ENSO, global mean sea level, global water cycle and north Pacific ocean mass

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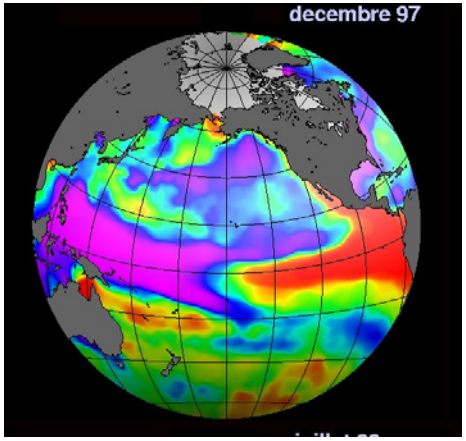
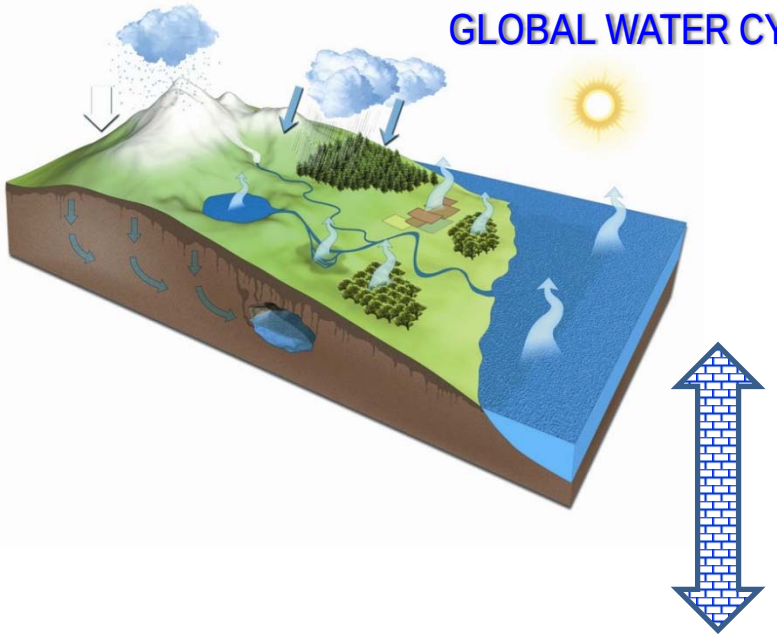
3. University of Cayenne, Guyane

