

A numerical study of the estuarine plume in the Congo River

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With the second largest river in the world by discharge volume of water, the Congo River strongly affects the sea surface salinity in the Eastern Atlantic Ocean. The Congo River estuary is also the location of several vulnerable ecosystems (e.g. Mangroves National Park). Despite its importance, there are very few published studies about the dynamics of the area.

The river estuary is characterized by a very deep canyon that directly connects the river to the deep sea. This unique feature strongly impacts the plume dynamics and the shelf circulation. From a numerical modelling perspective, the variation of the water column depth over a wide range of values and the steep slopes require flexible vertical coordinates and multiscale horizontal resolution. Modelling the baroclinic circulation along the Congo river-to-sea continuum therefore represents a very challenging test case for any numerical ocean model.

In this study, we show that the multi-scale coastal ocean model SLIM (<http://www.climate.be/slim/>) correctly represents the main features of the shelf and estuarine dynamics. SLIM solves the hydrostatic equations under the Boussinesq approximation on a single unstructured multi-scale mesh with the Discontinuous Galerkin finite element method. Beside assessing the model skill and its ability to capture the multi-scale processes that drive the estuarine circulation, we analyse how the horizontal mesh anisotropy can help improve the model results. Our results compare very favourably with in-situ data on the shelf and in the estuary and show the ability of the multi-scale coastal ocean model SLIM 3D to reproduce the exchange flow in the Congo River estuary.

The Constituent-oriented Age and Residence time Theory, CART (<http://www.climate.be/cart/>), further helps to evaluate the fate of riverine and oceanic waters in this complex ecosystem. In particular, the renewing water age gives the spatial and temporal variability of the estuarine waters ventilation time. Due to a high stratification and a low tidal mixing, vertical mixing is expected to be small, hence restricting the supply of oxygen from the surface waters to the more saline bottom waters. The renewing water age helps understand the hypoxia observed in the bottom of the submarine canyon.

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