

Horse River Wildfire

May 2016

UPDATED PRELIMINARY AIR QUALITY
ASSESSMENT

About this document:

This technical document was prepared to provide information on air quality during a wildfire that entered the urban area of Fort McMurray. The information provided in this report is preliminary; it does not provide a comprehensive assessment of all airborne contaminants, a neighborhood scale assessment, nor information about long-term livability of the impacted urban area.

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Introduction

Alberta Health (AH) retained Treissman Environmental Consulting Inc. and Millennium EMS Solutions Ltd. (MEMS) to support in their effort to assess the potential risk to human health associated with the Horse River Fire.

The following memo provides a preliminary air quality assessment of fire-affected areas during the progression of the wildfire. The goals of the assessment were to determine how air quality and odour potential were affected during the time period from April 24 to May 30, 2016; and to compare air quality indicators to human health based limits.

Approach

Data available from five permanent air quality monitoring stations in the Wood Buffalo Environmental Association (WBEA) network, the AEP mobile air monitoring lab (MAML) in Fort McMurray and four temporary stations measuring $PM_{2.5}$ in Fort McMurray were examined in relation to fire hot spots to determine the effects of the fire on air quality (and potentially on odour). The permanent WBEA stations included Fort McKay (AMS1), Fort McMurray Patricia McInnis (AMS6), downtown Fort McMurray Athabasca Valley (AMS7), Anzac (AMS 14) and Conklin (AMS21) (Figure 1). The AEP MAML lab was deployed in Fort McMurray during the fire, with data available between May 16 and May 22, 2016. This report examines $PM_{2.5}$ data from temporary air monitoring stations in Fort McMurray from April 24 to May 30, 2016 at the Courthouse, from May 10 to May 30, 2016 in the First Nations Health Centre, from April 24 to May 30, 2016 at Keyano College/REOC and from May 8 to May 30, 2016 at the Airport. The stations continued to operate past these dates. In addition a time series of the air quality index (AQI) and odour potential were also created.

Toxicity reference values (TRV) and air quality objectives

The reference points used in the assessment included Alberta Ambient Air Quality Objectives and Guidelines (AAQOs, except where the 1-hour guideline for $PM_{2.5}$ is referred to specifically, then AAQG) and United States National Ambient Air Quality Standards (US NAAQS). TRVs were given preference to AAQOs, when available, because they are more directly linked to health effects. A TRV value indicates the exposure limit or the amount of chemical identified to be a safe exposure concentration and is used in toxicity assessments to establish the relationship between the amount of a chemical to which a person is exposed over a specified duration and the potential for adverse health effects. TRVs can be selected from government agencies (such as Alberta Environment and Parks, AEP) or may be derived directly from literature. Efforts were made to select TRVs from Canadian sources (AEP, Health Canada, CCME, etc.); however, TRVs from non-Canadian sources were given preference over AAQOs if the TRV value was a more defensible exposure limit for health effects. Applicable AAQOs, US NAAQSs and TRVs are listed in Table 1.

Parameter	Exposure Time	Value ($\mu\text{g}/\text{m}^3$)	Value (ppb)	Type	Agency
Sulphur Dioxide (SO_2)	10 minute	500	191	TRV	WHO (2005)
	1 hour	450	172	AAQO	AEP (2016)
Total Reduced Sulphide (TRS)/ Hydrogen Sulphide (H_2S)	1 hour	14 ^A	10 ^A	AAQO	AEP (2016)
	24 hour	4	3	AAQO	AEP (2016)
Nitrogen Oxide Species ($\text{NO}/\text{NO}_2/\text{NO}_x$)	1 hour	188	100	US NAAQS	US EPA (2012)
Ozone (O_3)	1 hour	160	82	AAQO	AEP (2016)
Ammonia (NH_3)	1 hour	1400 ^A	2000 ^A	AAQO	AEP (2016)
Particulate Matter ($\text{PM}_{2.5}$)	1 hour	80	-	AAQG	AEP (2016)
	24 hour	30	-	AAQO	AEP (2016)

^AAAQO is based on odour perception and not on health effects.

An AEP AAQO or AAQG value was available for most parameters examined. A short-term (10 minute) TRV for SO_2 was selected from WHO (2005) based on controlled studies of exercising asthmatics and changes in pulmonary function. The US NAAQS value of 100 ppb for 1-hour NO_2 was selected for the assessment as it is based on an integrative synthesis of a large body of evidence on human health effects associated with the presence of NO_2 in air (US EPA 2012).

Wood Buffalo Environmental Association station air quality data

Continuous measurements of air quality and key meteorological variables from five permanent WBEA stations were plotted as a time series for the time period from April 24 to May 30, 2016 (Figures 2a to 7j). The time series for each parameter from the 2016 air quality data was compared to:

- a similar time period from 2015 (April 24 to May 30, 2015);
- the 95th percentile of air quality data from 2011 to 2015 (5 year baseline); and
- an AAQO, AAQG or TRV.

It should be noted that the 2016 data had not undergone the standard WBEA quality control measures or MEMS standard QA/QC measures due to the short time frames for data processing. Measurements from 2016 were visually quality controlled for Anzac data only by removing data points from the time period during which it was affected by a power outage that lasted for several days beginning approximately May 24. Data from this period is not shown in the figures in this report. No changes were made to 2015 data points.

Instrumentation in the WBEA stations was operated in a high-concentration environment. When $PM_{2.5}$ levels are high, there could be instantaneous saturation of the analyzers that measure other species, leading to inaccurate results. Also, there have been previous issues with ozone (O_3) instrumentation being biased high. This report presents the information available during the preliminary analysis, and discusses the broad implications of that information.

The time series of measurements from April 24 to May 30 2016 are shown in Figures 2a to 7j. The time series charts include the 1-h air quality and meteorology measurements made at each station, as well the calculated 24-h average of $PM_{2.5}$. The 1-hour and 24 hour data $PM_{2.5}$ from all five stations were also plotted on a log scale so as to better illustrate the variance in the data (Figures 7a to 7j). Also shown on each chart, where applicable, are AAQO or TRV values and the 95th percentile of 1-h observations during the period 2011-2015. The 5-year data would have included influences from urban, industrial and natural influences such as fires. For Conklin, 5-year data from Anzac were used.

Concentrations of air pollutants, as shown in each time series chart (Figures 2a to 7j), were highly variable and the highest concentrations were observed when the fire edge was nearest to and upwind of each station (fire edge and hot spot information from <http://cwfis.cfs.nrcan.gc.ca/home> are shown in Appendix A). Concentrations were highly dependent on wind direction which can vary substantially hour to hour. Concentrations in 2015 are generally lower than the 2016 measurements, even though meteorological conditions (wind speeds and temperatures) were not substantially different.

Interpretation of air quality episodes

For the April 24 to May 30 period, episodes were defined broadly based on periods when the hourly PM_{2.5} measurements at each site were above 80 µg/m³, which is the 1-hour Ambient Air Quality Guideline (AAQG). The episodes are not precisely defined but broadly based on concentration values and changes in wind direction. Up to five episodes were defined at each station. Data within each episode are summarized in Tables 2 to 5 below. The episodes in which 24-h PM_{2.5} concentrations exceeded the AAQO are placed was based on the start time of the 24-h period.

Episodes at Fort McKay (AMS 1) are presented in Table 2 below. During Episode 2, 1-hour PM_{2.5} concentrations were up to 40 times higher than the AAQG. During Episode 3, 44 hours were above the guideline and concentrations in three days were above the 24-hour AAQO of 30 µg/m³. Concentrations of total hydrocarbons (THC), non-methane hydrocarbons (NMHC) and total reduced sulphur (TRS) were elevated enough to create odour issues but were not unusually high.

	1	2	3
Start date & time	5/3/2016 13:00	5/6/2016 23:00	5/15/2016 21:00
Stop date & time	5/4/2016 11:00	5/8/2016 2:00	5/18/2016 1:00
Duration (h)	22	27	52
Max 1-h PM _{2.5} (µg/m ³)	146	3151	483
# of hours PM _{2.5} >80 µg/m ³	4	22	44
# of days PM _{2.5} >30 µg/m ³	0	2	3
Max 1-h Concentration			
Max 1-h THC (ppm)	2.5	4.6	3.0
Max 1-h NMHC (ppm)	0.3	1.7	0.5
Max 1-h TRS (ppb)	1.1	6.7	2.9
Wind direction range (deg)*	NNW	WNW/ENE	NW/NE

* All wind directions in this report are "blowing from"

	1	2	3	4	5
Start date & time	5/2/2016 9:00	5/5/2016 21:00	5/12/2016 22:00	5/14/2016 23:00	5/18/2016 21:00
Stop date & time	5/4/2016 22:00	5/10/2016 5:00	5/14/2016 11:00	5/18/2016 11:00	5/24/2016 5:00
Duration (h)	61	104	37	84	128
Max 1-h PM _{2.5} (µg/m ³)	5198	3399	623	1777	491
# of hours PM _{2.5} >80 µg/m ³	22	38	16	73	20
# of days PM _{2.5} >30 µg/m ³	3	4	2	4	3
Max 1-h THC (ppm)	8.6	6.3	3.9	4.5	2.9
Max 1-h NMHC (ppm)	3.8	2.4	1.1	1.5	0.5
Max 1-h TRS (ppb)	17	11	7.1	6.9	2.8
Wind direction range (deg)	NW/NE	NNW/NNE	S*	NE/NW	S*

* Variable winds

	1	2	3
Start date & time	5/2/2016 3:00	5/4/2016 21:00	5/11/2016 1:00
Stop date & time	5/4/2016 15:00	5/10/2016 8:00	5/20/2016 18:00
Duration (h)	60	131	233
Max 1-h PM _{2.5} (µg/m ³)	1340	3262	2361
# of hours PM _{2.5} >80 µg/ m ³	31	57	99
# of days PM _{2.5} >30 µg/ m ³	3	5	7
Max 1-h THC (ppm)	6.6	5.9	6.1
Max 1-h NMHC (ppm)	3	2.5	2.3
Max 1-h TRS (ppb)	9.5	10	13
Wind direction range (deg)	WNW/NNE	SE/ENE	S/WNW*

* Variable winds

Table 5 Anzac Episodes		
	1	2
Start date & time	5/13/2016 22:00	5/17/2016 12:00
Stop date & time	5/16/2016 5:00	5/21/2016 13:00
Duration (h)	55	97
Max 1-h PM _{2.5} (µg/m ³)	1006	294
# of hours PM _{2.5} >80 µg/m ³	34	16
# of days PM _{2.5} >30 µg/m ³	3	5
Max 1-h THC (ppm)	-	3
Max 1-h NMHC (ppm)	-	0.6
Max 1-h TRS (ppb)	-	4.3
Wind direction range (deg)	NE/SE	S/ENE

- Instrument not zero-span adjusted during part of this period

Mobile and temporary stations

The AEP MAML was deployed in Fort McMurray during the fire event, with data available from May 16 to May 22 at time of writing. Time series plots of select MAML parameters are shown in Figures 8a to 8d. Particulate measurements are consistent with WBEA measurements in the community but capture air quality at a number of locations in it after the main effect of the fire had passed (e.g., the maximum PM_{2.5} concentration was about 300 µg/m³ compared to values over 3000 µg/m³ at the Athabasca Valley site during the worst of the fire).

Four temporary stations measured PM_{2.5} in Fort McMurray with concentrations presented in Figure 9. Data are consistent with WBEA stations, with maximum values approaching 2500 µg/m³ at Keyano College on May 16 and about 1700 µg/m³ at the Courthouse station at the same time. Measurements since May 27, 2016 have been below the 1-hour AAQG of 80 µg/m³.

Air Quality Index and Air Quality Health Index

The Alberta Air Quality Index (AQI) is based on NO₂, SO₂, CO, O₃, PM_{2.5} and H₂S/TRS data. The highest of these determines the air quality index for the monitoring station, for the specific hour. The Health Canada Air Quality Health Index (AQHI), based on PM_{2.5}, SO₂ and NO₂, were calculated for each hour of each day and plotted in Figure 10. The AQHI is normally a 3-hour average. The indices are plotted on a log scale so as to better illustrate the variance in the data. Maximum AQI values were over 100 in Fort McMurray and were above 10 frequently during May 4 to May 20, 2016. The AQI values were less than 6 at all monitoring stations except Anzac from May 22 to May 30, and less than 4 at all stations from May 28 to May 31

Odour detection potential

Odour detection potential was assessed using an additive odour approach (Kim and Park 2008), as recommended by Fort McKay Sustainability Department (Adamache and Spink 2012). In this approach, the sum of the concentration of each constituent divided by the odour threshold value is determined. A sum greater than one indicates a potential for odour detection. This approach is conservative because it considers only positive synergistic effects, not potential masking effects.

The odour thresholds used in this report were taken from Nagata (2003) and refer to the levels at which half a population can just detect an odour. The odour potential presented here is therefore not a nuisance threshold, which would occur at high concentrations. Three measurements contributed to odour from measurements at continuous stations, including SO₂, NO₂ and TRS. Speciation of TRS was not available, nor was speciation of hydrocarbon concentrations which were not included in the odour detection potential. TRS was considered to be H₂S which according to Nagata has a very low odour detection threshold; a nuisance threshold would be at least an order of magnitude higher.

The odour detection potential is shown in Figure 11 and was almost entirely determined by TRS concentrations. Values are near or less than one until May 3 at Fort McMurray, May 6 at Fort McKay, and May 14 at Anzac, although the odour potential at Anzac may be understated given the missing data discussed previously. The odour detection potential was reduced beginning May 20 with values near one from May 27 to May 30.

Summary

The data indicates:

- Exceedances of AAQOs, AAQGs and TRVs were measured in episodes at several WBEA continuous stations, with the highest values measured in Fort McMurray. Therefore, while the episodes were defined by PM_{2.5} concentrations, exceedances of AAQOs and TRVs were also measured for CO, NO_x, and O₃.
- The start, end, and duration of episodes were determined by wind direction shifts. In the presence of fires in the area, episodes started and ended abruptly with changes in wind direction.
- Intensity of the episode was determined by distance to the upstream fire hot spots, wind speed, and the burn intensity of the fire.
- Measurements made using MAML and temporary PM_{2.5} stations were consistent with those from the WBEA stations.
- The Alberta AQI values at all stations was less than 4 from May 28 to May 30.
- Odour detection potential was at background levels from May 27 to May 30.

With respect to trends in the data, the highest concentrations were observed when the fire was at its closest upwind point to the monitoring stations. At the initial time of writing, the fire remained in the area but the fire edge was increasingly distant from Fort McMurray. Many locations within the fire edge continued to smolder. It would be expected that fuel supplies had been reduced and, even if the fire moved back toward the city, the predicted concentrations would be substantially less than already observed. However, exceedances of TRVs and AAQOs could still have been observed in that event. It was possible exceedances could also be observed under then-current conditions given the right combination of wind speed, wind direction, and atmospheric structure.

Other communities, such as Fort McKay, where dry fuel has not been exhausted, could yet experience equally high concentrations depending on weather and other factors.

Next steps

While fires continue to smolder in the region and the fire danger has by no means passed, the imminent danger appears to be past for Fort McMurray. All air quality indicators are much lower than during the fire. Many are near 2015 levels. Measurements of air quality in the community are less than AAQOs and TRVs. The AQI values at all stations examined in this report are reduced, as are odour potentials. While the monitoring data at the two Fort McMurray stations do not necessarily represent air quality at all locations in the community given local smoldering, and while occasional episodes with concentrations somewhat above AAQOs, AAQGs and TRVs may occur until fires are extinguished, we suggest that analysis of air quality find another focus.

References

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Appendix A: Figures

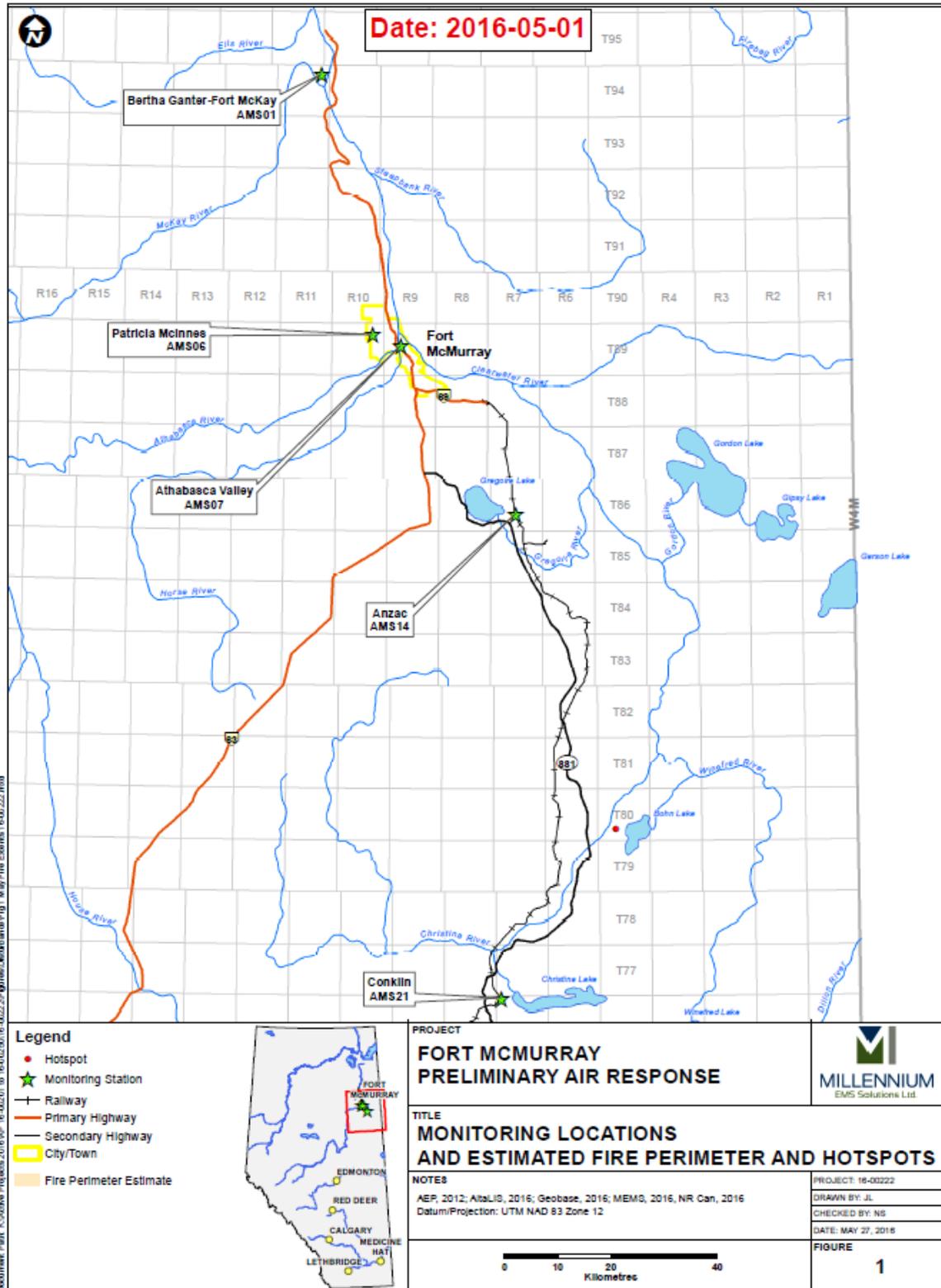


Figure 1 Monitoring station locations

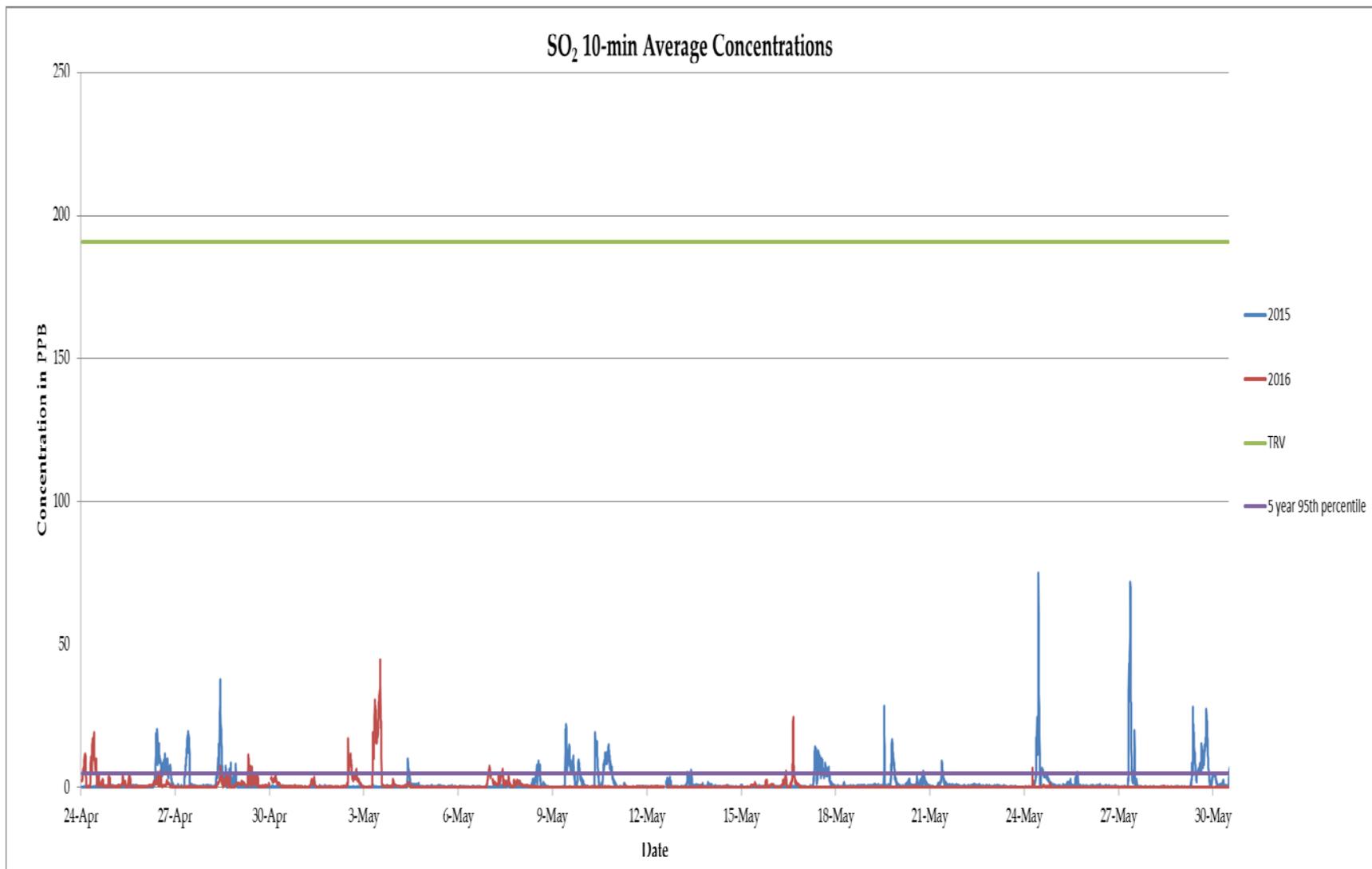


Figure 2a 10-minute SO₂ measurements at Fort McKay (AMS1).

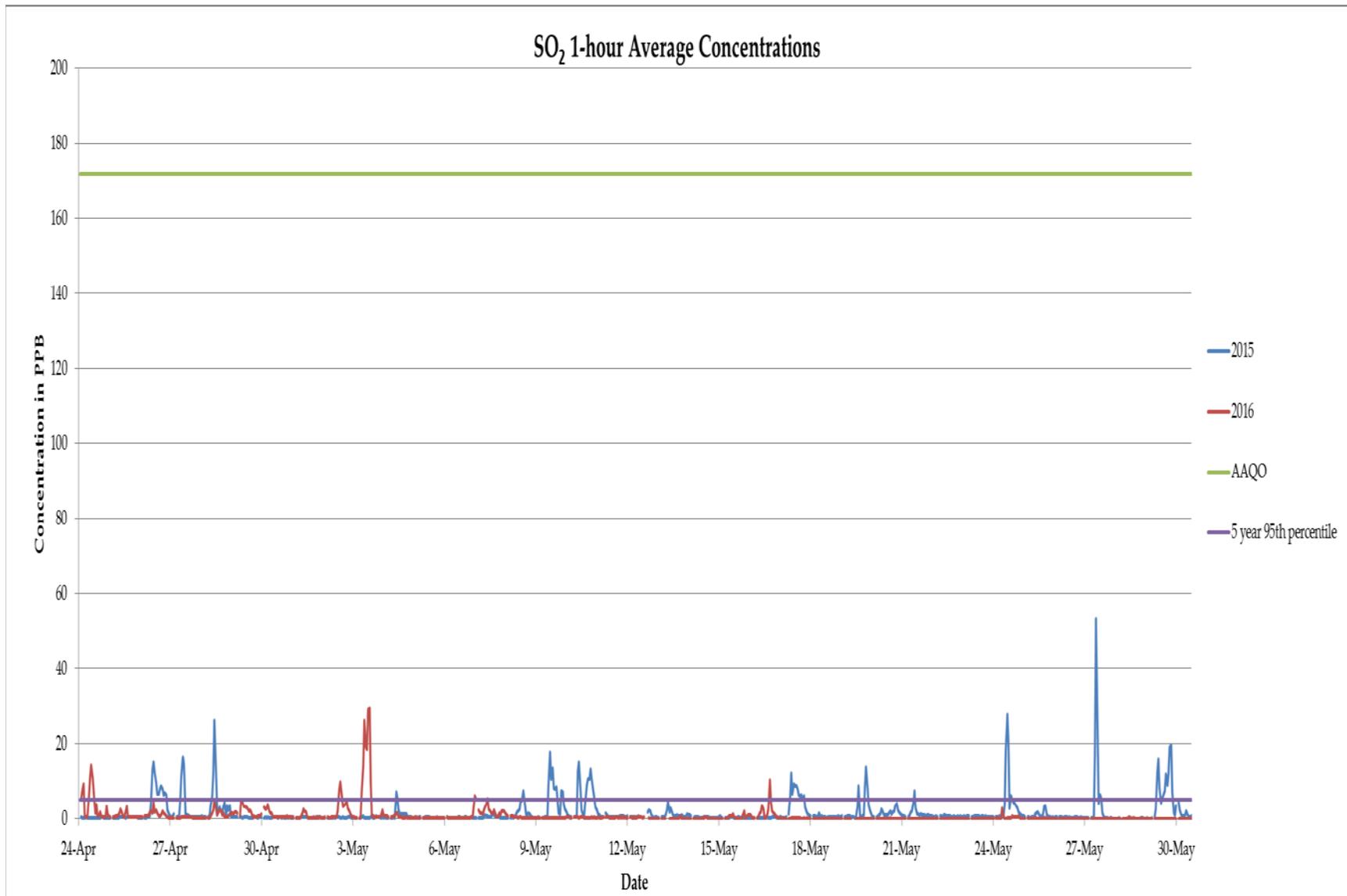


Figure 2b 1-hour SO₂ measurements at Fort McKay (AMS1).

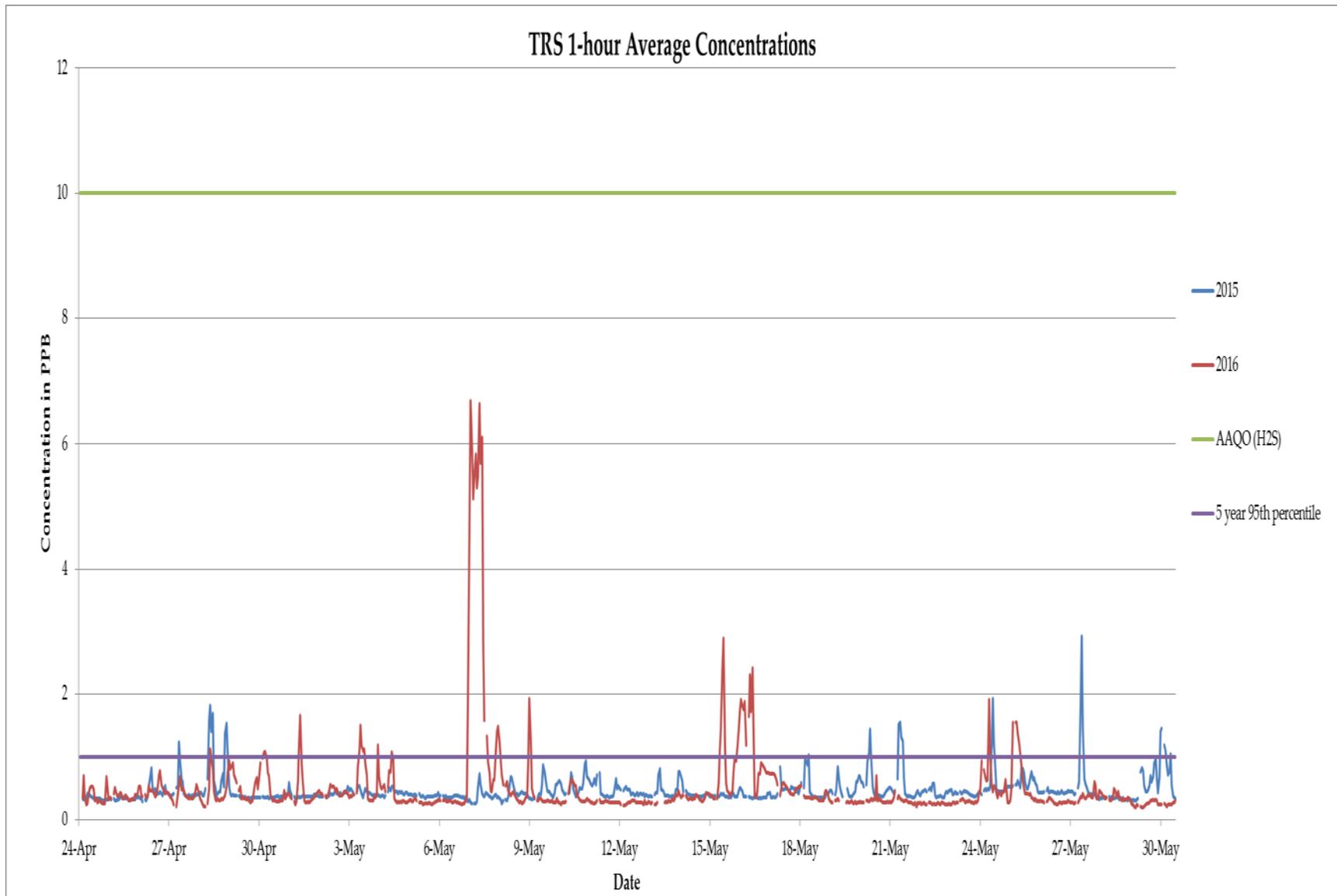


Figure 2c TRS measurements at Fort McKay (AMS1).

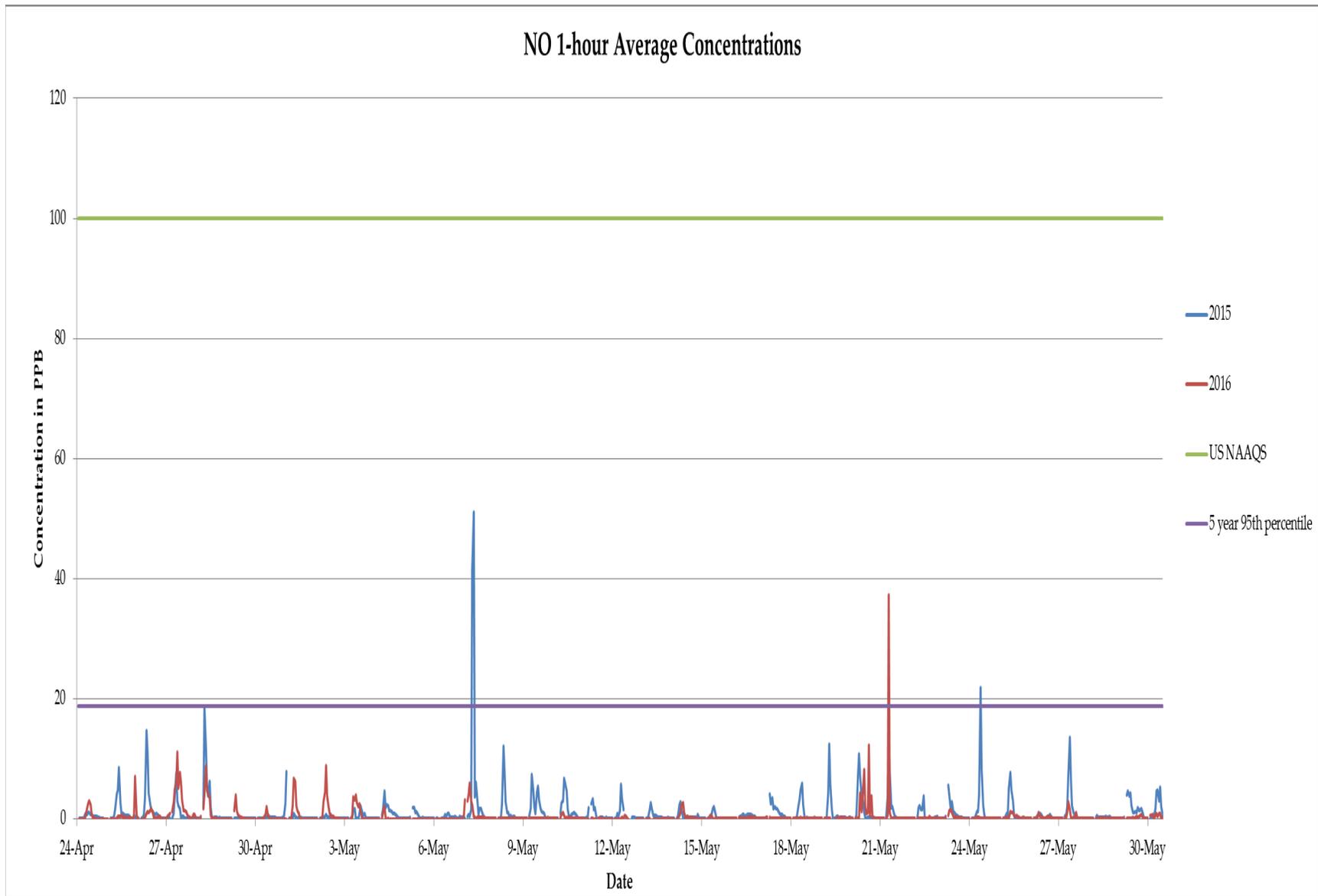


Figure 2d NO measurements at Fort McKay (AMS1).

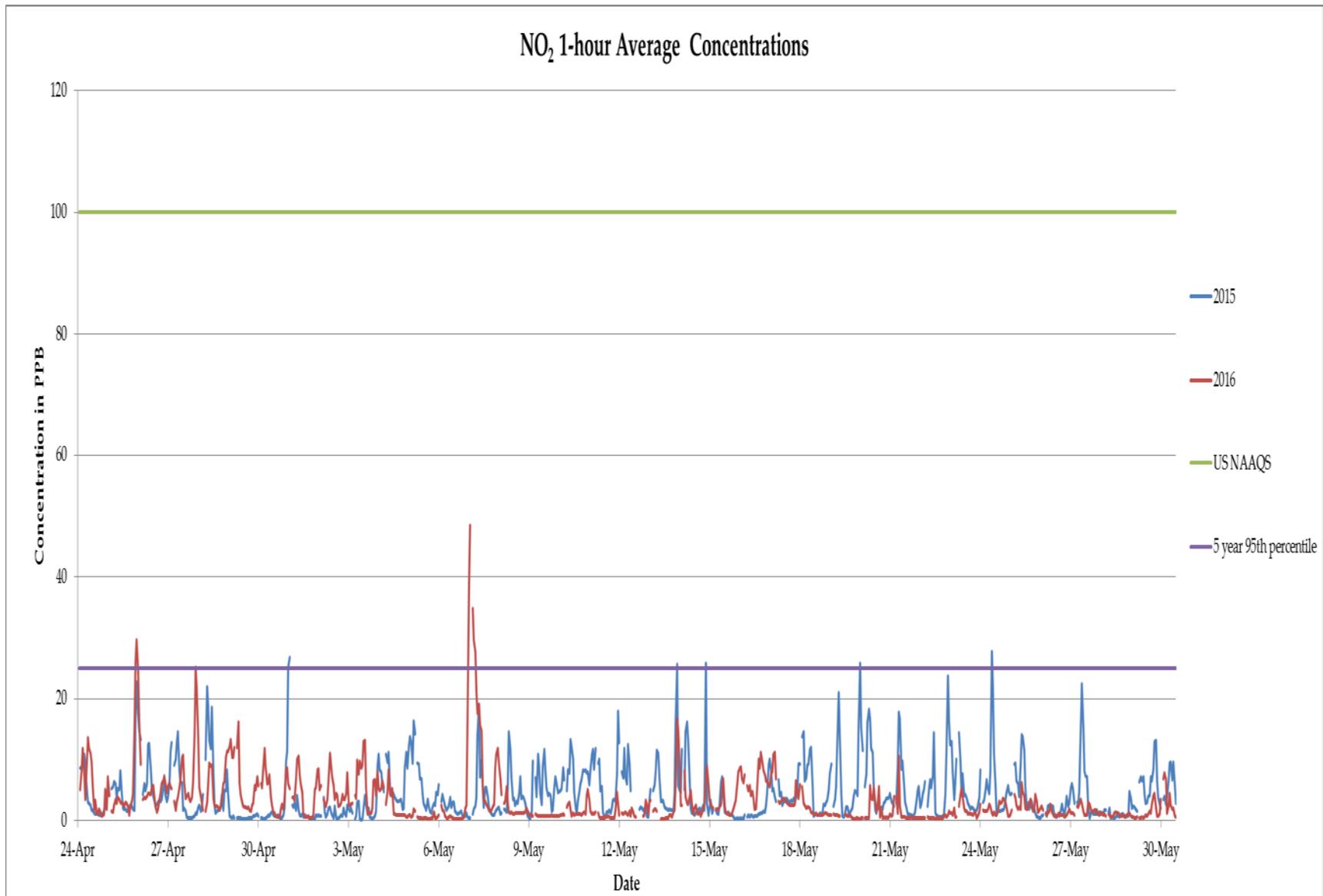


Figure 2e NO₂ measurements at Fort McKay (AMS1).

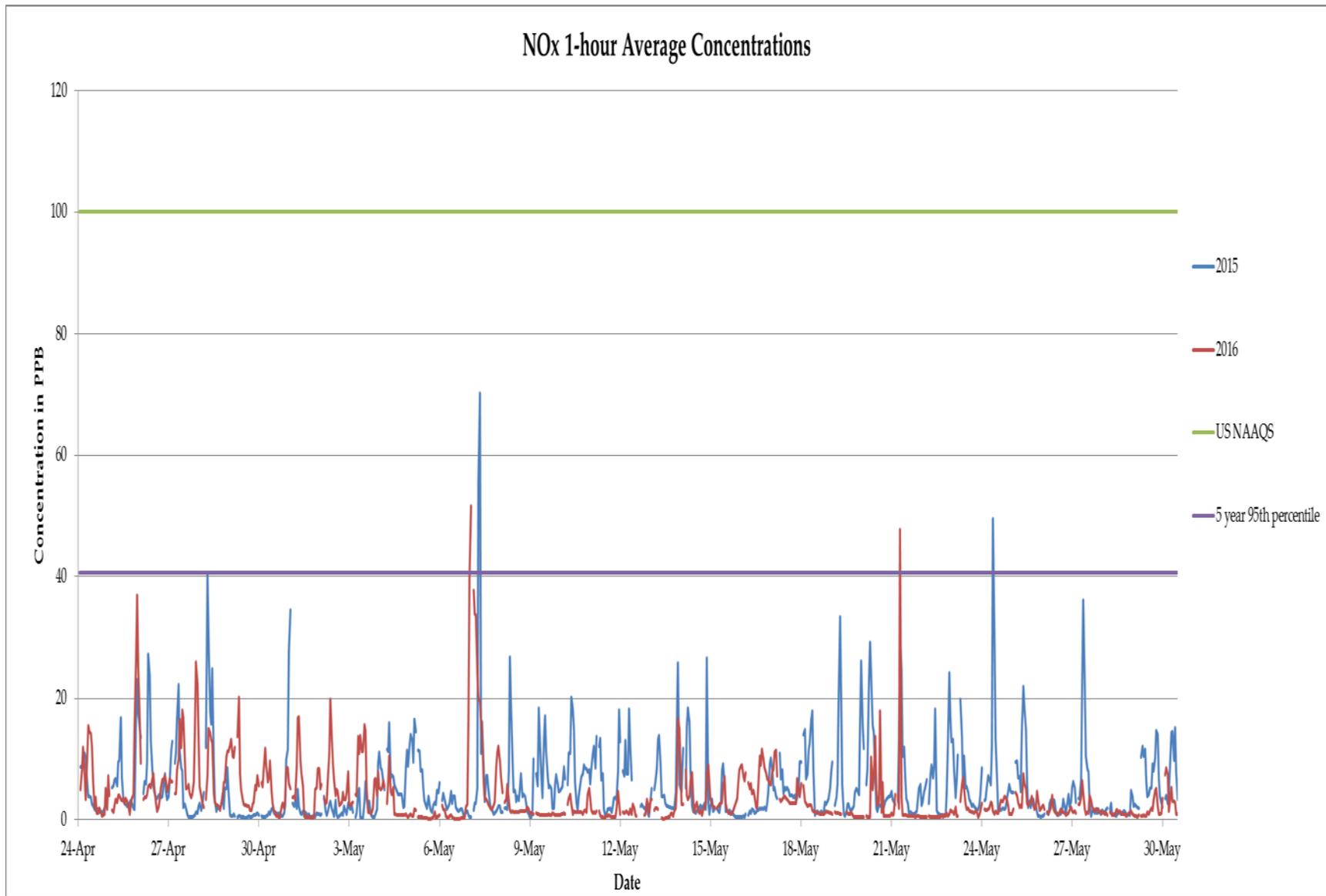


Figure 2f NOx measurements at Fort McKay (AMS1).

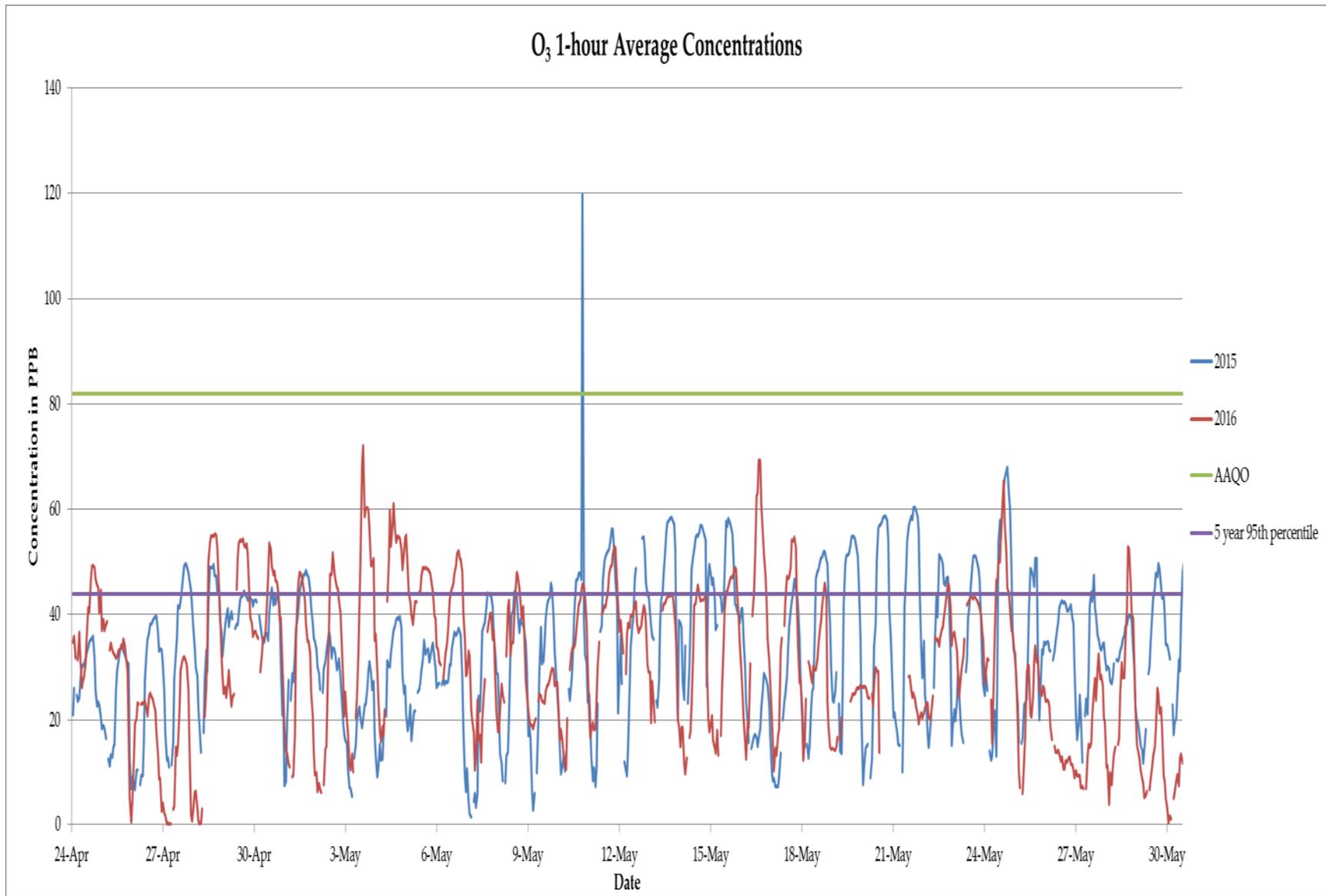


Figure 2g Ozone (O₃) measurements at Fort McKay (AMS1).

