INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS

IMPROVE

1st Quarter 2011 | The IMPROVE Newsletter | Volume 20 / Number 1

Monitoring update

Feature Article: Trends in haze and its constituents -- Report V, 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. Instrumentation that operates according to IMPROVE protocols in support of the program includes:

- 55 aerosol samplers
- 20 nephelometers
- 2 transmissometers
- 77 Webcamera systems
- 5 interpretive displays

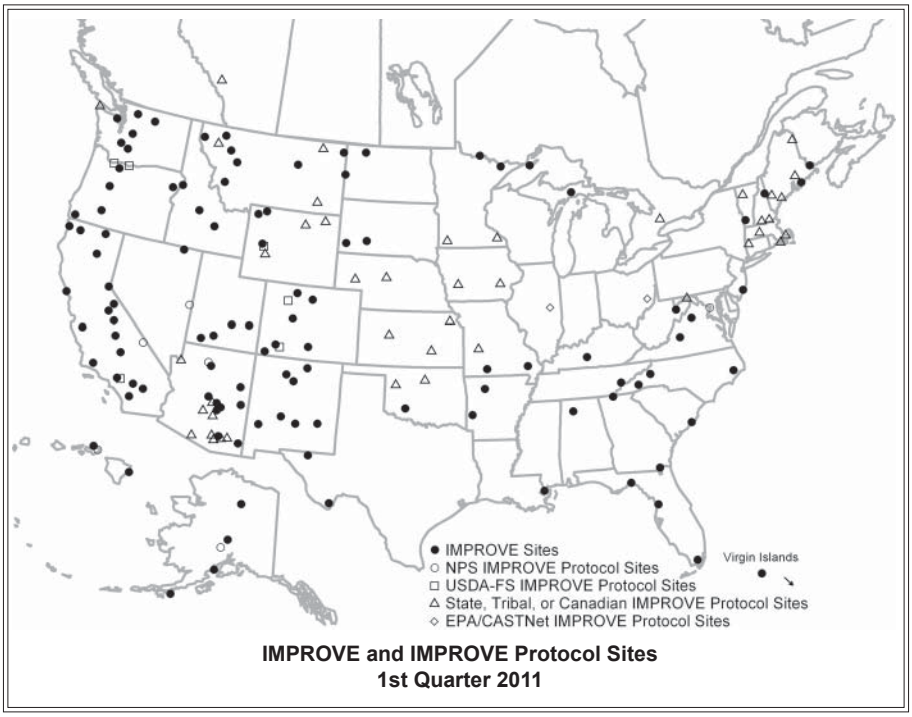
IMPROVE Program participants are listed on page 8. Federal land management agencies, states, tribes, regional air partnerships, and other agencies operate supporting instrumentation at monitoring sites as presented in the map below. Preliminary data collection statistics for the 1st Quarter 2011 (January, February, and March) are:

- Aerosol (channel A only) 94% collection
- Aerosol (all modules) 93% completeness
- Optical (nephelometer) 92% collection
- Optical (transmissometer) 70% collection

Environment Canada is providing funding for its second aerosol monitoring site. The Barrier Lake (BALA1) aerosol site in Alberta, near Banff National Park, began monitoring in January. The full story and site photograph can be found on page 6.

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 April 2010. Nephelometer and transmissometer data are available through December 2010 and December 2009, respectively. Webcamera real-time images and data are available on agency-supported Web sites:



IMPROVE and IMPROVE Protocol Sites
1st Quarter 2011

- National Park Service *http://www.nature.nps.gov/air/WebCams/index.htm*
- US 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 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 "Visibility Cameras."

***Monitoring update** continued on page 3....*

Visibility news

Steering committee meeting set for fall

The state of Maryland will host this fall's IMPROVE Steering Committee meeting in Frostburg, MD, October 25-27, 2011. Frostburg is the location of the Piney Run supersite, known to IMPROVE as the Frostburg Reservoir (FRRE1) monitoring site.

The annual meeting of federal land managers, regional planning organizations, and air quality managers of interested state agencies will include discussions of the status of monitoring throughout the program and future needs and planning. Researchers and scientists will also present related topics of interest such as the latest scientific findings associated with visibility or data analysis methods.

A one-day technical workshop will also be scheduled preceding the IMPROVE meeting. Agendas for both the workshop and meeting will be released later this summer.

