IMPROVE Steering Committee 2025 Annual Meeting

Date: November 18 – 19, 2025
Location: Virtual - Teams

Time: 11/18 9:00 am – 4:00 pm
11/19 9:00 am – 12:15pm

IMPROVE Steering Committee members present:

Name	Agency	Email
Angie Dickens	LADCO	dickens@ladco.org
Bret Schichtel	NPS	bret.schichtel@colostate.edu
Chuck Turner	MARAMA	charles.turner@deq.virginia.gov
Farrah Fatemi	NACAA	farrah.fatemi@deq.oregon.gov
Jay Baker	WESTAR	jbaker@westar.org
Jenny Hand	CIRA, CSU	jenny.hand@colostate.edu
Melinda Beaver	EPA	beaver.melinda@epa.gov
Scott Copeland	USDA FS / CSU	scott.copeland@colostate.edu
Tim Allen	USFWS	tim_allen@fws.gov
Xinrong Ren	NOAA	xinrong.ren@noaa.gov

Additional IMPROVE stakeholders present:

Name	Agency
Adam Conway	RTI International
Alex Murrain	UC Davis
Alex Sanchez	
Alexia Prosperi	USFS
Amelia Smith	RTI International
Andrea Baccarini	
Andrea Stacy	
Ann Dillner	UC Davis
Bethany Head	
Bill Malm	CIRA
Bonne Ford	CIRA, CSU
Brett Gantt	EPA
Brian Timin	
Chris Misenis	

- continued -

Additional IMPROVE stakeholders present:

Name	Agency
Christian Kirk	ARS
Dan Murphy	
Debra Miller	
Diana Aranda	
Don Shepard	
Genevieve Lariviere	ARS
Gregory Beachley	EPA
Holly Salazar	
Indu Thekkemeppilly Sivakumar	UC Davis
J. Lee Okeson	Montana DEQ
Jared Milano	Oklahoma DEQ
Jeff Sorkin	USFS
Jenny Hand	CIRA, CSU
Jiayuan Wang	
Jihee Ban	
Jill Webster	USFS
Jim Miller	NPS Air Resources Division
Jim Renfro	NPS GRSM, TN/NC
Jocelyn Mellberg	Texas Commission on Environmental Quality
John Watson	DRI
Judy Chow	DRI
Katarina Lindskog	RTI International
Kelly Petersen	
Kevin Barry	
Kurt Heine	Missouri Department of Natural Resources, Monitoring Unit
Marcus Langston	UC Davis
Margaret Earnest	Texas Commission on Environmental Quality
Margaret McCourtney	Minnesota Pollution Control Agency
Mark Jones	
Mark Tigges	ARS
Melanie Peters	NPS Air Resources Division
Melanie Pitrolo	USFS
Melissa Puchalski	EPA
Nicole Hyslop	UC Davis
Nikunj Dudani	Aerospec
Omar Hammad	Congressional Research Service
Pleasant Mcneel	USFS, Region 4
Ralph Perron	USFS
Rhonda Payne	WESTAR-WRAP
Robert Kotchenruther	EPA Region 10

- continued -

Additional IMPROVE stakeholders present:

Name	Agency
Satoshi Takahama	
Sean Raffuse	UC Davis
Shannon Reed	EPA Region 8
Sharon Davis	DEP
Sonia Kreidenweis	
Stephen Beene	Trinity Consultants - Regional Haze SME
Tom Moore	
Tony Prenni	NPS Air Resources Division
Tracy Dombek	RTI International
Xiaolu Zhang	EPA
Xiaoya Cheng	UC Davis

INTRODUCTION & WELCOME

Scott Copeland opened with welcoming comments and a brief review of the agenda.

NETWORK & LAB REVIEWS

Optical & Scene Monitoring Network Status – Mark Tigges

2WIN Nephelometer Network Updates

- 2WIN data processing and validation has been broken into two parts; ARS is currently working through Part 1.
  - Part 1
    - Provide a reasonable visibility metric for the operator and NPS Web Sites so that metric can be shared with visitors.
    - Work with Bonne Ford and Tony Prenni to develop an algorithm for the on-site datalogger.
  - Part 2
    - Validate and process the dataset from the 2WIN.
    - Establish procedures for daily, weekly, and monthly data review.
    - Submit monthly data files for inclusion in the IMPROVE database.
- ARS has determined that it will be advantageous to utilize an independent Campbell Scientific rather than the 2WIN internal logger. The 2WIN software to poll the internal datalogger is costly and unsophisticated. Other advantages of using an independent logger include:
  - Better control of calibrations and calibration checks
  - More flexible and adaptable on the fly; able to program custom flags, set custom counters, limits, and generate reports.

- Larger data capacity – the 2WIN logger holds 30 days of measurements; the Campbell holds 7,000 days of 1-hour averages
- Data can be flagged to exclude calibrations, calibration checks, and maintenance from valid ambient readings (75% rule)
- Calculations are transparent
  - There's an issue with how the 2WIN internal logger calculates the angstrom exponent; this is remedied by using the Campbell.
  - Programming the independent logger has helped ARS to understand the 2WIN measurements and internal algorithms better

2WIN Measurements Compared to IMPROVE Sampler Mass Measurements – Bonne Ford

- Several 2WINS are currently colocated with IMPROVE samplers over a broad geographic area with different compositions and meteorology to compare optical measurements with mass measurements.
- So far, the 2WIN data is comparing very well with the mass measurements, especially at low values; despite a slow deployment it looks like the 2WINS will be an enormous benefit to the network.

Discussion:

- None at this time.

IMPROVE Carbon Analysis Update – Judy Chow

- DRI analyzed 18,981 IMPROVE samples from October 2024 to November 2025, operating 10 - 20 hours per day.
- Although the task termination notice received on May 1, and the resulting loss of staff increased the sample backlog, the 2025 samples are expected to be completed by 4/30/2026.
- The non-dispersive infrared (NDIR) detectors (PP Systems SBA-5) need to be replaced, and the current part is discontinued. DRI is in the process of testing replacements including a PP Systems SBA-5+ and Li-cor LI-830 and LI-840A.
  - The PP Systems SBA-5+ shows low-PPM noise at the high temperature plateau; Judy is working with the manufacturer to get a new prototype to hopefully resolve this issue.
  - Li-840A shows comparable OC measurement with the current SPA-5 detector; the thermogram also closely coincides.
  - Final decision to be made in the next few months. The Li-Cor is much more expensive, so if the manufacturer can improve the sensitivity of the SBA-5+, DRI will likely go with this option.

- Judy presented about 40 publications from multiple countries that use IMPROVE methods or IMPROVE protocols. List of publications included in slide deck.

Discussion:

- Bret Schichtel: How much more expensive are the Li-Cors than the PP systems?
- Judy Chow: Li-Cors are $7,500 and PP Systems are about $1,500 with a 1-year lifetime so this would increase operating costs significantly.

