The reversal of multi-decadal trends in the tropical Pacific

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National Research FLAGSHIPS Wealth from Oceans

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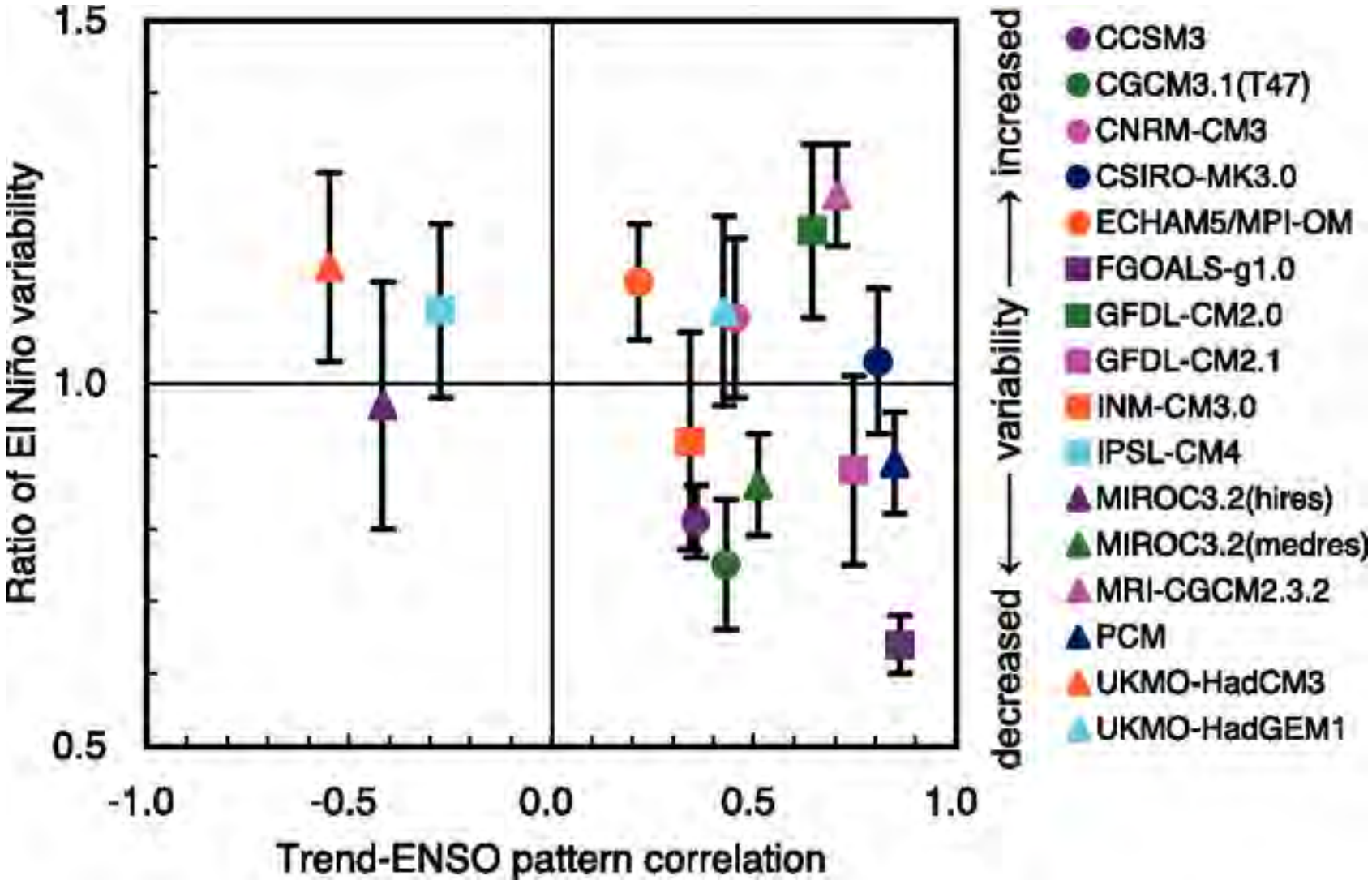
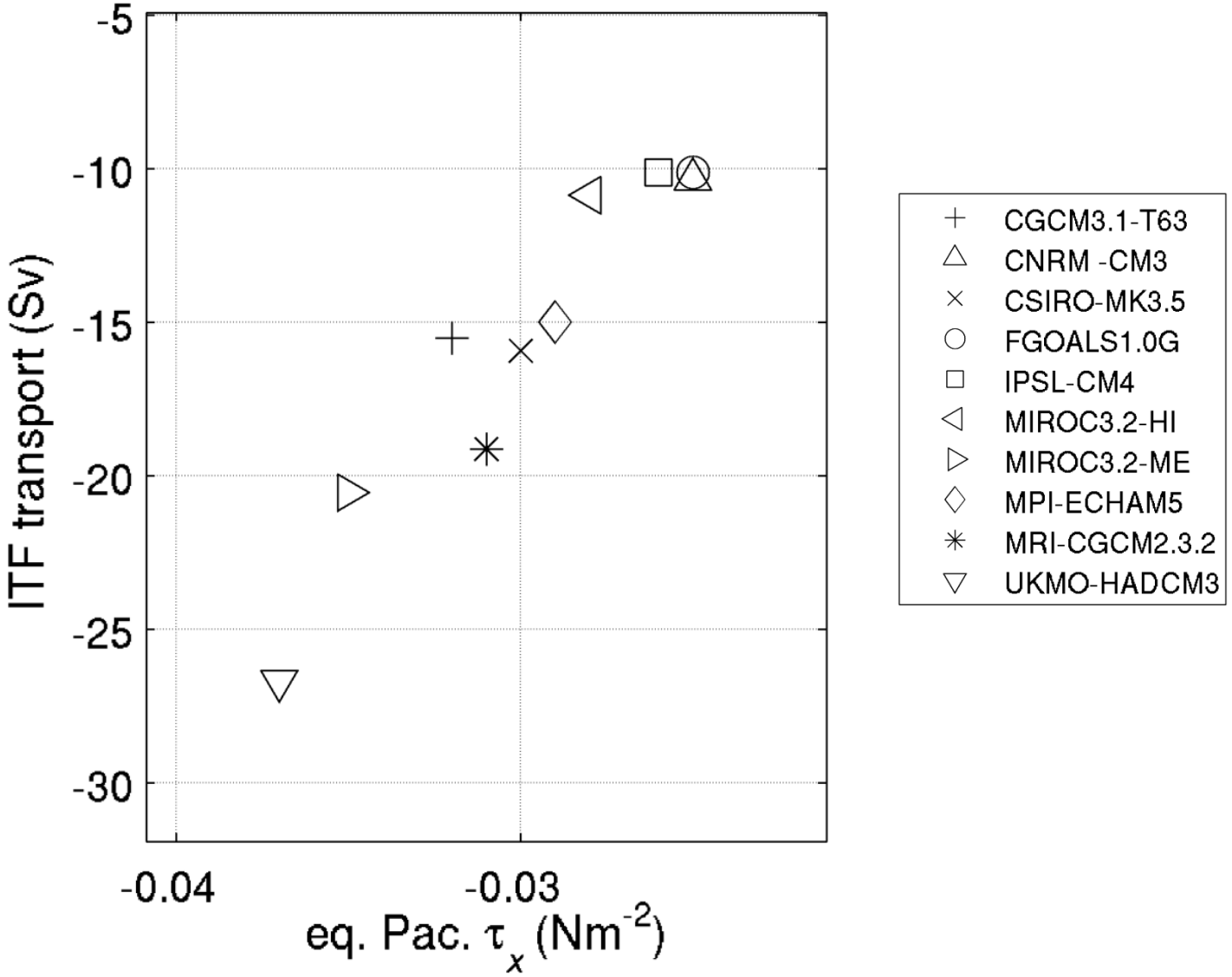
- **Tony Lee, NASA JPL**
- **Claus Boning, Arne Biastoch, Erik Behrens, IFM-GEOMAR**

