The KNMI’14 scenarios for sealevel rise along the North Sea coast

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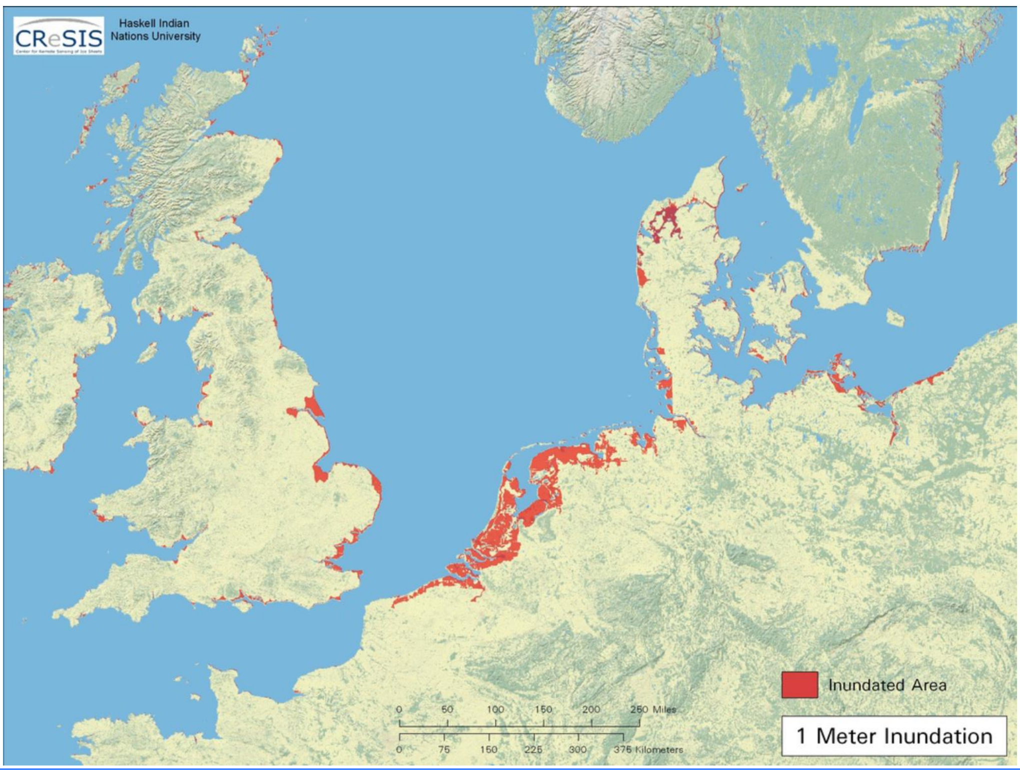
Why sea-level scenarios?



