Inter-basin coherent changes of sea level, SST and atmospheric circulation in the Pacific Ocean during recent decades

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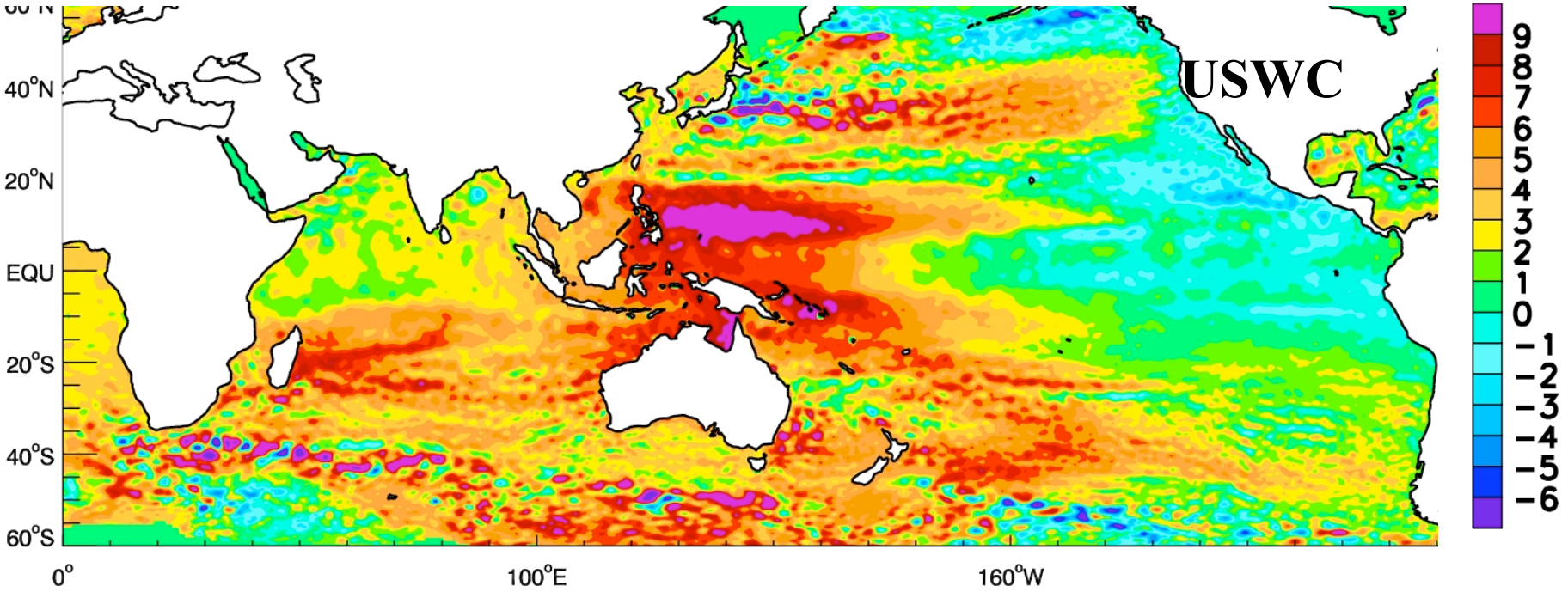
1. Background

Linear trend of AVISO multi-satellite sea level, 1993-2010 mm/yr



Bromirski et al. 2011:

US West Coast sea level fall since the 1980s: PDO;

Merrifield, 2011:

West Pacific sea level rise since 1993- associated with EQ easterlies & warm pool convection –but NOT with PDO or NPGO

Goal:

- Are the observed US West Coast sea level fall & western tropical Pacific sea level rise for the 1993-2010 satellite era independent, or are they due to an Inter-basin Pacific variability (also referred to as Interdecadal Pacific Oscillation; e.g. Power et al. 1999)? Indo-Pacific warm pool SST trend (25S-25N, 40E-180E);
- What are the structures of ocean (sea level & SST) and atmosphere (surface wind, SLP & convection) co-variations associated with the Inter-basin Pacific Variability, and the likely coupled signatures?

2. Approach: *data analysis* combined with *model experiments*

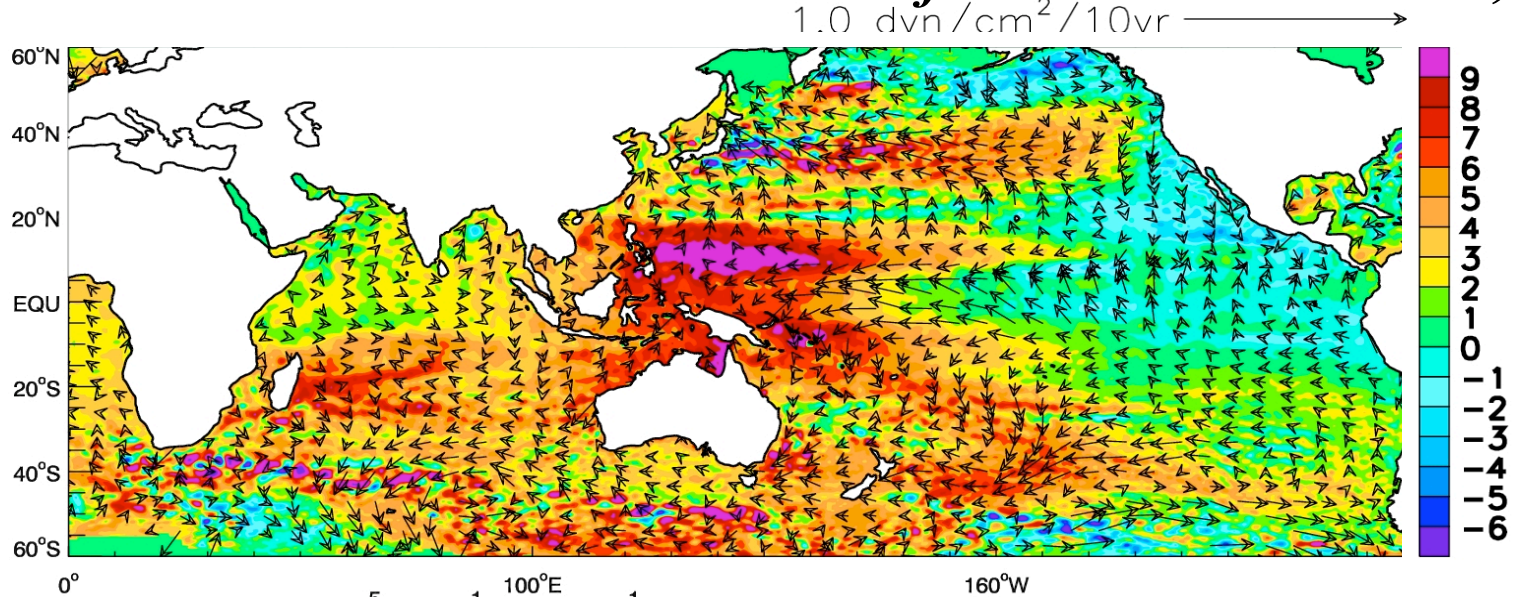
Data	Record Length
▪***Sea level:***	
Merged Satellite (AVISO)	1993-present
▪***SST:***	
HadISST	1870-present
Kaplan SST	1856-present
▪***Wind & SLP:***	
Cross-calibrated multiplatform (CCMP) merged satellite winds	1987-present
ERA-Interim Reanalysis winds	1989-present
20th Century (HadSLP2) SLP	1871 (1850)-present
▪***Convection***	
OLR	1979-present
GPCP precipitation	1979-present

