

BIOSPACE- Bio-Optical Studies of Predictability and Assimilation for the Coastal Environment FY2008-2012

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Oceanography Division

Lead Co-Pi's

Robert Arnone: Ocean Color; Igor Shulman: Modeling and Data Assimilation
William Teague: Field Measurements; ZhongPing Lee: Optical Modeling

Personnel

Physical and Biological Modeling; Data Assimilation

- John Kindle
- Igor Shulman
- Bradley Penta
- Jason Jolliff
- Stephanie Anderson
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Ocean Color: Robert Arnone +...

Field Measurements:

- William Teague
- Jeff Book
- Ewa Jarosz
- Andrew McQuaid, Mark Hulbert, Wes H

Optical Modeling and Measurements

- ZhongPing Lee
- Rick Gould
- PostDoc

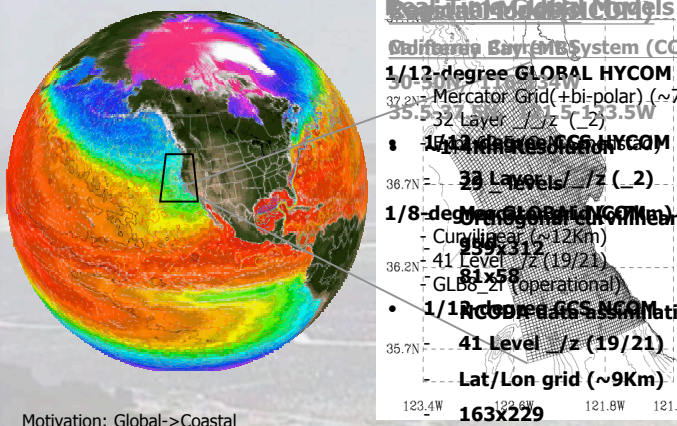
Variational Data Assimilation

- Scott Smith
- Post Doc

Objective

- Overall Goal: Predict 3-D optical properties of coastal ocean on time scales of 1-5 days.
- Objective: Improve our understanding of coupled bio-optical and physical processes in the coastal zone that govern the variability and predictability of the underwater light field on time scales of 1-5 days
- Hypothesis: Most accurate representation and prediction of optical properties requires fusion of remote sensing, in-situ observations and data-assimilative modeling using coupled optical-biological-physical models.

MODELS



Real-time Global Models

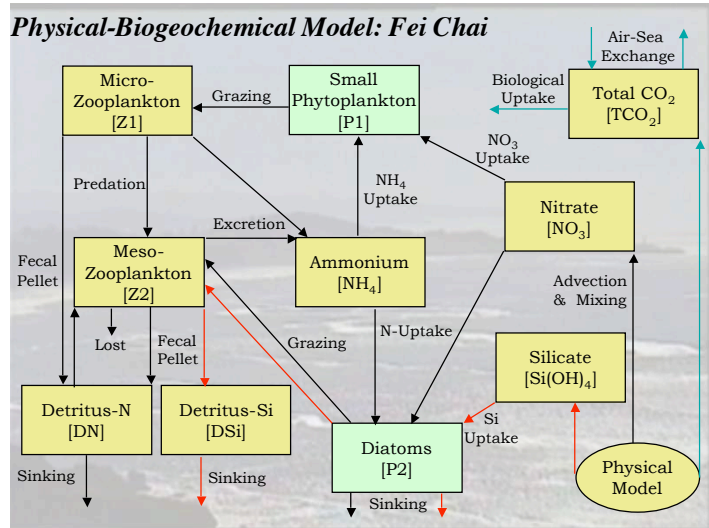
- **1/12-degree GLOBAL HYCOM**
- Mercator Grid (+bi-polar) (~7Kr)
- 32 Layer / z (-2)
- **1/11-degree CCS HYCOM**
- 28 Layer / z (-2)
- **1/8-degree ORCA OCM Near**
- Curvilinear (~12Km)
- 41 Level / z (19/21)
- GLB_21 (operational)
- **1/11-degree ORCA ASSIMILATION**
- 41 Level / z (19/21)

Lat/Lon grid (~9Km)

Motivation: Global->Coastal

123.4W 122.6W 121.8W 121.2W

163x229



Near Real-time Depiction of California Current System: Homepage - Mozilla Firefox

