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Southeast Environmental Research Center

GASEOUS CARBON EMISSIONS (METHANE AND CARBON DIOXIDE) FROM WETLAND SOILS IN A RE-CREATED EVERGLADES LANDSCAPE

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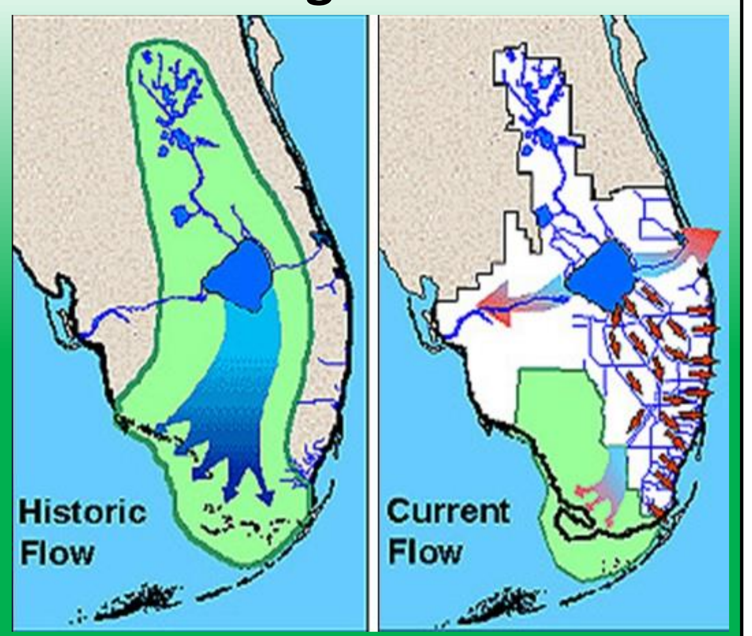
Carbon, Climate Change, and the Florida Everglades

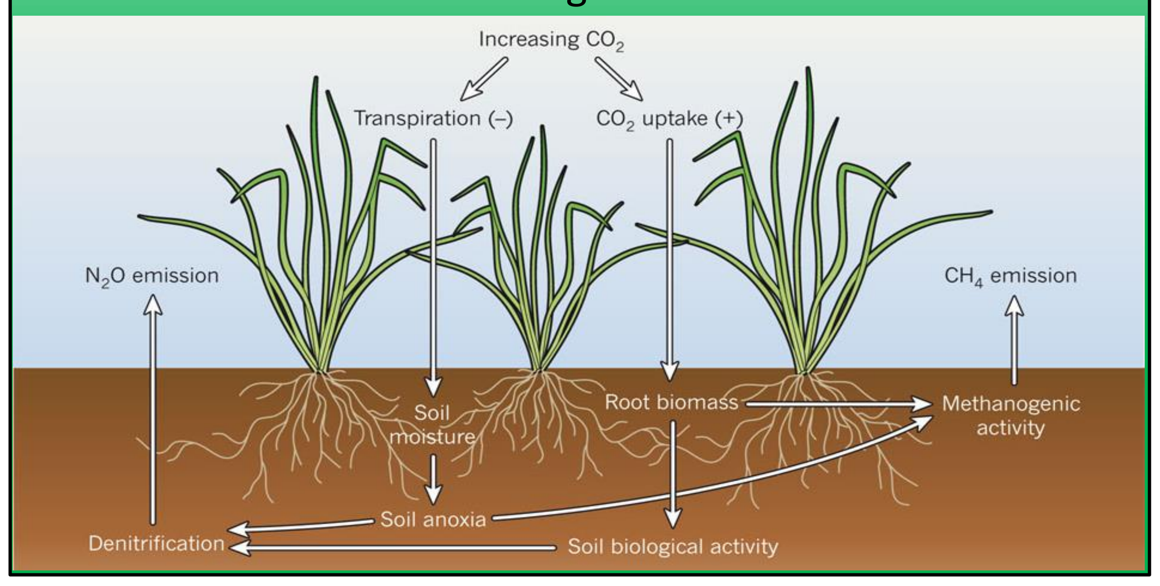
- Increasing methane (CH_4) and carbon dioxide (CO_2) emissions represent a global environmental issue.
- Wetlands (especially peatlands) are recognized as important components in the global carbon cycle, for both sequestration and emission potential.
- Over the last 130 years, land development and agriculture have severely impacted the Everglades.
- As part of restoration efforts, increasing water inputs to Everglades soils can stall decomposition and reduce CO_2 emissions, but increase CH_4 emissions.



