Building a Salt Marsh Greenhouse Gas Budget: Vertical Fluxes

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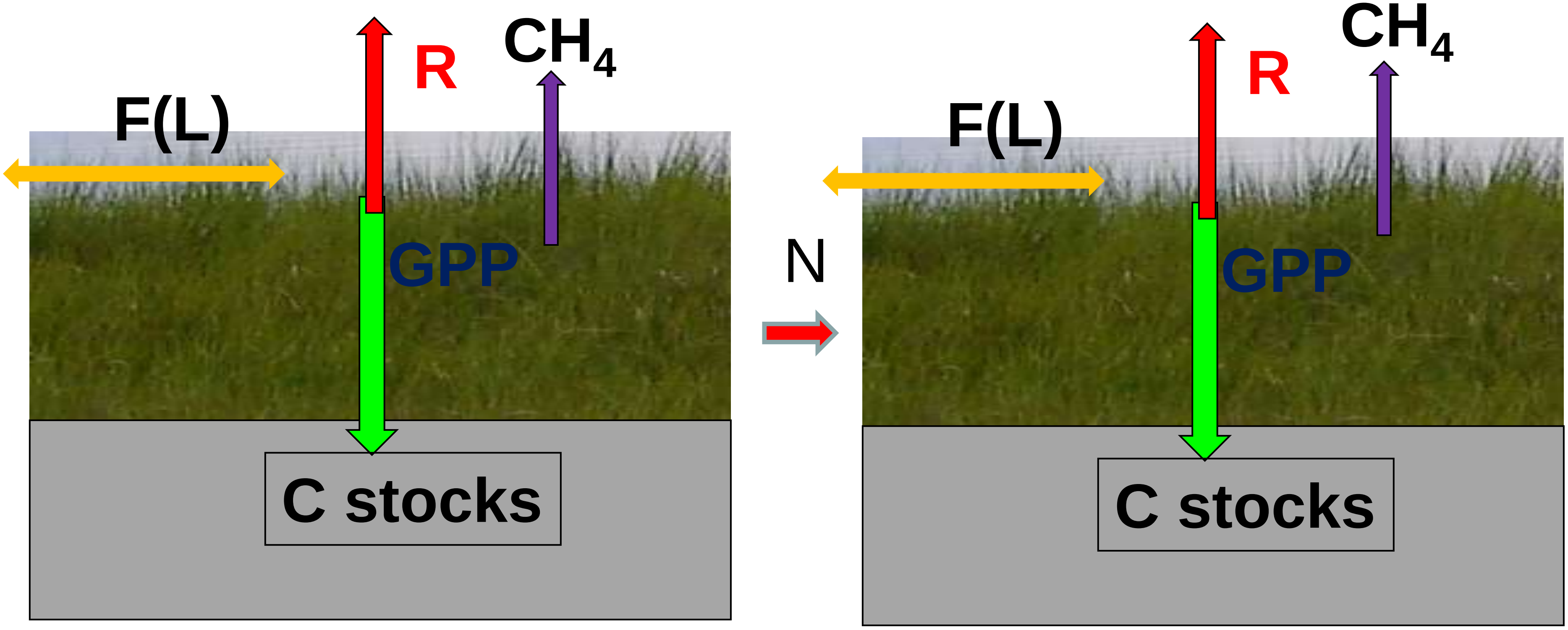
Objectives

- Quantify GHG (CO_2, CH_4) fluxes vertically, from a point measurement scaled to the annul accumulation.
- Understand the drivers of GHG fluxes, including temperature, light, tide, and salinity.
- Assess the impact of anthropogenic N loading on C sequestration and net GHG emissions.

Quantifying the carbon credit: Net Ecosystem Carbon Balance (NECB = dC/dt)



NECB = dC/dt = GPP – R – F(CH_4) – F(L)

NEP

Methods to measure blue carbon

1. Flux: Understand the mechanism and process

Net ecosystem C balance (NECB)

$NECB = dC/dt = NEP(CO_2) – F(CH_4) - F(L)$

$NEP = GPP - R$ (chamber or eddy flux)

