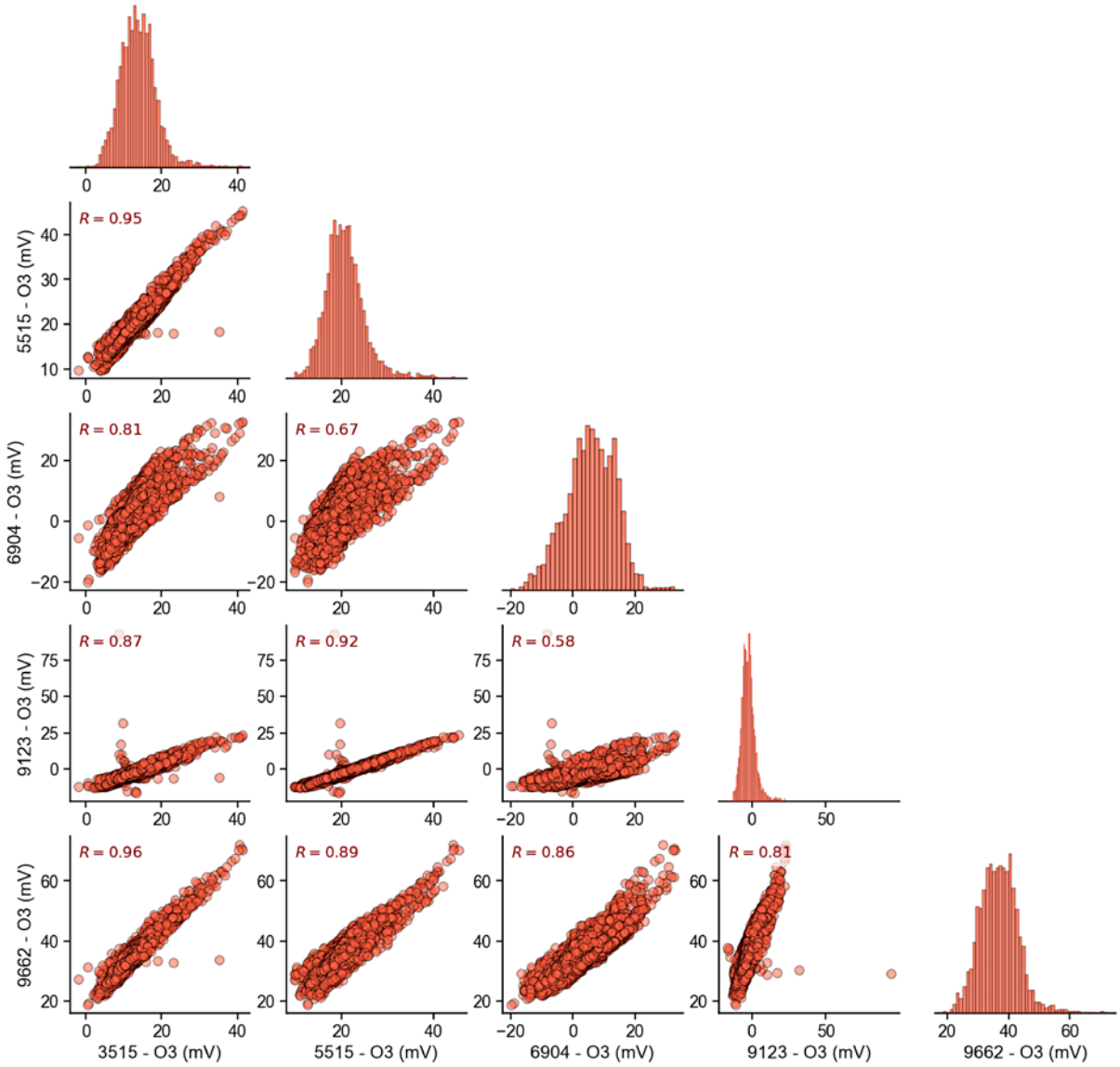


***Figure A8**: Intra-device correlation for manufacturer-reported data of O_3 from the Aeron sensor*

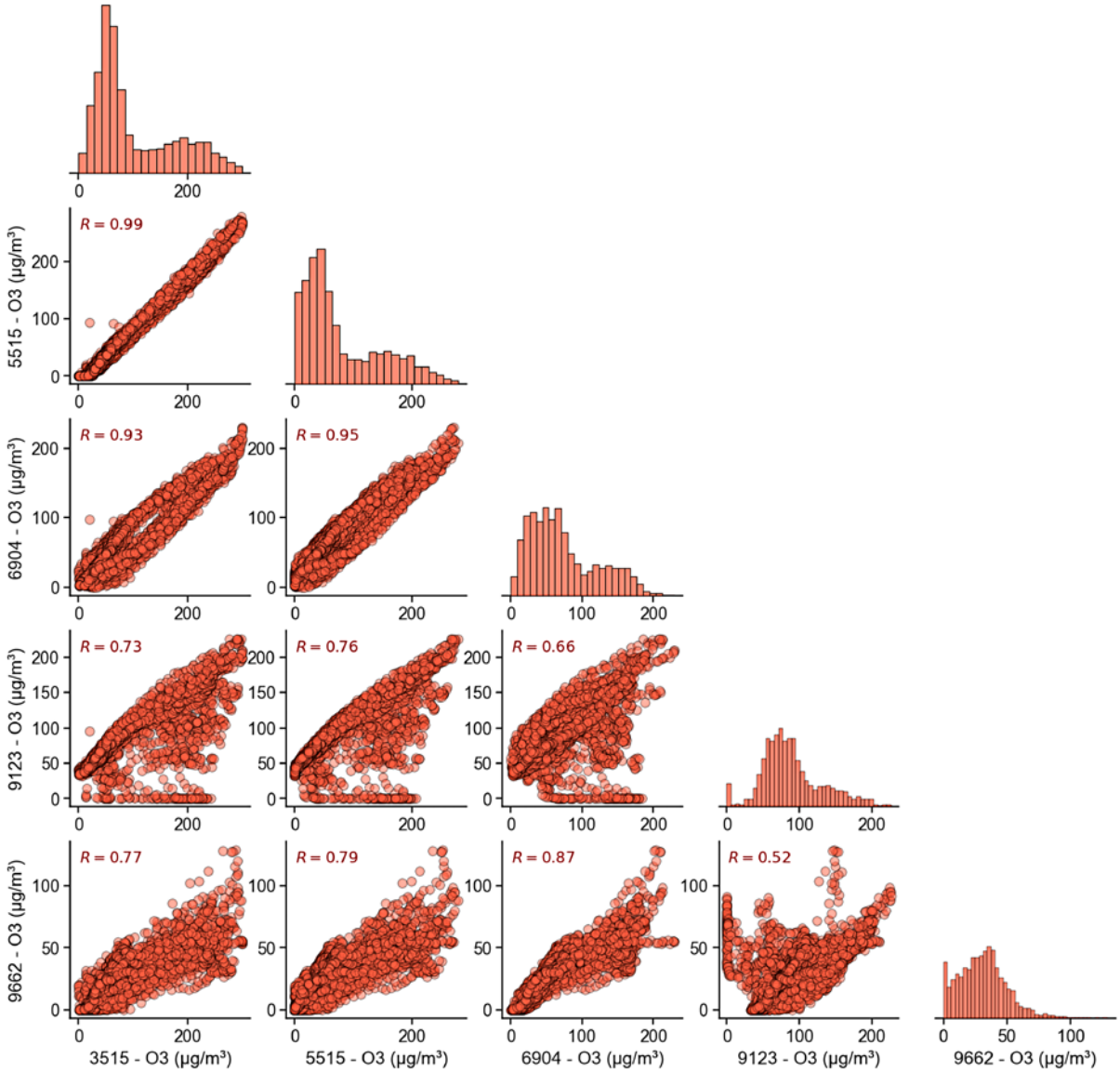


***Figure A9**: Intra-device correlation for raw data of CO from the Aeron sensor*

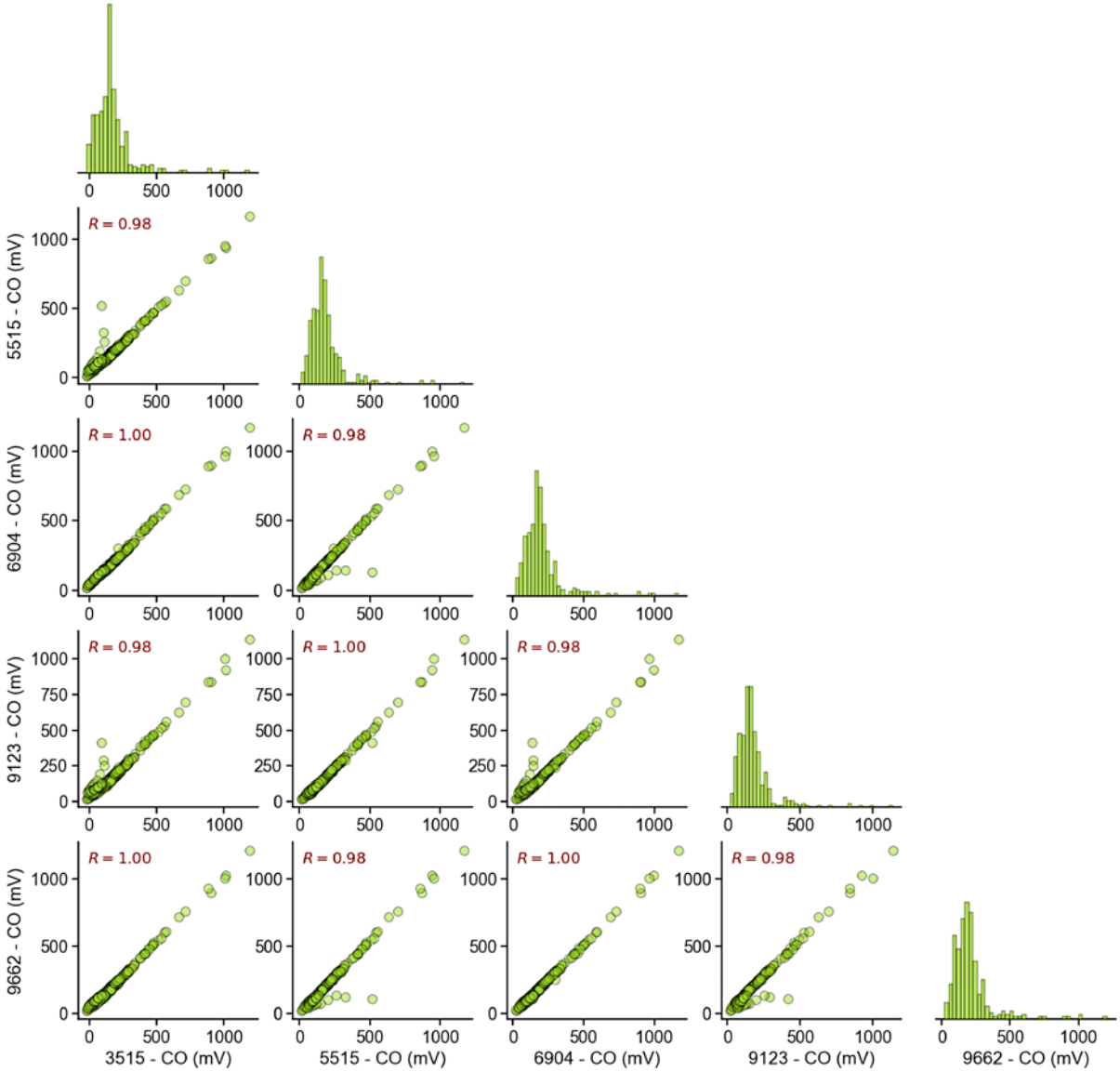
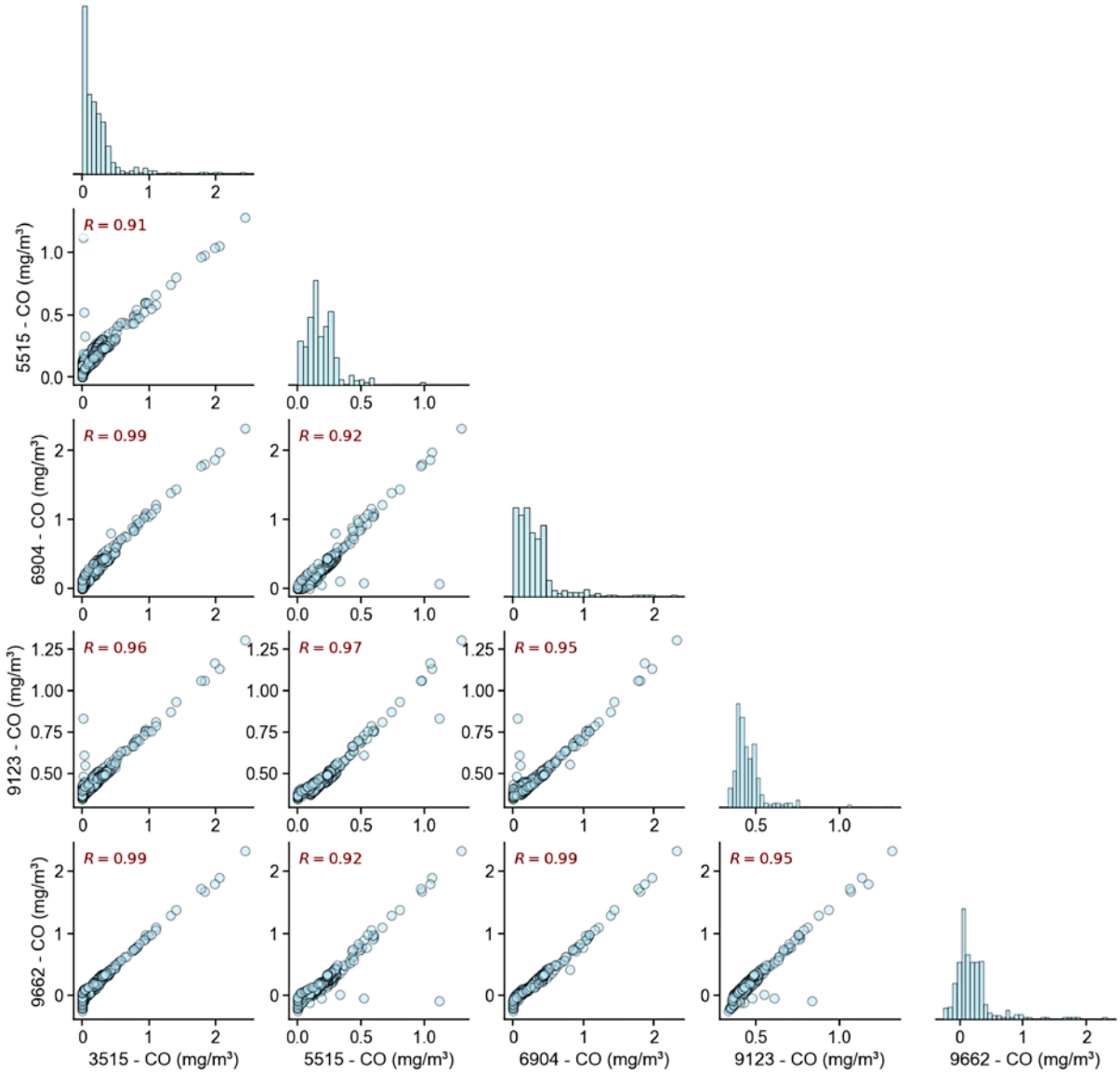


