Construction, validation and applications of the 53-yr atmospheric forcing NCC

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Outline

- NCC 53-yr forcing data for land surface models
- validate NCC with observed river discharges
- decadal variations of land water storage, effects on sea level variations and role of tropical regions

NCC 53-yr forcing data for LSMs

Ngo-duc, T., J. Polcher and K. Laval *(JGR, 2005)*

Why a 53-yr forcing data set?

To run an LSM in an off-line mode, a high quality atmospheric forcing data set is required.

The period of actual available forcing data is:

- Too far back to compare with recent remote –sensed data
- Too short for the detection and analysis of trends, such as those associated with global warming.

Building a long period atmospheric forcing data set for LSMs

NCC 53-yr forcing data for LSMs

NCC construction

Variables	Description	Unit
Rainf	Rainfall rate	Kg/m
Snowf	Snowfall rate	Kg/m
Tair	Near surface air temperature at 2m	K
Qair	Near surface specific humidity at 2m	Kg/kg
Wind	Near surface wind speed at 10m	M/s
Psurf	Surface pressure	Pa
Swdown	Surface incident shortwave radiation	W/m2
Lwdown	Surface incident longwave radiation	W/m2

Atmospheric forcing variables for LSMs

NCC 53-yr forcing data for LSMs

NCEP/NCAR Reanalysis — 6-hourly, ~1.875°, 1948-present

↓ Interpolation to the grid 1°×1°, differences in elevation between the grids were taken into account

NCEP

↓ CRU (Climate Research Unit) precipitation 0.5°×0.5°, 1901-2000

NPRE

↓ CRU temperature

NCRU

Specific humidity, pressure, precipitation

↓ Radiations: SRB (Surface Radiation Budget)

NCC — **6-hourly, 1°x1°, 1948-2000**

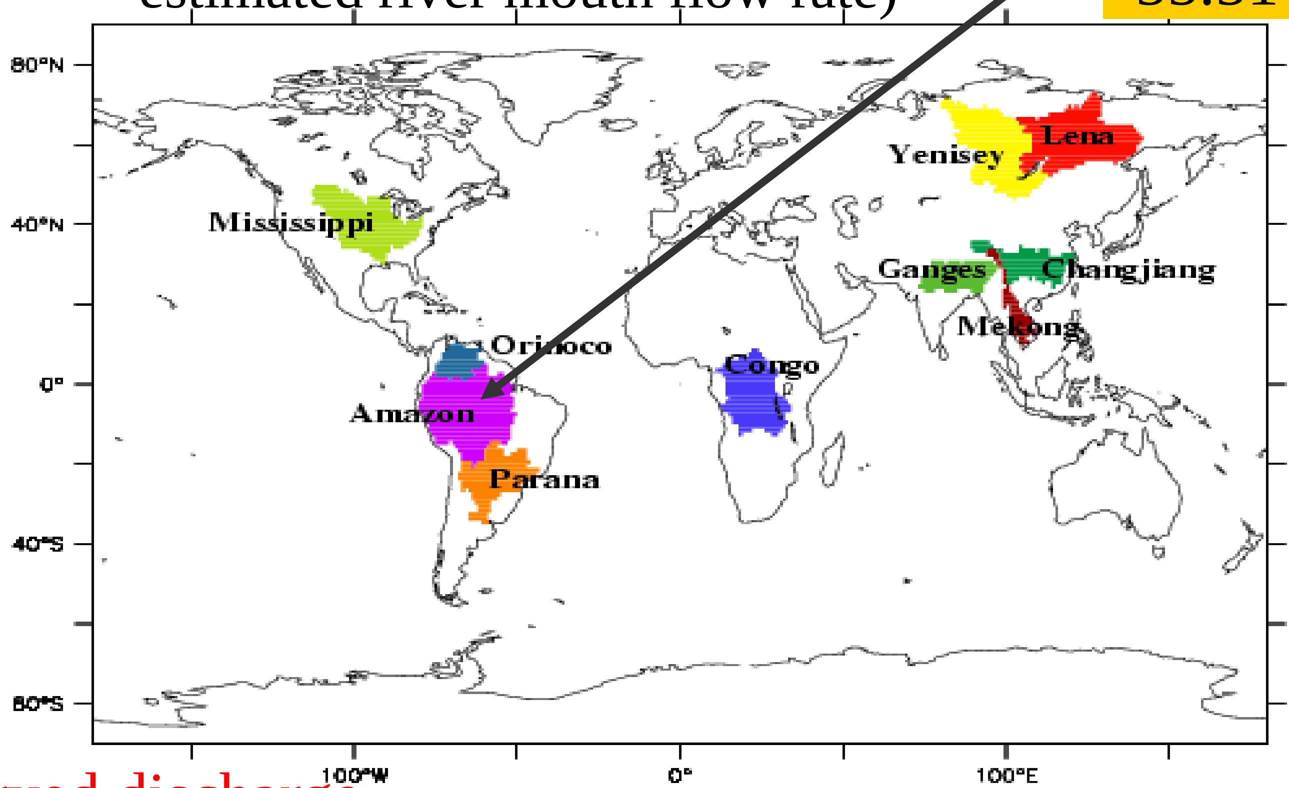
(NCEP Corrected by CRU)

