Zeespiegelstijging
meten, begrijpen, voorspellen

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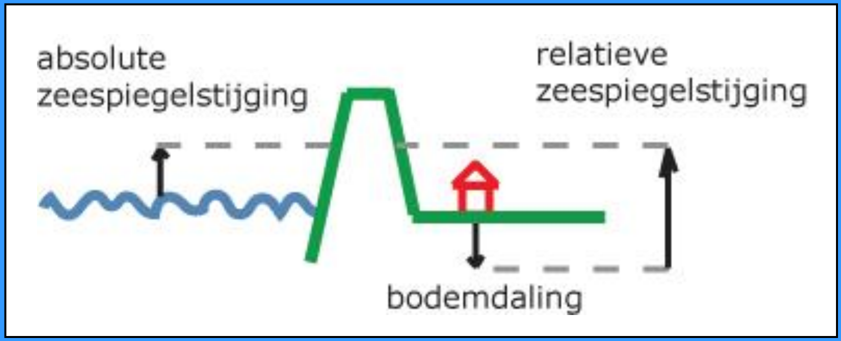
Global mean sea level rise

- more water — land ice melt, changing river discharge, changing land storage
- warmer water — ocean expansion

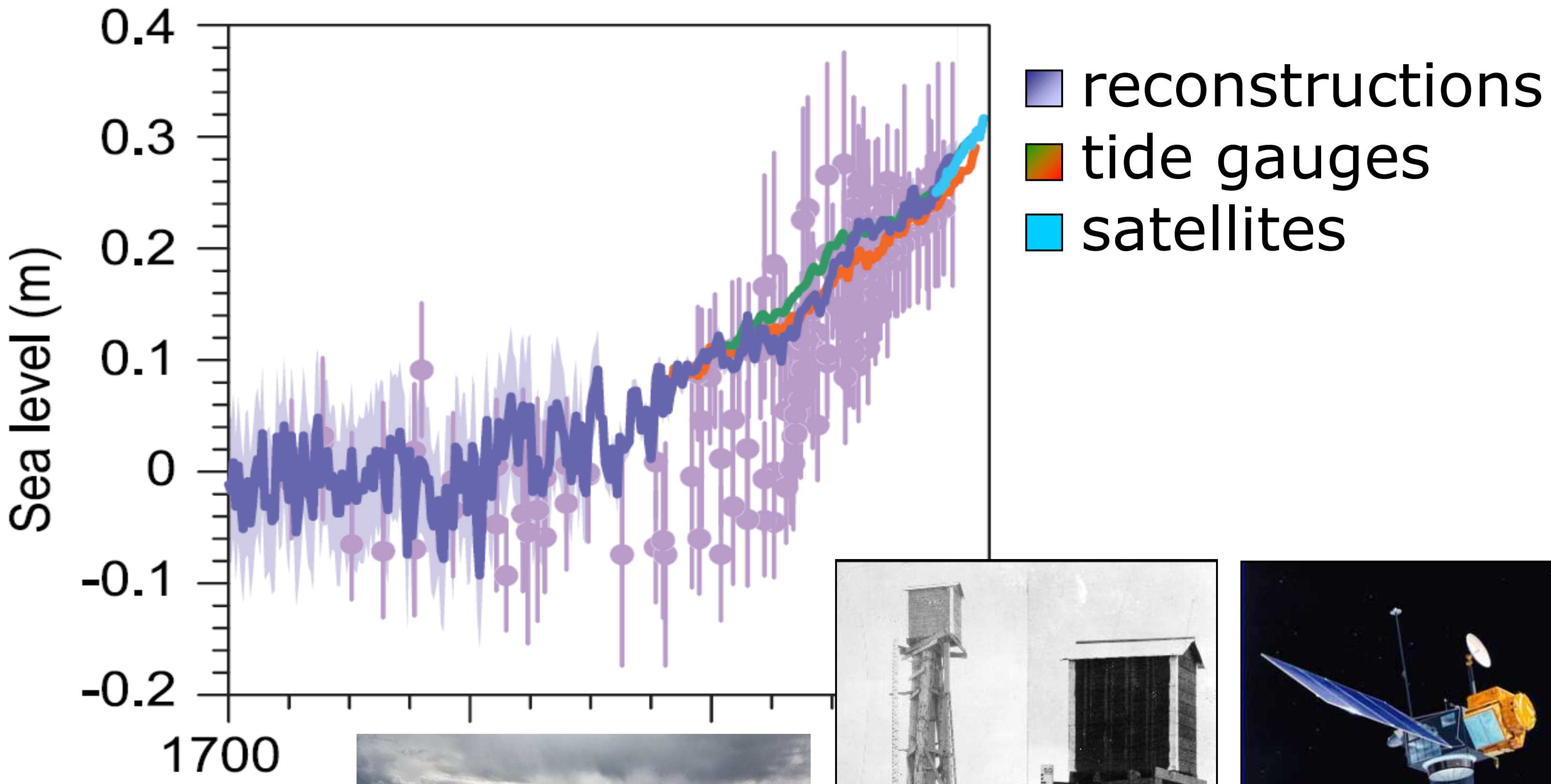


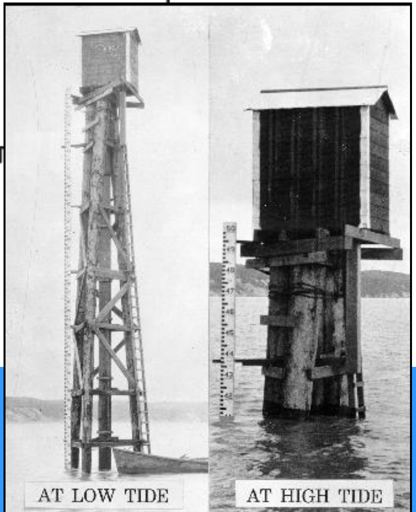
subsidence

Jakarta

OBSERVATIONS

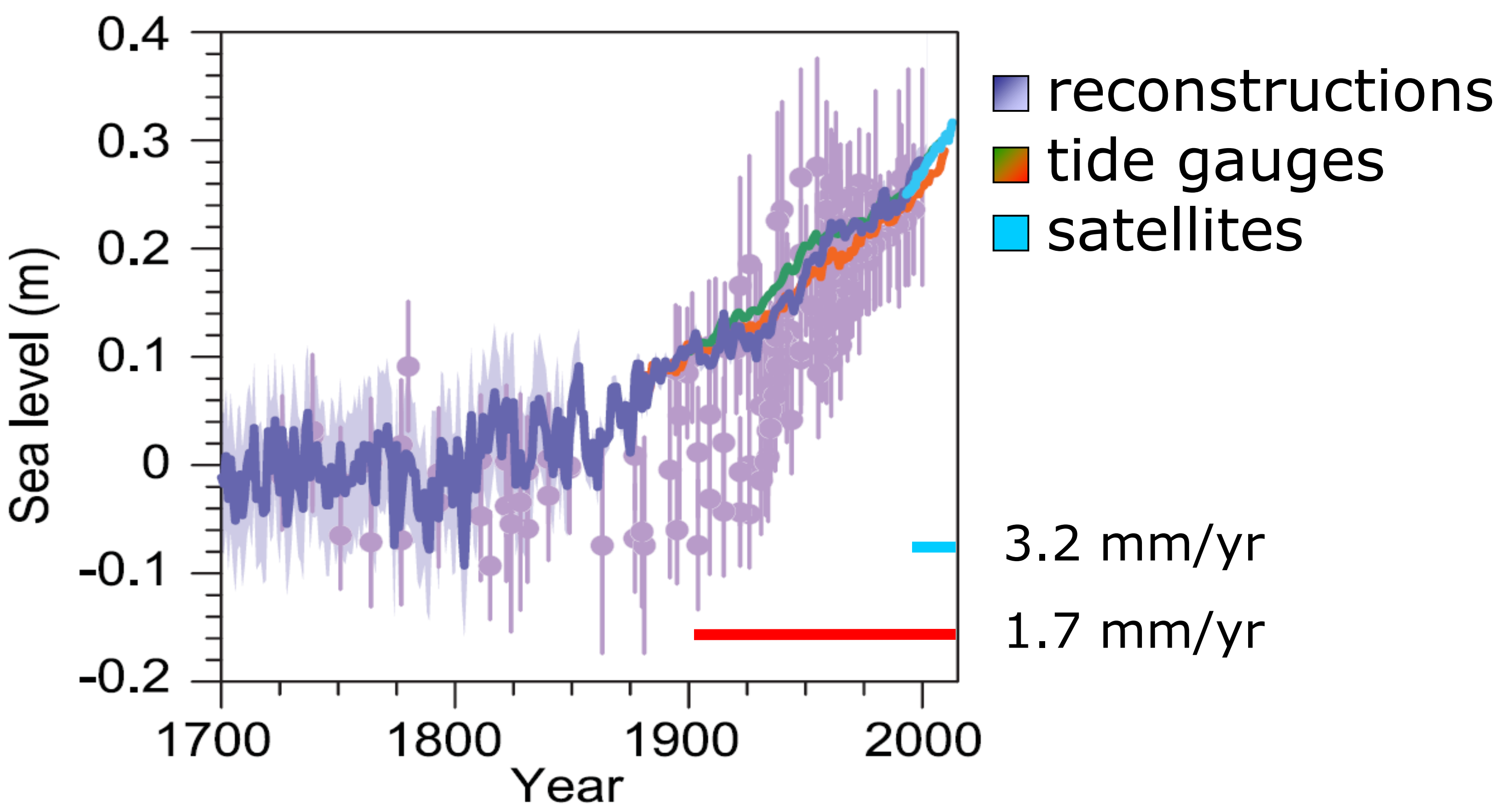
Global mean sea level rise





IPCC 5AR (2013)

