

Clean Air Status and Trends Network (CASTNET) Quarterly Data Summary for First Quarter 2018 (January through March)

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Introduction

This quarterly report summarizes the Clean Air Status and Trends Network (CASTNET) data collected during first quarter 2018. Trends in pollutants measured at eastern and western reference sites are shown. Results from the quality assurance/quality control (QA/QC) program are presented for first quarter data and include completeness and precision of filter concentrations and hourly O₃ concentrations. This report also analyzes data on continuous, trace-level NO_y from six sites and continuous SO₂ concentrations from one site. Other QC statistics are given in the CASTNET First Quarter 2018 Quality Assurance Report (Wood, 2018).

Figure 1. Fourth Highest Daily Maximum 8-hour Average O₃ Concentrations through First Quarter 2018



Figure 1 shows fourth highest daily maximum 8-hour average (DM8A) O₃ concentrations measured through first quarter 2018. No sites exceeded the 0.070 parts per million (ppm) National Ambient Air Quality Standard for O₃. Dinosaur National Monument, UT (DIN431), which measured exceedances of the NAAQS in the first quarters of 2016 and 2017, recorded a fourth highest DM8A concentration of 51 ppb in 2018. Lower concentrations were caused by an atypically low snowpack. The first quarter snowfall at DIN431 was 8.6 inches versus an average of 15.8 inches (National Resources Conservation Service, 2018). No additional maps are shown in this report because the maps of other measured first quarter 2018 mean concentrations were consistent with first quarter maps from previous years. No anomalies were identified on these maps.

Trends

Trend analyses were performed based on filter pack pollutant concentrations measured in micrograms per cubic meter (µg/m³) of air at the 34 eastern and 16 western reference sites during first quarter. Trends in quarterly mean filter pack and O₃ concentrations are shown using box plots in Figures 2 through 13.

First Quarter Concentrations

Quarterly mean HNO₃, SO₂, SO₄²⁻, Ca²⁺, and Mg²⁺ concentrations decreased at eastern sites in 2018, and NO₃⁻, NH₄⁺, total NO₃⁻, Cl⁻, K⁺, and Na⁺ concentrations increased. At the western sites, quarterly mean NH₄⁺, SO₂, and SO₄²⁻ concentrations decreased and HNO₃, NO₃⁻, total NO₃⁻, Cl⁻, Ca²⁺, K⁺, Mg²⁺, and Na⁺ mean concentrations increased.

Quarterly O₃ concentrations were analyzed using box plots constructed by averaging all valid hourly O₃ concentrations within first quarter 2018 by site and then averaging those averages for all eastern and western reference sites (Figure 13). Quarterly mean concentrations were higher at the western reference sites than at the eastern sites. The figure shows no change in first quarter 2018 mean O₃ concentrations at the eastern sites and a slight reduction at the western sites.

Figure 2. Trends in First Quarter Mean HNO₃ Concentrations

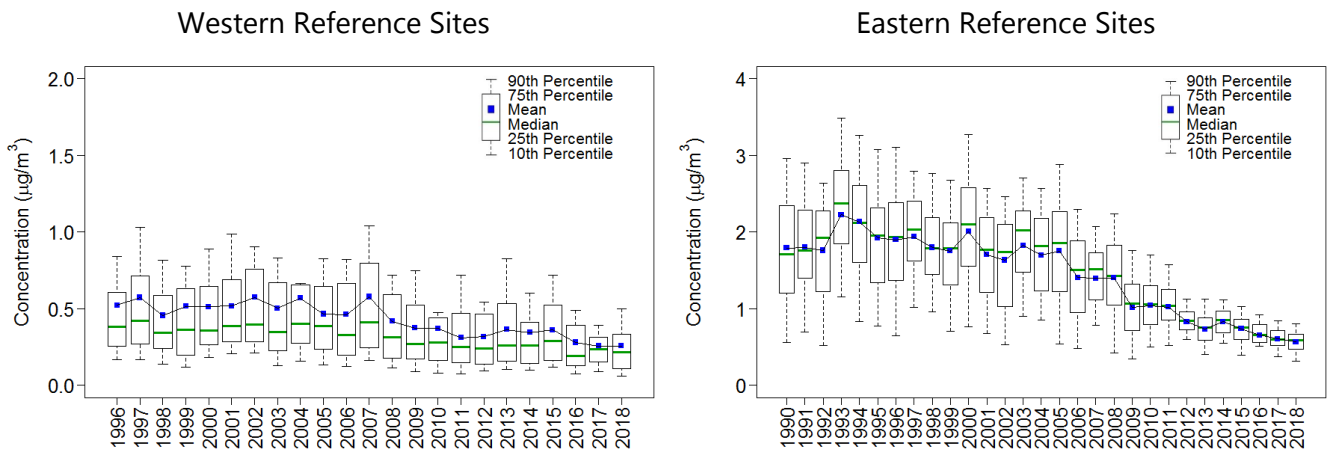
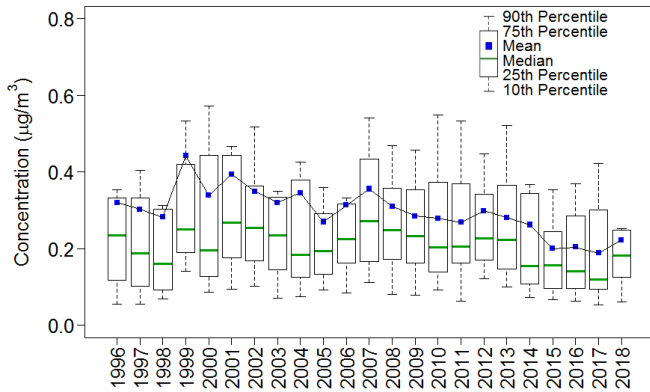


Figure 3. Trends in First Quarter Mean NO₃ Concentrations
Western Reference Sites



Eastern Reference Sites

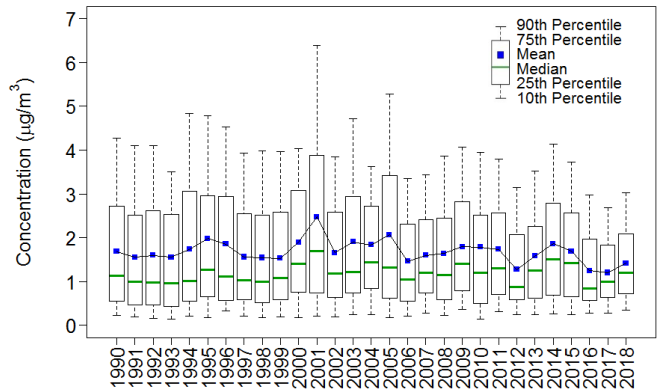
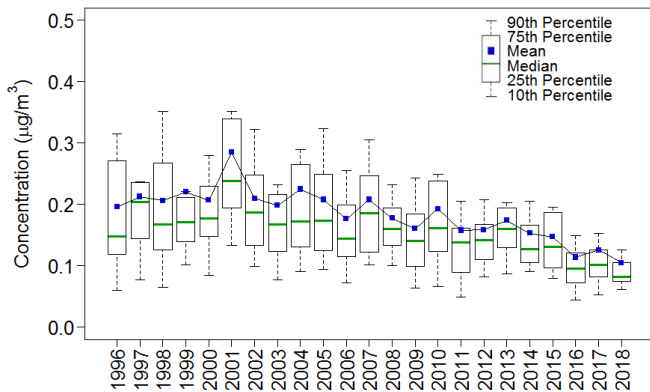


Figure 4. Trends in First Quarter Mean NH₄⁺ Concentrations
Western Reference Sites



Eastern Reference Sites

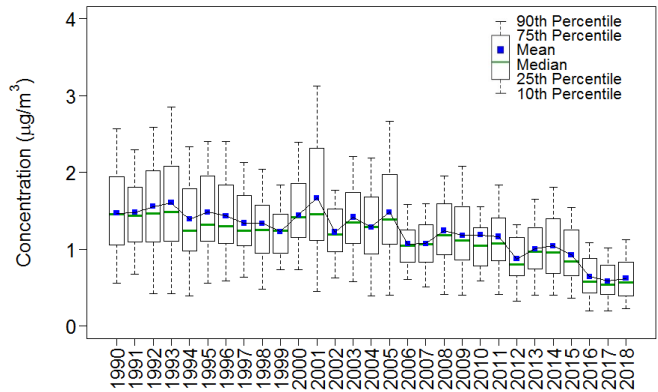
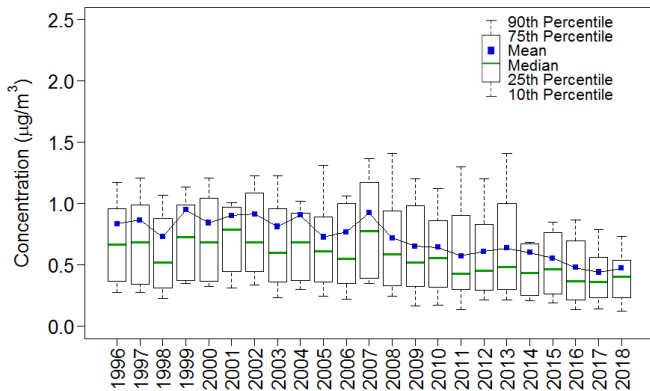


Figure 5. Trends in First Quarter Mean Total NO₃ Concentrations
Western Reference Sites



