2008 Calendar

IMPROVE

Interagency Monitoring of Protected Visual Environments

Colorado State University

IMPROVE Aerosol and Speciated Trends Networks (STN)

The national $PM_{2.5}$ Chemical Speciation Trends Network (STN) and the IMPROVE aerosol network generate aerosol composition data using similar sampling and analytical approaches. State, local, and tribal agencies deploy and operate the STN network, while federal land management agencies, and a variety of state, local, or tribal air pollution control agencies run the IMPROVE and IMPROVE protocol networks.

The STN network was established by regulation as a companion program to the official, mass-based Federal Reference Method (FRM) system for implementation of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). $PM_{2.5}$ speciation data provide information regarding the nature of the sources that contribute to high $PM_{2.5}$ levels. The regulations called for a network of approximately 300 sites to be operated by various state and local air quality agencies. The EPA determined that the program would utilize 54 sites at EPA-designated locations and approximately 200 filter-based speciation sites. In 1999, the EPA determined that the balance of the network would be made up of IMPROVE protocol sites. A few rural or background monitoring sites have also been equipped with $PM_{2.5}$ speciation monitors.

The IMPROVE network was designed in 1985 to fulfill the EPA's court-ordered requirement for a federal visibility monitoring program to protect and enhance visibility in 156 Class I areas. The network began operations at 20 remote locations in 1987 and expanded to 30 locations several years later. The monitoring system designed for IMPROVE included $PM_{2.5}$ mass and compositional analysis and PM_{10} mass analysis based upon filter sampling measurements. In 1998, the EPA increased its contribution to IMPROVE to permit monitoring of regional aerosol conditions representative of all of the federal Class I areas. This network expansion increased the total number of IMPROVE sites to 110. In 2000 and 2001, several states and tribes requested that additional speciation monitoring be conducted in rural areas and on tribal lands according to the IMPROVE protocol.

The STN and IMPROVE networks are similar in that samples are collected on a number of filter substrates chosen for compatibility with specific analysis methods, including Teflon for gravimetric mass and elements by X-ray fluorescence; quartz for carbon by thermal optical method; and nylon for nitrates and other ions by ion chromatography. In 2000, IMPROVE changed its monitoring protocol so that its sampling frequency would coincide with the STN monitoring sites (i.e., every third-day, 24-hour [midnight to midnight] sampling).

The two programs differ in a number of ways. The STN network uses one of three commercially available samplers that are designed to collect samples in urban areas, which typically experience higher concentrations than rural IMPROVE sites. These samplers were designed to have sample changes within 48 hours after every sampling period. The IMPROVE network employs a sampler specifically designed to operate in remote locations that often experience low ambient concentrations. The sampler operates unattended and is serviced once per week. The IMPROVE sampler flow rate is substantially higher than that used in the STN network to collect more mass at the expected lower concentrations.

As part of the routine monitoring program, the STN quantifies mass concentrations and $PM_{2.5}$ constituents, including trace elements, ions (sulfate, nitrate, sodium, potassium, and ammonium), elemental carbon, and organic carbon. Chemical analyses from both networks 1) provide an improved understanding of the emissions and dynamic atmospheric processes that influence particle formation and distribution; 2) determine the sources of pollutants that contribute to elevated PM concentrations; 3) facilitate the development of methods useful to decision makers in formulating and comparing control strategies; and 4) provide reliable means for estimating the impacts of control strategy options developed for PM.

Cherokee Nation, Oklahoma

January

"There's so much pollution in the air now that if it weren't for our lungs, there'd be no place to put it all."
- Robert Orben

Kent Curtis, Environmental Specialist II, is one of several site operators for the Cherokee Nation Environmental Programs (CNEP). Along with manning the IMPROVE sampler, other duties include being a network QA/QC manager, air toxics manager, and data analyst. Kent has a BS in environmental biology and geology from the University of Tulsa, and an MA in paleontology from the University of California in Berkeley. In his spare time, he enjoys reading, listening to world music, traveling, and gardening.

The Cherokees, acting through the CNEP, have been active in ambient air quality monitoring since 1996, when they obtained an EPA grant to produce GIS/Arcview maps of the lands of the Cherokee Nation and other Inter-Tribal Environmental Council (ITEC) member tribes in Oklahoma. These maps provided the foundation upon which they and other ITEC tribes built their air quality monitoring projects.

The Cherokee Nation has established a record of excellence through its leadership of ITEC, providing environmental services to 40 tribes within EPA Region 6 and to additional tribes throughout the United States. They also operate meteorological instruments at each of their five stations in Oklahoma and at two sites in New Mexico. They will use the data from various monitoring projects to assess the threat of different types and sources of air pollution on the health of tribal members. The CNEP also performs air permit reviews for emissions sources located within 50 miles of the Cherokee Nation's jurisdictional boundaries.

During the past five years, the CNEP has been increasing its participation in EPA, regional, and national monitoring programs and projects. It operates IMPROVE, CASTNet, Mercury Deposition Network (MDN), and passive ammonia and ozone samplers.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 1 Julian day New Year's Day National Environmental Policy Act, 1969 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	2 2 ◆ Check temperature at setup to assure it is within 10 degrees C of outdoor temperature.	3 3 ◆ Call UC Davis at 530-752-1123 to figure out how holidays affect sample change schedules.	4 4 IMPROVE particle sampling day	5 5
6 6	7 7 IMPROVE particle sampling day	8 8 Change IMPROVE particle cartridges.	9 9	10 10 IMPROVE particle sampling day	11 11	12 12
13 13 IMPROVE particle sampling day	14 14	15 15 Change IMPROVE particle cartridges.	16 16 IMPROVE particle sampling day	17 17	18 18	19 19 IMPROVE particle sampling day
20 20	21 21 Martin Luther King, Jr.	22 22 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	23 23	24 24	25 25 IMPROVE particle sampling day	26 26
27 27	28 28 IMPROVE particle sampling day	29 29 Change IMPROVE particle cartridges.	30 30	31 31 IMPROVE particle sampling day		

Dec 2007

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Feb 2008

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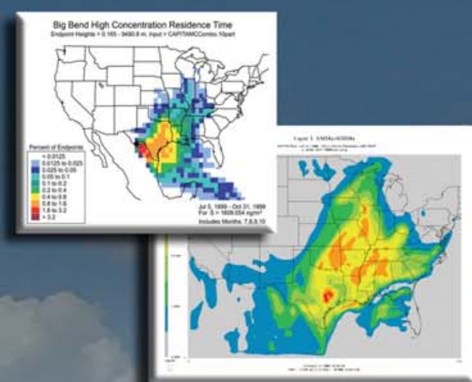
The History of IMPROVE Monitoring

Scene Monitoring

Aerosol Sampling



Data Modeling

Fire

Filters

Aerosol Monitoring Site

IMPROVE

Interagency Monitoring of Protected Visual Environments

1977

Clean Air Act Amendments establish the national goal to reduce existing and prevent future man-made visibility impairment in federal Class I areas.

1980

The EPA issues Phase I Visibility Rule that calls for monitoring of federal Class I area visibility.

1984

The Environmental Defense Fund sues the EPA for not implementing rules in states without visibility State Implementation Plans.

1985

The EPA initiates IMPROVE to monitor visibility at 20 federal Class I areas as part of the settlement agreement. IMPROVE objectives include

- establishing current visibility and aerosol conditions in federal Class I areas,
- identifying chemical species and emission sources responsible for existing man-made visibility impairment in federal Class I areas, and
- documenting long-term trends in visibility.

1987

The IMPROVE network puts in place a 20-site network with aerosol monitoring at all sites and optical and scene monitoring at most sites.

1991-92

Ten more sites with aerosol and some optical monitoring are added to track expected eastern sulfate changes.

1991-2000

Additional aerosol monitoring expands the network to 110 sites in support of the Regional Haze Rule, which requires each of the 155 visibility Class I areas have representative monitoring. The original process uses two criteria and professional judgment to select sites:

- Sites should be within 100 km of Class I area.
- Site elevation should be within the Class I area elevation range +100 feet or 10%.

State air agencies and federal land managers are asked to apply local air quality knowledge to verify that sites represent the Class I areas.

1998

The first urban IMPROVE site is established in Washington, D.C.

2000-01

All 110 Class I area sites now have aerosol samplers.

Sites are retrofitted with version II aerosol samplers.

33 IMPROVE protocol sites are added.

To be consistent with other monitoring networks, IMPROVE changes data reporting periods to correspond with the calendar year vs. the meteorological year.

2002

Ten tribes are operating IMPROVE protocol sites; 163 IMPROVE and IMPROVE protocol sites are operating.

2003

Collocated sampling is established at 24 sites to assess measurement precision.

2005

Eleven urban IMPROVE sites provide collocated data for comparison with the EPA Speciated Trends Network. These sites have collected data for one year.

IMPROVE sampler operation begins at the Egbert, Ontario monitoring site to assess comparability to PM speciation monitoring in Canada.

2007

IMPROVE network now has 166 IMPROVE and IMPROVE protocol sites reporting.

background photo: Jess Stryker

Theodore Roosevelt National Park, North Dakota

The quote, "The farther one gets into the wilderness, the greater is the attraction of its lonely freedom," by Theodore Roosevelt, seems a fitting tribute to the park named in his honor. Theodore Roosevelt National Park, located in Billings and McKenzie counties in southwestern North Dakota, was officially established as a national memorial park in the late 1940s and gained its current status as a national park in 1978.

The park receives nearly 500,000 visitors each year. The South Unit is the most visited and is adjacent to the historic city of Medora. People come to the park to enjoy the interesting scenery of the area (which extends well beyond the park's legal boundaries) and to see wildlife in natural habitats, be close to nature, and experience the park's wilderness and natural quiet. There are diverse landscapes ranging from jagged bentonite clay buttes to sagebrush flats, and from thick juniper and aspen to open river bottom. Visitors can also see bison, prairie dogs, feral horses,

and elk in the South Unit, and bighorn sheep and longhorn cattle in the North Unit. A multitude of smaller mammals, reptiles, birds, and insects are common.

The park enjoys relatively clear days, with most haze occurring during the dry summer when dusty conditions prevail. Smoke from occasional fires to the west can also contribute to haze in the summer. The primary local sources of pollution include vehicle emissions from I-94 running along the park's southern boundary, coal-fired plants in North Dakota and surrounding states, and nearby oil fields.

Emily Vesey (2nd from right), Biological Science Technician, Air Quality Specialist, serves as the primary operator of the Painted Canyon site. She spends the rest of her time raising cattle at a ranch near the park with her husband and family. She also works with the Billings County Ambulance and Fire departments. **Bill Whitworth** (far right), Chief of Resource Management, serves as the site supervisor and the primary backup for the air quality site. **Gary Luce** (2nd from left), Fire Management Specialist, serves as secondary backup for the site. He also operates a RAWS station at Painted Canyon. **Matt Weakland** (far left), Forestry Technician (seasonal) assists with air quality as needed.

February

"We never know the worth of water till the well is dry."
- Thomas Fuller, Gnomologia, 1732

- Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected.
- Watch for frost on the inlets.

