MODIS Team Member - Quarterly Report
Marine Optical Characterizations
September 1998

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NOAA/NESDIS

SUMMARY

The Marine Optical Characterization Experiment (MOCE) Team completed it's first year of providing the SeaWiFS Project continuous observations for there initialization and calibration tasks. Additionally, the team conducted one MOBY recovery and replacement cruise (MOBY L-35), and three MOBY calibration excursions at the Lanai mooring site (MOBY-L34, L36, L37). Several unexpected MOBY field repair operations were successfully accomplished. Radiometric, biological and atmospheric data were collected during the MOBY-L35 cruise. The team's goal this quarter has been to complete the MOBY preparation and cruise schedule requirements as soon as possible, allowing us more time to devote to the ever more pressing MOS red/blue overlap problem and other system development issues such as the mooring weather station. Team activities during the reporting period are shown in Figure 1.

FIELD OPERATIONS

MOBY-L35

The MOBY-L35 recovery and replacement cruise took place July 22 - July 27, 1998. The following personnel participated:

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

MLML - William Broenkow, Mark Yarbrough, Mike Feinholz, Stephanie Flora, Darryl Peters, John Heine

CHORS - Chuck Trees

University of Miami - Bob Evans

University of Hawaii - Mike Ondrusek

The sixth Marine Optical Buoy, MOBY206, was deployed on 24 July 1998 during the MOBY-L35 oceanographic cruise aboard the R/V Moana Wave. On 24 July, MOBY206 and MOBY205 made two sets of concurrent optical measurements at the Lanai mooring site at approximately 21:30 and 22:30 (GMT). Diver calibrations of the new MOBY were performed on 25 July.

During the five days of ship time, five oceanographic stations were occupied (Figure 2). Five Marine Optical System (MOS202) profiles were conducted: one concurrent with a SeaWiFS overpass, and two with MOBY profiles. Four CTD profiles (SBE0091 to SBE0094) were executed during the cruise and Secchi disc measurements were made near local noon each day. Fifty pigment samples were collected for processing on shipboard using the fluorometric technique. Out of the 50 samples, 19 were collected from four CTD casts with the rest (31) from near surface depths, during SeaWiFS overpasses and during station transit. These fluorometrically determined pigment data were transferred to the NOAA sponsor immediately after the cruise. In addition to the fluorometric pigment samples, duplicate samples were also collected for HPLC analysis back at the CHORS laboratory. A total of 53 HPLC samples were collected during the cruise. These samples will be processed in November after the next mooring replacement cruise. We delayed the processing of these samples because of problems with solvent/column contamination and the fact that the new fluorometer (FL3000) and UV6000LP detectors will be installed in early October. Waiting to process the samples on the new system will improve detection limits and decrease the uncertainty in the pigment data for these cruises.

Optical profiles were conducted using MD5 VIS and NIR systems for comparison with MOBY, MOS/SIS, and SPMR data sets.

Hand Held Contrast Reduction Meter (HHCRM) measurements, to derive the spectral transmittances, specifically bracketed each SeaWiFS overpass. Water vapor column, ozone column and aerosol optical depth during each overpass were measured using MICROTOPS II. Additional atmospheric transmittance measurements were made at the CIMEL site for comparison with CIMEL data.

Our surface -incident and profiling radiometers (SIS 101cfg04 and nMOS202cfg05) were calibrated for h-radiance and radiance response before and after the MOBY-L35 experiment. MOS204cfg02 was radiance-calibrated in July before its integration with MOBY206. Two complete sets of radiance and h-radiance calibrations were performed on MOBY206, with diver lamp scans and an integration time calibration before the new buoy’s deployment. Two sets of post-deployment radiometric calibrations of MOBY205 were carried out in August, and MOScfg03 was calibrated for radiance and wavelength and integration time in September after its removal from MOBY205.

The MD5 radiometer was calibrated before and after the cruise for spectral radiance, spectral irradiance, and wavelength. The HHCRM was calibrated using the OL420M standard source.

MOBY205 was successfully recovered on 25 July. MOBY was missing the top arm. The buoy received preliminary cleaning, was post-calibrated, dismantled, and placed in storage.

MOBY CALIBRATIONS

During this reporting period, the MOCE team and professional divers conducted three MOBY205 and MOBY 206 calibration excursions via Hawaiian Rafting Adventures (HRA) chartered dive boat to perform the diver calibrations. During the first trip (MOBY-L34, July 2-3), no final dive calibration was possible due to time constraints during the recovery cruise. The flopper stoppers (wire/dacron system) were replaced with wire/wire, 24 flopper system.

During the second trip (MOBY-L36, August 24-29), the wire/wire, 24 flopper system was replaced with wire/nylon 24 flopper system. Diver calibrations and optics cleaning were performed, and water samples for HPLC analysis were collected and filtered, GPS antenna and Argos transmitter were replaced. The GPS/MML Argos unit have been returned to Seimac Ltd. for reprogramming. The new operating mode will result in a longer life from the existing battery packs. The new programming will allow for the larger watch circle of our mooring so the unit transmits less often. The new firmware also corrects a multi-path problem with the internal trimble GPS which can also result in excessive Argos transmissions. With these changes, the unit's batteries should last for the full rated 120 day duration, eliminating the need for periodic field replacement of the unit.

The third trip took place September 16-20 (MOBY-L37). The MOBY206 tether, which had a cracked strain-relief, was replaced. Mooring System Inc. and Preformed Marine are trying to fix the tether strain relief problem. Preformed Marine has offered to re-design the system at no additional engineering charge. The re-designed units will not likely be available for the MOBY207 deployment. We will continue to use the temporary system provided by MSI until the new strain-reliefs are delivered. The damaged flopper system was replaced again with a nylon/nylon 12 flopper system. Diver calibrations (dirty and clean Ed and Lu) and optic cleaning were performed.

CIMEL SERVICE

The CIMEL system was serviced on 2 July during the MOBY-L34 diver calibration trip. During this service, re-routing of the cables was attempted as recommended by NASA to solve the asymmetric almucantar problem. The unit required extensive external cleaning and the metal shell connectors were wrapped with electrical tape to help prevent further corrosion. Subsequent reports from NASA indicate that the AM almucantar measurement was still erroneous. The replacement unit is prepared for possible installation during the next MOBY cruise.

The CIMEL system was served again on 23 July during the MOBY-L35 cruise. The AM almucantar problem was traced to binding of the robot cable on the main housing preventing free rotation of the instrument. The problem was fixed by attaching small cable tie "bearing" to the cable were it contacts the housing. The instrument has functioned properly since the repair.

The CIMEL system was again cleaned on 25 August during the MOBY-L36 diver calibration

trip.