Eastern Reference Sites

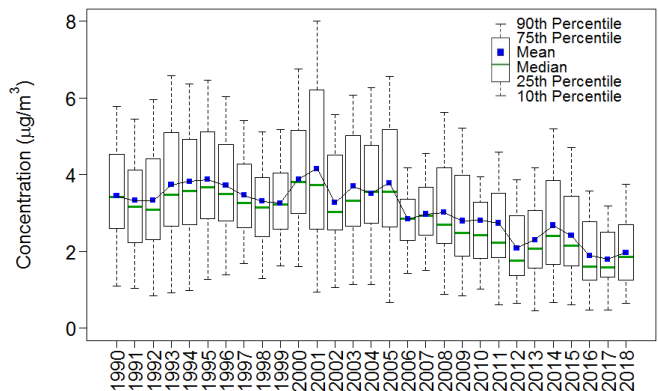
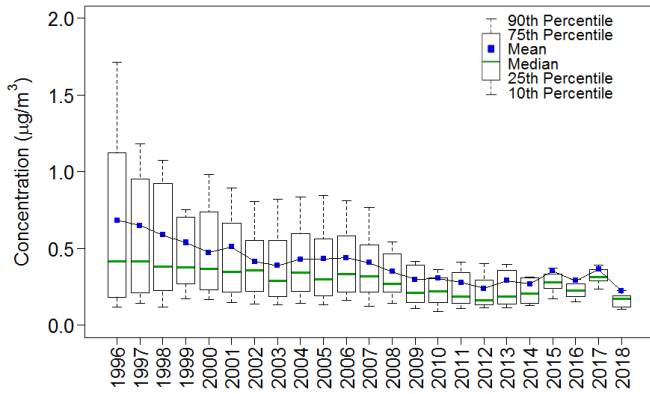


Figure 6. Trends in First Quarter Mean SO₂ Concentrations
Western Reference Sites



Eastern Reference Sites

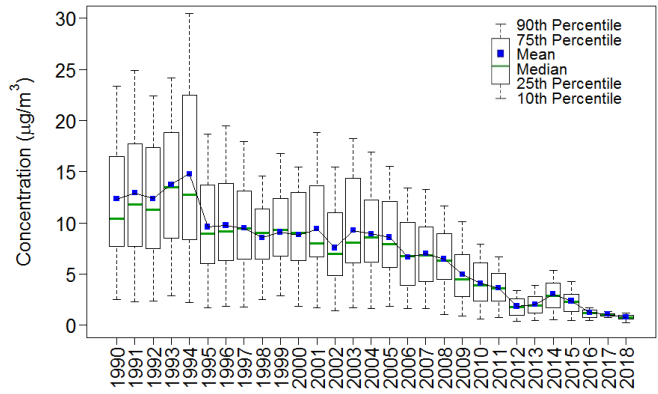
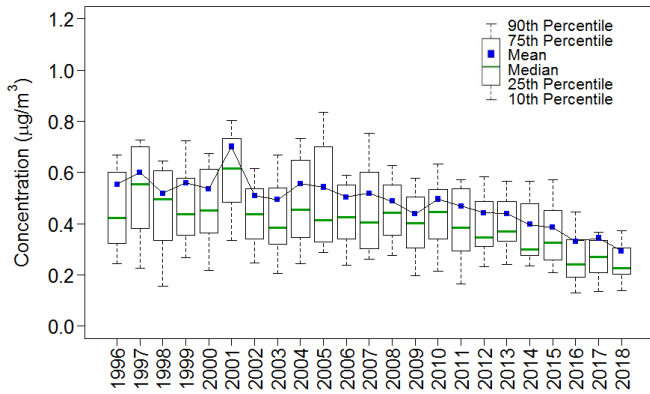


Figure 7. Trends in First Quarter Mean SO₄²⁻ Concentrations
Western Reference Sites



Eastern Reference Sites

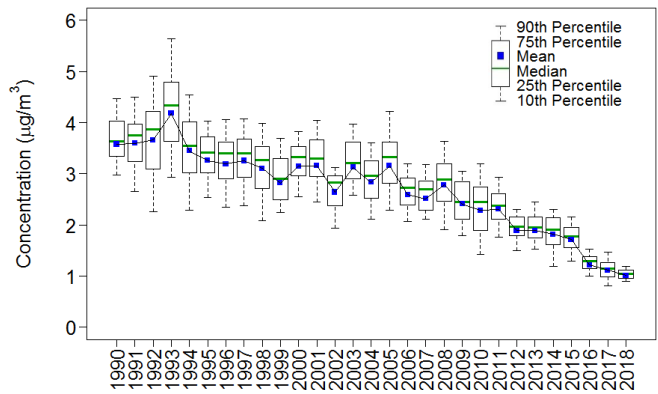
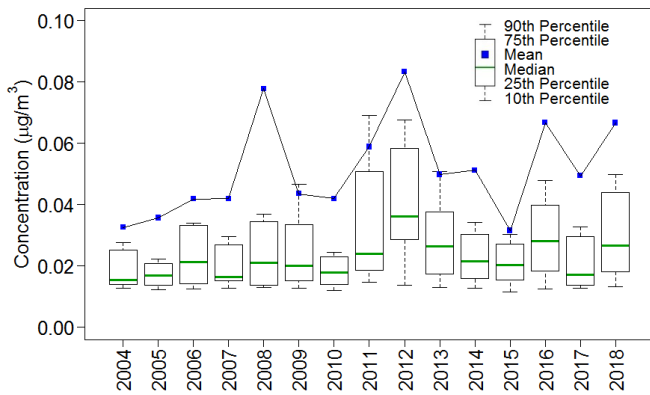


Figure 8. Trends in First Quarter Mean Cl⁻ Concentrations
Western Reference Sites