Models and Experiments

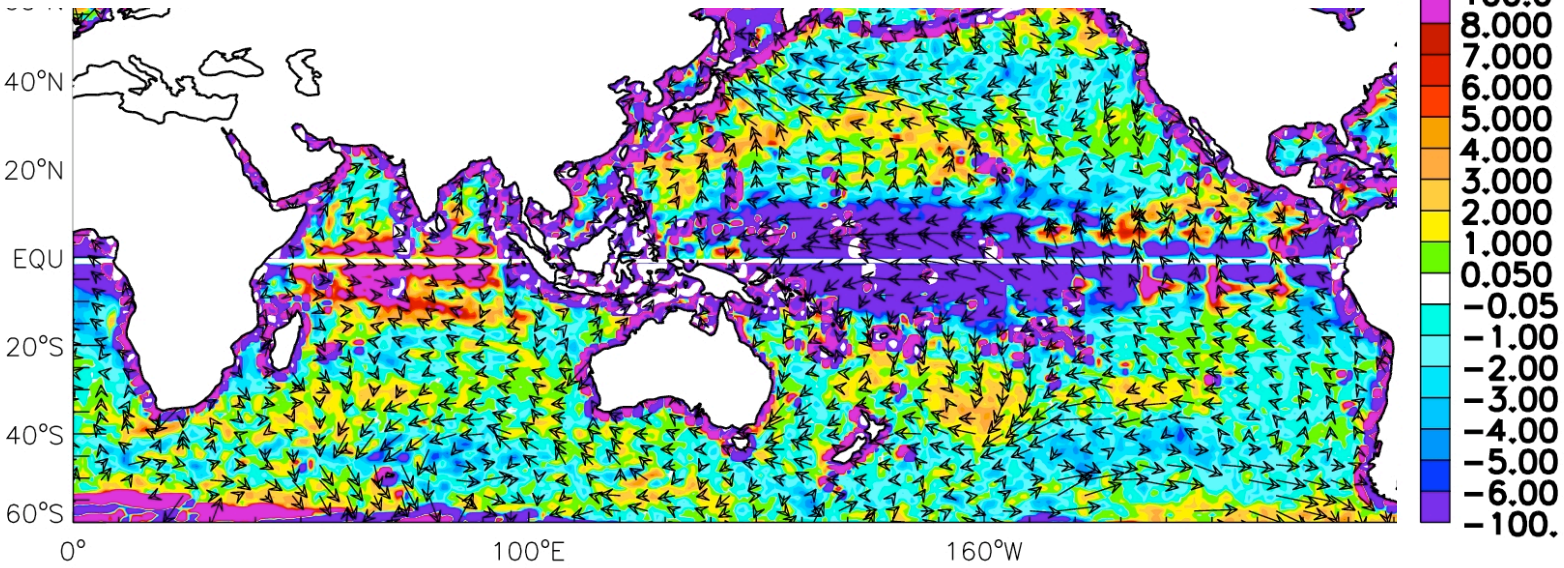
Models	Experiments
▪***AGCMs:*** ▪**GFDL AM2.1 &** ▪**GFDL GFS** ▪***NCAR CAM3 (T85)***	Forced by linear trend of HadISST for 1977-2006 ***60-member ensembles of 2 Experiments:*** [1] Global SST trend; [2] Indo-Pacific warm pool SST trend (25S-25N, 40E-180E); ***5-member ensembles*** Forced by monthly HadiSST in 20S-20N tropics.

