

AQS 1 Co-Location Field Trial at Atlanta, Georgia

August 2016 to April 2017



Authors

Jonathan Taylor

Geoff Henshaw

Acknowledgements

Aeroqual Limited would like to thank the following people and companies for their help with this project:

- The Georgia Environmental Protection Division for allowing access to their South De Kalb air monitoring site and for the use of their data.
- Eric Mallory and Thomas Wilbur of Wilbur Tech Services for the installation and operation of the AQS 1.

1 Introduction

The Aeroqual AQS 1 is an ambient air quality monitor that combines particulate matter and gas pollutant measurement in a compact package that can be quickly deployed.

A co-location trial of an Aeroqual AQS 1 and a reference air monitoring station was conducted in Atlanta, Georgia, USA. The AQS 1 was installed at the Georgia Environmental Protection Division's (GEPD) South De Kalb air monitoring site by J.J. Wilbur Company Inc.



The AQS 1 measured ozone (O_3) and particulate matter ($PM_{2.5}$). The reference station measured criteria pollutants and meteorological parameters including ambient temperature and relative humidity.

Field calibrations were not performed on the AQS 1 during the trial period. Reference station data was obtained from GEPD; this data was used as received. Data validation and adjustment is described in Appendix A.

This report presents the results of the co-location trial for the nine month period 01 August 2016 to 30 April 2017. It contains basic statistical information, line graphs and scatter plots. From the results of the comparison the coefficient of determination (r^2) has been calculated for 1-hour and 24-hour averaging periods.

1.1 Site location

The AQS 1 was installed at the GEPD South De Kalb air monitoring site located 12 km (7 miles) southeast of downtown Atlanta. The site is in an open field surrounded by trees and located in a residential area (Figure 1-2). The closest main road is 600 m (2,000 feet) to the north.

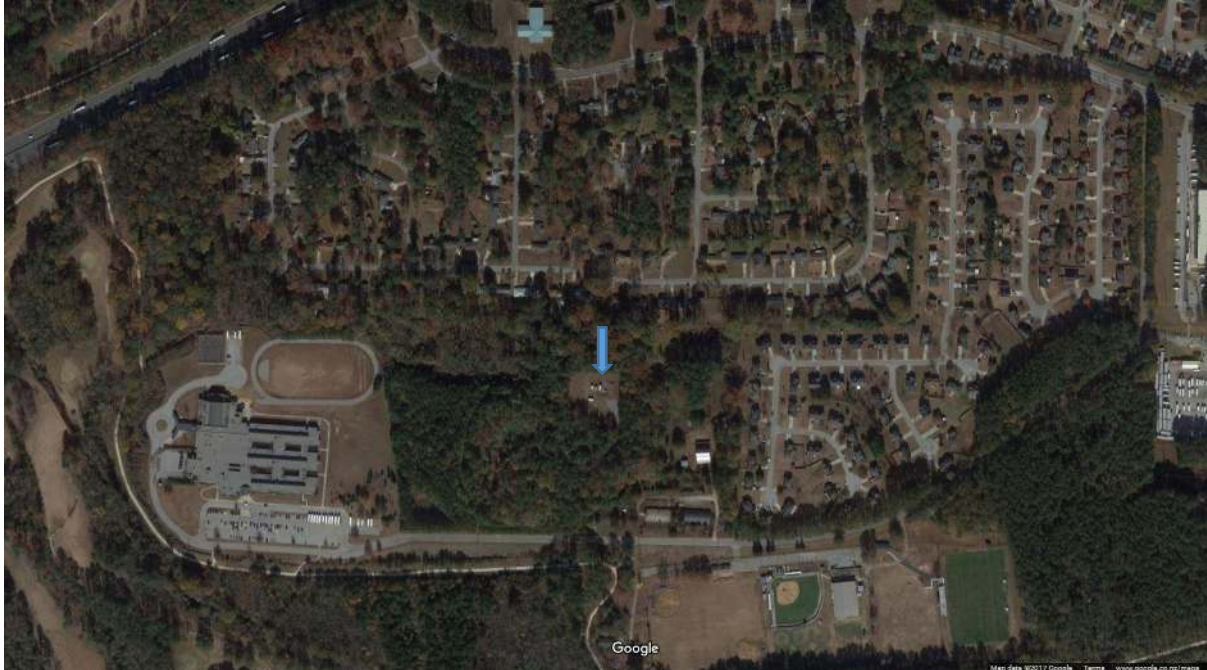


Figure 1: Aerial view of the area surrounding the South De Kalb air monitoring site (indicated by blue arrow)



Figure 2: Aerial view of the South De Kalb site with the AQS 1 (blue arrow) and reference instruments (green arrow)

1.2 Significant events

During the monitoring period there were several significant natural events. There were extreme weather events including Hurricane Matthew which passed beside the state of Georgia in early October 2016. In addition, there were several severe storms and tornados in the vicinity of Atlanta that occurred throughout the reporting period. During these events the AQS 1 was able to perform with no effect and withstood the extreme conditions.

