

Blue Carbon in Coastal Wetlands: Consideration of Lateral and Vertical Carbon and Greenhouse Gas Fluxes

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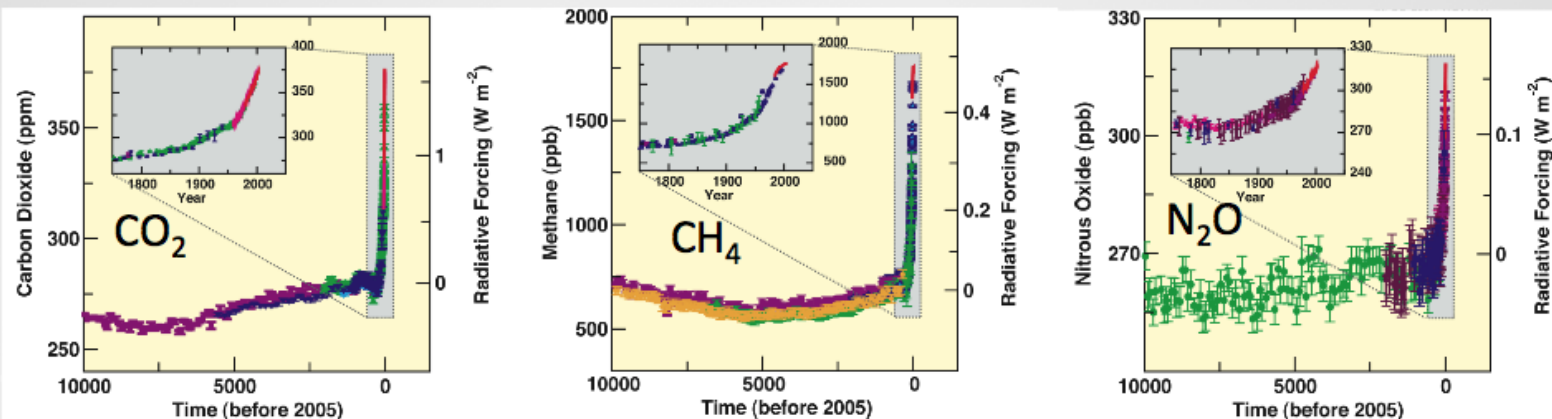
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Carbon sequestration & greenhouse gas fluxes in coastal ecosystems

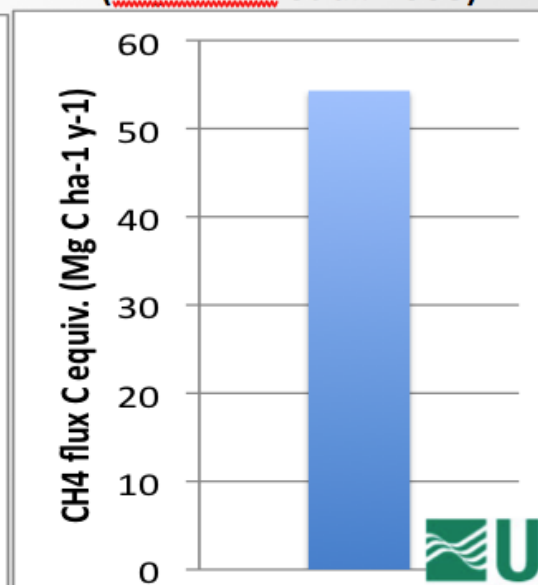
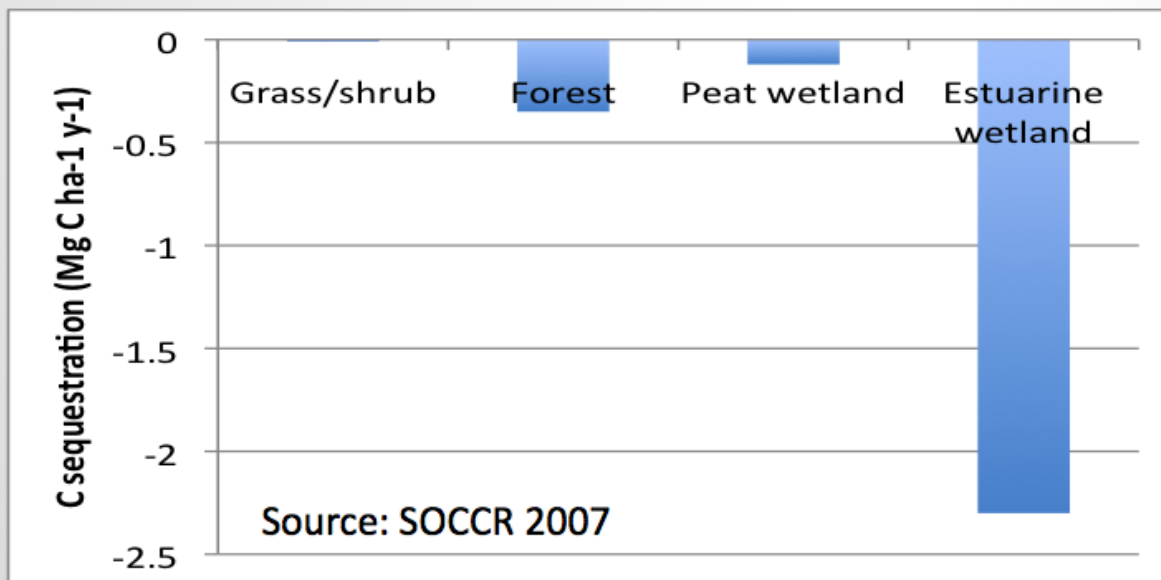


Atmospheric concentrations of CO₂, CH₄ and N₂O spanning the last 10,000 years (inset shows data since 1750). Figure from IPCC Fourth Assessment Report, 2007.

