CHARACTERIZING INFLUENCES OF PULSE-DISTURBANCE EVENTS ON BIOGENIC GAS DYNAMICS IN EVERGLADES PEAT SOILS

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Introduction

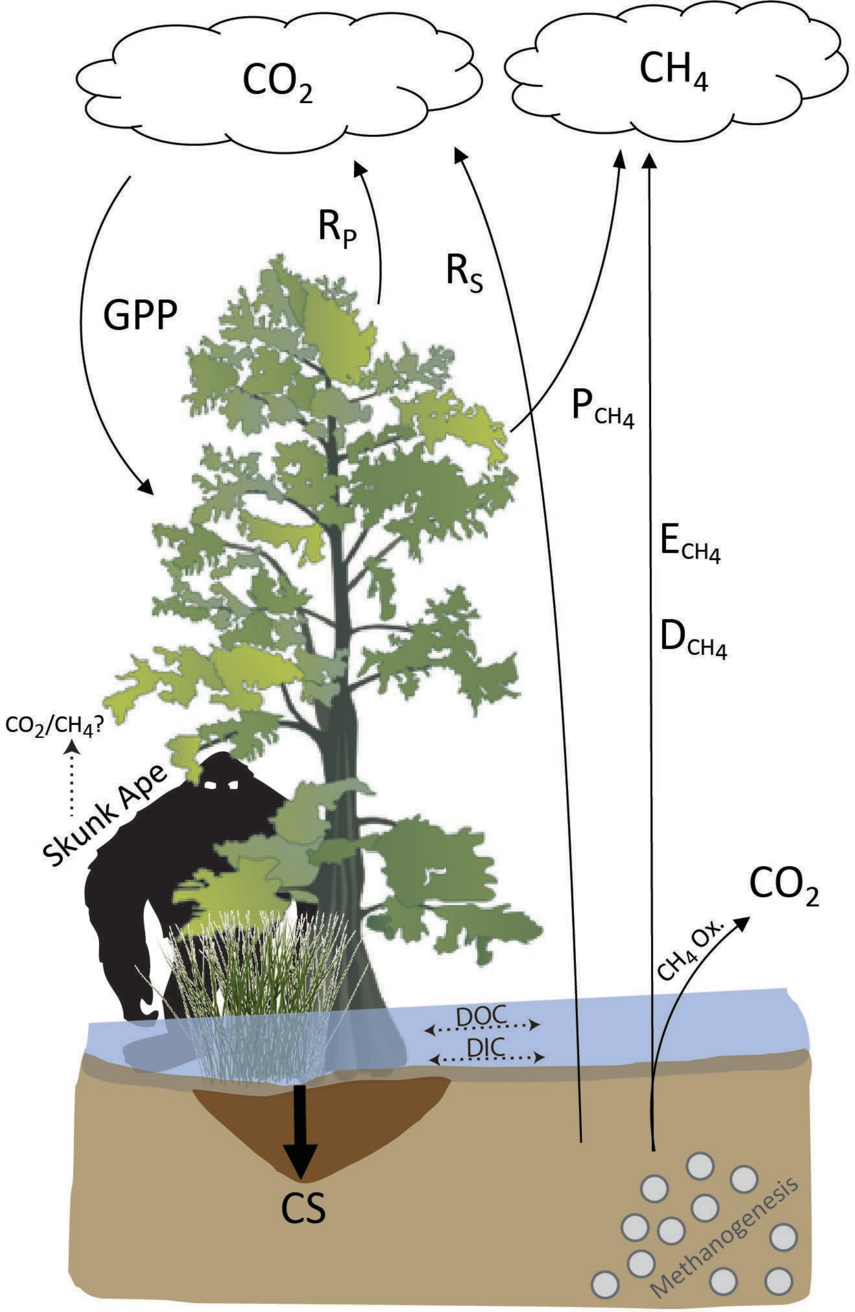
1. Wetlands are important component in regulating global climate.

2. Source or sink for methane (CH_4) and carbon dioxide (CO_2).

3. Largest contributor to natural CH_4 emissions, and account for ~25% of global CH_4 emissions.

4. Majority of CH_4 coming from tropical and subtropical wetlands.

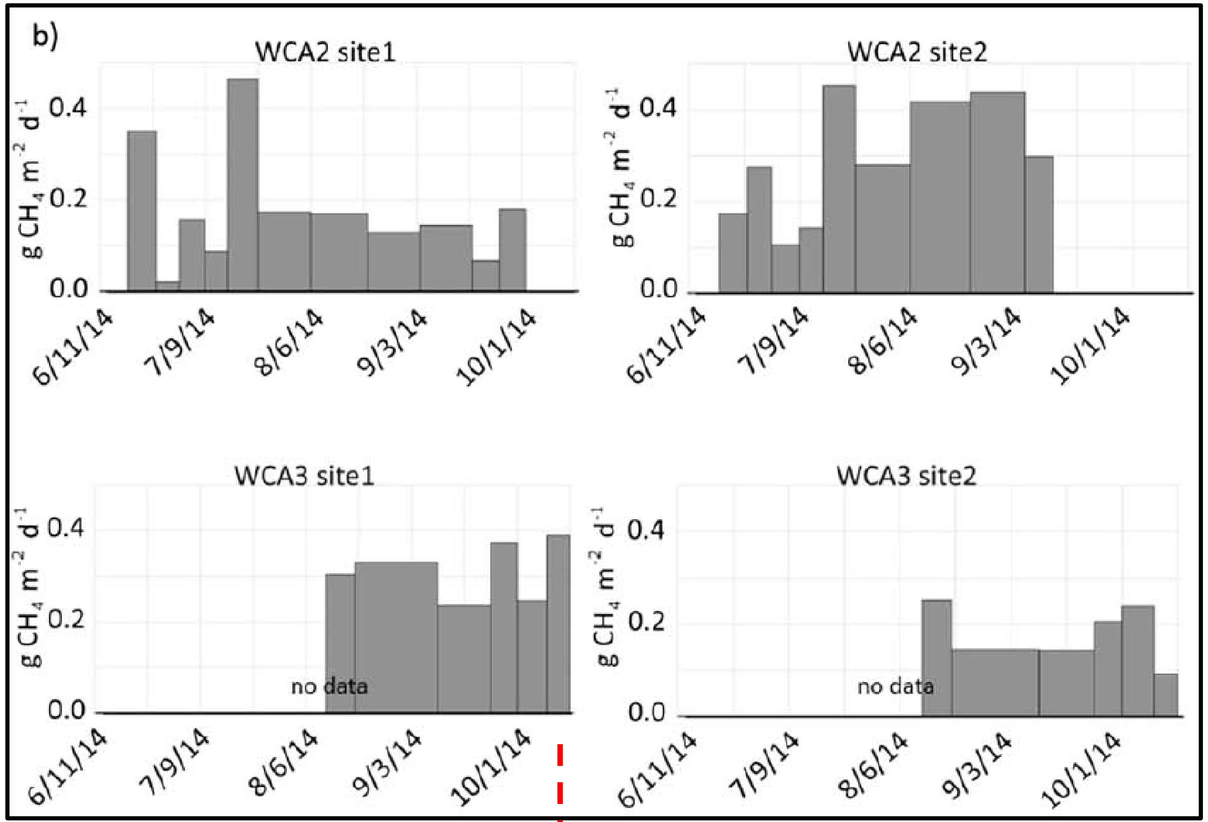
5. Skunk apes are not currently quantified in the carbon budget…



GPP = Gross Primary Productivity; Rp = Plant Respiration; R_S = Soil Respiration; P_{CH4} = Plant Methane; D_{CH4} = Diffusion Methane E_{CH4} = Ebullition Methane; CS = Carbon Sequestration; DIC = Dissolved Inorganic Carbon; DOC = Dissolved Organic Carbon.

