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, bicarbonate, 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 main stem.

Sampling was initiated in late March 2010, and was followed by approximately fortnightly sampling. Data presented here cover the period of March 2010 to March 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.

Results & Discussion

Figure 3-A: Seasonal variations of daily discharge (dotted lines) and δ¹³C of POC (grey symbols) and DOC (open symbols).

Figure 3-B: Relationship between daily discharge and δ¹³C-POC.

Figure 3-C: Relationship between daily discharge and δ¹³C-DOC, i.e. the difference between δ¹³C signatures of POC and DOC.

Figure 3-D: DOC versus (DA/Alv), i.e. ratio of vanillic acid to vanillin, for samples between March and mid September 2010.

Both δ¹³C-POC and DOC show relatively strong seasonal variations, although with different patterns, resulting in large differences in δ¹³C between these pools.

During low-flow conditions, phytoplankton likely makes a substantial contribution to the POC pool (high δ¹³C-POC, variable δ¹³C-DOC, low POC/DOC), whereas δ¹³C-DOC converges to more stable signatures at higher flows.

Flowpaths and sources of DOC are clearly more complex as seen in the δ¹³C-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 (DA/Alv) ratio.

Overall, δ¹³C 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 CO₂, (C) δ¹³C signatures of dissolved inorganic carbon, and (D) concentrations of dissolved CH₄, (open symbols) and N₂O (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 pool during low-flow conditions (~70%), but contributed only 20-30% to the total C pool during high discharge.

The partial pressure of CO₂ (pCO₂) showed a very strong seasonality, from values close to saturation during low-flow conditions (247 ± 203 ppm for Q<1000 m³ s⁻¹, n=10) to a maximum of 3750 ppm during the first stage of peak discharge. δ¹³C-DIC was negatively correlated with pCO₂.

The 10-fold range in pCO₂ indicates that capturing this seasonality is critical in estimating CO₂ exchange fluxes.

CH₄ 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. N₂O, in contrast, was only slightly oversaturated (112-165%), and lowest during low discharge.