



Air Quality Monitoring Protocol

Arctic Network Vital Signs Monitoring Program

Natural Resource Report NPS/ARCN/NRR—2012/552



ON THE COVER

ARCN Air Quality Monitoring Station AK06

Photograph courtesy of Gates of the Arctic National Park & Preserve

Air Quality Monitoring Protocol

Arctic Network Vital Signs Monitoring Program

Natural Resource Report NPS/ARCN/NRR—2012/552

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Acronyms

ARCN: Arctic Network Vital Signs Program
ARD: Air Resources Division
 Ca^{2+} : Calcium
CAL: Central Analytic Laboratory
 Cl^- : Chloride
CVAFS: Cold Vapor Atomic Fluorescent Detection System
EPA: Environmental Protection Agency
FGS: Frontier GeoSciences Inc.
GPMP: Gaseous Pollutant Monitoring Program
GPRA: Government Performance and Results Act
HAL: Mercury Analytical Laboratory
HDPE: High-Density Polyethylene
IMPROVE: Interagency Monitoring of Protected Visual Environments Network
 K^+ : Potassium
MADE: Mercury Atmospheric Deposition and Emissions
MDN: National Atmospheric Deposition/Mercury Deposition Network
 Mg^{+} : Magnesium
MOF: Mercury Observer Form
 Na^+ : Sodium
NADP: National Atmospheric Deposition Program
NADP/NTN: National Atmospheric Deposition/National Trends Network
 NH_4^+ : Ammonium
NM: National Monument
 NO_3^- : Nitrate
NOS: Network Operation Subcommittee
NP: National Park
NP&Pres: National Park and Preserve
NPRES: National Preserve
NPS: National Park Service
PDA: Personal Digital Assistant
PM; Particulate Matter
 $\text{PM}_{2.5}$: Particulate Matter (with aerodynamic diameter less than $2.5\mu\text{m}$)
 PM_{10} : Particulate Matter (with aerodynamic diameter less than $10\mu\text{m}$)
 PO_4^{3-} : Orthophosphate
QAP: Quality Assurance Plan
RTI: Research Triangle Institute
 SO_4^{2-} : Sulfate
SOP: Standard Operating Procedure
TOR: Thermal Optical Reflectance
WACAP: Western Airborne Contaminants Assessment Project

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PROTOCOL NARRATIVE

Version 1.0 (August, 2010)

The following table lists all changes that have been made to the protocol narrative since the original publication date. Any recommended or required changes added to the log must be complete and concise and promptly brought to the attention of the Project Leader. The Project Leader will review and incorporate all changes, officially complete the revision history log, and change the date and version number on the title page. For complete instructions, please refer to Instructions for Recording Revisions in SOP XX.

Revision History Log:

New Version #	Previous Version #	Revision Date	Author (full name, title, affiliation)	Location in Document and Description of Change	Reason for Change

Overview

This document is intended to provide guidance to natural resource managers and site operators who currently monitor, or are considering monitoring, air quality. The document describes air quality monitoring for wet deposition and regional haze in the Arctic Network Vital Signs Program; the types of data provided by monitoring; requirements for station siting, operation, and data handling. Managers are strongly urged to contact the Arctic Inventory and Monitoring Network Coordinator for additional guidance on air quality monitoring.

Background

Atmospheric deposition is the process by which airborne particles and gases are deposited to the earth's surface. This occurs either through precipitation, known as wet deposition, such as rain, snow, clouds, and fog or dry deposition which is a result of complex atmospheric processes such as sedimentation, impaction, and adsorption.

In general the processes of wet deposition are readily understood. Those of dry deposition can be described as follows. Sedimentation is where particles deposit from the atmosphere due to gravitation. The process of sedimentation is important in the dry deposition of sulfur and nitrogen acids, when the acids are first transformed chemically into gases and salts, before depositing under the influence of gravity. Sulphur dioxide, for example, is deposited as a gas and as a salt. Impaction is when small particles, interfacing a bigger obstacle, are not able to follow the curved streamlines of the air flow due to their inertia, so they hit or impact the obstacle. Adsorption is the process of attraction of airborne particles or gasses to an exposed surface of another particle.

Atmospheric deposition can include a wide variety of natural and anthropogenic pollutants including inorganic elements and compounds (e.g., nitrogen, sulfur, basic cations, mercury and other metals) and organic compounds (e.g., pesticides and herbicides). Once deposited, pollutants can have a variety of ecosystem effects. Nitrogen and sulfur compounds, for example, can result in acidification of freshwaters, loss of aquatic species, eutrophication of estuarine and near-coastal waterways, soil nutrient and base cation leaching, and vegetation changes.

Regional haze is air pollution that travels long distances and reduces visibility. This haze is composed of small particles that absorb and scatter light, affecting the clarity and color of what we see. Sources of haze are both urban and rural, such as motor vehicles, power plants, industrial and manufacturing processes, burning of vegetation and debris, as well as natural sources such as wildfire and windblown dust.

The National Park Service (NPS) is responsible for the protection and conservation of the areas it manages in order to “leave them unimpaired for the enjoyment of future generations” (Organic Act of 1916). NPS also has an affirmative responsibility under the Clean Air Act to protect parks and their resources from sources of air pollution, and to participate in national and regional initiatives to control air pollution.

Since the late 1970s, the NPS Air Resources Division (ARD) has managed a comprehensive air quality program, emphasizing the collection of credible air quality information to support scientifically sound resource management decisions in parks. In general, air quality monitoring

in parks, including monitoring of atmospheric deposition, ozone, and visibility, is done in conjunction with a variety of multi-partner national networks. Information on NPS air quality monitoring and access to data from individual sites is available at <http://www2.nature.nps.gov/air/monitoring/index.cfm>. Cooperation between NPS and the national air quality monitoring networks has been successful in producing high quality, defensible data that are spatially and temporally comparable, ARD also provides a broad context for an individual park's air quality data. It is strongly recommended that resource managers considering long-term air quality monitoring adopt this cooperative approach, because partnerships with national monitoring networks use limited funding more effectively and provide a more complete database on which to base air quality management decisions.

Monitoring data show that air pollution is affecting park resources nationwide. Therefore, consistent with the Government Performance and Results Act (GPRA), the NPS has established three air quality goals to meet by September 30, 2012:

Visibility in 95% of NPS reporting parks has remained stable or improved; ozone in 89% of NPS reporting parks has remained stable or improved; and atmospheric deposition in 79% of NPS reporting parks has remained stable or improved.

The ARD air resource management program uses several indicators to measure progress. One indicator looks at visibility trends on the clearest and haziest days. Another tracks changes in ozone concentrations based on the 3-year average of the annual fourth highest daily maximum 8-hour concentration. The final indicator focuses on wet deposition of sulfate, nitrate, and ammonium ions. An air quality program meets each of the above goals if it does not show statistically significant deterioration in any of the performance indicators used for individual goals during the most recent 10-year period for which data is available.

Certain resource management and research questions may be answered by short-term or episodic monitoring with methods outside the scope of this protocol. Such air quality monitoring and research activities by agency and university scientists can allow for a better understanding of ecosystems and how they might be affected by air pollution. Methodologies used for short-term monitoring will be developed and applied on a case by case basis and are outside the scope of this document.

One recent study, the Western Airborne Contaminants Assessment Project (WACAP; Landers et al. 2008), was initiated to determine the risk to ecosystems and food webs in western National Parks from the long-range transport of airborne contaminants. It was designed and implemented by the NPS's ARD in cooperation with many western National Parks, the Environmental Protection Agency (EPA), the US Geological Survey, the US Forest Service, Oregon State University, and University of Washington. The project objectives were: determine if contaminants are present in western National Parks; if present, determine where contaminants are accumulating (geographically and by elevation); if present, determine which contaminants pose a potential ecological threat; determine which indicators appear to be the most useful to address contamination, and; determine the sources for contaminants measured at the national park sites. More information and downloadable copies of the WACAP report are available at http://www.nature.nps.gov/air/studies/air_toxics/wacap.cfm.

The Arctic Network Vital Signs Program (ARCN) encompasses five national park units in western Alaska: Bering Land Bridge National Preserve (BELA), Cape Krusenstern National Monument (CAKR), Noatak (NOAT), Kobuk Valley National Park (KOVA), and Gates of the Arctic National Park and Preserve (GAAR). Much of the ARCN is wilderness or proposed wilderness, together the units comprise approximately 25% of the land area managed by the NPS.

In ARCN, park's airborne contaminants have the potential to affect biota and degrade visibility. Nonvascular plants (e.g., lichens, bryophytes, algae), fungi, soil arthropods and terrestrial and aquatic invertebrates are particularly sensitive to airborne contaminants (Hasselbach et al. 2005). In addition, ecosystems with low buffering capacity or areas with high pollution loads are at increased risk for damage. Generally speaking, forest ecosystems, high altitude environments, freshwater ecosystems, peatlands, barrens and areas dominated by lichen cover are highly susceptible to the numerous forms of air contaminants listed above. Air pollution also has the potential to biomagnify in the food chain with implications for top predators and subsistence hunters. The WACAP study, for example, reported that the average mercury concentration in lake trout (*Salvelinus namaycush*) exceeded the health threshold for human consumption at Burial Lake in Noatak, and some individual fish exceeded the human health threshold at Matcharak Lake in Gates of the Arctic.

Good visibility is essential to the enjoyment of national parks and scenic areas. The Clean Air Act contains a national goal of improving visibility in these areas. To meet this goal, the Environmental Protection Agency (EPA) adopted the Regional Haze Rule in July 1999 to reduce human-caused air pollution from multiple sources over broad geographic areas. The aim is to improve visibility over the next 60 years in 156 national parks and wilderness areas (known as "Class I" areas). The rule requires states to develop new, long-term strategies and demonstrate these strategies will make reasonable progress in improving Class I visibility on the haziest days (the worst 20%), and ensure no degradation on the clearest days (the best 20%). These strategies must address the transport of haze across state boundaries as well.

All of the ARCN park units are Class II air quality areas under the Clean Air Act. Air pollution sources in the ARCN include arctic haze, caused primarily by trans-Pacific transport of air pollutants including mercury and other toxics. In addition, mining activities contribute to local air pollution, with the world's largest zinc mine located just outside of NOAT. Mining trucks transport the ore through CAKR to a seaport, further affecting air quality (Brumbaugh & May 2008) by releasing metal laden dust into the air.

Class 1 airsheds are given the most protection from human caused air pollution in order to protect their pristine character. Class II airsheds allow for a greater amount of human caused pollution.

ARCN currently operates an ARD supported air quality monitoring site in Bettles, Alaska to monitor air quality in the network. Although Bettles is not within any of the ARCN parks it was chosen due to reliable power, year-round staffing and its location on the south side of the Brooks Range, representative of the bulk of the network's airshed.

This protocol addresses monitoring of wet deposition of contaminants and regional haze for ARCN in collaboration with the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), the National Atmospheric Deposition Program/Mercury Deposition Network (MDN), and the Interagency Monitoring of Protected Visual Environments Network (IMPROVE). Each nationwide air quality monitoring network establishes its own standardized sampling and analytical methods, which are peer reviewed during program development, and have subsequent periodic reviews. Subsequent sampling and method changes are reviewed by scientists from all agencies represented in the networks, generally through formal steering committee participation. The various national air quality network protocols, therefore, serve as the park air quality monitoring protocols (Table 1), and are referenced in the Appendices of this document.

Table 1. Lists the three nationwide networks that monitor air quality in ARCN.

Atmospheric Deposition Monitoring Networks Network	Measured Parameters	Information and Data
National Atmospheric Deposition Program/National Trends Network (NADP/NTN)	Wet deposition of sulfate, nitrate, ammonium, calcium, magnesium, potassium, sodium, chloride; pH, acidity	http://nadp.sws.uiuc.edu/
National Atmospheric Deposition Program/Mercury Deposition Network (MDN)	Wet deposition of mercury	http://nadp.sws.uiuc.edu/mdn/
Interagency Monitoring of Protected Visual Environments Network (IMPROVE)	Fine and total aerosol mass	http://vista.cira.colostate.edu/improve/

NADP/NTN began operation in 1978 and currently consists of over 240 stations nationwide. Samples are collected using a standardized protocol and are analyzed in a central laboratory using uniform techniques and procedures. The network provides information based on weekly precipitation samples that are analyzed for several chemical constituents, such as acidity (pH), sulfate, nitrate, ammonium, chloride, calcium, magnesium, potassium, and sodium. Data are presented in terms of concentration and deposition. Concentration data, expressed in milligrams per liter (mg/L) of precipitation are useful in determining spatial and temporal trends because they are not dependent on the amount of precipitation at each site, which can vary substantially from year to year. Wet deposition, expressed in kilograms per hectare per year (kg/ha/yr) is calculated by taking into account both the amount of precipitation and the concentration at each location. Years with higher amounts of precipitation will yield higher levels of wet deposition. Wet deposition data provide the total amount of pollutants actually deposited on the ground by rain and snow and quantify the pollutant input to ecosystems.

The IMPROVE is a cooperative monitoring effort governed by a steering committee composed of representatives from Federal and regional-state organizations. The IMPROVE monitoring program was established in 1985 to inform the creation of federal and state implementation plans for the protection of visibility in Class I areas (156 national parks and wilderness areas) as stipulated in the 1977 amendments to the Clean Air Act. The objectives of IMPROVE are: (1) to establish current visibility and aerosol conditions in mandatory class I areas; (2) to identify

chemical species and emission sources responsible for existing man-made visibility impairment; (3) to document long-term trends for assessing progress towards the national visibility goal; (4) and with the enactment of the Regional Haze Rule, to provide regional haze monitoring representing all visibility-protected federal class I areas where practical. IMPROVE has also been a key participant in visibility-related research, including the advancement of monitoring instrumentation, analysis techniques, visibility modeling, policy formulation and source attribution field studies.

The MDN is the mercury wet-deposition monitoring arm of the NADP. The MDN is the only network providing a long term record of total mercury (Hg) concentration and deposition in precipitation in the United States and Canada. Since January 1996, Frontier GeoSciences Inc. (FGS) has served as the Mercury Analytical Laboratory (HAL) and Site Liaison Center for the MDN. The MDN, coordinated through the NADP, was designed with the primary objective of quantifying the wet deposition of mercury in North America to determine long-term geographic and temporal distributions. The network has grown to incorporate over 95 sites in North America.