3. Results: Observed Trend

AVISO SSH & CCMP satellite surface wind stress trend, 1993-2010

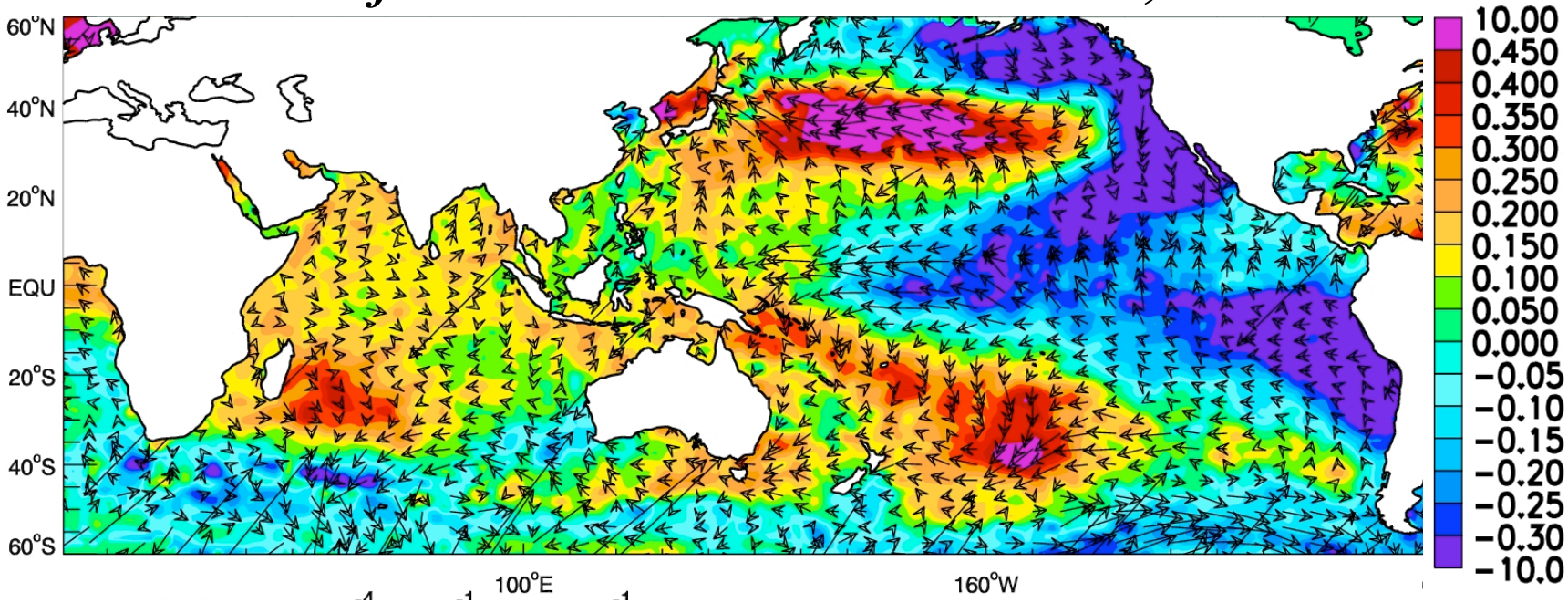


CCMP wind stress & Ekman pumping velocity trend, 1993-2010

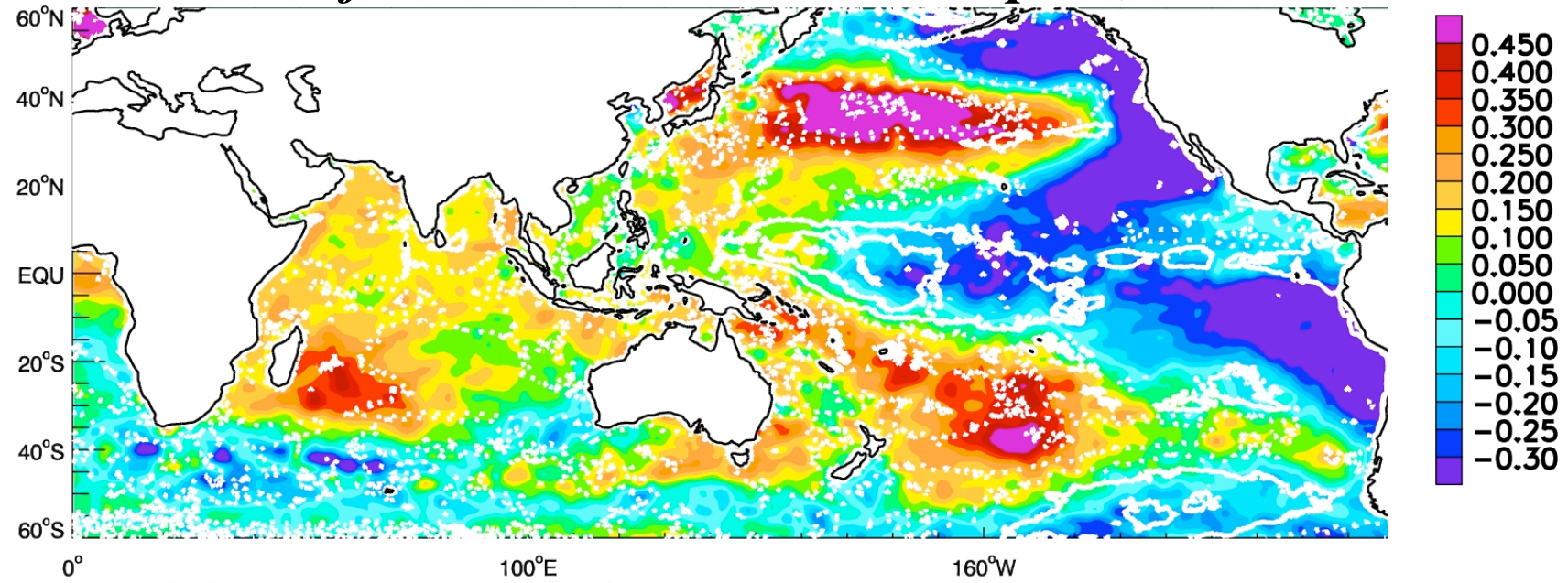


ERAI, similar

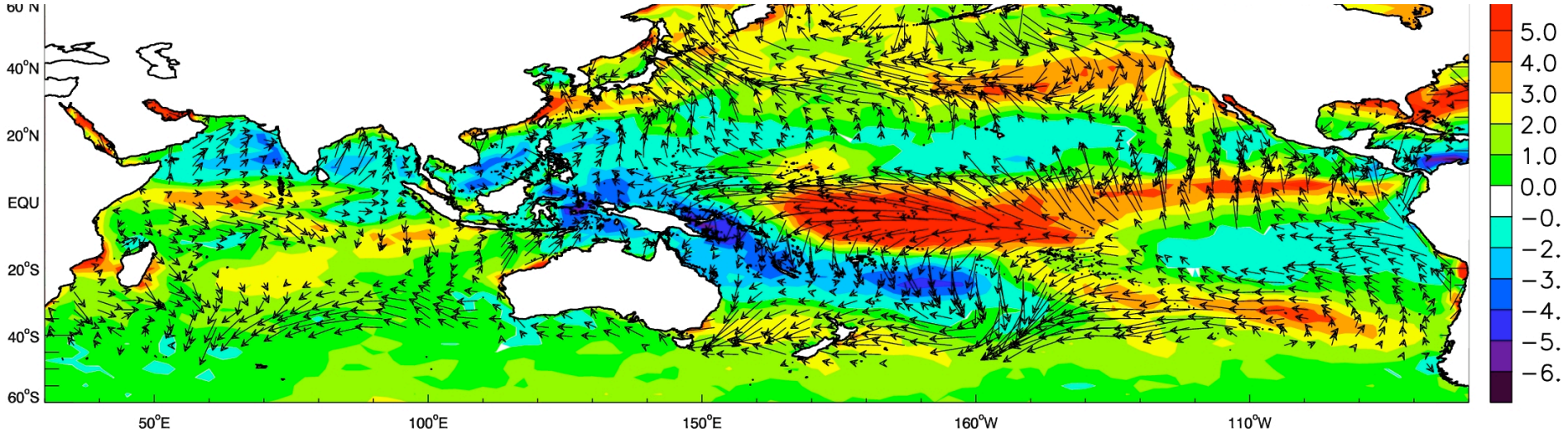
Linear trend of HadiSST & CCMP wind stress, 1993-2010



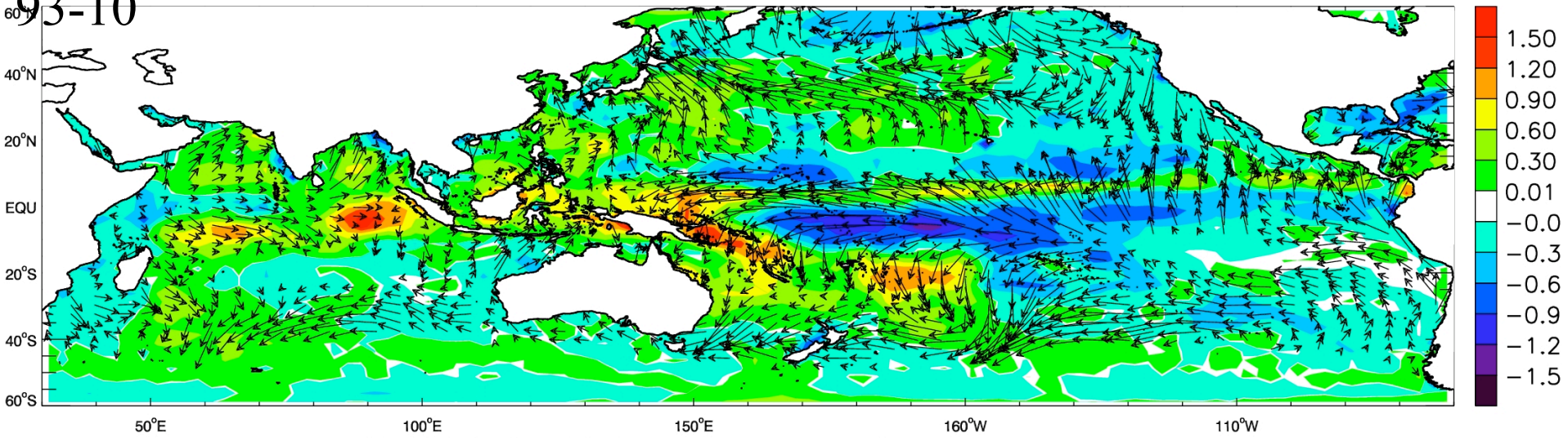
Linear trend of HadiSST & CCMP wind speed, 1993-2010



