

1/12° Pacific HYCOM: The End Of A Long Simulation

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1/12° Pacific HYCOM Modeling at NRL

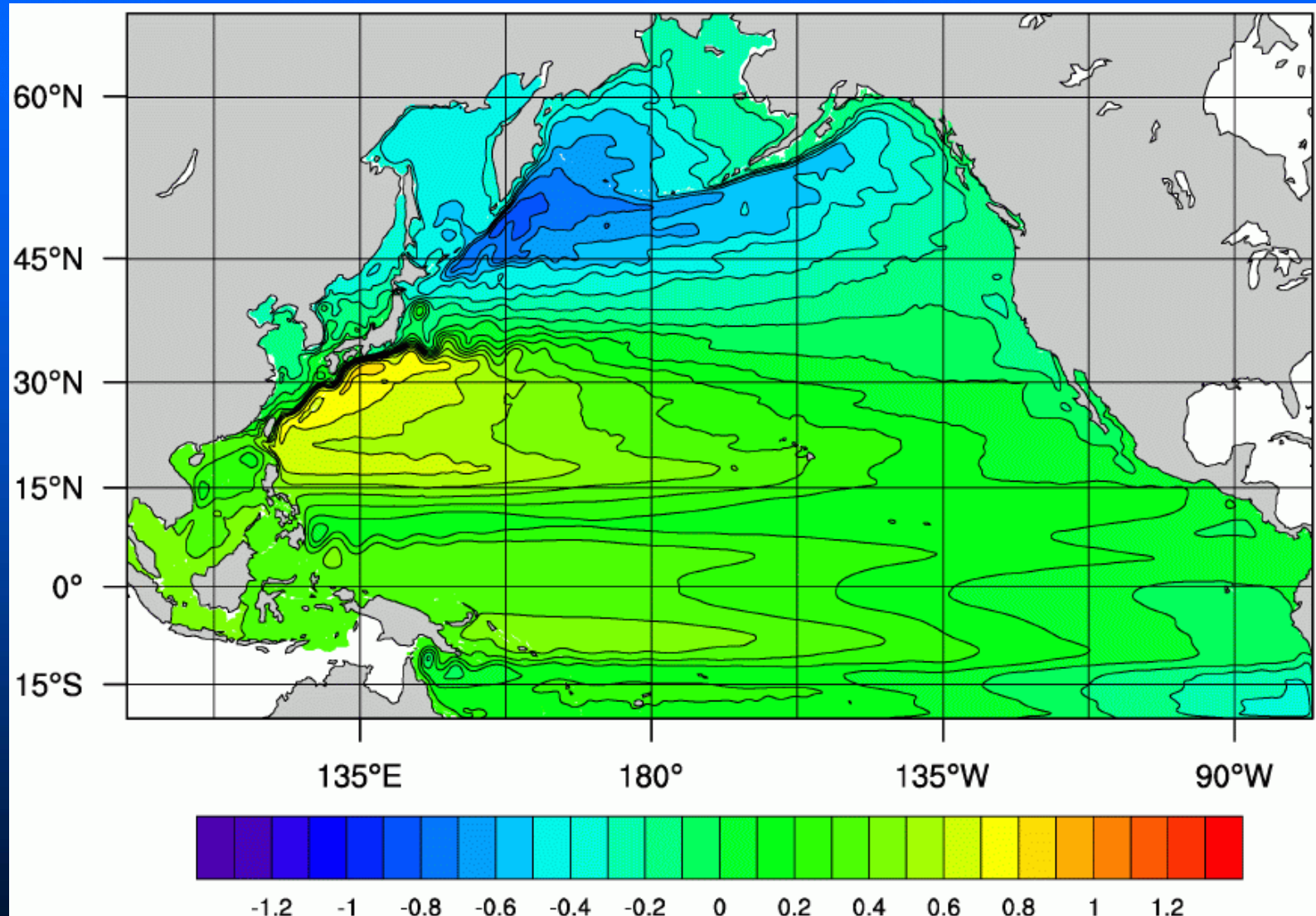
- Initial 1/12° Pacific modeling began in Dec 2001 on the IBM SP at the Maui High Performance Computing Center
- Part of the FY02-FY04 DoD HPC Challenge grant: “Basin-scale prediction with the HYbrid Coordinate Ocean”
- Original proposal called for 46 years of both climatological and interannual forced simulations
- Completed 60 years of integration under Challenge: 17 climatological + 43 interannual

Major 1/12° Pacific HYCOM Experiments

- Climatological forced:
 - HR winds/ECMWF fluxes: 14 years
 - ECMWF winds/ECMWF fluxes: 20 years
- Interannual forced: 3 or 6 hourly
 - ECMWF winds + fluxes: 1979 – 2003
 - **Highest horizontal/vertical resolution basin-scale simulation run for this long with interannual forcing**
 - Integrated on ARL IBM SP3
 - ~1.45E6 Sus (4900 hrs x 297 processors)
 - Took 11 calendar months to complete
 - Generated 17.3 Tb of output
 - FNMOC NOGAPS winds + fluxes: 2001 - 8/2004
 - Initial state from this experiment will be used in a simulation with data assimilation

