IMPROVE STEERING COMMITTEE
2020 ANNUAL MEETING

Date: Tuesday, October 13-14, 2020
Location: Virtual

Virtual Attendees (may not be complete):

Name	Organization
Joe Adlhoch	Air Resource Specialists
Scott Cismoski	Air Resource Specialists
Mark Tigges	Air Resource Specialists
Emily Vanden Hoek	Air Resource Specialists
Melissa Hovey	BLM
Derek Day	CIRA
Loretta Wilson	CIRA
Shawn McClure	CIRA
Gordon Pierce	Colorado Dept Public Health & Environment
Jenny Hand	Colorado State University
Judith Chow	DRI
Mark Green	DRI
Greg Beachley	EPA
Melinda Beaver	EPA
Brent Gantt	EPA
Melissa Puchalski	EPA
Joann Rice	EPA
Chuck Turner	MARAMA
Brandon McGuire	Montana Department of Environmental Quality
Margaret McCourtney	Minnesota Pollution Control Agency
Bret Schichtel	National Park Service - Air Resources Division
John Vimont	National Park Service - Air Resources Division
Tony Prenni	National Park Service - Air Resources Division
Pius Lee	NOAA
Tracy Dombek	RTI
Vinay Amin	UC Davis
Ann Dillner	UC Davis
Dominique Young	UC Davis
Josh Grant	UC Davis
Nicole Hyslop	UC Davis
Sean Raffuse	UC Davis
Tony Wexler	UC Davis
Warren White	UC Davis
Xialou Zhang	UC Davis
Xiaoya Cheng	UC Davis
Scott Copeland	USFS/CIRA
Karen Dillman	USFS
Anita Rose	USFS
Heidi Hales	Vermont Department of Environmental Conservation
Bob Lebens	Westar
Tom Moore	WRAP

WELCOME AND AGENDA REVIEW

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

NETWORK AND LABORATORY REVIEW

Optical Monitoring Network Status

Mark Tigges presented an update regarding optical and scene network status. A copy of their PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Site visits were impacted by the pandemic, either due to lack of access or personnel.
- Optec NGN-2 nephelometers will be replaced with Airphoton and/or Radiance Research models.
- All three models, along with Purple Air sensors, are currently operating at the Christman Field Test site for comparison.
- The Ambilabs2-WIM is operating indoors at the test site shelter.

➢ *Tony Prenni commented that the Ambilab instrument has three available wavelengths but can only operate two at a time.*
➢ *Bret Schichtel commented that the Purple Air sensors are heated to compare with the Radiance Research nephelometer and posed the question "Are cheap sensors useful"? He answered they are precise as a light scattering measurement but need better characterization for size cut. Adding an open-air nephelometer for testing and there should be more results to present at the 2021 meeting.*

Aerosol Monitoring Network Status

Nicole Hyslop and Sean Raffuse presented an overview of network status. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

Field Updates:
- There are currently 160 sites operational.
- 25 sites were shut down due to COVID-19, but most came back online within two months. (IKBA and MONT were still not operational as of October 2020).
- Laboratory personal were affected by shelter-at-home orders and no work was performed for one month. However, much of the network continued to operate.
- XRF, HIPS, and post-mass measurements resumed in Mid-May. Laboratory analysis and data delivery fell behind schedule as a result.
- January 2020 data have been delivered. February data are currently undergoing validation.
- Data are delivered monthly and then again after annual review.
- Field operations resumed in June by vehicle, by air in September.

- Service was scheduled for 83 sites, 65 have been completed.
- The laboratory is moving to a new off-campus location.
- Over 20 sites will not meet RHR data completeness requirements for 2020. 18 of which are due to COVID-19, 2 sites due to COVID and late sample changes, and 2 sites due to fire related power outages.
- Quarterly site status reports are sent out. Contact UCD if you would like to be added to the distribution list.
- Real time network summary web tool and new controllers are helping mitigate losses as many problems can be identified and resolved in a timelier manner.
- A new feature of the software is remote control of the sampler manifold, though not operational at all sites yet, allows UCD to fix "BI" or bad installation flags.
- A new feature to be implemented will be the ability to stop sampling on clogged filters based on flow rate. The lower threshold for flow rate needs to be defined as well as the ability to flag as fire related.
- Still looking into the possibility of active flow control. Brushless pumps are promising. Comparison testing is on-going at UCD, PORE, DENA, PHOE and is showing the flow rates to be more stable.
- Analysis should show if the DC pump is producing a collection bias.
- A new 5-channel pump driver is being developed and requires new electronics and new programming.
- Testing at UCD during heavy smoke days should yield more stable flow rate with active vs passive control.

