Boat-Based Eddy Covariance Measurements of CO$_2$ and H$_2$O Exchange Over Amazon and Tapajos Rivers and Lakes
Motivation

Richey et al, Nature, April, 2002

\[ F_c = k(c_w - \alpha c_a) \]

\[ k = \text{piston velocity (cm hr}^{-1}\text{)} \]

Grace and Malhi

piston velocity from chambers on Amazon and tributaries

Other approaches to measure \( k \)

1. tracer techniques
2. eddy covariance
Goal: Direct measurement of CO$_2$/H$_2$O flux across air-river interface using eddy covariance

1. Compare eddy covariance and chamber techniques for measuring CO$_2$ flux

2. Calculate $k$ from direct measurements on Amazon River and tributaries
Air-side CO$_2$ and H$_2$O Flux Measurement

sensor boom

CO$_2$/H$_2$O

wind

motion
Flux Footprint

For $U=4\text{m/s}$, $z=1.5\text{ m}$, 90% of flux with 200m fetch.
Water-side pCO$_2$ Measurement

Teflon tubing equilibrator

shower head equilibrator

Closed path IRGA
Sampling Strategy: Moving and Moored

Amazon
~5000 ppm CO2

Tapajos
~1000 ppm CO2

10 day ship track

km 83 tower
Raw Data

VERTICAL VELOCITY AND CO2 ARE POSITIVELY CORRELATED

VERTICAL VELOCITY AND H2O ARE POSITIVELY CORRELATED
Flux Corrections

DENSITY CORRECTION IS SMALL COMPARED TO CO2 SIGNAL

- CO2 MIXING RATIO
- CO2 CORRECTION DUE TO T AND H2O CONTAMINATION

TIME (seconds)

MIXING RATIO (PPM)
CO$_2$ Flux versus Wind Speed
Piston Velocity: Amazon only

Transfer Velocity versus 10-meter Wind Speed (river data not adjusted for Schmidt #)
Piston Velocity: Amazon & Tapajos

Transfer Velocity versus 10-meter Wind Speed (river data not adjusted for Schmidt #)

- Wanninkhof (1992)
- Jacobs et al. (1999)
- McGillis et al. (2001)
- AMAZON
- TAPAJOS

$k_{600}$ cm hr$^{-1}$ vs $U_{10}$
Next Steps

• Finish processing eddy flux data.
• Comparison with chamber measurements
• Additional measurements…
Conclusions

• Boat-based eddy covariance is facilitated by the high $\Delta pCO_2$ across the air-water interface and large river size.

• Piston velocity for the Amazon consistent with other methods and environments.

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