Soil properties determine fluvial losses of carbon in Amazonian headwaters

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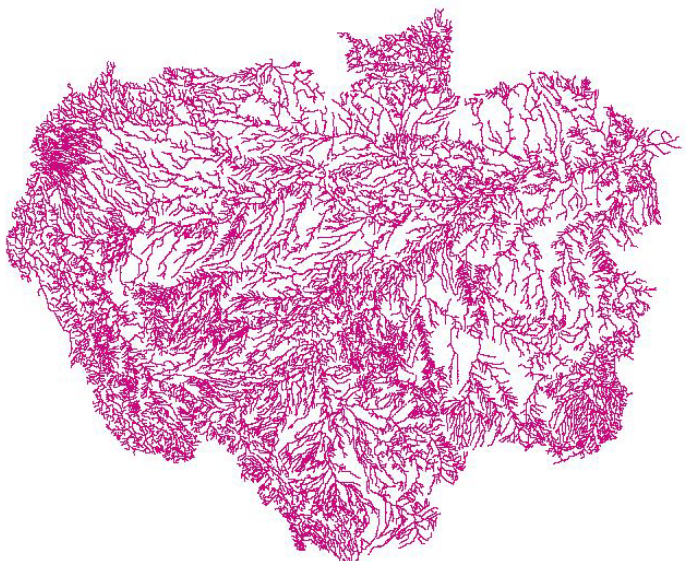
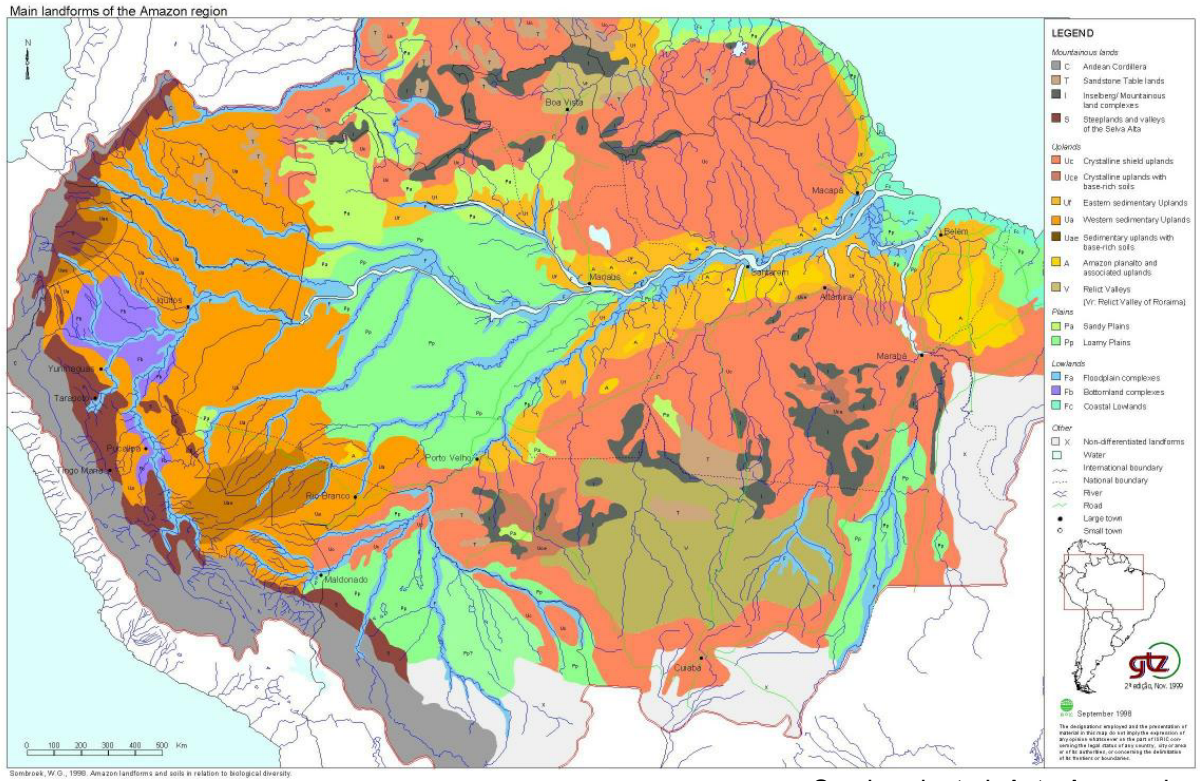
Soil Control on Stream Biogeochemistry

Soil Type Control on Stream Carbon Export? (Oxisol-Ultisol)



(3rd order and larger, Mayorga et al., 2005)



Sombroek et al. Acta Amazonica

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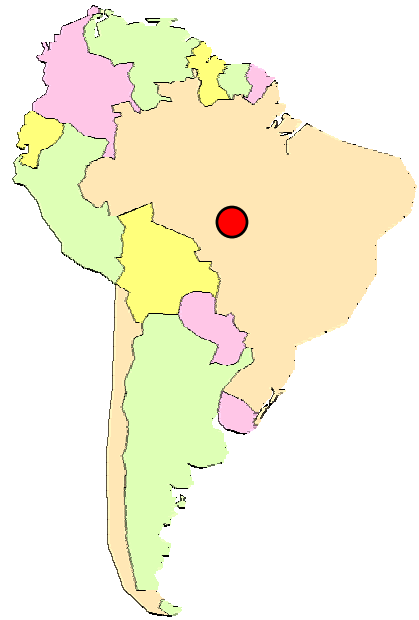
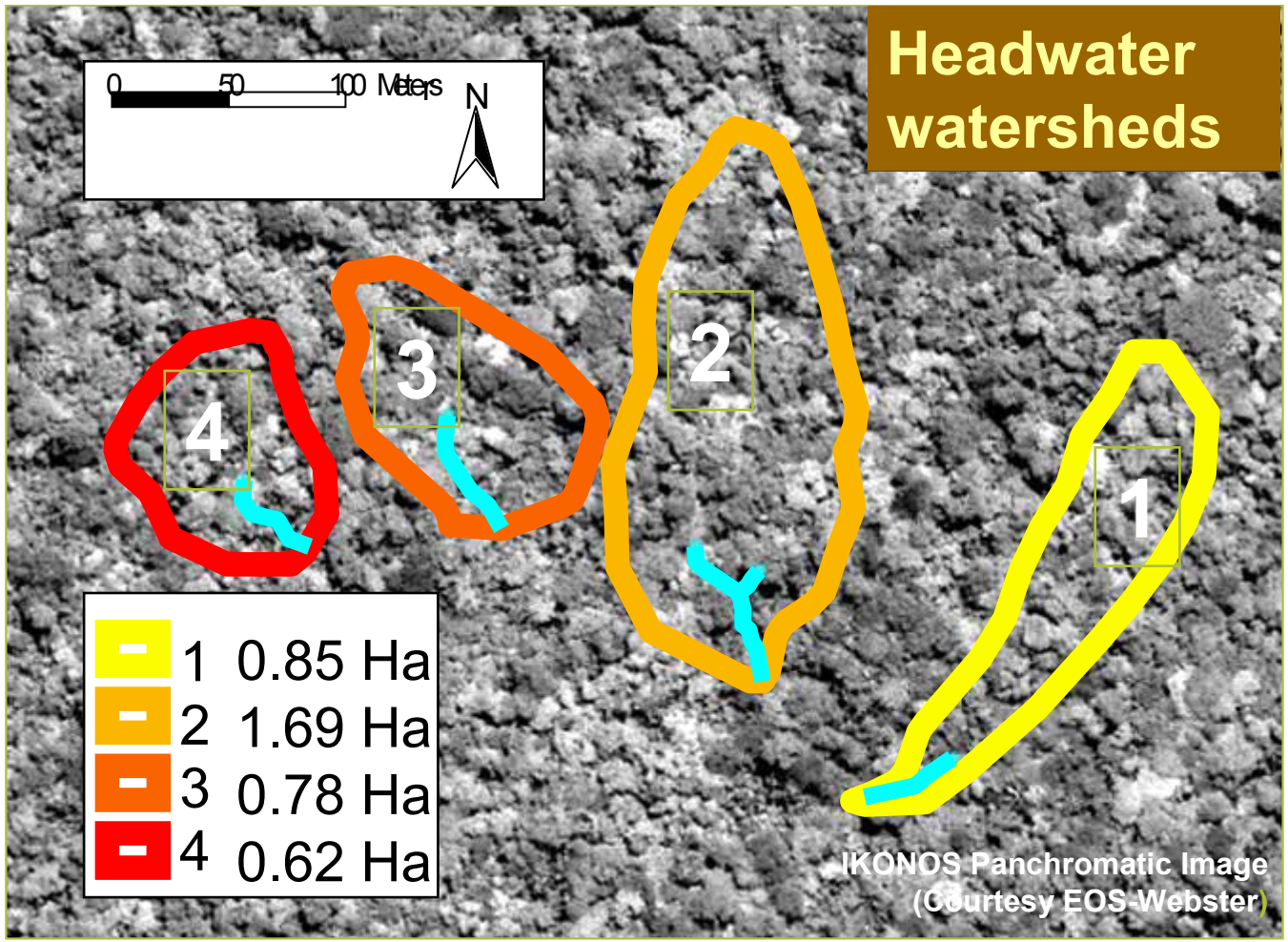
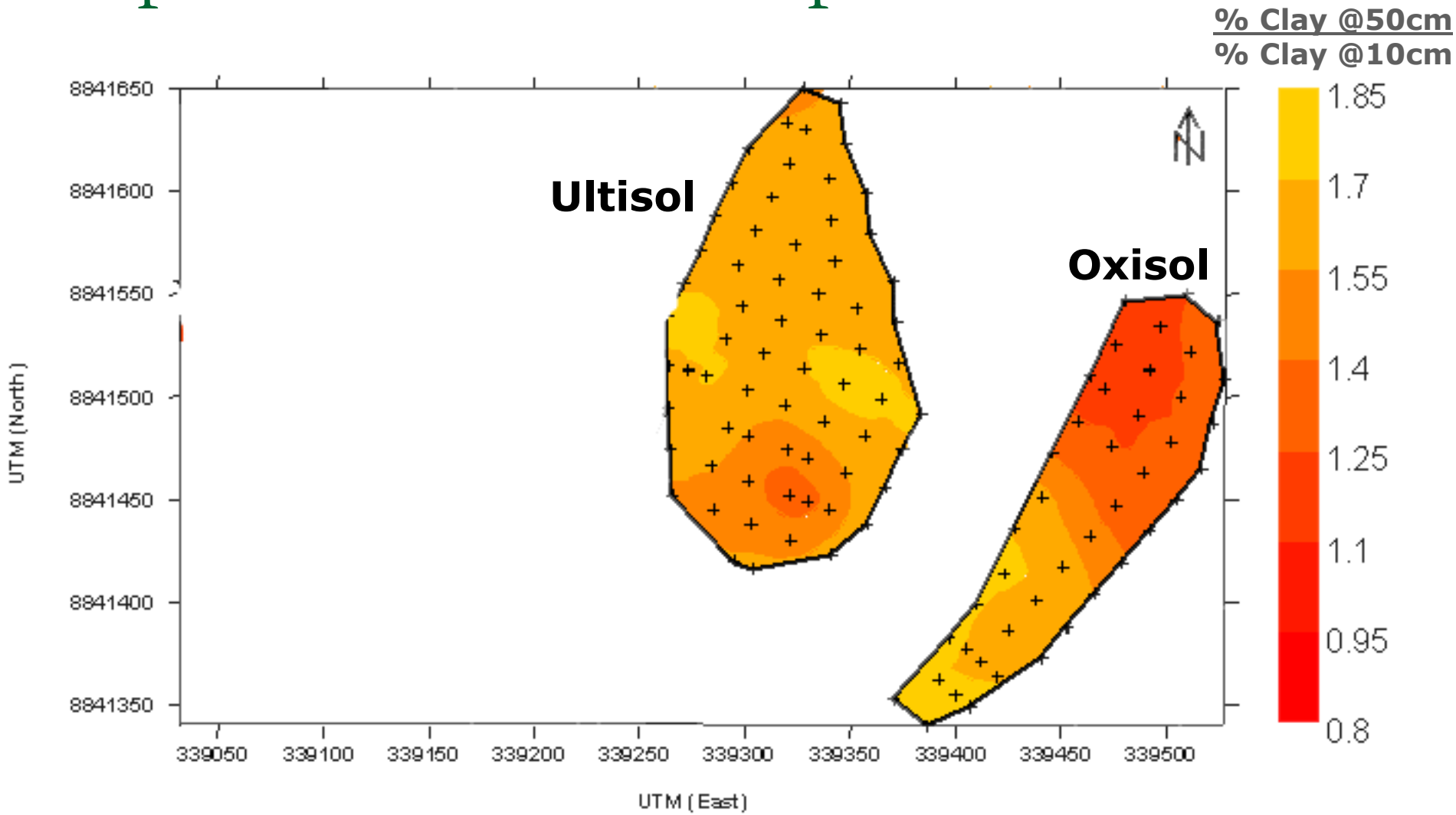
Flow paths and carbon export