Laboratory Updates:
- The MTL automated weighing chamber has been operational since October 2018.
- A second chamber is needed (likely leased) to catch up from COVID shutdown, facilitate move to the new location, and perform testing.
- Filters changed from Pall to MTL, and field blanks using the new filters saw mass gain.
- HIPS measurements could not be calibrated using some batches of these filters, so the filters were characterized with FTIR data to determine batch and facilitate HIPS calibration.
- Laboratory resumed using Pall filters instead of MTL.

QA Updates:
- 2019 showed an increase in RCM to $PM_{2.5}$ ratio especially in summer months.
- This did not coincide with the beginning of the new chamber.
- Collocated soil measurements at PHOE worsened in 2019.
- Using FTIR measurements in the data validation process to see if that helps validate OC measurements (using HIPS also for EC).
- Shelter-at-home time helped staff get caught up on overdue publications, including CSN and IMPROVE collocated measurements and SF-CIP-MS vs XRF comparisons.

> *Bill Malm asked if the differences were related to size cut. Nicole answered yes, the large particles on the IMPROVE filters were getting through.*

Data Management and Validation Updates:
- New features include the ability to better support special studies, supervising lab conditions, incorporating field notes and validation tools, and a new home for the CSN/IMPROVE archive tool.
- Flexibility is being added to the database to support non-standard studies that may sample on a schedule other than 1-in-3 day, use a different type of filter, or require a different type of analysis.
- Data infrastructure for filter preparation, flow control, validation need to be updated and/or developed to support these non-standard sampling regimes.
- The goal is to be able to fully support these setups without manual adaptations.
- Real time temperature and relative humidity probes are in use in the lab and recorded in the database to conditions are known for each sample weighing. This will also be useful in testing the environment of the new laboratory location.
- Working on integrating field notes into validation tools.
- New user management systems and new site support allows for more concurrent users that the previous archive site.

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:

- All audits during 2020 were performed by state auditors due to travel restrictions imposed by Colorado State University.
- Six audits were conducted in Colorado and Missouri, with one flow-rate failure.
- Over 130 sites have been audited overall. Sites in the Pacific Northwest and New England need to be audited.

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:

- Lab was able to stay open under COVID precautions and perform analysis.
- Instruments are calibrated daily.
- The MDL is calculated annually.
- For every 50 samples analyzed, 3 are duplicated. The percent difference should be within ±10% but is dependent on sample concentrations (higher limit for lower concentrations).
- Differences in nitrite are usually small (close to 0% with very few failures).

- 5% of batches are reanalyzed for additional validation – about 400 samples.
- Any sample failing to meet criteria are re-analyzed.
- Filter re-extraction is performed as another check .
- New instruments coming online: Aquion systems and autosamplers. These require less sample volume and fewer amounts of liquid reagents.
- Analysis between the old and new systems found no statistically significant differences between systems.
- A 2016 study reanalyzed samples for total sulfur and compared it to inorganic sulfate that had been previously reported. Geographical and seasonal differences were seen.
- Freeze-dried samples were reconstituted into organic matrix to be analyzed using a method developed by the University of North Carolina.
- Other compounds such as isoprene could help explain the differences between sulfur and sulfate.

- ➢ *Ann Dillner commented on the research funds provided by RTI to support UCD work to analyze organic sulfur compounds by IC and FTIR. Organic sources of sulfur become more important as other sulfur concentrations decrease.*
- ➢ *Joann Rice asked if the FTIR was done on nylon filters. Ann answered that FTIR is only performed on the Teflon filters. The nylon filters in RTI analysis look at the extraction and stability of solutions.*

- Research goals for 2020 included:
    - Evaluating IMPROVE samples using IC carbonate/bicarbonate methods and KOH for detection of tracers.
    - Continued analysis of targeted sampled for total sulfur by ICP-OES.
    - Collaborate with UNC to map tracers of interest and evaluate methods between laboratories.
    - Collaborate with UCD to evaluate organic sulfur on Teflon and Nylon filters.
- Method development for chloride analysis includes comparing KOH/CarbBicarb and Carb/Bicarb systems.
- To determine bias percentiles were studied showing a slight bias of 3-4 ppb on the KOH system.
- Different approaches are being used for storing such as freeze-dried, dissolved in deionized water, etc.
- On track to analyze 18,000 samples which is similar to the previous year.
- Goal is to develop single sources for standards to provide more quantitative data for researchers.

