Quantifying soil greenhouse gas emissions in relation to inundation and microbial respiration in tidal wetlands

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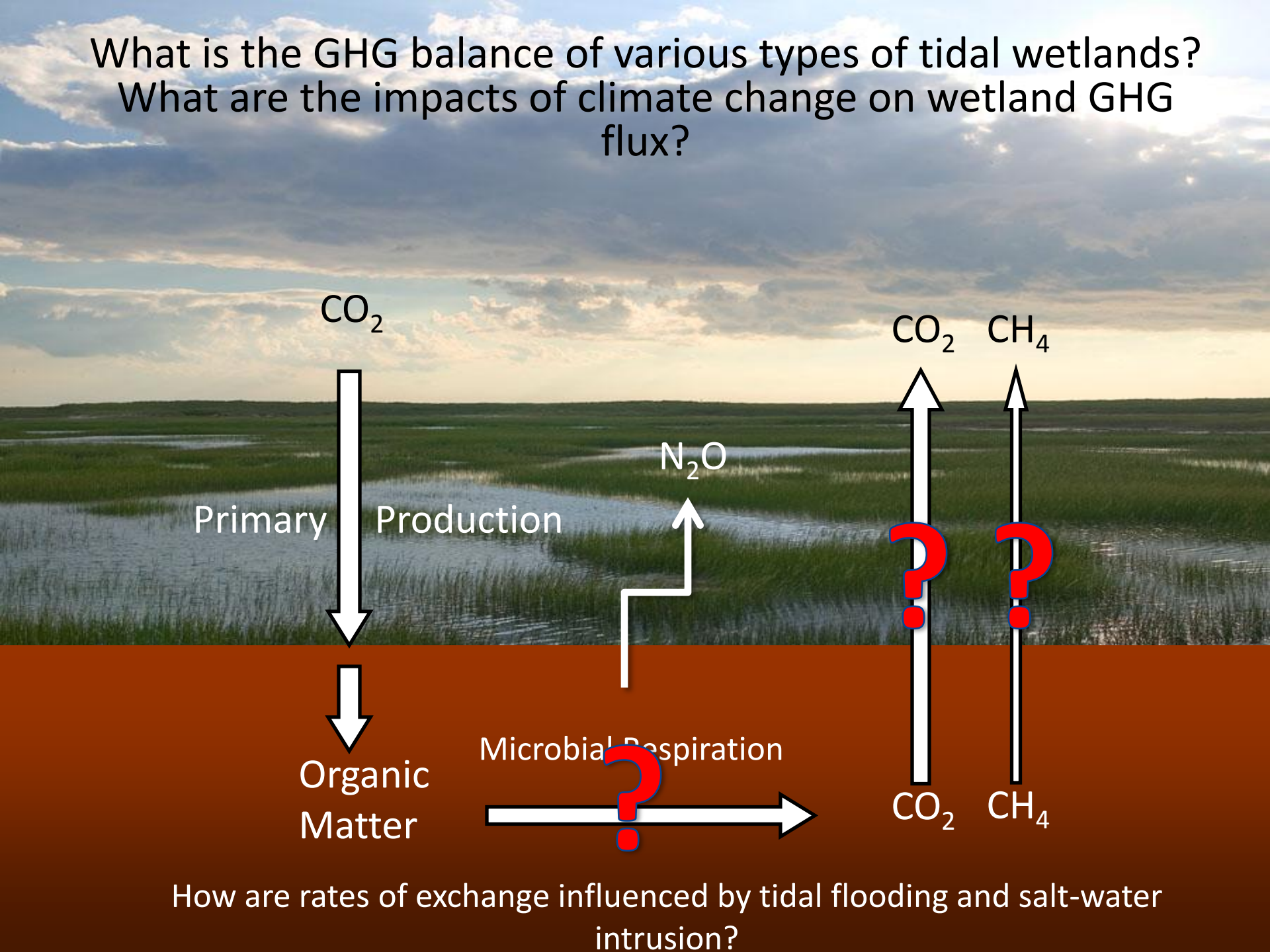
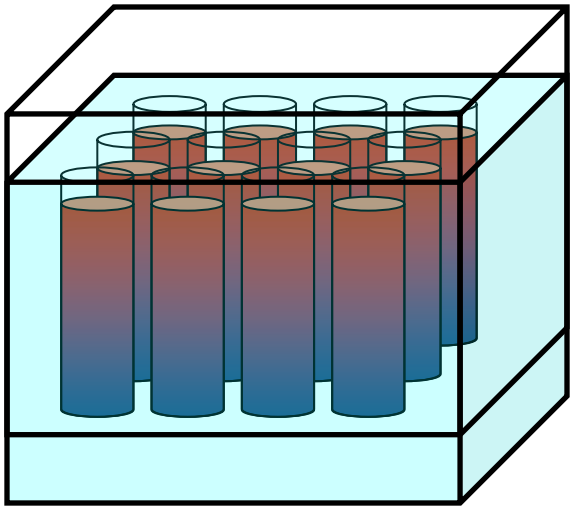
What is the GHG balance of various types of tidal wetlands? What are the impacts of climate change on wetland GHG flux?

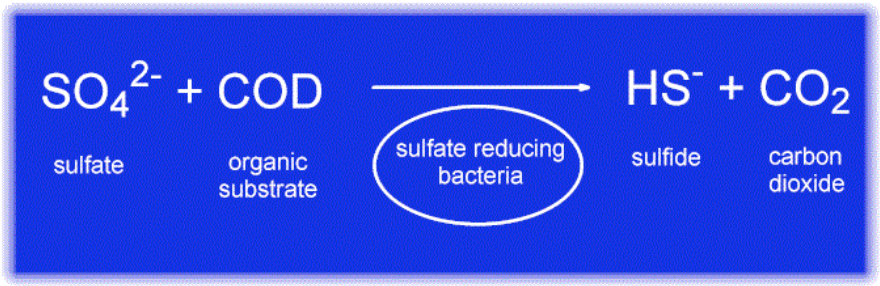


How are rates of exchange influenced by tidal flooding and salt-water intrusion?

