MODIS Team Member - Quarterly Report
Marine Optical Characterizations
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NOAA/NESDIS

SUMMARY

The team's major emphasis during this reporting period has been focused on the completion of the operational versions of the MOBY's. The team conducted two field experiments. The first MOBY-L13 field expedition was to the operations site in Honolulu, Hawaii, from July 24 to August 15, making necessary preparations for future field experiments. The first operational version of MOBY was completed, and the shore based calibration and testing were initiated. Further work was accomplished on mechanical and electrical assemblies on the second MOBY system. All the tasks were completed successfully. The results of the initial spectrometer test were excellent. The system have sub nanometer spectral resolution, while the sensitivity of the system is 1.5 to 2.0 times better then the old one.

From September 14 to September 21 the team conducted the MOBY-L14 deployment and process cruise at the Lanai mooring site. The MOBY was successfully deployed on the September 15. A series of test and diver calibrations were performed. Currently the MOBY is collecting data and transmitting the data nightly to MLML. Based upon the data we have so far, we should be able to operate MOS for 3 hours a day on a continuous basis. A complete set of bio-optical measurements were obtained at the site, including atmospheric transmittance observations at the MOBY and at the CIMEL sites. A high resolution pigment grid at the MOBY site was conducted for spatial variability.

MOBY-L13 EXPERIMENT

Members of the MOCE Team conducted field work and site maintenance in Hawaii, July 24 - August 15, 1996. The following personnel participated:

NOAA - Dennis Clark, Ed Fisher, Yuantao Ge, Phil Hovey, Ed King, Larisa Koval, Eric Stengel, Marilyn Yuen
MLML - Bill Broenkow, Mike Feinholz, Mike Hearne, Yi Liu, Mark Yarbrough
CHORS - Dan Sullivan, Chuck Trees
NASA - Stan Hooker
University of Miami - Jim Brown, Bob Evans

University of Hawaii - Mike Ondrusek
IOTSOA, PRC - Junwu Tang

The components of the operational versions of MOBY2 were delivered to the operations site. The first version of MOBY2 was completed. Further work was accomplished on mechanical and electrical assemblies on the second system (Figure 1). Three new MOS2 instruments (SN: 002, 004, 005) were finally assembled and delivered to Hawaii. The MOS2 C VAX station acquisition program for the new MOS2 CCD spectroradiometer was completed and tested. This program was used to calibrate three new MOS2 instruments and a completed MOBY2 system, incorporating MOS2 (SN: 005) (Figure 2).

The MOBY communications test modules were installed on the mooring buoy. The noisy Hawaii cell system caused some problem in the software. Serial buffer overflow would overwrite program memory space because the system accepts noise as valid information. To solve this problem, two fixes were implemented. Cell phones will be run in the error corrected mode only, with no fall back to the less secure modes. The limits checking to all the input buffers were added to prevent the overwrite problem from any other source as well. With this buffer fix, the unit operated without problem for four weeks until recovery on September 15.

Work on the new spectrometers was completed. They were installed in the new MOS. System calibration procedures were performed on all sensors (4 upwelling radiance ports, 4 downwelling irradiance ports). Wavelength calibrations were also carried out for both spectrometers in the system. The system demonstrated superior optical capability with minimal errors.

The angular response for the new irradiance collectors was measured. Development of this optical-mechanical device has been a time consuming iterative process since all modeling efforts failed to provide reasonable first approximations .It was found that the final design after two iterations had lead to a outstanding fiber optic collector with high throughput and low angular response deviation The throughput is about 1.5 to 2 times better than the old design.

The immersion factor for the new fiber optic irradiance collectors was measured at wavelength range from 350 nm to 1100 nm. The immersion factor for UV, VIS, and NIR wavelength range was calculated.

Radiance calibration for the new fiber was conducted using 420 M Integrating sphere. Irradiance calibration for the new collector was performed using Gamma 5000 lamp.

