INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS

IMPROVE

1st Quarter 2006 | The IMPROVE Newsletter | Volume 15 / Number 1

Monitoring update

Feature Article: IMPROVE network site assessment, 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 156 Class I federally protected areas. Additional instrumentation that operates according to IMPROVE protocols in support of the program includes:

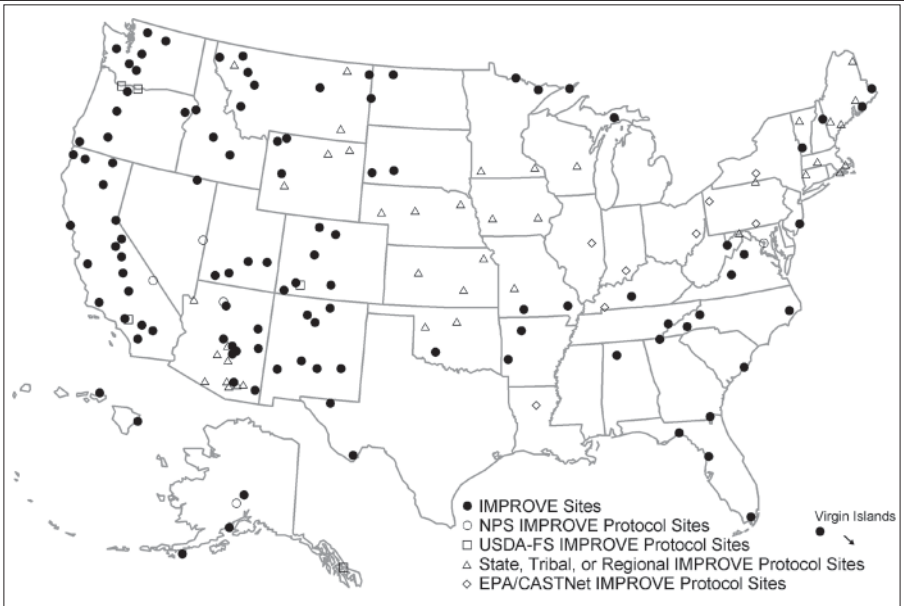
- 58 aerosol samplers
- 14 transmissometers
- 41 nephelometers
- 8 digital or film camera systems
- 56 Web camera systems
- 3 interpretive displays

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 2006 (January, February, and March) are:

- Aerosol (channel A only) 96% collection
- Aerosol (all modules) 95% completeness
- Optical (transmissometer) 94% collection
- Optical (nephelometer) 96% collection
- Scene (photographic) (does not include Web cameras) 83% collection

During January, the site at Old Town, ME, was moved to a rural location outside of town, and the site name was changed from Old Town (OLTO1) to Penobscot (PENO1). The Old Town site was in the middle of town and was fundamentally an urban site. The new Penobscot location is more suited to the IMPROVE siting criteria. The OLTO1 site will remain in operation for several months to provide comparison data for the two sites.

The Denali National Park & Preserve Webcamera will be moved in early summer to Wonder Lake. It has been operating from the Eielson Visitor Center, which is undergoing renovation. The Webcamera system will continue to view Mt. McKinley and operates generally from June through September, depending upon site access conditions.



IMPROVE and IMPROVE Protocol Sites
1st Quarter 2006

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://vista.cira.colostate.edu/views*.

Aerosol data are available through December 2004. Transmissometer and nephelometer data are available through December 2004 and December 2005 respectively. Photographic slide spectrums are also available on the IMPROVE Web site, under *Data*. Real-time Webcamera displays are available on a variety of agency-supported Web sites.

***Monitoring update** continued on page 6....*

Visibility news

New model high-resolution Webcamera designed for low power conditions

The new Remote Digital Camera System, model RDCS-200, uses a 6 megapixel high-resolution digital still camera, wide temperature range singleboard computer, and custom software to provide high quality digital still image capture and the ability to upload the images via the Internet for Web site presentation. It is ideal for remote areas having limited power, yet requiring monitoring on a frequent, scheduled basis.

