MODIS Team Member - Quarterly Report
Marine Optical Characterizations
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SUMMARY

The Marine Optical Characterization Experiment (MOCE) team conducted the SeaWiFS Initialization Experiment (MOCE-4) near the Hawaiian islands, two MOBY calibration excursions at the Lanai mooring site (MOBY-L26 and MOBY-L27), and a MOBY recovery and replacement cruise (MOBY-L28). Radiometric, biological and atmospheric data collected concurrently with SeaWiFS overpasses during MOCE-4 cruise were preprocessed, analyzed and submitted to NASA on March 10, 1998. Team activities during the first quarter of 1998 are shown in Fig. 1.

FIELD OPERATIONS

MOCE-4

The SeaWiFS Initialization Experiment took place January 26 - February 12, 1998. The following personnel participated:

NOAA - Dennis Clark, Marilyn Yuen, Edwin Fisher, Ed King, Eric Stengel, Larisa Koval, Yong Sung Kim

MLML - Mark Yarbrough, Mike Feinholz, Stephanie Flora, Brian Schlining

CHORS - Chuck Trees, Roberto Millan

University of Miami - Ken Voss, Judd Welton

Prior to the cruise, the profiling radiometer (MOS202) was calibrated for radiance, irradiance and wavelength, and the surface-incident radiometer (SIS 101) was calibrated for irradiance. A system calibration was performed on the fiber optic spectrometer system, where both the radiance and irradiance sensors were calibrated. The fiber optic irradiance sensor was calibrated using the standard lamp F-454 and the radiance sensor was calibrated using the integrating sphere OL420M.

During the eighteen days of ship time, seventeen oceanographic stations were occupied (Fig. 2, 3). Seventeen CTD casts and twenty-one MOS profiles were performed. Spectral water-leaving radiances were derived from MOCE-4 optics profiles coincident with 21 SeaWiFS overpasses.

The MOCE-4 MOS data (331 files, 13.9 Mbytes) and SIS data (2319 files. 25.5 Mbytes) were processed and presented to NASA.

Since this cruise was to validate NASA's SeaWiFS ocean color sensor, two sampling schemes were used. The first one pertained to coordinating vertical and near surface sampling with SeaWiFS overpasses. Triplicate pigment samples were collected at precisely the time of the overpass and were used to describe sample collection and measurement variability. The other sampling strategy was to perform a 10 by 10 km survey grid, upon completion of station, to determine spatial heterogeneity in pigment and particulate absorption fields. These high spatial resolution surveys were used to verify that the vertical samples collected during the SeaWiFS overpass were indeed indicative of the surrounding waters. Table 1 lists the number of HPLC, fluorometric, particulate absorption and dissolved organic absorption samples collected during MOCE- 4. The 321 HPLC pigment samples were placed in a LN_2 refrigerator and an-freighted to San Diego for analysis at CHORS.

The pigment samples collected for fluorometric analysis were processed on the ship using NOAA's Turner Designs Fluorometer. This fluorometer was calibrated using a chlorophyll a pigment standard provided by Mr. Mike Ondrusek, University of Hawaii.

Summary tables for all fluorometrically determined chlorophyll samples can be found in Appendix A. In general, these data support the conclusion that, during SeaWiFS overpasses, the pigment and particulate absorption measurements were very similar to those found within the 10 by 10 pixel survey area. Only a few stations were found to have statistically different concentrations during the overpass as compared to the surrounding waters. A review of the coincidental SeaWiFS imagery also indicated the presence of frontal features near these stations. The triplicate sampling strategy assisted in documenting the uncertainties in these measurements while at sea. A histogram of the near surface chlorophyll concentrations is shown in Figure 2 with a peak at 0.1 mg m-3. There were only a few samples with concentrations greater than 0.2 mg m-3 and these corresponded to samples taken near Molokai.

For particulate absorption, a similar trend was observed between the overpass stations and the 7 surveys around these stations. Appendix B summarizes these results at three selected SeaWiFS wavelengths. The coefficient of variation for triplicate particulate absorption samples during the surveys was about twice as large as that observed for fluorometrically determined chlorophyll a. It can be speculated that some type of optical damage to the particulates must have occurred as the water was pumped through the scientific seachest. For the vertical samples, the coefficient of variation was very similar to the chlorophyll values.

