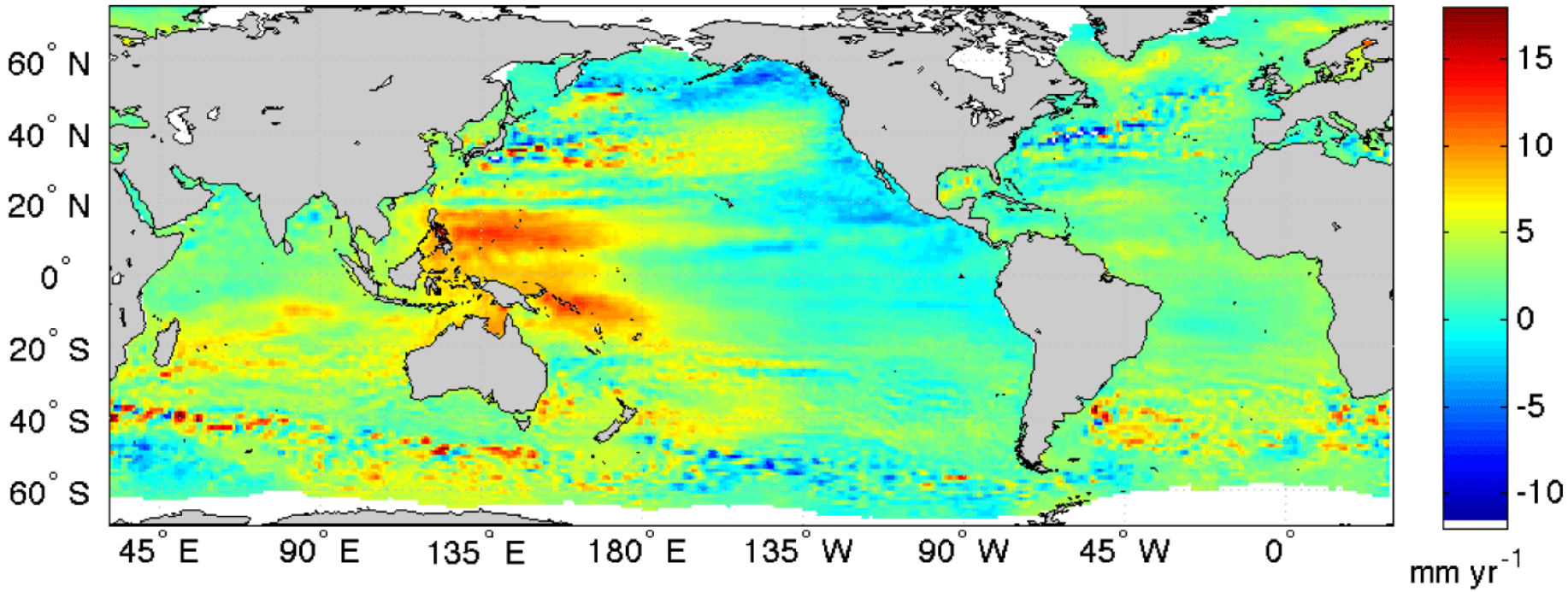
Observations and attribution of regional sea-level change

Mark A. Merrifield

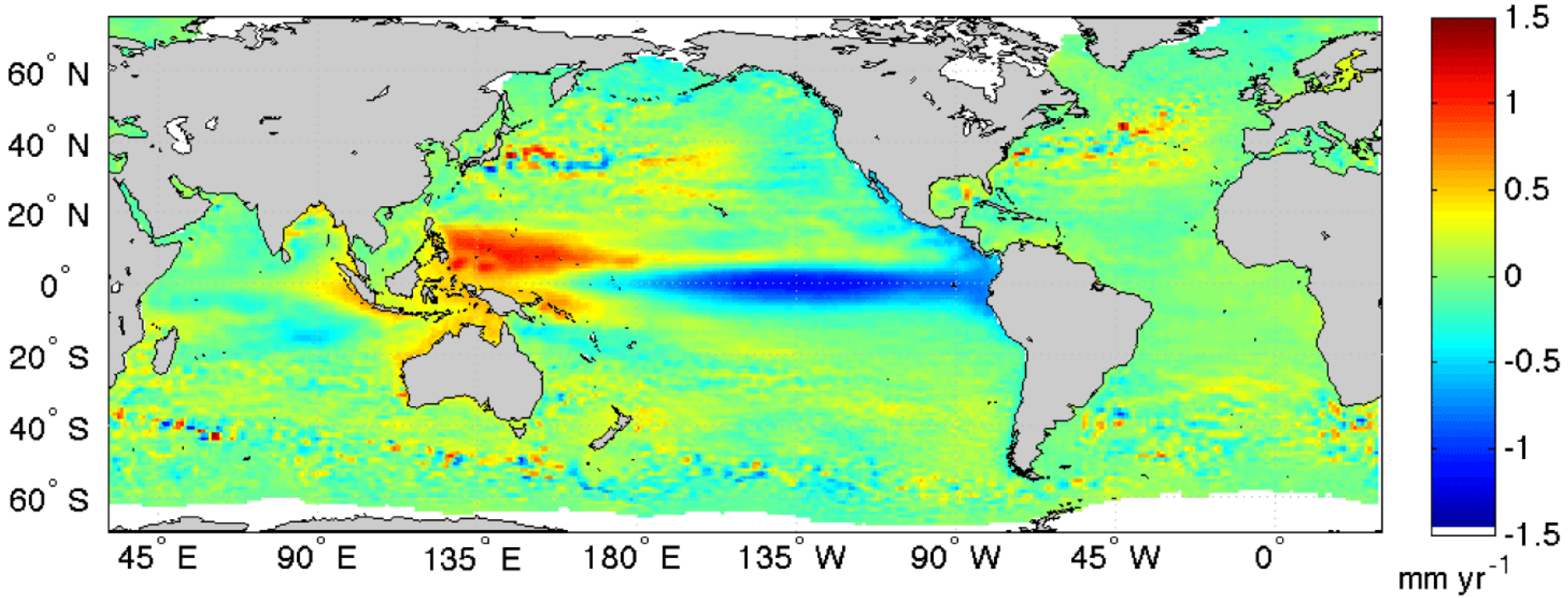
SSH trend 1993-2009



- High rates in the western tropical Pacific
- Low to negative rates in the eastern NorthPacific