Introduction: Previous Subtropical Wetland Studies

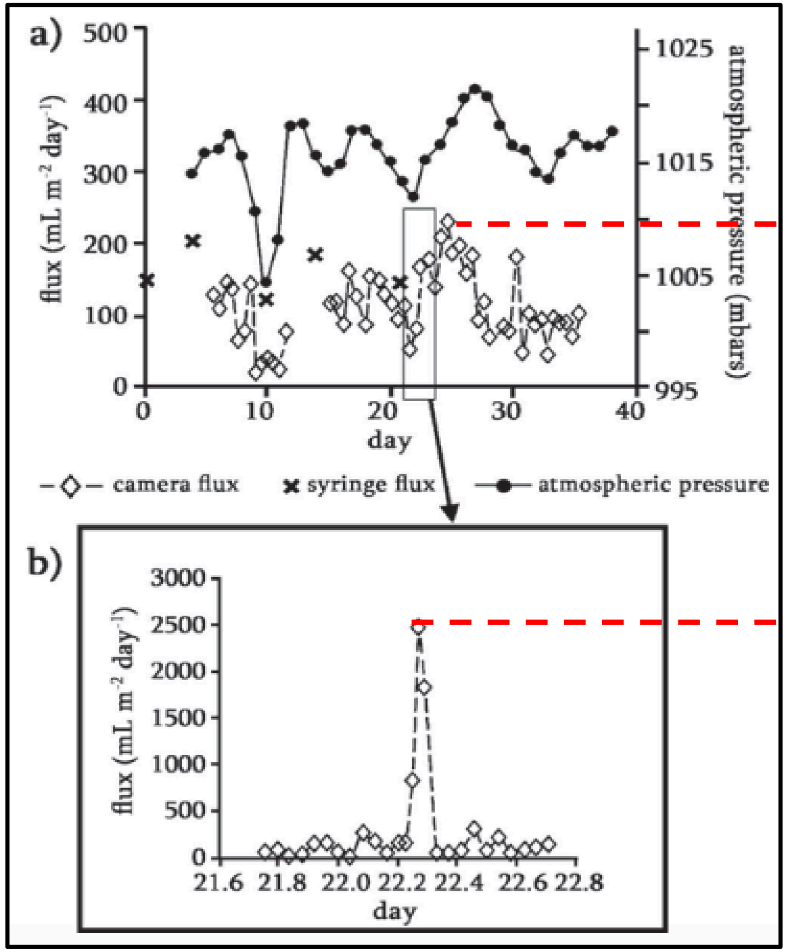
(1) **Spatial** Scale of Measurement: Biogenic Gas Production



Wright, W., and X. Comas (2016).

Ranging between 0.02 to 0.47 g CH4/m^2/d depending on site location

(2) **Temporal** Scale of Measurement: Biogenic Gas Flux



Comas, X. and Wright, W. (2012).

Daily

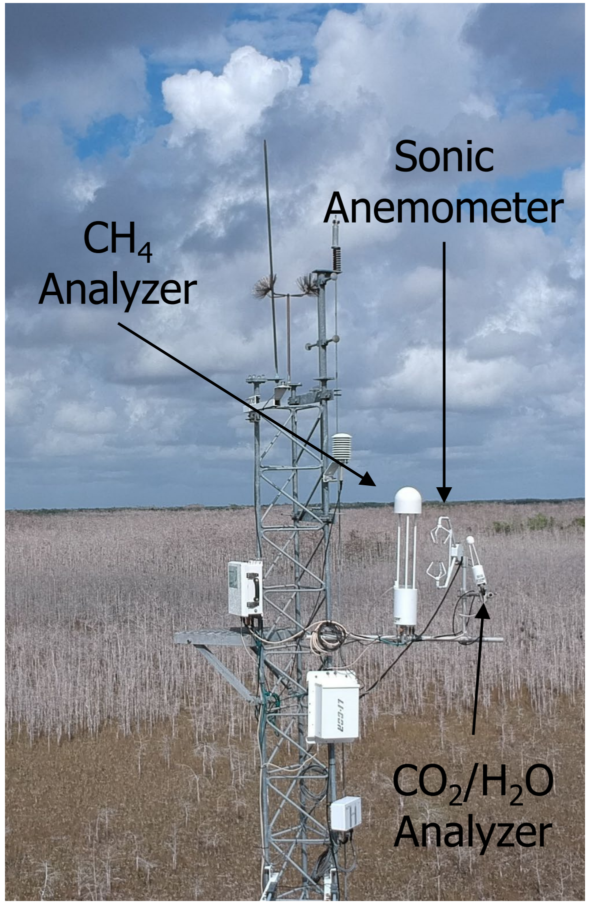
≈250 mL/m^2/d

Hourly

≈2500 mL/m^2/d

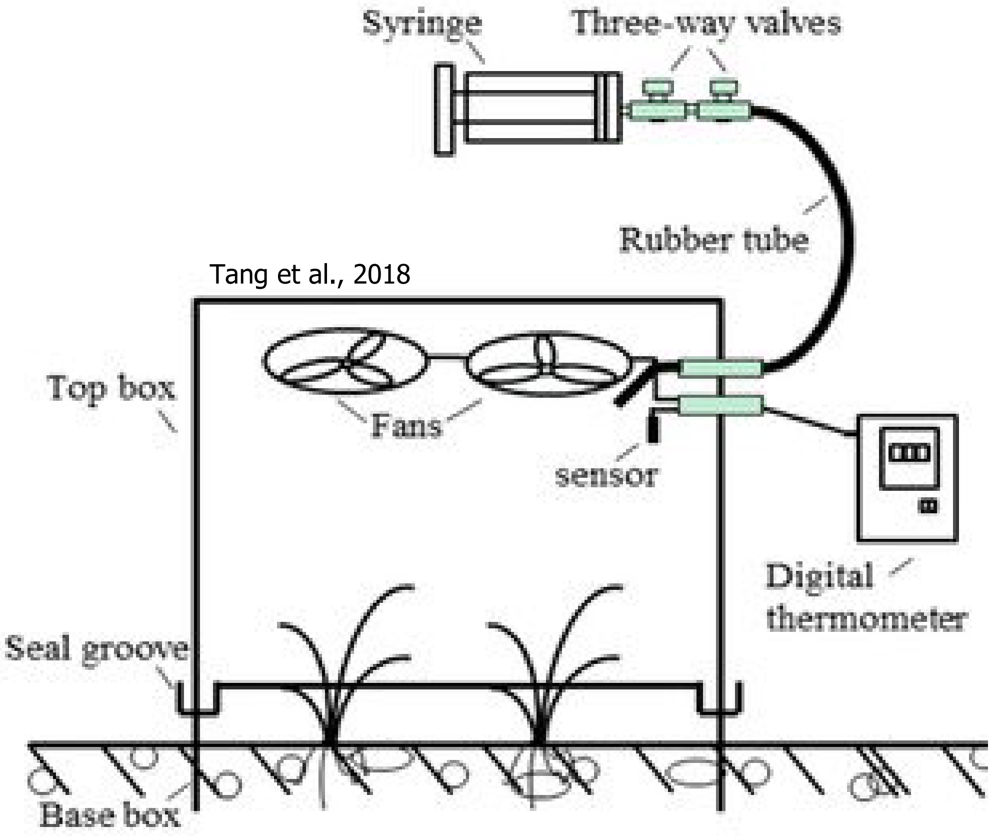
Introduction: Traditional Methodologies

Eddy Covariance



- Ecosystem Scale (100s m)
- Continuously measured area integrated flux
- 30 min flux average
- May overlook ebullition

Static Flux Chambers



- Plot Scale (10s m)
- Portable/low cost
- Better at defining flux variability due to environmental conditions and plant communities.
- Often filtered to remove ebullition

Introduction: Gas Trap Methodology

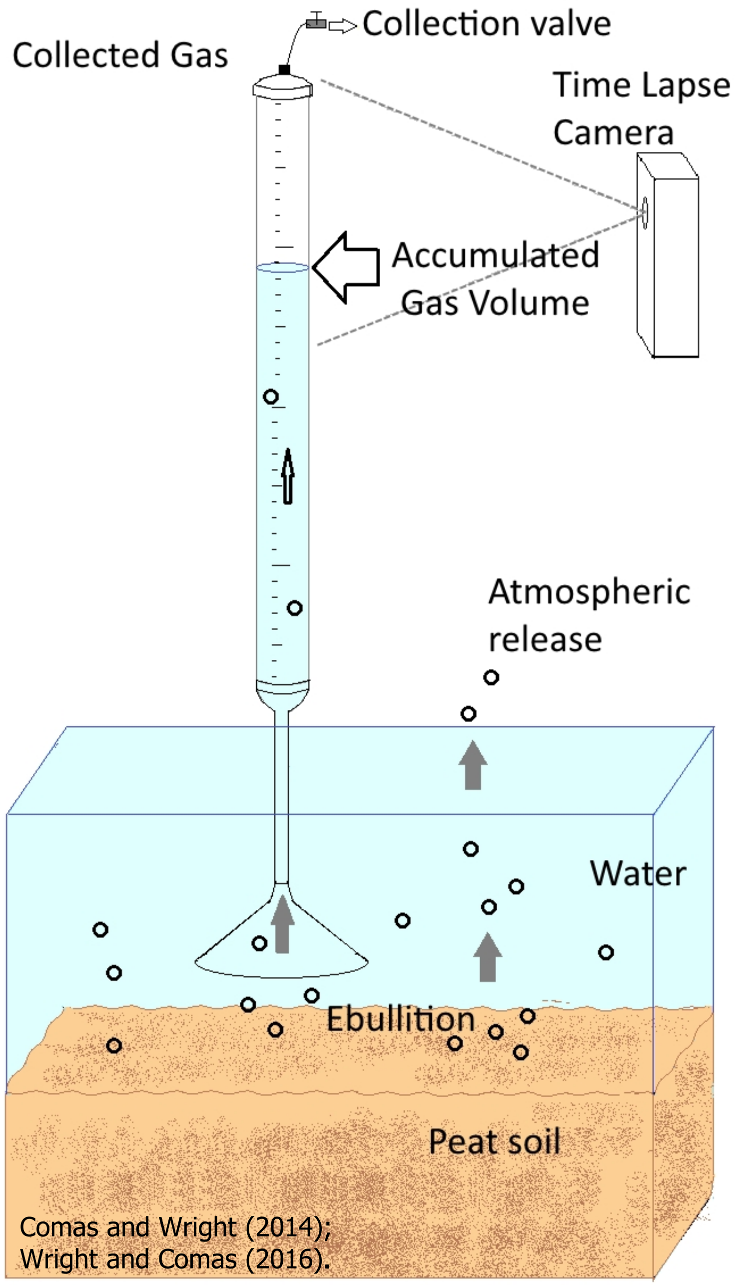
- This study employs eddy covariance techniques with a gas trap methodology.

