

MODIS Team Member - Final Report

Marine Optical Characterizations July - September 2004

**Dennis K Clark
NOAA/NESDIS**

SUMMARY

Since the launch of NASA's Moderate Resolution Imaging Spectrometer MODIS-Terra and MODIS-Aqua satellites, the Marine Optical Characterization Experiment (MOCE) Team has continued to acquire and provide at-sea observations for MODIS initialization and calibration tasks. The Marine Optical Buoy (MOBY) system has been acquiring optical and basic meteorological observations coincident with Terra and Aqua overpasses in support of the MODIS ocean color mission.

During this reporting period, the team conducted three field operations in Hawaii in support of the MOBY project. These cruises, designated MOBY- L108 through MOBY- L110, serviced the twenty-fifth, twenty-seventh, and twenty-eighth deployments of the MOBY systems (MOBY227, MOBY228). The team also set up and initiated one field campaign in Chesapeake Bay, Maryland, in attempt to characterize the biological and optical properties of highly turbid waters (Turbid-09).

The team is continuing to provide the SeaWiFS Project observations for their validation and long-term calibration tasks and to collaborate with NIST personnel in conducting stray light and temperature characterizations of the MOBY/MOCE optical systems. A summary of the team activities during this reporting period is shown in Figure 1.

FIELD OPERATIONS

During **MOBY- L108** (July 13 - 15, 2004), Mark Yarbrough and Terrence Houlihan flew to Maui on July 13 and sailed to the Lanai Mooring site on July 15 with Hawaiian Rafting Adventures (HRA) Captain Steve Juarez and his mate. They cleaned MOBY227, took underwater photographs for inspection, and collected two HPLC water samples. It was too rough to perform diver reference scans.

The MOBY- L109 MOBY replacement cruise occurred August 6 - 8, 2004 aboard the R/V Ka'imikai-O-Kanaloa (KOK). The KOK departed Honolulu, Hawaii on the morning of August 6, MOBY228 was deployed and MOBY227 was put under tow. On August 7, MOBY227 was recovered in Manele Bay and the Lanai CIMEL instrument was removed. Two stations and one oceanographic trackline were occupied with a total of 10 POC/PC samples collected and 14 MICROPRO casts were taken. Bulk water pigment samples were collected, concurrent with the MOCE data acquisition, and analyzed. Twelve fluorometric pigment samples were run at sea. Twelve 4-liter HPLC pigment samples were also collected and shipped under LN2 to CHORS for

analysis in San Diego. Both pigment data sets will be submitted to the MOCE Ocean Color database.

MOBY –L110 occurred August 16 - 19, 2004. Mark Yarbrough and Terrence Houlihan flew to Maui on August 16 and sailed to the Lanai Mooring site on August 18 with HRA Captain Steve Juarez and his mate to perform routine before cleaning diver reference lamp measurements on MOBY228 and reload the antifoulant tubes.

The bio-optical cruises in the northern Chesapeake Bay (**Turbid-09**) started on September 17. The M/V Lady Bug and a small pontoon boat were used for daily cruises that departed and returned to Ferry Point harbor. Setup aboard the boats started on September 21 and ended on September 29. Pre-cruise irradiance and wavelength calibrations were performed on September 27 and radiance calibrations on September 29. Steve Brown from NIST operated the new NIST Ship-Board Calibrator (SBC) during tests with MOS and FOS instruments aboard the Lady Bug. The SBC was left for the duration of the cruise for further inspections and testing. The pontoon boat has been fitted with a GPS system, riggings for the shadowing experiments, a filtration setup, FOS, and MD-5 radiometer. The first oceanographic station was occupied on September 30 and stations will be occupied during satellite overpasses for the remainder of the cruise which is in progress.

RADIOMETRIC STANDARDS & RADIOMETERS

Team personnel stationed at the NOAA operations facility at Snug Harbor, Hawaii continued maintenance of our NIST traceable radiometric standards and performed calibrations of our radiometers. At the end of September 2004, the MLML OL420 radiance standard (Lamp #07 NIST cal 12-Aug-2002) had provided 28.3 hours use (see Appendix 1 for details). The OL425 (Lamp #04 NIST cal 09-Aug_2002) had 48.8 hours use. FEL irradiance standard F454 (NIST cal #3 01-Feb-2001) had 45.6 hours, F471 (NIST cal #2 01-Feb-2001) had 38.9 hours, and GS132 (NIST cal #2 28-Jul-1998) had 0.0 hours use. Unfortunately, lamp F453 (NIST cal #2 29-Jul-1998) was damaged on July 9 with 42.6 hours.

The MLML OL425 was shipped to NIST for post-calibration of lamp #4, re-lamping, and pre-calibration of lamp #5 – anticipated return date is November 2004. The OL420 was shipped to Maryland for the calibrations during the Turbid-09 cruise and may be left with NIST for the calibrations at the end of October. The two FELs – F454 and F471 were hand-carried to Maryland for the Turbid-09 experiment and may be delivered to NIST for recalibrations if NIST scheduling permits. Two new NIST-calibrated FELs have been ordered and are awaiting calibrations via NIST FASCAL-II.

