High Resolution Modeling of the North Pacific and along the US West Coast Using a Nested HYCOM

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PARADIGM High-Resolution Basin-scale and Regional Process Studies

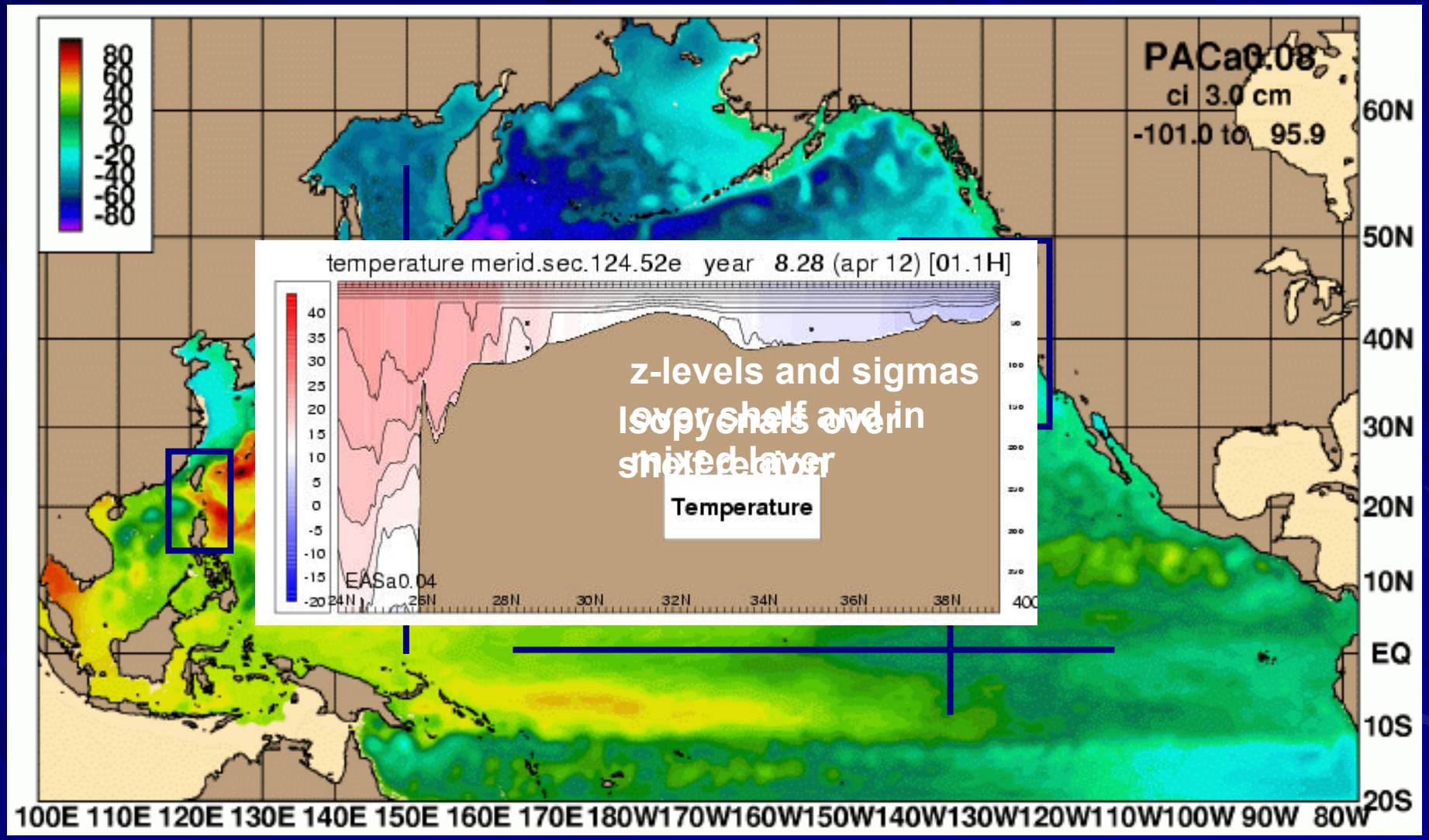
- Eddy resolving North Pacific basin simulations
  - Multi year: 1979-~ 2002
  - Embedded Ecosystem Model
  - Leverage NRL/NOPP HYCOM Efforts
- Science Issues
  - Mesoscale Processes
  - Subgrrid scale parameterizations
  - ENSO and Decadal Processes

Pacific HYCOM Model Configuration

- Horizontal grid: 1/12° equatorial resolution (2294 x 1362 grid points, 6.5 km spacing on average)
- 20°S to 65.8°N
- 20 vertical coordinates
- KPP mixed layer model
- Surface forcing: (wind stress, wind speed, thermal forcing, precipitation, relaxation to climatological SSS)
- Monthly river runoff (254 rivers)
- Buffer zone: ~3° band along southern and eastern boundary with relaxation to monthly climatological (GDEM3) T and S
- Closed boundaries along 20°S, in the Indonesian throughflow region and in the Bering Strait