The concept of Flux Density: Rate of GHG flux per unit area of ecosystem

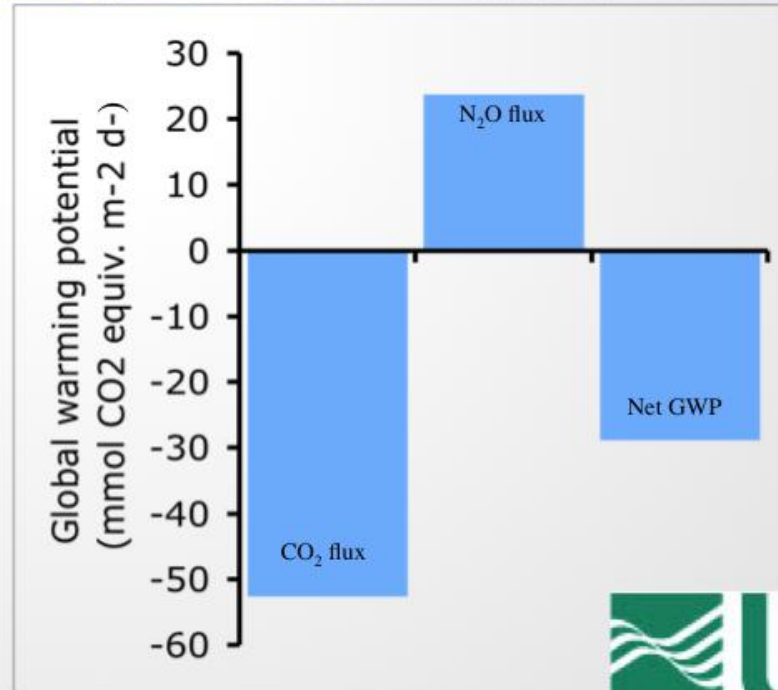
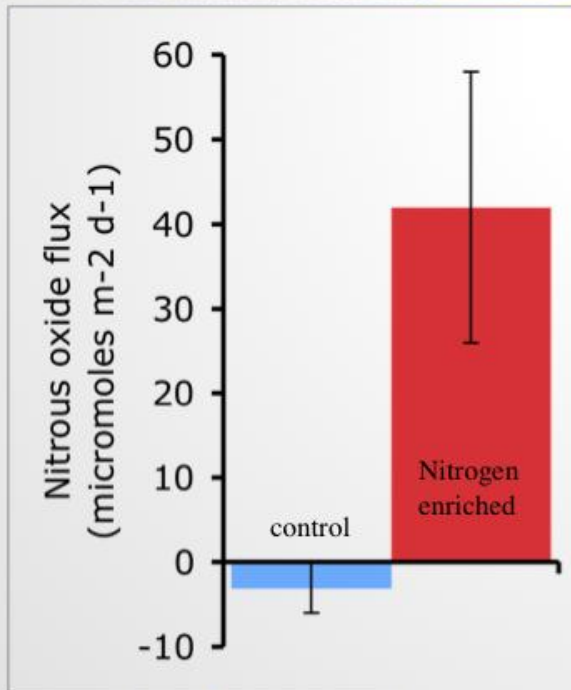
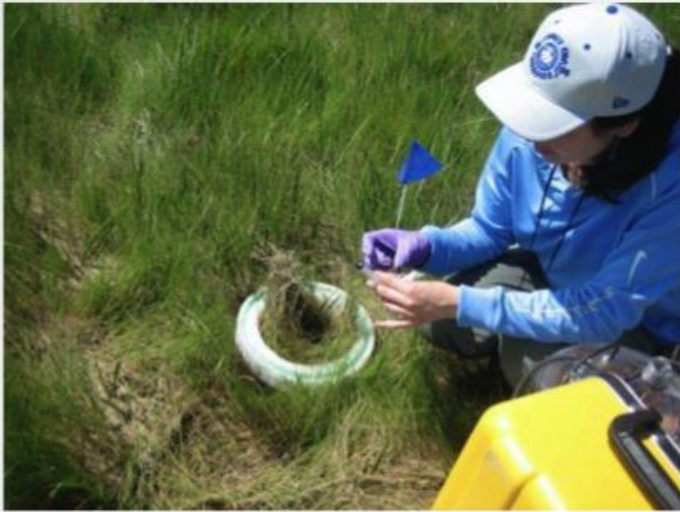
Is it worth managing C and GHG in coastal ecosystems?

Mangrove estuary in India
(Raikumar et al. 2008)

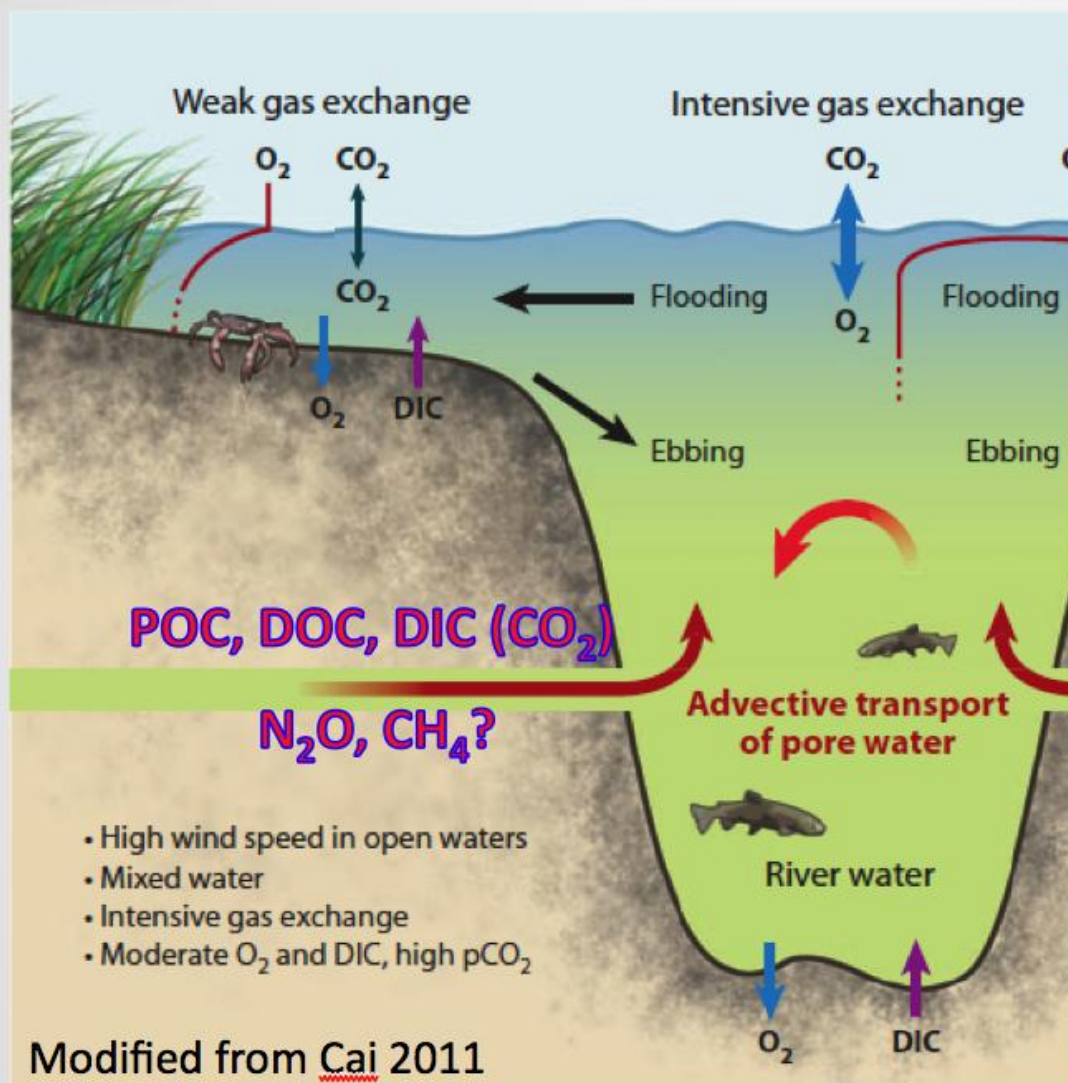


Greenhouse gases and carbon sequestration in salt marshes:

Can nitrogen loading shift coastal wetlands from a sink to a source of nitrous oxide?



In tidal wetland carbon and GHG budgets we also need to consider the lateral fluxes: C fluxes may be large...