Recent Carbon Research – John Watson

Evaluation of Methods to Estimate Natural Visibility Conditions

- Natural conditions estimates applicable to the Regional Haze Rule have evolved significantly, becoming increasingly complex over the past 35 years.
- The current chemical extinction formula is dominated by the small fraction at normal levels, except for high carbon concentrations during wildfires.
- When you look at the ratio of first IMPROVE algorithm to second IMPROVE algorithm b_{ext} (Mm^{-1}) for 2015-2024, the old formula was 30% higher at most sites; however, if you look at background sites, there's not much difference at all.
- Dust and carbon thresholds were calculated based on 2015-2024 (Mm^{-1}) datasets. These thresholds are picked as the minimum of the annual 95th percentiles over the period. The new thresholds still need to be compared with the EPA 2018 guidance thresholds; a comparison will be included in the report that's generated from this study.
- Did extensive literature review to see what background levels are globally, unfortunately there isn't a lot of new data (EBAS database from Global Atmospheric Watch, etc.) and data that are available aren't very relevant to what we see in the U.S.
- IMPROVE data from 2015-2024 indicate that the 10th percentiles at the cleanest sites are dominated by Raleigh scattering on cleanest days; 50th percentile doesn't increase by much. It's only when we get up to 90th percentile (few samples, likely influenced by events) that we see things increasing. It appears we have data in the lower percentiles at some sites that come close to natural conditions.
- Modeling has been recommended; John's team reviewed past modeling including:
    - 2006 Dan Jabobs, et. al., found that non-U.S. anthropogenic contributions for ammonium sulfate is fairly high; ammonium nitrate, carbon and organics are fairly localized
    - 2016 Naresh Kumar, et. al., showed some agreement with the Jacobs study
- More research needs to be done, but current findings include:
    - Recent data show that many sites are attaining dry b_{ext} close to or less than twice Rayleigh at the 90th percentile
    - The lowest 10th percentiles indicate that lower levels than current natural estimates can be achieved

- Episodic events appear to be identifiable, but thresholds should be updated with more recent data
- 2016 model results seem to show bias toward non-US and natural emissions, site dependent

Discussion:

- Bret Schichtel: The 10th percentile being low may not be surprising; this may be influenced by rain events that would lower concentrations to close to Rayleigh. At some point we should filter on precipitation and compare to low days where we know there's no precipitation.
  We're struggling with having an E and W natural background levels; it would be nice to get more spatial variability in values to use in Regional Haze Program. Do you think that this study will be able to provide greater spatial variation in these natural levels?
- John Watson: Even if you look at the 50th percentile it's not much different – you're getting a lot more than just the 10th percentile; I think this shows we can get to natural conditions. If we're talking about perception we're looking at ~ one deciview or twice Rayleigh as the perceptible level for a distant target. A lot of days are down at this level. That's even true with the higher percentiles as well; I think the most important thing in the new guidance is the method to address episodic variables. What I found surprising, particularly when looking back at the earlier projects, is how much improvement in the sulfate levels we have.

- Tony Prenni: With most impaired days moving more towards winter, did you look at seasonality in natural conditions?
- John Watson: Yes; however, the modeling dataset is not big enough to tell much about what's going on. It's mostly because of the humidity in the wintertime that we see levels going up, it's not so much that levels are higher. We'll address this to some extent in the report, but I don't know that we have a good case to make a seasonal vs annual case.

- Brian Timin: Original assumption was that the east has higher natural conditions, which I think stemmed from the higher assumption of sulfate in the east compared to the west. Do you think that's real? Are you seeing any information that would suggest that maybe the natural background in the east aren't much higher than the west based on sulfate? If you took away all of the anthropogenic emissions, I don't see a reason why the east would be higher.
- John Watson: The model does not imply that it's higher when you subtract anthropogenic.

- Bill Malm: Is all dust now considered to be natural? If so, that's a question that IMPROVE may need to address regarding human activity contributing to dust. Is all dust considered to be background now?
- John Watson: Coarse is considered anthropogenic, except for extreme events, but this material won't go that far. Maybe the coarse should go into natural.
- Bret Schichtel: There is a clear weekly cycle in dust; this can only be created through human activity. Not all of that dust is natural.
- Scott Copeland: Current algorithm doesn't treat all non-episodic dust as natural.

Ion Analysis – Tracy Dombek

- Tracy provided an overview of the MDL and process for ion analysis of nylon filters, including quality control activities.
- Nitrate and sulfate MDLs increased in 2024, nitrate came back down in 2025 and sulfate stayed the same.
- Analyzed through August 2025 so far; analyzing about 18,000 samples annually
- Control charts for ions were presented:
    - QC checks are performed on low, medium and high ranges on calibration curve with a bracket of ±10%; if samples fall outside that bracket, 10 samples between are reanalyzed
    - Control charts showing the 25th, 50th, and 75th percentile concentration of ions show for chloride, nitrate, sulfate the lab recovers within required limits.
- Duplicate precision charts for chloride, nitrite, nitrate and sulfate for 2025 samples show comparability; if duplicates aren't matching within ±10% bracket, they are reanalyzed (they generally do though). These also allow lab staff to identify potential contamination in sample and flag them.
- Samples are reanalyzed automatically in batches at a rate of 5% (some random, some suspicious) per 400. Seeing good precision on these.
- Extraction efficiencies are evaluated annually; seeing good recoveries, but nitrite is problematic because concentrations are under the detection limit, so noise shows up.
- Participating in the Climate Change Canada Proficiency Testing Program since 2023 which allows RTI to compare the lab's sample analyses with 26 other participating laboratory analyses. Has given good measurements of lab methods and how lab is doing overall; have gotten good or very good performance marks (comparing accuracy vs. precision).
- Working on developing methods for total nitrogen and orthophosphate using a segmented flow analyzer
    - Method development to calculate organic nitrogen through subtraction
    - Need to troubleshoot the inline conversion into ammonia in the segmented flow analyzer
    - Nitrogen compares well by IC and segmented flow analyzer
    - Able to measure orthophosphate with segmented flow analyzer as phosphorus (v. sensitive); great recoveries at low range; but measuring artifacts from filter breakdown from sitting in DI water so there's an interference. Going to try centrifuging or filtering samples.

Discussion:

- Nicole: UC Davis interested in comparing XRF phosphorus results to RTIs different techniques. Where do you think the contamination is coming from? Due to sitting in liquid phase or out of refrigeration?
- Tracy: Nylon filter degrades and puts particulates into samples. Teflon filters don't break down; they are stable in solution. Did not affect UC Davis data because those were Teflon

filters; UC Davis benefitting from lower detection limit on orthophosphate. It doesn't appear to be method related, it's just the filter breaking down.

Network Update – Nicole Hyslop

UC Davis 2025 Network Update

- 2025 site updates:
    - Florida site visits delayed due to shutdown; all other visits occurred
    - Several shelter relocations/rebuilds
    - Few sites came back on-line this year
    - Several non-operational sites
- Lab is caught up on XRF analysis and they are getting done faster as there are now 4 XRF instruments dedicated to IMPROVE. Could be a slight bottleneck with data validation, but we're making progress for this delivery deadline as well.
- Before government shutdown 13 sites failed the RHR completeness criteria. The shutdown resulted in an additional 20-21 sites failing
- New this year was the deployment of active flow control on $PM_{2.5}$ modules to almost the entire network. It appears to be working extremely well – flow rates are stable despite some very minor software bugs to be worked out.
- Working on developing flow control for PM_{10} modules – need to develop a new method for measuring the flow rate - testing multiple Venturi flow meters at UC Davis. This may result in more precise measurements, but more data are needed to verify.
- The clogging protocol that was implemented in 2024 (stop sampling if flow rate drops below 15 LPM for more than 15 minutes) and has been successful in keeping valid samples where over 18 hours have been collected.
    - Short duration (SD) and Time Out of Bounds (TO) flags were applied to these samples. This is a very small percentage of samples across the network.
- The multi-wavelength HIPS (4 @ 450, 553, 633, and 730 nm) is now in beta-testing, although some modification of laboratory software and re-tooling has been necessary.
    - The comparisons between the mono- and multi-HIPS measurements so far indicate a very tight relationship. Comparisons will continue for a few more months before putting the multi-HIPS into routine production.
- CSN analysis was transitioned onto new XRF instruments (Bruker), although this took 3 years which was primarily spent developing custom spectral processing software. The path forward for IMPROVE isn't clear yet – could transition to Bruker or retrofit Panalyitical instruments.
    - Concern with Brukers for IMPROVE is that they're more cumbersome to load and samples can be damaged; need to develop a new sample holder. Also, Bruker has not been great to work with. Ther are two potential paths:
        - Research and buy new instruments

