IMPROVE

Interagency Monitoring of Protected Visual Environments

2013 Calendar

IMPROVE Monitoring Update

IMPROVE
Interagency Monitoring of Protected Visual Environments

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. Instrumentation that operates according to IMPROVE protocols in support of the program includes 53 aerosol samplers, optical instrumentation (nephelometers and transmissometers), and scene instrumentation (Web camera systems). Interpretive displays are part of IMPROVE's educational outreach to the public.

New Standards Proposed

In June 2012, the U.S. Environmental Protection Agency (EPA) proposed to strengthen the National Ambient Air Quality Standards (NAAQS) for fine particulate matter (PM2.5) and retain the existing standards for coarse particles (PM10). Both fine and coarse particles cause visibility reduction/haze and respiratory problems.

The EPA is also proposing an entirely new PM2.5 visibility standard for urban areas. The two options being proposed for the 24-hour standard are 30 deciviews (dv) or 28 dv. Evidence from over 300 new studies performed since 2006 shows adverse health and other effects still manifesting under the current standards. The EPA will issue final standards by December 14, 2012. They anticipate making attainment/nonattainment designations by December 2014, and states would have until 2020 to meet the new standards.

PESA Hydrogen Analysis Discontinued

The IMPROVE steering committee has decided to discontinue Proton Elastic Scattering Analysis (PESA) effective with samples collected in January 2011. PESA has provided a measurement of hydrogen in PM2.5 samples collected on Teflon® filters. It was performed using a proton beam in the cyclotron at Crocker Nuclear Laboratory at UC Davis. Budget constraints sparked the decision to discontinue PESA. The hydrogen measurement is not needed for the Regional Haze Rule visibility analysis nor for most analyses of long-term aerosol trends or source apportionment.

EPA Develops IMPROVE Audit Video

The EPA Office of Air Quality Planning and Standards (OAQPS) produced a short, 17-minute educational video showing the steps in an audit of an IMPROVE aerosol sampler. The video is intended for a general audience who may be interested in the procedures included in an audit. The video is part of the EPA's list of chemical speciation standard operating procedures for field operations.

"Audit Procedures for the IMPROVE Air Sampler" is available online at http://www.epa.gov/ttn/amtic/spectraining.html.

Important Change

Starting in 2013 daylight savings time will no longer be used. Clocks will now operate exclusively on STANDARD TIME. Operators, do not try to correct the clocks in the spring! Letters will be mailed before spring and another label is being added to our controller doors stating that we need to maintain STANDARD TIME.

Site Changes

In 2012, two sites, COGO1 and HALE1, were eliminated. Two sites were moved: RICR1 was moved southwest to FLTO1, and LYBR1 was moved southeast to LYEB1. The San Gabriel site was replaced in September 2011 by new site WRIG1 to the east.

Colorado Smoke Impact

A 2-acre wildfire started by a lightning strike the evening of June 8, 2012, in the mountains west of Fort Collins, Colorado, grew to almost 10,000 acres one day later. The High Park fire eventually burned 80,000+ acres and destroyed 259 homes. Smoke lowered visibility in Fort Collins (a few miles east of the fire) to less than a mile. IMPROVE contractors (Air Resource Specialists [ARS], Colorado State University Department of Atmospheric Science, and the Cooperative Institute for Research in the Atmosphere), the National Park Service, and the Colorado Department of Public Health and Environment (CDPHE) deployed optical, aerosol, and gaseous monitors in and around Fort Collins to monitor the event in depth.

Satellite image of High Park fire plume, taken June 10, 2012.

High Park fire plume, taken June 12, 2012.

Flathead Indian Reservation, Montana

January

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

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 Tribes established the Tribal Air Quality Program in 1979 to monitor the air. The reservation was redesignated from a Class II to a Class I air shed in 1980, and an IMPROVE site was established on June 4, 2002, on Jette Mountain. 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.

Dec 2012

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

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

Feb 2013

S	M	T	W	T	F	S
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24	25	26	27	28		

Operator Involvement -- The Key to Network Success

The Network Sampler and Unforeseen Events

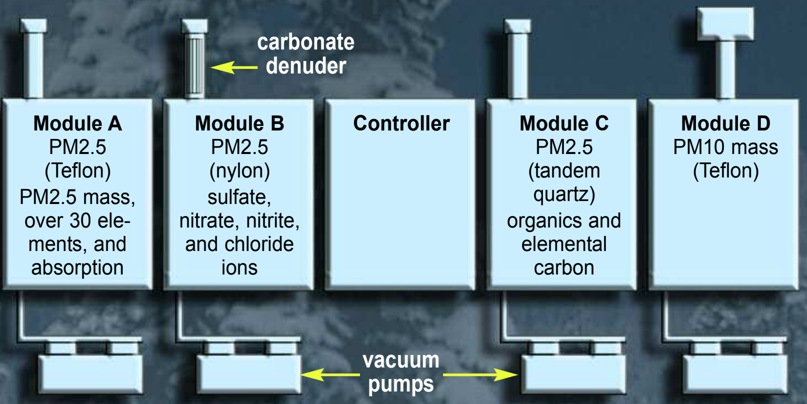
IMPROVE
Interagency Monitoring of Protected Visual Environments

IMPROVE Aerosol Monitor

The IMPROVE sampler is designed to obtain a complete signature of the composition of airborne particles affecting visibility. Four independent sampling modules measure mass, chemical elements, sulfate, nitrate, organics, and elemental carbon. The samplers run for 24 hours every third day, collecting the particulate matter on filters. These filters are retrieved once a week and sent to contracted laboratories for physical and chemical analyses.

Modules A, B, and C collect PM2.5 (fine) particles on Teflon, nylon, and quartz filters, respectively. Module D, on the right, has a larger inlet head that collects both PM2.5 (fine) and PM10 (coarse) particles on a Teflon filter. The inlets are normally 24 inches apart, with a controller module in the center that has no inlet. IMPROVE samples are intended to be collected under conditions as close to ambient temperature as possible.

Particle data are available on the IMPROVE web site, where you can also get more information on the IMPROVE program.



carbonate denuder

Module A
PM2.5
(Teflon)
PM2.5 mass, over 30 elements, and absorption

Module B
PM2.5
(nylon)
sulfate, nitrate, nitrite, and chloride ions

Controller

Module C
PM2.5
(tandem quartz)
organics and elemental carbon

Module D
PM10 mass
(Teflon)

vacuum pumps

IMPORTANT: Valid Measurements

Under the Regional Haze Rule, valid measurements require

- 75% of the possible samples for the year,
- 50% of the possible samples for each calendar quarter must be complete, and
- no more than 10 consecutive sampling periods may be missing.

Catastrophic Events

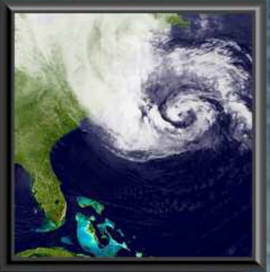
Catastrophic events, by definition, are sudden natural or man-made situations where change and destruction may occur without prior knowledge or preparation. Some examples of catastrophic events include severe thunderstorms and lightning strikes; blizzards and snowstorms; sandstorms; hurricanes, typhoons, tornadoes, and other high winds; floods; heat waves; wildfires; mudslides; hail storms; cold spells; ice storms; earthquakes; and volcanic eruptions. IMPROVE sampling sites have been and will continue to be impacted by catastrophic events. Some examples of events that have damaged sites in the past are highlighted at right.

San Gabriel Mtns. (SAGA1), 2009: Wild fires burned down the shed and all equipment. A new temporary stand (WRIG1) was erected shortly after at a nearby location.

Breton Island (BRIS1), 2010: Hurricane Isaac left a lot of damage and nine feet of water in the area. Water had also gotten into the meter box.

Lightning at Great Smoky Mtns. NP

High Park fire, Colorado



Hurricane Sandy

In Case of Emergency

Wildfires occur every year throughout the United States. These fires can occur in clusters and are often regional in scope, blanketing hundreds of square miles with smoke for days at a time. Many IMPROVE sites are located in the forests and grasslands where these fires occur, so IMPROVE samplers can be impacted by smoke from the fires. Moderate amounts of particulate material collected during these events provide interesting insights into the behavior and composition of wildfire smoke. But when the smoke becomes too thick, the sampler clogs and data are lost for those days.

Suggestions for operators in case of a foreseen emergency:

- Operators should first call the UC Davis Air Quality Group (AQG) lab and inform personnel of the situation. If they cannot contact a technician, they should leave a message with pertinent information such as the operator's name, the site name (printed on the side of each filter box), operator's phone number, and a brief description of the situation.
- Operators should assess the situation. If there is any possibility of danger, they should not attempt to visit the site. If it is safe to approach the site, it is preferred that the equipment be removed and stored in a secure and dry area. Note that in order to remove the equipment, a 5/32" and/or 1/8" hex L-key (Allen wrench) is required. The equipment is very heavy; modules weigh 45 lbs, while pumps weigh 22 lbs, so operators should be careful when lifting them out. The following steps are to ensure safe removal of the equipment:

    1. If time allows, run through final filter readings as if it were a normal Tuesday sample change. Leave the filters in the modules; they will provide support to the inner structure during transportation.
    2. After taking final readings, disconnect the power cord to the controller.
    3. If the site's breaker is accessible, turn it off.
    4. Disconnect all cables and vacuum hoses from underneath the modules and controller.
    5. Remove stacks by loosening the stack collar. The D module stack will have an internal brace that needs to be loosened with the 5/32" Allen wrench.
    6. Use the Allen wrench to free the module from the top bracket. This will allow the module to swing down and come off the wall. Modules are heavy (45 lbs), so be prepared for the weight.
    7. Remove the pumps by first disconnecting all vacuum hoses and power cables.
    8. If time allows, remove all cables and hoses. Some cables may be anchored to the stand or shed.
    9. Contact the UC Davis AQG lab at the earliest convenience.

Beacon Hill, Puget Sound, Washington

Beacon Hill is an urban-scale, NCore air monitoring site operated by the Department of Ecology with the support of the EPA. Since this site is also an EPA National Air Toxics Trends Site (NATTS), a PM2.5 Chemical Speciation Trends Network (STN) monitoring site, and serves as a platform for research projects conducted by other agencies and universities, there is a wide assortment of air monitoring instruments here that describe air quality and meteorological conditions for Seattle. The station is located within the Jefferson Park complex in the Beacon Hill neighborhood, just south of Seattle's urban core. The site was established in 1974 on the west side of the Beacon Hill Reservoir at 345 ft above Puget Sound. In 2006 the site was relocated 300 meters to the east to accommodate the construction of the new covered reservoir and Jefferson Park.

The operator, **Diane Bedlington**, stays very active. In addition to operating the IMPROVE, PM2.5, PM10, ECOC, PM2.5 speciation, and ozone samplers at Beacon Hill, she also operates the speciation sampler at the Puget Sound Clean Air Agency's Tacoma L St. site, ozone and meteorological instruments at Enumclaw's Mud Mountain Dam, an ozone sampler at Lake Sammamish State Park, and lead (Pb) samplers at the Auburn Municipal Airport. The Pb samplers are part of an EPA study looking at lead emissions at 15 general aviation airports across the nation.

In her spare time, Diane enjoys gardening, sewing, painting, reading, writing, and visiting with her grandchildren. She is pictured at right with her grandson Levi, age 15, on an educational visit to the Beacon Hill monitoring station.

Diane has held quite a variety of jobs, including being a mom, a grocery store clerk, and a nurses aide, and has worked for the Council on Aging to enable senior citizens to keep their independence. She was an extra in the movie "Heavens Gate", shot in Montana in 1974, during which she met and had her picture taken with Kris Kristofferson, Jeff Bridges, and Christopher Walken. She was also a chiropractic assistant and office manager, a house cleaner, and an accountant for a hearing aid company. After receiving her BA in human services in 1995, she began working for the Department of Ecology, first as a secretary for the Air Quality Program, then as an air monitoring operator / environmental specialist.

February

The proper use of science is not to conquer nature but to live in it.
– Barry Commoner

- ◆ Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected.
- ◆ Watch for frost on the inlets.

Jan 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
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27	28	29	30	31		

Mar 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	29	30
31						

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 Change IMPROVE particle cartridges.	6 37 IMPROVE particle sampling day	7 38	8 39	9 40 IMPROVE particle sampling day
10 41	11 42	12 43 Lincoln's Birthday IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	13 44	14 45 Valentine's Day	15 46 IMPROVE particle sampling day	16 47
17 48	18 49 Presidents' Day IMPROVE particle sampling day	19 50 Change IMPROVE particle cartridges.	20 51	21 52 IMPROVE particle sampling day	22 53 Washington's Birthday	23 54
24 55 IMPROVE particle sampling day	25 56	26 57 Grand Canyon National Park established, 1919 Change IMPROVE particle cartridges.	27 58 IMPROVE particle sampling day	28 59		

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

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

Of Interest to Operators...

IMPROVE
Interagency Monitoring of Protected Visual Environments

IMPROVE field operations benefit from an understanding of the issues identified during the field audit process. The issues outlined here are under site operator control, and awareness of these potential problems will improve overall data quality, decrease data loss, and aid troubleshooting field operations.

Operator Observations

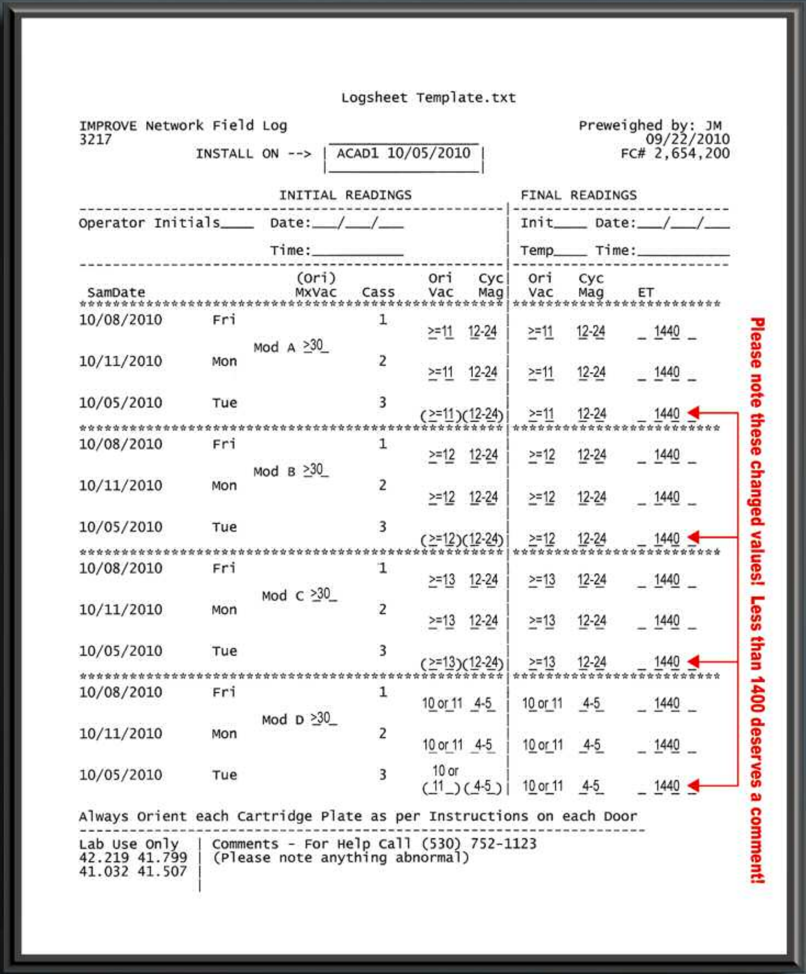
◆ Inspect sampler inlets every three months for insect infestations in the sampler inlet, flies in the module or released from cassette upon removal, and spider webs.
◆ Rodent infestation may occur, especially in fall and winter. Check wires and tubing for damage.
◆ Verify that the calibration plug is seated (at bottom of T-fitting where the inlet tube enters) in every module. Check at each filter exchange.
◆ Check the temperature at each setup to assure it is within 10 degrees C of outdoor temperature.
◆ Clocks should be reset when they vary by ±5 minutes or more.
◆ In November, December, and January, operators should call UC Davis (530-752-1123) to properly determine how the holidays will affect their sample change schedules in order to not lose samples.
◆ Periodically inspect the vacuum line for "rubbing spots". Pumps vibrate a lot and that means the vacuum lines also vibrate. If a vibrating line is touching another surface, it is likely the rubbing surface will eat away at the hose wall. Hoses are often found in this condition during UC Davis site visits. Call the lab (530-752-1123) and a replacement hose will be sent out quickly. Operators can reposition pumps so hoses don't touch corners.