Global mean sea level rise



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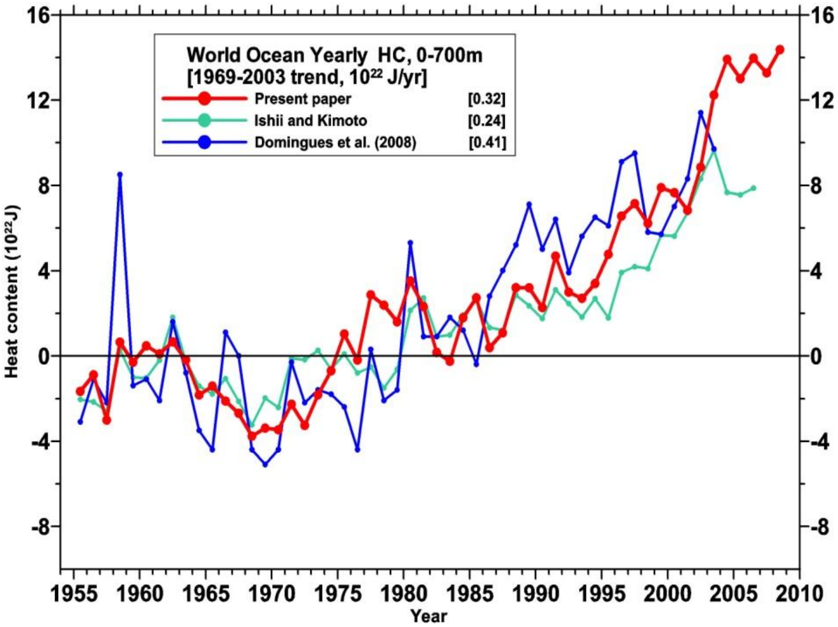
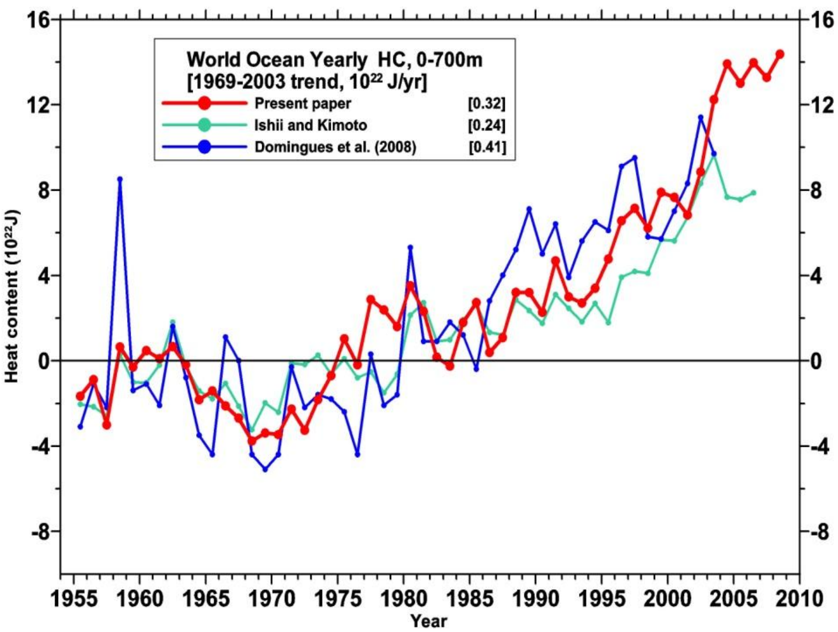
Ocean heat uptake



Levitus et al (2009)
0-700 m

Ocean heat uptake



Levitus et al (2009)
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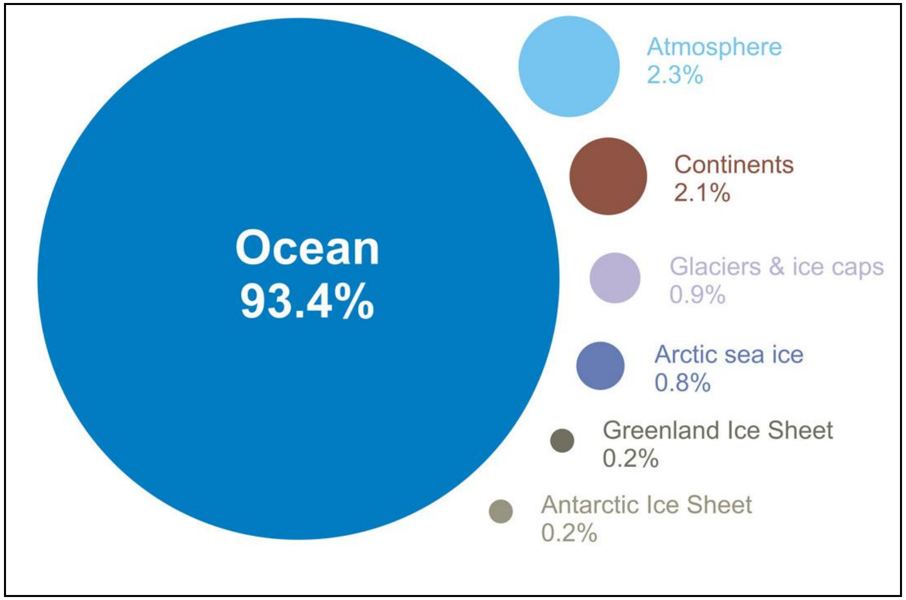
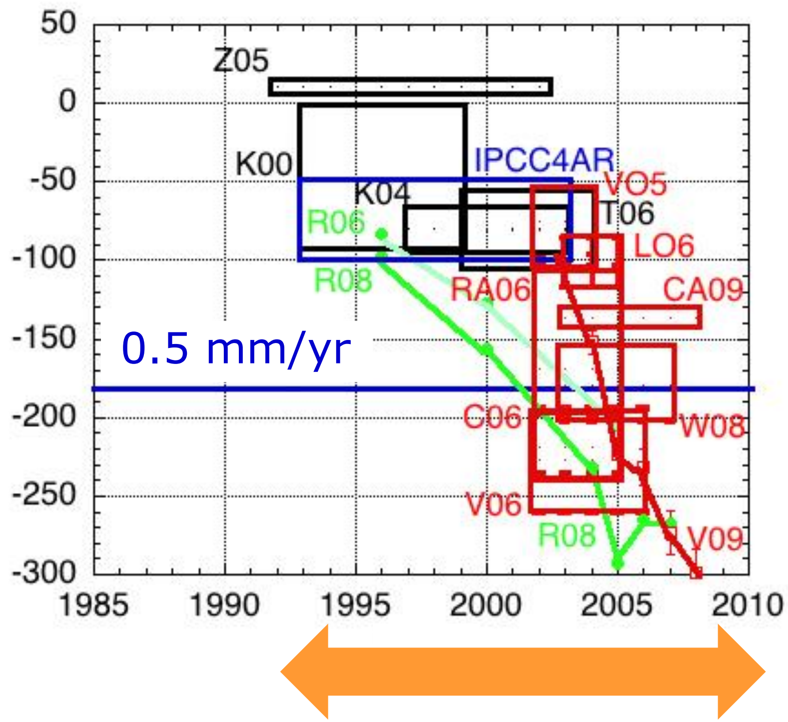
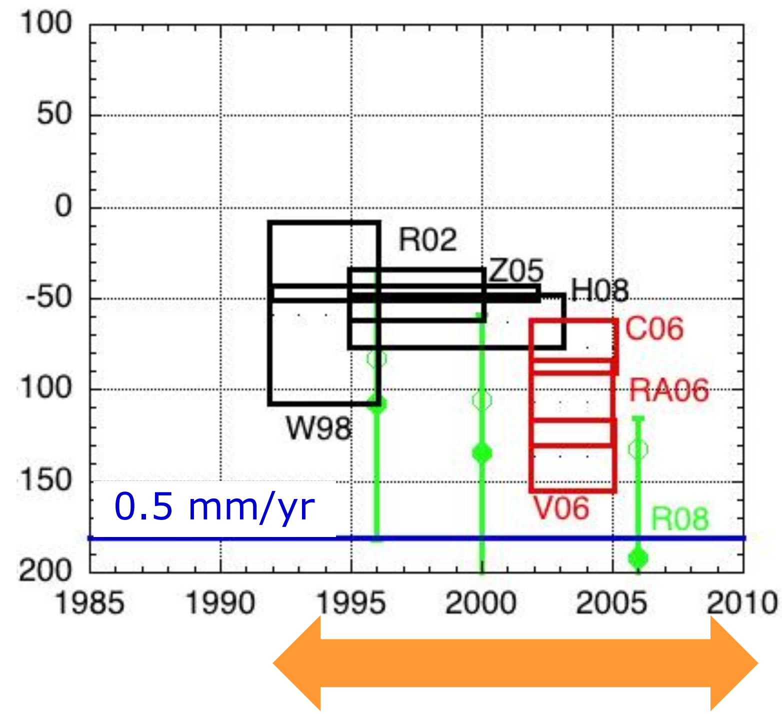


% energy content change ('93-'03)
[data source: IPCC (2007)]