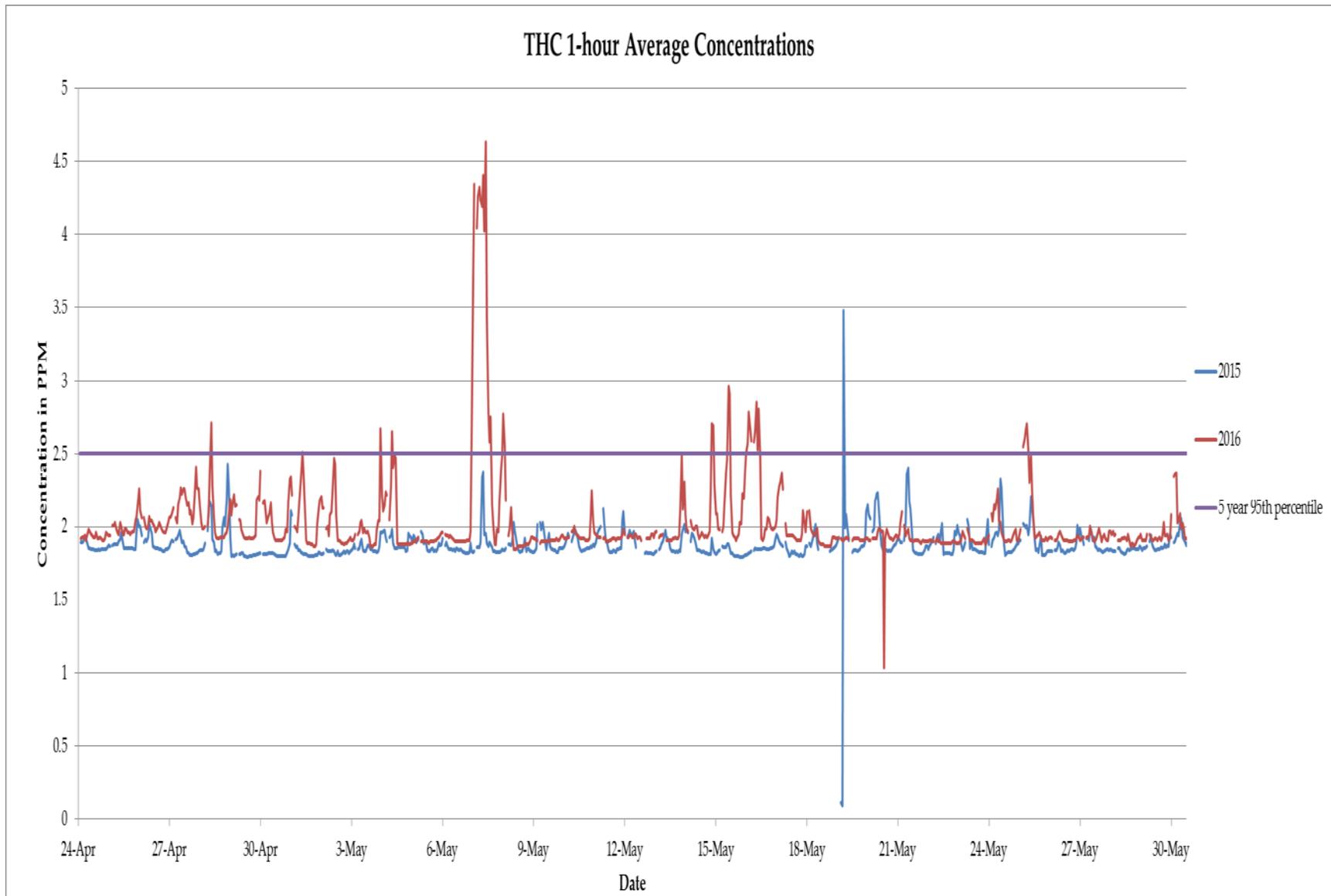


Figure 2h THC measurements at Fort McKay (AMS1).

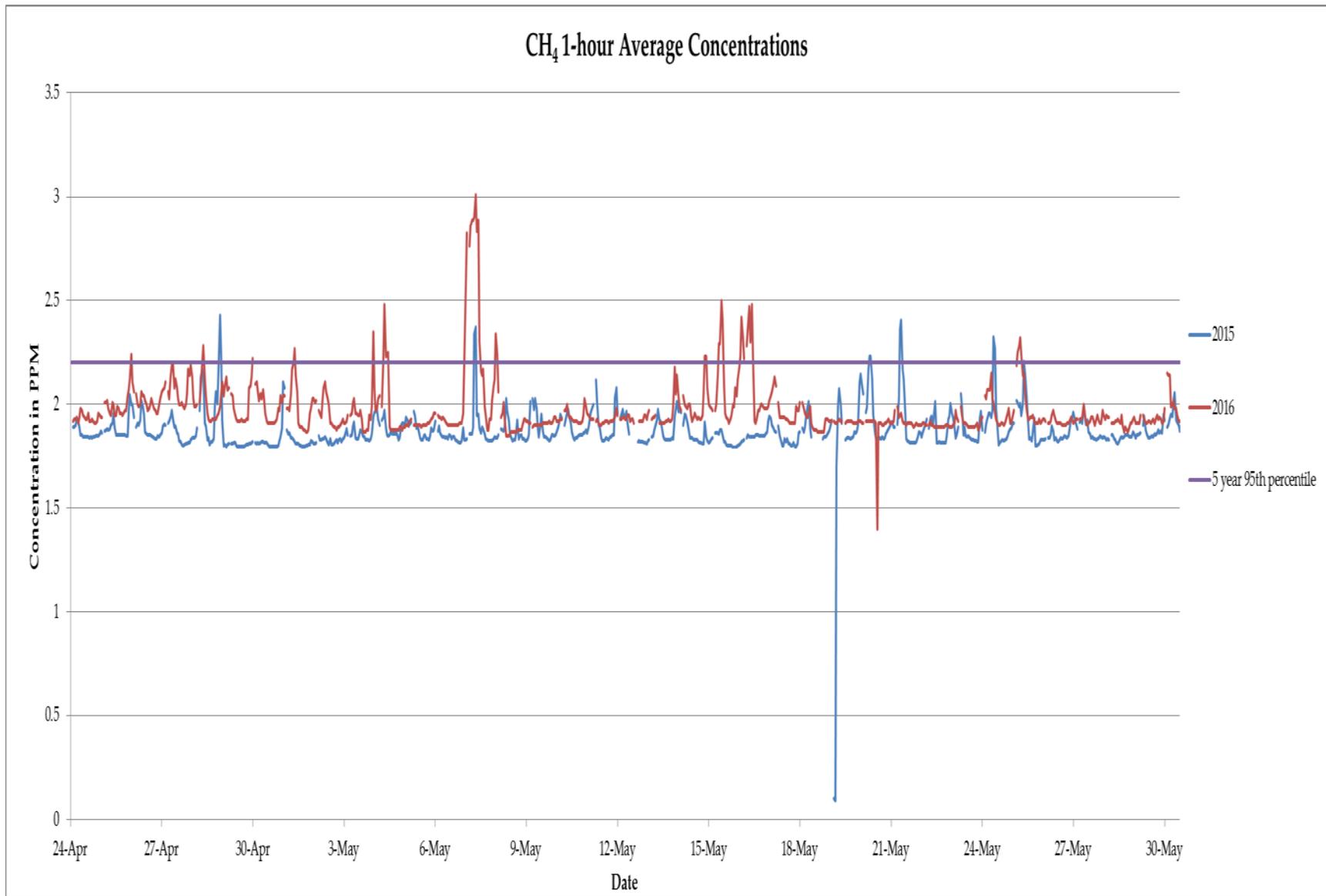


Figure 2i CH₄ measurements at Fort McKay (AMS1).

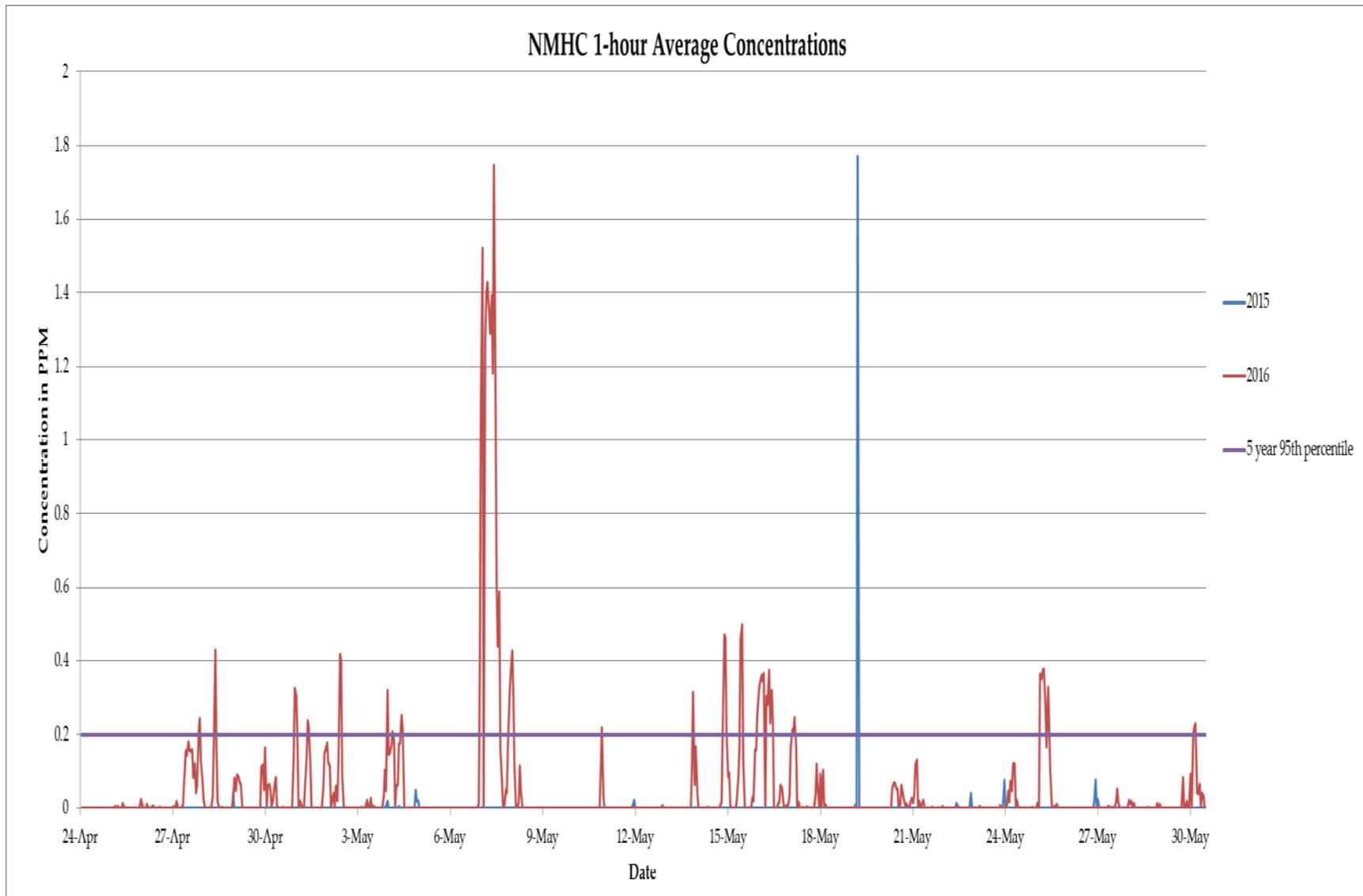


Figure 2j NMHC measurements at Fort McKay (AMS1).

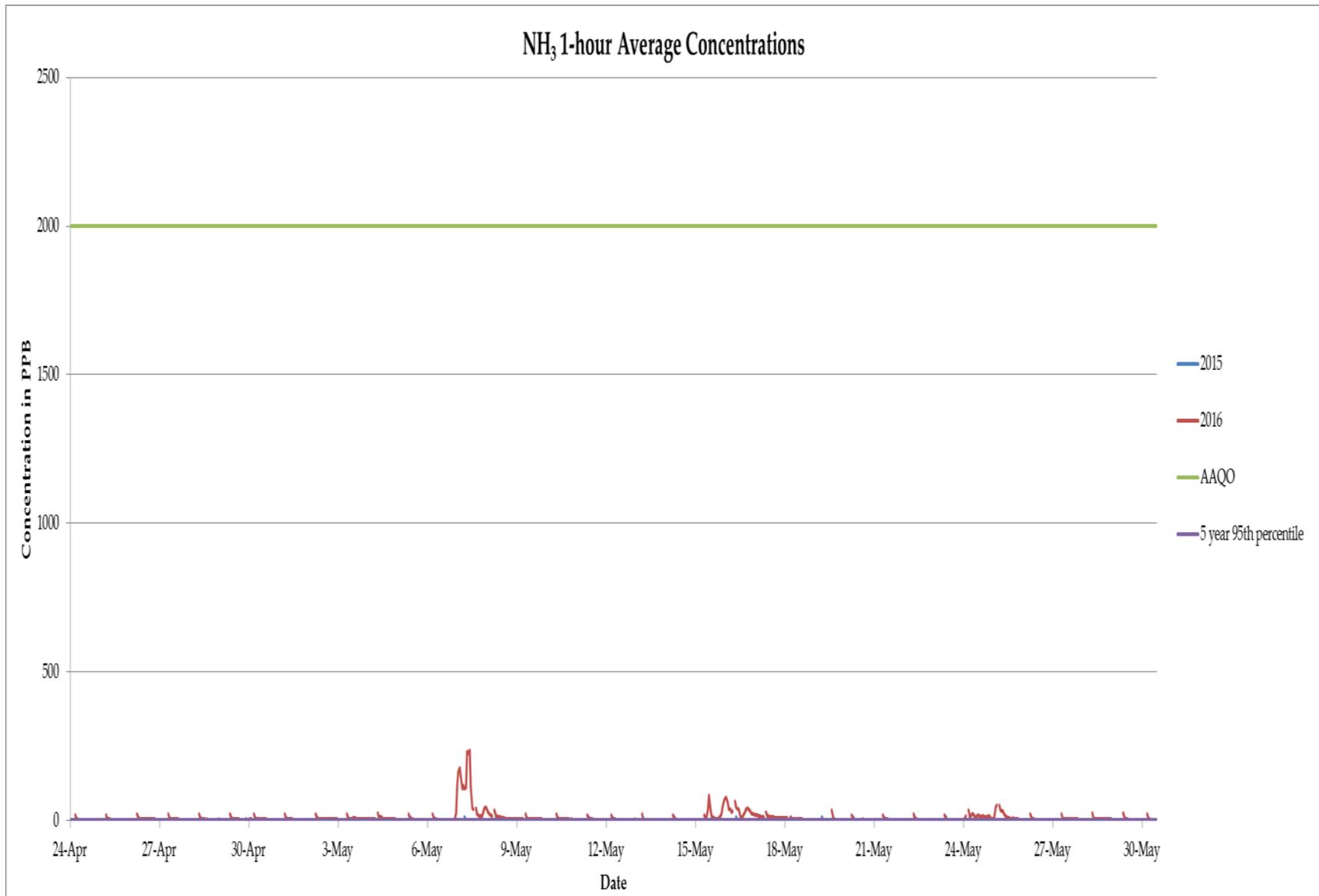


Figure 2k NH₃ measurements at Fort McKay (AMS1).

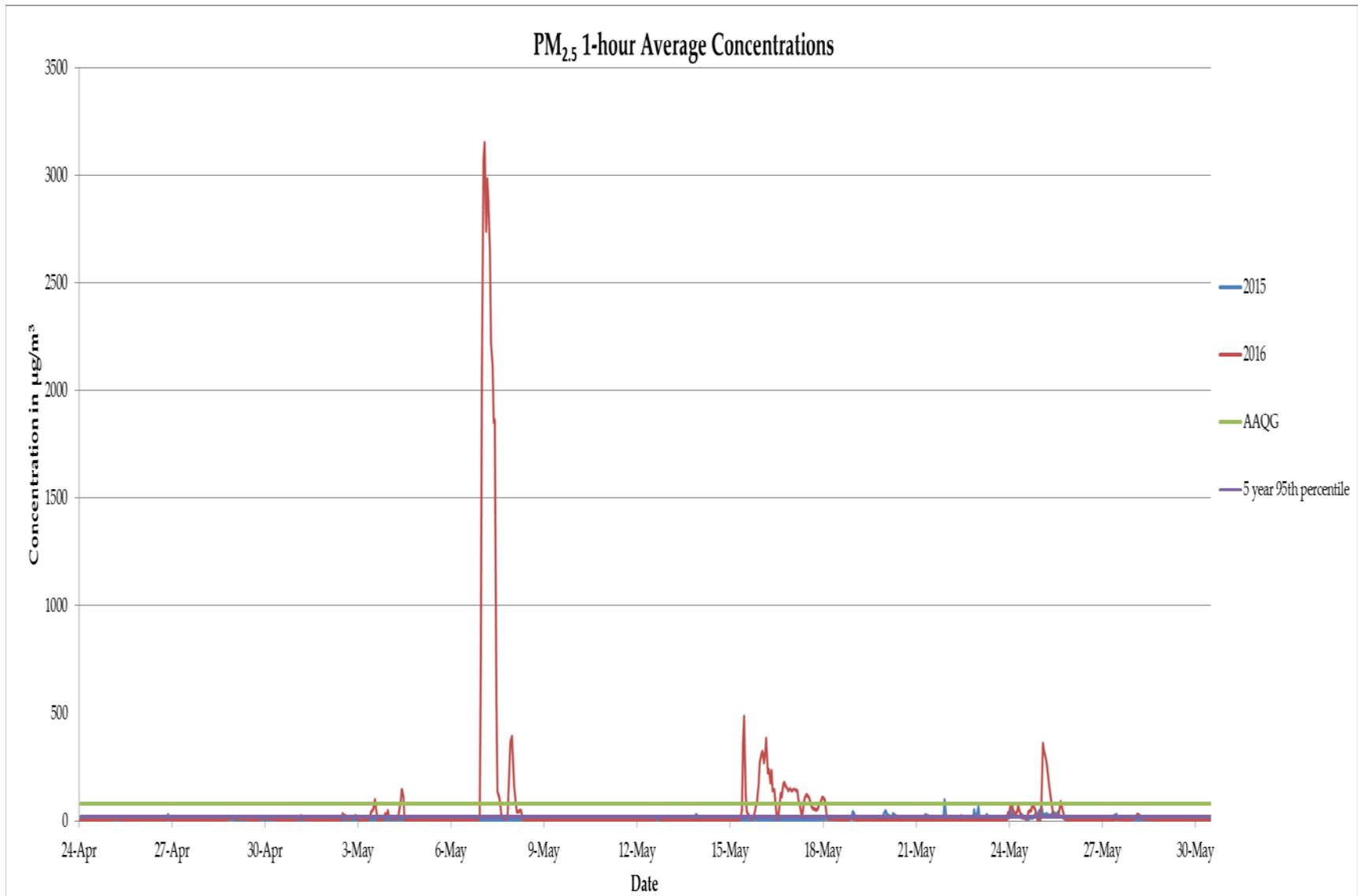


Figure 21 1-hour PM_{2.5} measurements at Fort McKay (AMS1).

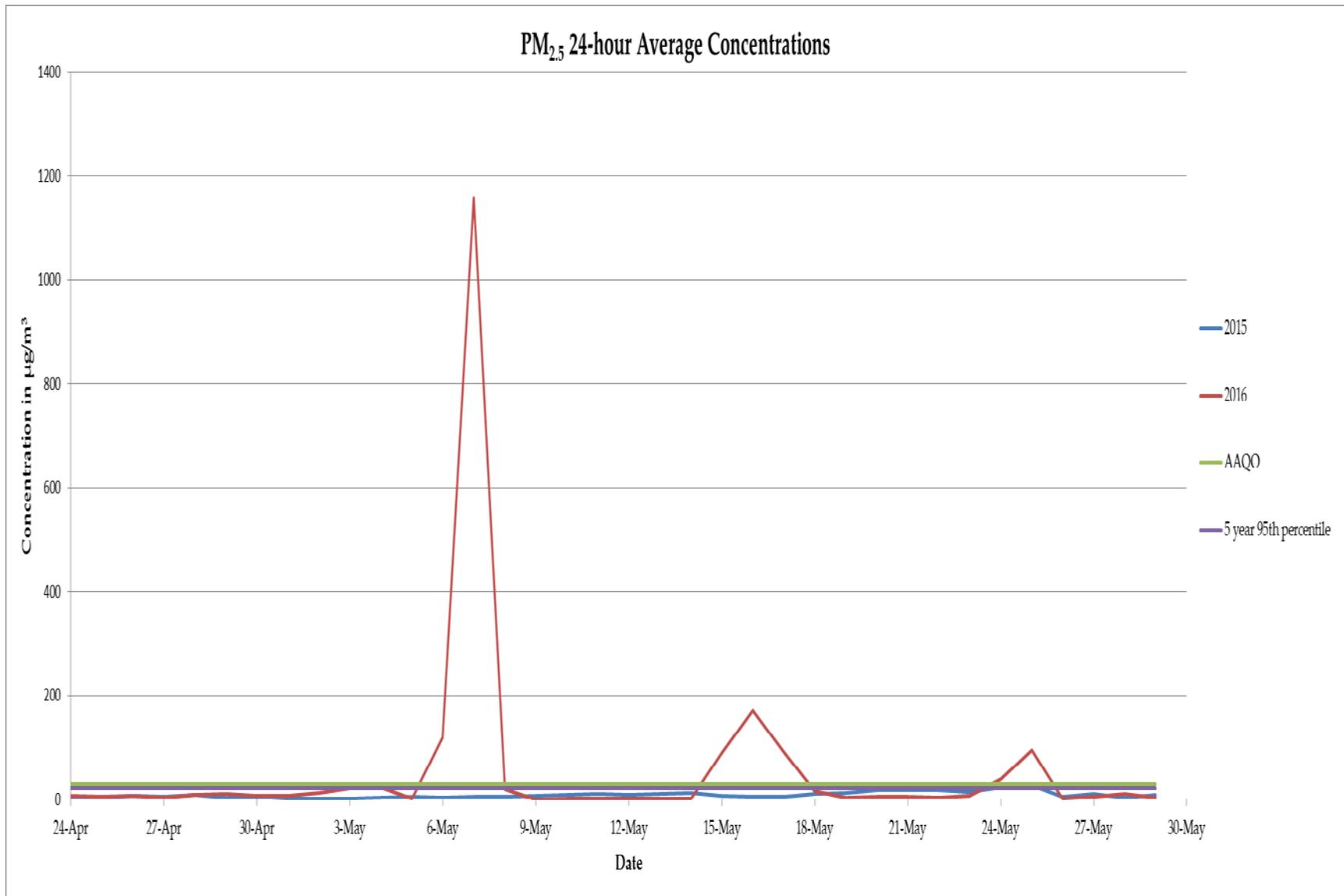


Figure 2m 24-hour PM_{2.5} measurements at Fort McKay (AMS1).

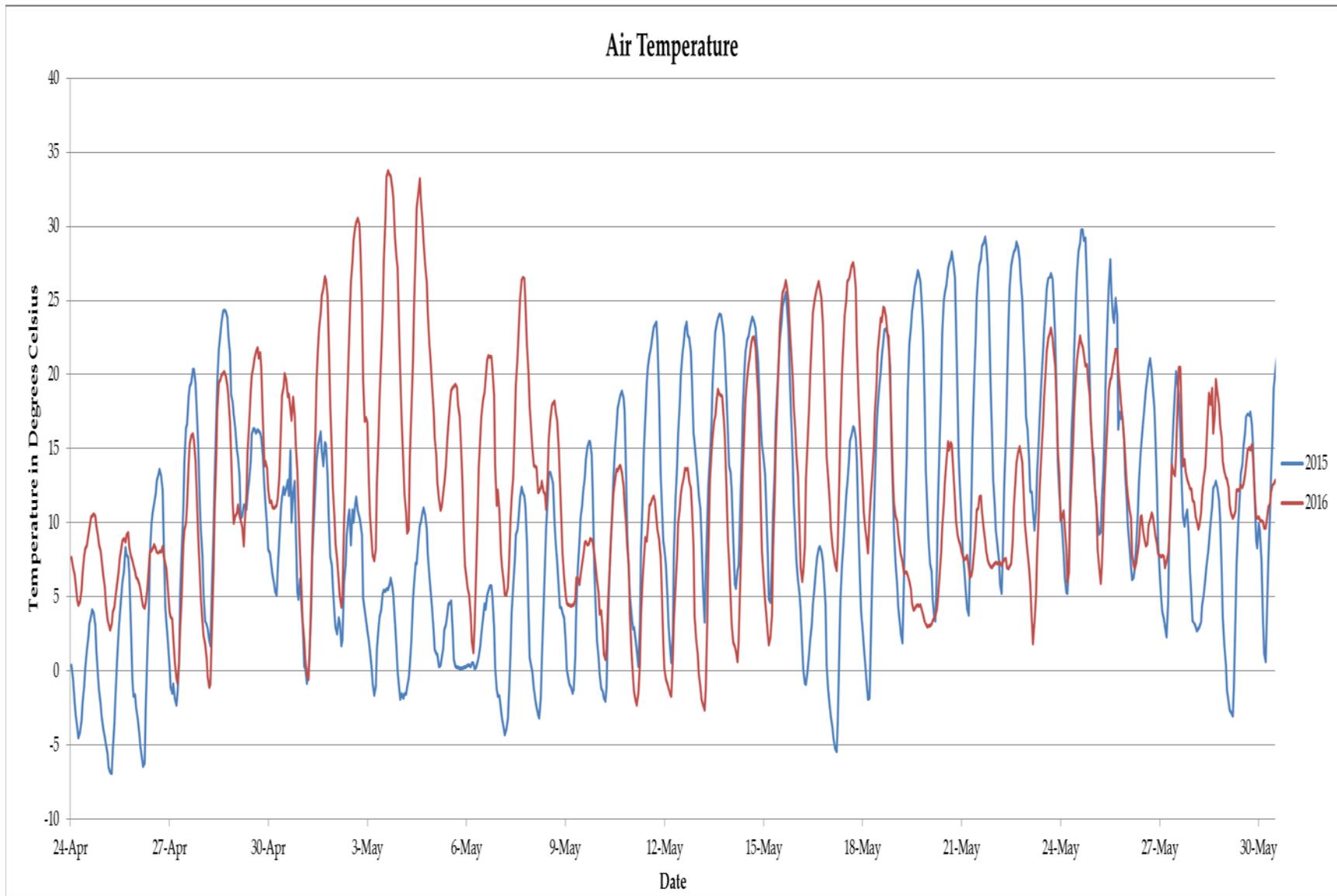


Figure 2n Air temperature measurements at Fort McKay (AMS1).

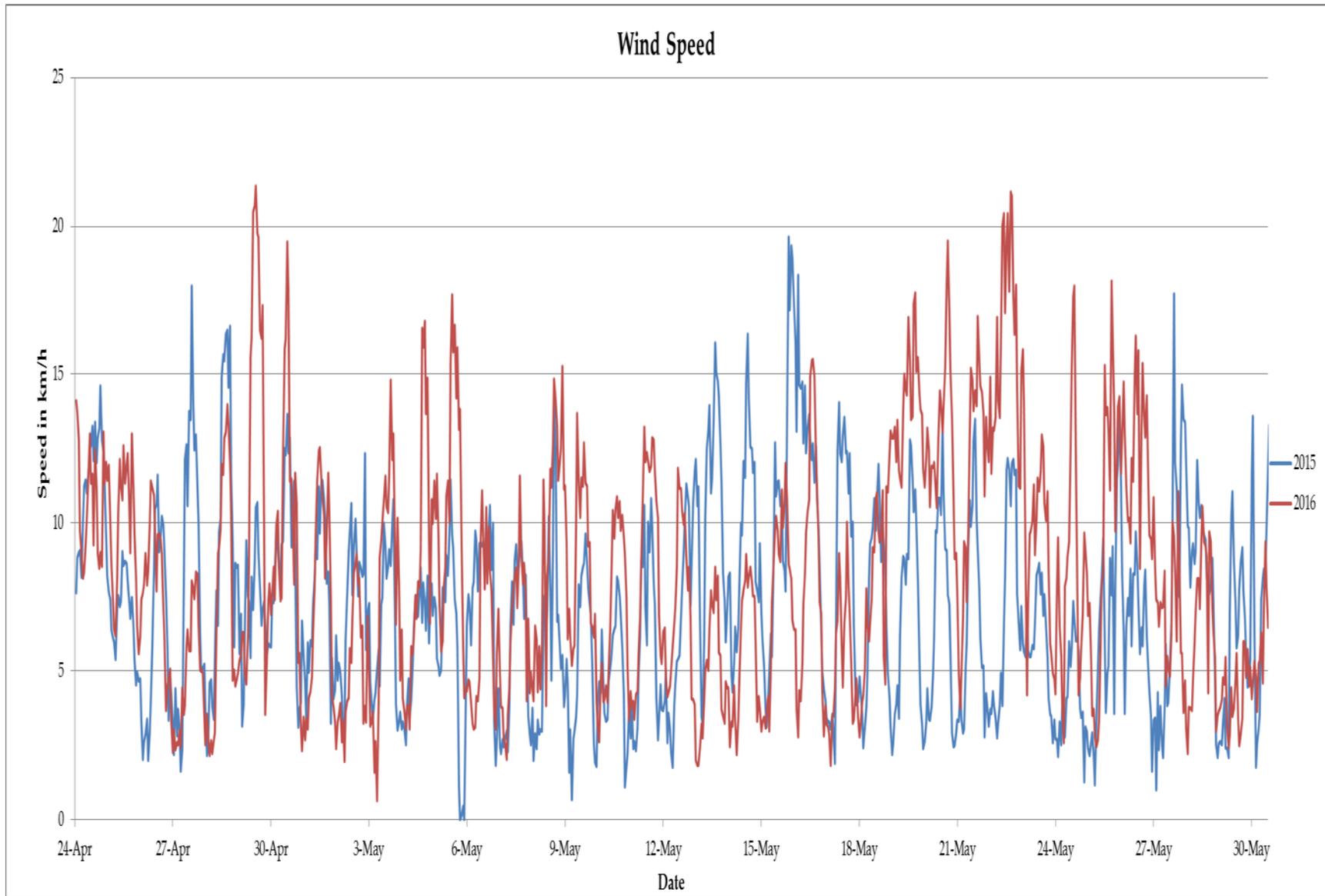


Figure 2o Wind speed measurements at Fort McKay (AMS1).

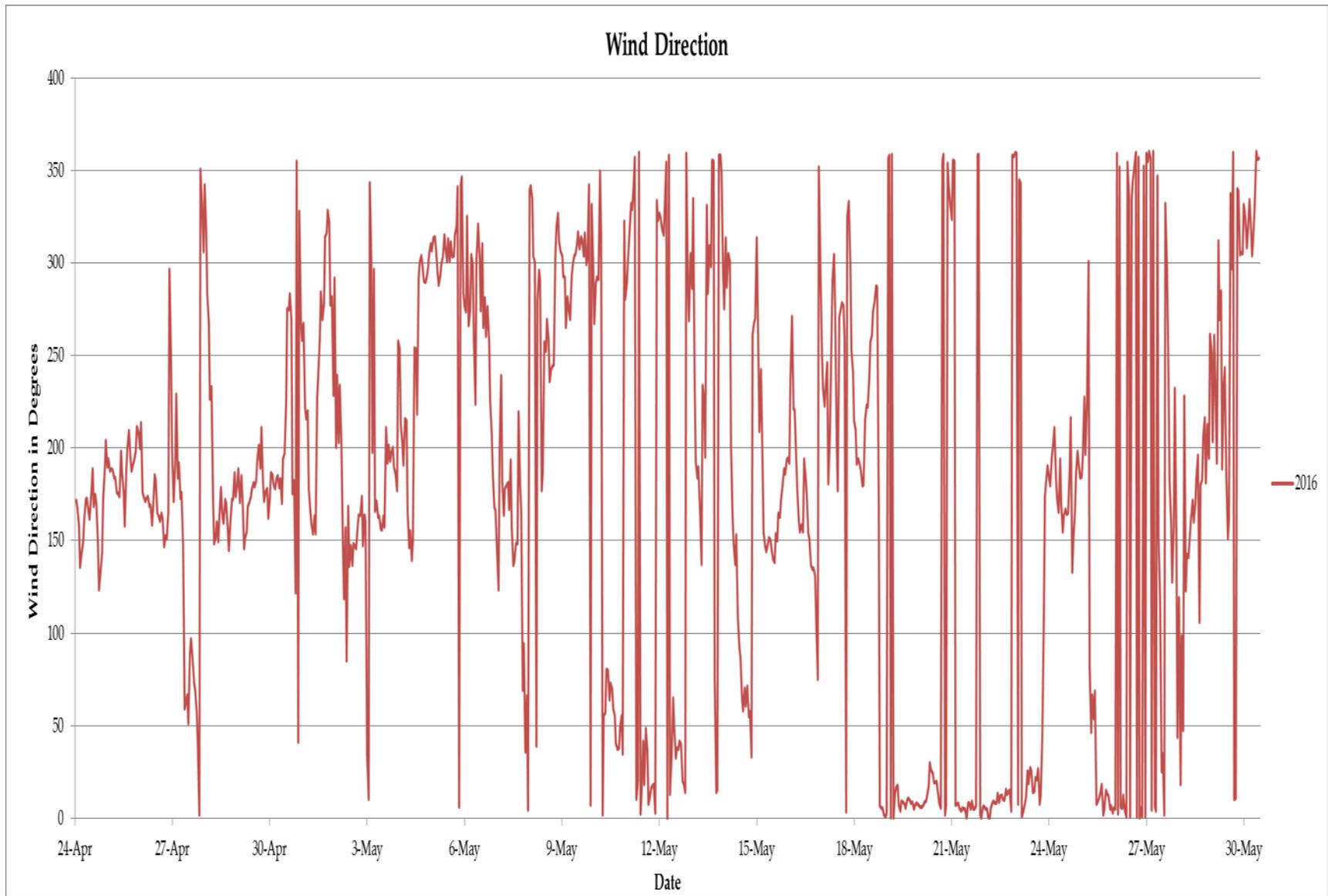


Figure 2p Wind direction measurements at Fort McKay (AMS1).

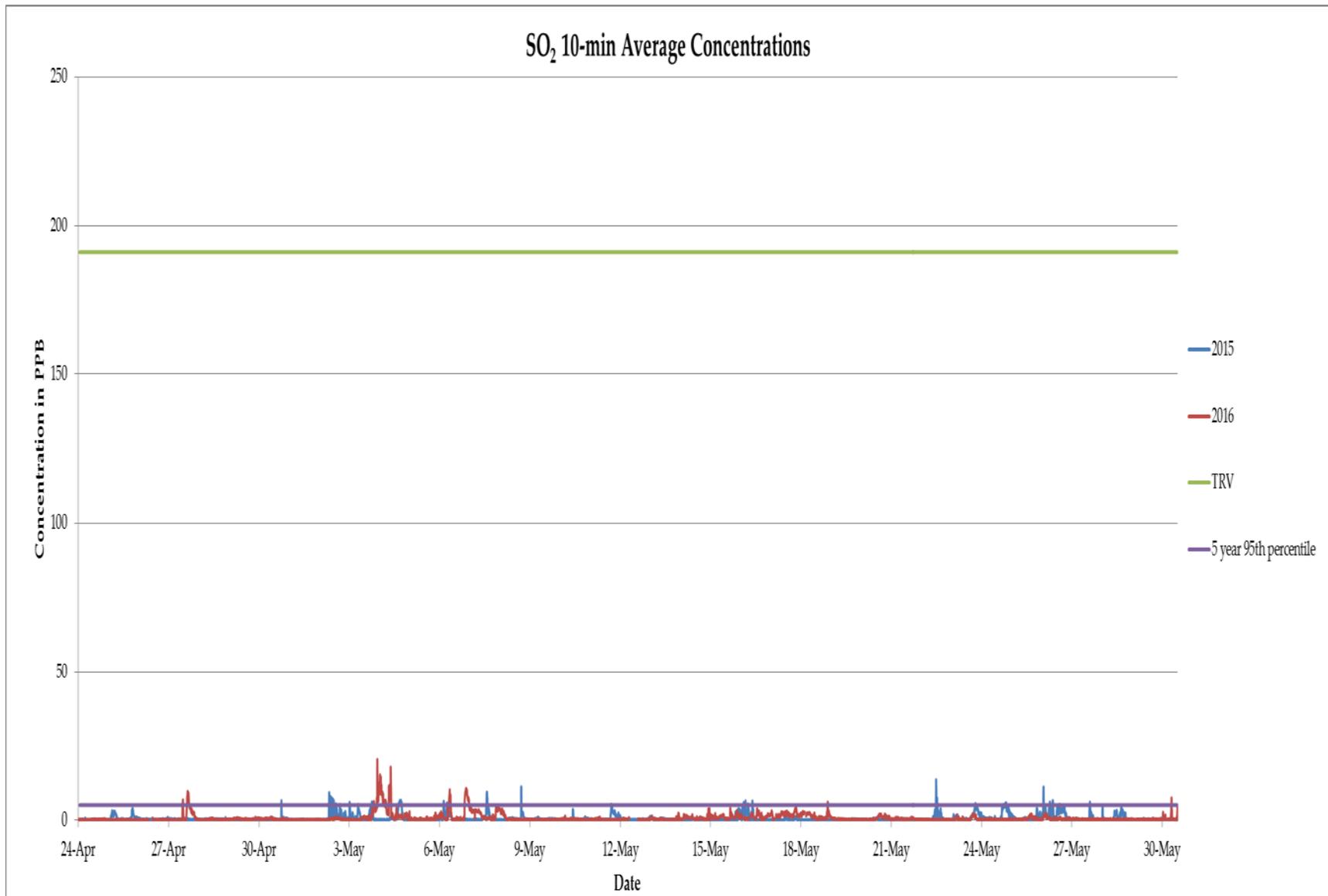


Figure 3a 10-minute SO₂ measurements at Patricia McInnes (AMS6).

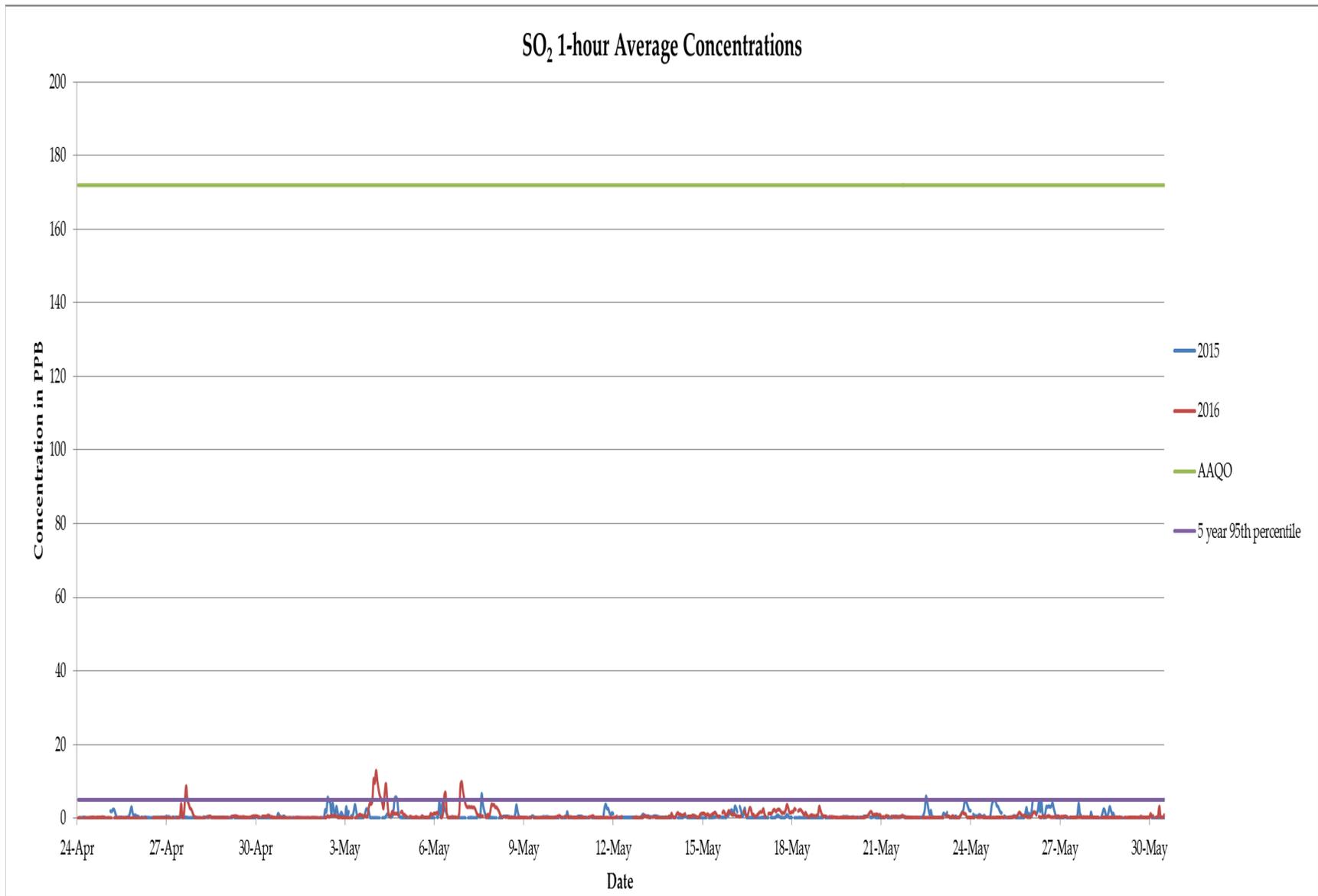


Figure 3b 1-hour SO₂ measurements at Patricia McInnes (AMS6).

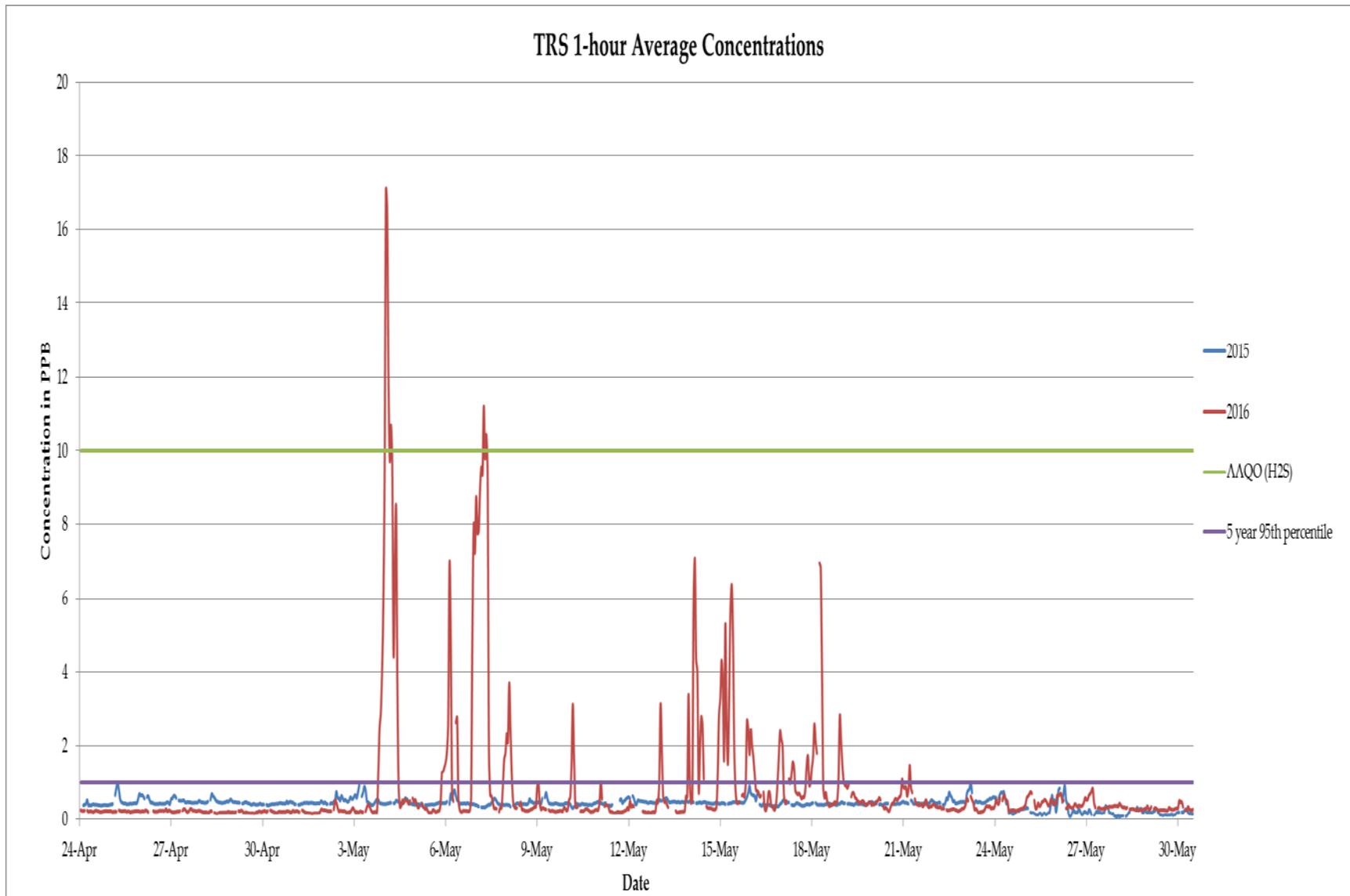


Figure 3c TRS measurements at Patricia McInnes (AMS6).

