

Scenario's voor zeespiegelstijging

Hoe komen ze tot stand en hoe (on-)zeker zijn ze?

Caroline Katsman

TU Delft / Vloeistofmechanica



met dank aan: Hylke de Vries (KNMI), Aimée Slangen (CSIRO), Mark Carson (Uni Hamburg, Sybren Drijfhout (KNMI/IMAU/SOC), Roderik van de Wal (IMAU), Bert Vermeersen (TUD), Riccardo Riva (TUD)

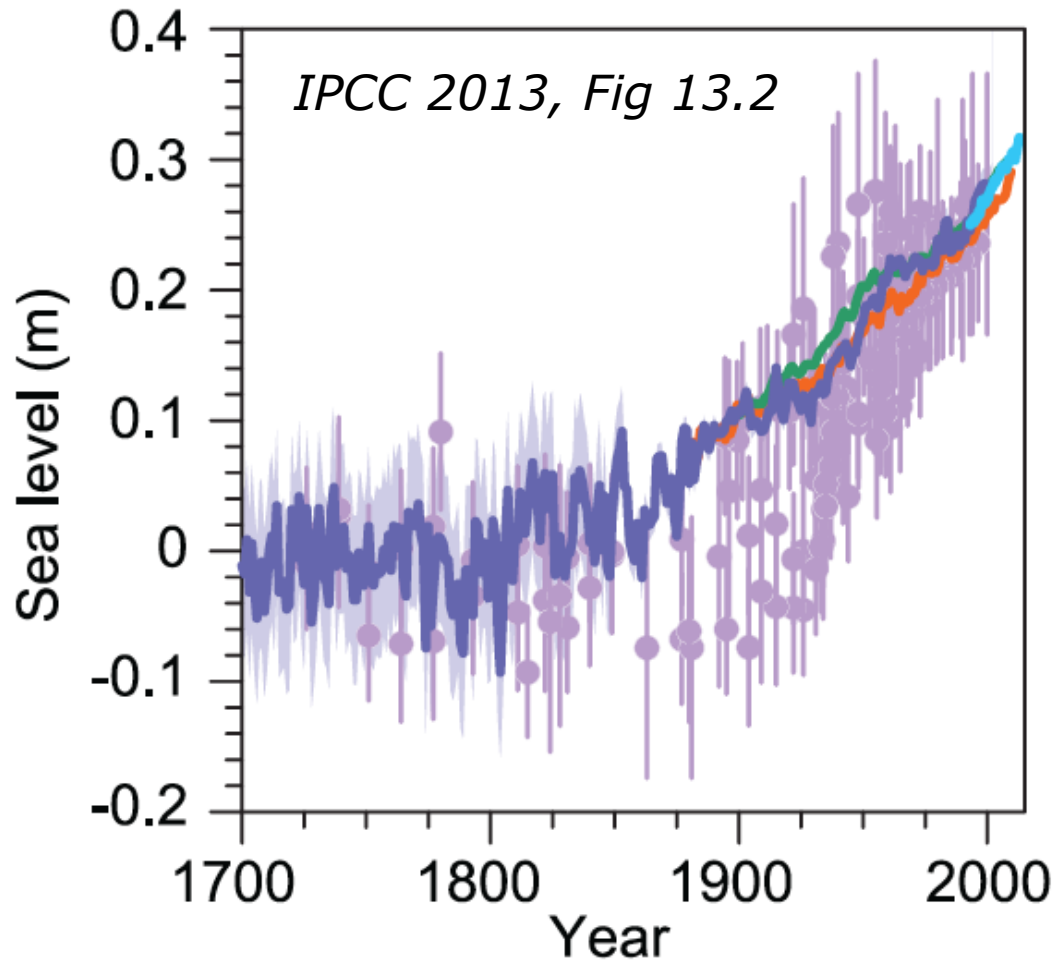
Zeespiegelstijging

- meer water
- warmer water



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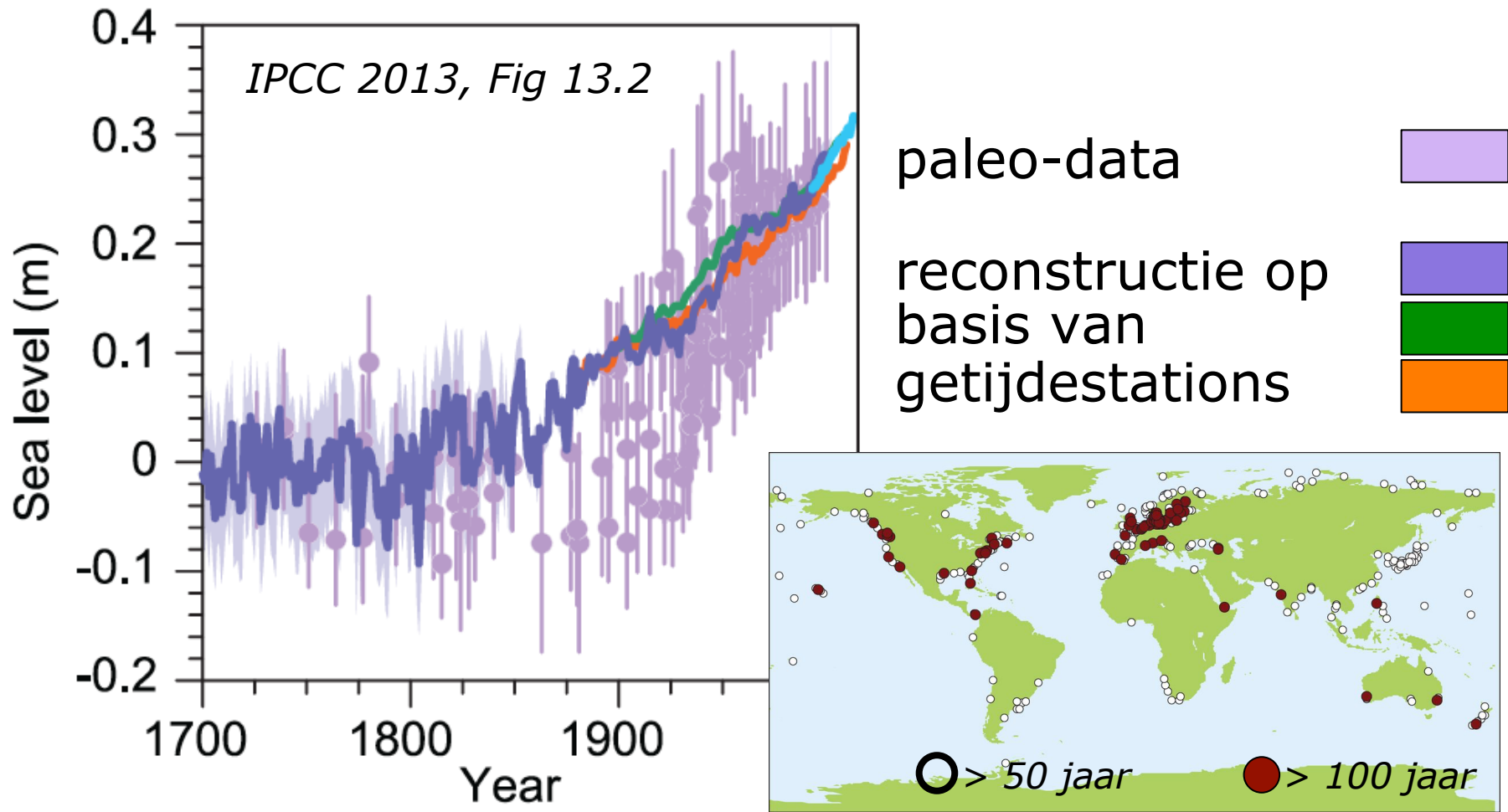
Observaties; wereldgemiddeld



