Ecohab: Hyperspectral Optical Properties Of Red-Tide Blooms

Helmut Maske
Center for Hydro-Optics and Remote Sensing
San Diego State University
6505 Alvarado Rd., Suite 206
San Diego, CA 92120
phone: (619) 594-2272 fax: (619) 594-8670 email: hmaske@oceanos.cicese.mx

James L. Mueller
Charles C. Trees
Center for Hydro-Optics and Remote Sensing
San Diego State University
6505 Alvarado Rd., Suite 206
San Diego, CA 92120
phone: (619) 594-2230 fax: (619) 594-8670 email: jmueller@chors.sdsu.edu
ctrees@chors.sdsu.edu
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LONG-TERM GOALS

The goal of our project is the bio-optical characterization of dinoflagellate and other red-tide blooms, to facilitate the optical detection and monitoring of these blooms from above the sea surface.

OBJECTIVES

We want to explain the origin of the red surface color of dense blooms of dinoflagellate and other organisms (*e.g. Mesodinium rubrum, Trichodesmium sp.*), the influence of fine scale depth distribution and the physiological status of the blooms on the color. Our working hypotheses assumes that the red color of dinoflagellate blooms originate from *in vivo* fluorescence of chl *a*, whereas, the color of other blooms is the result of selective spectral absorption by pigments. Given the strong depth dependence of the surface fluorescence signal (Maske, et al., 1998), we plan to measure the fine scale (0.2 m) near surface distribution of red-tide forming organisms, and compare them to the light field and inherent optical properties near the surface. We also plan to measure the elastic scattering and the absorption properties of the particles and obtain physiological information about the dinoflagellates with saturation pulse fluorometry.

APPROACH

We are going to take simultaneously 12 water samples (300 ml ea) between 0 m and 2.2 m depth with a specially designed water sampler. This tethered water sampler will be floated into a high density, undisturbed red-tide patch and then closed electrically. The water samples will be processed for pigment species, particulate absorption spectra and active fluorescence. At the same time, a tethered, buoyancy controlled bio-optical profiler (CTD, reflective tube hyperspectral photometer for absorption

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and attenuation, and hyperspectral radiometers for downwelling irradiance, and upwelling radiance) will measure profiles of near surface optical properties, and above water hyperspectral radiometers will measure incident irradiance and remote sensing reflectance. The vertical profiles of spectral downwelling irradiance and upwelling radiance will also be modeled with high vertical resolution, using the Hydrolight radiative transfer model with measured profiles of inherent optical properties. From comparisons of modeled and measured irradiance and radiance profiles and reflectance, we expect to gain information on the dominant source of the red-tide surface color.

WORK COMPLETED

The special high resolution water sampler is completed, although we have not yet tried it in the ocean. The bio-optical profiler system is in the final stages of integration, and field tests are planned for mid-October 1999. This project has supported the purchase and integration into the profiler of a HiStar underwater spectrophotometer. The water sampler and bio-optical profiling system will be deployed aboard a newly acquired 26 foot research vessel to sample red-tide blooms off the California coast. The Hydrolight model was acquired and Dr. J. Mueller participated in a short introductory course. While we await the occurrence of a red-tide bloom, we will use data acquired under normal circumstances off San Diego to gain experience with model and data intercomparisons.

RESULTS

We are currently near completion of equipment preparation needed for bio-optical sampling in red-tide blooms. We expect to be ready to respond to a bloom off central or southern California by December 1999. Our emphasis on developing special equipment for fine resolution, near surface bio-optical measurements and water sampling is justified by model results showing the sensitivity of surface color to the near surface fine scale distribution of the dinoflagellates (Maske *et al*., 1998).

IMPACT/APPLICATIONS

Our characterization of the near-surface hyperspectral inherent and apparent optical properties associated with red-tide blooms will provide a basis for assessing the feasibility of using hyperspectral remote sensing methods to identify the occurrence and distribution of specific red-tide organisms.

TRANSITIONS

None during this grant period.

RELATED PROJECTS

Dr. J. Mueller's NASA SIMBIOS contract supports the development of the basic bio-optical profiler, including the APV/CTD, and hyperspectral radiometers to measure $E_d(\lambda,z)$ and $L_u(\lambda,z)$ and above-water $E_s(\lambda)$ and remote sensing reflectance. Support for the CHORS research vessel is shared between this project, Dr. Mueller's SIMBIOS contract and SDSU cost sharing funds.

PUBLICATIONS

Maske., H., Mueller, J.L., Trees, C.C., Pegau, W.S., Zaneveld, J.R.V., and Millan, E. 1998. About the relation of ocean color and the depth distribution of red-tide forming particles. Presented at Ocean Optics XIV, Kailua-Kona, HI, November 10-13, 1998.