Work on the new Pigment and Absorption Filtration (PAF) van continued. This included installation of cabinets, lighting, electrical outlets and painting. Special cabinets were designed and built to hold two five gallon waste flasks, as well as vacuum pumps. The PAF van has two -12 placed filtration manifolds enabling simultaneous filtration of particulate absorption and fluorometric chlorophyll samples. A large volume 12 place positive pressure filtration system was installed in the PAF van to increase the volumes filtered (up to 4.2 liters) for HPLC analysis of oligotrophic waters. Electrical wiring of the PAF and Conditioned Electrical Supply vans were also performed.

Reinitialization of the CIMEL atmospheric measurement system was conducted at the NASA Aeronet site on Lanai.

Junwu Tang, lab director for remote sensing at the Institute of Ocean Technology State Oceanic Administration in the People's Republic of China, worked on Rainbow software development and implementation.

MOBY-L14 EXPERIMENT

The following personnel were involved:

NOAA - Dennis Clark, Ed Fisher, Yuntao Ge, Phil Hovey, Ed King, Larisa Koval, Eric Stengel, Marilyn Yuen
MLML - Mike Feinholtz, Drew Gashler, John Heine Yi Liu, Mark Yarbrough
SATLANTIC - Scott McLean
CHORS - Chuck Trees, Dan Sullivan
University of Miami - Joe Ritter
University of Hawaii - Mike Ondrusek

Carol Johnson, NIST, participated in MOBY calibration

Prior to the cruise, the final MOBY tests, calibrations, and preparations for the deployment were performed.

NIST participated in the calibration of the optical instruments associated with the MOBY project. Two Single Channel Multipurpose Sensors (SCAMPS) were used for monitoring the stability of our calibration standards of spectral radiance, irradiance, and field reference lamps. The two calibrated radiometers consist of filtered, temperature controlled, silicon photodiode with required amplifier electronics, power supplies and precision apertures (Fiure. 3). The final calibration of MOBY was performed using Sea WiFS transfer radiometer (SXR) and SCAMPS (Figure 4). Initial results indicate that the Team's calibration systems are within 1% of the NIST transfer radiometer.

During the calibration, a problem was found with the coupling gel used inside the fiber optics connectors. The problem seems to be caused by a reaction between the gel and the Methanol used to clean the optical interface prior to mating the connectors. As a precaution, all the other fiber optics connections were cleaned and re-mated using different chemicals.

After the initial calibration of the MOBY it became apparent that more control over the operation of the MOS CCDs via the MOBY operational parameters is needed. Now it seemed that more control is also needed over the CCD binning factors as well.

MOBY2 was deployed at the Lanai site on the September 15 (Figure 5). After four days of experimentation a good set of operational parameters for MOBY2 (integration time and binning factors) were determined, considering our desire to keep the bright days on scale and below the CCD saturation problem area. A series of diver calibration were performed during the period 16-21 September. The Mid irradiance port and the upper radiance port have an obvious problem which looks similar to the coupling gel failure on the same collectors discovered during calibration. We will not know what the problem is for sure until the buoy is recovered in November.

On the September 20 the humidity sensor indicated a leak in the surface control unit. The unit was recovered from the buoy, repaired, and successfully installed in time for the noon observations the next day (Figure 6). The source of the leak was determined to be bad welds. Presently MOBY is collecting data at noon and transmitting the data to MLML VAX 4000 once a day. The data are read into a file format used by the MLML data processing programs. The row CCD spectral radiances are adjusted by dividing by the integration times and subtracting the dark scans from the light. When sensor and fiber optics calibrations have been verified, the adjusted spectral upwelled radiance (Lu) scans will be converted into absolute radiometric units. For the present time, we are presenting only adjusted data in counts/sec (Figure 7). The surface irradiance (Es) data sets taken before and after each sub-surface radiance scan are averaged, and are also given here in adjusted units of counts/sec. Water-leaving radiances (Lw) are computed from Lu using attenuation coefficients calculated from the adjusted radiance values. These attenuation coefficients may be greatly in error, because we are not using sensor response for individual fiber optic/collector. The spectral Es and Lw are weighted with the SeaWiFS responses, and the integrated Es and Lw over the SeaWiFS bands are computed for bands 1-6 (412, 443, 490, 510, 555, 670 nm).