OSTST, Oct. 2011

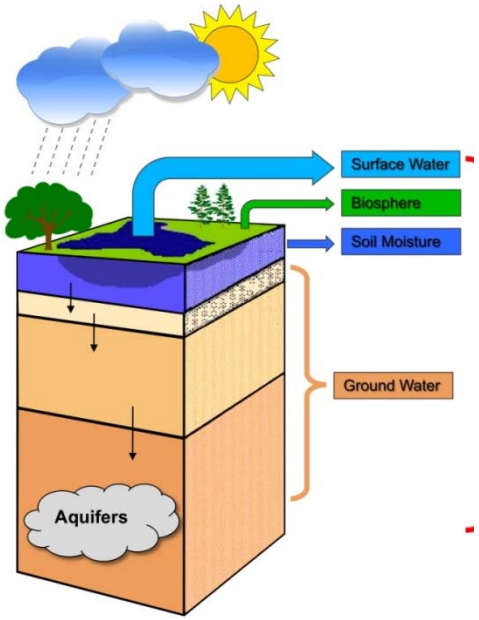
ENSO



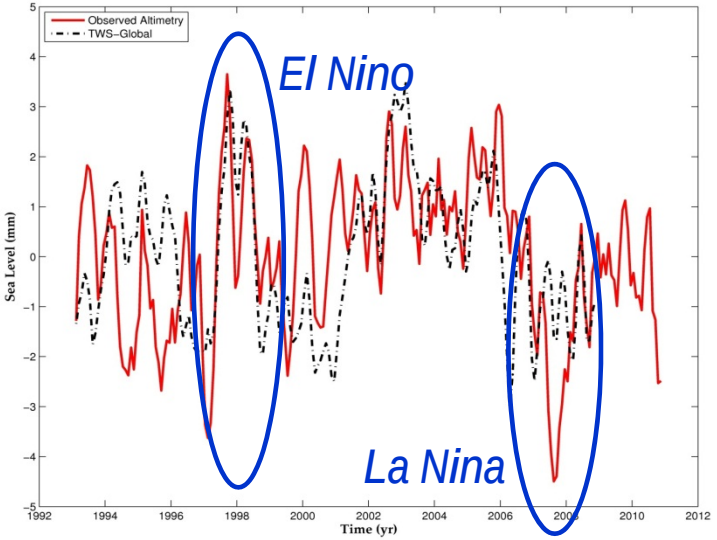
GLOBAL WATER CYCLE

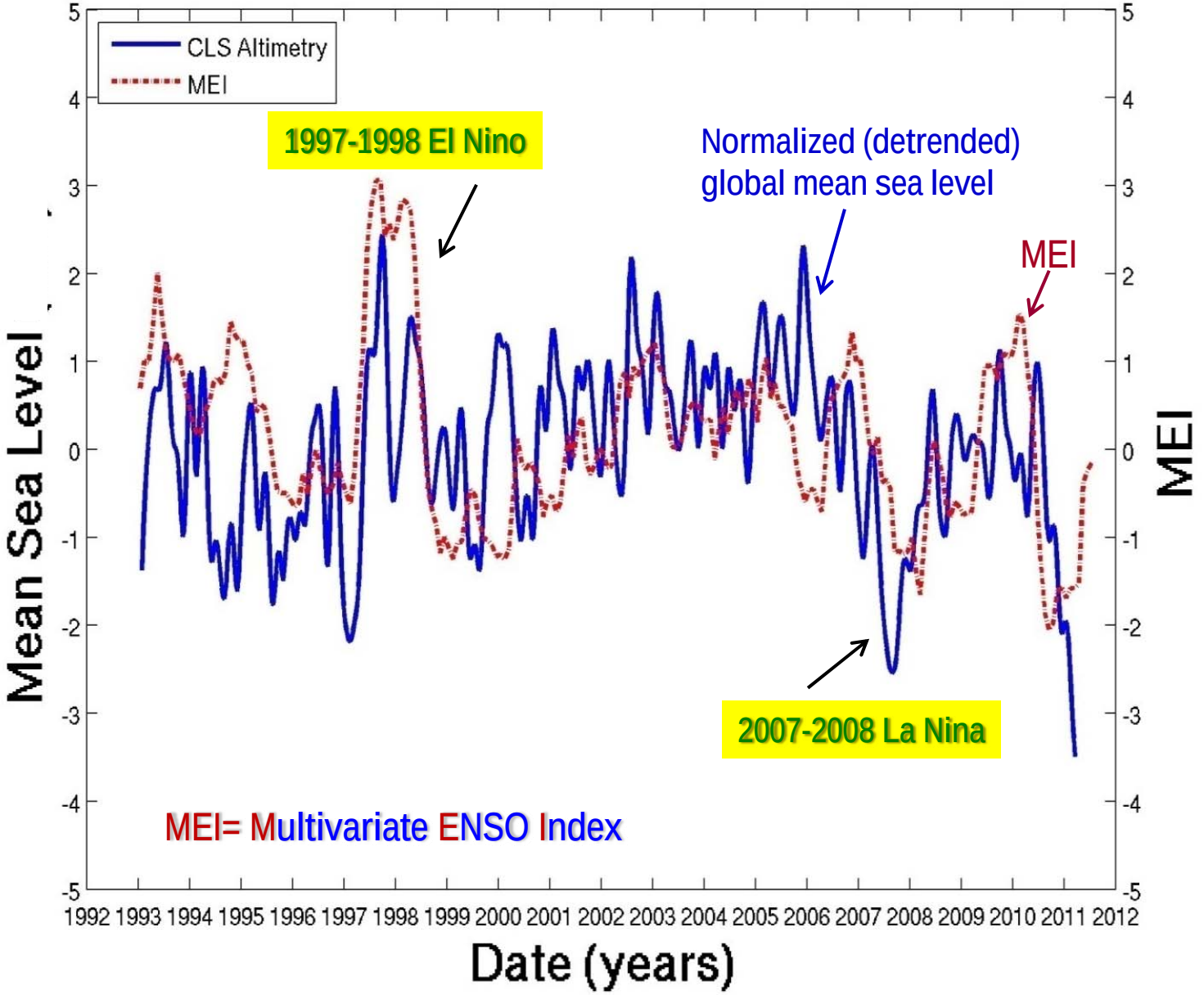


Land water storage



Global mean sea level



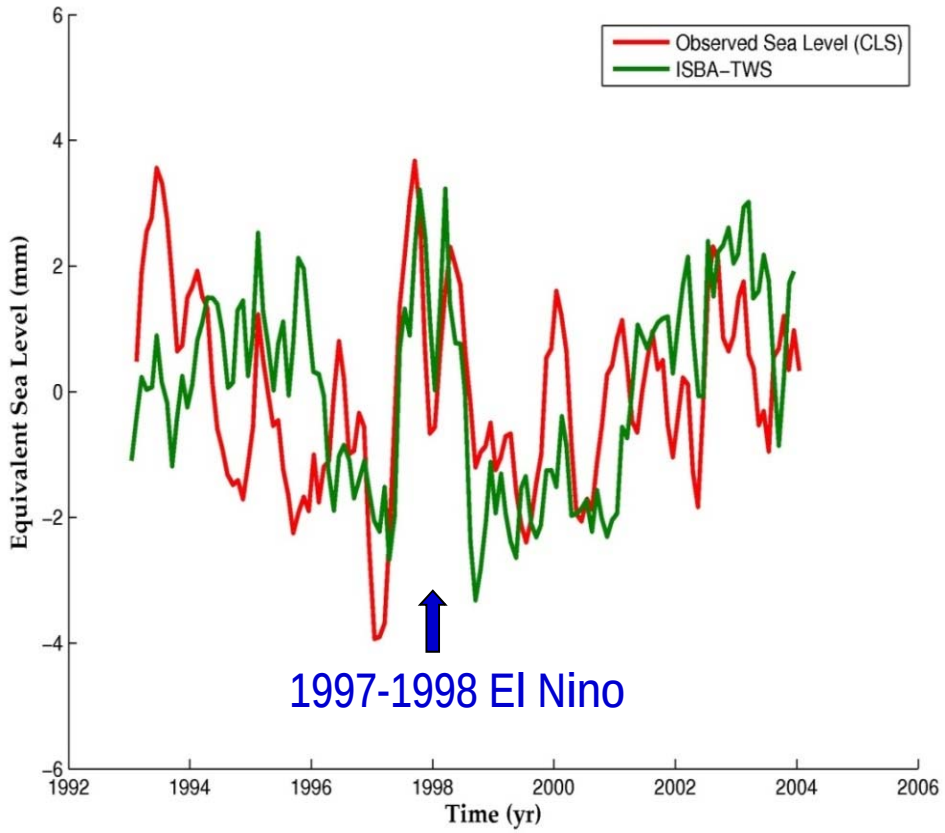


e.g., Nerem et al., 2010

Interannual global mean sea level

Global land water storage (based on the MeteoFrance hydrological model) *

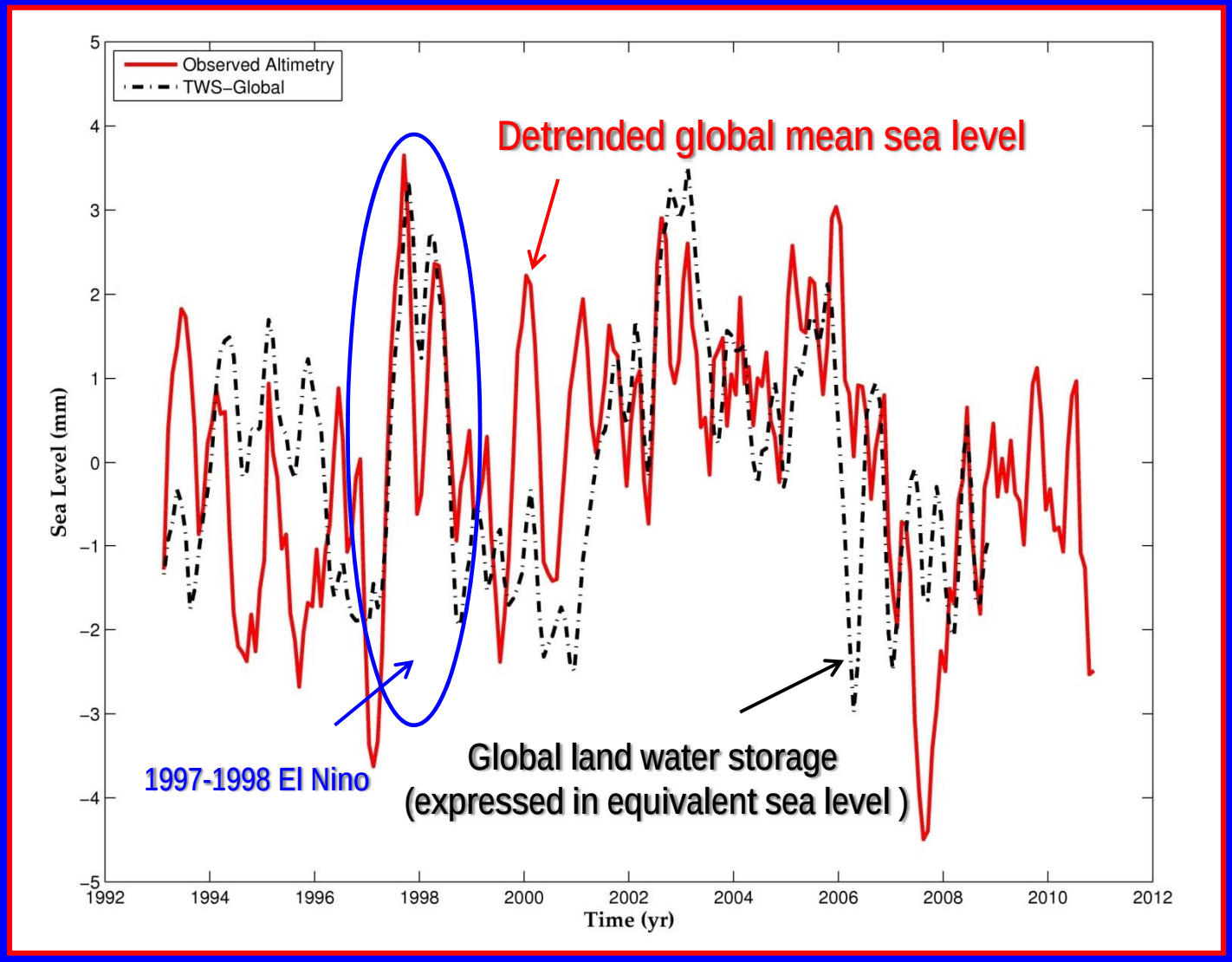
Detrended global mean sea level