Juruena
NW Mato Grosso



Flow paths and carbon export



Novaes Filho, *MS thesis*, UFMT

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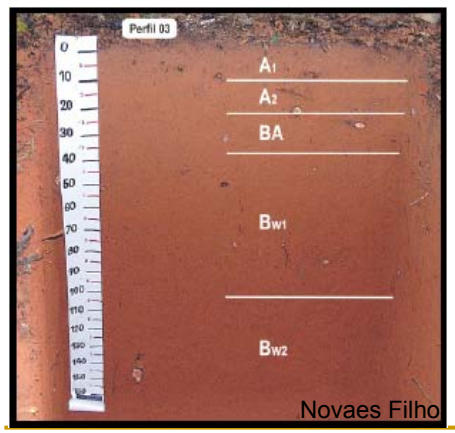
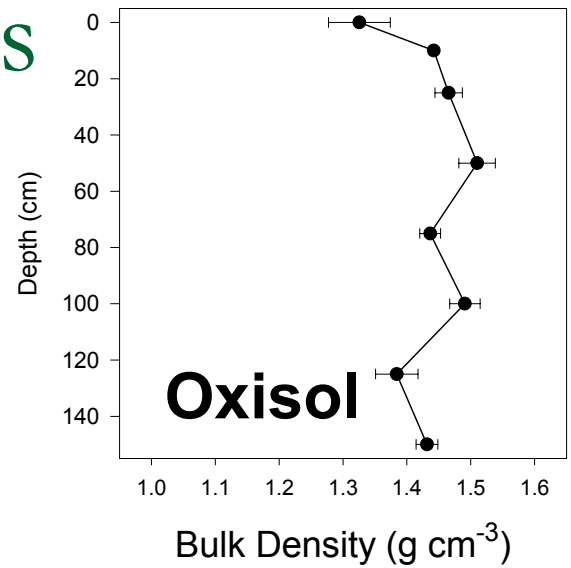
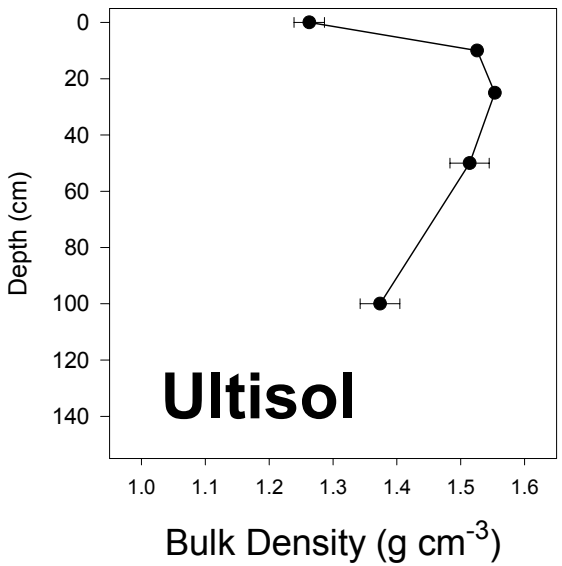
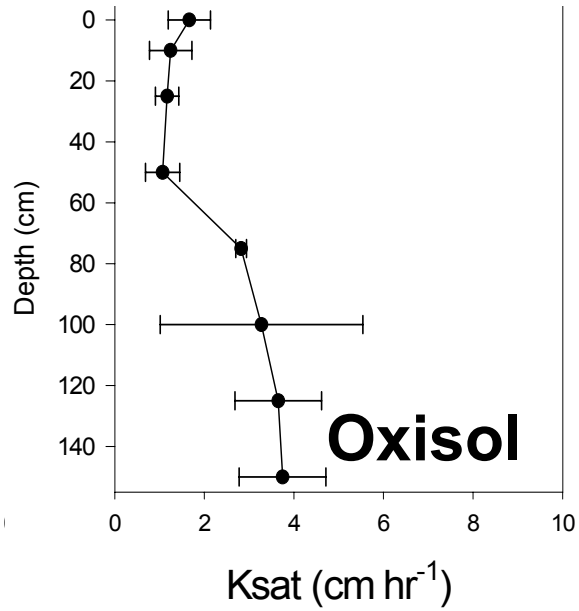
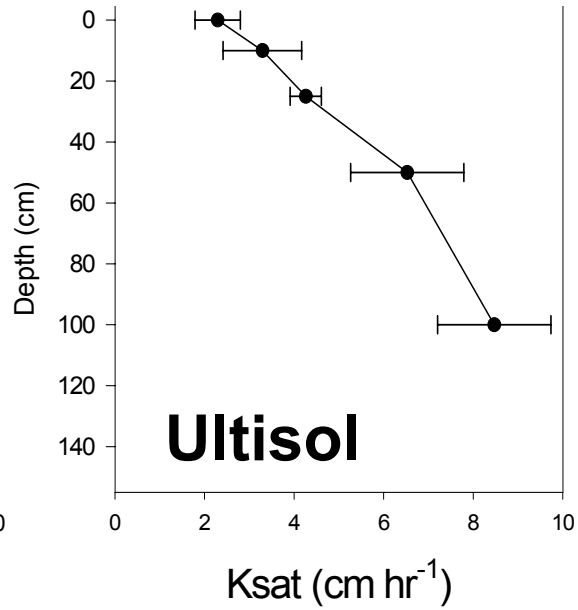
Soil Properties Controlling Hydrology