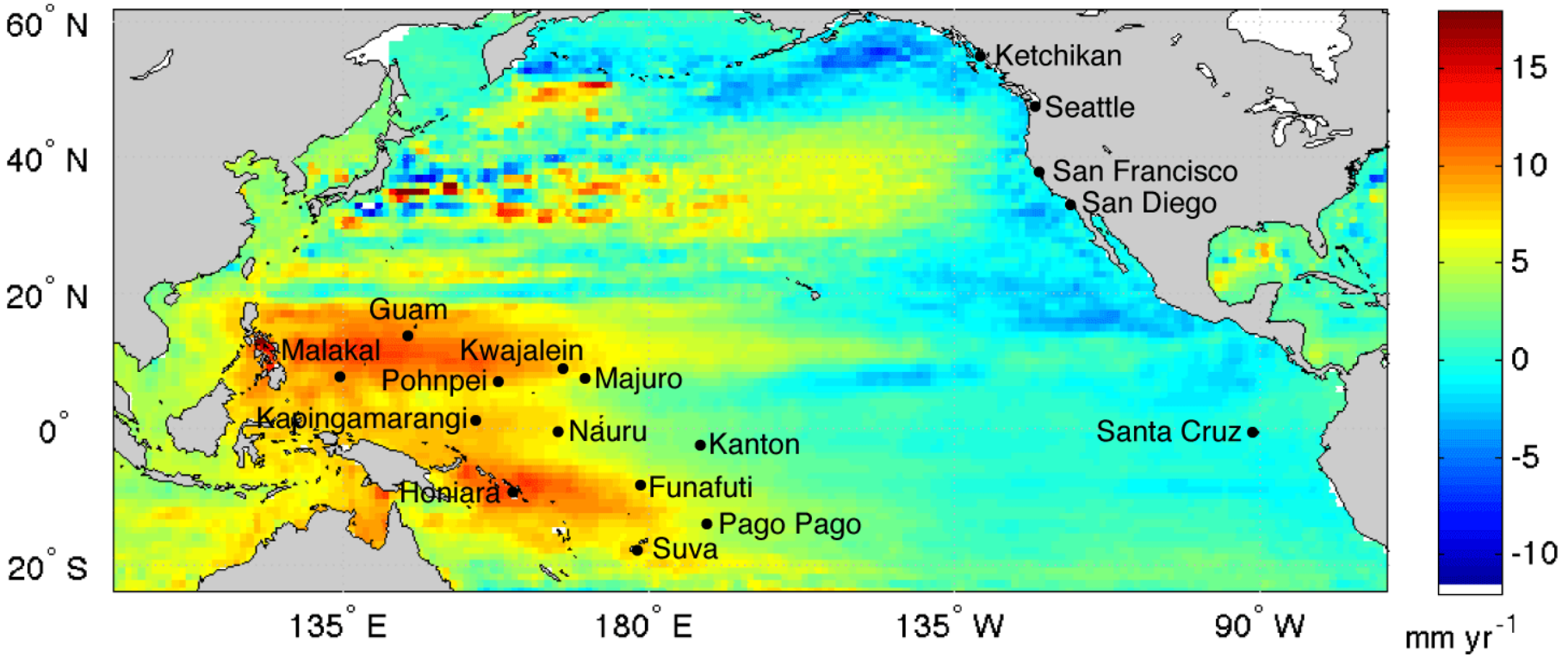
AVISO

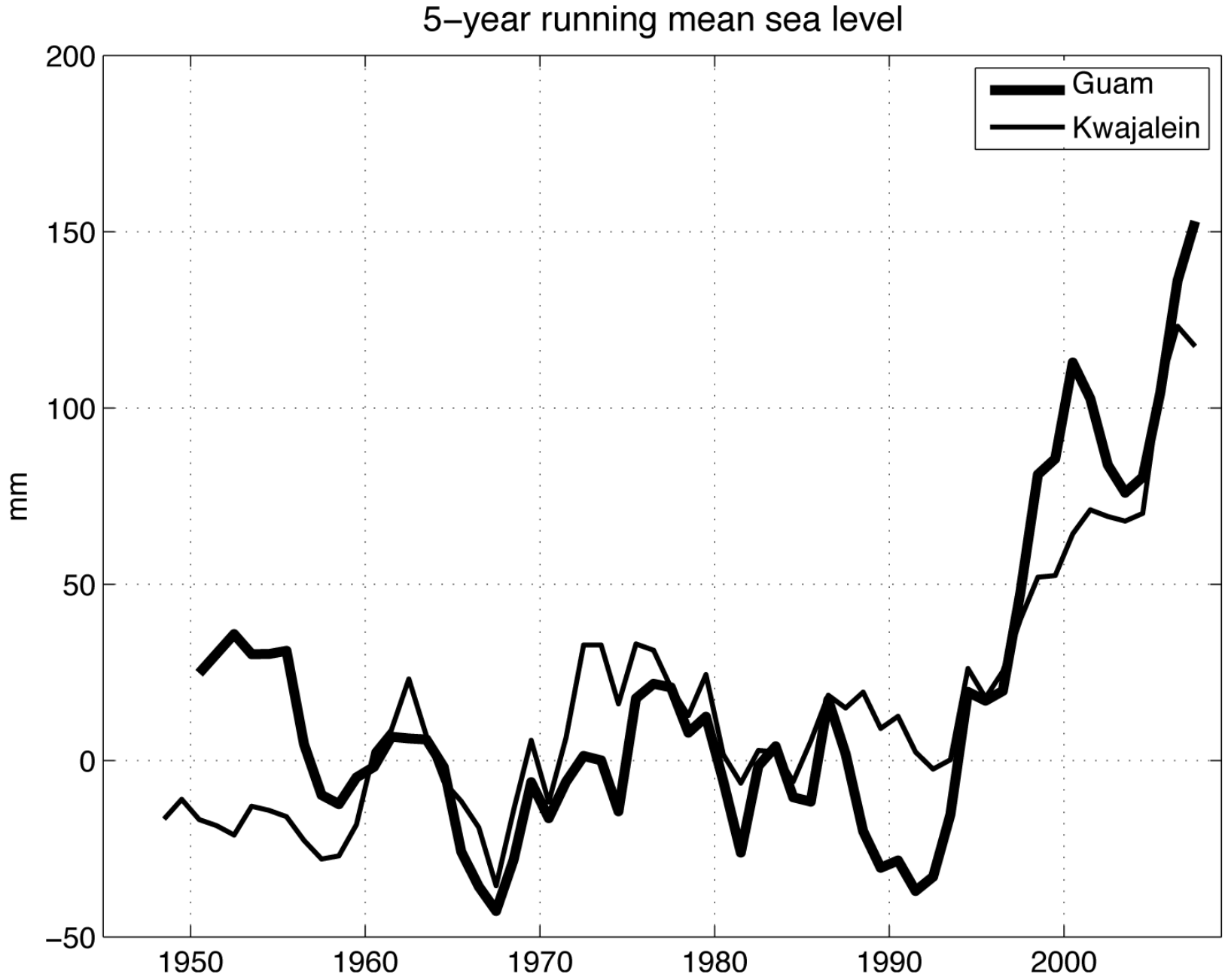
ENSO component of SSH trend

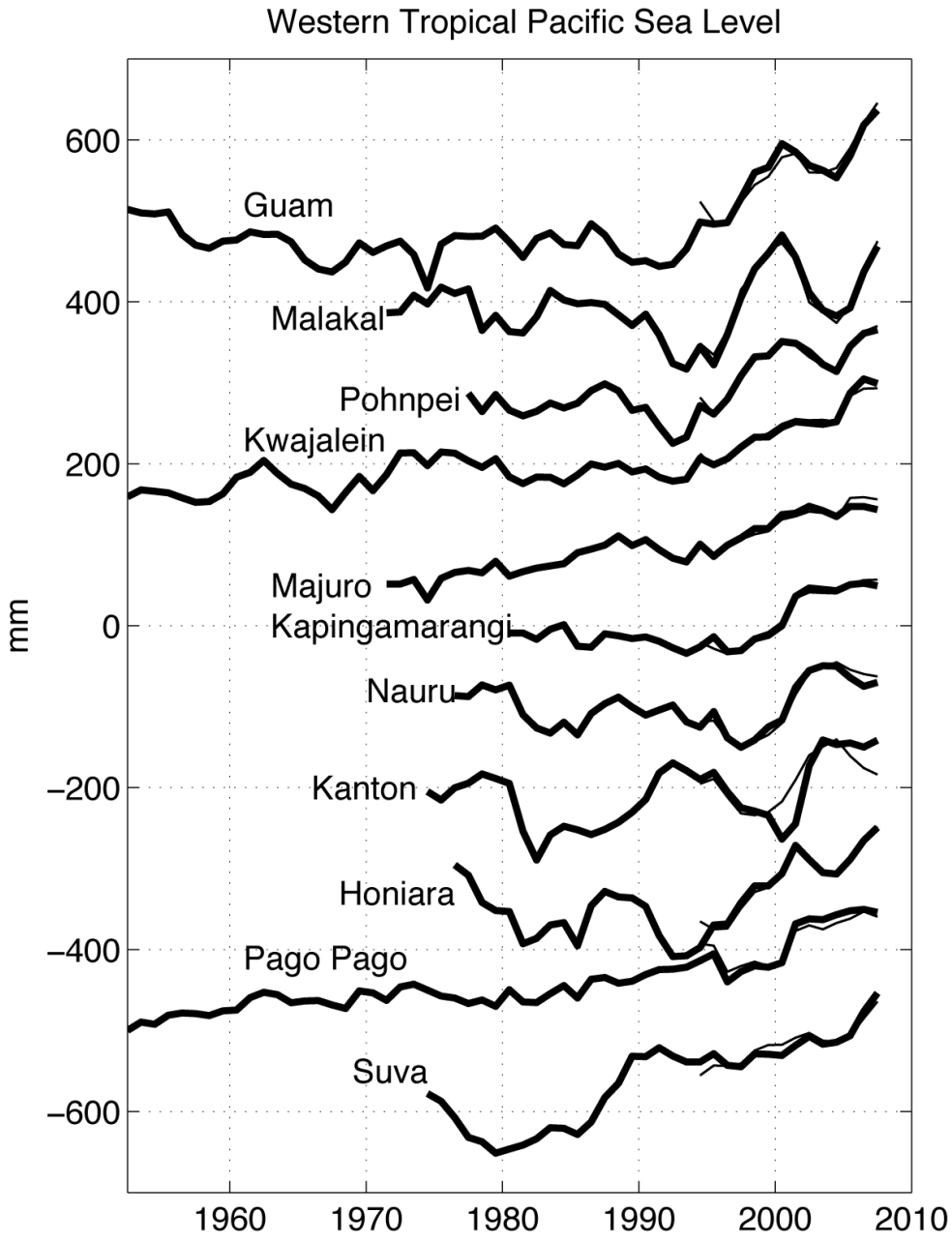


