United States
Environmental Protection
Agency

CASTNET is a long-term, rural monitoring network used to assess the environmental results due to emission reduction programs and pollutant impacts to sensitive ecosystems and vegetation.

Clean Air Status and Trends Network (CASTNET)

PROGRAM OVERVIEW

CASTNET is a long-term environmental monitoring network with 90 sites located throughout the US and Canada. CASTNET is managed and operated by EPA's Clean Air Markets Division (CAMD) in cooperation with the National Parks Service (NPS) and other federal, state and local partners. The network was established under the 1991 Clean Air Act Amendments to assess the trends in acidic deposition due to emission reduction programs, such as the Acid Rain Program (ARP), NO_x Budget Trading Program (NBP), and the Clean Air Interstate Rule (CAIR).

CASTNET measures ambient concentrations of sulfur and nitrogen species as well as rural ozone concentrations. Results from CASTNET are used to report on geographic patterns and temporal trends in acidic pollutants, deposition and regional ozone concentrations. CASTNET is the only network in the US that provides a consistent, long-term data record of acidic dry deposition fluxes.

CASTNET compliments the National Atmospheric Deposition Program's (NADP) National Trends Network (NTN). The NTN is considered the nation's primary source of wet deposition data and provides weekly wet deposition fluxes at more than 200 sites across the contiguous US, Canada, AK, and the US Virgin Islands. Nearly all CASTNET sites are collocated or near an NTN site. Together, these two monitoring programs provide data necessary to estimate long-term temporal and spatial trends in total deposition (wet and dry) as well as ecosystem health.

RECENT CHANGES TO CASTNET

In 2010, all ozone monitors at EPA-sponsored CASTNET sites were upgraded to meet the requirements in 40 Code of Federal Regulations (CFR) Part 58 and can now be used to determine compliance with the National Ambient Air Quality Standard (NAAQS) for ozone. Hourly ozone measurements also are submitted to the AIRNow website (www.airnow.gov) and to EPA's Air Quality System (AQS) database. CASTNET ozone data will be included in the 2011–2013 ozone attainment designations.

Between 2007 and 2011, EPA and NPS deployed more than 30 NADP Ammonia Monitoring Network (AMoN) sites at CASTNET sites. AMoN sites measure bi-weekly concentrations of ambient ammonia. Results from the Community Multi-Scale Air Quality (CMAQ) model estimated CASTNET was missing 10–40% of the total nitrogen budget before the addition of AMoN.

Meteorological measurements were discontinued at all but 5 EPA-sponsored CASTNET sites in 2010 due to budget constraints. EPA used hourly meteorological data from CASTNET sites as input to the Multi-Layer Model (MLM) to estimate dry deposition velocities (Vd). EPA began using historical hourly Vd to replace missing values for hours when one or more meteorological data values was invalid or missing. For sites with discontinued meteorological parameters, EPA now uses a historical average Vd.

In 2012, the EPA and NADP began using the Parameter-elevation Regression Independent Slopes Model (PRISM) to supplement NTN precipitation measurements to create interpolated wet deposition fluxes. Previously, the NADP only used precipitation data from NTN measurements to create the annual precipitation surfaces; however, sparse monitoring locations in the Western US with variable terrain caused known biases in the results. PRISM uses point observations, elevation, and climatic factors to estimate precipitation across the US. All historical wet deposition and total deposition maps have been using these new methods.

NETWORK OPERATIONS

As of January 2013, there are 90 CASTNET sites located in or near rural areas or sensitive ecosystems in 39 states and Ontario, Canada (see Figure 1). The NPS operates 26 sites, the Bureau of Land Management (BLM) operates 4 sites in Wyoming and NY DEC/NYSERDA operates 2 sites in New York. EPA operates a collocated site at Mackville, KY and NPS operates a collocated site at Yosemite NP, CA. EPA and NPS each operate independent sites at Rocky Mountain NP, CO for network-wide precision.