Johnson et al., in press, *Hydrological Processes*

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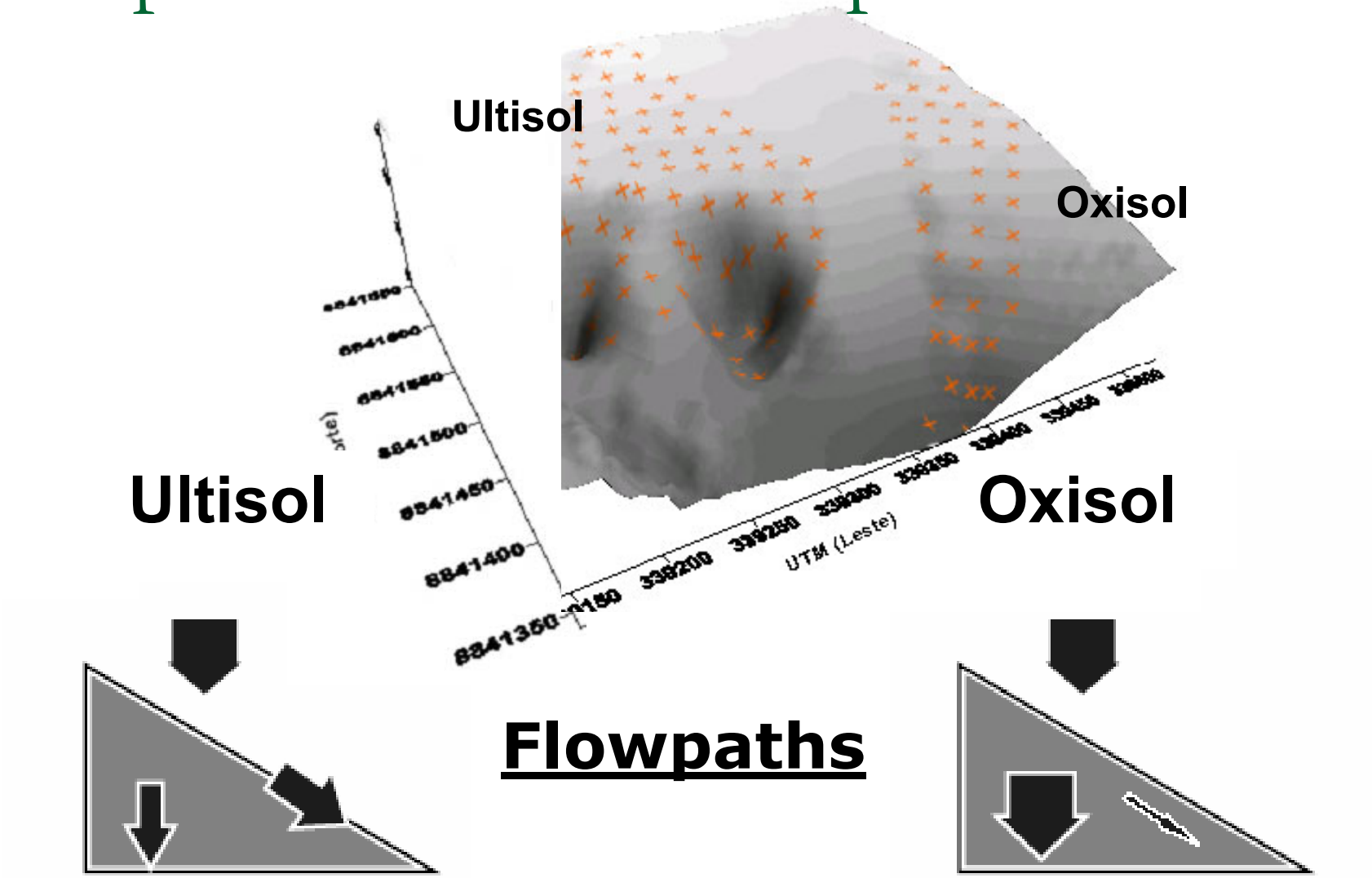
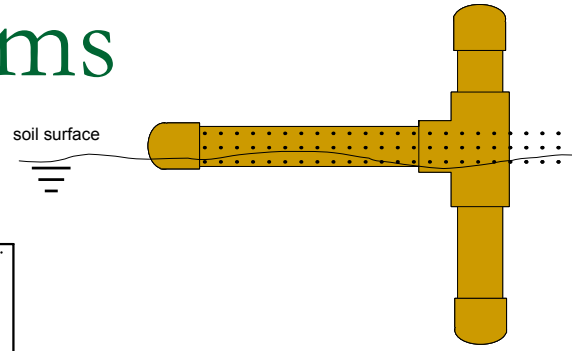
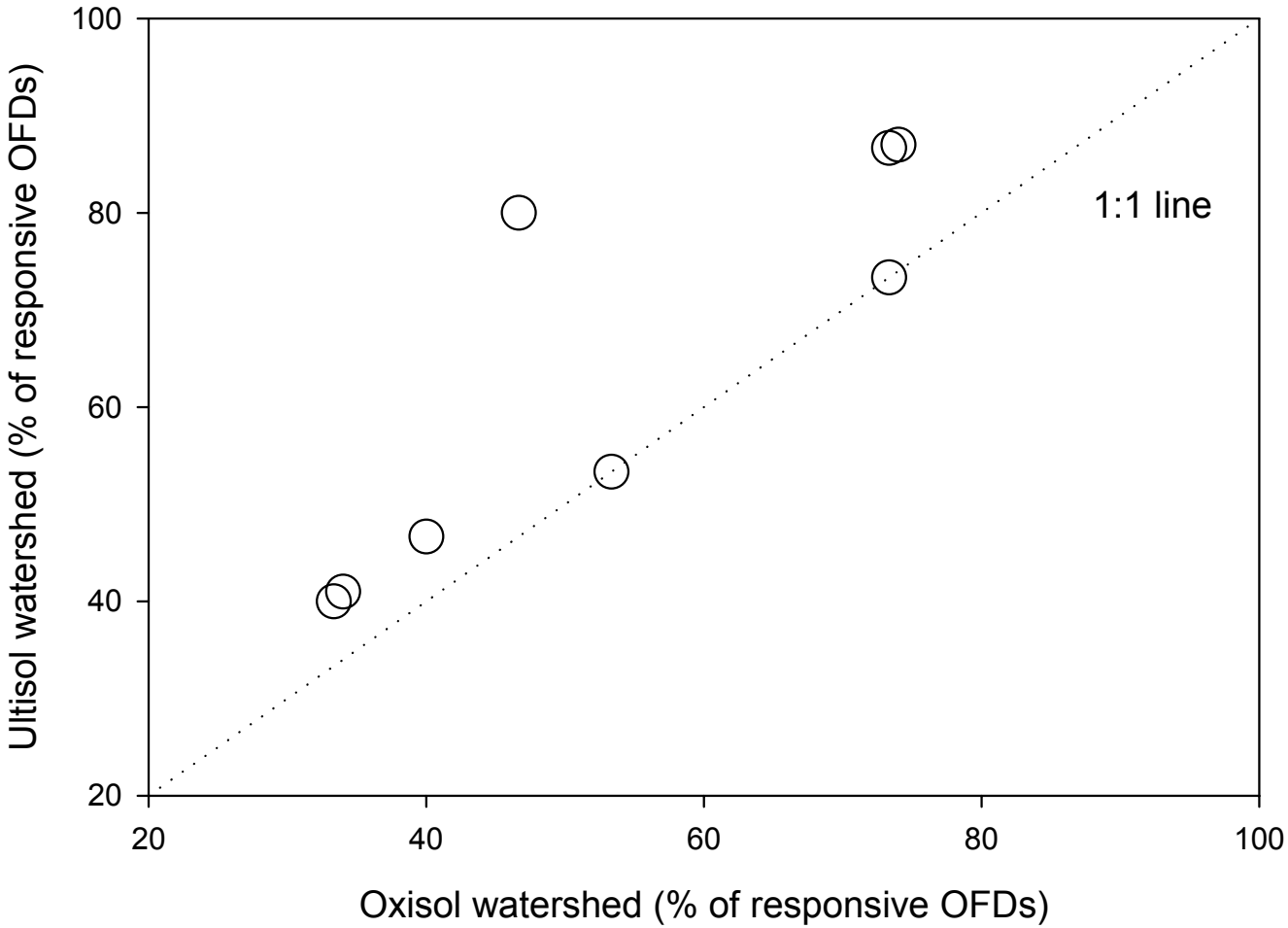
Flow paths and carbon export



Adapted from Elsenbeer, 2001, *Hydrological Processes* 15, 1751-1759
Johnson et al., in press, *Biogeochemistry*

