# IMPROVE STEERING COMMITTEE
# 2018 ANNUAL MEETING

**Date:**  Tuesday, October 16-17, 2018
**Location:**  Fort Collins, Colorado *relocated from St. Marks, FL due to Hurricane Michael*
CIRA Conference Room
**Time:**  8:00am – 5:30pm, 8:00am – 11:30am

## IMPROVE stakeholders present:

| | | |
|---|---|---|
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| Derek Day | CIRA | day@cira.colostate.edu |
| Ann Dillner | UC-Davis | amdillner@ucdavis.edu |
| Tracy Dombek | RTI | tdombek@rti.org |
| Katrine Gorham | UC-Davis | kgorham@ucdavis.edu |
| Mark Green | DRI | green@dri.edu |
| Jenny Hand | CSU/CIRA | jlhand@colostate.edu |
| Melissa Hovey | BLM | mhovey@blm.gov |
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| Sean Raffuse | UC-Davis | sraffuse@ucdavis.edu |
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| Tony Wexler | UC-Davis | aswexler@ucdavis.edu |
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## Remote Participants

| | | |
|---|---|---|
| *Tom Downs* | *Maine DEP* | *tom.downs@maine.gov* |
| *Nicole Hyslop* | *UC-Davis* | *nmhyslop@ucdavis.edu* |
| *Robert Kotchenruther* | *EPA* | *Kotchenruther.robert@epa.gov* |
| *Bob Lebens* | *WESTAR* | *blebens@westar.org* |
| *John Vimont* | *NPS* | *john_vimont@nps.gov* |

## WELCOME AND AGENDA REVIEW

Scott Copeland opened with welcoming comments, a review of a revised agenda, and introductions. Summary points are as follows:

- Thanks for everyone who was able to change travel plans on short notice. The meeting was originally scheduled to be held at the FWS St. Marks National Wildlife Refuge, but was relocated to the CIRA conference room in Fort Collins due to impacts from Hurricane Michael.

## NETWORK AND LABORATORY REVIEW

### Optical Monitoring Network Status

Mark Tigges presented an update regarding optical and scene network status. Joe Adlhoch discussed data substitution work ARS is performing for the WRAP. A copy of their PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Eleven (11) nephelometers are currently in operation, all but one (Grand Tetons) are collocated with IMPROVE samplers.
- Approximately half of the sites are self-service with a 2-year replacement cycle.
- Glacier will receive a new tipping tower to address safety concerns. This is the first time a tipping tower will be used in a nephelometer system.
- The digital camera network has received updates to be mobile friendly
  www.nps.gov/subjects/air/webcams.htm
- Image archives are also available https://npgallergy.nps.gov/AirWebCams/
- Updates to the WinHaze visual modeling platform are on-going. The new WinHaze application is web-based and mobile friendly using IMPROVE data for masking.
- ARS is performing data substitution work for the WRAP to be used by member states for Regional Haze planning and SIP development.

### Aerosol Monitoring Network Status

Katrine Gorham presented an overview of network status. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- There are currently 156 sites operational.
- Three (3) sites are offline due to funding issues, but expect to be back on line by year's end.
- One (1) site will be added in Toolik Field Station, AK (scheduled for installation in November 2018).
- Final 2017 data were delivered to AQS and FED in early October.
- The semi-annual quality assurance (QA) report was delivered October 12th for 2017 data. Feedback on the report is welcome and useful.

- Data advisories are available on the CIRA website.
- Ten (10) sites have been lost for 2018 due to completeness issues.
- New controllers have been deployed in about half of the network. New controllers lead to faster problem identification and troubleshooting. They are able to respond to issues much faster, preventing further data loss.

