Bio-Optical Profile Data Report

Coastal Transition Zone Program
R/V Point Sur
June 15–28, 1987

Curtiss O. Davis
W. Joseph Rhea

December 1, 1990

Prepared for
Office of Naval Research
Through an agreement with
National Aeronautics and
Space Administration
by
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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The research described in this publication was carried out by the Jet Propulsion Laboratory, California Institute of Technology, and was sponsored by the Office of Naval Research through an agreement with the National Aeronautics and Space Administration.

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ABSTRACT

Twenty vertical profiles of the bio-optical properties of the ocean were made during a research cruise on the R/V Point Sur, June 15–28, 1987, as part of the Coastal Transition Zone Program off Point Arena, California. Extracted chlorophyll values were also measured at some stations to provide calibration data for the in situ fluorometer. This report is a summary to provide investigators with an overview of the data collected. The entire data set is available in digital form for interested researchers, and requests for the data should be addressed to W. Joe Rhea, (818) 393-6095.
ACKNOWLEDGMENTS

The assistance of the Captain and crew of the R/V Point Sur and Chief Scientist Steve Ramp is gratefully acknowledged.
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v
INTRODUCTION

The Coastal Transition Zone (CTZ) Program, sponsored by the Office of Naval Research, is an interdisciplinary study of the physical causes and the physical, biological, and optical characteristics of the filaments of cold, salty water that extend over 300 km off the West Coast of North America. The cruise of the R/V Point Sur, June 15–28, 1987, was designed to study a representative filament off Point Arena, California. Guided by satellite sea-surface temperature maps, two surveys of the filament and adjacent waters were conducted. Additionally, a cluster of drifters was placed in the root of the filament and tracked by satellite for several months. One of the drifters was instrumented with a fluorometer, transmissometer, spectroradiometer, water sampler, and a thermistor chain. At the end of eight days, the instrumented drifter was recovered approximately 300 km to the southwest of the launch site. This report describes bio-optical profile data that were collected at 20 stations representative of the filament, freshly upwelled water near the coast, and the offshore water surrounding the filament.

DATA DESCRIPTION

Optical data were collected with a Bio-Optical Profiling System (BOPS), an updated version of the BOPS originally developed by Smith et al. (1984). The heart of the BOPS was a Biospherical Instruments MER-1048 spectroradiometer, which measures up- and downwelling spectral irradiance and upwelling spectral radiance. The MER-1048 also has sensors for Photosynthetically Available Radiation (PAR), depth, tilt, and roll. In addition, temperature and conductivity were measured with a Sea-Bird CTD, chlorophyll fluorescence was measured with a Sea Tech fluorometer, and beam transmission was measured with a Sea Tech 25-cm transmissometer. The MER-1048 acquired all the data 16 times a second, averaged it to four records a second, and sent it up the cable to a deck box and a Compaq-286 computer, which stored the data on the hard disk. The BOPS data (Table I) were filtered to remove obvious data spikes and a depth aberration, which occurred at 95 m, and then binned into one-meter averages and stored as ASCII comma-separated files.

At selected stations, extracted chlorophyll and phaeopigments were measured on water samples taken with the CTD rosette sampler immediately before or after the optical profile. Water samples (100 ml) were filtered on Whatman GF/F filters. Samples were extracted in 10 ml of acetone in the dark in a freezer for 24 h and then measured in a Turner Designs Model 10-005 Fluorometer calibrated with pure chlorophyll (Sigma Chemical Co.). Samples were remeasured after acidification with one drop of 5% HCl, and chlorophyll and phaeopigments were calculated according to Strickland and Parsons (1972).

INDIVIDUAL STATION DATA PROFILES

For each station (Table II), eight profiles are presented to give a graphical overview of the data (Figures 1–20). Data files are identified by a filename of the format:

Nyymmdde.MER

yy = Year
mm = Month
dd = Day
c = Cast order for each day.
i.e. 'a' = first cast of day
     'b' = second cast of day, etc.

