

# IMPROVE Steering Committee Meeting

October 16-17, 2018

Fort Collins, CO

(Note: originally planned for St. Marks NWR in FL, but moved due to hurricane.)

Presentations available at: <http://vista.cira.colostate.edu/Improve/steering-committee-meetings/>

Major discussion topics:

- Network & Lab Review
- Analytical Development
- Data Analysis
- Data Processing, Distribution and Quality
- IMPROVE Business

## *Network & Lab Review*

- Optical, Scene Monitoring (ARS)
  - 11 parks with nephelometers in operation, all LED-based
    - 10 collocated with IMPROVE monitors
    - Approx. ½ are self-service and get replaced every 2 years by local operator
    - Rest are full-service sites and get visited by ARS every 6-months, plus replaced every 2 years
    - Data recovery generally >90%
    - All modems upgraded to 4G in 2018
    - Raw nephelometer data website: <https://www.air-resource.net/NPSnephdata/>
  - 17 parks with cameras in operation
    - Over 8 million website hits to the cameras page, over 40% of these are mobile users [www.nature.nps.gov/air/webcams/index.cfm](http://www.nature.nps.gov/air/webcams/index.cfm)
    - 20-year camera archive webpage now operational <https://npgallery.nps.gov/AirWebCams/>
    - WinHaze website <http://vista.cira.colostate.edu/Improve/winhaze/>
    - Working with the Western Regional Air Partnership (WRAP) to evaluate the IMPROVE dataset and identify incomplete years and potential data substitutions
- Network Update (UC Davis)
  - 156 IMPROVE sites
  - New: Toolik, AK (to replace Gates of the Arctic site), starting Nov 2018
  - Offline: Barrier Lake (Canada), Sierra Ancha (AZ), Virgin Islands (restarting sometime)
  - 2017 data have been uploaded to EPA AQS and FED website
  - Semi-annual QA reports delivered for all 2017 data
  - Regional haze rule:
    - Can't exceed > 10 samples lost in a row
    - Can't exceed > 15 samples lost in a quarter
    - Can't exceed > 30 samples lost in a year

- In 2017, 15 sites lost
    - So far in 2018, 10 sites lost, plus a few on the cusp
    - Most losses due to operators missing samples, equipment problems, site access due to wildfire restrictions
  - Equipment upgrades
    - New controllers that have internet access and daily data downloads now installed in ½ of network, remainder planned in 2019
    - Allow for fast review of flow data and problem identification
    - Can remotely access to run diagnostics and fix configuration issues
    - New digital pressure transducers allow for universal flow constants
  - PurpleAir particulate sensors installed at 6 sites to test
  - Gravimetric measurements
    - MTL automated weighing system commenced operation in Oct. 2018
    - Temp and relative humidity controlled chamber for filter equilibration
    - Holds 400 filters that can be weighed in 24-hours using 5-hour equilibration period
      - Problem: 5-hour equilibration period does not match EPA PM<sub>2.5</sub> method which requires 24-hours equilibration
      - Testing to be done on equilibration time
- QA-Field Audits (CSU)
  - Over 100 site audits done since started in 2016
  - CO, AZ and MO state staff trained and doing routine IMPROVE audits, working on WY and MD
  - Looking at sampler and site integrity, site obstructions/vegetation and operator training/knowledge
  - Number of sites identified with vegetation, electrical and shelter/platform integrity issues
- Ion Analysis (RTI)
  - Approx. 18,000 samples analyzed /year
  - MDLs < 0.010 ppm
  - Method blanks <10 ppb
  - QC standards generally within 2%
  - Re-analysis generally within 2%
  - Round-robin with USGS for additional QA
- Carbon Analysis (DRI)
  - Approx. 1500 samples/month
  - All samples since 1/1/2016 have been run on new Model 2015 multiwavelength analyzer, now over 90,000 samples
  - 13 model 2015 analyzers in operation
  - Daily QC injections plus full calibration injections every 6 months
  - Some problems with the MnO<sub>2</sub> ovens due to glassware supplier closing and new suppliers not meeting specs
  - Are changing the calibration points to match the reducing OC trends
  - MDL approx. 0.1 – 0.6 ugC/cm<sup>2</sup>
- Data Validation and Data Management (UC Davis)
  - New sampler controller software

- Includes a touch screen and walk-through design
  - Automated weighing system software
    - Uses very small barcode printed on the support ring, so needed a good scanner/reader
  - Data validation now all web-based
    - New black carbon plots, estimated from TOR readings
    - New field blank data views and plots
    - Parameter data review plots
    - Reconstructed mass plots
  - Exploratory plots in development
    - Back-trajectory analyses overlaid on MODIS daily images
    - Sampling handing to look at last few samples versus long term trends
- IMPROVE QA Report
  - Semi-annual reports since Feb. 2017
    - Introduction
    - Concentration QC Checks
    - Analytical QC Checks
    - Documentation
    - Site Maintenance Summary