1. Net ecosystem C balance (NECB)

$$NECB = NEP - RCH_4 - FL$$

NEP: net ecosystem production, the net result of photosynthesis and ecosystem respiration, measured with closed transparent chamber

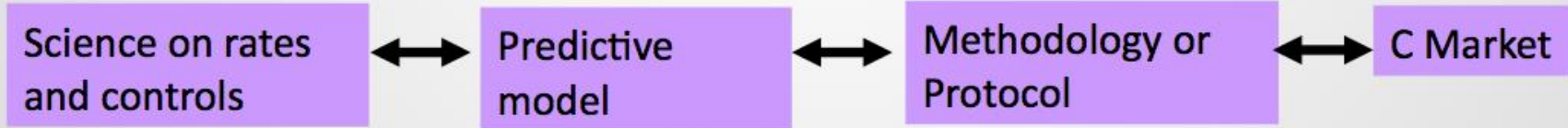
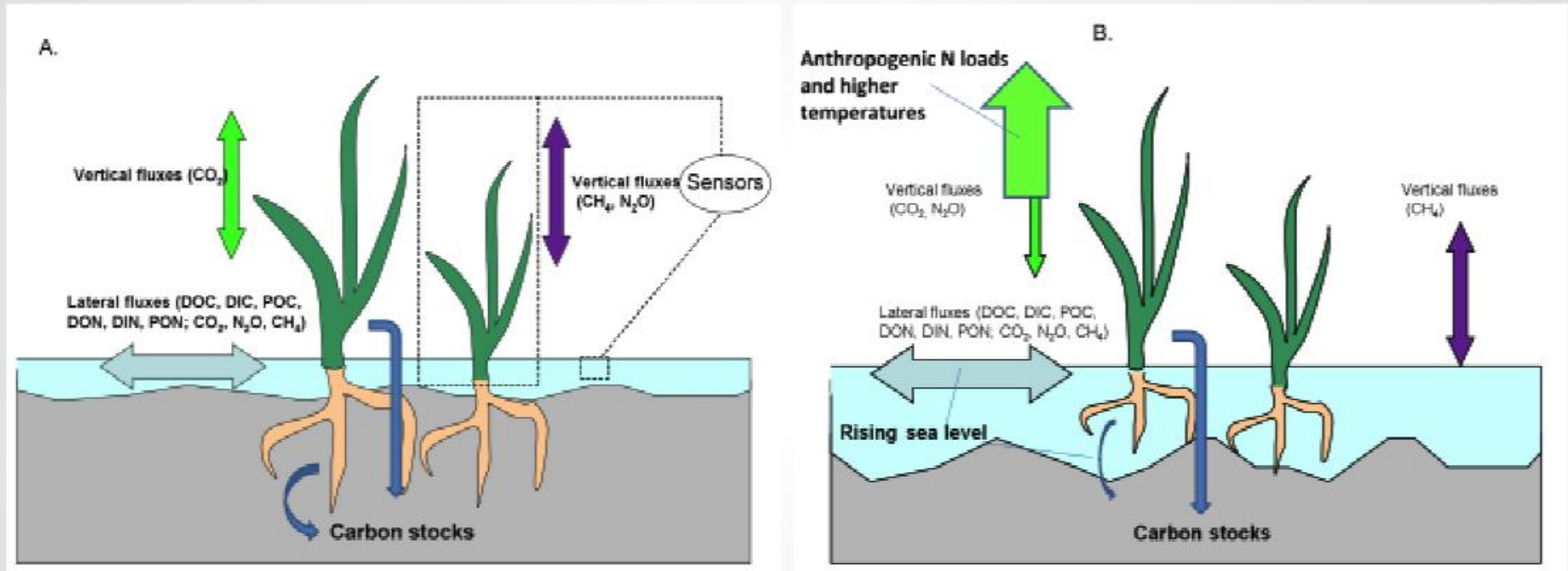
RCH_4 : CH_4 flux measured simultaneously with NEP.

FL: net lateral flux

2. Soil carbon stocks and their changes

NERRS Science Collaborative

Carbon Management in Coastal Wetlands: Quantifying Carbon Storage and Greenhouse Gas Emissions by Tidal Wetlands to Support Development of a Greenhouse Gas Protocol and Economic Assessment



Conceptual approach is to lateral flux measurements

Water flux ($u \times A$), m^3/s :

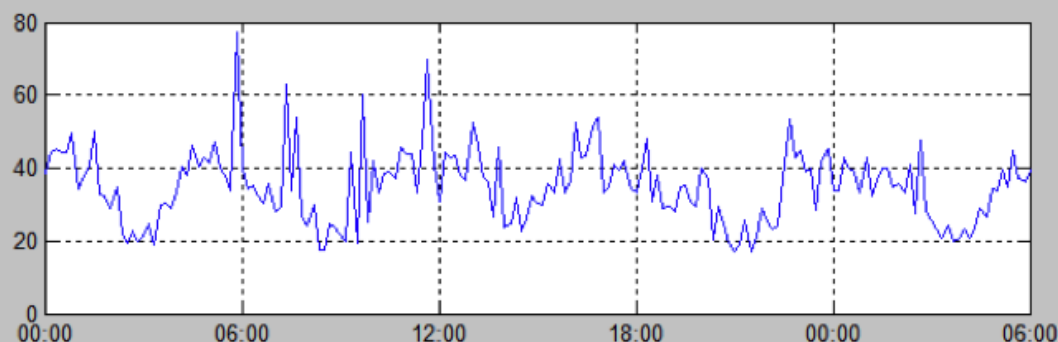
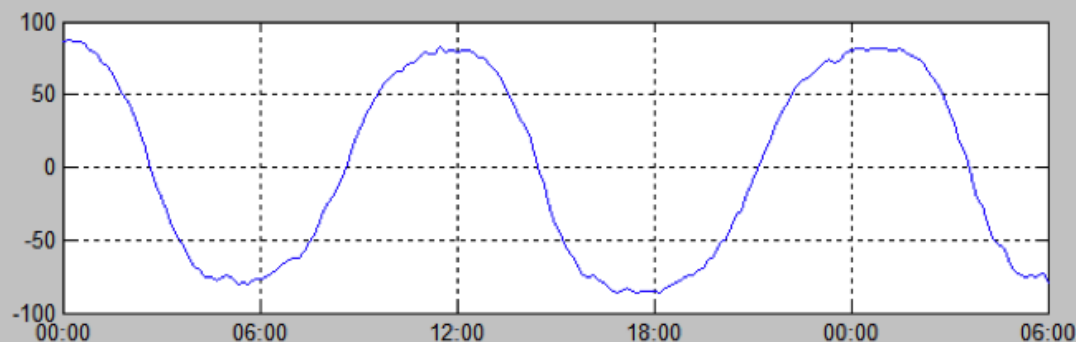
- High-frequency measurements to reduce error
- Maximum channel coverage
- Consistent procedure

Concentration (c), g/m^3 :

- Sufficient vertical/lateral sampling
- Look for proxy parameters that we can measure continuously