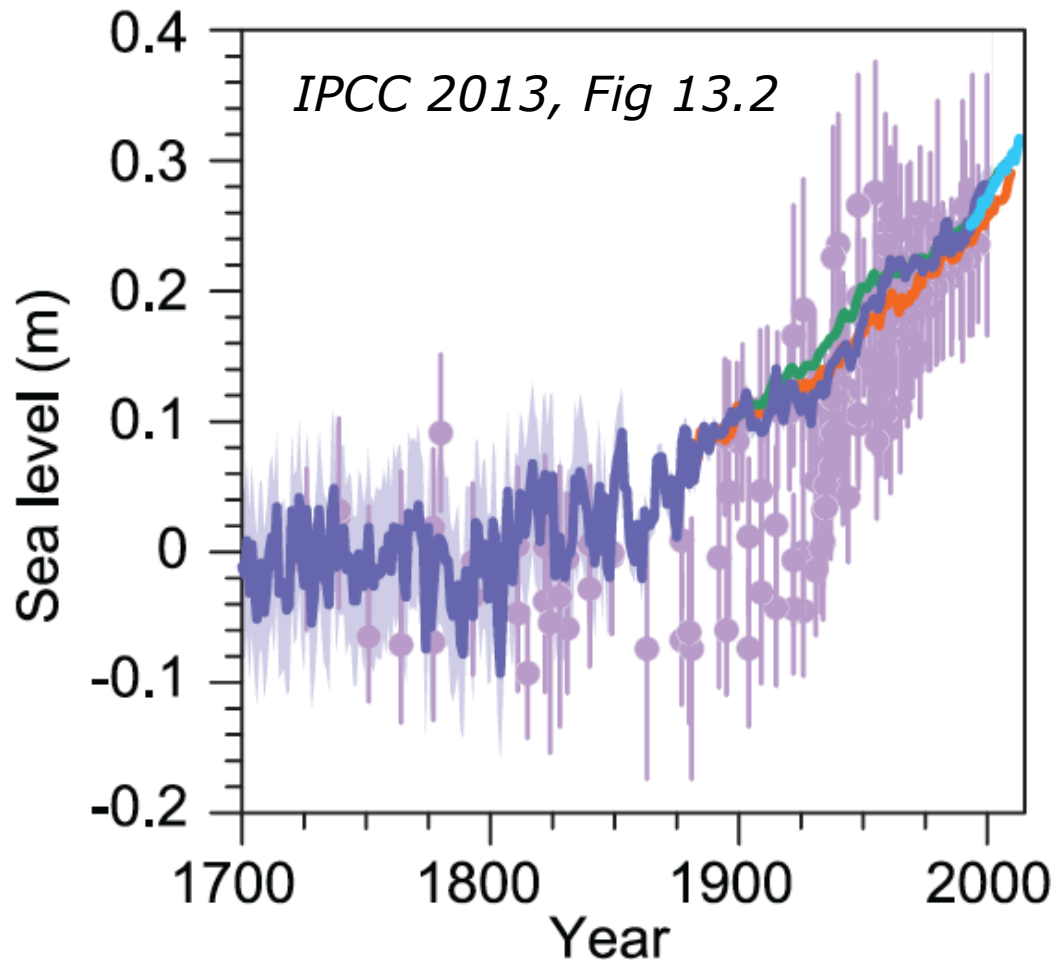
paleo-data



Observaties; wereldgemiddeld



Observaties; wereldgemiddeld



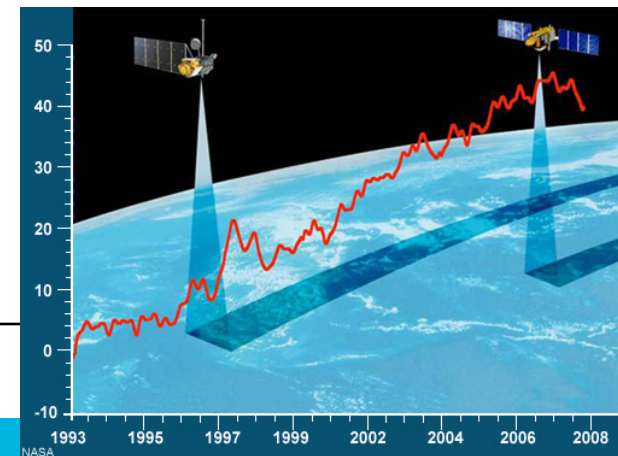
paleo-data



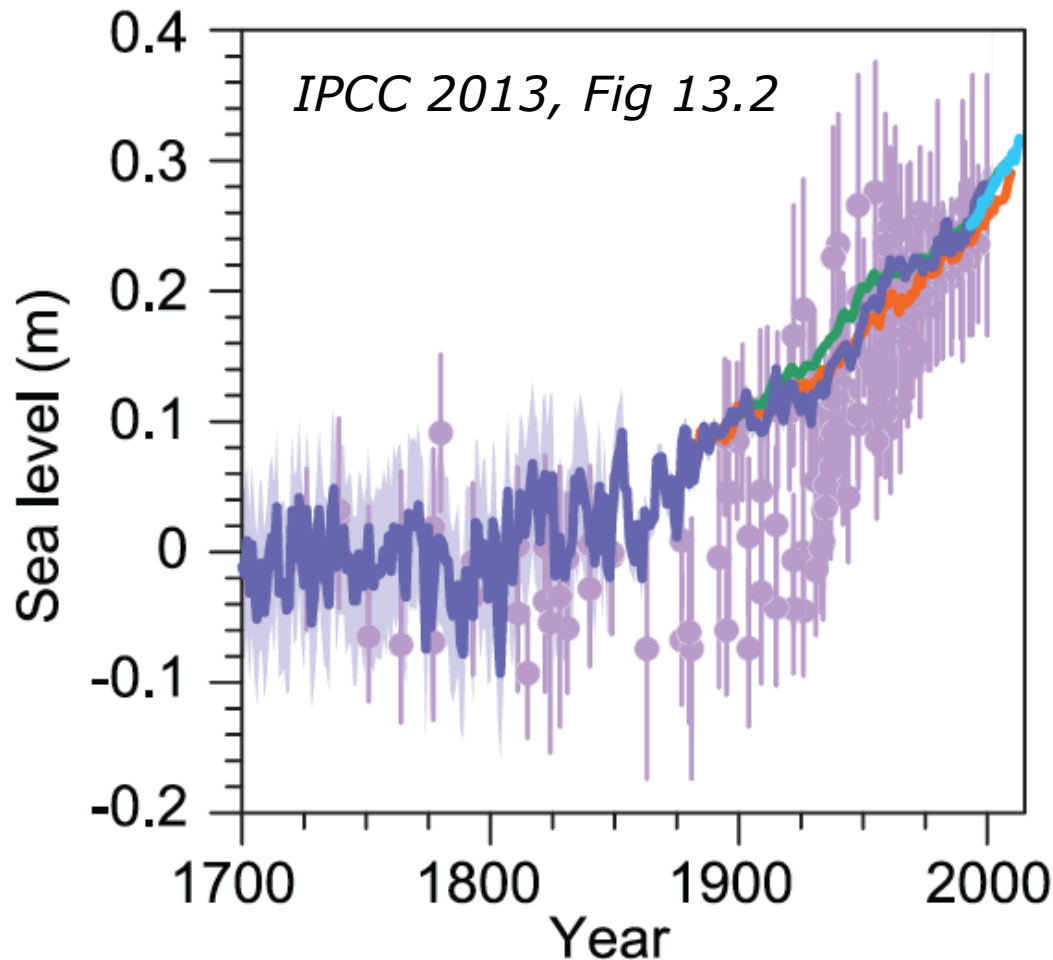
reconstructie op basis van
getijdestations



satellietmetingen



Observaties; wereldgemiddeld

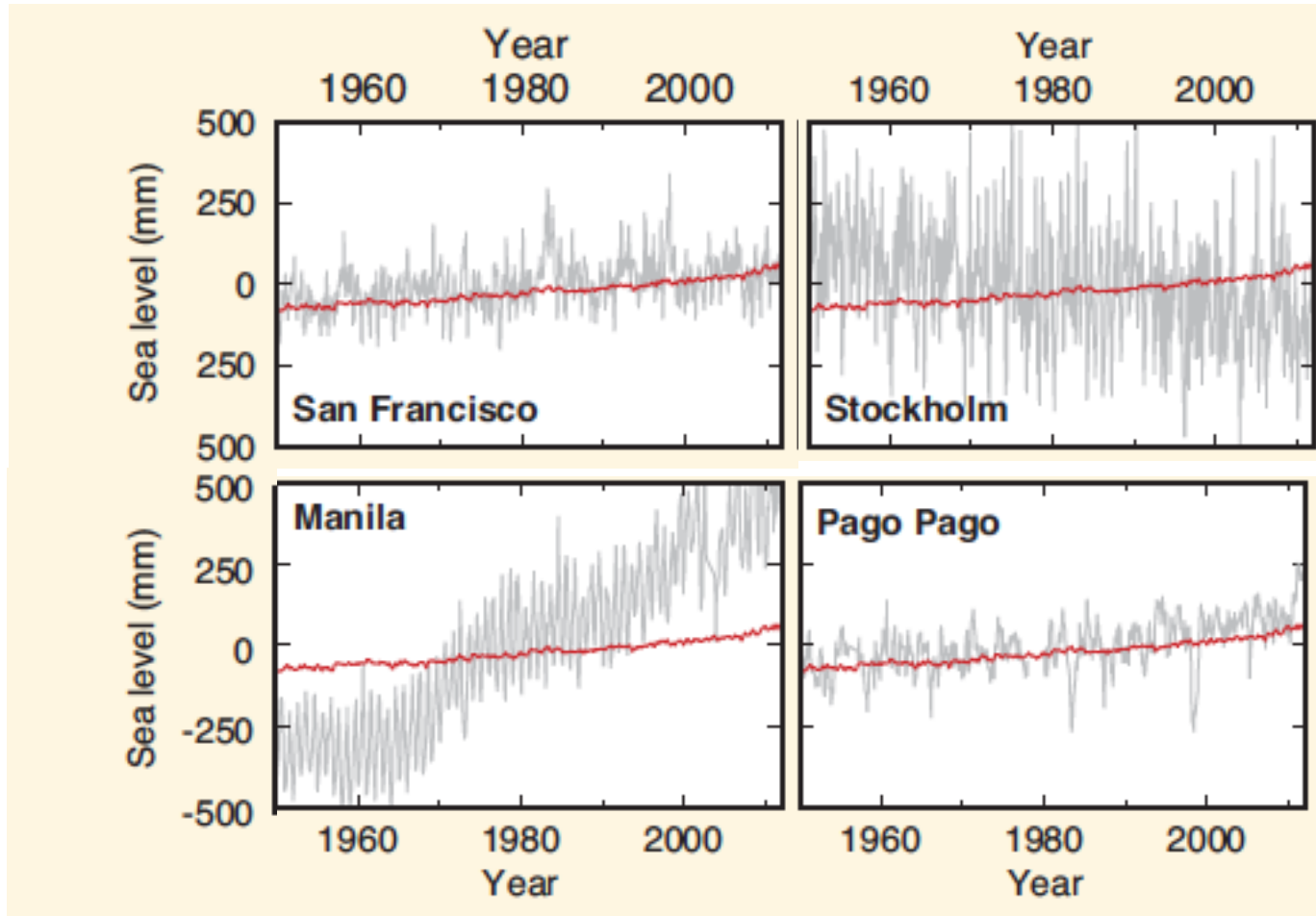


gemiddeld **tempo**:
1.7 mm/jaar (1901-2010)
2.0 mm/jaar (1971-2010)
3.2 mm/jaar (1993-2010)