        - Retrofit existing Panalytical instruments (parts will be very hard to get in near future).
            - Started stripping down instruments to component parts, replacing Panalytical electronics with accessible technologies, adapting the multi-wavelength HIPS firmware and data reduction algorithm. Basic functionality was achieved on September 17, 2025. Preliminary results show promising reproducibility.
- QA continuing projects include:
    - HIPS Light Absorption
    - PTFE Filter Properties – filter manufacturer changed from Pall to MTL in 2021 which coincided with a drop in the fAbs/ECR ratio; many investigations and reanalysis have been performed; no smoking gun found;
        - Collocated Pall and MTL PTFE filters to check if light absorption (HIPS) results differ
        - Compared the optical consistency– compared well
        - Compared light absorption – MTL filters were biased low compared to Pall
        - Looked at effects of scattering particles on light absorption – it didn't affect; however, the MTL (IMPROVE) 3 µm filters are biased low. The UC Davis team thinks it's because the filters are so thin they are exacerbating the sample deposit pattern on the filter (which affects HIPs measurement). Team is testing drain disks at PHOE to try to improve the bias issues seemingly caused by pixelated deposits and considering using the 2 µm pore size. They appear to perform better and align with CSN; tests indicate the 2 µm pores size will work; working on next steps still.
    - Cyclone cut point – $PM_{2.5}$ size cuts are not as clean as they could be; IMPROVE is consistently biased high for soil elements (compared to CSN); Nicole believes due to the cut point. Studies show that IMPROVE samplers getting larger particles than they should be. Colocated instruments at soil dominated sites show episodic poor agreement.
        - Testing using a pre-cut PM_{7} inlet on top of the $PM_{2.5}$ on collocated Phoenix module to see how much of a bias that introduces.

Discussion:

- Scott Copeland: When are you hoping to make a decision on 2 vs 3 µm pore size?
- Nicole Hyslop: 8-9 months, but what other comparisons would you like to see before then? Are there other concerns?
- Bill Malm: Can you put together a table or summary of all these issues to help prioritize them? What's most critical?
- Nicole Hyslop: Flow control is going to make precision better for sulfur, but soil elements have always had lower precision than expected. It's a sampling problem that adds uncertainties of 10-15% to precision of soil elements. Light absorptions measurements is a good thing for Warren to look at. I think the issue with filter and filter lots is really affecting

the ability to look at long-term issues. Most of our focus in the next year is going to be on the XRF measurements though.

- Bret Schichtel: Were you just looking at $PM_{2.5max}$ comparisons between 2 vs 3 µm pore sizes?
- Nicole Hyslop: Yes, it's complicated because I think the pore size for Pall filters is more similar to the 2 µm MTL filters. If we go with 2 µm MTL filters it will be more like the old Pall filters
- Bret Schichtel: If we're worried about a 1 or 2% bias then we should be looking at differences in speciation?
- Nicole Hyslop: We only have a few months of data so far, so don't have that information yet.
- Bret Shichtel: Do you think we'll get increased sensitivity, better precision, or better detection limits with rebuilt Panalytical versus the original?
- Nicole Hyslop: Hopeful that we'll get better sensitivity because detectors have improved in the last 10 years; will likely get better detection on the light elements.

ANALYTICAL DEVELOPMENT

A Field-Deployable, Automated Instrument for FTIR Analysis – Nikunj Dudani

- Built an automated instrument for real-time PM composition analysis
- This project emerged in trying to deal with the challenges of scaling up FTIR for a large network like the IMPROVE Network: the PTFE filters cause interference in regions of interest, and transporting and handling can be difficult for a large network
- In building the FTIR, they focused on high spatial uniformity, low size dependence, low chemical interference, high collection efficiency, and high collection mass flux.
- The instrument uses a radial electrostatic precipitator as a collector; a lot of time was spent designing an analytical model to predict the position characteristics in electrostatic precipitation.
- The aerosol infrared monitor prototype shows high collection efficiency and low size-dependence with testing; a very reliable spectrometer with high SNR is used for measurements and a CO_2 snow jet is used for cleaning
    - Has been optimized with a sample flow rate of 1.75 LPM and a collection cycle between 20-minutes up to 24-hours; the detection limit are 0.1 – 0.3 µg/m3 for one hour of sampling
    - Advantages:
        - no big vacuum parts or sensitive electronics
        - easy-to-use graphical interface
        - data analysis uses reference optical constants that can be measured with the instrument or use from literature
        - sampling parameters can be controlled
- Trial deployments of Airmon v1 in Athens, La Goy University and Japan, and Paris showed good match to reference PM

    - Still need to work on dust
- Want to build instrument soon

Discussion:

- Ann Dillner: Tell me more about how you'll quantify the soil peaks in your next phase?
- Nikunj Dudani: A fluidized bed of the samples is used and collect using our instrument and a size measurement to retrieve the mass based on the density.

- Bret Schichtel: How do you calibrate this instrument?
- Nikunj Dudani: We use AIRSpec as the standard and added profiles of sulfates and nitrates that we measured with the same instrument in the lab.

- Scott: It's a laboratory calibration?
- Nikunj Dudani: Not for all of the compounds, but we did for ammonium sulfate and nitrate. We had a mass reference measurement, but we also used literature's mass attenuation coefficient. For example, we used the real and imaginary refractive indices, got the attenuation coefficient from them and used that profile to fit directly into the FTIR to retrieve the mass; they match pretty well with our calibrations. Because we are measuring absorbance, we can use calibrations that exist as refractive indices, previous measurements, and our own measurements. So in this case, for the AIRSPec, we just use the standard absorption coefficient that Satoshi had in his standard air spec package. And that's what gave us the Athens and Japan data.
    - Ann Dillner: AIRSPec is the peak fitting algorithm that Satoshi and Lynn Russell have been using for a really long time, and that we're using quite a bit now too

- Bret Shichtel: Is any of this applicable to the FTIR of the IMPROVE filter?
- Ann Dillner: The calibrations are not directly applicable. We haven't tried to get them across to Teflon filters partly because of the interferences that Teflon causes.

- Scott Copeland: One of the slides you mentioned collection efficiencies of 64 to 80%. Can you tell me what collection efficiency means in that context?
- Nikunj Dudani: Actually, it was the charging transmission. We use unipolar charging, using different wire configurations to optimize. By changing different flow parameters and the voltages we were able to increase the combined efficiency. We are also testing different configurations of the wires to change the electric field inside the charger and optimize the charger further to get a high transmission, but that's essentially the only loss we observe in the instrument currently. Because as soon as the particles get charged, they have the sheath flow around them, which shields it from other electrostatic losses. The residence time in the collectors is not too high to get diffusion or Brownian losses.

