



Interpreting Dynamic Signatures of Land-water Coupling and In- stream Processes from pCO₂: from Small Streams to Big Rivers



Land-Water Synthesis
Group

LBA-ECO 11th Scientific Team
Meeting

September 27, 2007

CARBON THEME.....

CO₂ Evasion from Waters of the Central Amazon:

1.2 ± .3 Mg C ha⁻¹ y⁻¹ (basin ~ .5 Gt y⁻¹)

Net forest uptake: ~ 1 to ?? Mg C ha⁻¹ y⁻¹)

CO₂ Evasion (Tg C mo⁻¹)

30

25

20

15

10

5

0

T (>100m)

MF

S (<100 m)

MC

J F M A M J J A S O N D

1.77 × 10⁶ km²

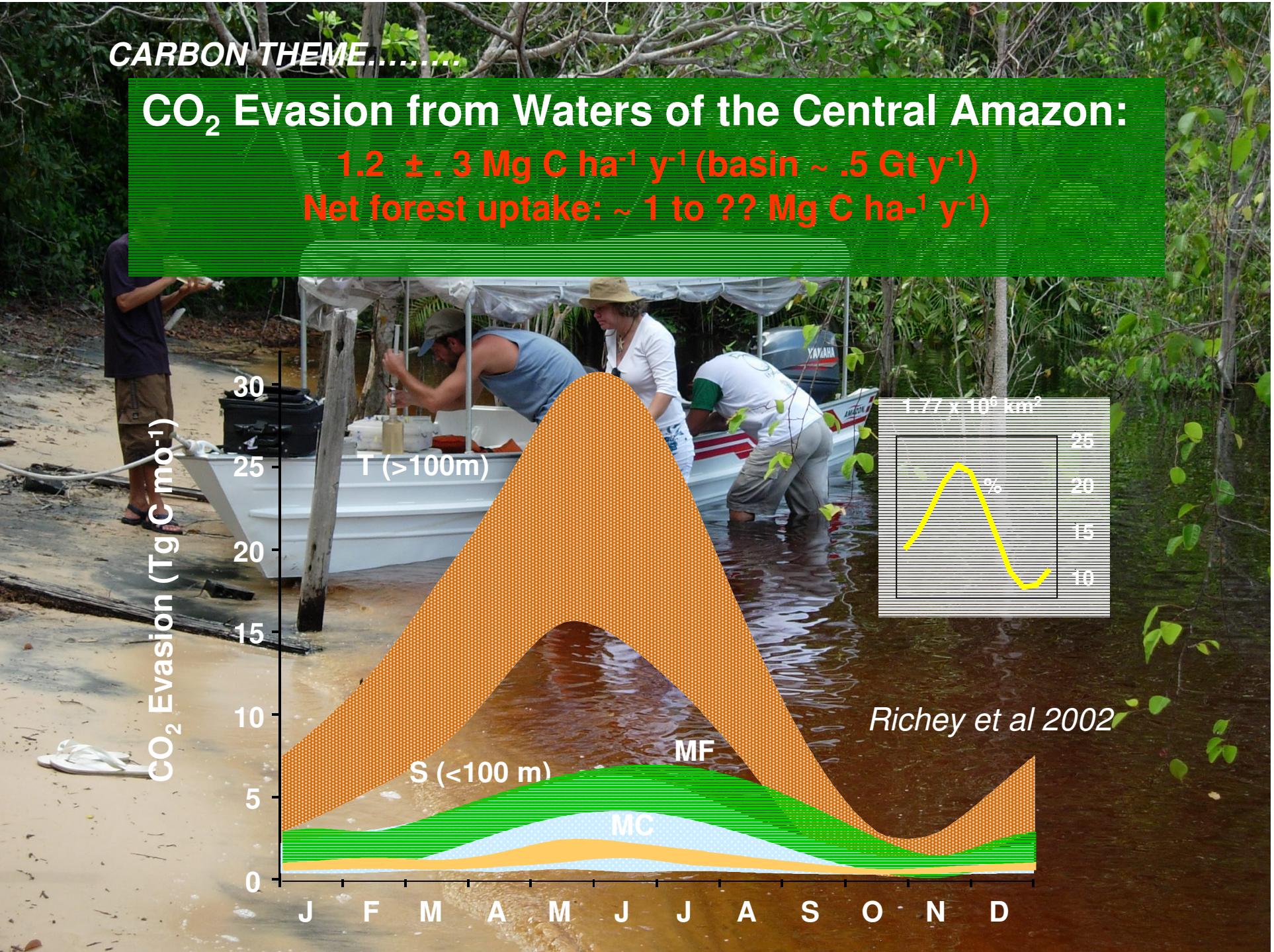
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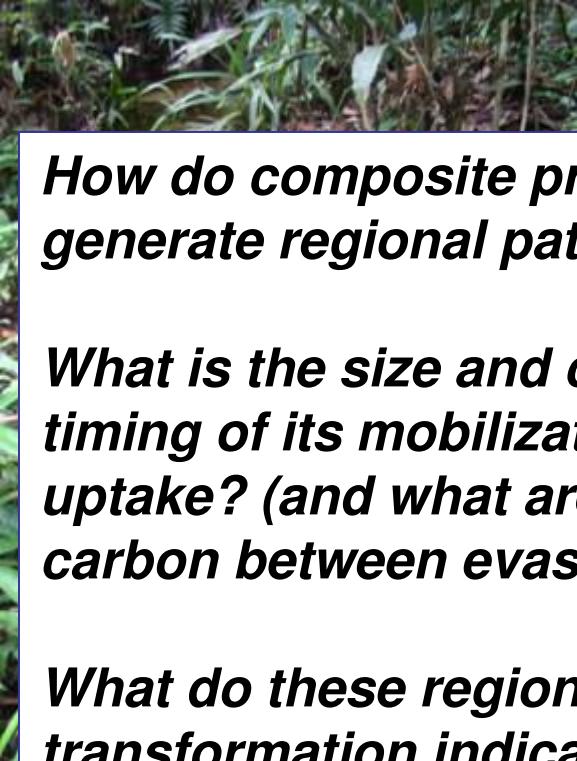
20

15

10

Richey et al 2002





How do composite processes of land-water interactions scale up to generate regional patterns?

What is the size and character of the riverine carbon pool and the timing of its mobilization compared to net atmosphere-land carbon uptake? (and what are the factors controlling the partitioning of carbon between evasion and fluvial export?).

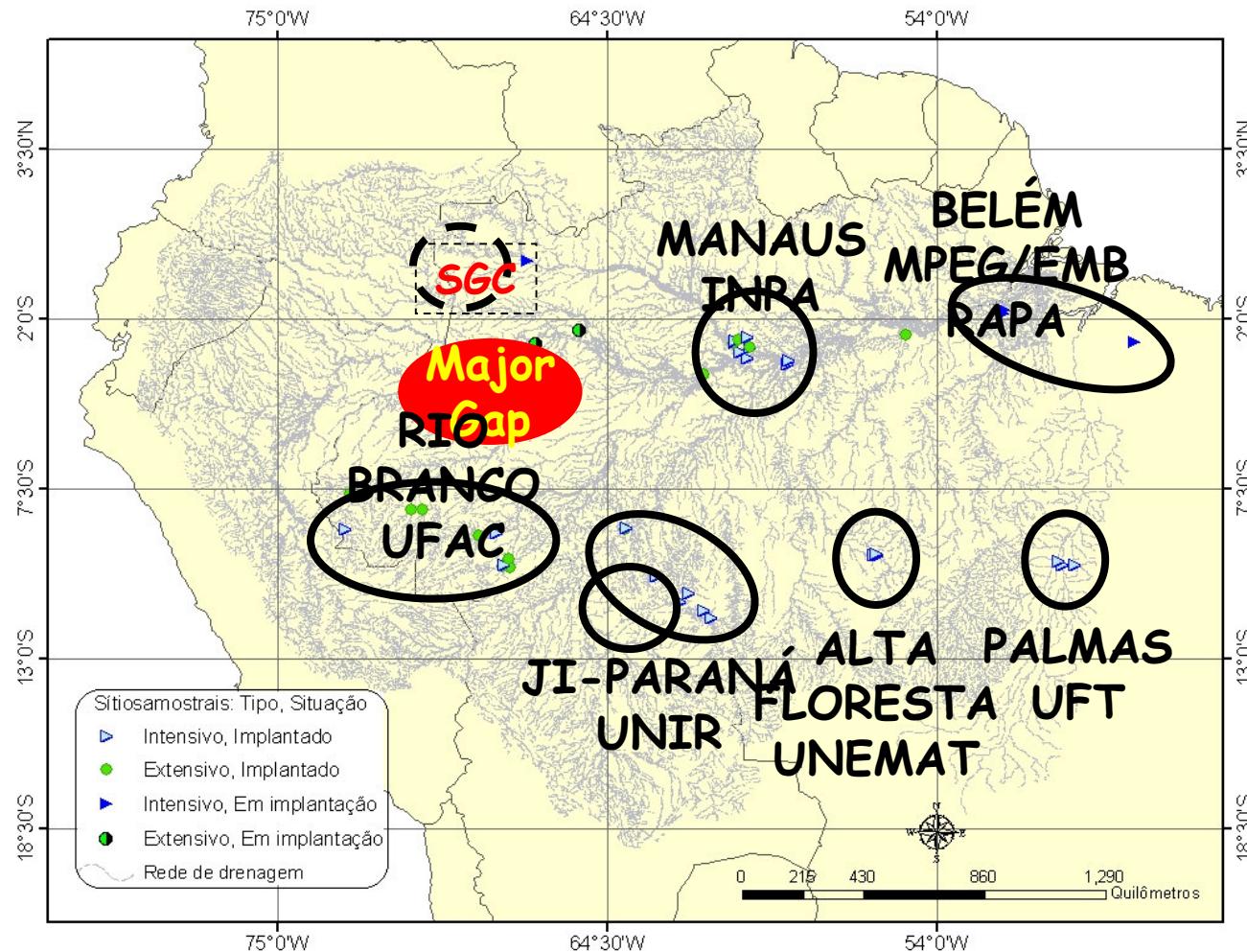
What do these regional patterns in carbon transport and transformation indicate about the overall relation among water movement, landscape structure (topography, soils), and vegetation structure and productivity across the Amazon basin?