- Segment of millimeter graduated clear PVC pipe with an inverted funnel and cut-off sampling valve attached on
- opposite ends.

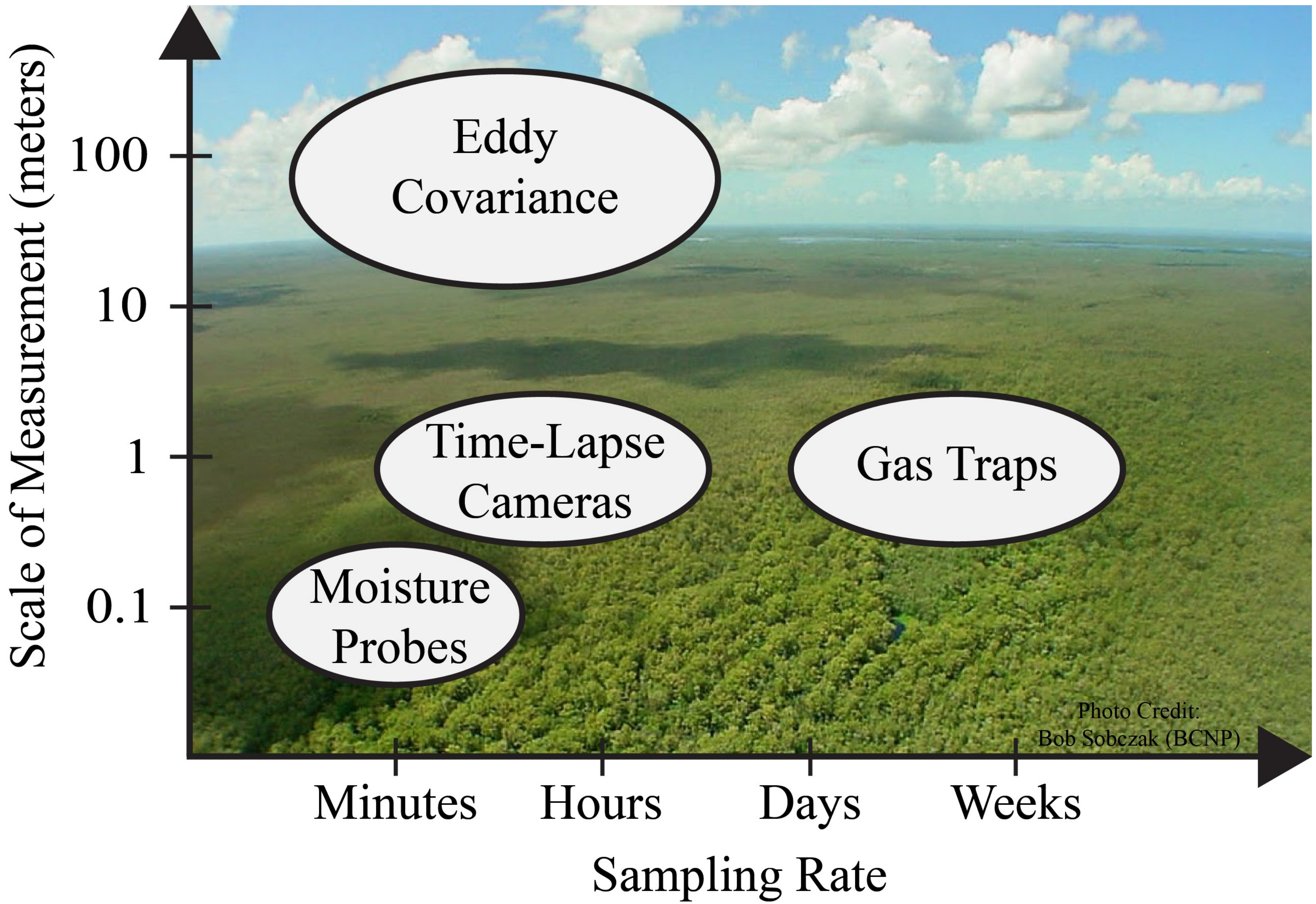
- Funnel is fixed approximately 20-30 cm above the soil surface where gas bubbles will enter and travel upward being stored in the millimeter graduated PVC chamber.

- Progressive displacement of the water by gas bubbles in clear PVC is captured by time-lapse cameras programmed to capture images every half hour.

*Specifically targets ebullition



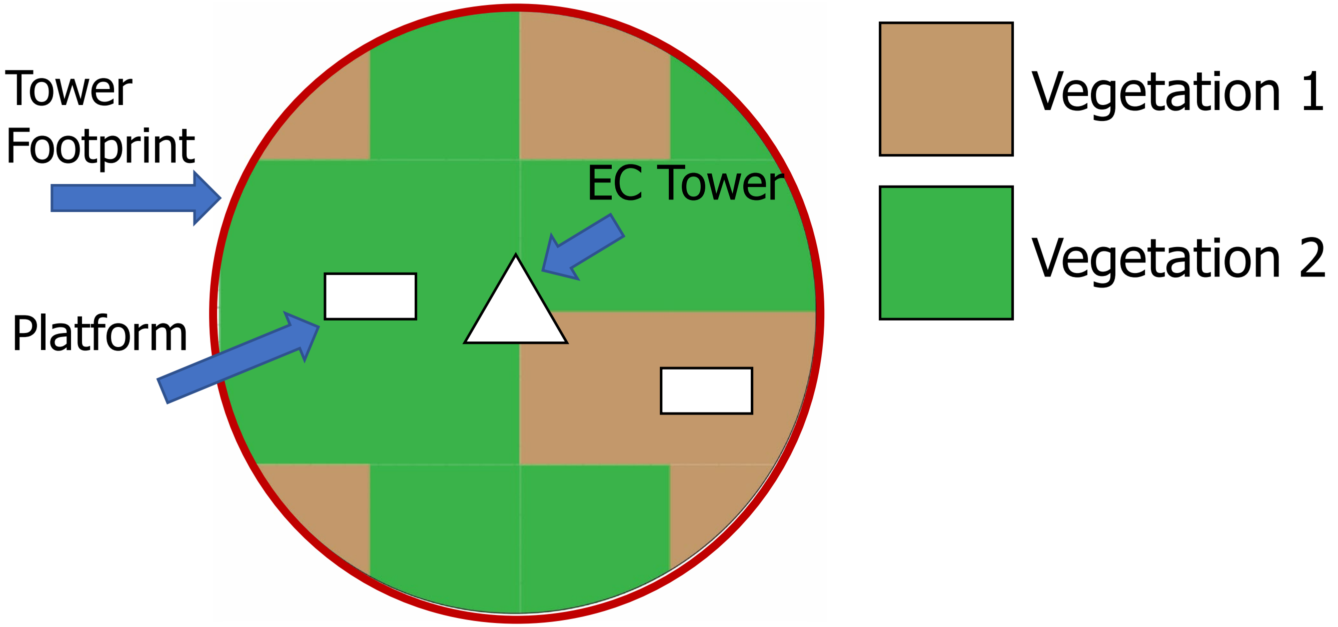
Methodology: Scales of Measurement



What is the proper **spatial** and **temporal <u>scale</u>** for measuring biogenic gas emissions from peat soils?