As always, part of the meeting will be devoted to a site tour. The Piney Run site is important to air quality researchers in the East. By the early 2000s the Maryland Department of the Environment (MDE) operated an air monitoring network of 23 sites across the state. In 2004, MDE deployed the Piney Run station to monitor the impact of interstate pollutant transport on air quality within the state. Piney Run is well suited to capture the regional characteristics of the air as it enters Maryland from the west and before it has traveled through the more industrialized and populated central areas of the state. The primary focus at Piney Run is to measure ozone and fine particulates, as well as their respective precursors and constituent species. The site is distinct due to its high elevation and western boundary location in rural Maryland.

Piney Run is operated by universities and regional and state organizations including IMPROVE, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) who sponsors the Rural Aerosol Intensive Network (RAIN), the Appalachian Laboratory at the University of Maryland Center for Environmental Science and the University of Maryland who contribute air quality measurements in support of MDE, and the Maryland Department of Natural Resources who operates the National Atmospheric Deposition Program (NADP), the National Trends Network (NTN), and the Mercury Deposition Network (MDN).

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.

New BLM representative appointed to IMPROVE Steering Committee

Dave Maxwell has been appointed by the Bureau of Land Management (BLM) to fill the BLM vacancy on the IMPROVE Steering Committee that was created when Scott Archer retired last spring. Dave transferred to the BLM National Operations Center in Denver last September after spending over 10 years with the National Park Service (NPS) Air Resources Division (ARD) in Denver. During Dave's tenure with the NPS, he managed the annual IMPROVE program budget of approximately $6,000,000.

At the BLM, Dave is an Air Resource Specialist responsible for overseeing air quality, meteorology, climate, and climate variability activities with BLM state and field offices throughout the western United States, and for addressing policy issues with the Washington, DC office. He provides support to a variety of organizations in the form of technical and contractual assistance, consultation, and guidance on air quality matters related to the National Environmental Policy Act (NEPA).

Although BLM does not operate any IMPROVE samplers, data from IMPROVE networks near BLM land are utilized for evaluating affected environments and determining potential environmental consequences for Resource Management Plans and Environmental Impact Statements. Dave has been a regular attendee at IMPROVE Steering Committee meetings since 2000.

Dave Maxwell can be contacted at the BLM. Telephone: 303/236-0489. Fax: 303/236-3508. E-mail: david_maxwell@blm.gov.

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Web sites receive enhancements to support Webcamera operations

Web sites that display near real-time digital images of visibility conditions in support of the IMPROVE Program or use IMPROVE operating protocols have been undergoing enhancements to keep pace with changing technology. These Web sites have been operating for a number of years, and newer technology allows site coding that enables more efficient data display, quicker page loading, and interactive features.

The Northeast Camera Network (CAMNET) Web site (*http://www.hazecam.net*) sponsored by the Northeast States for Coordinated Air Use Management (NESCAUM) is currently undergoing such an update. The site has been using the same coding since 1999, and the new database-driven redesign is expected to be released this summer.

The National Park Service recently upgraded its Web site camera pages and data display [see *The IMPROVE Newsletter* 2nd Qtr 2010]. The site has since added pages for a new Webcamera at both Hawaii Volcanoes and Shenandoah National Parks (*http://www.nature.nps.gov/air/WebCams*).

The Wyoming Department of Environmental Quality Air Quality Division has also been enhancing their Visibility Network Web site (*http://www.WyVisNet.com*) with new monitoring sites and pages, and new interactive features. The home page boasts a new "Parameter Map" feature. The visitor selects a parameter of interest such as hourly ozone, 8-hour ozone, 1-hour nitrogen dioxide, or 24-hour $PM_{2.5}$ or PM_{10}, and the state map updates with current values for each location monitoring that parameter, allowing the user to see all the current values in the state at a glance. Other new features include a look at the instrumentation inside an air quality shelter and a time-lapse video of the visibility conditions over the past 24 hours (visit *http://www.wyvisnet.com/chey.aspx?site=chey1*).

For more information about Webcamera monitoring, contact Scott Cismoski at Air Resource Specialists, Inc. Telephone: 970/484-7941. Fax: 970/484-3423. E-mail: scismoski@air-resource.com.

