

IMPROVE – CSN Carbonaceous PM Monitoring Workshop Topics
by Marc Pitchford, 11/6/07

Introduction:

A lot of information has been generated over the last five or more years to help address carbon monitoring data inconsistency and uncertainty issues for the IMPROVE and CSN programs (see Background section). However some of this information is not fully applicable (e.g. methods intercomparisons not using identical methodologies, inconsistent use of artifact correction methods) leading to misconceptions and confusion. Even with the use of the most applicable data we are not able to resolve some important issues. There is ample evidence that some of these issues have broad geographic and seasonal aspects and so would require additional information generated at many locations across an annual cycle. If that is the case, then it will require at least a year to collect the information and perhaps another year to process and assess it before we can substantially improve our understanding and methodologies associated with PM carbon monitoring. The ultimate goal of the workshop is to develop an action plan (18 to 24-month) to generate and assess the information required to meet the following needs.

1. Consistent approach for carbonaceous PM data artifact adjustment for both IMPROVE and CSN (new CSN monitoring methodologies, and if possible to back-adjust the old methodology data).
2. Algorithm that relates the IMPROVE (old and new analyzers) to the CSN (old methodology) carbonaceous PM data sets
3. Algorithm that relates the old and new IMPROVE analyzer data sets

Of these the first is perhaps the most important, since it is artifact-adjusted data from the two networks and two IMPROVE analyzers that we wish to relate to each other. Success in improving our approach to artifact adjustment and methods to jointly use various types of data are important for those who wish to use the IMPROVE and CSN data jointly (e.g. to estimate urban excess), to assess site-specific, regional and national carbonaceous PM long-term trends, and to consistently relate carbonaceous PM to air quality affects (e.g. health effects, visibility, radiation balance, etc.). A second goal of the workshop is to develop recommendations for interim approaches to these issues, since both IMPROVE and CSN must continue to operate and supply data while we address these issues over the next few years.

Background:

Carbonaceous PM (organic and elemental carbon species) typically is the first or second (after sulfate PM) largest contributor to PM mass concentration. The split between organic and elemental carbon (EC and OC) is important from an atmospheric optics (both visibility and radiative balance) perspective and is of significant interest to health affects research. Carbonaceous PM is also the aerosol component with the greatest difference in concentration between urban

and remote monitoring location (highest urban excess), giving it the distinction of being one of the most important locally-controllable PM components.

In spite of its importance, carbonaceous PM monitoring data has greater uncertainty than any of the other major PM components. Unlike the inorganic PM components, atmospheric carbonaceous PM is an unknown mixture of thousands of carbon containing compounds. The split among these between organic and elemental carbon is defined solely by the analytical method used and seems to be sensitive to what might seem to be minor variations in the application of any of several methods in common use. The most used sampling media for carbonaceous PM is quartz fiber filters, because of its stability at the high temperatures needed by the commonly used thermal analysis methodologies. However, pre-fired quartz filters when exposed to the atmosphere absorb significant quantities of gaseous organic carbon compounds that must be accounted for in some way to produce a measure of the carbonaceous PM. The quantity of the artifact is significant; it can be comparable to the amount of carbonaceous PM collected on the filter and the uncertainty in the artifact concentration is a large source of uncertainty in the measurement. The IMPROVE carbon data are adjusted by subtracting typical amounts of carbon measured on backup filters. Originally the CSN network made no artifact adjustments but has recently begun using carbon measured on field blanks for their artifact adjustment. The degree to which these adjustments are comparable and appropriate has been recently examined, but is not yet determined.

Both the IMPROVE and CSN use a form of thermal optical analysis applied to samples collected on quartz filters. However difference between the two networks, including use of different samplers, filters, analysis methodologies and processing of the data have resulted in data at collocated site that differs by more than the joint measurement uncertainty of the two methods. In order to remedy this situation, EPA is in the middle of a costly transition of the carbon monitoring and analysis by CSN to be that used by IMPROVE. For this change to yield the desired data comparability, the artifact adjustments must be appropriate for both networks.

