Regional sea-level rise projections

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and many more

Sea level projections

strong need to calculate response of sea level in a warming climate

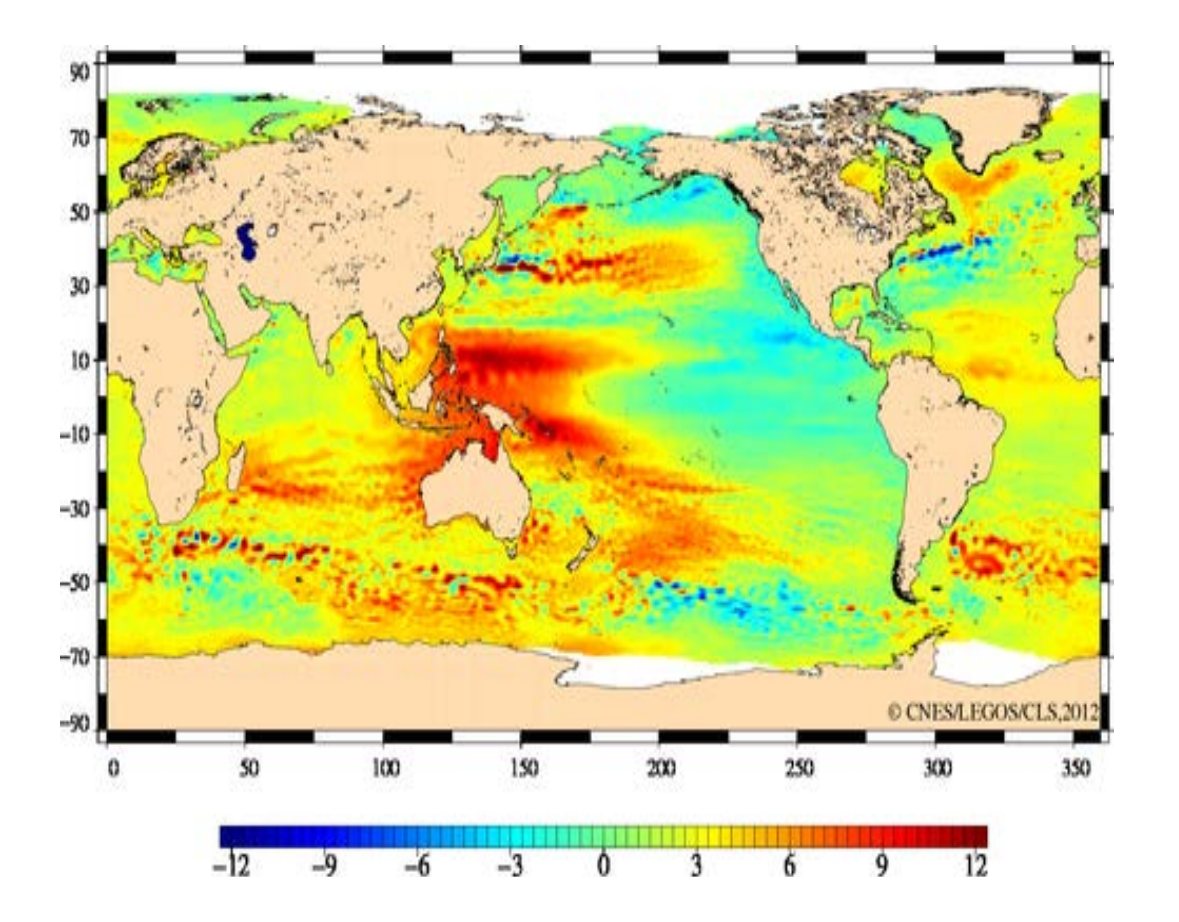
Sea level projections

strong need to calculate response of sea level in a warming climate

summed contributions of individual components

$\Rightarrow$ likely, global mean change

Regional sea level change



Sea level projections

strong need to calculate response of sea level in a warming climate

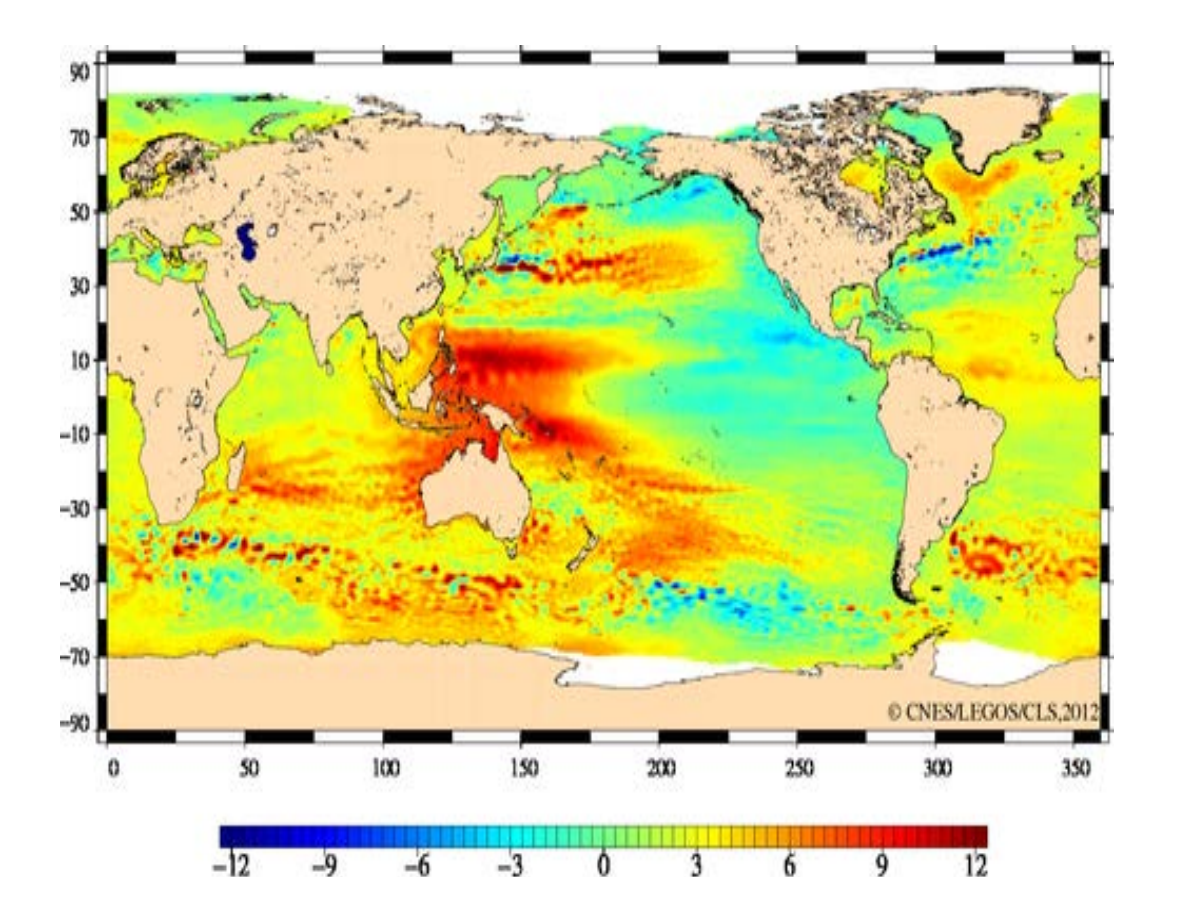
global mean thermal expansion
glaciers & ice caps
Greenland
Antarctica

coastal protection

regional change,

worst-case scenario

Regional sea level change



regional variations due to natural variability +
spatially varying long-term trends