Modules need to be kept clean and free of debris. The maintenance teams clean the enclosures (inside and out), but this is done only once a year. Operator help with this effort is appreciated.

Checking Value Ranges and Reporting Problems

It is important to be mindful of the values that get written down on the log sheets and what those values mean. Past problems included recording a value of 10.0 for the MxVAC for a 5-week stretch without reporting the incident to UC Davis technicians. One of the pumps had failed but it was not discovered until 12 consecutive samples were lost.

The log sheet template is a guide to help operators recognize a problem that requires immediate attention. The values chosen are deliberately broad because there is no tight band that will represent all sites. The log sheet values are affected by different versions of electronic equipment, as well as the site's elevation. For example, most sites under 5,000 feet will have a MxVAC value of 40, which represents the maximum vacuum of an ideal pump. The same pump will have an optimum value of 32 if it is at 10,000 feet, like at Wheeler Peak, NM, or White River Natl. Forest, CO. For this reason a minimum value of 31 was chosen. The ET values are the same for all sites. "ET" means elapsed time in minutes. They should all be 1440, which corresponds to a 24-hour sampling period. The exception is position 3 (which is the sample that runs on Tuesdays), which can be shorter because operators typically interrupt this sample when they do their filter changes on Tuesdays.



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                         Logsheet Template.txt

IMPROVE Network Field Log                               Preweighed by: JM
3217                                                          09/22/2010
               INSTALL ON --> | ACAD1 10/05/2010 |         FC# 2,654,200
                              |__________________|

                     INITIAL READINGS              FINAL READINGS
----------------------------------------------- | -------------------------
Operator Initials____  Date:___/___/___         | Init____  Date:___/___/___

                       Time:__________          | Temp____  Time:__________
----------------------------------------------- | -------------------------
                        (Ori)            Ori  Cyc|  Ori   Cyc
 SamDate                MxVac   Cass     Vac  Mag|  Vac   Mag    ET
*************************************************|*************************
10/08/2010     Fri               1               |
                                   >=11  12-24   |  >=11  12-24  _ 1440 _
                   Mod A >30_
10/11/2010     Mon               2               |
                                   >=11  12-24   |  >=11  12-24  _ 1440 _

10/05/2010     Tue               3               |
                                 (>=11)(12-24)   |  >=11  12-24  _ 1440 _
*************************************************|*************************
10/08/2010     Fri               1               |
                                   >=12  12-24   |  >=12  12-24  _ 1440 _
                   Mod B >30_
10/11/2010     Mon               2               |
                                   >=12  12-24   |  >=12  12-24  _ 1440 _

10/05/2010     Tue               3               |
                                 (>=12)(12-24)   |  >=12  12-24  _ 1440 _
*************************************************|*************************
10/08/2010     Fri               1               |
                                   >=13  12-24   |  >=13  12-24  _ 1440 _
                   Mod C >30_
10/11/2010     Mon               2               |
                                   >=13  12-24   |  >=13  12-24  _ 1440 _

10/05/2010     Tue               3               |
                                 (>=13)(12-24)   |  >=13  12-24  _ 1440 _
*************************************************|*************************
10/08/2010     Fri               1               |
                                 10 or 11  4-5   | 10 or 11  4-5  _ 1440 _
                   Mod D >30_
10/11/2010     Mon               2               |
                                 10 or 11  4-5   | 10 or 11  4-5  _ 1440 _
                                   10 or
10/05/2010     Tue               3               |
                                 (_11_) (_4-5_)  | 10 or 11  4-5  _ 1440 _

