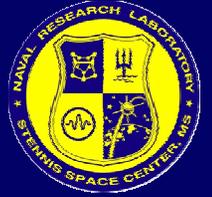


ASLO - TOS 2004 Ocean Research
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Operational Global Ocean Assimilation and Modeling with the Navy Coastal Ocean Model

Charlie N. Barron

Clark Rowley

A. Birol Kara

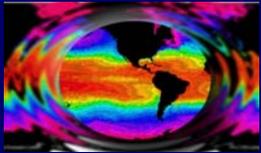
Robert C. Rhodes

Lucy F. Smedstad

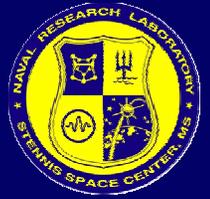
Jan M. Dastugue

Naval Research Laboratory Code 7323
Stennis Space Center, Mississippi

Supported by Oceanographer of the Navy
through SPAWAR PMW155

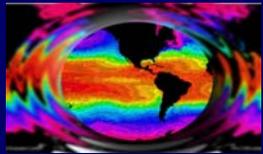


ASLO - TOS 2004 Ocean Research
Conference – Honolulu, Hawaii



Operational Global Ocean Assimilation and Modeling with the Navy Coastal Ocean Model

- Global NCOM System
- Validation Tests
- Operational Applications
- Planned Upgrades

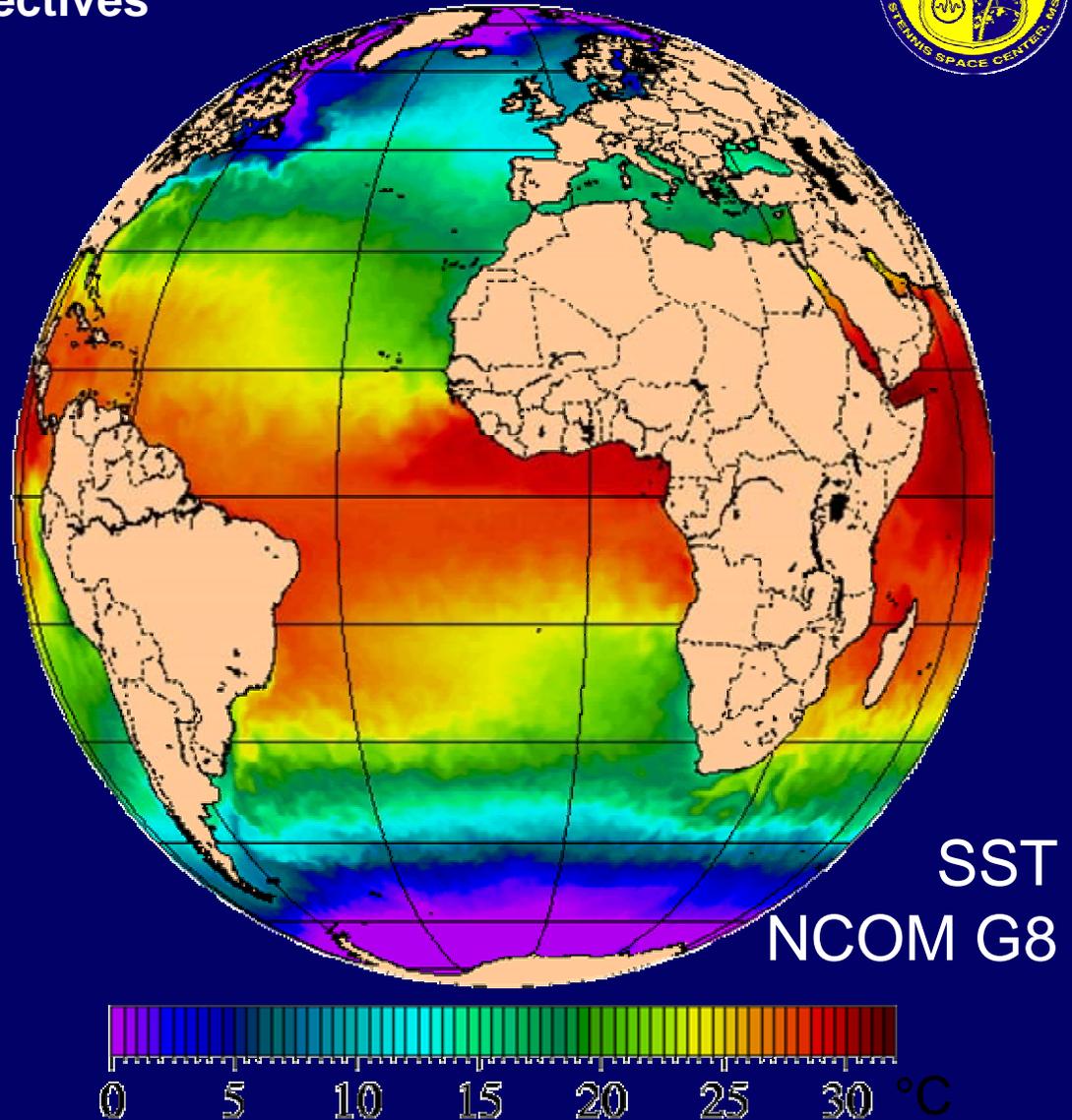


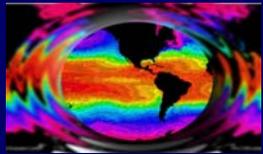
1/8° Global Navy Coastal Ocean Model (NCOM G8) Operational Objectives



NCOM G8, a moderate resolution, fully-global ocean forecast system, is to provide:

- initial/boundary conditions for real-time nested regional/coastal models
- short-term upper ocean predictions
- ice model host
- capability for a global coupled air/ocean system (NOGAPS)

