The importance of grid resolution, temperature and salinity for modelling the hydrodynamic regime in the Gulf of Guinea

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The hydrodynamic regime of the Gulf of Guinea is rather well studied. However, knowledge of the local hydrodynamic regime of the coastal waters of Benin and Lake Nokoué is less known despite its importance for the local fishermen and the general safety at sea. The hydrodynamic regime in lake Nokoué (Benin), a lagoon permanently connected to the Beninese coastal waters by means of a channel, is quite particular and the influence of the ocean is not well known. To study this, a nested chain of hydrodynamic models is developed. The chain starts with a model for the Gulf of Guinea, the consecutive models of the chain are higher in resolution and zoom in to the Beninese coastal waters. In this work, the first model that simulates the hydrodynamic regime in the Gulf of Guinea is discussed and preliminary results of the 3D numerical model are presented.

The modelling of the Gulf of Guinea, which extends from 8°W to 14°E and from 8°S to 7°N, is constructed with COHERENS (COupled Hydrodynamical and Ecological model for REgioNal and Shelf seas) model in 3D mode with a horizontal grid resolution of 1/4°. The depth is discretized into 75 sigma levels using a non-uniform s-grid. The model bathymetry has been generated by linearly interpolating the bathymetry data obtained from the GEneral Bathymetric Chart of the Oceans (GEBCO) with a spatial resolution of 15 arc-second. At the open sea boundary, the model was forced by daily sea surface current and sea elevation as well as salinity and temperature field, provided by forecast system GLO-CPL. The runoff forcing is provided from Global Flood Awareness System (GloFAS) and LISFLOOD model. The seven major rivers (Congo, Niger, Ogooué, Sanaga, Cross, Sassandra and Volta) of the region are prescribed in the model at the river boundaries. For river salinity and temperature, daily mean values are considered. Wind at 10m, mean sea level pressure and humidity were prescribed at the surface, and provided by the weather forecasts ERA5.

The first results showed that the number of vertical layers is critical in modelling the surface current correctly. Furthermore, the importance of temperature and salinity for a correct representation of the bottom currents also was crucial. Our results show good agreement with the model HYCOM and the satellite observations.

To improve the forecasting capabilities of this model, a dynamic bathymetry and tidal constituents as boundary conditions will be added. This model will be nested to a model with a high resolution (200m) that describes the connection between coastal waters and lake Nokoué in order to examine the impact of the hydrodynamic regime of the Gulf of Guinea on water circulation in lake Nokoué and the living world.

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