Biogeochemistry and transport fluxes from the Oubangui River, Central African Republic: preliminary results after one year of monitoring.

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Introduction

► The Congo River basin is the 2nd largest in the world in terms of discharge and catchment size, and has been estimated to transport 13.4 to 14.4 Pg y^{-1} of organic carbon, 85-90% of which is in the form of dissolved organic carbon (DOC) .

► A number of sampling programmes have produced extensive data on major and trace element and bicarbonate fluxes, and sediment and organic carbon flux data for a limited number of locations, both on the main Congo River and in some of its major tributaries. However, most data stem from the 1980's and 1990's, and very little data exists on organic matter geochemistry or carbon cycling.

► Since March 2010, we have re-initiated regular sampling on the Oubangui, one of the main tributaries of the Congo River, for a wide suite of biogeochemical parameters.

Site and Methods

► The Oubangui river is the second largest tributary of the Congo River basin, with a length of 2400 km from the source river (Uele) to its confluence with the Congo River, and a drainage basin of 644 000 km², of which 76% is located upstream of Bangui. The catchment is dominated by dry tree savannahs, with more humid forest situated downstream towards the confluence with the Congo mainstem.

► Sampling was initiated in late March 2010, and was followed by approximately fortnightly sampling. Data presented here cover the period of March 20th, 2010 to March 19th, 2011(28 sampling dates).

► Sampling and analytical procedures generally follow those described in Bouillon et al. (2009) and Spencer et al. (2009) for dissolved lignin.

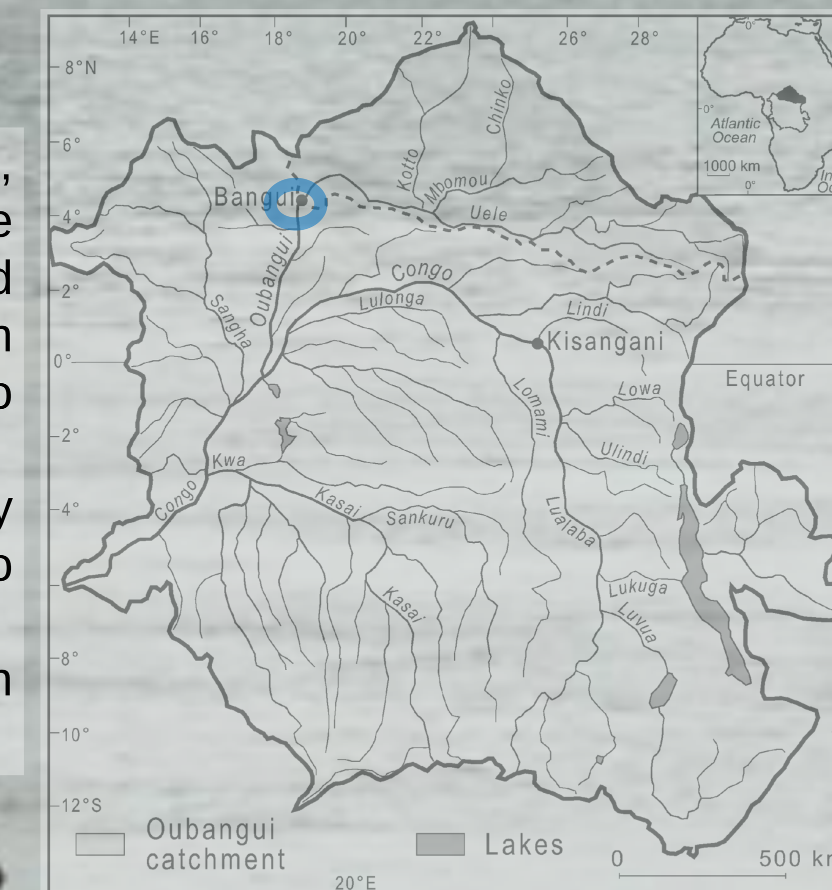

Figure 1: Location of the Oubangui catchment withing the Congo basin.