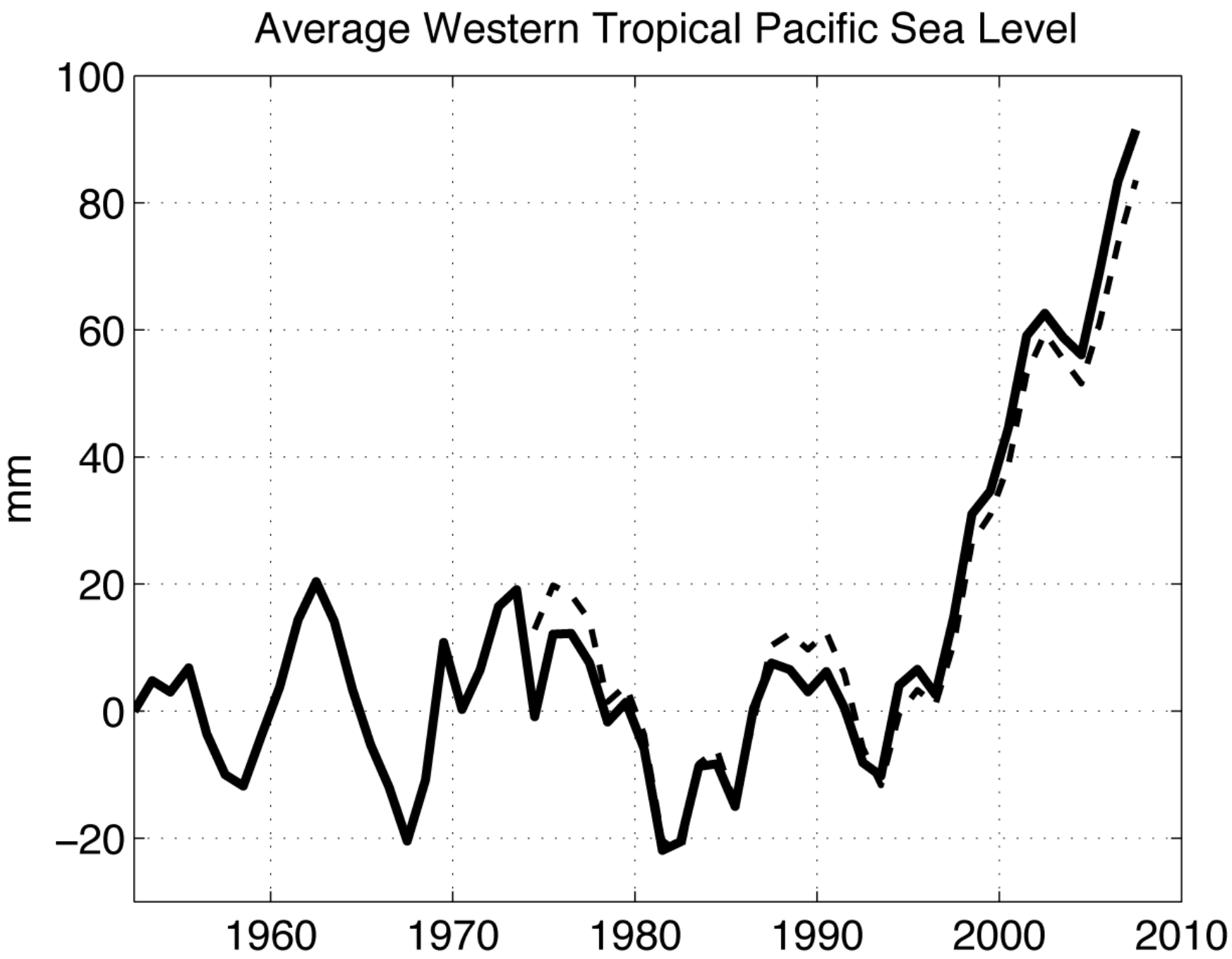
ENSO variability (Nino3, MEI, SOI) accounts for a small fraction of the observed trends

