NRL modeling during ONR Monterey Bay 2006 experiment.

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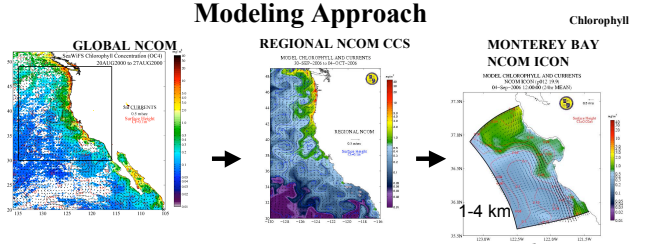
Support from projects:
ONR 32 "NRL modeling to support MURI ASAP experiment"
NRL 6.1 "Air-Sea Coupling in the Coastal Zone"
NRL 6.1 "Physical-Biological-Optical Modeling of the Coastal Environment"

Modeling Approach



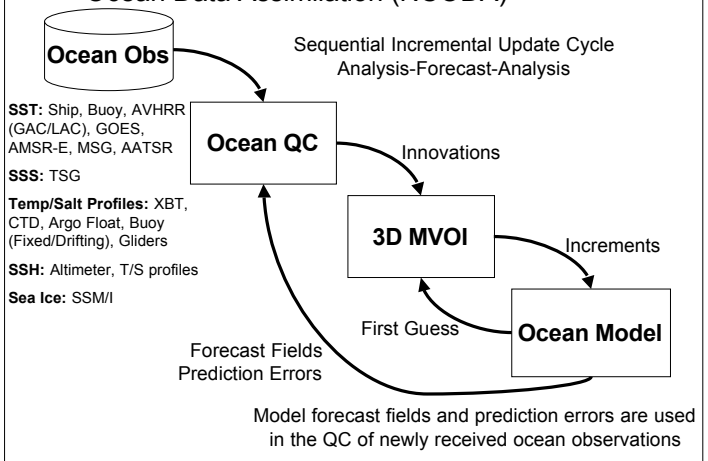
• To accommodate the wide range of horizontal scales of physical and biological oceanic processes we use a nested modeling approach in which global models provide boundary data to regional scale models which, in turn, feed coastal models and so on.

•Observational data from gliders, aircraft, AUVs and ship are assimilated by using the NRL Coupled Ocean Data Assimilation System.

NCOM Model

- **Primitive equations, 3D, hydrostatic model.**
- **Based on POM model but has options for using different advection schemes, open boundary conditions schemes, turbulence closure schemes, etc.**
- **Include routines for direct reading and processing atmospheric model COAMPS outputs. Possibility of two-way coupling with COAMPS.**
- **OSU tidal constants are used for tidal forcing**
- **Sigma or hybrid (sigma-z) (sigma on top, z on bottom) vertical coordinate systems.**
- **Parallelized code runs on different computer platforms.**

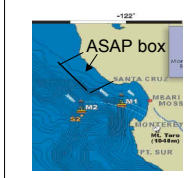
Ocean Data Assimilation (NCODA)



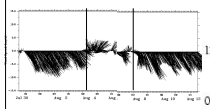
Real-Time Modeling Strategy

- **RUN 1 (non-assimilative run)** was initialized on July 11th from the regional model NCOM CCS and spun up with tidal forcing, COAMPS 3km surface fluxes and with the NCOM CCS on open boundaries. Testing of the COOP system. NCOM CCS and NCOM ICON model predictions were posted on the NRL web site, and were used by the AESOP group (Ramsay Harcourt) for surveys planning.
- **RUN 2 (only glider data assimilation)** was started from RUN1 on July 19th with assimilation of glider data from SIO gliders, and later from WHOI gliders.
- **RUN 3 (glider, aircraft, ship, AUVs data assimilation)** was started from RUN2 on July 26th (with the first aircraft survey) with assimilation of aircraft SSTs surveys and later (August 1, ROMS and HOPS came on line) with assimilation other data types.
- Model outputs were provided to the MB2006 data base, and were plotted on the ASAP Collaborative Ocean Observatory Portal (COOP) web site. NRL Web page provided real-time products from the hierarchy of different resolution data assimilating models.
- **Comparisons of RUNS 1-3 provide possibility to evaluate in REAL-TIME the impact of glider data assimilation on the model predictions.**

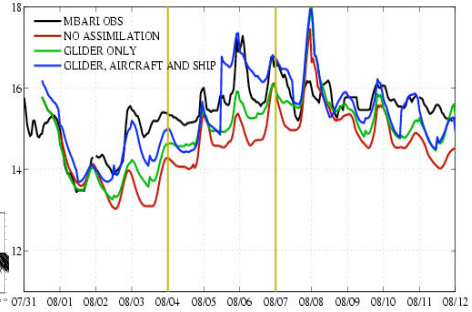
Impact of glider data assimilation
Comparisons of NCOM ICON and observed SSTs at M1



Wind at M2



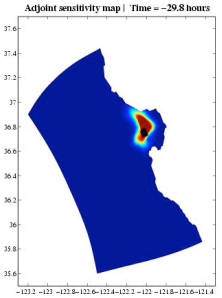
M1 SURFACE TEMERATURE

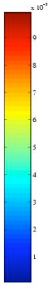


Upwelling **Relaxation** **Upwelling**

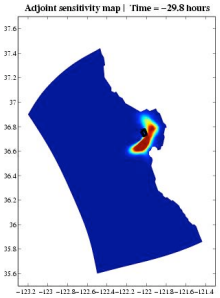
Adjoint sensitivity maps M1

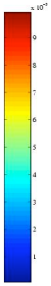
Upwelling





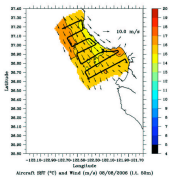
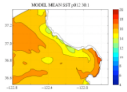
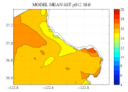
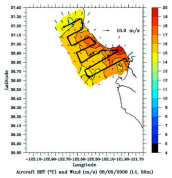
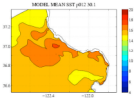
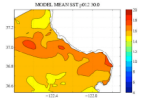
Relaxation