recente **snellere stijging** volgt uit
getijdestations en
satelliet metingen

in 1920-1950
vergelijkbaar hoog tempo waarschijnlijk

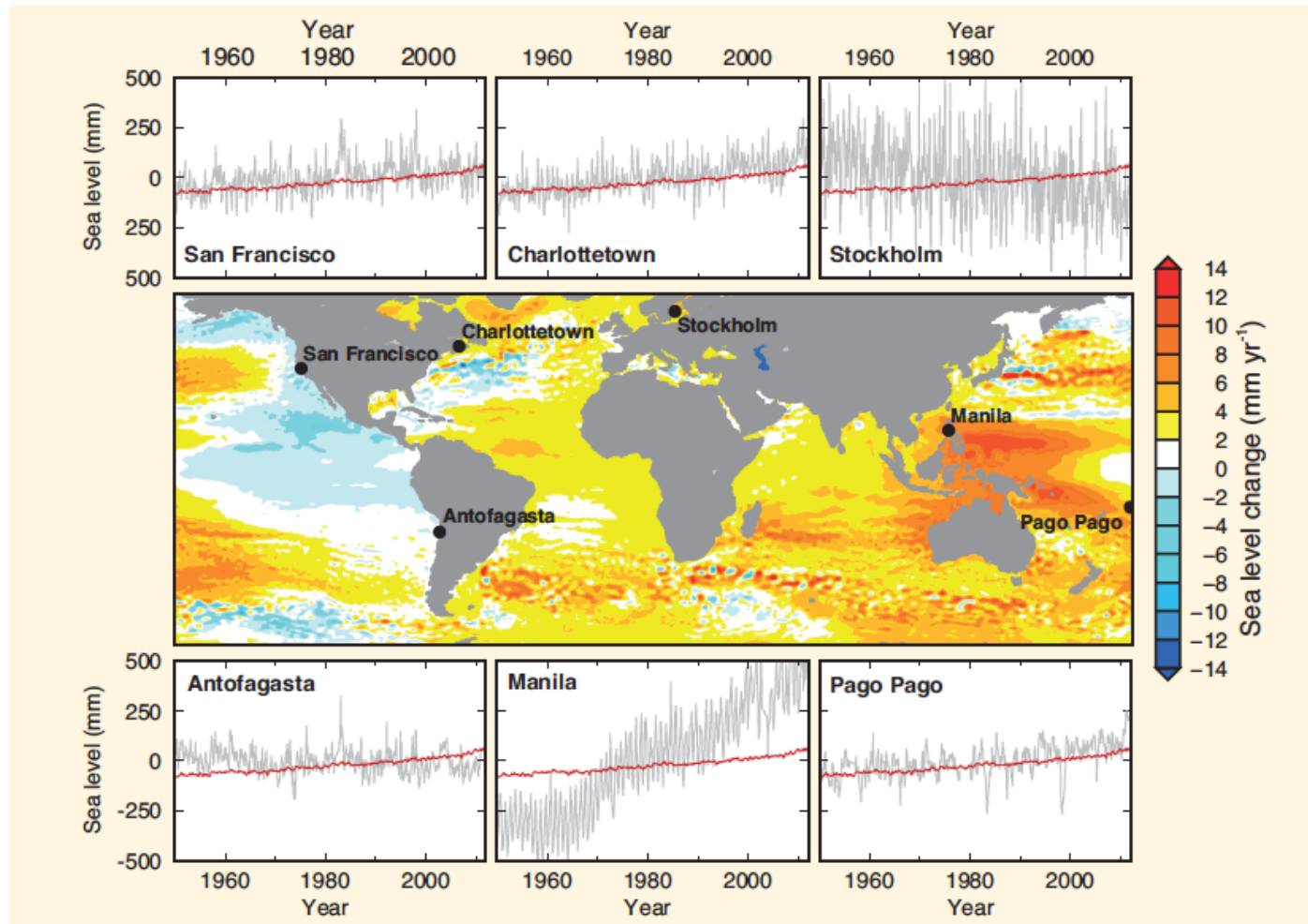
Regionale zeeniveau-veranderingen



getijdestations
1950-2012

wereldgemiddeld

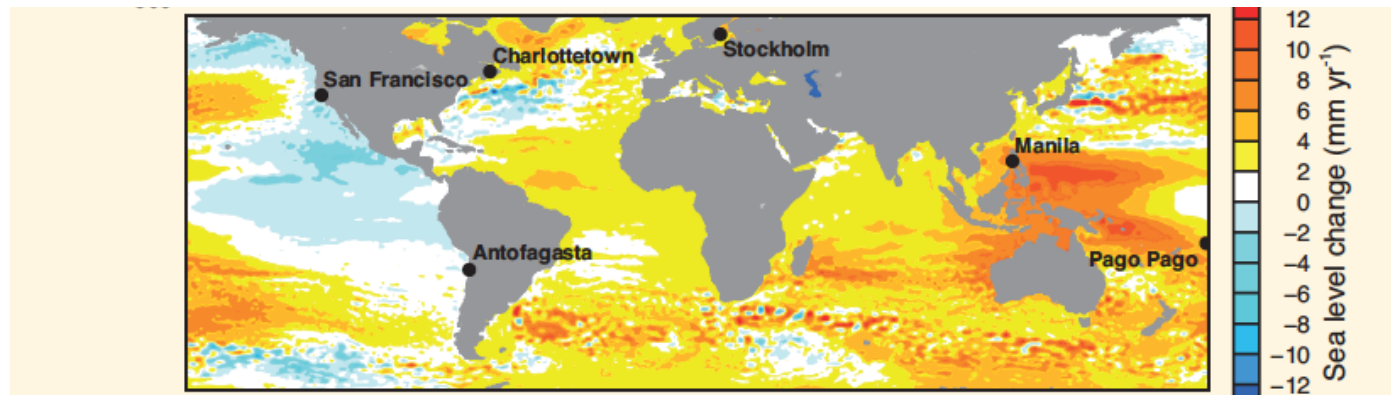
Regionale zeeniveau-veranderingen



satelliet
1993-2012

Regionale zeeniveau-veranderingen

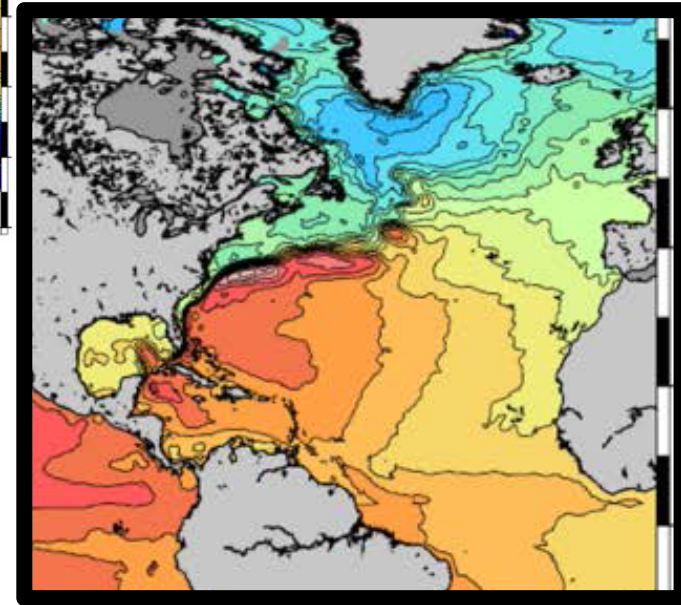
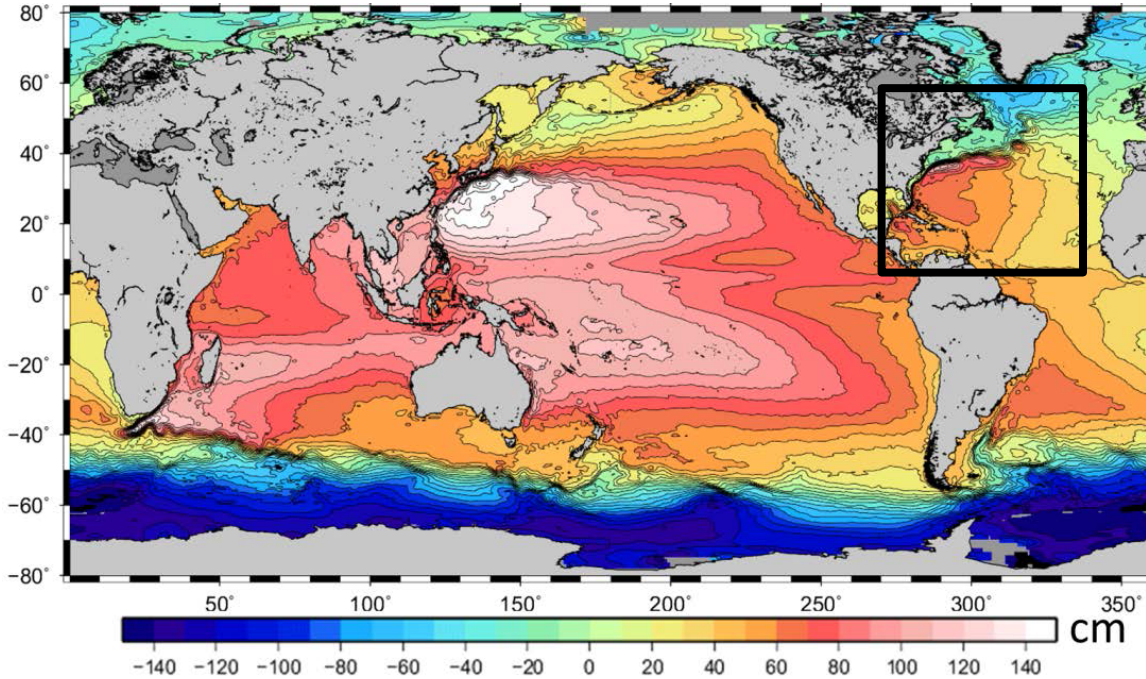
Welke **processen** veroorzaken dergelijke regionale verschillen?