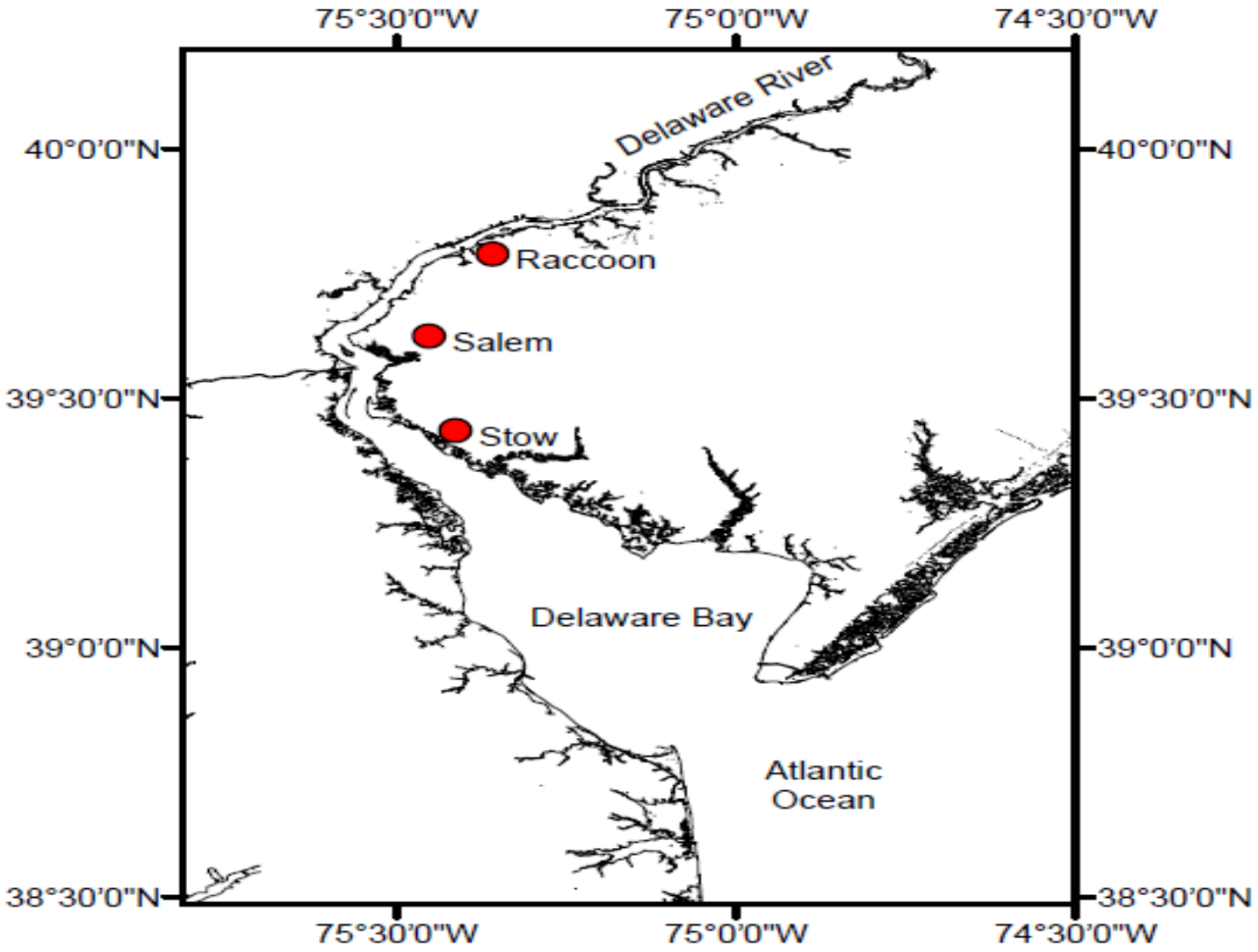
Methodology

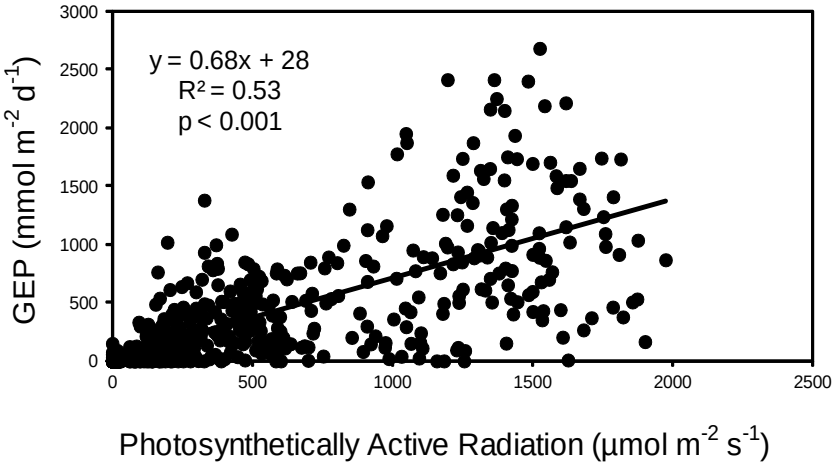
- Field-based static chamber
- Laboratory core experiments
- Microbial Pathways

