INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS

IMPROVE

1st Quarter 2009 | The IMPROVE Newsletter | Volume 18 / Number 1

# Monitoring update

**Feature Article:** Data losses during wildfire events, Page 4

## Network operation status

The IMPROVE (**I**nteragency **M**onitoring of **Pro**tected **V**isual **E**nvironments) Program consists of 110 aerosol visibility monitoring sites selected to provide regionally representative coverage and data for 155 Class I federally protected areas. Additional instrumentation that operates according to IMPROVE protocols in support of the program includes:

- 60 aerosol samplers
- 34 nephelometers
- 4 transmissometers
- 4 digital camera systems
- 58 Webcamera systems
- 5 interpretive displays

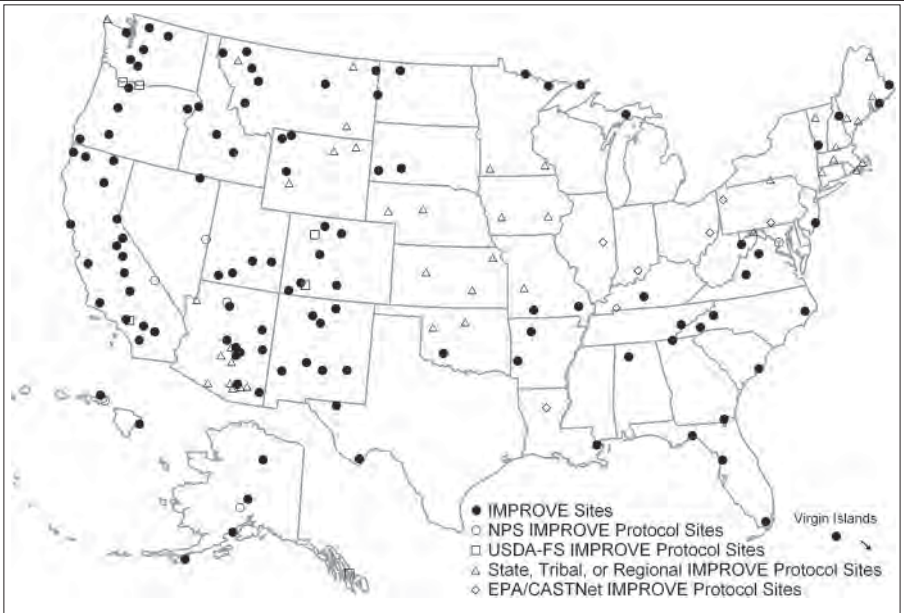
IMPROVE Program participants are listed on page 8. Federal land management agencies, states, tribes, regional air partnerships, and other agencies operate supporting instrumentation at monitoring sites as presented in the map below. Preliminary data collection statistics for the 1st Quarter 2009 (January, February, and March) are:

- Aerosol (channel A only) 94% collection
- Aerosol (all modules) 92% completeness
- Optical (nephelometer) 95% collection
- Optical (transmissometer) 84% collection
- Scene (photographic) (does not include Webcameras) 84% collection

The USDA-Forest Service acquired operation of an existing aerosol monitoring site in Ripple Creek Pass, CO, in March. The site is equipped with a four-module IMPROVE aerosol sampler.

## Data availability status

Data and photographic spectrums are available on the IMPROVE Web site at *http://vista.cira.colostate.edu/improve/Data/data.htm* and on the VIEWS Web site at *http://vista.cira.colostate.edu/views*. Aerosol data are available through June 2008. Nephelometer and transmissometer data are available through December 2008 and December 2007 respectively. Real-time Webcamera displays are available on agency-supported Web sites:




**IMPROVE and IMPROVE Protocol Sites**
**1st Quarter 2009**

- National Park Service *http://www.nature.nps.gov/air/WebCams/index.htm*
- USDA-Forest Service *http://www.fsvisimages.com*
- CAMNET (Northeast Camera Network) *http://www.hazecam.net*
- Midwest Haze Camera Network *http://www.mwhazecam.net*
- Wyoming Visibility Network *http://www.wyvisnet.com*
- Phoenix, AZ, Visibility Network *http://www.phoenixvis.net*

The EPA AIRNow Web site *http://airnow.gov* includes many of these as well as additional visibility-related Webcameras. Click on View Other Visibility Webcams.