Measurements

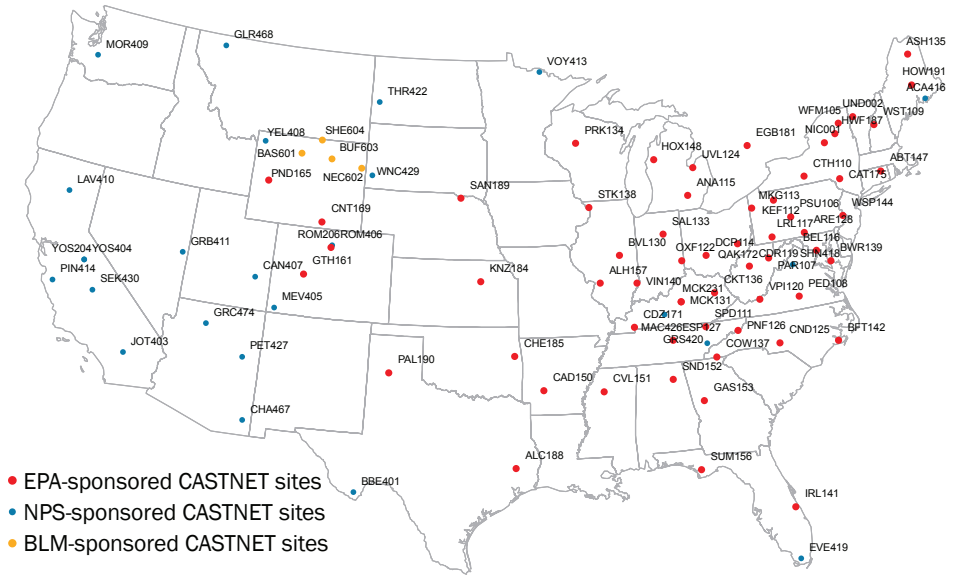
Each CASTNET site measures weekly concentrations of acidic pollutants, base cations and Cl- using a 3-stage filter pack with a controlled flow rate. Most CASTNET sites also include a temperature controlled shelter and continuous ozone monitoring system. The ozone inlet and filter pack are located atop a 10-m tower. Many sites are collocated with other monitoring networks such as NTN, AMoN, EPA's National Core Monitoring Network (NCore), and the Interagency Monitoring of Protected Visual Environments (IMPROVE).

Wet deposition is the fraction of atmospheric deposition deposited to the earth's surface by precipitation, predominately as rain, snow or cloud droplets.

Dry deposition is the fraction of atmospheric deposition that is deposited to the earth's surface by settling, impaction or adsorption.

Wet and dry deposition are combined to estimate the total deposition of pollutants (gases and particles) to the earth's surface.

Figure 1: CASTNET Site Map



January 29, 2013

Network Summary	
Number of Sites	90
Weekly Ambient Measurements	
Gaseous	Sulfur Dioxide (SO_2) Nitric Acid (HNO_3)
Particulate	Sulfate (SO_4^{2-}) Nitrate (NO_3^-) Ammonium (NH_4^+) Base Cations (Mg^{2+}, Ca^{2+}, K^+) Chloride ion (Cl^-)
Hourly Measurements	Ozone (O_3) Shelter Temperature 9-m temperature
Meteorological Parameters* (1-hour averages)	2-m Temperature Wind Speed and Direction Sigma Theta Solar Radiation Relative Humidity Precipitation Surface Wetness

*Meteorological measurements were discontinued at all but 5 EPA-sponsored CASTNET sites in 2010.

Data is polled remotely from each EPA-sponsored CASTNET site and updated daily on the CASTNET website. Data is quality assured using automated screening techniques, semi-annual calibration results, site operator comments and manual data review. Near real-time ozone data is loaded to EPA's AIRNow site. The data in AIRNow have not undergone rigorous QA checks. Final hourly ozone concentrations are reported to AQS monthly.

