2012 Calendar

IMPROVE

Interagency Monitoring of Protected Visual Environments

CIRA

Colorado State University

A Note from Retired IMPROVE Steering Committee Chair, Marc Pitchford

IMPROVE
Interagency Monitoring of Protected Visual Environments

Marc Pitchford, Desert Research Institute, Las Vegas, NV

Dr. Marc Pitchford initiated visibility research and monitoring programs in remote, pristine areas of the western United States in 1976 as part of an EPA project to assess the air quality impacts of major energy development in eight western states. The program expanded with the 1977 Clean Air Act Amendments that called for visibility protection for national parks and wilderness areas designated as federal Class I areas. As a result, the National Park Service established their air quality / visibility program in 1981. The EPA visibility monitoring program, which had been operational for several years in the western United States, was discontinued in 1981 because of the changing priorities of the new Reagan administration. The monitoring equipment from the EPA's 40+ network sites was transferred to the new NPS program.

In 1984, Dr. Pitchford was tasked by the EPA's Office of Air Quality Planning and Standards to prepare a plan for a national monitoring network for visibility-protected federal Class I areas, as required by the settlement of a lawsuit over the EPA's failure to implement the Phase I visibility regulations. To stretch limited resources, federal land management organizations pulled together, creating an interagency-sponsored monitoring program. Dr. Pitchford proposed a descriptive name for the program, Interagency Monitoring of Protected Visual Environments, and became the chair of the steering committee, a post he held until retirement in October 2011.

In the early years, IMPROVE data was used principally by program managers and scientists to better characterize and understand the causes of remote-area visibility impairment. The number and diversity of data users increased as a result of the regional haze language in the 1990 Clean Air Act amendments that established the Grand Canyon Visibility Transport Commission, followed later by the promulgation of the Regional Haze Rule (1999) and the initiation of five regional planning organizations representing subregions of the United States. The Regional Haze Rule mandates the use of IMPROVE (or equivalent) data to document long-term Class I area visibility trends.

Reflections on the IMPROVE Program

Dr. Marc Pitchford
photo: Desert Research Institute

As IMPROVE has evolved and expanded over the years, I have been guided by a vision of what it should be. While IMPROVE's goals and objectives are well documented and I have articulated that aspect of my vision in conversations with others, I have never attempted to succinctly write out a vision statement until now.

The Vision for IMPROVE

> *Vision:* IMPROVE provides for the generation and dissemination of consistent, high-quality atmospheric data needed to implement federal visibility protection for Class I areas, now and in the future.

Given the cost often associated with large-scale emission reductions, federal visibility protection is a high-stakes activity that is appropriately scrutinized by diverse interest groups. The IMPROVE program contributes to the credibility of the visibility protection process by having developed a reputation for generating good quality data by an open and well-documented process.

Maintaining data consistency across the network and over multiyear periods, as required to implement the Regional Haze Rule, is a reoccurring challenge in the face of both planned and inadvertent changes in the monitoring process. One might think that after over 20 years of operations, IMPROVE should be able to collect consistent data by merely freezing our operational protocols and applying them rigorously. However, samplers and analytical equipment deteriorate or may malfunction, no longer be supported by vendors, or be too costly to maintain, so they need to be replaced by newer models. Also, suppliers of filters and other required materials make changes to their manufacturing processes without notifying the users, resulting in differences that are not apparent until there's a jump in the data that we then attempt to understand. There are numerous examples of such seemingly benign changes in procedures, equipment or supplies that we have shown to be responsible for noticeable and occasionally significant changes in the data record.

Preserving IMPROVE's reputation for developing high-quality data is the reason that we devote significant time and resources to evaluations of data quality and consistency. It is also the reason that when data issues or deficiencies are detected, we highlight the concerns on the IMPROVE website by providing advice to data users, as well as taking the necessary measures to correct the defects we identify. This commitment to understanding and improving the quality of the data requires a vigorous, ongoing quality assurance research effort that sometimes results in delays in posting data and occasionally results in the embarrassment of identifying problem data. However, IMPROVE's policy to communicate our understanding of the quality of our data and the processes used to generate it is a professional responsibility, as well as a substantial reason for the confidence data users have in the information we provide.

Future Challenges

I expect that the reoccurring challenges of the past will continue into the future. These tend to fall into several categories, including coping with resource limitations, balancing data continuity against implementation of improved methods, and maintaining a top-notch program team.

Resource limitations manifest themselves in two distinct ways. The cost of labor, supplies and equipment increases every year, even in these times of low inflation. Yet the price paid per site has been constant for over a decade. Given recent and likely future federal budget problems, there isn't likely to be relief any time soon. IMPROVE has coped with this gradually tightening funding noose by employing innovations that reduce labor and often in the process increase the data quality. For example, the analytical efforts at UC Davis are being more automated with the use of filter barcodes and weighing, and elemental composition and optical absorption measurements are being transmitted directly to the relational database from the laboratory equipment. Expanding the network is another way to control the cost per site, because the incremental cost for adding a site is less than the total cost divided by the number of sites (which is the price we assess to operate the site). This is one of the motivations for our recent interest in expanding the IMPROVE network with monitoring sites in other countries (such as Canada and the Republic of Korea).

A substantial reduction in funds is the second category of resource limitation challenges. A number of years ago, the EPA notified the IMPROVE steering committee of a possible 15% reduction in financial support, part of an across-the-board reduction that would have required decommissioning nearly 30% of the IMPROVE sites due to the nonlinear cost (as mentioned in the previous paragraph). The steering committee responded by conducting an assessment to rank the priority of the sites based on the uniqueness of the data they generated compared with data from neighboring sites. States and regional air quality organizations, especially those with sites that were most likely to be decommissioned, sent letters of support to EPA requesting full funding. Fortunately, these cuts never materialized.

The primary purpose served by IMPROVE data is long-term-trends assessments for Class I area sites. This requires a stable set of measurements conducted with great care to avoid or minimize unintended, methodologically induced distortions of the trend. I've been asked, "Does this mean that IMPROVE will always use virtually the same filter-based sampling with subsequent laboratory analysis as the basis for its measured aerosol speciation and derived light extinction datasets?" The answer is no, but to make changes, the IMPROVE program needs to demonstrate that the replacement techniques will generate comparable or relatable data so that credible long-term-trends assessments can continue through the transition. IMPROVE has faced this challenge a number of times in the past. For example, the change to a newer thermal optical reflectance carbon analyzer required a substantial effort over nearly two years, including running paired analyses with the old and new analyzers on hundreds of samples and conducting experiments to more fully understand and adjust for the differences noted in the paired data. Conducting these assessments can be an expensive proposition, which works to discourage all but necessary or potentially big payoff methodological changes. I am confident that IMPROVE's monitoring approaches will continue to evolve, but only changes worth the required effort should be attempted.

Maintaining top-notch management and technical teams is a continuing challenge for any long-term program. IMPROVE has been blessed by a great deal of stability among its staff, but that has the downside of not making many vacancies for the next generation. The steering committee members and project leads among the contractor organizations need to actively seek and involve young scientists and project managers to replace us as we near retirement. A number of us have done this throughout the history of the IMPROVE program, with good results.

My Future

With my retirement from federal service, I can no longer represent NOAA on the IMPROVE steering committee. However, my new job as Executive Director of the Desert Research Institute Division of Atmospheric Sciences provides ample justification for my continued interest and future involvement in this program that has been such a large part of my professional career. I leave the steering committee in good hands with the election of Scott Copeland as the new chair and with Rick Saylor the new NOAA representative. I hope to be able to attend future steering committee meetings as one of the DRI representatives, and I invite you to involve me whenever doing so could be helpful.

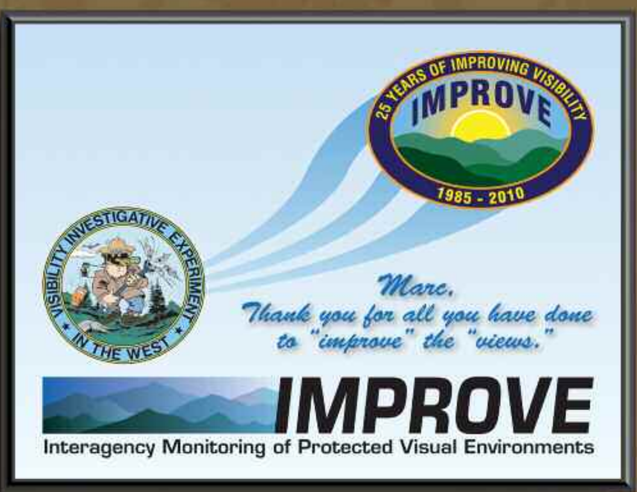
Marc Pitchford

Dr. Marc Pitchford has been an integral part of planning and developing visibility-related monitoring and research programs going all way back to 1976. His efforts as a research scientist for the Environmental Protection Agency and with the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory in the Special Operations and Research Division in Las Vegas were pivotal in the creation and implementation of the Interagency Monitoring of Protected Visual Environments (IMPROVE) Network. Dr. Pitchford served as the IMPROVE steering committee chair from its inception in 1984 until his retirement in October 2011. In 2009, Pitchford and the Integrated Science Assessment Team were honored with the EPA's Bronze Medal Award "for their exceptional scientific leadership, innovation, and service by transforming scientific assessments to support science-based air standards decisions."

Dr. Pitchford stepped down as IMPROVE steering committee chair to serve as the Executive Director of the Division of Atmospheric Sciences at the Desert Research Institute in Reno in November 2011. His leadership in the IMPROVE program and his commitment to excellence will be sorely missed. Awards were presented at the 2011 IMPROVE meeting.

John Molenar (left), ARS, and Warren White (right), UC Davis, presenting a mounted dissection of the IMPROVE sampler head

William Malm (right), NPS-CSU, presenting Marc a signed IMPROVE steering committee plaque



January

Be a yardstick of quality. Some people aren't used to an environment where excellence is expected.
– Steve Jobs

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 1 Julian day National Environmental Policy Act, 1969 New Year's Day IMPROVE particle sampling day	**2** 2	**3** 3 Change IMPROVE particle cartridges.	**4** 4 IMPROVE particle sampling day	**5** 5	**6** 6	**7** 7 IMPROVE particle sampling day
8 8	**9** 9	**10** 10 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	**11** 11	**12** 12	**13** 13 IMPROVE particle sampling day	**14** 14
15 15	**16** 16 Martin Luther King, Jr.'s Birthday IMPROVE particle sampling day	**17** 17 Change IMPROVE particle cartridges.	**18** 18	**19** 19 IMPROVE particle sampling day	**20** 20	**21** 21
22 22 IMPROVE particle sampling day	**23** 23	**24** 24 Change IMPROVE particle cartridges.	**25** 25 IMPROVE particle sampling day	**26** 26	**27** 27	**28** 28 IMPROVE particle sampling day
29 29	**30** 30	**31** 31 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.				

Dec 2011

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Feb 2012

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General Lab
(530) 752-1123

ARS: *Optical*:
Carter Blandford or
Karen Rosener
Photography:
Karen Fischer
(970) 484-7941

IMPROVE Monitoring Update

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 155 Class I federally protected areas. Additional instrumentation that operates according to IMPROVE protocols in support of the program includes

- 55 aerosol samplers,
- 20 nephelometers,
- 2 transmissometers.
- 77 Webcam systems,
- 5 interpretive displays,

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 October 2010. Nephelometer and transmissometer data are available through June 2011 and December 2010, respectively. Webcamera real-time images and data are available on agency-supported Web sites:

Visibility Information Exchange Web System:
http://views.cira.colostate.edu/web/
National Park Service: http://www.nature.nps.gov/air/WebCams/
USDA Forest Service: http://www.fsvisimages.com
CAMNET (Northeast Camera Network): http://www.hazecam.net
Midwest Haze Camera Network: http://www.mwhazecam.net
Wyoming Visibility Network: http://www.wyvisnet.com
Phoenix, Arizona Visibility Network: http://www.phoenixvis.net

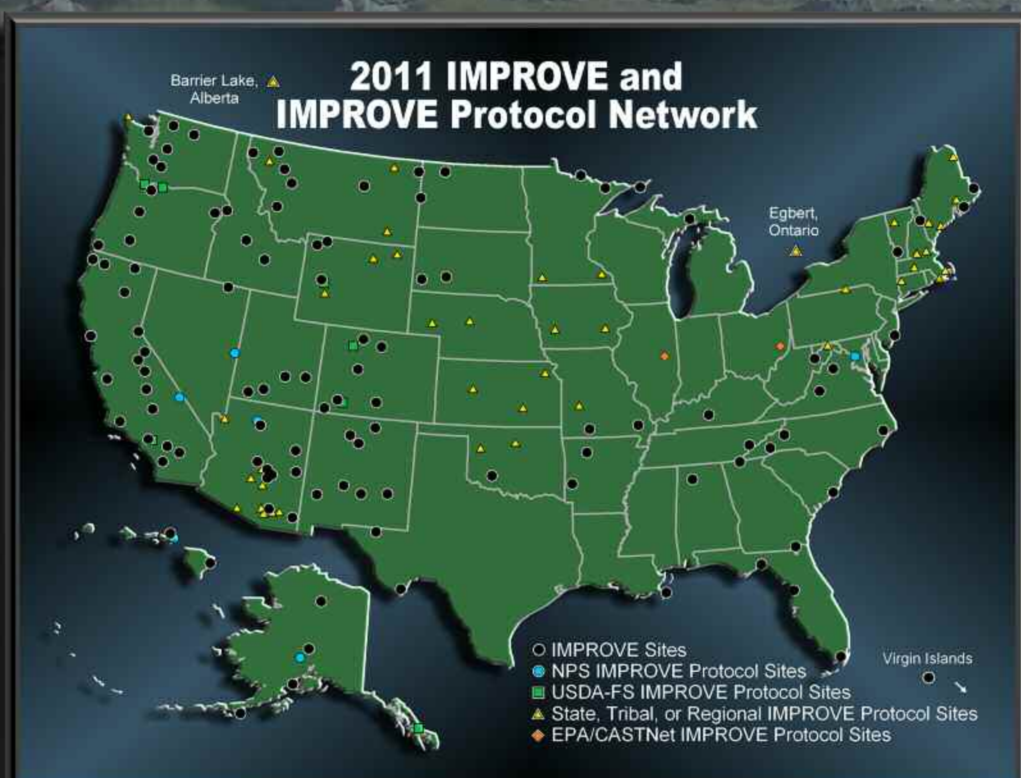
The Environmental Protection Agency (EPA) AIRNow Web site http://airnow.gov includes many of these as well as additional visibility-related Webcameras. Click on View Other Visibility Webcams.

