INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS

IMPROVE

4th Quarter 2003 | The IMPROVE Newsletter | Volume 12 / Number 4

Monitoring update

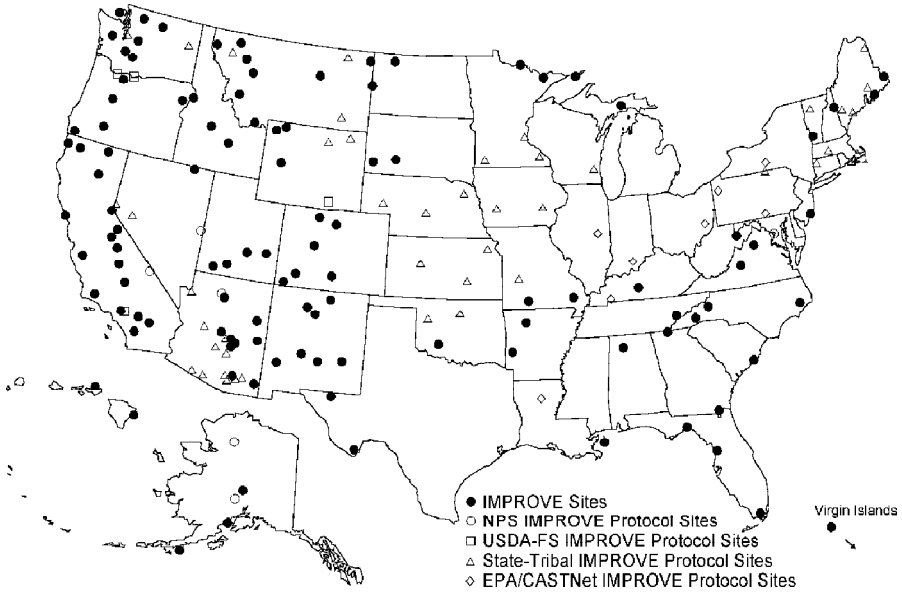
Feature Article: Asian dust event generates study of aerosols, Page 4

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 all 156 Class I federally protected areas. Additional instrumentation that operates according to IMPROVE protocol in support of the program include:

- 55 aerosol samplers
- 19 transmissometers
- 43 nephelometers
- 14 film or digital camera systems
- 42 Web camera systems
- 3 interpretive displays

IMPROVE Program participants are listed on page 8. Federal land managers, states, tribes, and other agencies operate supporting instrumentation at monitoring sites as presented in the map below. Preliminary data collection statistics for the 4th Quarter 2003 (October, November, and December) are:



IMPROVE and IMPROVE Protocol Sites
4th Quarter 2003

- Aerosol (channel A only) 96% collection
- Aerosol (all modules) 93% completeness
- Optical (transmissometer) 90% collection
- Optical (nephelometer) 96% collection
- Scene (photographic) 92% collection

One aerosol sampler was added to the IMPROVE Protocol network this quarter, sponsored by the National Park Service. The sampler was installed near Ambler, Alaska, a remote village above the Arctic Circle on the edge of Kobuk Valley National Park. Samplers were also installed at urban sites in Chicago and Detroit for a one-year collocated comparison with samplers in the EPA Speciation Trends Network.

Transmissometer systems were removed at Shenandoah National Park, VA, and Chiricahua National Monument, AZ, this quarter. The instruments were installed in December 1988 and February 1989, respectively. Shenandoah will continue to operate a nephelometer system. In addition, the state of Arizona installed Optec NGN-2 nephelometer systems at Chiricahua National Monument (December 2003) and Petrified Forest National Park (November 2003). These changes to the optical network were funded by the National Park Service and the state of Arizona.

Data availability status

Data are available on the IMPROVE Web site, at *http://vista.cira.colostate.edu/improve/Data/data.htm*. IMPROVE and other haze related data are also available on the VIEWS Web site, at *http://views.vista.cira.colostate.edu*. Aerosol data are available through July 2003. Transmissometer data are available through December 2002 and nephelometer data are available through September 2003. Photographic slide spectrums are also available on the IMPROVE Web site, under *Data*.