Always Orient each Cartridge Plate as per Instructions on each Door
-------------------------------------------------------------------
Lab Use Only  | Comments - For Help Call (530) 752-1123
42.219 41.799 | (Please note anything abnormal)
41.032 41.507 |
              |
```

Please note these changed values! Less than 1400 deserves a comment!

Changes

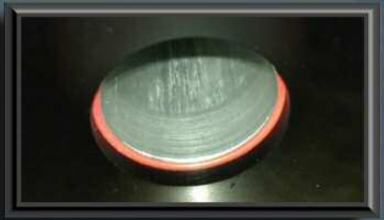
Starting in late 2012, UC Davis is placing a sticker on each down tube (stack) at the junction with the "T" or funnel (in the case of the PM10 module). The label says, "Insert stack up to this line" and has a black line at the edge. This is a reminder for any operator or IMPROVE technician to lower the stack into place until it makes a good seal. Not lowering the stack into position will cause sample loss! The label is intended to be an attention grabber to alert you to the situation. The following is a picture of the label setup.

New label indicates proper stack positioning.

In April 2012, anodizing dust was observed on some PM10 filters, shown at left. The dust is due to abrasion of the PM10 stack and may affect many samples from 2011 to 2012. The problem was documented at 14 sites, and UC Davis has made the following changes in response:

1. Installed a tripod to stabilize the stack in high winds,
2. Added an O-ring to avoid metal to metal contact, and
3. Labeled stacks to be installed at the proper height.

Tripod stabilizes the stack.

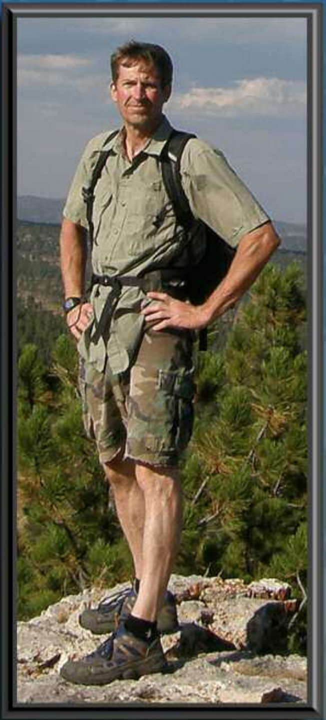


O-ring

Wind Cave National Park, South Dakota

March

Till now man has been up against Nature;
from now on he will be up against his own nature.
– Dennis Gabor



Marc Ohms, the IMPROVE operator at Wind Cave National Park, reports the visibility there as generally excellent, although wildfires and nearby Wyoming's coal mining and coal-fired power plants do pose concerns.

The national park built around Wind Cave is a unique blend of a mixed-grass prairie and ponderosa pine forest and is home to abundant wildlife, including elk, bison, antelope, deer, prairie dogs, and the endangered black-footed ferret. Under the surface lies one of the longest caves on Earth, with over 139 miles of passageways currently discovered. There is an active exploration program that discovers several miles of new passages each year.


A 2000-acre prescribed park fire

Marc has been at the park since 1998. Prior to that he worked at Jewel Cave Natl. Monument and for a short time at Mammoth Cave National Park. In addition to the IMPROVE site, he also maintains NADP and CastNet stations.

As you can see, he loves caves. He said, "I have had only one job in my entire life that was not at a cave. My duties as the park's physical science technician are quite varied, but in a nutshell, I look after the air, water, and cave resources of the park."

"The variety of my job keeps it very interesting and challenging. When I am not at work, I am hunting, fishing, caving, backpacking, hiking, or target shooting. If the weather keeps me inside, I am playing video games, tying flies, or reloading ammunition."

Feb 2013

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24	25	26	27	28		

Apr 2013

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

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 *60 Julian day* Yellowstone Natl. Park established, 1872	2 *61* IMPROVE particle sampling day
3 *62*	4 *63*	5 *64* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	6 *65*	7 *66*	8 *67* IMPROVE particle sampling day	9 *68*
10 *69* Daylight Savings Time Begins Note: Do not change sampler clock.	11 *70* IMPROVE particle sampling day	12 *71* Change IMPROVE particle cartridges.	13 *72*	14 *73* IMPROVE particle sampling day	15 *74*	16 *75*
17 *76* St. Patrick's Day IMPROVE particle sampling day	18 *77*	19 *78* Change IMPROVE particle cartridges.	20 *79* IMPROVE particle sampling day	21 *80*	22 *81*	23 *82* IMPROVE particle sampling day
24 *83*	25 *84*	26 *85* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	27 *86*	28 *87*	29 *88* IMPROVE particle sampling day	30 *89*
31 *90*	◆ Watch for lightning damage. ◆ Check site conditions (e.g., a tree growing beyond acceptance criteria).	◆ Electrical connections (e.g., extension cords) exposed to wet conditions should be GFCI protected. ◆ Watch for frost on the inlets.			**UC Davis**: *Sampler*: General Lab (530) 752-1123	**ARS**: *Optical*: Carter Blandford or Karen Rosener *Photography*: Karen Fischer (970) 484-7941

Biomass Burning: An Important Source of Reactive Nitrogen

IMPROVE
Interagency Monitoring of Protected Visual Environments

Bret Schichtel, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

Wild and prescribed fires occur every year in the western United States, burning millions of acres, causing significant emissions of particulate and gaseous pollutants. Wildfires are known to be an important source of fine particulate matter and volatile organic compounds and nitrogen oxides that contribute to ozone formation. These pollutants adversely impact human health, visibility, and ecosystems. Less is known about the emissions of reduced nitrogen compounds, including ammonia and organic nitrogen, that can contribute to ecosystem degradation.

The National Park Service - Air Resource Division (ARD) in cooperation with the Colorado State University (CSU) atmospheric chemistry program has been studying the composition of reactive nitrogen deposited in remote alpine environments including Rocky Mountain National Park and Grand Teton National Park. Methods are available to measure inorganic and organic oxidized nitrogen (NO_y) and inorganic reduced nitrogen compounds, i.e., ammonia (NH_3) and ammonium (NH_4), but not reduced organic compounds. CSU and ARD developed a method to semi-quantitatively measure these reduced organic compounds. It is semi-quantitative due to a number of poorly known artifacts and is best interpreted as an indicator of reduced organic nitrogen concentrations.

In the summer of 2011, a field study was conducted to measure the reactive nitrogen on the western border of Grand Teton National Park. As shown in Figure 1, the concentrations of the reduced organic nitrogen surrogate were low throughout the sampling period except for two events, one on Aug. 16 and the second Sept. 2. Smaller increases in ammonia were also evident. There was evidence that these spikes in concentrations were associated with impacts from diluted biomass burning plumes, and it was thought that biomass burning could be a significant source of these nitrogen compounds. However, to be sure, measurements in fresh plumes with high concentrations were needed.

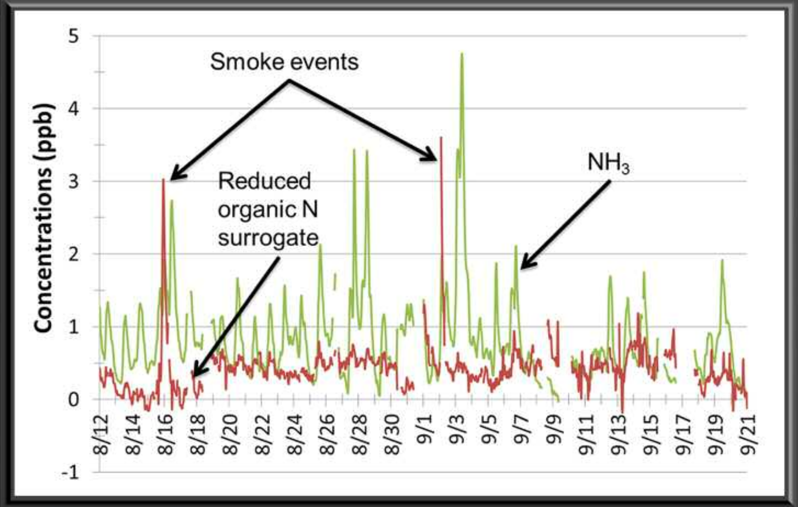

Figure 1. Concentrations of ammonia and the surrogate for reduced organic nitrogen western border of Grand Teton National Park in 2011.

Figure 2. Above: Emissions of particulate matter and gases from the High Park fire. Right: Colorado State University Foothills Campus and the smoke-filled sky from the High Park fire.

On June 9 the High Park fire started a few miles west of Colorado State University's Foothills Campus in Fort Collins, Colorado. The fire was not fully contained until three weeks later on July 1. The fire burned more than 130 square miles of heavily forested land, emitting thousands of tons of particulate and gaseous pollutants. These pollutants were regularly blown east into Fort Collins. While this was an unfortunate event, the CSU team activated a number of air quality monitoring instruments at the CSU Foothill Campus, providing the opportunity to measure the composition of fresh and somewhat aged biomass plumes.

Two weeks of the data are shown in Figure 3. Carbon monoxide (CO) is plotted on the top of the figure. Background CO concentrations are typically around 100 ppb. Concentrations above 500 ppb are a good indication of being in a smoke plume. As can be seen on 12 out of the 16 days plotted, the monitoring site was impacted by the smoke plume, with CO concentrations exceeding 4000 ppb during one episode. On these days one could also smell the smoke. Below the CO data, the NO_y, NH_3, and reduced organic nitrogen surrogate data are plotted. All three of these reactive nitrogen compounds increased when the biomass burning plume impacted the monitoring site.

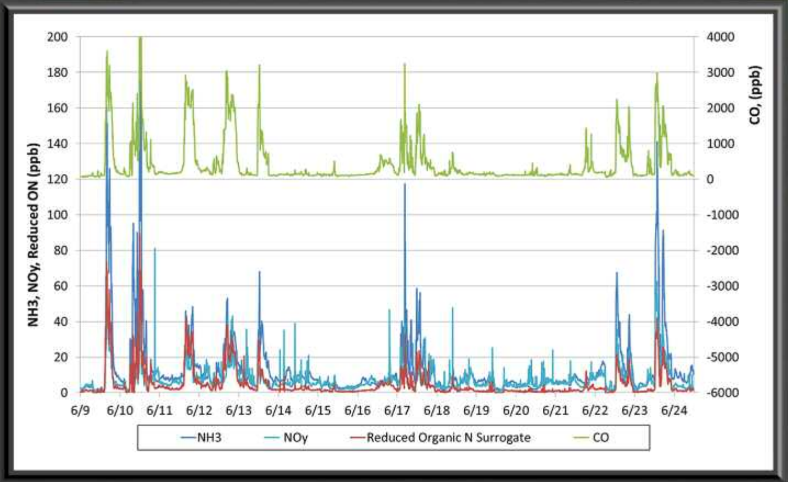

Figure 3. Concentrations of reactive nitrogen compounds and carbon dioxide during two weeks of the High Park fire. The measurements were taken at the Colorado State University Foothill Campus.

This is clear evidence that a biomass burning plume is a significant source of inorganic and organic oxidized and reduced nitrogen compounds impacting sensitive ecosystems. The emissions from these large wildfires can remain in the air for more than a week, transported over 1000 km and becoming a part of the background reactive nitrogen being deposited throughout the Rocky Mountains. Near a large wildfire, significant levels of reactive nitrogen can be deposited in sensitive ecosystems for a single event.

Barrier Lake Research Station, University of Calgary, Canmore, Alberta

As part of an Environment Canada pilot visibility monitoring study, the Rocky Mountain parks region of Canada was selected as a priority wilderness region to host a visibility monitoring site. The University of Calgary Biogeoscience Institute Barrier Lake Field Station in Kananaskis Country, Alberta, was chosen as the monitoring site to represent this region.

The site is located in the foothills of the Rocky Mountains approximately 30 kilometers (~18.5 miles) southeast of the entrance to Banff Natl. Park and 60 kilometers (~37 miles) west of Calgary.

The IMPROVE aerosol sampler was installed in January 2011. Given the cold climate, temperatures of -30°C (-22°F) are not uncommon in the winter, so the IMPROVE sampler is housed in a shed, with the pumps and control unit in a heated and insulated room and the sampling modules in another room that is maintained at ambient temperature.

Judy Buchanan-Mappin, Research Services Coordinator, and **Gary Wainwright**, Building Operations and Facility Management, maintain the instruments and do the weekly sampling. Gary lives on-site at the field station and keeps things running smoothly. In his spare time, he enjoys riding his Harley through the mountains and foothills of Alberta.

Judy coordinates and facilitates the research activities and the 20+ university courses that are offered each year. This includes maintaining the laboratory facilities and equipment and operating the weather station. In her spare time, she enjoys playing in the mountains.

April

> You have to hold yourself accountable for your actions, and that's how we're going to protect the earth.
>
> – Julia Butterfly Hill

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

◆ 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.

Mar 2013

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May 2013

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19	20	21	22	23	24	25
26	27	28	29	30	31	

2012 Western U.S. Wildland Fires

IMPROVE
Interagency Monitoring of Protected Visual Environments

Julie Winchester, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

The National Interagency Fire Center 2012 report stated that lower than normal rainfall in the spring, drought conditions through the summer, high temperatures, and an abundance of dry fuels created nearly perfect conditions for what may have been the worst wildfire season on record. The central Rockies and parts of the Ohio and the Mississippi river valleys experienced very dry conditions. Colorado and Wyoming recorded their fourth driest springs and Utah its fifth driest spring on record. Most of the western mountains entered the 2012 summer season with less than 50 percent of normal snowpack.

NASA's Terra satellite captured an image of heat from several fires and their plumes of smoke over Montana, Wyoming, Colorado, Utah, and South Dakota on July 2, 2012. In this MODIS image, hot spots are colored red and smoke appears light brown. The 2012 western wildfire season started in June and ran through late September.

This photographic view, taken by the Expedition 32 crew for the International Space Station's Crew Earth Observations experiment and Image Science & Analysis Laboratory at Johnson Space Center, covers much of the forested region of central Idaho. The dark areas are wooded mountains — the Salmon River Mountains, the Bitterroots, and Clearwater Mountains. Smaller fire "complexes" appear as tendrils of smoke near the sources and as major smoke plumes from fires in the densest forests. The linear shape of the smoke plumes gives a sense of the generally eastward smoke transport on September 3, 2012. (Note that the image is rotated so that north is to the right.) The smoke distribution also reveals another kind of transport. At night, when winds are weak, the cooling of the atmosphere near the ground causes cooler, denser air to drain down into the valleys. On September 3, this led to some smoke flowing west, down into the narrow Salmon and Lochsa river valleys, in the opposite direction from the higher winds and the thick smoke masses. (Caption by M. Justin Wilkinson, Jacobs / ESCG at NASA-JSC.)

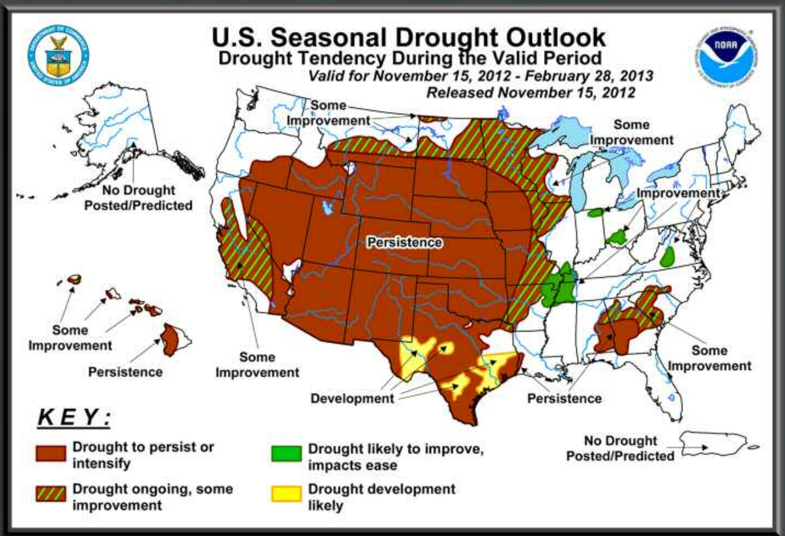
Historical Wildfire Trends

Climate Central, a nonprofit news and research organization, analyzed 42 years of U.S. Forest Service wildland fire records. The 2012 report concluded the following:

> "What defines a 'typical' wildfire year in the West is changing. In the past 40 years, rising spring and summer temperatures, along with shrinking winter snowpack, have increased the risk of wildfires in most parts of the West.
>
> - The number of large and very large fires on Forest Service land is increasing dramatically. Compared to the average year in the 1970s, in the past decade there were
>   - seven times more fires greater than 10,000 acres each year,
>   - nearly five times more fires larger than 25,000 acres each year,
>   - twice as many fires over 1,000 acres each year, with an average of more than 100 per year from 2002 through 2011, compared with less than 50 during the 1970s.
> - In some states the increase in wildfires is even more dramatic. Since the 1970s the average number of fires over 1,000 acres each year has nearly quadrupled in Arizona and Idaho, and has doubled in California, Colorado, Montana, New Mexico, Nevada, Oregon, Utah, and Wyoming.
> - On average, wildfires burn twice as much land area each year as they did 40 years ago. In the past decade, the average annual burn area on Forest Service land in the West has exceeded 2 million acres — more than all of Yellowstone National Park.
> - The burn season is 2-1/2 months longer than it was 40 years ago. Across the West, the first wildfires of the year are starting earlier and the last fires of the year are starting later, making typical fire years 75 days longer now than they were 40 years ago.
>
> Previous research reveals that climatic changes, including increasing temperatures and the earlier onset of spring snowmelt, have been linked to increasing levels of atmospheric greenhouse gases and are likely influencing these damaging fire trends. As average global temperatures rise, researchers project that the risk of wildfires in America's West will accelerate."