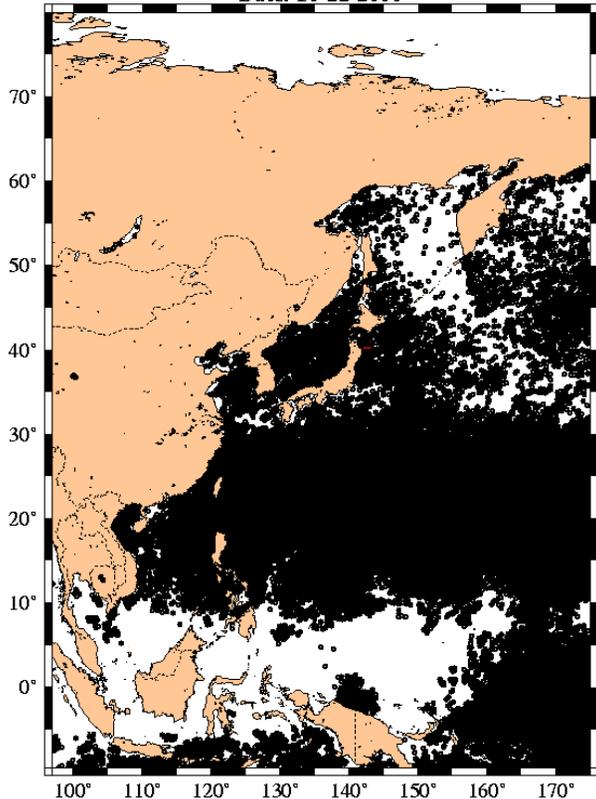




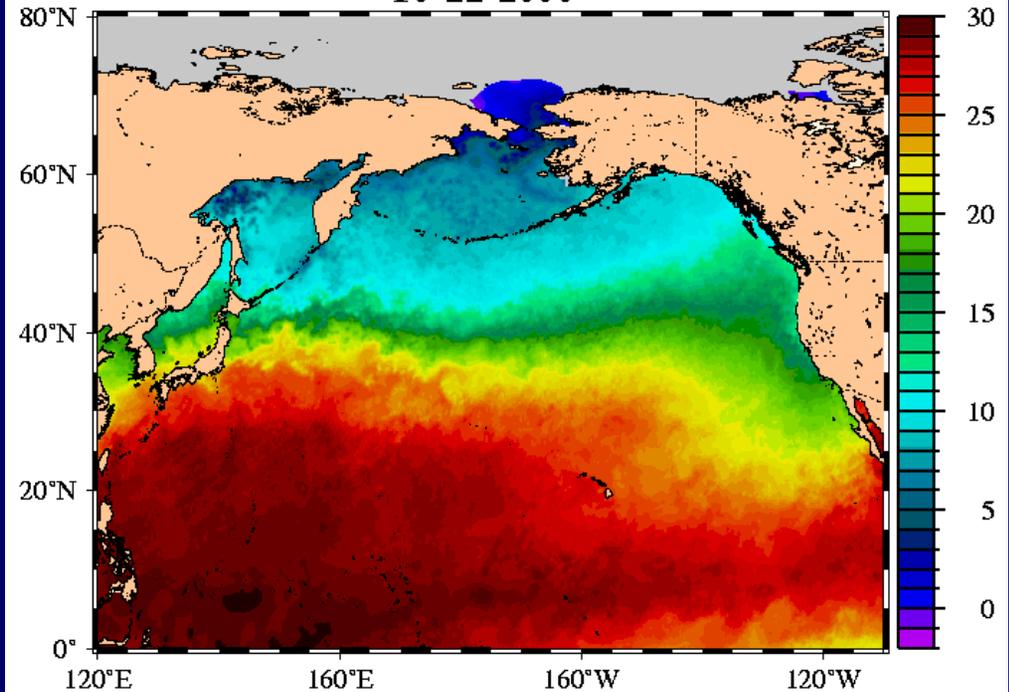
Daily MODAS2D OI of SST



Locations of Observations Used for SST OI
Date: 10-22-2000

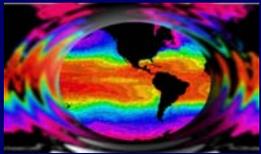


MCSST OI: Sea Surface Temperature (C)
10-22-2000

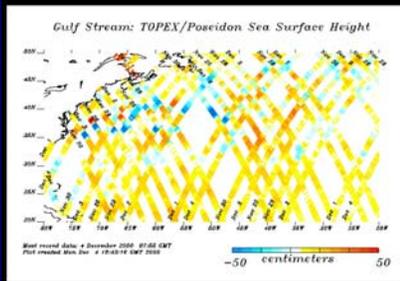


Naval Research Laboratory MODAS 2.1

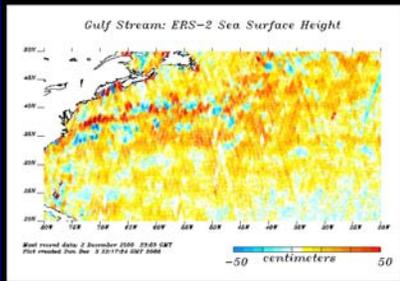
A first guess field and scattered satellite SST observations are combined in an optimal interpolation procedure to produce daily global $1/8^\circ$ SST fields.
see <http://www7300.nrlssc.navy.mil/altimetry>



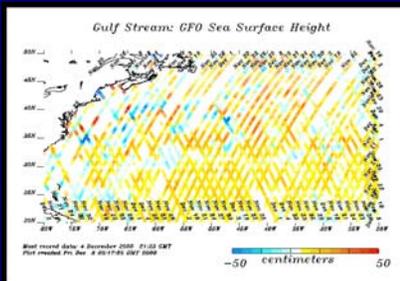
NLOM Assimilation of Altimeter Data



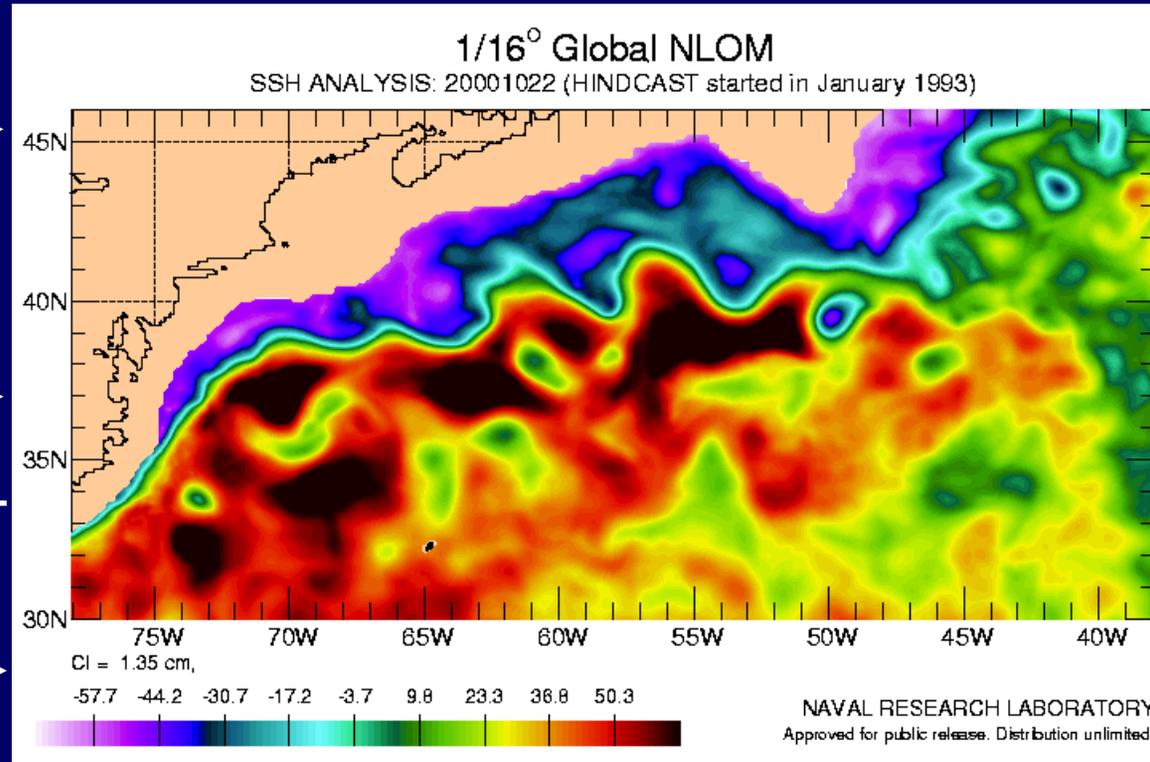
TOPEX,
JASON



ERS2,
ENVISAT



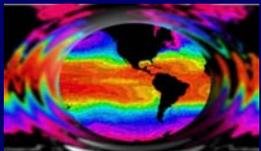
GFO



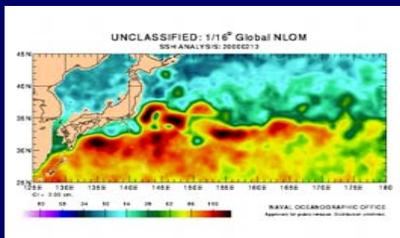
Operational 1/16° global NLOM assimilates gridded SST and track by track altimetry. NLOM bottom pressure anomaly can be used to partition height deviation into steric and non-steric SSH. MODAS uses SST and steric SSH estimate subsurface T,S. See http://www7320.nrlssc.navy.mil/global_nlom.



