Storm pulses of dissolved CO_2 in a forested headwater Amazonian stream explored using hydrograph separation

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LBA-ECO 11th Science Team Meeting

Amazon research focus

- Carbon balance of the Amazon
  - Is the Amazon a C source or sink?
- Importance of fluvial C fluxes
  - Terrestrial CO_2 efflux from large rivers and wetlands: 353 Tg C yr^{-1} (Richey et al., *Nature* 2002)

http://eobglossary.gsfc.nasa.gov/Study/LBA_Escape/Images/co2_sources.jp

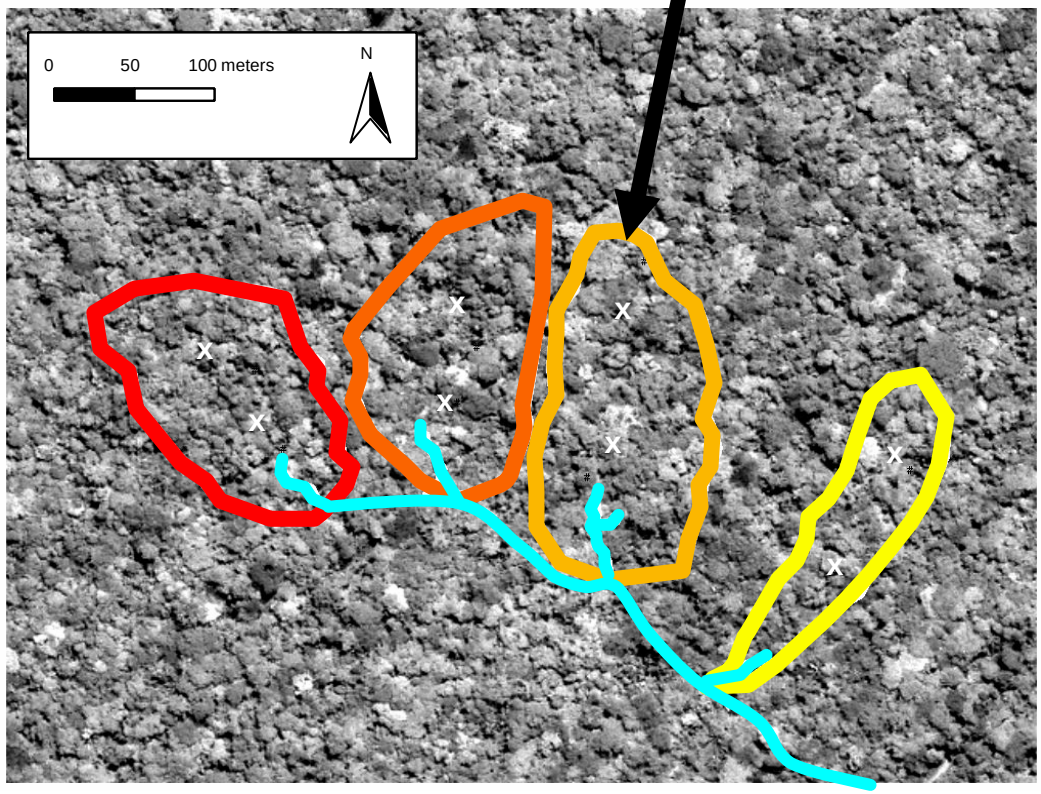
Orienting Question

- What are the key characteristics of fluvial carbon fluxes in headwater streams?
  - Headwater systems
    - terrestrial-aquatic connectivity highest of any spatial scale
    - ~70-80% of landscape