>
> — Climate Central 2012 Report

Drought Index

The outlook for next year may be just as dire. The National Climatic Data Center released this drought outlook October 18, 2012 (upper right). Prepared by the National Interagency Coordination Center Predictive Services Staff, the outlook is for drought to persist or worsen into the spring of 2013.

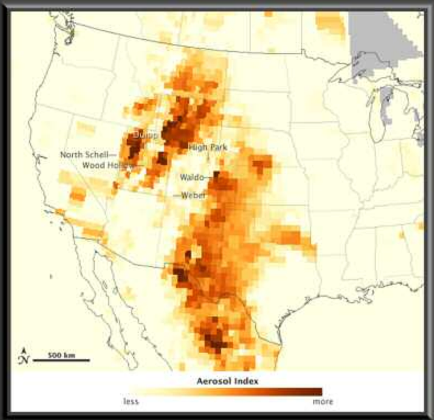


Air Pollution and Wildfire

Besides burning forests and torching houses, wildfires release tons of smoke and particulate matter into the air. According to Georg Grell, a meteorologist with the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Lab in Boulder, Colorado, the hotter the fire, the higher the smoke can go — and the farther it can travel. In addition, once smoke gets to certain altitudes, it's less likely to be washed out of the air by rainstorms. Grell says smoke from extremely hot fires can rise four to five miles into the atmosphere.

Research shows that wildfire emissions release nitrogen oxides (NO_X) and hydrocarbons (VOCs), which can form ozone as a result of chemical reaction in sunlight. Ground-level ozone levels both near and miles downwind of fires can reach levels that can exceed national ambient air quality standards.

This map, created using data from NASA satellites, shows particulate matter released by the wildfires throughout the United States. Reddish-brown areas have the highest levels of particulates while the lowest are light yellow. Heavy concentrations of smoke and aerosols have moved east and south into the plains states. The Suomi National Polar-orbiting Partnership satellite gathered this data on June 26, 2012.



Northern Cheyenne Reservation, Montana

In the rolling plains of southeastern Montana, near the epicenter of new fossil fuel developments, lies the Northern Cheyenne Reservation, a roughly 40 x 20-mile tract of land (450,000 acres in size) that is situated in the northern part of the Powder River basin, not far from the Little Bighorn Battlefield Natl. Mon. and adjacent to the Crow Indian Reservation. Recent coal bed methane (CBM) developments lie to the south, and underneath the reservation lies a wealth of coal contained within a 60- to 80-foot thick seam – one of the thickest coal deposits in the United States. To the north is the Western Energy mine that supplies the coal to the 2,260-megawatt, coal-fired Pennsylvania Power and Light Company (PPL) power plants – the second largest west of the Mississippi River.

Jay Littlewolf is the air quality administrator for the Northern Cheyenne Tribe. He supervises the IMPROVE site and the three monitoring sites which are funded by PPL Montana on the northern border of the reservation. The IMPROVE site is located at one of the PPL sites, about 13 miles south of Colstrip, Montana. The visibility there is generally good, with the exception of when there are wildfires and other sources to the west. Some plumes from the power plants are periodically visible and can even blow into the reservation if the winds are coming out of the north or northwest.

Mr. Littlewolf has been working at the sites for over 23 years, starting out as a technician and graduating into administration. He stays in touch with ARS (Air Resource Specialists in Fort Collins, Colorado), performs various office duties, writes grants, completes reports, and coordinates with various county and state agencies, the DEQ, the EPA, and the BIA (Bureau of Indian Affairs). As a result, his office is the most audited in the tribe due to its collaboration with multiple agencies. But he genuinely enjoys what he does. Not only can he work at his own pace, but the work in the field can also be a welcome respite from all the paperwork in the office. And he values the data his labors yield. He emphasizes he doesn't want to simply change filters and collect data, but he also educates himself about the nature of the data and what it's being used for.

Jay received a BS degree in film and television production from Montana State University in 1981. He lives on the reservation and likes to hunt, photograph with his new digital camera, and watch sports like baseball and basketball.

May

When a man throws an empty cigarette package from an automobile, he is liable to a fine of $50.
When a man throws a billboard across a view, he is richly rewarded.
– Pat Brown

Apr 2013

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Jun 2013

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 121 Julian day IMPROVE particle sampling day	2 122	3 123	4 124 IMPROVE particle sampling day
5 125	6 126	7 127 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	8 128	9 129	10 130 IMPROVE particle sampling day	11 131
12 132 Mother's Day	13 133 IMPROVE particle sampling day	14 134 Change IMPROVE particle cartridges.	15 135	16 136 IMPROVE particle sampling day	17 137	18 138 Armed Forces Day
19 139 IMPROVE particle sampling day	20 140	21 141 Change IMPROVE particle cartridges.	22 142 IMPROVE particle sampling day	23 143	24 144	25 145 IMPROVE particle sampling day
26 146	27 147 Memorial Day (Observed)	28 148 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	29 149	30 150	31 151 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

Assessment of Fire's Contribution to Ozone and Particulate Matter

IMPROVE
Interagency Monitoring of Protected Visual Environments

Thomas Moore, Western Governors' Association – Air Quality Program Manager, CIRA, Fort Collins, CO

The incidence of wildfire and prescribed fire activity and associated emissions show both inter-annual and geographic variability, but wildfire activity, as shown in Figure 1, has been generally increasing over the 1990 to 2011 timeframe, since the Clean Air Act was last amended.

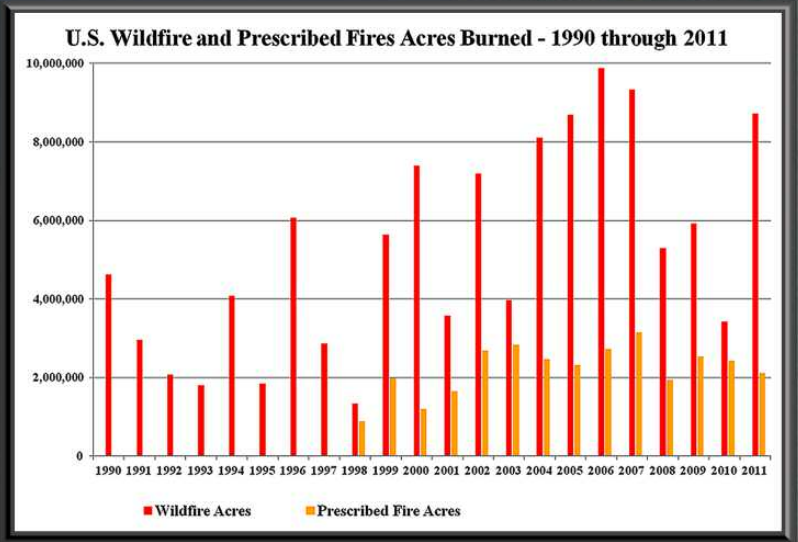

Figure 1: Acres burned by wild and prescribed fires from 1990 to 2011.

Figure 2: NASA photo of the Biscuit fire located in the Siskiyou National Forest, Oregon.

Figure 3: NASA photo of fires in northern California.

Fire emissions in the form of smoke, volatile organic hydrocarbons (VOCs), and nitrogen oxides (NO_X) contribute to ambient particle mass concentration (PM) and ozone (O_3) National Ambient Air Quality Standards (NAAQS). Figure 4 shows an isopleth map of total ozone on the left panel and regional-scale, chemical transport modeled ozone on the right. The fire referred to is shown in Figure 2. Note that it is estimated the fire can contribute in excess of 20 ppb of ozone in some areas of the country, easily resulting in violations of NAAQS standards.

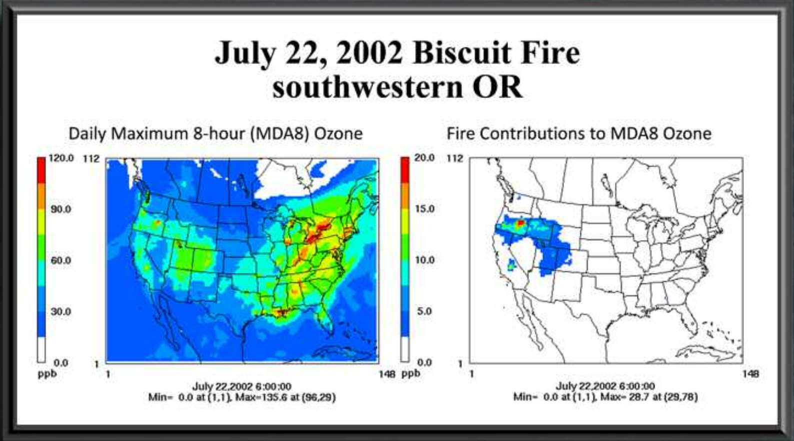

Figure 4: The panel above shows chemical transport model estimate of ambient ozone concentrations while the panel on the right shows the contributions of fire to those ambient levels.

Modeling and assessment tools are needed to rapidly estimate the relative contribution of fire emissions to ambient levels of ozone and PM concentrations. To that end, the Joint Fire Sciences Program (JFSP) has funded two projects. The Deterministic & Empirical Assessment of Smoke's Contribution to Ozone (DEASCO3) and Particulate Matter Deterministic & Empirical Tagging & Assessment of Impacts on Levels (PMDETAIL) projects will produce analytical results and a dynamic and accessible technical tool that enables federal land managers (FLMs) to participate more fully in ozone and PM air quality planning efforts. These separate projects, each leveraged against the other, will turn complex technical analyses of a series of well-chosen historical events (case studies) into accessible and instructive tables, charts, and maps that describe how and to what extent fires contribute to ambient ozone and PM concentrations. About 20 case studies in each project will be developed to characterize the relationship of emissions from fire to ozone and PM concentrations across a broad range of circumstances (e.g., geographic locations, fuel conditions, time of year, fire types, and contributions to elevated background levels and levels in excess of various existing and potential ozone and PM NAAQS). These suites of case studies will characterize situations analogous to those that FLMs may face with current conditions and in the future. The projects will also develop and publish new fire emissions inventories and computational modules for chemical transport models (CTMs) to simulate the atmospheric transformations of these emissions. The online tool will allow FLMs to survey, review, and grab the technical results and findings of the most analogous case studies to effectively contribute to the state and EPA processes of state implementation plan development, declaration of exceptional events, nonattainment area designations, establishing background and transport levels of ozone, and others. The table below outlines the technical and policy hypotheses associated with these two projects.

DEASCO$_3$ Hypotheses

Technical	Policy
Smoke from fire contributes to background concentrations of O_3 in large areas of the U.S.	Better quantitative information will help FLMs to assess the use of smoke management techniques to address nonattainment issues.
Fire/Smoke management can affect formation of O_3.	The rank order(s) in the online tool will help FLMs to be more effective in the air quality planning processes
Fire(s) cause/contribute to O_3 exceedances.	

PMDETAIL Hypotheses

Technical	Policy
Accounting for gas-particle partitioning of primary organic aerosol will reduce the contribution of primary PM emissions from fires and will reduce the predicted near fire (within 25 km) PM levels.	Improved quantitative information about fire emissions' contribution to PM levels will allow fire managers to demonstrate the change in air quality resulting from smoke management programs (e.g., individual fire management methods, cumulative fires, emissions reduction techniques), and more effectively participate in air quality planning efforts to address PM nonattainment areas.
The major contribution of fires to ambient PM will be secondary organic aerosol.	Improved quantitative information will increase FLMs' understanding of spatial and temporal variation in fire emissions' contribution to elevated PM and accommodate more effective and timely involvement of FLMs in air quality planning processes.
Oxidation of levoglucosan creates biases greater than a factor of 2 in existing chemical receptor model estimates of the contribution of fires to ambient PM levels.	
The updated regulatory and research CTMs (CAMx and PMCAMx) treating the fire PM emissions as semivolatile and reactive can simulate accurately the fire impacts on regional PM levels.	

Zion National Park, Utah

Jessica Jelacic is new to Zion National Park and has only been managing the air quality station there for a few months. She has spent the last few years living in West Virginia, Montana, and California, finally arriving in Utah. She is a GIS technician for the park and does a variety of work including cartography, data collection, data management, and spatial modeling.

Zion National Park is a unique area of sandstone cliffs and canyons in the desert of southwest Utah and is part of the Northern Colorado Plateau Air Quality Monitoring network. The park encompasses 146,592 acres and was designated a Class I air quality area in 1977.

The air quality station, which monitors ozone and particulate matter for Zion National Park, is located up Dalton Wash, outside the park boundaries on a flat mesa above the town of Virgin, Utah, about 15 miles west of the park entrance. Getting to the station can at times be difficult on the 4-wheel-drive road and takes a minimum of 25 minutes to drive. Any sort of inclement or wet weather can make the road impassable.

Jessica finds lots to do in the desert. She spends her time mountain biking, rock climbing, trail running, or simply exploring the area with her dog.

June

The universe is not required to be in perfect harmony with human ambition.
– Carl Sagan

May 2013						
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Jul 2013						
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21	22	23	24	25	26	27
28	29	30	31			

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 152 Julian day
2 153	3 154 IMPROVE particle sampling day	4 155 Change IMPROVE particle cartridges.	5 156 National Trails Day	6 157 IMPROVE particle sampling day	7 158	8 159
9 160 IMPROVE particle sampling day	10 161	11 162 Change IMPROVE particle cartridges.	12 163 IMPROVE particle sampling day	13 164	14 165 Flag Day	15 166 IMPROVE particle sampling day
16 167 Father's Day	17 168	18 169 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	19 170	20 171	21 172 IMPROVE particle sampling day	22 173
23 174	24 175 IMPROVE particle sampling day	25 176 Change IMPROVE particle cartridges.	26 177	27 178 IMPROVE particle sampling day	28 179	29 180
30 181 IMPROVE particle sampling day						

◆ Watch for lightning damage.

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

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

Ozone in National Parks

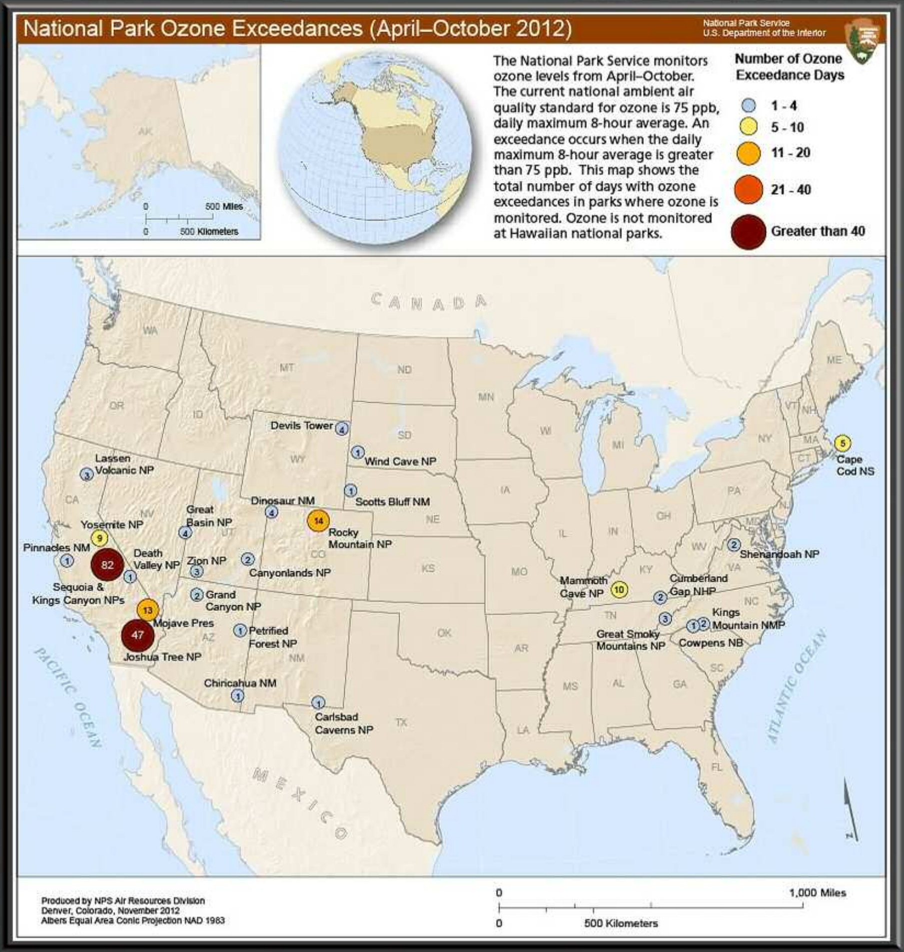
IMPROVE
Interagency Monitoring of Protected Visual Environments

Julie Winchester, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

The National Park Service (NPS) actively monitors ozone at many of its parks. The Environmental Protection Agency (EPA) sets an ozone standard at a level where ozone in the air becomes unhealthy to breathe. The NPS tracks the days when the standard is exceeded in the parks.

In 1997 the National Ambient Air Quality Standard for ozone changed from 85 ppb (parts per billion) to 75 ppb. In September 2011, the EPA was directed to back off a proposal to lower the 8-hour standard even more to somewhere between 60 and 70 ppb. (The World Health Organization recommends 51 ppb.) Any revisions won't be reconsidered until late in 2013.

From April through October 2012, 26 national parks had days that exceeded the ozone air pollution standard. Some parks had multiple exceedances. There were a total of 219 "Code Red" and "Code Orange" ozone days across the network. These kinds of days are considered ozone action days, when ozone levels exceed the current standard of 75 ppb averaged over an 8-hour period. Ozone levels above the standard are considered unhealthy to breathe, particularly among sensitive groups. People are asked to limit vigorous outdoor activities. Most ozone action days occur during the warmer months, from May through September.


National Park Ozone Exceedances (April–October 2012)

The National Park Service monitors ozone levels from April–October. The current national ambient air quality standard for ozone is 75 ppb, daily maximum 8-hour average. An exceedance occurs when the daily maximum 8-hour average is greater than 75 ppb. This map shows the total number of days with ozone exceedances in parks where ozone is monitored. Ozone is not monitored at Hawaiian national parks.

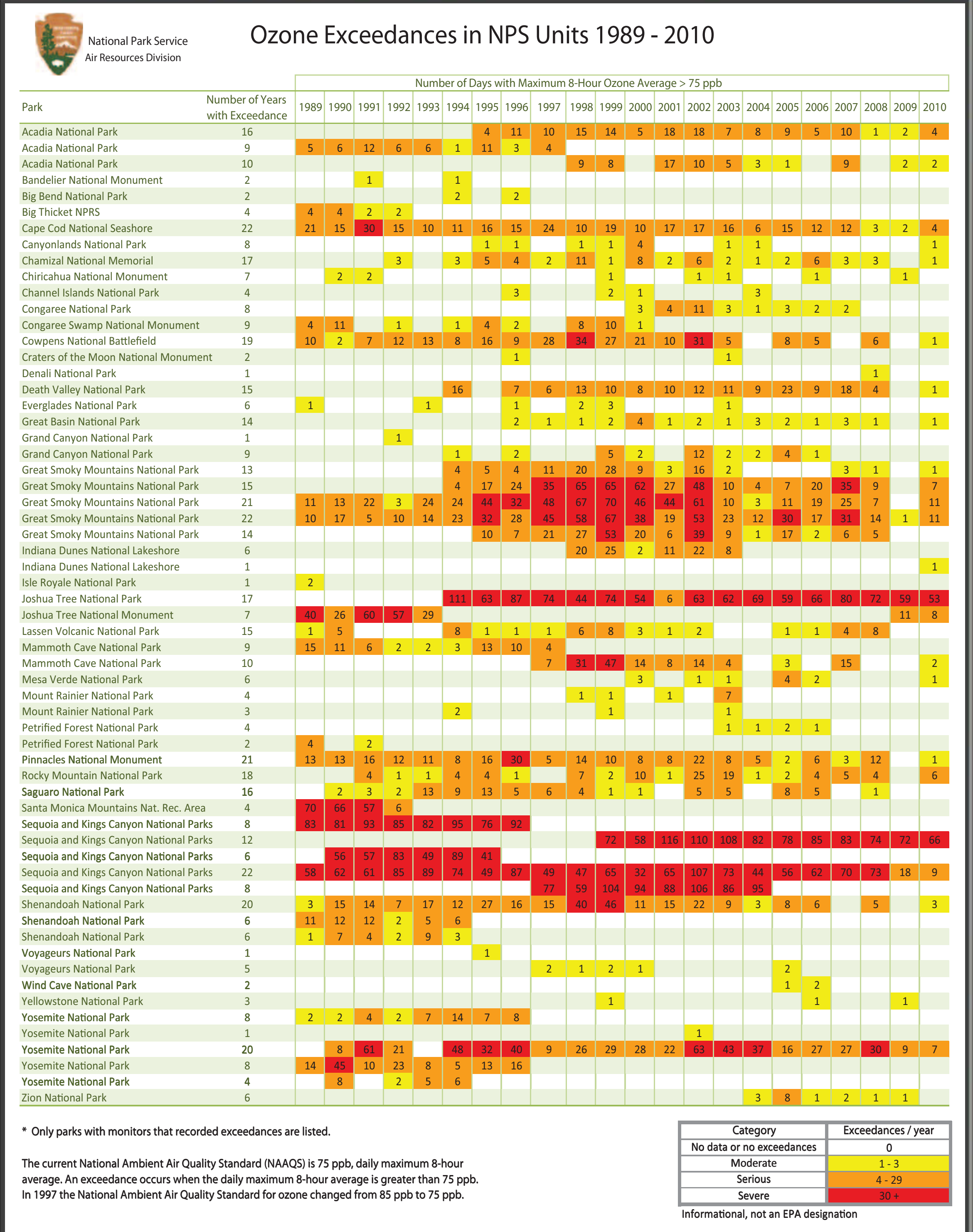
Produced by NPS Air Resources Division
Denver, Colorado, November 2012
Albers Equal Area Conic Projection NAD 1983

