INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS

IMPROVE

2nd Quarter 2005 | The IMPROVE Newsletter | Volume 14 / Number 2

Monitoring update

Feature Article: Review of IMPROVE light extinction equation, Page 4

Network operation status

The IMPROVE (**I**nteragency **M**onitoring of **Pro**tected **V**isual **E**nvironments) Program consists of 110 aerosol visibility monitoring sites selected to provide regionally representative coverage and data for 156 Class I federally protected areas. Additional instrumentation that operates according to IMPROVE protocol in support of the program includes:

- 65 aerosol samplers
- 15 transmissometers
- 41 nephelometers
- 11 film or digital camera systems
- 52 Web camera systems
- 3 interpretive displays

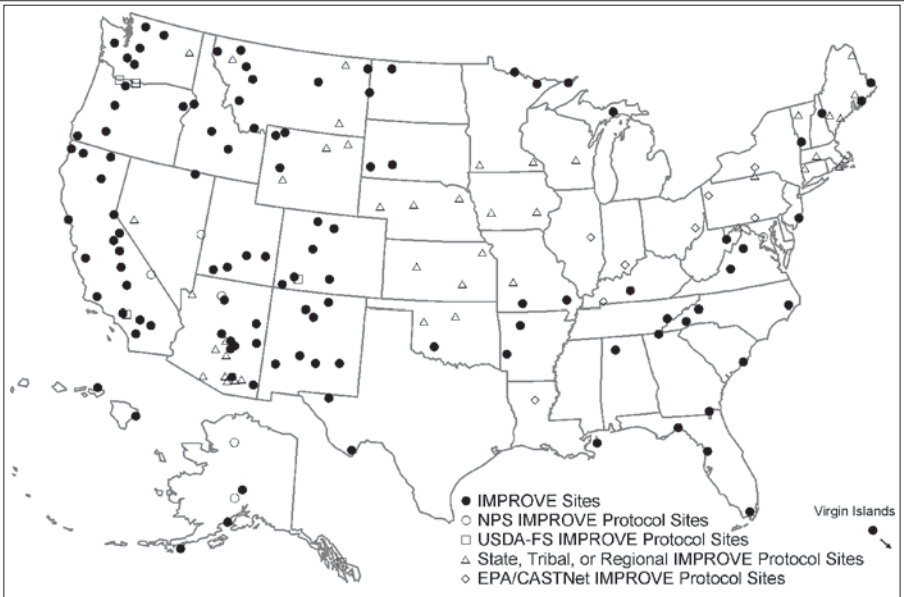
IMPROVE Program participants are listed on page 8. Federal land managing agencies, states, tribes, regional air partnerships, and other agencies operate supporting instrumentation at monitoring sites as presented in the map below. Preliminary data collection statistics for the 2nd Quarter 2005 (April, May, and June) are:

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

Aerosol samplers were removed from Hillside, AZ, and from Spokane, WA, during the 2nd quarter. Both sites were part of the IMPROVE Protocol network.

Three nephelometers ended monitoring in late March. The instrument at Great Gulf Wilderness, NH, operated during summers since June 1995, and the two at Columbia River Gorge National Scenic Area, OR, operated year-round since August 1993 (Wishram) and June 2001 (Zion).

One Web camera became operational in May; Detroit, MI, became the tenth camera in the MidWest Hazecam network, sponsored by the Lake Michigan Air Director's Consortium (LADCO).



IMPROVE and IMPROVE Protocol Sites
2nd Quarter 2005

Data availability status

Data are available on the IMPROVE Web site, at *http://vista.cira.colostate.edu/improve/Data/data.htm.* IMPROVE and other haze related data are also available on the VIEWS Web site, at *http://vista.cira.colostate.edu/views*.

Aerosol data are available through August 2004. Transmissometer and nephelometer data are available through December 2003 and March 2005 respectively. Photographic slide spectrums are also available on the IMPROVE Web site, under *Data*. Real-time Web camera displays are available on a variety of agency-supported Web sites.

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

Visibility news

Nephelometer span gas calibration multiplier reevaluated

The IMPROVE Program has used Optec NGN-2 integrating nephelometers in the optical monitoring network since 1993. The instruments, used to measure the scattering coefficient of a continuously sampled known volume of ambient air, are calibrated with clean (particle-free) air and a gas with known scattering properties. Experiments to reevaluate the calibration gas currently used showed a change was warranted in the calibration multiplier used in data processing. Because of these experiments, all historical nephelometer data have been reprocessed to include the change, and are available on the IMPROVE Web site.