Methodology: Experimental Design

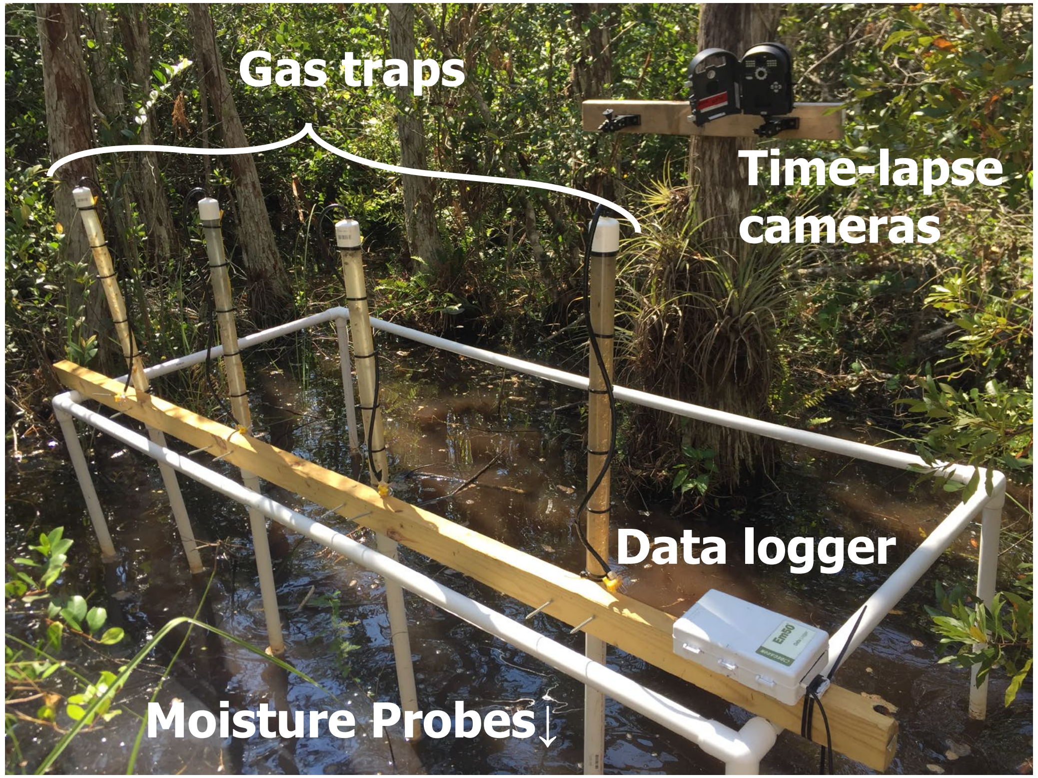
1: Identify existing vegetation communities.



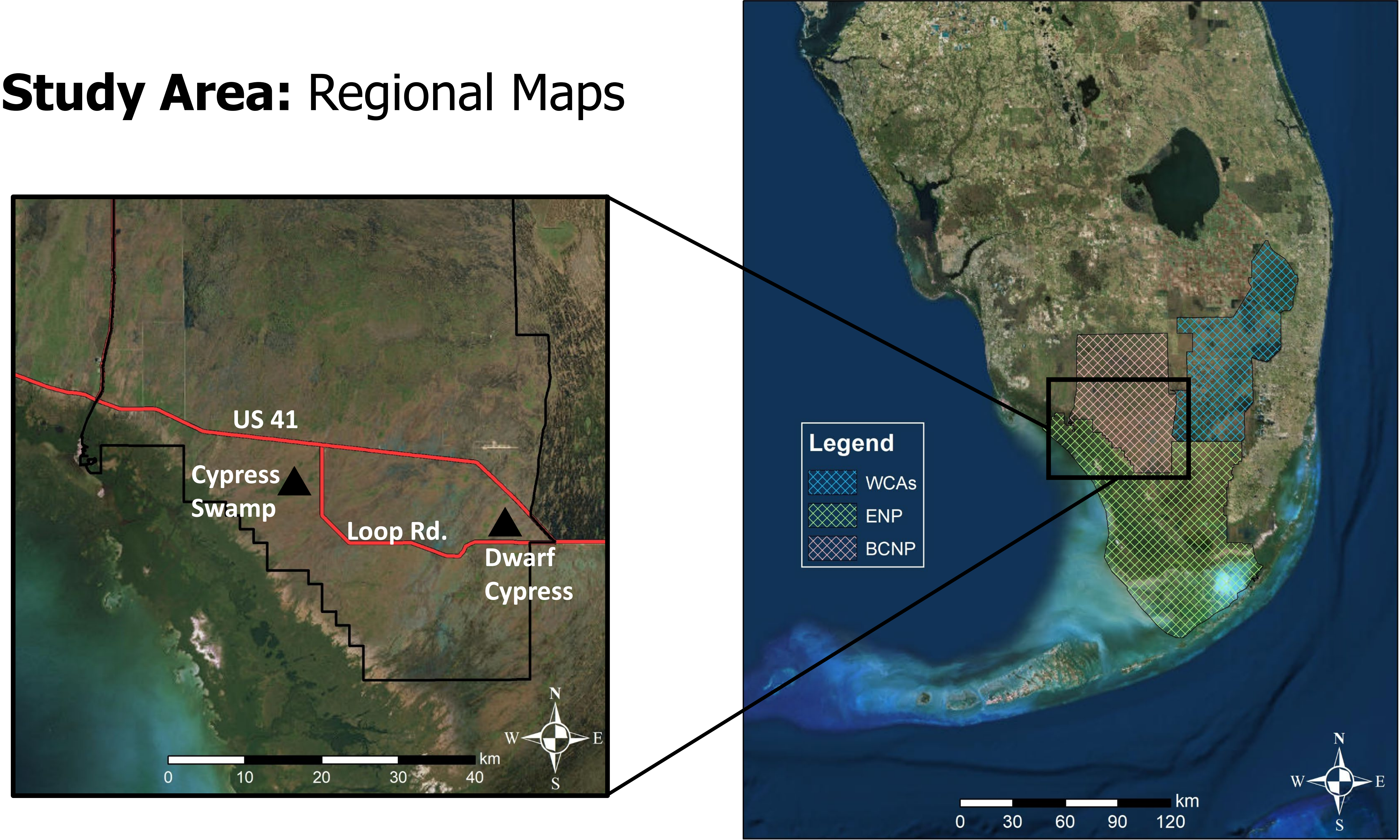
Q: How do soil CH_4 emissions from different vegetation communities compare to the overall flux observed by the EC tower?

2: Install platforms
3: Data collection
4: Data analysis

Cypress Swamp Platform

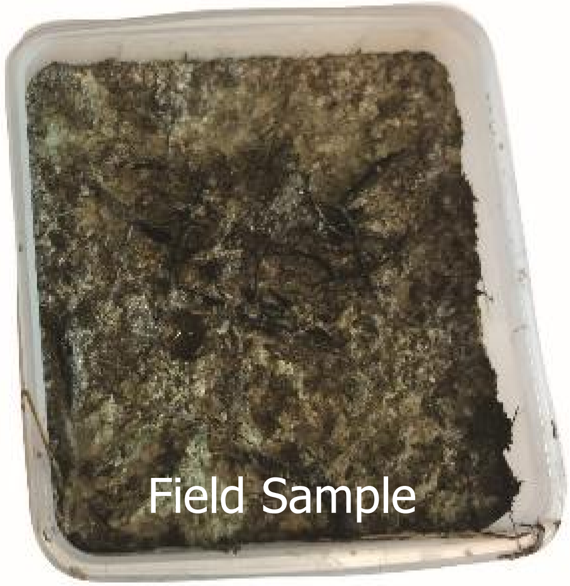


Study Area: Regional Maps



Study Area: Soils

Dwarf Cypress



Physical Properties	
Porosity	0.73
Bulk Density (g/cm^3)	0.36
Organic Matter %	24

