MODIS Team Member - Semi-annual Report
Marine Optical Characterizations
June 1998

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NOAA/NESDIS

SUMMARY

The Marine Optical Characterization Experiment (MOCE) team conducted the SeaWiFS Initialization Experiment (MOCE-4) near the Hawaiian islands, six MOBY calibration excursions at the Lanai mooring site (MOBY-L26, L27, L30, L31, L32, L33), and two MOBY recovery and replacement cruises (MOBY-L28 and MOBY-L29). Radiometric, biological and atmospheric data collected concurrently with SeaWiFS overpasses during the MOCE-4 cruise were preprocessed, analyzed and submitted to NASA on March 10, 1998. Team activities during the reporting period 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 irradiance spectrometer (SIS 101) was calibrated for. A system calibration was performed on the fiber optic spectrometer system for both of the radiance and irradiance. 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 on March 10, 1998.

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. 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. 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 airfreighted to San Diego for analysis at CHORS.

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 4 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 MOBY204 calibration excursions via Hawaiian Rafting Adventures (HRA) chartered dive boat to perform the diver calibrations and change the anti-foulant devices. During the first trip (MOBY-L26, January 12- 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 used in the past. The rocker stoppers were missing upon arrival. The rocker stopper system was replaced below the bridle. The rocker 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 8-10), dirty and clean calibrations were performed. The new brand, Used Detergent, which is intended specifically for salt water use, was used to clean the collectors this time. The data are not yet analyzed to determine if this soap works better.

Maintenance of MOBY205 required four trips to the Lanai mooring site via HRA dive boats. On May 4, during MOBY-L30, the buoy was inspected but it was inpossible to perform diver calibrations due to poor weather conditions. HRA personnel returned on May 15 (MOBY-L31), cleaned all optical collectors, and inspected the buoy. They noted that the rocker stoppers attached to the bottom of MOBY were missing. A full set of dirty and clean MOBY diver calibrations were performed during MOBY-L32 on June 2-3. A new set of rocker stoppers were installed. The first set had a break in the dacron line just about a foot below the shackle to the wire above. The Seimac Argos was replaced due to a failing battery. The Es calibration lamp was successfully used for the first time during this calibration. Inspection of the tether strain relief revealed a separation of most of the urethane boot from the metal attachment. Another trip (MOBY-L33) on June 21 was required to install a repair clamp to the broken tether strain relief. The application of the repair clamp required heroic effort by the divers as the weather was rough for performing this type of work close to the bouncing buoy. As it turns out, part of the problem was because the rocker stoppers were again lost. As before, the line had parted but this time about 6 feet below the shackle.

During this same day trip the sun shades were installed to the Cimel system. The unit developed GOES DCP/Cimel communication problem resulting in “blank” Cimel data transmissions from the site. The problem was traced to excessive temperature inside the new style housings causing spontaneous changes in the Vitel DCP communications setup parameters. The sun shades were added to the top of both battery and controller housings to see if the reduced heating would prevent reoccurrence of the communication problem. The units need better housings as a permanent fix for this heat problem. The plywood shades will only survive a short time. An additional unit will be setup and tested at the Honolulu MOBY site as soon as possible since it may be needed for installation on Lanai if the original unit cannot be fixed.

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 precalibrated 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 cl, 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 aluminum in order to prevent rusting.

MOBY-L29

Moby-L29 (M209SB) took place April 16-30, 1998. The following personnel participated:

NOAA - Dennis Clark, Phil Hovey

MLML - Mike Feinholz, John Heine, Darryl Peters, Mark Yarbrough

Hawaiian Rafting Adventures - Steve Juarez, Rob Wheelhouse

University of Hawaii - Mike Ondrusek

Before the cruise, the underwater profiling Marine Optical System, MOS202, and the Surface Irradiance Spectrometer, SIS 101, were calibrated for radiance response via the Optronic Laboratories OL420 sphere, and for irradiance response via the Gamma Scientific GS5000 system.

MOBY 205 was successfully deployed on April 21 with MOBY204 still in the water in order to obtain coincident measurements with both systems the next day (Fig .5). Simultaneous MOBY and SPMR measurements were made during both buoy data cycles on April 22 at the Lanai mooring site at approximately 21:30 and 22:30 (GMT). After the side-by-side optical profiles were made, MOBY204 was towed to the lee of Lanai where it was successfully recovered on April 23 (Fig. 6). No diver calibrations were possible on either system because of ship time limitations.

During the cruise, a new Cimel site (Instrument #93) was installed on the south side of Lanai (20.735 N, 156.922 W) (Fig. 7). The new location is easier to access than the old site on the west side of Lanai which should facilitate better service of the instrument.