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

Visibility news

NPS begins preserving park soundscapes

The National Park Service (NPS) has begun to monitor sound to research the effects that anthropogenic sound has on biological systems and on a park visitor's experience. Similar to air monitoring programs, the NPS' Natural Sounds Program is intended to heighten public and agency awareness of the value and character of park soundscapes (anthropogenic and natural sounds), so that this resource is documented and can be preserved without impairment. The NPS is also working to provide information on sound issues directly to park visitors and the general public through educational and interpretive programs. The service has established a new Web page dedicated to sound monitoring, visit *http://www1.nature.nps.gov/naturalsounds.*

A prototype sound monitoring system was installed in Great Smoky Mountains National Park, at Purchase Knob, in November. The system samples and stores high quality sound bites for research, and creates smaller sound bites for presentation on the image Web page, alongside real-time digital images of the view from Purchase Knob.

The solar powered sound monitoring system shown in the figure below is comprised of a microphone and a processing station (an enclosure containing a computer and other electronics). The microphone transmits sounds to the processing station approximately 100 feet away, via coaxial cable. This processing station collects and archives the data and in turn, transmits via wireless link to a base station computer approximately 1/4 mile away, where sound, digital images, ozone, and meteorological data are compiled and uploaded to the NPS Web site via the Internet.

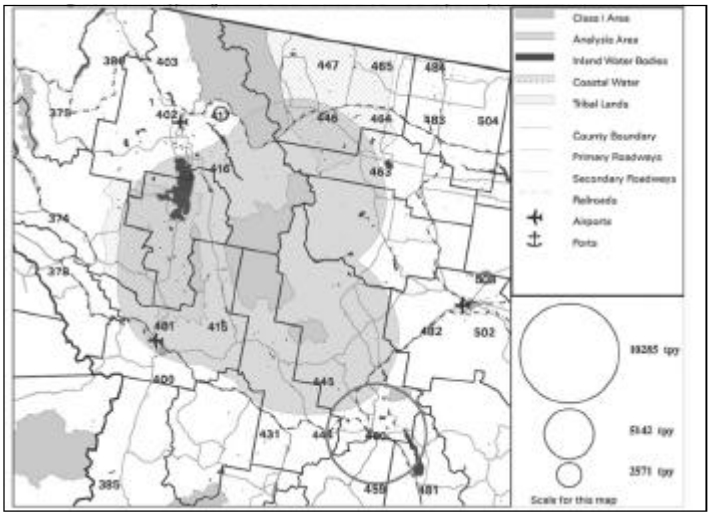
The sound monitoring system at Great Smoky Mountains National Park - Purchase Knob, consists of a processing station and a microphone. The microphone (inset) is located approximately 100' from the processing station in a stand of trees.

***Park soundscapes** continued on page 6....*

WRAP creates near emissions project

The Western Regional Air Partnership (WRAP) Sources In and Near Class I Areas Forum (In and Near Forum) has created a new project whose work is now taking shape on the WRAP's Web site. The Near Emissions project involves creating maps and tables that characterize and portray emissions in and near Class I areas in the WRAP states. States included in the region are: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming.

"Near" is defined as a 50 km area surrounding the borders of the Class I areas. The Web site currently includes maps for 82 groups, representing 117 national parks, national monuments, and wilderness areas. Data sets depicted on the maps include population density; land use/cover; and VOC, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and NH_3 emissions. Data values are derived from WRAP emission databases for the year 1996. The figure below is an example map; it depicts SO_2 emissions for western Montana (Mission Mountains/Scapegoat/Bob Marshall Wilderness). Tables are also available that list the specific emission sources in the areas of interest and the quantities of their emissions.



SO_2 emissions map for western Montana is an example of the many maps the WRAP's In and Near Forum is developing.

The project is not yet complete and all information is not yet available. Visit *http://www.wrapair.org/forums/class1/near/htmlfiles/main.html* for maps and information that have been completed, and visit often for updates. This project will help states to implement strategies to minimize future emissions and the resulting visibility impacts.

For more information contact Lee Alter at the Western Governors' Association. Telephone: 520/628-3173.E-mail: lalter@westgov.org.

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

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 operating the IMPROVE and IMPROVE Protocol networks. Sites that achieved 100% data collection for 4th Quarter 2003 are:

Aerosol

Acadia
Agua Tibia
Arendtsville
Badlands
Bandelier
Big Bend
Blue Mounds
Bridger
Bridgton
Brooklyn Lakes
Bryce Canyon
Cabinet Mountains
Caney Creek
Canyonlands
Cape Cod
Capitol Reef
Chassahowitzka
Cherokee
Chiricahua
Cloud Peak
Columbia Gorge East
Columbia Gorge West
Connecticut Hill
Crescent Lake
El Dorado Springs
Ellis
Fort Peck
Gates of the Mountains
Glacier
Great Basin
Great River Bluffs
Great Sand Dunes
Great Smoky Mountains
Guadalupe Mountains
Haleakala
Hawaii Volcanoes
Hercules-Glades
Hillside
Hoover
Ike's Backbone
Isle Royale
James River
Jarbidge
Joshua Tree
Kalmiopsis
Lake Sugema
Linville Gorge
Livonia
Lostwood
Mammoth Cave
Meadview
Mesa Verde
Mingo
MK Goddard
Mohawk Mountain
Moosehorn
Mount Baldy
Mount Hood
North Cascades
Northern Cheyenne
Okefenokee
Old Town
Olympic
Omaha
Organ Pipe
Pasayten
Petrified Forest
Phoenix
Pinnacles
Presque Isle
Proctor Research Center
Quabbin Reservoir
Rocky Mountain
Saguaro
St. Marks
San Gabriel
Sawtooth
Seney
Shining Rock
Sikes
Simeonof
Starkey
Sula
Tallgrass
Three Sisters
Trapper Creek - Denali
UL Bend
Viking Lake
Voyageurs
Walker River
Washington DC
Weminuche
White Mountain
White River
Wichita Mountain
Zion

Transmissometer

Badlands

Nephelometer

Big Bend
Grand Canyon (Hance)
Mammoth Cave
National Capital - Central
Seney
Shenandoah

Photographic

Red Rock Lakes

Operators of distinction

Site operator Matt Schomburg is the definition of flexibility. He knows that maintaining the air quality instrumentation at Great Gulf Wilderness is a challenge sometimes, but he rises to that challenge, and ensures the equipment runs as it should.

Matt is a Forestry Technician with the USDA-Forest Service in the White Mountain National Forest. He is the primary operator for the Great Gulf IMPROVE aerosol sampler and the NGN-2 nephelometer. Being a site operator is "a fight at times," says Matt, who dedicates extra time to replace controllers, electronic boxes, and other components if needed. "Some of the struggle is due to water problems at the site. I put two new roofs on the aerosol sampler and often have to chip ice off of it so the modules don't sustain water damage." He enjoys the responsibility of trekking up to the monitoring site to do weather checks. "It's a trip, but it's well worth it," says Matt.

In addition to maintaining the air quality instrumentation, Matt works at Androscoggin Ranger District's visitor center, and also serves as a backcountry ranger and wildland firefighter. "These various job duties allow me to be very flexible," says Matt, who feels very lucky and happy to have this work. He says his co-workers give an excellent team effort, helping each other out as needed. Matt aids others in grooming cross-country ski trails, building wood duck boxes, and helping out on the local search and rescue team and volunteer fire department.

Matt earned a B.S. degree in outdoor recreation and education, with a minor in biology, from Lynodon State College, VT. He worked at several Vermont state parks before moving to White Mountain National Forest. A native of New Hampshire, Matt has family within an hour or two drive. He hikes, canoes, bikes, and is a pretty good marathon runner. He recently completed a 9-day canoe trip with his father on the Connecticut River, and is now planning other trips.

Matthew Schomburg maintains the Great Gulf IMPROVE monitoring site at Camp Dodge, in the White Mountain National Forest, New Hampshire.

Feature article

Asian dust event generates studies of aerosols and visibility across the U.S.

Introduction

In April 2001, what may be the largest Asian dust event ever documented traveled to the United States. Scientific analyses concur that this event added to domestic atmospheric aerosol concentrations, transporting an estimated 110,000 metric tons of particulate matter, a value comparable to daily emissions of all U.S. sources. In some areas, the foreign dust, combined with domestic pollution, elevated urban particulate concentrations to levels associated with adverse health effects.[1]

IMPROVE aerosol and optical monitoring data were instrumental in analyzing this event. This article is a summary of three studies' results, focusing on IMPROVE aerosol network data, Speciation Trends Network aerosol data, and IMPROVE optical data.

