IMPROVE STEERING COMMITTEE Meeting
Skamania Lodge, Stevenson, WA
Oct. 21-22, 2010

Summary for MARAMA Monitoring Committee, April 12-13, 2011
IMPROVE
Particle Monitoring Network:
Status Report to
IMPROVE Steering Committee

Chuck McDade
Crocker Nuclear Laboratory
University of California, Davis
Stevenson, Washington
October 2010
IMPROVE Network
Urban Sites, 2010

[Map of the United States showing various cities marked as IMPROVE sites, Protocol sites, and STN sites.]
New Site at Barrier Lake
Near Banff, Alberta
Barrier Lake Station
University of Calgary
Barrier Lake Webcam
Available Online
Londonderry, NH

- Southern New Hampshire, near Manchester
- NCore site, collocated with other measurements
- To be operational before January 1, 2011
NETWORK PERFORMANCE:
CALENDAR YEAR 2009
2009 Sample Recovery (A Channel, PM$_{2.5}$ Teflon)

- 94% Q1
- 94% Q2
- 94% Q3
- 94% Q4
- 94% Annual A Channel
  2008 was 93%
2009 Sample Recovery (All channels, ABCD)

- 90% Q1
- 91% Q2
- 90% Q3
- 92% Q4
- 91% Annual ABCD
  2008 was 90%
Reasons for Sample Losses

Of the 9% of lost samples (ABCD):
- 40% Equipment problems
- 21% Operator no-show
- 20% Power outages
- 12% Incorrect filter cassette installation
- 7% Torn or damaged filter
A “complete” site has, for ABCD:

- >75% annual recovery
- >50% recovery in each quarter
- <11 consecutive missed samples

11 sites failed in 2009
(5 in ‘04, 6 in ’05, 4 in ’06, 7 in ’07, 13 in ’08)
Sites Failing RHR Requirements: Maintenance Error

- Grand Canyon (Hance), AZ (IMPROVE)
- Linville Gorge, NC (IMPROVE)
- Mohawk Mountain, CT (Protocol)
  - Failed annual, quarter, & consecutive criteria
  - PM-10 stack not properly replaced at 2008 maintenance
  - Discovered in data review by MF>MT

- Remedy for maintenance error
  - Checklist before leaving site
  - Electrical tape to secure stack after maintenance
  - Photos of each module
Sites Failing RHR Requirements: Weather

- Gates of the Arctic, AK (Protocol)
  - Failed quarter & consecutive criteria
  - Power & equipment failures due to severe winter weather
  - Park electrician repaired breakers
  - Pumps moved inside shelter
  - 2010 Winter was OK

- North Absaroka, WY (IMPROVE)
  - Failed consecutive criterion
  - Repeated lightning strikes, including one just after repair trip
Sites Failing RHR Requirements: Power Outages

- Glacier, MT (IMPROVE)
  - Failed consecutive criterion
  - Faulty electrical wiring. Park electrician repaired it.
- Indian Gardens, AZ (Protocol)
  - Failed quarter & consecutive criteria
  - Faulty electrical breaker. Park electrician repaired it.
- Meadview, AZ (Protocol)
  - Failed annual, quarter, and consecutive criteria
  - Power outages in entire area of Meadview
Sites Failing RHR Requirements: Operator Problems

- Thunder Basin, WY (Protocol)
  - Failed annual criterion
  - Recurring problems with missed samples and with equipment problems not reported promptly
  - Working with ARS to resolve
Sites Failing RHR Requirements: Repair Error

- Hell’s Canyon, OR (IMPROVE)
  - Failed annual, quarter, & consecutive criteria
  - Pump replaced but did not solve problems
  - Had to replace pump a second time

- Makah, WA (Protocol)
  - Failed consecutive criterion
  - Problem initially misdiagnosed as pump failure
  - Actually required controller replacement
DATA MANAGEMENT AND DELIVERY
Data Delivery