What are the effects of climate variability and human forcing on water and fluvial carbon mobilization?

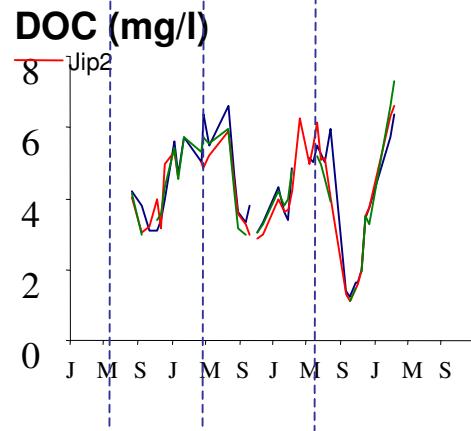
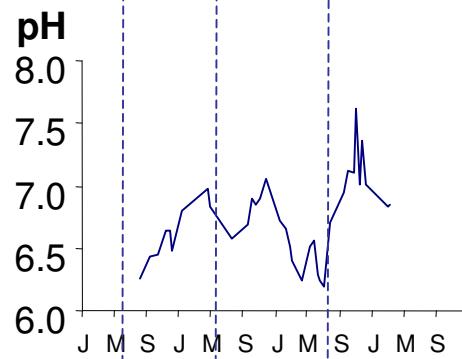
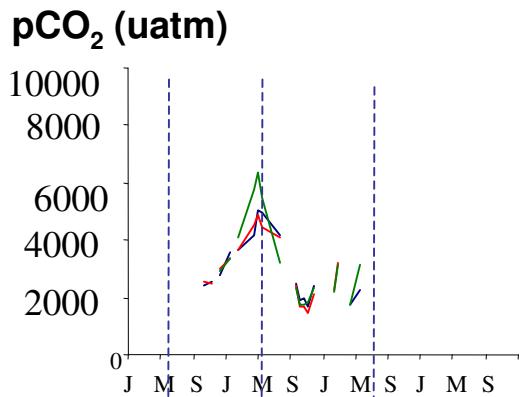
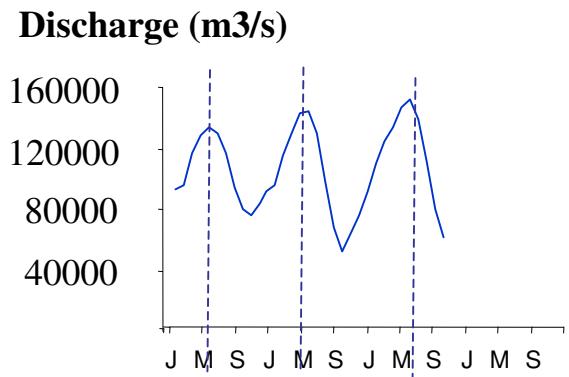


REDE BEIJA-RIO

Maestro: Alex Krusche



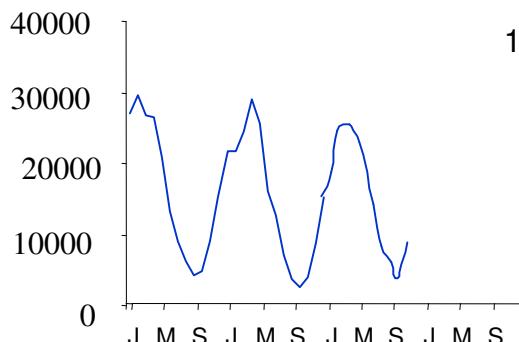
Solimoes (Manacapuru)
2004-2007



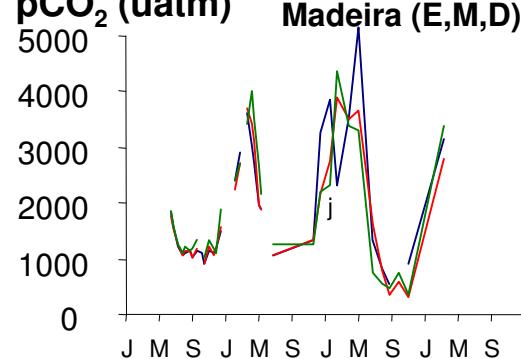
Madeira (Porto Velho)

2004-2007

Discharge (m³/s)

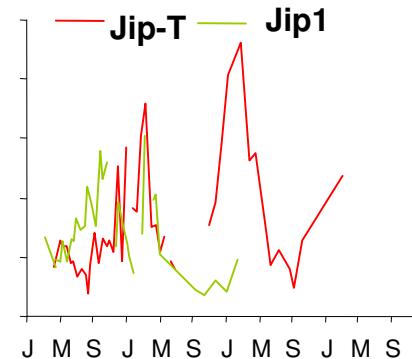


pCO₂ (uatm)

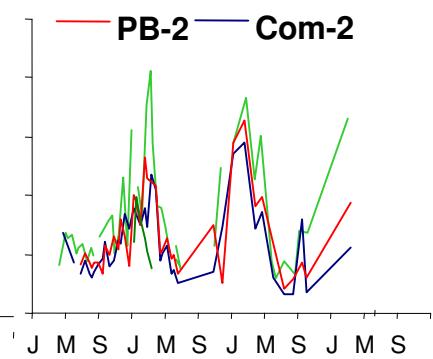


Madeira (E,M,D)

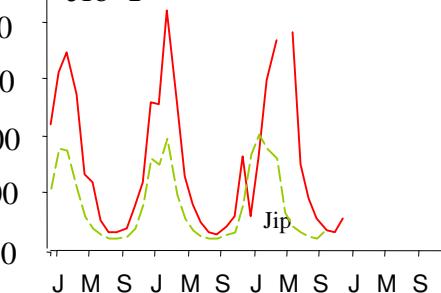
Jip-T **Jip1**



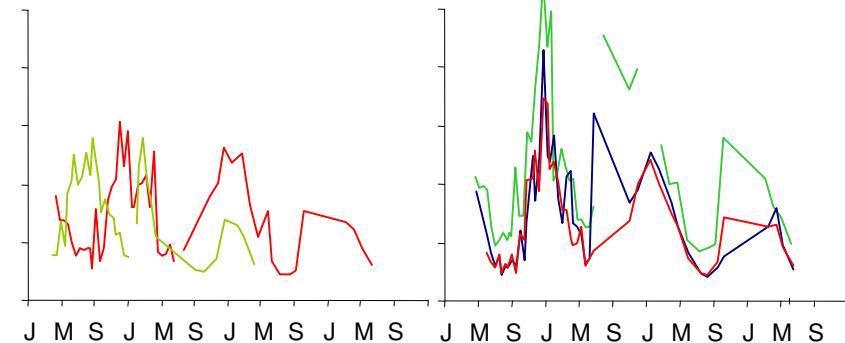
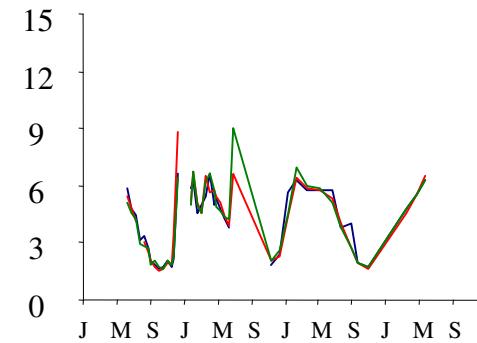
Uru
PB-2 **Com-2**