Objectives

ARCN

Determine the main components of air pollution within ARCN parks through participation in the NADP/NTN, MDN and IMPROVE national networks by monitoring arctic haze, and weekly levels of pH, sulfate, nitrate, ammonium, chloride, calcium, magnesium, potassium, sodium, and mercury in precipitation.

Determine the status and trends in air quality parameters as set forth in the NADP/NTN, MDN and IMPROVE national network monitoring protocols for the ARCN Parks.

Nationwide NPS Air Quality Monitoring Program

Determine levels of air pollutants in parks and correlate to observed effects.

Identify and assess trends in air quality.

Determine compliance with National Ambient Air Quality Standards.

Provide data for the development and revision of national and regional air pollution control policies.

Provide data for atmospheric model development and evaluation.

Use information to inform the public about conditions/trends in national parks.

Determine which air pollutants in parks contribute to visibility impairment.

Sampling Design

ARCN's wet deposition air quality monitoring will be administered and guided by ARD as part of its national wet deposition sampling protocol

(<http://www.nature.nps.gov/air/Pubs/all.cfm?CFID=13482942&CFTOKEN=45314566>). The specific air quality sampling for ARCN's ARD station in Bettles is outlined in the following sections.

Site Selection

The current ARCN air quality site was chosen based on criteria provided by the NADP and following consultation with staff of the NADP. If additional air quality sites are added to the ARCN, site selection will follow the NADP Site Selection and Installation Manual (<http://nadp.sws.uiuc.edu/lib/manuals.aspx>). Sites will be classified based on the population density within 15km of the site. Exceptions to siting criteria require approval of the QA Manager, the NADP Network Operation Subcommittee (NOS) Chair, and the NOS Vice Chair. All sites should endeavor to meet NADP siting criteria on a continual basis. Compliance with siting criteria will be documented as part of the Site Systems and Performance Survey program. Each site in an NADP network will be surveyed once every 3-4 years by an independent contractor as part of the quality assurance program.

Sampling Networks

NADP/NTN

The objective of the NADP/NTN protocols is to monitor weekly levels of pH, sulfate, nitrate, ammonium, chloride, calcium, magnesium, potassium, and sodium in precipitation. Samples are collected continuously in a wet deposition collector. The collector opens automatically during wet weather, allowing precipitation to fall into a collection bucket, and then closes as soon as the precipitation stops. The National Trends Network Site Operation Manual (<http://nadp.sws.uiuc.edu/lib/manuals.aspx>) discusses the sampling design in detail.

IMPROVE

The IMPROVE network monitors the chemical composition and mass of coarse (PM₁₀) and fine (PM_{2.5}) particulate matter in the air that contributes to Arctic Haze. The IMPROVE aerosol sampling site has a controller and four sampling modules, though the number of sampling modules can vary from 1 to 4 depending on the sampling requirements at the site. The modules run in parallel; the controller sends the same signals to each module. The four standard module types are designated A, B, C, and D. Module A collects fine particles (0 - 2.5 µm) on a stretched Teflon filter, and provides data on elemental composition of fine particles. Module B collects fine particles (0 - 2.5 µm) on a nylon filter, has a denuder before the nylon filter to remove acidic gases, and is used primarily for nitrate, though sulfate and chlorine data are also provided. Module C collects fine particles (0 - 2.5 µm) on a quartz fiber filter to measure organic and elemental carbon. Module D collects coarse particles (0 - 10 µm) on a stretched Teflon filter, and provides data on PM₁₀ mass loading, which is a weight analysis of the total amount of PM₁₀ particles accumulated on the filter. The Module D Teflon filter is followed by a quartz filter impregnated with K₂CO₃, used to collect SO₂ gas. Each module is independent, with a separate inlet, sizing device, flow measurement system, critical orifice flow controller, and pump. All modules are connected to a common controller clock which, for IMPROVE protocol sampling, is

programmed to collect samples every three days on the EPA-designated schedule. The samples are collected over 24 hours, starting at midnight, according to the local time convention (i.e., standard time or daylight saving time, as appropriate). The sampler will automatically change to and from daylight saving time, when necessary. The IMPROVE Standard Operating Procedure SOP 201 Version 3 (SOP 201-3) Sampler Maintenance by Site Operators (<http://vista.cira.colostate.edu/improve/Publications/publications.htm>) discusses the sampling design in detail.

MDN

Levels of Hg in precipitation are monitored weekly through participation in the MDN. Samples are collected in a wet deposition collector. The collector opens automatically during wet weather, allowing the precipitation to fall into the collector, and then closes as soon as the precipitation stops. All MDN sites follow standard procedures (<http://nadp.sws.uiuc.edu/lib/manuals.aspx>) and have uniform precipitation chemistry collectors and gages. The automated collector has the same basic design as the NADP/NTN collector but is modified to preserve mercury. Modifications include a glass funnel, connecting tube, bottle for collecting samples, and an insulated enclosure to house this sampling train. The funnel and connecting tube reduce sample exposure to the open atmosphere and limit loss of dissolved mercury. As an additional sample preservation measure, the collection bottle is charged with 20 mL of a one percent hydrochloric acid solution. The MDN Standard Operating Procedure Glass Sample Train Collection and Deployment-Trace Metal Clean Sample Handling (<http://nadp.sws.uiuc.edu/lib/manuals.aspx>) discusses the sampling design in detail.

Rain Gauge

The site also contains an ETI NOAH IV rain gauge, to measure the amount of precipitation and record when the precipitation collector is in sampling mode. Rainfall is recorded to the nearest 0.01 in. The rain gauge also monitors the wet deposition collectors, recording whether the collectors were properly open during wet periods and closed during dry periods. The Procedures for downloading rain gauge data using IPAG 110 PDA (Appendix A) discusses the rain gauge sampling design in detail.

Methods

Field Methods

NADP/NTN

In general, every Tuesday morning at 0900 local time the site operator changes the sample collection bucket, checks the rain gauge, downloads the data onto a personal digital assistant (PDA), completes a field observer report form, weighs and packages the sample, mails the sample to the NADP Central Analytical Laboratory, and emails the rain gauge data to the NADP Central Analytical Laboratory. These procedures take approximately 30-60 minutes, which does not include travel time to the site. The National Trends Network Site Operation Manual (<http://nadp.sws.uiuc.edu/lib/manuals.aspx>) and the Bettles Air Quality Station NADP/NTN Sampling Field Guide (Appendix B) discuss the site operation and sampling procedures in detail.

IMPROVE

The sample cartridges must be changed every Tuesday. It takes approximately fifteen minutes to change the sample cartridges. Because the sampler operates every 3 days, for two of every three Tuesday sample changes, the sampler will not be actively collecting samples. For one of every three Tuesday sample changes, the sampler will be actively collecting samples, and the sampling will have to be interrupted to change the sample cartridges. The procedures required to change the cartridges on sampling day are slightly more complicated than on the non-sampling days. The IMPROVE Standard Operating Procedure SOP 201 Version 3 (SOP 201-3) Sampler Maintenance by Site Operators (<http://vista.cira.colostate.edu/improve/Publications/publications.htm>) and the Bettles Air Quality IMPROVE Sampling Field Guide (Appendix C) discuss the sampling protocol in detail.

MDN

Every Tuesday morning at 0900 local time the site operator retrieves the previous weeks Hg (Mercury) wet deposition sample bottle, replaces the thistle tube assembly, packages the sample, completes the MDN Observer Form (MOF) for the previous weeks sample, replaces the sample collection bottle, and starts the next week's MOF, and mails the sample to FGS. These procedures take approximately 30-60 minutes, which does not include travel time to the site. The MDN Standard Operating Procedure Glass Sample Train Collection and Deployment-Trace Metal Clean Sample Handling ([Http://nadp.sws.uiuc.edu/lib/manuals.aspx](http://nadp.sws.uiuc.edu/lib/manuals.aspx)) and the Bettles Air Quality MDN Sampling Field Guide (Appendix D) discuss the site operating procedure in detail.

Laboratory Methods

NADP/NTN

NTN samples are continuously received at the Central Analytic Laboratory (CAL) for analysis. Upon receipt, the NTN samples are filtered into pre-washed 60-mL high-density polyethylene (HDPE) round bottles using 0.45 micrometer (μm) pore-size polyethersulfone filters. Conductivity and pH are measured on an unfiltered aliquot. After the NTN samples are filtered, there is no specified order of analysis (Table 2). For more details on NTN sample handling and analyses see the CAL QAP (<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>) and the laboratory SOPs (available upon request from the NADP). Additional information regarding Quality Assurance /

Quality Control (QA/QC) protocols, and Data acquisition and handling can be found in the NADP Quality Management Plan (<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>) and the Quality Assurance Plan (<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>).

Table 2. Analytes, Instrumentation, for NTN 2008

Analyte	Instrument
Calcium (Ca ²⁺)	Inductively Coupled Plasma-Optical Emission Spectrometer
Potassium (K ⁺)	Inductively Coupled Plasma-Optical Emission Spectrometer
Magnesium (Mg ⁺)	Inductively Coupled Plasma-Optical Emission Spectrometer
Sodium (Na ⁺)	Inductively Coupled Plasma-Optical Emission Spectrometer
Ammonium (NH ₄ ⁺)	Phenate (Flow Injection Colorimetry)
Orthophosphate (PO ₄ ³⁻)	Ascorbic Acid (Flow Injection Colorimetry)
Chloride (Cl ⁻)	Ion Chromatography, Dionex
Nitrate (NO ₃ ⁻)	Ion Chromatography, Dionex
Sulfate (SO ₄ ²⁻)	Ion Chromatography, Dionex
pH	pH meter / Combination Electrode
Conductivity	Conductivity meter

IMPROVE

The laboratory methods for the standard IMPROVE sampler containing four sampling modules (modules A – C), are listed below. For more details regarding the laboratory methods see the IMPROVE Quality Assurance Project Plan (<http://vista.cira.colostate.edu/improve/Publications/publications.htm>) Specific laboratory SOPs are available at <http://vista.cira.colostate.edu/improve/Publications/SOPs/ucdsop.asp>.

Module A collects PM_{2.5} particles on Teflon filters. These filters are analyzed by four methods at UC Davis:

- a. gravimetric analysis for PM_{2.5} mass,
- b. hybrid- integrating plate and sphere (HIPS) for optical absorption,
- c. proton elastic scattering (PESA) for hydrogen, and
- d. x-ray fluorescence for elements: sodium (Na) and lead (Pb).

Module B collects PM_{2.5} particles on nylon filters. A denuder before the nylon filter removes nitric acid and sulfur dioxide vapors. These filters are analyzed by ion chromatography for nitrate, chloride, sulfate and nitrite by Research Triangle Institute (RTI).

Module C collects PM_{2.5} particles on quartz filters. These filters are analyzed for organic and elemental carbon using Thermal Optical Reflectance (TOR) by Desert Research Institute (DRI).

Module D collects PM₁₀ particles on Teflon. These filters are analyzed by gravimetric analysis for PM₁₀ mass at UC Davis.

MDN

Samples are received in The Mercury Analytical Laboratory (HAL), in a designated shipping and receiving room. Immediately after pulling the sample from a cooler, the MDN bottle ID is verified against the MOF. Any site issues are documented in the MDN Site Issues Logbook and

the Site Liaison notified so relevant sample information can be gathered. Still encased in the bottle bags, the samples are transported to the Mercury Atmospheric Deposition and Emissions (MADE) receiving bench where the sample is checked for leaks and any observations regarding the sample state are noted. The MOF is completed at the bench and the information immediately entered in the MDN Data Management System. The sample and MOF are designated a run number that describes the year and batch the sample will be contained in. There are thirty samples per batch. Once a batch of thirty samples is collected, all samples in the batch are preserved to 1% BrCl in the original sample bottle. This step destroys any organic matter and releases any mercury to the Hg(II) oxidation state. Once preserved, the sample must stand overnight to ensure total oxidation. The sample is reduced during the analytical process and converted to the volatile elemental state. The elemental mercury is passed onto a gold trap where it is thermally desorbed into the flow of a cold vapor atomic fluorescent detection system (CVAFS). The receipt procedures are outlined in Program Overview 10, November 10, 2006 in FGS MDN-02 Sample Receipt Procedures and the analysis is detailed in FGS MDN-05 Hg Sample Analysis. Both documents are available upon request from FGS.

Data Handling and Analysis

NADP/NTN

The NTN (NADP) Quality Management Plan

(<http://nadp.sws.uiuc.edu/lib/qaplans/NADPQMP-Dec2003.pdf>)

(<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>) The NTN (NADP) Quality Management plan describes the NADP organization, quality management activities, policies, and procedures. It describes planning, documents and records, personnel qualification and training, and computer software and hardware.

The Central Analytical Laboratory (CAL) Quality Assurance Plan

(<http://nadp.sws.uiuc.edu/lib/qaplans/qapCal2006.pdf>)

The Central Analytical Laboratory (CAL) Quality Assurance Plan describes the operations of the analytical laboratory, including sample and data processing for the NTN. It further describes data retrievals, procedures, and programs that summarize, check, screen, edit, and report data.

IMPROVE

SOP 351 Version 2 (SOP 351-2) Data Processing and Validation

(http://vista.cira.colostate.edu/improve/Publications/SOPs/ucdavis_sops/sop351_V2.pdf)

The IMPROVE Data Processing and Validation standard operating procedure (SOP) document provides an overview of the procedures for processing and validating IMPROVE data. Data processing and data validation are performed in parallel.

MDN

NADP Quality Assurance Plan Mercury Analytical Laboratory, 2006

(<http://nadp.sws.uiuc.edu/lib/qaplans/qapHAL2006.pdf>)

(<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>) As HAL, FGS provides site support, sample processing, sample analysis, and data validation services for precipitation samples collected at the NADP/MDN monitoring sites. All these processes must follow documented quality assurance and quality control procedures. The Quality Assurance Plan

(<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>) describes these procedures and indicates how they are to be monitored and quantified. The QAP is reviewed annually and updated as necessary.