Llovel et al., 2011

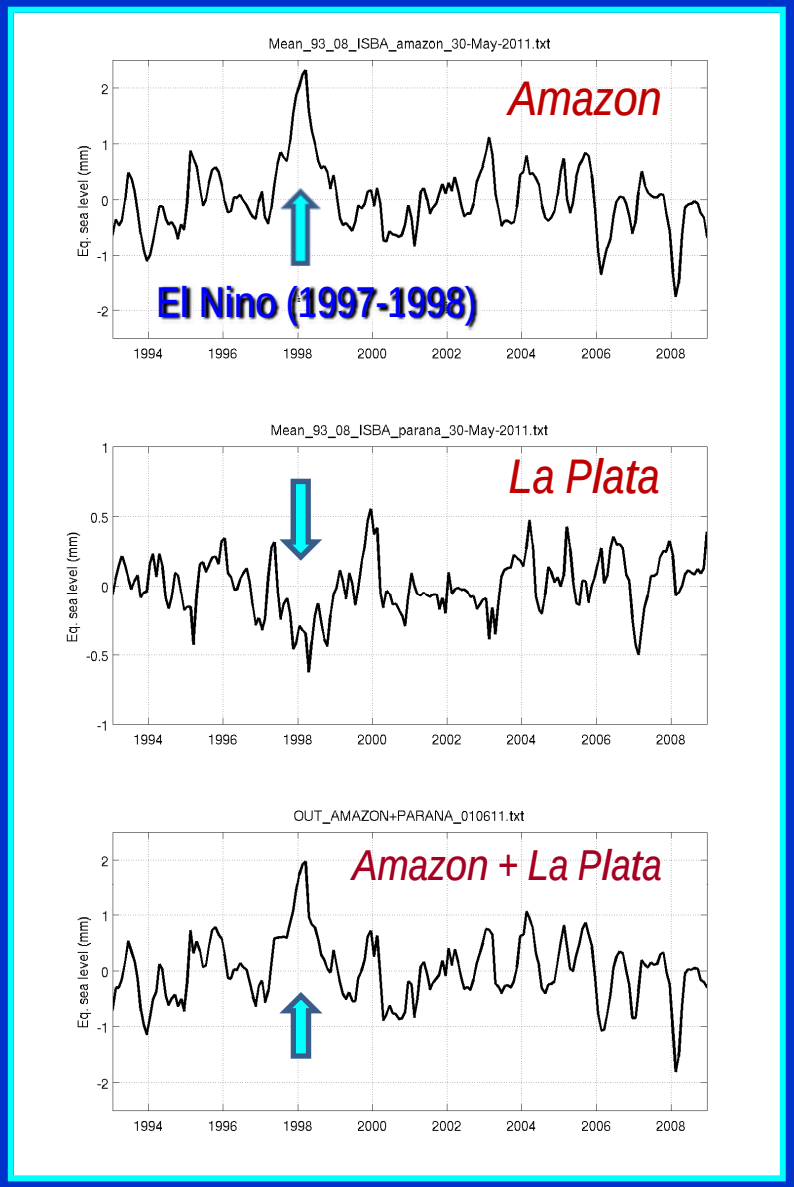
* Expressed in equivalent sea level

Detrended global mean sea level and total land water storage (based on the MeteoFrance hydrological model)



Update of Llovel et al. (2011)' study

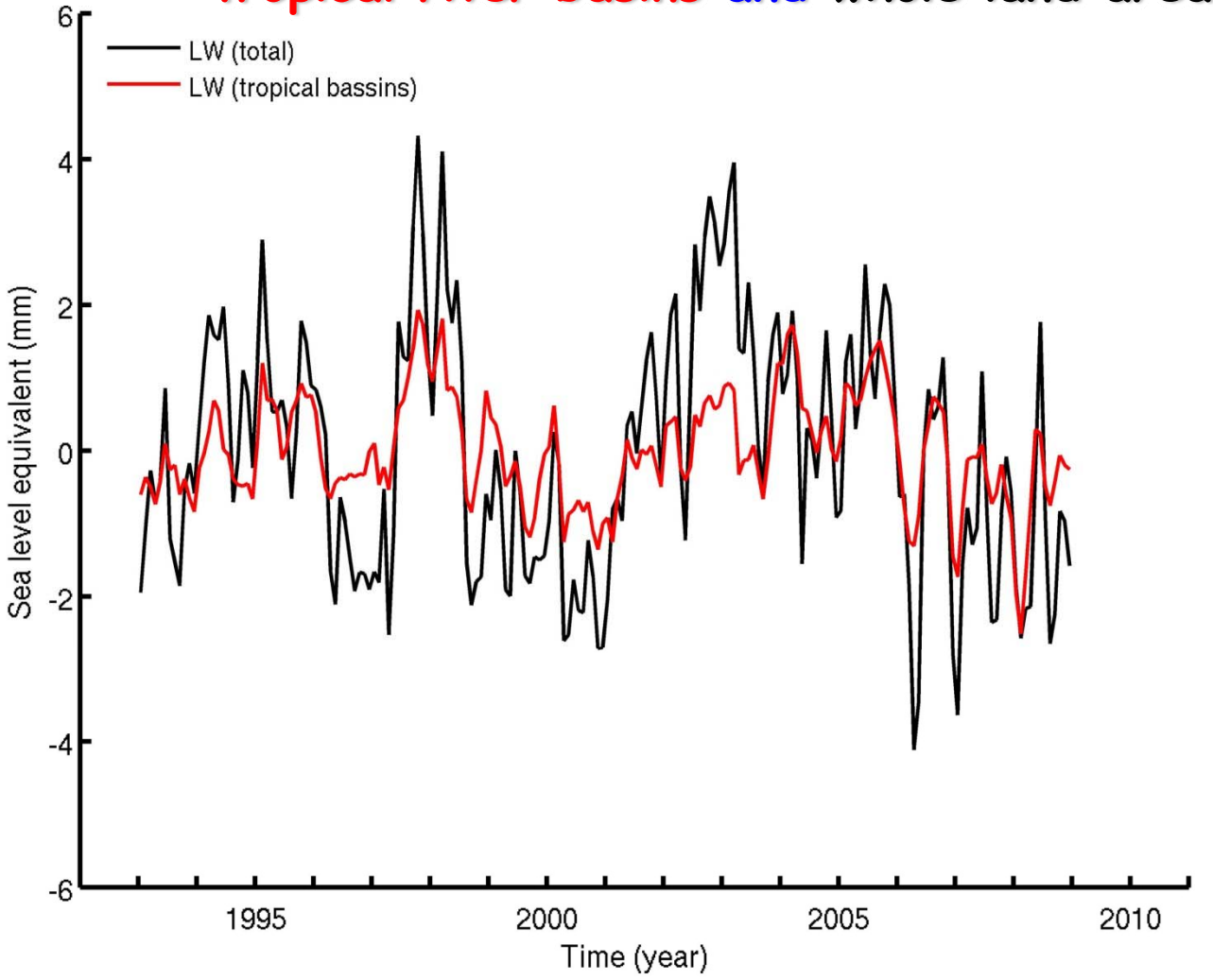
Land water storage change (mm ESL)



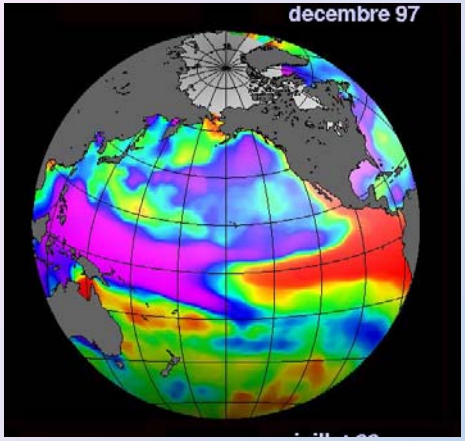
Contribution to sea level of total water storage change in the Amazon and La Plata basins (and sum of both)

