Semi-Annual Progress Report

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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

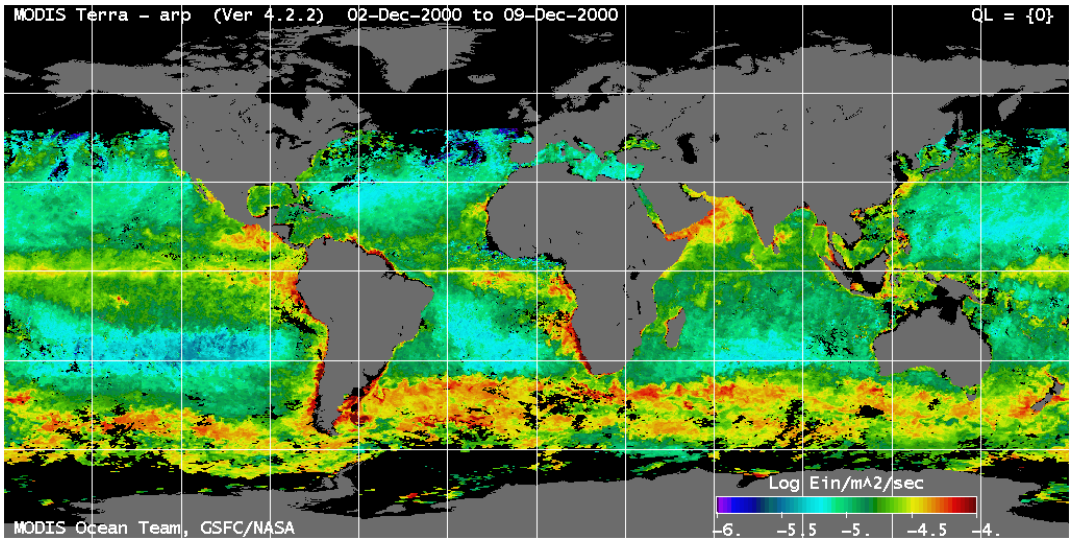
MODIS Validation Cruises.

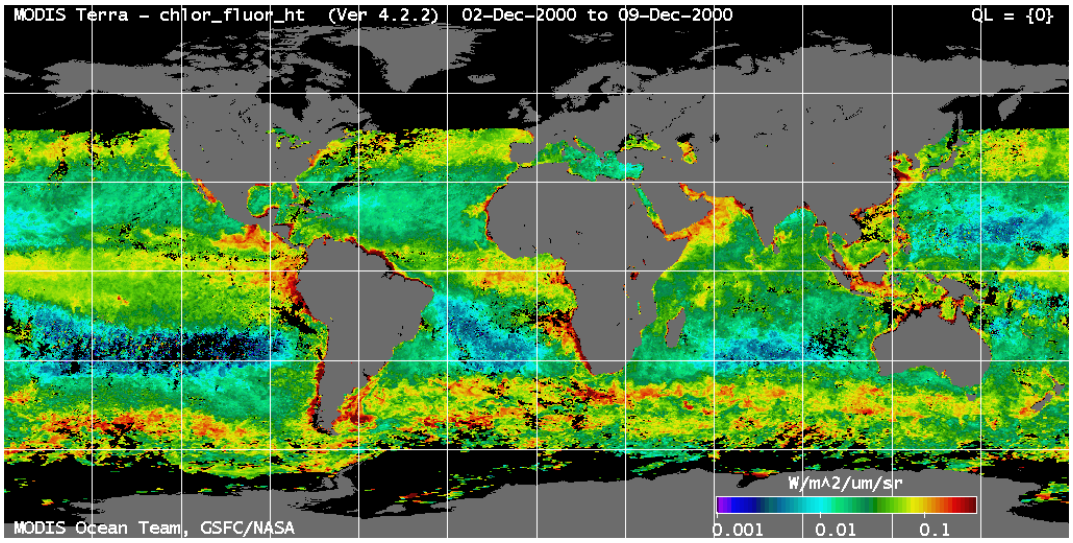
We conducted another cruise off the Oregon coast in May 2002. MODIS imagery was collected during this cruise using our EOS Direct Broadcast system. Fast Repetition Rate Fluorometry (FRRF) data were collected at over two dozen stations, along with bio-optical measurements collected by the Tethered Spectral Radiometer Buoy (TSRB). Data on particle size distributions and underway remote sensing reflectance (using a Satlantic MicroSAS) were also collected. Data were collected to compare the FRRF signal with the sun-stimulated fluorescence data collected by the TSRB and the underway reflectance. These data in turn are being compared with the MODIS imagery. Samples were also collected for pigment analysis and primary productivity. The cruises in 2021 are part of the GLOBEC study.