1/12° Pacific HYCOM Basin-scale Circulation

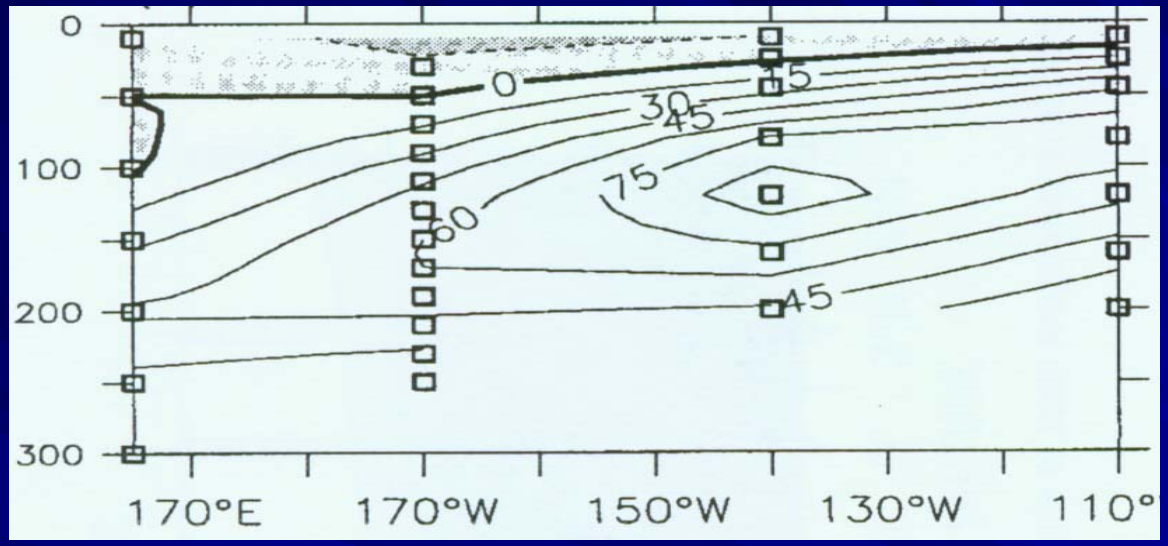
SSH Snapshot – 21 March



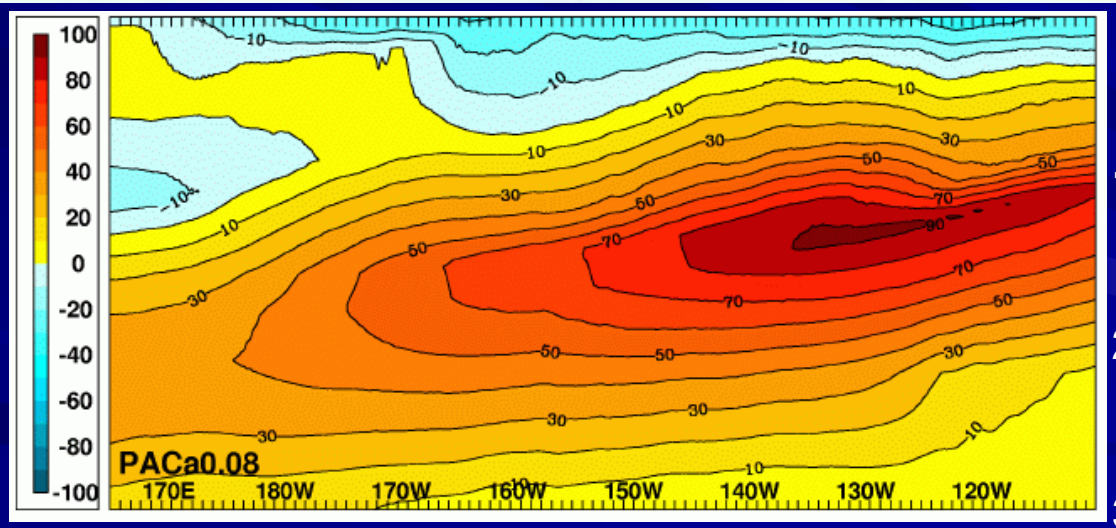
Forced with high frequency climatological ECMWF winds and thermal forcing

Velocity Cross-section Along the Equator

TOGA TAO data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 300 m
Section between 165°E and 110°W



EUC max velocity: 90+ cm/s



EUC max velocity: 90+ cm/s

100

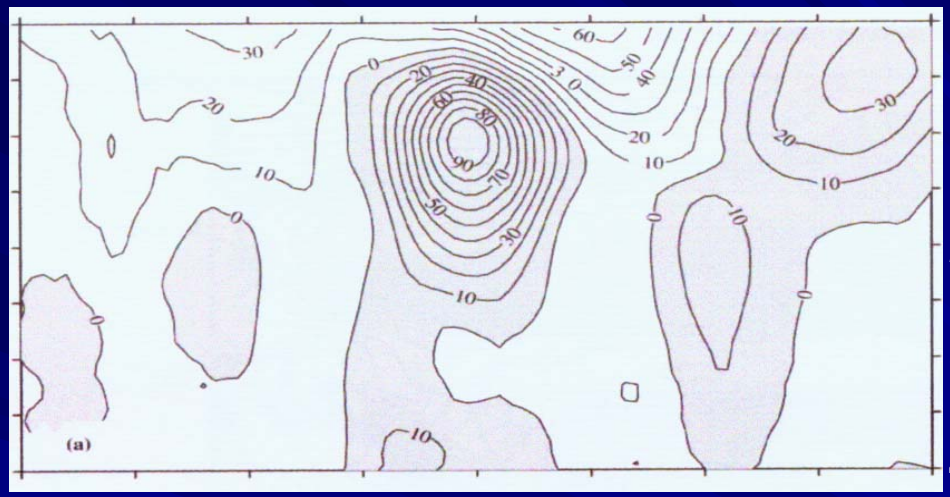
200

300

TOGA TAO buoy data from Yu and McPhaden (1999, JPO)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