NCC 53-yr forcing data for LSMs

NCC validation

The world's 10 biggest rivers (by the estimated river mouth flow rate)

Station Obidos
55.51W, 1.95S



Observed discharge

- GRDC (Global Runoff Data Center)
- Data at UCAR
- Data from the IRD HYBAM group *(Callède et al. 2002)*

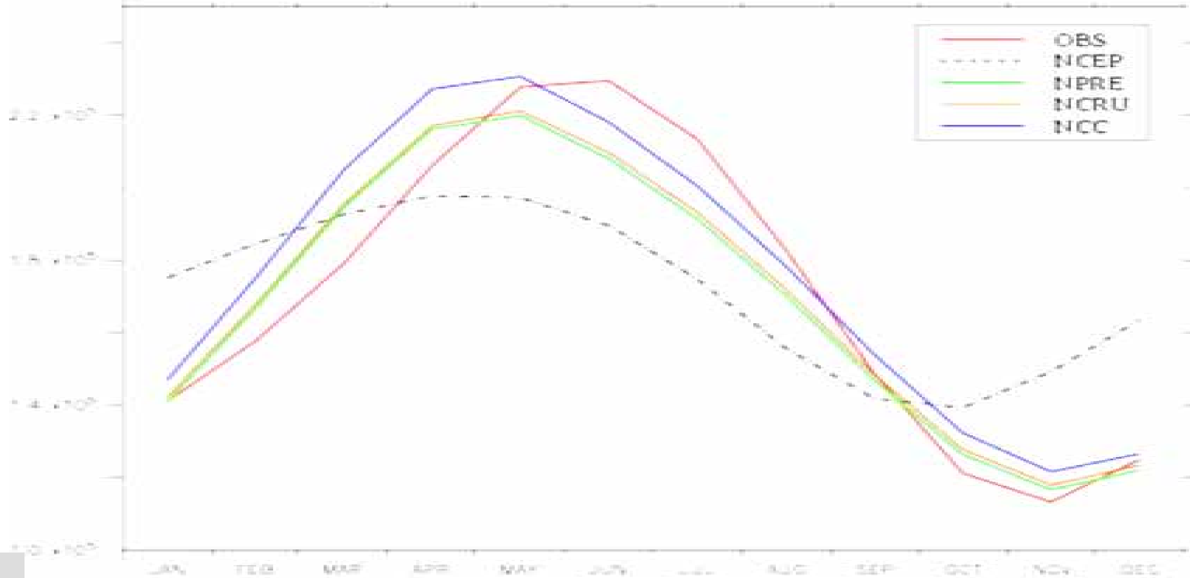
NCC 53-yr forcing data for LSMs

NCC validation

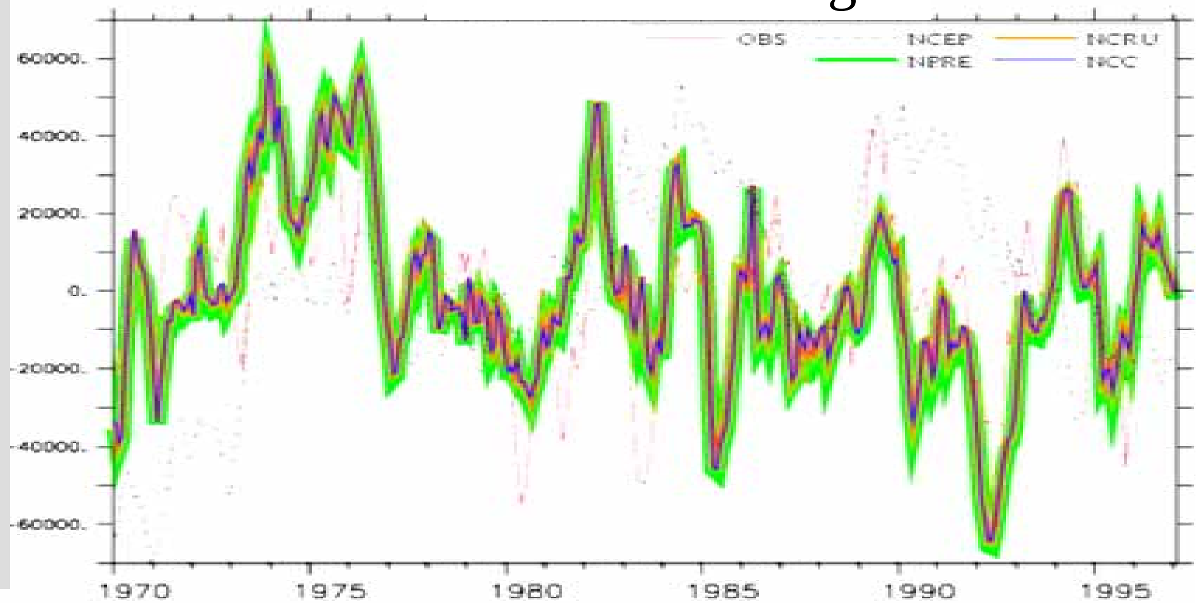
Station Obidos, Amazon

- quality of forcing data is improved after each adjustment
- High flow in simulated mean seasonal signal is too soon
- the temperature correction has a very little effect

Obidos station, Amazon (lon=-55.51,lat=-1.95)