*Monitoring update continued on page 7....*

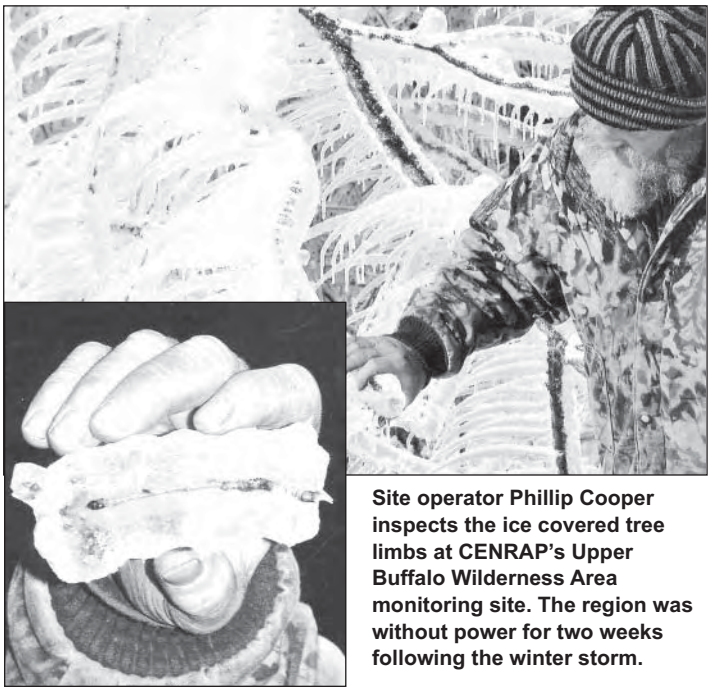
# Visibility news

## Upper Buffalo nephelometer hit by storm

The Central Regional Air Planning Association's (CENRAP's) nephelometer at the Upper Buffalo Wilderness Area in north-central Arkansas, was hit by a severe winter ice storm late January. National news networks across the country reported on the severity of the storm and the extent of power outages in the region. The photographs below captured the thickness of ice covering vegetation.

The monitoring site lost both instrument readings and communications during the storm. When power was restored to the site, the nephelometer did not resume normal function and was removed from operation for evaluation and repair. Diagnostics determined electronics failure occurred as a result of power surges associated with the storm. After repair and reinstallation, the nephelometer resumed normal operations. The site is located on a hilltop; it is not unusual for this site to be struck by lightning or other such storms.

*For more information contact Mark Tigges at Air Resource Specialists, Inc. Telephone: 970/484-7941. Fax: 970/484-3423. E-mail: mtigges@air-resource.com.*



**Site operator Phillip Cooper inspects the ice covered tree limbs at CENRAP's Upper Buffalo Wilderness Area monitoring site. The region was without power for two weeks following the winter storm.**

## Steering committee meeting set for fall

Wind Cave National Park, SD, will host an upcoming IMPROVE Steering Committee meeting, set for September 22-23, 2009. Meeting attendees will be able to experience a national park in the upper-Midwest region, participate in the two-day meeting, visit the IMPROVE monitoring site, and tour the cave in the famous Black Hills region. In addition to the famous cave, the park also features acres of mixed grass prairie, pine forest, and associated wildlife. Wind Cave National Park is a federally protected Class I area.

The meeting agenda will be available later, as the date draws nearer. Discussion topics will include status of the monitoring program, laboratory analysis, and data validation; special studies; scientific developments; and other topics of interest to the program.

*For more information contact Marc Pitchford at the National Oceanic and Atmospheric Administration. Telephone: 702/862-5432. Fax: 702/862-5507. E-mail: marc.pitchford@noaa.gov.*

## Upcoming regional conferences

Two conferences related to air quality in the Rocky Mountain Region are scheduled this fall:

Air Quality Impacts of Oil and Gas Production in the Rocky Mountains
September 15 - 16, 2009 in Centennial, CO. Sponsored by the Air & Waste Management Association. Visit *http://www.awma.org* for more information.

Air Quality Issues in the Rocky Mountain Region
November 17, 2009 in Golden, CO. Sponsored by the Air & Waste Management Association - Rocky Mountain States Section. Visit *http://www.awma-rmss.org* for more information.