- Scott Copeland: After you make this measurement, you then have to scale the values using "one-over" this collection efficiency? Is this collection efficiency critical?
- Nikunj Dudani: That's correct. There are two values we have to correct for: charger transmission and second is the spot (hyper-optimized collector). These are two

corrections that we make for all the masses, which we correct all the functional groups and they're the same for even different functional groups. We don't pick and choose and correct differently for each one of them. The transmission efficiency is monitored independently with the OPC; that it doesn't require an external calibration.

- Scott Copeland: So you're measuring the collection efficiency and then measuring what you collect?
- Nikunj Dudani: Correct. So, the instrument also has the OPC that measures the performance of the charger.

Storage Impact on IMPROVE Filters for Microbial Communities – Kevin Barry

- This study was performed to gain knowledge about how storage conditions of aerosol filters affect their microbial composition and ice nucleating particle (INP) concentrations
- Particularly interested in the biological ice nucleators, which are some of the rarest but can trigger freezing at the temperatures closest 0°C, so they tend to be the most important ones. INPs can also be used as a diagnostic tool to look at atmospheric stress. Some bacteria can undergo different stresses in the atmosphere which can change their INP property (temperature they freeze at).
- An IMPROVE test site composed solely of D Modules ran next to an established site to measure INPs and DNA looking at storage conditions:
    - Room temperature
    - Frozen at -20°C
    - Heated at 40°C
- Two approaches (although difficult to constrain both due to meteorological conditions):
    - 3 D-modules can be subjected to different time component, but one [temperature] treatment or,
    - Different [temperature] treatment components but one time
- Approximately 50 samples collected: 25 in summer/ 24+ in fall
- Seeing very consistent results between INP and DNA concentrations at various storage conditions out to one month; after one month there may be some degradation in INP concentrations
- Similarities in DNA concentration and bacterial taxonomy regardless of treatment on the order of 1 week; the relative abundance does not change significantly between immediate and 1 week (at each given storage temperature); the same is true for fungal taxonomies as well.
- If you look at ions (chloride, nitrite, nitrate, sulfate, and sodium) immediately, 1-week after, and 1-month after at the various temperatures, the concentrations are very similar; with some slight decreases after one month
- Aerosols collected with the IMPROVE Module D/PM_{10} Module show promise for bioaerosol and INP work; hoping to utilize other sites in the future
    - So far found consistency on the order of one month, but there's more work to do

- Similar concentrations as well as taxonomy for both bacteria and fungi
- Finish analyses at dedicated timepoints in the future (3-month, 6-month, 1-year) \
- Another batch of microbial sequencing:
    - Testing long-range ITS and 16S sequencing to give more resolution for both fungi and bacteria

Discussion

Tony Prenni: Is it easy to get sequencing off of these filters?
Kevin Barry: Great recovery and easier than I thought to get DNA off of the filters.

Nicole Hyslop: Would there be any interest in taking the FOCO1 samples after they've been sitting for a year to see if you see the same species when they're not in any kind of control outside of normal handling?
Kevin Barry: Yes, making a one-to-one comparison with total concentration and individual taxonomy to see what changes would be going on after a year. Some of the rarer taxa might change; after one year we may get out of the noise.

Scott Copeland: How did you measure the ice nucleation particle concentrations?
Kevin Barry: We resuspend the filter in ultra-pure deionized water and vortex it to release the particles; then we're able to aliquot them out into small droplets, and then we put it into the instrument that cools down slowly. Based on when those aliquots freeze, we can calculate the concentration and normalize it to per liter of air. It's crude, but straightforward.

Topics in FTIR Analysis – Ann Dilner, et. al.
Infrared Analysis of IMPROVE Filters the Depth and Breadth of What This Provides – Ann Dillner

- Cooperative agreement (CESU) funding supports the FT-IR analysis of Teflon filters collected at a subset of IMPROVE sites
    - 20+ sites used to calibrate FTIR spectra to TOR OC and TOR EC
        - Used to measure OC and EC at international sites operated by SPARTAN and NASA/MAIA
        - Smaller research projects – impact of smoke on the growth of plants
    - Sites collocated with the new ASCENT network
    - Sites to support DOE-funded organic hygroscopicity research
- Ann recently provided two plenary presentations on monitoring networks at AAAR; she focused on IMPROVE, CSN, SPARTAN, MAIA and ASCENT monitoring networks
    - One goal of talk was to share all of the different ways IMPROVE data are being used outside of the visibility world.
        - Cited a New York Times article (Nature article preview) related to increased mortality in the US due to Wildfire Smoke which used IMPROVE and CSN data

        - Cited another New York Times article related to the LA Wildfires looking at lead concentrations using the CSN and ASCENT networks
    - There were a lot of questions and interest in these talks and in IMPROVE/network data
- AAAR presentation focused on using IMPROVE data to study the influence of wildfire smoke and to guide undergraduate research and teach data-sharing principles in introductory courses.

Hygroscopicity of Organic Aerosol from Wildfire Emissions– Ann Dillner on behalf of Nagendra Raparthi, et. al.

- Research focuses on hygroscopicity of wildfire $PM_{2.5}$, particularly organic matter (OM); currently limited knowledge exists on hygroscopicity of organic matter.
- Hygroscopicity influences particle size, aqueous-phase chemistry, CCN activity, radiative effects, and particle lifetime.
- Nagendra developed a method to measure water uptake on pre-existing IMPROVE Teflon filters. Initially tested on lab-generated organic filter samples; this work applies it to ambient wildfire samples. Objectives are to:
    - Measure hygroscopicity of $PM_{2.5}$ from local and long-range transported wildfires
    - Derive organic matter hygroscopicity in local and long-range wildfire
    - Model hygroscopicity from chemical composition of wildfire samples
- Filters were exposed to three relative humidities (84%, 90%, 97%) to measure water uptake and FT-IR analysis performed to quantify organic functional groups.
- Chemical composition findings show that organics dominate wildfire $PM_{2.5}$ (50–80% of mass); ammonium sulfate (2–17%) present - important due to high hygroscopicity.
    - OM functional groups show ~50% oxygenated functional groups at Yosemite & Sequoia, ~60% oxygenated Canadian transport samples, some unaccounted mass, especially at Sequoia, possibly due to sampling artifacts or OM underestimation.
- Hygroscopicity (κ) Results – Total $PM_{2.5}$
    - Highest κ values generally correspond to higher sulfate, but organics also significantly influence κ.
    - Sequoia samples showed relatively constant κ (~0.04) across days.
    - Long-range transport samples showed higher κ, especially from Western Canada, not solely explained by sulfate.
- Organic-Only Hygroscopicity (κ _OM)
    - Derived using standard ZSR mixing rule and E-AIM model for inorganic components.
    - Higher oxygenated functional group fractions: higher κ_{OM}.
    - Yosemite & Sequoia (50% oxygenated OM): moderate κ_{OM}
    - Canadian samples (60% oxygenated OM): higher κ_{OM}.