- Data to be submitted soon through December 2009
- This period represents the second 5-year block of RHR data
- IMPROVE data are now delivered to EPA’s Air Quality System (AQS) database
<table>
<thead>
<tr>
<th>Network</th>
<th>Transmissometers</th>
<th>Nephelometers</th>
<th>Webcams and Exhibits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remote</td>
<td>Urban</td>
<td>Remote</td>
</tr>
<tr>
<td>NPS (12) -1</td>
<td>- (-1)</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>USFS (2)</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wyoming (3) -2 +3</td>
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<td>-</td>
<td>3 (+3)</td>
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<td>Arizona (3) -15</td>
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<td>- (-3) (?</td>
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<td>Colorado (4)</td>
<td>-</td>
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<td>Nevada (Clark County) (2)</td>
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<td>S. Carolina (VISTAS) (1)</td>
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<tr>
<td>Midwest Hazecam (0)</td>
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<td>-</td>
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<td>CAMNET (0)</td>
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<tr>
<td>CENRAP (0) -1</td>
<td>-</td>
<td>-</td>
<td>- (-1)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>(25) -21</td>
<td>2 (-3)</td>
<td>2 (-5)</td>
</tr>
</tbody>
</table>
Optical Data

- Nephelometer data through 06/30/2010 delivered to NPS/CIRA on 9/28/2010

- Transmissometer data (2 USFS sites - Bridger & San Gorgonio) through 12/31/2009 delivered to NPS/CIRA on 8/30/2010
NPS/Wyoming DEQ Partnership

- NPS and WDEQ have partnered to install an air quality/visibility station at Grand Teton NP:
  - Ozone & Meteorology
  - Nephelometer
  - Visibility Web Camera

- Installation expected Spring of 2011
NPS Webcam Network and Web Site Upgrades

November 2008: Start of partnership between NPS and Olympus to upgrade and support 16 site webcam network

Oct 2009 – Oct 2010: NPS funded upgrades of web site and server software infrastructure. All camera site upgrades complete.

Network Operations (NPS-Olympus Partnership funded)
- Technical support, backup equipment, communications, archive
- Annual agreements. Third and final agreement begins October 1, 2010

System Upgrades (NPS-Olympus Partnership funded)
- New digital SLRs (E420) and backups supplied by Olympus
- Hardware upgrades, computers and replacements (site dependent)
- All site upgrades completed as of October 22, 2010 (JOTR upgrade this week)

Web Site Upgrades (NPS-ARD funded)
- NPS-ARD redesigned web site went live early Summer 2010
- ARS developed server software to support camera system upgrades and new web site features
- New features include high resolution images (1600x1200 replaces 500x300), streamlined maintenance, greatly improved reliability and simplified changes to web site content and features
Air Quality Apps

- ARS is in the process of developing AQ applications for mobile devices (IPhone & Android platforms):
  - Simplified versions of visibility camera web pages
  - Access to displays of monitoring data
  - Tools to support field tech site visits
  - Any other good ideas???
IMPROVE Carbon Analysis

Judith C. Chow  (judith.chow@dri.edu)
John G. Watson
Jerome A. Robles
Dana L. Trimble

Desert Research Institute, Reno, NV

Presented at

the IMPROVE Steering Committee Meeting

Skamania Lodge, Stevenson, WA
October 21, 2010
Summary of Carbon Lab Operations

- Maintained 24 hours per day/6-7 days per week operation with 2 full-time and 4 part-time staff

- Recruited Post-Doctoral Fellow Jerome Robles (Chemical Engineer) to perform calibration and maintenance

- Completed IMPROVE backlog (June 2009)

- Analyzed over 23,000 IMPROVE samples (June 2010)
## IMPROVE Carbon Analysis following the IMPROVE_A Protocol

(7/09 – 6/10)

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>Samples Received</th>
<th>Analysis Completion Date&lt;sup&gt;b&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>7/1/09-12/31/09</td>
<td>11,390</td>
<td>2/21/10</td>
</tr>
<tr>
<td>1/1/10-6/30/10</td>
<td>10,880</td>
<td>9/9/10</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chow et al. (2007)

<sup>b</sup> Currently analyzing August and September 2010 samples
Refine Temperature Ramping for OC1 and OC2

- Create three set points:
  1. Force a 100% controller output (rapid heating)
  2. Turn heater off (stabilization)
  3. Provide fine adjustments
Status Viewer Program

Maintenance Details of CA#16

- Hovering mouse over analyzer box gives current status
- Single clicking on the instrument brings up scrollable maintenance history
- Double clicking on any instrument brings up list of PDF thermograms
Laboratory Improvements at UC Davis

Chuck McDade & Nicole Hyslop
Crocker Nuclear Laboratory
University of California, Davis
Stevenson, Washington
October 2010
PANalytical Epsilon 5 XRF
Why Change?