The data acquisition system was set up for the cruise. The system consists of 11 computers networked together with ethernet. Two GPS systems provide time and location information to synchronize all data collection system. They broadcast through RS232 interface to all other systems. A flux-date electronic compass gives heading and direction information. A notebook computer logs air pressure through a serial port connected to a digital pressure transducer. A relative humidity and temperature sensor monitors these two parameters and the data were recorded through a AD converter. Two wind sensors mounted on each side of the boat provide wind speed and direction. A Quadra 650 computer controls the VLST system, which provides sea water transmittance at 5 different channels, a fluorometer for the detection for chlorophyll concentration, and a depth transducer, which designates the layer of water column where these data were taken. The fluorometer and depth transducer plus a water pump were mounted on a V-fin (for towing at the speed of about 5-8 knots). Water was pumped through the VLST system. Flow rate was also measured. Discrete samples at specific time and location were taken for particle size distribution, pigment concentration, and total suspended matter analysis. Information including fluorescence, depth, transmittance, GSP time and location were all relayed to another lab through a serial port. Another computer takes in these information and displays it to the workers in the lab. After a sample was taken, they can login the data on this computer. A temperature salinity graph was controlled by a notebook computer. All activities were recorded by a master log which resides on a separate power book. A PowerPC 7100 burdens itself to back up all experimental data. In the process of setting up this system, a new compass had to be installed and tested. The relative humidity and temperature sensor had to be adjusted and calibrated. Many new LabVIEW software had to be rewritten. A serial port tester program was written to debug problems encountered.

During the 7 day cruise, samples were collected for fluorometric analysis in a near-realtime mode. Samples were also collected and frozen in liquid nitrogen for HPLC analysis at CHORS, San Diego. Software modifications were made to the HP Diode Array and Integrating Sphere system to improve processing speed and plotting capabilities. Three CTD casts (SBE0034-42) were performed during the cruise. Seawater for 53 TSM and 53 POC/PON analyses were sampled and filtered. Deep "particle-free" water was collected for the future irradiance collector immersion experiments.

An 8 km^2 survey grid was occupied around MOBY, measuring near surface *in vivo* fluorescence, temperature and beam attenuation using the towed system. Duplicate fluorometric chlorophyll samples were collected and analyzed onboard ship, as well as collection of HPLC samples for analysis at CHORS. Using one minute averaged chlorophyll corrected *in vivo* fluorescence, a surface contour map was generated. This survey showed that the chlorophyll field was heterogeneous with concentrations ranging from 0.042 to 0.110 mg m^-3. A contour map with sample spacing is shown in Figure 8.

A Satlantic Free-Fall Profiling Radiometer was deployed off the stern of the R/V Moana Wave to depth of up to 250 m (Figure 9). Four sets of three profiles each were made around the mooring with the data being analyzed using software provided by the manufacturer.

Atmospheric transmittance observations were performed at the MOBY and at the CIMEL sites. Good data were obtained. These data are being investigated.

Experiment of upwelling radiance measurement and self-shading effect were carried out (Figure 10). These data are also being analyzed.

After the cruise, the laboratory experiments were performed using MOS2 (SN: 002) to characterize the instruments' "linear" response to varying light levels, integration time, and CCD binning parameters.

MARINE OPTICAL BUOY - Software development

Personnel from Moss Landing Marine Laboratories have nearly finished the process, begun in February, of converting the VAX-based MLDBASE programs from the FORTRAN and C language to the Matlab language. All major MLDBASE low level, menu driven, oceanographic and time/data functions have been completed. The required NOAA processing program have also been defined. Although most of the programs operate the same as their VAX counterparts, there are exceptions were Matlab offers a more efficient way of manipulating data. The help written to accompany each Matlab MLDBASE file will show the inputs, outputs and examples of the use of each program. This help is being edited and will be finished soon.

DATA REDUCTION

MOCE-3

All the particulate and detrital absorption data collected during MOCE-3 were reprocessed. The data files were formatted according to SeaWiFS protocols and resubmitted to NASA.

A significant amount of time was spent on the MOCE-3 VLST data. There are still significant bugs in the processing software. The algorithm used to convert fluorescence to chlorophyll concentration is incorrect in the current version of the software. Further processing of any MOCE-3 VLST data is delayed until we have had the opportunity to correct the programming errors in the processing software utility routines.