Network Notes

The IMPROVE steering committee has accepted international associate memberships for Canada and the Republic of Korea (South Korea). These two nations join the state of Arizona, which is also an associate member of the IMPROVE Program.

photo: Tina Thompson

2011 turned out to be one of the most severe wildfire seasons in history, with numerous fires burning in the Southwest due to extremely dry conditions. Two IMPROVE monitoring stations in New Mexico and Arizona were impacted. The Gila Cliff Dwellings National Monument site in New Mexico was overrun with fire in May 2011. Site operator Gilbert Jimenez saved the sampler and modules with a fire protective foil. That fire consumed nearly 90,000 acres. Also in May, fire burned the entire Chiricahua National Monument. Approximately 220,000 acres burned, but fire crews cleared fuels from around the station and called for slurry drops. The site was saved, but some filter data will be unusable due to extreme particulate loading.



A history-making dust storm descended on Phoenix, AZ, on July 5, 2011. The Arizona Department of Environmental Quality's urban visibility monitoring network captured near-real-time documentation of the magnitude of the event, including Webcamera images from five different locations. Initial PM10 monitoring produced an astonishing 6348.6 $\mu g/m^3$ 1-hour average. Analysis from IMPROVE monitors throughout the state may provide additional information about the magnitude and extent of the storm.

photo: Daniel Bryant

Environment Canada is funding its second aerosol monitoring site, the Barrier Lake Station in Alberta, near Banff National Park. Sampling is intended to characterize regional air quality in the Banff National Park area and is part of an Environment Canada visibility monitoring pilot study.

Five IMPROVE protocol sites were closed in 2011 because of budget constraints, including Arendtsville, PA; Cadiz, KY; Livonia, IN; MK Goddard, PA; and Sikes, LA. All of these sites began operation in 2001 and were associated with the EPA's CASTNET network.

On November 1, 2011, Marc Pitchford retired from federal service and left the IMPROVE steering and chair position to become the Executive Director of the Division of Atmospheric Sciences at DRI in Reno, NV. Rick Saylor is the new NOAA representative. Scott Copeland is replacing Marc Pitchford as the steering committee chair.

Mount Rainier National Park, Washington

The air quality station at Mount Rainier includes IMPROVE, nephelometer, CASTNET, NADP, and recently-added AMoN instruments. At Paradise, there has been a precipitation sampler since 1986, an air quality Webcamera, and a Washington State Dept. of Ecology (WADOE) continuous ozone sampler. **Rebecca Lofgren** assists with the operation of the WADOE site during the winter months and is directly responsible for the rest of the air equipment year round.

Rebecca has a master's degree in environmental engineering and has been working at Mount Rainier National Park almost 10 years -- her first assignment to date.

Her primary duties are related to the NPS Inventory and Monitoring Program, and she is specifically involved with the long-term monitoring of glaciers, mountain lakes, and climate (which includes maintaining weather stations) at Mount Rainier NP. Her other duties include soundscape and night sky monitoring.

She says, "I met my husband at Mount Rainier NP while transporting 100 pounds of snow down from 10,000 feet for the Western Airborne Contaminant Project. He is the Mount Rainier Climbing Program manager. We have a three-year-old daughter." She adds, "In my spare time, I enjoy skiing, hiking, and chasing my three-year-old around, wherever her imagination takes her."

February

In every walk with nature one receives far more than he seeks.
– John Muir

Jan 2012

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Mar 2012

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 32 Julian day	2 33 Groundhog Day	3 34 IMPROVE particle sampling day	4 35
5 36	6 37 IMPROVE particle sampling day	7 38 Change IMPROVE particle cartridges.	8 39	9 40 IMPROVE particle sampling day	10 41	11 42
12 43 Lincoln's Birthday IMPROVE particle sampling day	13 44	14 45 Valentine's Day Change IMPROVE particle cartridges.	15 46 IMPROVE particle sampling day	16 47	17 48	18 49 IMPROVE particle sampling day
19 50	20 51 President's Day	21 52 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	22 53 Washington's Birthday	23 54	24 55 IMPROVE particle sampling day	25 56
26 57 Grand Canyon National Park established, 1919	27 58 IMPROVE particle sampling day	28 59 Change IMPROVE particle cartridges.	29 60			

- Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected.
- Watch for frost on the inlets.
- Watch for lightning damage.
- Check site conditions (e.g., a tree growing beyond acceptance criteria).

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Nitrogen Deposition in Western Class I Areas

IMPROVE
Interagency Monitoring of Protected Visual Environments

Mike Barna, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

Nitrogen deposition isn't the first thing that comes to mind when considering air pollution, and it doesn't have the immediacy of, say, urban smog or wildfire smoke plumes. But even though its effects appear subtle, over time it can alter the balance of sensitive ecosystems. For example, too much nitrogen can lead to eutrophication (i.e., the "bloom" of phytoplankton that can occur in estuarine and alpine waters) as well as shifts in alpine plant communities. Western national parks and wilderness areas, including those that are far removed from urban pollutant sources and industrial operations, are facing serious challenges with regard to nitrogen deposition. Measured deposition is trending upward at many monitoring sites in the West, and in some cases exceeds a "critical load" at which ecosystem impacts are likely.

A previous effort to address nitrogen deposition was undertaken during the 1980s with the inception of the National Acid Precipitation Assessment Program. Here the focus was on "acid rain" in the East, which was caused largely by nitrogen and sulfur emissions from coal-fired power plants. Since that time the focus of the air quality community has been greatly expanded to look beyond acid rain and to consider the role of nitrogen compounds emitted from agricultural operations (e.g., ammonia from fertilizer application and feedlot operations) as well as more "exotic" forms of nitrogen such as organic nitrates that form in the atmosphere through complex chemical reactions. The key to reducing nitrogen impacts will be understanding the role played by various emission sources as well as measuring the most important nitrogen-containing compounds.

One park in particular has been extensively studied with regard to the impacts of excess nitrogen: Rocky Mountain National Park in north-central Colorado. Previous studies such as RoMANS (the Rocky Mountain Atmospheric Nitrogen and Sulfur Study) as well as routine monitoring have indicated that current nitrogen deposition rates are considerably above the nitrogen "resource management goal" of 1.5 kg of nitrogen per hectare per year (or 1.5 kg N per hectare per year) of wet-deposited nitrogen. An important finding of RoMANS was the significant role that "missing" nitrogen species may be playing in terms of the overall nitrogen budget. For example, ammonia and organic nitrates were found to be a substantial portion of deposited nitrogen, but these species are not measured by existing deposition monitoring networks. To aid in our understanding of nitrogen deposition at this park and other sensitive Class I areas, an advanced air pollution model was used to simulate the complex evolution of important nitrogen species and to help quantify gaps in the observational record.

The role of nitrogen deposition in altering sensitive ecosystems is a current research effort that requires more study. Future work should focus on developing better techniques for measuring critical nitrogen species that are not currently part of existing monitoring networks, as well as modeling and receptor approaches for characterizing the emission sources that are contributing to the overall nitrogen load.

The maps in Figure 1 to the right show simulated dry, wet, and total nitrogen deposition from a regional air quality model. Class I areas are indicated as black circles. Major emission sources of ammonia (e.g., California's Central Valley and Idaho's Snake River Valley) and nitrogen oxides (e.g., coal- fired power plants and urban areas) are evident. Note that many regions are significantly above the "resource management goal" of 1.5 kg N per hectare per year for wet-deposited nitrogen. Although wet-deposited nitrogen is specified in this goal, it can be presumed that dry-deposited nitrogen is also contributing to the overall nitrogen load at many areas.

Air quality models can also be used to investigate the effects of an individual pollutant source. In Figure 2, the impact of the Craig Power Station, located in northwestern Colorado, is evaluated with regard to its contribution to nitrogen deposition at Rocky Mountain NP. This 650 megawatt coal-fired powerplant is the largest source of nitrogen oxides (NOx) within the state. A proposal to substantially reduce NOx emissions from current levels of 18,000 tons per year to 3,000 tons per year is being considered. Substantial reductions in deposited nitrogen, ranging from 0.10 to 0.15 kg N per hectare per year, are anticipated if these stringent pollution controls are adopted.

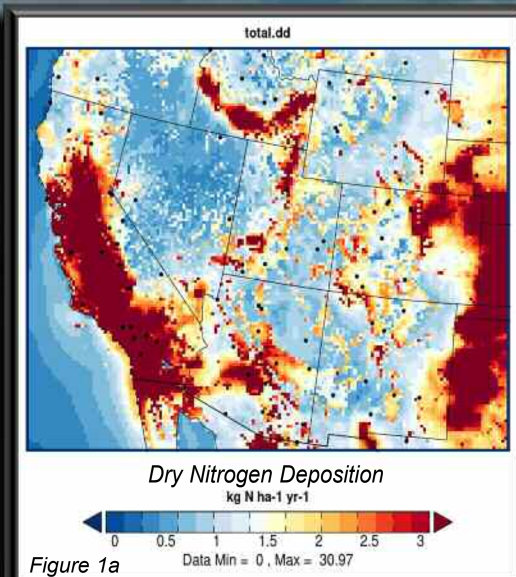

Figure 1a

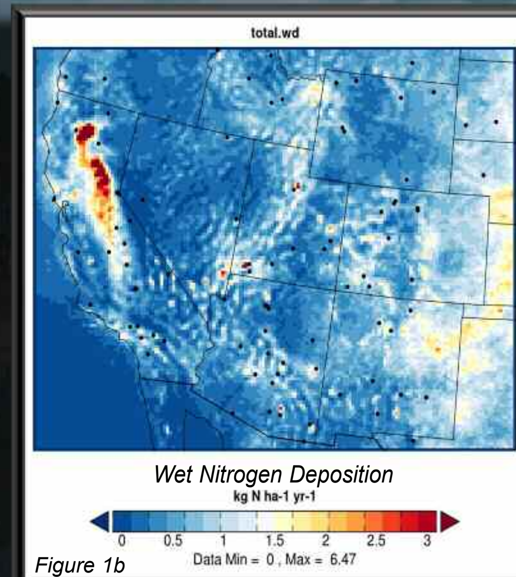

Figure 1b

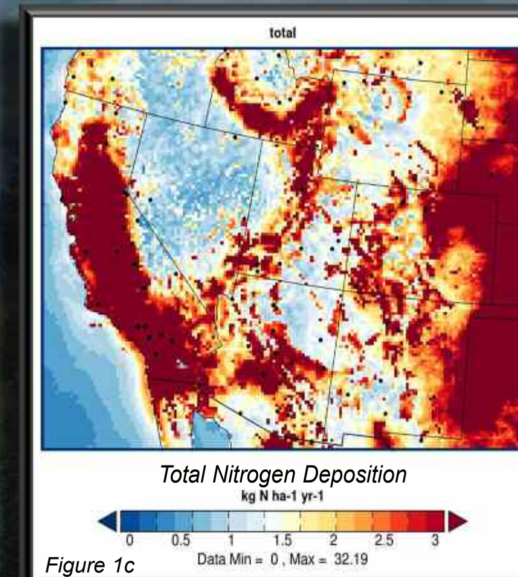

Figure 1c

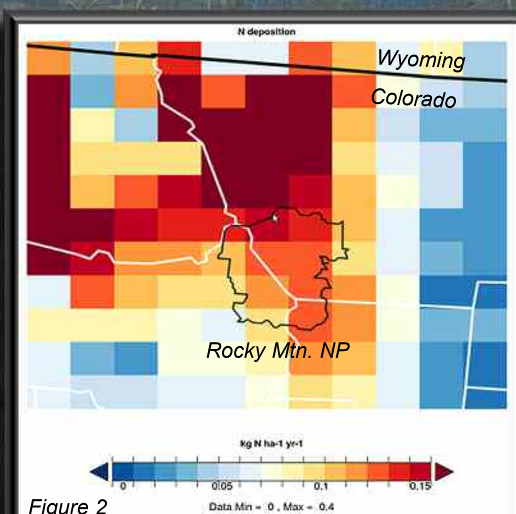

Figure 2

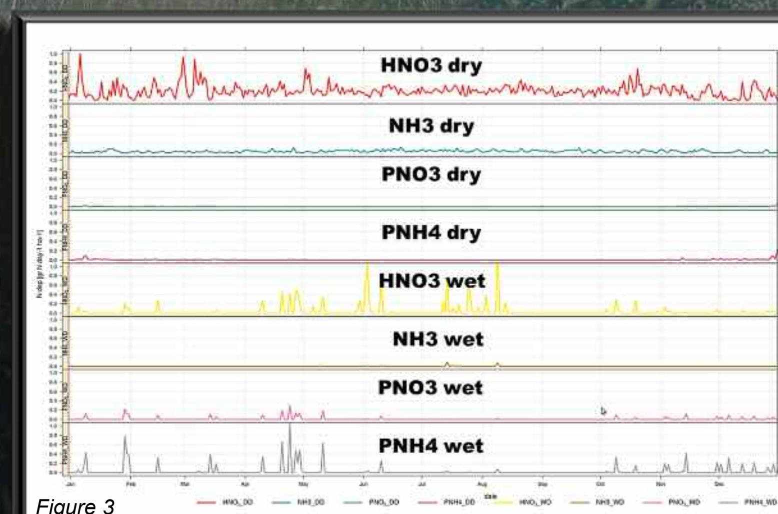

Figure 3

Figure 3: Simulated dry and wet deposition of important nitrogen species at Rocky Mountain NP, including nitric acid (HNO3), ammonia (NH3), particulate nitrate (PNO3), and particulate ammonium (PNH4).