- Existing XRF system has failing components, plus outdated electronics & computers
- Expertise to overhaul & redesign has retired
- Cost to overhaul & redesign could approach that of new instruments
- Excellent commercial systems are available; UCD’s system no longer offers a unique capability
- Commercial systems require less labor, thus long-term savings
Commercial System Advantages

- Data stability over time
- Fully developed, tested, & documented system
- Professional, user-friendly work environment
- Staffing depth
- Well-suited to running replicates & standards
Old & New Systems Agree for S When Calibrated Similarly

XRF Sulfur: DRI vs. UCD

\[ y = 0.9976x \]
\[ R^2 = 0.9979 \]
Challenges in the Analysis of Ammonia Collected on Phosphorous Acid-Coated Cellulose Filters for the IMPROVE NHx Study

Eva D. Hardison, David L. Hardison, Bryte H. Goodnight, Steven Walters
Pilot NH\textsubscript{x} Monitoring Study Sites

- Chiricahua, AZ
- Bandelier, NM
- Mesa Verde, CO
- Rocky Mtn, CO (collocated)
- Yellowstone, WY
- Glacier, MT
- Wind Cave, SD
- Bondville, IL (collocated)
- Cedar Bluff, KS

From: “Draft IMPROVE NH\textsubscript{x} Study Plan “ by Jeff Collett, Doris Chen and Derek Day, CSU, March 18, 2010; Bret Schichtel, NPS.
ME\textsuperscript{+} Std/Sample Overlay

With column heating (60 deg. C)

<table>
<thead>
<tr>
<th>No.</th>
<th>Ret.Time (min)</th>
<th>Peak Name</th>
<th>Height (μS)</th>
<th>Area (μS·min)</th>
<th>Plates (EP)</th>
<th>Amount (ppb)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.90</td>
<td>Methylamine</td>
<td>4.205</td>
<td>0.796</td>
<td>8419</td>
<td>0.915</td>
<td>RMB</td>
</tr>
</tbody>
</table>

Total:
4.205 0.796 8419.00 0.915
RTI’s Startling Discovery – Methylamines on Acid Impregnated Filters

- RTI successfully separated the two peaks and the mystery peak matched the methylamine standard.
Etching of Filter Cartridges by Phosphorus Acid on Filters

- Filter cartridges after repeated use with acid impregnated filters used in initial CSU field study
- Filter cartridges made from Polyoxymethylene plastic, i.e. Delrin
Stainless Steal Filter Cartridges

- To test if the Delrin filter cartridges are the source of the methylamines, UCD made 8 cartridges out of stainless steel.
Is methylamine real or a sampling artifact?

- Three sets of IMPROVE samplers, 2 with Delrin and 1 with SS cartridges were deployed at Brush, Colorado for 4 days.

- One Delrin and SS set was immediately extracted, the second Delrin set was kept in ziploc bag with acid paper towel for 2 weeks at room temp.
- No methylamine measured on “young” extracted samples
- Methylamines measured on aged samples
  - Total nitrogen (sum of ammonium and methylamine) was less than the NH$_4$ from the young samples (~50% left).
- Acid etching was evident on the Delrin cartridges
Next Steps

- New cartridges will be made from a non reactive plastic with phosphorus acid
- Candidate plastics include
  - polycarbonate (Lexan)
  - Noryl
- UCD is making sample cartridges for testing
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Summary for MARAMA Monitoring Committee, April 12-13, 2011
Part II
IMPROVE’s Evolution

Interagency Monitoring of Protected Visual Environments

Our national Parks and Wilderness Areas possess many stunning vistas and scenery. Unfortunately, these scenes are diminished by uniform haze causing discoloration and loss of texture and visual range. Layered hazes and plumes bright also detract from the scene. Recognizing the importance of visual air quality, congress included legislation in the 1977 Clean Air Act to prevent future and remedy existing visibility impairment in Class I areas. To aid the implementation of this legislation, the IMPROVE program was initiated in 1985. This program implemented an extensive long term monitoring program to establish the current visibility conditions, track changes in visibility and determine causal mechanisms for the visibility impairment in the National Parks and Wilderness Areas.

The purpose of this website is to provide access to the IMPROVE monitoring data resources and educational material on the science of visibility and regulations. First time visitors should visit the Overview section which summarizes the IMPROVE network and visibility science and regulations.

Website Categories

Data Resources  Tools  Publications  Special Studies  Visibility & Regulation Education  IMPROVE & Visibility Overview

IMPROVE Resources

Database  Metadata  Data Advisory, QA/QC  Graphics  Photos  Web Cams  IMPROVE Reports  Gray Literature

Bulletins

http://vista.cira.colostate.edu/IMPROVE
VIEWS

Air Quality Data, Tools, & Resources

VIEWS is an online system of tools and resources designed to provide easy access to a wide variety of air quality data. An advanced data acquisition and import system is used to integrate data from dozens of sources into a single, highly-optimized data warehouse in order to enable users to analyze datasets of widely-varying origin in a consistent, unified manner with a common set of tools and web services. More information...

Air Quality Data
- Query Wizard
- Data Files
- Dataset Inventory
- Network Browser
- Site Browser
- Summary Data

Air Quality Tools
- Contour Maps
- Trends Analysis
- Composition Analysis
- Spatial Patterns
- Back Trajectories
- Air Quality Index Maps

Air Quality Resources
- Documents
- Webcams
- Photographs
- Glossary
- Links
- Developers

News and Notes

08.31.2007 - New page: Dataset Index
A comprehensive list of the datasets available on VIEWS is being developed. When complete, these Dataset Descriptions will contain complete information on each individual dataset, including the parameters measured, the geographical extent, the frequency and duration of observations, the sampling and analysis methods used, and how to find and access the data on the VIEWS website. An incomplete, draft version of the index can be found here.

04.13.2007 - New data: IMPROVE RHR2 Data
New Regional Haze Rule data is available in raw form here. (See the note below for FTP login information.) NOTE: This data has not been imported into the integrated database yet, but is available in raw *.csv format in the meantime. If you have any questions about this data, please contact us. Thank you!

04.12.2007 - Important Notes: FTP Site Restrictions
Due to problems with unauthorized access we can no longer allow anonymous access to our public FTP site. From now on, you will be prompted to login when accessing FTP resources, so please use the following information to do so: Username: cira\guest; Password: orion. Thank you!

10.24.2006 - IMPROVE Steering Committee Meeting 2006
Final summary of the Sept 25-26 IMPROVE Steering Committee meeting Meeting Summary.

News & Environmental Science News

Making Of The Greenland Ice Sheet Happened (Thu, 17 Sep 2009 02:08:00 EDT)
Will all of the ice on Greenland melt and flow out into the sea, bringing about a colossal rise in ocean levels on Earth, as the global
To be Archived
News

**Alpha version of the FED now available**
The first draft version of the FED website and database is now available for limited exploration and testing.

**VIEWs database cloned for use by the FED**
The FED was initially created by making a "clone" of the VIEWs Integrated Database without satellite and modeled datasets.

**New and updated datasets will be imported**
During the first phase of FED development, selected datasets will be updated and new datasets will be added.

Data

**Use the Data Wizard for selecting raw data**
The FED Data Wizard is currently identical in functionality to the previous VIEWs Data Wizard.

**The Oct - Dec 2009 IMPROVE data is coming**
As soon as the IMPROVE data for October - December 2009 is delivered, it will be added to the FED database.

**Data Item #3**
Some description goes here...

Geolocation

![Map of location](image)

**Latitude:** 40.592
**Longitude:** -105.129
**City:** Fort Collins
**Region:** CO
**Country:** USA
**Zip Code:** 80523
**Area Code:** 970
**Domain:** COSTATE.EDU
**ISP:** COLORADO STATE UNIVERSITY
**TimeZone:** -07:00
**Weather Station:** FORT COLLINS (USC00146)
**Forecast:** Weather Underground

Local Air Quality

**Select a Dataset:** IMPROVE Aerosol
**Select a Site:** Acadia NP
**Select Parameters:** Selenium (Fine)
**Select Start Year:** 2008
**Select End Year:** 2009

For more advanced options in selecting and filtering data, visit the Query Wizard...