➢ *Derek Day noted that the new controller at Great River was not operational during his audit. UCD was not able to see the problem. Several reboots of the controller brought it back on-line.*
➢ *Sean Raffuse and Tony Wexler noted that data are only collected once per day, so a failure in the afternoon would not be noticed until the next day and sometimes issues with the controller display makes it appear it is not working when it actually is.*

- New controllers can only be monitored remotely at sites with internet connectivity, which can be an issue in more remote locations.
- Remaining controllers will be deployed in 2019.
- New controllers have digital pressure transducers to allow for universal flow constant across network

➢ *Derek Day asked if different elevations are an issue.*
➢ *Sean Raffuse replied that elevation is taken into account.*

- PurpleAir sensors have been deployed at six (6) IMPROVE sites.
- The MTL automated weighing system has been operational as of 10/5/2018. Long-term testing will include 5-10% of filters to be weighed on both the old and new systems.
- An aluminum contamination was discovered within the chamber and was mitigated with extra cleaning and monitoring how the filters are loaded,

➢ *Bret Schichtel asked if redundant samples will be equilibrated as well*
➢ *Katrine replied no they will be handled "as-is". Controlling RH in the building is limited and will fluctuate.*
➢ *Gordon Pierce asked how many filters the system holds*
➢ *Katrine & Sean replied that the system holds 400 plus one extra silo and that is run overnight. The system equilibrates in the morning and extra runs can occur on the weekends.*

## Quality Assurance – Field Audits

Derek Day presented updates regarding field audits. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Over one hundred (100) audits have been completed.
- In two (2) years, all audits within the continental US will be completed.
- Auditor training was completed for staff in CO, AZ, and MO. The WY auditor will also receive training as schedules allow.

- Most audit findings are related to safety issues, cleanliness, operator performance, and siting criteria (sites no longer meeting siting criteria are largely due to overgrown trees).

➢ *Bret Schichtel asked if sites visited by UCD for maintenance purposes are being evaluated for similar concerns and are they being reported*
➢ *Derek replied the observations are made and reported to proper personnel for follow-up.*

- Most sites passed the flow rate audits.
- Efforts are being made to get site operators more involved and invested in operations.

➢ *Tony asked if operator recognition in something like the status report or other newsletters would be beneficial.*
➢ *Derek replied most operators would really appreciate the recognition as some sites are difficult to access.*

➢ *Bret Schichtel asked how resolution of issues/findings are handled*
➢ *Derek replied that it is hard to document until the next audit is conducted.*
➢ *Sean stated that UCD takes site photos during each maintenance visit and it might be useful to share those with Derek to identify which issues have been addressed.*

## Ion Analysis

Tracy Dombek presented of the status of ion analysis. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- 18,000 samples were analyzed and reported within 60 days.
- Quality control checks are performed before and after every ten (10) samples.
- MDL is really more of an instrument detection limit than a method detection limit.
- QC standards are usually within ± 2%.
- RTI and 11 other labs are participating in round robin QA tests with the USGS laboratory. Four (4) samples per month are sent out for reanalysis by another lab.
- Other QA activities include duplicate analysis. Chloride is often a contaminant which is mitigated with additional cleaning. Duplicate analysis involves different technicians and different days.
- Duplicate analysis is producing good results for everything except nitrite. Nitrite can be picked up and seen in reanalysis.

➢ *Tony asked about the status of organic sulfated.*
➢ *Tracy replied they are working on sulfur species for Great Smoky Mountains National Park with Jason Surat from UNC) on potential grant opportunities to continue the analysis work. NADP and NOAA are looking at similar analysis for NH3.*

## Carbon Analysis

Mark Green presented of the status of carbon analysis from RTI. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- The lab currently analyzes samples from both the CSN and IMPROVE networks.
- Throughput was increased by 67% to address backlog.
- Samples are reported by month instead of by batch. Reporting times have decreased from 270 days to 160 days.
- Additional injections and calibrations are performed daily in addition to the six-month calibration schedule.
- The integration threshold was lowered from 2.0 to 0.72 which required re-reporting of data to UCD.
- This also required a recalibration of instruments based on the lower integration threshold.