### *Analytical Development*

- Determining Brown Carbon Concentrations by Multiwavelength TOA (DRI)
  - Can calculate the aerosol radiation absorption, assuming BrC absorption Angstrom exponent (AAE) is 1.0
  - Enhanced light attenuation by BrC at shorter wavelengths
  - Problem: BrC is not a single compound, so the mass absorption coefficient (MAC) varies
  - Picked 6 compounds out of 20 to test and derive a surrogate MAC
  - BrC is approx. 5-30% of monthly average OC, depending on the surrogate compound used
  - Fulvic acid and humic acid sodium salt working the best so far for surrogates
  - Higher BrC sites are in the eastern US, lower in the western sites
  - Higher BrC at urban CSN sites and lower at rural IMPROVE sites
- New Low-cost Non-destructive Analysis Method (UC Davis)
  - Use FTIR to measure
    - OC and EC (to replace TOR method)
    - OM
    - Inorganic ions
    - Aerosol sources and aging
  - 5-minutes per sample for analysis
  - With 3 instruments, can do 400-700 filters/week
  - Non-destructive
  - Problem: is Teflon filter type dependent and no gold-standard for comparisons
  - Have to compare to TOR to develop calibration curves
  - Ammonium interference that need to correct for
  - So far, correlations with TOR can achieve  $r^2 > 0.95$  and MDL 0.06 ug/m<sup>3</sup>

- CSN filters harder as larger filter, so lower distributed loading
- Higher OC at urban CSN sites and lower at rural IMPROVE sites
- FTIR for S analysis looking good
  - Calibrates well to XRF or IC with  $r^2 > 0.99$
- OM/OC approx. 1.8 for IMPROVE, 1.4 for urban CSN
- FTIR quantifies functional organic groups to directly estimate OM instead of needing to do regression analyses
- 5 functional groups and lab standard has 20 compounds to cover
- Will be working with SPARTAN filters for additional testing and with FRM samples
- Thoughts for the Future (UC Davis)
  - Flow control
    - Current pumps are orifice-controlled, so flow drops as filter loading increases
    - Maybe change to brushless DC motors along with active flow controllers for a cheaper (\$400 vs. \$260), smaller, more energy efficient system
    - Desire by group for UC Davis to buy and test a system and report back next year
  - Meteorology
    - Currently no met at IMPROVE sites
    - Maybe add a cheap met system, including relative humidity
  - Real-time PM
    - Maybe add PurpleAir sensors at sites for PM<sub>1</sub>, PM<sub>2.5</sub> and PM<sub>10</sub>
    - They also provide T, P and RH as a benefit
  - Multi-Angle Imager for Aerosols (MAIA) satellite
    - Partner with NASA
    - Add X Module (NSA-paid) at sites to correlate with satellite measurements

### ***Data Analysis***

- Trends in Fine Dust and Coarse Mass (CSU)
  - Fine dust (FD) assumed to be PM<sub>2.5</sub>
  - Coarse mass (CM) is PM<sub>10</sub> – PM<sub>2.5</sub>
  - Multiple linear regression suggests that dust is underestimated by approx. 20%
  - In spring, FD and CM source area is primarily in SW US vs central US in summer
  - From 2000-2016 trends analysis:
    - Less precipitation and more dust correlates with negative-phase Pacific Decadal Oscillation and La Nina conditions
    - Role of dust has increased as SO<sub>4</sub> and NO<sub>3</sub> have decreased over time
- Progress on Modifications to IMPROVE Measurements and Algorithms (NPS)
  - Fine mass (FM) has decreased over time, especially with decrease in sulfate
    - FM residual (FM-RCFM) is increasing
  - Light scattering underestimated versus nephelometer measured
  - Known biases affecting PM<sub>2.5</sub> mass
    - Water vapor on particles has been a lab issue
    - Organic multiplier (Roc = OM/OC) increasing over time and seasonal