satelliet
1993-2012

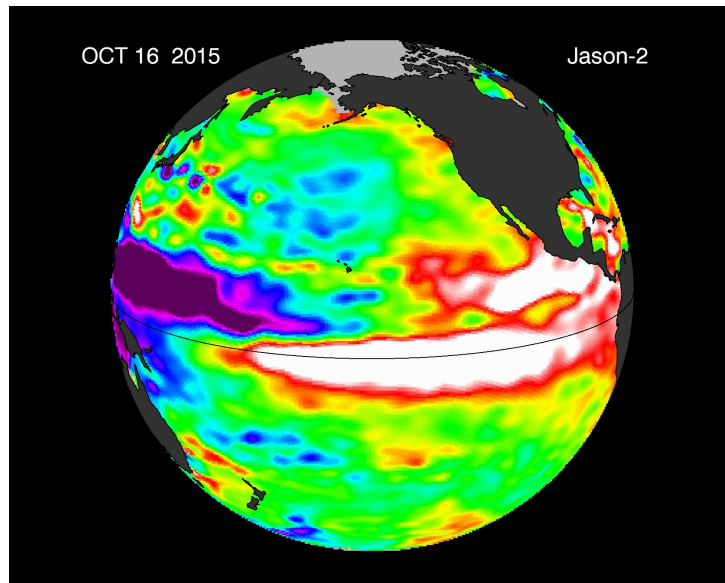
Hoe kunnen we scenario's voor **regionale zeespiegelverandering** maken?

Veranderingen in oceaandynamica

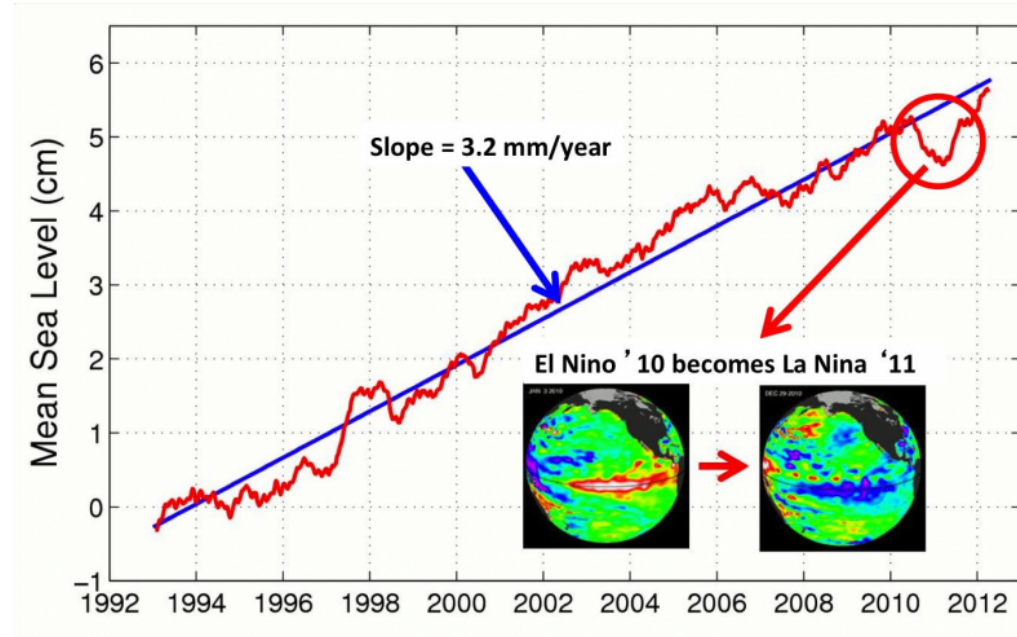


windgedreven circulatie

Veranderingen in oceaandynamica



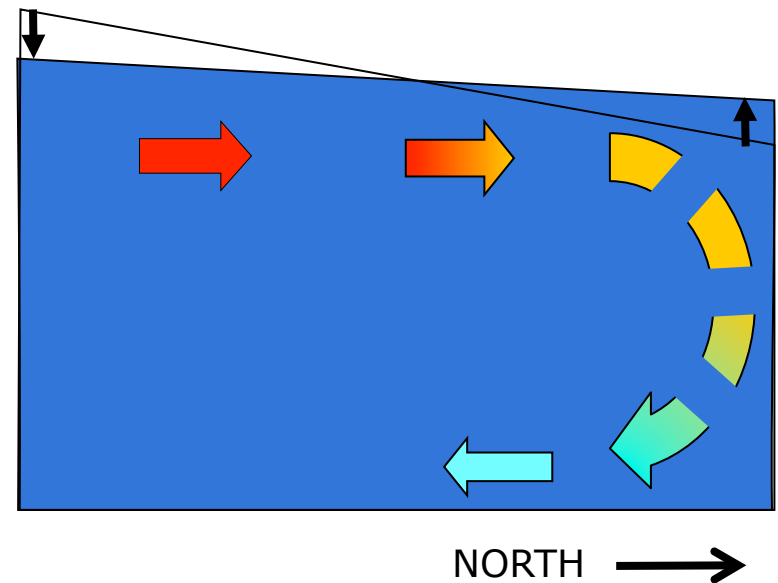
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Boening et al., 2012