In November 2016 there were major wildfires burning in areas of North Georgia, North Carolina, Tennessee and Alabama. The smoke from these fires caused high concentrations of particulate matter during the 9–15 November 2016. Visibility over Atlanta was reduced and the EPA issued a red alert for air quality.

2 Results

Basic statistics and correlation coefficients are displayed in Table 1. Graphs of data are displayed in Figures 3 to 9.

Table 1: Summary statistics for the 01 August 2016 to 30 April 2017

Average	Parameter	Minimum	Average	Maximum	Data Capture (%)	Correlation coefficient
1-hour	AQS 1 O ₃ (ppb)	2.0	22.3	81.3	100	0.97
	Reference O ₃ (ppb)	2.0	21.3	80.0	94 ¹	
24-hour	AQS 1 PM _{2.5} (µg/m ³)	5.9	11.9	62.2	100	0.73
	Reference PM _{2.5} (µg/m ³)	1.7	12.3	56.3	78 ²	

¹ O₃ analyser instrument error occurred from 11 to 21 October 2016.

² Instrument fault at times during the reporting period resulted in negative 24-hour averaged data. This data was invalidated (See Appendix).

AQS 1 vs Reference O₃ Comparison (1-hour Average)

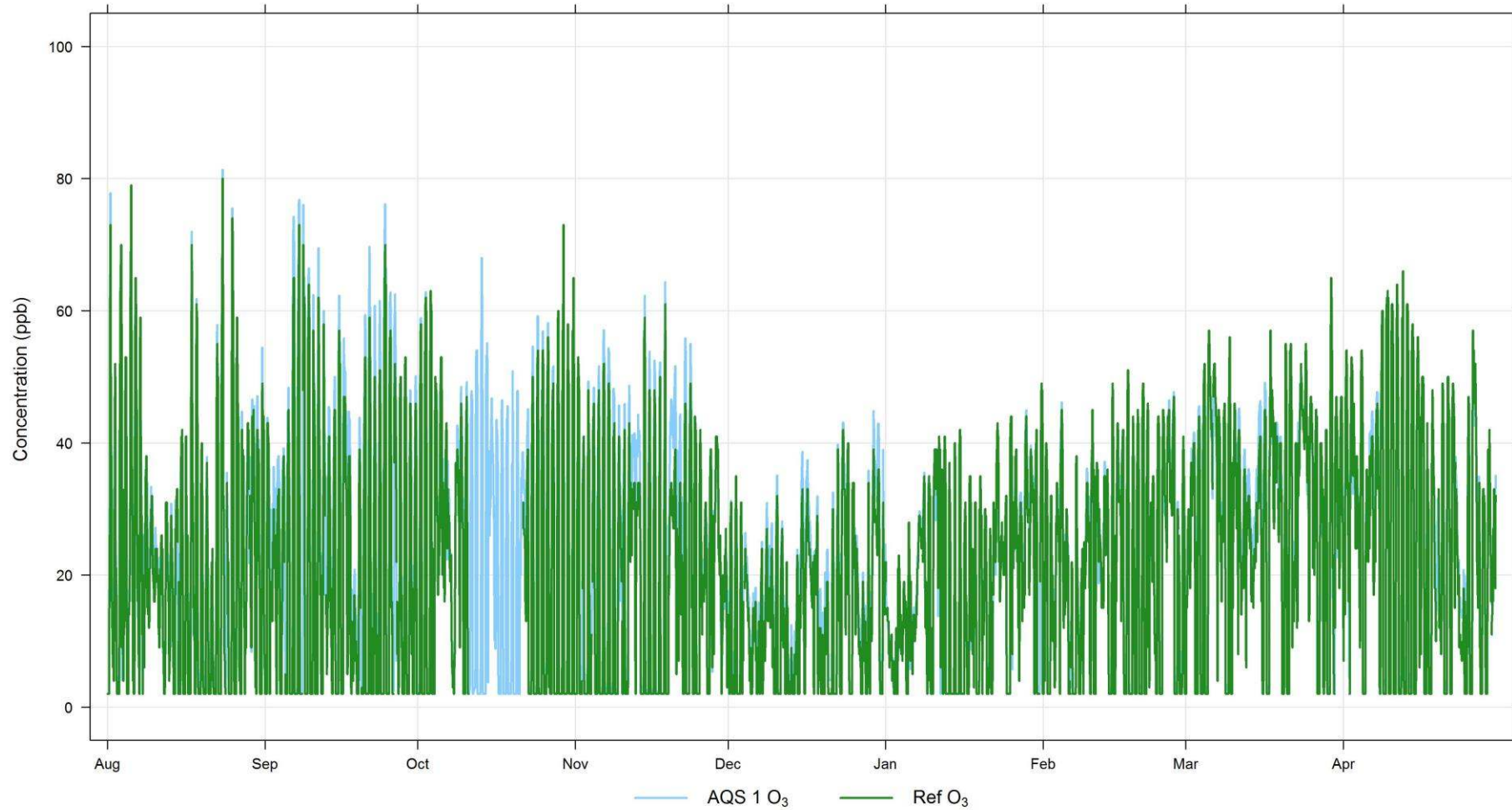


Figure 3: Hourly ozone comparison for 01 August 2016 to 30 April 2017

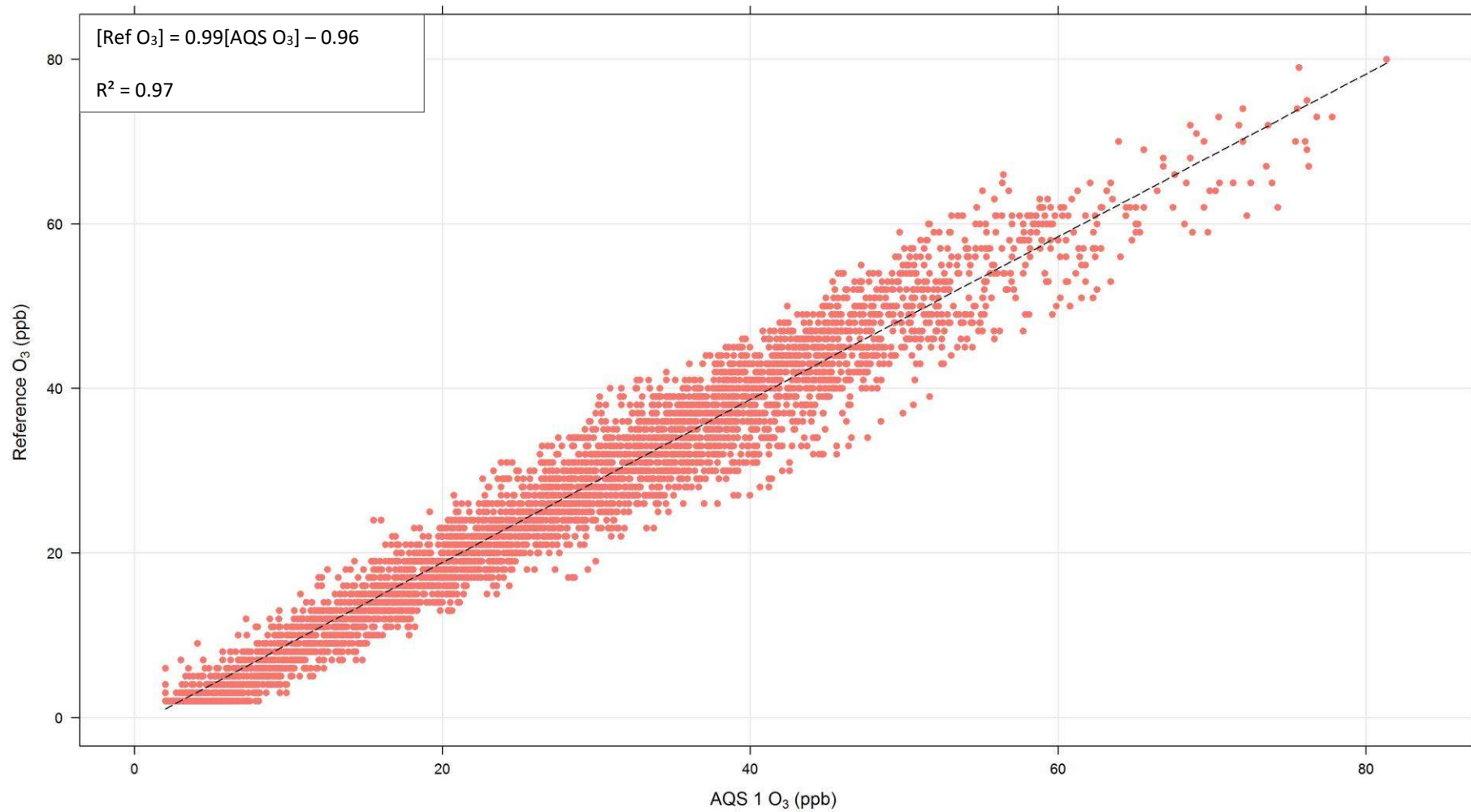


Figure 4: Hourly ozone scatter plot for 01 August 2016 to 30 April 2017

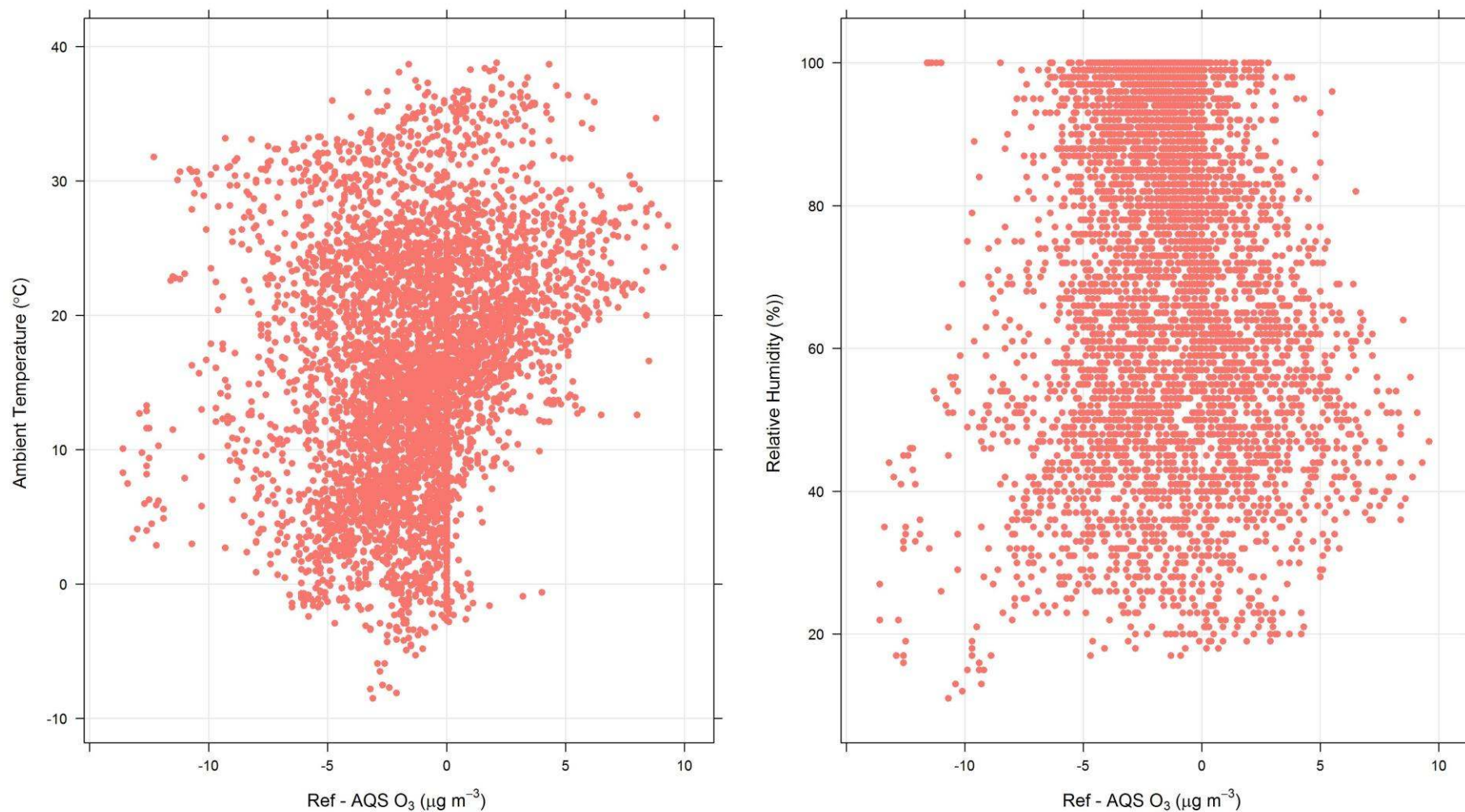


Figure 5: Scatter plots of the hourly O₃ difference (reference minus AQS 1 data) vs ambient temperature and relative humidity for 01 August 2016 to 30 April 2017

AQS 1 vs Reference PM_{2.5} Comparison (24-hour Average)