McVoy et al., 2011

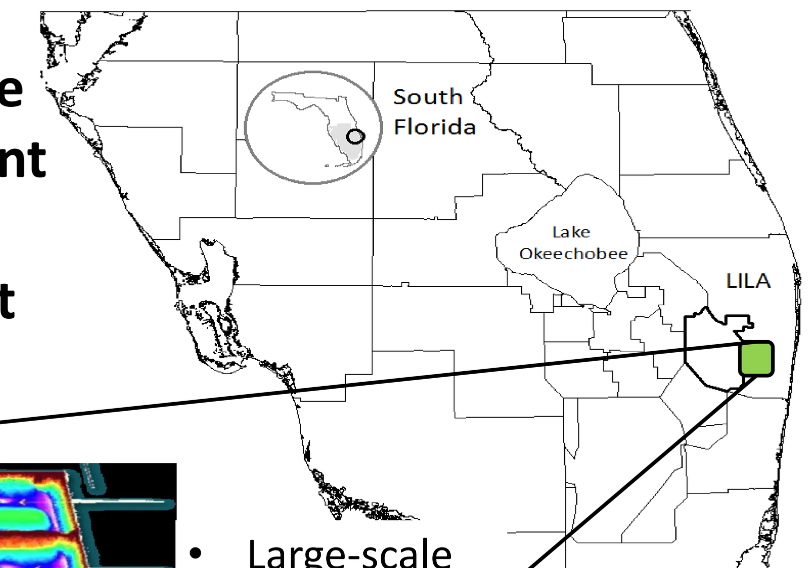
Methanogenesis in Wetlands

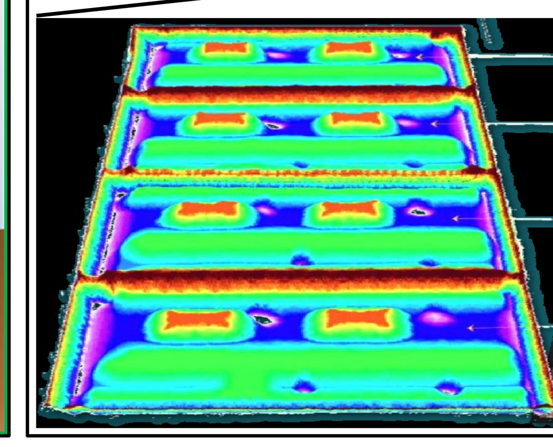
- Flooded soils → saturation (pore spaces filled).
- Under anaerobic (low-oxygen) conditions, further decomposition leads to CH_4 production, as anaerobic microbes break down organic materials.



Study Site

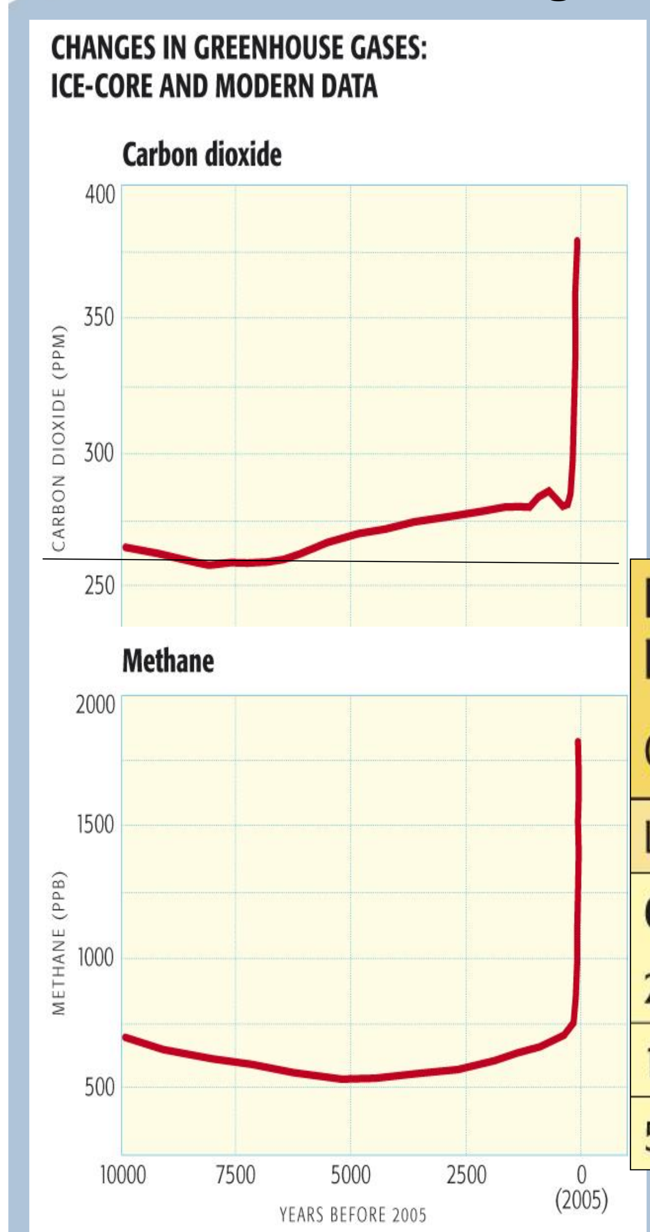
Loxahatchee Impoundment Landscape Assessment (LILA)



