Terrestrial Waters and Sea Level at interannual time scale

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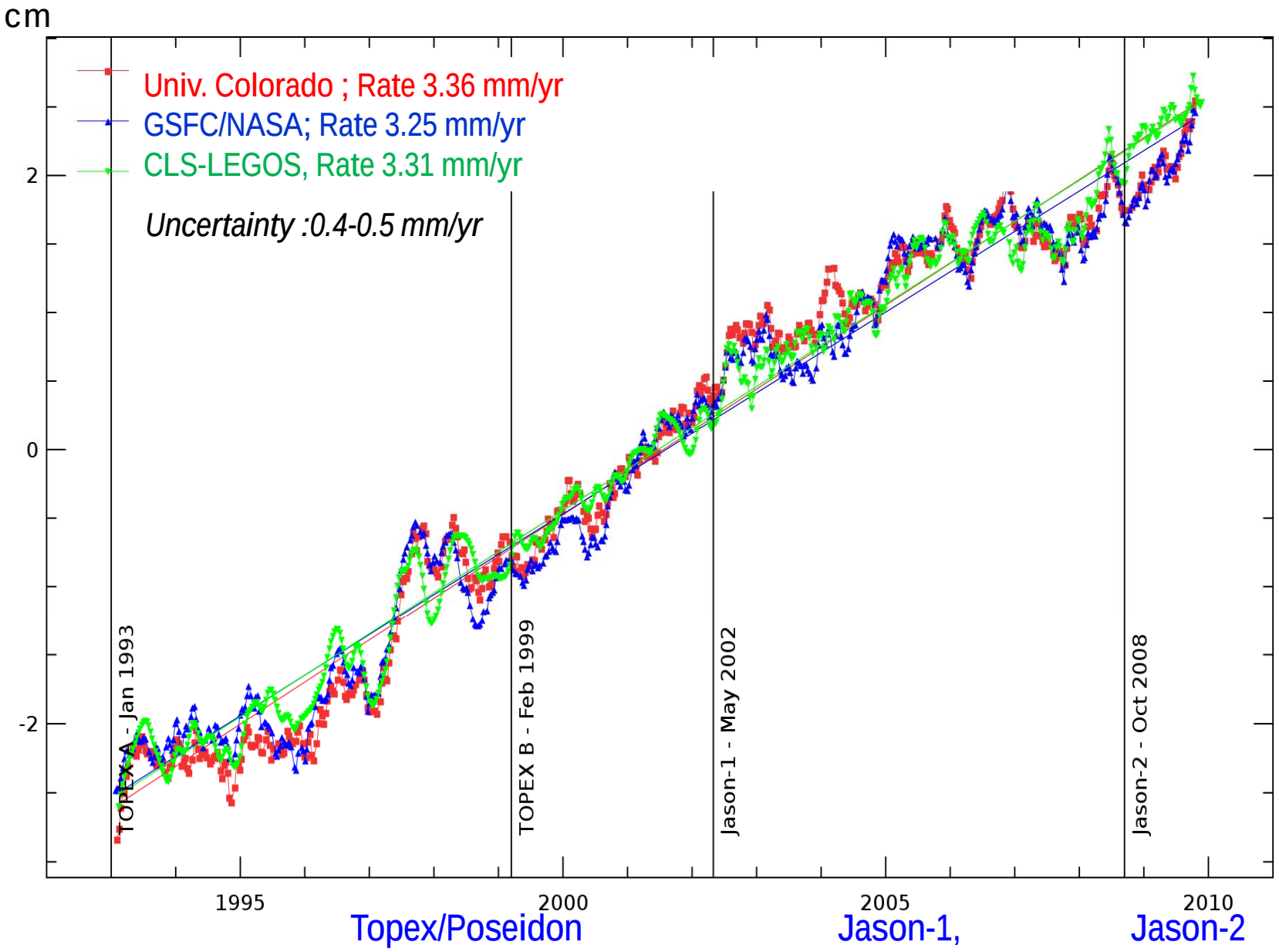
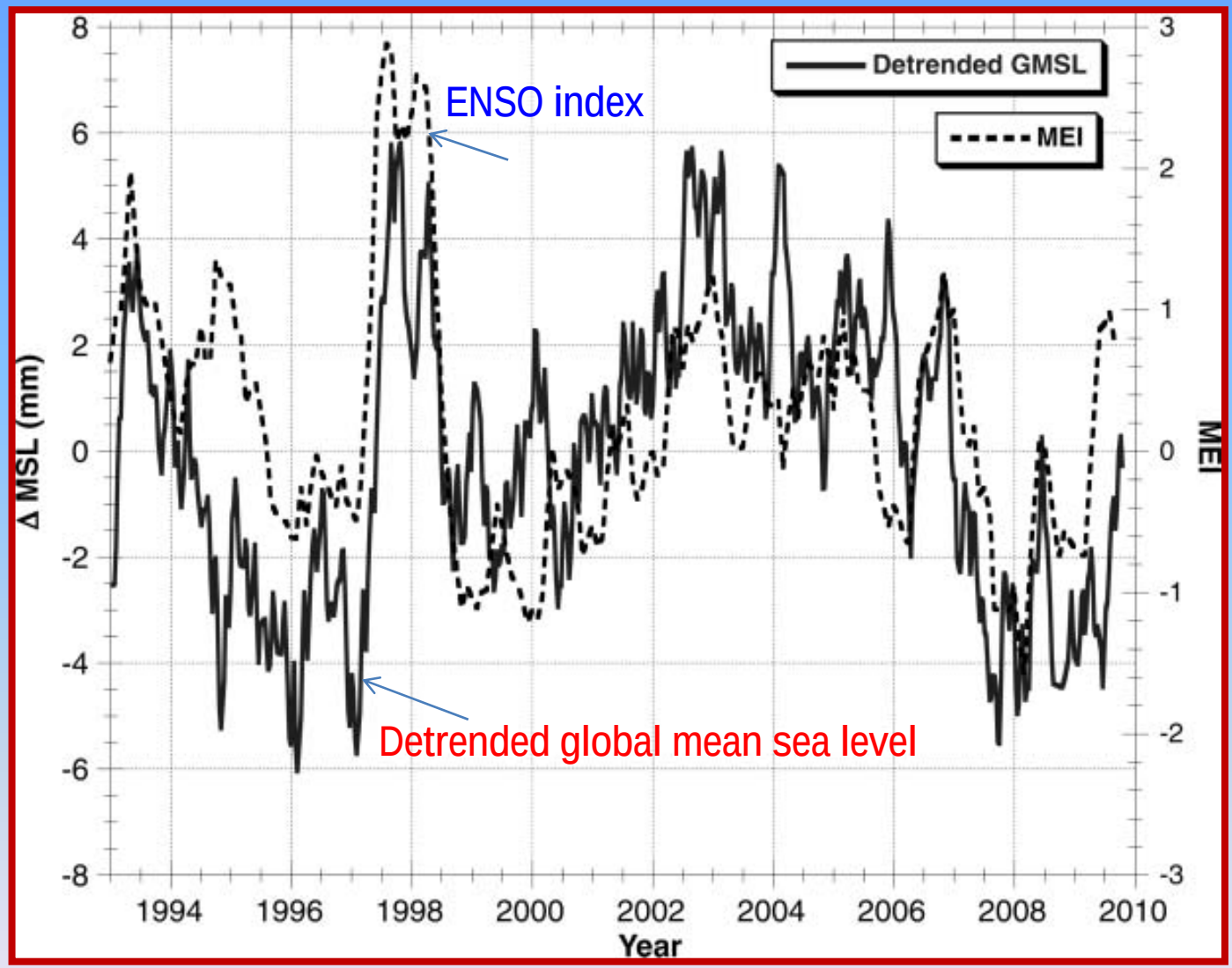
« Altimetry for Oceans and Hydrology »
OST-ST