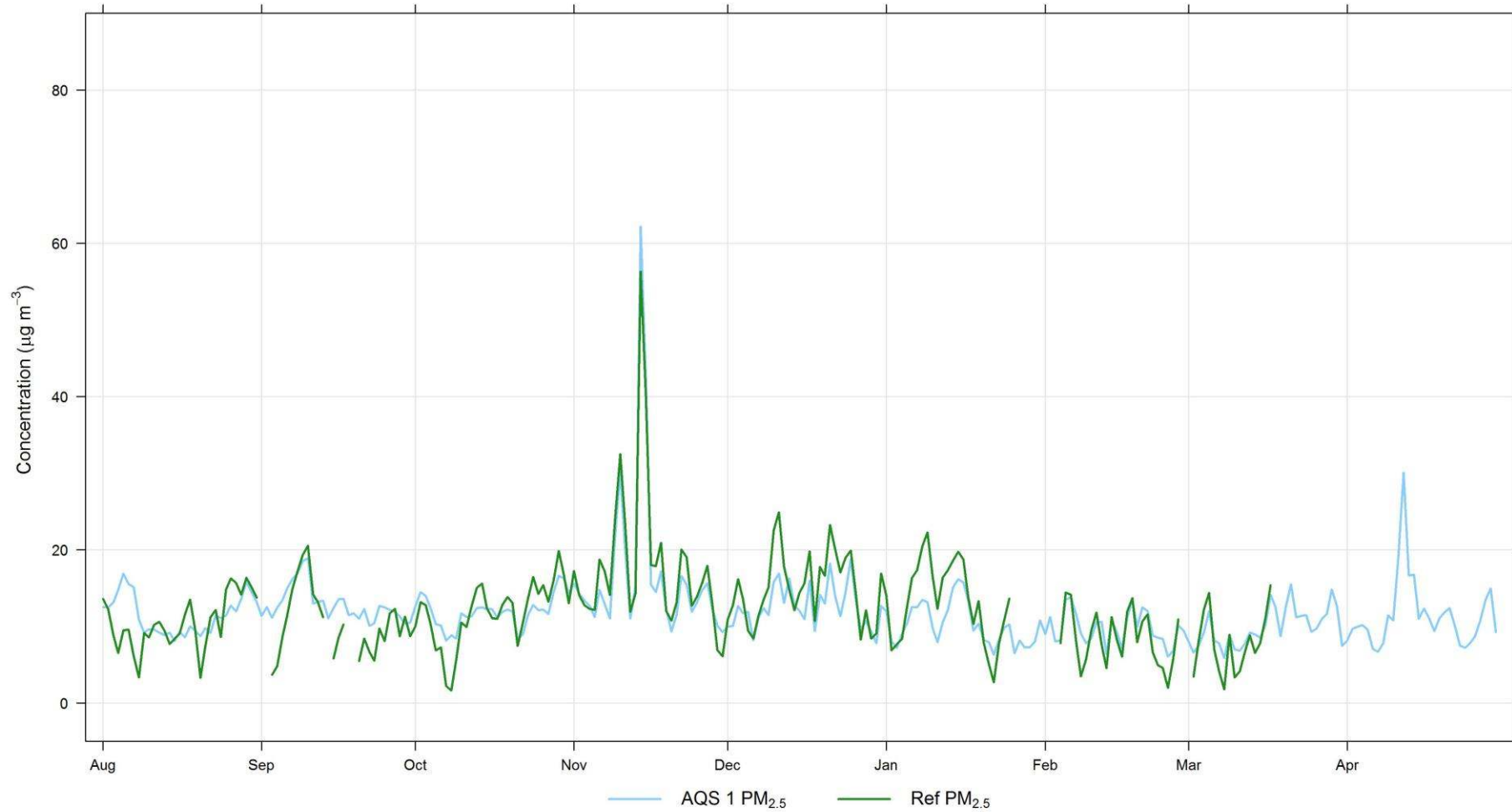


Figure 6: 24-Hourly PM_{2.5} comparison for 01 August 2016 to 30 April 2017

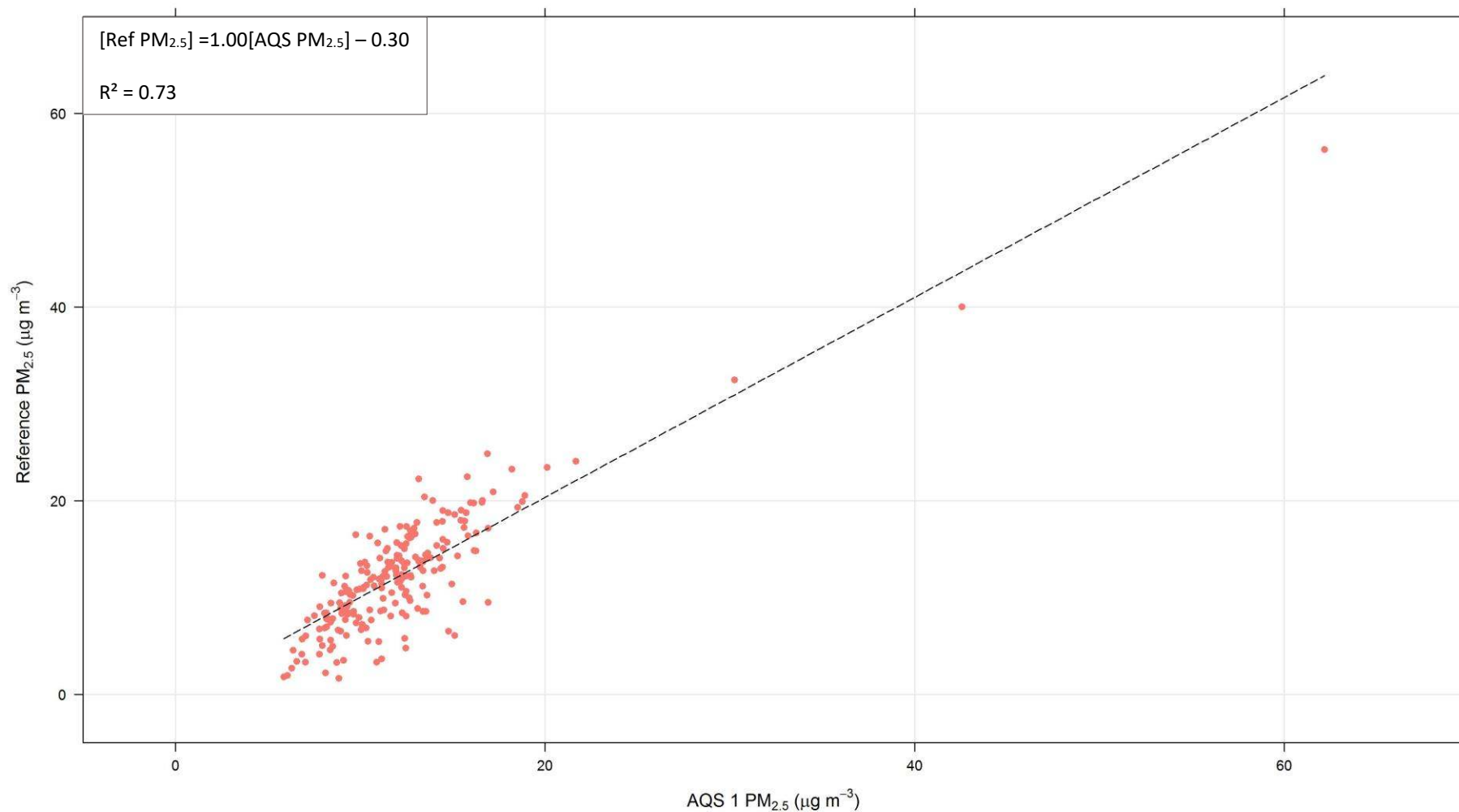