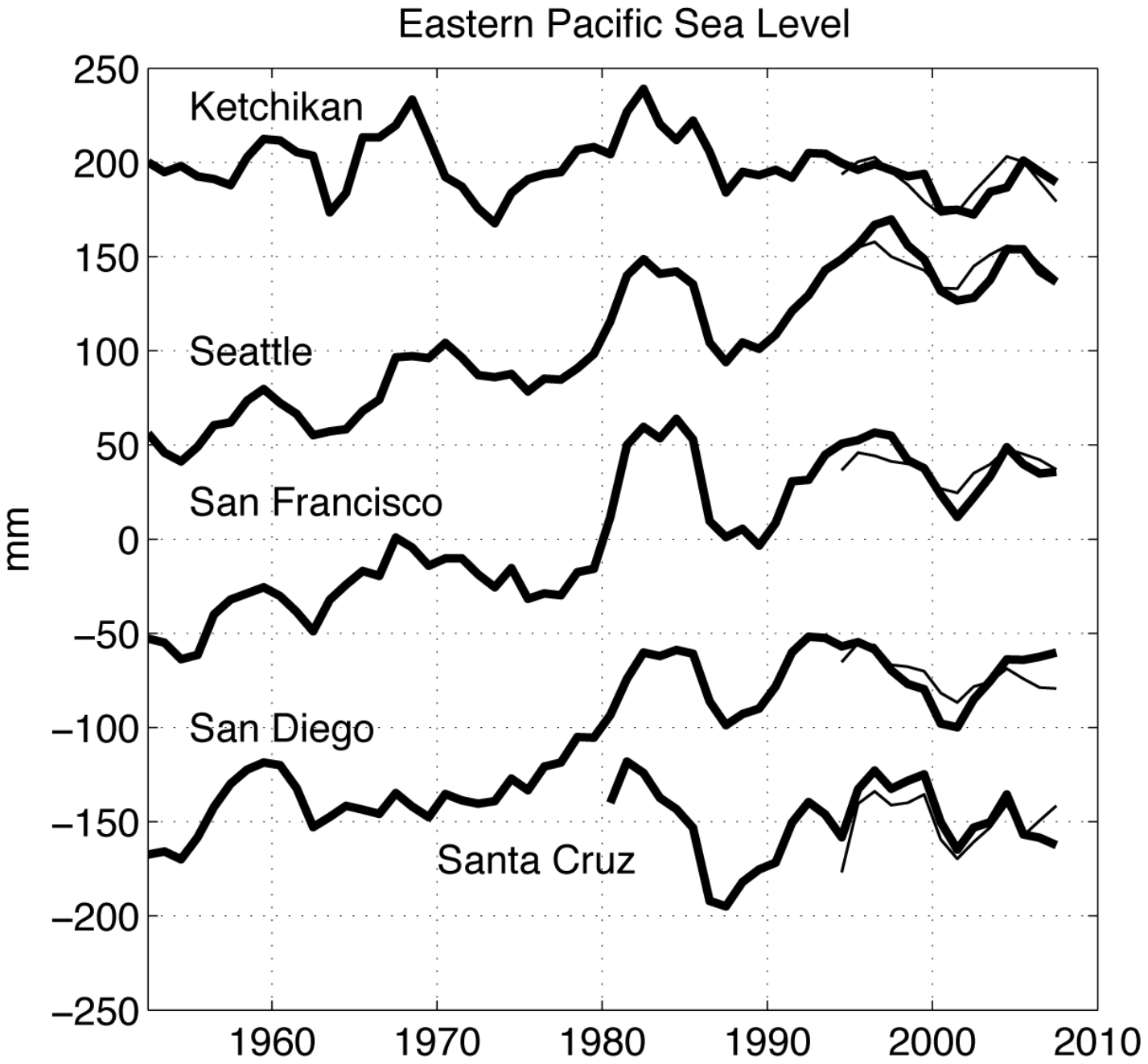
Tide gauge stations

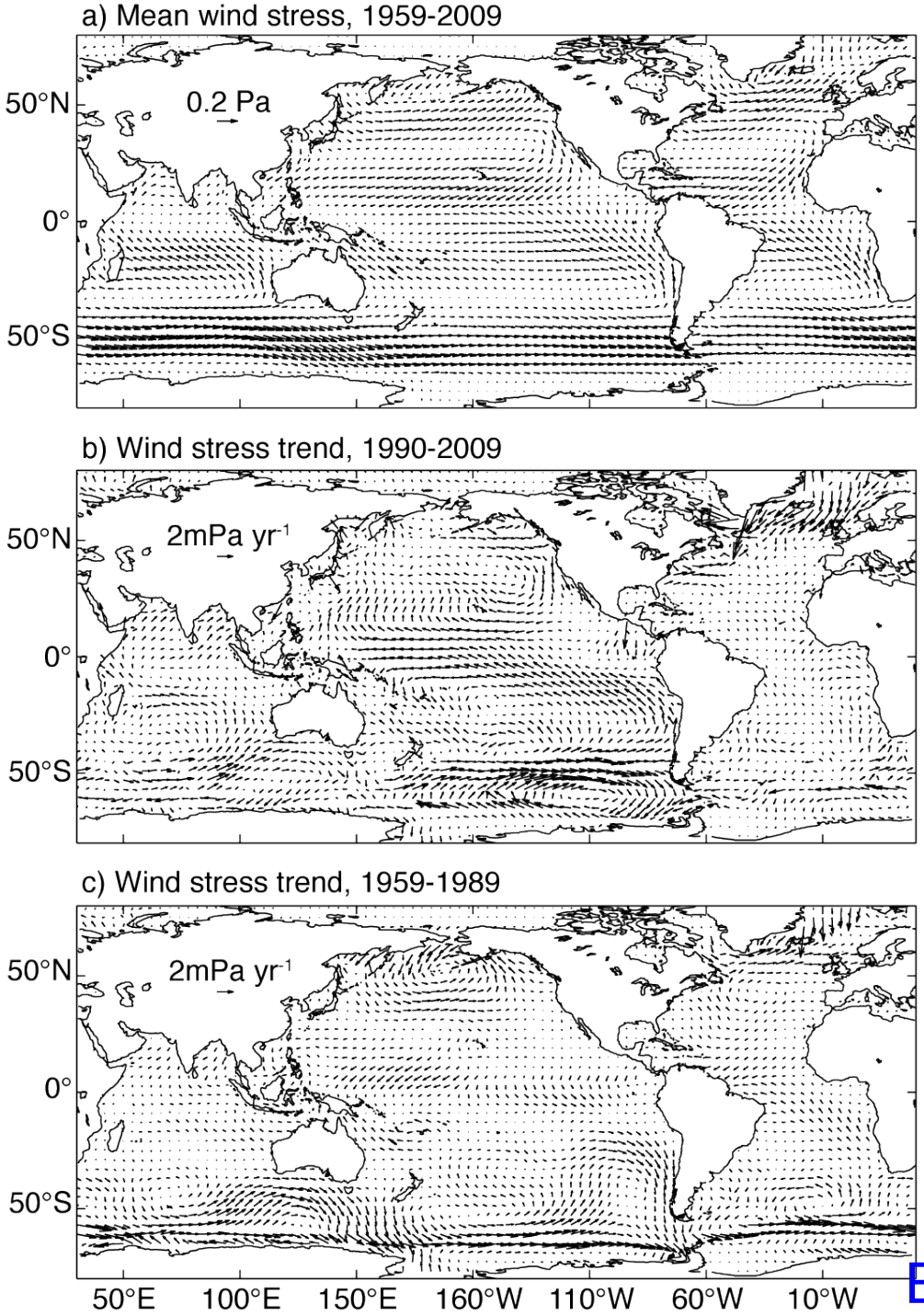



5–year running mean sea level
Guam
Kwajalein
mm
200
150
100
50
0
–50
1950
1960
1970
1980
1990
2000


Western Tropical Pacific Sea Level
600
400
200
0
−200
−400
−600
mm
Guam
Malakal
Pohnpei
Kwajalein
Majuro
Kapingamarangi
Nauru
Kanton
Honiara
Pago Pago
Suva
1960
1970
1980
1990
2000
2010

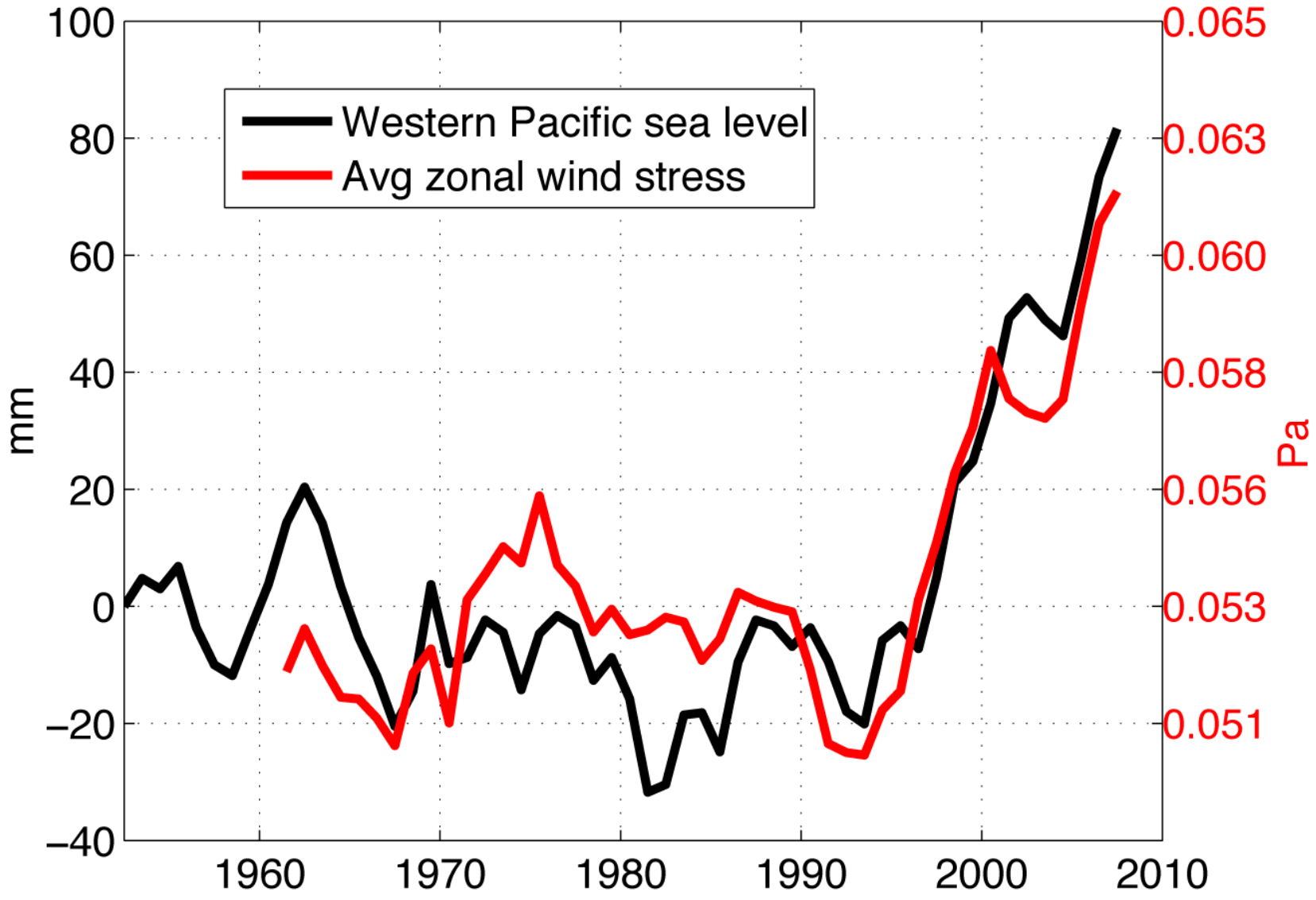

Average Western Tropical Pacific Sea Level
100
80
60
40
20
0
−20
mm
1960
1970
1980
1990
2000
2010


Eastern Pacific Sea Level
Ketchikan
Seattle
San Francisco
San Diego
Santa Cruz
mm
250
200
150
100
50
0
−50
−100
−150
−200
−250
1960
1970
1980
1990
2000
2010