Seney National Wildlife Refuge, Michigan

Jim Patton, a retired equipment operator, helps with maintenance projects at Seney National Wildlife Refuge in Upper Michigan and collaborates with his wife **Jody** in doing waterfowl counts, monitoring the reintroduced trumpeter swan flock, and taking other censuses and surveys. He has been the primary IMPROVE sampler operator there for the last three years. **Don Gardner**, a retired electrical engineer, also helps with maintenance projects and has been a backup sampler operator for two years. **Susan Vaniman**, a teacher and visitor center volunteer, is in training as an operator. They all remain in the area year-round, which was a factor in their recruitment.

Some other special studies underway in the refuge pertain to the Fire Science Network & Delivery Systems for the fire-dependent ecosystems of the northern lake states, the rapid ecological assessment of forests of the Great Lakes biology network, mixed pine forest restoration and fire ecology, common loon productivity and ecology, peat land ecosystem function and resilience to climate change, and the distribution of small mammals in relation to climate change.

The wildlife refuge is located midway between Lake Superior to the north and Lake Michigan to the south. The 96,000-acre refuge includes 25,150 acres of Class I wilderness, encompassing string-bog wetlands, sedge marsh, peatlands, cedar swamps, lowland scrub, and upland pine and hardwood forests. A variety of wildlife inhabit the refuge, including many migratory birds, trumpeter swans, ospreys, bald eagles, gray wolves, deer, foxes, and moose.

Current annual average visibility at Seney is about 47 miles, compared to natural visibility of 90 miles. Although the refuge is relatively isolated, a paper mill and power plant in Munising, 47 miles away, contribute to regional air quality impairment. Studies at Seney have also found high mercury concentrations in some large predatory fish, and vegetation surveys show ozone injury to several plant species.

March

Be careful the environment you choose, for it will shape you; be careful the friends you choose, for you will become like them.

– W. Clement Stone

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1 61 Julian day Yellowstone Natl. Park established, 1872 IMPROVE particle sampling day	2 62	3 63
4 64 IMPROVE particle sampling day	5 65	6 66 Change IMPROVE particle cartridges.	7 67 IMPROVE particle sampling day	8 68	9 69	10 70 IMPROVE particle sampling day
11 71 Daylight Saving Time begins	12 72	13 73 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	14 74	15 75	16 76 IMPROVE particle sampling day	17 77 St. Patrick's Day
18 78	19 79 IMPROVE particle sampling day	20 80 Spring begins Change IMPROVE particle cartridges.	21 81	22 82 IMPROVE particle sampling day	23 83	24 84
25 85 IMPROVE particle sampling day	26 86	27 87 Change IMPROVE particle cartridges.	28 88 IMPROVE particle sampling day	29 89	30 90	31 91 IMPROVE particle sampling day

Comparing Gravimetric to Speciated Mass – What Can We Learn?

IMPROVE
Interagency Monitoring of Protected Visual Environments

William Malm, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

The Environmental Protection Agency (EPA) and the federal land management community (National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, and Bureau of Land Management) operate extensive particle speciation monitoring networks that are similar in design but are operated for different objectives. Compliance (mass only) monitoring is also carried out using federal reference method (FRM) criteria at approximately 1000 sites. The Chemical Speciation Network (CSN) consists of approximately 50 long-term-trend sites, with about another 150 sites operated by state and local agencies. The sites are located in urban or suburban settings. The Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network consists of about 170 sites, all in nonurban locations.

Each monitoring approach has its own inherent monitoring limitations and biases. Determination of gravimetric mass has both negative and positive artifacts. Ammonium nitrate and other semivolatiles are lost during sampling, while on the other hand, measured mass includes particle-bound water. Furthermore, some species may react with atmospheric gases, further increasing the positive mass artifact. Estimating aerosol species concentrations requires assumptions concerning the chemical form of various molecular compounds, such as nitrates and sulfates, and organic material and soil composition.

Comparing data collected in the various monitoring networks allows for assessing uncertainties and biases associated with both negative and positive artifacts of gravimetric mass determinations, assumptions of chemical composition, and biases between different sampler technologies. All these biases are shown to have systematic seasonal characteristics. Unaccounted-for, particle-bound water tends to be higher in the summer, as is nitrate volatilization. The ratio of particle organic mass divided by carbon mass (Roc) is higher during summer and lower during the winter seasons in both urban and nonurban areas; however, Roc is lower in urban than nonurban environments.

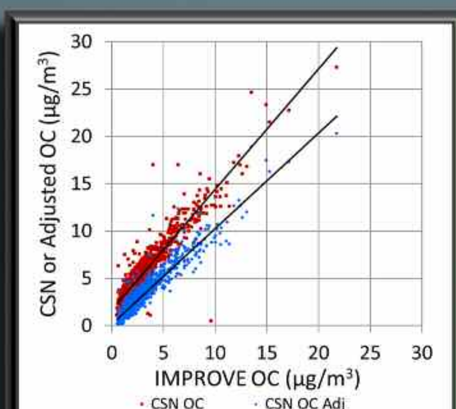

Figure 1. The CSN and IMPROVE OC concentrations for all collocated IMPROVE and CSN samplers that collected data in 2005 and 2006. The red data points are for the reported CSN OC concentrations and the blue data points are for the adjusted or corrected CSN carbon concentrations, assuming a 20% difference between the two techniques.

A number of different samplers are used in the CSN network. Only the data collected from the Met One sampler will be discussed here. Figure 1 shows a plot of CSN-derived organic carbon (OC) plotted against OC derived from the IMPROVE sampler. Notice that there is a systematic difference between the two sampling systems, with CSN being about 20% higher. It is suggested that this loss is associated with volatilization of semivolatile OCs (SVOCs) and may be dependent on filter face velocity. This suggests that there may be some loss of SVOCs from all sampling systems; however, the specific loss as a function of sampler characteristics cannot be addressed with the routinely collected data in the IMPROVE and CSN monitoring programs.

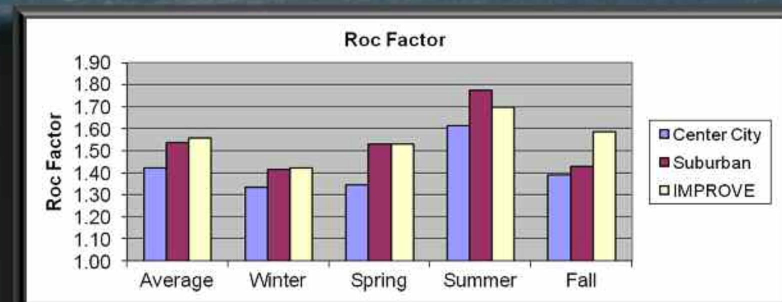

Figure 2: Roc factor for the IMPROVE and CSN monitoring networks.

Figure 2 shows that there is a rather dramatic seasonal difference in Roc factors, with winter and summer being at about 1.3–1.4 and 1.6–1.8, respectively. Spring and fall have intermediate values as compared to winter/summer. Because of less photochemistry during winter months, one might expect particulate organic matter to be less oxygenated and have lower Roc factors than summer months. Also, because urban areas are likely sources of OC, it might be expected that a "young" urban organic aerosol would have a lower Roc factor than a more aged rural or remote aerosol. Figure 2 shows that these differences, if they exist, are not large. The center city Roc factors are systematically lower than either suburban or rural sites but only by about 5–15%. Interestingly, suburban and rural Roc factors are about the same. Because the Roc factors between IMPROVE and CSN Met One monitoring systems are nearly the same, in spite of a 20% loss of OC using the IMPROVE system, it seems reasonable to hypothesize that the Roc factor of the volatilized SVOC is about the same as the OC that is retained.

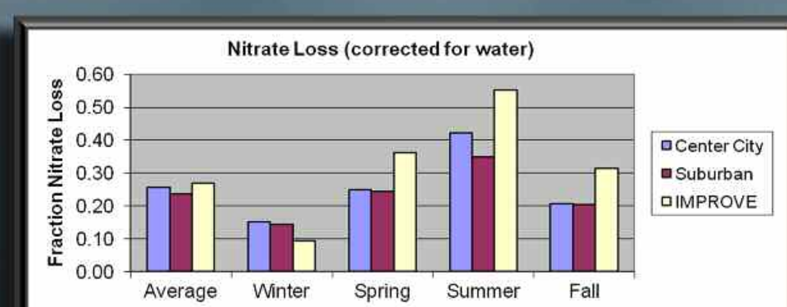

Figure 3: Average fraction of nitrate lost from a Teflon filter for the IMPROVE and CSN monitoring networks.

Estimated seasonal variability of nitrate volatilization from a Teflon filter is consistent with literature values. In Figure 3, winter fractional loss of nitrate is about 10%, while during the summer the average loss is estimated to be 40–50%, with spring and fall loss being intermediate compared to summer/winter. There is very little difference of nitrate volatilization between urban and nonurban sites.

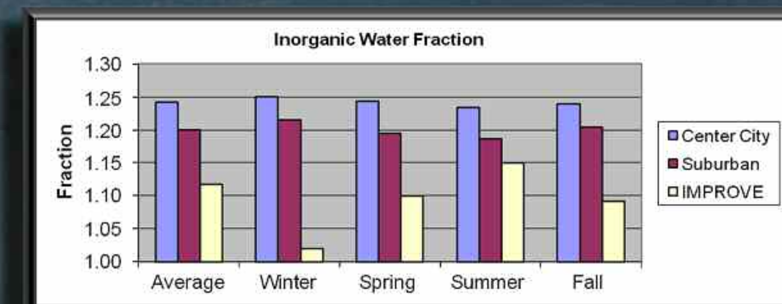

Figure 4: Average fractional increase in sulfate and nitrate mass due to retained water for the IMPROVE and CSN monitoring networks.

Figure 4 shows the average fractional increase in sulfate and nitrate mass due to retained water for the IMPROVE and CSN monitoring networks. Notice that water retention is on the order of 1.2–1.25 for center city / suburban sites. This range of fractional retention of water is consistent with measured and theoretical values of D/Do (wet over dry particle diameter) ratios of about 1.05–1.1 or an increase of mass of about 15–30% at 30–40% RH. It is greatest at center city sites and decreases as one moves to suburban and rural/remote areas. There is very little seasonal dependence for the center city / suburban sites but a very pronounced seasonal dependence for the rural / remote IMPROVE sites. There is little predicted water retention during the winter months, while during the summer season the water retention factor is 1.15. The difference between times when sulfates retain water at the low RH found in the laboratory may be due to sulfate neutralization and the mixing characteristics of urban aerosols. Sulfates during winter months tend to be more neutralized than during the summer and may not have deliquesced and therefore retained little water. Furthermore, measurements in the eastern areas of the United States, where most CSN monitors are located, show D/Do functions that have continuous growth curves showing neither deliquescence or crystallization characteristics.

White Mountain, Lincoln Natl. Forest, New Mexico

The Lincoln National Forest located in central New Mexico encompasses 1.1 million acres, of which the Smokey Bear Ranger District, **JoAnne Carpenter's** duty station, takes up 364,000 acres, and includes two wilderness areas. It was in one of these wilderness areas, the Capitan Wilderness, that Smokey Bear was found. As a bear cub, he was clinging to a tree in the Capitan Mountains during a fire there in 1950. He was rescued and adopted by the US Forest Service, and became the living symbol of Smokey Bear. His home was moved to the National Zoo in Washington, DC, until he was brought home to rest in the state park in Capitan, NM, after his passing in 1976.

JoAnne has been the resource clerk at the Smokey Bear Ranger Station in Ruidoso, NM, for almost three years as of the fall of 2011. Being the sampler operator for air quality monitoring is just one of her duties. She also does payroll, billing, purchasing, and distributing of hiking and camping information, sells maps, and issues fuelwood permits.

The IMPROVE site is in a Class I area and usually has clear visibility; however, there were several forest fires in 2011. One of these fires was quite large and very close to Ruidoso, burning over 10,000 acres and destroying five homes.

JoAnne says, "What I most like about taking the samples is that I get to leave the office and get outside at least once a week."

"I enjoy hunting, camping, riding ATVs, and caving in the numerous caves in the area. I have lived in Ruidoso for 19 years and enjoy being in the outdoors with my family and taking care of my animals."

April

After all, sustainability means running the global environment - Earth Inc. - like a corporation: with depreciation, amortization and maintenance accounts. In other words, keeping the asset whole, rather than undermining your natural capital. – Maurice Strong

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 92 Julian day	2 93	3 94 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	4 95	5 96	6 97 IMPROVE particle sampling day	7 98
8 99	9 100 IMPROVE particle sampling day	10 101 Change IMPROVE particle cartridges.	11 102	12 103 IMPROVE particle sampling day	13 104	14 105
15 106 IMPROVE particle sampling day	16 107	17 108 Change IMPROVE particle cartridges.	18 109 IMPROVE particle sampling day	19 110	20 111	21 112 IMPROVE particle sampling day
22 113 Earth Day	23 114	24 115 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	25 116	26 117	27 118 IMPROVE particle sampling day	28 119
29 120	30 121 Arbor Day IMPROVE particle sampling day					

Mar 2012

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May 2012

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20	21	22	23	24	25	26
27	28	29	30	31		

- Check for insect infestations in spring and summer (e.g., mud daubers in sampler inlet and spider webs).
- Check for melting ice on tops of sampler modules.