The map above shows parks with 2012 ozone exceedances.

In addition to affecting visitors, ozone has damaging effects on vegetation and may affect the biodiversity of ecosystems. Sensitive plants are more susceptible to diseases and damage. Plant growth can be inhibited and crop yields can be affected.

National Park Ozone Exceedances

The Air Resources Division of the National Park Service compiled the table to the right listing annual ozone exceedances by park from 1989 through 2010. Historically Sequoia and Joshua Tree national parks top the list of highest concentrations of ozone and the most days with levels above the acceptable limit. Not surprising since these parks are downwind of two of the biggest producers of NO_X and VOCs in the United States, the Los Angeles basin and the San Joaquin Valley. Other park units measuring unhealthy ozone levels include Great Smoky Mountains, Yosemite, Big Bend, and Rocky Mountain national parks, and the Mohave National Preserve. The good news is that network wide, most parks have seen little change in the number of days ozone is high and many have seen slight decreases in levels over the years. It is interesting to note that Rocky Mountain National Park generally exceeds standards less than 6 days a year. That number jumped to 12 in 2012, a year when the Front Range had some of the biggest fires on record.


National Park Service
Air Resources Division

Ozone Exceedances in NPS Units 1989 - 2010

Park	Number of Years with Exceedance	Number of Days with Maximum 8-Hour Ozone Average > 75 ppb																					
		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Acadia National Park	16							4	11	10	15	14	5	18	18	7	8	9	5	10	1	2	4
Acadia National Park	9	5	6	12	6	6	1	11	3	4													
Acadia National Park	10										9	8		17	10	5	3	1		9		2	2
Bandelier National Monument	2			1			1																
Big Bend National Park	2						2		2														
Big Thicket NPRS	4	4	4	2	2																		
Cape Cod National Seashore	22	21	15	30	15	10	11	16	15	24	10	19	10	17	17	16	6	15	12	12	3	2	4
Canyonlands National Park	8							1	1		1	1	4			1	1						1
Chamizal National Memorial	17				3		3	5	4	2	11	1	8	2	6	2	1	2	6	3	3		1
Chiricahua National Monument	7		2	2								1			1	1			1			1	
Channel Islands National Park	4								3			2	1				3						
Congaree National Park	8												3	4	11	3	1	3	2	2			
Congaree Swamp National Monument	9	4	11		1		1	4	2		8	10	1										
Cowpens National Battlefield	19	10	2	7	12	13	8	16	9	28	34	27	21	10	31	5		8	5		6		1
Craters of the Moon National Monument	2								1							1							
Denali National Park	1																				1		
Death Valley National Park	15						16		7	6	13	10	8	10	12	11	9	23	9	18	4		1
Everglades National Park	6	1				1			1		2	3				1							
Great Basin National Park	14								2	1	1	2	4	1	2	1	3	2	1	3	1		1
Grand Canyon National Park	1				1																		
Grand Canyon National Park	9						1		2			5	2		12	2	2	4	1				
Great Smoky Mountains National Park	13						4	5	4	11	20	28	9	3	16	2				3	1		1
Great Smoky Mountains National Park	15						4	17	24	35	65	65	62	27	48	10	4	7	20	35	9		7
Great Smoky Mountains National Park	21	11	13	22	3	24	24	44	32	48	67	70	46	44	61	10	3	11	19	25	7		11
Great Smoky Mountains National Park	22	10	17	5	10	14	23	32	28	45	58	67	38	19	53	23	12	30	17	31	14	1	11
Great Smoky Mountains National Park	14							10	7	21	27	53	20	6	39	9	1	17	2	6	5		
Indiana Dunes National Lakeshore	6										20	25	2	11	22	8							
Indiana Dunes National Lakeshore	1																						1
Isle Royale National Park	1	2																					
Joshua Tree National Park	17						111	63	87	74	44	74	54	6	63	62	69	59	66	80	72	59	53
Joshua Tree National Monument	7	40	26	60	57	29																11	8
Lassen Volcanic National Park	15	1	5				8	1	1	1	6	8	3	1	2			1	1	4	8		
Mammoth Cave National Park	9	15	11	6	2	2	3	13	10	4													
Mammoth Cave National Park	10									7	31	47	14	8	14	4		3		15			2
Mesa Verde National Park	6												3		1	1		4	2				1
Mount Rainier National Park	4										1	1		1		7							
Mount Rainier National Park	3						2					1				1							
Petrified Forest National Park	4															1	1	2	1				
Petrified Forest National Park	2	4		2																			
Pinnacles National Monument	**21**	13	13	16	12	11	8	16	30	5	14	10	8	8	22	8	5	2	6	3	12		1
Rocky Mountain National Park	18			4	1	1	4	4	1		7	2	10	1	25	19	1	2	4	5	4		6
Saguaro National Park	**16**		2	3	2	13	9	13	5	6	4	1	1		5	5		8	5		1		
Santa Monica Mountains Nat. Rec. Area	4	70	66	57	6																		
Sequoia and Kings Canyon National Parks	**8**	83	81	93	85	82	95	76	92														
Sequoia and Kings Canyon National Parks	12											72	58	116	110	108	82	78	85	83	74	72	66
Sequoia and Kings Canyon National Parks	**6**		56	57	83	49	89	41															
Sequoia and Kings Canyon National Parks	22	58	62	61	85	89	74	49	87	49	47	65	32	65	107	73	44	56	62	70	73	18	9
Sequoia and Kings Canyon National Parks	**8**									77	59	104	94	88	106	86	95						
Shenandoah National Park	20	3	15	14	7	17	12	27	16	15	40	46	11	15	22	9	3	8	6		5		3
Shenandoah National Park	**6**	11	12	12	2	5	6																
Shenandoah National Park	6	1	7	4	2	9	3																
Voyageurs National Park	**1**							1															
Voyageurs National Park	5									2	1	2	1					2					
Wind Cave National Park	**2**																	1	2				
Yellowstone National Park	3											1							1			1	
Yosemite National Park	**8**	2	2	4	2	7	14	7	8														
Yosemite National Park	1														1								
Yosemite National Park	**20**		8	61	21		48	32	40	9	26	29	28	22	63	43	37	16	27	27	30	9	7
Yosemite National Park	8	14	45	10	23	8	5	13	16														
Yosemite National Park	**4**		8		2	5	6																
Zion National Park	6																3	8	1	2	1	1	

* Only parks with monitors that recorded exceedances are listed.

The current National Ambient Air Quality Standard (NAAQS) is 75 ppb, daily maximum 8-hour average. An exceedance occurs when the daily maximum 8-hour average is greater than 75 ppb. In 1997 the National Ambient Air Quality Standard for ozone changed from 85 ppb to 75 ppb.

Category	Exceedances / year
No data or no exceedances	0
Moderate	1 - 3
Serious	4 - 29
Severe	30 +

Informational, not an EPA designation

White River National Forest, Colorado

July

Do your little bit of good where you are; it's those little bits of good put together that overwhelm the world.
– Archbishop Desmond Tutu

The White River (WHRI1) site is the second highest in altitude in the IMPROVE network, located atop Aspen Mountain at 11,200 feet. Located within the central mountains of Colorado, its elevation often subjects it to inclement weather conditions such as frequent lightning, especially during the 'monsoonal' summer months of July and August, and an average annual snowfall of 300 inches. While the Aspen Skiing Company provides gondola lift passes to Forest Service and Wilderness Workshop site operators during their summer and winter months of operation, IMPROVE site data collection and maintenance during the off season requires a 4WD vehicle to traverse 10 miles of dirt road that climbs 3000 feet in elevation. Operator **Dave Richie** sometimes hikes to the site, often with ski mountaineering equipment. He says, "The latter sounds challenging but is actually one of my favorite aspects of the 'commute'."

Due in part to drier climatic conditions, visibility in the western Colorado Mountains is among the best in the U.S., with an average deciview of 6.52 (about a 125-mile visual range). The site is well situated to monitor visibility impacts from regional sources that extend beyond state lines over a wide geographic area. Data indicate a decline in natural visibility, although nitrates and sulfates have been decreasing. The Bureau of Land Management projects that over *25,000* new natural gas wells will appear on federal lands in the Piceance Basin in the next 20 years. The Western Regional Air Partnership (WRAP) estimates that by 2018 the western U.S. will see a 20% increase in sulfate emissions and a 50% increase in nitrogen oxides.

Dave is a wilderness monitoring coordinator for the USDA Forest Service & Wilderness Workshop. He enjoys skiing and hiking with his wife Hilary and sons Sam (age 11) and August (age 7) and their dog Ripple. Dave also coaches his boys in swimming and Little League baseball and loves to read.

Below: View of Hunter Peak as seen from Aspen Mtn.

photo: Burnham W. Arndt

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

Jun 2013

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2	3	4	5	6	7	8
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30						

Aug 2013

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25	26	27	28	29	30	31

Edwin B. Forsythe National Wildlife Refuge

IMPROVE
Interagency Monitoring of Protected Visual Environments

Julie Winchester, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO

The Edwin B. Forsythe National Wildlife Refuge has been set aside as one of the East Coast's premier birding spots. It includes 42,000 acres of coastal habitat and about 6000 acres of wilderness protected under the Clean Air Act. The Brigantine Wilderness, located within the wildlife refuge, has its own environmental concerns based on its unique ecology.

Modern technology offers Edwin B. Forsythe an opportunity talk to visitors about a resource they cannot see or touch: clear air. The refuge hosts over 250,000 visitors each year, many of whom are not aware that air pollution is impacting visibility, wildlife, birdlife, plants, and water resources. Monitoring has allowed the refuge and the New Jersey Department of Environmental Protection (NJDEP) to track effects on resources. We now have a better understanding of air quality impacts:

- Average visibility is about 40 miles, reduced from about 115 miles under natural conditions. On the highest pollution days visibility is reduced to 15 miles.
- Nitrogen and sulfur compounds may cause acidification in ecosystems, leading to increases in weedy plant species and the loss of native species. Nitrogen and sulfur deposition at Forsythe is among the highest in the nation. However, monitoring data from 2000 to 2010 show that annual average nitrogen and sulfur from wet deposition in Forsythe decreased, likely from controls of sulfur dioxide at coal-burning power plants.
- Since acid deposition monitoring began in 1998, streams in the New Jersey Pine Barrens are reported to have the highest acidic levels in the National Acid Deposition Network.
- In June 2009, the NJDEP began monitoring atmospheric mercury at the refuge. Findings showed elevated mercury concentrations in fish and seafood, causing the NJDEP to recommend limited consumption of local catches.
- Ground-level ozone concentrations at the refuge sometimes exceed the 8-hour average National Ambient Air Quality Standard (NAAQS) set by the U.S. Environmental Protection Agency to protect public health. While ozone levels at the refuge have declined since the late 1990s, values are still about equal to national standards (75 parts per billion (ppb)), above the recommended standard of 60-70 ppb.

Atlantic City, seven miles distant, as seen from the refuge on relatively clear and hazy days.

The air quality monitoring station is just outside the visitor center and has been the subject of many visitor questions. The new visitor center will implement a multimedia touch screen display in early 2013 that will explain what the monitors are, what they measure, and what the refuge has learned through monitoring. The 27" display will be permanently installed next to a large window looking over the bay toward Atlantic City, New Jersey.

Visitor center

Air pollution is a chronic problem at this refuge. Since 1991, the U.S. Fish and Wildlife Service and the New Jersey Department of Environmental Protection (NJDEP) have worked together cooperatively to monitor and control air pollution. The refuge is in a highly industrialized air shed, with air pollution from many sources. If we don't protect air quality, wildlife and scenic values will be threatened.

Look out of the window to locate the refuge's air quality monitoring site, then explore what we monitor and why.

The opening screen of the interactive touch screen display

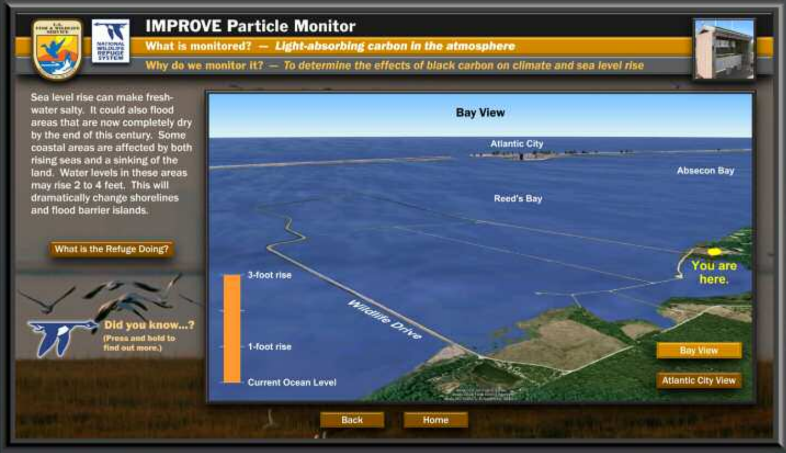
One interesting visual simulation shows visitors what the bay would look like with a 1-foot and 3-foot rise in sea level. Many will find this interesting in light of the fact that Hurricane Sandy caused a 5-foot rise in sea level last October. Rising seas would make freshwater salty, dramatically change shorelines, and flood barrier islands. The refuge is tracking changes and will use the information to plan for future salt marsh restoration projects.

Forsythe NWR web cam photo as Hurricane Sandy approaches the refuge

What is monitored? — *Light-absorbing carbon in the atmosphere*

Why do we monitor it? — *To determine the effects of black carbon on climate and sea level rise*

Sea level rise can make freshwater salty. It could also flood areas that are now completely dry by the end of this century. Some coastal areas are affected by both rising seas and a sinking of the land. Water levels in these areas may rise 2 to 4 feet. This will dramatically change shorelines and flood barrier islands.



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Sea level rise can make freshwater salty. It could also flood areas that are now completely dry by the end of this century. Some coastal areas are affected by both rising seas and a sinking of the land. Water levels in these areas may rise 2 to 4 feet. This will dramatically change shorelines and flood barrier islands.

At the top is a Google Earth image of the refuge. Below is a simulation of a 3-foot rise in ocean level.

The refuge is in a highly industrialized air shed affected by air pollution from both regional and local sources. Since 1991 the U.S. Fish and Wildlife Service Air Quality Branch and the NJDEP have worked together cooperatively to monitor and control air pollution.

Forsythe also cooperates in several national monitoring programs. Monitoring wet and dry pollutant deposition began in 1998 as part of the National Atmospheric Deposition Program, designed to track effects of acid rain. The refuge also participates in a partnership with the national Mercury Deposition Network to monitor mercury deposition and its effects in the refuge.

Medicine Lake National Wildlife Refuge, Montana

August

The supreme reality of our time is ... the vulnerability of our planet.
– John F. Kennedy

Damon Taylor is the biological science technician and IMPROVE site operator at Medicine Lake National Wildlife Refuge in Medicine Lake, Montana. Damon is tasked with an array of responsibilities at this station, including water quality monitoring, water level management, dove and duck banding, native prairie restoration, managing the invasive species program, and various maintenance tasks among other duties. He is originally from Oklahoma and graduated with a bachelor's degree in wildlife ecology and management from Oklahoma State University. He worked for the U.S. Forest Service in Nevada and the U.S. Fish and Wildlife Service in Oklahoma and Minnesota before moving to Montana. Damon's primary extracurricular activities involve hunting, fishing, taxidermy, and playing guitar. He lives in Medicine Lake with his chocolate lab Tank, who is his hunting and traveling partner. Damon has been involved with the outdoors his entire life and considers himself fortunate to have a job where he can give back to the environment that has given him so many life lessons.