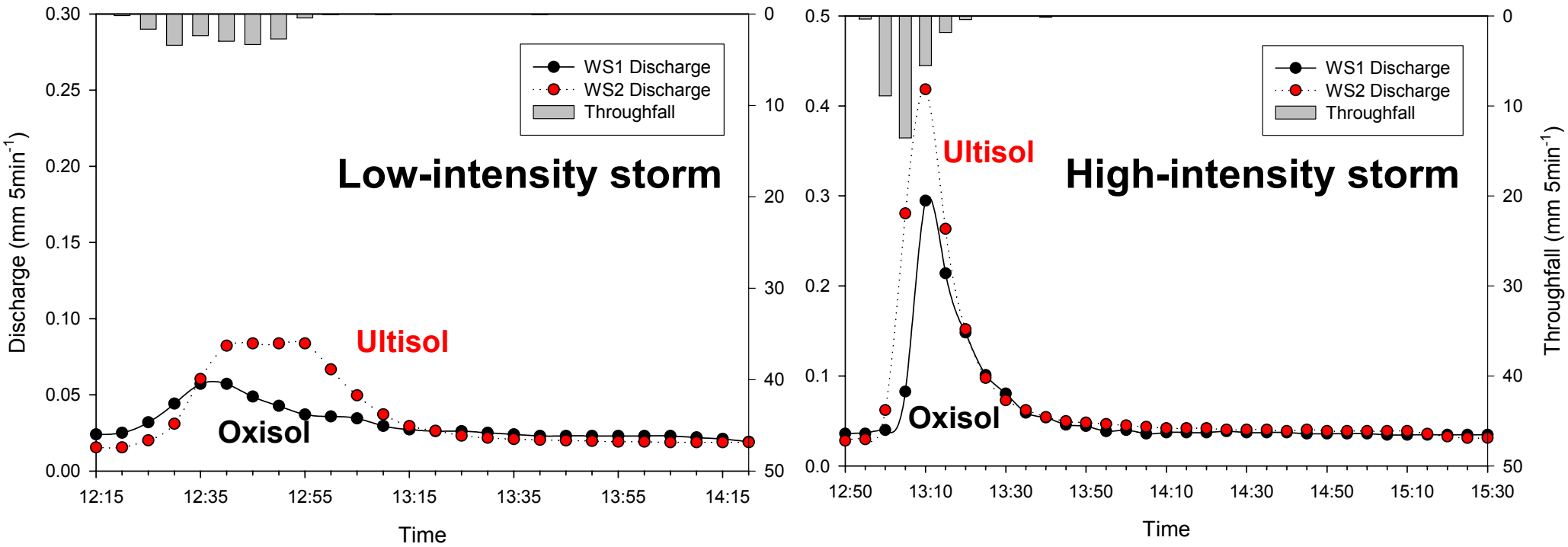
Overland Flow Response to Storms





Johnson et al., in press, *Biogeochemistry*

Stream Flow Response to Storms

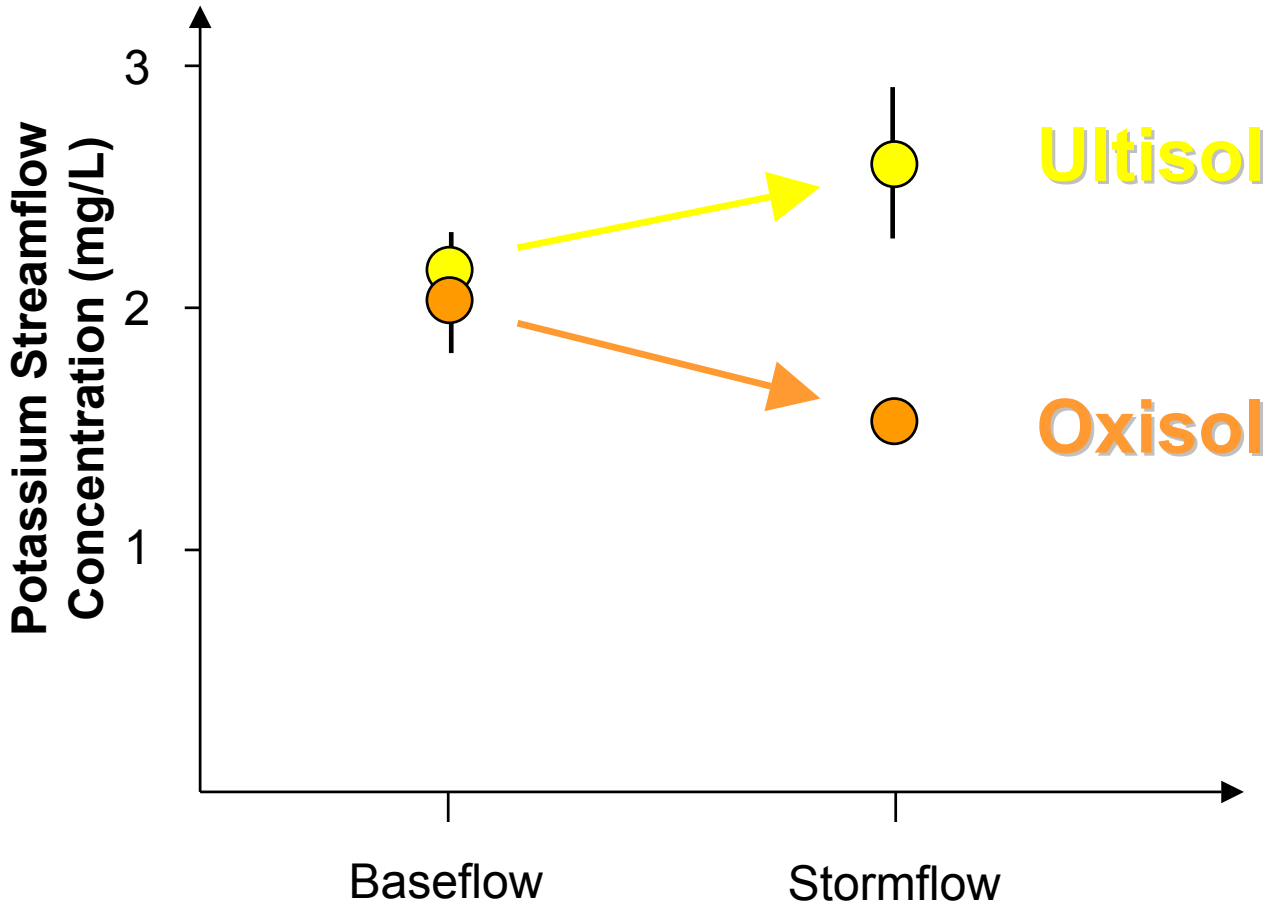


Ultisol 3.2 ± 0.2% of event precipitation

Oxisol 2.5 ± 0.3% of event precipitation

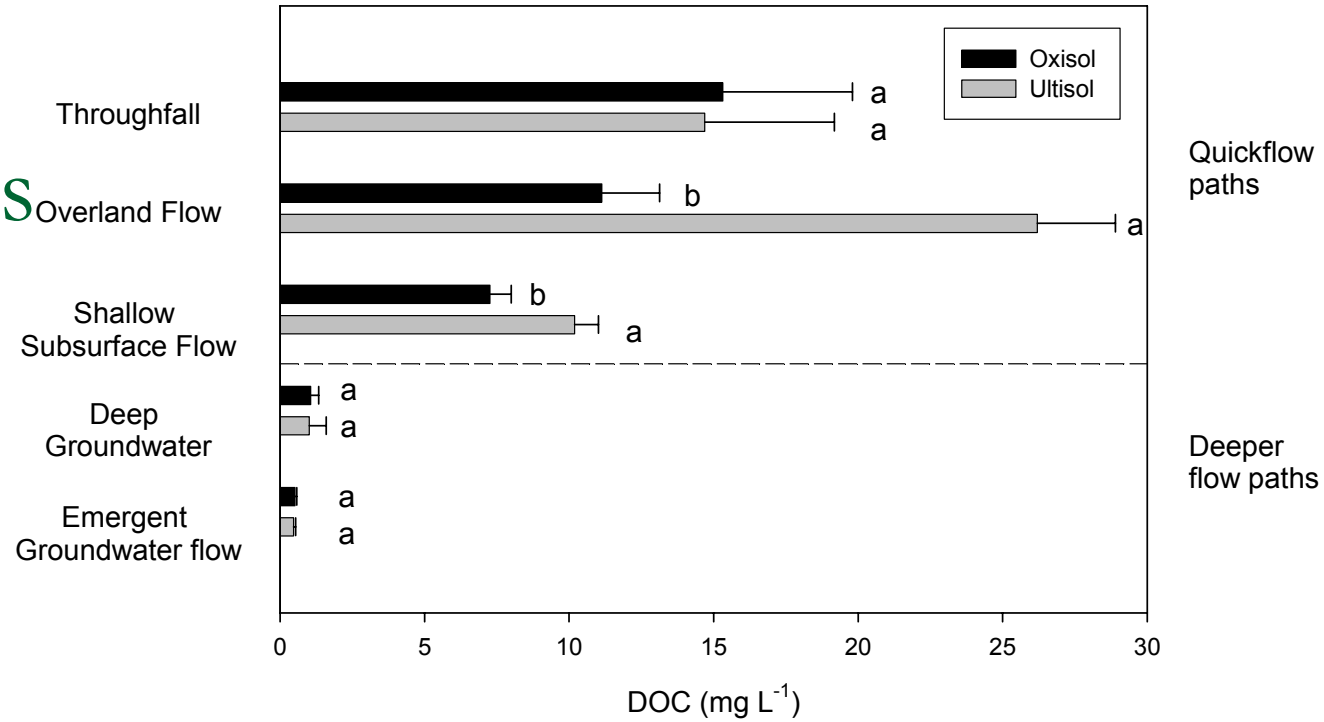
Johnson et al., in press, *Hydrological Processes*

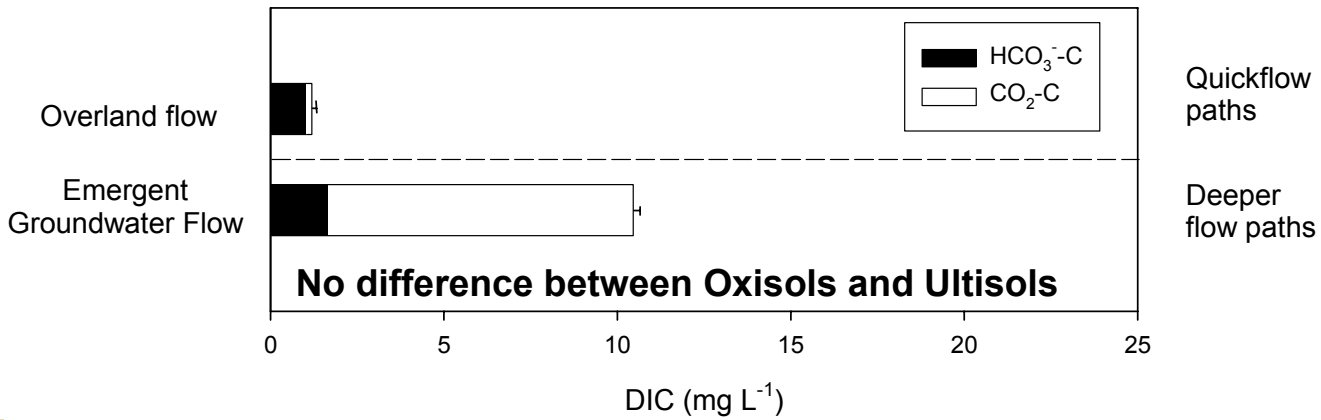
Stream Flow Response to Storms



(Means±s.e., N=45 and 33 for base- and stormflow)

Distribution of Mobile C Forms in Solution





Johnson et al., in press, *Biogeochemistry*

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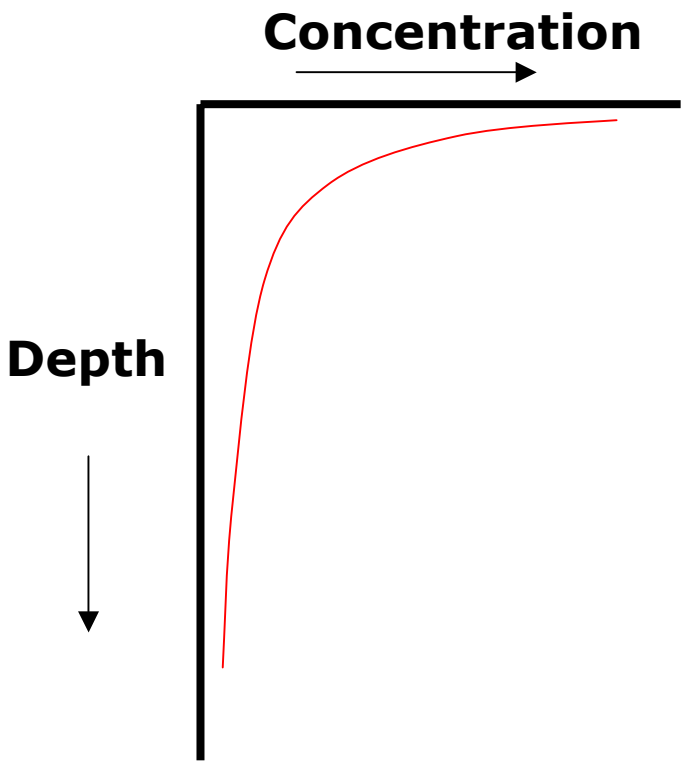
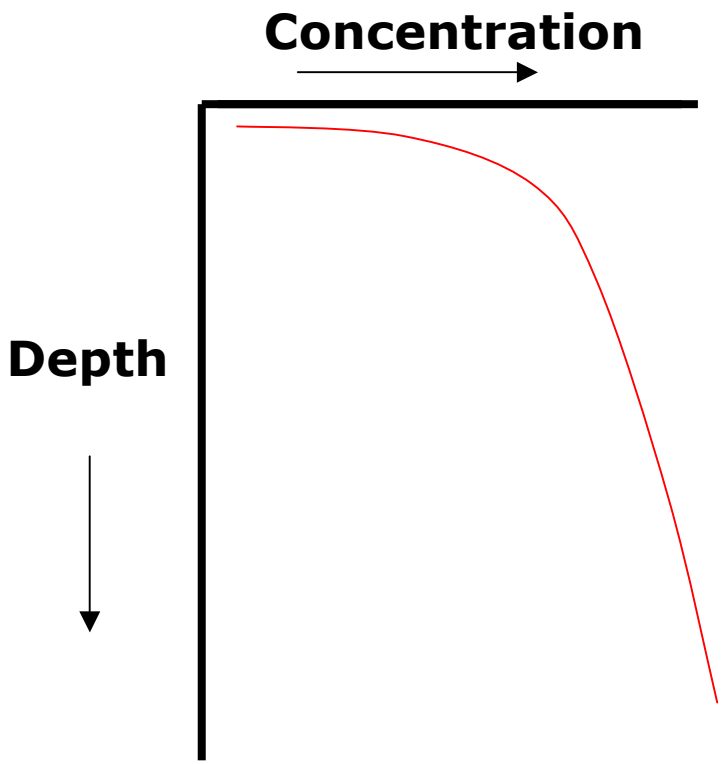
Distribution of Mobile C Forms in Solution