    - Western Canada sample: highest κ_{OM}, driven by high carboxylic acid content.
- Modeled $\kappa PM_{2.5}$ as a function of organic and inorganic composition S
    - Used stepwise multilinear regression used to obtain statistically significant predictors
- Conclusions
    - One of the first studies to quantify wildfire OM hygroscopicity directly from Teflon filters.
    - Wildfire $PM_{2.5}$ hygroscopicity is highly variable and strongly controlled by organic functional group composition and sulfate content.
    - OM hygroscopicity increases with oxygenation level of functional groups.
    - Developed model enables estimation of OM hygroscopicity in wildfire-affected aerosols using IMPROVE + FT-IR data.

Enhancing Organic Characterization from ACSM Mass Spectra Using Collocated Functional Groups Measurements at IMPROVE/ASCENT Site in Atlanta - Ann Dillner on behalf of Na Mao et. al.

- ASCENT network, a new U.S. monitoring network includes 12 sites, all collocated with other established networks (IMPROVE, EPA, etc.). The network uses ACSM (Aerosol Chemical Speciation Monitor), which are high–time-resolution aerosol mass spectrometers, to measure organics and inorganics.
- ACSM provides mass spectra but lacks chemical specificity due to ion fragmentation, while FTIR (on co-located IMPROVE samples) can measure functionality, enabling functional-group-based interpretation by training the ACSM with FTIR data (not one-to-one).
- Goal is to enhance chemical resolution of ACSM spectra using parallel FTIR functional groups and develop parameterizations to predict functional groups from ACSM spectra.
- This study used IMPROVE FTIR + ACSM data from the Atlanta ASCENT site to make the following functional group measurements:
    - Carbonyl (CO)
        - Carboxylic acid (COOH)
        - Nonacid carbonyl (naCO)
    - Alcohol (aOH)
    - Alkane (aCH)
- Time-series comparison shows good correspondence between FTIR OM and ACSM OA (R^2 high, OM ≈ 80% of OA). Gives confidence for further model development
- Developed models using Elastic Net (EN) regression to relate ACSM fragments to FTIR functional groups.
- Applied developed models to entire ACSM dataset (hourly), then averaged to monthly. Results show seasonal increases in carboxylic acids during summer, but no strong seasonal pattern for alcohols. Diurnal (hourly) behavior will be examined next.
- Conclusions:

- Developed models successfully predict functional groups because we have FTIR spectra
- COOH, CO, aOH, and aCH are well predicted
- naCO is not well predicted due to low concentration
- Demonstrates potential to enhance ACSM chemical resolution at ASCENT sites.

- Next steps: evaluate diurnal patterns, test models at other ASCENT sites, and determine whether site-specific or unified models are most effective.

International Speciated $PM_{2.5}$ Monitoring - Ann Dillner

- SPARTAN = Surface Particulate Matter Network, launched in 2012 to measure $PM_{2.5}$ in low- and middle-income countries with little or no monitoring to improve satellite-based $PM_{2.5}$ estimates for global health-impact assessments
- ~20 active; typically located in dense, highly polluted urban areas co-located with nephelometers and AERONET sun photometers for AOD measurements.
- Uses one Teflon filter to collect $PM_{2.5}$ samples. Species: gravimetric mass, OC and EC, soil and trace elements, anions and cations
- Key Findings from Spartan Global Data
  - FTIR OC vs. residual OM shows:
    - OM/OC ≈ 2.0, R^2 = 0.85 (consistent, credible calibration)
    - High-EC samples → near 1:1 line → more primary emissions
    - Low-EC samples → higher OM/OC → more secondary aerosol
  - EC concentrations correlate with national income:
    - Higher EC in lower-income countries (Africa, India, Bangladesh, China)
    - Lower EC levels in higher-income countries
- MAYA = Mission to Earth: Multi-Angle Imager for Aerosols, a NASA satellite mission to measure speciated aerosol for improved global health-impact assessments; expected to launch no earlier than 2026
- Surface networks supporting MAIA include IMPROVE, CSN, SPARTAN (expanded sites), Colorado State monitors, micro-nephelometers.
- Methods provide insight into sources and composition in regions with limited monitoring infrastructure:
  - SPARTAN Case Study 1: Pretoria, South Africa
    - Demonstrates how low cost, routine, and non-destructive FT-IR analysis was used for OM quantification and source apportionment in Pretoria, South Africa SPARTAN samples
  - Spartan Case Study 2: Addis Ababa (Addis), Ethiopia
    - Demonstrates how low cost, routine, and non-destructive FT-IR spectra used to measure OM and assess sources for PTFE filter samples

Discussion:

- Tony Prenni: In hygroscopicity study, ammonium sulfate and sea salt were accounted for but generally there are some nitrogen species as well. How were those dealt with?
- Ann Dillner: We used 2023 IMPROVE samples and the assumption was that the [ammonium] nitrate had all volatized and we analyzed filters by FTIR. There were no peaks where we'd expect to see nitrate, so we didn't account for them. We didn't consider the organic nitrogen; that could also be hygroscopic, yes?
- Tony Prenni: Yes, probably not as much as ammonium nitrate.
- Ann Dillner: We're not yet at the point of measuring organic nitrogen, but that's something we need to do.

- Satoshi Takahama: Regarding the hygroscopicity study: studies were done in the early 2000's using UNIFAC parameters to estimate hygroscopicity from functional group measurements with FT-IR. E-AIM also has some UNIFAC parameterizations. Have you considered using some of that information? You could compare with regression coefficients.
- Ann Dillner: We considered this but have not. It would be good to do.

- Bill Malm: What did your regression suggest that the κ was for sulfur or sulfate?
- Ann: The coefficient in our equation is 0.29 and that's multiplied by the ammonium sulfate mass divided by the $PM_{2.5}$ mass so that's not actually giving us the κ for ammonium sulfate; it's for the relative amount of ammonium sulfate. We should think about if that's a way to judge if what we're doing makes sense.

DATA ANALYSIS

Fine Dust and Coarse Mass - Jenny Hand

- Presentation of preliminary work on the relationship between fine dust ($PM_{2.5}$ soil) and coarse mass (PM_{10}–$PM_{2.5}$)
- Dust is the most abundant aerosol globally and affects air quality, visibility, climate, ecosystems, agriculture, and health creating an estimated $155B annual U.S. economic impact.
- IMPROVE provides two dust-related metrics:
  - Fine dust ($PM_{2.5}$ soil) from XRF, often assumed to be the tail of coarse particle mode.
  - Coarse mass (PM_{10} – $PM_{2.5}$), often assumed to be mainly mineral dust but can include other species.
- When looking at spatial patterns:
  - Maps of annual mean fine dust vs coarse mass show that both are high in the Southwest U.S., but fine dust extends farther east than coarse mass likely due to lower settling velocity.
  - Coarse mass increases in Great Plains and coastal areas, unlike fine dust
- When looking at seasonal patterns: Some regions show corresponding seasonality; others diverge.

