

Semi-Annual Progress Report

January 2002

Mark R. Abbott

College of Oceanic and Atmospheric Sciences

Oregon State University

MODIS Team Member, Contract # NAS5-31360

Task Objectives

The objectives of the last six months were:

- Continue analysis of data from MODIS validation cruises off Oregon
- Continue evaluation of MODIS imagery from several regions of the world ocean
- Continue chemostat experiments on the relationship of photosynthetic capacity to natural fluorescence properties
- Continue development of software for MODIS Direct Broadcast facility for cruise support
- Continue to develop and expand browser-based information system for in situ bio-optical data and MODIS imagery.

Work Accomplished

MODIS Validation Cruises.

We conducted another cruise off the Oregon coast in August 2001. MODIS imagery was collected during this cruise using our EOS Direct Broadcast system. Fast Repetition Rate Fluorometry (FRRF) data were collected at over two dozen stations, along with bio-optical measurements collected by the Tethered Spectral Radiometer Buoy (TSRB). Data were collected to compare the FRRF signal with the sun-stimulated fluorescence data collected by the TSRB. These data in turn are being compared with the MODIS imagery. Samples were also collected for pigment analysis. The cruises in 2001 are part of the Coastal Ocean Processes program supported by the National Science Foundation. More cruises are planned for 2002 as part of the GLOBEC study.

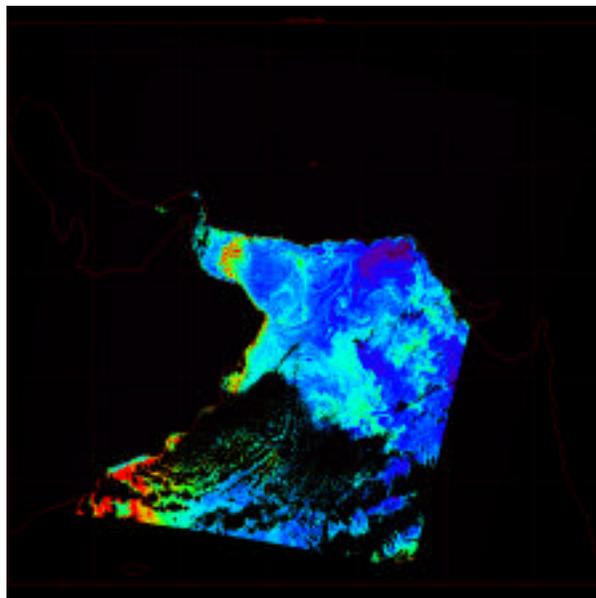
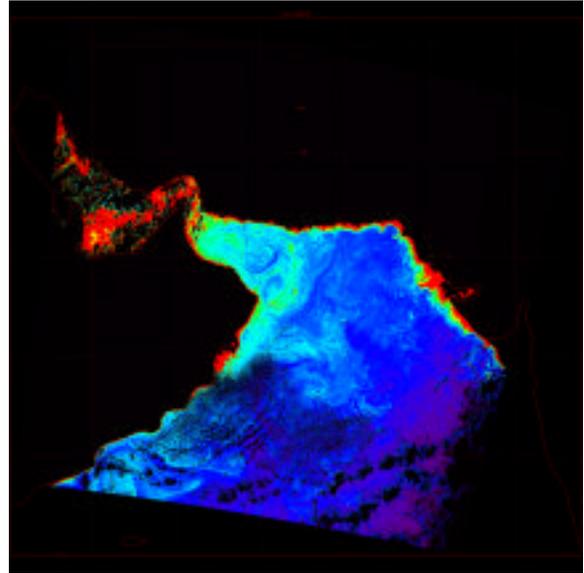
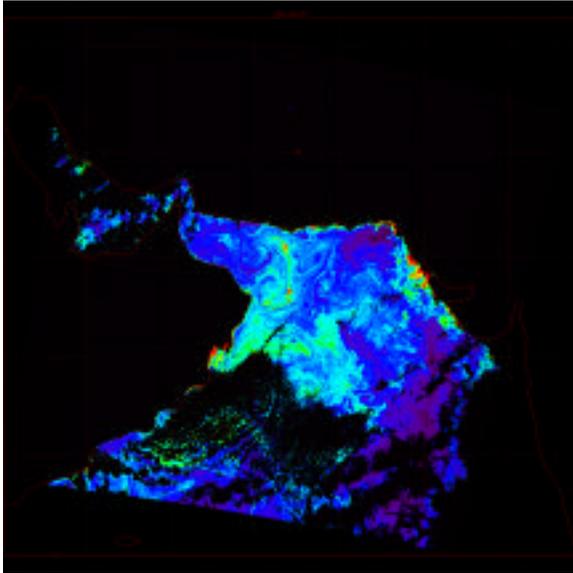
We continue to analyze the data from the GLOBEC cruises conducted in 2000. We now have completed the pigment analyses. We have acquired a Satlantic MicroSAS to measure reflectance spectra from just above the sea surface. The system will be used during the 2002 GLOBEC cruises. Our objective is measure the scales physiological change MODIS imagery which will then be used to improve satellite-based models of photosynthesis. Our approach is to compare the continuous FRRF data with the MicroSAS data to quantify the scales of variability. This information will be used to in comparison with MODIS-based estimates of physiological variability. However, the FRRF only measures F_v/F_M which includes changes in both the quantum yield of photosynthesis and non-photochemical quenching. Thus we are also conducting laboratory experiments that are described below.