<http://www7320.nrllsc.navy.mil/ccsrt/>

The Naval Research Laboratory - Stennis Space Center: 7331 Oceanography Division

Near Real-Time Depiction of the California Current System

- Overview**: Daily fields of currents (5m level), sea surface temperature (SST) and sea surface height (SSH) are shown for the real-time Global NCOM currently being tested for operational use at the Naval Oceanographic Office and for the real-time regional NCOM for the California Current System (NCOM-CCS) with an embedded ecosystem model. NCOM assimilates daily MCSST surface temperature values and synthetic profiles of temperature and salinity obtained from the MOCAS product. MOCAS registers satellite derived SST and SSH values to obtain the synthetic T and S profiles.
- 8-day means of NCOM currents and SSH contours are also shown together with corresponding means of chlorophyll concentrations from SeaWiFS and 5-day means for MODIS-AQUA (after January 2005). The NRL Ocean Color Section processes the SeaWiFS and MODIS-AQUA imagery using standard and newly developed algorithms to obtain a variety of bio-optical products. The chlorophyll fields shown in the SeaWiFS plots use the standard OC4 algorithm, and the MODIS-AQUA plots use the OC3m algorithm. Corresponding model chlorophyll fields with surface currents are also shown for the NCOM-CCS model.**
- Additional Links**:
 - Global Bio-Optical and Physical Processes
 - OC4R300 - Oceanographer Decision Products
- 18° Global NCOM**:
 - Latest Images
 - Archived Images
- High Resolution Coupled Bio-Physical NCOM-CCS**:
 - Latest Images
 - Archived Images
- Monterey Bay Experiment - Summer 2006**

Recent Advances in Remote Sensing: Role of Inherent Optical Properties in Bio-Optical Processes

Combined in APS algorithms (CDM)

Absorption Components:

$$a(\lambda, z) = a_w(\lambda) + \sum_i a_i^*(\lambda) c_i(z) + a_{cdom}(\lambda, z) + a_{particulates}(\lambda, z)$$

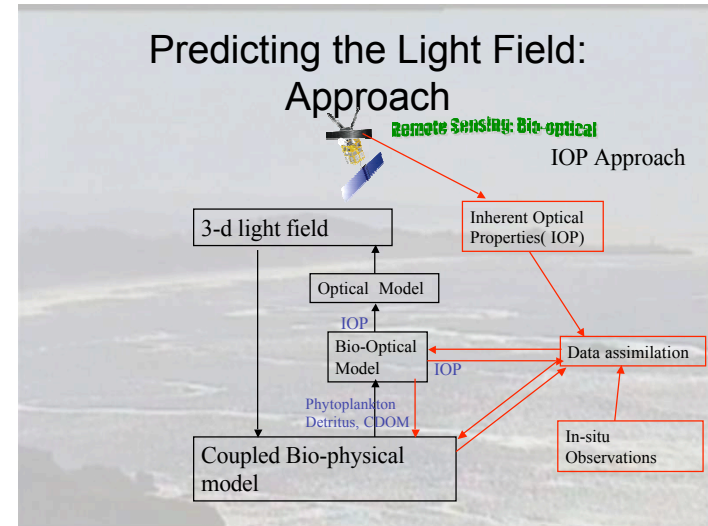
Total Absorption = Water + Chlorophyll + CDOM + Detritus, sediment, ...

