Semi-Annual Progress Report

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Task Objectives

The objectives of the last six months were:

- Update MODIS quality assurance information and MODIS software for reprocessing at the DAAC
- Continue analysis of data from MODIS validation cruises off Oregon
- Continue evaluation of MODIS imagery from several regions of the world ocean
- Begin 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 Software Updates and Quality Assurance

We prepared a MODIS Quality Assurance document that describes the basic MODIS fluorescence products and their limitations. We revised the product-specific quality flags as well as the quality level flags to be consistent with the MODIS Oceans suite. This approach was ratified at the MODIS Oceans meeting in Miami in April 2001.

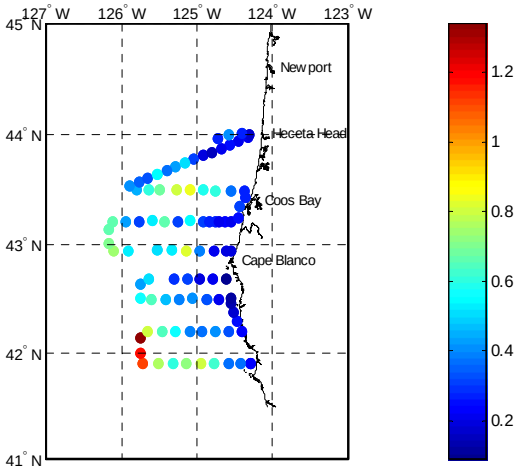
The Quality Assurance document can be found at
http://nugget.oce.orst.edu/ORSOO/MODIS/fluor/fluoresc.pdf

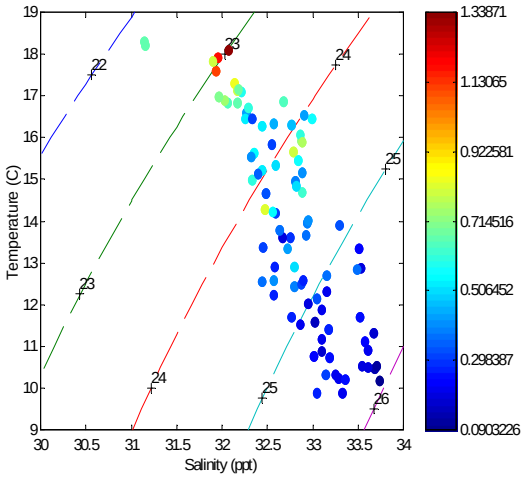
We revised the Chlorophyll Fluorescence Efficiency software to account for differences in the units between our Fluorescence Line Height (FLH) product and the Absorbed Radiation by Phytoplankton (ARP) product developed by Ken Carder. These changes have resulted in reasonable CFE estimates. The entire set of MODIS fluorescence products has been incorporated into the latest version of MODIS Oceans software and delivered to the GSFC DAAC. A description of the latest fluorescence images is presented later in this report.

MODIS Validation Cruises.

We conducted another cruise off the Oregon coast in May 2001. Fortunately MODIS was operating during the cruise this time, unlike the August 200 cruise. 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 will be 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. A second cruise is planned for August of this year.

We continue to analyze the data from the GLOBEC cruises conducted in 2000. We now have completed the pigment analyses. The figure below shows the ratio of photoprotective pigments to photosynthetic pigments as the color-coded dots. The map on the left shows that the offshore communities have a





