Update on Global and Regional HYCOM Modeling for the US West Coast

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NRL

HYCOM Evaluation

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MODELS

Real-Time Global Models

California Current System (CCS)
- 1/12-degree GLOBAL HYCOM
  - 30-30N, 116-154W
  - Mercator Grid (+bi-polar) (~7Km)
  - 32 Layer \( \rho/\sigma/z \) \((\sigma^2)\)
  - Expt 60.5 (O-M Smedstad)

- 1/8-degree GLOBAL NCOM
  - Curvilinear (~12Km)
  - 41 Level \( \rho/\sigma/z \) \((\sigma^2)\)
  - GLB8_2f (operational)

Regional Models

California Current System (CCS)
- 1/12-degree CCS HYCOM
  - 30-50N, 116-134W
  - Mercator grid (~7km)
  - 32 Layer \( \rho/\sigma/z \) \((\sigma^2)\)

- 1/12-degree CCS NCOM
  - Curvilinear (~12km)
  - 41 Level \( \rho/\sigma/z \) \((19/21)\)
  - GLB8_2f (operational)

Coastal Model (NCOM)

Monterey Bay (MB)
- 35.5-37.5N, 121.5-123.5W
- 1-4Km Resolution
- 29 \( \sigma \) levels
- Orthogonal curvilinear grid
- 81x58
- NCODA data assimilation

Motivation: Global->Coastal

Igor Shulman
### 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 hybrid layers with z-levels near surface, sigma in shallow water and isopycnal interior coordinates
- **KPP mixed layer model & thermodynamic sea-ice model**
- **Surface forcing:** 3 hourly wind stress, wind speed, thermal forcing, precipitation, relaxation to climatological SSS from .5 deg. NOGAPS
- **Monthly river runoff** (986 rivers)
- **Initialize from January climatology (GDEM3) T and S**, then SSS relaxation from PHC 3.0
- **NCODA used for data assimilation. Multi-variate OI scheme (see Smedstad et al poster)**
  - Assimilates altimeter SSH (3 altimeters), MCSST, observed profiles of T & S
  - Cooper-Haines vertical projection
1/8° Global NCOM Configuration

- Horizontal grid: 1/8° equatorial resolution
- Curvilinear grid from 78S to 90N
- Vertical coordinate surfaces: 40 hybrid layers with 19 sigma levels in upper 150m over 21 z-levels.
- Mellor-Yamada mixed layer model
- Surface forcing: 3 hourly wind stress, wind speed, thermal forcing, precipitation, relaxation to climatological SSS from .5 deg. NOGAPS
- Monthly river runoff (1003 rivers)
- Operationally available sea-surface temperature (MCSST) and altimetry (SSH) data are incorporated into the NAVO Modular Ocean Data Assimilation System (MODAS) and Navy Layered Ocean Model (NLOM) analyses with forecasts of SSH and SST.
- These surface fields are combined with the MODAS synthetic database to yield three-dimensional fields of temperature and salinity for assimilation into global NCOM.
Comparisons (Global Models)

Global NCOM with SeaWIFS
Chlorophyll: June 15, 2004

Global HYCOM with SeaWIFS
Chlorophyll: June 15, 2004

Global NCOM SSH Anomaly
June 15, 2004

Global HYCOM SSH Anomaly
June 15, 2004

Gridded Altimeter SSH-June 15
NAVO Data Fusion Center

Gridded Altimeter SSH-June 15 NAVO Data Fusion Center
Model Evaluation: Regional NCOM

Gridded Altimeter SSH –June15

NAVO Data Fusion Center
Model Evaluation: Anomaly Correlations
Regional NCOM-CCS

ANOMALY CORRELATION H002 DOMAIN (wrt 2000–2005 LTM)
GRIDDED ALTIMETER AND MODEL DAILY SURFACE HEIGHT
REGIONAL NCOM FULL DOMAIN

With MODAS Assimilation:
- Open Ocean
- Coastal (200Km)

With MODAS Assimilation
No Assimilation

Anomaly Correlations Relative to Gridded Altimeter Field from NAVO
Model Evaluation: Tide Gauges


CRESCENT CITY, CA

REGIONAL NCOM: \( r = 0.94, ss = 0.81 \)
GLOBAL NCOM: \( r = 0.91, ss = 0.66 \)
HTOI: \( r = 0.54, ss = 0.29 \)
Which mean is used makes a difference.