Post deployment calibrations of MOBY204 were performed in April and May via OL420 and OL 425 spheres, and the GS5000. The MOS204 instrument was removed from MOBY204 and calibrated in June for radiance response using OL420 and OL425 spheres, and for wavelength response using Oriel HgA, Kr, Ne, and Xe line-source lamps. All MOS calibrations also included scans of internal calibration sources, one incandescent lamp and two LED's.

DATA PROCESSING

The conversion of MLDBASE MOBY processing programs from Matlab 4.2 to Matlab 5.2 is nearly completed. The processing will shift from Matlab 4.2 to Matlab 5.4 in July. Most of the time was spent rewriting PLOTDAT_.M, MLDBASE graphics program. The program now takes advantage of Matlab 5.2's better graphics. The most significant changes are in the way the x/y axis labels and captions are placed. Log scaling is now done manually, with better results than Matlab's routine.

A Windows NT computer was purchased to process and store all MOBY data, homepages and images. The Windows NT machine will take over data storage from the VAX once it is retired.

Data processing from MOBY continues as a routine operation. Some operation bugs are uncovered from time to time. The data are published on the MOBY homepage so that NASA investigators are able to access the data in near real time. The previous day's data are put on the homepage by noon each day except for weekends and holidays.

The CTD data for MOBY-L14. MOBY-L15 and MOBY-L16 are being reprocessed using the latest version of CTD processing programs (Seasoft 4.225). Matlab CTD processing programs are being updated for the cruises MOBY-L14, MOBY-L15 and MOBY-L16. Updates include both the data and the header information specific to each CTD cast. Processed Seabird files are read in, variables are reordered, new variables are derived, bottle data are incorporated and text files are created.

The MOCE-4 data (humidity, barometric pressure, position. temperature, wind speed, VLST pigment concentration, compass, flow meter) have been processed and averaged into hourly files by day. The Chlorophyll a data have been processed using fluorometric derived pigments. Some of the MOCE-4 pigment data with SeaWiFS data have been matched up using the SeaDAS system. So far, the data match up very well. We are still in the process of matching SeaWiFS and MOCE-4 track line data.

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 A/D 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. Andor Technologies demonstrated their InstaSpec IV CCD camera system. A simple test shows that it is very promising. The CCD chip can be cooled down to -40 C just using the power supplied by the computer ISA bus and the built in fan. With a separate power supply and liquid circulation, it can be cooled to -80 C. Read out noise seems to be low, stability is high. The only drawback is that it is a 16 bit system.

In March, CHORS personnel received a newly purchased Thermo 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 a 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. During the installation and calibration of the UV6000, several problems were encountered. Because of the problems with the UV6000 software, the SpectraFOCUS detector is being used to analyze the MOCE-4 pigment samples. All 359 HPLC samples collected during the MOCE-4 cruise and several other mooring cleaning deployments were finished. These chromatograms will be processed and QC/QA in early July. Fluorometric chlorophyll a analysis was also performed on all samples.

SITE MAINTENANCE

Our facilities at Snug Harbor were home to several maintenance operations during the reporting period. The remainder of our equipment from Vertin Avenue in Salinas, CA was moved to Snug Harbor during two weeks in May. Shutting down the Vertin shop required disposing of surplus items, arranging for the disposal of hazardous materials, dismantling and packing of the modular offices, and crating the mill, lathe and other miscellaneous project equipment. A majority of the items shipped from Vertin shop to Hawaii will be housed in two recently acquired storage containers which have been modified for use as portable laboratories. One container will house the light machine equipment, the other will be an electronics laboratory with much needed bench space for working on instruments. A portion of the modular office components shipped from Vex-tin will be installed into the Hawaii site tent for use as a clean operating environment for the MOBY optical calibration systems. Additional space offered to us by the marine superintendent required the removal of a vast amount of unused equipment and assorted shipping containers. We have begun the task of clearing the yard space adjacent to the MOBY tent.

The process of rebuilding the power distribution van has starred. The converted container housing the power system electronics had become structurally unsound due to corrosion. The electronic equipment, air conditioner and wiring required removal from the existing container and reinstallation into one of the new aluminum portable vans. Due to the smaller size of the new aluminum van, some modifications to the UPS system wiring were required to accommodate the tighter fit, The installation of the air conditioner, most of the interior switching equipment, UPS racks, transformer and exterior connector mounts were completed at the end of April. The power van still requires the modification of the UPS units, UPS installation, some conduit installation and all wiring.