Aerosol analyses - IMPROVE network data

To determine the 2001 Asian dust event's impact upon the U.S., researchers at the University of Washington and the University of Colorado used IMPROVE $PM_{2.5}$ filter samples, and specifically looked at the elemental soil components of the dust. Meteorological and satellite-based data conclude that the first dust arrived in the U.S. on April 12 and persisted through April 22. Dates of soil concentration peaks shown by IMPROVE analyses concur and correspond directly to the meteorological and satellite information.[2]

During this period in mid-April 2001, a selection of IMPROVE aerosol sites in the west, central, and eastern U.S. showed a large spike in both silicon and PM_{10} (see Figure 1). Highest concentrations appeared at sites in the central West Coast, the Rocky Mountains, and the Southeast. Higher than usual concentrations were also seen in the northern sites from North Cascades National Park, WA, to Acadia National Park, ME. Generally, monitoring sites in the western U.S. showed their peak concentrations on April 16, while those in the eastern U.S. peaked on April 19 or 22.[1]

Analyses by the Environmental Protection Agency further showed record-high levels of fine soil at some monitoring sites in the U.S. For example, Canyonlands National Park, UT, recorded a soil concentration twice as high as any previous measurement on record (16.6 µg/m^3). In addition, this appeared to be the first Asian dust event that influenced East Coast fine soil concentrations, as was seen at Brigantine National Wildlife Refuge, NJ, which had a peak fine soil concentration of 7.8 µg/m^3 on April 22. Other monitoring sites along the East Coast also indicated some increase in fine soil concentrations over normal, from mid to late April.[2]

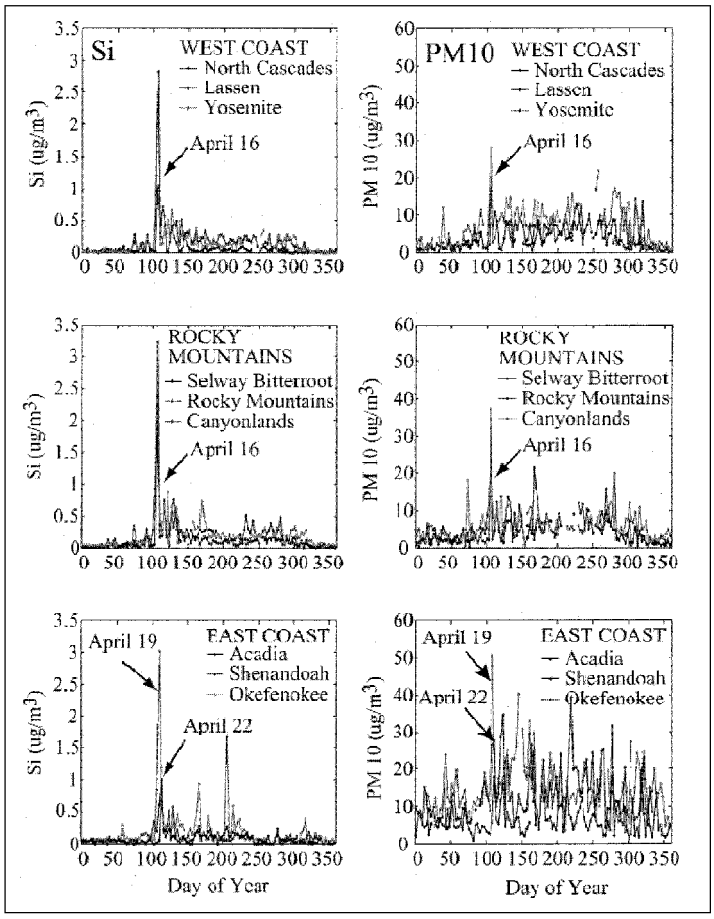


Figure 1. PM_{10} and Silicon (Si) (mg/m^3) for 2001 from IMPROVE sampling locations in the western, central, and eastern U.S. [1]

Analysis of IMPROVE aerosol sites across the U.S. also suggests that the Asian dust affected 80-90 of the 110 sites; the mean PM_{10} value peaked on April 16 at 19 µg/m^3 while the mean value for April 1-13 was 10 µg/m^3.[1] Also, 70 out of the 110 IMPROVE sites collected silicon concentrations of 0.3 µg/m^3 or greater on April 16, compared to only three sites a week earlier. This analysis indicates that the largest component of the particulate matter was mineral dust, and this dust had a consistent composition across most of the 110 IMPROVE sites.[1]

This apparent increase in dust can be correlated to Asian dust, as shown in Figure 2. The composition of the dust on April 16 (iron, calcium, aluminum, and silicon), using $PM_{2.5}$ data from all 110 IMPROVE aerosol monitoring sites, showed consistency among these elements and their relationship appeared similar to previous observations of Asian dust. This supports the thought that a single dust source affected particulate concentrations throughout the U.S.[1]