Data Reporting

NADP-NTN and NADP-MDN Data Products and Data Sets

The following section describes options for reporting wet deposition data, using data from GAAR and Denali NP as examples. Several data products are produced by the NADP for both the NTN and the MDN and are available on their website. These include national isopleth maps and time trend graphs of anions and cations for individual sites. Data can also be downloaded from the NADP website for more specific analysis. There is approximately a 5-6 month time lag between the time that samples are collected and the time that the data is available on the website. Maps generally are available by September of the year following collection.

Data Products

The following maps (Fig. 1, 2, 3, 4) and trend graphs (Fig 5, 6) were downloaded directly from the NADP website. It is important to remember that the two networks (NTN & MDN) may not exist at the same location. To access maps on the NADP homepage (<http://nadp.sws.uiuc.edu>), select the “Map Access” tab. Then choose the network, map type, analyte, year, and then “submit”. There are several map types to choose from; deposition, concentration, precipitation, and a site map. Once you enter into the NADP map viewer you can select new maps using the appropriate dropdown selections. Maps can then be saved as a PDF for incorporation into reports and presentations. Deposition data are useful for evaluating the amount of pollutant that is delivered to an ecosystem. Deposition, however, is dependent on precipitation amounts (deposition = concentration x precipitation) and may therefore differ significantly from year to year. Concentration data are useful for examining spatial and temporal trends, as concentration is not dependent on precipitation amount. Networks can use these maps to compare values in their region to values across the country.

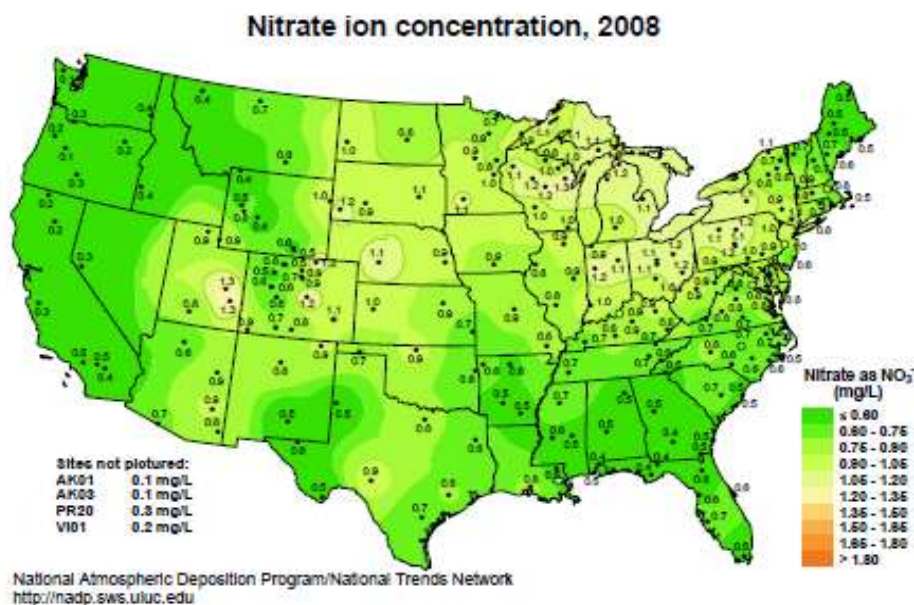


Figure 1. Spatial distribution of annual precipitation-weighted mean nitrate concentrations for 2008.

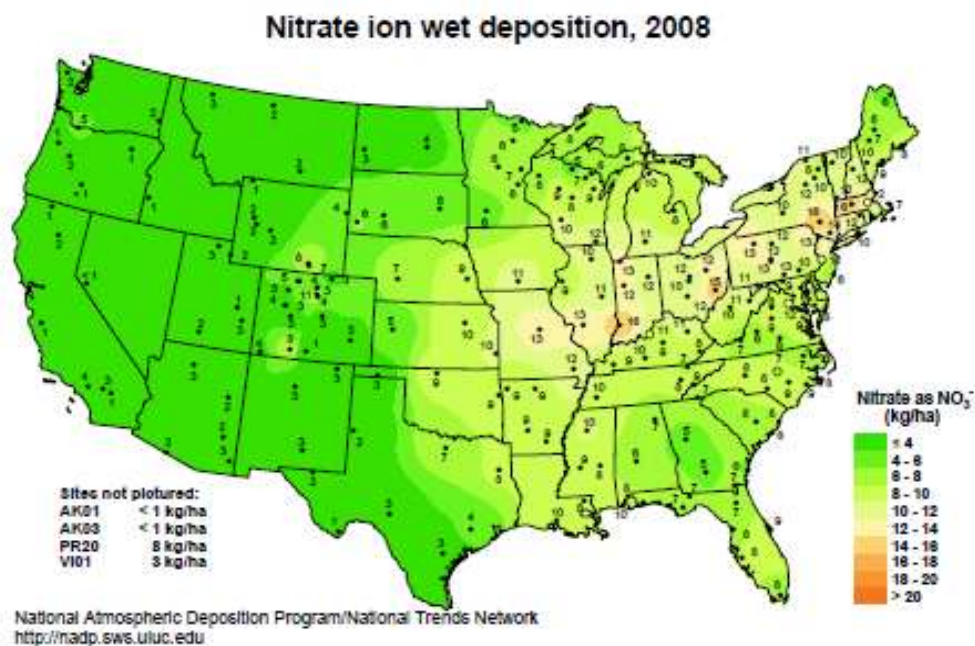


Figure 2. Spatial distribution of annual nitrate deposition for 2008.

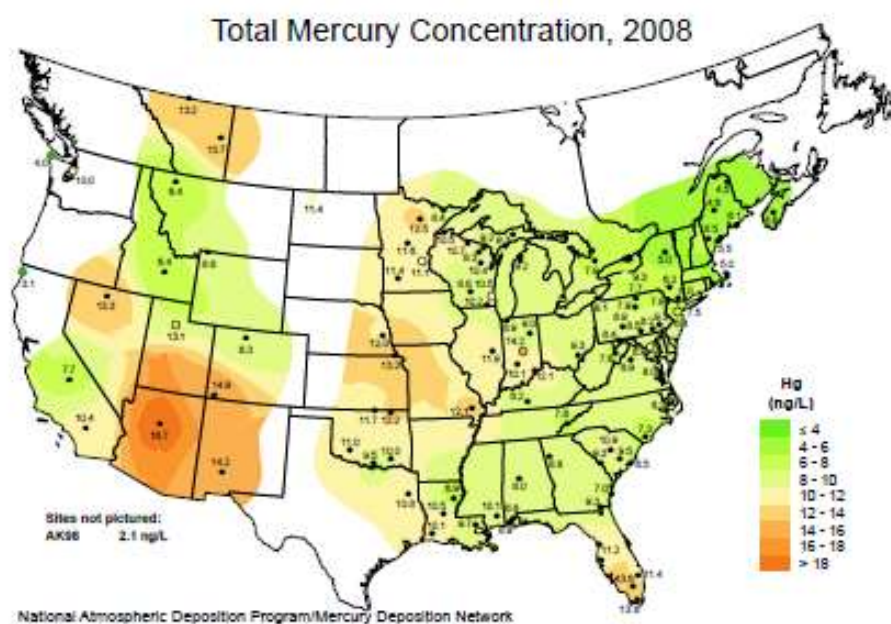


Figure 3. Spatial distribution of annual precipitation-weighted mean mercury concentrations for 2008.

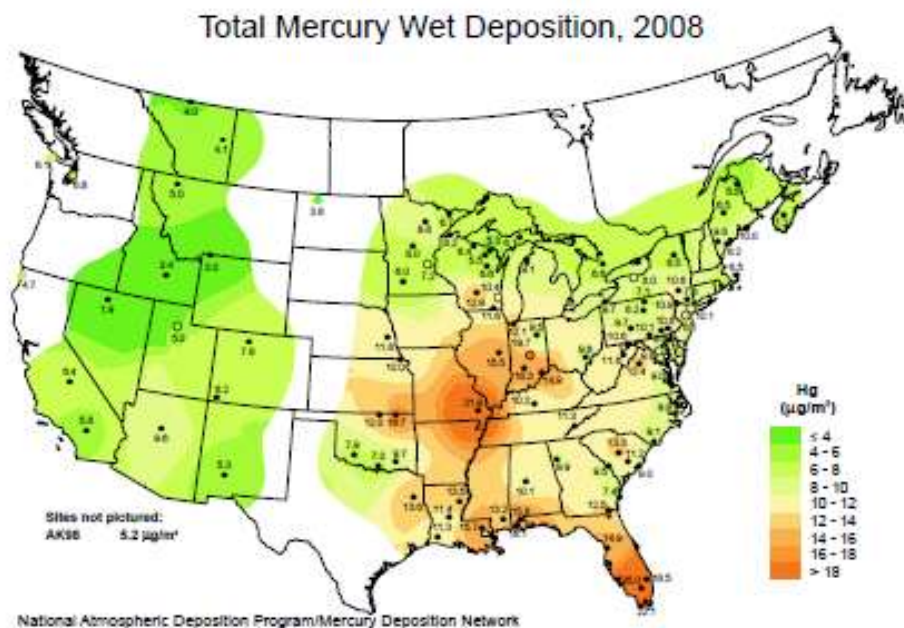


Figure 4. Spatial distribution of annual mercury deposition for 2008.

Time trends for individual monitoring locations are also available from the NADP website. To access trend graphs go to the NADP homepage and select the “Data Access” tab. Select a Network. Then select the desired site location from either the map or the table. The site location page includes site information and provides access to trend plots and annual, monthly, and weekly data (as well as daily data for precipitation). Selecting “Trend Plots” will display a table of the chemical species measured by NADP. A link to “Trends notes” describes how the trend lines were created and discusses data completeness criteria. Graphs can be copied and pasted into reports or presentations. Data are reported as concentrations (mg/L) or deposition (kg/ha/yr) of pollutants. Concentrations are useful for time trends, as they are not dependent on precipitation amounts. Deposition is useful for evaluating the wet loading of pollutants to the ecosystem. The Figures below show trends in concentration and deposition of NO₃ at Denali NP from 1980-2008 (Figures 5 and 6).

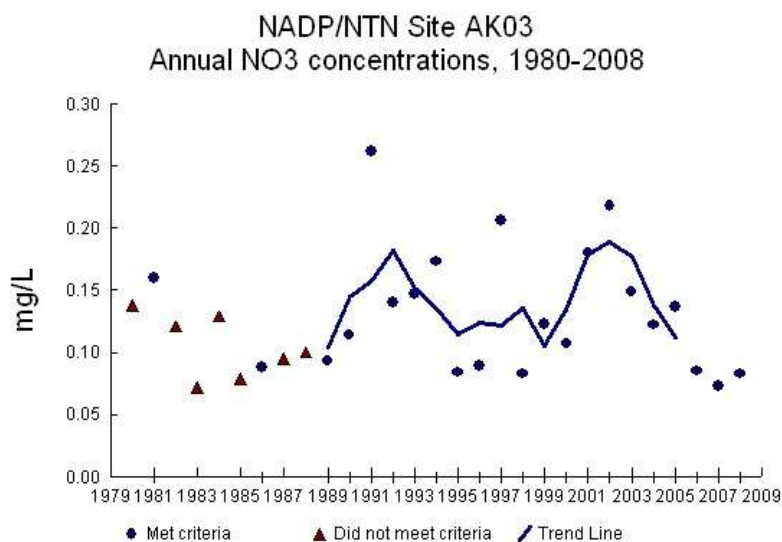


Figure 5. Trend lines (composed of a three-year, centered, weighted-moving average value) for the concentration of nitrate in precipitation at Denali NP for 1980-2008.

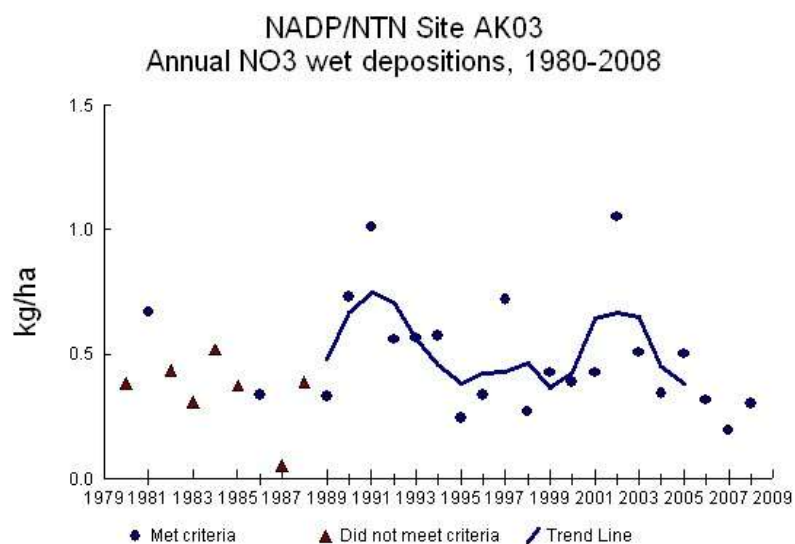


Figure 6. Trend lines (composed of a three-year, centered, weighted-moving average value) for the total annual deposition of nitrate at Denali NP for 1980-2008.

Data Sets

In addition to the NADP data products, for the NTN and MDN networks, discussed above concentration, deposition, and precipitation data can be downloaded directly from the NADP website (Table 3). This data can be used by NPS Inventory and Monitoring networks for more specific analyses and custom data products.

Table 3. Data sets that can be directly downloaded from the NADP website.

• Annual Data - data by calendar and water years - wet deposition totals - precipitation-weighted mean concentrations • Seasonal Data - wet deposition totals - precipitation-weighted mean concentrations • Monthly Data - precipitation-weighted mean concentrations • Weekly data - concentrations • Daily Data - daily precipitation data

Site data for wet deposition can be downloaded and from the NADP website for each individual monitoring site. Custom data products can be created in order to examine concentration and deposition data spatially or temporally across their network or evaluate sites within their network to other sites across the country (Figures 7, 8, and 9).