SeaWiFS PROTOCOL WORKSHOP & MEETING

C. Trees and P. Hovey traveled to Booth Bay, ME, to participate in Beta Intercalibration Exercise with colleagues at Bigelow Laboratory for Ocean Sciences from September 29 to October 3. The HP Diode Array and Integrating Sphere system were compared to four other spectrophotometers using 10 phytoplankton cultures. These cultures were selected to cover several phytoplankton groups with a variety of cell sizes.

Several turbid water samples from Booth Bay and nearby rivers were collected.

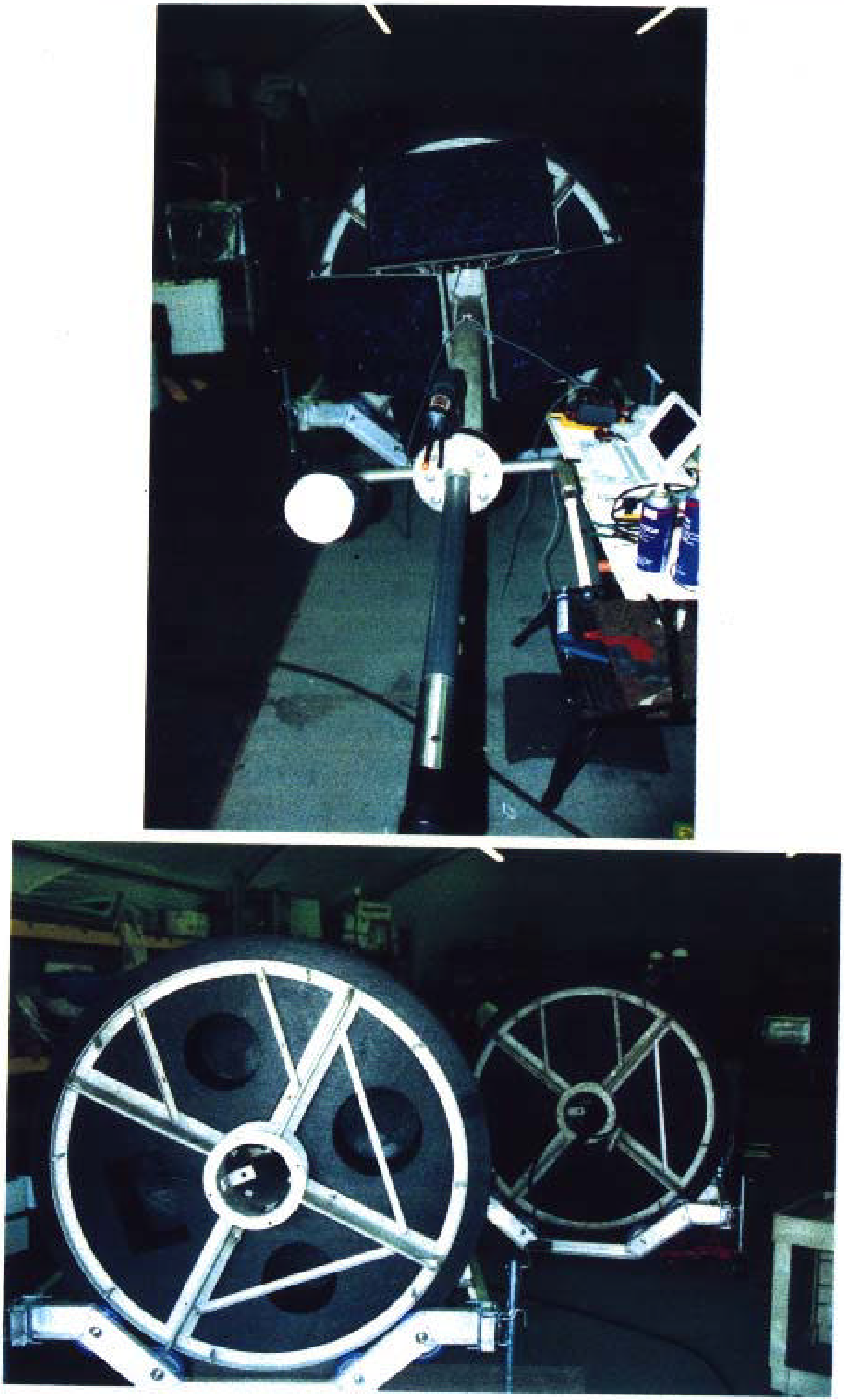


FIGURE 1.