Lisbon, October 2010

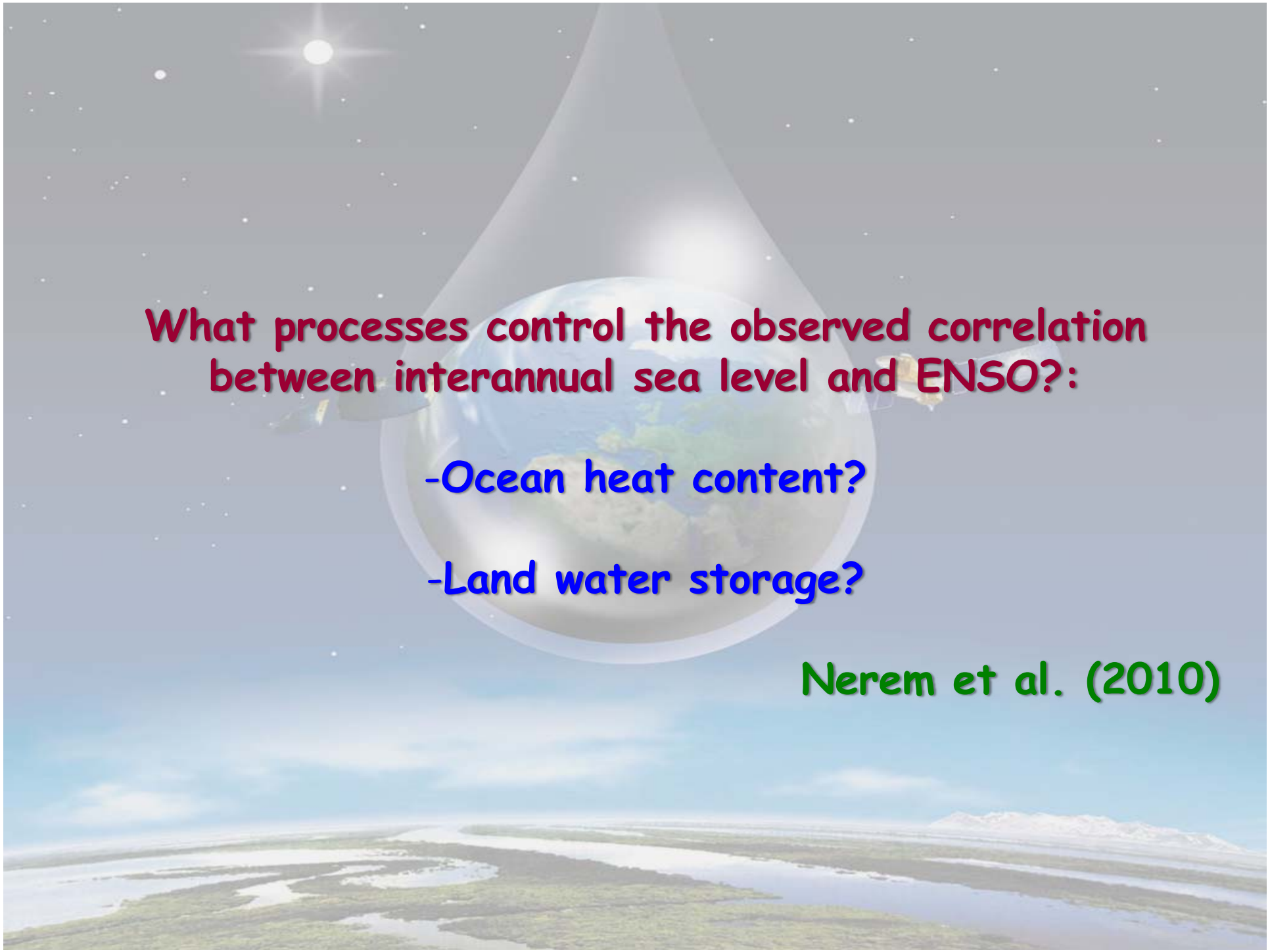
Altimetry-derived global mean sea level



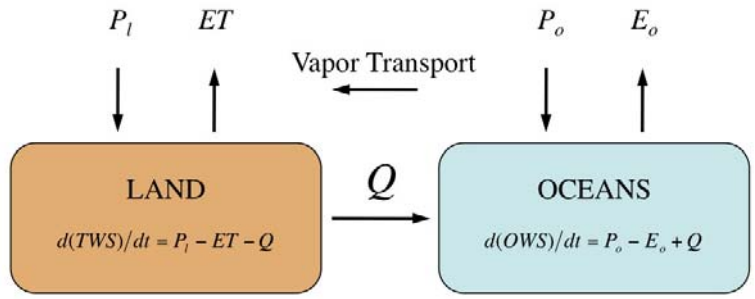


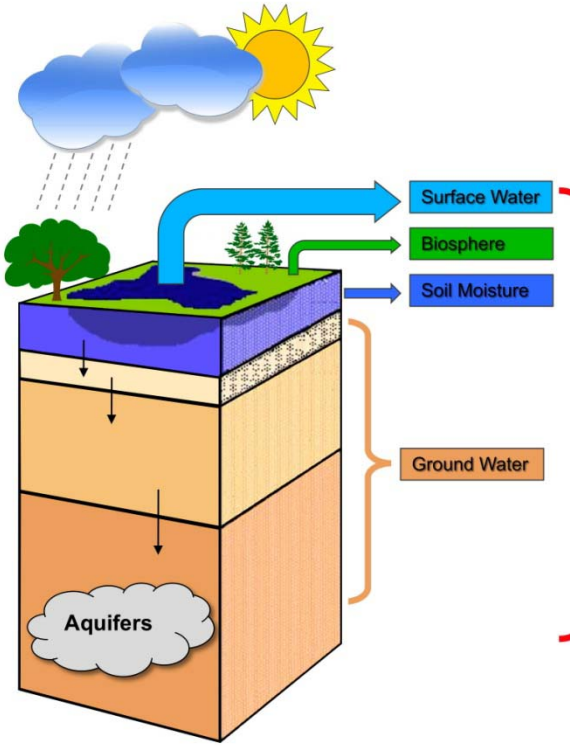
Nerem et al. (2010)

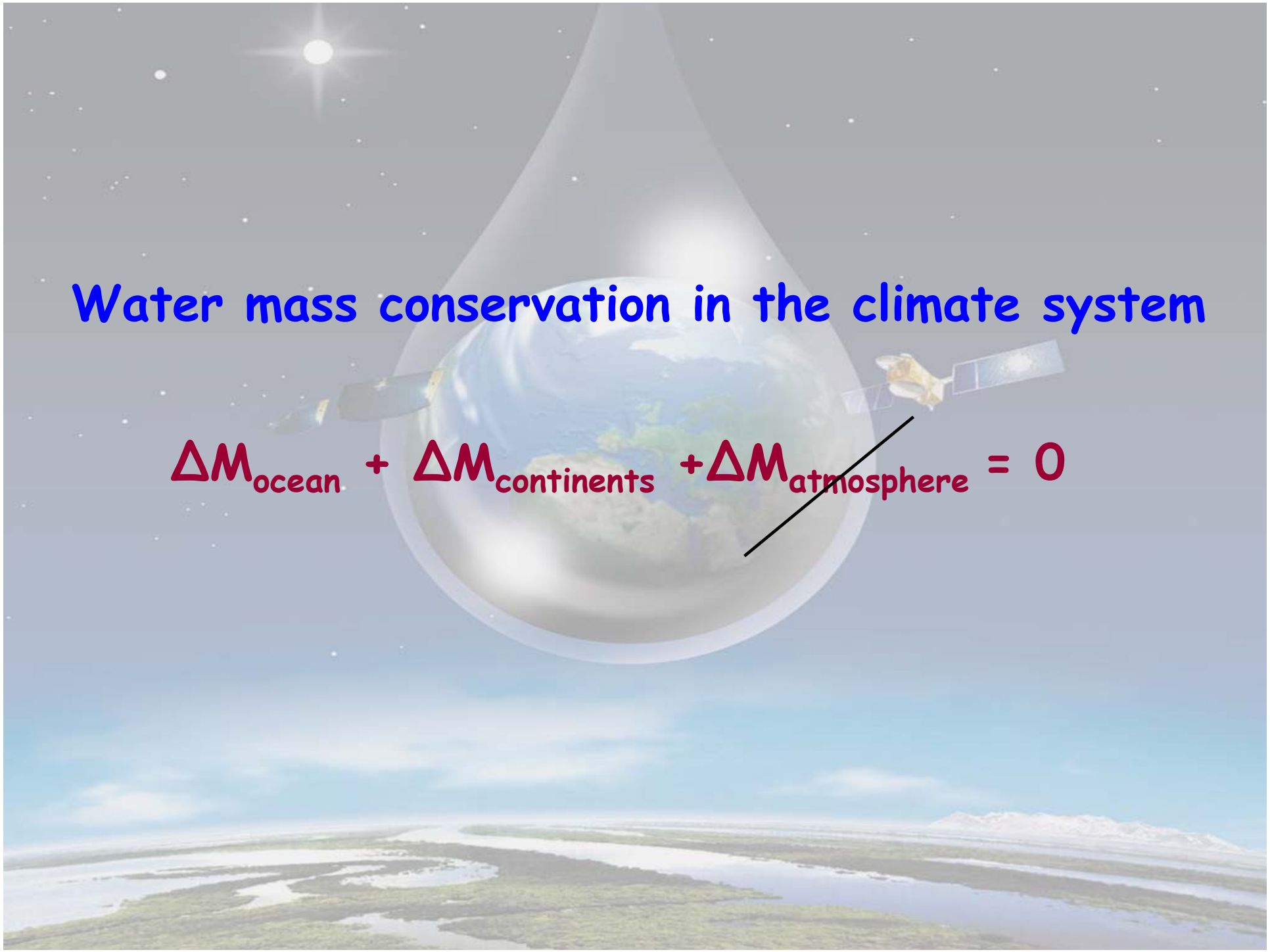
MEI: Multivariate ENSO Index


What processes control the observed correlation between interannual sea level and ENSO?:
-Ocean heat content?
-Land water storage?
Nerem et al. (2010)

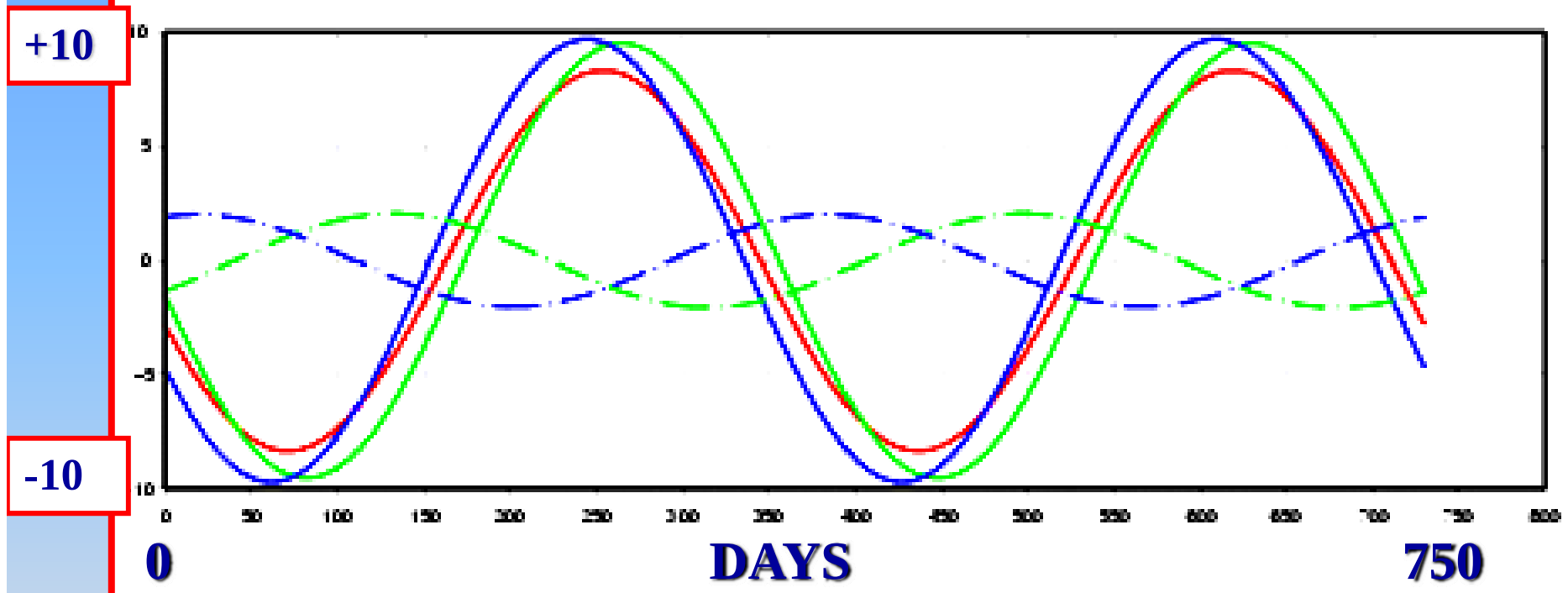
Global Water Cycle






Water mass conservation in the climate system
$\Delta M_{ocean} + \Delta M_{continents} + \Delta M_{atmosphere} = 0$