Several years ago IMPROVE's original carbon analyzers needed to be replaced because they were no longer repairable. In initial testing, the analyzer that was selected to replace the old system could not produce comparable data using nominally identical analysis conditions (i.e. consisting of selected temperatures and carrier gas composition). Extensive research of the causes of this lack of comparability identified two main causes: large temperature gradients between sample and temperature probe in the analyzers and diffusion leakage of oxygen into helium carrier gas for the older analyzers. By adjusting the nominal temperatures in the new analyzers to better mimic the actual sample temperatures of the older analyzers, the new analyzers were able to better reproduce the OC/EC split of the older analyzers, though the thermal

subfractions were not anticipated to be well reproduced. The new analyzer has been used for IMPROVE samples beginning January 1st 2005, but a recent trends assessment has identified a coincident increase in the networks EC to total carbon (TC) ratio.

Discussion Topics:

1. Artifact Adjustment
 - a. overview of pertinent evidence for a positive and a negative artifact
 - b. conceptual model(s) of the artifact
 - c. define our goals with respect to artifact adjustment for IMPROVE and CSN
 - i. for both CSN and IMPROVE either we want an artifact adjustment to give us a measure of PM OC in the atmosphere, or on the Teflon filter
 - ii. want to minimize the amount of uncertainty contributed by the artifact adjustment
 - iii. practical consideration (e.g. affordability and simplicity)
 - d. would additional measurements be useful (e.g. backup behind Teflon, denuder, more of the current measurements, etc.)?
 - e. develop an action plan
 - i. additional network measurements (locations, frequency, duration, etc.)
 - ii. special studies
 - iii. data analysis plan
 - iv. interim approaches for artifact adjustment
2. Relating IMPROVE to CSN data sets
 - a. overview of evidence showing differences between IMPROVE and CSN data set
 - i. principally collocated monitoring as opposed to a single lab trying to replicate the other's carbon analysis
 - ii. must address the artifact adjustment issue to be meaningful
 - iii. need to clearly delineate which versions of IMPROVE and CSN monitoring are being compared
 - b. define our goals
 - i. find a way to permit health exposure, and air quality trends assessment uses of the data through the transition from the traditional CSN to IMPROVE-like carbon monitoring
 - ii. develop (if possible) an algorithm to adjust either direction (i.e. old to new or new to old) network-wide, or regional or site-specific (also may need to consider seasonal variations)
 - c. would additional information be helpful (analysis of archived quartz filter, collocation at more sites or for greater periods of time, etc.)
 - d. develop an action plan
 - i. additional measurements (locations, frequency, duration, etc.)

- ii. special studies (e.g. new analysis of archived filters)
 - iii. interim advise to data users
- 3. Relating old and new IMPROVE analyzer data sets
 - a. overview of evidence for and against comparability and a trend discontinuity
 - b. develop hypotheses that could explain the evidence that we have for and against data comparability
 - c. define our goals
 - i. explain why we have any discontinuities
 - ii. which (if any) is the less biased data set
 - iii. develop (if possible) an algorithm(s) to adjust for biases in the old or new data sets (network-wide, regional, site specifically, etc.)
 - d. would additional information be helpful (e.g. analysis of archived quartz filters with new analyzer)?
 - e. develop an action plan
 - i. additional measurements (locations, frequency, duration, etc.)
 - ii. special studied (e.g. new analysis of archived filters)
 - iii. data analysis plan
 - iv. interim advise to data users

Anticipated Participants:

Given the narrow goals of this workshop (i.e. to develop an action plan to gather the appropriate information over the next 1 to 2 years needed to jointly address the carbon monitoring issues of IMPROVE and CSN), it is critical that we have those who have worked specifically on these issues plus those who are in management positions for the two networks to make decisions resource allocation. This is not intended to be a scientific conference or a workshop to inform or seek input from the broader scientific or air quality community. The list below is my attempt to identify those who are expected to be productive contributors to this workshop. Others may attend, but hopefully they will respect the intent of the workshop by being either productive, on-topic contributors or respectful observers.

Judy Chow, John Watson, Antony Chen, (others?), DRI
 Warren White, Chuck McDade, (others?), UCD
 Max Peterson, (others?) RTI
 Joann Rice, Neil Frank, (others?), EPA
 Bret Schichtel, Bill Malm, (others?), NPS
 Marc Pitchford, NOAA
 Jay Turner, Wash.U.