References

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Probst et al. (1994) Appl. Geochem. 9: 1-13.
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Acknowledgements

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Results & Discussion

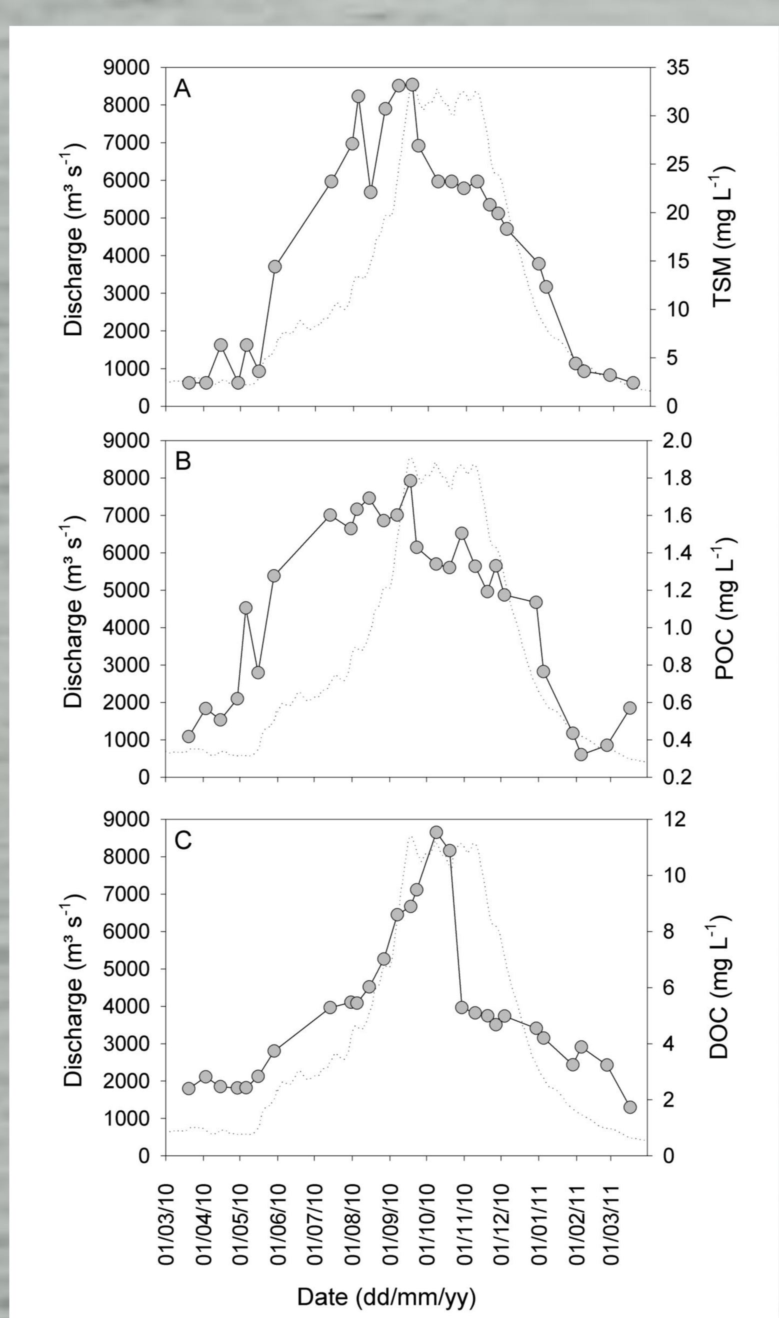

Figure 2: Seasonal variations of daily discharge (dotted lines) and (A) total suspended matter (TSM), (B) particulate organic carbon, and (C) dissolved organic carbon.

Both **TSM** and **POC** increase sharply during the rising stages of the hydrograph, and show clear hysteresis (i.e., lower concentrations at similar discharge during the falling limb).

Strong seasonality occurs in the contribution of POC to the TSM pool **(%POC/TSM)**, ranging between 4.8 and 25.7%, with highest values during low-flow conditions.

DOC concentrations increased almost linearly during the rising limb, and then dropped sharply during peak discharge. DOC consistently dominated over POC, contributing 67-97% of the total OC pool.

Annual fluxes were calculated using daily discharge data and by linear interpolations. This compared excellently with results from flow-regime stratified Beale's ratio estimators (performed in GUMLEAF v0.1). Our TSM and POC flux estimates are within 5% of values reported by Coynel et al. (2005) but our DOC flux is ~30% higher (0.702 vs. 0.540 Tg C y^{-1}), and our HCO_3^- flux is ~35% lower than previous estimates by Probst et al. (1994), despite similar hydrological conditions.