*For more information about either conference contact Dave Maxwell at the National Park Service. Telephone: 303/969-2810. Fax: 303/969-2822. E-mail: David_Maxwell@nps.gov.*

***Visibility news** continued on page 6....*

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IMPROVE Newsletters are also available on the IMPROVE Web site at *http://vista.cira.colostate.edu/improve/Publications/news_letters.htm.*

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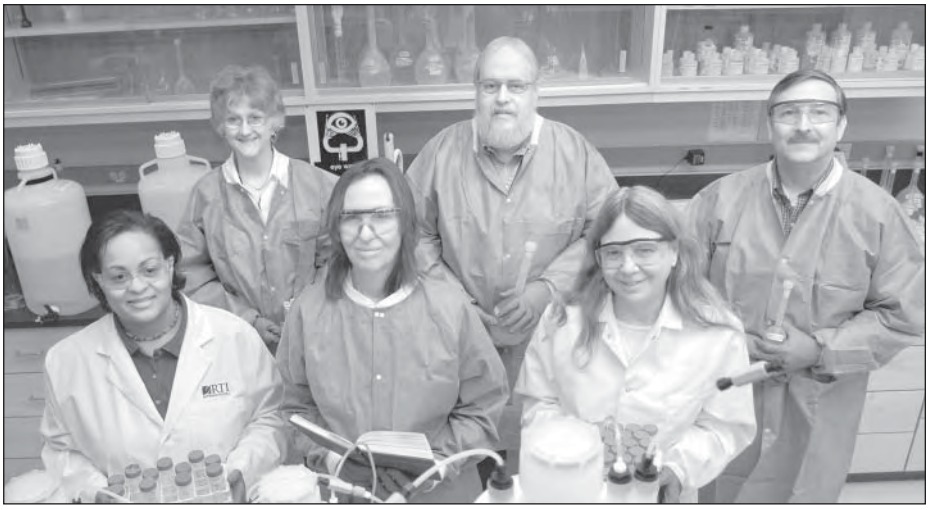
# Aspects of the job

## Ion analysis team at RTI International



The RTI International ion analysis team analyzes and reports on chemical loadings on the IMPROVE sampler B Module filters. From left to right are: Jennifer Garbutt, Eva Hardison, Christine Van Hise, David Hardison, Dorie Pickett, and Buddy Goodnight.

The ion analysis team at RTI International, in North Carolina, has prepared and analyzed filters for the IMPROVE program since 1985. Headed by Eva Hardison, the six-member staff currently provides analytical support for the IMPROVE monitoring network and for special studies such as the Joint Fire Sciences Program. "Our mission here at RTI is to provide air monitoring services and analytical data of the highest quality and in a timely manner," said Eva. "Our clients can then make the best possible decisions about their programs, and policymakers can then develop regulations needed to preserve our natural resources and our health."

UC-Davis loads B Modules with nylon filters for sampling and distributes them to monitoring sites. Exposed filters are then shipped from monitoring sites to UC-Davis, and the nylon filters are forwarded to RTI for analysis. RTI staff analyze and report anion loadings ($Cl^-$, $NO_2^-$, $NO_3^-$, and $SO_4^{2-}$) deposited on the filters. The filters are extracted using established procedures and the extracts are analyzed using ion chromatography. The IMPROVE network collects approximately 22,000 B Module filters annually. In past years of the IMPROVE contract, RTI staff prepared impregnated filters for $SO_2$ sampling, and analyzed and reported sulfate mass collected on these filters. The contract has also provided for passive sampler preparation and analysis support for several large ozone studies in national parks.

All six staff members, Eva Hardison, David Hardison, Buddy Goodnight, Dorie Pickett, Christine Van Hise, and Jennifer Garbutt, hold chemistry or biology degrees and have worked at RTI for several years.

Eva Hardison, Environmental Chemistry Department Manager, and David Hardison, Ion Analysis Lab Supervisor, met at RTI in 1977 and have been married for 15 years. Both are North Carolina natives, graduated from UNC-Chapel Hill, and are avid Tar Heel fans. They enjoy traveling, especially to national parks, vacationing on the North Carolina coast, and visiting the many potteries in Seagrove, NC, near Eva's hometown of Asheboro.

Buddy Goodnight, Ions Lab Technical Supervisor, has 29 years experience with Dionex Ion Chromatography (IC) systems and was a service engineer for Dionex for 12 years. He is responsible for day-to-day operations, technical troubleshooting, and hardware/software training for the 12 IC systems currently used. A North Carolina native, he earned a BS degree in Chemistry from North Carolina State University. He is married with two grown children and one grandchild, and spends time reading, fishing, and clay target sporting.