Jan 2008

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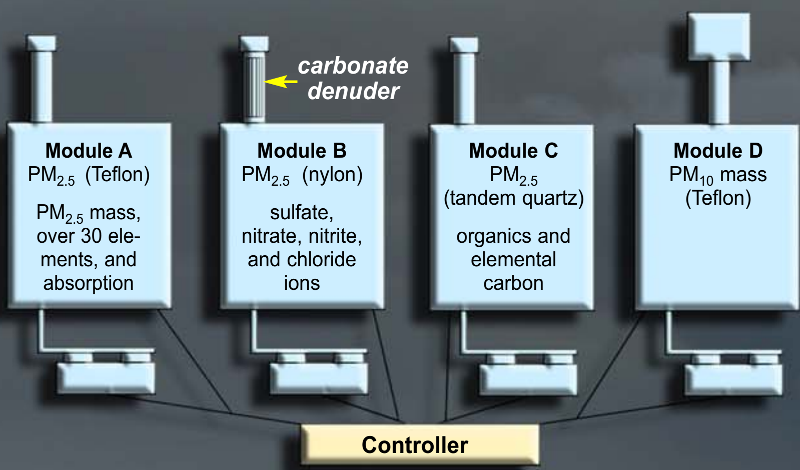
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 32 Julian day	2 33 Groundhog Day
3 34 IMPROVE particle sampling day	4 35	5 36 Change IMPROVE particle cartridges.	6 37 IMPROVE particle sampling day	7 38	8 39	9 40 IMPROVE particle sampling day
10 41	11 42	12 43 Lincoln's Birthday IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	13 44	14 45 Valentine's Day	15 46 IMPROVE particle sampling day	16 47
17 48	18 49 Presidents' Day IMPROVE particle sampling day	19 50 Change IMPROVE particle cartridges.	20 51	21 52 IMPROVE particle sampling day	22 53 Washington's Birthday	23 54
24 55 IMPROVE particle sampling day	25 56	26 57 Grand Canyon National Park established, 1919 Change IMPROVE particle cartridges.	27 58 IMPROVE particle sampling day	28 59	29 60	**UC Davis**: <u>*Sampler*</u>: General Lab (530) 752-1123 **ARS**: <u>*Optical*</u>: Carter Blandford or Karen Rosener <u>*Photography*</u>: Karen Fischer (970) 484-7941

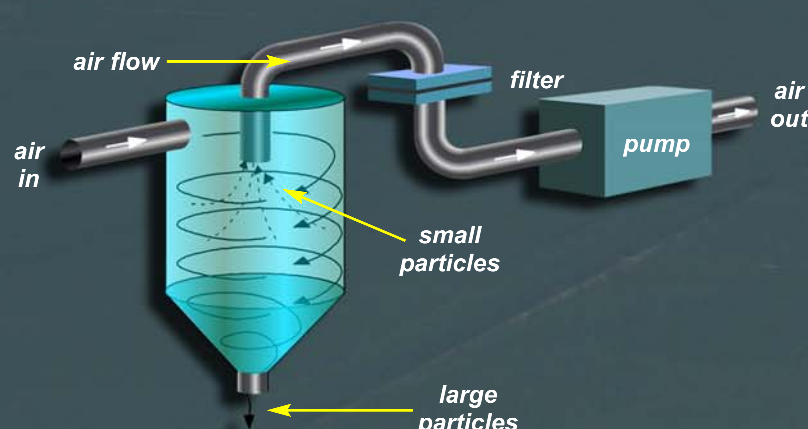
The Aerosol Sampler

Aerosol Monitoring



The standard IMPROVE particulate sampler has four sampling modules. Modules A, B, and C collect fine particles (2.5 microns and smaller [$PM_{2.5}$]), while module D collects larger particles (10 microns and smaller [PM_{10}]). Fine particles have the greatest impact on visibility, can adversely affect human health, and are often the result of human activities. The coarse mass (particles larger than 2.5 microns) is primarily composed of soil and carbonaceous material and is often of natural origins. 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.

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 are 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.



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 regulations use the average visibility values for the clearest days and the worst days. The worst days are defined as those with the upper 20% of impairment values for the year, and the clearest days as the lowest 20%. The goal is to reduce the impairment of the worst days and to maintain or reduce it on the clear days. For a 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. There are both annual and seasonal criteria. The criteria are

- 75% of the possible samples for the year must be complete,
- 50% of the possible samples for each 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 source contribution to visibility impairment 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 (nonsoil)	⇨	forest fires

Sample Protocol

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.)

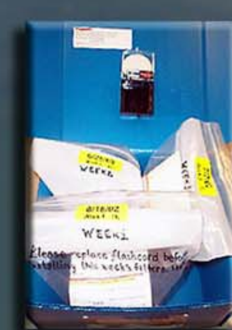
For two of the three weeks, the sampler will not be operating on the sample-changing day. The operator records final readings, replaces old cartridges, and records the initial readings. There are initial or final readings for the filter in position 3 for two of the three weeks. The log sheet and display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

Every third week, the sampler is operated when the operator arrives. When sample change is initiated the controller will

- suspend sampling,
- read flow rates on all filters 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 position 3 cassette 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 resumes collection on the filters in position 3.

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

If for any reason a backup person cannot make a change on a particular Tuesday or the "blue box" is late, or for any problem or question, the operator calls 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.



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

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

Module A filter pack

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

Okefenokee National Wildlife Refuge, Georgia

Ron Phernetton, operator of the Okefenokee IMPROVE station, is a retired forester who served many years as both a forester and fire management officer on the Okefenokee. Shortly after retirement from the Fish and Wildlife Service in 2000, Ron became the operator of the IMPROVE station as well as the NADP, NTN, and MDN sites.

Ron lives with his dog Pickles in the nearby Traders Hill Community. Several hobbies occupy his time, including growing roses and maintaining a model railroad layout.

The Okefenokee Swamp is a 438,000-acre, bog-filled depression located in the southeastern coastal plain. These wetlands and the uplands within and surrounding the Okefenokee support many fire-dependent ecosystems. One- to seven-year fire frequencies had maintained the open longleaf forest communities on the uplands, along with a mixture of bog forest and prairie-like openings within the swamp. A vast array of wildlife species are adapted to these rich but varied ecosystems.

As the coastal plain was settled, forests were harvested, roads were constructed, and large areas were cleared for fields, houses, and villages, which fragmented the upland forests. This altered the natural fire regime, changing the fire frequency to one fire in several decades. The once-open ecosystems within both upland and wetlands soon became clogged with dense understory species normally restricted to wetter areas. These drastic ecosystem changes eliminated the habitat required for many of the species associated with open uplands and wetlands, and set the stage in 2007 for a massive 563,000-acre fire that burned across the swamp and surrounding forest areas.

Efforts to restore this vanishing habitat have included utilization have of both natural and prescribed fires. Smoke from wildland fire is considered to be a natural event, but since several large cities with heavily polluting industries are located within 50 miles of the swamp, it's very important to monitor particulates from both natural and industrial smoke as they combine in the Class I airshed.

March

We do not inherit the earth from our ancestors.
We borrow it from our children.
- Native American Proverb

◆ Check that the calibration plug is properly fitting (bottom of T-fitting) at each filter change.

◆ Watch for frost on the inlets.

Feb 2008

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Apr 2008

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 61 Julian day Yellowstone Natl. Park established, 1872 IMPROVE particle sampling day
2 62	3 63	4 64 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	5 65	6 66	7 67 IMPROVE particle sampling day	8 68
9 69 Daylight Savings Time begins	10 70 IMPROVE particle sampling day	11 71 Change IMPROVE particle cartridges.	12 72	13 73 IMPROVE particle sampling day	14 74	15 75
16 76 IMPROVE particle sampling day	17 77 St. Patrick's Day	18 78 Change IMPROVE particle cartridges.	19 79 IMPROVE particle sampling day	20 80 Spring begins	21 81	22 82 IMPROVE particle sampling day
23 83	24 84	25 85 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	26 86	27 87	28 88 IMPROVE particle sampling day	29 89
30 90	31 91 IMPROVE particle sampling day					

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

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

Troubleshooting the Sampler

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 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.

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

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

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

2. "Lock out" the motor by rotating it toward the solenoids.

2. "Lock out" the motor by rotating it toward the solenoids.

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

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

For questions or problems with air sampler controllers or filters, contact Jose Mojica or Steven Ixquiac, UC Davis, at 530-752-1123. For sampler audits, ask for Steven Ixquiac.

The IMPROVE field operations benefit from an understanding of the audit findings process. This outline of issues was identified during audits conducted in 2005 and 2006. It includes only those issues that are under the control of the site operator. By being aware of these potential problems, we have an opportunity to improve the overall quality of the data and field operations.

Site Conditions

- Siting issues - generally a tree that has grown beyond the acceptance criteria
- Melting ice which is directly impinging on the tops of sampler module boxes

Safety Issues

- Inadequate railings (for example, where icy boards are used to get to modules)
- Inadequate space to service samplers and modules
- Electrical connections (temporary extension cords) exposed to wet conditions or in standing water (should be permanent service with GFCI protection)
- Vermin such as venomous spiders and snakes

Operator Errors -- Make sure filters are handled with proper procedures.

- Keep filter side down when loading and unloading and cap the cassettes immediately upon removal.
- If cartridge is dropped, report on the Field Data Sheet.
- Module and controller boxes should be kept clean.

Operator Observations

- Insect infestations in spring and summer, e.g., mud daubers in sampler inlet, flies in the module or released from cassette upon removal, and spider webs. Inspect sampler inlets every 3 months.
- Rodent infestation in fall and winter, with wires and tubing checked for damage.
- Calibration plug seated (at bottom of T-fitting where the inlet tube enters) in every module, checked at each filter exchange.
- Temperature checked at each setup to assure it is within 10°C of outdoor temperature
- Clocks should be reset when they vary by ±5 minutes or more from a cell phone.
- In November, December, and January, operators should call UC Davis (530-752-1123) to properly figure out how the holidays will affect their sample change schedules in order to not lose samples.

Comparison of Audit Findings 2005-2006

		2005		2006		
Total Audits		35		37		
Audit Data Missing				14		
Water Infiltration		1		0		
Leaks		2		1		
Vacuum Flow-Calibration	>10%	4		2		
Design Flow	>10%	5		4		
System Contamination		1		1		
Clock Failures	>60 min	2		1	unable to reset;	
				4	slightly out	
Operator Errors		3		1		
Missing Calibration Plugs		2		1		
Temperature	>10°C	3*	* ~10 with 5-9°C	2		
Siting issues		0		5		
Safety issues		0		1		

background photo courtesy of Oregon's Mt. Hood Territory

Mount Hood National Park, Oregon

April

"The activist is not the man who says the river is dirty. The activist is the man who cleans up the river."
\- Ross Perot

Todd Parker has worked in the Zigzag Ranger District in Mount Hood National Park since 1984 and is currently the district hydrologist. This area includes the Bull Run Watershed (municipal water supply for the City of Portland and about 1/3 of the rest of Oregon), Timberline, Ski Bowl, and Summit ski areas, a very large recreation residence program with 554 summer homes in the district, and the Sandy River and associated tributaries that provide habitat to salmon and steelhead trout. The varied resources in the district provide an interesting and challenging workload.

Todd reports, "The greatest part of the job in maintaining the IMPROVE site and associated webcam (http://www.fsvisimages.com/moho2/moho2.html) is the opportunity to get out on the mountain and experience all the variety the scenic environment has to offer. The excellent mid winter snowmobiling conditions also offer the opportunity for a lot of fun. During the late summer the huckleberry patch near the site provides operators opportunities for berry picking." Todd likes to run, walk the dog, build computers, and hang out with his family in his spare time. He lives with his wife Susan and two teenage boys in Portland, Oregon.

The Mount Hood IMPROVE site is adjacent to the Mount Hood Wilderness Area, near Tom, Dick, and Harry Mountain, and directly across the Camp Creek drainage from Mount Hood. Visibility for the most part is good, with five Cascade Range mountains (Mount Hood, Mount St. Helens, Mount Adams, Mount Rainer, and Mount Jefferson) visible on very clear days. In the summer, there are sometimes smoke impacts from forest fires in Mount Hood National Forest and surrounding forests. Other polluters include a coal-fired power plant in the Columbia River Gorge and traffic on Hwy. 26.

The biggest challenge to operating the site is access. For six months out of the year the site can only be reached by snowmobile through a developed ski area. The other six months, the site is accessible via an extremely rocky road which, according to Mr. Parker, will bounce your coffee cup out of the cup holder every time. The other challenge is the squirrel that lives in the shelter and likes to help with note taking during filter changes. The squirrel has many access holes in the shelter and has been known to use the one next to the operator's arm.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
UC Davis: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Karen Rosener *Photography*: Karen Fischer (970) 484-7941	◆ Check for insect infestations in spring and summer (e.g., mud daubers in sampler inlet and spider webs). ◆ Check for melting ice on tops of sampler modules.	1 92 Julian day Change IMPROVE particle cartridges.	2 93	3 94 IMPROVE particle sampling day	4 95	5 96
6 97 IMPROVE particle sampling day	7 98	8 99 Change IMPROVE particle cartridges.	9 100 IMPROVE particle sampling day	10 101	11 102	12 103 IMPROVE particle sampling day
13 104	14 105	15 106 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	16 107	17 108	18 109 IMPROVE particle sampling day	19 110
20 111	21 112 IMPROVE particle sampling day	22 113 Earth Day Change IMPROVE particle cartridges.	23 114	24 115 IMPROVE particle sampling day	25 116	26 117
27 118 IMPROVE particle sampling day	28 119	29 120 Change IMPROVE particle cartridges.	30 121 Arbor Day IMPROVE particle sampling day			

Mar 2008

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May 2008

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UC Davis Annual Site Maintenance

UC Davis field staff visit each IMPROVE staff annually for sampler maintenance, cleaning, and calibration. They spend about half a day at each site. Where possible they also meet with the site operator to hear the operator's specific concerns and to gain insight into local conditions.