Evaluation of MODIS Imagery

The latest versions of the fluorescence products are shown below. The images are from 1 December 2000 after switching MODIS to the B-side electronics. The images cover the Arabian Sea. These are the same images presented in the last Semi-Annual Report (July 2001), but they have been processed with the latest algorithms from the University of Miami. The first image is MODIS chlorophyll. Note that there is even less noise and banding than in the July report. This is the result of continuing improvements in the understanding of the sensor and changes in the algorithms.

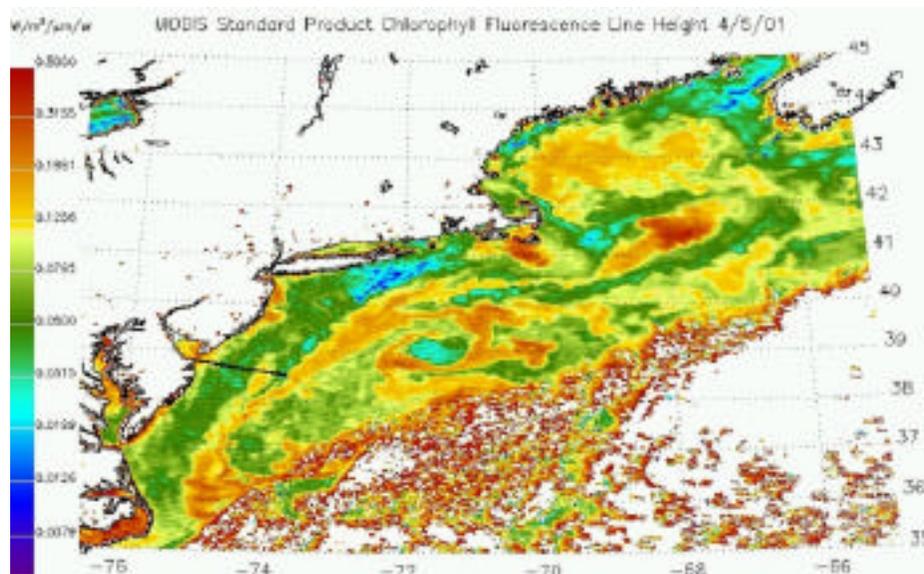
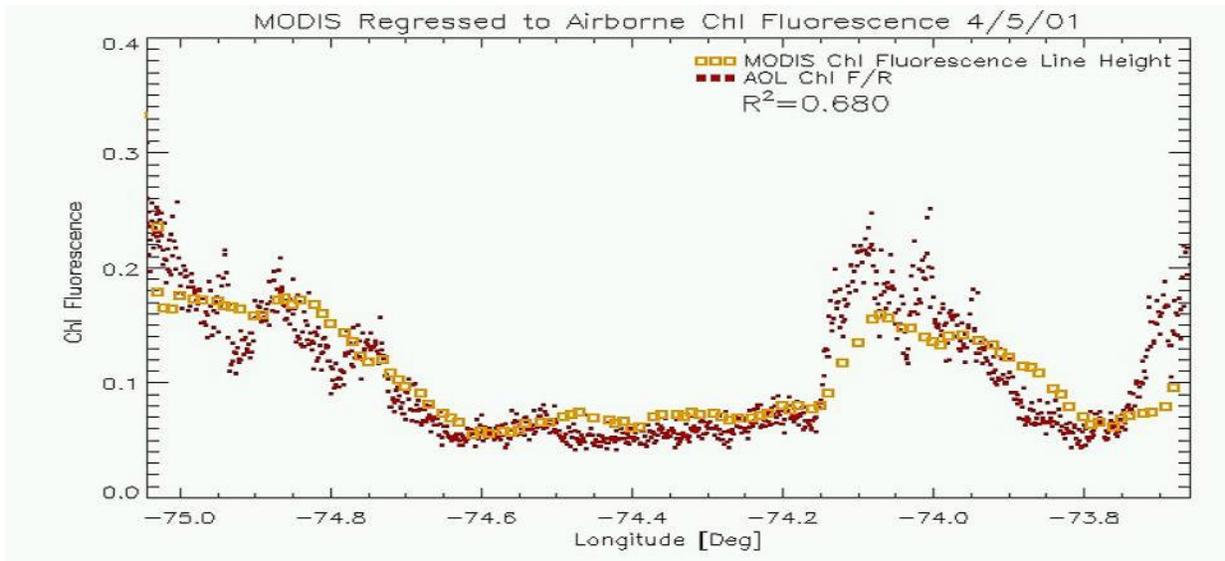
The second image is FLH. In general the patterns of FLH correspond to those of chlorophyll. However,