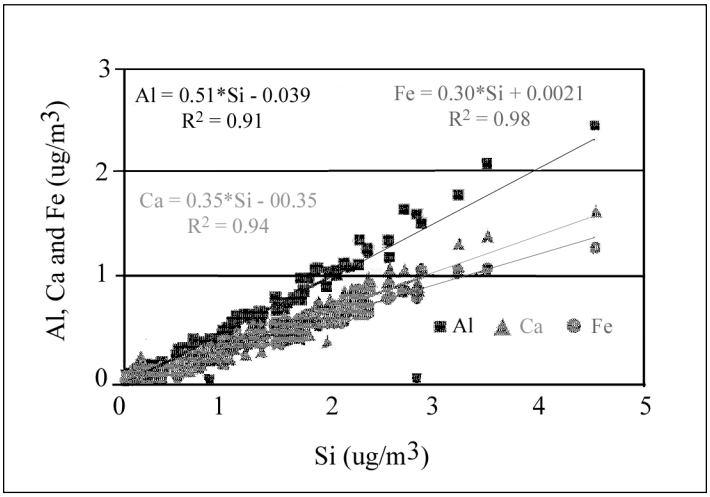


Figure 2. Scatterplot of Aluminum (Al), Iron (Fe), and Calcium (Ca), versus Silicon (Si) in 110 IMPROVE samples from April 16, 2001.[1]

Aerosol analyses - Speciation Trends Network data

Aerosol data from urban sites around the country, in the Environmental Protection Agency's Speciation Trends Network, were also examined. Table 1 shows the highest PM_{10} concentrations for April 2001, for six urban locations. As seen in the table and almost all other sites examined, PM_{10} concentrations peaked between April 16 and 20. The consistency in both the concentrations and peak dates indicates a large and far-reaching dust influence. Comparing the PM_{10} concentrations from pre-dust arrival to post-dust arrival, the Asian dust was shown to increase concentrations at these sites by 30-40 µg/m^3. At some sites, the Asian dust and domestic concentrations combined pushed PM_{10} concentrations to levels associated with adverse health impacts.[1] These urban locations have higher particulate concentrations than the IMPROVE sites, which are generally rural locations.

Table 1. Highest PM_{10} Value (24-Hour Ave.) for Each Site for April 2001.[1]

Site	Date	PM10 µg/m3
Tucson, AZ	April 17-18	85
Salt Lake City, UT	April 16	78
Aspen, CO	April 16	71
Savannah, GA	April 20	85
Atlanta, GA	April 20	67
Winston-Salem, NC	April 20	74

Optical analyses

Optical data for this event were also analyzed. The nephelometer and transmissometer data were quicker to undergo analysis because the optical instruments' operating properties result in real-time data, whereas aerosol filters take time to be collected and analyzed.

The Cooperative Institute for Research in the Atmosphere (CIRA) used optical data from Grand Canyon National Park, AZ, and Yosemite National Park, CA/Bliss State Park, CA, for analyses, selecting a time series of the light scattering, extinction, and relative humidity for the dust event.

Data from Grand Canyon showed the influence of Asian dust. On April 12 the area recorded near-Rayleigh extinction (15 Mm^{-1}) with low relative humidity. Extinction began to rise the next day, and by the afternoon of April 14, the extinction reached 80 Mm^{-1} with less than 50 percent relative humidity.[3] Extinction became approximately 50 percent larger than scattering levels, and by the evening of April 16, scattering and extinction decreased to typical levels and began to track each other again (see Figure 3), indicating an end to the Asian event. Analyses showed similar behavior at Yosemite National Park.

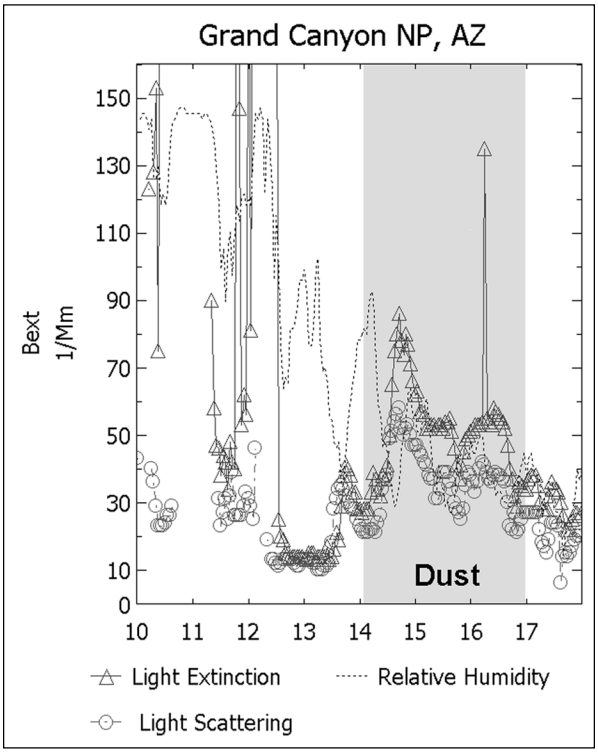


Figure 3. The light scatter, extinction, and relative humidity at Grand Canyon National Park, Arizona.[3]