Annual Mean Sea Level



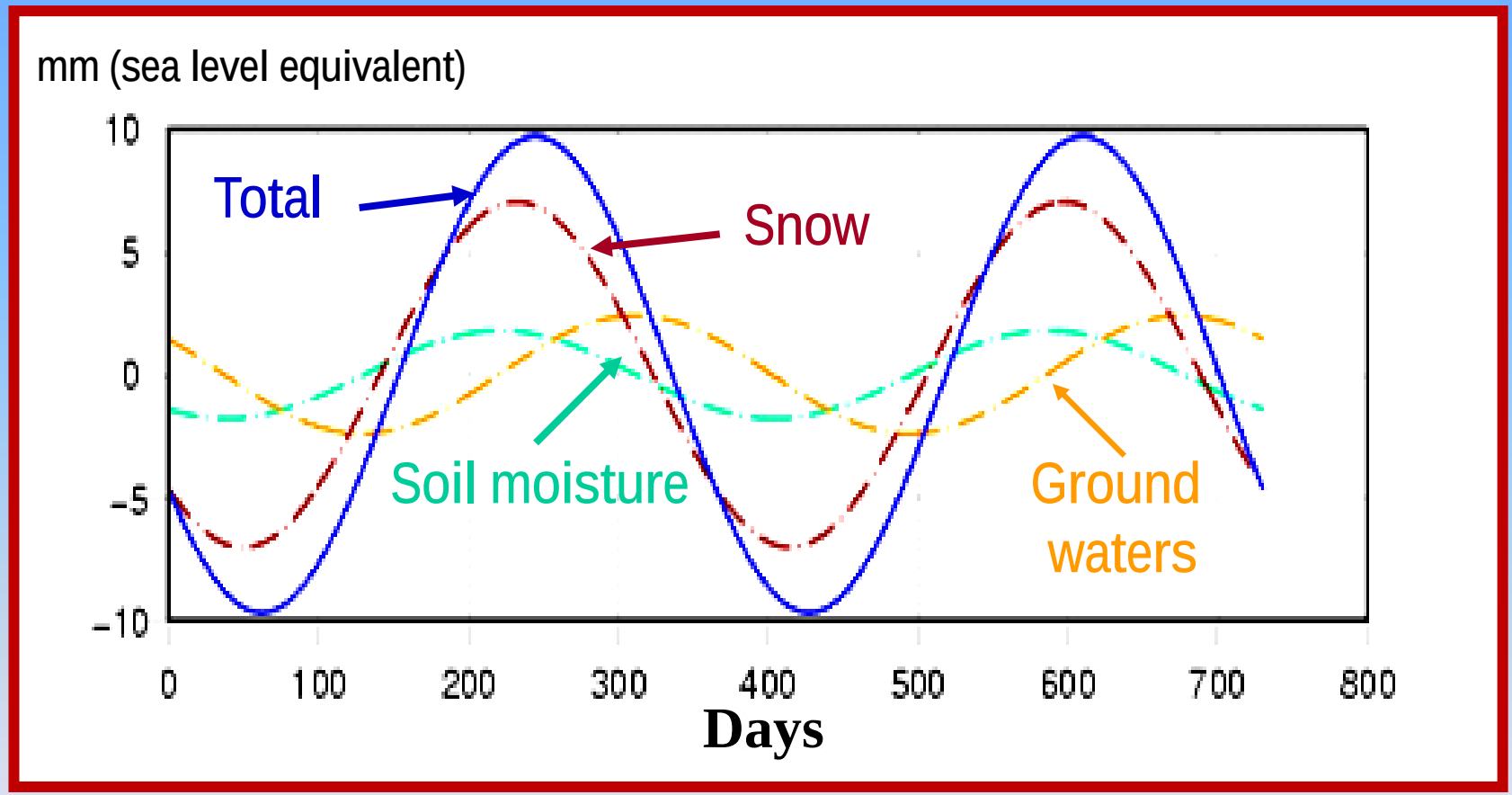
Altimetry-based minus thermal expansion

Land Waters (GSWP, Douville et al., 1999)

Land Waters (LaD, Milly & Shmakin, 2002)

Milly et al., 2003

Land Waters Contribution to Annual Mean Sea Level



Milly et al., 2003;

Also Chen et al., 1998, Minster et al., 1999, Cazenave et al., 2000, Biancamaria et al., 2010

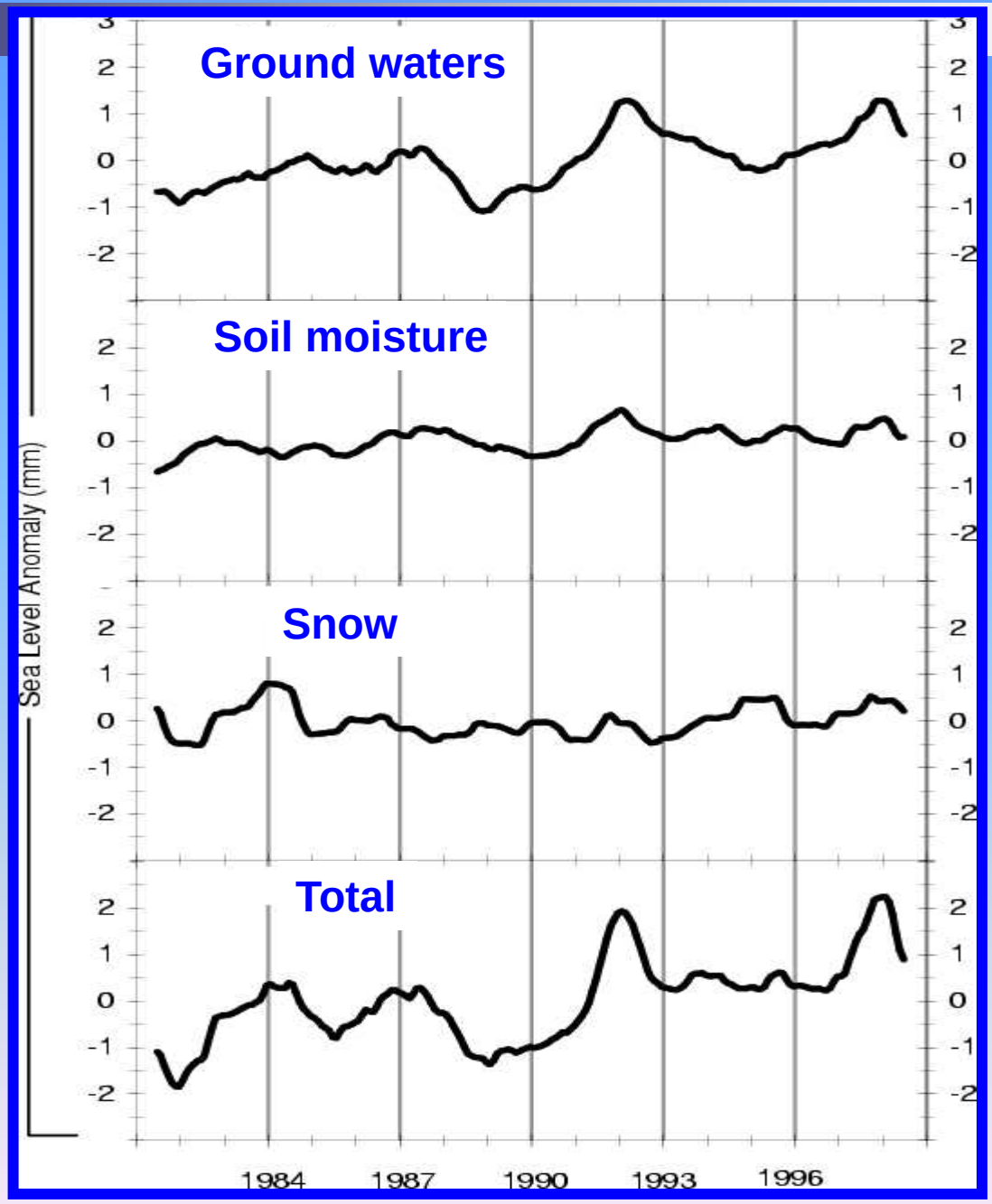
Milly et al., 2003

Ground waters

Soil water

Snow

Total



0.07 mm/yr

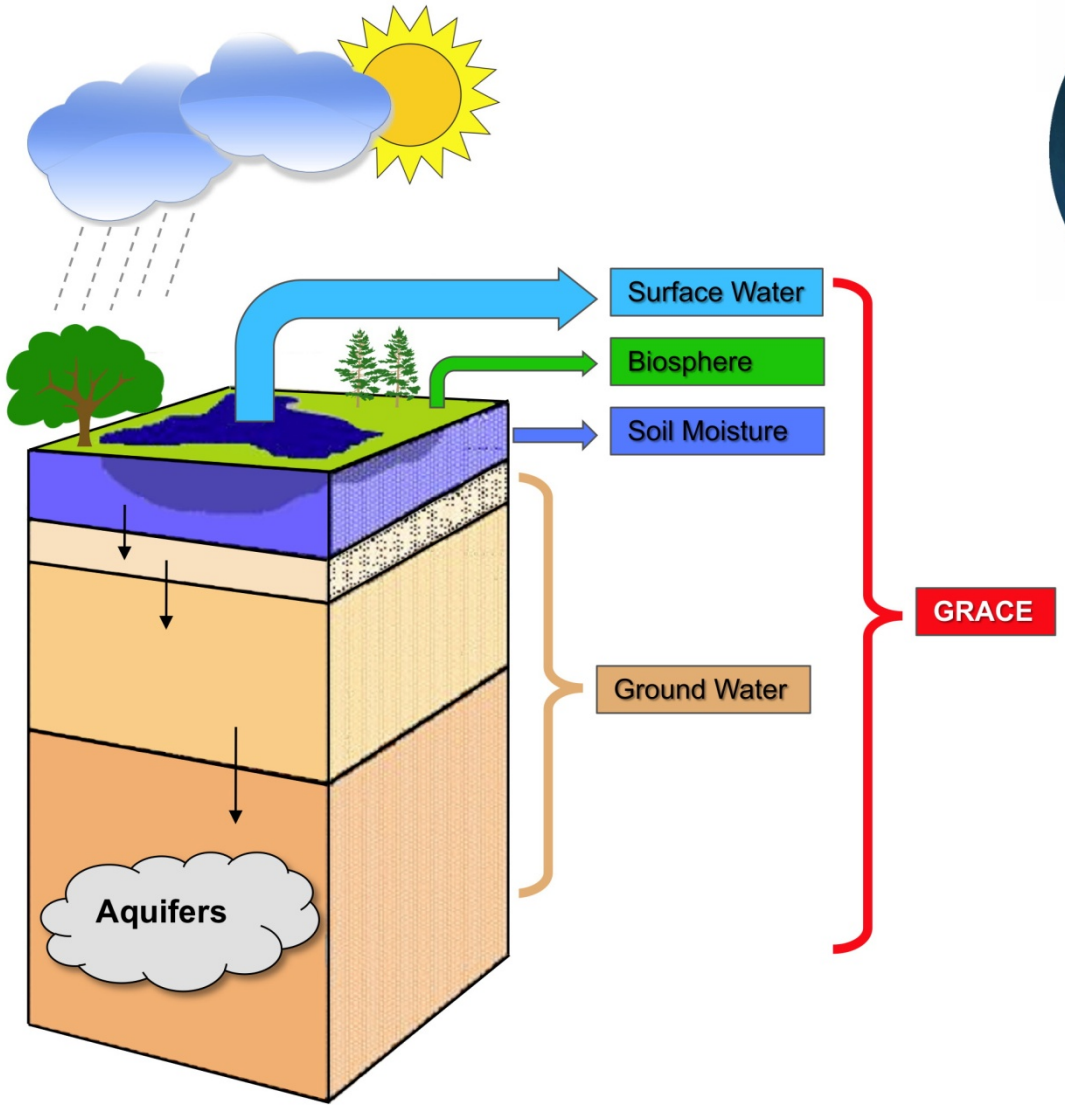
0.03 mm/yr

trends

0.02 mm/yr

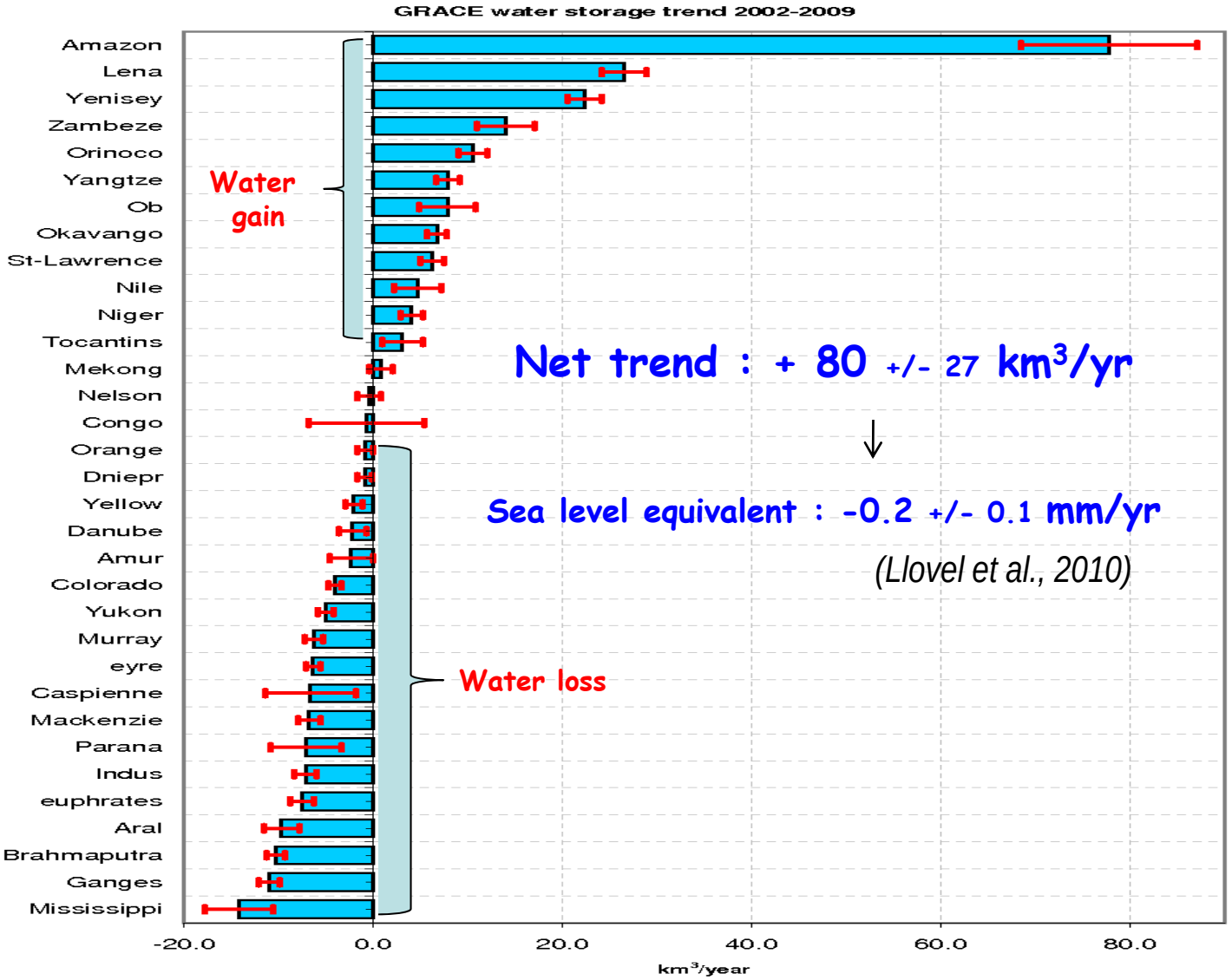
0.12 mm/yr

Trend contribution to sea level from land waters –LaD model- (1981-1998)

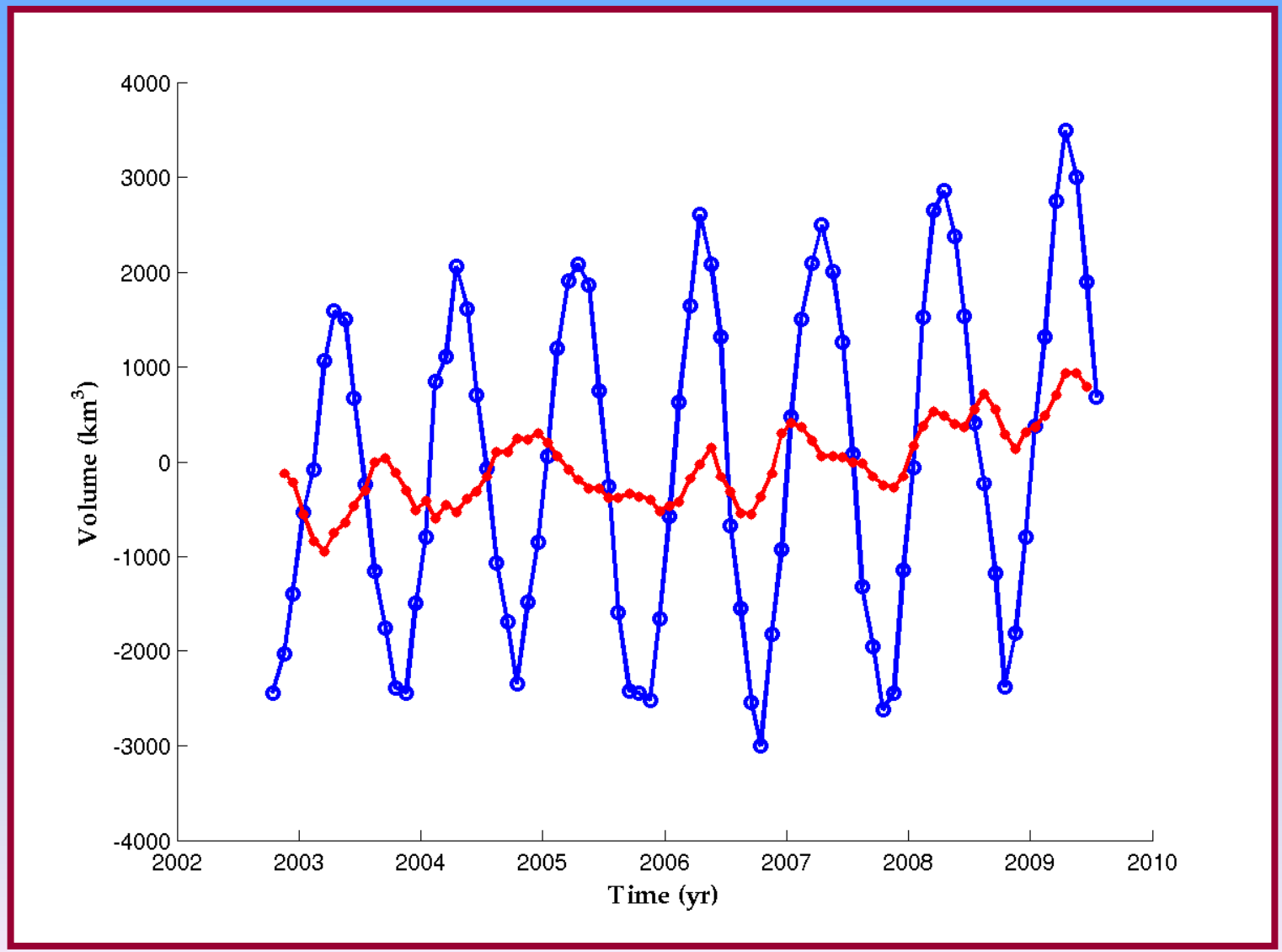

Surface Water
Biosphere
Soil Moisture
Ground Water
GRACE
Aquifers


GRACE
Gravity Recovery And Climate Experiment

GRACE-based water storage trend 2002-2009 (km^3/yr)

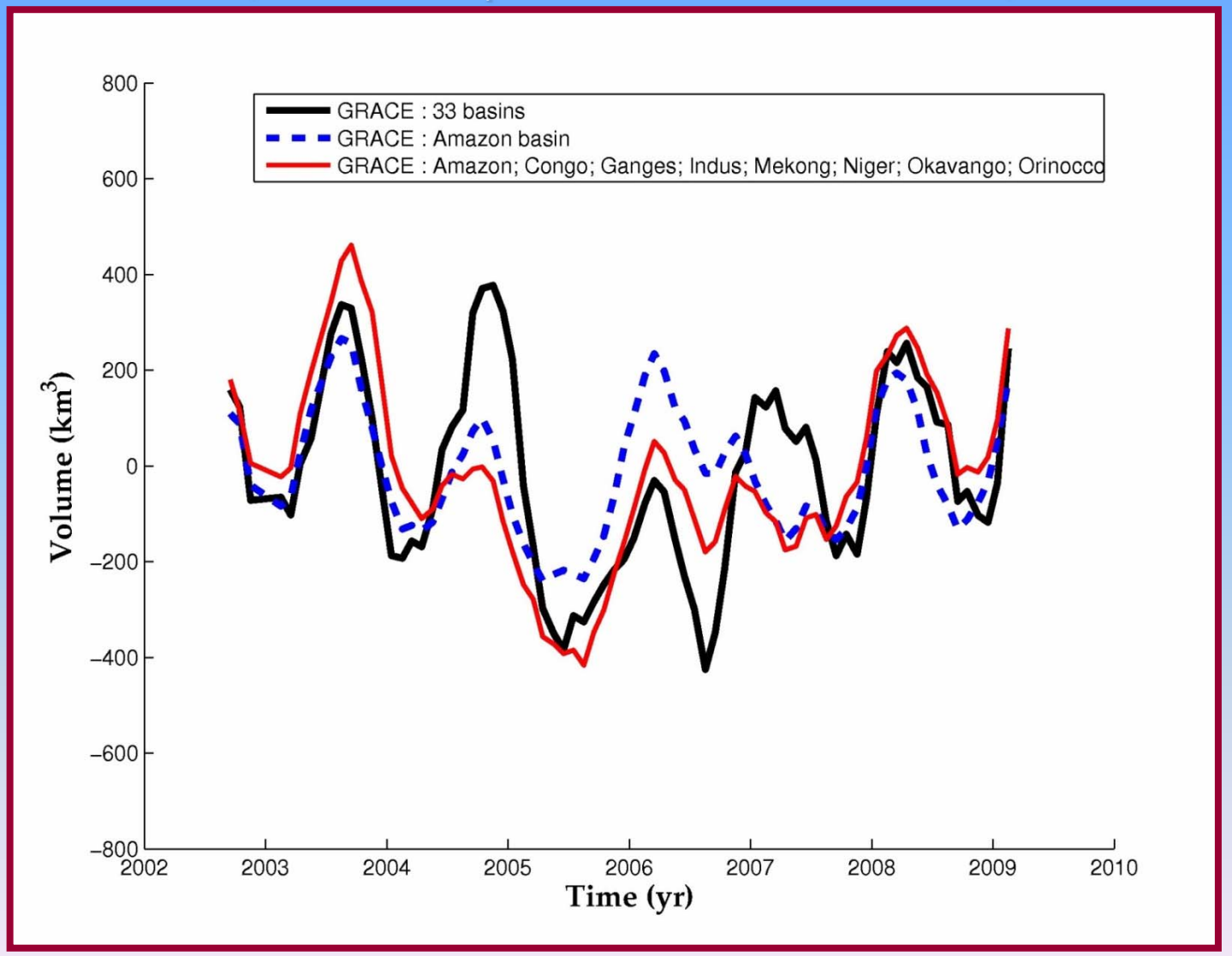


Total water volume variation –km^3- from GRACE (33 basins)



