Inherent Optical Properties in the Benthic Environment

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Award #: N000149710011

LONG-TERM GOALS

The long term goals of this effort are to delineate the small scale structure of the inherent optical properties (IOP) in the benthic environment and to investigate how small scale variations in the IOP affect radiative transfer and visibility in the benthic environment.

SCIENTIFIC OBJECTIVES

The primary objective this year was to determine the small scale temporal and spatial variability of the Inherent Optical Properties (IOP) during the CoBOP field experiment using the diver operated ac-9 developed last year.

APPROACH

We participated in the Coastal Benthic Optical Properties (CoBOP) experiment at Lee Stocking Island, the Bahamas, from 19 to 31 may, 1998. Our approach is to use the diver operated spectral absorption and attenuation meter (ac-9) developed by us in collaboration with Western Environmental Technology Laboratories (WET Labs). This device was used to measure these coefficients on small scales within coral reefs, seagrass beds and other benthic environments.

In order to insure calibration we brought along a Barnstead water purifier. Our ac-9 was intercalibrated with other IOP measurement devices during the experiment. The IOP measured were the spectral absorption and attenuation coefficients, with the spectral scattering coefficient obtained as a derived parameter. Data were collected and stored via an enclosed data-logger. The data logger sampled for 100 sec. per record. The underwater package also contained a battery pack and pump. Water was sucked into the ac-9 via a tube held by the diver. Wavelengths used were 412 nm, 440 nm, 488 nm, 510 nm, 532 nm, 555 nm, 650 nm, 676 nm, 715 nm. A second diver used a video camera to

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1998		**00-00-1998 to 00-00-1998**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Inherent Optical Properties in the Benthic Environment	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Oregon State University,College of Oceanography and Atmospheric Sciences,Corvallis,OR,97331**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002252.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**6**	

record the diver with the ac-9 package. Coordination of the times on the recorder and the video camera thus allow the determination of the IOP spectra over specific substrates.

Two sampling modes were employed. In the first a vertical profile of approximately 1.5m was taken at a specific location, followed by sampling 25 cm above the bottom. In the second mode we carried out transects at certain distances (typically 25, 50, 100, and 200 cm) above the bottom.

WORK COMPLETED

The instrument was calibrated prior to shipping to check for long term drift. Our participation in the CoBOP experiment was successful. Most of these surveys were carried out at N. and S. Perry reefs following the survey lines staked out there.

The ac-9 optical measurements were taken at the following dates, times, locations and depths:

Date	Time	Depth(s)	Location	Comments
5/21/98	2113-2137	Varied ~42'	S. Perry Reef	Data at 8 different sites. Vertical profiles.
5/22/98	1346-1413	Varied ~68'	N. Perry Reef	Data at 8 different sites. Vertical profiles.
5/22/98	2051-2107	20'	Rainbow Gardens	Data at 5 different sites. Vertical profiles.
5/23/98	1500-1526	Varied ~42'	S. Perry Reef	Data while swimming horizontally, in 100 sec. bursts. Took 11 sets of data along transect.
5/24/98	1854-1913	Varied ~60'	N. Perry Reef	Took data while swimming horizontally in 100 sec. bursts. Took 7 sets of data along transect.
5/24/98	2006-2020	Varied ~20'	Rainbow Reef	Data at 5 different sites. Vertical profiles each site.
5/25/98	1615-1627	Varied ~60'	N. Perry Reef	Took data while swimming horizontally in 100 sec. bursts. Took 7 sets of data along transect.
5/25/98	2045-2101	Varied ~60'	N. Perry Reef	Took data while swimming horizontally in 100 sec. bursts. Took 7 sets of data along transect.
5/28/98	1500-1518	Varied ~60'	N. Perry Reef	Took data while swimming horizontally in 100 sec. bursts. Took 7 sets of data along transect.
5/28/98	2117-2135	Varied ~42'	S. Perry Reef	Took data while swimming horizontally in 100 sec. bursts. Took 7 sets of data along transect.

In addition to the on-site data collecting, ac-9 water calibrations and comparisons with other AC-9's and HiStars were carried out on May 23rd.

Steve Ackleson's Histar, and Robert Maffione's ac-9 water calibrations were compared with Zaneveld's ac-9, on May 26.

Our (Zaneveld's) ac-9 was compared with Dave Phinney's ac-9, aboard the Suncoaster, May 27.

RESULTS

We determined that it is possible to measure the IOP on small space scales in the benthic environment using a diver operated ac-9. We successfully sampled coral reefs, sand bottoms, and eel grass beds at depths to 20 m

Data analysis is proceeding. Preliminary results indicate that for the times and locations sampled, the absorption spectrum was more dependent on the site than the depth. Figure 1 shows absorption and attenuation spectra at two sites and different height above the bottom. It is seen that the shape of the spectra do not vary with depth, while their magnitudes decrease with depth in the coral reef and sand bottom environment of North Perry Reef. There is not much indication of chlorophyll absorption. The spectrum has a low exponential slope, indicating presence of inorganic particles, probably resuspended carbonate. The spectrum from the Rainbow Reef site is more steeply sloped. This data was taken in an eel grass bed. The increased slope is probably due to the presence of more CDOM from decaying eel grass.

