Monitoring update

Network operation status

The IMPROVE (Interagency Monitoring of Protected Visual Environments) 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 includes:

- 53 aerosol samplers
- 19 transmissometers
- 43 nephelometers
- 14 film or digital camera systems
- 43 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 1st Quarter 2004 (January, February, and March) are:

- Aerosol (channel A only) 96% collection
- Aerosol (all modules) 95% completeness
- Optical (transmissometer) 93% collection
- Optical (nephelometer) 97% collection
- Scene (photographic) 73% collection

Instrumentation added to the networks this quarter includes a nephelometer at Cape Romain National Wildlife Refuge, SC, by the VISTAS group in January, and a nephelometer at Cohutta Wilderness, GA, by the USDA-Forest Service in February. A Web camera system was also installed at Point Reyes National Seashore, CA, in January.

Instrumentation that ended operation this quarter includes an aerosol sampler at Brooklyn Lakes, WY (ended December 2003), a nephelometer at Quaker City, OH (ended January 2004), and a camera system at San Juan Islands, WA, (ended February 2004).

A collocated IMPROVE aerosol sampler was installed at the Phoenix supersite in March. This sampler was installed for quality assurance purposes and is not considered a network instrument. It is the first collocated instrument at an IMPROVE site in an urban area.

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 August 2003. Transmissometer data are available through December 2002 and nephelometer data are available through December 2003. Photographic slide spectrums are also available on the IMPROVE Web site, under Data.

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Special studies

Nitrates are focus of aerosol ion study

A series of special study field campaigns is ongoing at several IMPROVE monitoring locations to examine aerosol ion composition and related sampling issues. The studies, conducted by scientists in Colorado State University’s Atmospheric Science Department, with assistance from the IMPROVE monitoring team at UC-Davis, are looking at the size distributions of aerosol ions, the chemical forms of aerosol nitrate, sampling issues related to accurate measurement of aerosol ion species (especially nitrate and ammonium), and temporal variability in PM$_{2.5}$ aerosol ion concentrations.

Five field campaigns have been completed to date, each lasting approximately one month:

- Bondville (February 2003)
- San Gorgonio (April and July 2003)
- Grand Canyon (May 2003)
- Brigantine (November 2003)
- An additional campaign is planned for July/August 2004 in Great Smoky Mountains National Park.

Measurements during the campaigns include:

- 24-hour denuder/filter-pack measurements to look at PM$_{2.5}$ ion composition, aerosol sampling artifacts, and key trace gas (NH$_3$; HNO$_3$) concentrations,
- 48-hour Micro Orifice Uniform Deposit Impactor (MOUDI) measurements to examine ion size distributions from approximately 0.1 - 10 µm, and
- A Particle Into Liquid Sampler (PILS) coupled to two ion chromatographs to look at PM$_{2.5}$ aerosol ion concentrations with a time resolution of 15 minutes.

Ions being measured by all three techniques include Na$^+$, K$^+$, NH$_4^+$, Mg$^{2+}$, Ca$^{2+}$, Cl$^-$, NO$_3^-$, and SO$_4^{2-}$.

Preliminary results from the studies indicate that large concentration variations are present within 24-hour periods at all of the studied locations. Aerosols at Bondville, for example, were observed to rapidly change between sulfate-dominated and nitrate-dominated forms and vice versa. Large diurnal swings in aerosol concentrations at San Gorgonio occur nearly every day in conjunction with daily upslope-downslope wind patterns. The form of nitrate present at different IMPROVE sites was also found to vary, with ammonium nitrate (NH$_4$NO$_3$) dominating at some sites (e.g., Bondville in winter) and coarse mode sodium or calcium nitrate dominating at other locations (e.g., during the Grand Canyon study). The importance of coarse mode nitrate observed in these campaigns is consistent with other recent observations in summertime special studies at Big Bend and Yosemite National Parks. Potential artifacts associated with ion sampling and extraction from nylon filters are also being studied. One clear initial result is that while nylon filters are efficient at retaining nitric acid that volatilizes from collected NH$_4$NO$_3$ particles, a significant fraction of ammonium collected as NH$_4$NO$_3$ on these filters is lost over the course of a 24-hour sample.

For more information contact Jeff Collett at Colorado State University. Telephone: 970/491-8697. Fax: 970-491-8449. E-mail: collett@lamar.colostate.edu.