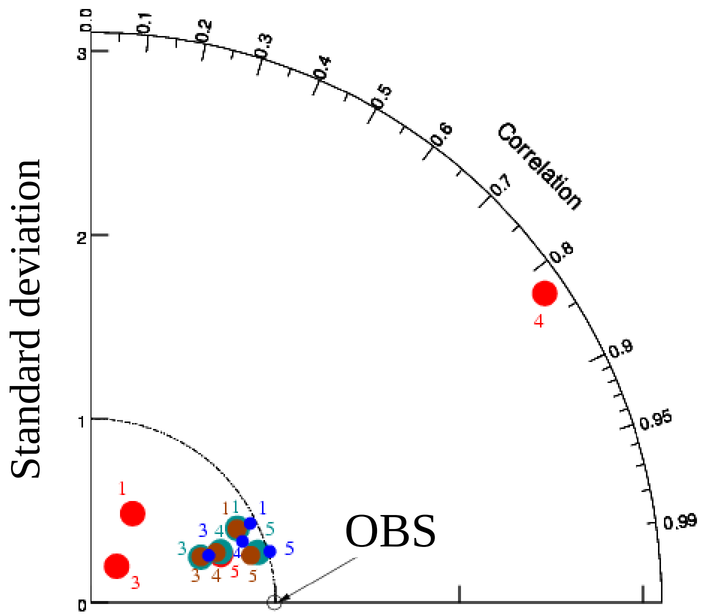


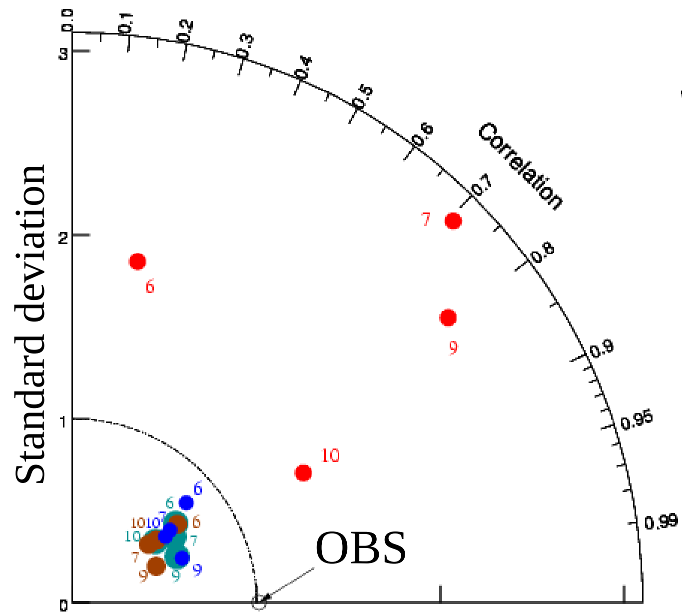
Mean seasonal signal



Anomaly signal

NCC 53-yr forcing data for LSMs

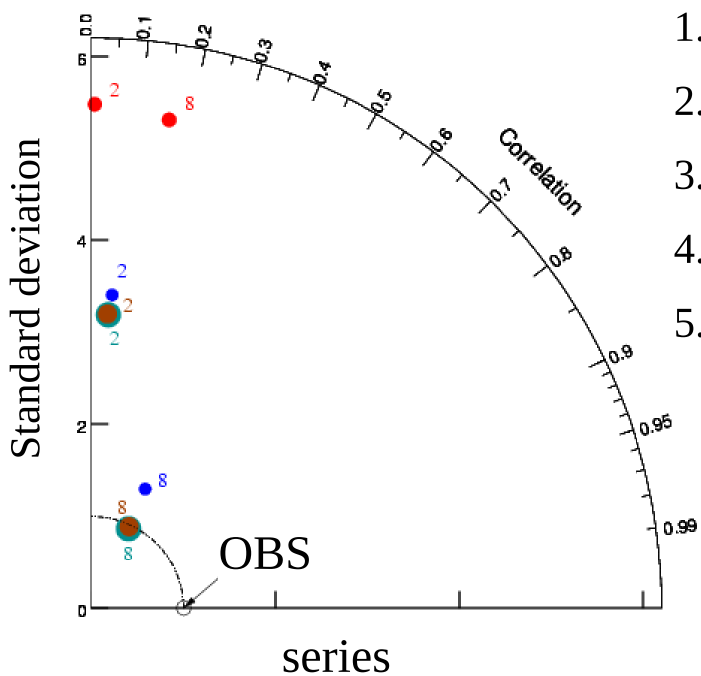




Taylor diagram

(Taylor, 2001)

The quality of forcing data is improved after each adjustment.



1. Amazon
2. Congo
3. Orinoco
4. Changjiang
5. Brahmaputra
6. Mississippi
7. Yenisey
8. Parana
9. Lena
10. Mekong

