Characterizing the responses of carbon dioxide, water, and energy exchange in Everglades peat and marl freshwater marshes to changes in hydroperiod

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Introduction

- Florida Everglades are highly productive, though oligotrophic
- Productivity is maintained by a tolerant emergent macrophyte, sawgrass (*Cladium jamaicense*), and abundant periphyton communities (Fig. 1)
- Periphyton NPP in the Everglades reported at some sites as 20,599 g C m⁻² yr⁻¹ (Ewe et al. 2006)

Hydroperiod is central in differentiating Everglades wetlands:
- **Long hydroperiod**: continuous water above the surface, peat soils, and low periphyton biomass
- Everglades peat soils were formerly the world’s largest single body of organic soils (Stephens and Johnson 1951)
- Drainage and other agricultural activities have led to substantial loss of this organic carbon
- **Short hydroperiod**: 6 months or less with water above the surface, marl soils, and high periphyton biomass
- Geochemical carbon fixation – large amounts of carbon are precipitated as calcium carbonate as CO₂ is reduced during photosynthesis: CO₂ + H₂O = H₂CO₃ = HCO₃⁻ + H⁺
- Calcium carbonate = CaCO₃ + 2HCO₃⁻ = CaCO₃ + CO₂ + H₂O
- Everglades water levels vary seasonally and with water management (regulated quantity and timing of water delivery), but evaporative losses are not well characterized
- Historical slow sheet flow to be restored: Comprehensive Everglades Restoration Plan (8 billion over 50 yrs)
- Everglades ecoregion is poorly represented by the current AmeriFlux network of eddy covariance sites (Hargrove et al. 2003)

Objective

- To determine the total CO₂ balance and the relative magnitudes of the biotic and abiotic CO₂ exchange processes in peat and marl forming wetlands of the Florida Everglades in response to changes in hydroperiod

Research Questions

1. What are the CO₂ balances of Everglades peat and marl forming wetlands?
2. What are the relative contributions of physiologically-based exchange and abiotic carbon precipitation to the net CO₂ flux?
3. What are the responses of CO₂ exchange processes to the dominant control, hydroperiod?
4. How does the contribution of macrophyte CO₂ flux vary with hydroperiod across the landscape?

Approach

- **Eddy covariance & microclimatic measurements** will be made in long and short hydroperiod wetlands
- **Chamber measurements** will be used to determine plot-level CO₂ exchange and ecosystem dark respiration
- **Macrophyte/periphyton removal treatments** will be used to determine the contribution of these elements to net ecosystem exchange (NEE) and ecosystem respiration
- **Geochemical techniques** will be used to estimate net carbonification and subsurface photosynthesis
- **Stable carbon isotope analysis** will be used to determine the contribution of ecosystem components to total ecosystem respiration
- **Process modeling** will be used to evaluate controls on fluxes and estimate landscape-scale macrophyte fluxes in response to changes in hydroperiod

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References: