Université de Liège

Africa TERVUREN

KONINKLIJK MUSEUM VOOR MIDDEN-AFRIKA

MUSEE ROYAL DE LAFRIQUE CENTRALE

ROYAL MUSEUM FOR CENTRAL AFRICA

KATHOLIEKE UNIVERSITEIT LEUVEN

First assessment of the biogeochemistry of the Congo River and its tributaries

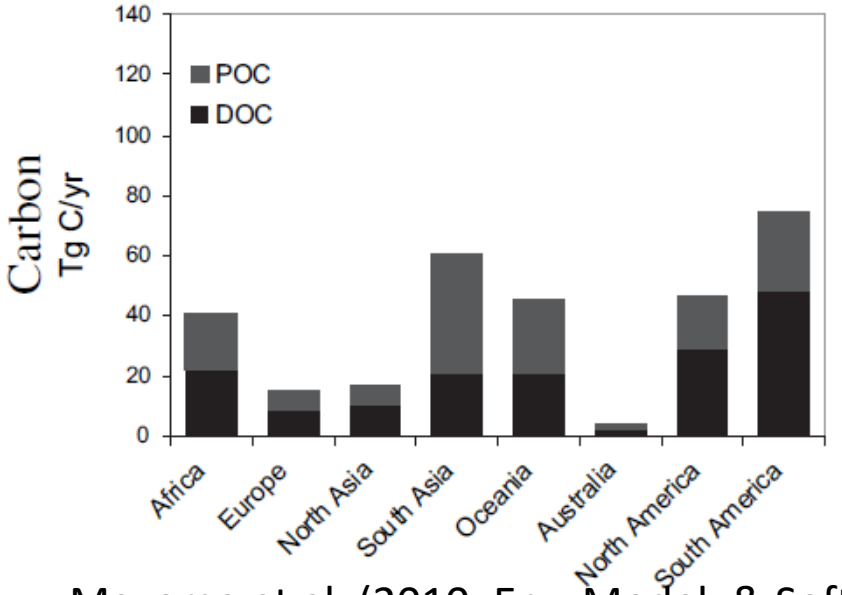
Darchambeau F., Borges A.V., Wabakanghanzi J.N., Massicotte P., Descy J.-P., Bouillon S.

Global riverine C fluxes

Estimates global: TOC: 430 10^{12} gC y^{-1} (Schlünz & Schneider 2000)
TC: ~900 10^{12} gC y^{-1}

Partitioned as ~35% DOC, 20% POC, 45% DIC (Meybeck 1993)

Estimates African rivers:
NEWS 1995: POC: 22.1 10^{12} gC y^{-1}
(~NEWS2) DOC: 24.6 10^{12} gC y^{-1}
DIC: no estimates



Mayorga et al. (2010, Env. Model. & Soft.)

C cyling in Africa rivers / AFRIVAL project

NEWS2 model suggests ~20% increase in TOC export from African rivers between 1970 and 2000 (Yasin et al 2010, Global Biogeochemical Cycles)

African continent is a major data gap

- majority of data from 1980's and 1990's
- often restricted to limited time scale monitoring of concentrations
- data often buried in grey literature, or raw data not reported

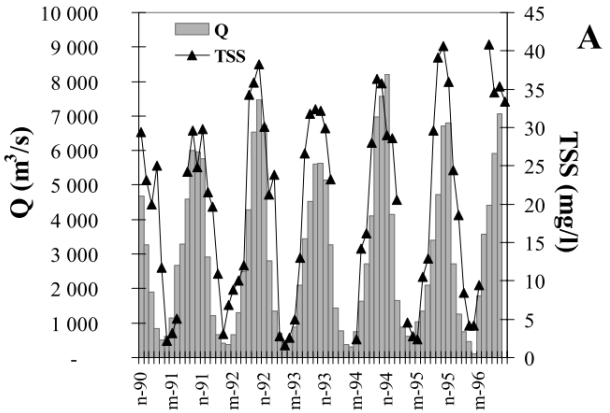
Few empirical datasets to validate model output – for data available, model output frequently does not match empirical data

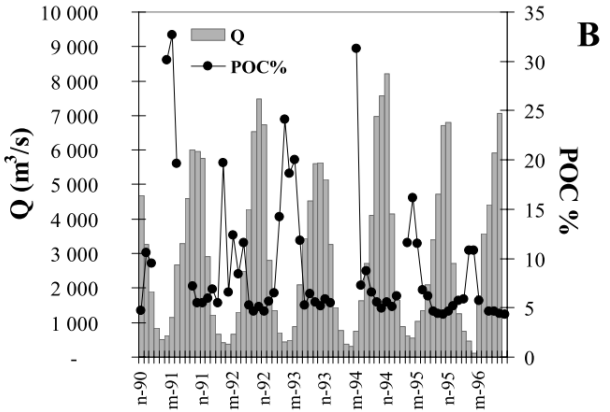
African continent represents wide range of settings to explore driving forces of C fluxes and cycling in river networks

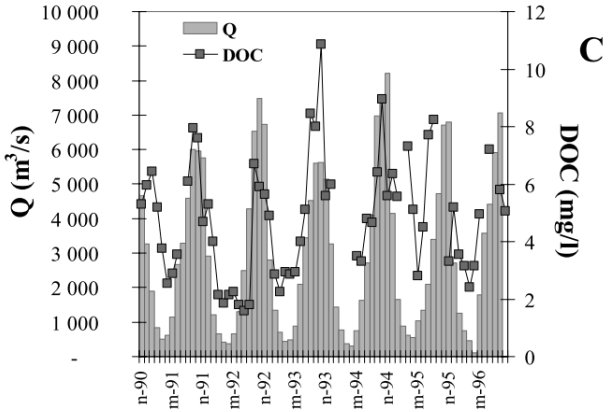
C cyling in Africa rivers / AFRIVAL project

Congo River basin:

- Among the 5 highest TOC fluxes of all world rivers;
- Older estimates often assumed constant TSM, POC and DOC concentrations over the year; order-of-magnitude estimates at best;
- Most extensive dataset estimates C export from mainstem based on 23 samples (Coynel et al. 2005 GBC)







C cyling in Africa rivers / AFRIVAL project

AFRIVAL research program in Congo River basin:

Congo river @ Kinshasasa: monthly sampling since October 2009
Oubangui @ Bangui: monthly sampling since March 2010

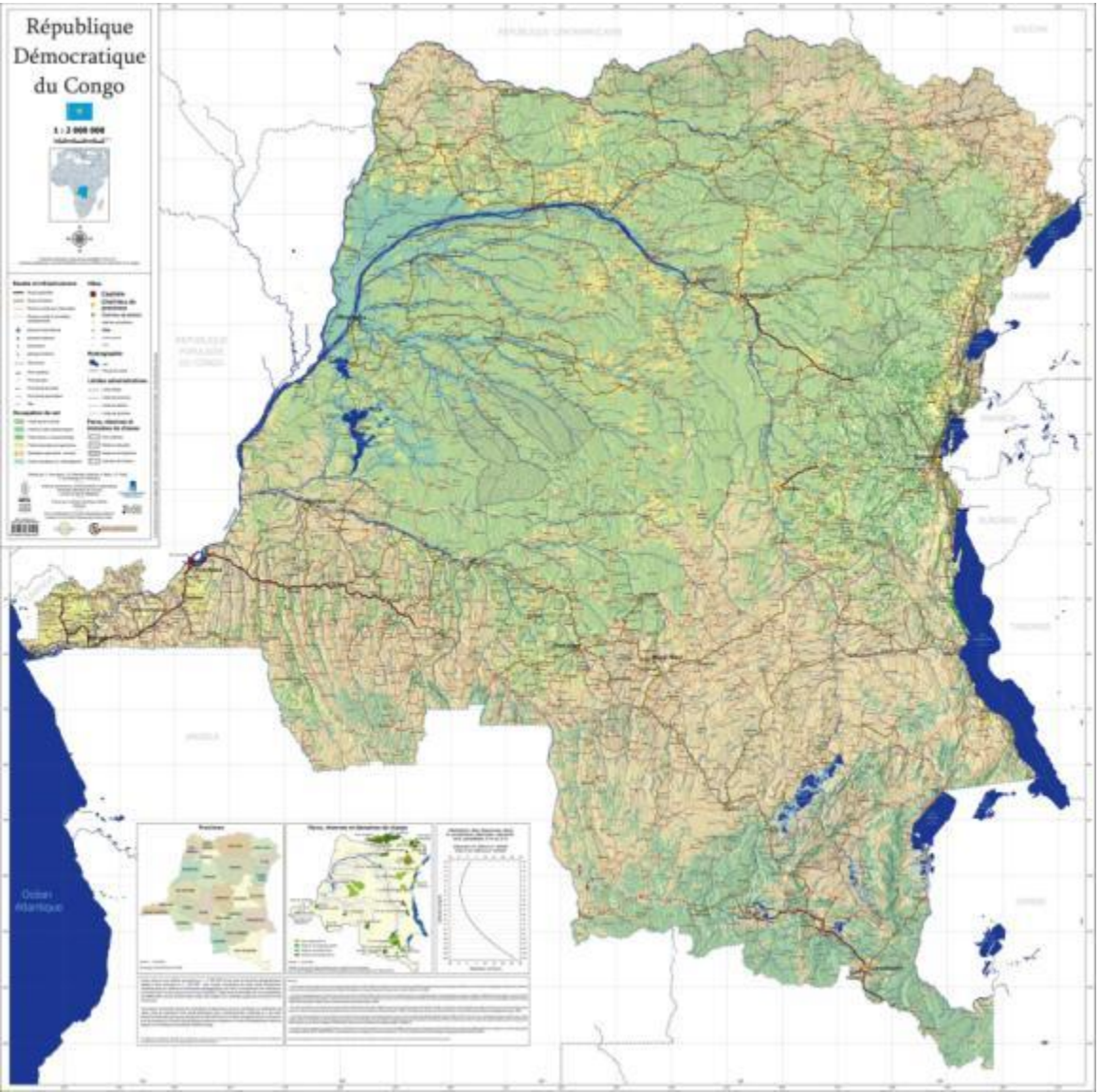
Congo cruise: June 2009 (21 stations)

May-June 2010 (53 stations)

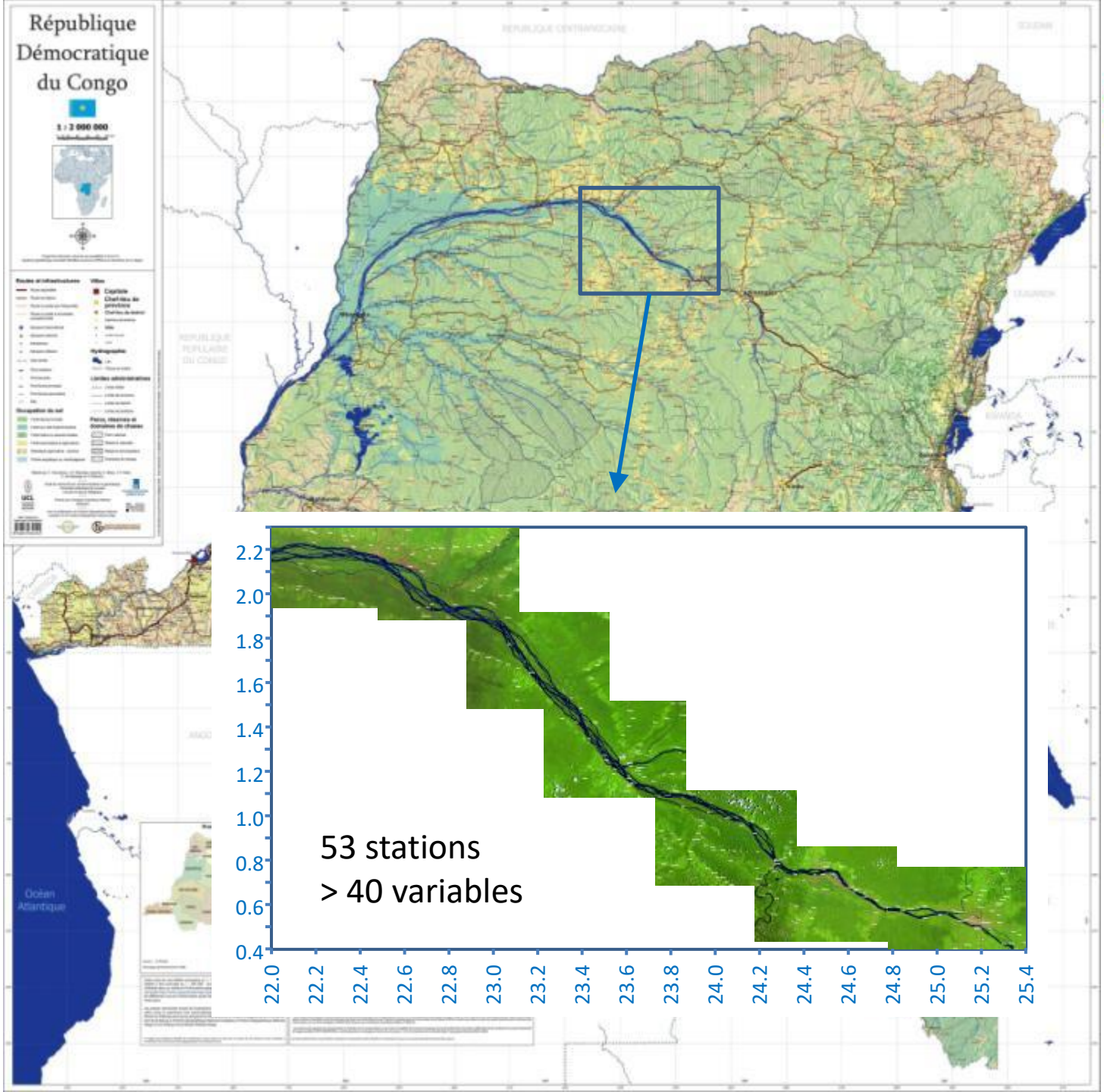
In the pipeline:

Congo River Spatial survey @ Kisangani and Lomami in March 2012
Congo cruise: Summer 2012, from Kisangani to Kinshasa (2000 km long)

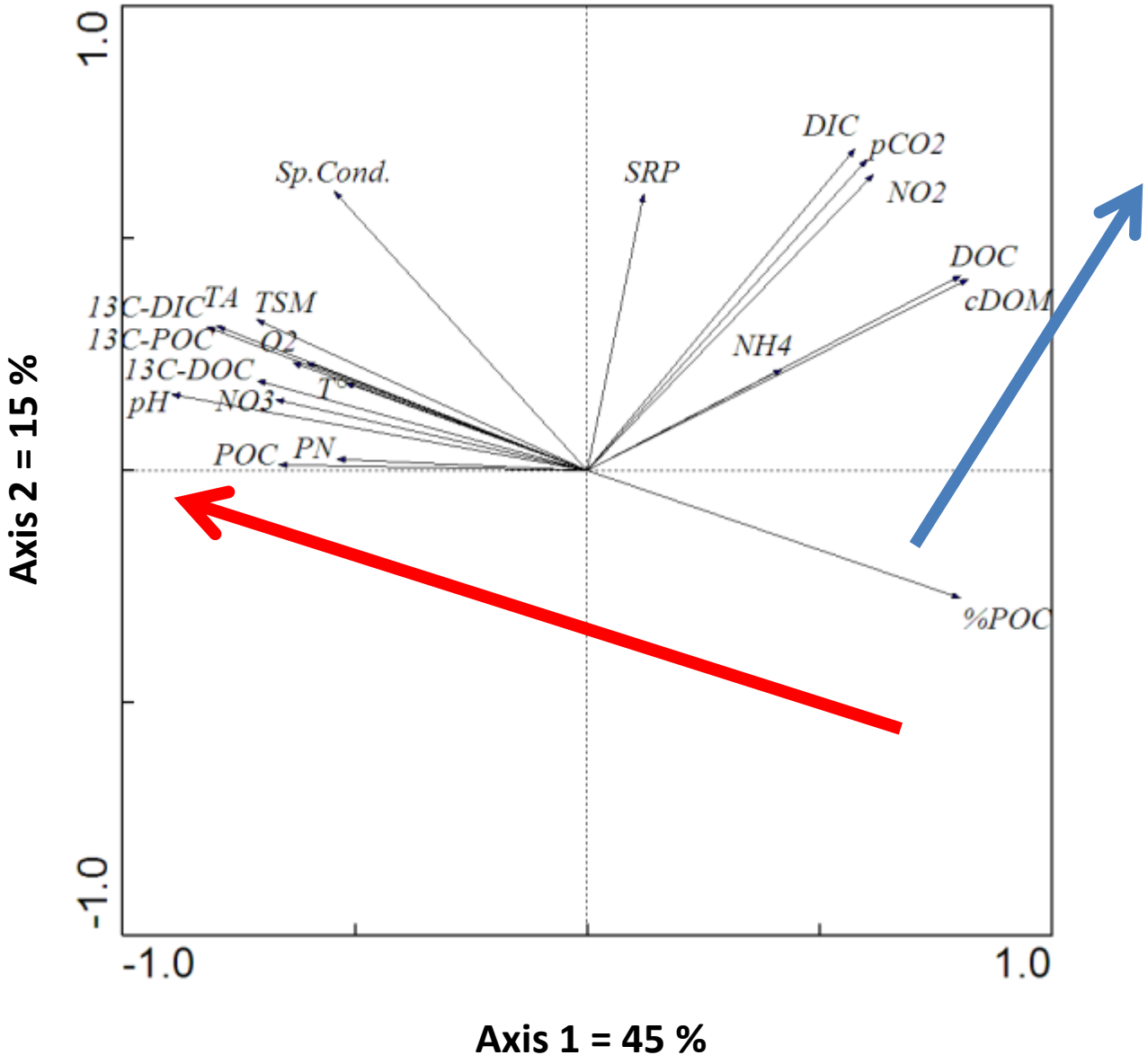
First assessment of the biogeochemistry of the Congo River and its tributaries: the Congo 2010 cruise



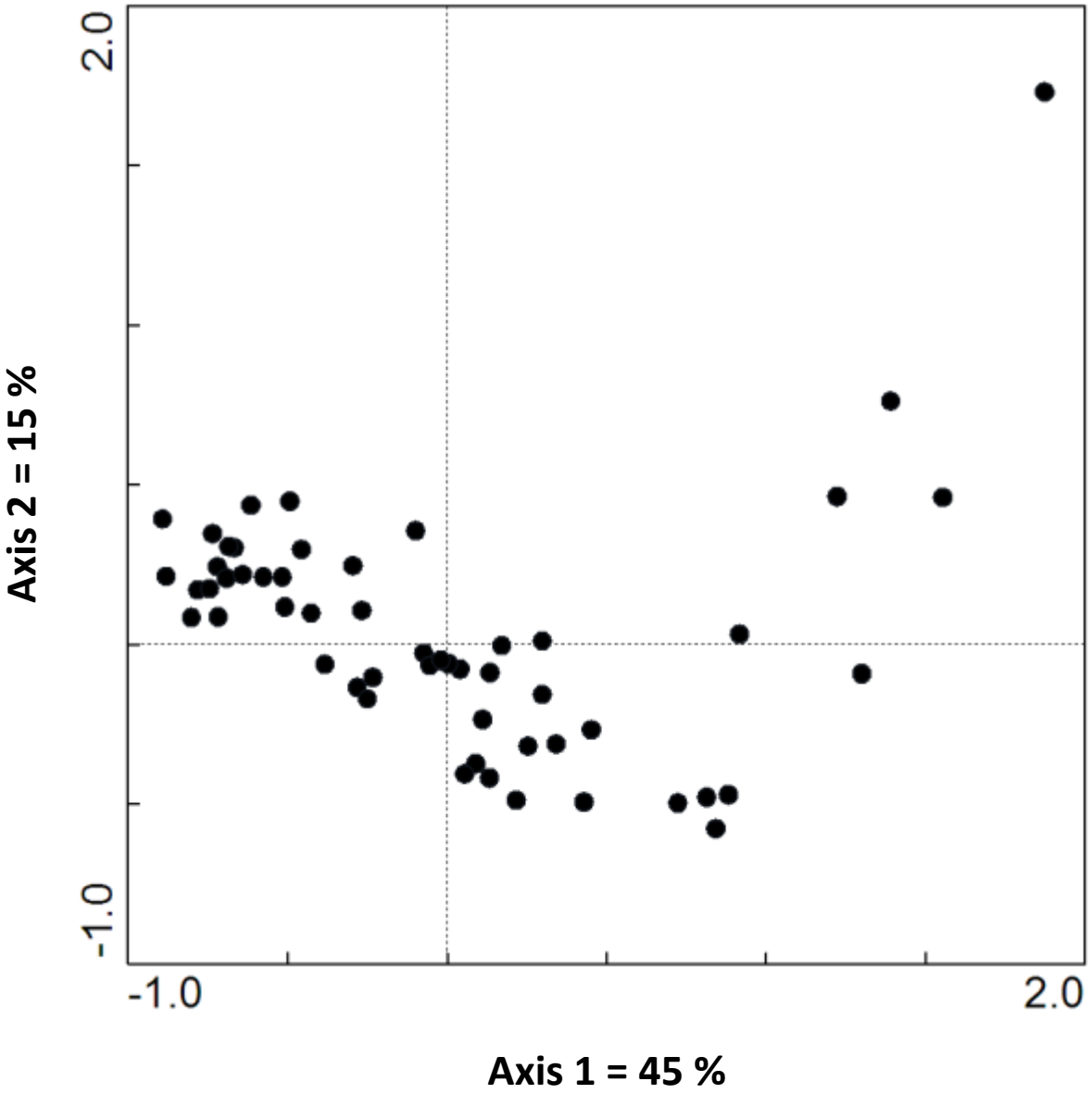
- Total length = ~4400 km
- Drainage basin = 3.7 10^6 km² (second only to the Amazon river basin)
- Water discharge = 1st river for Africa (World's second)
- World's second largest supplier of organic carbon to the oceans


République
Démocratique
du Congo
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
22.0
22.2
22.4
22.6
22.8
23.0
23.2
23.4
23.6
23.8
24.0
24.2
24.4
24.6
24.8
25.0
25.2
25.4
53 stations
> 40 variables
CONGO
2010