Before any other work is performed, the UC Davis scientists record and document the current operation of the sampler. These "as found" values provide a point of comparison with the previous year's calibration and also help to identify any particular issues that need to be addressed during the maintenance visit.

Each sampler module is disassembled and cleaned. Here, the cyclone is being removed for cleaning. Large particles that are separated from the $PM_{2.5}$ sample stream can settle into the cyclone cup, and the excess is removed each year.

The inlet is removed from each sampler stack and the stack is cleaned using a brush.

A complete flow calibration is performed on each sampler module. The observed sampler flows are entered into a laptop computer (seen on the workbench) and will form the basis for new calibration constants that will be used to calculate sampler flowrates during the upcoming year. For a sampler in good operating condition, these new constants usually differ little from the previous year's constants.

Even though the PM_{10} module has no cyclone, it also receives a thorough cleaning as part of the maintenance visit.

The sampler's electronic controller is checked thoroughly and any required updates are installed. During 2007, a redesigned temperature probe was installed at all sites, which required some on-site rewiring of the circuit boards.

Santa Lucia Ranger District, California

Annette Howell has operated the IMPROVE site in the Santa Lucia Ranger District since the fall of 2005. Her primary job is range management, where she oversees livestock grazing in the district. She's been with the Forest Service for 18 years, in fire, recreation, visitor information, and range management.

Annette's biggest challenge is not having funding to get backups during the busy California fire seasons and while she's away on vacation. Another challenge is finding the time to make the trip up to the site with a busy schedule. Still, she likes the opportunities to get out of the office and enjoy the views.

Annette likes to hunt, fish, and ride horses in her spare time. She also attends classes to work toward her BS degree in range management.

The IMPROVE site in the Santa Lucia district is on the southwestern edge of the 200,000-acre San Rafael Wilderness, inside the 2-million-acre Los Padres National Forest. It is within 25 miles of the Pacific Ocean near Santa Barbara, California. The San Rafael Wilderness is the scenic backdrop of the South Central Coast, ranging from Santa Barbara to Santa Maria. An increase in population and tourism has placed scenery high on the list of values unique to this area.

At most, visibility is only 30 miles, beyond which there is often a coastal fog. At times the fog moves up the Santa Ynez Valley below the site and reduces visibility to less than three miles. There are no nearby pollution sources. Southern California urban areas have little impact on the Los Padres because of the coastal influence and offshore winds.

Wildfire has been the biggest influence on air quality. The past two summers have seen two of the largest and longest-lasting fires in the state's history: the Day Fire in 2006 and the Zaca Fire in 2007. The Zaca Fire, the second largest fire in California history, burned over 240,000 acres and lasted two months. The smoke reached all the way to Reno, Nevada.

May

"When some high-sounding institute states that a compound is harmless or a process free of risk, it is wise to know whence the institute or the scientists who work there obtain their financial support."
- Lancet, editorial on the "medical-industrial complex", 1973

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

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

Apr 2008

S	M	T	W	T	F	S
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Jun 2008

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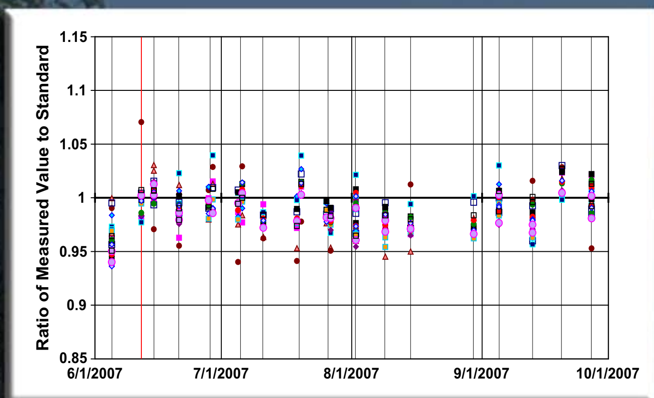
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

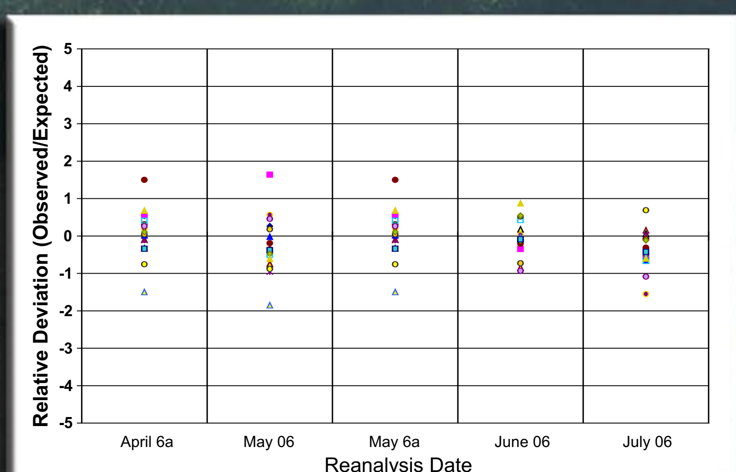
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1 122 Julian day ◆ Check for insect infestations (e.g., flies in the module or released from cassette upon removal, and spider webs).	2 123	3 124 IMPROVE particle sampling day
4 125	5 126	6 127 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	7 128	8 129	9 130 IMPROVE particle sampling day	10 131
11 132 Mother's Day	12 133 IMPROVE particle sampling day	13 134 Change IMPROVE particle cartridges.	14 135	15 136 IMPROVE particle sampling day	16 137	17 138 Armed Forces Day
18 139 IMPROVE particle sampling day	19 140	20 141 Change IMPROVE particle cartridges.	21 142 IMPROVE particle sampling day	22 143	23 144	24 145 IMPROVE particle sampling day
25 146	26 147 Memorial Day (observed)	27 148 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	28 149	29 150	30 151 IMPROVE particle sampling day	31 152

UC Davis Data Quality Assessment

IMPROVE data are carefully scrutinized before they are released to the public. Once data are obtained from the field or laboratory, they go through several stages of review to assess accuracy and self-consistency. Data that fail one or more tests are removed from the database or are flagged to indicate possible problems.

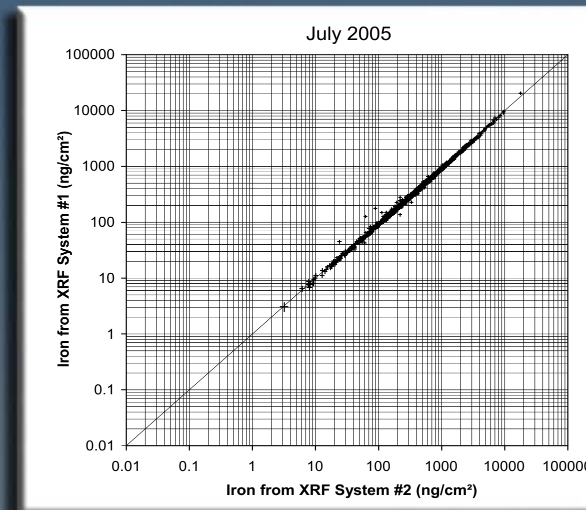


Teflon filters are analyzed by X-ray fluorescence (XRF) at UC Davis to determine the concentrations of chemical elements in the samples. Calibrations of the XRF systems are performed when physical changes are made to the system, such as the installation of a new detector. Calibration checks are performed frequently during the analysis of IMPROVE samples. If these checks indicate that values have drifted more than 10% from the calibration standards, then analysis is stopped and the XRF system is recalibrated. Individual elements are indicated by the colored points on the plot, and the vertical red line indicates that a new calibration was performed.

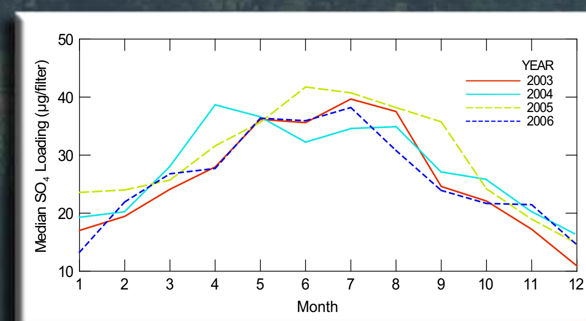


Each month a few IMPROVE samples from prior months are reanalyzed to demonstrate that the XRF system is providing results that are comparable to those seen in the past. This check accounts for possible interferences that may appear on actual field samples but may not be apparent from the analysis of calibration standards.

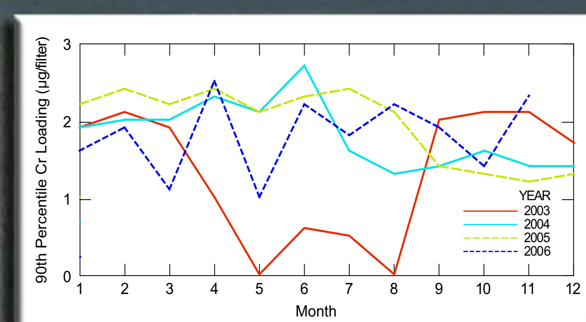
Samples are analyzed on two XRF systems, one designed to measure the lighter elements and the other to measure the heavier elements. Some elements, especially those near the middle of the atomic weight range such as iron, can be quantified by both systems. For these elements, the values obtained by both systems are compared as a reasonableness check. Substantial variations from historical behavior may trigger an investigation into XRF system performance.

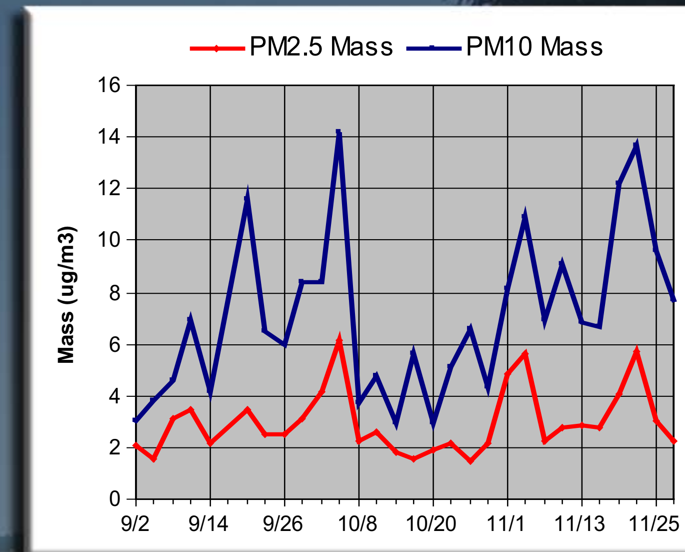


Once the lab analyses are completed for a given sampling month, the data are compared against data from the same calendar month in prior years. For abundant species that are detected on most filters, the network median values are compared. Here it can be seen that sulfate exhibits consistent seasonal behavior from year to year.



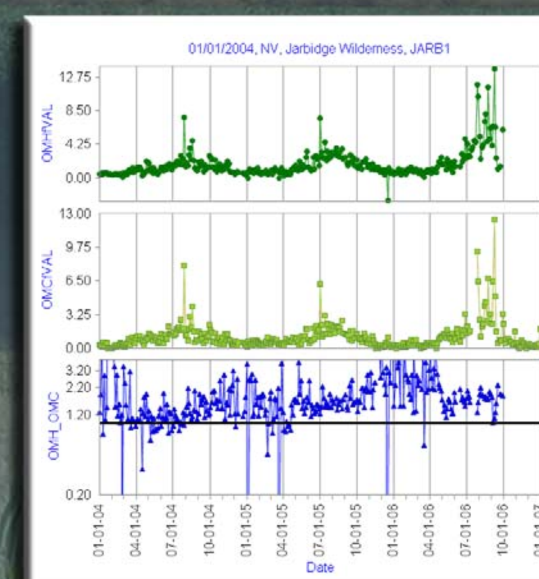
For elements that fall below detection limits much of the time, the network median value is zero. Thus, the 90th percentile values are used as a check of year-to-year consistency. Here it can be seen that chromium exhibited unusually low concentrations during the summer of 2003. The resulting investigations revealed that the XRF detector was failing during this period.





As a final check before final delivery by UC Davis, the data from different types of samples and analyses are compared against one another in a series of reasonableness checks. Here, PM_{10} and $PM_{2.5}$ mass are plotted together. It is expected that PM_{10} mass will be greater than or equal to $PM_{2.5}$ mass.