NCOM G8 Data Assimilation



ALPS



1/16° NLOM

SSH

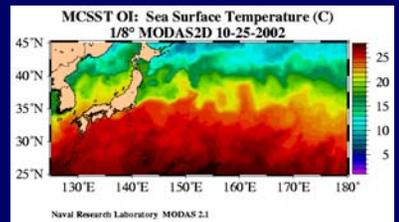
IN-SITU DATA

MODAS 3D

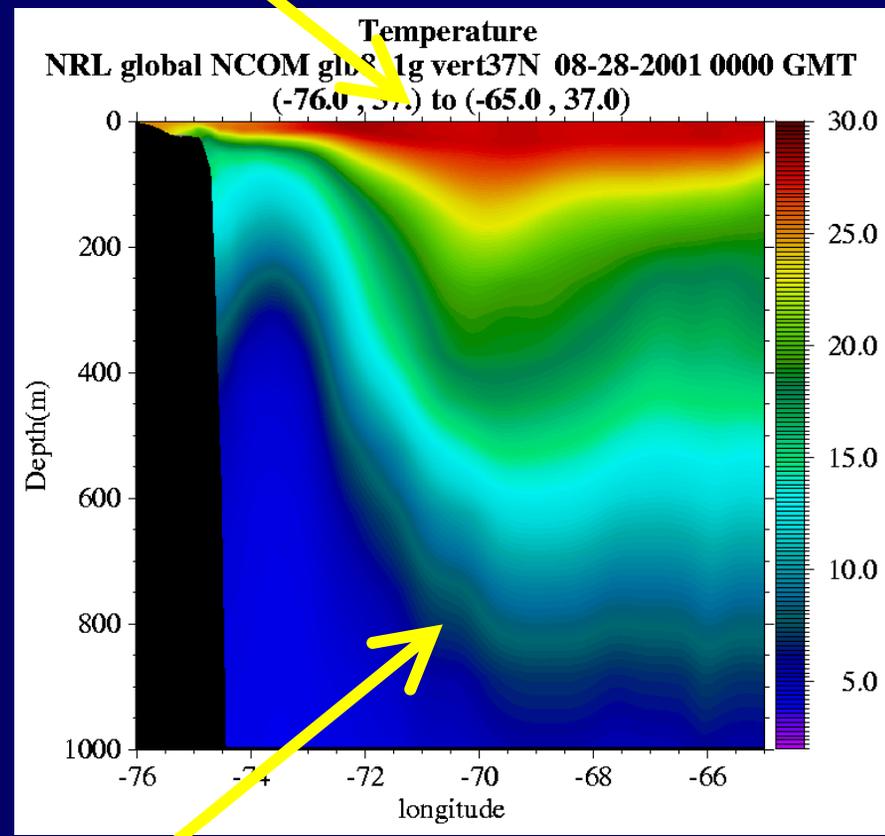
SST

MODAS 2D

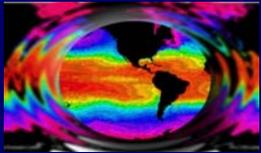
MCSST



SST & SSS Surface flux



3D T & S Relaxation



Global NCOM VTR: Experiments and Validation

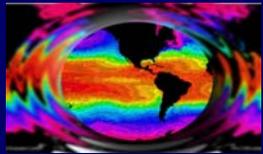


Model Experiments Covered

- NCOM G8 free-running hindcast 1998-2000
- NCOM G8 assimilative hindcast 1997-2002
- Bi-monthly NCOM G8 7 day forecasts 1998-2002

Validation Tests (vs. Unassimilated Data)

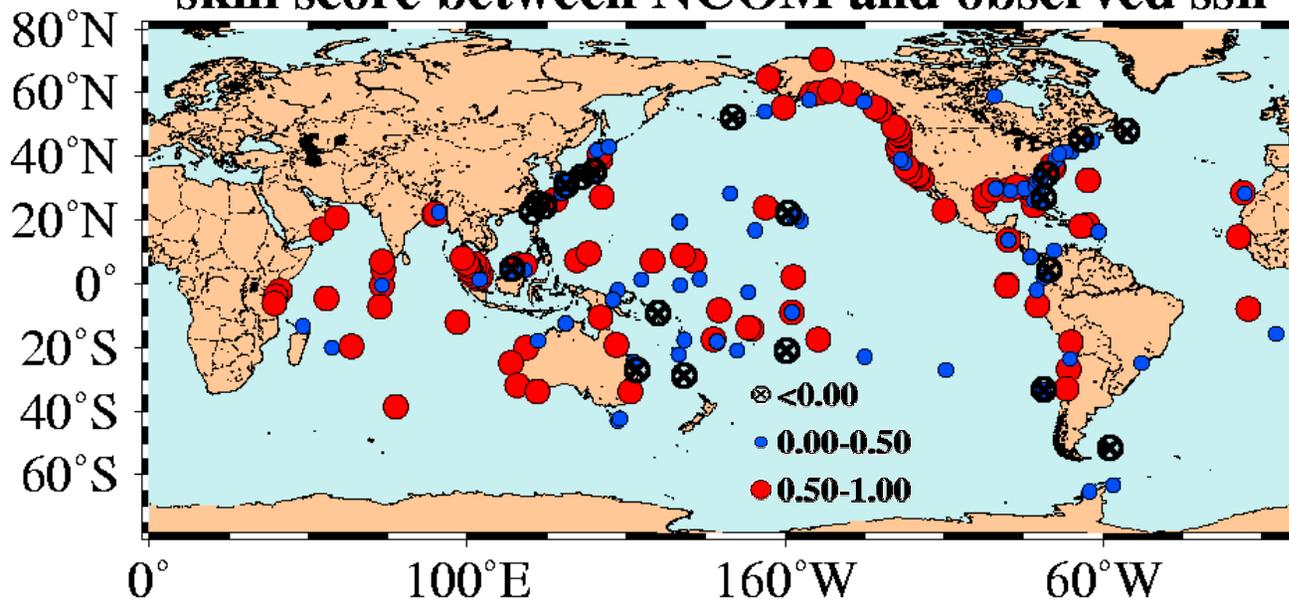
- **Sea Surface Height (analysis vs. sea level data)**
- Sea Surface Temperature (analysis/forecast vs. MCSSTs & buoys)
- **Mixed Layer Depth (analysis vs. profile data)**
- **Large, meso-scale circulation features (mean, analysis position)**
- Eddy kinetic energy/SSH variability (means)
- **Current cross sections (events, means)**
- **Drifter trajectories (Comparison with buoys Jun. – Nov., 2000)**
- 3D profiles and vertical cross sections (analysis vs. profile data)
- Transport through straits (total, means)
- Evaluation of NCOM + OSU global tides
- Evaluation of NAVO model response to NCOM boundary conditions



NCOM G8: SSH validation



1-day running mean for 1998 case glb8_2f
static inverse barometer effect applied
skill score between NCOM and observed ssh

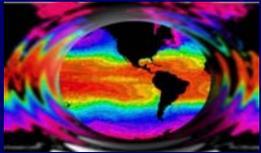


Daily medians

1998-2002	free	assim
Correl. R	.70	.76
Skill Score	.42	.51

Perfect skill is 1
Any positive score
indicates skill

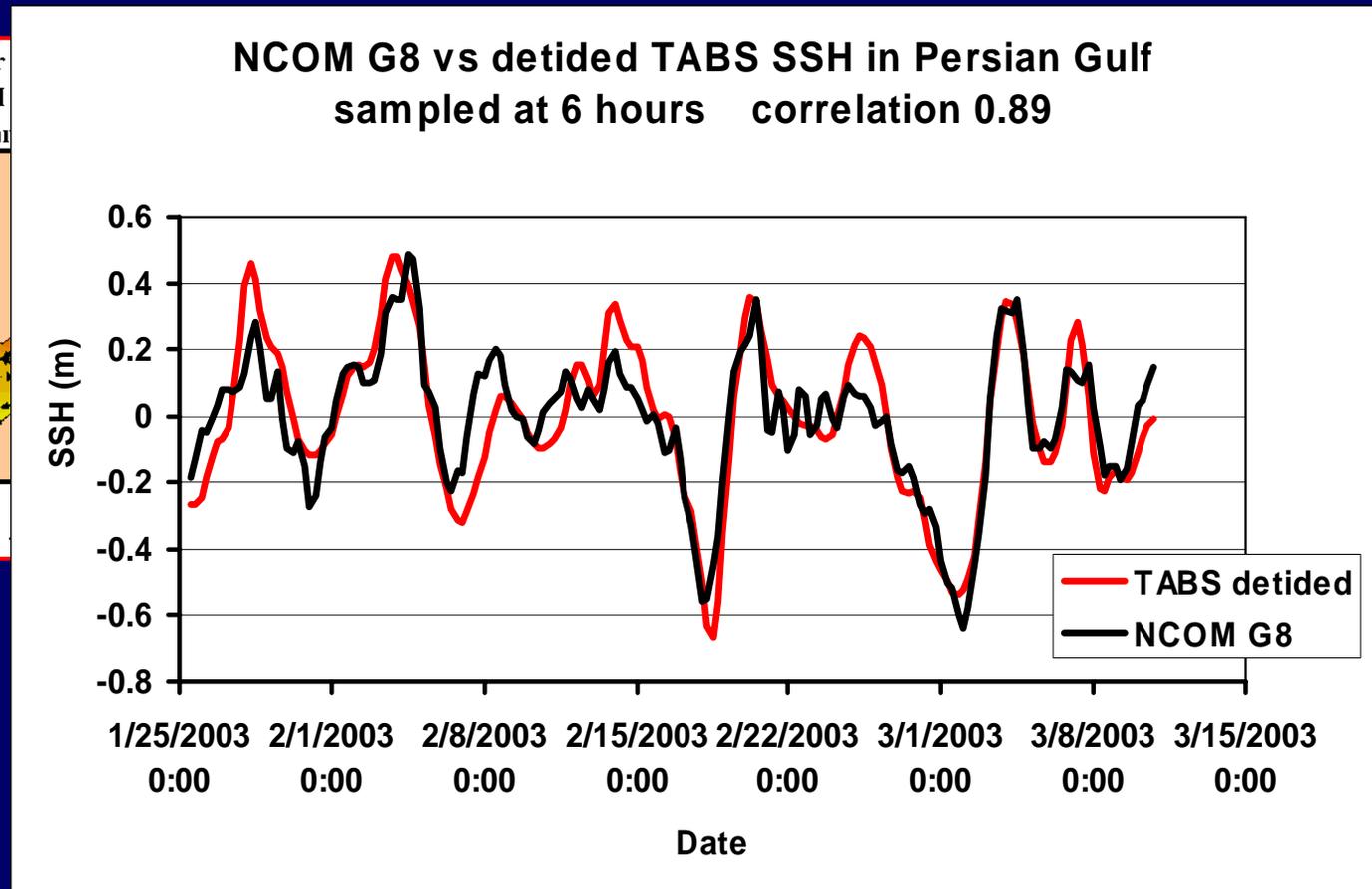
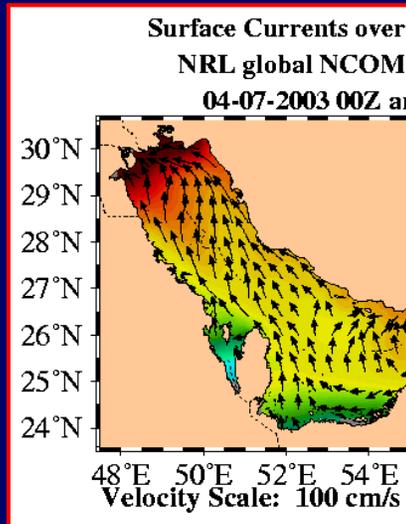
From 1998-2001, the NCOM G8 hindcast is compared with 612 unassimilated year-long sea level time series from global stations, where the data are referenced to common means and adjusted for the static inverse barometer effect. Assimilative median daily skill score is 0.51.