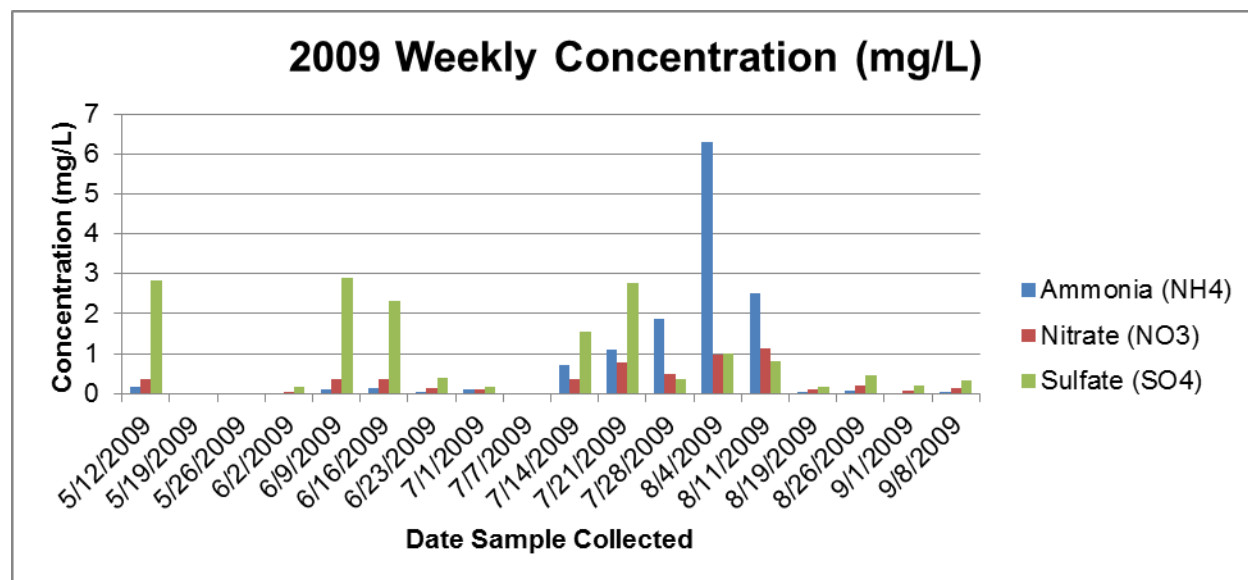


Figure 7. Concentrations in milligrams per liter (mg/L) of ammonium, nitrate, and sulfate in precipitation at Gates of the Arctic Park and Preserve, 2009.

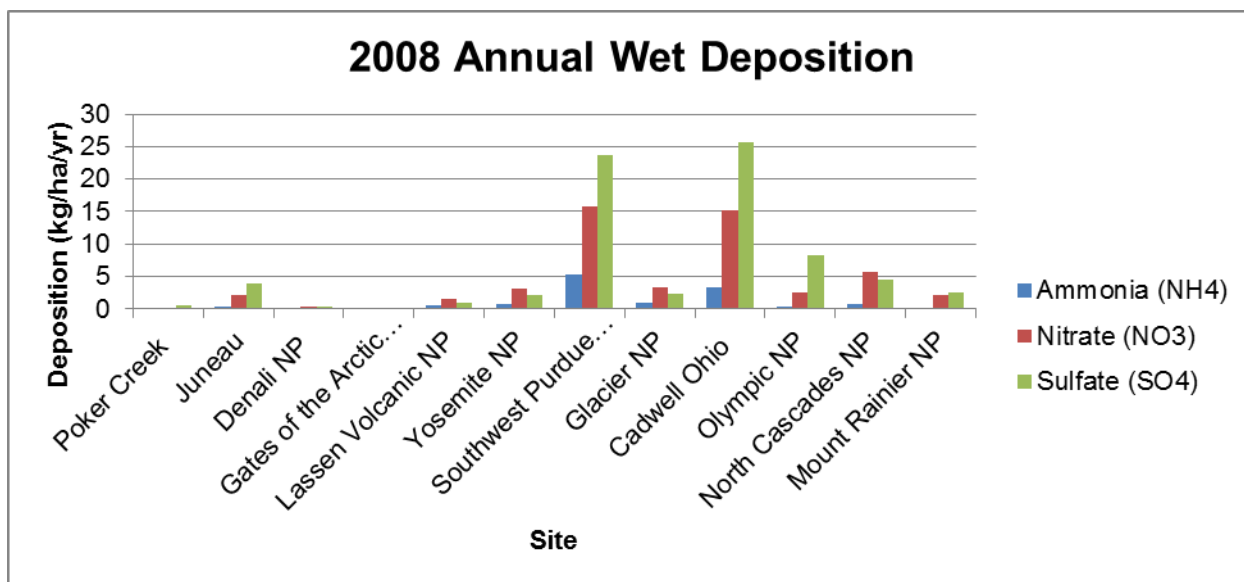


Figure 8. Wet deposition in kilograms per hectare per year (kg/ha/yr) of ammonia, nitrate, and sulfur at multiple sites, 2008.

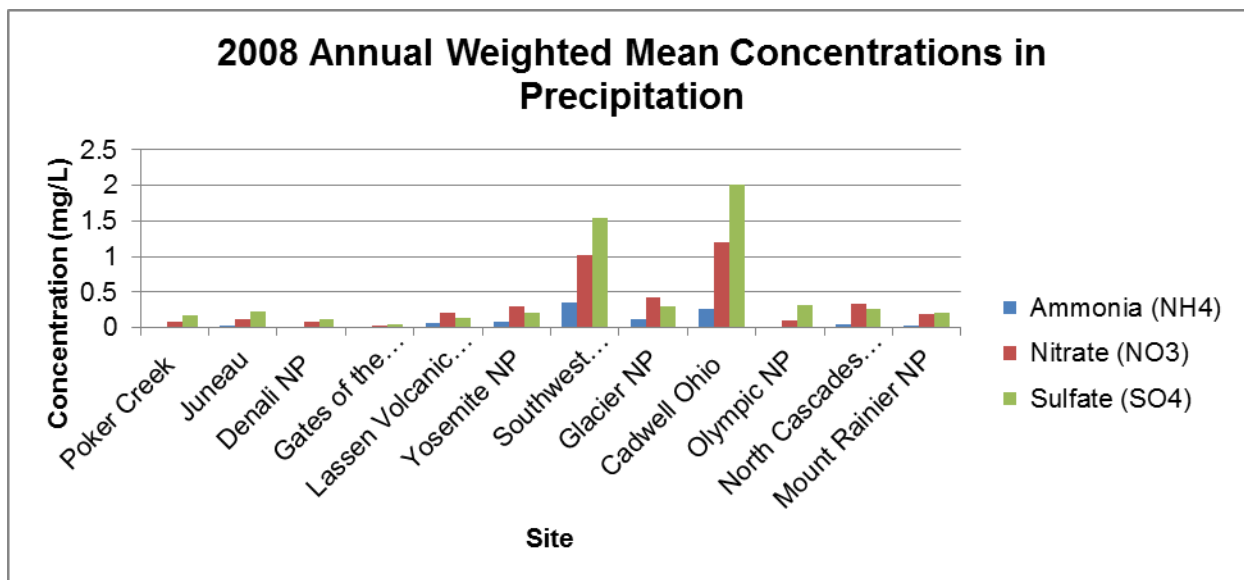
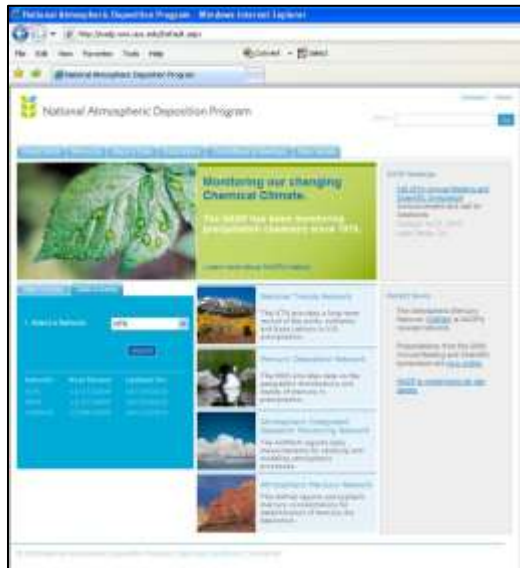


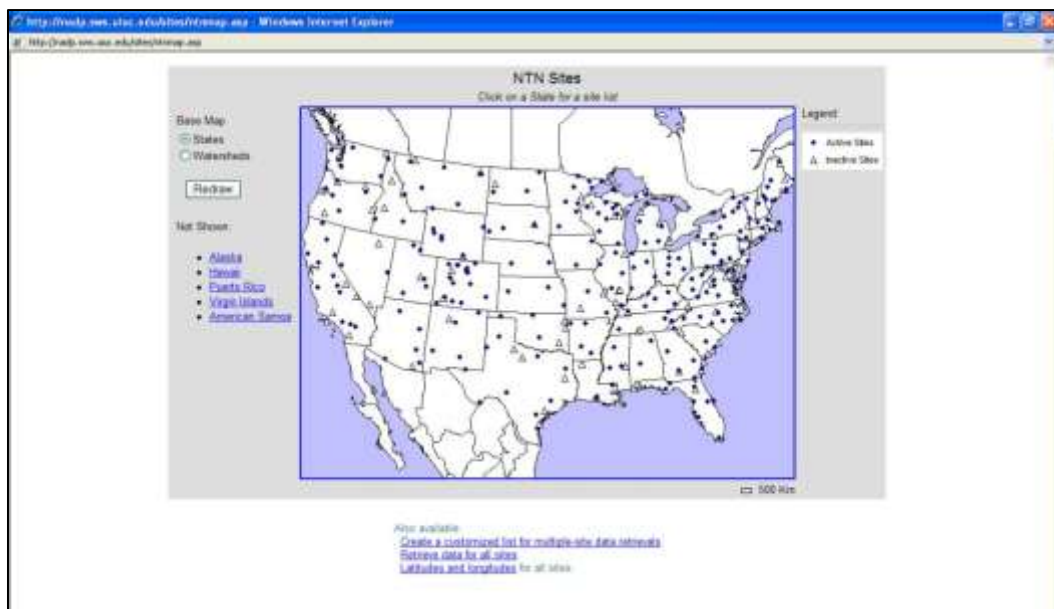
Figure 9. Concentrations in milligrams per liter (mg/L) of ammonium, nitrate, and sulfate in precipitation at multiple sites, 2008.

To access data for a specific site.

- Go to the NADP homepage
- Select the “Data Access” Tab – Select a Network



- Select Alaska



- Select a Site



- Select desired data set (e.g., Annual, Seasonal, Monthly, Weekly, Daily) and fill in the Data Selection Criteria and Intended Use sections; (Note: you will have to download concentration data in mg/L separately from deposition data in kg/ha).
- “Explanatory Notes” at the bottom of the webpage describe NADP’s four data completeness criteria and recommended values

NADP/NTN Monitoring Location AK06

Station: Gates of the Arctic National Park - Bettles (AK06)
Location: Yukon-Koyukuk Borough, Alaska
Dates of Operation: 11/4/2008 - Present
Latitude: 66.996
Longitude: -151.483
Elevation: 830 meters
USGS 1:24000 Map Name:
Operating Agency: [NPS for Resource Use Science](#)
Sponsoring Agency: [NPS for Resource Use Science](#)

NADP/NTN Wet Deposition Data Available:

Other NADP Data for this Site:

Annual Data: 11/4/2008 - Present

Annual Data:

- data by calendar and water years
- wet deposition totals
- precipitation-weighted mean concentrations

Seasonal Data:

- wet deposition totals
- precipitation-weighted mean concentrations

Monthly Data:

- precipitation-weighted mean concentrations

Weekly Data:

- concentrations

Daily Data:

- daily precipitation data

[Comments and Suggestions](#) | [Site Conditions](#)

- Select “Get Data”

Annual Data for Site: AK06 (Gates of the Arctic National Park - Bettles)

Data Selection Criteria:

Start Year: -- start year --
End Year: -- and year --
Type of Data: -- data type --
Report Format: -- report format --
Seasons to Return:
☒ Calendar Year (Jan - Dec)
☐ Water year (Oct - Sep)

Intended User:

Please select the category that best describes how you will use this data:

Research/Assessment:

- ☐ Atmospheric Deposition
- ☐ Ecosystem Processes
- ☐ Watershed Studies
- ☐ Aquatic Effects
- ☐ Terrestrial Effects
- ☐ Materials Effects

Education:

- ☐ College/University
- ☐ K-12
- ☐ Individual
- ☐ NSTA module user
- ☐ Other

Brief description of specific application:

Please Note:

There is approximately a 5-6 month time lag between the time that samples are collected and the time that they are available on the Web page.

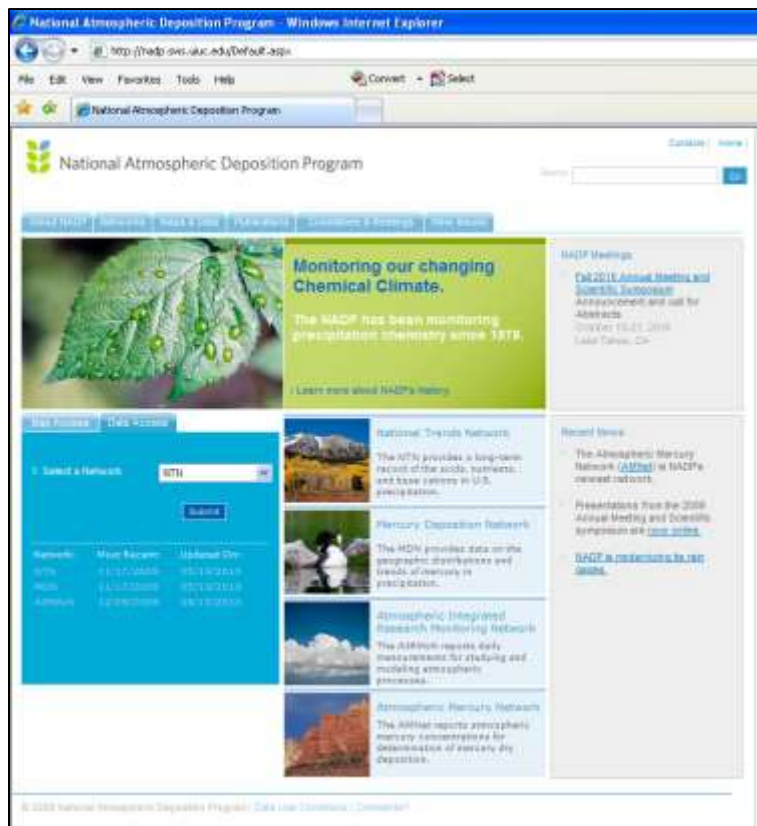
Data Documentation: Please Download For Later Use with Data Files!