OLR(W/m^2/decade) & CCMP p-stress (m^2/s^2/decade) trend, 93-10



GPCP Rain (mm/day/decade) & CCMP p-stress (m^2/s^2/decade) trend, 93-10

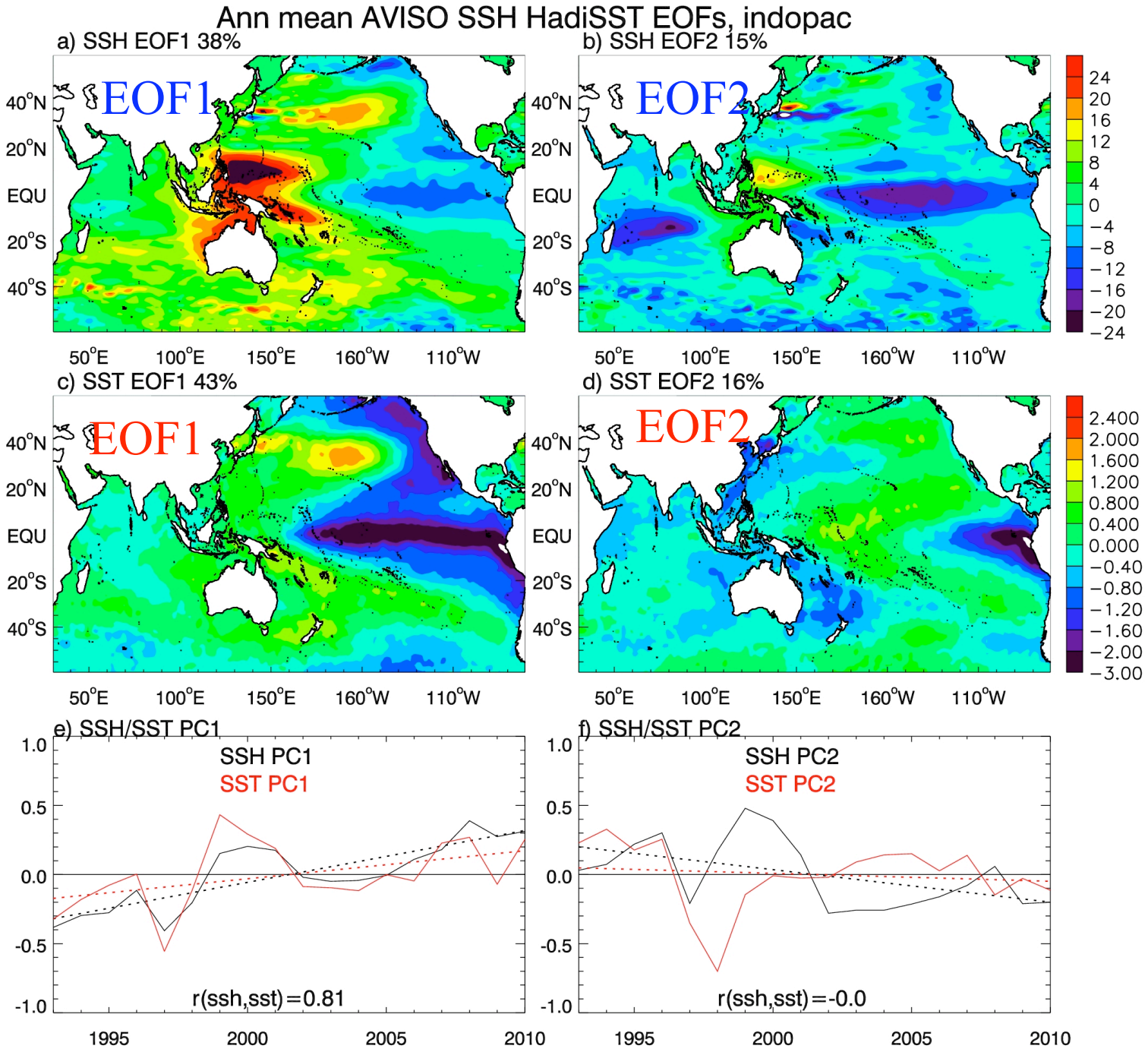


EOFs

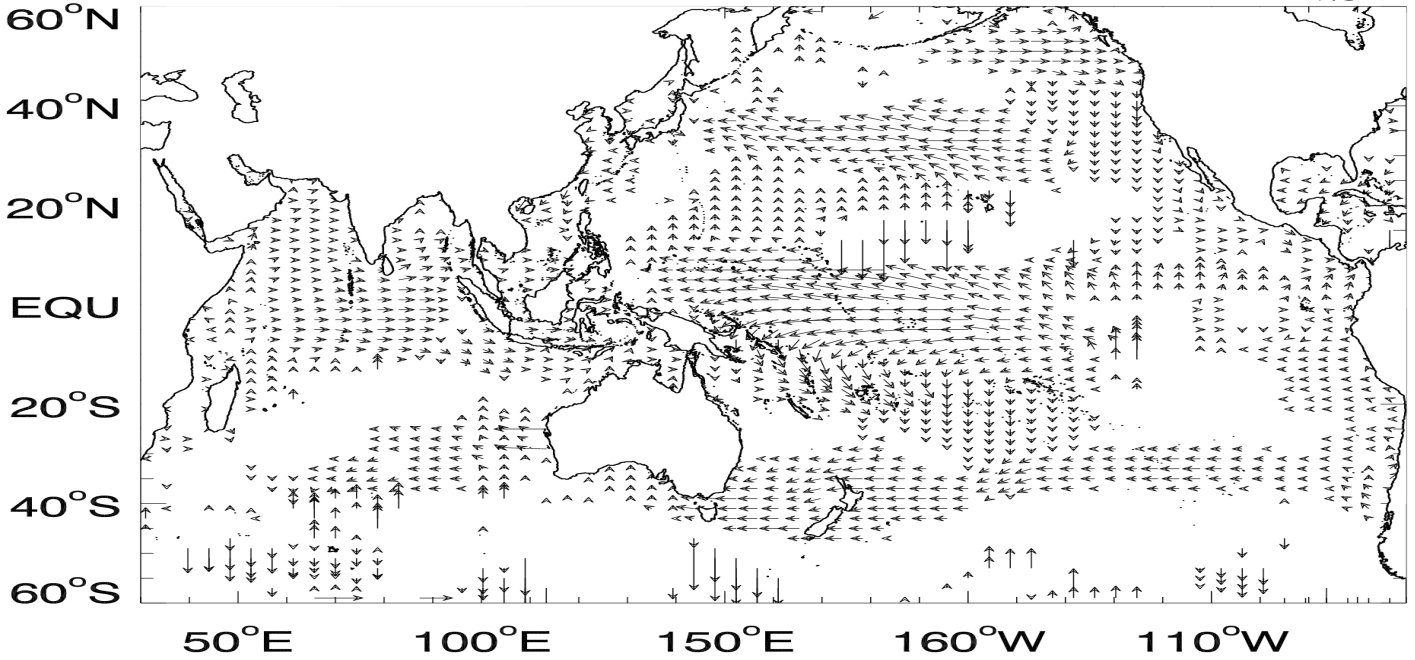
1993-2010

SSH

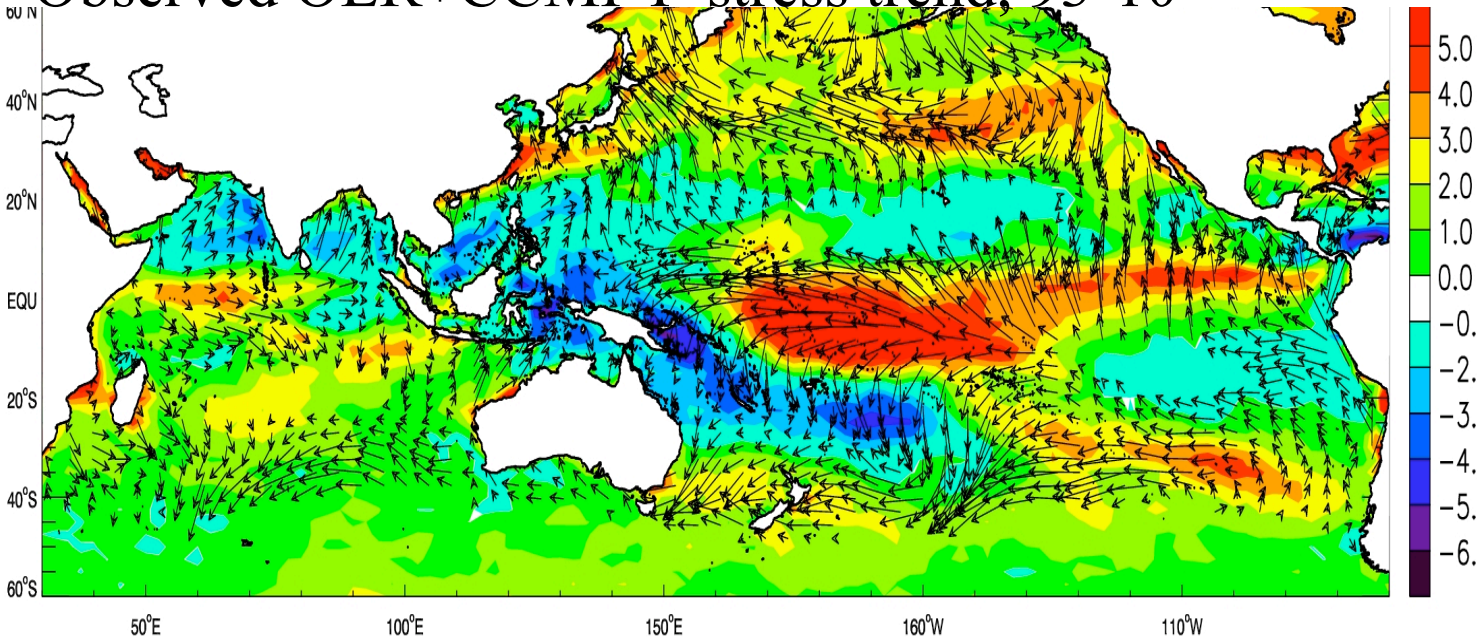
SST