Carbon Analysis

Judy Chow 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 analyzed approximately 1,410 IMPROVE samples per month.
- Operating schedules affect by COVID.
- 2019 analysis was completed in March 2020.
- On average 40 runs per day are dedicated to multiple quality control checks.
- Granulate MNO_2 is no longer available for sample oven. Supply is sufficient for now but looking for new supply and testing new packing methods.
- Quartz sample holder was replaced with one that has an embedded thermocouple that is more stable and has a longer lifespan.
- The "CalPeak" cooling fan cools the oven during final stage of analysis, rather than after, saving approximately 5 minutes between analyses.
- New procedures for data validation include:
  - Automated comparisons for replicates, reruns, and collocated samples.
  - Identification of extreme values.
  - Automatic notification of deviation from calibration peaks.
  - Use of visualization tools to examine relationship between light attenuation and brown carbon and temporal variations.

> *Bret Schichtel asked if there was any update to the modification OC/EC protocols. Judy answered that the optical measurements aren't compatible with a simple OC/EC determination. The time savings are achieved in data analysis rather than instrument performance. More advancement should be available in the coming months.*

DATA ANALYSIS

Trends Across Relocated IMPROVE Sites

Brent Gantt presented a PowerPoint discussing IMPROVE sites that have relocated. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- The Regional Haze Rule, based on the Clean Air Act, declared the goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas, which impairment results from man-made air pollution.
- The method for tracking the most impaired days has recently changed, putting a greater emphasis on anthropogenic impairment.
- Six IMPROVE sites have relocated since the initial baseline monitoring period intended to track regional haze metrics.
- Natural conditions for each IMPROVE site have also been recalculated based on the newer guidance.

- Goal is to generate procedures for combining sites as related to Regional Haze.

➢ *Tony Prenni commented that while running two sites concurrently for one year prior to relocation is desired, there are limitations due to lack of operators, land use, natural disasters, etc.*
➢ *Brett Gantt agreed, but defining procedures for planning could be helpful regardless of the reason for the closure or relocation.*
➢ *Scott Copeland asked and answered if the Steering Committee is the place to make the decision (answer: probably yes). The two sites that have been "officially" combined (LYBR and SYCA) were made in conjunction with the Forest Service. Scott recommended that the sponsoring agency needs to be involved in the discussion and decision, while there is currently no official consensus.*
➢ *Tom Moore commented that affected states should be consulted related to trend tracking. Operator limitations should be a priority for each state/agency.*
➢ *Brett Gantt commented that for NAAQS monitors, states consult with EPA for concurrence. If procedures are developed, they could be provided to states. Request/approval ownership could be with the state or agency or with the Committee. On-going discussions are necessary.*
➢ *Bret Schichtel agreed that formal procedures are needed, and it makes sense for those to come from IMPROVE as the guidance documents refer to the IMPROVE Steering Committee.*
➢ *Brett Gantt commented that EPA would like to see more formal documentation of the process rather that the informal nature of the process thus far.*
➢ *Tom Downs asked for sites with nitrate trends going up in a region will baseline conditions be recalculated?*
➢ *Brett Gannt answered it depends/*
➢ *Tom Moore commented that funding issues and possible site closures will impact sites that have an established baseline period (2000-2004) but no later data for comparison.*
➢ *Brett Gantt commented that site closures and relocations were not taken into consideration when the 2000-2004 baseline period requirement was established.*

Impacts on Haze in Remote Regions of the U.S.

Jenny Hand presented a PowerPoint discussing impacts of haze in remote regions across the United States as the 30th anniversary of the Clean Air Act Amendments. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- SO_2 and NO_x emissions have dropped by nearly 90% and 50% respectively in the last 30 years following the adoption of the Clean Air Act Amendments.
- Reconstructed extinction is underestimated, especially in the east.
- Trend in the annual mean extinction show strong reduction in Bext in the eastern US.
- Decreases are being driven by different species in different regions:
  - East: $AmmSO_4$, $AmmNO_3$, POM, EC, and fine dust (increasing coarse mass)

- o Intermountain West and Southwest: AmmSO$_4$, AmmNO$_3$, POM, EC, and fine dust (no change in coarse mass)
- o West: AmmSO$_4$, AmmNO$_3$, POM, EC, and fine dust (increasing coarse mass)
- Carbon has dominated haze in the west
- As contributions have changed (sulfate decreases in the east) other species become more important.
- As emissions from regulated sources continue to decline, contributions from other sources to haze have increased, suggesting additional strategies may be needed to protect visibility in the future.