Figure 7: 24-Hourly PM_{2.5} scatter plot for 01 August 2016 to 30 April 2017

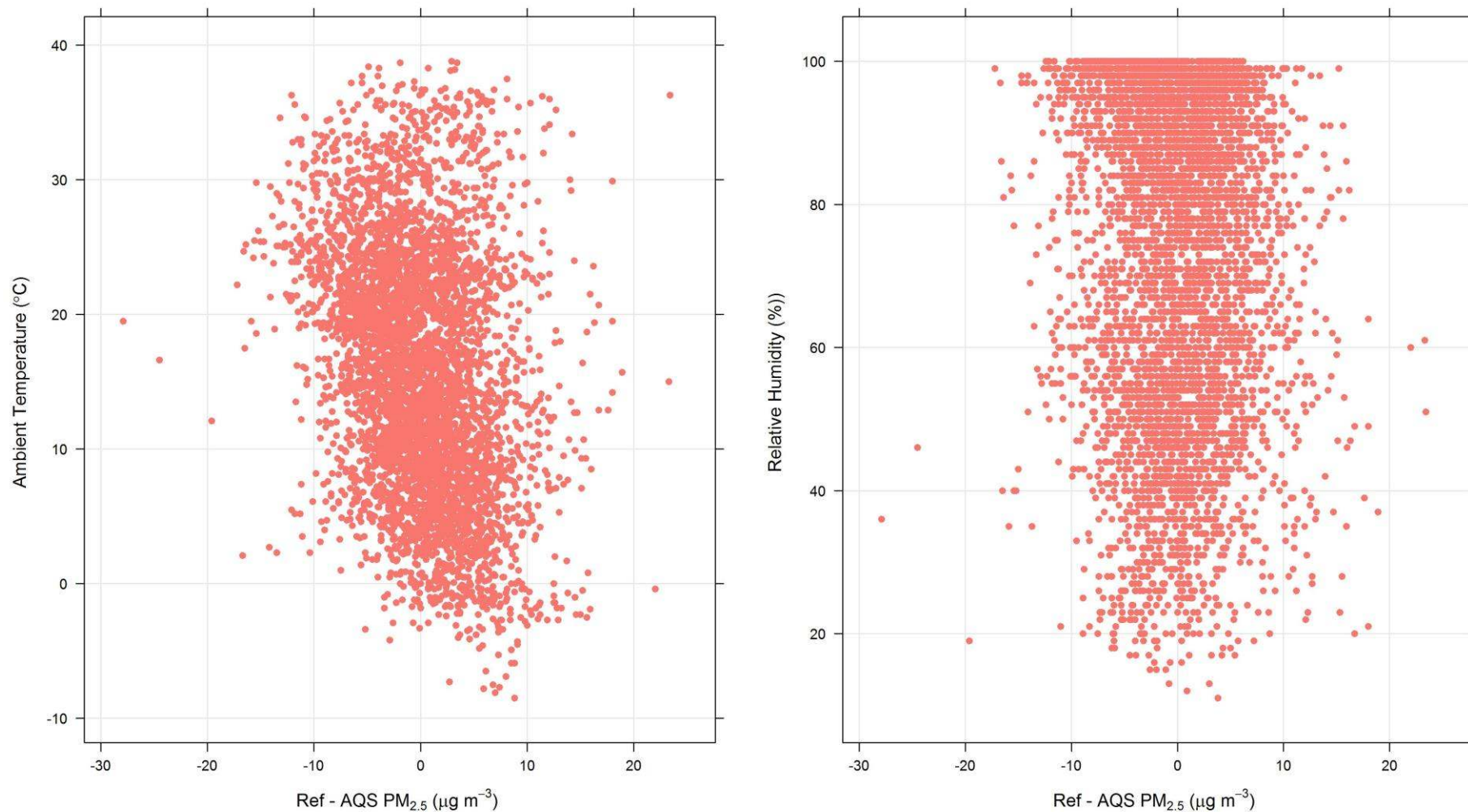


Figure 8: Scatter plots of the hourly PM_{2.5} difference (reference minus AQS 1 data) vs ambient temperature and relative humidity for 01 August 2016 to 30 April 2017