DATA PROCESSING

The conversion of MLDBASE MOBY processing programs from Matlab 4.2 to Matlab 5.2 is completed. All daily processing of MOBY data and HTML documents is done in Matlab 5.2. Matlab 5.2 has removed the ability to save figures as GIF images, so future Web site images will be JPEG images. The JPEG files are approximately 4 times larger than GIF images. This may require the removal of old deployments from the Web site to make room for new deployments. MLML personnel have begun reprocessing all MOBY deployments and writing 4 CD-ROMs for each deployment. MOBY201 and MOBY202 reprocessing is almost complete, while work continues on the rest of the deployments. The CD-ROMs will contain raw and processed MOBY data in MLDBASE and Matlab formats, all FORTH LOG files, compiled files of scientific and engineering data, MOBY deployment homepage, and any auxiliary data (such as satellite images and Lanai airport meteorological observations). A batch processing program was written to reprocess each deployment using a configuration file. The configuration file contains processing information for each MOB file in the deployment. The missing MOB files from deployment MOBY203, 04 and 05 have been received and are being checked for problems. MOBY203, 04 and 05 batch processing configuration files will be created and tested.

For the MOCE 4 HPLC pigment samples, it was decided that the analysis would be performed using the existing scanning detector (SpectraFOCUS 32-channel detector), because of the problems in getting the newly acquired UV6000LP Photodiode Detector working properly. This delayed the delivery of the MOCE 4 pigment data until July. Figure 3 shows a comparison between fluorometrically determined chlorophyll a measured on the ship (NOAA's fluorometer) with replicate samples processed back in the laboratory using the CHORS' fluorometer. From a previous MOBY cruise, it was found that the NOAA fluorometer was consistently higher than the CHORS fluorometer by about 6% when analyzing the same pigment extracts. The departure from a 1 to 1 relationship found in Figure 3 is caused by filtration volume differences between the fluorometric and HPLC samples. The volumes from the HPLC are around 4 liters and it is these samples which are processed at CHORS. For the fluorometric samples, processed on the ship with the NOAA fluorometer, only 1.12 liters are filtered. As filtration volumes increase, the particles retained on the filter fill in the voids between the glass fiber matrix, thus improving retention efficiencies. This increase in chlorophyll a concentration as filtration volumes increase has been observed on all MOBY and MOCE cruises.

Figure 4 shows the comparison between fluorometrically measured chlorophyll *a* on the CHORS' fluorometer and HPLC determined monvinyl plus divinyl chlorophyll *a*. The fluorometric estimate of chlorophyll *a* is 178% higher than that determined by HPLC. This is the largest uncertainty for the fluorometric method which we have observed in the waters around Hawaii. The variance in this plot is larger than previous comparisons, because during the HPLC analysis there were problems in separating the internal standard, canthaxanthin, from the photoprotectant carotenoid, zeaxanthin. Thus, the uncertainty for HPLC determined pigment concentrations will be somewhat higher than that found for other Hawaii cruises. The relationship between chlorophyll *a* and total accessory pigments is linear and very close to the

global average of 1.465 (Figure 5).

The MOBY, MOS, MD5 and SPMR data from the MOBY-L35 cruise were processed and compared. The four instruments show overall good agreement (Figure 6). The SPMR is off higher at 518 nm than other instruments. MOBY, MOS and MD5 agree really well from 400 nm up to 610 nm. MOBY, MOS and MD5 instruments were calibrated with the same standard. SPMR instrument was independently calibrated by its manufacturer. The agreement of the four instruments. demonstrates the good quality of the data sets.

INSTRUMENT DEVELOPMENT

CHORS personnel received a newly purchased Thermo Quest's FL3000 Scanning Fluorometer for the HPLC system, which replaces the older Linear 205 Fluorometer. The FL3000 has many improvements over the older Linear instrument, such as an enhanced red-sensitive PMT, improved signal-to-noise, smaller volume flow cell and improved optics. This detector will assist in improving the detection limits for the various chlorophyll degradation products (chlorophyllides, phaeophorbides and phaeophytins) that are found on phytoplankton samples. They also received new HPLC software, which runs on a different operating system than the previous one. The UV6000LP Photodiode Array Detector, which was purchased in February 1998, was sent back to the manufacturer for replacement of the HPLC system. The UV6000LP will replace the older SpectraFOCUS scanning absorption detector.

CHORS personnel purchased a Thermo Quest Crystal Capillary Electrophoresis (CE) system. This CE system will be used to separate and quantify phycobiliproteins, which are found in cyanobacteria and cryptophytes. Phycobiliproteins can contribute up to 50% of the total pigment content in tropical and subtropical areas. The CE system will use the SpectraFOCUS scanning absorption detector to identify and quantify the various phycobiliproteins (phycoerythrin, phycocyanin and allophycocyanin).

The work on the MOS spectrographs during this period included the final preparation of MOS4 for the MOBY206 deployment and preparation of MOS5 for the upcoming MOBY207 deployment. MOS5 received normal periodic vacuum pumping of the CCD heads, cooler circulation pump service and shutter replacement. Housing maintenance was limited to the repair of a few minor spots of corrosion. The unit required more extensive than usual disassembly to allow spectrograph modifications addressing the blue/red overlap problem. The red spectrograph was modified to reduce internal scattering. The gold reflective coating on a portion of the final mirror was stripped to allow absorption of the first order light within the glass of the mirror instead of reflecting it into the relatively inefficient light trap area. The pre-filter was changed from a 470 nm cut-on filter to a 580 nm cut-on filter to help reduce the effect of these changes on the MOS2 shipboard problem. We hope to make additional and more drastic changes to the MOS2 shipboard instrument. It is unclear if we will be able to make additional changes to the MOS5 instrument before the MOBY207 deployment.

We continue to work with Mooring Systems Inc. to finalize design details of the Mooring Meteorological Station as the buoy and tower construction begins. MSI promises delivery of the buoy hardware in the first week of December.

We continue to work on the new fiber optic underwater spectrometer system. Both the CCD cameras and spectrometer are ordered. A 4 track fiber input for the spectrometer has been designed and is being-evaluated. A double fiber feed through is being quoted by General Fiber Optics. A possible configuration of the shutter assembly was designed.

The Single Multipurpose Sensors (SCAMPS) were returned by the National Institute of Standards and Technology (NIST) after re-calibration. Mike Feinholz has been working with Howard Yoon (NIST) to finalize the SCAMPS calibration report and compile a comparison of our standard lamp calibrations versus SCAMPS measurements in order to track our long-term traceability to NIST. John Thomas Riley (NASA/GSFC) and our personnel worked at the Sand Island, HI operations site as part of the SeaWiFS Intercalibration Round Robin Experiment (SIRREX-6). Satlantic radiance heads were used to scan our Optronic OL420 and OL425 spheres for comparison with sources used by others in the bio-optics community. Three of our Spectral Irradiance Standards (FEL:F-453, F-454, GS-132) were re-calibrated by Charles Gibson (NIST) in July. These lamps, which were shipped in April and June, were returned in September, all in good condition. Our Optronic Laboratories OL420 Spectral Radiance Standard was returned to the manufacturer for re-lamp/re-calibration on 4 September having logged 61.7 hours of use since its last calibration on 11 June 1997.