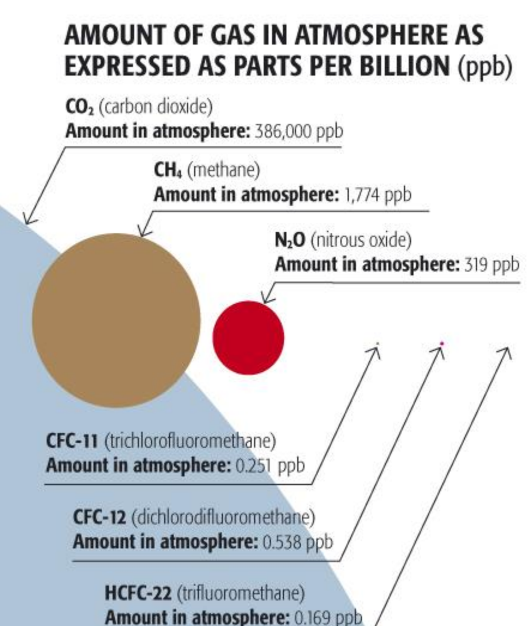


- Large-scale physical model
- Elevation gradient important for flooding, and CH_4 production

Greenhouse Gases (GHGs) and Global Warming Potential (GWP)



- Trapped solar radiation in atmosphere has a warming effect on the planet.
- Recent increases in the atmospheric concentrations of both CO_2 and CH_4 (linked to industrial revolution)



LIFETIME AND GLOBAL WARMING POTENTIAL OF HUMAN-GENERATED GREENHOUSE GASES

Gas	CO_2	CH_4	N_2O	CFC-11	CFC-12	HCFC-22
Lifetime years	Multiple	12	114	45	100	12
Global warming potential						
20 years	1	72	289	6,730	11,000	5,160
100 years	1	25	298	4,750	10,900	1,810
500 years	1	8	153	1,620	5,200	549

CH_4 has a GWP 72x greater than CO_2 in short-term spans

Objectives

- To quantify emission rates for CH_4 and CO_2 under prolonged wet and dry conditions in a recreated, peat-based Everglades wetland with varying topographic features; tree island, ridge and slough.
- To determine the effects of water levels and elevation on overall CH_4 and CO_2 emissions.
- To compare CO_2/CH_4 emission ratios across five main Everglades landscape components.

Hypotheses

- Areas of lower elevation – and therefore higher water levels over longer periods – were predicted to exhibit the highest concentrations of CH_4 (as anaerobic conditions lead to CH_4 production).
- The highest CO_2 concentrations were expected to occur at the highest elevations, which experience the least flooding (and the greatest exposure).
- CO_2/CH_4 ratios were likewise hypothesized to be highest at higher elevations.

