Clean Air Status and Trends Network (CASTNET)

Monitoring and Assessing the Effectiveness of Air Pollution Control Policies

Under several different mandates, the United States Environmental Protection agency (EPA) assesses the effectiveness of air pollution control efforts. These mandates include Title IX of the Clean Air Act Amendments (CAAA), the National Acid Precipitation Assessment Program (NAPAP), the Government Performance and Results Act, and the U.S. Canada Air Quality Agreement. One measure of effectiveness is whether sustained reductions in the amount of atmospheric deposition over broad geographic regions are occurring. However, changes in the atmosphere happen very slowly and trends are often obscured by the wide variability of measurements and climate. Numerous years of continuous and consistent data are required to overcome this variability, making long-term monitoring networks especially critical for characterizing deposition levels and identifying relationships among emissions, atmospheric loadings, and effects on human health and the environment. Using consistent procedures and quality-assured practices are important for observing long-term and significant changes in atmospheric composition. The landscape of air-quality and deposition monitoring networks provides a vital mechanism for determining how effective ongoing emission control policies and new regulatory approaches are in improving air quality and protecting the environment.

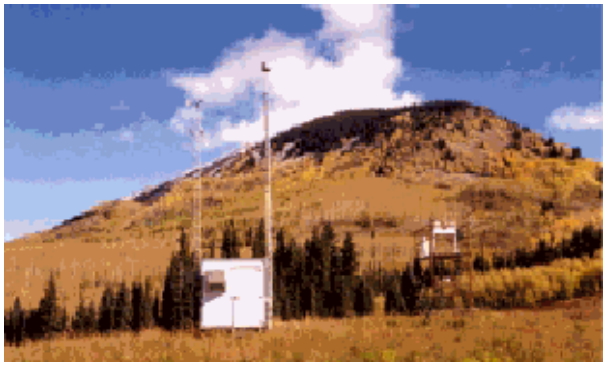
Primary Air-Quality and Atmospheric Deposition Monitoring Networks

The Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP) were developed to monitor dry and wet acid deposition, respectively. Monitoring site locations are predominantly rural by design to assess the relationship between regional pollution and changes in regional patterns in deposition. CASTNET also includes measurements of rural ozone and the chemical constituents of PM 2.5. Rural monitoring sites of NADP and CASTNET provide data where sensitive ecosystems are located and provide insight into natural background levels of pollutants where urban influences are minimal. These data provide needed information to scientists and policy analysts to study and evaluate numerous environmental effects, particularly those caused by regional sources of emissions for which long range transport plays an important role. Measurements from these networks are also important for understanding non-ecological impacts of air pollution such as visibility impairment and damage to materials, particularly those of cultural and historical importance.

Clean Air Status and Trends Network

In 1986, EPA established the National Dry Deposition Network (NDDN) to obtain field data on rural deposition patterns and trends at different locations throughout the United States. The network consisted of 50 monitoring sites that derived dry deposition based on measured air pollutant concentrations and modeled dry deposition velocities estimated from meteorology, land use, and site characteristic data. In 1990, amendments to the Clean Air Act necessitated a long-term, national program to monitor the status and trends of air pollutant emissions, ambient air quality, and pollutant deposition. In response, EPA in cooperation with the National Oceanic Atmospheric Administration (NOAA), created CASTNET from NDDN.

CASTNET provides atmospheric data on the dry deposition component of total acid deposition, ground-level ozone and other forms of atmospheric pollution. CASTNET is considered the nation's primary source for atmospheric data to estimate dry acidic deposition and to provide data on rural ozone levels. Used in conjunction with other national monitoring networks, CASTNET can help determine the effectiveness of national emission control programs. Established in 1987, CASTNET now comprises over 70 monitoring stations across the United States. The longest data records are primarily at eastern sites. EPA's Office of Air and Radiation operates a majority of the monitoring stations; however, the National Park Service operates approximately 30 stations in cooperation with EPA .