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

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

Operators of distinction

"Small things go wrong all the time," said IMPROVE site operator Paul Bohmann at Mesa Verde National Park, CO. "But that's what makes it interesting."

Paul joined the Mesa Verde staff in 1997 and was a park maintenance laborer until 2005. He became an Air Quality Technician in 2009, and now works two to three days a week. Although servicing the park's air quality instrumentation is his primary responsibility, Paul is often called in to help with other tasks including fence building, revegetation projects, and helping researchers in the field. His forestry background, coupled with his maintenance experience and outdoor recreation interests makes him the perfect person to perform all these tasks.

Paul likes the work at the air quality site and sees it as a challenge. "It is a unique job," said Paul. "No other park staff know about the air quality instrumentation here, so I have to call UC-Davis technicians to discuss problems. It takes a lot of communication to explain what the problem is to someone on the other end of the phone line who is not able to see the instrument themselves. There's a lot of back-and-forthing, a lot of head scratching, and a lot of repetitive experiments to troubleshoot something gone awry."

Six air quality instruments are on Paul's Tuesday visit list: the IMPROVE aerosol sampler, and samplers to measure ozone, oxides of nitrogen, dry and wet mercury, wet acid, and ammonium. Collection of the filters and water samples takes about four hours, and Paul tries to get them into the mail by noon, since the mail carrier arrives shortly after noon each day. The rest of the day is spent performing instrument maintenance, troubleshooting, or catching up on e-mails.

The remainder of Paul's time is spent operating his organic farm. His three-acre Community Supported Agriculture farm provides local customers with fresh produce as soon as it is harvested. Paul has been farming for almost five years and grows a wide variety of vegetables for those who embrace a healthy lifestyle.

IMPROVE site operator Paul Bohmann finds his job interesting and challenging at Mesa Verde National Park (MEVE1), in Colorado.

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

Feature article

Spatial and seasonal patterns and temporal variability of haze and its constituents in the United States: Report V

(by J.L. Hand[1], S.A. Copeland[1], D.E. Day[1], A.M. Dillner[2], H. Indresand[2], W.C. Malm[1], C.E. McDade[2], C.T. Moore[3], M.L. Pitchford[4], B.A. Schichtel[5], and J.G. Watson[6])

Introduction

The purposes of the IMPROVE network include identifying chemical species and emission sources for existing anthropogenic and natural visibility impairment, and documenting long-term trends for assessing progress towards national visibility goals. The IMPROVE report, released every 4 to 5 years, provides a summary of the data obtained through the IMPROVE network. A draft of Report V was released in March 2011 that covers the period from 2005 to 2008. One of the main goals of the IMPROVE report is to present the spatial and seasonal patterns of speciated aerosol concentrations and reconstructed light extinction coefficients (b_{ext}). In addition to patterns in absolute mass concentration and $b_{ext,}$ the spatial and seasonal distribution in the relative contribution of key aerosol species to reconstructed fine mass and b_{ext} are also reported. These analyses are important for understanding the causes of haze in the United States and its spatial and temporal variability. Furthermore, several studies are included that investigate related research topics in depth. For example, data from the Environmental Protection Agency's urban aerosol monitoring network (Chemical Speciation Network, or CSN) were included in the examination of the spatial and seasonal variability in aerosol mass concentrations and b_{ext} to investigate the differences in rural and urban aerosol concentrations and to estimate urban excess. Also new in this report is an examination of aerosol trends. Data from the network now span 20 years at many locations, providing the opportunity to study long-term trends in major aerosol species and their spatial variability. Finally, additional chapters cover topics such as an investigation into the biases in fine mass measurements, Regional Haze Rule metrics, new standards for X-Ray Fluorescence measurements, and ammonia/ammonium measurements. We highlight only a few results here but encourage the reader to peruse the report for more detail.