SITE MAINTENANCE

The wiring of the “utility power” portion of the power van is completed. This allowed usage of the power van to distribute properly grounded power to the instrumentation vans as usual, except for the lack of conditioned power. Lack of conditioned power required the use of small UPS units to power individual systems during the MOBY-L35 cruise. The van still requires installation and wiring of the Fortress UPS units.

MEETINGS

Dennis Clark attended the SIMBIOS meeting, September 21-25, 1998 in La Jolla, California.

MOCE Team Activities

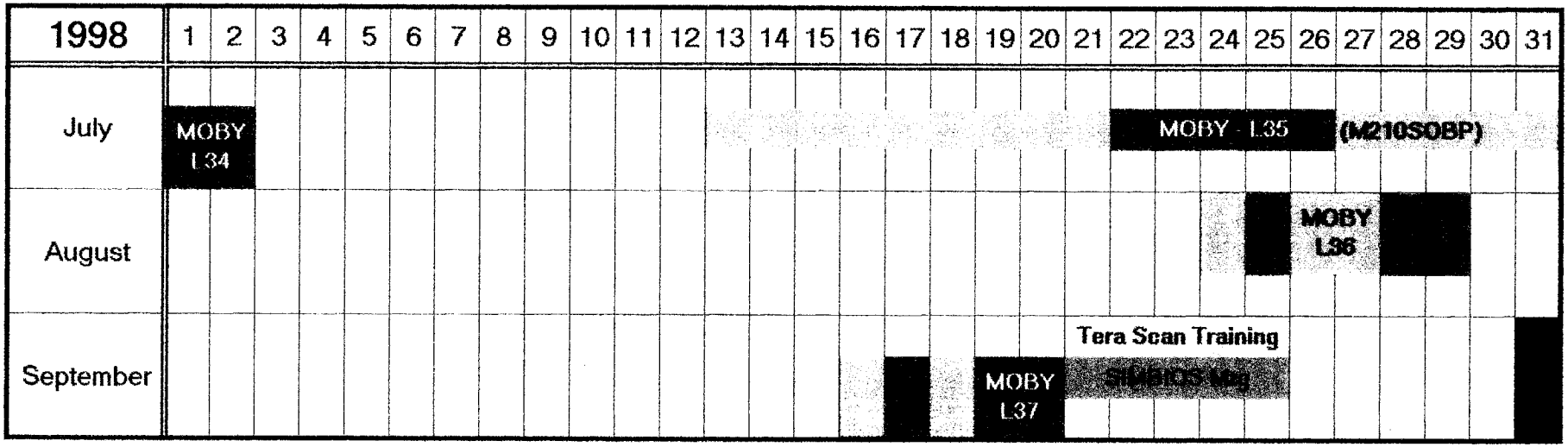


FIGURE 1.

M210SOBP
Station 1: MOBY I

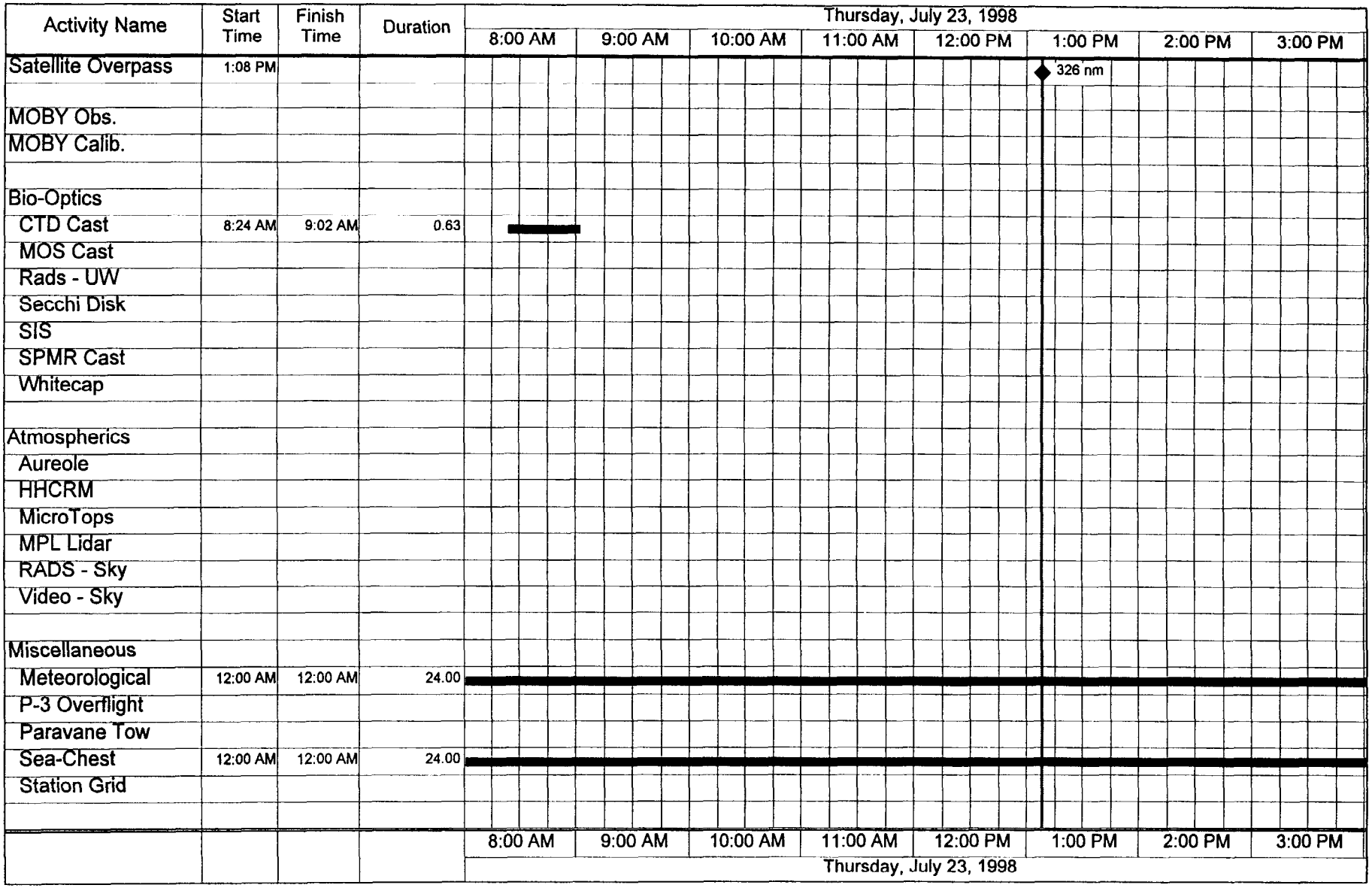
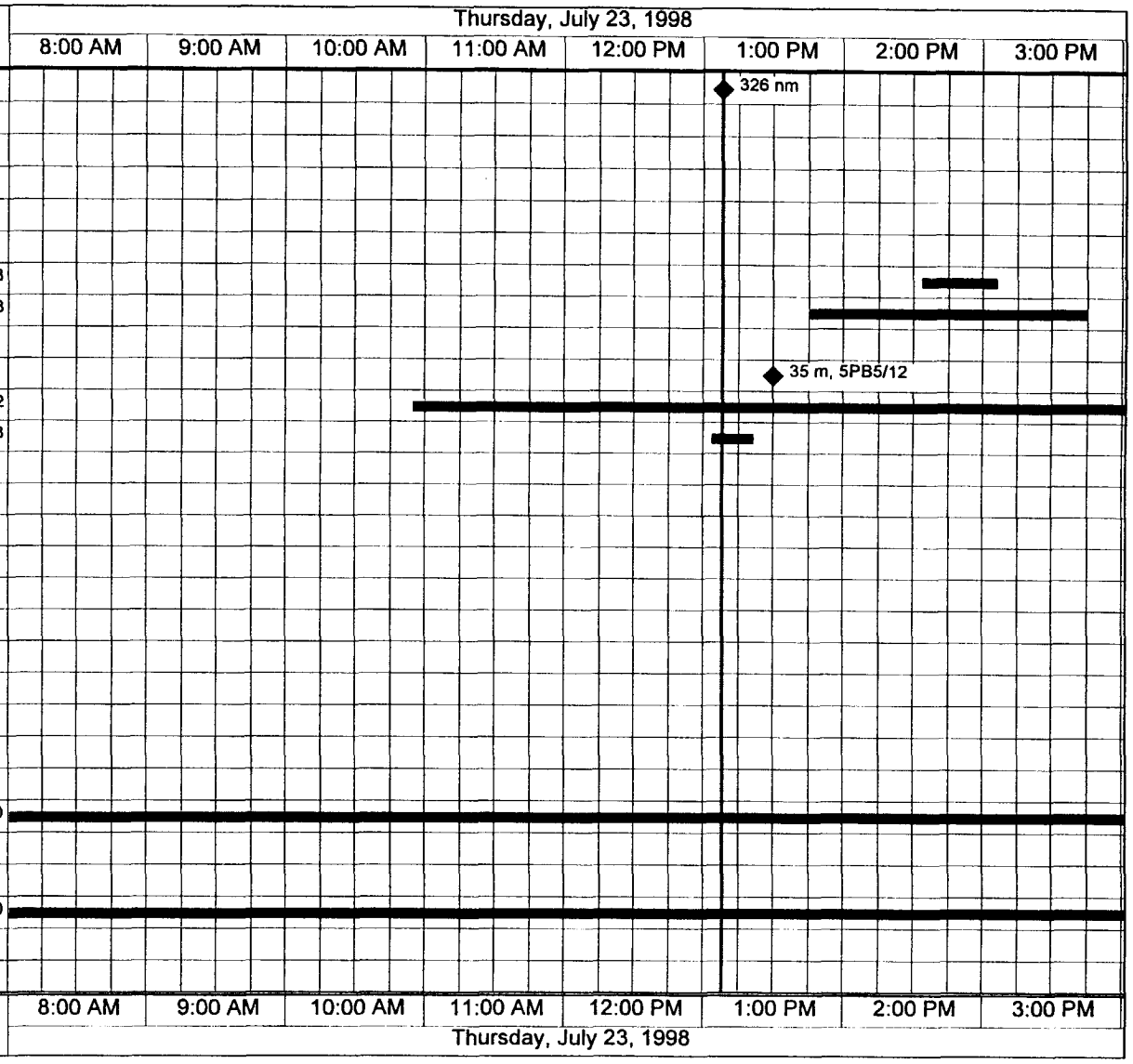