Figure 1. LILA Hydrograph with Sampling Events

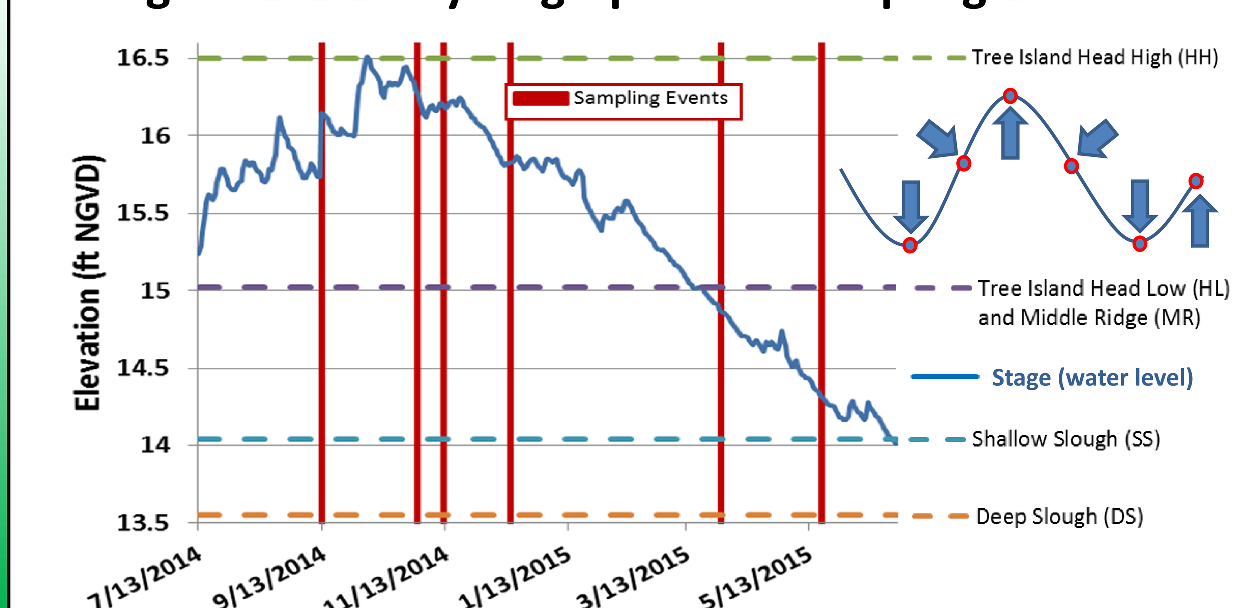
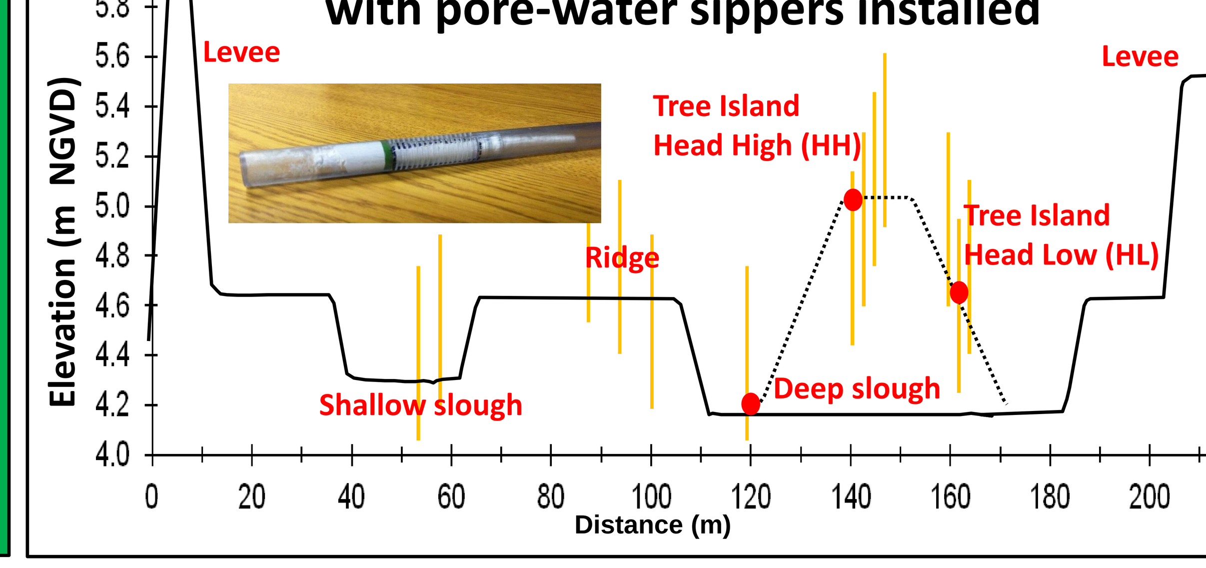