El Nino / La Nina episodes

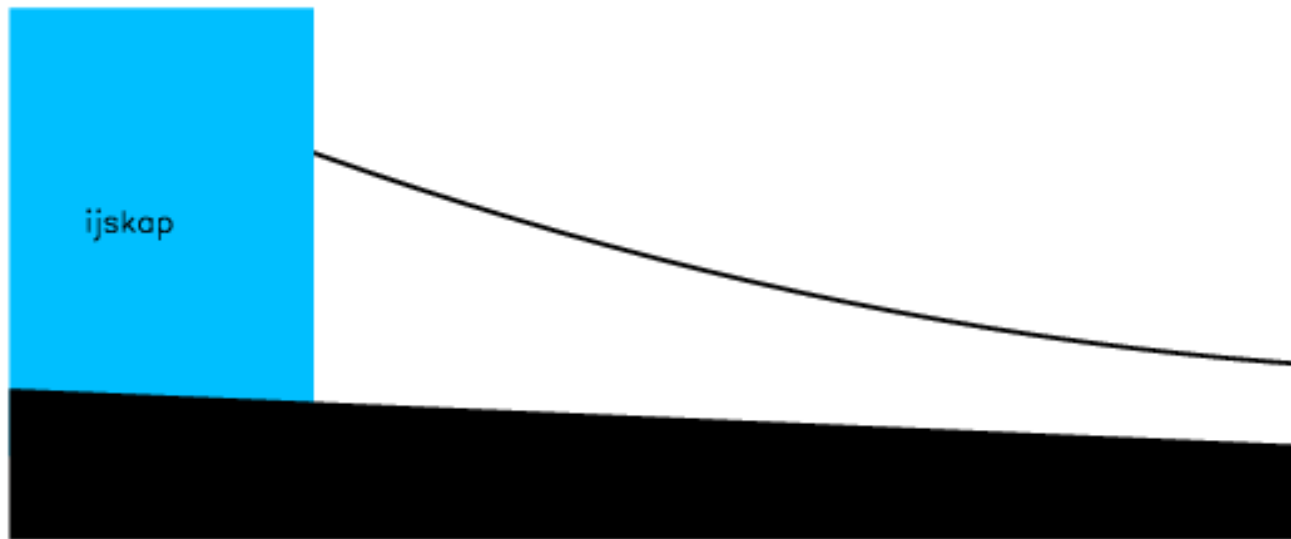
Veranderingen in oceaandynamica



afzwakken / stilvallen
Atlantic Meridional
Overturning Circulation

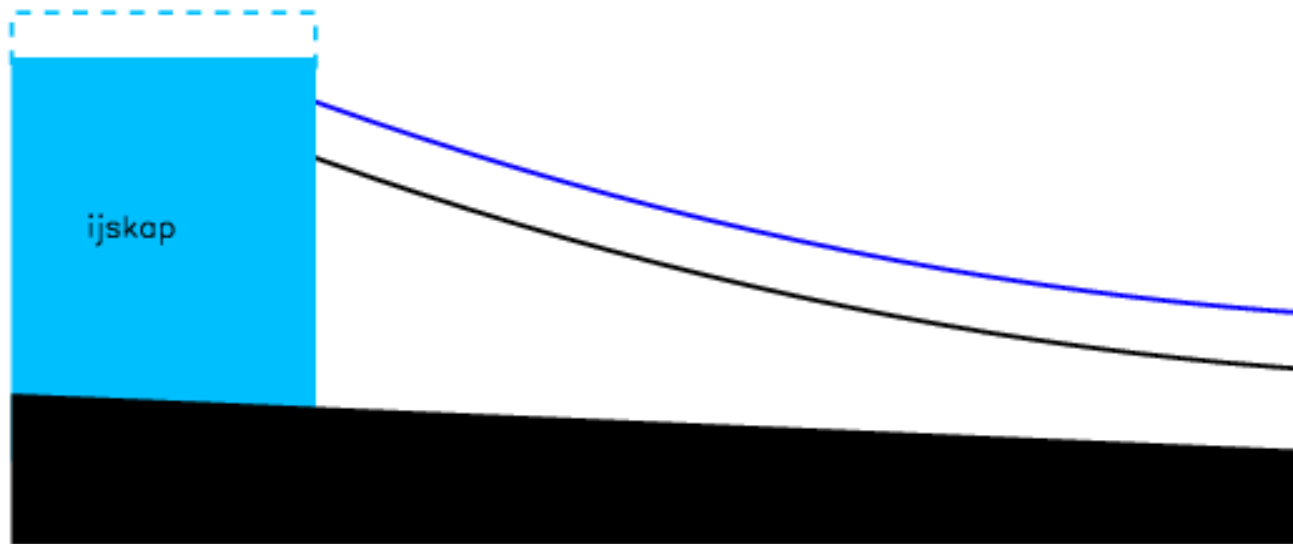
Zelfgravitatie effect

smeltwater verdeelt zich niet uniform over oceaan



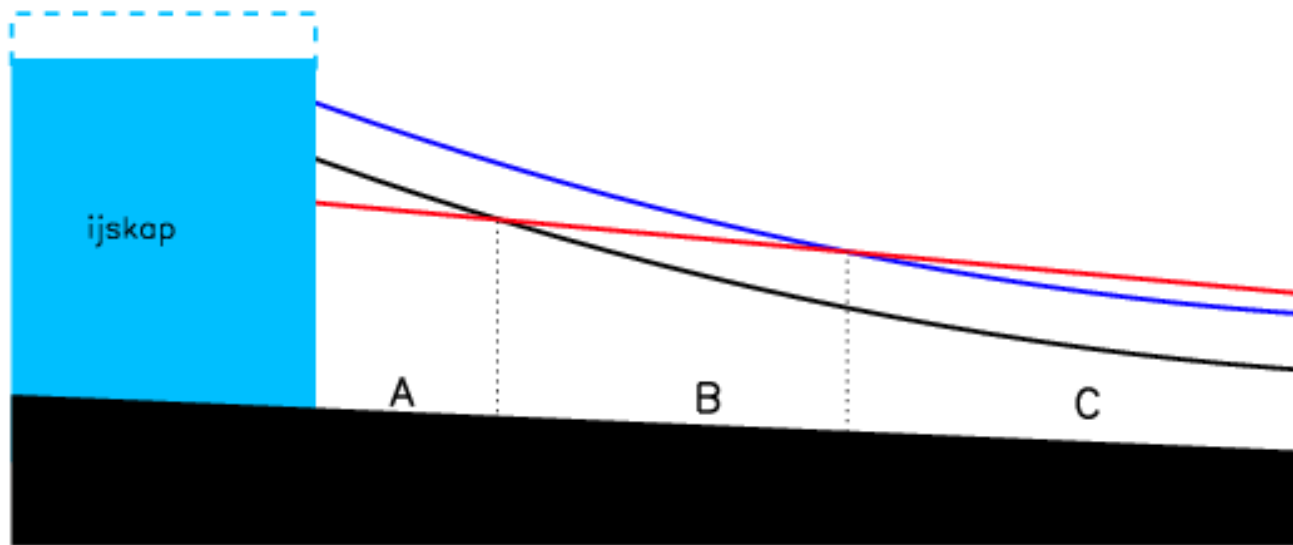
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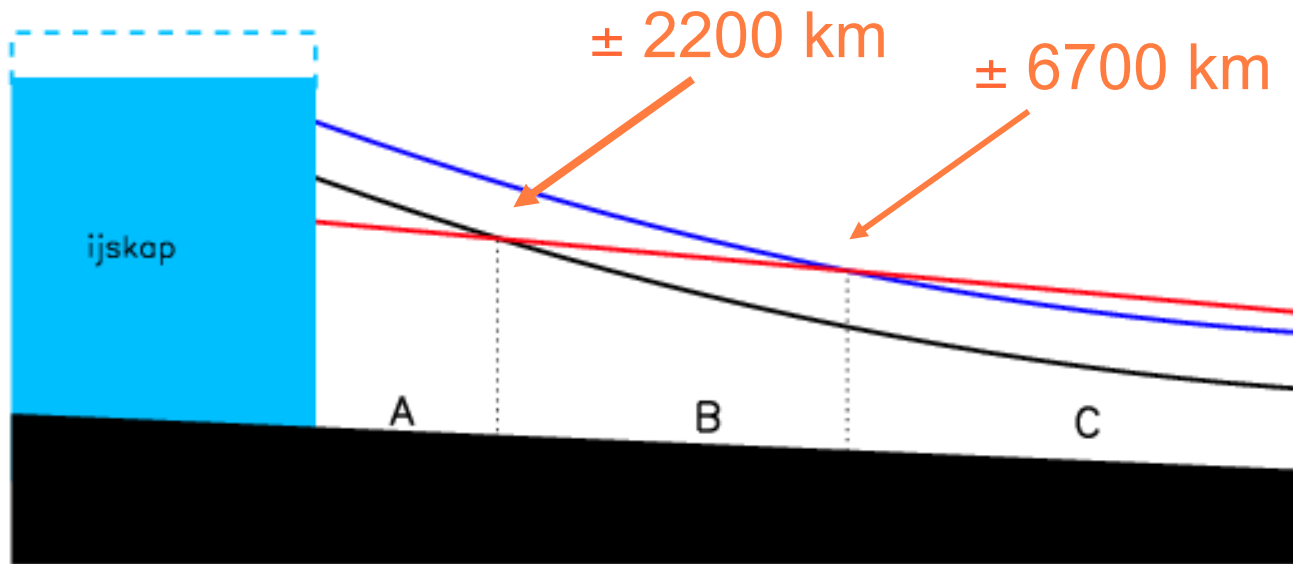
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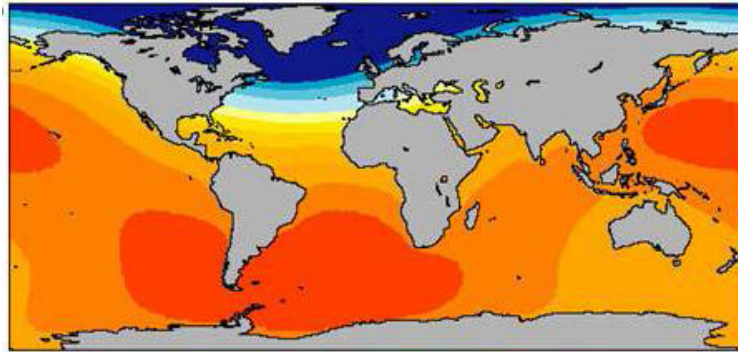


Zelfgravitatie effect

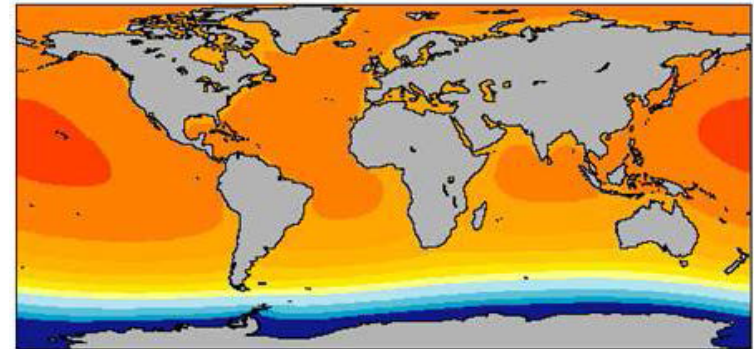
smeltwater verdeelt zich niet uniform over oceaan



