



CASTNET's NO_y Monitoring Network

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Introduction

For more than 25 years, the Environmental Protection Agency's (EPA) Clean Air Status and Trends Network (CASTNET) has collected ambient measurements of nitric acid, nitrate, and ammonium concentrations using a filter pack. However, key contributors to the nitrogen budget have been missing from CASTNET. Two of these components are ammonia (NH₃) and total reactive nitrogen (NO_y). Missing NH₃ measurements have been addressed by CASTNET's participation in NADP's Ammonia Monitoring Network (AMoN), which started in 2007. To develop a data set of NO_y measurements, EPA has established an NO_y monitoring network stretching from the east coast to the mountain west, which now features six EPA-sponsored CASTNET sites. In addition, NPS, a primary sponsor of CASTNET, features NO_y measurements at two of their CASTNET sites.



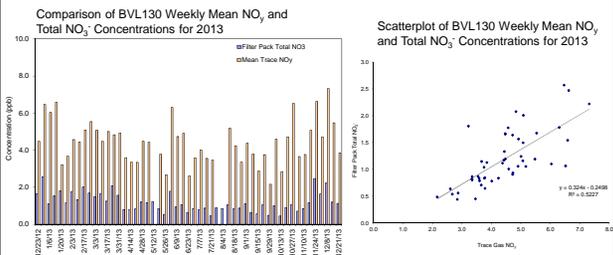
EPA-Sponsored NO_y Sites



AMEC is installing an enhanced NO_y monitoring system at BEL116, MD later this summer to further characterize total nitrogen. For more information, see Kevin Mishoe's talk Wednesday afternoon.

Filter Pack Comparisons

HNO₃ and particulate NO₃ are measured on CASTNET filter packs, and the sum is called total NO₃. Because NO_y is composed of HNO₃, particulate nitrate, and other gases and particles, a simple evaluation of the measurements is to compare the NO_y concentrations with total NO₃ concentrations. The figures below show comparisons of weekly average continuous NO_y measurements with weekly filter pack total NO₃ concentrations collected at BVL130, IL. The NO_y concentrations were consistently higher than the total NO₃ levels, as expected. The weekly total NO₃ concentrations, the average weekly NO_y levels, and their ratios are listed for all six sites in the table below. These were calculated as the average of all valid weekly filter pack concentrations and the average of mean NO_y values matching run time of the weekly filter packs. Ratios of NO_y to total NO₃ varied from 4.1 at BVL130 to 9.7 at BEL116, MD.



Summary of Total NO₃/NO_y Measurements for 2013

Site	Total NO ₃ (ppb)	NO _y (ppb)	Ratio
HWF187, NY	0.2	0.7	4.3
BEL116, MD	0.8	7.4	9.7
PNF126, NC	0.3	1.5	5.3
BVL130, IL	1.2	4.4	4.1
ROM206, CO	0.1	1.2	9.5
PND165, WY	0.2	0.6	4.2

Results

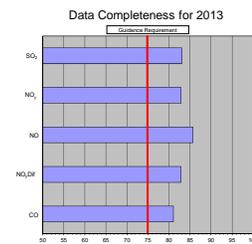
NO_y is defined as NO_x [nitrogen oxide + nitrogen dioxide] plus NO₃ [nitric acid, nitrous acid, peroxyacetyl nitrate (PAN), other organic nitrates, and nitrite]. NO_y and NO are sampled continuously and archived as 1-hour values. Typical concentrations at the six EPA-sponsored CASTNET sites measuring NO_y range from an average of 0.6 parts per billion (ppb) at HWF187, NY and 0.7 ppb at PND165, WY to 4.5 ppb at BVL130, IL to 10.2 ppb at BEL116, MD, which is a suburban site. The figures to the right present composite diurnal profiles of SO₂, NO_y, and O₃ for the entire year 2013 for BEL116 and BVL130. Below and to the right are diurnal plots of NO_y and O₃ for HWF187 (2013), PNF126, NC (Nov-Dec 2013), ROM206, CO (Nov-Dec 2013), and PND165 (May-Dec 2013). The profiles were constructed by averaging all values from the same hour for their respective periods. The figures illustrate the geographic differences in the evolution of photochemically reactive pollutants in the lowest boundary layer. The minimum and maximum mean composite NO_y and O₃ are summarized in the table below.