Wintertime average snowfall there is 27 inches. It is common for winter temperatures to reach as low as -30 degrees Fahrenheit with wind chills sometimes dropping to 60 below. These extreme conditions often make it difficult to operate the air quality site during the winter months.

Established in 1935, the refuge encompasses 31,702 acres and is located on the heavily glaciated rolling plains of northeastern Montana, between the Missouri River and the Canadian border. It provides important breeding grounds and stopover areas for a diverse assortment of migratory birds. The recent oil and gas boom concentrated in nearby North Dakota and expanding into Montana poses air and water quality concerns.

Jul 2013

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28	29	30	31			

Sep 2013

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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

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	1 213 Julian day	2 214 IMPROVE particle sampling day	3 215
4 216	5 217 IMPROVE particle sampling day	6 218 Change IMPROVE particle cartridges.	7 219	8 220 IMPROVE particle sampling day	9 221	10 222
11 223 IMPROVE particle sampling day	12 224	13 225 Change IMPROVE particle cartridges.	14 226 IMPROVE particle sampling day	15 227	16 228	17 229 IMPROVE particle sampling day
18 230	19 231	20 232 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	21 233	22 234	23 235 IMPROVE particle sampling day	24 236
25 237	26 238 IMPROVE particle sampling day	27 239 Change IMPROVE particle cartridges.	28 240	29 241 IMPROVE particle sampling day	30 242	31 243

Trends in IMPROVE $PM_{2.5}$ Mineral Soil Dust Concentrations

IMPROVE
Interagency Monitoring of Protected Visual Environments

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

Mineral soil dust aerosols emitted from erodible dry land surfaces play important roles in the earth's climate, visibility degradation, cloud processes, and marine and terrestrial biogeochemical cycles. High levels of airborne dust also have been shown to negatively impact human health.

The IMPROVE network analyzes $PM_{2.5}$ elemental species to reconstruct soil dust concentrations. Keep in mind that the $PM_{2.5}$ soil concentration is typically associated with the tail of the coarse-mode size distribution and therefore likely only captures a fraction of the total soil mass. The 2007-2010 annual mean $PM_{2.5}$ soil dust concentrations are shown in Figure 1. Concentrations were highest along the southern half of the United States, especially in the Southwest where the majority of emissions within the country originate (e.g., Great Basin, Colorado Plateau, and Mohave and Sonoran deserts). Annual mean concentrations in the Southwest are 2-4 times higher than elsewhere in the country, and contributions reach up to 40% of $PM_{2.5}$ mass and over 20% of $PM_{2.5}$ extinction, especially during spring. In the southeastern United States in summer, soil contributions reach nearly 20% of fine mass.

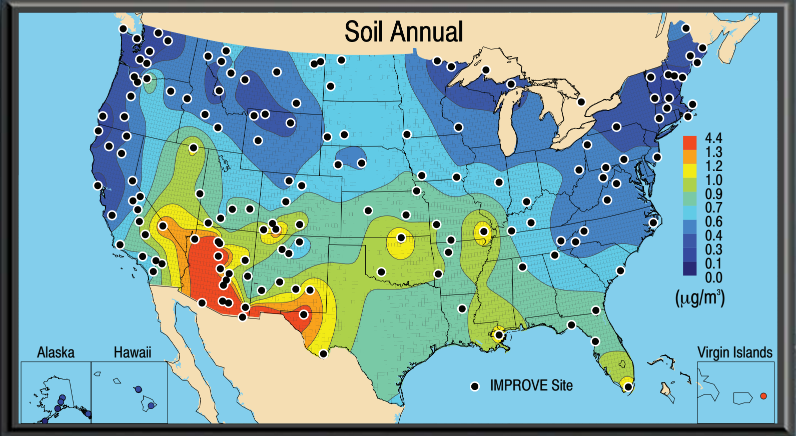

Figure 1. 2007-2010 annual mean IMPROVE $PM_{2.5}$ soil concentrations ($\mu g/m^3$), estimated by summing oxides of elements that are typically associated with soil. IMPROVE sites are noted by the location of circles.

In addition to local sources, many studies have identified the influence of long-range transport of soil dust in the United States, with impacts from Asia and Mexico in spring in the West and from North Africa in the Southeast in summer. Anthropogenic sources can also be important, as studies have suggested that soil dust exhibits a strong weekly cycle at most IMPROVE sites.

Dust storms are indicative of environmental deterioration, such as drought, soil erosion, land-use change, and desiccation of lakes and ground water depletion. Due to its role in these and other climate-related issues, understanding changes to soil concentrations over time is important. Trends analyses on annual and monthly mean data inform as to seasons and regions of the country that experience increased concentrations. With this motivation we computed soil trends at IMPROVE sites for 2000-2010 using Theil regression. Statistical significance (p) was assumed for $p < 0.10$.

Trends (% yr^{-1}) in annual mean soil concentrations are shown in Figure 2. Trend values were interpolated to produce isopleths to indicate large-scale spatial patterns. Trends were variable across the United States, with regions in the West and the Southeast corresponding to increased concentrations.

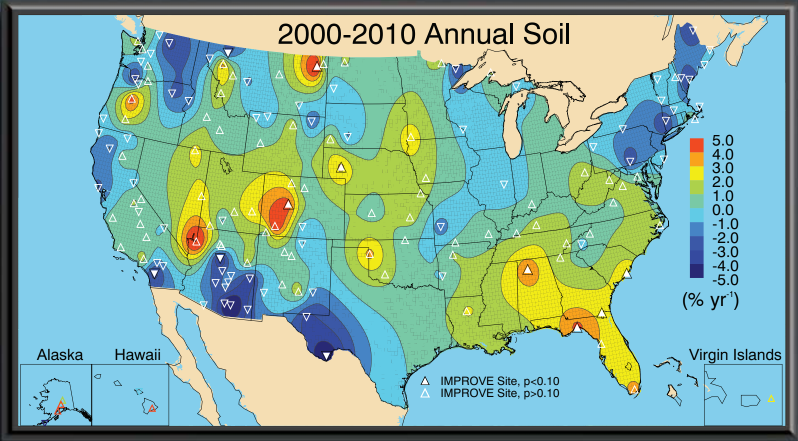

Figure 2. 2000-2010 trends (% yr^{-1}) in annual mean $PM_{2.5}$ soil dust concentrations at IMPROVE sites, noted by the location of triangles. Upward-pointing triangles indicate increased concentrations and vice versa. Filled triangles correspond to statistically significant trends ($p < 0.10$).

Trends in monthly mean concentrations for March, July, and November are shown in Figure 3a, 3b, and 3c, respectively. March monthly mean concentrations have increased significantly since 2000 across most of the United States. Trends in July monthly mean concentrations in the southeastern United States have also increased significantly. Recall that sites in the Southeast are frequently influenced by transport of dust from North Africa during summer. Finally, November monthly mean concentrations have increased significantly in the Southwest, and the central and Great Plains regions of the United States showed insignificantly increased concentrations.

Clearly, large regions of the United States have experienced increased soil concentrations during different seasons for reasons yet unknown. Understanding the causes of these positive trends will require investigating the role of local versus long-range dust transport as well as changes in local sources due to land-use change and drought conditions.

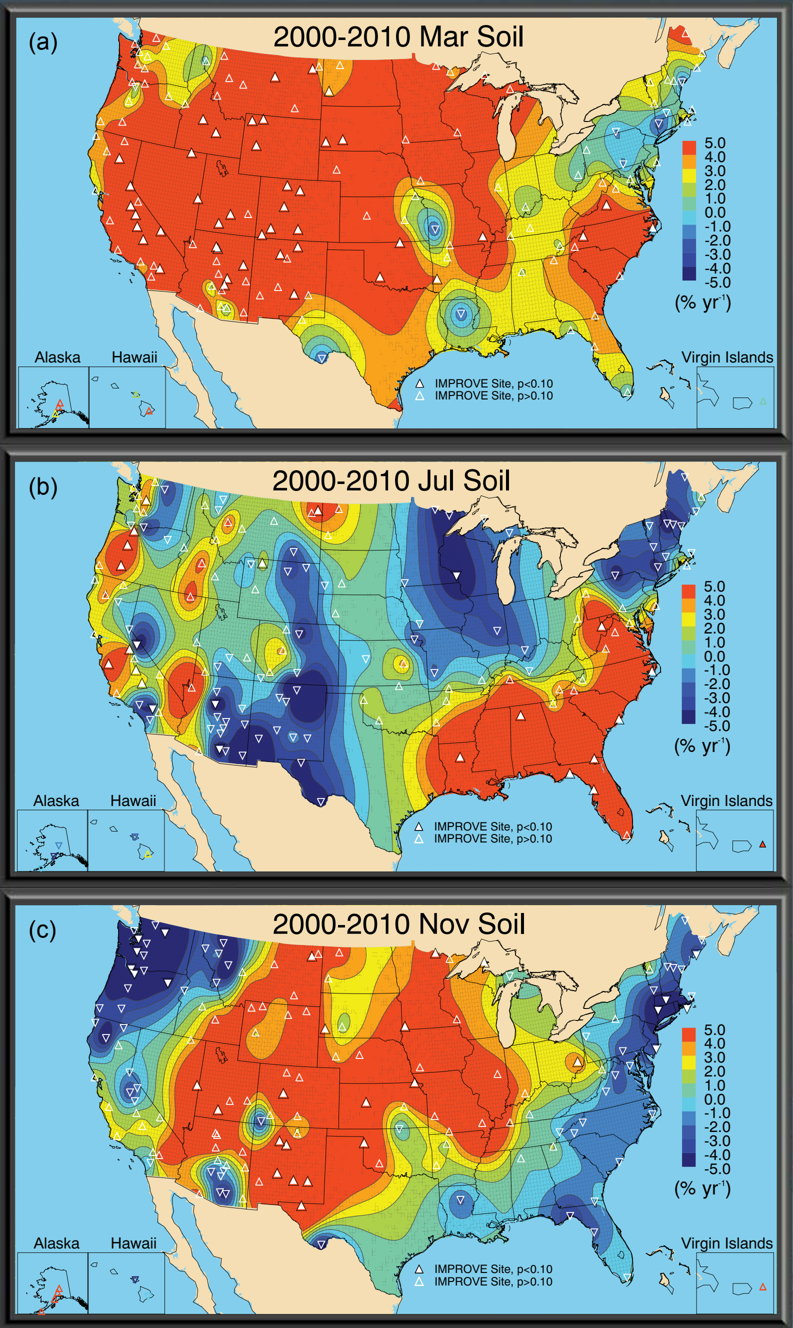

Figure 3. 2000-2010 trends (% yr-1) in (a) March monthly mean $PM_{2.5}$ soil dust concentrations at IMPROVE sites, noted by the location of triangles (b) July monthly mean trends (c) November monthly mean trends. Upward-pointing triangles indicate increased concentrations and vice versa. Filled triangles correspond to statistically significant trends ($p < 0.10$).

Rocky Mountain National Park, Colorado

Dyan Harden first became involved with air quality monitoring in Rocky Mountain National Park as a volunteer during the cold winter of 2003. That was the year of a 4-day snowstorm that dropped nearly 7 feet of snow. Dyan finds it interesting to see the different weather patterns over the years that she has been working on air quality site operations.

She says, “We used to have a transmissometer to measure visibility. It was a real challenge to switch on the light, make sure the beam was directed to a precise point 2 miles uphill, then drive up to Many Parks Curve overlook, crawl out underneath a boardwalk on a steep, icy hill in windy conditions, and catch the results of the receiver in time. Now the park has a nephelometer mounted on the roof of the air quality shelter, and the light has to move through just inches instead of miles. I am grateful that evolving technologies are making my job considerably easier.

Ms. Harden is the main operator for Rocky’s NDDN CASTNet, IMPROVE, NADP, nephelometer and AMoN sites. She has also had the opportunity to hike and snowshoe 2.5 miles up to the long-term NADP and research site at Loch Vale to assist in site needs such as sample collection and ensuring the site continues to conform to location standards.

Rocky Mountain National Park is a UNESCO-designated biosphere reserve and recently designated wilderness area. Dyan says, “When I think of Colorado, I think of crystal-clear blue skies, but the many fires in Colorado and nearby states this summer left us with many hazy, smoke-filled days. The current visual range in the park has been reduced to 30 to 90 miles from a natural range of 140 miles in the absence of pollution. Haze is a pretty good indicator of other forms of air pollution, such as nitrogen, to which our alpine tundra, comprising about 1/3 of the park’s area, is especially vulnerable.”

“I was born in Michigan and have a B.S. in natural resources from the University of Michigan. I have been working on and off for Rocky since 1999 and currently serve as a volunteer coordinator for restoration projects. I have a one-of-a-kind 8-year-old daughter who loves the outdoors. She and I saw our first mountain lion at our house not far from the southeast border of the park this summer. My favorite way to enjoy the outdoors is through hiking.”

September

In our rich consumers’ civilization we spin cocoons around ourselves and get possessed by our possessions.
– Max Lerner

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 244 *Julian day* IMPROVE particle sampling day	2 245 Labor Day	3 246 Change IMPROVE particle cartridges.	4 247 IMPROVE particle sampling day	5 248	6 249	7 250 IMPROVE particle sampling day
8 251	9 252	10 253 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	11 254	12 255	13 256 IMPROVE particle sampling day	14 257
15 258	16 259 IMPROVE particle sampling day	17 260 Change IMPROVE particle cartridges.	18 261 National Public Lands Day	19 262 IMPROVE particle sampling day	20 263 Pollution Prevention Week	21 264
22 265 IMPROVE particle sampling day	23 266	24 267 Change IMPROVE particle cartridges.	25 268 IMPROVE particle sampling day	26 269	27 270	28 271 IMPROVE particle sampling day
29 272	30 273					

◆ Watch for lightning damage.

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

Aug 2013

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Oct 2013

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

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

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

Positive Trends in Wintertime Particulate Sulfate and Nitrate Ion Concentrations in the Great Plains (2000-2010)

IMPROVE
Interagency Monitoring of Protected Visual Environments

Jenny L. Hand[1], Kristi A. Gebhart[2], Bret A. Shichtel[2], and William C. Malm[1], Cooperative Institute for Research in the Atmosphere, Colorado State

Introduction

Particulate nitrate and sulfate are important secondary aerosols formed through chemical reactions in the atmosphere. Their precursors (i.e., NO_X and SO_2, respectively) originate primarily from combustion processes. Sulfate ion concentrations are highest in the eastern United States, up to 5-10 times the concentrations in the West, due to the proximity of significant SO_2 sources. Nitrate ion concentrations are highest in southern California and the Midwest due to high NO_X emissions and available ammonia, respectively. Both sulfate and nitrate impact the atmosphere and environment through their contributions to visibility degradation, wet deposition to aquatic and terrestrial ecosystems, and cloud-condensation nuclei and cloud microphysical processes.

From 2000 to 2010 NO_X emissions in the U.S. have decreased 63% and SO_2 emissions have decreased 55%, based on data from the U.S. Environmental Protection Agency. On an annual basis, it appears that the expense and resources invested in emission reductions are resulting in measurable improvements in air quality; however, this is not the case for specific seasons and regions. In particular, we highlight significantly increased December monthly mean sulfate and nitrate ion concentrations from 2000-2010 at rural IMPROVE sites in the Great Plains of the U.S. We speculate as to possible causes for these trends and comment on implications for increased concentrations in this region.

Data and Methods

We used $PM_{2.5}$ sulfate and nitrate ion data analyzed by ion chromatography and artifact-corrected. A linear Theil regression was performed to determine the percent change in concentration over time (% yr^{-1}). We assumed that a trend was statistically significant at a 90% confidence level ($p \leq 0.10$) using Kendall tau statistics. All IMPROVE data and metadata, detailed descriptions of the network operations, and data analysis and visualization results are available from http://views.cira.colostate.edu/fed/.

Results

Isopleths of 2000-2010 trends in December monthly mean particulate sulfate and nitrate ion concentrations are presented in Figures 1a and 1b, respectively. Increased concentrations were associated with a swath of sites that extended from the northern Great Plains south into the central Great Plains. Many sites within this swath corresponded to trends of at least 5% yr^{-1} or higher, and the similarity between the spatial patterns in sulfate ion and nitrate ion trends was striking. The maximum sulfate ion trend within this swath was 17.5% yr^{-1} ($p = 0.06$) at Fort Peck, Montana, and the maximum nitrate ion trend of 11.1% yr^{-1} ($p = 0.01$) occurred at Wind Cave National Park, South Dakota. The patterns shown in these figures were observed only for December monthly mean trends. Timelines of data for these sites demonstrated a strong increase in concentrations beginning around 2006.

Implications

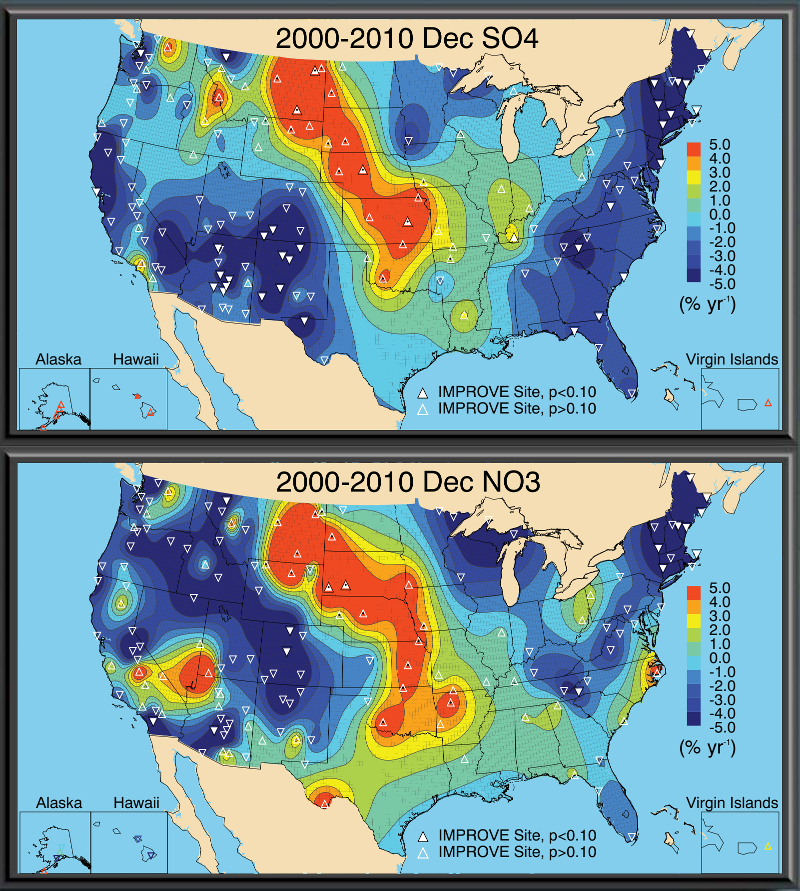

Figure 1. 2000-2010 Trends in December monthly mean concentrations in (a) particulate sulfate ion concentrations and (b) particulate nitrate ion concentrations. Upward- and downward-pointing filled triangles correspond to increasing and decreasing trends, respectively, that were significant at a 90% confidence level ($p < 0.10$). Unfilled triangles correspond to trends with significance levels of $p > 0.10$.

Both the location and timing of these trends have important implications. Increasing particulate nitrate and sulfate concentrations obviously intensifies their impacts to the environment, such as visibility degradation and acid precipitation. Nitrate is already a major contributor to fine mass at many sites in the northern and central Great Plains in winter. While sulfate concentrations historically have been highest in spring and summer in these regions, remarkably, the highest concentrations at sites within this swath shifted to winter and fall maxima in 2009 and 2010. In 2010 nearly every site in the swath of positive trends was associated with maximum sulfate concentrations during winter months.

The positive December monthly mean trends are important because they counter the national annual declining trends in NO_X and SO_2 emissions based on controls of regulated sources such as power plants and mobile sources. The similarity in the magnitudes and spatial patterns in December sulfate and nitrate ion trends suggests a common cause.