UC Davis: *Sampler*:
General Lab
(530) 752-1123

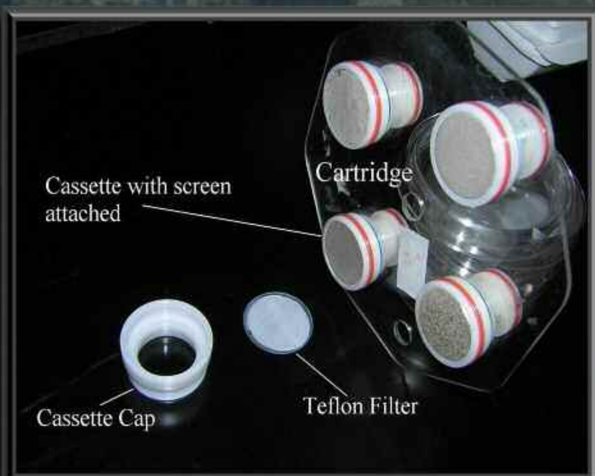
ARS: *Optical*:
Carter Blandford or
Karen Rosener
Photography:
Karen Fischer
(970) 484-7941

UC Davis Implements New Cassette Design for IMPROVE Aerosol Sampler

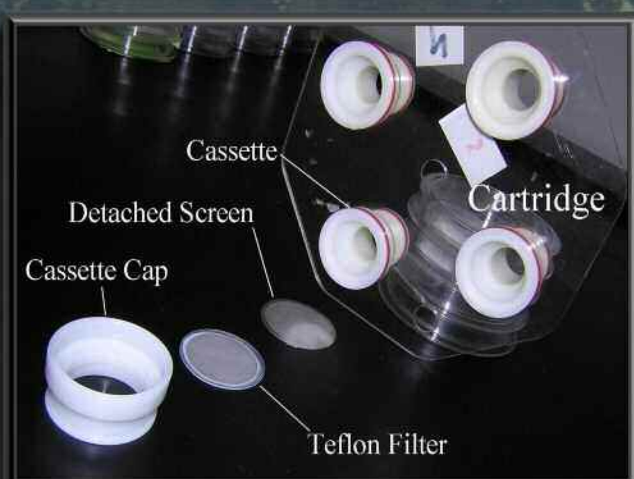
IMPROVE
Interagency Monitoring of Protected Visual Environments

Chuck McDade, University of California, Davis

UC Davis will begin implementing a new filter cassette design in spring 2012. In the new design, the metal screen supporting the filter will be detached. Current screens are permanently attached to the plastic cassette body. This should allow for more consistently uniform sample deposits on the filters, improving the reliability of measurements (i.e., X-ray fluorescence analysis) used to determine elemental concentrations. Because the cassettes are serviced and reassembled in the UC Davis laboratory, the change to the new cassette screens will be transparent to the site operators. The assembled cartridges that are shipped to the sites in blue boxes will look just the same before and after the change to the new screens.



The screen is permanently attached in the old cassette design.



In the new cassette design, the metal screen can be removed by the UC Davis laboratory technicians for cleaning and then reinstalled along with a clean filter for the next sampling event. Once the cassette is reassembled with the cassette cap in place, the filter fits snugly against the screen, just as it did with the old design.

Motivation for Change

The switch to the new design was motivated initially by some changes in the cassette manufacturing process. The IMPROVE network was in need of additional cassettes to replace damaged pieces and to accommodate new sites. Because of engineering changes in the manufacturer's shop, it was no longer possible to manufacture cassettes in precisely the same configuration as the existing cassettes. The scientists and engineers at UC Davis decided to take advantage of the opportunity to develop a superior design. Initial prototype tests at Davis indicated that a detached screen design would improve sample uniformity. The UC Davis group embarked on a redesign and testing program that led to the final detached screen cassette design.

Testing results indicate that the precision of the mass and elemental measurements using the new detached screen design is typically tighter, a welcome improvement over the previous design. The improved precision is likely the result of improved sample uniformity.

Shown to the right is the typical sample deposit pattern using attached screens. The deposit on the attached screen filter exhibits non-uniformity around the edge of the filter. This "dead zone" with no deposit is a result of the process used to press the screen into the plastic cassette body, whereby plastic clogs some of the screen holes around the perimeter.

The typical sample deposit pattern using detached screens is shown on the left. The deposit on the detached screen filter exhibits no edge effects, since intact holes extend all the way to the edge of the filter.

Different Screens for Different Modules

New screens are being purchased for all cassettes, but the existing plastic cassette bodies will be used with the detached screen design. Equipment in the UC Davis machine shop is used to punch the attached screen out of each unit and then smooth any rough edges that remain on the plastic body. Once that quick procedure is completed, the detached screen fits precisely into each cassette body. Some new cassette bodies, identical to the existing ones, are also being purchased to increase the inventory of available cassettes.

Only the 25-millimeter cassettes are being converted to the detached screen design. The 37-millimeter B-module cassettes will remain unchanged and will retain the attached screen design. The 37-millimeter nylon filters are extracted in solution, which is then used for ion analysis, so the uniformity of the sample deposit does not influence the analysis.

The 25 millimeter cassettes used in the A, C, and D modules will all be converted to the detached screen design in order to achieve consistency throughout the measurement set. The benefits of improved sample uniformity are expected only for the A-module Teflon filter. X-ray fluorescence, laser absorption, and proton beam hydrogen measurements applied to this filter each use an incident beam that covers only the central portion of the filter, so uniformity is crucial in extrapolating the results to the entire filter. The D-module PM10 Teflon filters are weighed only, so sample uniformity does not impact the analysis. The C-module employs a quartz filter with physical characteristics that differ from Teflon. Teflon is a plastic and Teflon filters are pulled down firmly to the surface of the screen when the vacuum pump is on. Hence, sample material is deposited only in the immediate area of the screen holes, so the characteristics of the screen can influence the sample deposit. The "imprint" of the screen holes can be seen clearly when Teflon filter deposits are viewed under a microscope. Quartz filters, on the other hand, are made of multiple layers of randomly oriented media and have a porous or fibrous texture that distributes the sample uniformly across the entire filter surface, independent of the geometry of the backing screen.

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.

Boulder Lake, Teton Natl. Forest, Wyoming

Ted Porwoll has a long history of air-quality-related work. He has worked as an air quality technician in the Bridger – Teton Natl. Forest, implementing and managing the forest's air quality monitoring program, the long-term lakes monitoring of five Bridger Wilderness lakes, and the bulk precipitation monitoring program, all since 1996. He manages and maintains two National Atmospheric Deposition Program (NADP) sites, two IMPROVE sites (with transmissometers), three remote automated weather stations (RAWS) for the Bridger - Teton Fire Program, and the Bridger Wilderness Webcamera site on Fortification Mountain. He implemented and managed the 1997 EPA Bridger Wilderness synoptic lakes survey, assisted Shoshone Natl. Forest with implementation of their long term lakes monitoring program, assisted several other national forests in development and implementation of their air quality monitoring programs, and participated in the evaluation of and commenting on numerous environmental documents for area and regional energy development projects. He has also participated in the Pinedale Anticline Working Group (PAWG) Air Quality Task Group, the University of Wyoming spatial ozone studies, and numerous other program development and assessment projects, including the USGS snowpack chemistry monitoring program.

Ted was born in Minnetonka, MN, in 1962, attended Vermillion Community College in Ely, MN, and received an AAS degree in natural resources 1984. He worked as a developed recreation technician, on the trail crew, and as a wilderness ranger in Shoshone National Forest until 1990. He then was employed as a wilderness manager in Routt National Forest in Colorado from 1991 to 1996, and since then has been working as an air quality technician in the Bridger – Teton National Forest in Wyoming.

May

I see humanity now as one vast plant, needing for its highest fulfillment only love, the natural blessings of the great outdoors, and intelligent crossing and selection.
– Luther Burbank

Apr 2012

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 122 Julian day Change IMPROVE particle cartridges.	2 123	3 124 IMPROVE particle sampling day	4 125	5 126
6 127 IMPROVE particle sampling day	7 128	8 129 Change IMPROVE particle cartridges.	9 130 IMPROVE particle sampling day	10 131	11 132	12 133 IMPROVE particle sampling day
13 134 Mother's Day	14 135	15 136 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	16 137	17 138	18 139 IMPROVE particle sampling day	19 140 Armed Forces Day
20 141	21 142 IMPROVE particle sampling day	22 143 Change IMPROVE particle cartridges.	23 144	24 145 IMPROVE particle sampling day	25 146	26 147
27 148 IMPROVE particle sampling day	28 149 Memorial Day (Observed)	29 150 Change IMPROVE particle cartridges.	30 151 IMPROVE particle sampling day	31 152		

Jun 2012

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Chiricahua National Monument Horseshoe II Fire, Summer 2011

IMPROVE
Interagency Monitoring of Protected Visual Environments

Chiricahua National Monument (NM), located in southeastern Arizona, was established in 1924 to protect a unique area of dramatic rock spires, pinnacles, columns, and balanced rocks. The Clean Air Act Amendments of 1977 gave the area air quality protection for resources that are potentially sensitive to air pollution, including vegetation, wildlife, water quality, soils, and visibility. At present, visibility has been identified as the most sensitive AQRV (air quality related value) in the monument. Although visibility in the monument is still superior to that in many parts of the country, views are often impaired by haze.

Since 1995, researchers and land managers have concentrated a great deal of effort in understanding fire and its effect on air quality. Air quality managers recognize the importance of fire in sustaining ecosystems and the inherent tradeoffs between prescribed fire and wildland fire occurrences. At the same time, land managers increasingly factor in fire emissions and the consequences to air quality. Although wildland fires occur throughout the nation, the largest and greatest number of fires occur in Alaska, the southeastern states, and the West. In the past year, the southeastern Arizona watersheds have become even drier as a weak monsoon in 2010 and a very dry winter in 2011 worsened already dry conditions. Areas of extreme and exceptional drought grew northward along the New Mexico border, giving rise to two large fires that raged during the summer of 2011 -- the Wallow and Horseshoe II fires.

Following 11 years of drought, conditions in Chiricahua NM were hot, dry, and windy, and fuel was plentiful. The Horseshoe II fire began on the east side of the Chiricahua Mountains on May 8, 2011. The fire was started by human activities and burned over 9,000 acres in its first day. The fire burned steadily northwest entering Chiricahua NM on June 8, 2011. The National Park Service acted promptly to:

1) preserve life: the monument was closed to protect both the public and employees of the monument;
2) preserve structures: historic and other buildings were wrapped with fire protective material in hope of saving them;
3) protect resources wherever possible.

Tina Thompson, the IMPROVE operator at Chiricahua, said they had been getting a lot of thick smoke in the area a week to two weeks before the fire entered the monument. When she performed the monthly special filter change, the orange filter was black from smoke, as were the other IMPROVE filters.

As the fire entered the monument, Thompson was quick to act. She says the Horseshoe II fire nearly burned up the station on the 15th. On Tuesday morning when she was doing the weekly site maintenance, the fire was only about a mile away. She asked fire crews to clean away all the brush in that area and do what they could to protect the monitoring equipment. Brush was cleared away and a crew was stationed there even as the fire burned close and hot. They sprayed a lot of water and dropped slurry to save the station. A subsequent visit on Wednesday (16th) proved that everything was still working, and a fire crew escort to the site on Thursday confirmed operations continued! Air Resource Specialists, Inc. confirmed that ozone data from the 15th through the 16th also showed spikes in ambient ozone throughout the period. The Chiricahua NM is 100% burned, but all the structures and the campground were saved!

The photo above shows the fire as seen from earth orbit on May 8, 2011. The fire was human-caused, eventually burning 222,954 acres.

photo: NASA's Marshall Space Flight Center

The following photos were taken by Tina Thompson.

Horseshoe II fire, June 8, 2011

Fire approaches the IMPROVE samplers on June 14.

RAWS weather station under fire wraps

The main station is prepared for the worst. Fire reached the station on June 15.

Pumper crew

Slurry drop

Linville Gorge, Pisgah Natl. Forest, North Carolina

Matthew Eldridge has worked in the Pisgah Natl. Forest for 13 years. He started as a 'seasonal' on the trail crew and is now a timber sale administrator. He has been the IMPROVE site operator in the Grandfather Ranger District for 4 years, as of the fall of 2011. The site is located at the head of Linville Gorge, which is a 12,000-acre designated wilderness area. From the rim of the gorge you can see the Linville River 2000 feet below. It is sometimes called the "Grand Canyon of the East".

Matthew says it can be challenging to find the time to run up to the site every Tuesday, but when he can't make it, he has two backups: **Matt Keyes** and **Jonathan Gortney**.

Mr. Eldridge says he enjoys working at the site because it's in a pretty location right off the Blue Ridge Parkway, although it can be a challenge to get to it in the winter time due to snow and ice. Sometimes when the snow is too deep, he has to walk in through the woods.

Matthew is married with two children. His hobbies include guitar playing, tennis, hiking, and birdwatching. His other duties in the district are mostly timber-related, but he also fights fires and oversees road maintenance contracts.

June

In a few decades, the relationship between the environment, resources, and conflict may seem almost as obvious as the connection we see today between human rights, democracy, and peace.
– Wangari Maathai

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(530) 752-1123

ARS: *Optical*:
Carter Blandford or
Karen Rosener
Photography:
Karen Fischer
(970) 484-7941

- ◆ Check for insect infestations throughout the summer (e.g., mud daubers, flies, spider webs).
- ◆ Watch for lightning damage during the summer.

May 2012

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Jul 2012

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22	23	24	25	26	27	28
29	30	31				

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 153 Julian day	2 154 IMPROVE particle sampling day
3 155	4 156	5 157 National Trails Day IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	6 158	7 159	8 160 IMPROVE particle sampling day	9 161
10 162	11 163 IMPROVE particle sampling day	12 164 Change IMPROVE particle cartridges.	13 165	14 166 Flag Day IMPROVE particle sampling day	15 167	16 168
17 169 Father's Day IMPROVE particle sampling day	18 170	19 171 Change IMPROVE particle cartridges.	20 172 Summer begins IMPROVE particle sampling day	21 173	22 174	23 175 IMPROVE particle sampling day
24 176	25 177	26 178 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	27 179	28 180	29 181 IMPROVE particle sampling day	30 182

Estimating Urban Excess Using IMPROVE and CSN Data

IMPROVE
Interagency Monitoring of Protected Visual Environments

Jenny Hand, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

Urban excess is defined as the difference in aerosol mass concentrations at an urban site compared to the regional background concentration. Urban excess studies provide estimates of the relative magnitude of local versus regional contributions to aerosol concentrations and subsequently increase our understanding of aerosol sources and lifetimes in the atmosphere. Different aerosol species correspond to a range in urban excess values, depending on their sources and lifetimes.