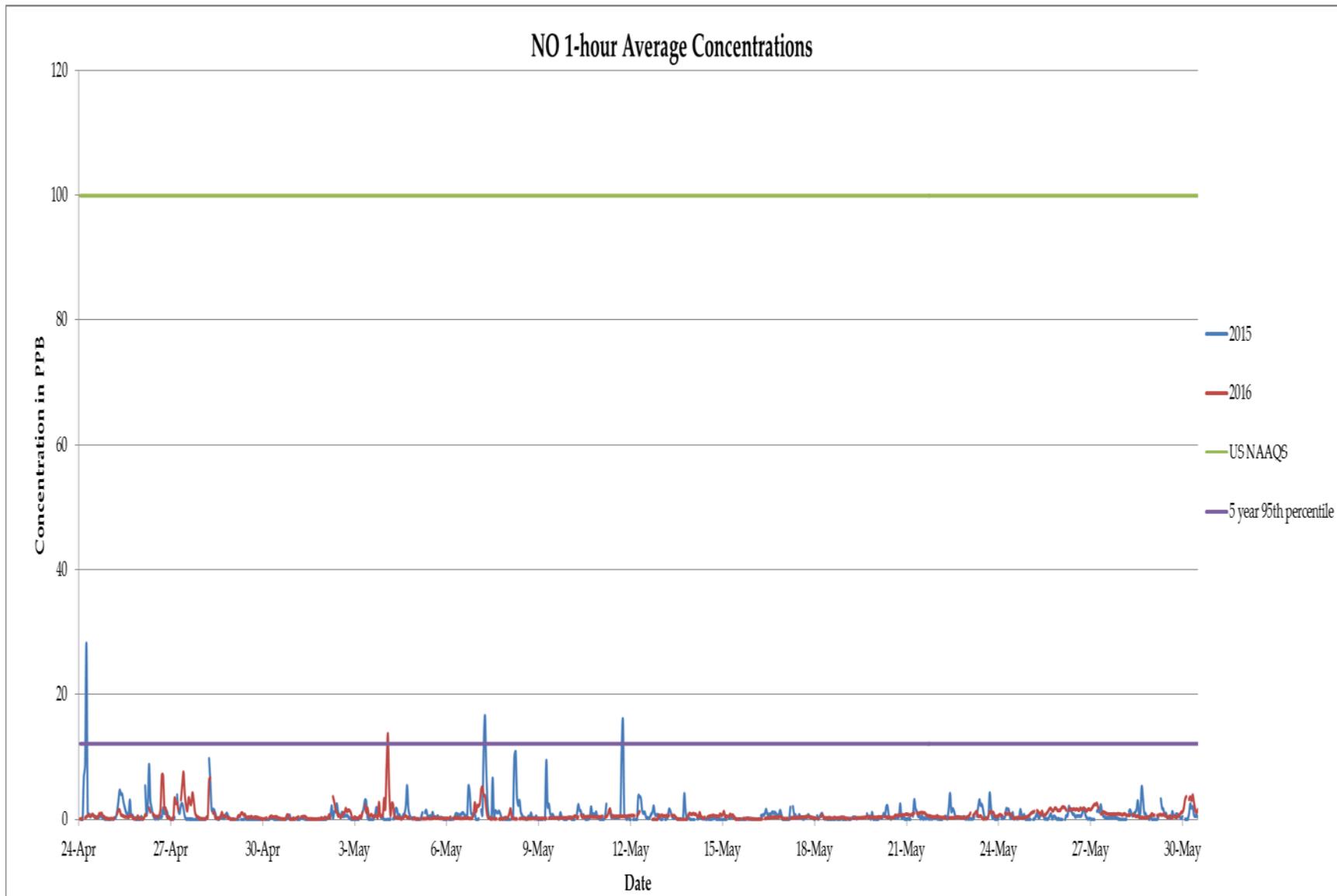


Figure 3d NO measurements at Patricia McInnes (AMS6).

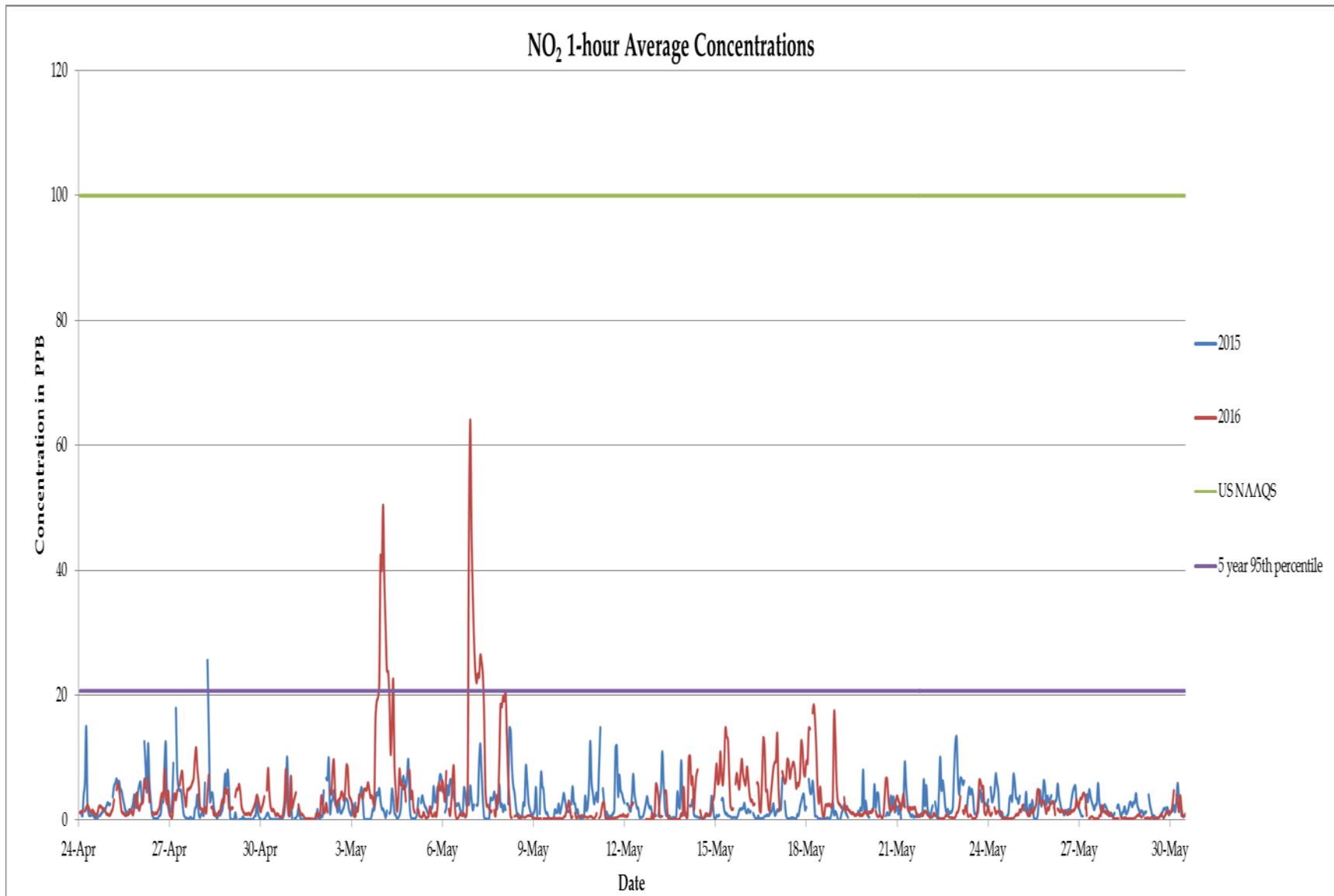


Figure 3e NO₂ at Patricia McInnes (AMS6).

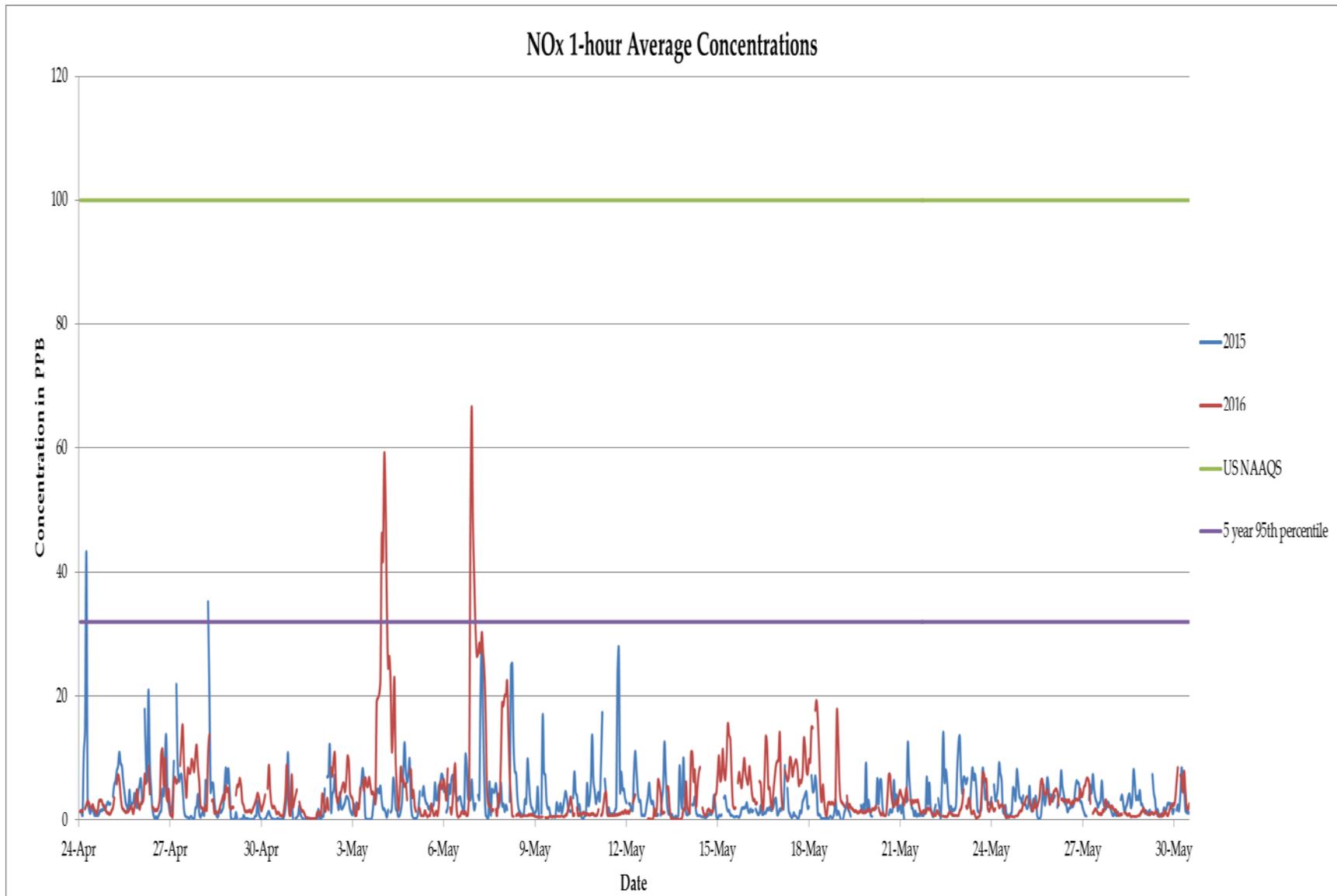


Figure 3f NO_x measurements at Patricia McInnes (AMS6).

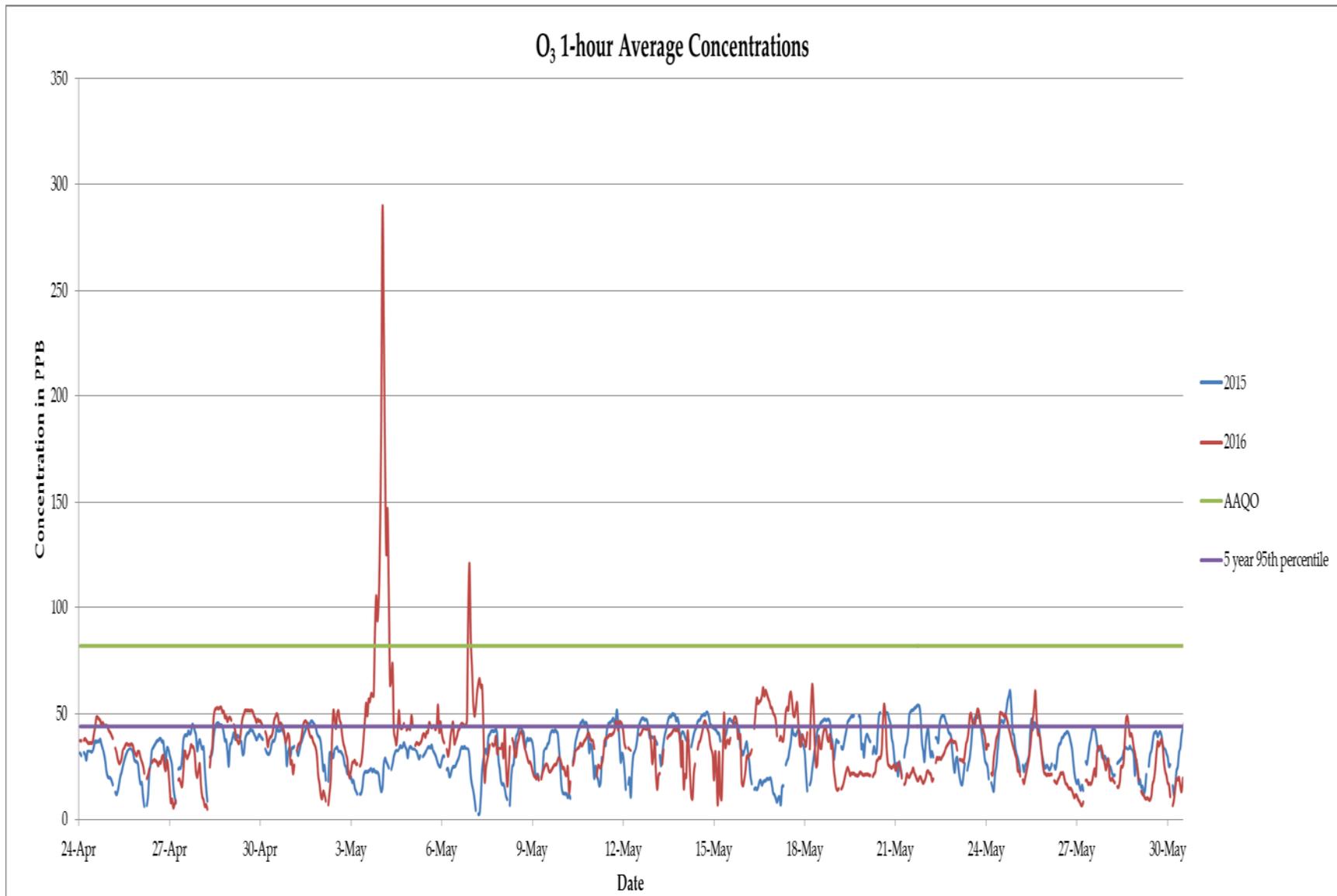


Figure 3g Ozone (O₃) measurements at Patricia McInnes (AMS6).

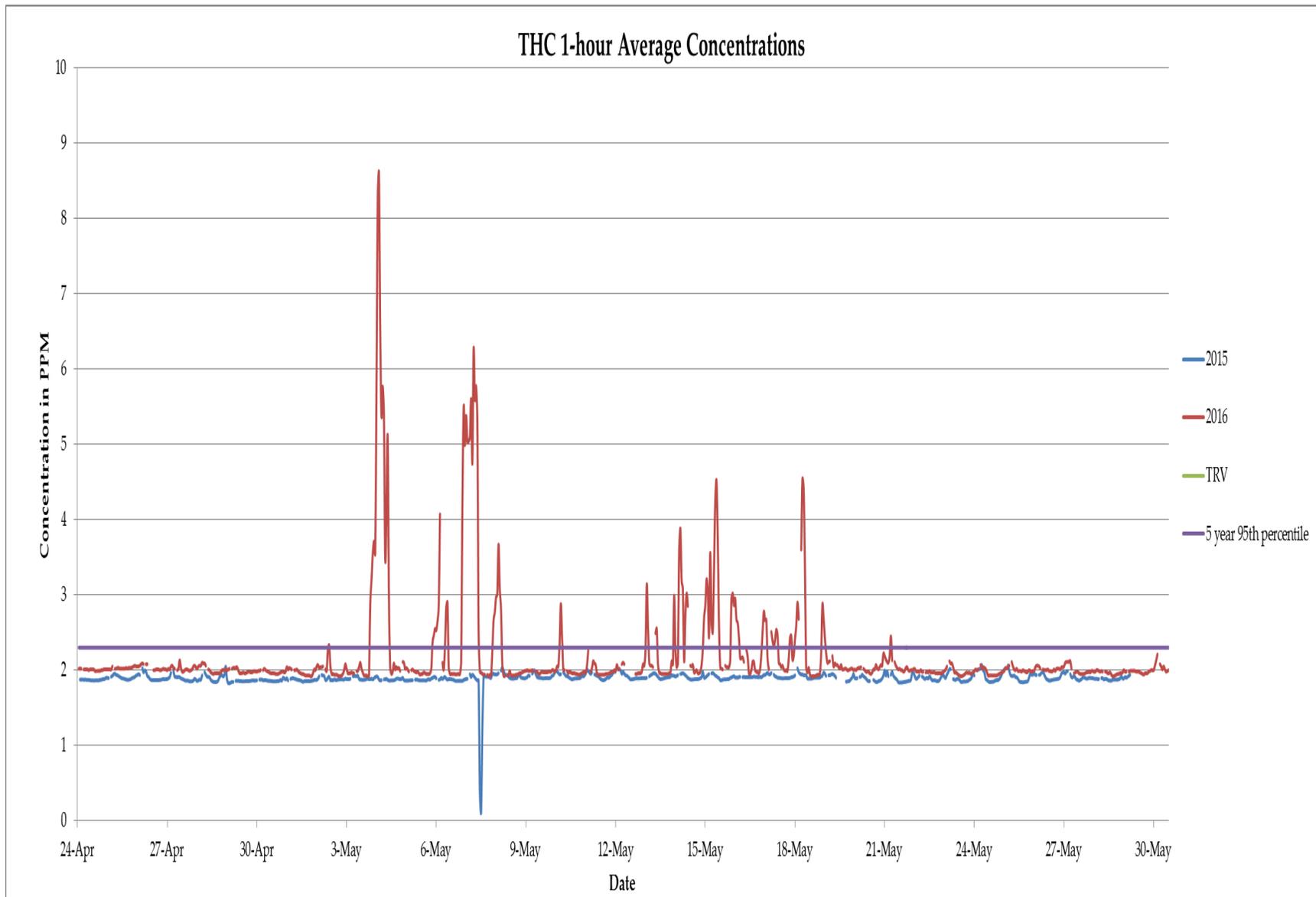


Figure 3h THC measurements at Patricia McInnes (AMS6).

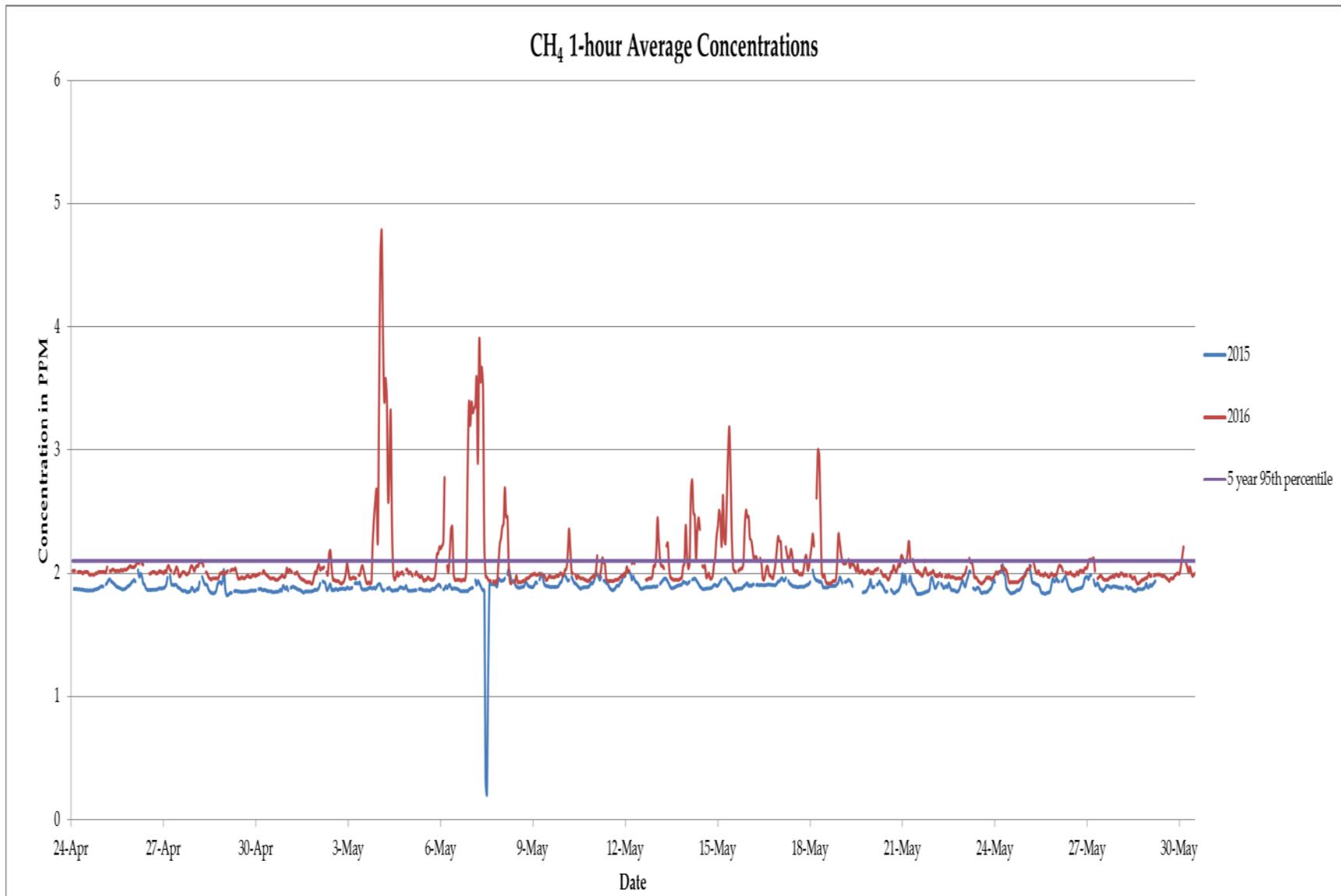


Figure 3i CH₄ measurements at Patricia McInnes (AMS6).

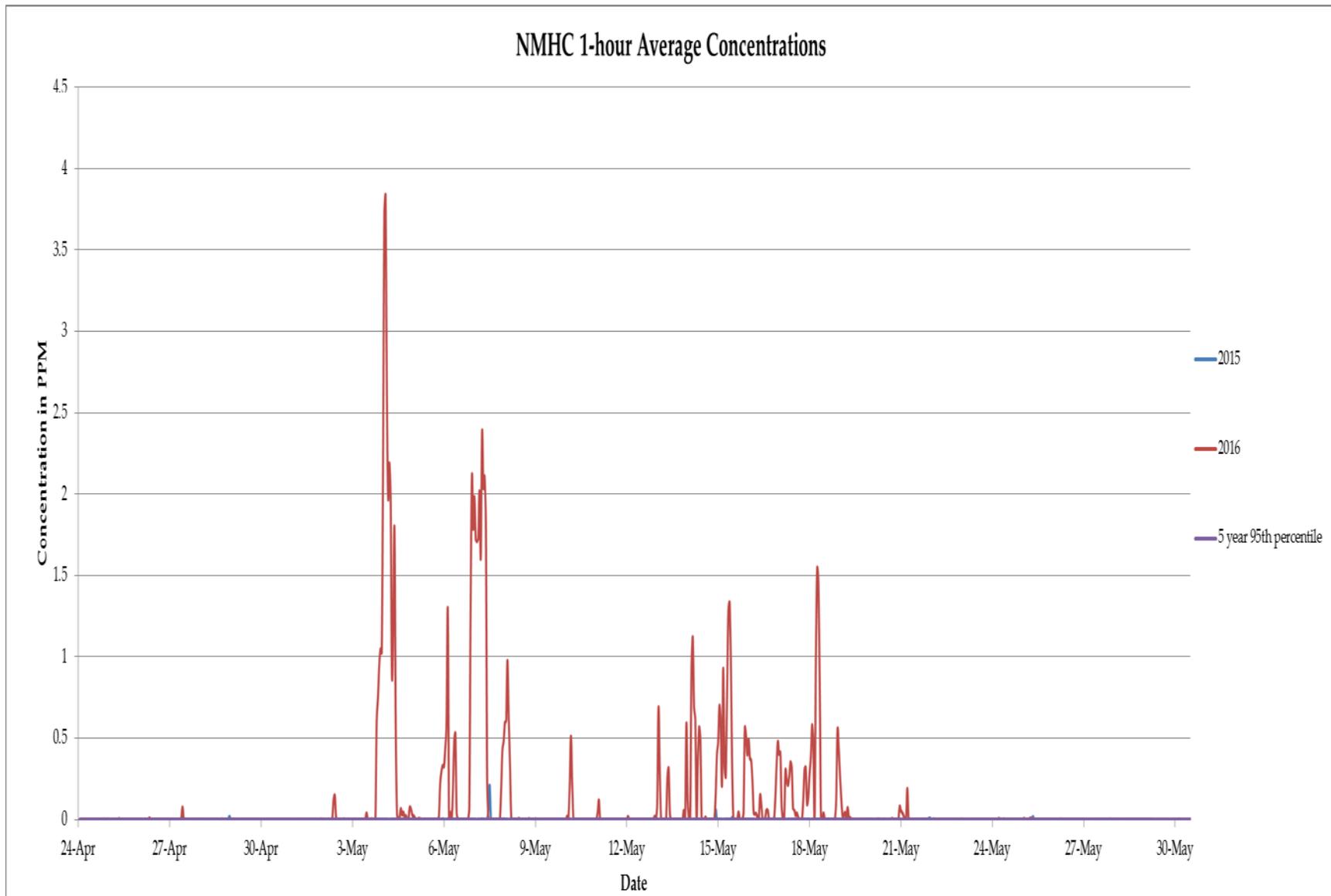


Figure 3j NMHC measurements at Patricia McInnes (AMS6).

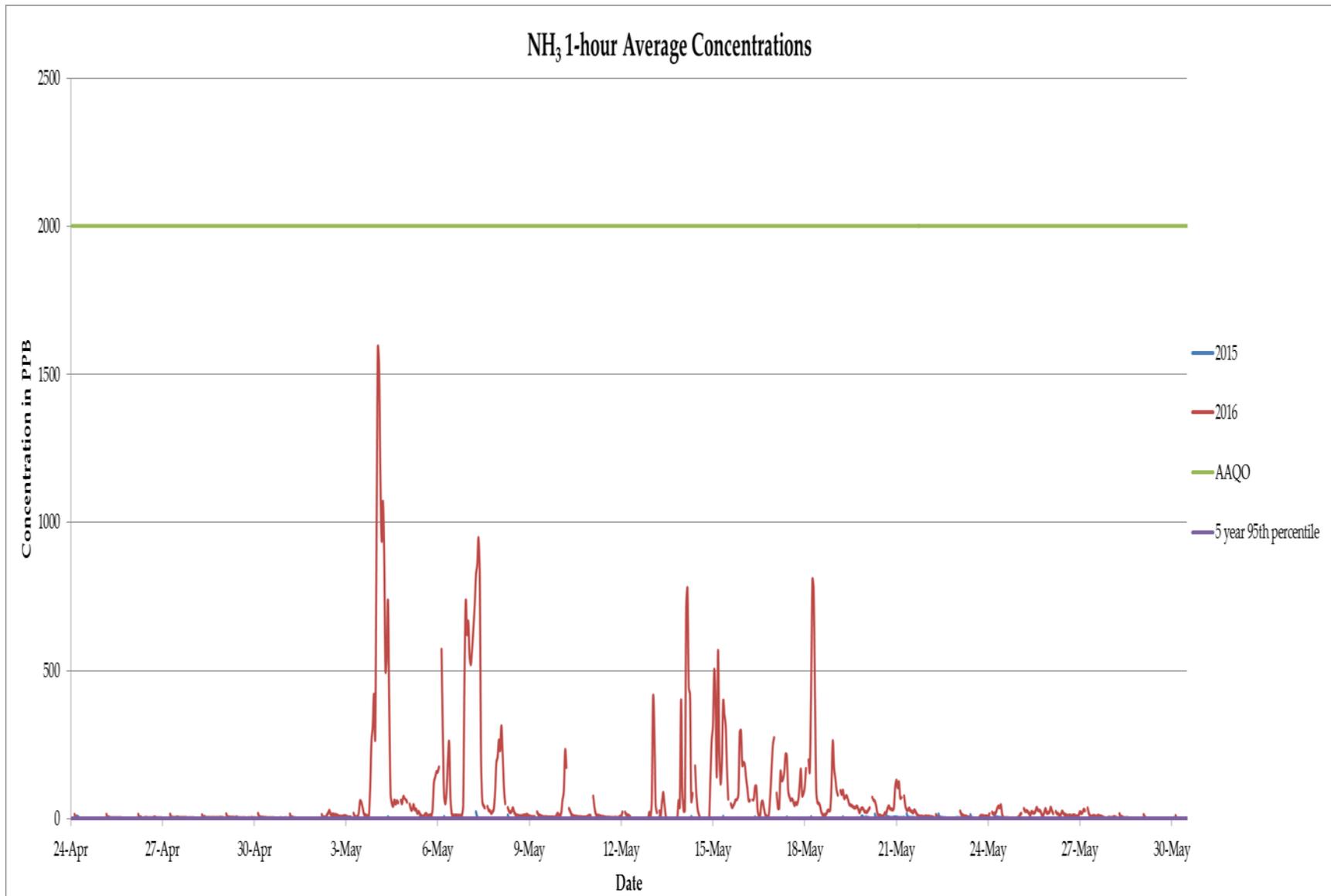
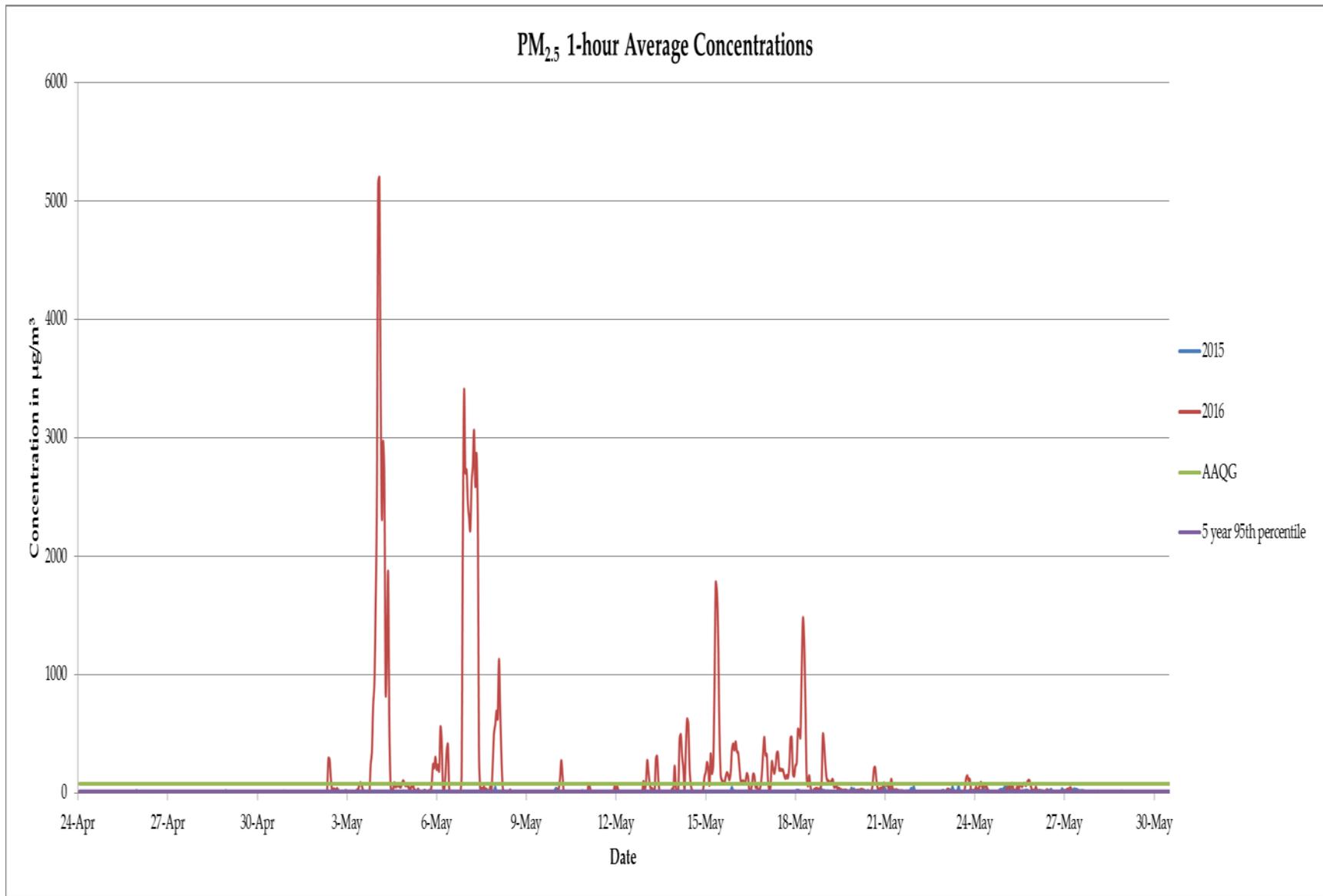


Figure 3k NH₃ measurements at Patricia McInnes (AMS6).



*Figure 3I 1-hour PM_{2.5} measurements at Patricia McInnes (AMS6).

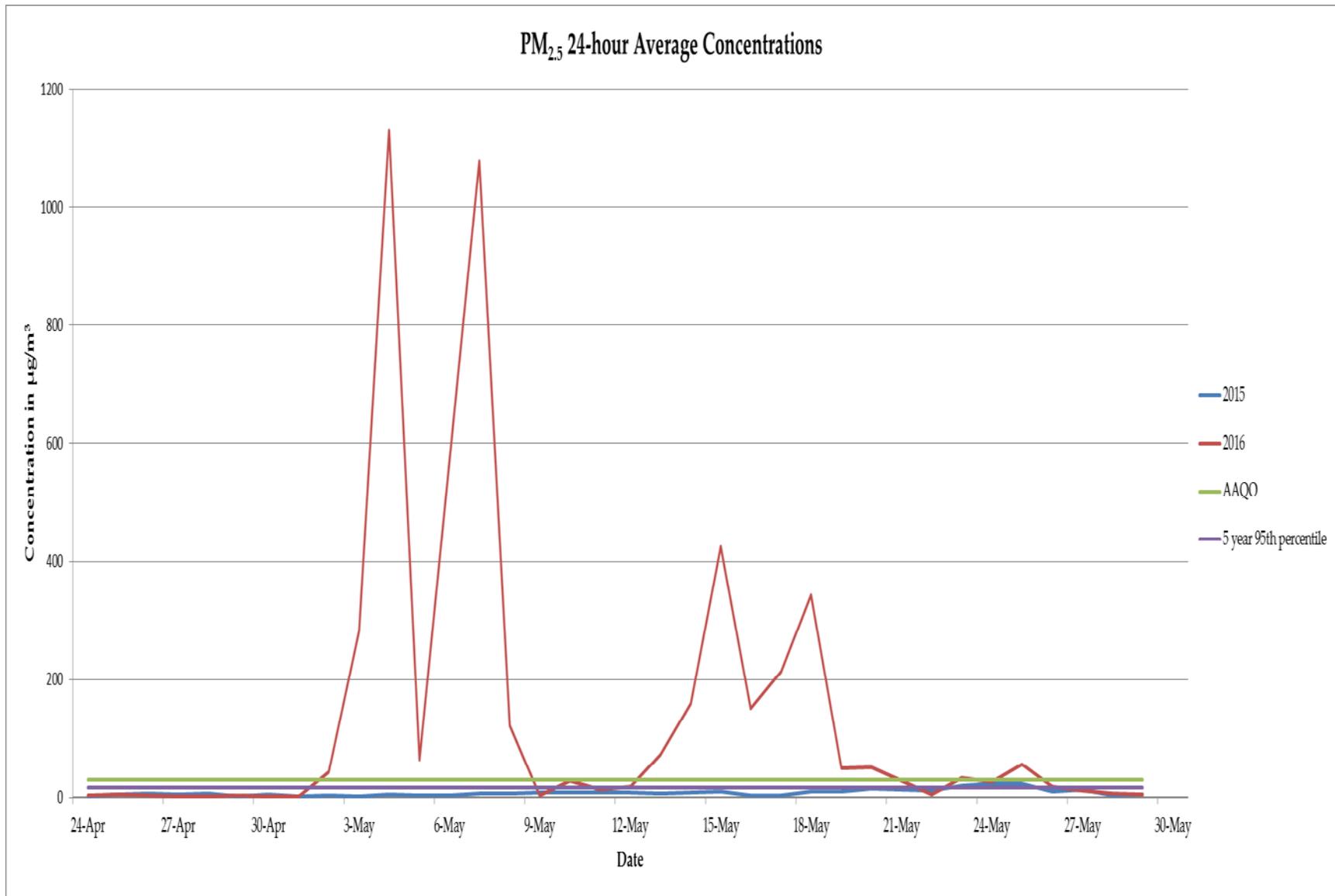


Figure 3m 24-hour PM_{2.5} measurements at Patricia McInnes (AMS6).

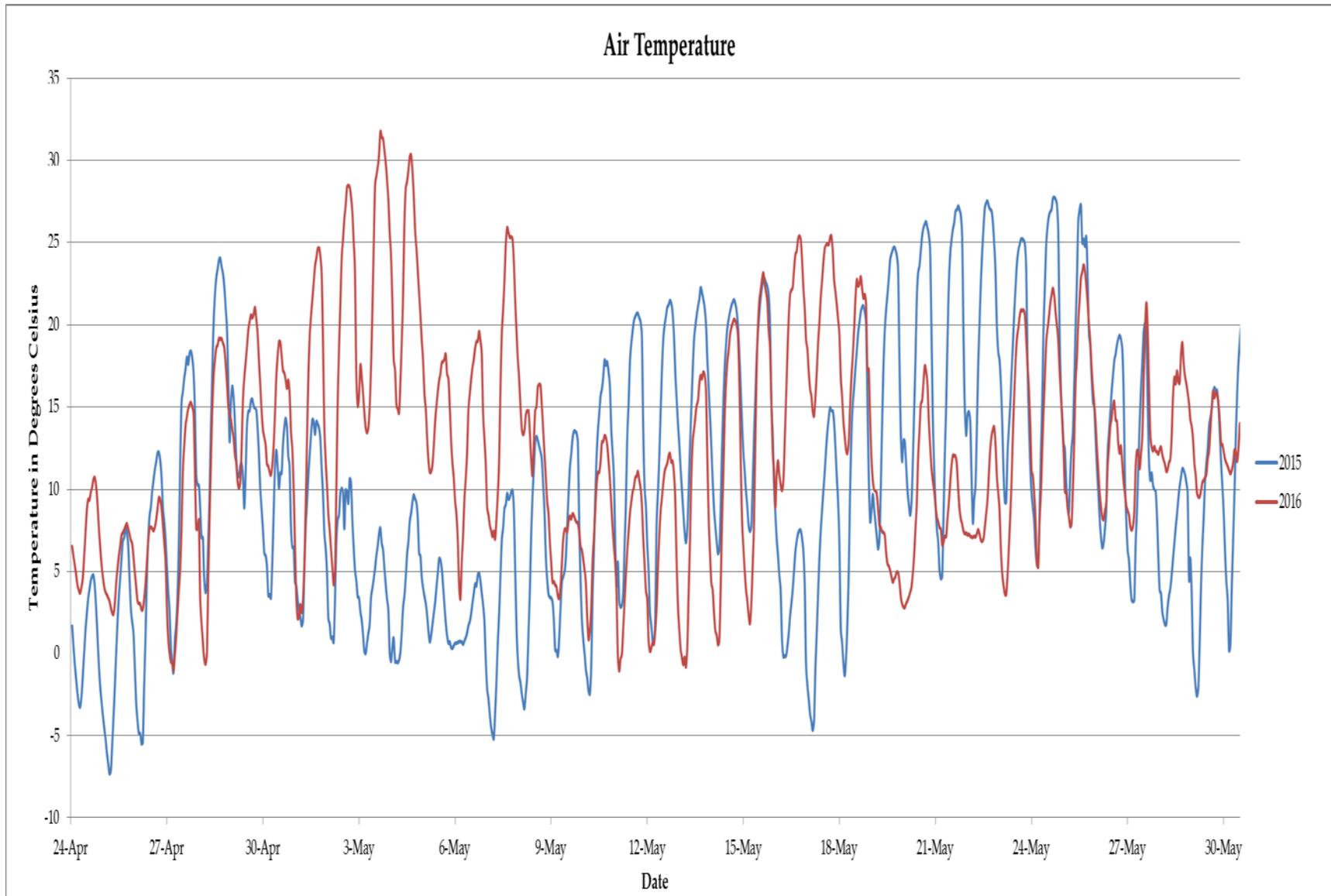


Figure 3n Air temperature measurements at Patricia McInnes (AMS6).

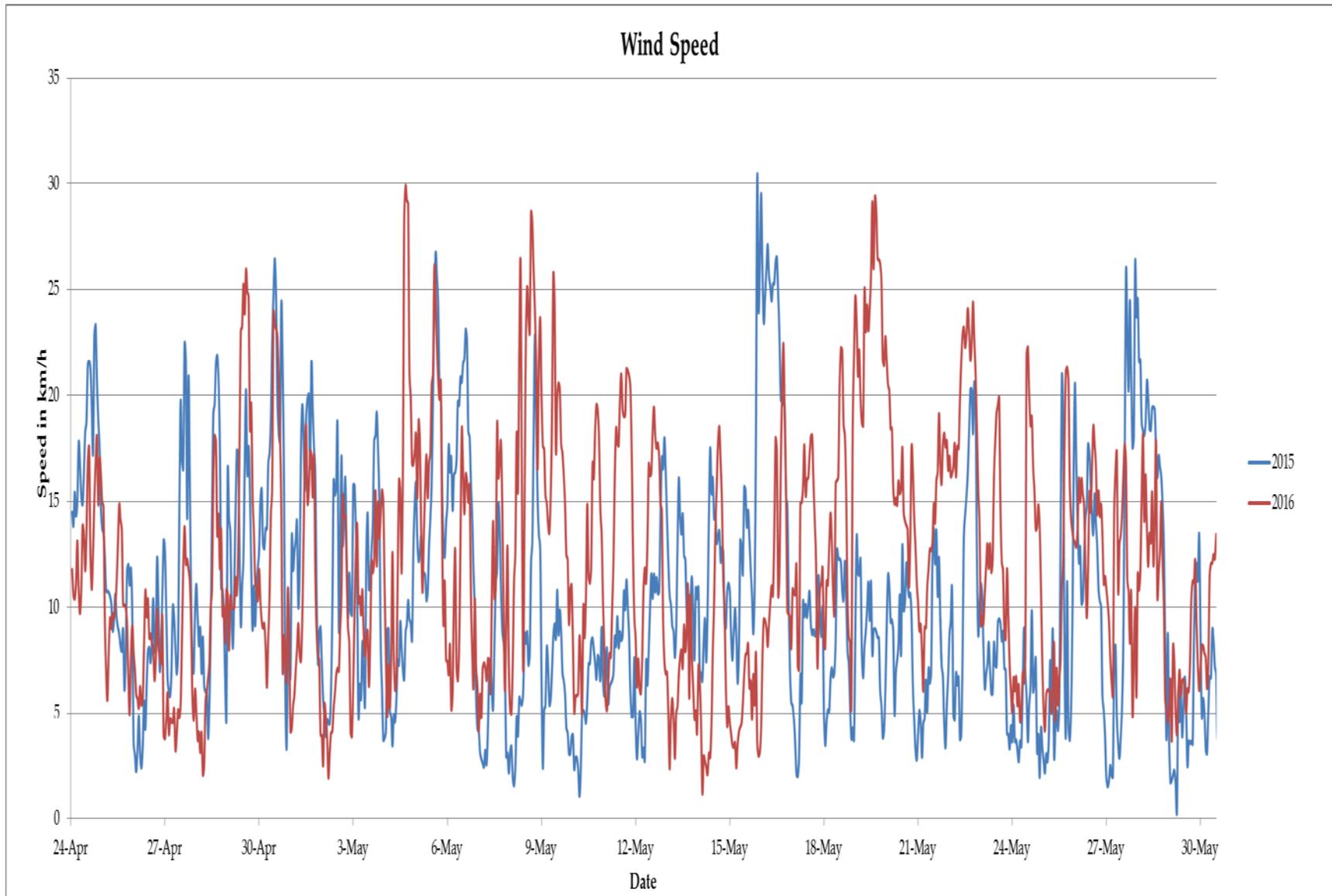


Figure 3o Wind speed measurements at Patricia McInnes (AMS6).

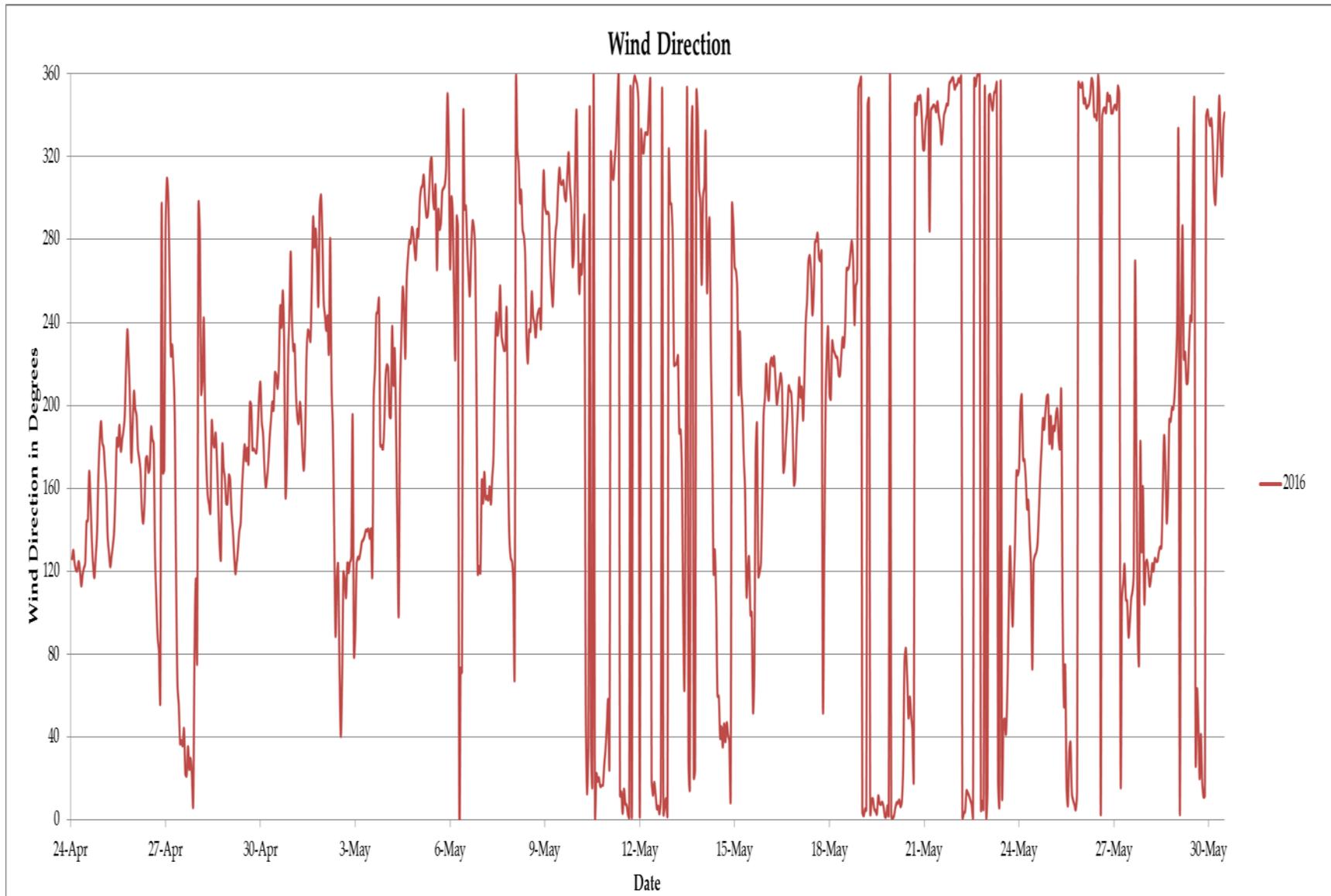


Figure 3p Wind direction measurements at Patricia McInnes (AMS6).