NCEP **NPRE**

NCRU **NCC**

Precipitation: most important improvement

Temperature: significant effect only at high latitudes

Radiation: improves discharge amlitudes.

Application of NCC

Effects of land water storage on global mean sea level over the past 50-yr

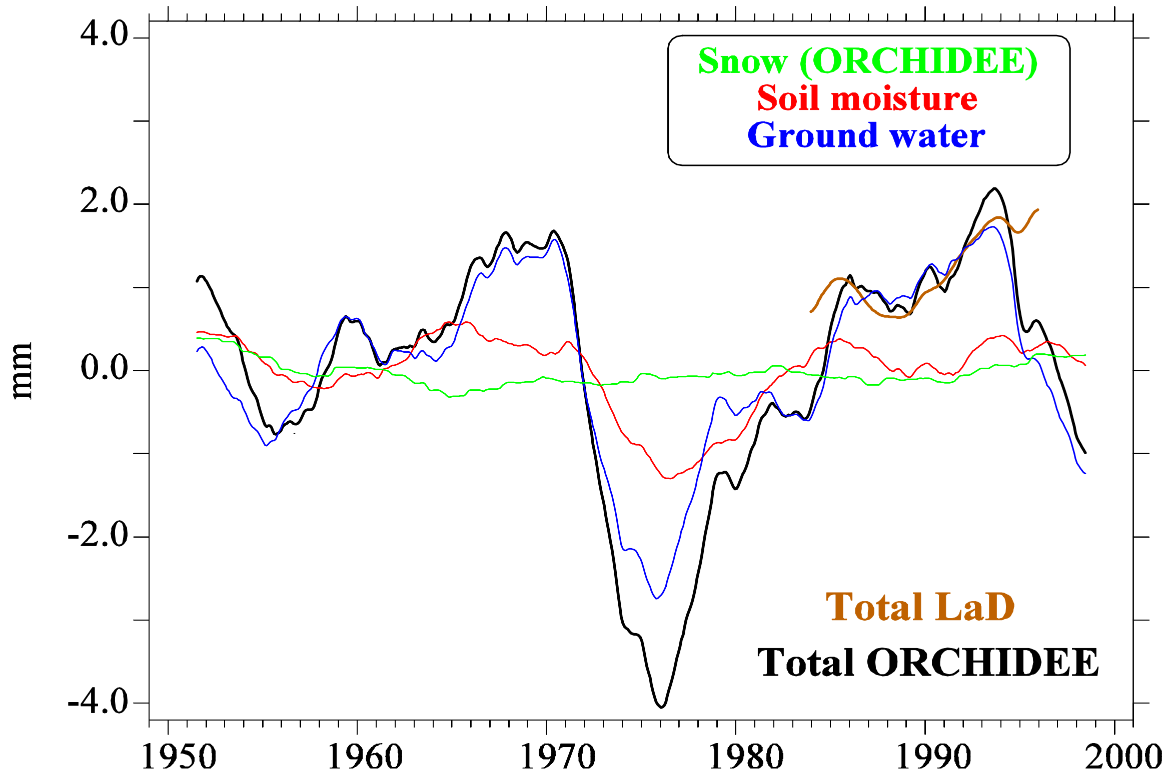
Over the past 50 yr, the rate of global mean sea level rise was on the order of **1.8** mm/yr, where:

- Thermal expansion contribution gives ~ **0.4** mm/yr
- Mountain glaciers melting accounts for ~ **0.4** mm/yr
- Greenland & Antarctica melting provide ~ **0.5** mm/yr

Summing all contributions ~**1.3** mm/yr of **1.8** mm/yr.

→ whether the difference (~ 0.5 mm/yr) can be explained by land water contribution?

Effects of land water storage on global mean sea level over the past 50-yr



5-yr moving average of water reservoirs changes expressed as equivalent global sea level anomalies.

- no significant trend was detected,
- strong decadal variability driven by precipitation,
- greatest variation is associated with ground water, followed by soil moisture,
- agreement between ORCHIDEE and LaD.

Ngo-Duc et al. *(GRL, 2005)*

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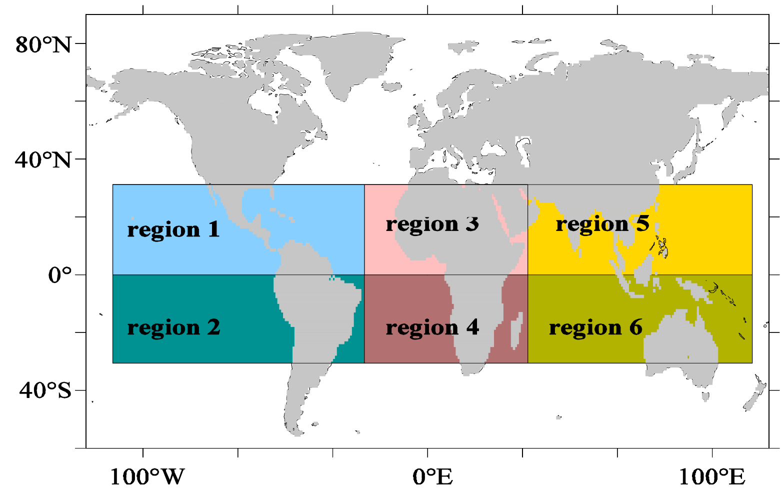
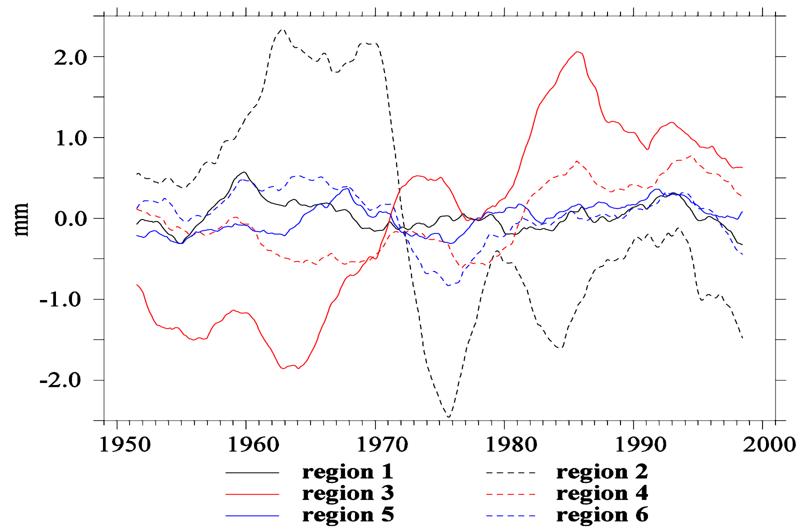
Effects of land water storage on global mean sea level over the past 50-yr