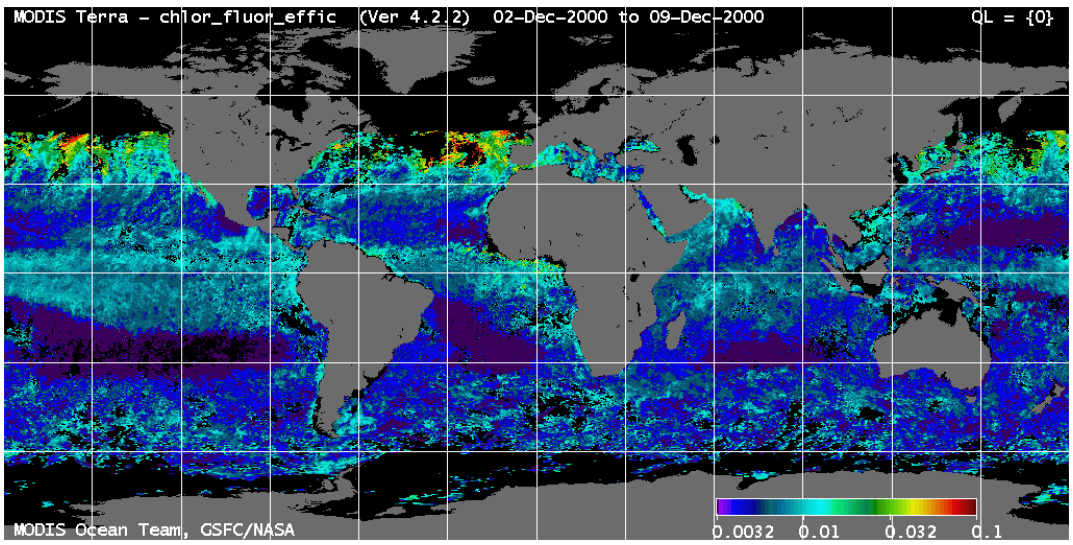
We continue to analyze the data from the GLOBEC and COAST cruises conducted in 2000 and 2001. We now have completed the pigment analyses. Our objective is measure the scales physiological change MODIS imagery which will then be used to improve satellite-based models of photosynthesis. Our approach is 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

Recent versions of the fluorescence products are shown below. The images are from 2 December 2000 after switching MODIS to the B-side electronics. The first image is MODIS ARP (absorbed radiation by phytoplankton). The second image is MODIS FLH. Note that there is general similarity between the images (as one would expect) but there are some significant differences. For example, much of the mid to high latitude areas in the North Pacific and North Atlantic have low ARP but high FLH, suggesting that phytoplankton are not photosynthesizing efficiently. The third image is MODIS CFE (chlorophyll fluorescence efficiency) which is generally inversely related to photosynthetic efficiency.