Once each month's data are available on the CIRA website, the individual results from each site are examined in time-series plots to visually search for unusual occurrences. This plot shows organic carbon mass estimated from the organic carbon measurements (OMC), organic carbon mass estimated from the hydrogen measurements (OMH), and the OMC/OMH ratio for the IMPROVE site at Jarbidge Wilderness, Nevada.



Sac and Fox Nation, Kansas

Rick Campbell mans the IMPROVE station for the Sac and Fox Nation. He graduated in 2004 with a bachelor's degree in conservation and wildlife management but found a niche operating the samplers and other monitors, and has continued working in the air monitoring field for the last three years. He participates in the Central Regional Air Planning Association and the Missouri River Valley Tribal Air Toxics Study. His other duties include working on a variety of environmental issues such as surface water monitoring, recycling, maintaining wetland areas, and working with GPS/GIS. He enjoys working outdoors in a rural area and dealing with prescribed fires and wildfires. Off-hours, he likes to hunt and spend time with his wife and daughter.

Visibility in the Sac and Fox Nation is usually good, but there are bad days created by the many coal-fired power plants, light industry, and pipeline-related facilities in the area. A unique study, the Missouri River Valley Tribal Air Toxics Study, is investigating the river valley's effect on pollutant transport and how it affects human health. This study, along with the Central Regional Air Planning Association and the U.S. EPA Region 7, uses the data provided by the IMPROVE monitor. Leland Grooms of the EPA Region 7 has used this data for national presentations on the river valley study.

The monitoring site has a meteorological station and has also hosted a "Super Site" with ammonia and passive ozone monitors. This fall a wet deposition mercury monitor and the possible addition of a CASTNet system will further enhance the site.

June

"The universe is not required to be in perfect harmony with human ambition."
- Carl Sagan

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 153 Julian day	2 154 IMPROVE particle sampling day	3 155 Change IMPROVE particle cartridges.	4 156	5 157 National Trails Day IMPROVE particle sampling day	6 158	7 159
8 160 IMPROVE particle sampling day	9 161	10 162 Change IMPROVE particle cartridges.	11 163 IMPROVE particle sampling day	12 164	13 165	14 166 Flag Day IMPROVE particle sampling day
15 167 Father's Day	16 168	17 169 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	18 170	19 171	20 172 IMPROVE particle sampling day	21 173 Summer begins
22 174	23 175 IMPROVE particle sampling day	24 176 Change IMPROVE particle cartridges.	25 177	26 178 IMPROVE particle sampling day	27 179	28 180
29 181 IMPROVE particle sampling day	30 182					

- Check for insect infestations throughout the summer (e.g., mud daubers, flies, spider webs).
- Watch for lightning damage during the summer.

May 2008

S	M	T	W	T	F	S
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18	19	20	21	22	23	24
25	26	27	28	29	30	31

Jul 2008

S	M	T	W	T	F	S
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13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

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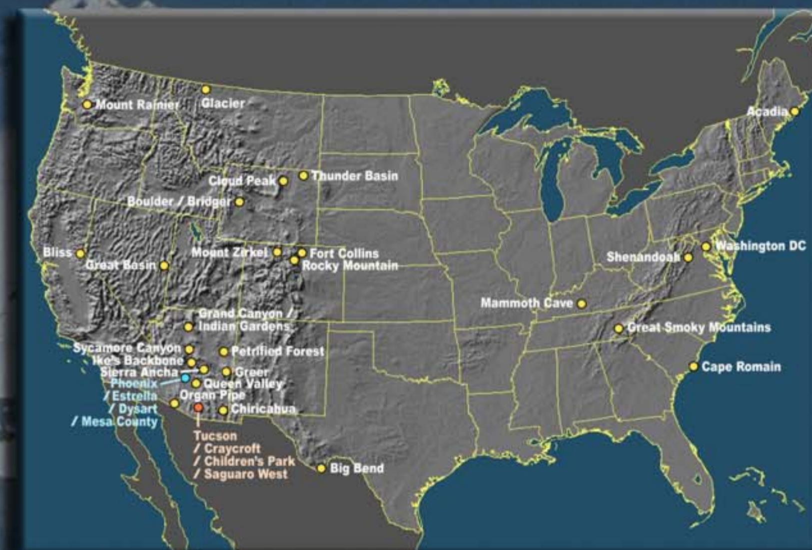
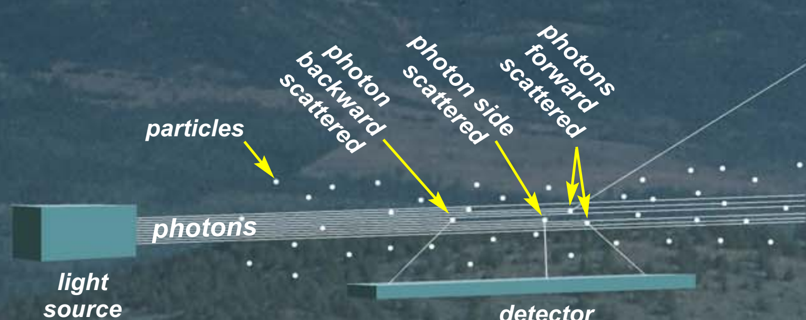
Measuring Temperature and Humidity

The Optec NGN-2 nephelometers have 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.

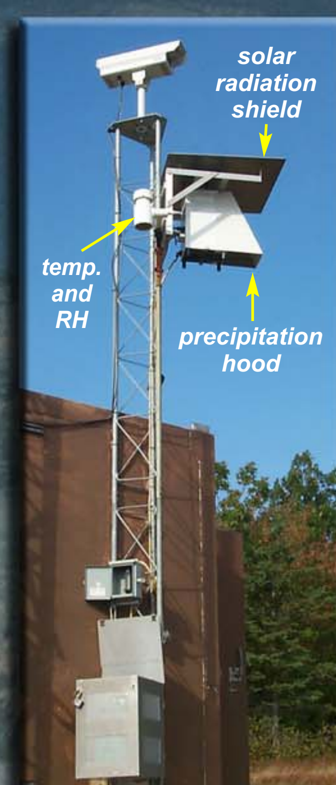


Current status of nephelometer sites in 2007



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.

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 keep direct sunlight off the monitor. This allows the instrument to be maintained at close to ambient temperatures. Temperature and relative humidity sensors are installed as part of the standard nephelometer configuration.



When hydroscopic aerosols such as ammonium sulfate, ammonium nitrate, or sea salt are present in the ambient atmosphere, aerosol scattering (b_{sp}) increases nonlinearly with increasing relative humidity (RH). At 85% RH, ammonium sulfate scattering is approximately two and a half times as great as at 50% RH; and at 95% RH it's approximately fives times higher. NGN-2 open-air integrating nephelometers are operated at a limited number of IMPROVE aerosol sites to measure the ambient aerosol scattering coefficient (b_{sp}). These data are used to verify the IMPROVE reconstructed extinction equation. The NGN-2 was designed to operate as close to ambient temperature as possible. However, due to heating by the light source and electronics, the temperature in the measurement chamber is slightly (typically about 1.0° C) higher than ambient. Thus the RH in the chamber is lower, resulting in a measured b_{sp} that is lower than actual ambient b_{sp}. At low RH this is a very small error. However, at high relative humidities (>85%), even an increase in temperature in the chamber as small as 1.0° C will result in about a 10% lowering of the relative humidity in the chamber. If highly hydroscopic aerosols are present, b_{sp} measured by the nephelometer can underestimate the actual b_{sp} by nearly 100%. To reduce this error, ambient temperature and relative humidity are routinely measured at the inlet of the nephelometer. These data, along with the measured temperature in the optical scattering chamber of the nephelometer, are used to calculate the actual relative humidity in the measurement chamber and adjust the measured aerosol scattering to actual ambient relative humidity. The cor- rected aerosol scattering is then used to determine the proper reconstructed aero-sol extinction equation.

Computer-generated photographs showing the same pollutant loading at humidities of 10%, 50%, and 90%. Notice the small difference between 10% and 50% humidities, and the much greater difference between 50% and 90%.

Lava Beds National Monument, California

Jason Mateljak is the physical science technician and primary operator of the IMPROVE station at Lava Beds Natl. Mon. Jason enjoys outdoor pursuits such as caving, canyoneering, and backpacking. His primary activities involve the management of cave resources.

Backup operators are Shane Fryer, Kristina Deeg, and Anna Iwaki.

Visibility at Lava Beds Natl. Monument is generally good, with the rim of Crater Lake National Park in southern Oregon often visible almost 100 miles away. Even so, visibility in the monument is often impaired by haze, particularly from agricultural burning, dust, wildfires, and woodstove emissions.

Operators at this IMPROVE site report few difficulties. In addition to air sampling, there are several unique research projects going on that are related to air quality and the monument's viewshed. Lava Beds is trying to become a Dark Sky preserve and is making efforts to improve management for this purpose. Personnel are also making efforts to understand the relationship between climate change and the increases and decreases in ice levels in the caves. Additionally, there's a large effort to restore the historic cultural landscape of the monument, specifically in the northern part of the park, in relation to the Modoc wars. Due to fire suppression, much of the area has become overgrown with junipers, which are being removed to restore the ecosystem and former landscape. Lastly, monument personnel are currently engaged in identifying undiscovered cave resources. Cave reconnaissance has been conducted intensively for two field seasons and should be followed by systematic inventorying and monitoring. Several of the new caves have ice resources, rare plant species, or endemic invertebrates that are dependent on the current climate and air quality.

July

"Ironically, rural America has become viewed by a growing number of Americans as having a higher [quality of life] not because of what it has, but rather because of what it does not have!"

- Don A. Dillman, Annals of the American Academy of Political and Social Science, January 1977

Jun 2008

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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 183 Julian day Change IMPROVE particle cartridges.	2 184 IMPROVE particle sampling day	3 185 ◆ Check temperature at each setup to assure it is within 10 degrees C of outdoor temperature.	4 186 Independence Day	5 187 IMPROVE particle sampling day
6 188	7 189	8 190 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	9 191	10 192	11 193 IMPROVE particle sampling day	12 194
13 195	14 196 IMPROVE particle sampling day	15 197 Change IMPROVE particle cartridges.	16 198 National Parks Day	17 199 IMPROVE particle sampling day	18 200	19 201
20 202 IMPROVE particle sampling day	21 203	22 204 Change IMPROVE particle cartridges.	23 205 IMPROVE particle sampling day	24 206	25 207	26 208 IMPROVE particle sampling day
27 209	28 210	29 211 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	30 212	31 213 ◆ Watch out for vermin (e.g., venemous spiders and snakes).		

Aug 2008

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24	25	26	27	28	29	30
31						

External Quality Assurance Support

The National Air and Radiation Environmental Laboratory (NAREL) is an EPA facility located in Montgomery, Alabama, that provides QA support for several speciation laboratories, including those that analyze IMPROVE filters. NAREL provides QA support in three main areas: [1] it prepares and distributes performance testing (PT) samples, [2] it performs on-site inspections of the testing laboratories, and [3] it conducts special studies as needed. The special studies are experimental investigations to answer specific scientific questions about data quality.

The EPA's National Air and Radiation Environmental Laboratory in Montgomery

Performance Testing Samples

NAREL prepares and maintains a stock of PT filter samples. Several "almost identical" filter samples are prepared at NAREL by using multiple collocated samplers that are programmed to simultaneously collect $PM_{2.5}$ from the ambient air. NAREL has enough equipment to prepare up to eleven replicates during each collection event. Some of the replicates from each collection event are analyzed at NAREL, and the remaining replicates are submitted to the testing laboratories as single-blind PT samples. NAREL usually provides each lab with a set of Teflon filters for the analysis of several elements by X-ray fluorescence. Teflon filters are also used to determine the gravimetric mass of captured particles. Each lab also receives a set of nylon filters that must be extracted, and then the extract is analyzed using ion chromatography. NAREL provides a set of quartz fiber filters that are analyzed using a thermal-optical technique that reports several carbon fractions. Results from the PT samples are submitted to NAREL for comparison to expected values.

Collocated samplers at NAREL used to make replicate filter samples.