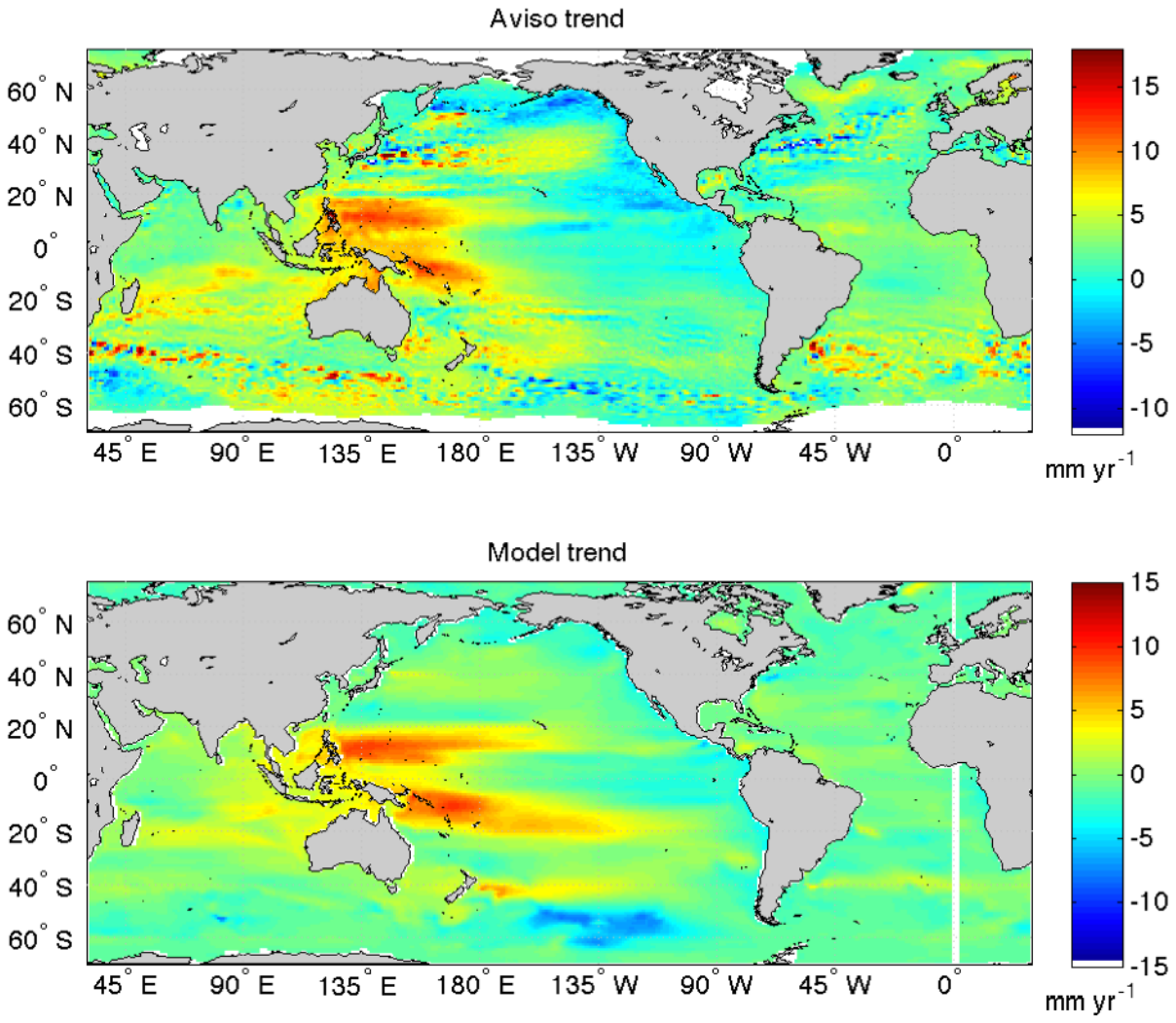

a) Mean wind stress, 1959-2009
0.2 Pa
50°N
0°
50°S
b) Wind stress trend, 1990-2009
2mPa yr-1
50°N
0°
50°S
c) Wind stress trend, 1959-1989
2mPa yr-1
50°N
0°
50°S
50°E
100°E
150°E
160°W
110°W
60°W
10°W

ECMWF ORA-S3

Western Pacific sea level and Trade Wind strength

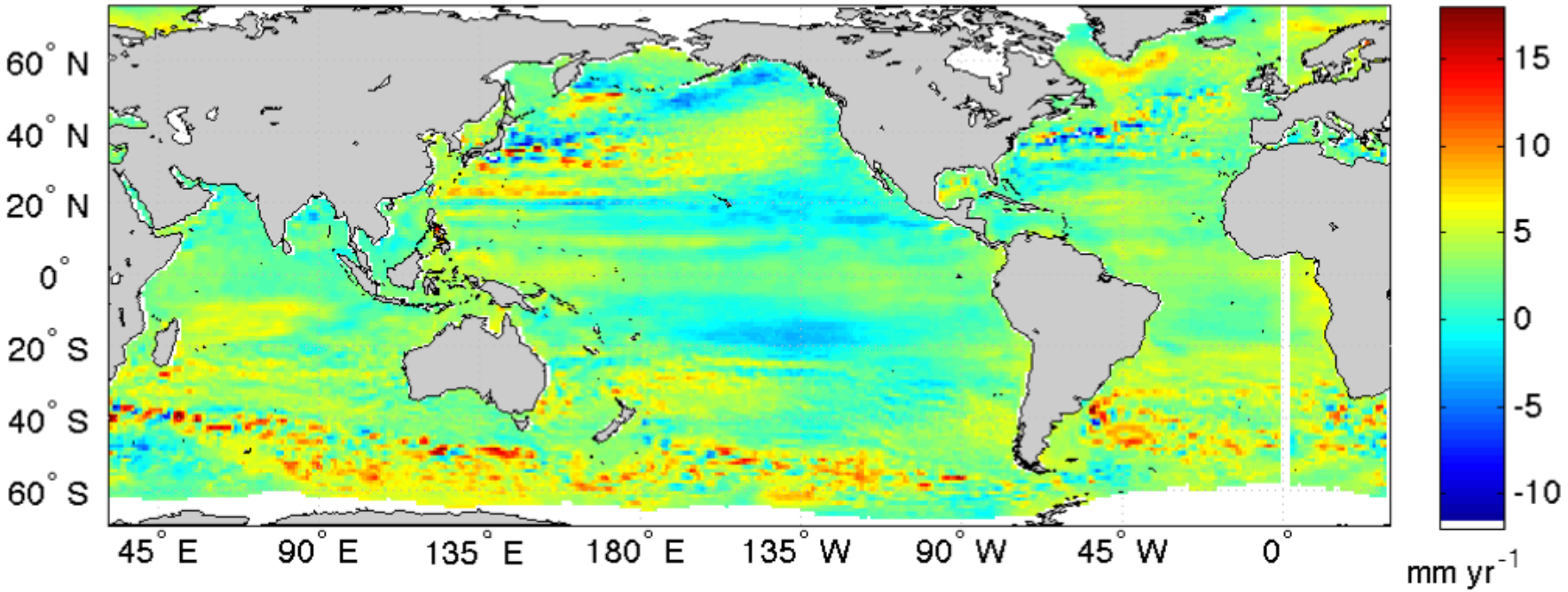


POP model simulation forced by wind stress trend pattern – Mat Maltrud (LANL)