Nephelometer comparison study

A 6-month nephelometer comparison study began in April, using eight instruments from three manufacturers. Air Resource Specialists, Inc. staff and researchers from the Cooperative Institute for Research in the Atmosphere and Colorado State University are cooperatively performing the study in Fort Collins, Colorado.

Nephelometers in the study include:

- 1 Optec NGN-2 ambient nephelometer
- 2 Modified, size-cut Optec NGN-2 nephelometers
- 1 Optec NGN-3 size-cut nephelometer
- 2 Ecotech M9003 integrating nephelometers
- 2 Radiance Research M903 nephelometers

Meteorological parameters are also used. Heating of the sample air can occur in nephelometers. This heating can modify the ambient aerosols, particularly at high relative humidities. The Radiance Research and Optec instruments use flash-style and halogen lamps, respectively, as light sources, which can contribute to sample chamber heating. The more recently developed Ecotech nephelometers use cooler light emitting diodes (LEDs) as the light source instead of standard lamps.

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.
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 2004 are:

### Aerosol
- Addison Pinnacle
- Badlands
- Bandelier
- Big Bend
- Bliss
- Blue Mounds
- Bondville
- Bosque del Apache
- Bridger
- Bridgton
- Brigantine
- Bryce Canyon
- Cabinet Mountains
- Caney Creek
- Cape Cod
- Cape Romain
- Casco Bay
- Cedar Bluff
- Chassahowitzka
- Chiricahua
- Cohutta
- Connecticut Hill
- Craters of the Moon
- Crescent Lake
- Death Valley
- Denali
- Dolly Sods
- El Dorado Springs
- Ellis
- Gates of the Mountains
- Glacier
- Great Basin
- Great Gulf
- Great Sand Dunes
- Great Smoky Mountains
- Hawaii Volcanoes
- Hells Canyon
- Hercules-Glades
- Hoover
- Isle Royale
- Jarbridge
- Kalmiopsis
- Linville Gorge
- Livonia
- Lye Brook
- Mammoth Cave
- Martha’s Vineyard
- Meadowview
- Medicine Lake
- Mesa Verde
- MK Goddard
- Mohawk Mountain
- Moosehorn
- Mount Rainier
- Mount Zirkel
- Northern Cheyenne
- Okefenokee
- Old Town
- Pass Montane
- Pinnacles
- Presque Isle
- Proctor Research Center
- Quabbin Reservoir
- Quaker City
- Rocky Mountain
- Saguaros
- Saguaros West
- Salt Creek
- San Gorgonio
- Seney
- Shenandoah
- Sikes
- Simeonof
- Snoqualmie Pass
- Starkey
- Sycamore Canyon
- Theodore Roosevelt
- Three Sisters
- Trapper Creek - Denali
- Upper Buffalo
- Washington DC
- Weminuche
- White Mountain
- Wind Cave
- Yosemite
- Zion

### Transmissometer
- Bandelier
- Grand Canyon (South Rim)
- Grand Canyon (In Canyon)
- Petrified Forest
- San Gorgonio

### Nephelometer
- Big Bend
- Grand Canyon (Hance)
- Mammoth Cave
- Mount Rainier

### Photographic
- Red Rock Lakes

Operators of distinction

Retirement isn’t all that for Bob Palko, site operator at White Mountain Wilderness, New Mexico. After 25 years of teaching school in nearby Ruidoso, Bob retired, but he still keeps busy with various activities and interests, one of which is maintaining an aerosol sampler for the IMPROVE Program. His dedication to the operation of the site is reflected in the amount of data collected. The site collected 93% of all possible data in 2003, with help from back-up operators Coy Stambaugh and Cheryl Palko.

Bob contracts with the USDA-Forest Service to run the aerosol sampler, which is the only air quality piece of equipment at White Mountain. “The site is actually between two wildernesses,” said Bob. “It lies between the White Mountain Wilderness and the Capita Mountains Wilderness, in the south-central part of the state.” The very remote region does see some tourists, however, who come primarily to ski. Every Tuesday Bob ensures the filter cartridges are changed, and mails the exposed ones back to the laboratory for analysis. “The site is not unusual,” said Bob, “it has occasionally received lightning strikes since its installation in January 2002. And for a period of about 10 days or so the power was out due to its being connected to the local village well pump, which was undergoing maintenance.”