Ingredients regional projection

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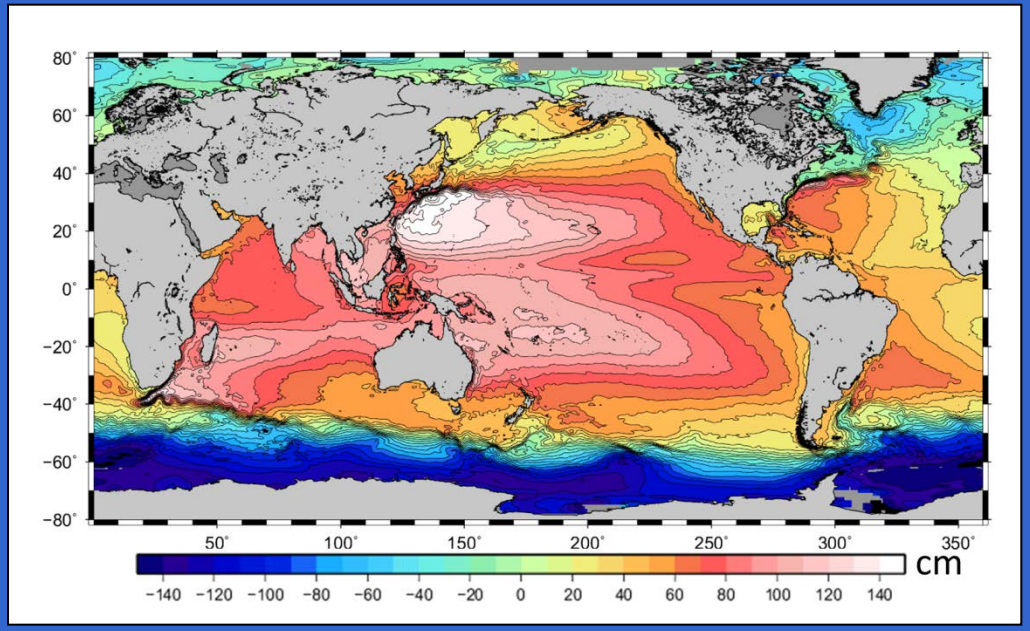
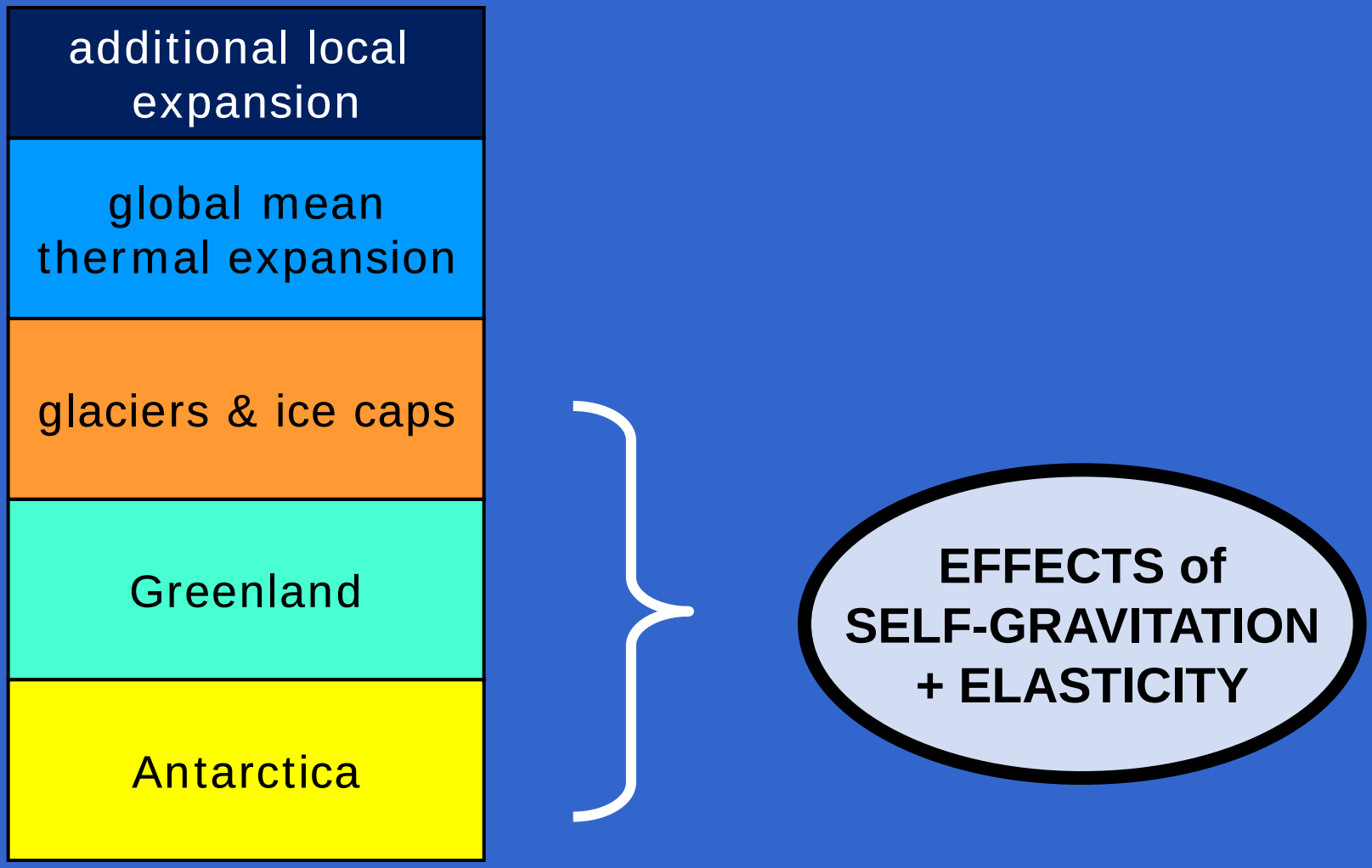
additional local expansion
global mean thermal expansion
glaciers & ice caps
Greenland
Antarctica



[AVISO]

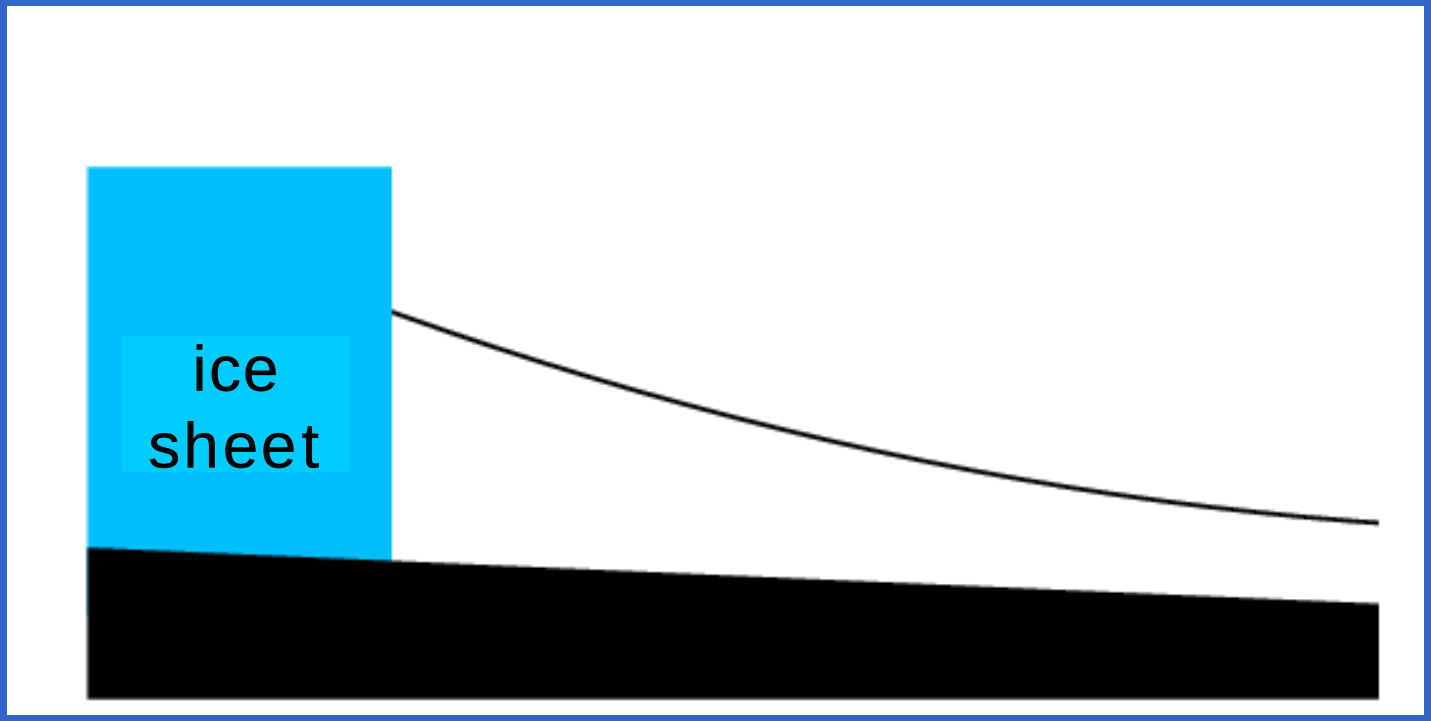
- changes in ocean dynamics and ocean density
- atmospheric loading