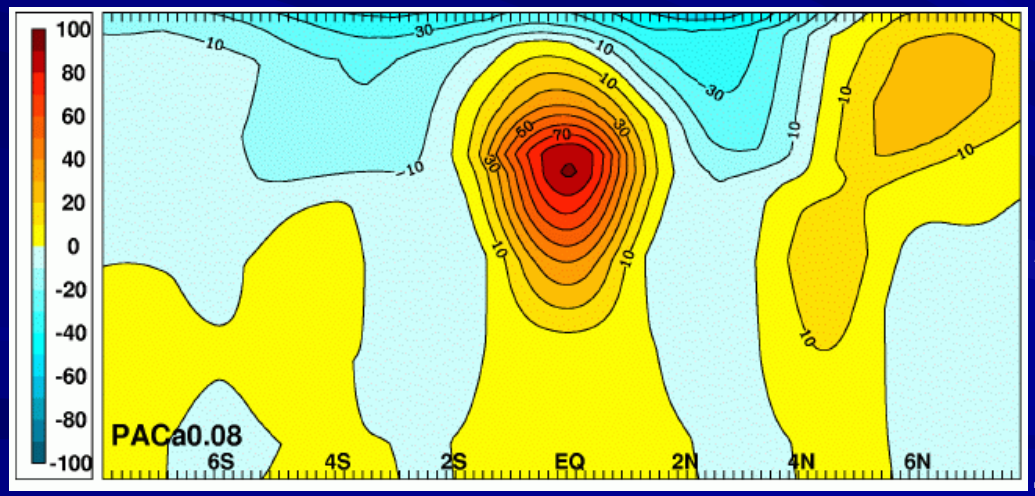
Velocity Cross-section Across the Equator at 135°W

CTD/ADCP data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 400 m
Section between 8°S and 8°N



100
200
300
400

EUC max velocity: 90+ cm/s at ~105 m depth



100
200
300
400

EUC max velocity: 90+ cm/s at ~140 m depth

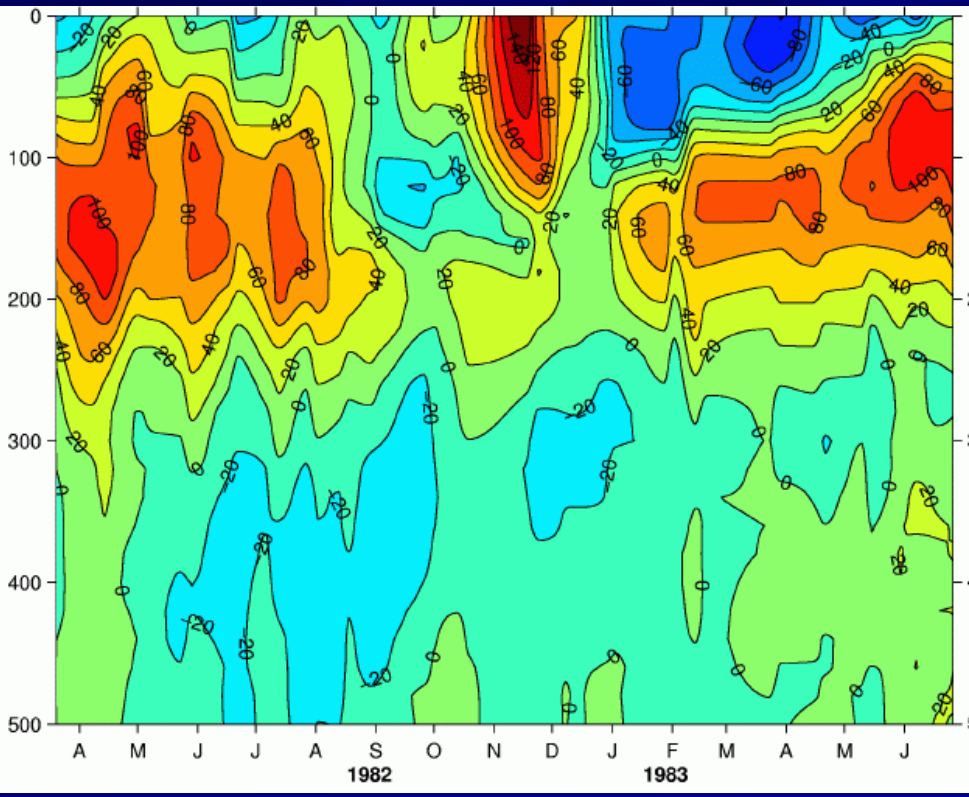
CTD/ADCP data from Johnson et al. (2001, JPO)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

