2003 Calendar

IMPROVE

Interagency Monitoring of Protected Visual Environments

THE IMPROVE PROGRAM

GRAND CANYON NATIONAL PARK

The Interagency Monitoring of Protected Visual Environments (IMPROVE) Program is a cooperative air quality monitoring effort between federal land managers; regional, state and tribal air agencies; and the Environmental Protection Agency. The IMPROVE monitoring program was established in 1985 to aid in the implementation of the 1977 Clean Air Act goal of preventing future and remedying existing visibility impairment in 156 Class I areas (National Parks, Wilderness Areas, and Wildlife Refuges). The network began operating in 1988 and currently consists of 163 monitoring sites collecting aerosol and optical data. These data are critical for the implementation of our national goal to reduce regional haze in Class I areas by establishing the current visibility conditions, tracking the progress toward attaining the goal, and identifying the chemical species and emission sources responsible for existing visibility impairment.

IMPROVE Network Regions

Grand Canyon National Park is among the most extensively monitored parks in the country. Qualitative measurements of air quality were first made in 1972. Scene monitoring to document haze impacts on scenic views began in September 1983. More intensive visibility monitoring was initiated in July 1987 with the installation of a transmissometer, nephelometer, and particle sampler. IMPROVE protocols began in 1988 and are overseen by Carl Bowman, Air Quality Program Director, who also oversees Grand Canyon's Dataram real-time smoke monitoring program. In 1989 an additional transmissometer and a particle sampler were installed to sample inner canyon air. In addition to visibility monitoring, Grand Canyon participates in numerous other air quality monitoring programs. The National Park Service Gaseous Pollutant Monitoring Network and EPA Clean Air Status and Trends Network (CASTNet) measure ozone, sulfur dioxide, and dry acid deposition. Precipitation samples are analyzed for acidity and various dissolved pollutants as part of the nationwide National Trends Network (NTN). Ultraviolet radiation is measured as part of the USDA national UV-B monitoring network, and dioxin levels are measured through the National Dioxin Ambient Monitoring Network (NDAMN).

Air pollution impairs visibility at Grand Canyon N.P., obscuring views to some extent 90% of the time. Visibility today is 60 miles less than it would be under natural conditions and averages about 20% worse in the inner canyon as compared to visibility on the rim. The rich history of monitoring and intensive monitoring campaigns over the years have supplied a long term, high quality record of many air quality parameters. These measurements enable us to understand the nature of the air quality problem and to identify major sources contributing to the problem.

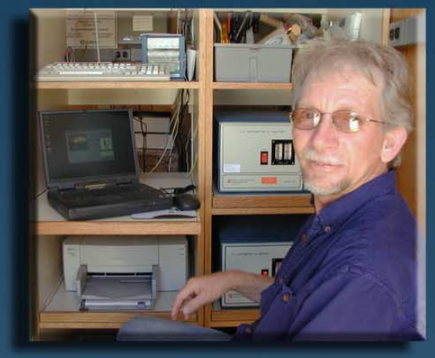
Through cooperative research programs involving federal and state agencies, and with the active participation of industry, the contribution of two power plants on the Colorado Plateau has been identified. As a result, these plants are installing, or have installed, pollution control equipment to reduce emissions. However, the visibility continues to be degraded from sources both in the vicinity of the park and from those located up to hundreds of miles away. To find further solutions to the air quality problem at Grand Canyon National Park, resource managers are actively participating in the Western Regional Air Partnership (WRAP). WRAP is a cooperation consisting of 13 western states, tribes, the U.S. Departments of Agriculture and the Interior, and the EPA working to address regional air quality problems and find solutions to regional haze across the western states.

Hazy and Clear Days

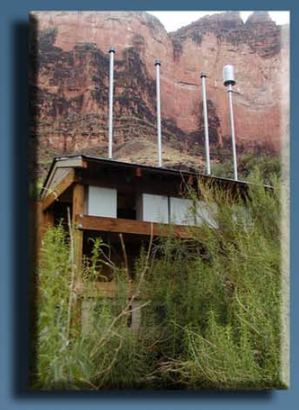
For current visibility, see the Web cam at
www2.nature.nps.gov/ard/parks/grca/grcacam/gracam.htm.

Grand Canyon National Park

March 2003



Hernan Abreau **was born in Puerto Rico. As a biologist for the U.S. Fish and Wildlife Service, he worked for many years on the Endangered Puerto Rican Parrot Project. In 2001 Hernan moved to Grand Canyon National Park with his wife and two daughters, becoming an integral part of the air monitoring programs. IMPROVE site operations include a weekly hike of 4.5 miles descending 3600 feet below the rim to service the inner canyon aerosol monitor ("a task I very much enjoy!"). In addition, Hernan reviews data, maintains the visibility web cam, and helps as needed with the Dataram smoke monitoring program. Data collection percentages at Grand Canyon are impressive; both optical and aerosol data collection was 100% for the 2nd and 3rd quarters of 2002!**



Grand Canyon's inner canyon aerosol sampler is located at Indian Gardens and is accessible only by foot.

The Abyss air quality monitoring site, located near Hopi Point, is the center for collecting meteorological, ozone, sulfur dioxide, and wet/dry deposition data.

Located near the Yavapai Museum, the IMPROVE transmissometer measures air quality between the rim and the receiver station at Phantom Ranch in the inner canyon.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"We are at the very beginning of time for the human race. It is not unreasonable that we grapple with problems. But there are tens of thousands of years in the future. Our responsibility is to do what we can, learn what we can, improve the solutions, and pass them on." Richard P. Feynman - Theoretical Physicist 1918-1988						1 IMPROVE particle sampling day
2	3	4 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	5	6	7 IMPROVE particle sampling day	8
9	10 IMPROVE particle sampling day	11 Change IMPROVE particle cartridges.	12	13 IMPROVE particle sampling day	14 100th Anniversary of the creation of the National Wildlife Refuge System	15
16 IMPROVE particle sampling day	17 St. Patrick's Day	18 Change IMPROVE particle cartridges.	19 IMPROVE particle sampling day	20	21 Spring Begins	22 IMPROVE particle sampling day
23	24	25 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	26	27	28 IMPROVE particle sampling day	29
30	31 IMPROVE particle sampling day					

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ARS: *Optical*:
Carter Blandford or
Dave Beichley
Photography:
Karen Fischer
(970) 484-7941

"Operator Involvement-- The Key to Network Success"

IMPROVE MONITORING METHODS

DOLLY SODS - OTTER CREEK WILDERNESS AREA

Monitoring methods can be categorized into three classes:

Optical Monitoring

Nephelometers and transmissometers record the optical characteristics of the atmosphere, providing measurements from which estimates of visual range can be calculated. Optical measurements cannot be used to identify sources of air pollution.

The transmissometer makes a long path measurement of extinction (the total amount of light lost over a viewing path due to both scattering and absorption).

The integrating nephelometer makes a point or localized measurement of scattering due to atmospheric particles and gases.

Scene Monitoring

Cameras and time-lapse video record the changing appearance of a scene as haze levels, lighting, cloud cover, and vegetation vary.

Aerosol Monitoring

All IMPROVE program sites conduct aerosol monitoring. Aerosol samples give information about the type of particles that affect visibility. Through sample analysis, particle size, chemical composition and concentration are characterized. Particle measurements in conjunction with optical measurements allow estimation of the sources of visibility-reducing aerosols and causes of impairment.

Located in the Monongahela National Forest of West Virginia, the Bearden Knob monitoring site is located 10 miles equidistant from the Dolly Sods and Otter Creek Class I Wilderness Areas. The monitoring location was chosen to be representative of air quality conditions common to both wilderness areas. The Wilderness Act of 1964 mandates the Forest Service to manage these areas as "a place where protection of natural processes is the highest priority use."

The plant life and climate in this part of the southern Appalachians resembles northern Canada, and many species found here are near their southernmost range. These ecosystems are particularly sensitive to wet and dry deposition. Spruce and fir forests found at higher elevations are more susceptible to the effects of acid deposition than other types of forests, especially where clouds can be as acid as vinegar. At elevations above 3,000 feet the fragile high elevation lakes and perennial streams of the area have low acid neutralizing capacity and the Forest Service is concerned about chronic acidification.

IMPROVE aerosol sampling began in the Dolly Sods / Otter Creek area in September 1991. Current IMPROVE data show that half the time visibility is 32 miles or less, and on 10% of the haziest days visibility is less than 15 miles. Current average annual visibility at Dolly Sods / Otter Creek is about 24 miles compared to the natural visibility of 90 miles. Sulfate particles are by far the greatest contributor to this visibility-reducing haze, and the sulfur dioxide emissions that produce sulfates come largely from coal combustion.

Dolly Sods - Otter Creek Wilderness Area

Air Quality monitoring at Bearden Knob, WV, and *Layne Godwin* seem almost inextricable. Injuries from a car accident while working for the West Virginia State Police necessitated Godwin's retraining in computer technologies and then as a site operator at the Northeastern Research Station of the Forest Service in 1991. Since then, much of the site's evolution mirrors Layne's dedication and initiative. He commutes to the site every other day - an hour "in good weather" - from home in Elkins, West Virginia. The Canaan Valley - home to the three East Coast ski resorts of Canaan Valley, Timberline, and Snowshoe - has some of the fiercest weather in the lower 48, rivaling even frigid climes like International Falls, MN for the distinction of the "coldest spot in the nation." Layne describes one 7-foot snow day in particular and the more routine winter temperatures of -30 degrees as one of the more finger-numbing challenges of monitoring here.

Rain Gauge Tipping Bucket

Although being a father to four boys keeps him busy, Layne maintains an exemplary data capture history, including 100% aerosol and nephelometer data collection in the second quarter of 2002! In addition to two Anderson particulate samplers employed to QA/QC IMPROVE monitoring, Layne services an ozone monitor, sulfur dioxide/nitrogen oxide gas monitors, and a full complement of meteorological instruments.

Bearden Knob air quality monitoring site.

