1/12° Global HYCOM Evaluation and Validation

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1/12° HYCOM/NCODA/PIPS

- **Capability:** Provide accurate 3D temperature, salinity and current structure; depict the location of mesoscale features such as oceanic eddies and fronts

- **Progress:** 1/12° global HYCOM/NCODA running in real-time in the NAVOCEANO operational queues; Validation testing has begun

- **Issues:**
  - Complete coupling of HYCOM/PIPS via ESMF (NRL)
  - Get NCODA working in curvilinear part of grid (NRL)
  - Need OcnQC running operationally (NAVOCEANO)
1) Perform first NCODA analysis centered on tau = -120
2) Run HYCOM for 24 hours using incremental updating (√) over the first 6 hrs
3) Repeat steps 1) and 2) until the nowcast time
4) Run HYCOM in forecast mode out to tau = 96, eventually to tau = 120

Approximate run times* (using 379 IBM Power 5+ processors):
1) Six NCODA analyses: 0.9 hrs/analysis = 5.4 hrs
2) Five HYCOM hindcast days @ 150 sec Δt: 1.1 hrs/day = 5.5 hrs
3) Four HYCOM forecast days @ 150 sec Δt: 1.1 hrs/day = 4.4 hrs
4) Total: 15.3 hrs

* Timings do not include PIPS coupling; assimilation in the Mercator part of grid only
1) Perform first NCODA analysis centered on tau = -126, i.e. 18Z
2) Run HYCOM for 24 hours using incremental updating over the first 6 hrs starting at 18Z
3) Repeat steps 1) and 2) until the nowcast time
4) Run HYCOM in forecast mode out to tau = 96, eventually to tau = 120

Under this scheme the incremental updating ends at the nowcast time (00Z) whereas in the previous scheme incremental updating ended at 06Z and the 00Z nowcast actually represents an 18-hour forecast from the previous day. Most results shown in this presentation are from 18-hour forecasts.
FY07 Validation Tasks

1. Mixed layer depth / sonic layer depth / deep sound channel
   • Compare simulated vs. observed for non-assimilated buoys

2. Vertical profiles of T&S
   • Quantitative comparison of simulated vs. observed for non-assimilated buoys

3. Large scale circulation features
   • Determine correct placement of large scale features

4. Eddy kinetic energy / sea surface height variability
   • Determine if the system has a realistic level and distribution of energy at depths

5. Sea surface temperature
   • Evaluate whether the models are producing acceptable nowcasts and forecasts of sea surface temperature

6. Coastal sea level
   • Assess the model's ability to represent observed sea surface heights
Mean Sea Surface Evaluation

1992-2002 Mean dynamic ocean topography (0.5°)

Mean ocean dynamic topography data has been obtained from Nikolai Maximenko (IPRC) and Peter Niiler (SIO)
Mean Sea Surface Evaluation

2004 Mean sea level from 1/12° global HYCOM/NCODA

From the 1/12° global HYCOM/NCODA hindcast simulation
Mean shifted by 8.7 cm; standard deviation of difference = 9.6 cm
Sea surface height variability

Oct 92 – Nov 98 SSH variability based on T/P, ERS-1 and ERS-2 altimeters (from Collecte, Localisation, Satellites (CLS))

SSH variability over 2004 from the 1/12° global HYCOM/NCODA hindcast simulation
Eddy Kinetic Energy Comparison
Surface EKE in the Gulf Stream

Observations from Fratantoni (2001) – Based on 1990-99 surface drifters
Eddy Kinetic Energy Comparison
EKE at ~700 m in the Gulf Stream

Observations from Schmitz (1996)

NCOM - 2004

HYCOM - 2004
Mixed Layer Depth Comparison

2004 MLD difference: HYCOM minus unassimilated MEDS profiles

MLD = negative temperature difference of 0.5°C between the surface and depth; data averaged in 0.5° bins

Mean error: -3.0 m
RMSE: 43.7 m
Mixed Layer Depth Comparison

2004 MLD difference: HYCOM minus unassimilated MEDS profiles

MLD = negative temperature difference of 0.5°C between the surface and depth; data averaged in 0.5° bins

- 4232 Profiles
- Mean error: -2.1 m
- RMSE: 41.6 m
Temperature Structure Comparison

Locations of TAO and PIRATA buoys used in this evaluation

Buoys are divided into two sets based on the vertical sampling and continuity of the time series over calendar year 2004

Set 1 (denoted by o’s): 1, 20, 40, 60, 80, 100, 120, 140, 180, 300, 500 m.
Set 2 (denoted by x’s): 1, 25, 50, 75, 100, 125, 150, 200, 250, 300, 500 m.
Temperature Structure Comparison

2004 subsurface temp at 140°W, 2°N
Buoy / HYCOM / nonassim HYCOM

Temperature difference
Buoy - HYCOM / Buoy - nonassim HYCOM

Significant impact of temperature profile assimilation via NCODA
Temperature Structure Comparison
HYCOM vs. non-assim HYCOM – Mean error – 47 TAO/PIRATA buoys 2004

Set 1

Set 2
Temperature Structure Comparison

HYCOM vs. non-assim HYCOM – Skill score – 47 TAO/PIRATA buoys 2004
Sea Surface Temperature Comparison

HYCOM vs. MODAS – Mean error – white area = ± .25°C

Over 2004 from the 1/12° global HYCOM/NCODA hindcast simulation

Basin-wide mean error: 0°C, RMSE: .2°C
Sea Surface Temperature Comparison

HYCOM vs. MODAS – Skill score

Over 2004 from the 1/12° global HYCOM/NCODA hindcast simulation

Basin-wide skill score: .90
Sea Surface Temperature Comparison
Unassimilated MEDS SST vs. HYCOM vs. NCOM

Over 2004 from the 1/12° global HYCOM/NCODA hindcast simulation and operational 1/8° global NCOM; MEDS = Marine Environmental Data Services
Coastal/Island Sea Level Comparison
Simulated vs. observed sea level at 84 coastal / island stations during 2004

Correlation
- HYCOM vs. Obs. median $r = .79$
- NCOM vs. Obs. median $r = .80$

RMSE
- HYCOM vs. Obs. median RMSE = 5.6 cm
- NCOM vs. Obs. median RMSE = 5.7 cm
Coastal/Island Sea Level Comparison

RMSE improvement

(HYCOM – observed) – (NCOM – observed)

Simulated vs. observed sea level at 84 coastal / island stations during 2004
FY08 Validation Tasks

1. Below layer depth gradient
   - Compare simulated vs. observed for non-assimilated buoys

2. Comparison with drifting buoys
   - Evaluate the model’s ability to produce ocean currents that yield drifter and ARG0 float trajectories similar to observations

3. Current cross sections
   - Evaluate model velocity cross-sections through qualitative and quantitative comparisons

4. Provide boundary conditions to nested models
   - Nest East Asian Seas NCOM and Relocatable NCOM within HYCOM and compare inner model with the solution when forced NCOM

5. Eddy tracking
   - Evaluate the model’s ability to track mesoscale eddies

6. Ice drift, thickness and concentration
   - Assess the model’s ability to represent sea ice