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

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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

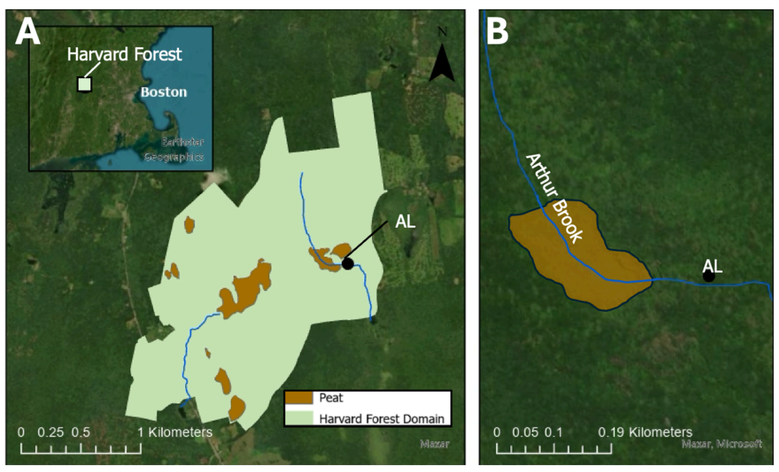

Fig. 1: *Map of Harvard Forest showing location of AL. Image courtesy of Jiyeong Hong*

Fig. 2: *Photograph of AL sampling site with. 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
- Initial conditions:
  - pH - 5.2
  - Temperature - 12° C

3 Methods

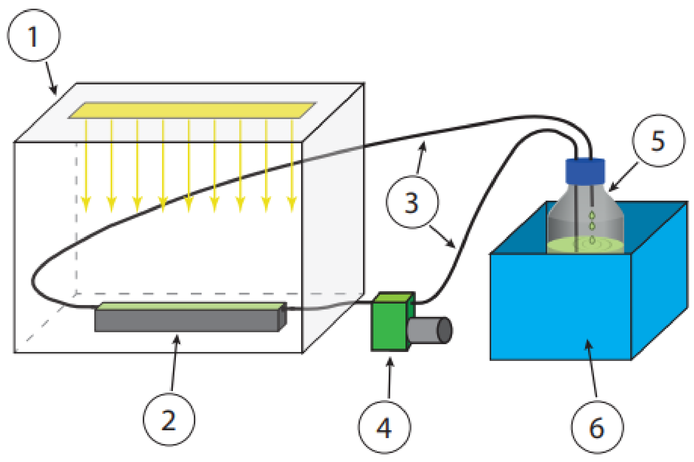

Fig. 3: *Schematic of experimental setup; only one sample shown for clarity.*
(1) Solar simulator
(2) Quartz flow cell
(3) Teflon-coated (PTFE) tubing
(4) Miniature diaphragm pump
(5) Sample bottle
(6) Temperature controlled water bath
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- Prepared four 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

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[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