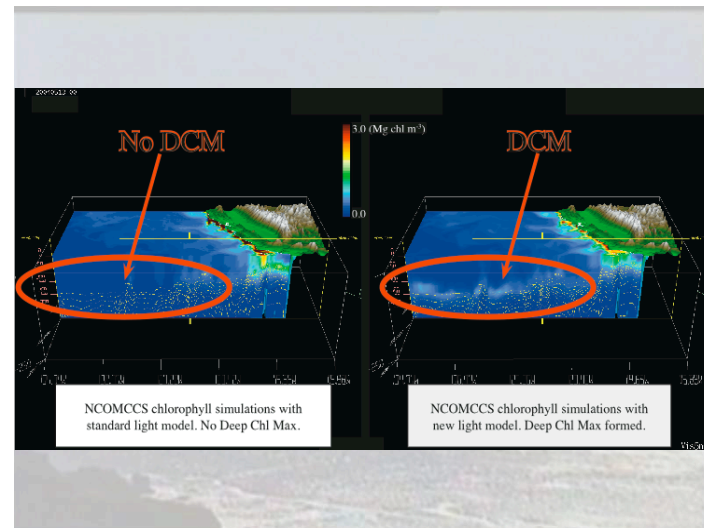
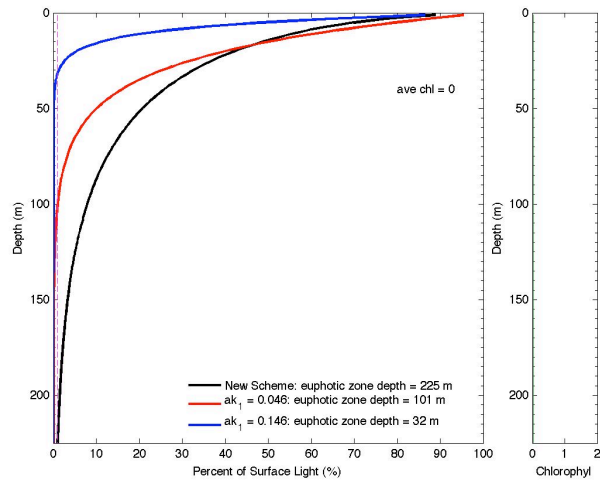
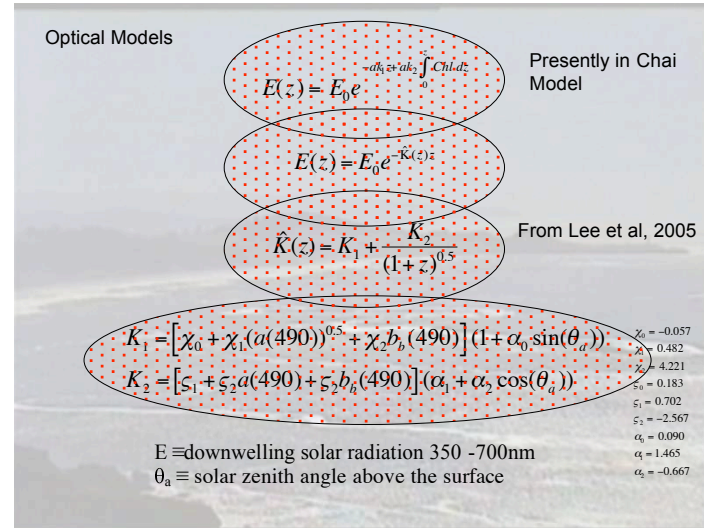
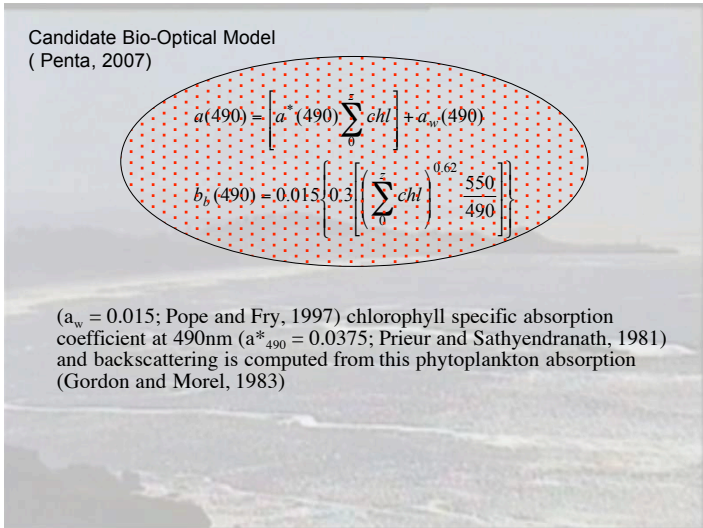
a_{ϕ}^* = chlorophyll Specific Absorption Coefficient

Scattering (b_{λ}) and Backscatter (bb_{λ}) Components

$$bb_{\lambda} \text{ total} = bb_{\lambda w} + bb_{\lambda p}$$

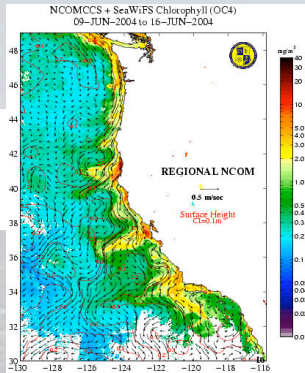
particles (size, shape, composition) organic inorganic