Eastern Reference Sites

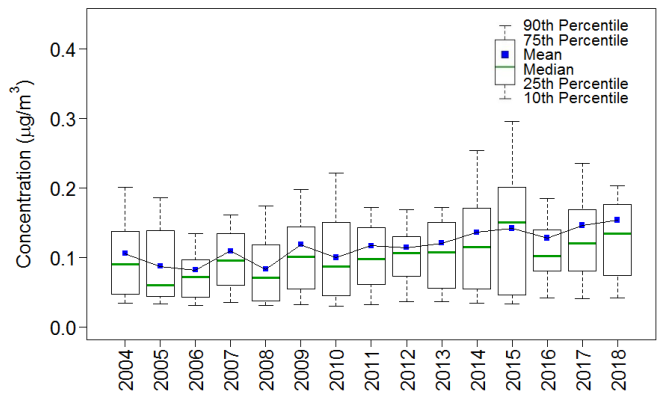


Figure 9. Trends in First Quarter Mean Ca²⁺ Concentrations

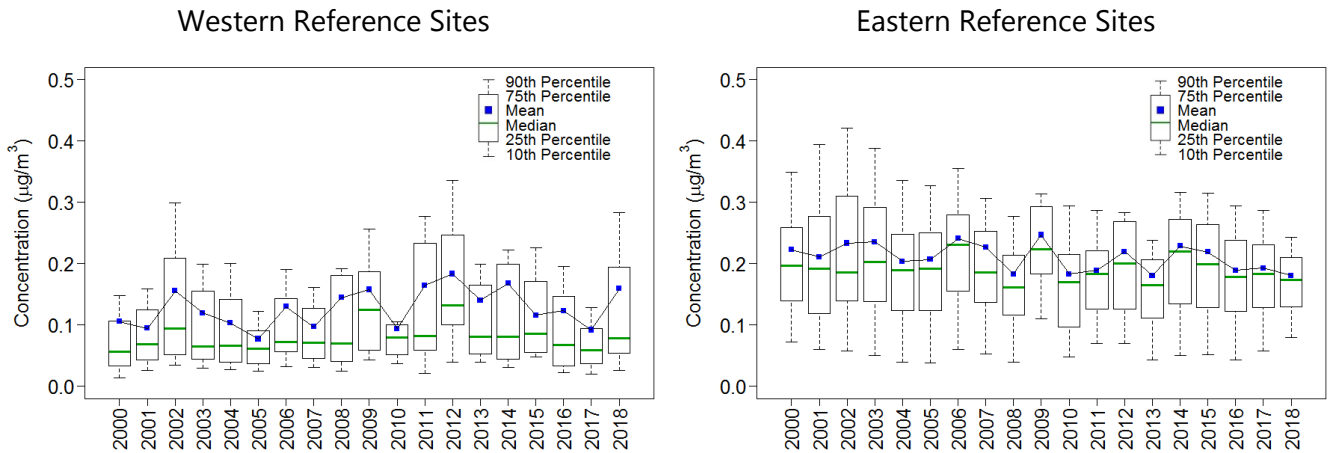


Figure 10. Trends in First Quarter Mean K⁺ Concentrations

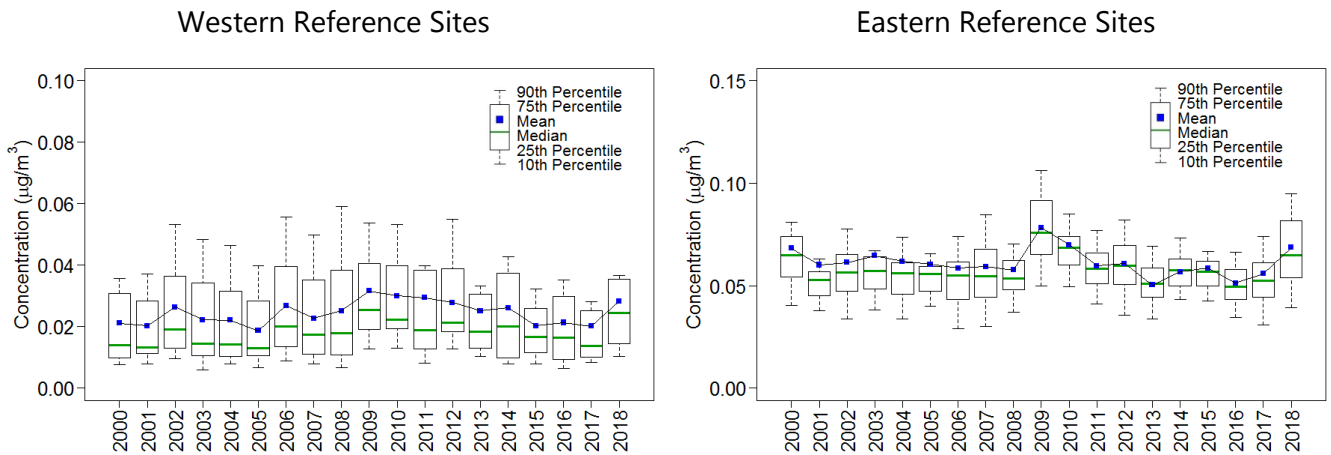


Figure 11. Trends in First Quarter Mean Mg²⁺ Concentrations

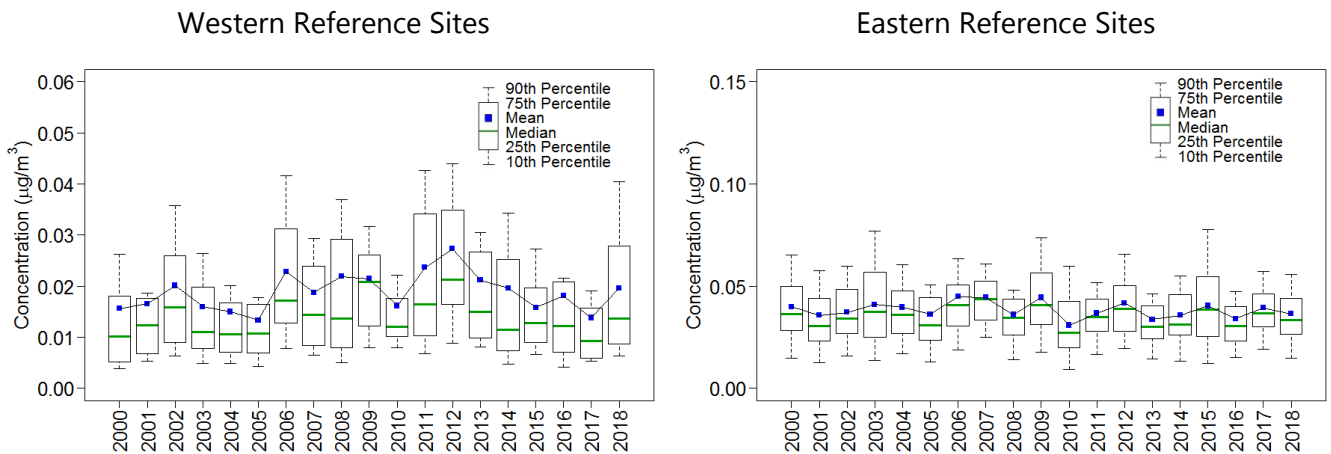
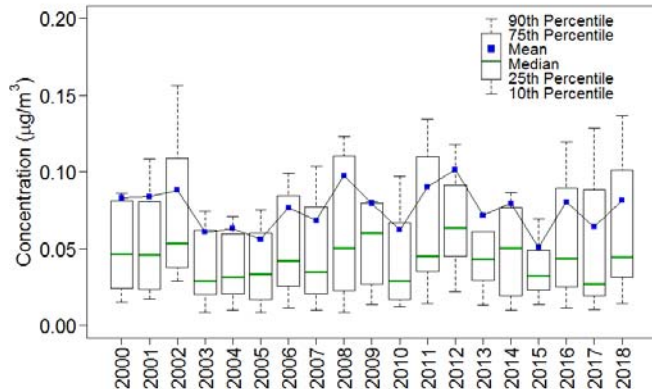


Figure 12. Trends in First Quarter Mean Na⁺ Concentrations
Western Reference Sites



Eastern Reference Sites

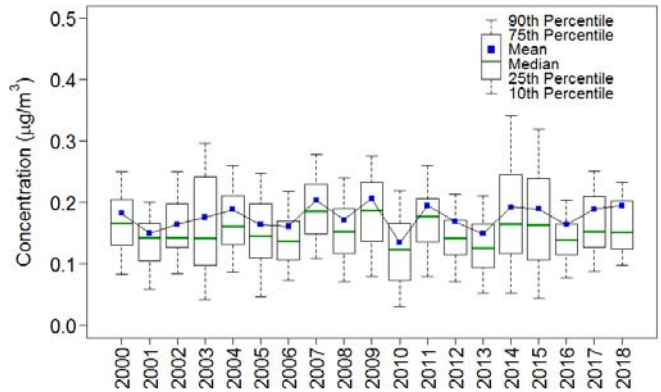
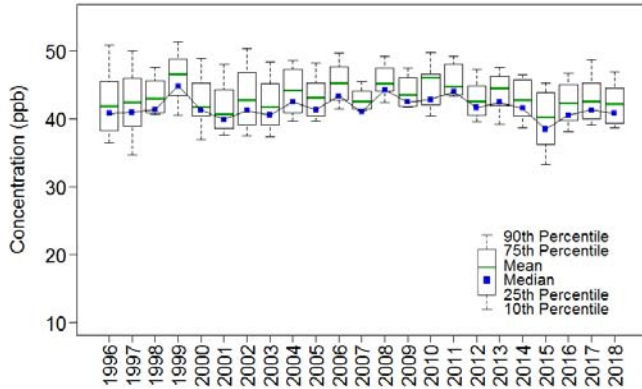
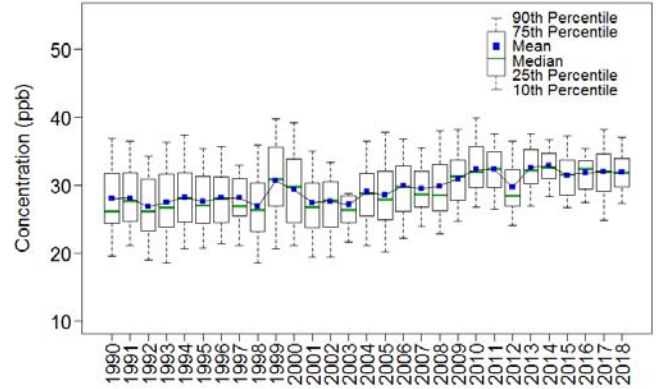


Figure 13. Trends in First Quarter Mean O₃ Concentrations
Western Reference Sites



Eastern Reference Sites



Changes in 3-year Average First Quarter Concentrations

Three-year averages of quarterly mean concentrations of total NO₃⁻, NH₄⁺, SO₂, and SO₄²⁻ were reduced over the period 1990–1992 through 2016–2018 for eastern reference sites and 1996–1998 through 2016–2018 for western reference sites. Three-year averages of first quarter mean O₃ concentrations increased at the eastern sites and showed no change at the western sites. Tables 1 and 2 summarize changes in 3-year average first quarter concentrations.

Table 1. Eastern Reference Sites: 3-Year Mean Nitrogen, Sulfur, and O₃ Pollutant Concentrations

	Total NO ₃ ⁻ (µg/m ³)	NH ₄ ⁺ (µg/m ³)	SO ₂ (µg/m ³)	SO ₄ ²⁻ (µg/m ³)	O ₃ (ppb)
1990–1992	3.4	1.5	12.5	3.6	28
2016–2018	1.9	0.6	1.0	1.1	32
Percent Change	-44	-59	-92	-69	15

Table 2. Western Reference Sites: 3-Year Mean Nitrogen, Sulfur, and O₃ Pollutant Concentrations

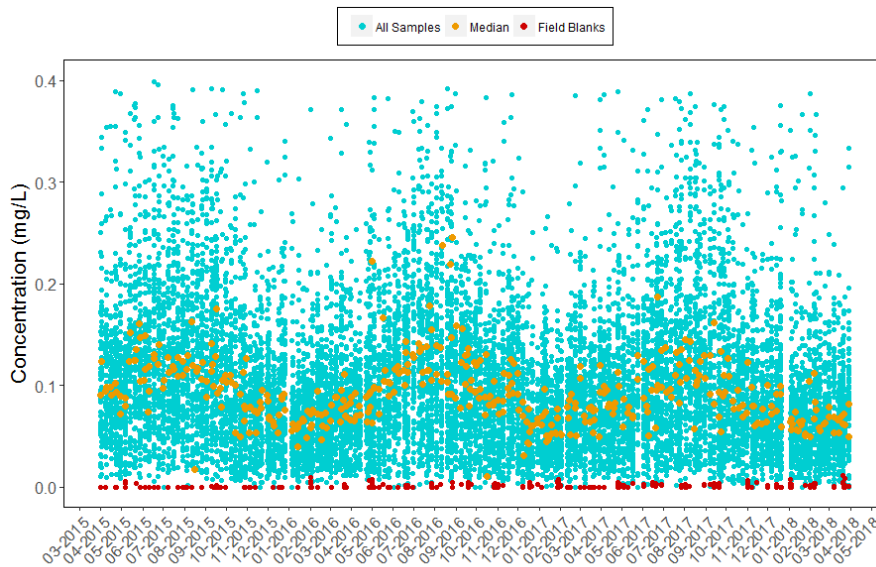
	Total NO ₃ ⁻ (µg/m ³)	NH ₄ ⁺ (µg/m ³)	SO ₂ (µg/m ³)	SO ₄ ²⁻ (µg/m ³)	O ₃ (ppb)
1996–1998	0.8	0.2	0.6	0.6	41
2016–2018	0.5	0.1	0.3	0.3	41
Percent Change	-43	-44	-54	-42	0

Time Series of Laboratory Analysis Parameters for All Sites

Figures 14 through 24 give time series of laboratory-analyzed concentrations of field samples and field blanks (FB) in milligrams per liter (mg/L) of 11 parameters from second quarter 2015 through first quarter 2018. These figures provide indications of potential issues with concentration measurements relative to detection and reporting limits.