Direct measurement of dry deposition flux is expensive and time consuming so dry deposition fluxes (D) are calculated as the measured pollutant concentration (C) multiplied by the modeled Vd. However, alternative measurement methods are currently being developed and, once available, will be used to compare estimated dry deposition fluxes from CASTNET to direct deposition measurement results.

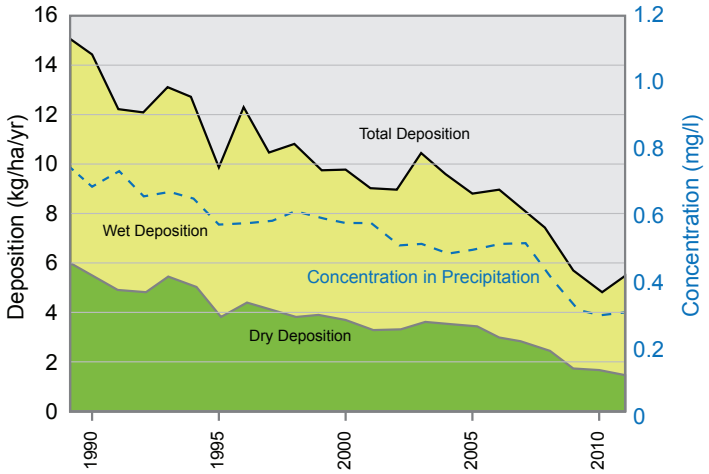
ACCOUNTABILITY AND RESULTS

Emission reduction programs such as the ARP, NBP and CAIR have led to significant reductions in sulfur and nitrogen pollutants as well as ambient ozone concentrations. The purpose of CASTNET is to quantify the environmental results of these emission reduction programs. Results of these programs are summarized in CAMD's annual reports (www.epa.gov/airmarkets/progress/progress-reports.html).

Acidic deposition

CASTNET reports on the long-term, regional trends of acid deposition. Figures 2 and 3 show the dry, wet and total deposition trends in sulfur and nitrogen deposition in the Eastern US between 1989 and 2011. The 3-year averages of total sulfur deposition decreased by 62% (13.9 kg/ha to 5.3 kg/ha) between 1989–1991 and 2009–2011 in the Eastern US. Total nitrogen deposition decreased by 31% (8.0 kg/ha to 5.5 kg/ha) over the same time period.

Figure 2: Trend in Sulfur Deposition (kg/ha/yr) with Concentration in Precipitation (mg/l) in the Eastern US



Ozone

CASTNET is the primary network for measuring rural ozone concentrations and used to assess changes in background ozone concentrations, a known indicator of climate change. The 3-year average of the 4th highest daily maximum rolling 8-hour average ozone concentration has decreased 19% be-

tween 2000–2002 (83 ppb) and 2009–2011 (67 ppb) in the Eastern US. The Western US realized a 5% reduction over the same time period (73 ppb reduced to 67 ppb). CASTNET ozone measurements will be used in non-attainment designations for the 2011–2013 monitoring season. Figure 4 shows the 3-year averages of the 4th highest daily maximum for 2009–2011 from CASTNET sites meeting the completeness criteria.