Temperature and salinity data were from the Sea-Bird CTD. Salinity was calculated from the temperature and conductivity measurements using the standard equations for practical salinity units (Millero et al., 1980). Occasional spikes in salinity were observed at the surface and at the thermocline. This is an artifact caused by the fact that the response time of the conductivity sensor does not exactly match that of the temperature sensor.

Data from the Sea Tech fluorometer are presented in fluorescence units. The fluorometer data were calibrated using extracted chlorophyll and phaeopigment values from water samples taken immediately before or after a number of optical profiles (Table III). Average chlorophyll plus phaeopigment values for the entire cruise give the following equation for calibrating the Sea Tech fluorometer data: chl + phaeo = 0.236 + 0.127 fluor, where r² = 0.77 and n = 27.

Beam transmissometer (25-cm path length, 660-nm wavelength) data were recorded in percent transmission (T; value in pure water = 91.3%). The attenuation of a beam of light is defined by Jerlov (1976):

\[ T = e^{-cr} \]

where
- \( c \) is the beam attenuation coefficient in m⁻¹
- \( a \) is the absorption coefficient
- \( b \) is the total scattering coefficient
- \( T \) is the fraction of light transmitted over path length \( r \).

Then, for this data set, \( c \) can be calculated from the following equation (\( r = 0.25 \) m):

\[ c = -4 \ln(\%T/100) \]

The radiance, irradiance, and PAR data are presented in calibrated units based on a laboratory calibration conducted by Biospherical Instruments on June 11, 1987. A second calibration after the cruise showed no significant deviation from these values. The spectral light data are presented as a plot of spectra near the surface (dashed line) and then at every five meters (5 m, 10 m, 15 m, etc.). Typically, the surface reading is for 2 m; however, during rough weather, the first usable readings are from greater depth, as indicated on the figures. This is calibrated radiance data, but no corrections for ship shadow or other artifacts have been made to the data. We have developed routines for correcting such artifacts, calculating \( K \), etc., following the guidelines of Smith and Baker (1984, 1986) and Gordon (1985), and the reader is referred to those references for a discussion of these problems.

The data are available in digital format for researchers who wish to work with the actual data. Individuals who are interested in working with the data should request it in digital form from Joe Rhea ((818) 393-6095). The data can be provided in a number of formats compatible with most standard computing environments.
REFERENCES


TABLE I.

Data Channels

0. Number of data points averaged into bin
1. 410-nm Downwelling Irradiance (μW/cm²/nm)
2. 441-nm Downwelling Irradiance (μW/cm²/nm)
3. 488-nm Downwelling Irradiance (μW/cm²/nm)
4. 520-nm Downwelling Irradiance (μW/cm²/nm)
5. 550-nm Downwelling Irradiance (μW/cm²/nm)
6. 560-nm Downwelling Irradiance (μW/cm²/nm)
7. 589-nm Downwelling Irradiance (μW/cm²/nm)
8. 633-nm Downwelling Irradiance (μW/cm²/nm)
9. 666-nm Downwelling Irradiance (μW/cm²/nm)
10. 671-nm Downwelling Irradiance (μW/cm²/nm)
11. Depth of averaged bin (m)
12. Tilt (angles in degrees (-45 to +45))
13. Roll (angles in degrees (-45 to +45))
14. 410-nm Radiance (μW/cm²/nm/sr)
15. 441-nm Radiance (μW/cm²/nm/sr)
16. 488-nm Radiance (μW/cm²/nm/sr)
17. 520-nm Radiance (μW/cm²/nm/sr)
18. 550-nm Radiance (μW/cm²/nm/sr)
19. 633-nm Radiance (μW/cm²/nm/sr)
20. 589-nm Radiance (μW/cm²/nm/sr)
21. 671-nm Radiance (μW/cm²/nm/sr)
22. 694-nm Radiance (μW/cm²/nm/sr)
23. 410-nm Upwelling Irradiance (μW/cm²/nm)
24. 441-nm Upwelling Irradiance (μW/cm²/nm)
25. 488-nm Upwelling Irradiance (μW/cm²/nm)
26. 520-nm Upwelling Irradiance (μW/cm²/nm)
27. 550-nm Upwelling Irradiance (μW/cm²/nm)
28. 560-nm Upwelling Irradiance (μW/cm²/nm)
29. 589-nm Upwelling Irradiance (μW/cm²/nm)
30. 633-nm Upwelling Irradiance (μW/cm²/nm)
31. 671-nm Upwelling Irradiance (μW/cm²/nm)
32. 694-nm Upwelling Irradiance (μW/cm²/nm)
33. Transmissometer - 25 cm (% transmission)
34. Fluorometer (fluorescence units)
35. PAR (10^17 quanta/cm²/s)
36. Temperature (deg C)
37. Conductivity (mmho/cm)
38. Salinity (PSU)
39. Density (g/cm³)
40. 520-nm Surface Irradiance (ship mounted)
41. 410-nm Surface Irradiance (ship mounted)
42. 589-nm Surface Irradiance (ship mounted)
43. 683-nm Surface Irradiance (ship mounted)
### TABLE II.