Vingerafdrukken smeltwater

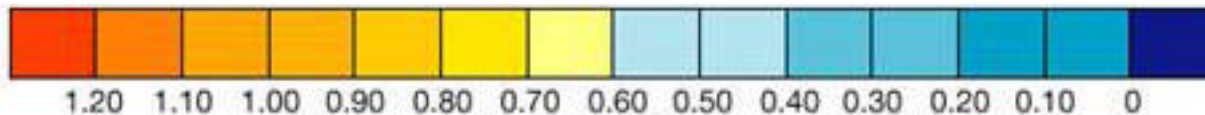
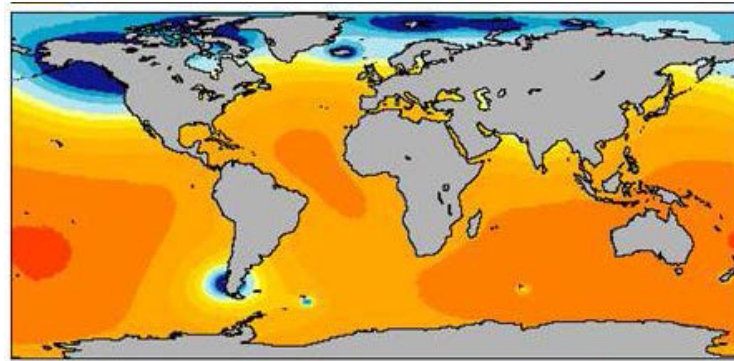


Groenland

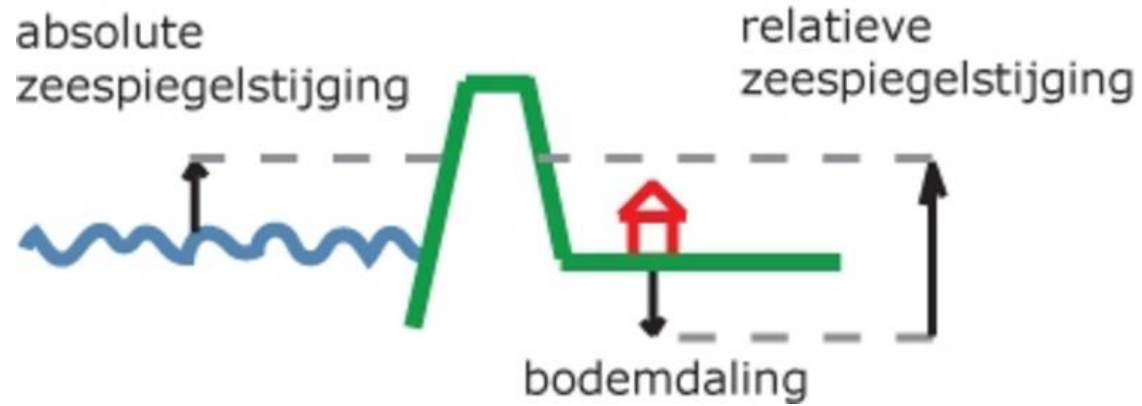


Antarctica

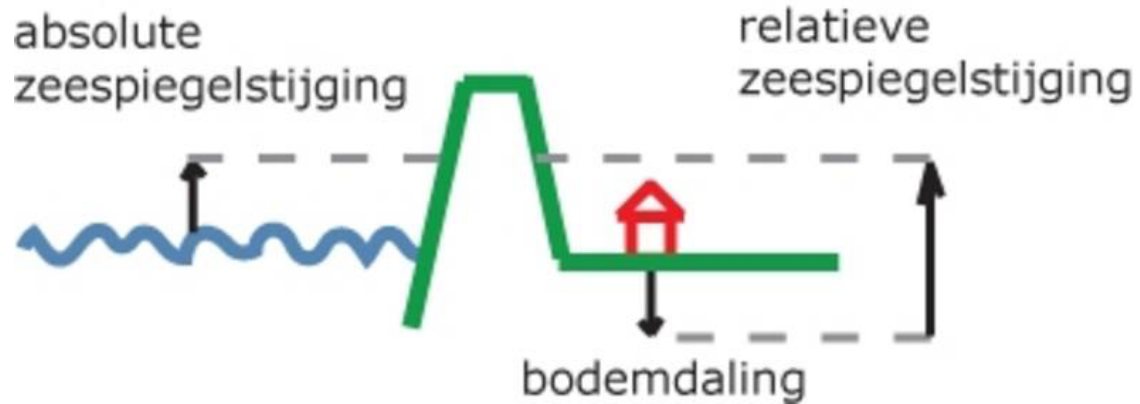
gletsjers



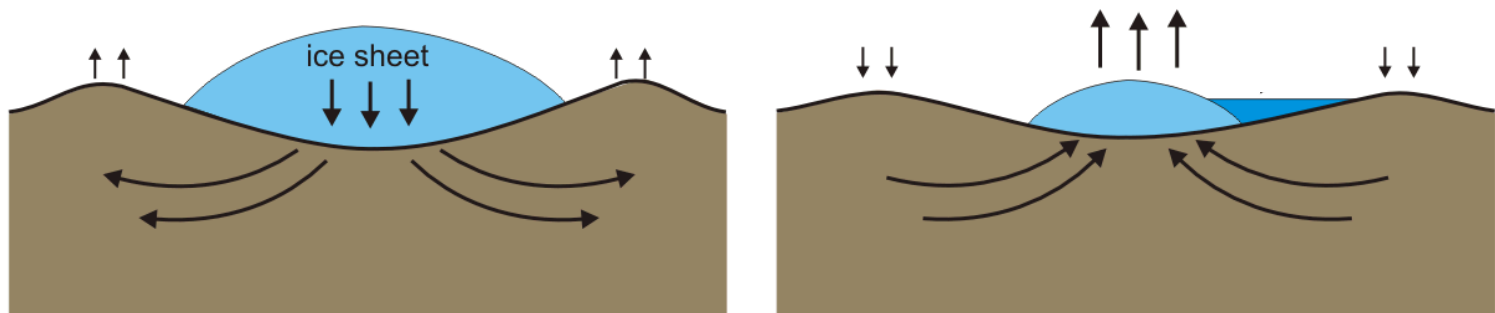
Bodembeweging



Bodembeweging



postglaciale opheffing (GIA)



Mondiaal gemiddeld scenario

uitzetting oceaan



gletsjers

Groenland

Antarctica



opslag op land



Regionaal scenario

uitzetting oceaan



veranderingen
oceaandynamica

gletsjers

Groenland

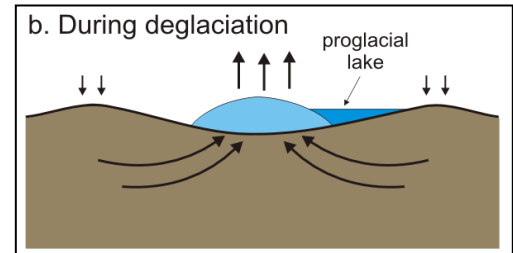
**ZELF-
GRAVITATIE**

Antarctica

opslag op land



postglaciale
opheffing



IJskapbijdragen

Surface Mass Balance

(netto effect sneeuwval en afsmelten) gebaseerd op ΔT , ΔP uit klimaat/ijskapmodel

IJsdynamica

(veranderingen in gletsjer uitstroom) gebaseerd op extrapolatie van observaties

→ **zeer onzeker**

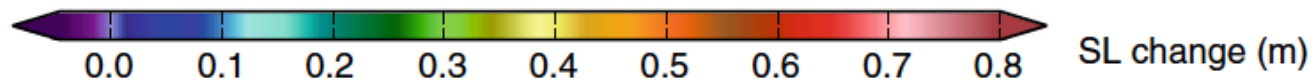
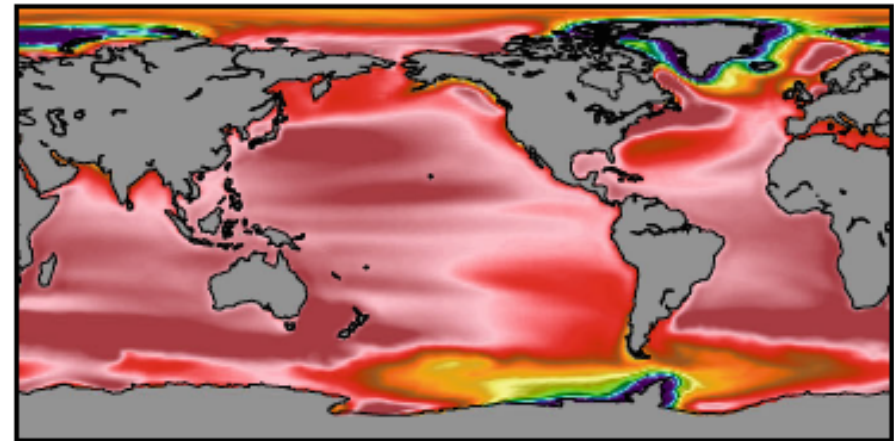
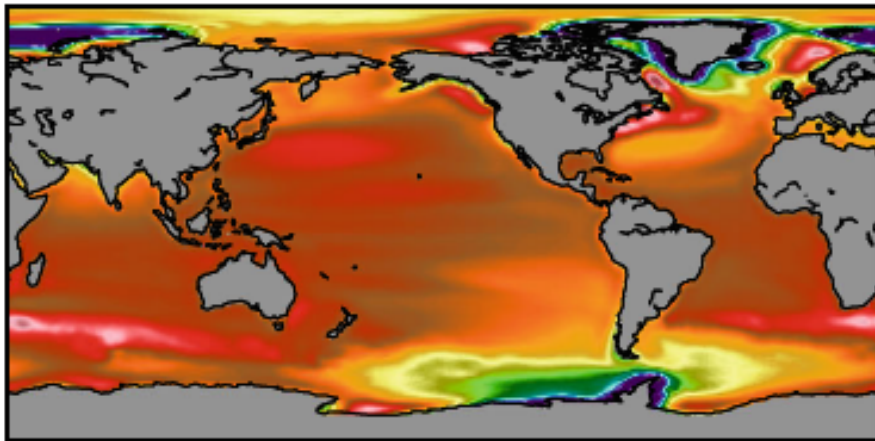