- Feng, M., M. J. McPhaden, and T. Lee (2010), Decadal variability of the Pacific subtropical cells and their influence on the southeast Indian Ocean, Geophys. Res. Lett., 37, L09606, doi:10.1029/2010GL042796.
- Feng, M., C. Boning, A. Biastoch, E. Behrens, E. Weller, Y. Masumoto (manuscript)

Changes in tropical Pacific SSTs and El Niño variability simulated by AOGCMs



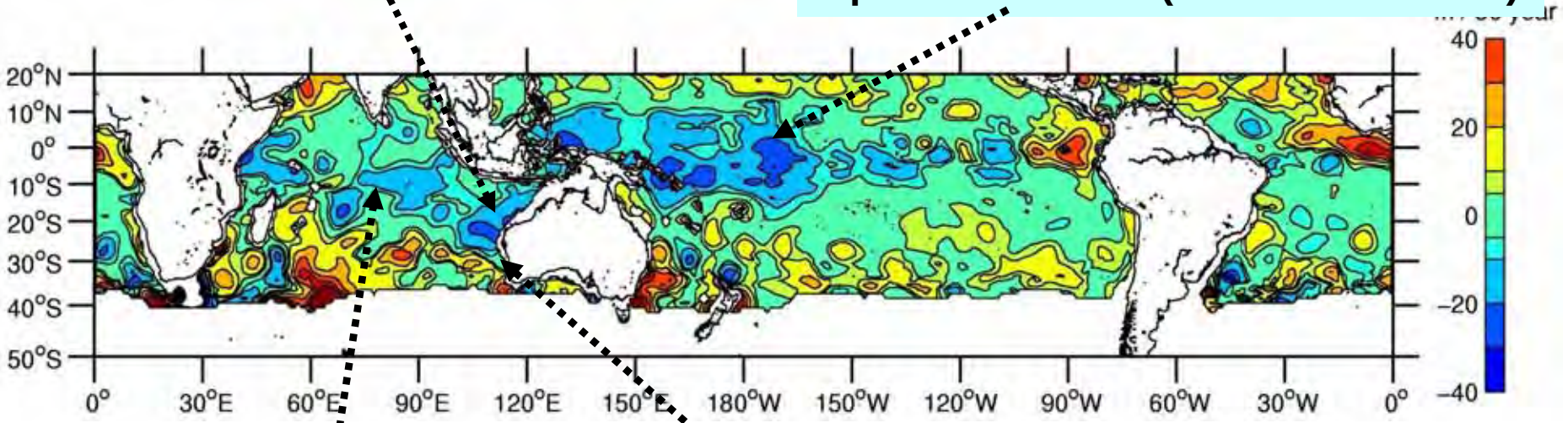
Relationship between equatorial Pacific winds and Indonesian Throughflow transport in AOGCMs



Changes of 14°C isotherm depth derived from World Ocean Database (1950's – 1990's)

Indonesian Throughflow transport reduced by 30% (Wainwright et al. 2008)

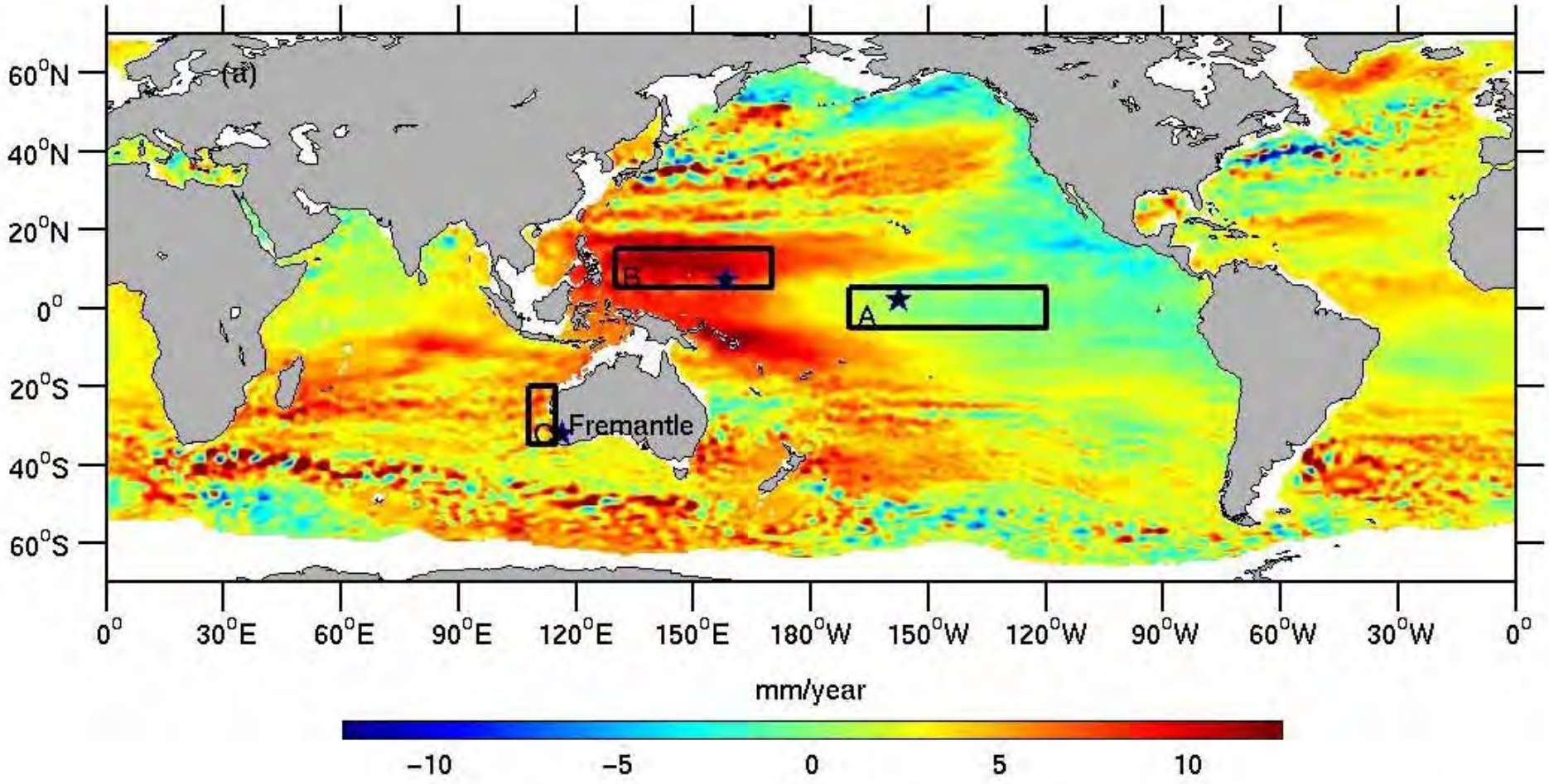
Slowdown of the subtropical cells (McPhaden and Zhang 2002)
Thermocline shallower in the equatorial Pacific (Vecchi et al. 2006)