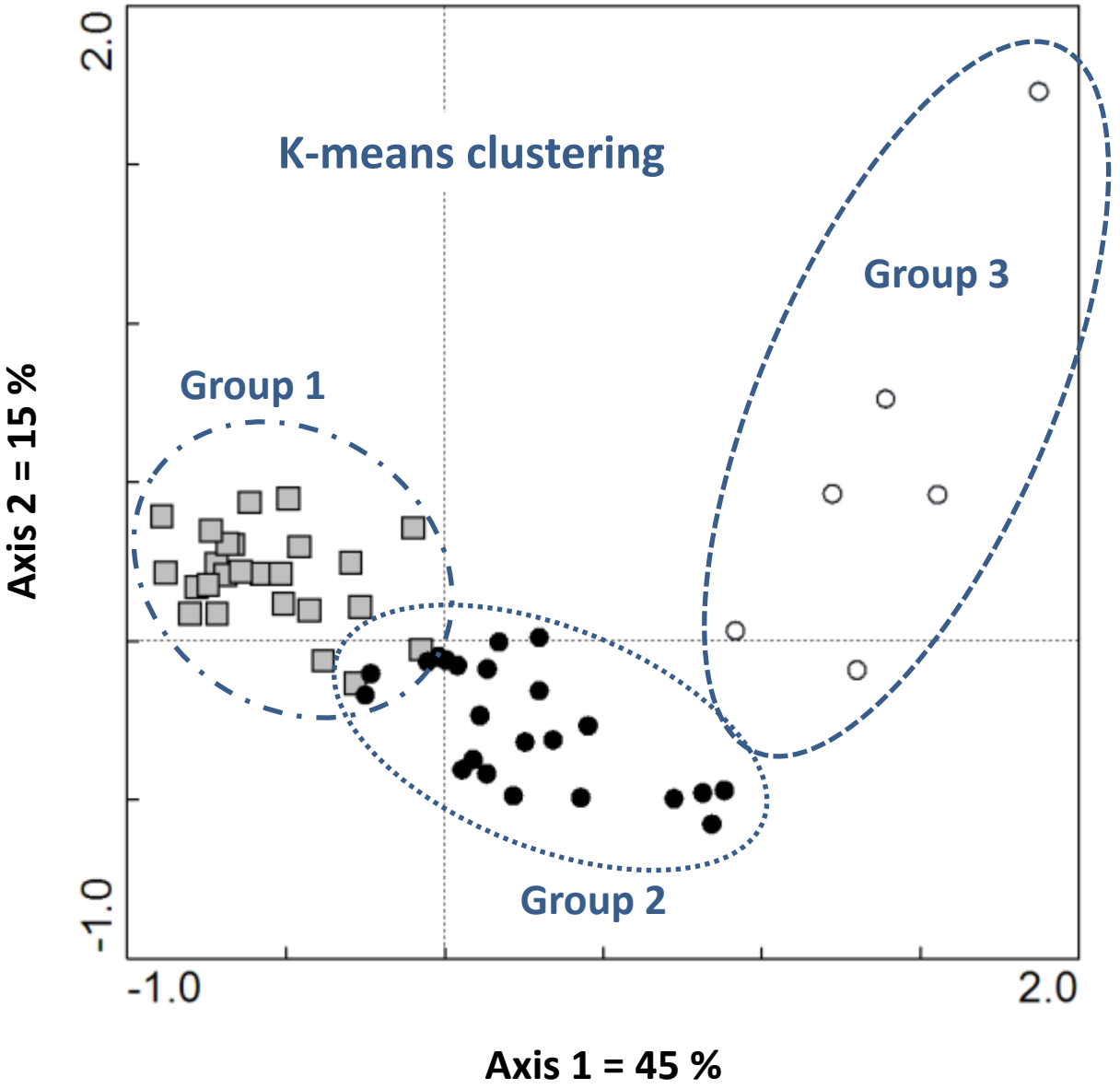
Principal component analysis



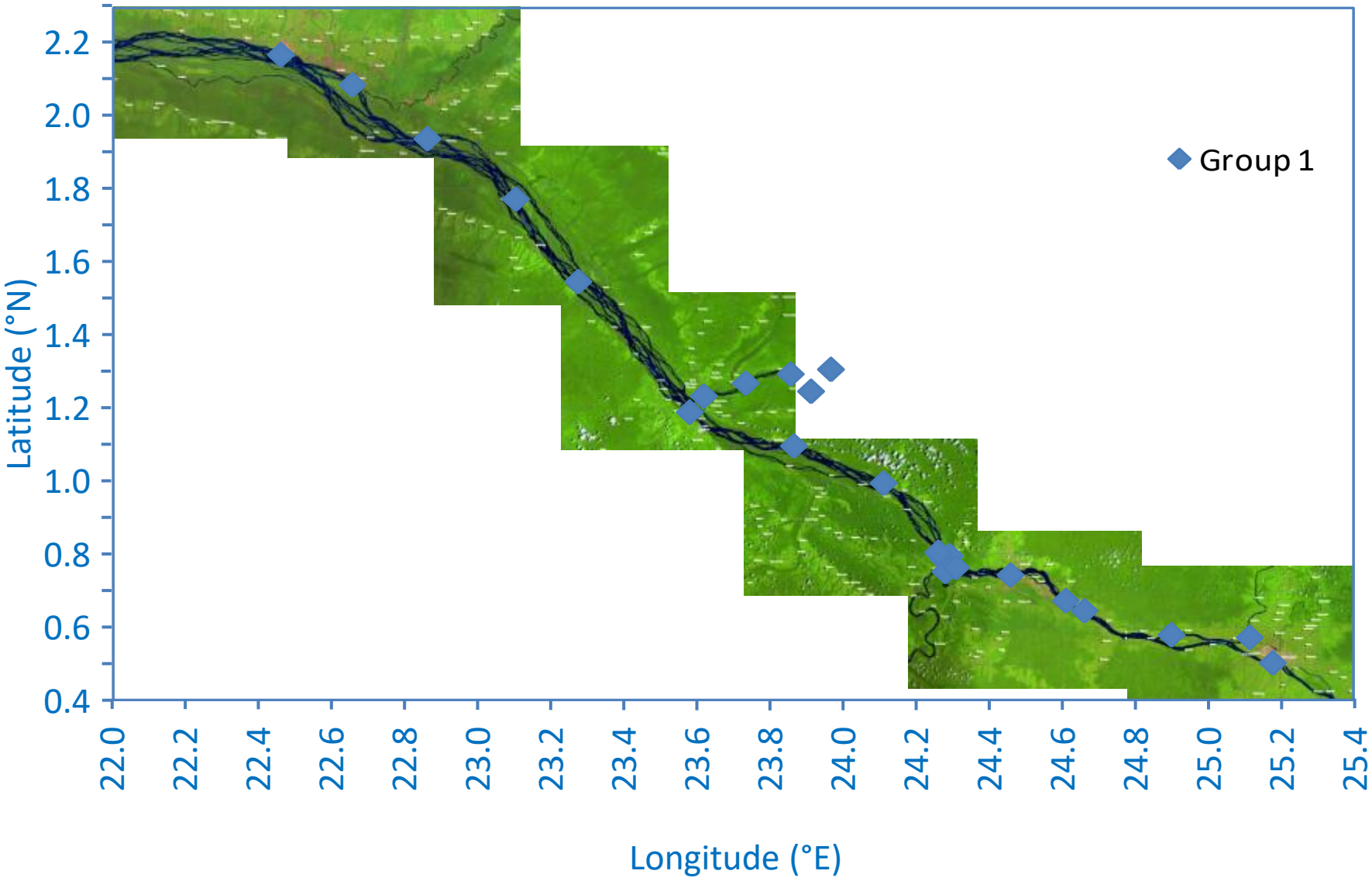
Principal component analysis



Principal component analysis



Congo River 2010 BGC dataset



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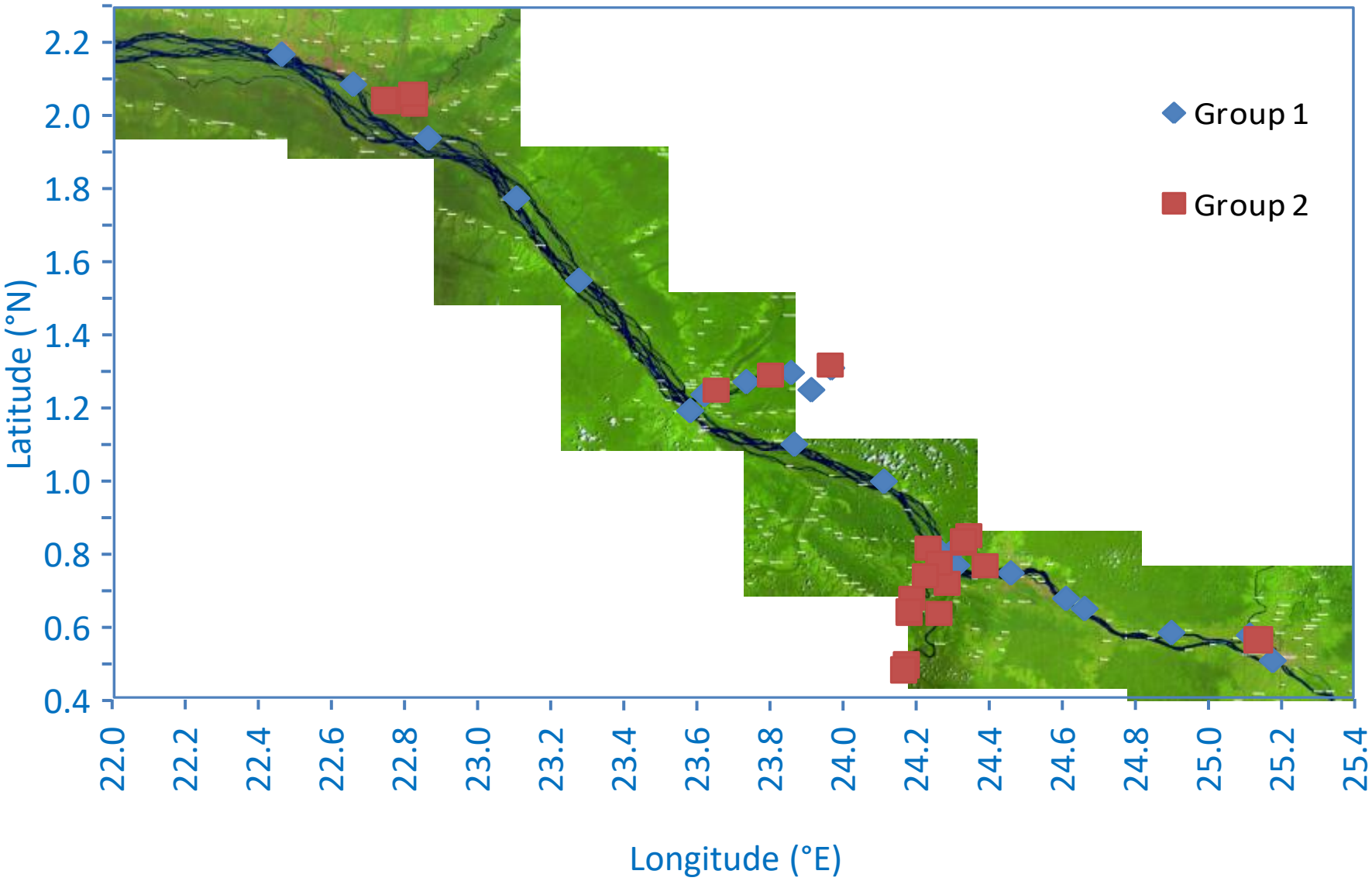
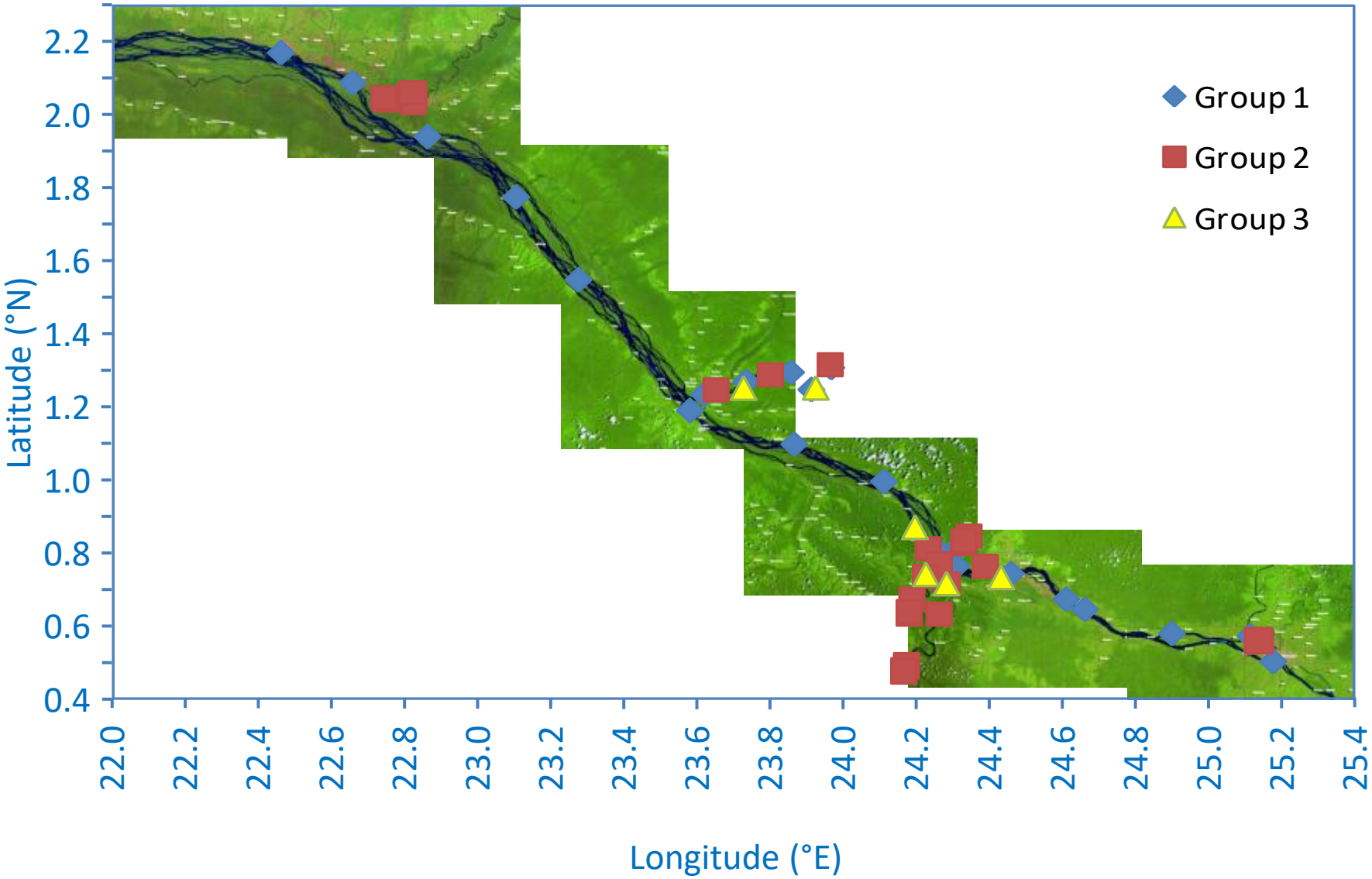
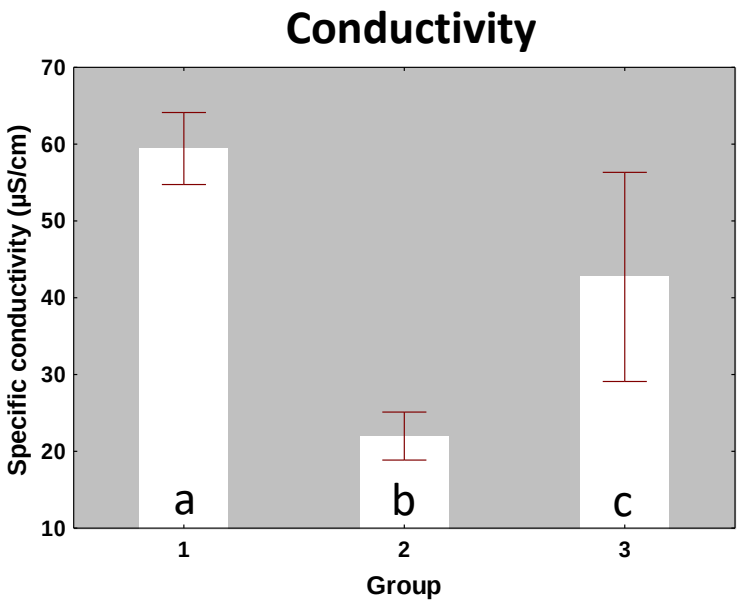
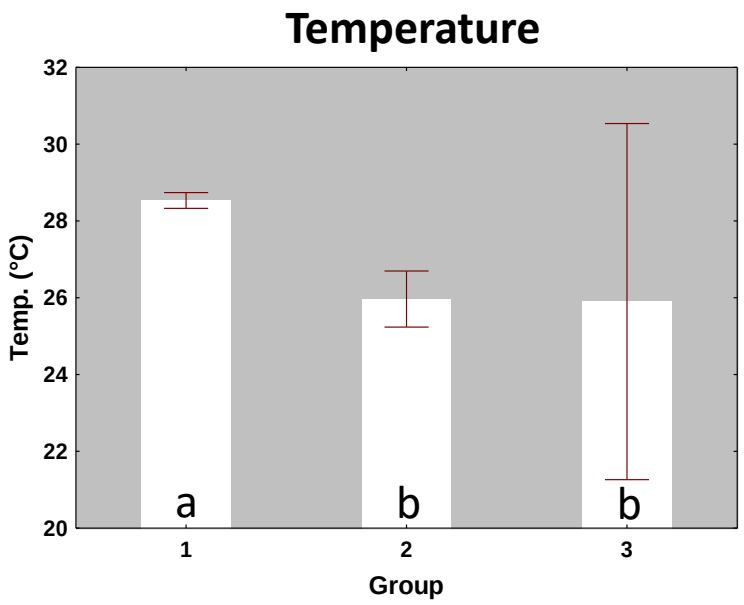


