Seasonal and spatial variability of primary production in the Mozambique Channel

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Background:

The surface circulation in the Mozambique Channel changes from the northern part, where the system is under dominance of the monsoons, to the central and southern parts, where mesoscale eddies are more frequent. Despite these differences in the physics between the three regions, satellite-based primary production shows that the whole region is characterized by similar seasonal variability of primary production, in which winter is the most productive season of the year. In the present study we investigate the mechanisms driving the seasonal and temporal variability of new and primary production in the Mozambique Channel.

Methods:

We used Regional Ocean Modelling System (ROMS) configurations applied for the Mozambique Channel at two different horizontal resolutions, the higher (child/embedded) resolution (1/12°) and the lower (parent/outer) resolution (1/4°), coupled to Pelagic Interaction Scheme for Carbon and Ecosystem Studies (PISCES) to investigate the physical processes and the main nutrient (nitrate) driving the seasonal and spatial variability of new and primary production in the Mozambique Channel. Sensitivity model experiments were carried out in order to investigate the mechanisms controlling the annual cycle of Primary Production in the Mozambique Channel.

Results:

The embedded simulation was more effective in representing the surface circulation as well as the Primary Production variability in the Mozambique Channel, showing better agreement with the observational data.

Modelled Primary Production integrated over the euphotic zone in the Mozambique Channel indicates a clear seasonal cycle in the region, with higher production rates in winter, followed by intermediate rates in spring and fall and a minimum production rates in summer. The highest value of Primary Production in the Mozambique Channel was of about 0.3 g C m^{-2} day^{-1} during winter and the lowest value was of approximately 0.1 g C m^{-2} day^{-1} during summer. The integrated new production follows the same seasonal variability of primary production, with the higher value of ~ 0.15 g C m^{-2} day^{-1} during winter, yielding an average *f*-ratio of 0.5 in the entire region. New production in winter results from vertical advection and entrainment of nitrate from below the euphotic zone mainly because of stronger wind stress in the north and negative heat flux in the center/south. However, in central and southern parts of the channel mesoscale eddies enhances the primary production. During the rest of the year, the entire system depends on remineralisation of organic matter, which sustains phytoplankton growth at the subsurface.

Surface phytoplankton biomass in the Mozambique Channel is higher in winter, where small class/group contributes with more than 60 % of the total phytoplankton biomass. The increase in phytoplankton abundance in the region is accompanied by enhancement in zooplankton biomass. Grazing on phytoplankton by zooplankton increases in linear proportion of phytoplankton biomass, despite deepening of the MLD during winter. This is explained by increase in primary production which exceeds the pressure on phytoplankton by zooplankton, an indication that the phytoplankton abundance in the region is mainly controlled by zooplankton.

Keywords: Seasonal, Mixed Layer Depth, nitrate, new production, primary production, Mozambique Channel