Possible effects on subtropical dome (Alory et al. 2007)
Strengthening of southern STC (W.Q. Han)
C. Boning (personal communication)

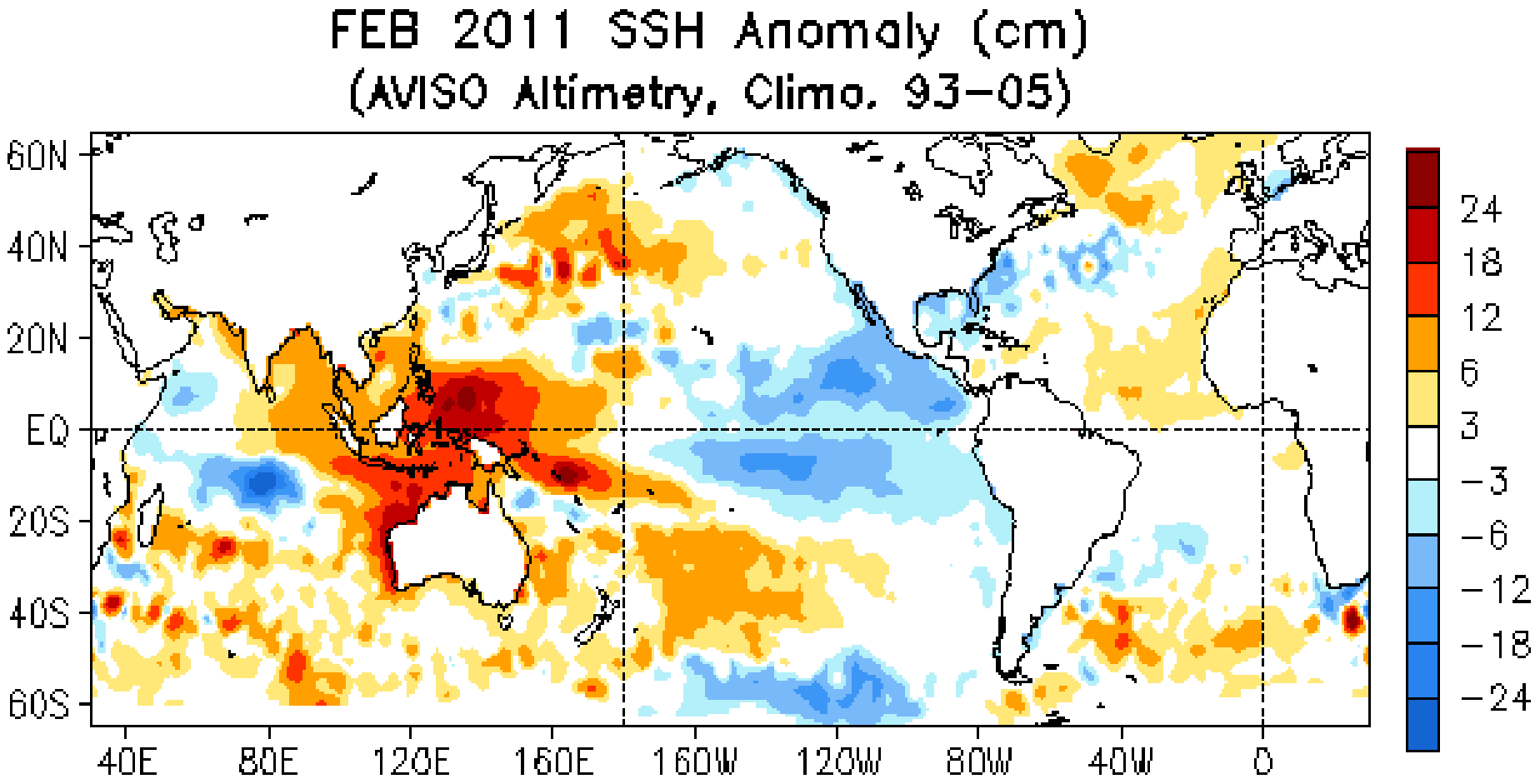
Reduction of the Leeuwin Current transport (Feng et al. manuscript)