CCMP P-stress regressed onto AVISO SSH PC1, 93-10, rmin=0.3

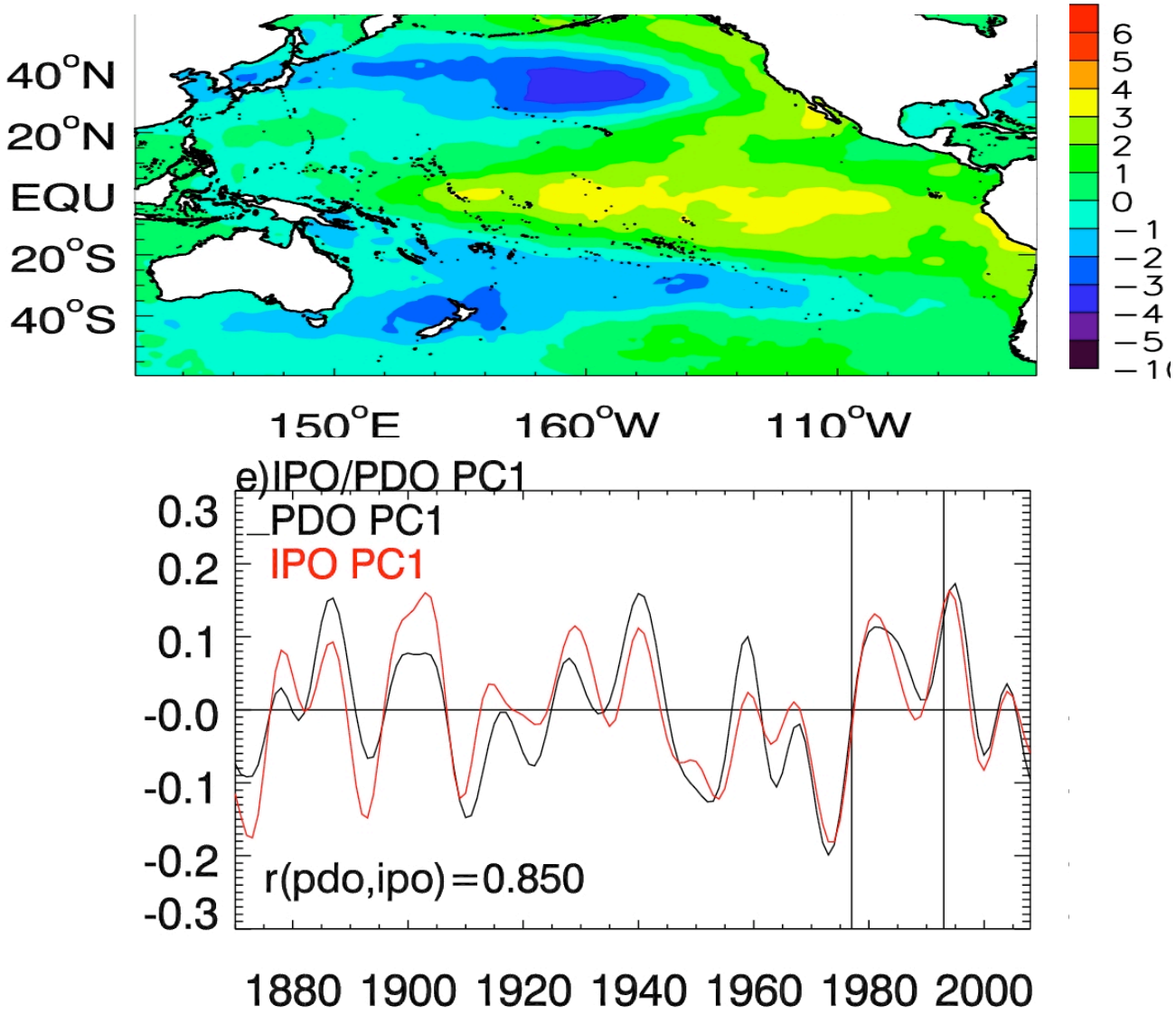


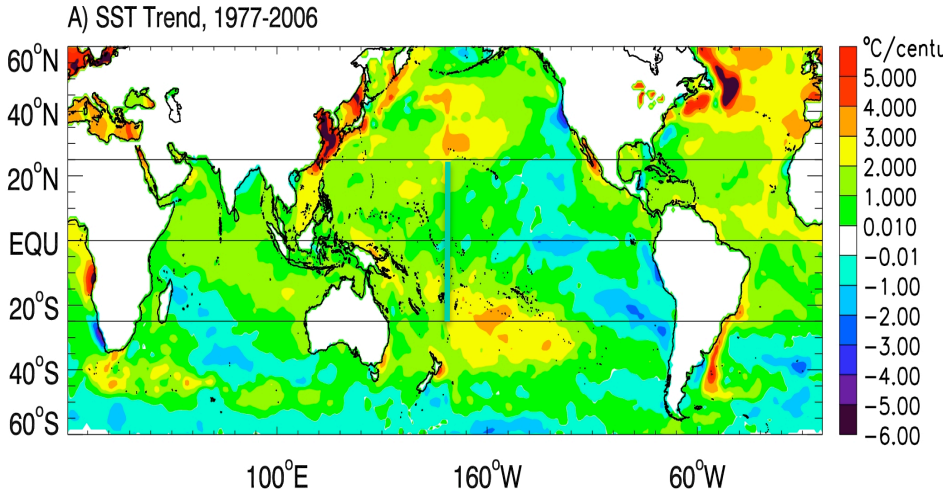
Observed OLR+CCMP P-stress trend, 93-10



EOF1 for lowpassed 8yr SST, 1870-2010

Inter-basin Pacific Decadal-multidecadal Variability EOF1