Radiometric calibrations during the reporting period included:

1. July 2004 NIST-2004-01 MOS202 and SIS101, Post-MOBY-L106 MOS204 (Post-B26/Pre-B28)
2. August 2004 NIST-2004-01 MOS202, SIS101, and MOBY228, Pre-MOBY-L109 Pre-deployment MOBY228
3. September 2004 Pre-Turbid_09 MOS202, SIS101, and FOS.

The yearly NIST/MLML radiometric intercalibrations were conducted in July and August at the

MOBY Operations site in Honolulu, Hawaii. Integrating Sphere Sources (ISS) from MLML, OI420 and OL425, were compared with the NIST NPR using radiometers from MLML, SLM-L412 and L870, and the NIST VXR. Source measurements were repeated two or three times during each experimental setup, and setups were repeated on two different days. Preliminary results indicate the MLML ISS values are within expected calibration uncertainties, except 412 nm VXR & SLM using the OL420 (~4%), and VXR 412 nm using NPR (~4%). These discrepancies require further investigation. Plans were made to schedule recalibration and re-lamping of the MLML ISS at NIST (see calibration maintenance, Appendix 1) and SLM irradiance recalibration using the SIRCUS at NIST. Additionally, two weeks were spent characterizing the Cosine response and Reference Plane distance for MLML radiometers MOS202cfg12 and SIS101cfg04. From these measurements, an algorithm is being developed to correct the MOS and SIS irradiance as a function of solar zenith angle. Preliminary results indicate that there will be an insignificant correction to the MOS and SIS irradiance collector reference plane used during absolute irradiance calibration.

During August and September, we continued working on the MOBY reprocessing calibration database. All calibrations by NIST and Optronic Laboratories of all radiance and irradiance standards, from 1992 to present, were interpolated from raw calibration values to a 0.25 nm interval using a consistent application of a Black Body fit suggested by NIST (NBS Tech Note 594-13, April 1977, Saunders and Shumaker). This will eliminate inconsistencies where calibrations were performed over different wavelength ranges, with different interpolation schemes, and where pre- and post-calibrations were performed by different organizations. Where appropriate, lamp pre- and post-calibration data will be averaged before interpolating to the MOS/MOBY wavelengths for derivation of system responses. Initial end-to-end tests of the response database were successful, and final reprocessing is scheduled to begin as soon as possible.

Detailed listings of calibrations and maintenance for each standard and instrument are provided in Appendix 1.

STRAY LIGHT/TEMPERATURE CHARACTERIZATION

During this reporting period, we worked on the changes to the MOS Profiler, MOS ROV and MOBY stray light correction algorithms. It was determined that the off CCD correction was negligible in an attempt to improve the ROV fit and subsequently was removed from the MOS and MOBY algorithms. A number of other methods were tested to make the interpolated MOS Profiler laser observations work better for the ROV data. An offset still exists in the blue-red overlap for blue water data. It was determined that the ROV would need to be sent off to NIST for a complete laser characterization. The ROV laser observation data will then be interpolated and used to process only the ROV data.

DATA PROCESSING

MOBY/MOS/SIS

MOBY now acquires three files a day, coincident with the SeaWiFS and the two MODIS overpasses. MOBY acquisition times are 20:40 (Aqua), 22:47 (SeaWiFS), and 00:10 (Terra) GMT. MOBY only transmits two files (MODIS Aqua and Terra) each day. The SeaWiFS files are downloaded at the end of each deployment and processed. MLML personnel process the 20 and 23 hour files the following day. All files are weighted to MODIS and SeaWiFS bands.

The new interpolated MOS Profiler laser observations used to process MOS profiler data did not reduce the offset in the blue-red overlap for blue water data. The programs were changed so an additional; offset was subtracted from the system response and in-water data (in ADU/pixel/second). This worked well for the blue water data but not for the green water data from the MOCE-5 experiment. An offset was added to the interpolated laser observations and the offset subtracted from the system response and in-water data were removed. After a few adjustments this worked well for both blue and green water data using a value of $5e-6$ added to the interpolated laser observations for all MOS profiler data. The offset in the blue-red overlap still exists for a few stations from the MOCE-5 experiment even after the red spectrograph parameters were changed. One more problem still needs to be resolved in the UV before the MOS stray light correction algorithm is complete.

The problems found with the blue LED flashlight and the MOS ROV and profiler indicate that changes to the MOBY data are also required. The MOBY laser observations collected for the stray light correction were not as numerous as for the MOS profiler, so the MOBY laser observations could not be interpolated and required a different approach. The upturn in the overlap region is modeled with an exponential curve and then removed during the iterative process of stray light correction. The stray light corrected data looked very good until deployment 225 when the integration time was changed for the blue spectrograph during radiance measurements. Correcting deployments after 225 required an additional offset be subtracted from the system response and in-water data (in ADU/pixel/second). The same type of correction worked for deployment 226 which had similar problems. The only difference between the even and odd deployment corrections were for deployments 206, 208, and 210. These three deployments used a different fiber (low OH) and the amplitude of the exponential curve had to be reduced to make the overlap area matchup. Much of the MOS and MOBY stray light correction work was done during the MOBY-L109 experiment.