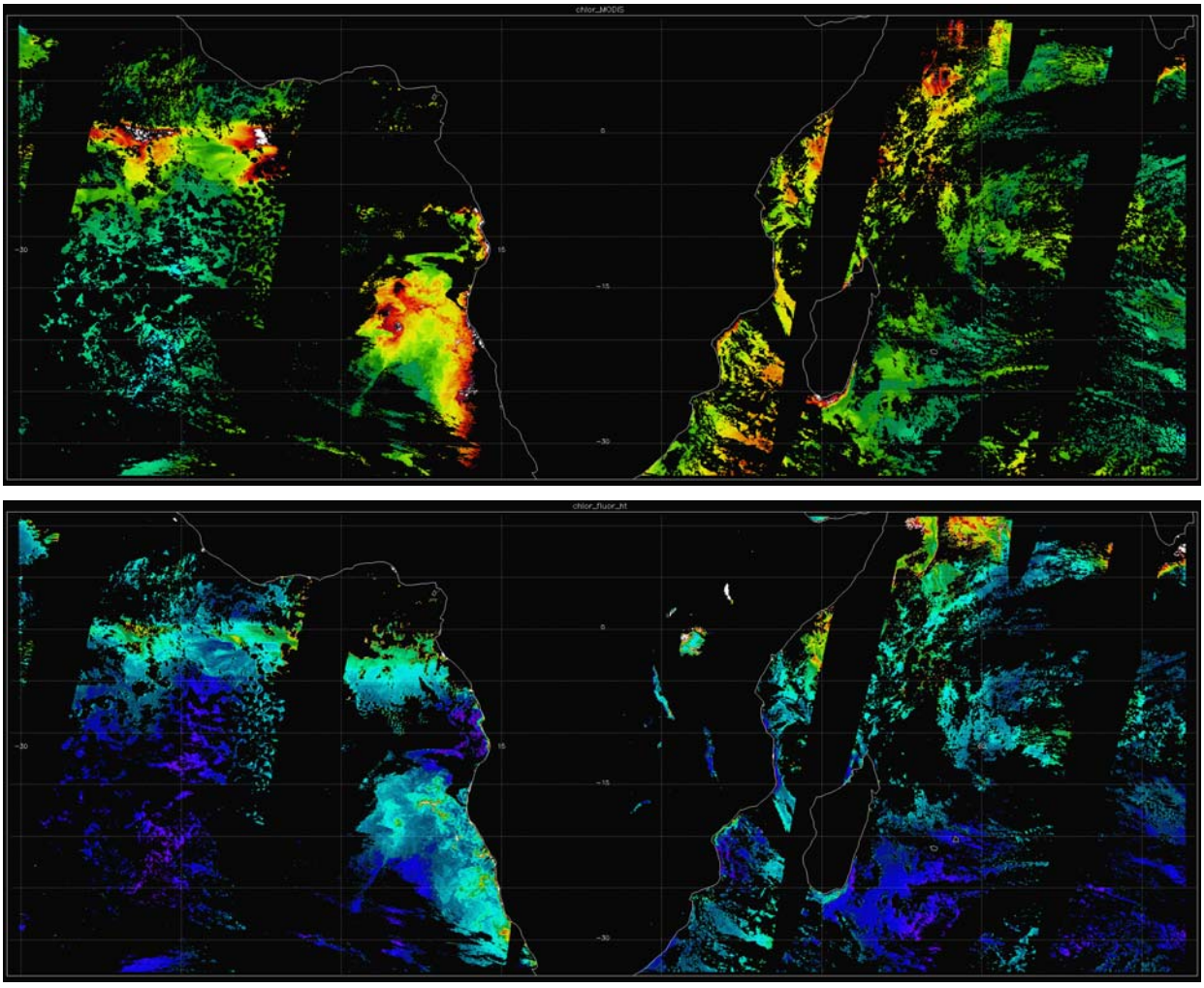


These latest images are far superior to earlier versions of the MODIS products. Since the MODIS water-leaving radiances have now been declared valid by Howard Gordon, we can declare the FLH product to

be valid as well. Moreover, the aircraft data collected by Frank Hoge also confirms the quality of the MODIS fluorescence products. Ken Carder has also declared ARP to be valid, so CFE (which depends on FLH and ARP) is also valid.