![Graph of data](image)

**Featured Substance**

**Name:** Titanium dioxide
**CAS Number:** 13463-67-7
**ACN Number:** X1002582-6
**Density:** 4.26
**DOT Number:** 2546.37
**Comments:** White powder, odorless
**Molecular Weight:** 79.8658
**Melting Point:** 1955
**Boiling Point:** 2900
**Water Solubility:** insoluble, <0.1 g/100 ml at 20°C

**Featured Term**

**Visibility Index:** Have been formalized for aerosol, optical, and scenic attributes. Aerosol indexes include mass concentrations.
Datasets to be included

- IMPROVE aerosol data
- Forest Service NRIS-Water quality data
- Hourly ozone concentrations (ppb) from continuous ozone monitors, including all EPA/AQS monitors, CASTNET monitors, NPS portable ozone monitors, 1988 to present
- Weekly passive ozone concentrations (ppb) from NPS passive ozone samplers
- Hourly meteorological parameters, including temperature, relative humidity, scalar wind speed, scalar wind direction, vector wind speed, vector wind direction, dew point, solar radiation, rainfall, and barometric pressure
- Hourly PM$_{2.5}$ concentrations
- Hourly PM$_{10}$ concentrations
- Hourly NO$_2$ concentrations
- Hourly SO$_2$ concentrations
- Hourly CO concentrations
- CASTNET model estimates for hourly concentrations, dry deposition velocity, and dry deposition flux
- Weekly wet deposition concentrations, including Ca, Cl, K, Mg, Na, NH$_4$, NO$_3$, SO$_4$, and Hg (mg/l and meq/l)
- Weekly wet deposition, including Ca, Cl, K, Mg, Na, NH$_4$, NO$_3$, SO$_4$, and Hg (kg/ha)
- Nephelometer visibility measurements
- Night sky brightness imagery
Derived Values

- **IMPROVE Derived Values and Statics:**
  - missing data estimated using algorithms specified in the Regional Haze Rule guidance documents
  - daily IMPROVE ambient particulate concentrations for ammonium nitrate, ammonium sulfate, coarse material, soil, organic mass, soot, sea salt, gravimetric PM$_{2.5}$, and gravimetric PM$_{10}$
  - daily IMPROVE extinction estimates for ammonium nitrate, ammonium sulfate, coarse material, soil, organic mass, soot, sea salt, Rayleigh, total extinction, and deciview
  - daily IMPROVE visibility estimates in kilometers
  - annual mean, best days, median days, and worst days IMPROVE ambient particulate concentrations for ammonium nitrate, ammonium sulfate, coarse material, soil, organic mass, soot, sea salt, gravimetric PM$_{2.5}$, and gravimetric PM$_{10}$
  - 3- and 5-year averages of annual mean, best days, median days, and worst days IMPROVE ambient particulate concentrations for gravimetric PM$_{2.5}$
  - annual mean, best days, median days, and worst days IMPROVE extinction estimates for ammonium nitrate, ammonium sulfate, coarse material, soil, organic mass, soot, sea salt, Rayleigh, total extinction, and deciview
  - annual mean, best days, median days, and worst days IMPROVE visibility estimates in kilometers

- **Ozone Statistics**
  - daily maximum 1-hour ozone concentrations
  - annual maximum 1-hour ozone concentrations
  - annual 2nd highest 1-hour ozone concentrations
  - 3- and 5-year means of the annual 2nd highest 1-hour ozone concentration
  - daily maximum 8-hour ozone concentrations (calculated in accordance with EPA protocols)
  - annual maximum, 2nd highest, 3rd highest, and 4th highest 8-hour ozone concentrations, occurring during the local ozone monitoring season (determined in accordance with EPA protocols)
  - 3- and 5-year averages of the annual maximum, 2nd highest, 3rd highest, and 4th highest 8-hour ozone concentrations
  - 3-year average of the annual 4th highest 8-hour ozone concentrations (determined in accordance with EPA protocols)
  - 5-year average of the annual 4th highest 8-hour ozone concentrations
  - annual 90th percentile of 1-hour ozone concentrations
  - 3- and 5-year averages of the annual 90th percentile of 1-hour ozone concentrations
  - annual highest 3-month maximum ozone SUM60 (calculated in accordance with EPA protocols)
  - 3- and 5-year averages of the annual highest 3-month maximum ozone SUM60
  - annual highest 3-month maximum ozone W126 sum (calculated in accordance with EPA protocols)
  - 5-year averages of the annual highest 3-month maximum ozone W126 sum
  - 3-year average of the annual highest 3-month maximum ozone W126 sum (calculated in accordance with EPA protocols)
  - annual mean 1-hour ozone concentration
  - annual mean 1-hour ozone concentration, calculated over the ozone season
  - 5-year average 1-hour ozone concentration
  - number of hours with 1-hour ozone concentration over 100 ppb during ozone season