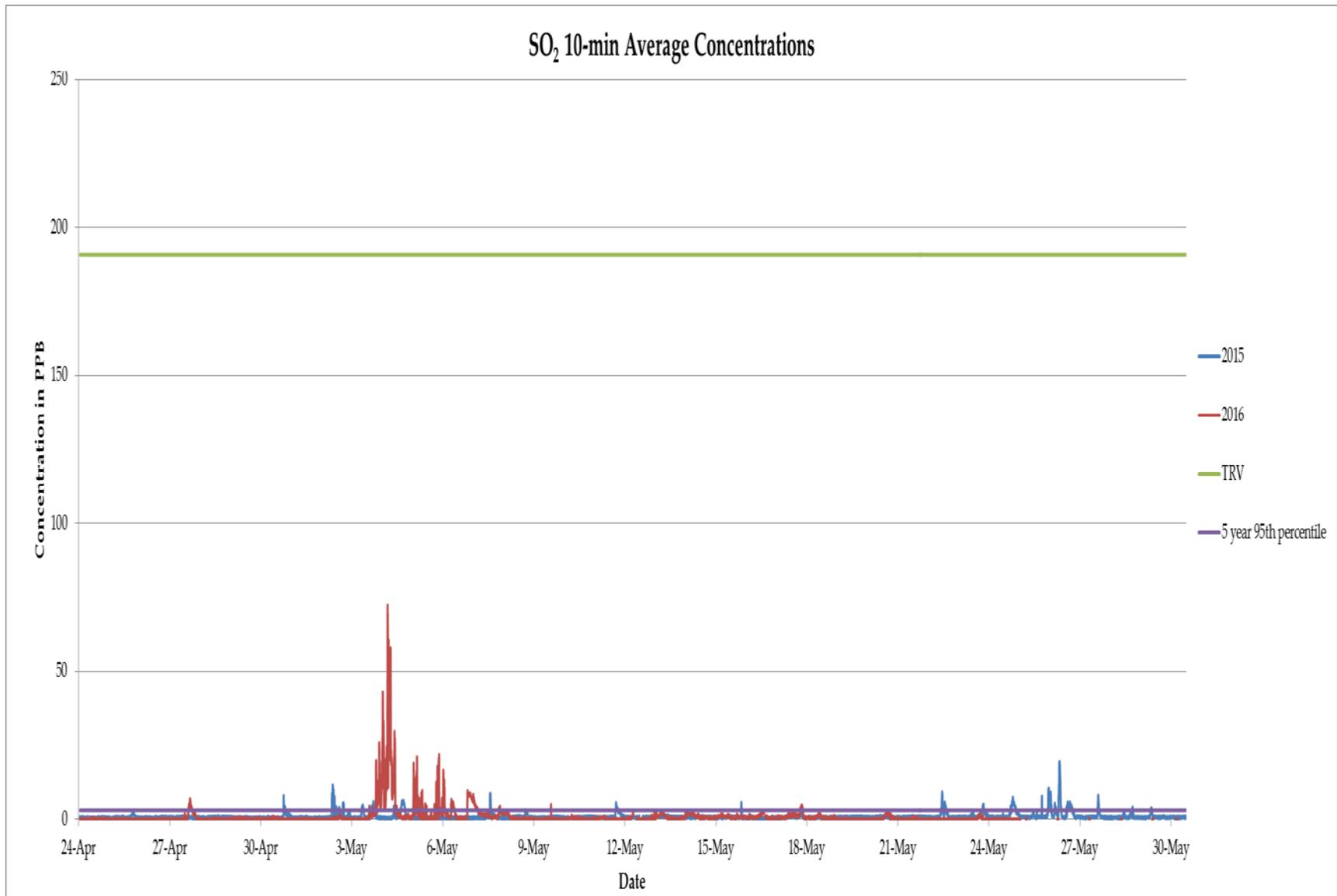


Figure 4a 10-minute SO₂ measurements at Athabasca Valley (AMS7).

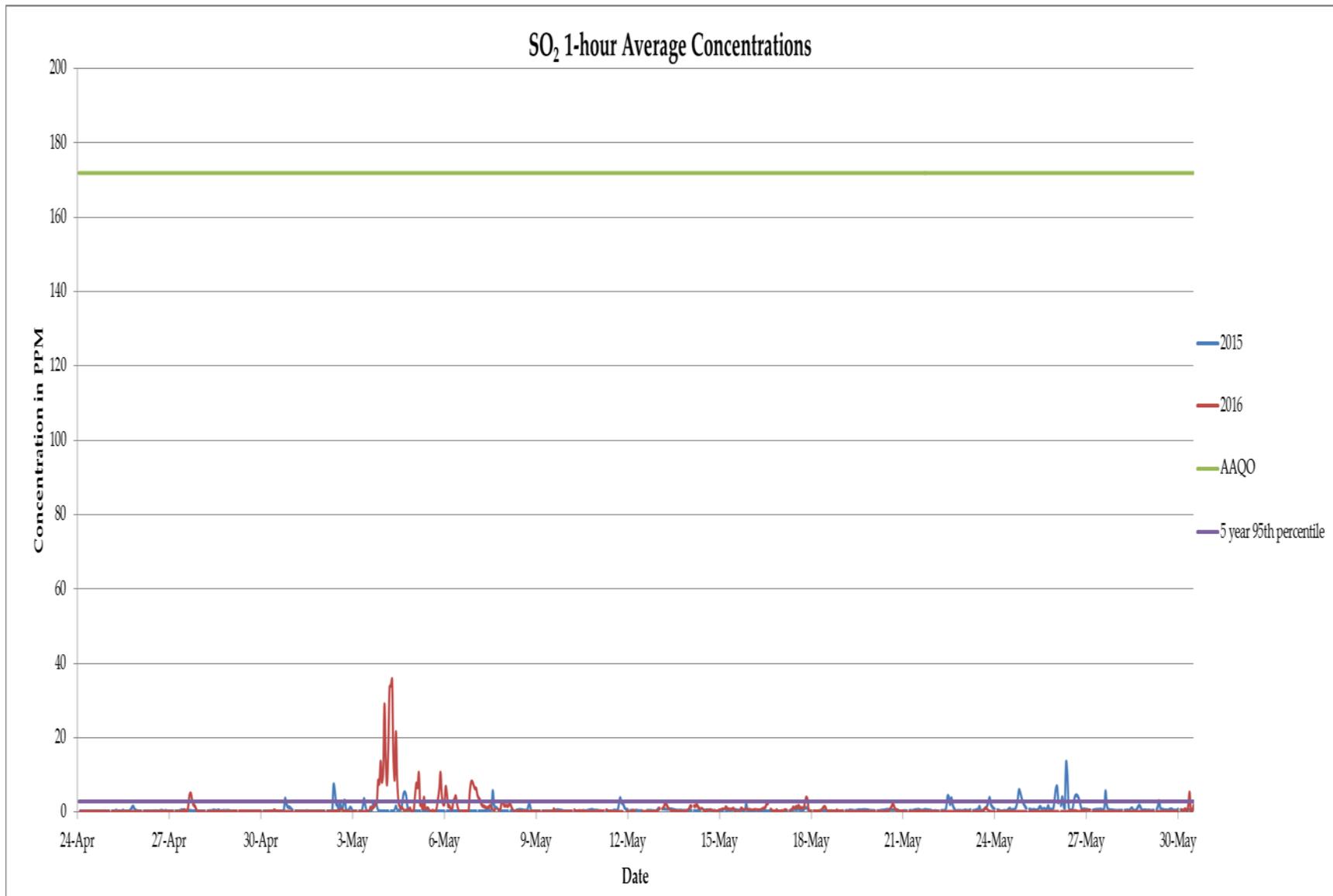


Figure 4b 1-hour SO₂ measurements at Athabasca Valley (AMS7).

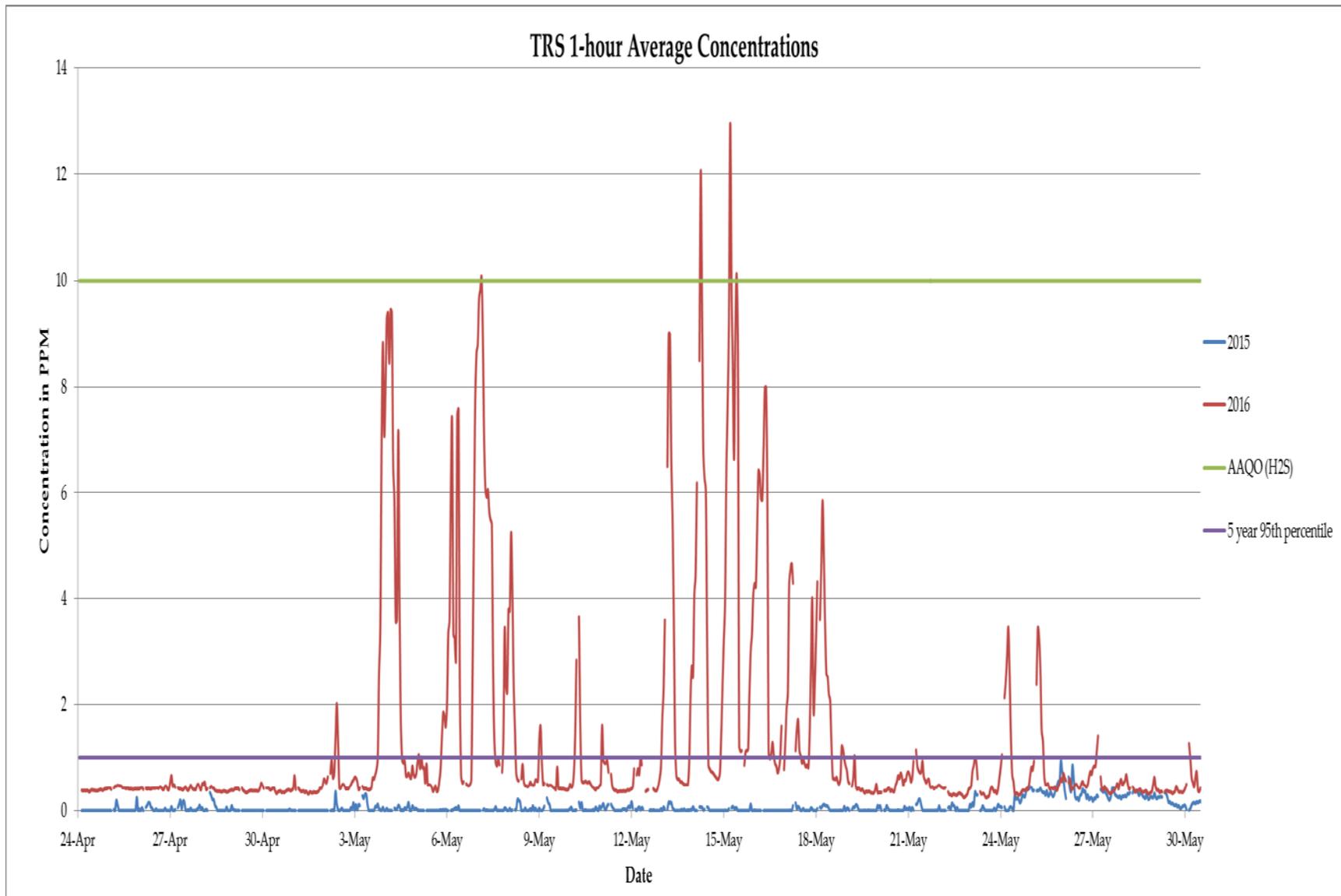


Figure 4c TRS measurements at Athabasca Valley (AMS7).

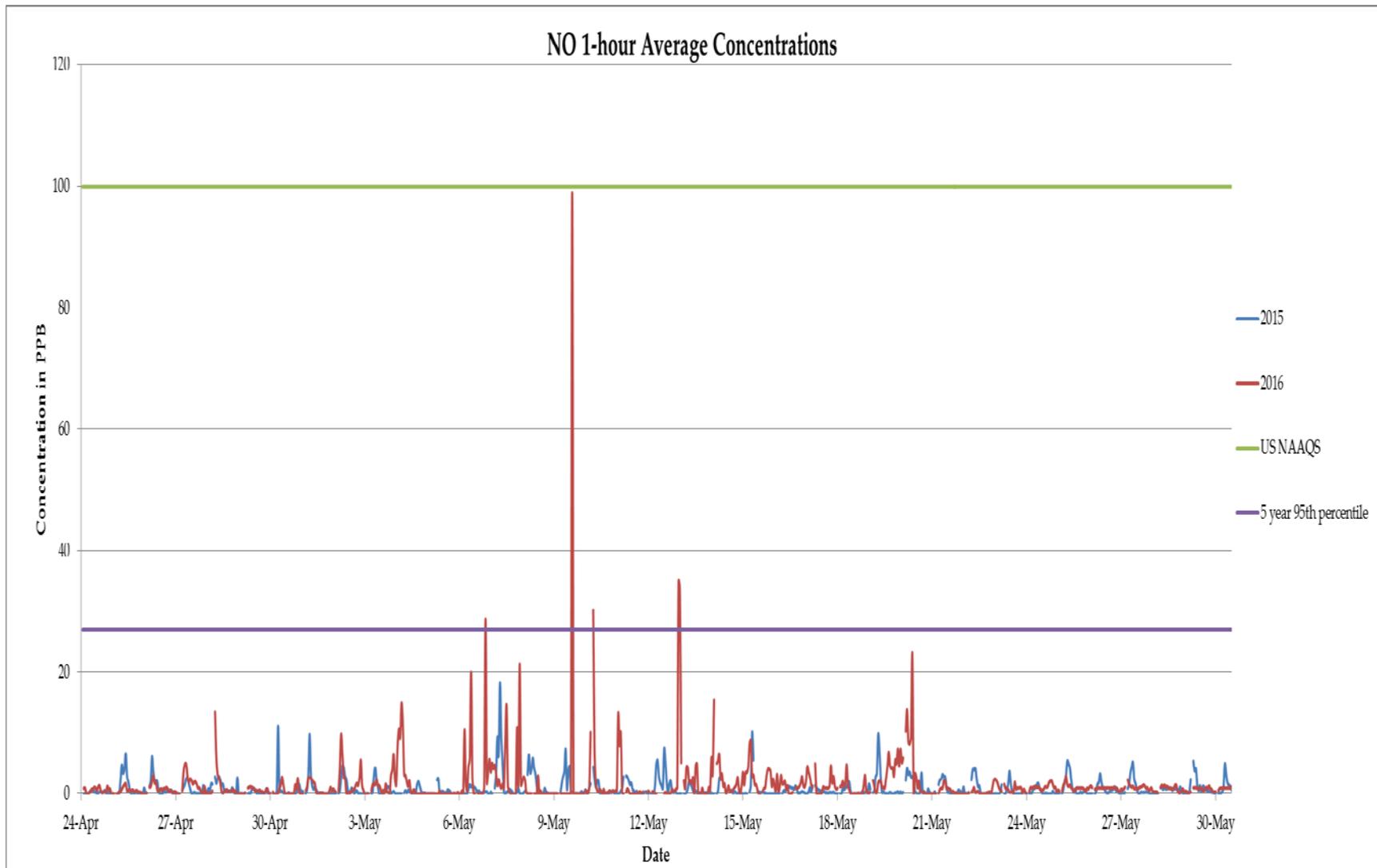


Figure 4d NO measurements at Athabasca Valley (AMS7).

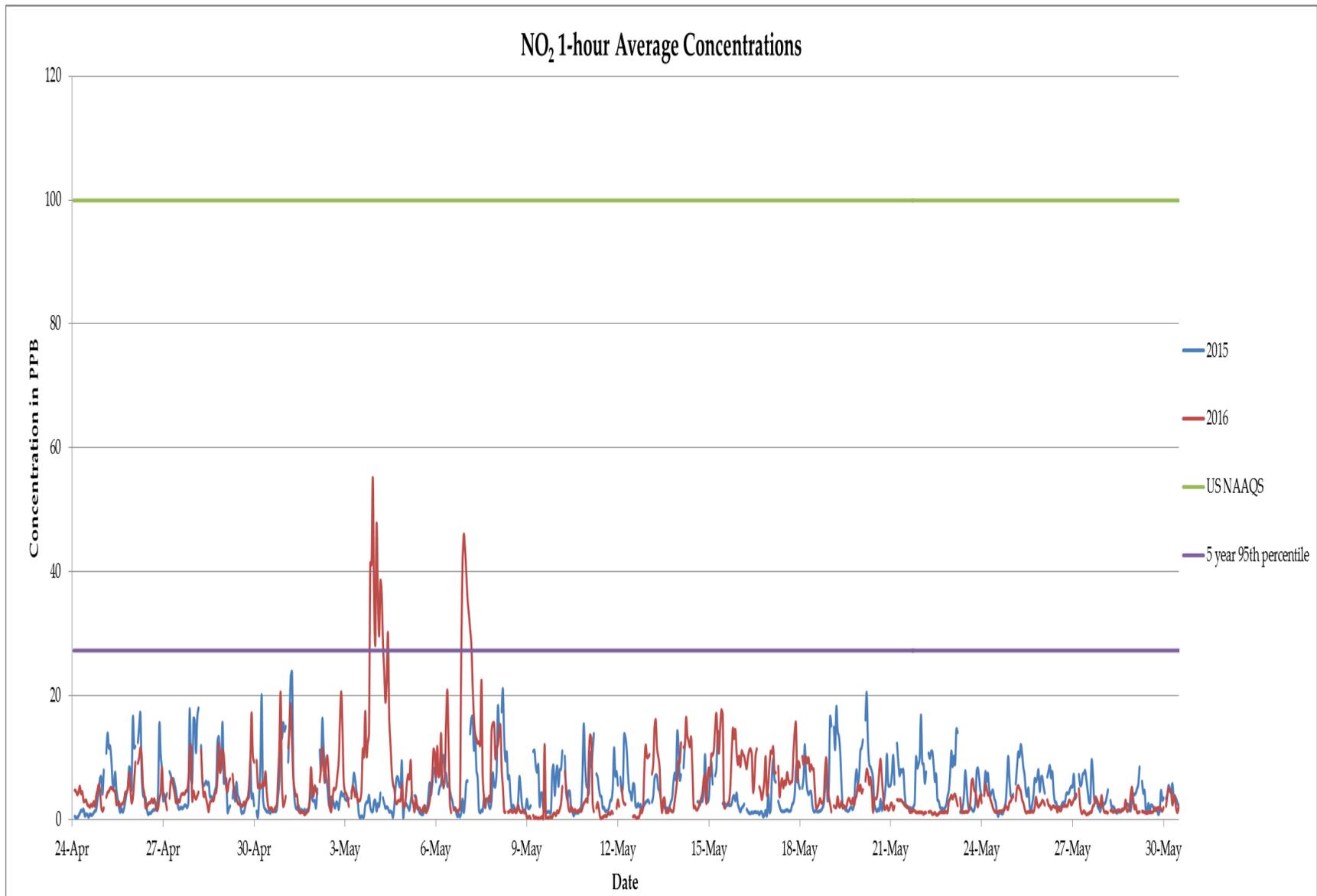


Figure 4e NO₂ measurements at Athabasca Valley (AMS7).

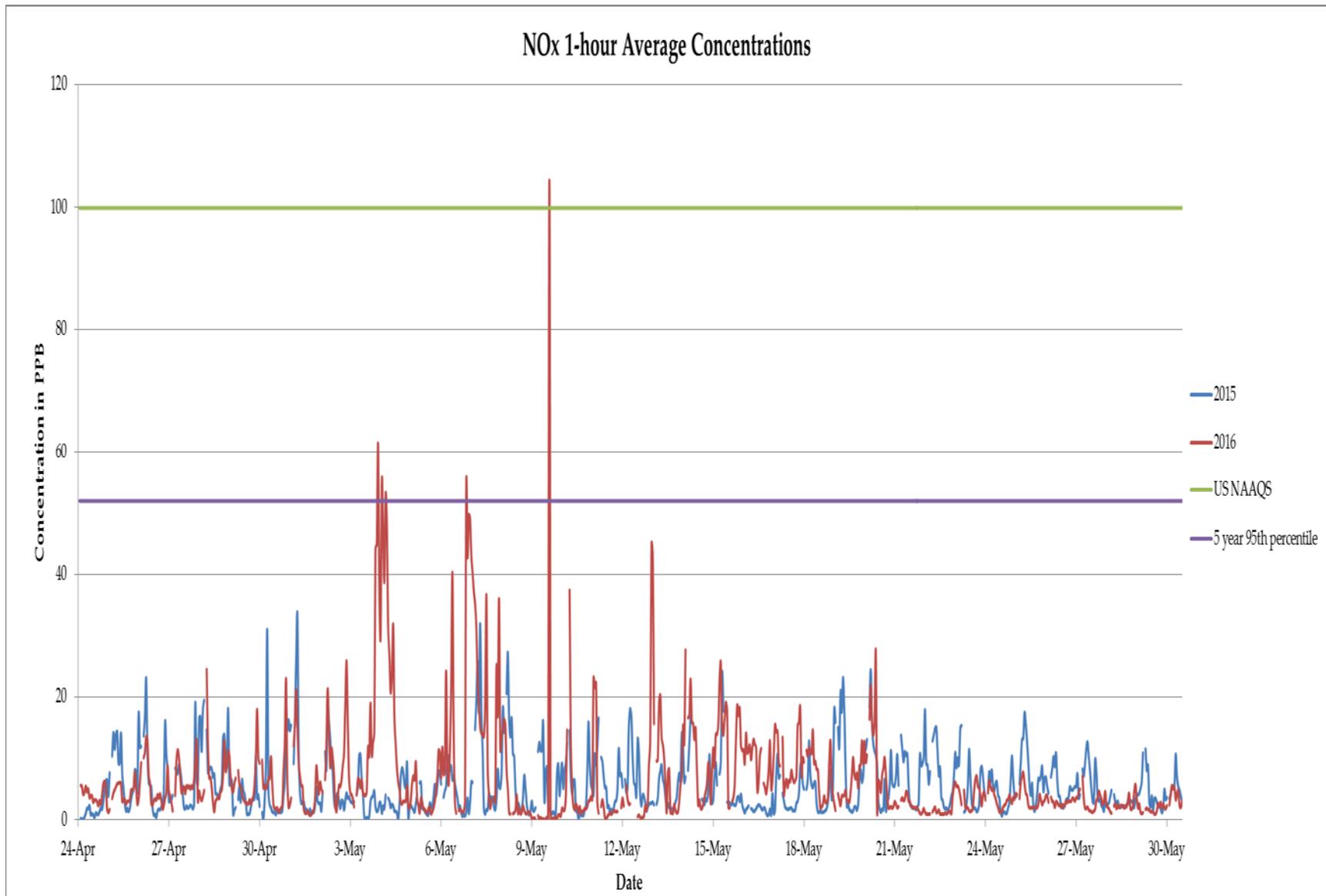


Figure 4f NO_x measurements at Athabasca Valley (AMS7).

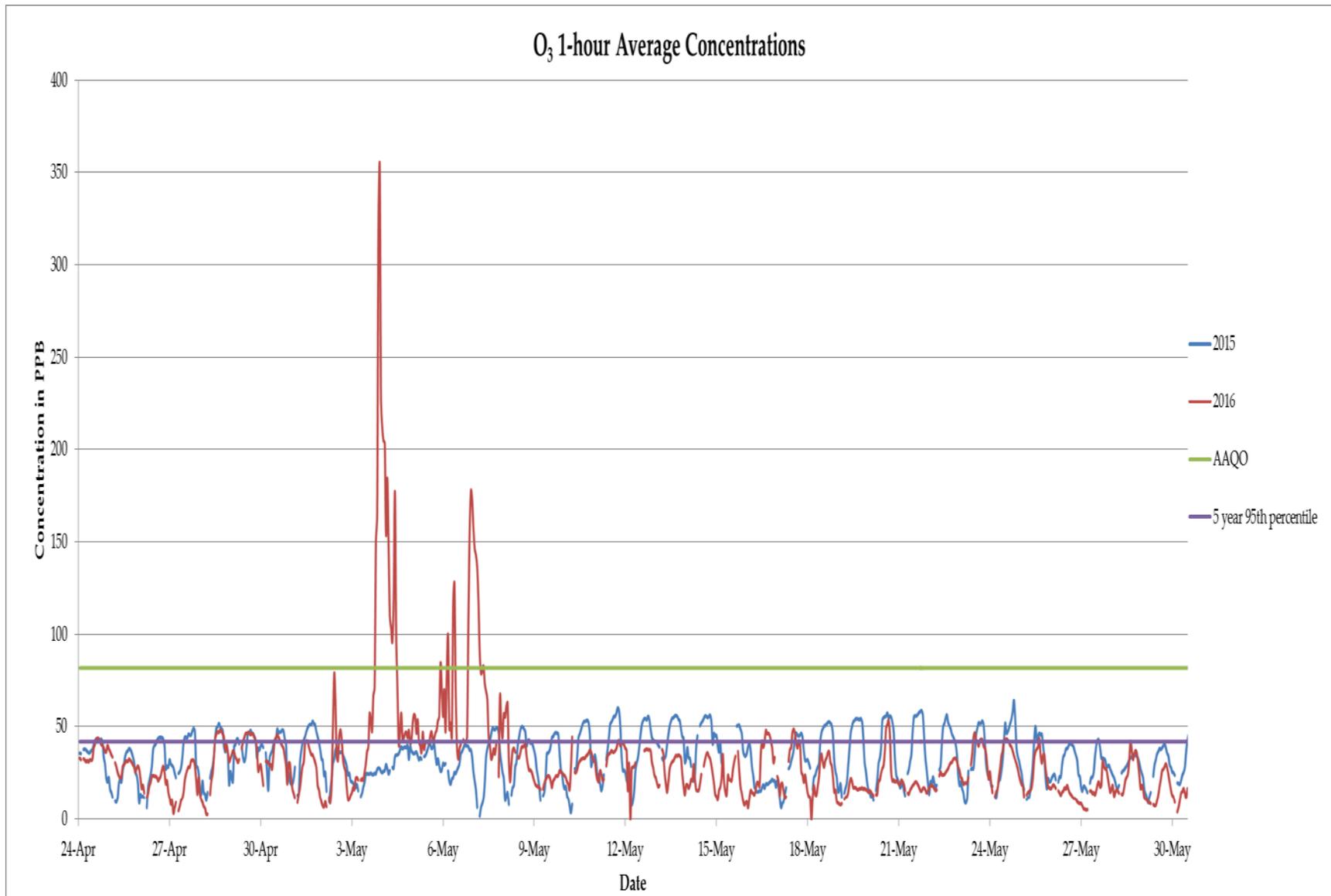


Figure 4g Ozone (O₃) measurements at Athabasca Valley (AMS7).

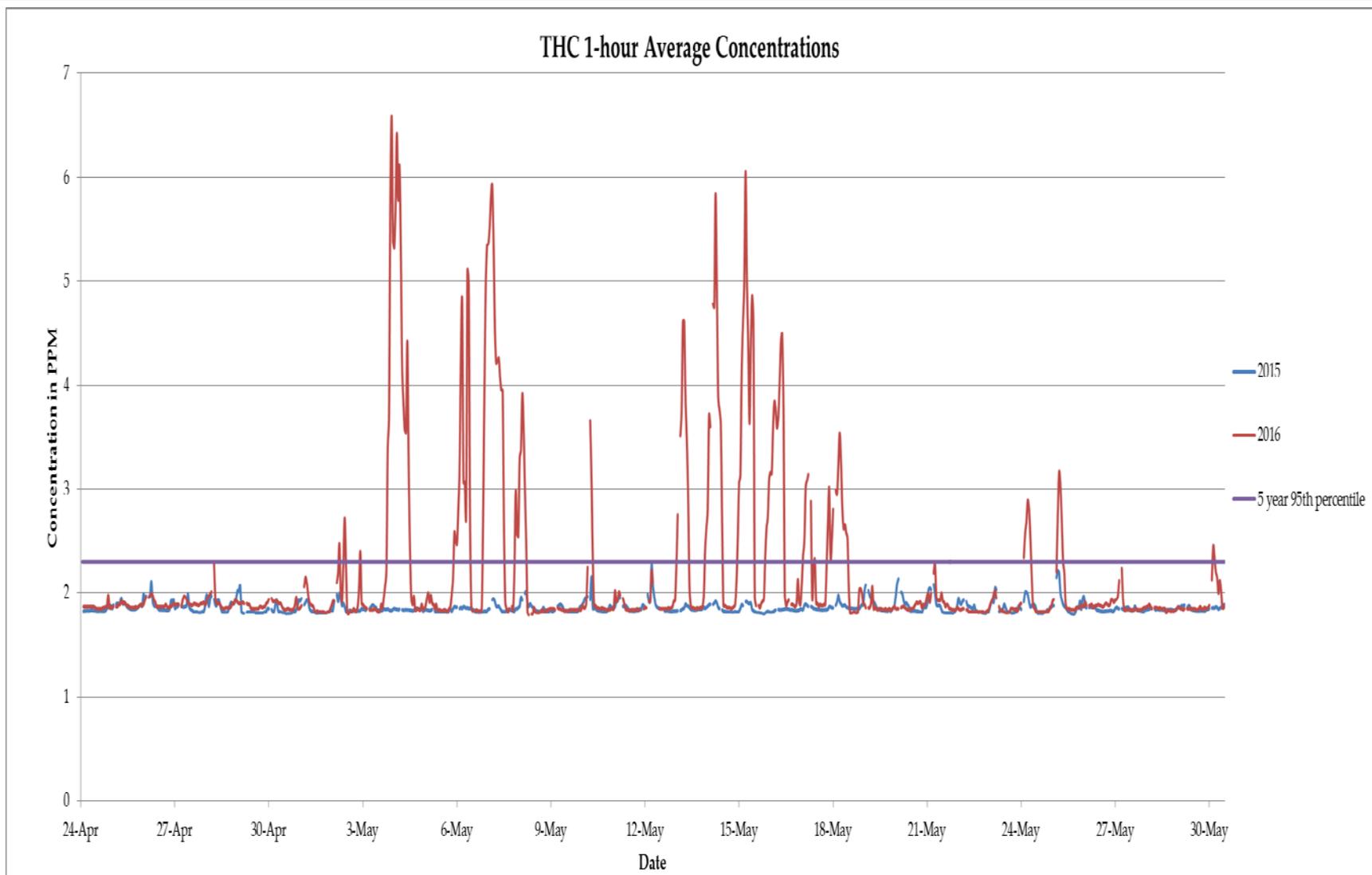


Figure 4h THC measurements at Athabasca Valley (AMS7).

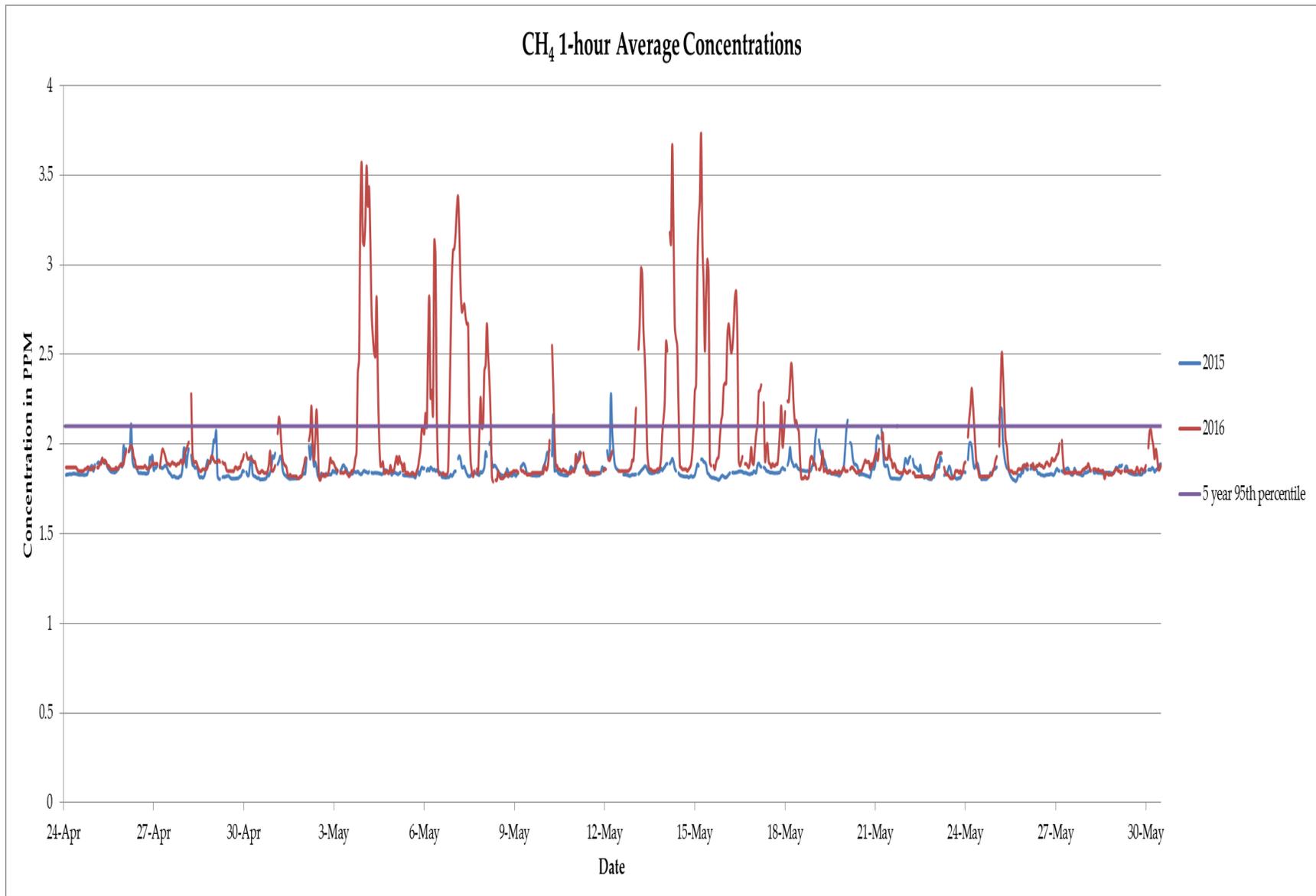


Figure 4i CH₄ measurements at Athabasca Valley (AMS7).

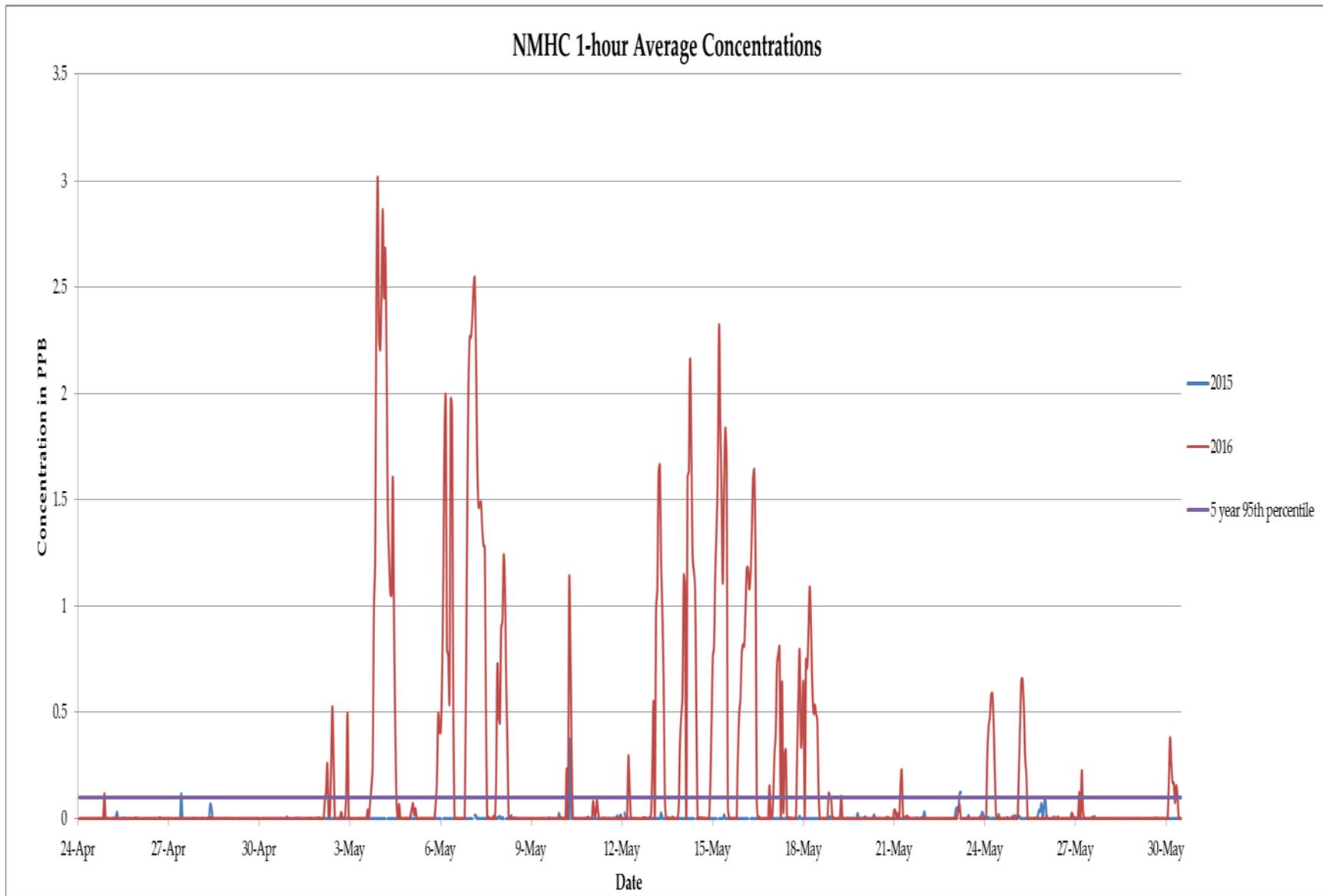


Figure 4j NMHC measurements at Athabasca Valley (AMS7).

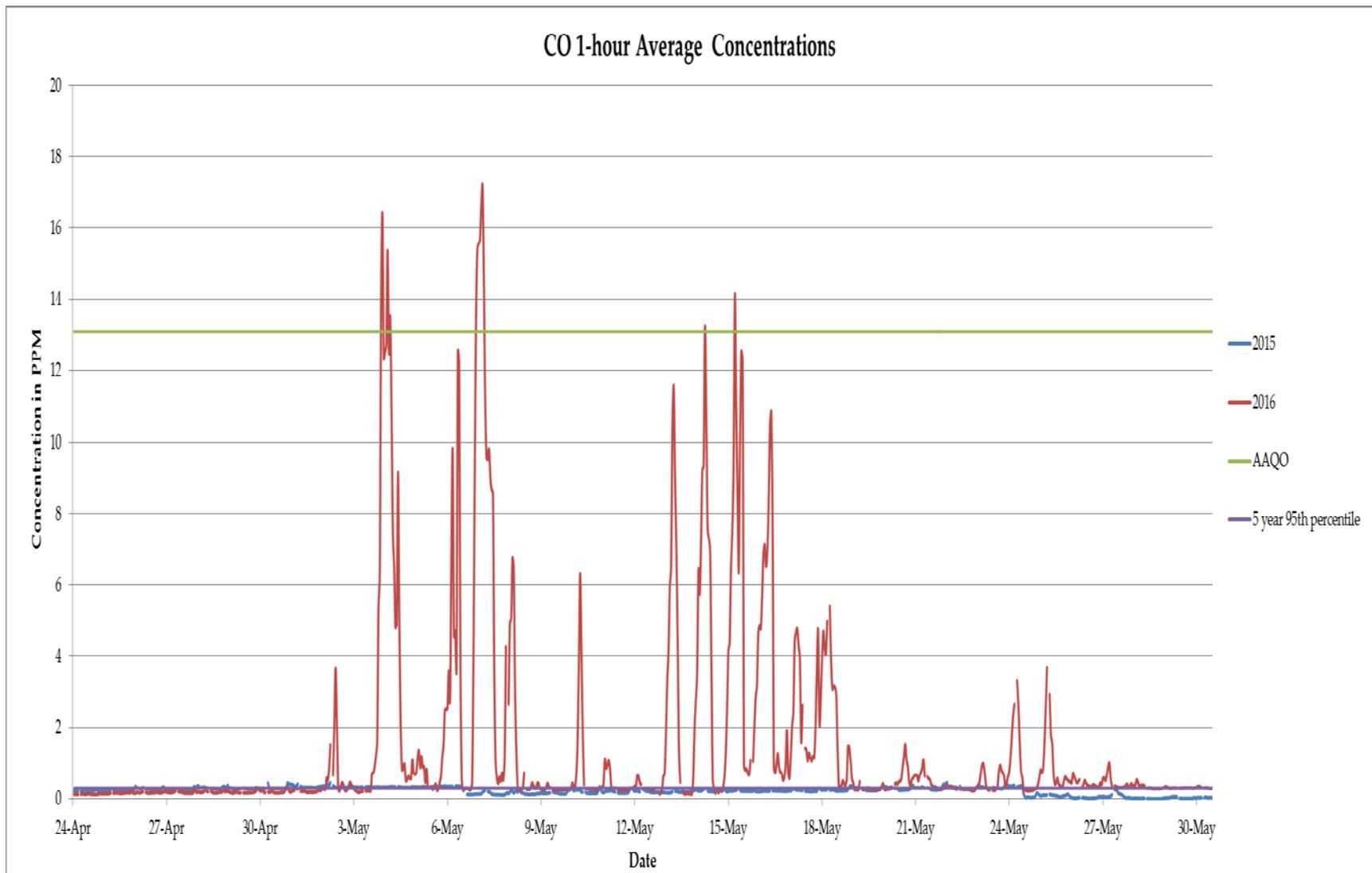


Figure 4k CO measurements at Athabasca Valley (AMS7).

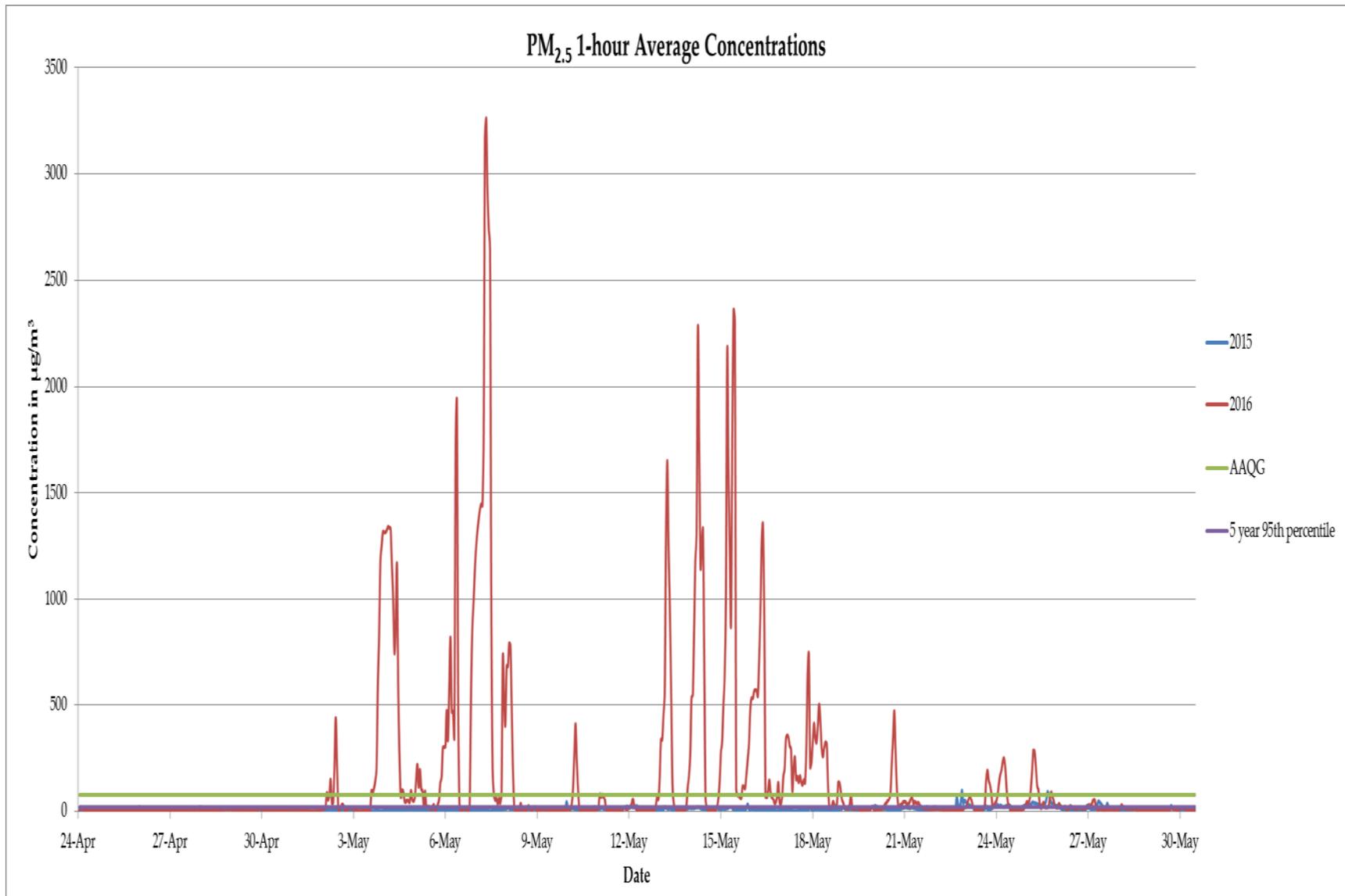


Figure 4I 1-hour PM_{2.5} measurements at Athabasca Valley (AMS7).