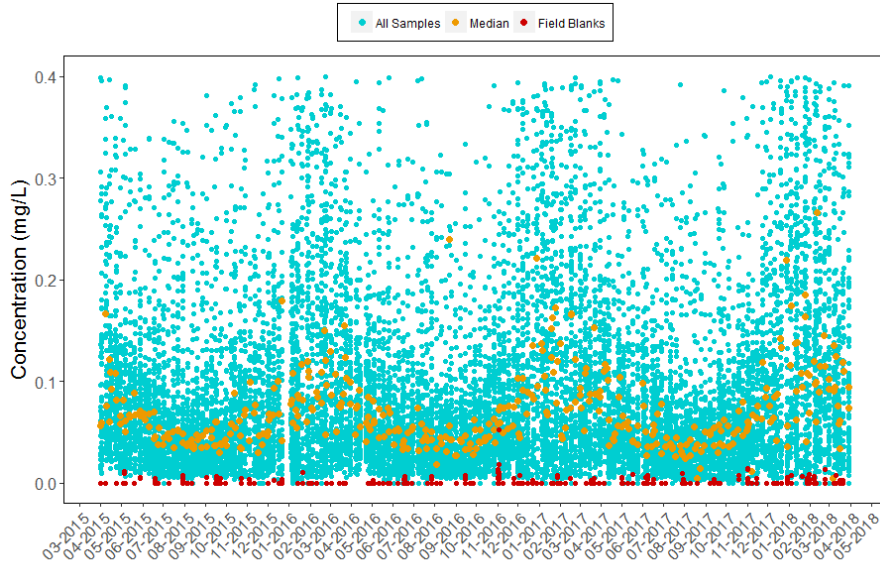
Review of filter pack analysis control charts during preparation of the First Quarter 2018 QA Report indicated possible potassium contamination (Figure 22). Note the field blank results at the end of the quarter. A corrective action was initiated. During the investigation, non-conformance to the established washing procedures for filter pack housings was observed. The technician was retrained and subsequent conformance to documented procedures was verified. Additionally, several sets of filter packs were prepared as process blanks to verify effectiveness of the corrective actions. Four sets have been analyzed to date. All results were within the established measurement criterion.

Figure 14. Concentrations of NO₃⁻ (as N) from Nylon Filters



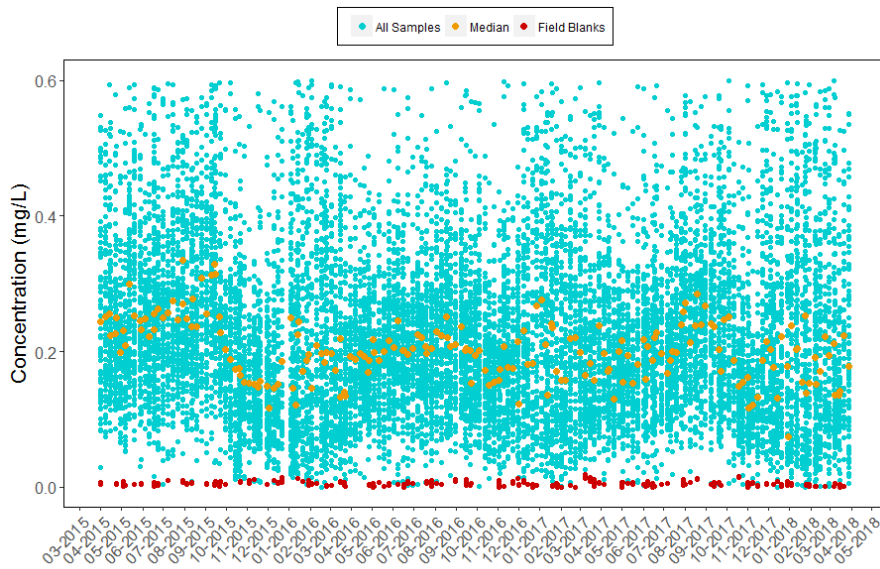
Note: Nominal reporting limit is 0.008 mg/L.

Figure 15. Concentrations of NO_3^- (as N) from Teflon Filters



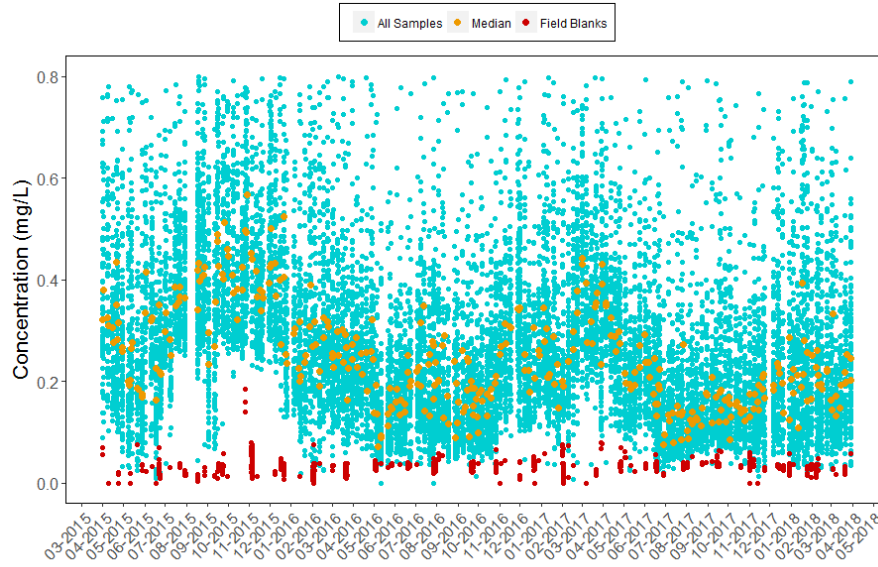
Note: Nominal reporting limit is 0.008 mg/L.

Figure 16. Concentrations of NH_4^+ (as N) from Teflon Filters



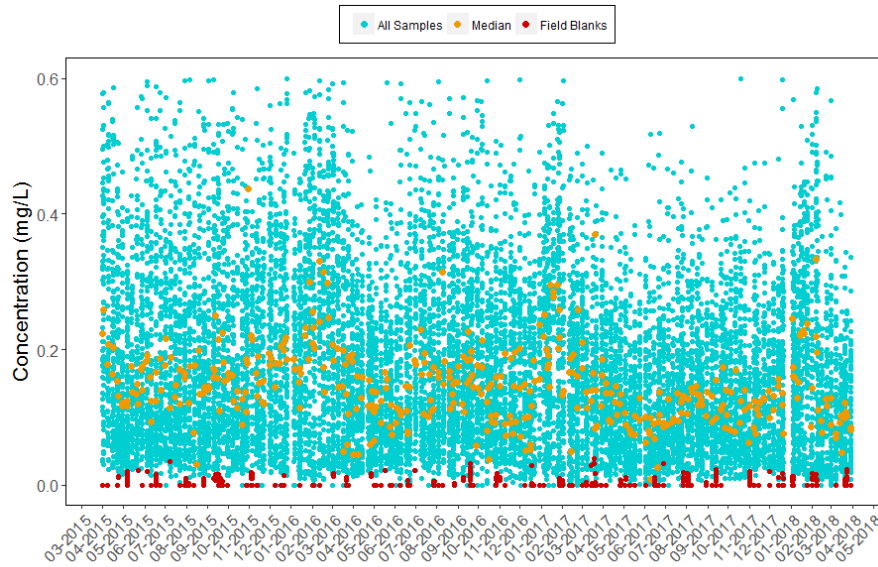
Note: Nominal reporting limit is 0.020 mg/L.

Figure 17. Concentrations of SO₂ from K₂CO₃ Impregnated Cellulose Filters



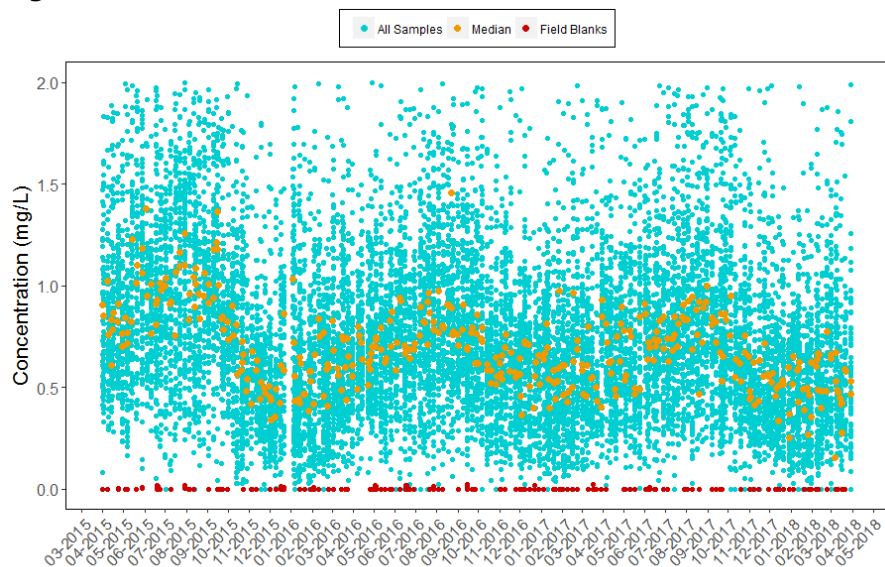
Note: Nominal reporting limit is 0.040 mg/L.

