The Influence of Interannual Carbon Variability on Long-Term Sequestration in Proximate Northern Forests and Wetlands

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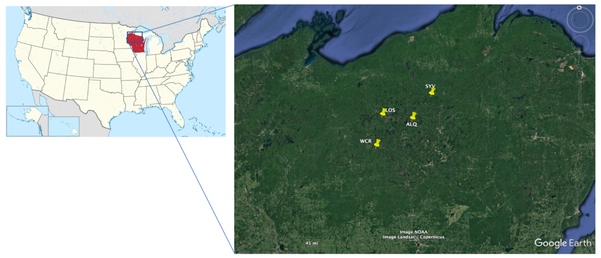
Introduction and Motivation

- To counter anthropogenic emissions, ecosystem restoration is essential
- Wide variety of biomes may be considered for restoration
- **Which biomes will provide *sustained* carbon sequestration on decadal scales? And what drives year-to-year variability between sites?**

Sites

Figure 1: Site locations in northern Wisconsin and Michigan's Upper Peninsula, USA



- Wetlands → US-ALQ, US-Los
- Unmanaged Forest → US-Syv
- Managed Forest → US-WCr
- To incorporate another possible carbon driver, streamflow data was used via the United States Geological Survey (USGS)
  - US-ALQ → 3 gages
  - US-Los: → 1 gage
  - US-Syv: → 1 gage
  - US-WCr: → No gage

Figure 2: Relative locations of Ameriflux sites and USGS streamflow gages. From Bear River gage to US-Los is ~4 km (left). Distance from gage at Cisco Lake Outlet and US-Syv is ~8 km (top right). HWY M, Sayner, and No. 3 gages are ~3.7 km, ~0.6 km, and ~0.24 km from US-ALQ respectively (bottom right).

Methods and Results

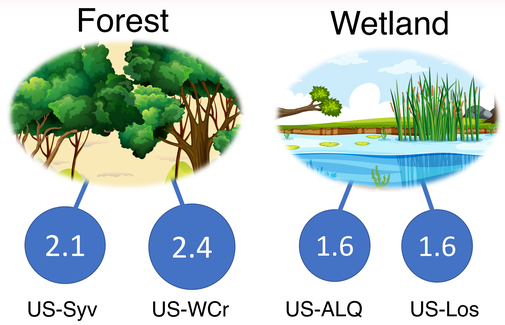


Figure 3: Averaged standard deviation of NEE across years for the wetland and forest sites. Units are kg C m^{-2} yr^{-1}.

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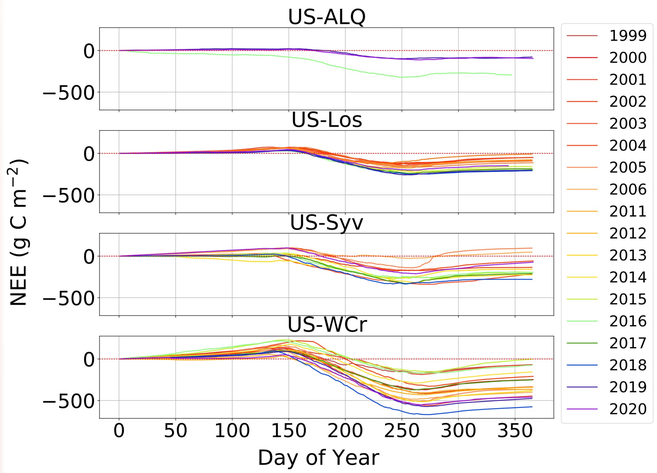

Figure 4: Cumulative NEE across all sites and years

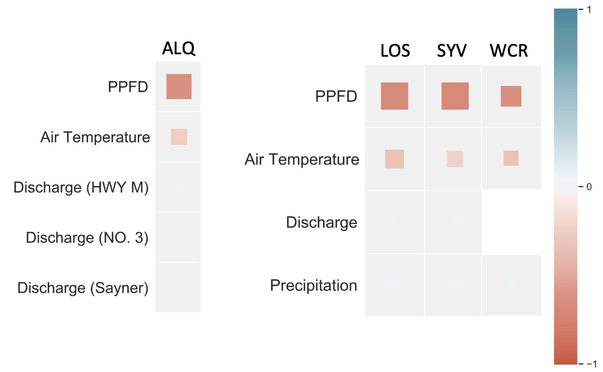

Figure 5: Carbon drivers listed for each site with square size and color representing magnitude of Pearson correlation coefficient when plotted against NEE.

- Forest sites were found to have more interannual variability than wetland sites (Figure 3 and 4)
- Forest sites accumulated substantially more carbon per year on average than wetland sites (Figure 4)
- Pearson regression analysis shows that radiation and air temperature were dominant drivers of NEE across years, with little to no correlation with discharge or cumulative precipitation (Figure 5)

Discussion

- A trade-off between forest and wetland carbon sequestration:
  - **Forest** carbon dynamics are **highly variable** but have **high rates of uptake** from year to year.
  - **Wetlands** are **less variable** but have **lower rates of uptake**
- Risks of sequestration reversal make wetlands more reliable for long-term carbon storage
- Maximizing received PPFD via afforestation or other means will maximize uptake for both ecosystem types

Future Work and Implications

- Further investigation to be carried out on carbon-water dynamics via wavelet coherence analysis
- Findings will
  - Help **tailor restoration efforts** across different ecosystem types based on drivers
  - Inform policy on the most economically viable methods for **maximizing sequestration in the long-term**
  - **Generate other research pathways** by conducting similar studies in other regions

Acknowledgments

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