Developed by Air Resource Specialists, Inc., the RDCS-200 replaces the flashcard-based RDCS-100 and can be configured to capture images using the same schedule and protocols. High-resolution images are collected at visibility monitoring sites onto a USB flash drive, which is capable of storing over one month of 6 megapixel images taken three times daily. The system is programmed to capture images as often as every minute.

The system is PC-based and runs a custom high-reliability embedded version of Microsoft Windows XP. Custom camera control software used in the model HRDC-1 system (in Web-based networks across the country) controls all aspects of camera control and image transfer. A Pocket PC PDA provides the user interface (display, keyboard, and mouse) for the computer. The Pocket PC uses custom software to handle configuration, troubleshooting, and image alignment.

Indicator lights provide a quick summary of the system status to the site operator. An integrated watchdog component will reset the computer in the event of computer problems.

The system supports upload of captured images to Internet FTP and/or Web sites using standard Windows connections. Connectivity options including telephone modem, CDMA/GSM/GPRS wireless modem, WiFi, LAN, cable, DSL, and satellite.

The RDCS-200 system can operate on 110 volt AC line or 24 volt DC solar power. Both power sources charge the integrated 28 amp-hour battery for operation overnight and during short power outages. The entire system can be housed in as small as a 16” x 16” x 8” environmental enclosure.

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

The self-contained RDCS-200 high resolution digital camera system is designed for remote areas with limited available power. The system is easily operated and maintained, and can upload images to the Internet for Web site presentation.

IMPROVE Steering Committee meeting scheduled

The IMPROVE Program’s steering committee will gather at Mammoth Cave National Park, KY, September 26-28, 2006, for their annual meeting. The three-day meeting will include presentations and discussions regarding the status of network operations, investigations and special studies, the audit and quality assurance programs, and other topics relevant to the program.

Mammoth Cave National Park staff will host a cave tour the evening of September 26 for meeting attendees. A field trip to the monitoring site will also be on the agenda. Mammoth Cave has a comprehensive monitoring site, which includes an IMPROVE aerosol sampler, CASTNet filter pack, ambient nephelometer, wet deposition instrumentation, Webcamera, gaseous samplers, and meteorology sensors.

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.

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)

EPA proposes new particulate standards

The EPA proposed new, stronger National Ambient Air Quality Standards for particulate matter in December 2005. The proposed standards include three basic areas:

Fine Particles - The EPA proposes to revise the level of the 24-hour $PM_{2.5}$ standard from 65 micrograms per cubic meter ($\mu g/m^3$) to 35 $\mu g/m^3$, and to retain the level of the annual standard at 15 $\mu g/m^3$.

Coarse Particles - The EPA proposes to revise the 24-hour PM_{10} standard in part, by establishing a new indicator for thoracic coarse particles (generally between 2.5 and 10 µm in diameter), called the $PM_{10-2.5}$ standard.

Sources Included/Excluded - The proposed $PM_{10-2.5}$ standard includes any ambient mix of particles that are dominated by resuspended dust from high-density traffic and by industrial/construction sources, and excludes any ambient mix of particles that are dominated by rural windblown dust/soils and generated by agricultural or mining sources. (Currently only urban areas with populations >100,000 have sufficient collected data, so sources from urban areas are included). The proposed $PM_{10-2.5}$ standard is 70 $\mu m/m^3$. If accepted, the current 24-hour PM_{10} standard will be revoked.

If accepted, two implementation schedules would apply, one for $PM_{2.5}$ and the other for $PM_{10-2.5}$.

Possible timeline for fine particles ($PM_{2.5}$)

- The new standard would be effective in December 2006.
- States would make recommendations to the EPA by December 2007, using data from 2005-2007, for areas to be designated attainment and nonattainment.
- EPA would make final designations by December 2009; those designations would become effective in April 2010.
- State Implementation Plans, outlining how states will reduce pollution to meet the standards, would be due in April 2013.
- States would have to meet the standards by April 2015.