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

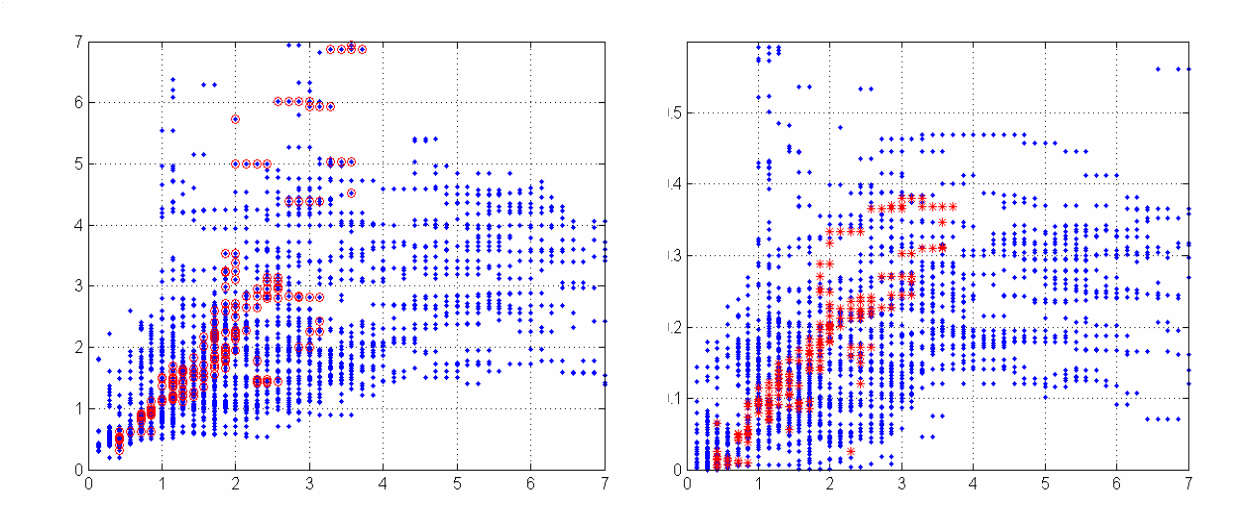
We have also used MODIS fluorescence data to explore the possibility of improved chlorophyll estimation in coastal waters where traditional absorption-based algorithms often fail. Hoge demonstrated that FLH provided more consistent results in Case 2 waters in the Atlantic. The two figures below from 25 June 2002 cover the waters around southern Africa. The top image is MODIS chlorophyll and the bottom image



is MODIS FLH. In general, the patterns are similar but note that near the center of the image, the chlorophyll values are masked out along the SW coast of Africa, but there is valid FLH data. It is likely that the chlorophyll algorithm failed because of sediment and other non-chlorophyll materials in the water.

A more quantitative analysis was done with imagery collected during the August 2000 GLOBEC cruise. We compared MODIS chlorophyll estimates with ship-based estimates. The figure below on the left (note that the red points correspond to ship data collected within 12 hours of the MODIS image) shows a generally linear relationship at values less than 2 mg/m^3 but MODIS overestimates chlorophyll content at higher values. The comparison with FLH (on the right) shows a more linear relationship. Thus FLH may

improve our estimates of chlorophyll in coastal waters.



Chemostat Experiments

Amanda Ashe has continued 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 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. These data show that CFE is nearly constant over a wide range of growth rates if the phytoplankton community is close to equilibrium with its environment. However, if there is a change in light availability or nutrient availability, CFE is higher at lower specific growth rates. Changes in the energy distribution system will make complicate models of either chlorophyll or productivity derived solely from fluorescence.

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 May 2002 cruise. We have just acquired the necessary hardware to collect Aqua data and we will be installing the hardware and software this summer.

EOSDIS Plans

We are developing a set of Web services using Microsoft's .net framework. The application uses a 3-tiered architecture that consists of the client, the web server and the database. Updates to the user interface and any event handling happen on the client using VBScript or JavaScript. Data is retrieved using server side scripts that run under Active Server Pages on the web server. The starting page itself is generated on the fly using the same technique while the tree-like structure is populated from XML data islands that are loaded in a similar manner. If the "plot" option is selected, data is also automatically transferred to the plot controls once it is retrieved. Only those parameters that can be plotted are shown in the drop down lists. This was implemented using XML attributes. The data can then be viewed as a 2D plot, 3D plot or histogram.

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 and 2003
- 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 now declared valid.