Each CASTNET dry deposition station measures:

- weekly average atmospheric concentrations of sulfate, nitrate, ammonium, sulfur dioxide, and nitric acid.
- hourly concentrations of ambient ozone levels.
- meteorological conditions required for caclulating dry deposition rates.

Dry deposition rates are calculated using atmospheric concentrations, meteorological data, and information on land use, vegetation, and surface conditions. CASTNET complements the database compiled by NADP. Because of the interdependence of wet and dry deposition, NADP wet deposition data are collected at all CASTNET sites. Together, these two long-term databases provide the necessary data to estimate trends and spatial patterns in total atmospheric deposition.

CASTNET Methods

Atmospheric concentration data are collected at each site with open-faced, 3-stage filter packs. The filter pack contains a teflon filter for collection of particulate species, a nylon filter for nitric acid and a base-impregnated cellulose (Whatman) filter for sulfur dioxide. Filter packs are exposed for 1-week intervals (i.e., Tuesday to Tuesday) at a flow rate of 1.5 liters per minute (3.0 liters per minute for western sites), and sent to the Harding ESE, Gainesville, FL laboratory for chemical analysis.

The teflon filter is extracted in deionized water with sonication and shaking, then analyzed for sulfate, nitrate and ammonium ions. Nylon filters are extracted in IC eluent with 0.05 percent hydrogen peroxide and then analyzed for sulfate and nitrate. The Whatman filter is extracted in deionized water with 0.05 percent hydrogen peroxide and analyzed for sulfate and nitrate. Atmospheric concentrations are then calculated based on the mass of analyte in each filter extract and the volume of air sampled. The sulfate, nitrate and ammonium in teflon filter extract are interpreted as particulate species (listed below as TSO4, TNO3 and TNH4, respectively). The nitrate in the nylon filter extract is interpreted as nitric acid (listed below as NHNO3). The sum of sulfate in the nylon and cellulose filter extracts is interpreted as sulfur dioxide (listed below as SO2). Nitrate in cellulose filter extracts is not interpreted, since it likely represents a host of oxidized nitrogen species.

National Atmospheric Deposition Program

The NADP was initiated in the late 1970s as a cooperative program between federal and state agencies, universities, electric utilities, and other industries to determine geographical patterns and trends in precipitation chemistry in the United States. Collection of weekly wet deposition samples began in 1978. The size of the NADP Network grew rapidly in the early 1980s when the major research effort by the NAPAP called for characterization of acid deposition levels. At that time, the network became known as the NADP/NTN (National Trends Network). By the mid-1980s, the NADP had grown to nearly 200 sites where it stands today as the longest running national atmospheric deposition monitoring network.

The NADP analyzes the constituents important in precipitation chemistry, including those affecting rainfall acidity and those that may have ecological effects. The NTN measures sulfate, nitrate, hydrogen ion (measure of acidity), ammonia, chloride, and base cations (calcium, magnesium, potassium). To ensure comparability of results, laboratory analyses for all samples are conducted by the NADP's Central Analytical Lab at the Illinois State Water Survey. A new subnetwork of the NADP, the Mercury Deposition Network (MDN), measures mercury in precipitation.

State/Local/National Air Monitoring Stations

Ozone data collected by CASTNET are complementary to the larger ozone data sets gathered by the State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS) networks. Most air quality samples at SLAMS/NAMS sites are located in urban areas, while CASTNET sites are in rural locations. Hourly ozone measurements are taken at each of the 50 sites operated by EPA. Data from these sites provide information to help characterize ozone transport issues and ozone exposure levels.

Interagency Monitoring of Protected Visual Environments

The Interagency Monitoring of Protected Visual Environments (IMPROVE) is a collaborative monitoring program to establish present visibility levels and trends and to identify sources of anthropogenic impairment. The National Park Service and U.S. EPA are the lead funding agencies for the IMPROVE Network. IMPROVE began with 20 long-term monitoring sites in 1987, and currently is expanding to encompass 108 sites in parks and wilderness areas across the United States.