Ingredients regional projection



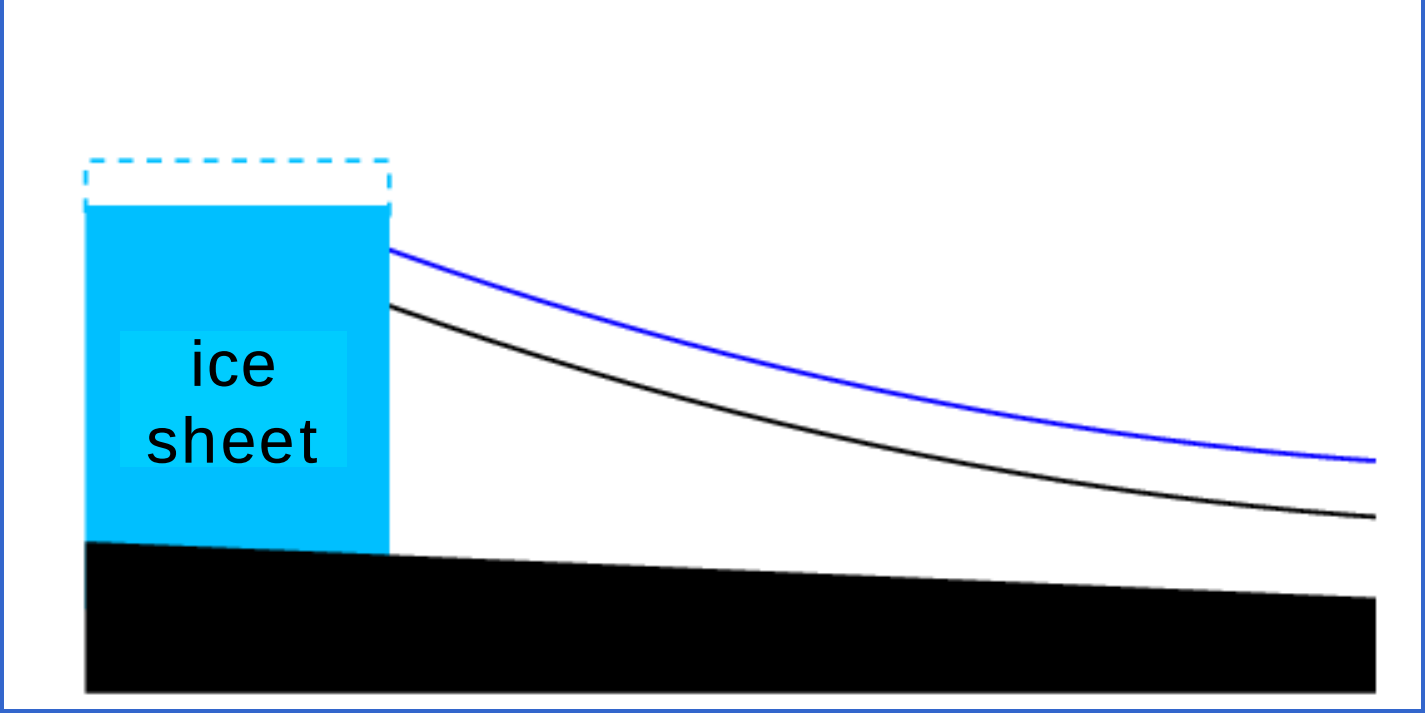
Self-gravitation effect

gravitational pull on ocean towards large (ice)mass



Self-gravitation effect

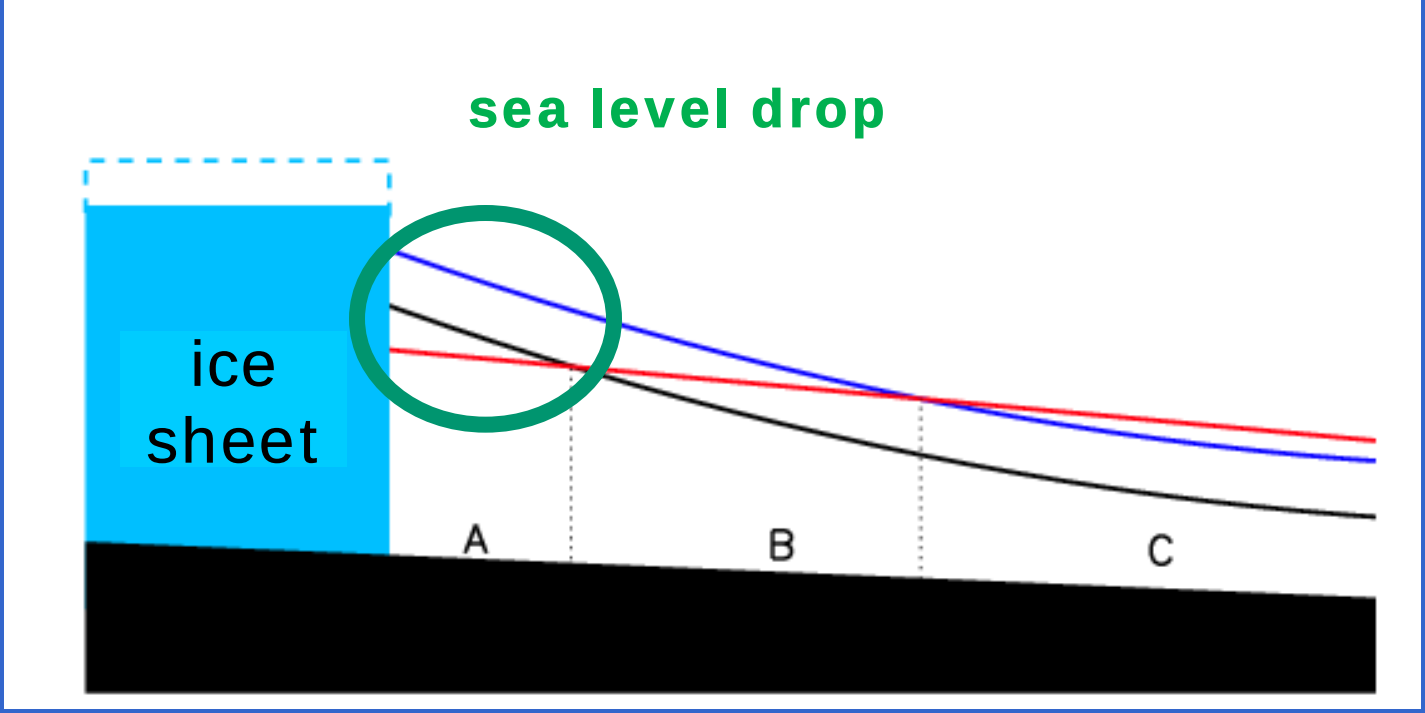
ice mass loss $\Rightarrow$ melt water added to the ocean



Self-gravitation effect

ice mass loss $\Rightarrow$ melt water added to the ocean

$\Rightarrow$ sea level tilts



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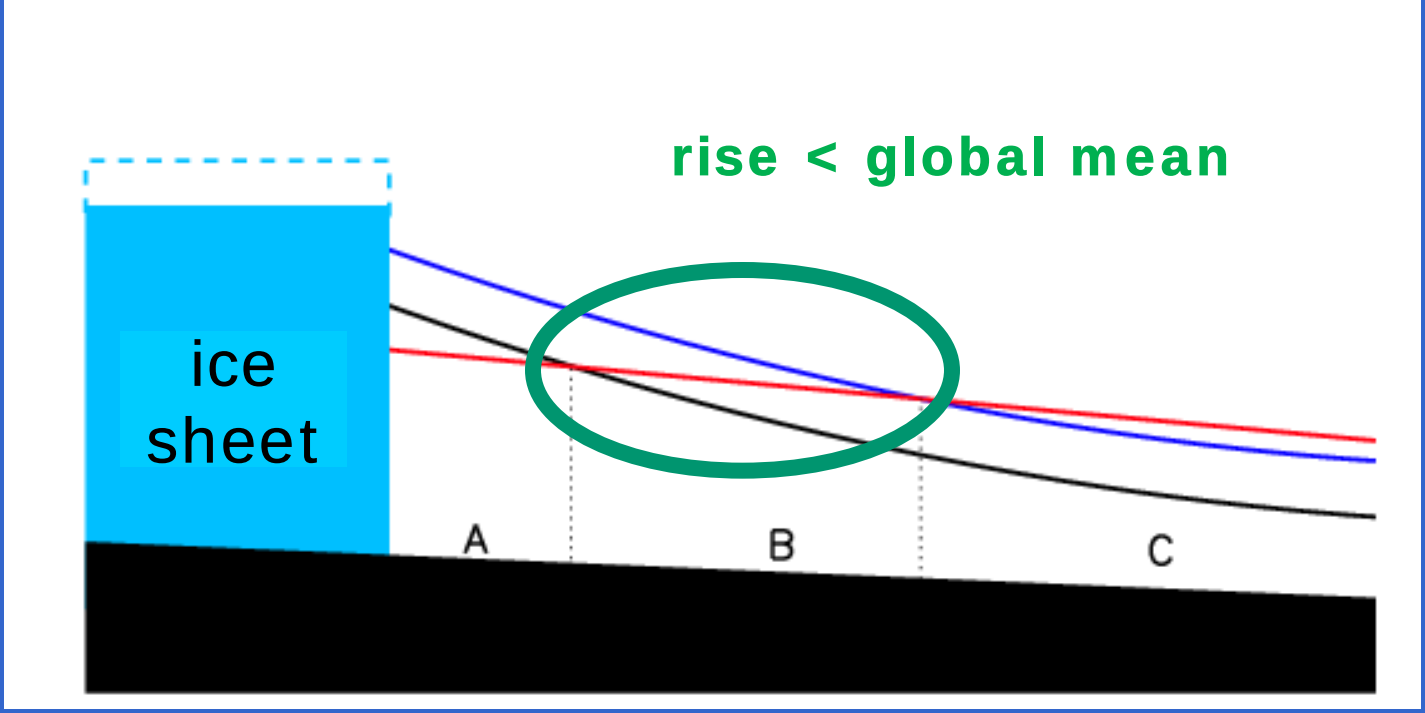

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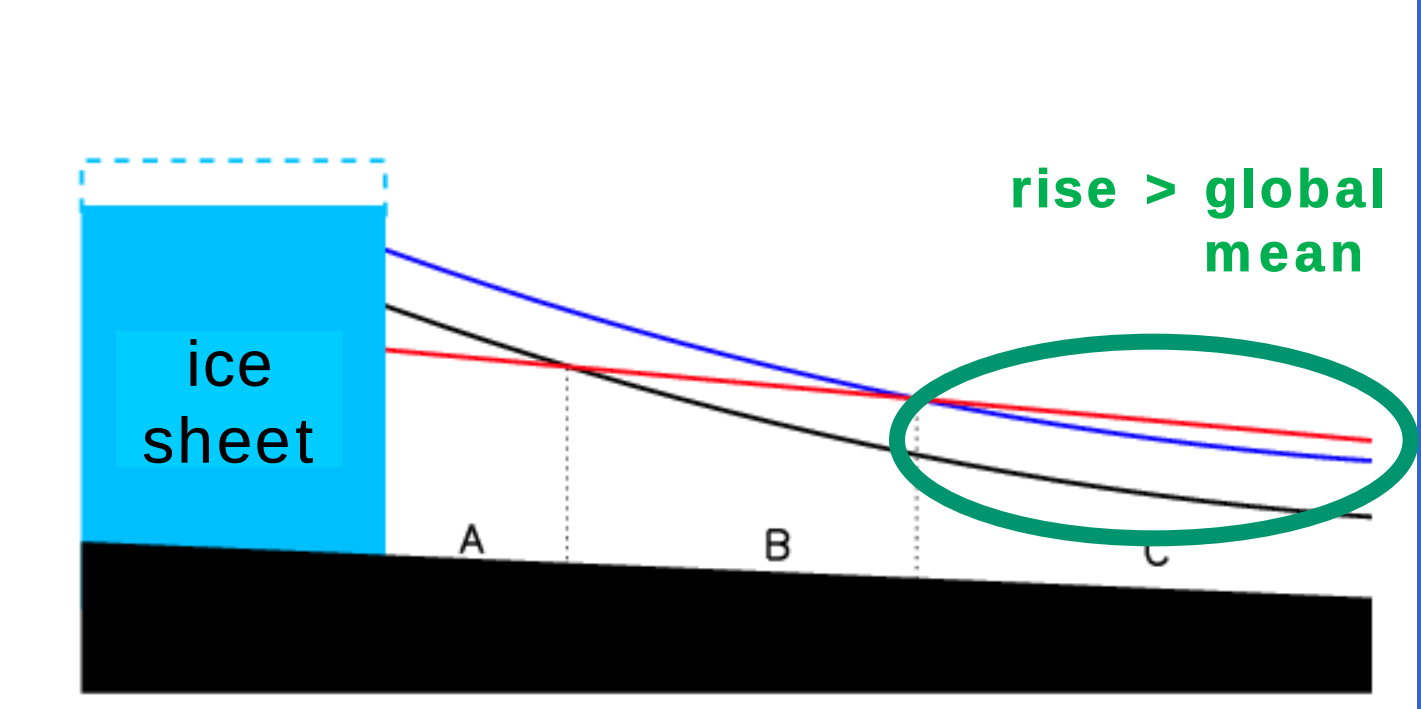