April 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"Of all ebriosity, who does not prefer to be intoxicated by the air he breathes?" Henry David Thoreau		1 Change IMPROVE particle cartridges.	2	3 IMPROVE particle sampling day	4	5
6 Daylight Saving Time Begins IMPROVE particle sampling day	7	8 Change IMPROVE particle cartridges.	9 IMPROVE particle sampling day	10	11	12 IMPROVE particle sampling day
13	14	15 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	16	17	18 IMPROVE particle sampling day	19
20	21 IMPROVE particle sampling day	22 Change IMPROVE particle cartridges.	23	24 IMPROVE particle sampling day	25	26
27 IMPROVE particle sampling day	28	29 Change IMPROVE particle cartridges.	30 IMPROVE particle sampling day			

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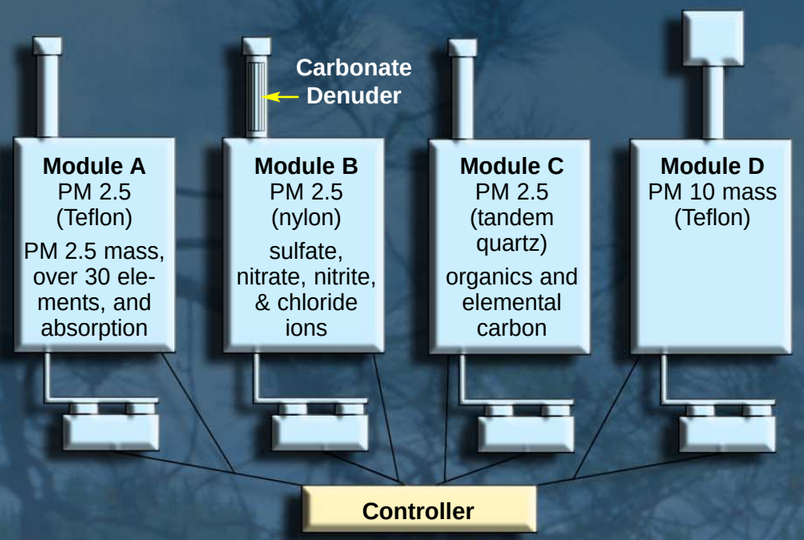
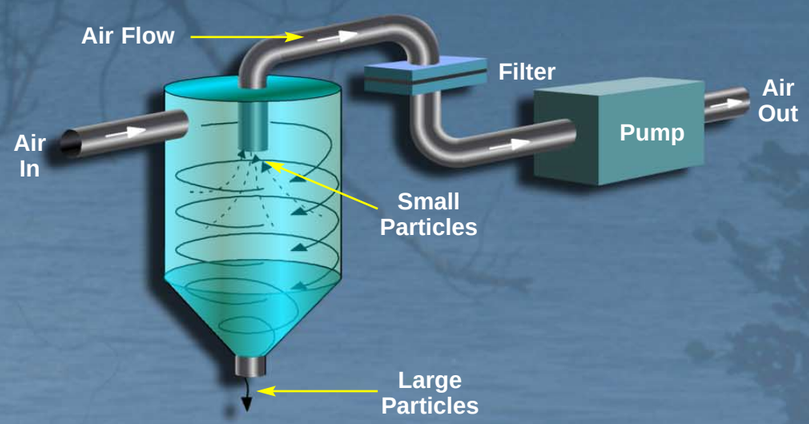
IMPROVE AEROSOL SAMPLER

SENEY NATIONAL WILDLIFE REFUGE



The standard IMPROVE particulate sampler has four sampling modules. Modules A, B, and C collect fine particles (2.5 microns and smaller (PM2.5)), while Module D collects larger particles. Fine particles have the greatest impact on visibility, can adversely affect human health, and are often the result of human activities. Module D collects particles 10 microns and smaller (PM10). The coarse mass (particles larger than 2.5 microns) is primarily composed of soil and carbonaceous material and is often of natural origins. The aerosols are separated by size using a cyclone shown in the figure below.



The IMPROVE fine particle modules employ a cyclone at the air inlet which spins the air within a chamber. Fine particles are lifted into the air stream where they will be siphoned off and collected on a filter substrate for later analysis. The large particles impact on the sides of the chamber and fall into a collection cup at the bottom.

The version II aerosol sampler was introduced into the IMPROVE network in 1999. It employs a new microprocessor controller and implements an upgraded filter cassette design. IMPROVE aerosol data are used for assessing the contribution of various sources to haze. In addition, these data are the basis for tracking progress related to the regional haze regulations.

IMPORTANT: VALID MEASUREMENTS

A visibility impairment value is calculated for each sample day. To get a valid measurement, all four modules must collect valid samples. The Regional Haze Regulation uses the average visibility values for the clean days and the worst days. The worst days are defined as those with the upper 20% of impairment values for the year, and the clean days as the lower 20%. The goal is to reduce the impairment of the worst days and to maintain or reduce it on the clean days. The annual values for each five-year block will be averaged, and trends examined. For your site's data to be considered under the Regional Haze Regulations, criteria have been set to determine the minimum number of daily samples needed to have a valid year. Because concentrations of the groups vary seasonally, there are both annual and seasonal criteria. The criteria are:

- 75% of the possible samples for the calendar year must be complete.
- 50% of the possible samples for each calendar quarter must be complete.
- No more than 10 consecutive sampling periods may be missing.

Filter analysis provides concentrations and composition of atmospheric particles. Common fine particles include sulfates, nitrates, organic material, elemental carbon (soot), and soil. An indication of sources can be obtained from the analysis of trace elements.

vanadium/nickel	petroleum-based facilities, autos
arsenic	copper smelters
selenium	power plants
crustal elements	soil dust (local, Saharan, Asian)
potassium (non-soil)	forest fires

The Seney National Wildlife Refuge is found in the Upper Peninsula of Michigan, midway between the Great Lakes of Michigan and Superior. The 96,000-acre refuge includes 25,150 acres of Class I wilderness, encompassing string-bog wetlands and a mosaic of other habitats, including cedar swamps, old growth hemlock, white pine, and a mixture of upland spruce, fir, pine, aspen, and northern hardwoods.

IMPROVE monitoring began at Seney in December 1999 as part of the network expansion called for by the U.S. EPA regional haze regulations. The National Atmospheric Deposition Program began monitoring the following year. In 2002 the Midwest Regional Planning Organization, the state of Michigan, and the U.S. Fish and Wildlife Service began a cooperative effort to better understand the causes of regional haze in the upper Midwest. Continuous PM 2.5 mass, ozone, meteorology, light scattering (nephelometer), and daily speciated PM 2.5 monitoring are conducted at the site.

IMPROVE data show current annual average visibility at Seney is about 47 miles, compared to natural visibility of 90 miles. In general, sources that contribute to air quality impacts at Seney include paper mills and electric generating plants. Studies at Seney have found high mercury concentrations in some large predatory fish, and vegetation surveys show ozone injury to several species of plants including milkweed.

The Seney Web cam is part of the Midwest Regional Planning Organization's (RPO) visibility camera network. The network includes seven Web-based cameras providing the public with current images and air quality conditions. For current visibility from the Seney fire tower see the Web cam at www.mwhazecam.net/seney.html.

Seney National Wildlife Refuge

Marilyn Heet, **wife of Assistant Refuge Manager Gary Heet, is the IMPROVE site operator at Seney. Marilyn draws upon 22 years of experience working as a medical laboratory technician and is motivated by her concern for the environment. Marilyn's diligence resulted in an aerosol data completeness of 96% for 2002!**

The Heets live in Gulliver, Michigan, about 30 miles south of the refuge. They have been married for 30 years and have two sons; David, age 19, attends Bay College in nearby Escanaba, and Andrew, age 17, is a senior in high school. Marilyn enjoys gardening, reading, sewing, and card games. She also loves animals and wildlife. At present, the Heet's household includes five cats, one guinea pig, one horse, a Springer spaniel, a Brittany, and Marilyn's new Pomeranian, Lassie. Marilyn is also active in avian rehabilitation, primarily hawks and owls. Gary likes to fish and hunt and deal in antique bottles, arrowheads, and other items on Ebay.

Marilyn on top of the shelter housing the nephelometer and meteorological towers. Lassie often accompanies Marilyn to the site.

The air quality monitoring site at Seney is the location of air quality sampling systems for a number of programs including EPA's Clean Air Status and Trends (CASTNet) and IMPROVE networks, the National Atmospheric Deposition Program (NADP), and other special monitoring programs initiated to better understand the causes of haze at Seney.

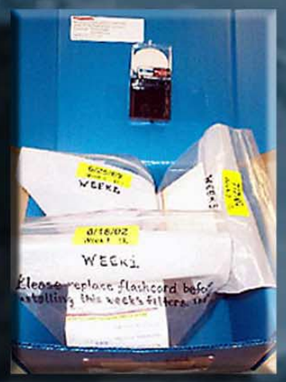
May 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be." Isaac Asimov			**UC-Davis**: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Dave Beichley *Photography*: Karen Fischer (970) 484-7941	1	2	3 IMPROVE particle sampling day
4	5	6 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	7	8	9 IMPROVE particle sampling day	10
11 Mother's Day	12 IMPROVE particle sampling day	13 Change IMPROVE particle cartridges.	14	15 IMPROVE particle sampling day	16	17 Armed Forces Day
18 IMPROVE particle sampling day	19	20 Change IMPROVE particle cartridges.	21 IMPROVE particle sampling day	22	23	24 IMPROVE particle sampling day
25	26 Memorial Day	27 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	28	29	30 IMPROVE particle sampling day	31

"Operator Involvement-- The Key to Network Success"

IMPROVE AEROSOL SAMPLING PROTOCOLS

ACADIA NATIONAL PARK



Each "blue box" contains:

1 flash memory card
3 labeled Ziplock© bags
1 bag/week labeled with install date and 4 color-coded cartridges, one for each module.

Stack of filter cartridges with log sheet.

Four cartridges:
Red for Module A
Yellow for Module B
Green for Module C
Blue for Module D

The "blue box" has three dates listed on the box. These are the dates on which the filters must be installed (all Tuesday dates).

If for any reason you or your backup cannot make a change on a particular Tuesday or the "blue box" is late, or for any problem or question, immediately call UCD's General Lab at (530) 752-1123. Discussing a problem first will avoid confusion, and a proper diagnosis is more likely to be made. NO problem is too small; it could be a sign of bigger problems, such as unusual readings. E-mail to UCD field operations should only be used if phone contact cannot be made. E-mail addresses are in the format of *Lastname*@Crocker.UCDavis.Edu.

The IMPROVE network operates on the one-day-in-three protocol. Sample change is always on Tuesday. (Arrangement of ambient filters varies each week; pattern repeats every third week.)

For two of the three weeks, the sampler will not be operating on the sample-changing day the operator records final readings, replaces old cartridges, and records the initial readings. There will be initial or final readings for the filter in position 3 on two of the three weeks. The log sheet and display indicate when values for position 3 are recorded.

Every 3rd week, the sampler will be operating when the operator arrives. When sample change is initiated the controller will:

- Suspend sampling.
- Read flow rates on all filters and display and record information.
- Transfer the cassette in position 3 from the old cartridge to the new one. (New cartridges have no cassette in position 3. The cassette in position 3 has a black O-ring attaching it -- the only one that can be removed without a special tool.)
- Transfer the cassette and install a new cartridge. After the initial readings are taken, the sampler will resume collection on the filters in position 3.

The field blanks in position 4 are transparent to the operator and to the sampler controller. Flow rate measurements are not taken for field blanks.