DOC – surficial

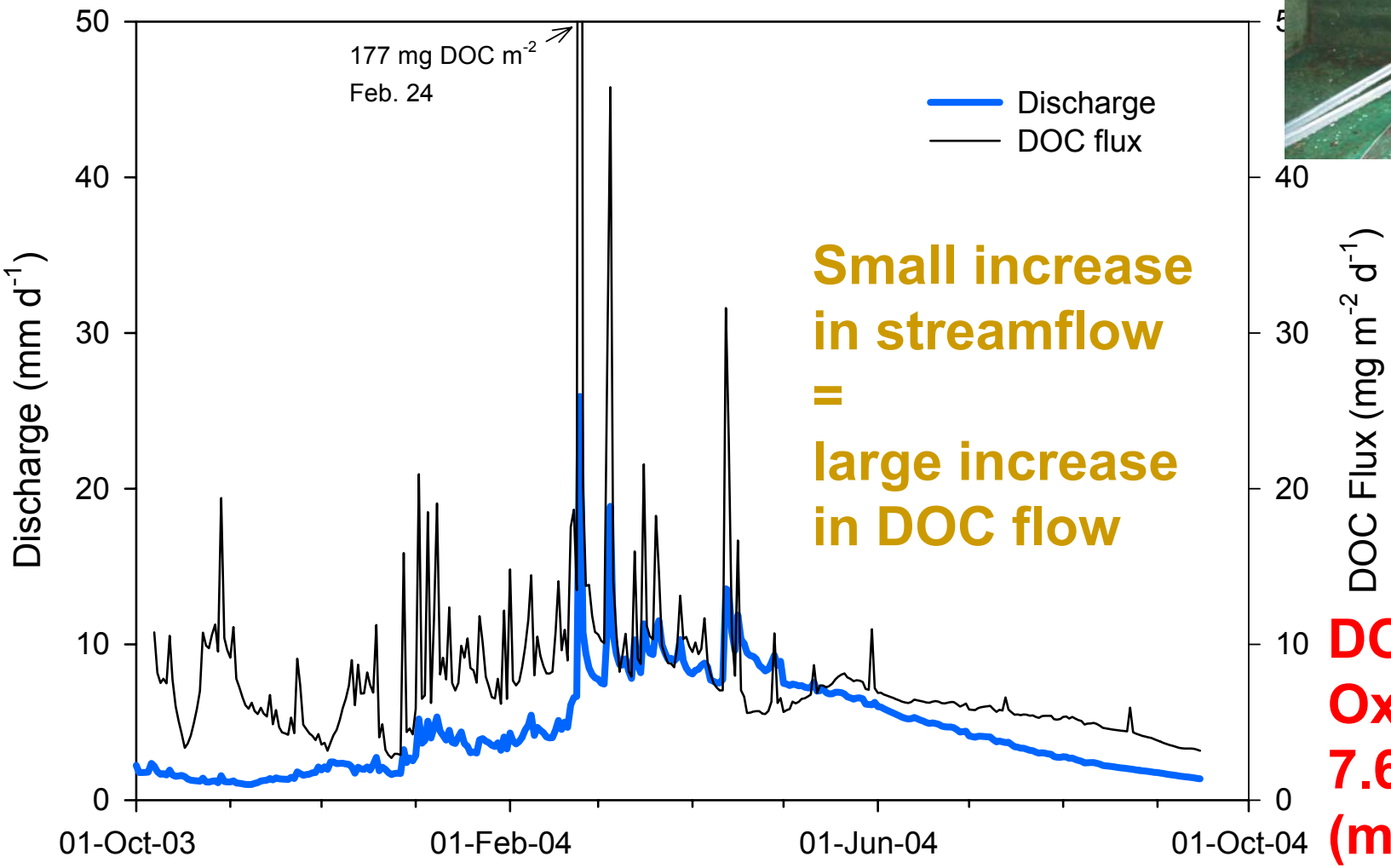


DIC – deep soil



Johnson et al., in press, *Biogeochemistry*

Stream Flow Response to Storms



Small increase in streamflow = large increase in DOC flow

DOC (stream): Oxisol < Ultisol
$7.6_{\pm 0.30} < 9.2_{\pm 0.25}$ (mg/m²/day)

Johnson et al., in press, *Hydrological Processes*

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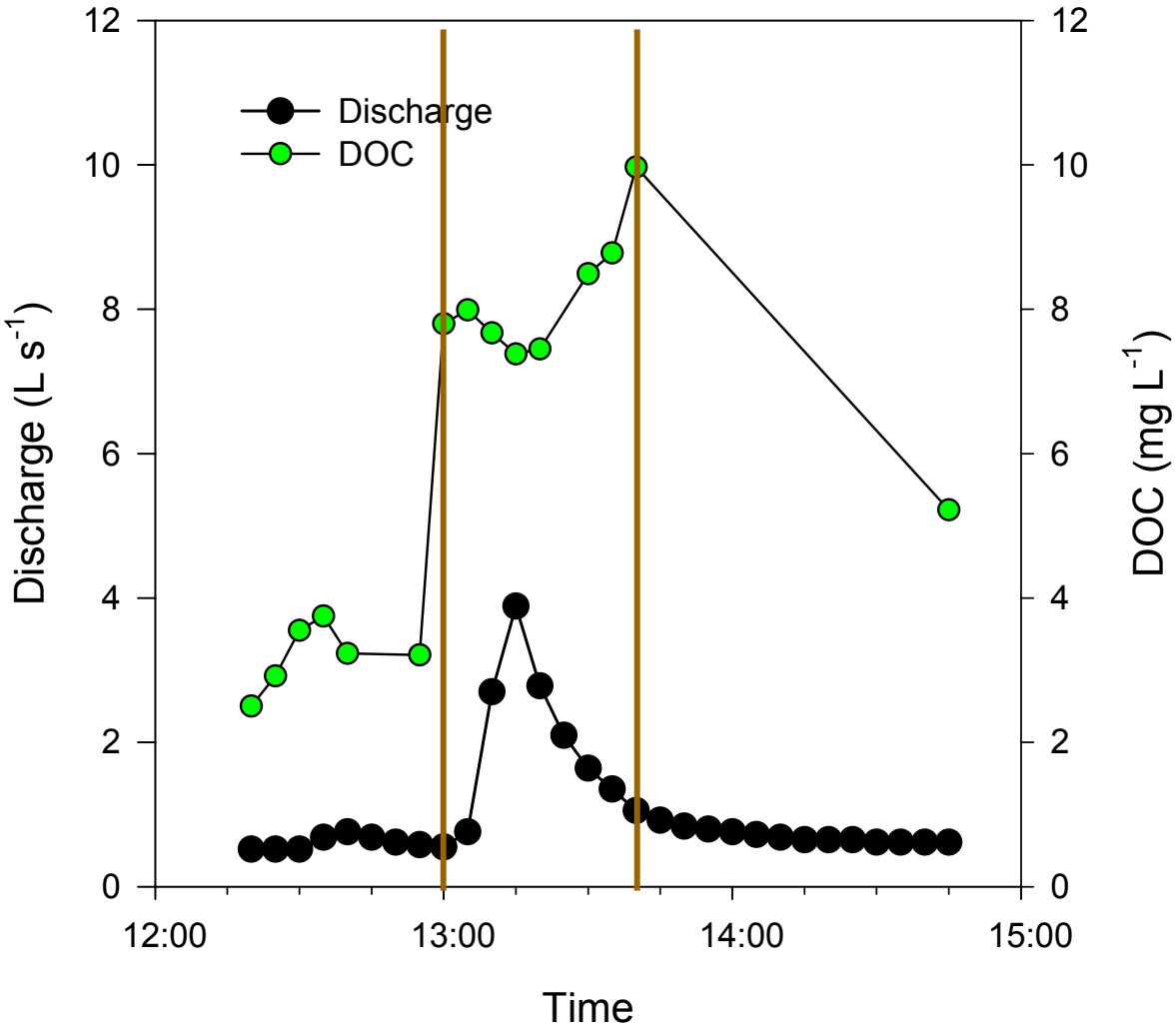
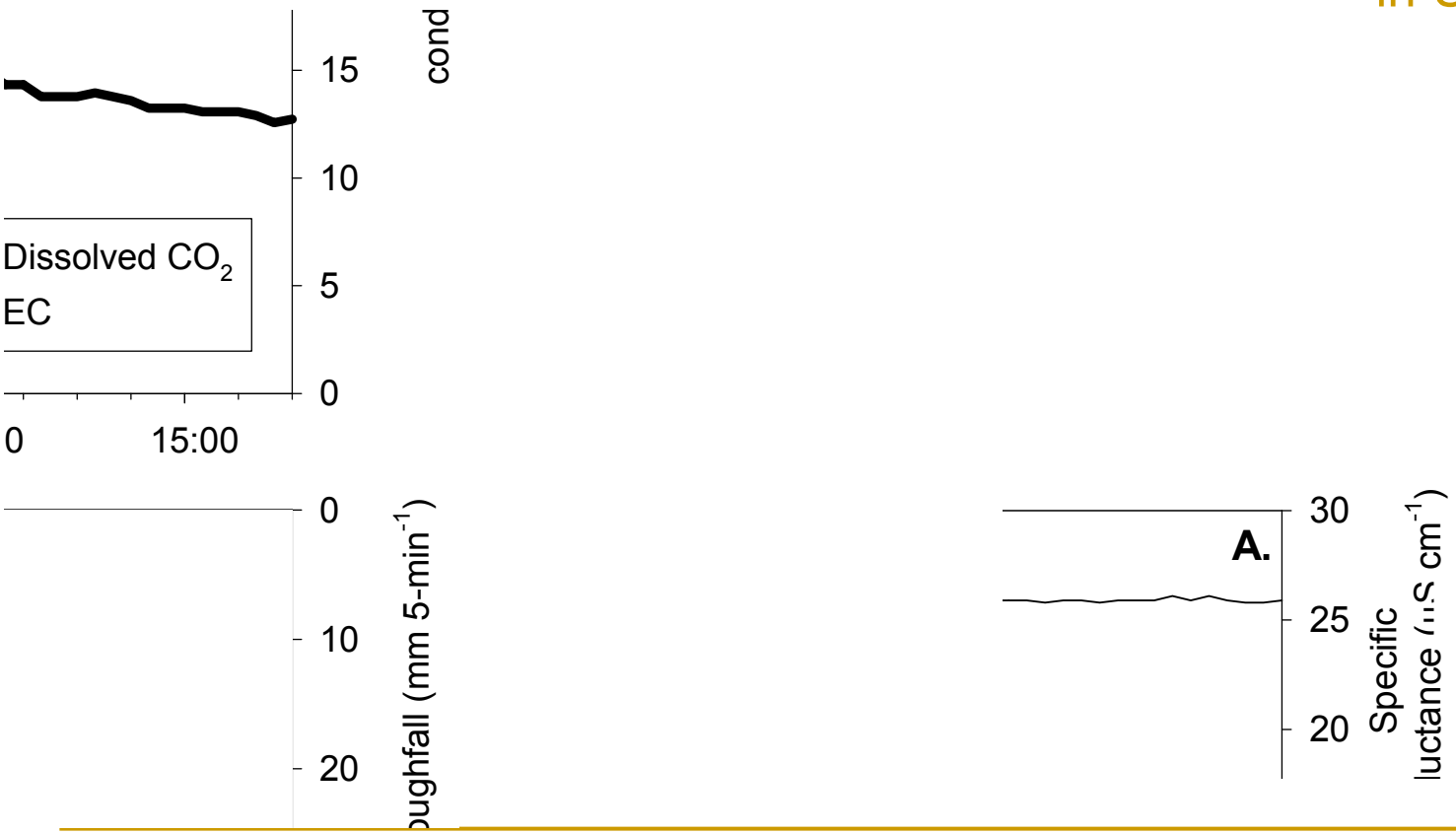
Stream Flow Response to Storms - DOC