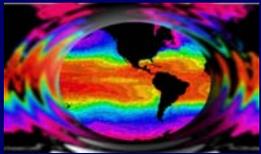


Persian Gulf extracted from NCOM G8



A Navy buoy deployed in late January 2003 measured sea level in northwestern Persian Gulf until damaged in mid March. Comparisons of the detided buoy observations with the independent NCOM G8 model results referenced to the same mean demonstrates the accuracy of the model predictions.

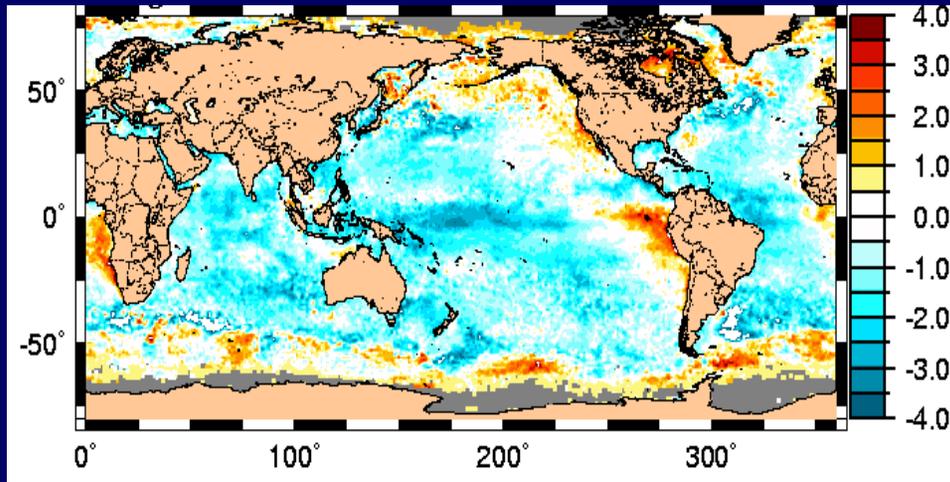




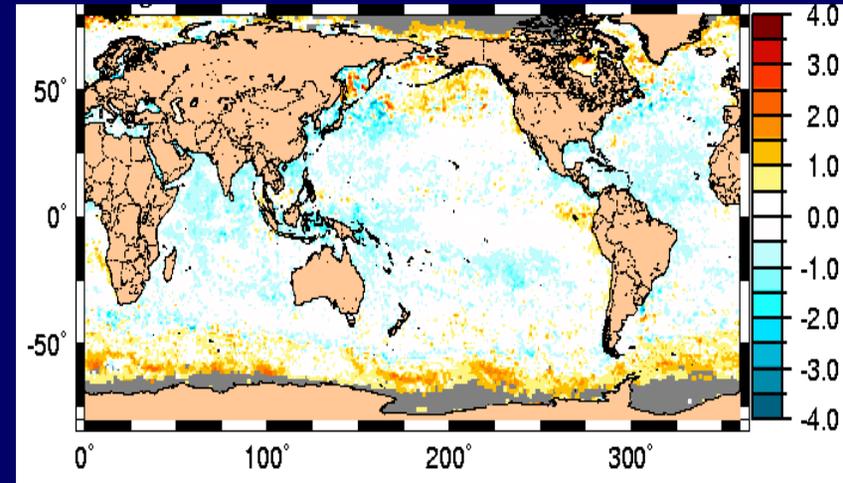
NCOM G8: SST Nowcast validations



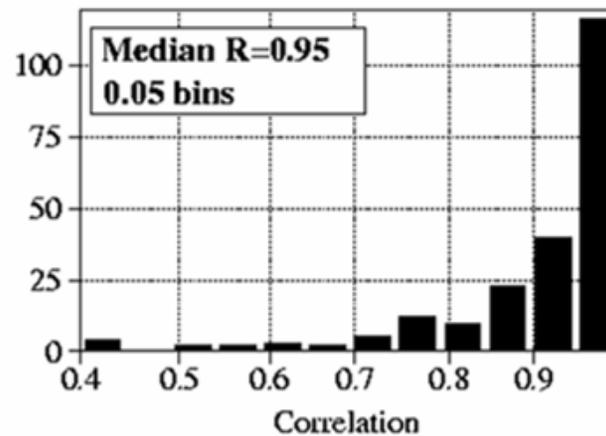
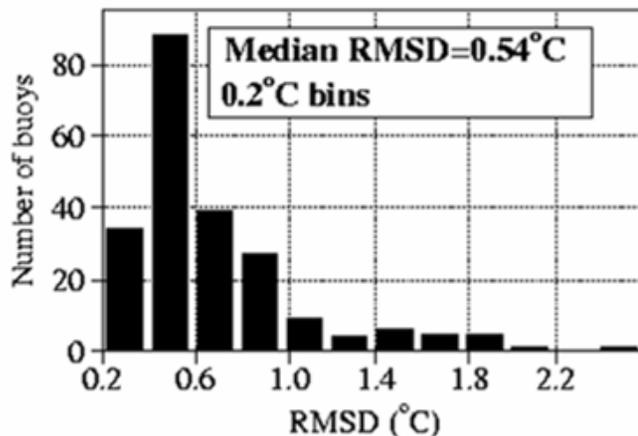
Monthly Mean Difference for October, 2000 of NCOM G8 – 9km Pathfinder SST



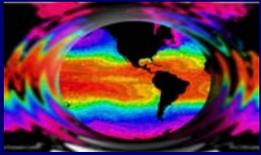
Free – Running



Assimilation Run



RMS difference and Correlation (R) between 219 unassimilated buoys and assimilative 1/8° global NCOM SST for 1998-2000.



