Distribution of zooplankton biomass in the northern Benguela Upwelling System

Field investigations and model simulations

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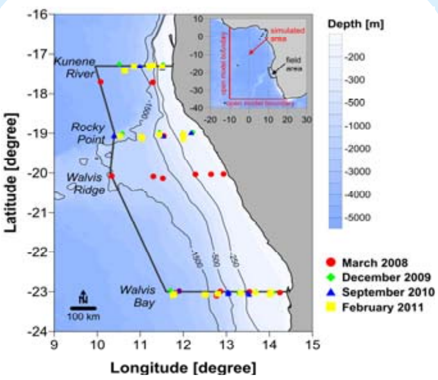


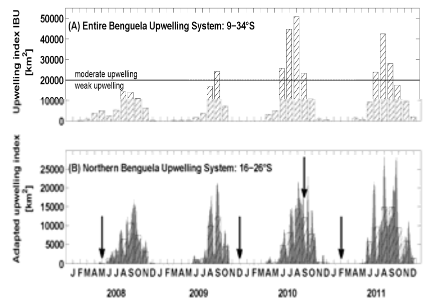
MOCNESS hauls during 4 cruises in the study area

Introduction

The Benguela Upwelling System, which is driven by south-easterly trade winds blowing alongshore South-western Africa, is one of the four most productive upwelling systems of the worlds oceans. We studied the distribution of mesozooplankton biomass in the northern Benguela Upwelling System (N-BUS) in the framework of the project GENUS (Geochemistry and ecology of the Namibian Upwelling System) during 4 expeditions in different seasons in the years 2008-2011 and compared the field measurements with model results.

Material & Methods

Mesozooplankton were sampled in 73 hauls with a Double-MOCNESS (Multiple Opening and Closing Net and Environmental Sensing System, mesh-size 330 µm). From 489 single samples wet weight was determined. A 3-D ecosystem model, developed by IOW (Schmidt & Eggert) was applied on the studied area. Furtermore remotely sensed sea surface temperatures (SSTs) as well as surface chlorophyll a concentrations were analysed to investigate the influence of environmental parameters.



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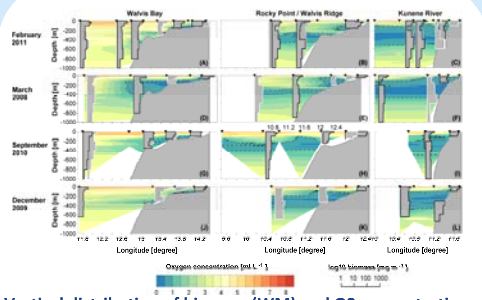
Results and Discussion

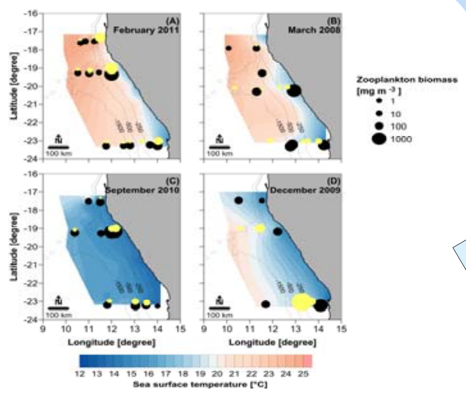
SSTs indicate that the most intense upwelling occurred in August and September in all studied years. Even though surface chlorophyll a concentrations were very variable throughout the year, highest peaks were detected in September, following the maxima in upwelling of nutrient rich water.

In March/April, maxima in field data occurred in deeper waters, where extensive oxygen minimum zones biased the vertical distribution. The numerical model reproduced this vertical pattern and simulated zooplankton feeds on detritus at depth.



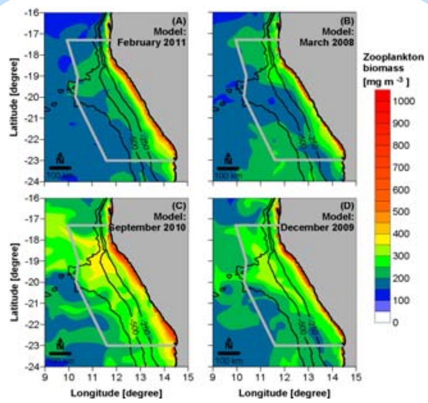
Vertical distribution of biomass (WM) and O2 concentrations during the different seasons

Because offshore biomass values in the upper 200 m were relatively constant over seasons and years, we suggest that the bulk of zooplankton produced due to upwelling partly retained on the shelf, while another part moved downward along the slope at the end of the high production period. We can only speculate that this downward shift might be caused by ontogenetic migrations or due to feeding migrations to profit from the nepheloid layers off the Namibian shelf-break



Measured biomass (WM) in the upper 200 m and measured SST during different cruises

Highest zooplankton concentrations in the upper 200 m occurred above the outer shelf and shelf-break six month after the upwelling peaks in February, while maxima were calculated for September in the simulated data. Although the temporal development differed in the two approaches, the vertical distribution of zooplankton was similar but the simulated data generally exceeded the field data in biomass with an increasing trend towards the open ocean.

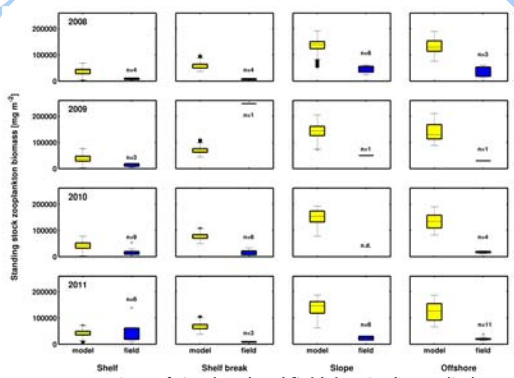


Simulated zooplankton biomass

(mg m-3) of the surface water (0-200 m)

Data are 5 day averages of the 15th of the respective months

The slightly lower biomass and carbon values calculated in our data compared to those in the middle of the 2000s suggest a decreasing trend in zooplankton biomass for the Namibian shelf. Although it seems to be a paradox, upwelling favourable conditions potentially amplified by climatic changes, might lead to a decrease in zooplankton over the inner shelf due to enhanced export of biomass.



Comparison of simulated and field data in the studied area during the sampling periods

Conclusions

Despite some differences both methods provide valuable information. The field sampling can be used for ground-truthing, taxonomic analysis and to detect variabilities and stochastic events whereas the data simulation, after further modification, can be used to smoothen variabilities and to forecast future developments in the zooplankton standing stock on the Namibian shelf under different climate change scenarios.