Nephelometer calibrations are currently performed using HFC 134a gas, also known by the DuPont trade name, SUVA. SUVA has a high light scattering coefficient, is inexpensive, widely available, and causes negligible environmental effects. Nephelometer calibration depends entirely on the published SUVA scattering coefficient, expressed as a multiple of Rayleigh (clean air) scattering, which has been reported in the range of 7.1 to 7.3. Based on early tests, the IMPROVE protocols historically used a value of 7.1.

Air Resource Specialists, Inc. (ARS) performed a series of experiments last August to reevaluate the scattering coefficient of SUVA. For these experiments, zero (Rayleigh) air, carbon dioxide, Freon 12, and Freon 22 provided reference standards, and a newly manufactured nephelometer (Optec NGN-2A) was used to measure the scattering of these various gases. Results show the raw nephelometer count was extremely linear when plotted against the known scattering coefficients. Using this linear relationship, the nephelometer counts for SUVA were related to a multiple of Rayleigh. The following calculated multiples of Rayleigh scattering for SUVA were recorded:

$7.24 \pm .05$ ($r^2 = 0.99986$)
$7.20 \pm .10$ ($r^2 = 0.99951$)
$7.26 \pm .04$ ($r^2 = 0.99991$)

A value of 7.25 was chosen as an approximation of these multipoint calibrations, and replaces the multiplier of 7.1 that had previously been used. This new multiplier effectively increases the NGN-2 scattering coefficient by approximately 2.5%.

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

Mobile laboratory designed for special studies

IMPROVE will soon have a mobile aerosol laboratory for use in special studies. The laboratory was designed collaboratively by scientists from Colorado State University and the University of California at Davis, and will be used by experimenters from various institutions. It will be easily deployed to remote locations where existing laboratory space is unavailable.

The 20-foot by 8-foot laboratory will be mounted on a truck body. The front half of the laboratory will house a chemistry lab, with benchtop space, a deionized water supply, and a glove box for handling samples in a very clean environment. The back half will house an array of gas, aerosol, and optical instruments. Gas sampling will include carbon monoxide, ozone, ammonia, nitric oxide, and nitrogen dioxide. Aerosol sampling will include samplers for continuous ions and carbon in fine particles, particle sizing instrumentation, MOUDI samplers for size-resolved aerosol chemistry, and a humidified tandem differential mobility analyzer (HTDMA) for investigating the hygroscopic properties of aerosols. Atmospheric optics will be measured using a nephelometer for light scattering and an aethalometer for light absorption.

The laboratory vehicle utilizes International Trucks' "Green Diesel" technology. This system was chosen because it has much lower emissions than conventional diesel, gasoline, or natural gas vehicles. Primary particulate matter emissions are especially low, an advantage when sampling ambient particulate matter. The vehicle's engine can be used to power an electrical generator for the laboratory when line power is unavailable. The laboratory can be used while the vehicle is moving, or when stationary.

The mobile laboratory is currently being outfitted by a laboratory specialty company in Kansas. Delivery is expected in late summer, when it will be transported to Fort Collins for instrument installation and testing by Colorado State University. Its first use will be in a special study to assess air quality in the Colorado Front Range area, in the vicinity of Rocky Mountain National Park.

For more information contact Chuck McDade at the University of California-Davis. Telephone: 530/752-7119. Fax: 530/752-4107. E-mail: mcdade@crocker.ucdavis.edu.

Monitoring Site Assistance:
Aerosol sites: contact University of California-Davis
telephone: 530/752-7119 (Pacific time)
Optical/Scene sites: contact Air Resource Specialists, Inc.
telephone: 970/484-7941 (Mountain time)

Grand Canyon visibility reaches unacceptable levels

Numerous fires have burned across Arizona already this summer, causing Grand Canyon National Park personnel to warn visitors and park staff of potentially harmful air quality levels in the park. Visibility levels, as recorded by the in-canyon transmissometer, reached unacceptable levels in late June and remained unacceptable through late-July. Particulate levels from portable samplers were classified in EPA's "sensitive risk" category.

As the satellite map image below shows (Figure 1), fires in the Southwest produced thick smoke from Nevada eastward to Kansas. The largest of the fires, in central Arizona, had consumed 200,000 acres by June 30. Fires in southern Nevada poured heavy smoke into Grand Canyon.