Site Description

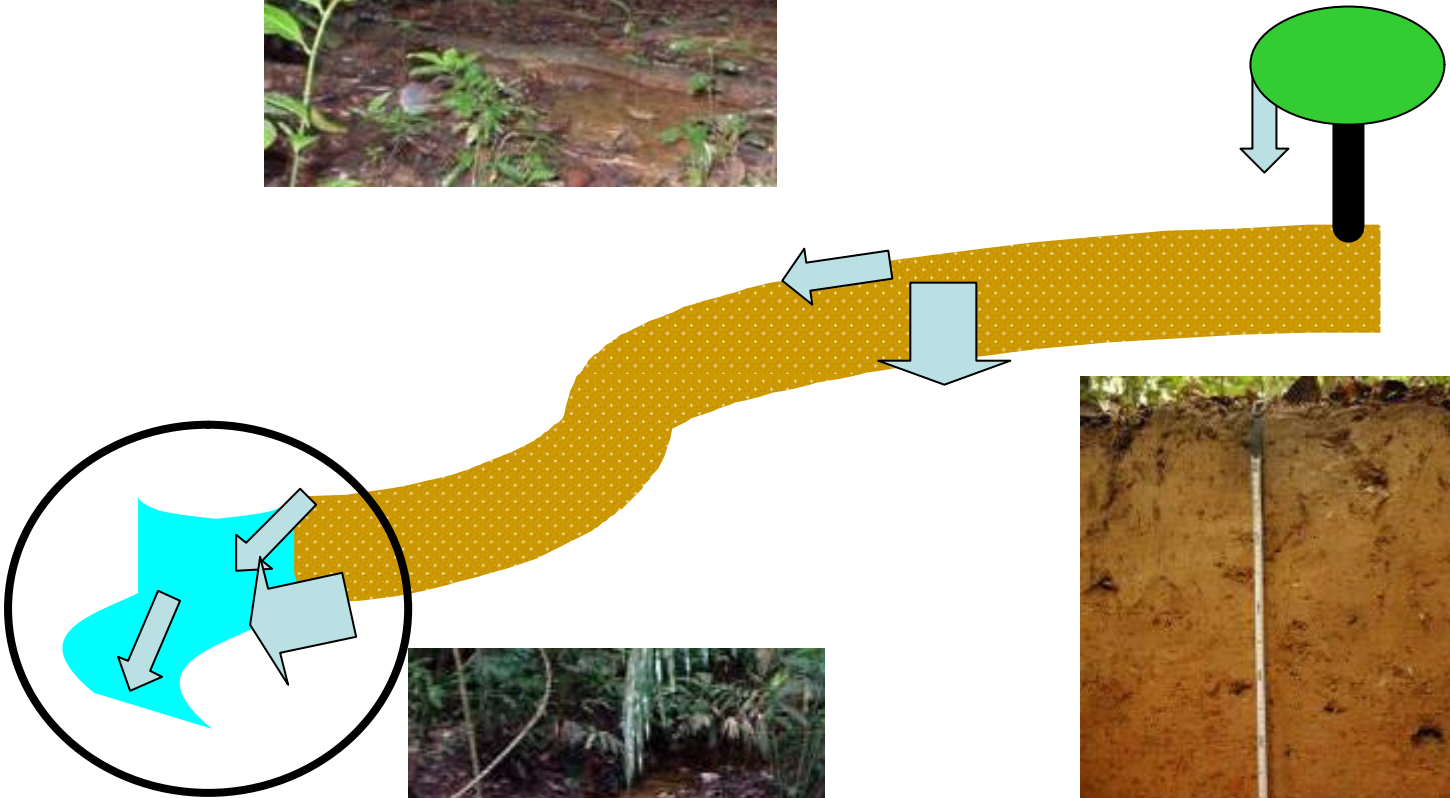
Juruena, Mato Grosso

Stormflow study Watershed



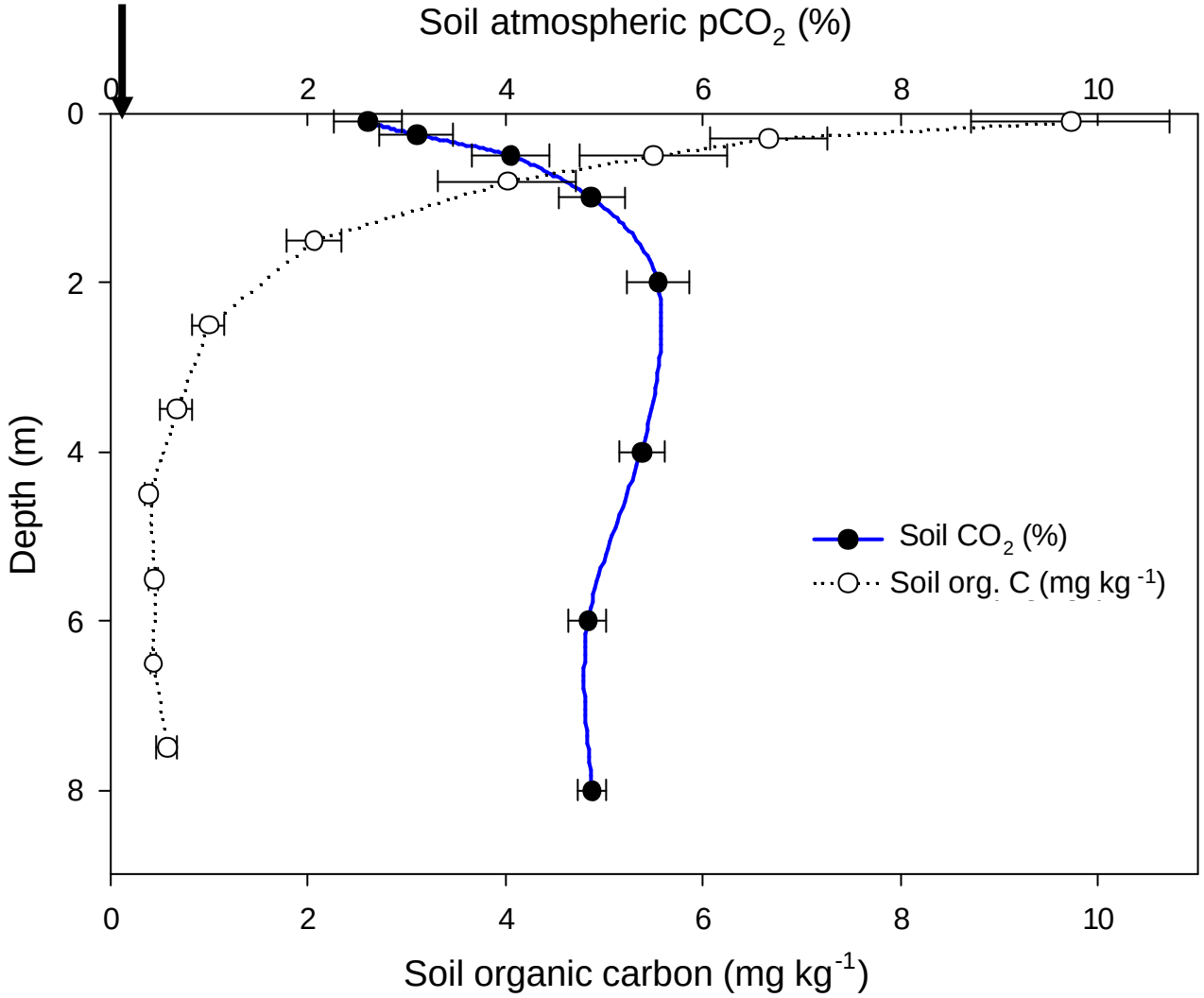
IKONOS Panchromatic Image (Courtesy EOS-Webster)