For questions or problems with:
Filter boxes, flashcards, and sample changes: contact Sujan Bhattarai, Joan Hancock, Jose Avena, Jose Mojica, or Steven Ixquiac at (530) 752-1123.
Controllers, equipment malfunctions, sampler maintenance, and flow adjustments: contact Jose Mojica at (530) 752-9044, {or cell phone number (530) 867-4391}, or Steven Ixquiac at (530) 752-4108 {or cell number: (530) 304-1468}.
Sampler audits: Steven Ixquiac (see above).

Comprised of a cluster of islands on the Maine coast, Acadia National Park is positioned within the broad transition zone between eastern deciduous and northern coniferous forests. The park hosts several species of plant communities at the edge of their geographic range. While surrounded by the ocean, the entire fabric of Acadia is interwoven with a wide variety of freshwater, estuarine, forest, and intertidal ecosystems. Pollutants from the industrialized Midwest and metropolitan northeast are transported into the park with the winds. Acadia was named one of five most polluted parks by the National Parks Conservation Association in their 2002 *Code Red: America's Five Most Polluted Parks* report.

Acadia National Park has had an air quality monitoring program since 1979. Acadia's air resource program is collaborative, involving the National Park Service Air Resources Division, the Maine Department of Environmental Protection, the U.S. Geological Survey, EPA, universities, and other states. By studying the effects of air pollution on park plants, soil, and water, park managers hope to learn how to protect these resources and the views for which the area is well known. Acadia is one of 14 national parks established as regional index sites to monitor environmental stressors and related ecosystem response.

IMPROVE monitoring began at Acadia in 1987 and includes optical, scene, and aerosol monitoring. Monitoring data show that visibility conditions have improved slightly from 1988 through 1998, but visibility levels are still less than half what they should be at "natural background" levels. Summertime visibility averages about 33 miles. Scientists estimate that approximately 70%of Maine's polluted air comes from outside the state.

Summer ozone levels occasionally exceed federal health standards. The highest ozone concentration reported in Maine was measured at Acadia (Isle au Haut) on June 15, 1988. Ozone concentrations above the federal health standard have been shown to damage sensitive park vegetation.

The effects of atmospheric deposition are another major concern at the park. Acadia's rocky soils give streams little protection from acid rain. Some of the park's headwater streams have experienced episodic acidification, with a pH less than 5.0, between that of black coffee and tomato juice. For two decades, the average pH for precipitation has ranged between 4.4 and 4.6, and fog pH has measured as low as 3.0.

Recent studies discovered high concentrations of mercury in several freshwater fish species sampled in park lakes. The major source of mercury in lakes appears to be deposition from the atmosphere, and it then concentrates in the food chain.

Clear, Hazy, and Very Hazy Days

For current visibility, see the Web cam at www.hazecam.net/acadia.htm.

Acadia National Park

IMPROVE site operator *Bill Gawley* has assisted Acadia's Air Resource Management head Bob Breen since 1993. Bill is a singer-songwriter in the folk tradition and has created an album of his work on CD. He says he has even more time to devote to that interest now that his three children are in college and long cold winters keep him inside. Data recovery here is always one of the highest in the nation. Optical data collected at Acadia was near 100% during the first three quarters of 2002, while aerosol data completeness was near 90% for the year.

IMPROVE monitoring site at McFarland Hill near Cadillac Mountain

Nephelometer tower with Web cam looking NE toward Round Mountain 20 miles distant

Meteorological tower at McFarland Hill

June 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2 IMPROVE particle sampling day	3 Change IMPROVE particle cartridges.	4	5 IMPROVE particle sampling day	6	7
8 IMPROVE particle sampling day	9	10 Change IMPROVE particle cartridges.	11 IMPROVE particle sampling day	12	13	14 Flag Day IMPROVE particle sampling day
15 Father's Day	16	17 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	18	19	20 IMPROVE particle sampling day	21 Summer Begins
22	23 IMPROVE particle sampling day	24 Change IMPROVE particle cartridges.	25	26 IMPROVE particle sampling day	27	28
29 IMPROVE particle sampling day	30					

"The air was so elastic and crystalline that it had the same effect on the landscape that a glass has on a picture, to give it an ideal remoteness and perfection."

Henry David Thoreau, A Week on the Concord and Merrimac Rivers

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FILTER JOURNEYS

MAMMOTH CAVE NATIONAL PARK

Filters cycle through several processes before they reach the monitoring site and after they return to the University of California-Davis.

Pre-Shipping...

1. Clean A and D module filters must be pre-weighed on a balance before shipping the blue box. Clean B and C module filters are simply placed in a cassette without being weighed. This process is called uploading.

2. The uploader weighs the A and D filters. Each filter has an ID according to the site it will be sent to and the date that the filter will be used. Each A and D filter's weight is automatically recorded in a database.

3. After the box has been uploaded, the work is double-checked. This is the final process before the box is shipped out.

After Return From the Field...

4. After the log-sheets and flashcards are removed from the box, the data in the flash card is read and automatically placed into a database.

5. After the flash card is read into the database, its data is compared to the data written on the log sheets. Any problems a box might have are dealt with at this point.

6. The B and C filters are placed in a petri dish with the corresponding identification sticker.

7. The B and C petri dishes are placed in trays in a particular order generated by the database.

8. After the B and C filters are downloaded, the box moves on to the post-weighing station where the sampled A and D filters are weighed.

9. After post-weighing, the filter is stored in a pre-labeled slide mount for later analysis.

10. After downloading the B and C filters and post-weighing the A and D filters, the box is placed back at the uploading station to start the process again.

Mammoth Cave National Park has the longest recorded cave system in the world. It is located in the scenic Green and Nolin River valleys of south central Kentucky. Many natural resources in the park are subject to unfavorable influences from a variety of sources due to its proximity to some of the nation's most polluting coal-fired utility plants in the nearby Ohio Valley. Many of these utilities were built before the passage of the 1977 amendments to the Clean Air Act and are subject to less stringent regulations. Mammoth Cave was named the third most polluted national park in the National Parks Conservation Association's 2002 report *Code Red: America's Five Most Polluted Parks*.

Air quality monitoring at Mammoth Cave National Park began in 1992, and current monitoring is extensive. Measurements include IMPROVE aerosol, scene, and light scattering (nephelometer) measurements in addition to ozone, sulfur dioxide, carbon monoxide, nitric oxide, and total reactive nitrogen. Atmospheric deposition data including mercury are collected through the National Acid Deposition Program (NADP), and the National Dry Deposition Network (NDDN). Air quality monitoring has led to a better understanding of impacts on Mammoth Cave resources.

- Three out of every four park visitors never venture underground but instead enjoy the park's 70 miles of trails with scenic views of rolling forested hills and valleys. Estimated annual average natural visibility at Mammoth Cave is 113 miles. Currently, air pollution reduces average visual range to approximately 14 miles from June through August. Visibility may get worse. There are 26 new power plants proposed over the next five years, of which eight will be coal-fired.
- Mammoth Cave has one of the highest nitrate and sulfate loadings of any national park. Current rainfall can be 10 times more acidic than natural conditions.
- Mammoth Cave often measures high ozone concentrations. Scientists are investigating whether ozone exposure in the park reduces growth in black cherry and sycamore trees, both ozone-sensitive species that provide key nesting grounds for an endangered species, the Indiana bat.
- Mercury concentrations may impact the park's seven endangered freshwater mussel species.

Air resource manager Bob Carson represents Mammoth Cave in the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) Regional Planning Organization. The organization is a collaborative effort of state governments, tribal governments, and various federal agencies established to initiate and coordinate activities associated with the management of regional haze, visibility and other air quality issues in the Southeastern United States.

For current visibility, see the Web cam at
www2.nature.nps.gov/ard/parks/maca/macacam/macacam.htm.

Mammoth Caves National Park

Bob Carson **heads the Air Resources Specialist Science and Resources Management Division at Mammoth Cave. He has overseen the program's evolution and until last year was solely responsible for IMPROVE monitoring operations at the park. IMPROVE site operator Johnathon Jernigan joined the program in January 2002 and brings considerable knowledge and ability to the job. After graduating from Western Kentucky University with a BA in Mathematics in 1996, Jonathon earned his master's a year later at the same institution. His thesis studied airflow and temperature at Mammoth Cave. He participated in cave atmospheric studies with the Student Conservation Association and taught full time in the mathematics department at the university. He has completed two statistical studies on atmospheric data collected at Mammoth Cave's air quality stations prior to his full time appointment at the park. Aerosol and nephelometer data collected averaged 98% for 2002!**

Mammoth Cave's IMPROVE air quality monitoring site

Air resource specialist Bob Carson changing the IMPROVE sampler filters

Green River Bluffs overlook, the location of the IMPROVE scene monitoring camera

July 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"No problem can be solved from the same level of consciousness that created it." Albert Einstein		1 Change IMPROVE particle cartridges.	2 IMPROVE particle sampling day	3	4 Independence Day	5 IMPROVE particle sampling day
6	7	8 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	9	10	11 IMPROVE particle sampling day	12
13	14 IMPROVE particle sampling day	15 Change IMPROVE particle cartridges.	16	17 IMPROVE particle sampling day	18	19
20 IMPROVE particle sampling day	21	22 Change IMPROVE particle cartridges.	23 IMPROVE particle sampling day	24	25	26 IMPROVE particle sampling day
27	28	29 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	30	31		

UC-Davis: *Sampler*:
General Lab
(530) 752-1123

ARS: *Optical*:
Carter Blandford or
Dave Beichley
Photography:
Karen Fischer
(970) 484-7941

"Operator Involvement-- The Key to Network Success"

TROUBLESHOOTING THE FILTER CHANGE

HOOVER WILDERNESS AREA

The first step in correctly diagnosing and solving any problem is to call UCD's General Lab at (530) 752-1123. No problem is too small, and a correct diagnosis is more likely to be made.

Has a filter or filter cartridge been dropped?

The cartridges are well protected and unless the operator is physically forcing air through the media there should be no immediate problem. Pay careful attention to any fluctuation in the normal readings on that particular set of filters. As with any significant event, note it on the logsheet and detail what occurred. Notify UCD about any questions or concerns.

What if the filter gets wet?

Although this can significantly affect the sample, UCD may or may not be able to send a replacement. Call the lab so that UCD can deal with it properly and note it on the logsheet.

Missed changing filters on the regular Tuesday?

Immediately call UCD to get instructions before proceeding with the sample change. Experienced operators should still call UCD to advise of any deviation in the sample changing schedule.

** If there are remaining sampling days in the week:* Remove the exposed filters as would normally be done, and put in the clean filters that were to have been installed on the last change day. Make a note on the logsheet.

** If the week is completely missed:* Remove the exposed filters as would normally be done but do not put in the filters for the missed change day. Keep these in the shipping box and send them back to UCD when both weeks in that box have passed. Install the appropriate filters for the current week. Make a note on the logsheet of the filters that were not installed.