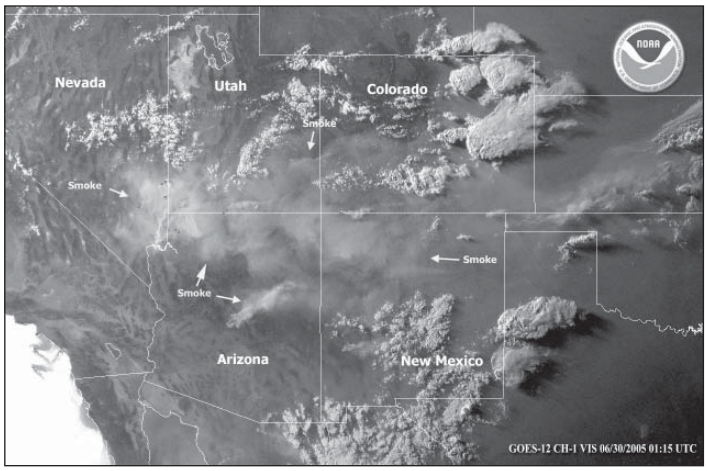


Figure 1. Numerous fires through much of the Southwest produced thick smoke, as seen in this NOAA satellite image, June 30, 2005.

After July 1, local fires had the most effect on Grand Canyon's visibility. Weather conditions remained fairly constant through mid-July, and air quality patterns fell into a daily routine. Rapid cooling at night encouraged heavy smoke to settle into the canyon overnight. Light winds during the day increased the ventilation, resulting in clearer visibility in the afternoons. Carl Bowman, Air Quality Specialist at Grand Canyon National Park, has prepared daily smoke reports since the fires began to have an affect on the park's visibility.

As seen in Figure 2, strong daily swings in visibility showed the dominant influence of local fires. Light winds and thermal ventilation beginning July 13 allowed hourly transmissometer readings (broken line), and the 24-hour averages (solid, dark line) to improve slightly. It took the arrival of monsoon rains around July 20 to begin putting out the fires, and visibility improved to "acceptable" levels July 26. "Average" visual conditions in early July were twice as hazy as the haziest 20% of July days (determined from long-term, instrument-specific readings). Park management defined unacceptable visibility as when the 24-hour average light extinction remained within the haziest 20% of the time for a full 24-hour day.

Real-time photographs, as well as hourly visibility levels and weather conditions in the canyon are available, updated every 15 minutes, at *http://www2.nature.nps.gov/airwebcams/parks/grcacam/grcacam.cfm*. Note that the camera looks above the rim and the transmissometer looks into the canyon, thus, local haze-like smoke may affect the photograph and visual range figures differently.

For more information contact Carl Bowman at Grand Canyon National Park. Telephone: 928/638-7817. Fax: 928/638-7755. E-mail: carl_bowman@nps.gov.