- [Explanatory Notes](#) contain important information about the data file.
- [Advisory](#) contains important information regarding use of data beginning in 1994.
- [Format Descriptors](#) - outlines the data format (useful for input into other software applications):
 - o [Standard format](#)
 - o [Delimited format](#)

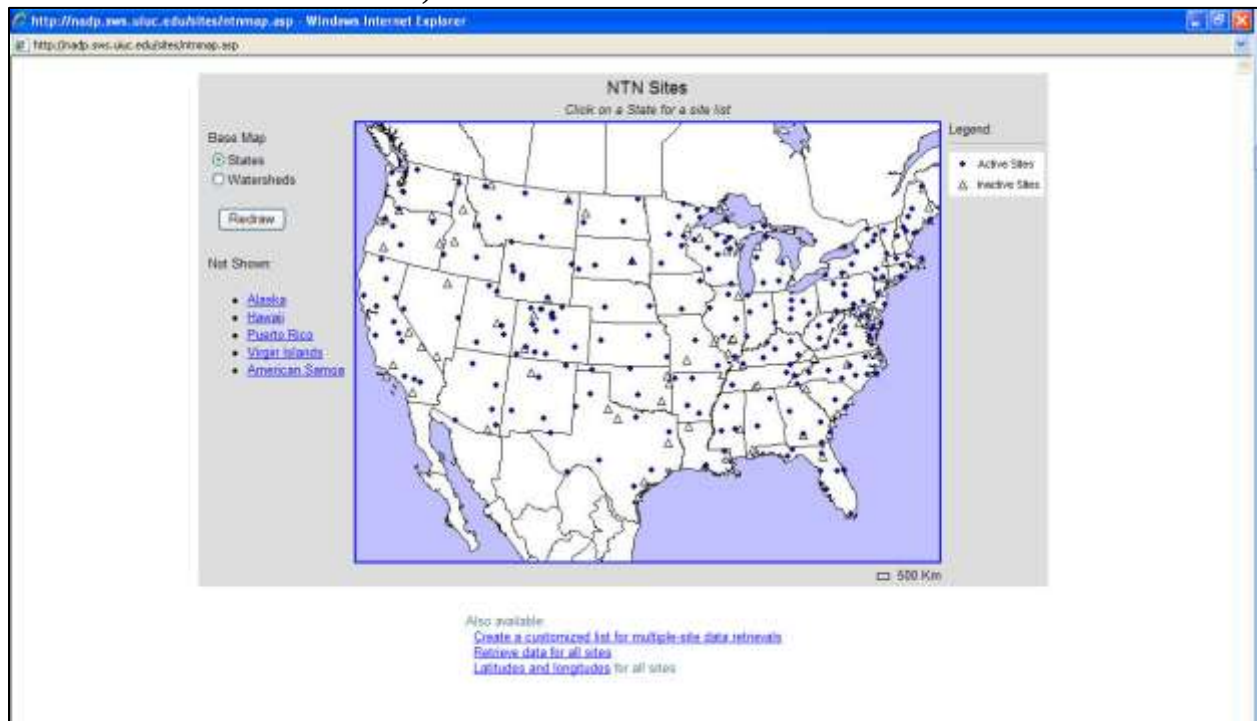
[Comments and Suggestions](#) | [Site Conditions](#)

To create a custom data site list.

- NADP homepage (<http://nadp.sws.uiuc.edu/>)
- “Data Access” Tab - Select a Network



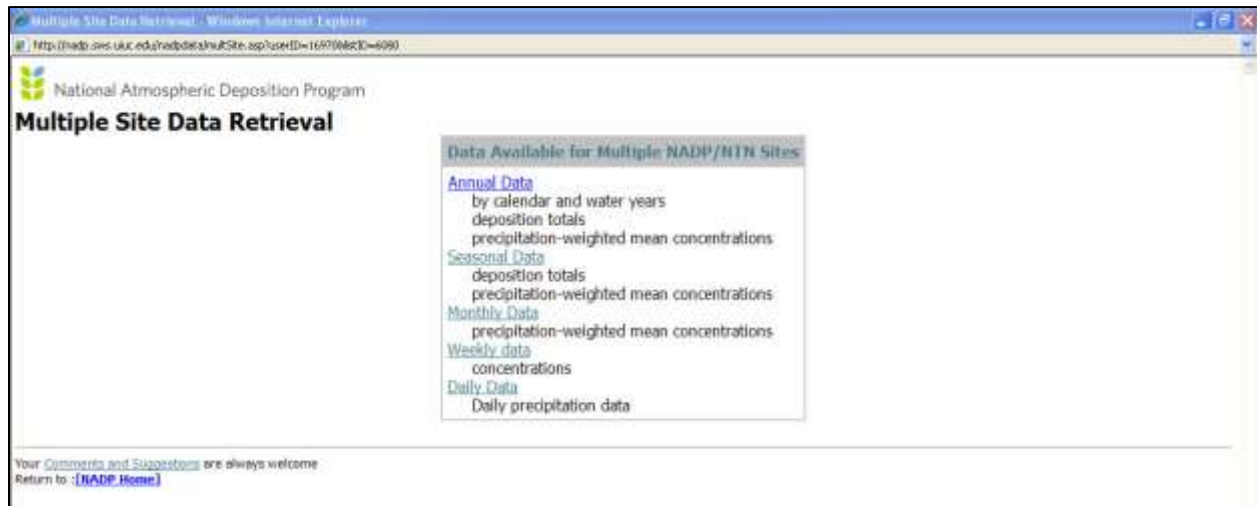
- “Create a customized list for multiple-site data retrievals” (you may have to fill out the data access authorization)



- Use an existing list or scroll to bottom of page and create “List Name” (e.g., Gates of the Arctic Comparison) and any other information under “Description”;
- Select desired sites.
- Select “Retrieve Data” “Go.”

List Name	Site Count	Description
Gates of the Arctic	3	
Gates of the Arctic Comparison	3	Gates of the Arctic Comparison
Gates of the Arctic	3	

- Select desired data set (e.g. Annual Data, Seasonal Data, Monthly Data, Weekly Data, Daily Data) and fill in the Data Selection Criteria and Intended Use sections; choose water year (Oct-Sept) or calendar year (Jan-Dec)(Note: you will have to download concentration data in mg/L separately from deposition data in kg/ha).



- “Explanatory Notes” at the bottom of the webpage describe NADP’s four data completeness criteria and recommended values.
- Select “Get Data”

Ref=Custom6080

Annual Data for Custom Site List

Data Selection Criteria:	Intended Use:
Start Year: -- start year -- End Year: -- end year -- Type of Data: -- data type -- Report Format: -- report format -- Seasons to Return: ☒ Calendar Year (Jan - Dec) ☐ Water year (Oct - Sep)	Please select the category that best describes how you will use this data Research/Assessment: ☐ Atmospheric Deposition ☐ Ecosystem Processes ☐ Watershed Studies ☐ Aquatic Effects ☐ Terrestrial Effects ☐ Materials Effects Education: ☐ College/University ☐ K-12 ☐ Individual ☐ NSTA module user ☐ Other Brief description of specific application
Get Data Reset	
Please Note: There is approximately a 5-6 month time lag between the time that samples are collected and the time that they are available on the Web page.	
Data Documentation: Please Download For Later Use with Data Files! • Explanatory Notes contain important information about the data file. • Advisory contains important information regarding use of data beginning in 1994. • Format Descriptions - outlines the data format (useful for input into other software applications): ◦ Standard format ◦ Delimited format	

[Comments and Suggestions](#) | [Use Conditions](#)

The NADP publications page (<http://nadp.sws.uiuc.edu/lib/>) contains additional information on wet deposition data and trends. ARD can also provide guidance on accessing, analyzing, interpreting, and reporting wet deposition data.

IMPROVE Data Products and Data Sets

The IMPROVE website provides access to raw data and a variety of data products and reports (<http://vista.cira.colostate.edu/improve/>). In addition to providing access to raw data the IMPROVE provides reports, publications and a variety of data products that support its program objectives.

Personnel Requirements and Training

At least one primary and one backup site operator are required for on-site maintenance as well as for data downloading, sampling, and sample processing.

Roles and responsibilities

On-site personnel, responsible for weekly visits, sample collection and data acquisition, are staff at parks where air quality monitoring stations occur. Technical support is provided by the NPS–ARD or EPA employees and affiliated contractors. Data downloading and sampling is the responsibility of the ARCN site operator.

Training procedures

Contractors are required to provide staff with adequate training to perform equipment inspections and calibrations. Park staff is typically trained on the job by other staff experienced with the procedures. This on-the job training is supplemented with additional training, as needed, during site inspection and calibration visits by contractors. All laboratory analyses are performed under contract, with contractors being responsible for training their employees.

Operational Requirements

Annual workload and field schedule

Depending on the air quality monitoring equipment present, weekly visits for routine maintenance require one person for up to eight hours per week. Additional time for emergency repairs or unscheduled equipment checks (due to observed problems with data) also can require up to eight hours per week. These costs are currently incurred by the host parks, with financial support from the NPS–ARD. The costs of semiannual inspections, laboratory analyses, shipping and handling of samples, and data management are not known; these are incurred by the NPS–ARD and the EPA at a scale that is difficult to differentiate at the network level. The workload for ARCN staff consists of data retrieval, archiving, analysis, and report preparation.

Facility and equipment needs

This protocol describes several ongoing programs, and is based on the assumption that the programs will continue to be externally funded. Facilities and equipment are described in the narrative above and in the SOPs. ARCN does not plan to fund additional air quality monitoring in the network park units.

Literature Cited

- Landers, D. H., S. L. Simonich, D. A. Jaffe, L. H. Geiser, D. H. Campbell, A. R. Schwindt, C. B. Schreck, M. L. Kent, W. D. Hafner, H. E. Taylor, K. J. Hageman, S. Usenko, L. K. Ackerman, J. E. Schrlau, N. L. Rose, T. F. Blett, and M. M. Erway. 2008. The fate, transport, and ecological impacts of airborne contaminants in western national parks (USA). EPA/600/R-07/138. U.S. Environmental Protection Agency, Office of Research and Development, NHEERL, Western Ecology Division, Corvallis, Oregon.
- National Park Service, Air Resources Division. 2009. Air quality in national parks: 2008 annual performance and progress report. Natural Resource Report NPS/NRPC/ARD/NRR—2009/151. National Park Service, Denver, Colorado
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- Brumbaugh, W.G., and May, T.W., 2008, Elements in mud and snow in the vicinity of the DeLong Mountain Regional Transportation System Road, Red Dog Mine, and Cape Krusenstern National Monument, Alaska, 2005–06, U.S. Geological Survey Scientific Investigations Report 2008–5040. 30 p.

Appendix A

SOP #1: Bettles Air Quality Station NADP-NTN Sampling Field Guide

Prior to arrival at the site backup or new site operators must review the following documents: “National Trends Network (NTN) Site Operation Manual”, specifically section 3 “NTN Site Operating Procedures”, and the “NADP procedures for downloading rain gauge data using IPAG 110 PDA”. These are the approved SOPs which contain important QA/QC and sampling information. This field guide is to be used in conjunction with the approved SOPs. The field guide addresses site specific issues that occur at the Bettles Air Quality Station.

Special Notes regarding the “NTN Site Operating Procedures”:

- This site does not have the Belfort B5-780 rain gauge. So disregard those instructions in the NTN Site Operating Procedures.
- Since the NTN sample is processed in the shed 30ft from the collector wrapping the sample in a bag and carrying it in the black box is not necessary. However, the box good to use so you can keep sampling equipment off the ground.

1. Upon arrival at the site note arrival time, initials, current station temp, max and min station temp, current weather, and the condition of the equipment in the log book.

- Complete section 2 of the previous week’s Field Observer Report Form (FORF) and section 1 of next week’s FORF.

2. Using a Rubbermaid container carry the new bucket and lid to the collector, along with the following supplies: rain gauge PDA, previous week’s FORF, next week’s FORF, and a squeeze bottle of distilled water (summer), or a snow brush (winter).

- Check sensor temperature
- Inspect dry-side bucket for dirt and debris.
- (Winter) brush snow from the collector lid and frame.
- 1st Tuesday of each month replace dry side bucket.
- 1st Tuesday of each month check and if necessary level the collector.
- Open the Rubbermaid and leave lid upside down.

3. Empty the contents of dry side bucket on the ground, being careful not to touch the inside or rim of the bucket. Replace the bucket and clip in the handle.

4. Activate the NADP/NTN sensor with distilled water or snow. Using the lid bag as a glove (carefully turn it inside-out without touching the inside of the bag), snap the new lid onto the wet-side bucket. Remove bucket from collector and place in lid of the Rubbermaid.

5. Install the new bucket, using the bag as a glove, and clip in the handle. **Do not touch and inside surfaces of the bucket.**

6. Close collector lid.

- Facing away from the collection bucket blow on the sensor.
- Record sample off time and date in section 3 of the previous weeks FORF.
- Record sample on time and date in section 3 of the next weeks FORF.

7. Return with the bucket and supplies to the station, complete the FORF and process the sample for shipment (see steps 8 and 9).

- Big Ziploc bags in good condition can be recycled. Fold and place on shelf.
- Twist ties are also recycled. Place used ties in cup on shelf.
- (Winter) allow snow to melt by hanging bucket above the base board heater. Collect the MDN and IMPROVE samples. The snow should be melted when done, so the sample can be processed.

8. Complete previous week's FORF and process the sample for shipment.

-Download the previous week's data from the rain gauge onto the PDA. Step by step instructions are contained in "Procedures for downloading raingage data using IPAQ Model 110 PDA"

- (Winter) If the rain gauge cylinder is overloaded with slush it needs to be removed and ½ gallon of new antifreeze added. Place used antifreeze in the used antifreeze container.

- Complete Section 6

- Make sure scale is level.
- Wipe off moisture on the exterior of the bucket
- Weigh Bucket + Lid + Sample and record weight
- Record CAL bucket weight, written on side of bucket
- Record CAL lid weight, written on side of lid
- Calculate sample weight

- Pour sample into 1-liter nalgene and record in section 8.