Chemist Dorie Pickett processes and analyzes filter samples using IC for anions and cations for the IMPROVE and other monitoring programs. She also prepares passive sampling modules to measure oxides of nitrogen, ozone, nitrite, nitrate, sulfate, and ammonium. Dorie moved to North Carolina to attend college and fell in love with the state and its people. She later moved to Research Triangle Park to measure air emissions from stacks for the EPA's OAQPS Emission Measurement Branch. She quilts and bakes cheesecakes for friends and family, and enjoys hiking and trout fishing in the Great Smoky Mountains, as well as deep sea fishing off the North Carolina coast.

Christine Van Hise operates the ion chromatograph and analyzes air quality samples from loaded filters. After graduating college and searching for chemistry jobs, she was attracted to the beauty of North Carolina, and quickly decided that is where she wanted to be. Christine enjoys hiking on the many trails in the mountains and gardening at home.

Rounding out the lab staff, Jennifer Garbutt analyzes air quality filters in the ions lab for the National Park Service. Also a native of North Carolina, Jennifer and husband Quincy are the proud parents of their 2 year-old daughter Gabriella. Jennifer also enjoys hiking in local parks, sampling international dishes, and spending time with her friends.

# Feature article

## Data losses during wildfire events (by C. McDade, University of California - Davis)

### Introduction

Wildfires occur every year throughout the United States. These fires can occur in clusters and are often regional in scope, blanketing hundreds of square miles with smoke for days at a time. Many IMPROVE sites are located in the forests and grasslands where these fires occur, so IMPROVE samplers can be impacted by smoke from the fires. Moderate amounts of particulate material collected during these events can provide interesting insights into the behavior and composition of wildfire smoke. However, when the smoke becomes too thick, the sampler clogs and data are lost for those days.

### Regional Haze Rule intent

Smoky days lie at one extreme of the distribution of particulate concentrations, and crystal-clear days lie at the other extreme. These extreme days are of great interest to data analysts and are the focus of much of the federal Regional Haze Rule (RHR) analysis. Reducing the visibility impacts on the haziest days and maintaining excellent visibility on the clearest days are at the heart of the RHR's purpose.

Analysis of IMPROVE data under the Regional Haze Rule is intended to establish a baseline of existing visibility conditions at the beginning of the 21st century and then to track progress toward the mid-century goal of achieving natural visibility conditions. IMPROVE data are analyzed to evaluate the conditions that lead to the 20% haziest days and the 20% clearest days. When smoke episode data are missing due to filter clogging, those days that represent the very hazy days are not included in the analysis, and typically drive down the average aerosol concentrations determined on the haziest days.

### Filter clogging example

Every IMPROVE sampling day begins at midnight with a fresh set of filters. As particles are collected on the filters, the flow resistance through the filters gradually increases and the flowrate decreases. On most days, this decrease in flowrate is gradual and slight, and it has no significant impact on sampling. But on very hazy days, the clogging can become sufficiently severe that the sample must be declared invalid, and in some cases the filter actually ruptures. IMPROVE has strict quantitative criteria for invalidating clogged filters. The flowrate is recorded electronically by the IMPROVE sampler every 15 minutes and is stored on the sampler's flashcard. If the flowrate remains below 15 liters/minute for more than one hour, then the sample is declared invalid. At such low flowrates the sampler calibration is no longer accurate, so the flowrate cannot be determined quantitatively.

Figure 1 below shows an example of the decrease in flowrate during a sampling day when the filter is clogging. The figure illustrates the 15-minute flowrate data for the Module A Teflon® filter at the Weminuche Wilderness, CO, monitoring site during June 27, 2005, shown by the dotted line. For comparison, the solid line shows the flowrate on the prior sampling day, June 24, before the clogging event occurred. The June 27 clogging event coincided with extremely high organic and elemental carbon concentrations at Weminuche, consistent with a smoke episode. In Figure 1, the flowrate on the fresh filter began in excess of 22 liters/minute and immediately began decreasing. By noon, the flowrate had dropped below 15 liters/minute, IMPROVE's data validity limit.