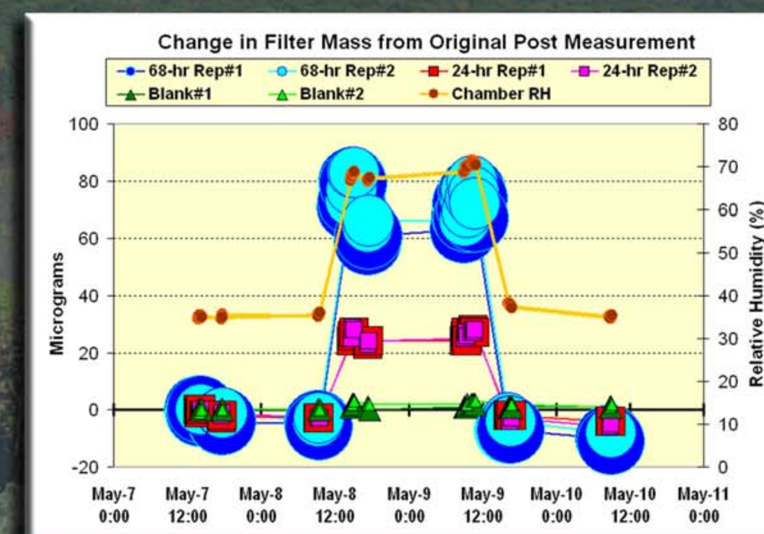
Laboratory Audits

Scientists from NAREL travel to the testing laboratories to perform technical systems audits (TSAs). The TSA is an on-site facility inspection and includes interviews with laboratory staff to determine compliance with the Quality Assurance Project Plan (QAPP), standard operating procedures (SOPs), and good laboratory practices. Results from the most recent PT samples are usually discussed during the audit. It is common practice to carry supplies from NAREL to the audit, such as standards and data loggers, so that quick experimental measurements may be taken during the audit. The auditors are usually scheduled to be on site for two days or less.

On-site audit at RTI International's Sample Handling and Archival Lab

Special Studies

A special study was recently performed at NAREL to experimentally investigate the following question: After particulate matter (PM) has been collected onto the surface of a Teflon filter, how is the gravimetric mass measurement affected by humidity in the weighing room? An experiment was performed by weighing six test filters repeatedly within a weighing chamber where the temperature was held constant at 70°C and relative humidity was the controlled variable. Two of the test filters were heavily loaded during a 68-hour collection event, two filters were moderately loaded during a 24-hour collection period, and two test filters were blanks. All six filters were 25-mm Teflon filters that are typically used in the IMPROVE sampling network.



Effect of humidity on the measurement of gravimetric mass

All filters were weighed several times on May 7th and 8th while the chamber relative humidity (RH) was maintained at about 35%. The graph above shows constant mass for all six filters during this period. At approximately noon on May 8th, the chamber humidity was increased to over 60% RH, and filter weighing continued. There was a dramatic increase in mass for the heavily loaded 68-hour replicate filters and a smaller increase in mass for the moderately loaded 24-hour replicates, but no increase in mass was observed for the blank filters. At approximately noon on May 9th, the chamber humidity was returned to about 35% RH, and filter weighing continued until the experiment was terminated on May 10th.

This experiment was able to show that mass measurement can be affected by humidity. The experiment also showed that increases in mass due to high humidity seem to be reversible.

Mohawk Mountain, Connecticut

Adam Augustine has been the primary IMPROVE station operator at the Cornwall Mohawk Mountain site since 2004. He also maintains a total of four comprehensive air monitoring sites for the Connecticut Department of Environmental Protection (CTDEP).

While earning his degree in environmental science, Adam worked seasonally with the CTDEP from 2000 to 2004 before becoming full-time four years ago. He also has experience in asbestos abatement monitoring. In his spare time he enjoys hunting, fishing, camping, mountain biking, ATV and snowmobile riding, and spending time in Vermont. His co-workers can always count on Adam to bring his homemade venison jerky!

The Mohawk Mountain site is located in the town of Cornwall at an elevation of 1656 feet. This site is part of the Rural Aerosol Intensive Network (RAIN), which is a high-elevation monitoring network of aerosol- and visibility-related parameters in the northeast United States under the Mid-Atlantic and Northeast Visibility Union (MANE-VU) regional planning organization. The primary purpose of the RAIN network is to collect highly time-resolved speciated fine particle measurements to determine how air pollution relates to and affects visibility and regional haze. There is a hazecam at this site as part of CAMNET (www.hazecam.net), which ties in visibility through live pictures with corresponding air quality conditions. IMPROVE measurements are important in this network as they are a reference for the continuous measurements. This site is also slated to be designated one of the 75 national EPA NCore sites.

Even though it can be extremely cold and windy on top of Mohawk Mountain, the part that Adam dislikes most is during warmer weather, when the yellowjackets are out in full force. He can always count on going through a few cans of bug spray during the summer.

Although air quality has improved here, there still are 8-hour ozone exceedance days. In fact, the highest 1-hour and 8-hour ozone measurements observed in 2007 were at this site (157 and 123 ppb, respectively).

August

"When you use a manual push mower, you're 'cutting' down on pollution, and the only thing in danger of running out of gas is you!"
- Grey Livingston

- Watch for lightning damage.
- Check site conditions (e.g., a tree growing beyond acceptance criteria).

Jul 2008

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Sep 2008

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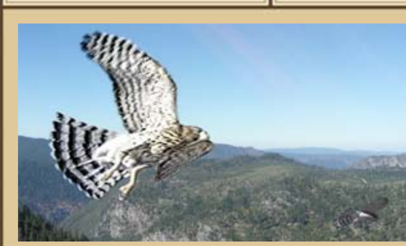
28	29	30				

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 214 Julian day IMPROVE particle sampling day	2 215
3 216	4 217 IMPROVE particle sampling day	5 218 Change IMPROVE particle cartridges.	6 219	7 220 IMPROVE particle sampling day	8 221	9 222
10 223 IMPROVE particle sampling day	11 224	12 225 Change IMPROVE particle cartridges.	13 226 IMPROVE particle sampling day	14 227	15 228	16 229 IMPROVE particle sampling day
17 230	18 231	19 232 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	20 233	21 234	22 235 IMPROVE particle sampling day	23 236
24 237	25 238 IMPROVE particle sampling day	26 239 Change IMPROVE particle cartridges.	27 240	28 241 IMPROVE particle sampling day	29 242	30 243
31 244 IMPROVE particle sampling day						



- The Glacier Bay site operator reported a pair of nesting turtle-back hawks who made their home in front of the transmissometer installation and are interfering with the light beam.

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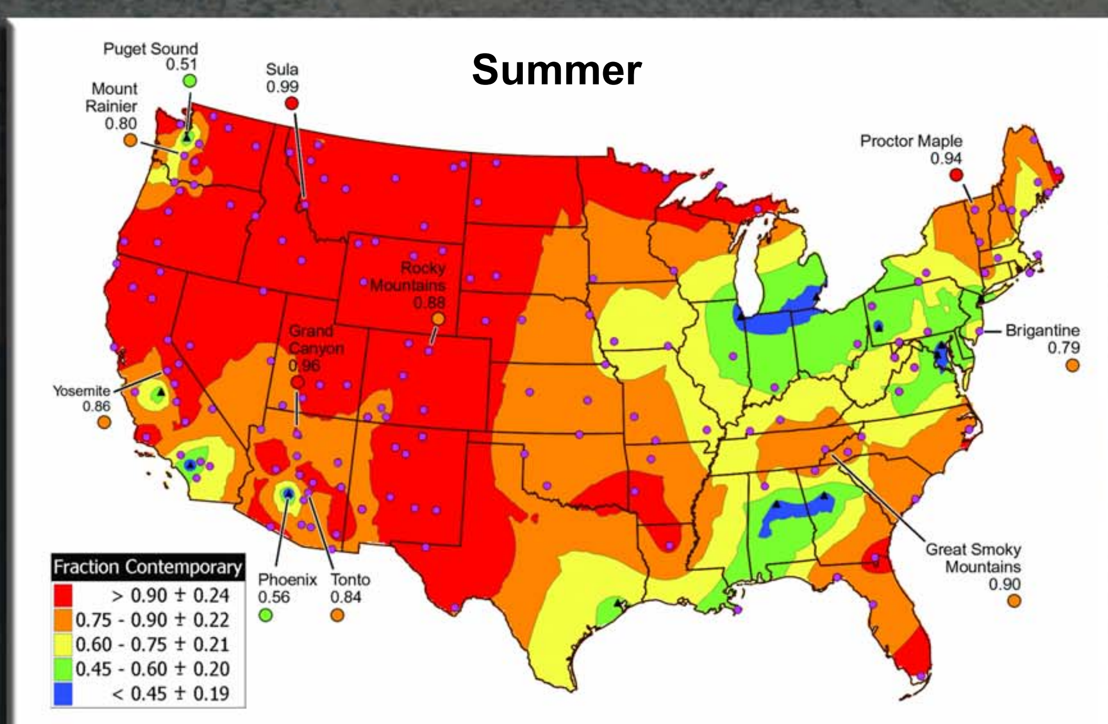
ARS: *Optical*:
Carter Blandford or
Karen Rosener
Photography:
Karen Fischer
(970) 484-7941

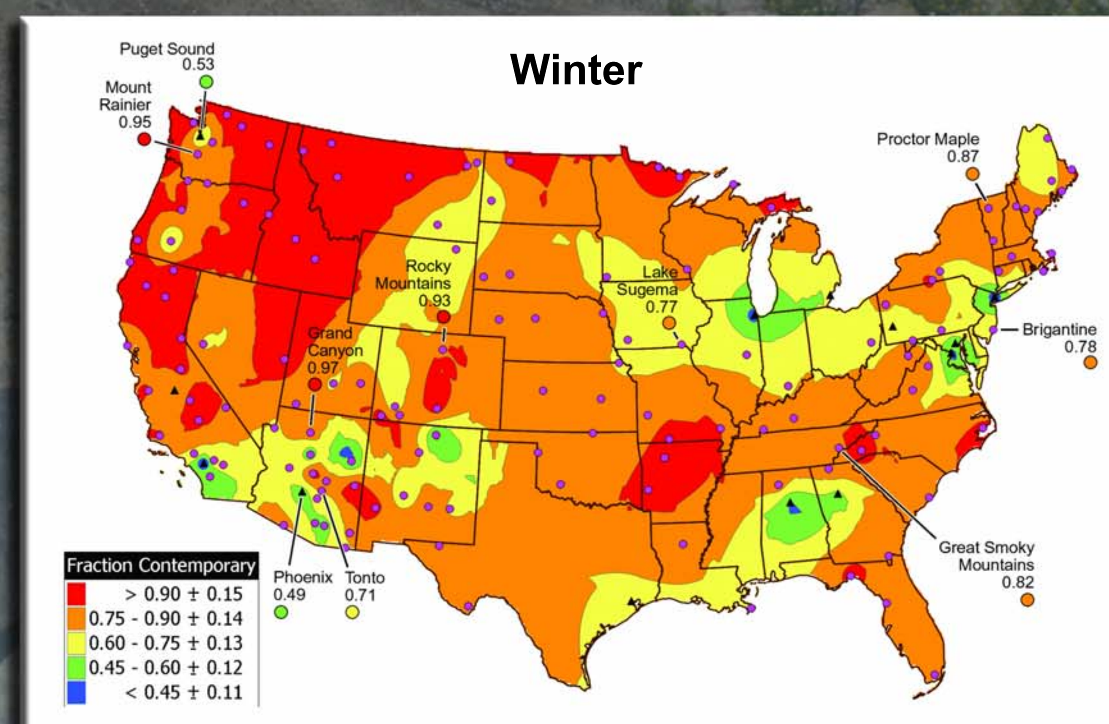
Modern vs. Ancient Carbon Emissions

How much of the organic particles in the atmosphere were generated from modern emissions (within the last few hundred years) versus emissions from millions of years ago (fossil fuels such as oil/gas and coal)?

Carbonaceous aerosols typically contribute 25% to 50% to fine particulate matter and haze. Using a measured radiocarbon isotope (i.e., carbon-14), the carbonaceous aerosol can be divided into a contemporary fraction from emissions linked to modern biological sources, such as smoke from residential wood burning and wildfires, pollen, and meat cooking; and a fossil fraction arising from mobile sources burning gasoline and diesel fuel, coal-fired power plants, oil heating, and others. In a special study, fine particulate carbon-14 was measured at 12 sites for a winter and summer season and used to estimate the fraction of contemporary carbon (Fc) across the United States.

Carbonaceous aerosols in rural areas are predominately contemporary with Fc generally greater than 90% in the Northwest and 60-90% in the Southwest. In the eastern United States, there is a region of low Fc from Illinois to the Atlantic seaboard with Fc generally less than 75% but greater than 75% in the surrounding area. Urban areas also have high Fc, generally around 50%. The urban contemporary carbon concentrations are often greater than at neighboring rural sites, indicating human contributions. This particularly occurs in the winter because of residential wood burning.