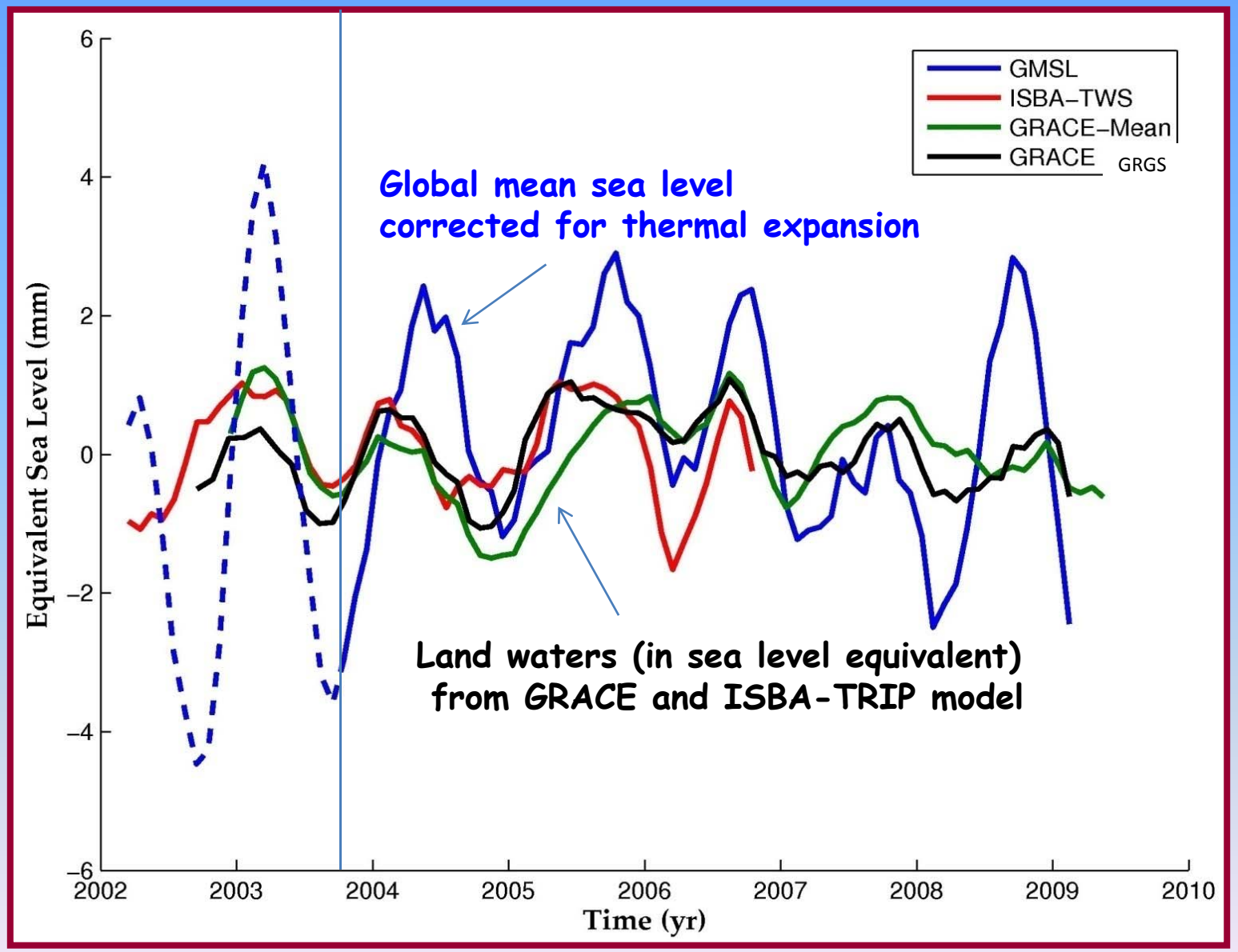
Llovel et al., 2010

Total water volume –km^3- from GRACE (33 river basins)
(seasonal cycle and trend removed)

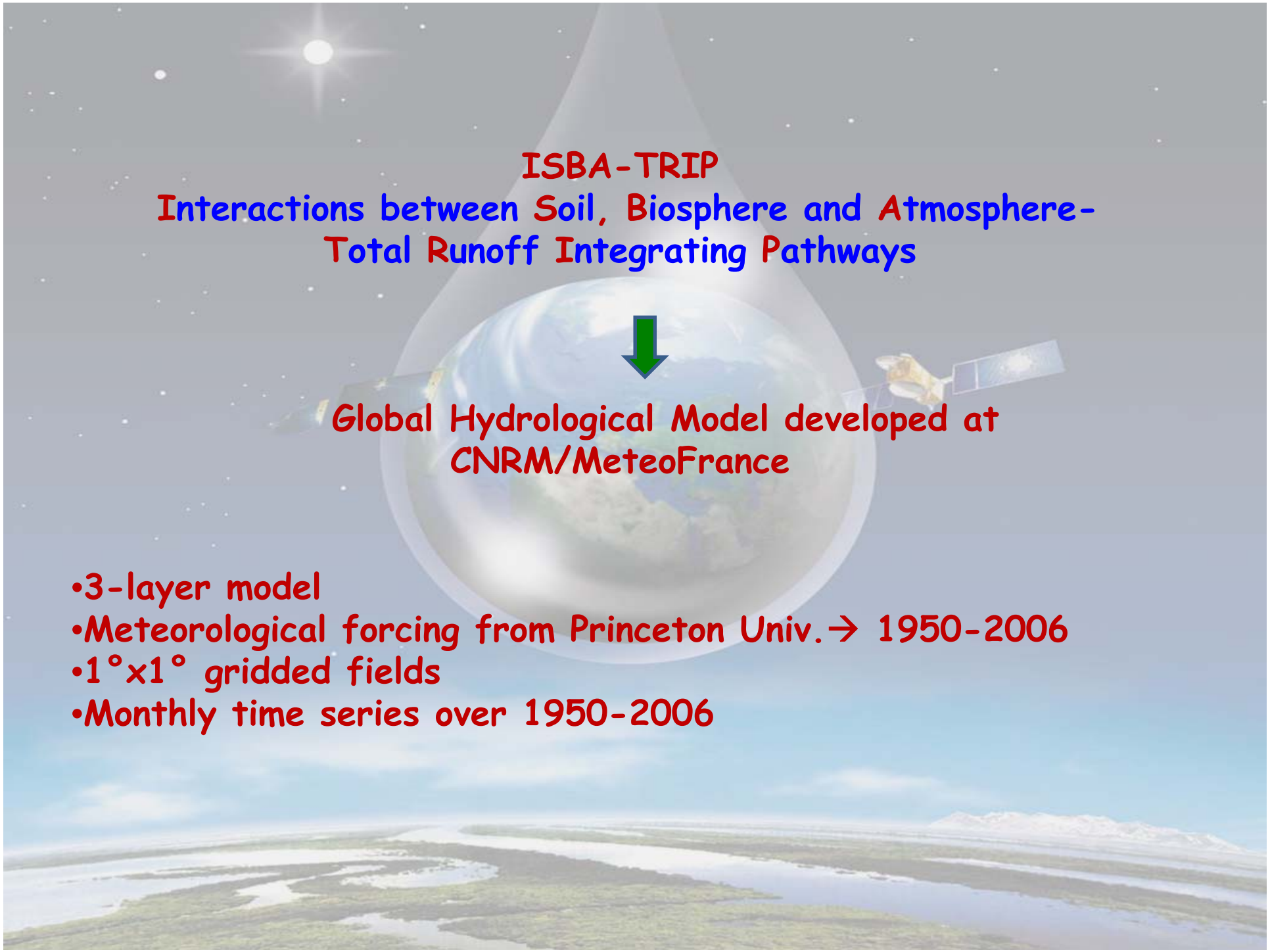


Llovel et al., 2010

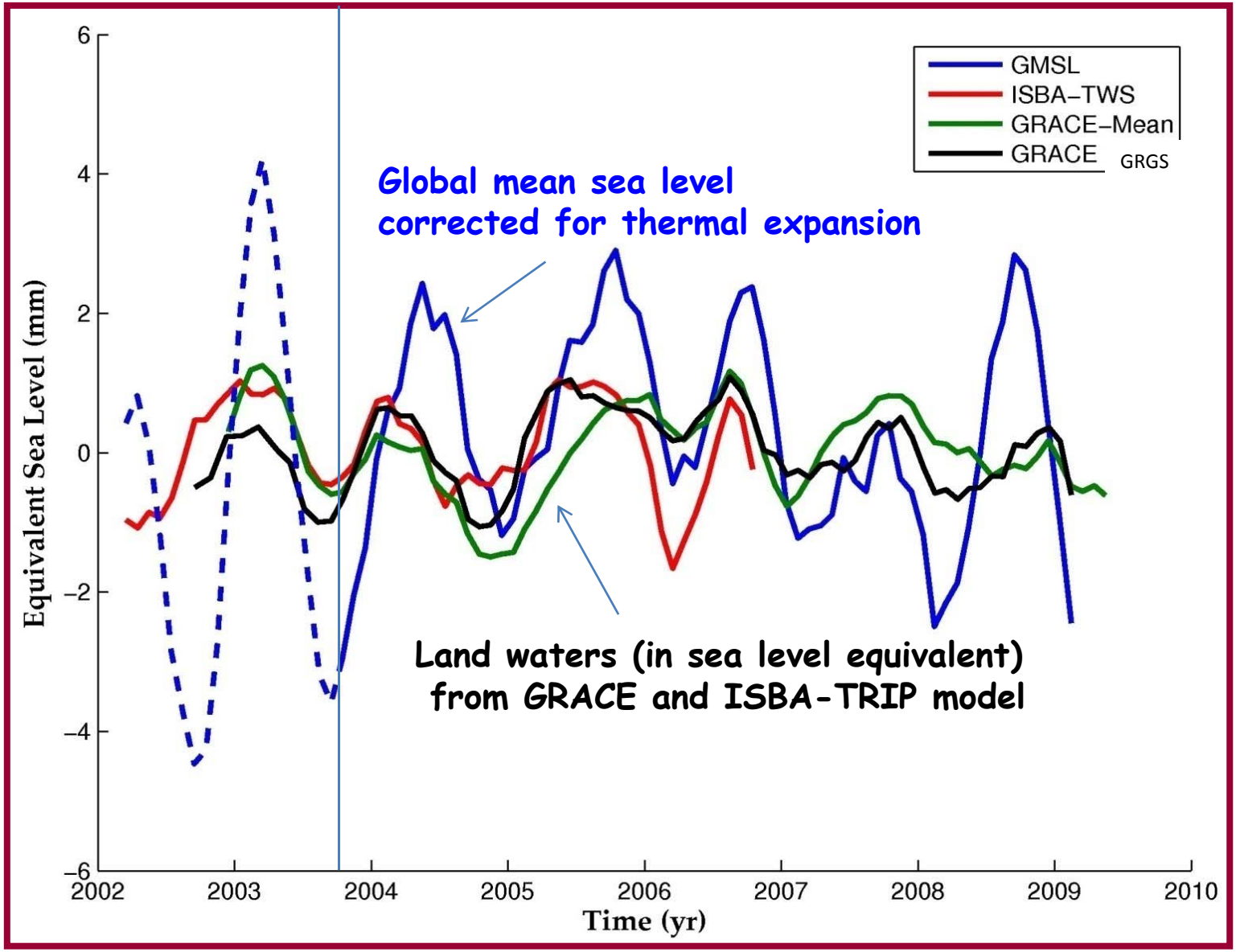
Interannual global mean sea level and land waters