FIGURE 2.

M210SOBP

Station 2: CIMEL Site

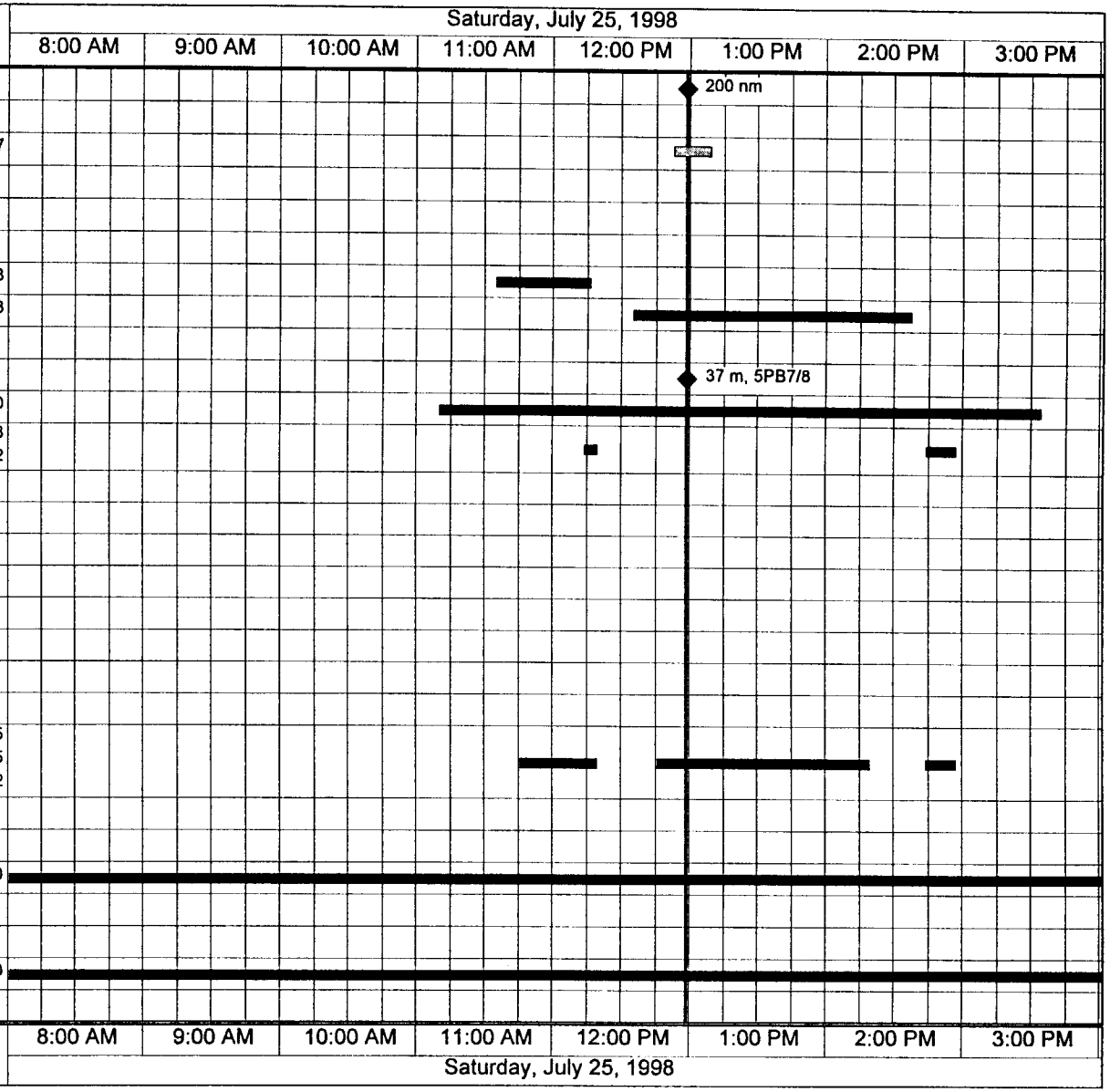
Activity Name	Start Time	Finish Time	Duration
Satellite Overpass	1:08 PM		
MOBY Obs.			
MOBY Calib.			
Bio-Optics			
CTD Cast	2:34 PM	3:06 PM	0.53
MOS Cast	1:46 PM	3:45 PM	1.98
Rads - UW			
Secchi Disk	1:30 PM		
SIS	10:55 AM	5:02 PM	6.12
SPMR Cast	1:04 PM	1:21 PM	0.28
Whitecap			
Atmospherics			
Aureole			
HHCRM			
MicroTops			
MPL Lidar			
RADS - Sky			
Video - Sky			
Miscellaneous			
Meteorological	12:00 AM	12:00 AM	24.00
P-3 Overflight			
Paravane Tow			
Sea-Chest	12:00 AM	12:00 AM	24.00
Station Grid			