Mass loss ice sheets



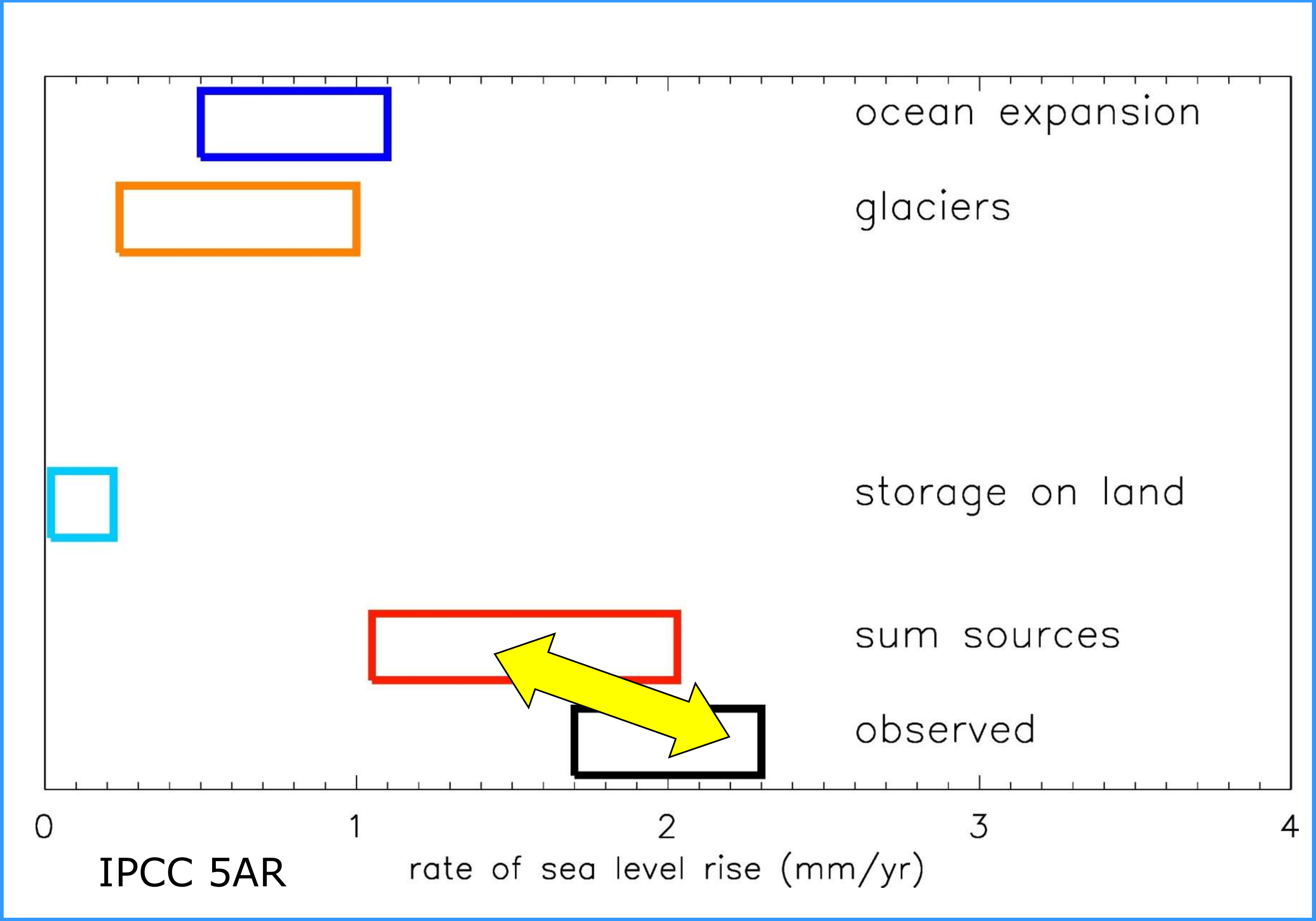
Greenland



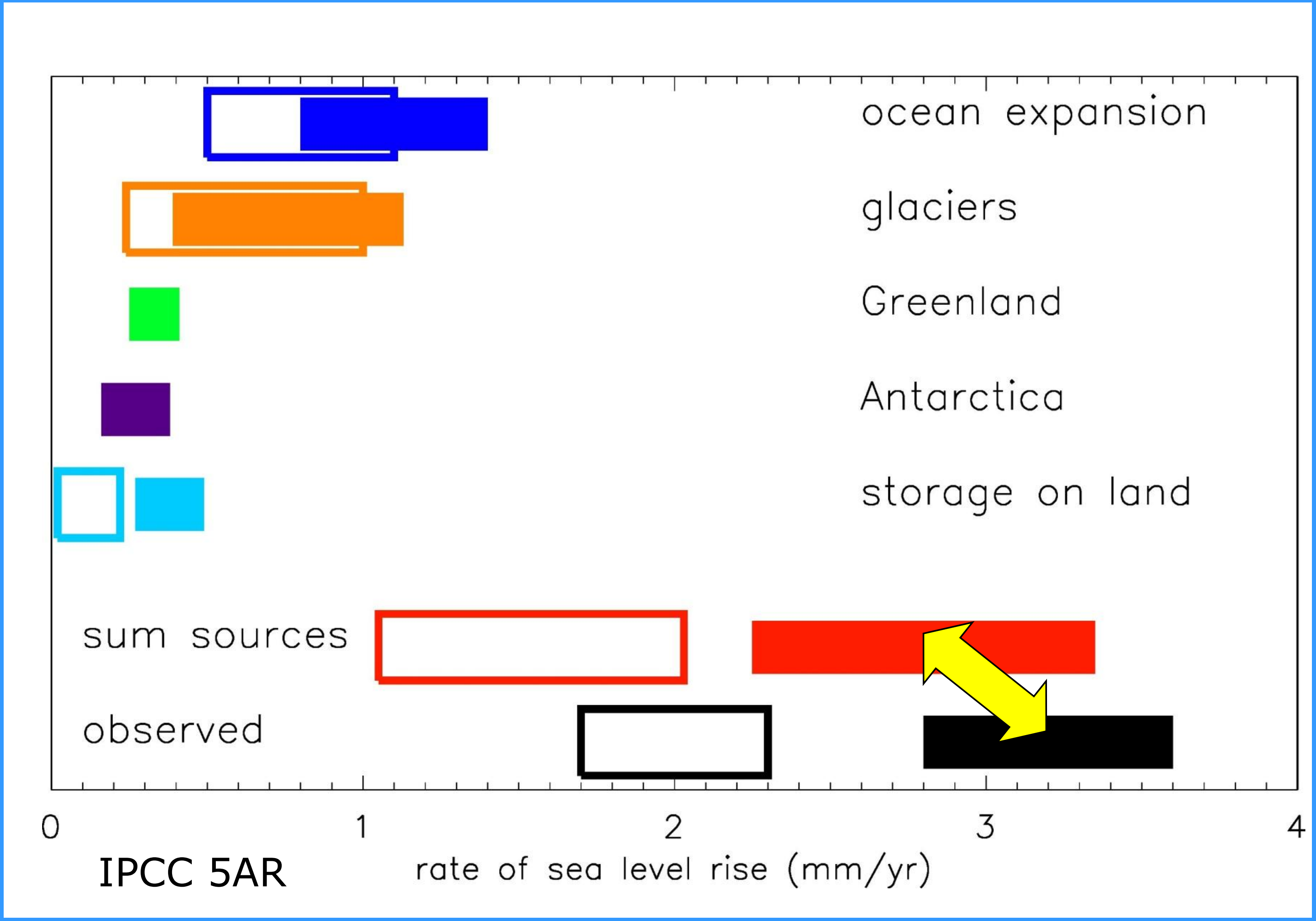
West-Antarctic ice sheet

[compiled by Roderik van de Wal for Delta Commission / Katsman et al (2011)]

Sea level budget [1971-2010]



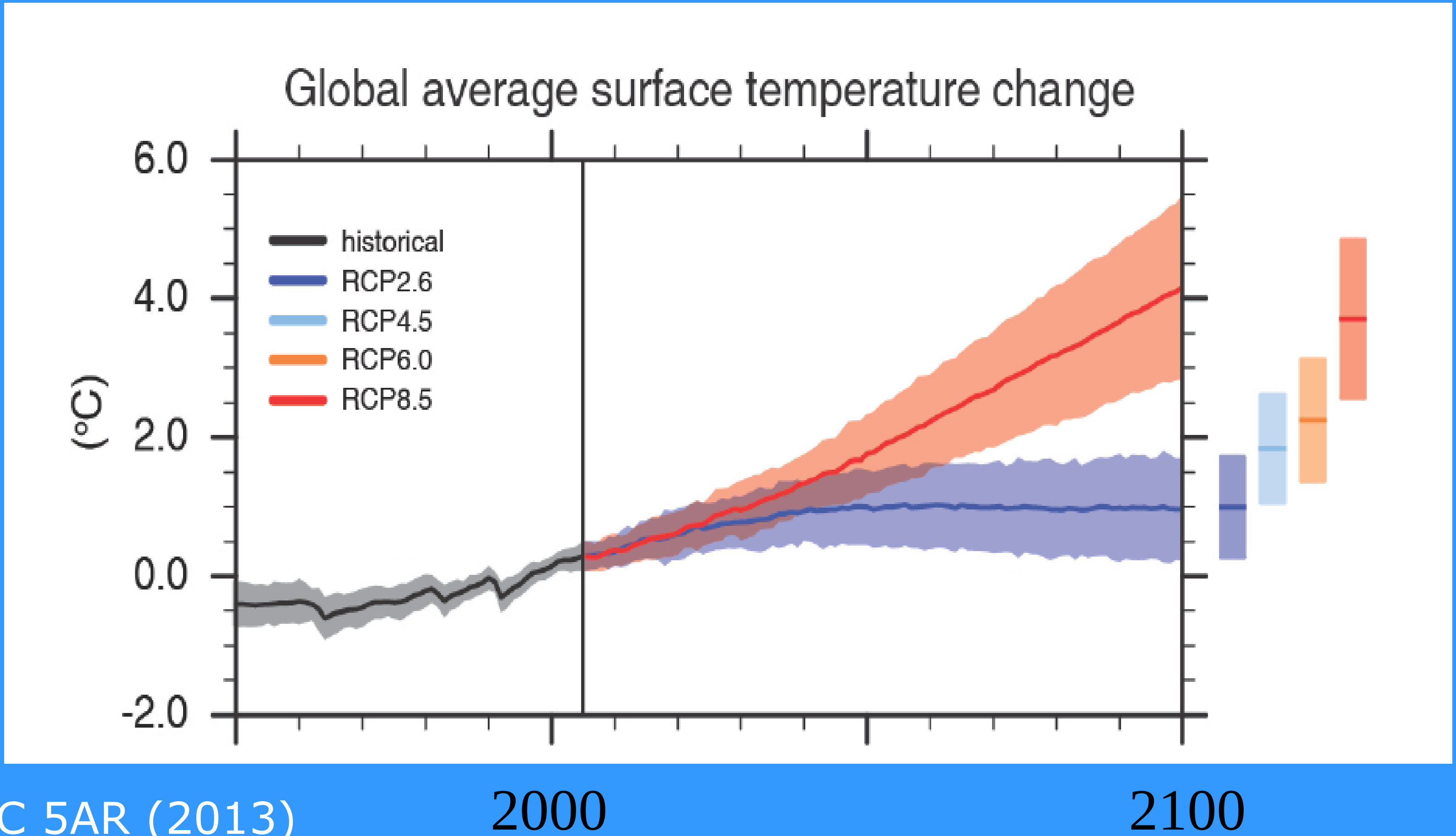
Sea level budget [1993-2010]



FUTURE SEA LEVEL RISE

Global mean temperature rise

Increase for 2081–2100: 0.3°C - 4.8°C
(depending on emission scenario)



IPCC 5AR (2013)

Sea level projections

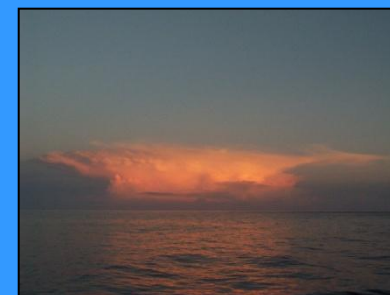
summed contributions of individual components