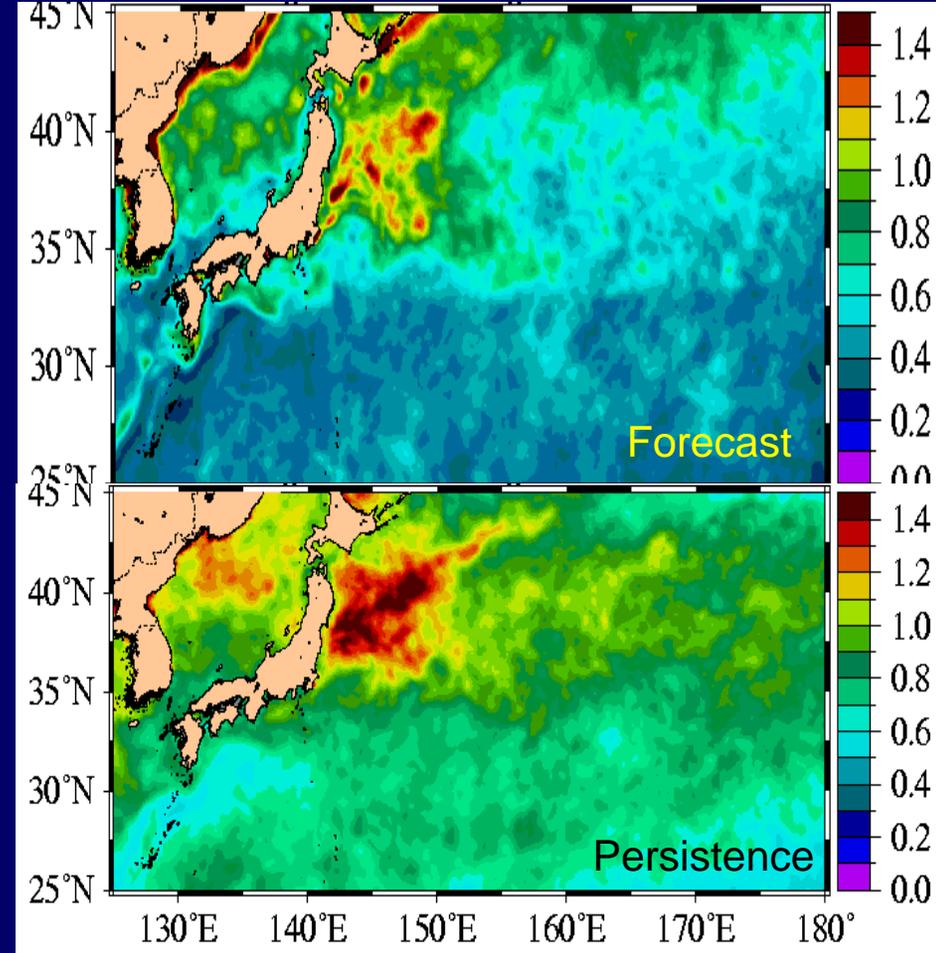
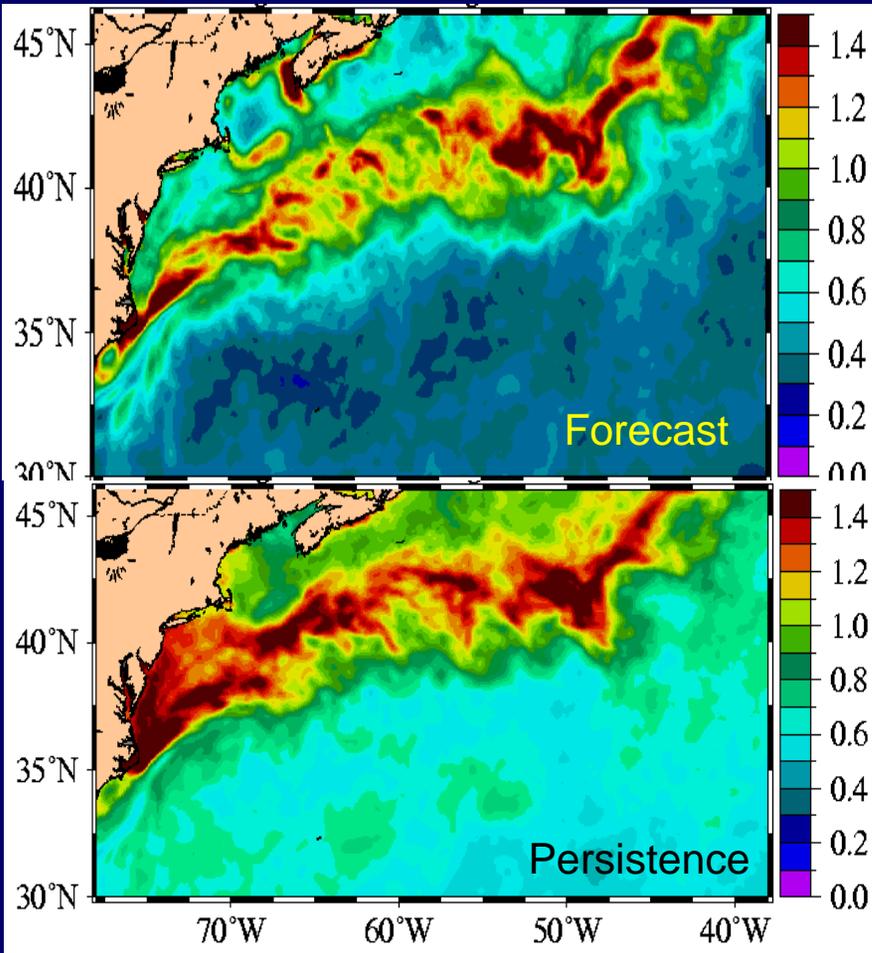
NCOM G8: SST forecast validation

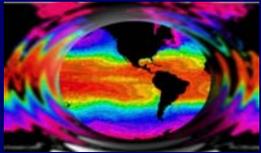


Mean 7-day RMS SST forecast error for 1998-2002

Gulf Stream

Kuroshio





NCOM G8 Mixed-Layer Depth

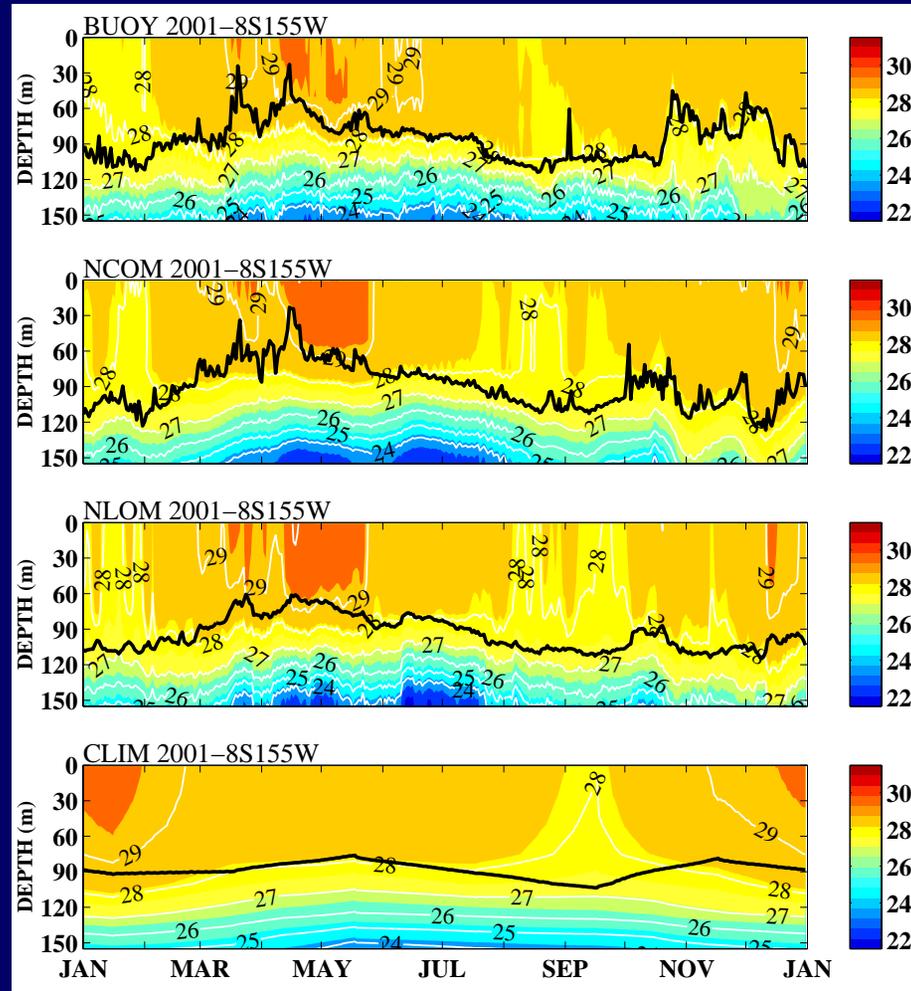


Daily temperature
(5°S, 155°W)
TAO buoy

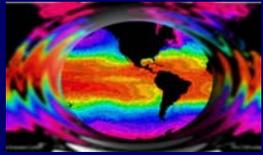
1/8° Global NCOM

1/8° MODAS
dynamic climatology
with NLOM SSH

1/8° MODAS
climatology



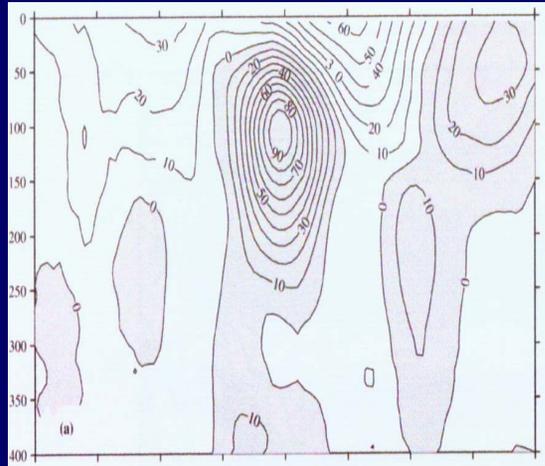
In comparison with 71 unassimilated, equatorial year-long time series of MLD (1998-2000), assimilative NCOM G8 had -8.6 m bias and 19.4 m RMS error for MLD on the order of 100 m.