Possible timeline for coarse particles ($PM_{10-2.5}$)

- EPA would not designate attainment and nonattainment areas until it has three consecutive years of data showing $PM_{10-2.5}$ levels. EPA anticipates that data will be available in 2012.
- States would make recommendations in July 2012 for areas to be designated attainment and nonattainment.
- EPA would make final designations in May 2013; those designations would become effective in July 2013.
- State Implementation Plans would be due in July 2016.
- States would have to meet the standards by July 2018.

For additional information, visit EPA's Web site at *http://www.epa.gov/air/particles/actions.html*. If passed, the effective date of the revised standards is expected by September 2006.

National Park Service Webcamera pages to include time series data

The National Park Service Air Resources Division (NPS ARD) will begin a project this spring, to add various data charts to the NPS Webcamera pages. The most recent 10 days of data will be displayed in time series charts, including 1-hour and 8-hour ozone, 1-hour and 24-hour $PM_{2.5}$, ambient temperature, relative humidity, wind speed, and wind direction. The main NPS Webcamera page can be found at *http://www2.nature.nps.gov/air/WebCams/index.cfm.*

ARD staff are developing computer programs that will collect and store the data , and create the data charts. They may also access the EPA AirNow data files to get data from state-operated sites at or near national parks.

One site will be chosen for testing, and after it appears operational, the capability will be added to the remaining NPS Webcamera sites. It is unknown at this time when this project will be completed.

ARD staff are also discussing another new Web page that would have annual charts of ozone and other air quality parameters for each park, so visitors could become aware of temporal and spatial trends in the data. This page would be updated annually.

For more information contact Dave Joseph at the National Park Service. Telephone: 303/969-2816. Fax: 303/969-2822. E-mail: david_joseph@nps.gov.

***Networks achieve** continued on page 6....*

Feature article

IMPROVE network site assessment

(by M. Pitchford, National Oceanic and Atmospheric Administration; B. Schichtel, National Park Service; H. Iyer, Colorado State University; and C. McDade and W. White, University of California - Davis)

Introduction

The Regional Haze Regulations (RHR) call for tracking of haze trends for all federal Class I areas with visibility protection, as a means to assess the effectiveness of mandated emission control programs designed to reduce haze levels. The RHR require aerosol speciation data to establish a five-year averaged baseline and subsequent five-year averages of haze levels for the haziest and cleanest 20% of days. Federal land managers, through the IMPROVE Program, monitor these speciated aerosols at 110 sites representative of 156 Class I areas of the nation. Approximately 50 additional sites employ identical monitoring methods, and are funded by states, tribes, and other federal agencies. These sites expand coverage of the Class I areas and improve our understanding of particulate matter and haze in regions without Class I areas.

A panel of scientists completed an assessment of the IMPROVE aerosol network, to determine the extent that monitoring sites adequately represent all of the Class I areas without redundancy. The IMPROVE Program expects funding reductions in future years; one obvious means of reducing the expense of operating the network is to decommission monitoring sites with data similar to neighboring sites.

This article describes the methodology and preliminary results of an assessment of the level of redundancy/uniqueness of the IMPROVE aerosol monitoring sites, indicates how such a methodology can be used to identify sites for decommissioning, and describes alternative cost-saving strategies.

Assessment methodology and results

The methodology developed to assess each of the monitoring site's degree of uniqueness (or redundancy) was to use the major aerosol component concentration data from neighboring sites to predict the corresponding data measured at the site. The major component concentrations used in these assessments are fine and coarse mass, and fine sulfate, nitrate, organic and elemental carbon, and soil for each monitoring site for 2003 and 2004.