global mean thermal expansion

glaciers & ice caps

Greenland

Antarctica



Sea level projections

summed contributions of individual components

global mean thermal expansion

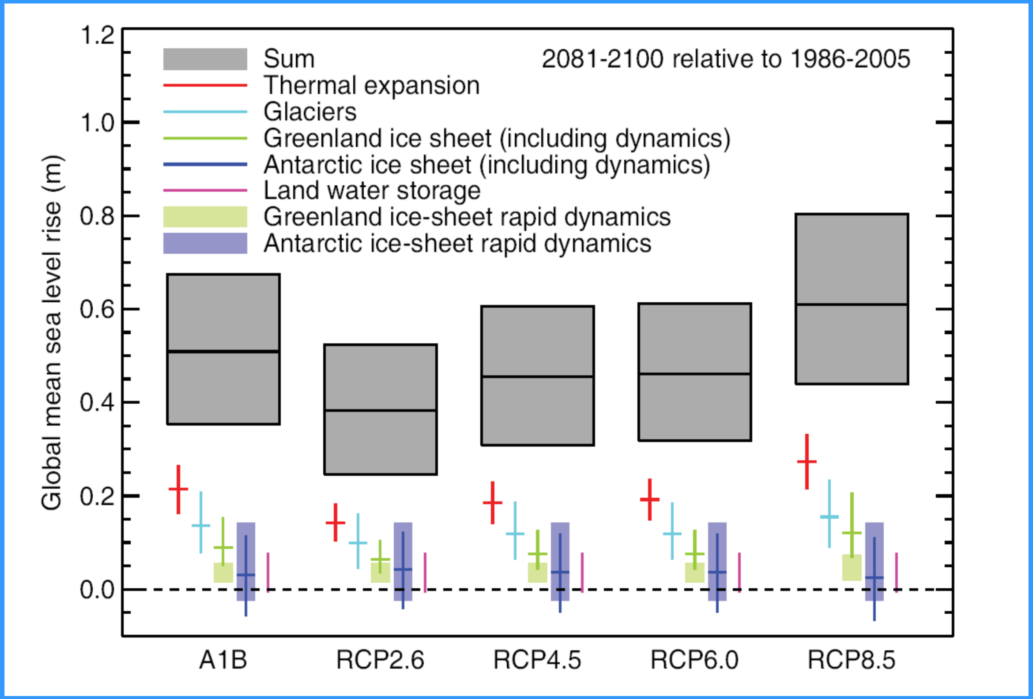
glaciers & ice caps

Greenland

Antarctica

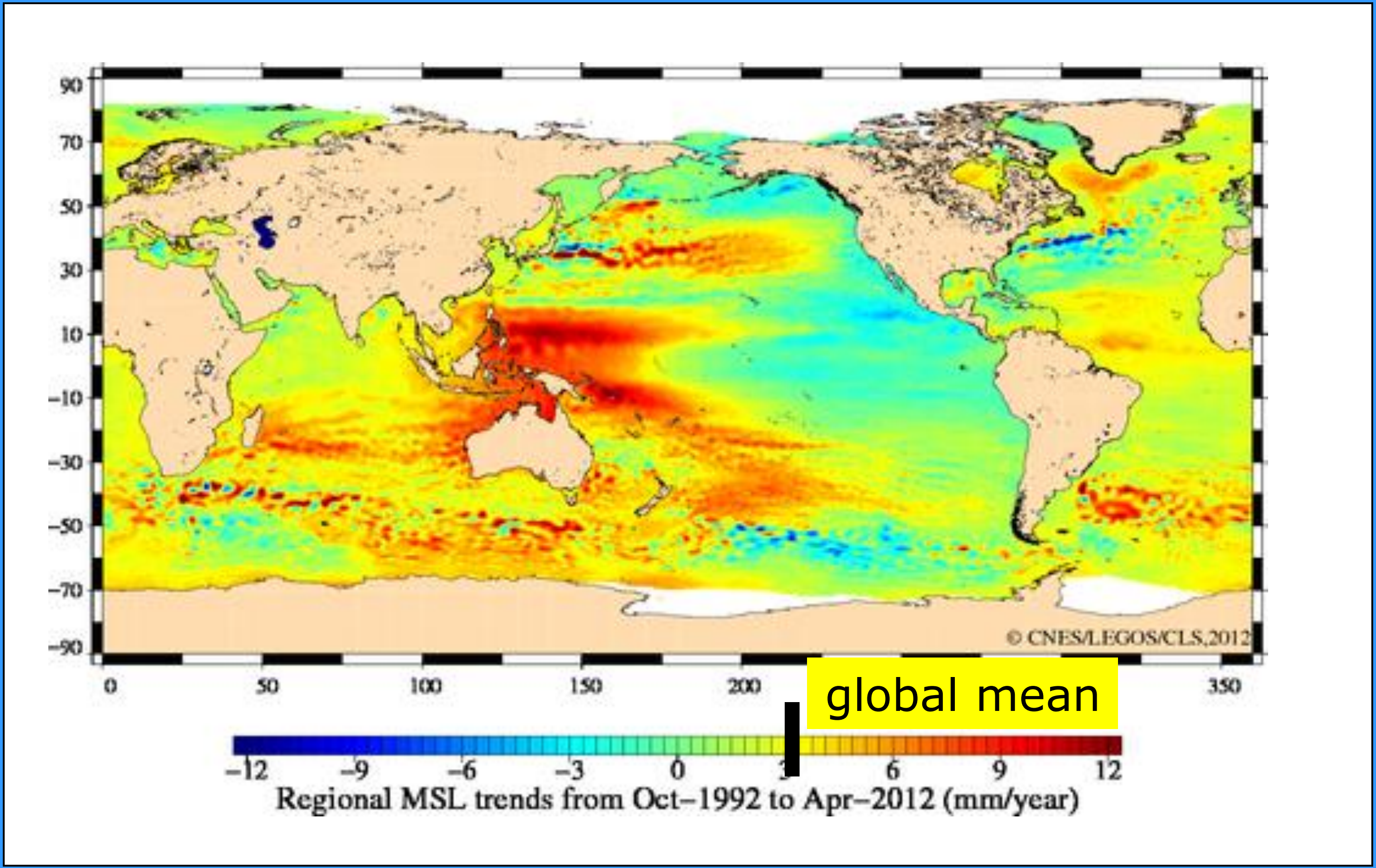
36-81 cm

IPCC 5AR (2013)