$CaCO_3$ rich
High periphyton presence

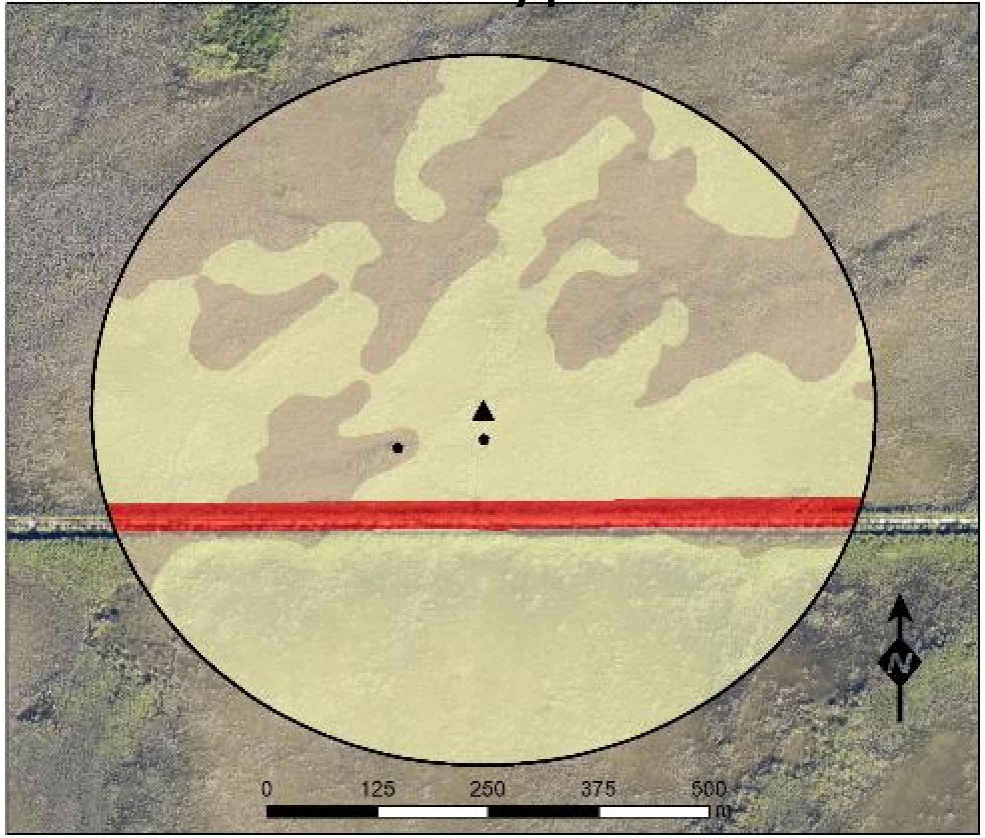
Cypress Swamp

Physical Properties	
Porosity	0.83
Bulk Density (g/cm^3)	0.23
Organic Matter %	51

Cypress litter derived
No visible periphyton

Study Area: Vegetation maps

Dwarf Cypress



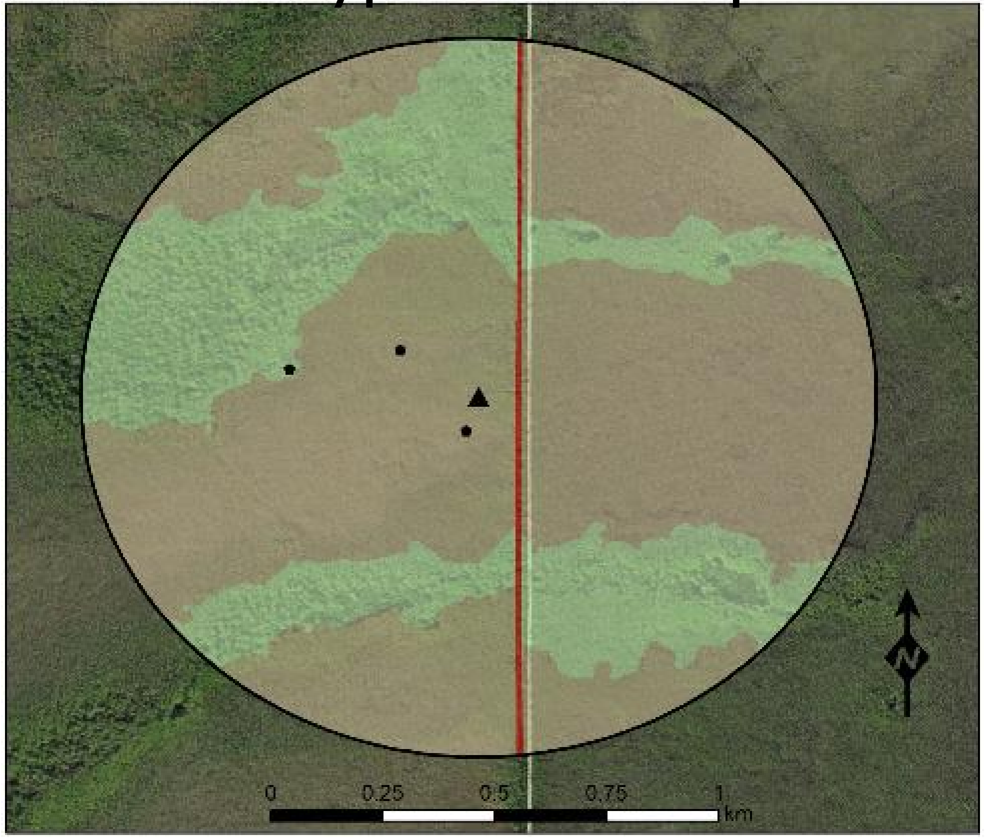
Vegetation Type	Area (m^2)	%
Marl Prairie	317,120	63
Cypress	160,391	32
Road	24,976	5
Footprint Total	**502,487**	**100**

Legend

- Marl Prairie
- Cypress
- Swamp Forest
- Road
- EC Tower
- Platforms

Modified from Welch and Madden (1999) and Duever (2004)