Basin-wide Mean Circulation

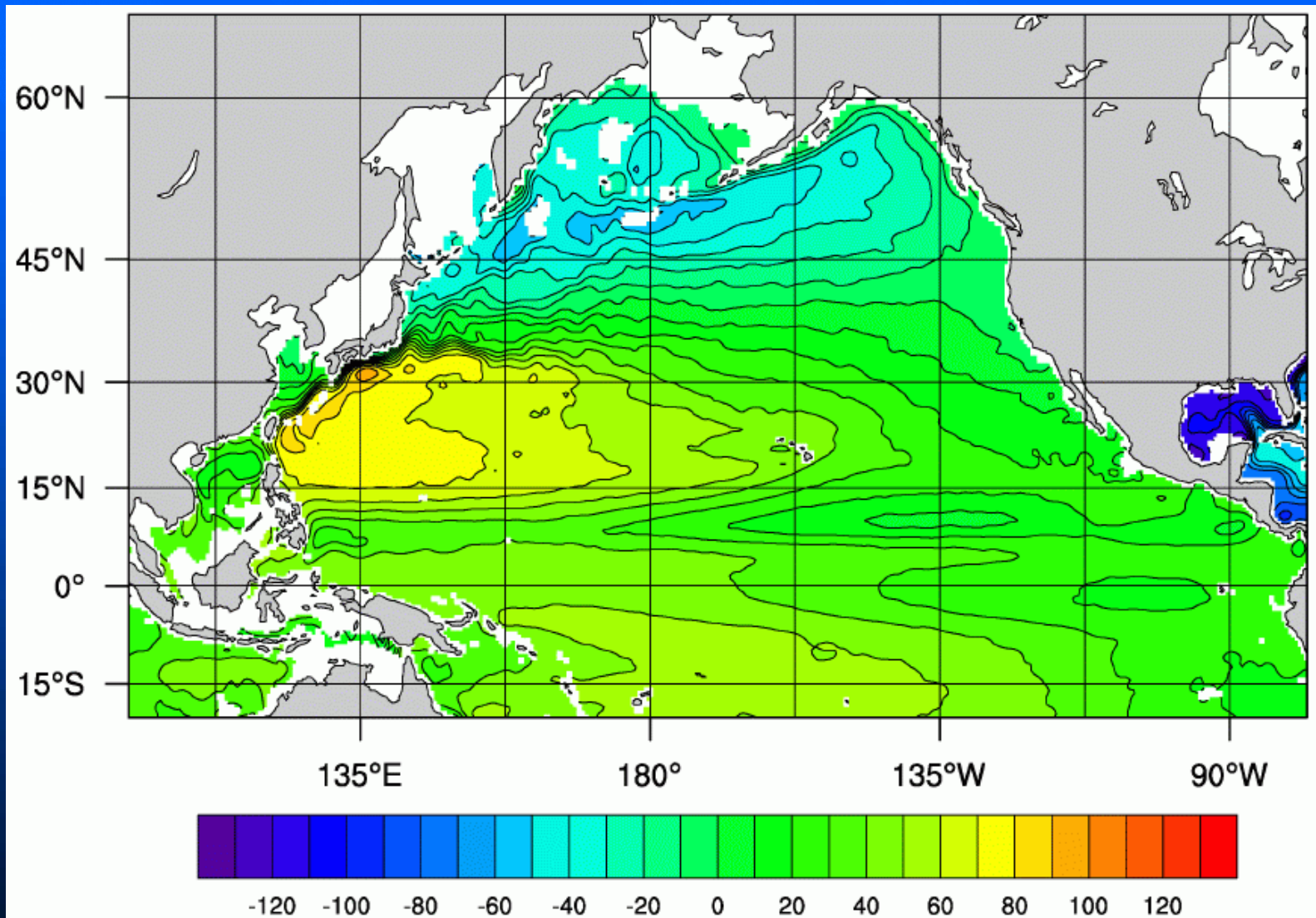
HYCOM Mean SSH



1/12° Pacific HYCOM – ECMWF climatological forcing

Basin-wide Mean Circulation

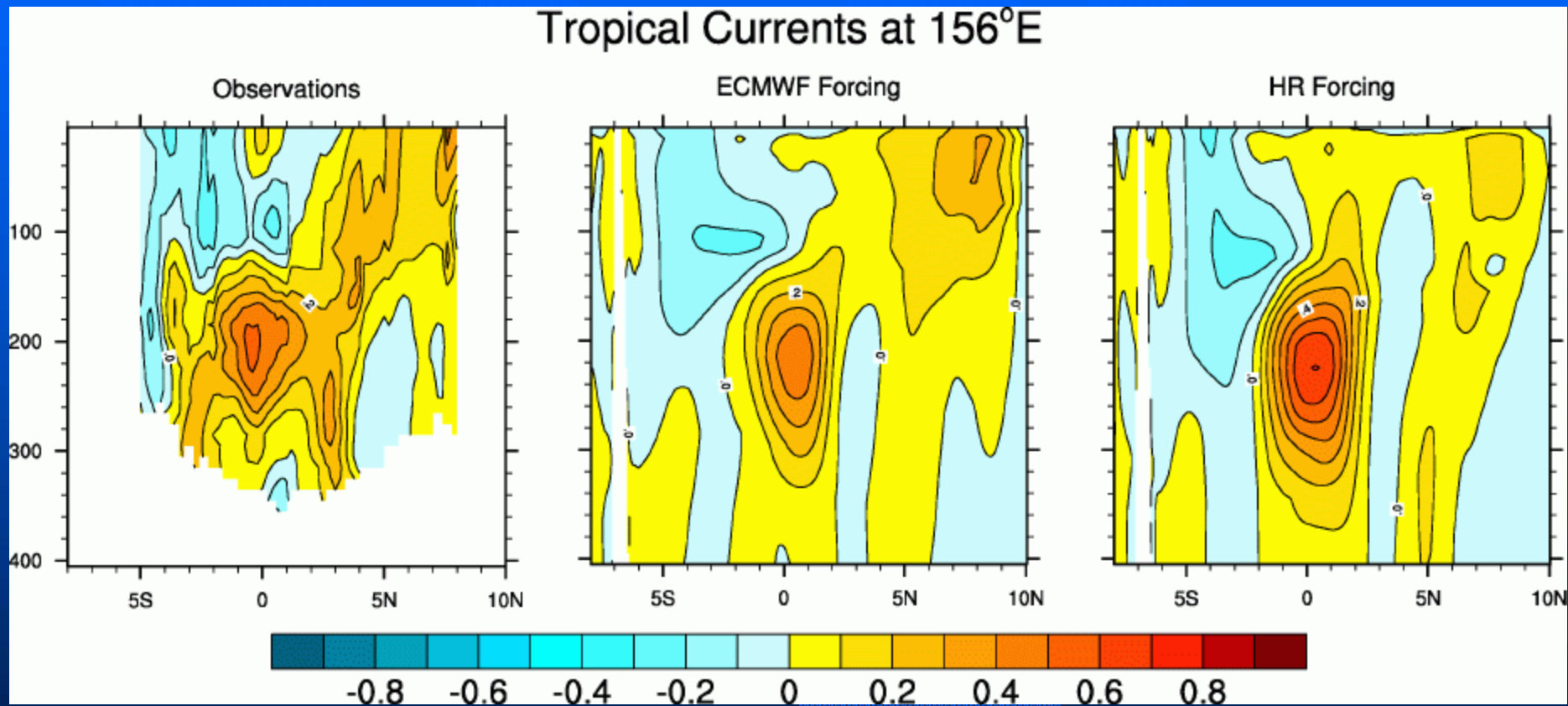
1992-2002 Mean SSH



Niiler et al. (2003, GRL) – 40 cm bias removed

Tropical Current Systems

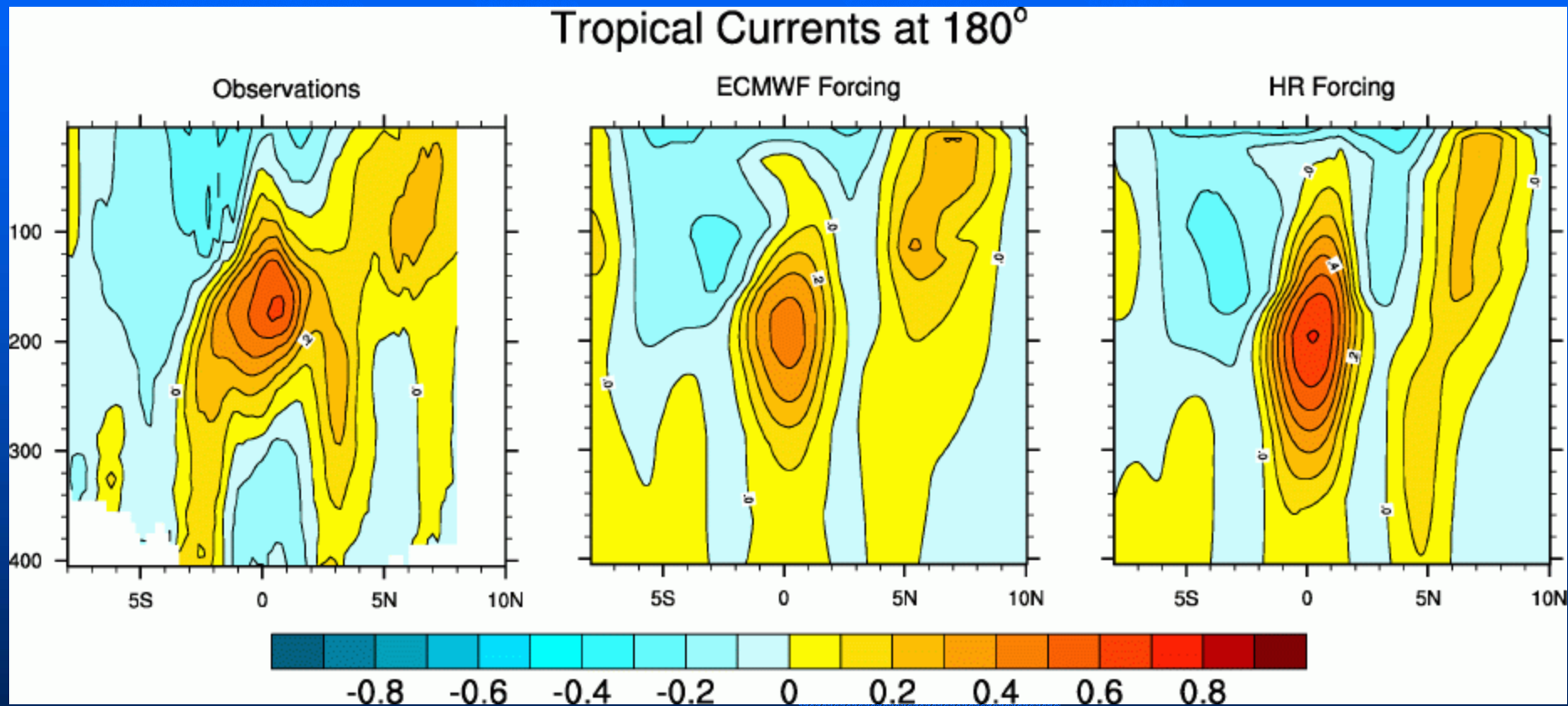
Zonal velocity across the equator



Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Tropical Current Systems

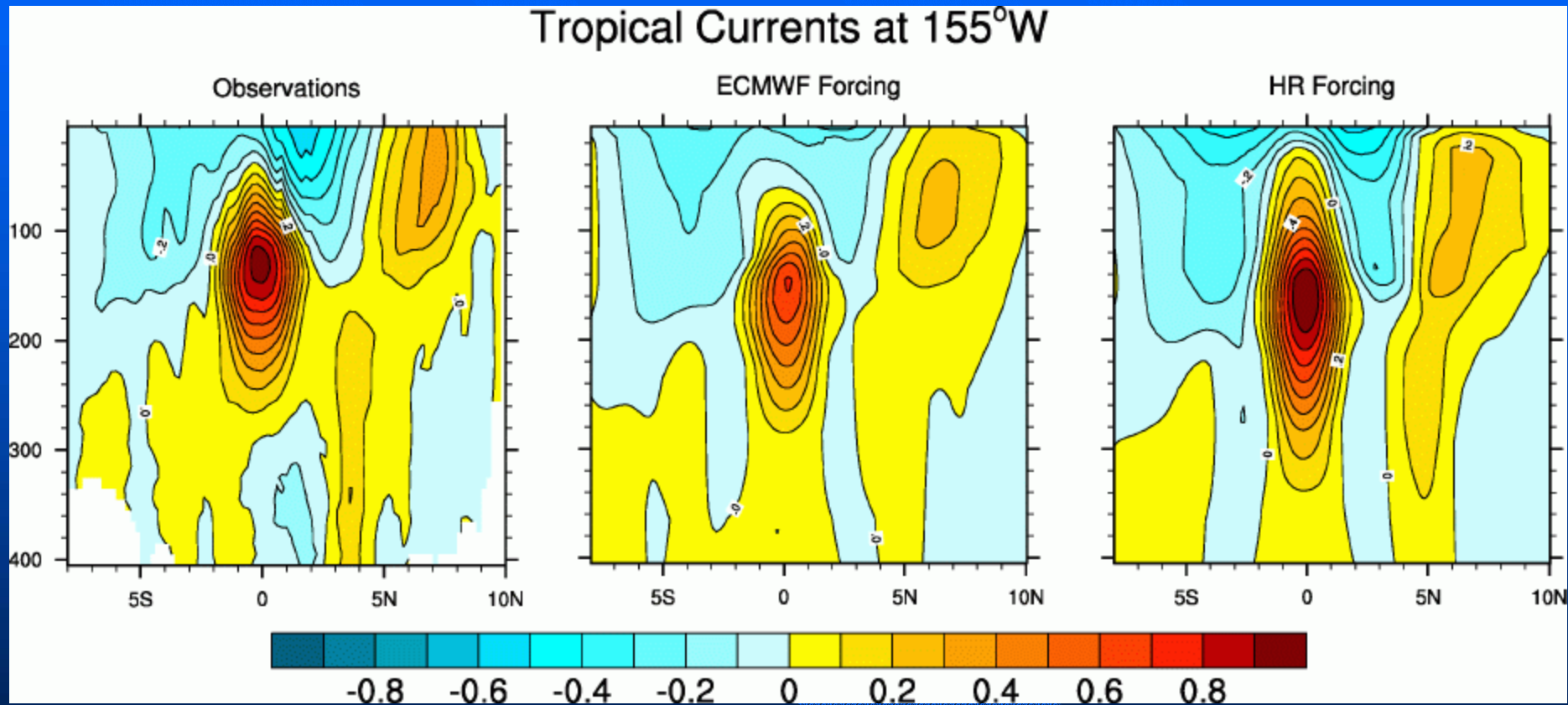
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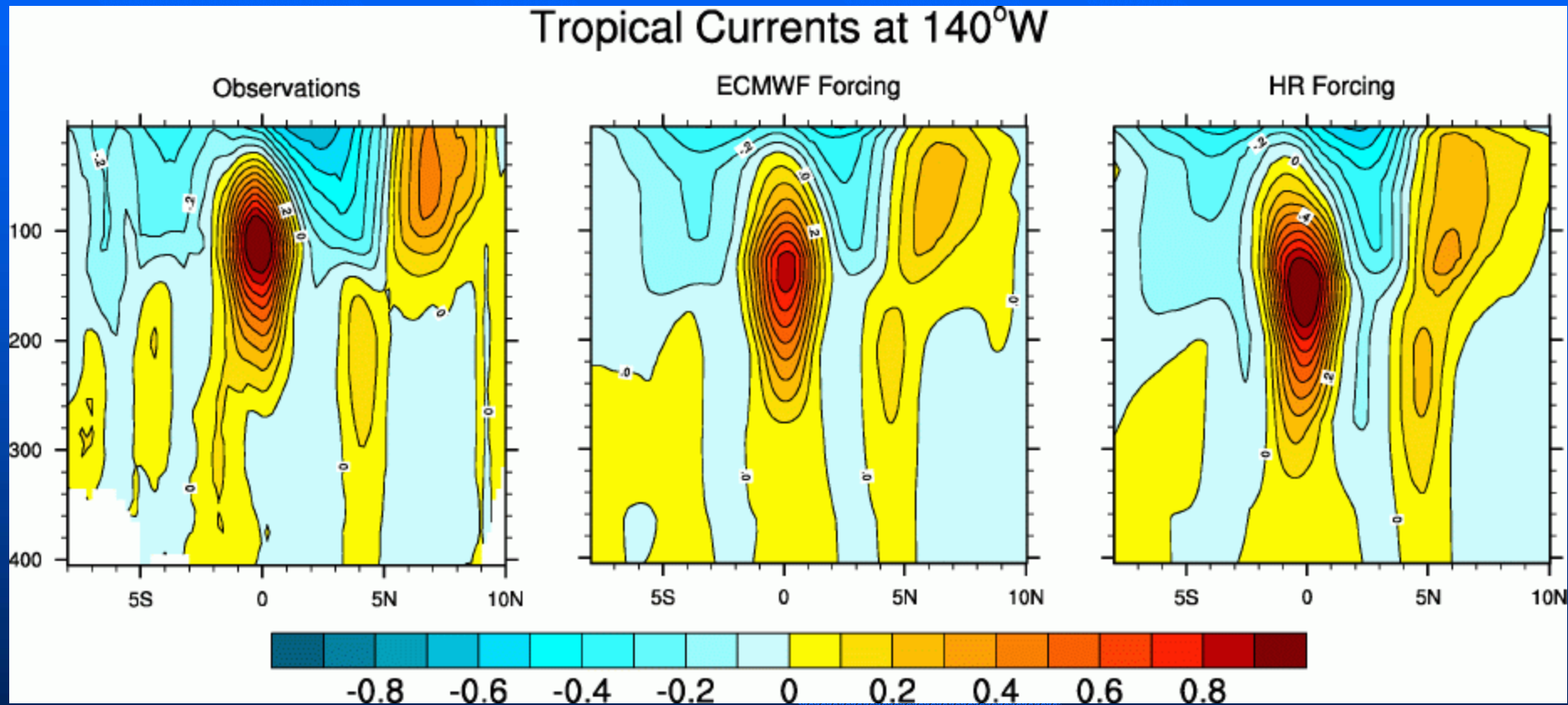
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Tropical Current Systems

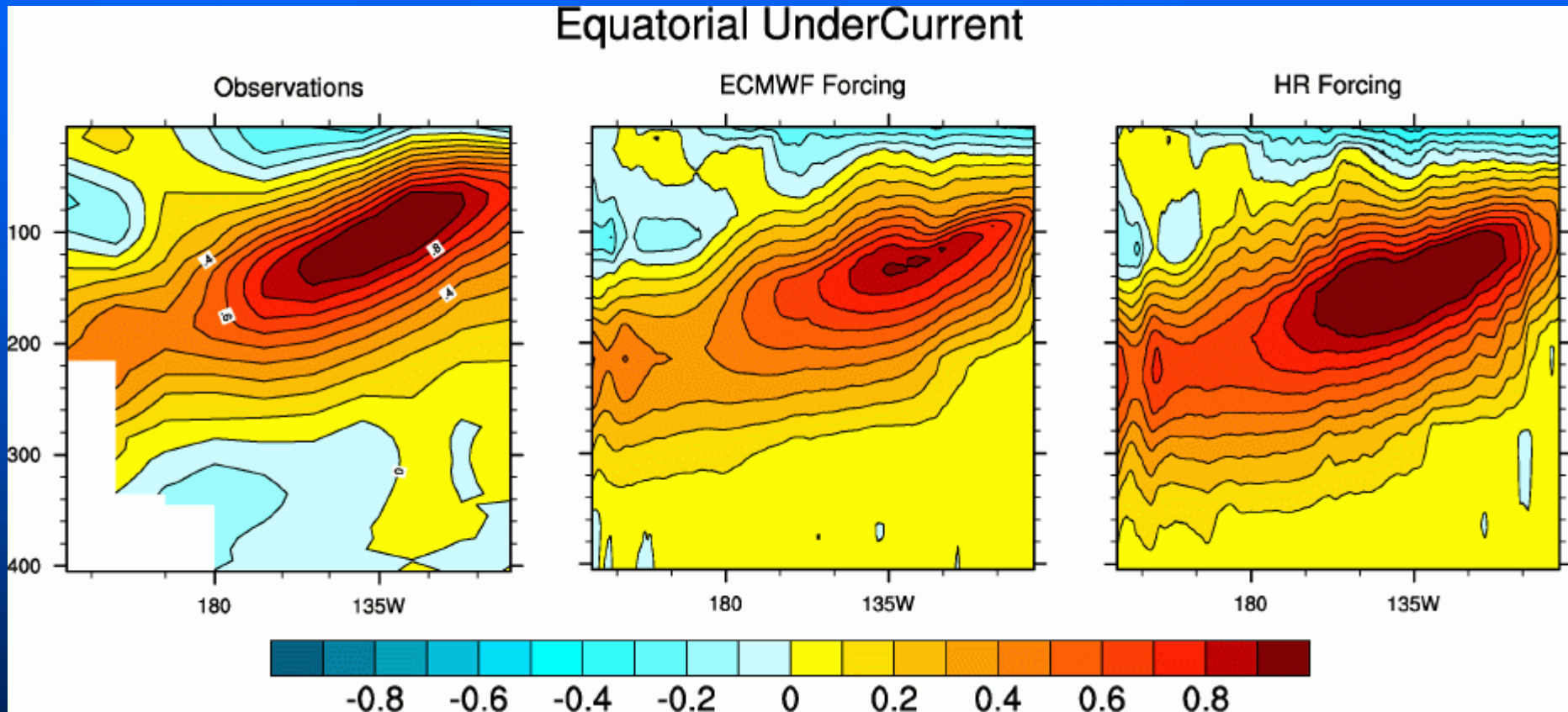
Zonal velocity across the equator



Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

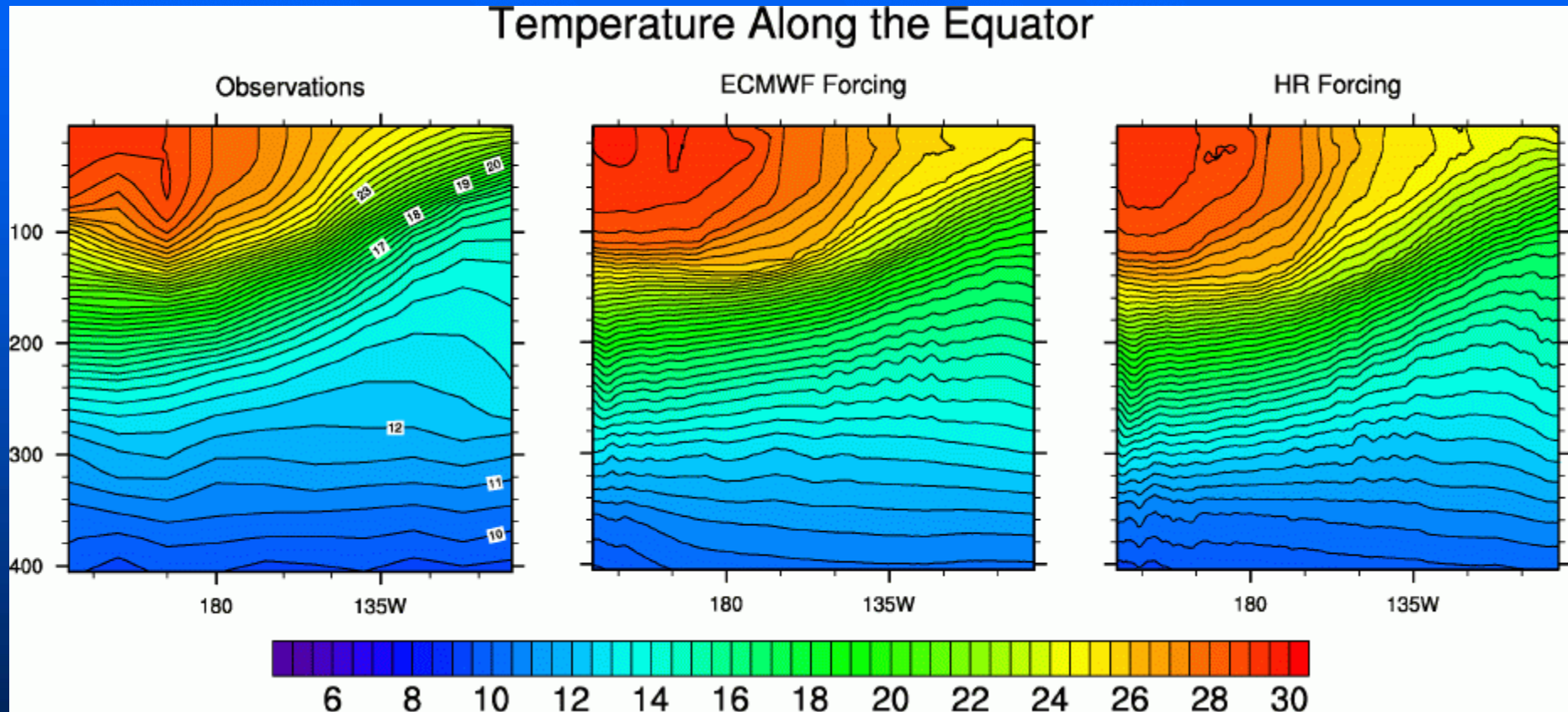
Equatorial Currents

Zonal velocity along the equator



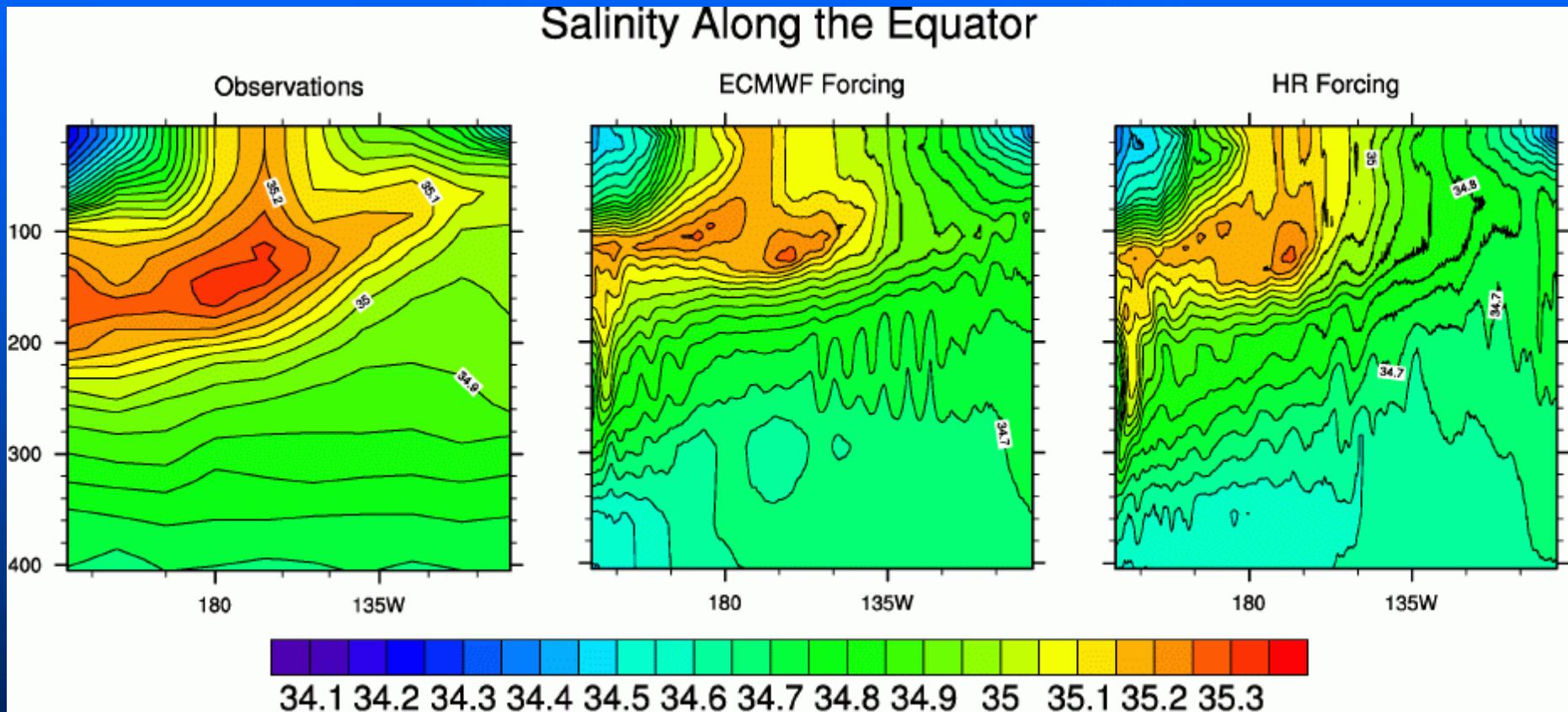
Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Equatorial Temperature



Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Equatorial Salinity



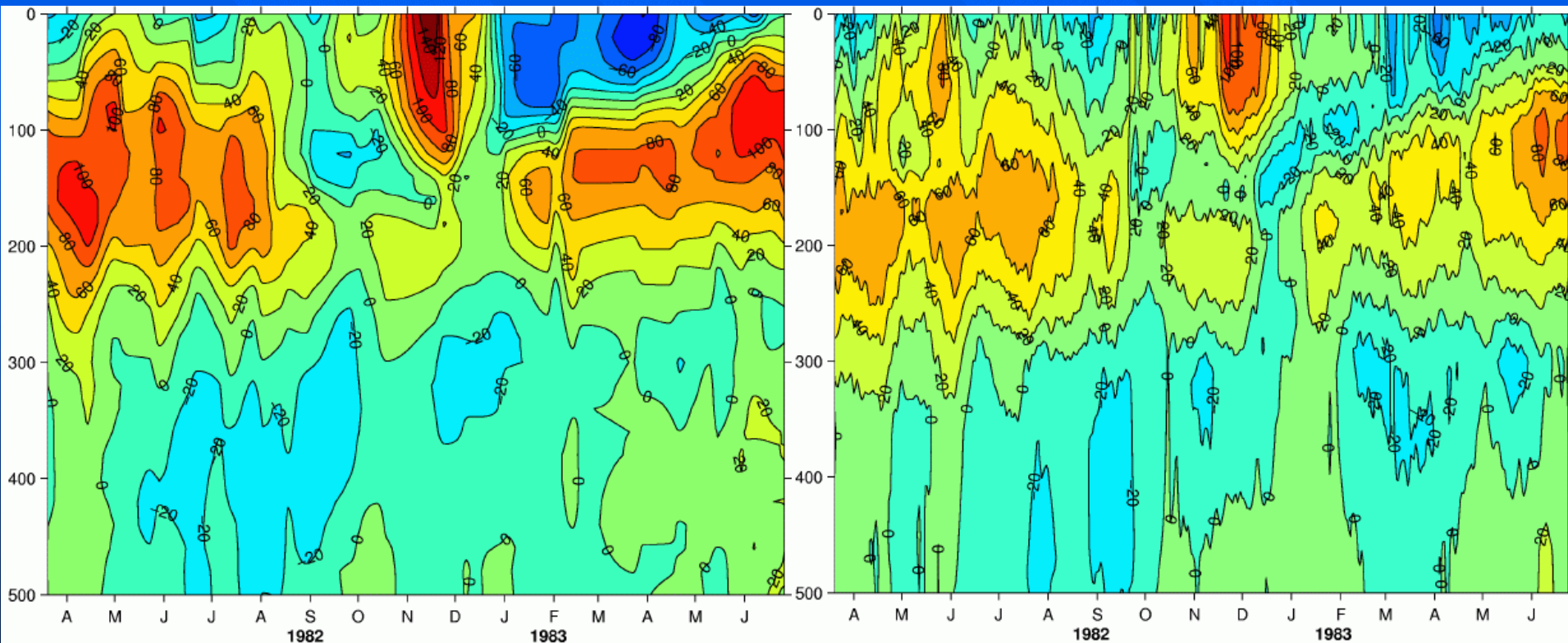
Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

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

Zonal velocity on the Equator at 159°W

Adapted from Firing et al. (1983)

1/12° Pacific HYCOM

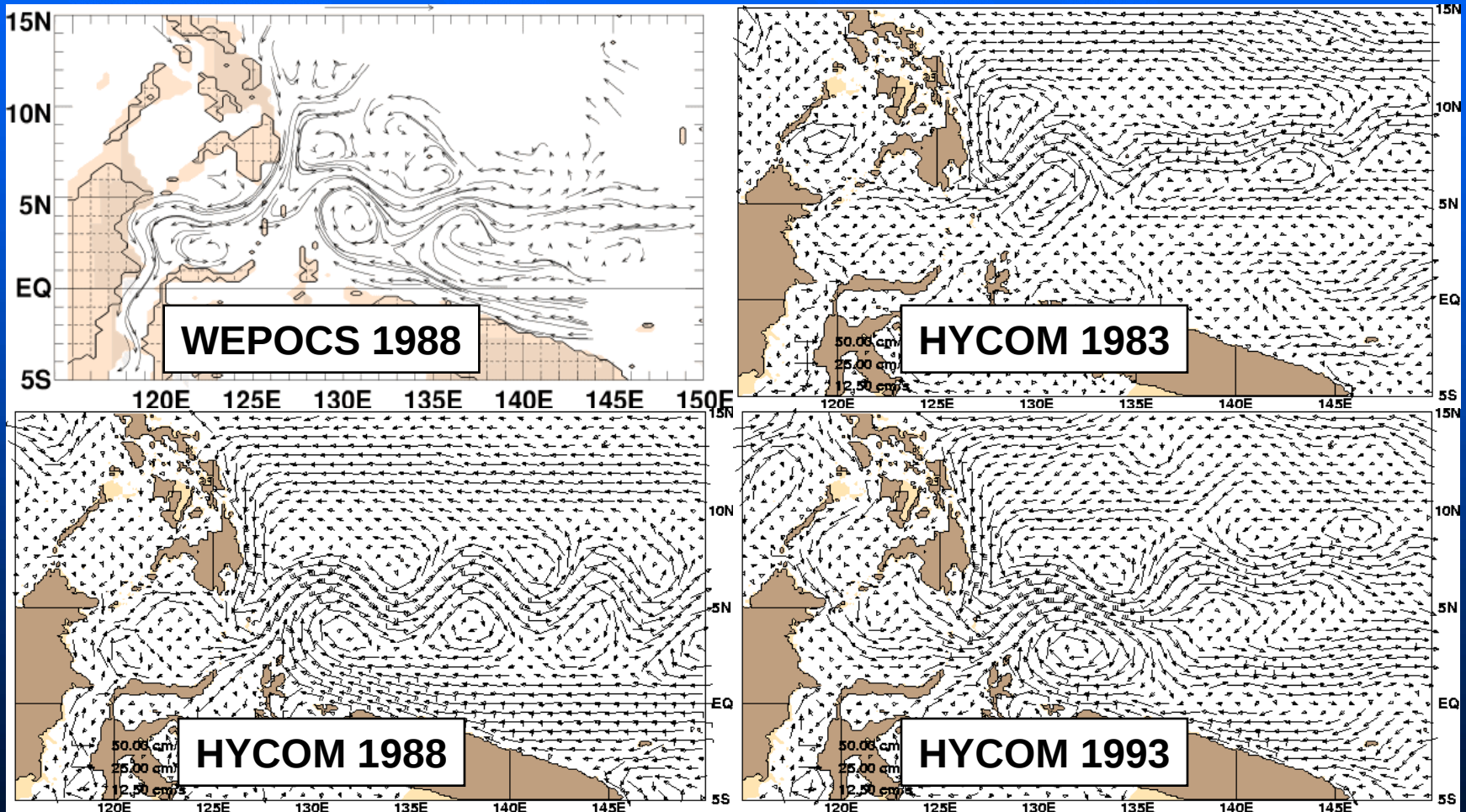


Yellow/red = eastward flow, blue = westward flow
HYCOM forced with interannual ECMWF winds and heat fluxes
No oceanic data assimilation

Currents in the Western Equatorial Pacific

WEPOCS III observations vs. HYCOM

July-August-September upper ocean currents



WEPOCS from Lukas et al. (1991, JGR)