This difference between the scattering measured by the nephelometers (b_{sp}) and extinction measured by the transmissometers (b_{ext}) is a clear indication of the dust's impact. Researchers know that dust absorbs some radiation; however, the large difference is most likely due to an underestimation of

coarse particle (>2.5 µm) scattering by the nephelometers. The continuous light scattering and extinction data completes the temporal variability that aerosol samplers cannot measure. Also, the near real-time availability of these data provides important information for understanding the event as it occurred.

Conclusions

Long-term transport of dust from Asia to North America is not common, but growing evidence suggests that these dust events are becoming more common. Studies have linked this apparent increase to changes in climate (including an increase in drought conditions), and land use practices in China.[2]

The analyses discussed herein show that global transport of particulate matter can and do, impact air quality in far-reaching regions not previously considered and far from the original source.[1] Not only can visibility be impaired, but air quality can be brought to conditions that are known to adversely affect health of individuals. Nationwide monitoring networks are integral in collecting data, as well as the importance of making these data readily available for scientists and researchers.

References

[1] Jaffe, D., J. Snow, and O. Cooper, 2003, The 2001 Asian Dust Events: Transport and Impact on Surface Aerosol Concentrations in the U.S., EOS, Transactions, American Geophysical Union, 84(46):501-516, November. *http://faculty.washington.edu/djaffe/Jaffe2003c.pdf*

[2] Environmental Protection Agency, 2003, National Air Quality and Emissions Trends Report, 2003 Special Studies Edition, EPA 454/R-03-005, September. *http://www.epa.gov/air/aqtrnd03/index.html*

[3] Schichtel, B., 2001, IMPROVE optical monitoring network captures Asian dust event, The IMPROVE Newsletter, 10(2):2-3, Spring.

For more information contact:
Dan Jaffe at the University of Washington
Telephone: 425/352-5357, E-mail: djaffe@u.washington.edu.
Jim Szykman at the EPA
Telephone: 757/864-2709, E-mail: szykman.jim@epa.gov.
Bret Schichtel at CIRA
Telephone: 970/491-8581, E-mail: schichtel@cira.colostate.edu.

Visibility news *continued from page 2 ....*

IMPROVE 2004 calendar distributed

The 2nd edition IMPROVE calendar, 2004, has been distributed to all monitoring site operators. If you haven't gotten yours yet, it is on its way. This 12-month, wall-sized calendar was created by the Cooperative Institute for Research in the Atmosphere (CIRA), and features site operators and monitoring-related topics such as troubleshooting filter changes, operator support contacts, special studies, data uses, and more.

For more information or for additional calendars, contact Julie Winchester at CIRA. Telephone: 970/491-8443. Fax: 970/491-8598. E-mail: winchester@cira.colostate.edu.

Park soundscapes *continued from page 2....*

The microphone captures ambient park sounds for 30 seconds every 5 minutes. High quality clips are saved for detailed analyses by NPS sound experts. A 15-second sound file is extracted and uploaded every 15 minutes to the base station via a wireless connection. The sound file, image file from a digital photographic system, associated ozone data (collected by the state of North Carolina) and meteorological data (collected by the National Oceanic and Atmospheric Administration) are then uploaded to *http://www2.nature.nps.gov/air/WebCams/parks/grsmpkcam/grsmpkcam.htm*.

For more information contact Skip Ambrose, NPS Sound Monitoring Specialist. Telephone: 970/267-2102. E-mail: skip_ambrose@nps.gov.

ADEQ launches Phoenix visibility Web site

Arizona's Department of Environmental Quality (ADEQ) made public its new Phoenix Visibility Index Web site in December. The site displays real-time images and data every 15 minutes, and estimates a visibility index value every 4 hours for the Phoenix metropolitan area.