MEETINGS and PUBLICATIONS

All MOBY Team Members located in the Washington D.C. area attended a **MODIS Science Team Meeting** at the BWI Airport Marriott, July 13 – 15, 2004. The meeting consisted of plenary and discipline specific group meetings. The Ocean discipline group meeting primarily discussed MODIS processing status and product suite and ocean algorithm selections. Specific algorithm group leaders were selected to explore algorithms for each product and were tasked with organizing algorithm group meetings to test and recommend product algorithms.

Appendix 1: Calibrations and maintenance schedules for MLML standards and instruments

• SLM

09-Jan-2004	Pre-L104	OL425-W6D100 after MOS204c08
24-Jan-2004	Pre-L104	OL425-W6D100 after MOBY226 Lu Pre-Cal
27-Jan-2004	Pre-L104	GS5000-F454 after MOBY226 Ed Pre-Cal
30-Jan-2004	Pre-L104	GS5000-F454 after MOS202 & SIS101
14-Feb-2004	Post-L104	OL420-W5D100 after FOS Lu
17-Mar-2004	Post-L104	OL425-W6D100 after MOBY225 Lu Post-Cal
19-Mar-2004	Post-L104	GS5000-F471 after MOBY225 Ed Post-Cal
17-Apr-2004	Post-L104	OL425-W6D100 after MOS205cfg09 PosB25/PreB27
28-Apr-2004	Pre-L106	OL425-W6D100 after MOBY227 Lu Pre-Cal
30-Apr-2004	Pre-L106	GS5000-F471 after MOBY227 Ed Pre-Cal
04-May-2004	Pre-L106	GS5000-F454 after MOS202cfg12 & SIS101cfg04
25-May-2004	Post-Oahu6	OL420-W5D100 after FOS Lu (YSKim)
11-Jun-2004	Post-L106	OL425-W6D100 after MOBY226 Lu Post-Cal
15-Jun-2004	Post-L106	GS5000-F471 after MOBY226 Ed Post-Cal

• SIS101

30-Jan-2004	Pre-L104	GS5000-F454 1/10X gain via Es cfg04
04-May-2004	Pre-L106	GS5000-F454 1/10X gain via Es cfg04

• MOS202

29-Jan-2004	Pre-L104	GS5000-F454 via DN Ed cfg12
30-Jan-2004	Pre-L104	OL425-W6D100 via UP Lu cfg12
30-Jan-2004	Pre-L104	OL420-W5D100 via UP Lu cfg12
31-Jan-2004	Pre-L104	HgA, Ne, Kr, Xe via UP Lu cfg12
04-May-2004	Pre-L106	GS5000-F454 via DN Es cfg12
05-May-2004	Pre-Oahu6	HgA, Ne, Kr, Xe via DN Es cfg12
12-May-2004	Pre-Oahu6	OL420-W5D100 via UP Lu cfg12 on Klaus Wyrтки
26-May-2004	Post-Oahu6	OL420-W5D100 via UP Lu cfg12 on Klaus Wyrтки
26-May-2004	Post-Oahu6	“Blue” LED Dive Lights via UP Lu cfg12 on Klaus Wyrтки

• MOS204

09-Jan-2004	Post-L104	OL425-W6D100, HgA, Ne, Kr, Xe via UP Lu cfg08
Apr/May	NA	Deployed via MOBY226

• MOS205

Jan/Feb	NA	Deployed via MOBY225
16-Apr-2004	Post-L104	HgA, Ne, Kr, Xe via UP Lu cfg09 < PostB25 / PreB27
17-Apr-2004	Post-L104	OL425-W6D100 via UP Lu cfg09 < PostB25 / PreB27

• MOBY225

17-Mar-2004 Post-L104
19-Mar-2004 Post-L104

OL425-W6D100 via LuB,M,T < Post-Cal
GS5000-F471 via EdB,M,T,S < Post-Cal

• MOBY226

24-Jan-2004 Pre-L104
27-Jan-2004 Pre-L104
11-Jun-2004 Post-L106

OL425-W6D100 via LuB,M,T < Pre-Cal
GS5000-F471 via EdB,M,T,S < Pre-Cal
LED "flashlight" via LuB,M,T before&after
cleaning

11-Jun-2004 Post-L106
11-Jun-2004 Post-L106
15-Jun-2004 Post-L106

"blue" LED dive light #3 via LuMOS,Bot
OL425-W6D100 via LuB,M,T < Post-Cal
GS5000-F454 via EdB,M,T,S < Post-Cal

• MOBY227

28-Apr-2004 Pre-L106
30-Apr-2004 Pre-L106

OL425-W6D100 via LuB,M,T < Pre-Cal
GS5000-F471 via EdB,M,T,S < Pre-Cal

MOCE Team Activities

2004	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		
July								N A S A						MOBY L108																			
August																																	
September																																	

Figure 1