***Figure A10**: Intra-device correlation for manufacturer-reported data of CO from the Aeron sensor*



Airveda

***Figure A11**: Intra-device correlation for raw data of $PM_{2.5}$ from the Airveda sensor*

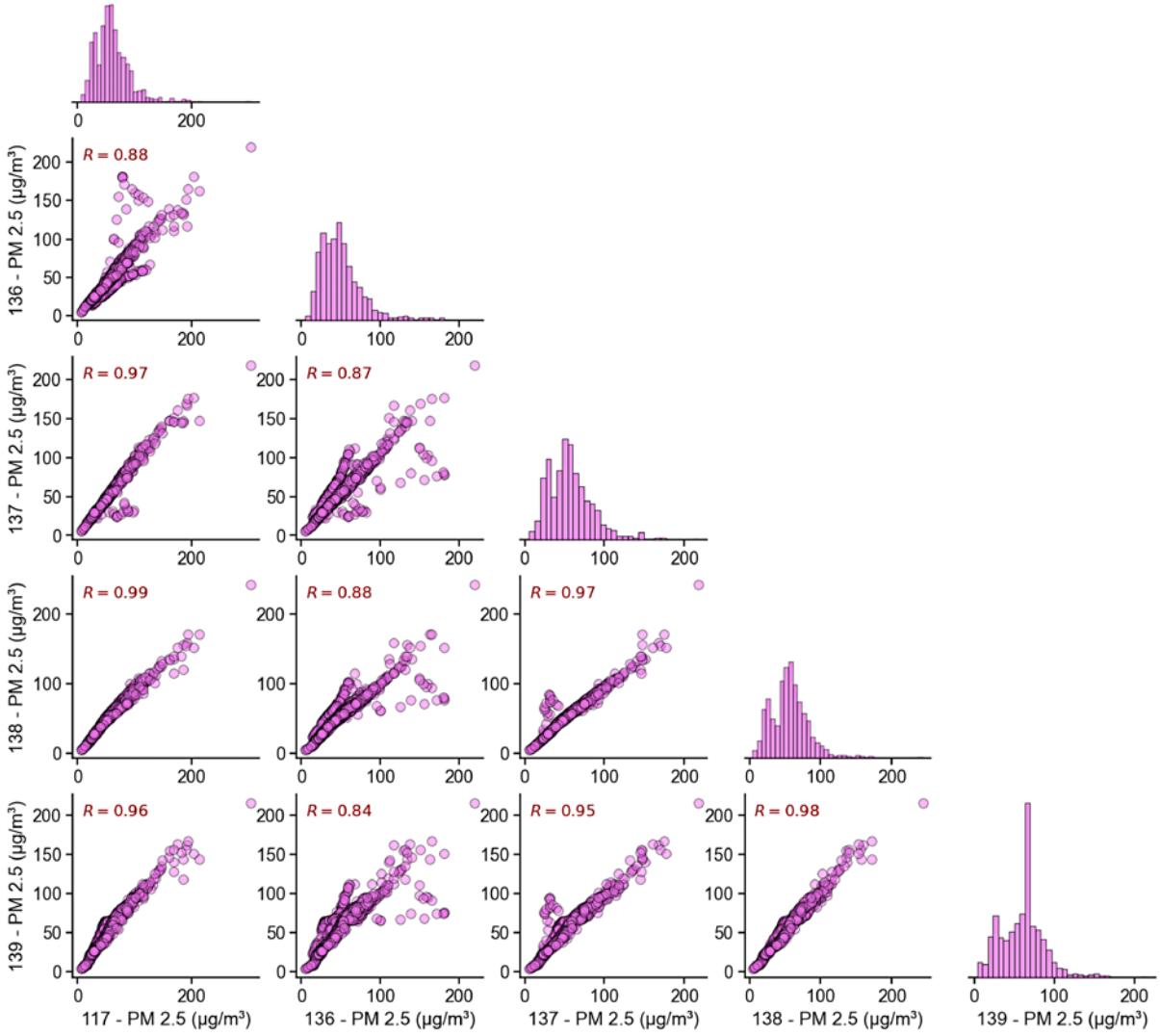


***Figure A12**: Intra-device correlation for manufacturer-reported data of $PM_{2.5}$ from the Airveda sensor*

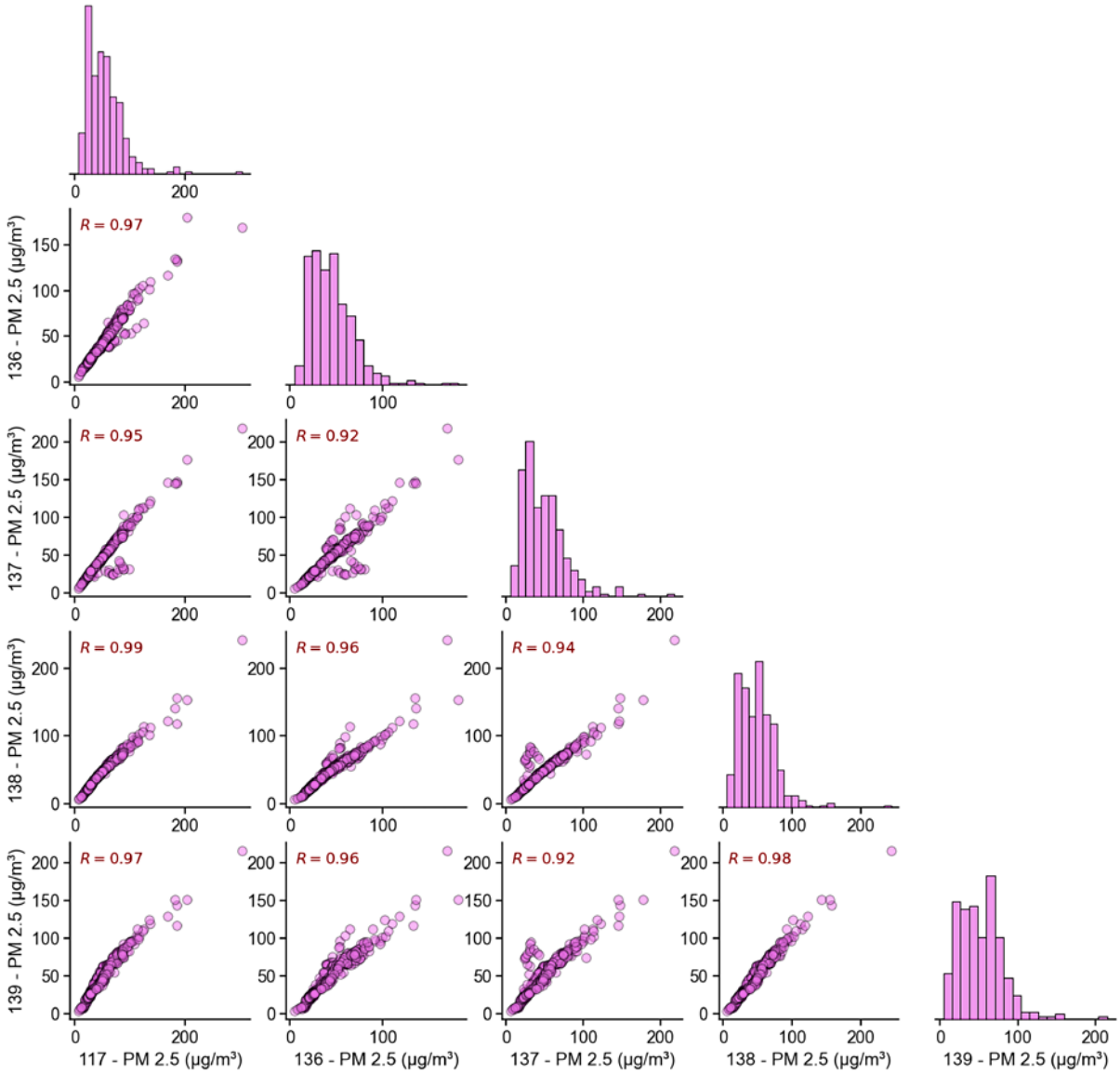


***Figure A13**: Intra-device correlation for raw data of PM_{10} from the Airveda sensor*

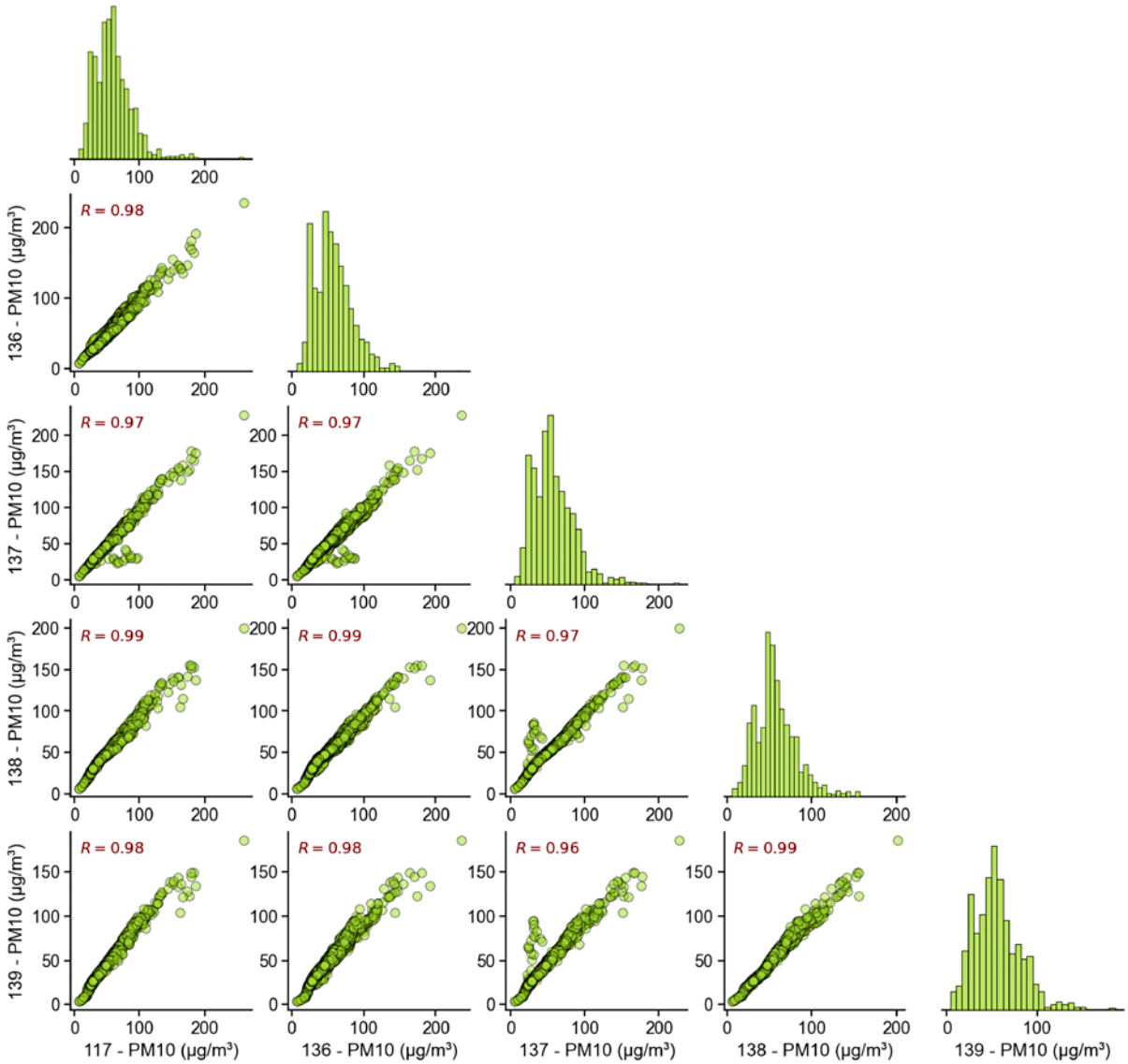


***Figure A14**: Intra-device correlation for manufacturer-reported data of PM_{10} from the Airveda sensor*

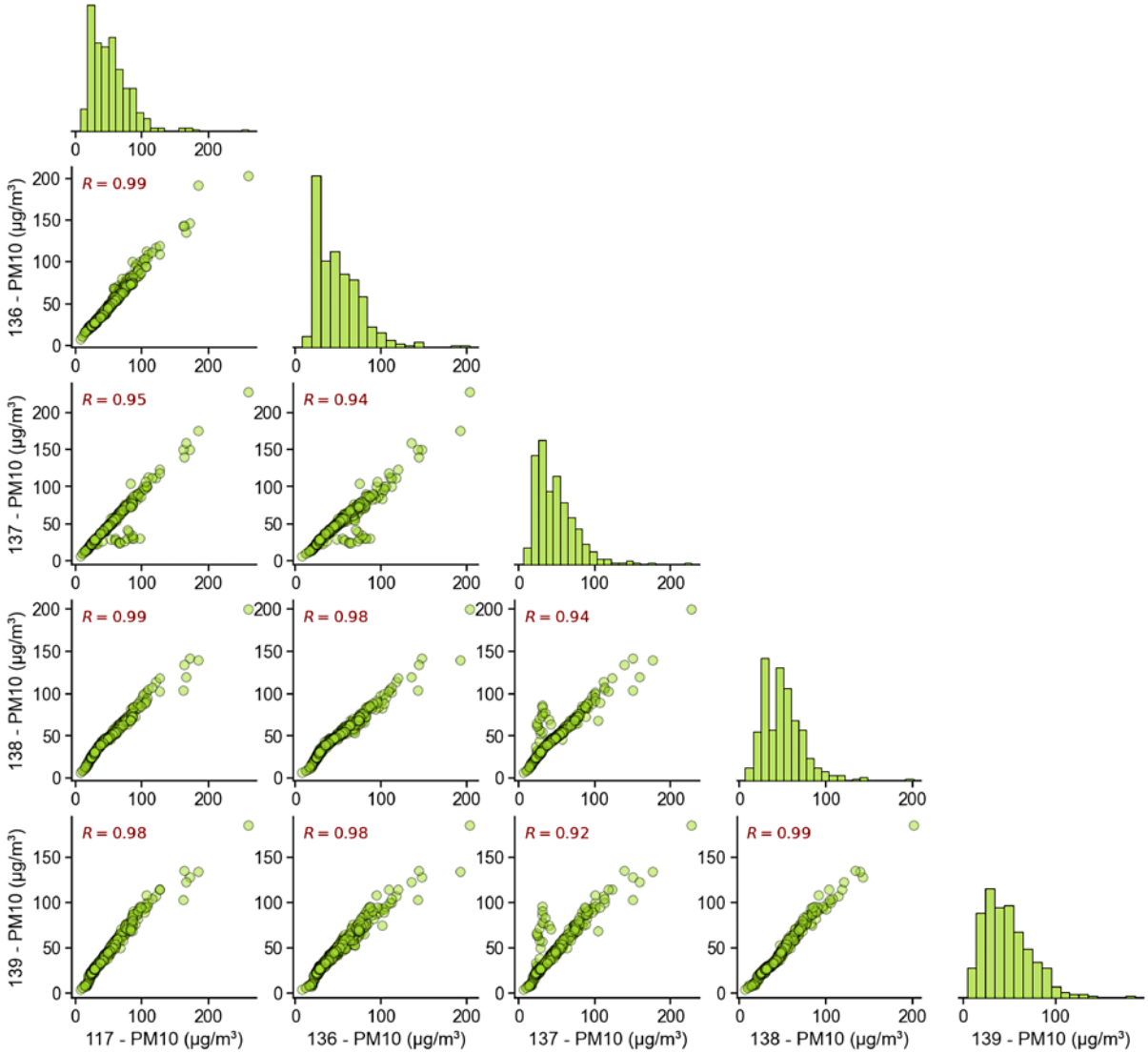


***Figure A15**: Intra-device correlation for raw data of NO_2 from the Airveda sensor*

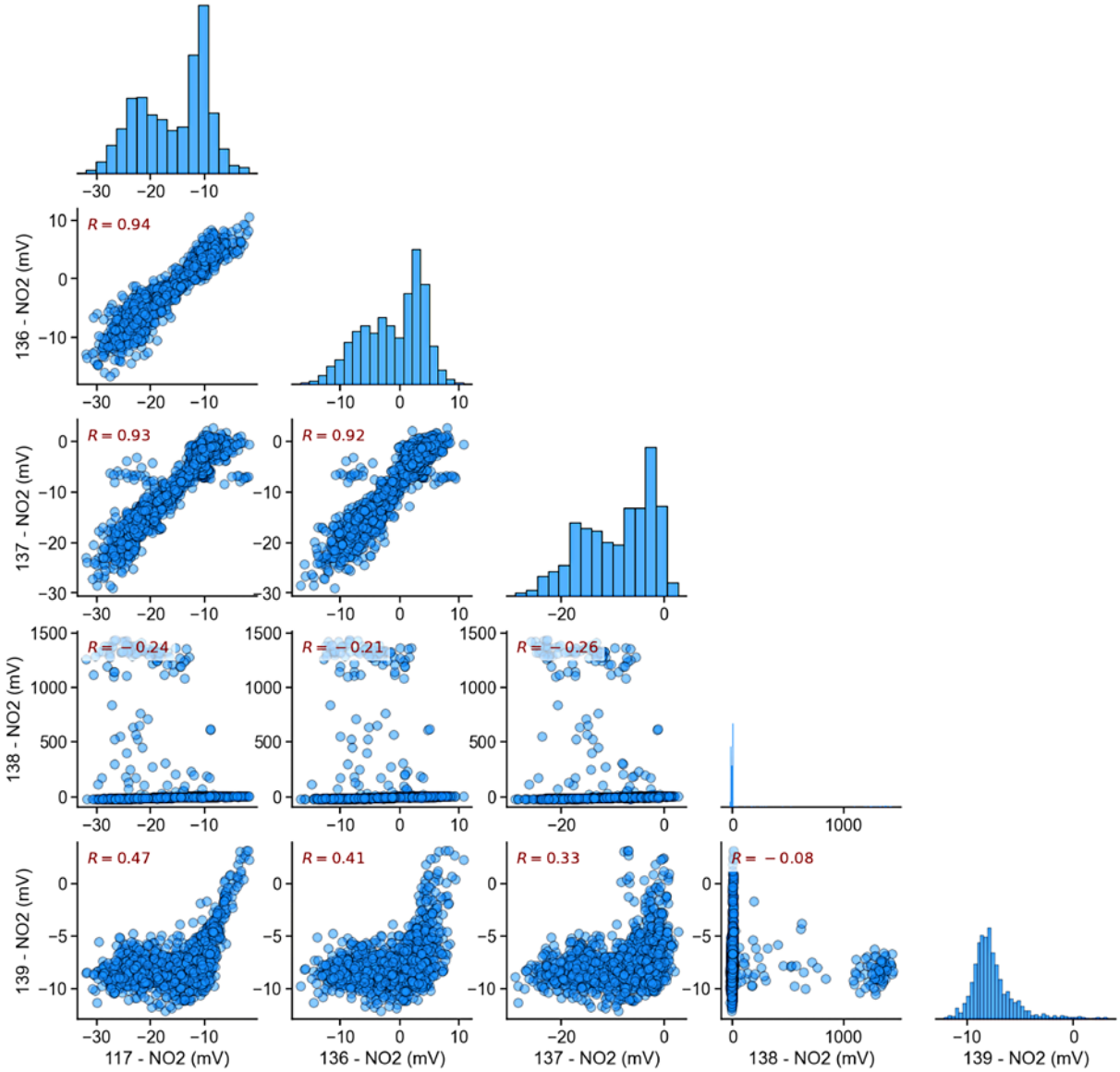


***Figure A16**: Intra-device correlation for manufacturer-reported data of NO_2 from the Airveda sensor*

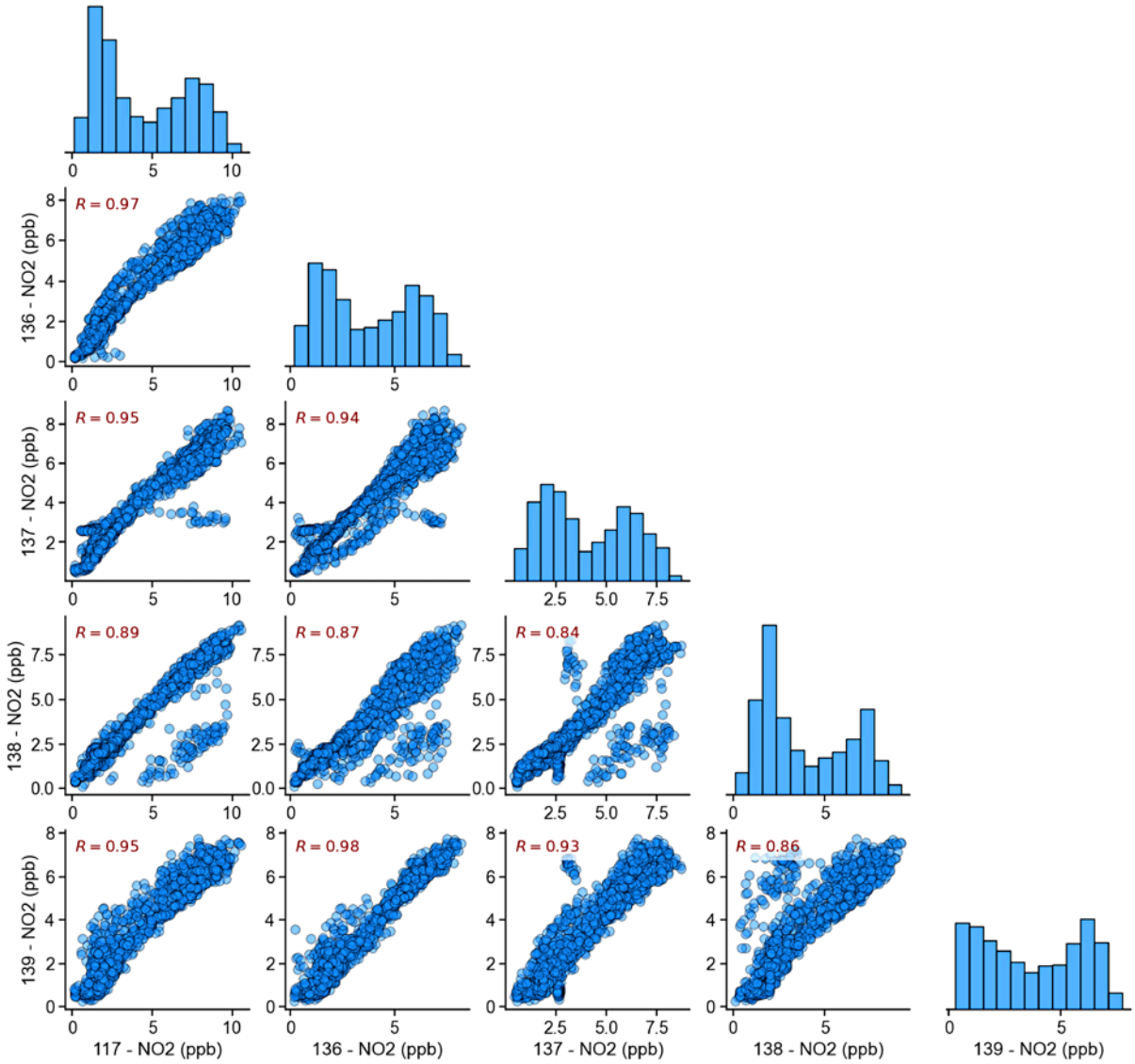


***Figure A17**: Intra-device correlation for raw data of O_3 from the Airveda sensor*

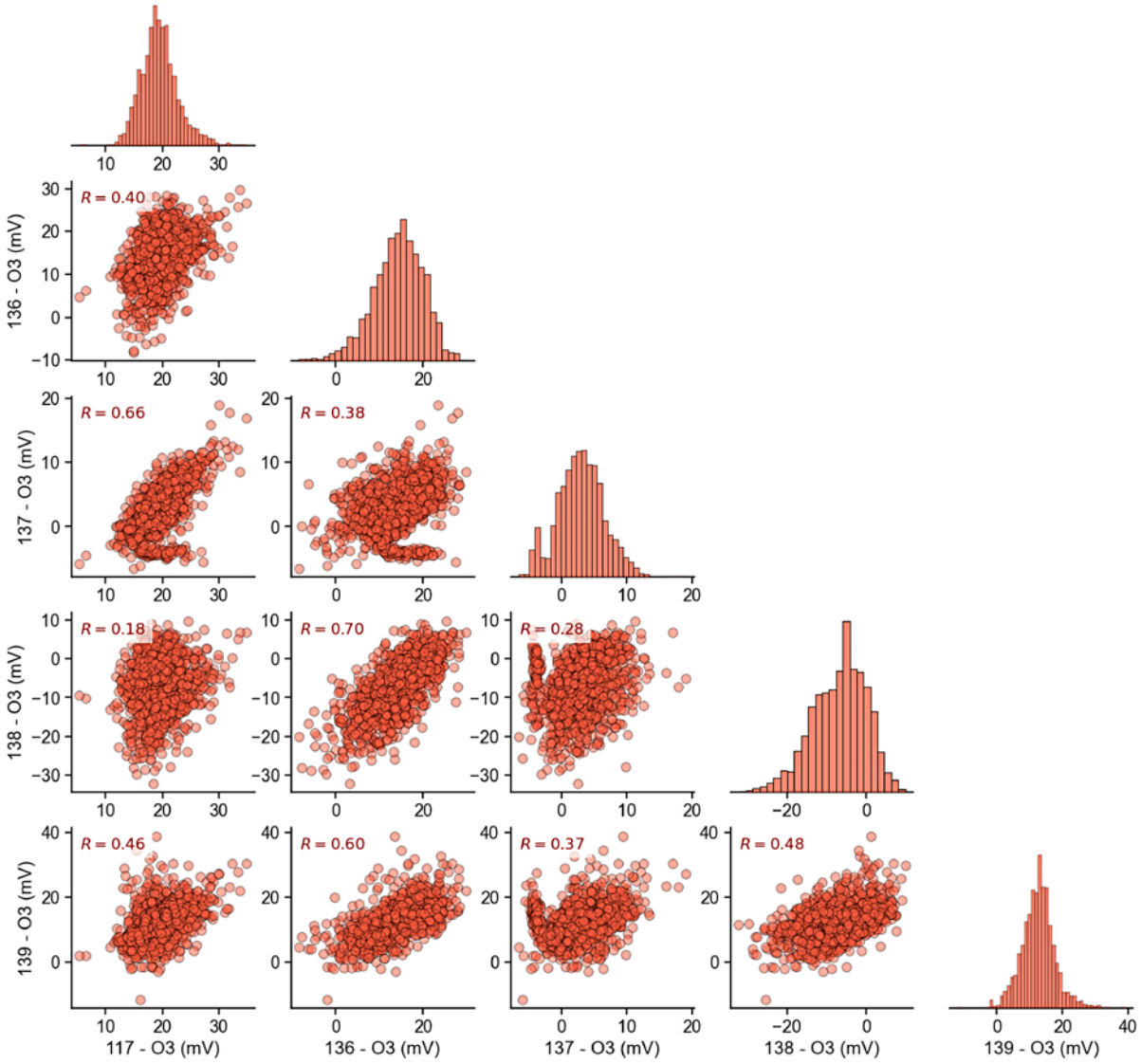


***Figure A18**: Intra-device correlation for manufacturer-reported data of O_3 from the Airveda sensor*

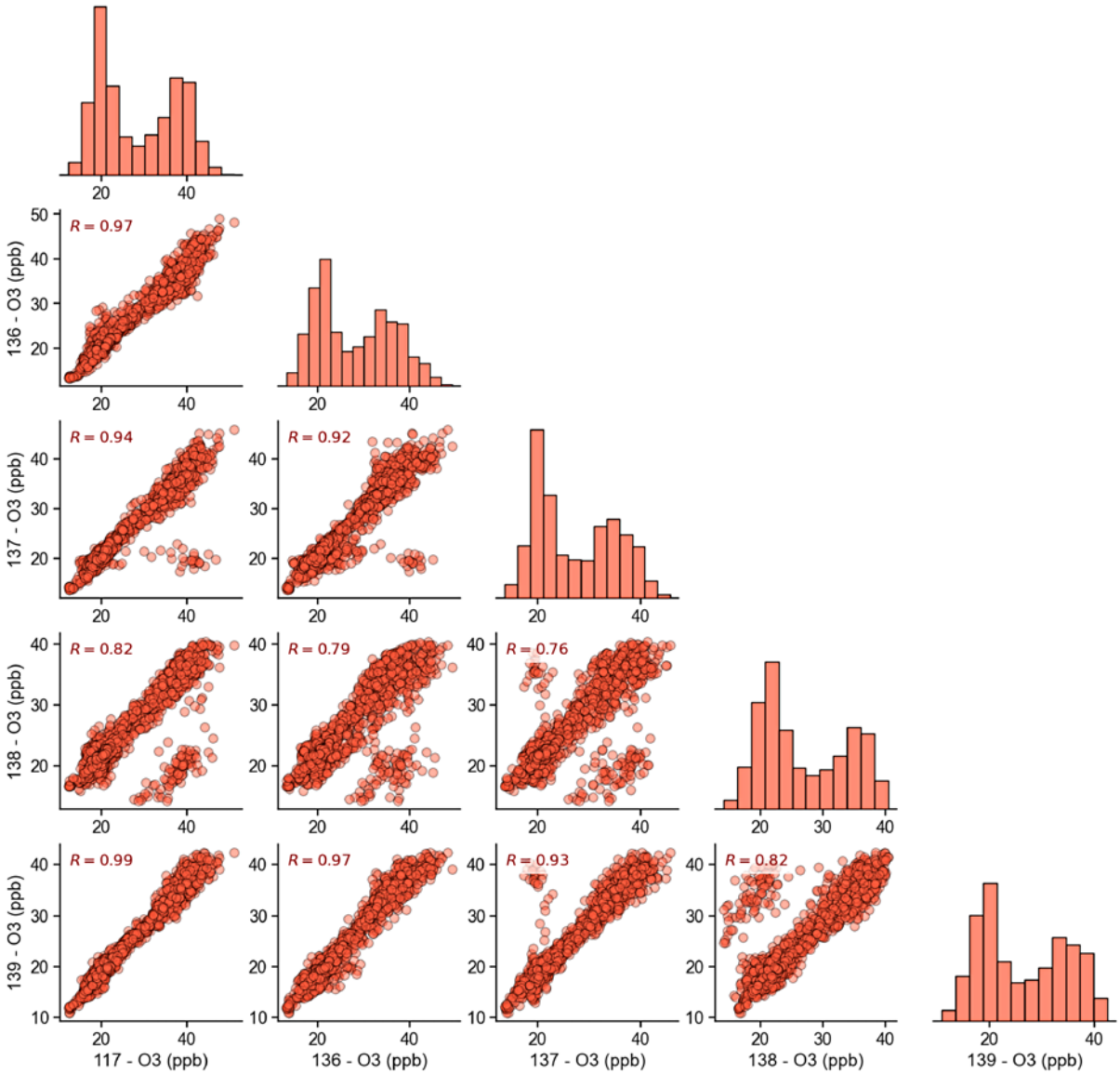


***Figure A19**: Intra-device correlation for raw data of CO from the Airveda sensor*

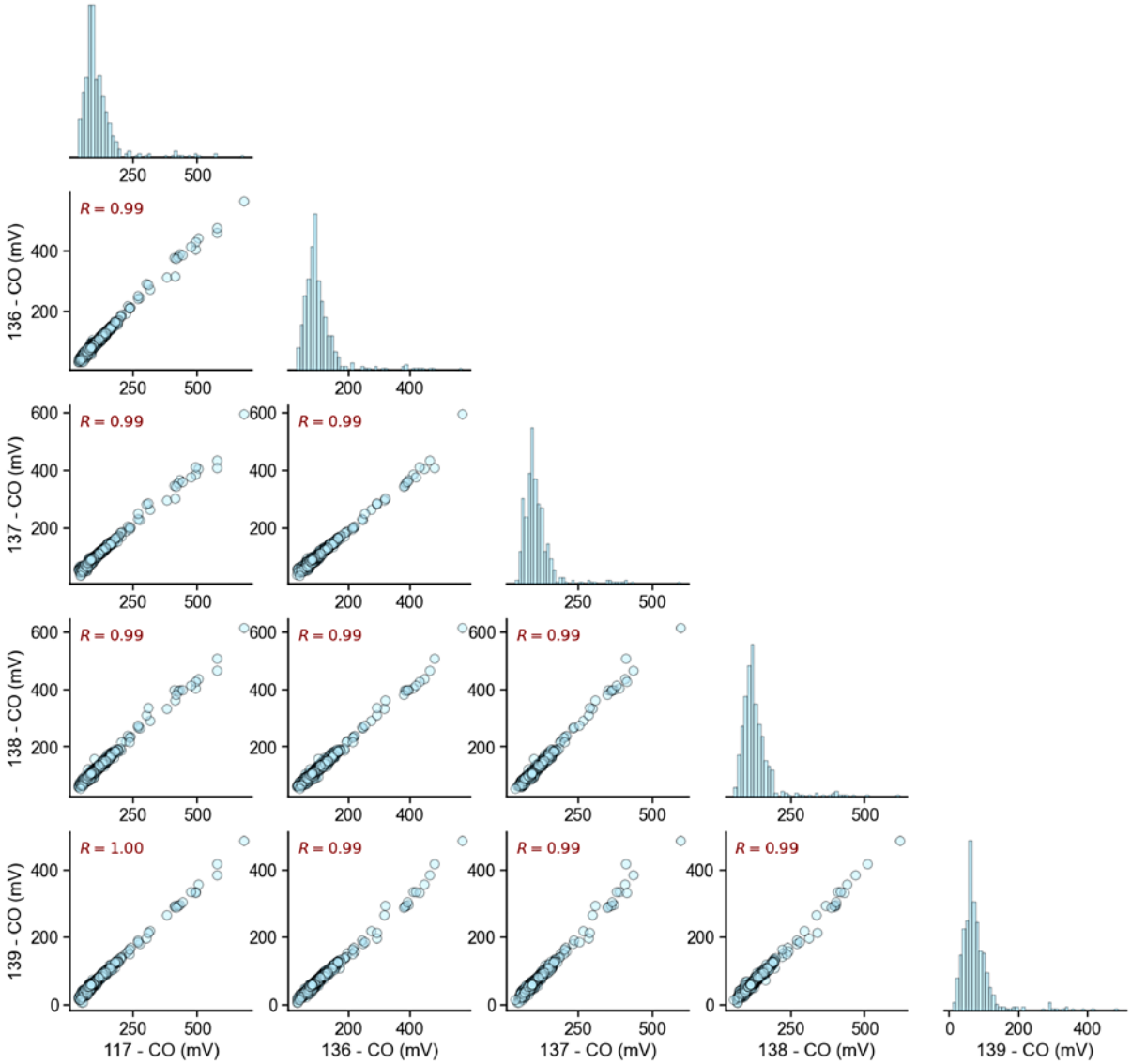
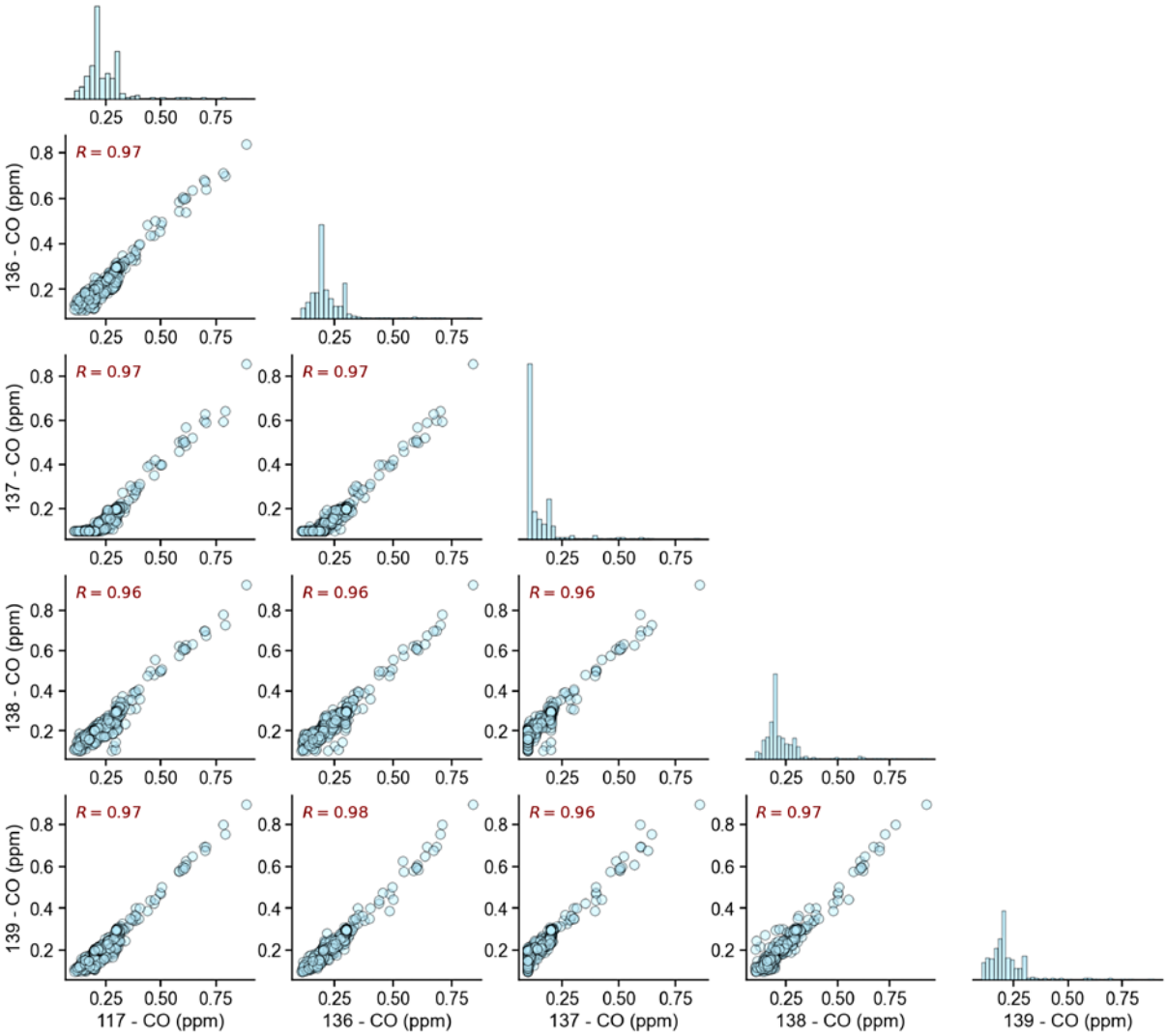