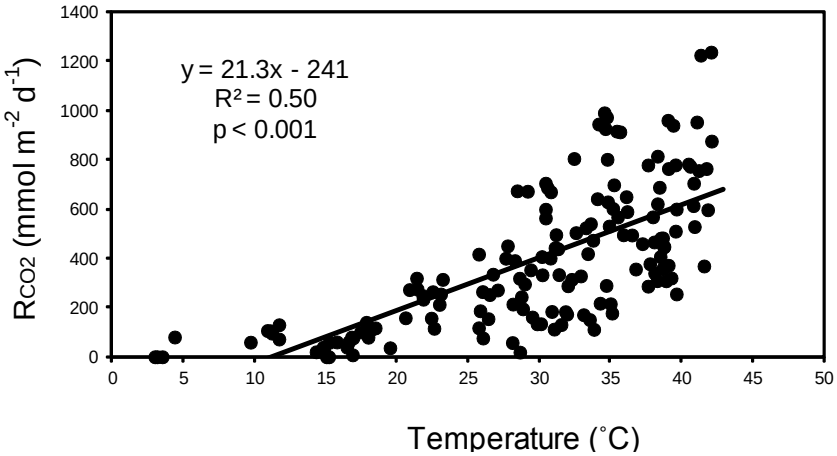


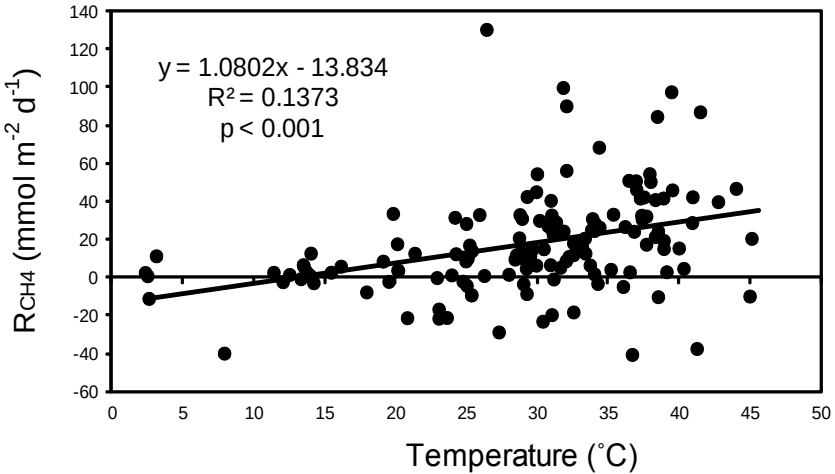


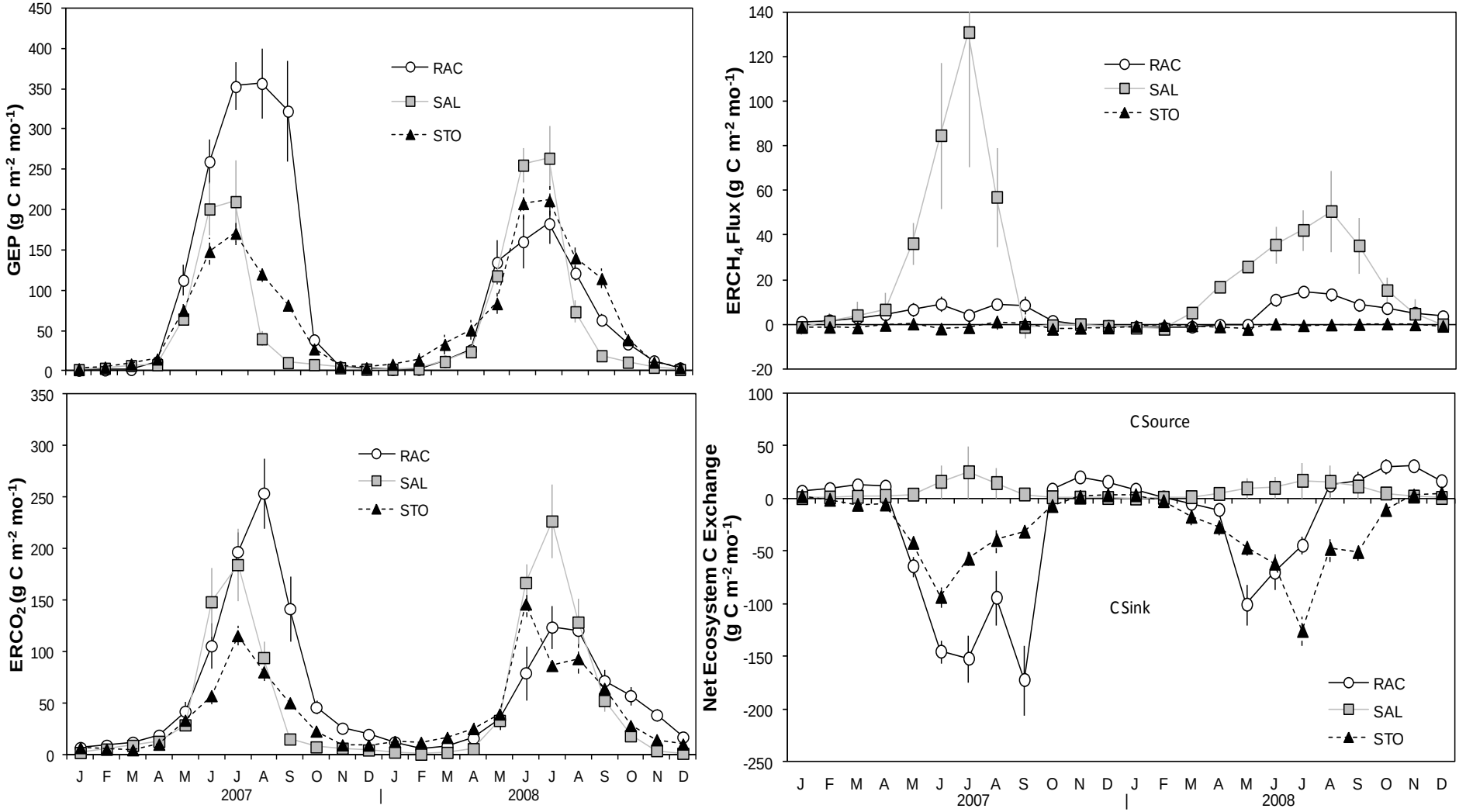
Field Based Static Chamber

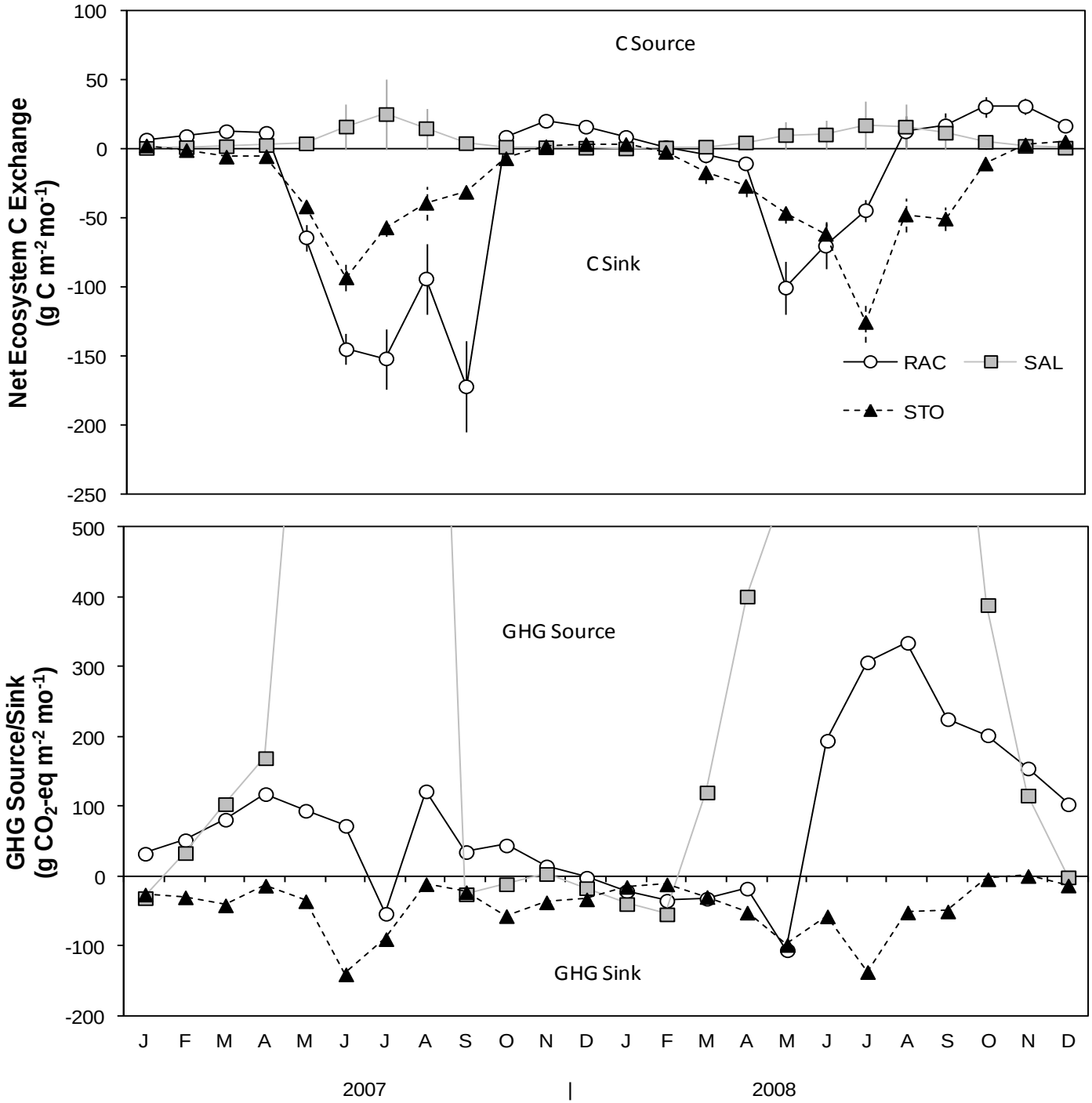



y = 0.68x + 28
R² = 0.53
p < 0.001
GEP (mmol m-2 d-1)
Photosynthetically Active Radiation (µmol m-2 s-1)

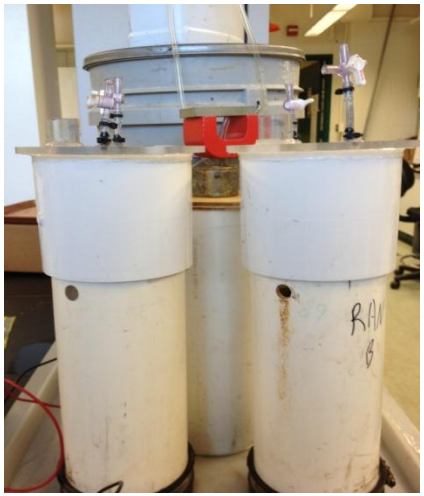

y = 21.3x - 241
R² = 0.50
p < 0.001
RCO2 (mmol m-2 d-1)
Temperature (˚C)

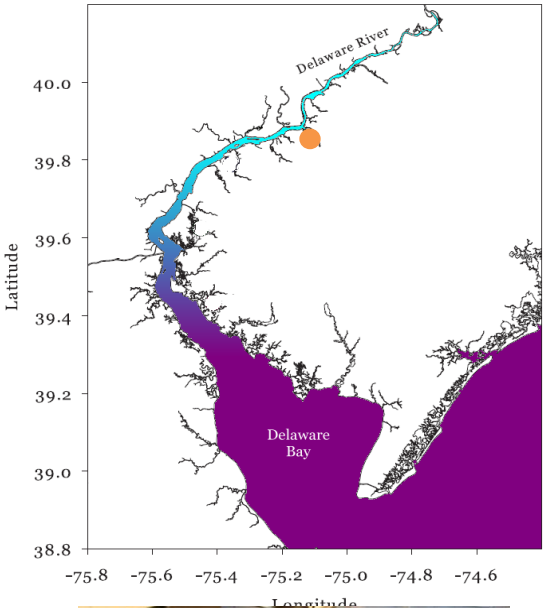

y = 1.0802x - 13.834
R² = 0.1373
p < 0.001
RCH4 (mmol m-2 d-1)
Temperature (˚C)


GEP (g C m-2 mo-1)
RAC
SAL
STO
ERCH4 Flux (g C m-2 mo-1)
ERCO2 (g C m-2 mo-1)
Net Ecosystem C Exchange (g C m-2 mo-1)
CSource
CSink
J F M A M J J A S O N D J F M A M J J A S O N D
2007
2008


C Source
C Sink
Net Ecosystem C Exchange
(g C m-2 mo-1)
RAC
SAL
STO
GHG Source
GHG Sink
GHG Source/Sink
(g CO2-eq m-2 mo-1)
J F M A M J J A S O N D J F M A M J J A S O N D
2007
2008