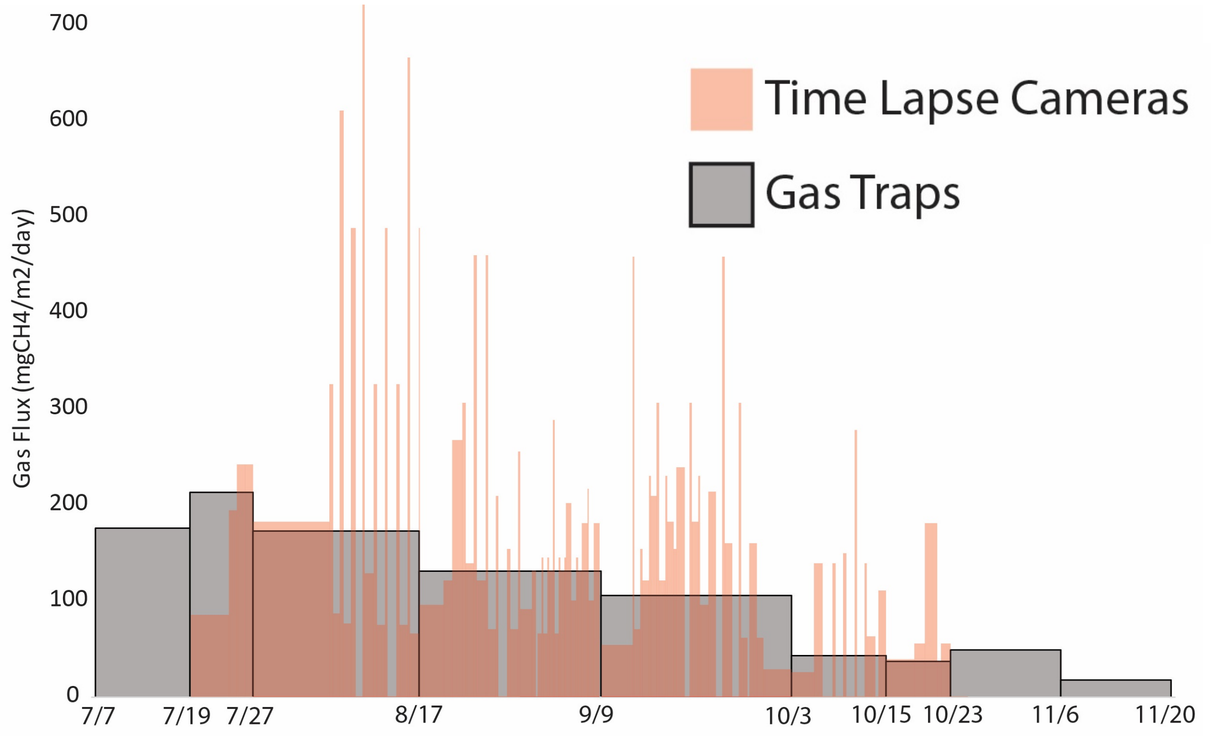
Cypress Swamp



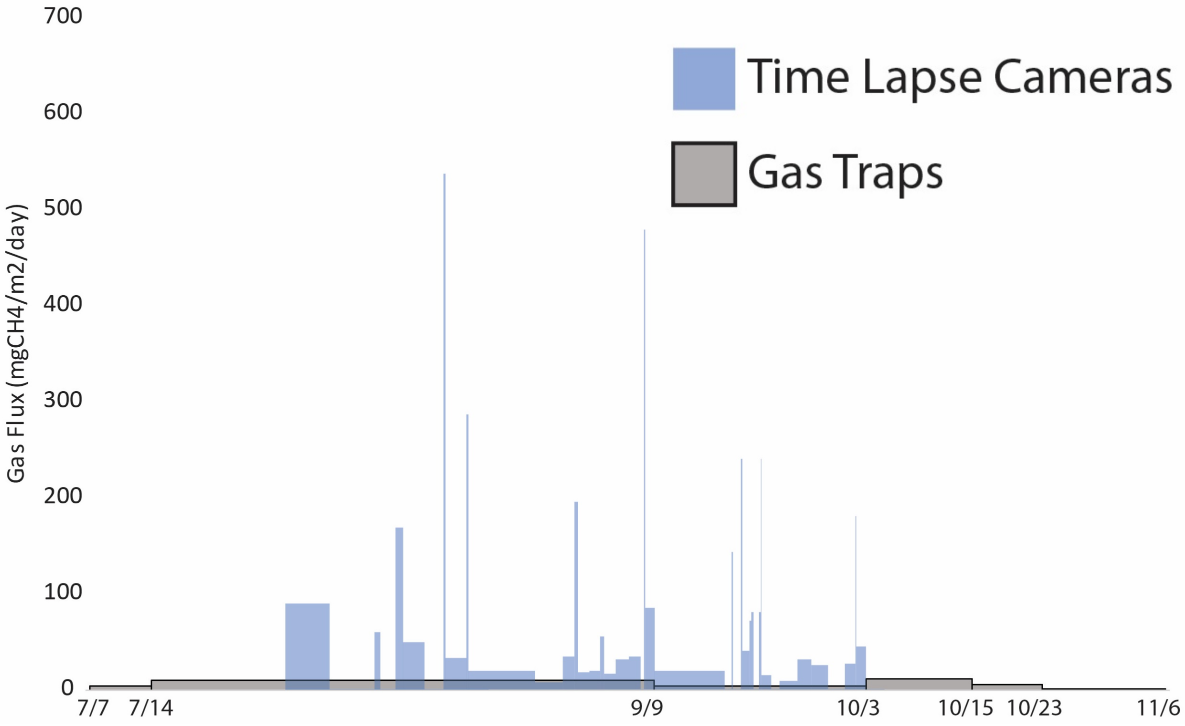
Vegetation Type	Area (m^2)	%
Cypress	1,370,295	68
Swamp Forest	622,825	31
Road	17,165	1
Footprint Total	**2,010,285**	**100**

Results: Big Cypress CH_4 – Site Comparison

Dwarf Cypress



Cypress Swamp

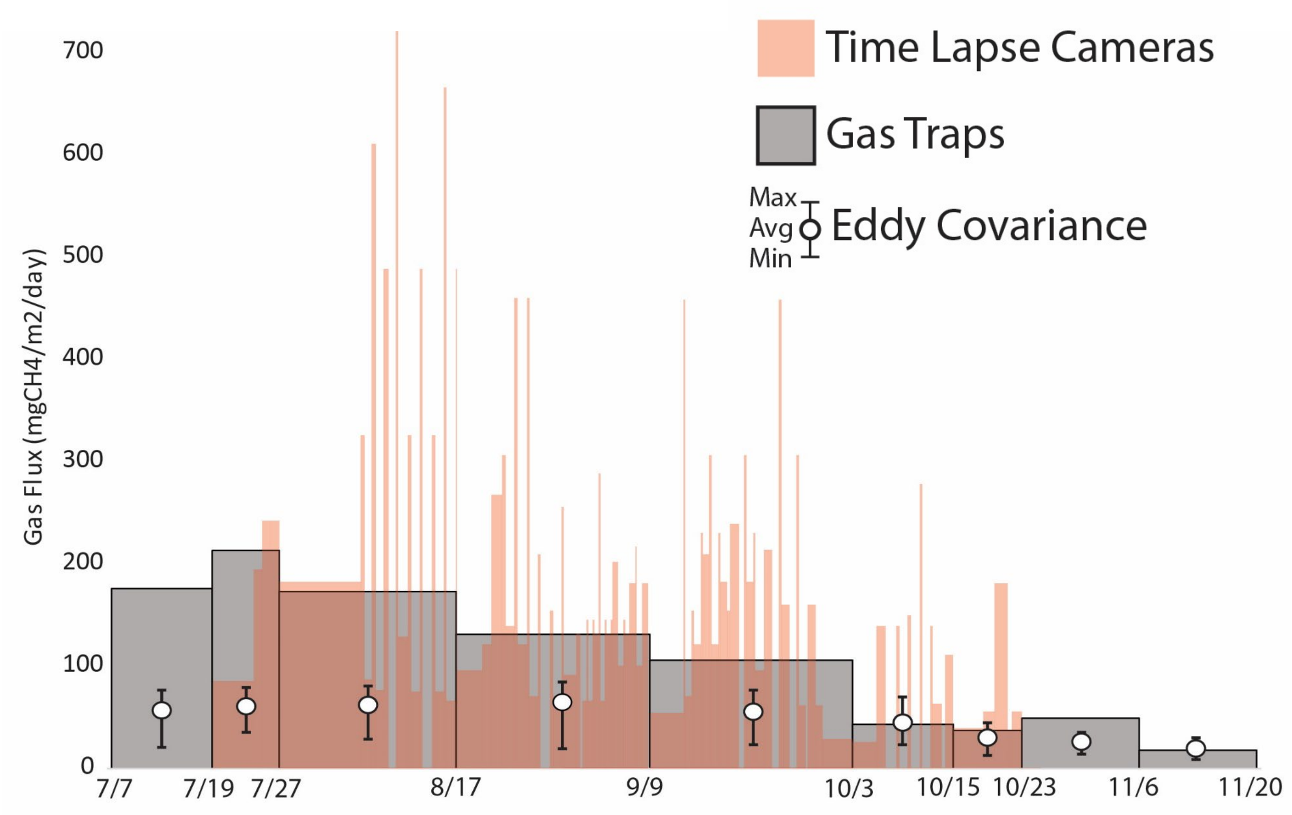


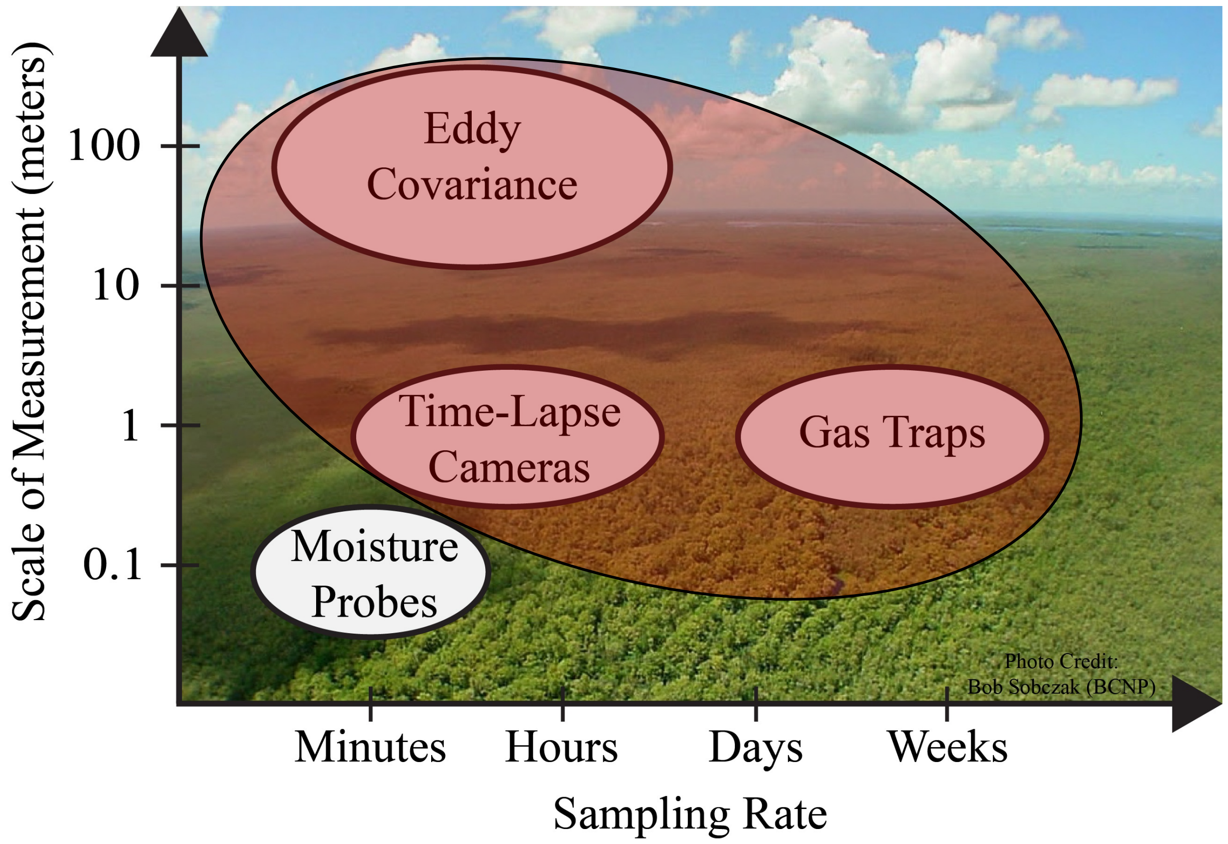
*No EC CH_4 analyzer at site

Higher CH_4 accumulation (i.e. released)
Regular ebullition events
Larger ebullition events