Images from high-resolution digital camera systems from several locations in and around Phoenix are uploaded to the Web site every 15 minutes. Associated visibility data from a transmissometer system are uploaded every hour and are used to estimate the visibility index value. Visit *http://www.phoenixvis.net* to learn about Phoenix air quality, and see *The IMPROVE Newsletter* (1st Quarter 2003) for a detailed discussion on how the index was created.

For more information contact Mike Sundblom at the ADEQ. Telephone: 602/771-2364. Fax: 602/771-2299. E-mail: sundblom.michael@ev.state.az.us.

The Phoenix Visibility Index Web site made its debut in December. The site displays real-time visibility images and a visibility scale, and offers other information about air quality in the Phoenix metropolitan area.

EPA proposes Interstate Air Quality Rule

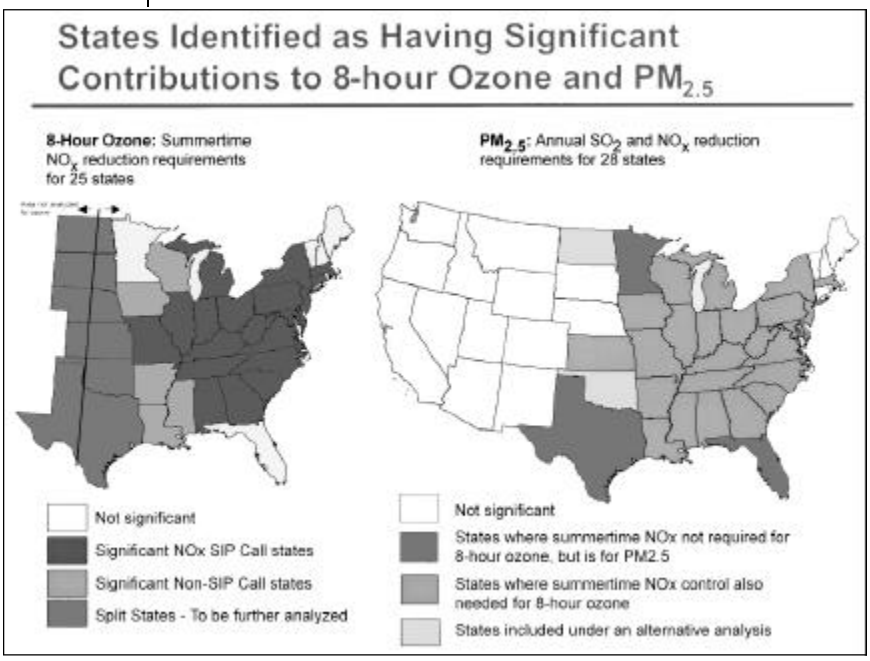
In December, the Environmental Protection Agency (EPA) proposed a series of integrated air quality rules intended to significantly reduce sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury emissions from utility companies. One of these rules is the Interstate Air Quality Rule.

The rule would require reduction of SO_2 and NO_x emissions in 29 eastern states and the District of Columbia; areas determined to have power plants that significantly contribute to fine particle and ozone pollution in other downwind states in the eastern U.S. Under this proposed rule, SO_2 emissions would be reduced by 3.6 million tons in 2010 and by 2 millions tons annually thereafter, resulting in approximately a 70 percent reduction below current emission levels. Similarly, NO_x emissions would be reduced by 1.5 million tons in 2010 and by 1.8 million tons annually thereafter, resulting in approximately 65 percent reduction below current emission levels.

Affected states would be required to revise their state implementation plans to include control measures ensuring these emission reductions. Other states are also being analyzed for their contributions as well.

The proposed rule suggests states use either a cap and trade program to ensure the utilities meet the necessary reductions, or to meet an individual state emissions budget through measures of the state's choosing. Emissions would be permanently capped and could not increase in the future. The proposed rule would protect public health and environmental resources including visibility and sensitive ecosystems, without causing reduction in affordable energy.

In 1997 the EPA established fine particle and 8-hour ozone standards in an effort to reduce SO_2 and NO_x emissions. Implementation of these standards is now taking place, which should help the affected states even more.



The EPA has identified states with significant contributions to 8-hour ozone (left) and PM2.5 (right) emissions in the proposed Interstate Air Quality Rule.

Similar rules proposed in December involve controlling mercury emissions from electric utilities. The mercury rules and the Interstate Air Quality Rule will be posted soon to the Federal Register. A public comment period will remain open for 60 days after posting.

For more information on the proposed Interstate Air Quality Rule, visit http://www.epa.gov/interstateairquality.