Total flux ($u \times A \times c$), g/s

Analytes: CO_2 , DIC, DOC, CH_4 , POC, N_2O , N, P



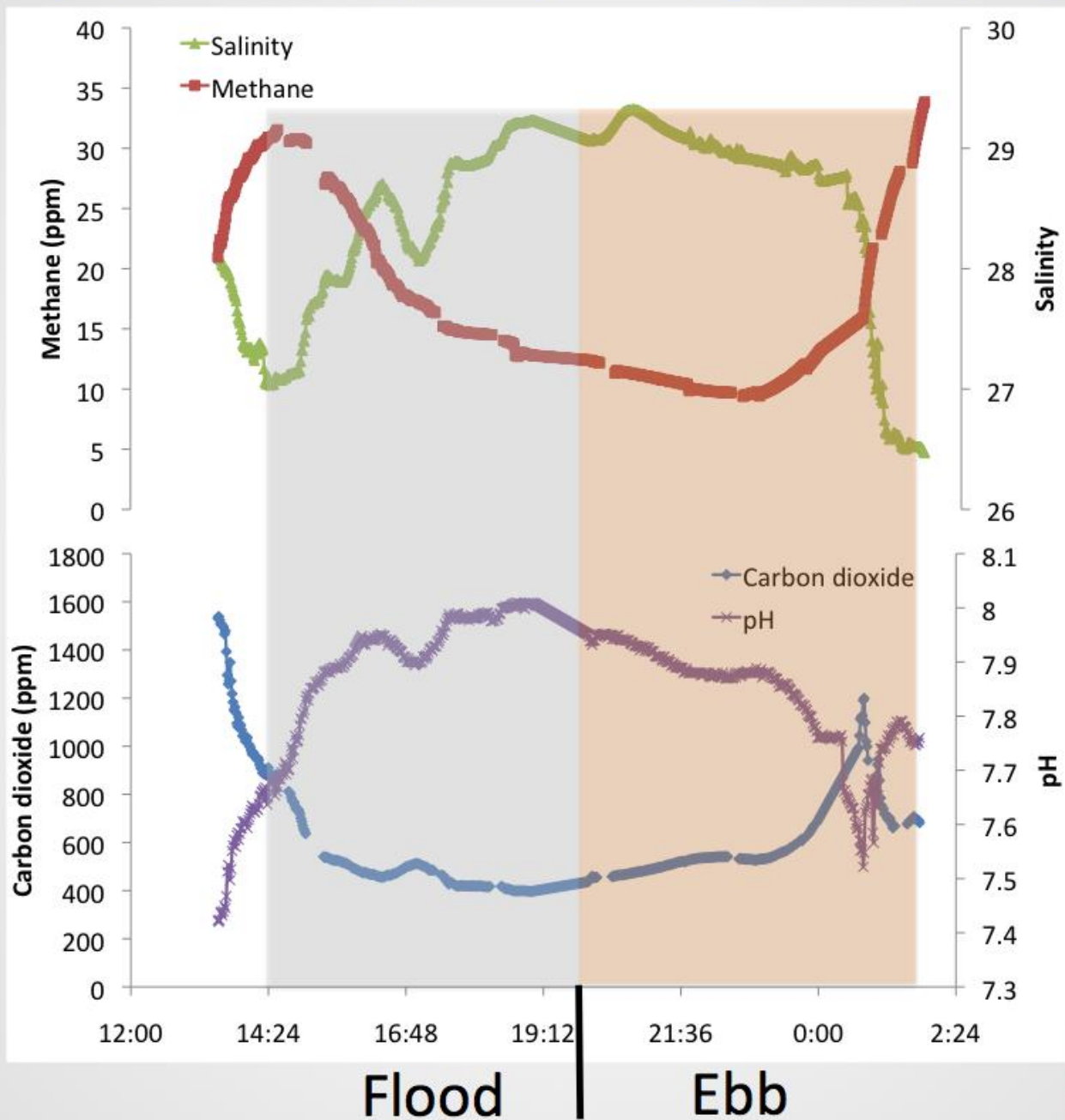


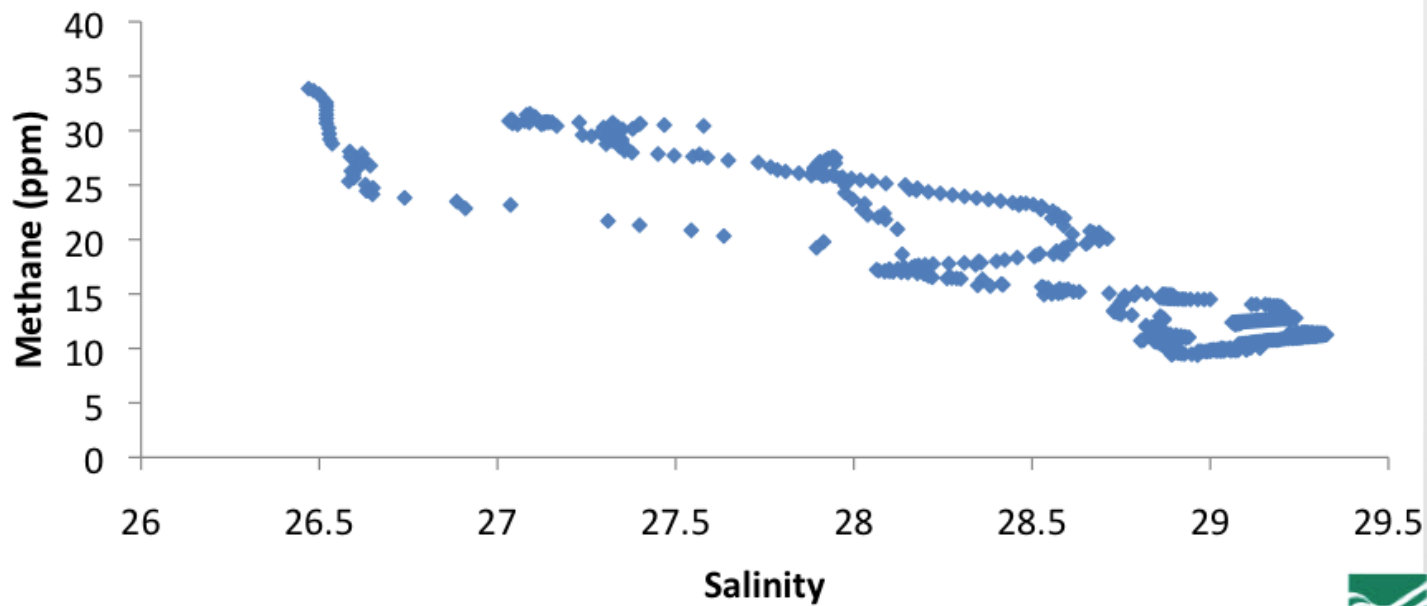
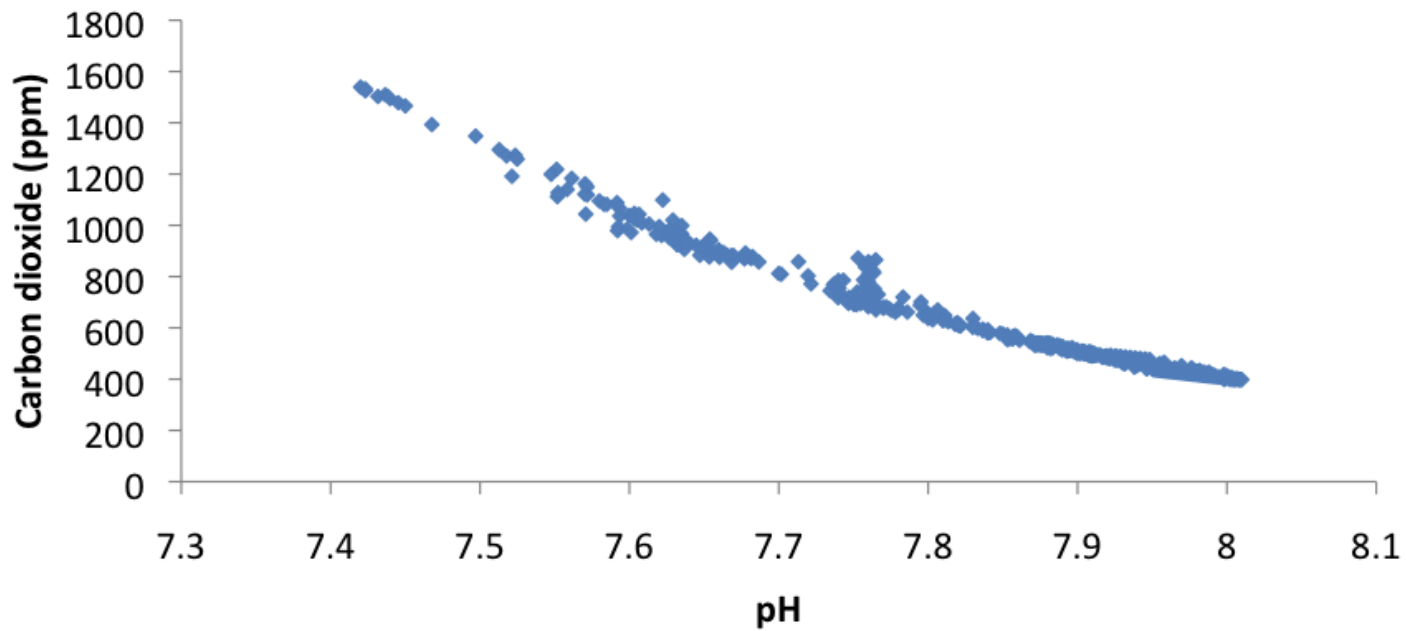
From Sage Lot Pond, 2 preliminary data sets related to lateral fluxes:

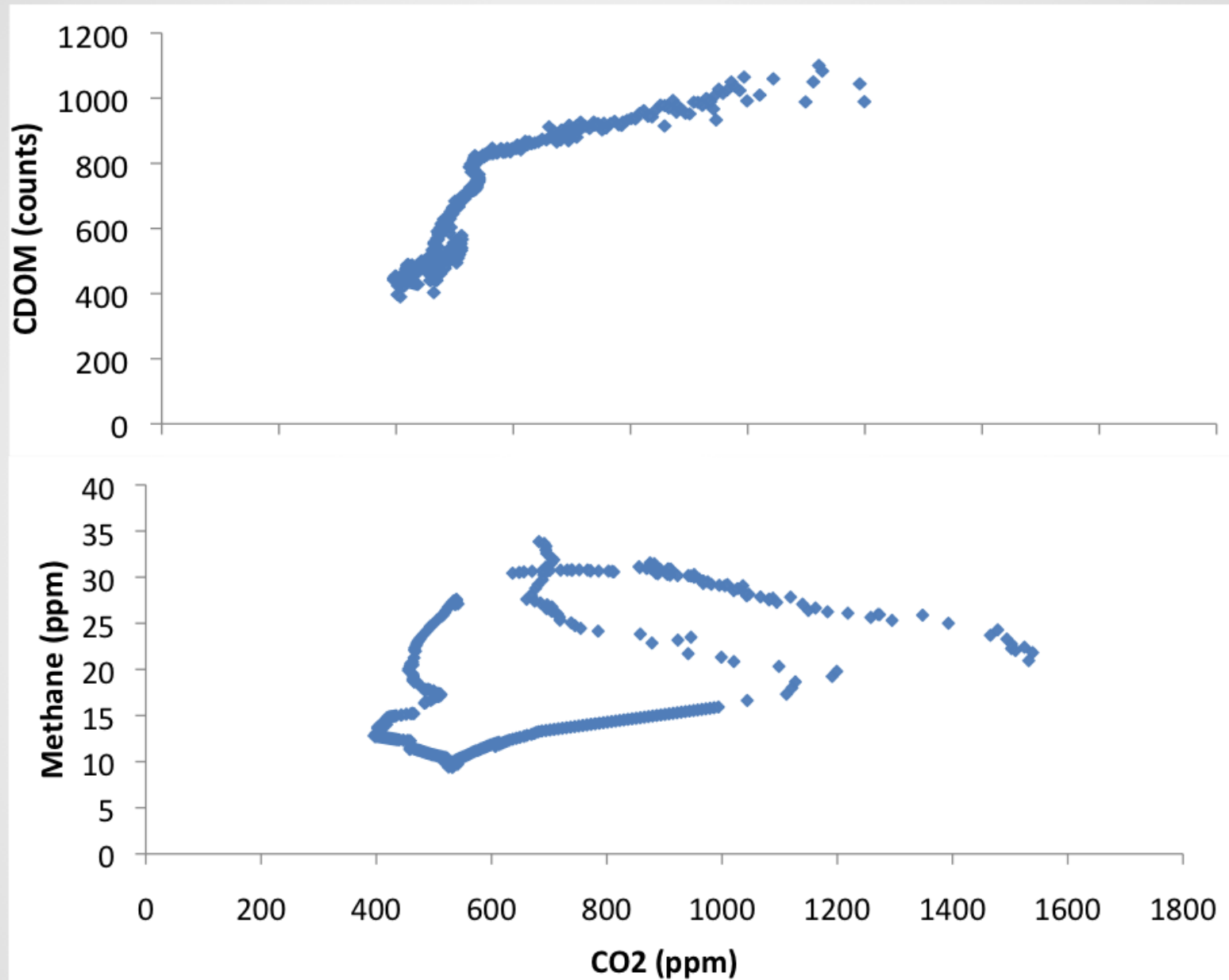
1. April 9, 2012—Full tidal cycle with gas measurements
2. April 4 to 17—Continuous sensor deployments