The metric used to assess the degree of uniqueness is the fractional error as defined by the equation below:

$$FE \equiv \frac{2}{n}\sum_{i=1}^{n}\frac{|p_i - o_i|}{(p_i - o_i)}$$

where p_i and o_i are the predicted and observed component concentration data for sample period *i,* and *n* is the total number of sample periods used in the assessment.

This fractional error metric was used for several reasons: it accounts for both errors in accuracy and bias, it incorporates the relative errors for all concentrations, it equally weights over- and underestimated values, and it is a robust metric not overly influenced by a few outlying data points. For these reasons the fraction error is often used in model evaluation studies to assess the quality of fit for multiple models.

An inverse distance (1/r) weighted spatial interpolation approach was used to predict each sample period's concentration at a site from concentrations measured at the five nearest monitoring sites within 500km for the same sample period.

Overall results are summarized in contour maps; Figure 1 summarizes the fractional error for aerosol light extinction calculated from the aerosol components for the two years. Figure 2 shows the maximum fractional error among the major aerosol component for each site for the two years. A high fractional error indicates uniqueness, and a low fractional error indicates redundancy. This map contains no weighting of the components by their contemporary contributions to extinction, so it is not as sensitive to long-term changes in the causes of haze. Both maps show greater redundancy in the center of the country, the northeastern U.S., and southern Arizona.

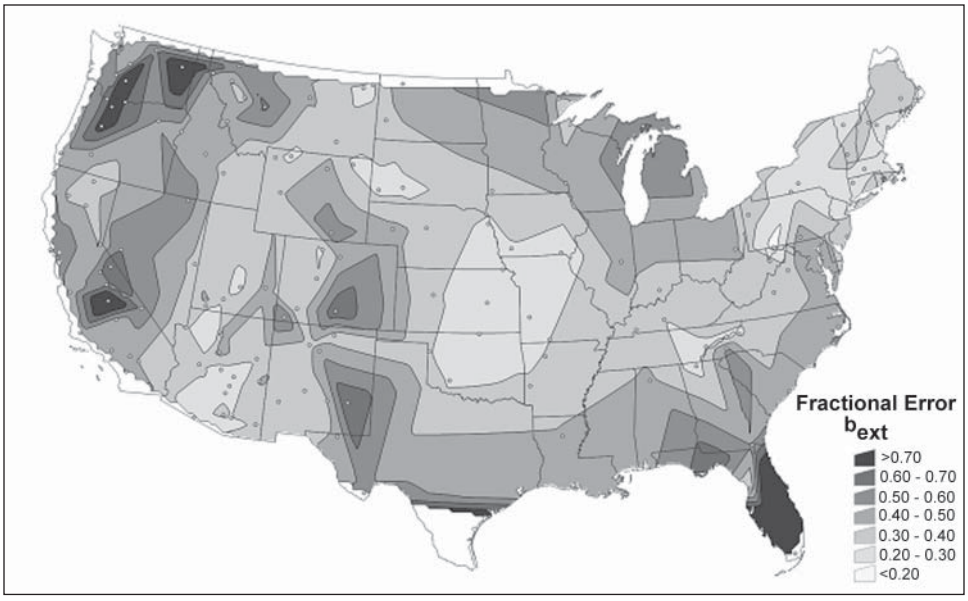


Figure 1. Contour map of the aerosol light extinction fractional errors using 2003-2004 data.