Vector Correlation

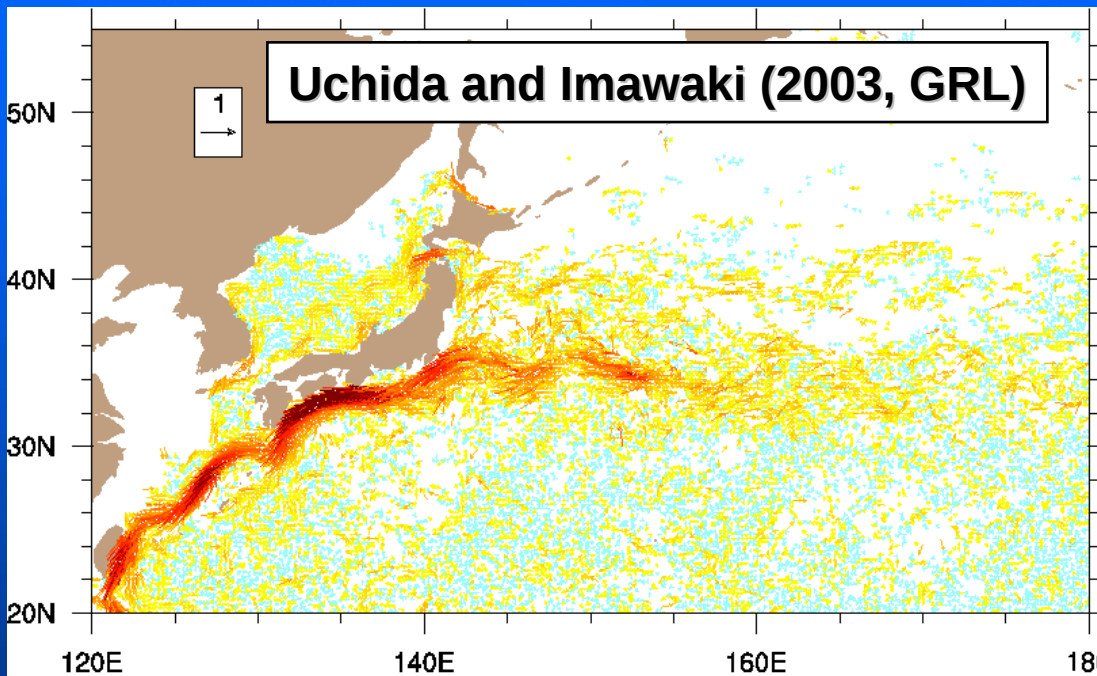
WEPOCS III observations vs. HYCOM

**WEPOCS III JAS 1988 mean vs. HYCOM
JAS means for individual years**

1980	.34	1987	.31
1981	.46	1988	.60
1982	.47	1989	.51
1983	.11	1990	.32
1984	.52	1991	.37
1985	.53	1992	.43
1986	.33	1993	.50

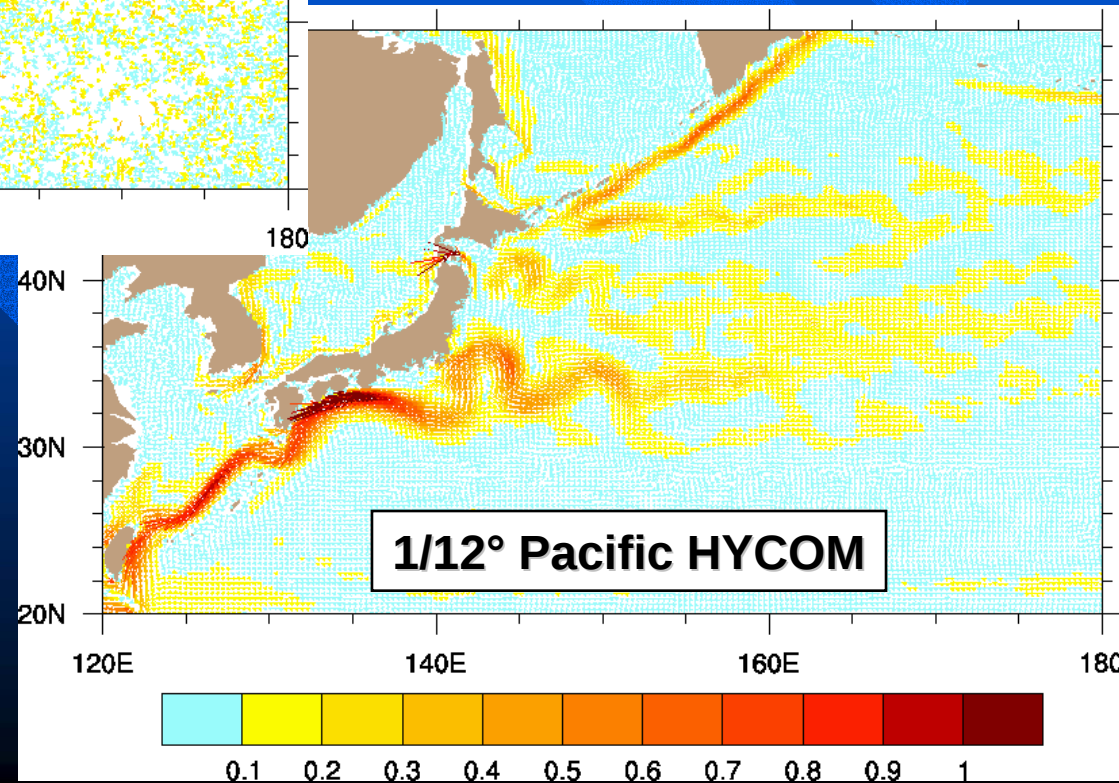
Kuroshio Extension Surface Currents

Vectors color-coded by speed



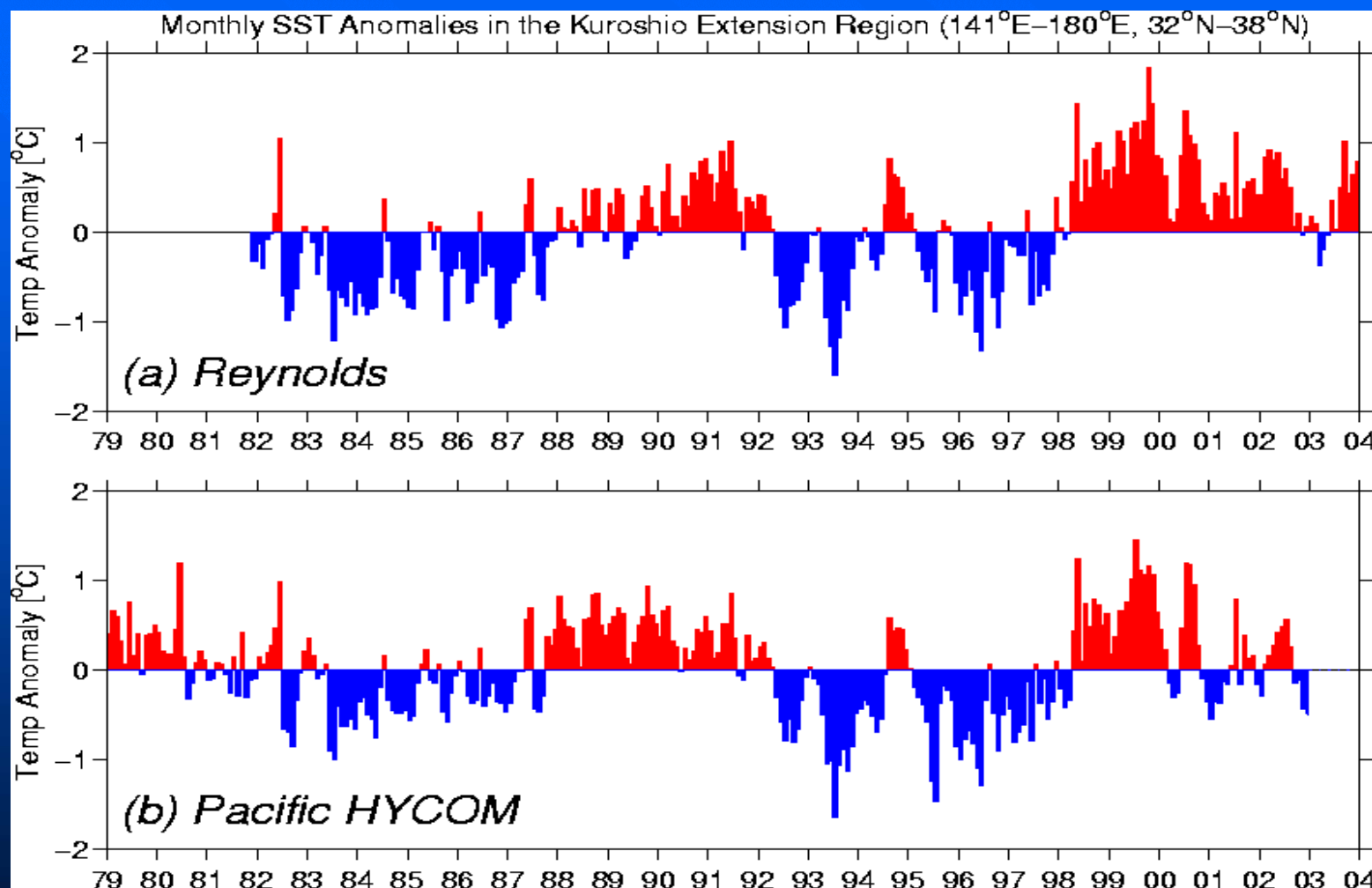
Jan 1993 – Dec 2000
model mean

Oct 1992 – Dec 2000 mean
based on a combination of
surface drifter and satellite
altimeter data