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4 Results

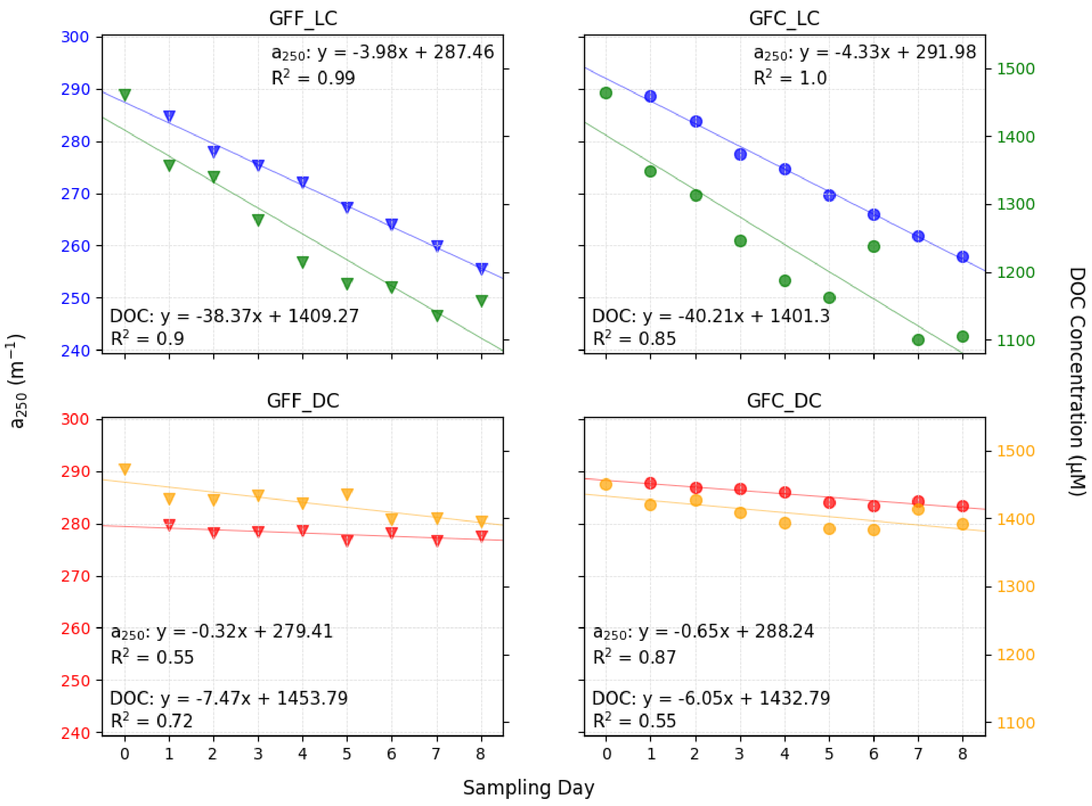

Fig. 4: *Absorption coefficient at λ=250 nm and DOC concentration shown over time per sample. For LC samples, blue - a_{250} and green - DOC. For DC, red - a_{250} and yellow - DOC.*

- **DOC concentration decreased by up to 24%, while a_{250} decreased by up to 11%** in LC samples; DC samples show much smaller changes
- Shows 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. 5: *Equation used for calculation of $SUVA_{254}$, a strong indicator of DOC aromaticity.[2]*

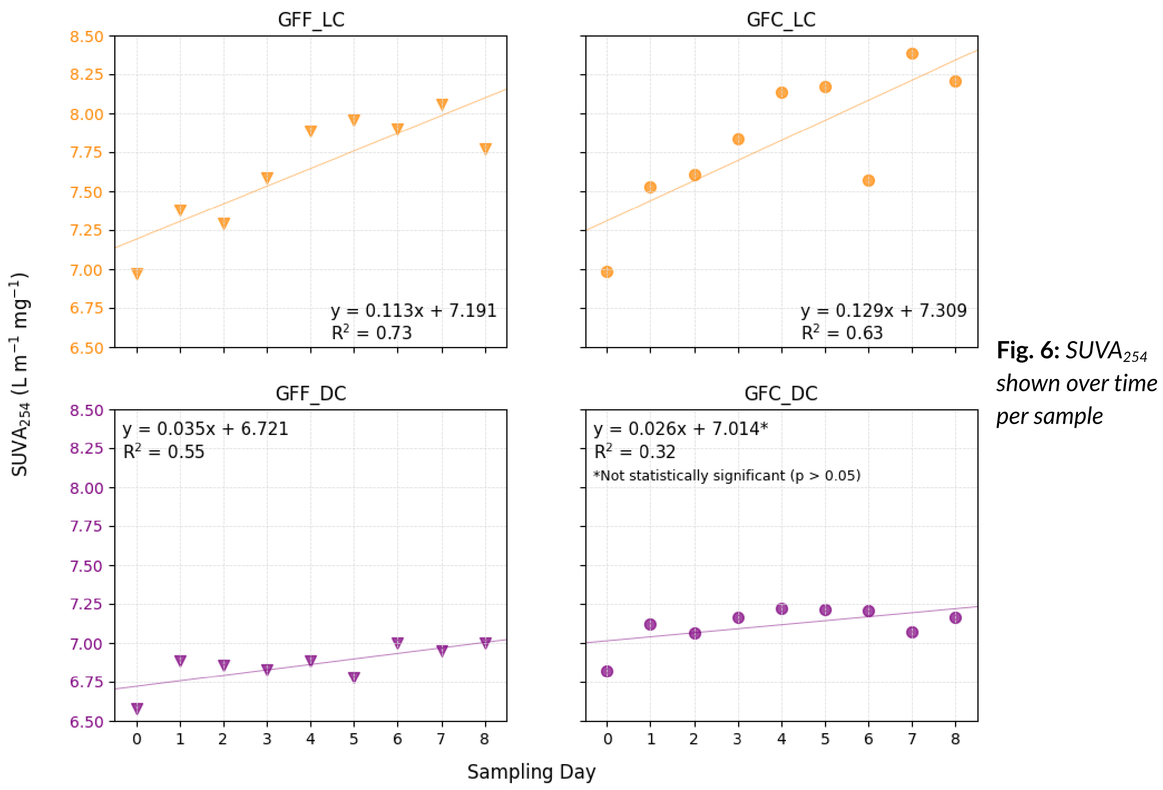

Fig. 6: *$SUVA_{254}$ shown over time per sample*

- **$SUVA_{254}$ 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 period to better observe trends
- Run experiments with a variety of filter sizes to further observe effects of differing microbial communities