Rainfall-runoff, flowpaths and C



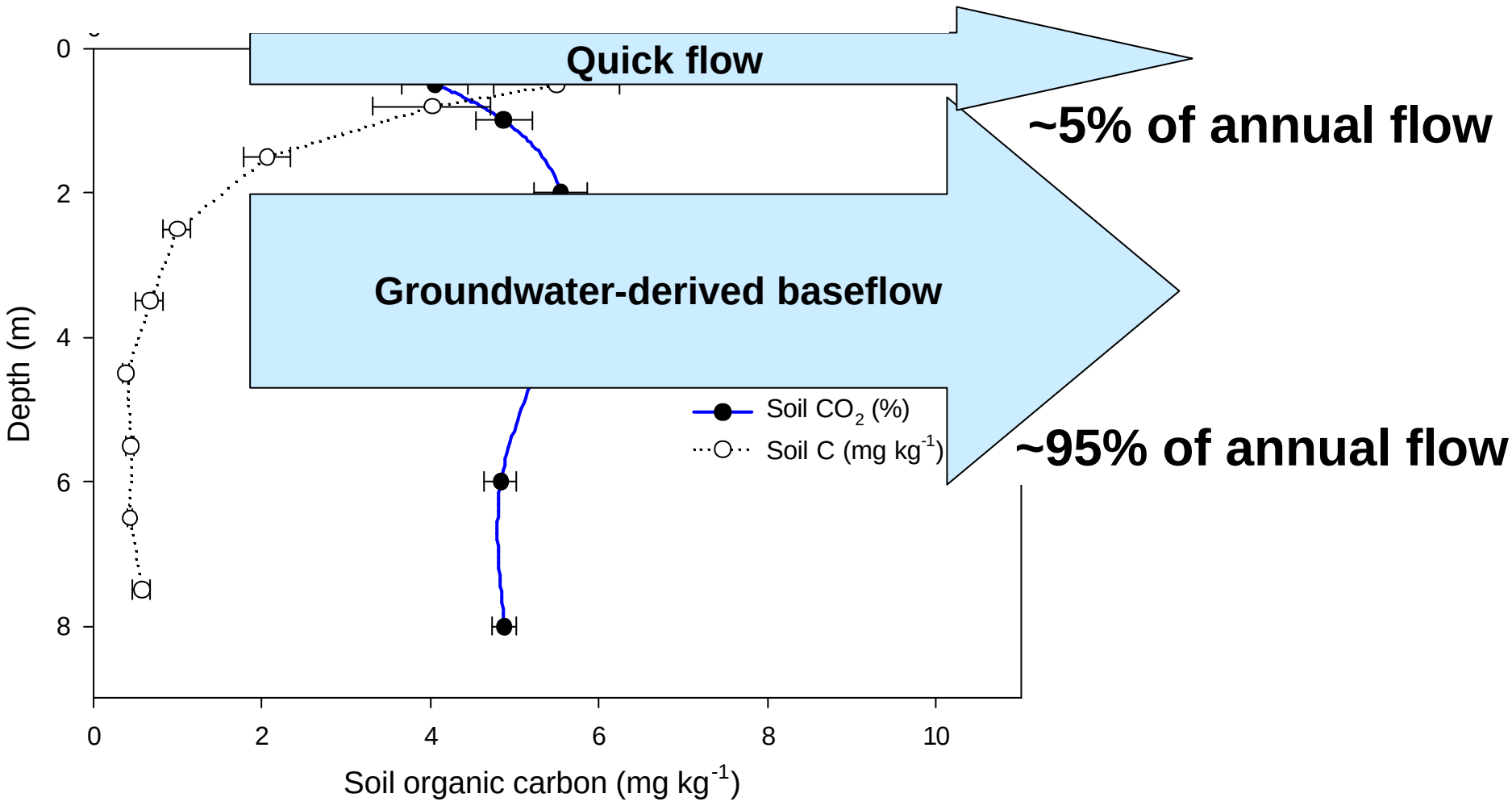
Carbon forms in soil