Ingredients regional projection

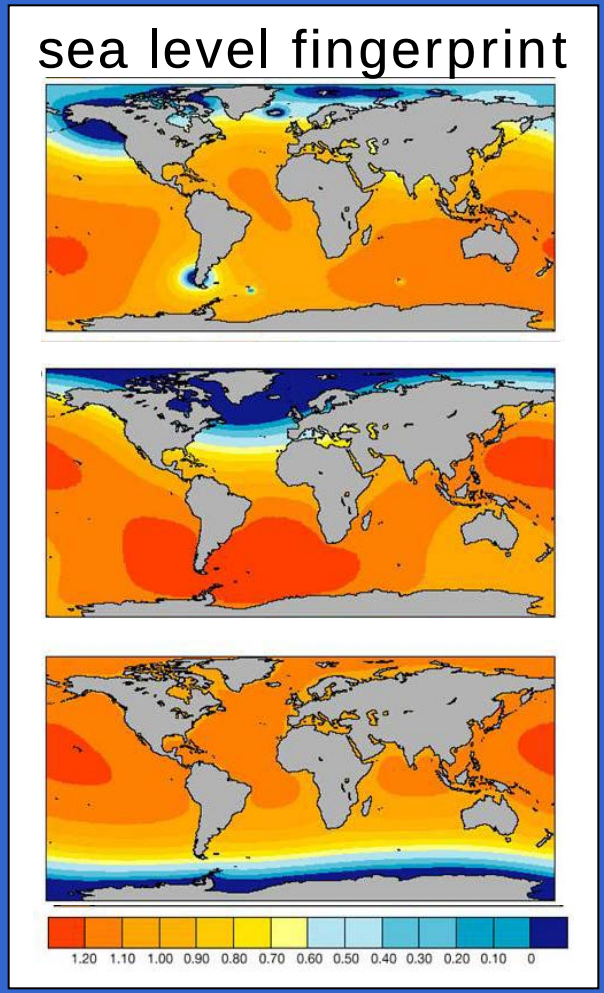
additional local expansion

global mean thermal expansion

glaciers & ice caps

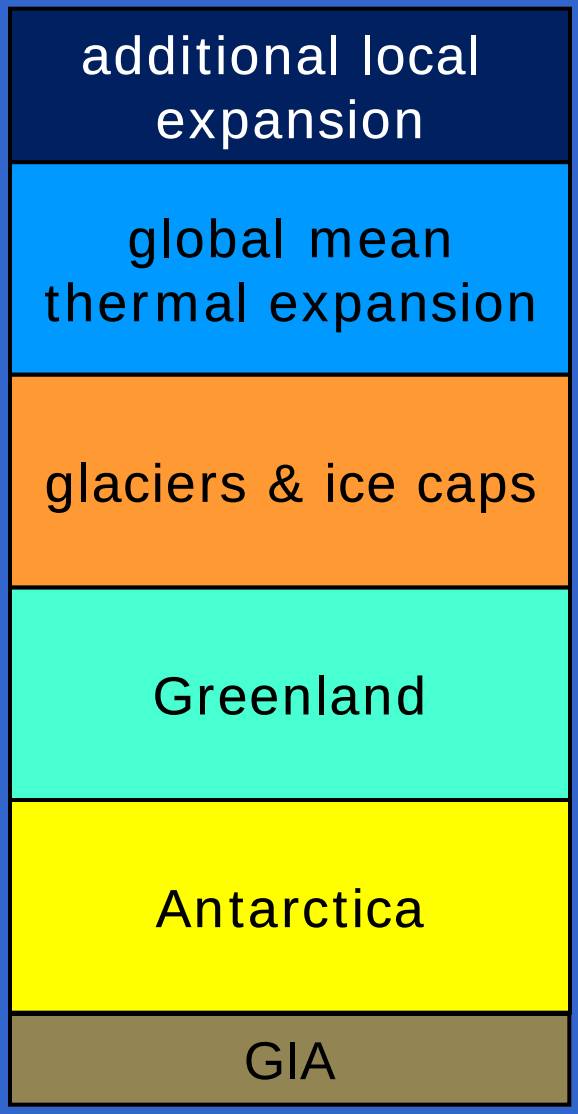
Greenland

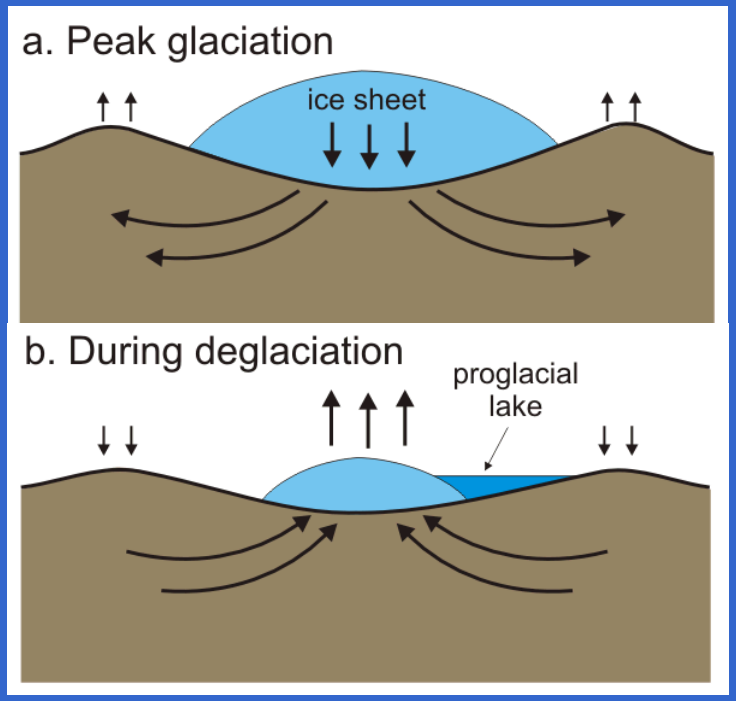
Antarctica



Mitrovica et al (2001)

Ingredients regional projection





Ingredients regional projection

land storage

additional local expansion

global mean thermal expansion

glaciers & ice caps

Greenland

Antarctica

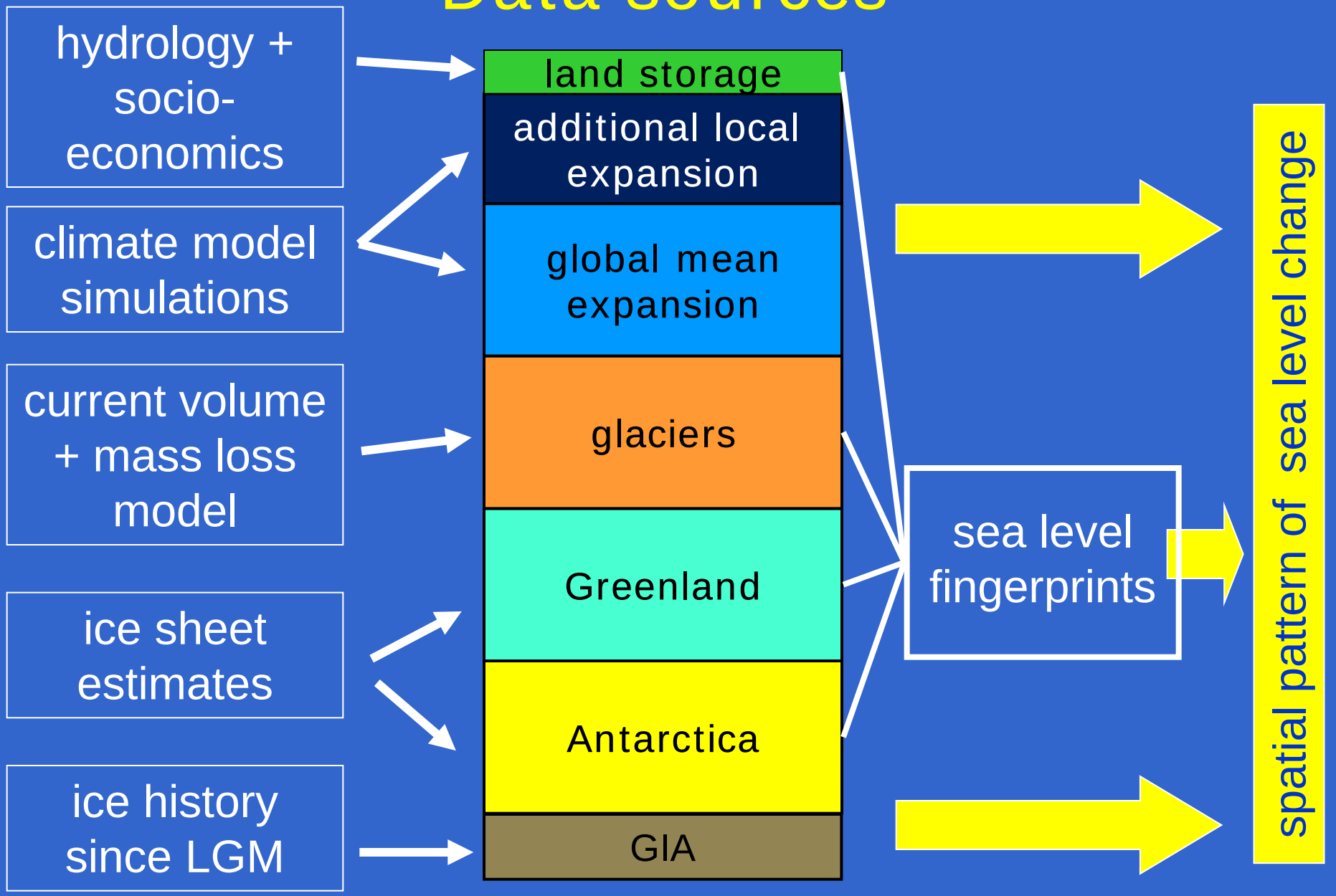
GIA

dam building

groundwater mining

NOTE:
self-gravitation needs to be accounted for

Data sources

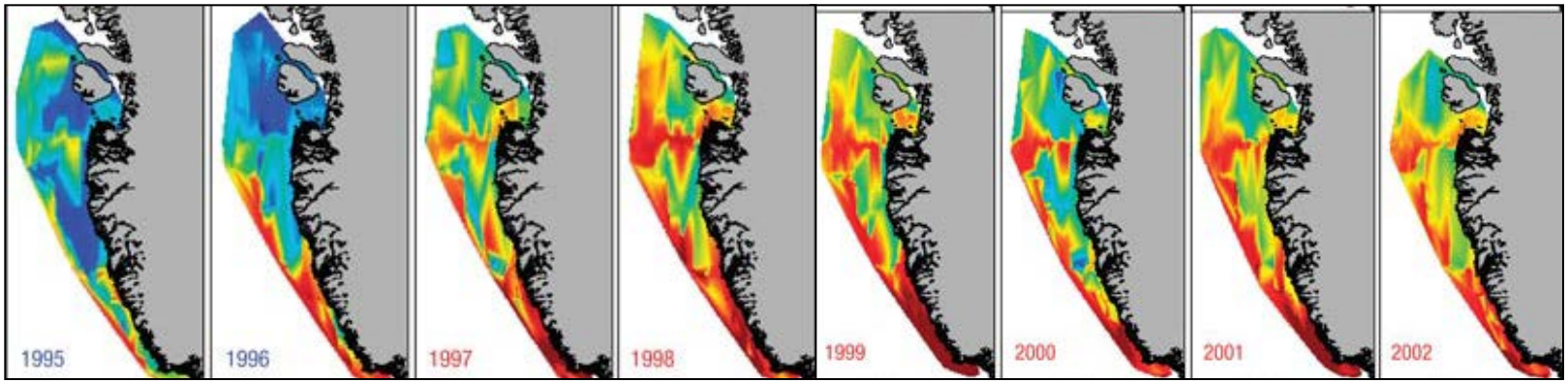


Caveat

- ice sheet $\Rightarrow$ ocean interactions
- ocean $\Rightarrow$ ice sheet interactions