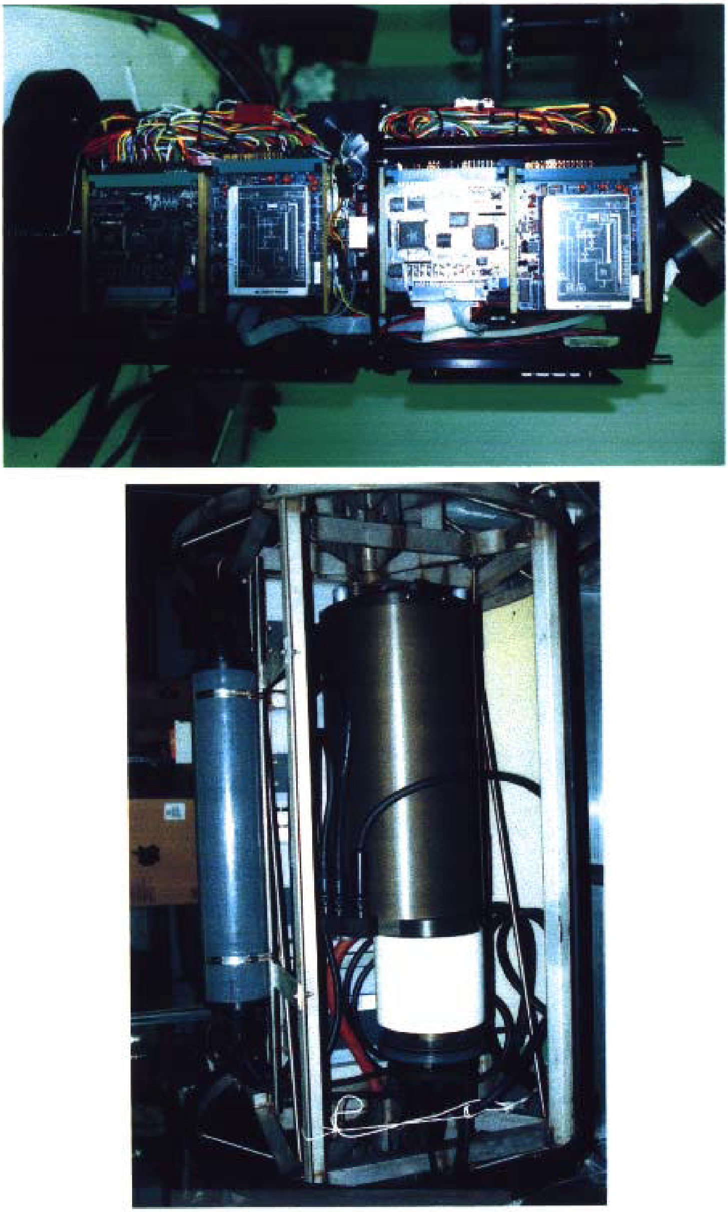


FIGURE 2.