Expressed in equivalent sea level (ESL) (mm)

Contributions to sea level of tropical river basins and whole land area



Expressed in equivalent sea level

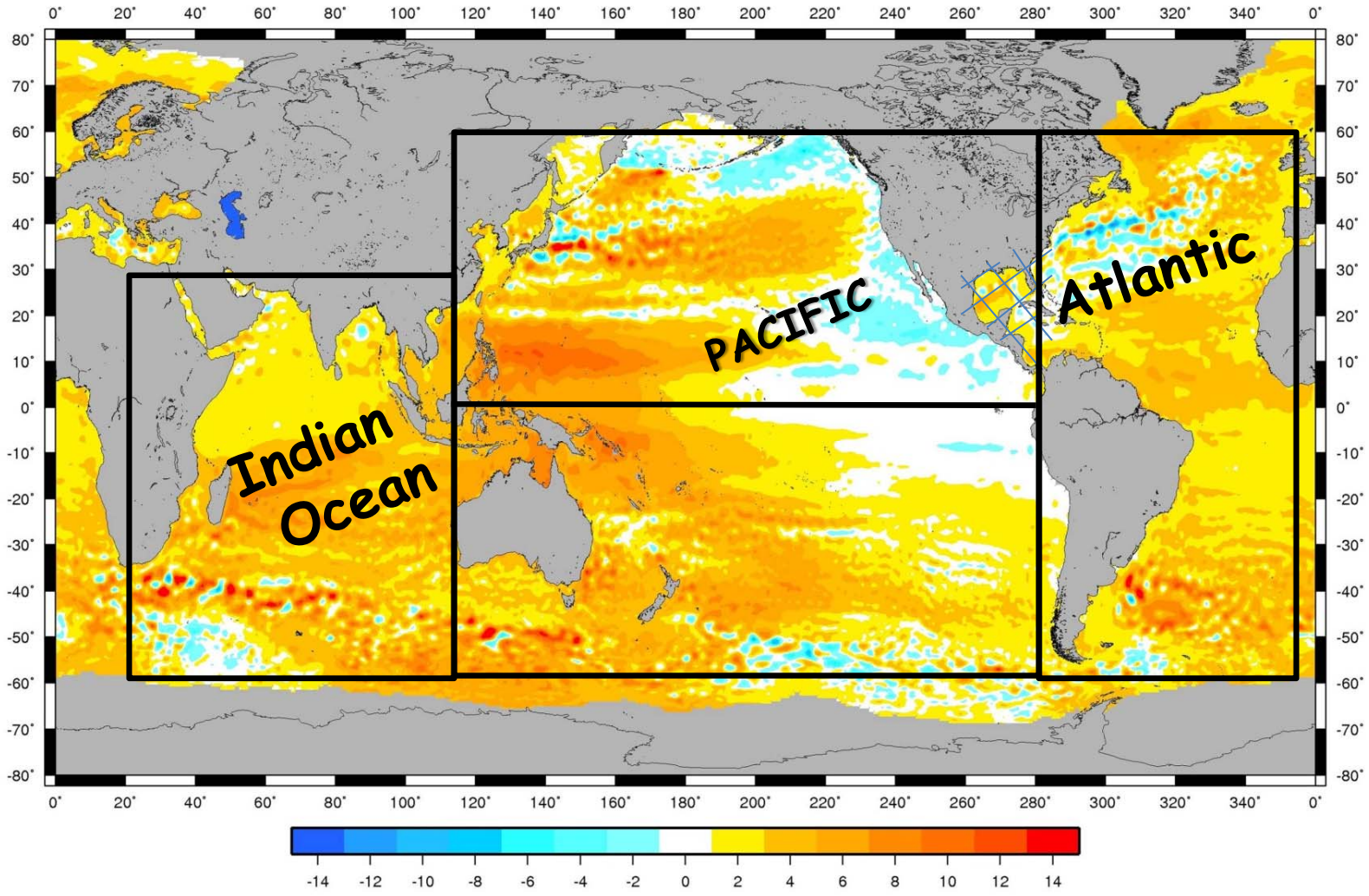


El Nino → More rain over oceans
Less rain over land

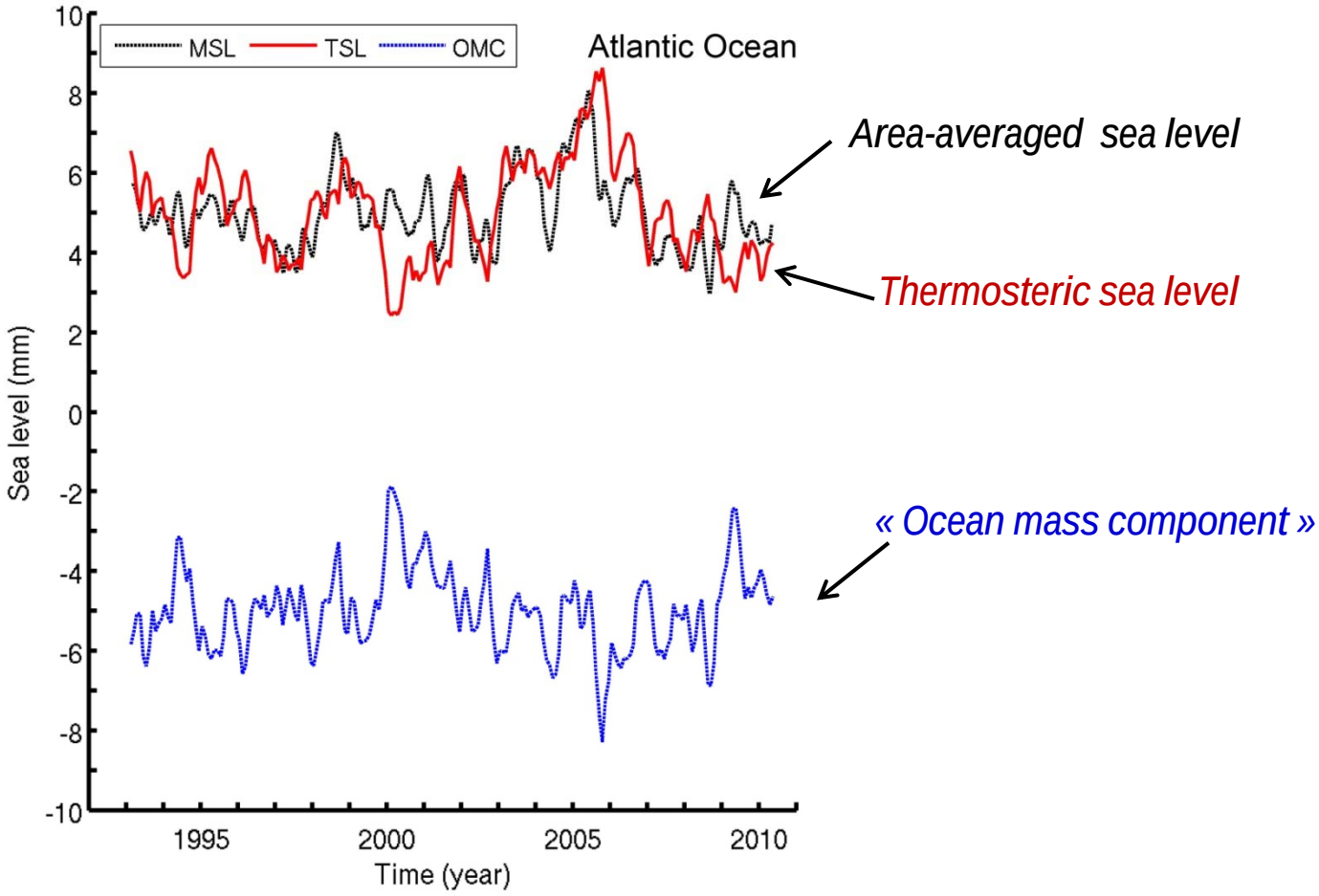
(e.g., Gu & Adler 2011)

Which ocean basin is responsible for the positive (negative) anomaly seen in the global mean sea level during El Nino (La Nina)?