Lower CH_4 accumulation (i.e. released)
Sporadic ebullition
Smaller ebullition events

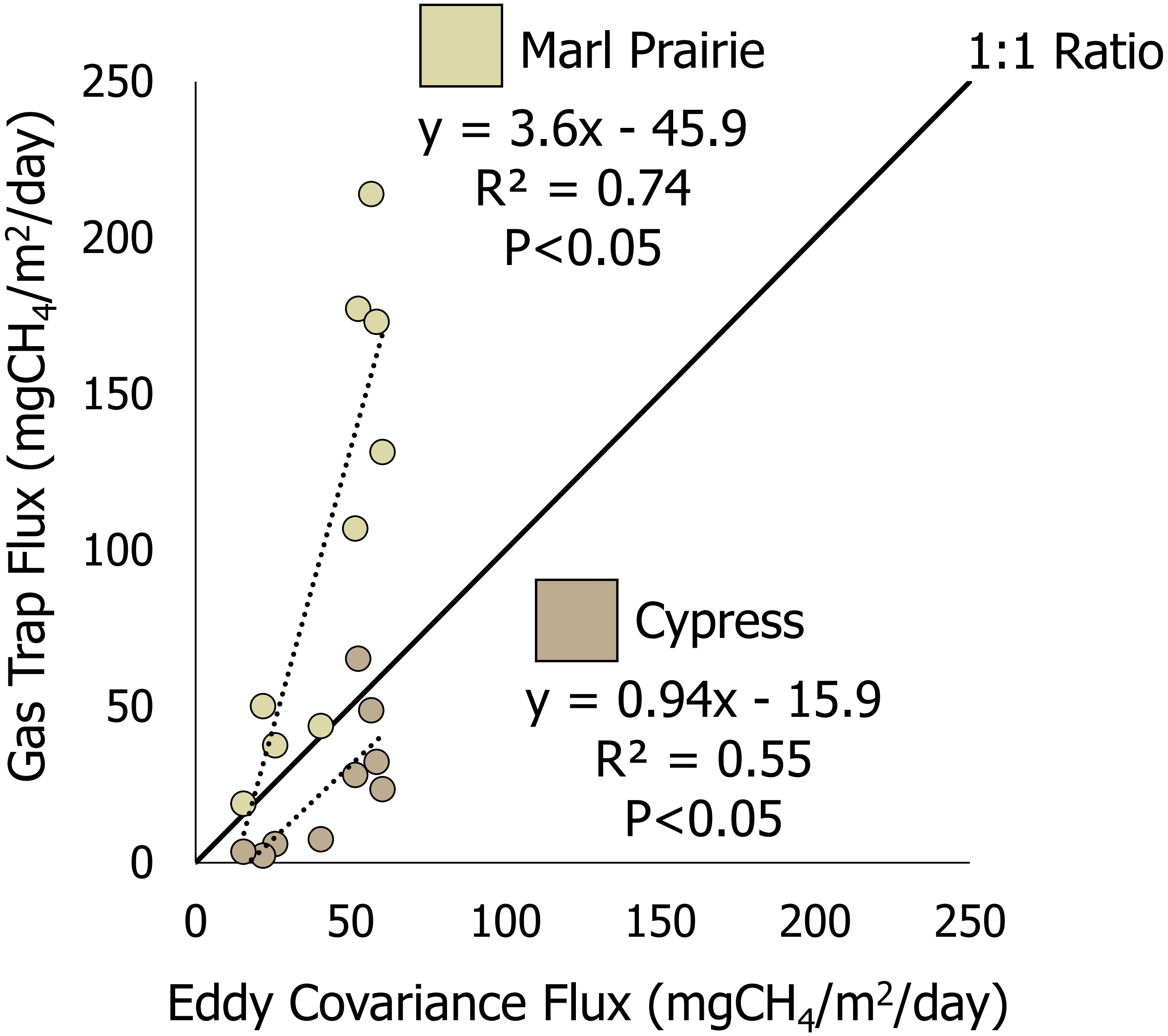
Results: Big Cypress CH_4 – Scale Comparison





Results from gas traps and time lapse cameras help to demonstrate how assessing CH4 flux at different spatial and temporal scales yields different flux estimates.

Results: Dwarf Cypress – CH_4 Flux by Vegetation Type



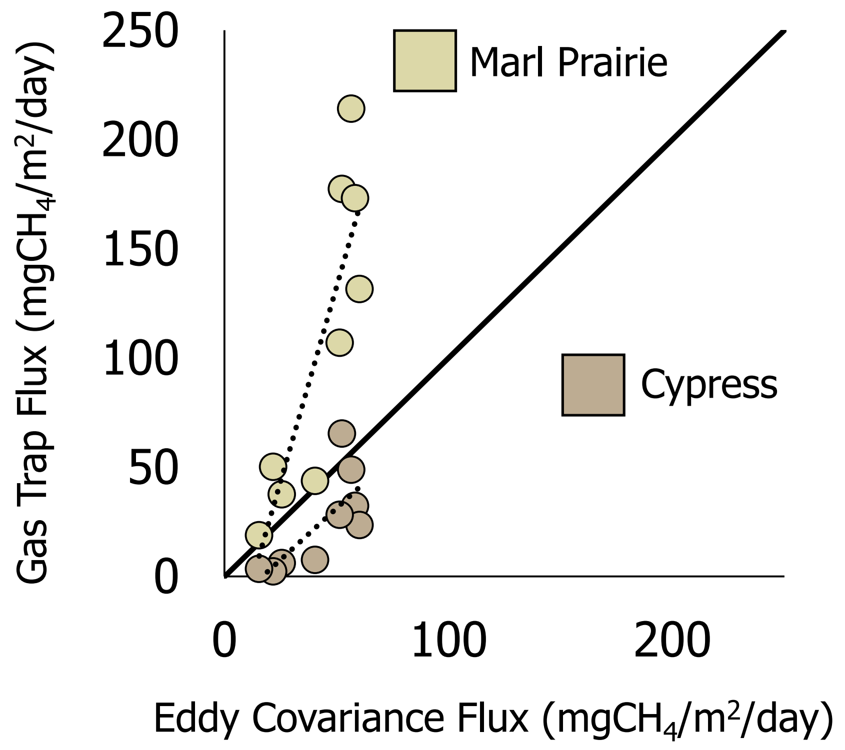
CH_4 flux from Marl Prairie > Cypress

Possible Explanations?

1. Periphyton mats may provide readily fermented compounds for methanogenesis (Bachoon, 1990).
2. CH_4 production partially stimulated by buffering effect of carbonates (Le Mer and Roger, 2001).
3. CH_4 oxidation rates in peat soils > CH_4 oxidation rates in marl soils (King et al., 1990; Happell and Chanton, 1993).

