Pacific HYCOM

E. Joseph Metzger[†], Harley E. Hurlburt[†],
Alan J. Wallcraft[†], Luis Zamudio[‡] and Patrick J. Hogan[†]

[†]Naval Research Laboratory, Stennis Space Center, MS
[‡] Center for Ocean-Atmospheric Prediction Studies, Florida State University

8th HYCOM Consortium / 1st HYCOM NOPP GODAE Meeting
19-21 August 2003
NCEP, Camp Springs, MD

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 2003		**00-00-2003 to 00-00-2003**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Pacific HYCOM	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory,Stennis Space Center,MS,39529**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**27**	

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 Modeling Progress

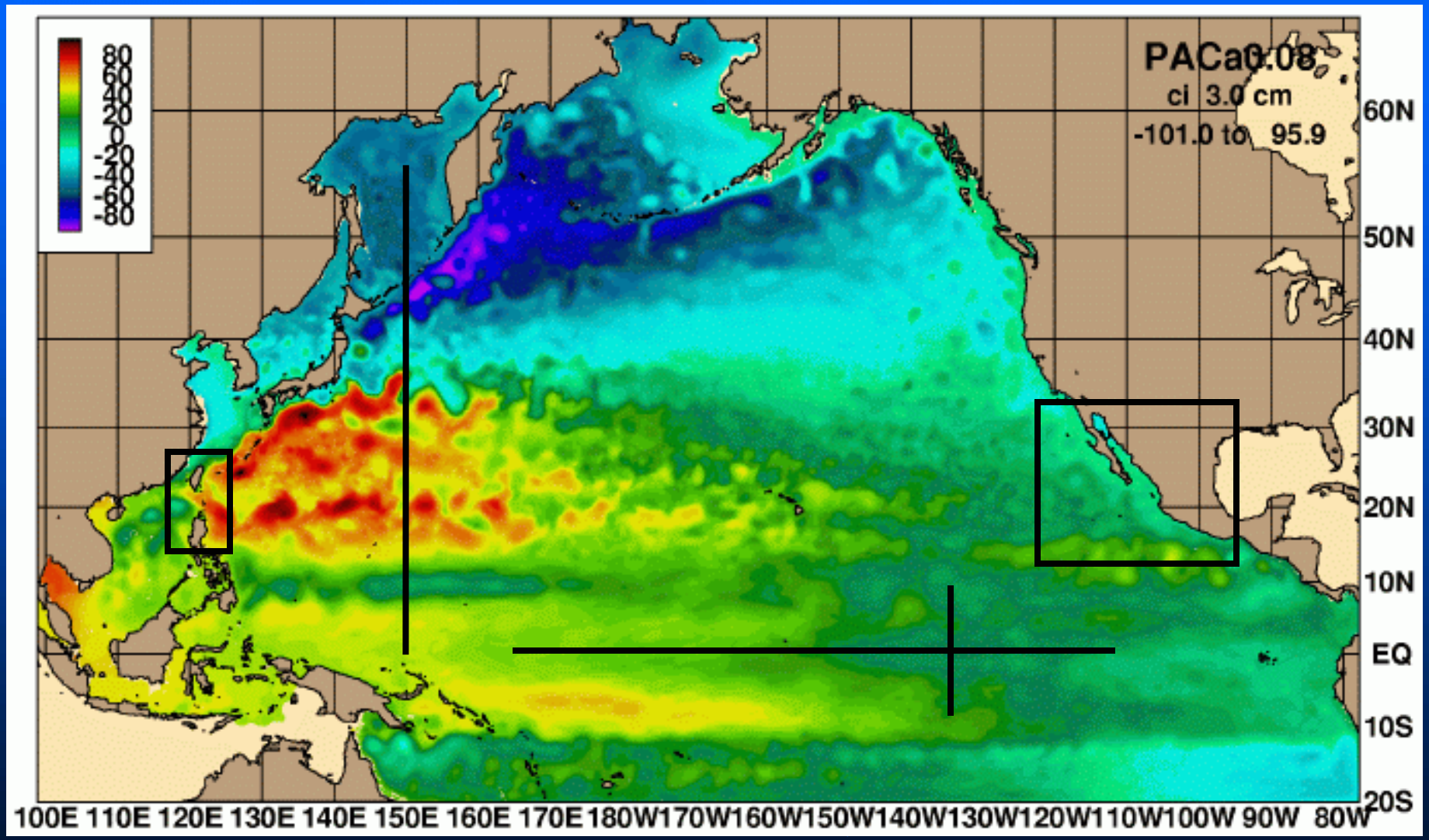
- 1/12° simulations (started from 1/6° simulations)
  - high frequency Hellerman and Rosenstein (1983, JPO) (HR) climatological forced simulation (9.5 years) – version 2.0.02
  - high frequency European Centre for Medium-range Weather Forecasts (ECMWF) climatological forced simulation (13.5 years) – version 2.0.02
  - high frequency European Centre for Medium-range Weather Forecasts (ECMWF) climatological forced simulation (6.5 years) – version 2.1.09
  - 1979-2003 European Centre for Medium-range Weather Forecasts (ECMWF) interannual forced simulation (through January 1985) – version 2.1.09
  - FNMOC NOGAPS/ECMWF interannual simulation January 2001 – December 2001, a period that spanned the life cycle of Hurricane Juliette – version 2.1.09

Improvements Between the Two ECMWF Forced Simulations

- HYCOM code upgrade: v2.0.02 ⇨ v2.1.09
  - Thin deep isopycnal layer capability
  - PLM vertical remapping for fixed coordinate layers
  - COARE 2.6 heat flux (flxflg = 4) vs. Kara *et al.* (flxflg = 2)
  - Bug-fixed ice model
- Longwave SST correction
- Monthly shortwave attenuation coefficients - turbidity
- Relaxation (surface salinity and at southern boundary) based on GDEM3
- Precipitation based on 1991-2001 ECMWF data
- Monthly river input (254 rivers)

1/12° Pacific HYCOM Basin-scale Circulation

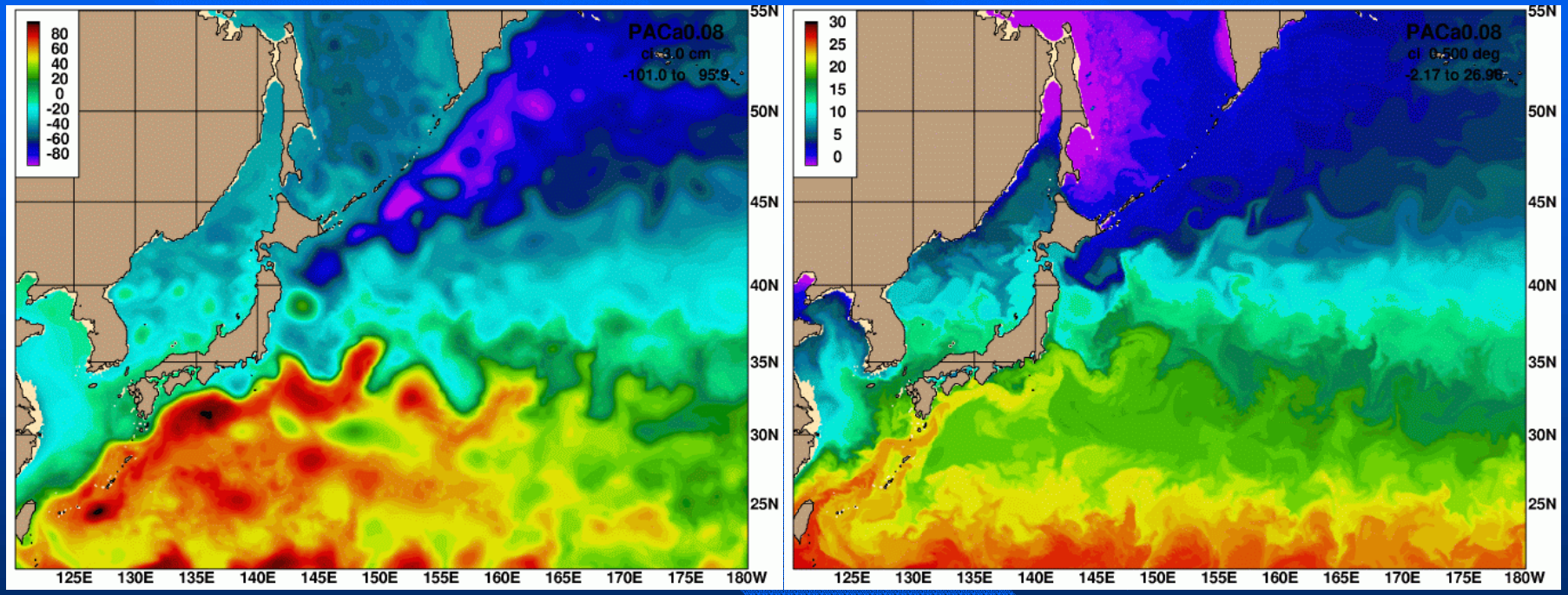
SSH Snapshot – 21 March



Forced with high frequency climatological ECMWF winds and thermal forcing

1/12° Pacific HYCOM

Zoom on the Kuroshio
SSH and SST Snapshot – 21 March

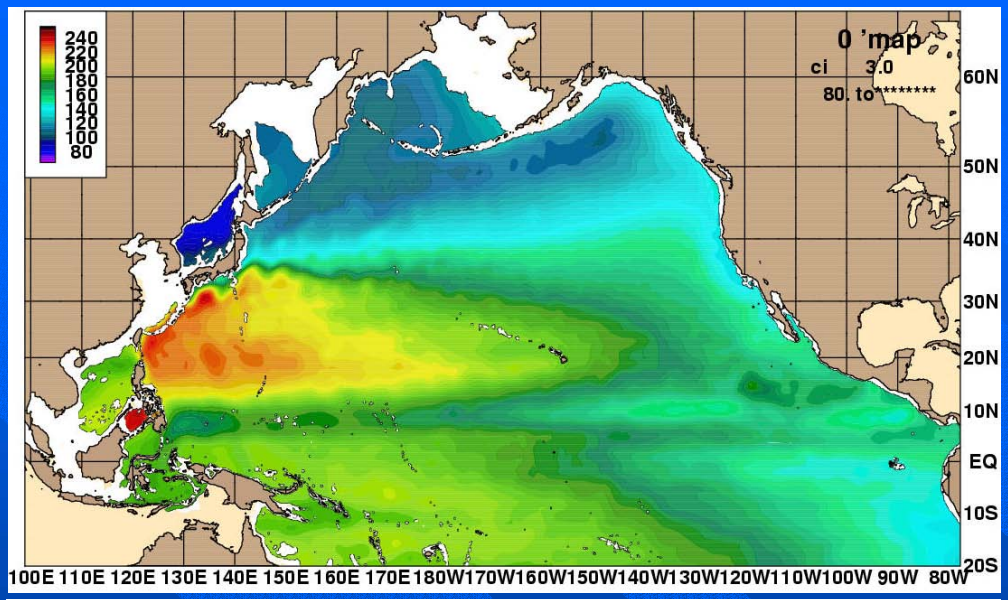


Forced with high frequency climatological ECMWF winds and thermal forcing

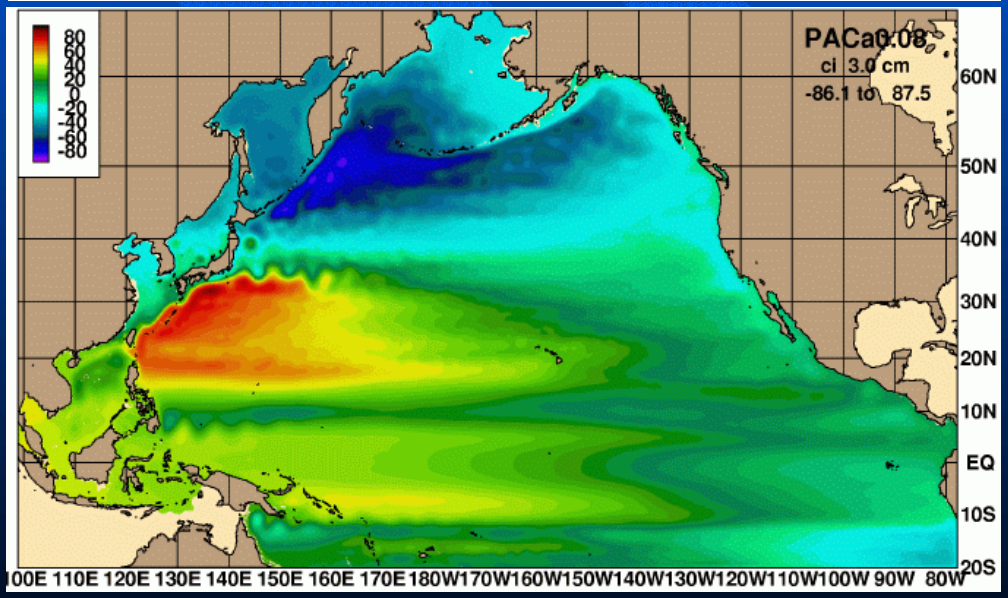
Comparison of the Basin-scale Circulation

MODAS climatology vs. 1/12° Pacific HYCOM

Mean dynamic height (dyn cm) wrt 1000 db



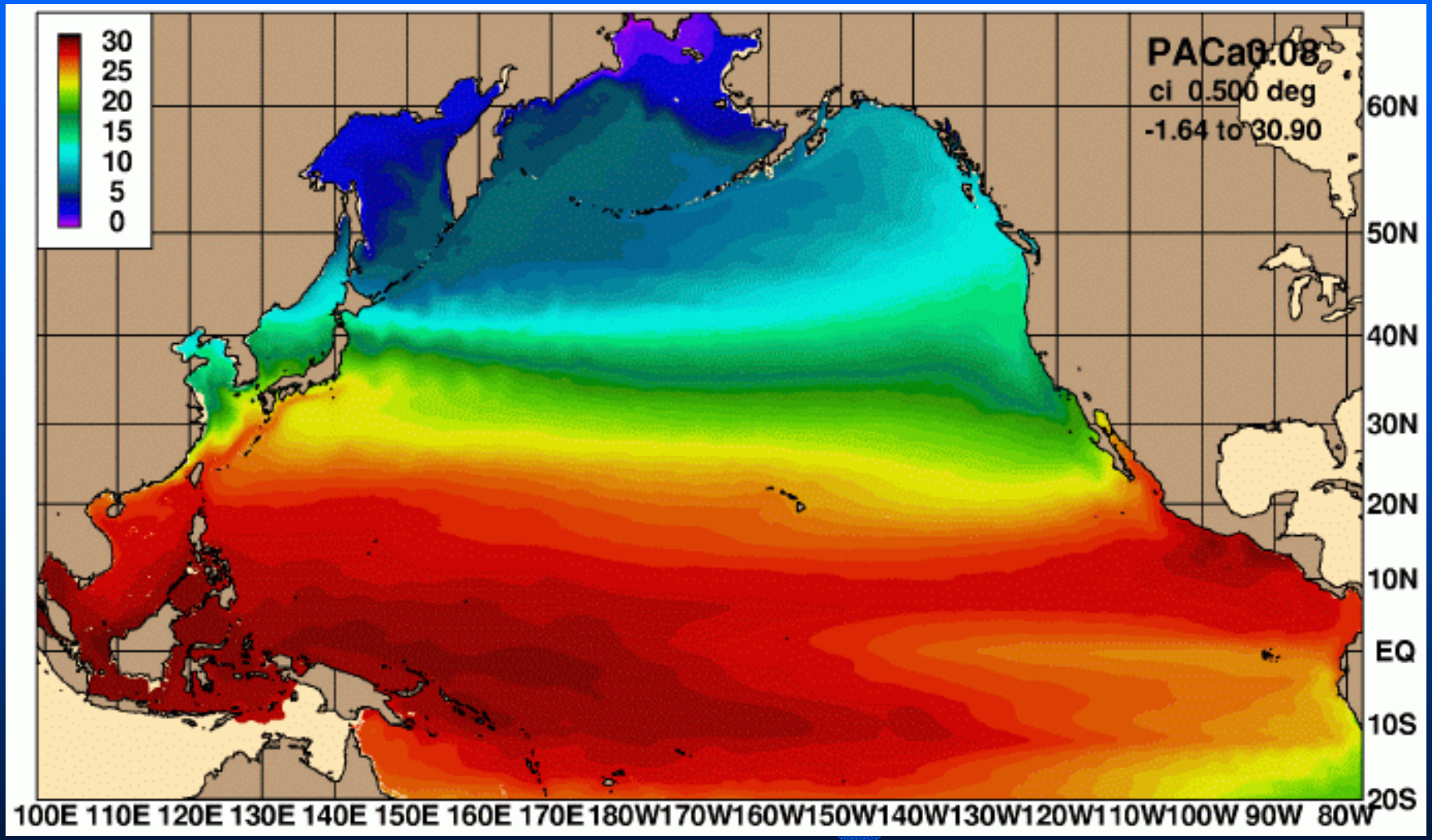
4-yr mean SSH (cm)



Forced with high frequency climatological ECMWF winds and thermal forcing

1/12° Pacific HYCOM Basin-scale SST

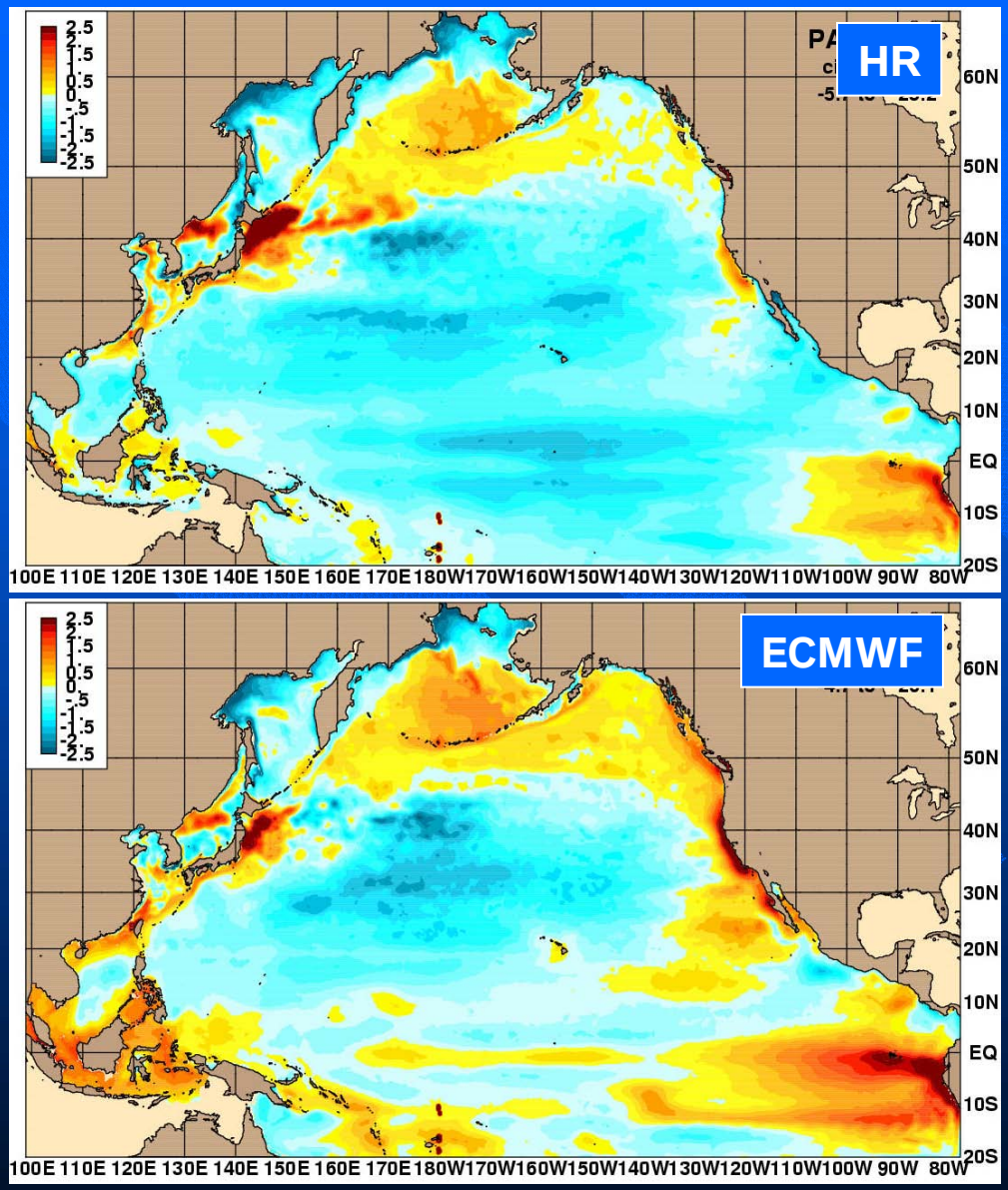
4 year mean



Forced with high frequency climatological ECMWF winds and thermal forcing

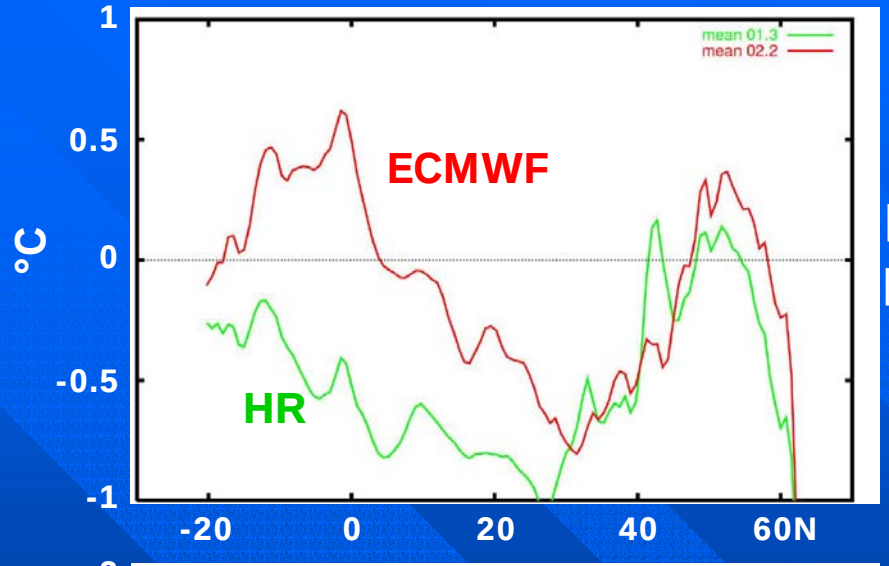
Comparison of the Basin-scale SST

Pathfinder vs. 1/12° Pacific HYCOM SST Mean Error

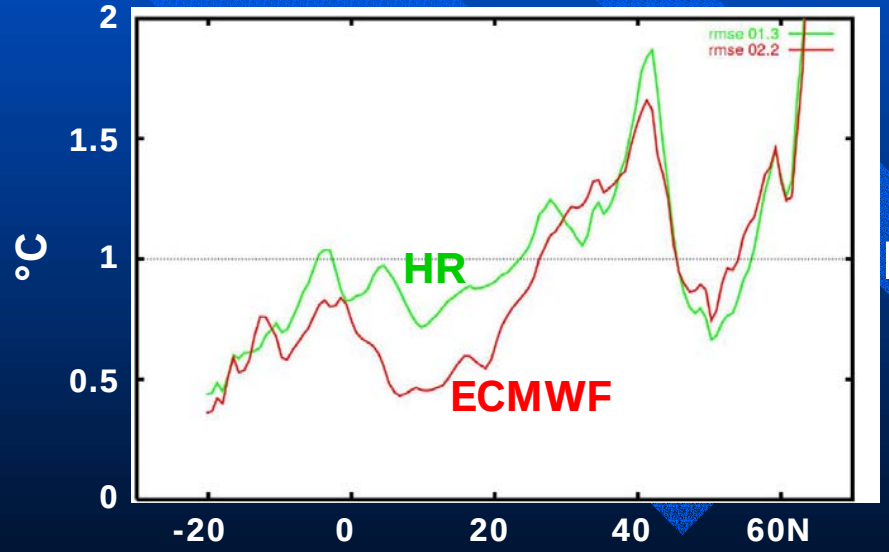


Comparison of the Zonal Average SST

Pathfinder vs. 1/12° Pacific HYCOM



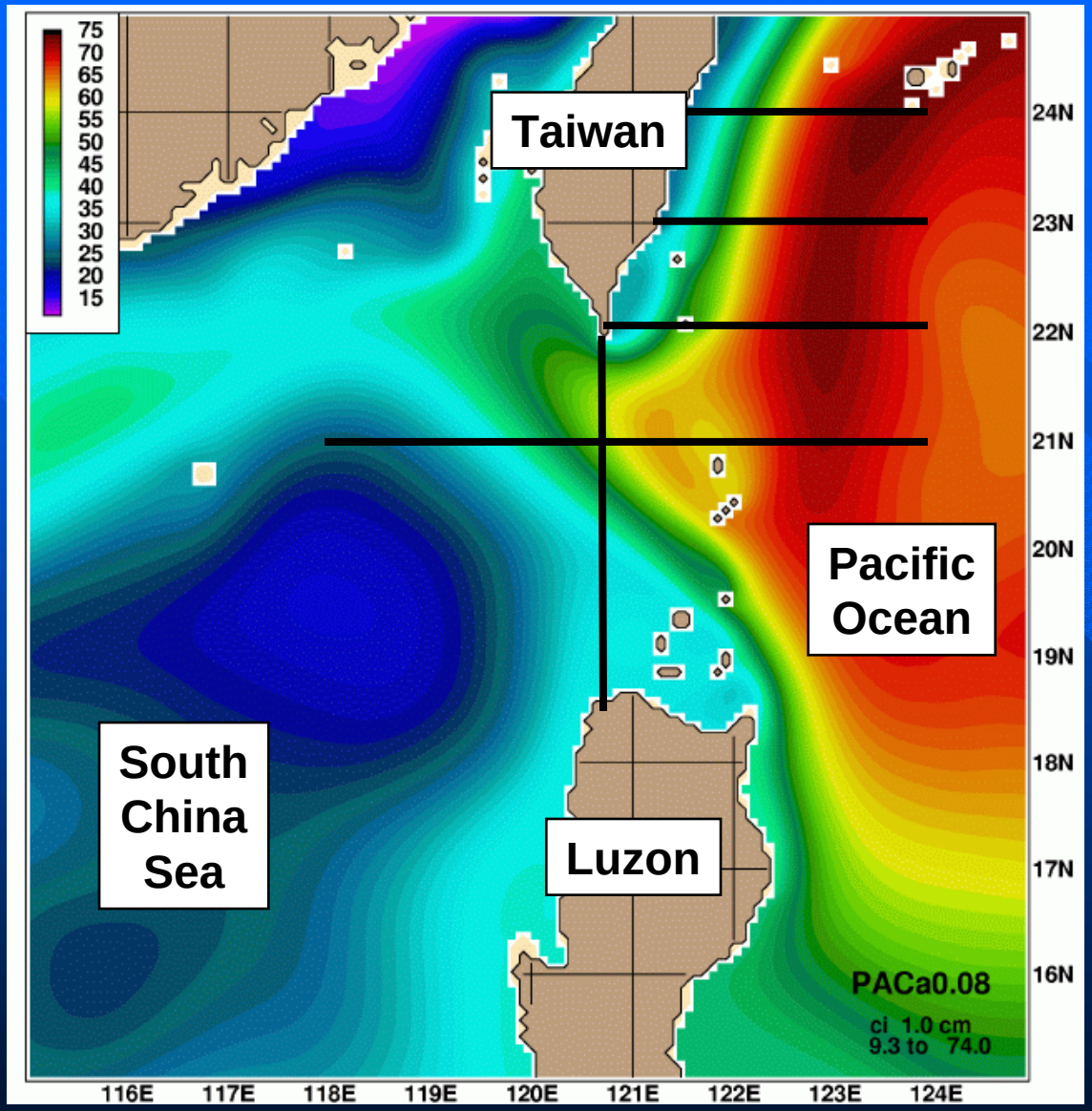
Mean Error



RMSE

Include latitude-weighted domain average somewhere

Mean SSH in Luzon Strait

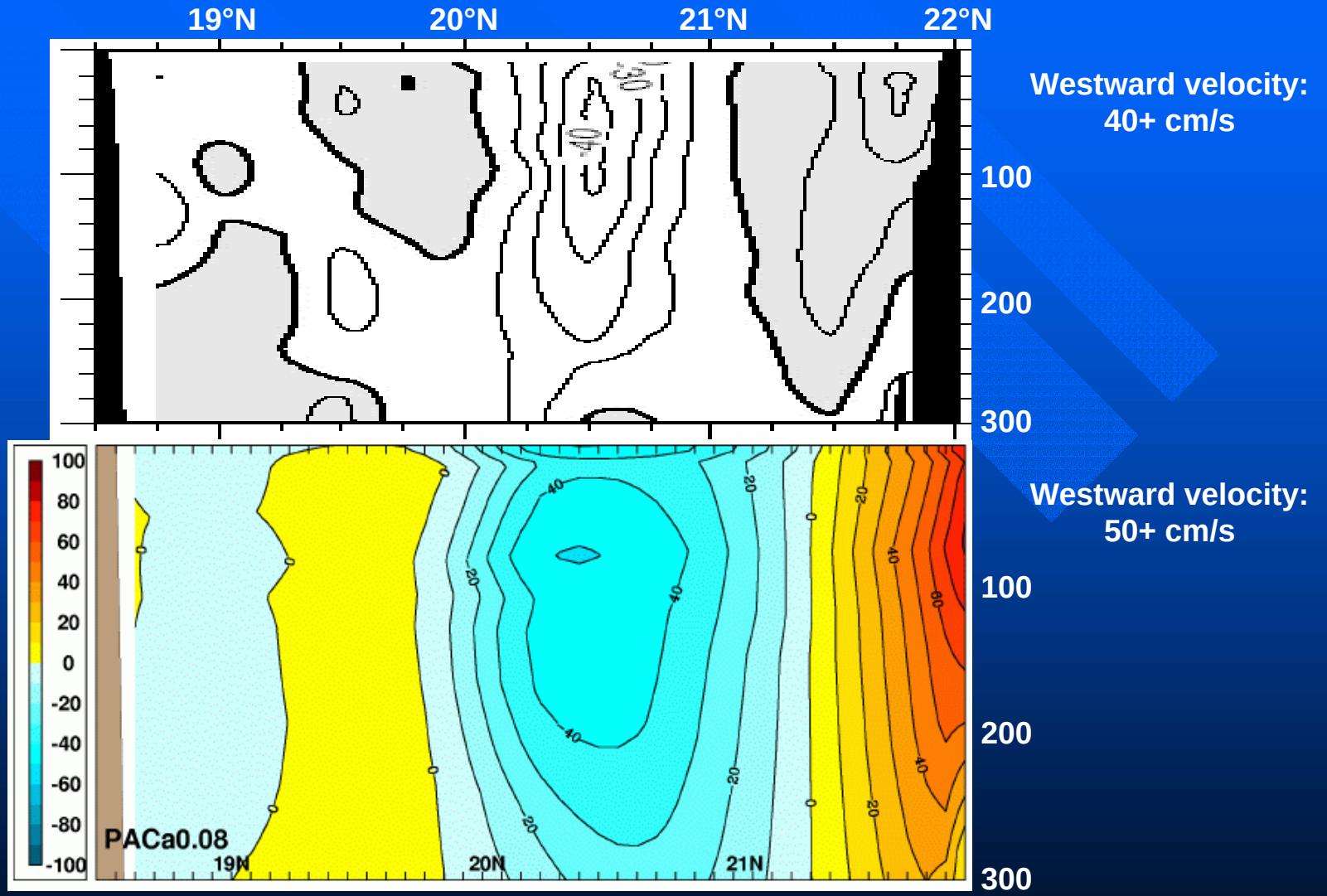


Forced with high frequency climatological ECMWF winds and thermal forcing

Velocity Cross-section Across Luzon Strait

Sb-ADCP data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 300 m

Section along 120.75°E between Taiwan and Luzon



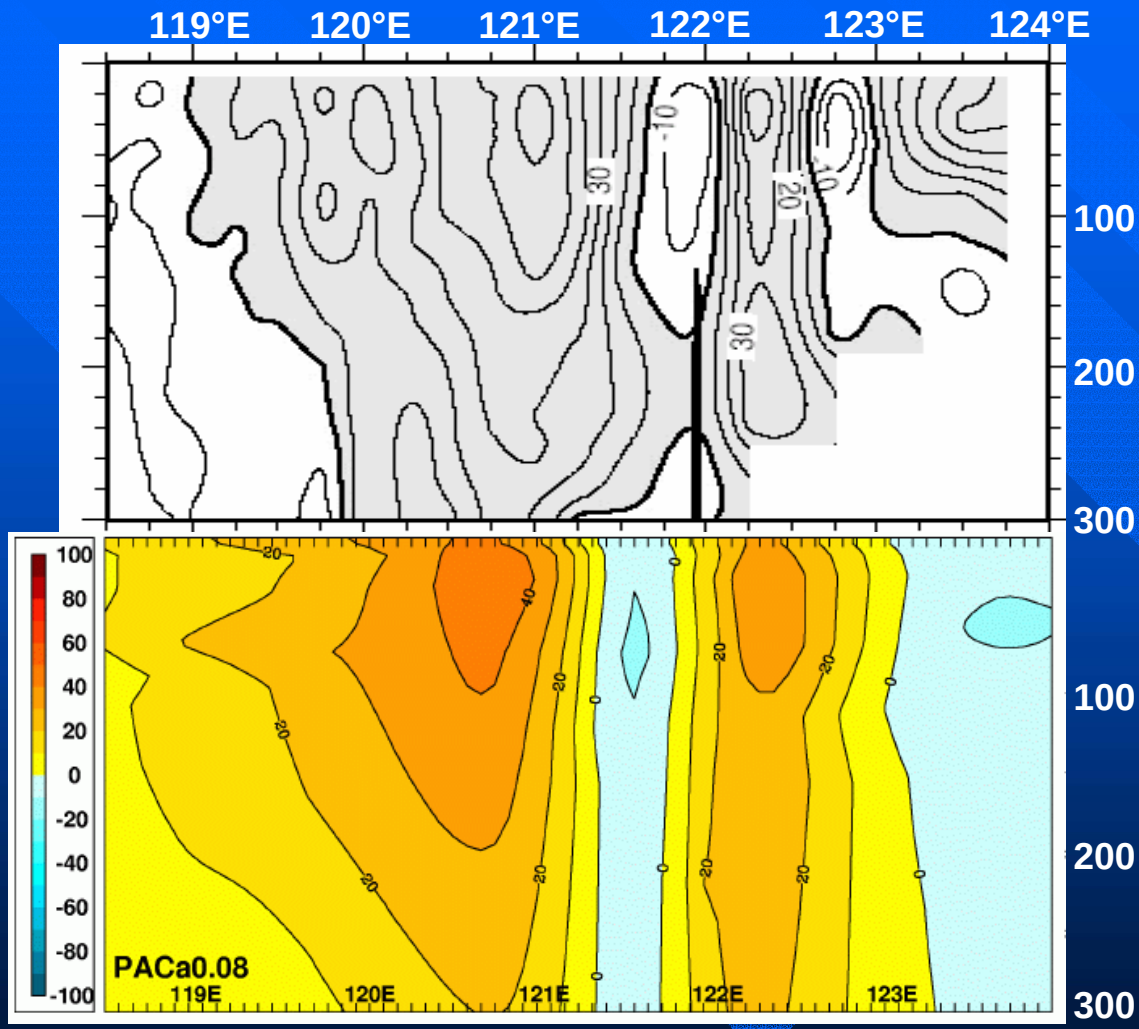
Sb-ADCP data from Liang et al. (2003,DSR Pt. II)

4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing

No ocean data assimilation in HYCOM

Velocity Cross-section Along Luzon Strait

Sb-ADCP data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 300 m
Section along 21°N between 118.5°E and 124.0°E



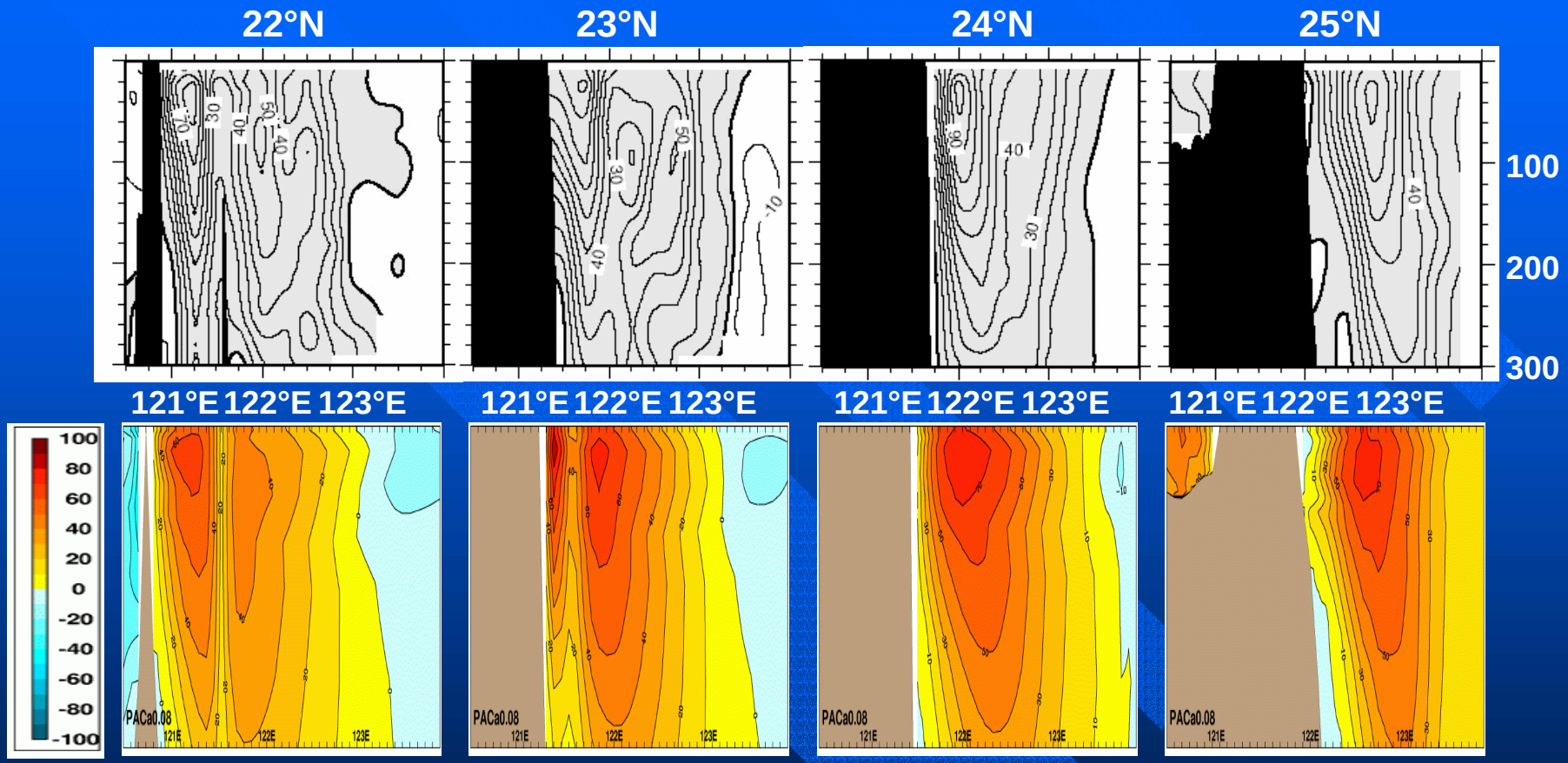
Northward velocity of western core: 60+ cm/s

Northward velocity of western core: 40+ cm/s

Sb-ADCP data from Liang et al. (2003, DSR Pt. II)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

Velocity Cross-sections East of Taiwan

Sb-ADCP data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 300 m
Sections at 22°N, 23°N, 24°N and 25°N

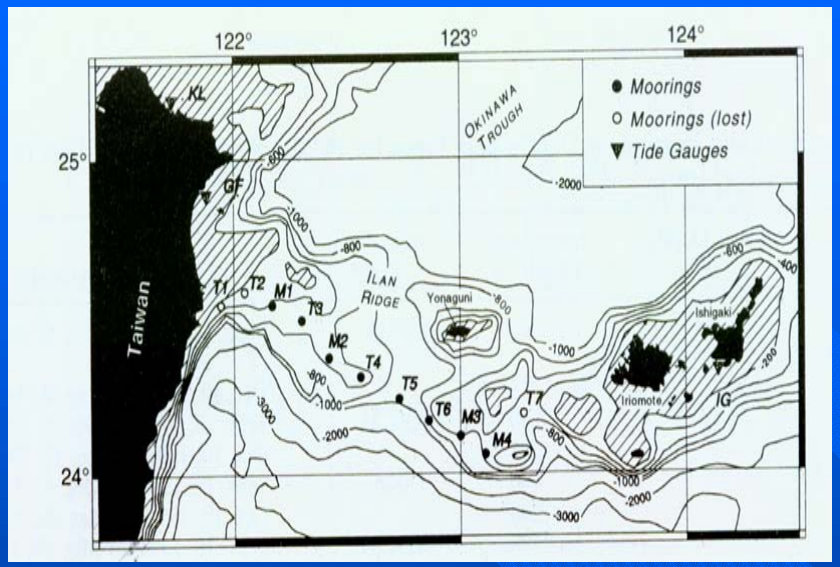


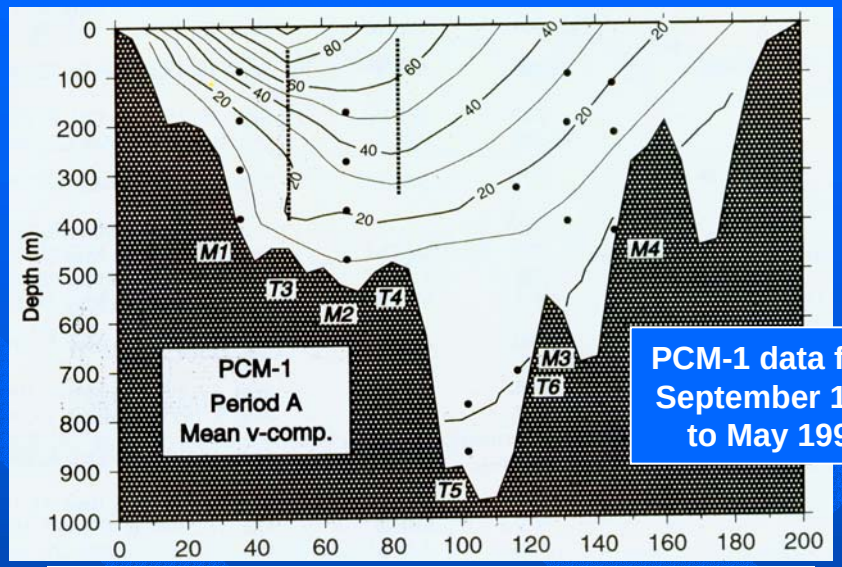
Sb-ADCP data from Liang et al. (2003, DSR Pt. II)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

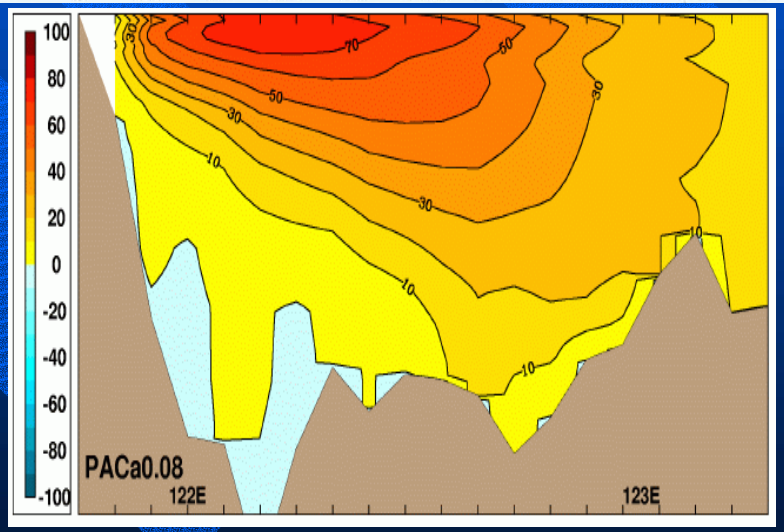
Note how the two-core Kuroshio merges to a single jet in both the observations and HYCOM from the south to north along the Taiwan coast

Velocity Cross-section at WOCE PCM-1

Current meter data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 1000 m





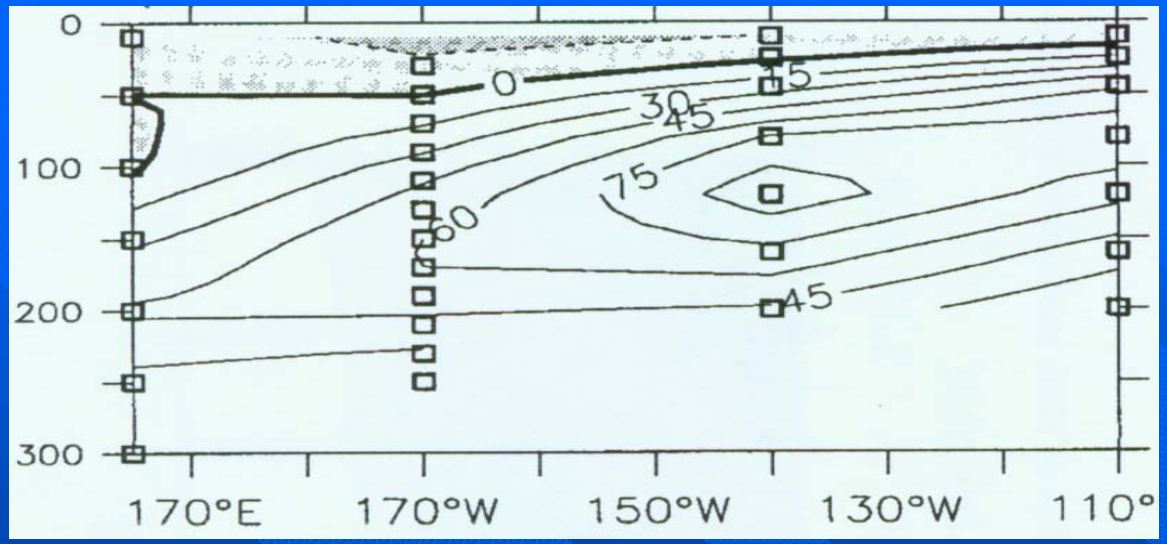


Note the westward intensification of the Kuroshio in the channel between Taiwan and the Ryukyu Islands

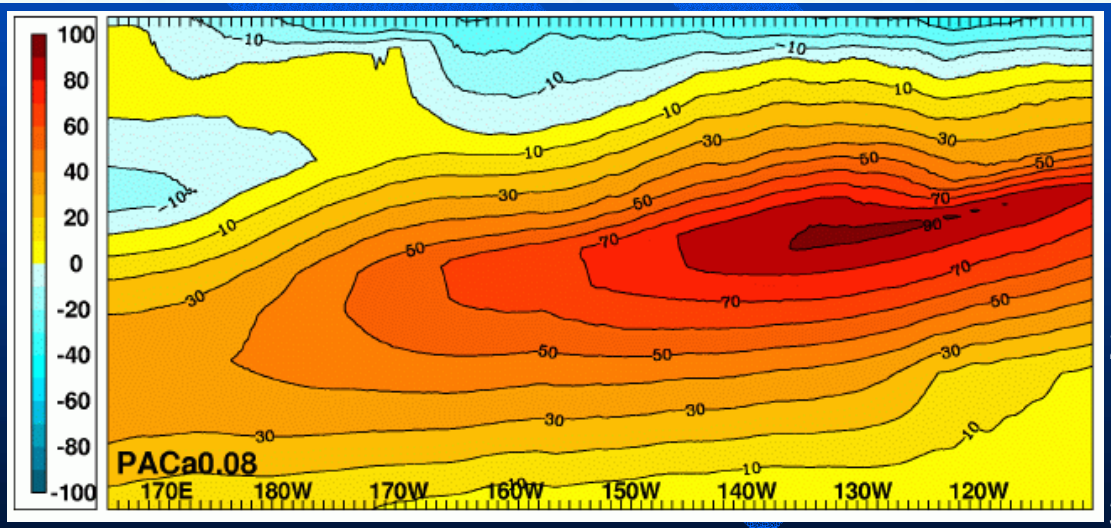
Current meter data from Lee et al. (2001, JGR)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

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

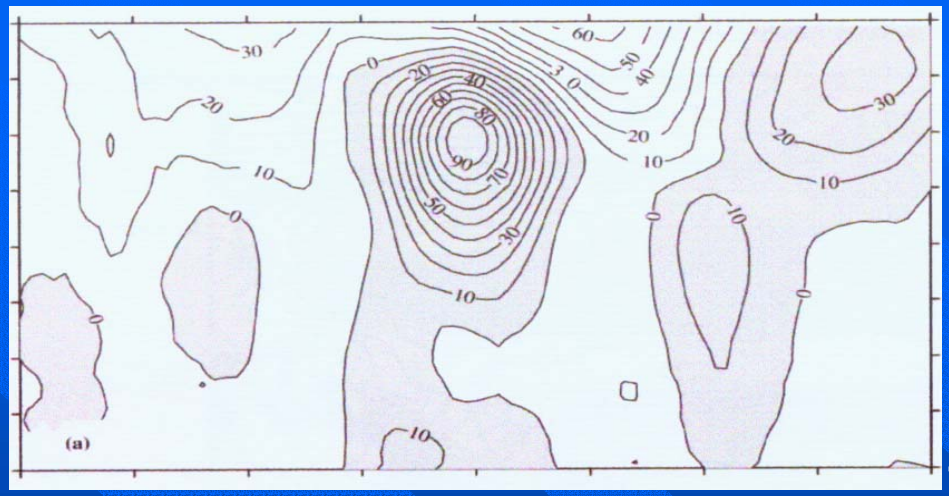
200

300

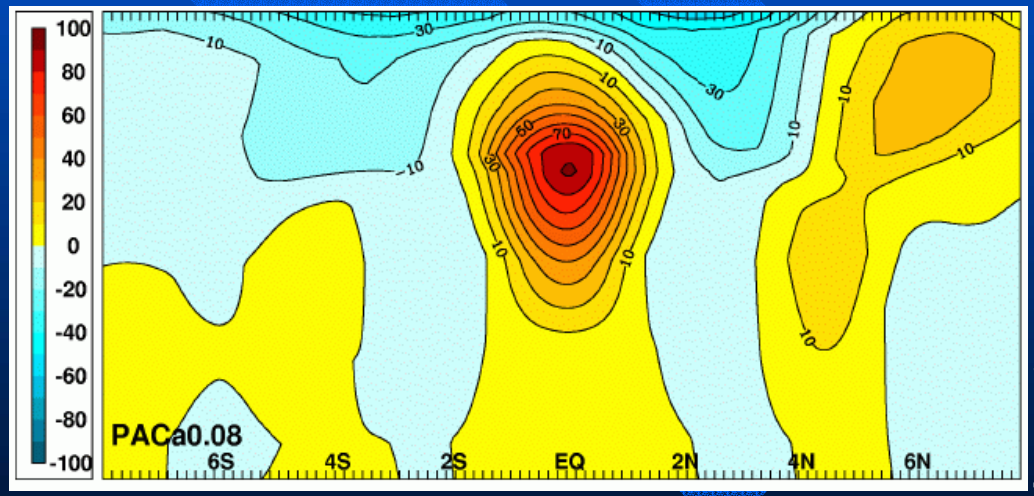
TOGA TAO buoy data from Yu and McPhaden (1999, JPO)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

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



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

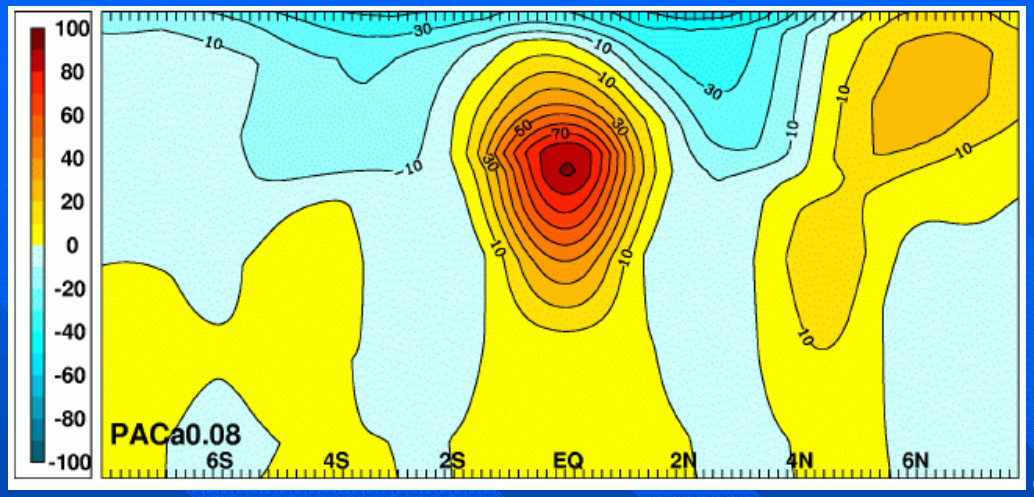


EUC max velocity:
90+ cm/s at
~140 m depth

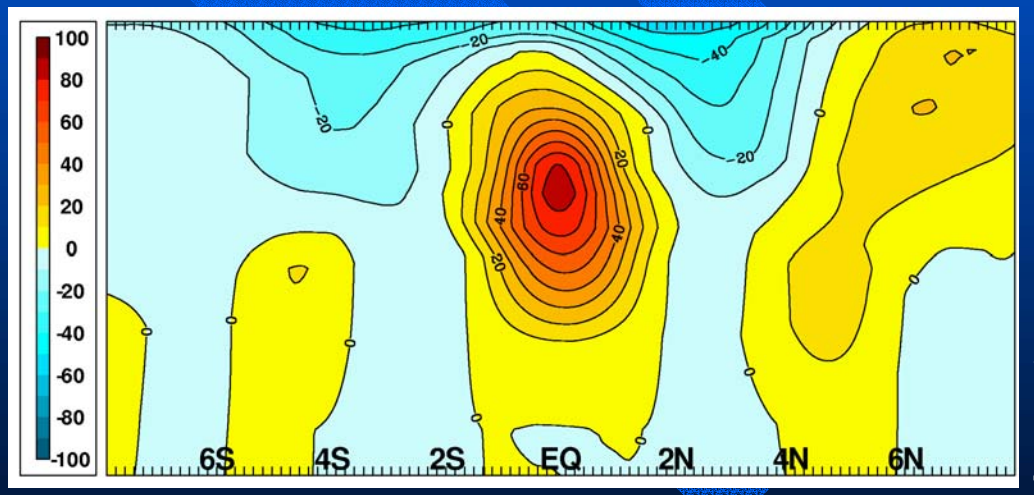
CTD/ADCP data from Johnson et al. (2001, JPO)
4 year mean from HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

Velocity Cross-section Across the Equator at 135°W

1/12° Pacific HYCOM v2.1.09 (top) vs. v2.0.02 (bottom) in the upper 400 m
Section between 8°S and 8°N



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

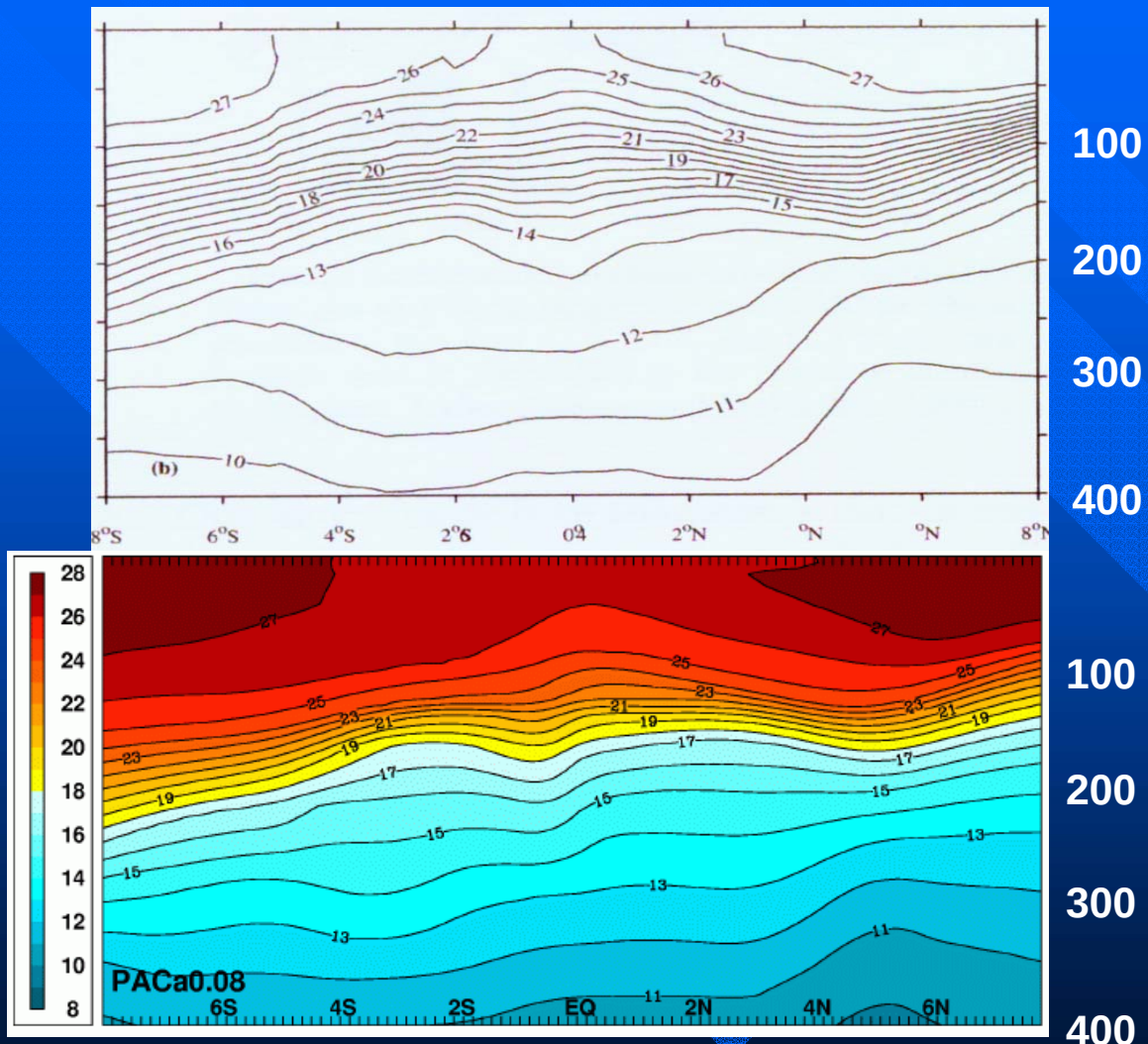


EUC max velocity:
80+ cm/s at
~145 m depth

HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

Temperature Cross-section Across the Equator at 135°W

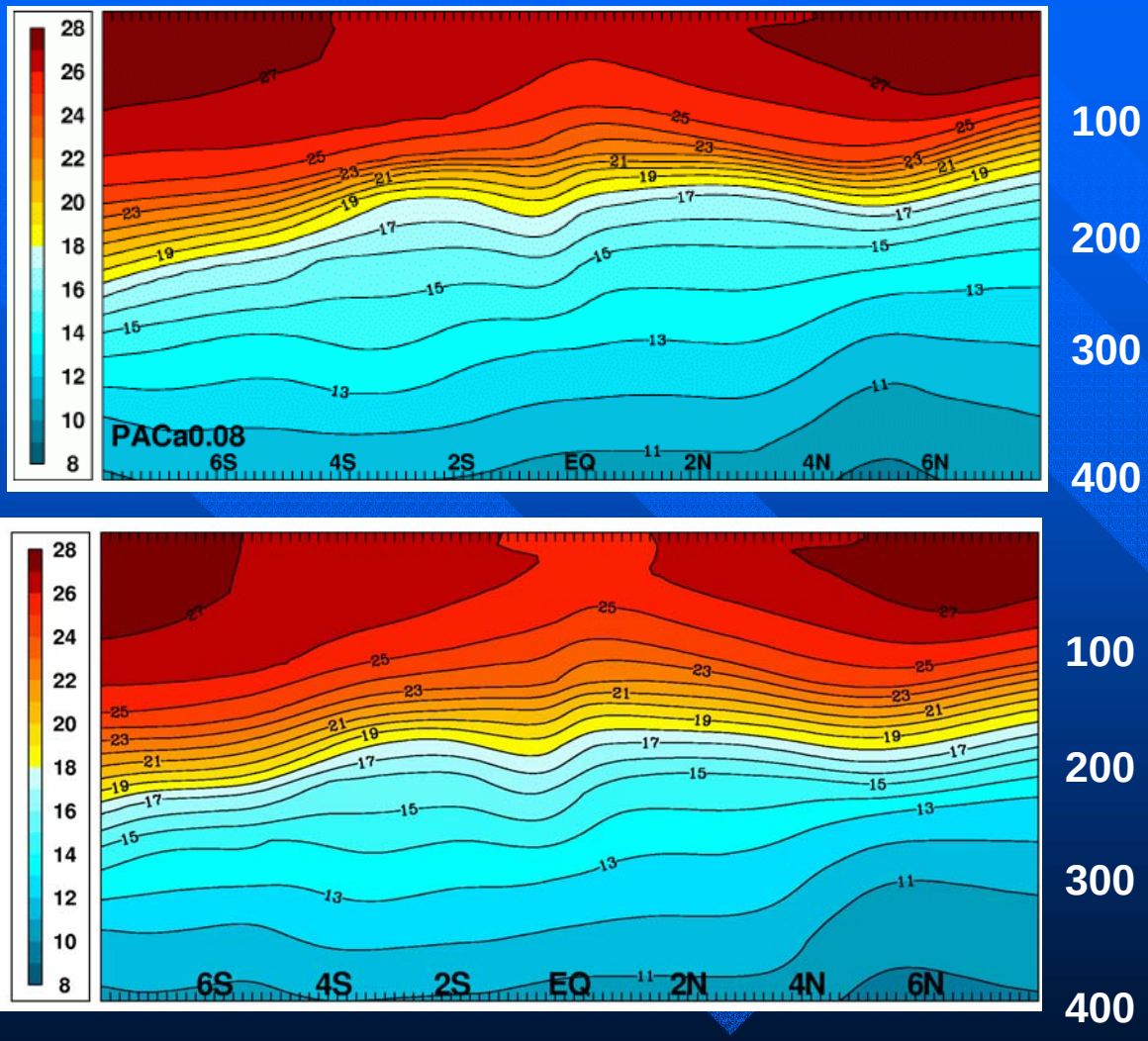
CTD/ADCP data (top) vs. 1/12° Pacific HYCOM (bottom) in the upper 400 m
Section between 8°S and 8°N