note the paired vortices off the tip of the Arabian Peninsula. There filamentous structures of high and low FLH that are not consistently related the same features in the chlorophyll image. This is clearly shown in the third image of CFE. The left vortex has lower CFE than the right vortex. This is consistent with our basic understanding of ocean processes. the counterclockwise rotating left vortex should be associated with upwelling and nutrient inputs, leading to higher productivity and lower CFE. The reverse is true for the right, clockwise rotating vortex. Note also that CFE is in the range of 1-2%, which is consistent with previous laboratory studies. Obviously, there is much more information to be extracted



from this set of images, but the quality of the data is now worthy of scientific research.

Frank Hoge collected AOL natural fluorescence data and compared them with a MODIS image of the Gulf Stream. The next figure shows the MODIS image and the AOL flight line. Note that the estimates of FLH from MODIS and AOL are in excellent agreement. We expect to continue the use of AOL data as



part of our validation strategy.

At this point in time, we are waiting for Howard Gordon to declare that the water-leaving radiances are validated. When this occurs, then the FLH products will be declared valid as well. Validation of the CFE product depends on ARP. When Ken Carder declares his product to be valid, then CFE will be valid as well. We expect that both products will be validated soon. We will continue analysis of time series of MODIS fluorescence products from the Oregon coast and from Hawai'i to ensure that the products are valid. Given the low water-leaving radiance signal in the red wavelengths, traditional validation approaches, such as those derived from MOBY data for the blue and green wavelengths, are not sufficient. Long-term consistency in the data record and "reasonableness" of the signal levels for a particular ocean regime, are the only ways to validate fluorescence products at the present time.

For the development of fluorescence-based photosynthesis products, we will rely on continued work with laboratory and field studies.

Chemostat Experiments

Amanda Ashe has begun the validation of the physiological parameters derived from the field measurements obtained by the FRRF with a series of laboratory experiments. This includes comparison of the FRRF data with data on the full range of physiological measurements acquired by our new Walz

PAM fluorometer, such as non-photochemical quenching. We are also comparing the FRRF data with oxygen evolution curves and photosynthesis versus irradiance (P vs. E) curves obtained from the natural fluorescence chemostat.

Direct Broadcast

Our EOS Direct Broadcast facility (<http://picasso.oce.orst.edu/ORSOO/MODIS/DB/>) continues to operate. The complete set of MODIS ocean products is produced daily, and these are now available from our web site. We have streamlined the processing to support reprocessing of our entire archive of raw data, beginning from February 2001. We have implemented the latest algorithms from Miami and MCST, and we are using these data in our validation procedures.

We provided cruise support for the August 2001 cruise. A workshop for US EOS-DB users was held in early September 2001 on the slopes of Mt. Hood, Oregon. A CD containing all of the presentations has been produced and copies can be requested from Jasmine Nahorniak (jasmine@coas.oregonstate.edu).

EOSDIS Plans

We continue to develop a COM+ event model at the database end. The system will allow monitoring of events and provide interested clients with notifications. The system will monitor the satellite data being received, as it enters the database. When it detects certain variations in the data, a message can be sent to a remote client. These variations could be simple changes in drifter locations or far more complex patterns involving multiple parameters. Data from the ESO DB system are being loaded automatically into the data base.

Anticipated Future Actions

- Continue testing and evaluation of MODIS fluorescence algorithms with MODIS data
- Prepare for receipt of MODIS Aqua data
- Bio-optical cruises and moorings off the Oregon coast in 2002
- Continue to develop and expand browser-based information system for in situ bio-optical data.

Problems and Solutions

The MODIS software is now available for the Direct Broadcast site. This is a significant improvement! We can now generate all of the MODIS Oceans products using the latest versions of the algorithms. The support from MCST and the University of Miami is greatly appreciated!

The quality of the latest MODIS products is superb. The only limitation is sufficient processing capacity within EOSDIS to generate all of the MODIS data using a consistent set of algorithms.

The MODIS fluorescence data products are close to being declared valid.

Lack of final budget numbers has made personnel planning very difficult. We hope this will be resolved soon.