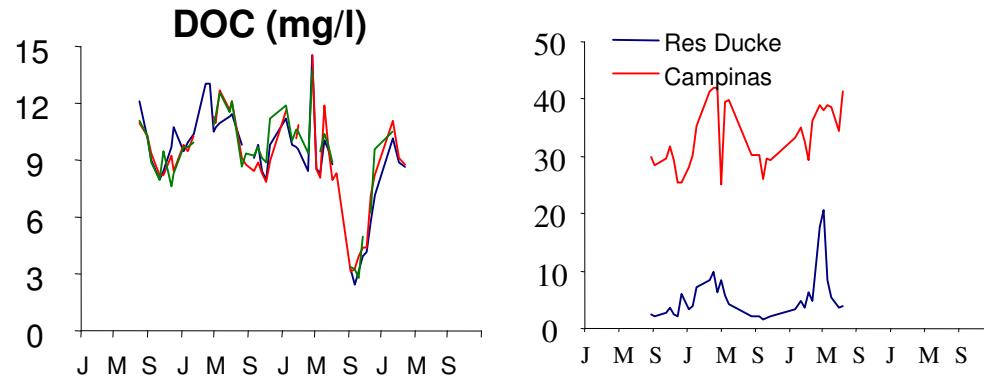
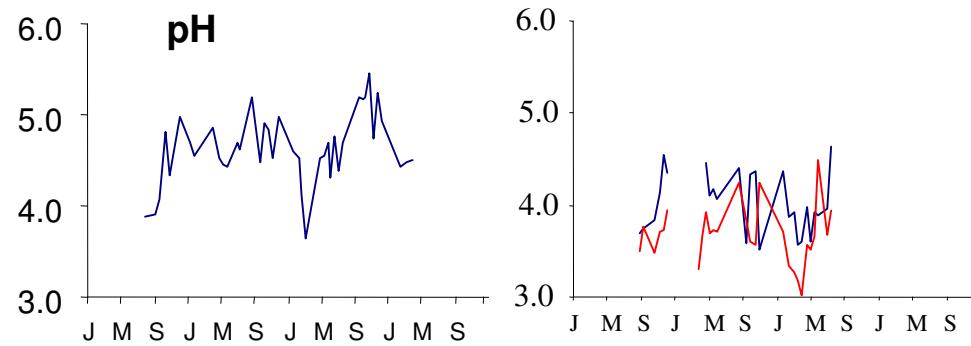
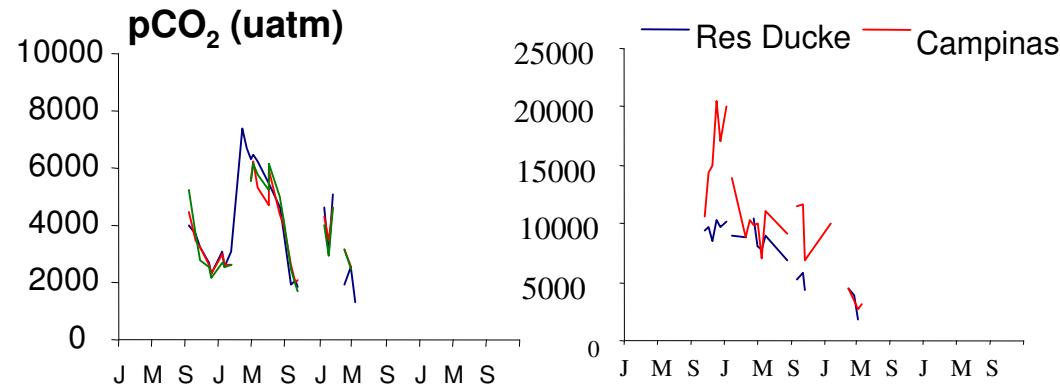
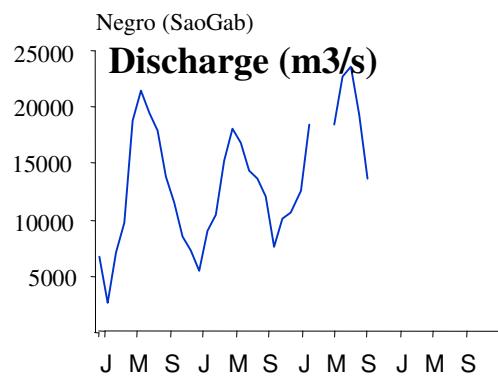
Jio-T



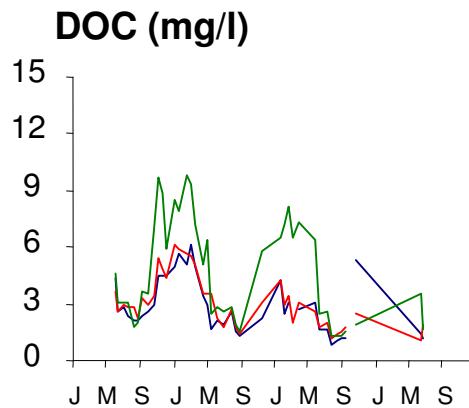
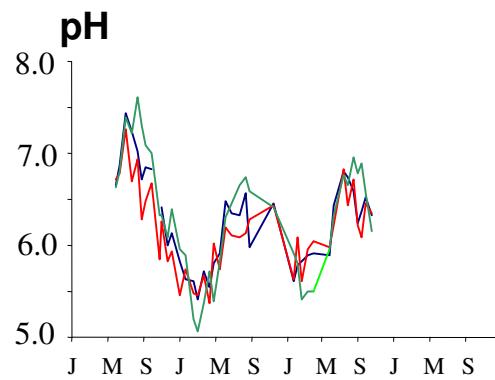
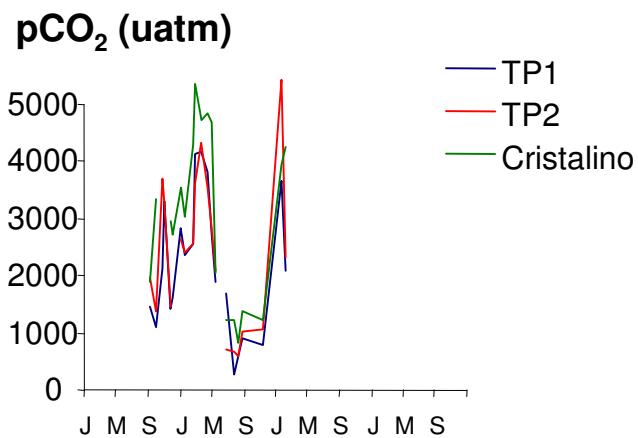
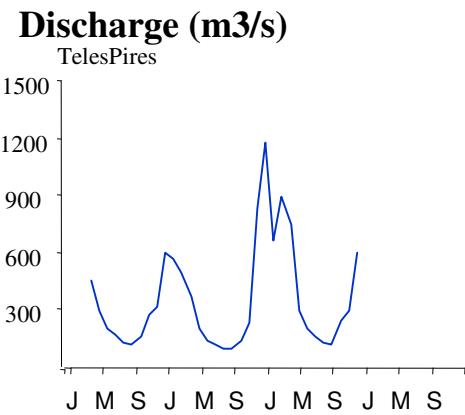
DOC (mg/l)