    - Both fine dust and coarse mass peak in spring in the Southwest.
    - Fine dust peaks in the summer in the Southeast and coarse mass stays relatively flat due to Saharan dust transport.
    - Fine dust shows spring influence from Asian transport in the Northwest; coarse mass does not.
- When looking at long-term trends:
    - Unlike sulfate/nitrate, dust/coarse trends show no widespread declines
    - Some western sites show increasing coarse mass, not reflected in fine dust
    - Eastern Appalachians: declining fine dust, but coarse mass more stable
    - Suggests different sources, transport behavior, or composition between fine and coarse fractions
- How are CM and FD related?
    - Fine dust may be the tail of the coarse mode dust distribution (assumed in the IMPROVE reconstructed extinction equation), *BUT* possible that coarse mode dust has a larger size distribution that doesn't reach into the fine mode and coarse mass includes non-mineral species (organics, nitrate, sulfate)
    - Other studies (MOUDI measurements) at IMPROVE sites indicate that there is some coarse nitrate in the $PM_{2.5}$ size range
- To explore, Jenny's team did a linear regression of coarse mass and fine dust to derive the slope and intercept:
    - Slopes and intercepts vary strongly by season and region.
    - In some areas the dust in coarse mass can be 10–20x higher than measured in fine mass.
    - Intercept should tell us what the remaining coarse mass is that's not fine dust; can be fairly large which suggests significant non-dust coarse material (summertime in central U.S., coastal).
- Performed a multilinear regression to try to determine if the tail of any of these species is extending into the fine mode
    - Seeing high statistical significance for dust coefficient; areas with high coefficients align with areas with high intercepts
    - Much lower statistical significance for nitrate coefficients except in the southwest (winter/spring) and in coastal areas
- Compared MLR and LR results, which indicate:
    - Consistent results for dust contributions.
    - Consistent results for coarse mass estimates.
    - Reasonably accurate reconstructions of coarse mass across seasons and sites.
- Next Steps
    - Plan to repeat analyses with Theil-Sen regression (more robust to outliers).
    - Need to interpret species contributions more rigorously.
    - Improved coarse-mode understanding can:

- Inform visibility modeling, since extinction assumptions (e.g., mass extinction efficiency of 0.6) may be wrong if coarse mass contains hygroscopic species.
- Improve $PM_{2.5}$ regulatory and health assessments, as dust and coarse contributions grow relative to declining sulfate/nitrate.

Discussion:

- Brett Gantt: How much did you consider the different composition of the fine dust as influencing the extrapolation to the coarse mode (Fe, Al ratios)?
- Jenny Hand: We haven't looked at that yet; the multipliers used in the dust equation used have been adjusted based on previous fine mass studies, but not further than that. Will look at.

- Satoshi Takahama: Do you have an idea about the source of coarse particle sulfates? We see sulfur scattering in FTIR spectra around 1- 1.5 μm; not often associated with dust in high quantities. Some seasons show very little dust but a lot of sulfate.
- Jenny Hand: Probably depends on where you are. It could be sea salt or gypsum, it could possibly fertilizer; there have been studies about how sulfur in fertilizer has gone up. We've not looked at fertilizer a lot from an air quality perspective.

- Bret Schichtel: I'm skeptical that we're seeing 10 μg per cubic meter of sulfate in the in the coarse mass at Sequoia. Have you looked at White Sands where we know there is significant gypsum?
- Jenny Hand: Yes, what we see there is consistent as well.

Nitrate Study – Amy Sullivan

Investigation of Wintertime Nitrate at Mammoth Cave and Great Smoky Mountains National Parks – Amy Sullivan, et. al.

- Wintertime nitrate concentrations are consistently higher than other seasons at Mammoth Cave and Great Smoky Mountains National Parks. Although nitrate likes to form in colder temperatures it is also semi-volatile so its formation and evaporation are a complex function of the gas phase precursors ammonia and nitric acid, the meteorological conditions, and existing particle composition. These factors can also determine the particle liquid water content and the pH. It's important to identify the main sources of the nitrate if you really want to be able to understand how to control emissions.
- Measurements made at existing IMPROVE sites at each park in January-February to measure HNO_3, NH_3, $PM_{2.5}$, PM_{10}, integrated $PM_{2.5}$ anions and cations, CH_4, CO_2, $PM_{2.5}$ and PM_{10} mass, and NO_2
- Observed
    - Higher gas-phase and aerosol-phase nitrate and ammonium at Mammoth Cave relative to Great Smokies.

- Distinct variations between gas-dominated and particle-dominated episodes.
- Meteorology similar at both sites, especially temperature, indicating regional behavior. Dataset divided into Period A: colder conditions (before Jan 25), and Period B: warmer conditions (after Jan 25).
- PILS data show nitrate, sulfate, and ammonium generally track with $PM_{2.5}$; nitrate generally dominates changes in $PM_{2.5}$ with some exceptions (sulfate spike with WD change)
- Ammonia spikes during warm Period B and coincides with drops in particle nitrate/ammonium and lowest $PM_{2.5}$ values. Temperature appears to be driving the pattern.

- Nitrate Episode Characterization
  - Dataset split at 50th percentile threshold of nitrate concentration to compare high- vs low-nitrate conditions:
    - High-nitrate periods dominated by nitrate in $PM_{2.5}$.
    - Low-nitrate periods show more sulfate and higher ammonium
- Residence Time Analysis shows a clear shift in major transport pathway from Period A to Period B
  - Period A: north–northwest / central U.S. transport; provokes nitrate-dominated episodes (likely agricultural NH_3 and combustion NO_x sources).
  - Period B: shift to south–southwest and southeast flow; provokes transition to sulfate-dominated aerosol.
- Thermodynamic Modeling (ISORROPIA II)
  - Mammoth Cave: good model agreement for nitrate, ammonium, and ammonia; poorer fit for low-level nitric acid
  - Great Smokies: good agreement for nitrate and ammonia; weaker agreement for ammonium and nitric acid due to very low concentrations.
  - Including real-time PILS and Picarro also showed good agreement (nitrate, ammonium, ammonia) between model and measurements; slight systematic ammonium underprediction observed.
    - Ion balance suggests consistent cation deficiency, indicating possible missing cations or acids.

- Conclusions:
  - Winter nitrate is a dominant component of $PM_{2.5}$ at both sites.
  - Regional transport patterns significantly influence nitrate vs sulfate episodes.
  - Initial ISORROPIA modeling shows strong model–measurement agreement and readiness for scenario simulations.
  - Wintertime PM variability is jointly driven by thermodynamics, precursor availability, and regional transport.

Discussion:

- Bret Schichtel: How do you control nitrate episodes? Do you reduce ammonia (agriculture) or NO_X (combustion) – these are very different control scenarios. At this point, thermodynamic modeling has not yet reached a point where we can identify the limiting factor.
- Amy Sullivan: Correct; next step is to manipulate the model to explore more.

- Angie Dickens: NOAA CSL has used the ratios of nitric acid to nitrate and ammonium to ammonia to understand limiting factors. Have you done anything similar with measured data?
- Amy Sullivan: We haven't looked at ratios; wanted to use thermodynamic model so that they can more rigorously approach it and start to look at PH and the role of liquid water content as well.

- Amelia Smith: What do you believe to be the contributing sources of the shift from nitrate to sulfate dominance seen in Period B?
- Amy Sullivan: Wind direction shift very important; when sulfate concentrations were high, potassium and sodium were also higher. Not certain of the exact source (local, regional?).

DATA PROCESSING, DISTRIBUTION AND QUALITY

IMPROVE QA Activities – Bonne Ford

Technical System Audits (2016–2025 Cycle)

- Purpose: Ensure network sampling sites follow the Quality Assurance Project Plan (QAPP) and Standard Operating Procedures (SOPs).
- Requirement: Each site must be audited at least once every 10 years by a trained auditor (lead CSU auditor or state partners).
- Audit Coverage:
    - 226 audits completed since 2016 (mostly by Derek and state partners).
    - Four sites remain unaudited: Egbert, Toolic Lake, Carlsbad Cavern, and McDonald Pass (a new site replacing Gates of the Mountains).
    - Carlsbad's planned audit in October was canceled due to a shutdown.
- 2025 Audit Results
    - 15 sites audited in 2025.
    - Only Shamrock Mine failed all flow checks, likely due to new auditors and new flow control procedures; Colorado plans to redo the audit.
    - Colorado (CDPHE) performed flow-check–only audits; full TSAs were done by the lead auditor.
- Key Issues Identified
    - Infrastructure aging:
        - Zion Canyon: significant structural deterioration.