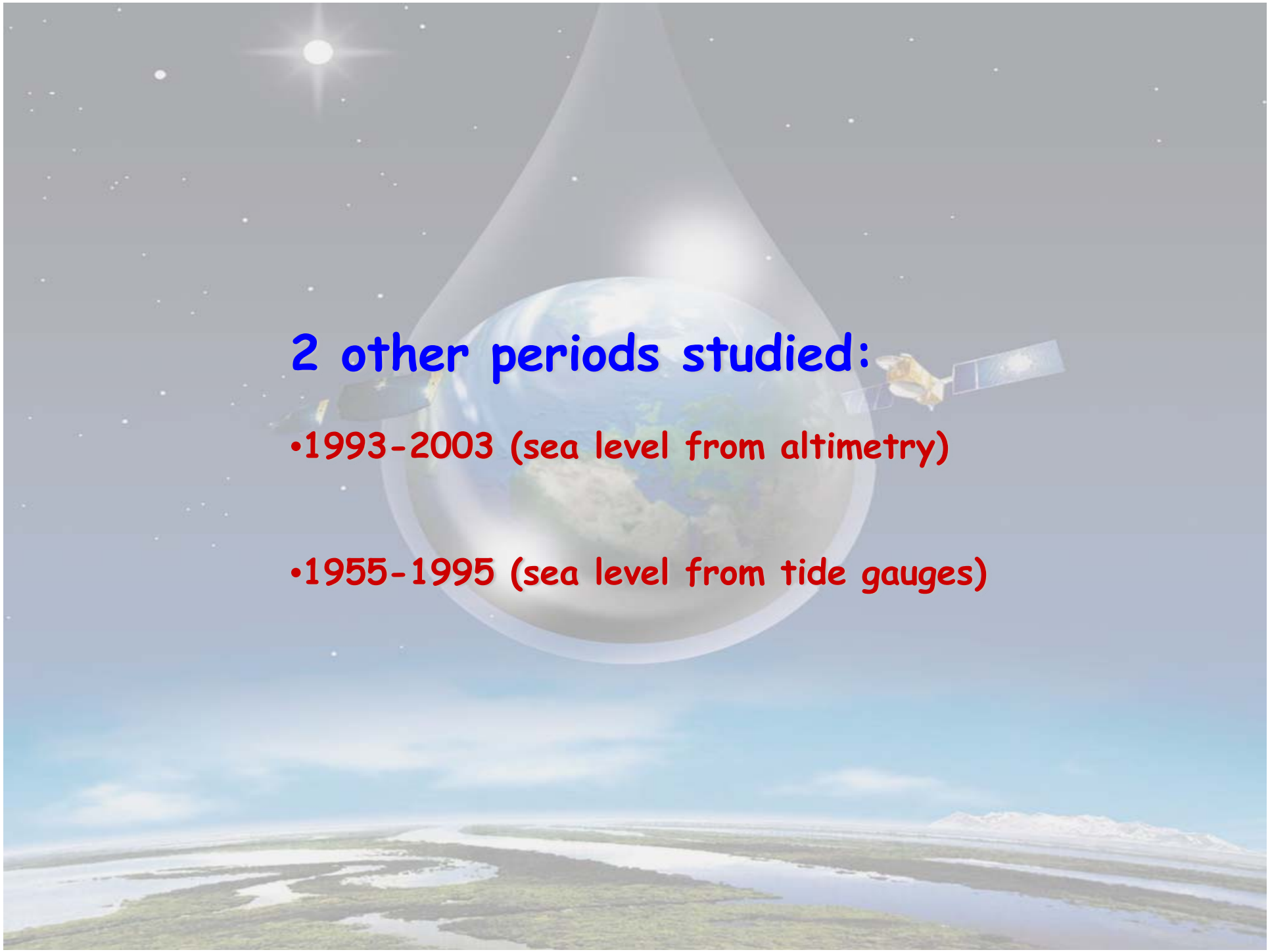
Llovel et al., 2010


ISBA-TRIP
Interactions between Soil, Biosphere and Atmosphere-
Total Runoff Integrating Pathways
Global Hydrological Model developed at
CNRM/MeteoFrance
•3-layer model
•Meteorological forcing from Princeton Univ.→ 1950-2006
•1°x1° gridded fields
•Monthly time series over 1950-2006

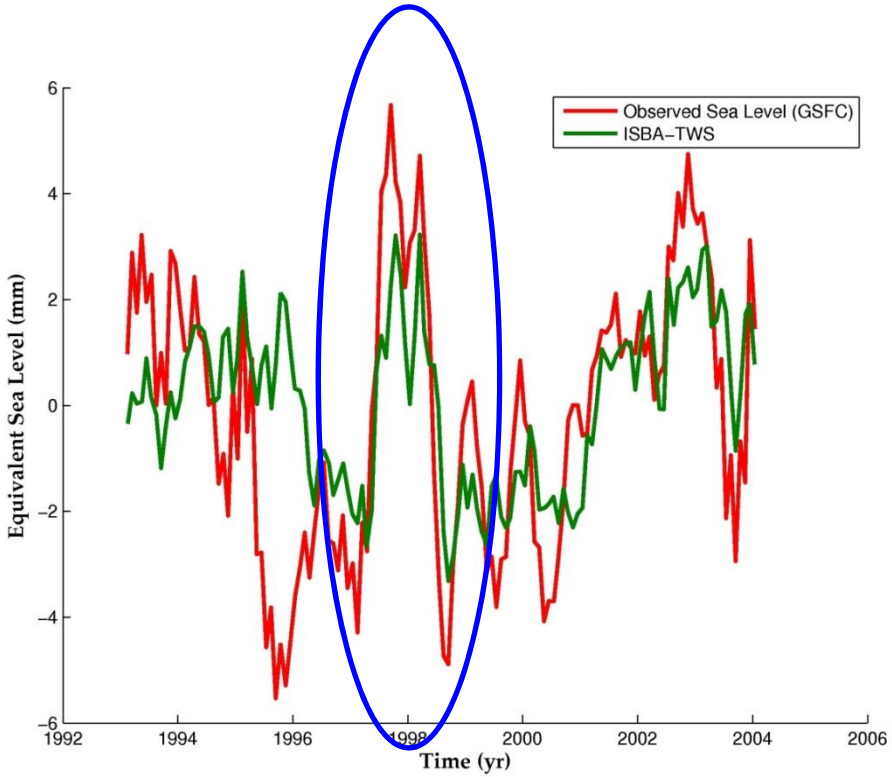
Interannual global mean sea level and land waters

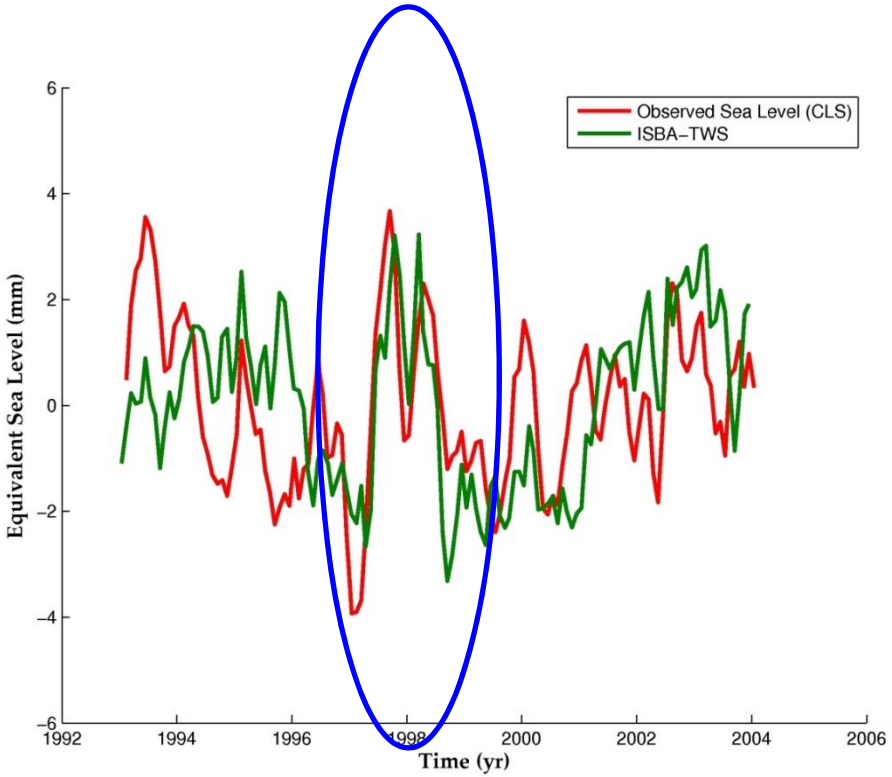


Llovel et al., 2010


2 other periods studied:
•1993-2003 (sea level from altimetry)
•1955-1995 (sea level from tide gauges)