Area-averaging of altimetry-based sea level data

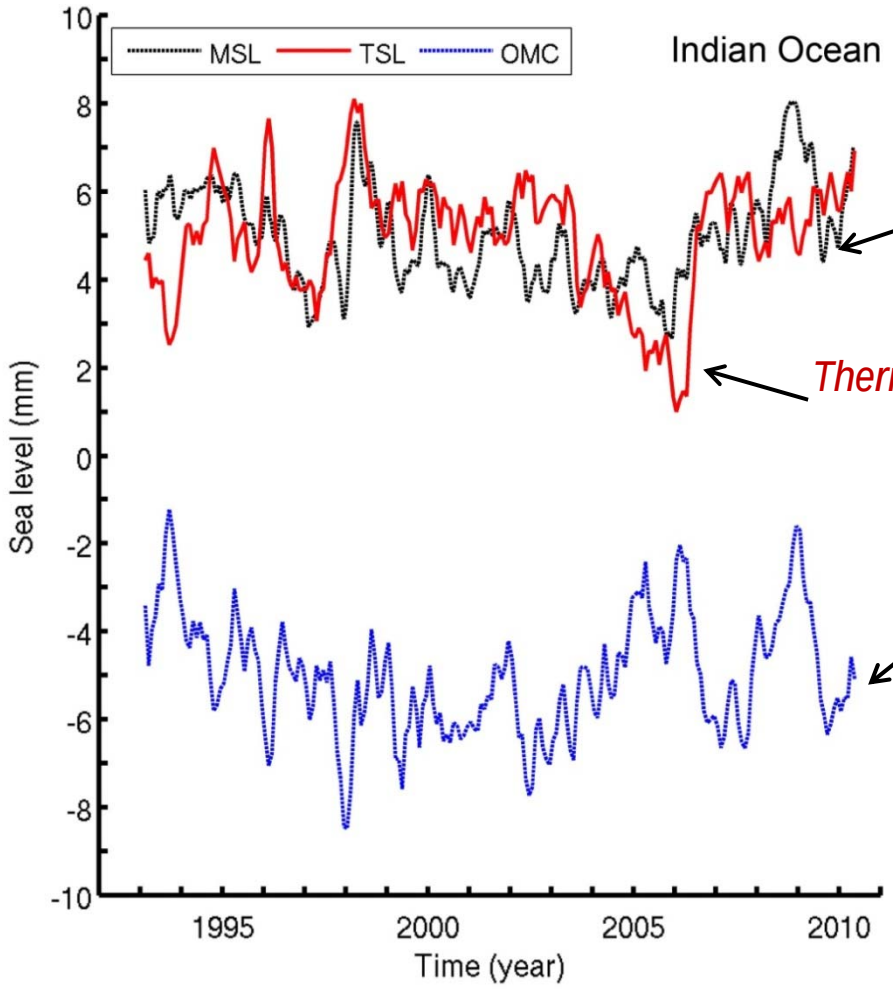


Atlantic Ocean



Weighting by the ratio of the averaging area to the total ocean surface

Indian Ocean



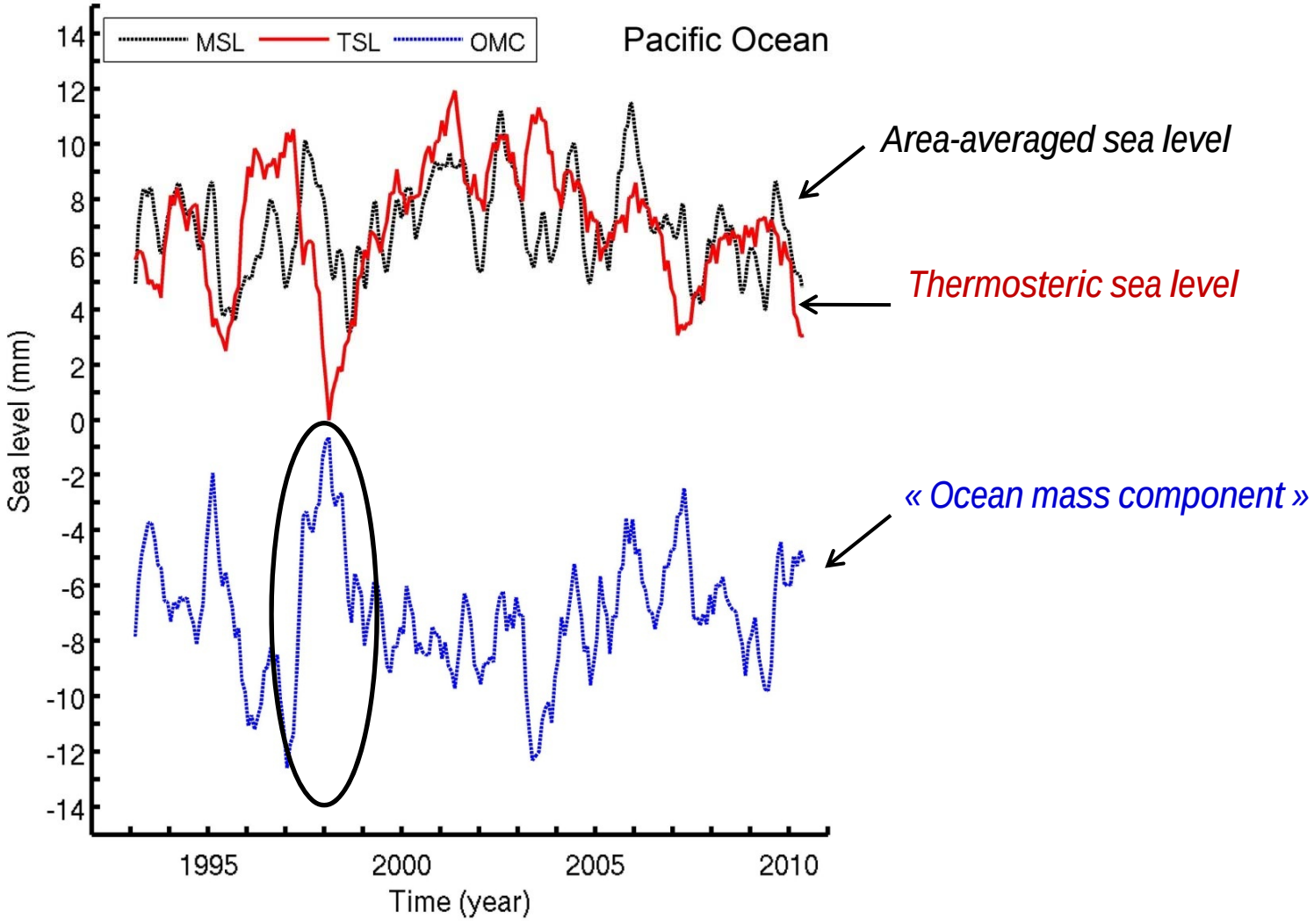
Area-averaged sea level

Thermosteric sea level

« Ocean mass component »