M210SOBP

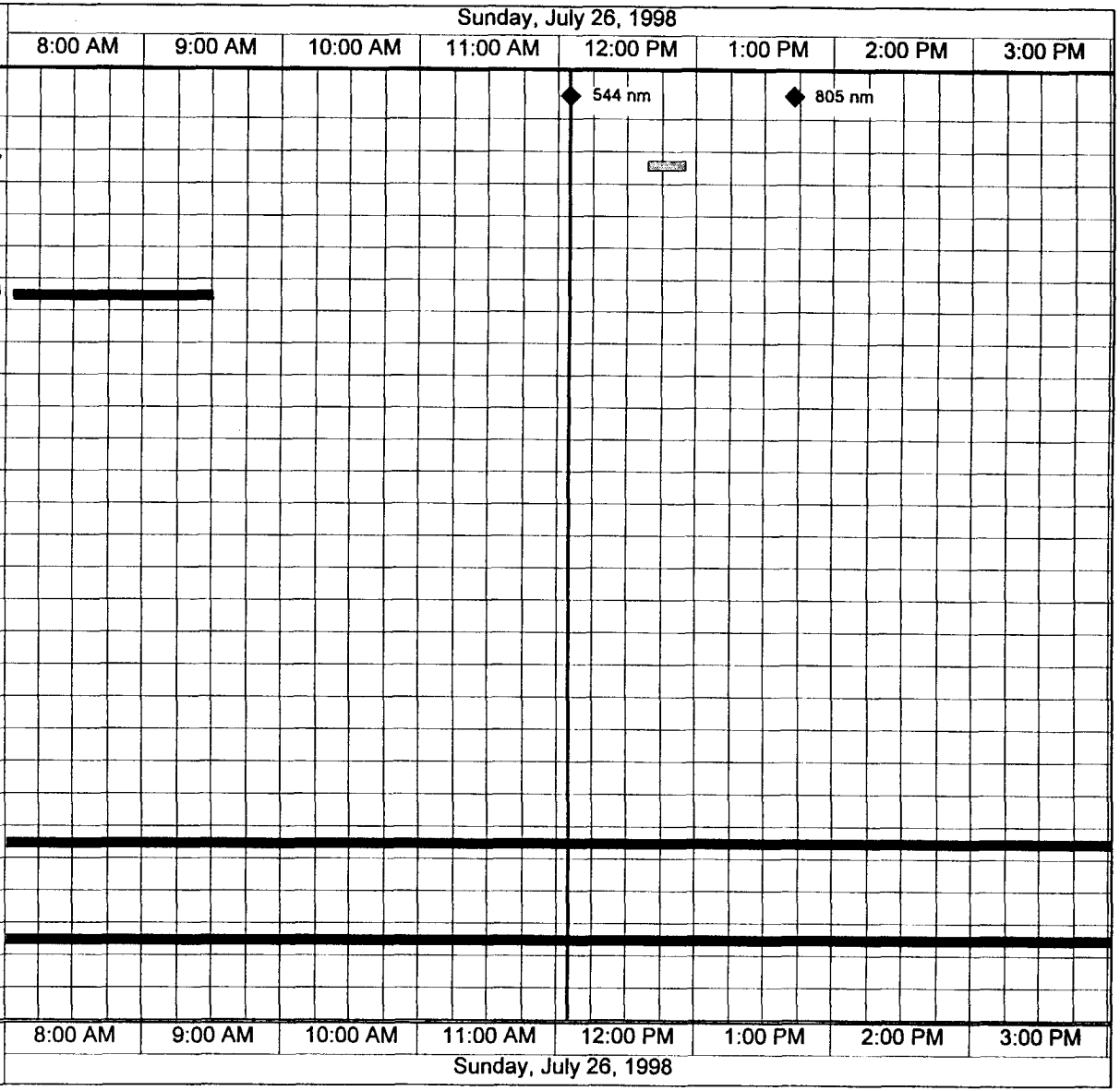
Station 3: MOBY II

Activity Name	Start Time	Finish Time	Duration
Satellite Overpass	12:59 PM		
MOBY Obs.	12:53 PM	1:09 PM	0.27
MOBY Calib.			
Bio-Optics			
CTD Cast	11:35 AM	12:16 PM	0.68
MOS Cast	12:35 PM	2:37 PM	2.03
Rads - UW			
Secchi Disk	12:59 PM		
SIS	11:10 AM	3:34 PM	4.40
SPMR Cast	12:14 PM	12:19 PM	0.08
	2:44 PM	2:57 PM	0.22
Whitecap			
Atmospherics			
Aureole			
HHCRM			
MicroTops			
MPL Lidar			
RADS - Sky			
Video - Sky	11:46 AM	12:19 PM	0.55
	12:46 PM	2:19 PM	1.55
	2:44 PM	2:57 PM	0.22
Miscellaneous			
Meteorological	12:00 AM	12:00 AM	24.00
P-3 Overflight			
Paravane Tow			
Sea-Chest	12:00 AM	12:00 AM	24.00
Station Grid			