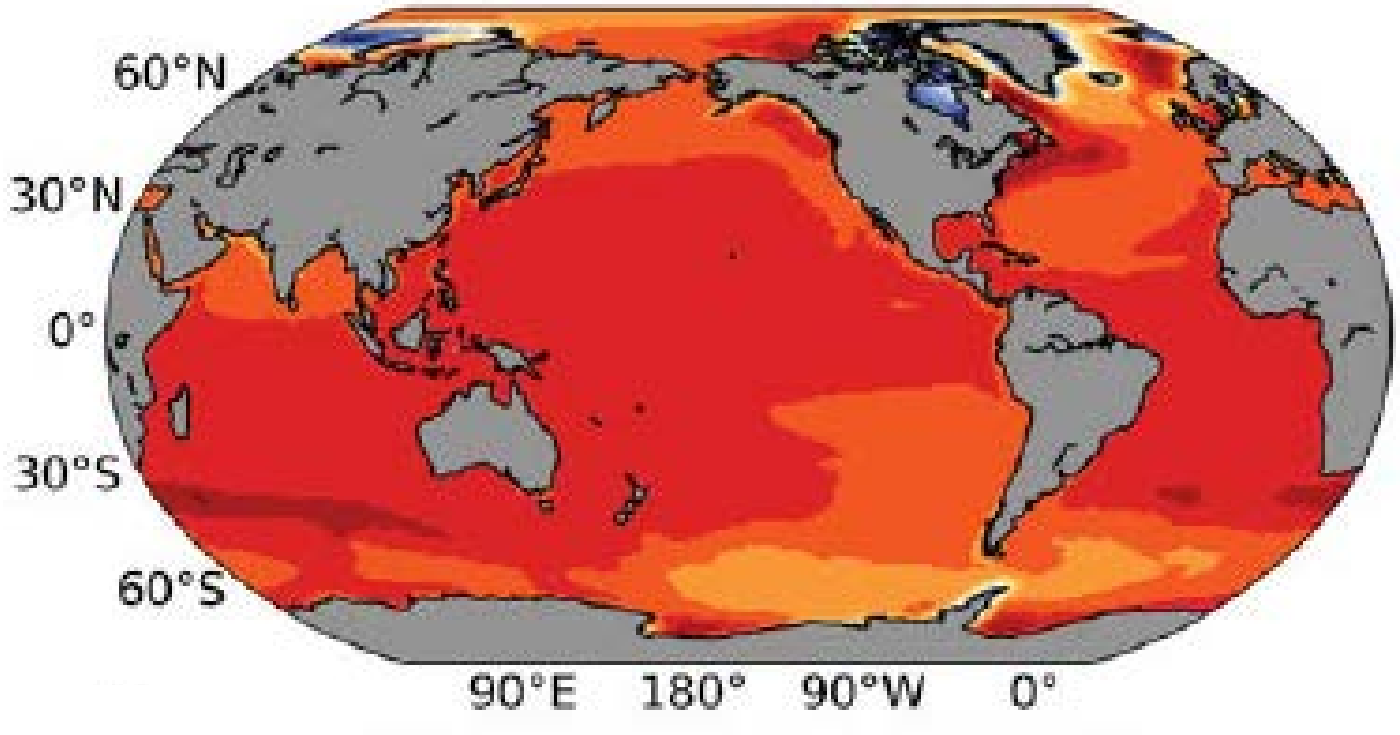
melt water affects ocean currents

glacier acceleration triggered by ocean warming



Holland et al. (Nat. Geosc., 2008)

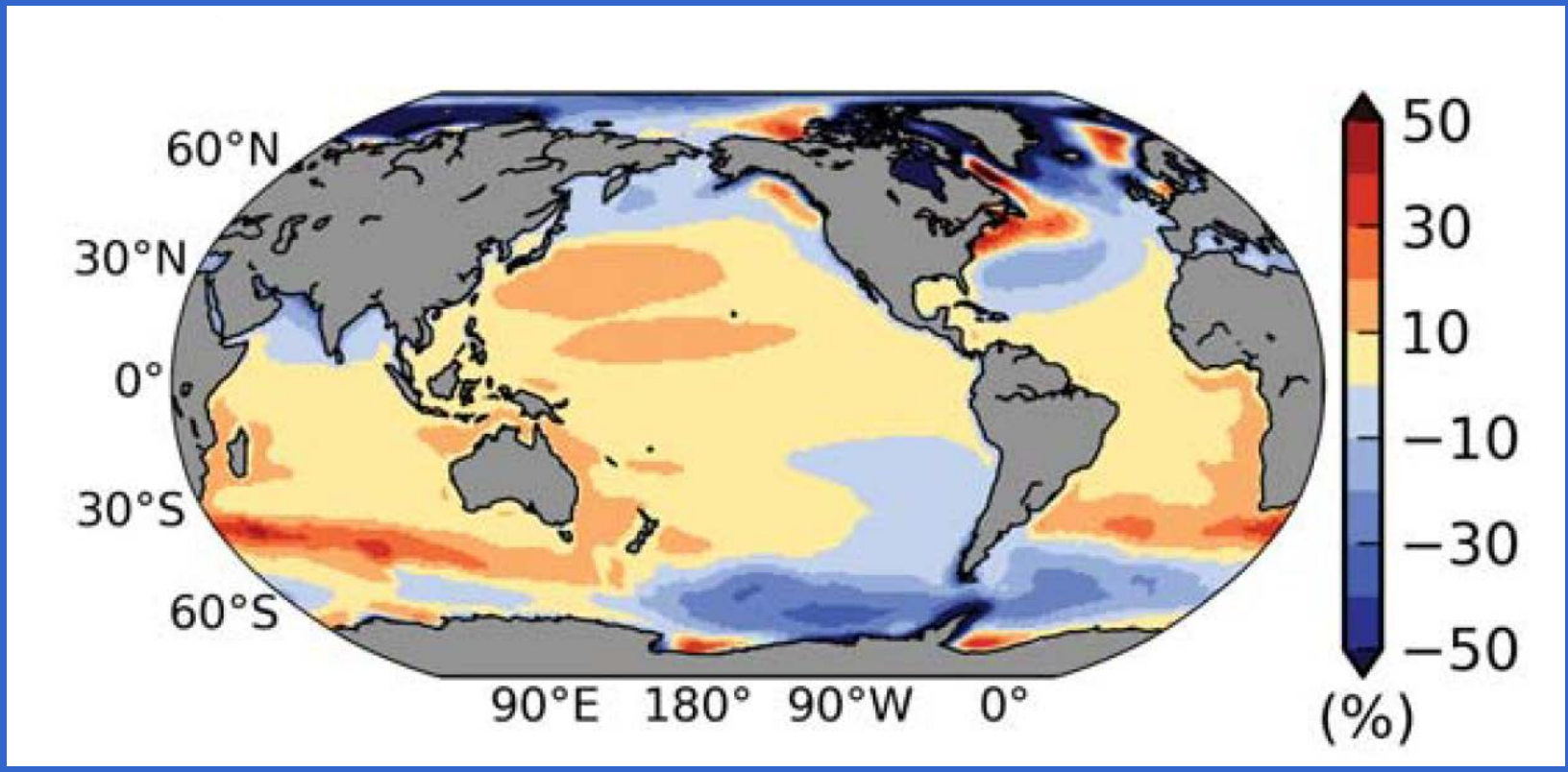
Regional projection – RCP4.5



global mean
0.50 ± 0.13m

IPCC AR5 Final Draft September 2013

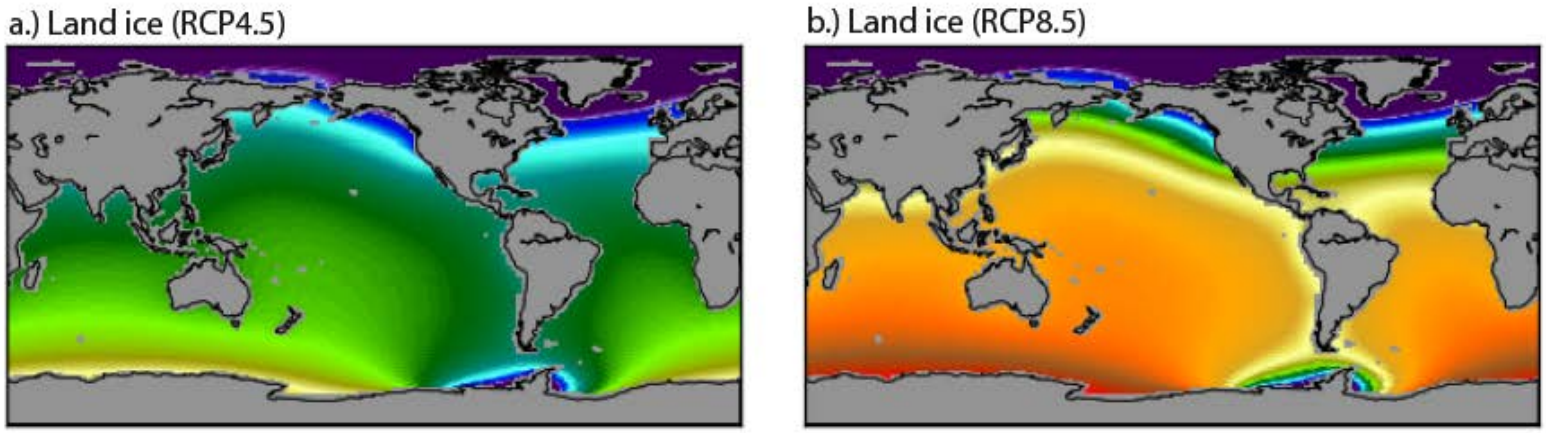
Regional projection – RCP4.5



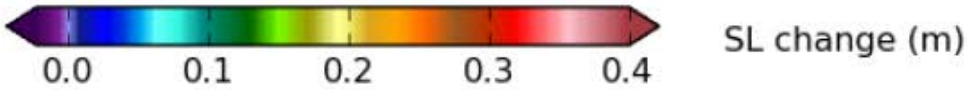
deviation from global mean (in %)