Spatial patterns in deciview

No discussion of the IMPROVE report would be complete without a presentation of haze conditions in deciview (dv) units from reconstructed light extinction coefficients. Deciview values include the contributions from ammonium sulfate, ammonium nitrate, particulate organic matter (POM), light absorbing carbon, fine soil, sea salt, coarse mass, and site-specific Rayleigh scattering. The rural IMPROVE, spatially interpolated 2005–2008 annual mean deciview (dv) map is presented in Figure 1. Values at rural sites ranged

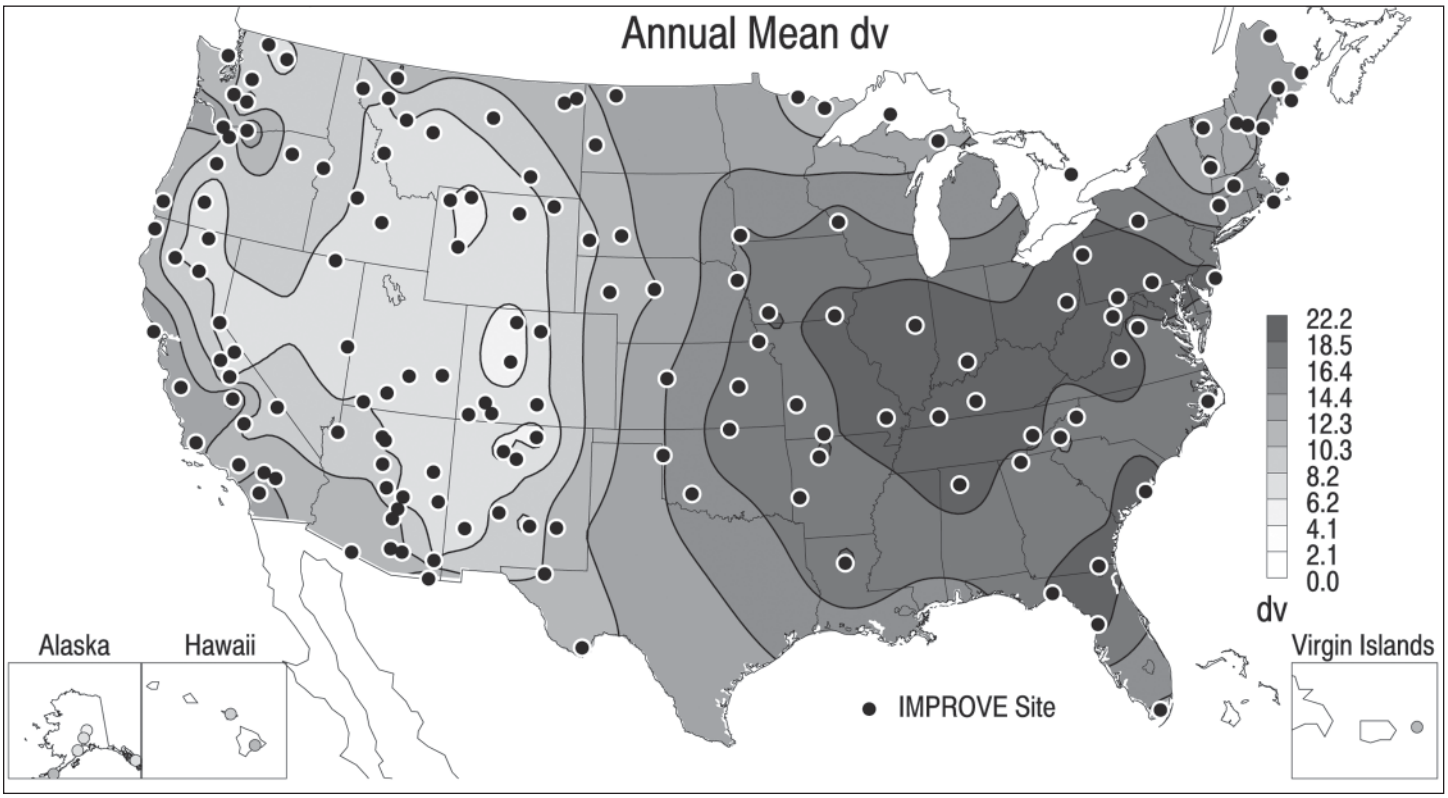

Figure 1. IMPROVE annual mean deciview (dv) for 2005–2008. Deciview is derived from the logarithm of the reconstructed light extinction coefficient.

from 4.7 dv at White River, CO (WHRI1), to 22.2 dv at Mammoth Cave, KY (MACA1). Generally, the highest dv values corresponded to eastern sites and along the Ohio River Valley, where annual mean dv values over 20 were common. Lower dv values (<10) corresponded to western sites, especially in the Intermountain West. Western coastal sites were associated with dv values ranging from 12 to 14 dv, as did sites in the northeastern U.S. While dv values such as those presented in the map in Figure 1 are important for assessing average visibility conditions in the U.S., understanding the causes of haze requires further investigations into the spatial and seasonal variability of the aerosol species responsible.