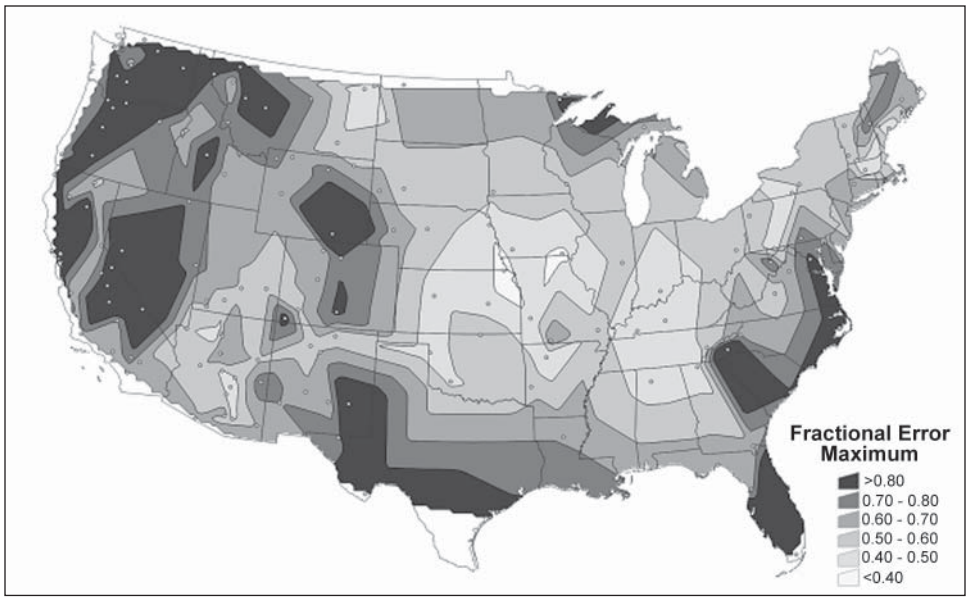


Figure 2. Contour map of the maximum fractional errors among all components.

Objective approach to site reductions

The assessment's results show that data from some monitoring sites is well predicted from neighboring sites, but it doesn't indicate which sites, if removed, would produce a less redundant network. The approach used for determining a priority list of sites for decommissioning starts by adding to the list the site having the smallest relative error in aerosol light extinction. Then its data is removed and the fractional errors for the other neighboring sites are recalculated. Because they no longer have the benefit of the data from the removed site, the relative errors of the remaining neighboring sites will likely increase.

This process is repeated as many times as needed. It doesn't, however, take into consideration other factors that may be important, including: the length of the data record, historic data completeness, collocation of other instrumentation, degree of adherence to siting criteria, integrity of site infrastructure, and the willingness of sponsors to identify supplemental resources. Figure 3 shows the results of the site reduction process.

Alternate cost-saving methods

The RHR specifies IMPROVE or equivalent 24-hour aerosol speciation monitoring on a three-day sampling frequency, be used to estimate haze levels for all of the visibility protected Class I areas. The trends of interest are the annual averages of the 20% cleanest and 20% haziest haze conditions which are then combined into 5-year averages.

EPA's guidance for tracking regional haze trends defines the data completeness criteria and indicates that three years of data should be complete for each five-year period. Based on these criteria, one cost-saving method may be that the IMPROVE network can operate without each site every year. A second method may be that if it were possible to predict with confidence which of the sample periods are among the 20% cleanest and 20% haziest, it would be possible to reduce the analytical cost associated with many of the collected samples.

RHR guidance indicates that three complete years of data are required for every five-year average period is adequate for tracking haze trends. So, four years of monitoring during every five-year period would be adequate. Sites could take turns being mothballed for one year. Shutting down sites for two years out of every five would leave no safety margin for unanticipated monitoring problems and could cause an incomplete data set. This mothball approach can support a larger network for the same funding, though all sites would have a maximum effective data recovery of 80% over the five-year cycle. It would also complicate traditional trends and episode analyses having the one-year blind period every five years.

Figure 3. Map shows the locations of the 40 most redundant sites selected using aerosol light extinction with fraction error recalculation after removal of data for each site selected (also shows locations of all IMPROVE sites).

Site assessment continued on page 6....

***Site assessment** continued from page 5....*

The other cost-saving option is to reduce the number of samples analyzed. Based on analysis of past data, the highest and lowest 25% of haze estimated using only gravimetric mass concentrations and the growth factors would capture almost 90% of the haziest days and cleanest days as determined by complete analysis.