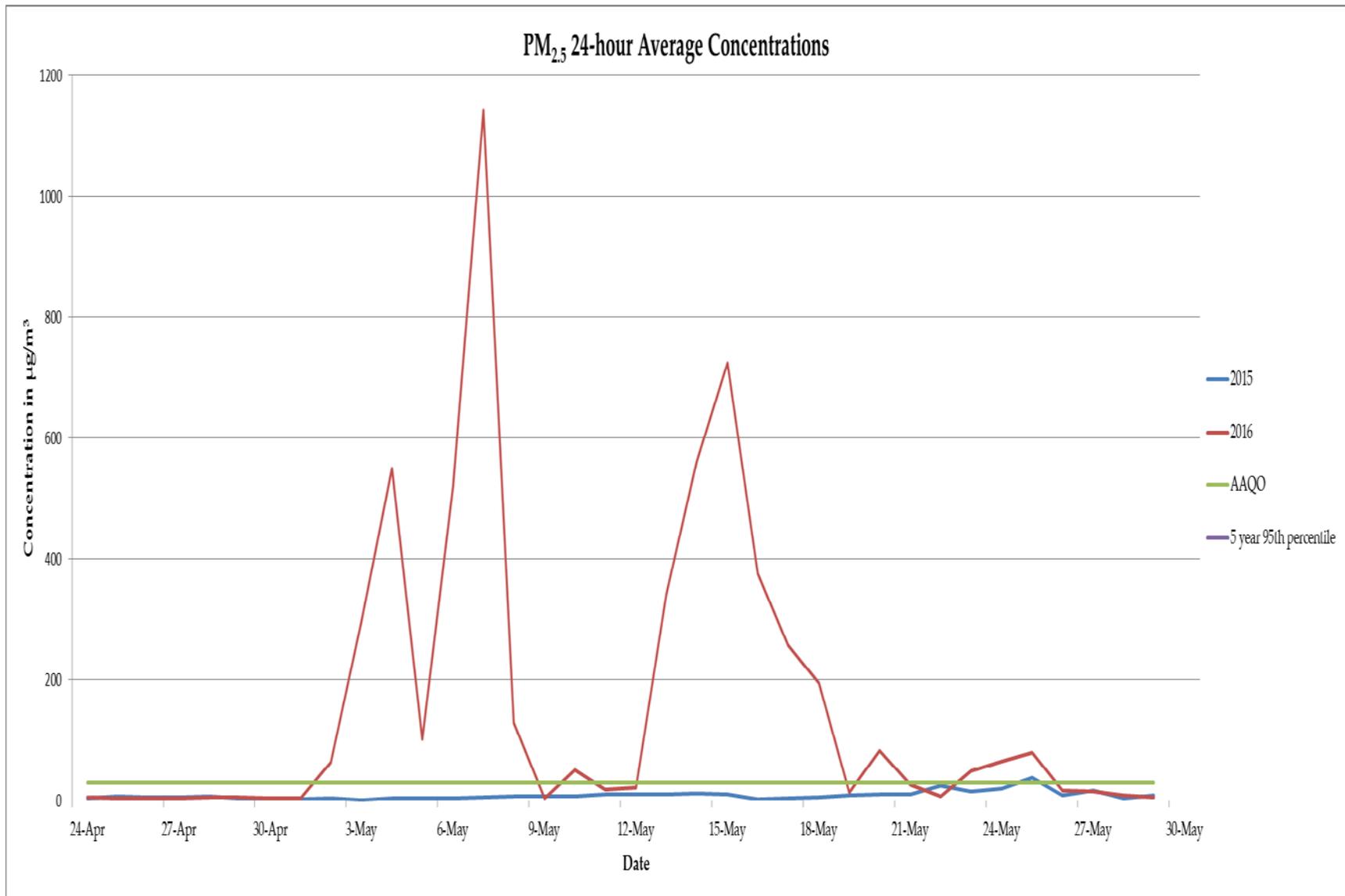


Figure 4m 24-hour PM_{2.5} measurements at Athabasca Valley (AMS7).

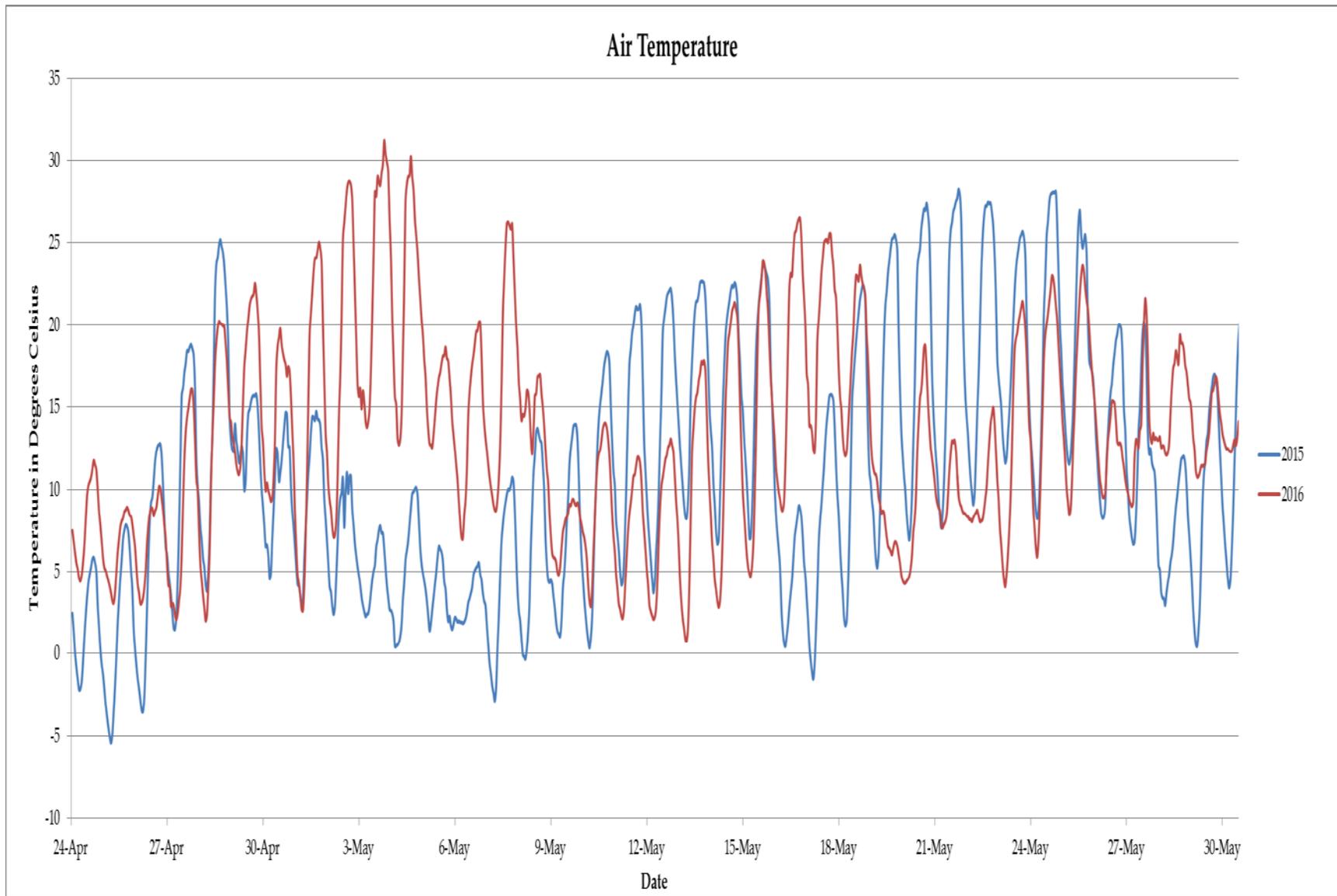


Figure 4n Air temperature measurements at Athabasca Valley (AMS7).

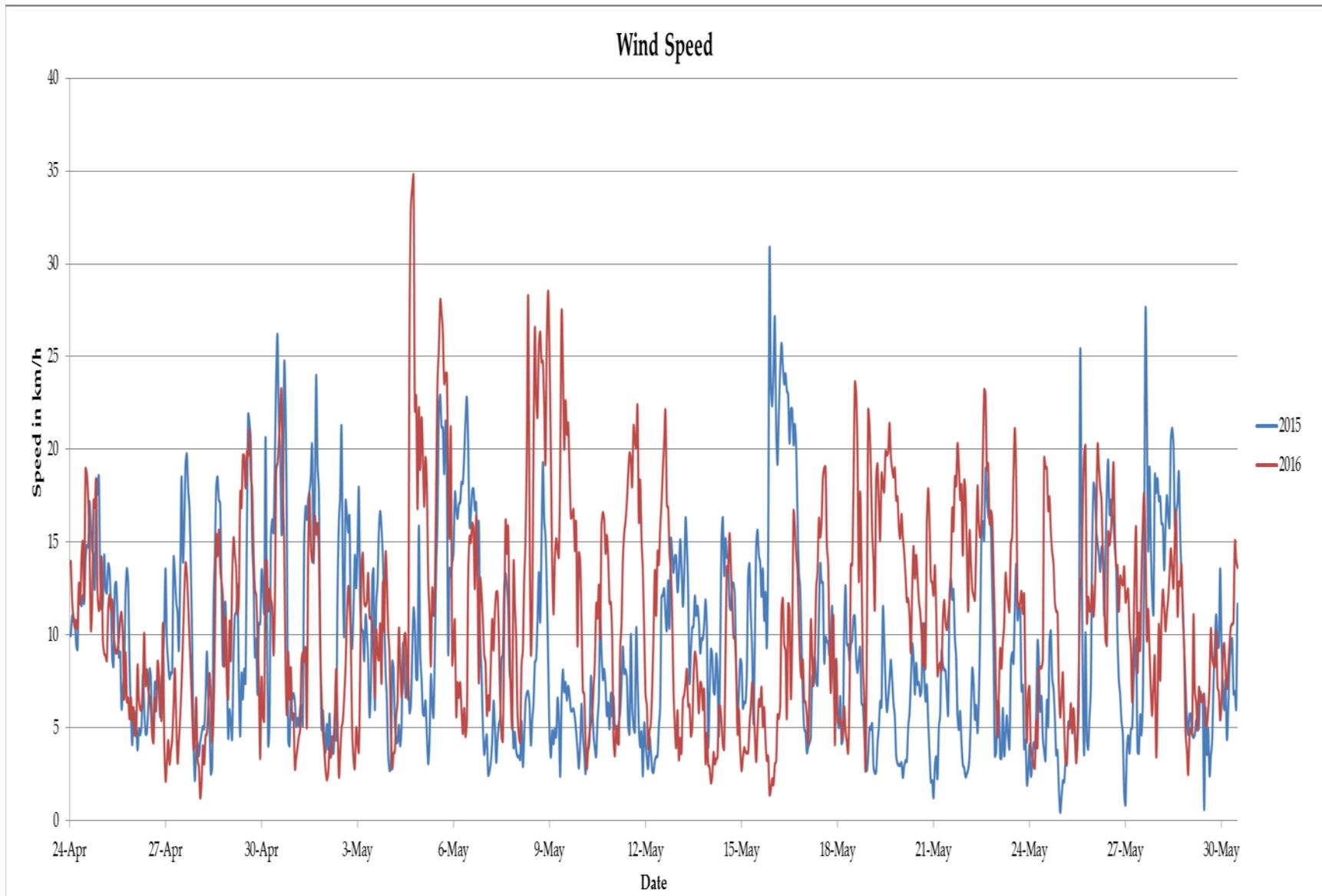


Figure 4o Wind speed measurements at Athabasca Valley (AMS7).

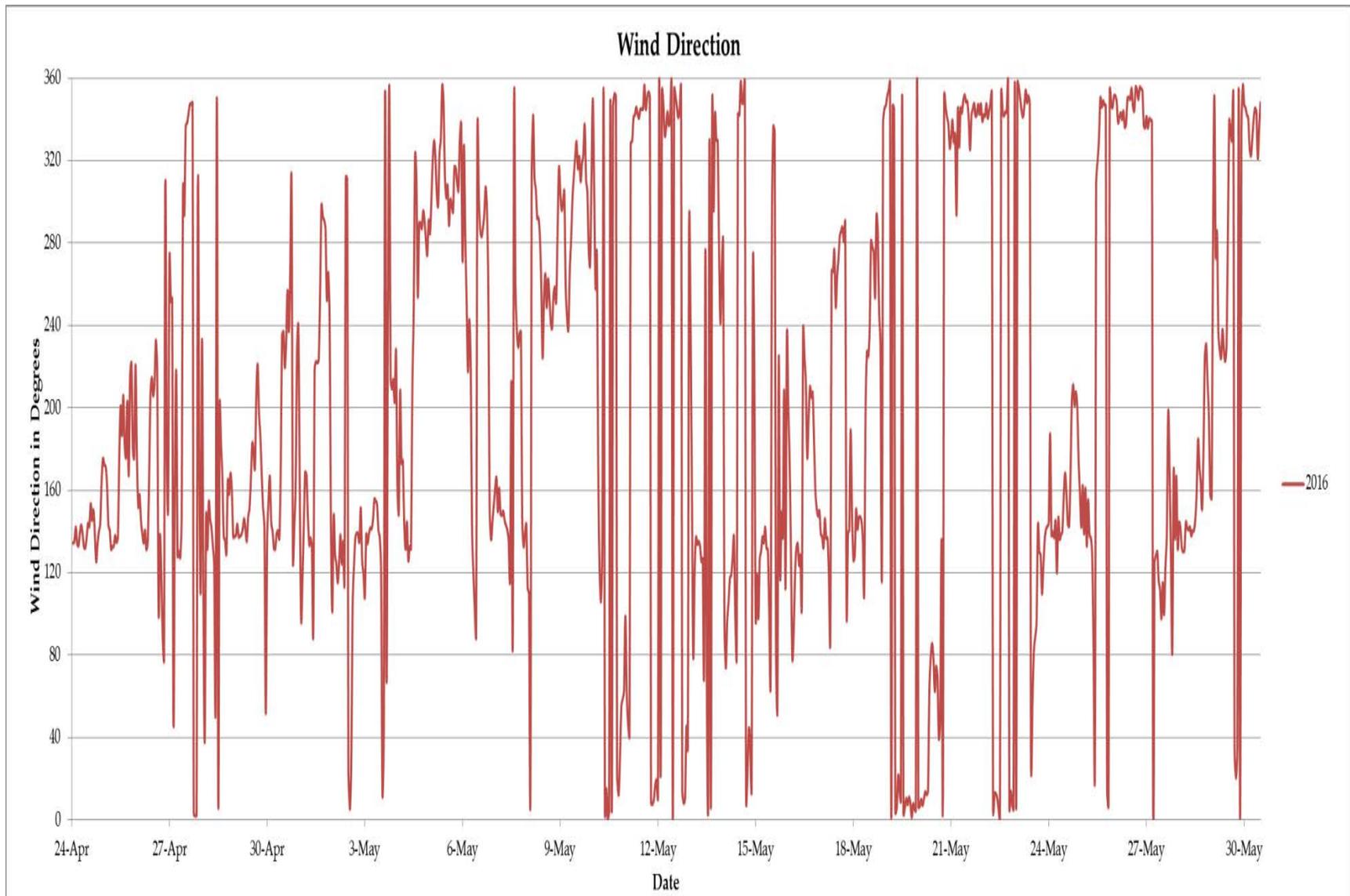


Figure 4p Wind direction measurements at Athabasca Valley (AMS7).

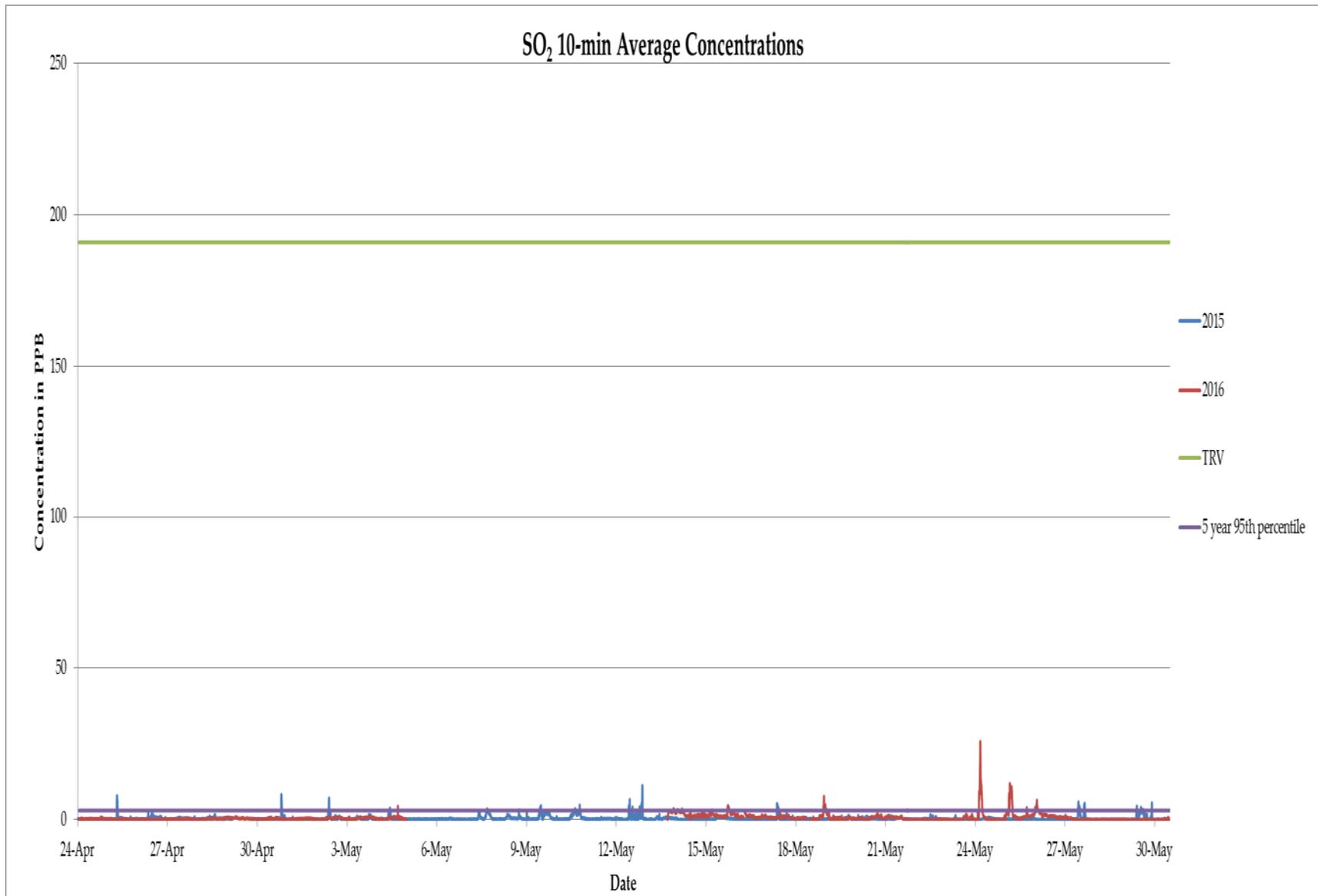


Figure 5a 10-minute SO₂ measurements at Anzac (AMS14).

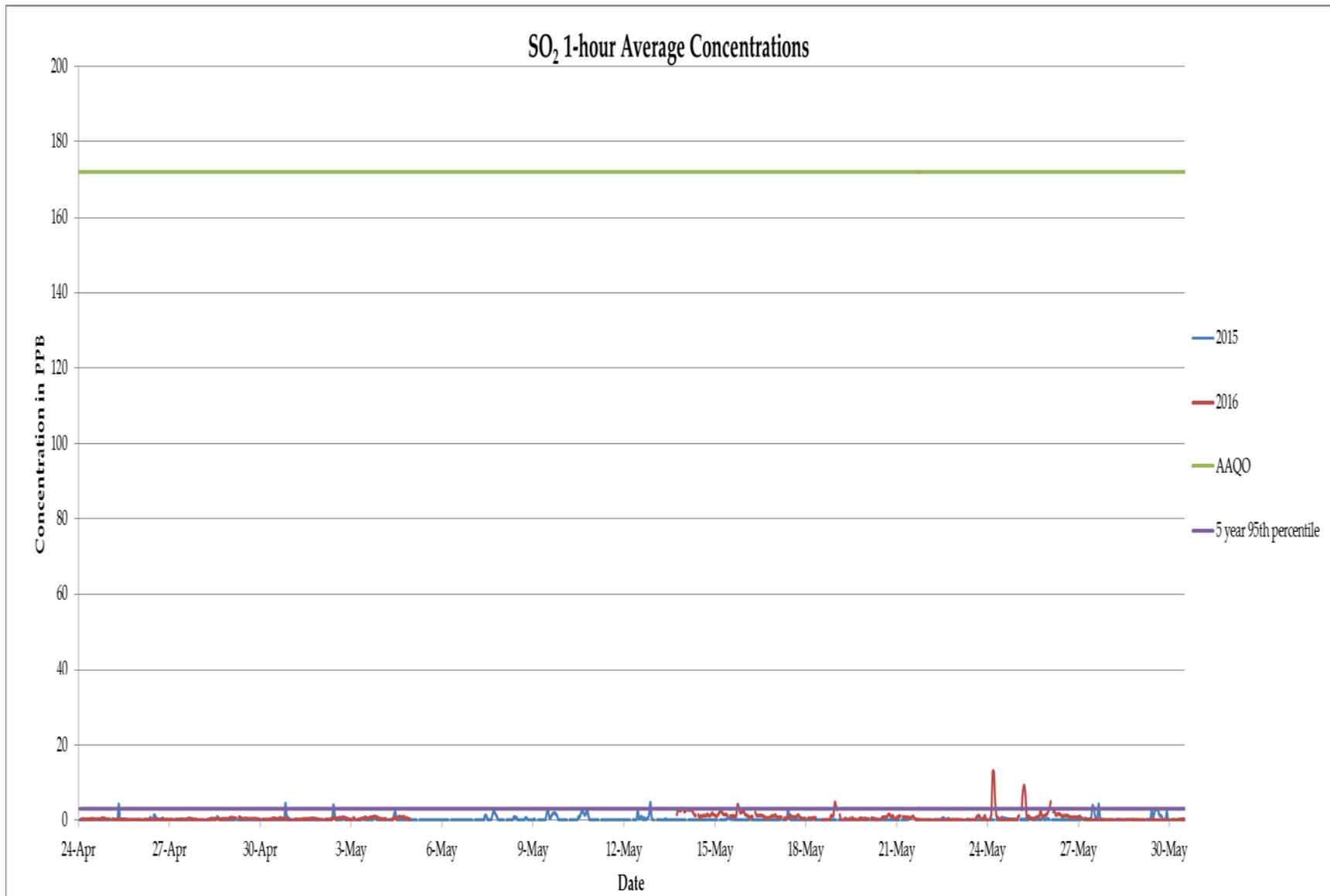


Figure 5b 1-hour SO₂ measurements at Anzac (AMS14).

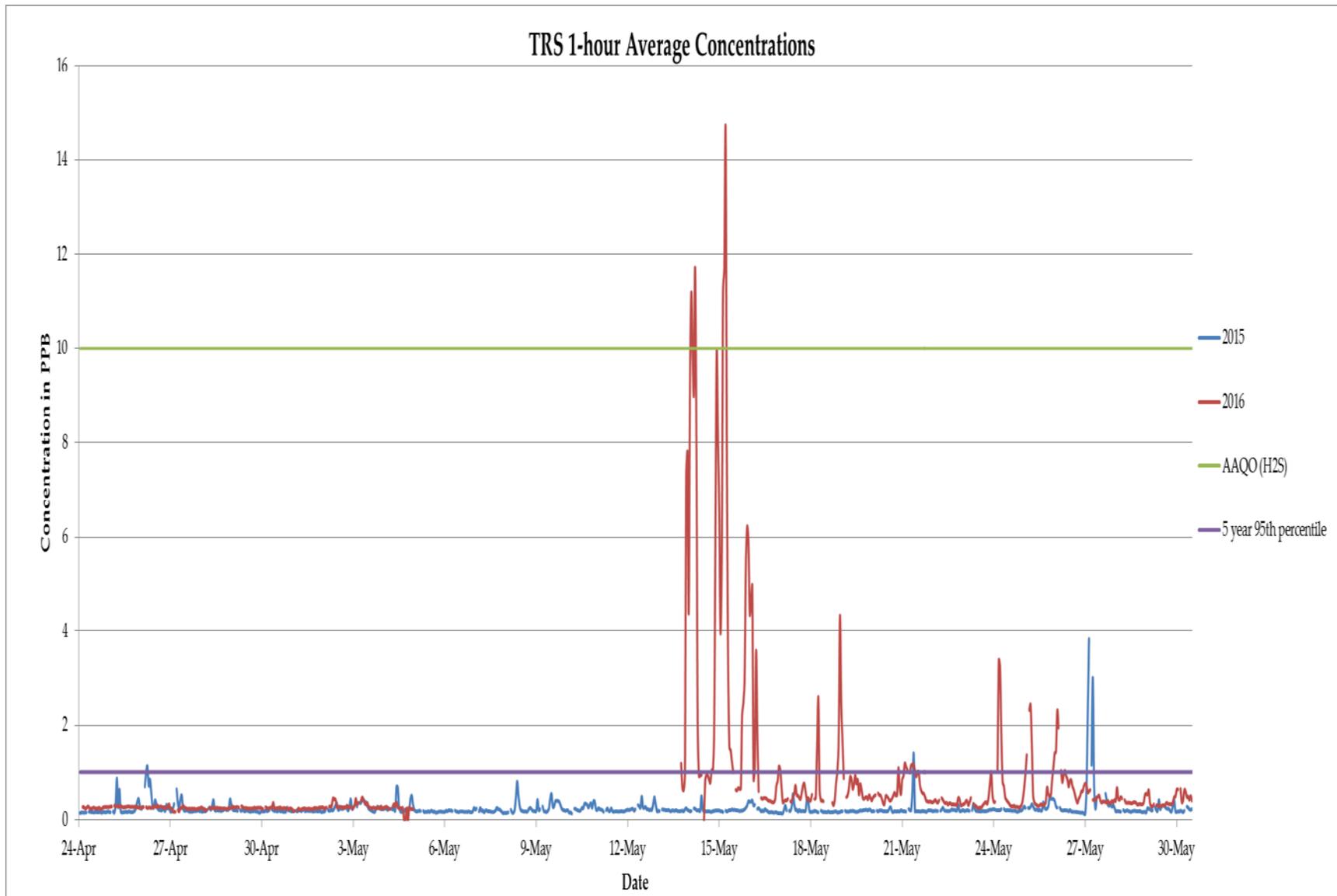


Figure 5c TRS measurements at Anzac (AMS14).

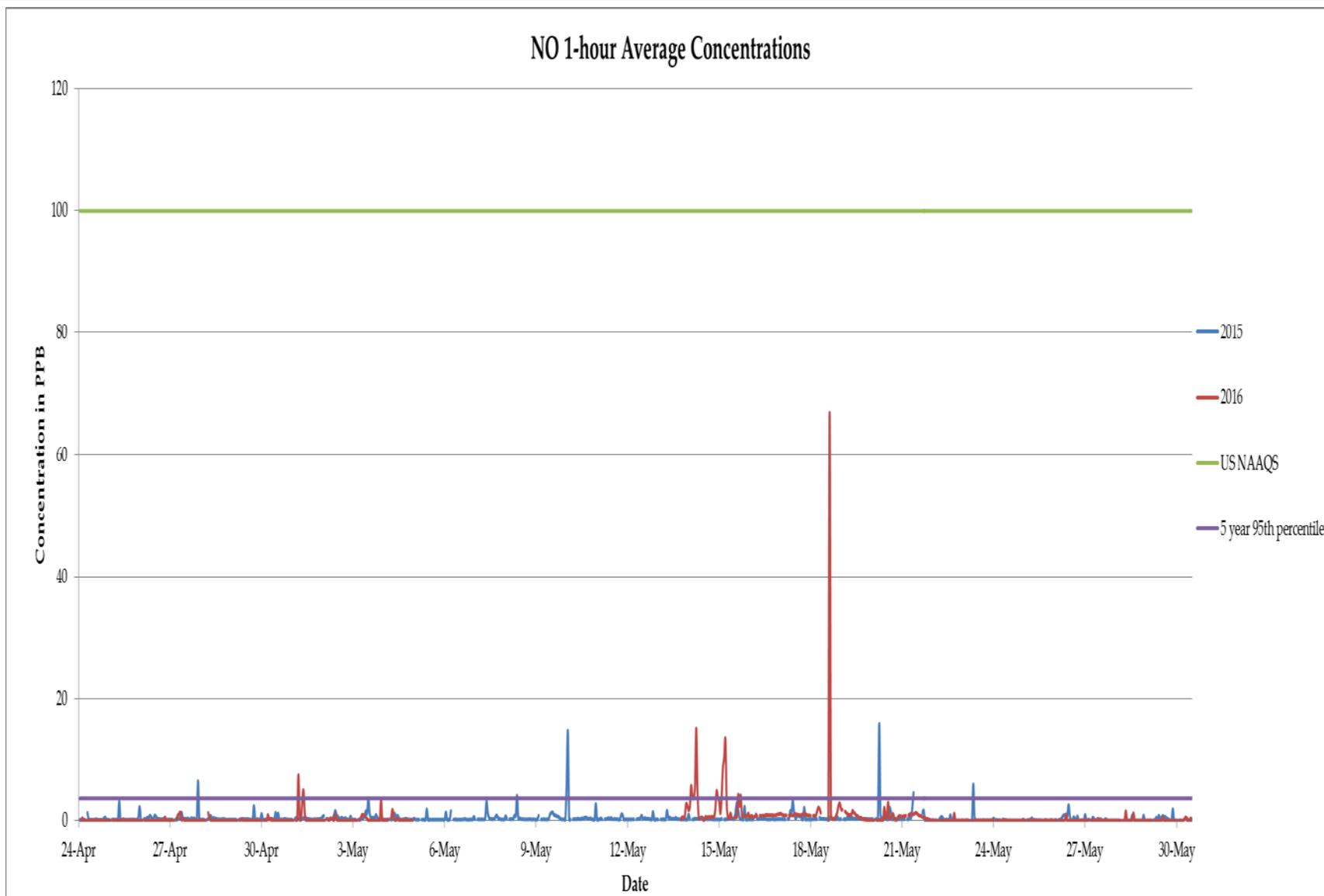


Figure 5d NO measurements at Anzac (AMS14).

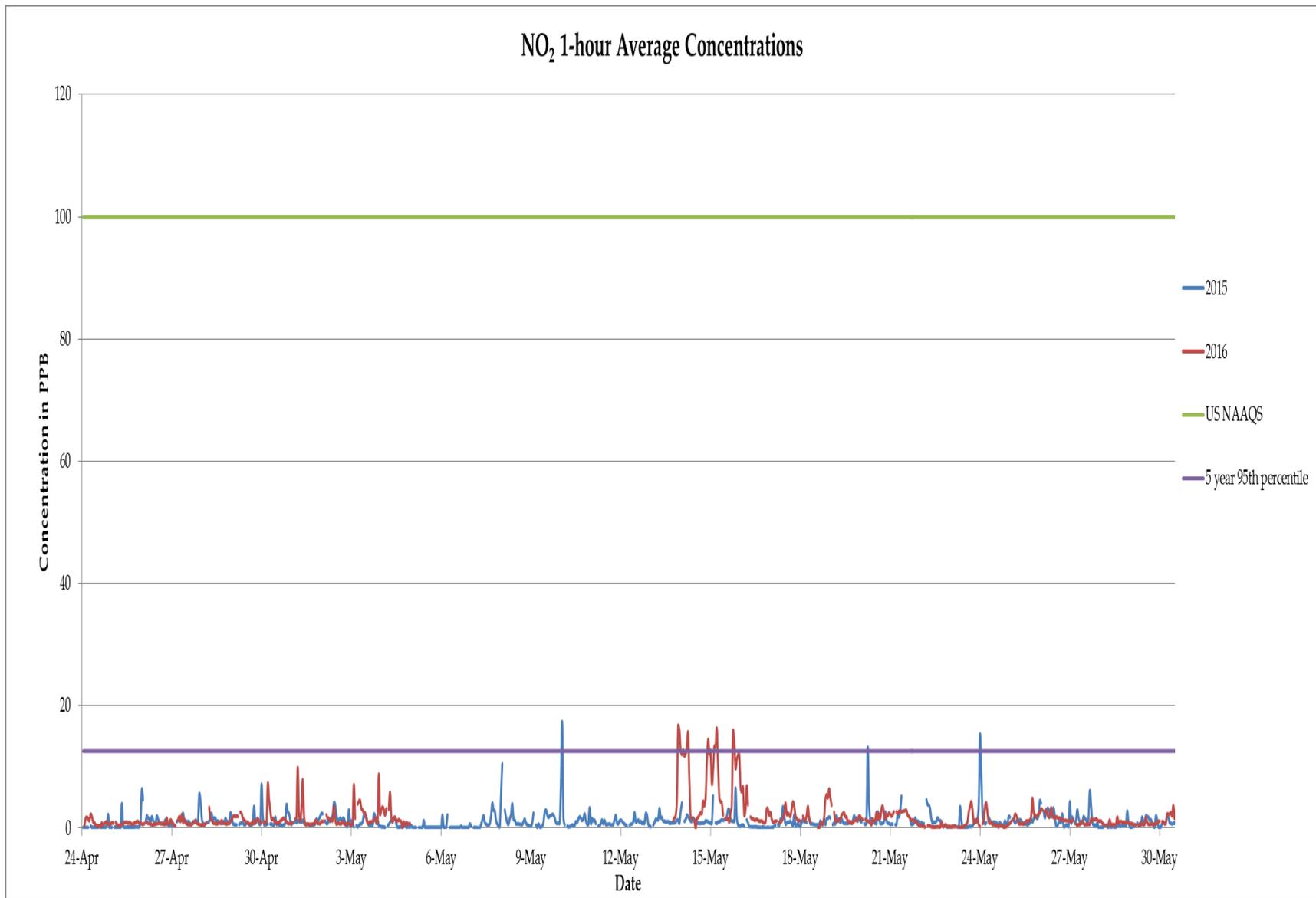


Figure 5e NO₂ measurements at Anzac (AMS14).

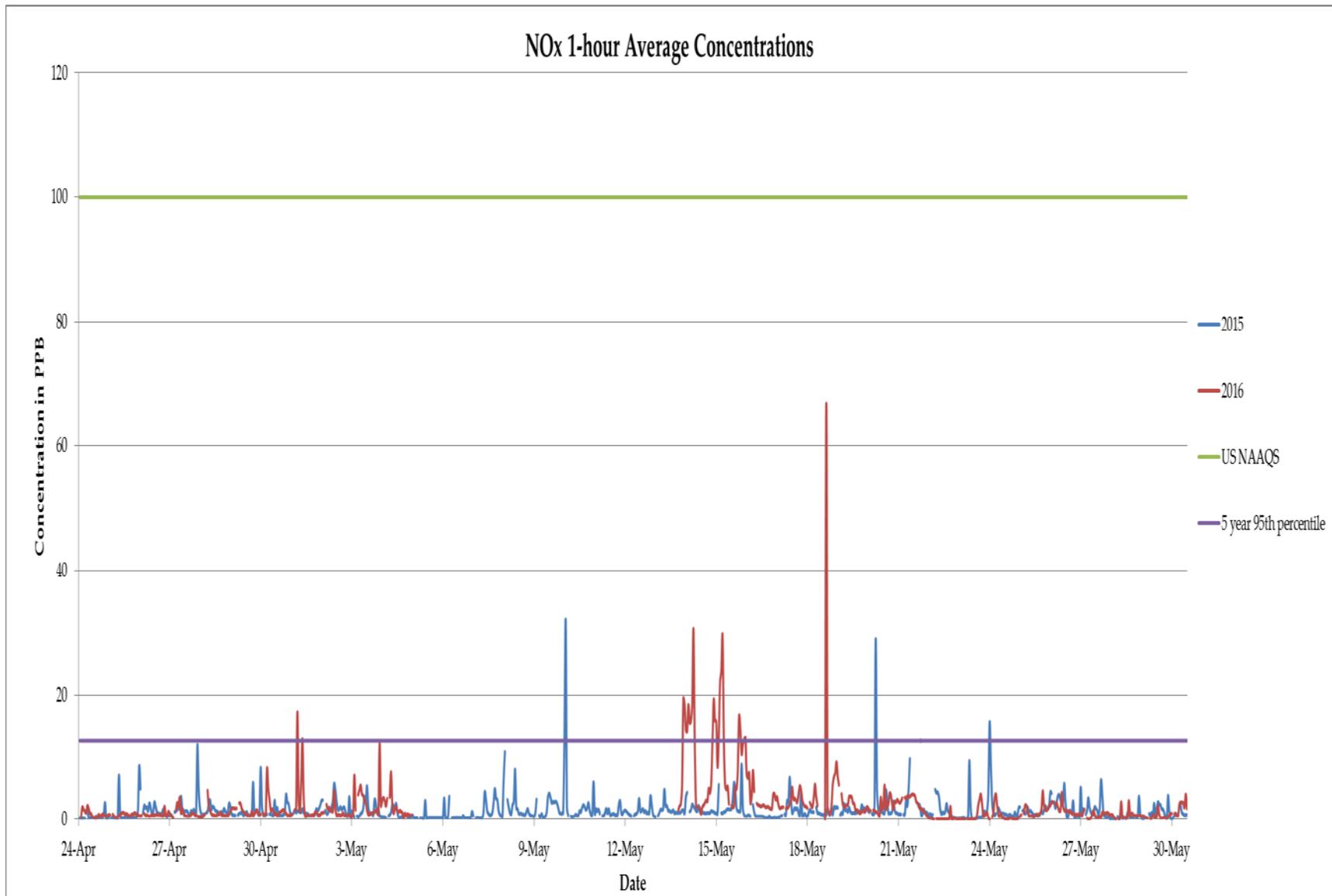


Figure 5f NO_x measurements at Anzac (AMS14).

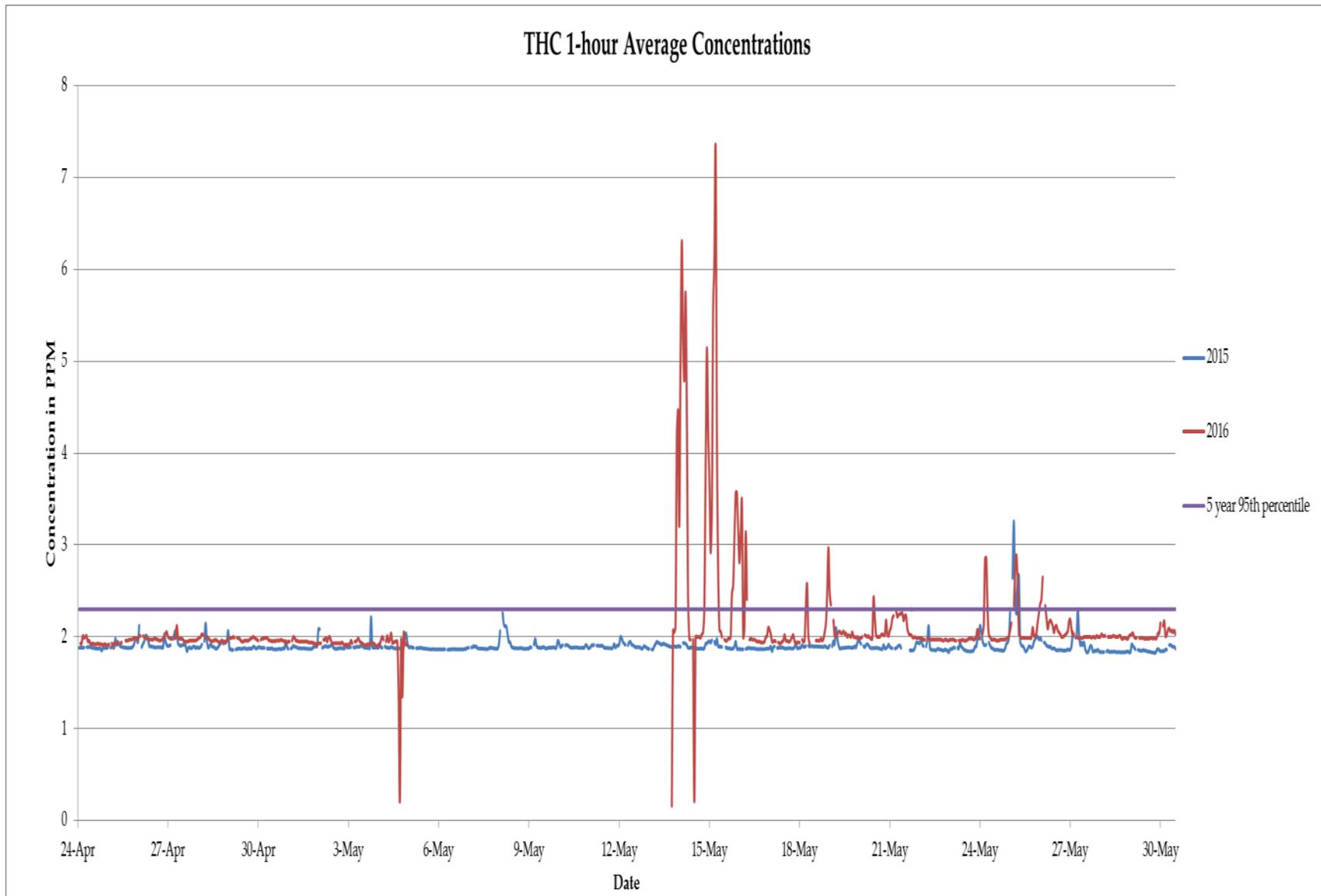


Figure 5h THC measurements at Anzac (AMS14).

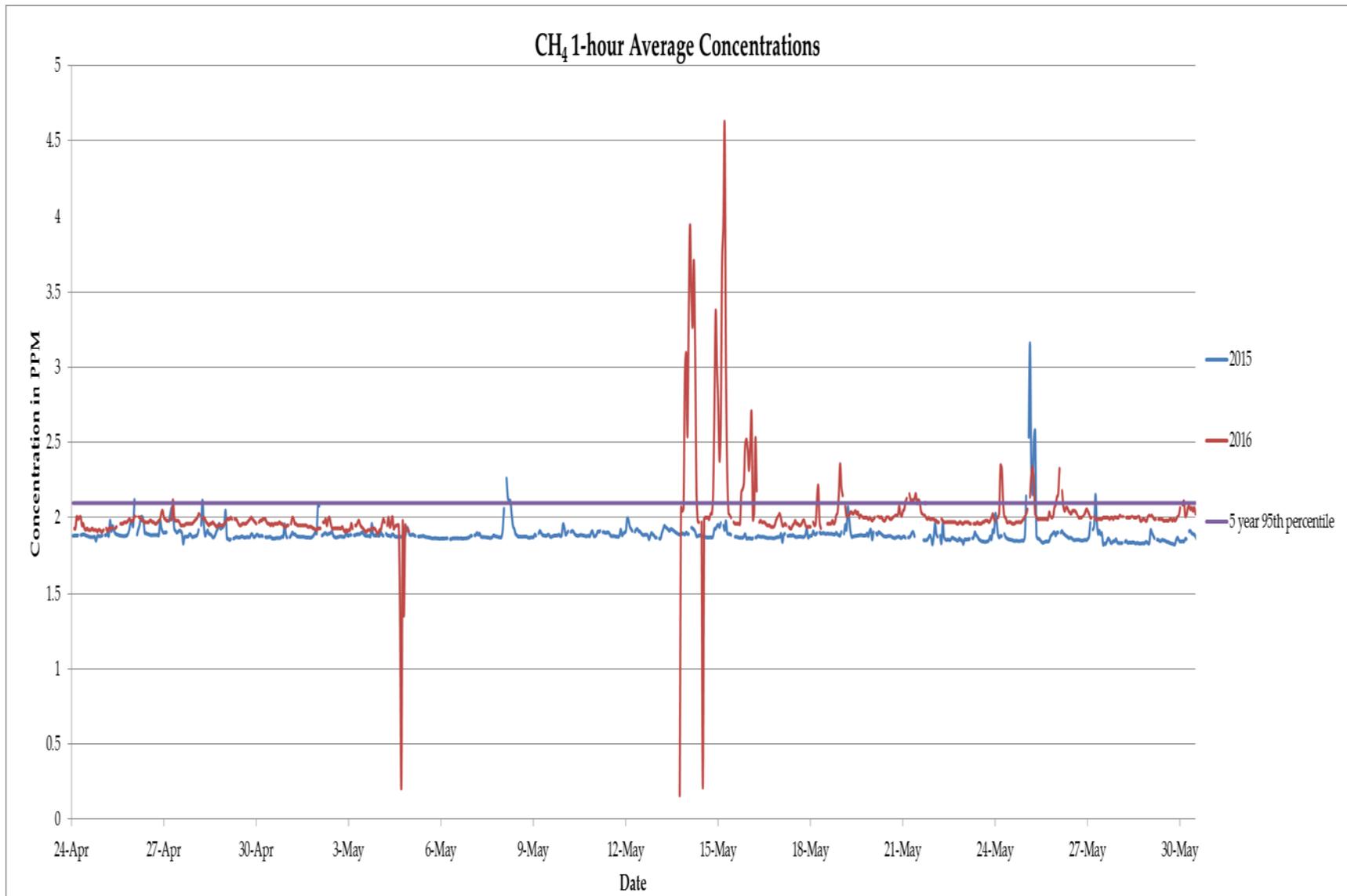


Figure 5i CH₄ measurements at Anzac (AMS14).