- Early DOC flushing from soil surface at onset of rain
- High DOC concentrations even after discharge ceased
- Greater surficial flow in Ultisols creates greater DOC export than in Oxisols



Stream Flow Response to Storms – CO_2

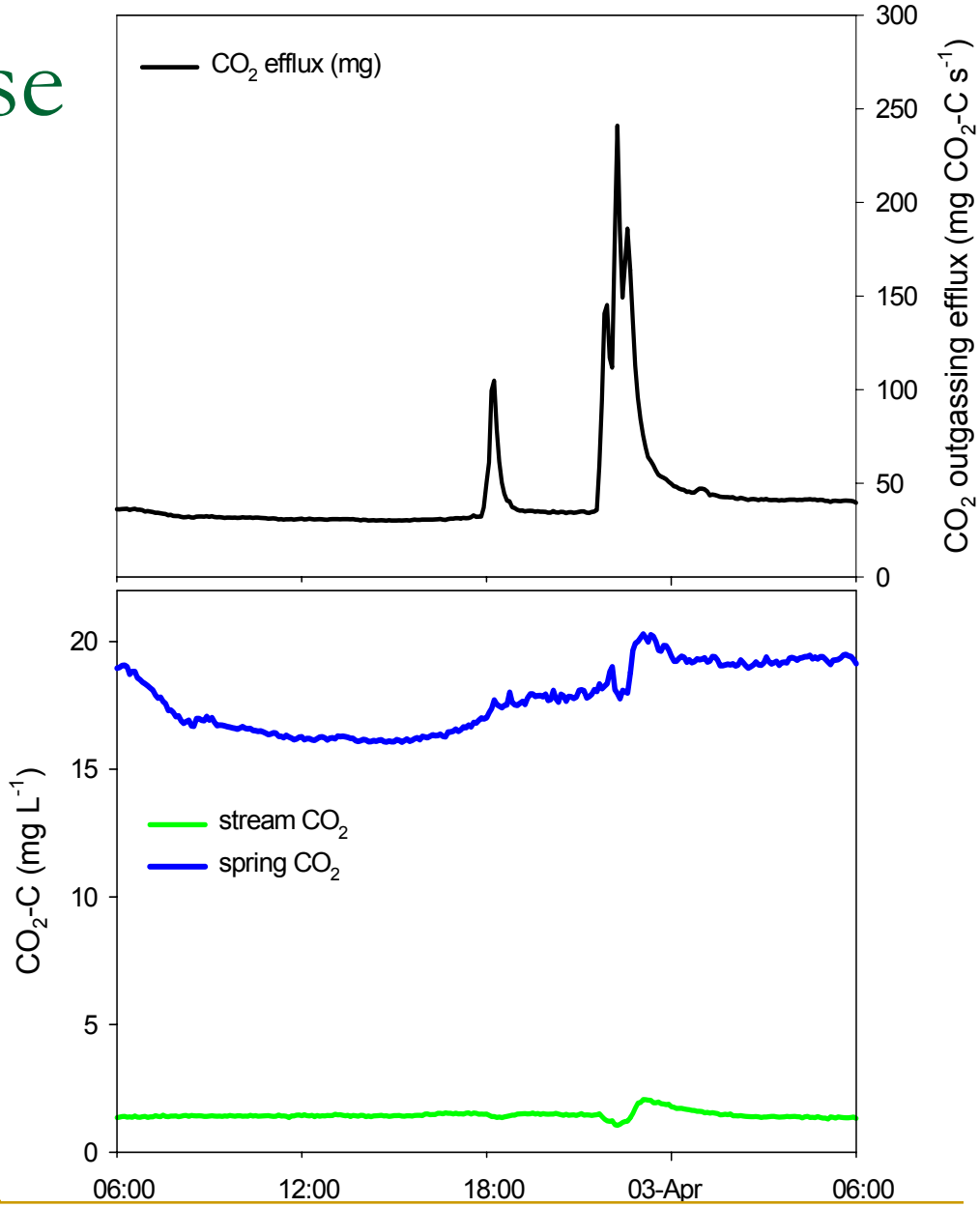
- Late CO_2 flushing from groundwater after rainfall
- Greater deep flow in Oxisols may create greater CO_2 export than in Ultisols



Stream Flow Response to Storms

CO_2 (stream):
Oxisol > Ultisol
$8.6 \pm 1.3 > 4.6 \pm 0.7$
(mg CO_2-C/L)

Does greater deep flow in Oxisols create greater total C losses than in Ultisols?



Take-Home Messages

Surficial flow paths are dominated by DOC, deep flow paths by DIC.

Differences in stream losses of DOC and DIC between soil types are more pronounced than those of water due to different flow paths.

Deep soil flow paths may lead to greater C losses than surficial flowpaths!

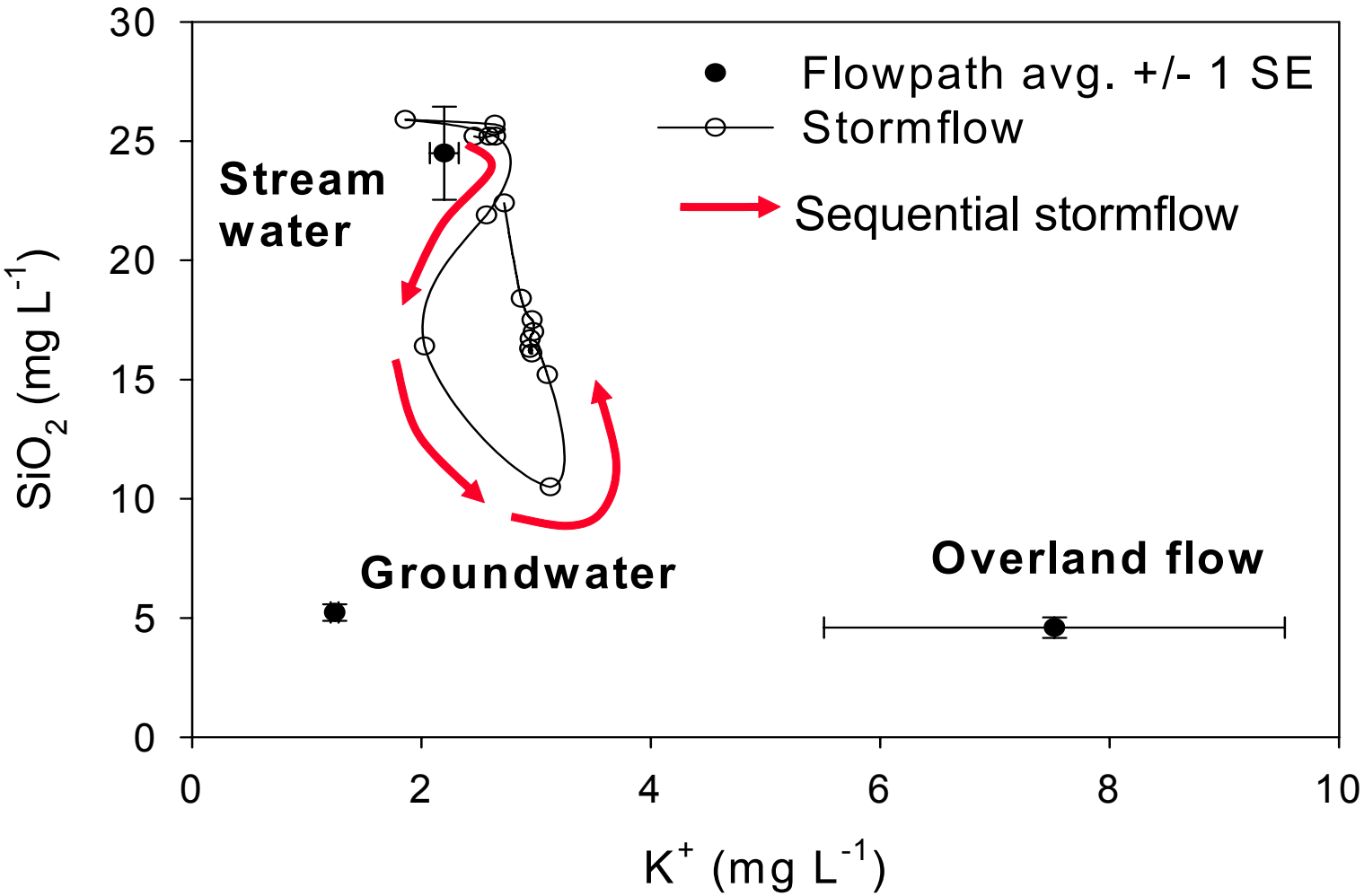
Models that predict stream C exports have to consider soil properties.