➢ *Bill Malm commented that it is important to look at fractional contributions over time. Sulfates and organics have both gone down (sulfates faster).*
➢ *Jenny replied that organics are not hydroscopic, which plays a role.*

ANALYTICAL DEVELOPMENT

HIPS and the Future of Light Absorption

Warren White presented an update regarding HIPS analysis performed by UCD. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Aerosol absorption in the atmosphere is not easily measured from filter based samples.
- Absorption of particulate matter on a filter is different from in situ particles in the air.
- Random measurement error (noise) is unknown. It is only known if it is constant.
- Error can be introduced by personnel, instruments, manufacturers, etc.
- Collocated precision is a good measure of total uncertainty.
- 2017 shows improvement due to instrument upgrade to the HIPS system.
- Precision does not describe calibration and/or loading effects, contributing to bias.
- It is hard to test upper limits of uncertainty in an ambient environment due to lack of high enough concentrations.
- CSN samples, designed for urban environments, might be suitable.
- Seasonally grouped samples from IMPROVE and CSN were compared.
- IMPROVE site collocated with urban CSN sites showed nonlinear loading effects in high absorption samples.
- Drift of HIPS calibrations should be minimal at low loadings.

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ANALYTICAL DEVELOPMENT (CONTINUED)

Identification of Smoke-Impacted IMPROVE Samples

Amir Yazdani presented an update regarding FTIR analysis to identify IMPROVE samples impacted by smoke. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Biomass burning samples have distinct profiles and tracer signatures.
- These can be identified and quantified, which makes the method desirable.
- Chamber experiments with FTIR tracer compared to ToF-AMS show high correlation with AMS.
- FTIR is advantageous because it is non-destructive.
- Levoglucosan and lignin in FTIR analysis can be used as a smoke identifier.
- Chemical groups can identify fire types (wildfire, prescribed burning, residential wood burning).
- FTIR measurements generally agree with AMS and IC and are supported by satellite and ground-based observations.

➢ *Tony Prenni asked how tracers were used.*
➢ *Amir answered spectral profiles labeled as burning or biogenic had high potassium.*
➢ *Bret Schichtel asked, regarding slide 14, how high concentrations related to loading on the filter. Amir answered that over 300 samples with high concentrations from IMPROVE were selected.*
➢ *Ann Dillner commented that the samples used were selected based on modeling looking for high concentrations related to fire. They were sampled by FTIR before destructive analysis with the expectation that they were high smoke days.*
➢ *Tom will provide Ann with write-up on filter selection process.*

Inter-Comparison of Thermal-Optical Carbon Measurements by Sunset and DRI Analyzers

Xiaolu Zhang presented an update regarding TOA (Thermal Optical Analysis) between DRI and Sunset instruments. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- CSN changed analysis method in 2018.
- Comparisons between the DRI and Sunset instruments were conducted to understand measurement uncertainty and consistency due to differences in software and instrumentation.
- OP is a critical peak, as it marks the split between OC and EC.
- Replicate analysis was performed by each lab using two punch from each filter studied.
- Archived filters remained stable and showed good agreement in both comparisons.

- Carbon subfractions compared OC2/OC3 to EC1, showing better agreement than other subfractions, indicating carbon migration.
- Carbon migration could be due to slight differences in sample temperatures, peak integration scheme, or residence time.
- Missing OP or a later shift in transmittance is forcing a split between OC and EC and likely underestimates EC.
- TOA measurements are protocol and instrument dependent.
- Extremely dark samples are likely underestimating EC due to erroneous OC/EC split.

➢ *Xiaoliang asked if the instrument returns to baseline before moving to next step. On Slide 12 the EC3 does not show a return to baseline. If more EC is not being captured a heavily loaded sample error might be small.*
➢ *Xiaolu replied that timing is not always "x" seconds before the next analysis starts. It is software related.*

Estimating LAC Concentrations from fabs Values

Bill Malm presented an update regarding estimating light absorbing carbon concentrations from fabs values. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- To compare past and future trends LAC from fabs must be equivalent to LAC from TOR.
- To estimate LAC from fabs one must first develop a TOR fabs mass absorption efficiency (MAE). This can be complicated in some regions by small amounts of iron absorption.
- MAE varies as a function of LAC concentrations. This could be a result of:
  - Analytical methods
  - Fabs biases lower as filter loading increases
  - Physical characteristics of the carbon aerosol
- Independent of concentration the percentile seems to be a function of the decile.