Atmospheric CO_2
(~400 ppm = 0.04%)



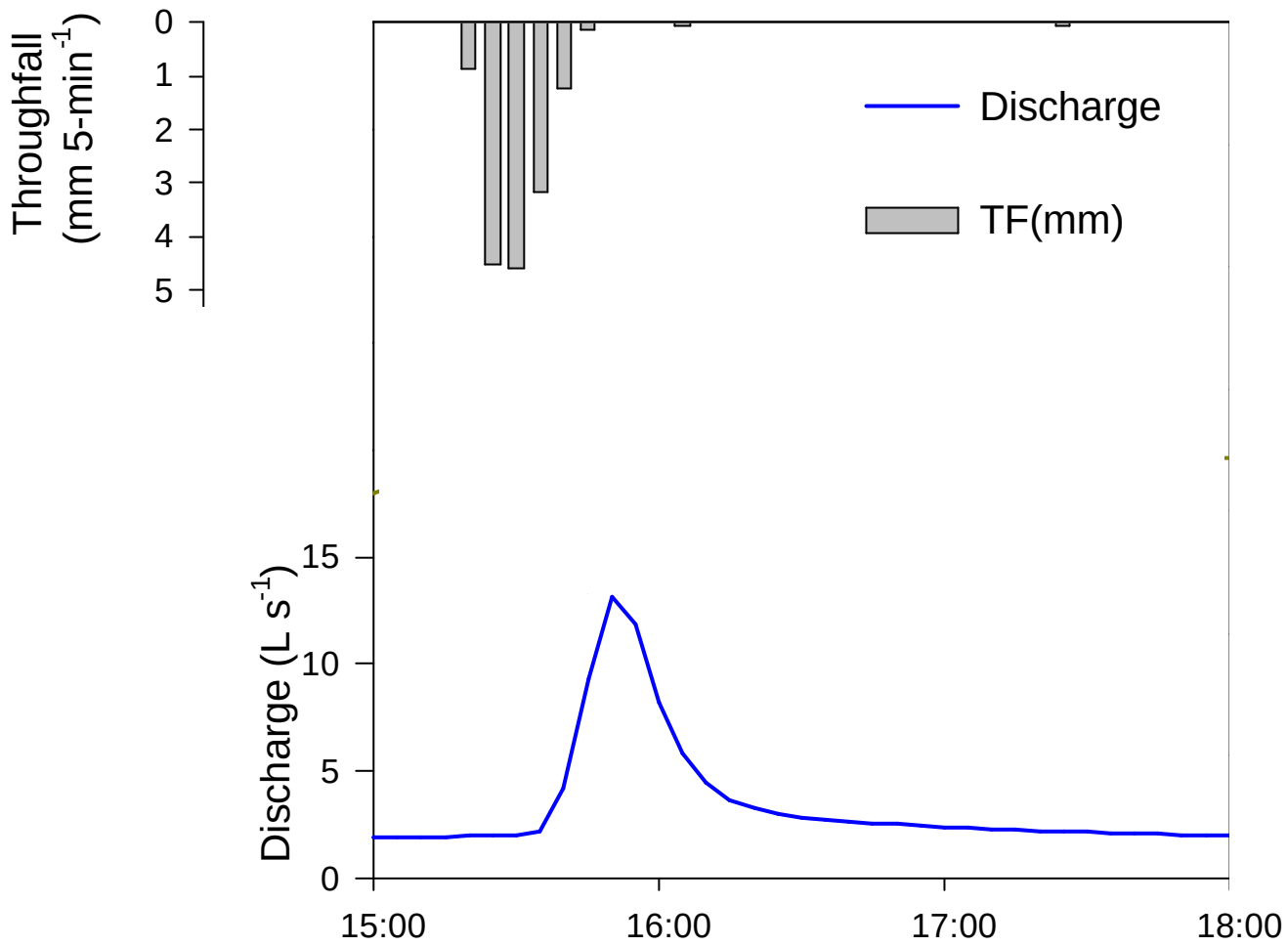
Johnson et al., Submitted.

