2023 Canadian Wildfire Impacts on Air Quality in the Northeastern United States

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1. Introduction

- The 2023 Canadian wildfire season burned approximately 42 million acres of land. By 28 June 2023, ~20 million acres of land was burned across Canada, and by 26 July 2023, the number of acres burned rose to ~30 million acres. Wildfires in British Columbia, Alberta, and Quebec caused severe smoke-impact events in the northeast United States during June and July of 2023.
- This research focuses on June and July of 2023 to assess the smoke event impacts on visibility in the Northeast (NE) as well as 2023 deviations from the 2012-2023 average.

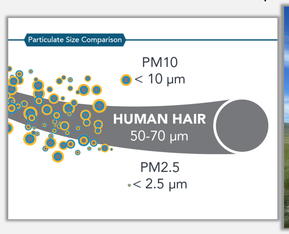


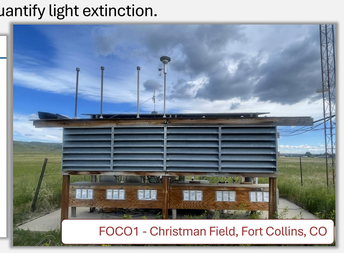
Wilkes-Barre, PA
7 June 2023 (R)

- Aerosol composition is dependent on certain factors, including emission source.
- Aerosols impact visibility by their ability to scatter and absorb light. One way to quantify visibility is through light extinction (b_{ext}), which has the units of inverse megameters (Mm^{-1}).
- Despite having a short residence time, fine particulate matter (PM) particles can influence human health as well as climate and the environment.

2. IMPROVE Network

- The IMPROVE (Interagency Monitoring of Protected Visual Environments) ground-based network monitors air quality in remote and rural areas across the United States.
- Every 3 days at each of the 155 active sites, 24-hour speciated aerosol measurements of PM2.5 (mass of particles with diameters less than 2.5 μm) are taken.
- PM10 and PM2.5 samples are collected at the sites, and these species measurements can be used to quantify light extinction.

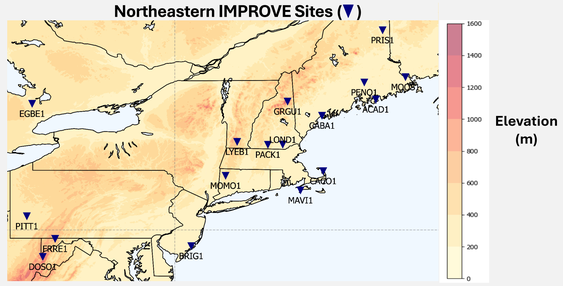




FOCO1 - Christman Field, Fort Collins, CO

- Aerosol species concentrations from 17 northeastern sites were used to understand visibility impairment across the region. Specifically, **organic aerosol mass (OM)** and **elemental carbon (EC)** are two species of interest as wildfires are a common emission source for both species.
- In addition to the IMPROVE network, multiple data sources and products were utilized, including:
  - NOAA Hazard Mapping System (HMS) fire and smoke product
  - Level 3 aerosol optical depth (AOD) data from the Suomi NPP Visible Infrared Imaging Radiometer Suite (VIIRS)

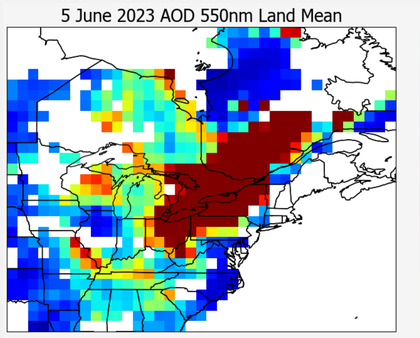
Northeastern IMPROVE Sites (▼)