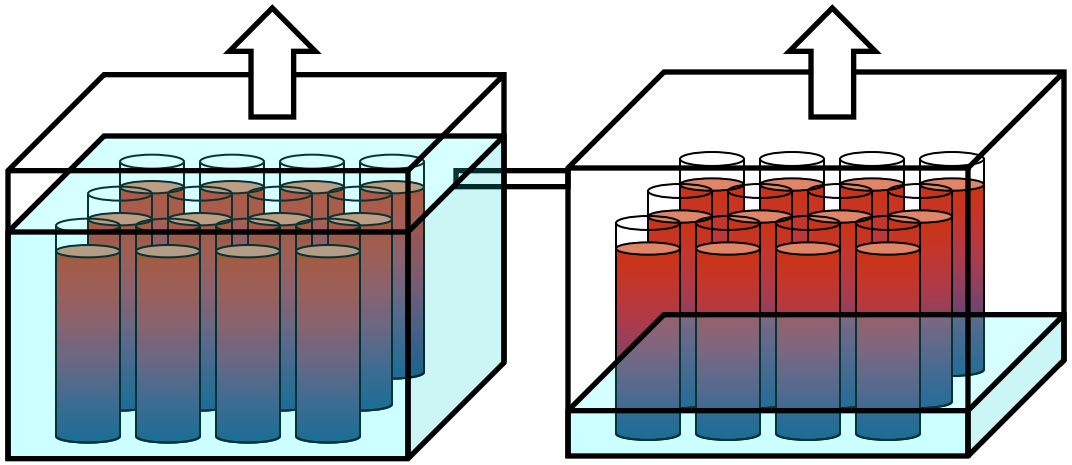
Laboratory Experiments

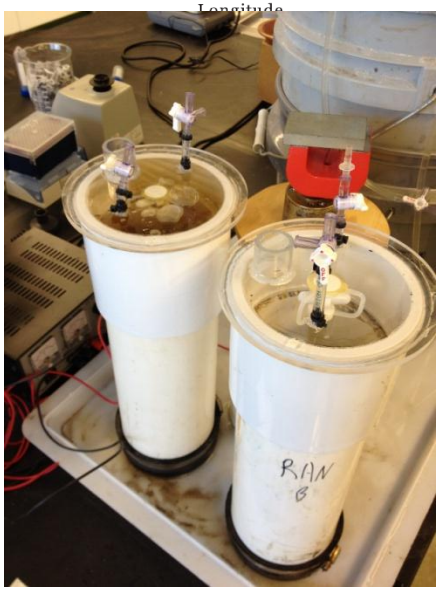


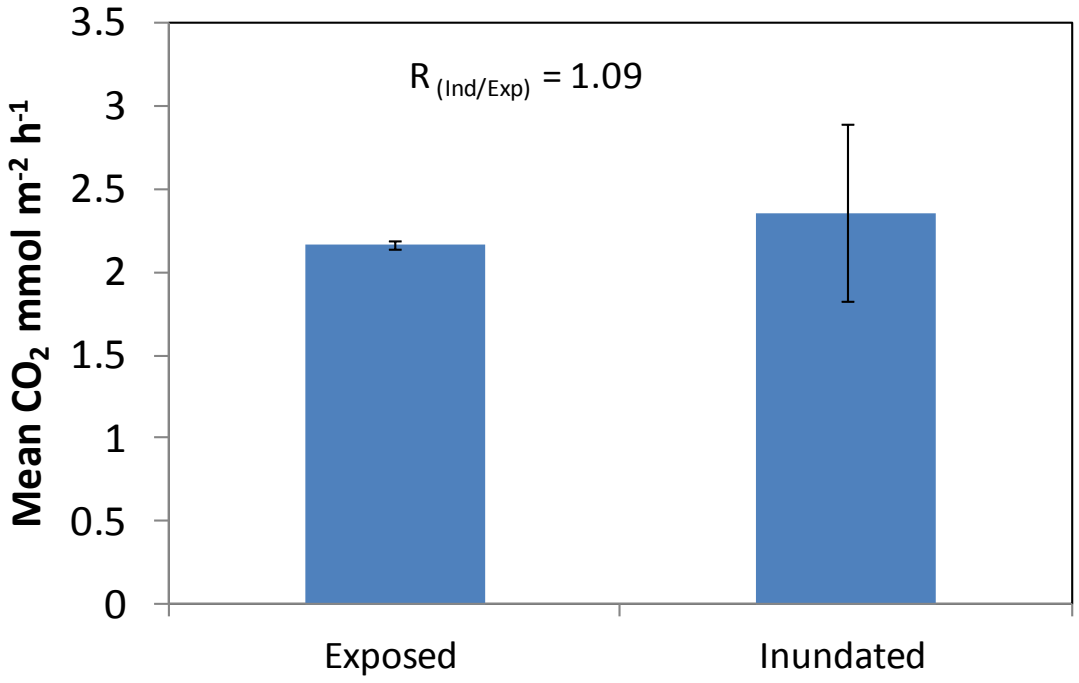


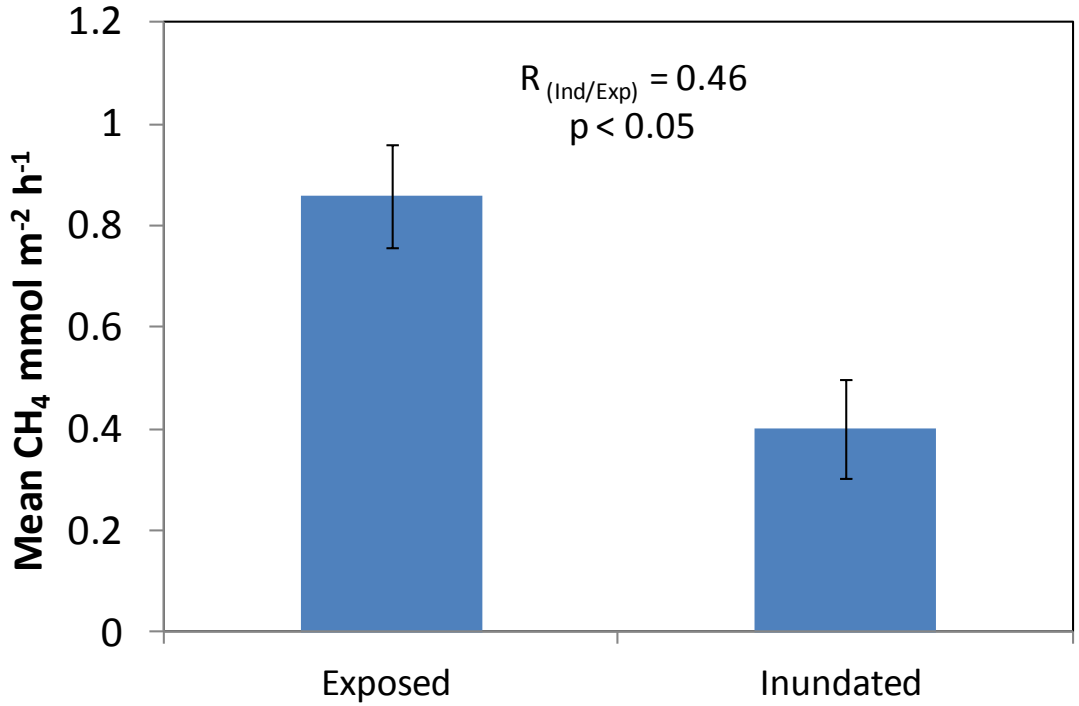
CO_2 & CH_4
Gas Flux Rates

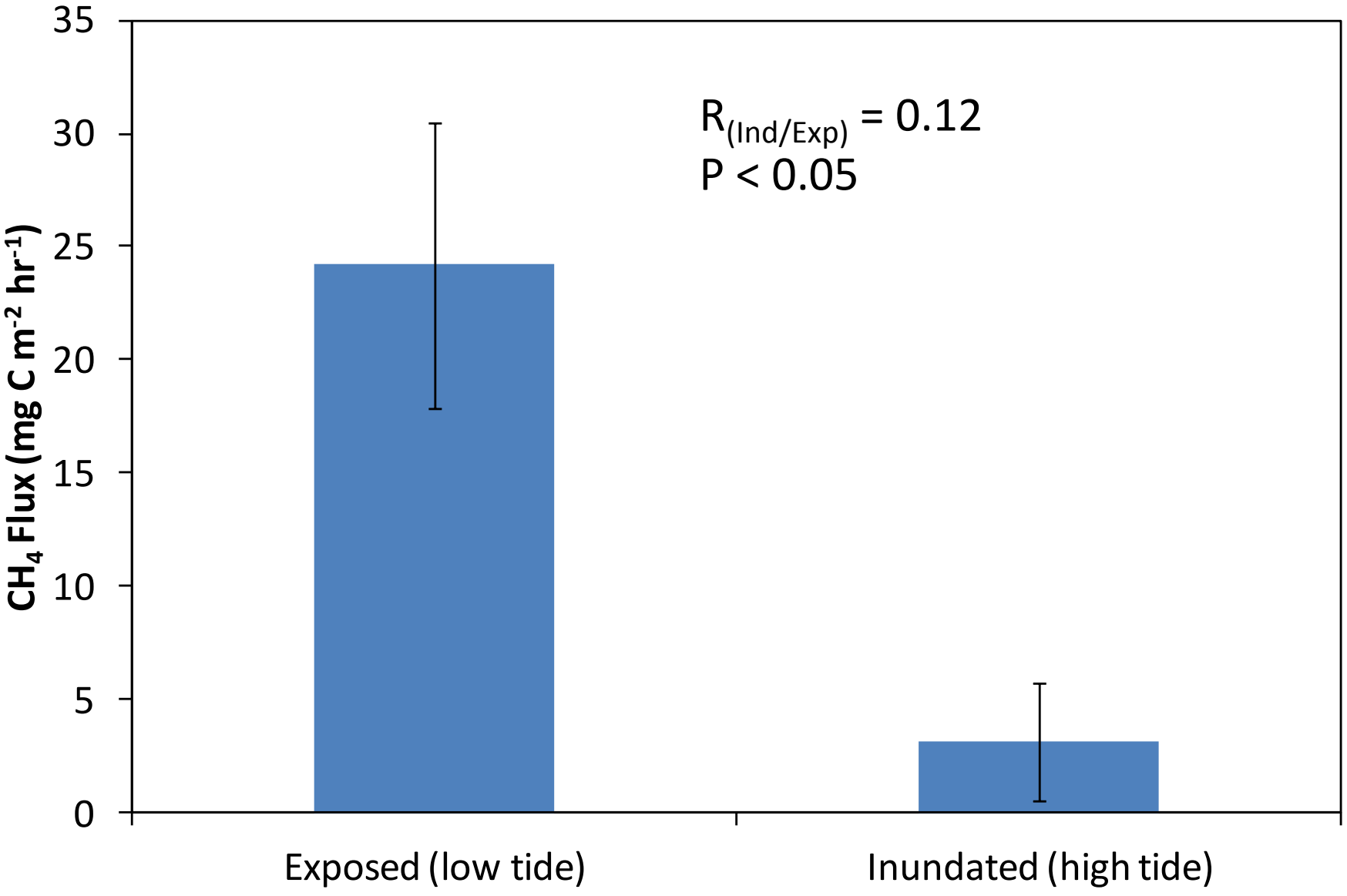
CO_2 & CH_4