NEP: net ecosystem production

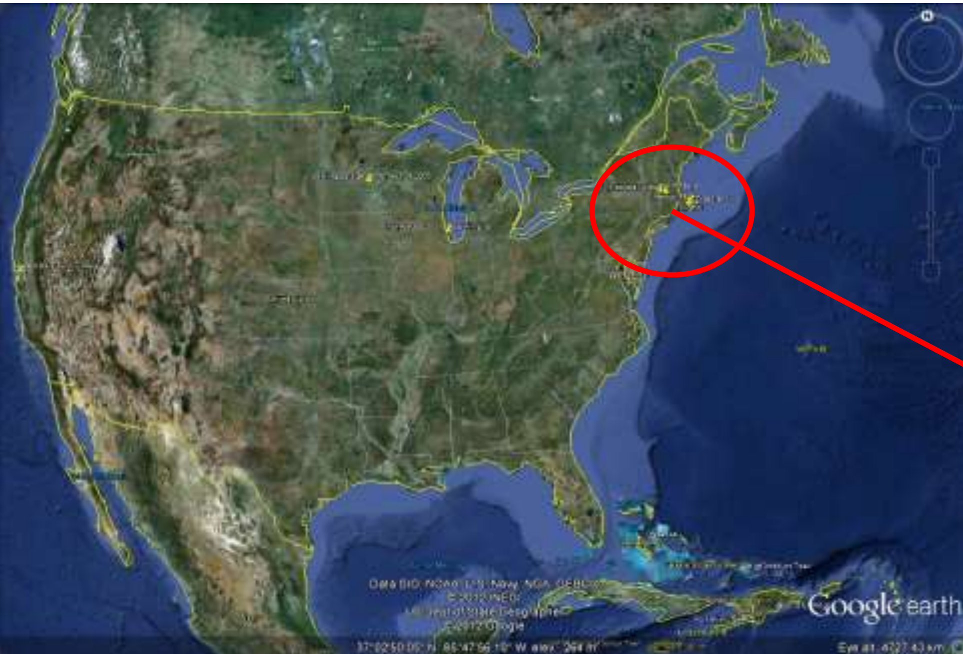
$F(CH_4)$: CH_4 flux measured simultaneously with NEP.

