



Phosphorus speciation and transformation along transects in the Benguela upwelling region

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Transformation of phosphate (PO_4) introduced by upwelling into the surface was studied in the upper 20 m layer along four transects perpendicular to the coast of Namibia from August 27th to September 15th 2011. Concentrations of inorganic nutrients, dissolved and particulate organic phosphorus (DOP, POP), and particulate organic carbon and nitrogen (POC, PON) were measured and the respective stoichiometry were determined besides measurements of [^{33}P] PO_4 uptake rates. The fate and interactions of these components are described in relation to both, the distance from the coast and a calculated "pseudoage" of the water masses along perpendicular transects. PO_4 decreased from $1.6 \mu\text{M}$ in the upwelling cell near the coast to $0.4 \mu\text{M}$ at remote stations. The decrease in PO_4 was lower than that of nitrate, resulting in a lower N:P ratio seawards (from 12-16 to 5-9). Based on [^{33}P] PO_4 uptake measurements, a median PO_4 turnover time of 57 days corresponding to a distance of about 100 km from the shore, indicated complete PO_4 consumption within the transects and thus the need for an additional PO_4 supply to sustain the gradient. PO_4 depletion was only partially reflected in increasing DOP concentrations. In our bioassays, DOP was produced by heterotrophic bacteria but was mineralized again to PO_4 within a few days. Accordingly, PO_4 depletion is not evidenced by increasing POP concentrations along the transects. Consistent with declining POC and PON concentrations, produced particulate matter is removed from the upper surface layer and seems to be predominantly transformed in the pelagic layer. Only a small proportion is exported by sedimentation into deeper water layers or to the bottom. In summary, the observed PO_4 gradient in the upper 20m surface layer seems to be the result from remineralization and/or input from layers below besides input in the upwelling center.