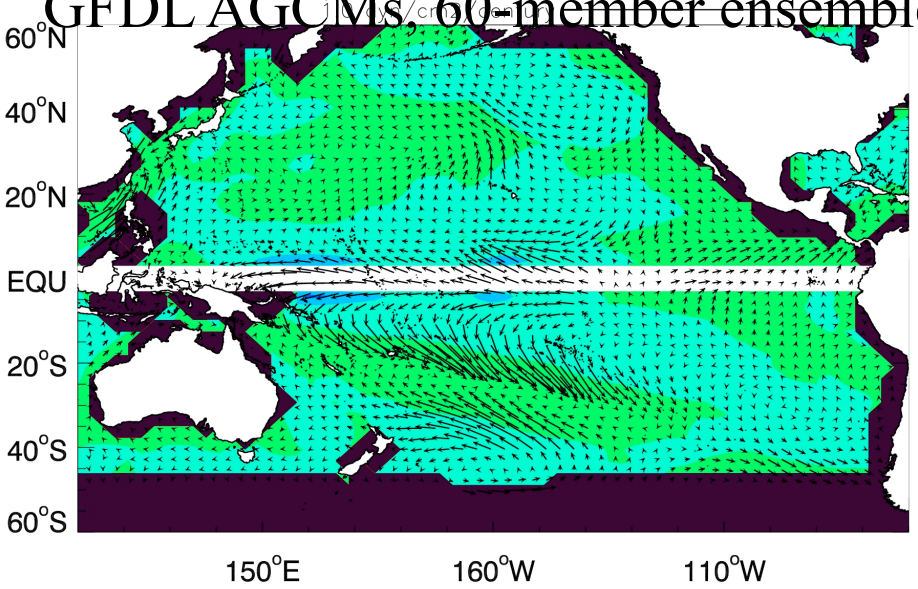


HadiSST trend for 1977-2006,
which is used to forced
GFDL AM2.1 & GFS

Warm Pool :
(40E-180E, 25S-25N)

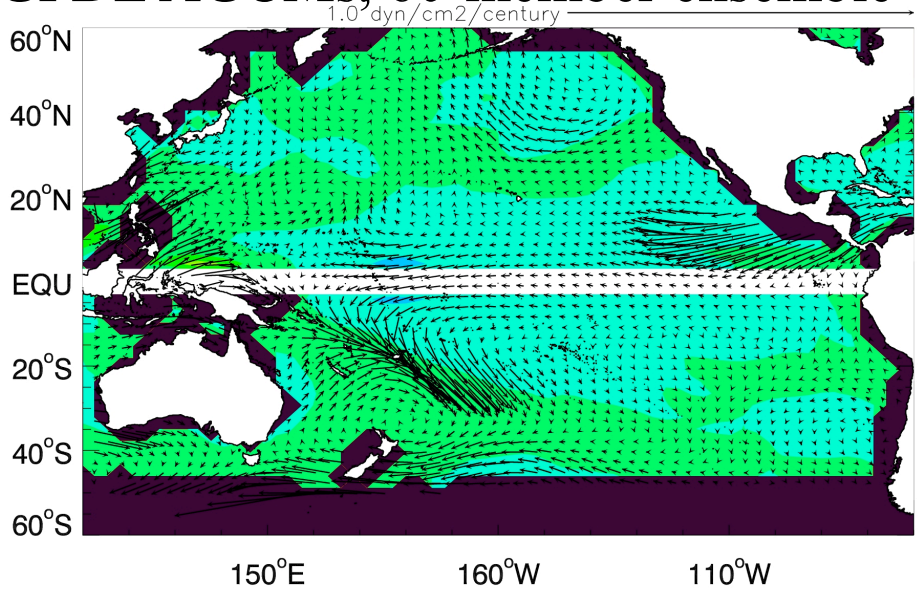
Global SST trend forcing:

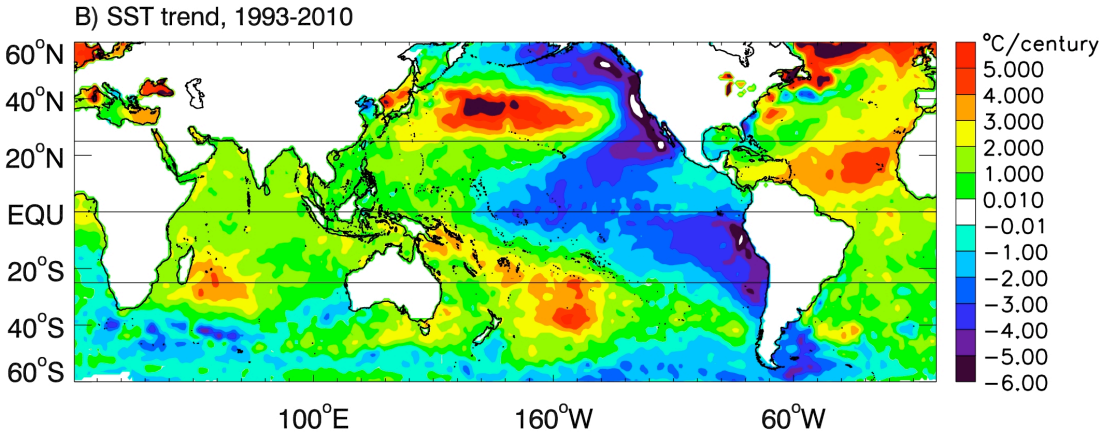
GFDL AGCMs, 60-member ensemble



Warm pool SST trend forcing:

GFDL AGCMs, 60-member ensemble

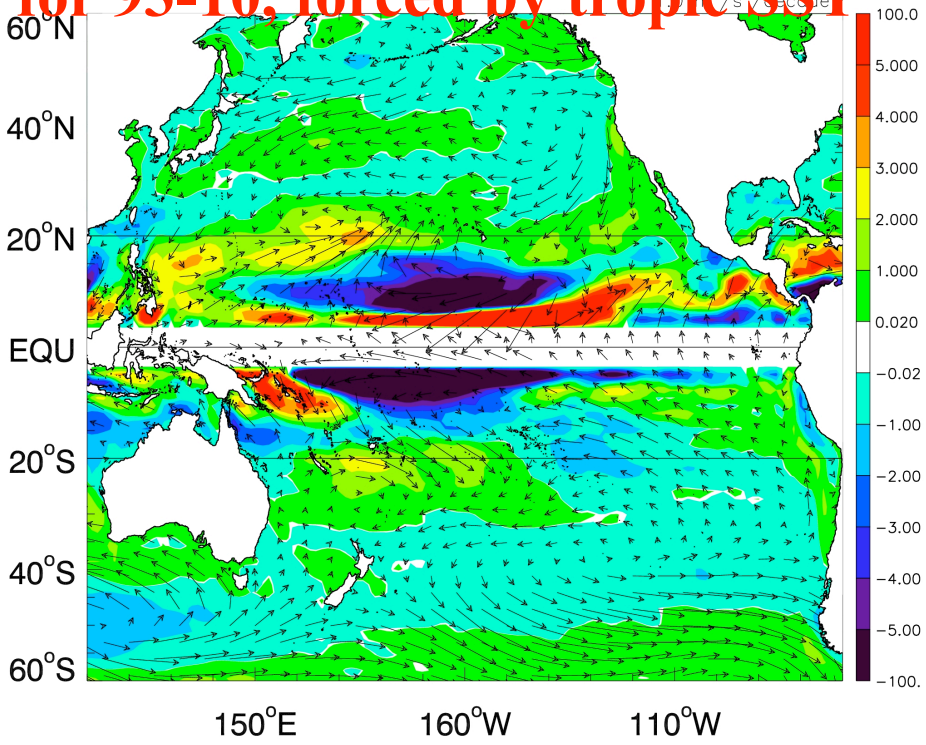




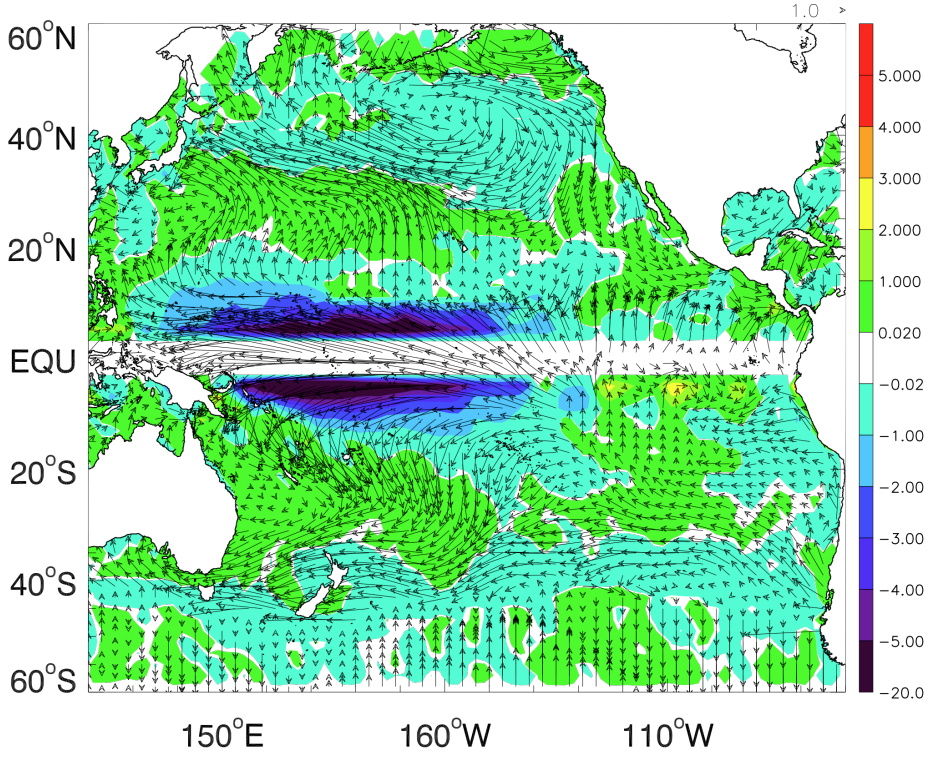
HadiSST trend for 93-10

Monthly SSTs of tropics (20S-20N) are used to force CAM3, T85

5-member ensemble of CAM3
Linear trend of P-stress
for 93-10, forced by tropic SST



Linear trend of CCMP P-stress linear fitted to AVISO SSH PC1,93-10



4. Summary

- Sea level fall along the USWC and rise in the western tropical Pacific Ocean since early 1990s appears to result from the phase change of the Inter-basin Pacific Decadal & multi-decadal Variability;
- The Inter-basin Pacific Variability has cohesive changes of sea level, SST, surface wind and convection across the Pacific basin;
- The surface wind pattern appears to be largely driven by tropical SST change, which suggest that air-sea coupling in the tropics is likely a key component of the Inter-basin Pacific Variability. [These results, however, do not preclude the feedbacks and influence from the mid- and high-latitude oceans via both atmospheric and oceanic bridges.]

Acknowledgements:

NSF CAREER award OCE 0847605;