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

Temperature Cross-section Across the Equator at 135°W

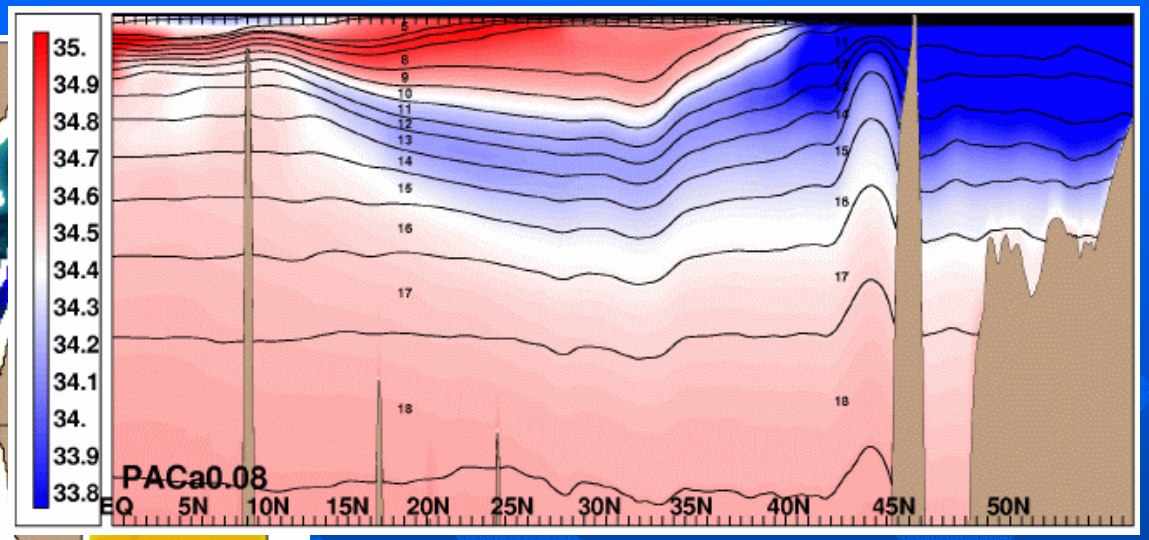
1/12° Pacific HYCOM v2.1.09 (top) vs. v2.0.02 (bottom) in the upper 400 m
Section between 8°S and 8°N

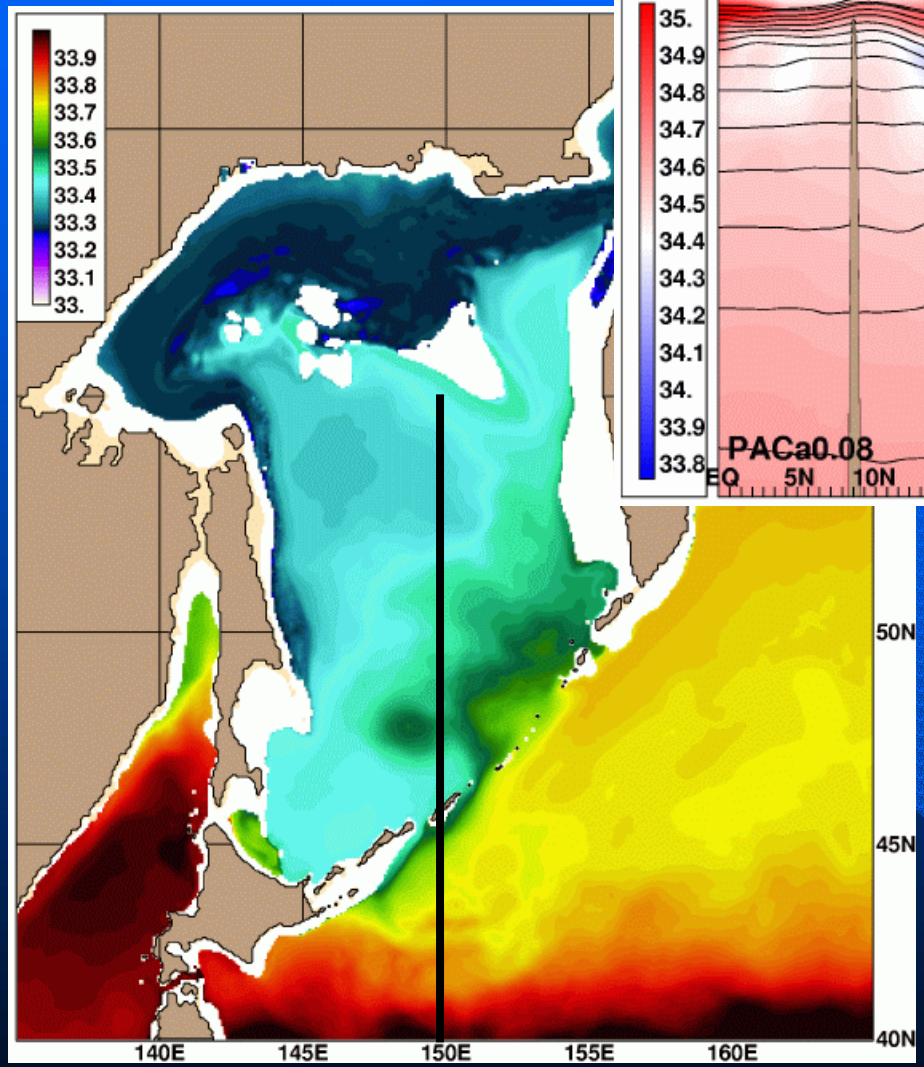


HYCOM forced with high-frequency ECMWF winds and thermal forcing
No ocean data assimilation in HYCOM

North Pacific Intermediate Water in HYCOM

Salinity vs. depth along 150°E





Salinity on layer 13 – 26.8 σ_θ

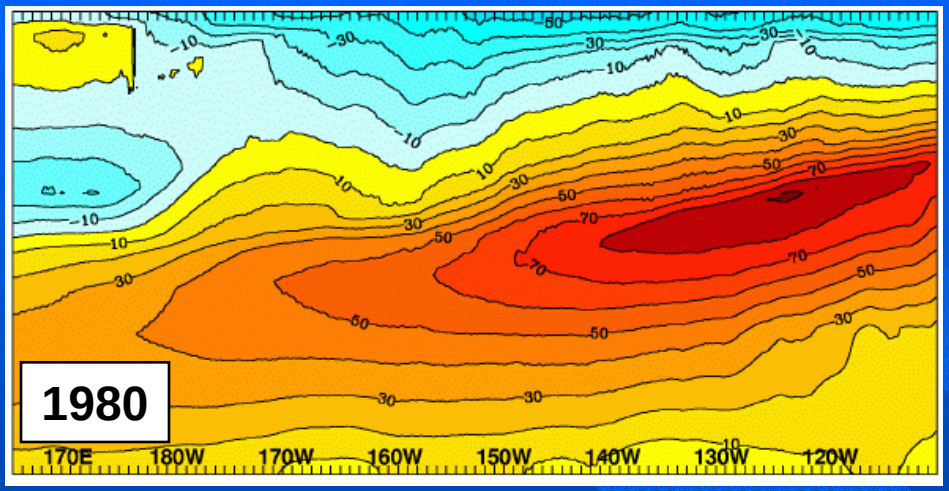
Formation processes (?)

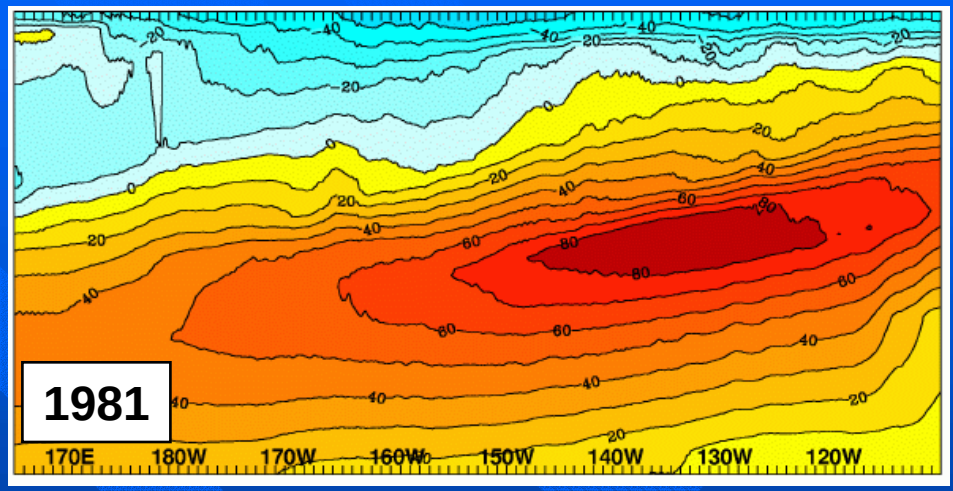
- Subduction of fresh, subpolar surface water along Oyashio Front
- Formation confined to Sea of Okhotsk
  - River influx
  - Brine rejection

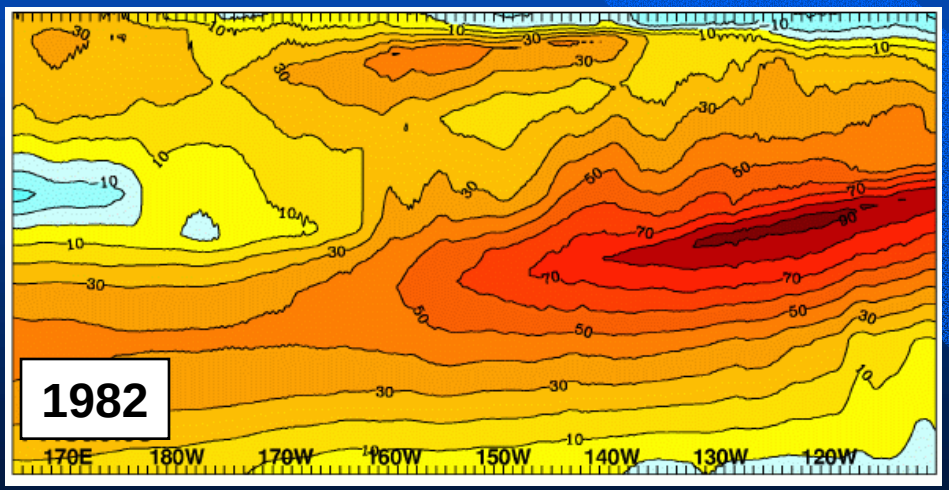
Interannual Variability in 1/12° Pacific HYCOM

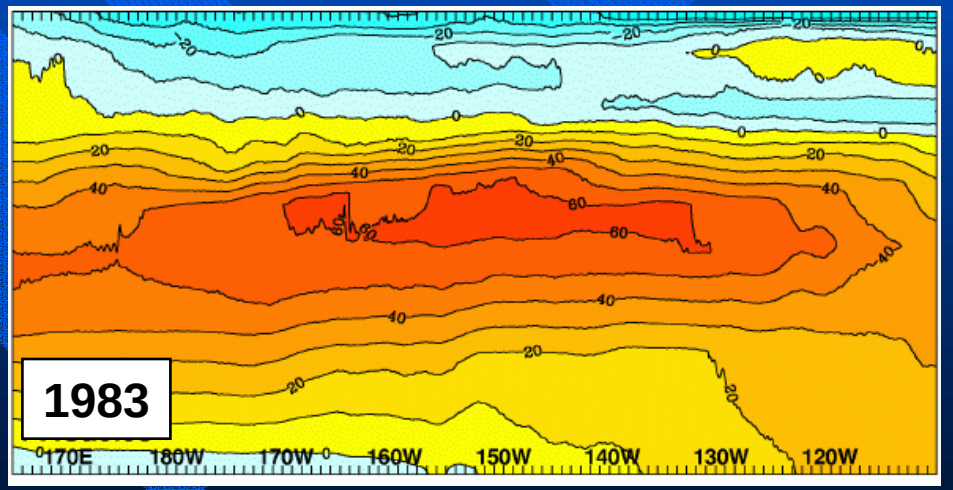
Equatorial Undercurrent

Annual mean zonal velocities along the Equator (165°E-110°W)