➢ *Bret asked if there is a non-linearity in the calibrations curves and are those curves available for review.*
➢ *Mark replied that curves are available, but not at the meeting. The curves might have a bit of a curve at the lower end.*

## Data Management and Validation Update

Sean Raffuse presented an update regarding the database and software management updates by UCD. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- The new database and software management system came on line this year, including re-designed controllers and automated weighing system.
- The new controller has a touch screen and was developed in-house.
- Data management from new controller allows for identification of issues much sooner, including receiving flow data daily instead of waiting for flash cards.
- Color coded screen in management tool displays site status and issues.
- Logs can be reviewed daily by staff.
- The automated weighing system includes the ability to use barcodes to track filters (using a QR code printed on the filter ring, as printing on the filter would cause interference). New software was developed to handing QR code filter tracking.
- Black carbon can be estimated from laser readings provided by TOR.
- Automated view of field blanks versus samples show sample swaps

➢ *Bret asked if there was a correlation between field blanks and method blanks*
➢ *Tracy commented that field blanks show higher concentrations.*

- Newly developed validation tools create plots to show individual site values, site medians, and network medians by parameter. Reconstructed daily mass values and back trajectories to assess transport are also available.

> *Donna Kenski asked if these tools are available to the public.*
> *Sean replied they are not public at this time.*

- Future work involves further improvement of the controller software, data handling, altering, response, data validation process and to integrate FTIR analysis.

## Quality Assurance Report

Xiaolu Zhang presented the semi-annual QA report for 2017. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Sections of the report include concentration level QC checks to compare outliers as well as analytical QC checks on replicates.
- Replicate QC checks uncovered an issue with the nylon filters from 2005-2011, a 2015 baseline shift when a new batch of filters was used, and the summer of 2017 when there was a known lab contamination issue.
- The next semi-annual QA report will be delivered by April 2019.
- Report also includes site maintenance summaries, repair items, field audit results, and UCD site visits.
- Next steps include standardizing the report content for future reports.
- The next report will include a XRF analytical section.

# ANALYTICAL DEVELOPMENT

## Estimating Brown Carbon Concentrations by Multi-wavelength Thermal/Optical Analysis

Mark Green presented a PowerPoint regarding estimating brown carbon by multi-wavelength thermal/optical analysis. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Methods to calculate carbon absorption assume the absorption Angstrom exponent for black carbon is 0 and anything greater than zero can be attributed to brown carbon.
- Brown carbon is not a single compound, so compound mass absorption will vary with compounds.
- The solution is to measure MAC for several brown carbon standards and express brown carbon concentrations as a range.
- Considered approximately 20 compounds.
- Fulvic acid and humic acid sodium salt produced repeatable results.
- Brown carbon concentrations were estimated in IMPROVE and CSN data sets.

- Brown carbon estimates and organic carbon concentrations tracked well during a 2016 Everglades fire.

> *Donna Kenski asked if the comparison holds for other types of fire/combustion.*
> *Mark replied they are typically similar, but not always a 1:1 ratio.*
> *Sean asked what was driving the seasonal pattern.*
> *Answer: not sure we know completely but could be wood burning or residential heating during winter months in the CSN network and fires for IMPROVE network – though the list of 10 sites with the highest concentrations are not typically in fire prone areas.*

## Low-Cost Non-Destructive Analysis Method

Ann Dillner presented a PowerPoint providing an overview of FTIR work done by UCD to provide low-cost, non-destructive carbon measurements for the network. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- The goal of the new analysis method is to reproduce OC/EC from Module A.
- Strengths of the method include low-cost, non-destructive, Teflon filters are routinely collected with no gas phase adsorption, and the analysis method provides information regarding functional groups.
- Limitations to the method include complex calibration methods, reliance on the filter manufacturer, and the lack of directly comparable methods for functional groups to validate the data.
- A calibration derived using one year of IMPROVE data (2015) from all sites (this accounts for variability in composition and filter).
- Based on network wide metrics, retaining a small subset of sites with TOR data provides sufficient data for FTIR calibration.