Figure 2. Cross-section of LILA macrocosm with pore-water sippers installed



Results

Fig. 3: CH_4 Concentrations Across Sites

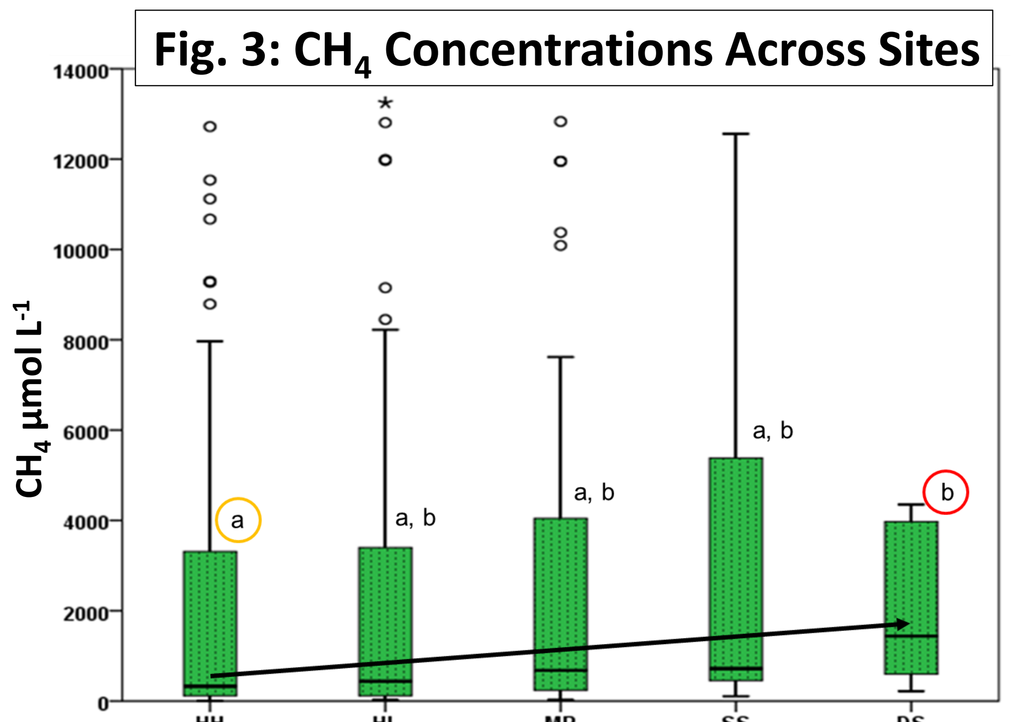


Fig. 4: CO_2 Concentrations Across Sites

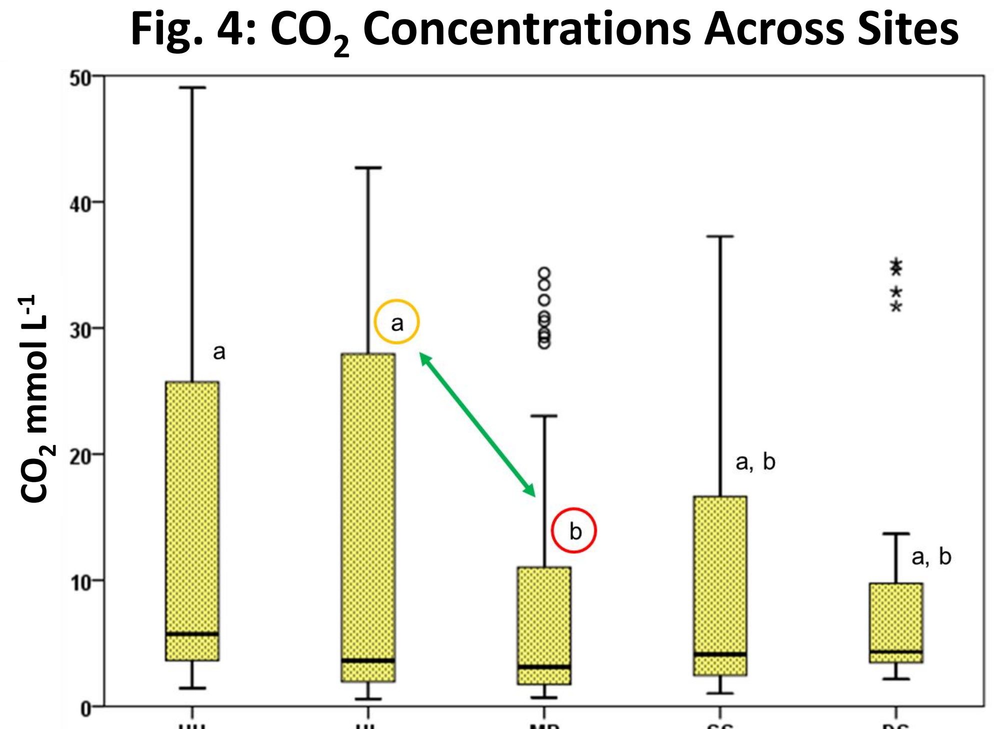