Carbon forms in hydrologic flowpaths



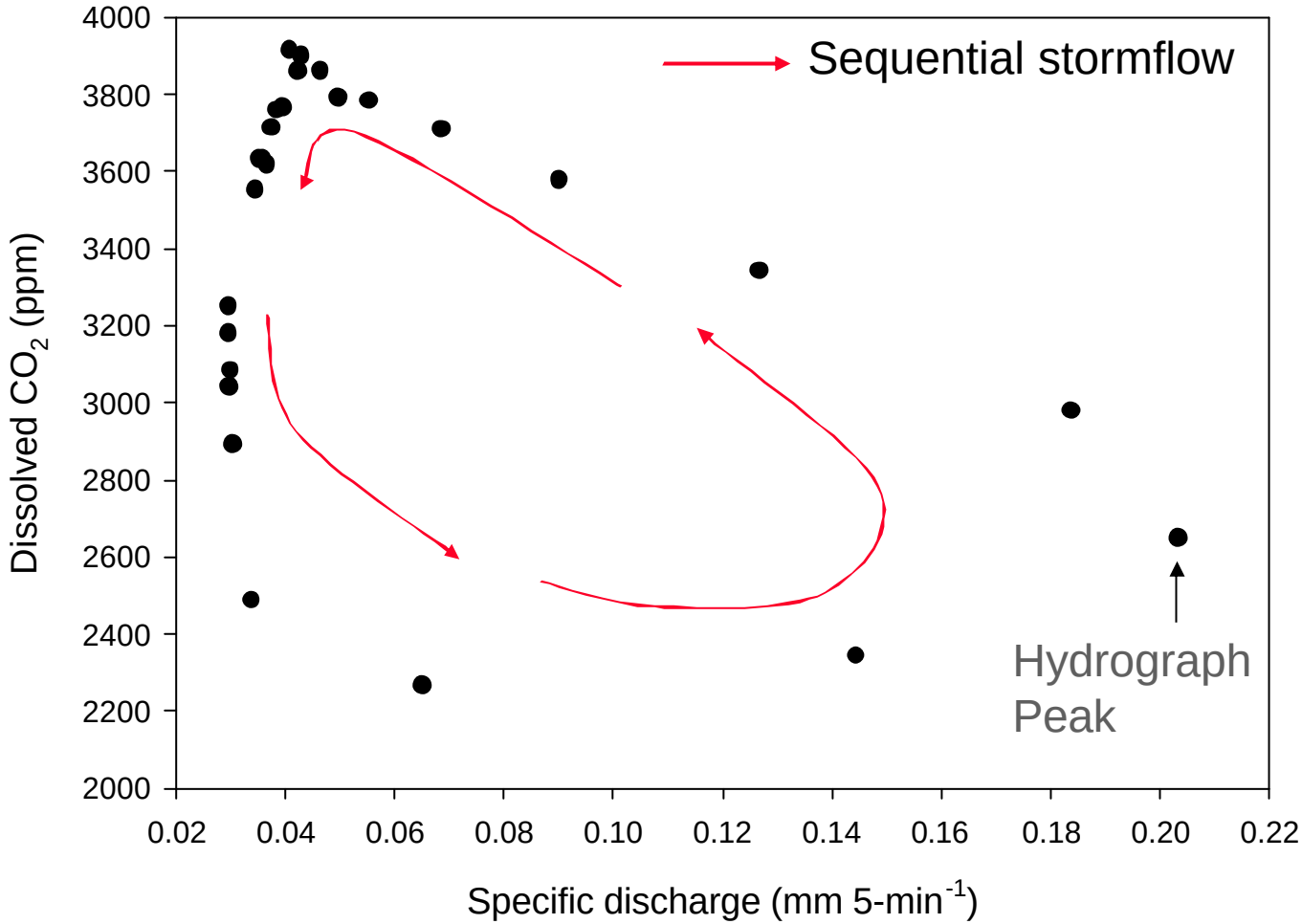
Johnson et al. 2006, Biogeochemistry.

Rainfall-runoff and the "CO_2 pulse"