Figure 18. Concentrations of SO₄²⁻ from Nylon Filters



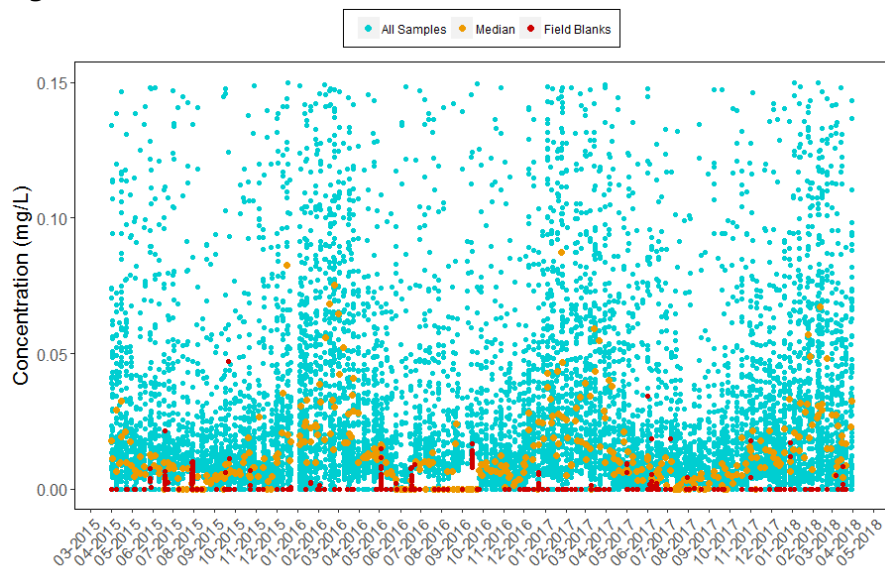
Note: Nominal reporting limit is 0.040 mg/L.

Figure 19. Concentrations of SO_4^{2-} from Teflon Filters



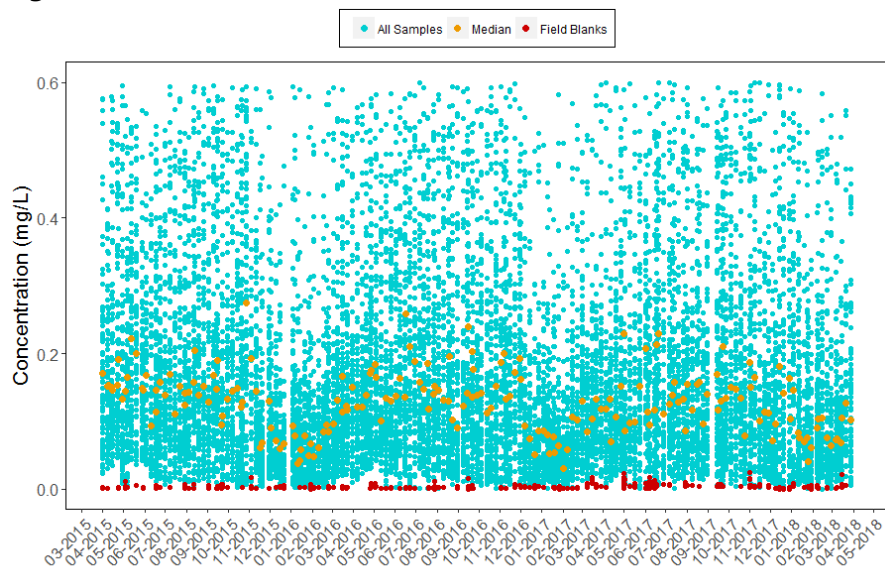
Note: Nominal reporting limit is 0.040 mg/L.

Figure 20. Concentrations of Cl^- from Teflon Filters



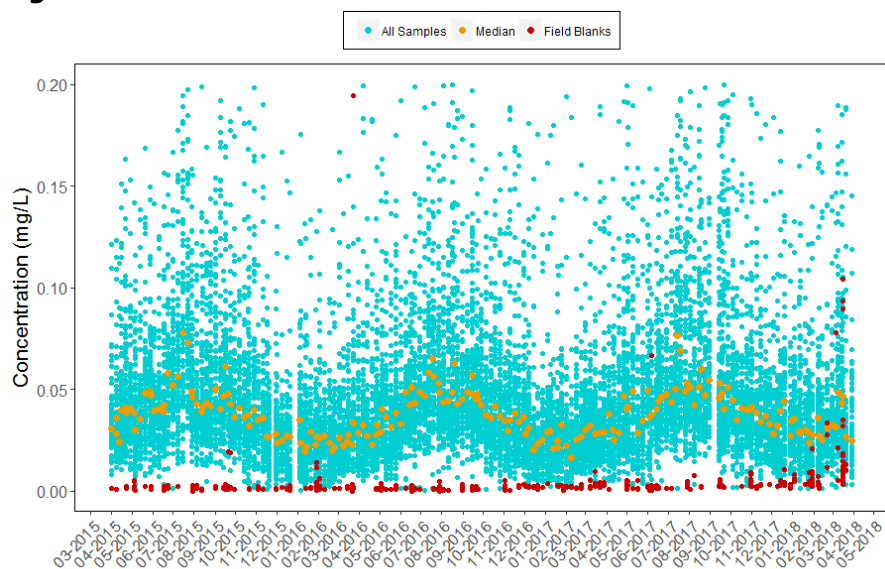
Note: Nominal reporting limit is 0.020 mg/L.

Figure 21. Concentrations of Ca²⁺ from Teflon Filters



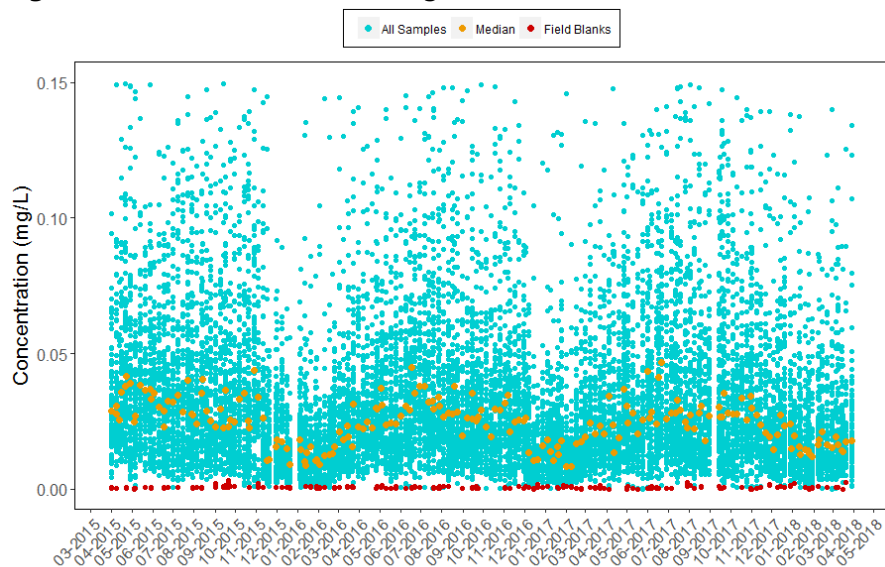
Note: Nominal reporting limit is 0.006 mg/L.

Figure 22. Concentrations of K⁺ from Teflon Filters



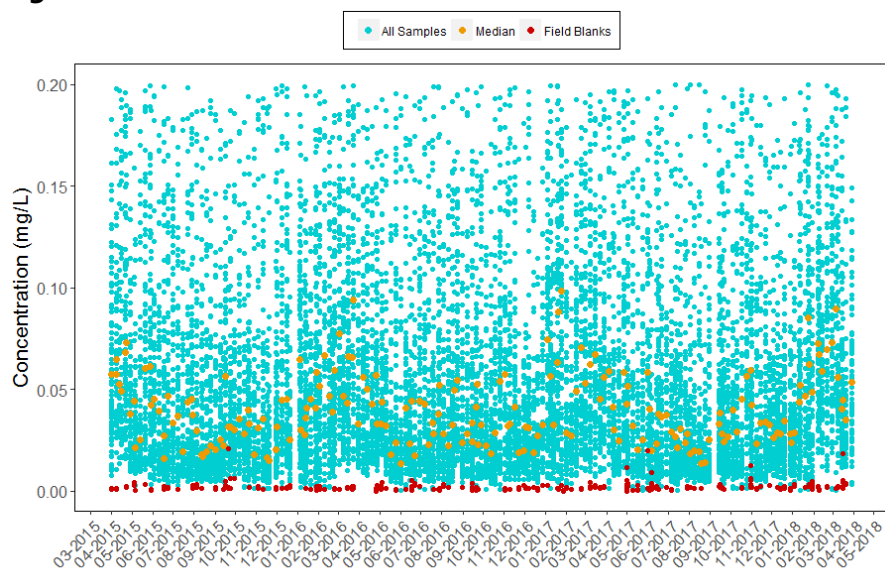
Note: Nominal reporting limit is 0.006 mg/L.

Figure 23. Concentrations of Mg²⁺ from Teflon Filters



Note: Nominal reporting limit is 0.003 mg/L.

Figure 24. Concentrations of Na⁺ from Teflon Filters



Note: Nominal reporting limit is 0.005 mg/L.

