

Carbon and oxygen budget in the deep, strongly stratified Congo River Estuary

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Abstract

The Congo River region of freshwater influence (ROFI) is characterized by a deep canyon that connects the river to the deep ocean by cutting through the continental shelf (Shepard & Emery, 1973). In the estuary, high discharge of freshwater and very small vertical mixing within the canyon restricts the supply of oxygen from the surface waters to the more saline bottom waters, where the remineralisation of riverine particulate organic carbon leads to hypoxia (Eisma & Van Bennekom, 1978). We study the dynamics of the Congo River ROFI by applying the multi-scale baroclinic coastal ocean model SLIM 3D (www.slim-ocean.be) to this challenging environment. Model results compare favourably against in-situ observation in the estuary, suggesting that the exchange flow is correctly simulated. Using water ages as a diagnostic tool allows gaining deeper insight into the fate of riverine and oceanic water.

We use the simulated renewing time of the canyon's water body by oceanic water ($R = 20$ d) to calculate an oxygen and carbon budget of the subhalocline water body from the remineralization of POC.

The renewing oceanic waters originate from the Eastern Atlantic equatorial oxygen minimum zone. At a representative station in the canyon 60 km offshore the oxygen concentration was measured as $0,05 - 0,1$ [mol O₂/m³] at water depths of 200 - 500 [m]. Following Eisma & Kalf (1984) we split the recent Congo River POC flux of 5260 [mol C s⁻¹] (Coynel et al., 2005) into 50 % settling into the subhalocline water body, the other 50 % being advected offshore with the surface plume. Given these assumptions for the oxygen and carbon boundary fluxes, only 15 % of the settling POC are remineralised by aerobic degradation within the canyon, confirming oxygen limitation and leaving a substantial fraction of available labile POC undegraded (generally 35 % of tropical riverine POC are labile; Ittekkot, 1988). Summing up, the canyon's oxygen balance is ocean oxygen- rather than river POC - controlled, and scenarios of even substantial future POC-flux reductions by land use change and/or reservoir construction within the catchment should therefore not imply significant changes in the Congo River estuarine's oxygen balance.

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