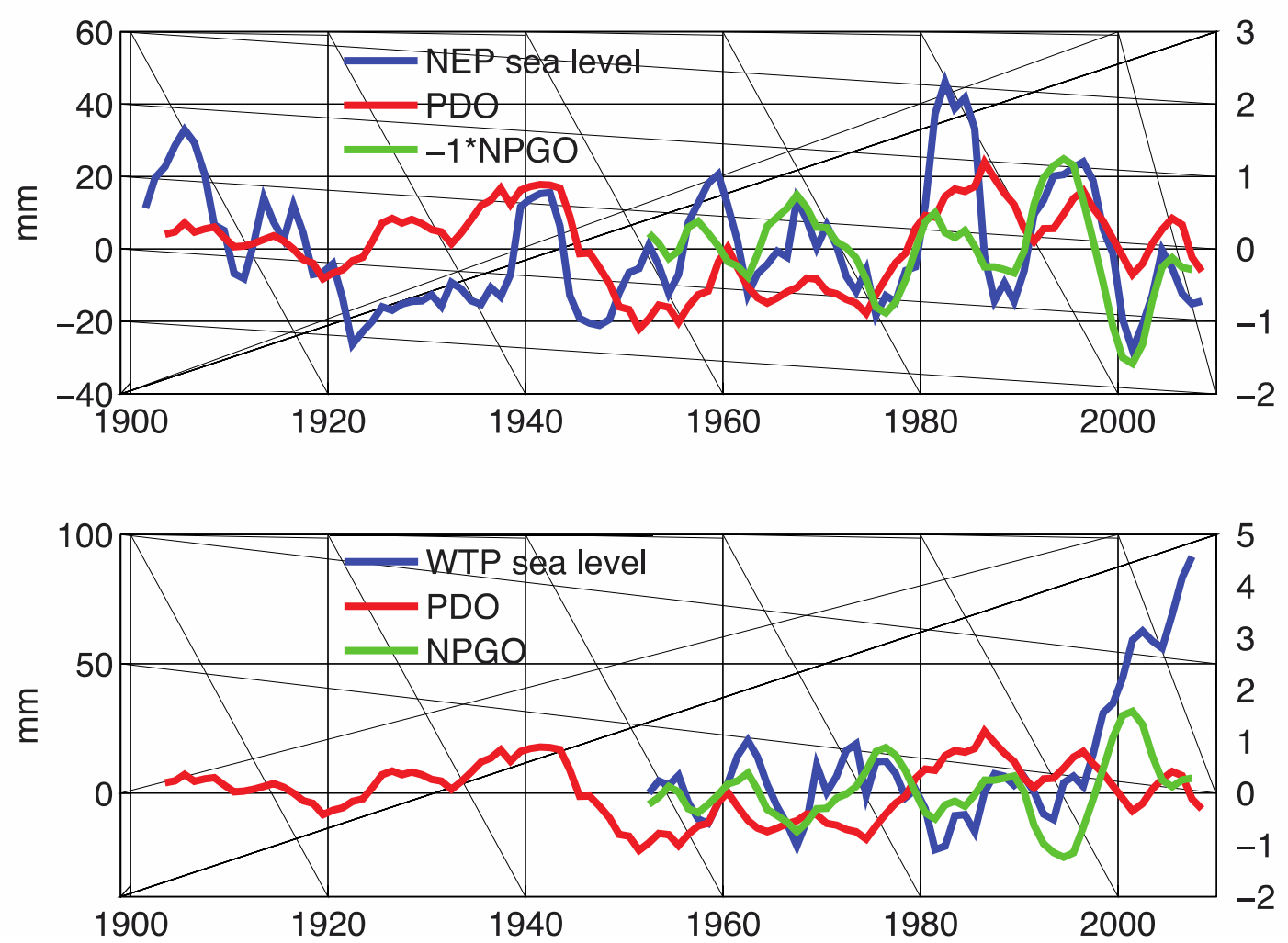


POP model simulation forced by wind stress trend pattern – Mat Maltrud (LANL)

Aviso – model trend

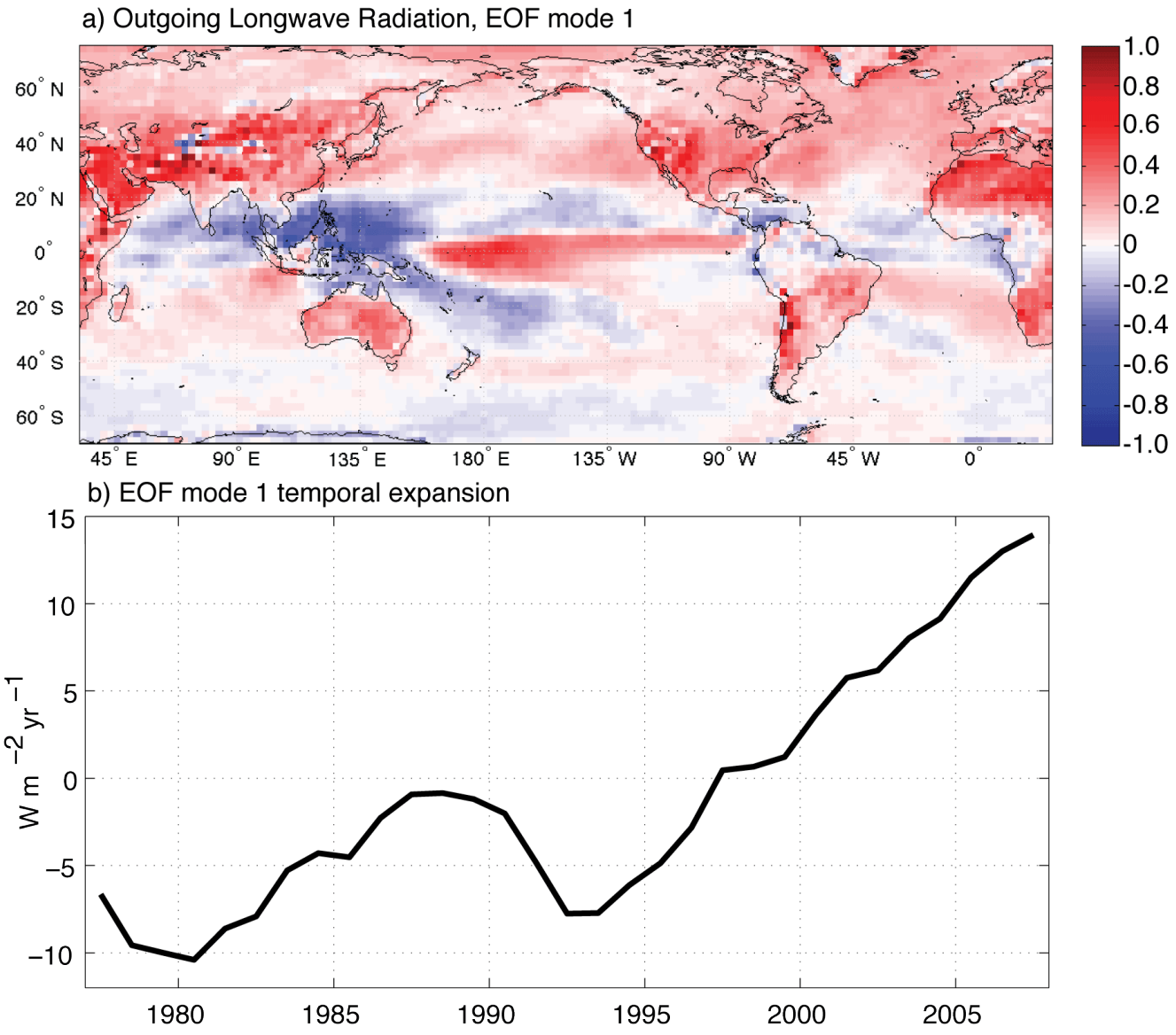


Regional Pacific sea level and climate indices



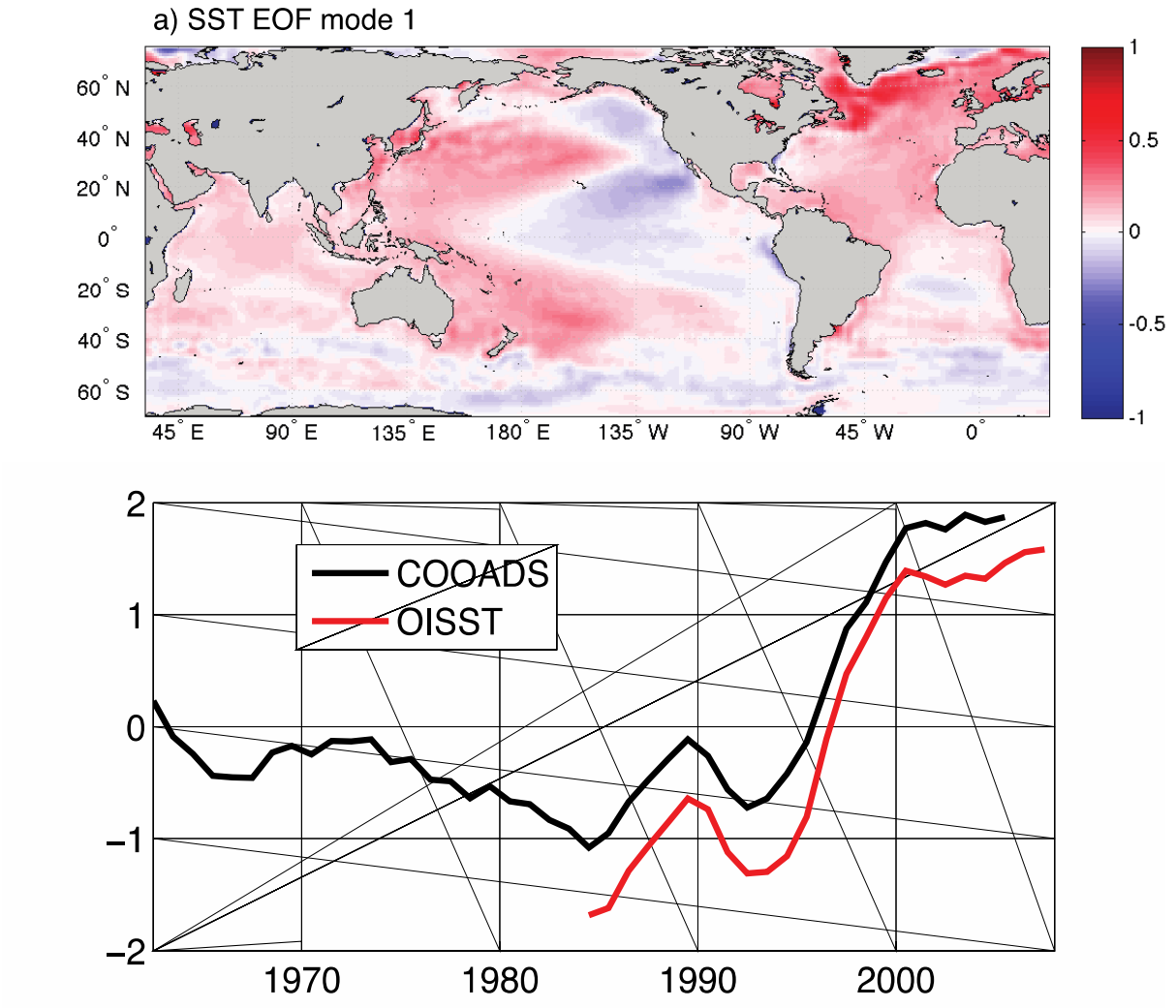
NPGO – North Pacific Gyre Oscillation, Di Lorenzo et al. (2008)