F(L): net lateral flux

2. Stock (C): Long-term soil/sediment carbon stocks and their changes

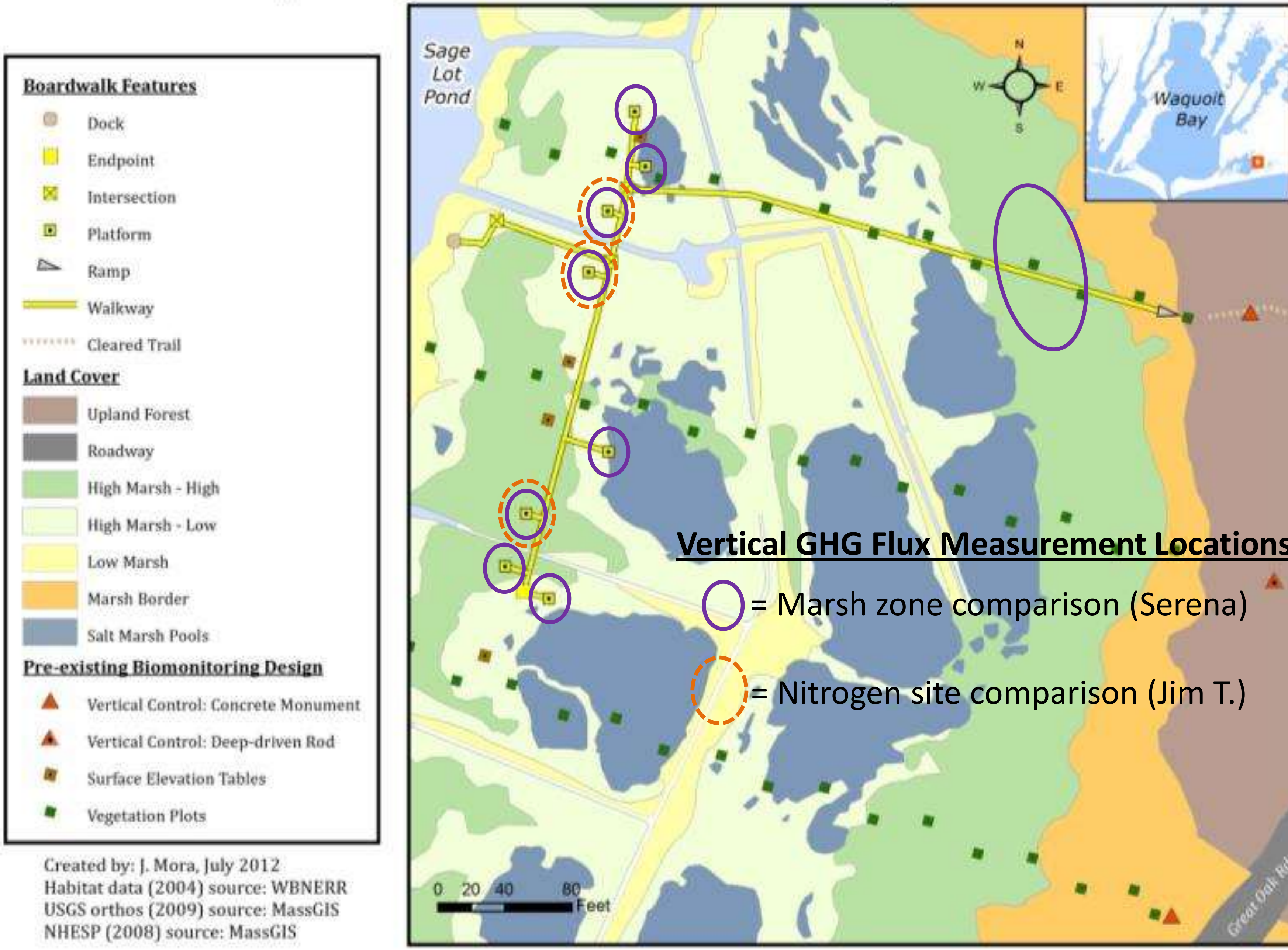
3. Modeling

Study sites



N loading:
1-10 $gN/m^2/y$

Waquoit Bay NERR Salt Marsh Observatory Boardwalk

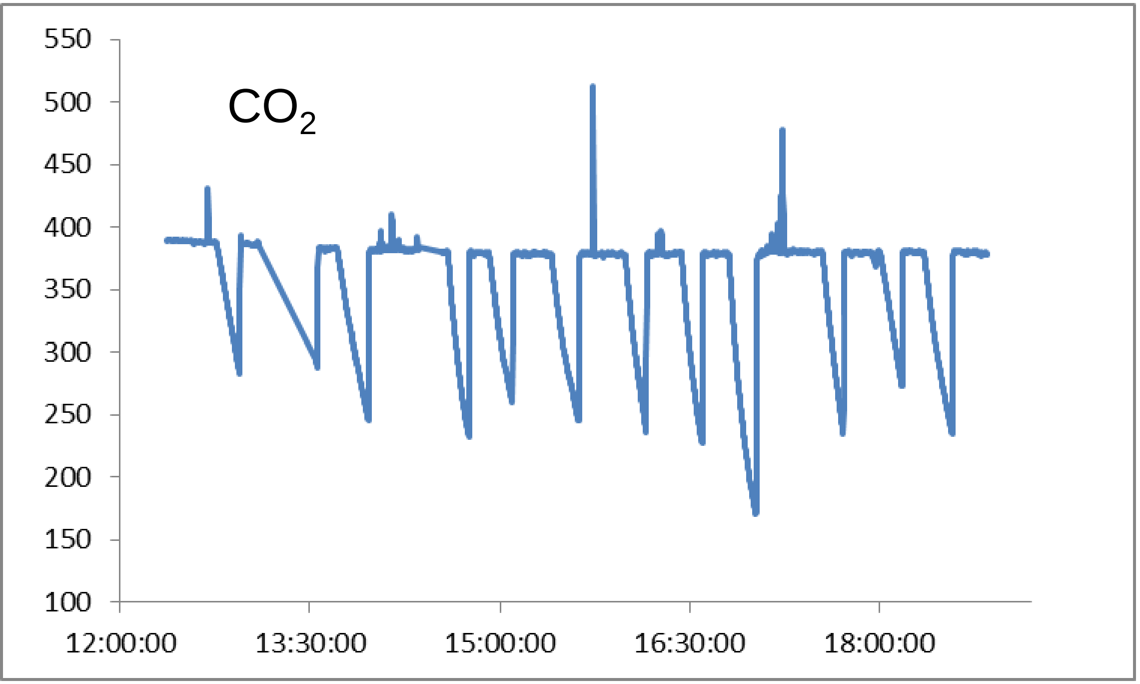


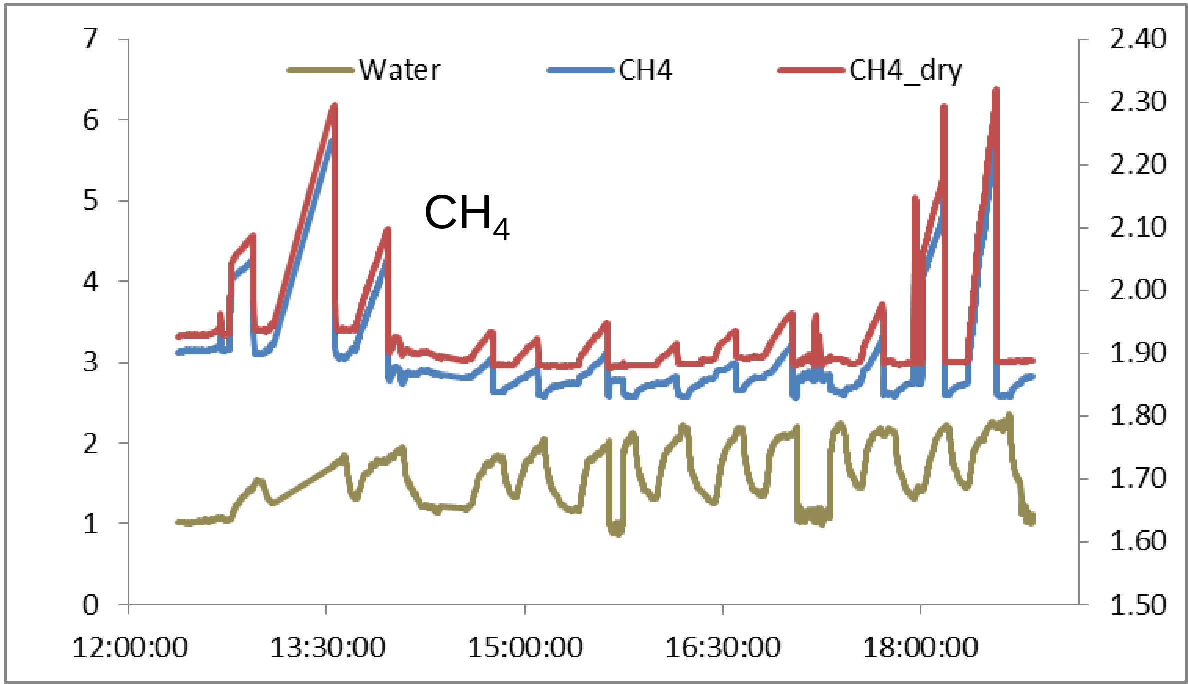
We need long boardwalk

In-situ GHG flux measurement

$CO_2/CH_4/N_2O$

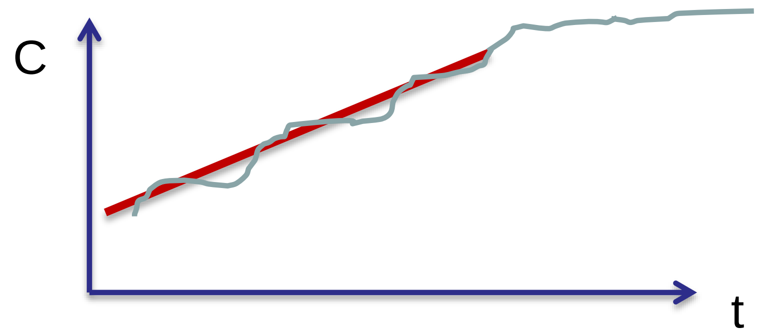
Raw data:
Gas concentration inside the chamber





Calculating flux from chamber measurement

$$F = \frac{dC}{dt}\frac{V}{A}$$



where C is mole concentration (μmol m^{-3}), V is volume (m^3), and A is area (m^2).