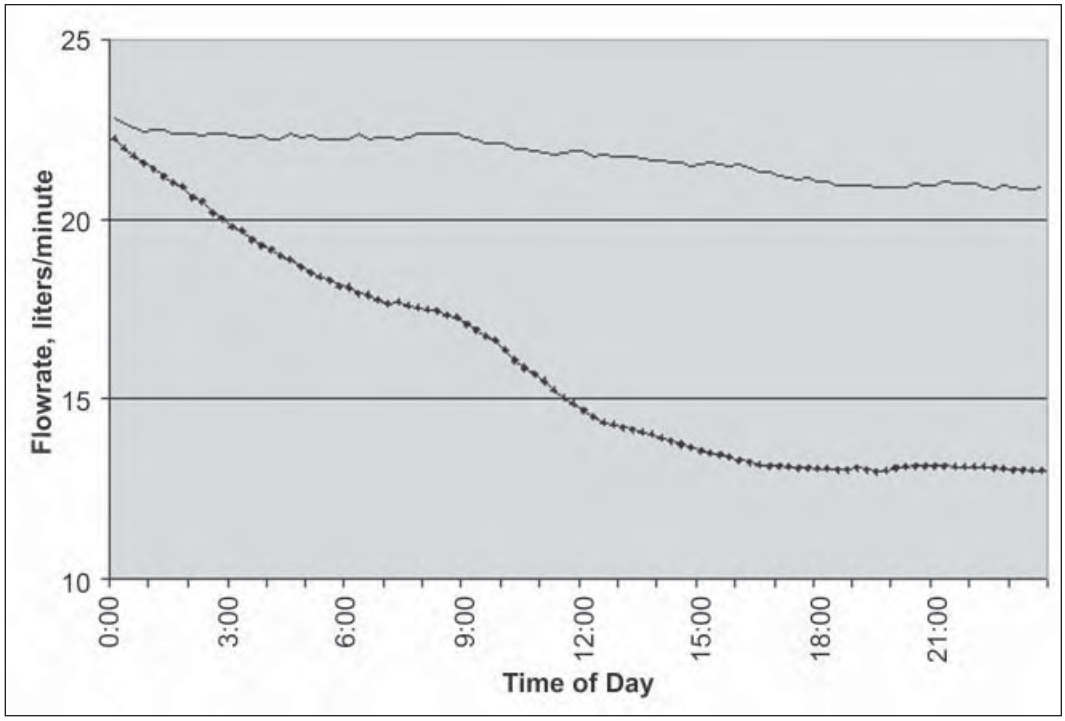



**Figure 1. Module A flowrate at Weminuche -- June 27, 2005 (dotted line), and June 24, 2005 (solid line).**

Due to its texture, the Teflon® filter (Modules A and D) is the most likely of the IMPROVE filters to clog. Teflon® is plastic, susceptible to clogging as particles accumulate. Quartz and nylon filters on the other hand, are more porous and thus are able to maintain low to moderate flow resistance even as they collect particles. Nylon (Module B) and quartz (Module C) filters tend to clog less frequently than do Teflon® filters. This principle is illustrated in Figure 2 below. The dotted line shows the flowrate trace for the Module C quartz filter at Weminuche for the same clogging event, June 27, 2005. As in Figure 1, the solid line shows the flowrate on June 24. The flowrate on June 27 decreased somewhat throughout the day, starting at 23.4 liters/minute and finished the day at 21.6 liters/minute. This slight decrease is well within IMPROVE's validation limits and does not approach the 15 liters/minute limit that was violated before noon with the Teflon® filter.

In a typical year, approximately 50 sample days suffer from clogging in one or more sampler modules, out of a total of around 20,000 sample days collected. Here, a sample day is defined as the set of four filters collected at a site on a single day. So, a very small percentage (less than 1%) of total sample days are lost due to clogging. However, the lost days can be among the most extreme hazy days in the year.

### Data substitution

The Regional Haze Rule allows for substitution of missing data under very specific circumstances. However, the default substitution approach does not work for sample dates with two or more missing species, as when the two Teflon® filters clog. The RHR also allows for states to develop their own substitution methods. For example, some states have used data from neighboring sites when missing entire sampling periods and failing the RHR completeness criteria (see *http://vista.cira.colostate.edu/views/web/documents/substitutedata.aspx*). Substituting data from nearby sites does not work particularly well for clogged samples; if the neighboring site was impacted by the event, then it is also likely clogged (and if it is not impacted then it is not very representative).

Dr. Donna Kenski with the Lake Michigan Air Directors Consortium (LADCO) developed a technique to allow valid data from clogged samples to be included in RHR metrics. If the valid data for a sample yields a high enough deciview value (with clogged filter values set to zero) to place the sample in the haziest 20% of days, then the sample is averaged into the metric. This technique works well to recover high contributions to haziest days from individual species such as ammonium nitrate and organic carbon.

### Conclusion

The Regional Haze Rule distinguishes between regional wildfire events and localized fires that may occur in the immediate vicinity of an IMPROVE site (for example, a nearby structural fire). Notes from IMPROVE site operators' log sheets can identify occurrences of localized fires. When available, this information is stored with the IMPROVE data on the VIEWS Web site allowing states to identify data from these days and to exclude them from regional analyses.