REGIONAL VARIATIONS

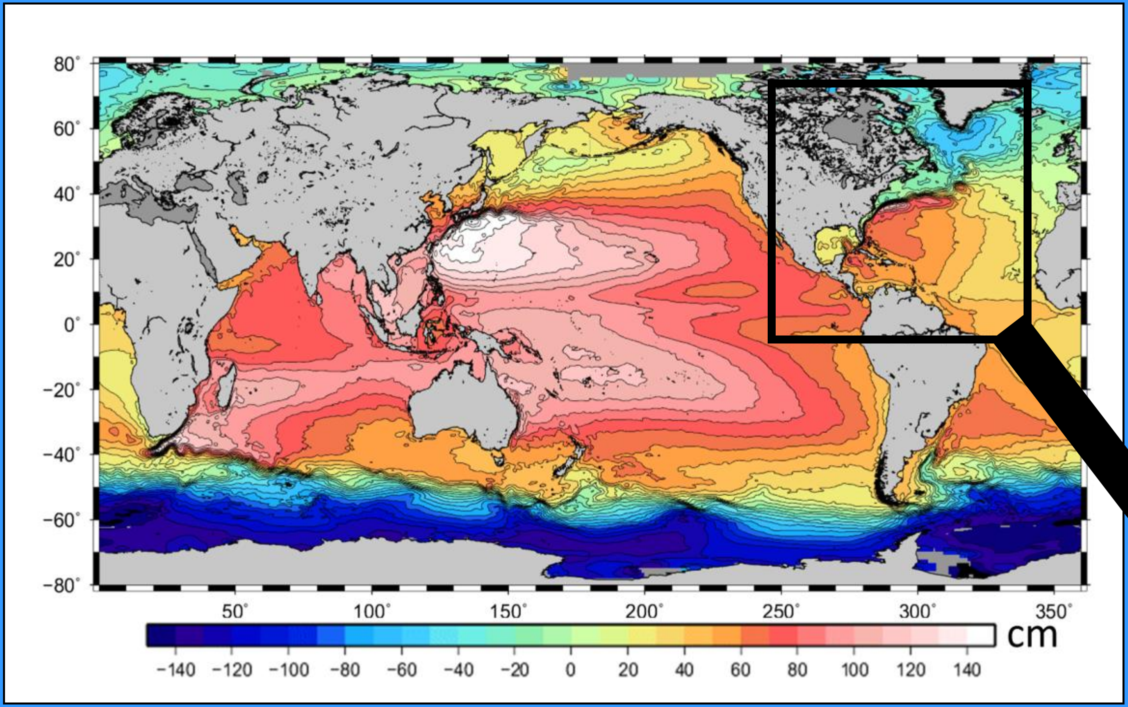
Observed sea level change

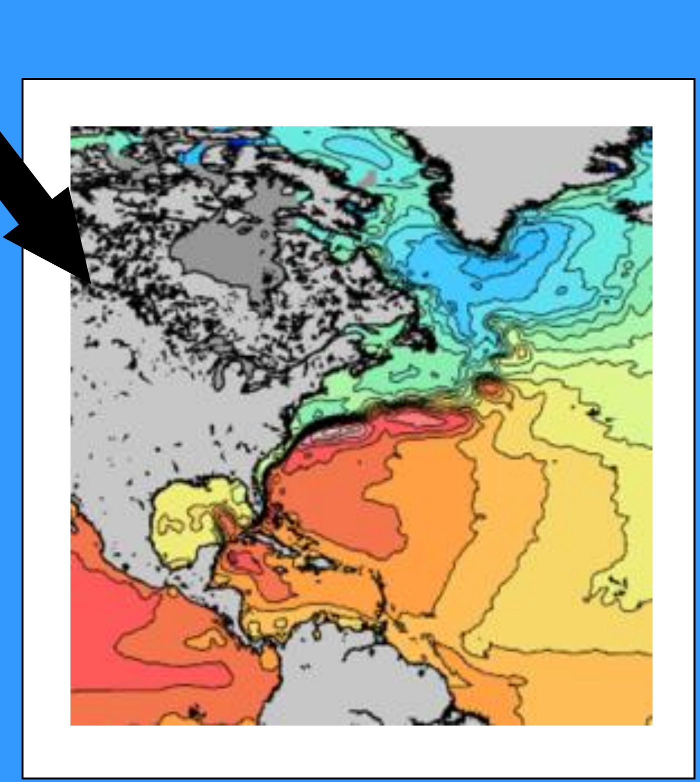


natural variability +

spatially varying long-term trends

Changing ocean density & dynamics



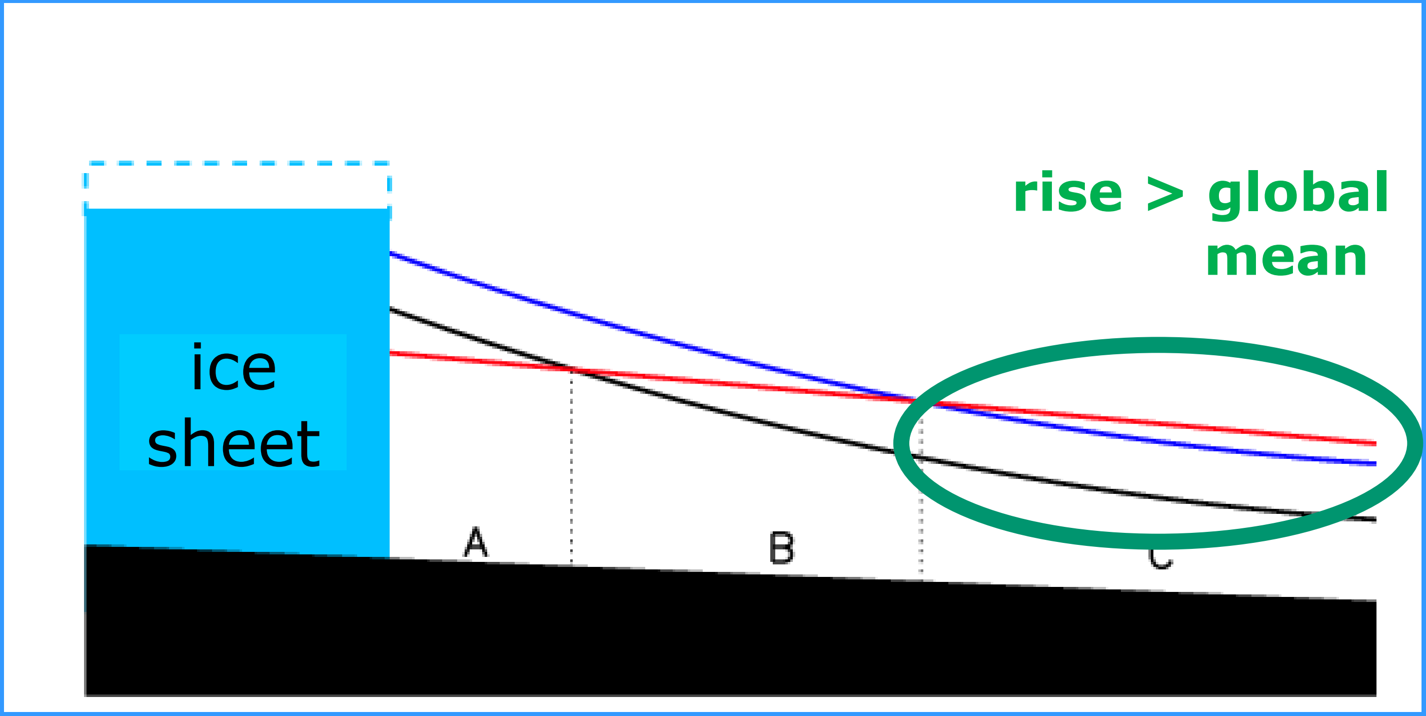


+ atmospheric loading

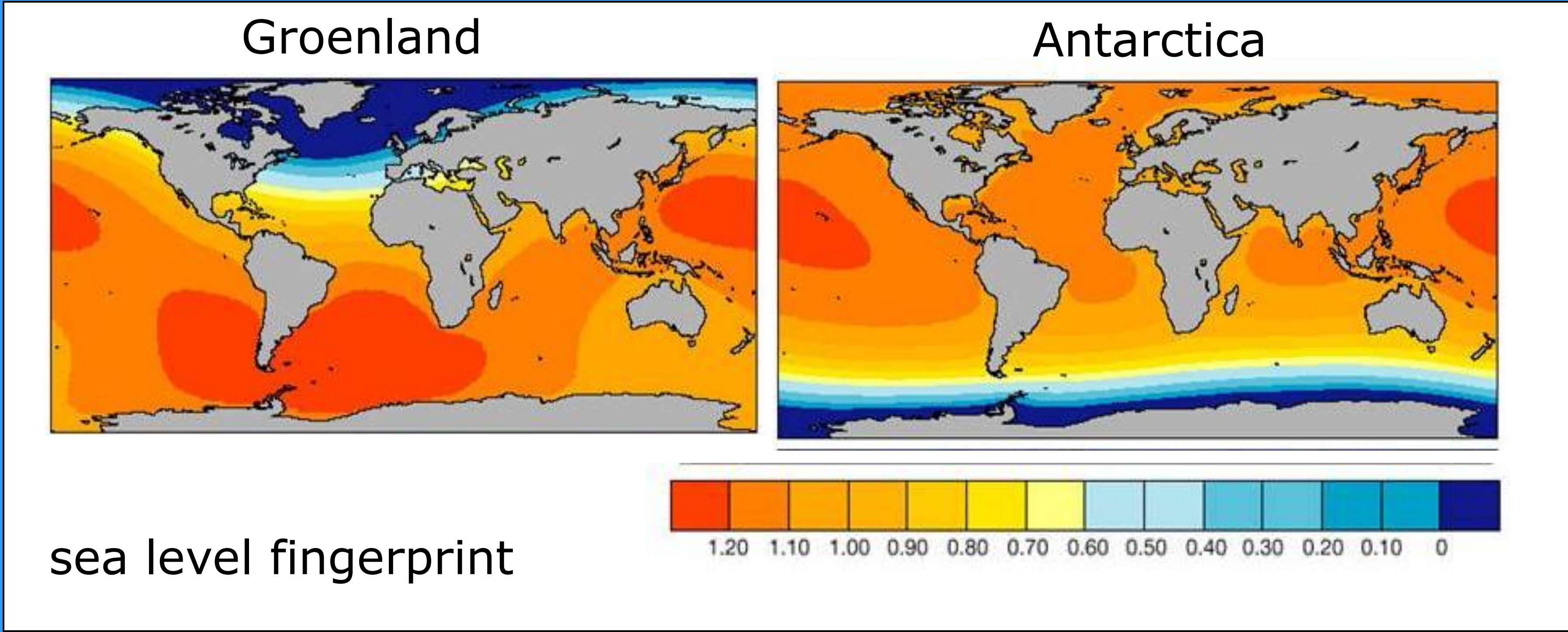
Self-gravitation effect

ice mass loss ⇒ melt water added to the ocean

⇒ sea level tilts

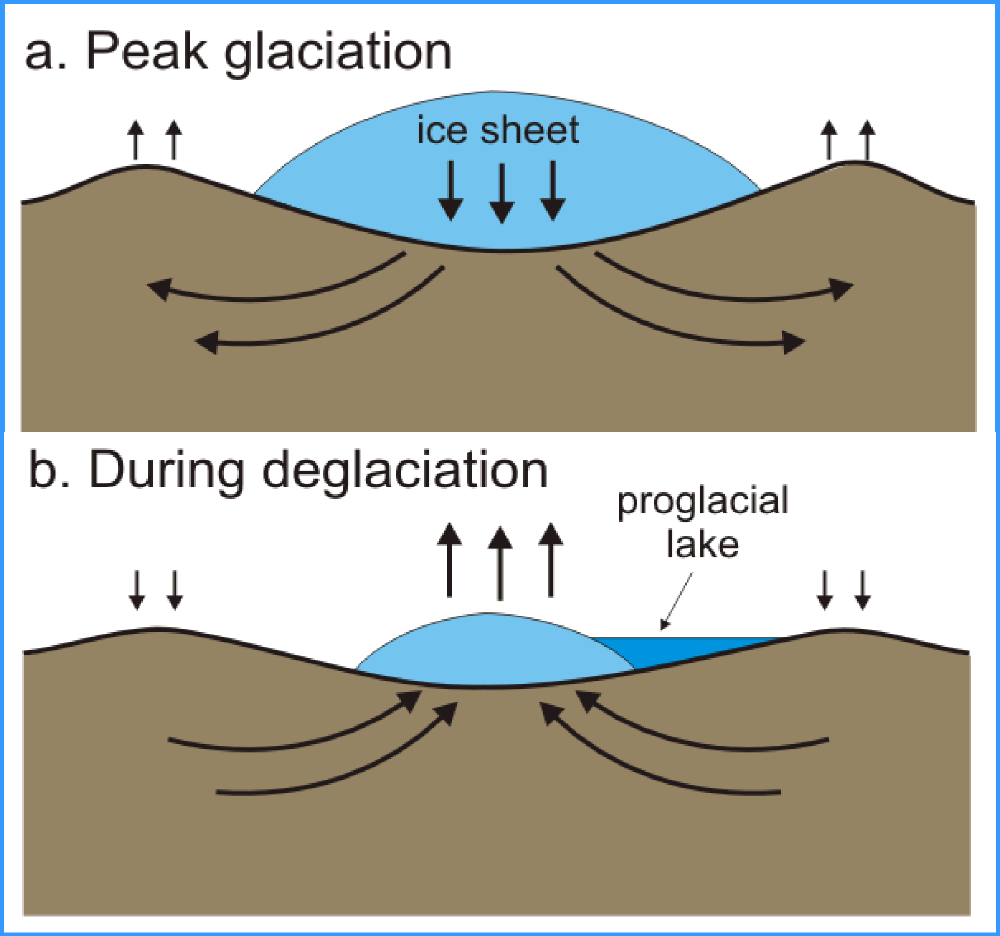


Self-gravitation effect

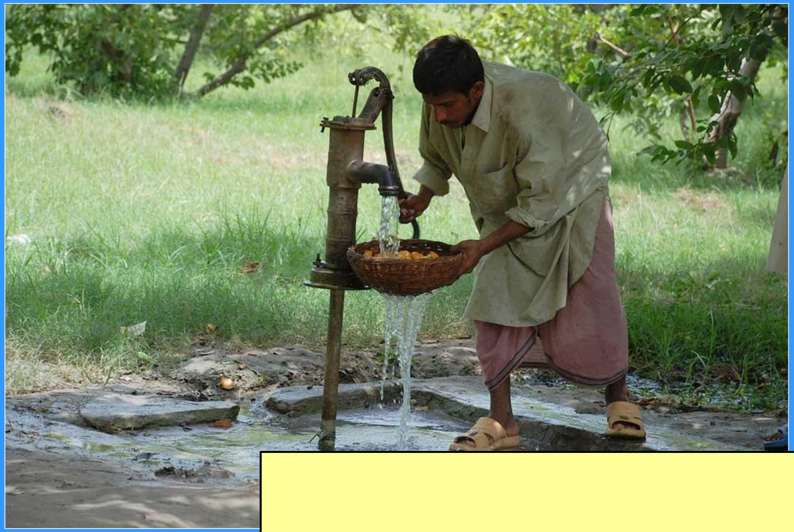


Mitrovica et al (2001)

Glacial Isostatic Adjustment



Land water storage



building of dams

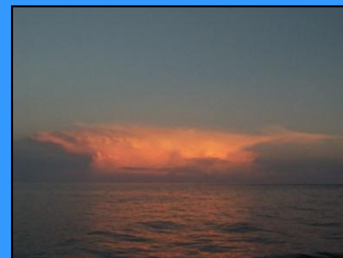
ground

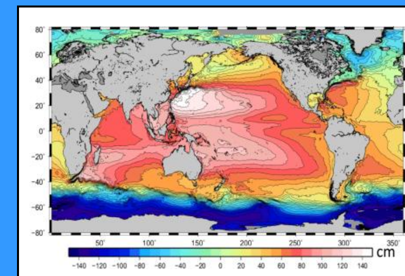
NOTE:
self-gravitation
needs to be
accounted for