- place barcode stickers, that have the same sample identification numbers, on the FROF and the bottle bag. Then complete the sample bag information.
- If no sample was collected place FORF into dry sample envelope with barcode sticker on envelope.
- Note sample condition in section 5.

- Record the following in Section 7

- Precipitation Data and total rain gauge depth from PDA (See Item 11).
- Calculate sample depth
- To determine if the sample depth and the rain gauge depth are within 5%, multiply the sample depth by 0.05. If this value is greater than the difference between the sample depth and the rain gauge depth than the two depths are not within 5% of one another.

- Order any supplies that are needed in section 9.

- Record any notes in section 10.
- Place barcode sticker on FORF.
- Note site operation in section 4.

10. Place sample in mailer box with the white and yellow FORF copies and priority mail to laboratory. The pink copy of the FORF is placed in the file folder at the Air Quality station. Leave next week's FORF on counter.

NADP-NTN Site Liaison Contact information:

National Atmospheric Deposition Program
Central Analytical Laboratory
Illinois State Water Survey
2204 Griffith Drive, Dock B
Champaign, IL 61820-7495

1-800-952-7353

11. Download raingauge data (see instructions below) and record precipitation data on FROF.



National Atmospheric
Deposition Program

Procedures for downloading raingage data using IPAQ Model 110 PDA

Version iPaq110-2.1
1/13/2008

NADP Raingage Download
Procedure

Connecting via Bluetooth

What is Bluetooth? It's a short-range wireless protocol that the PDA uses to communicate with the rain gauge.



Left Softkey

Right Softkey

1. **Charge the PDA:** Before traveling to the site, make sure the PDA is adequately charged.
2. **Turn on the PDA:** Upon arrival at the site, turn on the PDA using the on/off switch.
3. **Open the IPAQ Wireless Manager:** Using either hardware button 1 or the left softkey, open the IPAQ Wireless Manager.
4. **Turn Bluetooth On:** If the large round button on the Bluetooth Manager is green, the bluetooth radio is turned on. If it is gray and has a red X in it, turn the radio on by clicking the button and wait a few seconds to till it turns green. To maximize battery life, leave the WLAN button off.
5. **Click the Bluetooth Connections Link**

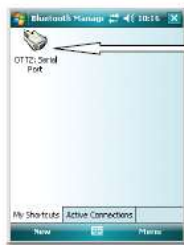
Click here (4)
to turn
Bluetooth on.



Click here (5) to view Bluetooth shortcuts

NADP Raingage Download
Procedure

Downloading from a NADP Raingage

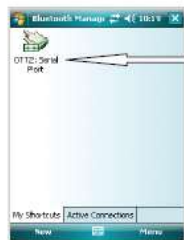


Click here (6)

6. **Open the connection to the raingage.** The Bluetooth manager should display an icon for your rain gage. It will look like the one shown to the left, but the label may vary depending on the rain gage at your site. **Double tap** on the icon to open the connection. A window will open showing that the connection is being attempted. When the connection is established, the icon will change and appear like the one below.



7. **Close the Bluetooth Manager** Tap on the X in the upper right hand corner of the screen to close the Bluetooth Manager. Then close the IPAQ Wireless window by tapping on it's X. This will return you to the Today screen.

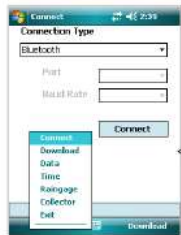


Click here (7)

Icon showing a connection has been established

NADP Raingage Download Procedure

Downloading from a NADP Raingage



8. **Start the NADPrain program:** Tap the right softkey to start the NADP Rain program. It may take up to 10 seconds for the program to load and initialize.
9. **Start Retrieve Data:** Tap on the Retrieve Data from Raingage button to open the data retrieval form. This form has seven screens:
 1. Connect
 2. Download
 3. Data
 4. Time
 5. Raingage
 6. Collector
 7. Exit.
10. The name of the current page will be shown at the top of the page. You can navigate between them using the softkeys. The right softkey will move to the next screen, and the left softkey will move to the previous page. You can also jump to any page performing a Tap and Hold on any empty portion of the screen. This will display a context menu that allows you to choose any page. The top of the page displays the name of the current page

NADP Raingage Download Procedure

Connecting to the Rain gage



11. **Connect to the raingage:** Unless you have been directed otherwise, leave the connection type on the default entry. For iPAQs, this will be labeled Bluetooth. For a Dell Axim, it will be Bluetooth (COM7). Then click on the button that says "Connect". The Port and Baud Rate options are only used if you connect to the rain gage using a RS-232 cable.
12. **Wait for connection:** It will take a few seconds for the connection to be established. During this time, you will be shown a rotating wait cursor. When the connection is established, the rotating cursor will disappear and the word "Connected" will appear at the bottom of the screen.
13. **Move to the Raingage page:** Click on the Right softkey to move to the Raingage page

Downloading from a NADP Raingage



Click on this triangle to open the calendar



Tap on these triangles to change the month. Tap on a date to select it and close the calendar



Hours and minutes are selected by drop-down menus



Click here to clear the message box (15)



12. **Select the start date:** To change the date, click on triangle in the date box. This will open the calendar. Clicking on a date will select that date and close the calendar. If you need to change the month, click on the triangles in the top corners of the calendar display.
13. **Select the start time:** To change the hour, click in the hour box and select the hour from the drop down box. Click in the minute box to select the quarter hour that followed the sample. Lastly, click on either the AM or PM button, as necessary.
14. **Click on the download button:** This is the large button immediately below the time. A progress bar will be displayed during the transfer.
15. **Wait for the download:** After the download completes, a message box will appear that displays the number of records downloaded. There will be approximately 100 records for a week-long sample. Click on the message box to clear it.
16. **Change to the data page:** Click on the Right Softkey (data) to view daily amounts.
17. **Select sample start/end times:** The data tab will allow you to select the sample start and end dates and times. These are initialized to the first and last records that were just downloaded from the raingage. Adjust these to the correct values, so they show the quarter hour following the actual time the sample was changed. Select the appropriate network, and tap the "View" button.

Viewing Daily Precipitation Amounts

Date	wetExp	dryExp	missedExp	Cycles
10/15/06	0.54	0.13	0.00	1.68
10/16/06	0.00	0.00	0.00	1.04
10/17/06	0.00	0.00	0.00	0.00
Total	0.54	0.13	0.00	2.74

Drag this border to widen the date column, if necessary

Drag here to scroll left and right, if necessary

18. **View daily amounts:** The daily precipitation amounts in inches will be displayed in a new window. If you selected AIRMoN as the network, hourly, rather than daily values will be displayed.
19. **Scroll if needed:** Not all of the data can be displayed in the window, so scroll bars are provided at the bottom and possibly the right side of the window. You need to adjust any of the column widths by dragging the right edge of the column border.
20. **Also displayed are the following columns:**
 1. wetExp: wet exposure, hours
 2. dryExp: dry exposure, hours
 3. missedExp: missed exposure, hours
 4. Cycles: the number of times the collector opened and closed
21. **Repeat 13-16, if necessary:** If more than one collector are connected to the raingage, you can close this window (after recording the values) and enter sample start and end times for the sample from the other collector.

Exposure Definitions and Notes

- Wet exposure: The time the collector was open and the optical sensor indicated that precipitation was occurring
- Dry exposure: The time the collector was open, but the optical sensor indicated that precipitation was not occurring, and the collector should have remained closed. A sample with total dry exposure times exceeding 6 hours may be flagged as undefined and disqualified.
- Missed exposure: The time the collector was closed, but the optical sensor indicated that precipitation was occurring, and the collector should have been opened.
- A fourth possible state is not monitored or reported. This is when the collector is closed and no precipitation is falling.
- A small amount of dry exposure and missed exposure is inevitable, due to the differences between the optical and grid sensors. In certain conditions such as dry blowing snow, extensive periods of dry exposure will be recorded. This is also due to equipment limitations, and do not automatically invalidate a sample.

Clock and Raingage status

22. **Check the datalogger clock:** Change to the Time page. Tap the Check Time button and wait for a response. Any difference between the datalogger and PDA clocks will show in the Difference text box. If it is not zero, tap set time to update the datalogger clock.
23. **Check the Raingage status:** Change to the Raingage page, and tap on the refresh button if necessary. This page shows you the current status of the raingage. **The information shown varies by raingage type**
 - **ETI Noah IV:** The Reported Precip and Particle Counts are cumulative since the last 15 minute reporting period, and reset to zero on the quarter hour. The possible values of the Optical sensor box are Off, On, and Blocked. If the Optical sensor box says Blocked, determine what is causing the blocked situation and correct it. The holes in the bucket may be mis-aligned. If you have just reassembled the gage, you may have forgotten to plug the optical sensor cables into the sockets underneath the bucket, or plugged the plugs into the wrong sockets.
24. **Service Mode:** The gage should be put into service mode whenever you perform maintenance that could be misinterpreted precipitation. For example, the gage should be in service mode whenever you add antifreeze, or whenever a field technician performs a calibration check. While in service mode, the gage will not report as precipitation any additions to the weighing chamber. It will automatically return to monitoring status after 5 minutes, or when you hit the stop button. To maintain service mode, hit the refresh button. This will reset the timeout to 5 minutes.

Precipitation Collector Status



24. **Check the status of the Precipitation Collectors:** Change to the Collector page. For each collector, this will show if the collector is open or closed, and if the collector has power. To test the connection between a collector and the raingage, trigger the collector to open and tap on Refresh after the collector fully opens. If you have an N-Con MDN collector, you can use this page to verify that you turned the collector back on after servicing the collector.
25. **Disconnect and Exit:** Change to the Exit page. Tap on Disconnect to end the Bluetooth connection to the raingage. Then tap on Exit to end the Program.
26. **Turn off the Radio:** When you return to the Today screen, tap the green Bluetooth icon to turn off the Bluetooth radio. When off, it will turn grey and display a red x. This will help preserve battery life.

Transmitting data

- If the electronic gauge is your only NADP rain gauge, record the daily precipitation values from the PDA on the field form. Specify in the notes section of the field form that the daily values are from an electronic gauge.
- We are asking some sites to continue operating their Belfort raingage for a year, so we can investigate possible data biases introduced by the equipment change. If you are one of these, please continue to analyze the Belfort chart to determine the daily values. Record these on the Belfort chart instead of the field form.
- To transmit the electronic data, connect your PDA to your desktop computer using the sync cable. On your desktop, click on My Computer, and then on Mobile Device. This will display the files in the My Documents folder of the PDA. Two files with data are created each time you download. One file will have a .txt extension, and the other will have a .xml extension. The first part of the name will be identical, and will contain your NADP siteid, the date and the time. For example, if I download from IL11 on Sept 3, 2006 at 10:00 am, the filenames will be:
 - IL1120060903T1000.txt
 - IL1120060903T1000.xml
 You can drag these files to the Archive directory that you created during Activesync setup.
- Each time you download, please email both of these files to me at blarson@uiuc.edu. In your email, please write the start and end dates and times for the sample. Also please mention if you have added antifreeze. Emailing the data is just a temporary measure until we complete a desktop or web application that will automate this process.

Misc. Notes

- You should not need to manually adjust the time of the PDA. Each time you connect the PDA to your desktop computer, the ActiveSync software will synchronize the PDA's clock to the time of the desktop computer. However, if you arrive at the site and discover that the PDA is on the wrong date, You can set it by tapping on Start, then on Settings. Tap on the System tab, then on the Clocks and Alarm Icon. Correct the date and time, and then tap OK to save.
- If you need to display the daily precipitation values after you have disconnected from the raingage, click on "Recall Prior Data" on the main NADP Rain page. This will read in the last set of data that was downloaded, and allow you to display the daily values after selecting sample start and end times.

PDA Introduction



The PDA Screen

This photo shows the PDA's Today page. The Today page is what is shown on the PDA when no programs windows are visible. It is similar to the desktop on your PC.

You interact with the PDA by softly tapping on the touch-sensitive screen with the stylus. Tapping the screen is similar to clicking with a mouse. There are three types of taps:

- Single tap: Tap once.
- Double tap: Tap twice in rapid succession.
- Tap and hold: Press the stylus to an object on the screen and hold it there for a few seconds. If the screen object has a context menu, a menu of choices will appear. This is similar to right-clicking with a mouse on a desktop computer.

In most situations, you will only use the single tap method. If you are required to use the double tap or tap and hold methods, we will point that out.

The light sensor adjusts the brightness of the screen based on the ambient light. Make sure you are not covering it with your hand, or the screen may be more difficult to see on a sunny day.

Appendix B

SOP #2: Bettles Air Quality Station NADP-MDN Sampling Field Guide

Backup or new site operators must review the “MDN Glass Sample Train collection and Deployment-Trace Metal Clean Sample Handling standard operation procedure” (SOP) prior to arrival at the site. This is the approved sampling SOP which contains important QA/QC and sampling information. This field guide is to be used in conjunction with the approved SOP. The field guide addresses site specific issues that occur at the Bettles Air Quality Station.