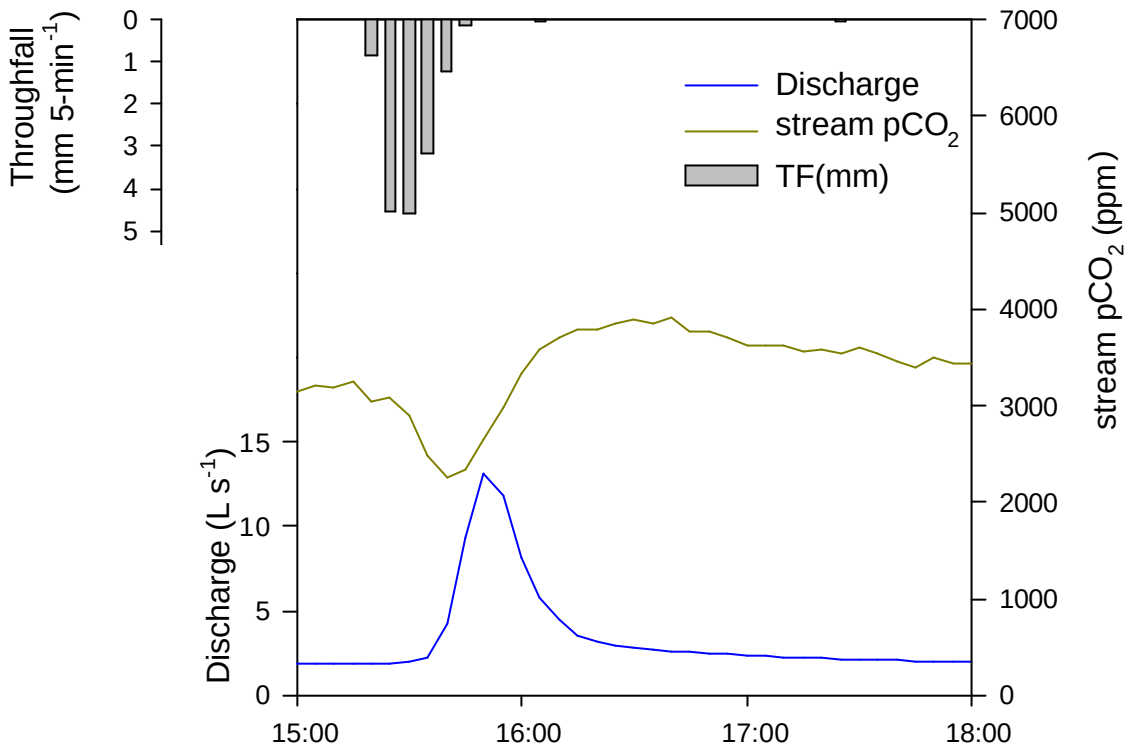
Johnson et al, (in press). *Water Resources Research*

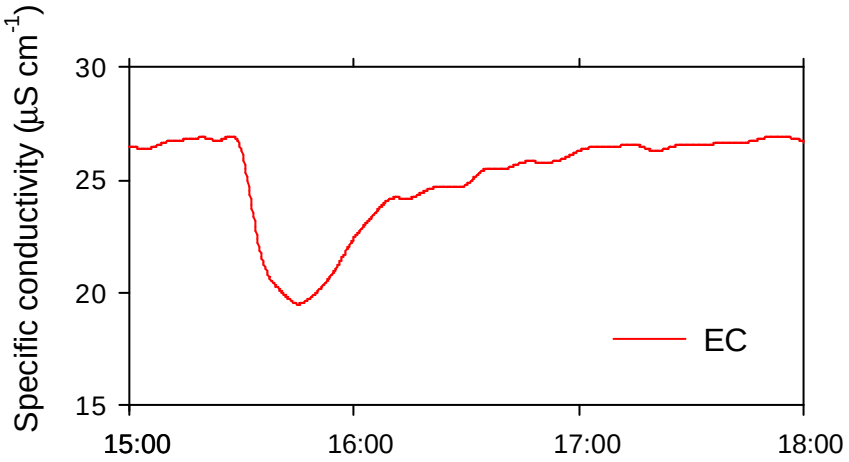
Hysteresis of dissolved CO_2 in stormflow