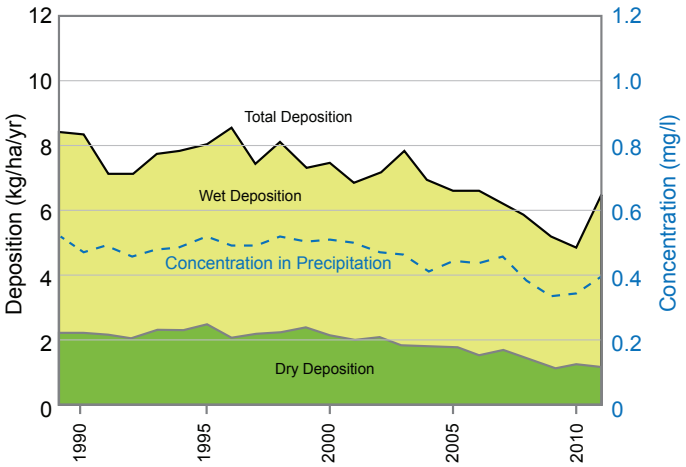
RESEARCH AREAS

Direct Deposition Measurements

CAMD has deployed an 8-inlet ozone sampling system on a 30 meter tower at the Howland AmeriFlux site to determine if this is a viable method for measuring the gradient above and below a forest canopy. Preliminary results show ozone loss at night within the canopy which is consistent with previous direct measurement techniques. In addition, filter packs were deployed within and below the forest canopy to determine if loses could be seen in a weekly integrated sample.

EPA's Office of Research and Development (ORD) is evaluating a direct deposition analyzer which can be used to validate model results.

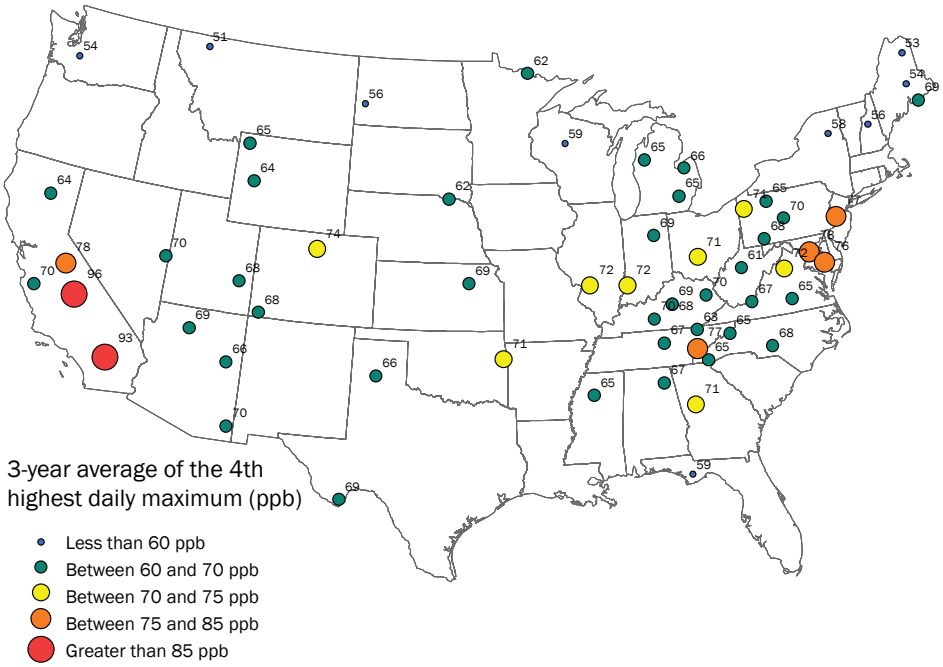
Figure 3: Trend in Nitrogen Deposition (kg/ha/yr) with Concentrations in Precipitation (mg/l) in the Eastern US



Total Deposition

CASTNET is continuing development of an improved method for estimating total deposition that uses measurement data where available and modeled results where measurements are lacking. These products will support critical loads research and help prioritize improvements in existing routine monitoring networks.

Figure 4: Three-year averages of the 4th highest daily maximum ozone concentrations (ppb) for 2009–2011



DATA AVAILABILITY

CASTNET Data: Aggregates of ambient concentrations and dry and total deposition fluxes, and site information can be downloaded from the CASTNET website under Download Data (www.epa.gov/castnet/clearsession.do). The CASTNET annual report provides long-term trends, regional patterns of pollutants and network quality assurance results. The annual report can be found under Documents and Reports (www.epa.gov/castnet/documents.do).

NADP Data: NTN wet deposition estimates and ambient NH_3 concentrations can be downloaded from the NADP website (nadp.isws.illinois.edu/).

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