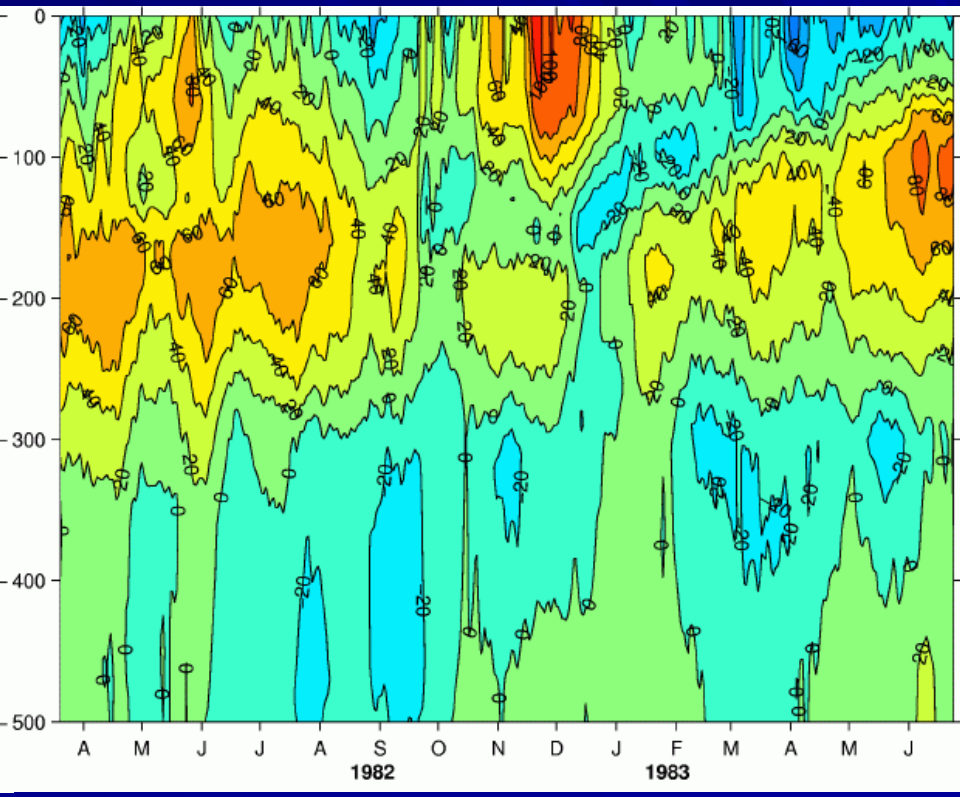
Disappearance of the Equatorial Undercurrent During the 1982-83 El Niño

Zonal velocity on the Equator at 159°W

Adapted from Firing at al. (1983)