Reconstructed b_{ext} values in the eastern U.S. were dominated by ammonium sulfate (40–80%), especially during summer months. Ammonium sulfate was also an important contributor to b_{ext} in the northwestern and southwestern U.S., especially in summer, but to a much lower degree than at eastern sites (up to 40%). Ammonium nitrate contributions to b_{ext} ranged from 20% to 40% at eastern sites; at sites in the Midwest they were 40% or greater, especially in winter. Soil was an important contributor to b_{ext} at southwestern U.S. sites (up to 20% at some locations), and ammonium nitrate was an important contributor along the West Coast (~40% in winter). Contributions of POM to b_{ext} were typically 20% or more at sites in the Southwest, but were much higher at northwestern U.S. sites. Contributions of up to 80% or more occurred at some northwestern sites during summer, most likely associated with biomass burning.

Temporal trends in IMPROVE aerosol species

Aerosol trends are important for determining whether emission mitigation strategies are effective in meeting goals for improving air quality and visibility, and determining trends in aerosol species is a major purpose of the IMPROVE network. Long-term and short-term trends (1989–2008 and 2000–2008, respectively) in speciated aerosol mass concentrations were computed for approximately 50 to 150 sites depending on the time period. In particular, we focused on the 10th, 50th, and 90th percentiles in mass concentrations, and on winter, spring, summer, and fall seasons for sulfate ion, nitrate ion, total carbon (the sum of organic and light absorbing carbon), fine soil, gravimetric $PM_{2.5}$ mass (FM), and coarse mass concentrations. Results of statistically significant short- and long-term trends suggest that concentrations of most species are decreasing around the country for most parameters investigated, although to varying degrees. An example of long-term trend results for 50th percentile FM concentrations is shown in the map in Figure 2.

Report V continued on page 6....