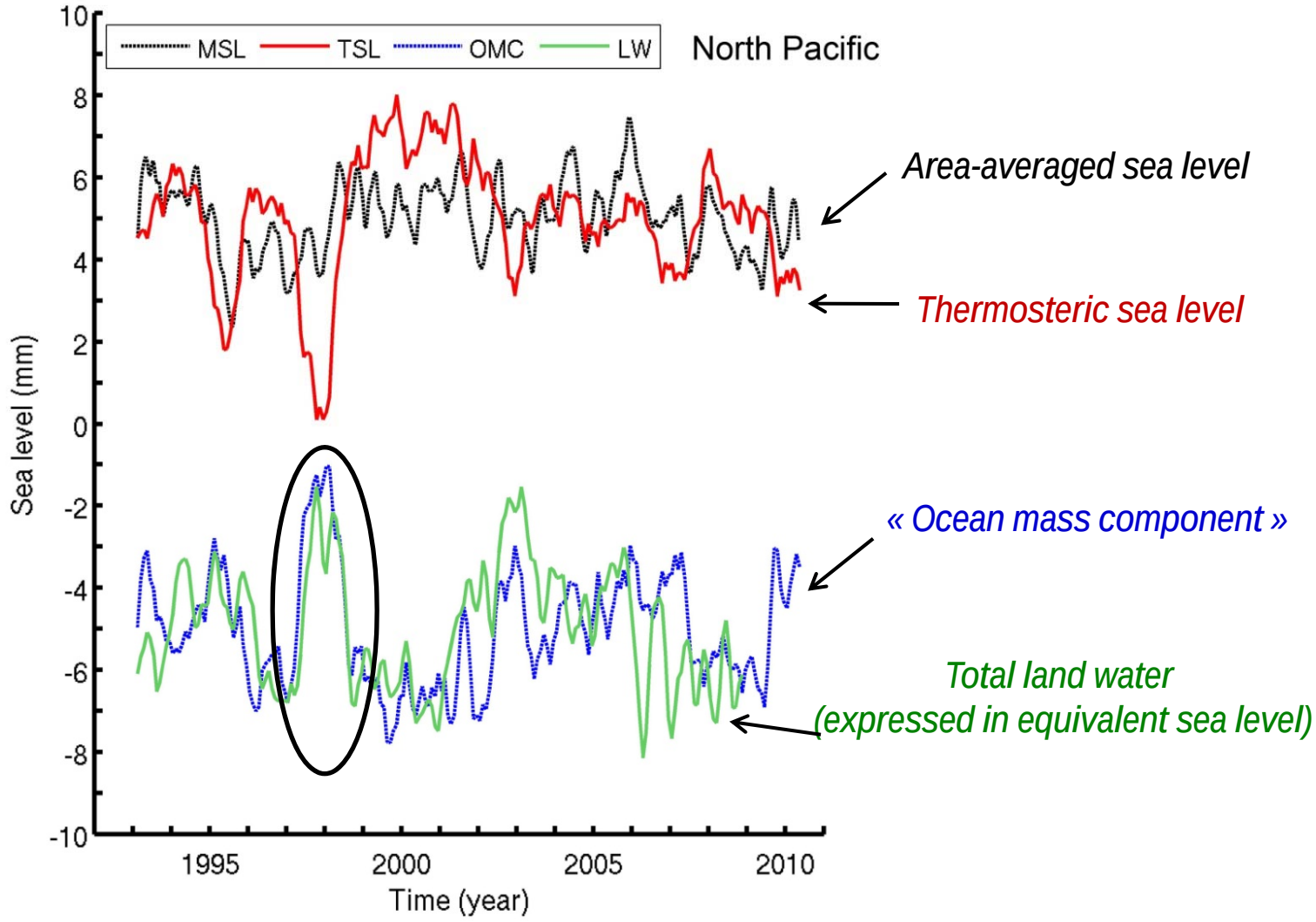
Weighting by the ratio of the averaging area to the total ocean surface

Pacific Ocean



Weighting by the ratio of the averaging area to the total ocean surface

North Pacific Ocean



Weighting by the ratio of the averaging area to the total ocean surface

North Pacific water budget

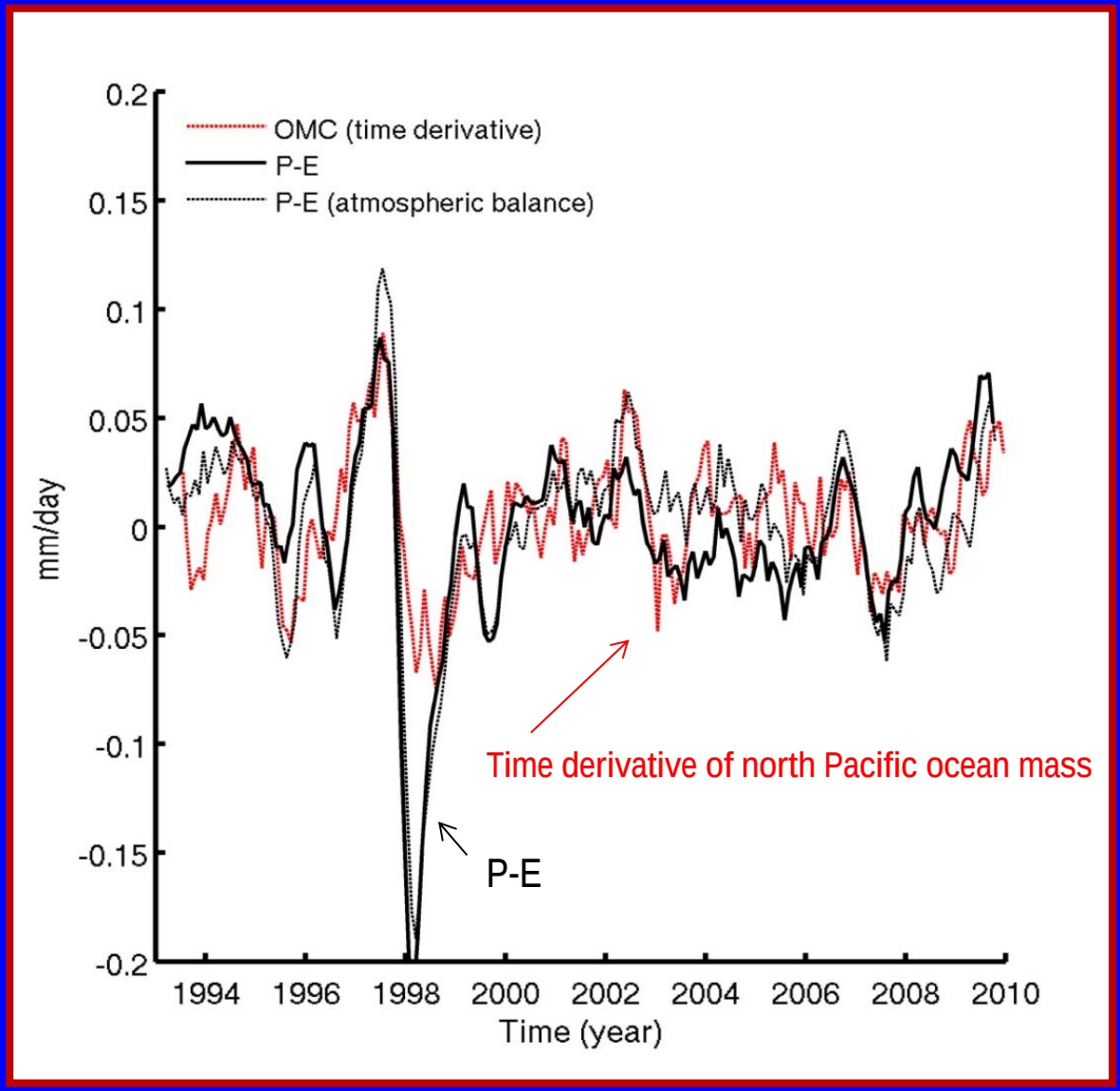
- $dW_{nP}/dt = P-E+R$ oceanic water balance