IPCC AR5 Final Draft September 2013

Moderate Warm

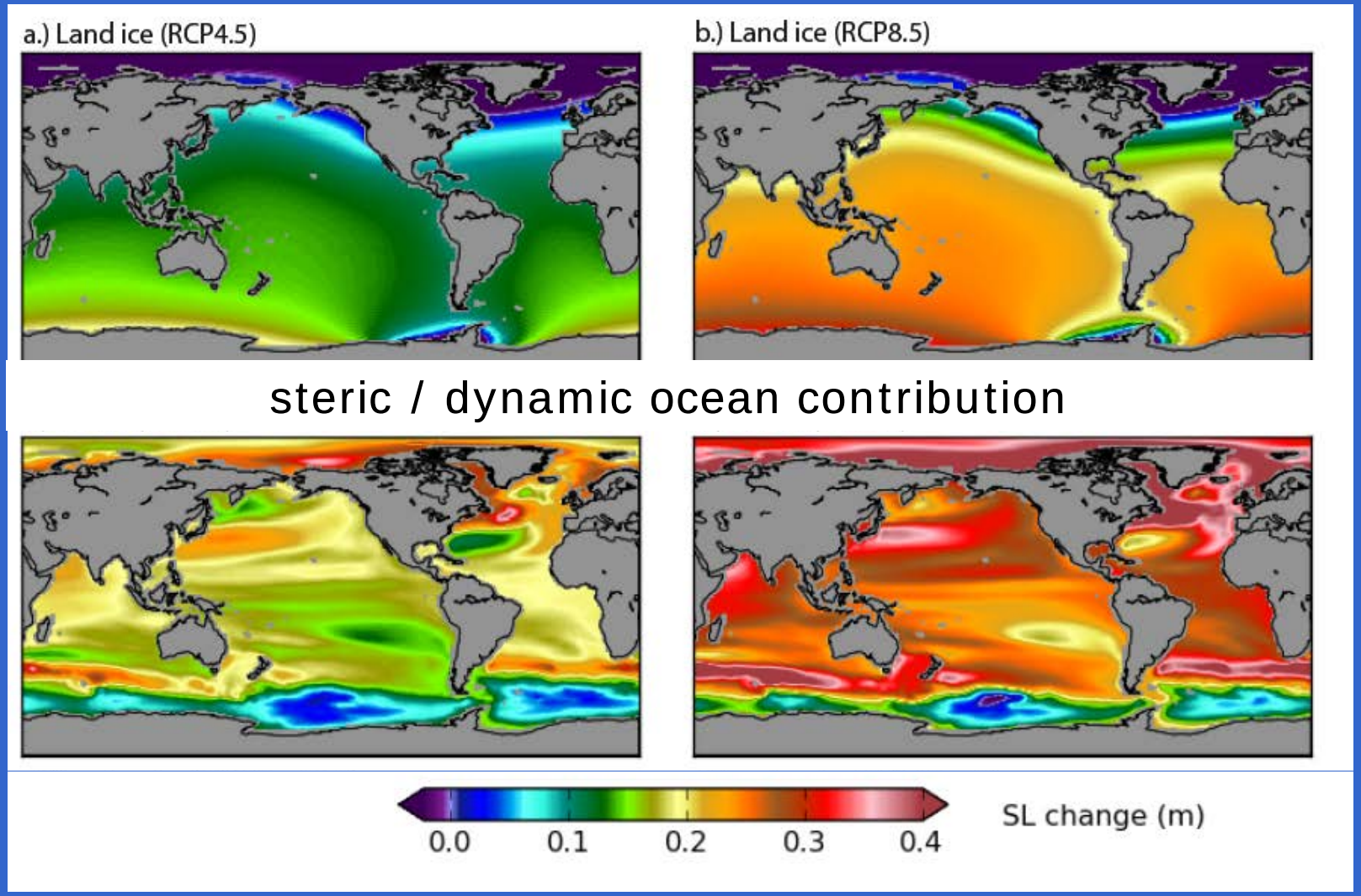


glaciers + ice sheets surface mass balance



Slangen et al (under revision)

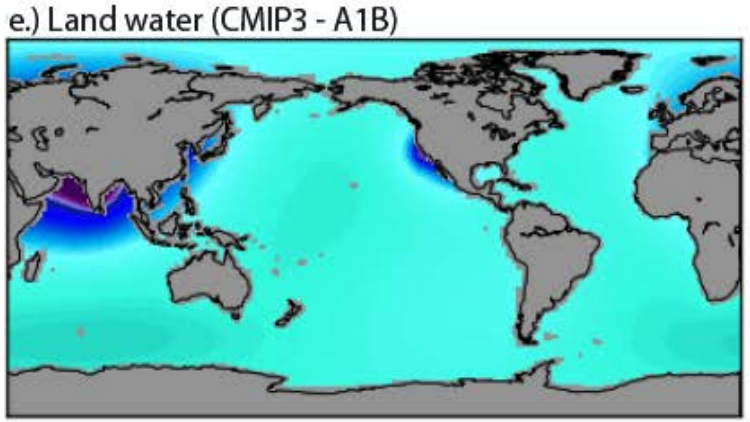
Moderate Warm

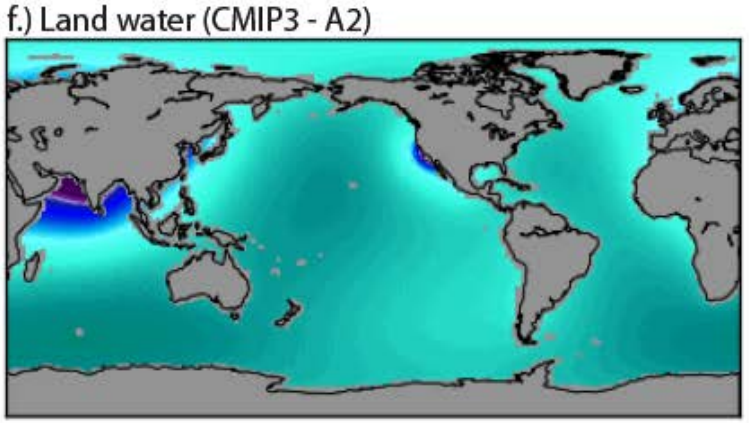


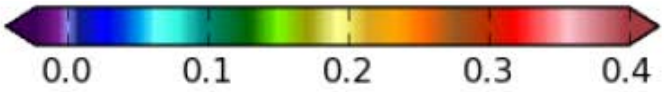
Slangen et al (under revision)

Moderate

Warm







Slangen et al (under revision)

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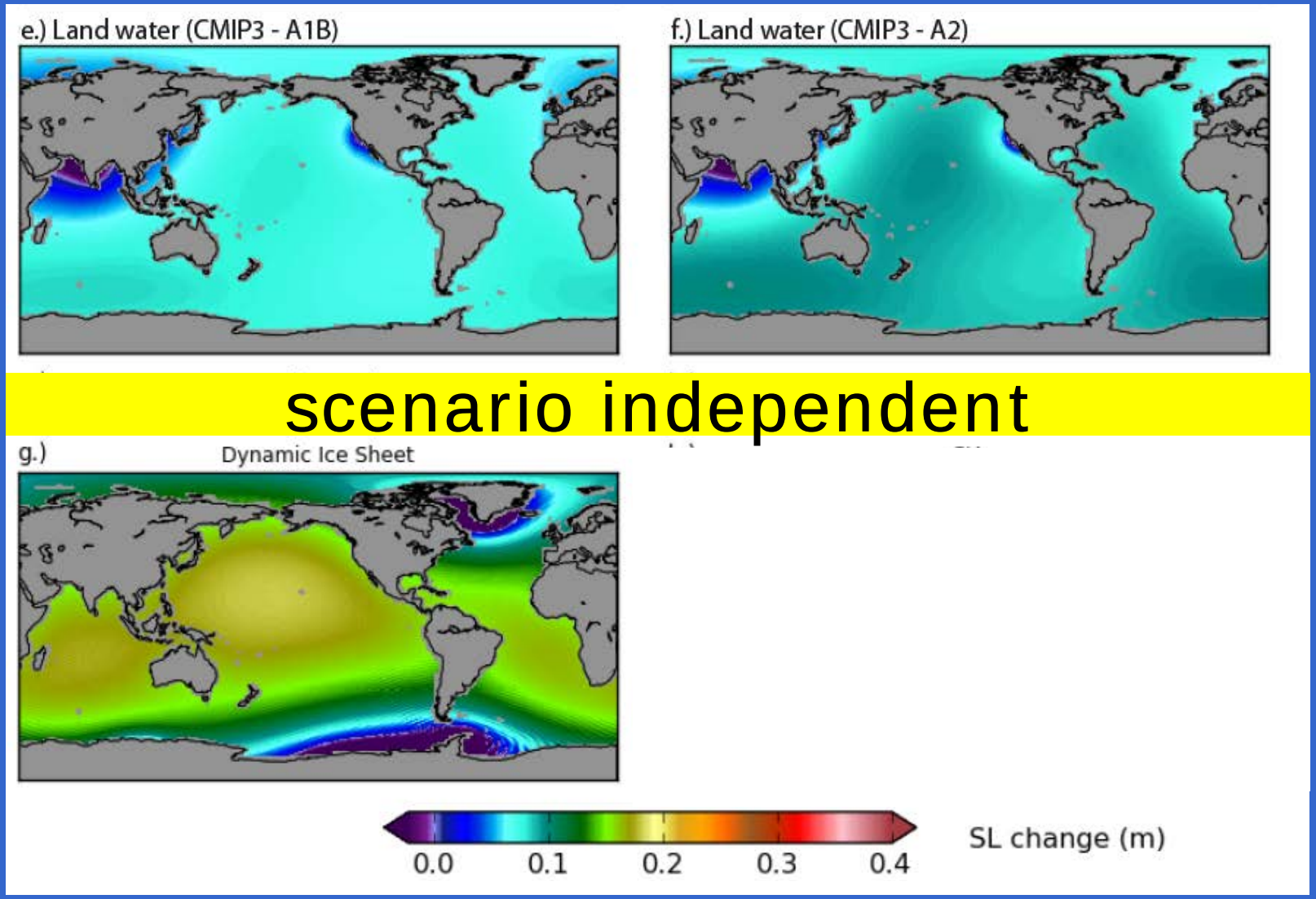

