The Navy Coupled Ocean Data Assimilation (NCODA) system in HYCOM

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http://www.hycom.org

HYCOM NOPP/GODAE  
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The Navy Coupled Ocean Data Assimilation (NCODA) system in HYCOM
Atlantic near real-time system

- 1/12° Atlantic (28°S to 70°N)
- Running in near real-time (on Wednesday)
  - Assimilates the satellite altimeter analysis from the MODAS operational system at the Naval Oceanographic Office (NAVOCEANO)
  - Mean SSH from the 1/12° MICOM (ECMWF)
  - Vertical projection via the Cooper and Haines technique (1996, JGR)
  - FNMOC/NOGAPS atmospheric forcing
  - Relaxation to the MODAS SST analysis
- 10 day hindcast, 14 day forecast
- Provide boundary conditions for coastal models

http://www7320.nrlssc.navy.mil/ATLhycom1-12/skill.html
http://www.hycom.org
White/black line is the frontal analysis of MCSST observations performed at NAVOCEANO. Black line represents data more than four days old.

http://www.hycom.org
Sequential Incremental Update Cycle
Analysis-Forecast-Analysis

MVOI - simultaneous analysis 5 ocean variables
temperature, salinity, geopotential, velocity (u,v)

Navy Coupled Ocean Data Assimilation (NCODA)

Ocean Obs
SST: GAC/LAC
MCSST, GOES,
Ship, Buoy
Profile: XBT,
CTD, PALACE
Float, Fixed Buoy,
Drifting Buoy
Altimeter SSHA
SSM/I Sea Ice

Ocean QC

3D MVOI
Innovations

HYCOM Model

Forecast Fields
Prediction Errors

First Guess

Increments
HYCOM/NCODA coupling

- HYCOM to 3D z-grid
- NCODA analysis on z-grid
- Use the NCODA analysis in an incremental updating of the HYCOM variables.
- Daily NCODA analysis
1/12° GULF OF MEXICO HYCOM CONFIGURATION

- Horizontal grid: 1/12° (258 x 175 grid points, 6.5 km spacing on average)
- 18°N to 31°N
- 20 vertical coordinates
- Bathymetry: 5m coastline
- Surface forcing from FNMOC/NOGAPS
- Monthly river runoff
- Nested Boundary:
  relaxation to the 1/12° Atlantic HYCOM T, S, U and V along open boundary, (no assimilation in these experiments)
HYCOM identical twin SSH and SST data

Ocean model sampled along observed tracks

Model sampled at observed MCSST locations

TOPEX - white   ERS2 - black
HYCOM identical twin results
“Observed” track and MCSST locations

SSH increments

29 August 1999
Day 1

18 October 1999
Day 50

SST

SSH

29 August 1999
Day 1

18 October 1999
Day 50
HYCOM identical twin results

“Observed” track and MCSST locations

Truth 29 August 1999  Analysis, day 1

Truth 18 October 1999  Analysis, day 50
HYCOM identical twin results
Temperature and salinity sections along 25.08ºN
“Observed” track and MCSST locations

Truth

Analysis, day 1
29 August 1999

Truth

Analysis, day 50
18 October, 1999
HYCOM identical twin results
RMSE vertical profiles (0-500m)
“Observed” track and MCSST locations

29 August 1999 18 October 1999

RMSE error (50.4)
Mean error (50.4)
1/25° GULF OF MEXICO HYCOM CONFIGURATION

- Horizontal grid: 1/25° (517 x 349 grid points, 3.5 km spacing on average)
- 18°N to 31°N
- 20 vertical coordinates
- Bathymetry: real coastline (minimum depth 2m)
- Surface forcing from FNMOC/NOGAPS
- Monthly river runoff
- Nested Boundary:
  relaxation to the 1/12° Atlantic HYCOM climatological T, S, U and V along open boundary
HYCOM nowcast SSH with the NAVO frontal analysis of MCSST observations (white/black lines, black data > 4 days old)
1/12° Global HYCOM Configuration

- Horizontal grid: 1/12° equatorial resolution
  - 4500 x 3298 grid points, ~6.5 km spacing on average, ~3.5 km at pole

- Mercator 79°S to 47°N, then Arctic dipole patch

- Vertical coordinate surfaces: 32 for $\sigma_2^*$

- GISS mixed layer model

- Thermodynamic (energy loan) sea-ice model

- Surface forcing: wind stress, wind speed, thermal forcing, precipitation, relaxation to climatological SSS

- Monthly river runoff (986 rivers)

- Initialize from January climatology (GDEM3) T and S, then SSS relaxation from PHC 3.0
  - No subsurface relaxation to climatology
1/12° Global HYCOM Mean SSH (05.6)

Original

Rubber sheeted

Nicolas Choplain
1/12° Global HYCOM
Hindcast started 12 November 2003

SSH 17 November 2003

HYCOM nowcast SSH with the NAVO frontal analysis of MCSST observations (white/black lines, black data > 4 days old)
1/12° Global HYCOM Mean SSH (05.6)

Original

Rubber sheeted

Nicolas Choplain
Comparison of mean SSH to mean dynamic topography from XBTs.

Track 63

Track 109
1/12º Global HYCOM
Hindcast started 12 November 2003

SSH date: Feb 25, 2004
1/12° Global HYCOM

Hindcast started 12 November 2003

SSH 12 November 2003

sea surface height 30 November 2003 (60.4)
1/12° Global HYCOM

NCODA observations 17 November 2003

SSH

SSH Observations 17 Nov 03 00Z 9 km grid

Satellite SST 17 Nov 03 00Z 9 km grid

In situ SST

In Situ SST 17 Nov 03 00Z 9 km grid

Profile Observations 17 Nov 03 00Z 9 km grid

Profiles
1/12º Global HYCOM
Hindcast started 12 November 2003
Mean SSH January 2004

No assimilation
Assimilation

HYCOM mean SSH with the mean pathway of the Gulf Stream ±1 stdv
HYCOM mean SSH with the mean pathway of the Kuroshio ± 1 stdv
1/12° Global HYCOM
Hindcast started 12 November 2003
January 2004

140°W 2°N

38°W 4°N

95°W 0°N

0°E 0°N
Future

- Update rubber sheeted mean SSH (in the Gulf Stream region)
- Continue present run (to real time)
- Include rest of domain in assimilation
- Test assimilation of ice concentration in the Bering Sea
1/12° Global/Atlantic HYCOM

February 2004

1/12° Global HYCOM

38°W 4°N

Temperature at: 38W04N 21-Jan-2004

Depth (m)

PIRATA

HYCOM analysis (60.4)

0 5 10 15 20 25 30

Temperature (°C)

1/12° Atlantic HYCOM

0°E 0°N

Temperature at: 000e00n 21-Jan-2004

Depth (m)

PIRATA

HYCOM nowcast (9.1)

0 5 10 15 20 25 30

Temperature (°C)