Summer and winter fractions of fine particulate contemporary carbon (Fc). Circles are the Fc estimated from measured carbon-14 concentrations. The isopleths are spatial interpolations of the Fc estimated at IMPROVE sites from relationships between IMPROVE organic and elemental carbon and carbon-14 concentrations. In the East, the interpolation artificially spreads the low Fc in the urban areas to neighboring rural areas.

Death Valley National Park, California

Cindy Duriscoe operates the IMPROVE station at Death Valley. She also does data analysis for temperature and ozone levels and operates Environmental Education, a consulting business. She enjoys hiking and backpacking with family and friends and observing and photographing the night sky in parks across the nation with her husband Dan.

Death Valley National Park is an unusual place, and in many ways, unique. It presents its own challenges relating to air quality, particularly in regard to the weather. Although temperatures can get down to 32 deg. F in winter, which is very tolerable, they can range up to 128 deg. F in summer. These sometimes exceptionally high temperatures require that station visits be done early in the morning. But the extremely hot days only last about two months, with most of the year being pleasant, although it can be very windy at times.

Visibility in the park is affected mainly by blowing dust, haze after it rains, or humid conditions. The park is also exposed to occasional fire smoke and smog from the Los Angeles and Las Vegas metropolitan areas. Ozone levels and the number of days at high levels have increased in the park over the past five years.

In addition to air quality data being used to assist in visibility studies, particulate data are being analyzed to see

if a correlation exists for a decline in nutrient production in the Devil's Hole water system where the endangered pupfish live.

September

"There is hope if people will begin to awaken that spiritual part of themselves, that heartfelt knowledge that we are caretakers of this planet."
- Brooke Medicine Eagle

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
UC Davis: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Karen Rosener *Photography*: Karen Fischer (970) 484-7941	1 245 Julian day Labor Day	2 246 Change IMPROVE particle cartridges.	3 247 IMPROVE particle sampling day	4 248	5 249	6 250 IMPROVE particle sampling day
7 251	8 252	9 253 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	10 254	11 255	12 256 IMPROVE particle sampling day	13 257
14 258	15 259 IMPROVE particle sampling day	16 260 Change IMPROVE particle cartridges.	17 261	18 262 National Public Lands Day IMPROVE particle sampling day	19 263	20 264 Pollution Prevention Week
21 265 IMPROVE particle sampling day	22 266 Autumn begins	23 267 Change IMPROVE particle cartridges.	24 268 IMPROVE particle sampling day	25 269	26 270	27 271 IMPROVE particle sampling day
28 272	29 273	30 274 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.				

Aug 2008

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Oct 2008

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◆ Check for rodent infestations in the fall and winter.

Fresh Biomass Smoke: Implications for Visibility and Climate Change

Why Study Smoke?

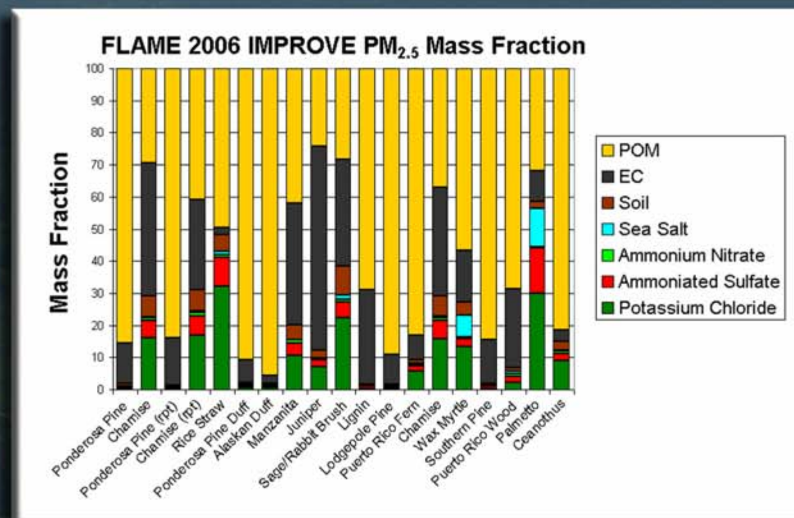
Biomass smoke is one of the largest sources of fine particles (diameters < 2.5 µm) globally. Smoke can have deleterious heath effects as well as contribute to visibility degradation. It can also impact the radiative balance of the atmosphere by scattering and absorbing sunlight. Its biogeochemical impacts are important because it removes nutrients from sources. Smoke influences cloud microphysics by affecting cloud formation and lifetime.

Smoke properties can vary widely based on the fuel type and moisture content and the flame conditions of the fire. Atmospheric aging processes and mixing with ambient aerosols also alter smoke properties. Investigating fresh and aged smoke using laboratory experiments, in situ and remote sensing measurements, and modeling studies is a very active area of research. However, there are still large uncertainties in key smoke parameters, such as its optical and chemical properties. Until these uncertainties are reduced, fully and accurately quantifying the effects of smoke on our environment and climate will be difficult.

Does Smoke Absorb Water?

A particle is described as "hygroscopic" when it has the ability to absorb water. Some particles do not absorb any water when exposed to humid environments, while other particles absorb significant amounts of water when they're exposed to high relative humidity (RH). Hygroscopic properties depend largely on the particle's chemical composition. For example, inorganic salt particles (like sea salt or ammonium sulfate) absorb water when exposed to high RH, whereas most carbonaceous particles tend not to absorb much water, and particles that are a mixture of both fall somewhere in between. Understanding whether particles are hygroscopic is very important for predicting their contribution to visibility degradation and climate change. When a particle absorbs water, its size increases significantly and its composition changes, both of which affect how efficiently it scatters sunlight. Clearly, determining whether smoke is hygroscopic is an important consideration for understanding its impact on visibility and radiative forcing, and whether it can efficiently alter cloud properties.

Particles take up water in the following way. When increasing ambient humidity reaches a point known as deliquescence, particles undergo a transition from solid to liquid phase and continue to grow with increased RH. When the RH is decreased, the particles lose water through evaporation until a point called efflorescence, at which they spontaneously crystallize to solid phase. The RH at which this occurs is lower than for deliquescence, therefore the amount of water a particle has associated with it can differ significantly depending on whether a particle is exposed to increasing or decreasing RH. The RH of deliquescence and efflorescence differs for different chemical species. For example, sea salt will deliquesce at an RH of 75%, compared to 80% for ammonium sulfate.
Smoke particles are composed primarily of carbonaceous species (~50-60% organic carbon and 5-10% elemental carbon, or soot) but also contain inorganic species, such as ionic salts and soil minerals. The relative amounts of carbon versus inorganic species can vary significantly depending on fuel type, as shown in the following figure; therefore we expect the hygroscopic properties of smoke particles to vary as well.



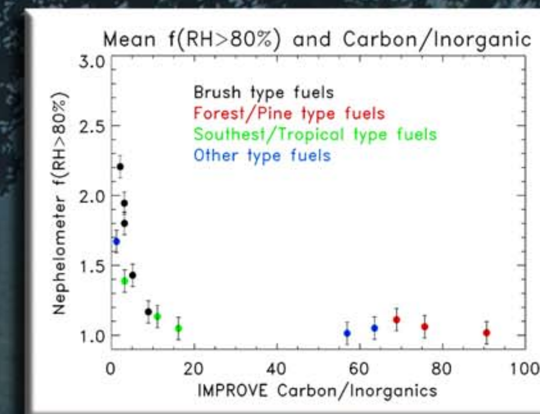
Laboratory Studies of Fresh Smoke

The hygroscopic nature of smoke was one of the many properties investigated during the 2006 FLAME experiment (Fire Lab at Missoula Experiment). Measurements were conducted at the U.S. Forest Service Rocky Mountain Research Station Fire Sciences Laboratory in Missoula, Montana, from May 21st to June 9th, 2006. This facility houses a burn chamber where laboratory experiments were performed to investigate fresh biomass smoke. Typically, a measured quantity of biomass was burned on a continuously weighed platform in the middle of the chamber. The fire was ignited and allowed to extinguish naturally and the instruments sampled for roughly two hours. Nineteen burns were performed.

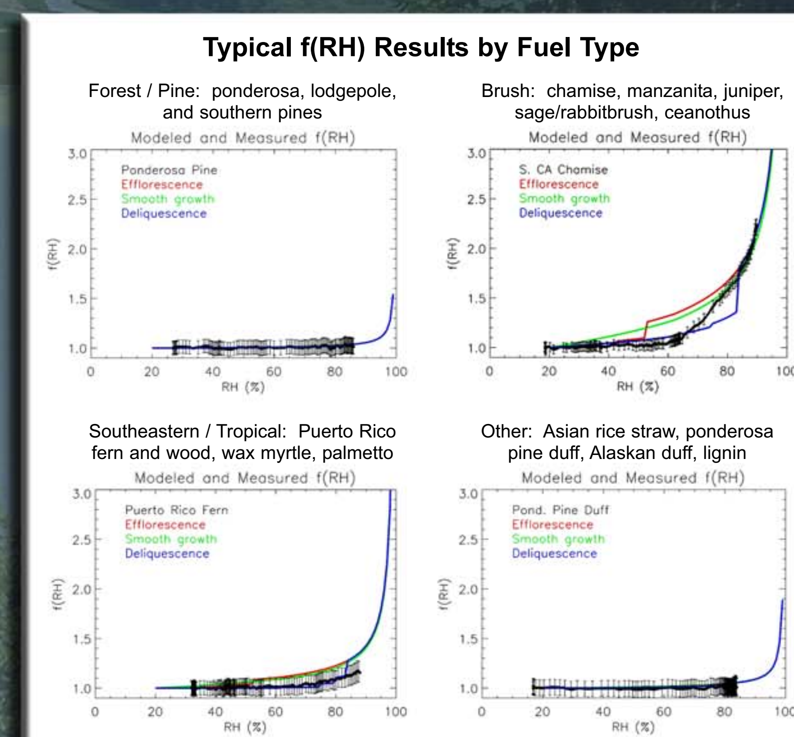
As part of this experiment, two nephelometers simultaneously measured the light scattered from particles that were both dry and humidified. Measuring the scattered light from particles in both of these environmental conditions allows us to explore the role of RH on the optical properties of biomass smoke aerosols and to determine whether and to what degree smoke particles absorb water. The ratio of the light scattered from humidified particles to the light scattered from dry particles is referred to as the humidification factor (f(RH)). Graphically, these results are presented with RH on the x-axis and the f(RH) ratio on the y-axis. A value of f(RH) = 1 over a range of RH values corresponds to particles that do not take up any water, so the humidified and the dry scattering are the same. In contrast, ionic salt such as fine mode ammonium sulfate particles is hygroscopic and has a corresponding f(RH) ~2.9 for RH~ 80%.

Results

Results from burns of several biomass fuels showed large variability in the amount of water absorbed. The four major fuel types demonstrated a range of hygroscopicity from 1.01 to 2.21, with the mean f(RH>80%) for all burns of 1.36±0.08. These values fall within previously observed ranges.



Mean f(RH>80%) as a function of the ratio of carbon (POM+EC) and inorganics, plotted as a function of fuel type



Great River Bluff State Park, Minnesota

Dick Tieben has been the main operator of the IMPROVE site at Great River Bluff State Park in Minnesota since the site's inception in 2002. Operational duties have been shared with the park managers and other seasonal staff workers, but Dick is the "go to" guy. He has also been involved in nitrogen monitoring studies in the park.

Wintertime operation always brings with it problems related to extreme cold and lots of snow, as well as more frequent equipment malfunctions. But Dick sees the positives in any season and says, "This area has its own intrinsic beauty in the winter."

Dick is married, has two daughters, and is an avid outdoorsman. He hunts deer in the bluff lands and is especially fond of 'shed' hunting - the art of finding shed deer antlers. He's quite good at it and holds his secrets close.

The establishment of the 3000-acre Great River State Park in 1976 grew out of the need to preserve the bluff land areas and create greater recreational access to this pleasantly scenic corridor in southeastern Minnesota bordered by the Mississippi River. Although the great glaciers didn't cover this area, their meltwaters helped shape this land through erosion. Today, the ever-moving waters of the swollen Mississippi and its tributaries continue to slowly carve through hundreds of feet of sedimentary layers and gradually enhance the great bluff faces.

Within the park are two Scientific and Natural Areas (SNA's), which are home to a number of diverse plant and animal communities. Researchers use them to study the uncommon Henslow's sparrow and the bluff land rattlesnake.