***Figure A20**: Intra-device correlation for manufacturer-reported data of CO from the Airveda sensor*



Airvoice

***Figure A21**: Intra-device correlation for manufacturer-reported data of $PM_{2.5}$ from the Airvoice sensor*

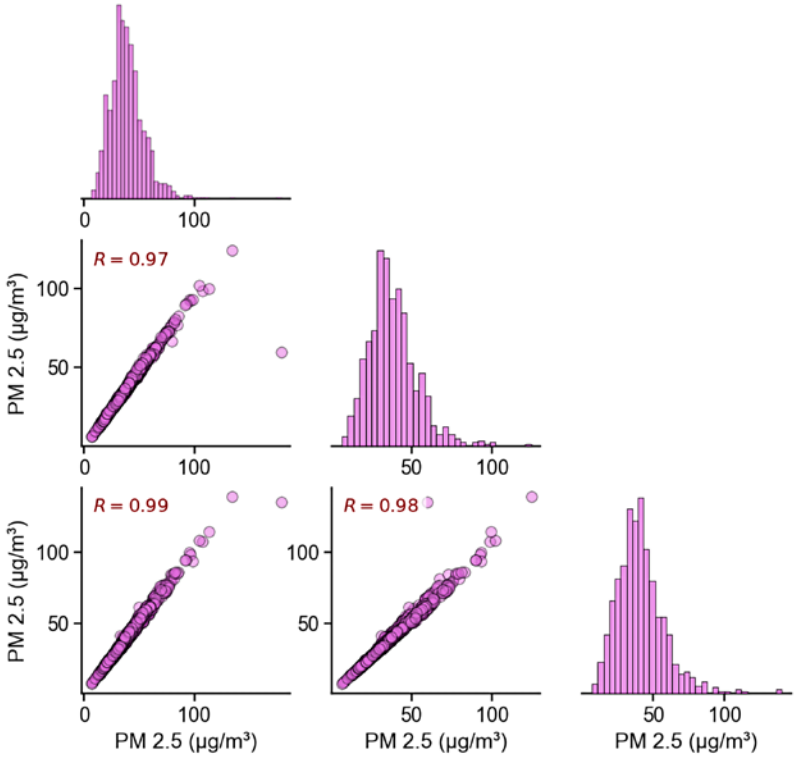


***Figure A22**: Intra-device correlation for manufacturer-reported data of PM_{10} from the Airvoice sensor*

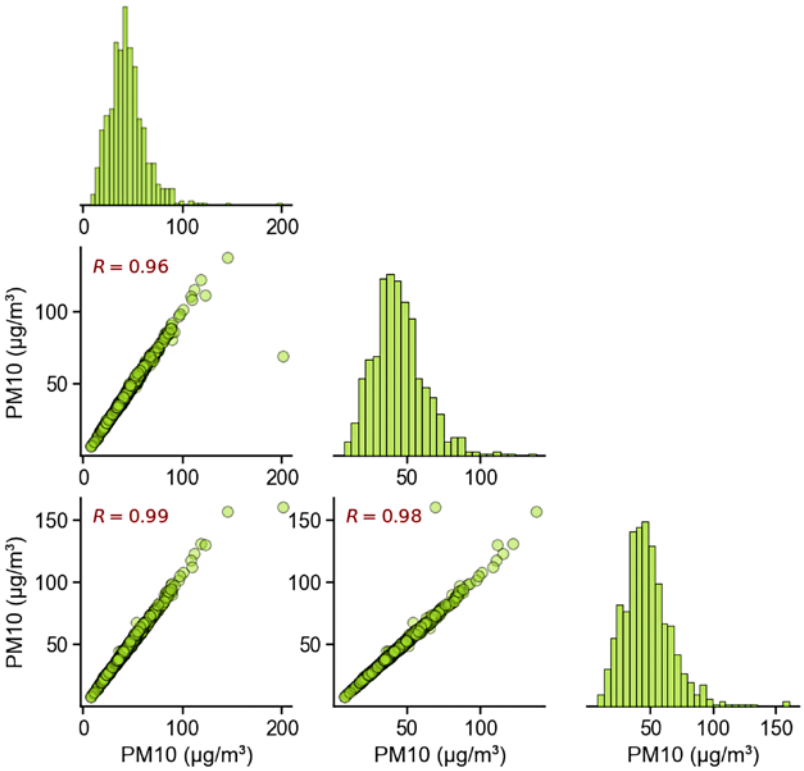


***Figure A23**: Intra-device correlation for raw data of NO_2 from the Airvoice sensor*

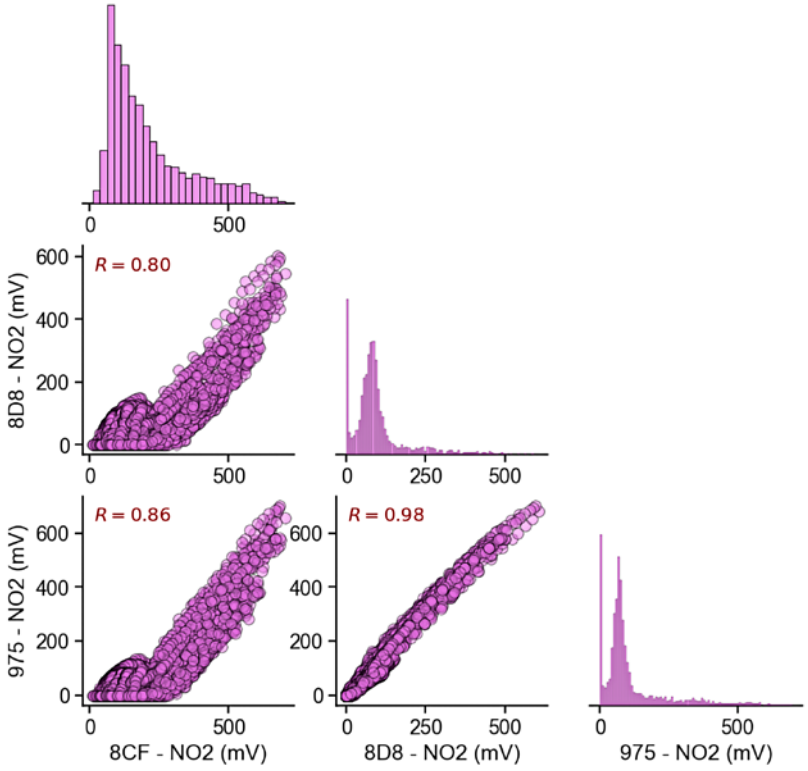


***Figure A24**: Intra-device correlation for manufacturer-reported data of NO_2 from the Airvoice sensor*

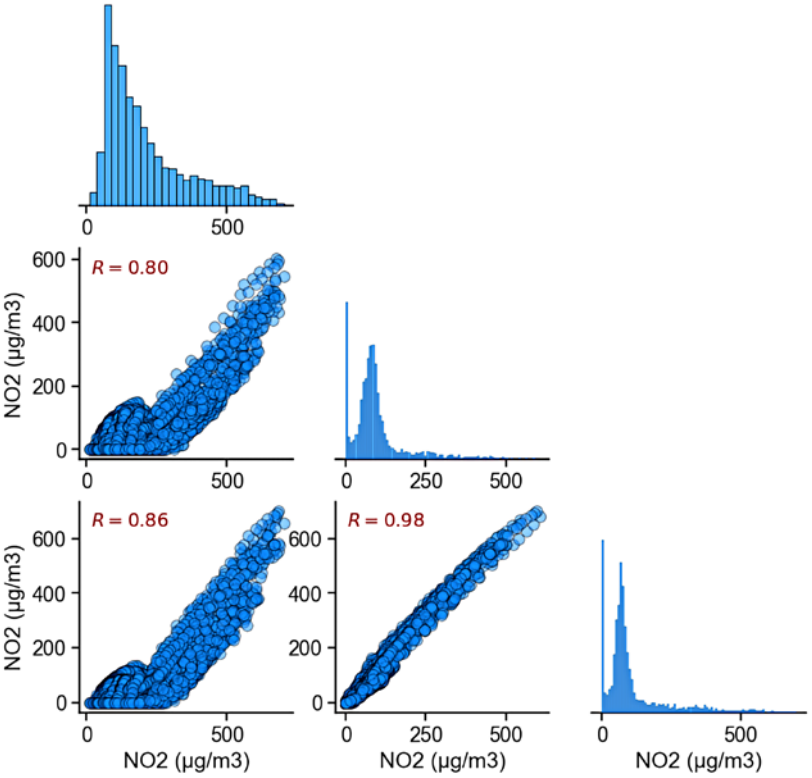


***Figure A25**: Intra-device correlation for raw data of O_3 from the Airvoice sensor*

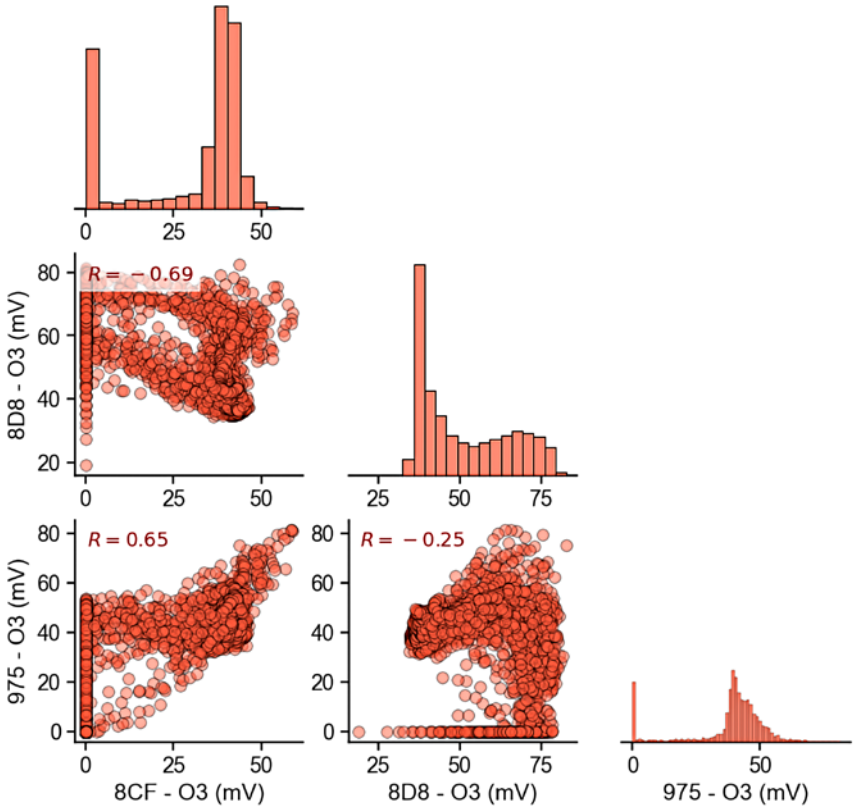


***Figure A26**: Intra-device correlation for manufacturer-reported data of O_3 from the Airvoice sensor*

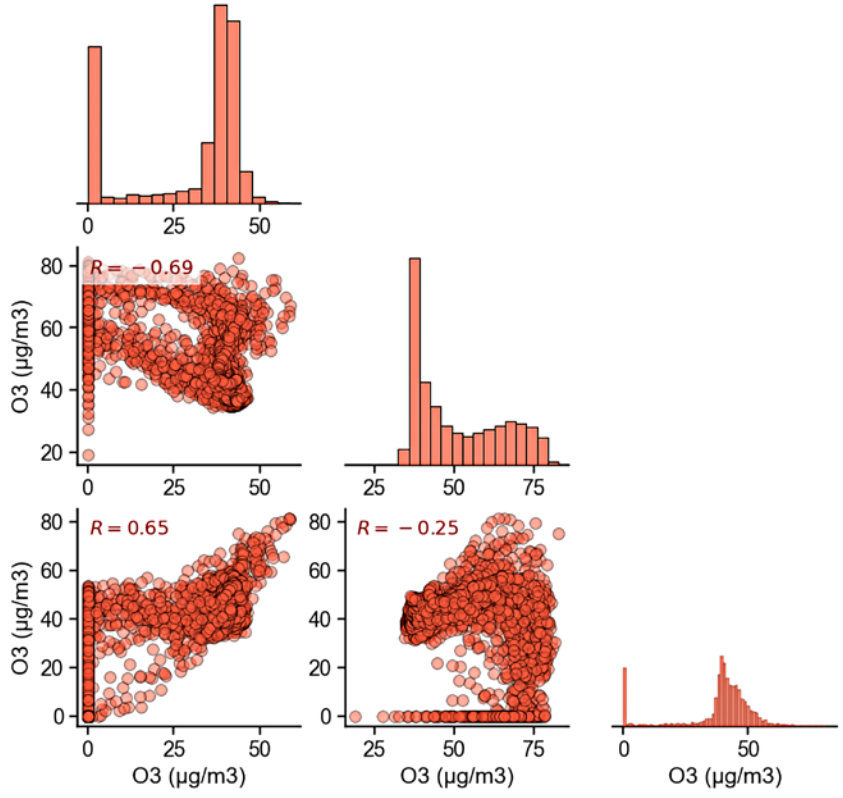


***Figure A27**: Intra-device correlation for raw data of CO from the Airvoice sensor*

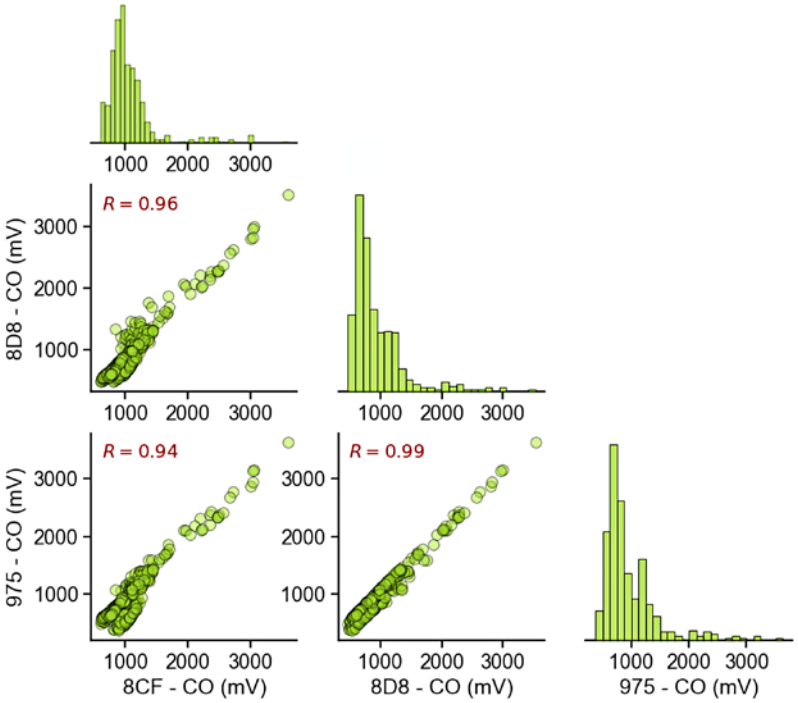
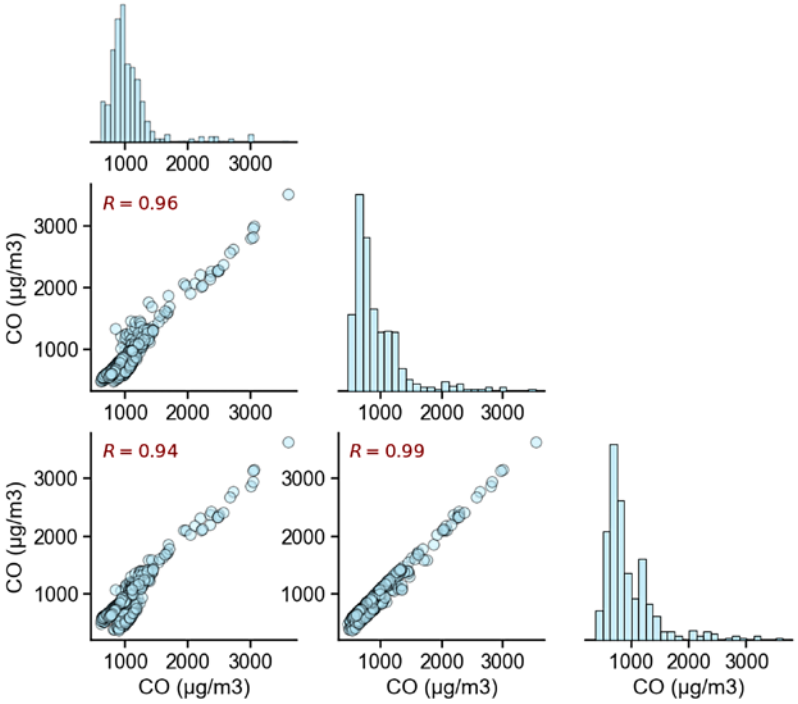


***Figure A28**: Intra-device correlation for manufacturer-reported data of CO from the Airvoice sensor*



Aurassure

***Figure A29**: Intra-device correlation for manufacturer-reported data of $PM_{2.5}$ from the Aurassure sensor*

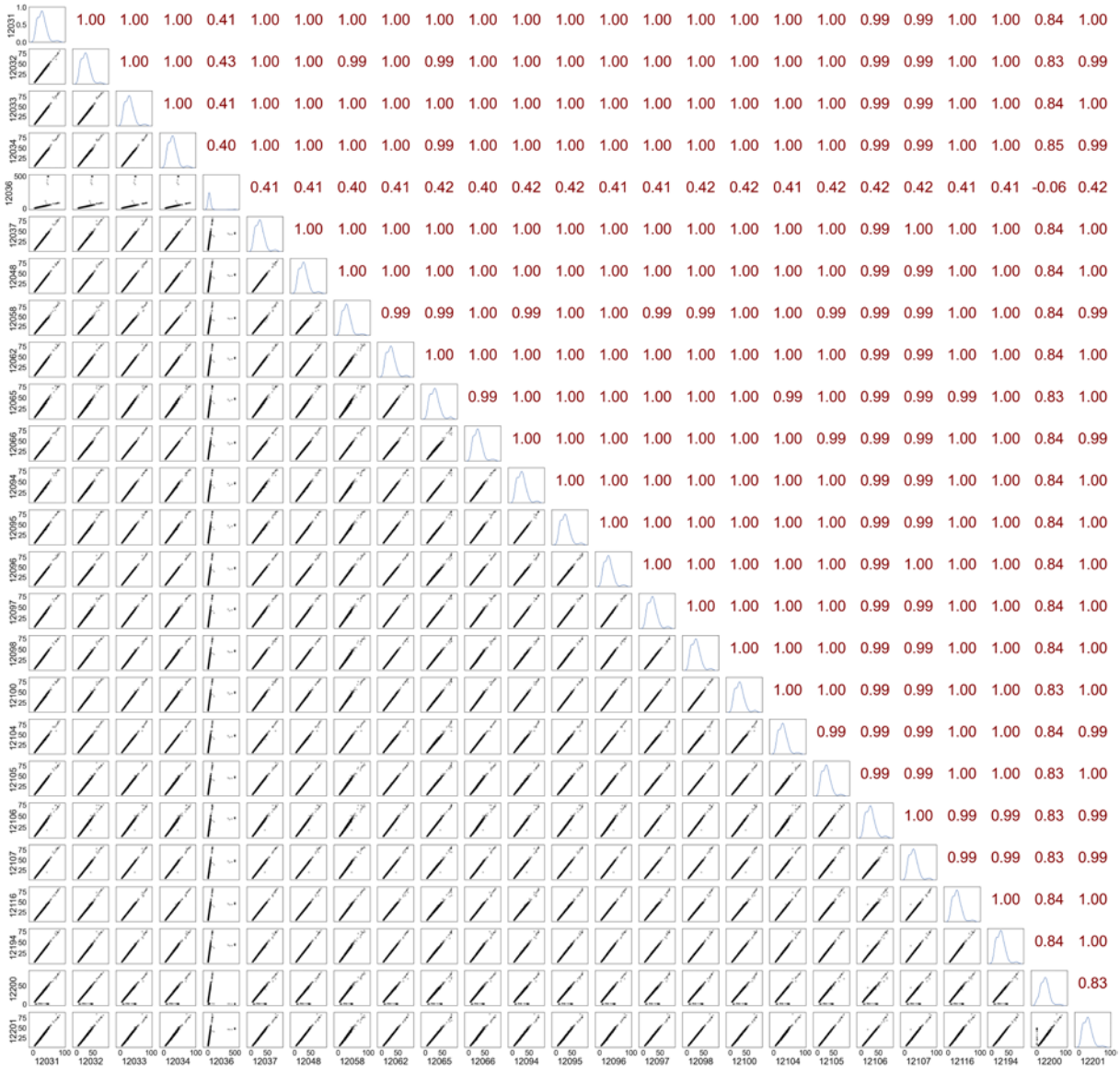


***Figure A30**: Intra-device correlation for manufacturer-reported data of PM_{10} from the Aurassure sensor*

***Figure A31**: Intra-device correlation for manufacturer-reported data of NO_2 from the Aurassure sensor*

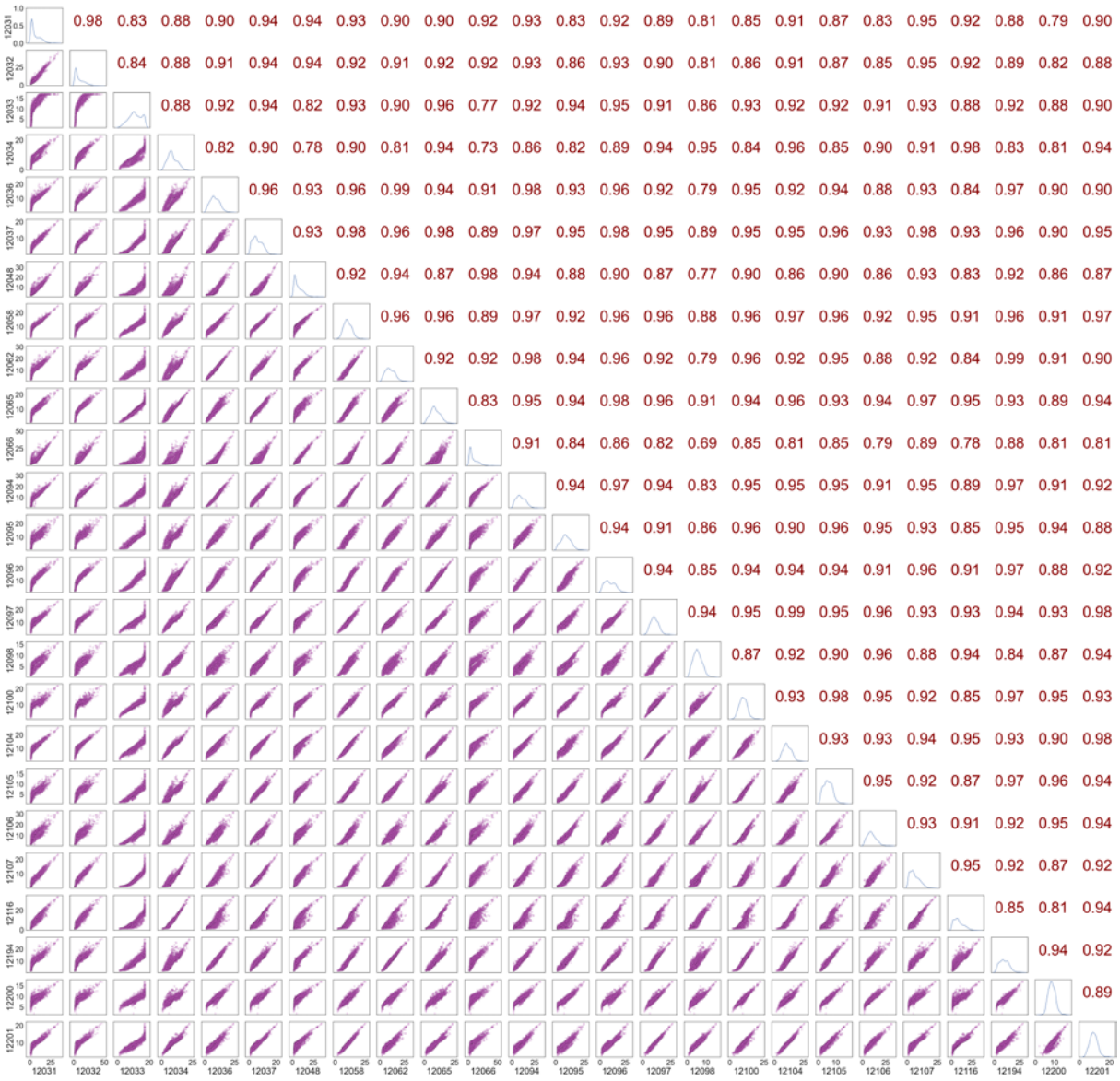


***Figure A32**: Intra-device correlation for manufacturer-reported data of O_3 from the Aurassure sensor*

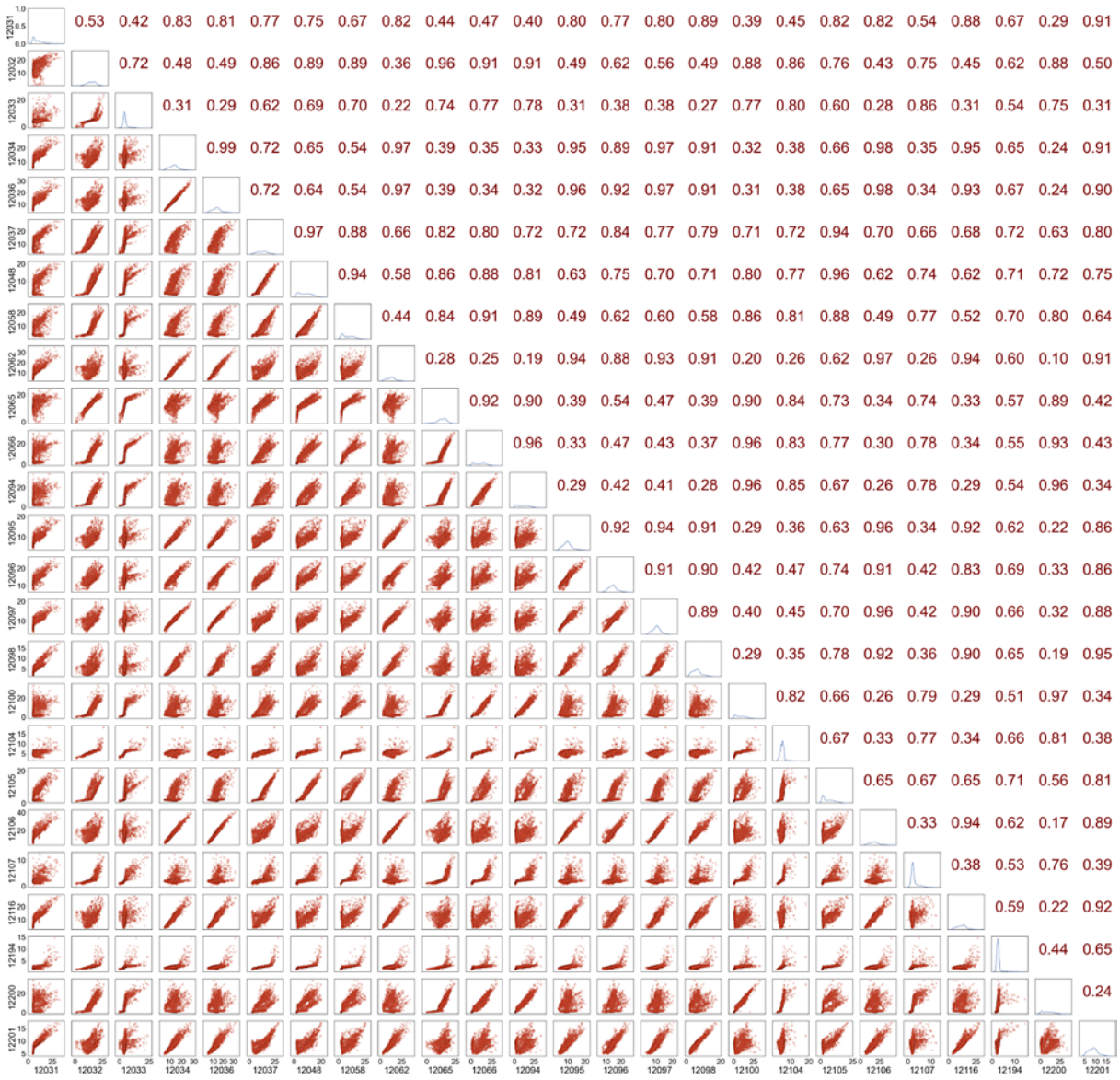
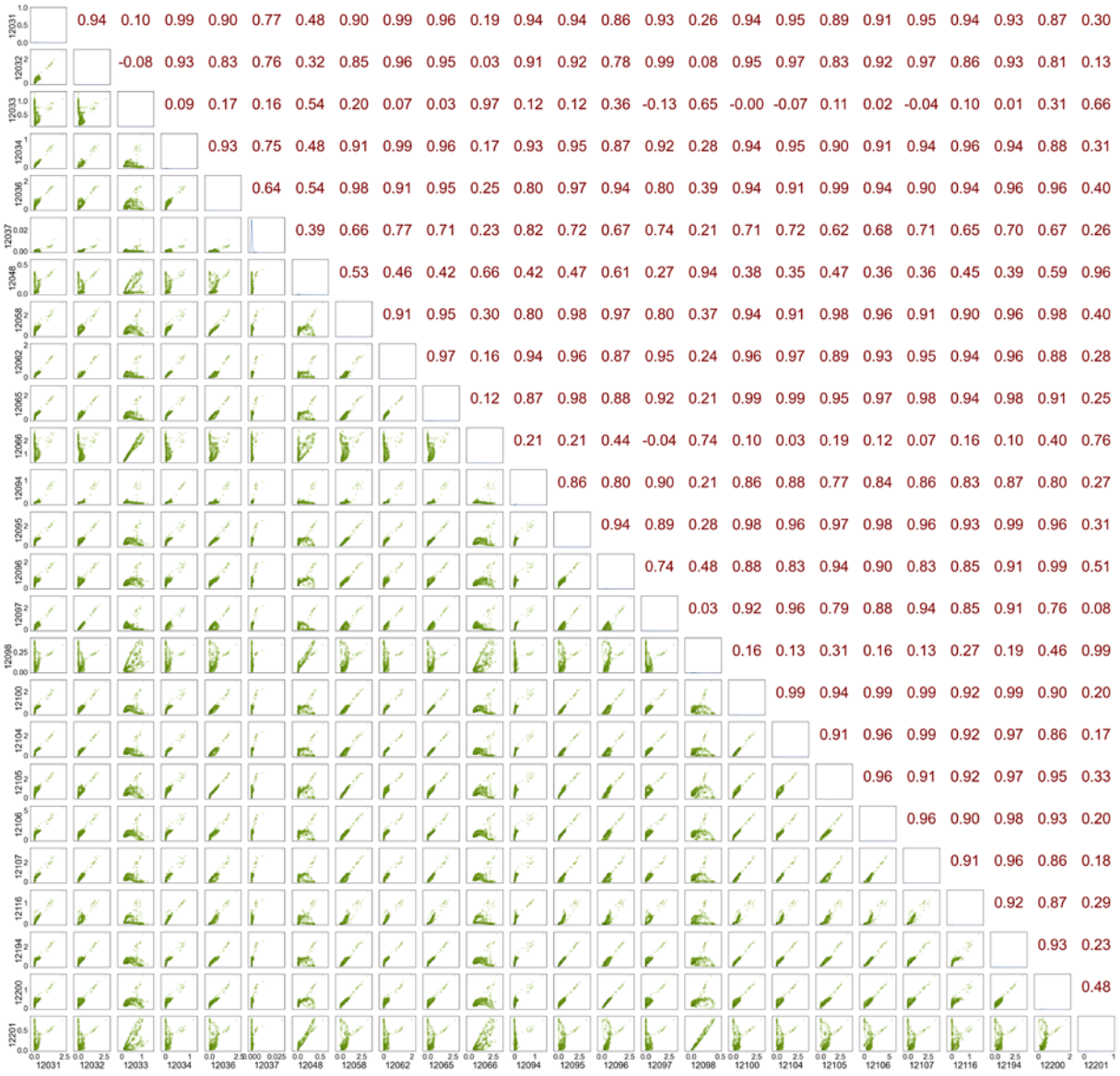