## Flow Control, Meteorology, Sensors, and MAIA

Tony Wexler presented a PowerPoint providing suggestions for upgrades and enhancements in the network. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- The Gast pumps currently used to regulate flow have limitations and the network may benefit from switching to lower cost brushless motors.
- Meteorology is not currently collected at the IMPROVE sites (unless collocated with sensors from another network or agency).
- Adding relative humidity and wind speed/direction sensors would improve the quality of the data set.
- Adding low-cost $PM_{10}$, $PM_{2.5}$ and $PM_1$ data using something like a Purple Air sensor would provide near real-time particulate data to accompany the 1-in-3 day PM data collected on the filters.
- Consider using Multi-Angle Imager for Aerosols in conjunction with NASA to determine $PM_{2.5}$ concentrations.

- ➤ *Bret commented that Pittsburgh and Atlanta are being upgraded to full IMPROVE sites, instead of carbon only*
- ➤ *Scott requested a cost quote from UCD for pump replacements and Purple Air sensors.*
- ➤ *Tony comments that some sites are potentially going to see a change in long-term trends because the new pumps are able to maintain flow during periods of high loading. Perhaps prioritizing replacement at sites that typically see high loading or experience multiple failures.*

# DATA ANALYSIS

## Trends in Fine Dust and Coarse Mass

Jenny Hand presented a PowerPoint discussing current status and dust trends and how it contributes to $PM_{2.5}$, $PM_{10}$, and visibility. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Coarse mass is usually assumed to be mineral dust, but may not always be the case.
- Reconstruction analysis suggests dust has been underestimated by 20% over the last 13 years.
- A 2011 panalytical change was seen in soil component fractions, somewhat in total soil mass.
- Dust contribution to $PM_{2.5}$ varies with season.
- Contributions to $PM_{10}$ vary even more.
- In some cases relative contribution to visibility from dust has increased while other compounds such as sulfate/nitrate have decreased.

- ➤ *Bret commented that current Regional Haze Rule guidance treats some dust on Most Impaired Days as natural, but as other sources like roads, ATV's, climate change, etc start to impact data, a more sophisticated interpretation of dust to identify natural and anthropogenic sources may be necessary.*

## Modifications to IMPROVE Measurements and Algorithms

Bret Schichtel presented a PowerPoint discussing progress of modifications to IMPROVE measurements and algorithms. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Small and large fractions refer to particle size distribution that have different light scattering properties.
- It is assumed that aerosols shift to larger sizes for higher mass concentrations.
- The IMPROVE equation compared to optical measurements suggests sulfate scattering efficiencies are trending down in Eastern US, but constant in the West.

- An assumption in the IMPROVE equation is that lower masses mean less aged aerosol and more aerosol is in the smaller mode, which is less efficient at scattering visible light.
- Studies have shown relationship between scattering efficiency and mass over short periods, but are now looking at dependence over the years with trending aerosol concentrations.
- Concentrations and size distribution are more likely correlated and driven by aging process.
- Uncontrolled RH in the laboratory has likely increased the relative water on filters, increasing bias, but should be resolved with new RH controlled weighing chamber.
- Ammoniated sulfate appears to be moving from ammonium bisulfate in the early 2000's to ammonium sulfate today. (The East is more acidic than the West).
- Fine soil may be underestimated by 15-20% and any revision to the IMPROVE equation should include increased soil – should have minimal impacts on RHR metrics.
- Any revision should also account for Roc Seasonal variations, Roc long-term trends and possibly regional variations.
- Reconstructed Bext associated with large decreases in sulfate aerosol is now underestimated in the East.
- Findings should be published and incorporated in revising the IMPROVE equation.

➤ *Ann asked if there could be flexibility in the new equation to address improvements in the carbon analysis*
➤ *Bret answered that evolving carbon measurements within the IMPROVE program will affect metrics A decision on carbon measurements should be made before changes to the algorithm are implemented.*
➤ *Tony commented that other folks outside of outside of the IMPROVE community also use the data and should be considered. It was also noted that users should use the data "as-is" with all the biases and assumptions.*
➤ *Joann asked if there was interest in a carbon monitoring workshop. Many answered that there is, John Vimont commented that a workshop would be a great way to get informed opinions of different techniques but would be an advisory meeting rather than a decision making forum. Bill commented that modelers should be involved as well.*

### Reinterpreting TOR Analysis

Bill Malm presented a PowerPoint discussing various methods of measuring carbon and which are most appropriate and cost effective. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- TOR thermograms contain an E1 peak that includes pyrolyzed carbon (OP) and light absorbing carbon/elemental carbon (EC).
- There is evidence that EC is underestimated and that a significant fraction of EC evolves as OP and is counted as OC.
- Possible causes of underestimating EC include matter that is darker resulting in change in reflectance, heating processes, chemical structures that may be wavelength dependent, or other issues yet to be identified.