M210SOBP
Station 4: Kalohi Deep

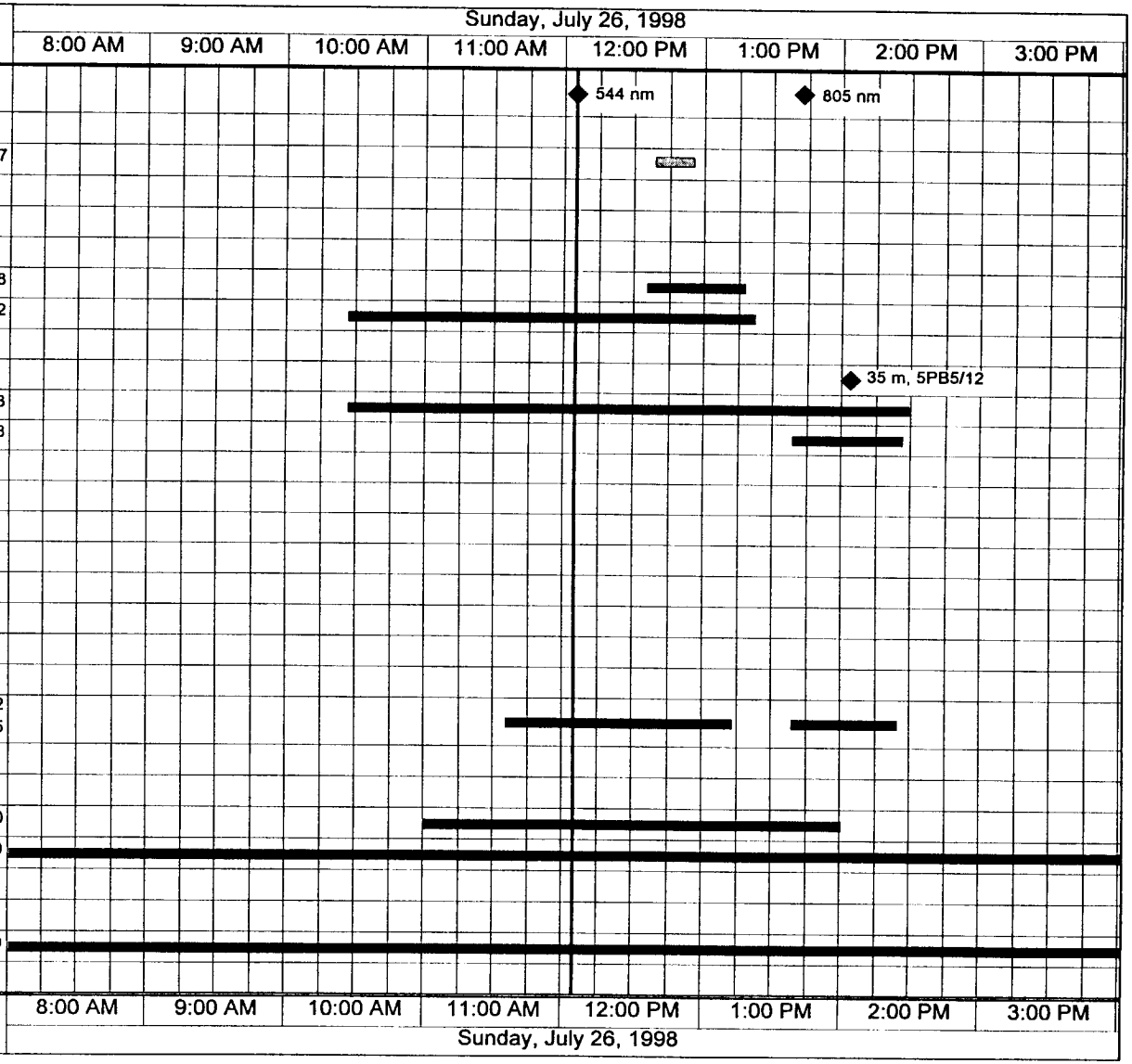
Activity Name	Start Time	Finish Time	Duration
Satellite Overpass	12:05 PM 1:43 PM		
MOBY Obs.	12:39 PM	12:55 PM	0.27
MOBY Calib.			
Bio-Optics			
CTD Cast	8:04 AM	9:30 AM	1.43
MOS Cast			
Rads - UW			
Secchi Disk			
SIS			
SPMR Cast			
Whitecap			
Atmospherics			
Aureole			
HHCRM			
MicroTops			
MPL Lidar			
RADS - Sky			
Video - Sky			
Miscellaneous			
Meteorological	12:00 AM	7:00 PM	19.00
P-3 Overflight			
Paravane Tow			
Sea-Chest	12:00 AM	7:00 PM	19.00
Station Grid			



M210SOBP

Station 5: MOBY III

Activity Name	Start Time	Finish Time	Duration
Satellite Overpass	12:05 PM 1:43 PM		
MOBY Obs.	12:39 PM	12:55 PM	0.27
MOBY Calib.			
Bio-Optics			
CTD Cast	12:36 PM	1:17 PM	0.68
MOS Cast	10:27 AM	1:22 PM	2.92
Rads - UW			
Secchi Disk	2:04 PM		
SIS	10:27 AM	2:29 PM	4.03
SPMR Cast	1:39 PM	2:26 PM	0.78
Whitecap			
Atmospherics			
Aureole			
HHCRM			
MicroTops			
MPL Lidar			
RADS - Sky			
Video - Sky	11:36 AM 1:39 PM	1:13 PM 2:24 PM	1.62 0.75
Miscellaneous			
MD - 5	11:00 AM	2:00 PM	3.00
Meteorological	12:00 AM	7:00 PM	19.00
P-3 Overflight			
Paravane Tow			
Sea-Chest	12:00 AM	7:00 PM	19.00
Station Grid			