Trouble with the "red button"-controlled motors:

Sometimes when the weather turns cold, the electric motor that raises and lowers the solenoids works very slowly. If this occurs, or if the red-buttons fail to work for any reason, follow these steps:

Modules A-C:
The motor is located in the top right area.

1. Disengage motor by gently pushing down on the top of the motor.

2. "Lockout" the motor by rotating it toward the solenoids.

3. Raise and lower the solenoids by turning the handwheel at the top of the module.

Module D:
The motor is located in the bottom left area.

1. Disengage motor by gently pushing up on the bottom of the motor.

2. "Lockout" the motor by rotating it toward the solenoids.

3. Raise and lower the solenoids by turning the handwheel at the bottom of the module.

For questions or problems with:
Filter boxes, flashcards, and sample changes: contact Sujan Bhattarai, Joan Hancock, Jose Avena, Jose Mojica, or Steven Ixquiac at (530) 752-1123.
Controllers, equipment malfunctions, sampler maintenance, and flow adjustments: contact Jose Mojica at (530) 752-9044 [cell: (530) 867-4391], or Steven Ixquiac at (530) 752-4108 [cell: (530) 304-1468].
Sampler audits: Steven Ixquiac (see above).

The area now known as the Hoover Wilderness was first recognized in 1931 by the Forest Service as an area in need of protection. This primitive area, expanded in 1957, was designated as the Hoover Wild Area. With the passage of the 1964 Wilderness Act, Hoover became one of the first wildernesses in the National Wilderness Preservation System. An adjoining 72,000 acres of pristine national forest lands are being considered for a future addition to this wilderness.

The Hoover Wilderness is rugged and scenic with 12,000-foot mountains, high alpine lakes, and beautiful meadows, but little timber. Rain, snow, strong winds, and bitter cold can occur in all seasons. The Hoover Wilderness shares its western border with Yosemite National Park. This is the only IMPROVE site that is representative of the Sierra Nevada Wilderness east of the divide, and is significant because it provides the only data to give a glimpse of "east side" air quality.

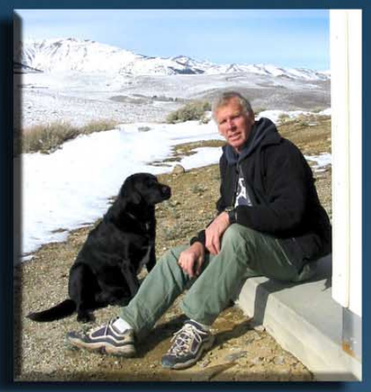
The Hoover IMPROVE site is located on Conway Summit on the north edge of the Mono Lake Basin in eastern California at an elevation of 8,400 feet. The site is just east of the Sierra Nevada crest and was selected by virtue of its proximity to the Hoover Wilderness of the Toiyabe and Inyo National Forests and Yosemite National Park.

IMPROVE aerosol monitoring began at Hoover in July 2001. Current annual average visibility is about 75 miles, a little more than half of the estimated natural visibility. On the clearest days visibility approaches 125 miles, but is often 35 miles or less on very hazy days. The greatest visibility impairment occurs during the late summer and fall months, July through October. The particles primarily responsible for visibility reduction in this area are made up of biogenic carbon, which comes primarily from forest fires, but also from secondary organic aerosols associated with biogenic gaseous emissions.

The USDA Forest Service and the Western Regional Air Partnership (WRAP) are involved in a collaborative effort of tribal governments, state governments, and various federal agencies to address western regional air quality issues in order to comply with the EPA's regional haze regulations. The Hoover IMPROVE site will provide data about current visibility conditions and enable the Forest Service to track progress toward the national goal of one day achieving natural visibility conditions in the wilderness.

Hoover Wilderness Area

August 2003



Larry Ford spent 20 years at the Scripps Institution of Oceanography at the University of California at San Diego. After five years in marine geology and 15 years as principal photographer, he took a year's leave of absence and moved to Mono Lake. Now, twenty years later, he works for the Forest Service on the Mono Lake Ranger District as the assistant manager for the Mono Basin National Forest Scenic Area. His responsibilities include habitat restoration, management of the water resources, interpretation, law enforcement, and the operation of the IMPROVE particle sampler. Access from late spring through early fall is drivable, but during the rest of the year it can be "very interesting," he reports. "Winds in excess of 100 mph are not uncommon and pile the snow into chest-deep drifts in places while leaving bare, frozen ground in others. Even though there's a major highway nearby it can feel very isolated; the storms can be frightening. Some days I imagine myself snowshoeing across a hostile Antarctic landscape with snow blowing horizontally and visibility nearly zero. My trusty, four-footed companion, Caly, is always there, probably wondering if I've lost my mind but allowing me to break track until we get to the welcome shelter of the IMPROVE site." Ford's site data capture is among the highest with 93% of the data being collected in 2002.

Larry Ford and Caly changing IMPROVE sampler filters

Larry is an avid cross-country skier, coaches the Mammoth High School cross-country ski team and spends his spare time doing woodworking, gardening, and raising chickens, all while trying to keep up with a son and daughter, both students at the University of Nevada, Reno!

Hoover Wilderness aerosol monitoring site.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"You cannot escape the responsibility of tomorrow by evading it today." Abraham Lincoln "There is nothing more practical in the end than the preservation of beauty." President Theodore Roosevelt					1 IMPROVE particle sampling day	2
3	4 IMPROVE particle sampling day	5 Change IMPROVE particle cartridges.	6	7 IMPROVE particle sampling day	8	9
10 IMPROVE particle sampling day	11	12 Change IMPROVE particle cartridges.	13 IMPROVE particle sampling day	14	15	16 IMPROVE particle sampling day
17	18	19 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	20	21	22 IMPROVE particle sampling day	23
24	25 IMPROVE particle sampling day	26 Change IMPROVE particle cartridges.	27	28 IMPROVE particle sampling day	29	30
31 IMPROVE particle sampling day						

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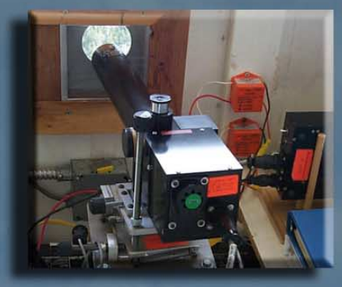
IMPROVE TRANSMISSOMETER

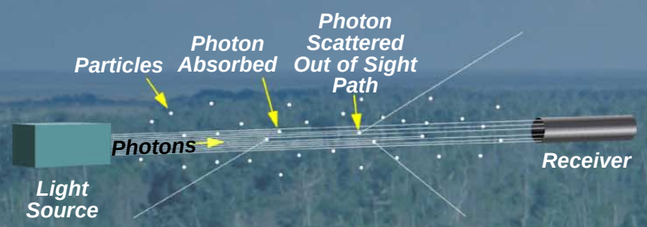
CAPE ROMAIN NATIONAL WILDLIFE REFUGE

Receiver



Transmitter

The Optec, Inc. LPV-2 long path transmissometer has been used by IMPROVE since 1986. Transmissometers provide the most direct measure of the extinction properties of the atmosphere. Extinction is a measure of the number of photons both scattered and absorbed over a known distance through the atmosphere. Extinction data is useful for relating visibility directly to particle concentrations.



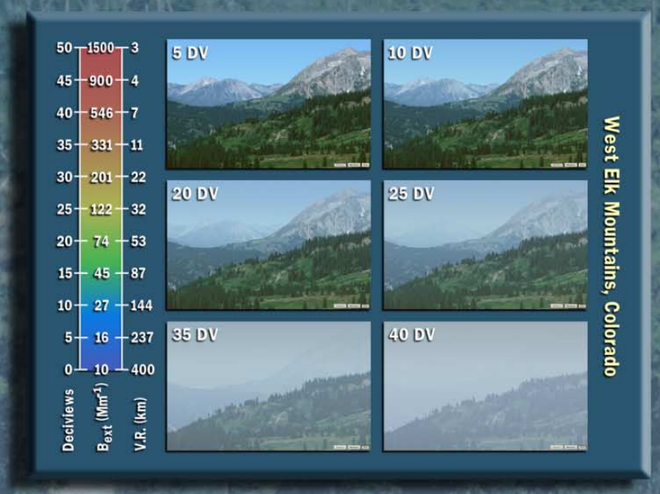
The system consists of an incandescent light source (or transmitter), and a computer-controlled photometer receiver. The transmitter emits a uniform light beam precisely aimed at a receiver located from 1 to 10 kilometers away. The transmissometer receiver measures only the photons that successfully pass through the atmosphere. The receiver isolates transmitter light from ambient light and records the transmission of the intervening atmosphere. Visibility results are calculated and reported as visual range or extinction.

Troubleshooting - The majority of transmissometer problems are caused by:

1. **Misalignment**
2. **Incorrect system timing**
3. **Dirty windows** - Clean window glass once a week. Use canned air or alcohol.
4. **Inadequate power** - Check all surge protector indicator lights. If any are red, contact Carter Blandford or Dave Beichley at ARS at (970) 484-7941. Clean and inspect the solar panels, and fill the lead-acid batteries as needed with distilled water.

Things to Avoid:

1. **Lamp Changes** - Remove lamp by pulling it straight out of the transmitter body. Don't loosen screws on the lamp alignment plate/system or it will need recalibration.
2. **Transmitter Focus** - Do not change the focus of the transmitter telescope or the system will need recalibration.
3. **Radio Transmission** - Do not transmit with hand-held radios within 10 feet of either transmissometer component or the timing may need to be reset.
4. **Computer Resets** - Avoid unnecessary computer resets or the OFF/ON timing may be disrupted.



A comparison of deciviews, light extinction, and visual range, with samples of various haze levels.

The Cape Romain National Wildlife Refuge site is located close to the intercoastal waterway in the marshlands of South Carolina. This area provides habitat for 337 species of birds; contains the largest nesting rookery for brown pelicans, terns, and gulls on the South Carolina coast; plays an integral role in recovery of the endangered red wolf; and hosts the largest nesting population of loggerhead sea turtles outside the state of Florida.

IMPROVE aerosol monitoring began at Cape Romain in September 1994. IMPROVE data shows that current annual average visibility is about 21 miles, compared to estimated natural visibility conditions of 90 miles. Summer months are haziest with 70% of the visibility degradation attributed to sulfates. The refuge also monitors atmospheric deposition as part of the National Atmospheric Deposition Program (NADP). Ozone injury has been documented on vegetation such as sweetgum, virginia creeper, and loblolly pine. Pollution sources include local steel and aluminum manufacturers, vehicle traffic around Charleston, cargo terminals, and power plants.

The U.S. Fish and Wildlife Service actively participates in the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regional planning organization. VISTAS is a collaborative effort of state governments, tribal governments, and various federal agencies established to initiate and coordinate activities associated with the understanding and management of regional haze, visibility, and other air quality issues in the southeastern United States. The VISTAS regional planning organization has chosen Cape Romain as a "focus site" with monitoring expanding in 2003 to include continuous PM2.5 mass, sulfate, carbon, ammonium, nitrogen oxides, and light scattering by a nephelometer.