Time Series of Concentration Differences from Co-located Sites

Figure 25. Time Series of Filter Concentration Differences between MCK131 and MCK231, KY

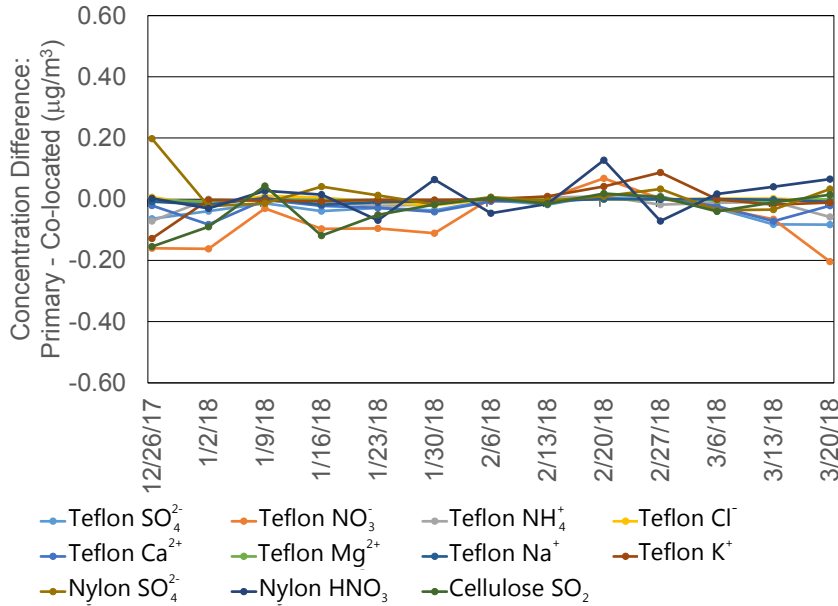
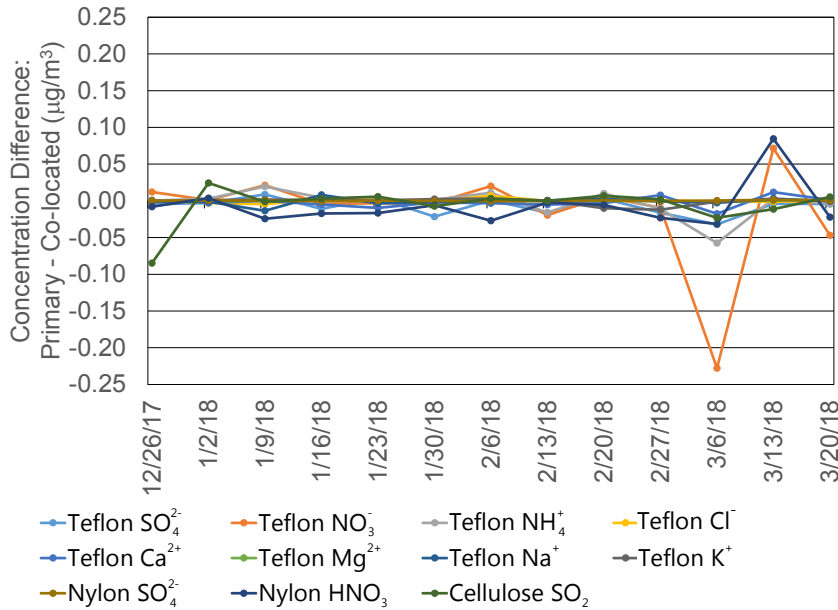


Figure 26. Time Series of Filter Concentration Differences between ROM406 and ROM206, CO



Precision of Filter Pack Concentrations

Table 3 shows mean absolute relative percent differences (MARPD) for concentrations measured at MCK131/231 and ROM406/206 during first quarter 2018. The MARPD values met the 20 percent criterion.

Table 3. Precision (MARPD) for Co-located Filter Pack Data during First Quarter 2018

	SO ₄ ²⁻	NO ₃ ⁻	NH ₄ ⁺	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Cl ⁻	HNO ₃	SO ₂	Total NO ₃ ⁻
MCK131/231, KY											
\bar{X} (μg/m ³)	1.04	1.47	0.64	0.19	0.03	0.12	0.08	0.05	0.77	0.77	2.23
\bar{Y} (μg/m ³)	1.07	1.52	0.65	0.21	0.03	0.12	0.07	0.06	0.76	0.79	2.26
MAD	0.03	0.07	0.01	0.02	0.00	0.01	0.01	0.01	0.04	0.04	0.08
MARPD	2.76	5.19	2.39	9.30	6.83	4.34	15.73	10.56	6.25	4.67	4.12
ROM406/206, CO											
\bar{X} (μg/m ³)	0.29	0.25	0.13	0.09	0.01	0.04	0.02	0.02	0.25	0.15	0.49
\bar{Y} (μg/m ³)	0.30	0.26	0.13	0.09	0.01	0.04	0.02	0.02	0.25	0.15	0.51
MAD	0.01	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.01	0.07
MARPD	5.05	12.97	10.86	8.64	5.24	10.81	15.84	10.47	12.22	6.90	10.53

Completeness for Filter Pack Concentrations

Table 4 shows CASTNET sites with less than 90 percent completeness for weekly filter pack concentrations. Comments are included to provide information on why these sites experienced low data completeness.

Table 4. Sites with less than 90 Percent Data Completeness for Filter Concentrations for First Quarter 2018

Site ID	Teflon SO ₄ ²⁻	Teflon NO ₃	Teflon NH ₄ ⁺	Teflon Minor Cations	Teflon Cl ⁻	Nylon HNO ₃	Nylon SO ₄ ²⁻	Cellulose SO ₂	Comment
BWR139, MD	76.9	76.9	76.9	76.9	76.9	76.9	76.9	76.9	There were two samples installed for two weeks during the quarter plus one sample that was lost.
CND125, NC	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	The flow pump was off during one sampling week. Another week was flagged as "calibrator onsite," which may be recovered during level 3 data validation.
ESP127, TN	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	There were two samples installed for two weeks during the quarter.
EVE419, FL	76.9	76.9	76.9	76.9	76.9	76.9	76.9	76.9	The tower was down because of Hurricane Irma and filter packs did not resume until 01/16/2018.
GRS420, TN	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	Four samples were invalidated because of failed flow system leak checks.
HOW191, ME	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	A snowstorm and associated power failure affected two weeks of sampling.
KIC003, KS	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	There were two samples installed for two weeks during the quarter along with one sample that was invalidated due to suspect data. Another sample was invalidated due to polling issues.
LRL117, PA	76.9	76.9	76.9	76.9	76.9	76.9	76.9	76.9	There were three samples installed for two weeks during the quarter.
NEC602, WY	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	Four samples were invalidated due to suspect data.
NIC001, NY	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	There was an undetected leak in the flow system affecting six sampling weeks. The site operator was retrained in leak check procedures.
PNF126, NC	76.9	76.9	76.9	76.9	76.9	76.9	76.9	76.9	A data logger malfunction affected two samples, and a power outage affected a third sample..
THR422, ND	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	There was an extended power outage from 02/21/2018 to 02/27/2018 and again from 3/23/2018 to 3/27/2018.

Precision of Ozone Concentrations

Time series of co-located hourly O₃ concentration differences for first quarter 2018 are provided in Figures 27 and 28 for MCK131/231 and ROM406/206, respectively. The figures indicate no consistent bias between the co-located analyzers at these site locations.

Figure 27. Time Series of the Differences in Co-located O₃ Concentrations for MCK131/231, KY

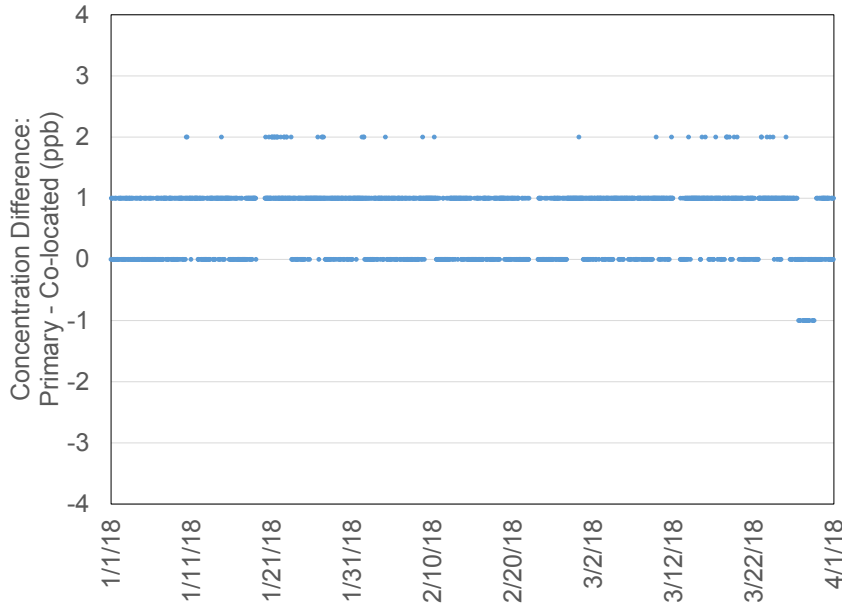


Figure 28. Time Series of the Differences in Co-located O₃ Concentrations for ROM406/206, CO

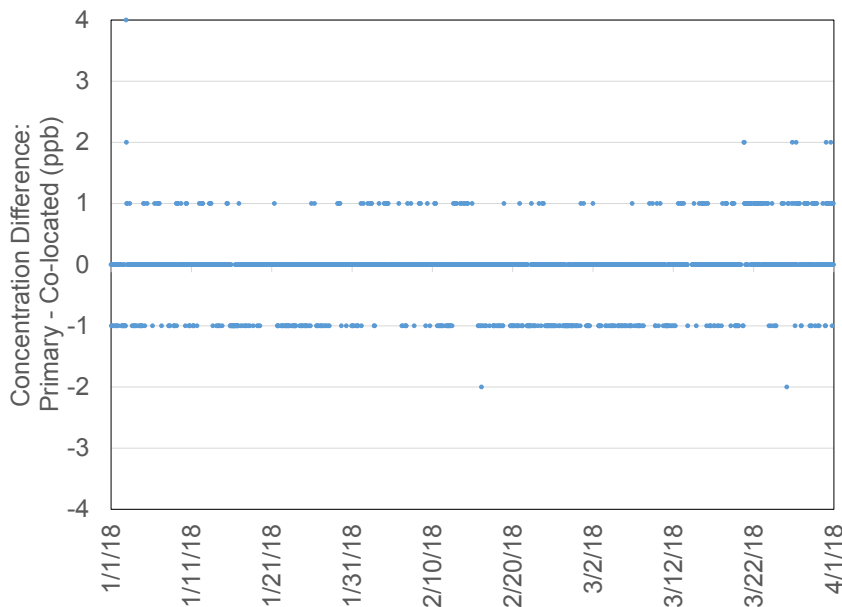


Table 5 gives MARPD data for O₃ data measured at the two co-located sites.