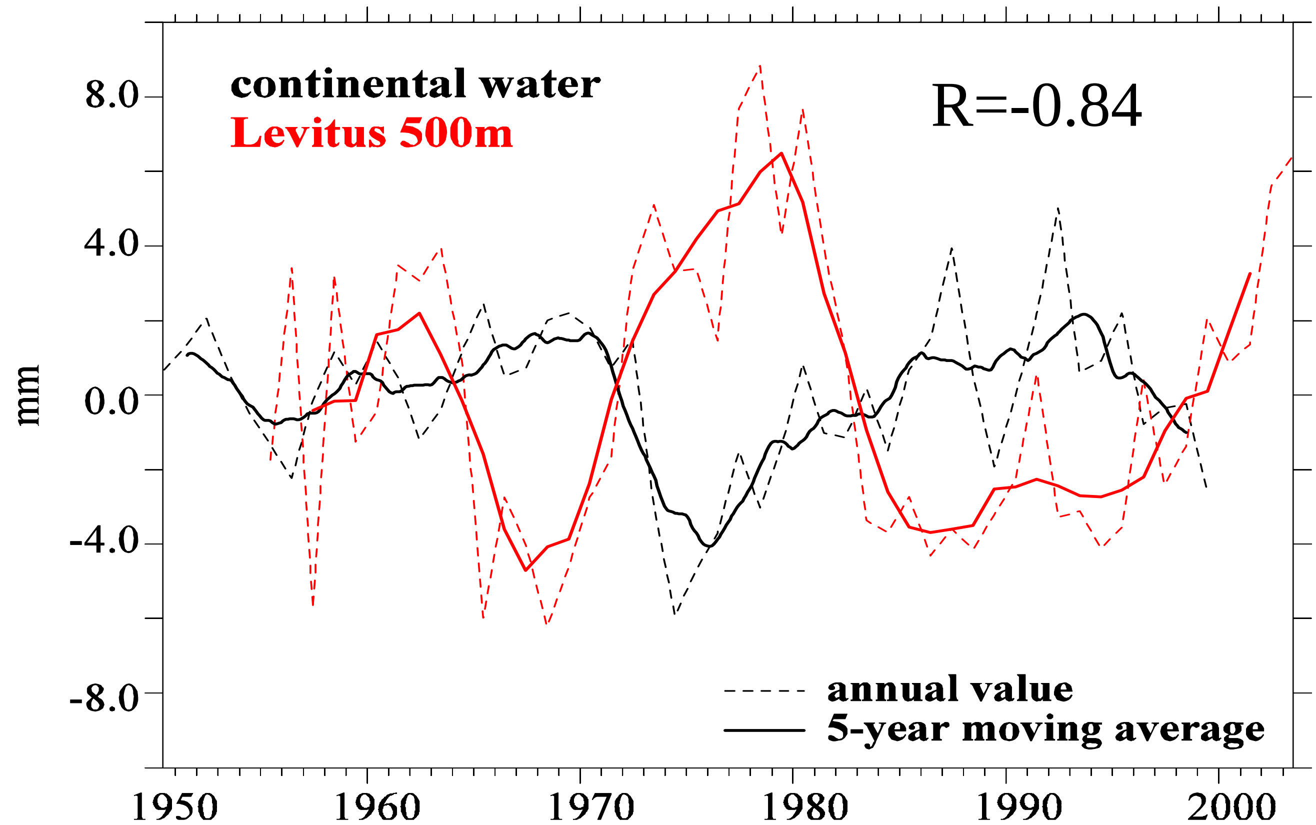


5-yr moving average time series of changes in land water storage for the six studying regions

- the strong decrease of the global signal in the early 1970s is due to changes in the Amazon basin.
- during the past 50 yr, the northern tropical Africa lost water to the benefit of the oceans.
- regions 2 and 3 seem to be anti-correlated (-0.78) ⟶ a possible teleconnection mechanism