To be fair to HYCOM simulation, all analyses performed with 2004 mean
Model Evaluation: Domain Averaged Anomalies

Problem with GFO

Data: Oct. 6-20
Affects HYCOM and Nests
Corrected for GFO Issue

AREA-AVERAGED DAILY ANOMALY (wrt 2004)
OVER H002 DOMAIN

MEAN 2004
ALTIMETER (HT01) = -2.7936e-15
GLOBAL HYCOM 60.5°C = -5.0986e-13
GLOBAL NCOM = -1.3222e-10
REGIONAL NCOM 41.2°C = 8.4726e-05

Corrected for GFO Issue
Model Evaluation: Anomaly Correlations
Global HYCOM and NCOM; Regional NCOM-CCS

Global NCOM and HYCOM

Regional NCOM: Forced by NCOM and HYCOM

Anomaly Correlations Relative to Gridded Altimeter Field from NAVO
COMPARISONS (Global Models)

Global NCOM SSH Anomaly
June 16 2004

Global HYCOM SSH Anomaly
June 16 2004
Global NCOM and HYCOM

Model Evaluation: Tide Gauges

Global HYCOM and NCOM nest represent Coastal Kelvin Wave Pulses More Accurately
Sub-surface Evaluation of Global Models: Line 67

Global NCOM with SeaWIFS Chlorophyll Concentration (OC4)
NCOM gb82 SSH ANOMALY
15-JUN-2004

Global HYCOM with SeaWIFS Chlorophyll: June 15 2004

Global NCOM SSH Anomaly
June 15 2004

Global HYCOM SSH Anomaly
June 15 2004
Sub-surface Evaluation of Global Models: Line 67

GEDEM Climatology

June 8-11 2004

Global HYCOM

Global NCOM

Global HYCOM
Sub-surface Evaluation of Global Models: Line 67

GEDEM Climatology

October 24-27 2004

Global NCOM

Global HYCOM

Observations
For Nests that span 47N:

- HYCOM tools do not generate geometry
- Use ‘ISUBAREGION’ to re-grid from outer to inner nest
- Re-grid from Global HYCOM after extracting a cut-out
CONCLUSIONS and Plans

- Data Assimilative Global HYCOM vs. Global NCOM
  - Open Ocean: Both Global NCOM and HYCOM provide adequate representations of mesoscale variability in CCS domain; variance of HYCOM SSH may be more accurate
  - Coastal: Global HYCOM provides more accurate representation of coastal Kelvin waves and remote forcing for coastal nests
  - Sub-surface: ‘Thermocline spread’ produces a warm bias in upper 200m; slightly worse in HYCOM relative to NCOM
- Plans:
  - Impact of remote forcing on biological response: HYCOM/NCOM
  - Examine global HYCOM for 2004-2007 period
  - Sensitivity to boundary values: Global HYCOM/NCOM, HYCOM-CCS/NCOM-CCS: Monterey Bay NCOM and 2006 ASAP experiment
  - Real-time NCOM-CCS forced by Global HYCOM
  - Real-time data assimilative HYCOM-CCS
Evaluation of Global Models: Cross Sections

Global NCOM with SeaWIFS
Chlorophyll: June 15 2004

Global NCOM SSH Anomaly
June 15 2004

Global HYCOM with SeaWIFS
Chlorophyll: June 15 2004

Global HYCOM SSH Anomaly
June 15 2004

Global NCOM T Section@36 +/-1
June 15 2004

Global HYCOM T Section@41 +/-1
June 15 2004
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