Model Evaluation: Regional NCOM

NCOM Regional (CCS) with SeaWifs Chlorophyll

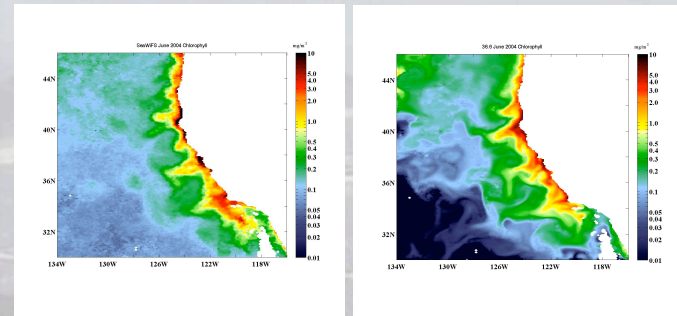


Overlay of model currents and SSH with SeaWifs Chlorophyll.

Surface Chlorophyll Comparisons with SeaWiFS

SeaWiFS Chl: June 2004

Model Chl: June 2004

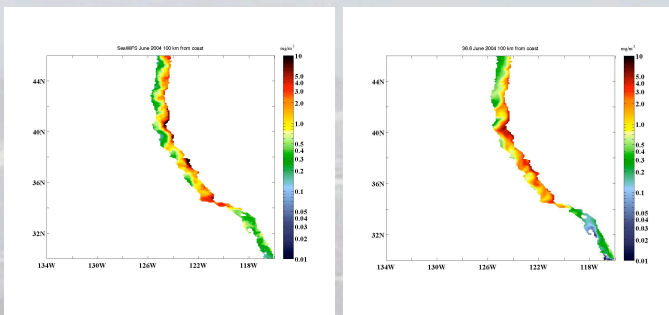


Examine correlation between fields over period 2000-2005

Surface Chlorophyll Comparisons with SeaWiFS

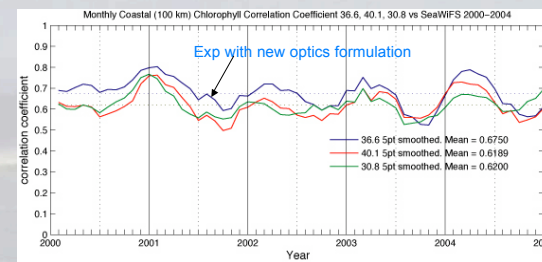
SeaWiFS Chl: June 2004

Model Chl: June 2004



Compare Chlorophyll fields within 100km of coast

Surface Chlorophyll Comparisons with SeaWiFS



Time series of monthly correlations along coast Between Model and SeaWiFS Chl.

Coastal Chl metrics can be used to evaluate model sensitivity to new formulations or forcing. Blue curve is run with new optics formulation showing improved response. (Penta: 2007)

Scientific Issues

- **Bio-optical Modeling**
 - Relationship between Model Biological Output and IOP
 - Efficient and accurate models to simulate light propagation when water column is non-homogeneous
- **Joint Assimilation of Physical and Bio-optical Data**
 - Initialization of Ecosystem Model
 - Choice of model variables and parameters for direct inference
 - Balanced adjustment of model variables which are not inferred
 - Modeling and estimation of error covariances for models and observations
- **Remote Sensing: Continued refinement of APS**
 - Algorithms to detect major phytoplankton size groups
 - Separating CDOM and detritus

The End

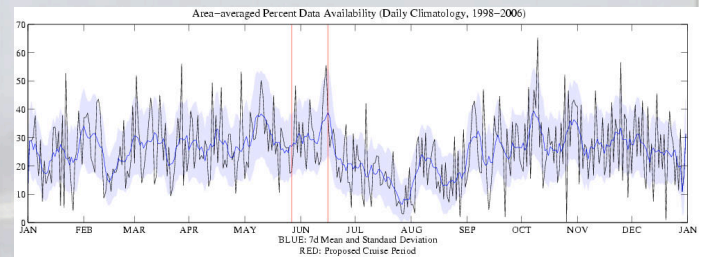
BIOSPACE: NRL ARI (FY2008--2012)

Bio-Optical Studies of Predictability and Assimilation in the Coastal Environment



Joint Assimilation of Physical and Bio-optical Observations

Cruise period: May 27—June 17 2008



Averaged over MB model domain