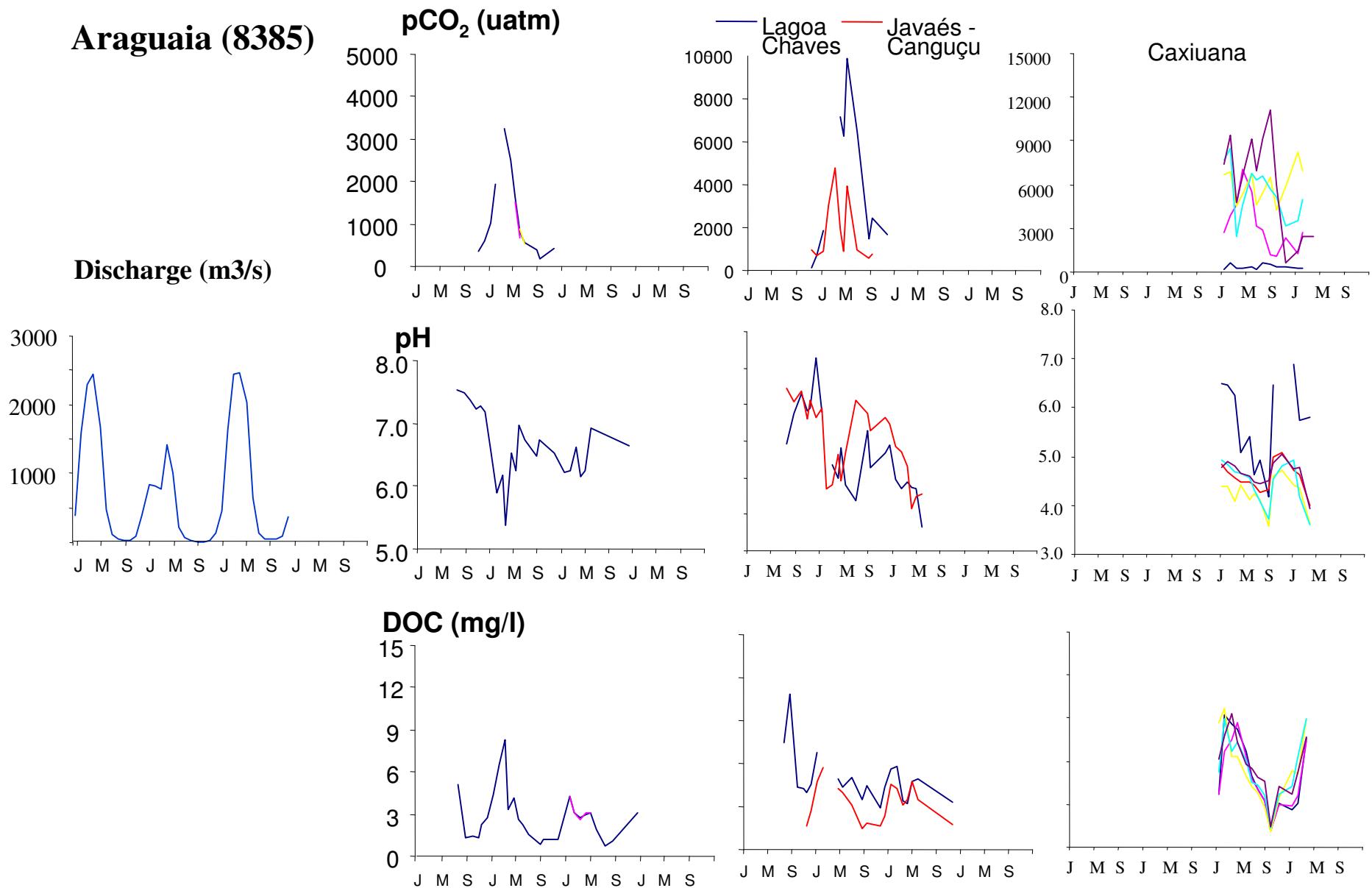
Rio Negro 2004-2007

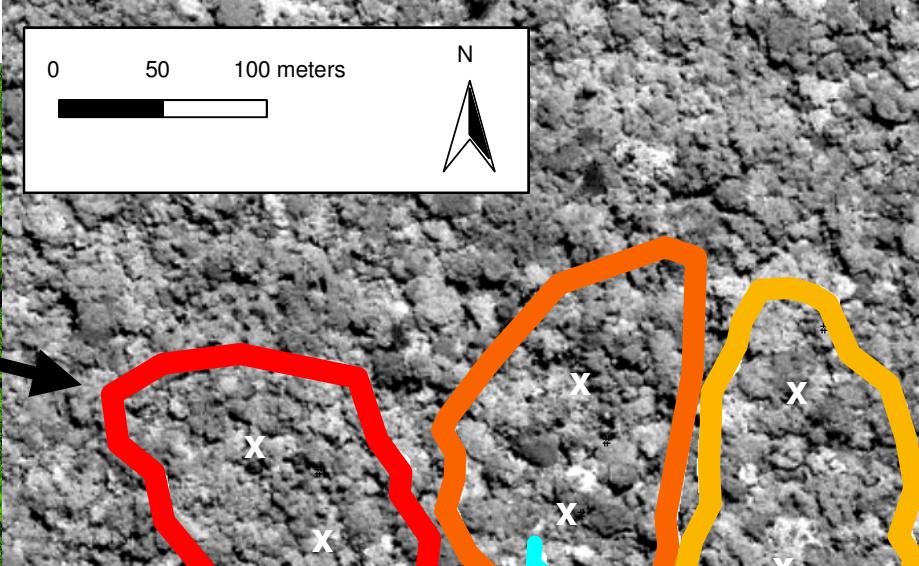


Teles Pires (upper Tapajós) 2004-2007



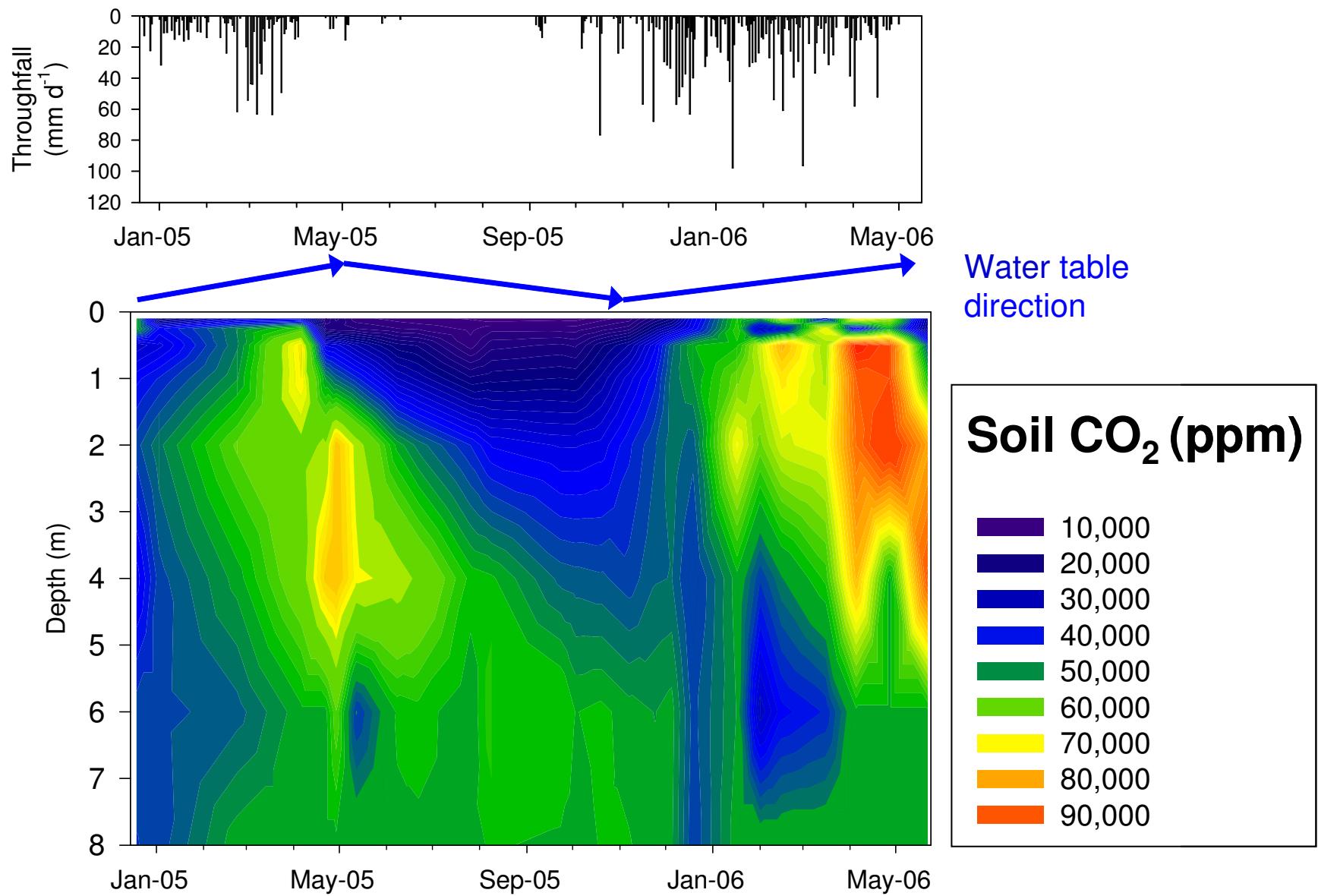
Araguaia (8385)





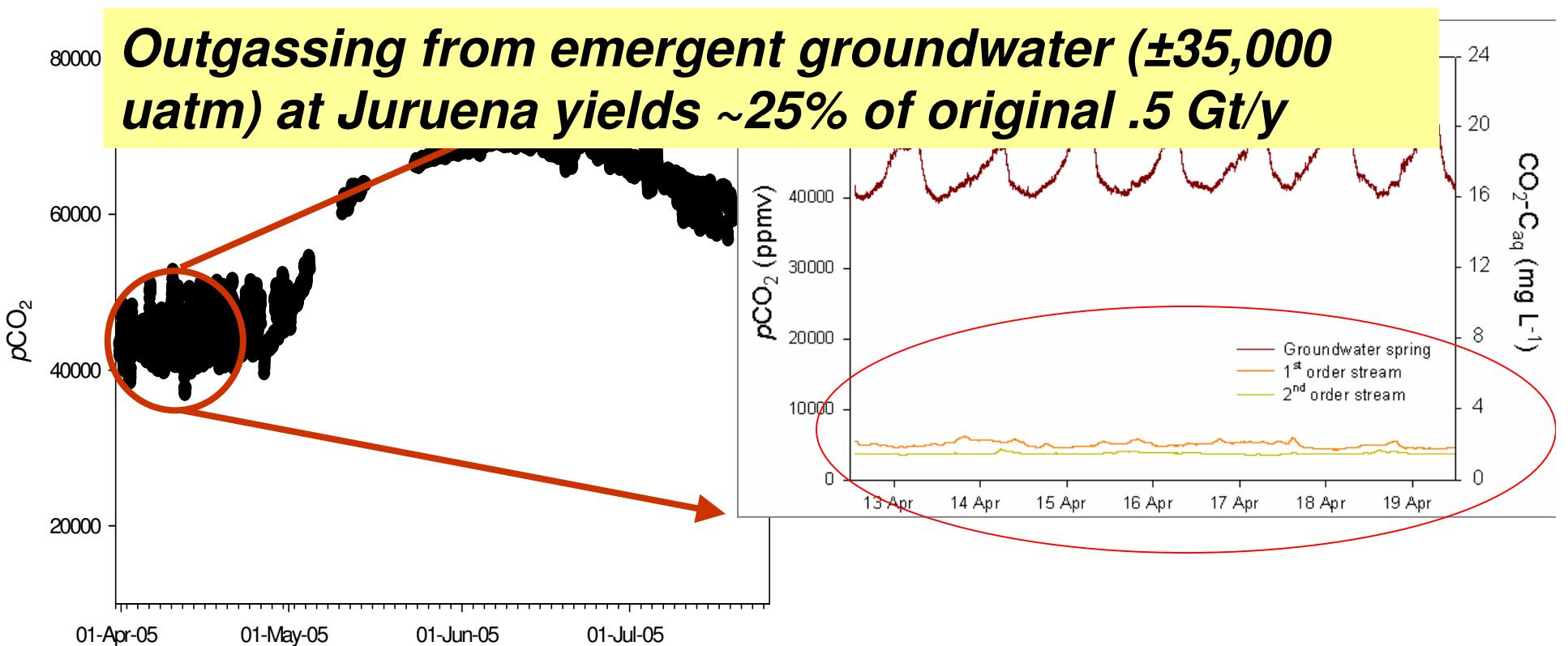
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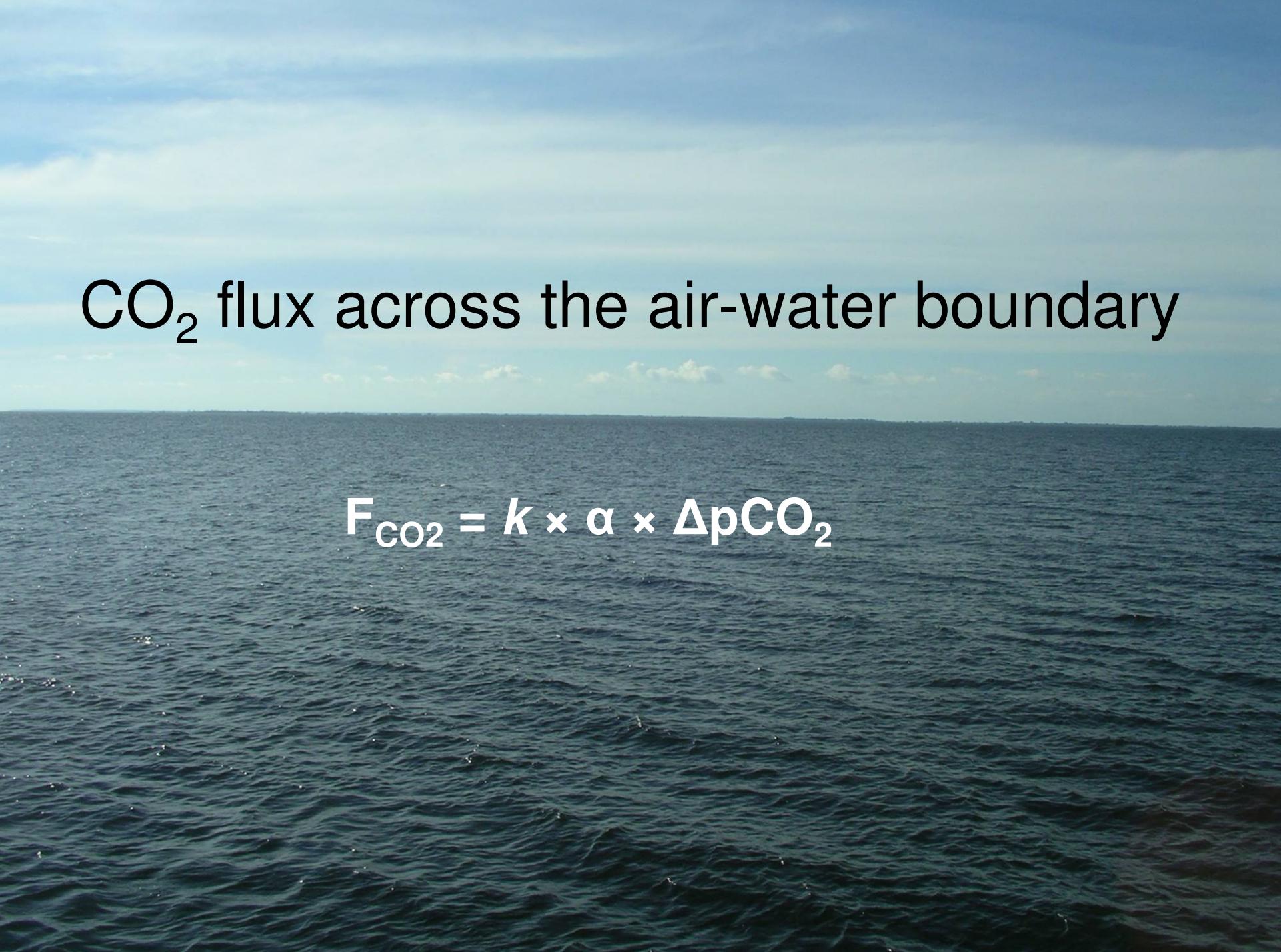
Seasonality of CO₂ in soil atmosphere