Winter Notes:

- When it gets below zero the vinyl gloves begin freezing. When it gets really cold, -40°F or colder, the gloves get brittle even while you are wearing them. You need to keep them tucked into your jacket or bibs to keep them warm, it helps.
 - Next to the collection funnel containing the glass funnel-thistle tube assembly is a drain funnel with a tube running through the heated chamber. When it gets really cold, -30°F or colder, the heated chamber is not warm enough to prevent water vapor from freezing the lid to the funnel. By manually helping the lid to open you can break the seal and then clean out the ice. Proactively, it is good just to check the funnel and clean any ice before it freezes closed.
 - As the outside temperature changes, adjustments may need to be made to the space heater in order to keep the temperature in the chamber within an appropriate operating range (40°F – 100°F)
 - In the winter, cleaning the collector consists of brushing off the snow before you start sampling.
1. Complete section 2, of the previous week’s MDN Observer Form (MOF). Complete section 1 of next week’s MOF.
 2. Check Total Mercury for analysis type in section 4 on next week’s MOF.
 3. Approach the collector from downwind. Bring the following supplies:

Summer

Red cooler with fresh sampling supplies
6 pairs of gloves
Previous week’s MOF
Next week’s MOF
Paper towels
409 glass cleaner
Kimwipes
Mili-Q water

Winter

Red cooler with fresh sampling supplies
5 pairs of gloves
snow brush
Previous week’s MOF
Next week’s MOF

4. Record the Max/Min temperature (Section 9, previous week's MOF).
5. Reset the Max/Min thermometer.
6. **Wearing a new set of gloves**, screw the cap onto the sample bottle. Place sample bottle in its original sample bottle bag, and place into the previous week's shipping cooler.
 - Record sample off date and off time (Section 3, previous week's MOF)
 - Record if overflow is present (Section 8, previous week's MOF)
7. Remove old dry side bag from dry side bucket.
8. **Wearing a new set of clean gloves**, replace the dry side bag.
9. **Wearing a new set of clean gloves**, while opening clean the collector lid.
 - Use the Mili-Q water and kimwipes while the lid moves.
10. Remove the glass funnel-thistle tube train, and place into the previous week's shipping cooler.
11. (Summer) clean the collector. (Winter) check drain funnel and clean out ice buildup.
12. The 1st Tuesday of each month check and if needed level the collector.
13. **Wearing a new set of clean gloves**, place the new sample bottle into the overflow container leaving the cap in place.
 - Record the Sample Bottle MDN# (Section 3, next week's MOF)
14. Assemble the new glass funnel-thistle tube train, and insert into the 1st chimney with the Ziploc bags on.
15. Remove the Ziploc bags.
16. Raise the sample bottle on the bottle jack up to just below the thistle tube, allowing room to remove the bottle cap.
17. **Wearing a new set of clean gloves**, remove the cap and place in the bottle bag and store inside the enclosure.
18. Adjust the height of the sample bottle to meet the thistle tube. Ensure that the weight of the glass funnel-thistle tube train is primarily supported by the mouth of the sample bottle.
 - Record sample on date and on time (Section 3, next week's MOF)

19. Facing away from the sample chimneys, blow off any remaining water from the rain sensor. The lid should cycle back and come to rest on top of the funnel.

20. Complete the previous weeks's MOF and place the yellow and white copies in the shipping cooler. The pink copy is placed in the file folder at the Air Quality station. Leave next week's MOF on counter.

- Enter Rain Gauge precipitation data. Only from Tuesday to Tuesday.

21. Ship sample to Frontier Geo Science. Place white and yellow copies of the MOF into the cooler. Preprinted mail labels are in a file folder at the Air Quality station.

NADP-MDN Site Liaison Contact Information:

Frontier Global Sciences

MDN Hg Analytical Lab

11720 North Creek Pkwy North

Suite 400

Bothell, WA 98011

(206) 622-6960

Appendix C

SOP #3: Bettles Air Quality Station IMPROVE Sampling Field Guide

Backup or new site operators must review the IMPROVE Standard Operating Procedure – SOP 201 Version 3 (SOP 201-3) sampler Maintenance by Site Operators prior to arrival at the site. This is the approved sampling SOP which contains important QA/QC and sampling information. The following check list is a field guide to be used in conjunction with the approved SOP. This field guide is to be used in conjunction with the approved SOP. The field guide addresses site specific issues that occur at the Bettles Air Quality Station.

1. The second week in the three week sampling cycle the pumps will be running when you arrive at the station. This is good, samples are being collected (see item 13). It is OK to interrupt the sampling to replace the cartridges. On the third week the flash card will be replaced (see Item 17).

Begin by filling out name, date, and time on previous weeks Field Form which is hanging on the wall next to the control module.

Control Module Screens

2. Open the control module door (which is located in the heated side of the building) if the pumps are not running this initial screen will be displayed.

A	B	C	D
OFF	OFF	OFF	

OR

If the pumps are running this screen will be displayed.

05/11/10	11:35	Tue
Fil 30n	Temp=107V	
Fil 1	Fil 2	Fil 3
24hrs	24hrs	11hrs

Press the Enter button to begin.

3. Select (F1) to collect Final Filter Readings

F1 = Filter Readings
F2 = Change Date & Time
F3 = Advanced Menu
Enter = AUTO MODE

4. Select (Yes) to Continue.

Filter Reading	
Press	
Yes	to Continue
No	to Cancel

5. The screen will read “Testing memory card.”
- it will then go through a series of screens.

Testing Memory Card

6. Then the pumps will come on and this window will be displayed.

Storing exposed filter readings.

7. Press the number corresponding to your initials, or press 4 and Enter you initials.

Select a number
Primary: 1 - ZR
Backup: 2- BA, 3 – TW
4- Enter new operator

8. Record the temperature measurement, “T=95V”, in the blank labeled “CurTemp” on the top right of the logsheet. (The temperature measurement is displayed in units of millivolts.)

Used Week: 05/05/10
Logsheet Entry T=95V
05/06/10 10:37am Tue
Hit ENTER when ready

9. Hit Enter, and the following screen will appear.

10. The pumps will turn on as the Final Readings are collected for each cassette. Record the Final Readings (Vac, Mag, and ET) for each module on last week's Field Log.

- Press (F4) to go to the next Filter, or (F3) to return to the previous reading.

IMPROVE Network Field Log						Preweighed by: PL		
2566		INSTALL ON =>		SIPSI 08/24/2004		08/31/2004		
0.014,957						Cur Temp		
INITIAL READINGS						FINAL READINGS		
Operator's Initials: _____		Date: ____/____/____		Time: _____		Date: ____/____/____		Time: _____
SamDate	SamTime	Mod	Cass	Vac	Mag	Vac	Mag	ET
08/25/2004	0000 Wed	Mod A	1	---	---	---	---	---
08/28/2004	0000 Sat		2	---	---	---	---	---
08/31/2004	0000 Tue		3	---	---	---	---	---
08/25/2004	0000 Wed	Mod B	1	---	---	---	---	---
08/28/2004	0000 Sat		2	---	---	---	---	---
08/31/2004	0000 Tue		3	---	---	---	---	---
08/25/2004	0000 Wed	Mod C	1	---	---	---	---	---
08/28/2004	0000 Sat		2	---	---	---	---	---
08/31/2004	0000 Tue		3	---	---	---	---	---
08/25/2004	0000 Wed	Mod D	1	---	---	---	---	---
08/28/2004	0000 Sat		2	---	---	---	---	---
08/31/2004	0000 Tue		3	---	---	---	---	---

After Finals Move Cassette to Hole in Next Cartridge Plate
Always Orient each Cartridge Plate as per Instructions on each Door

Lab Use Only 42.709 41.062 41.275 40.331 42.213 39.018	comments: _____	For Help Call (509) 752-1123
---	-----------------	------------------------------

Mod (A)			
Cass	Vac	Mag	ET
(FIL 1) 12		15	
1440			

This completes last week's Field Log. It can be placed in last week's sample cartridge Ziploc bag.

11. Select Continue with clean readings, select (F4).

F3	-	GO Back to take EXPOSED Readings
F4	-	Continue with CLEAN Readings

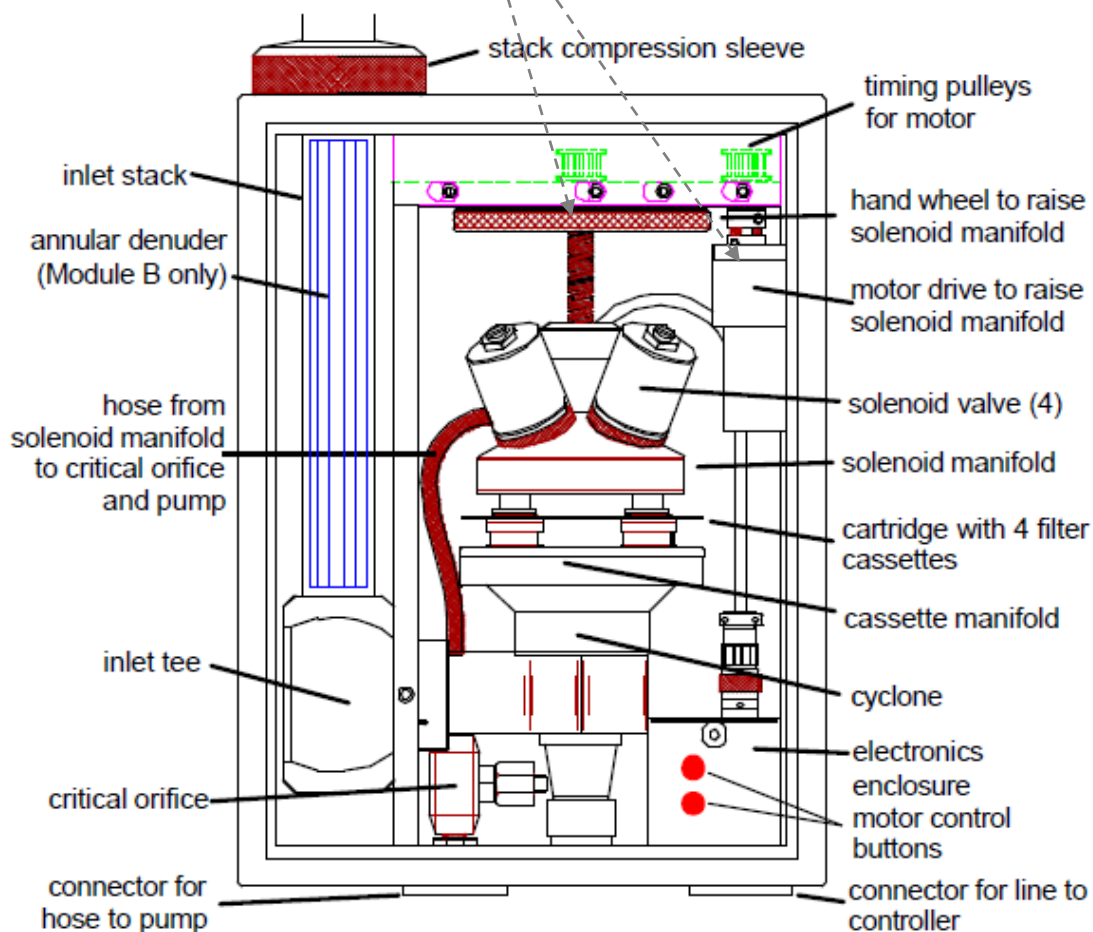
12. The following screen will appear. Hit Enter.

USE Week: 05/11/2010
Logsheet Entry T=107
05/11/10 11:40a Tue
HIT ENTER When Ready

13. If it is a standard sampling day the screen will now prompt you to change the filter cartridges. These two screens will alternate on the display. Remove last week's filter disks and install the new ones.

STANDARD change Remove EXPOSED
↑ ↓
Catridges & insert The clean cartridges Press ENTER if done

(Winter) at -20°F and colder the motor that opens the solenoid manifold does not work. The motor need to be disconnected and the solenoid manifold opened by hand. To open just turn the wheel by hand.



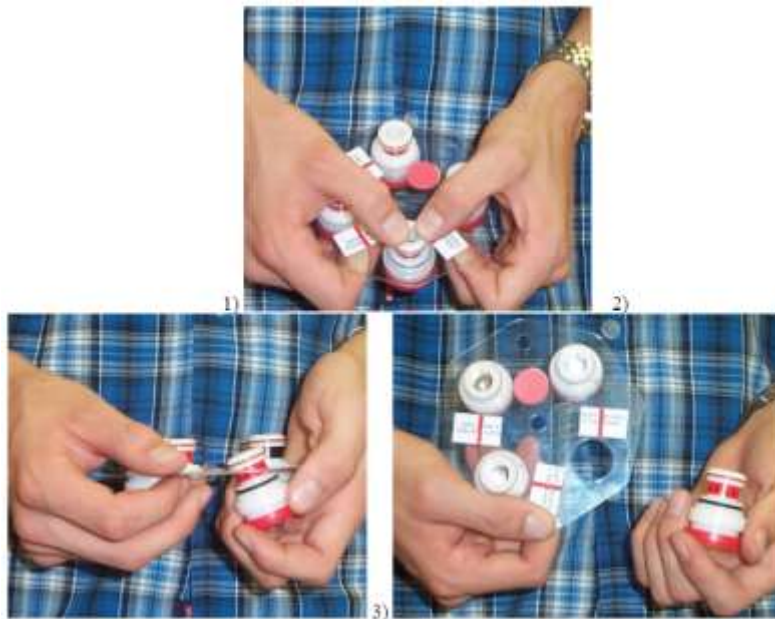
If it is a Tuesday where the Modules are collecting samples you will need to transfer the cartridges with the black O-ring from last weeks cartridge to this weeks cartridge (see picture below) and the screens on the right will alternate on the display.

NON-STANDARD change Remove EXPOSED Cartridges and move



O-RING to the CLEAN Cartridges & insert The CLEAN cartridges Press ENTER if done

Transferring Black O-ring cartridge



14. Press Enter when finished. The Pumps will begin to run as the clean readings are being recorded.

- Place the completed Field log in last week's Ziploc bag.
- On the new Field Log record your initials, date, time.

15. Record Initial Readings

- The MxVac for each module is only entered once.
- Use (F4) to move to the next cassette

Mod (A)
Cass MxVacVac
Mag
(FIL-1)40 12 32

IMPROVE Network Field Log				Preweighed by: PL			
2566				08/03/2004			
INSTALL ON: SIPS1 08/24/2004				0.014.957			
INITIAL READINGS				FINAL READINGS			
Operator's Initials: _____		Date: ____/____/____		Init: _____		Date: ____/____/____	
Time: ____:____:____		Time: ____:____:____		Time: ____:____:____		Time: ____:____:____	
SumDate	StrTim	MxVac	Cass	Vac	Mag	Vac	Mag
08/25/2004	0000 Wed		1				
08/28/2004	0000 Sat	Mod A	2				
08/31/2004	0000 Tue		3				
08/25/2004	0000 Wed		1				
08/28/2004	0000 Sat	Mod B	2				
08/31/2004	0000 Tue		3				
08/25/2004	0000 Wed		1				
08/28/2004	0000 Sat	Mod C	2				
08/31/2004	0000 Tue		3				
08/25/2004	0000 Wed		1				
08/28/2004	0000 Sat	Mod D	2				
08/31/2004	0000 Tue		3				

After Finals Move Cassette to Hole in Next Cartridge Plate
Always Orient each Cartridge Plate as per Instructions on each Door

Lab Use Only 42.708 41.002 41.275 40.331 42.213 39.018	comment: _____	For Help Call (530) 752-1123
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16. When the Initial Readings are all collected, check that all the blanks on the left side of the log sheet are filled in. If complete press (F4) or to redo press (F3)

F3 – GO BACK to take
CLEAN filter readings
F4 – FINISH

17. The Pumps will come on and this screen will appear on the display. On the third week of sample collection you will be prompted to replace the flash “memory” card with a new one which is located in the 1st week sample cartridge bag in the next box of samples. Place the flash card with the third week of completed sample cartridges.