> *Joann asked since EC is such a small fraction, how much is the trend impacted? Differences between CSN and IMPROVE were seen.*
> *Tony asked what the EC sources for wilderness areas? Answer: fires, traffic and biogenics.*
> *Bret commented that other absorbing compounds like soil and brown carbon would also be considered*

## DAY 2 – OCTOBER 17, 2018

## DATA ANALYSIS

### NH$_x$ Study

Bret Schichtel presented a PowerPoint summarizing the CSN/NHx study in the Southeastern United States. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- The IMPROVE NHx study used phosphoric acid impregnated cellulose backup filters to collect $NH_3$ and volatilized $NH_3$ from nylasorb filters.
- Filters were analyzed for $NH_4^+$ and methylamine by ion chromatography.
- These results were compared against the URG reference method at CSU, with good agreement.
- Monthly average concentrations were measured from Spring 2011 to Summer 2012.
- From May-November 2017, samples were collected in the Southeast using the URG denuder/filter pack, CSN, and IMPROVE samples.
- High correlations were seen between the ADS and IMPROVE samplers, and moderate correlations between ADS and CSN. Larger biases were seen at higher concentrations for CSN.

- Disagreement between methods could be a result of:
  - Difference in filter type (Teflon vs. nylon)
  - Is the CSN inlet scrubbing $NH_3$? (answer: no)
  - Bias may be more related to $NH_4^+$ rather than $NH_3$
  - Cellulose filters have large pore size and may be losing particles.
- Recommendations and Next Steps:
  - NHx sampling is not suitable for humid environments
  - The bias at low concentrations in the CSN samples needs to be addressed
  - Filter handing protocols need to be developed
  - A comparison of the cellulose filters should be run to test particle collection efficiency
  - Collocated CSN/IMPROVE measurements should be collected to further test the method

➢ *Derek commented that URG/ASD has an even finer filter with smaller pore size.*
➢ *Tony Wexler asked if the NHx includes amines. Answer: no*
➢ *Tony also commented that some companies are pursuing real-time ammonia using sensors similar to Purple Air, which might work better in humid environments. However, the precision is quite poor.*


## Potential IMPROVE Data Patching and Algorithm Change

Donna Kenski presented a PowerPoint proposing a suggested modification of the IMPROVE data patching algorithm. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Currently data patching is not performed if more than one extinction component is missing.
- Guidance for tracking progress (2003) permits substitution of more than on component.
- Multiple patching is not overly complicated to implement and would retain important days that would otherwise be lost.

➢ *Bret asked if patching saved any years that would have otherwise been lost. Answer: yes, a small number.*
➢ *Bret commented that the guidance documents are in flux and could we potentially change the patching process now. Answer: current guidance allows for multiple patching if it is shown that there is a < 10% difference in Bext values.*

## Website Updates

Tony Prenni presented updates to the IMPROVE, FED, and TSS websites. Summary points are as follows:

- The WRAP Technical Support System Version 2 (TSSv2) is currently in development. Feedback and tool testing is welcome. Contact info is included at the bottom of the home page.
- The original TSS was the delivery mechanism for data used for planning purposes.
- Currently only monitoring data is available on TSSv2. Modeling tools and emissions data will be available at a later date.
- TSSv2 plans to "freeze" data. Any future updates to the IMPROVE dataset will be captured on the FED.