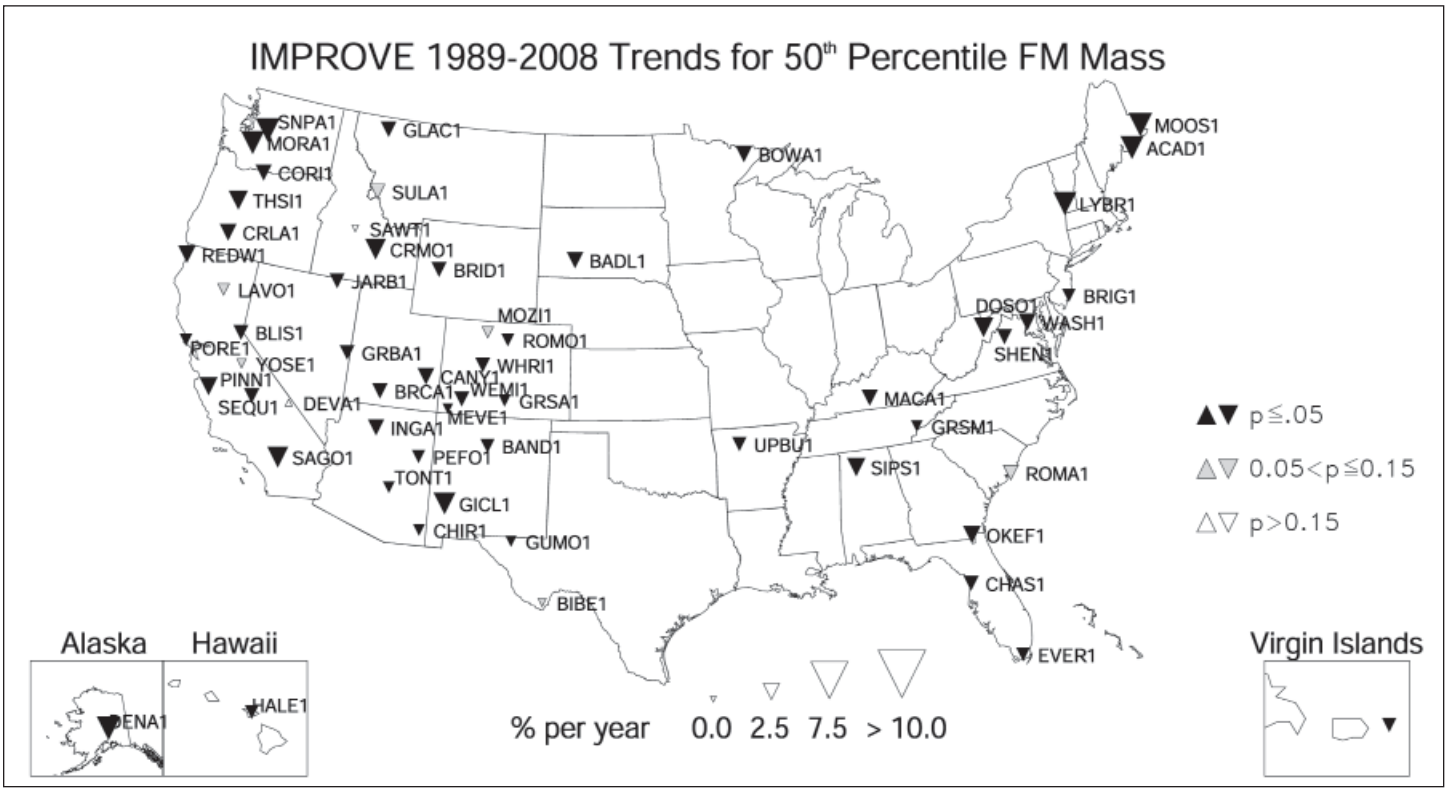

Figure 2. IMPROVE long-term trends (1989–2008) in $PM_{2.5}$ fine mass (FM) 50th percentile mass concentrations. Upward- and downward-pointing black triangles correspond to increasing and decreasing trends at a significance of p≤0.05. Gray triangles correspond to a significance of 0.05<p≤0.15. Unfilled triangles correspond to insignificant trends (p>0.15). The position of the triangle corresponds to an IMPROVE site location.

Report V continued from page 5....

Long-term trends in FM 50th percentile concentrations were negative at all the sites shown in Figure 2. The largest negative trends were associated with sites in the Northwest such as Snoqualmie Pass, WA (-4.1% yr^{-1}), and Mount Rainier, WA (-4.0% yr^{-1}). In the Northeast, the sites at Moosehorn, ME (-4.1% yr^{-1}), and Acadia, ME (-3.9% yr^{-1}), were associated with large negative trends. Sites in the Southwest with large negative trends corresponded to San Gorgonio, CA (-3.5% yr^{-1}), and Gila, NM (-3.7% yr^{-1}). The least negative long-term 50th percentile FM trend corresponded to Big Bend, TX (-0.6% yr^{-1}).

Changes in FM concentrations such as those observed at Acadia have direct effects on haze levels observed at a site. The front cover of Report V provides a striking example of the difference in the visibility observed at Acadia corresponding to the FM concentrations in 1989 versus 2008. The results from the IMPROVE trend studies suggest that FM aerosol concentrations are decreasing, and subsequently visibility is improving for most rural sites around the United States. However, in terms of control strategies, it is important to understand the trends for an individual species, as they may differ from FM trends due to the species' particular sources and seasonality. Therefore, similar maps for all the species and parameters mentioned earlier are provided in the report.

Report availability

A draft of IMPROVE Report V is available for download from *http://vista.cira.colostate.edu/improve/Publications/Reports/2011/2011.htm*. This report will be finalized by June 2011 and will be available from the same Web page.

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Visibility news

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New IMPROVE Protocol site joins network in Western Canada

In January 2011, sampling began at a new site at Barrier Lake, Alberta, located on the eastern edge of the Rocky Mountains close to Banff National Park. The site is located on the grounds of the Barrier Lake Station, a field research facility operated by the University of Calgary. Environment Canada provides the funding for operating this site.

Aerosol sampling at Barrier Lake is intended to characterize regional air quality in the Banff National Park area as part of an Environment Canada visibility monitoring pilot study. Collocated with the IMPROVE sampler are an Optec NGN-2a nephelometer and basic meteorological measurements. In addition, a digital camera will be installed in the near future to record information on visual air quality. This suite of visibility monitoring instrumentation will facilitate the assessment of visibility conditions in this scenically important region of Canada.