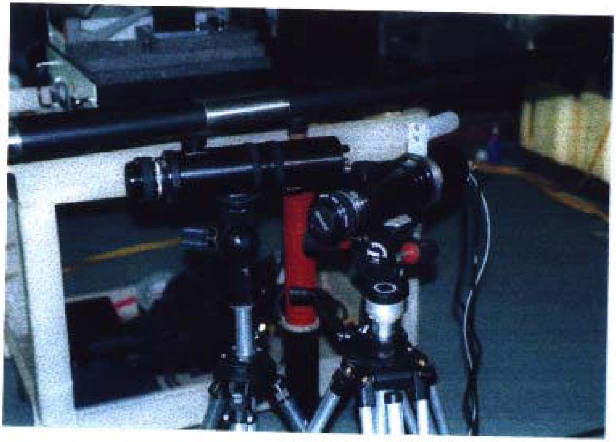
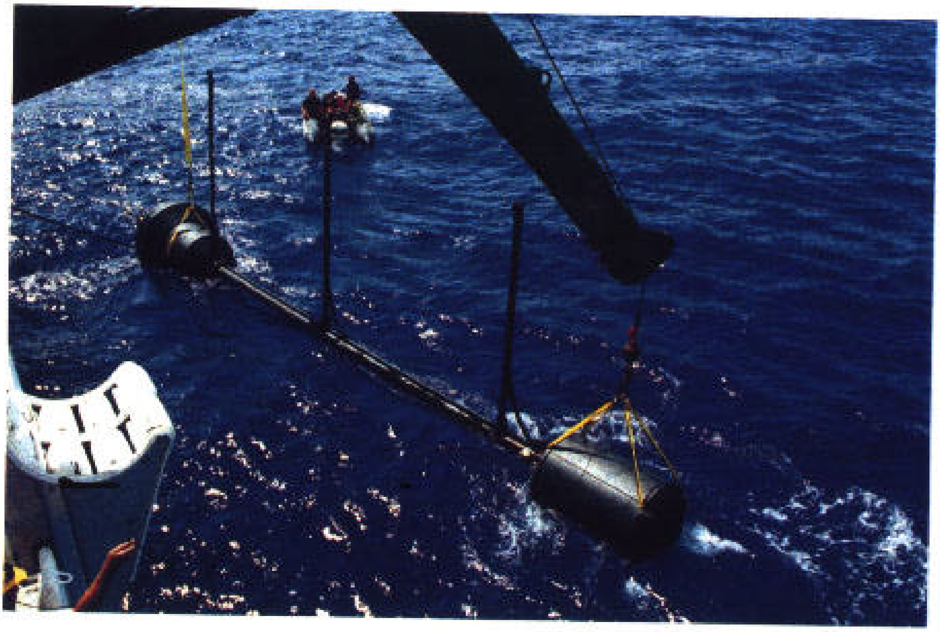


FIGURE 3.

FIGURE 4.



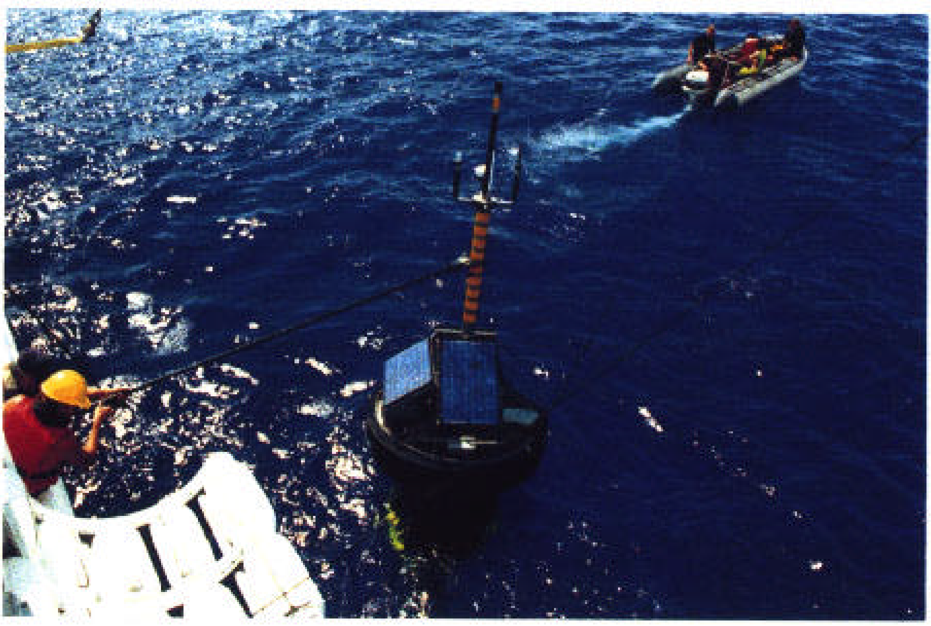


FIGURE 5.

FIGURE 6.