Detrended global mean sea level
Land water storage from the ISBA-TRIP model



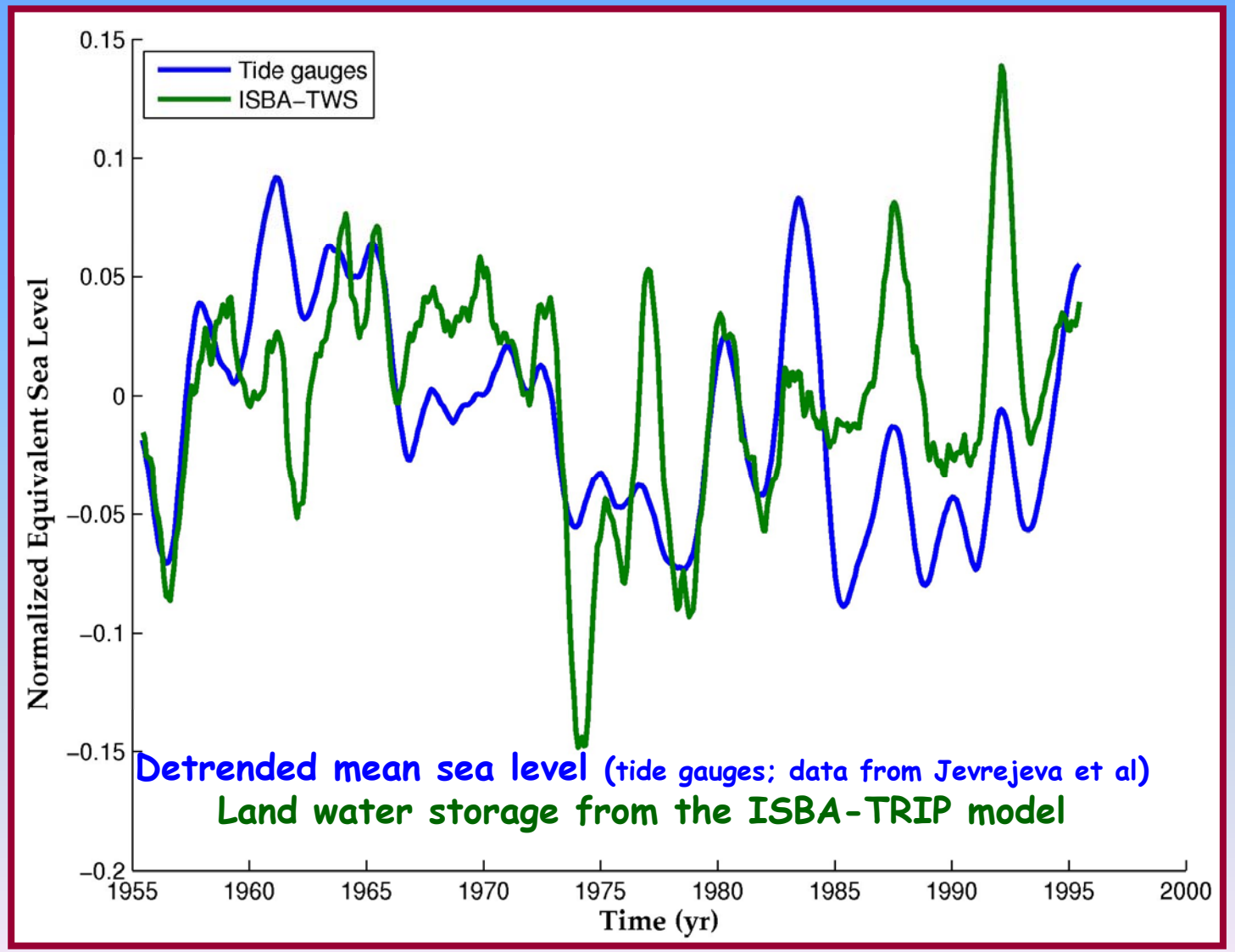


Sea level data from GSFC (Beckley et al.)

Sea level data from CLS (Ablain et al.)

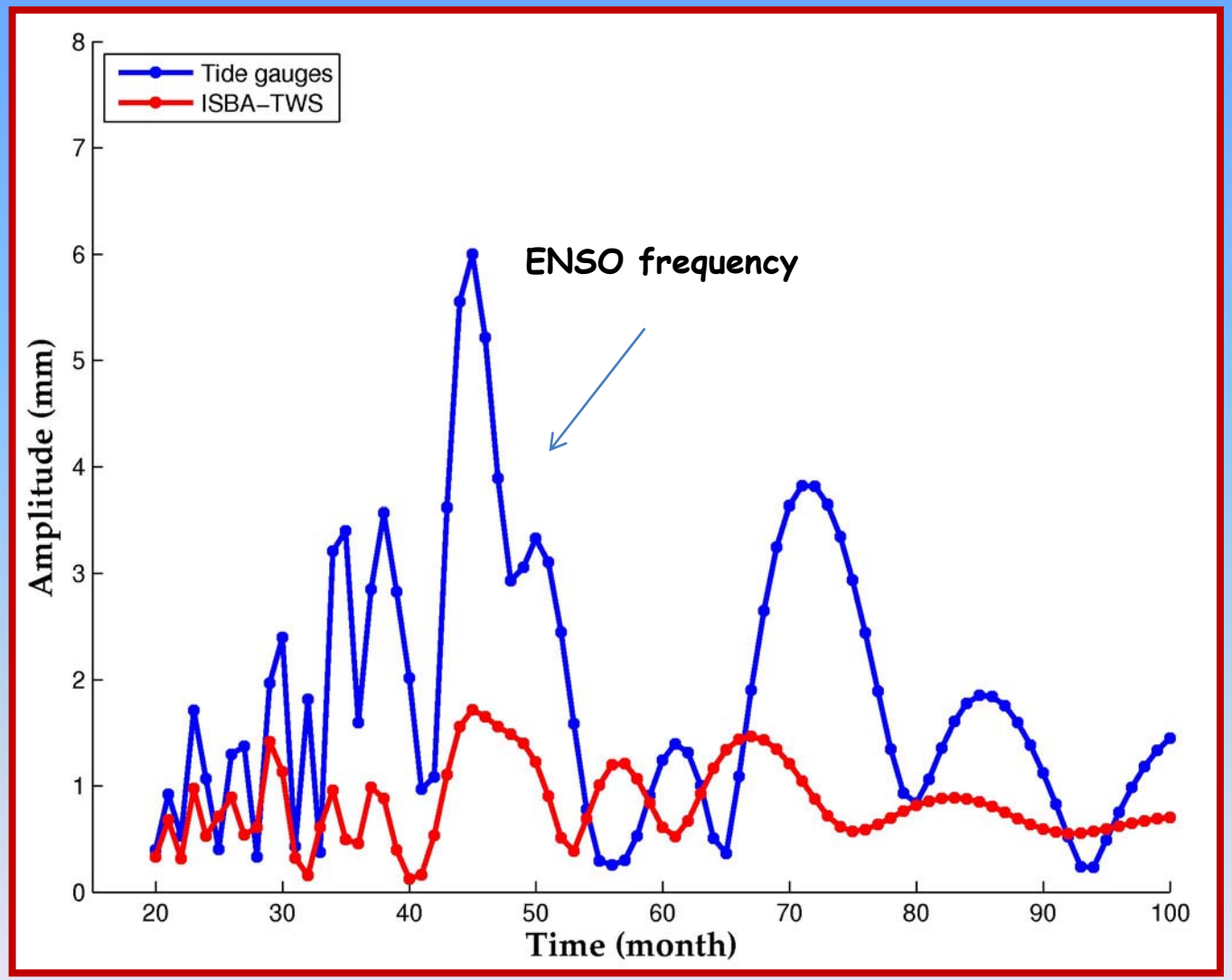
Llovel et al., 2010

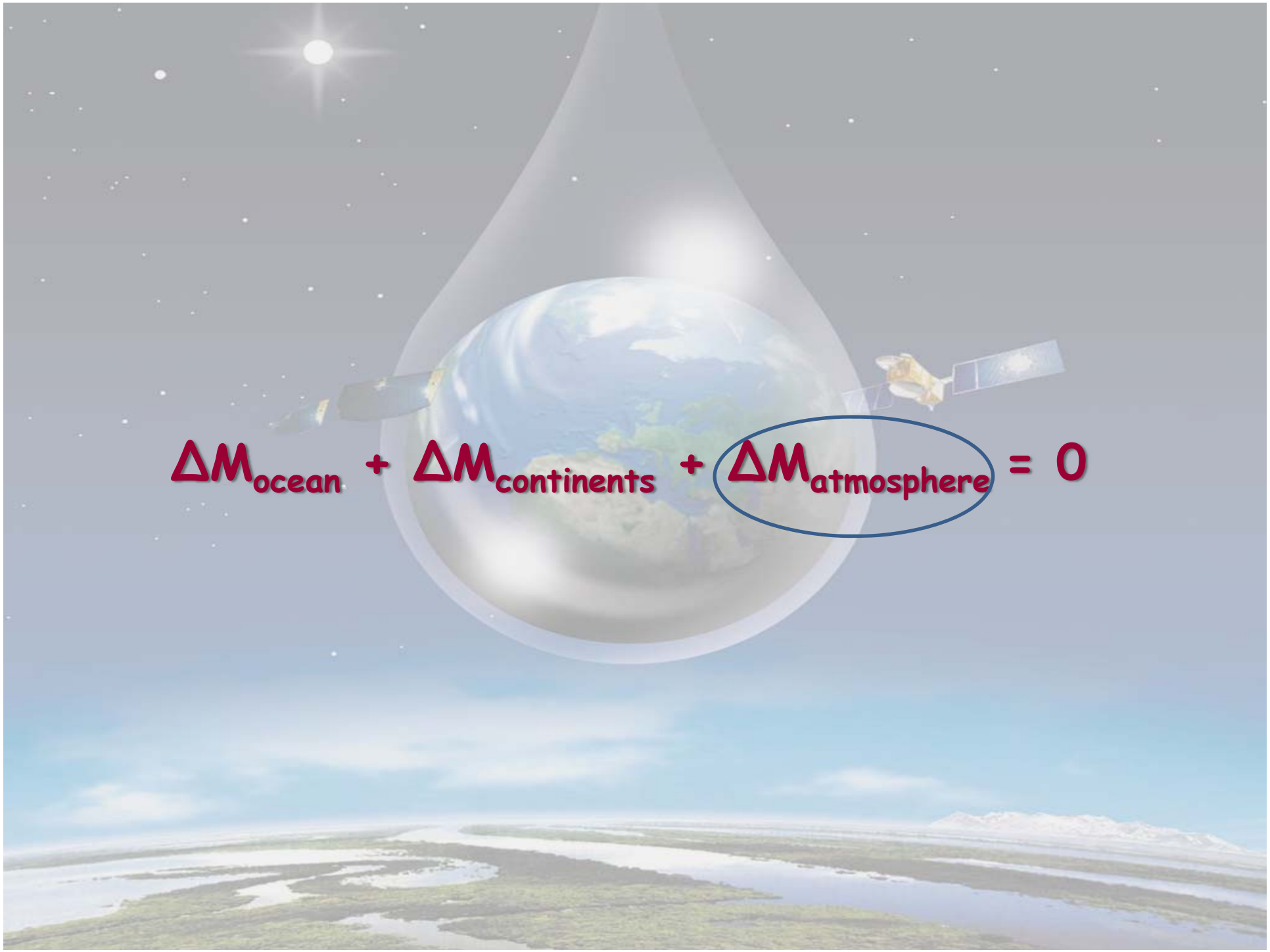
Global mean sea level and land waters (1955-1995)



