Coastal Benthic Optical Properties (CoBOP) of Coral Reef Environments: Effects of Changes in the Spectral Quality and Quantity of the Underwater Light Field and Elevated Temperatures on Small Scale (0.01 to 0.1 m) Optical Properties of Corals

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LONG-TERM GOAL

My principal goal is to understand the mechanistic basis for changes in the flourescent signatures, both host and algal symbiont, of corals. Changes in the spectral quantity and quality of visible and ultraviolet radiation will have effects on the quantum yield of photosynthesis and affect the fluorescent signatures of the algal symbionts as will changes in the temperature of the surrounding seawater. Additionally, I wish to relate bottom reflectance measurements of coral reefs to hyperspectral remote sensing reflectance measurements made from buoys or airborne platforms.

OBJECTIVES

The Coastal Benthic Optical Properties (CoBOP) project is directed at understanding the optical properties of coastal benthic communities in general, and in particular, coral reefs. Coral reef communities are coastal areas of high water transparency which make them ideal systems to study optical signatures originating from the benthos. The scientific objectives of my project are:

1. to attain optical closure for coral reef communities

2. to understand the causes of benthic optical variability

    a. determine the spectral signatures, both fluorescent and reflectance, of reef organisms
    b. determine the effects of the physical environment on the physiology of reef organisms and assess those effects on optical signatures
    c. identify the temporal and spatial scales of variability in these optical signatures
    d. to help evaluate the use of underwater systems to quantitatively measure fluorescent optical signatures

APPROACH

The approach is an interdisciplinary one that looks at two specific questions. 1) measure photosynthesis and active fluorescence of two species of reef forming corals (*Montastraea faveolata* and *Montastraea cavernosa* at 10 and 18 m) to examine the relationship between chlorophyll fluorescence and photosynthesis in collaboration with Drs. Paul Falkowski and Maxim Gorbunov. 2) measure the bottom reflectance of coral reefs and relate those optical signals to hyperspectral

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measurements of remote sensing reflectance using measurements of apparent and inherent optical properties and modeling in collaboration with Drs. Charles Mazel and Robert Maffione.

WORK COMPLETED

During this proposal the CoBOP program was able to establish its long-term research site on Lee Stocking Island in the Bahamas. A fast repetition rate fluorometer has been tested in two field seasons and proven to provide accurate, and non-invasive, measurements of the quantum yield of phototosystem II. This instrument continues to be used in studies of photosynthesis and environmental stress on corals. During the May 1999 field season initial measurements of bottom reflectance and hyperspectral remote sensing reflectance using the Satlantic TSRB buoy and an airborne hyperspectral sensor were conducted. Presently we are workin on obtaining optical closure at two shallow-water sites using these data and optical data from water column measurements.

RESULTS

Results from the fast repetition rate fluorometer (FRRF) clearly show a diel cycling of the quantum yield of PSII fluorescence related to non-photochemical quenching during supersaturation with visible and UV radiation. FRRF measurements can also be used to detect temperature induced "bleaching" or the loss of its algal symbionts. We are presently analyzing our oxygen flux data to relate these changes to traditional measures of photosynthesis. A complete set of measurements is now available to test for optical closure on shallow coral reef sites. This data set is presently being analyzedd for presentation and manuscript preperation.

IMPACT/APPLICATIONS

Two specific impacts of the work completed to date are the use of an underwater FRRF for obtaining fluorescent signatures *in situ* and using this instrumentation as a tool to detect whether corals have been exposed to environmental stress that might lead to bleaching or mortality. Secondly, the successful deployment of the Satlantic hyperspectral TSRB buoy and coordinated measurements from in water and airborne platforms is a first for the CoBOP program.

TRANSITIONS

The data collected from the 1998 and 1999 field seasons is presently being analyzed and prepared for publication. In that process other members of the CoBOP team will be able to utilize a complete data set on two species of coral at two depths to look at factors influencing the optical properties of those corals. Information from the May 1999 field season of the present award is already being used to plan for our final field campaign in CoBOP.

RELATED PROJECTS

Charlie Mazel-ONR, CoBOP
Robert Maffione-ONR, CoBOP
Paul Falkowski-ONR, CoBOP

PUBLICATIONS

Lesser, M. P., C. Mazel, D. Phinney, and C. S. Yentsch. Light Absorption and Utilization by Colonies of the Congeneric Hermatypic Corals, *Montastraea faveolata* and *Montastraea cavernosa*. (Limnology and Oceanography, in press)