1/12° Pacific HYCOM

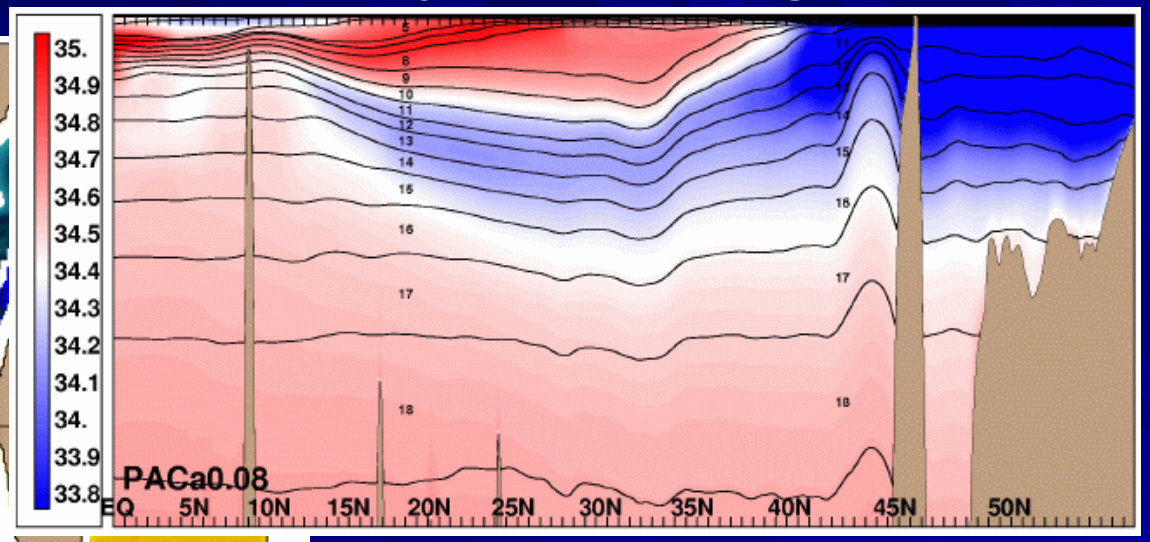


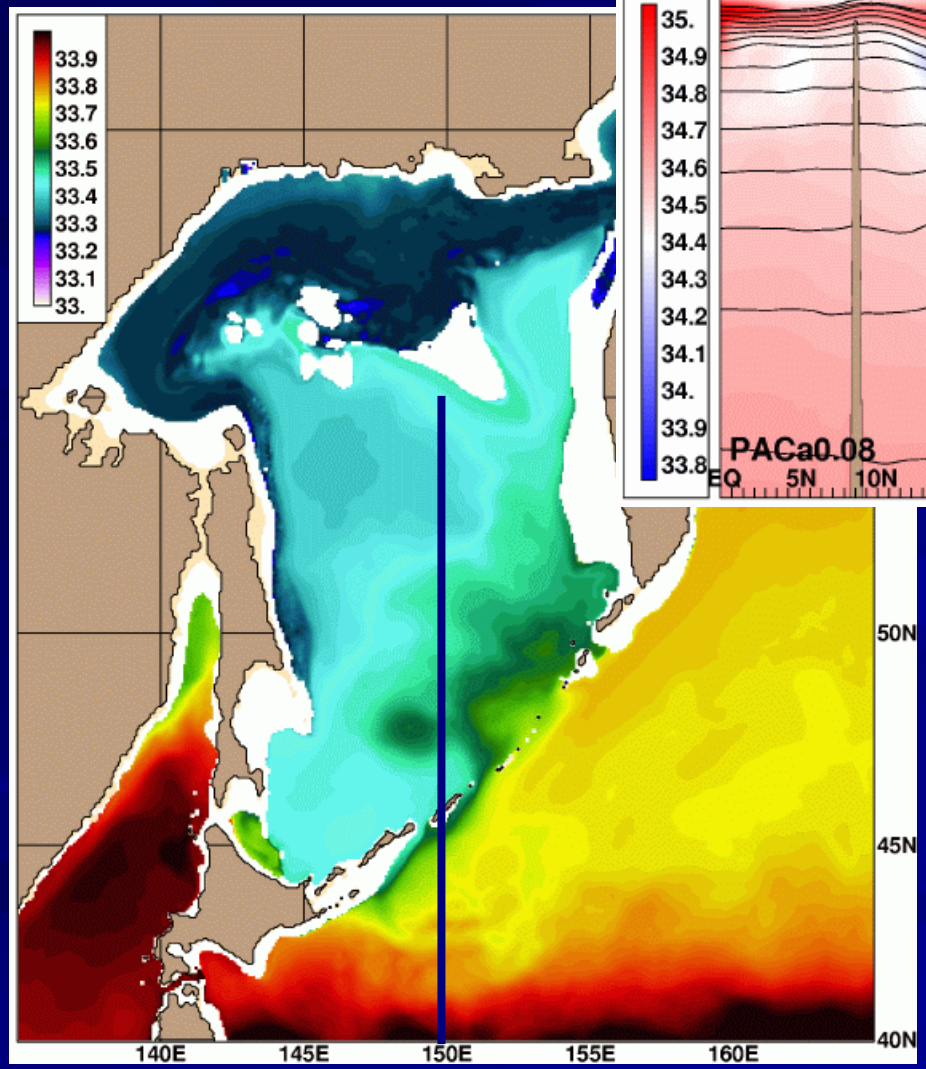


Yellow/red = eastward flow, blue = westward flow
HYCOM forced with interannual ECMWF winds and heat fluxes
No oceanic data assimilation