Linear trends of altimeter sea level anomalies during 1993-2008



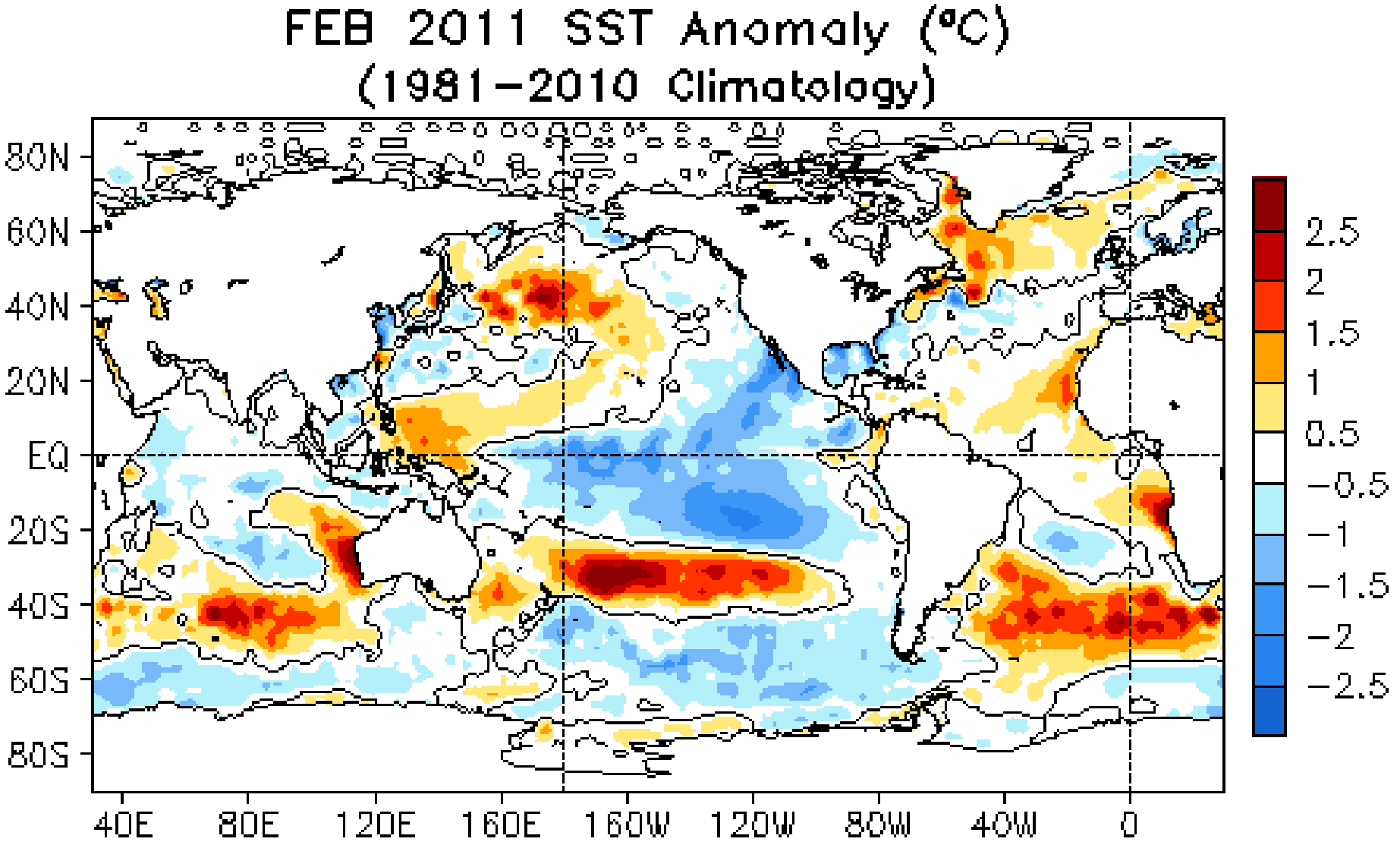
Feng, McPhaden, Lee 2010

One of the strongest La Nina events



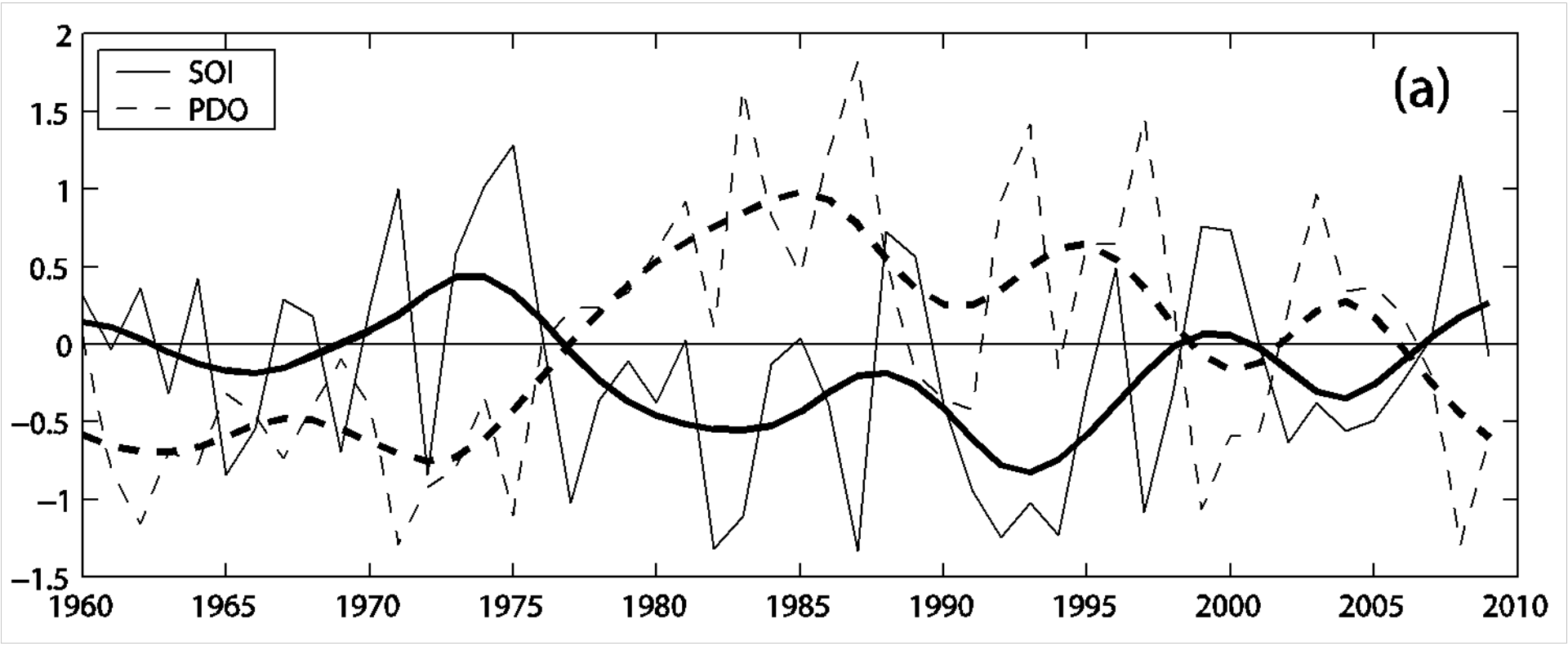
NCEP-CPC