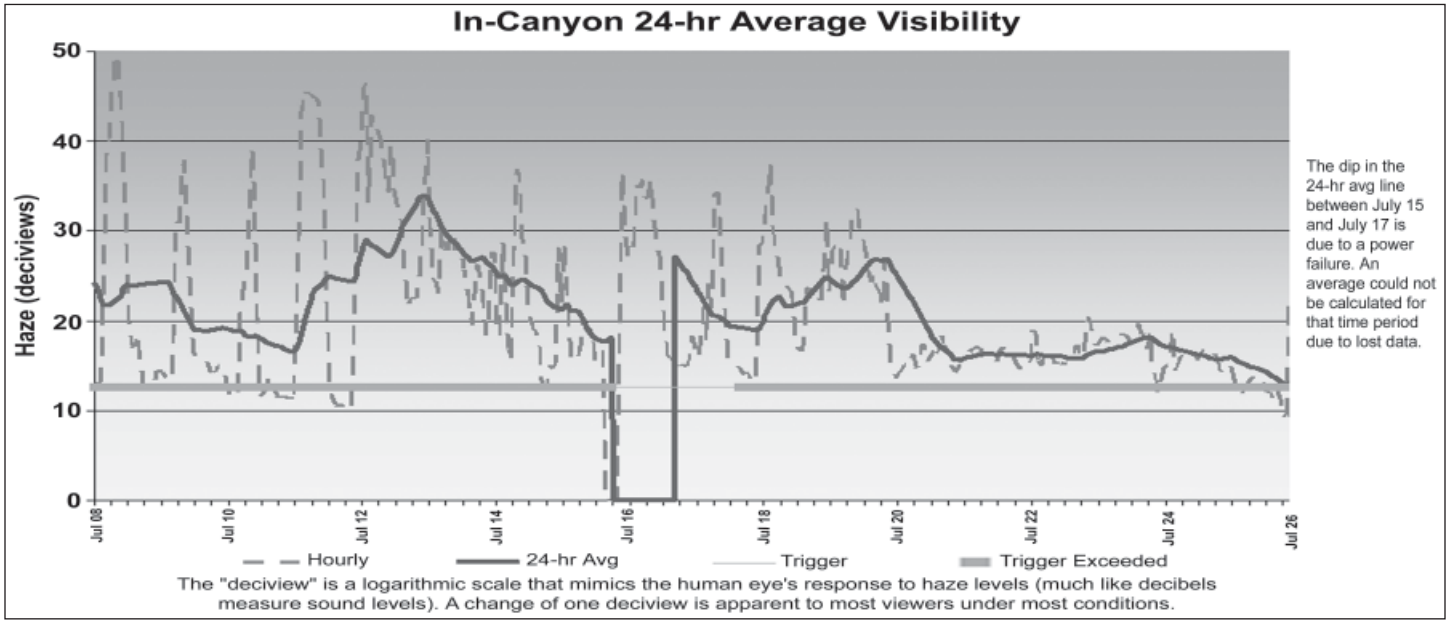


Figure 2. Visibility in Grand Canyon National Park, AZ, from July 8 - July 26, 2005. The broken line shows hourly In-Canyon transmissometer visibility readings. The solid, dark line is 24-hour averages of these readings, and the light, thick line is the "visibility trigger".

Feature article

Review of the IMPROVE equation for estimating ambient light extinction coefficients

(by J.L. Hand, Colorado State University/CIRA, and W.C. Malm, National Park Service/CIRA)

Introduction

Compliance under the Regional Haze Rule is based on IMPROVE protocols for reconstructing aerosol $PM_{2.5}$ mass concentrations and light extinction coefficients (b_{ext}) from speciated mass concentrations. The current IMPROVE equation used to estimate total light extinction coefficients associated with measured aerosol species is:

$$b_{ext} = (3.0)f(RH)[(NH_4)_2SO_4]+(3.0)f(RH)[NH_4NO_3]+ (4.0)[POM]+(1.0)[Soil]+(0.6)[CM]+(10.0)[LAC] \quad (1)$$

The formulation of the equations used in the mass and IMPROVE b_{ext} reconstructions requires a number of assumptions. Each assumption has associated uncertainties with obvious consequences for reconstructed extinction. We have recently reviewed the assumptions and some associated uncertainties inherent to this formulation, and suggest several refinements based on data that support modifications to the assumptions. Refinements of several of the assumptions, however, are not possible at this time, either because existing data do not warrant them, or because further measurements are required. Suggested refinements of the IMPROVE equation include:

- Changing the R_{oc} factor used to compute particulate organic matter ($POM=R_{oc}\cdot OC$)
- Modifying the *f(RH)* scattering enhancement curve to reflect some water associated with particles below a relative humidity of 40%
- Including sea salt in reconstructed mass and extinction equations
- Modifying values of dry mass scattering efficiencies to reflect current data and functional relationships between mass scattering efficiency and mass concentration

The following discussion provides a brief description of the motivation behind these suggestions. These recommendations are tentative; final refinements to the IMPROVE equation await future discussions of the modifications proposed here.

Particulate organic matter (*POM*) and the R_{oc} multiplier

Estimating the contributions of organic carbon aerosol to mass or scattering requires an estimate of the total mass associated with organic carbon. The organic carbon multiplier (R_{oc}) used to compute particulate organic material is an estimate of the average molecular weight per carbon weight for organic carbon aerosol, and takes into account contributions from other elements associated with the organic matter.