Slangen et al (under revision)

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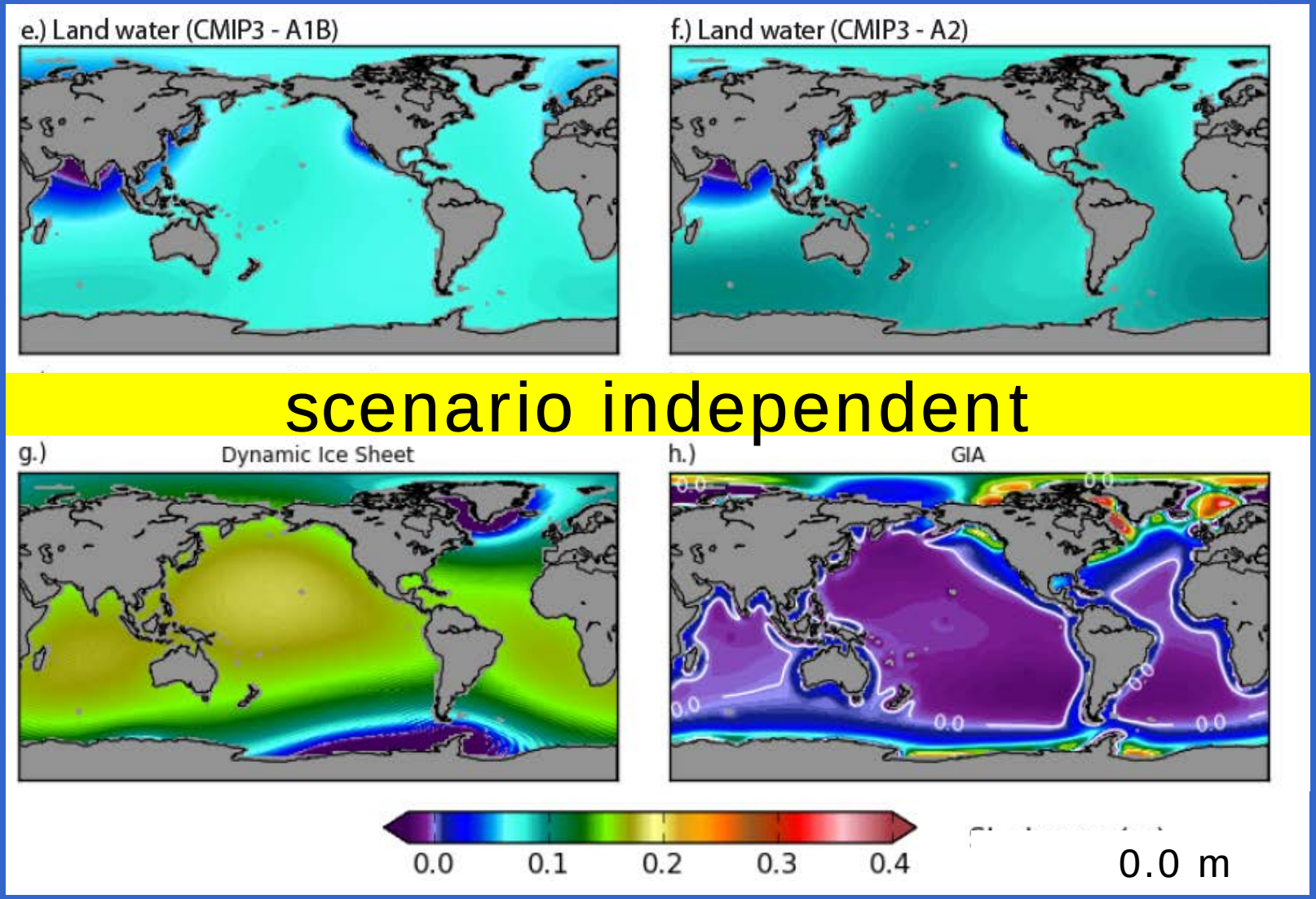
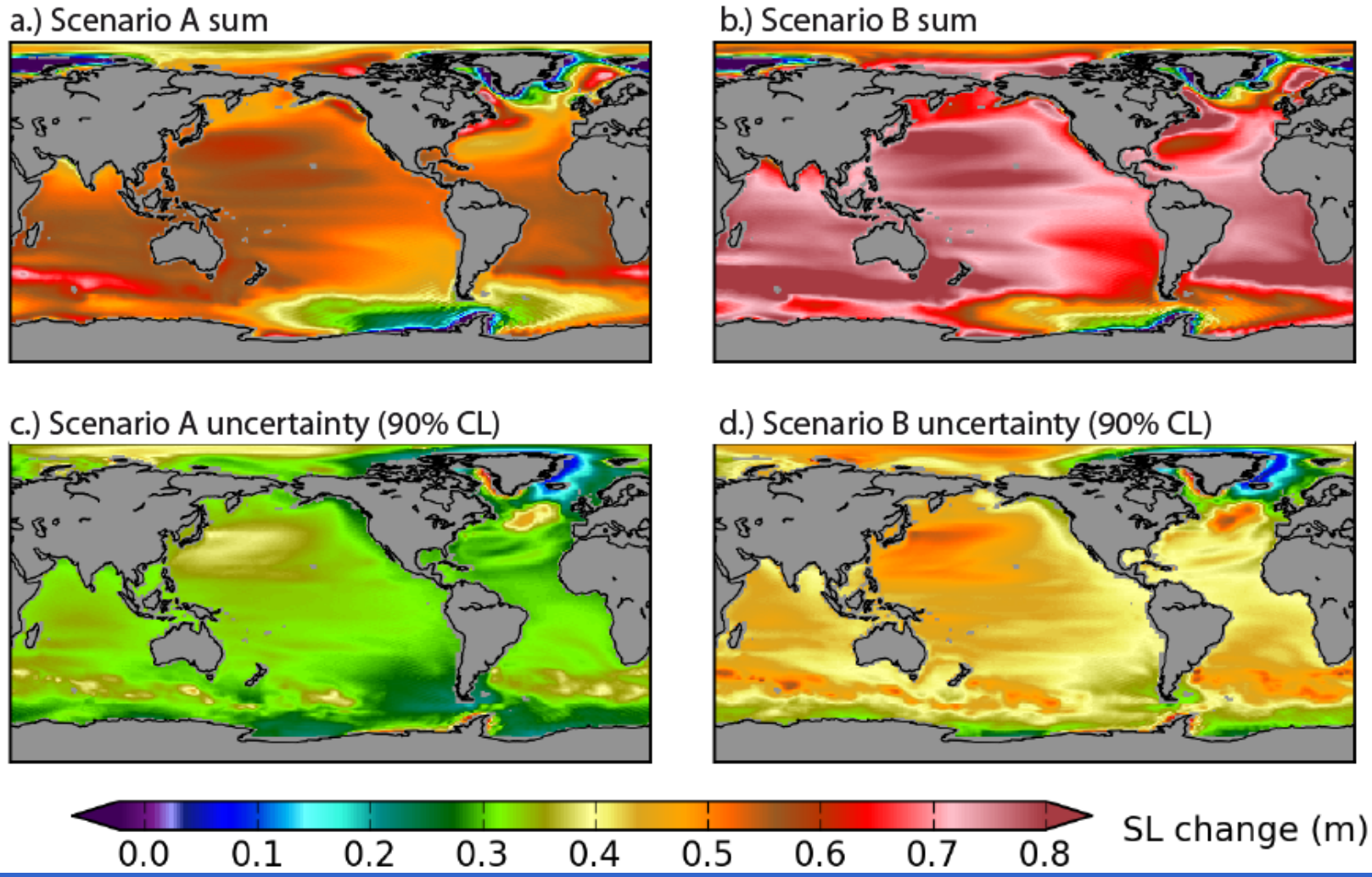


Slangen et al (under revision)

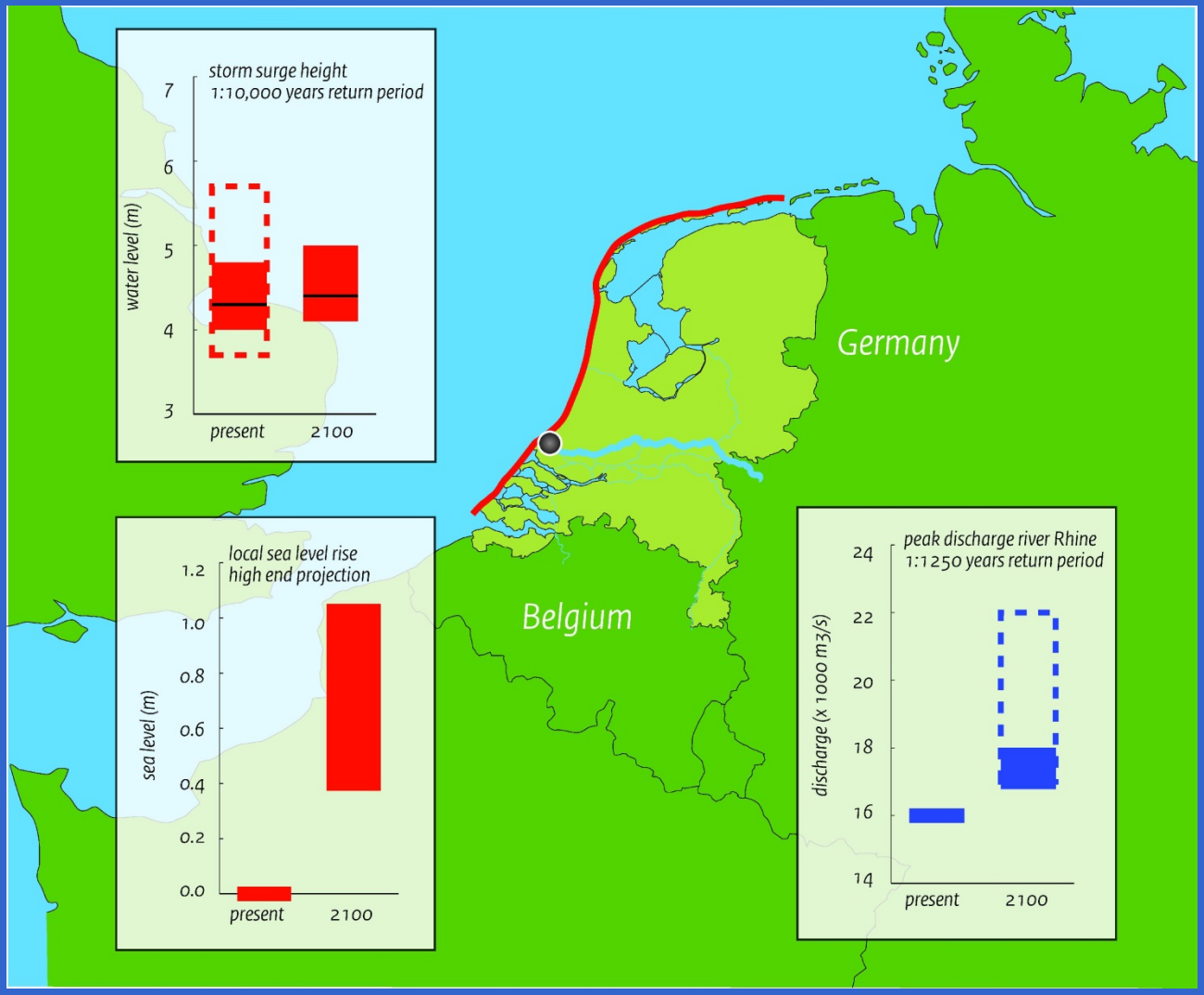
Moderate Warm



Slangen et al (under revision)