Gas Flux Rates





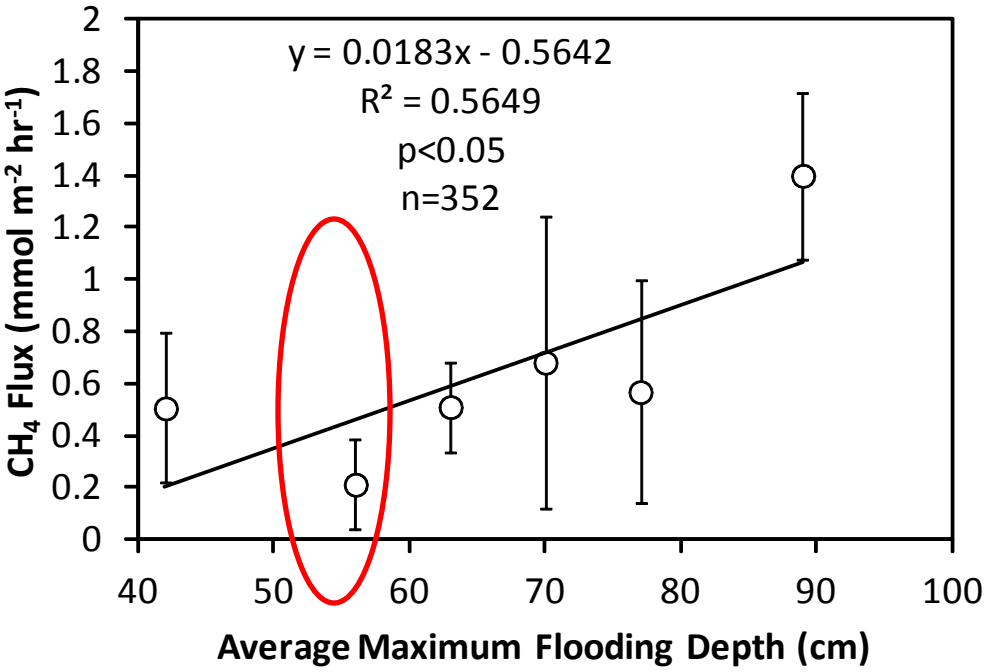

3.5
3
2.5
2
1.5
1
0.5
0
Mean CO_2 mmol m^{-2} h^{-1}
$R_{(Ind/Exp)}$ = 1.09
Exposed
Inundated


1.2
1
0.8
0.6
0.4
0.2
0
Mean CH_4 mmol m^{-2} h^{-1}
$R_{(Ind/Exp)}$ = 0.46
$p < 0.05$
Exposed
Inundated