***Figure A33**: Intra-device correlation for manufacturer-reported data of CO from the Aurassure sensor*



Respirer

***Figure A34**: Intra-device correlation for raw data of Plantower $PM_{2.5}$ from the Respirer sensor*

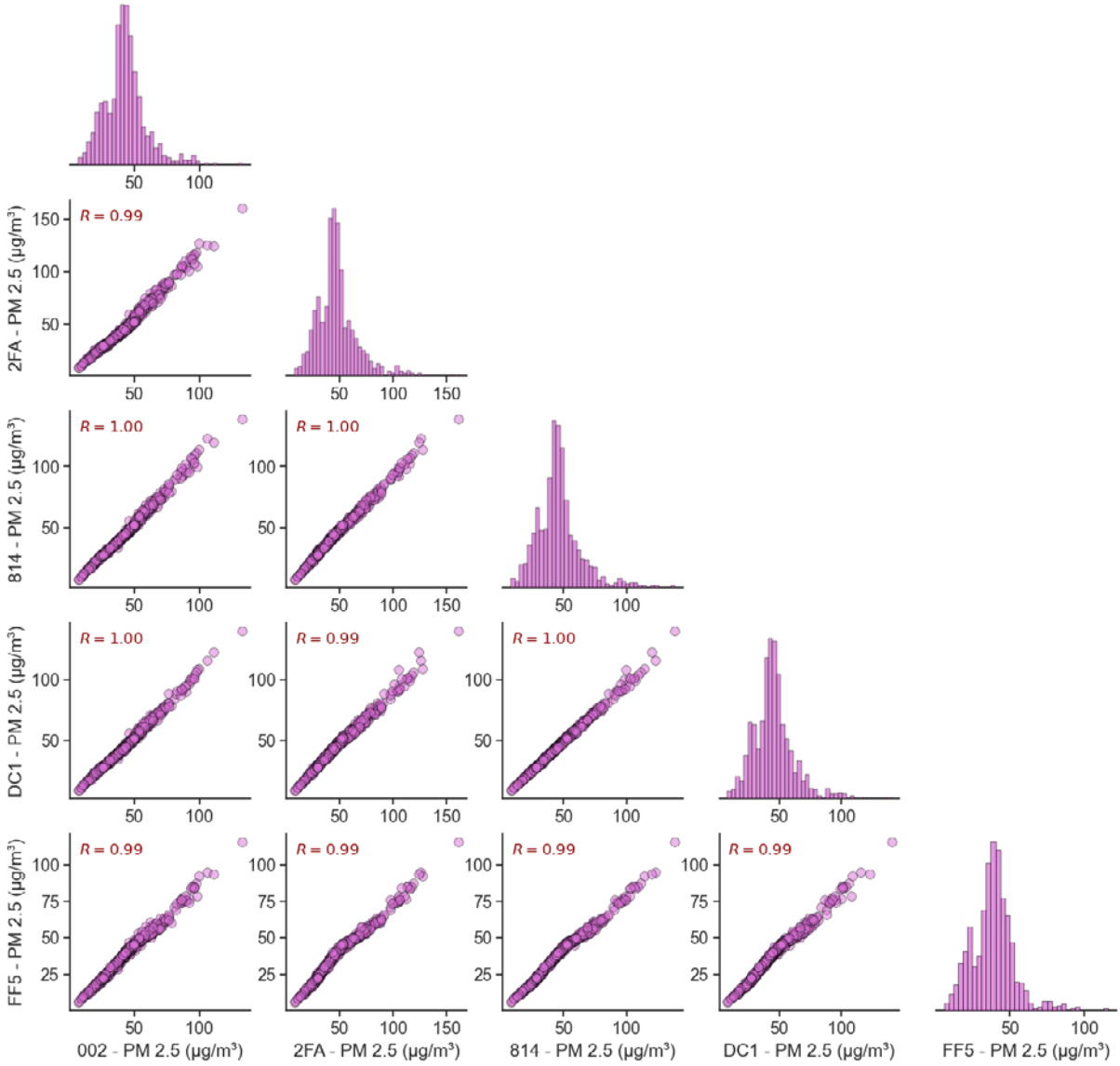


***Figure A35**: Intra-device correlation for raw data of OPC $PM_{2.5}$ from the Respirer sensor*

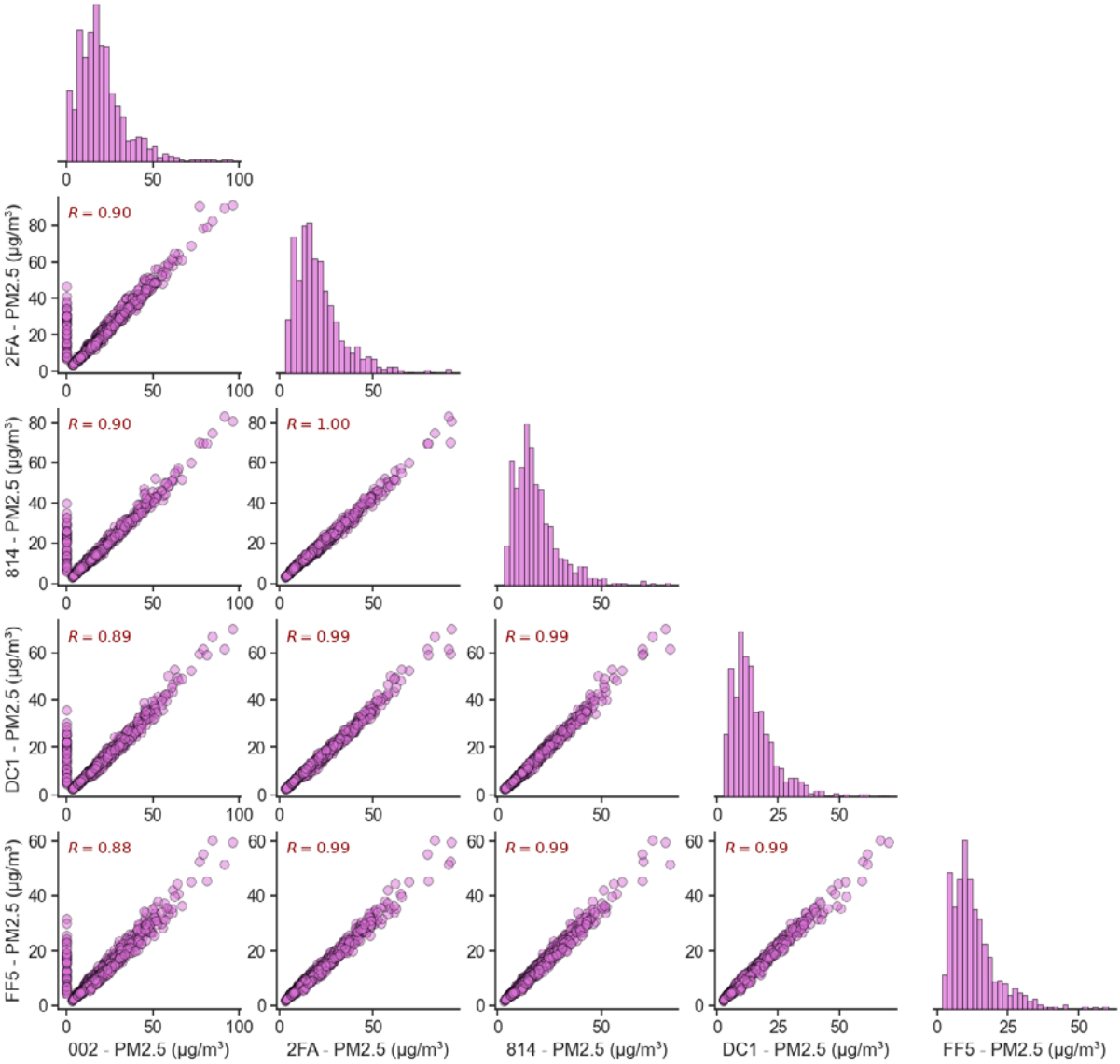


***Figure A36**: Intra-device correlation for raw data of Plantower PM_{10} from the Respirer sensor*

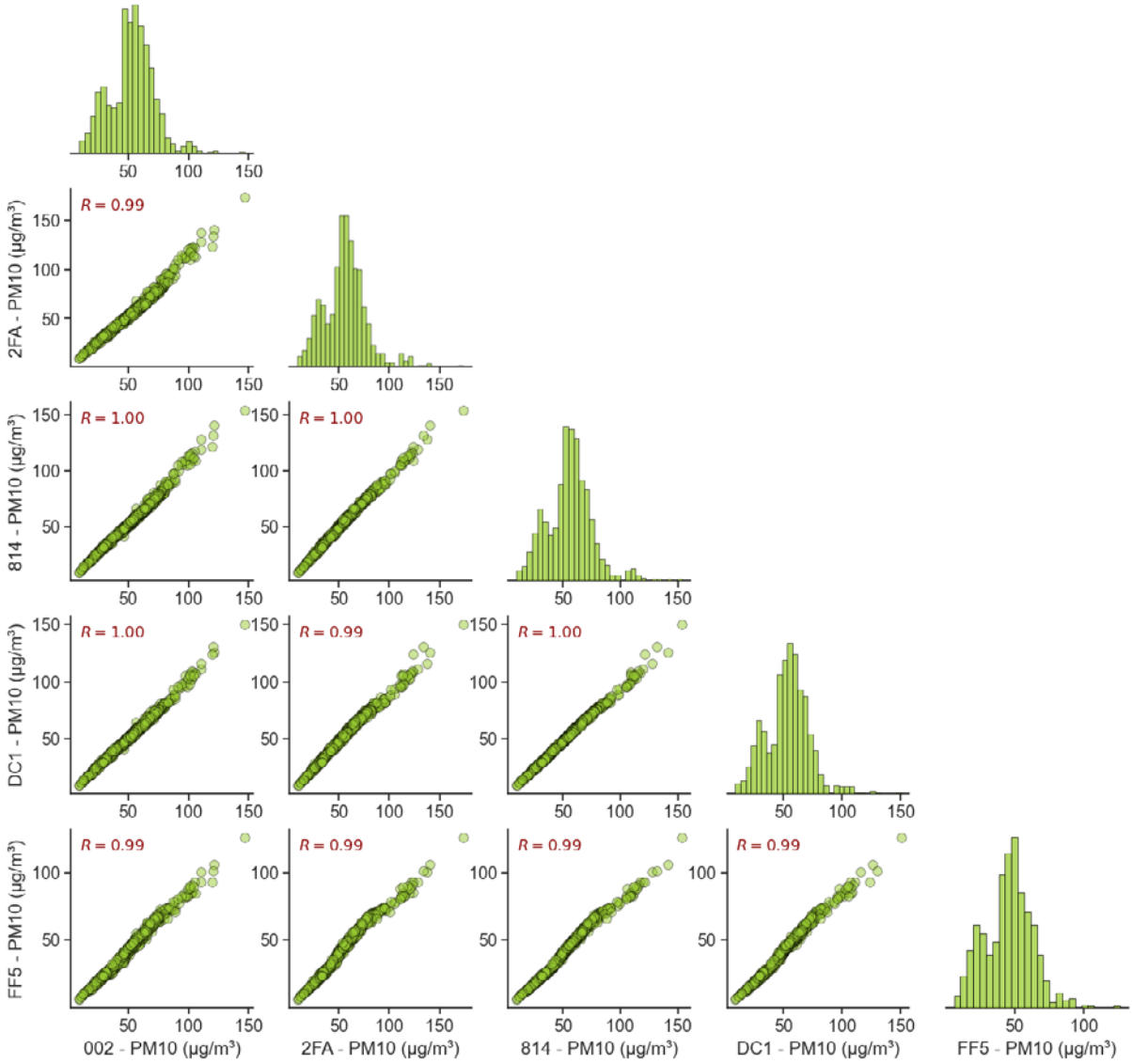


***Figure A37**: Intra-device correlation for raw data of PM_{10} from the Respirer sensor*

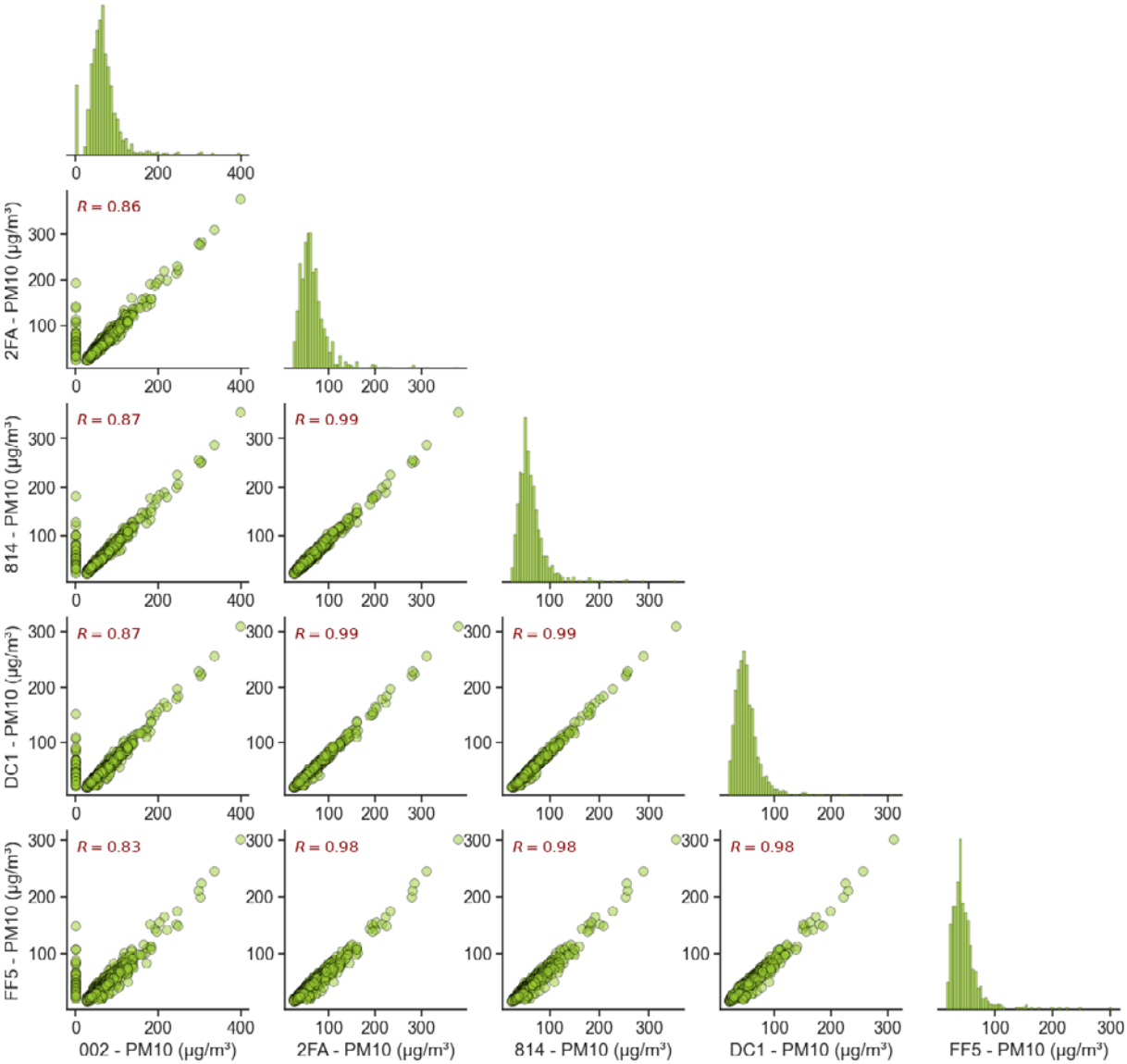


***Figure A38**: Intra-device correlation for raw data of NO_2 from the Respirer sensor*

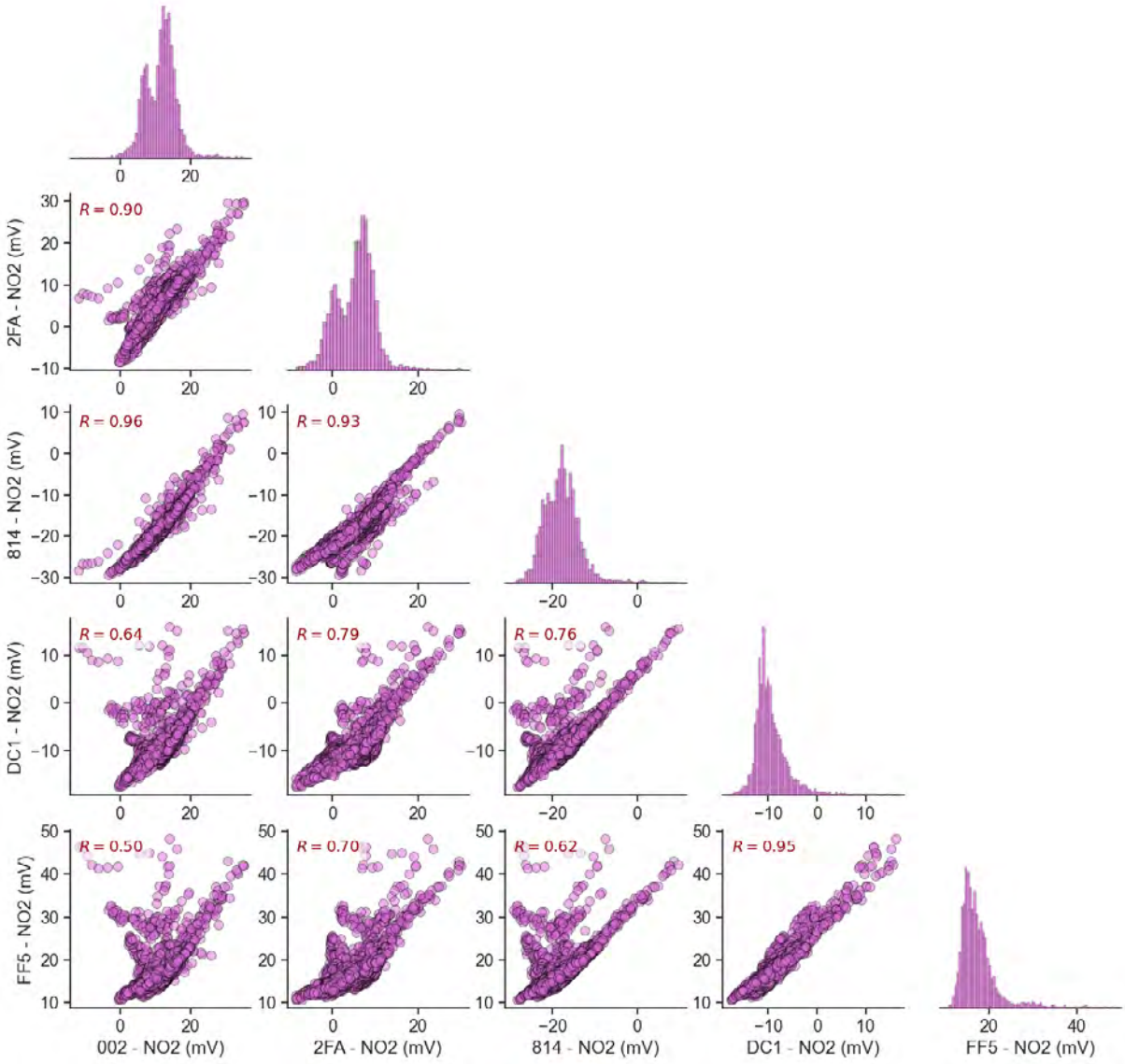


***Figure A39**: Intra-device correlation for raw data of O_3 from the Respirer sensor*

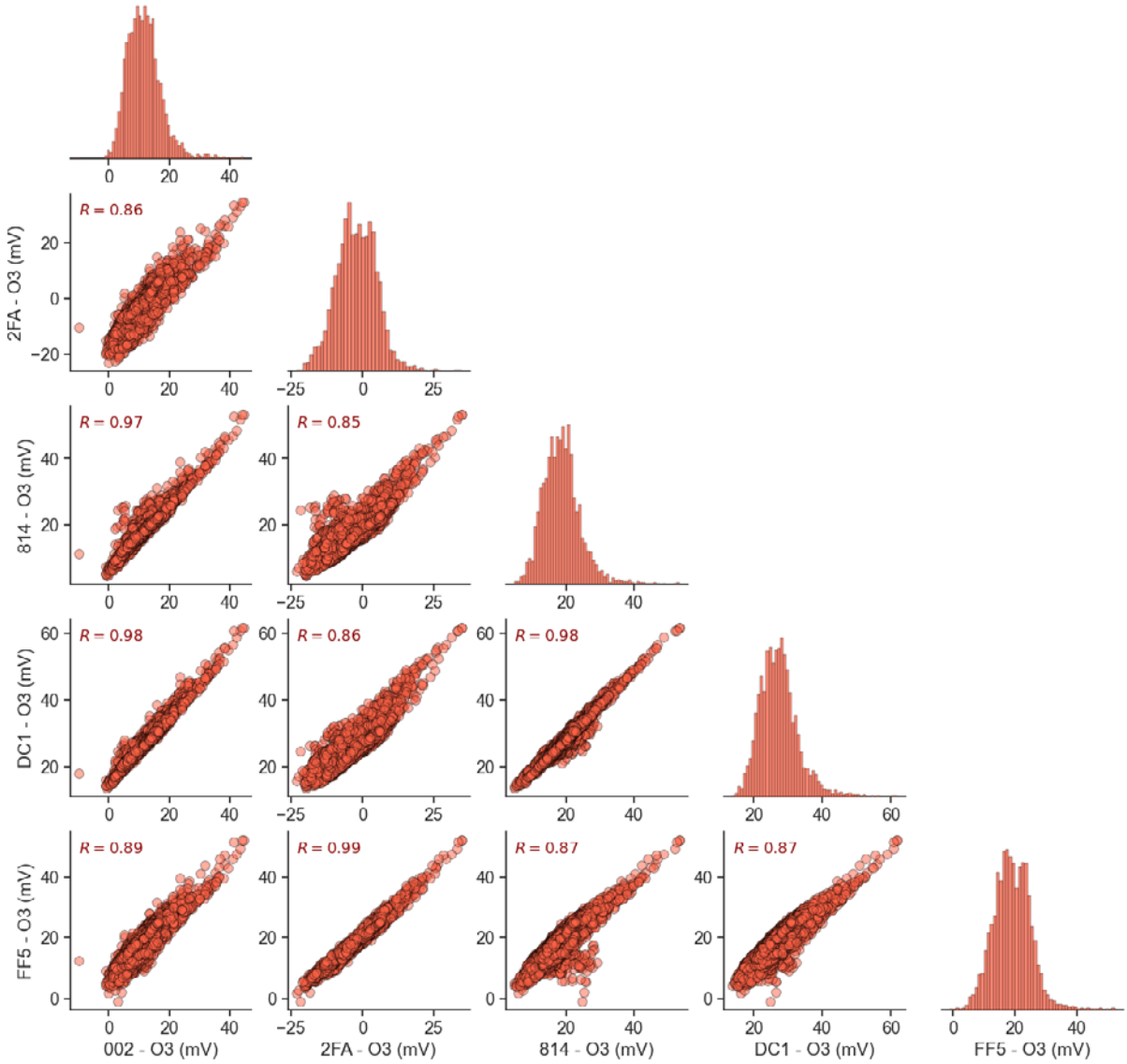
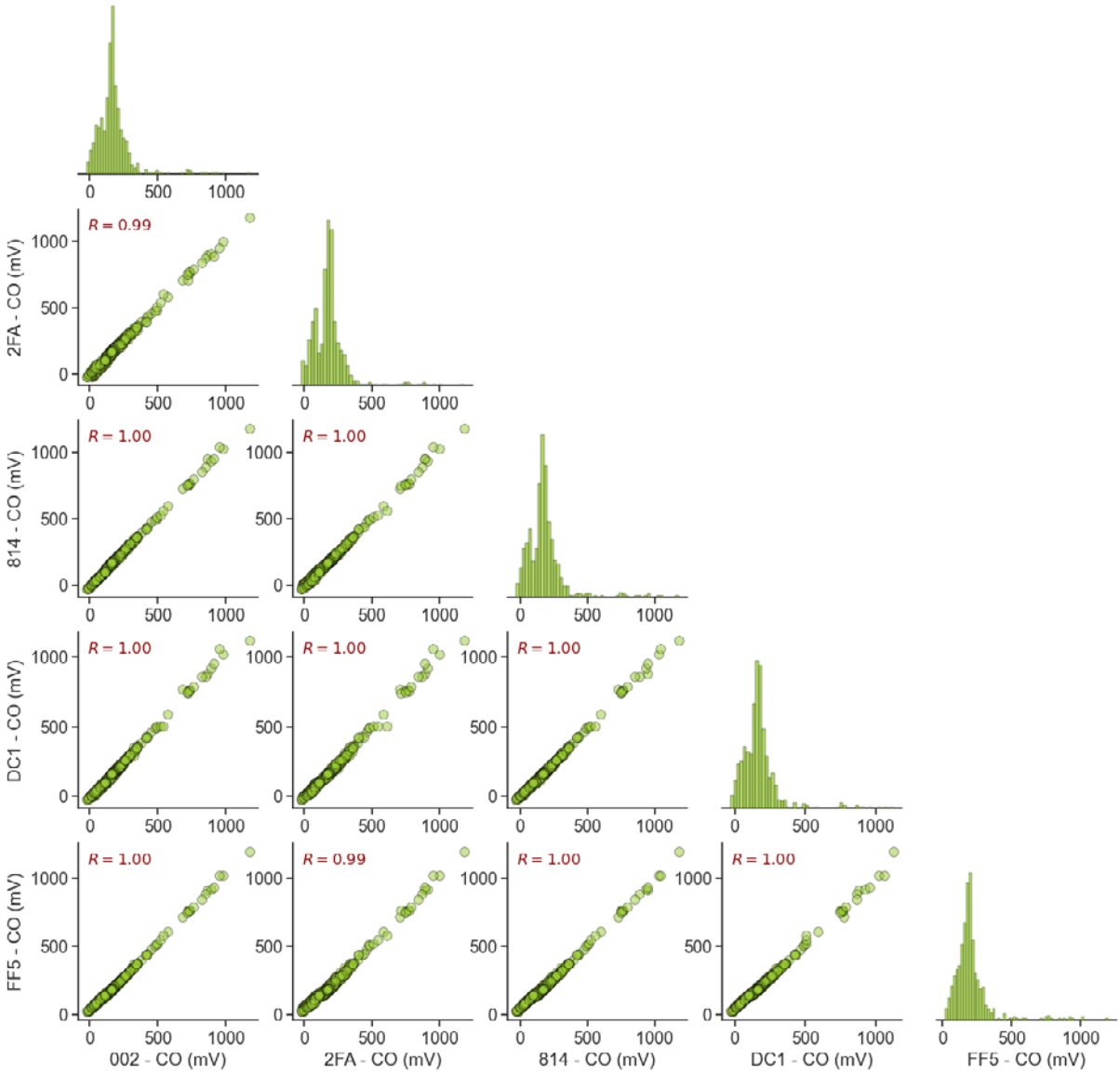