The advantage of this gravimetric screening approach is that a larger overall network can be operated at any particular funding level. Samples would be available for subsequent analyses if needed. A disadvantage is an extended delay in data accessibility caused by having to wait until the end of each calendar year before selecting the sample periods for full compositional analyses. Another disadvantage is that the data sets produced would be missing the central 50%, which would limit their value for other purposes.

Conclusion / Next steps

An objective methodology for identifying IMPROVE sites with data that can be predicted by the data from neighboring sites was demonstrated to show regions where there are sites that might be pruned to reduce network operation costs in response to anticipated budget reductions. Other important factors, however, must be considered and other organizations that have important input to any decisions concerning the change to the combined IMPROVE and IMPROVE Protocol networks site configuration and operations.

The next major step is to develop a transparent consensus-based decision process that involves all of the organizations that sponsor and have a significant interest in the IMPROVE Program. That process will need to incorporate other information including non-objective technical and regulatory factors in determining the best approach to reduce the cost of the network to a level consistent with available funds. The IMPROVE Steering Committee Chair (Marc Pitchford), working with others, will take responsibility for the development and application of such a process.

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.

Monitoring update

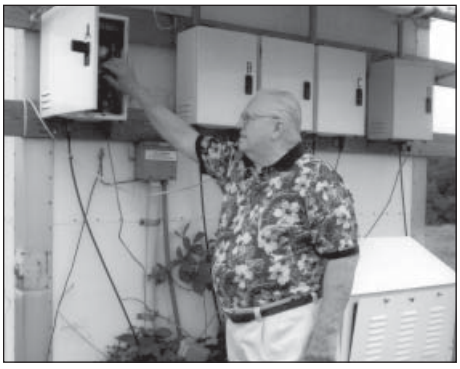
continued from page 1 ....

Operators of distinction

According to Mary Lou Trainer, she and husband Jim try to maintain their Quaker City IMPROVE aerosol sampler as well as possible. They are accomplishing this feat since their filter collection is usually 100% or very nearly that every quarter.

The Environmental Protection Agency approached the Trainers 12 years ago, exploring the possibility of locating a monitoring site on their farmland in Ohio. The location was selected, in part, due to the land being the third or fourth highest point in the state. “We have quite a variety of instrumentation at the site,” said Mary Lou, “the IMPROVE aerosol sampler, CASTNet filter pack, and lots of meteorology.”

The Trainers have owned the farm for 33 years and are well acquainted with the air quality and visibility problems in the region. Even so, visiting air quality technicians remark how scenic the area is, and with the Trainer’s help, they hope it stays that way. One of the scenic features visible from the monitoring site is a view of Senecaville Lake, the third largest lake in the state.



IMPROVE site operators Jim and Mary Lou Trainer use a cooperative approach to servicing and maintaining the air quality instrumentation at Quaker City, Ohio.

During the past 12 years, the operator pair established a system of servicing the IMPROVE Protocol site that works well for them. Jim changes the instrument filters and performs the physical and operational checks of the instrumentation, while Mary Lou records their servicing findings and maintenance performed on the paperwork and computer logs. “This routine enables us to do a complete servicing visit in one hour,” said Mary Lou, “That’s only if everything is working properly.”

Both Trainers enjoy their air quality work. “We absolutely love being a part of the network of air quality research,” said Mary Lou, “except when we have to perform a site visit and there’s a foot of snow on the ground....” Even then, Mary Lou and Jim trek to the site weekly, to achieve the most collection possible. You can’t document the air quality if you haven’t collected its data.