> *Tom Moore commented that the terms "RHR2" and "Impairment" are not as clear as they could be. "RHR2" relates to a changes in the IMPROVE algorithm (using the 2nd equation), whereas"RHR3" is misleading because it is not related to a change in the algorithm, but rather a change in the guidance.*

## IMPROVE Data and RHR Metrics

Scott Copeland presented a PowerPoint summarizing the status of 2017 IMPROVE data. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

> 2017 IMPROVE data delivered 10/12/2018.
> > o 2017 metrics are low (clear), but not quite as low as 2016.
> RHR2 and Impairment metrics available in FED soon.
> Proposing to consider "PC" flagged ion data as valid for RHR metrics.
> Discussion on "freezing" data sets. Decision is to keep IMPROVE/FED database with the most current data. States and MJOs may freeze data as needed for their SIP development.

## The Second Planning Period of the RH Program

       Melinda Beaver presented a PowerPoint summarizing the how the EPA and states are preparing for the second planning period under the Regional Haze Program. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- On-going work includes helping states resolve issues with first implementation period actions and supporting states for the second and future implementation periods.
- Many states have approved SIPs, some with partial approval and some with partial FIP.
- Key principles for implementation include reducing state planning burdens for states complying with CAA, leveraging emission reductions that will further improve visibility, and ensuring states are on the path to complying with the Clean Air Act.
- The timeline for implementation is:
  - Fall 2018 – final recommendations for most-impaired-days and methods for adjusting glidepath
  - Spring 2019 – updated natural conditions estimates
  - Spring/Summer 2019 – updated 2028 visibility models
  - Spring 2019 – final guidance on regional haze SIP development should be available
- 2016 Regional Haze Rule revisions were finalized on January 10, 2017.
- Key changes between the 1$^{st}$ and 2$^{nd}$ rules include:
  - The focus going forward is on reasonable progress, as opposed to BART
  - Visibility benefits were one of the five factors for BART in round one, but are not one of the four statutory factors for reasonable progress.
  - Tracking metric focuses on anthropogenic impairment (vs. haziest days)
  - Applicable regulations can be found in CFR 51.308 (f) and not section (d)

- *Bret asked if the end point changes with each SIP period. Answer: yes*
- *Bret asked if it would be frowned upon if the IMPROVE equation changed between now and 2021? Answer: most states would likely use the existing equation and guidance in current SIP development, but might be used in the next 5-year progress period.*
- *Gordon Pierce with Colorado commented that it is already too late in this process to switch to a new equation for current SIP.*
- *Bret commented that last time the states were able to use either equation. Would there be pressure to use a new equation when available? Answer: current guidance endorses the 2$^{nd}$ IMPROVE algorithm that states can cite.*

# BUDGET

## Budget Analysis & Discussion

Tony Prenni led a discussion regarding the IMPROVE budget. He indicated that the best guess for future funding indicated that there would be flat funding next fiscal year, so estimates for cost reduction or funding increases may be necessary again to offset rising costs.

- A new site in Alaska will come on-line, funded by the BLM for five years.
- Atlanta and Pittsburgh will become full IMPROVE sites (previously carbon only).
- Site repairs and changes were largely funded by overhead funds.
- Additional work could include looking at how reconstructed scattering and nephelometer intercomparison shows disagreement in recent years, as the nephelometer is critical for assessing IMPROVE equation.
    - Equipment in the current optical network is quite old (20+ years)
    - There may be funds to purchase an additional 1-2 nephelometers for intercomparison study.
- The RFP for the optical network will come out in 2019
- Need to start thinking about upgrading network.

## IMPROVE Steering Committee Business

Scott Copeland led a discussion regarding IMPROVE business updates.

- ➢ *Scott Copeland will continue to serve as IMPROVE Steering Committee Chair*
- ➢ *Scott reached out to the tribal contact at TAMS (Farshid Farsi) to invite tribal participation on steering committee.*
- ➢ *The first IMPROVE sample was collected on March 1, 1988 – marking 30 complete years of sampling.*
- ➢ *Suggested locations for the 2019 meeting include Point Reyes, CA or coordinating with NADP, and possibly hosting a 1-day carbon workshop if there is enough interest.*

## Review Agenda and Wrap Up

The IMPROVE business meeting was adjourned at 11:30am. The business meeting was followed by a visit to the Rocky Mountain National Park monitoring station.