***Figure A40**: Intra-device correlation for raw data of CO from the Respirer sensor*



Sensit

***Figure A41**: Intra-device correlation for manufacturer-reported data of Plantower $PM_{2.5}$ from Sensit*

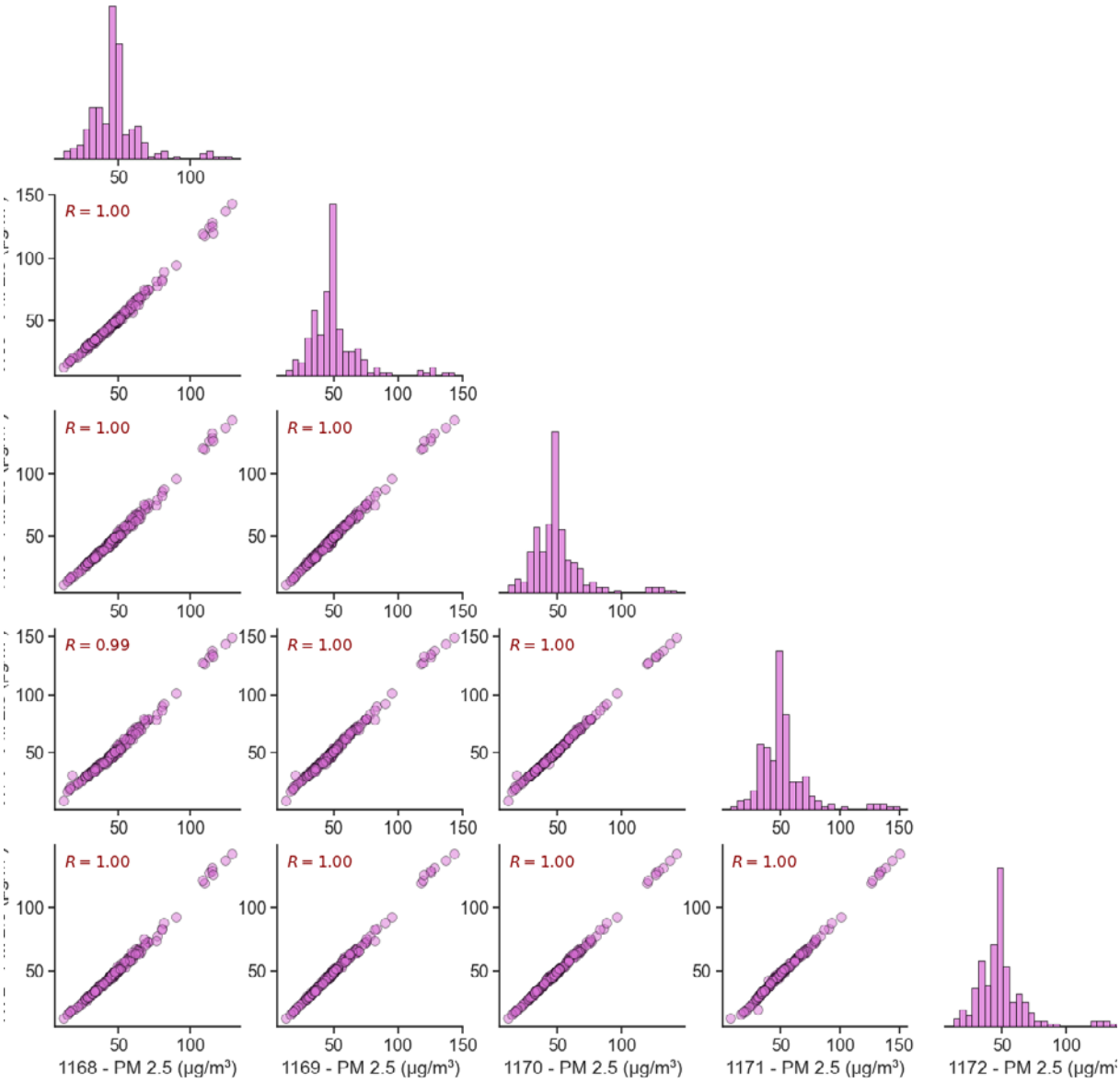


***Figure A42**: Intra-device correlation for manufacturer-reported data of Plantower PM_{10} from Sensit*

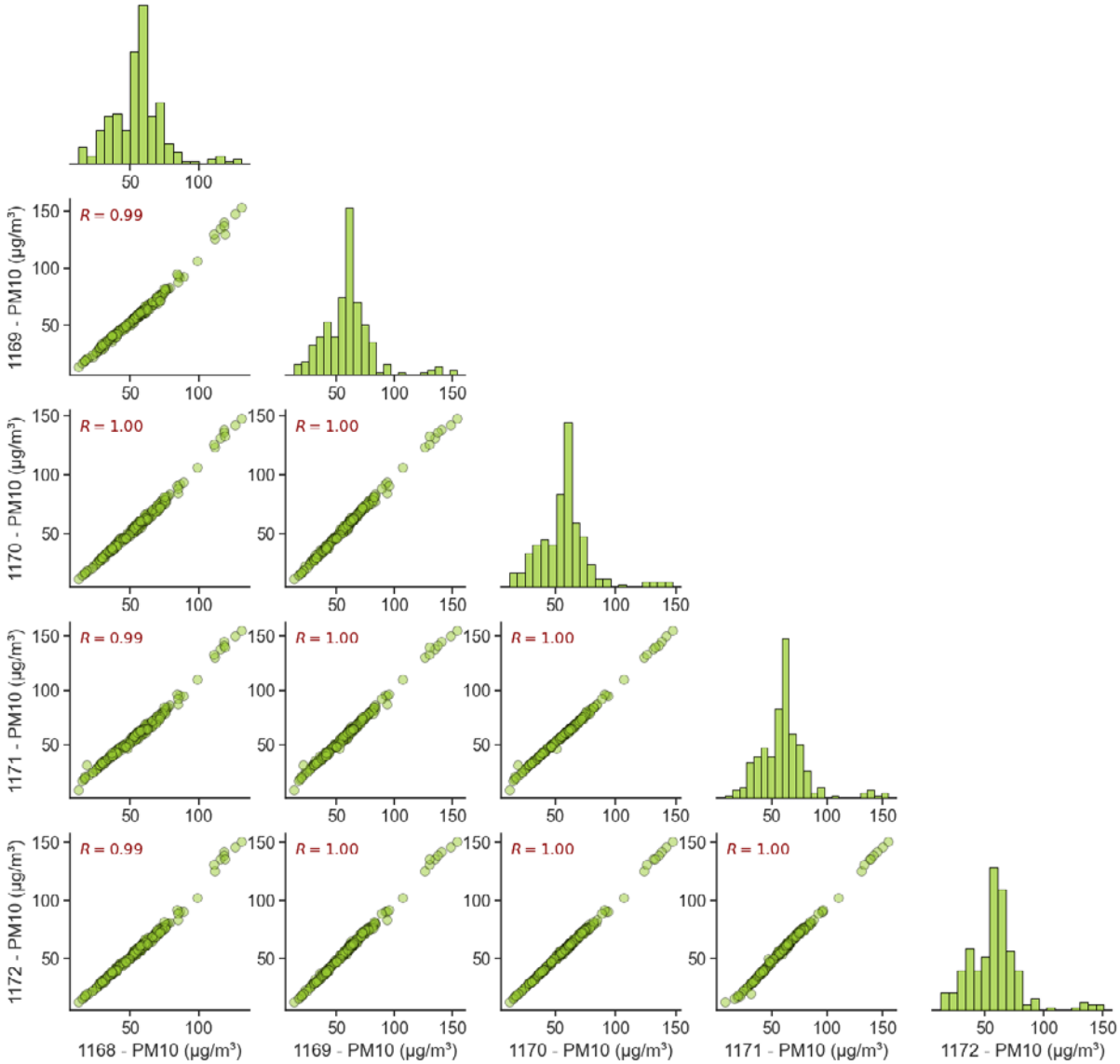


***Figure A43**: Intra-device correlation for manufacturer-reported data of OPC $PM_{2.5}$ from Sensit*

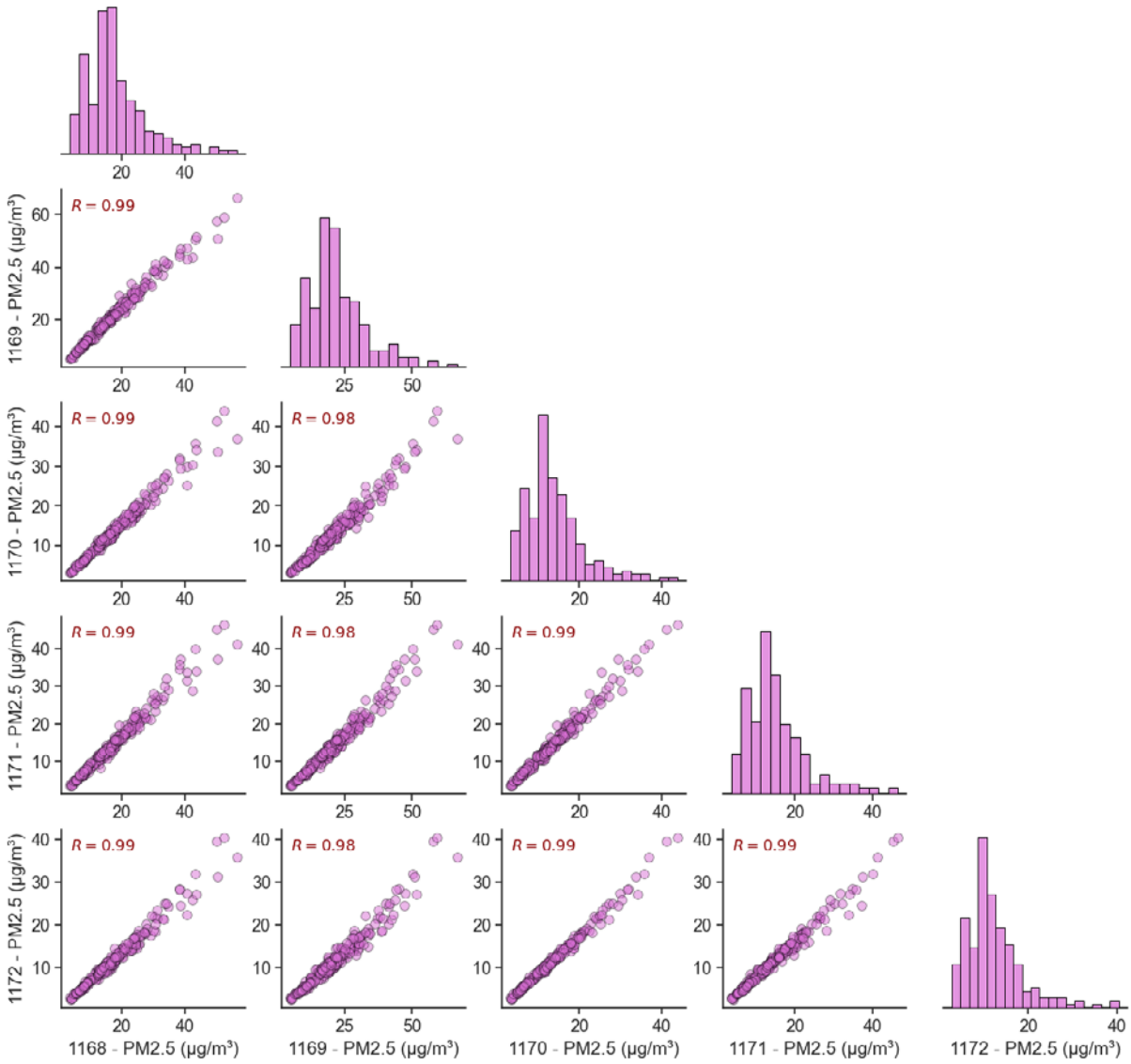


***Figure A44**: Intra-device correlation for manufacturer-reported data of OPC PM_{10} from Sensit*

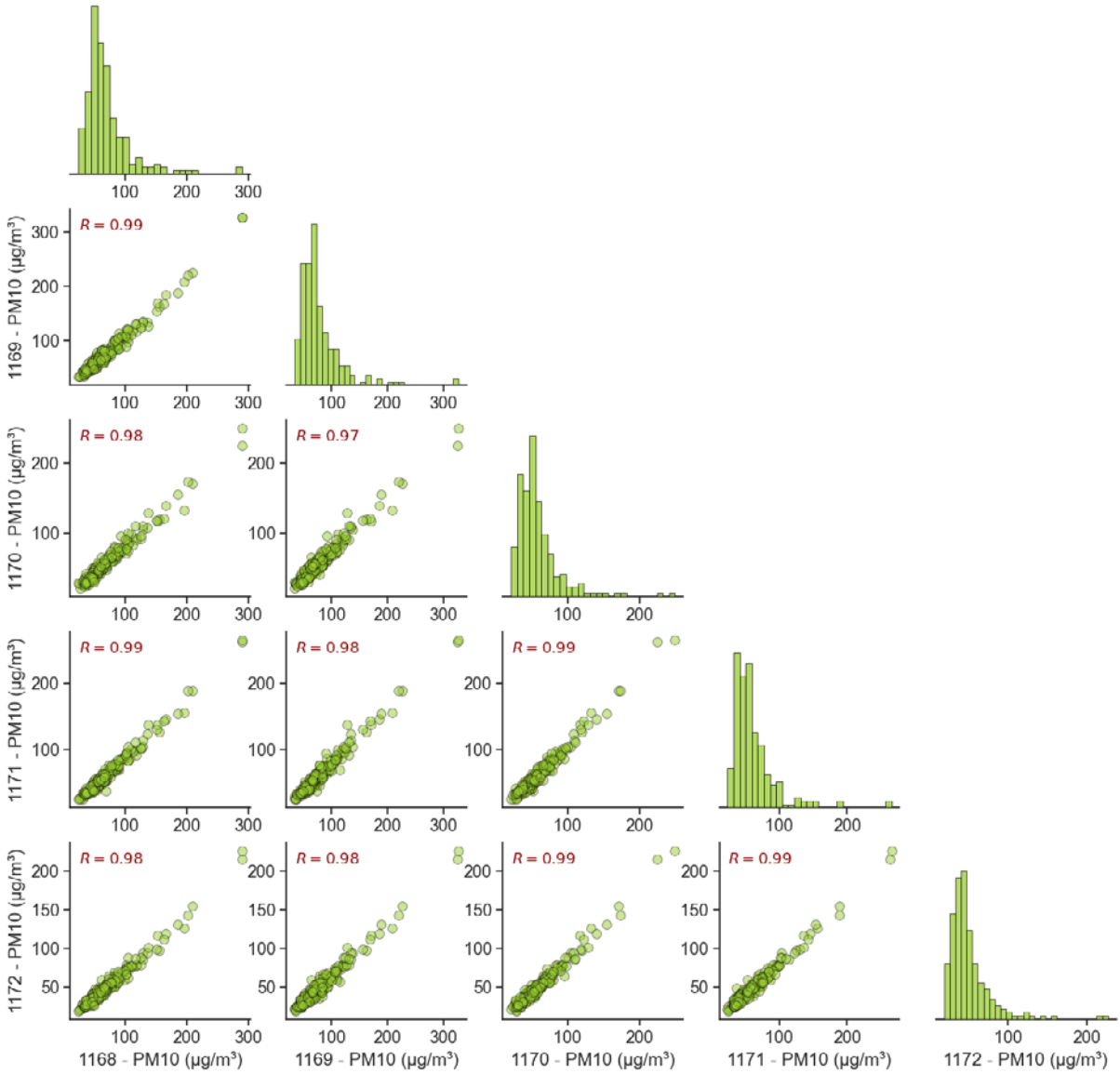


***Figure A45**: Intra-device correlation for raw data of NO_2 from Sensit*

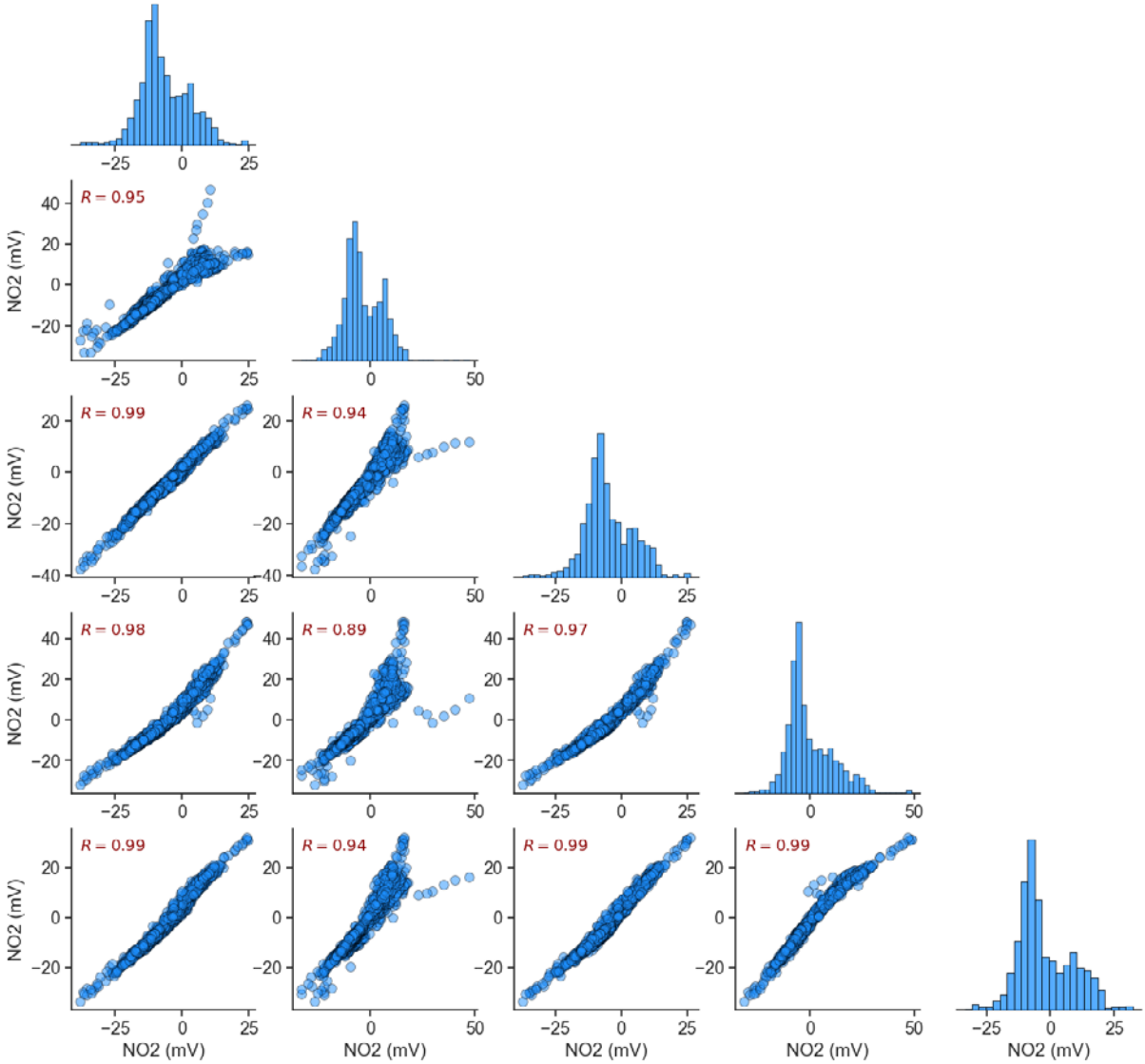


***Figure A46**: Intra-device correlation for manufacturer-reported data of NO_2 from Sensit*

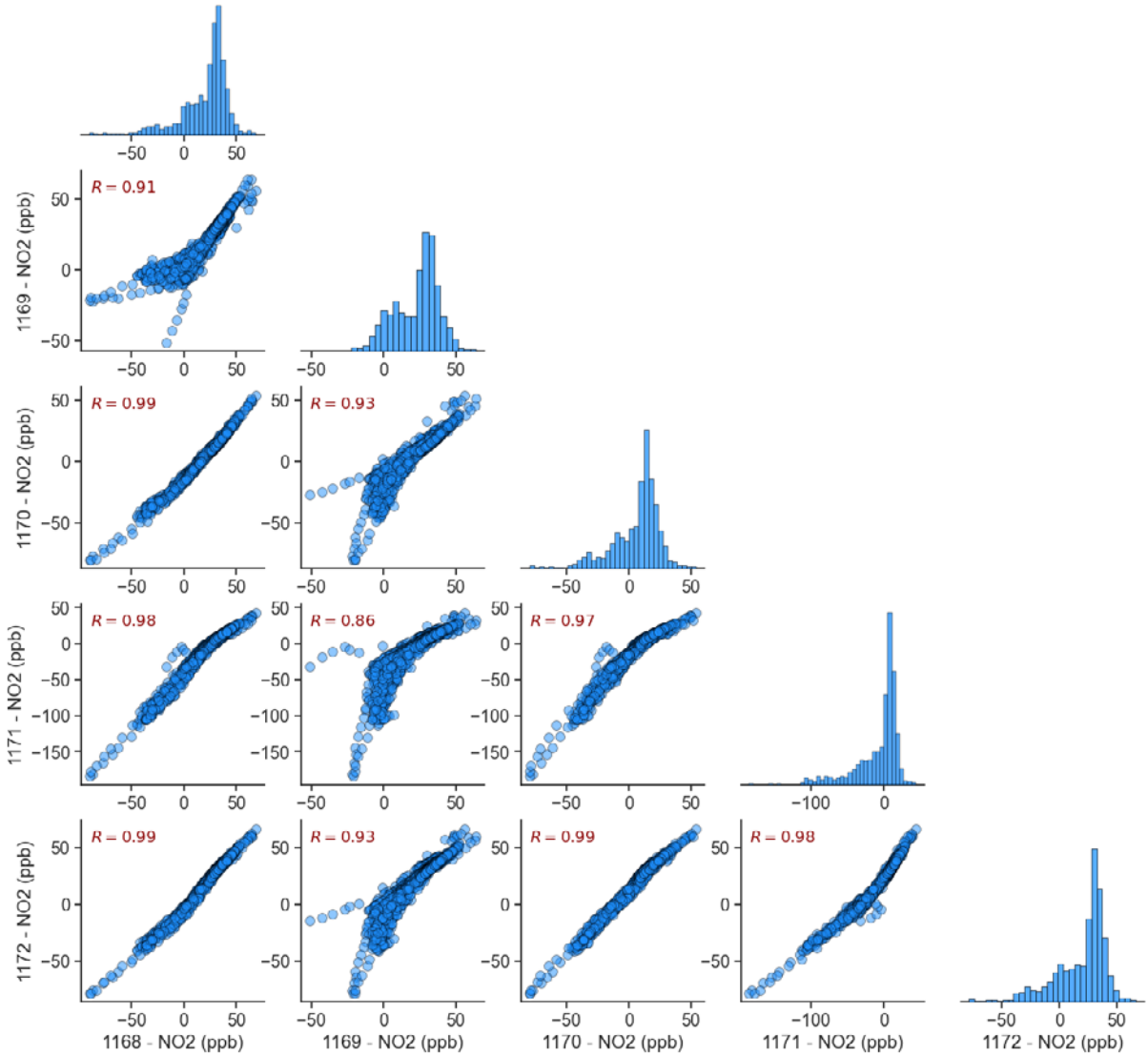


***Figure A47**: Intra-device correlation for raw data of O_3 from Sensit*

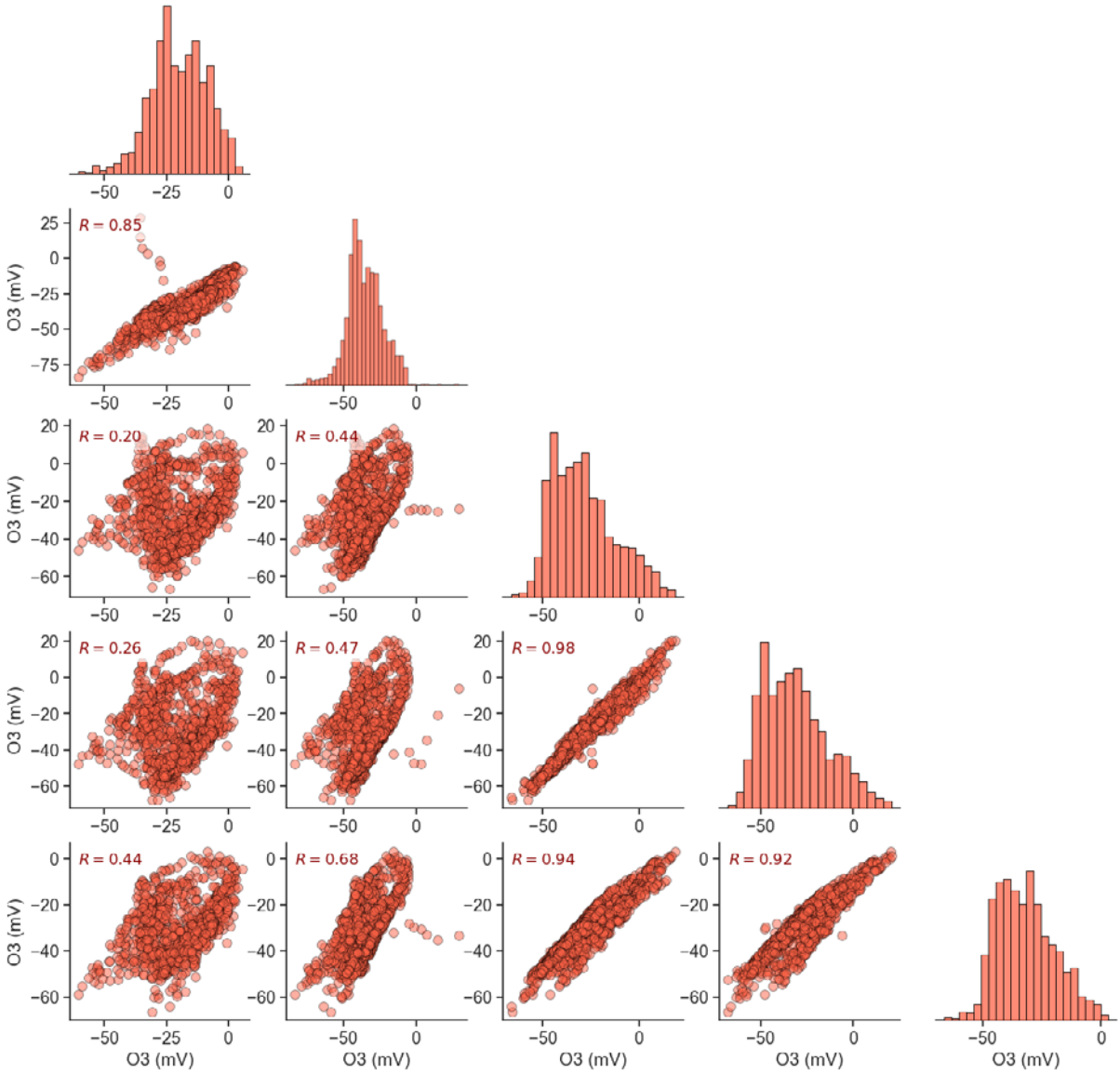


***Figure A48**: Intra-device correlation for manufacturer-reported data of O_3 from Sensit*

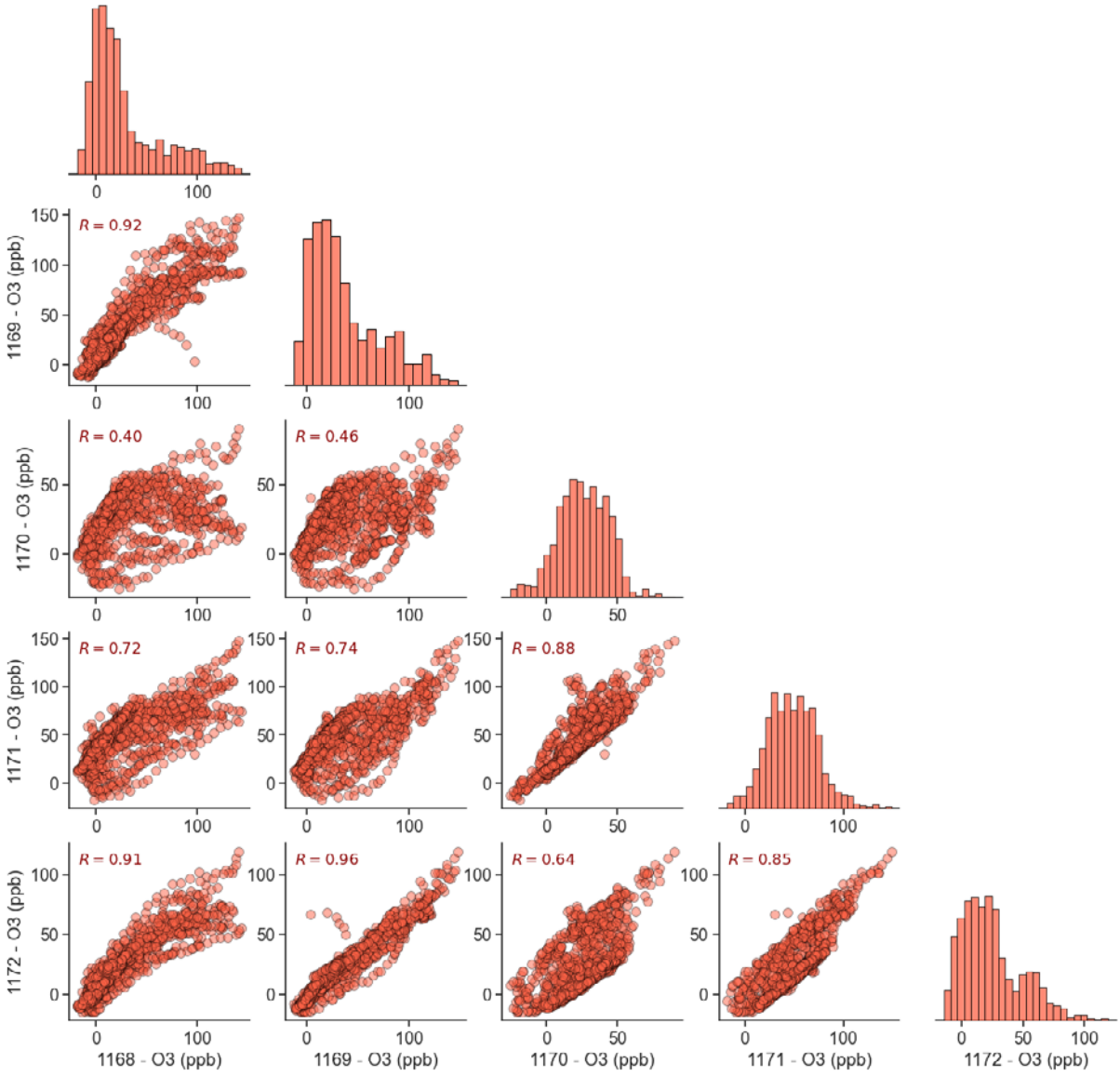


***Figure A49**: Intra-device correlation for raw data of CO from Sensit*

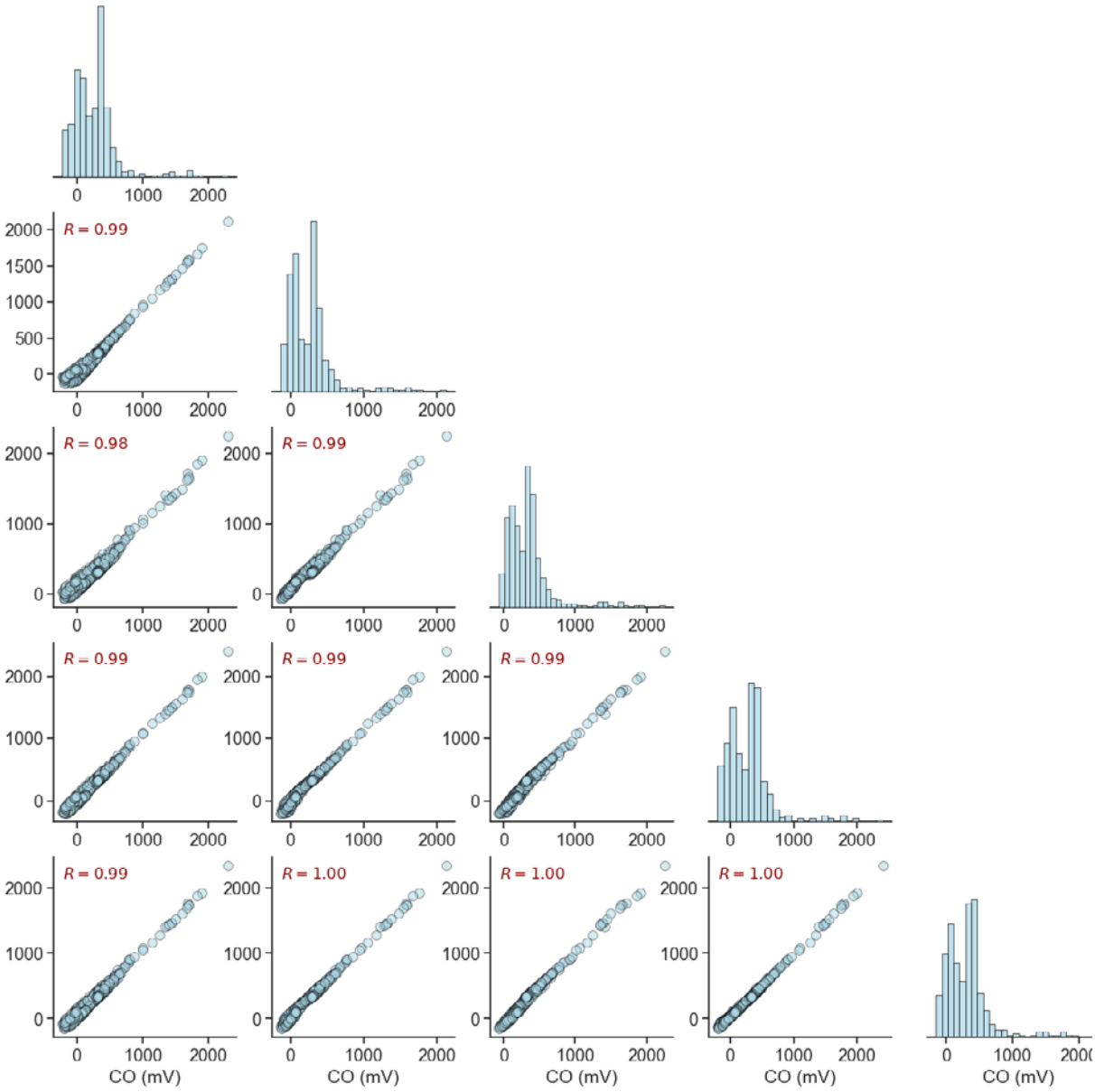
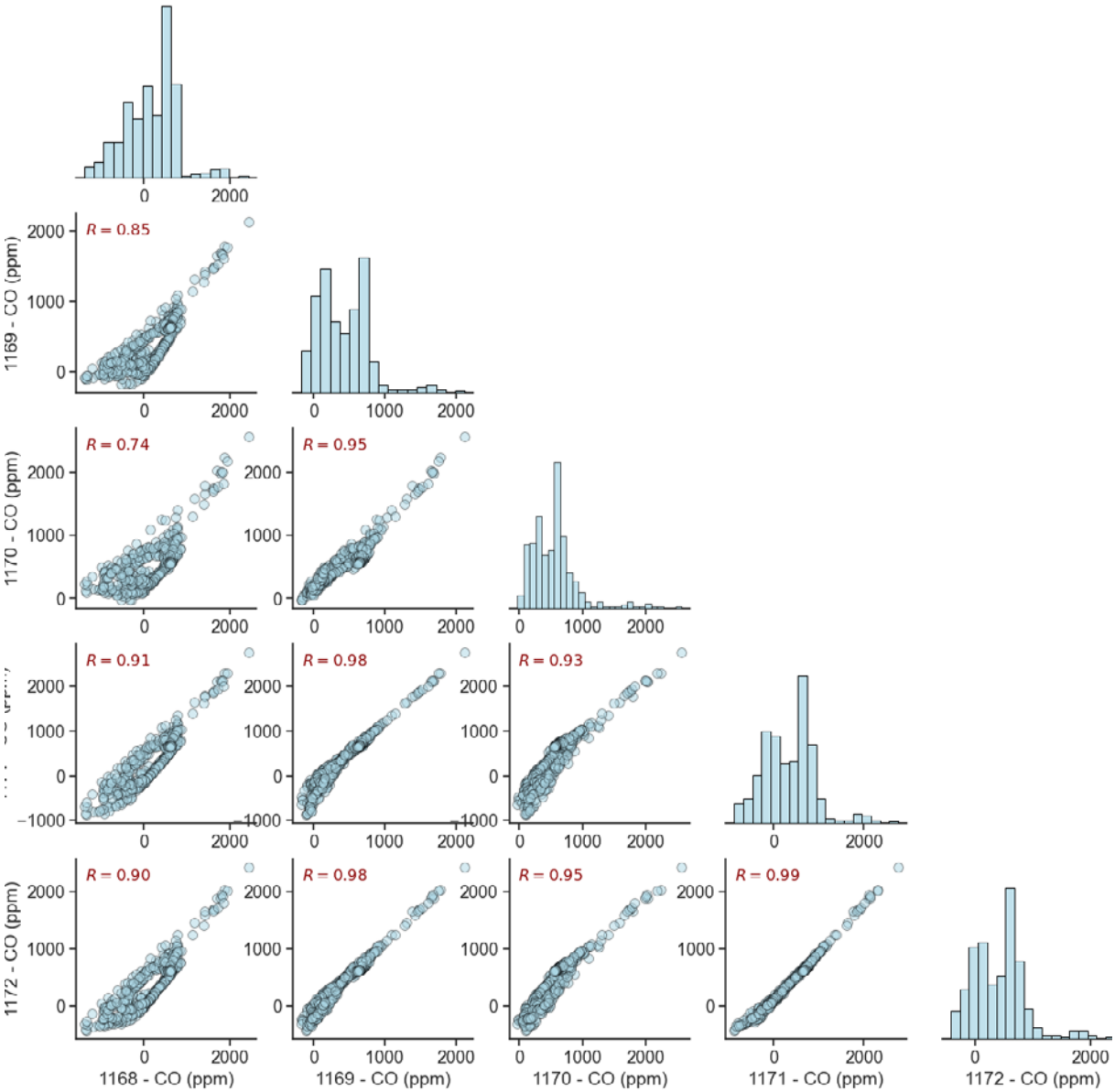


***Figure A50**: Intra-device correlation for manufacturer-reported data of CO from Sensit*

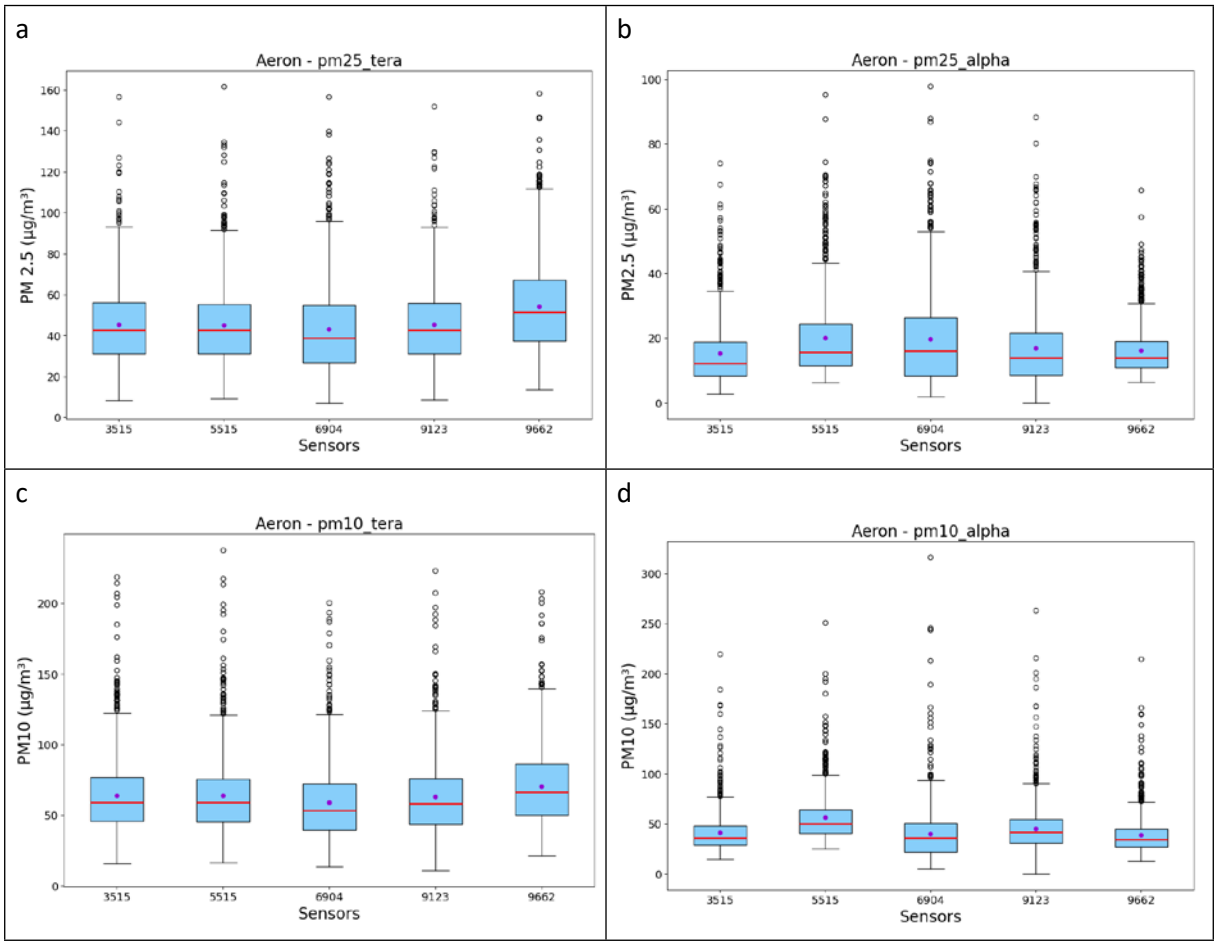


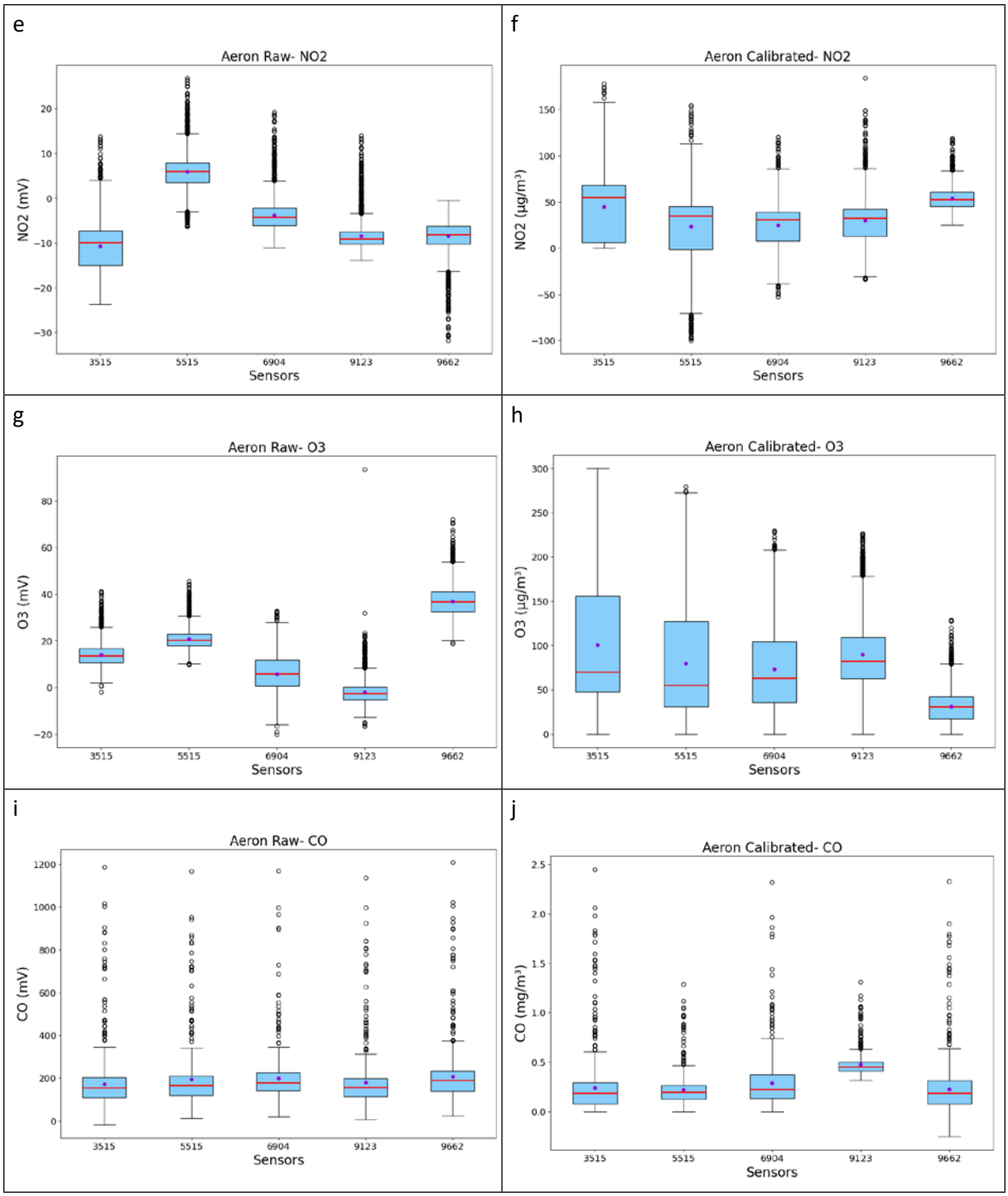
Annexure C: Intra-model Precision of Sensors – Data Distribution

This sub-section presents the data distribution of multi-pollutant air sensors from six Indian manufacturers: Aeron, Airveda, Airvoice, Aurassure, Respirer, and Sensit. The evaluation involved 3 to 25 sensor nodes from each manufacturer and was conducted at the Indi-SET facility. The pollutants assessed include $PM_{2.5}$, PM_{10}, NO_2, CO, and O_3.