REGIONAL PROJECTIONS

Regional projections

ocean expansion

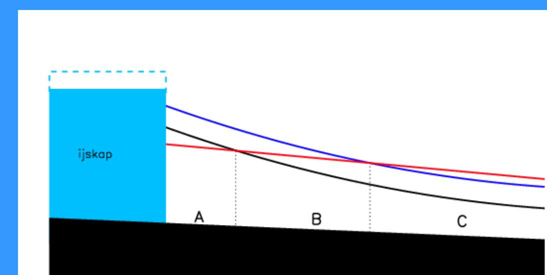




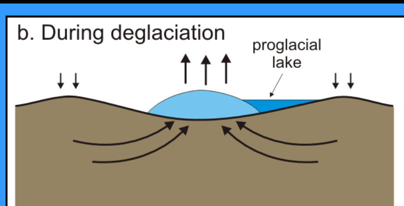
glaciers & ice caps

Greenland

Antarctica



GIA

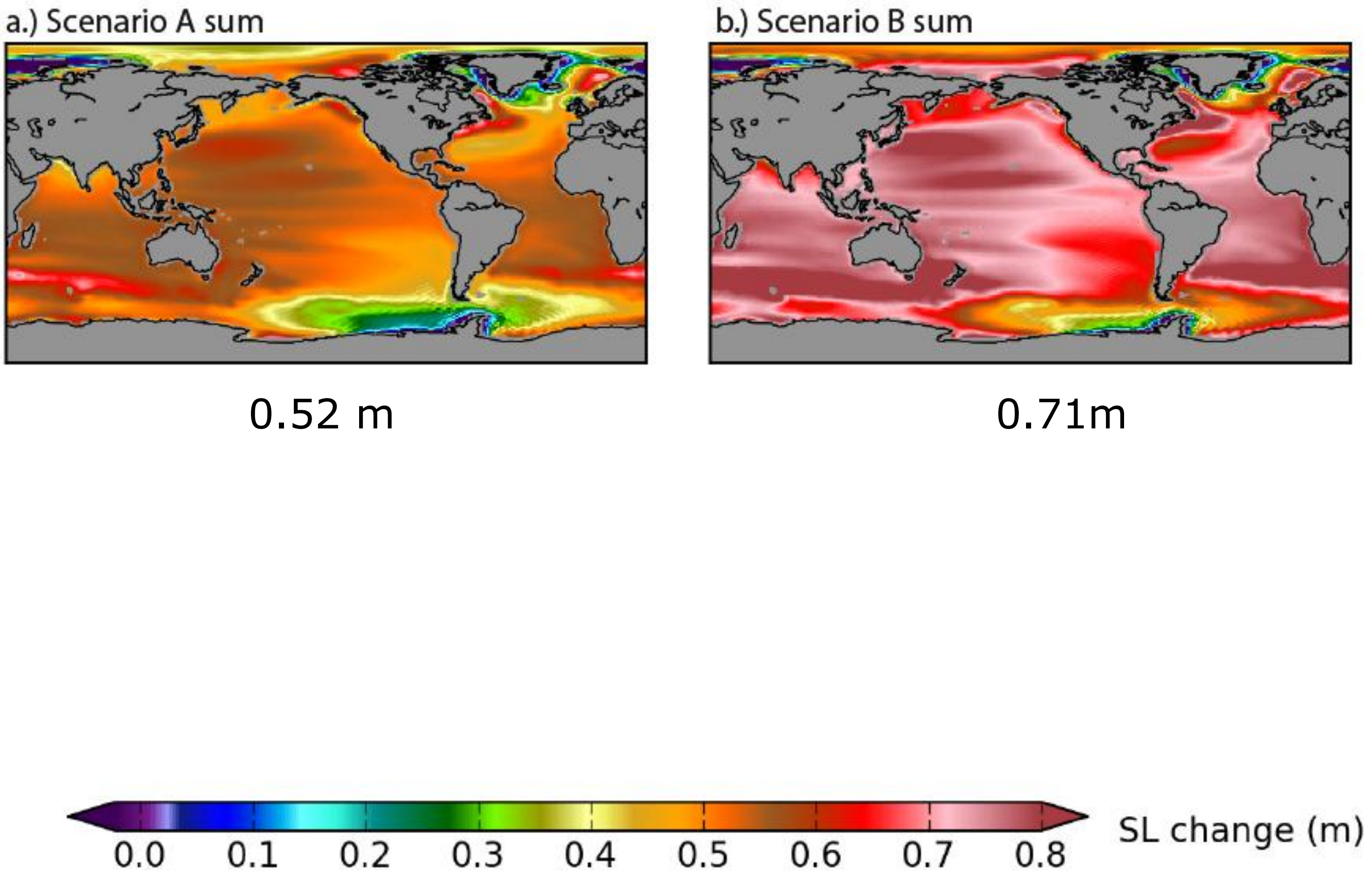


Slangen et al (accepted)