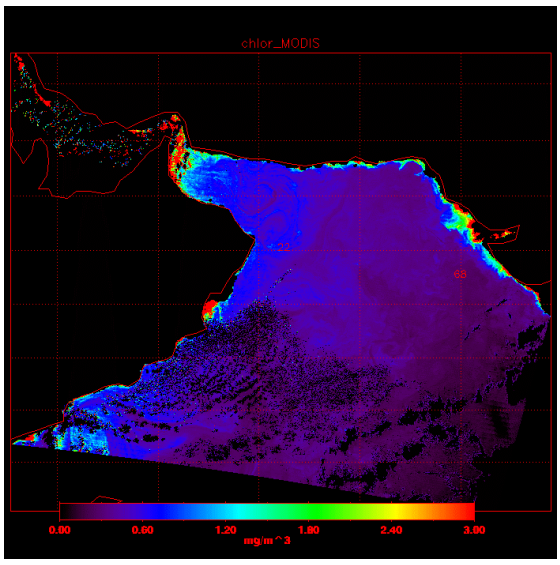
higher proportion of photoprotective pigments. This can also be seen in the figure on the right that plots the ratio of the two types of pigments on a temperature/salinity basis. Phytoplankton communities in the freshly-upwelled waters nearshore have a lower fraction of photoprotective pigments as expected. In the January Semiannual report, we noted that these nearshore communities fell off a simple linear relationship between photosynthetic capacity (as determined by FRRF measurements) and FLH/chlorophyll. As expected, a simple relationship between FLH and photosynthetic capacity is unlikely, and improved models of primary productivity must combine FLH, chlorophyll and an understanding of the oceanographic processes.

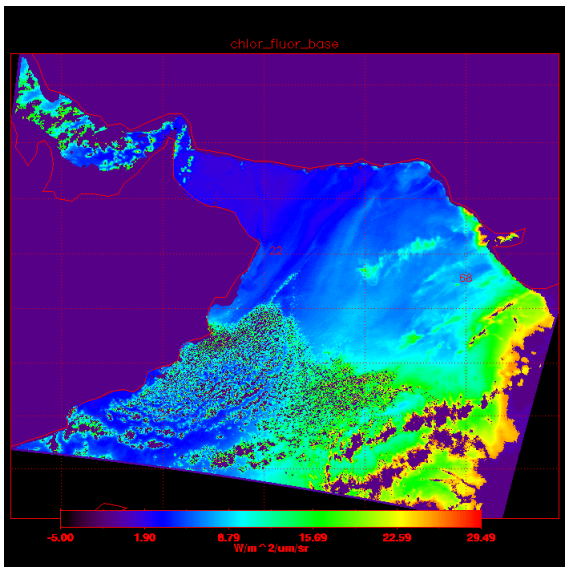
The second deployment of the GLOBEC bio-optical moorings was recovered, and no usable data were retrieved. This was the result of a series of design flaws by the manufacturer. These have now been corrected. The third deployment with the improved sensor packages will be recovered this fall. All of the bio-optical drifters from the GLOBEC 2000 deployment have now failed. We are preparing drifters for continued deployments next year.

All of the GLOBEC data can be obtained from our web site at:
http://nugget.oce.orst.edu/ORSOO/oregon/drifters/