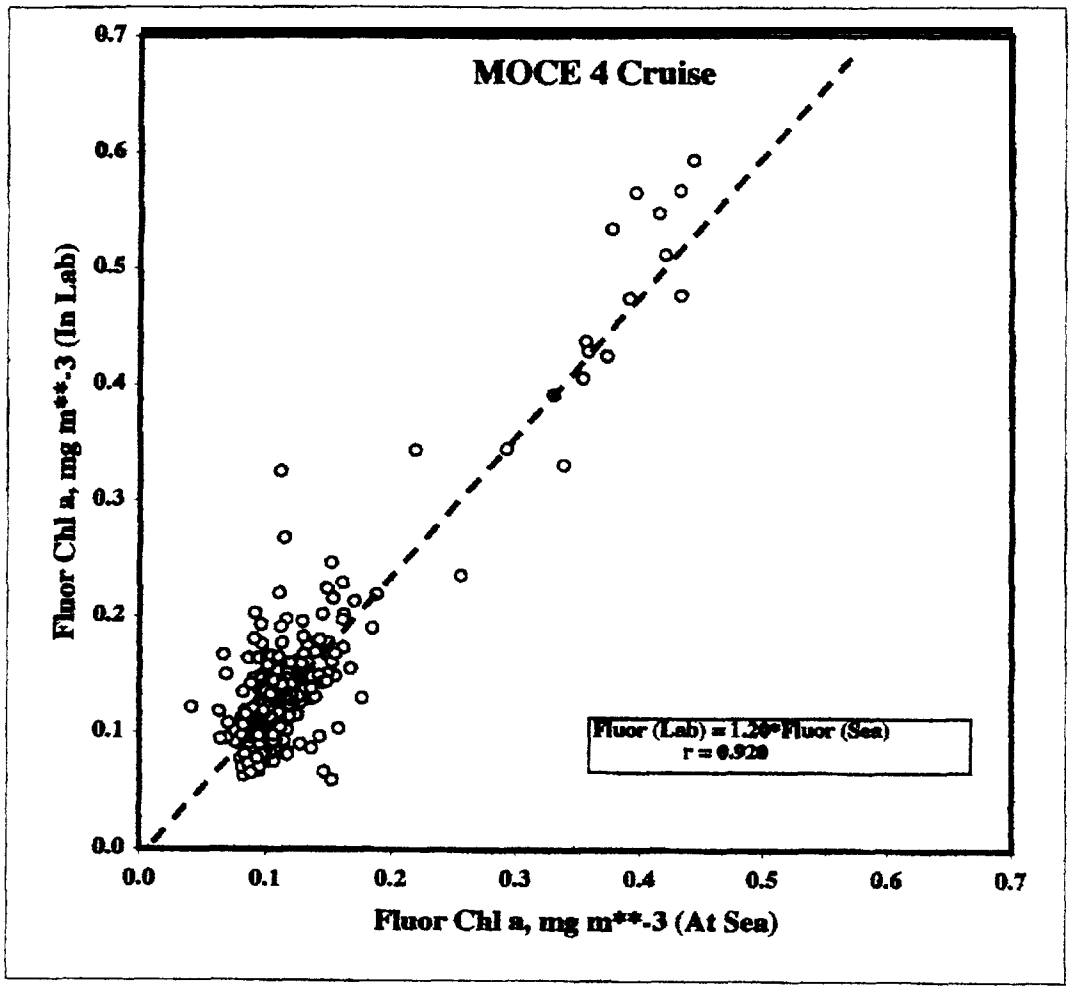


FIGURE 3. Comparison between fluorometrically determined chlorophyll a concentrations measured at sea and replicate samples processed in the laboratory using the same method.

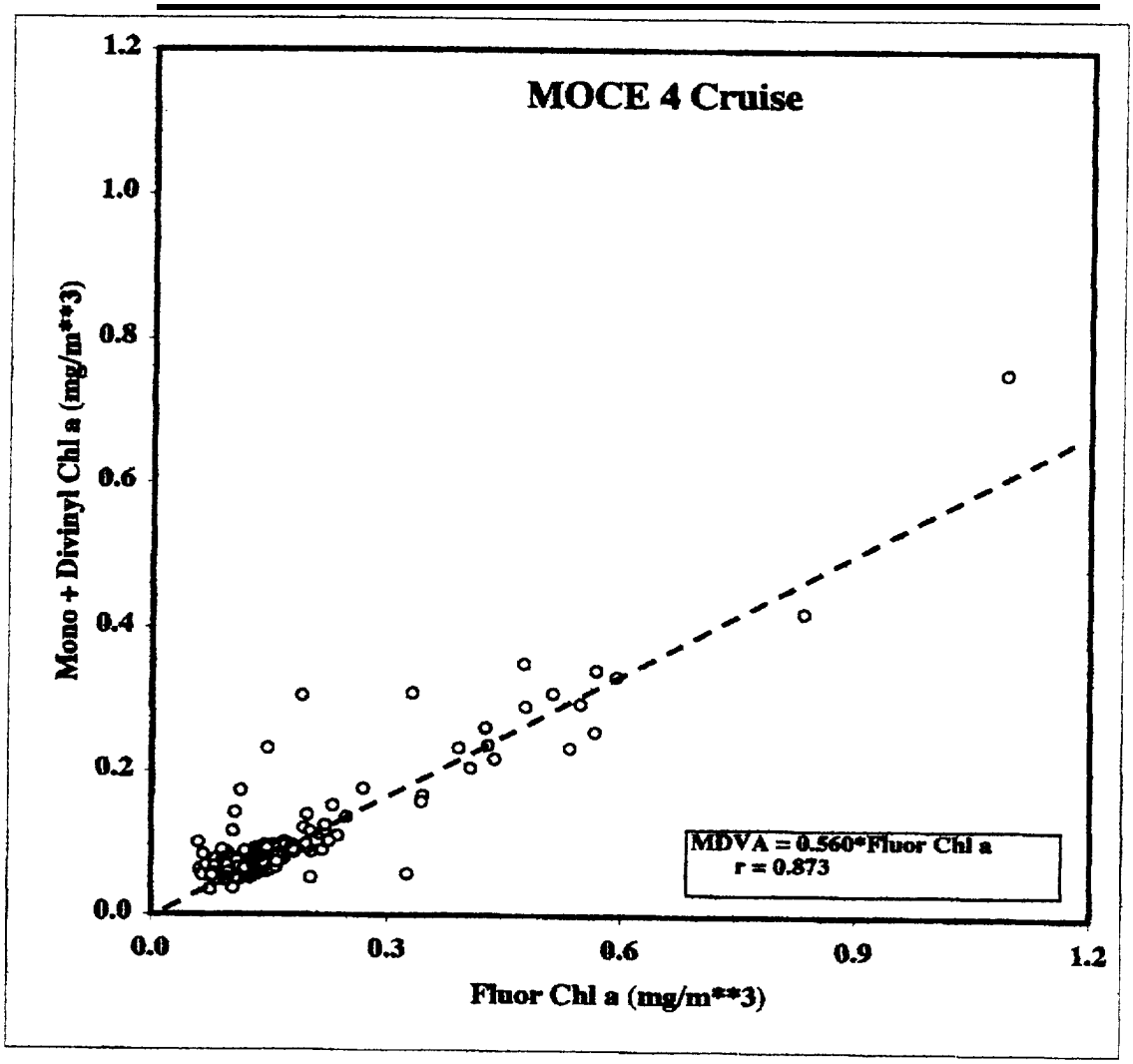


FIGURE 4. Comparison between fluorometrically measured chlorophyll a and HPLC measured monovinyl plus divinyl chlorophyll a