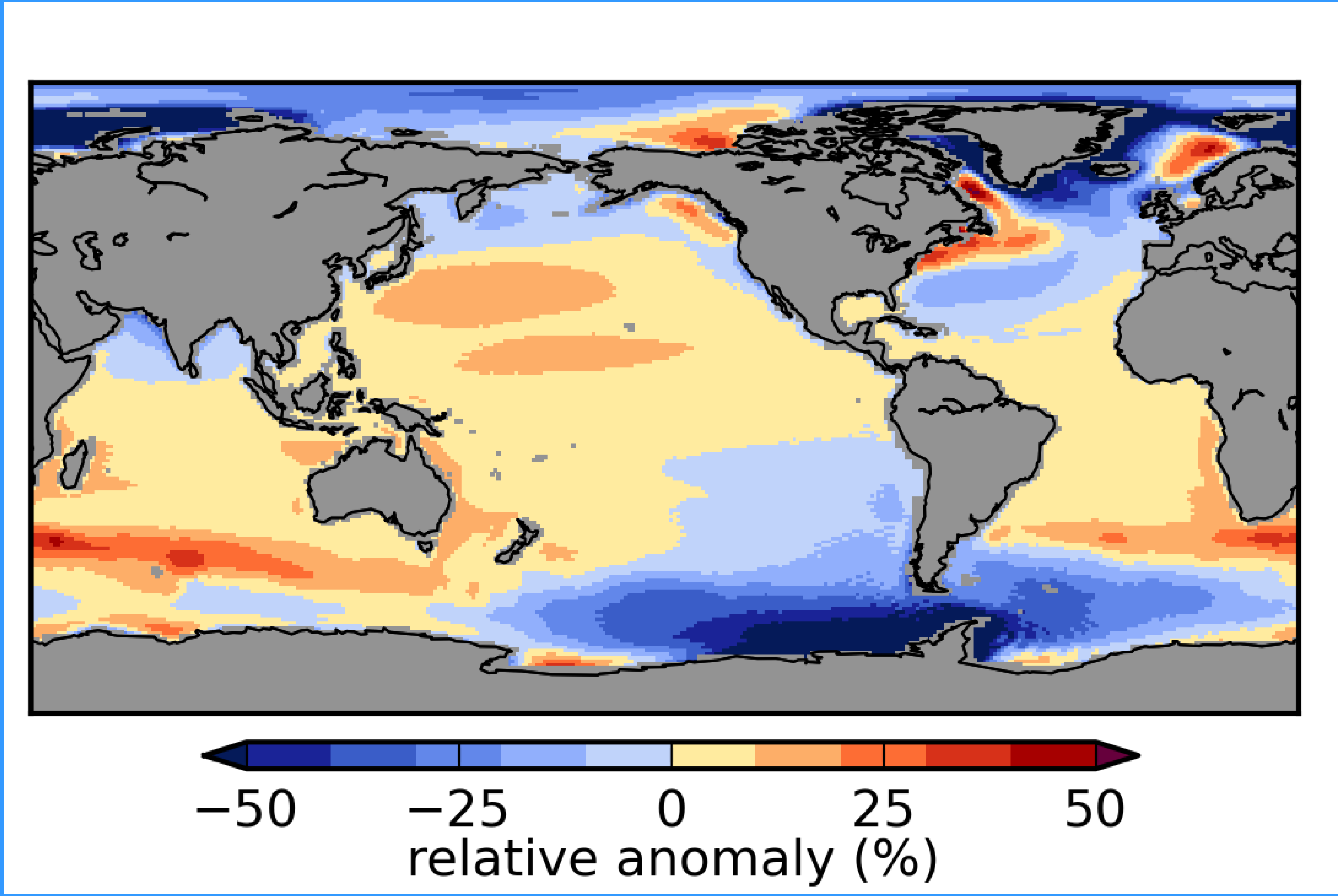
land storage

Moderate

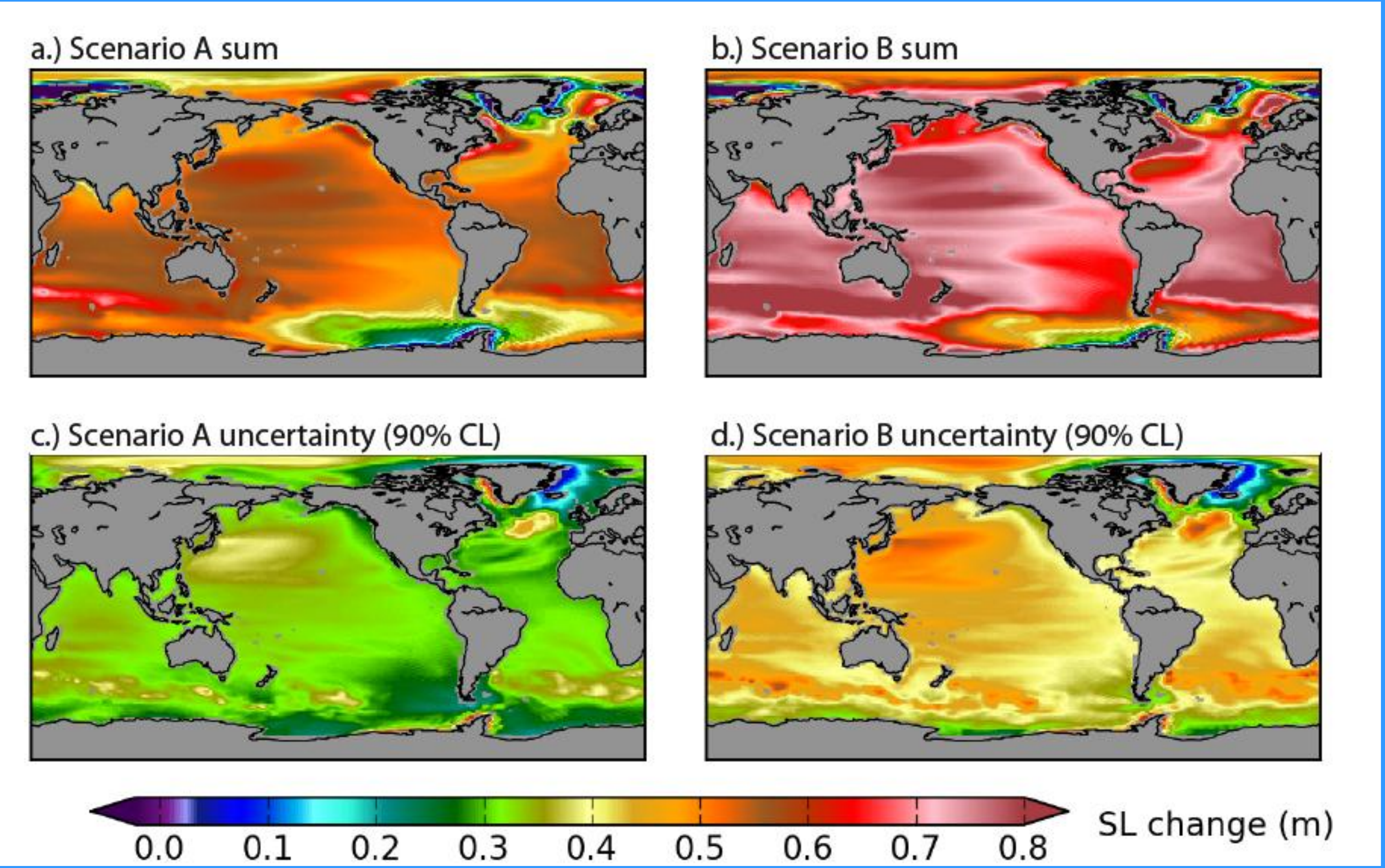
Warm



Spatial variations

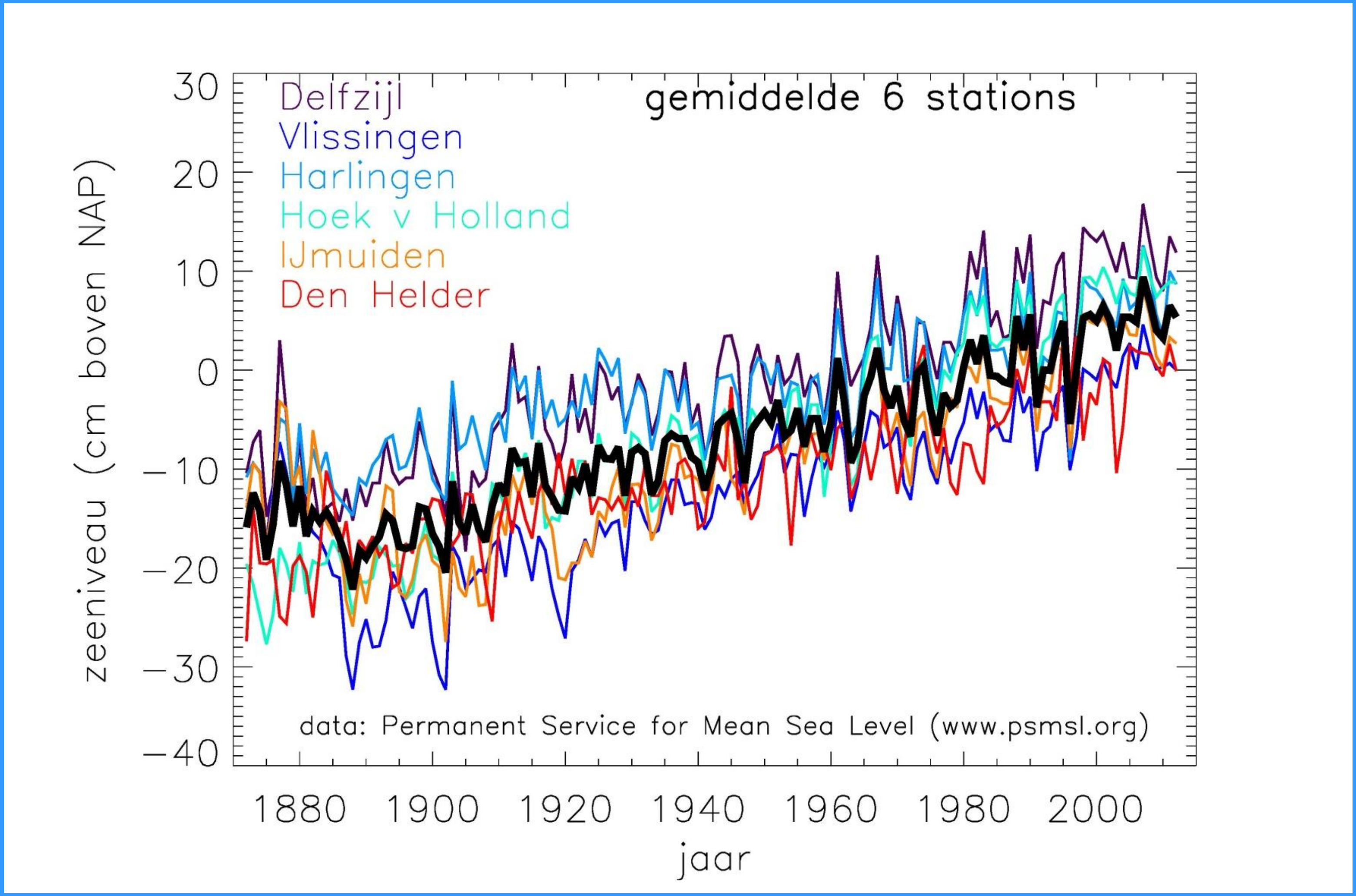


Moderate   Warm



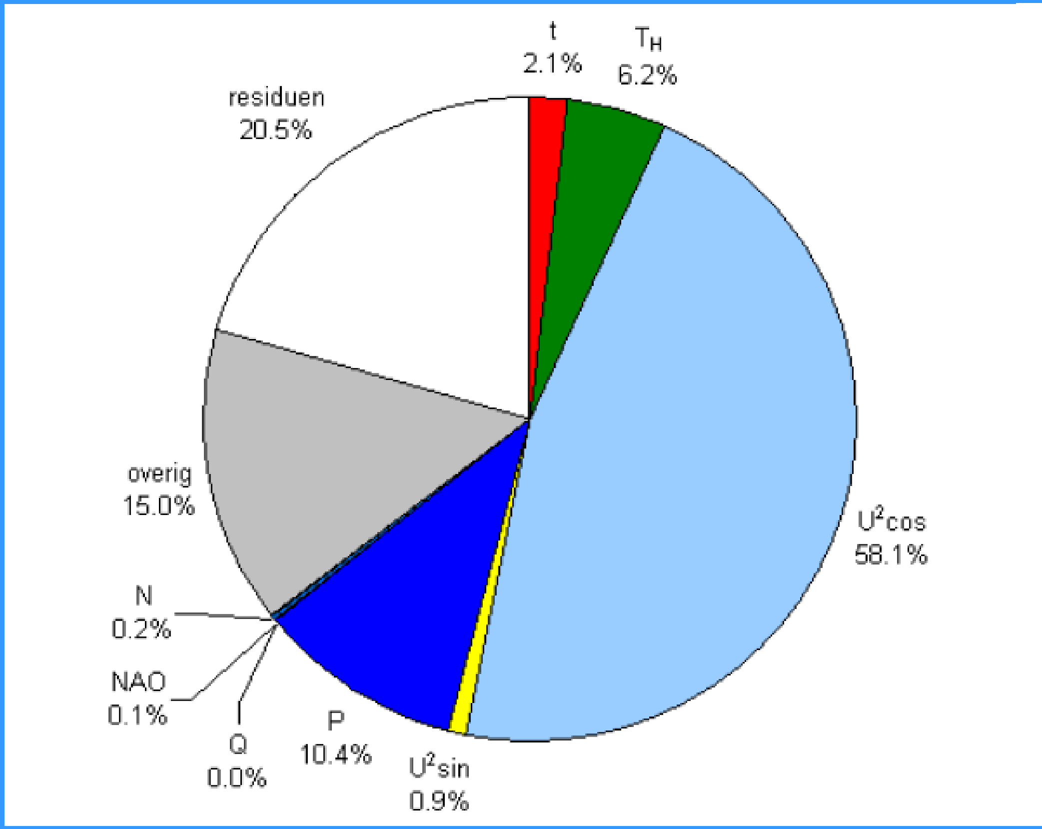
VALIDATION
using observations?

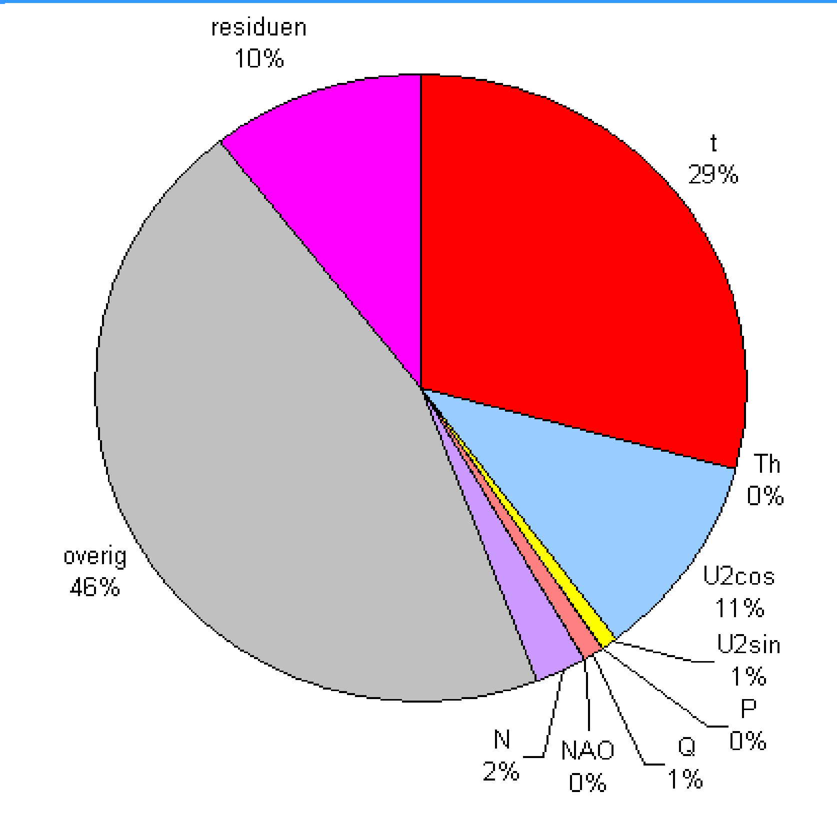
Understanding natural variability



Statistical analysis

Explained variance (daily versus yearly data)