1987 R/V Point Sur CTZ Cruise—Station Summary

<table>
<thead>
<tr>
<th>FILENAME</th>
<th>Sta (Cast)</th>
<th>Time (Ship)</th>
<th>Latitude Deg Min</th>
<th>Longitude Deg Min</th>
<th>Comments</th>
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<td>0736</td>
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<td>N38 33.9</td>
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<tr>
<td>j870617b</td>
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<td>N38 34.8</td>
<td>W123 56.45</td>
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<td>W125 07.59</td>
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</tr>
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<td>046</td>
<td>1030</td>
<td>N37 46.9</td>
<td>W125 22.04</td>
<td>Blue water station</td>
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<td>N38 35.1</td>
<td>W125 35.08</td>
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<td>1120</td>
<td>N38 31.3</td>
<td>W123 20.67</td>
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<td>N38 11.4</td>
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TABLE III.

Extracted Chlorophyll and Phaeopigment Values
(Note: 3-m Depth = sample from underway system)

<table>
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<tr>
<th>Date</th>
<th>Sta</th>
<th>Depth (m)</th>
<th>Chl. (mg/l)</th>
<th>Phaeo-pigments (mg/l)</th>
<th>Total (mg/l)</th>
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<td>0.38</td>
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STATION PROFILES
Figure 1. File: j870616a
Figure 2. Continued
Figure 3. Continued
Figure 4. File: j870616d

JETZ 06-16-87 Loc: STA 12

Lat: 39° 7.30' N Long: 124° 12.42' W File: j870616d
JETZ 06-17-87  Loc: drift launch  Lat: 38° 33.88’ N  Long: 124° 02.91’ W  File: j870617a

Figure 5. File: j870617a
Figure 6. File: j870617b
Figure 6, Continued
Figure 7. File: j870618a
Figure 8. File: J670619a
Figure 8. Continued
Figure 9. File: j870619b
Figure 9. Continued

JETZ 06-19-87  Loc. sta 51
Lat: 38° 35.08' N  Long: 125° 35.08' W  File: j870619b

dashed line = 2 m
solid = 5 m, 10 m, ...

log, PAR (10^-7 quanta/cm^2/s)
Figure 11. Continued
JETZ 06-20-87 Loc: sta 59 Lat: 39° 06.79' N Long: 123° 51.83' W File: j870620d

Figure 12. File: j870620d
Figure 12. Continued
Figure 13. File: j870621a
Figure 15.
File: j870625a

JEITZ
06.25.87
Loc: sta 79
Lat: 38° 31.33' N
Long: 123° 20.67' W
File: j870625a
Figure 16. File: j870626a
Figure 16. Continued
Figure 18. File: j870626c
Figure 18. Continued
Figure 19. Continued
Twenty vertical profiles of the bio-optical properties of the ocean were made during a research cruise on the R/V Point Sur, June 15-28, 1987, as part of the Coastal Transition Zone Program off Point Arena, California. Extracted chlorophyll values were also measured at some stations to provide calibration data for the in situ fluorometer. This report is a summary to provide investigators with an overview of the data collected. The entire data set is available in digital form for interested researchers, and requests for the data should be addressed to W. Joe Rhea, (818) 393-6095