Thanks

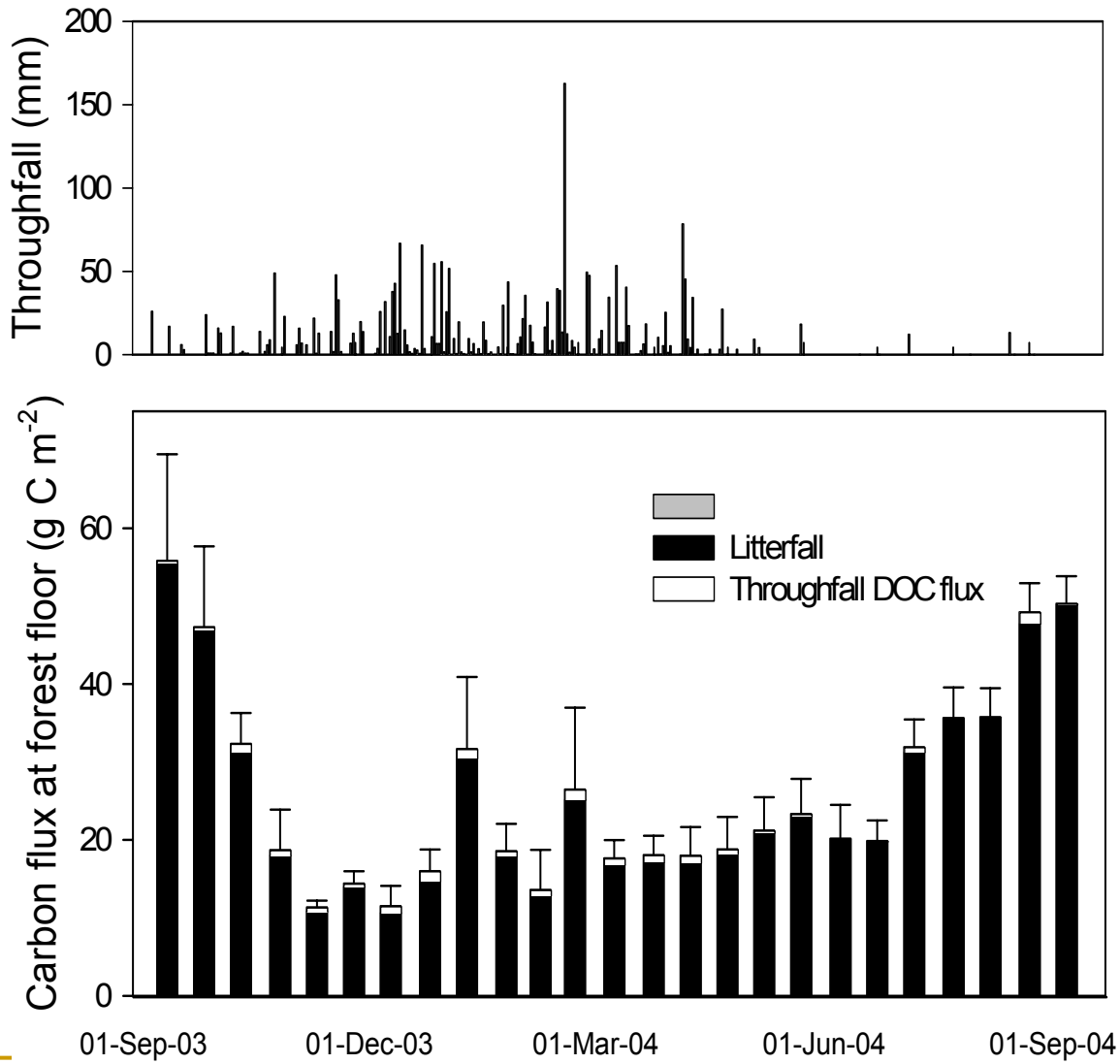
- Financial and great logistic support by NASA under LBA-ECO ND-11.
- Alex Krusche, Jeff Richey and their groups for invaluable advice.
- Mara Abdi, Evandro da Silva, Carlos Passos and all other group members of ND-11 in Mato Grosso and Ithaca.
- The entire field team in Juruena: Paulo Nunes, Benedito, Elielton.
- Rohden Inc. and Apolinario Schuler for permission to work in their forest and incredible logistic support.
- The entire LBA group.

