Optical and Chemical Analysis of Driving Factors for DOC Concentration and Composition

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The 3rd HSSPF

1. Introduction

- Dissolved organic carbon (DOC) refers to carbon stored in organic compounds that are dissolved in freshwater and saltwater bodies
- DOC is insufficiently understood despite making up a significant portion of Earth's carbon pool
- **Objective**: Analyze the **combined effect of solar radiation and microbial activity on DOC concentration and composition** using samples taken from a headwater stream in Harvard Forest

2. Study Site

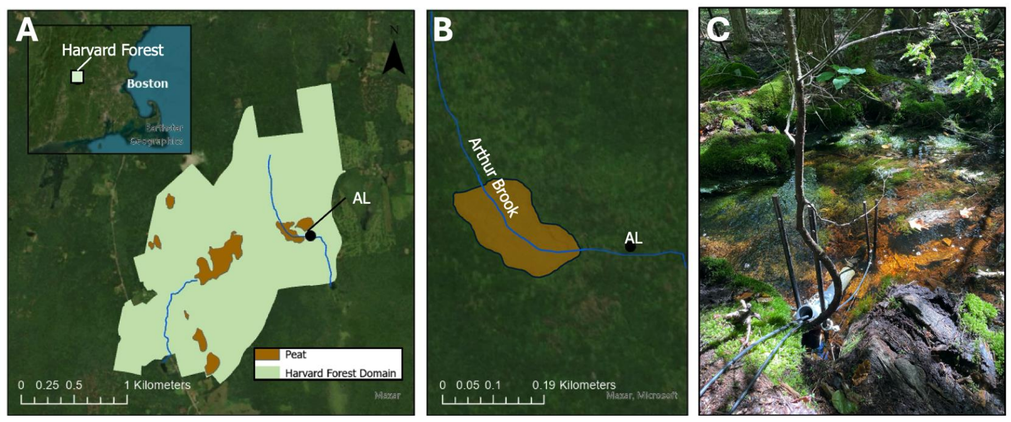

Fig. 1: *Map of Harvard Forest showing location of AL and photograph of AL sampling site. Image courtesy of Jiyeong Hong.*

Arthur Lower (AL):

- DOC mainly comes from peatland upstream
- DOC variations primarily caused by seasonal changes in swamp vegetation
- Sample collected July 16th, 2025

3. Methods

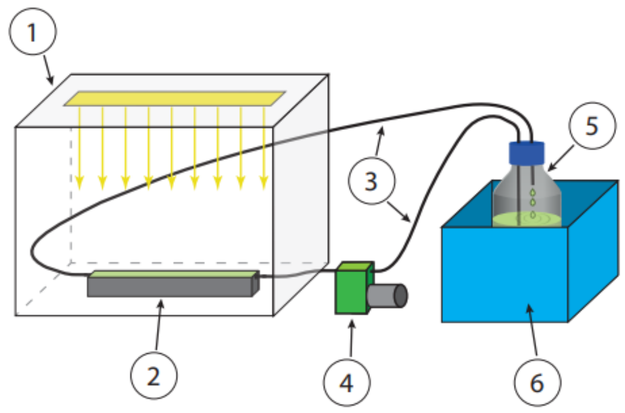

Fig. 2: *Schematic of experimental setup; only one sample shown for clarity.*
(1) Solar simulator
(2) Quartz flow cell
(3) Teflon-coated (PTFE) tubing
(4) Miniature diaphragm pump
(5) Sample bottle
(6) Temperature controlled water bath
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- Prepared four one-liter treatments of Arthur Lower sample
  - Two treatments filtered through a 1.5-micron glass fiber filter (GFC), while the other two were filtered through a 0.7-micron glass fiber filter (GFF)
  - The GFC treatments had a more complete microbial community
- One GFC and GFF treatment were exposed to light (LC) via the setup above; remaining two treatment used as dark control (DC)
- Solar simulator programmed to emulate typical light exposure during the day
- Subsampled each treatment once daily for eight days to analyze UV-visible absorbance and DOC concentration, using a UV-visible spectrophotometer and a TOC analyzer respectively

References:

[1]Martin, P.; Woo, O. Y.; Chen, Y.; Tan, C. Y.; Yang, C. T.; Zhou, Y.; Mayer, B. Quantifying Interactive Photochemical and Microbial Removal of Terrestrial Dissolved Organic Carbon: From Experiments to Modelling — Running Head: Light-Enhanced Microbial DOM Degradation. ESS Open Archive 2024, preprint.

[2]Weishaar, J. L.; Aiken, G. R.; Bergamaschi, B. A.; Fram, M. S.; Fujii, R.; Mopper, K. Evaluation of Specific Ultraviolet Absorbance as an Indicator of the Chemical Composition and Reactivity of Dissolved Organic Carbon. Environ. Sci. Technol. 2003, 37(20), 4702–4708. DOI: 10.1021/es030360x

Acknowledgments:

CEISMC Georgia Tech Center for Education Integrating Science, Mathematics, and Computing