DOCUMENTATION

A MOCE web page was developed, providing immediate availability and easy access to general cruise information for MOCE team members and other pertinent individuals. This web page provides up-to-date access to cruise schedules, cruise logs, cruise maps, and cruise station summaries. The page, still under development, is fully functional and is linked to the official Marine Optics Team NOAA homepage. The URL for the MOCE page is http://orbit20i.nesdis.noaa.gov/~marilyn/

MEETINGS

Charles Trees attended the 2nd International Meeting on Planktology April, 1998, in Merida, Mexico. He presented data from various MOCE cruises.

Dennis Clark attended the MODIS Ocean Team meeting, June 8-9, 1998 at Goddard Space Flight Center.

Dennis Clark attended the MODIS Science Team Meeting, June 24-26, 1998 at Goddard Space Flight Center.

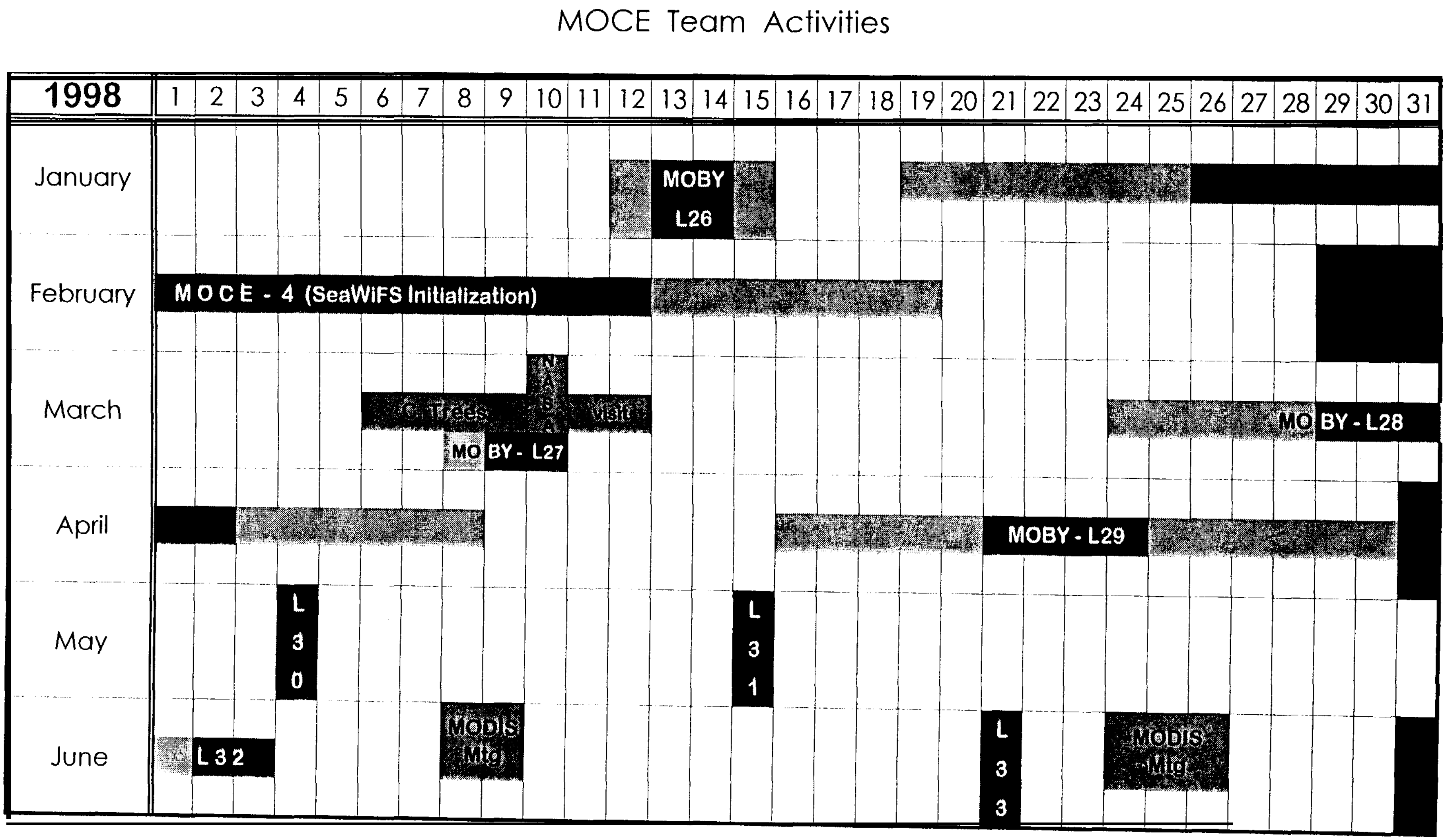
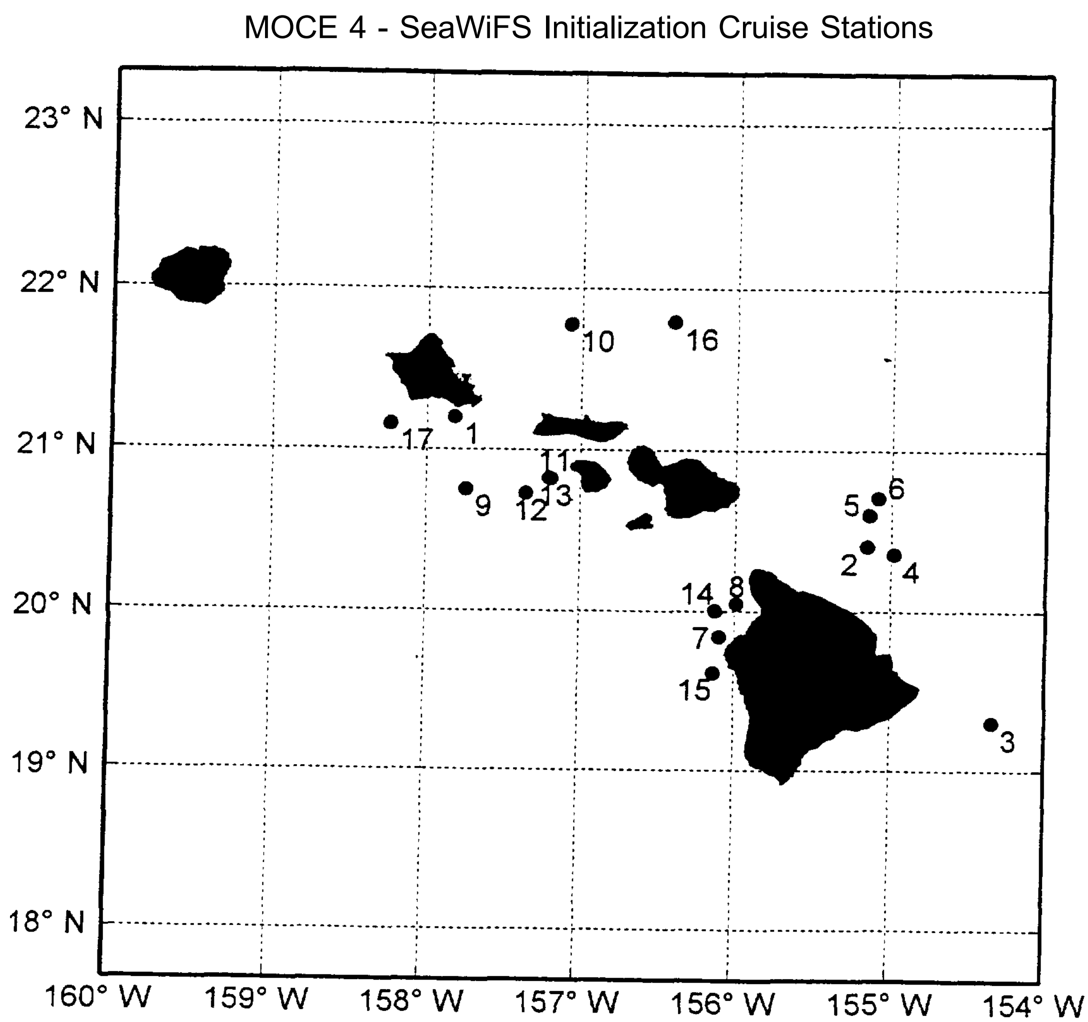