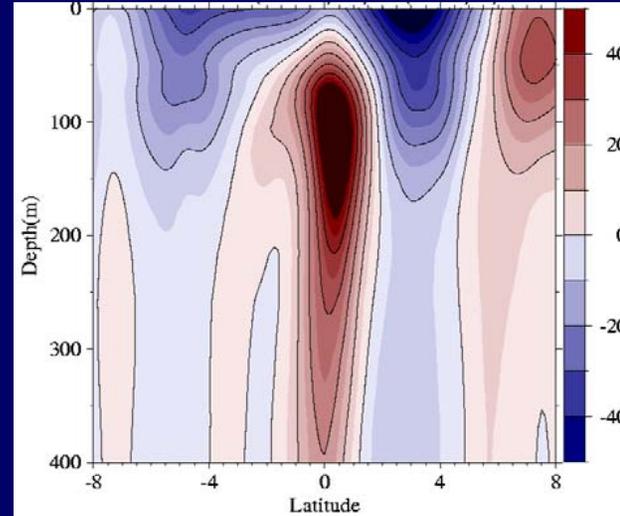
NCOM G8 Equatorial Undercurrent



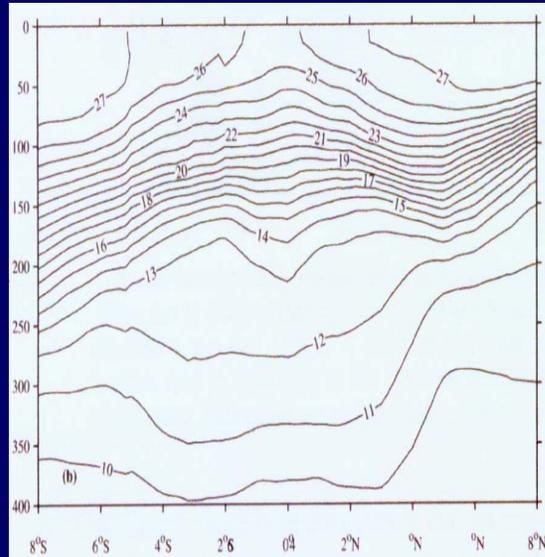
Velocity section and Temperature Section across equator at 135° W between 8° S and 8° N



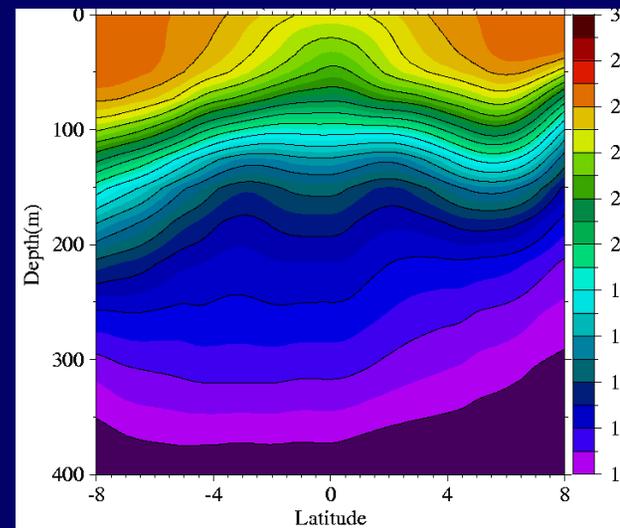
ADCP
Mean
Eastward
Speed
(Johnson
et. al, 2001)



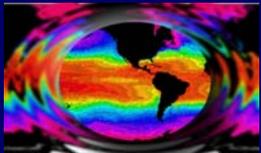
NCOM G8
Mean
Eastward
Speed
1998-2000



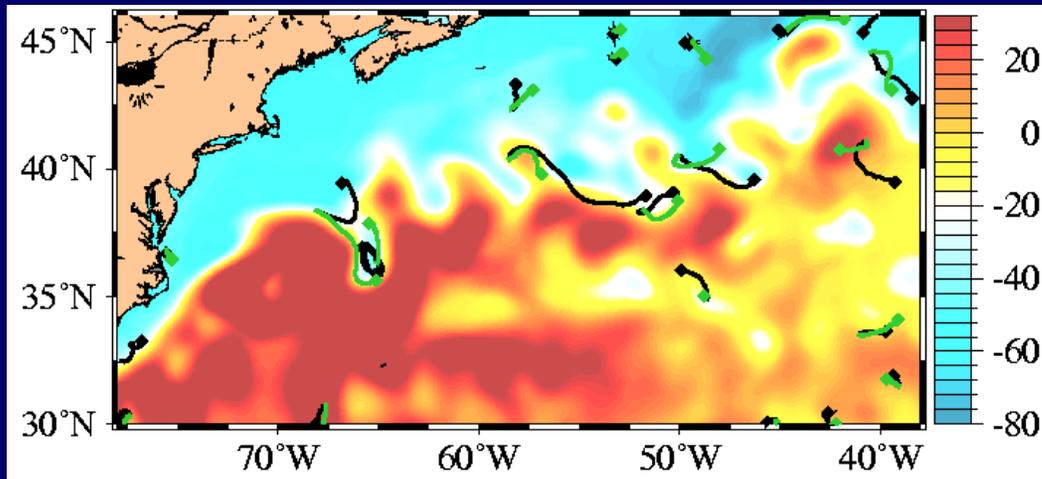
CTD
Mean
Temp.
(Johnson
et. al, 2001)



NCOM G8
Mean
Temp.
1998-2000

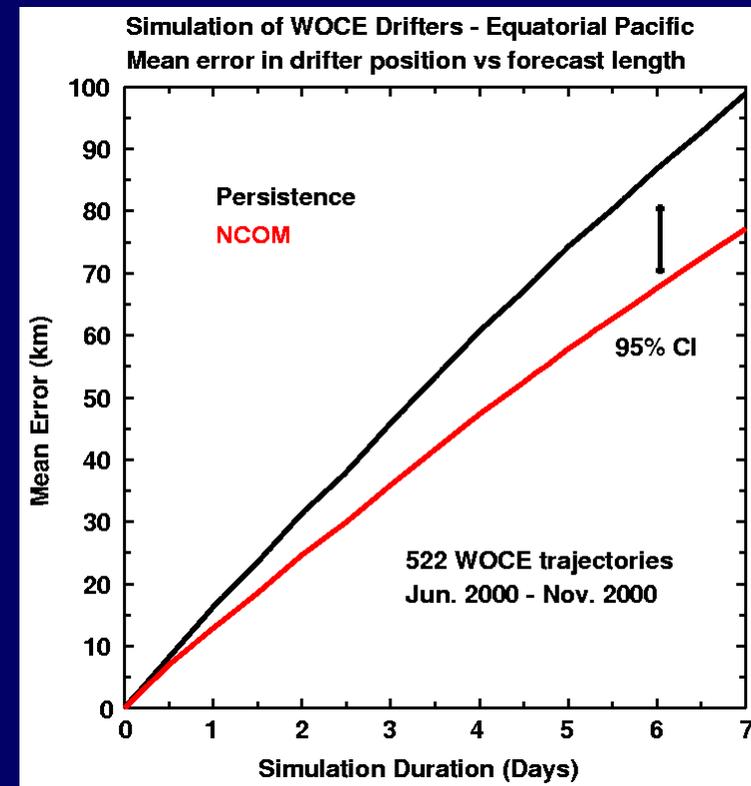


NCOM G8 Drifter Trajectories

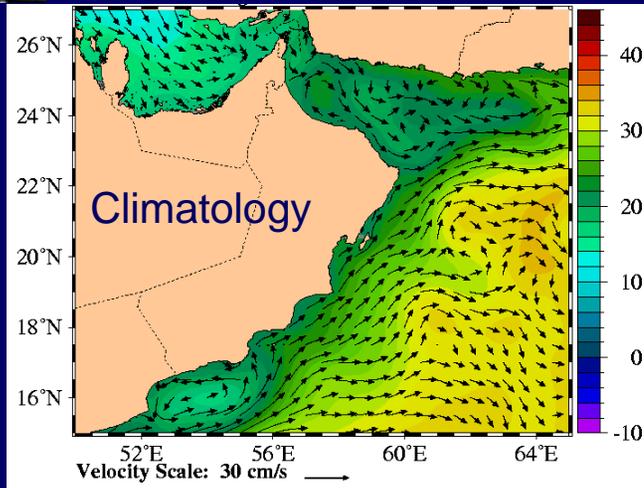
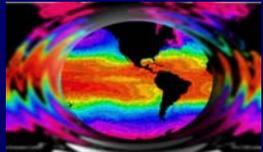


Above: Comparison between WOCE drifter trajectories (black) and trajectories simulated in data-assimilative global NCOM (green). Seven-day trajectories starting on 31 July 2002, superimposed on NCOM SSH.