Results: Dwarf Cypress – Upscaling Gas Trap Fluxes

$$F_T = f_{MP}F_{MP} + f_C F_C$$



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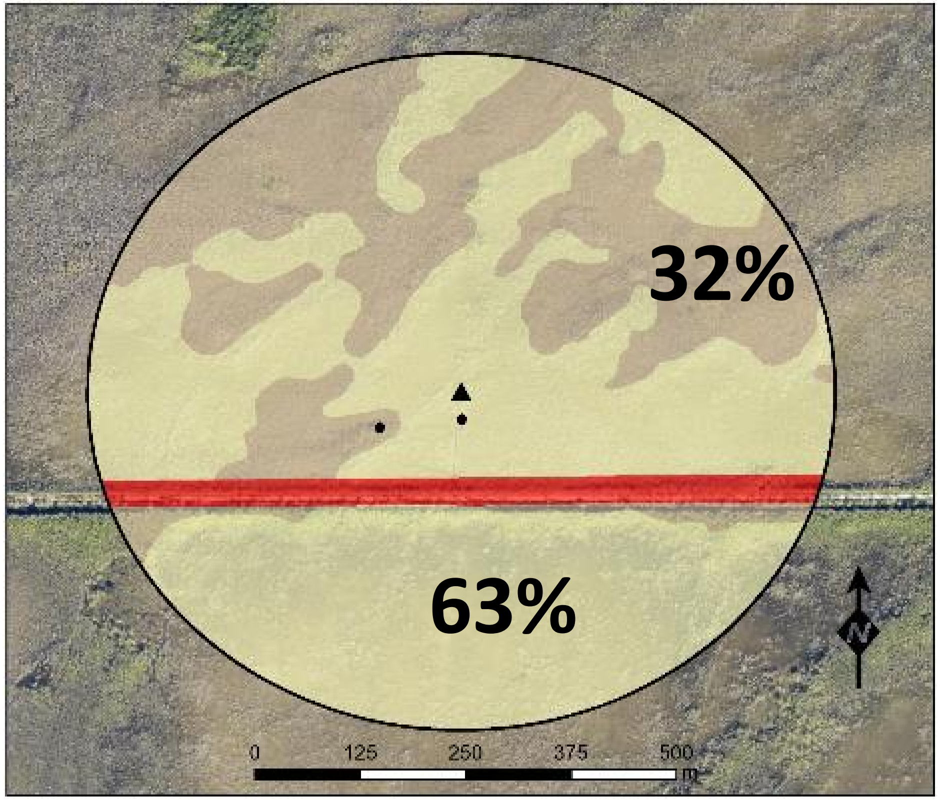
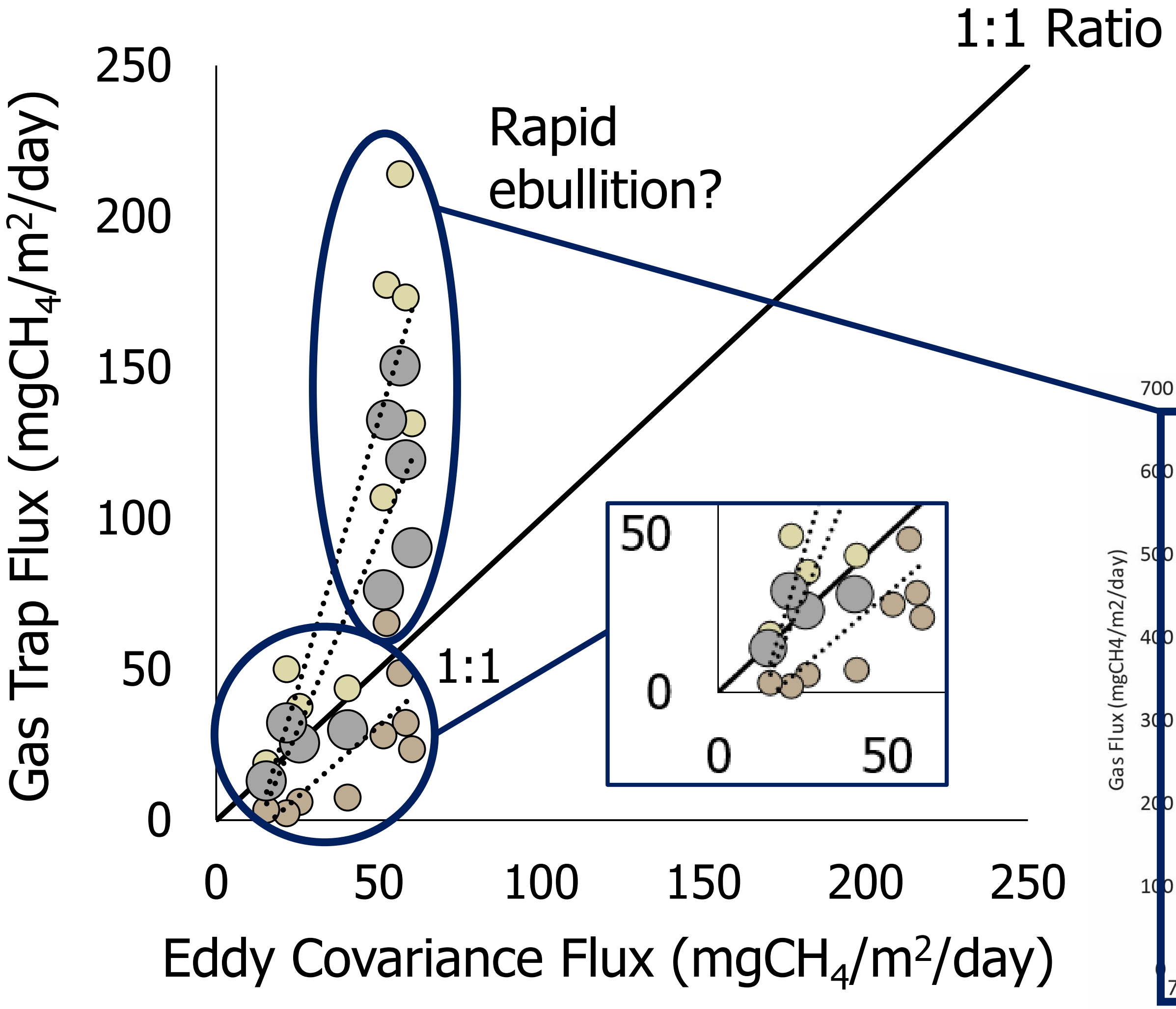
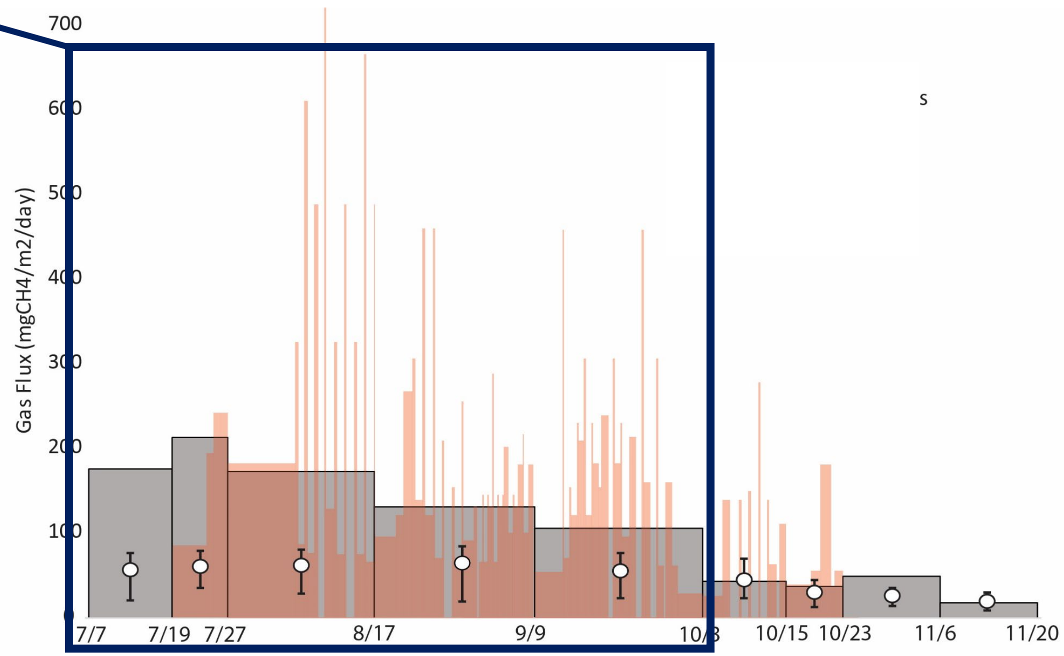


Results: Dwarf Cypress – Up-Scaled Gas Trap Flux



Summary Statistics

Dwarf Cypress – mgCH₄/m²/day						
Vegetation	**n**	$\overline{EC}$	$\overline{GT}$	X	r	P
Marl Prairie	9	42.6	105.9	3.6	0.74	<0.05
Cypress	9	42.6	24.1	0.9	0.55	<0.05
Scaled	9	42.6	74.4	2.5	0.73	<0.05



Conclusions:

1. EC tower may not properly represent ecosystem variability within their footprint, and may also be missing rapid ebullition events.

2. Gas traps and time lapse cameras can reveal CH_4 flux heterogeneities between vegetation communities otherwise masked by eddy covariance.

3. Complementary eddy covariance and gas trap measurements supports enhanced characterization of CH_4 flux heterogeneities across vegetation communities in subtropical wetlands.

Thank You!

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