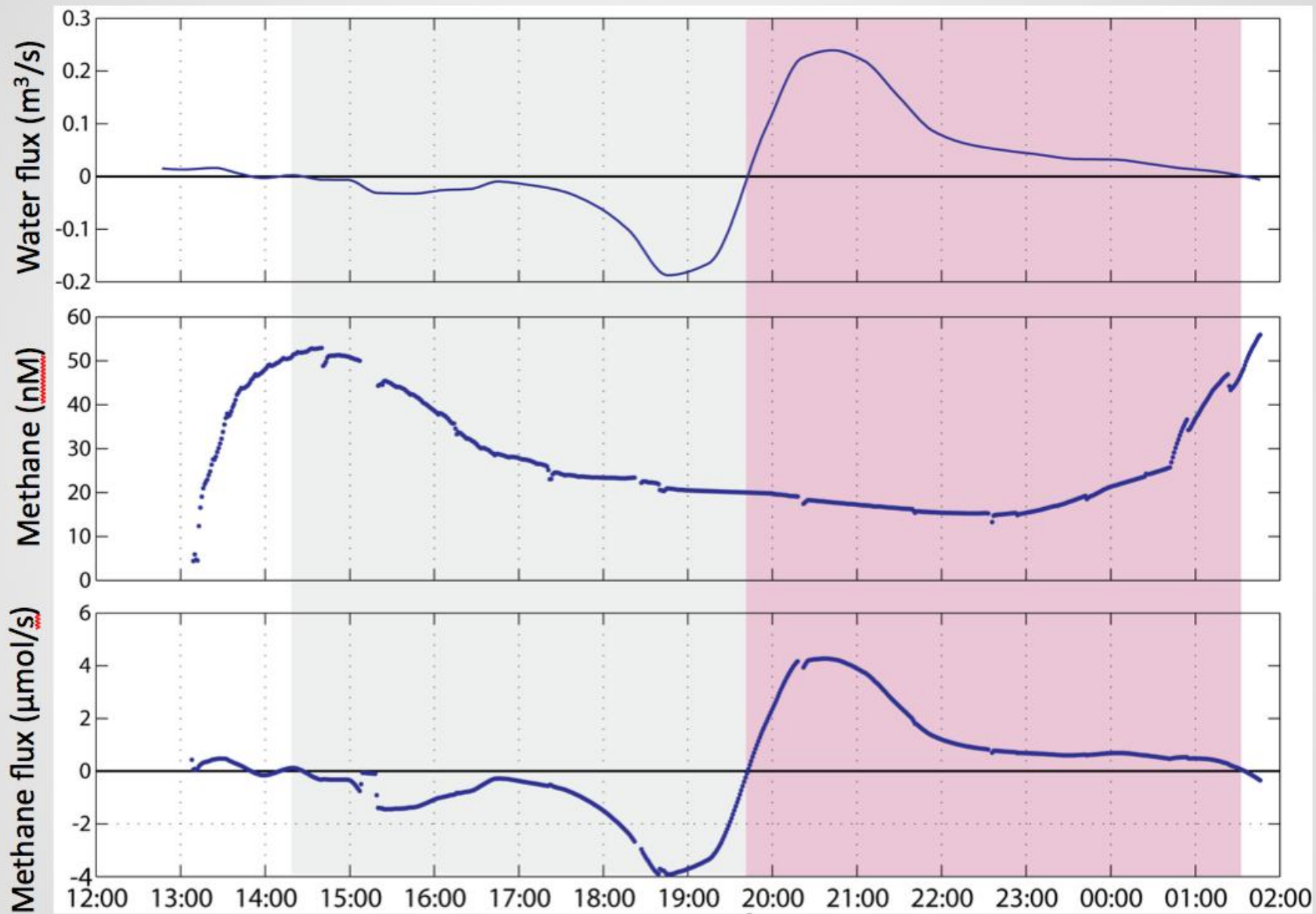


April 9, 2012—Full tidal cycle with gas measurements



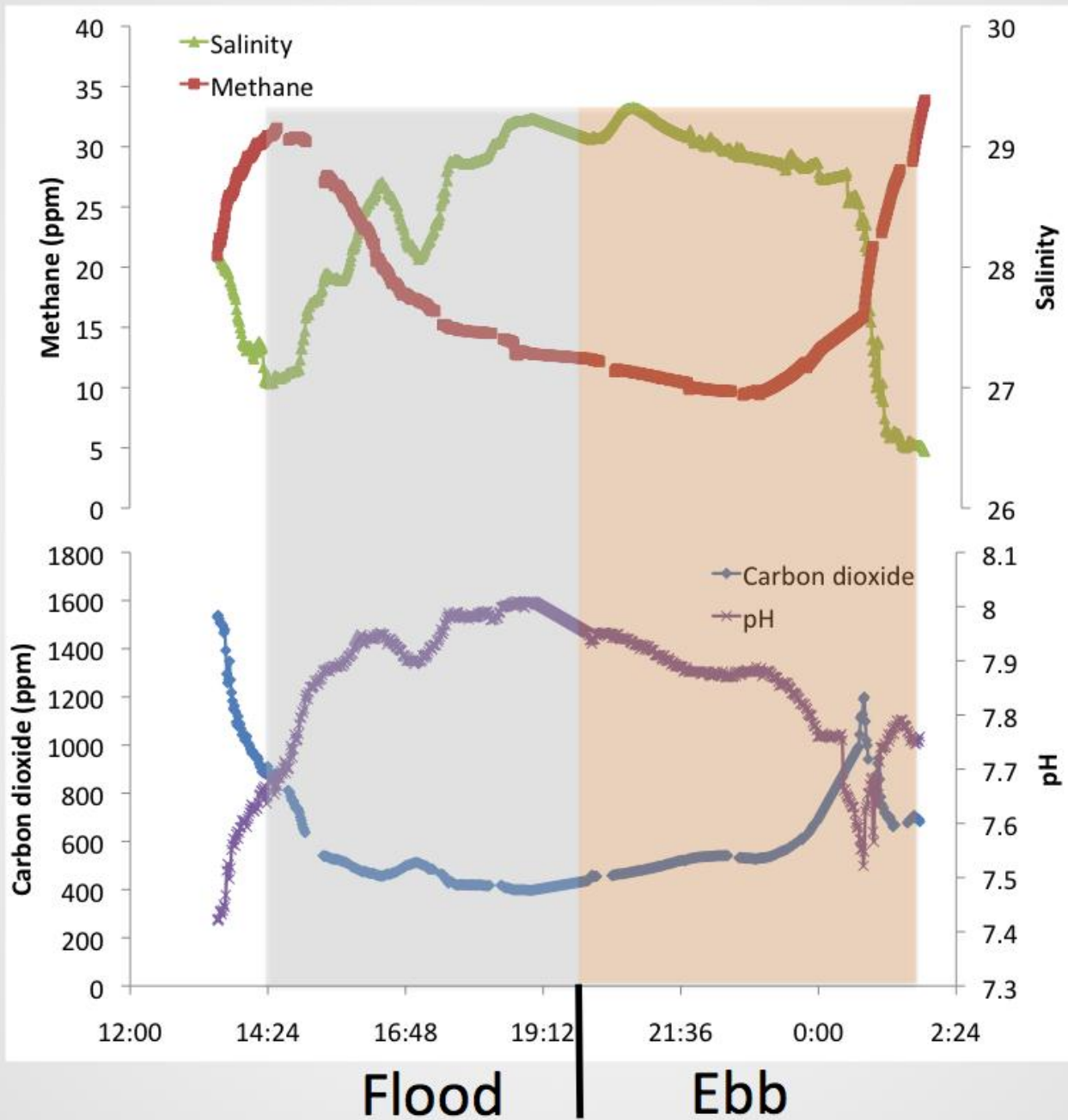




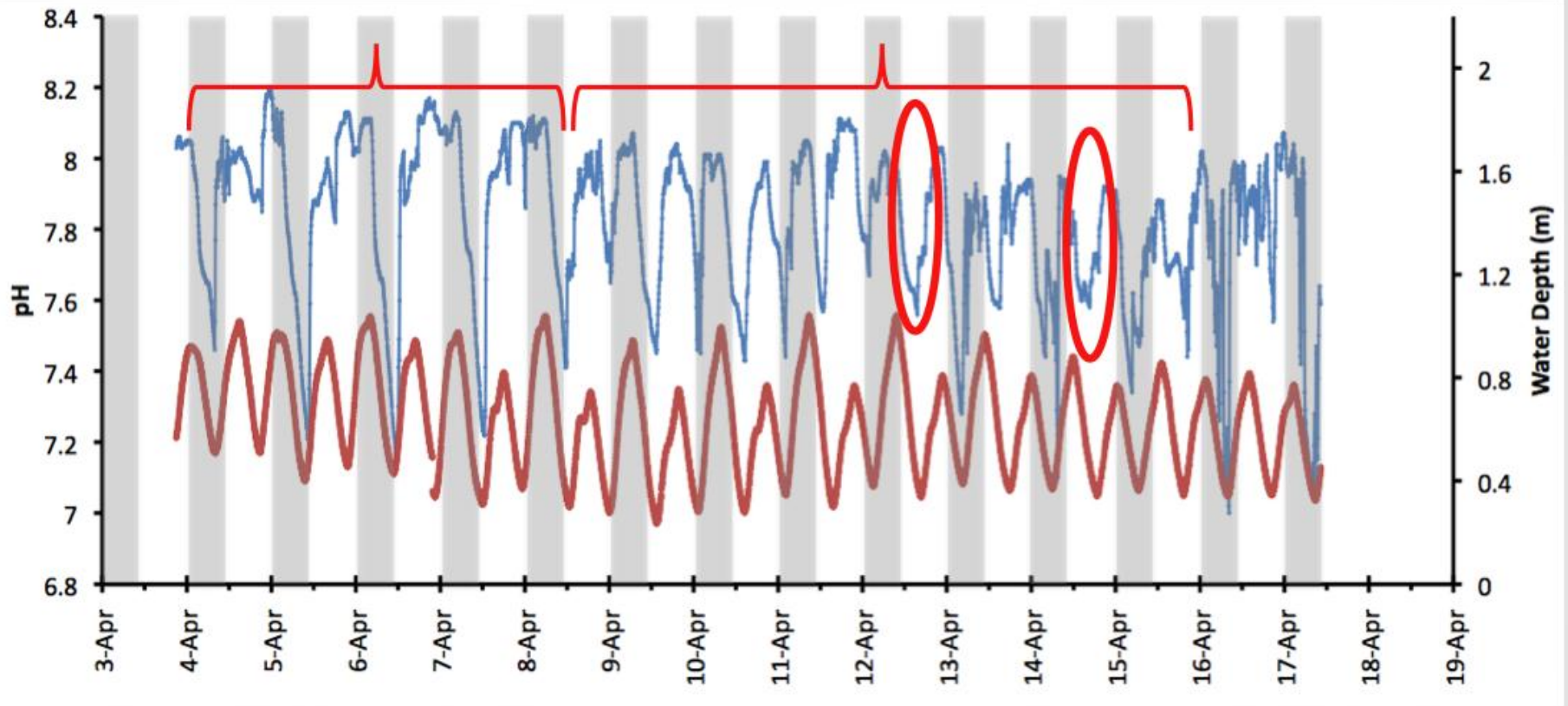


Flood

Ebb



April 4 to 17—Continuous sensor deployments
(Shading indicates nighttime)

