Short-term patterns of vertical particle flux in the northern Benguela upwelling: a comparison between sinking POC and respiratory carbon consumption

N. Osmaa, I. Fernández-Urruzola, T.T. Packardb, L. Postelb, M. Gómezb, F. Pollehneb

a Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global, ULPGC, 35017, Canary Islands, Spain.
b Zooplankton Ecology Group, Baltic Sea Research Institute, D-18119 Rostock, Wamenünde, Germany.

INTRODUCTION

Both loss of material from the water column and gain to the sediment are important processes in marine ecology and biogeochemistry, as the transport balance between water and sediment controls quantity and quality of marine life. Upwelling systems, as hotspots of marine productivity, are particularly interesting in this concern. Here, we have studied the short-term variability of vertical carbon flux on the Namibian shelf by two alternative approaches: Respiration associated C flux models (Fc), which are based on modeling the respiratory carbon consumption in the water column, by the integration of vertical profiles of the respiratory electron transport system (ETS). Second, automatic sediment traps (STs) that were successively moored and collected sinking material with daily sampling periods.

Temporal variability was stronger than the effect of distance between stations. Thus, high respiration rates in the water column as well as high particle export rates were attributed to filaments of upwelling water arising from the south, while lower rates were associated with more oligotrophic waters. Therefore, in order to compare both approaches, these two distinct situations were considered.

Location & Seawater characteristics

NAM006R and NAM011D displayed similar water characteristics but they were notably different from NAM011R, which was sampled ten days later. The first two were attributed to cold water filaments, while the third corresponded to a later temporal stage of these waters.

From Sediment Traps

Fluxes of all variables distinguished two sedimentation states at the two stations: a high-sea period that was mainly dominated by diatoms, and a low-sea period where the coccolithophore importance increased.

Comparison: ST vs Fe

During the high-sea period, the POC flux values from STs were higher than those from the Fe models. During the low-sea period, the Fe values were twice the ST values. This discrepancy is explained by differences in the plankton community structure and their settling velocities.

CONCLUSIONS

Regardless of distance to shore, upwelling filaments generated two distinct situations:

- During high-sea period, the predominance of diatoms formed fast sinking particles which yielded higher POC values in the STs than in the respiration-based Fe calculations.
- The low-sea period, characterized by slow sinking particles, sustained a relatively higher water column respiration. Fe values were higher than the values from the STs.

Table I. Equation parameters for the power function respiration model of the CO2 production, \( R_{ CO2 } \) (mmol CO2 m⁻² d⁻¹).

<table>
<thead>
<tr>
<th>Station</th>
<th>( k_p )</th>
<th>( k_p )</th>
<th>( k_p )</th>
</tr>
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<tbody>
<tr>
<td>NAM006R</td>
<td>-4.80</td>
<td>0.91</td>
<td>0.07</td>
</tr>
<tr>
<td>NAM011D</td>
<td>-4.58</td>
<td>0.79</td>
<td>0.07</td>
</tr>
<tr>
<td>NAM011R</td>
<td>-4.58</td>
<td>0.79</td>
<td>0.07</td>
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From the \( R_{ CO2 } \) profiles (Fig. 3), the \( R_{ CO2 } \) is estimated and the best fit for each profile determined (Table I). Then, definite integrals of total \( R_{ CO2 } \) are calculated from any depth below the euphotic zone (\( z_e \)) to the seafloor (\( z_{ seafloor} \)). The resultant carbon flux models (Fc) are shown in Fig. 4.