Dissolved organic material (DOM) absorption was measured only during the overpass stations and these data have been tabulated in Appendix C. Because of the very low concentrations in these waters, the standard measurement technique for DOM, which uses a 10 centimeter quartz cell, is not sensitive enough to obtain high quality data. The uncertainty in this measurement is shown in Appendix C for one triplicate sample taken at Station 4. The use of DOM absorption data for SeaWiFS validation or in-water modeling efforts is not recommended.

Radiometric data using the Satlantic profiling system were collected. Hand Held Contrast Reduction Meter (HHCRM) measurements, to derive the spectral transmittances, specifically bracketed each overpass. Water vapor column, ozone column and aerosol optical depth during each overpass were measured using MICROTOPS. Sun Photometer calibrations were performed on February 6 through a Langley calibration procedure.

The whole MOCE- 4 cruise ran smoothly from the technical standpoint as no equipment failures or problems occurred with the power, tow fish, MOS, SIS or Satlantic systems. The MOBY Argos unit required replacement because the battery failed prematurely.

A Macintosh/cell phone based shipboard internet access system was provided for use during the MOCE- 4 cruise. Internet availability allowed access to near-real-time GOES images, daily SeaWiFS imagery, weather information and E-mail. Though the system had severe limitations compared to the land-line standards, it seemed to be useful.

The Skycam video system was placed back in operation. Video was acquired coincident with the in-water measurements during the cruise.

Diver calibrations were performed on February 8 via Hawaiian Rafting Adventures dive boat and professional divers.

MOBY CALIBRATIONS

During this reporting period, the MOCE team and professional divers conducted two MOBY calibration excursions via Hawaiian Rafting Adventures chartered dive boat to perform the diver calibrations and change the anti-foulant devices. During the first trip (MOBY-L26, January 12 to January 15), dirty and clean data sets were collected. Simple Green soap was used to clean the collectors, reasoning that a soap usable in salt water would clean the collectors better. The data seem to indicate that Simple Green soap works better than the dish soap we used in the past. The flopper stoppers were missing upon arrival. The flopper stopper system was replaced below the bridle. The flopper stoppers were lost due to a twisted shackle which caused the line to jump out of the thimble and wear through. Future lines will use thimbles that are large enough so they will not bind on the shackle pin and become fouled.

During the second trip (MOBY-L27, March 8 to March 10), dirty and clean calibrations were performed. Used Detergent, which is intended specifically for salt water use. The data are not yet analyzed to determine if this soap works better.

MOBY-L28

MOBY-L28 (M208OBP) took place March 29 - April 2, 1998. The following personnel participated:

NOAA - Dennis Clark, Ed Fisher, Ed King, Larisa Koval, Eric Stengel, Marilyn Yuen

MLML - Mike Feinholz, Mark Yarbrough, Yong Sung Kim, Stephanie Flora, Darryl Peters and John Heine

University of Hawaii - Mike Ondrusek

Precruise preparations included radiometric calibration of the MOBY, including two complete calibrations of all radiance and irradiance sensors (three for Lu-Bot and Ed-Bot), wavelength calibration check on Ed-Bot, and integration time calibration on Lu-Bot. Calibrations were processed prior to the cruise so appropriate MOBY integration times could be programmed before deployment. Fast turn-around of this system response was critical since both MOBY 204 and 205 were to be operated simultaneously during MOBY-L28 with no allowance for a "test" profile by the new buoy.

Many of the twelve-conductor cables on the top of the buoy required replacement at the last minute due to cracking of the cable jackets. All the other buoys will be inspected for similar damage and in the future all exposed cables will require additional protection. All the cables on this buoy were wrapped with tape to help protect them from exposure.

MOS2-5 developed a problem with the blue detector system during calibration. The problem was traced to a failing shutter mechanism. The blue system's shutter was replaced. MOS2-5 was disassembled to check the red system shutter. The red system shutter was found to be in good condition. MOS2-5 was reassembled, tested and resubmitted for the pre-calibration. The shutter failed because a rubber stop in the shutter mechanism had slid from its mounting post on one side of the older shutter, blocking half of the shutter from opening. The rubber stops on the older shutter are becoming stiff with age and the mechanisms are starting to show some wear. The shutters in all MOSes will be inspected during their next service.

The MD5 radiometer was pre-calibrated for spectral radiance, spectral irradiance, and wavelength. The (HHCRM) was calibrated using the OL420M standard source.