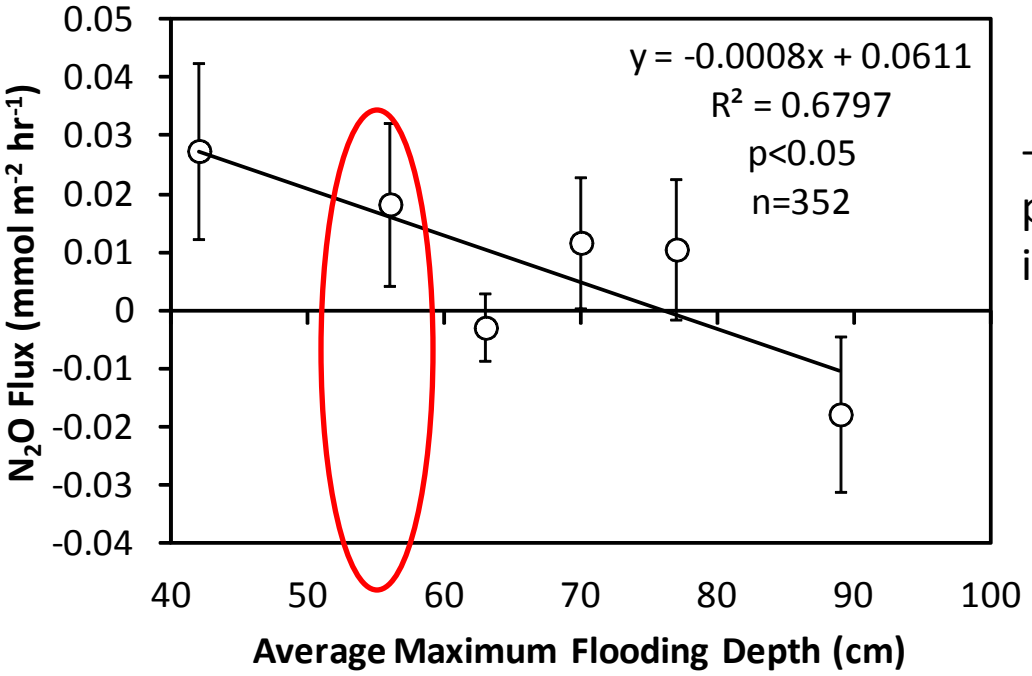


Adapted from Neubauer *et al* 2000;