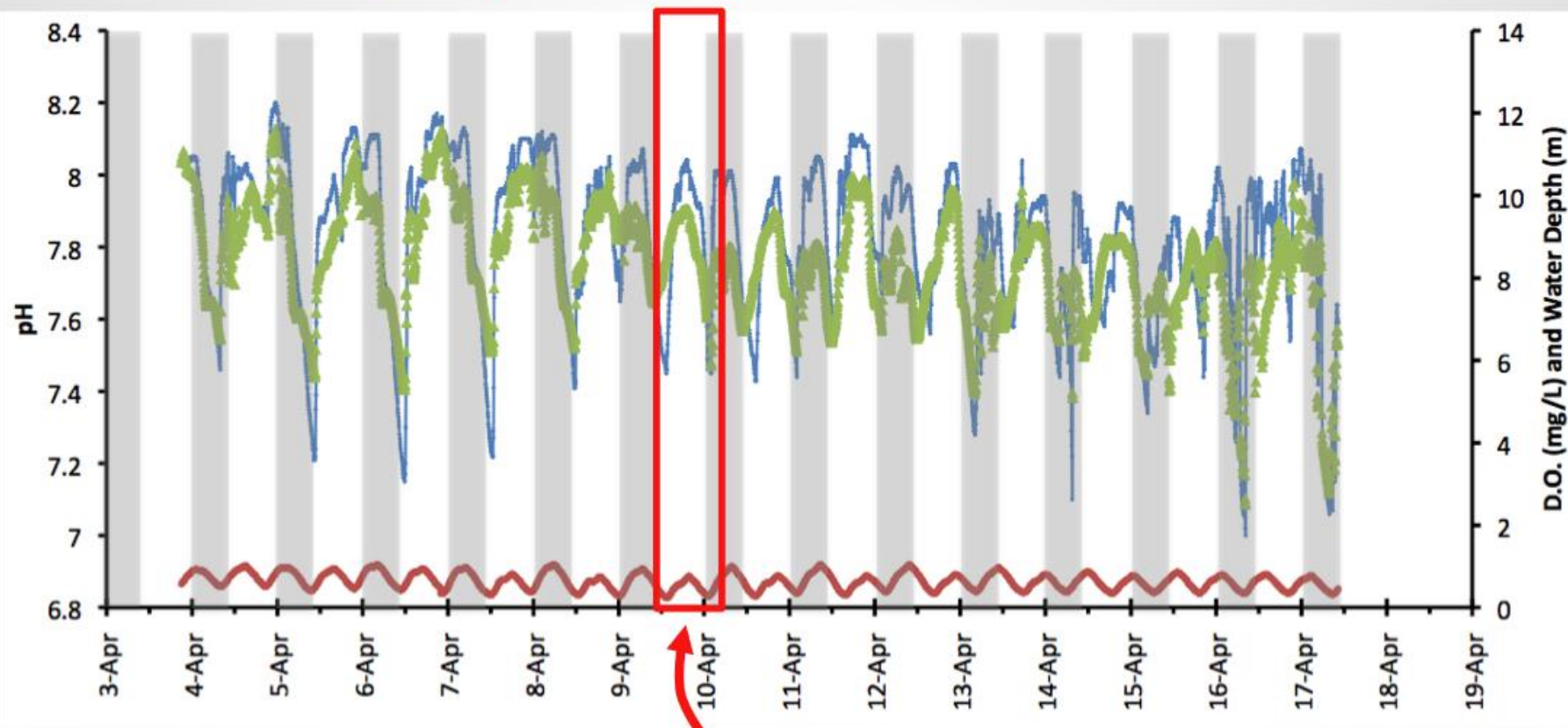


Why does a substantial drop in pH fail to occur in some cases?

Is it related to diurnal cycles? At first appears so, but clear exceptions occur...

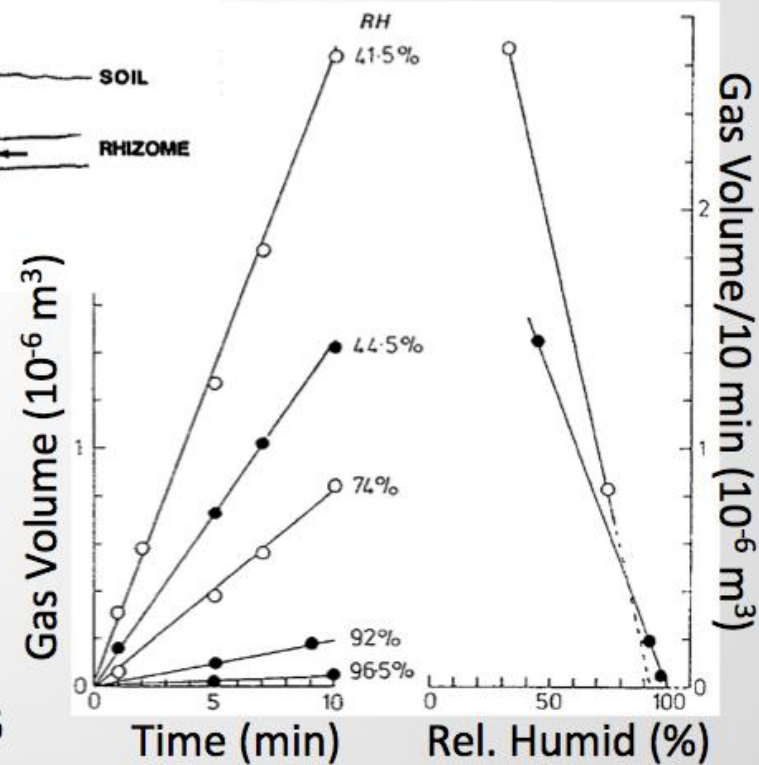
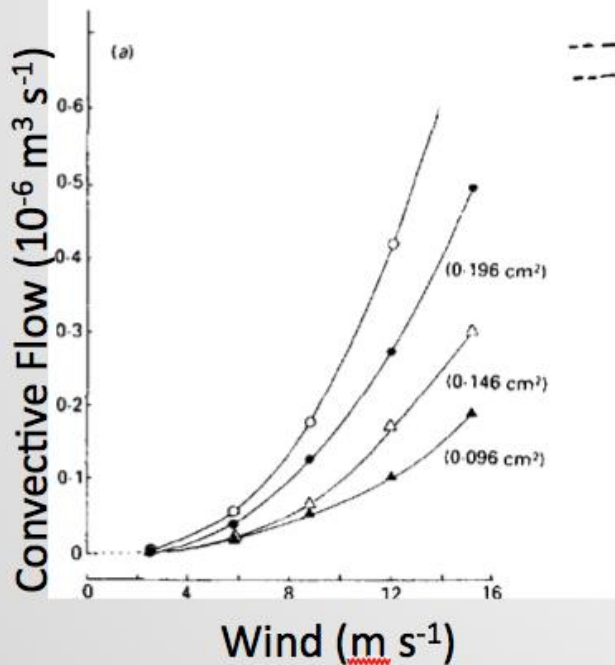
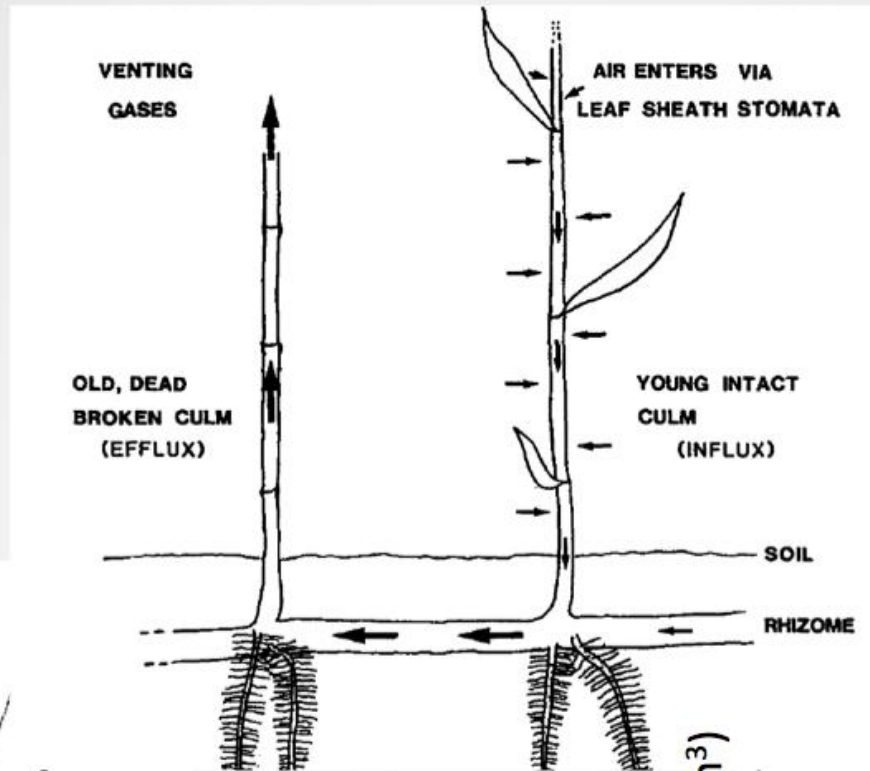
Three hypotheses come to mind though there may be other candidates:

1. Wind speed variations result in varying gas exchange between surface water and atmosphere, oxygenated and removing CO_2 from creek water: **Not likely**
2. Sunlight intensity = CO_2 uptake and O_2 production in surface waters due to PP by MPB, macroalgae, phytoplankton: **Possible, though has critical implications for estimation of CO_2 and DIC flux from wetlands.**
3. Humidity and Venturi induced convection: **Possible...**



20 mph winds, yet D.O. and pH minima occur

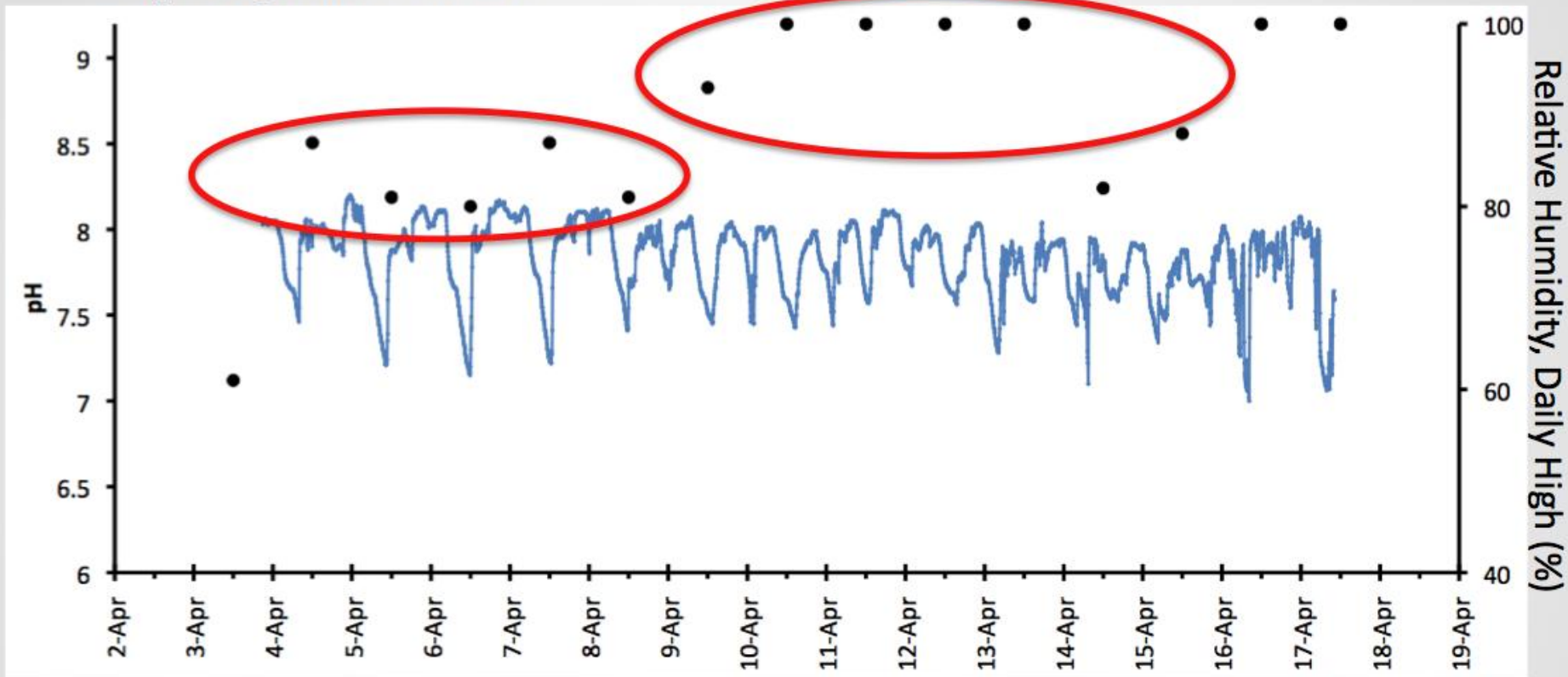
Humidity- and Venturi-Induced Convection: Enhanced with low humidity, sunlight, wind



Armstrong et al. 1996

Lower Humidity: pH depression
only at nighttime low tides

Higher Humidity: pH depression
at all low tides



-There may be multiple controls, but the result suggests that CO₂ exports may be sensitive to variations in weather, and/or responding to processes occurring on the scale of a few days.

Interpretations and Comments on Methods

- Reduced salinity (groundwater-influenced) porewater seems to be the major source for high CH_4 concentrations at low tide.
- The wetland may be a net sink for CH_4 .
- Wetland porewater seems to be the major source for CO_2 .
- CO_2 fluxes may be influenced by weather or other processes that affect porewater gas concentrations.
- High sensitivity of flux calculations to small differences in concentration at times of major water flux is a critical feature and limitation: Insufficient frequency of measurements or insufficient accuracy could contribute to the lack of consensus in the literature about the role of coastal wetlands as exporters or importers of carbon.
- Continuous data appears to be necessary, given the high degree of variability on daily timescales and sensitivity of calculations to small differences in concentration between flood and ebb tide.
- If measured CO_2 concentrations are indeed affected by primary production in surface water, this poses a challenge for estimating lateral fluxes by these tidal exchange methods.

Primary collaborators and contributors in the wetland work

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