Some possibilities can be speculated. Oil and gas development in several states located in the swath of positive trends has been significant and is projected to further increase. Oil and gas production and associated activities are sources of NO_X and to a lesser degree SO_2. SO_2 can be emitted from flaring of hydrogen sulfide gas (H_2S) in regions with sour gas basins, such as in northern Wyoming, northern North Dakota, and northeastern Oklahoma, and from diesel motor emissions and mobile sources associated with oil and gas production. Population has also increased in towns associated with oil and gas development. Trends based on census data suggest an increase in population (~0.4 - 1.2% yr^{-1} from 2000 to 2009) in states associated with increasing sulfate and nitrate trends.

Long-range transport is also a possible cause. Emissions of NO_X, SO_2, and reduced sulfur species from oil sand operations in Alberta, Canada, are significant. Concentrations in both NO_2 and reduced sulfur species have increased considerably from 2000 to 2010 at industry monitoring sites near the oil sands. Back trajectories for sites in the northern Great Plains, such as Fort Peck, Montana, implicate this area. However, back trajectory analyses do not pinpoint any individual source area as being responsible for increasing trends at all sites. They do suggest that a combination of local and long-range sources are likely responsible. Increased sulfate ion and nitrate ion concentrations are likely a combination of typical winter meteorological patterns that transport high concentrations into the region or trap increased local concentrations during stagnation events.

The success of regulatory efforts in reducing annual pollutant concentrations in the United States apparently does not extend to the historically clean Great Plains region, where winter concentrations have significantly increased, unlike other times of the year. Additional analysis is necessary to understand the sources and causes of these positive trends. If unregulated emission sources are responsible, it has important implications for our current air quality mitigation strategies.

More information can be found in the published article by Hand et al., Atmospheric Environment 55 (2012) 107-110.

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State University, Fort Collins, CO

Loup Loup Ski Resort, Pasayten, Washington

Ron Mackie has been involved with air quality monitoring for roughly 25 years, starting with the installation of the equipment in Pasayten. He was the general manager of the Loup Loup Ski Bowl located at the top of Little Buck Mtn. in Washington. The ski area is named after Loup Loup Pass which is en route. Ron had been instrumental in the ski area's development and operation. He had been a logger in the 70s and 80s, later became involved with ski sales and rentals, then with marketing and advertising for newspapers, and now works for an electric company. He had been reading meters for the last 3-1/2 years but now works in the company's office, although he remains an outdoor person whose heart is still in the ski industry. An energetic and industrious man, he loves what he does and still runs several businesses, including a ski rental shop that is currently being managed by his youngest son.

Ron likes to play in the water and loves snorkeling, SCUBA diving, waterskiing, jet skiing, and boating. He was a sailboard instructor for several years in the 80s, back when he had his sporting goods stores.

He has been married for 26 years, has three sons in their 20s and 30s, and also has two dogs and three cats. The dogs love riding with Ron on his 4-wheeler to the top of the mountain to the IMPROVE sampler site.

Wintertime access to the IMPROVE samplers is often by 4-wheel ATV that Ron outfits with tracks. His youngest son Dustin, who is 6'3" and weighs 220 lbs., is often seated up front as a counterweight to keep the tracks in the snow when going up steep hills. In the summers, Ron often rides his motorcycle to the site – to conserve on gas and to have fun.

While the vistas in the area are occasionally shrouded by the pall of smoke from a wildfire, the otherwise clear air usually affords excellent views from atop the mountains.

October

> There is a great need for the introduction of new values in our society, where bigger is not necessarily better, where slower can be faster, and where less can be more.
>
> – Gaylord Nelson

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Sep 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 29 30		**1** *274 Julian day* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	**2** *275*	**3** *276*	**4** *277* IMPROVE particle sampling day	**5** *278*
6 *279*	**7** *280* IMPROVE particle sampling day	**8** *281* Change IMPROVE particle cartridges.	**9** *282*	**10** *283* IMPROVE particle sampling day	**11** *284*	**12** *285*
13 *286* IMPROVE particle sampling day	**14** *287* Columbus Day (Observed)	**15** *288* Change IMPROVE particle cartridges.	**16** *289* IMPROVE particle sampling day	**17** *290*	**18** *291*	**19** *292* IMPROVE particle sampling day
20 *293*	**21** *294*	**22** *295* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	**23** *296*	**24** *297*	**25** *298* IMPROVE particle sampling day	**26** *299*
27 *300*	**28** *301* IMPROVE particle sampling day	**29** *302* Change IMPROVE particle cartridges.	**30** *303*	**31** *304* Halloween IMPROVE particle sampling day	Nov 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 29 30	

A New Visibility Metric:
Unimpaired Visibility

IMPROVE
Interagency Monitoring of Protected Visual Environments

William C. Malm, Cooperative Institute for Research in the Atmosphere, Colorado State

Written discussions concerning atmospheric optics and sky color can be traced back as far as the ancient Greek civilization. Much of early photometry can be attributed to Bouguer who, in addition to other contributions, derived the exponential law of attenuation of a collimated beam of light, as well as recognized quantitatively that the apparent brightness of an object is the sum of air light and the attenuated image-forming information from some landscape feature of interest. In fact, he stated that if one looks carefully, a tree-covered mountain is visible if the difference between the brightness of the mountain and background sky is about 1 part in 50 or a contrast of 0.02! Lambert in 1774 actually presented algebraic equations of these relationships. Up until about 1970, visibility research was mostly concerned with aircraft operations and the military's need to identify and recognize targets from the air, ocean, underwater, and to some degree, space.

During this time period, visibility was almost exclusively used to denote the human capability to detect, recognize, and identify objects by means of the human visual mechanism without the aid of intervening sensor systems. In the early 1970s the National Park Service (NPS) and other federal land managing agencies were mandated with the responsibility of preserving and protecting the features and natural beauty of NPS units for the enjoyment of present and future generations. Part of this mandate is derived from the Clean Air Act (CAA) and its amendments that charge the federal land managers of mandatory federal Class I areas with the responsibility of protecting the air-quality-related values (including visibility) of the units under their jurisdiction.

In the context of being able to see and appreciate scenic landscape features, visibility is more than being able to see a black object, or any other object for that matter, at a distance for which the contrast reaches a threshold value. Coming upon a mountain an observer does not ask, "How far do I have to back away before the vista disappears?" Rather, the observer will comment on the color of the mountain, on whether geological features can be seen and appreciated, or on the amount of snow cover resulting from a recent storm system. He or she may comment on the contrast detail of nearby geological structures or on shadows cast by overhead clouds. A more relevant question to a visitor to a scenic area such as a national park or wilderness area is at what distance can an observer see no change in scenic quality under conditions of an increase in haze or atmospheric extinction?

Whereas the farthest distance an observer can see a landscape feature is a threshold problem, the level of contrast that can be just discerned or noticed, the unimpaired visual range question presents itself in the context of a suprathreshold issue in that the question becomes one of how much contrast change from some base contrast can be noticed.

The simplest relationship between the increase or decrease in contrast that can be just noticed is Weber's law [equation 1] $\Delta C = kC_i$, where $\Delta C = Cf - C_i$ and Cf and C_i are the contrast of some landscape feature after and before the introduction of atmospheric haze as represented by some increase in atmospheric extinction, b_{ext}, and k is a constant determined empirically.

Consider an atmosphere free of atmospheric particles. The contrast of landscape features as a function of distance and atmospheric extinction is given by [equation 2] $C_i = C_o e^{-b_{ray} r}$, where b_{ray} is the Rayleigh scattering coefficient. The ensuing contrast of landscape features as a function of distance under this increase in extinction is [equation 3] $C_f = C_o e^{-(b_{ray}+b_{ext})r}$. Substituting equations 3 and 2 into equation 1 and solving for r defines the unimpaired visual range as [equation 4] $V_{ur} = \text{const}/b_{ext}$, where const = $-\ln(1 + k)$. For a value of $k = -0.16$, const = 0.17 and the unimpaired visual range is given by [equation 5] $V_{ur} = 0.17/b_{ext}$.

Figure 1 is a plot of visual range in red and unimpaired visual range in blue. In a particle-free atmosphere, the visual range is 391 km, while the unimpaired visual range is infinite in that it is defined relative to a Rayleigh atmosphere. It should be kept in mind that even though $V_{ur} = \infty$, objects farther than 391 km cannot be seen. At atmospheric particle concentrations equal to Rayleigh, or about 0.01 km^{-1} (total $b_{ext} = 0.02$ km^{-1}), $V_r = 196$ km and $V_{ur} = 17$ km, while at $b_{ext} =$ 0.10 km^{-1}, the two visual ranges are 39 km and 1.7 km, respectively. Under the above assumptions, the increase in particle scattering that would cause a just noticeable change in landscape visual air quality would occur at a value that is about 8% greater than Rayleigh scattering, or about 0.0008 km^{-1}.

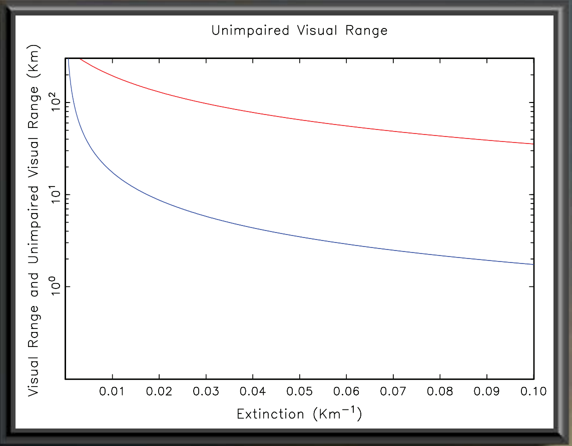

Figure 1: Plot of visual range (red) and unimpaired visual range (blue) as a function of particle extinction.

In Figure 2, the farthest landscape feature just visible on the horizon is Navajo Mountain, as seen from a Bryce Canyon National Park overlook. Navajo Mountain is 130 km distant while the unimpaired visual range is on the order of a few kilometers.

Figure 3a is an annual average isopleth map of unimpaired visual range while Figures 3b and 3c show similar maps for the months of June and December. The average lowest unimpaired visual range of less than 1 km is along the Ohio river valley and parts of northern Mississippi, Alabama, and Georgia, while the best unimpaired visual range of about 18-20 km is along the Rocky Mountains, extending all the way from central Montana down to northern New Mexico. There is also an area of relatively high unimpaired visual range is along the border of Utah and Nevada. Areas of Southern California also have areas of unimpaired visual range of less than 1 km.

Figure 2: An example of scenic landscape features at the visual and unimpaired visual range.

June and December maps of annual average unimpaired visual range show the monthly average extremes that make up the annual average. The unimpaired visual range is at its lowest during the summer months and highest during the winter. Unimpaired visual range is greater than about 40 km in parts of the western United States while the areas of lowest unimpaired visual range shifted from the central-eastern to the central United States. The ability to see unimpaired landscape features at distances of greater than 40-50 km is really quite striking and indicative of very clear air.

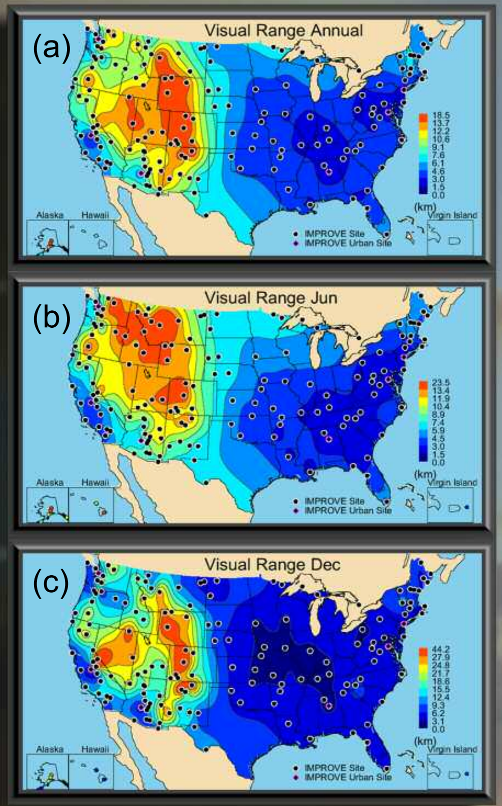

Figure 3: Isopleth maps of annual, June, and December average unimpaired visual ranges.

Egbert, Ontario

This site is located near the small community of Egbert in Essa Township at Environment Canada's Centre for Atmospheric Research Experiments and is part of a collaboration between IMPROVE and the Canadian Air and Precipitation Monitoring Network (CAPMoN). The facility is surrounded by a mixture of forest and agricultural land, and the location is intended to be regionally representative of air quality in south-central Ontario. The IMPROVE samplers are located on the roof of the Clean Air Building (below) along with a wide array of air quality and meteorological measurement instrumentation.

Mr. Dennis Z. Krejci supports the CAPMoN network on site, 365 days a year, regardless of the weather. Egbert experiences a wide variety of weather conditions, strongly influenced by its position between three of the five Great Lakes. Winters can bring down strong arctic air masses, high winds, and blizzards from the north. Summers can bring sudden heavy rains or severe thunderstorms. In the fall there can be days with near-zero visibility due to thick fog. The roof of the air building is even equipped with special fog lights to help with instrument operations.

Mr. Krejci operates air quality monitors and samplers and precipitation collectors. He collects precipitation daily and prepares it for further lab analysis with accompanying daily documentation. He also participates in the ongoing mercury deposition monitoring program, operates other instruments measuring the concentrations of PM2.5 and PM10, and operates climate chemistry equipment.

Dennis, who says he is not an 'urban' person, enjoys the rural outdoors, loves nature and its beauty, is interested in and tracks the weather, and appreciates working near where he lives. His hobbies center around enjoying the lakes that surround him and his family – especially beautiful Lake Simcoe, which is very close to his residence. He also enjoys year-round hiking with his family in county forests and in a Tiffin conservation area with ponds and hiking trails.

November

You can never get enough of what you don't need to make you happy.
– Eric Hoffer

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

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

Oct 2013

S	M	T	W	T	F	S
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27	28	29	30	31		

Dec 2013

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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

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

◆ Watch for frost on the inlets.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 305 Julian day	2 306
3 307 Daylight Savings Time Ends IMPROVE particle sampling day	4 308	5 309 Election Day Change IMPROVE particle cartridges.	6 310 IMPROVE particle sampling day	7 311	8 312	9 313 IMPROVE particle sampling day
10 314	11 315 Veterans Day	12 316 IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	13 317	14 318	15 319 America Recycles Day IMPROVE particle sampling day	16 320 National Park Service established, 1916