During the cruise (March 29 - April 2), two stations were occupied near Lanai yielding 3 CTD and 2 MOS profiles. Forty-eight HPLC samples were collected. These samples were shipped to CHORS and transferred to LN_2 refrigerators. There has been some delay in processing these HPLC samples since there is a steep learning curve on the use of the new UV6000LP detector and its associated software. Thirteen pigment standards were purchased from Carbon 14 Centren, Copenhagen, Denmark, in preparation for calibrating the new UV6000LP detector: alloxanthin, chlorophyll c1, chlorophyll c2, diadinoxanthin, fucoxanthin, lutein, prasinoxanthin, 19-hex-fucoxanthin, neoxanthin, peridinin, violaxanthin, zeaxanthin and 19-but-fucoxanthin. In addition, divinyl chlorophyll *a* and *b* standards were shipped to CHORS by Dr. R. Bidigare of the University of Hawaii.

Atmospheric transmittance, ozone column and water vapor column were measured at overpass time.

The recovery of MOBY 204 and deployment of MOBY205 during MOBY-L28 was not accomplished due to winds reaching 40 knots and seas to 18 feet during the entire cruise. The deployment was postponed until later in April. MOBY-L28 MOS data (29 files, 1.3 Mbytes) and SIS data (349 files, 3.8 Mbytes) coincident with two SeaWiFS overpasses are presently being processed.

The MD5 underwater measurements were conducted to continue our study of instrument self-shading effects. The data are presently being processed and analyzed.

After the cruise, several days were spent on site maintenance. This included washing, derusting, and painting the stacked huts. The upper portion of one of the stacked hut units was disassembled and a new platform is being made out of aluminium in order to prevent rusting.

INSTRUMENT DEVELOPMENT

Development of a new underwater instrument to measure upwelling radiance and downwelling irradiance with minimal self-shading effect is continuing. Several new configurations are being investigated. A PC/104 format CPU (a 3.6 x 3.8 inch single card computer format), VGA card, IDL hard disk, and CD-ROM drive were procured and assembled. This computer system will serve as a development system for the software. Once the software is written, the CPU will be used in the new instrument in an embedded configuration. Three possibilities are considered regarding the spectrometers. One company, CVI, produces a miniature fiber optic spectrometer with a CCD detector which uses 12 bit A/D conversion. They are looking at customizing it using 16 bit detectors and ND conversions for us. Another possibility is Ocean Optics Inc. which has a single card spectrometer, with the spectrometer, detector and controlling electronics integrated on a single card. The drawback is we have to provide our own A/D conversion. They are working on a version that has serial interface, which will be available in June. The last option is to use the American Holographic dual channel fiber optic spectrometer.

In March, CHORS personnel received a newly purchased Then-no Quest's UV6000LP Photodiode Detector. This is a unique High Performance Liquid Chromatography (HPLC) absorption detector that utilizes a revolutionary patented "Light Pipe" flowcell, enabling it to have five times greater sensitivity than other Photodiode Array Detectors. The flowcell is 50 mm in length and has a flowcell volume of only 10 ml, as compared to other conventional cells with 40 ml or more per flowcell. The UV6000LP scans from 190 to 800 nm (1.2 nm resolution) at 20 Hz with 20 bit A/D conversion. The analog circuitry is protected by an encapsulated module, thus ensuring thermal stability with much improved signal to noise ratio. In addition, the UV6000LP is compatible with existing Thermo Quest HPLC instrumentation, which includes a pump, vacuum degasser, autosampler, fluorescence detector, and automated software.

DOCUMENTATION

A prototype web page was developed, which will provide immediate availability and easy access to general cruise information for MOCE team members and other pertinent individuals. This web page will provide up-to-date access to cruise schedules, cruise logs, cruise maps, cruise station summaries. This web page way be linked to our team's NOAA web site.