Spare Slides for Discussion

Stream Flow Response to Storms

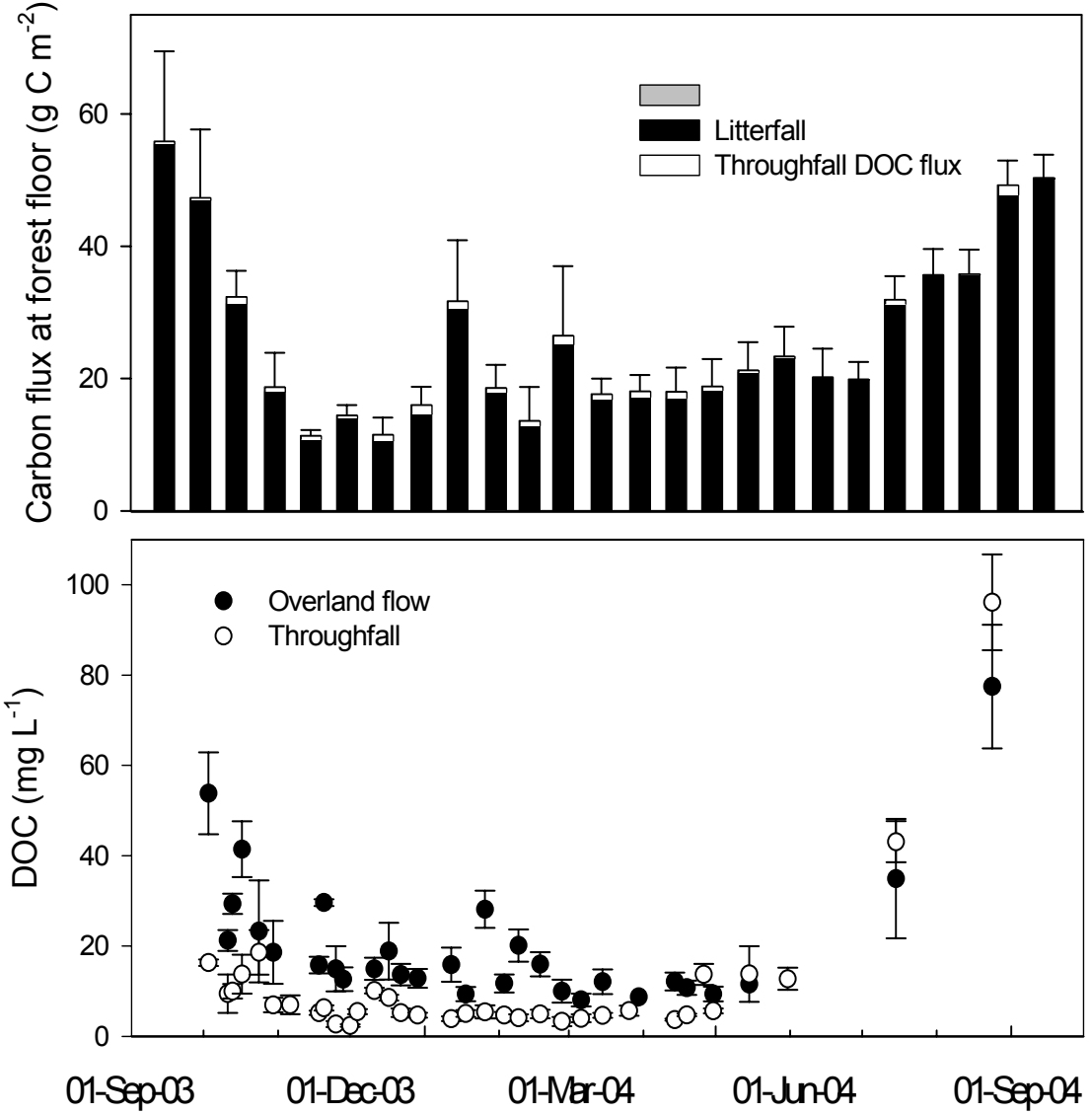


From C Production to C Flow



Johnson et al. unpubl. data

From C Production to C Flow



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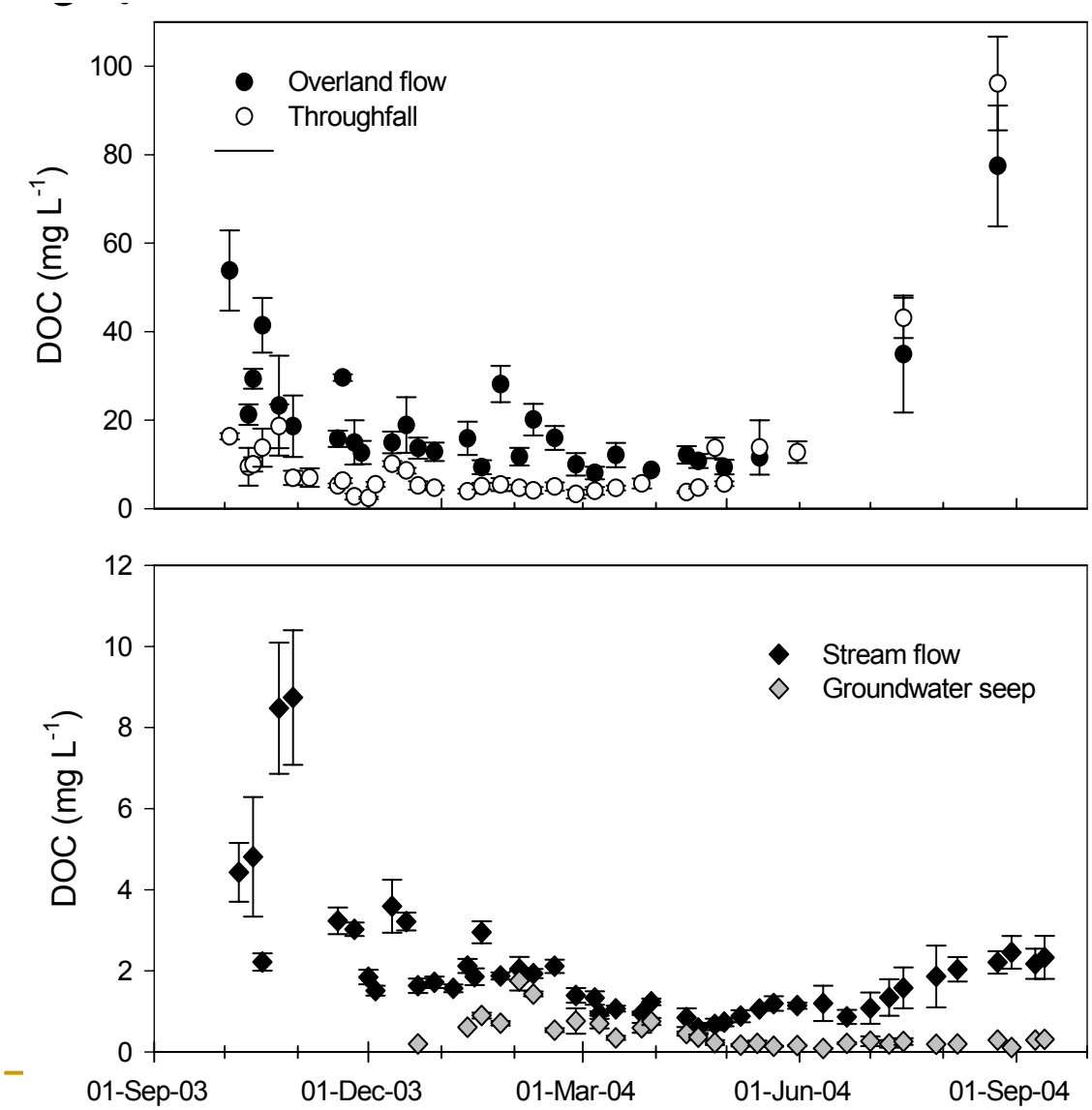
From C Production to C Flow

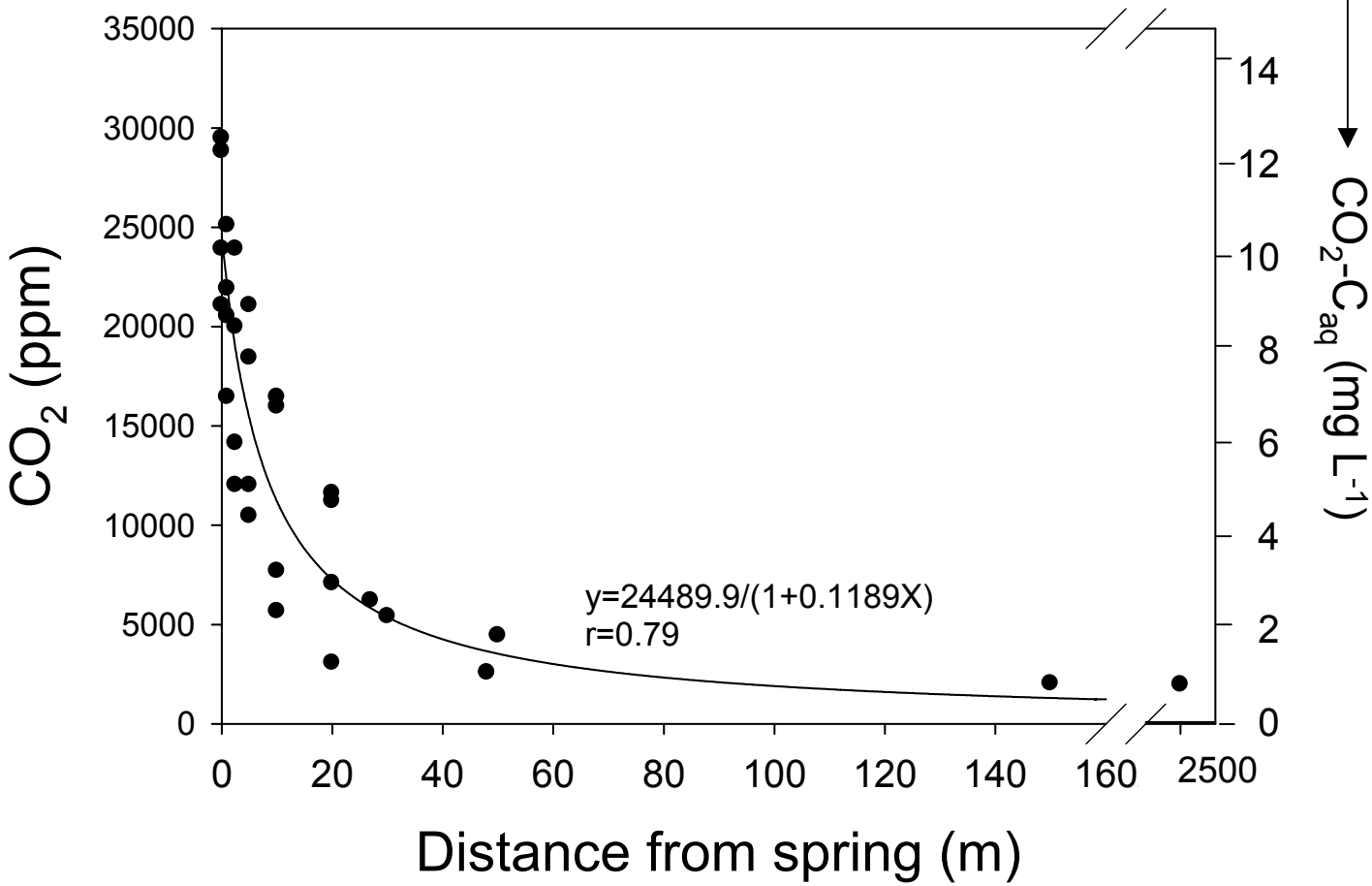


- Streamflow DOC concentrations tracking the aboveground DOC concentrations
- DOC flushing with groundwater recharge
- Seasonality important for determining annual C budgets, but what about storms?

Johnson et al., unpubl. data

Outgassing of CO_2 from Streams

(via Henry's Law)



Forested Ultisol-Oxisol
Southern Amazon, Juruena, MT
N=30 (from 4 watersheds)

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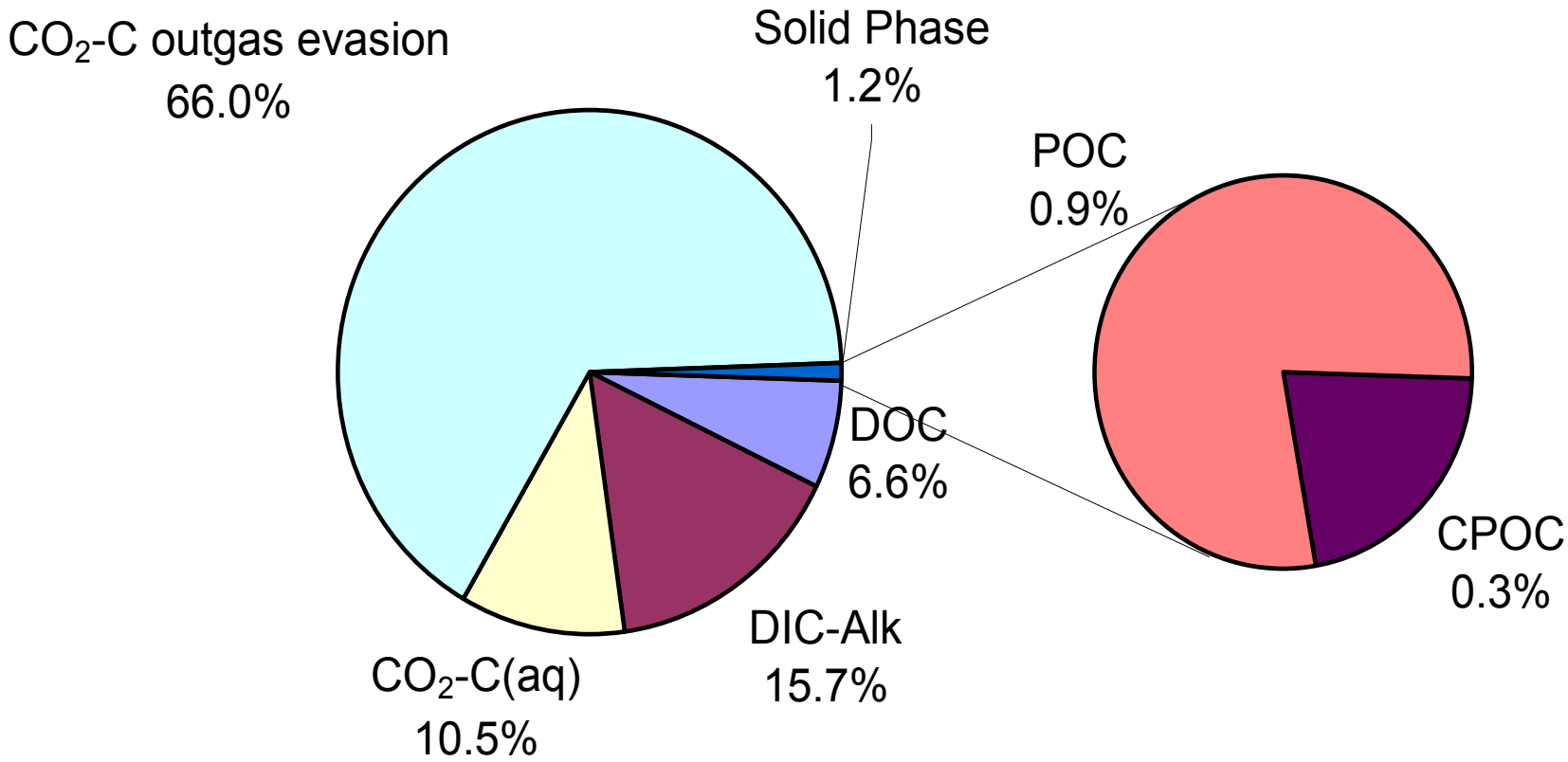
Proportion of Different C Species



(rainy season 2004)

Forested Oxisol
Southern Amazon, Juruena, MT
(from 1 watershed)

From C Production to C Flow

Not only DOC…..

Selva et al., unpubl. data

Inorganic C Flow in Subsoils?

Groundwater emergence

Stream Flow Response to Storms

Johnson et al., in press