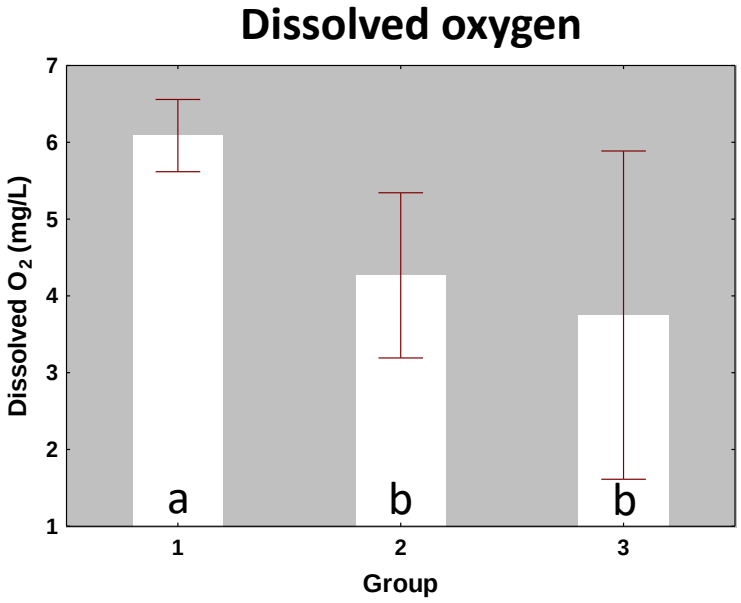
Congo River 2010 BGC dataset

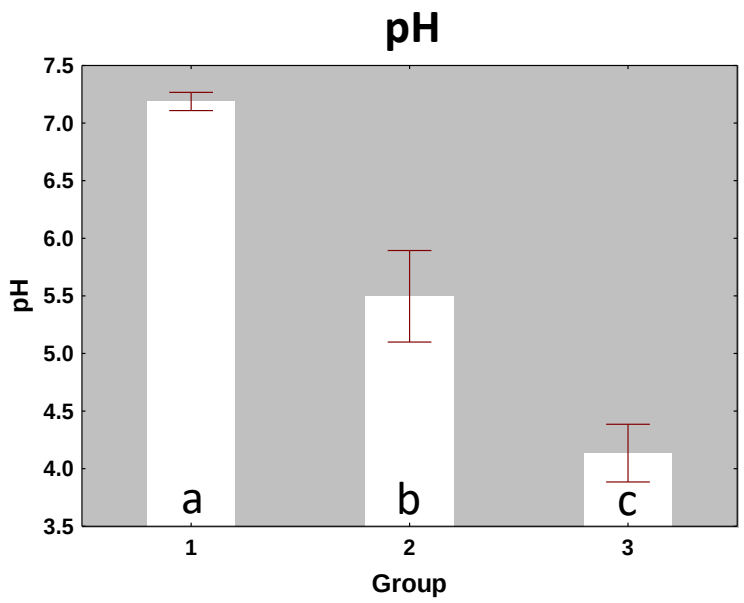


Congo River 2010 BGC dataset

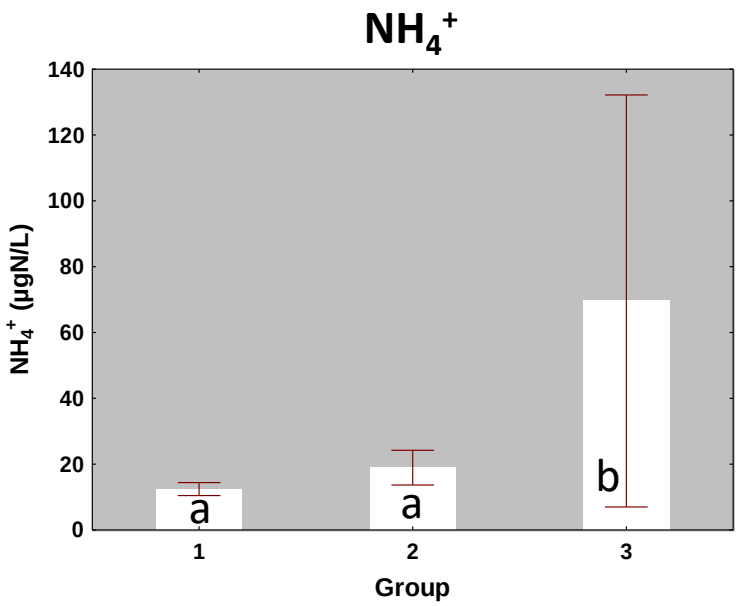


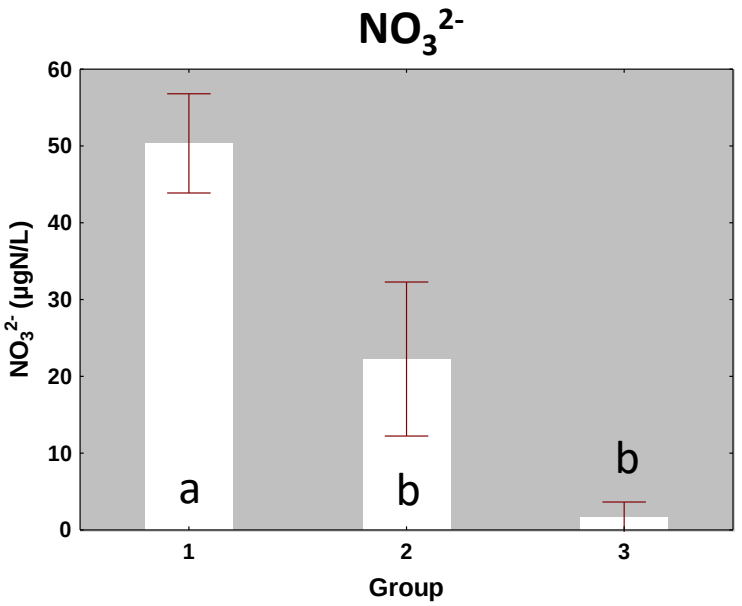


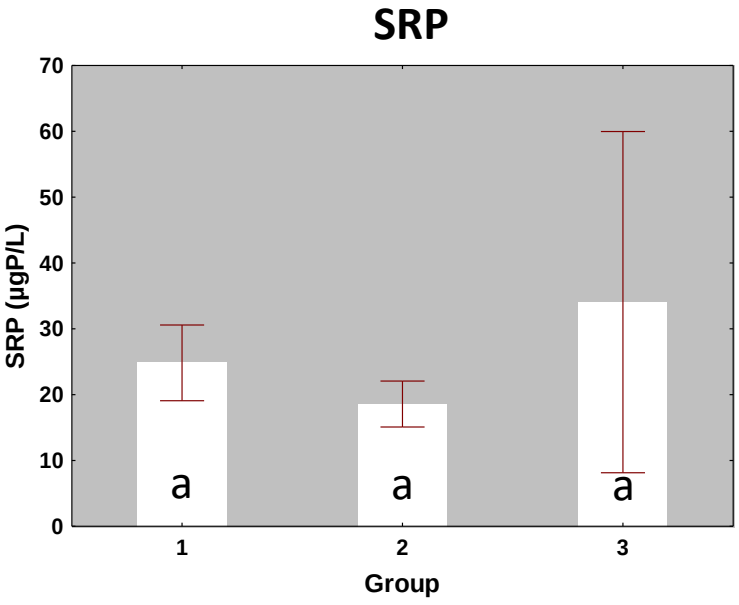


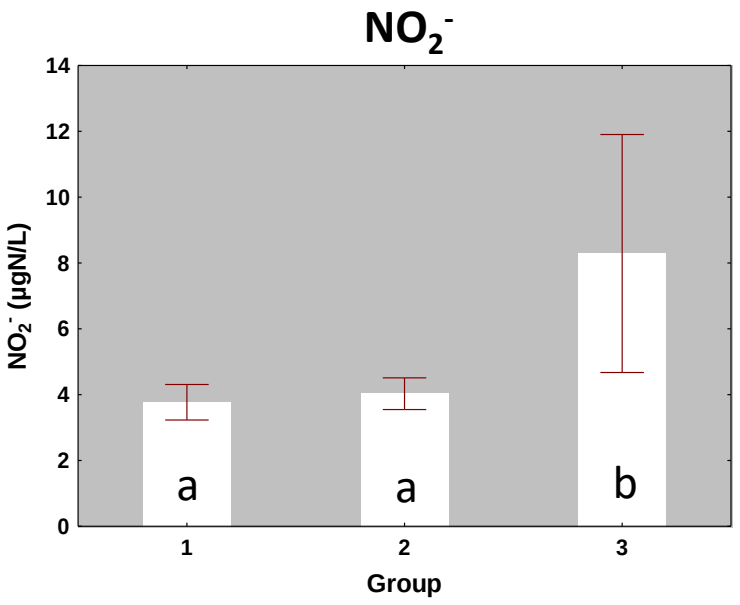


Congo River 2010 BGC dataset

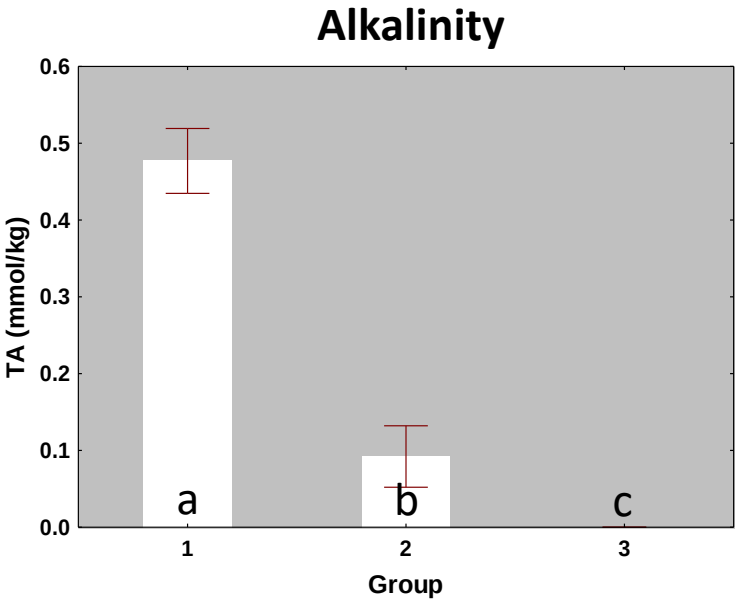


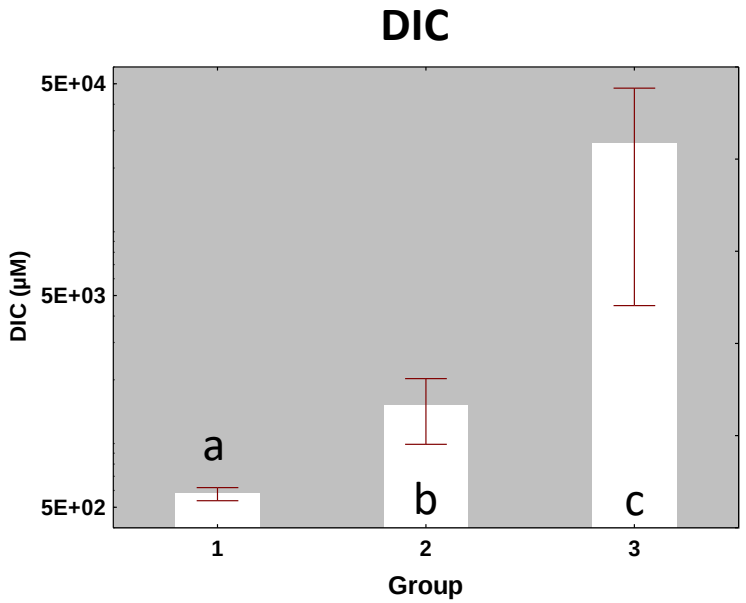


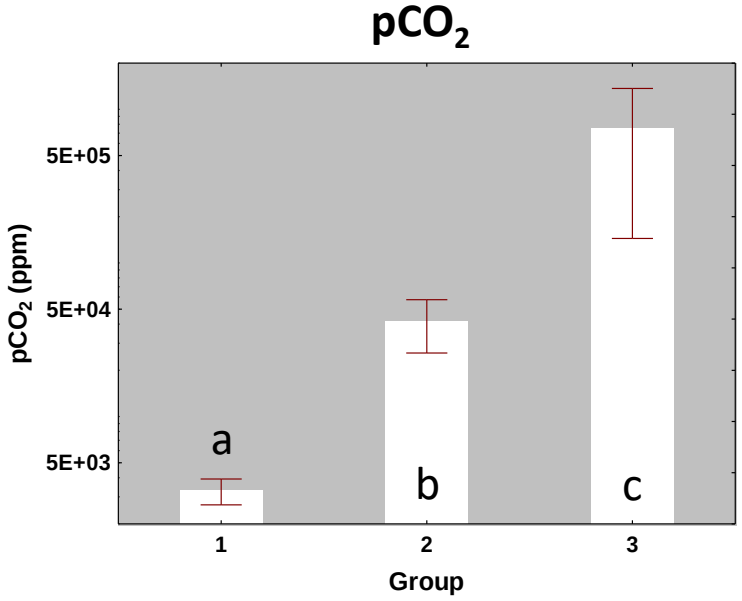




Congo River 2010 BGC dataset

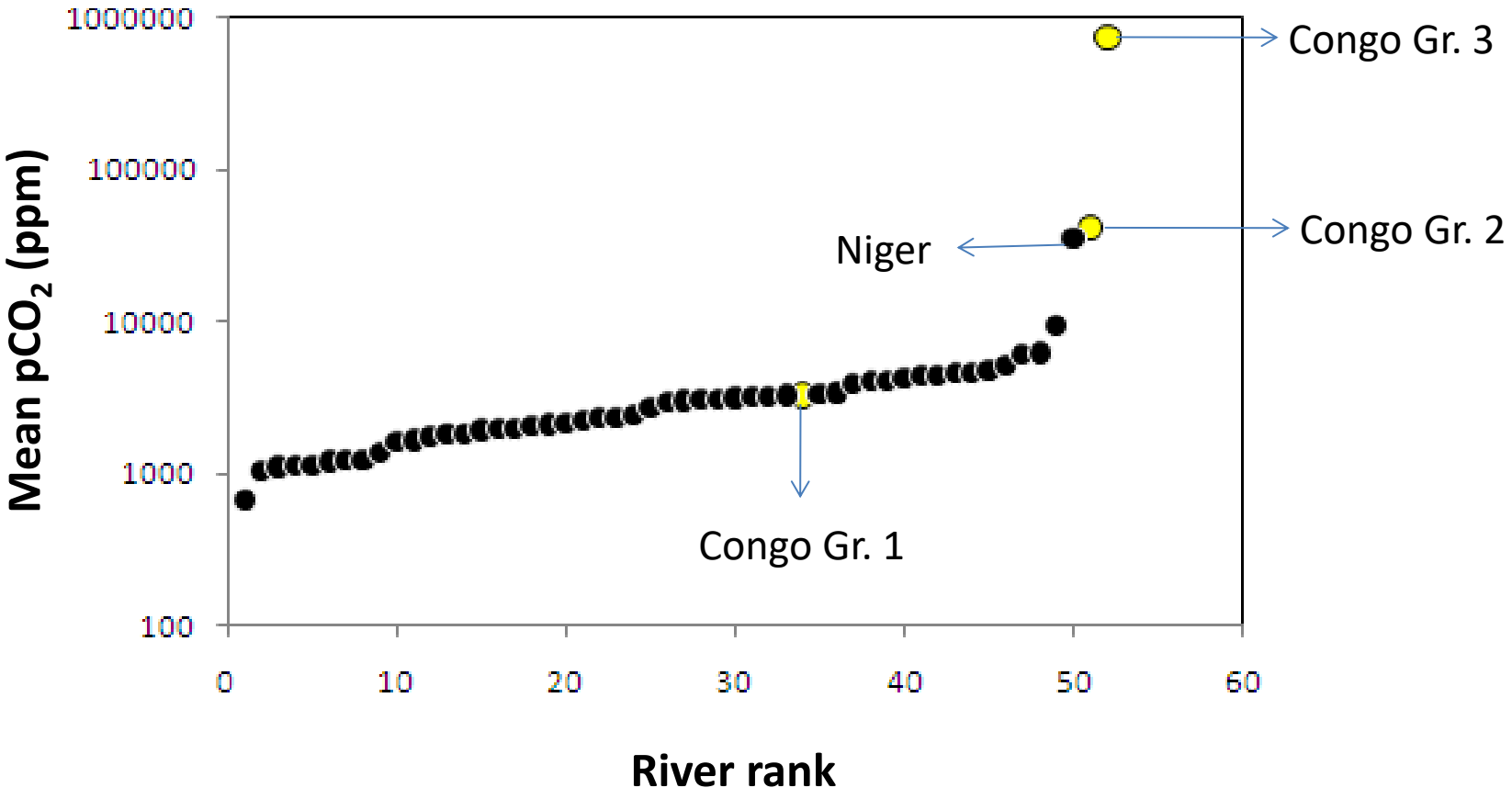






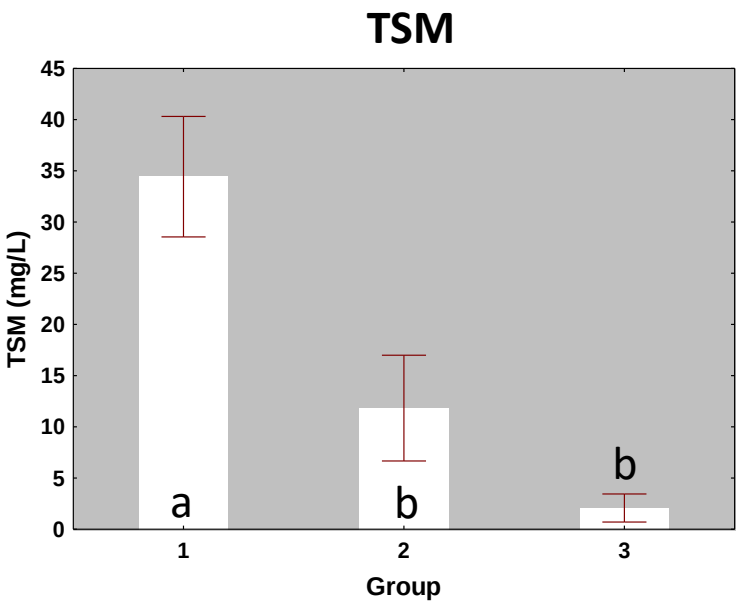
pCO_2 in Rivers

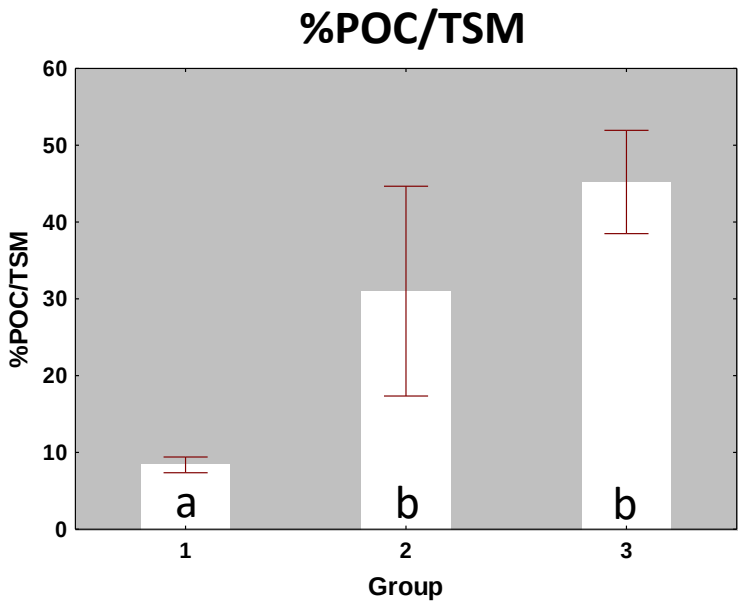
(based upon pH and TA)

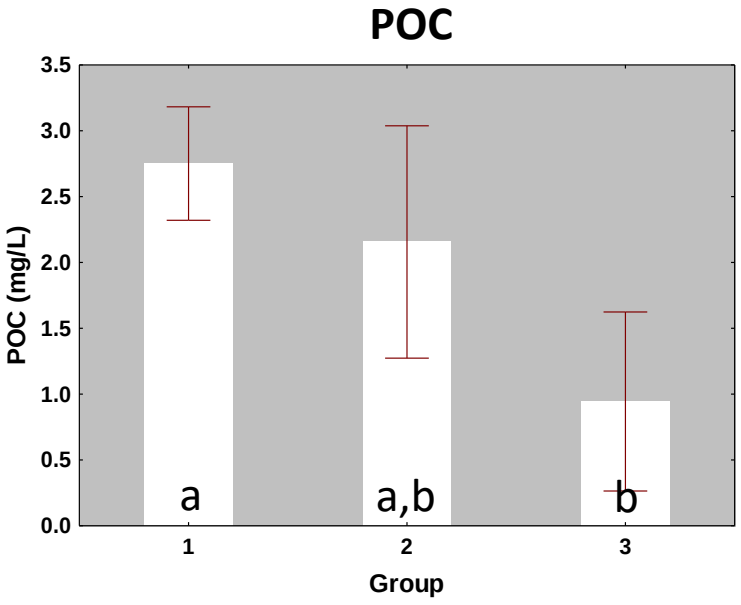


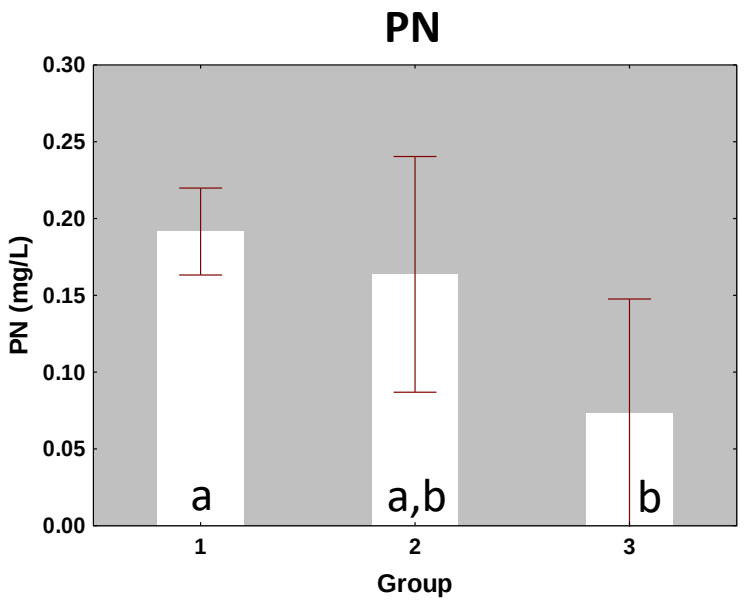
(data review from Cole & Caraco 2001 Mar. Freshw. Res.)