One moment please
Storing Clean Readings

18. The clean filter readings will now be recorded on the flash card, and a series of temporary informational screens (“One moment please.”) will indicate the status. Then the sampler will return to the AUTO MODE, and a current status screen will be displayed.

05/06/10 08:00 * TUE			
A	B	C	D
OFF	OFF	OFF	

----OR----

If it is a sampling Tuesday, the sampler will resume sampling on Filter3. A series of informational screens will appear indicating that the pumps are being started and the sensors are being recorded. Then, a current status screen will appear.

05/06/10 04:00p * Tue			
Fil 3 ON,		Temp=95V	
Fil 1	Fil 2	Fil3	
0hrs	0hrs	0hrs	

19. Make certain that a current status is showing on the screen before you leave.

20. If you have any problems during the sample change, contact UC Davis (see info below).at (530)752-1123.

21. If this is the last (third) bag of samples in the Box, return the box containing the sample cartridges for the three weeks and the old memory card to UC Davis as soon as possible. Simply reverse the mailing label in the plastic pocket and send the box through the U.S. mail.

Contact Information:

Crocker Nuclear Laboratory
One Shields Avenue
University of California
Davis, CA 95616-8569

(530)752-1123
fieldops@crocker.ucdavis.edu

Appendix D

SOP #4: Preparing an Annual Air Quality Report

This SOP gives step-by-step instructions for producing annual air quality monitoring reports by park unit. Efficient reporting of monitoring results is critical in assisting park resource managers with management decisions. An example report in the proper format is provided as Appendix F of this document. Please use the text provided in this report as a template for preparing future reports.

Annual ARCN air quality reports are prepared only for parks with more than one type of monitoring, currently including Gates of the Arctic NP (GAAR), which is a Class II air quality area. It is not necessary for individuals preparing annual ARCN air quality reports to have strong backgrounds in air quality. The report can be prepared sufficiently without extensive background, but the preparer is required to interpret graphs acquired from external sources. If the preparer desires more in-depth interpretation, s/he should contact Air Resources Division personnel for more information (<http://www.nature.nps.gov/contact/>; Ellen_Porter@nps.gov; or John_D_Ray@nps.gov).

Report Format

Annual reports should be written in Natural Resource Data Series format. A template and documentation can be found on the NPS Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/index.cfm>).

Report content

Reporting for each park will include air quality parameters monitored in that park. At GAAR, wet deposition, and particle (or aerosol) visibility are monitored.

Introduction

This section should not change appreciably from one reporting interval to the next.

Methods

This section will not change appreciably from one reporting interval to the next unless monitoring methods are changed.

Results

NPS-ARD summary. The NPS-ARD reports trends in air quality parameters every year, with associated statistical significance, in compliance with the Government Performance and Results Act (GPRA) for NPS sites with long-term monitoring. For wet deposition, the parameters are annual sulfate, nitrate, and ammonium concentrations for the past 10 years.

A nonparametric regression technique (the Theil test) is used to determine statistically significant trends. Probabilities of $\leq 5\%$ are considered to be statistically significant. Increasing or decreasing concentration trends with probabilities of $\leq 15\%$ are also considered to allow for early detection of deteriorating or improving conditions.

To download the NPS–ARD summary:

1. Direct the web browser to <http://www2.nature.nps.gov/air/who/npsPerfMeasures.htm>.
2. Select “detailed results” and save in O:\Monitoring\Vital Signs\Air Contaminants\Reports\Annual reports using the existing file name.
3. Select Back. Right-click on the graphic displaying air quality trends in all parks and save as a .gif file for use as Figure 1 in park-specific air quality reports.
4. If possible, open the file in Adobe Acrobat (the full version, not the Reader) and extract the page with the Air Quality Trends in National Parks, Year–Year” graphic (Document/Extract Pages/Extract Pages As Separate Files).
5. Ascertain information from “detailed results” report for park of interest (GAAR).

Use this information to prepare first paragraph of the report’s “Results” section.

.

Wet deposition (NADP).

Concentration data—. Because concentration is not dependent on precipitation amount, concentration data are useful for examining spatial and temporal trends.

To download concentration graphics:

1. Direct the web browser to the NADP homepage (<http://nadp.sws.uiuc.edu/>). Choose “Isopleth Maps”, then “Annual Isopleth Maps”.
2. Select the appropriate year.
3. Select both the .gif and .pdf options for “SO₄ Concentrations” (sulfate).
4. Save the files in the report folders for GAAR, adding the park code, year, and “conc” to the file name (e.g., GAAR_2004_SO₄conc.gif).
5. Repeat steps 3–4 for both “NO₃ Concentrations” (nitrate) and “NH₄ Concentrations” (ammonium).

Deposition data—. Deposition data are useful for evaluating the amount of pollutant that is

delivered to an ecosystem. Deposition is dependent on precipitation amounts (deposition = concentration $\times$ precipitation), and therefore may differ significantly from year to year.

To download deposition graphics:

1. Follow steps 1–2 above.
2. Select both the .gif and .pdf options for both “N Deposition from NO₃ and NH₄” (nitrogen deposition from nitrate and ammonium) and “SO₄ Deposition” sulfate deposition.
3. Save the files in the report folders for GAAR, adding the park code and year to the file name (e.g., GAAR_2004_SO4dep.gif).

Note: These maps will be the same in all park reports for the reporting year.

Use this information to prepare the “Atmospheric deposition/Regional patterns” portion of the “Results” section.

Site summary—.

To download site summary data:

1. Direct the web browser to the NADP homepage (<http://nadp.sws.uiuc.edu/>), choose “Data Access”, and then click on the appropriate state (Alaska).
2. Select the appropriate site Gates of the Arctic, SiteID AK06.
3. Select “Annual Data Summaries”, then select the appropriate year. Save this pdf file to the report file as ParkName_Year_NADP_Summary.pdf (e.g., GAAR_2004_NADP_Summary.pdf).

Site trends—. As noted above, concentrations are useful for temporal trends, as they are not significantly influenced by yearly fluctuations in rainfall.

To download site trend data:

1. Repeat steps 1–2 above.
2. Select “Trend Plots”.
3. Select NO₃, “mg/L” for units, and click “Create Plot”. Save as ParkName_Year_no3_trends.mht (Web Archive, single file; e.g., GAAR_2004_no3_trends.mht).
4. If Adobe Acrobat (the full version—not the Reader) is available, right-click on the image and Convert to Adobe PDF. Save as ParkName_Year_no3_trends.pdf.

5. Select Back, repeat steps 3–4 for NH₄ , “mg/L” for units. Save the graph as Park-Name_Year_nh4_trends.mht[/pdf] (e.g., GAAR_2004_nh4_trends.mht).

6. Select Back, repeat steps 3–4 for SO₄ , “mg/L” for units. Save the graph as Park-Name_Year_so4_trends.mht[/pdf] (e.g., GAAR_2004_so4_trends.mht).

A link to “Trends notes” describes how the trend lines were created and discusses data completeness criteria.

Use this information to prepare the “Atmospheric deposition/Site trends” portion of the “Results” section.

IMPROVE

Spatial and seasonal trends—. To download spatial and seasonal trends data for Gates of the Arctic:

1. Direct the web browser to the VIEWS website (<http://vista.cira.colostate.edu/views/>). On the left, under Annual Summary, select “Spatial Patterns”.
2. Select “Worst 20% days”, “aerosol_bext”, and year of interest.
3. Click on park of interest. The map will take a while to load.
4. Right-click on the map and save in O:\Monitoring\Vital Signs\Air Contaminants\Reports as Parkname_ Year_bext_Worst20Map.gif (e.g., GAAR_2004_bext_Worst20Map.gif).
5. If Adobe Acrobat (the full version—not the Reader) is available, right-click on the image and Convert to Adobe PDF. Save as Parkname_Year_ bext_Worst20graph.pdf.
6. Repeat steps 4–5 for the bar graph below the map. Save as Parkname_Year_ bext_Worst20graph.gif[/pdf] (e.g., GAAR_2004_bext_Worst20graph.gif).

7. Select “Best 20% days”. The map will update automatically but, again, takes a while. Repeat steps 4–6. Save as Parkname_Year_bext_Best20graph.gif[/pdf].

Use this information to prepare the “Visibility/Spatial and seasonal trends” portion of the “Results” section.

Site trends—. To download site trends data:

1. Direct the web browser to Direct the web browser to the VIEWS website (<http://vista.cira.colostate.edu/views/>). On the left, under Annual Summary, select “Trends”.
2. Under “Site Selection/Site Selection Panel,” select “Show”.
3. Select the park(s) of interest.
4. Under “Parameters,” select “aerosol_bext”.
5. Under “Aggregations” select “Best 20%”, “Worst 20%”, and “1 Year” moving average.
6. Under “Display Options” select “Timeline” chart and “Line”.
7. Select “Update”.
8. Right-click on the map and save in VO:\Monitoring\Vital Signs\Air Contaminants\Reports as Park-Name_bext_trends_Date.png (e.g., GAAR_2004_bext_Worst20Map.png).
9. If Adobe Acrobat (the full version—not the Reader) is available, right-click on the image and Convert to Adobe PDF. Save as ParkName_bext_trends_Date.pdf.
10. Open (“Show”) spreadsheet under graph; note value of aerosol_bext for 20% worst days. This value is the average light extinction value for the 20% worst days and can be used in visibility discussion to summarize annual information. Also note the value of aerosol_bext for 20% best days.

Use this information to prepare the “Visibility/Site trends” portion of the “Results” section.

Composition of visibility-reducing fine particles—. To download particle data and graphs:

1. Direct the web browser to the VIEWS website (<http://vista.cira.colostate.edu/views/>). On the left, under Annual Summary, select “Composition”.
2. Under “Site Selection/Site Selection Panel,” select “Show”.

3. Select the park(s) of interest, update chart.
4. Right-click on the bar chart and save in O:\Monitoring\Vital Signs\Air Contaminants\Reports as Park-Name_hazecomp_Date.png (e.g., GAAR_hazecomp_2-2006.png).
5. If Adobe Acrobat (the full version—not the Reader) is available, right-click on the image and Convert to Adobe PDF. Save as ParkName_hazecomp_Date.pdf.
6. Repeat steps 5–6 for the pie charts. Save as ParkName_hazecomp_piechart_Date.png[/pdf].

Use this information to prepare the “Visibility/Composition” portion of the “Results” section.

Discussion and Conclusions

Briefly describe the status and trends of each of the air quality. If you desire more in-depth discussion or interpretation of a particular parameter, contact Air Resources Division personnel for assistance (<http://www.nature.nps.gov/contact/>; Ellen_Porter@nps.gov, or John_D_Ray@nps.gov).

Revision History Log

Previous version number	Revision date	Author	Changes made	Reason for change	New version number

Appendix E

SOP #5: Revising the Protocol Narrative and SOPs

This Standard Operating Procedure explains how to make and track changes to the Air Quality Monitoring Protocol Narrative and associated SOPs for the Arctic Network (ARCN) units of the National Park Service (NPS). The protocol narrative and SOPs were based on existing procedures for acquiring air quality data, and on current perceptions of the types of analyses and reports most useful to park managers and researchers. However, the protocol narrative and SOPs will require modifications as sensors, equipment, laboratory procedures, data retrieval capabilities, and information needs change. Changes should be evaluated first in terms of cost and benefit, then subjected to appropriate review and, if approved, implemented in a timely manner.

SOP #5 must be followed when making changes to ensure that previous data collection and processing procedures are clearly understood when using and interpreting historical datasets. Similarly, clearly articulating new methods is key to credible interpretation of data acquired since the implementation of changes. Personnel making changes must be familiar with this SOP to ensure that proper reviews are conducted and that documentation standards are followed.

Procedures

1. Data collection and availability. The ARCN air quality monitoring effort relies on an existing station that is sponsored by various national programs. Tracking changes in data collection methods and data availability will require data management staff to frequently review air quality station metadata and data availability. Station metadata should be reviewed at least once each year. Data access evaluation is accomplished through the annual acquisition of air quality data and documentation of changes in data access policies.
2. Review. Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by ARCN Inventory & Monitoring staff. An outside review is required for substantive changes to methods. Regional and national NPS staff and outside experts familiar with air quality monitoring and data analysis will review major changes.
3. Documentation. All changes must be documented. Updated protocol revisions must be recorded in the Revision History Log that accompanies the protocol narrative and each SOP. Changes are recorded only in the protocol narrative or the SOP being modified. Version numbers will increase incrementally by hundredths (e.g., version 1.01, version 1.02, etc.) for minor changes. Major revisions will be designated with the next whole number (e.g., version 2.0, 3.0, 4.0, etc.). The following must be recorded: previous version number, date of revision, author of revision, paragraphs and pages where changes are made, and reason for the changes along with the new version number.

4. Master Version Table. Narrative and SOP updates may occur independently. That is, a change in one SOP will not necessarily invoke changes in other SOPs; a narrative update may not require SOP modifications. All narrative and SOP version changes must be noted in the Master Version Table (MVT), which is maintained in this SOP. Any time a narrative or an SOP version change occurs, a new Version Key Number (VK#) must be created and recorded in the MVT, along with the date of the change and the versions of the narrative and SOPs in effect. The VK# increases by increments of whole integers (e.g., 1, 2, 3, 4, 5). The protocol narrative, SOPs, and data should not be distributed independently of this table.

5. Record-keeping. Previous versions of the protocol narrative and SOPs must be archived in the ARCN Air Quality Protocol Library.

Revision History Log

Previous version number	Revision date	Author	Changes made	Reason for change	New version number

Master Version Table

Version Key #	Date of change	Narrative	SOP #1	SOP #2	SOP #3	SOP #4

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NPS 965/115748, July 2012

National Park Service
U.S. Department of the Interior



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