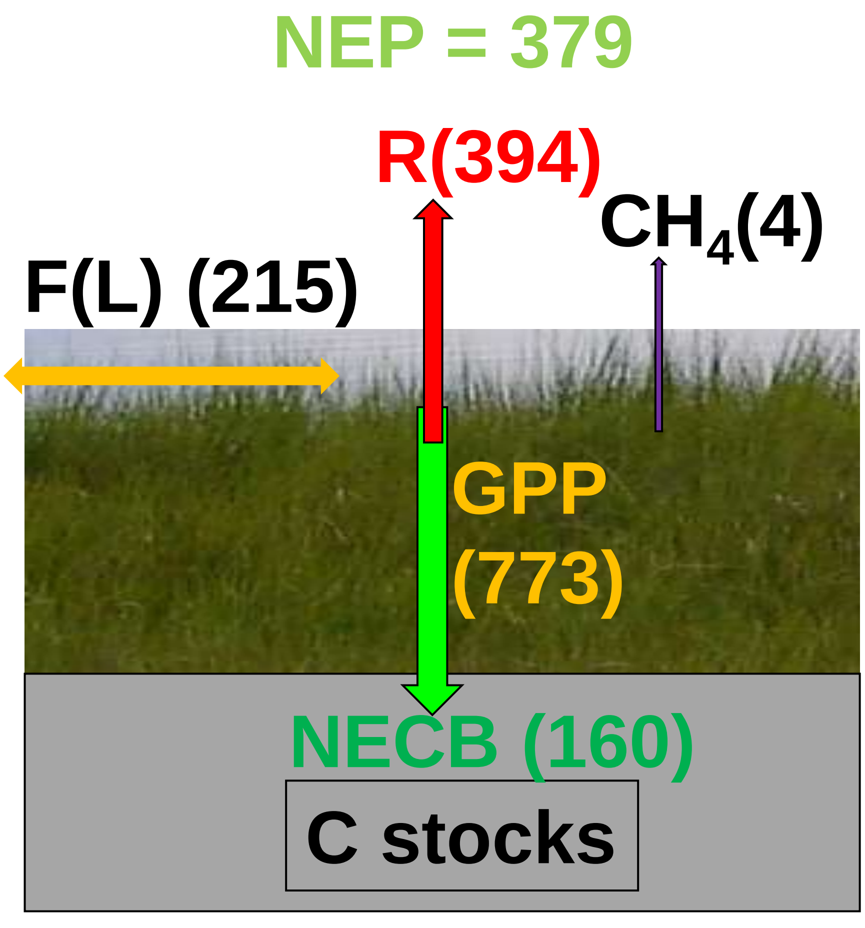
$$C = \frac{C_v P}{RT}$$

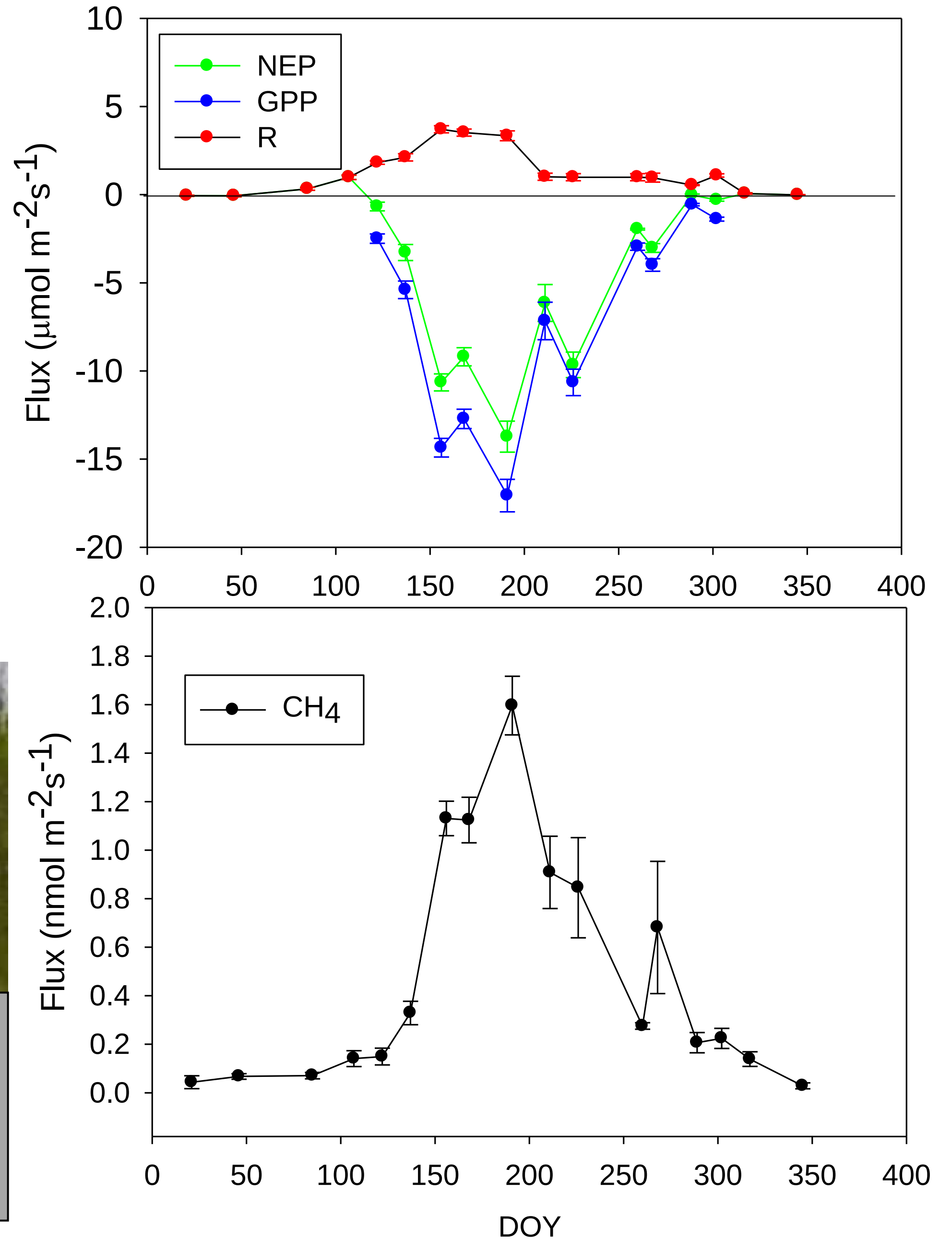
where C_v is volume concentration (ppm), P is air pressure (Pa), T is soil absolute temperature (K), and R is universal gas constant (8.3144 J mol^{-1} K^{-1}).