Temporal/spatial $p\text{CO}_2$ variability

- Seasonal and diurnal variability in $p\text{CO}_2$ of emergent groundwater



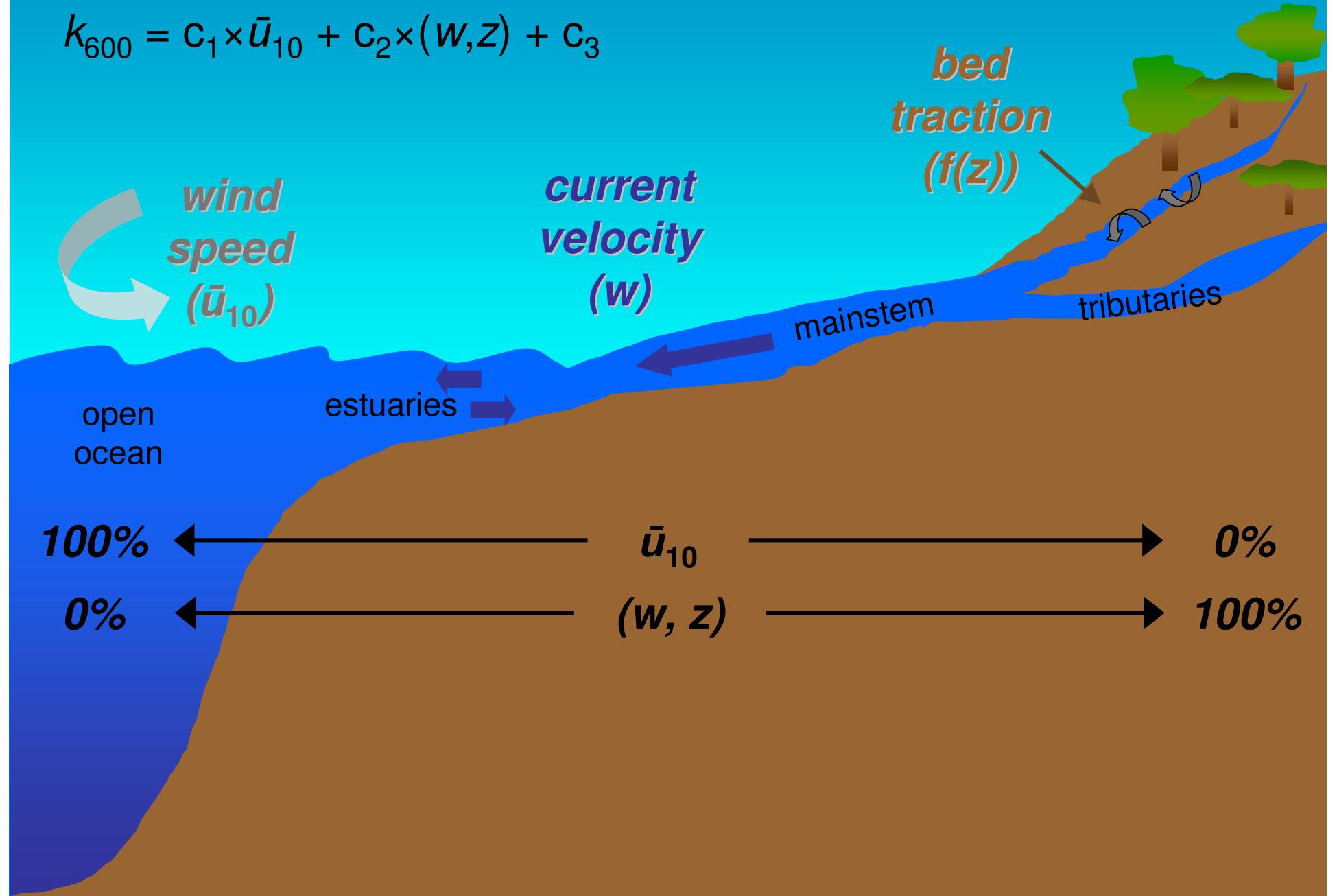


CO_2 flux across the air-water boundary

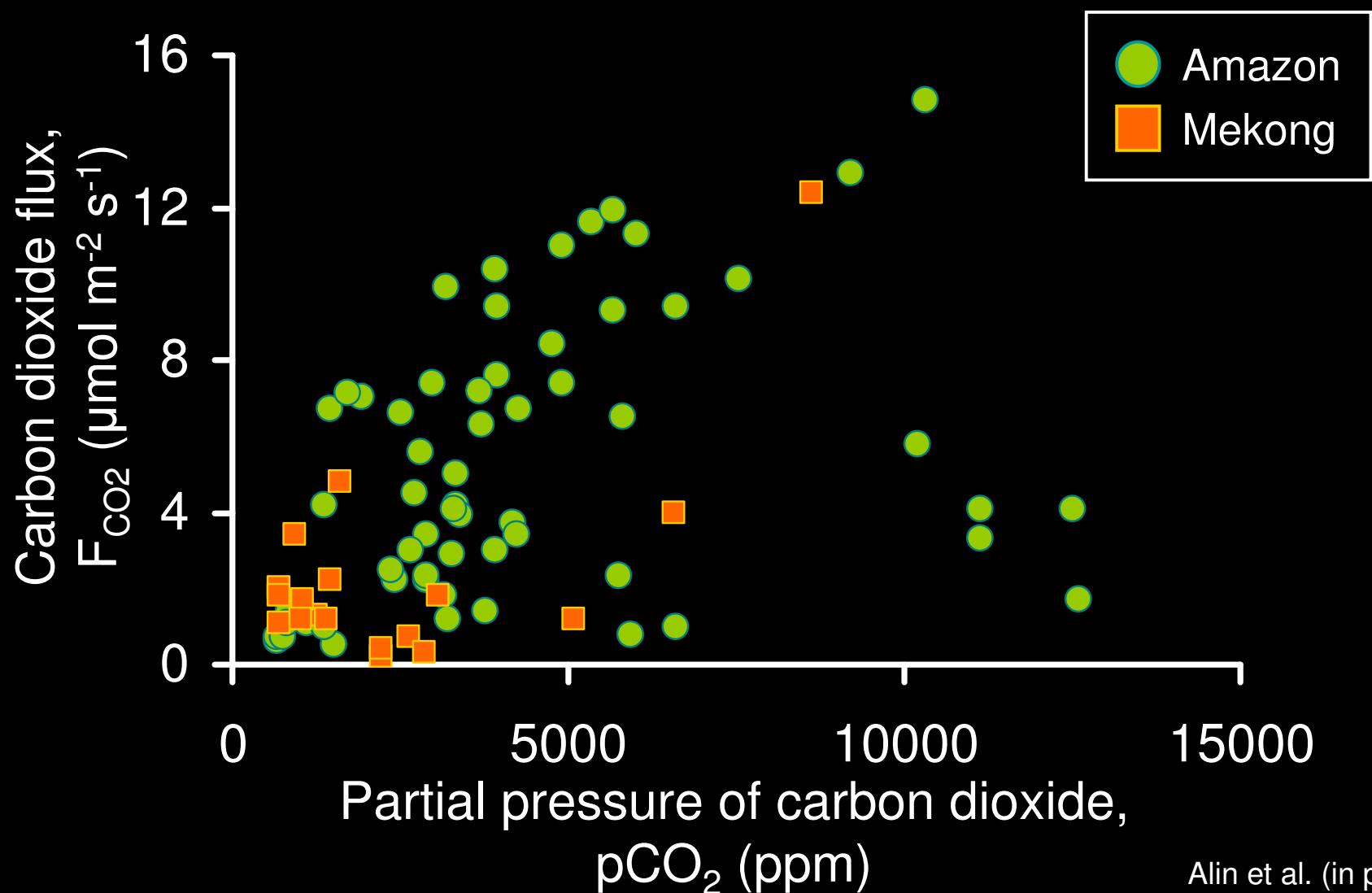
$$F_{\text{CO}_2} = k \times \alpha \times \Delta p_{\text{CO}_2}$$