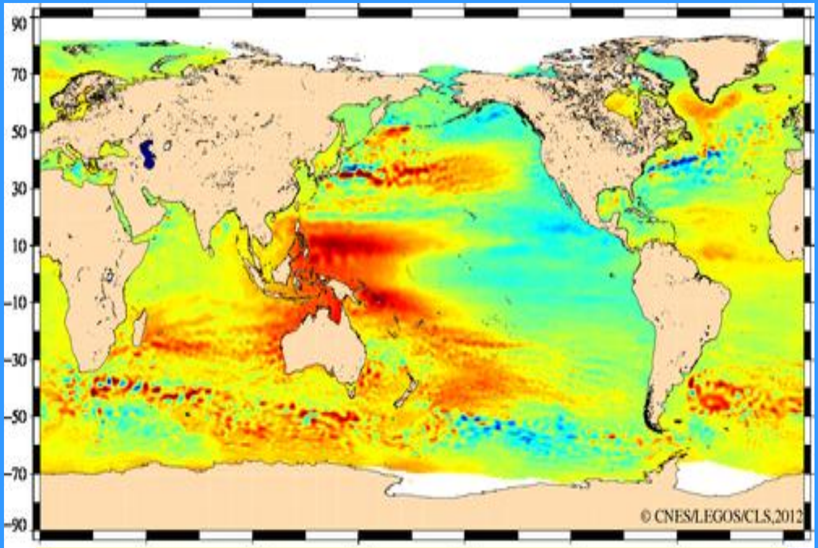




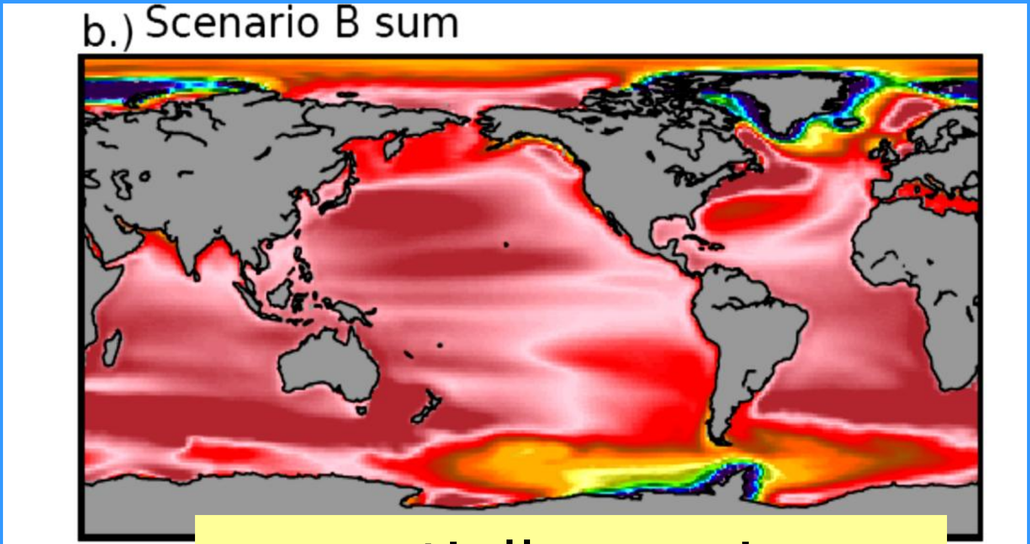
HKV / Deltares / KNMI (2013)

Pattern analysis

IDEA: 20 years of altimetry must have captured 10-30% of signal expected for the 21st century



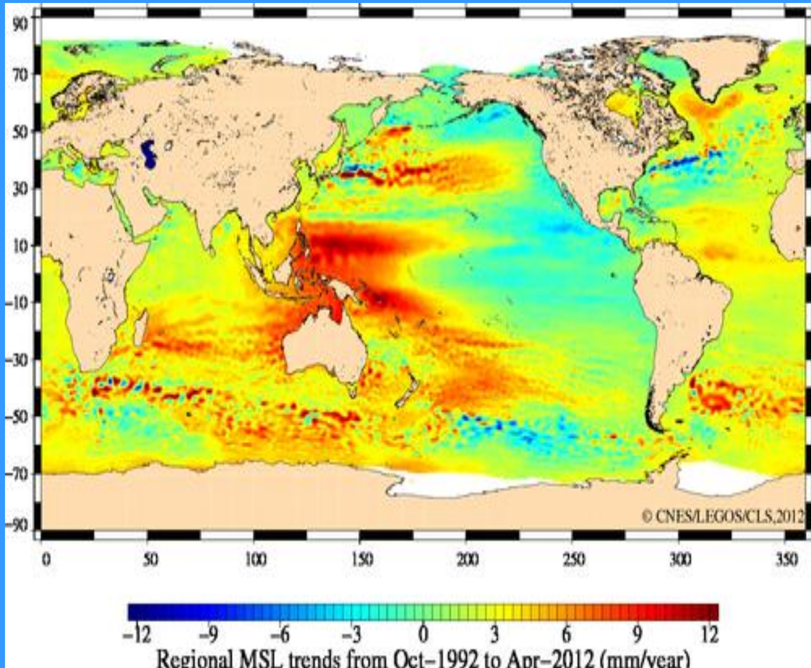
includes
natural variability

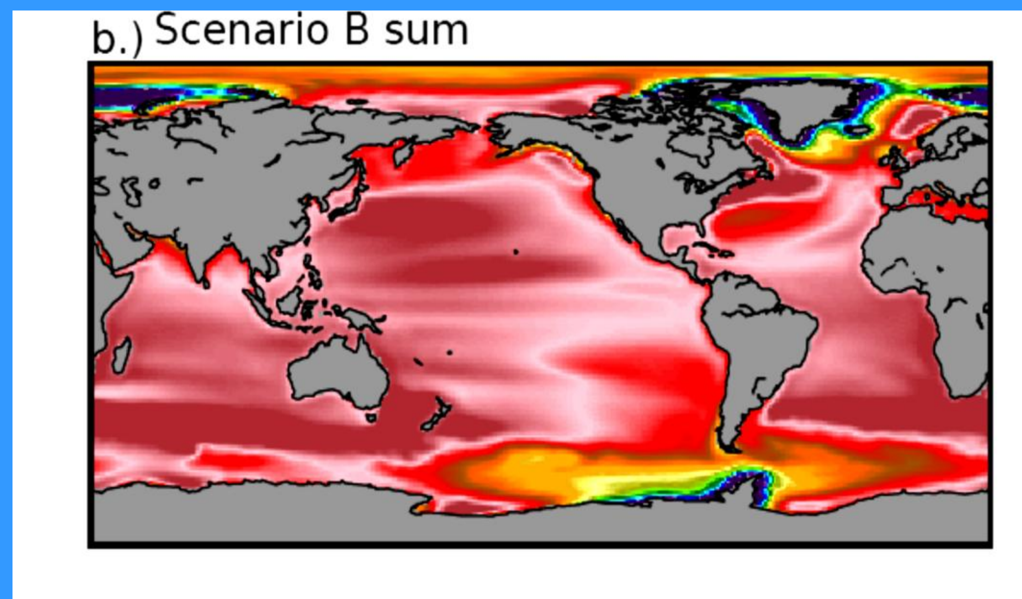


spatially varying
long-term trendss

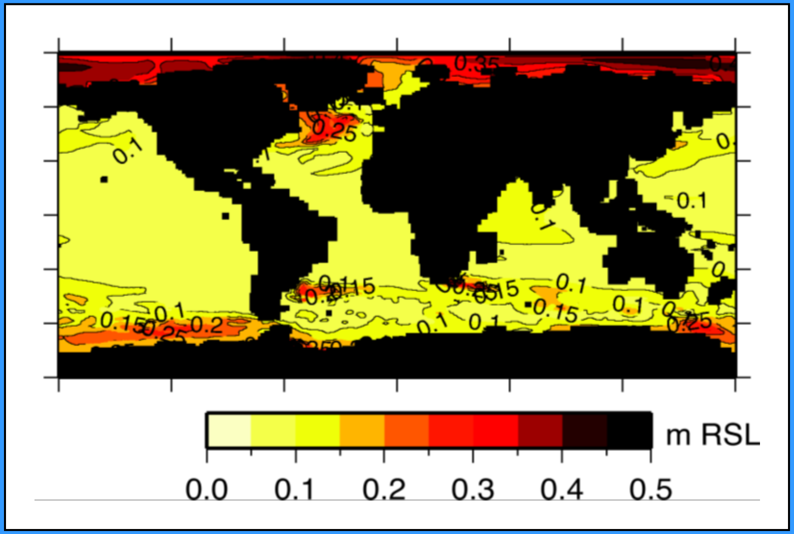
Pattern analysis

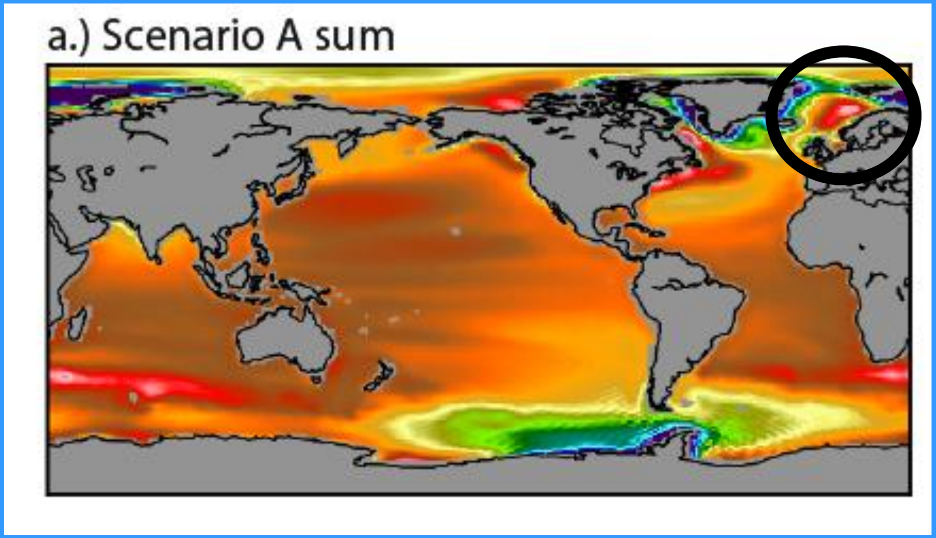
PROJECT: separate the natural variability from the long-term, forced regional changes to assess the quality and merits of the regional sea level rise projections





High-resolution modelling North Sea





IPCC 4AR models

IPCC 5AR models

SUMMARY

- Sea level is rising, it happens faster than in the 20th century, and is expected to accelerate further
- Various processes result in large regional variations in sea level, now and in the future
- Developing regional sea level rise projections requires a multidisciplinary approach

  (ocean / ice / solid Earth / hydrology)
- Understanding of the (natural, short-term) variations in observed sea level is required to connect observations and projections
- For this, we need long observational records of sea level change and its driving variables and high-resolution models