Interdecadal Variability in the Kuroshio Extension

SST anomalies (140°E-180°, 32°-38°N)



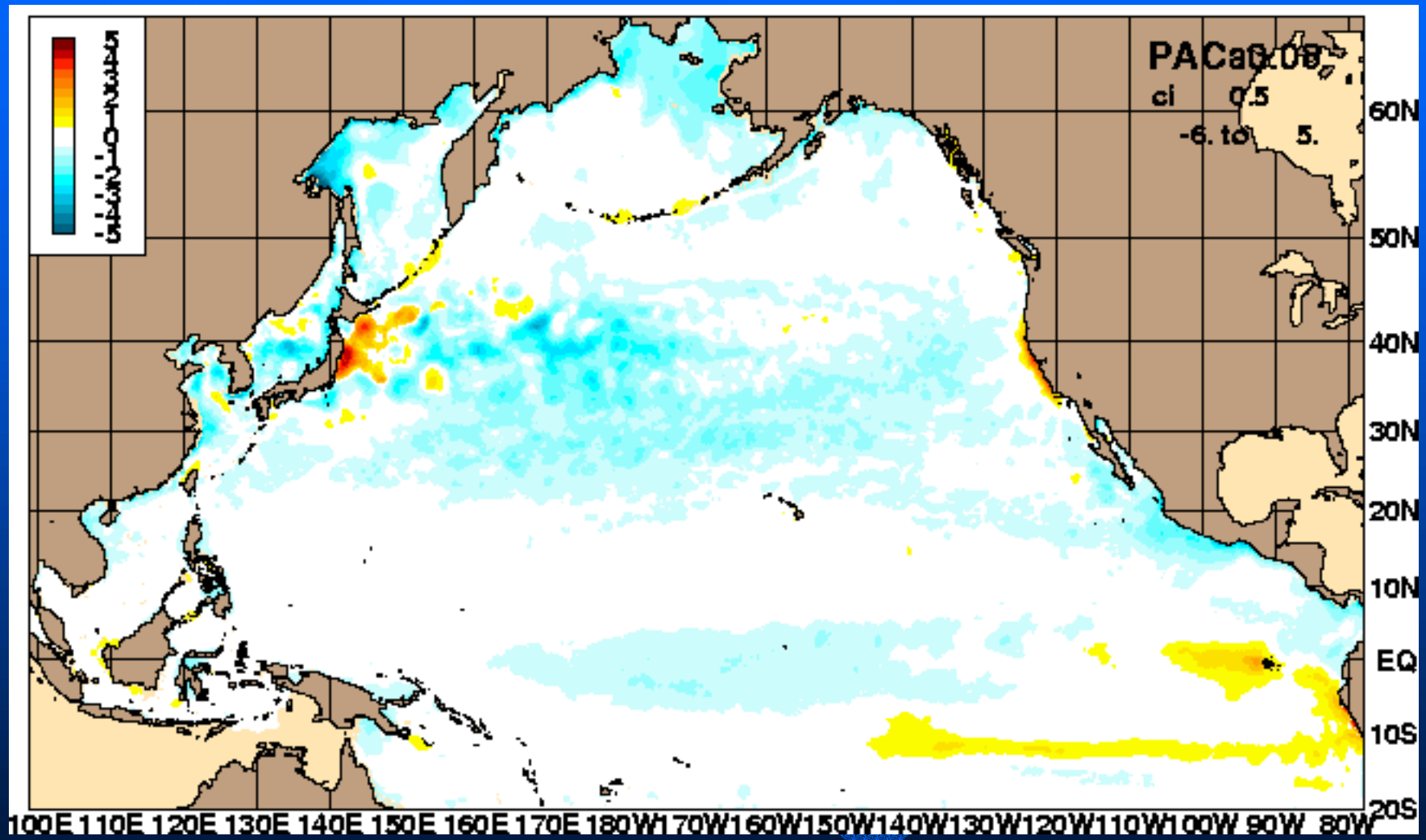
Observations from Reynolds and Smith (1994, J. Climate)

Anomaly relative to 1982-2001 monthly climatology

Collaboration with B. Qiu and S. Chen (U. Hawaii)

MODAS SST vs. 1/12° Pacific HYCOM

2003 Mean error



NOGAPS wind/thermal forcing; radiative fluxes corrected to SOC mean
White area $\pm 0.5^{\circ}\text{C}$

Scientific Interest in Pacific HYCOM Output

- **Z. Yu (U. Hawaii)**

- project to study equatorial subsurface countercurrents, namely the Tsuchiya Jets

- **E. Firing and F. Ascani (U. Hawaii)**

- project to study sub-thermocline extra-equatorial jets
- symmetric currents extending from about 400 – 1500 m with eastward (westward) flow $\sim 1.5^\circ$ ($\sim 3^\circ$) on either side of the equator

- **J. Kool (RSMAS)**

- Developing an agent-based model of intraspecific genetic diversity; using HYCOM output for development and testing

Scientific Interest in Pacific HYCOM Output

- **L. Rothstein and Y. Luo (U. Rhode Island)**
 - Looking at the Mixed Water Region in the Kuroshio Extension region
 - Analyzing the Kuroshio's impact on the subtropical/subpolar exchange processes
- **P. Niiler and C. Ohlmann (UCSD)**
 - ONR funded project to compare HYCOM output with 1990-1999 drifting buoy data in the California Current region
- **W. Cheng (U. Washington)**
 - Comparing model pycnocline transport across 9°S/9°N with observations

Scientific Interest in Pacific HYCOM Output

- **Y. Jia (U. Hawaii - IPRC)**

- Developing nested Hawaiian Islands HYCOM
- Using BC's from 1/12° Pacific HYCOM
- Plans call for a high resolution model with data assimilation to predict near-shore sea states, and to provide information for local fisheries, search and rescue operations and hazard management

- **L. Thompson (U. Washington) and K. Kelly (APL)**

- ONR funded project to evaluate 1/12° Pacific HYCOM using satellite and in situ observations
- Long term goal is to improve high resolution ocean models through evaluation and analysis of model subsurface and thermal structure

Future Plans for Pacific HYCOM

- Begin a simulation with data assimilation
 - NCODA system developed by Jim Cummings
 - FNMOC NOGAPS forcing
 - Start in 2001 and integrate to near real-time
- Transition a near real-time, data-assimilative, semi-operational Pacific HYCOM nowcast/forecast system to NAVOCEANO by the end of FY05
 - Will probably run once per week
 - 1/12° is the target resolution for the **global** nowcast/forecast system set for transition to NAVOCEANO in FY07