Bio-Optical Profile Data Report
Coastal Transition Zone Program
R/V Thomas Washington
June 24–July 21, 1988

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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REPORT COASTAL TRANSITION ZONE PROGRAM, R/V
THOMAS WASHINGTON, JUNE 24 – JULY 21, 1988
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Unclas
23 vertical profiles of the bio-optical properties of the ocean were made during a research cruise on the R/V Thomas Washington, June 24--July 21, 1988, as part of the Coastal Transition Zone Program off Point Arena, California. 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. Joseph Rhea, (818) 393-6095.
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ABSTRACT

Twenty-three vertical profiles of the bio-optical properties of the ocean were made during a research cruise on the R/V Thomas Washington, June 24–July 21, 1988, as part of the Coastal Transition Zone Program off Point Arena, California. 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 Thomas Washington and Chief Scientist Tim Cowles is gratefully acknowledged.
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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 Thomas Washington, June 24–July 21, 1988, 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, two clusters of drifters were placed in the root of the filament and tracked by satellite for several months. One of the drifters in the first cluster was instrumented with a fluorometer, transmissometer, spectroradiometer, and a water sampler. At the end of seven 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 23 stations representative of the filament, freshly upwelled water near the coast, and the offshore water surrounding the filament. Of particular interest is a time series of seven stations taken at approximately noon each day next to the instrumented drifter.

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 is a Biospherical Instruments MER-1048 spectroradiometer, which measured 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 then binned into one-meter averages and stored in the form of ASCII comma-separated files.

INDIVIDUAL STATION DATA PROFILES

For each station (Table II), eight profiles are presented to give a graphical overview of the data (Figures 1–23). Data files are identified by a filename of the format:

Nyymmdc.MER

where:
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. Average chlorophyll plus phaeopigment values for the entire cruise give the following equation for calibrating the Sea Tech fluorometer data: chl + phaeo = 0.288 + 0.218 fluor, where $r^2 = 0.77$ and $n = 136$.

Beam transmissometer (25-cm path length, 660-nm wavelength) data were recorded in percent transmission ($%T$; value in air was set to 100%). The attenuation of a beam of light is defined by Jerlov (1976):

$$c = a + b$$

and

$$T = e^{-cr}$$

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 \((%T/100)^*0.949\)$$

The radiance, irradiance, and PAR data are presented in calibrated units based on a laboratory calibration conducted by Biospherical Instruments on June 21, 1988. 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

<table>
<thead>
<tr>
<th>0. Number of data points averaged into bin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 410-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>2. 441-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>3. 488-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>4. 520-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>5. 550-nm Downwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>6. 560-nm Downwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>7. 589-nm Downwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>8. 633-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>9. 656-nm Downwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>10. 671-nm Downwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>11. 683-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>12. 694-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>13. 710-nm Downwelling Irradiance (µW/cm²/nm)</td>
</tr>
<tr>
<td>14. Depth of averaged bin (m)</td>
</tr>
<tr>
<td>15. Tilt (angles in degrees (-45 to +45))</td>
</tr>
<tr>
<td>16. Roll (angles in degrees (-45 to +45))</td>
</tr>
<tr>
<td>17. 410-nm Radiance (µW/cm²/nm/sr)</td>
</tr>
<tr>
<td>18. 441-nm Radiance (µW/cm²/nm/sr)</td>
</tr>
<tr>
<td>19. 488-nm Radiance (µW/cm²/nm/sr)</td>
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<td>20. 520-nm Radiance (µW/cm²/nm/sr)</td>
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<tr>
<td>21. 550-nm Radiance (µW/cm²/nm/sr)</td>
</tr>
<tr>
<td>22. 633-nm Radiance (µW/cm²/nm/sr)</td>
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<tr>
<td>23. 656-nm Radiance (µW/cm²/nm/sr)</td>
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<tr>
<td>24. 683-nm Radiance (µW/cm²/nm/sr)</td>
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<td>25. 410-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<td>26. 441-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<td>27. 488-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>28. 520-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>29. 550-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<td>30. 589-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<td>31. 671-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>32. 694-nm Upwelling Irradiance (µW/cm²/nm)</td>
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<tr>
<td>33. Transmissometer - 25 cm (% transmission)</td>
</tr>
<tr>
<td>34. Fluorometer (fluorescence units)</td>
</tr>
<tr>
<td>35. PAR (10¹⁷ quanta/cm²/s]</td>
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<tr>
<td>36. Temperature (deg C)</td>
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<tr>
<td>37. Conductivity (mmho/cm)</td>
</tr>
<tr>
<td>38. Salinity (PSU)</td>
</tr>
<tr>
<td>39. Density (g/cm³)</td>
</tr>
<tr>
<td>40. 520-nm Surface Irradiance (ship mounted)</td>
</tr>
<tr>
<td>41. 410-nm Surface Irradiance (ship mounted)</td>
</tr>
<tr>
<td>42. 589-nm Surface Irradiance (ship mounted)</td>
</tr>
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<td>43. 683-nm Surface Irradiance (ship mounted)</td>
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<tr>
<td>c880720e</td>
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<tr>
<td>c880721a</td>
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</table>
Figure 1. Continued
CTZ 07-05-88  Loc: sta 06 op 1  Lat: 38° 49.8' N  Long: 124° 20.1' W  File: c880705d
Depth (m)  Salinity (psu)
0  32.0  33.0  33.5  34.0
50
100
150
0
50
100
150
Fig. 3. File: c880705d
Transmission (% trans.)
70  75  80  85  90  95  100
Fluorometer (Fluor. units)
0  10  20  30  40  50  60
Temperature (deg C)
17  15  13  11
0  50
100
150
Depth (m)
Figure 3. Continued
Figure 4. File: c880706b

CTZ
07-06-88
Loc: sta 10 op 2
Lat: 38° 20.3' N
Long: 124° 09.2' W
File: c880706b

Depth (m)

Salinity (psu)

Transmissometer (% trans.)

Temperature (deg C)

Fluorometer (Fluoro. units)

Depth (m)

Depth (m)
Figure 4. Continued
CTZ 07-06-88  Loc: sta 11 op 2  Lat: 38° 24.2' N  Long: 124° 22.3' W  File: c880706c

Figure 5. File: c880706c
Figure 6. File: c880707a
Figure 6. Continued
Figure 7. Continued

CTZ
07-07-88
Loc: sta.17 op 2
Lat: 38° 07'2.1' N
Long: 124° 54'1.1' W
File: e880707b

dept (m)

LOG \text{PAR (10}^{-17} \text{quanta/cm²/s)}

(\text{W/m²})^{n}

Wavelength (nm)

dashed line = 2 m
solid = 5 m, 10 m,...
Figure 8. File: c880708a
Figure 8. Continued
Figure 9. File: c880708b
Figure 10. File: c880709b
Figure 10. Continued
Figure 12. File: c880710b
Figure 12. Continued
Figure 13. Continued
Figure 14. Continued
Figure 15. File: e880715a
Figure 16. File: c880716b

CTZ
Loc: sta 66 op 2
Lat: 37° 44.71' N
Long: 125° 29.8' W
File: c880716b

Salinity (psu)

Transmissometer (% trans.)

Temperature (deg C)

Fluorometer (Fluo. units)
Figure 18. Continued
Figure 19. Continued
Figure 20. File: c880720a

CTZ 07-20-88  Loc: sta 80 np 2  Lat: 37° 37.1' N  Long: 124° 28.6' W

File: c880720a
Figure 21. Continued