Zeespiegelstijging 21ste eeuw

RCP4.5

RCP8.5

+ ice sheet dynamics

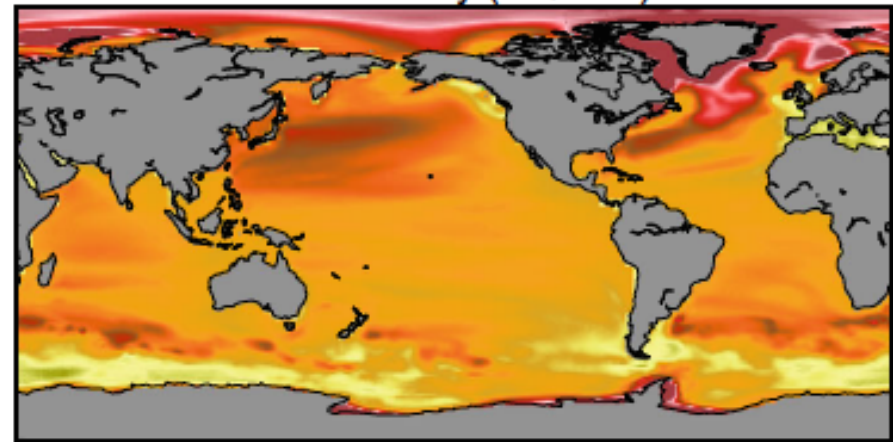
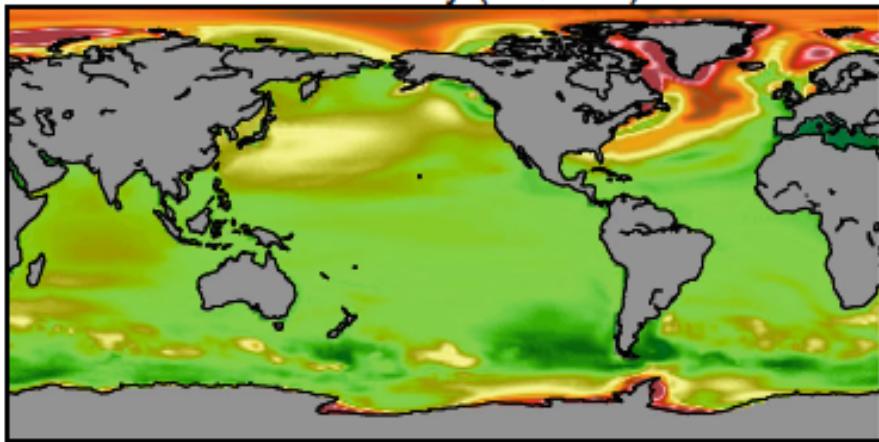


Zeespiegelstijging 21ste eeuw

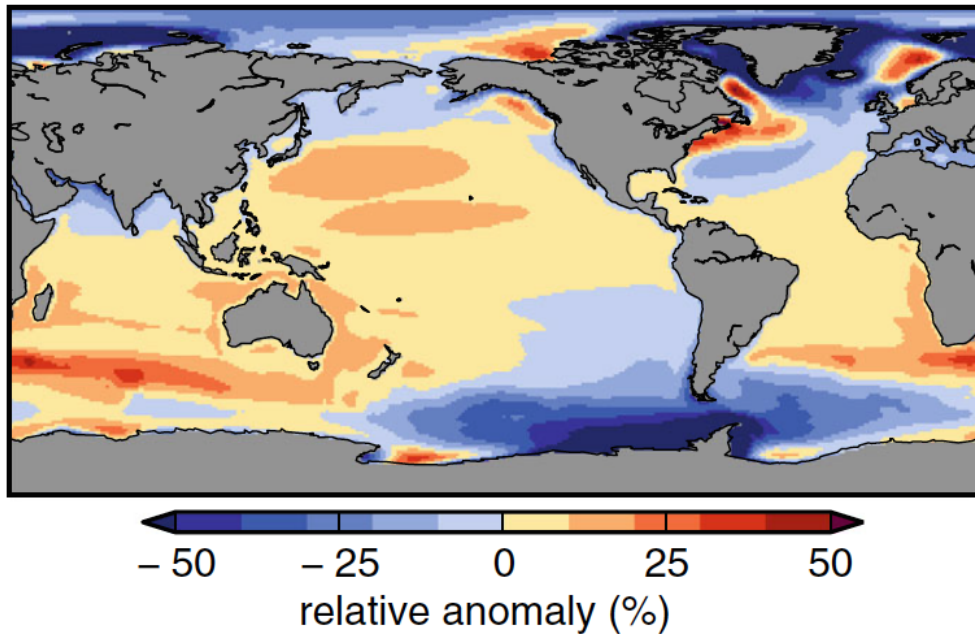
RCP4.5

RCP8.5

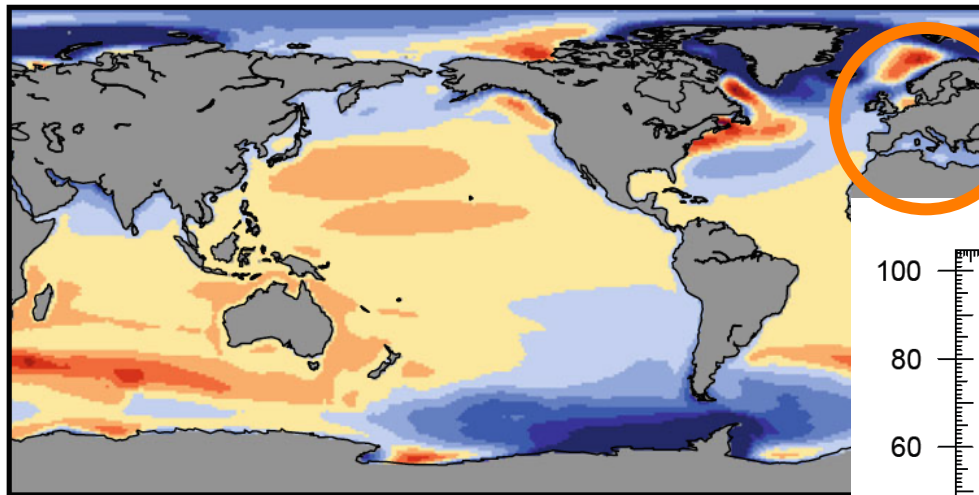
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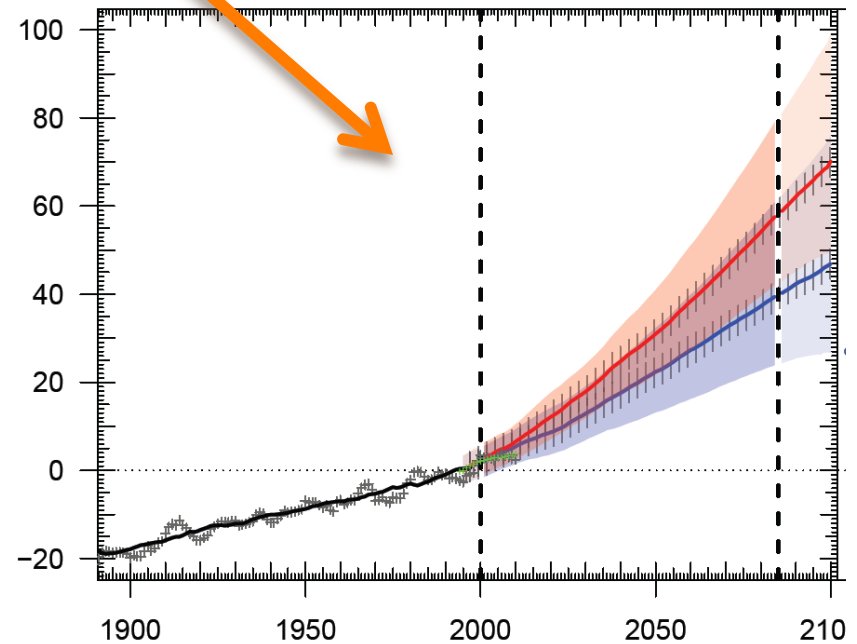
Scenario Nederlandse kust