MOCE Team Activities

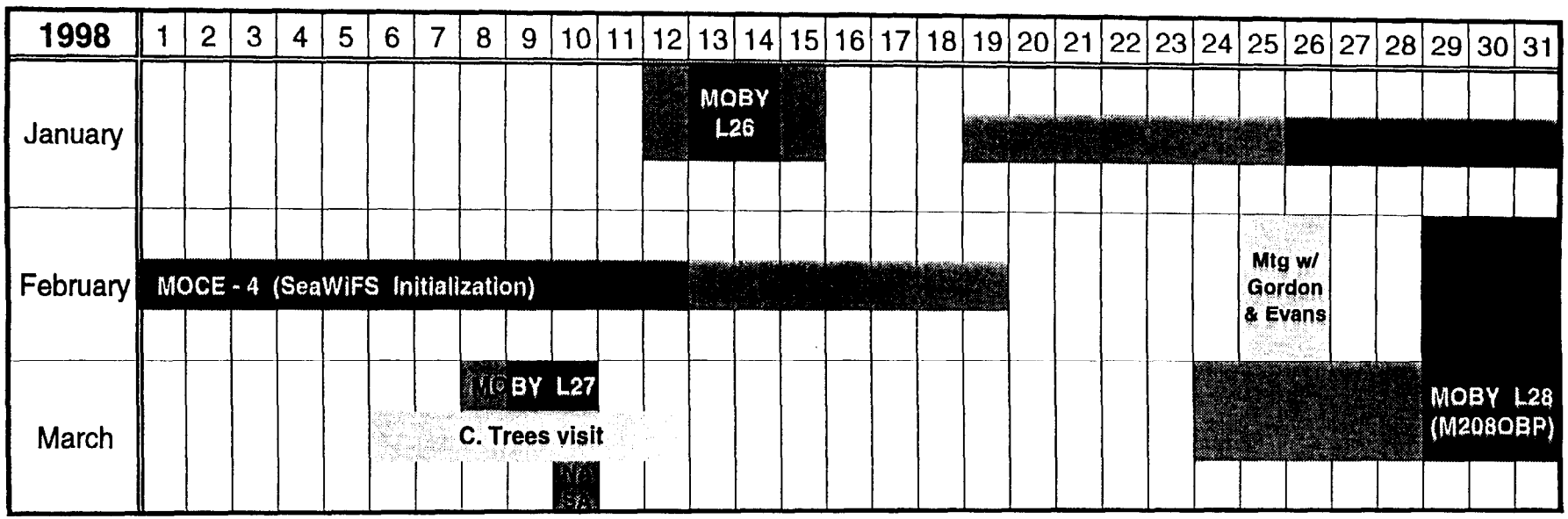

FIGURE 1.

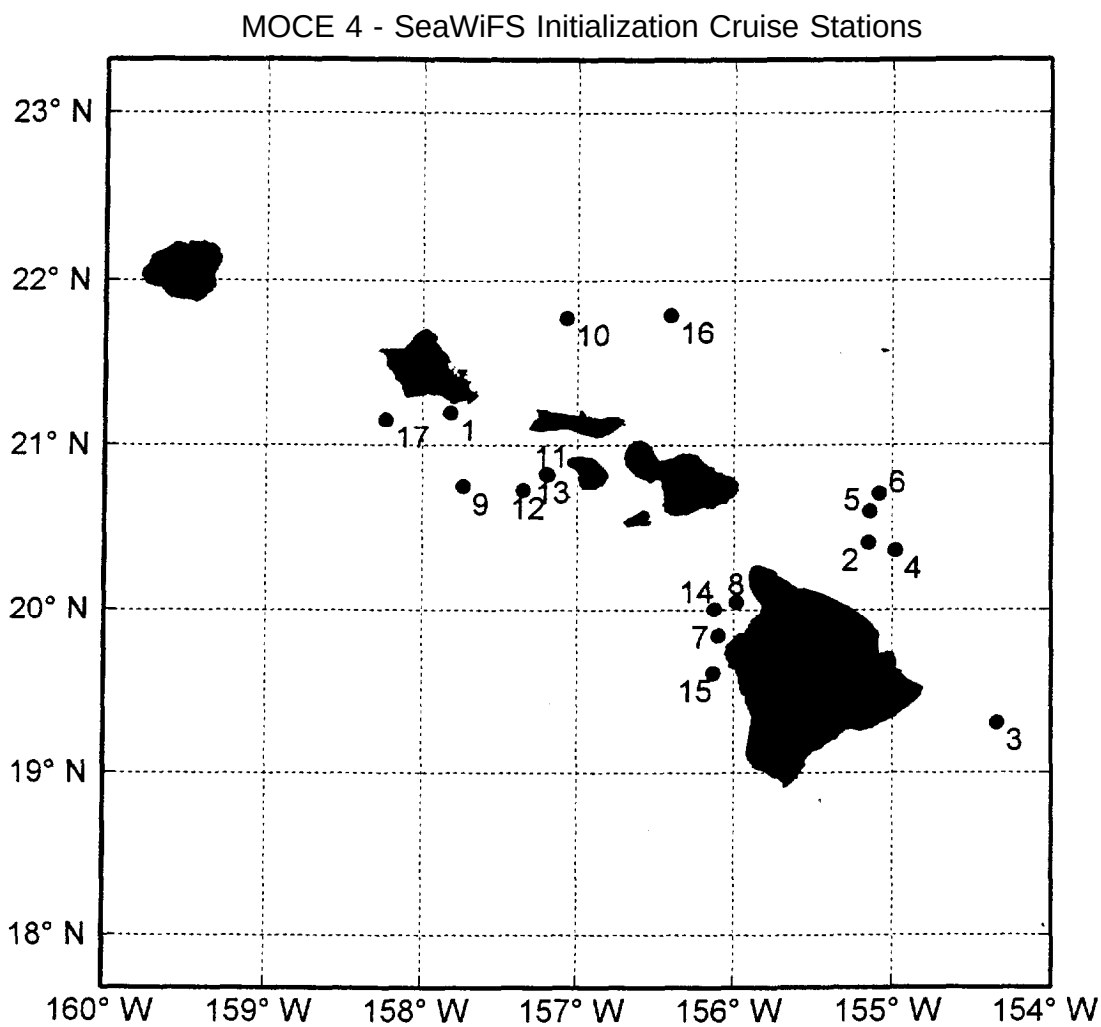
MOCE 4 - SeaWiFS Initialization Cruise Stations
23° N
22° N
21° N
20° N
19° N
18° N
160° W
159° W
158° W
157° W
156° W
155° W
154° W
10
16
17
1
11
9
12
13
5
6
2
4
14
8
7
15
3