Table 5. Quarterly Precision (MARPD) for Co-located O₃ Concentrations

Site Pair	Quarter	Start Date	MARPD	Records
MCK131/231, KY				
	2	04/01/17	0.6	2047
	3	07/01/17	0.9	1932
	4	10/01/17	1.8	2041
	1	01/01/18	2.1	1979
ROM406/206, CO				
	2	04/01/17	1.5	2061
	3	07/01/17	1.3	1716
	4	10/01/17	0.8	2074
	1	01/01/18	0.6	2023

Completeness for O₃ Concentrations

Table 6 shows CASTNET sites with less than 90 percent completeness for hourly O₃ concentrations. Comments are provided for these sites. The annual average for each site is included for reference.

Table 6. Sites with less than 90 Percent Data Completeness for O₃ Concentrations

Site ID	Q1 2018	Q2 2017– Q1 2018	Comments
ALH157, IL	86.2	90.3	The ozone analyzer malfunctioned on 01/08/2018 and was replaced on 01/19/2018.
ARE128, PA	89.0	96.1	The leak check cap was left installed on 02/27/2018, and the ozone analyzer sample pump subsequently malfunctioned. The pump was replaced on 03/06/2018.
BAS601, WY	88.8	91.4	The pump on the ozone analyzer seized from 02/08/2018 through 02/14/2018.
CND125, NC	89.2	87.1	The sample pump malfunctioned on 02/20/2018 and was replaced 02/27/2018.
GTH161, CO	88.6	96.3	The sample pump malfunctioned on 01/03/2018 and was replaced 01/12/2018.
MKG113, PA	89.9	88.8	The ozone line dryer failed on 12/31/2017 and was bypassed on 01/10/2018.
PNF126, NC	82.4	81.4	The data logger malfunctioned on 01/11/2018 and was replaced 01/23/2018. Power was off at the site from 02/21/2018 to 03/02/2018.
QAK172, OH	85.7	94.4	Data were invalidated for intermittent excursions above acceptable bench temperature during late February and early March. The issue was resolved after the site operator removed paperwork that had been left on top of the analyzer.
STK138, IL	89.9	91.1	The site analyzer malfunctioned on 03/13/2018 and was replaced 03/17/2018.
ZIO433, UT	44.8	44.8	The ozone analyzer malfunctioned 01/23/2018 and was replaced 02/09/2018. The replacement analyzer malfunctioned 02/13/2018. Another spare analyzer was sent and installed on 03/13/2018.

Filter Pack Total Nitrate and Continuous Trace-level NO_y Concentrations at Six CASTNET Sites

Figures 29 through 34 show a comparison of weekly average continuous NO_y measurements with weekly filter pack total NO₃⁻ concentrations collected at the six sites with NO_y measurements. The NO_y concentrations were consistently higher than the total NO₃⁻ levels at all sites. The average weekly NO_y levels, the weekly total NO₃⁻ concentrations, and their ratios for the six sites are shown in Table 7. Weekly NO_y levels were higher than the weekly total NO₃⁻ concentrations. Ratios of NO_y to total NO₃⁻ varied from 3.87 at PND165 to 6.27 at DUK008.

Table 7. Summary of Total NO₃⁻ and NO_y Measurements for First Quarter 2018

Site ID	Elevation	Total NO ₃ ⁻ (ppb)	NO _y (ppb)	Ratio
DUK008, NC	164	0.66	4.04	6.27
BVL130, IL	213	1.42	5.04	3.89
HWF187, NY	497	0.35	1.41	4.87
PNF126, NC	1216	0.45	1.69	4.49
PND165, WY	2386	0.10	0.36	3.87
ROM206, CO	2742	0.15	0.72	4.80