Min/Max Summary

Site	NO _y (ppb)		Ozone (ppb)		Elevation (m)	Direction
	Min	Max	Min	Max		
HWF187, NY	0.6	0.9	25	36	497	East
BEL116, MD	5.0	12.8	16	43	47	East
PNF126, NC	1.3	1.7	34	38	1216	East
BVL130, IL	3.3	5.8	21	41	213	East
ROM206, CO	0.7	1.7	43	47	2742	West
PND165, WY	0.5	0.7	42	49	2386	West

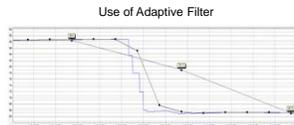
QA/QC

The chart to the right shows a summary of the percent completeness of trace-level gas concentrations measured during 2013 at the six EPA-sponsored trace-level sites. For reference, the red line shows the completeness requirement of 75% for continuous SO₂ per QA Handbook, Vol. 11, App. D. AMEC field personnel are working internally and with the Teledyne API to improve data completeness.



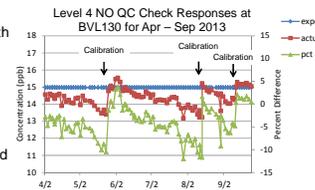
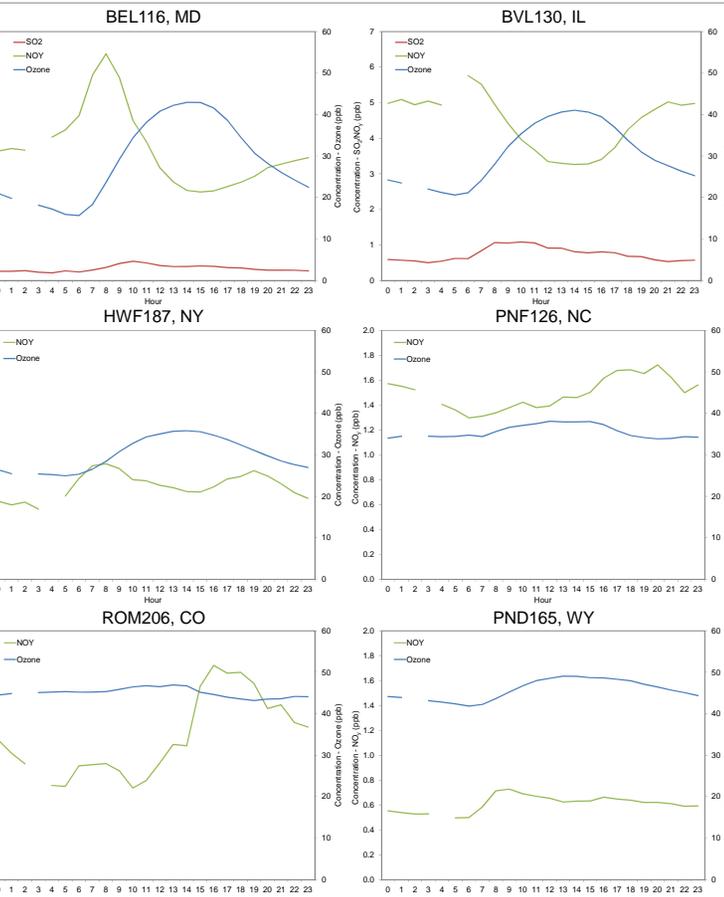
Operational Issues

Since deployment of the Teledyne API equipment, AMEC has encountered several significant issues that have impacted data completeness. AMEC is working with the manufacturer on solutions to these issues and, over the past year and half, many have been resolved resulting in improved completeness in 2014. These include replacement of several controller boards and other components that have caused disruptions in data collection. One issue of interest is Teledyne API's use of an adaptive filter to "smooth" concentrations. While key to ambient concentrations, this feature has presented challenges to performing automated QC checks and calibrations. The figure to the right shows the differences in analyzer response with and without the adaptive filter. When not in use, the analyzer responds much more rapidly.



Dealing with Analyzer Drift

Another operational issue that AMEC has dealt with is the drift in NO_y, NO, and NPN QC check results seen at several of the NO_y sites. AMEC is finding that remote calibrations and adjustments are required in between the scheduled semi-annual site visits. AMEC monitors performance of the analyzer and initiates a remote calibration when responses approach the 10% criterion for span and precision checks. The graph to the right shows an example of the drift of the NO Level 4 check.



Summary

NO_y data are used as part of the NCore program and provide information to atmospheric modelers, policy makers, and scientists studying environmental impacts. CASTNET now includes an eight site NO_y monitoring network representing an excellent range of locations from pristine to rural to suburban. Concentrations from ROM206, CO were recently used as part of the Front Range Air Pollution and Photochemistry Experiment (FRAPPE) study. Data produced from these sites may be used in the future in the development of a SO₂/NO_y secondary standard.