File: DAILYMBY.TXT

FhdS 1: NOAA Marine Optical BuoY
FhdS 2: Position: 20*49.33' N 157*11.46' W

DscS 1: Julian Day
DscS 2: GMT Time (HH.MM)
DscS 3: Observation Date (YY.MMDD)
DscS 5: Water-Leaving Radiance SeaWiFS Band 1 (Adjusted Counts/Sec)
DscS 6: Water-Leaving Radiance SeaWiFS Band 2 (Adjusted Counts/Sec)
DscS 7: Water-Leaving Radiance SeaWiFS Band 3 (Adjusted Counts/Sec)
DscS 8: Water-Leaving Radiance SeaWiFS Band 4 (Adjusted Counts/Sec)
DscS 9: Water-Leaving Radiance SeaWiFS Band 5 (Adjusted Counts/Sec)
DscS 10: Water-Leaving Radiance SeaWiFS Band 6 (Adjusted Counts/Sec)
DscS 13: Surface Irradiance SeaWiFS Band 1 (Adjusted Counts/Sec)
DscS 14: Surface Irradiance SeaWiFS Band 2 (Adjusted Counts/Sec)
DscS 15: Surface Irradiance SeaWiFS Band 3 (Adjusted Counts/Sec)
DscS 16: Surface Irradiance SeaWiFS Band 4 (Adjusted Counts/Sec)
DscS 17: Surface Irradiance SeaWiFS Band 5 (Adjusted Counts/Sec)
DscS 18: Surface Irradiance SeaWiFS Band 6 (Adjusted Counts/Sec)

Xdat:

N	JDay	GMT	ObsDate	Lw_SW1	Lw_SW2	Lw_SW3	Lw_SW4	Lw_SW5	Lw_SW6	Es_SW1	Es_SW2	Es_SW3	Es_SW4	Es_SW5	Es_SW6
1	260	22.28	96.0916	2872	3776	4412	3156	1464	176	404818	635125	943990	1046331	914980	959219
2	261	22.29	96.0917	1627	2175	2594	1858	876	147	248837	379777	547735	600510	516467	530912
3	262	22.28	96.0918	561	744	897	646	308	37	195696	299265	432446	473169	407524	416695
4	263	22.23	96.0919	1375	1808	2144	1533	728	180	404401	631486	934267	1034832	902271	1934525
5	264	-	96.0920	-	-	-	-	-	-	-	-	-	-	-	-
6	265	-	96.0921	-	-	-	-	-	-	-	-	-	-	-	-
7	266	22.50	96.0922	612	812	977	703	334	165	195614	306340	454684	503880	439845	1976514
8	267	22.49	96.0923	654	873	1053	769	379	196	191898	300004	444355	491989	429096	1932340
9	268	22.49	96.0924	722	973	1191	875	429	226	172537	268529	395866	437167	380542	1702327
10	269	22.50	96.0925	807	1095	1351	1004	503	280	174977	271863	399854	441342	383234	1708039
11	270	22.49	96.0926	582	771	921	650	298	121	187849	293654	434847	481278	419794	1892962
12	271	22.49	96.0927	788	1099	1397	1020	490	224	234197	369298	551736	612512	536097	2422574
13	272	22.49	96.0928	583	767	913	639	290	113	191734	299187	442131	489335	425996	1915728
14	273	22.49	96.0929	666	891	1093	802	388	197	188528	294423	435625	481988	420273	1889682
15	274	-	96.0930	-	-	-	-	-	-	-	-	-	-	-	-
16	275	22.49	96.1001	720	961	1169	860	419	222	188674	294877	436498	483137	421247	1900179
17	276	22.49	96.1002	713	941	1143	838	406	204	188047	293919	435084	481618	419960	1891650
18	277	-	96.1003	-	-	-	-	-	-	-	-	-	-	-	-

FIGURE 7.