Gas exchange continuum

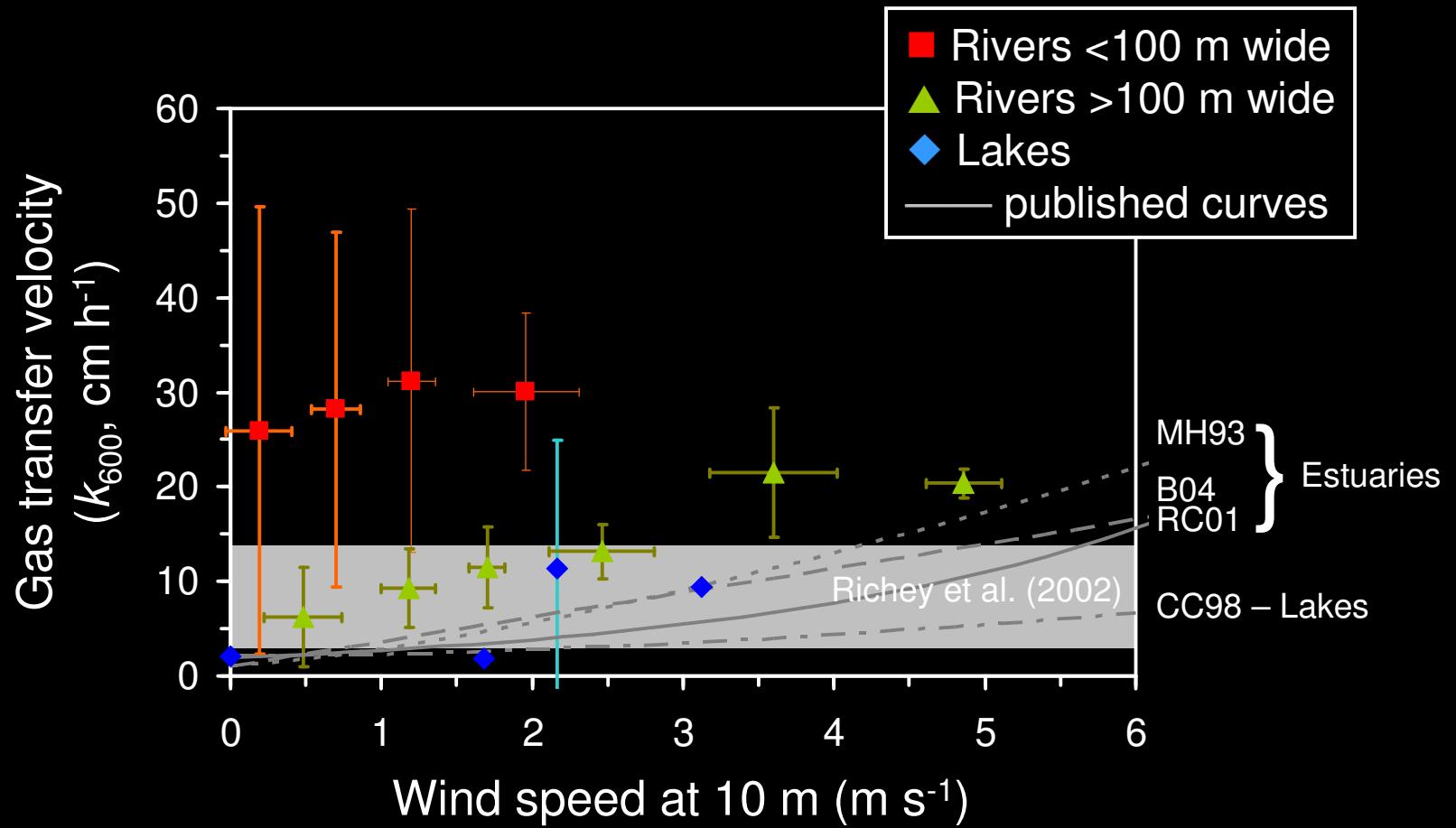
$$k_{600} = C_1 \times \bar{u}_{10} + C_2 \times (w, z) + C_3$$



CO_2 outgassing in the Amazon and Mekong basins



Gas transfer velocity across environment types



Environmental control of gas exchange velocity:

w = water current velocity (cm

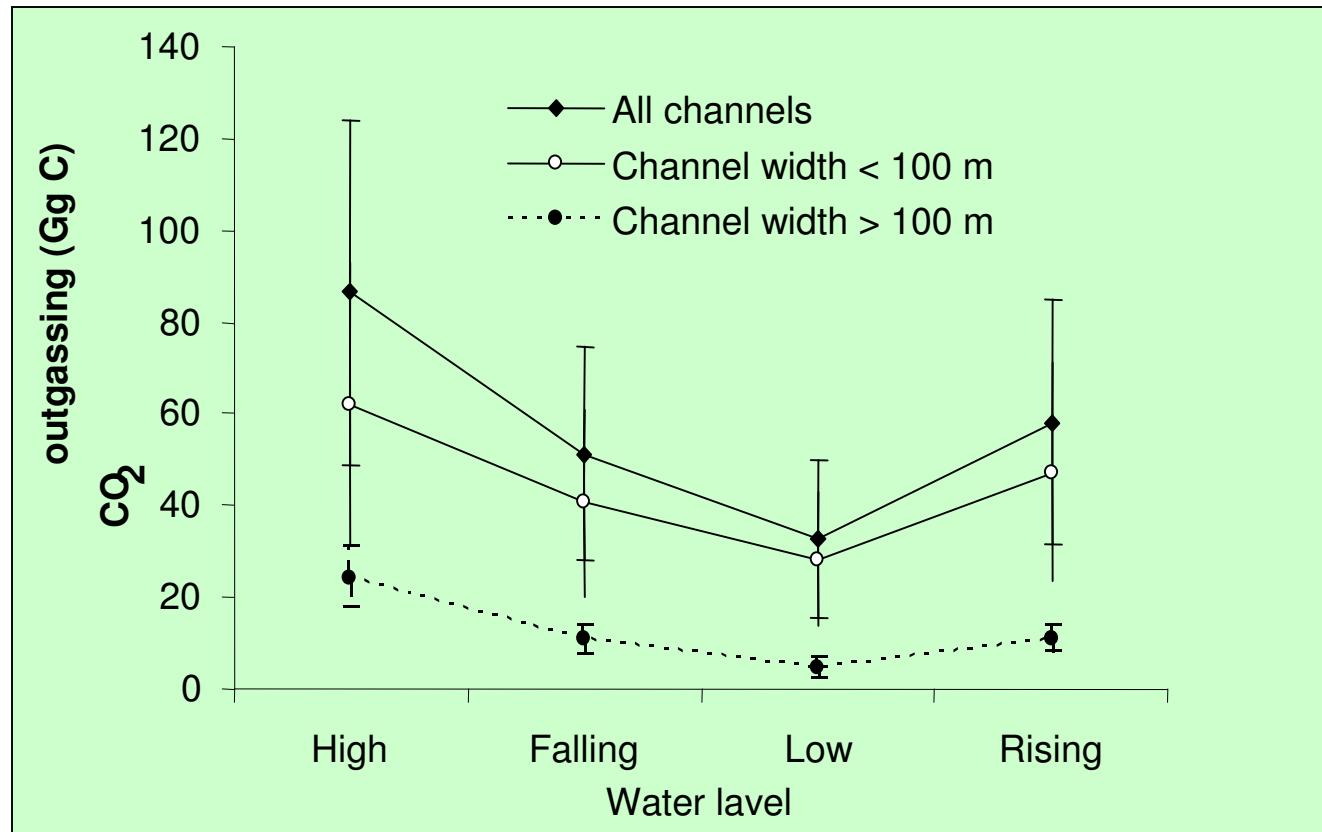
s^{-1})

z = water depth (m)

Alin et al. (in prep)

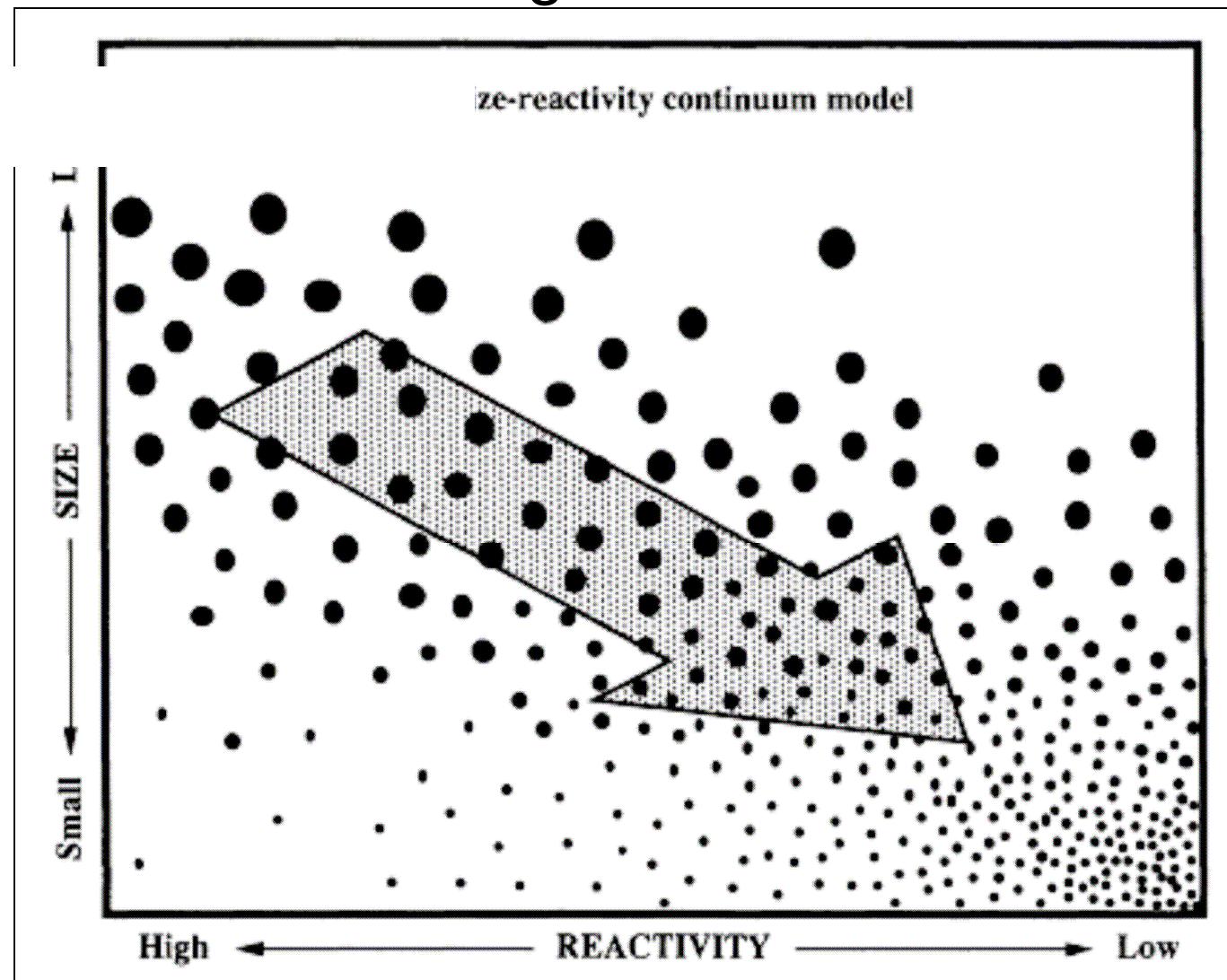
“Small river surface areas and their role in CO₂ outgassing for local and regional net carbon emissions in the southwestern Amazon River Basin”