Aeron

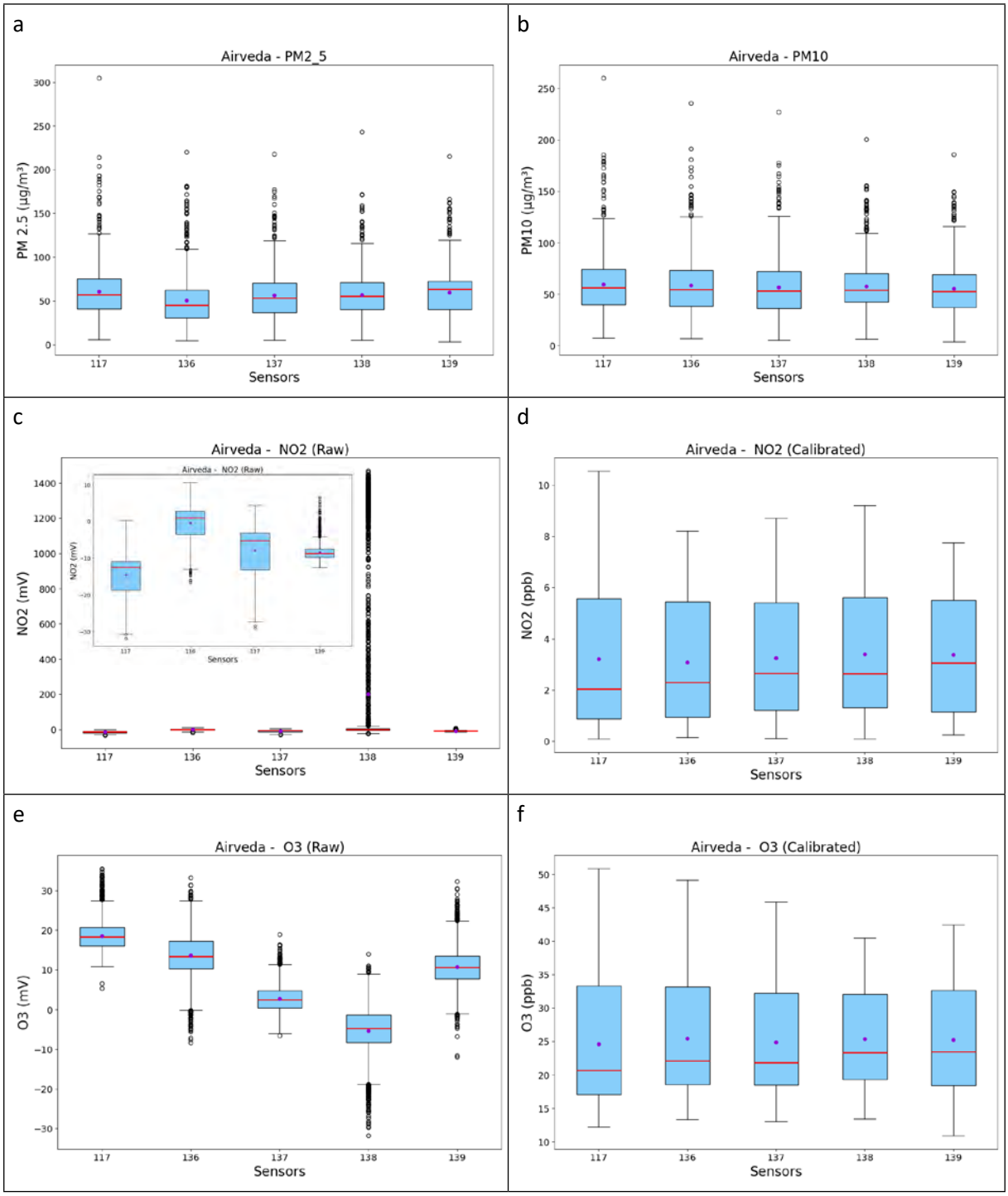
***Figure A51**: Intra-model data distribution of hourly averaged PM (both Tera Sensor and Alphasense OPC) and 15-minute averaged gas pollutants (Alphasense) from each Aeron device. (a) and (b) $PM_{2.5}$ reported from the Tera Sensor and Alphasense OPC, respectively; (c) and (d) PM_{10} reported from the Tera Sensor and Alphasense OPC, respectively; (e) and (f) Raw values and manufacturer-reported values of NO_2, respectively: (g) and (h) Raw values and manufacturer-reported values of O_3, respectively; and (i) and (j) Raw values and manufacturer-reported values of CO, respectively.*

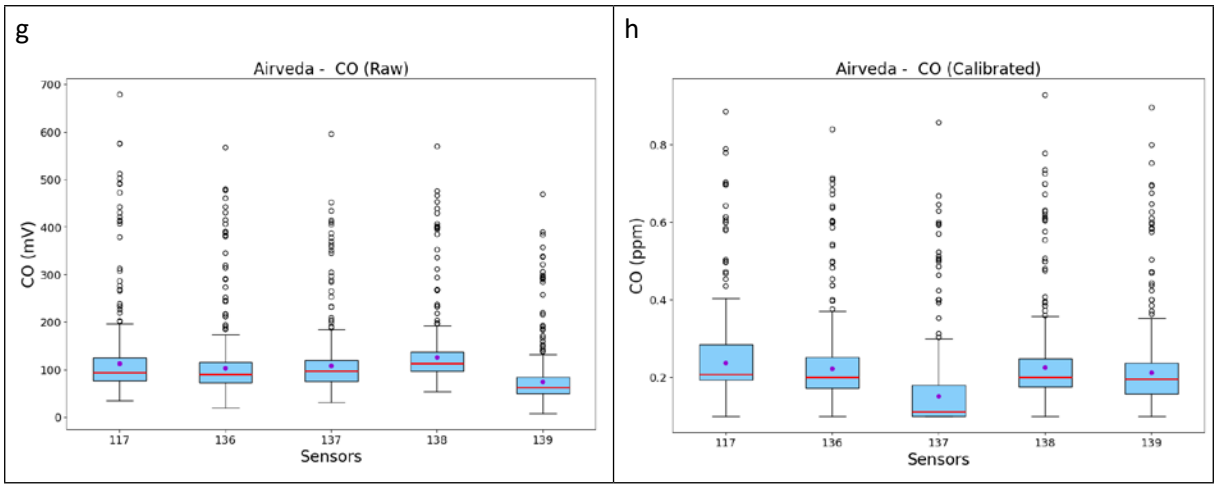



e
Aeron Raw- NO2
NO2 (mV)
Sensors
3515
5515
6904
9123
9662
f
Aeron Calibrated- NO2
NO2 (µg/m³)
Sensors
g
Aeron Raw- O3
O3 (mV)
Sensors
h
Aeron Calibrated- O3
O3 (µg/m³)
Sensors
i
Aeron Raw- CO
CO (mV)
Sensors
j
Aeron Calibrated- CO
CO (mg/m³)
Sensors

Airveda

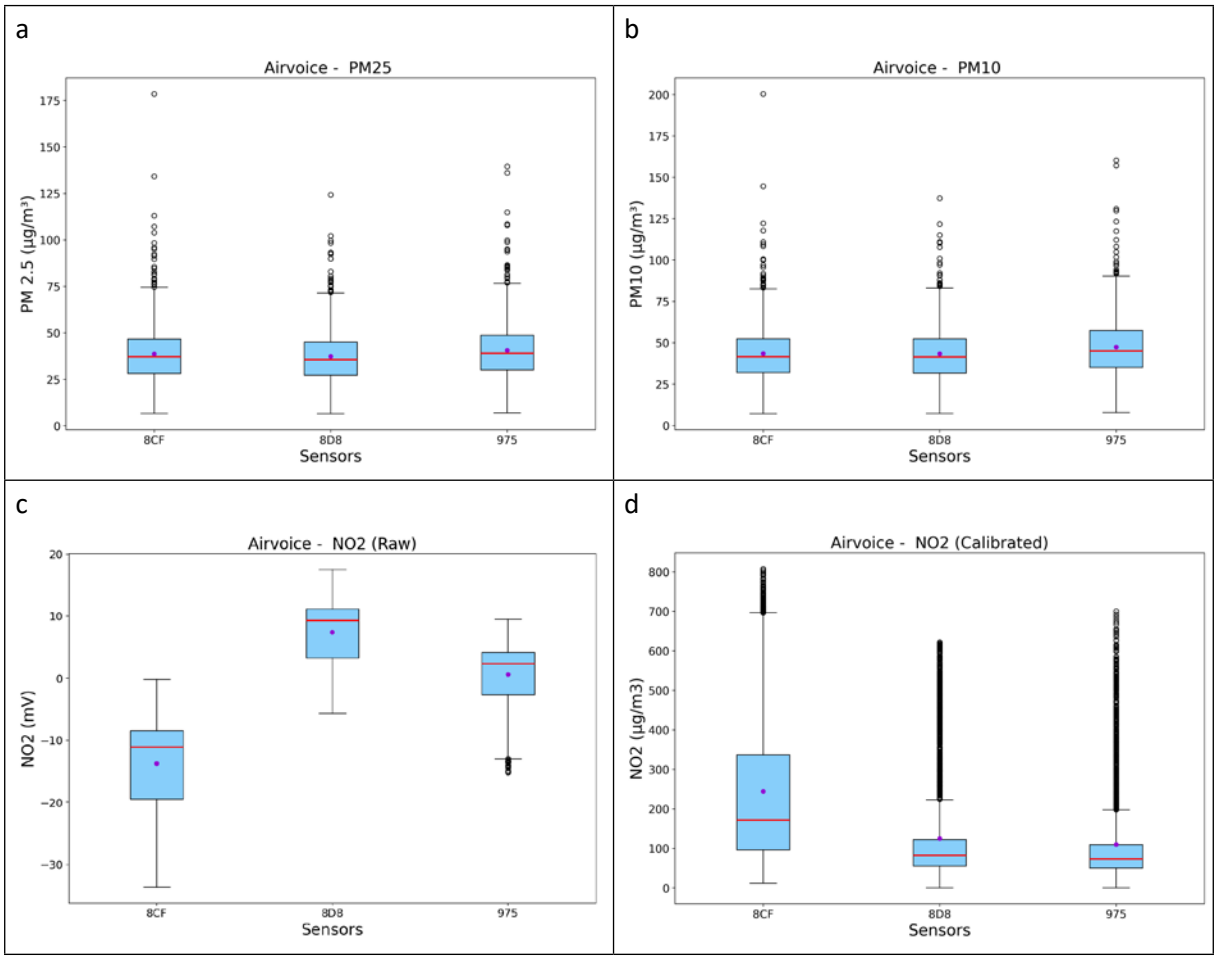
***Figure A52**: Intra-model data distribution of hourly averaged PM (Plantower) and 15-minute averaged gas pollutants (Alphasense) from each Airveda device. (a) and (b) $PM_{2.5}$ and PM_{10} reported from the Plantower sensor, respectively; (c) and (d) Raw values and manufacturer-reported values of NO_2, respectively (Inset in (c): Enlarged view of four devices plotted on a shortened y-axis to highlight their distribution); (e) and (f) Raw values and manufacturer-reported values of O_3, respectively; and (g) and (h) Raw values and manufacturer-reported values of CO, respectively.*

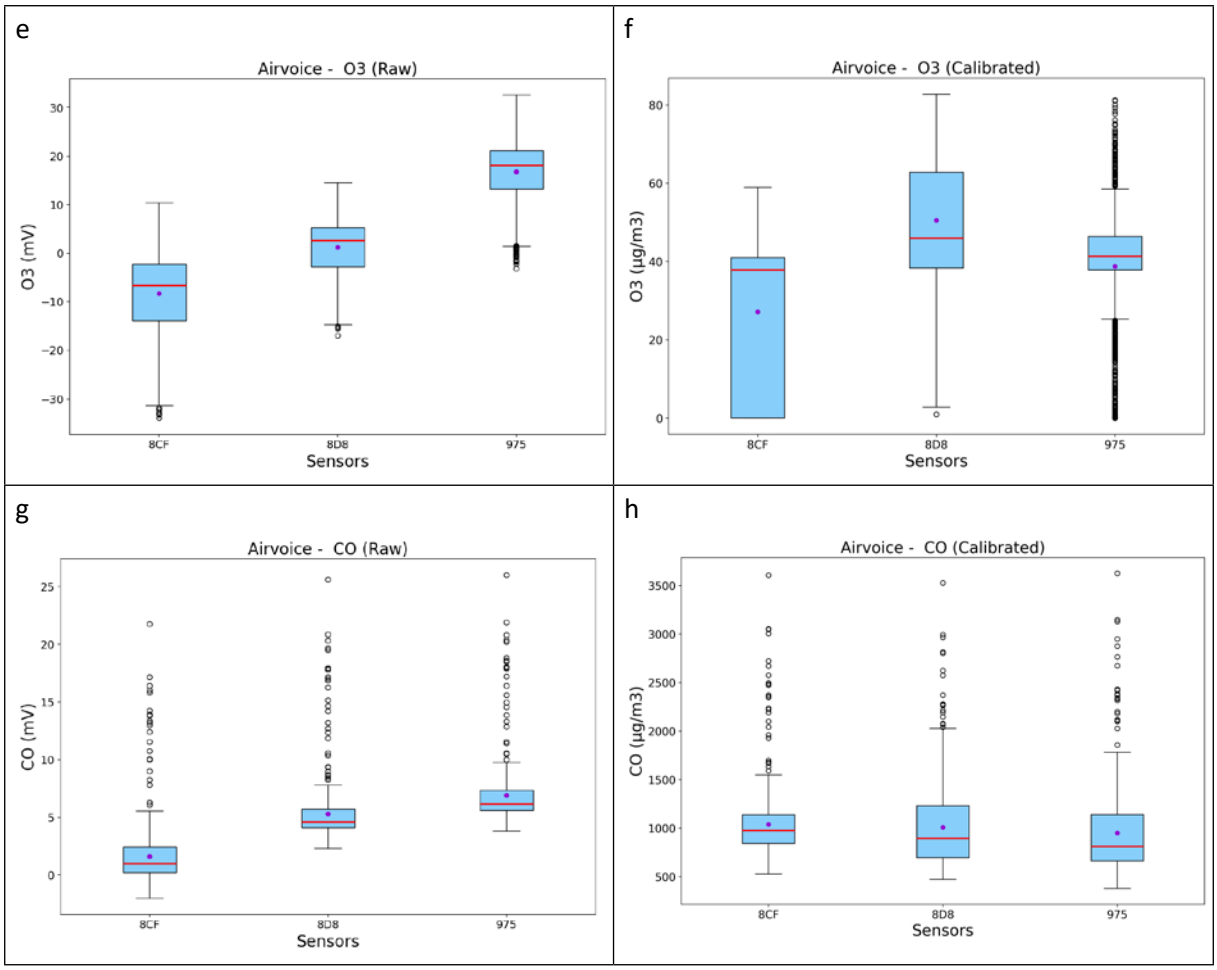




Airvoice

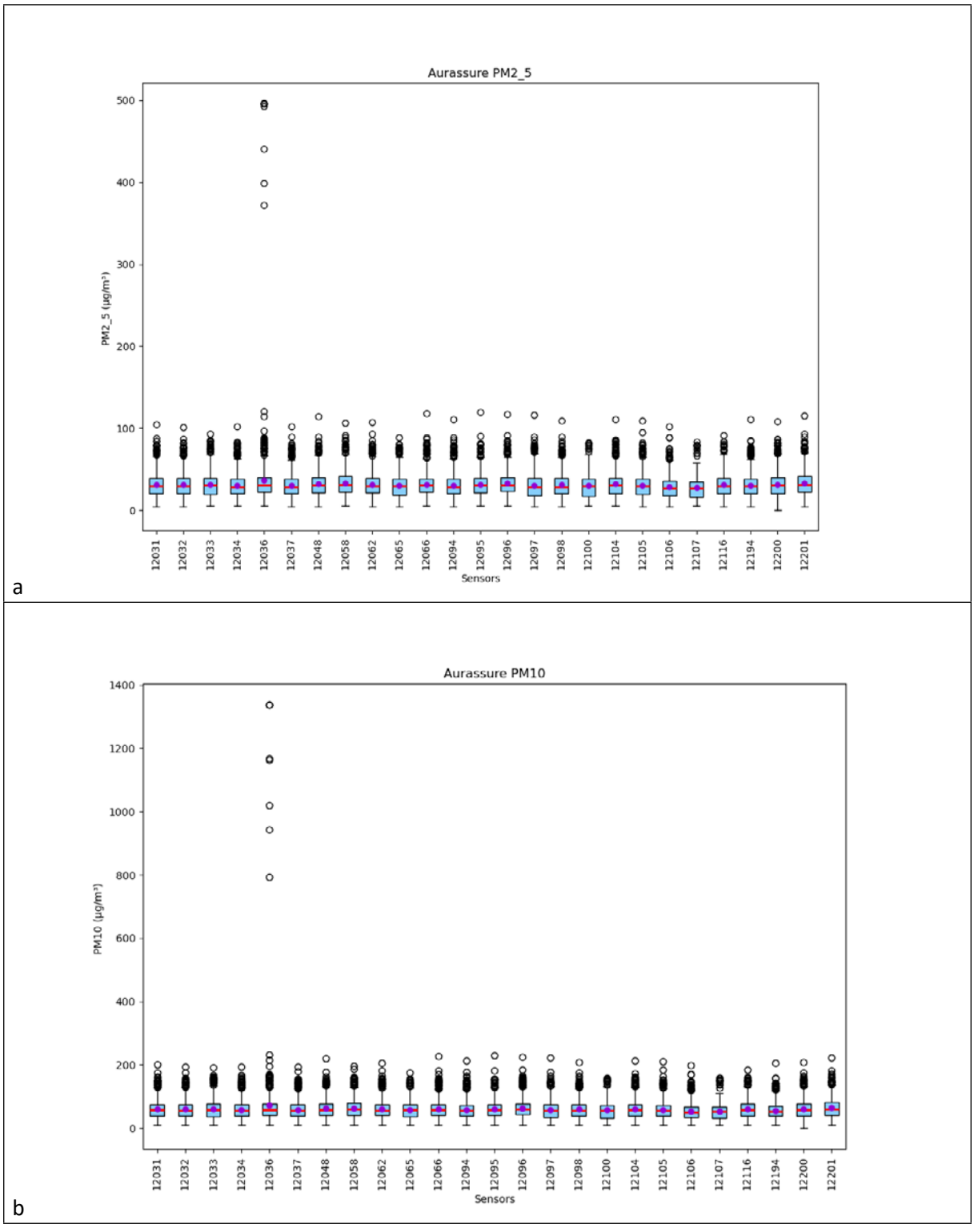
***Figure A53**: Intra-model data distribution of hourly averaged PM (Plantower) and 15-minute averaged gas pollutants (Alphasense) from each Airvoice device. (a) and (b) $PM_{2.5}$ and PM_{10} reported from the Plantower sensor, respectively; (c) and (d) Raw values and manufacturer-reported values of NO_2, respectively; (e) and (f) Raw values and manufacturer-reported values of O_3, respectively; and (g) and (h) Raw values and manufacturer-reported values of CO, respectively.*

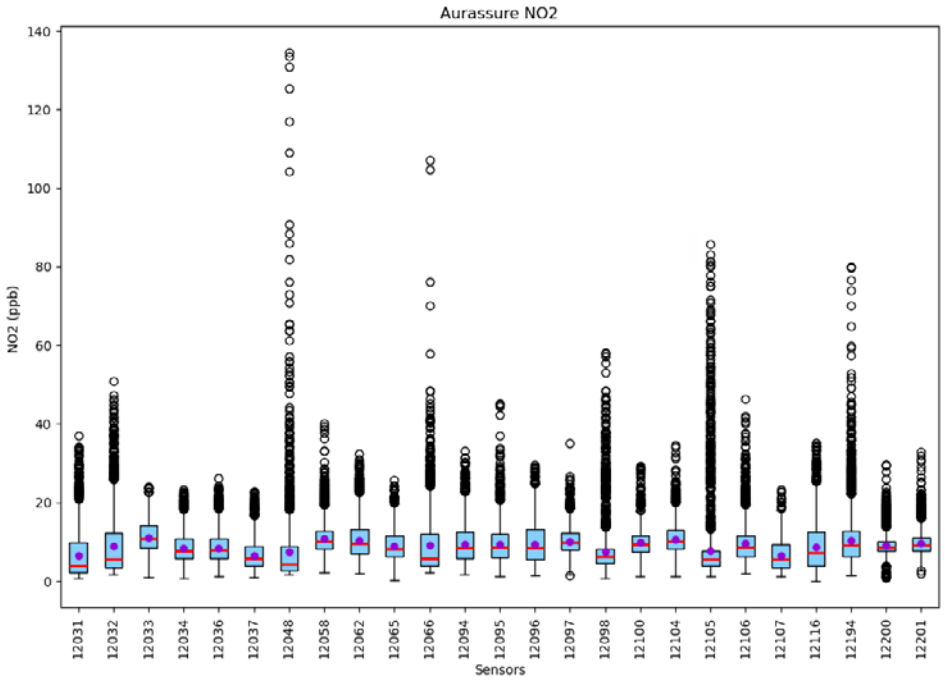



e
Airvoice - O3 (Raw)
O3 (mV)
30
20
10
0
−10
−20
−30
8CF
8D8
975
Sensors
f
Airvoice - O3 (Calibrated)
O3 (µg/m3)
80
60
40
20
0
8CF
8D8
975
Sensors
g
Airvoice - CO (Raw)
CO (mV)
25
20
15
10
5
0
8CF
8D8
975
Sensors
h
Airvoice - CO (Calibrated)
CO (µg/m3)
3500
3000
2500
2000
1500
1000
500
8CF
8D8
975
Sensors

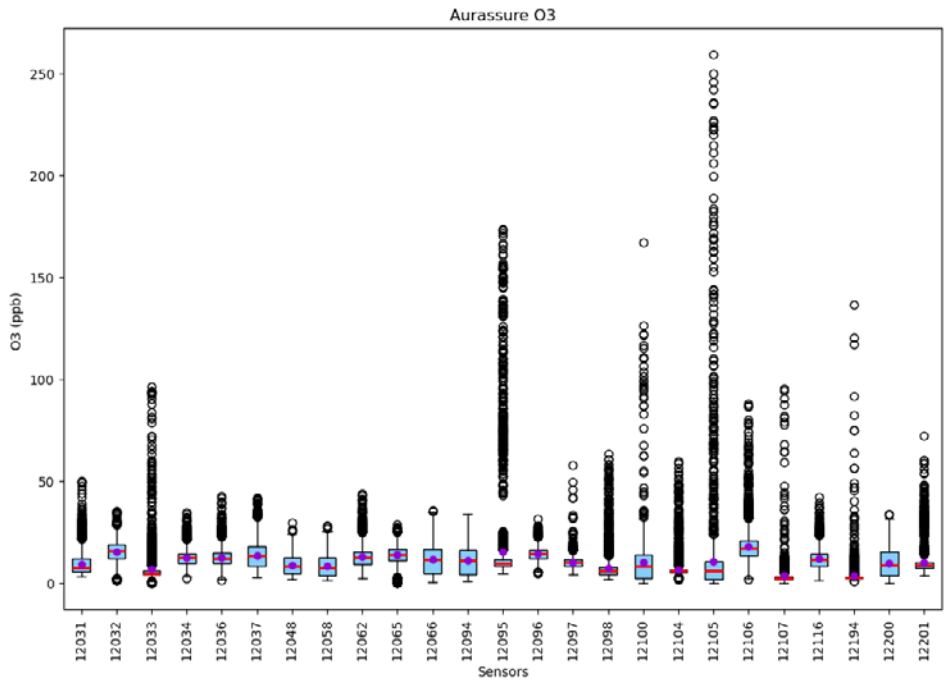
Aurassure

***Figure A54**: Intra-model data distribution of hourly averaged PM and 15-minute averaged gas pollutants from each Aurassure device and AQMS. (a) and (b) $PM_{2.5}$ and PM_{10} reported from the Sensirion sensor, respectively; (c) to (e) NO_2, O_3, and CO reported using the EC Sense sensor, respectively.*

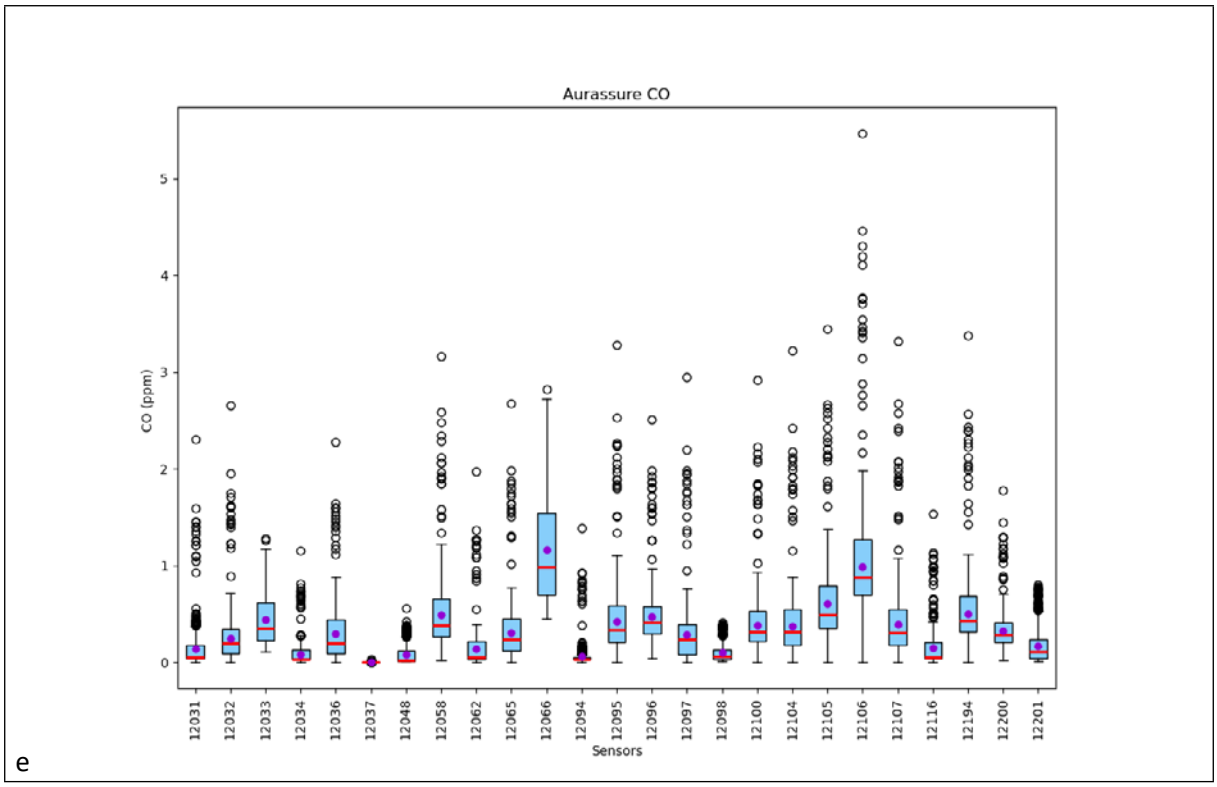



Aurassure NO2
NO2 (ppb)
0
20
40
60
80
100
120
140
12031
12032
12033
12034
12036
12037
12048
12058
12062
12065
12066
12094
12095
12096
12097
12098
12100
12104
12105
12106
12107
12116
12194
12200
12201
Sensors

c

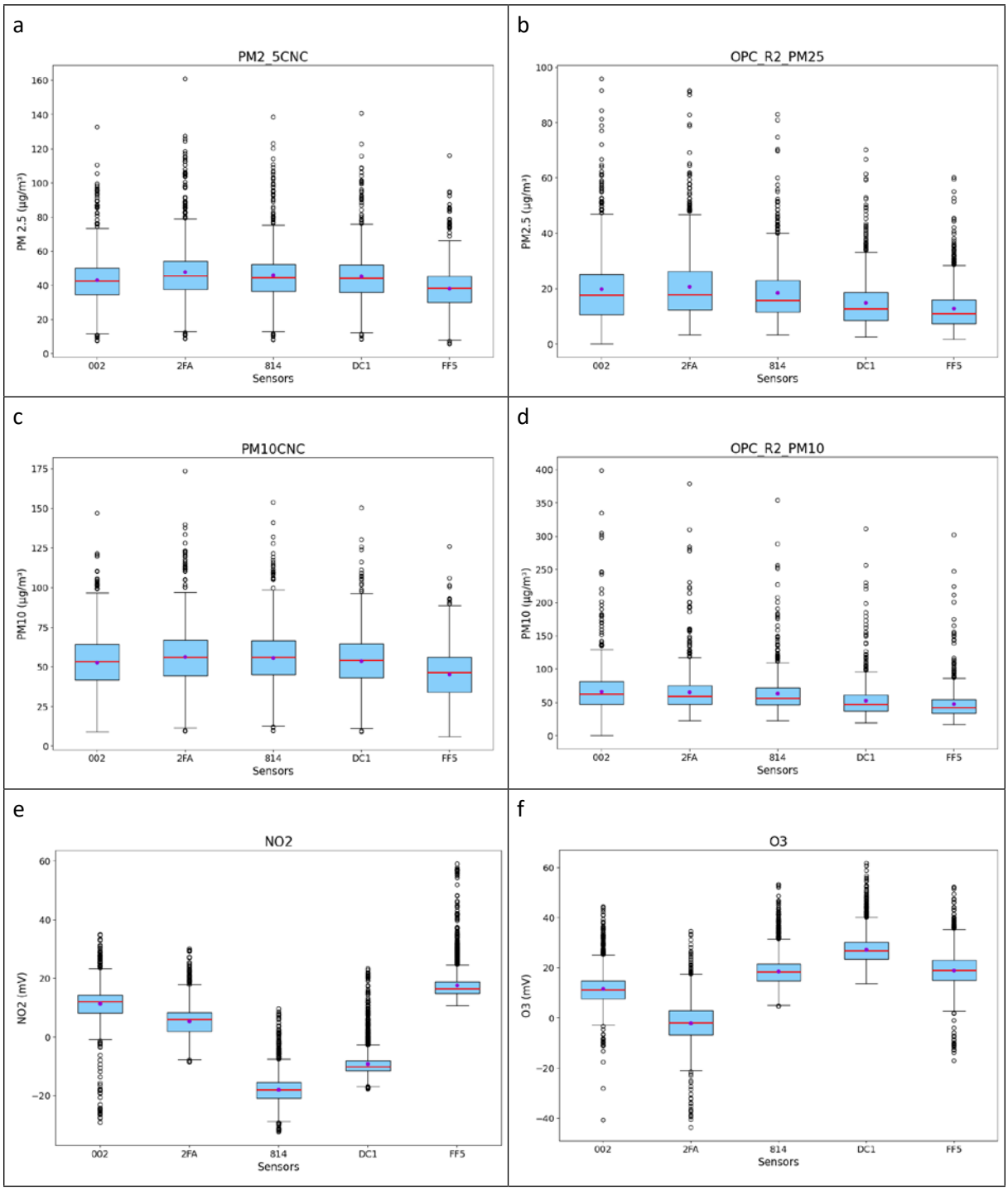

Aurassure O3
O3 (ppb)
0
50
100
150
200
250
12031
12032
12033
12034
12036
12037
12048
12058
12062
12065
12066
12094
12095
12096
12097
12098
12100
12104
12105
12106
12107
12116
12194
12200
12201
Sensors