Because the organic compounds that compose *POM* are largely unknown, the approach for taking into account other elements in *POM* mass has been to apply an average multiplier. The current value of 1.4 applied in the IMPROVE equation dates back to samples collected in an urban location in the early 1970s and 1980s. More recently[1], solvent extractions from archived IMPROVE filters at five sites have been used to directly measure *POM* mass and carbon content, and to derive an average R_{oc} of 1.92 (range of 1.58-2.58). Another recent study[2] has demonstrated that an R_{oc} factor of approximately 1.8 allowed for closure in fine mass and light scattering coefficients for periods that encompassed both pristine conditions as well as the impacts of biomass burning and regional haze. Also, better agreement between measured and reconstructed fine mass was found by applying an R_{oc} factor of 1.8 during a biomass burning event in the New England and mid-Atlantic state regions[3]. A recent review article[4] about the R_{oc} multiplier recommends a factor of 1.6±0.2 for urban organic aerosols, a factor of 2.1±0.2 for non-urban organic aerosols, and values ranging from 2.2 to 2.6 for samples with impacts from biomass burning. These recent studies suggest that the current factor (R_{oc}=1.4) used to estimate particulate organic material in the current IMPROVE equation is undoubtedly low.

We estimated R_{oc} from IMPROVE data by applying an ordinary least square multiple-linear regression analysis using:

$$PM_{2.5,i} = a_1[(NH_4)_2SO_4]_i + a_2[NH_4NO_3]_i + a_3[OC]_i + a_4[LAC]_i + a_5[soil]_i + a_6[sea\ salt]_i \quad (2)$$

The annual mean value of R_{oc} derived from the above equation is shown for all IMPROVE sites in Figure 1, with obvious spatial trends. The annual mean coefficient over all sites is R_{oc} = 1.7 ± 0.2, with 158 sites having significantly valid coefficients. On a seasonal basis, the coefficients do not vary significantly. Based on estimates reported from other studies and the analysis performed here, we recommend an R_{oc} value of 1.8.

Scattering enhancement curve (*f(RH)*)

The hygroscopicity of atmospheric aerosols is an important characteristic that determines how a particle will behave in a changing relative humidity (RH) environment. Soluble particles will uptake water, resulting in increased mass and particle size, both of which determine how efficiently particles scatter light, as well as their atmospheric lifetimes.

It is likely that a large fraction of hygroscopic particles exist in supersaturated equilibrium as aqueous droplets below their deliquescence RH, based on the numerous studies that report a smooth function of particle growth with relative humidity rather than step-wise growth behavior.

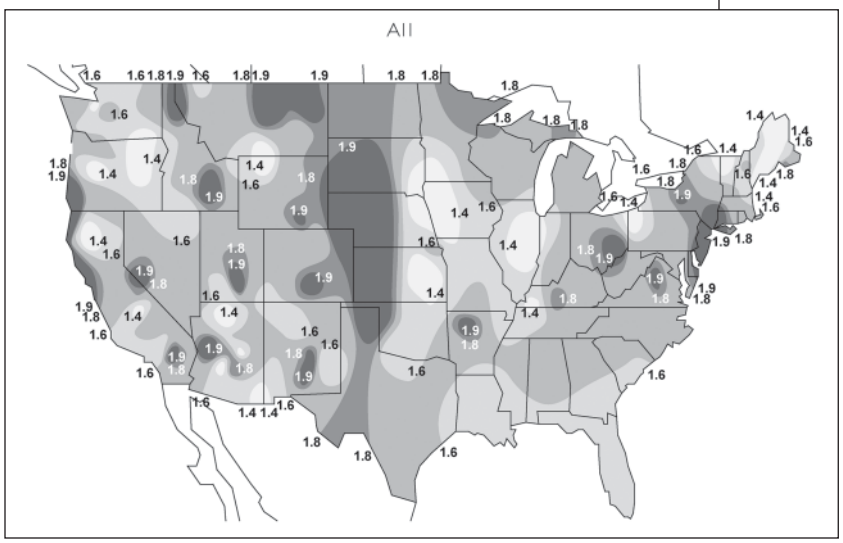


Figure 1. Annual mean value of R_{oc} multiplier derived from an ordinary least square multi-linear regression analysis.

The current *f(RH)* growth curve used in the IMPROVE equation is based on an interpolated particle growth curve between the ascending and descending branches of growth for ammonium sulfate, and reaches a value 1 at 40% RH (no water is associated with the particles below 40% RH)[5]. We propose applying an *f(RH)* growth curve corresponding to equilibrium calculations for ammonium sulfate below the deliquescence point to 0% RH, using the AIM (Aerosol Inorganics Model) with the "no solids" option[6]. This smooth curve approximates the behavior observed for mixtures of aerosols as observed in various studies, however, it differs from the current curve in that it allows water to be associated with the aerosol for RH values below 40%. The *f(RH)* scattering enhancement curve is consistent with the value of dry mass scattering efficiency used to compute extinction coefficients, therefore modifications made to one parameter must also be made to the other.