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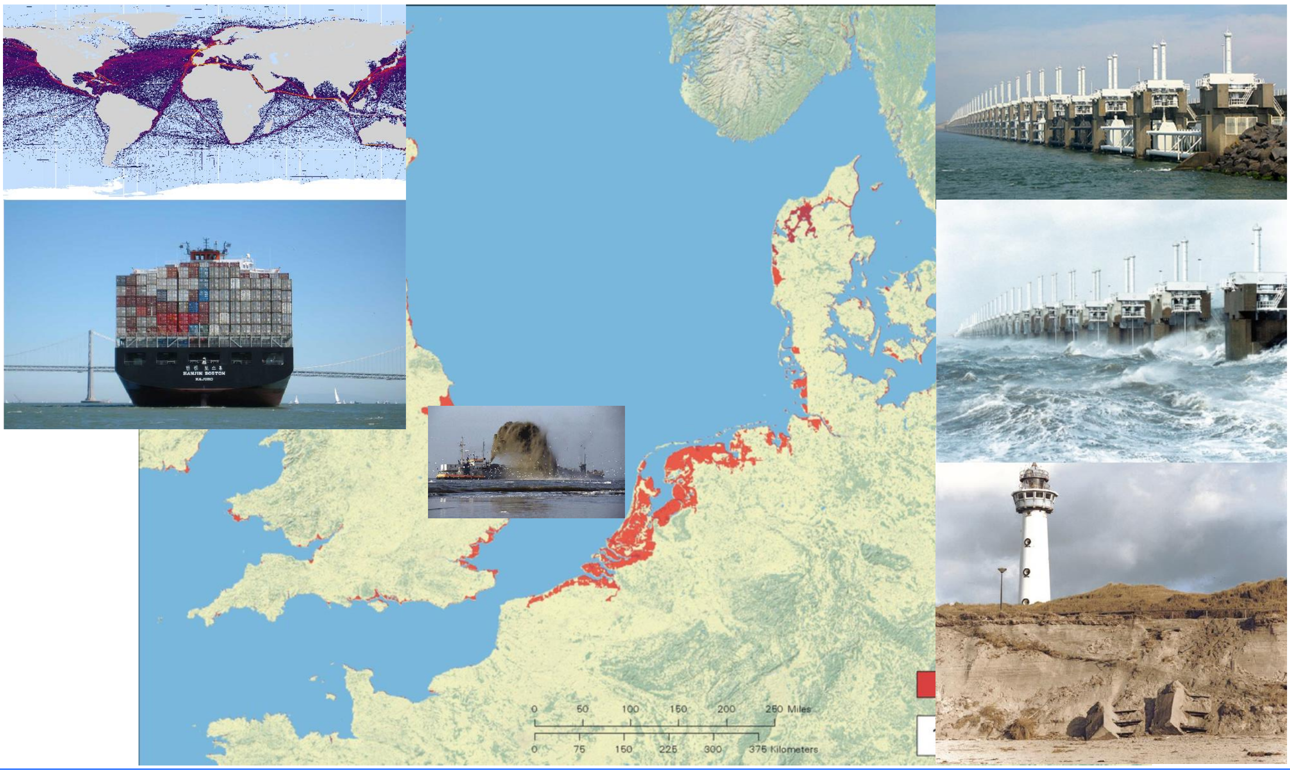

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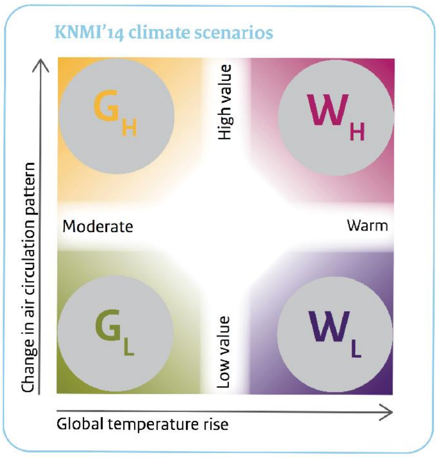
Responsibility to inform

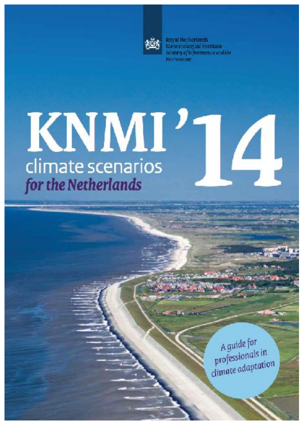
- Governments
- Companies
- Public
- ...

- Safety & Warning
- ...
- Opportunities

Scenarios

Consistent and plausible pictures of the future climate. Intended as a tool for climate impact studies and adaptation measures





Not only for sea level
Not long-term forecasts. Not the most extreme.