Johnson et al, (in press). *Water Resources Research*

Hydrograph Separation: TRANSEP

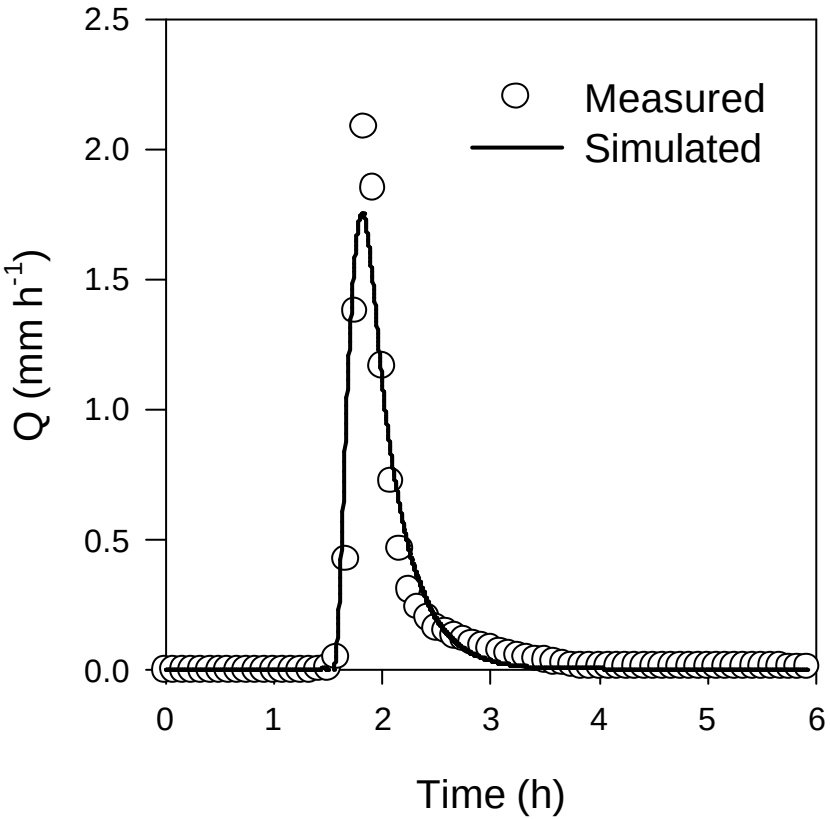




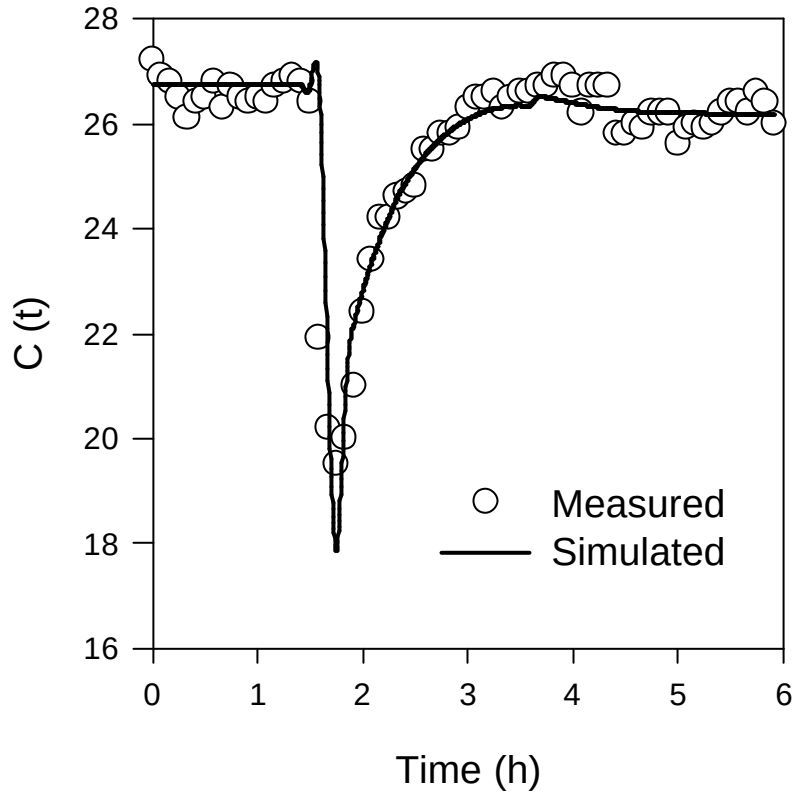
Johnson et al, (in press). *Water Resources Research*

Measured and modeled...