Sea salt

Although contributions from sea salt to coarse mass (and indirectly to fine mass) currently are not included in the reconstructed mass equation, sea salt can be a significant fraction of the fine mass at many coastal locations, as well as contribute significantly to light scattering. Because sea salt is hygroscopic, the added effects of water mass to light scattering in coastal higher RH environments could also be important. Difficulties in computing sea salt from IMPROVE network data arise because sodium ion data (the strongest indicator of sea salt) are not available. Elemental sodium data are available from X-ray fluorescence (XRF) analyses; however, sensitivity issues regarding poor detection of sodium result in large uncertainties corresponding to sodium from XRF[7]. Issues also arise when using the chloride ion or chlorine to estimate sea salt because reaction of gaseous nitric acid with sea salt produces sodium nitrate particles and the release of gaseous hydrochloric acid. The depletion of chloride during this reaction results in an underestimation of sea salt when using chloride to compute it. For non-coastal sites the inclusion of sea salt is not expected to have a considerable impact on reconstructed light scattering, so underestimating the contribution at those sites is not significant.

The multiple-linear regression analysis in Equation 2 included sea salt as $1.6 \cdot Cl^-$ (NaCl). This analysis suggests that east and west coastal sites underestimate sea salt mass by about 10% on average, even with some chloride depletion. We recommend that sea salt be included in the reconstructed fine mass equation as $1.8 \cdot Cl^-$ (sea salt is 55% Cl by weight as defined by the composition of sea water)[8] because of the uncertainties related to sodium measurements. The contributions of sea salt to the light extinction equation (including its hygroscopic properties) should also be included.

Mass scattering efficiencies

Suggesting modifications to dry mass scattering efficiencies (α) is more difficult. Estimates of dry mass scattering efficiencies depend on the aerosol composition and size distribution, both of which vary temporally and spatially, and typically are unknown without extensive measurements. We performed a comprehensive literature review that suggests the current values applied in the IMPROVE formulation are realistic, however, lowering mass scattering efficiencies for inorganic salts would be more consistent with available data. We also suggest that POM mass scattering efficiencies should be decreased, however, at least under some circumstances, the POM mass scattering efficiency is most likely higher than what is currently assumed. We recommend no changes to mass scattering efficiencies for fine soil and coarse mass, nor do we recommend changes to the LAC mass absorption efficiency.

Investigations of estimates of mass scattering efficiency from IMPROVE mass and nephelometry data suggest a functional dependence of mass scattering efficiencies on mass concentrations in that as mass concentrations increase, mass scattering efficiencies also tend to increase at most sites in an approximately linear fashion. Because there is no recognizable spatial pattern in this functional dependence for the sites investigated, we recommend that the same functional dependence of mass scattering efficiency for inorganic species (α_{inorg}) and (α_{POM}) be applied at all sites.

The refined IMPROVE equation is proposed as:

$$b_{ext} = (\alpha_{inorg})f(RH)_{new}[(NH_4)_2SO_4]+(\alpha_{inorg})f(RH)_{new}[NH_4NO_3]+(\alpha_{POM})[\text{POM}]+(1.0)[Soil]+(0.6)[CM]+(1.0)f(RH)_{new}[sea\ salt]+(10.0)[LAC] \quad \textbf{(3)}$$

IMPROVE equation continued on page 6....

***IMPROVE equation** continued from page 5....*

where: $f(RH)_{new}$ includes water below RH = 40 %.

$POM = 1.8 \cdot OC$

$sea\ salt = 1.8 \cdot Cl^-$

$\alpha_{inorg} = 3(0.7+0.02 \cdot M_{mix})$

$\alpha_{POM} = 3.63(0.7+0.02 \cdot M_{mix})$

$M_{mix} = [(NH_4)_2SO_4]+[NH_4NO_3]+[POM]$

Further discussion and analyses are ongoing to finalize the form of the IMPROVE equation. For a more comprehensive review of the IMPROVE equation, download a draft of the report at *http://vista.cira.colostate.edu/improve/Publications/GrayLit/016_IMPROVEeqReview/IMPROVEeqReview.htm.*

References

[1] El-Zanan, H.S., D.H. Lowenthal, B. Zielinska, J.C. Chow, and N. Kumar, Determination of the organic aerosol mass to organic carbon ratio in IMPROVE samples, *Chemosphere, In Press,* 2005.