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. The first image is

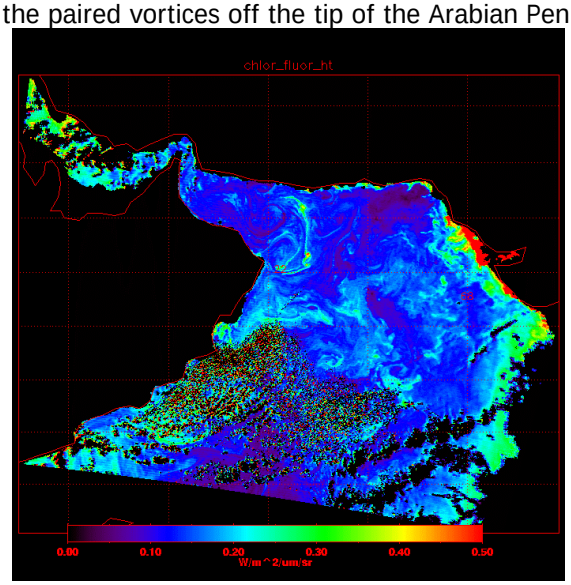


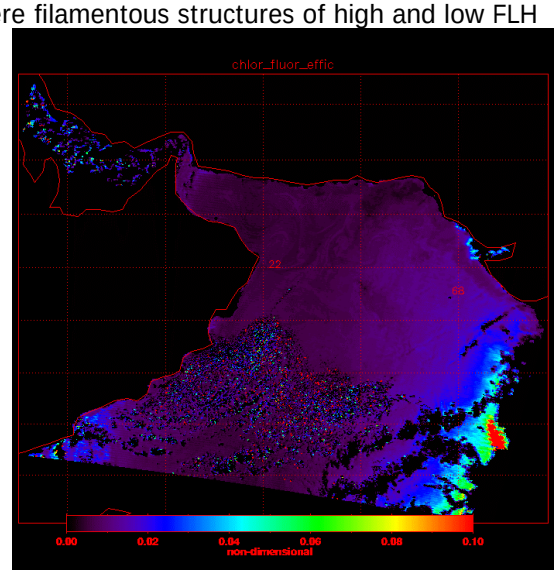


MODIS chlorophyll. Note that there is much less noise and banding than in earlier versions of the MODIS data. The Miami group has made enormous progress in understanding the behavior of the MODIS sensor, resulting in greatly improved data quality.

The second image shows the fluorescence baseline, which is primary method for atmospheric correction for the fluorescence products. Note that the baseline image has spatial patterns that are clearly "atmospheric," with long, wispy structure.

The third 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 fourth 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. We will continue our analyses as more data become available for the period November 2000 – June 2001. It is truly unfortunate that MODIS is now back on the A side electronics which are significantly noisier.

Chemostat Experiments

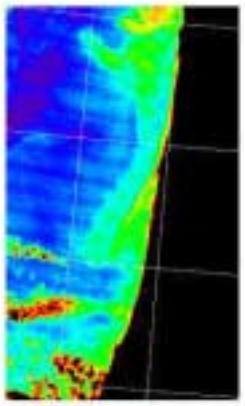
We have hired a new laboratory/field assistant, Amanda Ashe. Ms. Ashe had previously worked for Dr. Barney Balch (Bigelow Marine Laboratory) who is a co-investigator with Howard Gordon. Ms. Ashe brings considerable expertise in field and laboratory work in bio-optics and phytoplankton physiology. She has recently begun a new set of chemostat experiments, continuing the work started by Sam Laney. She is now investigating the relationship of photosynthetic capacity as measured by FRRF with oxygen evolution.

Direct Broadcast

Our EOS Direct Broadcast facility (http://nugget.oce.orst.edu/ORSOO/MODIS/DB/) is now full operational. We have implemented the complete set of MODIS ocean products, and these are now available from our web site. These Level 3 products combine all passes from a single day onto a single grid covering the our ground station footprint and centered on Corvallis, Oregon. These are produced using "old" ancillary data so that they are available in near real-time; final versions with the complete ancillary data are produced approximately one week later. We maintain a rolling online archive of one weeks' worth of data.

We provided cruise support for the May 2001 cruise. We developed a crude "chlorophyll" image using the 500m resolution bands as the cruise was focusing on small-scale horizontal structures in the coastal ocean. An example of such an image is shown below where we calculated the ratio of the 550 nm band

to the 470 nm band. Although there is some banding in the image, there is much more structure apparent in this 500m resolution image than in the corresponding 1km resolution image. We are rewriting some of the DB software in Java to improve its functionality and robustness. A workshop for US EOS-DB users is planned for early September 2001 on the slopes of Mt. Hood, Oregon.



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.

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 2001
- Continue to develop and expand browser-based information system for in situ bio-optical data.

Problems and Solutions

The most significant concern now is access to consistently-processed time series of MODIS Level 2 and Level 3 data. Most of the issues discussed in the last report have now been overcome. The University of Miami team is to be congratulated for their hard work! The data now being produced is simply fantastic! As the DAAC begins to deliver the “one consistent year,” we expect to be able to perform quantitative analyses of algorithm performance. The unfortunate anomaly from last June that resulted in switching to the A side electronics is extremely disappointing, as the noise level was significantly higher.

The second concern regards the MODIS DB processing software. We are still concerned that the basic L0/L1B software available to the EOS DB community does not reflect the latest understanding of the sensor. Moreover, we have implemented the MODIS ocean processing system, but the larger community is still trying to acquire these software tools.