SAM meets STEM

4. Results

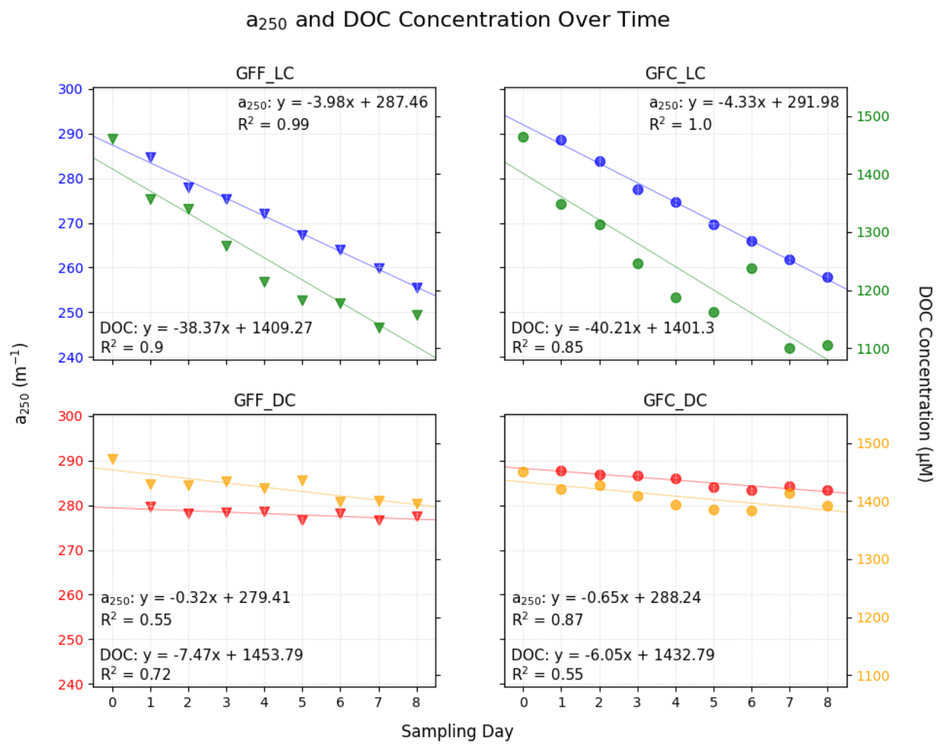

Fig. 3: *Absorption coefficient at λ=250 nm and DOC concentration shown over time per sample. For LC samples, blue - a250 and green - DOC. For DC, red - a_{250} and yellow - DOC.*

- DOC concentration decreased by up to 24%, while a_{250} decreased by up to 11% in LC samples; DC samples show much smaller changes, showing that sunlight increases rate of DOC degradation
- DOC concentration decreases at a faster rate than a_{250}, indicating that non-colored DOC is decaying more quickly than colored DOC

$$SUVA_{254} = \frac{a_{254}\ (m^{-1})}{\ln 10 \times DOC\ (mg\ L^{-1})}$$

Fig. 4: *Equation used for calculation of SUVA254, a strong indicator of DOC aromaticity.[2]*

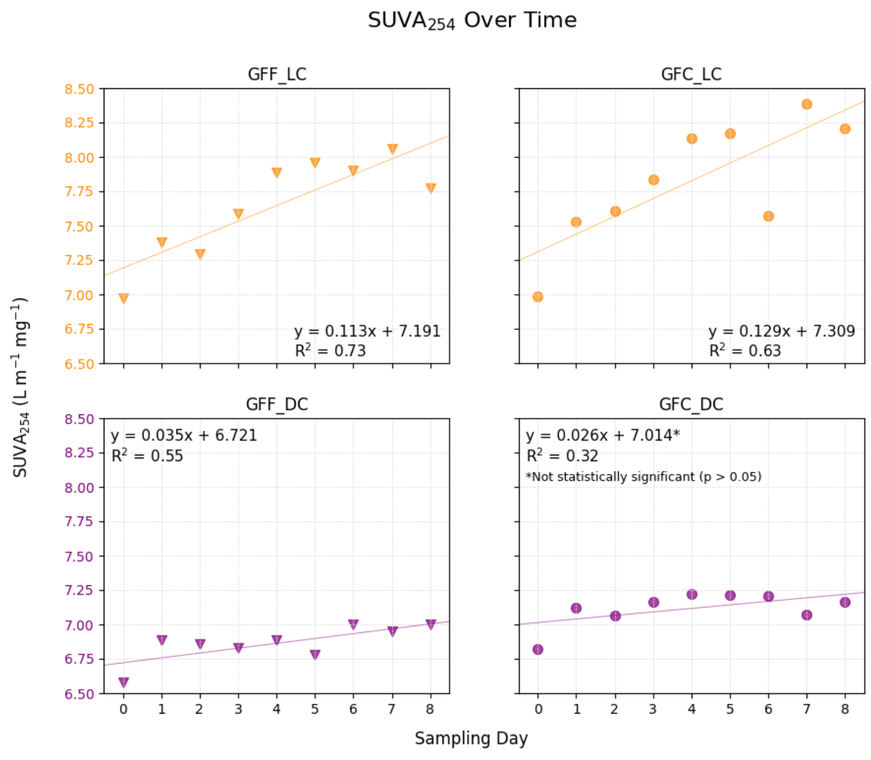

Fig. 5: *SUVA254 shown over time per sample*

- $SUVA_{254}$ increased by up to 17% in LC samples, indicating that non-aromatic DOC is decaying faster
- Decrease in non-aromatic DOC is most likely caused by combined effect of radiation and microbial activity

5. Conclusion

- **Effect of Sunlight:** Accelerate DOC degradation via photochemical reactions
- **Effect of Microbes:** Break down non-colored DOC and non-aromatic compounds at a faster rate than sunlight can break down aromatics, leading to increases in aromaticity
- **Future Work:**
  - Run study over a longer time to better observe trends
  - Run experiments with a variety of filter sizes to further observe effects of differing microbial communities