Estimating Total Deposition Using NADP and CASTNET Data

Authors: Christopher M. Rogers[1], Robert Larson[2], Melissa Puchalski[3], Donna Schwede[4], Gary Lear[3], David Gay[2]

[1] Amec Foster Wheeler; [2] University of Illinois, National Atmospheric Deposition Program Office; [3] US Environmental Protection Agency, Office of Air & Radiation, Clean Air Markets Division; [4] US Environmental Protection Agency, Office of Research and Development
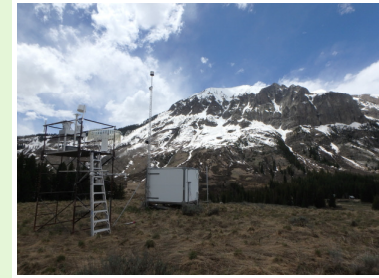
Beaufort, NC (NTN/AMoN/CASTNET)
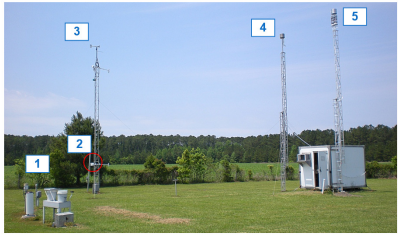
NC06/BFT142

Note: 1 NADP/NTN precipitation sampling systems
2 AMoN sampler
3 Meteorological tower
4 NO_y converter tower (part of CASTNET monitoring at select sites)
5 CASTNET filter pack tower (with special study ADS monitoring)

Gothic, CO (NTN/AMoN/CASTNET)

CO10/GTH161

References:
TDEP Fact Sheet – http://nadp.sws.uiuc.edu/committees/tdep
Schwede and Lear - A novel hybrid approach for estimating total deposition in the United States – Atmospheric Environment (2014)

For more than 40 years, efforts have been made to estimate total sulfur and nitrogen deposition in the United States using a combination of measured concentrations in precipitation and in the air, precipitation amounts for wet deposition, and various modeled or estimated deposition velocities for dry deposition. Long-term monitoring of sulfur and nitrogen pollutants has provided program accountability under the Clean Air Act Amendments and other EPA emission reduction programs. Initially, interest in deposition resulted from the focus on acid rain and the impacts on property and ecosystems from this phenomenon, which was dominated by sulfur species. Ambient sulfur concentrations and deposition have decreased dramatically in the Eastern United States (~60% and ~85%, respectively) between 1990 and 2013. Reductions in nitrogen species have been less dramatic and associated deposition and ecosystem impacts, ncluding critical loads applications, have gained more interest within the scientific community.

The National Atmospheric Deposition Program (NADP) has operated the National Trends Network (NTN) since 1978 and the Atmospheric Integrated Research Monitoring Network (AIRMoN) since 1992. Both networks measure concentrations of anions and cations in precipitation and use precipitation amounts to calculate wet deposition. NTN currently features more than 250 sites measuring weekly concentrations and AIRMoN has seven sites measuring event-based concentrations. In 2007, NADP added the Ammonia Monitoring Network (AMoN) to measure ambient concentrations of ammonia.
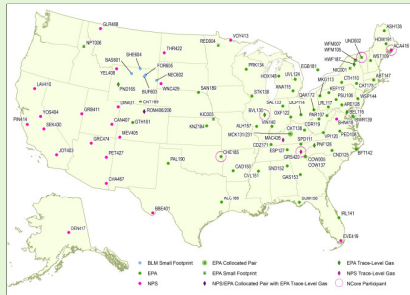
The Clean Air Status and Trends Network (CASTNET) was established in 1987 to assess trends in ambient air quality and deposition of acidic pollutants due to emission reduction programs. CASTNET currently operates more than 90 sites. CASTNET uses a filter pack and active flow system to measure weekly integrated ambient air samples of species similar to those measured by NADP. CASTNET methodology includes combining concentrations with estimated, modeled deposition velocities to calculate dry deposition of gases and particles.