FIGURE 2.

MOCE - 4 : Station Summary

Date	Julian	Station	Station	Start Time	Start Position		End Time	End Position		Overpass Time & Distance					
(local)	Day	#	Name	(local)	(deg N)	(deg W)	(local)	(deg N)	(deg W)	(local)	(nm)	(orbit #)	(local)	(nm)	(orbit #)
26-Jan-98	26	1	Diamond Head	12:09	21.201	157.819	16:05	21.235	157.848	12:03	594	2646.61	13:40	757	2647.60
27-Jan-98	27	2	Mauna Kea 1	9:59	20.404	155.145	15:19	20.500	155.116	12:47	25	2661.61			
28-Jan-98	28	3	Cape Kumukahi	8:24	19.303	154.343	14:22	19.323	154.358	11:54	721	2675.63	13:31	634	2676.61
29-Jan-98	29	4	Mauna Kea 2	9:06	20.355	154.980	14:53	20.386	154.998	12:38	101	2690.63			
30-Jan-98	30	5	Mauna Kea 3	9:22	20.601	155.142	15:16	20.604	155.207	11:45	849	2704.65	13:22	510	2705.63
31-Jan-98	31	6	Mauna Kea 4	9:56	20.706	155.081	14:59	20.709	155.119	12:29	227	2719.65			
1-Feb-98	32	7	Keahole Point	12:02	19.830	156.090	16:07	19.848	156.101	13:13	386	2734.65			
2-Feb-98	33	8	Kawaihae Bay 1	9:26	20.039	155.987	13:36	20.108	156.025	12:20	354	2748.67			
3-Feb-98	34	9	FAD - P	10:58	20.755	157.744	13:54	20.726	157.721	13:04	261	2763.67			
5-Feb-98	36	10	N of Molokai	10:58	21.773	157.069	14:12	21.809	157.116	12:55	136	2792.69			
6-Feb-98	37	11	MOBY Site 1	10:01	20.822	157.198	14:23	20.845	157.203	12:02	608	2806.70	13:39	743	2807.69
7-Feb-98	38	12	Nadir	11:42	20.722	157.345	14:47	20.731	157.350	12:46	11	2821.71			
8-Feb-98	39	13	MOBY Site 2	8:58	20.825	157.192	14:49	20.856	157.220	11:53	735	2835.72	13:30	620	2836.71
9-Feb-98	40	14	Kawaihae Bay 2	10:30	20.002	156.128	13:40	20.086	156.183	12:37	115	2850.73			
10-Feb-98	41	15	Kona	9:08	19.616	156.134	16:39	19.561	156.101	11:44	863	2864.74	13:21	497	2865.73
11-Feb-98	42	16	N of Maui	10:30	21.790	156.413	13:45	21.766	156.407	12:28	241	2879.74			
12-Feb-98	43	17	Barbers Pt.	11:03	21.155	158.234	14:44	21.194	158.265	13:12	372	2894.75			

GMT= Local+ 10

FIGURE 3.