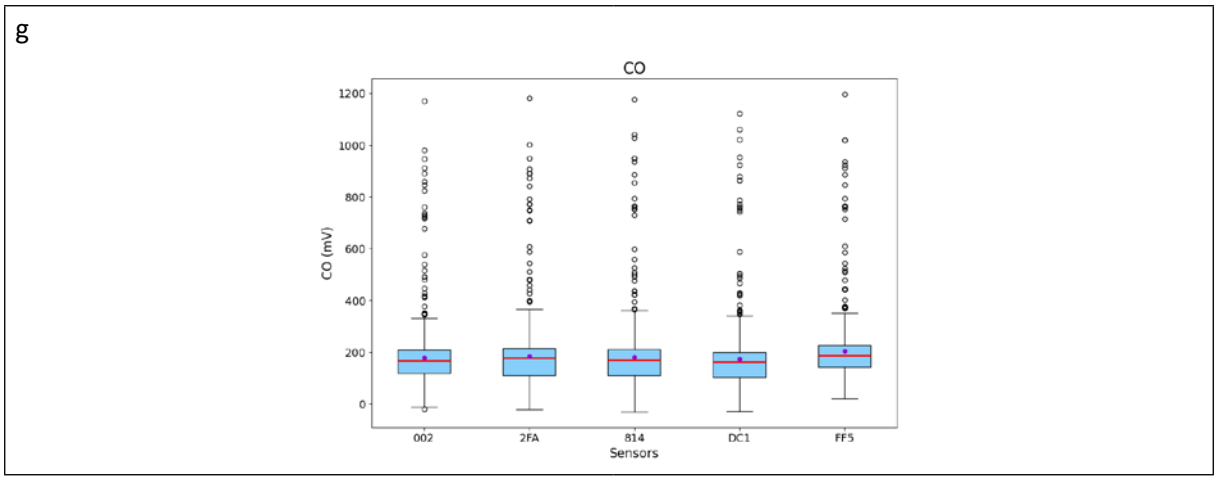
d


Aurassure CO
CO (ppm)
0
1
2
3
4
5
12031
12032
12033
12034
12036
12037
12048
12058
12062
12065
12066
12094
12095
12096
12097
12098
12100
12104
12105
12106
12107
12116
12194
12200
12201
Sensors
e

Respirer

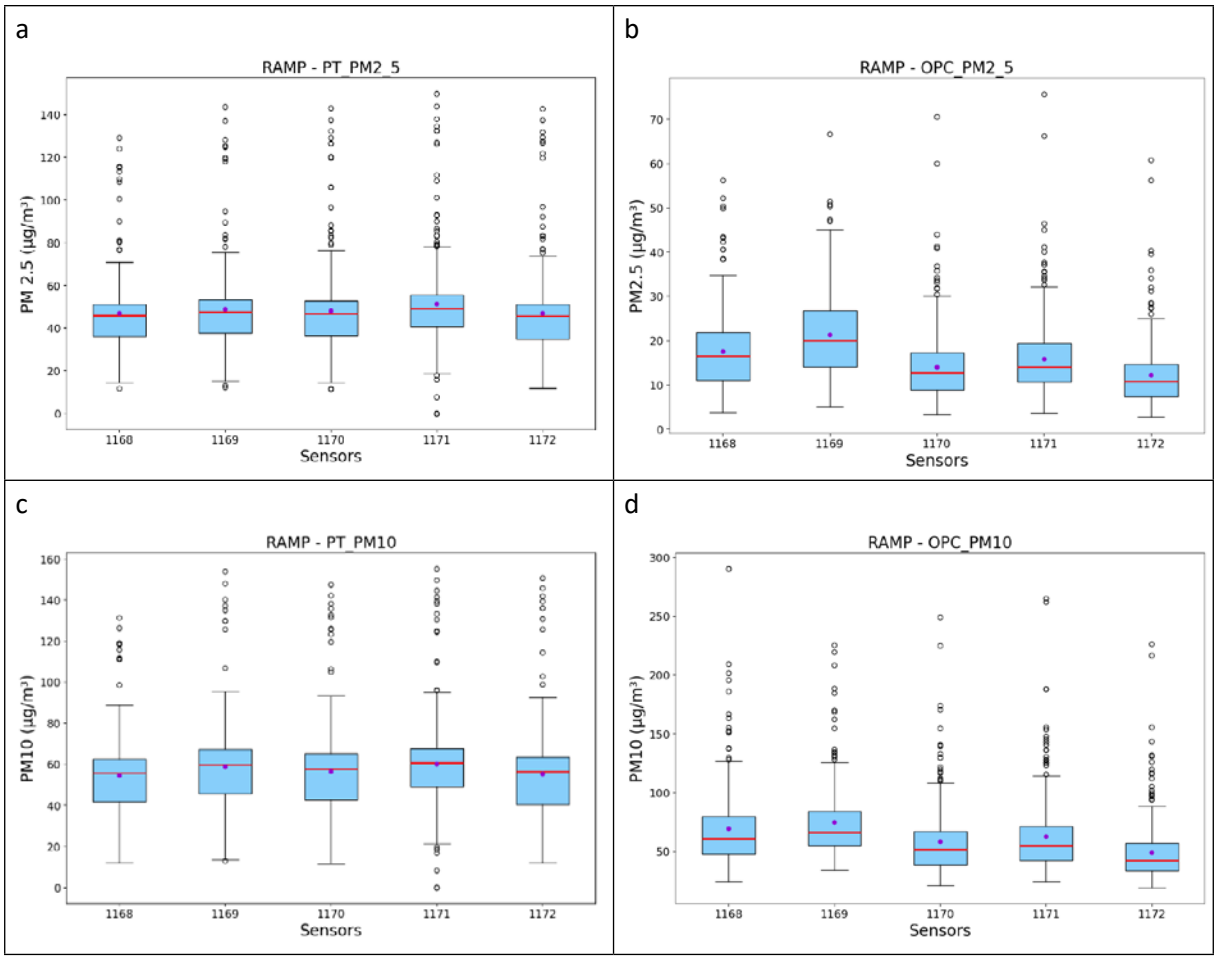
***Figure A55**: Intra-model data distribution of hourly averaged PM and 15-minute averaged gas pollutants (raw values) from each Respirer device. (a) and (b) $PM_{2.5}$ reported from the Plantower sensor and Alphasense OPC, respectively; (c) to (g) Raw values of NO_2, O_3, and CO, respectively, reported using the Alphasense sensor.*

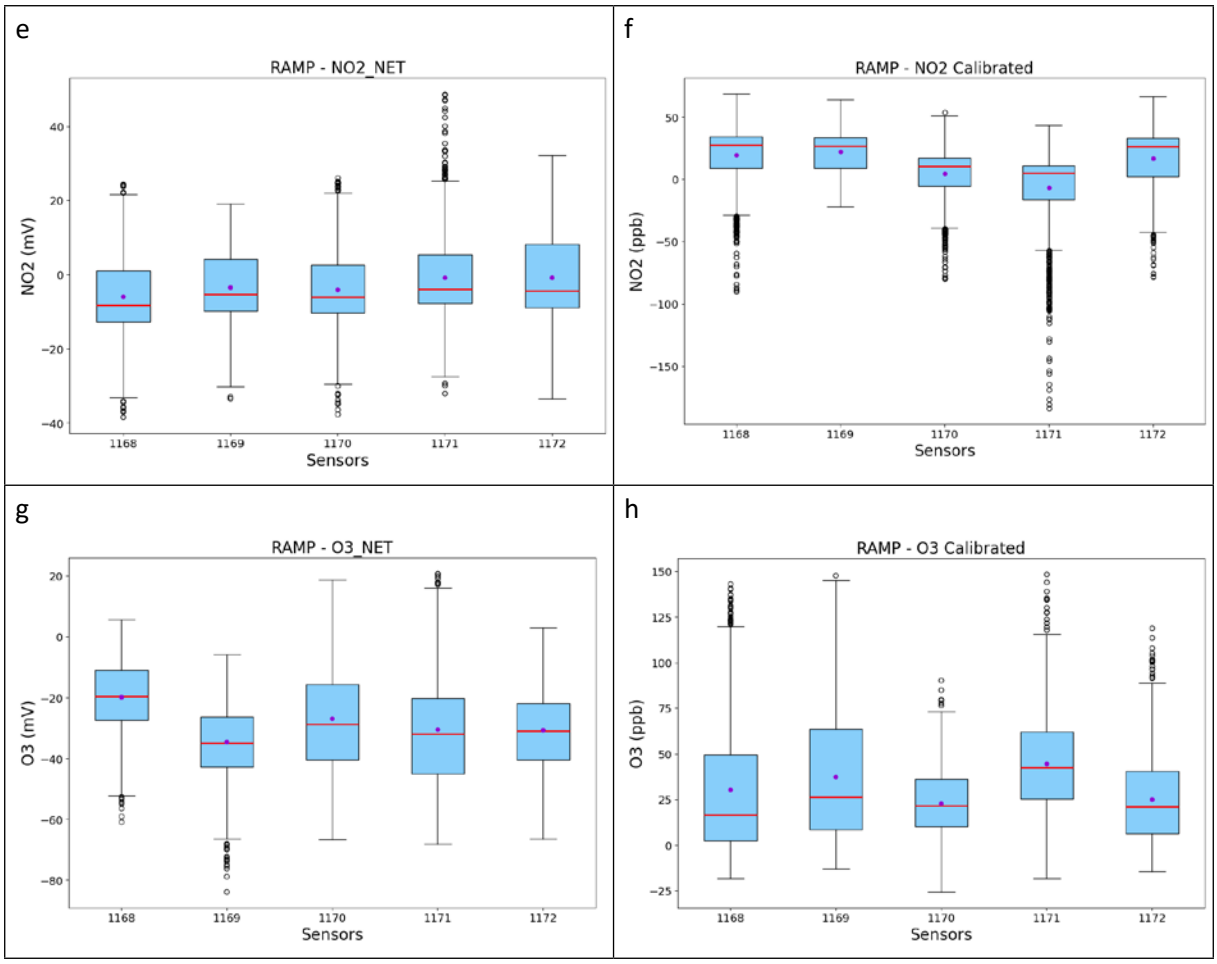




Sensit

***Figure A56**: Intra-model data distribution of hourly averaged PM (both Plantower and Alphasense OPC) and 15-minute averaged gas pollutants (Alphasense) from each Sensit device. (a) and (b) $PM_{2.5}$ reported from the Plantower sensor and Alphasense OPC, respectively; (c) and (d) PM_{10} reported from the Plantower sensor and Alphasense OPC, respectively; (e) and (f) Raw values and manufacturer-reported values of NO_2, respectively; (g) and (h) Raw values and manufacturer-reported values of O_3, respectively; and (i) and (j) Raw values and manufacturer-reported values of CO, respectively.*



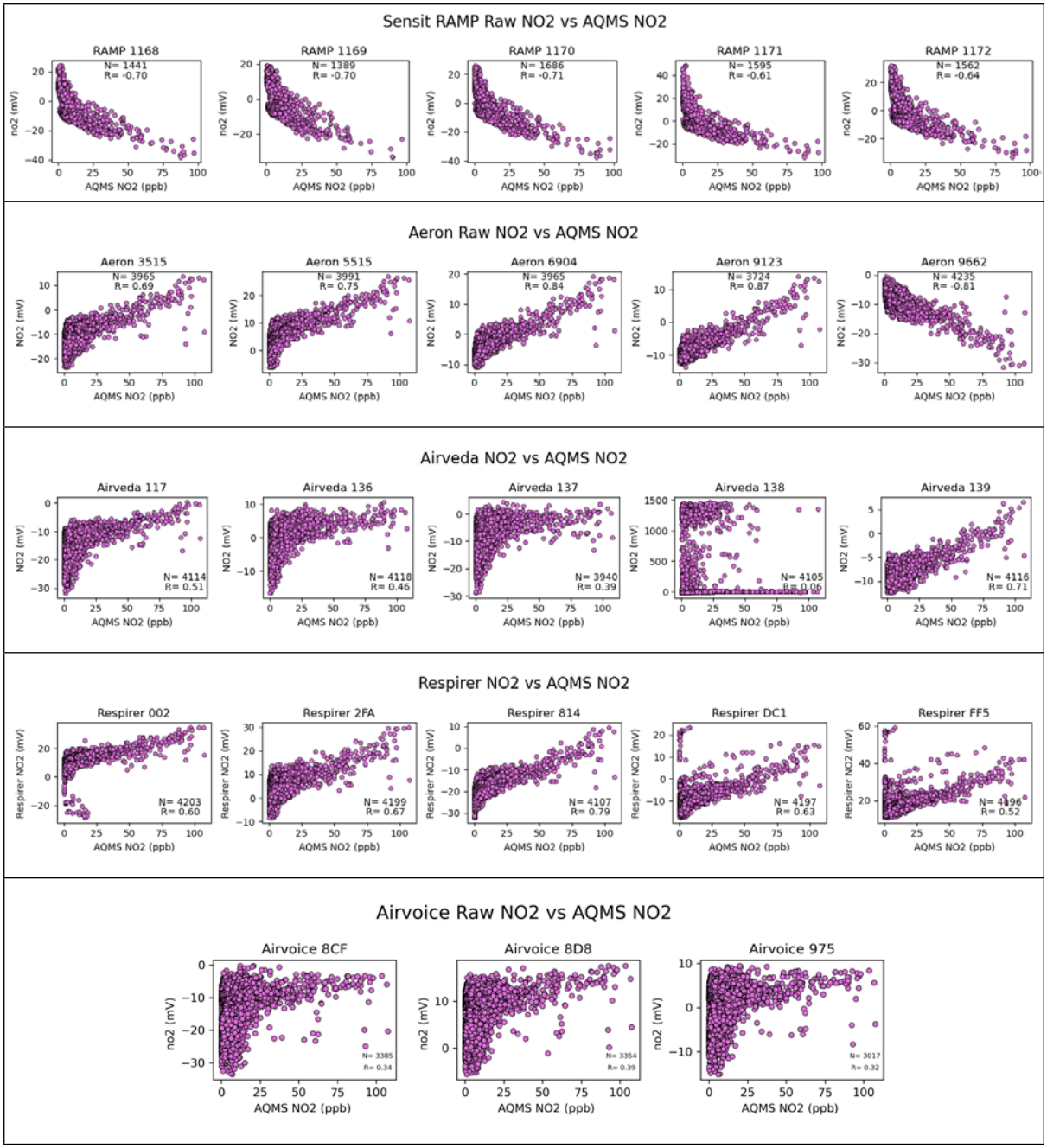

e
RAMP - NO2_NET
NO2 (mV)
Sensors
1168
1169
1170
1171
1172
f
RAMP - NO2 Calibrated
NO2 (ppb)
Sensors
g
RAMP - O3_NET
O3 (mV)
Sensors
h
RAMP - O3 Calibrated
O3 (ppb)
Sensors

Annexure D: Performance of Various Sensors

This sub-section provides the performance comparison of raw and manufacturer-calibrated values with the AQMS-reported values. Further, 1-hour averaged data are used for PM, and 15-minute averaged data are used for gas pollutants.

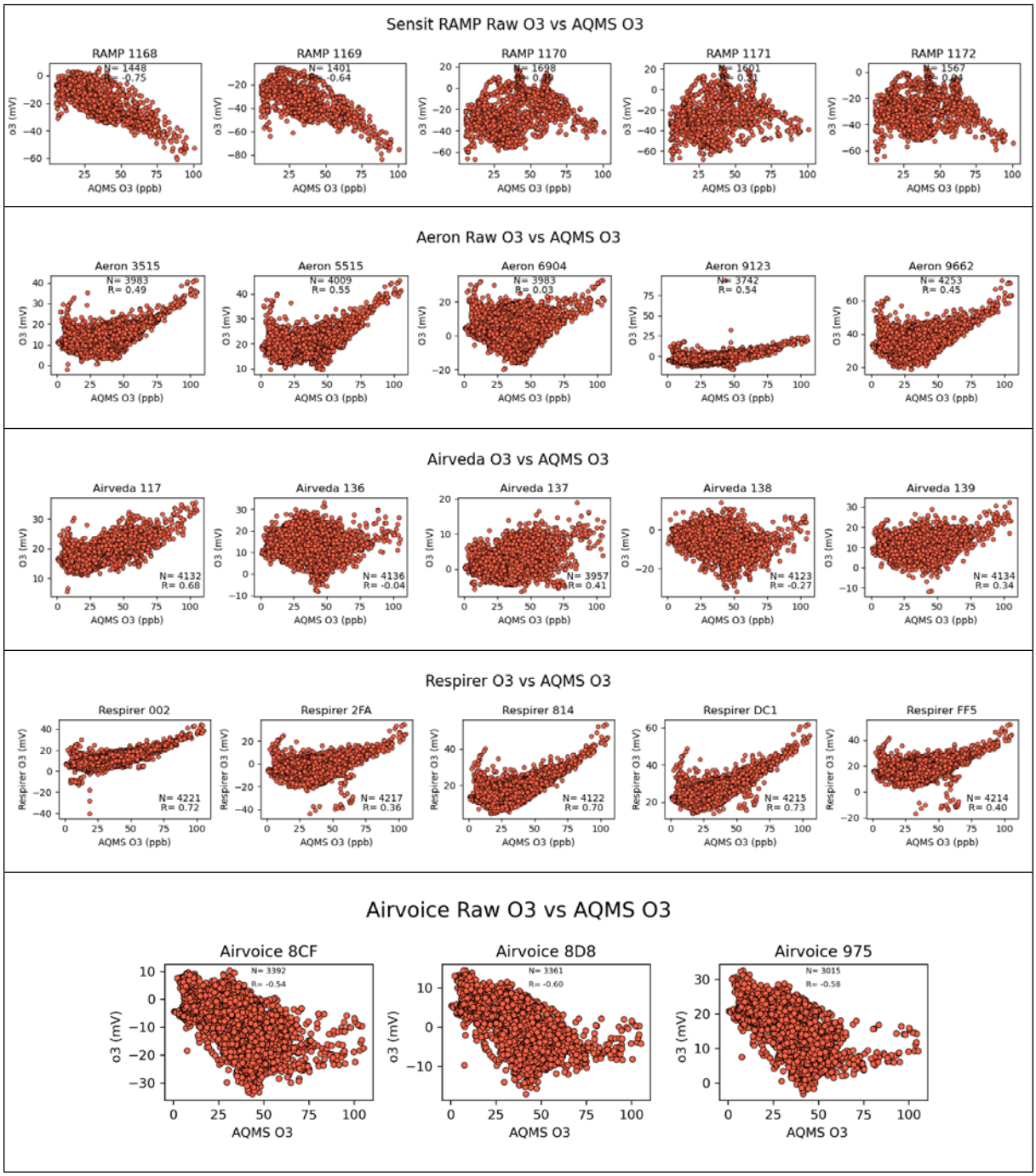
Sensor (raw) with AQMS: NO_2

***Figure A57**: Comparison of raw NO_2 measurements reported from the sensor nodes against the reference instrument*



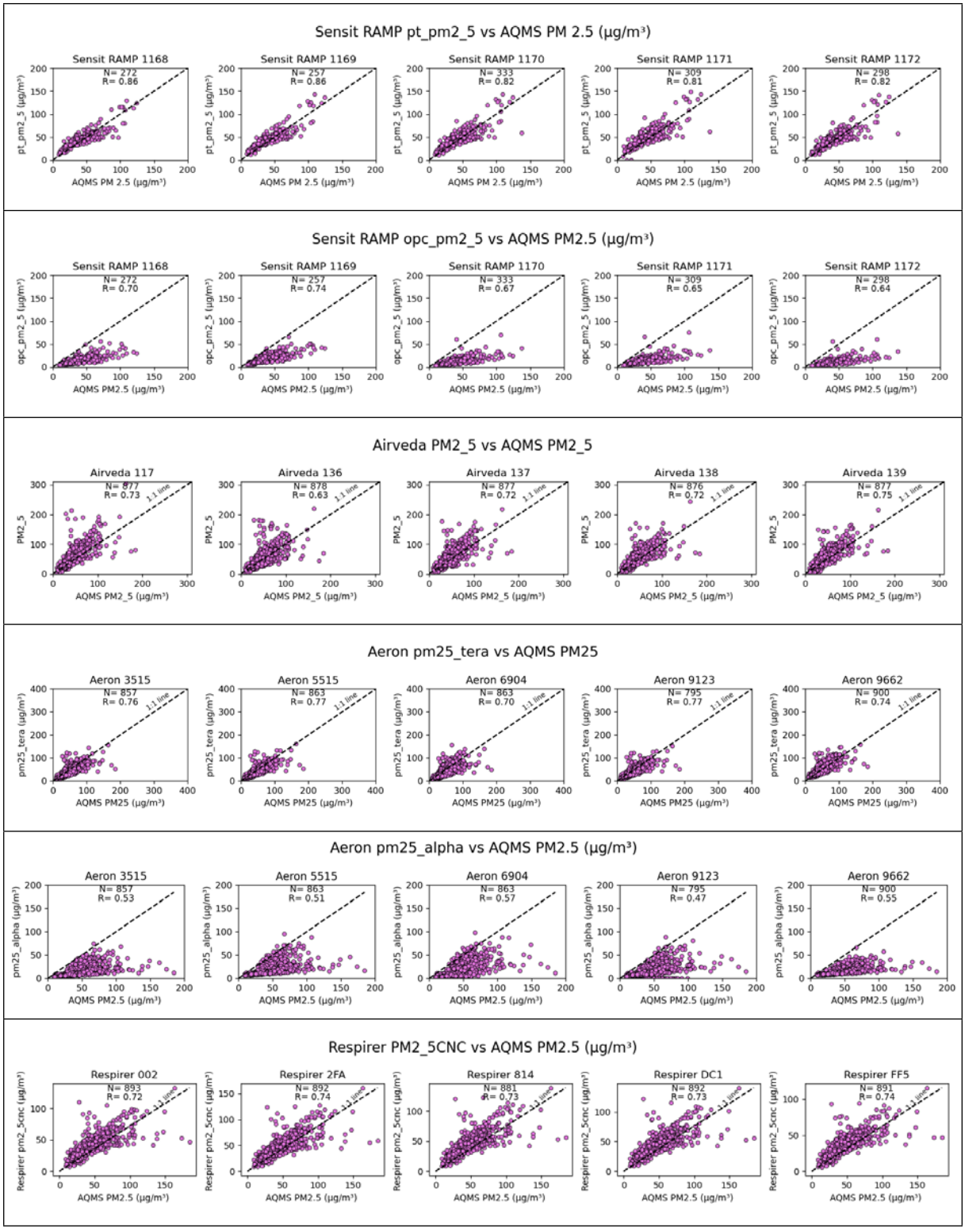
Sensor (raw) with AQMS: O_3

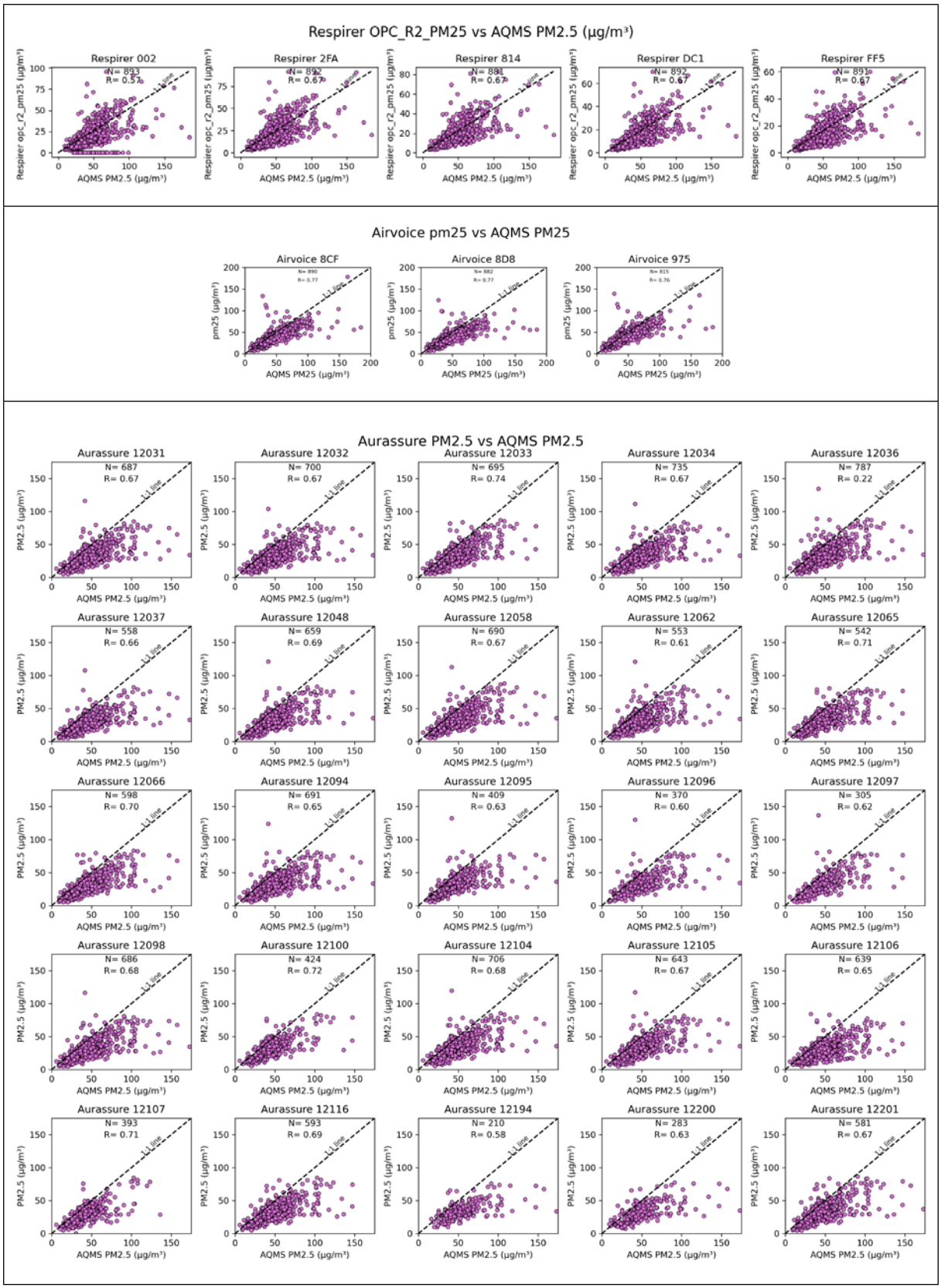
***Figure A58**: Comparison of raw O_3 measurements reported from the sensor nodes against the reference instrument*