[2] Malm, W.C., D.E. Day, C. Carrico, S.M. Kreidenweis, J.L. Collett, Jr., G. McMeeking, T. Lee, J. Carrillo, Inter-comparison and closure calculations using measurements of aerosol species and optical properties during the Yosemite Aerosol Characterization Study, *J. Geophys. Res., accepted for publication,* 2005.

[3] Poirot, R.L. and R.B. Husar, Chemical and physical characteristics of wood smoke in the northeastern U.S. during July 2002: Impacts from Quebec forest fires, Paper #94, A&WMA Specialty Conference: Regional and Global Perspectives on Haze: Causes, Consequences and Controversies, Asheville, NC, October 25-29, 2004.

[4] Turpin, B.J. and H.-J. Lim, Species contributions to $PM_{2.5}$ mass concentrations: Revisiting common assumptions for estimating organic mass, *Aerosol Sci. Technol., 35,* 602-610, 2001.

[5] Sisler, J.F. and W.C. Malm, The relative importance of soluble aerosols to spatial and seasonal trends of impaired visibility in the United States, *Atmos. Environ., 28(5)*, 851-862, 1994.

[6] Clegg S.L., P. Brimblecombe, and A.S. Wexler, A thermodynamic model of the system H+-NH4+-Na+-SO42--NO3--Cl--H20 at 298.15 K, *J. of Phys. Chem. 102A*, 2155-2171, 1998.

[7] White, W.H., R.A. Eldred, P.J. Feeney, C.E. McDade, B.P. Perley, D.J. Shadoan, and P.H. Wakabayashi, Behavior of fine-particle elemental data near the detection limit, Paper #24, A&WMA Specialty Conference: Regional and Global Perspectives on Haze: Causes, Consequences and Controversies, Asheville, NC, October 25-29, 2004.

[8] Seinfeld, J.H. and S.N. Pandis, *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, John Wiley, NY, pp 444, 1998.

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Monitoring update

continued from page 1 ....

Operators of distinction

The Confederated Salish & Kootenai Tribes of the Flathead Reservation, MT, established an air quality program in 1979. In 2002, an IMPROVE sampler was added to the program, and the Flathead Reservation site began collecting data. Air Quality Technician Allan Bunce devotes a full-time job to the air quality effort by servicing and maintaining the IMPROVE site, and two other particulate monitoring sites in northwest Montana.

Allan learned his air quality skills and knowledge on the job, and by attending trainings held by the Institute for Tribal Environmental Professionals. He is further advancing his environmental training by attending the Salish & Kootenai College and expects to complete a B.S. degree in environmental quality in 2007.

"Servicing the three sites is a full week's work," said Allan. "It takes time to calibrate the instruments, and preventive maintenance is crucial because it saves a lot of time later on." Getting to the IMPROVE site takes about an hour's drive up to a peak where a fire lookout used to be. Winter conditions warrant a little extra effort, but the spring and fall seasons are the worst because of icy roadways.

Last fall and winter, the Flathead sampler began exhibiting some problems, and Allan spent many weeks determining what the problem was. "We tried lots of little steps," said Allan. He kept on top of the situation, and working with UC-Davis personnel, he tried numerous troubleshooting procedures, including replacing all the modules. It was finally determined that a new, nearby cell phone tower was causing interference with the sampler, and the solution was to shield the sampler's cables.

Allan spends time caring for his five children, and to relax, he spends time in the mountains hunting, fishing, and camping.

Air Quality Technician Allan Bunce has maintained the IMPROVE aerosol sampler at the Confederated Salish & Kootenai Tribes of the Flathead Reservation, MT, since 2002.