Potential Carbonaceous Aerosol Measurements in IMPROVE

Bret Schichtel presented an update regarding carbonaceous measurements in the IMPROVE network. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- Carbonaceous particles have the largest mass and are the largest contributors to haze.
- They are difficult and expensive to measure.
- Examining the pros and cons of measurements methods as IMPROVE moves toward a new carbon contract.

- Considered methods include TOR, FTIR, measurements derived from TC and filter absorption or a hybrid system of HIPS/fabs. It should also be suitable for the CSN network.
- It is important to capture changes that are attributed to physical changes and not analytical changes.
- Network goals for CSN (fine PM and health NAAQS) and IMPROVE (Regional Haze) are different.
- No current traceable OC/EC standards, which are necessary for consistency in long term networks.
- UCD is working on establishing calibration curves from FTIR. Smoke aerosols are different than mobile sources. With no global calibration dataset, multiple calibration models are likely necessary.
- TC can be calibrated and a TC-fabs measurement reproduces TOR LAC and OC well.
- As samples are heated Fe gets darker which affects the TOR analysis.
  As concentrations gets lower the MDL of the instrument becomes a factor

DATA PROCESSING, DISTRIBUTION, AND QUALITY

IMPROVE Data and RHR Metrics

Scott Copeland presented a PowerPoint summarizing the status of 2019 IMPROVE data. A copy of the PowerPoint presentation accompanies these minutes. Summary points are as follows:

- 2019 data are expected to be available soon on the FED and WRAP TSSv2 websites.
- Changes were made between the dataset delivered in October 2019 vs April 2020. These changes include:
  - Small data redelivery
  - Multiple patching implementation (up to 2 per sample day)
  - WRAP data substitution effort
- All changes are documented in publicly available PowerPoint presentation.
- Sierra Ancha has not operated for several years due to lack of operator. Pursuing a site that is more accessible and has operator support.
- Currently there is no formal process for handling data from sites that relocate.
- SYCA and LYBR were combined in consultation with affected FLMs, states and EPA. Other agencies should have buy-in on their sites. More work to formalize procedures forthcoming (see discussions related to Brett Gantt's presentation on relocated IMPROVE sites).
- Other processes should be formalized as technology and measurement methods will advance before 2064 and how data should be handled needs to be documented.

BUDGET

Budget Analysis & Discussion

Tony Prenni led a discussion regarding the IMPROVE budget.

- Many contracts are in the RFP/renewal phase.
- A reasonable budget forecast is problematic.

IMPROVE Steering Committee Business

Scott Copeland led a discussion regarding IMPROVE business updates.

- *Scott Copeland will continue to serve as IMPROVE Steering Committee Chair*
- *Bret Schichtel suggested the development of an IMPROVE Charter or Manual of Operations to answer or define:*
  - *How Does the Committee Function?*
  - *Define and document the purpose of the IMPROVE Steering Committee*
  - *Define roles and responsibilities for the chairman and its members*
  - *Formalize ad hoc groups (RHR, data quality, assessments, online presence)*
  - *Formalize procedures for moving sites, combining data trends, sharing filters, equipment, expertise*
  - *Develop modern steering committee structure (chair, VP, secretary, etc.)*
- *Calls for volunteers to work on with an ad-hoc group to develop and define such procedures.*
- *Suggested options for the next meeting include another virtual meeting in Spring 2021 with possible in-person meeting later in the year, depending on circumstances.*

IMPROVE Steering Committee – Closed Session

After the general meeting adjourned, the Steering Committee members met.

- *There was a discussion of carbon measurement in the context of the presentations made.*
- *The following motion was made and unanimously approved to facilitate the writing of the carbon measurement RFP and the subsequent evaluation of proposals.*
  Motion: The IMPROVE steering committee recommends that the request for proposal for carbonaceous measurements allows for alternative measurements from which OC and EC concentrations can be derived that are comparable to historical TOR OC and EC concentrations. This will allow the continuation of the tracking of trends in space and time of historically defined OC and EC. Such measurement systems could consist of combinations of FTIR or TC in combination with an fabs measurement.
- *The closed session was adjourned.*