Figure 2 shows transects at N. Perry Reef. These transects are taken in several sections of 100 second intervals. The figure shows transects at two depths above the bottom. It was found that the beam attenuation coefficient was both lower and less variable higher above the bottom. This indicates that resuspension affects IOP both horizontally and vertically on scales of less than a meter.

Data were made available to Drs. Philpot and Mobley who have used the IOP as inputs to radiative transfer models.

The diver-operated ac-9 was easy to operate but we would like to make the following improvements prior to participating in next year's experiment:

1. In situ visualization of observed absorption or attenuation spectrum.
2. Diver controlled sampling period (currently preset).
3. Light to indicate active sampling.
4. Depth gauge and distance above bottom.
5. Event marker with indicator light.

IMPACT/APPLICATIONS

For the first time we have determined small scale horizontal variability of IOP in the benthic environment. A major application of this data is to test the plane parallel assumption often used in radiative transfer i.e. it is assumed that IOP do not vary horizontally. This greatly simplifies the calculations but little data existed to test the assumption.

TRANSITIONS

Our data are being used by Drs. Philpot and Mobley as inputs into benthic radiative transfer models. The calibration methods developed are being used by other scientists using IOP devices.

RELATED PROJECTS

None

REFERENCES

J. Ronald V. Zaneveld, Andrew H. Barnard, and James L. Washburn, A diver operated absorption and attenuation meter. To be submitted to J. Ocean. Atmos. Instr.

http://photon.oce.orst.edu OSU Ocean Optics home page
ftp://photon.oce.orst.edu Anonymous ftp site