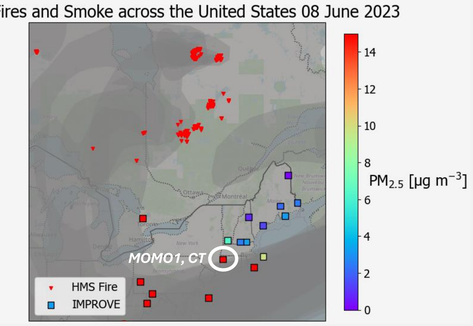


3. 2023 Canadian Wildfires

June 2023

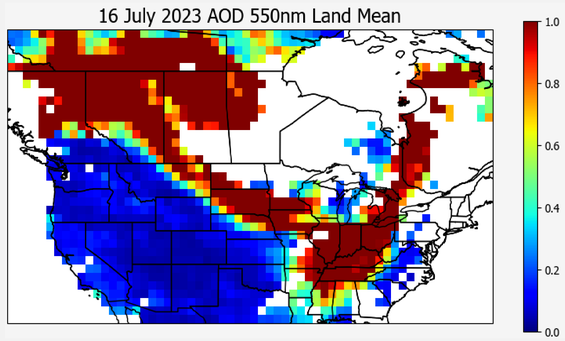
A low pressure system steered smoke from southern Quebec across northeastern IMPROVE sites. Fresh smoke plumes and high concentrations of PM2.5 continuously moved into the region over the 5-8 June.

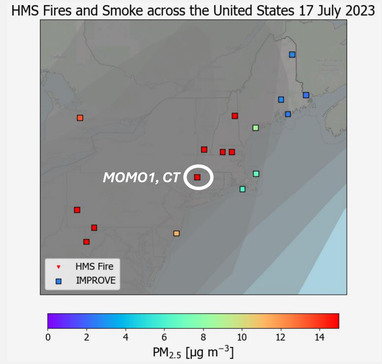




July 2023

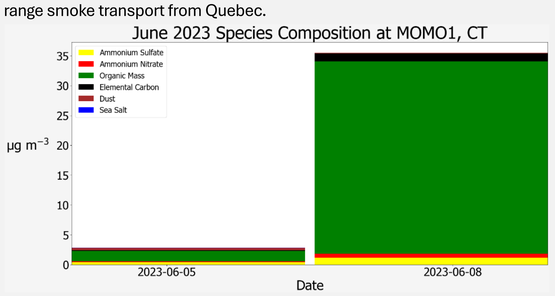
A trough transported smoke from British Columbia and Alberta across North America and into the Northeast. Aged, diluted smoke moved into the region. The 16-18 of July experienced a regional impact of smoke in the Northeast.

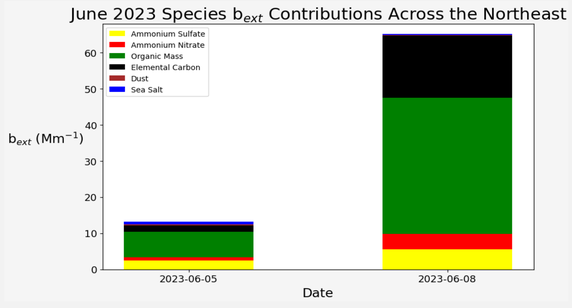




4. Air Quality Impacts in the Northeast United States

- Poor to hazardous air quality conditions were recorded at sites located across PA, MD, NY, NJ, and CT on 8 June 2023. Skies were heavily discolored by the short-range smoke transport from Quebec.