Cape Romain National Wildlife Refuge

The Cape Romain National Wildlife Refuge achieved an impressive 99% data capture for 2002, in spite of the fact that site operators *Sarah Dawsey* and *Mary Catherine Martin* devote most of their time to wildlife studies for the endangered red wolf and loggerhead sea turtle programs. Sarah, who has been at the refuge since 1986, also oversaw the completion of a five year record of scene monitoring data for the air quality program.

Proper management of air resources is vital to protecting and maintaining the nation's fish and wildlife resources. There are nearly 540 units in the National Wildlife Refuge System. The Service manages 21 Class I areas, wilderness areas exceeding 5,000 acres and totaling 2.3 million acres of natural areas, that provide habitat for a wide variety of wildlife. The Service is required by the Clean Air Act to preserve, protect, and enhance air quality and air quality related values including visibility, flora, fauna, soil, water quality, cultural and historical resources, and virtually all resources that are dependent upon and affected by air quality. Many of these areas are currently, or have the potential to be, impacted by air pollution.

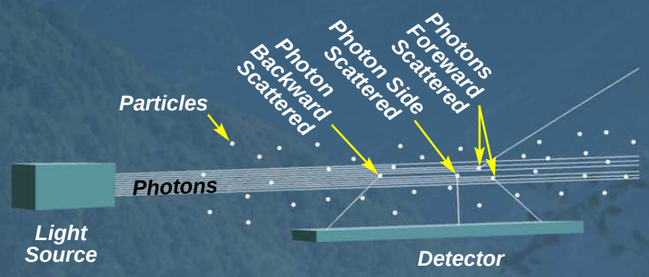
September 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
UC-Davis: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Dave Beichley *Photography*: Karen Fischer (970) 484-7941	1 Labor Day	2 Change IMPROVE particle cartridges.	3 IMPROVE particle sampling day	4	5	6 IMPROVE particle sampling day
7	8	9 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	10	11	12 IMPROVE particle sampling day	13
14	15 IMPROVE particle sampling day	16 Change IMPROVE particle cartridges.	17	18 IMPROVE particle sampling day	19	20
21 IMPROVE particle sampling day	22	23 Autumn Begins Change IMPROVE particle cartridges.	24 IMPROVE particle sampling day	25	26	27 IMPROVE particle sampling day
28	29	30 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	**“An area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.”** Definition of Wilderness from the Wilderness Act of 1964			

IMPROVE NEPHELOMETER

SEQUOIA - KINGS CANYON NATIONAL PARKS

The Optec NGN-2 ambient nephelometer has been used by IMPROVE since 1993. Nephelometers measure the amount of light (photons) scattered by particles and gases in the atmosphere. This measurement combined with estimates of the absorption coefficient (from aerosol monitoring filters) can be used to determine the average total light extinction.



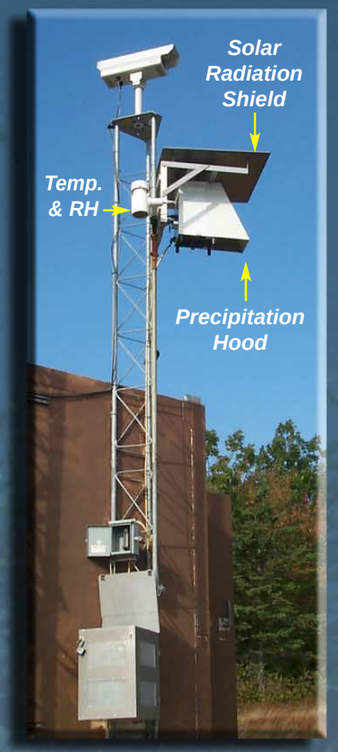
The Nephelometer draws ambient air into a chamber where light of known intensity is emitted over a path parallel to a photodiode detector. With this configuration only the photons that are scattered will be detected. The instrument is designed in such a way that the sampling chamber and light source are confined to a small volume so the instrument makes a "point" or localized measurement of scattering. A direct estimate of atmospheric scattering is made by measuring the light scattered from the front, back, and sides of the optical chamber. Because the scattered light is integrated over a large range of scattering angles, the instrument is referred to as an INTEGRATING nephelometer.

Troubleshooting Front Panel Error Codes:

1. **Error Code -400 (4), door closed, no neph readings:** The lamp is out. Replace lamp, reset neph and check lamp counts (>2000).
2. **Error Code -500 (5), door closed, no neph readings:** Rain event. No operator intervention is required. Readings will return when the sensor is dry.
3. **Error Code -600 (6), door closed, no neph readings:** Incorrect chopper frequency. Reset nephelometer.
4. **Error Code -900 (.920), door closed, locked-up analog readings:** Possible lamp out and/or serial interface malfunction. Reset blue earth and neph. If code changes to -400, replace lamp and check lamp counts.)
5. **Error Code -900 (.920), door open, analog readings only:** Serial data interface failure. Reset Blue Earth serial data buffer and neph and check for serial reading following POST (Power On Self Test).

*Note: When power outages or surges occur, the data logger may lose its program. Reset on the site.

Standard nephelometer stations are mounted near the top of a 14-foot tower on the north face. A solar radiation and precipitation shield are installed to protect the instrument from severe precipitation (rain, hail, snow) and keeps direct sunlight off the monitor. This allows the instrument to be maintained at close to ambient temperatures. Temperature and relative humidity sensors are often installed as part of the standard nephelometer configuration.



Established in 1890, Sequoia is the second-oldest national park in the country. A small portion of what is now Kings Canyon was also set aside in 1890 as General Grant National Park. Since 1940, Sequoia and Kings Canyon, located in the southern Sierra Nevada in California, have been managed as one unit. Sequoia-Kings Canyon National Parks (SEKI) are named for its groves of giant sequoias, including the General Sherman tree, the most massive tree on earth. Sequoia and Kings Canyon contain some of America's most awe-inspiring scenery. Park peaks include Mount Whitney, the tallest mountain in the U.S. outside of Alaska. Sequoia and Kings Canyon are home to numerous mammal species, and the topographic diversity supports more than 1,200 plant species.

The SEKI air resources program has been involved in air quality monitoring for almost 20 years, one of the longest running air programs in the National Park Service. IMPROVE monitoring began in this park in March of 1992. IMPROVE data show that average annual visibility is about 40 miles, and park views are often completely obscured by air pollution. Natural visibility levels in the west are estimated to be about 140 miles. In addition to visibility monitoring, ongoing air quality monitoring activities include ozone, nitrogen oxides, particulates, UV radiation, synthetic chemicals, meteorology, and wet/dry deposition chemistry.

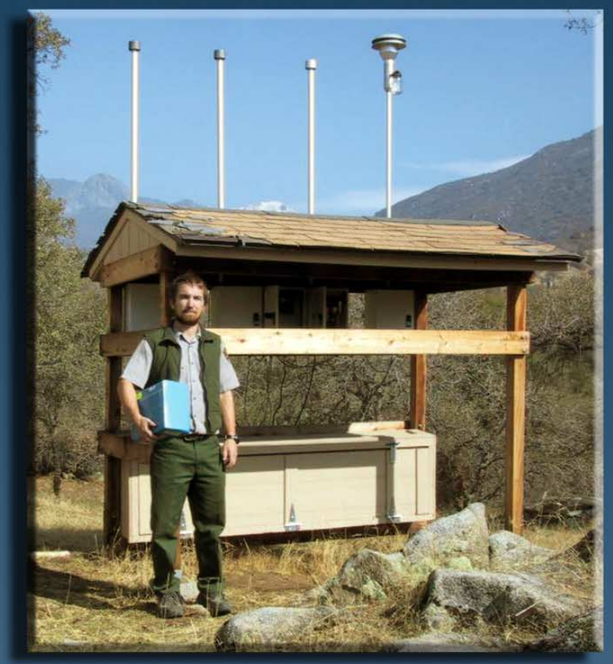
Because of high concentrations of ground-level ozone, the air in SEKI is often unhealthy to breathe. High levels occur more days than in any other national park. Ponderosa and Jeffrey pine trees show extensive injury to their foliage at present ozone levels. One study found that nearly 90% of Jeffrey pines in or near the Giant Forest showed visible signs of ozone injury. Although chronic acidification is currently not a problem in high-elevation lakes, there are episodes when the ability of some lakes and streams to neutralize acids gets reduced and waters become acidic for short periods. This is most likely to happen during snowmelt and during the "dirty" rainstorms of summer and early fall. There has also been a slow, continuous increase in atmospheric nitrogen deposition in park watersheds.

Sequoia-Kings Canyon National Parks were named as among the five most polluted parks by the National Parks Conservation Association in their 2002 report, *Code Red: America's Five Most Polluted Parks* report. At present, the worst impacts are tied to wind transport of air pollutants from the Central Valley of California, especially from April to October. Sources of pollutants include vehicle emissions, agricultural activities, prescribed and wildland fire, and industrial emissions of fine particles.

Looking west toward the San Joaquin Valley and the Coast Range (NPS photo)

Sequoia - Kings Canyon National Parks

October 2003



Originally from the Catskills of upstate New York, site operator *Hassan Basagic* began working in the national parks during his college years. Upon graduation from the State University of New York at New Paltz with a degree in geography, he moved west. Hassan continued his NPS career with positions at Yellowstone, Yosemite, Denali, Hovenweep, Natural Bridges, Canyonlands, Joshua Tree, and now Sequoia-Kings Canyon. Hassan enjoys climbing and backpacking, budget travel, and good cooking!

The SEKI IMPROVE station is located near Ash Mountain headquarters - elevation 1,650 feet. The site is one of three air quality stations within the park - which makes for busy Tuesdays! Weather and terrain are not usually a hindrance, but "the autumn assault by the acorn woodpeckers can be a problem!" Data collection from the aerosol site at SEKI was 100% for the 3rd quarter 2002!

Meteorological tower on the edge of the Giant Forest (NPS photo)

Ozone injury to Jeffrey Pine

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"Today we must seek the best ways to achieve the common goal of leading to posterity a nation of fresh air, clean water, and natural beauty." President George W. Bush Announcing the National Parks Legacy Project at Sequoia National Park			1	2	3 IMPROVE particle sampling day	4
5	6 IMPROVE particle sampling day	7 Change IMPROVE particle cartridges.	8	9 IMPROVE particle sampling day	10	11
12 IMPROVE particle sampling day	13 Columbus Day	14 Change IMPROVE particle cartridges.	15 IMPROVE particle sampling day	16	17	18 IMPROVE particle sampling day
19	20	21 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	22	23	24 IMPROVE particle sampling day	25
26 Daylight Saving Time Ends	27 IMPROVE particle sampling day	28 Change IMPROVE particle cartridges.	29	30 IMPROVE particle sampling day	31 Halloween	**UC-Davis**: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Dave Beichley *Photography*: Karen Fischer (970) 484-7941

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IMPROVE SCENE MONITORING

WHITE RIVER NATIONAL FOREST

Scene monitoring uses still and/or time-lapse photography (including digital imagery) to provide a qualitative record of visual air quality. Photography documents the appearance of a scene under a variety of air quality and illumination conditions at different times of day and during different seasons. Images during stable periods may yield more information in areas susceptible to ground-based or elevated layered hazes. Photography should be collocated with aerosol and optical monitoring equipment to aid in data presentation. Five years of photography is considered sufficient to create a representative record of variations in visibility conditions.