Data from the rural IMPROVE network and EPA's urban Chemical Speciation Network (CSN) sites were combined to explore the spatial variability in major aerosol species, as well as their impacts on urban excess. Urban excess, defined as the ratio of urban to rural concentrations, was investigated for 2005–2008 annual mean ammonium sulfate (AS), ammonium nitrate (AN), particulate organic matter (POM = 1.8 OC), and light absorbing carbon (LAC) mass concentrations. Additional discussions regarding the spatial variability and urban excess in mass concentrations, including the absolute differences in concentration, in these and other species can be found in the IMPROVE V report.

The spatial distribution of AS was very similar for both the rural and urban sites, suggesting that regional impacts of high AS concentrations influenced both urban and rural sites similarly (see Figure 1a). The ratio of urban to rural AS concentrations are shown in Figure 1b. In addition to the southern California area, higher ratios occurred for a swath of area southeast of the Appalachian Mountains and the Ohio River valley. The lowest ratios occurred in the central, western, northwestern, and northeastern United States. Although AS is predominantly regional in nature, some urban excess in AS occurred.

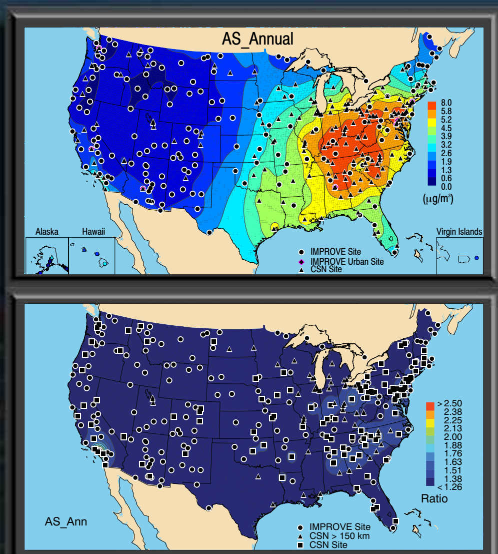

Figure 1(a) IMPROVE and CSN PM2.5 ammonium sulfate (AS) 2005–2008 annual mean mass concentrations (µg/m^3). (b) Interpolated ratios of urban (CSN) to rural (IMPROVE) annual mean AS concentrations for 2005–2008. In all figures, IMPROVE sites are shown as circles; CSN sites used in the analysis are shown as squares. CSN sites with no IMPROVE site within 150 km are shown as triangles. These sites were not used in the analysis.

AN concentrations were highest in regions corresponding to locations where its precursors ammonia and nitric acid concentrations were the highest (Figure 2a), such as in the Midwest, resulting in the highest AN concentrations for rural sites. Generally, urban concentrations of AN were considerably higher than rural concentrations, as demonstrated by estimates of urban excess (Figure 2b). Several western cities corresponded to relatively high ratios with sharp spatial gradients.

The highest rural annual mean POM concentrations corresponded to a large area in the Southeast. (Figure 3a), most likely associated with biogenic emissions and perhaps biomass smoke emissions. The West was associated with more localized regions of higher POM concentrations, most likely from biomass burning emissions. Higher POM concentrations and more localized impacts of urban POM sources were apparent in the West, with sharper gradients compared to the East. Urban excess in POM is shown in Figure 3b. Several western cities were associated with higher ratios, as well as a swath of area to the southeast of the Appalachian Mountains in the East.

The IMPROVE rural annual mean LAC concentrations in the West are typically relatively low, compared to the rural concentrations in the East, such as in the southern United States and Ohio River valley areas, as well as parts of Pennsylvania (Figure 4a). Major hot-spots of LAC concentrations were associated with urban sites. Urban LAC concentrations generally were localized around individual site locations in the West and were more regional in extent in the East, although not to the degree of POM. The ratio of urban to rural LAC concentrations demonstrated the localized impact from primary emissions of LAC on surrounding rural regions. Fewer sites in the East were associated with higher ratios compared to western sites (Figure 4b). Although areas associated with high ratios were similar for POM and LAC, LAC ratios were much larger, suggesting urban LAC sources were significantly larger than rural sources. In addition, LAC urban excess estimates were less regional in extent than POM, indicating local source contributions of LAC rather than more regional sources like biomass combustion from controlled or wild fires.

Analyses of interpolated IMPROVE and CSN aerosol concentrations provided spatial patterns of urban excess for the United States. For certain species, such as POM, LAC, and AN, annual mean urban concentrations were considerably higher than rural concentrations. As a summary, the urban excess mean ratios for AS, AN, POM, and LAC were 1.4 ± 0.3, 2.5 ± 1.3, 1.9 ± 0.9, and 3.3 ± 1.9, respectively.

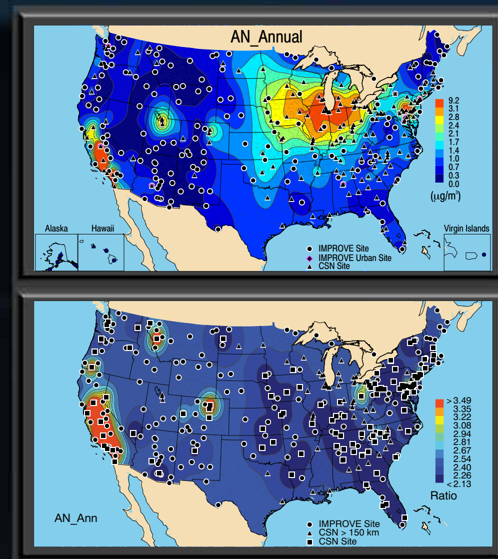

Figure 2(a) IMPROVE and CSN PM2.5 ammonium nitrate (AN) 2005–2008 annual mean mass concentrations (µg/m^3). (b) Interpolated ratios of urban (CSN) to rural (IMPROVE) annual mean AN concentrations for 2005–2008.

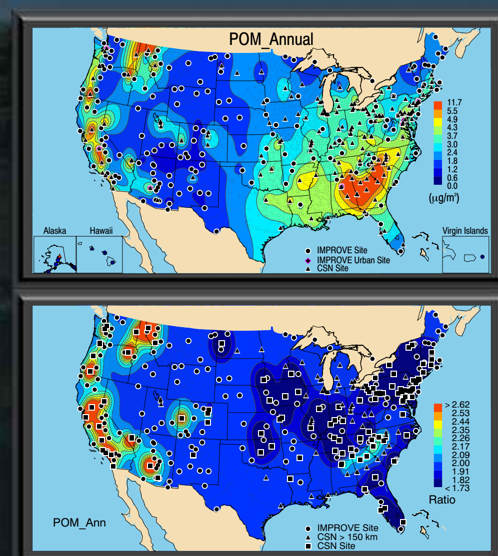

Figure 3(a) IMPROVE and CSN PM2.5 particulate organic matter (POM) 2005–2008 annual mean mass concentrations (µg/m^3). (b) Interpolated ratios of urban (CSN) to rural (IMPROVE) annual mean POM concentrations for 2005–2008.

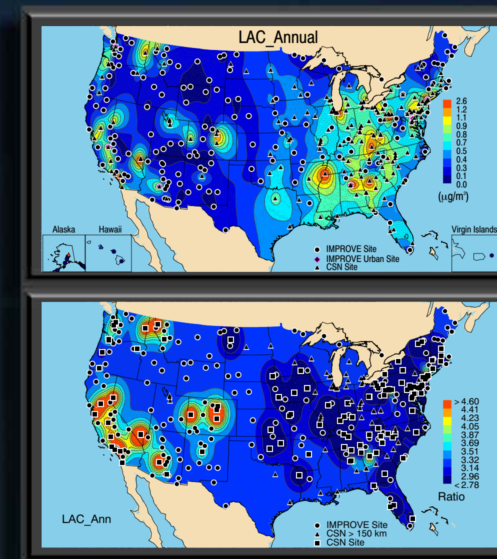

Figure 4(a) IMPROVE and CSN PM2.5 light absorbing carbon (LAC) 2005–2008 annual mean mass concentrations (µg/m^3). (b) Interpolated ratios of urban (CSN) to rural (IMPROVE) annual mean LAC concentrations for 2005–2008.

Old Town, Penobscot Indian Nation, Maine

Native American tribes contribute to the ongoing effort to reduce regional haze. **Bill Thompson**, a Penobscot Indian who chairs the National Tribal Air Association, runs a single-person air program for his tribe. In addition to the IMPROVE site, he maintains an NADP and MDN (Mercury Deposition Network) site up in the mountains, which is a six-hour round-trip drive every Tuesday. At the DNR (Dept. of Natural Resources) building, he runs an ozone monitor and calibrator collocated with a full meteorological station.

The Penobscot Nation is located on an island in the middle of the Penobscot River. All of the islands north are also reservation land, as the Penobscots have been a river culture people there for several millennia.

Local impacts on air quality include the emissions of several paper mills along the river, including one a mile downstream, and a growing landfill a mile in the other direction.

Bill's toy box includes IAQ (Indoor Air Quality) devices such as a mold impactor, a CO detector, two Minivols (particulate matter filtration devices), charcoal radon test kits, and a flashlight and dust mask. Bill enjoys being job shadowed by tribal youth, commenting, "It's amazing how fast these kids pick up on technology these days." He says he's witnessed teens being able to grasp performing "multi-points" within an hour, when it took him a whole day to get comfortable with it. He adds, "It's great to see that our youth will be able to pick up the ball when it's their turn to protect human health and the environment."

Bill is married with "two great kids" and has been re-elected as vice chief for his tribe. He remarks,"Service to others is a tribal tenet of ours. Together, we can build us all up. But, boy, don't I enjoy doing this air quality work! Everyday I go to work with my tail wagging."

July

Whatever the mind of man can conceive and believe, it can achieve.
– W. Clement Stone

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 183 *Julian day*	**2** 184 IMPROVE particle sampling day	**3** 185 Change IMPROVE particle cartridges.	**4** 186 Independence Day	**5** 187 IMPROVE particle sampling day	**6** 188	**7** 189
8 190 IMPROVE particle sampling day	**9** 191	**10** 192 Change IMPROVE particle cartridges.	**11** 193 IMPROVE particle sampling day	**12** 194	**13** 195	**14** 196 IMPROVE particle sampling day
15 197	**16** 198 National Parks Day	**17** 199 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	**18** 200	**19** 201	**20** 202 IMPROVE particle sampling day	**21** 203
22 204	**23** 205 IMPROVE particle sampling day	**24** 206 Change IMPROVE particle cartridges.	**25** 207	**26** 208 IMPROVE particle sampling day	**27** 209	**28** 210
29 211 IMPROVE particle sampling day	**30** 212	**31** 213 Change IMPROVE particle cartridges.				

Jun 2012

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Aug 2012

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Karen Rosener
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Temporal Trends in IMPROVE Aerosol Species

IMPROVE
Interagency Monitoring of Protected Visual Environments

Jenny Hand, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

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 PM2.5 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 1.

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

Changes in FM concentrations such as those observed at Acadia have direct effects on observed haze levels observed. Figure 2 provides a striking example of the difference in the visibility observed at Acadia corresponding to the FM concentrations in 1989 versus 2008. We used WinHaze 2.9.9 (Air Resource Specialists, 2011) to model the view of scenic areas with specified air quality levels. WinHaze is a computer software program that simulates visibility conditions from user-specified scenes and speciated aerosol concentrations or visibility levels. 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.

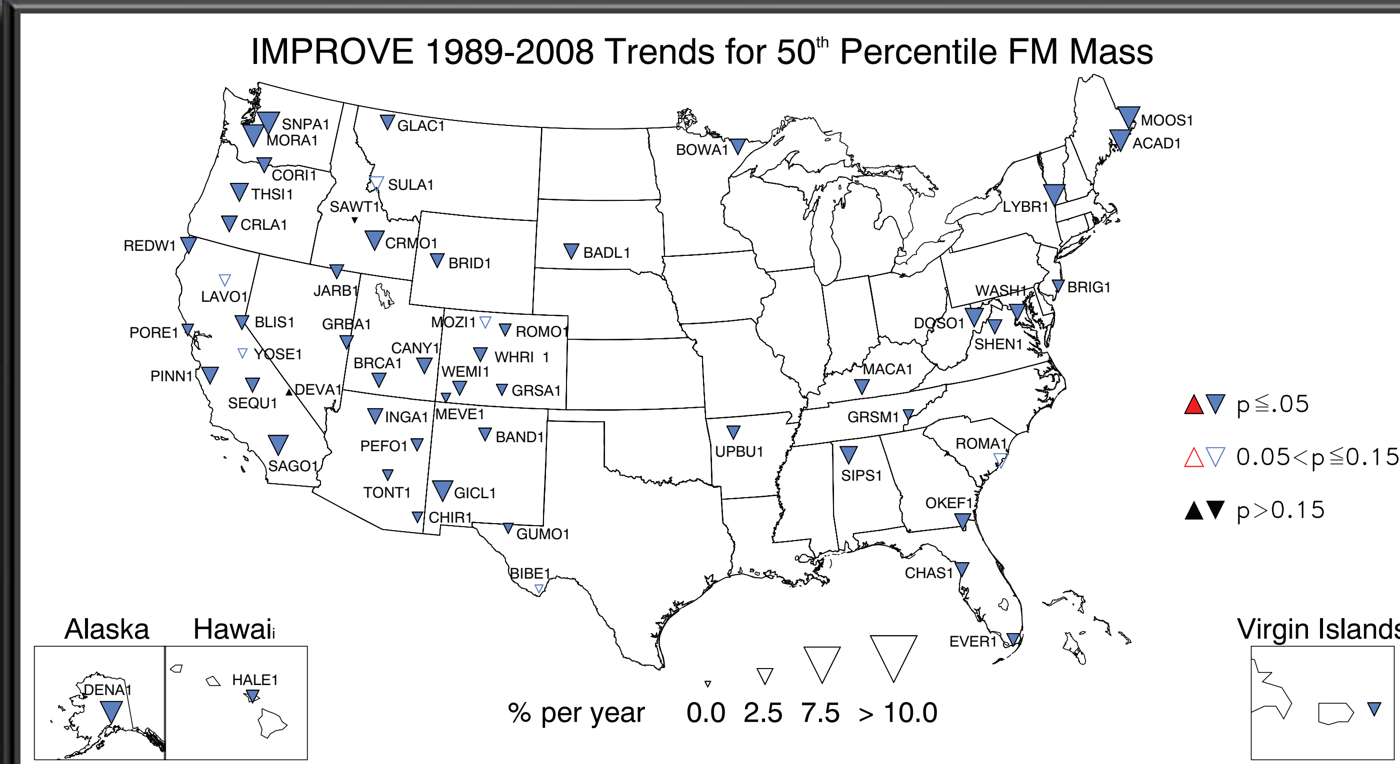

Figure 1. Long-term (1989–2008) trends (% yr-1) in 50th percentile PM2.5 gravimetric fine mass (FM) concentrations.