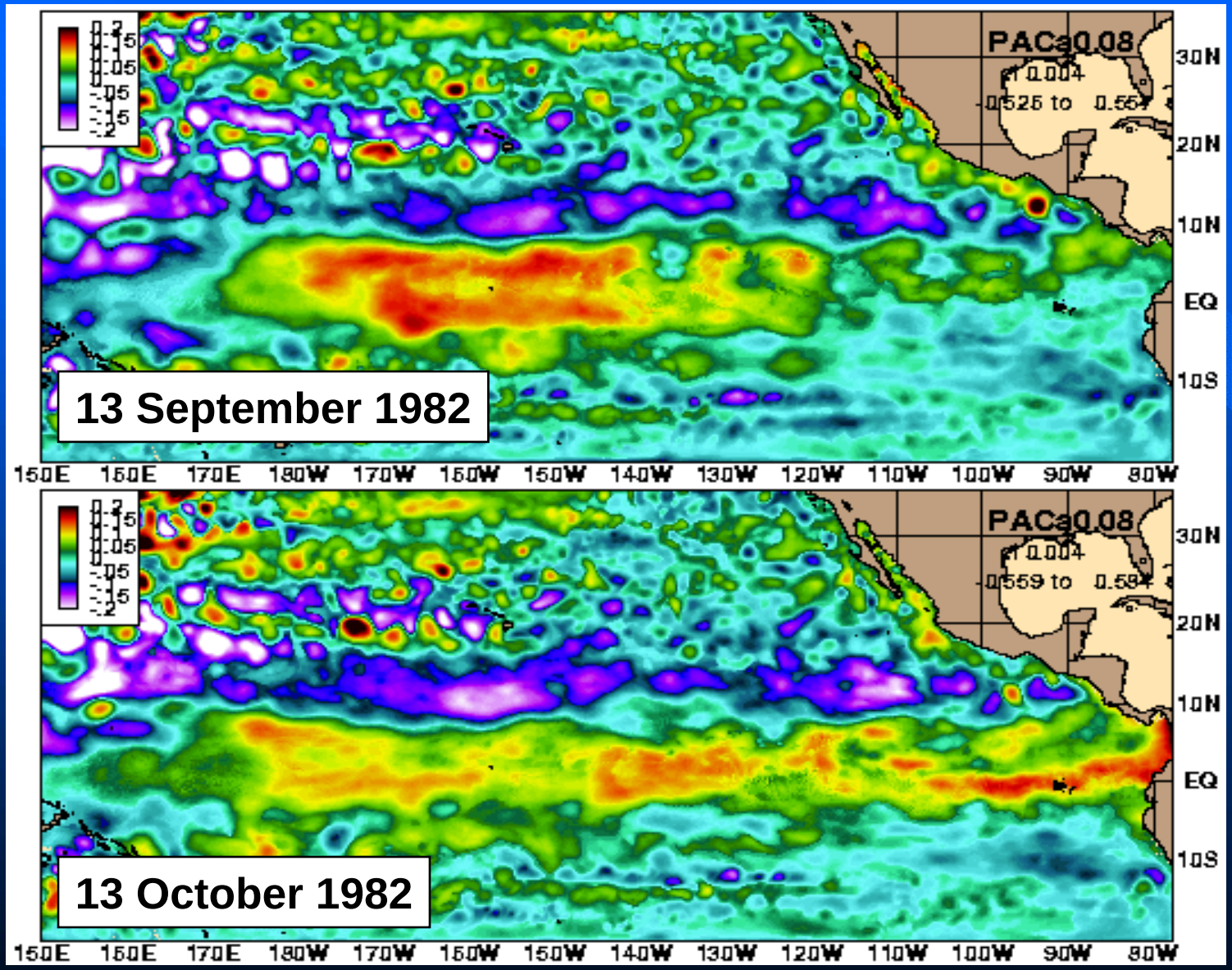




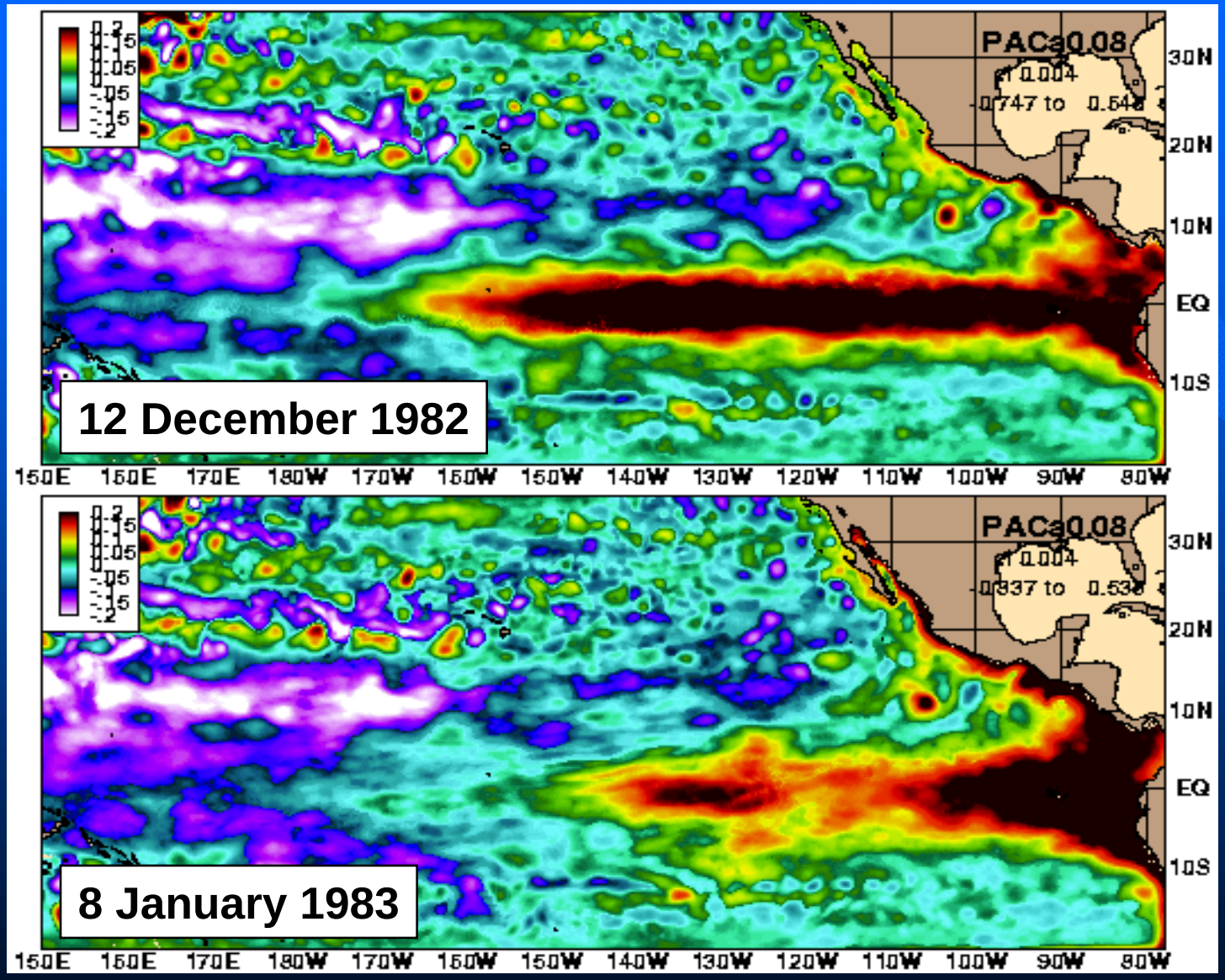




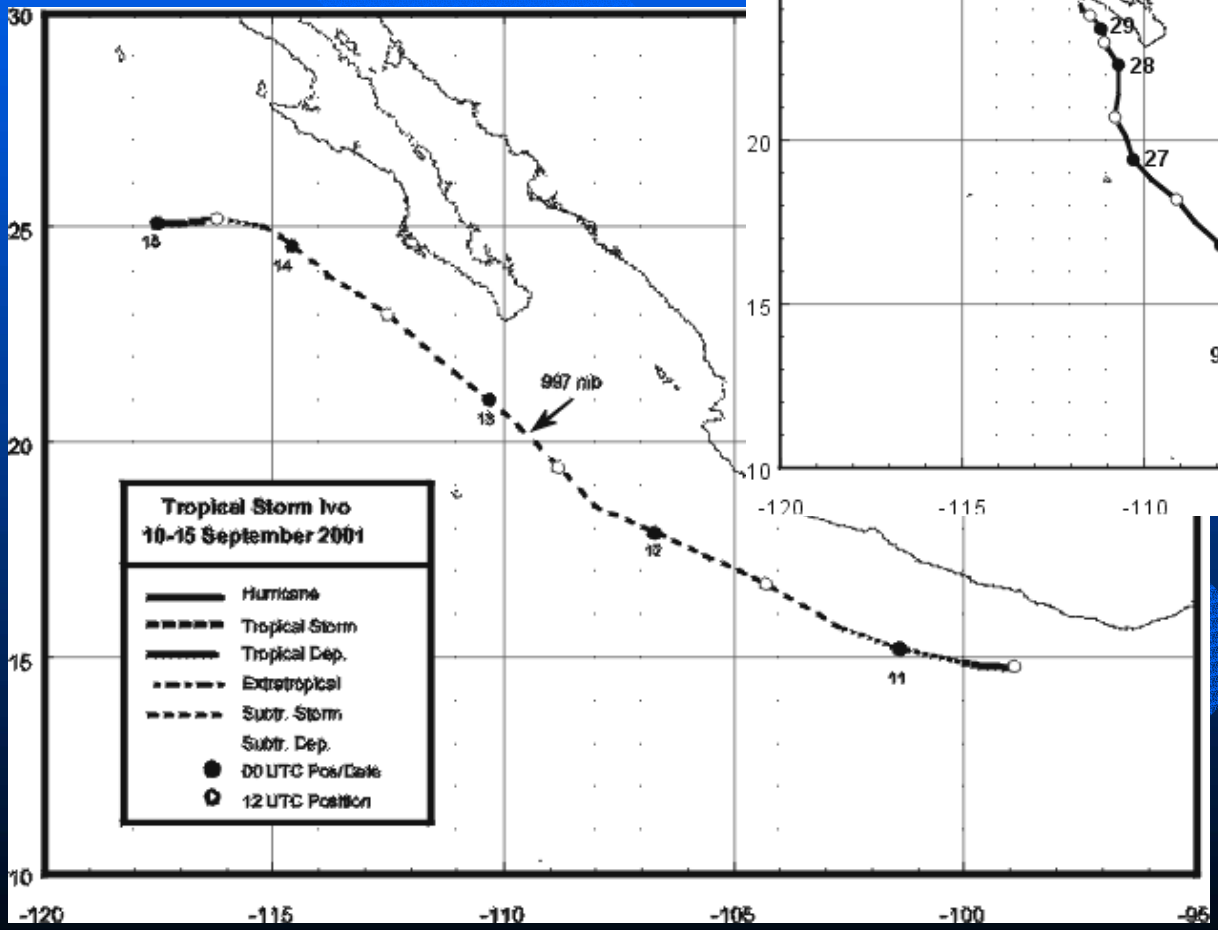
El Niño in 1/12° Pacific HYCOM

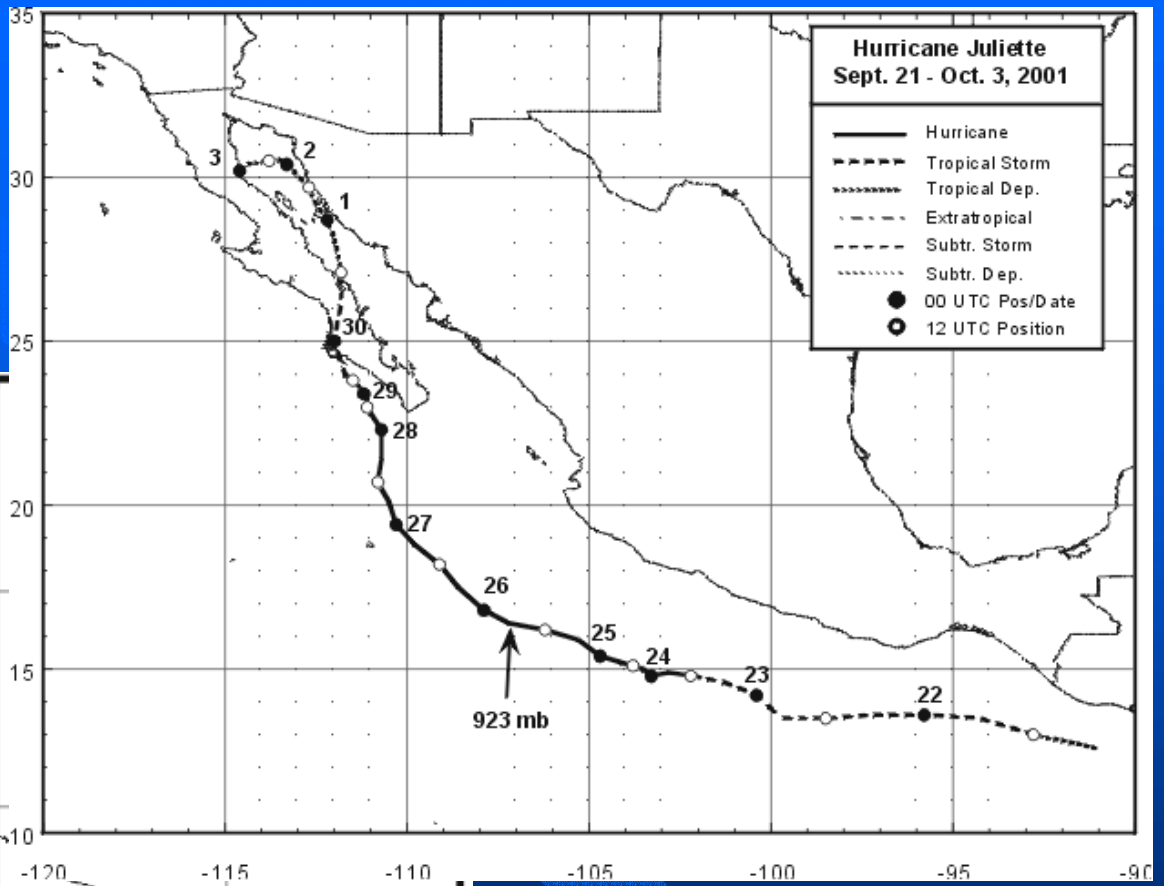


El Niño in 1/12° Pacific HYCOM



Tracks of Tropical Storm Ivo and Hurricane Juliette

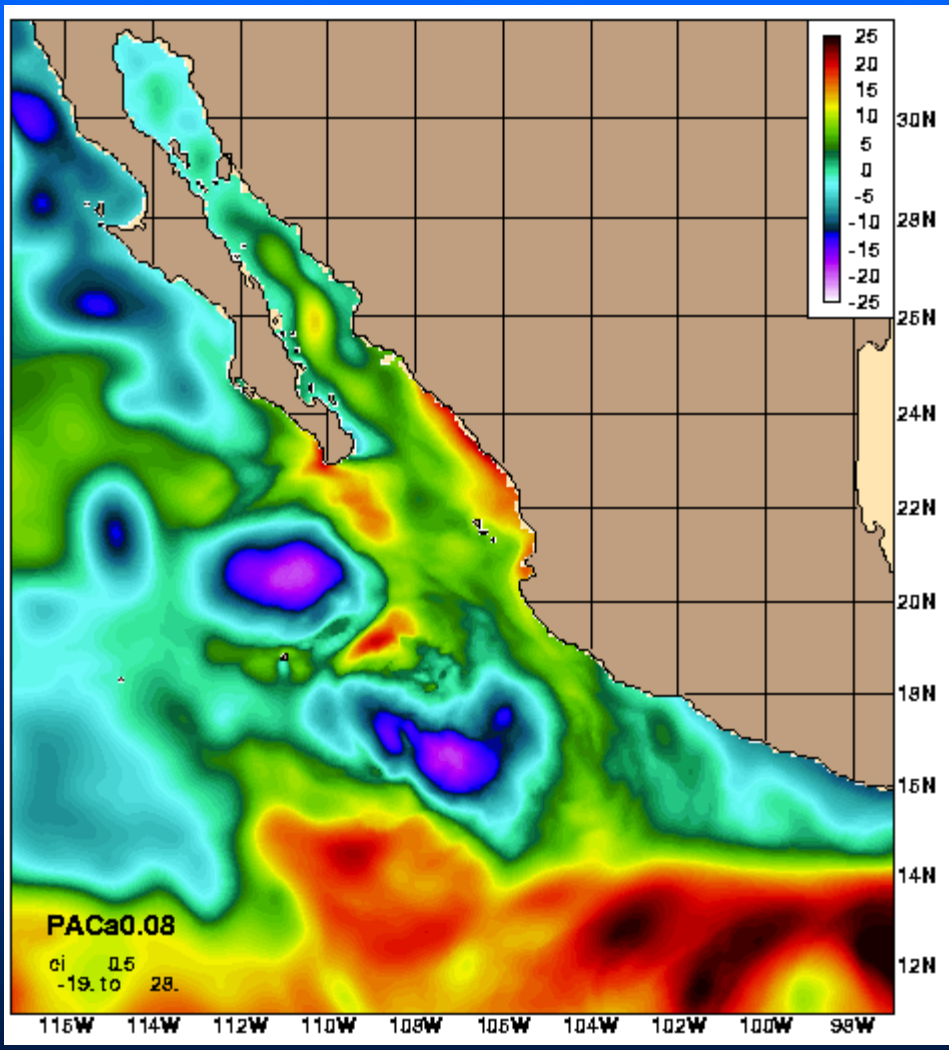




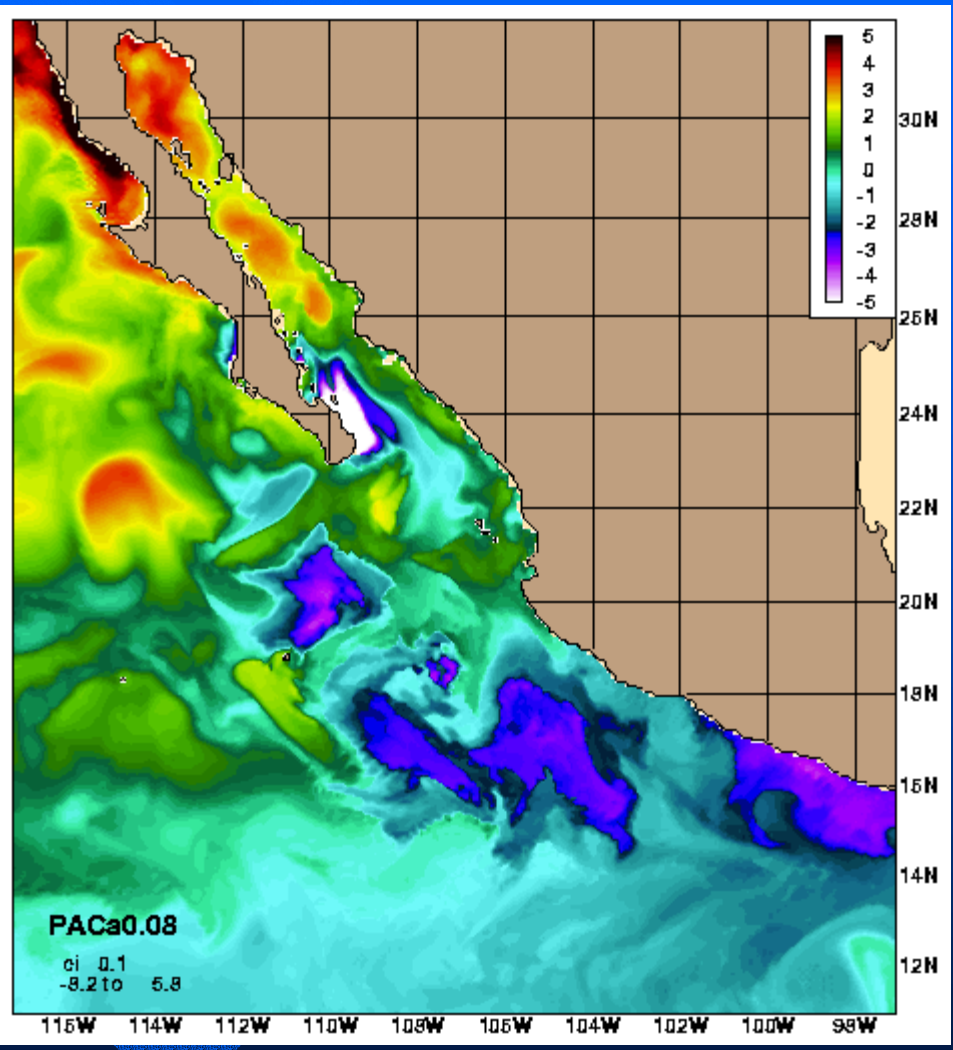
Source: National Hurricane Center

1/12° Pacific HYCOM Response to Hurricane Juliette

SSH anomaly – 28 September 2001

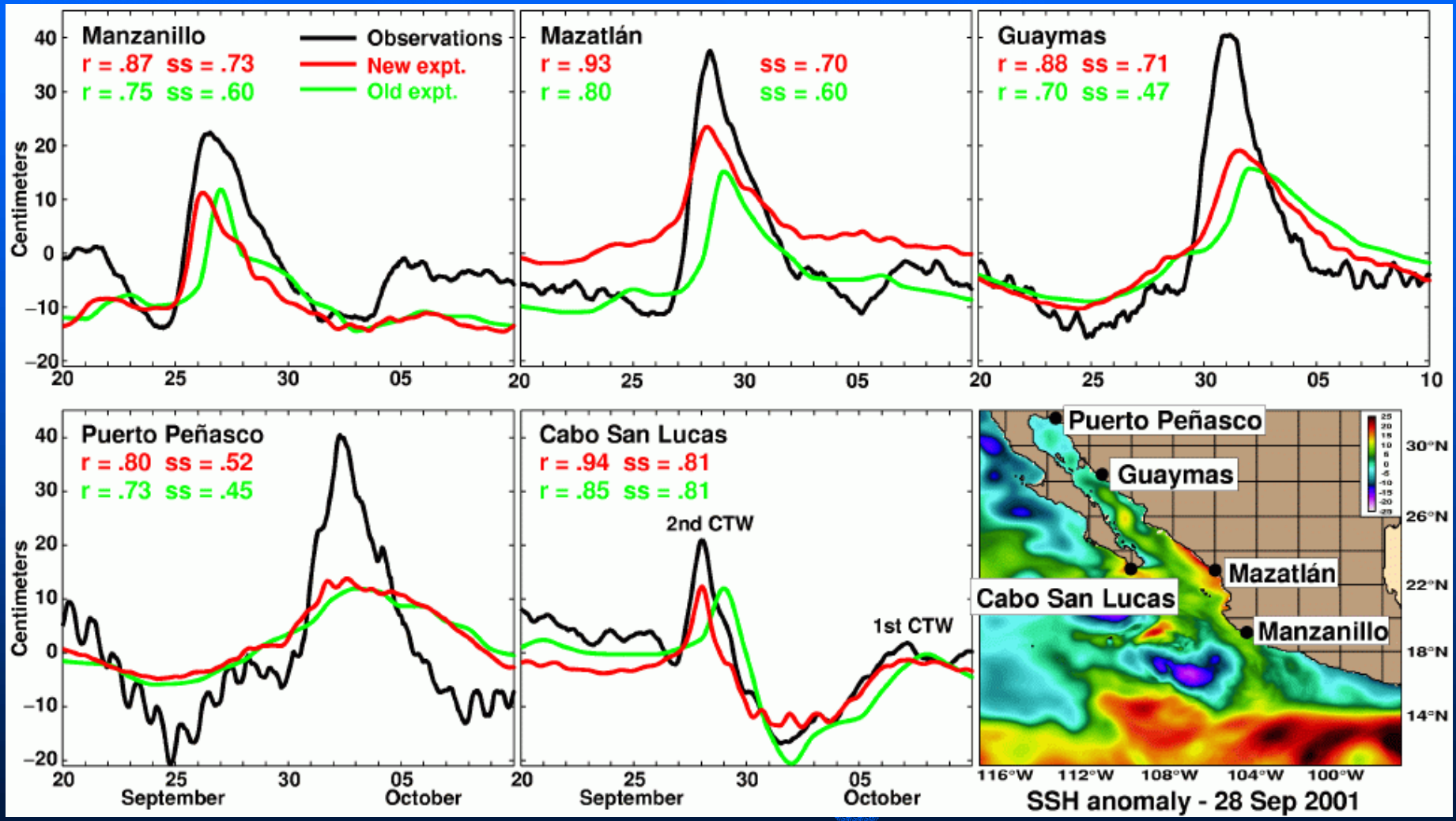


SST anomaly – 30 September 2001



1/12° Pacific HYCOM forced with FNMOC NOGAPS/ECMWF winds and FNMOC NOGAPS thermal forcing. No data have been assimilated into this model.

Observed Versus Modeled Sea Level Anomaly Along the Mexican Coast Associated With the Coastally Trapped Waves (CTW) Generated by Hurricane Juliette in Sept/Oct 2001



1/12° Pacific HYCOM forced with FNMOC NOGAPS/ECMWF winds and FNMOC NOGAPS thermal forcing. No data have been assimilated into this model. Sea level data provided by the University of Hawaii and the Secretaria de Marina de México (Mexican Navy).