Congo River 2010 BGC dataset

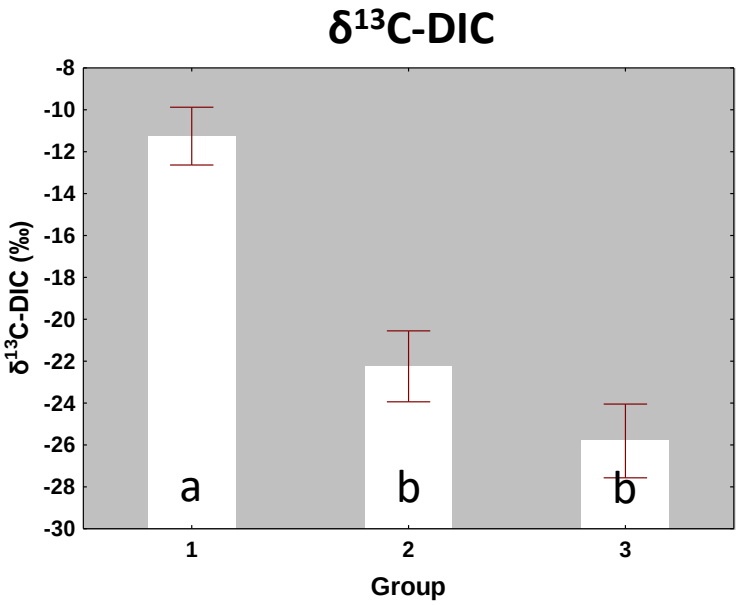


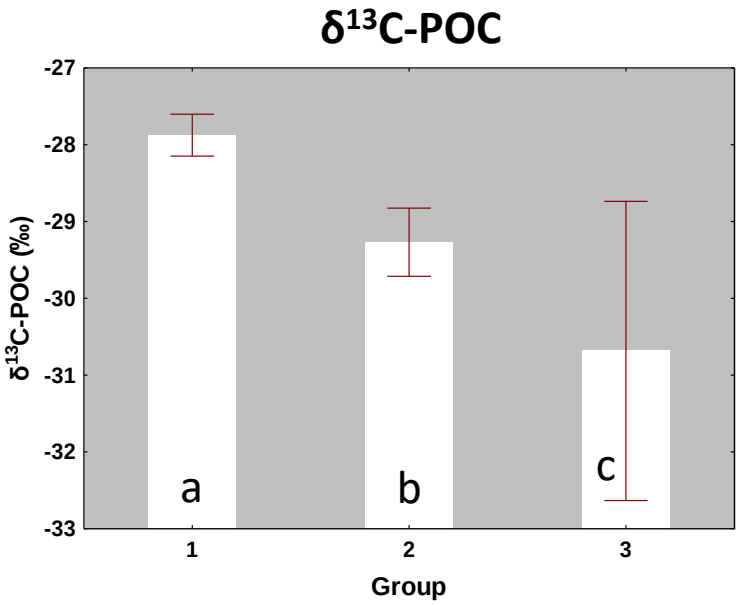


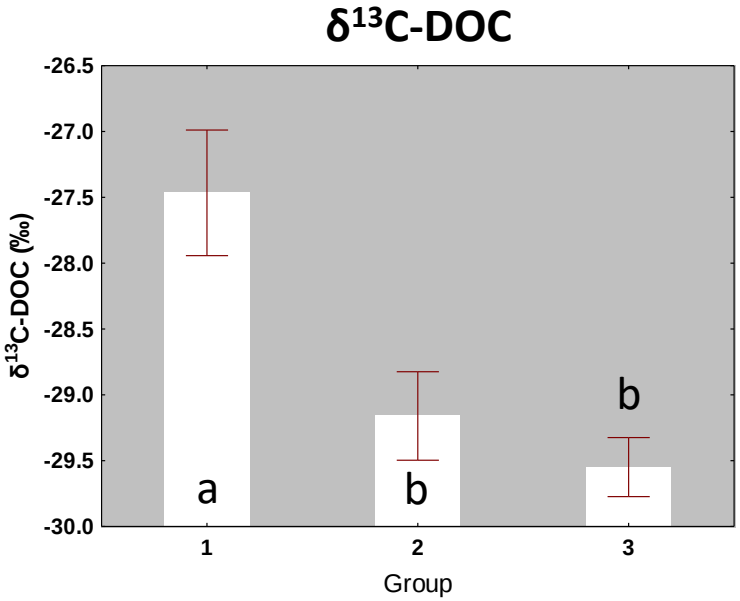




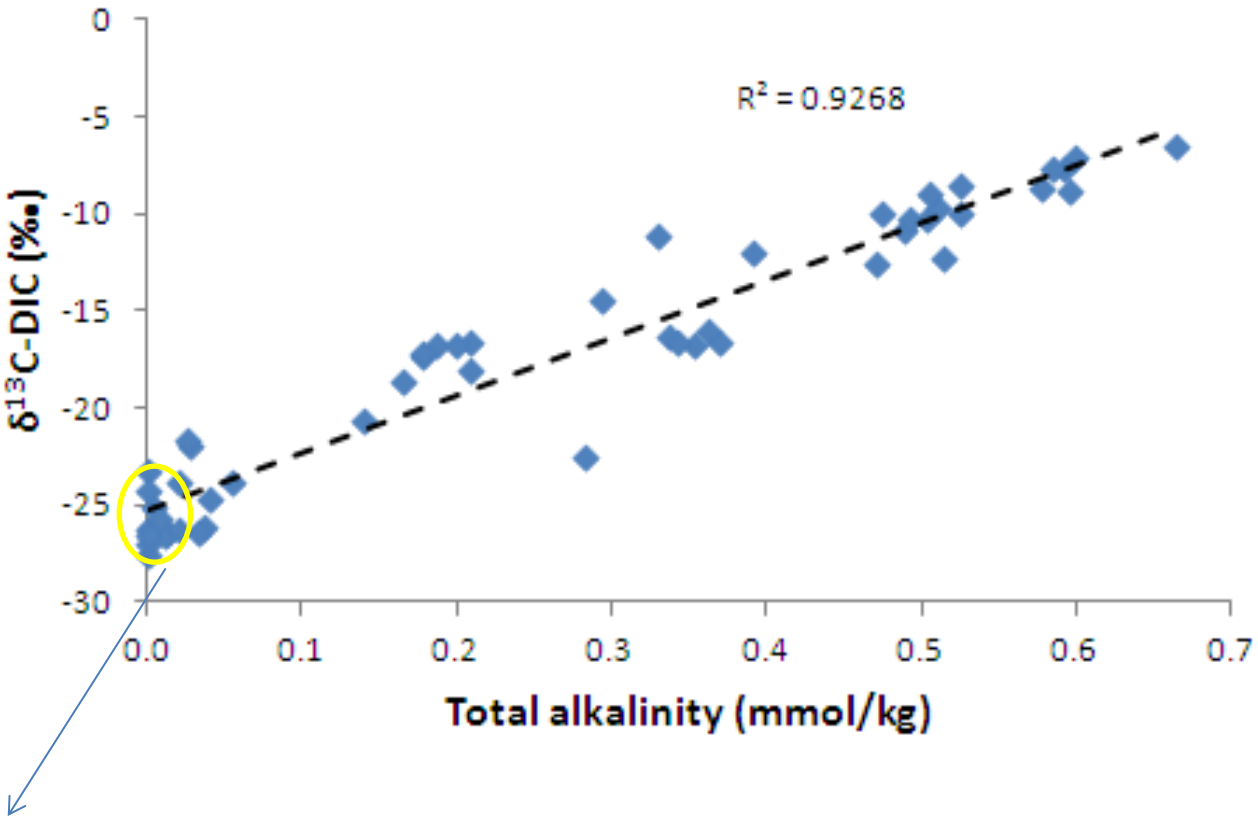
Congo River 2010 BGC dataset





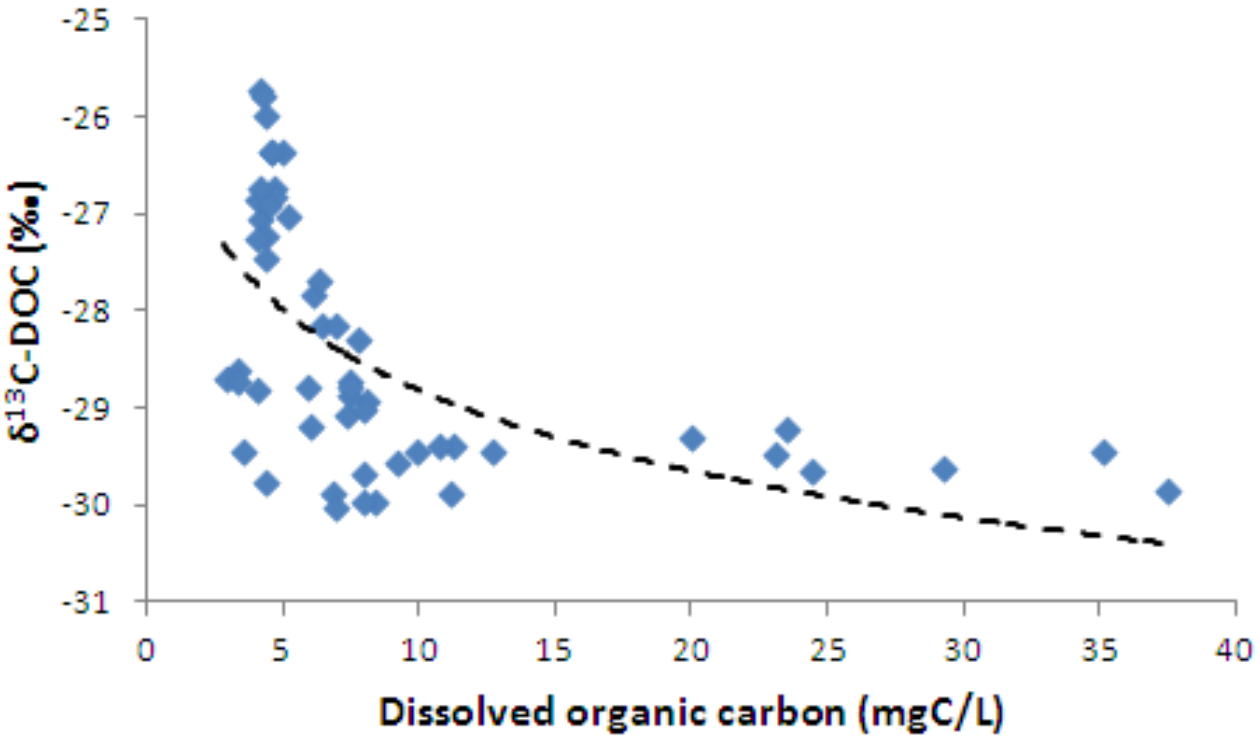


Congo River 2010 BGC dataset



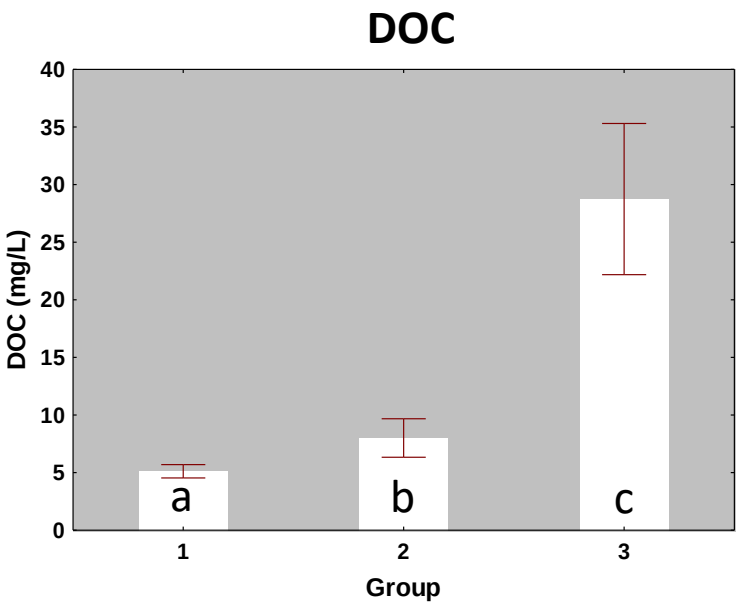
Signature of pure CO_2 (mix from soils and in situ respiration) ➔ low signal of C4 plants while they dominated watersheds

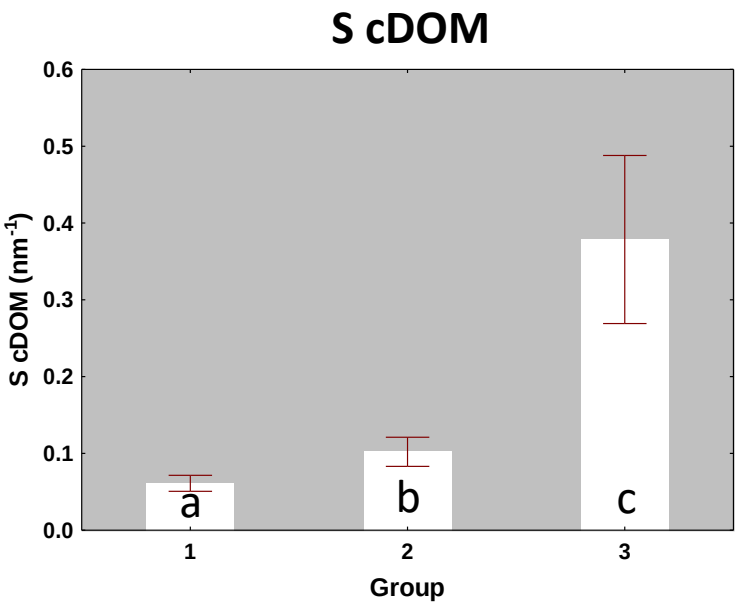
Congo River 2010 BGC dataset



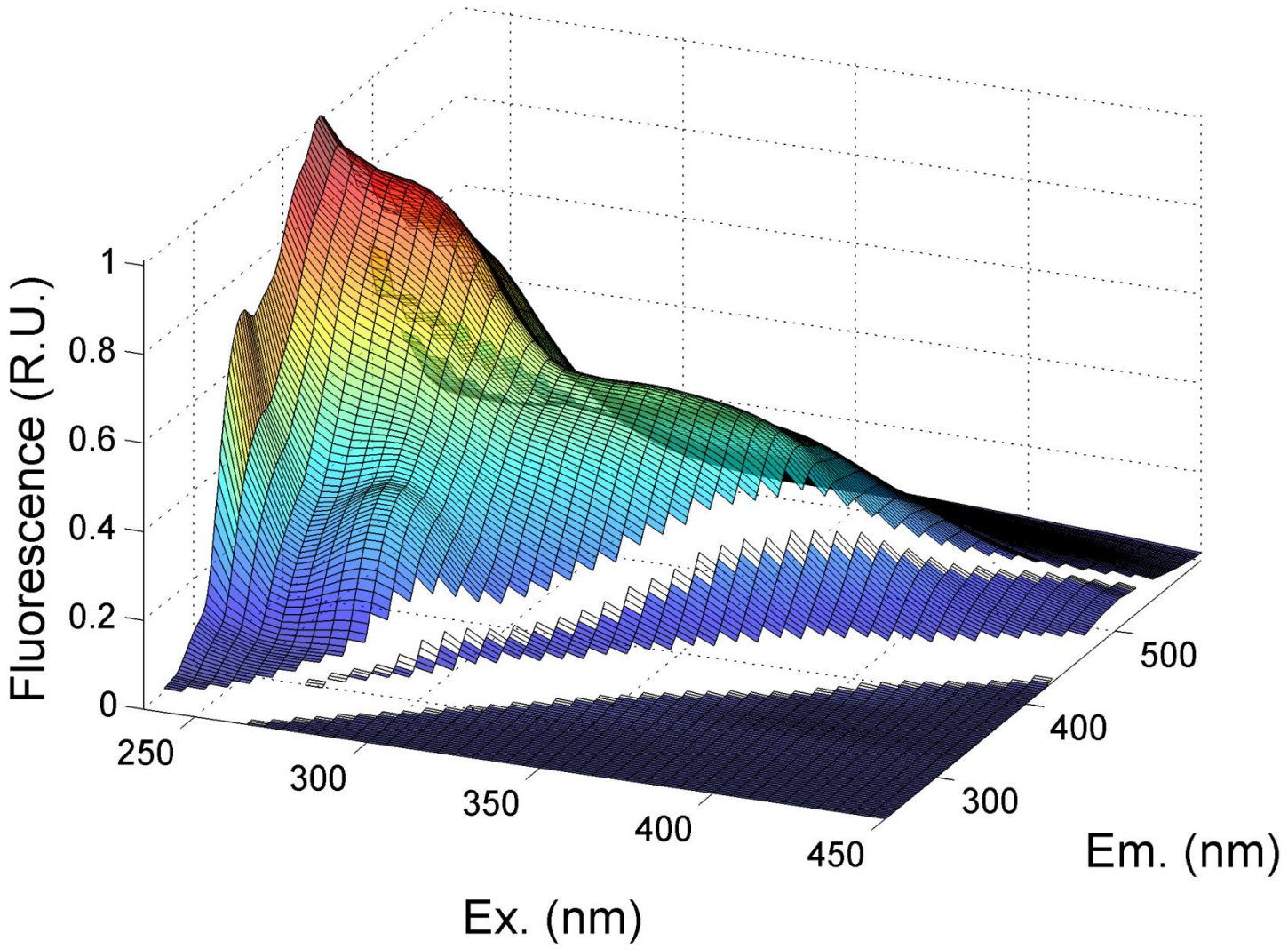
High variations at low DOC concentrations, because higher contribution of phytoplankton to the POC pool