...hydrograph



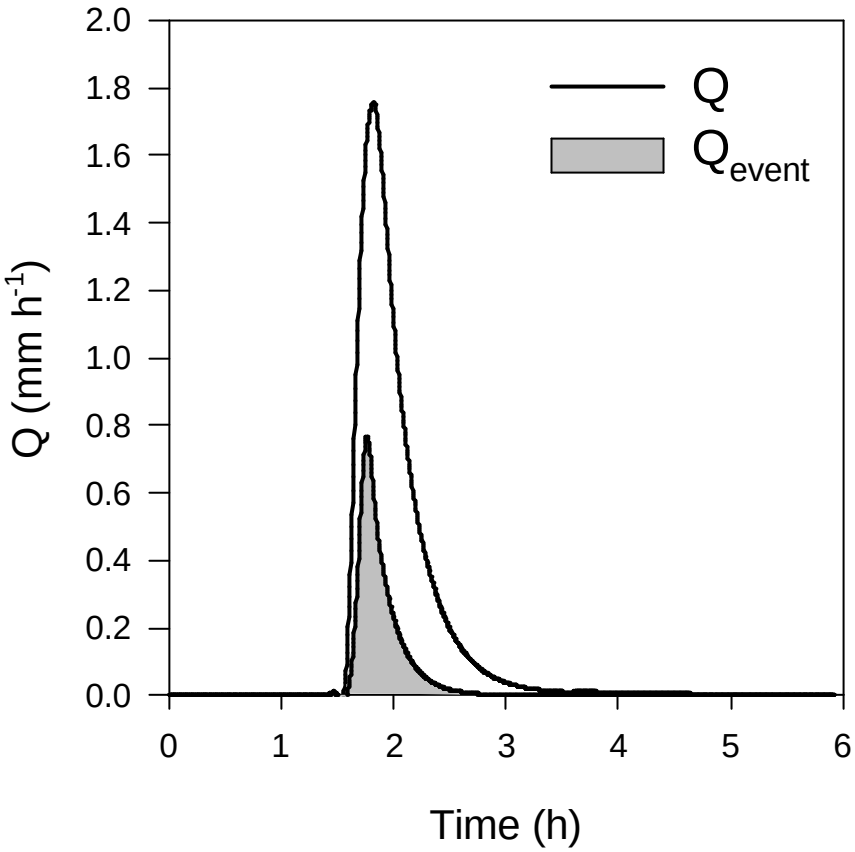
...chemograph



Johnson et al, (in press). *Water Resources Research*

Event water vs. pre-event water

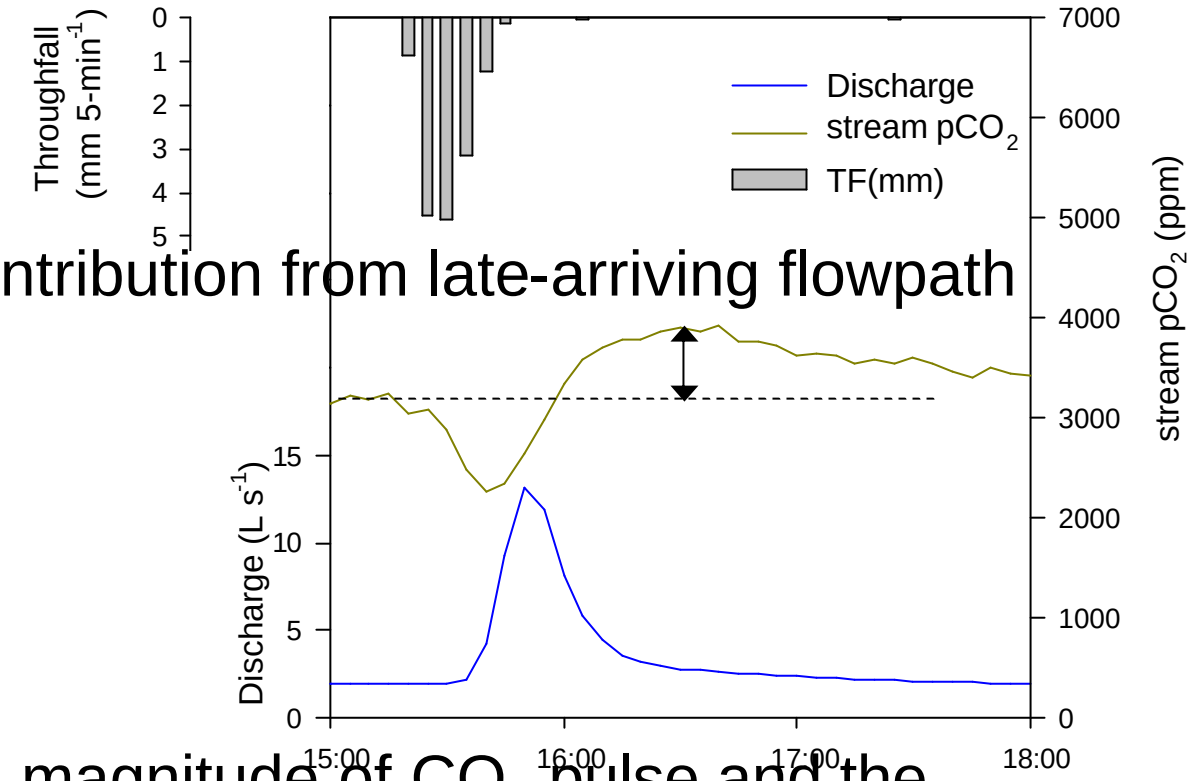
- ~80% of stormflow is pre-event water (PEW)
  - 79% ± 12%
    (mean ± 1 SD)
    (n = 14 storms)
  - Range:
    52% - 96% PEW
- Function of antecedent soil moisture
  - wetter soils have higher pre-event fractions



Q = discharge

Johnson et al, (in press). *Water Resources Research*

Rainfall-runoff and the "CO_2 pulse"



- CO_2 pulse requires contribution from late-arriving flowpath
- Relationship between magnitude of CO_2 pulse and the event-water fraction …suggesting that:
  - CO_2 pulse driven by an event-water flowpath (e.g. subsurface stormflow)

Johnson et al, (in press). *Water Resources Research*

Conclusions

- Pre-event water dominates stormflow (~80%)
  - tropical forests similar to temperate-zone forests
- "CO_2 pulse" is event-water driven
  - subsurface stormflow (event-water) transports "pre-event" CO_2 from soils to streams
- Situation may be very different for pastures and cultivated fields

Agradecimentos

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Cornell University

UNIVERSIDADE FEDERAL DE MATO GROSSO

Thank you! Questions?