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

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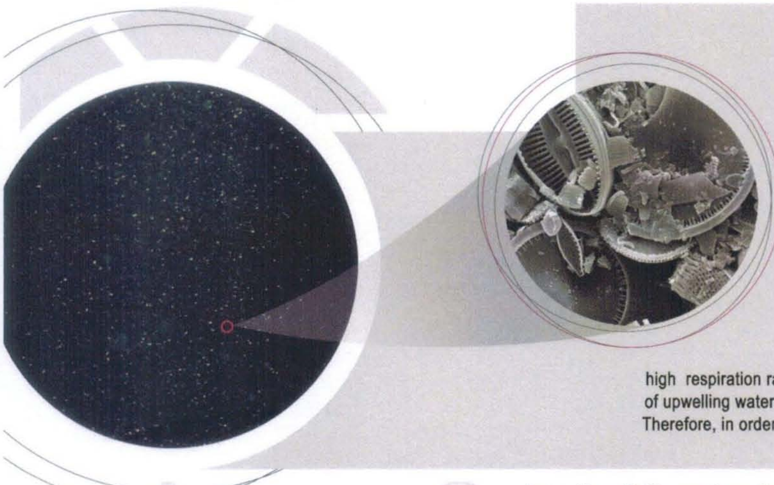

INTRODUCTION

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 hotspot 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 organic 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 succesively moored and that 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 .

From Sediment Traps

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

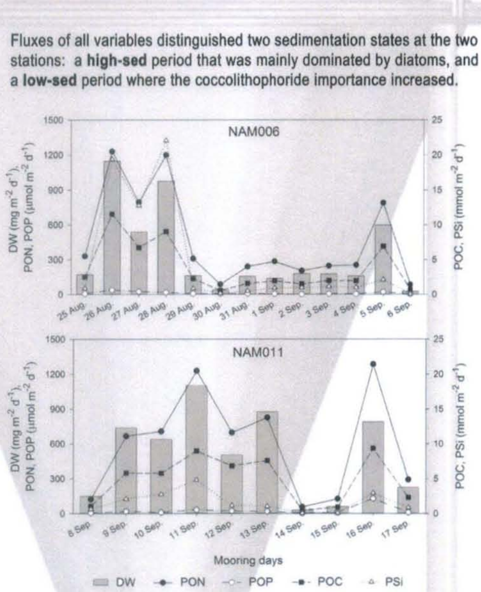

Fig. 5. Vertical fluxes of mass (dry weight, DW), particulate organic nitrogen (PON), phosphate (POP), carbon (POC) and silica (PSi).

Location & Seawater characteristics

NAM006R and NAM011D displayed similar water characteristic 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.

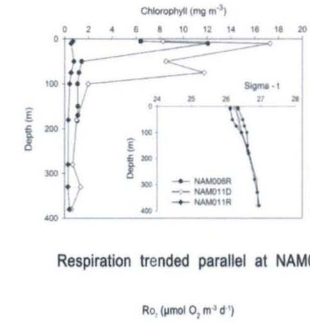

Fig. 2. Depth - profiles of chlorophyll and seawater density (sigma-t).

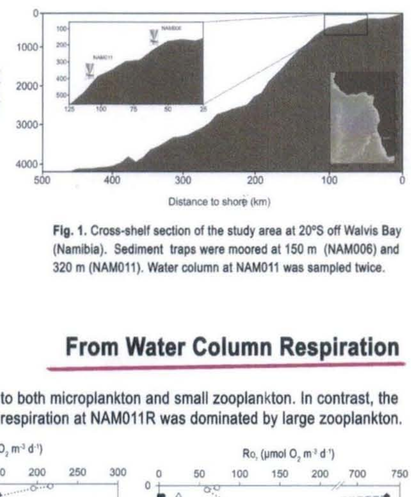

Fig. 1. Cross-shelf section of the study area at 20°S off Walvis Bay (Namibia). Sediment traps were moored at 150 m (NAM006) and 320 m (NAM011). Water column at NAM011 was sampled twice.

From Water Column Respiration

Respiration trended parallel at NAM006R and NAM011D due to both microplankton and small zooplankton. In contrast, the surface respiration at NAM011R was dominated by large zooplankton.

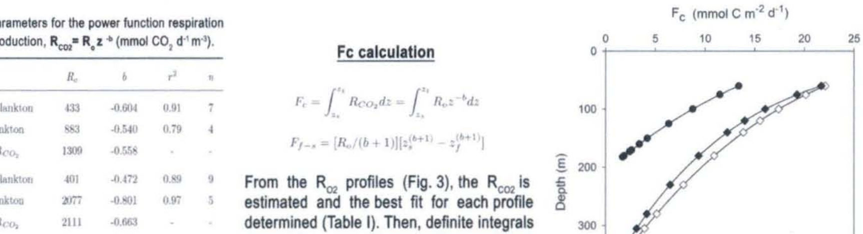

Fig. 3. Respiratory oxygen consumption (R_{O2}) depth profiles of microplankton and size-fractionated zooplankton.

Comparison: ST *vs* Fc

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

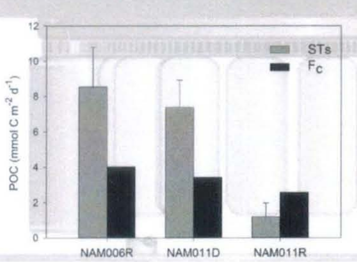

Fig. 6. Comparison between STs and Fc POC flux values.

Table I. Equation parameters for the power function respiration model of the CO_2 production, $R_{CO2} = R_o z^{-b}$ (mmol CO_2 d^{-1} m^{-3}).

Station		R_o	b	r^2	n
NAM006R	Microplankton	433	-0.604	0.91	7
	Zooplankton	883	-0.540	0.79	4
	Total R_{CO_2}	1309	-0.558	-	-
NAM011D	Microplankton	401	-0.472	0.89	9
	Zooplankton	2077	-0.801	0.97	5
	Total R_{CO_2}	2111	-0.663	-	-
NAM011R	Microplankton	63	-0.140	0.90	7
	Zooplankton	18737	-1.254	0.97	5
	Total R_{CO_2}	8464	-0.939	-	-

Fc calculation

$$F_c = \int_{z_s}^{z_f} R_{CO_2} dz = \int_{z_s}^{z_f} R_o z^{-b} dz$$

$$F_{f-s} = [R_o/(b+1)][z_s^{(b+1)} - z_f^{(b+1)}]$$

From the R_{O2} 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_f) to the seafloor (z_s). The resultant carbon flux models (Fc) are shown in Fig.4.

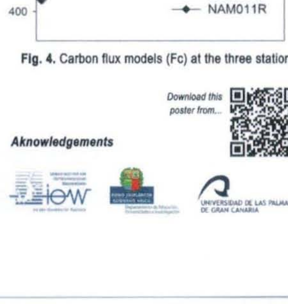

Fig. 4. Carbon flux models (Fc) at the three stations.

CONCLUSIONS

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

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

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Aknowledgements

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