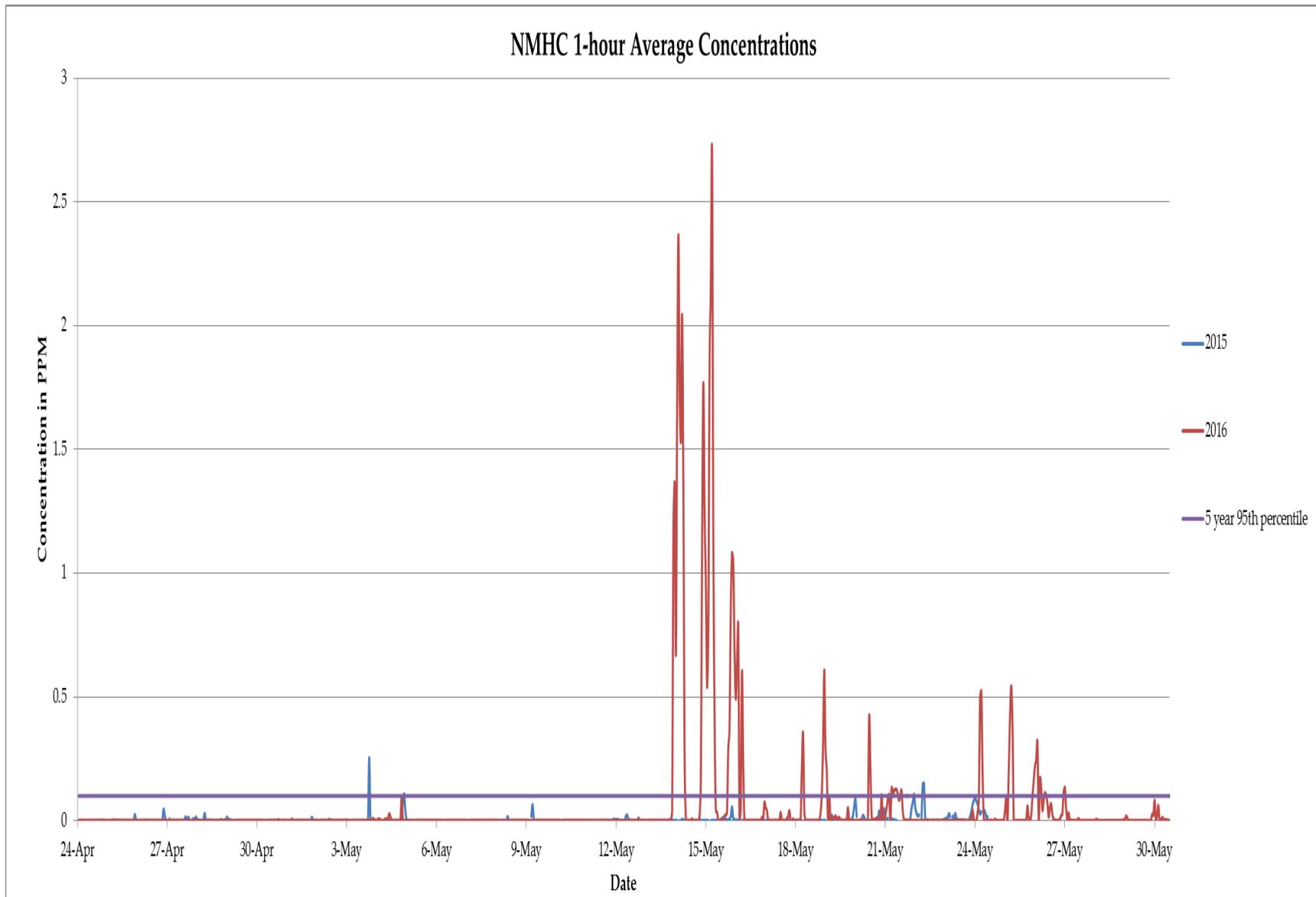


Figure 5j NMHC measurements at Anzac (AMS14).

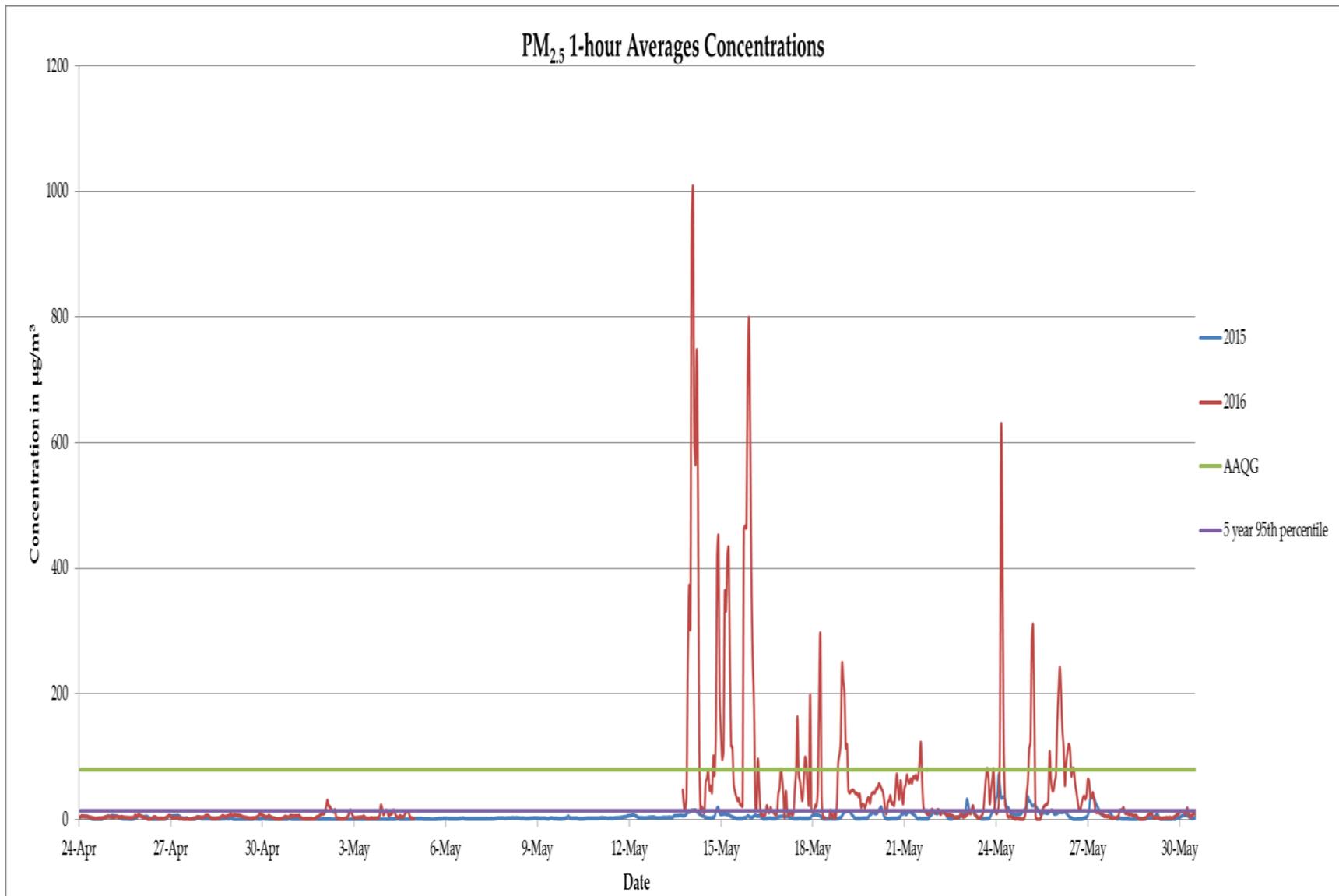


Figure 5k 1-hour PM_{2.5} measurements at Anzac (AMS14).

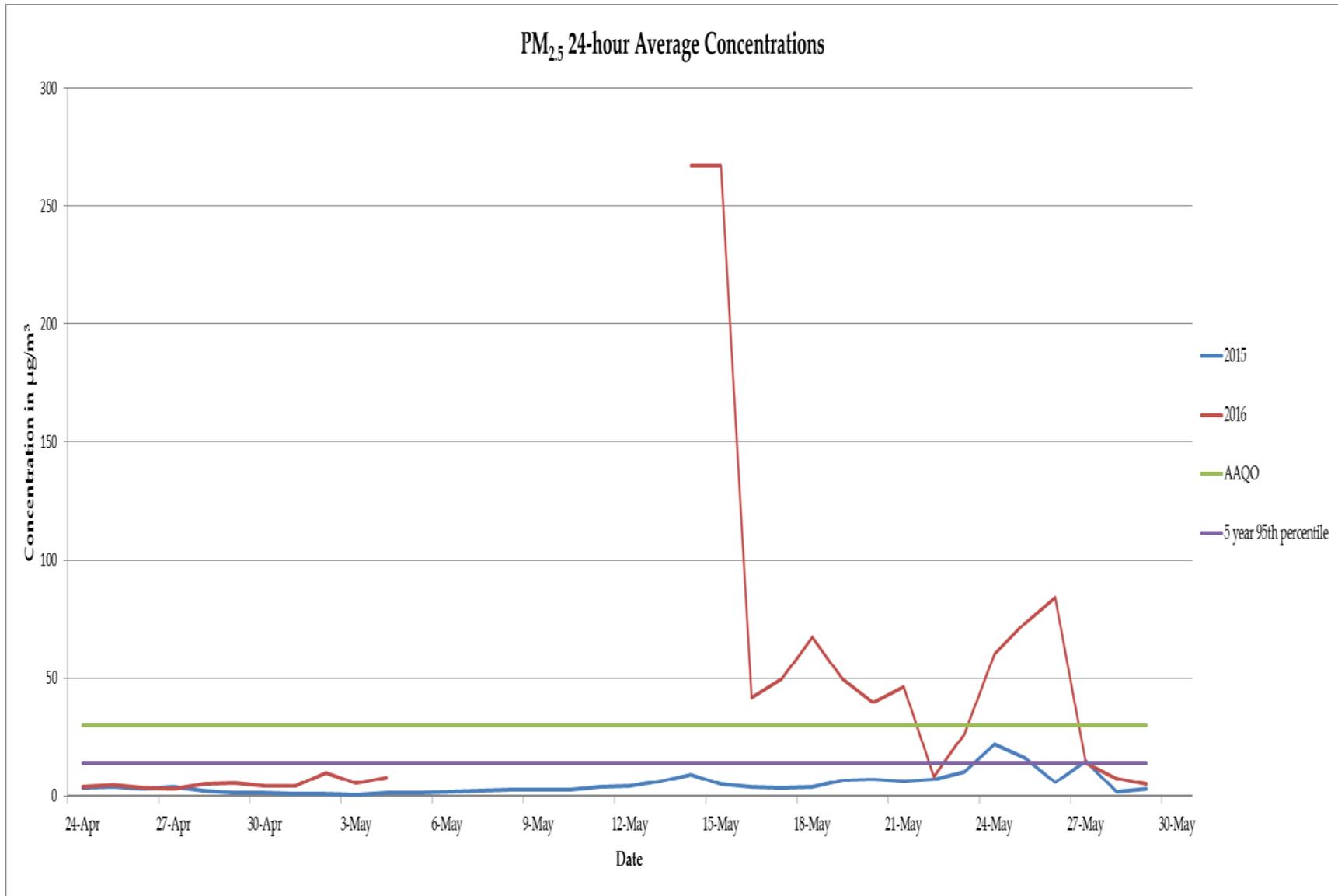


Figure 51 24-hour PM_{2.5} measurements at Anzac (AMS14).

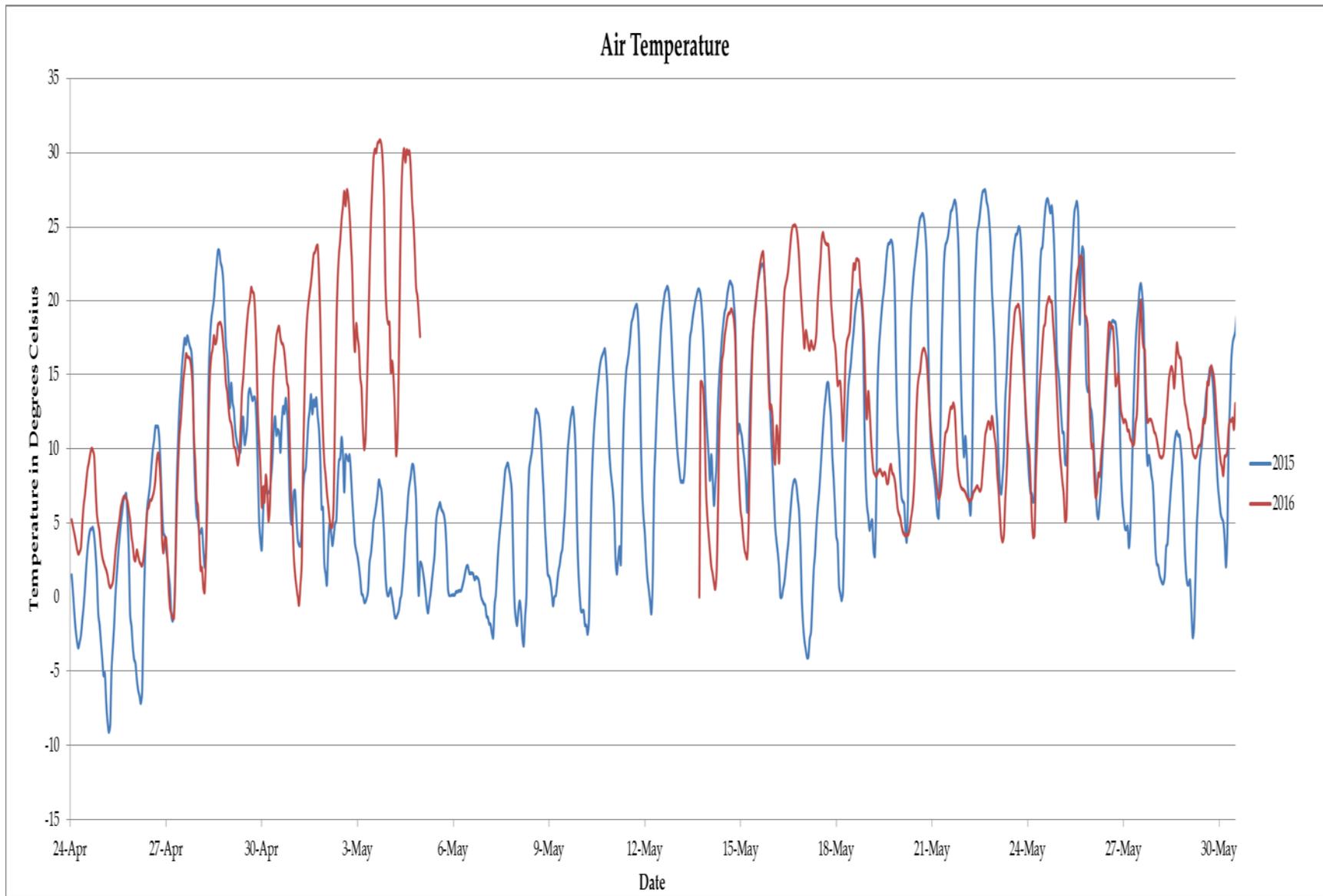


Figure 5m Air temperature measurements at Anzac (AMS14).

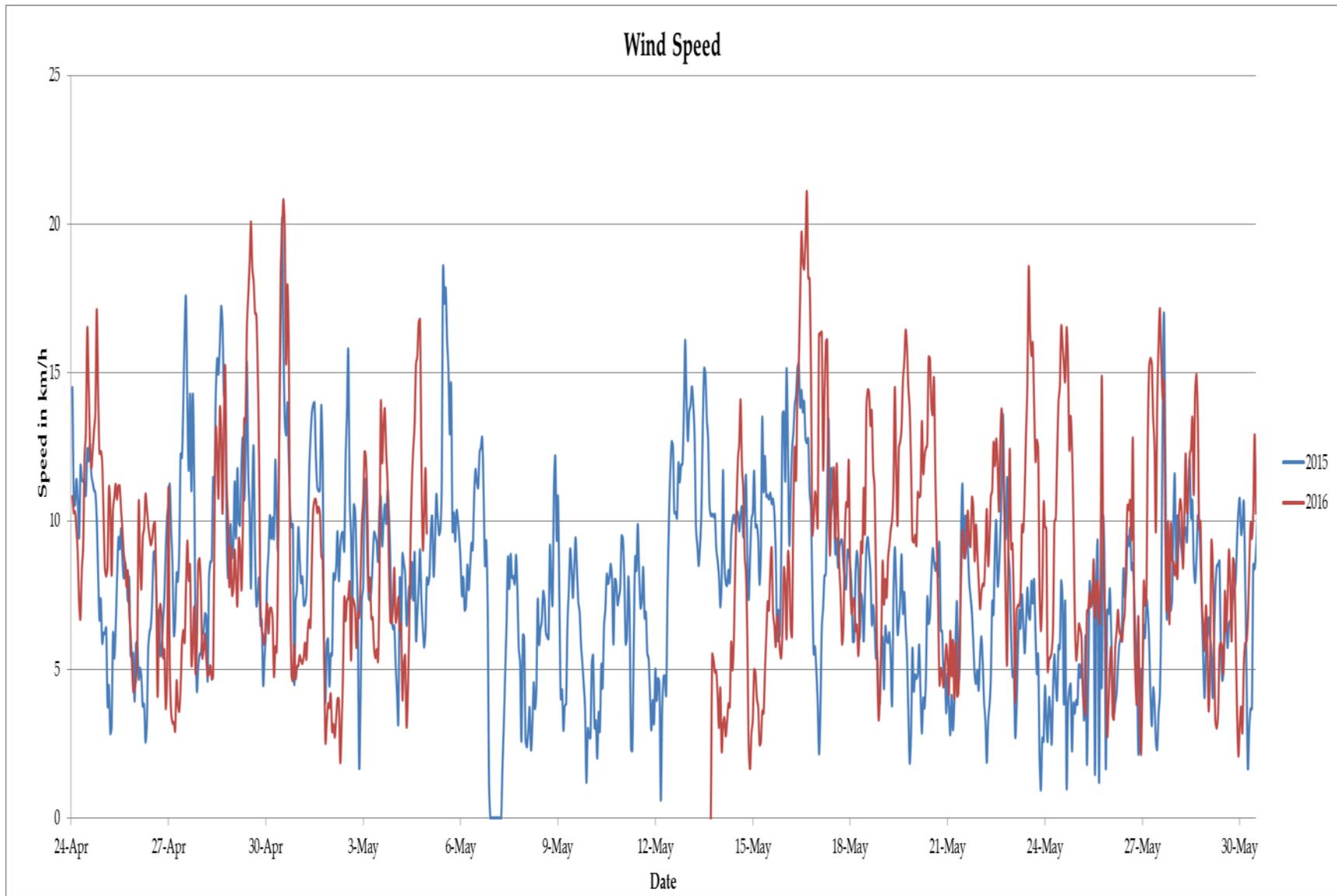


Figure 5n Wind speed measurements at Anzac (AMS14).

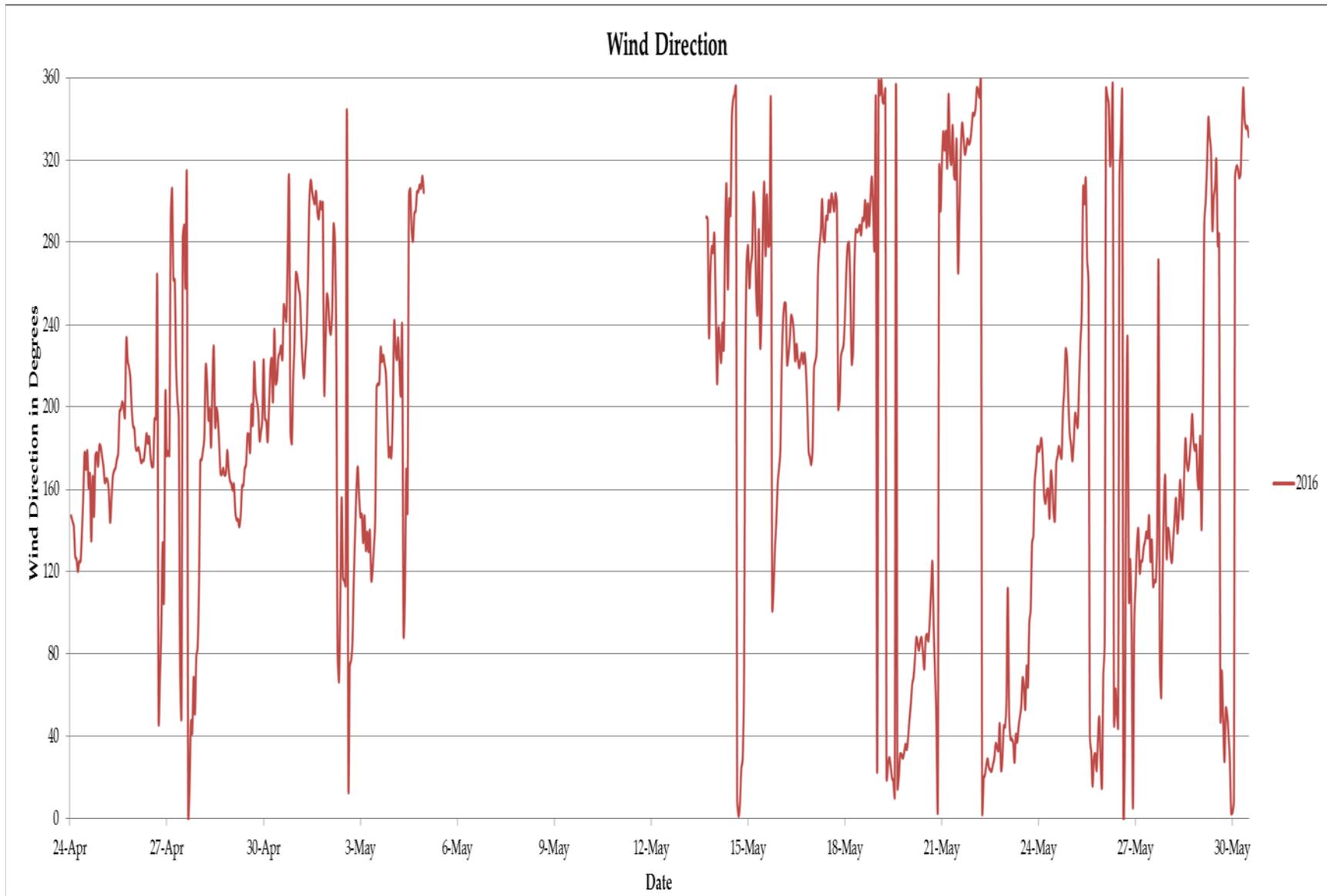


Figure 5o Wind direction measurements at Anzac (AMS14).

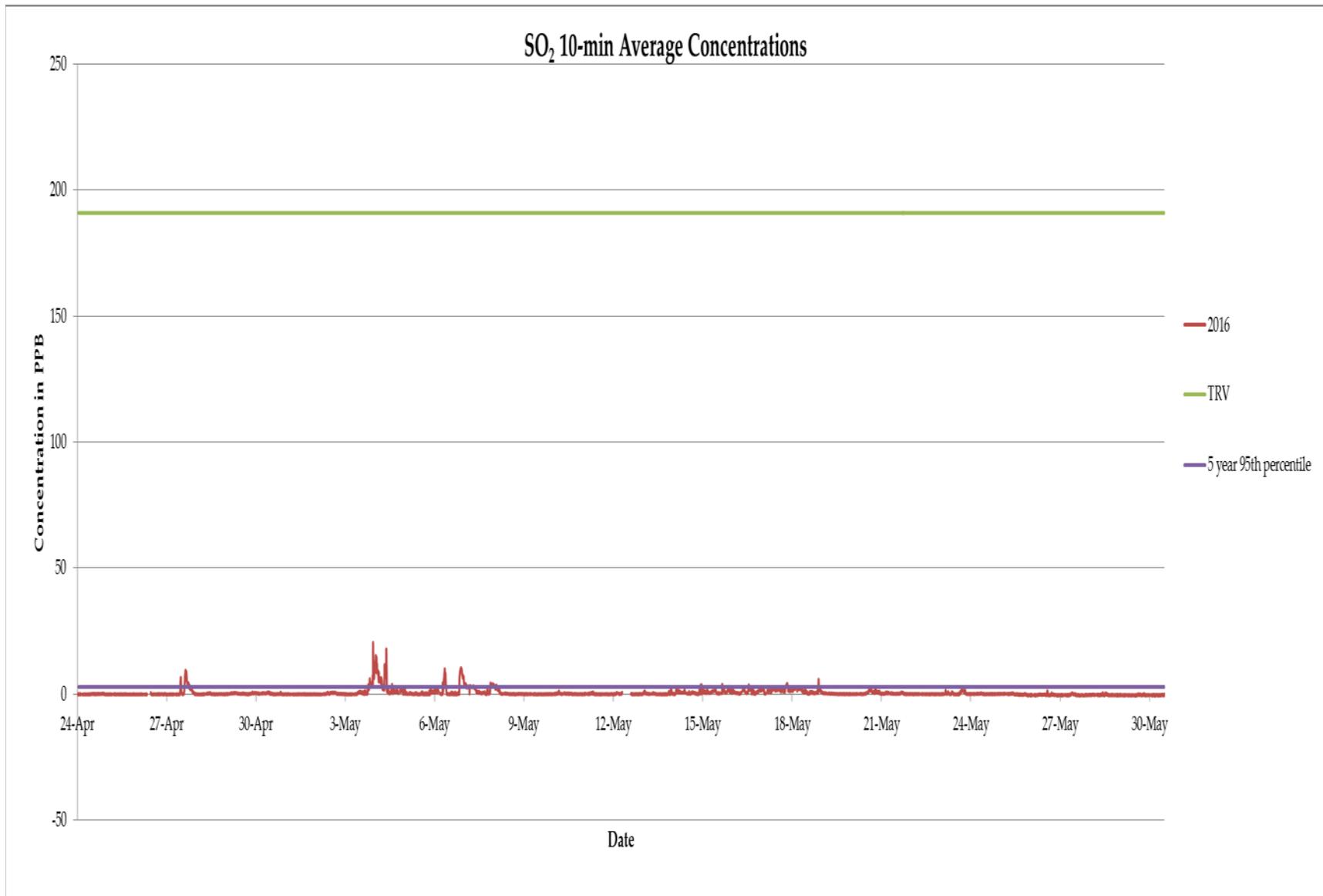


Figure 6a 10-minute SO₂ measurements at Conklin (AMS21).

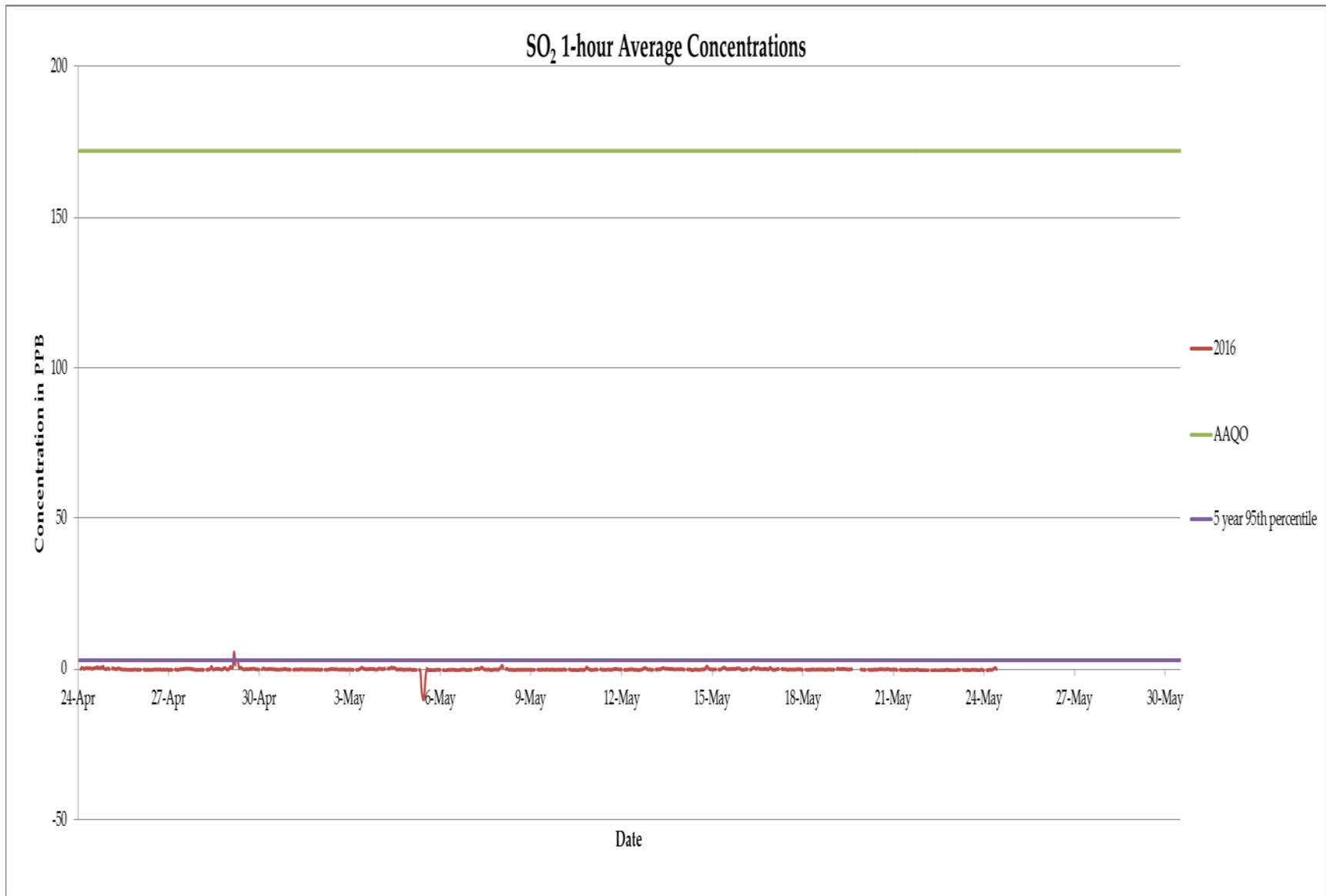


Figure 6b 1-hour SO₂ measurements at Conklin (AMS21).

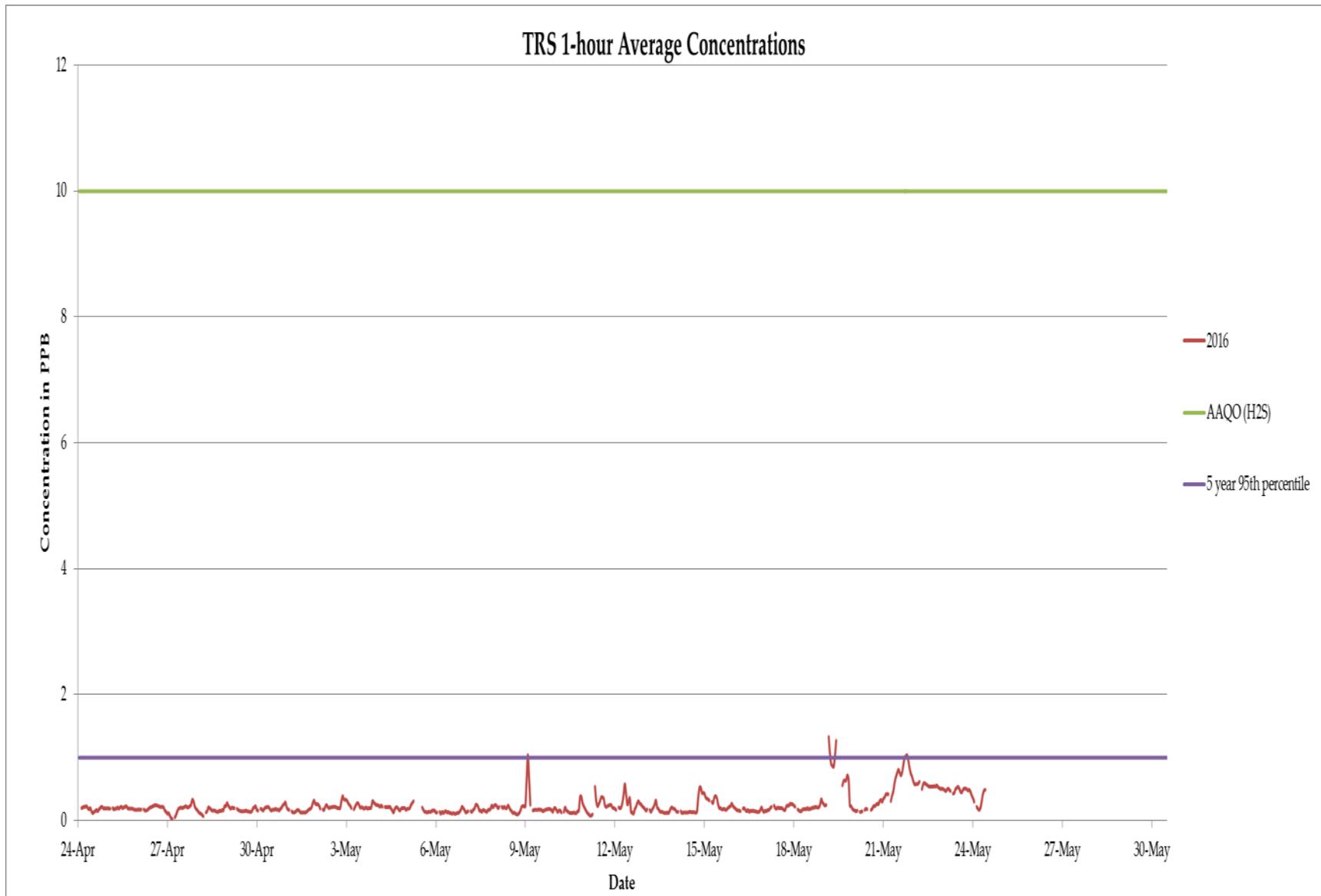


Figure 6c TRS measurements at Conklin (AMS21).

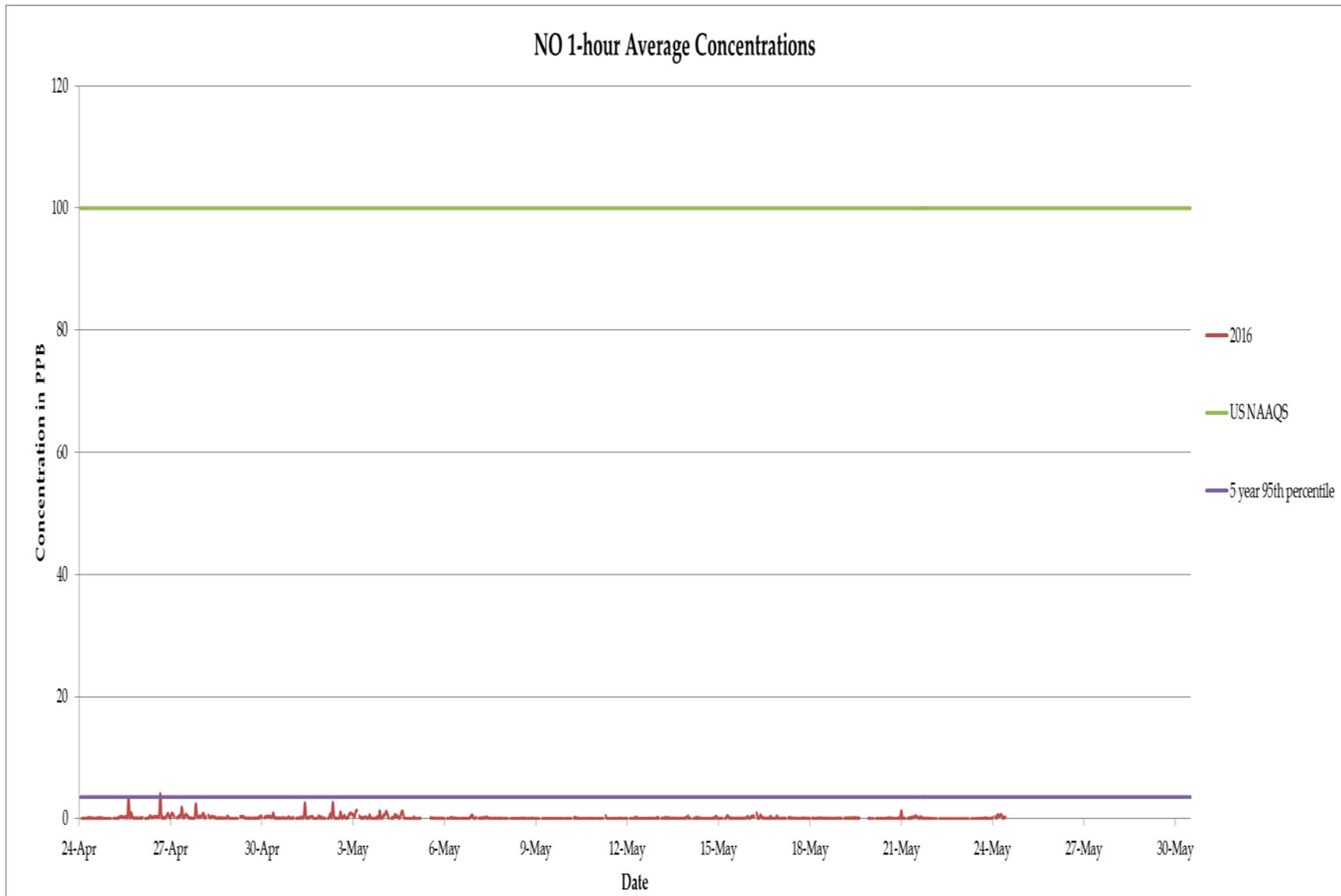


Figure 6d NO measurements at Conklin (AMS21).

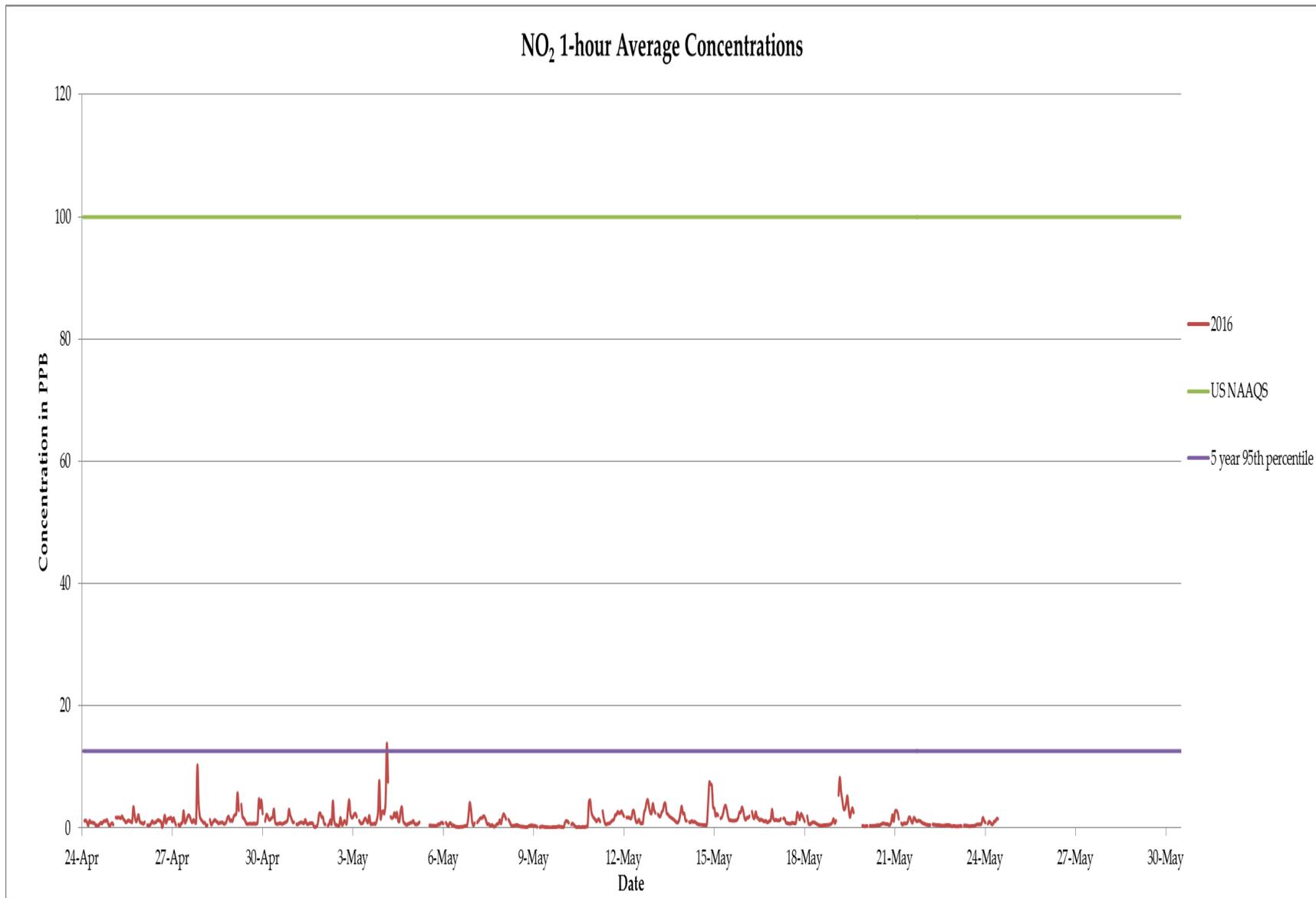


Figure 6e NO₂ measurements at Conklin (AMS21).

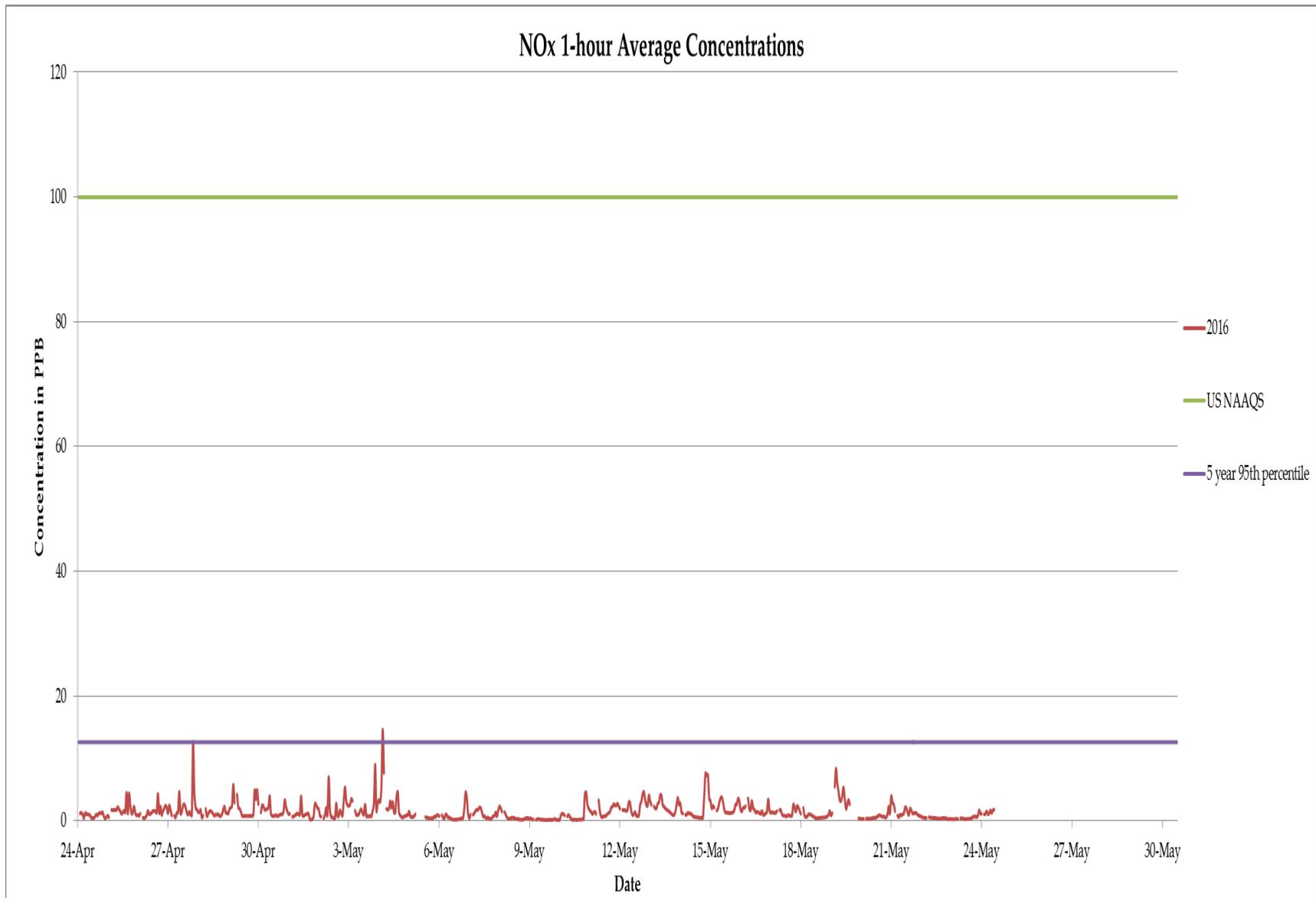


Figure 6f NO_x measurements at Conklin (AMS21).

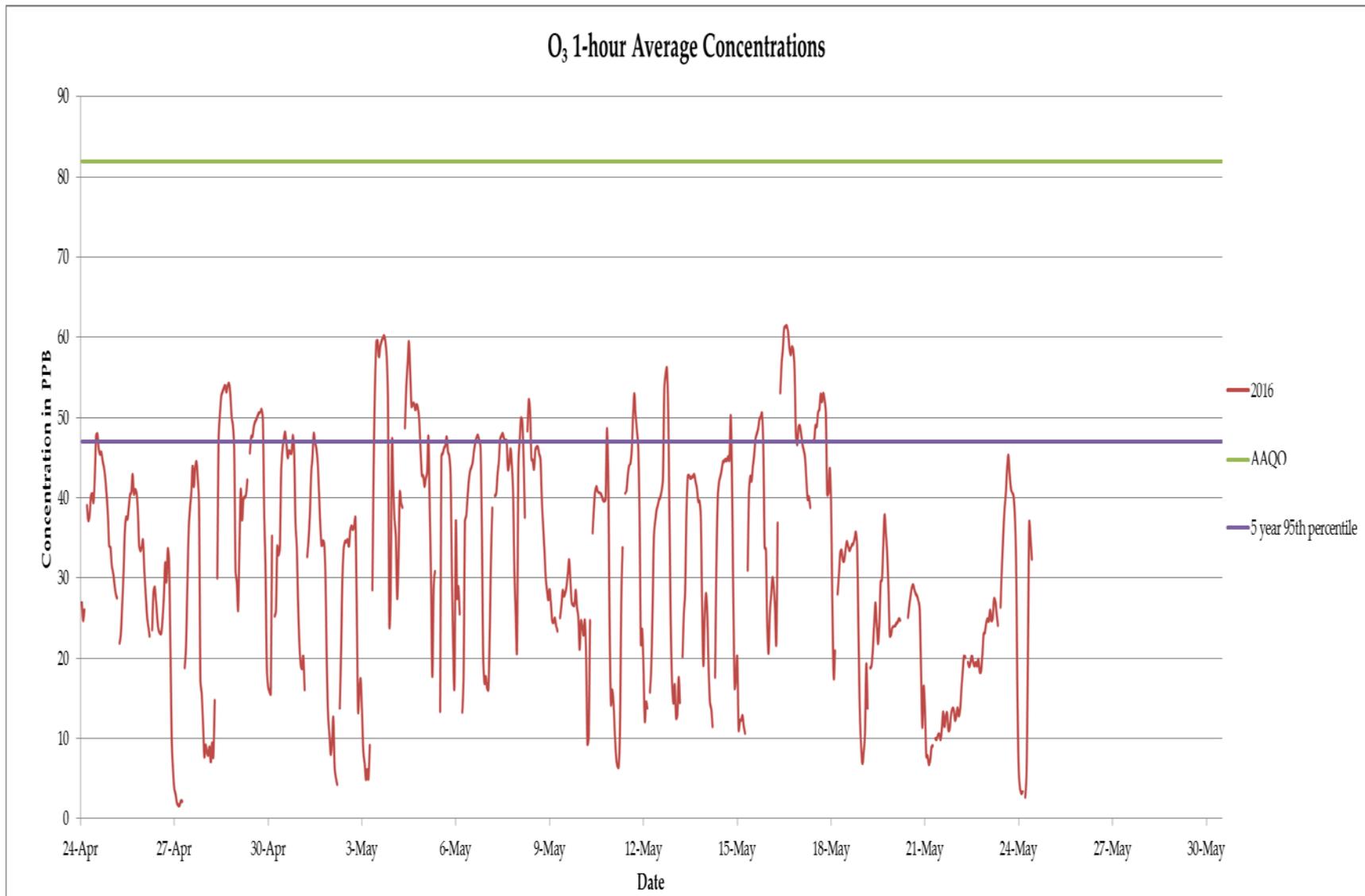


Figure 6g O₃ (ozone) measurements at Conklin (AMS21).