Massive fish kills off the west coast of Australia



NCEP-CPC

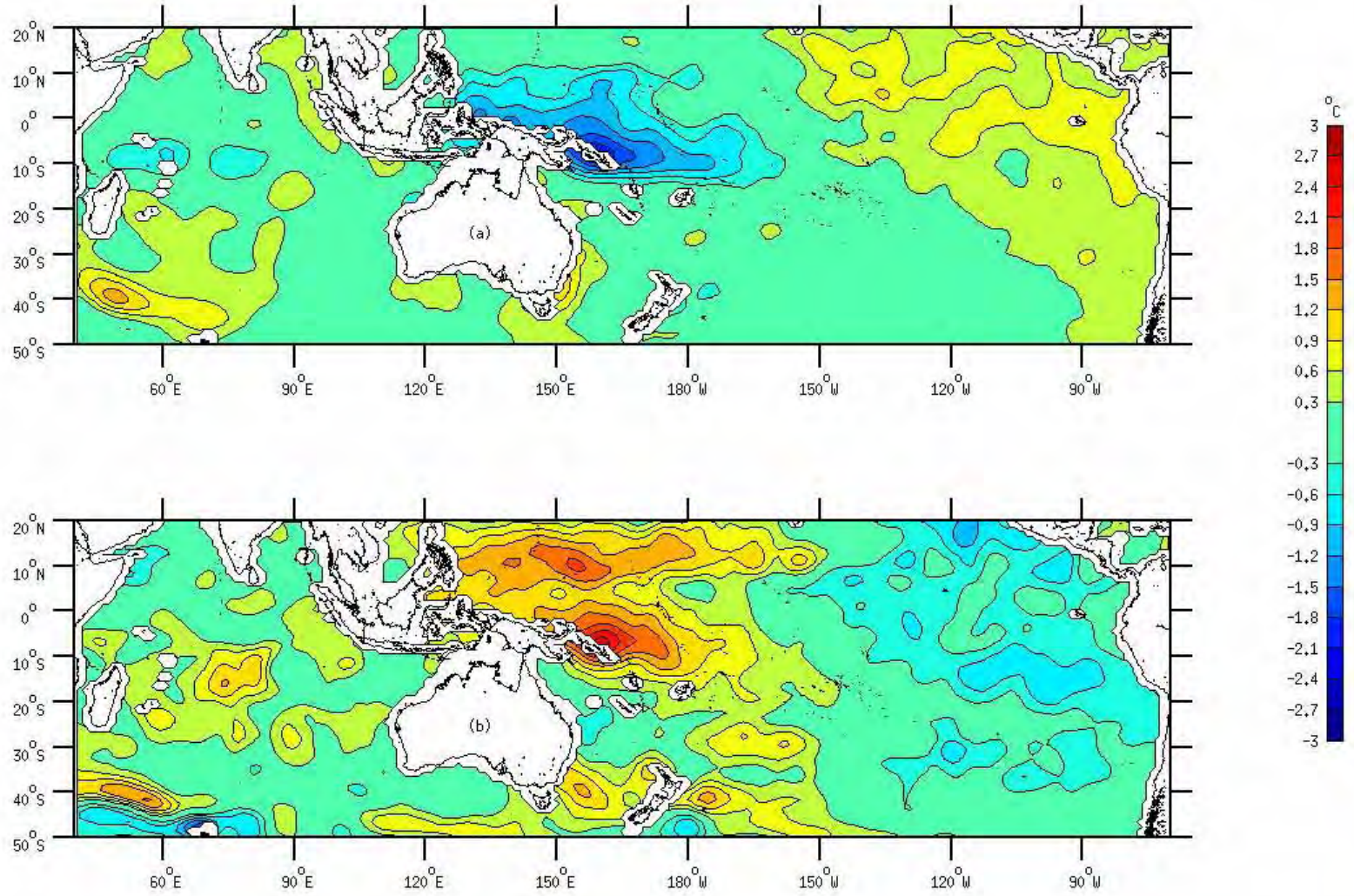
A phase transition ~1993



Linear temperature changes in the 0-300 m

1960-1993

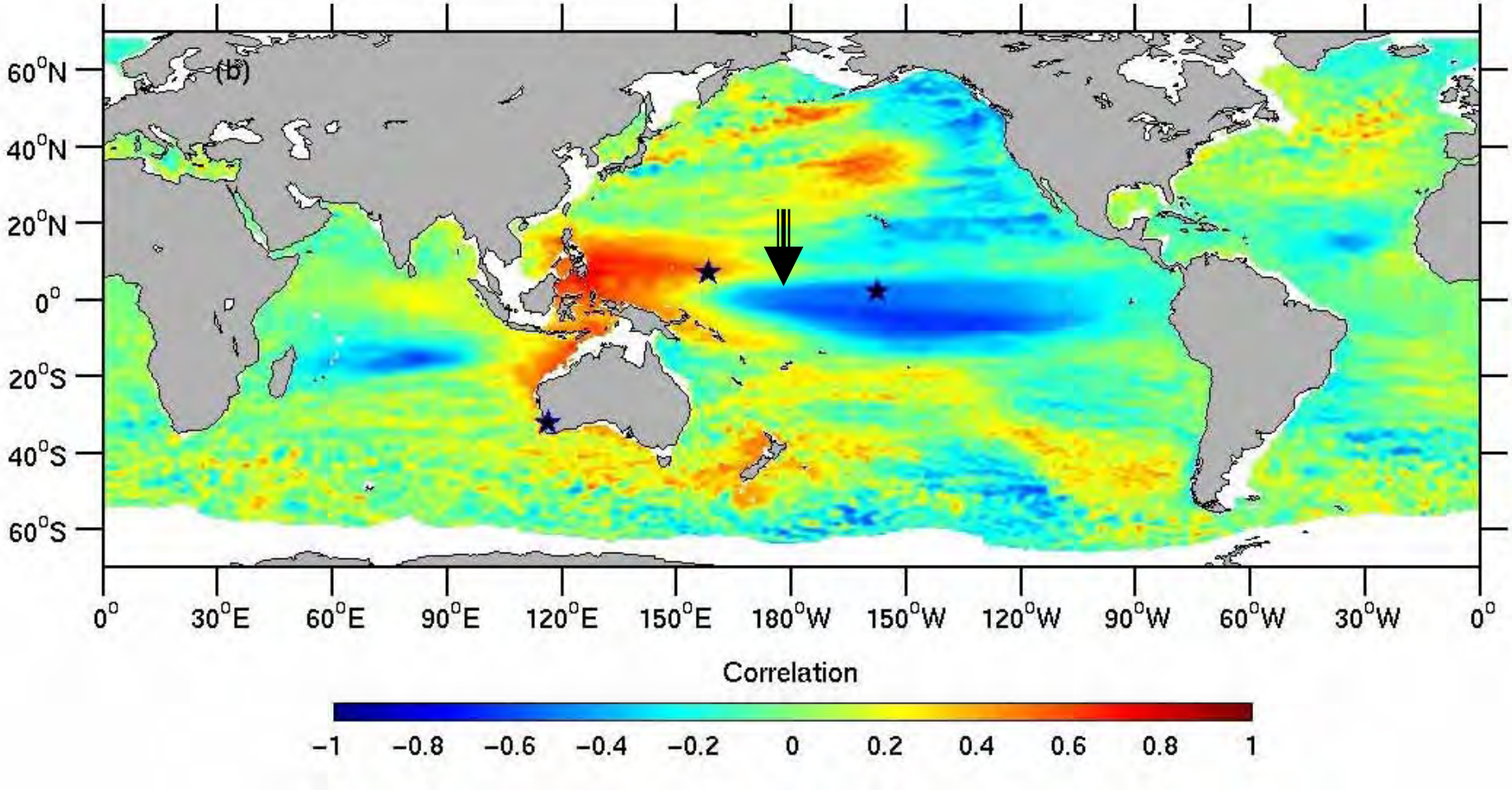
1993-2009



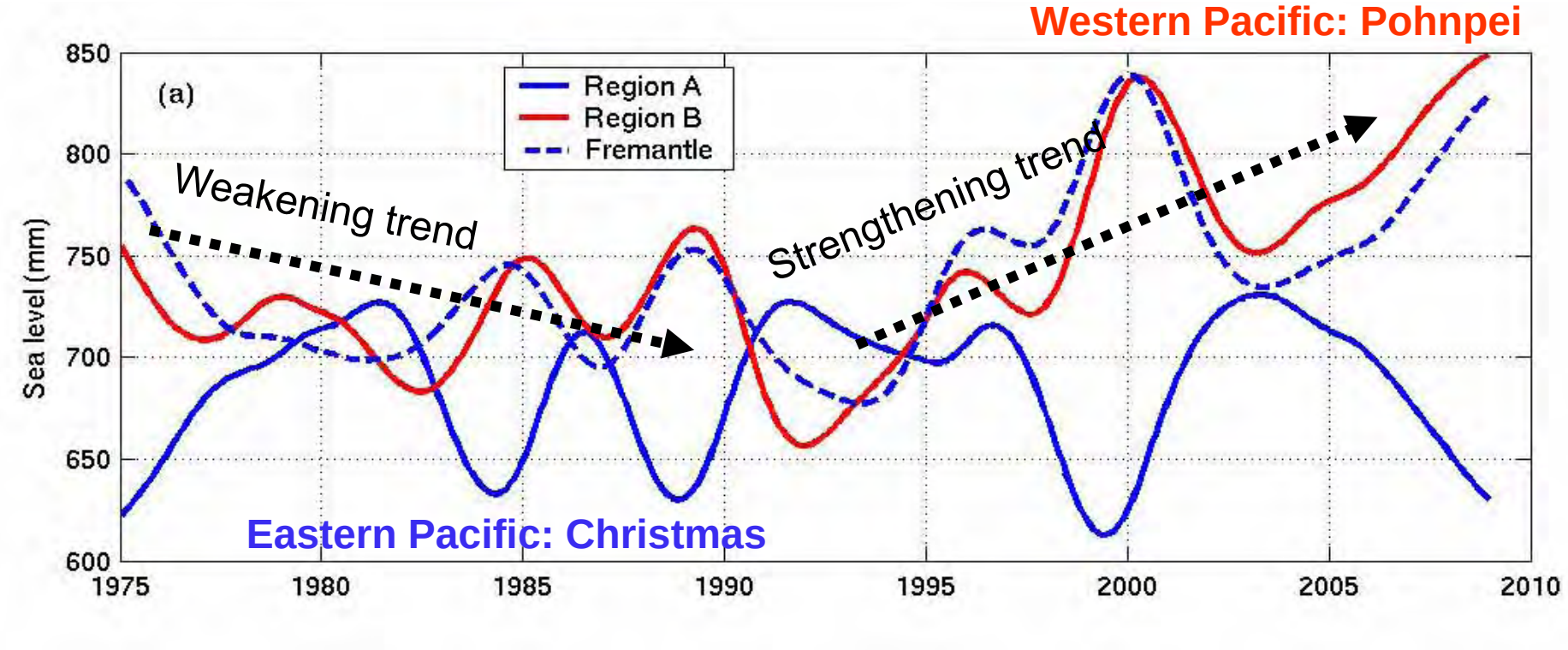