The worst case for data loss would be the destruction of an IMPROVE sampler during a fire. In a few cases in which fires have been predicted to come close to an IMPROVE monitoring site, alert operators have removed the sampler and have stored it in a safe place until the fire passed.

*For more information contact Chuck McDade at the University of California-Davis. Telephone: 530/752-7119. Fax: 530/752-4107. E-mail: mcdade@crocker.ucdavis.edu.*

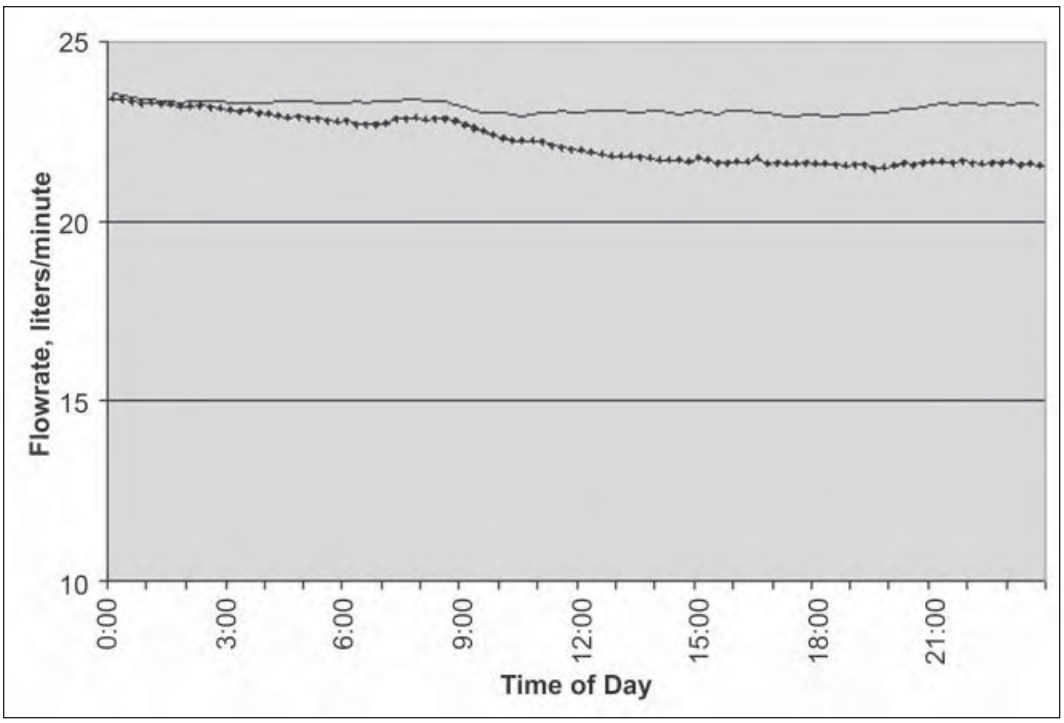



**Figure 2. Module C Flowrate at Weminuche -- June 27, 2005 (dotted line), and June 24, 2005 (solid line).**

# Visibility news continued from page 2 ....

## Rising sulfur dioxide at Hawaii Volcanoes NP cause for additional monitoring

Significant changes to air quality in Hawaii Volcanoes National Park, Hawaii, began in 2007 and occurred throughout 2008. Rumblings and eruptions of Kilauea Volcano caused sulfur dioxide ($SO_2$) and particulate emissions at the summit to reach very high levels, and the park to evacuate most staff and visitors on two occasions. Because of this increased volcanic activity, National Park Service (NPS) and United States Geological Survey (USGS) staff at the Hawaiian Volcano Observatory increased air monitoring at the observatory station. Exceedances of the federal primary health standard for $SO_2$ at the summit of Kilauea were higher in 2008 than any previous years.

In June 2008, an NGN-3 $PM_{2.5}$ size-cut nephelometer was installed to assess the dynamics and estimate the magnitude of particulate concentrations in the park. Particle concentrations often rose to very high levels and over 10 exceedances of the National Ambient Air Quality Standard of 35 $\mu g/m^3$ (24-hour average) occurred between July 2008 and March 2009.