Table 1. Summary of the type and number of samples collected during MOCE Cruise.

Analysis	Type	Number
HPLC Pigment	SeaWiFS Overpass	59
	Stations	80
	Grid/Transit	182
Fluorometric Pigment	SeaWiFS Overpass	59
	Stations	79
	Grid/Transit	171
Particulate Absorption	SeaWiFS Overpass	61
	Stations	79
	Grid/Transit	156
Dissolved Organic Absorption	SeaWiFS Overpass	24
	Stations	79
	Grid/Transit	5

Appendix A. Fluorometrically determined chlorophyll concentrations (mg m^{-3}).

	Min	Max	Mean
Grid/Transit Data			
Chl Surface (0-3m)	0.041	0.314	0.107
CTD Data			
Chl Surface (0m)	0.068	0.170	0.120
Chl DCM	0.330	0.528	0.398
Depth DCM (m)	60	145	108

	Discrete				Fluor Converted			
Grid	Mean	Std Dev	C.V.	n	Mean	Std Dev	C.V.	n
1	0.097	0.007	7.6	20	0.097	0.007	7.4	298
2	0.095	0.005	5.5	23	0.095	0.006	6.2	341
3	0.097	0.010	9.9	21	0.097	0.010	10.7	378
4	0.120	0.015	11.9	22	0.121	0.016	12.8	401
5	0.112	0.011	10.3	22	0.110	0.011	9.8	396
6	0.108	0.013	12.5	21	0.106	0.012	11.5	384
7	0.090	0.007	7.9	21	0.098	0.007	7.4	345

	OP #1	OP #1	OP #1	OP #1	OP #2	OP #2	OP #2	OP #2
Station	Mean	Std Dev	C.V.	n	Mean	Std Dev	C.V.	n
1	0.110	--	--	1	--	--	--	--
2	0.095	--	--	1	--	--	--	--
3	0.089	--	--	1	0.095	--	--	1
4	0.090	0.010	10.6	3	--	--	--	--
5	0.094	0.009	10.0	3	0.102	0.004	3.6	3
6	0.113	0.006	5.4	3	--	--	--	--
7	0.096	0.003	2.8	3	--	--	--	--
8	0.150	0.004	3.0	3	--	--	--	--
9	0.078	0.008	10.0	3	--	--	--	--
10	0.154	0.006	4.2	3	--	--	--	--
11	0.143	0.006	4.3	3	0.139	0.014	10.2	3
12	0.118	0.001	1.2	3	--	--	--	--
13	0.106	0.008	7.3	3	0.104	0.007	6.4	3
14	0.107	0.002	2.2	3	--	--	--	--
15	0.094	0.008	8.8	3	0.086	0.004	4.4	3
16	0.090	0.007	8.2	3	--	--	--	--
17	0.071	0.009	12.0	3	--	--	--	--

Appendix B. Particulate Absorption coefficients (m^{-1}) for three SeaWiFS channels.

	SeaWIFS Overpass #1									
	Mean Particulate Abs				Stdev Particulate Abs			C.V. Particulate Abs		
Station	443	490	510	n	443	490	510	443	490	510
1	0.0121	0.0071	0.0043	1	--	--	--	--	--	--
2	0.0157	0.0096	0.0052	1	--	--	--	--	--	--
3	0.0136	0.0078	0.0046	1	--	--	--	--	--	--
4	0.0175	0.0101	0.0059	1	--	--	--	--	--	--
5	0.0177	0.0101	0.0058	3	0.0008	0.0004	0.0002	4.6	4.1	2.8
6	0.0175	0.0100	0.0058	3	0.0004	0.0004	0.0001	2.3	3.8	1.1
7	0.0164	0.0097	0.0054	3	0.0005	0.0001	0.0000	3.3	0.9	0.9
8	0.0208	0.0117	0.0068	3	0.0031	0.0014	0.0007	15.0	11.6	10.8
9	0.0157	0.0091	0.0053	3	0.0017	0.0009	0.0005	10.8	9.8	10.3
10	0.0196	0.0110	0.0062	3	0.0028	0.0013	0.0006	14.1	11.6	9.8
11	0.0218	0.0126	0.0073	3	0.0005	0.0004	0.0003	2.2	3.5	4.6
12	0.0209	0.0114	0.0067	3	0.0030	0.0017	0.0012	14.2	15.0	18.4
13	0.0185	0.0111	0.0063	3	0.0010	0.0005	0.0003	5.3	4.9	4.4
14	0.0202	0.0117	0.0067	3	0.0005	0.0004	0.0003	2.5	3.0	3.9
15	0.0154	0.0089	0.0052	3	0.0007	0.0003	0.0001	4.4	3.7	1.7
16	0.0163	0.0098	0.0057	3	0.0011	0.0006	0.0004	6.6	6.2	6.7
17	0.0150	0.0088	0.0051	3	0.0004	0.0002	0.0003	2.8	2.5	4.9