NOAA

Correlation between sea level difference between Pohnpei and Christmas and altimeter sea levels

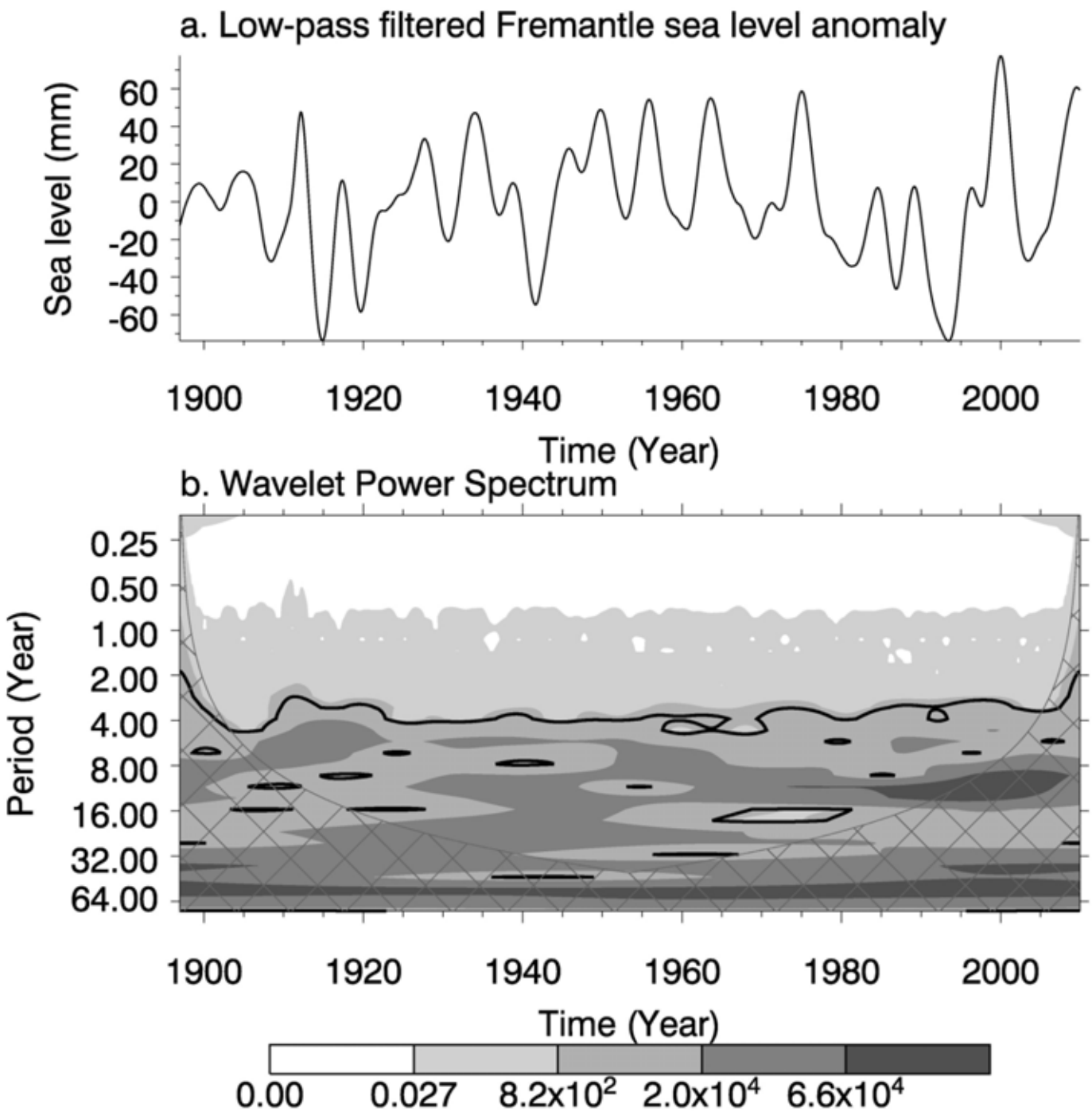
- Sea level difference can be used as an index of the strength of the Pacific subtropical cells