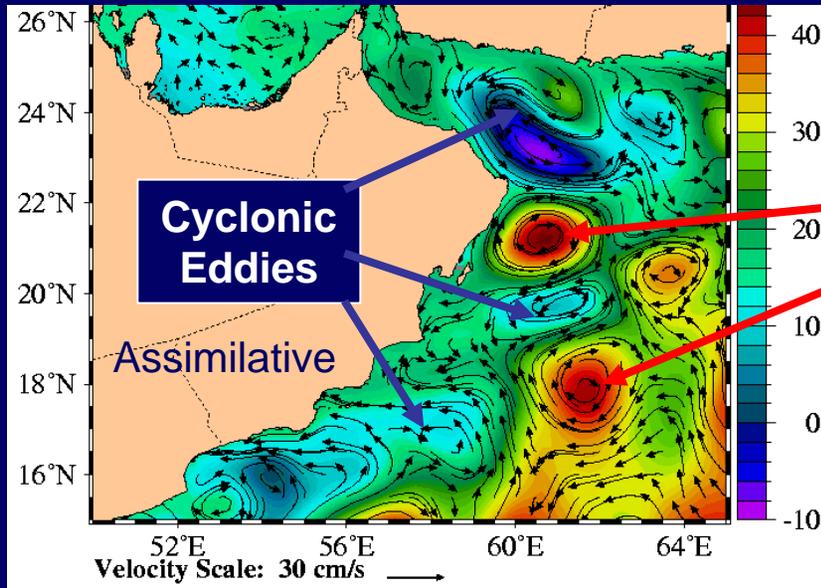
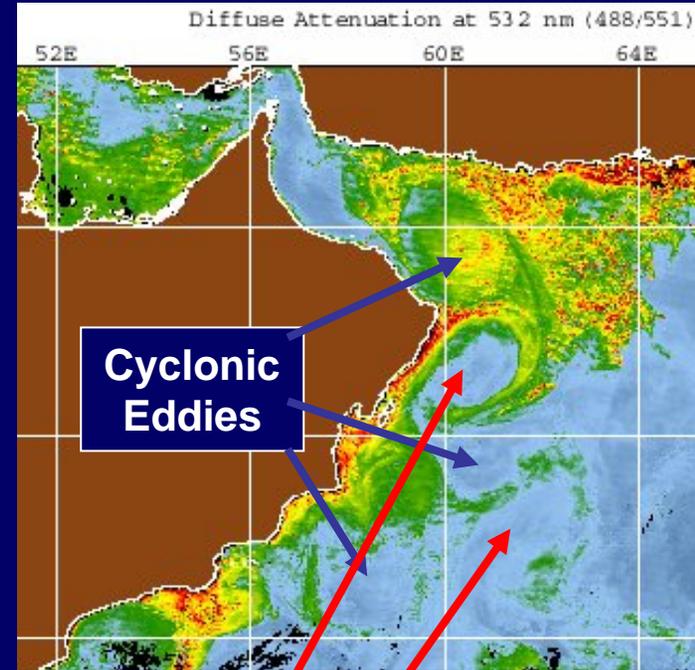
Right: Mean error in drifter position predicted by assimilative NCOM hindcasts (red) or persistence (black).



NCOM G8 Mesoscale Features

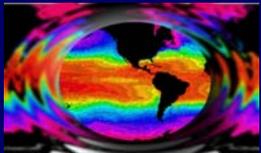


**Global NCOM 3 Oct 2002
Surface Currents over Height (cm)**



Anticyclonic Eddies

**MODIS composite
30 Sep – 7 Oct 2002
Diffuse Attenuation
Coefficient at 532 nm
NRL Ocean Optics
www7333.nrlssc.navy.mil**

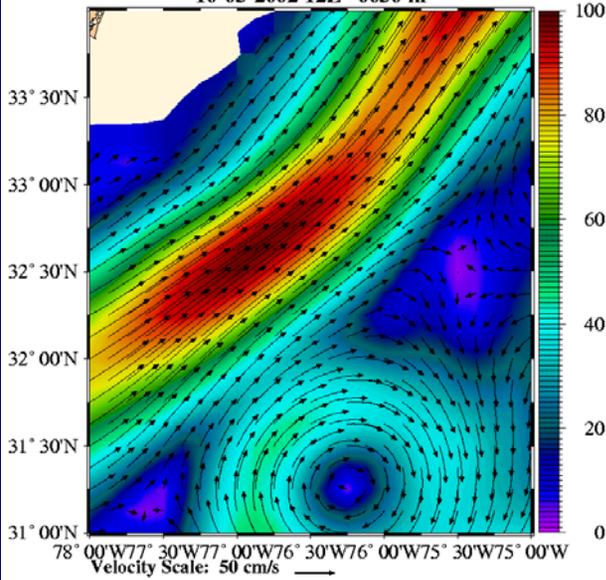


NCOM G8 for JTFEX 03-1

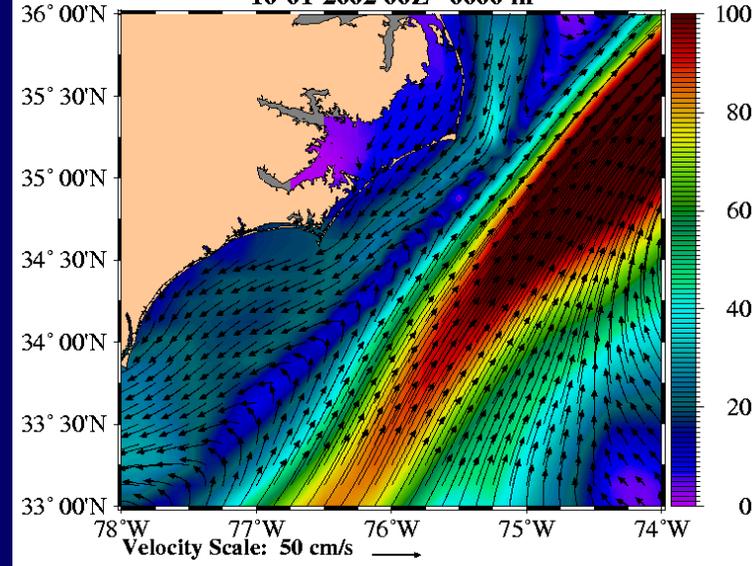


NCOM G8 data was used in support of Joint Task Force Exercise (JTFEX) 03-1 in October 2002.

Currents over Speed (cm/s)
NRL global NCOM glb8_1g hindcast
10-03-2002 12Z 0030 m



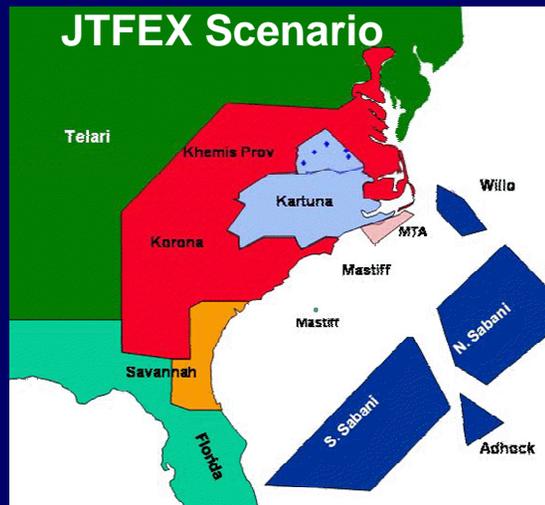
Surface Currents over Speed (cm/s)
NRL global NCOM glb8_1g hindcast
10-01-2002 00Z 0000 m