- Sulfur vs sulfate
  - Sulfate normalization factor of 20 may be okay
  - Fine soil underestimated approx. 15-20%
  - Need to develop an IMPROVE v3 equation
- Reinterpreting TOR Carbon Analyses (CSU)
  - Is the split in the analysis between OP (pyrolyzed carbon) and LAC-EC (light-absorbing carbon) correct?
  - Evidence that LAC is underestimated and some remains as OP
  - This affects regression analyses to determine Roc (organic multiplier)
  - Roc is increasing across the US, but OP/total carbon is decreasing
- Potential Evolution of Carbon Measurements (NPS)
  - Total carbon (TC may be a better measurement to use
  - TC and filter absorption ( $f_{abs}$ ) can be calibrated and is stable
  - TC less expensive than using TOR
  - What is the impact on carbonaceous trends?
  - OC and EC can be estimated from TC and  $f_{abs}$  using regression equations and correcting for iron, but with significant uncertainties and would break existing OC and EC trends
  - Hold an IMPROVE Carbon Monitoring Workshop to discuss the issues?
    - Develop a new carbon monitoring plan
    - Provide recommendations for the future
- NH<sub>x</sub> Study (CSU)
  - Good correlation with URD denuder/filter pack in Colorado in 2010-12 using IMPROVE module and nylon filter and acid-impregnated cellulose filter for NH<sub>3</sub>
  - CSN/IMPROVE study in the SE US
    - Humid in SE US
    - Good correlation at one site, poor at another
    - Lab investigation found NH<sub>4</sub><sup>+</sup> being lost on denuder nylon filter and captured on backup denuder cartridge as NH<sub>3</sub>
    - Not an issue in dry climates due to nylon filter characteristics
  - CSN biased low compared to IMPROVE due to different type of cellulose filter collecting fewer NH<sub>4</sub><sup>+</sup> particles
  - Need more work/research

### ***Data Processing, Distribution and Quality***

- Potential IMPROVE Data Patching Algorithm and Modification (LADCO)
  - Currently missing values are “patched” with the quarterly 5-year median value for only 1 missing component in the equation
  - IMPROVE guidance actually allows for substitutions for multiple missing components in the equation
  - Would allow for more days to be retained for regional haze rule impairment metric calculations
  - Can save data years for some sites in some areas
  - Does not appear to have a significant impact to trends as changes are subtle
- IMPROVE/FED/TSS Websites Update (CSU)
  - WRAP Technical Support System (TSS) under re-development

- Beta version for testing
  - Let CSU/CIRA know of problems or suggestions
  - <http://views.cira.colostate.edu/tssv2/>
- IMPROVE Data and Regional Haze Rule Metrics (USFS)
  - 2017 data in EPA AQS and FED
  - Some RTI data from 2017 (~450 samples) flagged with “potential contamination” code
    - Any possible contamination likely in noise level
    - Data advisory being developed
  - Draft “extra data patching” guidance sheet being developed
  - For SIP planning, should data years be “frozen” after data patching?
    - Do states want this or should databases remain living?
    - Will states essentially freeze data at a certain time via a download date for impairment metric calculations?
    - WRAP will develop a document on how will use IMPROVE data for regional haze and if need to freeze data or not on the TSS
  - Impairment technique 1-pagers will be posted
- Preparing for the Second Planning Period (EPA)
  - SIPs due 7/31/2021
  - EPA working with states
  - Looking for ways to leverage other emissions reductions programs to reduce burden
  - Regional Haze Reform Roadmap signed 9/18/18
    - Outlines tools and implementation guidance
    - Fall 2018 – Final recommendations on selecting the 20% most impaired days
    - Spring 2019 – Updated natural visibility conditions estimates
    - Spring/Summer 2019 – Updated 2028 visibility modeling (including estimates of US and international source contributions for Class I Areas)
    - Spring 2019 – Final guidance on regional haze SIP development
  - Second period will focus on reasonable progress (RP), not BART
  - No specific analytical methodology for RP
  - Tracking metric now uses anthropogenic impairment, not worst visibility

### ***IMPROVE Business***

- Budget
  - Site repairs and maintenance to be funded through overhead costs
  - DINO winter study starting with IMPROVE, nephelometer and long-term webcam
  - Virgin Islands site to re-start
  - NPS additional funding will be used to buy 1-2 new nephelometers as newest ones in operation are 20+ years old
  - June 2018 – May 2019 budget
    - Income \$6,112,526
      - \$5,285,590 from EPA (flat over past years)
      - Remainder from NPS/USFS/BLM/misc.

- Expenses \$5,990,556
      - UC Davis, DRI, RTI, CIRA QA/QC, overhead, misc.
    - In-kind income from operators, FLM's puts total budget about \$8,404,360
  - Projections:
    - 2018-2019 = \$131,970 surplus
    - 2019-2020 = \$95,353 deficit
    - 2020-2021 = \$242,314 deficit
  - RFP for optical network will be issued in 2019
- Steering Committee Business
  - Scott Copeland the chair for next year
  - 6 or 8 tribal IMPROVE sites (funded through EPA)
    - Invite tribes to next year's meeting and/or have a tribe as a committee member
  - Now over 30 years of operation since original 20 sites were established
  - Next meeting suggestions:
    - Point Reyes, CA along with a Carbon Measurement Workshop (as near to UC Davis)
    - In conjunction with the 3-year NADP conference (location TBD)
    - St. Marks, FL