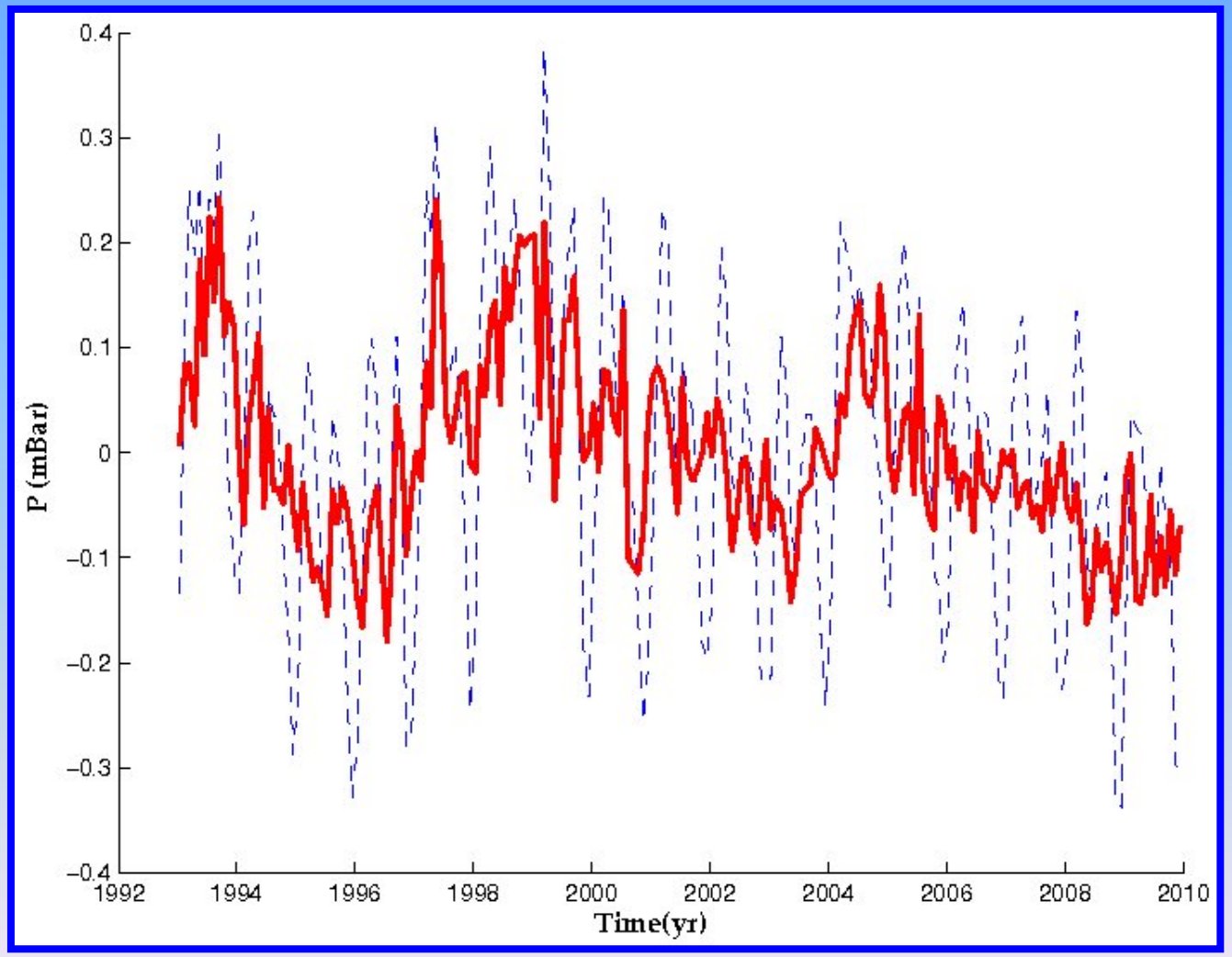
Llovel et al., 2010

Amplitude Spectra

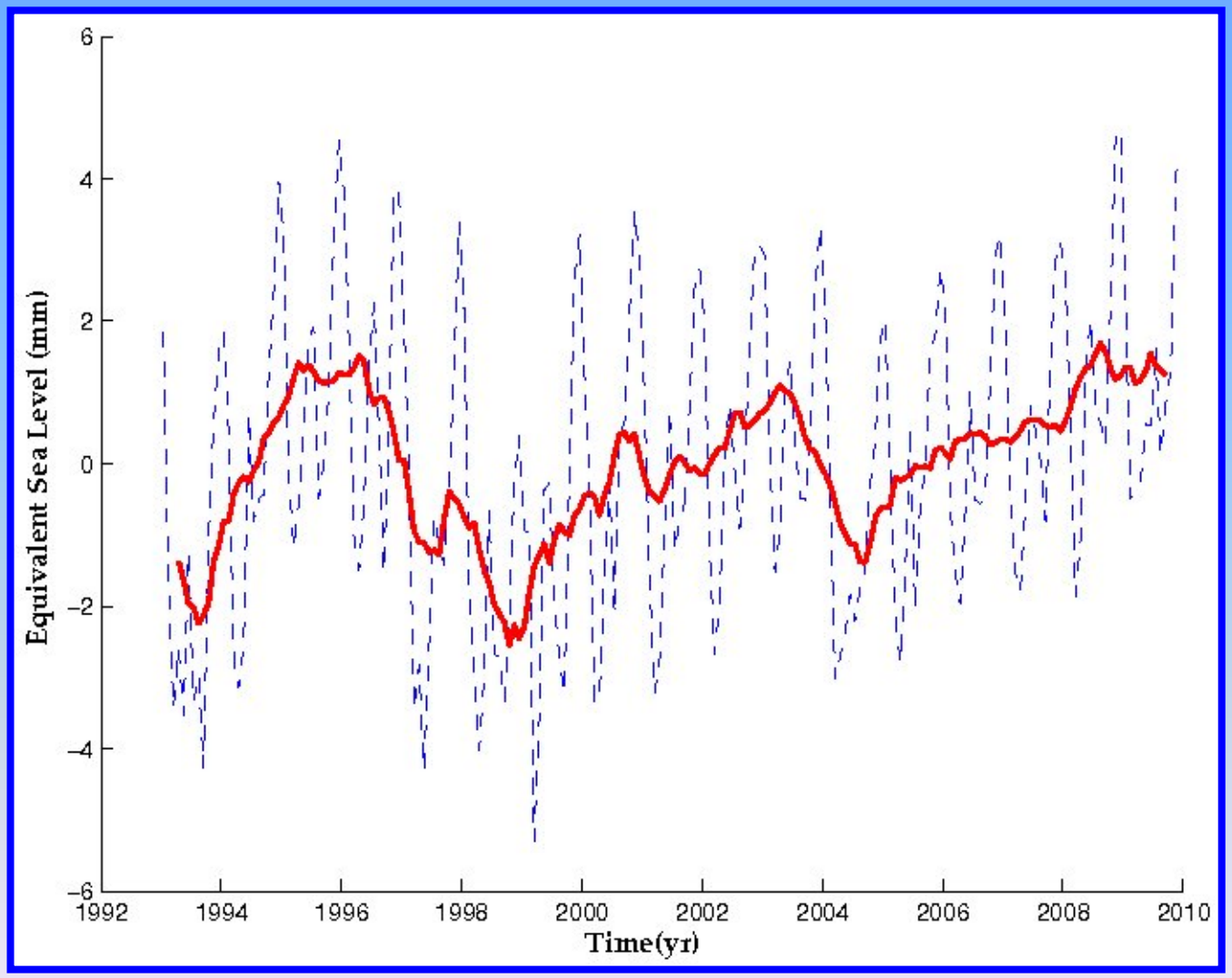


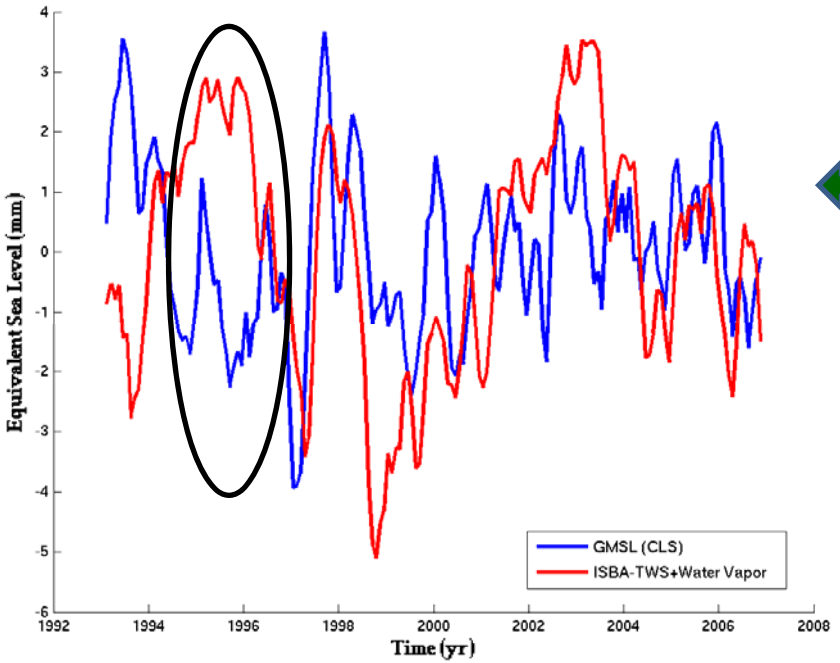

$\Delta M_{ocean} + \Delta M_{continents} + \Delta M_{atmosphere} = 0$

Global mean surface pressure (HPa) –Altimetry era– Data from NCEP



Water vapor variation expressed in sea level equivalent (mm)

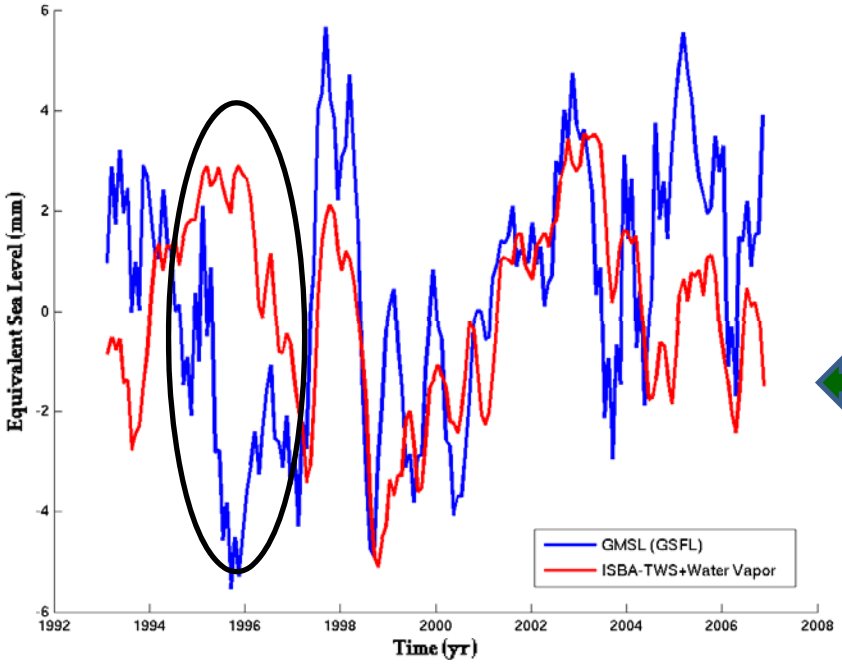




Sea level data from CLS

detrended global mean sea level (blue curve)

land waters (from ISBA-TRIP) + atmospheric water vapor (red curve)



Sea level data from NASA/GSFC

Conclusion/Perspectives

- Encouraging results about causes of the interannual variability in global mean sea level
  → implications for the global water cycle at interannual time scale

- Suggestion that interannual variations of thermal expansion are small

- Constraints on land surface models (interannual time scale)

- Combined use of different in orbit sensors (SWOT, SMOS, GRACE….)
  → constraints on the dominant source of interannual variability
  (surface waters, soil moisture, ground waters?)

- The atmospheric reservoir (water vapor) more important than previously assumed → needs more investigation


Thanks you for attention