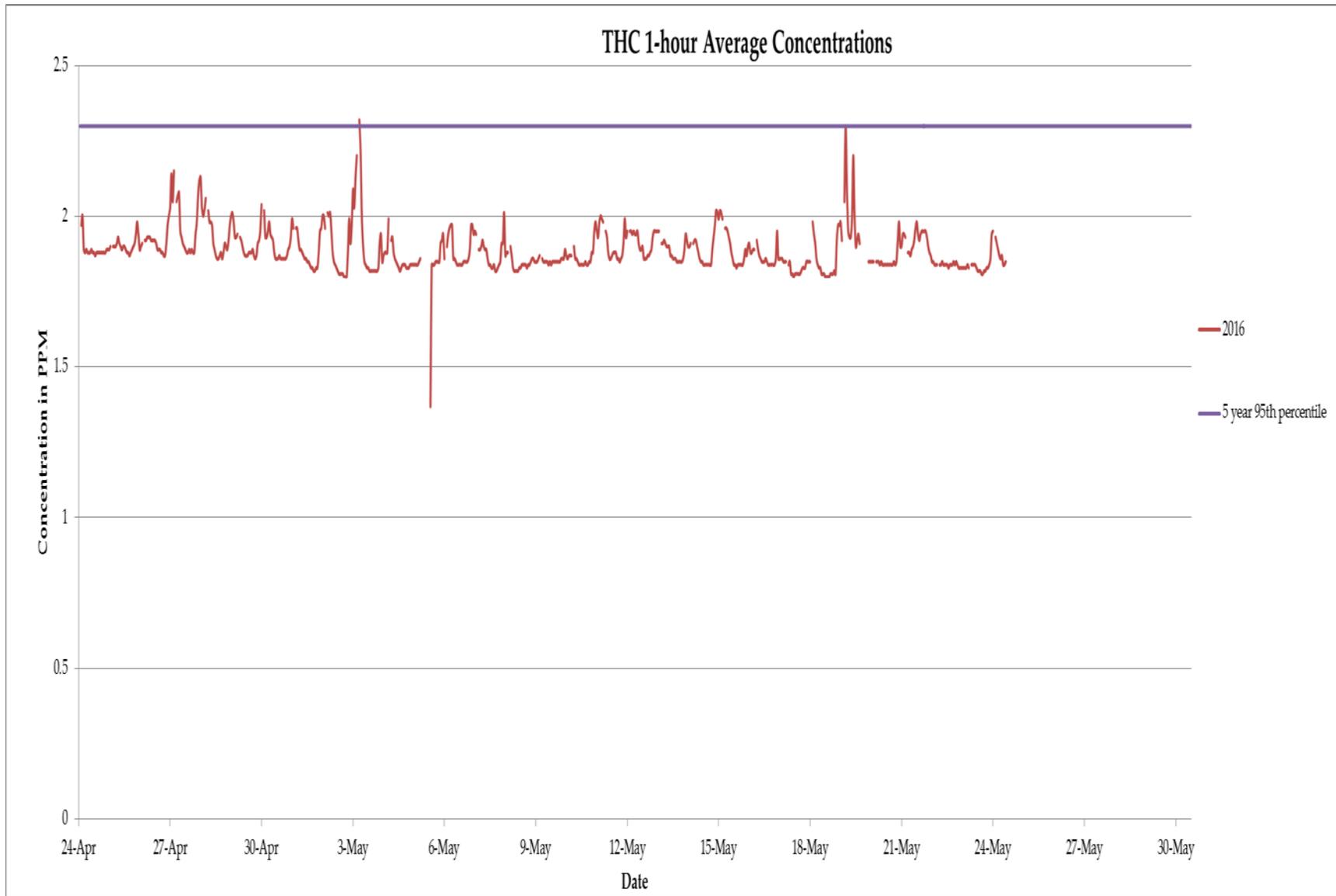


Figure 6h THC measurements at Conklin (AMS21).

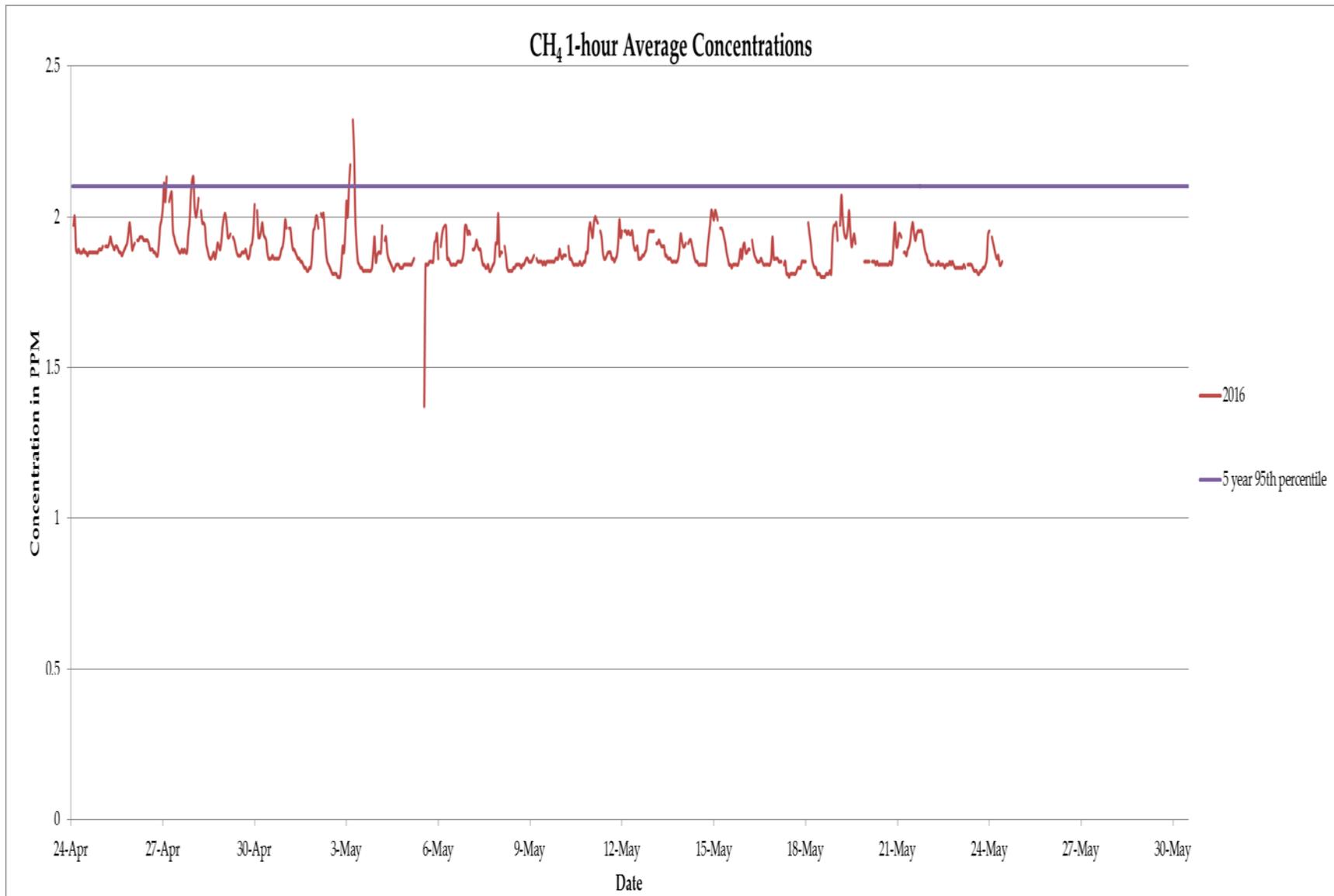


Figure 6i CH₄ measurements at Conklin (AMS21).

NMHC 1-hour Average Concentrations

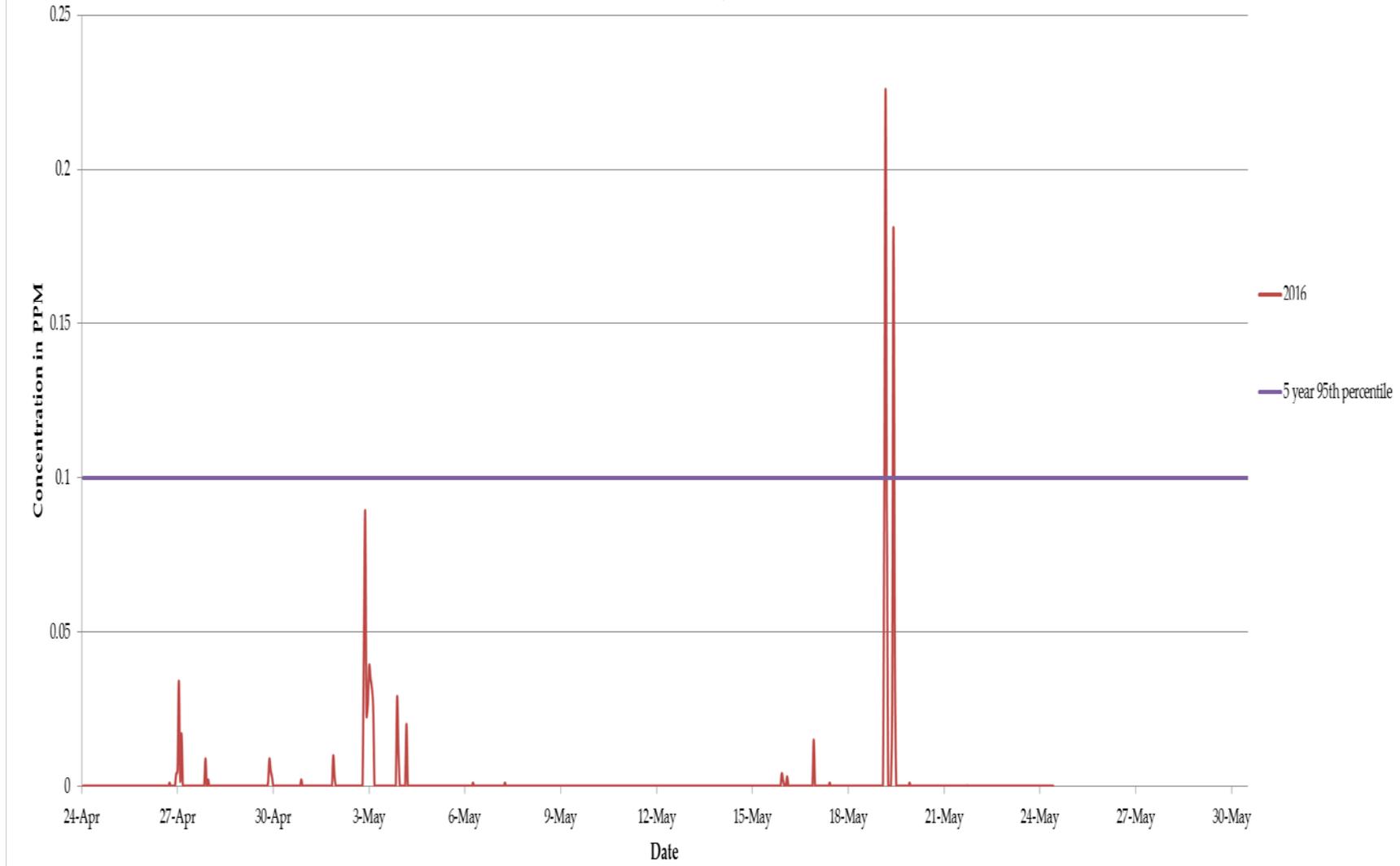


Figure 6j NMHC measurements at Conklin (AMS21).

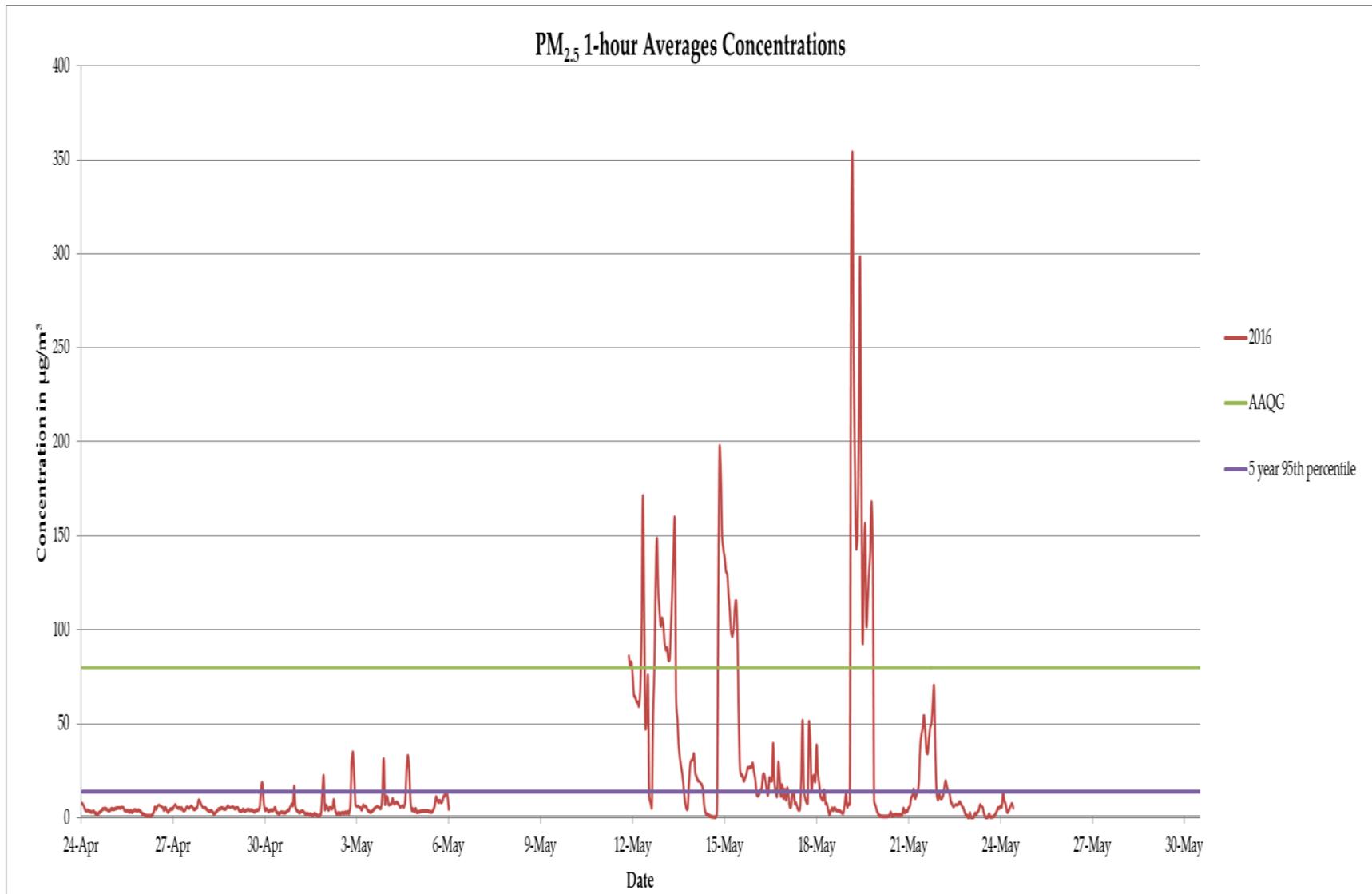


Figure 6k 1-hour PM_{2.5} measurements at Conklin (AMS21).

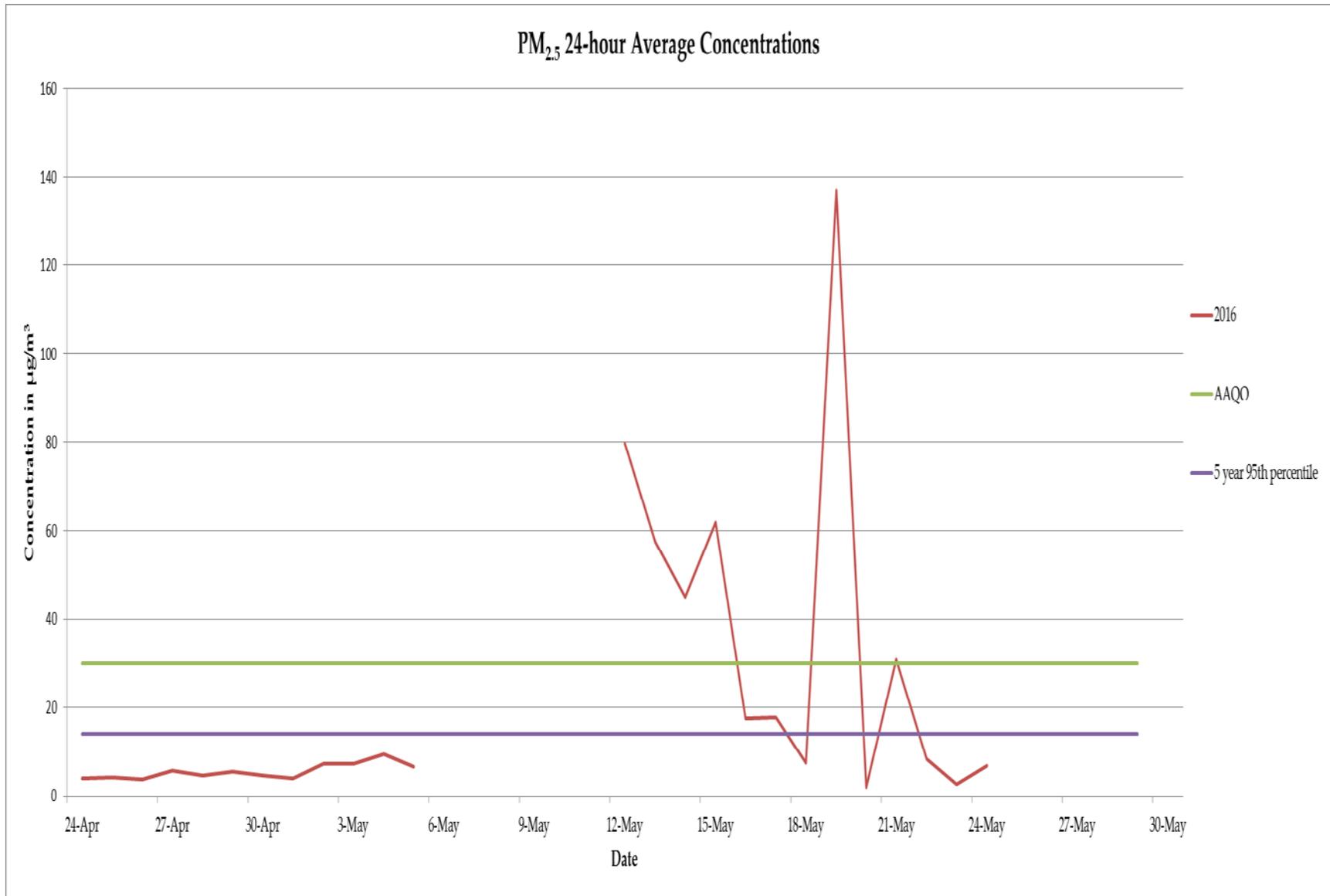


Figure 6I 24-hour PM_{2.5} measurements at Conklin (AMS21).

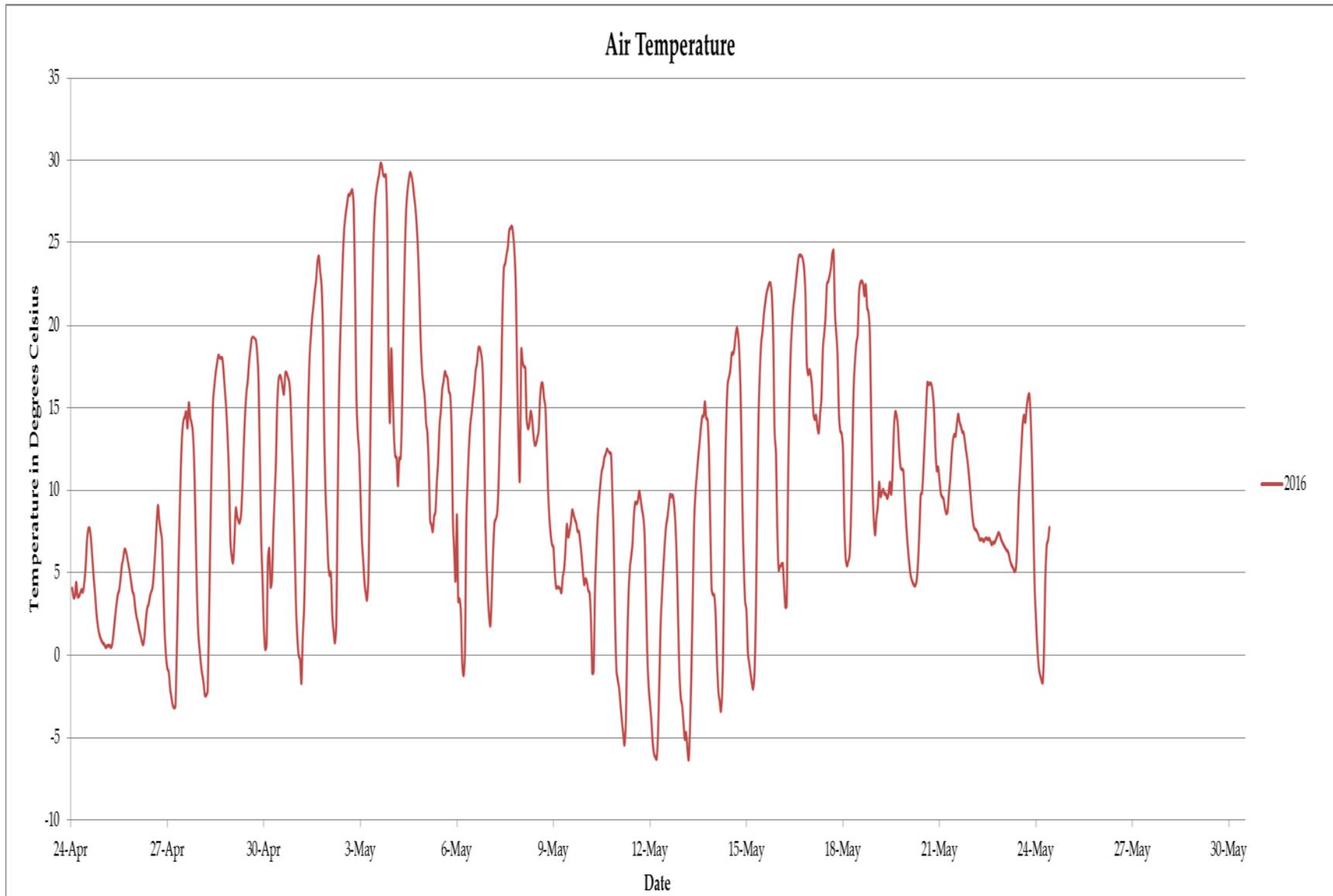


Figure 6m Air temperature measurements at Conklin (AMS21).

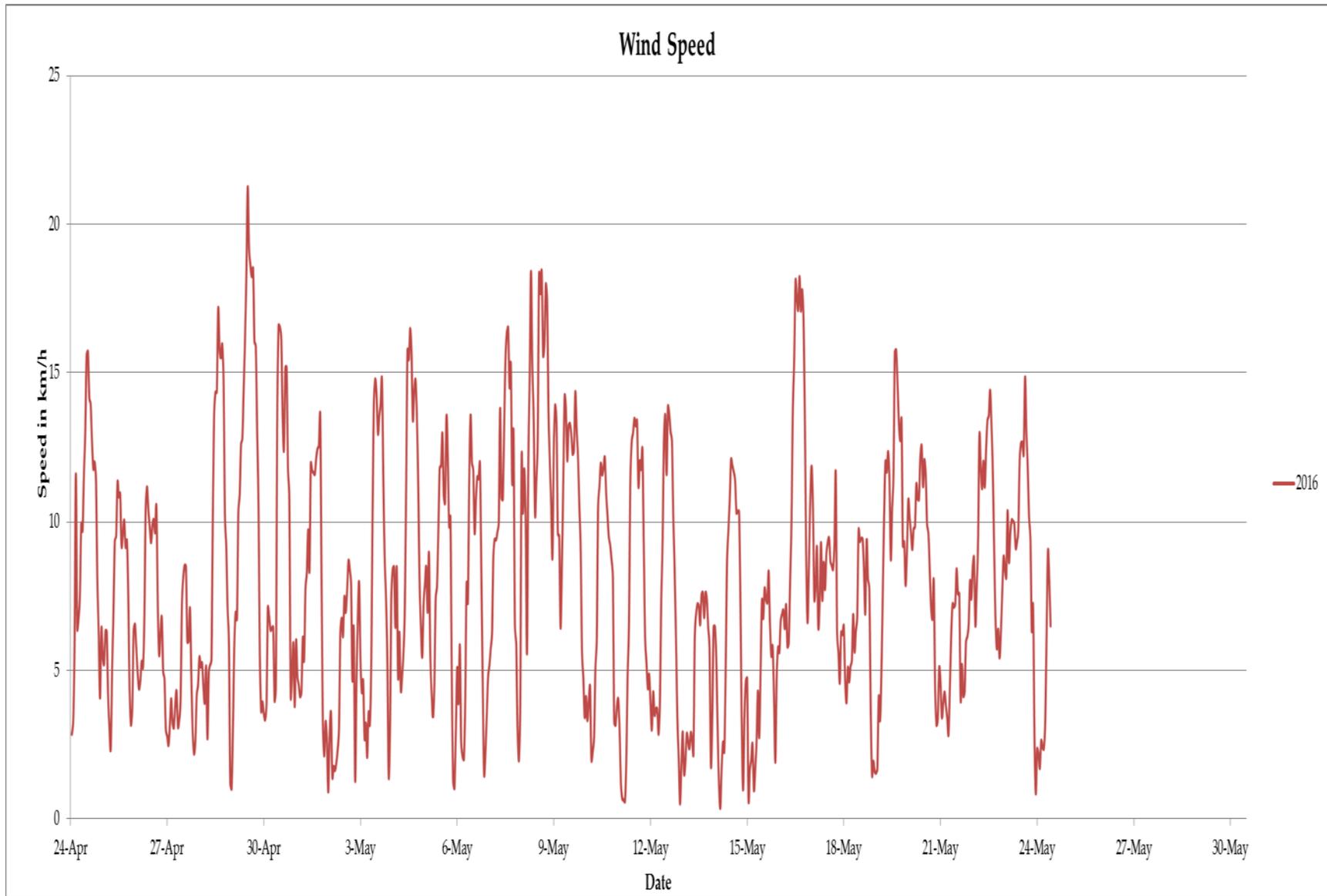


Figure 6n Wind speed measurements at Conklin (AMS21).

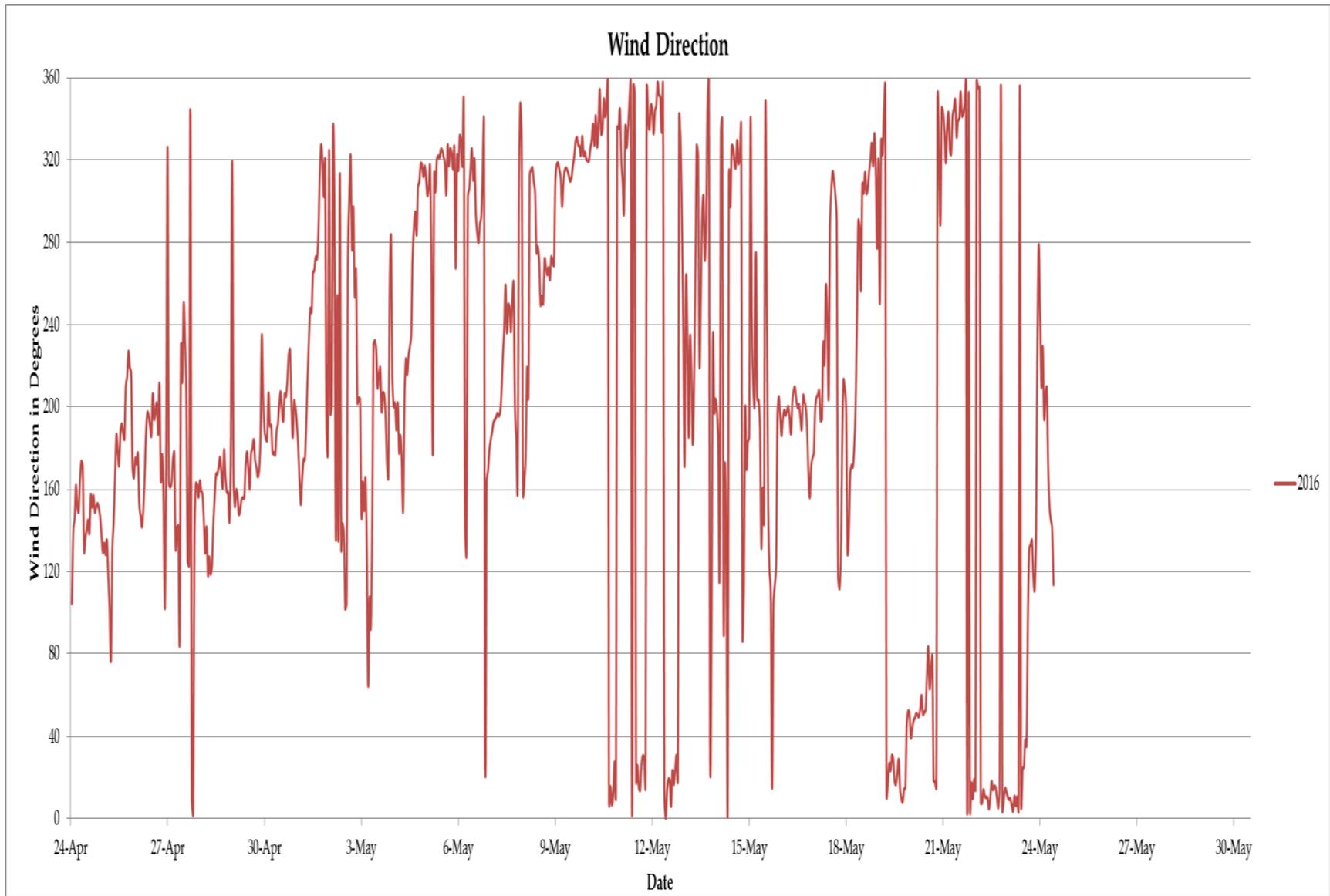


Figure 6o Wind direction measurements at Conklin (AMS21).

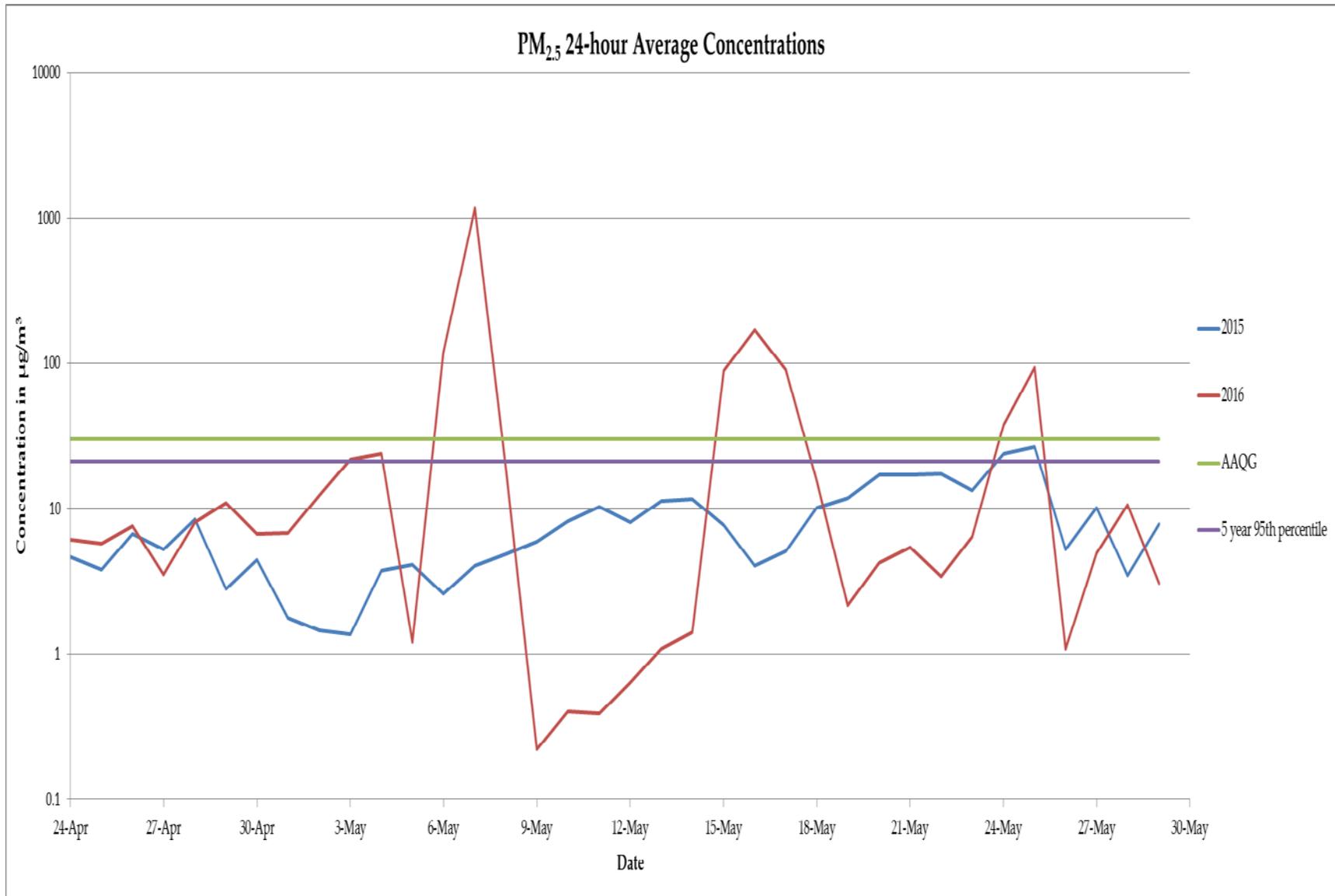


Figure 7a 24-hour concentrations of PM_{2.5} at Fort McKay (AMS1) – log scale.

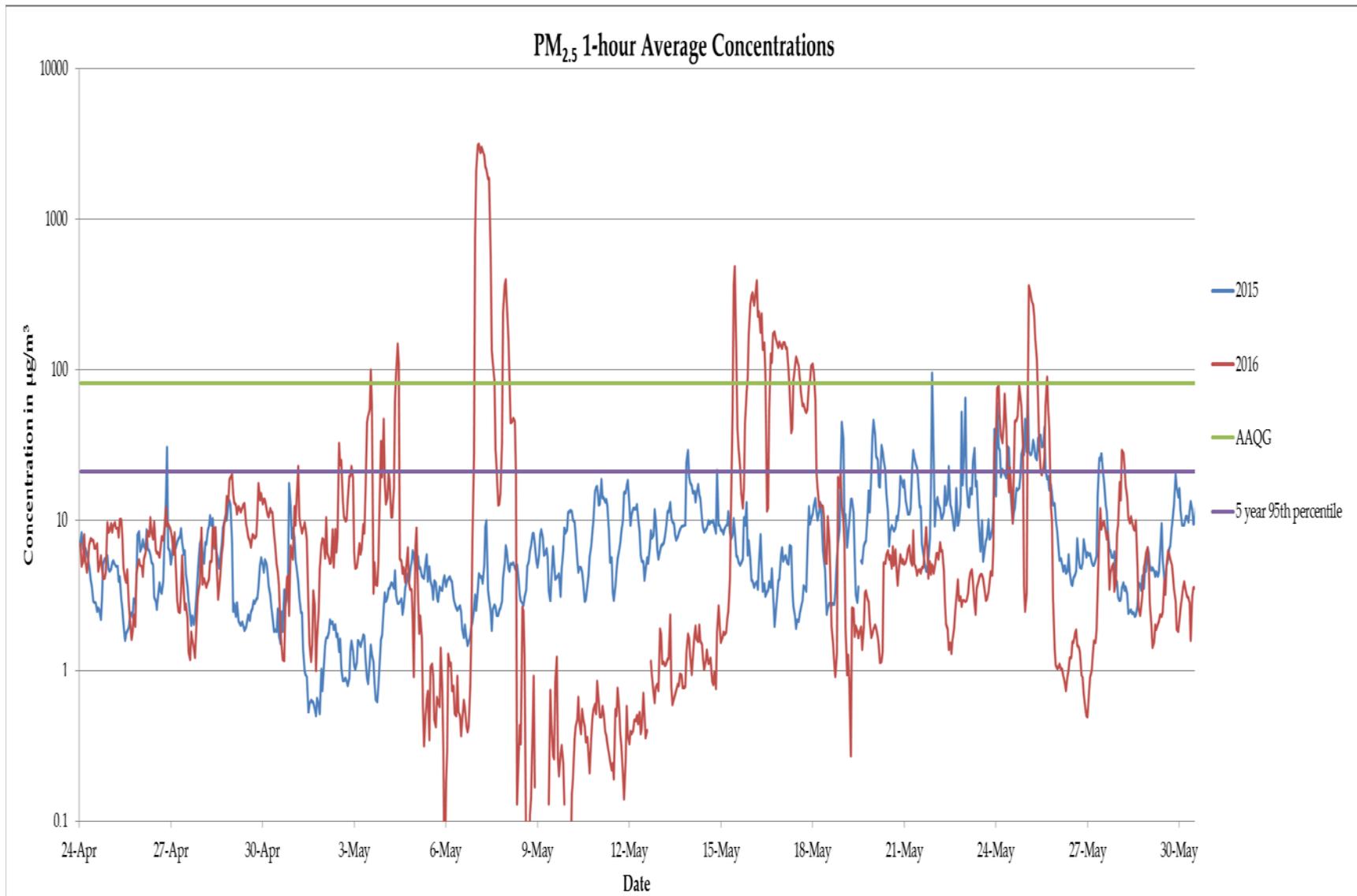


Figure 7b 1-hour concentrations of PM_{2.5} at Fort McKay (AMS1) – log scale.

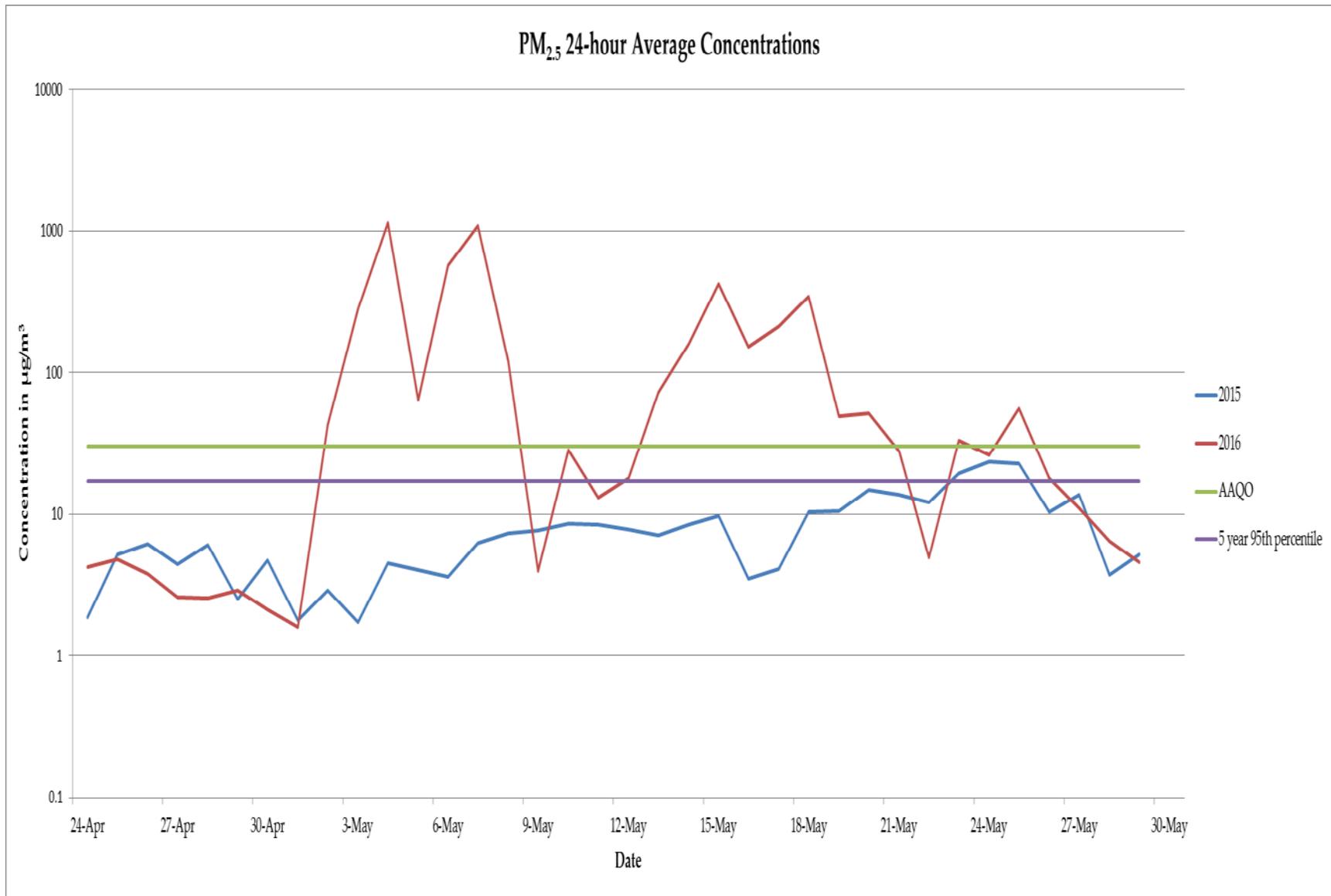


Figure 7c 24-hour concentrations of PM_{2.5} at Patricia McInnes (AMS6) – log scale.

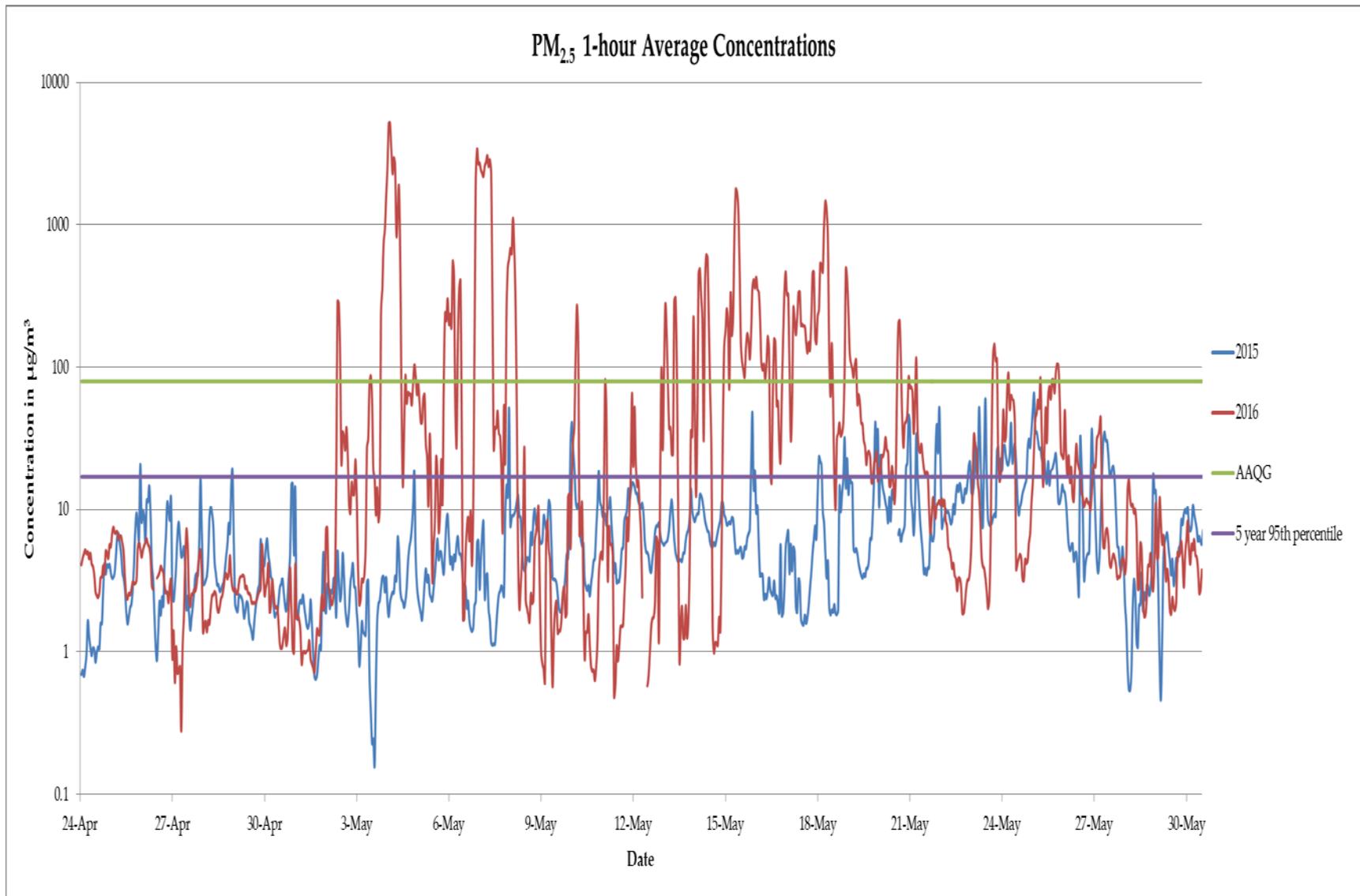


Figure 7d 1-hour concentrations of PM_{2.5} at Patricia McInnes (AMS6) – log scale.