Impact of glider data assimilation

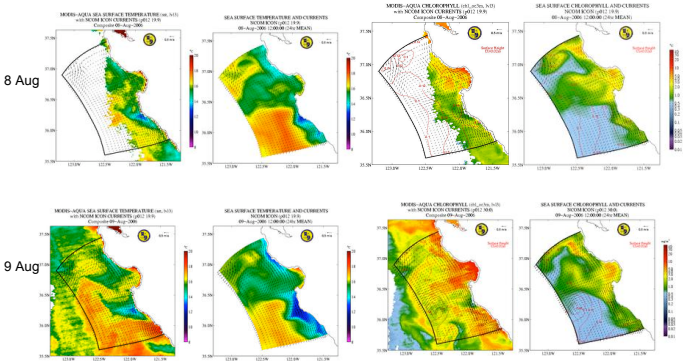
Comparisons between Aircraft and NCOM ICON model SSTs.

	Aircraft SST	NCOM ICON SST	NCOM ICON SST
		With assimilation only gliders	With assimilation gliders and other assets
Aug. 8 Upwelling			
Aug. 5 Relaxation			

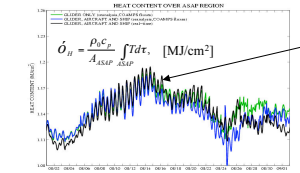
Comparisons satellite-observed and NCOM model-predicted SST and Chlorophyl.

8 Aug

9 Aug



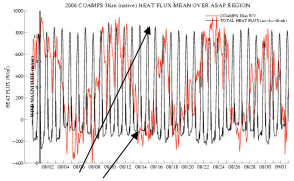
ASAP BOX HEAT STUDY

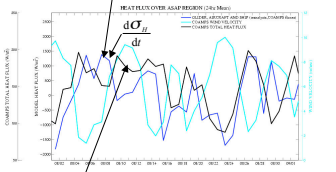


$$\dot{Q}_H = \frac{\rho_0 c_p}{A_{ASAP}} \int_{ASAP} T d\tau, \quad [\mathrm{MJ/cm^2}]$$

Heat flux semi-diurnal variability ~ 10^4 W/m^2

24 hour averaged heat flux variability ~ 10^3 W/m^2





$$\frac{d\bar{Q}_H}{dt}$$

COAMPS surface heat flux diurnal variability ~ 10^2-10^3 W/m^2

24 hour averaged COAMPS surface heat flux variability ~ 10^2 W/m^2

What is next?

OBJECTIVES

- How much dynamical variability of the environment can be predicted and explained with the model assimilating gliders surveys?
- Simulate the typical situation of the Navy operations in areas with restricted access: nested fine resolution coastal models are initialized from larger scale operational models and products, and glider surveys are used for assimilation.
- Optimization of sampling strategies with gliders.
- Study of the Ano Nuevo upwelling center heat/mass budget based on observations and models.
- Study of coupled bio-optical-physical processes.

APPROACH

- Conduct hindcast experiments with assimilation of "latest-the-greatest" QCed observations.
- Continue evaluation of real-time predictions and compare them with hindcast runs
- Data denial experiments. Evaluate effectiveness of observations provided by various assets.
- Virtual Pilot Experiments of sampling strategies optimization with dynamical control of gliders. Integrate the model predictions into algorithms and software for the dynamical control and coordination of gliders.

Future Plans

NRL 5 year project:

Bio-Optical Studies of Predictability and Assimilation for the Coastal Environment (BIOSPACE , Oct. 2007 –Oct. 2012)

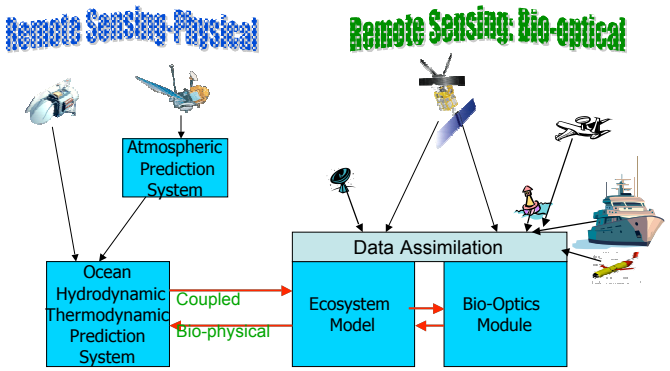
Objectives: Improve our understanding of

- Coupled bio-optical and physical processes in the coastal zone
- The variability and predictability of the coastal ocean's optical properties on time scales of 1-5 days, i.e., the time scales of accurate atmospheric forecasts.

Test area: Monterey Bay

Planned experiments: FY2008 and FY2010

Goal: Real-time Coupled Ocean Prediction Systems



BIOSPACE
NRL Field Program
FY08

- **Observational assets**
  - 4 Slocum Gliders
    - Continuous profiles to maximum depth of 200m
      - **T, S, fluorescence, backscattering, attenuation, current speed**
  - Scanfish
    - CTD, spectral backscattering, absorption
    - Complements high spatial and temporal sampling
    - Will participate in both survey and adaptive sampling modes
  - SEPTR Real-time bottom-mounted Profiler
- **Examine**
  - Vertical structure of Physical, optical/bio-optical properties
  - Relationship to Satellite vertically integrated measurements
  - Space-time variability of physical-bio-optical properties
  - Sampling strategies