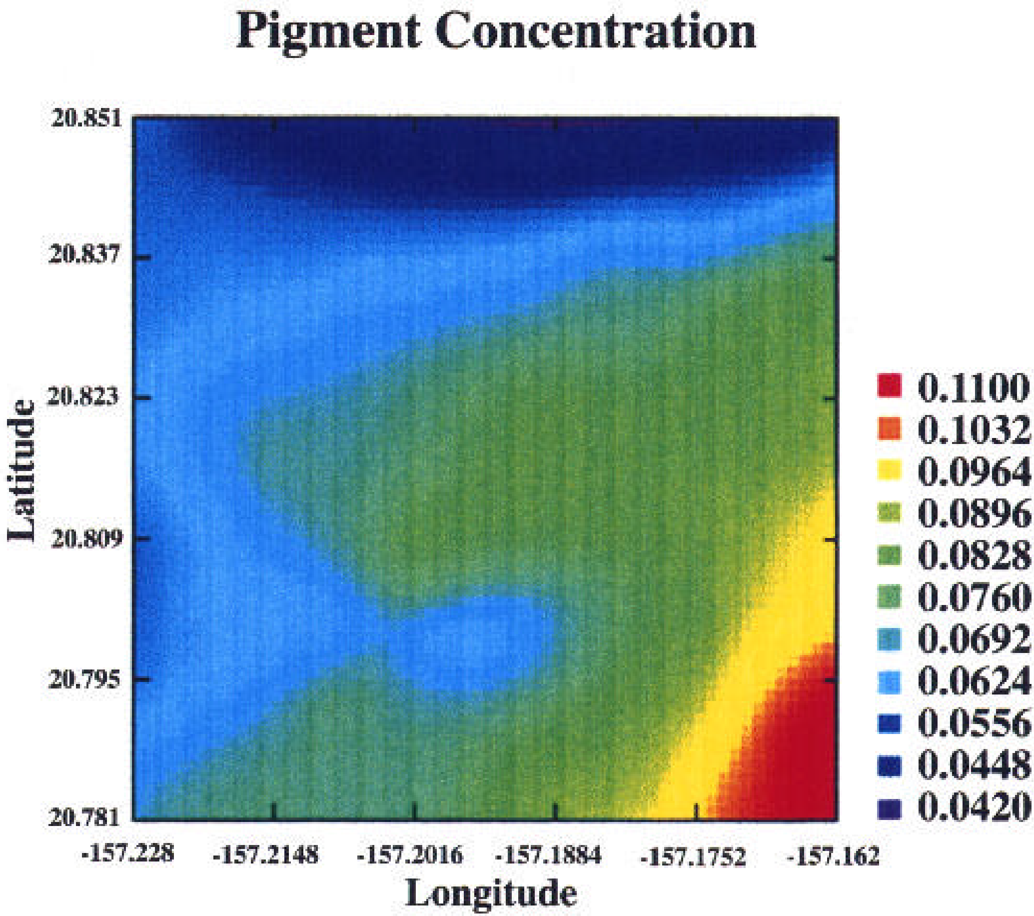

Pigment Concentration
20.851
20.837
20.823
20.809
20.795
20.781
Latitude
-157.228
-157.2148
-157.2016
-157.1884
-157.1752
-157.162
Longitude
0.1100
0.1032
0.0964
0.0896
0.0828
0.0760
0.0692
0.0624
0.0556
0.0448
0.0420

FIGURE 8.

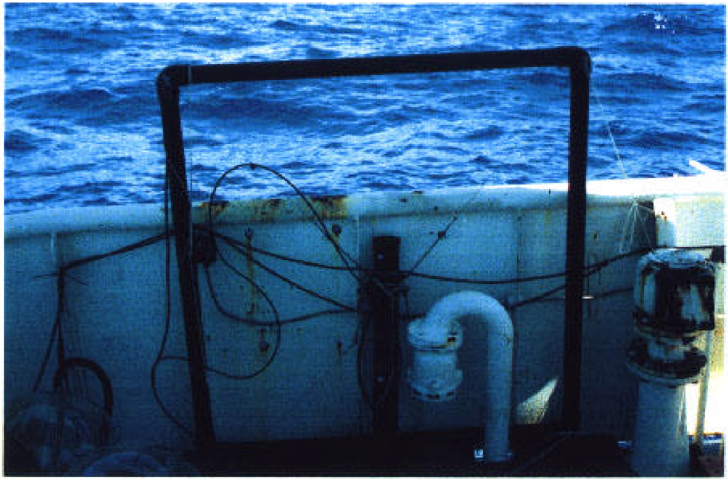


FIGURE 9.

FIGURE 10.