MOCE Team Activities
1998
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
January
February
March
April
May
June
MOBY L26
MOCE - 4 (SeaWiFS Initialization)
Trees
NASA
Visit
MOBY - L27
MOBY - L28
MOBY - L29
L 30
L 31
L 32
MODIS Mtg
L 33
MODIS Mtg

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
1
2
3
4
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16
17

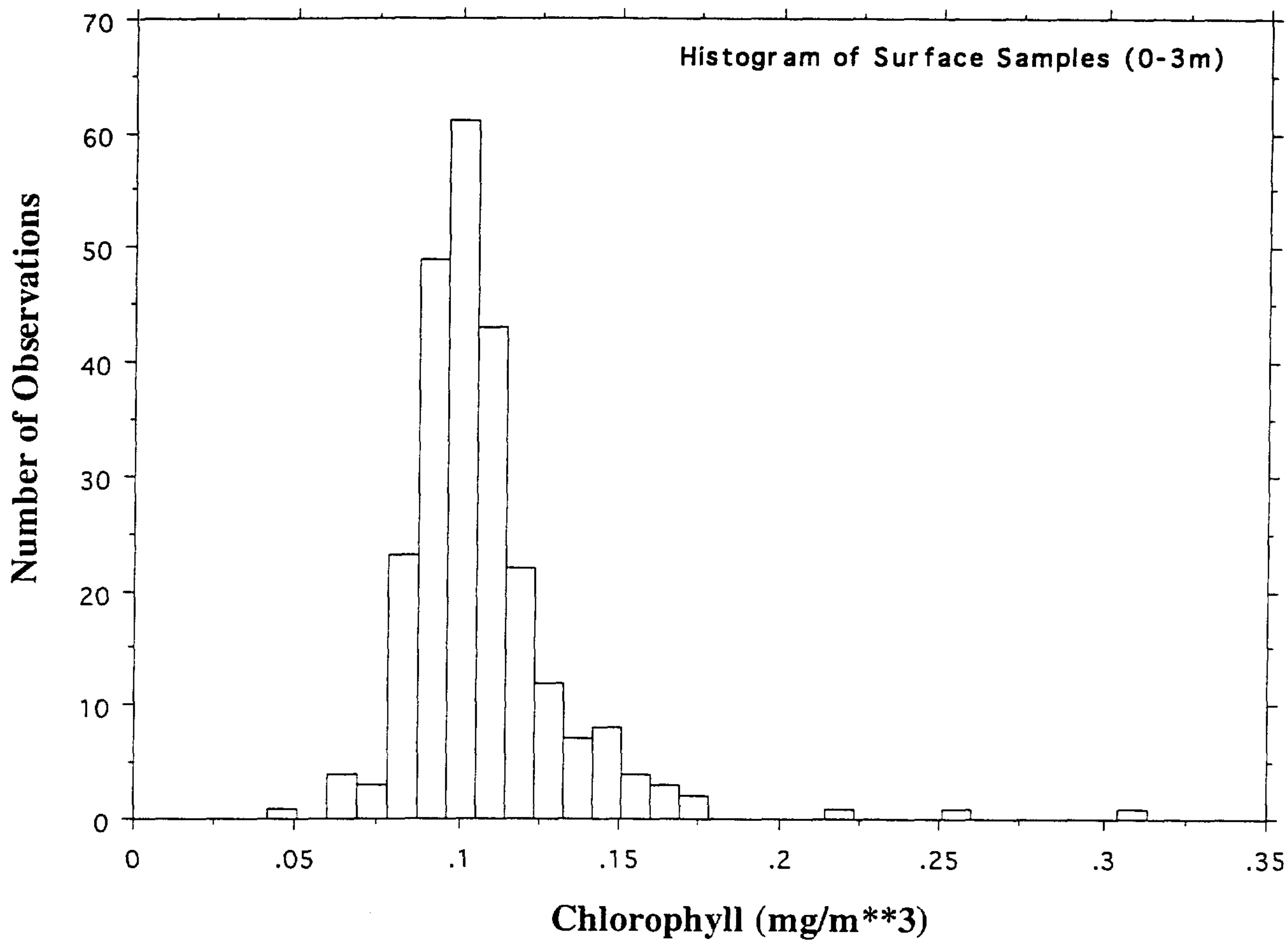
FIGURE 2.

MOCE - 4 : Station Summary

Date (local)	Julian Day	Station #	Station Name	Start Time (local)	Start Position (deg N)	Start Position (deg W)	End Time (local)	End Position (deg N)	End Position (deg W)	Overpass Time & Distance (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+1Ø

FIGURE 3.



Histogram of fluorometrically determined chlorophyll concentrations from samples collected near the surface (0 to 3 meters) during the MOCE 4 SeaWiFS Validation Cruise.

FIGURE 4.

FIGURE 5.

FIGURE 6.

FIGURE 7.

Table 1. Summary of the type and number of samples collected during MOCE 4 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.

Station	SeaWIFS Overpass #1									
	Mean Particulate Abs				Stdev Particulate Abs			C.V. Particulate Abs		
	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

Station	SeaWIFS Overpass #2									
	Mean Particulate Abs				Stdev Particulate Abs			C.V. Particulate Abs		
	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 443	490	510	n	Stdev Particulate Abs 443	490	510	C.V. Particulate Abs 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 443	490	510	n	SeaWIFS Overpass #2 DOM Absorption 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