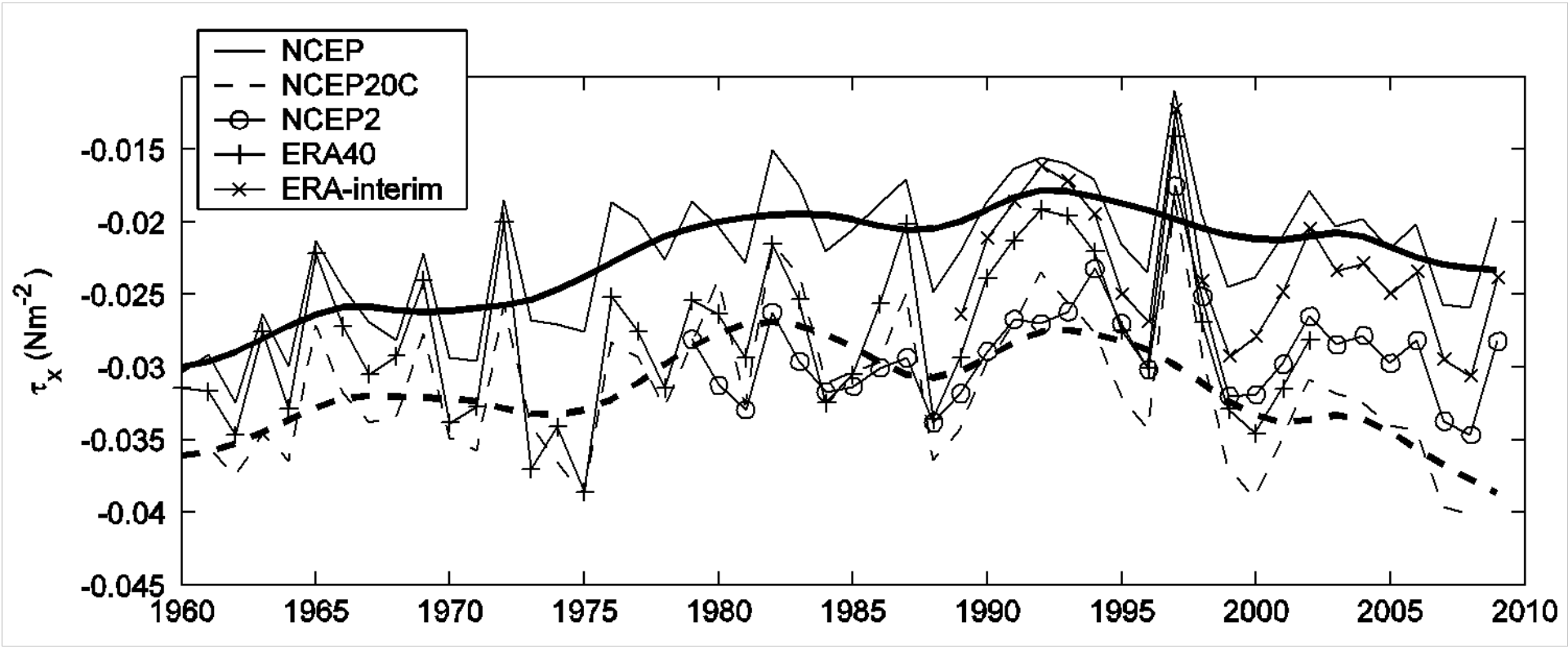
Reversal of multi-decadal trends since 1993



Feng, McPhaden, Lee 2010


a. Low-pass filtered Fremantle sea level anomaly
Sea level (mm)
60
40
20
0
-20
-40
-60
1900
1920
1940
1960
1980
2000
Time (Year)
b. Wavelet Power Spectrum
Period (Year)
0.25
0.50
1.00
2.00
4.00
8.00
16.00
32.00
64.00
1900
1920
1940
1960
1980
2000
Time (Year)
0.00
0.027
8.2x10^2
2.0x10^4
6.6x10^4

Discrepancies among reanalysis products on the recent trend of equatorial Pacific winds



Linear changes in zonal equatorial Pacific wind stress (10^{-3} Nm^{-2})

	1960-1993	1993-2008
NCEP-1	12.9 (1.7)	-6.4 (2.8)
NCEP-2	--	-8.1 (2.8)
NCEP-20C	8.4 (2.1)	-11.5 (3.3)
ERA40	7.6 (2.6)	--
ECMWF interim	--	-7.8 (3.4)

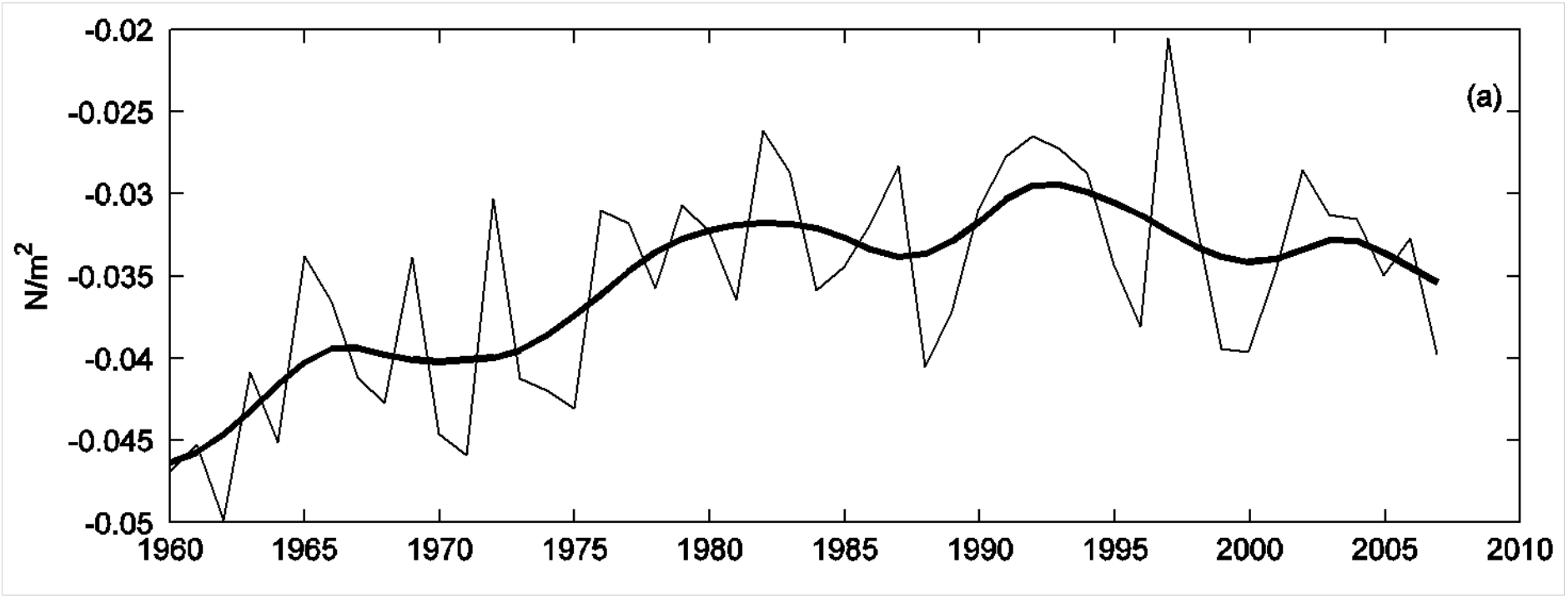
ORCA025 model

- Global ¼ degree horizontal resolution
- 6 m vertical resolution near surface, 20 layers in the upper 500 m
- Surface forcing based on bulk forcing methodology (Large and Yeager 2004) according to “CORE” protocol