North Pacific Intermediate Water in HYCOM

Salinity vs. depth along 150°E



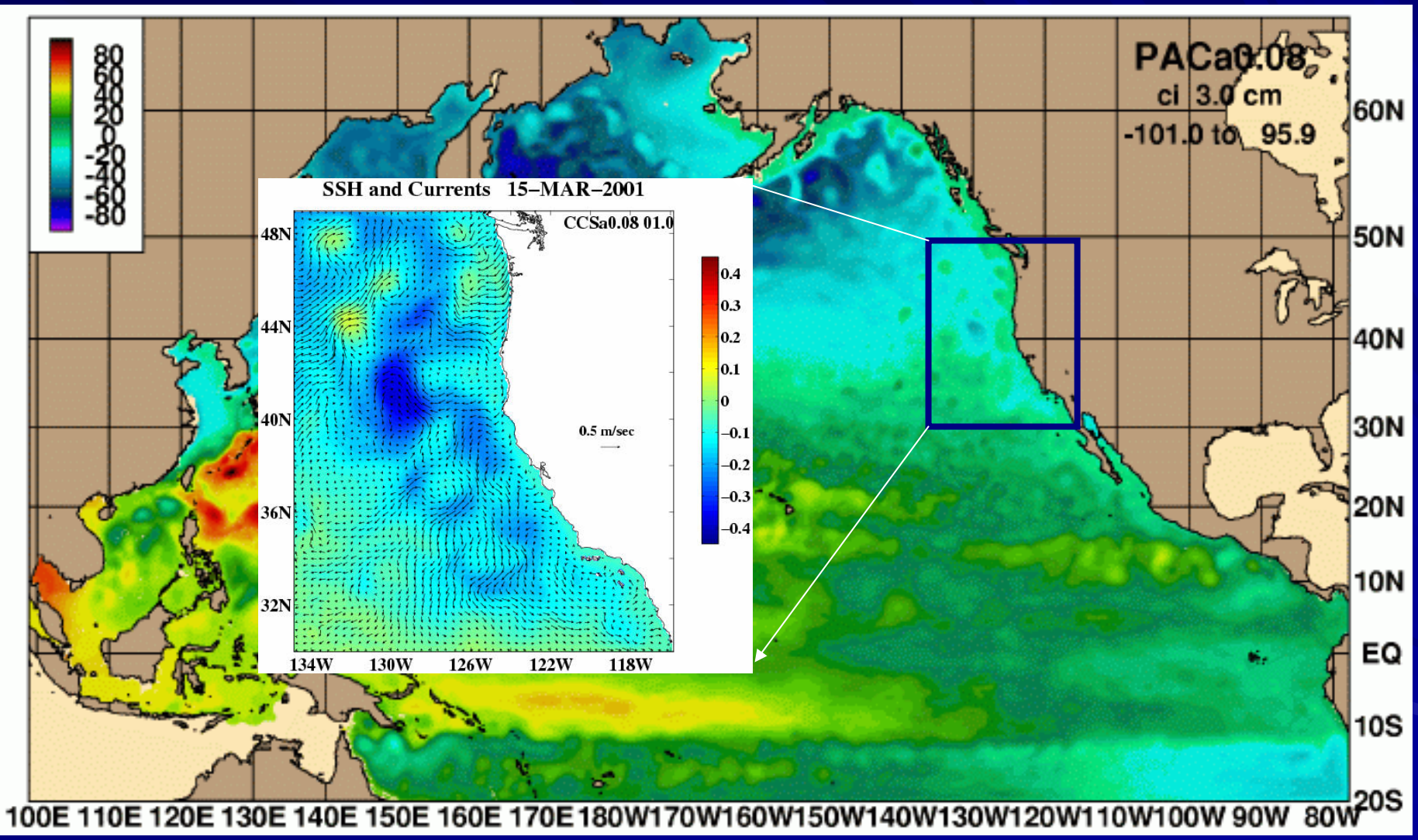


Salinity on layer 13 – 26.8 σ_θ

Formation processes (?)

- Subduction of fresh, subpolar surface water along Oyashio Front
- Formation confined to Sea of Okhotsk
  - River influx
  - Brine rejection