        - Bryce Canyon and Capitol Reef: minor structural concerns; repairs needed soon.
        - Canyonlands: outdated pump box, water intrusion, and old electrical systems; repairs now completed.
    - Operator turnover:
        - High turnover leading to lapses in training, unfamiliarity with resources (SOPs, tracking tools, videos).
        - Several operators expressed low morale and uncertainty about management support or job stability.
    - Flow control transition:
        - Generally successful; operators reported improved ease of use.
        - Some confusion with new flow-check procedures and leak-check protocols.
- Overall Audit Findings
    - The network is performing well.
    - Most issues found over the 10-year audit period were minor (e.g., tree clearance, cleanliness, filter handling).
    - Serious data-impacting issues are rare.
    - When issues arise, the field team typically resolves them before re-audit.

Quality Assurance (QA) Program Updates

- Quality Management Plan (QMP) v2 approved in January 2025.
- QAPP revision in progress; delayed due to contract disruptions and the government shutdown.
- Drafts from labs received in late summer; revisions currently underway with additional comments pending.

Website and Documentation Maintenance

- Updated SOPs being collected and posted.
- The IMPROVE website is undergoing 508-compliance updates, temporarily breaking some links; fixes are in progress.

Timeline

- QAPP review expected to shift from November into December–January.
- Despite delays, steady progress continues, though revisions are challenging due to extensive historical content.

Discussion:

- Bret Schichtel: Great that audits are identifying issues, are there lingering issues that don't get resolved?
- Bonne: Most of the issues do require follow up (shelter replacements, tree cutting, etc.) but are minor; we don't see lingering issues like we used to due to the advancements that the field team has made.

IMPROVE Data and RHR Metrics – Scott Copeland

- Changelog presented to track changing meta values related to the impairment framework and other key updates. Key update:
  - New Meta-Site: ZION_RHTS
    - It merges two Zion locations: the high-elevation Zion site near the interstate and the Zion Canyon site near Springdale
    - This is the first time data were scaled for a relocated site, rather than measurements used. Similar scaling approaches may be needed for other locations in the future.
- Network Trends from 2022–2024 show:
  - Year-to-year variability is normal: some sites rise or fall slightly, but overall air quality continues to improve.
  - As of 2024 Southern Great Plains, Atlanta, and Pittsburgh now have enough data (5 years) to compute most impaired days
  - Some longstanding sites (e.g., Viking Lake, Lake Sugema) have closed, creating gaps but not fundamentally altering regional trends.
- Comparing 2024 to 2002 shows dramatic nationwide reductions in visibility-impairing pollutants, especially sulfate and nitrate.
  - 44 of 148 sites (~ one-third) recorded their cleanest "most-impaired day" ever in 2024.
- New data are available this year for short-duration (SD) samples (new protocol to shut samplers off during events to avoid clogging and preserve otherwise-lost data—valuable for understanding extreme events)
  - Most short-duration events are driven by high carbon (OC/EC); almost none are caused by dust.
  - Most samples under 10 $\mu g/m^3$ - no clogging
  - 10–50 $\mu g/m^3$ - occasional SD events begin.
  - 50–100 $\mu g/m^3$ and above: shutdowns become common, and at very high loads nearly universal.

Discussion:

Margaret: Where can I find the SD qualifiers in the data?

Scott Copeland: They are not in the Regional Haze Metric files because they're not "valid". You need to look at the IMPROVE raw data. If you're getting data from FED, it's possible that they slipped through. Try again on FED and if you don't see them let me know.

Third IMPROVE Light Scattering Algorithm – Bonne Ford

- The first IMPROVE equation used fixed mass scattering efficiencies and simple assumptions about particle hygroscopic growth (f(RH)).
- Because nephelometer comparisons showed underestimation on hazy days and overestimation on clear days, a second (revised/split-mode) IMPROVE equation was introduced in 2007. This method partitions aerosol mass into "small" and "large" modes using a 20 $\mu g/m^3$ cut point, which effectively changes mass scattering efficiencies depending on concentration.
- Although the second equation worked well for the early 2000s, later studies show its performance has degraded.
    - Declining sulfate concentrations have caused the equation to assign too much mass to the small mode, producing unrealistically low mass scattering efficiencies, which isn't supported by observed aerosol size distributions. The resulting bias has steadily increased over time across the network.
    - Attempts have been made to fix the second equation including:
        - Tests to lower or vary the cut point, and other adjustments
        - Optimal cut points differed randomly by site and year, making a consistent implementation across the entire network impractical.
        - Improvements would require additional nephelometer data and annual recalculations, making the method unstable for regulatory use.
- A case could be made to return to the first equation:
    - Updated analyses using both long-term Optec nephelometer data (2001–2022) and newer 2WIN nephelometer data (2022–2024) show that the first IMPROVE equation now performs better overall than the second.
        - The second equation consistently has larger bias—especially at the mid-range extinction levels that define current "mid-90" haze days.
- Bonne's team is recommending updates to the first equation by:
    - Using updated mass estimates, including updated soil/dust equation, monthly OM/OC ratios, species-specific hygroscopic growth curves (f(RH)), inclusion of sea salt
    - Using mass scattering efficiencies similar to the original first equation, with slight adjustments based on new size-distribution modeling.
    - Retaining a single size distribution for each species (no concentration-dependent split-mode).
- This approach is more stable, better matches current measurements, and is more consistent with observed aerosol behavior.

Group Discussion on Implementation of New Algorithm

- Bonnie confirmed that she recalculated all Regional Haze metrics (including new 95th-percentile cutoffs and means) using the updated equation and updated assumptions (OM/OC ratios, species-specific f(RH) curves, updated soil equation, etc.).
    - She noted some uncertainty in the climatological f(RH) values due to lack of access to original hourly RH datasets, but sensitivity testing suggests differences <10%.
- The new algorithm improves long-term trend accuracy compared to Equation 2, which introduces bias as concentrations decline over time.
- Optical monitoring remains essential because it allows evaluation of these algorithms.
- There is ongoing EPA rulemaking related to the Regional Haze Rule; the public-comment docket closes December 1.
    - Several members expressed concern about moving too quickly, noting that:
        - The paper behind the algorithm is submitted but not yet peer-reviewed or published.
        - States may be alarmed if the algorithm changes trends (e.g., flattens progress).
        - Releasing numbers first would allow states and stakeholders to understand the impact.
    - Others suggested at least acknowledging in the docket that:
        - Improvements to the extinction algorithm are under evaluation.
        - A new algorithm may be considered.
        - Optical monitoring should continue.
        - Some noted that when IMPROVE Equation 2 replaced Equation 1, states were temporarily allowed to use either equation in SIPs.
- There was no solid consensus to endorse the new algorithm now or to submit a formal recommendation to EPA before December 1. Most members preferred:
    - Distributing the draft paper and presentation to the Steering Committee.
    - Generating and sharing updated Regional Haze metrics using the proposed algorithm.
    - Allowing the broader community (states, FLMs, RPOs) time to review and comment.
    - Possibly providing docket comments indicating that algorithmic improvements are being evaluated, without endorsing a specific method.
- A suggestion was made that the Steering Committee could vote later on whether to pursue adoption after reviewing impacts.
- Bonne will email the Steering Committee her presentation and the draft manuscript.
- Bonne, Scott and Bret will work on generating Regional Haze metrics using the new algorithm, recognizing that updated f(RH) climatologies may require substantial effort.
- The group may submit general comments to the EPA docket noting that:
    - Improvements to the extinction algorithm are being investigated.