Figure 2. Split-image of visibility conditions in Acadia, ME (ACAD) for 50th percentile speciated aerosol levels in 2000 (left-side) and 2008 (right-side). Both images correspond to a relative humidity of 80%. Images were generated using WinHaze 2.9.9.

Bridgton, Maine

August

All is connected ... no one thing can change by itself.
– Paul Hawken

Peter Lowell, sampler operator near Bridgton, Maine, enjoys his work in the relatively clear air of northern New England -- air which does little to hide the snow-topped White Mountains and the beautiful reds and oranges of the region's hardwood forests in the fall. There are no nearby pollution sources.

It can be a difficult site to operate in the winter because it's on a ridge top in the downwind direction from Mount Washington, a 6288-foot New Hampshire mountain that is the highest point in New England and is notorious for snagging some of the most brutal winter weather in the lower 48 states. But people like the views from up there, so visibility information is now being shared with the Mt. Washington Observatory.

Mr. Lowell has been the executive director of the Lakes Environmental Association, Maine's largest lakes association, for 40 years. He appreciates the opportunities to be outside and away from his desk that operating a sampler gives him and is happy to be a part of the gathering of useful long-term data.

Peter enjoys playing hockey, water skiing, and spending time with his grandchildren.

Jul 2012

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Sep 2012

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 *214 Julian day* IMPROVE particle sampling day	2 *215*	3 *216*	4 *217* IMPROVE particle sampling day
5 *218*	6 *219*	7 *220* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	8 *221*	9 *222*	10 *223* IMPROVE particle sampling day	11 *224*
12 *225*	13 *226* IMPROVE particle sampling day	14 *227* Change IMPROVE particle cartridges.	15 *228*	16 *229* IMPROVE particle sampling day	17 *230*	18 *231*
19 *232* IMPROVE particle sampling day	20 *233*	21 *234* Change IMPROVE particle cartridges.	22 *235* IMPROVE particle sampling day	23 *236*	24 *237*	25 *238* IMPROVE particle sampling day
26 *239*	27 *240*	28 *241* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	29 *242*	30 *243*	31 *244* IMPROVE particle sampling day	**UC Davis**: *Sampler:* General Lab (530) 752-1123 **ARS**: *Optical:* Carter Blandford or Karen Rosener *Photography:* Karen Fischer (970) 484-7941

Operator Involvement -- The Key to Network Success

Spatial Patterns in Deciview

IMPROVE
Interagency Monitoring of Protected Visual Environments

Jenny Hand, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

Visibility conditions are often represented in deciview (dv) units, derived 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 the map below. Values at rural sites ranged from 4.7 dv at White River, Colorado (WHRI1), to 22.2 dv at Mammoth Cave, Kentucky (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 values of dv (<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 Northeast. While dv values such as those presented in the map are important for assessing average visibility conditions in the United States, 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 East were dominated by ammonium sulfate (40–80%), especially during summer months. Ammonium sulfate was also an important contributor to b_{ext} in the Northwest and Southwest, 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.

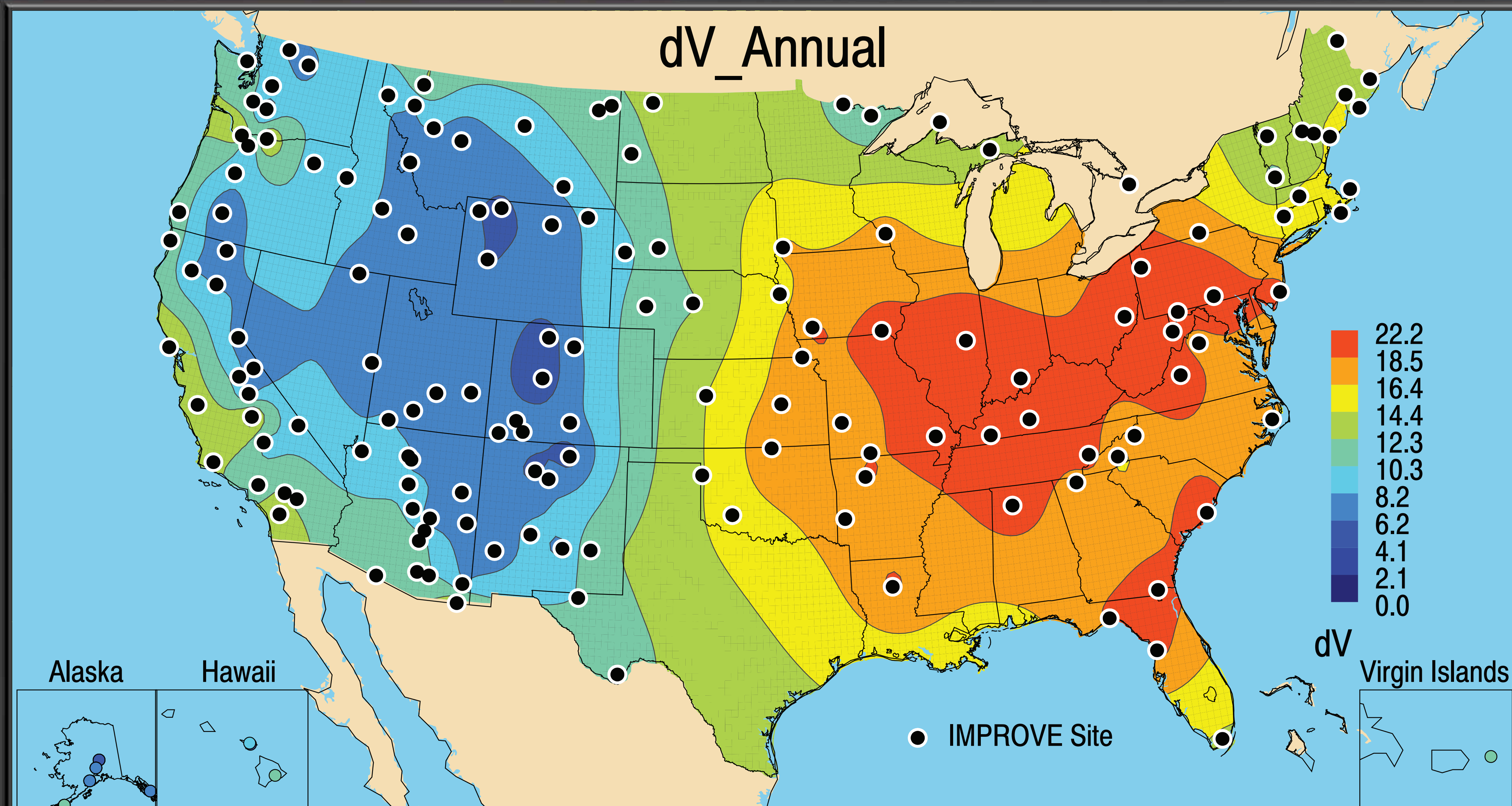

Figure 1. Annual mean PM2.5 deciview (dv) for 2005–2008 for rural IMPROVE sites.

Blue Mounds State Park, Minnesota

Dan McGuire is well familiar with Blue Mounds State Park in Minnesota, having worked there for 19 years, 17 of those as the buildings and groundskeeper. The park is located in the extreme southwest corner of the state, only a few miles from the Iowa and South Dakota borders. It is one of the largest prairie parks in Minnesota, with 1500 acres of prairie that preserve a wide array of rare and common plants and wildlife.

One of the main features of Blue Mounds is a bison herd of 100 animals. In 1961, three bison were brought to the park from Fort Niobrara Wildlife Refuge near Valentine, Nebraska. The bison have a range of 533 acres that can be viewed by the park visitors from different points around the pasture.

Other park features include a Sioux quartzite outcrop (where climbing is allowed), prickly pear cacti, and the rare western prairie fringed orchid.

The occasional challege in operating the IMPROVE site is bad winter weather, as is often the case in northern states. The vast expanses of open prairie allow for a lot of wind that can produce blizzard conditions and snow drifts with only a few inches of snow. The winds often shift the next day, drifting everything over again.

Dan's daily duties include the feeding and care of the bison herd, giving out work assignments to park staff, and general maintence. He serves as banquet chairman for the local chapter of the National Turkey Federation and just finished a 4-year term on the Luverne Country Club board and three years on the Region 4 Safety Commitee for the Department of Natural Resouces. He enjoys hunting turkeys, deer, and pheasants and playing golf as much as possible with his free time.

September

Conservation is a state of harmony between men and land.
– Aldo Leopold

◆ Check for rodent infestations in the fall and winter.

Aug 2012

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Oct 2012

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 245 Julian day
2 246	3 247 Labor Day IMPROVE particle sampling day	4 248 Change IMPROVE particle cartridges.	5 249	6 250 IMPROVE particle sampling day	7 251	8 252
9 253 IMPROVE particle sampling day	10 254	11 255 Change IMPROVE particle cartridges.	12 256 IMPROVE particle sampling day	13 257	14 258	15 259 IMPROVE particle sampling day
16 260	17 261	18 262 National Public Lands Day IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	19 263	20 264 Pollution Prevention Week	21 265 IMPROVE particle sampling day	22 266 Autumn begins
23 267	24 268 IMPROVE particle sampling day	25 269 Change IMPROVE particle cartridges.	26 270	27 271 IMPROVE particle sampling day	28 272	29 273
30 274 IMPROVE particle sampling day						

◆ Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected.

◆ Watch for frost on the inlets.

◆ Watch for lightning damage.

◆ Check site conditions (e.g., a tree growing beyond acceptance criteria).

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Photography:
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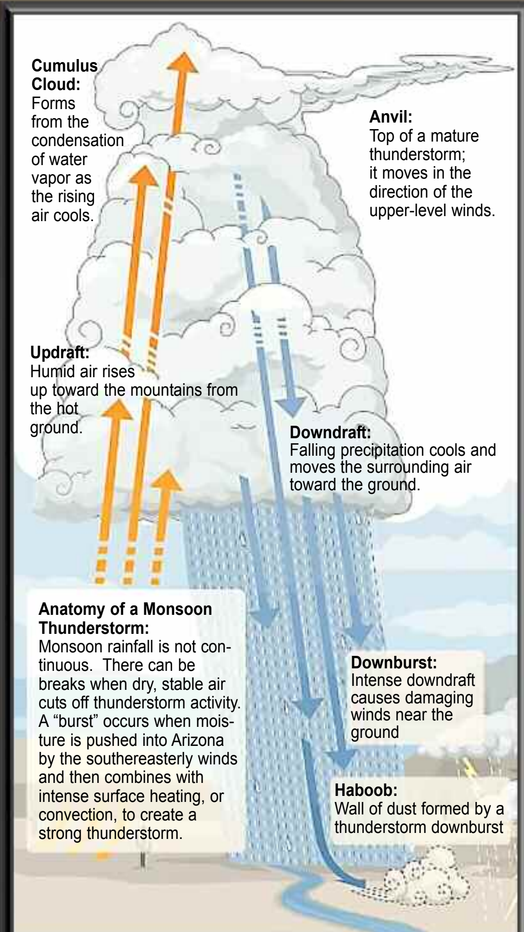
Operator Involvement -- The Key to Network Success

Exceptional Events: Arizona Dust Storms, 2011

IMPROVE
Interagency Monitoring of Protected Visual Environments

Summer 2011 was the hottest and driest on record in the Sonoran desert of southern Arizona surrounding Phoenix. Temperatures exceeded 110 degrees on 33 days, which is significant when the average is only around 18 such days. The dry La Niña winter and spring contributed to the state's extreme drought status last summer, coming on the heels of a long-term dry cycle reaching back to 1996. Precipitation statewide was only 70% of average. Summer wildfires raged into the fall, watering holes and range lands dried up, and weak monsoons brought no relief. Fallow land and empty lots, cleared and waiting for development in better economic times, left a lot of disturbed soil dust just waiting to be picked up. The stage was set for the creation of some super-sized dust storms (sometimes called "haboobs"). In fact, six major storms descended on the Phoenix area last summer.

A haboob is an intense dust storm regularly observed in arid regions. The word haboob is from an Arabic word meaning "strong wind". They usually form late in the evening as by-products of severe thunderstorms. Extreme daytime heating causes thermal gradients, creating conditions that raise warm air up into the atmosphere where it cools and is slammed to the ground in thunderstorm outflows or by strong pressure gradients that cause an increase in wind velocity over a wide area. Gusting winds pass over loose surface dust and sand, causing particles to vibrate and "leap". As they repeatedly strike the ground, they loosen and break off smaller particles, which then begin to travel in suspension. Columns of dust are created that can move at speeds of 30 mph and reach heights of 7,000 feet. Drought, poor farming and grazing practices, construction activity, and wind contribute to the formation of dust storms. A cold front that moves into a dry air mass and produces no precipitation can create the type of dust storm that was common during the Dustbowl years.