Congo River 2010 BGC dataset



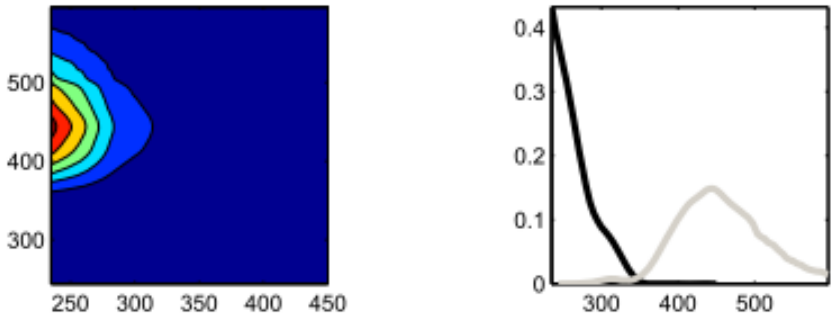


fDOM

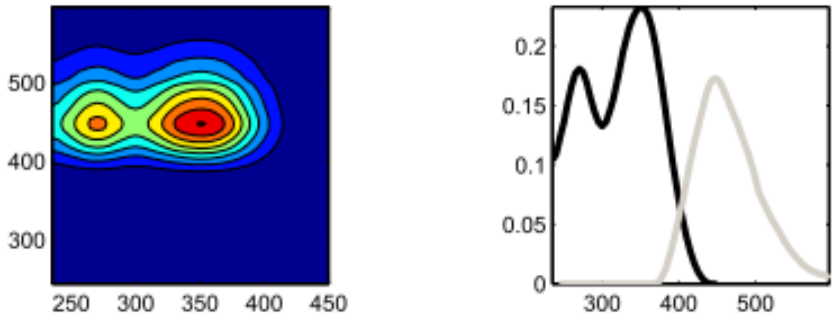

Fluorescence (R.U.)
1
0.8
0.6
0.4
0.2
0
250
300
350
400
450
Ex. (nm)
300
400
500
Em. (nm)

fDOM (PARAFAC analysis)