- Updated methods will need review, transparency, and community feedback.
- The broader adoption timeline will likely extend into next year so the algorithm can be integrated with updated natural conditions estimates.

IMPROVE BUSINESS

Network Operations Subcommittee Report – Melinda Beaver

- Melinda Beavers (EPA), chair of the IMPROVE Network Operations Subcommittee, provided a brief update on the subcommittee's activities, focusing mainly on quality assurance/quality control items.
- EPA and its QA contractor conducted a Technical Systems Audit of the RTI Ions Laboratory in March. The final report was provided to IMPROVE's QA manager (Bonne). No findings were identified for the IMPROVE ions lab—indicating strong performance. The report specifically noted good data-review practices.
- EPA intends to continue conducting periodic laboratory TSAs as resources permit, leveraging overlap between CSN and IMPROVE when possible.

Data Analysis and Reporting Subcommittee – Jenny Hand

- Jenny Hand (CSU–CIRA), chair of the IMPROVE Data Analysis Subcommittee, provided an overview of the committee's role and activities from the past year.
- Bonne has nearly completed coding all Regional Haze Rule metrics in Python and will distribute the code soon—this has been a major effort.
- Scott continues to update annual RHR Metrics each year
- Due to new CSU/Colorado compliance rules, many IMPROVE documents may temporarily be inaccessible. Users should email the team if documents aren't available or if links are broken.

Outreach and Communication Subcommittee – Jay Baker

- Jay Baker (WESTAR) reported on the activities of the IMPROVE Communication and Outreach Subcommittee.
- Several outreach efforts were planned early in the year, but many could not be completed due to shutdowns, budget constraints, and staffing limitations.
- Some activity was highlighted including:
  - Washington Post, Bloomberg, em PLUS articles
  - Overwhelming public comment related to air quality monitoring
- Jenny and Scott delivered IMPROVE monitoring training to western U.S. states, with hopes of delivering across the U.S., but this will likely pause for the time being due to shifting timelines for the RHR revision.

- Cost-cutting committee coordinated broad outreach to agencies, RPOs, and organizations to gather input during the cost-cutting process. Many stakeholders responded—most urging minimal cuts.
- A subcommittee meeting will be scheduled in the coming months at which time they'll continue discussing website improvements and future outreach priorities.

2025 IMPROVE Budget – Jim Miller & Tony Prenni

- The BLM agreement to fund the Toolik Lake site ended; the site has been decommissioned.
- The U.S. Forest Service continues support for three protocol sites (Boulder Lake, Columbia Gorge, Shamrock Mine).
- DOE is expected to continue funding the Southern Great Plains site, but the agreement is not yet finalized.
- Additional site closures may be necessary depending on future cost-savings decisions.
- Funding Overview
    - Total IMPROVE funding this year: ~$6.12M; down from $6.17M
    - Deficit: ~$54K (compared to ~$150K last year)
    - The deficit is being covered through NPS overhead.
- For the past decade, costs have consistently outpaced funding, except for a surplus period around 2014–2018.
- Multiple new RFPs approaching:
    - Operations & filter analysis (award expected spring–summer 2025)
    - Ion analysis (expected summer 2026)
    - Optical & scene monitoring (expected summer 2026)
- Costs are expected to increase, as contract prices rarely decrease.
- No indication of increased EPA funding; funding from other agencies (NPS, USFS, DOE) remains uncertain for FY26–27.
- Additional cost savings will be necessary, reinforcing the need to continue and finalize the cost-savings process discussed over the past year.

Discussion:

- Scott Copeland: Is it possible that the deficit will shrink next year?
- Jim Miller/Tony Prenni: Expect the deficit to grow, not shrink, especially with new contract costs.
- Scott Copeland: The cost-savings framework was intentionally designed to give NPS contracting agents flexibility to implement cuts as needed under uncertain future funding.
- Linda: Did we save any money related to the lapse in appropriations?
- Jim Miller: Contracts were allowed to continue during the federal funding lapse; only minor savings occurred due to some unprocessed filters.
- Nicole Hyslop: Most samples had already been shipped before the shutdown. Any savings from reduced analysis were minimal and offset by additional logistical costs. Unused filters

may be saved for special studies but are not normally analyzed because of storage/contamination issues.

IMPROVE Cost-Savings Proposal – Scott Copeland

- Following Tony's identification of an ongoing budget shortfall last year, the Steering Committee began a formal cost-savings process.
- Initial efforts focused on defining a list of core sites to retain full sampling, but this evolved into identifying the first sites that would shift to reduced sampling or be shut down if needed.
- A refined list was developed after review of technical analyses, stakeholder input, and agency considerations.
- Reduced Sampling (1-in-6 instead of 1-in-3):
    - Two tiers of sites were identified; Tier 1 would be reduced first, then Tier 2 only if additional cuts are required.
- Potential Site Shutdowns:
    - Several sites will be shut down; primarily urban sites and IMPROVE sites where it is difficult to keep reliable operators.
- Exact timing of implementation depends on new contract awards (expected 2026). Cuts may need to occur before issuing new task orders, depending on contract costs. Some site shutdowns are happening already where operators are unavailable.

The group discussed a number of topics including:

- Difficulty of restarting sites once they shut down.
- The representativeness of class I areas if sites are reduced or shut down.
- Need for updated Regional Haze Rule completeness criteria under reduced sampling.
- Equity across MJOs—some regions face a higher proportion of cuts due to how core-site rankings played out.
- Uncertainty about actual savings until contract bids are received.

A motion was made, and seconded to adopt the revised cost-savings site list, including:

- Updated Tier 1 and Tier 2 lists.
- Corrections for site naming.
- An added requirement that Steering Committee receive timely updates and meet as needed once actual contract costs are known.

Vote Result:

- All Steering Committee members present voted YES, indicating strong but reluctant consensus due to necessity of budget constraints.
- Jim and Tony now have authority to implement reductions as needed once contract and budget realities are known.

Committee Business – Scott Copeland

Leadership Transition

- Scott Copeland concluded his tenure as Chair after 14 years of service; Scott has made enormous contributions to the IMPROVE program during his time. Bret Schichtel was formally welcomed as the new Chair and Melinda Beaver as the new Vice Chair.
- Bret highlighted upcoming challenges including:
    - Cost-savings and long-term structural stability.
    - Lab-related issues, Regional Haze Rule support, natural background work, and the new IMPROVE equation.
    - Primary goal: Ensure IMPROVE remains a strong, functional, scientifically valuable network for the next 40 years.

Future Meeting Location

- A motion was made and seconded to hold next fall's Steering Committee meeting in the Asheville area (Lake Junaluska), to coincide with the A&WMA Visibility Conference. The meeting will be held in a hybrid format.

Meeting adjourned