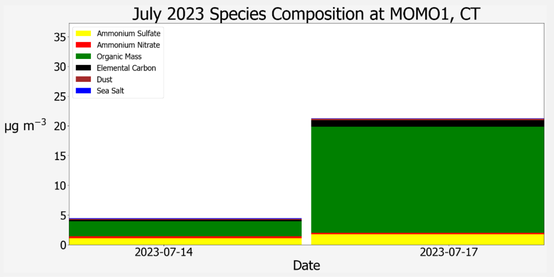


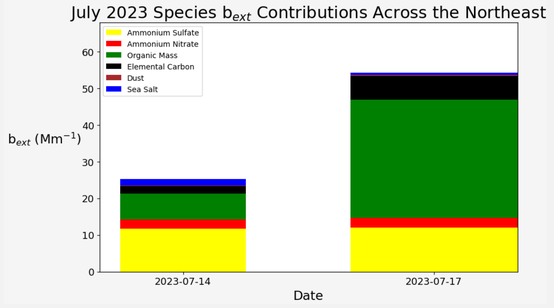


8 June 2023 across the Northeast (NE)

80% of PM2.5 mass was OM *(typically 50-60% in the NE during June)*
Average light extinction: **80.5 Mm^{-1}** *(typically ~30-40 Mm^{-1} in the NE during June)*
37.7 Mm^{-1} of the average NE light extinction is attributable to OM

- Poor air quality conditions were recorded at sites located in states extending from MD up to southern ME. Skies were discolored by the long-range transport of dilute smoke concentrations from British Columbia and Alberta.



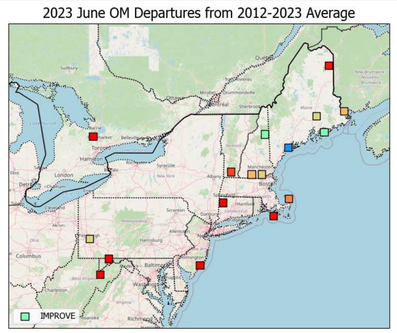


17 July 2023 across the Northeast (NE)

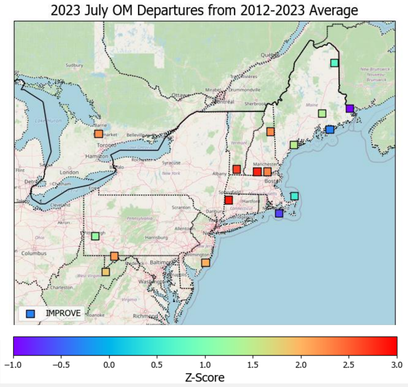
75% of PM2.5 mass was OM *(typically 50-60% in the NE during July)*
Average light extinction: **68.5 Mm^{-1}** *(typically ~30-40 Mm^{-1} in the NE during July)*
32.2 Mm^{-1} of the average NE light extinction is attributable to OM

5. 2023 OM Deviations from 2012-2023

- June 2023 OM concentrations across most of the 17 sites deviated from the 2012-2023 mean by 2 - 3 z-scores, indicating that rare deviations in OM occurred during June 2023.



- July 2023 OM concentrations deviated from the 2012-2023 mean by 1 - 2.5 z-scores across most of the 17 sites, indicating that relatively rare to rare deviations in OM occurred during July 2023.



6. Conclusions

June 2023

- Fresh smoke from Quebec heavily impaired visibility in the NE.
- Average northeastern visibility (8 June 2023): 80.5 Mm^{-1}.
  - *OM attributed to 37.7 Mm^{-1} of this average NE light extinction.*
- OM accounted for 80% of the average NE PM2.5 mass (8 June 2023).
- OM concentrations deviated by 2 - 3 z-scores across most NE sites in June 2023, indicating that deviations in OM were rare.





7 June 2023 Wilkes-Barre, PA

July 2023

- Diluted smoke from Alberta and British Columbia impaired visibility in the NE.
- Average northeastern visibility (17 July 2023): 68.5 Mm^{-1}.
  - *OM attributed to 32.2 Mm^{-1} of this average NE light extinction.*
- OM accounted for 75% of the average NE PM2.5 mass (17 July 2023).
- OM concentrations deviated by 1 - 2.5 z-scores across most NE sites during July 2023, indicating that deviations in OM were relatively rare to rare.

7. Acknowledgments

Thank you to the following databases for their 2023 archived data: IMPROVE - Federal Land Manager Environmental Database, NOAA HMS fire and smoke product, SNPP VIIRS - NASA EARTHDATA archive center.

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