Outstanding sites

Data collection begins with those who operate, service, and maintain monitoring instrumentation. IMPROVE managers and contractors thank all site operators for their efforts in caring for IMPROVE and IMPROVE Protocol networks. Sites that achieved 100% data collection for 2nd Quarter 2005 are:

Aerosol (Channel A)

Acadia	Glacier	Quabbin Reservoir
Arendtsville	Grand Canyon	Quaker City
Badlands	Great Basin	Rocky Mountain
Baltimore	Great Gulf	Rubidoux
Birmingham	Great Sand Dunes	Saguaro
Bondville	Great Smoky Mountains	Saguaro West
Bosque del Apache	Guadalupe Mountains	Salt Creek
Bridgton	Haleakala	San Gabriel
Brigantine	Hawaii Volcanoes	Sawtooth
Cabinet Mountains	Hoover	Seattle
Cadiz	Isle Royale	Seney
Caney Creek	Jarbidge	Sequoia
Canyonlands	Lava Beds	Shenandoah
Cape Romain	Mammoth Cave	Sikes
Capitol Reef	Meadview	Snoqualmie Pass
Casco Bay	MK Goddard	St. Marks
Cedar Bluff	Mohawk Mountain	Starkey
Chassahowitzka	Moosehorn	Sula
Cherokee	Mount Baldy	Sycamore Canyon
Chicago	Mount Hood	Theodore Roosevelt
Chiricahua	New York	Trapper Creek-Denali
Cloud Peak	North Cascades	UL Bend
Columbia Gorge West	Northern Cheyenne	Upper Buffalo
Connecticut Hill	Okefenokee	Viking Lake
Death Valley	Old Town	Voyageurs
Detroit	Olympic	Weminuche
Dolly Sods	Organ Pipe	White River
Douglas	Petrified Forest	Wichita Mountain
Ellis	Point Reyes	Wind Cave
Fresno	Proctor Research Center	Yosemite
Gates of the Mountains		

Transmissometer

Bandelier	Great Basin	San Gorgonio
Big Bend	Grand Canyon (In Canyon)	Thunder Basin
Bridger		

Nephelometer

Acadia	Mammoth Cave	Sycamore Canyon
Big Bend	Mayville	Tucson Central
Children's Park	Petrified Forest	Tucson Mountain
Cloud Peak	Phoenix	Virgin Islands
Grand Canyon (Indian Gardens)	Sierra Ancha	

Photographic

Agua Tibia	Monture	Red Rock Lakes
Gates of the Mountains	Mount Zirkel	Wichita Mountains

Sites that achieved at least 95% data collection for 2nd quarter 2005 are:

Aerosol (Channel A)

Addison Pinnacle	Gila	Pinnacles
Atlanta	Great River Bluffs	Presque Isle
Big Bend	Hercules-Glades	Sac and Fox
Boundary Waters	Houston	San Gorgonio
Breton	James River	San Pedro Parks
Bridger	Kaiser	Simeonof
Cohutta	Kalmiopsis	Thunder Basin
Columbia Gorge East	Lassen Volcanic	Tonto
Crater Lake	Lostwood	Walker River
Craters of the Moon	Mesa Verde	Washington DC
El Dorado Springs	Pasayten	Wheeler Peak
Frostburg Reservoir	Petersburg	White Pass

Transmissometer

Badlands	Glacier	Rocky Mountain
Canyonlands	Guadalupe Mountains	

Nephelometer

Cape Romain	Grand Canyon (Hance)	Seney
Cedar Bluff	Ike's Backbone	Shell Oil
Chiricahua	Mount Rainier	Thunder Basin
Craycroft	Mount Zirkel	Upper Buffalo
Dysart	Muleshoe Ranch	Vehicle Emissions
Estrella	Organ Pipe	Wichita Mountains
Great Smoky Mountains		

Photographic

Aqua Tibia North	Bosque del Apache	Bryce Canyon

Sites that achieved at least 90% data collection for 2nd quarter 2005 are:

Aerosol (Channel A)

Bliss	Livonia	Redwood
Blue Mounds	Martha's Vineyard	Shamrock Mine
Bryce Canyon	Medicine Lake	Shining Rock
Cape Cod	Monture	Sierra Ancha
Crescent Lake	Mount Rainier	Sipsey
Denali	Mount Zirkel	Swanquarter
Everglades	Nebraska	Tallgrass
Flathead	North Absaroka	Three Sisters
Hells Canyon	Omaha	Trinity
Indian Gardens	Phoenix	Tuxedni
Joshua Tree	Pittsburgh	Zion Canyons

Transmissometer

-- none --

Nephelometer

Bliss	Greer	Queen Valley
Dolly Sods	National Capital	Shenandoah

Photographic

Grand Canyon

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IMPROVE STEERING COMMITTEE

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

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

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