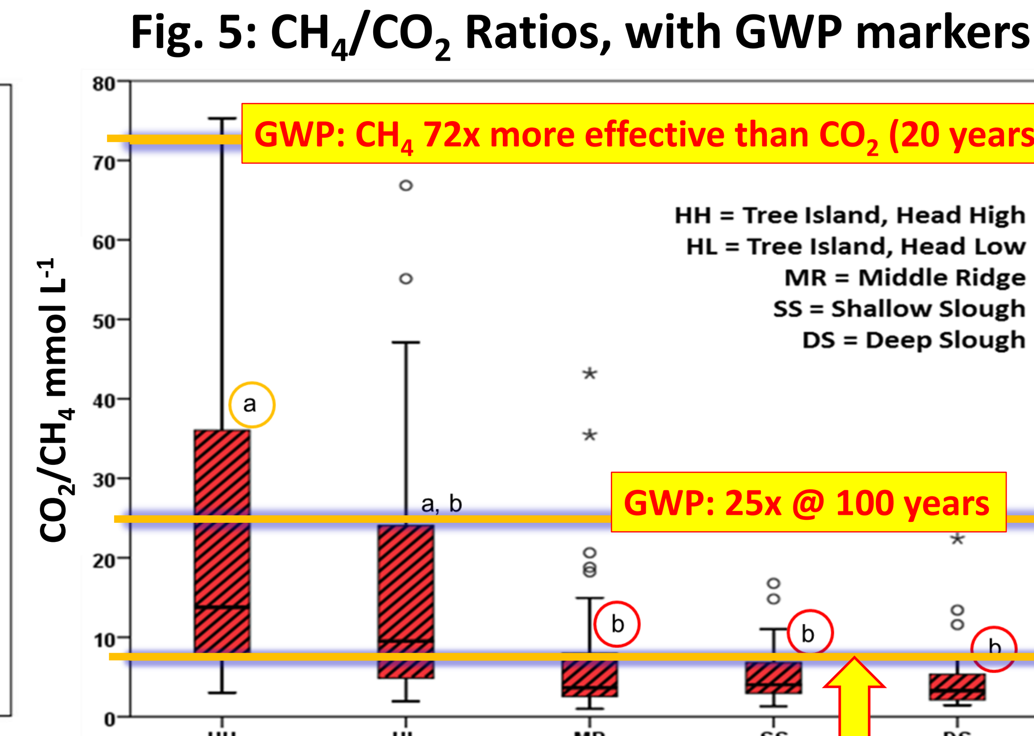


Fig. 5: CH_4/CO_2 Ratios, with GWP markers



HH = Tree Island Head High HL = Tree Island Head Low MR = Middle Ridge SS = Shallow Slough DS = Deep Slough

Fig. 6: Average CO_2 Efflux Rates (LICOR)