Therefore,

$$F = \frac{dC_v}{dt}\frac{P}{RT}\frac{V}{A}$$

CO_2 and CH_4 fluxes in the pristine site (Sage Lot)



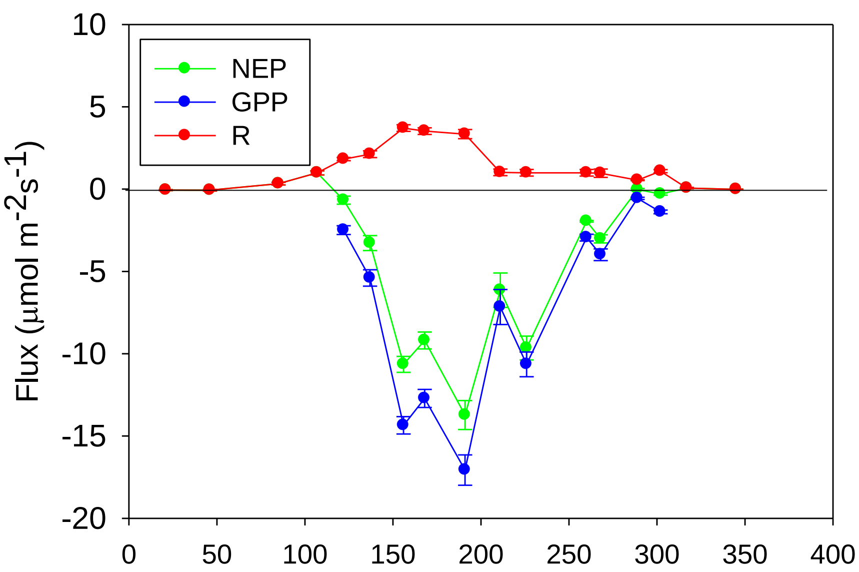


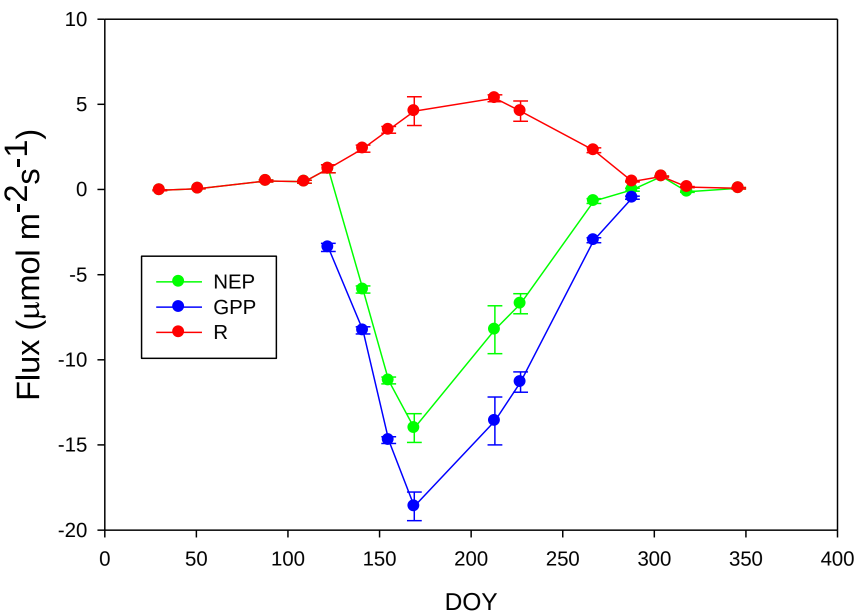
Tang et al. unpublished

CO_2 fluxes across N gradient

Hamblin Pond

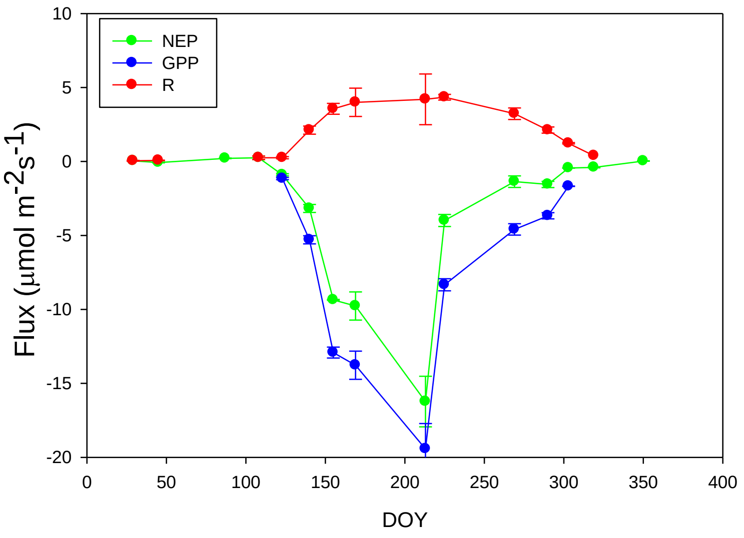
Low N



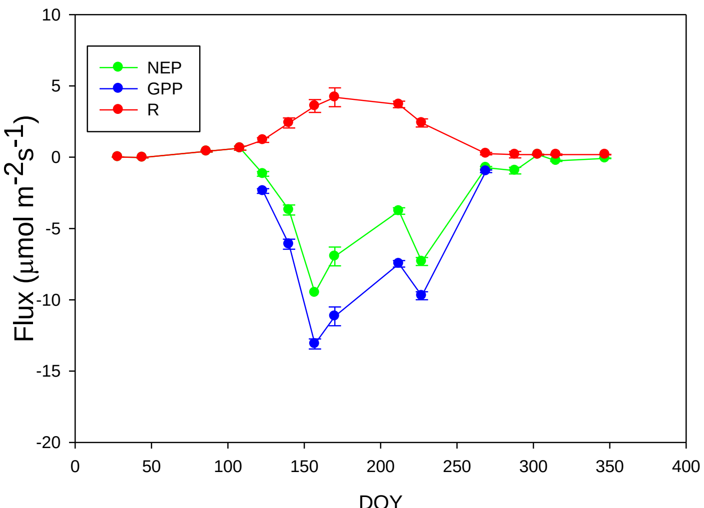