Troubleshooting: The majority of unusable visibility photographs result from operator error or insufficient system maintenance.

1. **Camera and system settings vary from site to site.** Check the settings specified for your particular camera type and monitoring protocols. Call Karen Fischer at ARS with questions at (970) 484-7941.

2. **Timer events:**
   Normal events are:
   Event 1=0900, Event 2=1200, Event 3=1500

3. **Film:**
   a: If the film did not advance…
   Check/change the camera battery.
   Attempt to take a manual photograph.
   Test camera/timer/battery connections.

   b. Film stored in a freezer or refrigerator must thaw at room temperature for at least 2 hours before loading in camera.

Morning, Low Sun Angle | *Morning, Layered Haze* | *Afternoon, Clear, Snow* | *Afternoon, Hazy* | *Afternoon, Clouds*

These photos from Canyonlands National Park, UT illustrate how scene quality varies under different lighting and atmospheric conditions.

The two and one-quarter million acre White River National Forest is located in the heart of the Colorado Rocky Mountains. The scenic beauty of the area (ten of its peaks pierce 14,000 feet), along with ample recreation opportunities, account for the fact that White River consistently ranks as one of the top five forests nationwide for total recreational use. The largest concentration of ski lifts outside of Europe's Alps is found here, as is the nation's largest elk herd.

IMPROVE aerosol monitoring began here in 1993 and IMPROVE data show that visibility in this region is some of the best in the continental United States. Current annual average visibility is just over 100 miles with organics and sulfates contributing 37% and 30% of the visibility-reducing particles. The monitor samples air masses common to the Maroon Bells, West Elk, Eagles Nest, and Flat Tops Wilderness Areas of Colorado.

Just as the IMPROVE monitoring program is a cooperative effort, other interested parties contribute to a variety of air quality monitoring efforts in the White River National Forest. The Aspen Wilderness Workshop, a non-profit organization, and the Aspen Skiing Company's environmental foundation have funded surface water monitoring since 1985, and 35 mm camera scene monitoring since 1991. Over 77% of forest lands in this district are designated as wilderness areas (Hunter-Fryingpan, Collegiate Peaks, and Maroon Bells-Snowmass). Air quality monitoring is a high priority. IMPROVE data from this site were used in a cooperative research effort by federal and state agencies with the active participation of industry to determine the visibility impact of a coal-fired utility near Hayden, Colorado, in the Mount Zirkel Wilderness Area. Since then the plant has been retrofitted with new pollution control equipment resulting in significant reductions of sulfur dioxide and nitrogen oxides.

White River National Forest

November 2003

***Michael Braudis*, site operator for the IMPROVE site atop Aspen Mountain at 11,200 feet, brings vitality and ingenuity to his work. A rock and ice climber and mountain bike competitor, Michael willingly hikes or snowshoes the 3,000 vertical feet to and from the site each Tuesday when the skier gondola is closed for "off" season. Last year, Michael moved the Version II sampler from outside to an enclosed building to facilitate better data recovery. He also moved the Aspen District's campsite monitoring program into the digital age with GPS mapping and digital camera technologies.**

IMPROVE aerosol monitor atop Aspen Mountain inside the Aspen Ski Area

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"Wilderness is protected, nurtured, and sustained by increasingly competent and committed managers, supported by expanded scientific knowledge and growing political strength from a public that increasingly understands and appreciates wilderness." The Forest Service Vision for Wilderness						1
2 IMPROVE particle sampling day	3	4 Change IMPROVE particle cartridges.	5 IMPROVE particle sampling day	6	7	8 IMPROVE particle sampling day
9	10	11 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	12	13	14 IMPROVE particle sampling day	15
16	17 IMPROVE particle sampling day	18 Change IMPROVE particle cartridges.	19	20 IMPROVE particle sampling day	21	22
23 IMPROVE particle sampling day	24	25 Change IMPROVE particle cartridges.	26 IMPROVE particle sampling day	27 Thanksgiving	28	29 IMPROVE particle sampling day
30						

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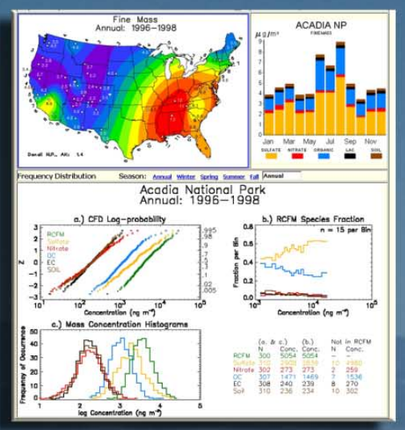
IMPROVE WEB SITE
Graphically Displaying Your Data

COLUMBIA RIVER GORGE NATIONAL SCENIC AREA

Measurements from most IMPROVE sites are summarized graphically on the IMPROVE Web site using the IMPROVE graphical viewer. The viewer is interactive and can be accessed through the IMPROVE Web site main page, at vista.cira.colostate.edu/improve/Data/GraphicViewer.

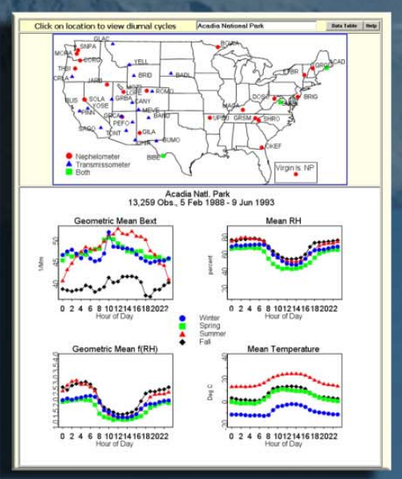
IMPROVE Monitoring Metadata - Site information including location, sampling equipment, and history of changes at the monitoring site.

1. *Select a sampler type.*
2. *Select a map location.*
3. *Select a location code from the table to view detailed metadata.*



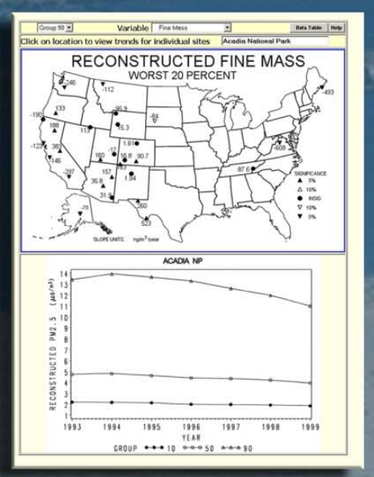
Spatial and Seasonal Patterns - Annual spatial patterns of PM2.5, light extinction, and contributions of major aerosol types are plotted. Seasonal bar charts of PM2.5, light extinction, and the contributions of major aerosol types are plotted. Frequency distributions of all aggregated values are also shown.

1. *Select a map location.*
2. *Select a variable from the pull down menu.*



Diurnal Cycle - Diurnal cycles for light scattering, extinction, relative humidity, and temperature data. Diurnal cycles are presented for sites with transmissometer or nephelometer monitors and encompass the entire data record at each site.

1. *Select a map location. Data for that site is summarized.*



Long-Term Trends - The long term trends (1988 - 1998) for selected IMPROVE monitoring sites are shown for fine mass and its major aerosol types, along with light extinction and the contributions of major aerosol types to light scattering.

1. *Select a map location.*
2. *Select a group from the pull-down menu:*
   10 (best 20%),
   50 (median 20%), or
   90 (worst 20%) days.
3. *Select a variable to plot.*

The Visibility Information Exchange Web System Program

The VIEWS website vista.cira.colostate.edu/VIEWS provides access to other data resources, including metadata from several other monitoring networks, an integrated aerosol database, graphical summaries of data analyses, and extensive catalogs of air quality information.

The Columbia River cuts its way through the Cascade Range eroding a river canyon 80 miles long and 4,000 feet deep. The Columbia River Gorge was designated the first National Scenic Area by Congress in 1986. The Cascade Range affects climate, flora, and fauna in the region and the climate varies considerably from one end of the gorge to the other. The west end has a mild, moist climate, while the east end exhibits wide temperature ranges and approaches semiarid conditions. The gorge's natural wind-tunnel effect has made this area one of the world's foremost windsurfing playgrounds.

There are two IMPROVE monitoring stations, one installation at each end of the gorge. The Wishram, Washington site, installed in 1993 at the east end of the gorge, is operated by the Forest Service. The Mount Zion site at the west end was installed in 1997 and is operated by the Washington Department of Ecology. Meteorological and geographic factors combine with pollutant concentrations to create unique air quality issues within the gorge. Valley walls and temperature inversions tend to restrict the dispersion of pollutants that are emitted from pollution sources within the scenic area and those carried in with winds from either end of the gorge. IMPROVE data show that visibility in the area is impaired. The worst visibility occurs in the fall and winter months when prevailing winds are out of the east. Sulfur accounts for most of the visibility impairment followed by nitrogen and carbon. The primary sources of air pollutants in the gorge are from the Portland and Vancouver urban areas and from sources within the scenic area. There are two major highways, two rail lines, barge traffic, two aluminum smelters, a pulp mill, two power plants, and several urban centers within and at both ends of the gorge.

Air quality related lichen monitoring shows some nitrogen-loving species in high abundance and some species with known sulfur sensitivities in unusually low abundance, indicating that ecosystem diversity and function may be affected by air pollution. Tissue analysis of lichen shows that nitrogen and sulfur deposition is as high or higher in the gorge than in any other areas sampled in the Pacific Northwest. In most years, ozone levels have been monitored at levels high enough to impact terrestrial ecosystems.

Columbia River Gorge National Scenic Area

Mark Kreiter **is the Forest Service site operator at the Wishram site at the east end of the Columbia River Gorge. He is also the hydrologist for the Columbia River Gorge National Scenic Area and the Mt. Hood National Forest. Currently, Mark is working on salmon restoration projects where he collaborates with other private and state entities. Mark's efforts on behalf of IMPROVE resulted in data completeness of 97% for 2002!**

Mark says, "I love fly fishing and fly tying, playing the guitar, cross-country skiing, hiking and camping. I have two teenage daughters that provide all kinds of excitement! I am a native Washingtonian currently living in the small community of White Salmon, Washington. My forest service career has taken me to some pretty awesome spots including areas around Mt. Rainier and Mt. St. Helens."