Numerous methods have been employed using NADP and CASTNET data to estimate total deposition. Ideally, the two networks act as sister networks, each providing part of the total deposition. NADP initially used precipitation amounts from onsite raingages only, but currently incorporates Parameter-elevation Relationships on Independent Slopes Model (PRISM) modeled precipitation amounts to allow for improved resolution between site locations and in complex terrain. CASTNET has historically used the Multi-layer model (MLM) to estimate deposition velocities to get point estimates of dry deposition. For sulfur species, combining the NADP and CASTNET wet and dry deposition estimates was an adequate method. However, the increased interest in nitrogen deposition showed that this method was missing key components of total nitrogen deposition including ammonia dry deposition, organic nitrogen in both wet and dry deposition, and the dry deposition of other non-measured species (i.e. NO_2, HONO, PAN).
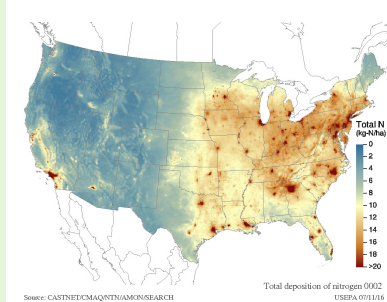
Current NADP Sites
(NTN 269, AMoN 103, AIRMoN 7 sites)
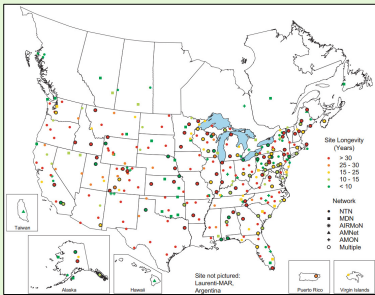
Current CASTNET Sites
(95 sites)

Total Nitrogen Deposition: 2000-2002

Total Nitrogen Deposition: 2012-2014

Pct of Total Nitrogen Deposition from Dry Deposition: 2012-2014
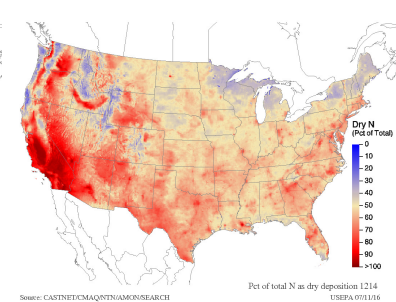
Total Sulfur Deposition: 2000-2002

Total Sulfur Deposition: 2012-2014

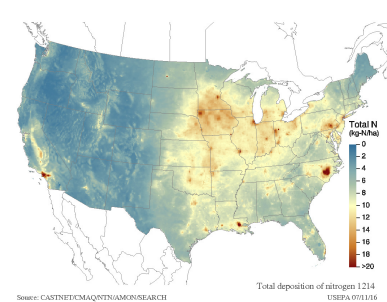**Pct of Total Sulfur Deposition from Dry Deposition: 2012-2014**

Recently, the NADP Total Deposition Science Committee (TDEP) has developed a hybrid method combining the measurements of NADP, CASTNET, and SouthEastern Aerosol Research and Characterization (SEARCH) with the model output from EPA's Community Multiscale Air Quality (CMAQ) model to provide continuous spatial and temporal estimates of total deposition. Modeled estimates provide non-measured pollutants and improve the understanding of the complicated processes that make up total deposition estimates.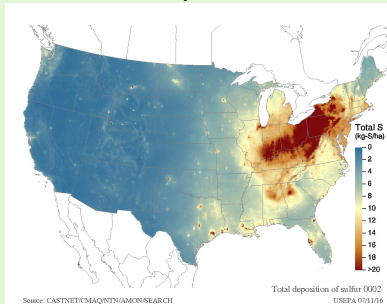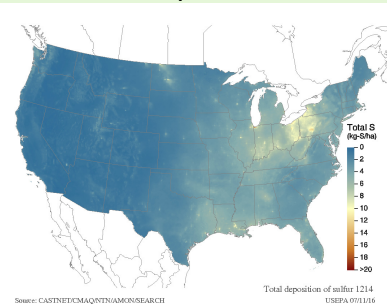 Examples of the hybrid method are shown to the right.