Great Pond

High N

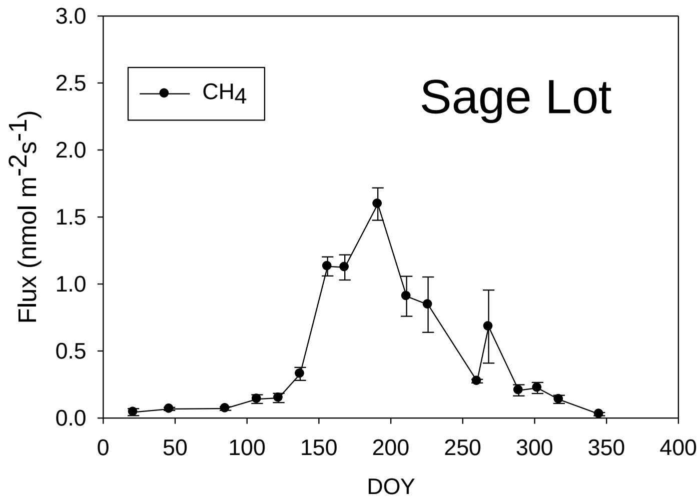


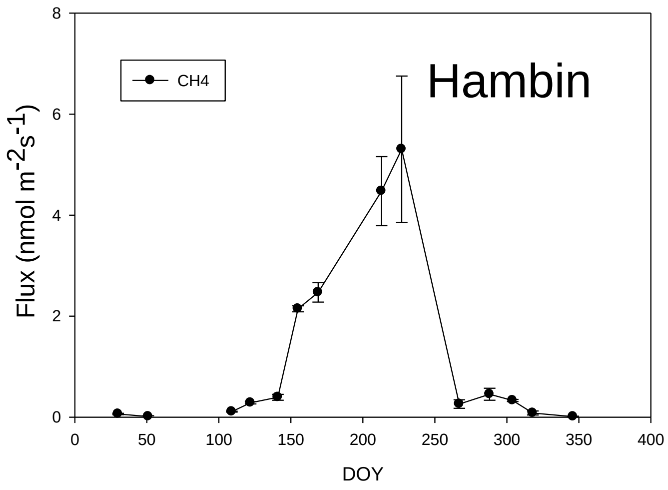
Eel Pond



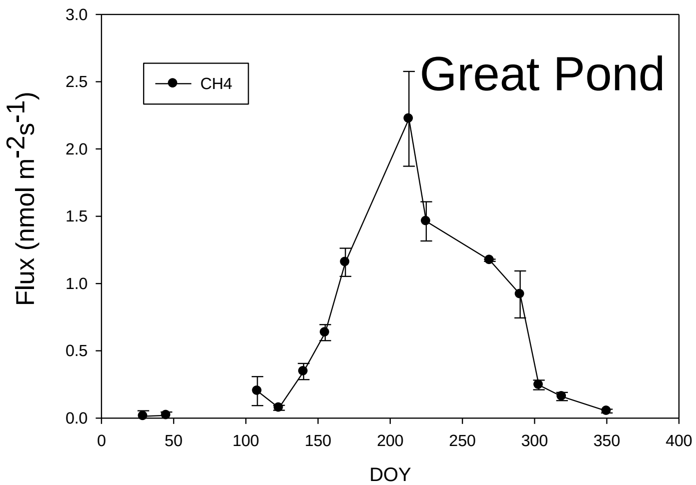
CH_4 fluxes across N gradient

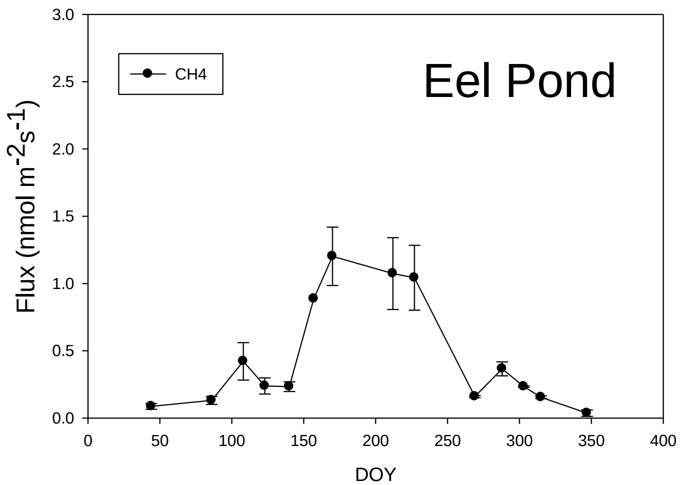
Low N





High N





Summary

- The salt marsh is a significant carbon sink (~ 160 gC $m^{-2}y^{-1}$). Restoration or conservation of this carbon sink has a significant social benefit for carbon credit.
- CH_4 fluxes are 3 orders of magnitude less than CO_2 fluxes in the salt marsh.
- Carbon fluxes are driven by light, salinity, tide, and temperature. Small amounts of N loading (1-10 gN $m^{-2}y^{-1}$) did not change the carbon fluxes.