Field Manipulations

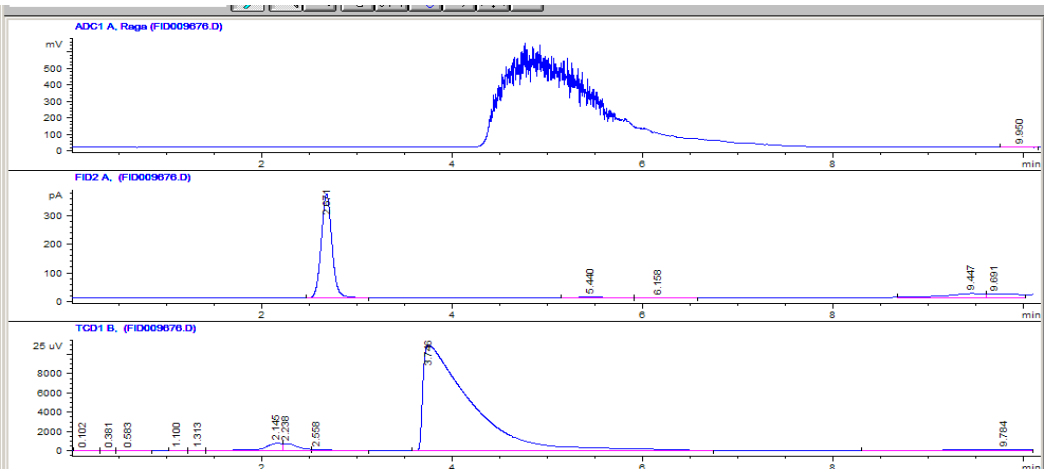


5.5 mg CO_{2eq} m^{-2} hr^{-1} per centimeter of inundation

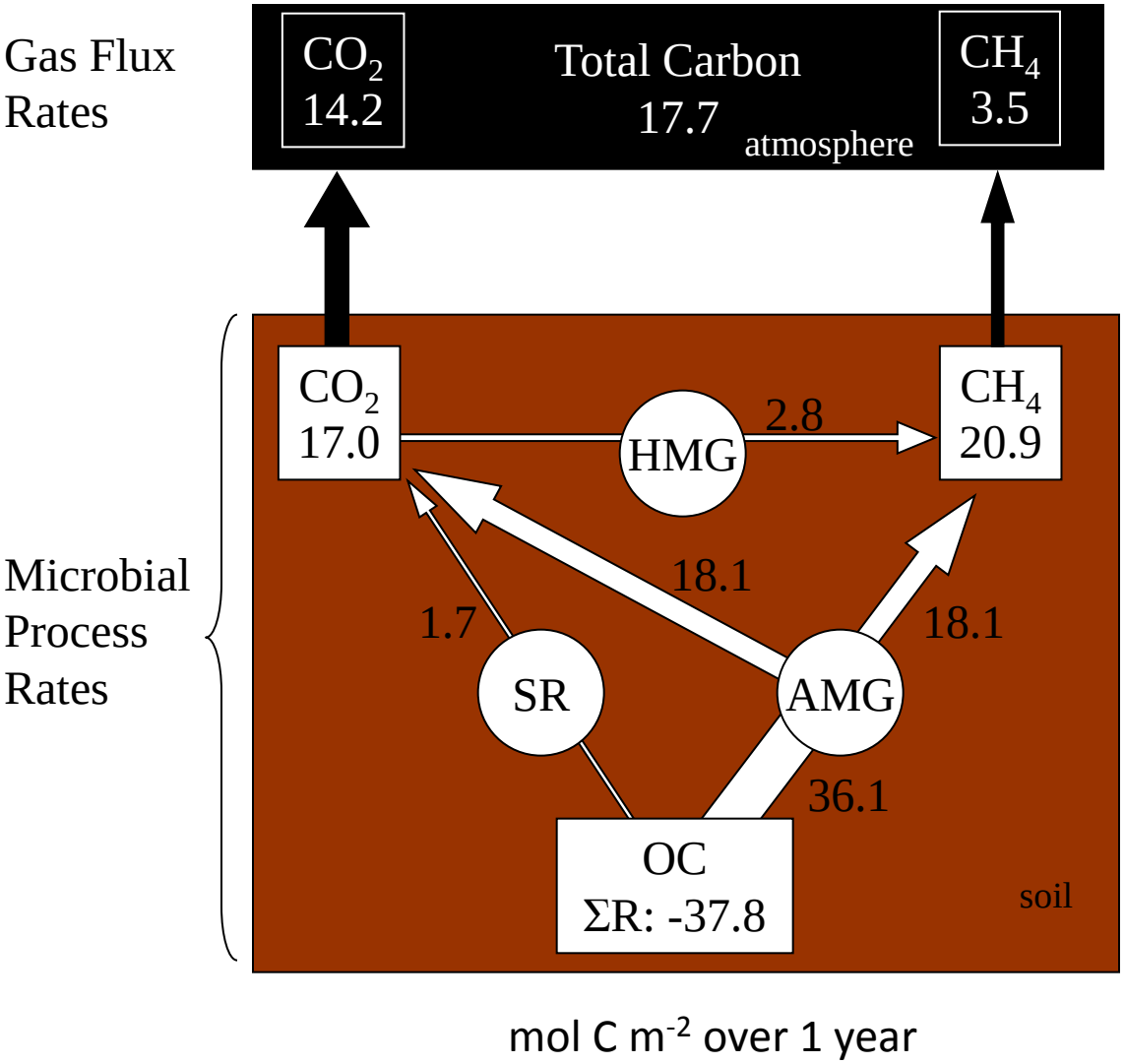


-2.8 mg CO_{2eq} m^{-2} hr^{-1} per centimeter of inundation

Microbial Rate Measurements



Microbial Pathways: Laboratory Experiment

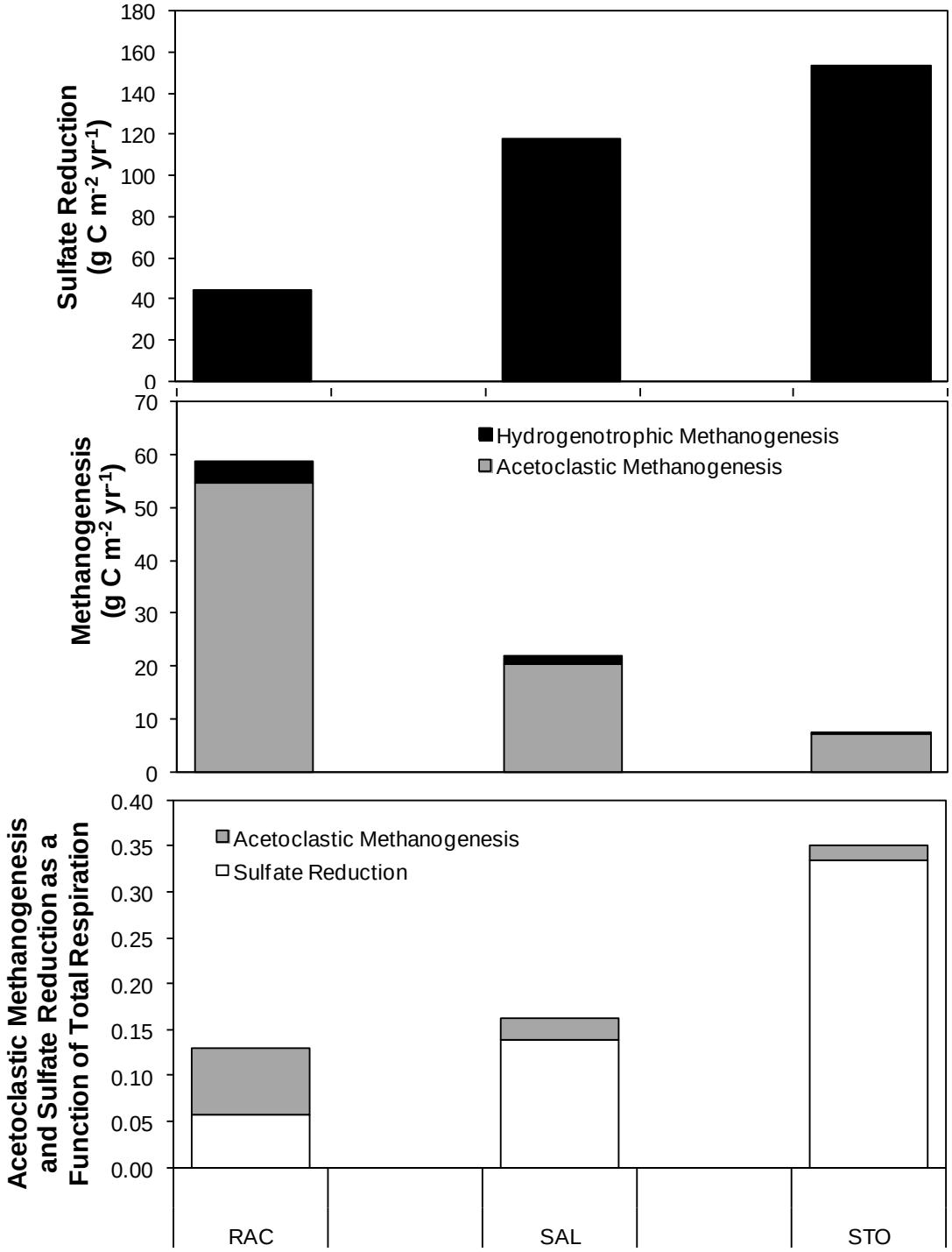


Sulfate Reduction (SR):
$CH_2O + SO_4^{2-} + 2H^+ \rightarrow CO_2 + H_2S + H_2O$

Acetoclastic Methanogenesis (AMG):
$2CH_2O \rightarrow CH_4 + CO_2$

Hydrogenotrophic MG(HMG):
$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

mol C m^{-2} over 1 year


Sulfate Reduction (g C m-2 yr-1)
180
160
140
120
100
80
60
40
20
0
Methanogenesis (g C m-2 yr-1)
70
60
50
40
30
20
10
0
Hydrogenotrophic Methanogenesis
Acetoclastic Methanogenesis
Acetoclastic Methanogenesis and Sulfate Reduction as a Function of Total Respiration
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Acetoclastic Methanogenesis
Sulfate Reduction
RAC
SAL
STO

Pros, Cons, and Overcoming Limitations

- Microbial Rate Measurements
  - Pros: Direct assessment, mechanistic
  - Cons: Multiple pathways, indirect link to flux
  - Measure more processes
- Field Based Manipulations
  - Labor intensive

Pros, Cons, and Overcoming Limitations

- Laboratory Experiments
  - Pros: Relatively easy, controlled conditions
  - Cons: Controlled conditions
  - Good for addressing specific questions
- Field Based Static Chamber
  - Pros: Unmanipulated
  - Cons: Snapshot of flux