Maria de Fátima F.L. Rasera et al

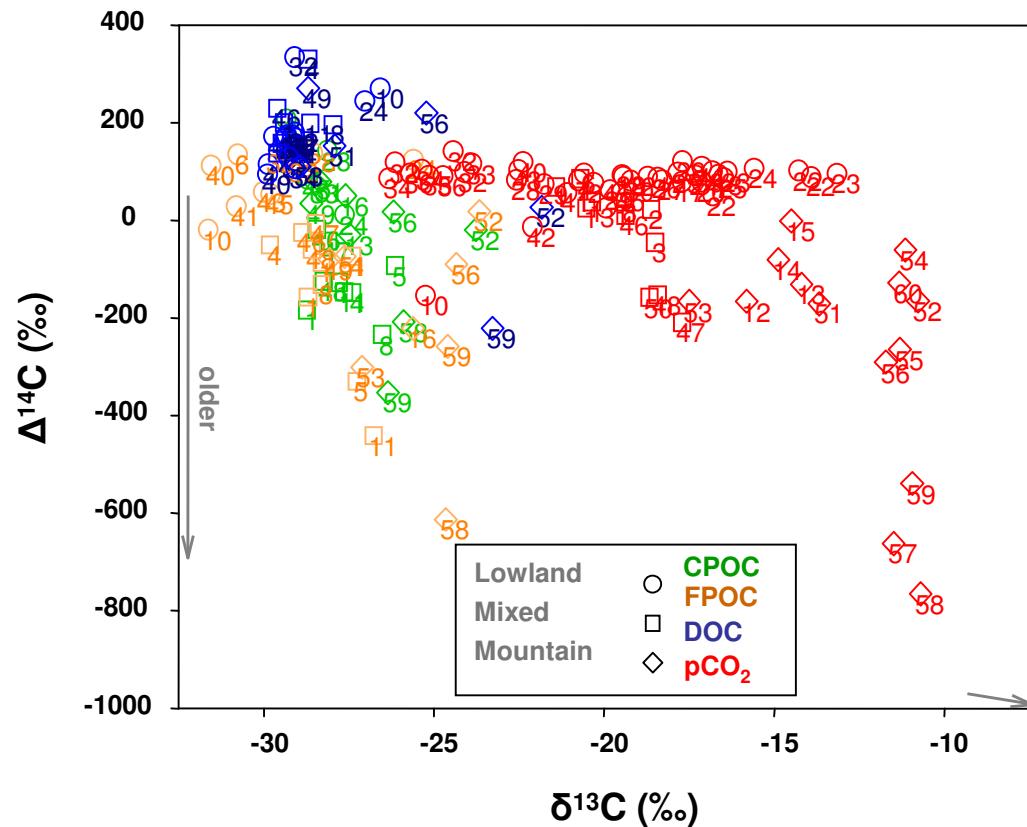


CO₂ outgassing totals 86 ± 47 Tg C yr⁻¹, releasing to the atmosphere about 31.5 Tg yr⁻¹ (or, 51% more carbon than our previous results.

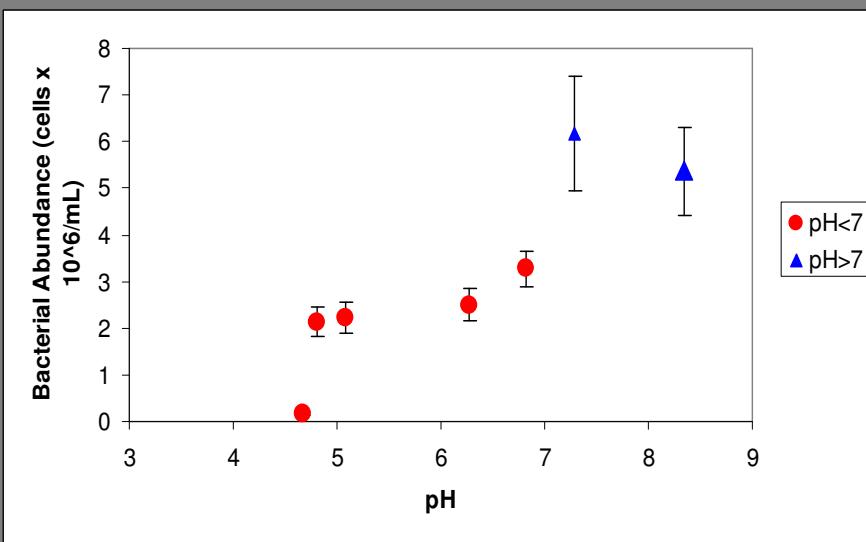
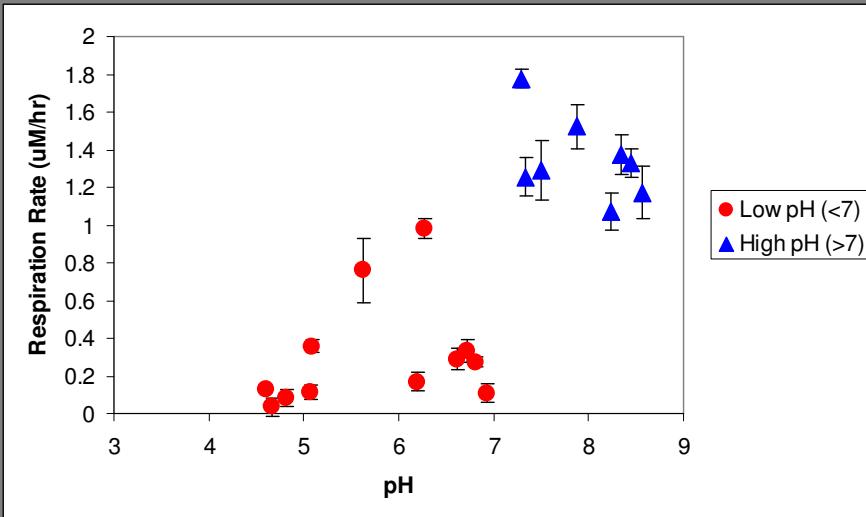
High Molecular Weight DOC Selectively Degraded



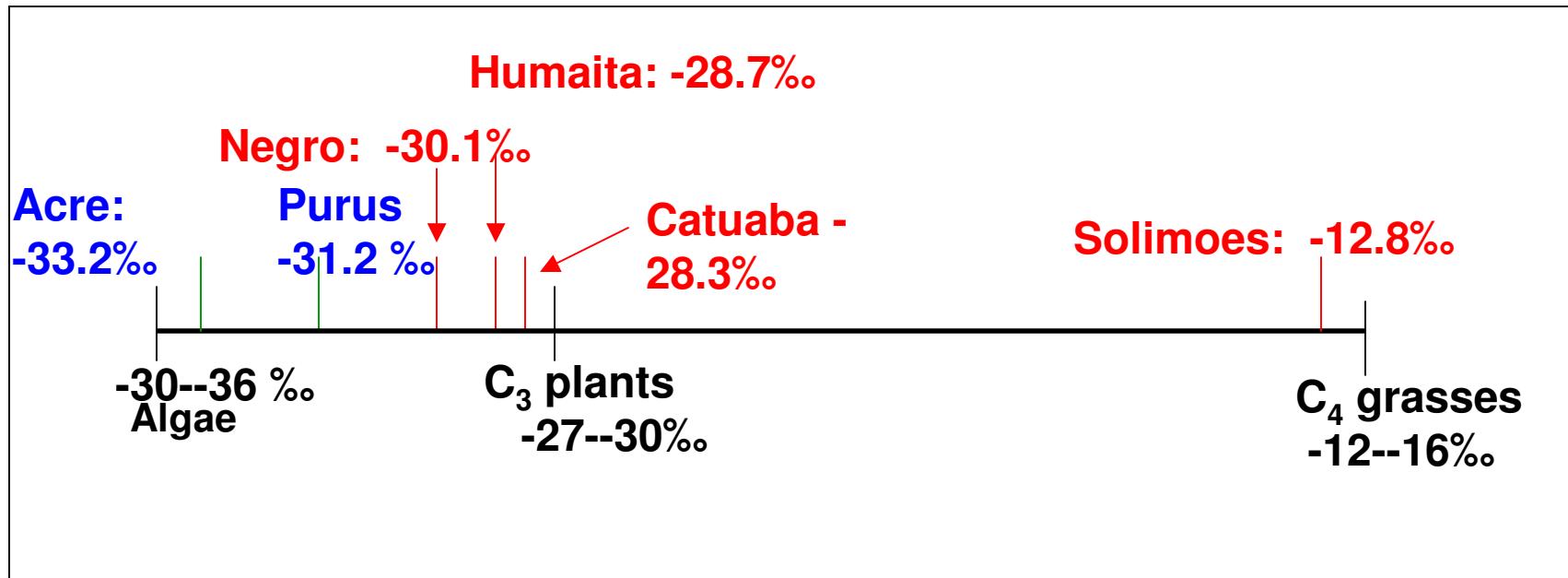
2005 (Mayorga et al) Isotopic Constraints on C Cycling “Young Carbon being respired”