The IMPROVE aerosol sampling site at Wishram, WA

A view of the gorge from Beacon Rock State Park

December 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
UC-Davis: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Dave Beichley *Photography*: Karen Fischer (970) 484-7941	1	2 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	3	4	5 IMPROVE particle sampling day	6
7	8 IMPROVE particle sampling day	9 Change IMPROVE particle cartridges.	10	11 IMPROVE particle sampling day	12	13
14 IMPROVE particle sampling day	15	16 Change IMPROVE particle cartridges.	17 IMPROVE particle sampling day	18	19	20 IMPROVE particle sampling day
21	22 Winter Begins	23 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	24	25 Christmas	26 IMPROVE particle sampling day	27
28	29 IMPROVE particle sampling day	30 Change IMPROVE particle cartridges.	31 New Year's Eve	**"What it lies in our power to do, it lies in our power not to do."** Aristotle		

"Operator Involvement-- The Key to Network Success"

IMPROVE DATA USES

BRYCE CANYON NATIONAL PARK

Federal Land Managers (FLMs), states, tribes, and other monitoring entities share IMPROVE monitoring information. A centrally located, national visibility database archive is coordinated by EPA for all historical and future visibility monitoring information and data. Protocols are in place to assure that data collected today can be used in future applications and new source review models. Visibility monitoring data are used in each of the following applications:

1. *Visibility Protection Program:* Data are used to identify existing conditions and determine long-term trends. Program data are also used to assess progress toward existing national goals.

2. *Prevention of Significant Deterioration (PSD) Program Requirements:* Visibility data that describe existing conditions can be used as input for New Source Review (NSR) models and to assess a proposed source's potential impact on a particular PSD area.

3. *State Implementation Plans (SIPs), Federal Implementation Plans (FIPs), and Tribal Implementation Plans (TIPs):* Visibility data can be used to quantify existing conditions, support trend analysis, and support impairment designation policies in SIPs, FIPs, and TIPs. Monitoring programs in turn, enable the enforcement of emission limitations and other air quality-related control measures.

4. *Federal Documents (e.g. Regional Assessments, Management Plans, Environmental Impact Statements, etc.):* Visibility data that describe existing conditions are often referenced in federal documents to denote resource conditions prior to land management changes. Data presentations can also be used in political forums to aid in the understanding of existing conditions and need for future air quality-related policy and/or regulations.

5. *Acid Rain Program:* The links between acid rain and visibility degradation, although indirect are quite strong. Of particular importance is the relationship of visibility to the air pollutants associated with acid deposition -- i.e., the relationship of visibility to nitrogen dioxide, nitrate aerosols, and (especially) sulfate aerosols.

6. *Fire Emissions Inventories:* Natural and prescribed fire emissions often impact visibility in Class I and other protected natural areas. With the development of increased fire programs, existing and future visibility data can be used to evaluate the visibility impacts of fire emissions.

7. *Fine Particulate Standards:* Existing visibility-related PM2.5 and PM10 data may be used to supplement Federal Reference Method measurements (e.g. to estimate regional background concentrations) in association with new fine particulate standards.

8. *Other Uses for Non-Class I Area Management:* Visibility data can be used to document the frequency, dynamics, intensity, and causes of urban hazes, establish visual air quality acceptance criteria, and evaluate daily air quality indexes.

Bryce Canyon National Park in southern Utah is named for one of a series of horseshoe-shaped amphitheaters carved from the eastern edge of the Paunsaugunt Plateau. The colorful Claron limestones, sandstones, and mudstones have been shaped by erosion into thousands of pinnacles, spires, and mazes, collectively called "hoodoos". Ponderosa pines, high elevation meadows, and fir-spruce forests border the rim of the plateau, while panoramic views of three states spread beyond the park's boundaries. Surrounded by deserts, these highlands get much more rain than the lowlands below and stay cooler during hot summers.

One year after Congress enacted the 1977 amendments to the Clean Air Act, teleradiometer and aerosol monitoring began at Bryce Canyon National Park, one of six parks within the so-called "Golden Circle" of national parks in the Four Corners region of the Southwest. This region is one of the most intensely monitored in the network and boasts some of the nation's best air quality. The park identifies three magnificent views, or "integral vistas", deserving the most stringent visibility protection. An integral vista is a scenic view which extends beyond Class I boundaries, which view is deemed critical to the enjoyment of the area. Vistas from Bryce, Paria, and Yovimpa Point[s] have been identified as integral to visitor enjoyment, and the National Park Service seeks to protect these views from intrusions such as smoke plumes, strip mines, or other encroachments. Studies at the park have consistently identified clear air and unobstructed views among visitors' top priorities.

IMPROVE data show that annual average visibility at Bryce Canyon is about 95 miles but on the 10% cleanest days visibility approaches natural levels of 140 miles. Preliminary trend analyses show there may be some degradation or worsening of visibility conditions on the haziest days at the park. Layered hazes and plumes from a nearby power plant create visibility impairment that can frequently be seen from some Bryce Canyon viewpoints especially during the winter when air masses are stable. Bryce Canyon's monitoring efforts are part of a collaborative effort by tribal governments, state governments, various federal agencies, and private industry to better understand and manage regional haze, identify visibility impacted areas, and identify sources of haze on the Colorado Plateau and across the western states. Additionally Bryce Canyon has successfully cooperated with private entities to mitigate proposed coal strip mining in the nearby Alton coal fields.

Clear and Hazy Days

Bryce Canyon National Park

Site Operator and Park Ranger *Steve Mazur* has been the air quality specialist at Bryce Canyon National Park since 2000. His official duties, however, lead him to wear many different hats. Under supervisor Clyde Stonaker, Steve is a National Park Service Ranger in the Protection Division. Collateral duties include law enforcement, search & rescue, emergency medical services, health & fitness, and backcountry patrol operations.

Steve has been the IMPROVE site operator and administrator for almost three years. Additionally he collects ozone data and wet and dry acid deposition data as part of the National Acid Deposition Program (NADP), and participates in USDA snow surveys.

Air sampling sites are located at 8,000 and 9,000 feet. Winter access is often difficult, requiring skiing or snowshoeing to service these sites. An avid fitness enthusiast, Steve spends free time back country hiking, skiing, cycling, weight training, flying, running, fishing, and doing road trips.

Plume blight on Navajo Mountain as captured by the scene camera.

January 2004

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
"In the end, our society will be defined not by what we create but by what we refuse to destroy." John Sawhill, The Nature Conservancy			**UC-Davis**: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Dave Beichley *Photography*: Karen Fischer (970) 484-7941	1 New Year's Day IMPROVE particle sampling day	2	3
4 IMPROVE particle sampling day	5	6 Change IMPROVE particle cartridges.	7 IMPROVE particle sampling day	8	9	10 IMPROVE particle sampling day
11	12	13 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	14	15	16 IMPROVE particle sampling day	17
18	19 Martin Luther King Jr. IMPROVE particle sampling day	20 Change IMPROVE particle cartridges.	21	22 IMPROVE particle sampling day	23	24
25 IMPROVE particle sampling day	26	27 Change IMPROVE particle cartridges.	28 IMPROVE particle sampling day	29	30	31 IMPROVE particle sampling day

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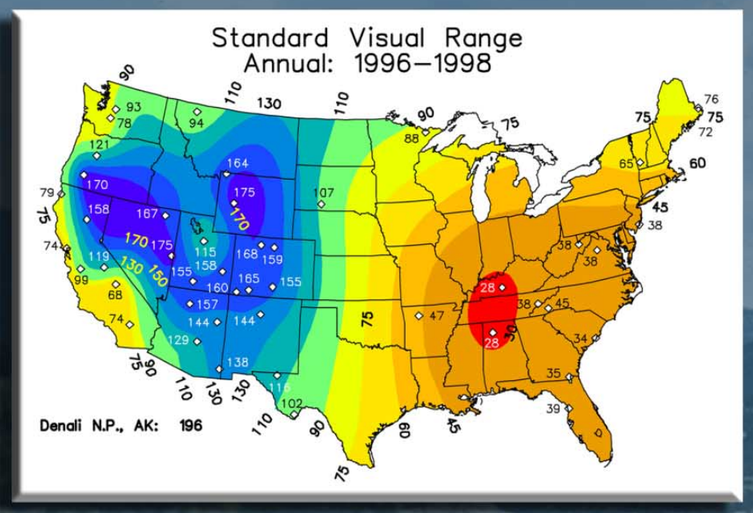
AIR POLLUTANT SPATIAL TRENDS

NORTH ABSAROKA WILDERNESS AREA



Visibility conditions throughout the United States reported as standard visual range in kilometers. Annual visibility in the Eastern U.S. averages between 15 and 35 miles. Annual visibility in the Western U.S. averages between 35 and 90 miles.

Comparative sizes of airborne particles.

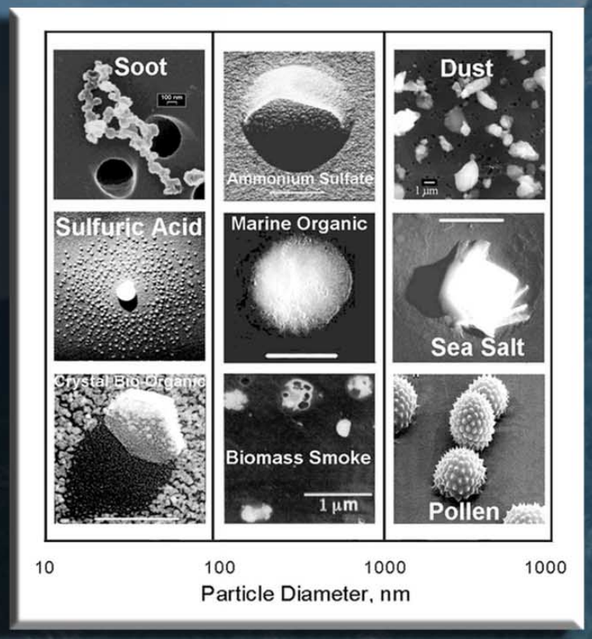
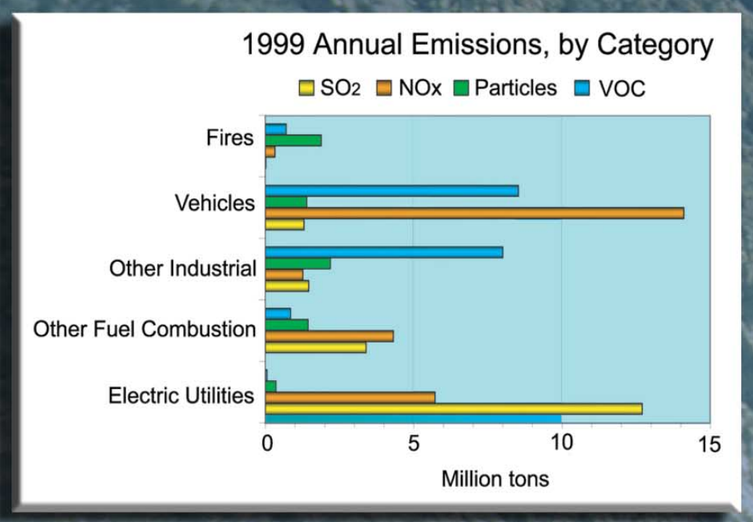
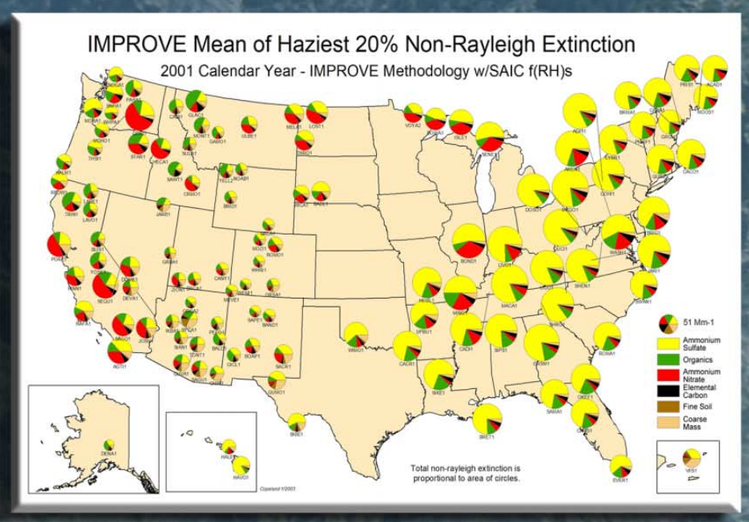