The Mississippi River valley lends itself to transport of pollution. The large city of La Crosse, Wisconsin, sits in the valley about ten miles south of the park. Thirty-five miles to the north is a large coal-fired power plant in Alma. The valley is subject to poor visibility from time to time. The IMPROVE site here is one of six speciated sites across Minnesota. The data gathered at these sites help in assessing visibility degradation in northern Minnesota and in studying the ammonium nitrate deposition issue across the Midwest.

October

"Why should man expect his prayer for mercy to be heard by What is above him when he shows no mercy to what is under him?"
- Pierre Troubetzkoy

Sep 2008

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Nov 2008

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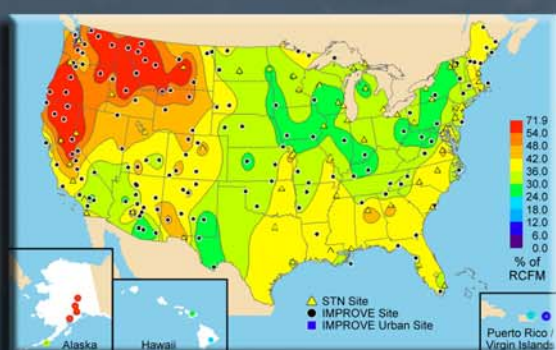
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 275 Julian day ◆ Check wires and tubing throughout the fall and winter for rodent damage.	2 276	3 277 IMPROVE particle sampling day	4 278
5 279	6 280 IMPROVE particle sampling day	7 281 Change IMPROVE particle cartridges.	8 282	9 283 IMPROVE particle sampling day	10 284	11 285
12 286 IMPROVE particle sampling day	13 287 Columbus Day (Observed)	14 288 Change IMPROVE particle cartridges.	15 289 IMPROVE particle sampling day	16 290	17 291	18 292 IMPROVE particle sampling day
19 293	20 294	21 295 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	22 296	23 297	24 298 IMPROVE particle sampling day	25 299
26 300	27 301 IMPROVE particle sampling day	28 302 Change IMPROVE particle cartridges.	29 303	30 304 IMPROVE particle sampling day	31 305 Halloween	**UC Davis**: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Karen Rosener *Photography*: Karen Fischer (970) 484-7941

FLAME Fire Lab at Missoula Experiment

Smoke from wild and prescribed fires can be a significant contributor to regional haze (visibility impairment) and may contribute to global climate change. Such contributions are often clear near fire sources but can also be significant as smoke plumes are diluted during transport over hundreds and thousands of kilometers. Current monitoring technology is not capable of separating out anthropogenic emissions such as mobile sources or other industry-related activity from wild or prescribed fire emissions. Some preliminary estimates suggest that a large fraction of the fine particle carbon present in Class I areas in the western United States may be associated with smoke, while other estimates suggest that, at least near urban areas, this fraction may be substantially less. Because fine particle carbon composes as much as half of total aerosol fine particle mass in parts of the western United States (see map below), it is an important contributor to regional haze.

One approach to quantifying fire contributions to airborne particulate matter concentrations is the use of smoke markers. In this approach a compound or set of compounds produced as part of the smoke emitted from a fire is tracked as the plume is transported downwind and diluted.

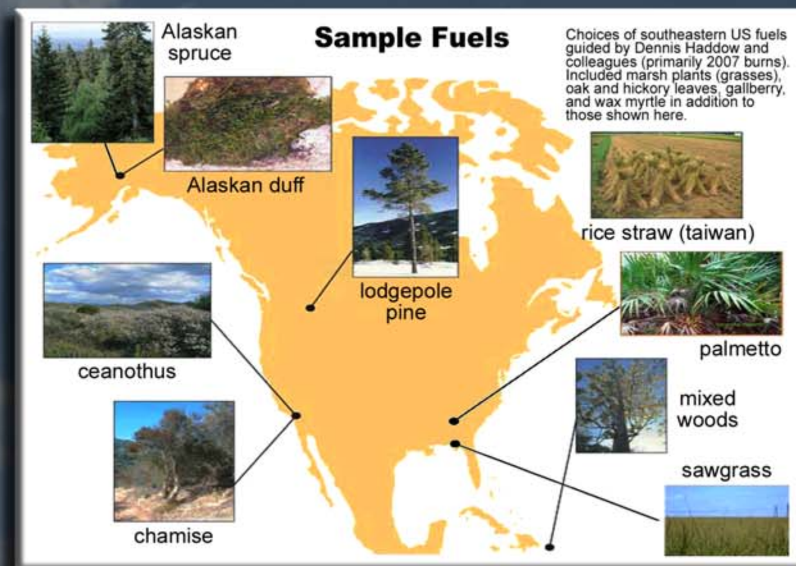


Fractional contribution of organic carbon to aerosol fine particle mass as measured by the IMPROVE network.

The FLAME Experiment

The goal of the FLAME project is to characterize particulate matter emissions from wildland fires and look at the impact those emissions have on regional air quality and visibility. Emphasis is placed on biomass burning in the western and southeastern United States. Fuels of interest in the West include California mixed chapparal, Arizona, Utah, and Colorado chamise stands, sagebrush-grass and shrubs of the Great Basin and Intermountain West, western long-needled pine, samples of forest floor litter from beneath dense conifer stands, and Alaskan duff. Fuel samples from the southeastern United States included marsh plants, grasses, oak and hickory leaves, gallberry, and wax myrtle.

Laboratory work was conducted at the U.S. Forest Service's Missoula Fire Science Laboratory in two phases. Phase I occured in May/June 2006 and Phase II in May/June 2007. A series of controlled experimental burns of different wildfire fuels were conducted. Measurements of smoke emission composition profiles were made to provide source profiles for different classes of fires.



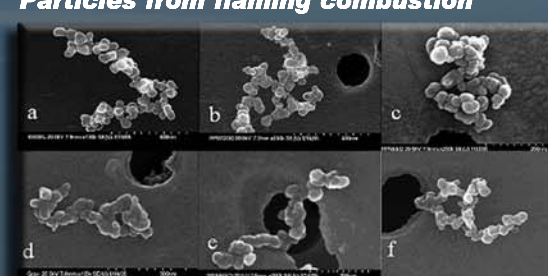
Fuels were burned in a large room under controlled conditions on a continuously weighed fuel bed. Smoke was captured by an inverted funnel into a 1.6 meter diameter stack. The room was pressurized with outside air conditioned to standard temperature and relative humidity. From a sampling platform 18 meters above the fuel bed, samples were drawn into a small residence chamber with ports for $PM_{2.5}$ sample collection.

Combustion Facility

1. fire pit, hood
2. white pine needles heading burn
3. sagebrush backing burn

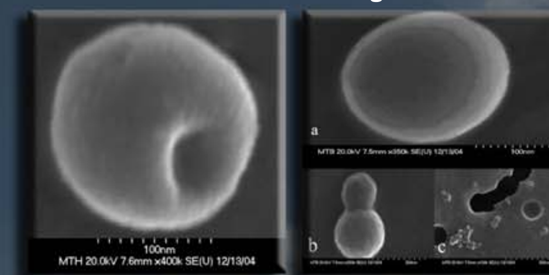
Time-resolved measurements support the fact that different fuels and burn conditions produce different particle size distributions, which in turn have different optical properties. It is also clear that the development of the combustion process includes a transition from the flaming to the smoldering combustion phase. The fuels that combusted primarily via flaming phase had higher elemental carbon and often had high inorganic content (sulfates, chlorides). The fuels that combusted primarily via the smoldering phase consisted largely of organic carbon (appearing yellow or light tan on filters).

Particles from flaming combustion



Soot particles from the flaming combustion of a) poplar wood, b) ponderosa pine wood, c) ponderosa pine needles, d) dambo grass, e) white pine needles, and f) sagebrush.

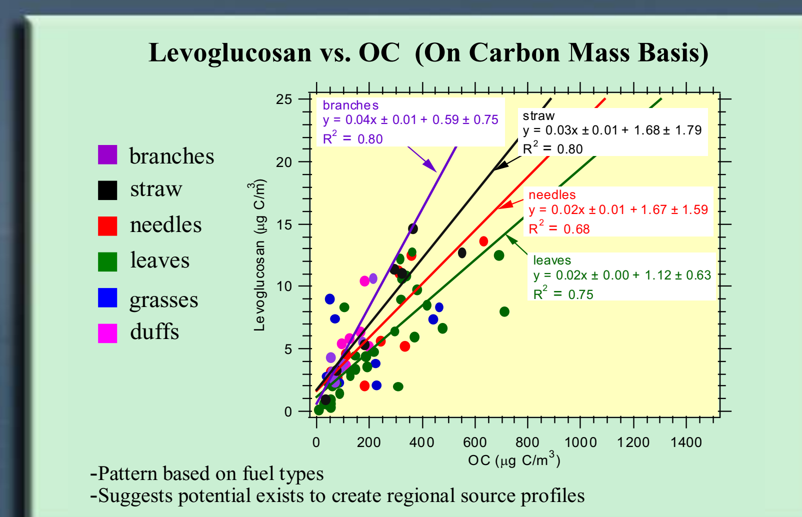
Particles from smouldering combustion



Particle from the combustion of Montana grass showing structural defects sometimes found in spherical tar balls originating from the combustion of wet fuels

Tar balls from the flaming combustion of Montana grass and tundra cores. These occur as individual spherical particles (a) as well as in small (b) and large (c) clusters.

Current approaches to identification of wood smoke contributions to particulate organic carbon rely on the use of organic molecular markers. A comprehensive study of several individual polar organic compounds was conducted to examine compositional similarities and differences between biomass types and combustion conditions. Of these individual compounds, the molecules levoglucosan and methoxylated phenol were found to be the dominant species in most source samples.



The graph above shows that the ratio of levoglucosan to carbon is quite stable within species types (branches, straw, needles, leaves, grasses, or duff) but varies by as much as a factor of two between these fuel types. Consequently it will be important to understand the mixture of fuels that are burned to establish an estimate of levoglucosan to carbon ratios that can be used in source apportionment models.

Guadalupe Mountains National Park, Texas

John Cwiklik, the IMPROVE site operator at Guadalupe Mtns. Natl. Park, was raised in northern Illinois. He volunteered at Glacier National Park during the summer of 1985, performing backcountry patrols in the Two Medicine area. In 1987 he began working as an NPS seasonal employee, and for seven seasons worked at Rocky Mountain, Sequoia, Badlands, and Cuyahoga Valley national parks. In 1991, he landed a permanent law enforcement ranger job at the Jefferson Natl. Expansion Memorial in St. Louis. In 1995, he transferred to Guadalupe Mountains. As a ranger in a small park, his duties are varied, including backcountry patrols, firefighting (both wildland and structural), EMT, and resource and campground management. Among John's hobbies are photography, traveling, skiing, and cooking (which is especially handy since the nearest restaurants are 50 miles away).

The park, located in far western Texas along the New Mexico border, was established to preserve the finest example of exposed fossilized reef, which makes up the spine of the Guadalupe Mountains. It protects 86,000 acres, from desert grasslands and white gypsum sand dunes to the ponderosa pine / Douglas fir forests of the high mountains. The four highest points in Texas are found here, with Guadalupe Peak (elevation 8,749 feet) being the tallest and soaring 5,000 feet above the northern Chihuahuan Desert grasslands to the west. Mild winters make this park a year-round hiking spot.

The visibility at Guadalupe Mountains is some of the best in the region. The nearest major city is El Paso, Texas, 100 miles to the west. The nighttime dark skies are excellent for star gazers. And McKittrick Canyon is known in western Texas as the place to see fall colors.

Occasional snows in winter do not stay around long, but the winds do. Winter storms hitting the Rocky Mountain Front Range and the Great Plains generate winds around Guadalupe Pass that occasionally top 100 mph. Dust storms frequently reduce visibility to 10 miles or less.

November

"What's the use of a house if you haven't got a tolerable planet to put it on?"
- Henry David Thoreau

- Check sampler inlets every 3 months.
- Call UC Davis at 530-752-1123 to figure out how holidays affect sample change schedules.