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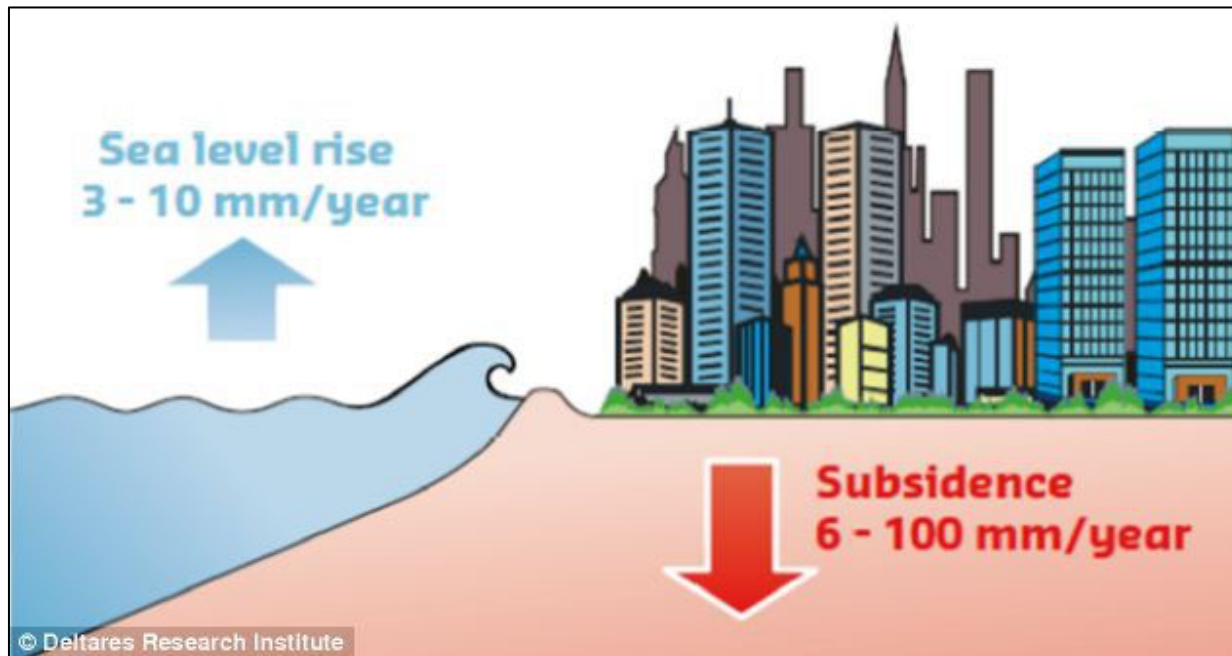


- 50 - 25 0 25 50
relative anomaly (%)



Wat ontbreekt (nog) ?

Lokale bodembewegingen anders dan GIA



Jakarta

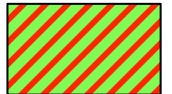
©Deltares

Wat ontbreekt (nog) ?

Lokale bodembewegingen anders dan GIA



Oceaan-landijs interacties

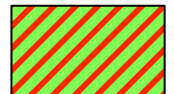
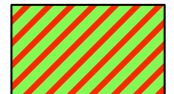


Wat ontbreekt (nog) ?

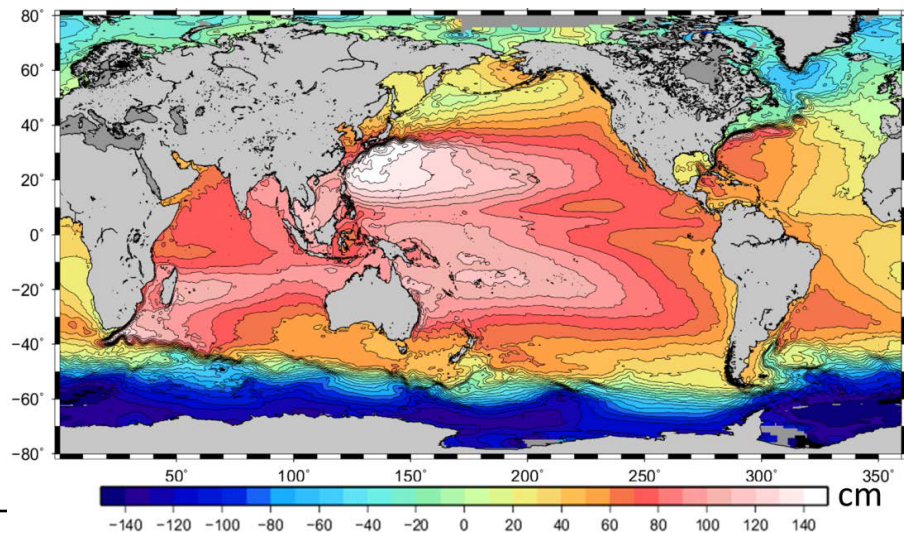
Lokale bodembewegingen anders dan GIA

Oceaan-landijs interacties

Landijs-oceaan interacties



*smeltwater
beïnvloedt
oceaancirculatie*



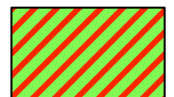
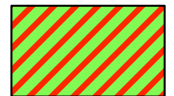
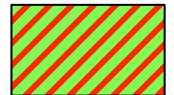
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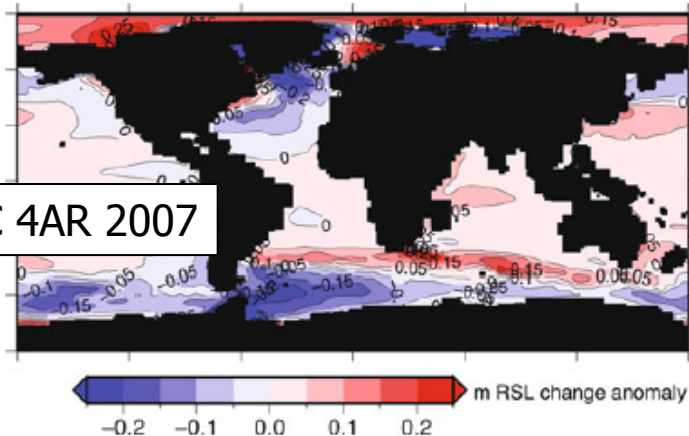
Oceaan-landijs interacties

Landijs-oceaan interacties

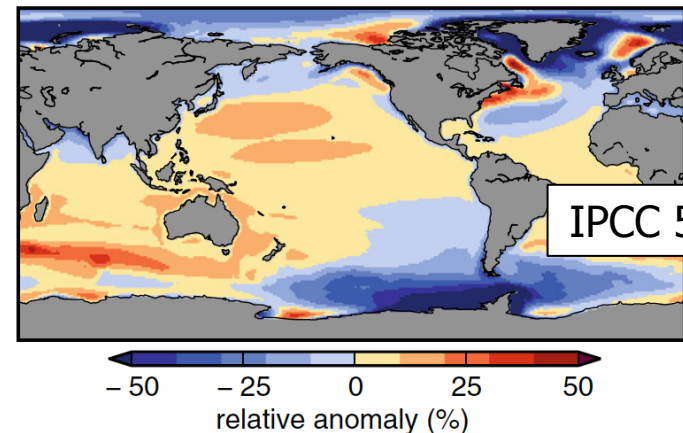
Van oceaan naar kust



IPCC 4AR 2007



IPCC 5AR 2013

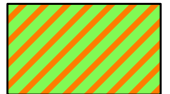


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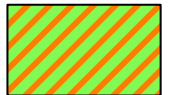
Lokale bodembewegingen anders dan GIA



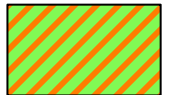
Oceaan-landijs interacties



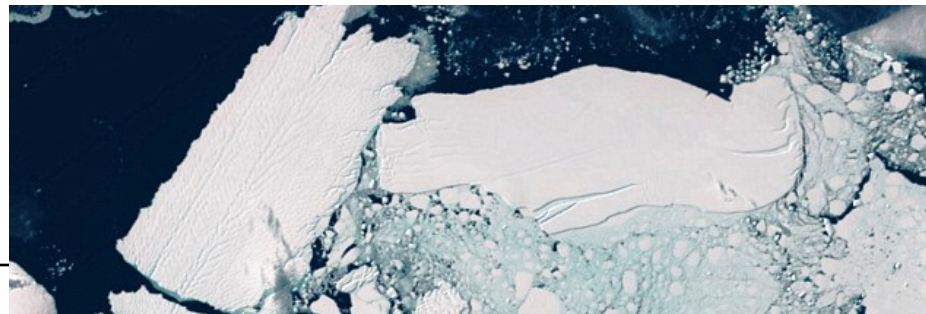
Landijs-oceaan interacties



Van oceaan naar kust



Bijdragen ijskap dynamica



Tot slot

Scenario's voor zeespiegelstijging worden geconstrueerd op basis van informatie uit verschillende bronnen / modellen

Regionale effecten zijn van belang

Meer gedetailleerde modellen geven meer vertrouwen in de resultaten aan de kust

De grootste onzekerheid van de scenario's zit in de toekomstige bijdrage van de **ijsskapedynamica**