Since Bob made a career in teaching, this is his first job in the air quality field. In addition to servicing the aerosol sampler, Bob also is a structure protection specialist for the New Mexico Type II Incident Management Team. His skills are called upon during wildland fires; the team also assisted with the Columbia Space Shuttle Recovery mission in early 2003. Bob’s other activities and interests are traveling (he has been to Europe several times), hiking, and being a WWII history buff. He and his wife moved to New Mexico in 1973, where they raised two daughters, and the house he built near the White Mountain Wilderness is still called home today.
Regional haze in the Mid-Atlantic/Northeast Visibility Union (MANE-VU) domain is driven by a combination of transported aerosols from sources within and outside of the 12-state region. Determining the relative contribution of source regions to visibility degradation is a key task under the Regional Haze Rule. A new network of sites is being deployed in Spring 2004 to assess this issue.

The Rural Aerosol Intensive Network (RAIN) is coordinated by the Northeast States for Coordinated Air Use Management (NESCAUM), but is a cooperative effort of MANE-VU member state air agencies. RAIN covers the region from western Maryland (near large sulfur sources in the Ohio River Valley), through northwest Connecticut (a “swing” site expected to have impact from a wide range of source locations and types), to Acadia National Park on the Maine coast — the proverbial “end of the tailpipe” transport receptor site. The initial network consists of these three rural, moderate elevation (700 to 2,500 feet) sites, in a southwest to northeast line (see Figure 1), all with detailed particulate matter and visibility-related measurements. The network design includes highly time-resolved (1-2 hour) aerosol mass, composition, and optical property measurements to provide enhanced insight into regional aerosol generation and source characterization, factors that drive short-term visibility, and aerosol model performance and evaluation.

Highly time-resolved aerosol data are at the core of this network, since they can provide dramatic insight into source influence and atmospheric and chemical processes (much of this information is lost when sampling on a daily time scale). An example of this is the hourly relationship between sulfate (SO$_4$) and sulfur dioxide (SO$_2$) at the summit of Mt. Washington, NH, (6,300 ft.) during a major regional haze event in August 2002 (see Figure 2). The left axis shows SO$_4$ and SO$_2$ in molar units for direct comparison, and the right axis shows them in more commonly used units. The bottom plot is the percent sulfur (S) converted from SO$_2$ to SO$_4$. The onset of the event mid-day UTC (7AM local time) on August 11th shows both SO$_4$ and SO$_2$ rising rapidly over a few hours and then dropping somewhat. The percent S converted shows a relatively smooth rise during this same period, a much less dynamic signal. Over the four core days of the event, August 12th through August 15th, the percent converted gradually rises from about 25% to 75%, which implies a more aged air mass later in the event.

Many other useful temporal aspects of these data are in this example that would be inaccessible from 24-hour duration samples. From a “sub-daily” short-term visibility perspective, factors such as the rapid changes in sulfate shown here combined with strong diurnal cycles in relative humidity can result in very large deviations across a day from average visual range. RAIN will provide both direct hourly measurement of visual range and most of the factors that drive it in the eastern U.S., which will provide opportunities to improve our understanding of the overall process.

Recent advances in measurement technologies have made it practical to deploy continuous methods for measuring real-time sulfate and elemental/organic aerosol carbon, that are both relatively straightforward to run and provide high quality data. The Sunset Laboratory field carbon analyzer and the new Thermo

**Figure 1.** RAIN network in the Northeast U.S. Three monitoring locations are shown on a SW to NE line, in western Maryland, northwest Connecticut, and Acadia National Park, Maine.
Environmental sulfate analyzer (based on a method developed at Harvard) will be used at the RAIN sites; this will be the first use of these new methods in routine ongoing state-run networks. (The Mt. Washington 2002 hourly sulfate data are from an early version of the Harvard/Thermo analyzer). These methods, combined with other more routine measurements such as IMPROVE aerosol, Optec NGN-2 (wet) nephelometers, continuous PM$_{2.5}$, trace SO$_2$, ozone, meteorology, and automated digital visibility cameras (CAMNET), make up the RAIN core monitoring lineup. The RAIN network design is an example of supplemental measurements at IMPROVE sites which help fill in the detailed temporal details of the physical, optical, and chemical features of regional haze. This network might also serve as a template for the new rural “Type 2” Ncore Environmental Protection Agency monitoring network design. Some of the RAIN sites will have additional related measurements, including “true” trace carbon monoxide, reactive oxidized nitrogen containing compounds (NO$_x$), dry scattering (Optec NGN-3a nephelometer), and other measurements.