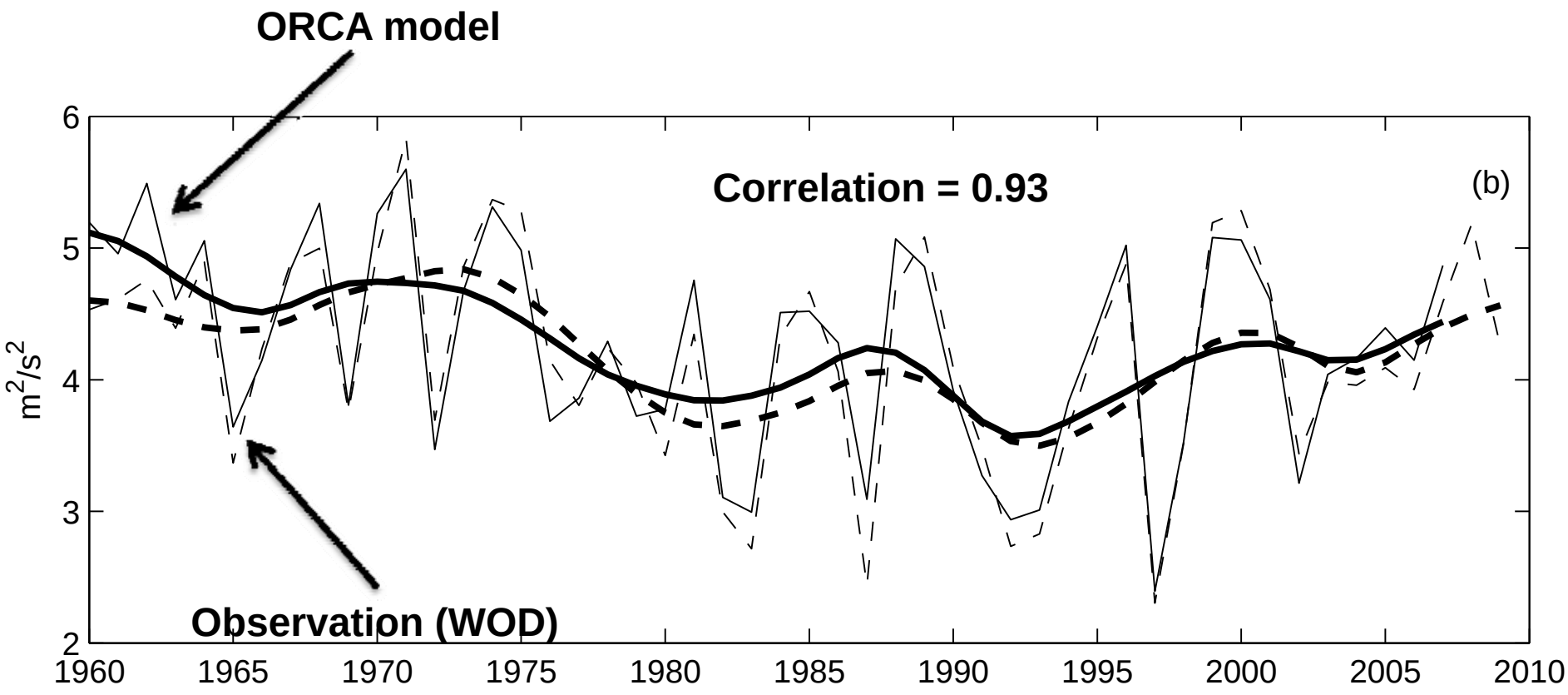
- CORE: Co-ordinated Ocean-Ice Reference Experiments

- Monthly output during 1960-2007

Annual mean zonal wind stress of ORCA025 (CORE forcing)



Annual mean zonal surface steric height difference between west Pacific and east Pacific

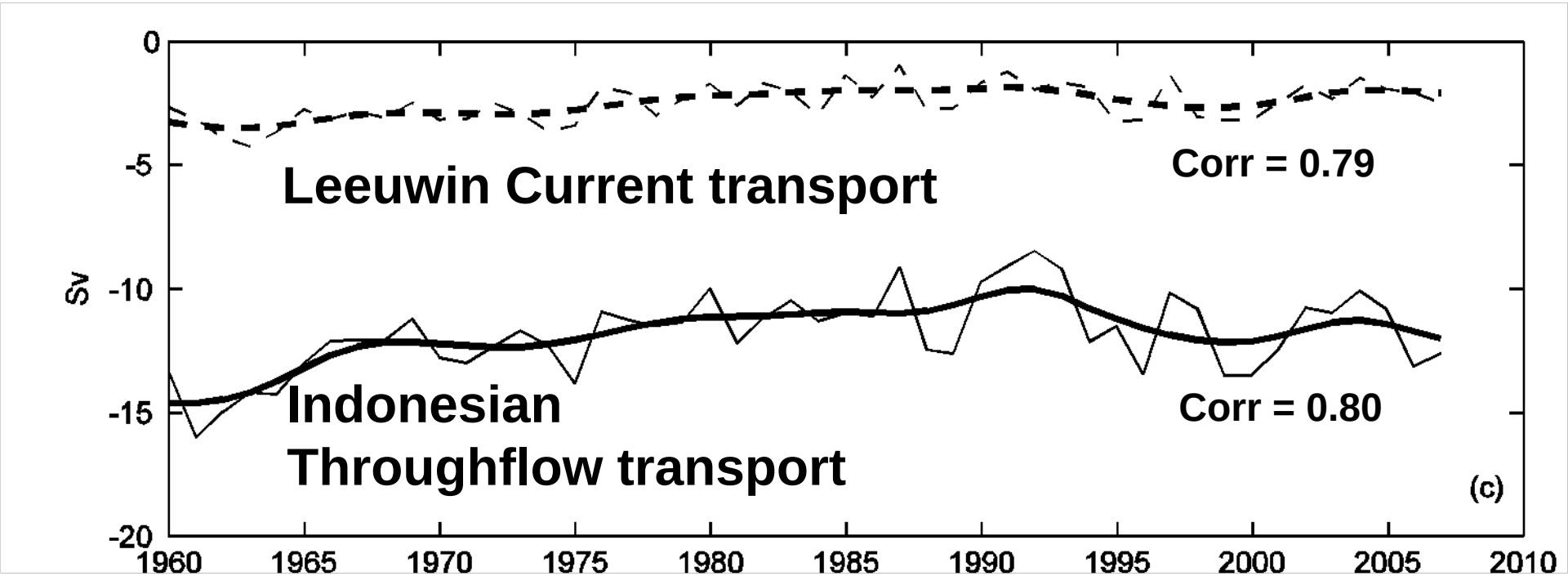


Linear changes in zonal steric height differences along the equatorial Pacific

	1960-1993	1993-2007
ORCA025	**-1.5 (0.4)**	**0.8 (0.6)**
WOD	**-1.3 (0.7)**	**1.1 (0.6)***

*1993-2008

ORCA Indonesian Throughflow transport



Multi-decadal trends using linear regressions with zonal equatorial wind stress

	Indonesian Throughflow (Sv)		Leeuwin Current (Sv)	
	1960-1993	**1993-2008**	1960-1993	1993-2008
ORCA025	**4.7 (0.7)**	**-0.6 (1.3)**	1.9 (0.4)	0.4 (0.6)
NCEP-1	**2.5 (0.3)**	**-1.3 (0.5)**	1.2 (0.2)	-0.6 (0.3)
NCEP-2	**--**	**-1.6 (0.3)**	--	-0.7 (0.3)
NCEP-20C	**1.6 (0.4)**	**-2.3 (0.6)**	0.8 (0.2)	-1.0 (0.3)
ERA40	**1.5 (0.5)**	**--**	0.7 (0.2)	--
ECMWF interim	**--**	**-1.5 (0.7)**	--	-0.7 (0.3)

Summary

- **There has been a reversal of multi-decadal trend of tropical Pacific climate after 1993**
- **The weakening trend of the Indonesian Throughflow has also reversed after 1993**
- **It is crucial to have correct wind forcing to simulate the multi-decadal climate reversal processes in the Indo-Pacific**

  - **Climate change or enhanced natural decadal climate variability?**

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Thank you

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