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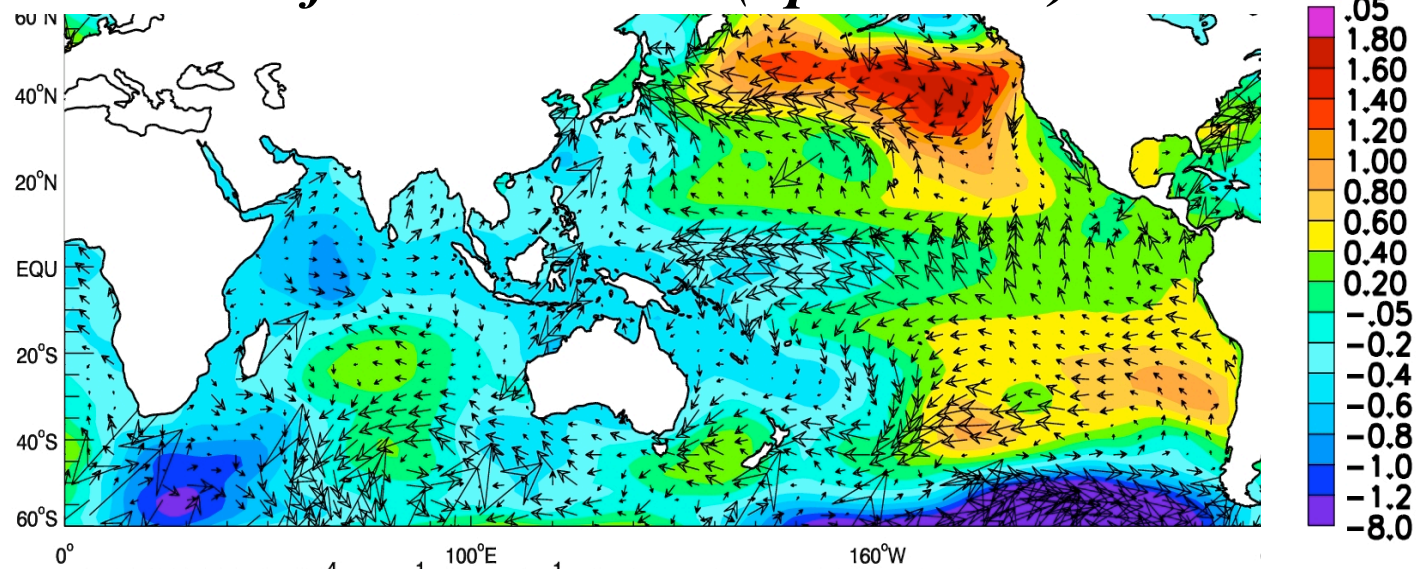
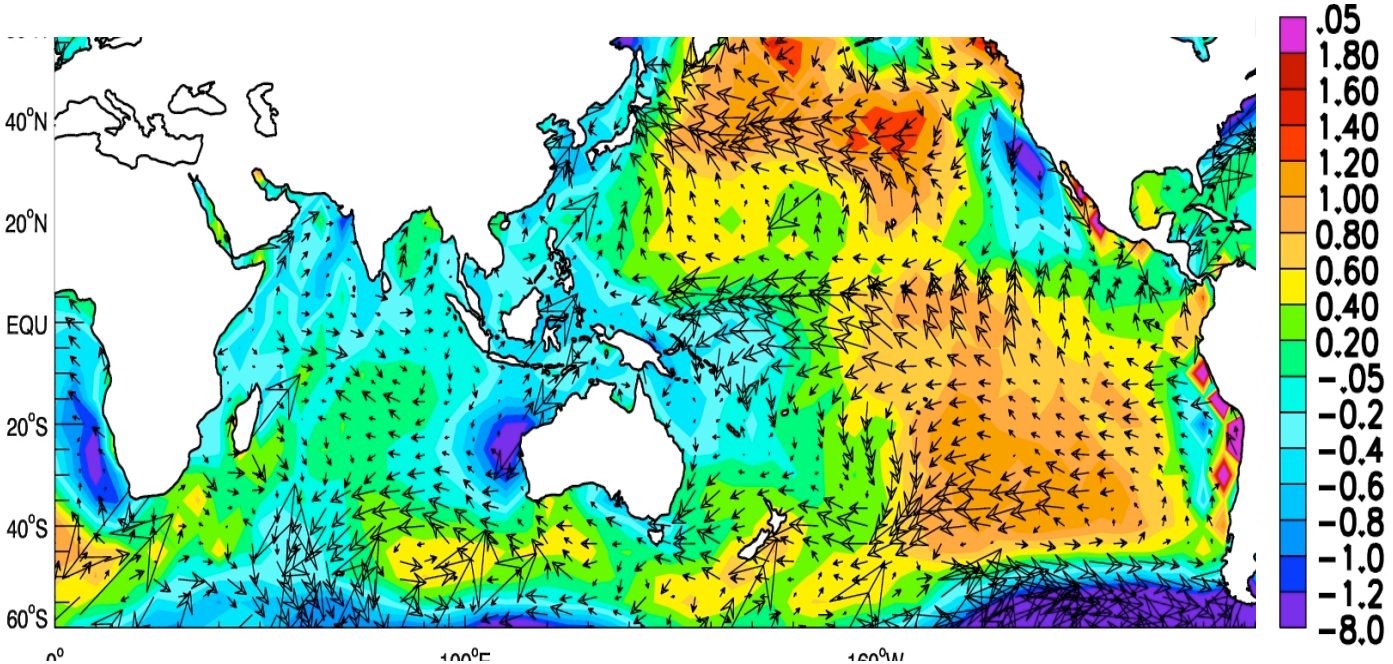
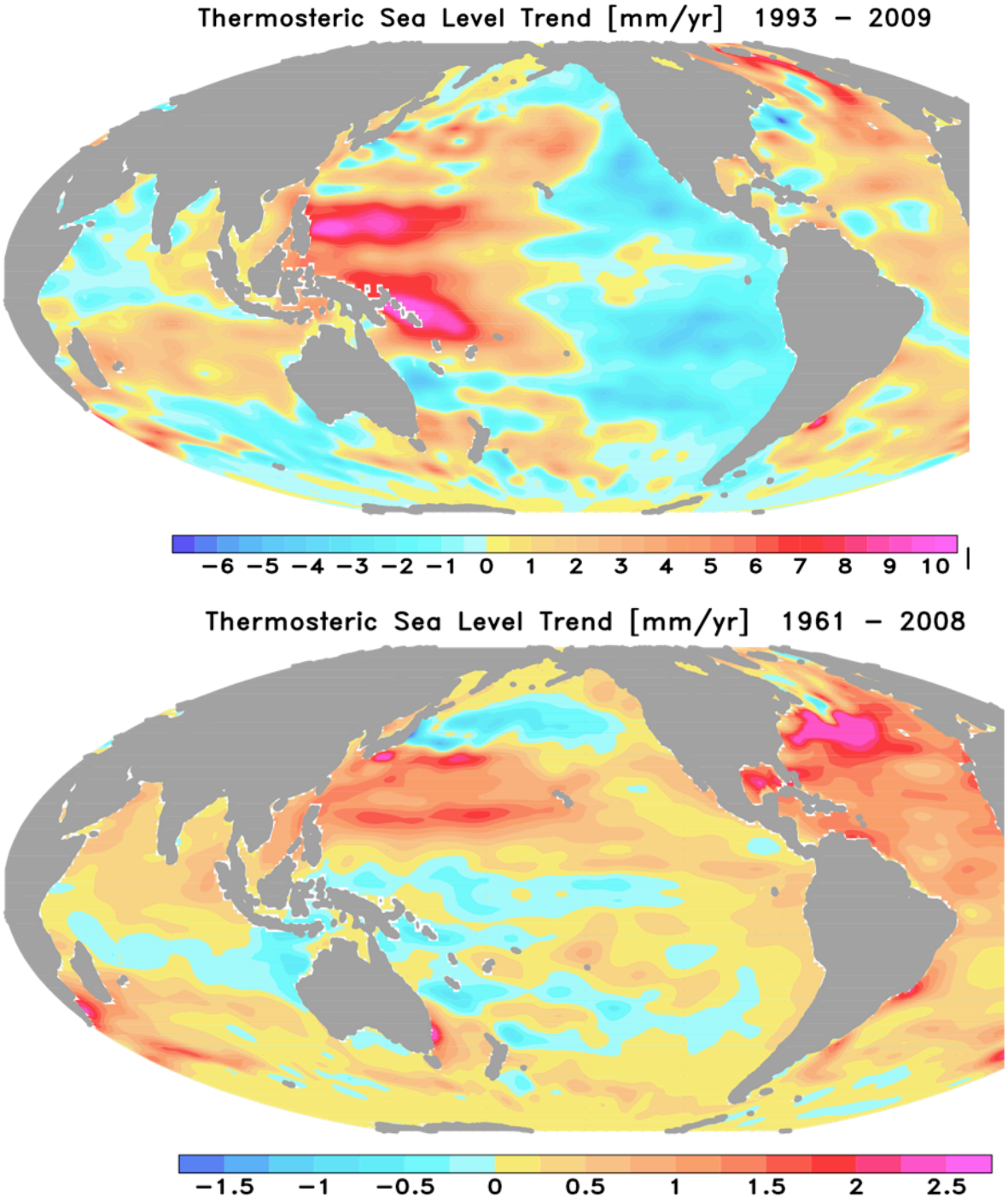
Linear trend of 20th cent SLP (hpa/decade) + CCMP wind, 1993-2010



Linear trend of HadSLP2 (hpa/decade) + CCMP wind, 1993-2010




Thermosteric Sea Level Trend [mm/yr] 1993 – 2009
−6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6 7 8 9 10
Thermosteric Sea Level Trend [mm/yr] 1961 – 2008
−1.5 −1 −0.5 0 0.5 1 1.5 2 2.5