As part of the “Technology Transfer” process of new measurement methods from research-oriented sites to routine state/local agency deployment, one of the early tasks of RAIN will be to evaluate and optimize the carbon and sulfate aerosol method’s operational parameters. One example of this optimization process is the wide range of choices on how the Sunset Laboratory carbon analyzer could be run. Numerous operational issues and options were identified prior to the start of the RAIN program. These include the magnitude of organic carbon (OC) blanks (which could be a substantial amount relative to rural OC aerosol levels even with the OC sample stream denuder), and the option of a 2-hour cycle for “OC1-2-3-4” thermal fractions, which might be useful for OC source-type characterization especially on a time-resolved basis (and also gives a substantial reduction in the OC blank value). Yet to be determined is how the Sunset carbon analyzer (a thermal/optical transmission (TOT) method) might be run to give a more

IMPROVE-like elemental carbon (EC)/OC thermal/optical reflectance (TOR) measurement. We are working closely with Sunset Labs on these and other issues related to this method.

A longer term goal of RAIN is to enhance the network with other measurements and sites in future years. A National Weather Service Automated Surface Observing System (ASOS) visibility sensor at a RAIN site would allow the large network of existing ASOS data to be “tethered” to visibility measurements we understand well. Strong aerosol acidity, nitric acid, and ammonia are measurements that would be desirable on either an integrated or real-time basis. There are no continuous nitrate measurements in RAIN at this time, since available methods are not yet sufficiently robust, and nitrate is not (yet) a major factor at these sites. Measurements similar to those in RAIN done to the west and south of the MANE-VU domain (Ohio and Virginia for example) would greatly enhance our understanding of the impact of the large sulfur source region in and around the Ohio River Valley on regional visibility. We expect to make data from RAIN available in real-time to Web data resources like VIEWS, FASTNET, and AIRNow.

RAIN would not be possible without the ongoing support of the participating state air agencies in MD, CT, and ME, as well as the National Park Service and MANE-VU.

For more information contact George Allen at NESCAUM. Telephone: 617/367-8540 x235. Fax: 617/742-9162. E-mail: Galien@nescaum.org.
WinHaze visual air quality modeler updated

WinHaze version 2.9.6 was released by Air Resource Specialists, Inc. in March. The freeware computer-imaging software program simulates visual air quality differences of various scenes. First created in 1998, the software now contains 134 national park, wilderness, and urban scenes. It allows users to view visual air quality scenarios on their desktop computer as a supplement to air quality monitoring. Users can model scenes using different optical parameters or aerosol species, to simulate effects they have on the scenes. The freeware can be downloaded from the Web by logging onto http://www.air-resource.com. Click on What’s New for system information and download (the file is 153mb).

WinHaze is also available on CD. Call Air Resource Specialists, Inc. Telephone: 970/484-7941. Fax: 970/484-3423. E-mail: info@air-resource.com.

Operators achieve 93% collection for 2003

Collection statistics for the IMPROVE and IMPROVE Protocol aerosol networks show an impressive 93% data collection for 2003, indicating that site operators operated and maintained their aerosol samplers efficiently. Collected data undergo validation, using specific criteria stipulated by the Regional Haze Rule. For these data to be used to track progress in improving visibility, and be included in preparing state implementation plans, monitoring sites must achieve:

- At least 75% annual completeness
- At least 50% completeness in each calendar quarter
- Have no more than 10 consecutive missed samples

Out of 165 sites in the networks, only 8 failed to meet these criteria. Generally, sites that failed did so because of unique situations, and most involved the 10 consecutive missed sample stipulation. The University of California-Davis, the program’s aerosol monitoring contractor, is implementing new procedures that will further assist operators in obtaining the highest possible collected samples. These procedures are:

- Field staff will stress to operators the importance of not missing 10 consecutive samples.
- Field staff will ship replacement equipment by overnight courier (on-site repairs are not attempted), to sites that approach the 10 or more limit.
- Field staff will be sent directly to the site if other remedies have failed (or if the site is approaching the 10 or more limit).

Collection statistics for each site for 2003 are provided in the following listing.

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First Class Mail

IMPROVE STEERING COMMITTEE
IM PRO V E Steering Committee members represent their respective agencies and meet periodically to establish and evaluate program goals and actions. IM PRO V E-related questions within agencies should be directed to the agency’s Steering Committee representative. Steering Committee representatives are:

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A associate Membership in the IM PRO V E Steering Committee is designed to foster additional IM PRO V E-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. A associate M ember representatives are:

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

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