30m currents around Gulf Stream

Surface currents near Cape Hatteras

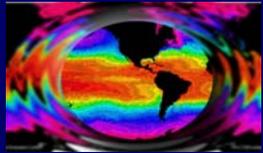
JTFEX Scenario



HS Truman Battle Group



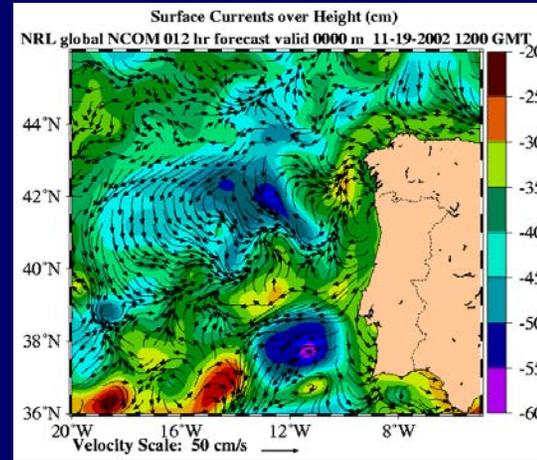
Helicopter from anti-submarine squadron 7 engaged in ASW



NCOM G8 for Prestige Oil Spill

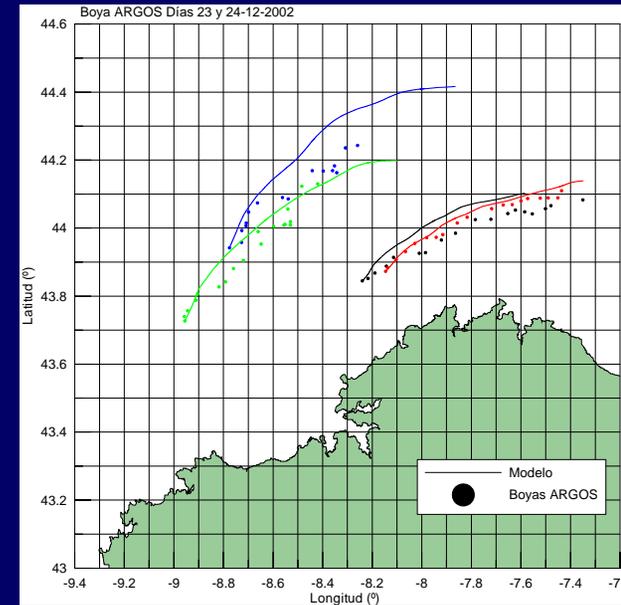


When the MV Prestige split and sank off the coast of Galicia, Spain, NRL aided response by providing forecasts from NCOM G8 within 6 hours of the request. A relocatable model was soon nested in NCOM G8 to improve forecast accuracy.

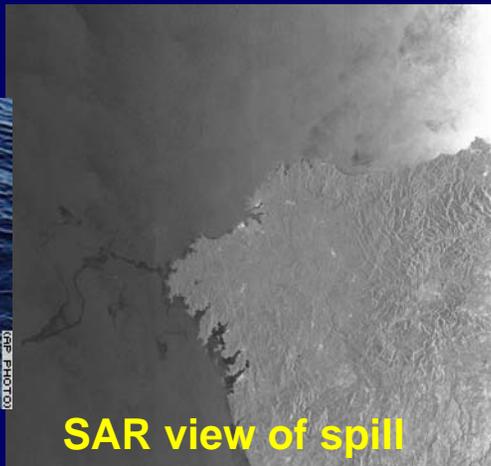


NCOM G8 surface currents, sea surface height

Comparison of observed trajectories with forecasts from NRL Galicia model (G. Peggion) nested in NCOM G8

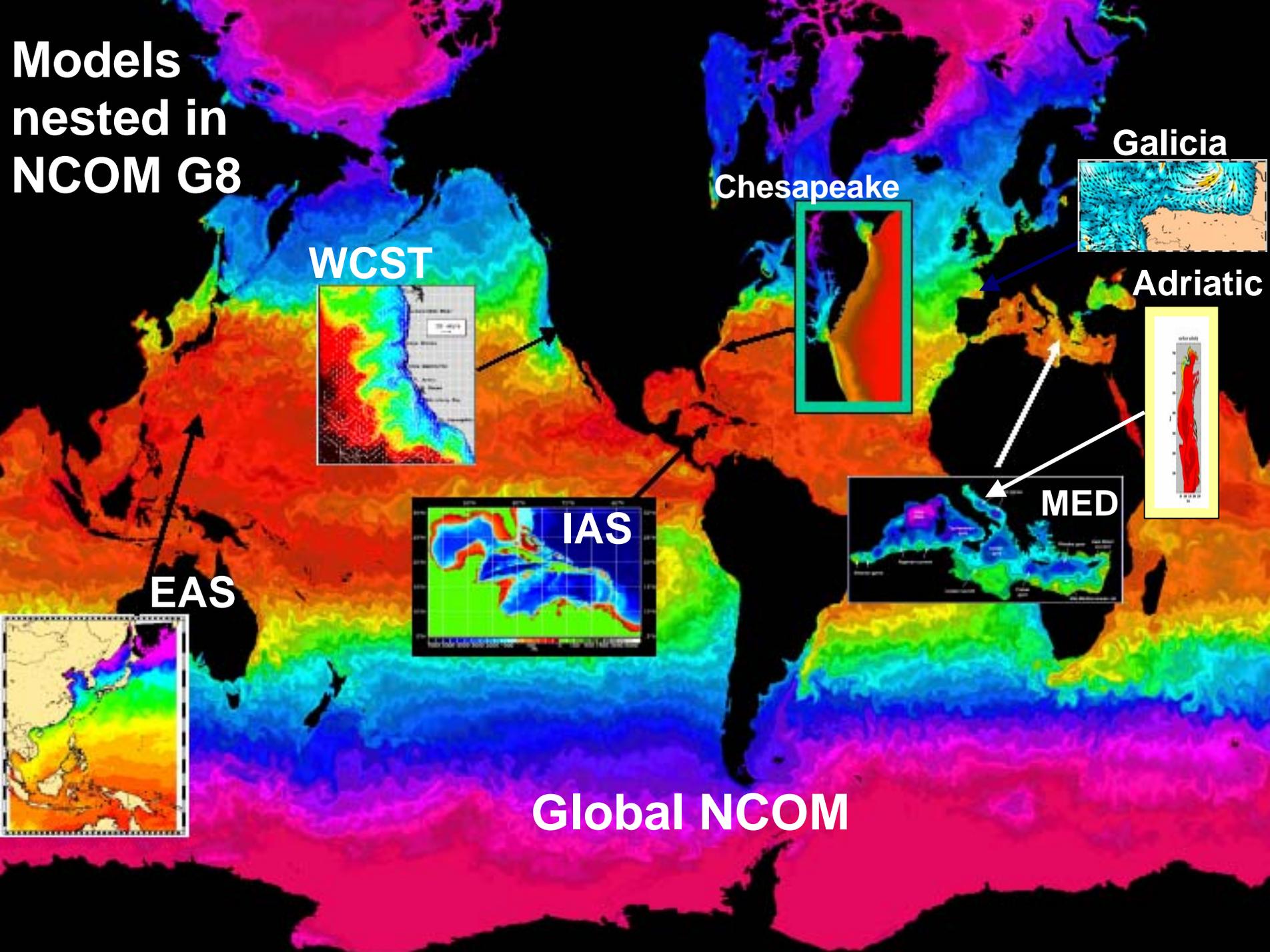


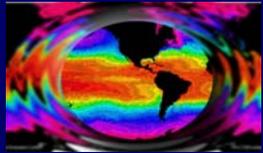
Prestige sinking



SAR view of spill

Models nested in NCOM G8





NCOM G8 Planned Upgrades

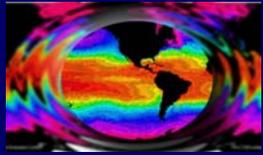


FY04

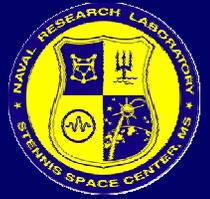
- Assimilation of Profile Data (Plan to use OCN_MVOI system at NAVOCEANO)
- Other Assimilation Upgrades (Improved mean for derivation of MODAS synthetics, use of $1/32^0$ NLOM SSH planned for upgrade in FY04)

FY05

- PIPS 3.0 Ice Model added to NCOM G8 system (based on Los Alamos CICE model)
- Assimilation upgrades using OCN_MVOI



Operational Application of Ocean Satellite Observations through Global NCOM



For more information on global NCOM,
please refer to the website:

www.ocean.nrlssc.navy.mil/global_ncom