Species	Flux
TSM (Tg y^{-1})	2.326
POC (Tg C y^{-1})	0.141
PN (Tg N y^{-1})	0.0143
DOC (Tg C y^{-1})	0.702
DIC (Tg C y^{-1})	0.485
Average annual composition	
%POC/TSM	6.1
POC/PN	9.9

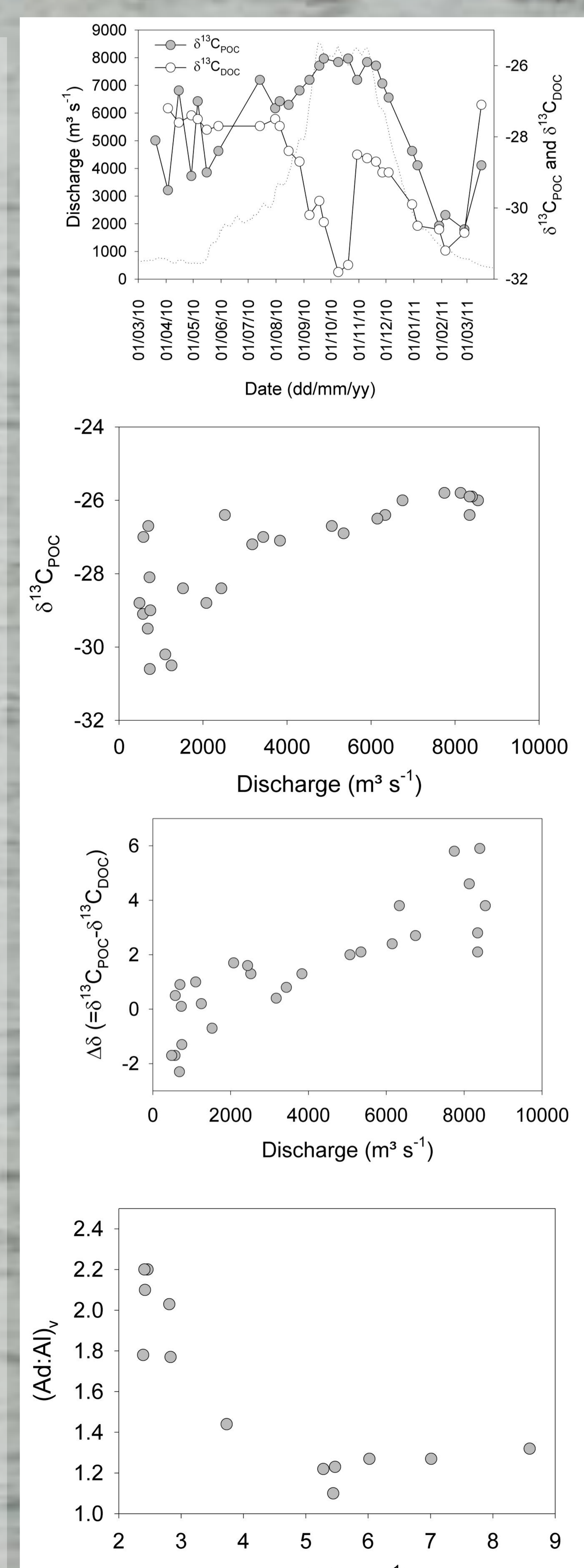

Figure 3-A: Seasonal variations of daily discharge (dotted lines) and δ^{13}C of POC (grey symbols) and DOC (open symbols).
Figure 3-B: Relationship between daily discharge and δ^{13}C-POC.
Figure 3-C: Relationship between daily discharge and $\Delta\delta$, i.e. the difference betweeen δ^{13}C signatures of POC and DOC.
Figure 3-D: DOC versus (Ad:Al)v, i.e. ratio of vanillic acid to vanillin, for samples between March and mid September 2010.

Both **δ^{13}C-POC and DOC** show relatively strong seasonal variations, although with different patterns, resulting in large differences in δ^{13}C between these pools.

During low-flow conditions, **phytoplankton** likely makes a substantial contribution to the POC pool (high %POC, variable δ^{13}C, low POC/PN), whereas δ^{13}C-POC converges to more stable signatures at higher flows.

Flowpaths and sources of DOC are clearly more complex as seen in the δ^{13}C-DOC pattern. Preliminary data on dissolved lignin composition **less degraded DOC during the initial rise in the hydrograph** (higher DOC), as indicated by the lower (Ad:Al)v ratios.

Overall, δ^{13}C data in both POC and DOC suggest **little inputs from C4 vegetation** despite their prevalence in much of the catchment.

