Towards a Model of Carbon Mobilization, Advection, and Reaction in the Amazon River

As the LBA “Community,” we have a set of “linked” questions (possibly, with a common solution):

• What are hydrologic flow paths and magnitudes?
• How are CO$_2$ and OM mobilized from the land surface to and through fluvial systems?
• What controls transformations of N from land to streams?

• HOW CAN WE PULL IT TOGETHER?
physical forcing via remote sensing
(solar radiation, FPAR, rainfall, temperature)

terrestrial NPP
and biomass turnover
via CASA ecosystem model

hydrology
via VIC model

soil biogeochemistry
via ROMBUS model

aquatic biogeochemistry
via ROMBUS model

ground biogeochemistry
via GIS
(vegetation, soil, topography, river network, etc.)

CO₂ fixation

water flux

carbon flux

CO₂ evasion

heterotrophic respiration

autotrophic respiration

DOC, DIC

DOC

POC

DIC

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DOC

POC

DIC
SISTEMA DE "INFORMATICA"

CO₂, CH₄

Production via Terrestrial Biosphere Model

Detrital Particulate Organic Matter (>2mm)

Metabolic Carbon (soluble)

Structural Carbon (insoluble)

Mineral-Associated OM (FPOM) (0.1 µm - 63 µm)

HMW DOC (1-30 kDa)

LMW DOC (<1 kDa)

CH₄

Particulate Organic Matter (FPOM) (63 µm - 2 mm)

CPOC

DIC

Dissolved Organic Matter (DOM) (<0.1 mm)

VHMW DOC (>30 kDa)

VHMW FPOC (>30 kDa)

HMW DOC (1-30 kDa)

HMW FPOC (1-30 kDa)

LMW DOC (<1 kDa)

LMW FPOC (<1 kDa)

Black Carbon (soot and charcoal)

Structural Carbon (insoluble)

Metabolic Carbon (soluble)

Living Organic Carbon

Production via Terrestrial Biosphere Model

Biotic fluxes

Abiotic fluxes

CPOC

CO₂, CH₄
“MESO/MACROSCALE: Variable Infiltration Capacity –n Layer (VIC-nL), with River Routing Scheme

Ji-Parana (Victoria et al). ~8km
Micro/Mesoscale: Distributed Hydrology-Soil Vegetation Model (DHSVM) (~150m/>150m?)

Overstory
Upper rooting zone
Lower rooting zone
Saturated zone

Excess
Sub-surface flow
Mae Chaem, Chiang Mai, Thailand
Vegetation scenarios

Scenario I: No crops
Scenario II: Double crop uniformly
Scenario III: Double crops in highlands
Scenario IV: Double crops in lowlands
Daily discharge at basin outlet

Daily discharge, m³/s

- Observed
- Veg 89
- Veg 00

Date range: 11/95 to 10/00
Needs for a “River basin Organic Matter and Biogeochemistry Synthesis Model”

- Uses measurable and mechanistically meaningful pools
  - CPOM
  - FPOM
  - DOM

- Capacity to model processes
  - Mineralization (OC → CO$_2$)
  - Degradation (OC$_{\text{fast}}$ → OC$_{\text{slow}}$)
  - Sorption (DOC → FPOC)

Mayorga & Aufdenkampe, 2002
ROMBUS
(River basin Organic Matter and Biogeochemistry Synthesis Model)
Upland Source Element
(Production > $|\Delta Storage|$, physically & chemically converts rock to sediment)

Colluvial Buffer Element
($|\Delta S| > P$, controls sediment delivery ratio by regulating delivery to channel network)

River Network Element
($P \approx 0$, specifically for in-channel routing & evolution of wash load and bed load, and calculating transfer to FP and channel bed)

Channel Bed Storage
(Element significance decreases DS)

Floodplain Storage
(Element significance increases DS)

Floodplain Lakes
(permanent)

Delta & Ocean Sinks

Rolf Aalto
DHSVM (?) Detailed site -> upscaling?

“detailed” LBA-team sites