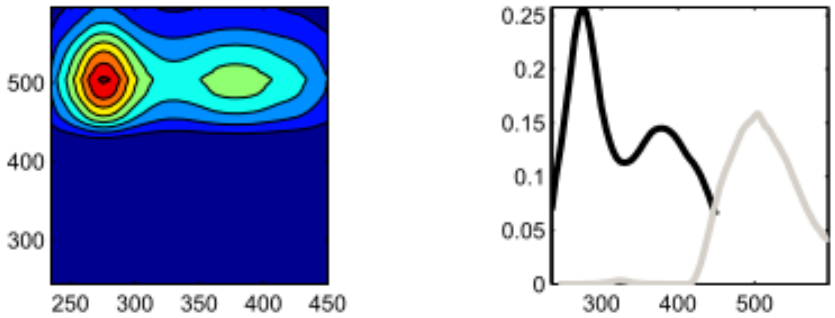
Component 1 = Photoproducts



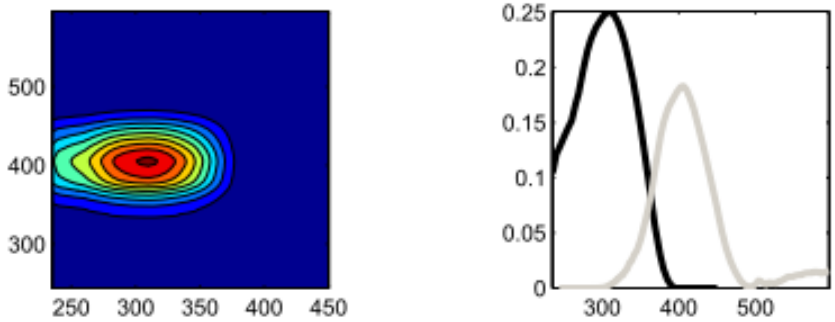
Component 2 = Fulvic acids



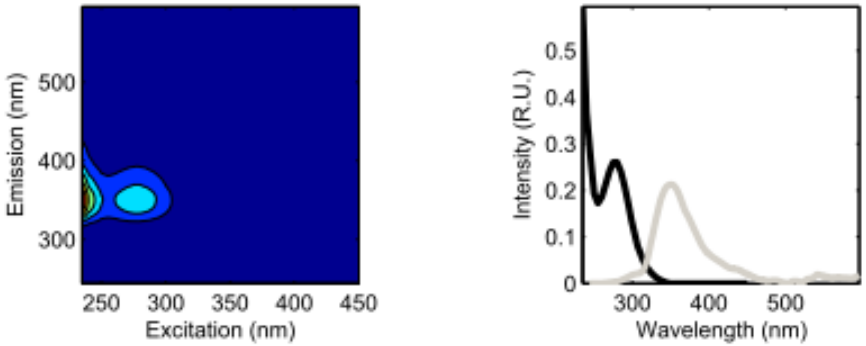
Component 3 = Humic acids



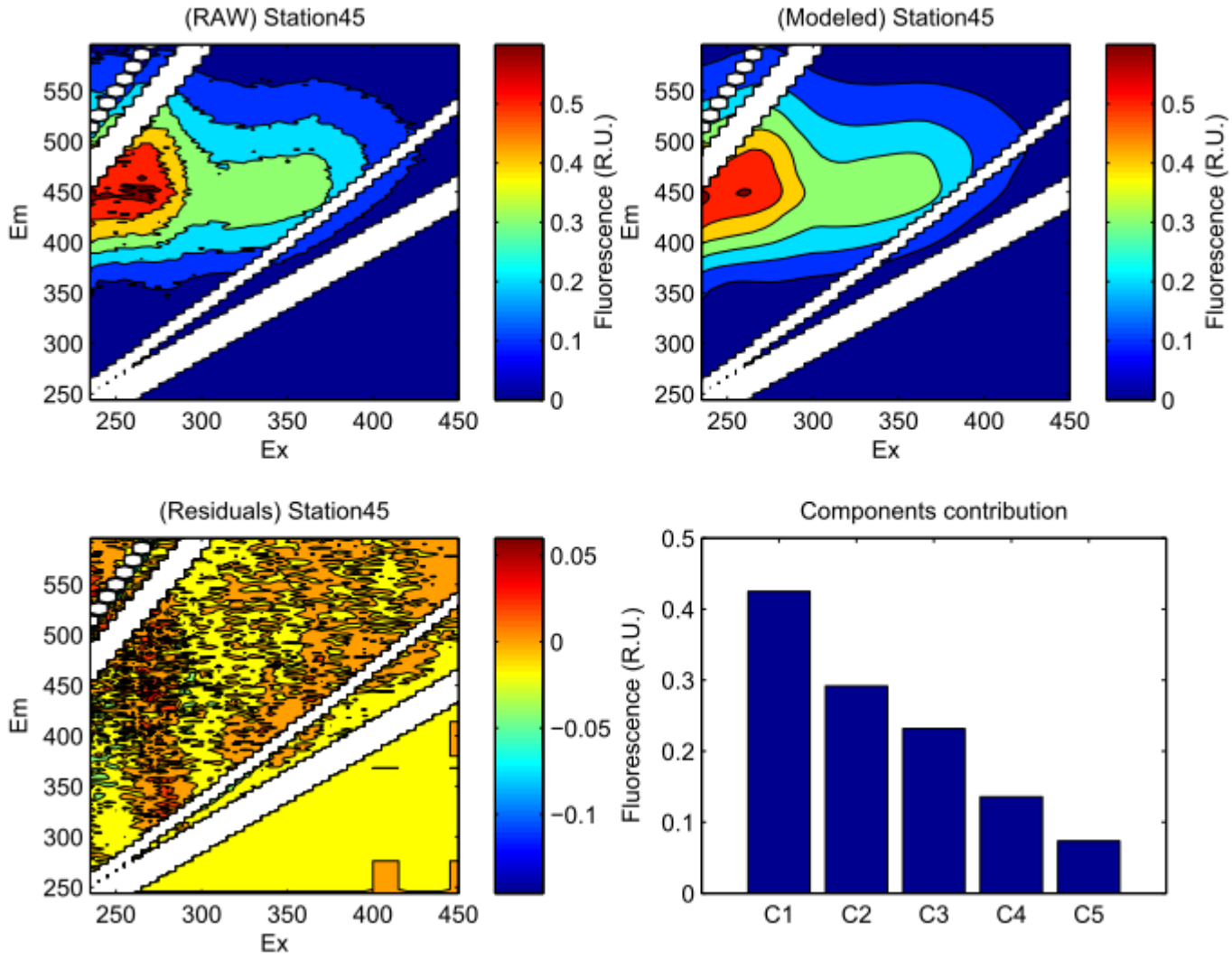
Component 4 = Unidentified



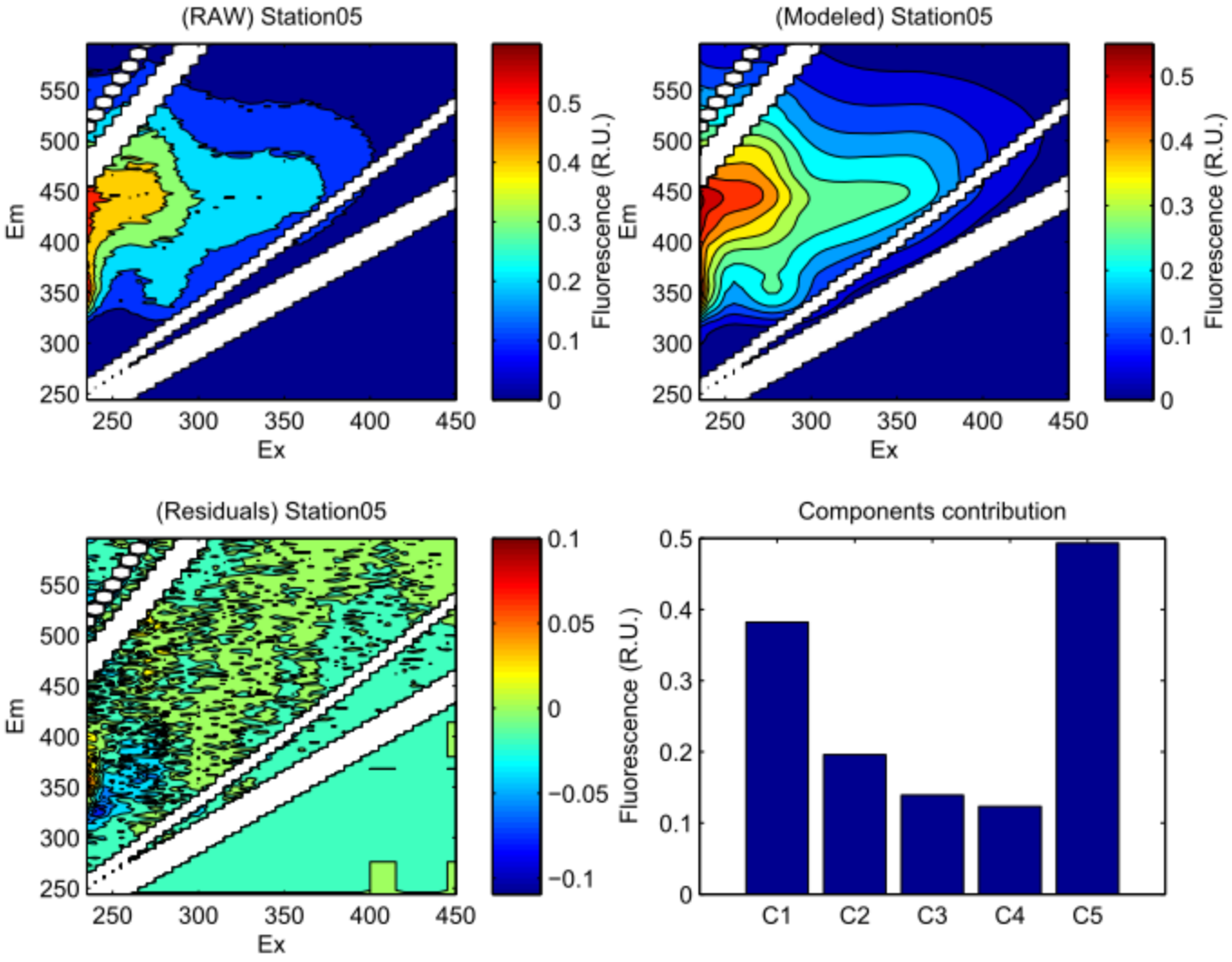
Component 5 = Protein-like



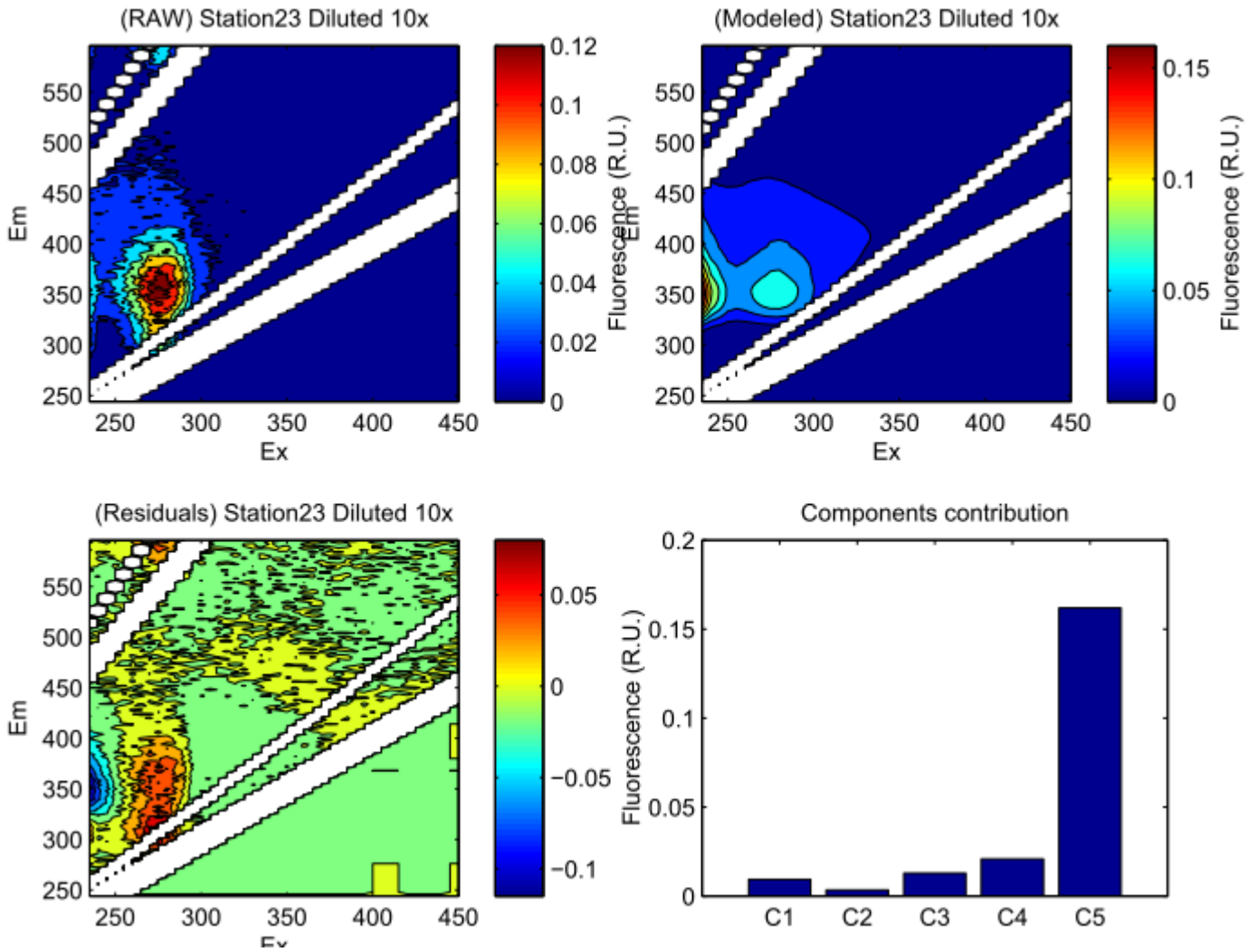
Congo River 2010 BGC dataset



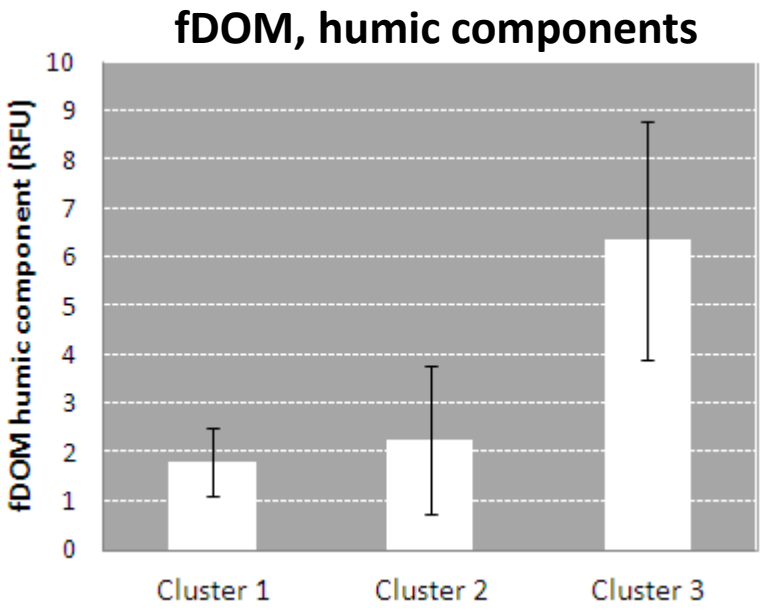
Congo River 2010 BGC dataset

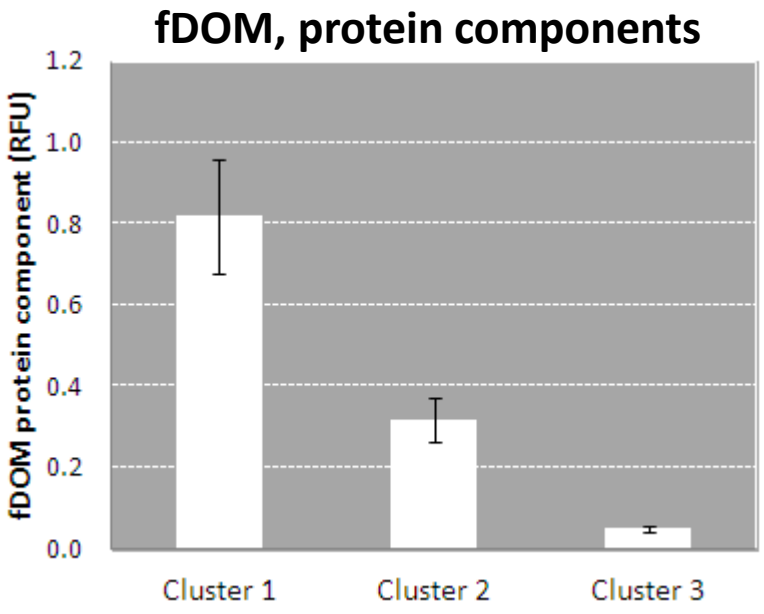


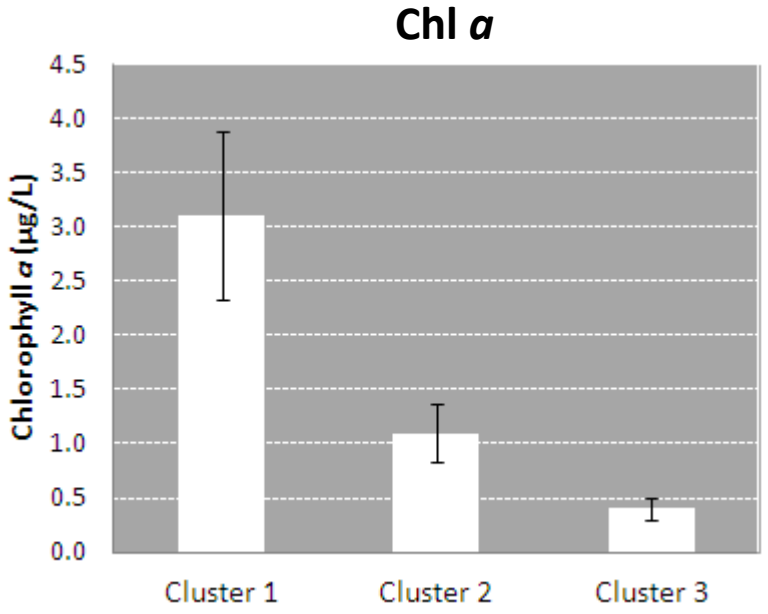
Congo River 2010 BGC dataset



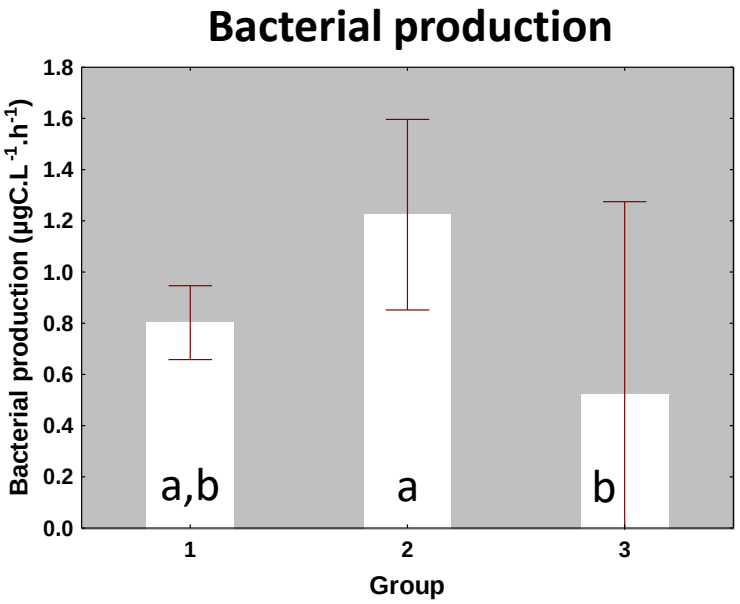
Congo River 2010 BGC dataset

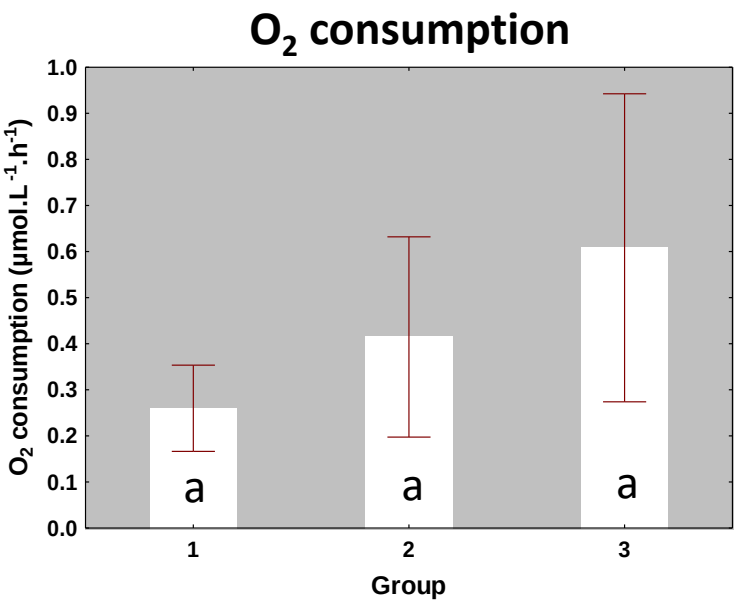






Congo River 2010 BGC dataset





	Group 1 = Main stem + Aruwimi	Group 2 = Lomami + Itimbiri + small rivers	Group 3 = small rivers (black waters)
Conductivity	± 80	± 20	± 50
pH	± 7.0	± 5.5	± 4.0
Alkalinity	Moderate	Low	No
pCO_2	Slighty oversaturated	Hightly oversaturated	Very hightly oversaturated
TSM	High	Moderate	No suspended matter
%POC/TSM	Low	Moderate	Very high
NO_3^- vs NH_4^+	$NO_3^- > NH_4^+$	$NO_3^- = NH_4^+$	$NO_3^- < NH_4^+$
DOC and cDOM	Low	Low	Very high
O_2 consumption	→	→	→
$\delta^{13}C$-DIC	- 12	- 22	- 25
$\delta^{13}C$-POC	- 28	- 29	-31
$\delta^{13}C$-DOC	- 27.5	-29.0	-29.5

Carbon fluxes from Congo River: knowns and unknowns
mostly unknowns…

Data gaps & requirements:

- very few monitoring records for quantitative flux measurements
  - discharge data frequently lacking
  - historical data often inaccessible
  - required for regional models and calibrations/validations

- basin-wide studies to understand C cycling and processing during river transit

- process measurements: production, respiration, recycling

- high spatial/seasonal variability: driving processes need need to understood & modeled for upscaling

- compilation/digitizing of data and public access

- long-term collaborations with local institutes & capacity building