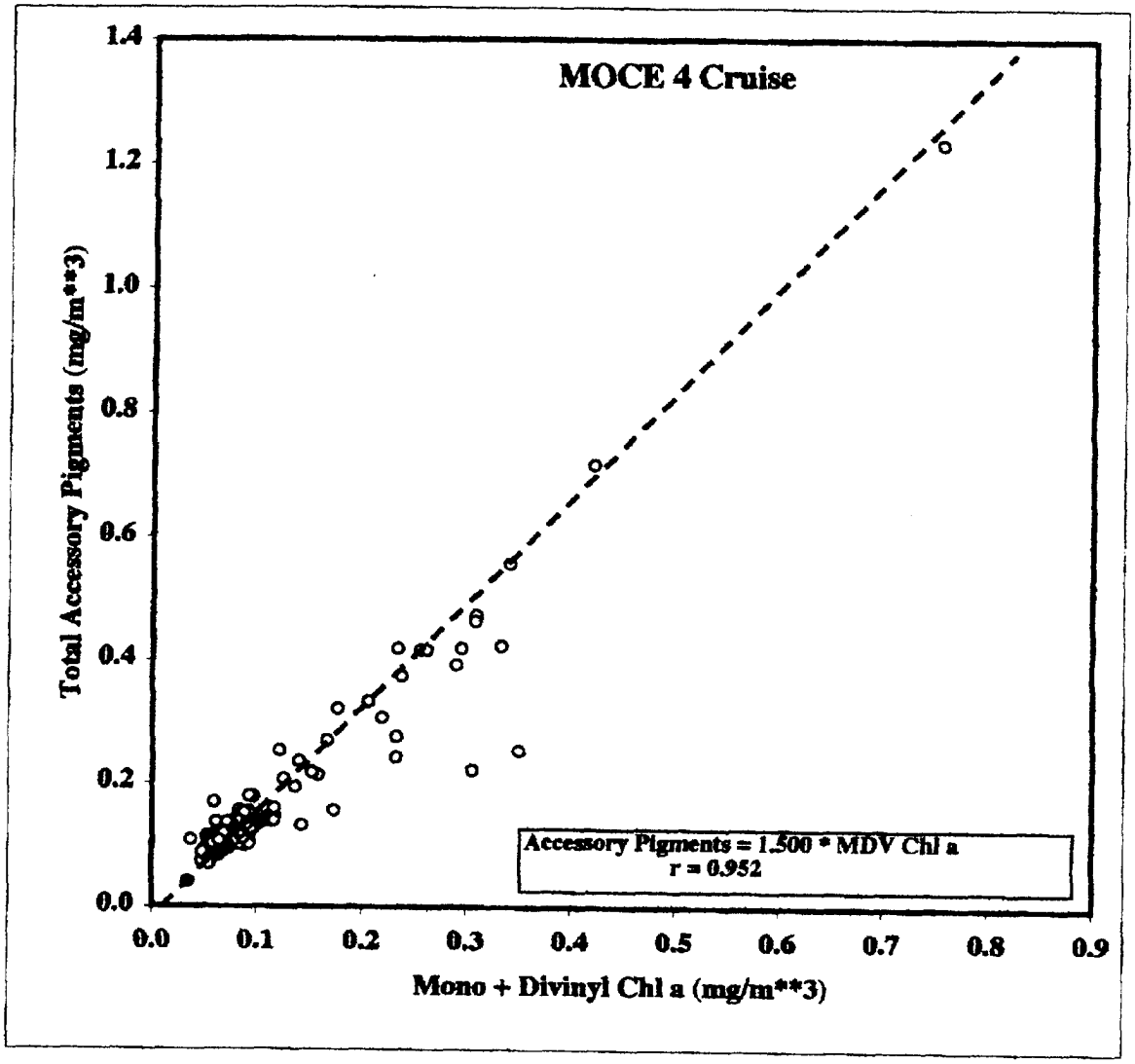


FIGURE 5. Monvinyl plus divinyl chlorophyll a versus total accessory pigment concentration.

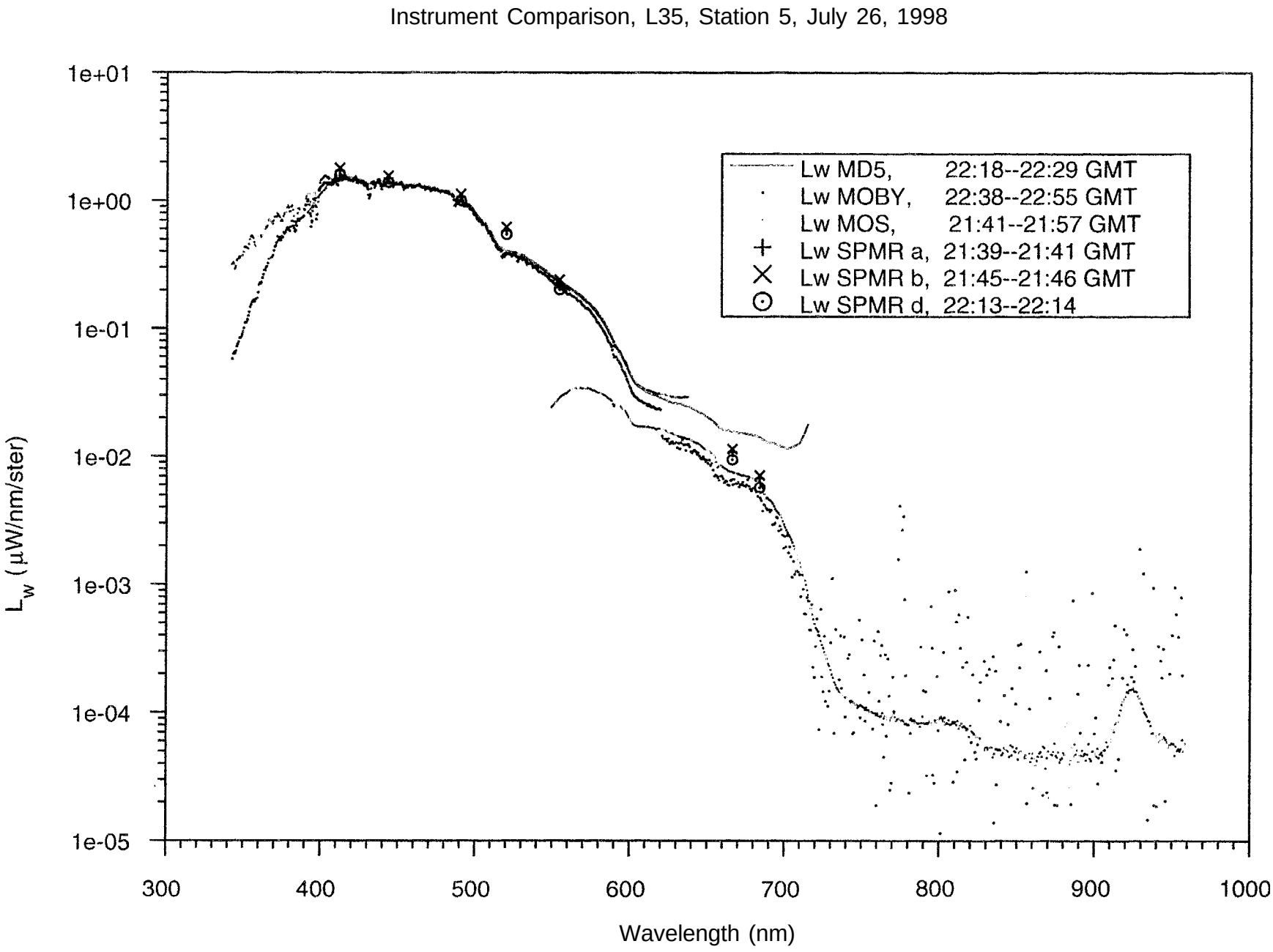

Instrument Comparison, L35, Station 5, July 26, 1998
Lw MD5, 22:18--22:29 GMT
Lw MOBY, 22:38--22:55 GMT
Lw MOS, 21:41--21:57 GMT
Lw SPMR a, 21:39--21:41 GMT
Lw SPMR b, 21:45--21:46 GMT
Lw SPMR d, 22:13--22:14
1e+01
1e+00
1e-01
1e-02
1e-03
1e-04
1e-05
L_w (μW/nm/ster)
300
400
500
600
700
800
900
1000
Wavelength (nm)

FIGURE 6.