Update of IMPROVE Carbon Analysis

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Presented at:
2020 IMPROVE Technical Steering Committee Meeting
Virtual Meeting
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Objectives

• Report status of IMPROVE carbon analyses

• Review internal quality control (QC) checks

• Discuss operational challenges and improvements
DRI’s Environmental Analysis Facility (EAF) continuously operates 10-13 Model 2015 Multiwavelength Carbon Analyzers
(2016-Present, analyzed over ~160,000 samples with ~82,000 for IMPROVE)
Carbon Laboratory Operations
(July 2019 - June 2020 samples, n= ~18,000)

• Received ~1,410 IMPROVE samples per month (varies from ~400 to 3,200 samples per month)

• Operated ~24 hour/day, 5-6 days/week during December-February; reduced to ~50% capacity during March-May period; currently at ~15-17 hours/day, 4 days/week with one supervisor, one software engineer, and three laboratory technicians

• Dana Trimble was promoted to Program Manager (Division of Hydrological Sciences), and Vinay Amin has assumed responsibility since October, 2019
Completed analyses of 2019 samples in March, 2020 and currently analyzing July-August samples

(July 2019 to June 2020 samples)

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>Sample Receive Dates</th>
<th>Number of Samples Received</th>
<th>Analysis Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/1/19-12/31/19</td>
<td>7/19/19-3/18/20</td>
<td>9,471</td>
<td>March 2020</td>
</tr>
<tr>
<td>1/1/20-6/30/20</td>
<td>1/30/20-9/2/20*</td>
<td>9,190*</td>
<td>October 2020</td>
</tr>
</tbody>
</table>

*as of 10/8/20
Carbon throughput averaged ~100 samples per day*

(January 2019 – October 2020)

*Excludes calibration runs and includes other projects
Eliminated carbon backlog since February, 2020 with more fluctuation in recent months

(January, 2019 – September, 2020)
Average reporting time from sample receipt reduced by ~70%

(June, 2019 – August, 2020)
Average 40 runs per day are dedicated to multiple quality control (QC) checks
(October 2019 - September 2020)

n=14,648 QC runs per year
Granulate manganese dioxide ($\text{MnO}_2$) for sample oven is no longer available

(Sigma Aldrich [the supplier for $\text{MnO}_2$] switched granular crystalline to fine powder $\text{MnO}_2$)

The fine powder MnO$_2$ restricts gas flow and induces pressure build up (due to agglomeration). Continue searching for new suppliers and testing new packing methods. Have sufficient MnO$_2$ for now.
Carbon Hardware Improvements

(Replaced the quartz sample boat [with Nickel-Chromium wire holder] with single Kanthal alloy metal boat)

Advantages:
- More stable - screws onto thermocouple
- Easy replacement - remove screw and slide off
- Enclosed thermocouple - minimizes break of “thermocouple tip”
- Longer lifespan - without chipping/distortion

Thermocouple

Embedded Thermocouple

Old, quartz boat

New, Kanthal Alloy boat (mixture of iron, chromium, and aluminum)
Initiated pre-run laser check to ensure the proper lasers signals.
Implemented the “Cal Peak” cooling fan to save ~300 seconds between analysis (Cools the oven during the final stage of analysis, rather than after analysis)
Established new protocols for data validation

• Initiated automation to increase accuracy and efficiency
  - Generate comparisons for replicates, reruns, and collocated samples
  - **Identify extreme values** (e.g., high, low, zero, and negative)
  - Monitor deviations from calibration peaks and send alert of instrument malfunction
  - **Streamline data validation and reporting process**

• Created visualization tools
  - Examine relationship between light attenuation and elemental carbon
  - **Evaluate temporal variations** (e.g., comparison with historical medians)
DRI publications and reports using the IMPROVE_A protocol (n=43)


DRI publications and reports using the IMPROVE protocol (continued)


• Hidy, G.M., Chow, J.C., Watson, J.G., (2017). Critical review summary: Air quality measurements—From rubber bands to tapping the rainbow. EM, 21,


DRI publications and reports using the IMPROVE protocol (continued)