1/12° Pacific HYCOM Basin-scale Circulation with nested US West Coast HYCOM

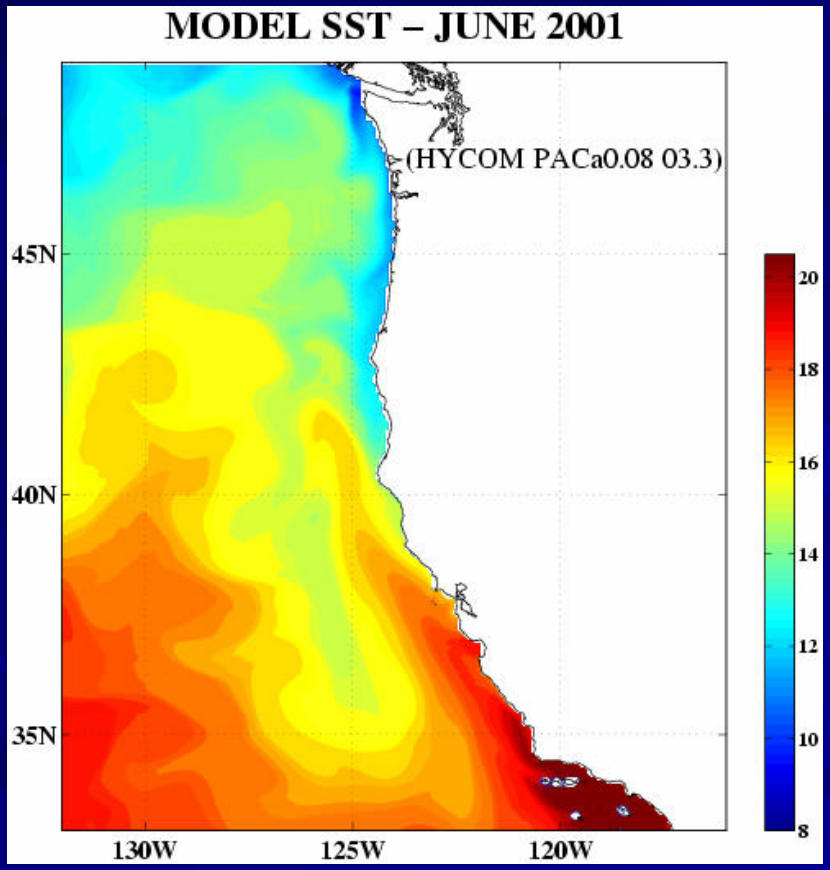


Forced with high frequency ECMWF winds and thermal forcing

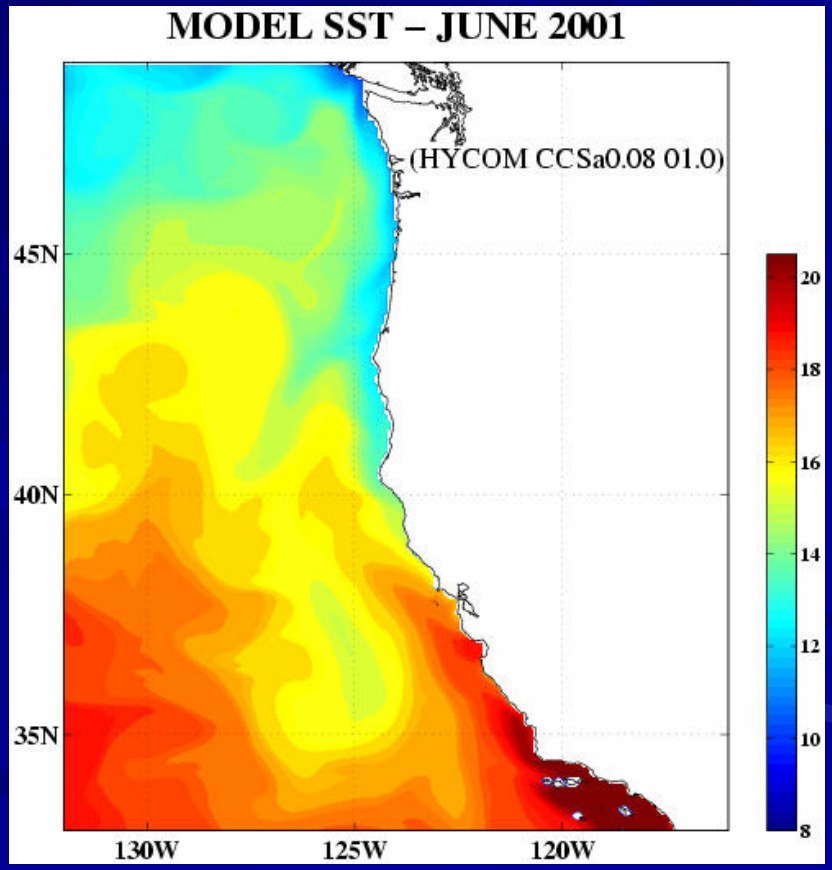
SSH Snapshot – 21 March

1/12° Pacific HYCOM Basin-scale Circulation with nested US West Coast HYCOM

Pacific Basin HYCOM



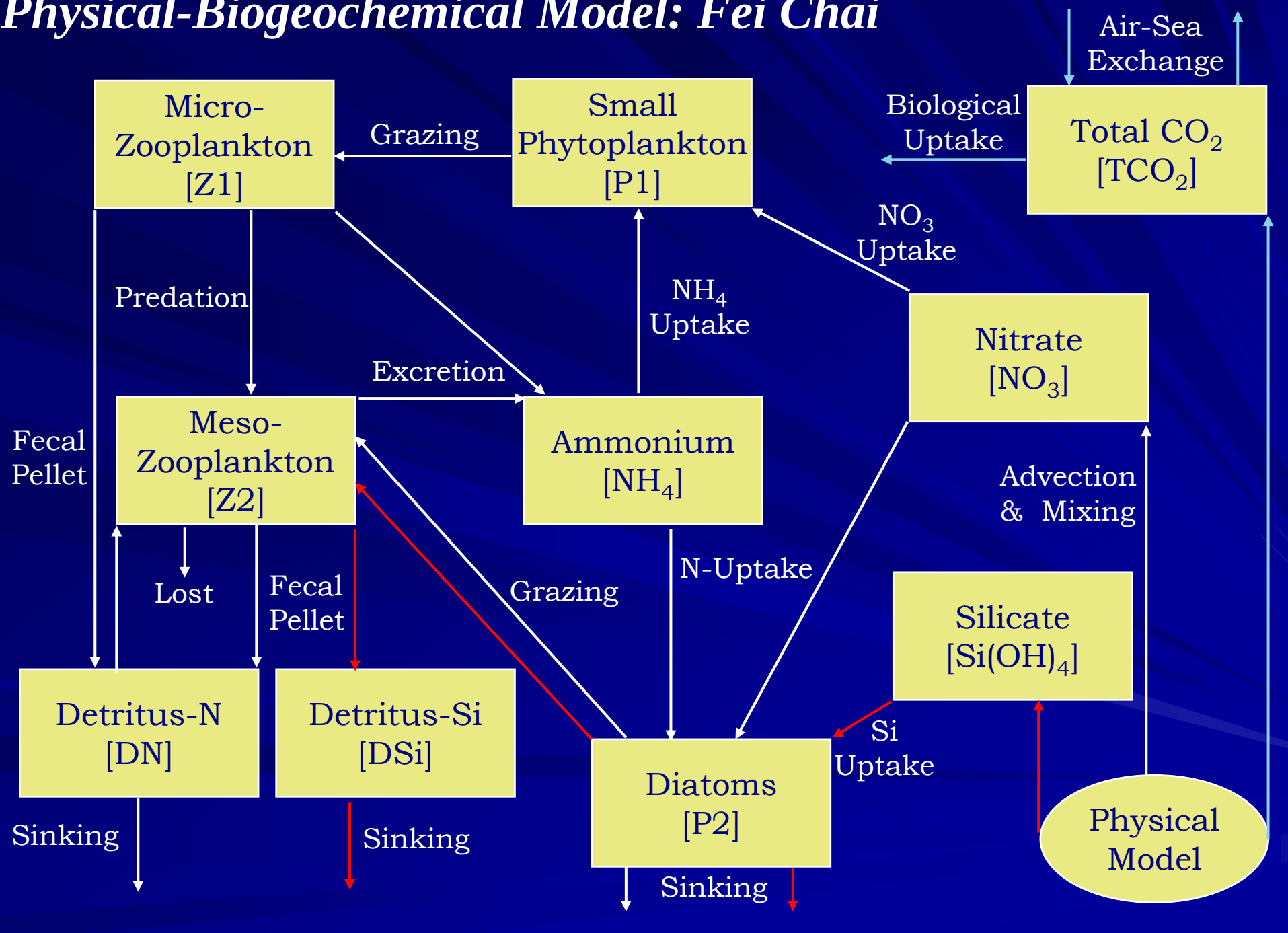
Nested US West Coast HYCOM



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



NRL Test Region: US West Coast: 1/12^0 West Coast Model nested within Global NCOM(1/8th deg.) (Regional Model; 1/24th deg by 10/03)