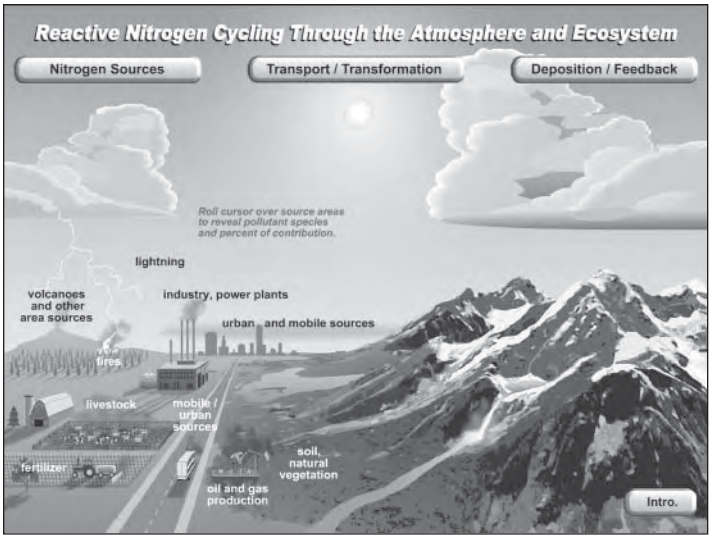
These measured high particulate values reinforced the NPS' decision to install an EPA-certified instrument for measuring $PM_{2.5}$. In January 2009, the NPS installed the SHARP (Synchronous Hybrid Ambient Real-time Particle) monitor, which is currently a candidate for EPA certification. Preliminary comparisons of the SHARP and NGN-3 suggest the NGN-3 may have been underreporting events. Average particle concentrations reported by the SHARP since January had maximum 15-minute values > 300 $\mu g/m^3$, and a maximum 24-hour average of 61 $\mu g/m^3$ falling into the "unhealthy for sensitive groups" category of EPA's Air Quality Index.

All air quality and meteorology data collected in the park are uploaded every 15 minutes to the park's $SO_2$ alert system and hourly to EPA's AIRNow Web page. The state has also enhanced its monitoring and reporting of air quality in populated areas of the Big Island. NPS Air Resources Division and Hawaii Volcanoes National Park staff are working to update the alert system, which can be found at *http://www.nature.nps.gov/air/WebCams/parks/havoso2alert/havoalert.cfm.* Increased particulate and $SO_2$ levels and corresponding increased sulfate levels are having an impact on the visibility of this Class I area and other areas of the Big Island. An IMPROVE aerosol sampler operates at the Visitor Center to quantify these impacts.

*For more information contact John Ray at the National Park Service. Telephone: 303/969-2820. Fax: 303/969-2822. E-Mail: John_D_Ray@nps.gov.*

## Educational presentation teaches nitrogen cycling through atmosphere and ecosystem

The Cooperative Institute for Research in the Atmosphere (CIRA), in conjunction with the National Park Service, has produced an interactive educational presentation developed from information gained from the Rocky Mountain Atmospheric Nitrogen and Sulfur (RoMANS) Study. The highly graphic and interactive presentation, titled Reactive Nitrogen Cycling Through the Atmosphere and Ecosystem, steps schoolage children through the sources and contribution levels of excess nitrogen in the atmosphere, its transport, and its deposition back into the ecosystem. Details of each process are provided through cursor movements, allowing a thorough understanding of each process. The presentation also shows effects of transport and effects to the ecosystem during the deposition stage.




**The nitrogen cycling educational presentation is a tool for schoolage children for learning about excessive nitrogen in the atmosphere and its processes as it travels through the ecosystem.**

The RoMANS study provided the basic information for the development of the presentation. Performed in 2006, the study included a core monitoring site within Rocky Mountain National Park, CO, and numerous satellite sites located throughout the state. Collected data helped scientists determine the origination and transport of nitrogen pollutants into the park.

The presentation can be found on the IMPROVE Web site at: *http://vista.cira.colostate.edu/improve/Education/ReactiveN/NitrogenCycling.swf.*

*For more information contact Julie Winchester at CIRA. Telephone: 970/491-8443. Fax: 970/491-8598. E-mail: Winchester@cira.colostate.edu.*

# Monitoring update *continued from page 1 ....*

## Outstanding sites

Data collection begins with those who operate, service, and maintain monitoring instrumentation. IMPROVE managers and contractors thank all site operators for their efforts in caring for IMPROVE and IMPROVE Protocol networks. Sites that achieved 100% data collection for 1st Quarter 2009 are:

### Aerosol (Channel A)

| | | |
|---|---|---|
| Acadia | Grand Canyon | Pack Monadnock |
| Arendtsville | Great Basin | Pasayten |
| Badlands | Great Gulf | Petrified Forest |
| Big Bend | Great Smoky Mtns | Phoenix |
| Bliss | Guadalupe Mountains | Pinnacles |
| Blue Mounds | Haleakala Crater | Point Reyes |
| Bondville | Hawaii Volcanoes | Presque Isle |
| Bosque del Apache | Ike's Backbone | Puget Sound |
| Boundary Waters | Indian Gardens | Quabbin Reservoir |
| Breton | Isle Royale | Redwood |
| Bridgton | Jarbidge | Rocky Mountain |
| Brigantine | Kalmiopsis | Sac and Fox |
| Bryce Canyon | Lake Sugema | Saguaro |
| Caney Creek | Lassen Volcanic | Saguaro West |
| Cape Romain | Linville Gorge | San Gorgonio |
| Chassahowitzka | Livonia | Sawtooth |
| Chiricahua | Makah | Seney |
| Cloud Peak | Mammoth Cave | Sequoia |
| Cohutta | Martha's Vineyard | Shining Rock |
| Columbia Gorge East | Medicine Lake | Snoqualmie Pass |
| Craters of the Moon | Mesa Verde | Starkey |
| Crescent Lake | MK Goddard | Sula |
| Death Valley | Mohawk Mountain | Tallgrass |
| Denali | Mount Baldy | Theodore Roosevelt |
| Dolly Sods | Mount Hood | Three Sisters |
| Dome Land | Mount Rainier | Trapper Creek-Denali |
| Douglas | Nebraska | Viking Lake |
| Egbert | Okefenokee | Virgin Islands |
| Frostburg Reservoir | Organ Pipe | Weminuche |
| Gila | | |

### Nephelometer

| | | |
|---|---|---|
| Big Bend | Ike's Backbone | Phoenix |
| Children's Park | Mammoth Cave | Shenandoah |
| Estrella | Mount Rainier | Tucson Mountain |
| Greer | Organ Pipe | Vehicle Emissions |

### Transmissometer

-- none --

### Photographic

Shamrock Mines

Sites that achieved at least 95% data collection for 1st Quarter 2009 are:

### Aerosol (Channel A)

| | | |
|---|---|---|
| Agua Tibia | Hercules-Glades | Quaker City |
| Bridger | James River | Queen Valley |
| Cape Cod | Lava Beds | Simeonof |
| Cherokee | Lostwood | Swanquarter |
| Crater Lake | Meadview | Wichita Mountains |
| Fresno | Moosehorn | Yosemite |
| Hells Canyon | Mount Zirkel | |

### Nephelometer

| | | |
|---|---|---|
| Chiricahua | Great Basin | Queen Valley |
| Craycroft | Hance | Sierra Ancha |
| Dysart | Indian Gardens | Sycamore Canyon |
| Glacier | Petrified Forest | Tucson |

### Transmissometer

-- none --

### Photographic

Agua Tibia
Gates of the Mountains

Sites that achieved at least 90% data collection for 1st Quarter 2009 are:

### Aerosol (Channel A)

| | | |
|---|---|---|
| Addison Pinnacle | Hoover | Sikes |
| Cabinet Mountains | Kaiser | Sipsey |
| Capitol Reef | Monture | St. Marks |
| Casco Bay | Olympic | Tonto |
| Cedar Bluff | Penobscot | Trinity |
| Columbia Gorge West | Proctor Research Center | Tuxedni |
| El Dorado Springs | Salt Creek | UL Bend |
| Everglades | San Gabriel | Voyageurs |
| Flathead | San Rafael | White Mountain |
| Glacier | Shamrock Mines | White Pass |
| Haleakala | Shenandoah | White River |

### Nephelometer

| | | |
|---|---|---|
| Cape Romain | Mount Zirkel | National Capital |

### Transmissometer

San Gorgonio

### Photographic

-- none --

**Monitoring Site Assistance:**

Aerosol sites: contact University of California-Davis
telephone: 530/752-7119 (Pacific time)

Optical/Scene sites: contact Air Resource Specialists, Inc.
telephone: 970/484-7941 (Mountain time)

IMPROVE

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**TO:**

First Class Mail

## 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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* Steering Committee Chair

**ASSOCIATE MEMBERS**
Associate Membership in the IMPROVE Steering Committee is designed to foster additional comparable monitoring that will aid in understanding Class I area visibility, without upsetting the balance of organizational interests obtained by the steering committee participants. Associate Member representatives are:

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