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 2006 are:

Aerosol (Channel A)

Acadia
Arendtsville
Badlands
Baltimore
Bandelier

Birmingham
Bondville
Bridgton
Cadiz
Cape Cod

Cape Romain
Casco Bay
Cedar Bluff
Chiricahua
Columbia Gorge East

Columbia Gorge West
Connecticut Hill
Death Valley
Denali
Dolly Sods

Douglas
Everglades
Flathead
Frostburg Reservoir
Gates of the Mountains

Gila
Glacier
Grand Canyon (Hance)
Great Basin
Great River Bluffs

Great Sand Dunes
Great Smoky Mountains

Haleakala
Hells Canyon
Hoover
Ike's Backbone
Isle Royale

James River Face
Jarbidge
Joshua Tree
Kalmiopsis
Lassen Volcanic

Lava Beds
Livonia
Mammoth Cave
Martha's Vineyard
Meadview

Medicine Lake
Mingo
MK Goddard
Mohawk Mountain
Mount Hood

Mount Rainier
North Absaroka
North Cascades
Okefenokee
Old Town

Olympic
Organ Pipe
Pasayten
Petersburg
Phoenix

Point Reyes

Proctor Research Center
Quabbin Reservoir
Quaker City
Rocky Mountain
Sac and Fox

Saguaro
Saguaro West
San Gabriel
San Gorgonio
San Pedro Parks

San Rafael
Sequoia
Shamrock Mine
Sikes
Simeonof

Sipsey
Snoqualmie Pass
St. Marks
Sula
Three Sisters

Trapper Creek-Denali
Trinity
UL Bend
Upper Buffalo
Viking Lake

Virgin Islands
Voyageurs
Washington D.C.
Weminuche
Wind Cave

Zion Canyon

Transmissometer

Bandelier
Bridger
Canyonlands

Grand Canyon (South Rim)
Grand Canyon (In Canyon)

Great Basin
Rocky Mountain
San Gorgonio
Thunder Basin

Photographic

Agua Tibia
Grand Canyon

Monture

Shamrock Mine

Nephelometer

Bliss
Children's Park
Chiricahua
Estrella

Grand Canyon (Hance)
Grand Canyon (Indian Gardens)

Greer
Ike's Backbone
Mammoth Cave
National Capital

Petrified Forest
Phoenix

Seney
Sierra Ancha
Sycamore Canyon
Tucson Central

Tucson Mountain
Thunder Basin

Sites that achieved at least 95% data collection for 1st quarter 2006 are:

Aerosol (Channel A)

Addison Pinnacle
Big Bend
Bridger

Chassahowitzka
Cherokee
Crater Lake

Craters of the Moon
El Dorado Springs
Hawaii Volcanoes

Indian Gardens
Kaiser
Lake Sugema

Lye Brook
Monture
Moosehorn

New York
Pinnacles
Queen Valley

Salt Creek
Starkey
Swanquarter

Sycamore Canyon
Tallgrass
Theodore Roosevelt

Tuxedni
White Mountain
White River

Transmissometer

Badlands

Guadalupe Mtns.

Cloud Peak

Nephelometer

Acadia
Big Bend
Boulder
Cape Romain
Cloud Peak

Cohutta
Craycroft
Dolly Sods
Dysart

Mayville
Organ Pipe
Vehicle Emissions
Wichita Mountains

Photographic

Gates of the Mtns.

Sites that achieved at least 90% data collection for 1st quarter 2006 are:

Aerosol (Channel A)

Blue Mounds
Bosque del Apache
Boundary Waters
Bryce Canyon
Cabinet Mountains

Caney Creek
Capitol Reef
Cloud Peak
Crescent Lake

Ellis
Fresno
Great Gulf
Linville Gorge
Lostwood

Mesa Verde
Mount Baldy
Mount Zirkel
Northern Cheyenne

Petrified Forest
Presque Isle
Sawtooth
Seney
Shining Rock

Thunder Basin
Wichita Mountain
Yosemite

Transmissometer

Glacier

Nephelometer

Lake Tahoe Boulevard
Mount Rainier

Mount Zirkel
Queen Valley

Upper Buffalo

Photographic

-- none --

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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:

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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:

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

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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:

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