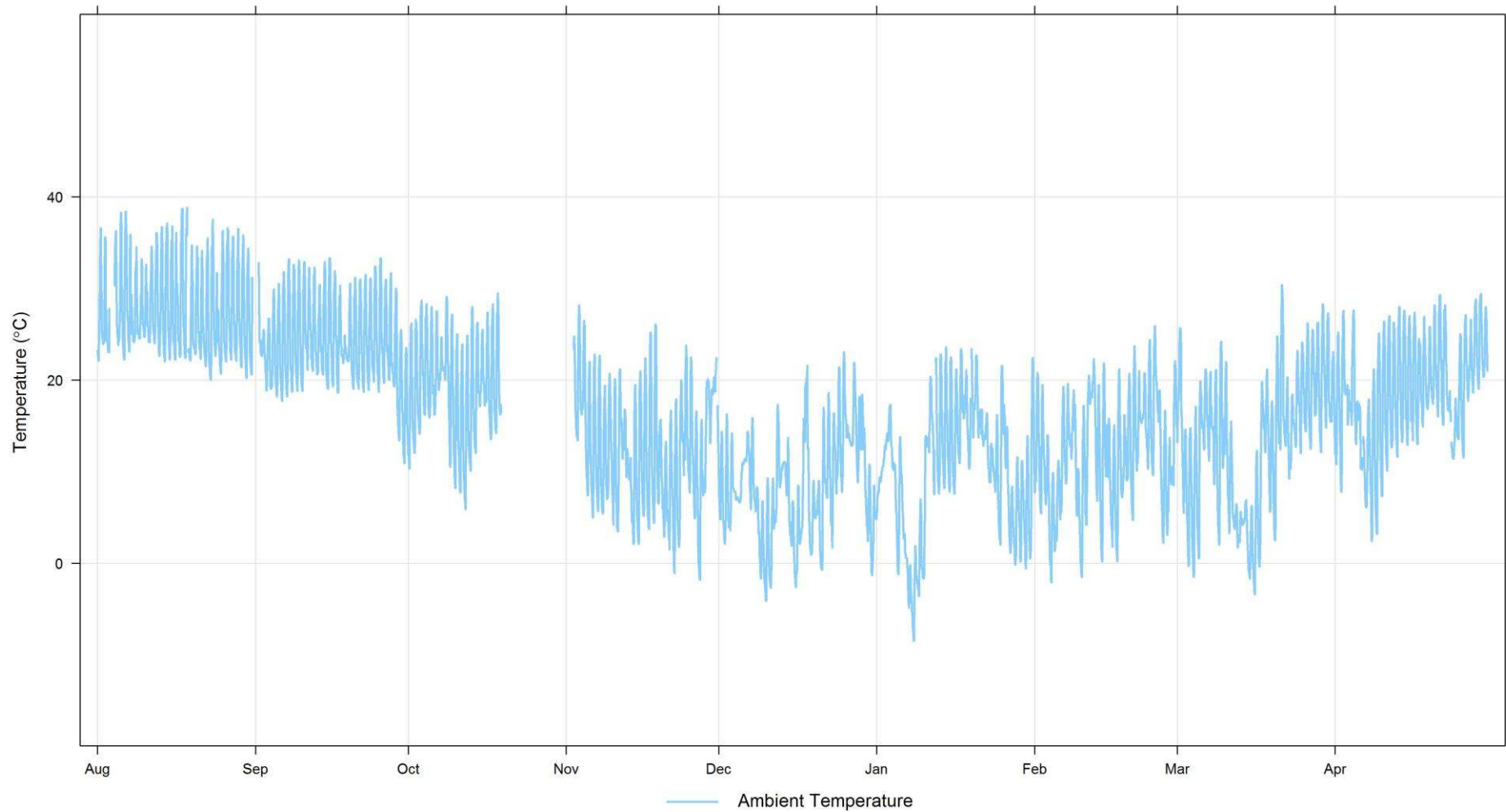


Figure 9: Hourly reference ambient temperature and AQS 1 internal temperature for 01 August 2016 to 30 April 2017

3 Evaluation

The Aeroqual AQS 1 achieved a data capture rate of 100 % and performed without faults over the period of the trial. The AQS 1 was allowed to operate without any standard routine maintenance procedures performed (calibration checks, filter changes, etc.) The O₃ and PM_{2.5} was calibrated by using 1 week of reference instrument data. The O₃ module was calibrated four times and the PM_{2.5} was calibrated once during the reporting period.

The 1-hour average O₃ concentrations measured by the AQS 1 showed excellent correlation with the reference O₃ analyser with an $r^2 = 0.97$. The slope was 0.99 with an offset of -0.96 ppb.

The 24-hour average PM_{2.5} concentrations measured by the AQS 1 also showed a good correlation to the reference PM_{2.5} instrument with an $r^2 = 0.73$. The slope was 1.0 with an offset of -0.30 µg/m³.

The AQS 1 was exposed to hourly ambient temperatures that ranged from -8.5 to 30.4 °C and hourly relative humidity that ranged from 11.0 to 100.0 %. No significant temperature or relative humidity interference effects were observed on either the AQS 1 O₃ or PM_{2.5} measurements (Figure 5 and Figure 8). In addition, the AQS 1 was not affected by extreme weather events during the reporting period.

In conclusion, the AQS 1 performed consistently well over the 9 month test period with all measurements closely matching those of the reference station values.

A Data Validation

Reference data

Negative PM_{2.5} data resulting in a low or negative 24-hour average was removed due to it most likely being an instrument fault.

Period	Description
1/9/16 10:00 to 2/9/16 10:00	PM _{2.5} data invalidated
14/09/16 10:00 to 15:00	PM _{2.5} data invalidated
18/09/16 13:00 to 19/09/16 13:00	PM _{2.5} data invalidated
26/01/17 15:00 to 31/01/17 23:00	PM _{2.5} data invalidated
18/03/17 00:00 to 01/05/17 00:00	PM _{2.5} data invalidated

AQS 1 data

Summary of data validation:

Period	Description
01/08/16 00:00 to 26/09/16 20:00	Ozone calibrated based on reference data comparison during the period 01/08/16 00:00 – 07/08/16 23:59
28/08/16 19:53 to 13/03/17 16:35	PM _{2.5} linear baseline correction (auto-zero was turned off during this period)
26/09/16 20:01 to 24/11/16 06:00	Ozone calibrated based on reference data comparison during the period 27/09/16 00:00 – 03/10/16 23:59
01/10/16 00:00 to 30/04/17 23:59	PM _{2.5} calibrated based on reference data comparison during the period 01/10/16 00:00 – 07/10/16 23:59
24/11/16 06:01 to 31/12/16 23:59	Ozone calibrated based on reference data comparison during the period 25/11/16 00:00 – 01/12/16 23:59
01/01/17 00:00 to 30/04/17 23:59	Ozone calibrated based on reference data comparison during the period 01/01/17 00:00 – 07/01/17 23:59