The monitoring site is well-removed from major emission sources and thus should be representative of the region. There is light vehicle traffic within the Barrier Lake Station grounds, and a local highway approximately 200 meters to the northwest; otherwise, the surrounding area is remote and unoccupied.

The IMPROVE sampler is installed in a shelter, with the sample modules located in an unheated section to achieve ambient temperature sampling and with the controller and pumps located in an adjacent heated section to provide warmth for the operator while recording readings. The site is serviced weekly by scientific staff from the Barrier Lake Station.

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

The Barrier Lake Station (BALA1), near Calgary, Alberta, is the latest station to join the IMPROVE aerosol network.

Monitoring update *continued from page 3 ....*

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 2011 are:

Aerosol (Channel A) - 50% of all sites

Acadia
Badlands
Bandelier
Big Bend

Bliss
Bondville
Boulder Lake
Bryce Canyon

Caney Creek
Canyonlands
Cape Cod
Cape Romain

Capitol Reef
Chassahowitzka
Cherokee
Chiricahua

Columbia Gorge East
Dolly Sods
Douglas
Egbert

Ellis
Everglades
Flathead
Fresno

Frostburg Reservoir
Gates of the Arctic
Gila
Grand Canyon

Great Basin
Great River Bluffs
Great Sand Dunes
Great Smoky Mtns.

Haleakala
Haleakala Crater
Hoover
Ike's Backbone

Indian Gardens
Isle Royale
James River
Joshua Tree

Lake Sugema
Linville Gorge
Londonderry
Lostwood

Mammoth Cave
Mesa Verde
Mohawk Mountain
Moosehorn

Nebraska
North Cascades
Northern Cheyenne
Okefenokee

Olympic
Organ Pipe
Pack Monadnock
Pasayten

Point Reyes
Presque Isle
Proctor Research Ctr.
Puget Sound

Quabbin Reservoir
Quaker City
Redwood
San Gorgonio

San Rafael
Seney
Sequoia
Shamrock Mines

Snoqualmie Pass
St. Marks
Starkey
Sycamore Canyon

Theodore Roosevelt
Three Sisters
Trapper Creek-Denali
Tuxedni

UL Bend
Viking Lake
Virgin Islands
Voyageurs

Weminuche
White Pass
White River

Nephelometer - 35% of all sites

Big Bend
Dysart
Estrella

Glacier
Indian Gardens

Shenandoah
Vehicle Emissions

Transmissometer - 0% of all sites

-- none --

Sites that achieved at least 95% data collection for 1st Quarter 2011 are:

Aerosol (Channel A) - 12% of all sites

Breton
Brigantine
Cloud Peak
Crater Lake
Death Valley
Great Gulf
Guadalupe Mountains

Hawaii Volcanoes
Hells Canyon
Kalmiopsis
Lassen Volcanic
Mount Hood
Queen Valley

Salt Creek
San Pedro Parks
Sawtooth
Upper Buffalo
Wind Cave
Wrightwood

Nephelometer - 40% of all sites

Acadia
Great Smoky Mtns.
Hance

Mammoth Cave
Mount Rainier
National Capital

Rocky Mountain
South Pass

Transmissometer - 50% of all sites

San Gorgonio

Sites that achieved at least 90% data collection for 1st Quarter 2011 are:

Aerosol (Channel A) - 21% of all sites

Birmingham
Bridger
Cabinet Mountains
Cedar Bluff
Columbia Gorge West
Craters of the Moon

Crescent Lake
Denali
El Dorado Springs
Hercules-Glades
Jarbidge
Kaiser

Lava Beds
Makah
Martha's Vineyard
Meadview
Medicine Lake
Mount Baldy

Mount Zirkel
Penobscot
Petrified Forest
Pinnacles
Rocky Mountain

Saguaro West
Shenandoah
Sula
Swanquarter
Tallgrass
Tonto

Trinity
Wichita Mountain
Yellowstone
Yosemite
Zion Canyon

Nephelometer - 10% of all sites

Cloud Peak
Great Basin

Transmissometer - 0% of all sites

-- none --

Monitoring Site Assistance:
Aerosol sites: contact University of California-Davis
telephone: 530/752-1123 (Pacific time)
Optical/Scene sites: contact Air Resource Specialists, Inc.
telephone: 970/484-7941 (Mountain time)

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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:

STATE OF ARIZONA

Currently vacant