Sensor (manufacturer-reported) with AQMS: $PM_{2.5}$

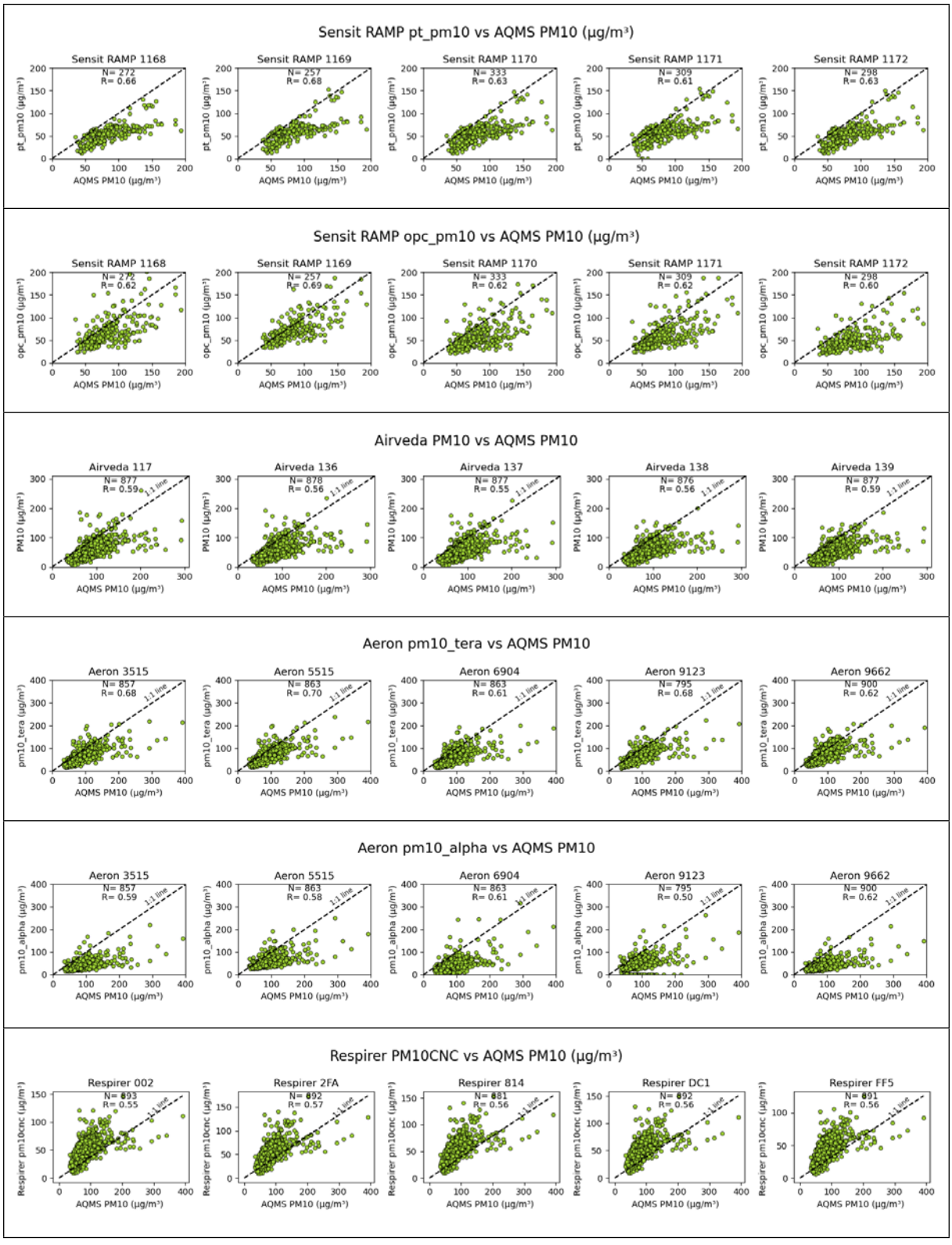
***Figure A59**: Comparison of manufacturer-reported $PM_{2.5}$ measurements reported from the sensor nodes against the reference instrument*

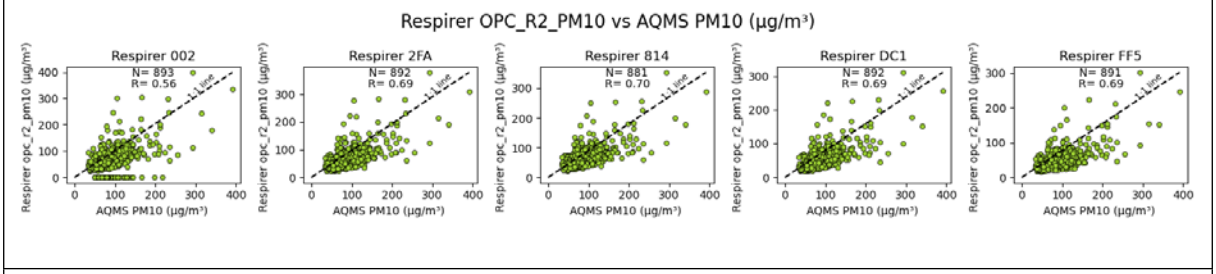


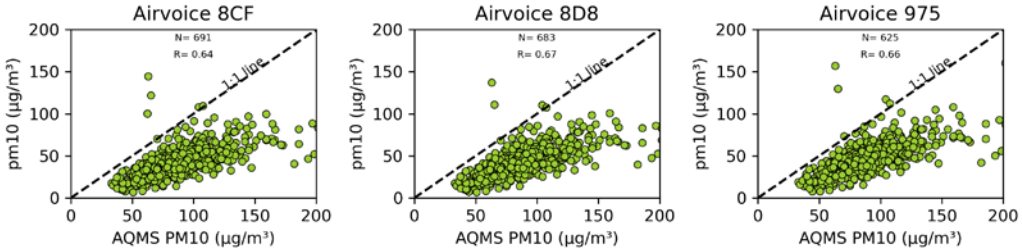

Respirer OPC_R2_PM25 vs AQMS PM2.5 (µg/m³)
Respirer 002
N= 893
R= 0.57
Respirer 2FA
N= 892
R= 0.67
Respirer 814
N= 881
R= 0.67
Respirer DC1
N= 892
R= 0.67
Respirer FF5
N= 891
R= 0.67
Respirer opc_r2_pm25 (µg/m³)
AQMS PM2.5 (µg/m³)
1:1 line
Airvoice pm25 vs AQMS PM25
Airvoice 8CF
Airvoice 8D8
Airvoice 975
pm25 (µg/m³)
AQMS PM25 (µg/m³)
Aurassure PM2.5 vs AQMS PM2.5
Aurassure 12031
N= 687
R= 0.67
Aurassure 12032
N= 700
R= 0.67
Aurassure 12033
N= 695
R= 0.74
Aurassure 12034
N= 735
R= 0.67
Aurassure 12036
N= 787
R= 0.22
Aurassure 12037
N= 558
R= 0.66
Aurassure 12048
N= 659
R= 0.69
Aurassure 12058
N= 690
R= 0.67
Aurassure 12062
N= 553
R= 0.61
Aurassure 12065
N= 542
R= 0.71
Aurassure 12066
N= 598
R= 0.70
Aurassure 12094
N= 691
R= 0.65
Aurassure 12095
N= 409
R= 0.63
Aurassure 12096
N= 370
R= 0.60
Aurassure 12097
N= 305
R= 0.62
Aurassure 12098
N= 686
R= 0.68
Aurassure 12100
N= 424
R= 0.72
Aurassure 12104
N= 706
R= 0.68
Aurassure 12105
N= 643
R= 0.67
Aurassure 12106
N= 639
R= 0.65
Aurassure 12107
N= 393
R= 0.71
Aurassure 12116
N= 593
R= 0.69
Aurassure 12194
N= 210
R= 0.58
Aurassure 12200
N= 283
R= 0.63
Aurassure 12201
N= 581
R= 0.67
PM2.5 (µg/m³)
AQMS PM2.5 (µg/m³)

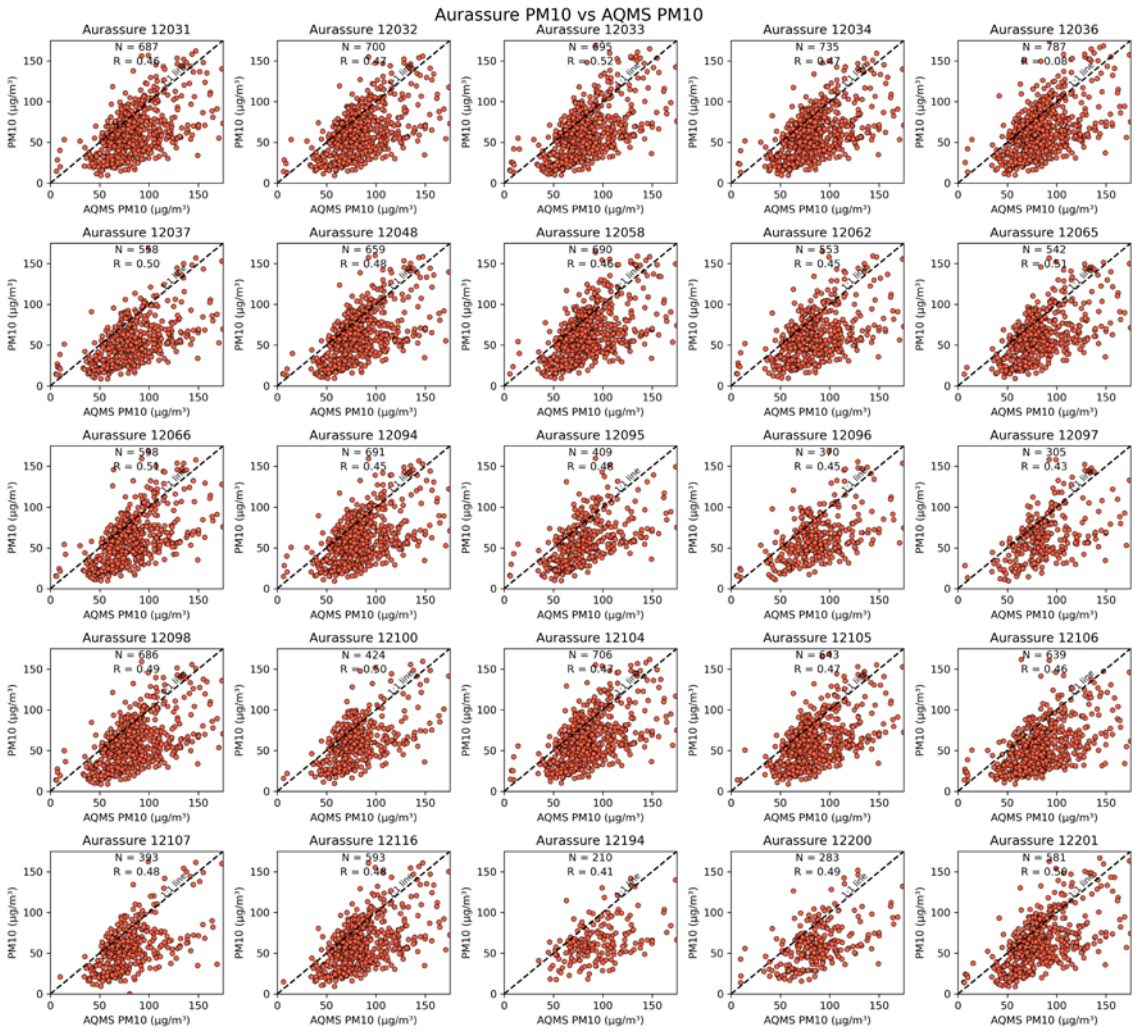
Sensor (manufacturer-reported) with AQMS: PM_{10}

***Figure A60**: Comparison of manufacturer-reported PM_{10} measurements reported from the sensor nodes against the reference instrument*



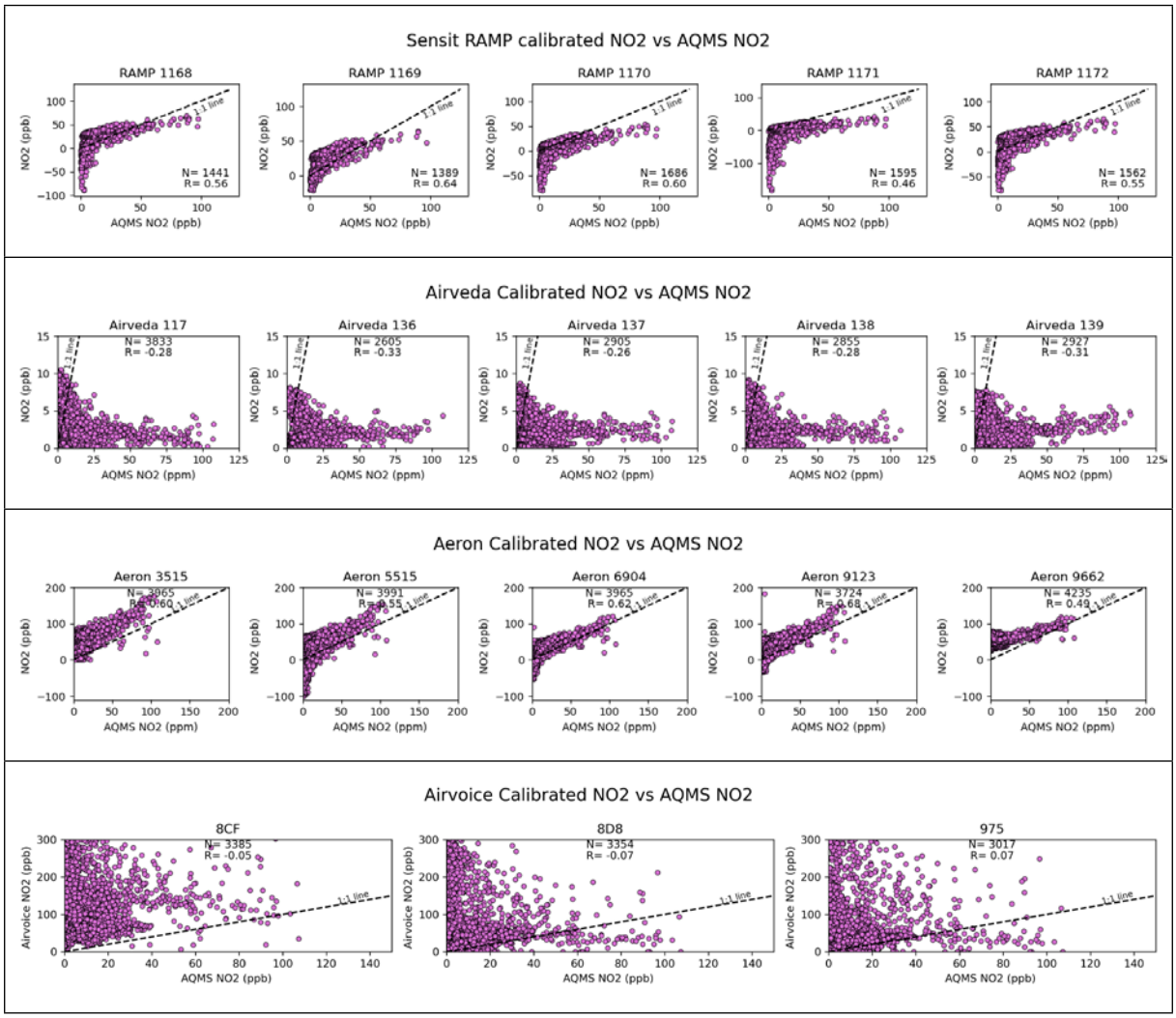

Respirer OPC_R2_PM10 vs AQMS PM10 (µg/m³)
Respirer 002
N= 893
R= 0.56
Respirer 2FA
N= 892
R= 0.69
Respirer 814
N= 881
R= 0.70
Respirer DC1
N= 892
R= 0.69
Respirer FF5
N= 891
R= 0.69
1:1 line
Respirer opc_r2_pm10 (µg/m³)
AQMS PM10 (µg/m³)

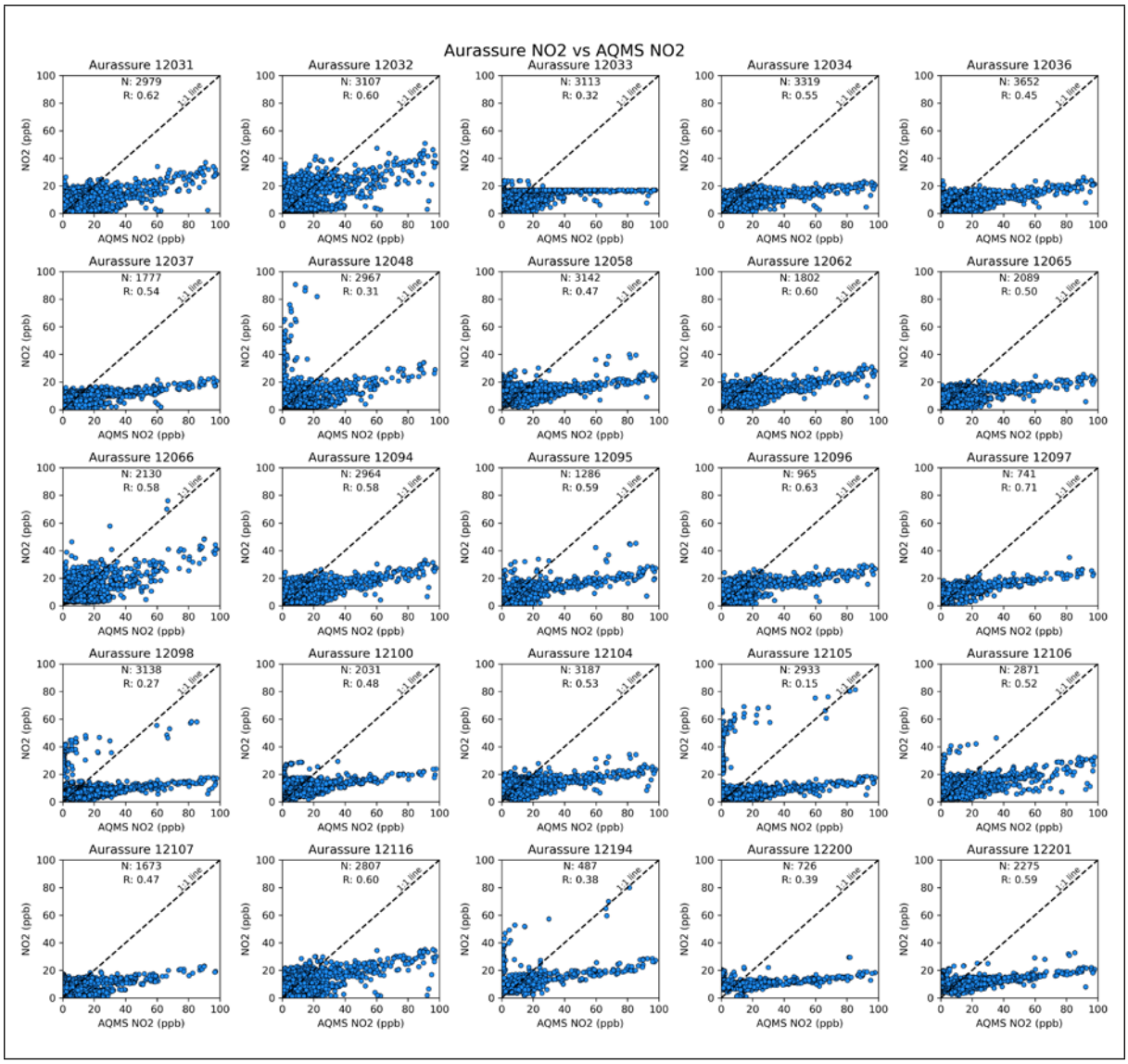

Airvoice pm10 vs AQMS PM10
Airvoice 8CF
N= 691
R= 0.64
Airvoice 8D8
N= 683
R= 0.67
Airvoice 975
N= 625
R= 0.66
1:1 line
pm10 (µg/m³)
AQMS PM10 (µg/m³)


Aurassure PM10 vs AQMS PM10
Aurassure 12031
Aurassure 12032
Aurassure 12033
Aurassure 12034
Aurassure 12036
Aurassure 12037
Aurassure 12048
Aurassure 12058
Aurassure 12062
Aurassure 12065
Aurassure 12066
Aurassure 12094
Aurassure 12095
Aurassure 12096
Aurassure 12097
Aurassure 12098
Aurassure 12100
Aurassure 12104
Aurassure 12105
Aurassure 12106
Aurassure 12107
Aurassure 12116
Aurassure 12194
Aurassure 12200
Aurassure 12201
1:1 line
PM10 (µg/m³)
AQMS PM10 (µg/m³)

Sensor (manufacturer-as-reported) with AQMS: NO_2

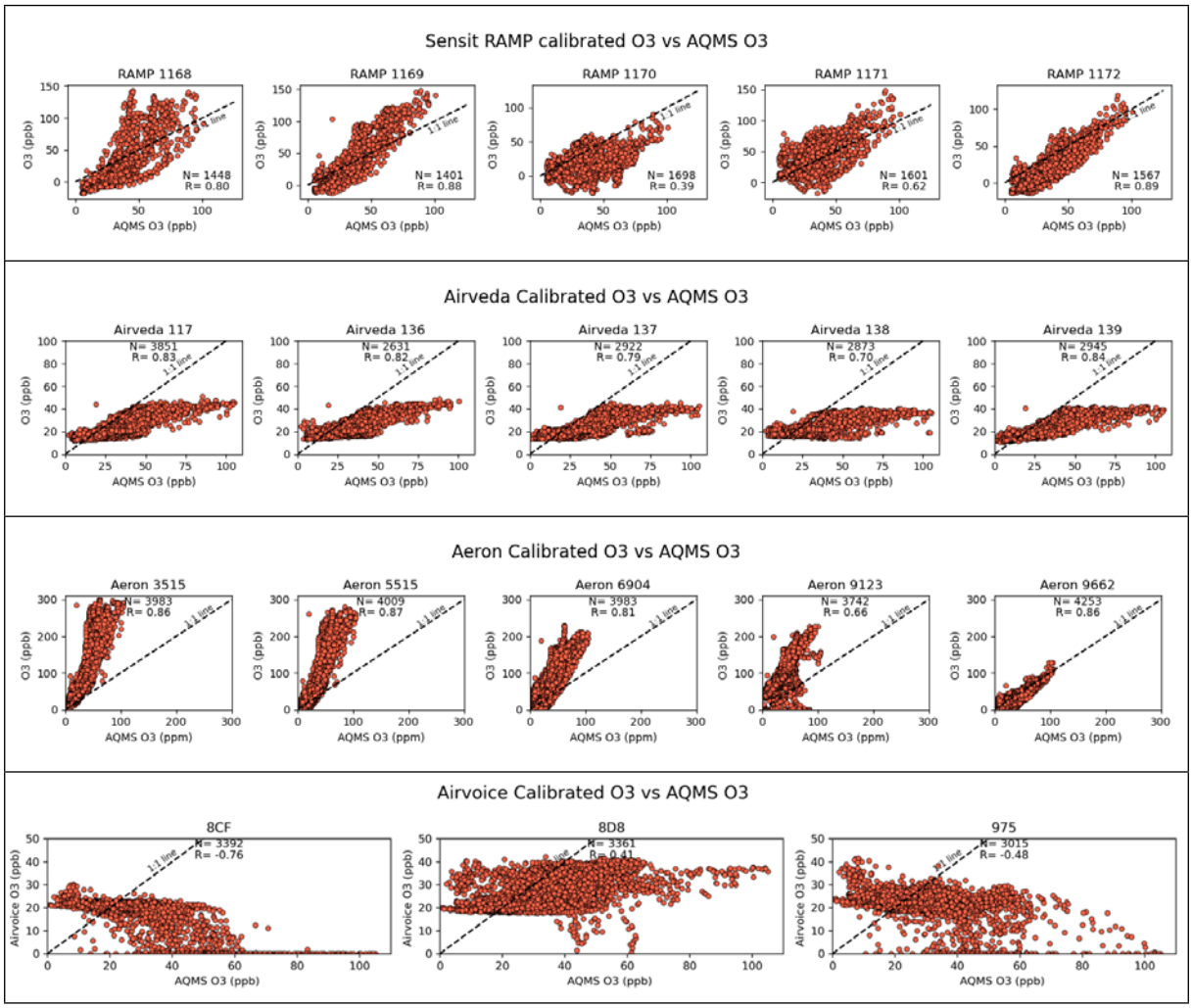
***Figure A61**: Comparison of manufacturer-reported NO_2 measurements reported from the sensor nodes against the reference instrument*

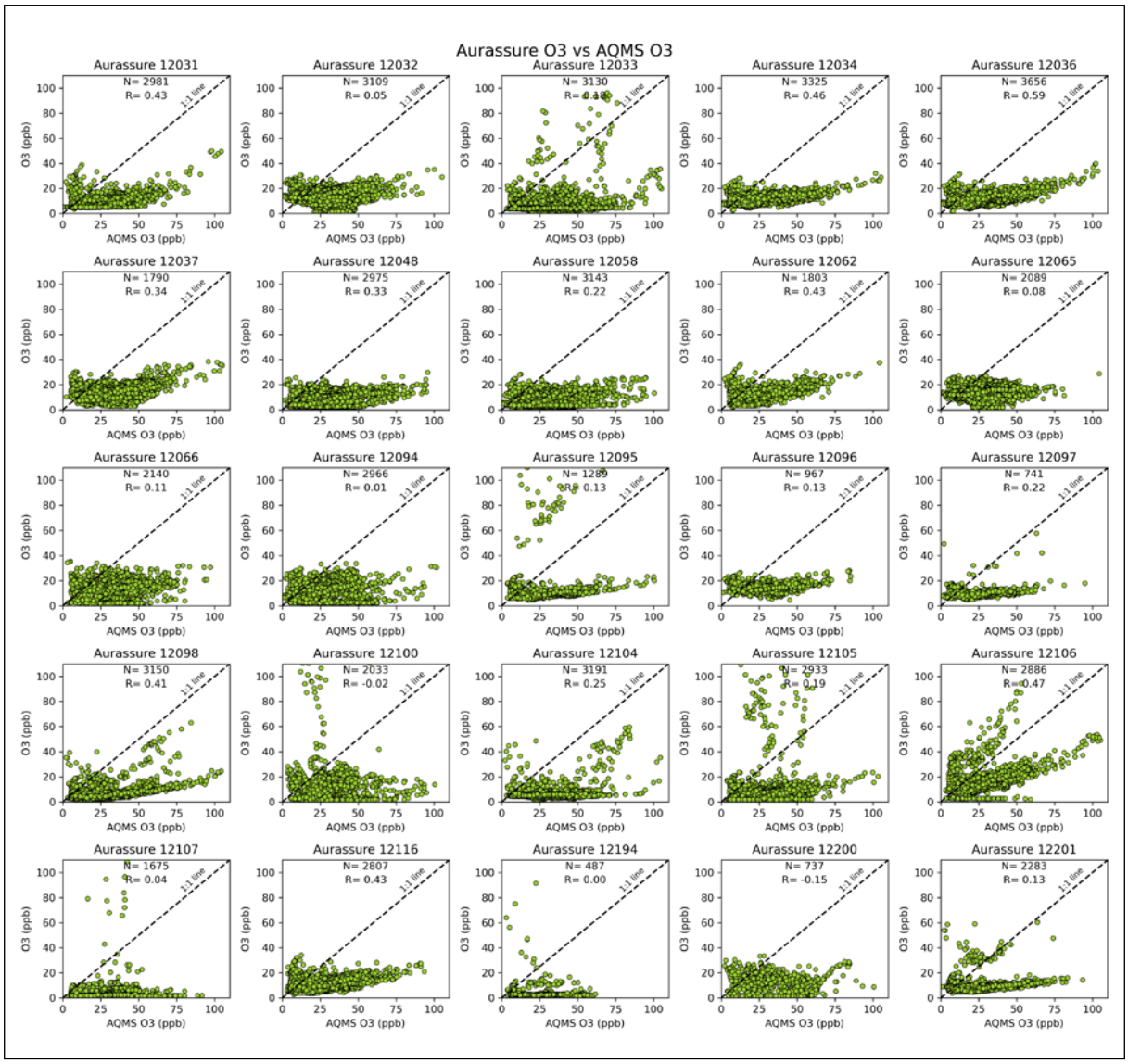



Aurassure NO2 vs AQMS NO2
Aurassure 12031
N: 2979
R: 0.62
Aurassure 12032
N: 3107
R: 0.60
Aurassure 12033
N: 3113
R: 0.32
Aurassure 12034
N: 3319
R: 0.55
Aurassure 12036
N: 3652
R: 0.45
Aurassure 12037
N: 1777
R: 0.54
Aurassure 12048
N: 2967
R: 0.31
Aurassure 12058
N: 3142
R: 0.47
Aurassure 12062
N: 1802
R: 0.60
Aurassure 12065
N: 2089
R: 0.50
Aurassure 12066
N: 2130
R: 0.58
Aurassure 12094
N: 2964
R: 0.58
Aurassure 12095
N: 1286
R: 0.59
Aurassure 12096
N: 965
R: 0.63
Aurassure 12097
N: 741
R: 0.71
Aurassure 12098
N: 3138
R: 0.27
Aurassure 12100
N: 2031
R: 0.48
Aurassure 12104
N: 3187
R: 0.53
Aurassure 12105
N: 2933
R: 0.15
Aurassure 12106
N: 2871
R: 0.52
Aurassure 12107
N: 1673
R: 0.47
Aurassure 12116
N: 2807
R: 0.60
Aurassure 12194
N: 487
R: 0.38
Aurassure 12200
N: 726
R: 0.39
Aurassure 12201
N: 2275
R: 0.59
1:1 line
NO2 (ppb)
AQMS NO2 (ppb)

Sensor (manufacturer-reported) with AQMS: O_3

***Figure A62**: Comparison of manufacturer-reported O_3 measurements reported from the sensor nodes against the reference instrument*




Aurassure O3 vs AQMS O3
Aurassure 12031
N= 2981
R= 0.43
Aurassure 12032
N= 3109
R= 0.05
Aurassure 12033
N= 3130
Aurassure 12034
N= 3325
R= 0.46
Aurassure 12036
N= 3656
R= 0.59
Aurassure 12037
N= 1790
R= 0.34
Aurassure 12048
N= 2975
R= 0.33
Aurassure 12058
N= 3143
R= 0.22
Aurassure 12062
N= 1803
R= 0.43
Aurassure 12065
N= 2089
R= 0.08
Aurassure 12066
N= 2140
R= 0.11
Aurassure 12094
N= 2966
R= 0.01
Aurassure 12095
N= 1289
R= 0.13
Aurassure 12096
N= 967
R= 0.13
Aurassure 12097
N= 741
R= 0.22
Aurassure 12098
N= 3150
R= 0.41
Aurassure 12100
N= 2033
R= -0.02
Aurassure 12104
N= 3191
R= 0.25
Aurassure 12105
N= 2933
R= 0.19
Aurassure 12106
N= 2886
R= 0.47
Aurassure 12107
N= 1675
R= 0.04
Aurassure 12116
N= 2807
R= 0.43
Aurassure 12194
N= 487
R= 0.00
Aurassure 12200
N= 737
R= -0.15
Aurassure 12201
N= 2283
R= 0.13
1:1 line
O3 (ppb)
AQMS O3 (ppb)

Annexure E: Advantages and Disadvantages of Various Model Algorithms

***Table A3**: Advantages and disadvantages of the various algorithms used for developing calibration models*

Method	Advantage	Disadvantage
Linear regression	Easy and fast, no hyperparameters to tune, and coefficients are easy to obtain. Test values can be outside the range of training values, and the method will extrapolate.	May not be able to capture non-linear relationships in the data.
Quadratic regression	Easy and fast, no hyperparameters to tune, and coefficients are easy to obtain. Test values can be outside the range of training values, and the method will extrapolate.	May not be able to capture non-linear relationships in the data.
Random forest regression	Provides feature importance and high-quality results. Is robust to noise because we average over multiple trees.	Highly prone to overfitting, computationally intensive, and many hyperparameters to be tuned.
Support vector regression	It provides feature importance, high-quality results, and robustness to noise as we average over multiple trees.	Somewhat highly prone to overfitting, computationally intensive, and many hyperparameters to be tuned.
XGBoost regression	It focuses on minimising the loss function only on high residual points, making it relatively more robust to outliers and giving it a high generalisation capacity. The radial kernel helps to generalise non-linear relationships easily.	Long training time for large data sets underperforms when the number of features significantly exceeds the number of data points.

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