- **Dry and Wet Deposition Statistics**
  - annual mean deposition concentrations, including Ca, Cl, K, Mg, Na, NH$_4$, NO$_x$, and Hg (mg/l and meq/l)
  - 3- and 5-year averages of annual mean deposition concentrations (mg/l), including Ca, Cl, K, Mg, Na, NH$_4$, NO$_x$, SO$_x$, and Hg
  - annual total wet deposition, including Ca, Cl, K, Mg, Na, NH$_4$, NO$_x$, SO$_x$, and Hg
  - 3- and 5-year averages of annual total wet deposition, including Ca, Cl, K, Mg, Na, NH$_4$, NO$_x$, SO$_x$, and Hg

- **Trend Statistics**
  - trend slope and p-value for monitors in and near parks, including 10-year trends for 3-year averages of the annual 4th highest 8-hour ozone, and annual wet deposition concentrations of NH$_4$, NO$_x$, and SO$_x$ and visibility conditions on the best and worst days
  - annual values used to compute 10-year trend slopes

- **Other Derived Datasets**
Possible Secondary PM Standard Based on Urban Visibility

For Presentation at the IMPROVE Steering Committee Meeting (10/21/10 – 10/22/10)
by Marc Pitchford
PM NAAQS Review Process

- Last EPA review of PM NAAQS (completed 2006)
  - Solicited comments on a visibility based secondary standard with a sub-daily PM\(_{2.5}\) mass concentration indicator
  - Ultimately set the secondary standard equal to the primary standard
  - Court remanded this decision, said EPA failed to identify a protective level and to justify setting primary equal to secondary

- Current review (scheduled completion 2011)
  - Considers three alternative indicators, each as daylight 1-hour values excluding periods with relative humidity > 90%
    - PM\(_{2.5}\) mass,
    - Directly measured PM\(_{2.5}\) light extinction and
    - Speciated PM\(_{2.5}\) mass-calculated light extinction
  - Identifies a range of PM light extinction Candidate Protective Levels (CPL) based on reanalysis of urban visibility preference surveys
  - Assessment entails generating hourly PM light extinction values for 15 urban areas over three year using PM measurements and model output to compare to the CPL
  - Assessment also shows effectiveness of PM light extinction versus PM mass concentration indicators using alternative NAAQS scenarios
Alternate Ways to Determine PM Light Extinction and Relationship to Visual Air Quality

<table>
<thead>
<tr>
<th>Measured Quantities</th>
<th>Derived Characteristics</th>
<th>Relationship Steps from PM Light Extinction to VAQ</th>
<th>Non-Air Quality Information</th>
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</thead>
<tbody>
<tr>
<td>(1) Dry PM Mass Concentration</td>
<td>Dry PM Characteristics</td>
<td>Ambient PM Light Extinction</td>
<td>Scene and Lighting Characteristics</td>
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<tr>
<td>Dry PM Composition</td>
<td>IMPROVE Algorithm</td>
<td>WinHaze Modeling</td>
<td></td>
</tr>
<tr>
<td>Ambient Relative Humidity</td>
<td>(3) Speciated PM Calculated Light Extinction</td>
<td>Perceived Visual Air Quality (Images)</td>
<td>Public-Scene Contextual Information</td>
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<td></td>
<td>Valuation Studies</td>
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<tr>
<td>(2) Directly Measured PM Light Extinction</td>
<td>Ambient PM Light Extinction</td>
<td>Value of Improved VAQ</td>
<td></td>
</tr>
</tbody>
</table>
Thoughts on Alternative Indicators

• **PM$_{2.5}$ mass** measured by continuous FEM instruments does not including the effects of humidity and composition making its relationship to PM light extinction both noisy and regionally/seasonally biased, so it is not favored.