Strong to severe thunderstorms produce downburst winds, aided by gravity, that produce strong outflow winds that create walls of dust that can move long distances at high speeds.

Illustration: National Weather Service, Tucson Weather Forecast Office; NWS Forecast offices in Flagstaff and Phoenix

Dust storm approaching Stratford, Texas in 1935

Photo: NOAA Photo Library, historic National Weather Service collection

A dust storm approaches Phoenix, Arizona on July 5, 2011. The storm brought winds gusting over 50 mph. National Weather Service radar data estimated the dust cloud reached a height of at least 5000 to 6000 ft. The storm front stretched almost 100 miles and traveled at least 150 miles.

Photo: Bryan Snider

Not surprisingly, particulate matter air quality monitors in the Phoenix metropolitan area registered violations of federal dust-pollution air quality standards a record number of times last year. By late September, Arizona Department of Environmental Quality (ADEQ) IMPROVE monitoring sites measured dust levels exceeding federal limits 85 times. The urban area has been working to comply with federal standards for PM10 particulate levels for several years. PM10 particles are dust particles that are one-tenth the width of a human hair. State air managers say these events should be classified as "exceptional events" under EPA policies and rules, precipitated by a series of natural conditions that are beyond the state's control.

National Weather Service Phoenix office, 7:45 p.m., July 5, 2011, the oncoming dust storm, and the aftermath. Employee cars are covered in dust and the air remains hazy, nearly three hours after the storm moved through.

Photos: National Weather Service

On March 14, 2007, the EPA finalized a rule to establish criteria to determine if air quality monitoring data has been influenced by exceptional events such as unplanned fires or destructive dust storms.

The Exceptional Events Rule (EER) became effective May 21, 2007. The EER allows the ambient air quality data used in making regulatory decisions to be flagged and excluded from calculations in determining whether or not an area has attained the National Ambient Air Quality Standards (NAAQS). Exceptional events are unusual or naturally-occurring events that can affect air quality but are not reasonably controllable using techniques agencies might implement in order to attain and maintain the NAAQS.

Local air quality managers must gather the documentation needed to explain the high number of exceedances to federal regulators. The number of violations could make it difficult for the region to meet its air quality goal of three consecutive years staying in compliance with federal dust pollution standards. Failure to meet the goal could jeopardize federal funding for transportation projects in the state.

"The trouble for us is, this monsoon season has been problematic," said Eric Massey, ADEQ Air Quality Division director. "(We've had) six of the really large, I'd almost call them epic, dust events, including the ones that made national news."

ADEQ officials argue that the 2011 events prove that the EPA's exceptional-events rule is not entirely applicable for western states that tend to have high dust levels. The EPA released a draft guidance document in an effort to clarify the exceptional-events requirements. Currently, the EPA is soliciting local governments' comments on the draft guidance.

Quabbin Reservoir, Massachusetts

Since 1985, the Massachusetts Department of Environmental Protection (DEP) has operated an air monitoring station at the summit of Big Quabbin Hill, located at Quabbin Reservoir. The Quabbin, which supplies drinking water to 51 communities in the greater Boston area, is the largest unfiltered water supply in the country, which attests to the watershed protection efforts of the Massachusetts DCR (Department of Conservation and Recreation). The Quabbin monitoring station is part of a larger network of sites operated by the DEP throughout Massachusetts and was established to study and monitor acid deposition and ozone in rural areas in the state. Since that time the facility has broadened its monitoring to include all aspects of air assessment. This station now measures most criteria pollutants including ozone, trace SO_2 & NO_X, PM_{10}, six meteorological parameters, acid deposition, rainfall, and IMPROVE-measured particulates and is classified as a PAMS (Photochemical Assessment Monitoring Station) site with an operating GC (gas chromatograph). Due to the characteristics of ozone transport and summer wind patterns, this site receives air from most East Coast cities and provides valuable information on summer air quality in the Northeast.

Mark DuComb has been an environmental analyst with the Massachusetts DEP for nearly 37 years and has been the primary operator of the IMPROVE samplers since the study began at the Quabbin in the late '80s. Although he worked in the Air Assessment Lab for the first few years, he has enjoyed the outdoor aspect of field work in the 30+ years since. Mark is presently the field supervisor for the central and western regions and oversees the operation of 12 monitoring sites. One of the most enjoyable aspects of Mark's field work is establishing and building a new site from the ground up. He says, "Planning and installing instrumentation, including the wiring and plumbing, allows me to setup a site that will operate efficiently and that will be comfortable for the field analyst and is a welcome diversion from daily activities."

A lifelong resident of Massachusetts, Mark lives with his wife Roberta in Monson, while their two children, Andrew and Lauren, are attending college. Mark enjoys camping with the family, overnight hiking, gardening, helping with the local Boy Scout troop, and fly fishing, especially in the Swift River, which flows cold and clean out of the Quabbin Reservoir.

October

Every time I have some moment on a seashore, or in the mountains, or sometimes in a quiet forest, I think this is why the environment has to be preserved.
– Bill Bradley

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
UC Davis: _Sampler_: General Lab (530) 752-1123 **ARS**: _Optical_: Carter Blandford or Karen Rosener _Photography_: Karen Fischer (970) 484-7941	1 275 Julian day	2 276 Change IMPROVE particle cartridges.	3 277 IMPROVE particle sampling day	4 278	5 279	6 280 IMPROVE particle sampling day
7 281	8 282 Columbus Day (Observed)	9 283 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	10 284	11 285	12 286 IMPROVE particle sampling day	13 287
14 288	15 289 IMPROVE particle sampling day	16 290 Change IMPROVE particle cartridges.	17 291	18 292 IMPROVE particle sampling day	19 293	20 294
21 295 IMPROVE particle sampling day	22 296	23 297 Change IMPROVE particle cartridges.	24 298 IMPROVE particle sampling day	25 299	26 300	27 301 IMPROVE particle sampling day
28 302	29 303	30 304 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	31 305 Halloween			

Sep 2012

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Optec Develops LPV-4 LED Transmissometer for Optical Visibility Measurements

IMPROVE
Interagency Monitoring of Protected Visual Environments

John V. Molenar, Air Resource Specialists, Ft. Collins, CO

Background and Early Development

A transmissometer directly measures the irradiance of a light source after the light has traveled over a finite atmospheric path. The transmittance of the path is calculated by dividing the measured irradiance at the end of the path with the calibrated initial intensity of the light source. The average extinction (b_{ext}) of the path is calculated from the transmittance and length of the path. It is attributed to the average concentration of all atmospheric gases and ambient aerosols along the path. Transmissometers are the only instrument able to make a completely ambient measurement of b_{ext} without perturbing or selectively sampling atmospheric aerosols or gases.

In 1985, the National Park Service funded the development of a long-path transmissometer. Jerry Persha (Optec, Inc.) constructed the prototype instrument (LPV-0). Initial testing of the transmissometer was done during fall 1985. In February 1986, Optec, ARS, and NPS staff conducted the first field test at Grand Canyon National Park over path lengths up to 15 km (9.3 miles).

After analysis of the data, the instrument was upgraded to the LPV-1 and a second round of intensive field trials was completed during the fall of 1986 at Meteor Crater, Arizona. The study compared the LPV-1 transmissometer with other existing optical instrumentation: integrating nephelometers and contrast measurements by teleradiometers of natural and artificial black targets. The transmissometer proved to be an instrument that could accurately measure ambient b_{ext}, leading to its commercialization as the LPV-2 transmissometer. The LPV-2 has successfully operated at many sites in the IMPROVE, National Park Service, U.S. Forest Service, state, urban, and special study visibility networks since 1986.

Figure 1: Jerry Persha (Optec, Inc) at Grand Canyon National Park, testing prototype LPV-0 transmissometer – February 1986

Operational Theory

The LPV transmissometer receiver incorporates sophisticated optics and electronics to collect the modulated light of the transmitter, separate it from background ambient light and amplifier noise, and measure the irradiance. The LPV receiver has proven to be a robust instrument; the basic operation of the system has remained essentially unchanged in the past 25 years, with the only upgrades being better and more stable electronic components and software. This has not been true for the transmitter.

The LPV-2 transmitter uses a 15-watt tungsten filament lamp as the light source. The lamp output is increased by a factor of 100 with the use of a Koehler projection system, which collects the light in a solid angle of 11° as seen from the filament and concentrates it into a 1° cone. The output of the lamp is stabilized by reflecting with a glass slide approximately 8% of the light in an area 0.17° in diameter from the central axis to a silicon photodiode detector. The output of the detector is fed into a feedback circuit that increases the lamp voltage as needed to maintain a constant lamp output. The signal is mechanically chopped at 78.125 Hz to provide for a modulated beam that can be detected day or night by the receiver.

Figure 2: Configuration of LPV-2, LPV-3, and LPV-4 transmitters

Recent Developments and Improvements

Early transmissometer data indicated that the output of the transmitter was not being held constant but was increasing at a rate of about 2% per 500 hours of lamp operation. This was eventually traced to the problem of the light reflected in the transmitter to the optical feedback circuit being polarized because the reflection angle was near the angle at which light is completely polarized upon reflection. As the filament in the incandescent lamp aged, the degree of polarization of the light changed. Since the feedback detector was receiving only one plane of polarization, it was increasing the lamp output too much. This was addressed with the introduction of the LPV-3 transmitter, which changed the angle of the feedback optics and removed the glass slide, using the back of the chopper as the reflective surface (Figure 2).

These modifications reduced but did not completely eliminate the lamp brightening issue. The need for multiple lamps with multiple calibration constants and the use of a mechanical chopper to modulate the light source required additional servicing of the system, increased costs to operate the instrument, and required a careful examination and interpretation of extinction data after collection.

By 2009 light-emitting diode (LED) light sources had become brighter and less expensive. LED light sources successfully replaced the tungsten filament lamps in most currently operating Optec Next Generation Nephelometers. In 2010, Optec and ARS funded the development of the LPV-4 LED transmitter to further address transmissometer transmitter issues. LED light sources use less power, have a useful life of over 10,000 hours, can be electronically modulated, and are unpolarized. This reduces power requirements, removes the need to have multiple calibrated lamps for a year of operation, eliminates data loss due to chopper motor failures, and eliminates the lamp brightening issue (Figure 2).

In Fall 2010, Optec constructed a prototype LPV-4 transmitter, which ARS began testing in November 2010 at its Ft. Collins, Colorado, testing facility. The figure below shows the raw output of the transmitter from November 30, 2010, to April 7, 2011. This was over 3,000 hours of continuous operation without a failure. In addition, transmitter output has shown no apparent increase in brightness on the cleanest days during this period. Currently, the transmitter is being tested by operating it continuously in a laboratory and completing a thorough calibration every 300-500 hours when very clean ambient conditions exist. Results of this test are expected by early 2012.

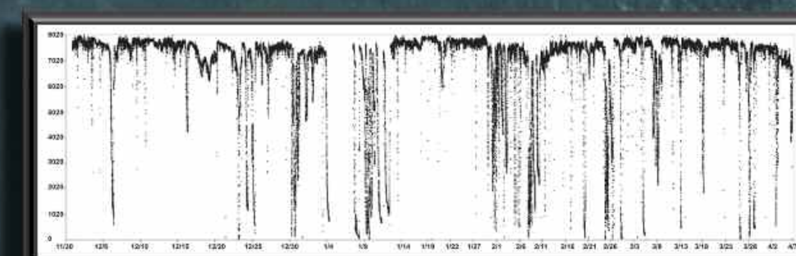

Figure 3: Timeline of raw output from LPV-4 LED transmitter 11/30/2010 to 4/7/2011 (3000+ hours of continuous operation). Large drops in raw counts are due to weather conditions (rain, fog, snow, ice) on windows.

For more information contact John Molenar at ARS. Telephone: 970/484-7941; Fax: 970/484-3423; E-mail: jmolenar@air-resource.com

Frostberg Reservoir, Maryland

Site operator **Keith Felts** has spent his career in the environmental discipline. Although now retired, he has continued that same discipline as operator of the Frostburg Reservoir IMPROVE protocol site in western Maryland since 2005. Complete site servicing takes one to two full days. In addition to the IMPROVE aerosol sampler, the site is also home to the Maryland Department of the Environment's rural NCore station and has numerous gaseous samplers, acoustic sounders, and meteorological sensors. Keith considers it 'his site' and if something goes awry, he steps in to correct it. "If it's broke, you try and fix it," said Keith. "I am responsible for getting it working and keeping it working."

Servicing can be difficult at times, especially during the winter months. Last winter the area experienced 23 feet of snow, necessitating the use of snow shoes and/or cross country skis to get to the monitoring shelters. "It seems every other year is a bad one," said Keith.

He holds an associate's degree in pollution abatement technology. His professional career has included environmental consulting, stack emissions testing, and working in the environmental department of a local power company. "I've always been interested in environmental concerns," said Keith. "I like to be aware of what's going on and want to stay involved." When a friend told him about the job opening for an air quality site operator in 2005, Keith readily applied for it.

Keith was born in and has spent much of his life in and near Washington, D.C. He served in the U.S. Air Force for four years and has also lived in Tennessee and Virginia. He currently lives in a cabin in the quiet woodlands of western Maryland, and spends his free time enjoying the outdoors doing what he pleases, including fishing, bird hunting, camping, hiking, and other similar pleasures.

November

Keep close to nature's heart ... and break clear away, once in awhile, and climb a mountain or spend a week in the woods. Wash your spirit clean.
– John Muir

- Check for rodent infestations in the fall and winter.
- Watch for frost on the inlets.

