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Analysis of Arabian Sea Oxygen Time Series

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LONG-TERM GOALS

My long term goal is to contribute to our understanding of how ocean-atmosphere interactions affect the dynamics of marine phytoplankton populations. Of particular interest to me are the tropical and sub-tropical regions where seasonal changes in the winds and the associated changes in the depths of the mixed layer and thermocline can be used a laboratory for understanding how longer time scale changes in the earth's climate system might have affected or will affect the primary production of the ocean.

OBJECTIVES

I wish to describe how a natural phytoplankton community would be affected by changes in the depth of the mixed layer and thermocline. The challenge is to measure the net primary production of the phytoplankton without altering their light and nutrient environment in the process of making the measurements. I am working on a methodology that will allow me to quantify primary production with out confinement.

APPROACH

I participated in the ONR central Arabian Sea mooring experiment in collaboration with other scientists making optical and physical oceanographic measurements. My approach was to continuously sample the dissolved oxygen concentration at six different depths (2, 10, 30, 50, 80 and 110 m) in the vertical with sensors mounted on the mooring. Two sensors (2 and 10 m depth) were in the mixed layer throughout the experiment. Light and temperature were continuously sampled at the surface and at the depths of the six mooring instrument packages. A thermistor chain provided additional detail on the vertical structure of temperature. From these data we can reconstruct how the depths of the mixed layer and thermocline varied over time. From the mixed layer depth time series, surface irradiance and information on how PAR is attenuated with depth I computed the amount of light a phytoplankton cell would receive in the mixed layer assuming it behaves like a passive tracer. The net productivity is calculated from the hourly changes in oxygen concentration corrected for air-sea exchange.

WORK COMPLETED

1. Mooring oxygen sensor data has been calibrated against hydrocast oxygens collected along side the mooring during the deployment. Plots of the time series are available in the LDEO mooring data reports. Digital data is available at the LDEO web page (<http://www.ldeo.columbia.edu>). Click on data repositories, then Bioinfo, and then mooring data Arabian Sea.

2. A multi-authored paper was written in which a figure of diel oxygen variability time series is shown and a discussion is given of the possible cause and effect relationship between shoaling isotherms, high levels of shear and high level of diel oxygen variability (Rudnick, Weller et al. 1997, EOS:78).
3. A photosynthesis-gas exchange numerical model has been developed in MathCad. Output from this model for various combinations of oxygen saturation, mixed layer depth and gas transfer velocity was used to get a feeling for how the magnitude of the gas exchange correction varies over the mooring time series. The results of this analysis was presented at the JGOFS Arabian Sea Data Workshop in Durham, NH and at the AGU Ocean Sciences meeting in San Diego.

RESULTS

Two replicate, 140 day long, high temporal resolution times of dissolved oxygen were obtained at a remote oceanic location. I have shown that it possible to use these data to obtain a time series of the rate of primary production of an unconfined, natural community of plankton.

IMPACT/APPLICATION

I have demonstrated the feasibility of measuring the net productivity of unconfined natural populations of plankton. This will allow us to quantify the effects of turbulence and vertical motion on plankton rate processes in a direct way that has not been possible with bottle incubation methods.

TRANSITIONS

RELATED PROJECTS

REFERENCES

PUBLICATIONS

Dickey, T., J. Marra, D. Sirgurdson, R. Weller, C. Kinkade, S. Zedler, J. Wiggert and C. Langdon (1998). "Seasonal variability of bio-optical and physical properties in the Arabian Sea: October 1994-October 1995." Deep-Sea Res.

Rudnick, D. L., R. A. Weller, C. C. Eriksen, T. D. Dickey, J. Marra and C. Langdon (1997). "Moored instruments weather Arabian Sea monsoons, yield data." EOS **78**(11): 117, 120-121.