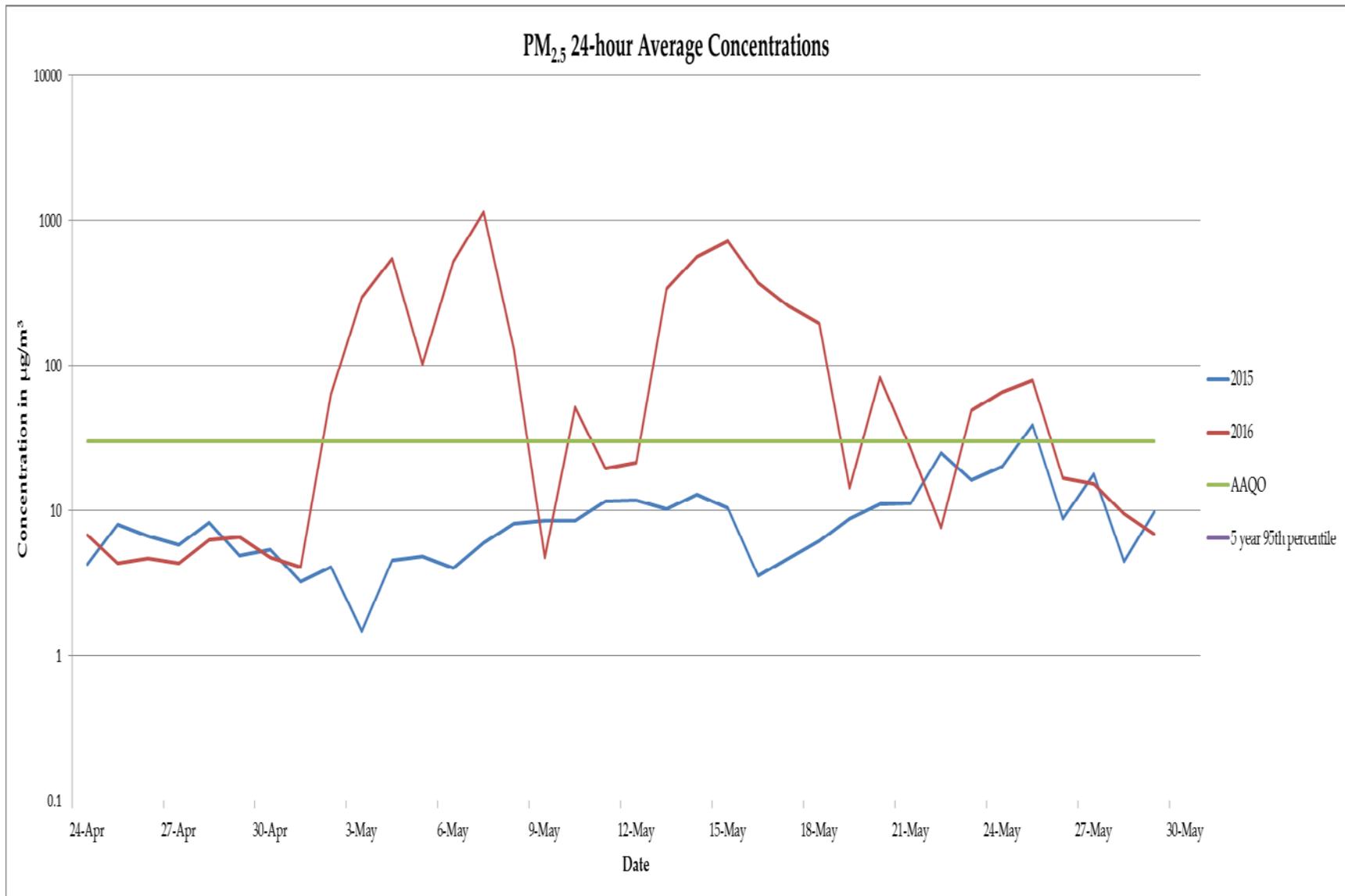


Figure 7e 24-hour concentrations of PM_{2.5} at Athabasca Valley (AMS7) – log scale.

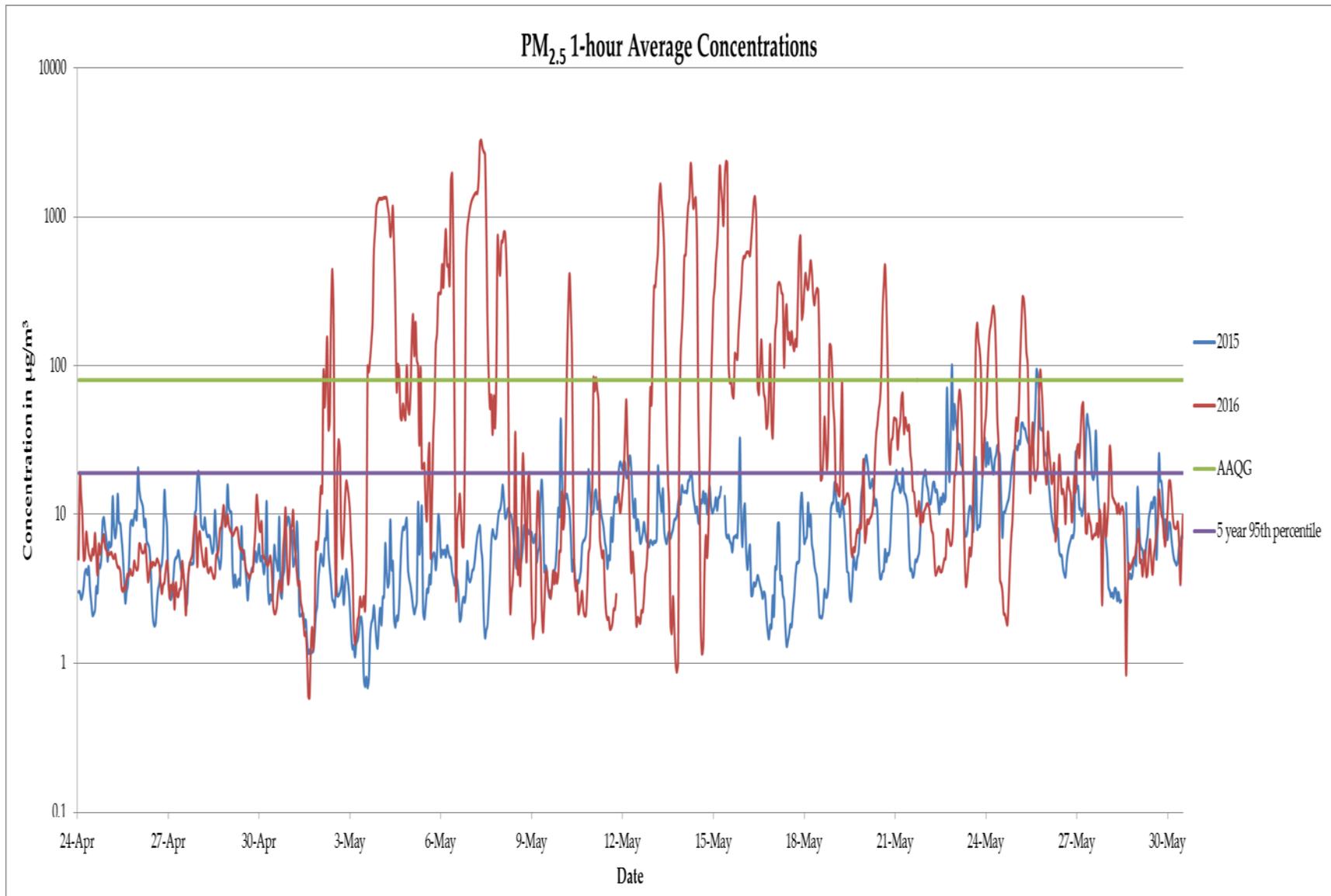


Figure 7f 1-hour concentrations of PM_{2.5} at Athabasca Valley (AMS7) – log scale.



Figure 7g 24-hour concentrations of PM_{2.5} at Anzac (AMS14) – log scale.

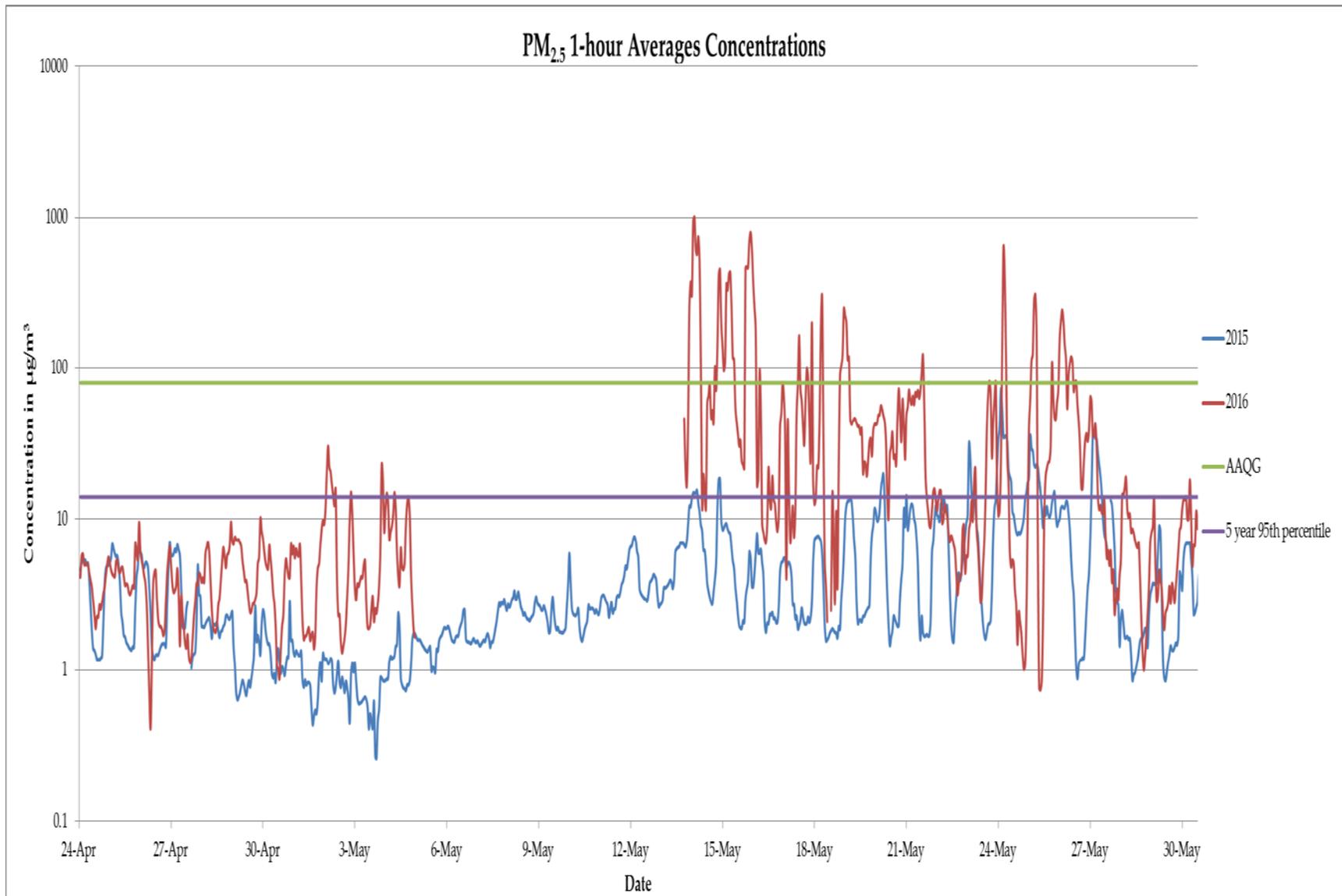


Figure 7h 1-hour concentrations of PM_{2.5} at Anzac (AMS14) – log scale.

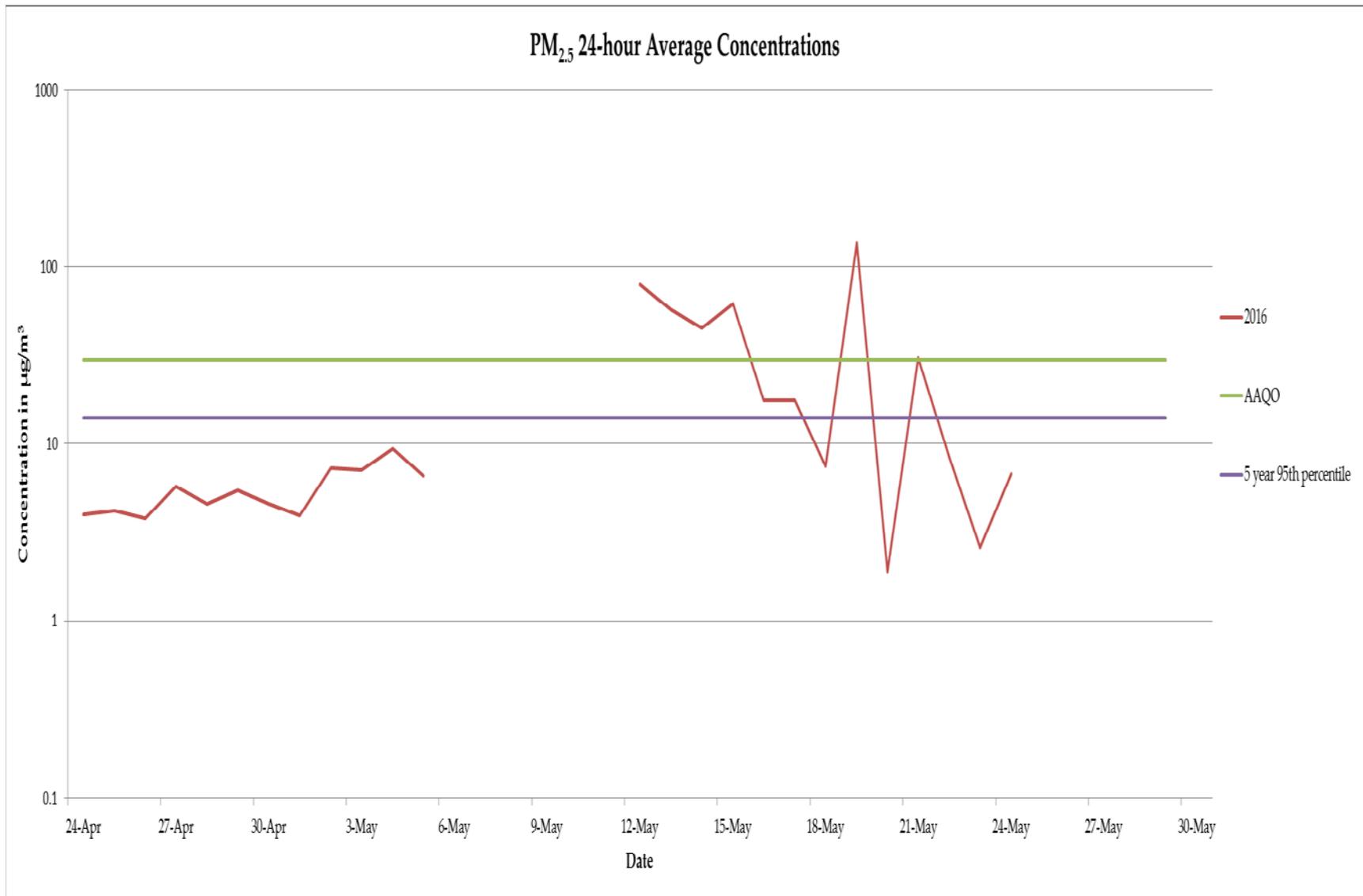


Figure 7i 24-hour concentrations of PM_{2.5} at Conklin (AMS21) – log scale.

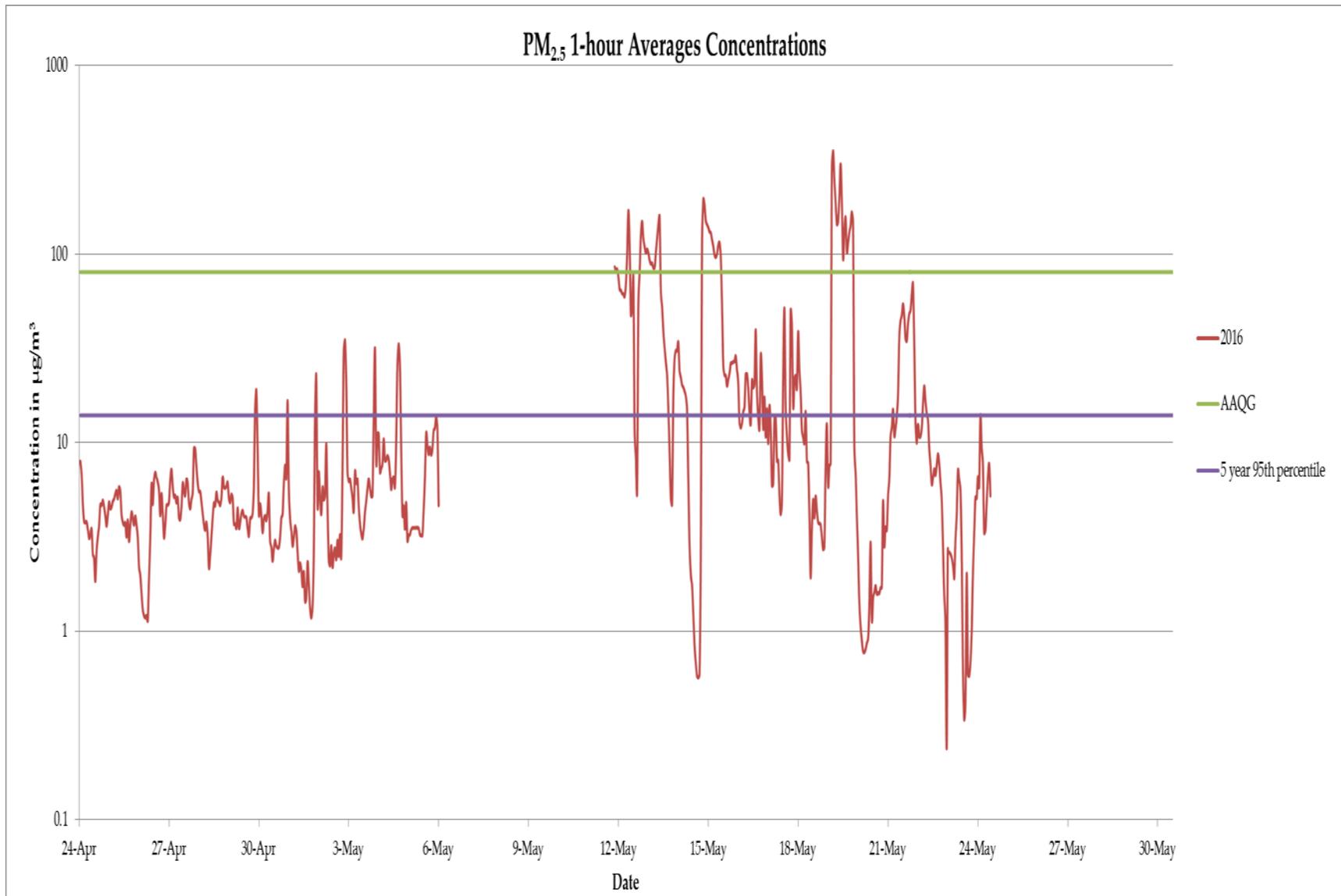


Figure 7j 1-hour concentrations of PM_{2.5} at Conklin (AMS21) – log scale.

PM₁ 1-min Average Concentrations

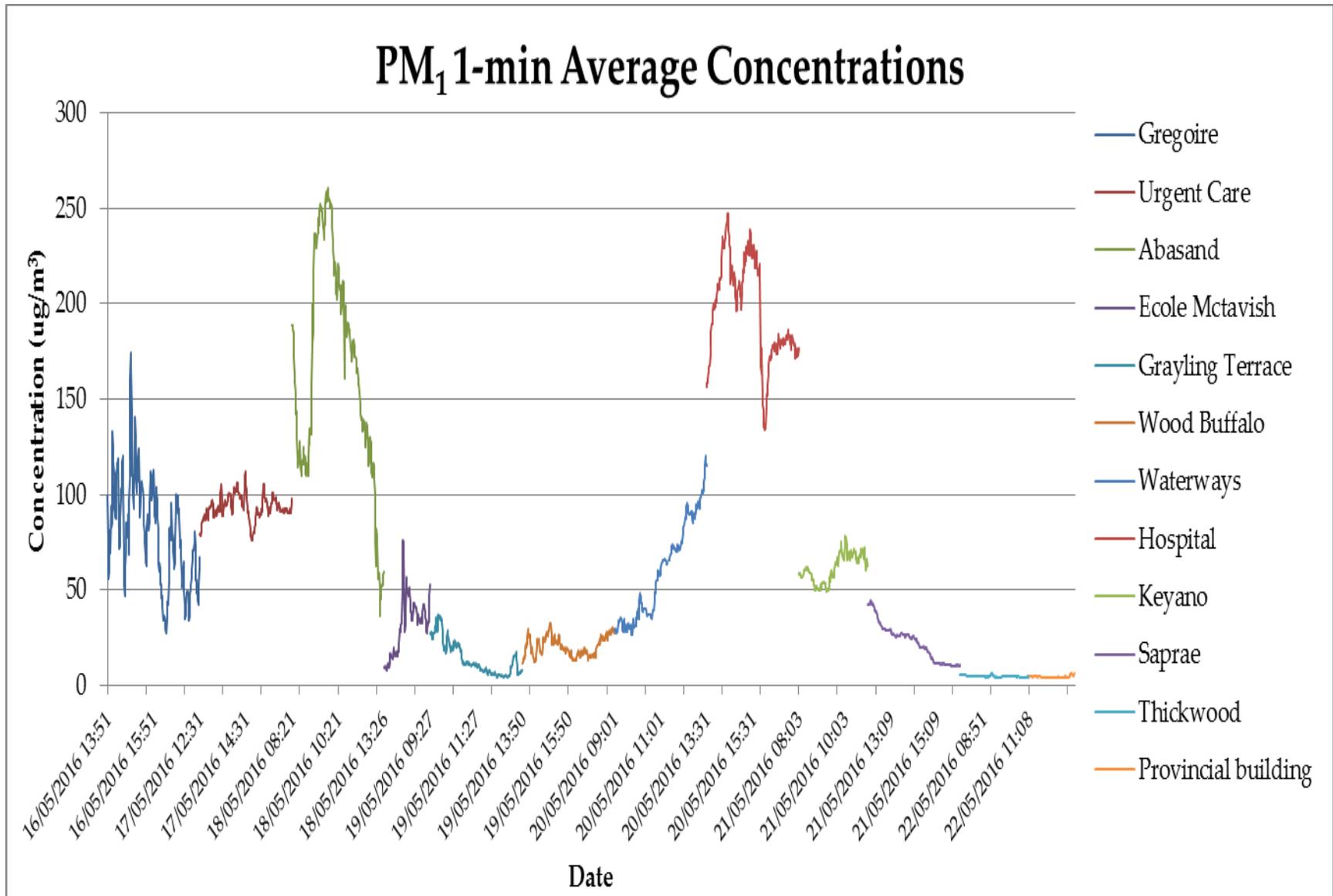


Figure 8a Continuous PM₁ measurements from MAML.

PM_{2.5} 1-min Average Concentrations

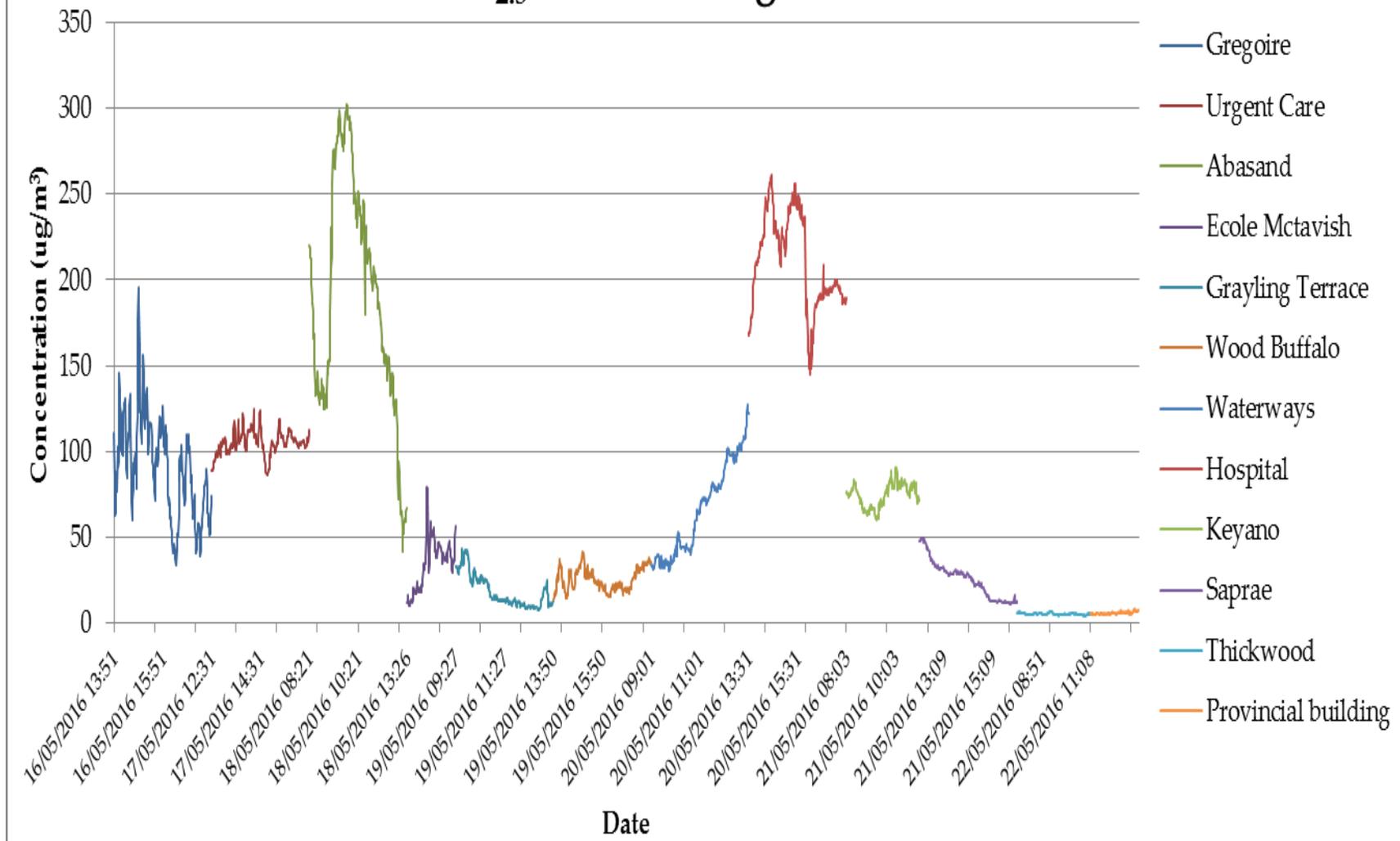


Figure 8b Continuous PM_{2.5} measurements from MAML.

PM₁₀ 1-min Average Concentrations

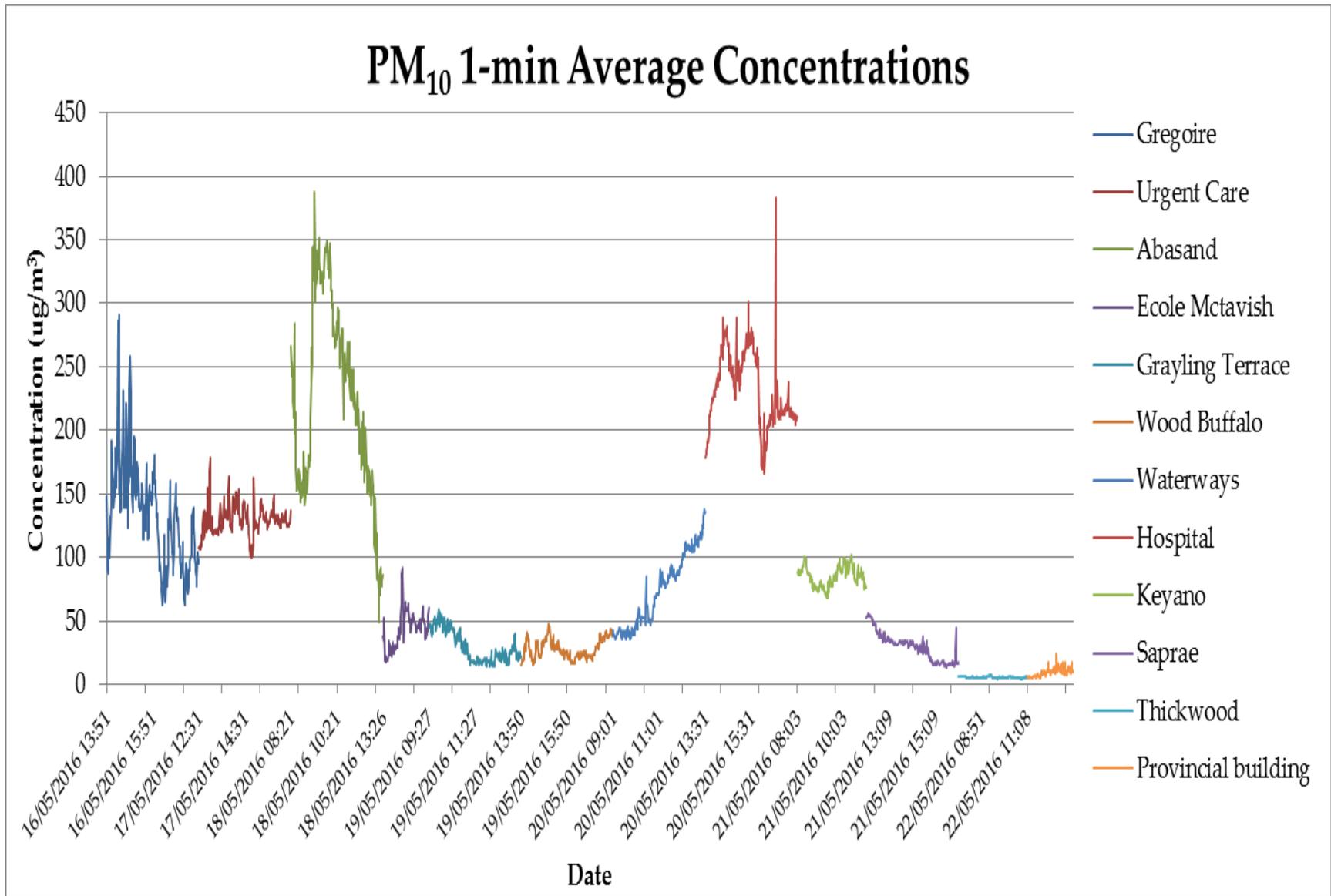


Figure 8c Continuous PM₁₀ measurements from MAML.

TRS 1-min Average Concentrations

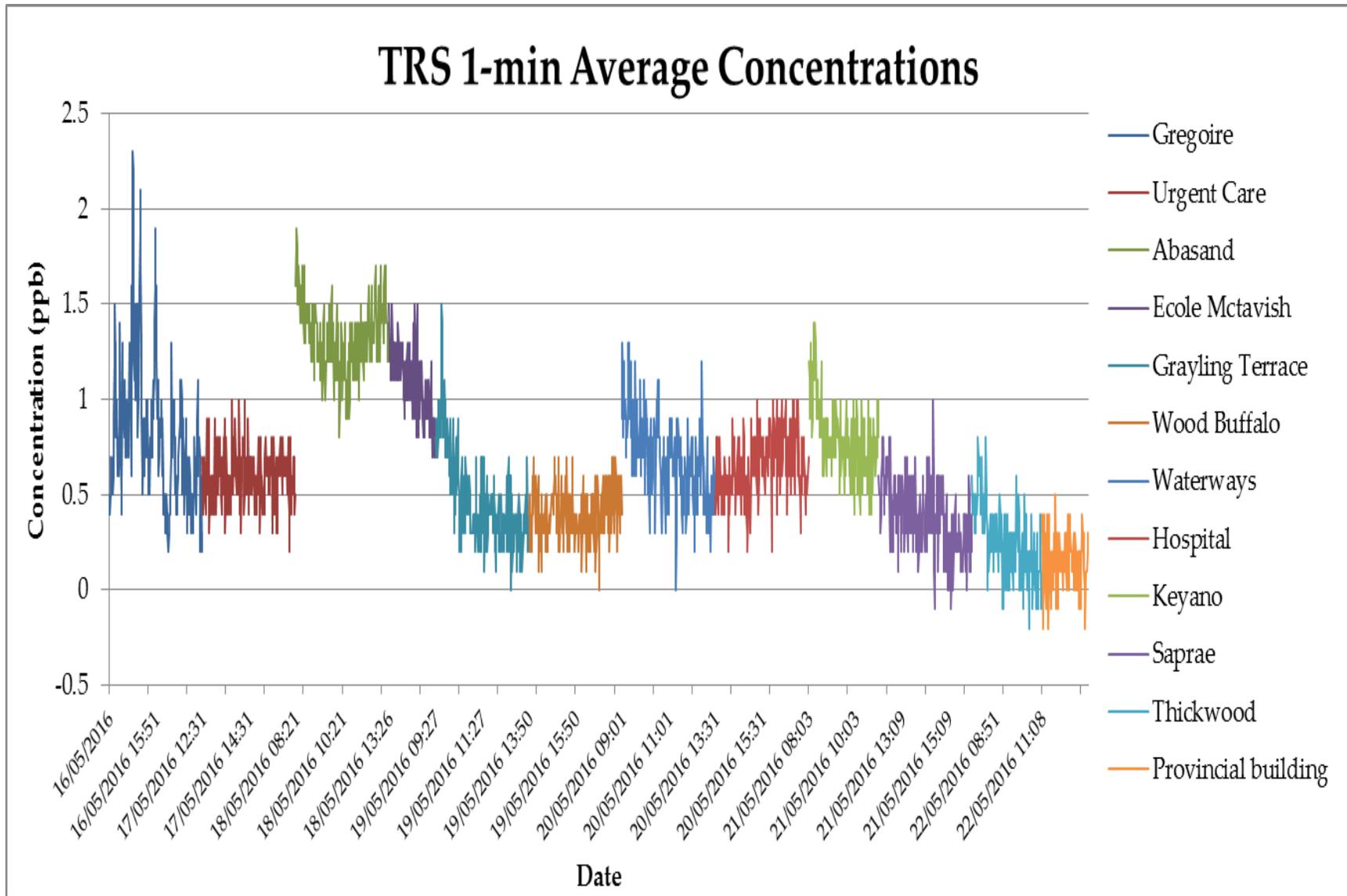


Figure 8d Continuous TRS measurements from MAML.

Particulate Monitoring Station Data PM_{2.5} 1-hour Average Concentrations

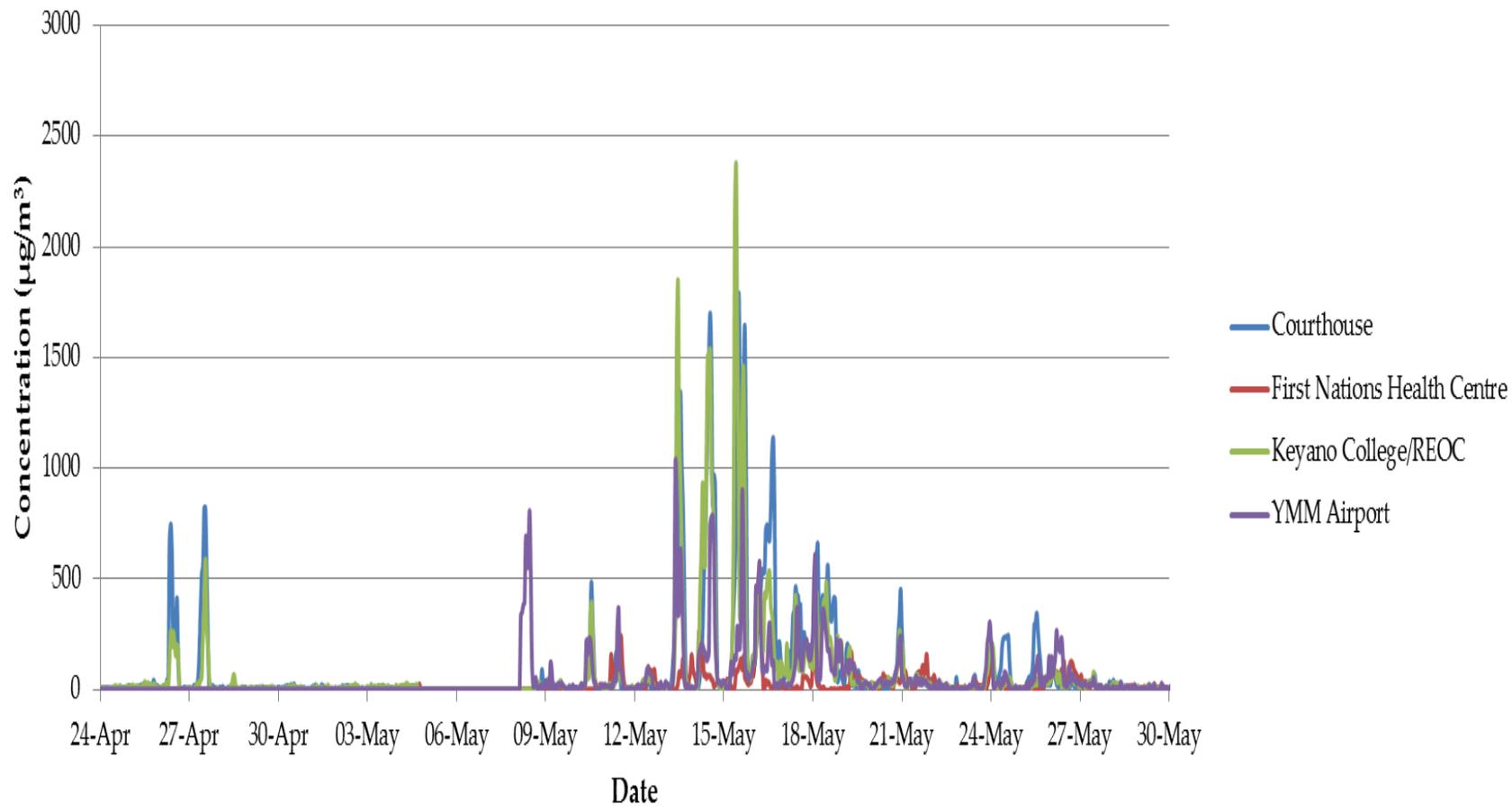


Figure 9 PM_{2.5} measurements at temporary stations.

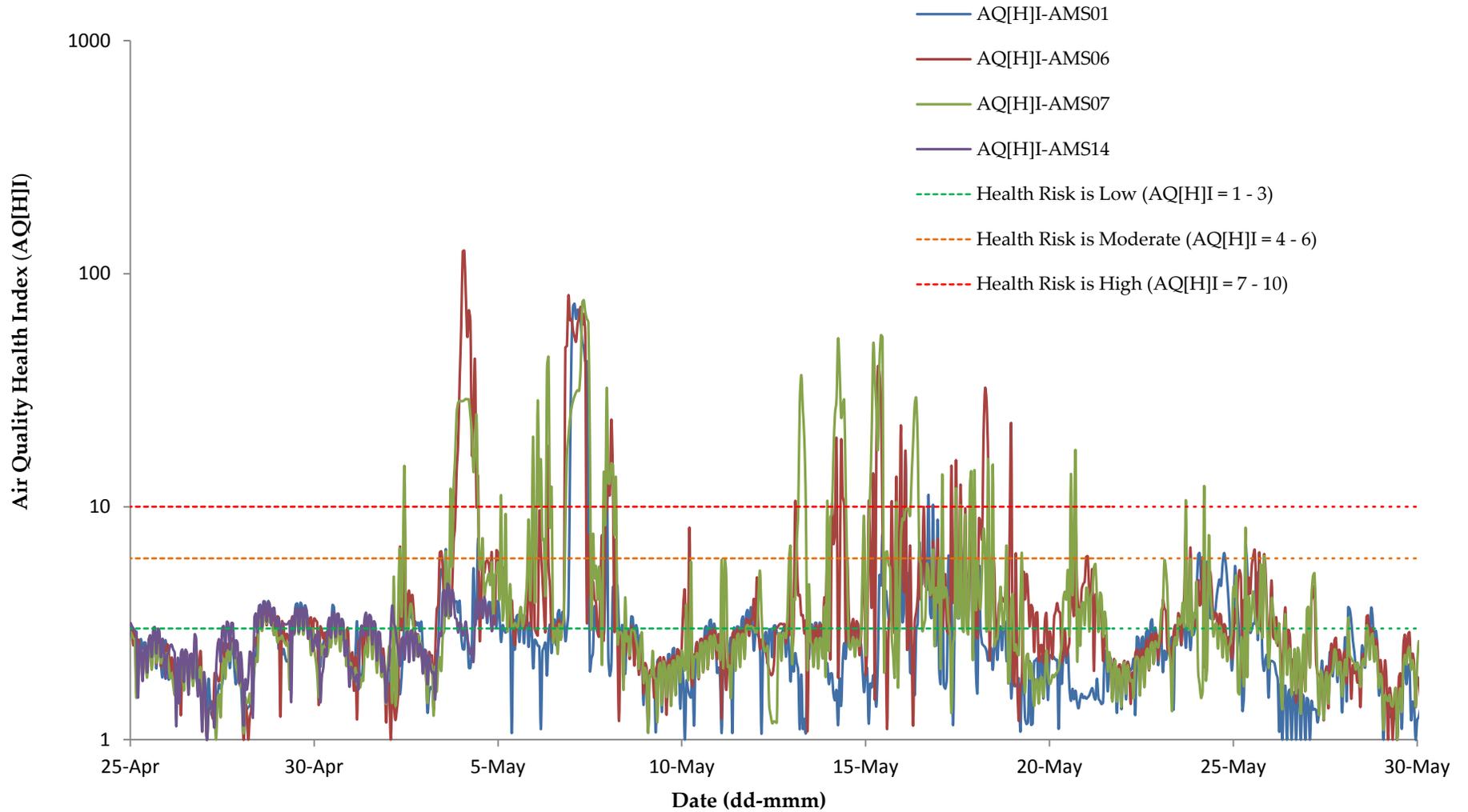


Figure 10 Air Quality (Health) Index (AQ[H]I). The Alberta Air Quality Index (AQI) value is presented whenever the calculated AQI is a value of 6 or greater. In all other cases the AQHI is displayed.

Odour Potential

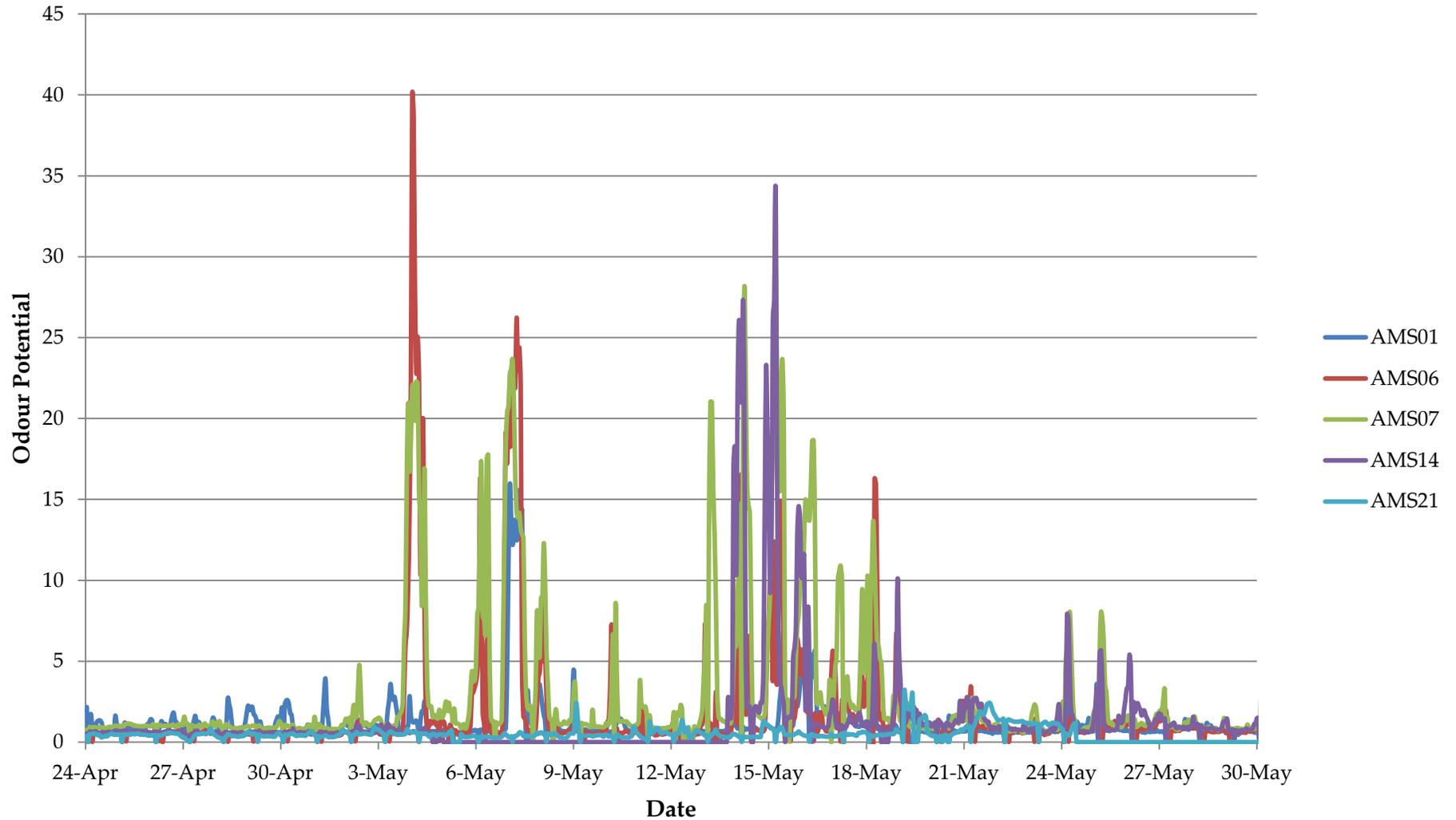


Figure 11 Additive odour detection potential.



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