Example of an integrated flood risk assessment

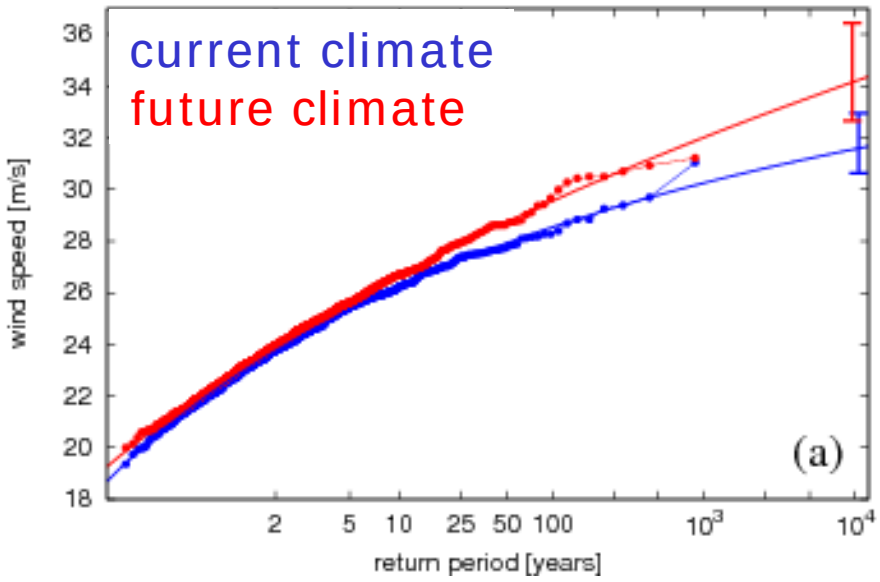
Integrated flood risk assessment



Katsman et al (Clim. Change, 2011)

Storms & surges

wind speed



Sterl et al (Oce. Sci, 2009)

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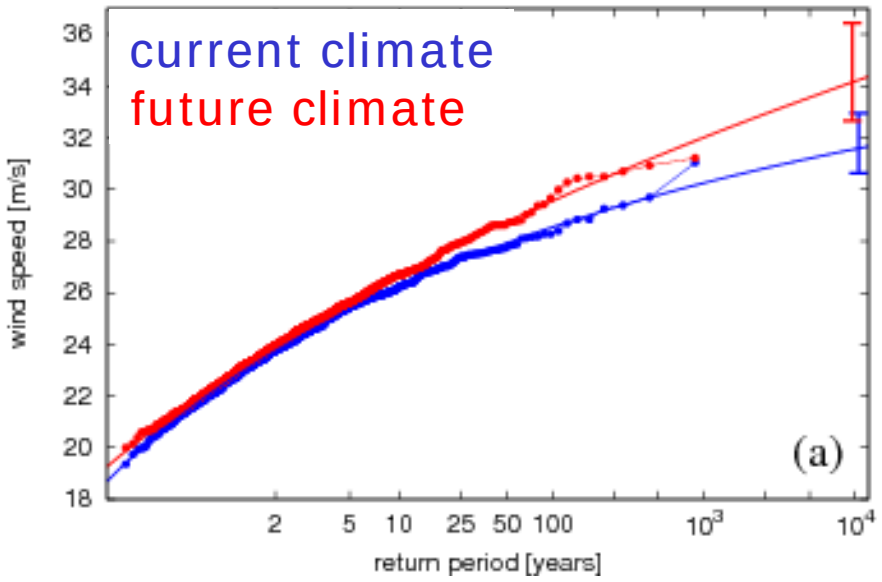
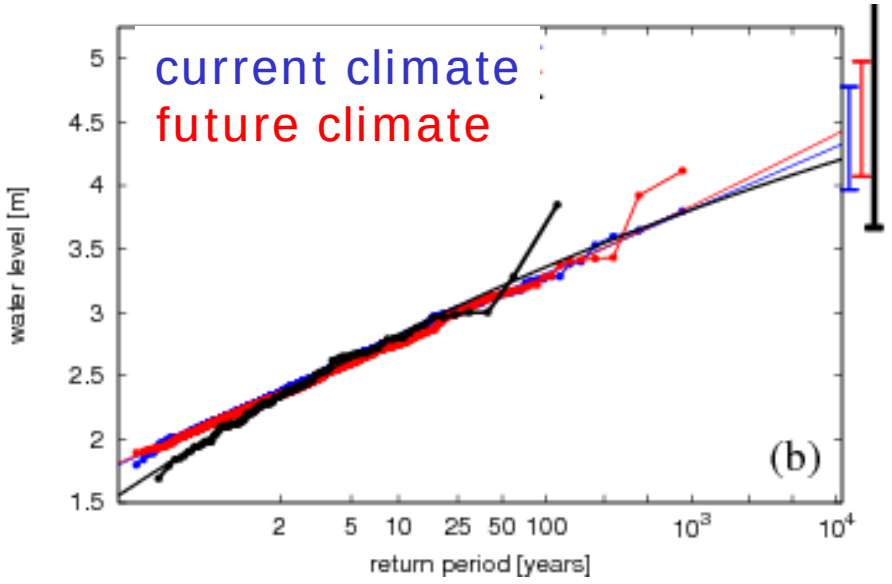


surge height Hoek van Holland



Sterl et al (Oce. Sci, 2009)

Extreme river discharge

- 1:1250 year discharge of the Rhine river increases by **5 to 40%** due to changes in the amount and character of precipitation in the catchment area

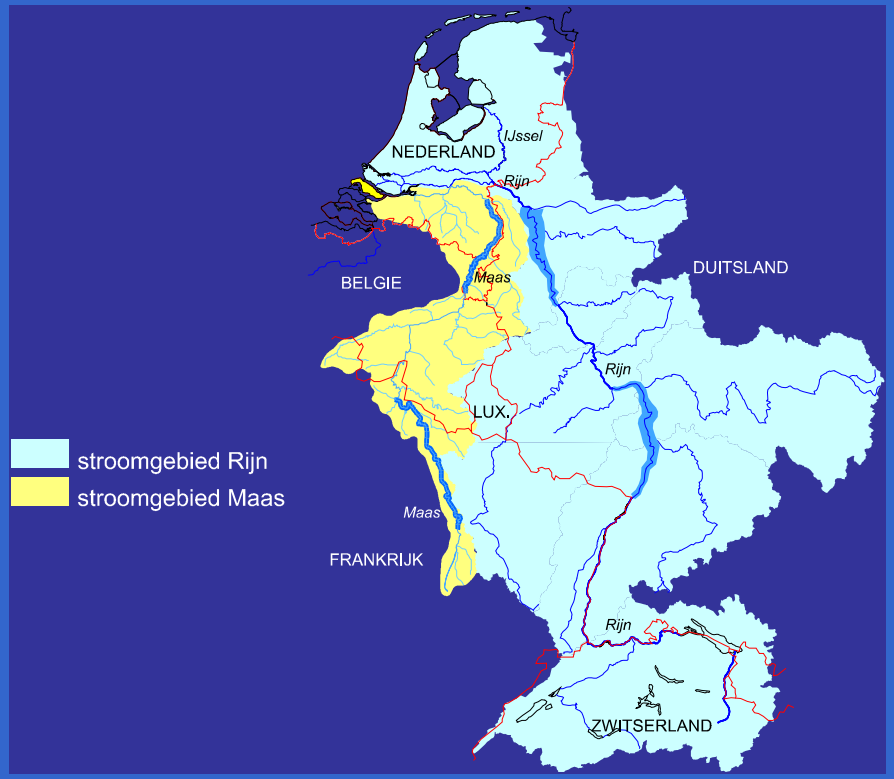
Beersma et al (2008)

Extreme river discharge

- 1:1250 year discharge of the Rhine river increases by **5 to 40%** due to changes in the amount and character of precipitation in the catchment area

- upstream flooding in Germany is anticipated to reduce the peak discharge before it reaches the Netherlands

- extreme discharge increases by **10%**



Beersma et al (2008)

Impacts: Rotterdam harbor

Maeslant storm surge barrier - closure frequency

- current: once every 10 years

Katsman et al (Clim. Change, 2011)

Impacts: Rotterdam harbor

Maeslant storm surge barrier - closure frequency

- current: once every 10 years
- 2100, with extreme sea level rise:
  - once every few years – few months

Katsman et al (Clim. Change, 2011)

Impacts: Rotterdam harbor

Maeslant storm surge barrier - closure frequency

- current: once every 10 years
- 2100, with extreme sea level rise:
  - once every few years – few months
  - larger chance that closure of the barrier coincides with high river discharge

Katsman et al (Clim. Change, 2011)

Summary

- Regional sea level rise projections can be constructed as the sum of contributions from multiple sources
- The resulting projections shows a larger than average rise in the tropics and along the US east coast, and a smaller than average rise at high latitudes, in particular near regions of ice mass loss
- A caveat in the current methodology is the contribution of ocean-ice sheet interactions
- Possible changes in storm surges and increased river discharge also need to be considered in a country's flood protection strategy