A Regional HYCOM Model for the US West Coast

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US West Coast HYCOM

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- NRL 6.2 Coastal Ocean Nesting Studies (CoNESTS) Project ---w. Pat Hogan
  - Evaluate HYCOM as a coastal Model
  - Implement Regional HYCOM for US west coast.

- NOPP PARADIGM Project: Partners for the Advancement of Interdisciplinary Global Models ---with Eric Chassignet
  - Incorporate Biological Model into HYCOM
1/12° Pacific HYCOM Basin-scale Circulation with nested US West Coast HYCOM

Forced with high frequency ECMWF winds and thermal forcing

SSH Snapshot – 21 March
1/12° Pacific HYCOM Basin-scale Circulation with nested US West Coast HYCOM

Nested HYCOM uses same resolution and forcing as Pacific HYCOM to test bc. Simulation begins on January 1, 2001; no data assimilation is included.
Physical-Biogeochemical Model: Fei Chai et al.


Meso-Zooplankton [Z2] → Ammonium [NH₄]


NO₃ Uptake → NH₄ Uptake → Diatoms [P2] → NH₄ Uptake

Fecal Pellet → Meso-Zooplankton [Z2] → Predation → Total CO₂ [TCO₂]

Air-Sea Exchange

N-Uptake → Biological Uptake

Physical-Biogeochemical Model: Fei Chai et al.
Physical-Biogeochemical Model: NPZD (Lima, Olson and Doney)

Physical Model

Nitrate [NO₃]

Excretion

Ammonium [NH₄⁺]

N-Uptake

Grazing

Sinking

Consump.

Mort.

Remin.

Predation

Detritus-N [DN]

Phytoplankton

Sinking

Air-Sea Exchange

Total CO₂ [TCO₂]

Biological Uptake

Physical-Biogeochemical Model: NPZD (Lima, Olson and Doney)
Evaluation of Nested HYCOM

Model SSH comparisons with observations from tide gauges (atm. pressure corrected)

ECMWF Forcing
Phytopl.: NPZD Coupled to HYCOM.

Ecosystem Model Response

Model Phytoplankton

NOGAPS Forced Experiment

SST and Currents  15-JUN-2001

Phytopl.: NPZD Coupled to HYCOM.
Pacific HYCOM/ Regional HYCOM

**Pacific Model**

**Regional Model**

**SST and Currents  15–JUN–2001**

**NOGAPS Forcing**

**NOGAPS Forcing**
ECMWF vs. NOGAPS?

TIDE GAUGE, HYCOM PAC and CCS [60 day]

MONTEREY BAY, CA

HYCOM PAC 03.4: r = 0.93, ss = 0.79
HYCOM CCS 04.0: r = 0.92, ss = 0.75
HYCOM PAC 06.2: r = 0.67, ss = 0.43
HYCOM CCS 03.4: r = 0.63, ss = 0.38

Pacific and Regional Simulations
Pacific HYCOM: ECMWF vs. NOGAPS

NOGAPS Forcing

SST and Currents 15–JUN–2001

ECMWF Forcing

SST and Currents 15–JUN–2001
Regional HYCOM: ECMWF vs. NOGAPS

NOGAPS Forcing

SST and Currents  15–JUN–2001

ECMWF Forcing

SST and Currents  15–JUN–2001
Differences in Forcing for Pacific Experiments

- ECMWF case uses stresses formed from 10m winds
- NOGAPS case uses direct model stresses offset by ECMWF mean
  - Hybrid wind set
  - NOGAPS mean replaced by ECMWF mean (as determined above)

Hypothesis: Responses explained by differences in wind stress curl patterns
Wind Stress Curl Distributions
May 2001

ECMWF 10m winds

NOGAPS 10m winds

NOGAPS Direct stresses
Dynamics of Coupled Models: COAMPS

Flux Coupler: Accounts for Large Land-Sea Gradients by interpolating fields from the native atmospheric grid using the atmospheric model land mask. Otherwise, ocean points are corrupted.

Operational COAMPS along West Coast of US

Standard Interpolation: No land mask information

Flux Coupler Applied using land mask information

Ocean model response may be corrupted unless atmospheric forcing has been carefully interpolated to ocean model grid using native atmospheric fields and model land mask.
Sensitivity to Wind forcing

TIDE GAUGE, HYCOM 05.1 and 04.5 [60 day]

MONTEREY BAY, CA

HYCOM 05.1: \( r = 0.83, \text{ss} = 0.68 \)
HYCOM 04.5: \( r = 0.9, \text{ss} = 0.72 \)

ECMWF Stresses from 10m winds

NOGAPS Hybrid Direct Stresses
Sensitivity to Wind forcing

NOGAPS Hybrid Stresses

SSH and Currents 15–AUG–2001

NOGAPS L&P Stresses

SSH and Currents 15–AUG–2001
Sensitivity to Model Version

Both Experiments have same forcing, same Boundary values

HYCOM Version . 2.1.09

HYCOM Version . 2.1.27+

Forced by NOGAPS HYBRID Stesses

Forced by NOGAPS HYBRID Stesses
Recommendations for Pacific Data Assimilative Runs

- Use latest version of Model Code
- Use stresses based on NOGAPS 10m winds instead of direct stresses
  - Unless NOGAPS stresses become available on native grid.
Sensitivity to Boundary Values

TIDE GAUGE, HYCOM 05.6 and 05.3 [60 day]

MONTEREY BAY, CA

HYCOM 05.6: $r = 0.58$, $ss = 0.3$
HYCOM 05.3: $r = 0.88$, $ss = 0.71$

ECMWF Boundary Values (3.4)
NOGAPS Boundary Values (6.2)
Sensitivity to Boundary Values

ECMWF (3.4) Boundary Values

NOGAPS (6.2) Boundary Values
Plans

Pacific Basin HYCOM Simulation (1/12°)
- Evaluate Real-time, assimilative Pacific HYCOM
  - US west Coast region
  - Compare with Observations/ NCOM

Nested Eastern Pacific HYCOM
- Force with High Resolution COAMPS (81/27/9/3 km)
- 2-3 km resolution experiments
- Evaluate HYCOM
  - As a coastal Model
  - Coupled Ecosystem model(s)
  - Impact of vertical coordinate on Ecosystem response
  - Impact of Model choice on Ecosystem response
    - HYCOM; NCOM; ROMS
- Real-time HYCOM for the US west Coast
  - Force with Real-time COAMPS (3 km Resolution)
  - Add data assimilation for physical component
  - Boundary conditions from Real-time Pacific HYCOM
  - Combine with Real-time MODIS Ocean Color
Plans

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The End