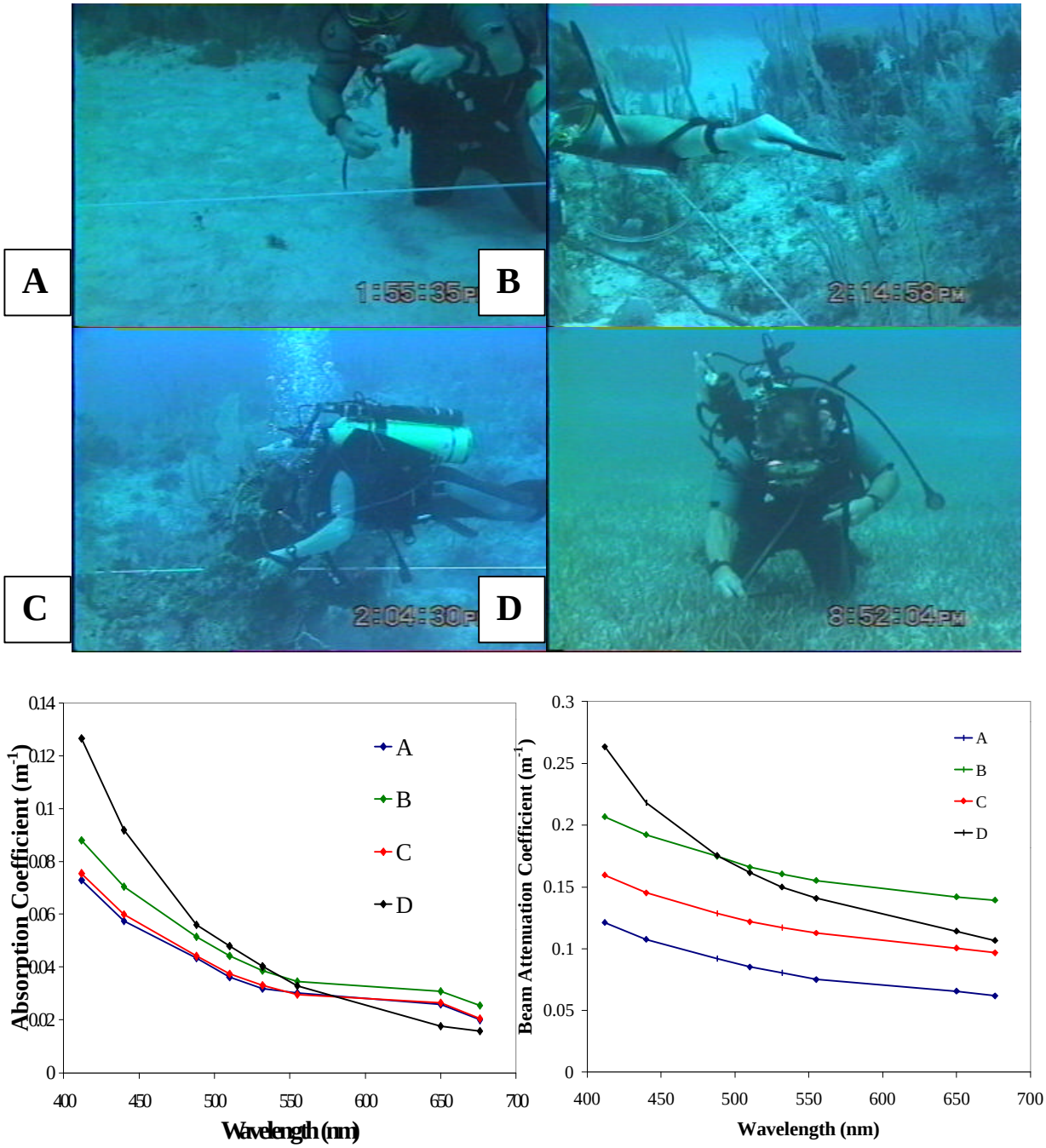

Figure 1. - Spectral Absorption and beam attenuation coefficient obtained from 4 vertical profiles; 0.5 m above sandy coral bottom (A), 0.2 m above sandy coral bottom (B), below coral head (C), and 0.1 m above seagrass bottom (D). Video images are shown above.

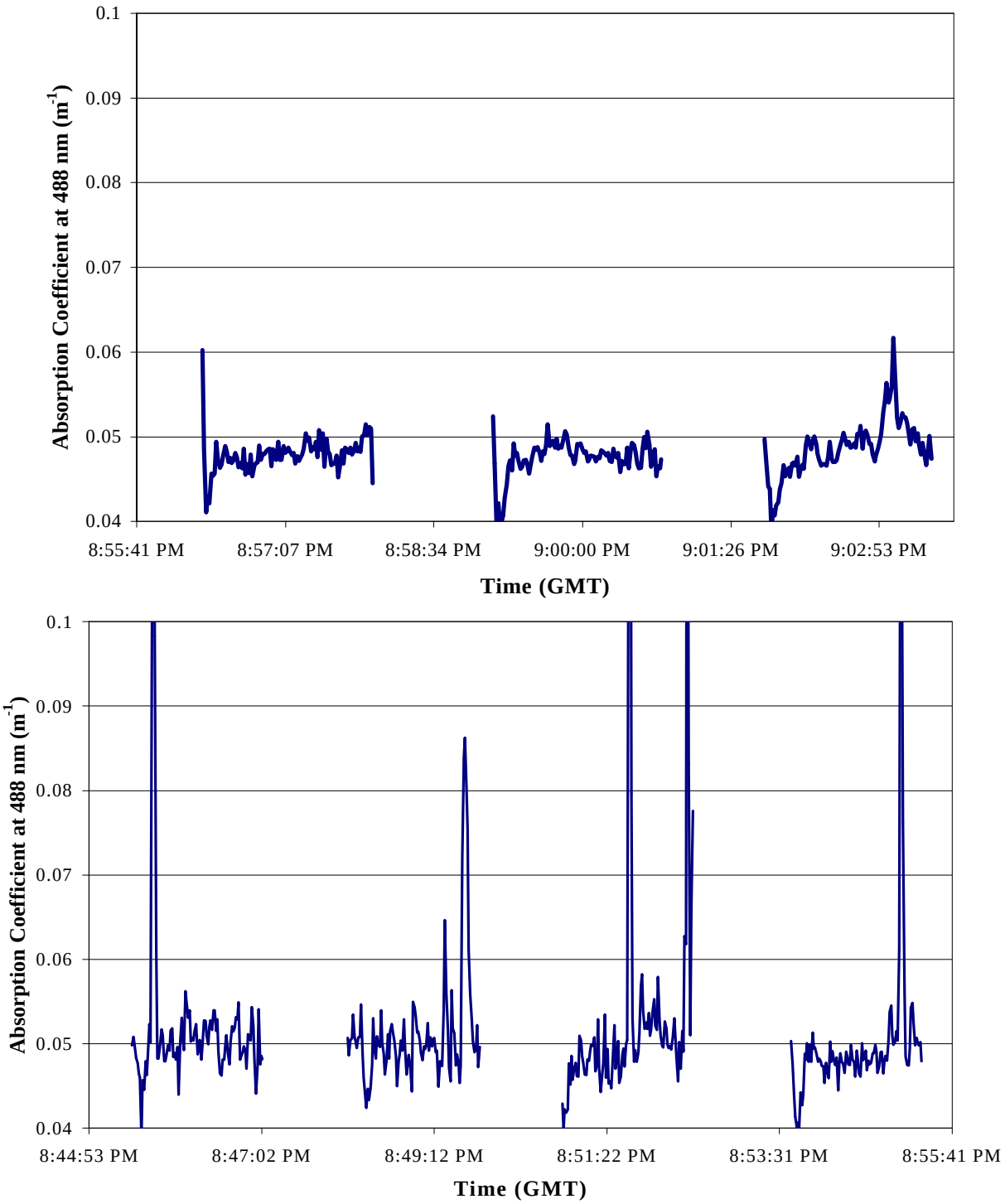

Figure 2. - Horizontal transect of the absorption coefficient at 488 nm made on May 25th at North Perry Reef at 1 m and 0.1 m above the bottom. Top panel is measurements made at 1 m above the bottom, bottom panel for measurements made 0.1 m above the bottom.