Image prepared by Rudy Husar, Center for Air Pollution Impact and Trend Analysis, Washington University, St. Louis, MO.



Annual emissions of air pollutants from different major source categories for 1999, in millions of tons. Particle emissions include fine and coarse particles.



This map represents the contributions of six major pollutants on the 20% haziest days. Note that extinction is significantly higher in the east, largely due to higher sulfate concentrations, while higher nitrate concentrations contribute to haze in southern California and Washington's Columbia River Gorge.

The North Absaroka Wilderness Area lies in the Shoshone National Forest which encompasses the area from the Montana state line south to Lander, Wyoming, and includes portions of the Absaroka, Wind River, and Beartooth Ranges. Yellowstone National Park borders the area to the west. The Shoshone National Forest was set aside in 1891 as part of the Yellowstone Timberland Reserve, making it the first national forest in the United States. The terrain is varied, ranging from sagebrush flats to rugged mountains many of which are snow-clad most of the year.

The North Absaroka ("Ab sor ka") IMPROVE aerosol sampler is located on Dead Indian Hill - so named for an Indian killed in battle as local lore tells it. In spite of its name, the 8,000 foot elevation site provides a beautiful 360 degree view of the Greater Yellowstone Ecosystem, home to an abundance of wildlife, including the grizzly bear and wolf. The site was chosen for its proximity to the North Absaroka and Washakie Wilderness Areas, both in Wyoming. Particulate monitoring began here in January 2000, and though access by vehicle is only about two miles, winter drifts can make the last half mile feel considerably longer. Nine months of the year there is snow on the ground and the area receives "some sort of snowfall every month of the year," says operator Janice Stratman.

IMPROVE data show the current annual average visibility at Absaroka is about 100 miles, compared to estimated natural visibility of 140 miles. On the clearest days visibility can be 126 miles, occurring most often during the winter months. Visibility drops to about 58 miles on the haziest days during late summer and early fall. The particles responsible for visibility reduction in this area are made up of biogenic carbon, which comes primarily from forest fires, but also from secondary organic aerosols associated with biogenic gaseous emissions. The second largest contributor to visibility reduction is sulfates which come primarily from fossil fuel combustion.

North Absaroka Wilderness Area

Site Operators *Ed and Janice Stratman* began monitoring here on contract with the Forest Service about 3 years ago. "We do everything from cutting firewood to balancing budgets, from snow removal to cooking and cleaning cabins for the guests," say the Stratmans. While the nearest post office for receiving and sending filter substrates is 30 miles away in Cody and the nearest neighbor is 12 miles distant, these and other inconveniences are taken in stride. Indeed, the rewards of raising their seven children in this pristine landscape have been well worth the effort. Ed teaches math part-time at a nearby college (50 miles away) and is a member of the local volunteer fire department. Aerosol data completeness for 2002 averaged 90%.

Winds blew the shelter on its side before the crew arrived to install the aerosol sampler.

With a little muscle and ingenuity, the shelter was made ready.

February 2004

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 IMPROVE particle sampling day	2 Groundhog Day	3 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	4	5	6 IMPROVE particle sampling day	7
8	9 IMPROVE particle sampling day	10 Change IMPROVE particle cartridges.	11 IMPROVE particle sampling day	12 Lincoln's Birthday IMPROVE particle sampling day	13	14 Valentine's Day
15	16 President's Day	17 Change IMPROVE particle cartridges.	18	19	20	21 IMPROVE particle sampling day
22 Washington's Birthday	23	24 Special IMPROVE particle change. Move cassette #3 from old cartridge to new cartridge. IMPROVE particle sampling day	25	26	27 IMPROVE particle sampling day	28
29	**"…the health of humans and ecosystems are inseparable; clean air is essential; and science is a foundation for taking action…"** National Forest Service Air Program Vision Statement					

UC-Davis: *Sampler*:
General Lab
(530) 752-1123

ARS: *Optical*:
Carter Blandford or
Dave Beichley
Photography:
Karen Fischer
(970) 484-7941

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Sites With ≥90% Data Completeness in 2002

Site	State	Agency	Completeness
Arendtsville	PA	EPA	100
Ft Peck	MT	Assiniboine & Sioux Tribes	100 *
Grand Canyon	AZ	NPS	100
Isle Royale	MI	NPS	100
Mount Hood	OR	FS	100
Petrified Forest	AZ	NPS	100
Rocky Mountain	CO	NPS	100
Three Sisters	OR	FS	100
Bondville	IL	EPA	99
Cabinet Mountains	MT	FS	99
Chiracahua	AZ	NPS	99
Hercules-Glades	MO	FS	99
MK Goddard	PA	EPA	99
Connecticut Hill	NY	EPA	99
Great Basin	NV	NPS	99
Presque Isle	ME	Micmac Tribe	99
Saguaro	AZ	NPS	99
Simeonof	AK	FWS	99
Starkey	OR	FS	99
Addison Pinnacle	NY	STATE	99
Moosehorn	ME	FWS	99
Seattle	WA	QA	99
Cape Romain	SC	FWS	99
Snoqualamie Pass	WA	FS	99
Wheeler Peak	NM	FS	99
Sac and Fox	KS	Sac & Fox Nations	98 *
Mammoth Cave	KY	NPS	98
Nebraska	NE	FS	98 **
Big Bend	TX	NPS	98
Everglades	FL	NPS	98
North Cascades	WA	NPS	98
Lake Sugema	IA	STATE	98 *
Denali	AK	NPS	98
Mohawk Mountain	CT	STATE	98
Quaker City	OH	EPA	98
Saguaro west	AZ	STATE	98
Hawaii Volcanoes	HI	NPS	98
Quabbin Reservoir	MA	STATE	98
Guadalupe Mountains	TX	NPS	97
Great Gulf	NH	FS	97
Bandelier	NM	NPS	97
Gila	NM	FS	97
Great Smoky Mtns	TN	NPS	97
Lostwood	ND	FWS	97
James River	VA	FS	97
Pinnacles	CA	NPS	97
Bosque del Apache	NM	FWS	97
Columbia Gorge East	WA	FS	97
Wichita Mountain	OK	FWS	97
Trapper Creek-Denali	AK	NPS	97
White Mountain	NM	FS	97
Upper Buffalo	AR	FS	96
Medicine Lake	MT	FWS	96
San Gabriel	CA	FS	96
Voyageurs	MN	NPS	96
Shenandoah	VA	NPS	96
Casco Bay	ME	STATE	96
Lava Beds	CA	NPS	96
Olympic	WA	NPS	96
Washington DC	DC	NPS	96
Seney	MI	FWS	96
Yosemite	CA	NPS	96
Northern Cheyenne	MT	Northern Cheyenne Tribe	96 *
Badlands	SD	NPS	95
Monture	MT	FS	95
Wind Cave	SD	NPS	95
Proctor Research Center	VT	STATE	95
Pasayten	WA	FS	95
Queen Valley (Superstition)	AZ	STATE	95
Cherokee	OK	Cherokee Tribe	95 *
Livonia	IN	EPA	94
Sula	MT	FS	94
Death Valley	CA	NPS	94
Sycamore Canyon	AZ	FS	94
Zion	UT	NPS	94
Kalmiopsis	OR	FS	94
Salt Creek	NM	FWS	94
Okefenokee	GA	FWS	94
Bliss	CA	FS	94
Cadiz	KY	EPA	94
Phoenix	QA	QA	94
Swanquarter	NC	FWS	94
Hoover	CA	FS	93
Mount Baldy	AZ	FS	93
Hells Canyon	OR	FS	93
Mount Rainier	WA	NPS	93
Great Sand Dunes	CO	NPS	93
Craters of the Moon	ID	NPS	93
Joshua Tree	CA	NPS	93
White Pass	WA	FS	93
Flathead	MT	Confederated Salish & Kootenai Tribes of the Flathead Res.	92 *
Cloud Peak	WY	STATE	92 *
Thunder Basin	WY	STATE	92 *
Bridger	WY	FS	92
Crater Lake	OR	NPS	92
Lye Brook	VT	FS	92
Dolly Sods	WV	FS	92
Gates of the Mountains	MT	FS	92
Yellowstone	WY	NPS	91
San Gorgonio	CA	FS	91
Lassen Volcanic	CA	NPS	91
Sawtooth	ID	FS	91
Caney Creek	AR	FS	91
Great River Bluffs	MN	STATE	91 **
Chassahowitzka	FL	FWS	91
Weminuche	CO	FS	90
Columbia Gorge West	WA	STATE	90
Canyonlands	UT	NPS	90
Brigantine	NJ	FWS	90
Ellis	OK	STATE	90 *
North Absaroka	WY	FS	90

LEGEND:

NPS	National Park Service
FS	USDA Forest Service
FWS	US Fish and Wildlife Service
EPA	Environmental Protection Agency
STATE	State Sponsored
QA	Quality Assurance Site
*	Site started in 2nd quarter
**	Site started in 3rd quarter

Three new sites were added in January 2003:
Organ Pipe, AZ, State of Arizona
Martha's Vineyard, MA, Wampanoags Tribe
Zion Canyon, UT, NPS