	SeaWIFS Overpass #2									
	Mean Particulate Abs				Stdev Particulate Abs			C.V. Particulate Abs		
Station	443	490	510	n	443	490	510	443	490	510
1	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--
5	0.0179	0.0107	0.0062	3.0000	0.0003	0.0002	0.0000	1.5	1.5	0.3
6	--	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--	--	--
9	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	--	--	--	--
11	0.0218	0.0124	0.0071	3.0000	0.0008	0.0005	0.0003	3.9	3.9	3.7
12	--	--	--		--	--	--	--	--	--
13	0.0176	0.0104	0.0059	3.0000	0.0005	0.0003	0.0002	2.6	2.9	2.9
14	--	--	--	--	--	--	--	--	--	--
15	0.0148	0.0086	0.0048	3.0000	0.0008	0.0005	0.0003	5.5	5.5	6.0
16	--	--	--	--	--	--	--	--	--	--
17	--	--	--	--	--	--	--	--	--	--

Grid	Mean Particulate Abs				Stdev Particulate Abs			C.V. Particulate Abs		
	443	490	510	n	443	490	510	443	490	510
1	0.0181	0.0106	0.0062	20	0.0044	0.0026	0.0015	24.6	24.9	24.8
2	0.0181	0.0108	0.0066	23	0.0016	0.0011	0.0008	8.8	10.1	11.9
3	0.0204	0.0121	0.0073	21	0.0025	0.0014	0.0010	12.2	11.8	13.6
4	0.0194	0.0117	0.0070	22	0.0040	0.0025	0.0017	20.5	21.5	24.0
5	0.0174	0.0101	0.0060	22	0.0017	0.0012	0.0008	9.5	11.5	12.6
6	0.0157	0.0091	0.0054	21	0.0038	0.0022	0.0013	24.2	24.6	24.7
7	0.0153	0.0090	0.0053	21	0.0021	0.0014	0.0010	13.5	15.6	19.9

Appendix C. Dissolved organic material absorption coefficients (m^{-1}).

Station	SeaWIFS Overpass #1 DOM Absorption				SeaWIFS Overpass #2 DOM Absorption			
	443	490	510	n	443	490	510	n
1		--	--	1	--	--	--	--
2	0.0093	0.0083	0.0075	1	--	--	--	--
3	0.0098	0.0088	0.0080	1	0.0105	0.0099	0.0093	1
4*	0.0233	0.0218	0.0205	3	--	--	--	--
5	0.0110	0.0116	0.0106	1	0.0273	0.0287	0.0262	1
6	0.0110	0.0119	0.0107	1	--	--	--	--
7	0.0113	0.0134	0.0119	1	--	--	--	--
8	0.0248	0.0255	0.0239	1	--	--	--	--
9	0.0536	0.0554	0.0498	1	--	--	--	--
10	0.0058	0.0069	0.0055	1	--	--	--	--
11	0.0104	0.0113	0.0099	1	0.0086	0.0091	0.0078	1
12	0.0074	0.0091	0.0077	1	--	--	--	--
13	0.0040	0.0036	0.0027	1	0.0048	0.0045	0.0040	1
14	0.0136	0.0151	0.0130	1	--	--	--	--
15	0.0056	0.0070	0.0059	1	0.0080	0.0099	0.0084	1
16	0.0126	0.0132	0.0118	1	--	--	--	--
17	0.0030	0.0042	0.0029	1	--	--	--	--

* Triplicates	Std (443)	Std (490)	Std (510)	CV (443)	CV (490)	CV (510)
	0.0098	0.0107	0.0105	42.3	48.9	51.1