• **Directly measured PM$_{2.5}$ light extinction** by optical instrumentation is considered the most accurate approach to monitoring light extinction, but there is no EPA approved FRM for it and approval is a multiyear effort, so it can’t be used in this review cycle.

• **Speciated PM$_{2.5}$ mass-calculated light extinction**, while not as accurate as direct measurements, better estimates PM$_{2.5}$ light extinction, than PM$_{2.5}$ mass and can be determined using existing EPA approved monitoring methods, so it is the favored indicator.
Speciated PM$_{2.5}$ mass-calculated light extinction

Original IMPROVE algorithm without Rayleigh and coarse mass terms.

Rearranged terms to show how the relationship between PM$_{2.5}$ light extinction and PM$_{2.5}$ mass concentration depends on PM$_{2.5}$ composition and relative humidity

\[
\text{PM}_{2.5} \text{ LE} \approx 3 \times f(\text{RH}) \times [\text{Sulfate}] + 3 \times f(\text{RH}) \times [\text{Nitrate}] + 4 \times [\text{Organic Mass}] + 10 \times [\text{Elemental Carbon}] + 1 \times [\text{Fine Soil}]
\]

\[
\text{PM}_{2.5} \text{ LE} \approx ((3 \times (f(\text{RH}) - 1) \times \text{HF} + \text{DLEE})) \times \text{PM}_{2.5}
\]

where HF is the hygroscopic fraction and DLEE is the dry light extinction efficiency, both only dependent on PM$_{2.5}$ composition

• Input data sources being considered
  o Hourly PM$_{2.5}$ mass from FEM continuous monitors
  o Hourly Relative Humidity from continuous monitors
  o Monthly averaged HF and DLEE from collocated CSN monitors

• Issues of concern
  o FEM continuous monitors occasionally generate 1-hour outliers – use of screening and/or multi-hour averaging and causes of the outliers are being investigated
  o Use of monthly averaged composition approximates the light extinction quite but makes it harder to know the components responsible for any hourly value
Assessment of Alternative Secondary PM NAAQS Scenarios

• 18 PM light extinction scenarios considered
  – 3 alternative CPL values;
  – 2 alternative indicators: maximum daily 1-hour and all daylight hours PM light extinction
  – 3 alternative frequencies: the 3-year mean of the 98th, 95th and 90th annual percentile values

• 2 PM$_{2.5}$ mass concentration scenarios
  – Current NAAQS: 15 µg/m$^3$ – annual; 35 µg/m$^3$ – daily
  – 12 µg/m$^3$ – annual; 25 µg/m$^3$ – daily

• Process to simulate meeting alternative scenarios
  – Subtract daily air quality model estimates of policy relevant background (PRB) levels from current conditions
  – Determine the amount of linear rollback of the hourly or daily non-PBR PM needed to achieve the scenario requirements
PM NAAQS Review Schedule - Annotated

• Integrated Science Assessment
  – Finalized December 2009

• Risk and Exposure Assessments
  – Quantitative Health Risk Assessment finalized June 2010
  – Urban-Focused Visibility Assessment finalized July 2010

• Policy Assessment
  – Second draft released for CASAC and public review in June 2010

• Proposed rulemaking – February 2011 Secondary NAAQS might be separated from the primary to allow more time to deal with issues and to get more public feedback on options. Decision should be made in a month or two.

• Final rulemaking – October 2011 If separated, the secondary standard could be delayed by as much as a year.

• For more information:
  http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_index.html
Preview of the IMPROVE Report V

Jenny Hand

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Outline of Report

1. Description of the IMPROVE network
2. Protocol, equipment and analytical changes (UC Davis)
3. Spatial distribution of mass concentrations from IMPROVE and CSN
4. Spatial distribution of reconstructed aerosol extinction from IMPROVE and CSN
5. Spatial variability in monthly mean mass concentrations from IMPROVE and CSN
6. Spatial variability in monthly mean aerosol extinction from IMPROVE and CSN
7. Trend Analysis
8. Urban Excess
9. Regional Haze Rule analysis (Moore and Copeland)
10. Rocky Mountain Atmospheric Nitrogen and Sulfur Species Study (RoMANS)
11. Ammonia sampling (Day)
12. Fine mass biases (Malm)
Draft Report Online Now