Effects of land water storage on global mean sea level over the past 50-yr

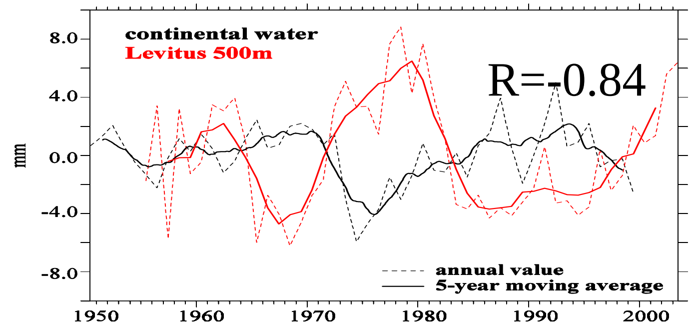
Relations between land water and thermosteric sea level fluctuations



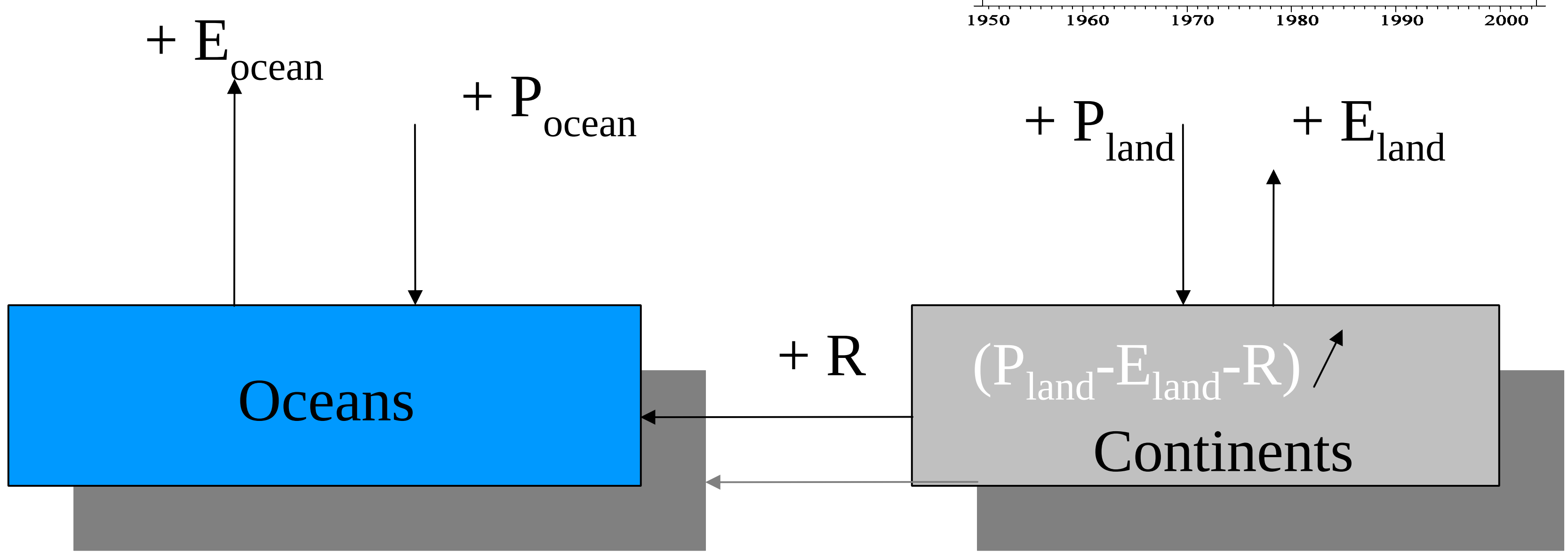
High anti-correlation

Effects of land water storage on global mean sea level over the past 50-yr

Relations between land water and thermosteric sea level fluctuations



Hypothesis



Sea level ↗ due to thermosteric effect

T_{ocean} ↗ → Land water ↗ → Ocean mass ↘ → Sea level ↘

oceans warmer → continents wetter → negative feedback to sea level

Conclusions

The NCC forcing data set was successfully constructed and validated

ORCHIDEE forced by NCC simulates well land water components: good agreement with the river discharge observations

Over the past 50-yr: no significant trend but a strong decadal variability of land water storage, mainly due to changes in South America and northern tropical Africa.

Warming of the ocean influences the water cycle, leading to increased storage of land water, which in turn partly compensates for the thermal expansion contribution to sea level change.

To download the NCC data (~40GB):

http://dods.lmd.jussieu.fr/cgi-bin/nph-dods/Dods/NCC/