Special studies

Montana smoke and carbon study

The USDA-Forest Service Fire Science Laboratory in Missoula, Montana, hosted a two-week laboratory study of biomass smoke in November 2003. Researchers from the Fire Lab, Colorado State University, the Desert Research Institute, and the Georgia Institute of Technology performed the study using a variety of instrumentation including aerosol optical, physical, and chemical techniques.

The study focused on characterizing primary smoke emissions from forest fuels including pine and hardwoods, pine needles, and duff cores. Researchers from Colorado State University examined the optical and hygroscopic properties, size distribution, and chemical composition of the smoke, using IMPROVE aerosol samplers, size-cut nephelometers, aethalometers, hi-vols, and other particulate samplers.

Data are now undergoing analyses and technical papers are expected to be available later this year.

For more information contact Kip Carrico at Colorado State University. Telephone: 970/491-8667. E-mail: carrico@lamar.colostate.edu.

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525

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. Steering Committee representatives are:

U.S. EPA
Neil Frank
US EPA MD-14
Emissions, Monitoring and Analysis Div.
Research Triangle Park, NC 27711
Telephone: 919/541-5560
Fax: 919/541-3613
E-mail: frank.neil@epamail.epa.gov

NPS
William Malm
Colorado State University
CIRA - Foothills Campus
Fort Collins, CO 80523
Telephone: 970/491-8292
Fax: 970/491-8598
E-mail: malm@cira.colostate.edu

BLM
Scott Archer
Sciences Center (RS-140)
P.O. Box 25047
Denver, CO 80225-0047
Telephone: 303/236-6400
Fax: 303/236-3508
E-mail: sarcher@blm.gov

USDA-FS
Rich Fisher
Air Program Technical Manager
USDA-Forest Service
2150A Centre Avenue
Fort Collins, CO 80526
Telephone: 970/295-5981
Fax: 970/295-5988
E-mail: rfisher@lamar.colostate.edu

FWS
Sandra Silva
Fish and Wildlife Service
P.O. Box 25287
12795 W. Alameda
Denver, CO 80225
Telephone: 303/969-2814
Fax: 303/969-2822
E-mail: sandra_v_silva@fws.gov

NESCAUM
Rich Poirot
VT Agency of Natural Resources
103 South Main Street
Building 3 South
Waterbury, VT 05676
Telephone: 802/241-3807
Fax: 802/244-5141
E-mail: richpo@dec.anr.state.vt.us

STAPPA
Ray Bishop
Dept. of Environmental Quality
Air Quality Division
707 North Robinson
PO Box 1677
Oklahoma City, OK 73101-1677
Telephone: 405/720-3162
Fax: 405/720-4101
E-mail: ray.bishop@deq.state.ok.us

WESTAR
Robert Lebens
715 SW Morrison
Suite 503
Portland, OR 97204
Telephone: 503/478-4956
Fax: 503/478-4961
E-mail: blebens@westar.org

MARAMA
David Krask
Maryland Dept. of the Environment
ARMA/Air Quality Planning and Monitoring
1800 Washington Blvd.
Baltimore, MD 21230-1720
Telephone: 410/537-3756
Fax: 410/537-4243
E-mail: dkrask@mde.state.md.us

NOAA
Marc Pitchford *
c/o Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119-7363
Telephone: 702/862-5432
Fax: 702/862-5507
E-mail: marcp@snsc.dri.edu
* Steering Committee chair

ASSOCIATE MEMBERS

Associate Membership in the IMPROVE Steering Committee is designed to foster additional IMPROVE-comparable visibility 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
Darcy Anderson
Arizona Dept. of Environmental Quality
Air Quality Division
1110 W. Washington Street L120A
Phoenix, AZ 85007
Telephone: 602/771-7665
Fax: 602/771-4444
E-mail: anderson.darcy@ev.state.az.us

Government organizations interested in becoming Associate Members may contact any Steering Committee member for information.

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Fort Collins, CO 80525

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The IMPROVE Program was designed in response to the visibility provisions of the Clean Air Act of 1977, which affords visibility protection to 156 federal Class I areas. The program objectives are to provide data needed to: assess the impacts of new emission sources, identify existing human-made visibility impairments, and assess progress toward the national visibility goals as established by Congress.

To submit an article, to receive the IMPROVE Newsletter, or for address corrections, contact:

Air Resource Specialists, Inc.
Gloria S. Mercer, Editor
Telephone: 970/484-7941 ext.221
Fax: 970/484-3423
E-mail: info@air-resource.com

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