The Importance of pH, Particulate Carbon, and Photosynthesis in Controlling Water-Column Respiration Rates in the Central and Southwestern Amazon Basin – Erin Ellis et al

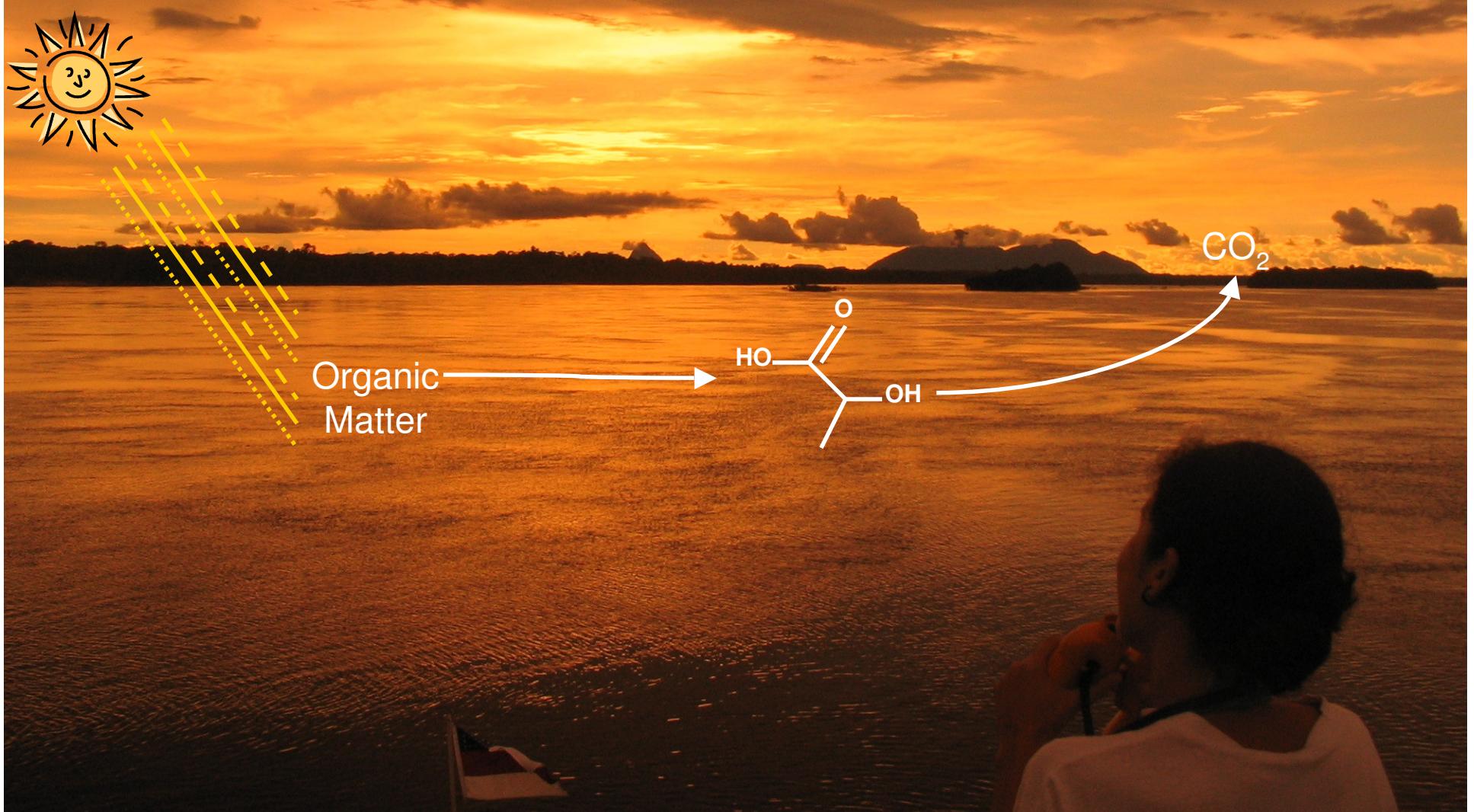


Sources of Respired CO₂

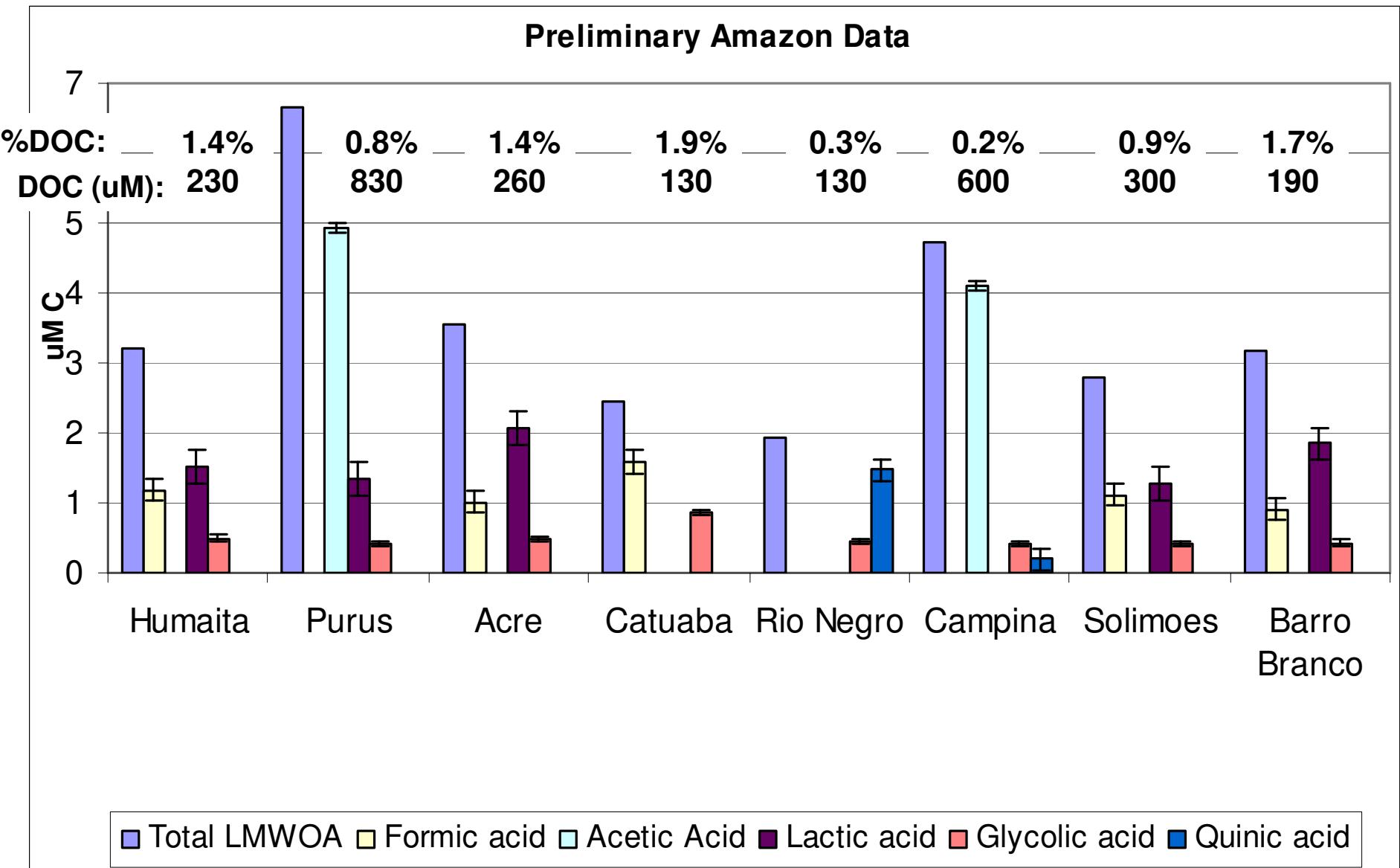


Photochemical production of low molecular weight organic acids in the Rio Negro

Sonya Marie Remington et al



Ambient LMWOA concentrations are low relative to total DOC concentration.



Measure photochemical production rate in Rio Negro

Apr '07:

$7.5 \mu\text{M LMWOA-C hr}^{-1}$



*The photochemical production rate
of LMWOAs in the Rio Negro is a
order of magnitude larger than
measure respiration rates.*

Quartz test tubes.

Dark controls.

4-8 hour incubations in
natural sunlight.

Light sensor.

Potential CO₂ Sources & Timing

.... And much more data being analyzed – but answer “not quite in”...

- Patterns of Hydrograph/pCO₂/pH/DOC exhibits a high degree of “environmental coherence” across scales, from seeps to big rivers; likely differentiated by local/regional landscapes
- 2002 estimate seems conservative
- *How to dial in to overall basin Carbon budget – is the land/water coupling and fluvial system ‘de-coupled’ to some extent from the upland, and how do you “count” it?*