- $P-E = -(dP_{water}/dt + divQ)$ atmospheric water balance

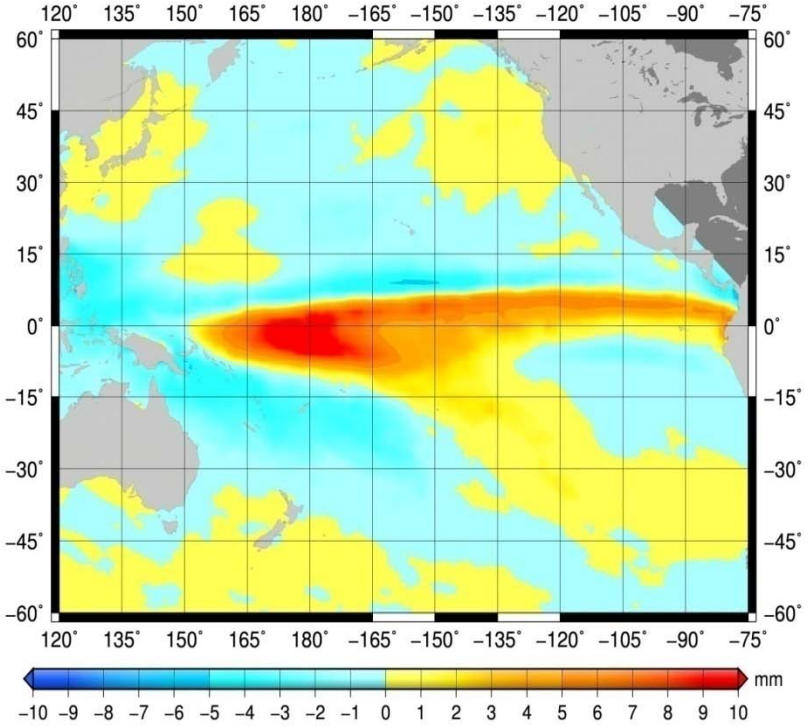
W_{nP} : north Pacific ocean mass
P : precipitation, E : evaporation; R : runoff
P_{water} : precipitable water
divQ : moisture flux divergence