Oct 2012

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Dec 2012

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30	31					

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1 306 Julian day	2 307 IMPROVE particle sampling day	3 308
4 309 Daylight Saving Time ends	5 310 IMPROVE particle sampling day	6 311 Election Day Change IMPROVE particle cartridges.	7 312	8 313 IMPROVE particle sampling day	9 314	10 315
11 316 Veterans Day IMPROVE particle sampling day	12 317	13 318 Change IMPROVE particle cartridges.	14 319 IMPROVE particle sampling day	15 320 America Recycles Day	16 321 National Park Service established, 1916	17 322 IMPROVE particle sampling day
18 323	19 324	20 325 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	21 326	22 327 Thanksgiving	23 328 IMPROVE particle sampling day	24 329
25 330	26 331 IMPROVE particle sampling day	27 332 Change IMPROVE particle cartridges.	28 333	29 334 IMPROVE particle sampling day	30 335	**UC Davis**: *Sampler*: General Lab (530) 752-1123 **ARS**: *Optical*: Carter Blandford or Karen Rosener *Photography*: Karen Fischer (970) 484-7941

Operator Involvement -- The Key to Network Success

Changes at the UC Davis Laboratory

IMPROVE
Interagency Monitoring of Protected Visual Environments

The University of California, Davis (UC Davis), Air Quality Laboratory supports the particulate measurements network for the IMPROVE program. Laboratory personnel are committed to enhancing IMPROVE aerosol measurements and understanding the uncertainties and limitations of existing measurements. To that end, in 2011 the UC Davis laboratory obtained new instrumentation and moved the laboratory into new quarters within the Crocker Nuclear Laboratory building. New instrumentation has been acquired to stay abreast of current technology and further insure the reliability of aerosol measurements within the network. Gravimetric mass is now determined using one of two Mettler XP6 microbalances.

The Mettler XP6 microbalance is ideal for weighing the smallest sample amounts and is designed to reach the highest measurement performance with the best repeatability values.

Color-coded stickers identify each type of filter.

Cassettes are cleaned thoroughly and then uploaded with new nylon, and quartz filters.

Filter cassettes awaiting downloading and weighing

Stored filters awaiting XRF analysis

Filter storage and the computer screen at the download station

Pollutants introduced into the atmosphere by human activities include heavy metals, which are harmful to plants and animals and are known to be carcinogenic. Elemental concentrations are now determined using one of two PANalytical Epsilon 5 X-ray fluorescence (XRF) instruments. This spectrometer excels in the analysis of medium to heavy metals. Because XRF is a nondestructive technique, samples can be reused over and over again. These instruments replaced old equipment that had become obsolete and increasingly unreliable.

PANalytical Epsilon 5 XRF instruments

New Teflon filters are weighed using the XP6 microbalance and then placed into their corresponding cassettes.

Filters are put in petri dishes to await XRF analysis.

Filters are moved from petri dishes to XRF filter analysis cups before being placed in the Epsilon 5.

Epsilon 5 XRF filter analysis cups

A Crocker-designed vacuum head picks up the filters.

New Crocker-designed sample trays increase throughput.

The laboratory space has been reconfigured so that the blue shipping boxes are handled in a shipping area that is separate from the laboratory. The boxes coming from the field sites are often dusty, so keeping them away from the laboratory avoids contamination.

The filter cassettes from each box are placed in a clean plastic tray and taken to the laboratory on a cart. The filters are downloaded from the cassettes in the laboratory. The nylon and quartz filters are shipped to the Research Triangle Institute for ion analysis and to Desert Research Institute for carbon analysis. The Teflon filters are retained at UC Davis for weighing, XRF, laser absorption analysis, and proton elastic scattering analysis (PESA).

The cassettes are then loaded with fresh filters to be shipped to the field.

Filter cassettes on a cart, to be moved from the lab to the shipping area

In the shipping area, each site has a dedicated tray.

Boundary Waters Canoe Area, Minnesota

The Boundary Waters IMPROVE samplers are located in northeastern Minnesota, about 20 miles east of Ely, in an area that sees extremes in weather. The state record low temperature of -60 degrees F was set only 30 miles away in 1996, while the summertimes can see temperatures exceeding 100 degrees F. A couple feet of snow usually accumulates at the site each winter, but in 2010 it received over 50 inches of snow in December alone. The remoteness of the site creates obstacles in diagnosing, communicating, and fixing problems, due to the limited resources available on hand and in the small town of Ely. Communication and power lines fail fairly often. There are also swarms of black flies, mosquitoes, and deer flies to keep local residents and operators like **Jon Van Alstein** company.

The visibility here is generally very good. The site is in a transition zone between the East and West, so there are some very dirty days. Regional sources of sulfates and nitrates are of most concern in this region. Dust from open pit iron ore mines to the south is also monitored. A proposed nickel-copper and PGE (platinum group elements) mine to the south is another concern.

Boundary Waters Wilderness Area, within the Superior National Forest, is the most heavily used wilderness in the country and is popular for research, such as the ongoing five-year study of watershed cycling of mercury in response to fire. The air sampling site, sponsored by the Minnesota Pollution Control Agency (MPCA), EPA, and USDA Forest Service, has collected acid rain and ozone data for decades, which led to the state passing the first acid rain regulation in the nation in 1982. Later additions to the site were IMPROVE visibility monitoring with photos (1985-1991), aerosol sampling (1991-present), a nephelometer (1993-1997), an NADP MDN (1995), a continuous $PM_{2.5}$ monitor (2005), and a digital "haze cam." MPCA will be adding SO_x and NO_x monitors in 2012.

Along with maintaining multiple instruments at the site, Jon works as a hydrological technician, testing the water quality of beaches and wells throughout Superior NF, and is involved with fisheries and water quality monitoring of lakes and streams. He received a B.S. and an M.S. in geology and geophysics and worked for the Wisconsin Geological and Natural History Survey and a geophysical laboratory that tested compressional and shear wave velocities through rock cores. After college he worked for the EPA as a contract aquatic biologist and has even worked as a Great Lakes captain on various EPA-owned research vessels, as well as a first mate on the R/V Lake Explorer II.

In his spare time, Jon bow hunts, fishes, skis, snowshoes, hikes, fixes old houses, and maintains some rental properties he owns.

December

Pushing production out of America to nations without our environmental standards increases global environmental risks.
– Frank Murkowski

Nov 2012

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Jan 2013

S	M	T	W	T	F	S
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6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 336 Julian day
2 337 IMPROVE particle sampling day	3 338	4 339 Change IMPROVE particle cartridges.	5 340 IMPROVE particle sampling day	6 341	7 342	8 343 IMPROVE particle sampling day
9 344	10 345	11 346 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	12 347	13 348	14 349 IMPROVE particle sampling day	15 350
16 351	17 352 IMPROVE particle sampling day	18 353 Change IMPROVE particle cartridges.	19 354	20 355 IMPROVE particle sampling day	21 356 Winter begins	22 357
23 358 IMPROVE particle sampling day	24 359	25 360 Christmas Change IMPROVE particle cartridges.	26 361 IMPROVE particle sampling day	27 362	28 363	29 364 IMPROVE particle sampling day
30 365	31 366 New Year's Eve					

- Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected.
- Watch for frost on the inlets.
- Watch for lightning damage.
- Check for rodent infestations in the fall and winter.

UC Davis: *Sampler*:
General Lab
(530) 752-1123

ARS: *Optical*:
Carter Blandford or Karen Rosener
Photography:
Karen Fischer
(970) 484-7941

Operator Involvement -- The Key to Network Success

Operator Support

Air Resource Specialists, Inc. (ARS) supports visibility monitoring networks for federal land management agencies, state agencies, municipalities, Indian nations, and private industry. ARS currently supports over 100 visibility monitoring sites nationwide and is the prime contractor to the IMPROVE program and the National Park Service and Forest Service visibility monitoring and data analysis programs.

ARS strongly encourages operators to call if there are any questions about parts, supplies, or instrument operations. It may be wise to call for instructions and troubleshooting advice before attempting to solve any problems. For questions or problems with IMPROVE sites, call 800-344-5423. For issues concerning special studies or non-IMPROVE sites, call 970-484-7941.

***Carter Blandford**, senior data analyst, performs data collection and validation and provides operator support for transmissometers and nephelometers.*

***Karen Rosener**, data analyst, performs data collection and validation and provides operator support for transmissometers and nephelometers.*

***Karen Fischer**, photographic specialist, performs image collection and system troubleshooting and provides operator support for photographic systems.*

***Marty Mills**, electronics technician, performs servicing of transmissometers and nephelometers and troubleshooting of power-related instrument problems.*

The University of California, Davis, laboratory supports over 150 monitoring sites nationwide, including processing over 5,000 filters each month. Handling large volumes of filters and associated data requires carefully designed operating procedures that minimize errors between site operators and laboratory collection and analysis. As with any well-crafted plan, things can go wrong. Good communication between site operators and laboratory personnel coupled with an awareness of potential problems can improve overall data quality, decrease data loss, and aid in timely troubleshooting of field operations.

Three people in the lab are responsible for receiving the samples, preparing them for analysis, and preparing new samples for deployment. More importantly, they are great at helping operators figure out the content of each filter box if ever there is a filter mix-up. They can also track shipments for operators in case their boxes are late, and schedule UPS pickups for operators who do not get visited by UPS on a daily basis. In short, for anything dealing with the actual filter boxes, these are the people to call.

***Tetsuya Anthony Kawamoto**,*
Sample Lab Technician /
Operator Support
530-754-8770

Ashleigh Cathleen Matzoll
Sample Lab Technician /
Operator Support
530-752-4186

Leland Gee
Sample Lab Technician /
Operator Support
530-754-8770

In case of any equipment problems, operators can call any of the following four people. (They are also experts with blue box filter mix-ups.)

***Doug Gordon**,*
Operator / Field Support
530-752-1123

Michael Truong
Operator / Field Support
530-752-0933

Jose Mojica
Field Supervisor / Operator /
Data / Field Support
530-752-9044

Parijata (Pari) Prabhakara
(coming on board in November, 2011)
Operator / Field Support, 530-752-4905

The UC Davis crew in a lighter moment.

Flathead Indian Reservation, Montana

The Flathead Indian Reservation contains 1.25 million acres of forested mountains and sheltered valleys just west of the Continental Divide in northwestern Montana. Approximately 28,360 people live within the reservation boundaries. A moist maritime influence from the Pacific Ocean dominates the reservation's climate, particularly during winter months when low clouds blanket the region.

The Confederated Salish and Kootenai Tribe established the Tribal Air Quality Program to monitor air in 1979. The reservation was redesignated from a Class II to a Class I air shed in 1980. An IMPROVE site was established on June 4, 2002, on Jette Mountain in the beautiful Confederated Salish and Kootenai Reservation. There are actually three monitoring sites on the reservation, with meteorological stations at two of the locations. The data are used by the Western Regional Air Partnership to meet the EPA's Montana Federal Implementation Plan.

The IMPROVE site on Jette Mountain is operated by **Chuck Page** and **Randy Ashley**. Chuck is employed as an air quality specialist and has been the primary site operator since the fall of 2008. As in many northern and mountainous sites, one of the biggest challenges is access to the site during the winter months. When the snow gets too deep, a snowmobile or snowshoes are required.

The visibility there is very good, especially now that the major pollution source on the reservation and several other major sources off the reservation have gone out of business due to the poor economy. The biggest influence now on air quality at the site are wildfires in the summer months.

Chuck has a B.S. in environmental sciences from Salish and Kootenai College and a B.S. in wildlife biology from the University of Montana. In his free time, he likes to play basketball, run, and fish with his children. He has been married for seventeen years to Yolanda and has four children -- two boys and two girls ranging from four to twenty-one years of age. He likes being out in the field and enjoying the area.

January

When we try to pick out anything by itself, we find it hitched to everything else in the universe.
– John Muir

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
(Dec 2012)		1 New Year's Day; IMPROVE particle sampling day; Special cartridge change: move cassette 3 from old cartridge to new.	2	3	4 IMPROVE particle sampling day	5
6	7 IMPROVE particle sampling day	8 Change IMPROVE particle cartridges.	9	10 IMPROVE particle sampling day	11	12
13 IMPROVE particle sampling day	14	15	16 IMPROVE particle sampling day	17	18	19 IMPROVE particle sampling day
20	21 Martin Luther King, Jr.'s Birthday	22 IMPROVE particle sampling day; Special cartridge change: move cassette 3 from old cartridge to new.	23	24	25 IMPROVE particle sampling day	26
27	28 IMPROVE particle sampling day	29 Change IMPROVE particle cartridges.	30	31 IMPROVE particle sampling day	(Feb 2013)	

Dec 2012

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Feb 2013

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

The Night Sky from Mt. Whitney, California

Photo Mosaic by Dan and Cindy Duriscoe and R. and L. Pilewski, National Park Service

Mount Whitney is the highest summit in the "lower 48" states at an elevation of 14,505 feet and is located in the park boundaries of Sequoia National Park. The Smithsonian Institution Shelter, also known as the Mount Whitney Summit Shelter, was originally built in 1909 for their astronomers. This image of Mount Whitney's summit taken at night commemorates the 100th anniversary of the shelter.

For questions or problems with optical or scene monitoring equipment, contact Mark Tigges, Air Resource Specialists, Ft. Collins, CO, at 970-224-9300.
For questions or problems with air sampler controllers, filters, or audits, contact Jose Mojica, UC Davis, at 530-752-1123.

We would like to thank all the contributing IMPROVE sampler operators who took time out of their busy schedules to send us their site descriptions, photos, and personal stories and insights. These efforts help to enrich this publication and put a human face on our program.

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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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. The Associate Member representative is

STATE OF ARIZONA

ENVIRONMENT CANADA

MINISTRY OF ENVIRONMENT, REPUBLIC OF KOREA

Front cover photo: Old Windmill at Sunset, on S. Garrison St. in Lakewood, Colorado. Photographer: Jeff Lemke