Comments received by April 22 will be considered in preparation of the final report.
Decreases in elemental carbon and fine particle mass in the Rural United States

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IMPROVE
Interagency Monitoring of Protected Visual Environments
Widespread Decreases in Elemental Carbon

Symbol size: magnitude of trend
Color saturation: absolute amount of EC

- EC trends from 1990 – 2004
- Too few sites had data before 1990 and after 2004 aging instrumentation were replaced which could potentially biases trends
Why to believe EC trends are real:

1) All samples used same protocol, same instruments at DRI

2) Internal consistency:
   *Similar trends from EC on quartz filters, measured blackness of teflon filters*

3) Consistent with other data sets:
Potential Measurement Artifacts

\[
\frac{EC}{TC} \times \frac{A}{M}
\]

DE-SEASONALIZED EC/TC

M = median of all 1990-2007 daily network medians in given month
A = median of the twelve M.

- During the course of the network operation changes have occurred that could influence trend analysis
TEMPORAL PATTERNS IN EC/OC EDGES

Bret Schichtel, NPS
1. TC filter analysis is stable, reproducible and has no temporal biases

2. In 2005 IMPROVE moved to new TOR analyzers. After extensive testing, DRI has shown that the new TOR analyzers produce equivalent EC/OC splits as a properly operating old analyzer.
   1. The EC/OC shift from 2004 to 2005, noted by Warren, are possibly due to the analyzers used prior to 2005 degrading over time.

3. The average TC concentrations (particularly winter) have generally decreased at IMPROVE sites since 1990

4. The average EC trends (particularly winter) have also generally decreased at IMPROVE sites and at a higher rate.
   1. Dan Murphy has shown corroborating, independent trends in EC and absorption
MY INITIAL WORKING ASSUMPTIONS

- EC/OC ratios from major source categories, e.g. diesel have not appreciably changed over time.
- The highest EC/OC ratios at a given site are due to dominate contributions from a single source type or consistent mixture of sources.
- A long term trend in these EC/OC ratios is an indication of a change in the analyzers as opposed to the atmosphere.
- No doubt there are limits to this hypothesis.
The trend lines are for the years 1989-2004. The 97th and 3rd percentiles are surrogates for the edges of the EC-OC scatter plots.

At Washington DC:
+ There is a significant, near linear, decreasing trend in the EC/OC ratio from 1989 – 2004 for the edges and median EC/OC values
+ In 2005, when new analyzers used, the EC/OC ratios returned to the 1989-90 levels
+ EC/OC ratios in 1995 are higher then previous and post years and for the 97th percentile, it is similar to the 1989-90 and 2005 levels.

These trends are less discernable at the rural sites
RESULTS

- We have trends in the EC/OC (EC/TC) ratios
- These trends may be due to analytical issues as opposed to atmospheric changes.
- These results indicate (at least to me) that the EC/OC ratios may have actually been relatively constant over the past 20 years.
- If the EC/OC trends are false then they would accentuate decreasing trends or moderate increasing EC trends
In summary, since 2005:

TOR ‘elemental’ carbon has declined relative to total mass and total carbon, but HIPS ‘black’ carbon has not.

The large charring artifact that is subtracted in reporting ‘elemental’ carbon has increased in relative importance.

The fraction of ‘organic’ carbon that chars exhibits some empirical dependence on sulfate and chloride loadings.

Until our understanding of the measurements is sufficient to explain these observations, I’m with Dilbert …
Which of the TOR fractions are driving our observed decrease in EC? Recall:

- He
- He + O₂
- Optical monitoring

Fractions:
- \(OC_1, \ldots, OC_4\)
- \(EC_1, \ldots, EC_3\)
- OP
- OC
- EC
Can I get a rough estimate for the EC trend?

No, I don't trust you with numbers.

What?

You're the kind of guy who will remove useful qualifiers and distribute a figure as if it is true in all cases.

Decisions will be made. People will get hurt.

For everyone's sake, the safest thing I can do is make an annoying humming sound until you go away.

HMMMMMM - MMMMMMMMMMM - MMMMM.

Half of life is making people go away.

HUMMM - MMMMM
Full Presentations Available at http://vista.cira.colostate.edu/improve/