Figure 29. Comparison of DUK008 Weekly Mean NO_y and Total NO₃⁻ Concentrations

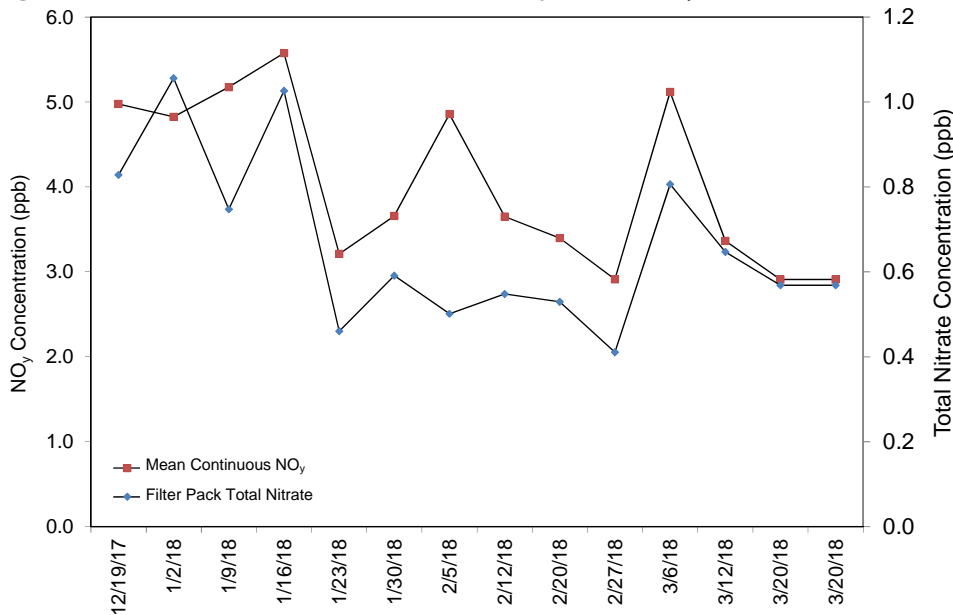


Figure 30. Comparison of BVL130 Weekly Mean NO_y and Total NO₃ Concentrations

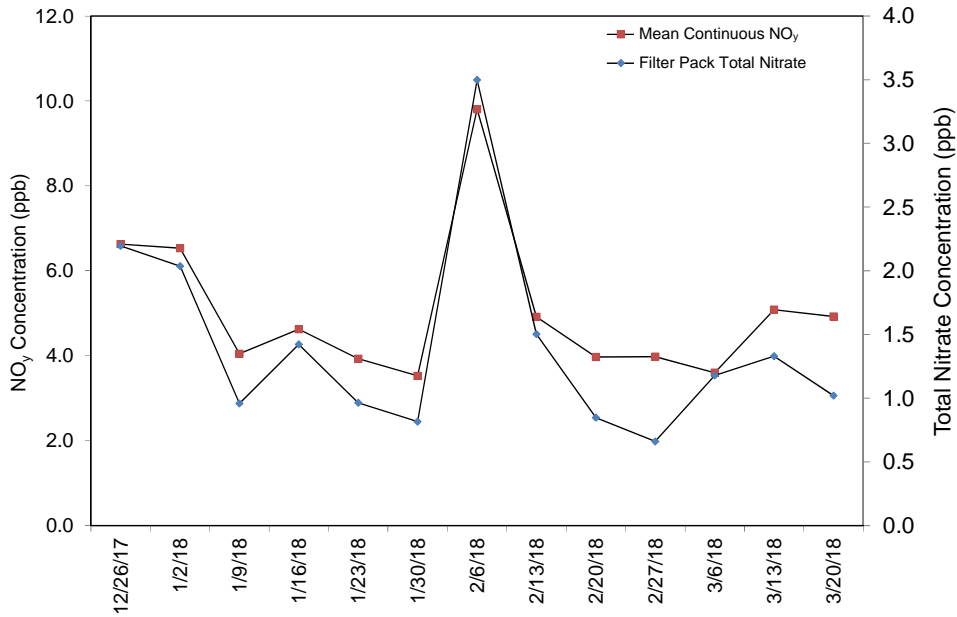


Figure 31. Comparison of HWF187 Weekly Mean NO_y and Total NO₃ Concentrations

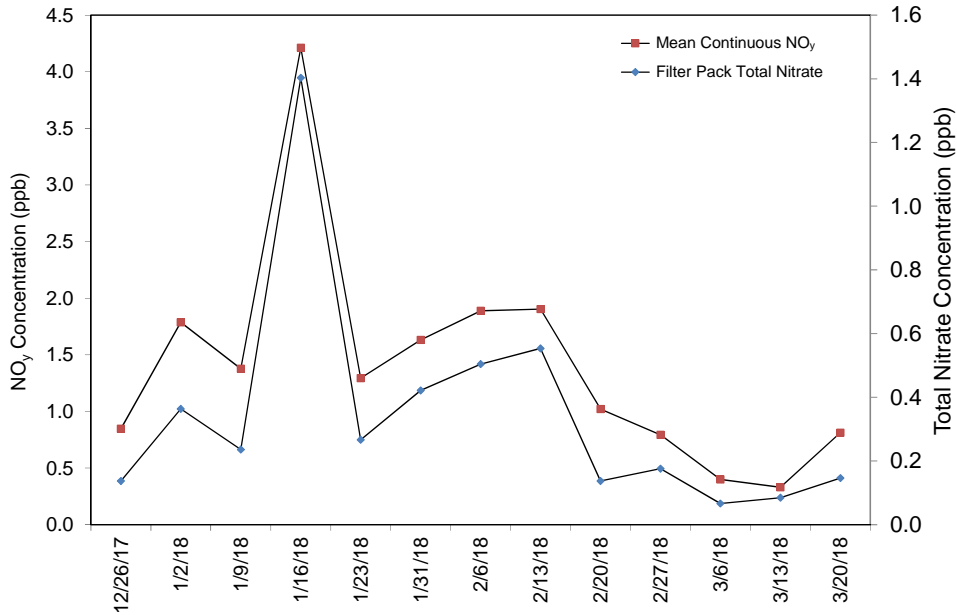


Figure 32. Comparison of PNF126 Weekly Mean NO_y and Total NO₃⁻ Concentrations

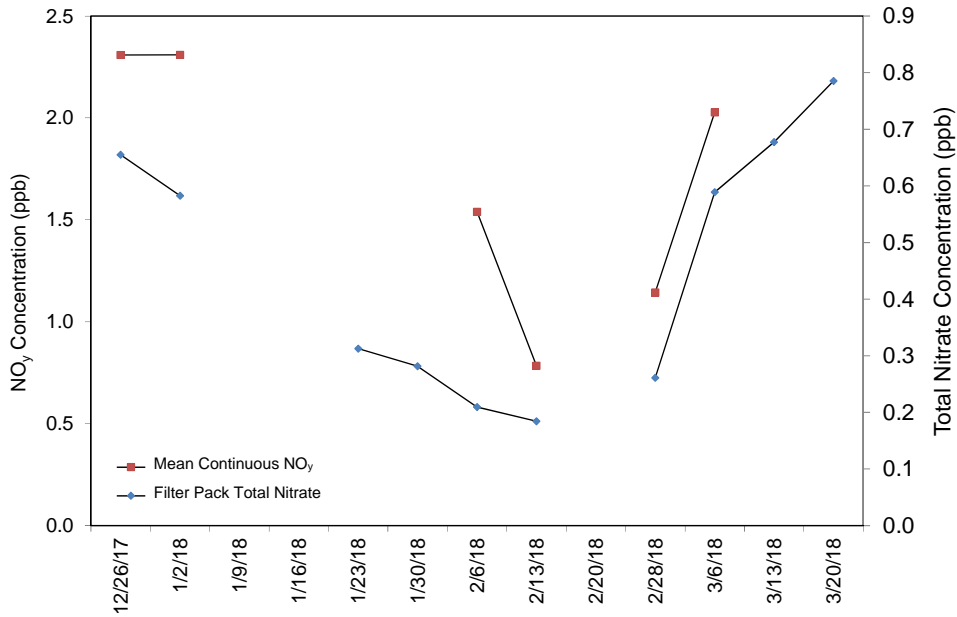


Figure 33. Comparison of PND165 Weekly Mean NO_y and Total NO₃⁻ Concentrations

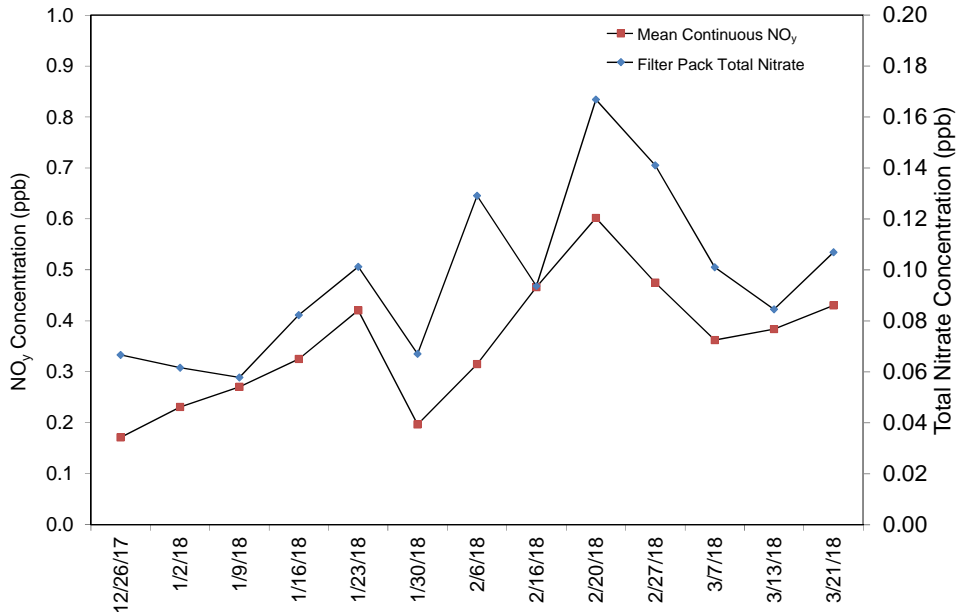
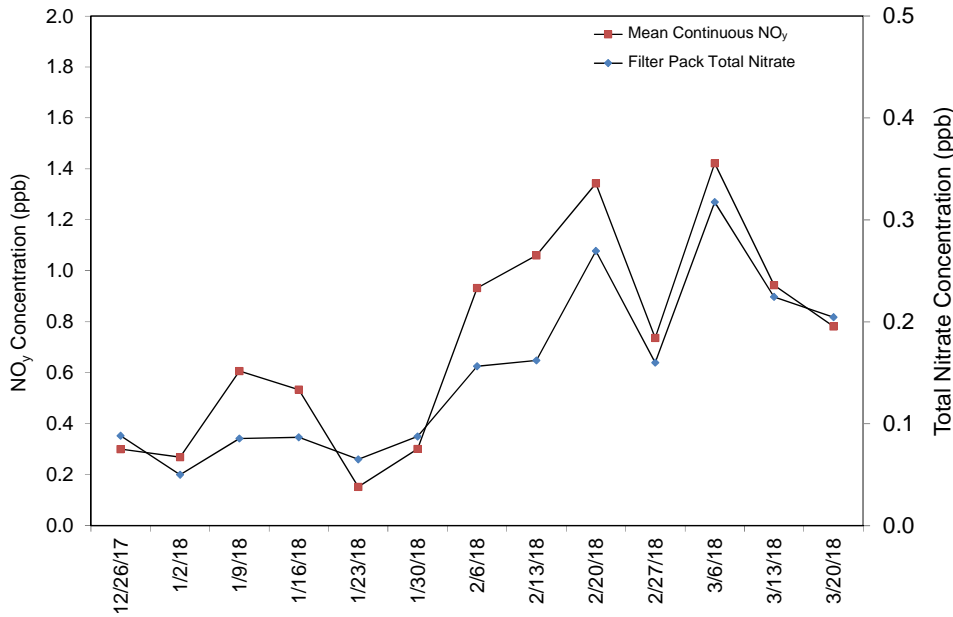


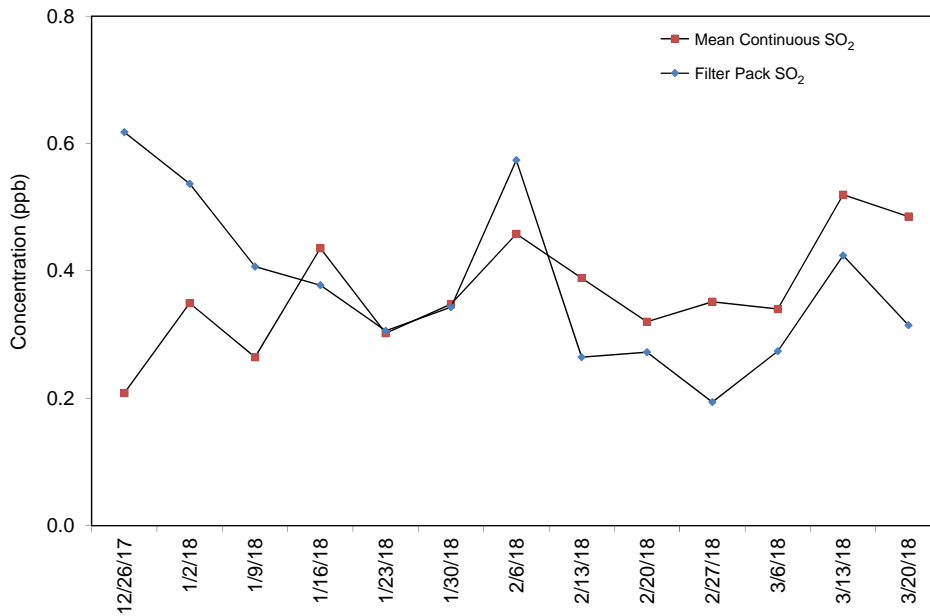
Figure 34. Comparison of ROM206 Weekly Mean NO_y and Total NO₃ Concentrations



Filter Pack and Continuous Trace-level Gas Sulfur Dioxide Concentrations

Figure 35 provides a diagram that compares weekly filter pack SO₂ concentrations with continuous trace-level gas data measured at BVL130. The continuously measured trace-level concentrations were higher than filter pack concentrations except for four weeks during the quarter.

Figure 35. Comparison of BVL130 Weekly Mean SO₂ Concentrations



References

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