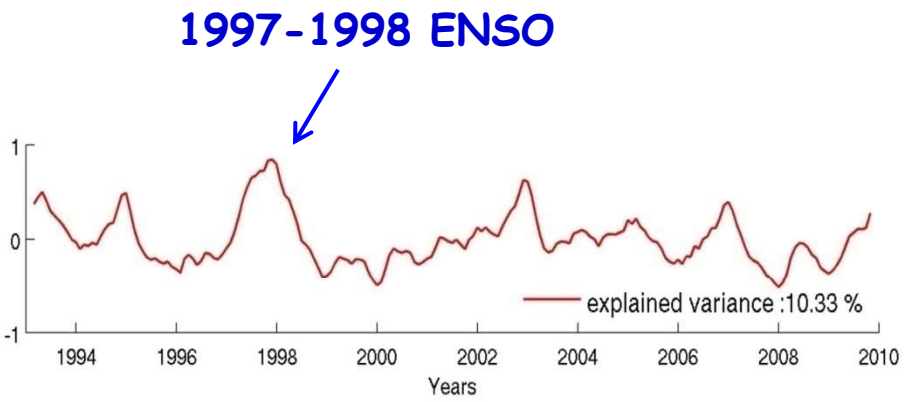
Data from ERA-Interim

Time derivative of the North Pacific ocean mass and P-E



1st mode of the P-E
EOF decomposition over the Pacific



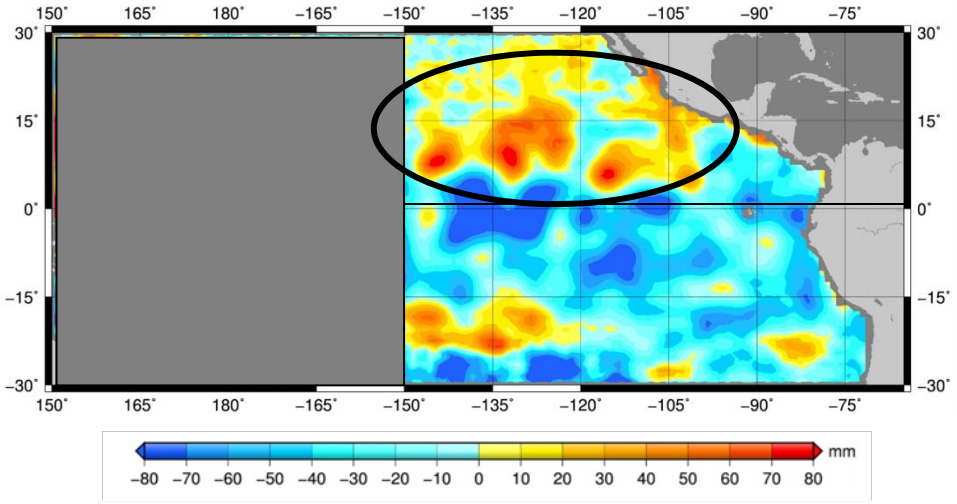


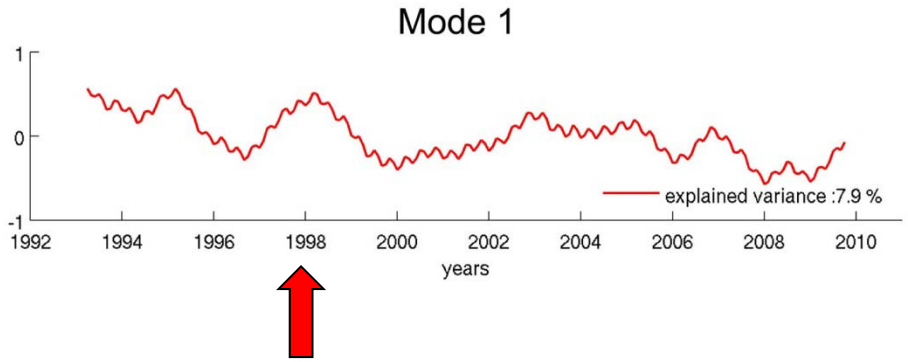
Conclusions

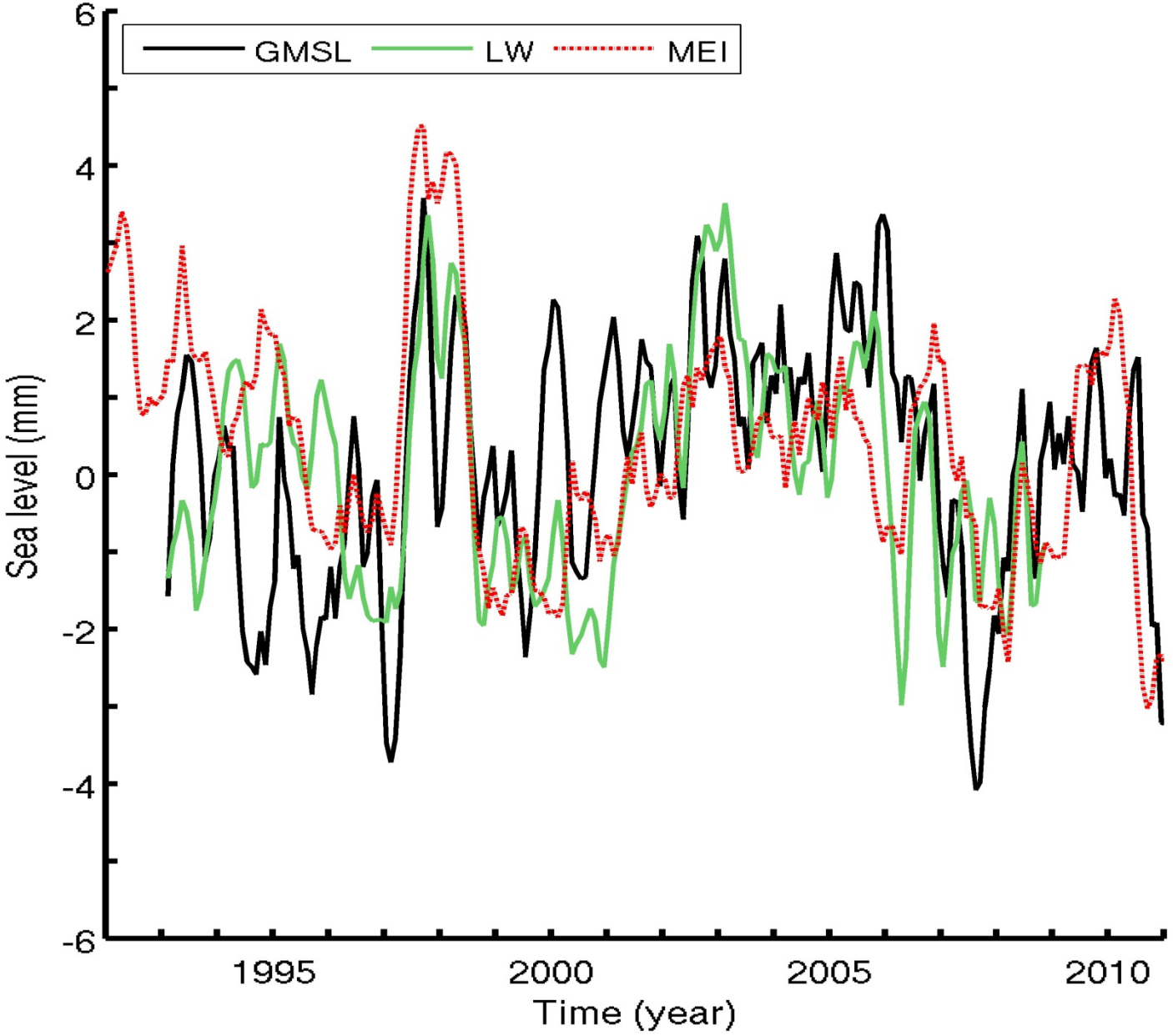
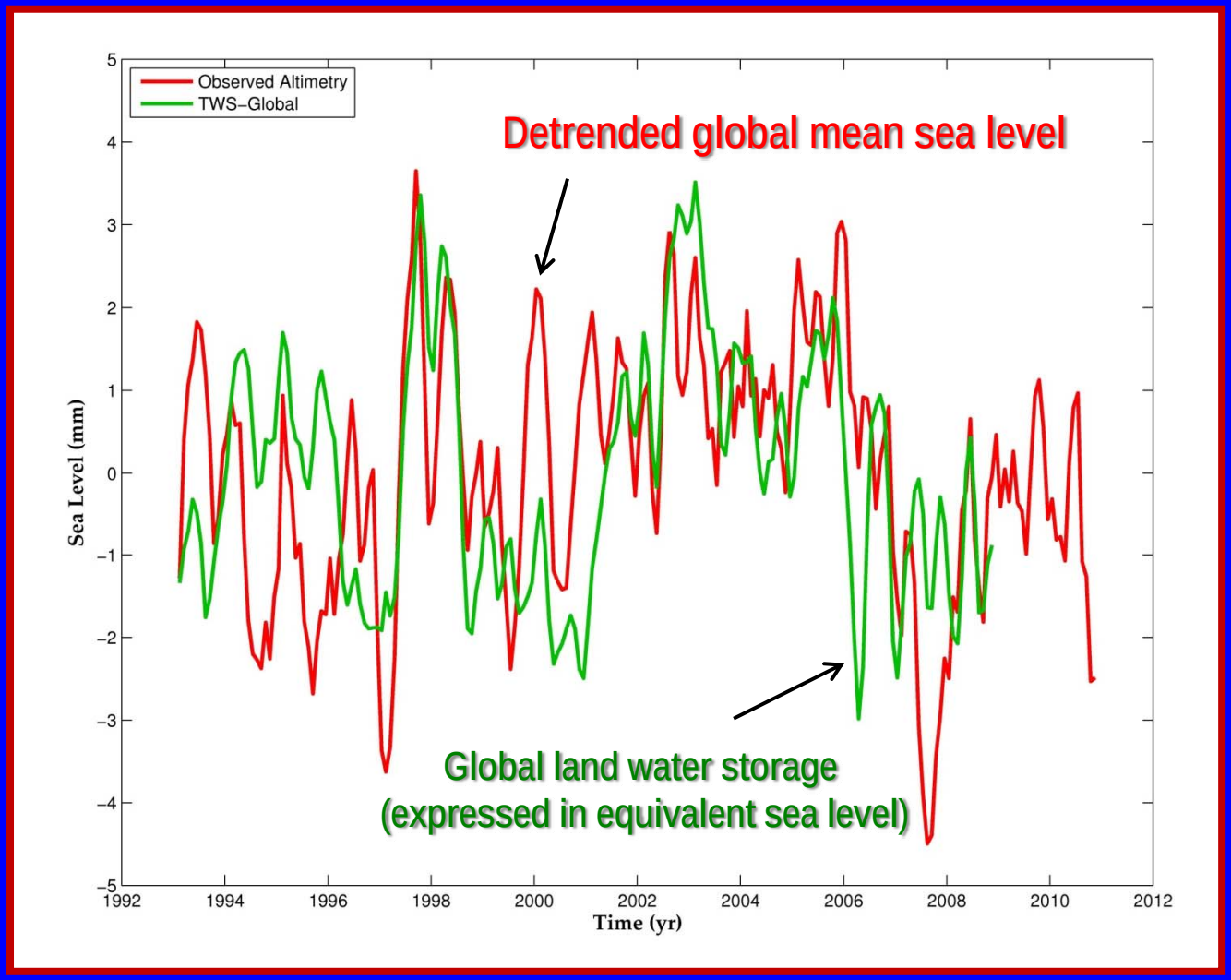
- Interannual variability of the global mean sea level directly related to ENSO-driven changes in the global water cycle
- The positive anomaly of the global mean sea level seen during El Nino essentially due to (tropical) north Pacific ocean mass increase
- North Pacific ocean mass increase during El Nino well explained by net precipitation (P-E) increase in that region
- Positive (P-E) anomaly asymmetrical wrt equator during El Nino
- Dominant role of the tropical north Pacific but whole north Pacific involved

Thanks for your attention

1st mode of the EOF decomposition of the eastern tropical Pacific ocean mass






GMSL
LW
MEI
6
4
2
0
-2
-4
-6
Sea level (mm)
1995
2000
2005
2010
Time (year)

Detrended global mean sea level and total land water storage