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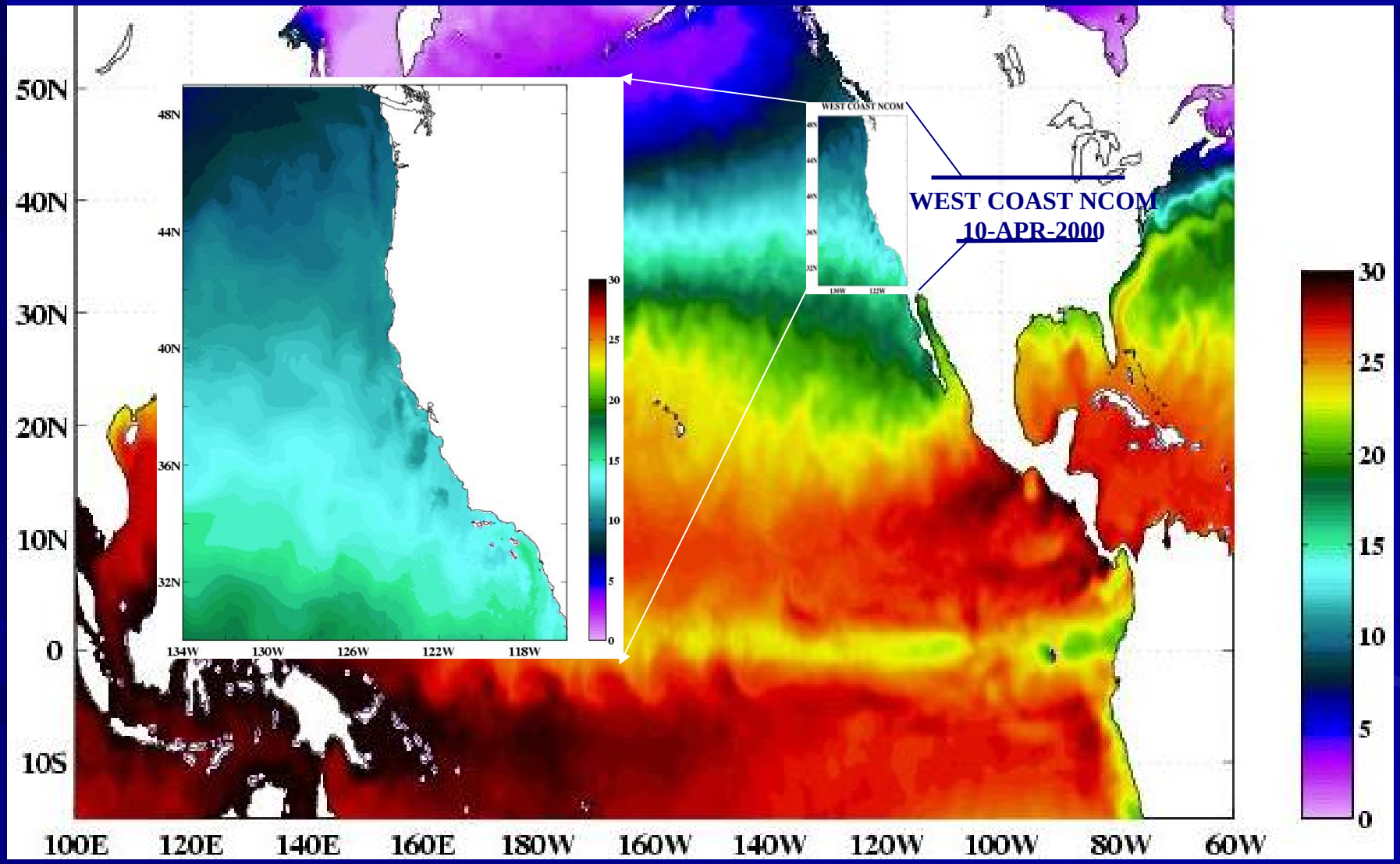

Summary

- Pacific Basin HYCOM Simulation($1/12^0$)
  - 1979—2002: Currently at ~1995
    - ECMWF Reanalysis Forcing (6 hourly)
    - ~18 hrs/model month on IBM SP3 (305 process.)
    - Preliminary Analysis: Excellent agreement with observations throughout basin
  - 2-3 year run with data assimilation (~ 99-01)
  - Nested Eastern Pacific HYCOM
    - Completed: Next Step---coupled Ecosystem mod.
    - Coastal-Open Ocean exchanges
  - Recent / Future HYCOM Developments
    - Advection Scheme: MPDATA $\longrightarrow$ FCT2 (Implemented)
    - Separate time step for tracers (Future)