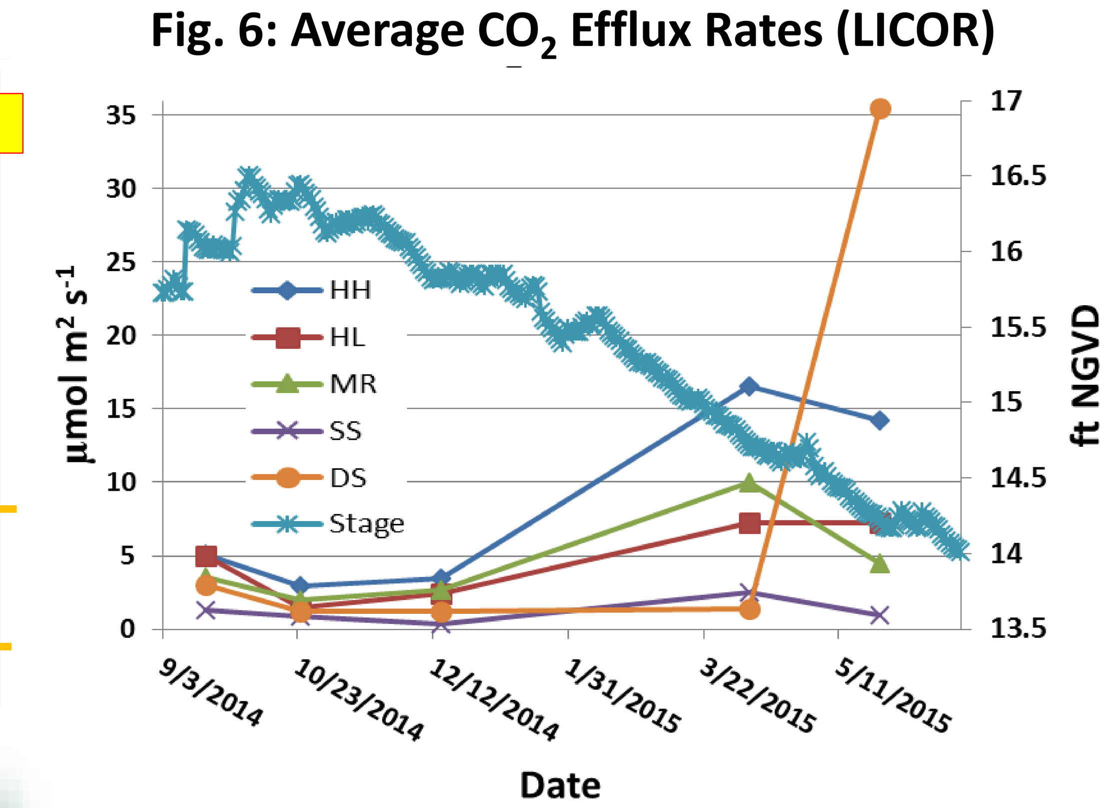


Fig. 7: Statistical Correlations

Statistical Correlations (Pearson 2-tailed) N = 271

	LILA Stage	Inundation (cm)	Days Flooded
Redox (mV)	-.405** .000	-.168** .006	.218** .000
CH4 umol L-1	.425** .000	.376** .000	.047 .445
CO2 mmol L-1	.420** .000	.205** .001	-.126* .038
CO2/CH4 ratrio	-.440** .000	-.415** .000	-.177** .003

*. Significant at the 0.05 level.**. **. Significant at the 0.01 level.

Discussion

- Flooding influenced the production of both CH_4 and CO_2 in this re-created Everglades landscape.
- Significant differences were found primarily between the two end-points along the elevation gradient; between the Tree Island Head High and the Deep Slough sites (Figure 3).
- Flooding and drying had an inverse relationship with average CO_2 efflux rates (Figure 6).
- Stage (water levels), Inundation (depth of flooding), and Days Flooded correlated as expected with Redox Potentials, CH_4 and CO_2 concentrations, and CO_2/CH_4 ratios (Figure 7).
- The average CO_2/CH_4 ratio across all sites within a macrocosm: 22 (mol:mol). Given the GWP of each GHG, CH_4 had a disproportionately greater impact than CO_2, for at least a 100-year span.
- Water management in wetlands should therefore consider the disproportionate GHG effect of CH_4 compared to CO_2 in these areas.
- Future study of carbon inputs would give a sense of the overall carbon balance of the system.

ACKNOWLEDGEMENTS
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