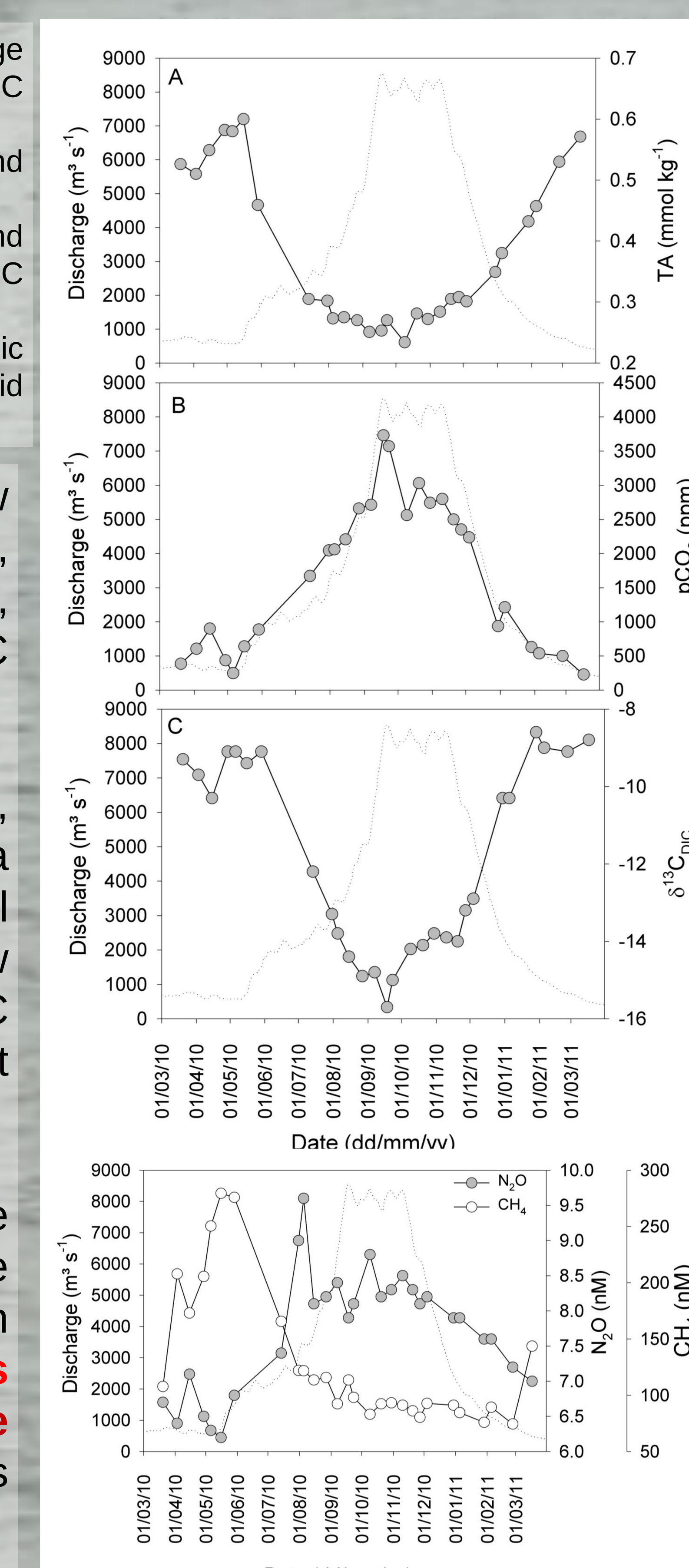

Figure 4: Seasonal variations of daily discharge (dotted lines) and (A) total alkalinity, (B) partial pressure of CO_2, (C) δ^{13}C signatures of dissolved inorganic carbon, and (D) concentrations of dissolved CH_4 (open symbols) and N_2O (grey symbols).

Total alkalinity ranged between 0.234 and 0.600 mmol kg^{-1}, and showed a strong decrease during high discharge.

DIC was the dominant C pool during low flow conditions (~70%), but contributed only 20-30% to the total C pool during high discharge.

The **partial pressure of CO_2** (pCO_2) showed a very strong seasonality, from values close to saturation during low-flow conditions (470 ± 203 ppm for Q<1000 m³ s^{-1}, n=10) to a maximum of 3750 ppm during the first stage of peak discharge. δ^{13}C-DIC was negatively correlated with pCO_2. The ~10-fold range in pCO_2 indicates that capturing this seasonality is critical in estimating CO_2 exchange fluxes.

CH_4 was consistently highly oversaturated (3450 to 13200%), with highest concentrations towards the end of the dry season, and low, stable values of ~100 nmol L^{-1} during high discharge. **N_2O**, in contrast, was only slighly oversaturated (112-165%), and lowest during low discharge.