OLR EOF Mode 1 (43.7% of variance)

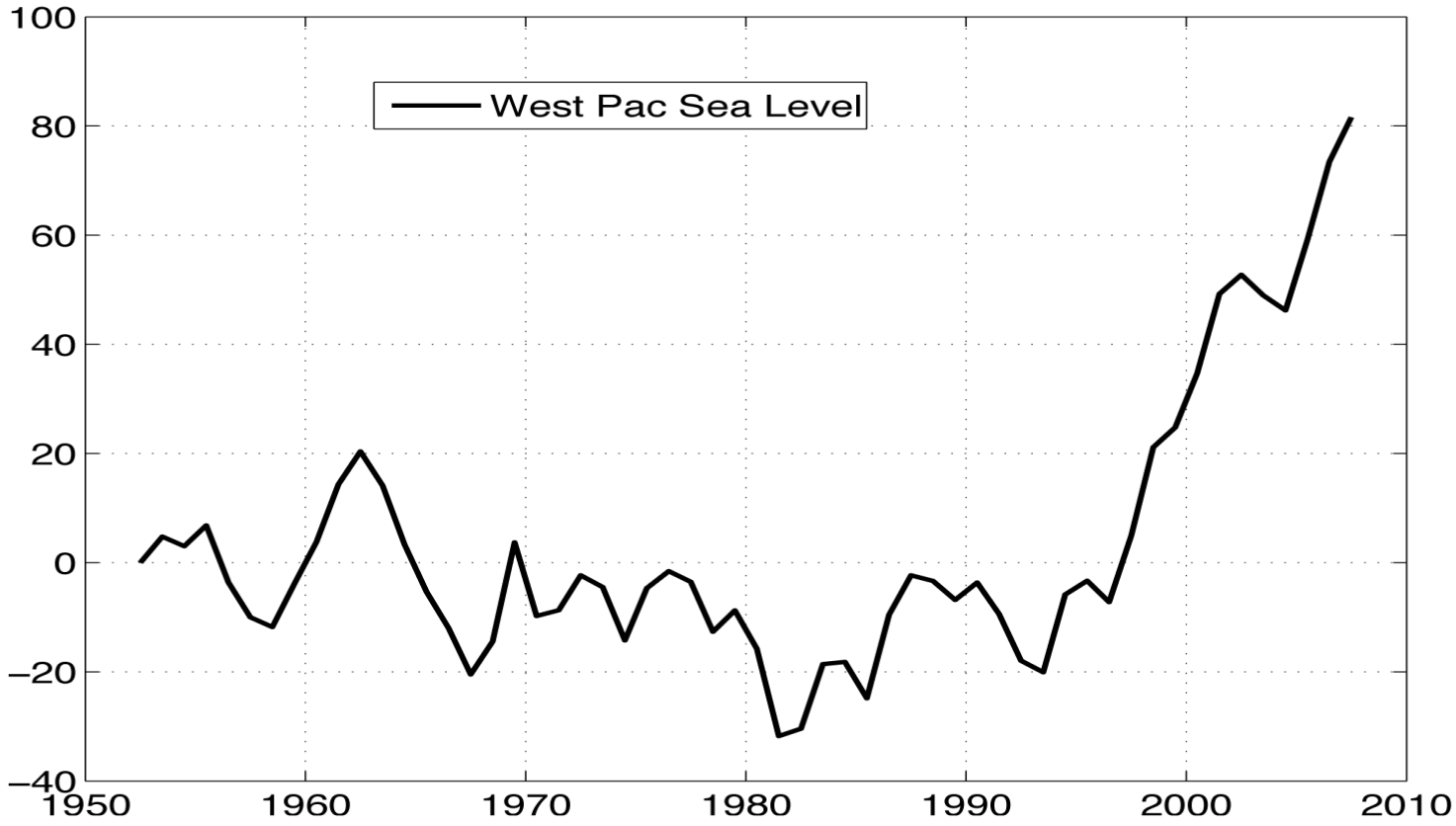


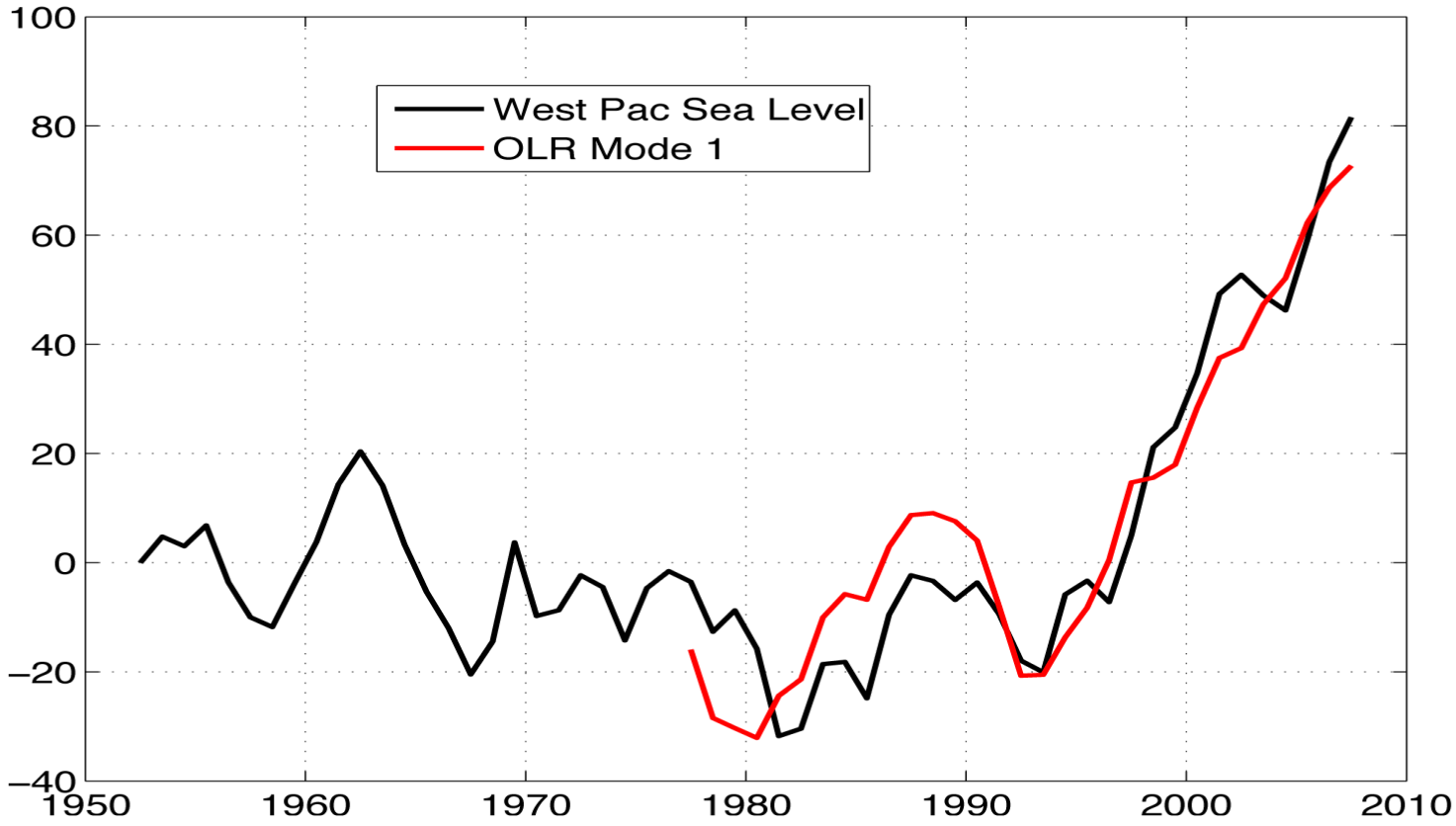
Interpolated OLR, NOAA/OAR/ESRL PS

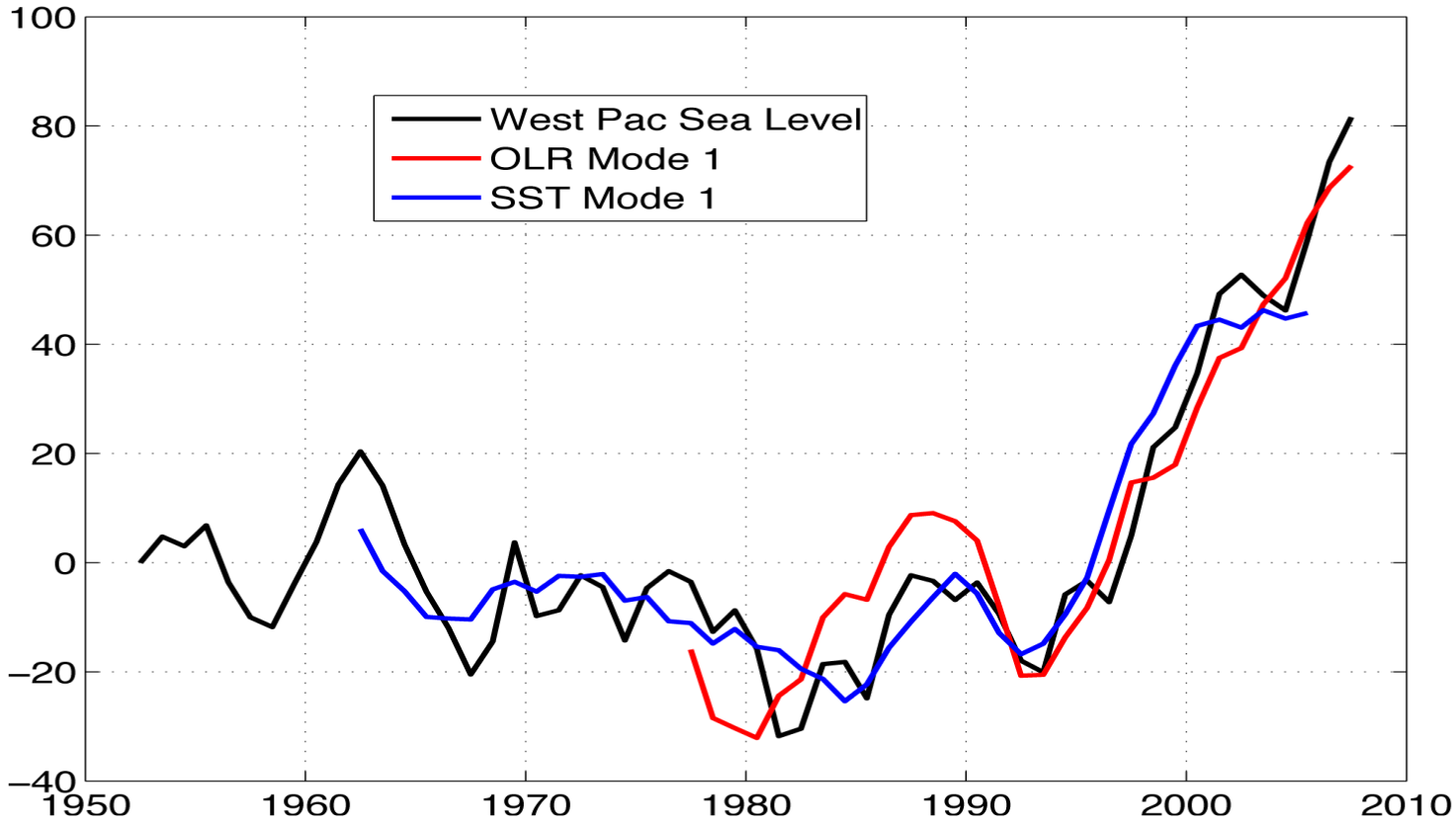
SST EOF mode 1 (50.5% of variance)

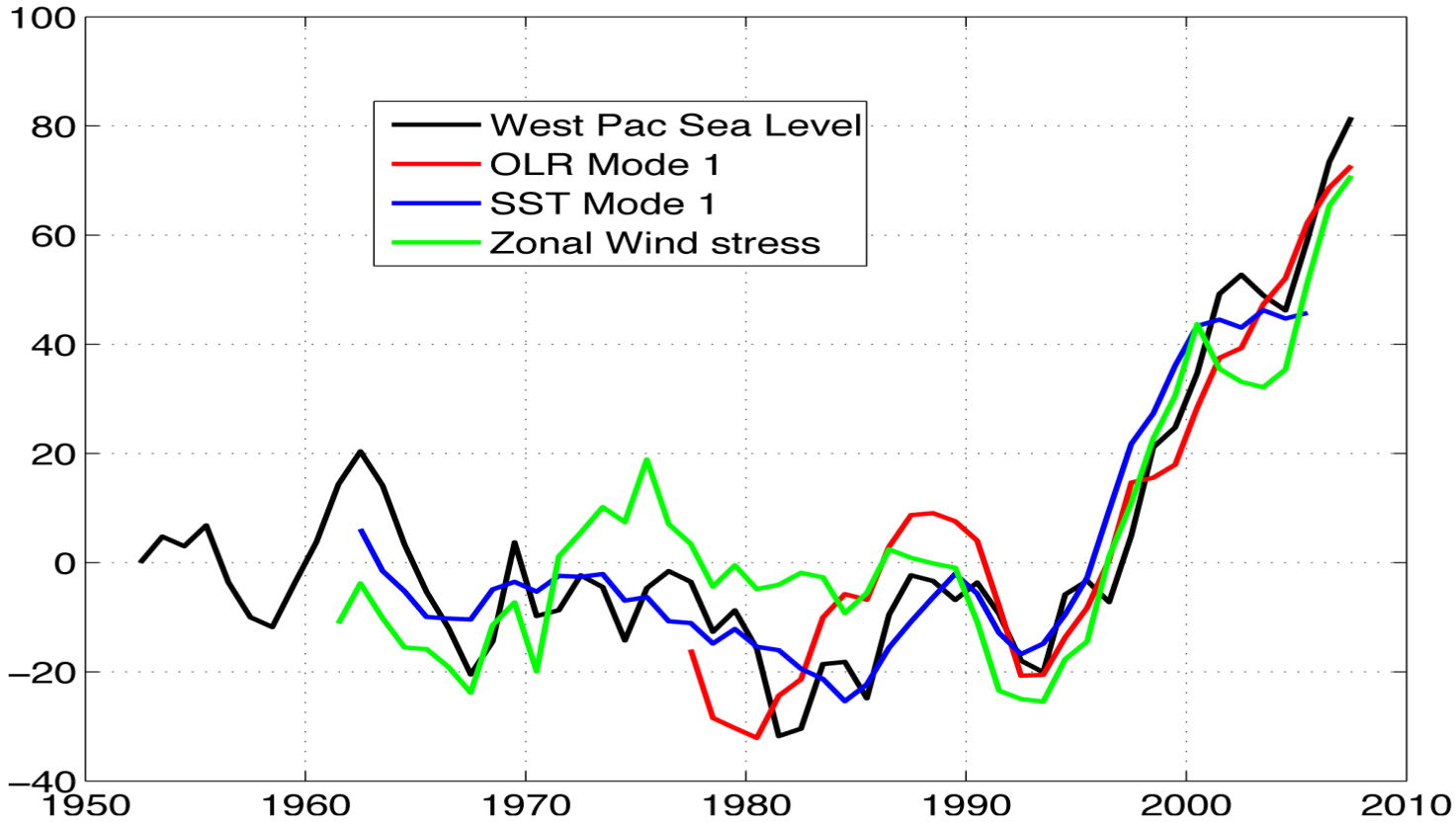


NOAA Optimum Interpolation SST


West Pac Sea Level
100
80
60
40
20
0
−20
−40
1950
1960
1970
1980
1990
2000
2010


West Pac Sea Level
OLR Mode 1
100
80
60
40
20
0
−20
−40
1950
1960
1970
1980
1990
2000
2010


West Pac Sea Level
OLR Mode 1
SST Mode 1
100
80
60
40
20
0
−20
−40
1950
1960
1970
1980
1990
2000
2010


West Pac Sea Level
OLR Mode 1
SST Mode 1
Zonal Wind stress
100
80
60
40
20
0
−20
−40
1950
1960
1970
1980
1990
2000
2010

Conclusions

- Since the early 1990s, sea-level trends have
  - increased in the western tropical Pacific as a result of a multidecadal increase in Trade wind strength
  - weakened or decreased in the Northeast Pacific, indistinguishable from decadal oscillations, but may be connected with Trade wind pattern
- Global measures of warming (OLR, SST) have tracked the increase in Trade winds
- Hypothesis: Warming trends have led to more vigorous Pacific Trades winds via a spin-up of the Hadley circulation (increased latent heat, deep convection, and surface winds)
- Future work: Why the change in the early 1990s? Model validation of Hadley circulation hypothesis.

Questions ?

A Shift in Western Tropical Pacific Sea Level Trends during the 1990s
M. A. Merrifield, Journal of climate 2011