Oct 2008

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Dec 2008

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 306 Julian day
2 307 Daylight Savings Time ends IMPROVE particle sampling day	3 308	4 309 Election Day Change IMPROVE particle cartridges.	5 310 IMPROVE particle sampling day	6 311	7 312	8 313 IMPROVE particle sampling day
9 314	10 315	11 316 Veterans Day IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	12 317	13 318	14 319 IMPROVE particle sampling day	15 320 America Recycles Day
16 321 National Park Service established, 1916	17 322 IMPROVE particle sampling day	18 323 Change IMPROVE particle cartridges.	19 324	20 325 IMPROVE particle sampling day	21 326	22 327
23 328 IMPROVE particle sampling day	24 329	25 330 Change IMPROVE particle cartridges.	26 331 IMPROVE particle sampling day	27 332 Thanksgiving	28 333	29 334 IMPROVE particle sampling day
30 335						

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

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

Operator Involvement -- The Key to Network Success

RoMANS

Rocky Mountain Atmospheric Nitrogen and Sulfur Study

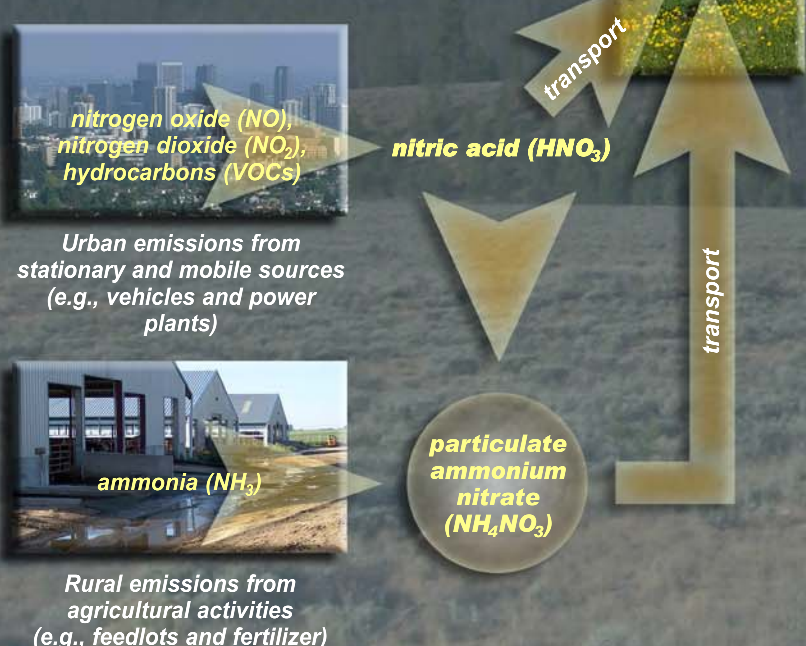
Rocky Mountain National Park (RMNP) is experiencing a number of effects from the deposition of atmospheric nitrogen and sulfur compounds. These effects include visibility degradation, changes in ecosystem function and surface water chemistry from atmospheric deposition, and human health concerns due to elevated ozone concentrations. The nitrogen compounds include both oxidized (e.g., NO_x) and reduced (e.g., NH_3) nitrogen. Emissions of nitrogen compounds need to be reduced to mitigate these effects.

Effects of Increasing Reactive Nitrogen in Remote Areas in and near Rocky Mountain National Park

- Increased haze, reducing visibility
- Lower capacity to sequester atmospheric nitrogen deposition
- Nitrogen enrichment and shifts in diatom communities in alpine lakes
- Nitrogen enrichment in organic soil layer and Engelmann spruce needles on eastern slope
- Acidification of lakes

The Urban-Rural Interface

Nitrogen emissions from urban areas and power plants are primarily in the form of nitrogen oxides (NO and NO_2), while nitrogen emissions from agricultural activity are generally in the form of ammonia or related amines. Nitrogen oxides form nitric acid (HNO_3), which reacts with ammonia to form particulate nitrate (NH_4NO_3), which affects visibilty. Along with its gaseous precursors, it is transported and then deposited in high alpine aquatic and terrestrial nitrogen-sensitive ecosystems.



Study Objectives

- Characterize the atmospheric concentrations of sulfur and nitrogen species in gaseous, particulate, and aqueous phases (precipitation and clouds) along the east and west sides of the Continental Divide.
- Identify the relative contributions to atmospheric sulfur and nitrogen species in RMNP from within and outside of the state of Colorado.
- Identify the relative contributions to atmospheric sulfur and nitrogen species in RMNP from emission sources along the Colorado Front Range versus other areas within Colorado.
- Identify the relative contributions to atmospheric sulfur and nitrogen species from mobile sources, agricultural activities, and large and small point sources within the state of Colorado.

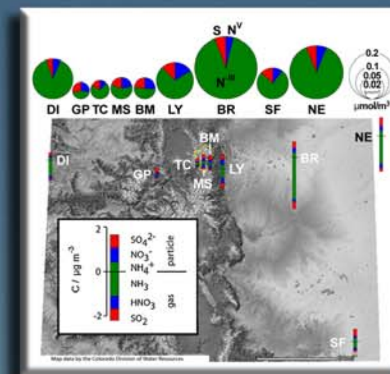
The Measurement Program

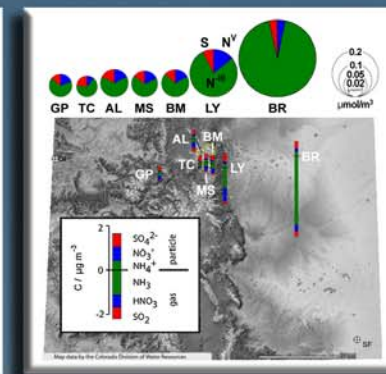
The RoMANS measurement campaigns occurred during March-April 2006 and July-August 2006, primarily because spring and summer seasons historically have high deposition fluxes and correspond to two uniquely different mechanisms for transport of nitrogen and sulfur into RMNP. Spring upslope conditions and afternoon convective activity lead to showers and enhanced wet deposition. This 3-dimensional map shows the positions of monitoring sites within the park area.

Preliminary Analysis Results

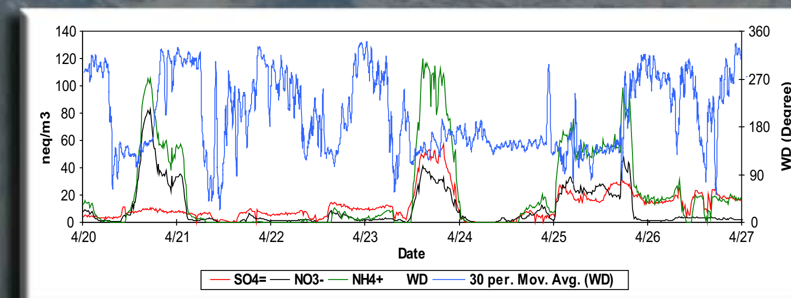
The following maps show the locations of monitoring sites as vertical colored bars. Colored bars below the zero (0) line correspond to average concentrations of gases while those above the zero line correspond to particulates. Green represents ammonia / ammonium, blue represents nitric acid / nitrate, and red sulfur dioxide / sulfate. The pie charts at the top of the graphs are scaled to total average concentrations of ammonia + ammonium (green), nitric acid + nitrate (blue), and sulfur dioxide + sulfate (red). Lowest concentrations are found in the mountains while the highest are along the Front Range and northeastern Colorado. Highest ammonia concentrations are found around Brush, where there are high-density animal feeding operations. Deposition associated with gases is greater than for particulates. Average concentrations are higher during the summer than spring seasons.

The timeline (center right) shows sulfate (red), nitrates (black), ammonium (green), and wind direction (blue) at the Core monitoring site in





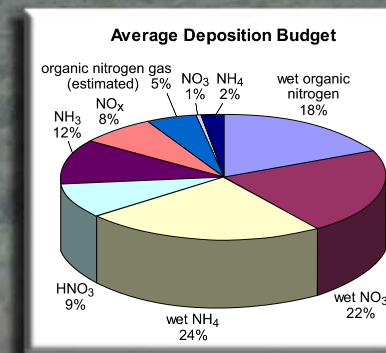
RMNP. When the winds blow from the east (Front Range), pollutant concentrations increase, while from any other direction the concentrations decrease. On April 23, an upslope event occurred (light winds from the east) and atmospheric concentrations increased and then decreased almost to zero as they were wet-deposited (rain) out of the atmosphere. This one event contributed most of the wet deposition during the spring field campaign. In general, concentrations of pollutants vary widely and the pollutant mix between sulfates, nitrates, and ammonium varies between episodes.



Summary

This pie chart shows the average fractional contributions associated with various wet and dry nitrogen species deposited in the RMNP area. The important things to note are

- total nitrogen deposition was about twice as high during the summer compared to spring,
- about 45% of nitrogen deposition is not being measured in the current monitoring programs (NAPD & CASTNET),
- deposition of nitrogen is about 2/3 wet (rain and snow) and 1/3 dry (particles and gases),
- organic nitrogen may be about 25% of total deposition and is not currently being measured.



Sawtooth National Forest, Idaho

December

"Study nature, love nature, stay close to nature. It will never fail you."
- Frank Lloyd Wright

Steve Rogers, the operator at Sawtooth National Forest, works in Facility Maintenance at the Stanley Ranger Station. His primary responsibility is the facility program for the Sawtooth National Recreation Area (SNRA). He's a member of the safety committee, a wildland fire fighter, a forest protection officer (FPO), and the primary IMPROVE site operator.

Steve retired from the Air Force in 2002, where he had worked in civil engineering, utilities, water & waste, contracting, and heavy equipment. He then worked in the log-home business for a short time. For the last five years, he's been working for the Forest Service. He says, "I really feel fortunate to work here. I enjoy this area. Working and living in a playground like this is wonderful. Winter can be extreme, but it is a postcard beautiful landscape!"

He likes to bicycle, hike, take whitewater trips, ski, snowmobile, and volunteer in the local community school programs. He also participates in search and rescue, the Rural Fire Dept., and is a member of the Salmon River Snowmobile Club and Sawtooth Ski Club.

At Sawtooth, nature can be harsh, with wintertime temperatures sometimes dropping as low as 35 degrees below zero. Steve Rogers describes the visibility and air quality in the area as being excellent, except when there are wildfires. He attributes the clear air to the remoteness of the locale and the lack of any nearby industry.

The SNRA is a 756,000-acre portion of Sawtooth National Forest. It is one of the largest recreation areas in the United States, containing 40 peaks over 10,000 feet, more than 300 high mountain lakes, and the headwaters for four of Idaho's major rivers. Within the SNRA is a 217,000-acre wilderness area.

In addition to air sampling, other studies include Chinook salmon observations during August and a weed inventory in the wilderness area.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
UC Davis: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Karen Rosener *Photography*: Karen Fischer (970) 484-7941	1 336 *Julian day* ◆ Check wires and tubing throughout the fall and winter for rodent damage.	2 337 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	3 338 ◆ Call UC Davis at 530-752-1123 to figure out how holidays affect sample change schedules.	4 339	5 340 IMPROVE particle sampling day	6 341
7 342	8 343 IMPROVE particle sampling day	9 344 Change IMPROVE particle cartridges.	10 345	11 346 IMPROVE particle sampling day	12 347	13 348
14 349 IMPROVE particle sampling day	15 350	16 351 Change IMPROVE particle cartridges.	17 352 IMPROVE particle sampling day	18 353	19 354	20 355 IMPROVE particle sampling day
21 356 Winter begins	22 357	23 358 IMPROVE particle sampling day Special IMPROVE particle change. Move cassette 3 from old cartridge to new.	24 359	25 360 Christmas	26 361 IMPROVE particle sampling day	27 362
28 363	29 364 IMPROVE particle sampling day	30 365 Change IMPROVE particle cartridges.	31 366 New Year's Eve			

Nov 2008

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A Dark Sky Over Death Valley, California

Photographer: Dan Duriscoe, U.S. National Park Service

This natural glow over Death Valley is in danger. The above 360-degree full-sky panorama is a composite of 30 images taken two years ago in Racetrack Playa. The image has been digitally processed and increasingly stretched at high altitudes to make it rectangular. In the foreground on the right is an unusually placed rock that was pushed by high winds onto Racetrack Playa after a slick rain. In the background is a majestic night sky, featuring thousands of stars and many constellations. The arch across the middle is the central band of our Milky Way Galaxy. Light pollution is threatening dark skies like this all across the United States, and therefore the International Dark-Sky Association and the U.S. National Park Service are suggesting methods that can protect them.

For questions or problems with optical or scene monitoring equipment, contact Mark Tigges, Air Resource Specialists, Ft. Collins, CO, at 970-224-9300.
For questions or problems with air sampler controllers or filters, contact Jose Mojica or Steven Ixquiac, UC Davis, at 530-752-1123. For sampler audits, ask for Steven Ixquiac.

IMPROVE STEERING COMMITTEE

IMPROVE Steering Committee members represent their respective agencies and meet periodically to establish and evaluate program goals and actions. IMPROVE-related questions within agencies should be directed to the agency's steering committee representative.

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Front cover photo: Looking into Yosemite Valley from atop Sentinal Dome. Photographer: Jeff Lemke