17 321	18 322 IMPROVE particle sampling day	19 323 Change IMPROVE particle cartridges.	20 324	21 325 IMPROVE particle sampling day	22 326	23 327
24 328 IMPROVE particle sampling day	25 329	26 330 Change IMPROVE particle cartridges.	27 331 IMPROVE particle sampling day	28 332 Thanksgiving	29 333	30 334 IMPROVE particle sampling day

Operator Involvement -- The Key to Network Success

A Promising Method for Measuring OM/OC on IMPROVE Teflon Filters Using FT-IR

IMPROVE
Interagency Monitoring of Protected Visual Environments

A.M. Dillner, T.C. Ruthenburg, Crocker Nuclear Laboratory, IMPROVE Group, University of California, Davis, CA

Introduction

Organic material (OM) is major contributor to fine particulate matter in urban and rural regions and is included in the Regional Haze Rule calculations. Organic material is composed of organic carbon (OC) and its associated oxygen, hydrogen, sulfur, and nitrogen. OM is currently estimated in the IMPROVE network by multiplying OC obtained from thermal optical reflectance (TOR) analysis of quartz filters by a constant value called OM/OC. IMPROVE currently uses a value of 1.8 for OM/OC. However, OM/OC varies by site, season, and sampling event and is expected to range from 1.3 to 2.2 or higher. Below, we discuss a promising method for measuring OM and OM/OC on Teflon filters collected in the IMPROVE network.

Fourier Transform – Infrared Spectroscopy (FT-IR) is a method that can be used to non-destructively determine OC and OM in particulate matter samples collected on Teflon filters. In the IMPROVE network, samples collected on Teflon are currently analyzed nondestructively for particle mass, elements, and light absorption and then stored for possible reanalysis. FT-IR measures the amount of types of chemical functional groups based on the way the functional group absorbs infrared light. Organic bonds of interest to particulate matter samples are aliphatic C-H, carbonyl (C=O), acid O-H, alcohol O-H, organonitrates, amines, and organosulfates.

OC is the sum of the carbon mass from each functional group that contains carbon, and OM is sum of the all of the organic functional groups. The OC, OM, and OM/OC can be determined for each sample analyzed. FT-IR is not able to quantify individual compounds in particulate matter samples, and to date, no one has quantified graphitic carbon using FT-IR. Here we describe an FT-IR method for quantifying organic material on IMPROVE Teflon filters and show that the method compares well to TOR OC measured on the quartz filter and that the OM/OC at several IMPROVE sites vary by site, sample, and season.

Methods

The FT-IR instrument is calibrated using laboratory-generated standards which are Teflon filters loaded with varying amounts of different OMs. Standards of OM are made using the apparatus shown in Figure 1. Solutions of individual compounds are atomized, and dry particles of the compound are collected onto Teflon filters, and the gravimetric mass of the compound on the filter is measured. The standards are scanned by a Bruker Tensor 27 FT-IR in transmission mode. Figure 2 shows that functional groups have characteristic absorbances (peak location and peak shape in the spectrum) and that the peak height or area increases with increasing mass on the filter. Standards are made with 1, 2, or 3 compounds in layers of different compounds to more closely mimic ambient OM.

Partial least squares regression (PLSR) is used to create a calibration from the standards by regressing the absorbing regions of the infrared spectrum against the known functional group mass. Separate calibrations are made for each functional group included in the calibration to date: alcohol O-H, carboxylic acid O-H, alkane C-H and carbonyl C=O. Functional group mass is (functional group mass) / (standard compound molecular mass) times mass on filter, where the mass on the filter is obtained by weighing the Teflon filter before and after adding a layer of compound. Two-thirds of the standards are used for calibration and one-third are used as a test set. The calibration can be improved by including more standards with the carbonyl functional group and adding standards and a calibration for additional functional groups.

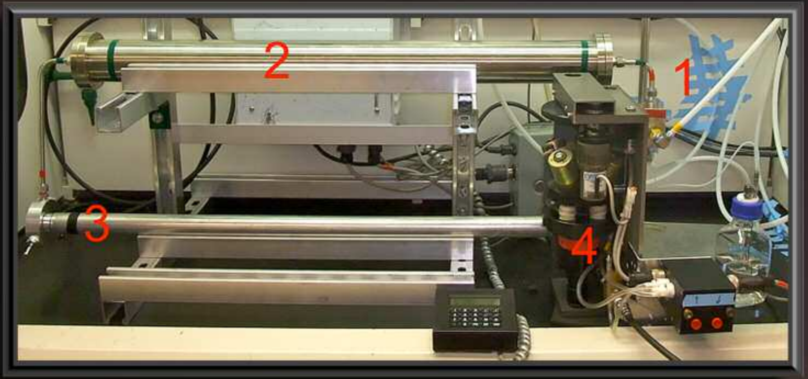


Figure 1. Organic material standards used to calibrate the FT-IR instrument are made using the above apparatus. Solutions of a single organic compound are atomized (1). The resulting droplets are dried in a diffusion dryer (2) and mixed with particle free air (3) before being collected on a Teflon filter with an IMPROVE sampler (4).

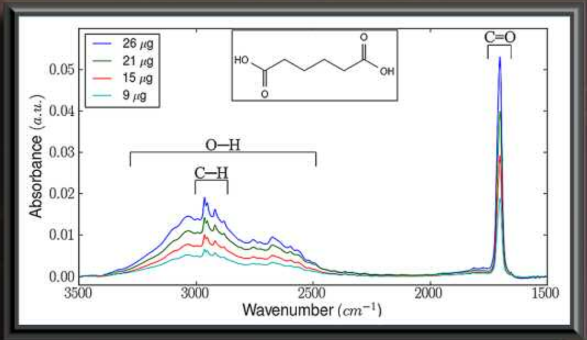


Figure 2. FT-IR spectra of four different masses of adipic acid, a linear dicarboxylic acid molecule. Each functional group in carboxylic acids, carbonyl (C=O), carboxylic acid OH (O-H), and linear alkane CH (C-H), absorb with a chacteristic peak location and peak shape and increase with increasing mass on the filter.

IMPROVE Teflon filters from several sites (shown in Figure 3) for samples collected from January through August 2011 were analyzed by FT-IR and the corresponding artifact corrected OC measured by TOR was obtained from the VIEWS (Visibility Information Exchange Web System) website.

Results

OC from FT-IR analysis of IMPROVE Teflon filters at eight sites is compared to the total OC as reported on the VIEWS website in Figure 4. There is reasonable agreement between the two methods as indicated by the slope of the regression being close to 1. The correlation between the two methods is also reasonable but there is some scatter. Figure 5 shows that the OM/OC calculated from the FT-IR measurements of OM and OC is generally higher than 1.8, with the distribution centered around 2.2. Although this is higher than is typically determined by other methods, 2.2 may be a reasonable value for the rural sites in the IMPROVE network. OM/OC varies by sample at a given site and for most sites increases in summer months but is generally higher at Proctor Maple Research Facility and St. Marks than at Mesa Verde and Phoenix.

FT-IR is a promising method for nondestructively obtaining OM/OC for each sample in the IMPROVE network, using the Teflon filters that are already being collected. The measured functional groups provide additional information about the composition of the OM than can be used to evaluate sources and/or age of the particulate matter.

Figure 3. Teflon filters collected in 2011 were analyzed by FT-IR at the sites shown.

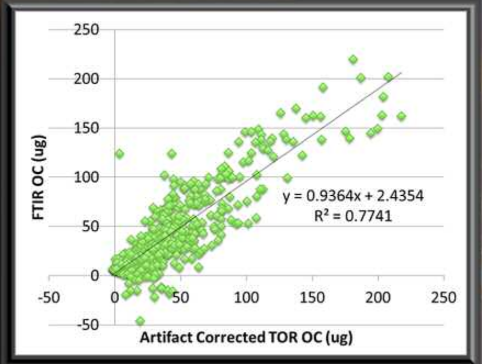


Figure 4. Organic carbon determined from measuring functional groups on Teflon filters at eight IMPROVE sites using FT-R compared to artifact-corrected organic carbon obtained from thermal optical reflectance method on quartz filters. The TOR data was obtained from the VIEWS website.

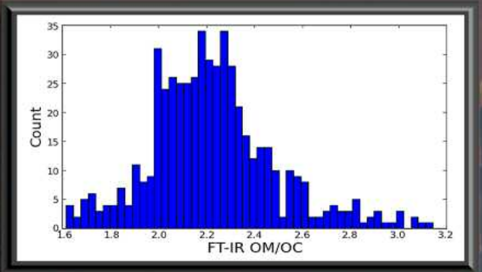
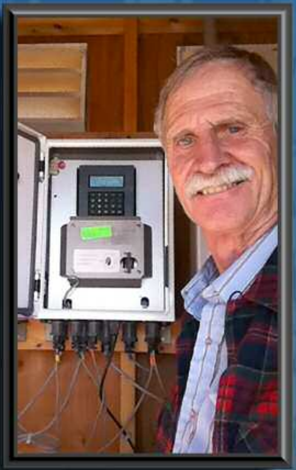


Figure 5. The distribution of OM/OC ratios for eight IMPROVE sites for samples collected January through August 2011.

Saguaro National Park, Arizona

December

There is hope if people will begin to awaken that spiritual part of themselves, that heartfelt knowledge that we are caretakers of this planet.
– Brooke Medicine Eagle



Saguaro National Park consists of two units that form bookends on either side of Tucson, Arizona. The Rincon Mountain District on the east is 68,000 acres in size and ranges in elevation from 2,400 to 8,666 feet. The Tucson Mountain District to the west is 24,000 acres and tops out at 4,687 feet. Although Saguaro was a national monument when the Clean Air Act Amendment of 1977 was passed, it is a Class I area because its 70,000-acre wilderness was designated prior to the law's passage.

Because almost a million people live in close proximity to the park, maintaining clean air has been a priority for years. Tucson has little heavy industry, so smokestack pollution is not an issue, but mobile sources and area sources such as mines, agricultural fields, and dust from land cleared for development can impair visibility. Regional haze can be transported from urban centers such as Phoenix, San Diego, and Nogales, Sonora, Mexico.

An IMPROVE monitoring station was established in the east unit of the park in 1987. It has operated continuously since then, although for some years it was a protocol station with only Module A. With the expansion of the IMPROVE system about a decade ago, the station at Saguaro East was upgraded to include all four modules. At the same time, the Arizona Department of Environmental Quality and the Pima County DEQ partnered with the park to install and operate a protocol IMPROVE station at the west district of the park. The park provides staff to change the filters and maintain both stations, while ADEQ pays for analysis of the filters from Saguaro West.

The IMPROVE data are used by both the state agency and federal land managers to gauge progress on maintaining clear skies. The operators of the two sites at Saguaro are **Philip Brown**, a long-time interpreter and technician in the park, and **Kitra Henker**, a student employee from the University of Arizona. Both Philip and Kit have many other duties in addition to operating the sites, including offering interpretive programs (Philip) and helping treat exotic plants (Kit).

Kit is pursuing a degree in marine biology. In her free time she likes to SCUBA dive.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 *335 Julian day*	2 *336*	3 *337* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	4 *338*	5 *339*	6 *340* IMPROVE particle sampling day	7 *341*
8 *342*	9 *343* IMPROVE particle sampling day	10 *344* Change IMPROVE particle cartridges.	11 *345*	12 *346* IMPROVE particle sampling day	13 *347*	14 *348*
15 *349* IMPROVE particle sampling day	16 *350*	17 *351* Change IMPROVE particle cartridges.	18 *352* IMPROVE particle sampling day	19 *353*	20 *354*	21 *355* IMPROVE particle sampling day
22 *356*	23 *357*	24 *358* IMPROVE particle sampling day Special cartridge change: move cassette 3 from old cartridge to new.	25 *359* Christmas	26 *360*	27 *361* IMPROVE particle sampling day	28 *362*
29 *363*	30 *364* IMPROVE particle sampling day	31 *365* New Year's Eve Change IMPROVE particle cartridges.				

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

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

Nov 2013

S	M	T	W	T	F	S
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Jan 2014

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26	27	28	29	30	31	

Operator Support

IMPROVE
Interagency Monitoring of Protected Visual Environments

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 for 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

Barbara Colletta
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.)

Parijata (Pari) Prabhakara
Operator / Field Support
530-752-4905

Michael Truong
Operator / Field Support
530-752-0933

Reuben Krofft
Operator / Field Support
530-752-3440

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

The group

Proctor Maple Research Center, Underhill, Vermont

You don't need a lot of experience being an IMPROVE site operator to be a good one. **Daniel Brese** has proven this, as he is quick to troubleshoot and correct problems, sometimes before UC Davis technicians can offer advice. Daniel, an environmental technical specialist for the Air Pollution Control Division at the Vermont Agency of Natural Resources, has maintained the Proctor Maple Research Center (PMRF1) air quality monitoring station in northern Vermont for about 15 months. The center focuses its research on the sugar maple tree, its sap, and its syrup. "The tree and its products are economically important to our state," said Daniel, "and it's culturally significant here and in Canada."

The air monitoring station at the center is equipped with an IMPROVE aerosol sampler as well as a variety of gaseous, particulate, air toxics, and heavy metal samplers. The station is located in a rural area that can be difficult to visit. Daniel reports that "Circumstances may change drastically overnight, and a 30-inch snowfall can make hiking into the station a challenge."

He is also responsible for operation of three other stations in the state's air monitoring network, and his efforts help in real-time assessment of criteria air pollutants in the region. Another of Daniel's current projects is finalizing the relocation of the state's air quality laboratory, which sustained heavy flood damage last August. "Literally everything was washed away," said Daniel. "The lab is important in maintaining the integrity of our air program and our goal is to have it fully operational again."

Daniel holds a BS in biology and an MS in ecology and has studied conservation in various parts of the country, including remote western prairies in Oregon and Kansas, alpine tundra in New Mexico, and eastern forests. He is a Vermont native who moved back to the state to be closer to family and live the lifestyle he enjoys with all its outdoor richness. In his free time, Daniel likes to ski and run. A recent venture in hard cider making has proven successful, and a cold, bubbly hard cider is his drink of choice after a long day's work.

January

The probability that we will fail in the struggle ought not to deter us from the support of a cause we believe to be just.
– Abraham Lincoln

Dec 2013

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Feb 2014

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23	24	25	26	27	28	

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

Pollutant Types, Molecules, and Source Classifications

This composite illustration shows the basic air pollution source types emitting various pollutants into the atmosphere.

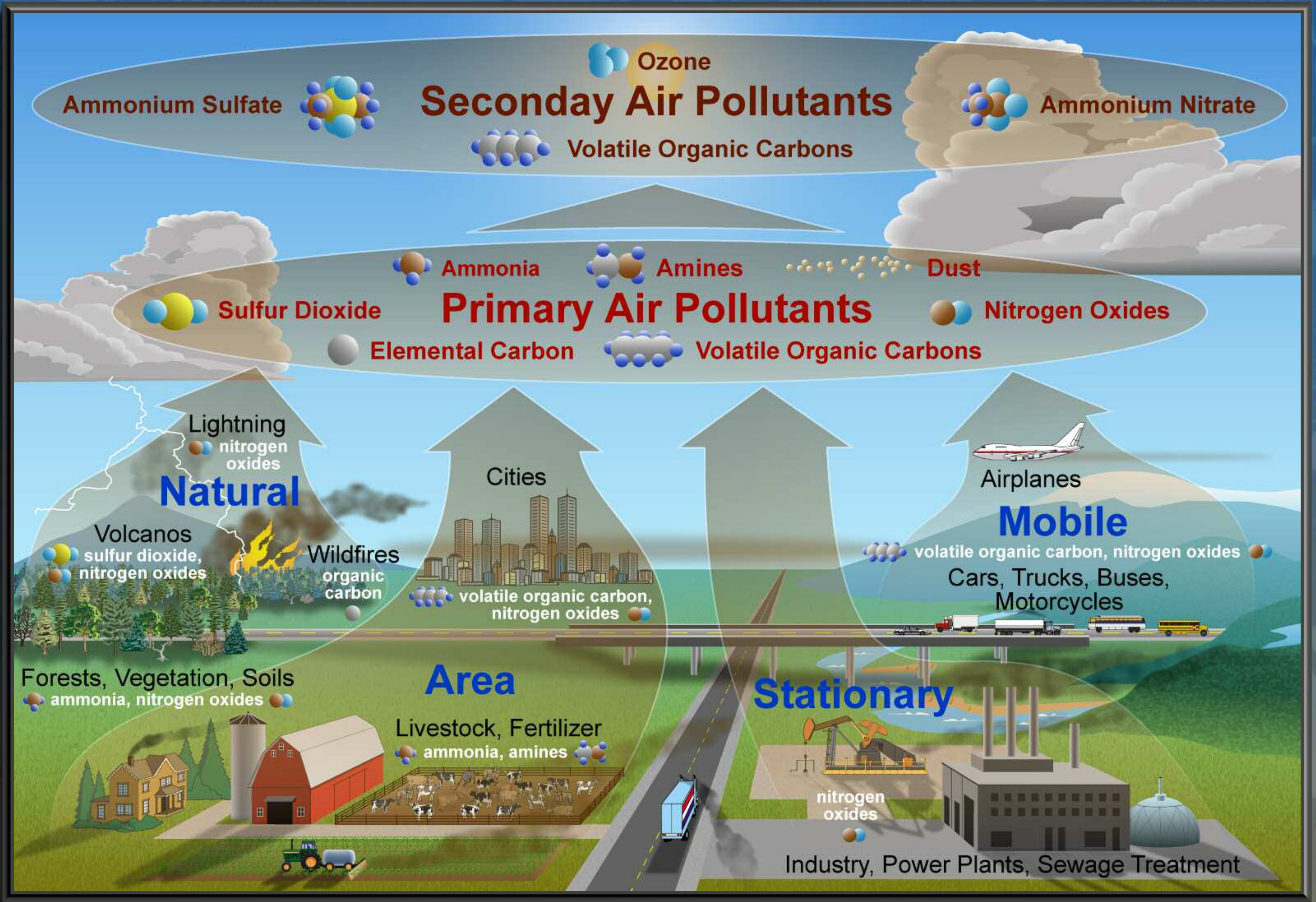
Sulfur dioxide can chemically convert to ammonium sulfate particles and deposit to the earth's surface as dry particles or can combine with moisture in the air to form "acid rain." The sulfate particles that remain in the atmosphere also cause visibility impairment, particularly as humidity increases.

Nitrogen oxide and hydrocarbon (VOC) gases cause the formation of ozone and other photochemical oxidizing agents that cause eyes to burn, throat irritation, coughing, chest discomfort, and can stunt or kill vegetation. Nitrogen dioxide can cause acidification of cloud water and form nitric acid vapor or can change into nitrate particles. The deposition of these species is a large part of the acid rain problem. Furthermore, particulate nitrate can cause visibility impairment, and as with sulfur dioxide, this impairment worsens in humid conditions.

Hydrocarbon gases can convert into carbon particles, and these can be emitted directly from fires and diesel engines. These carbon particles also contribute significantly to visibility impairment.

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 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

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ENVIRONMENT CANADA

MINISTRY OF ENVIRONMENT, REPUBLIC OF KOREA

Front cover photo: Butte Near Four Corners. Photographer: Jeff Lemke