Objective

Construct a (new) set of sea-level scenarios tailored to the Dutch coast

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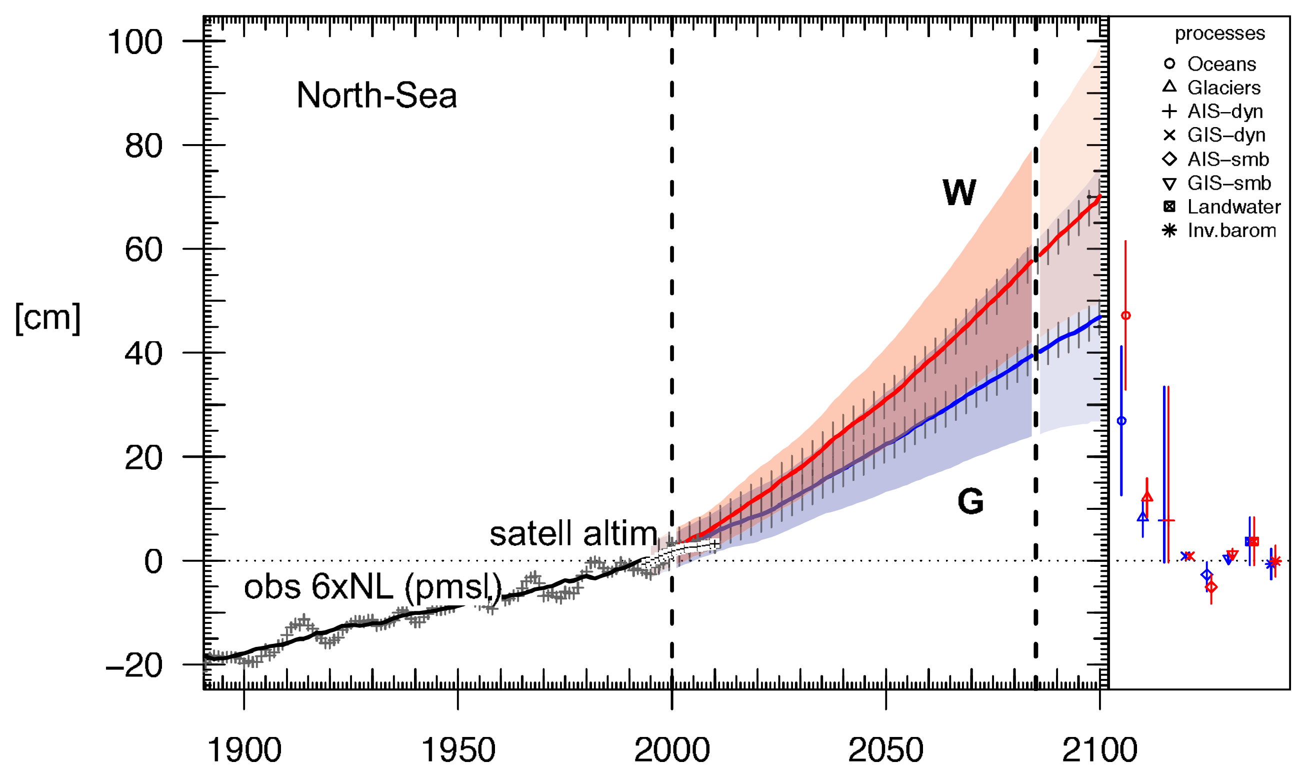
Construct a (new) set of sea-level scenarios tailored to the Dutch coast

Constraints
Consistent with IPCC-AR5
Consistent with KNMI'14 (temperature based)
Include uncertainties

Two scenarios: moderate (G) and warm (W)



Construction

Approach: 4 steps

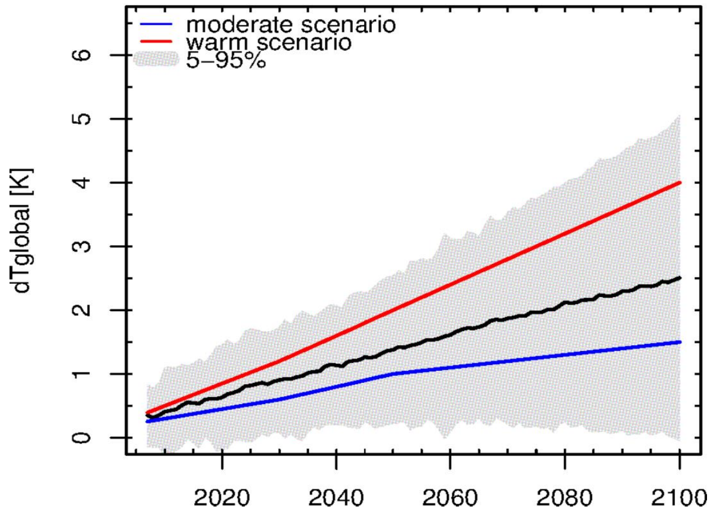
- Step 1: Global Temperature Pathways
- Step 2: Contributions. Multi-model approach
- Step 3: Regionalization using “fingerprints”
- Step 4: Combine contributions statistically

Step 1: Global temperature Pathways

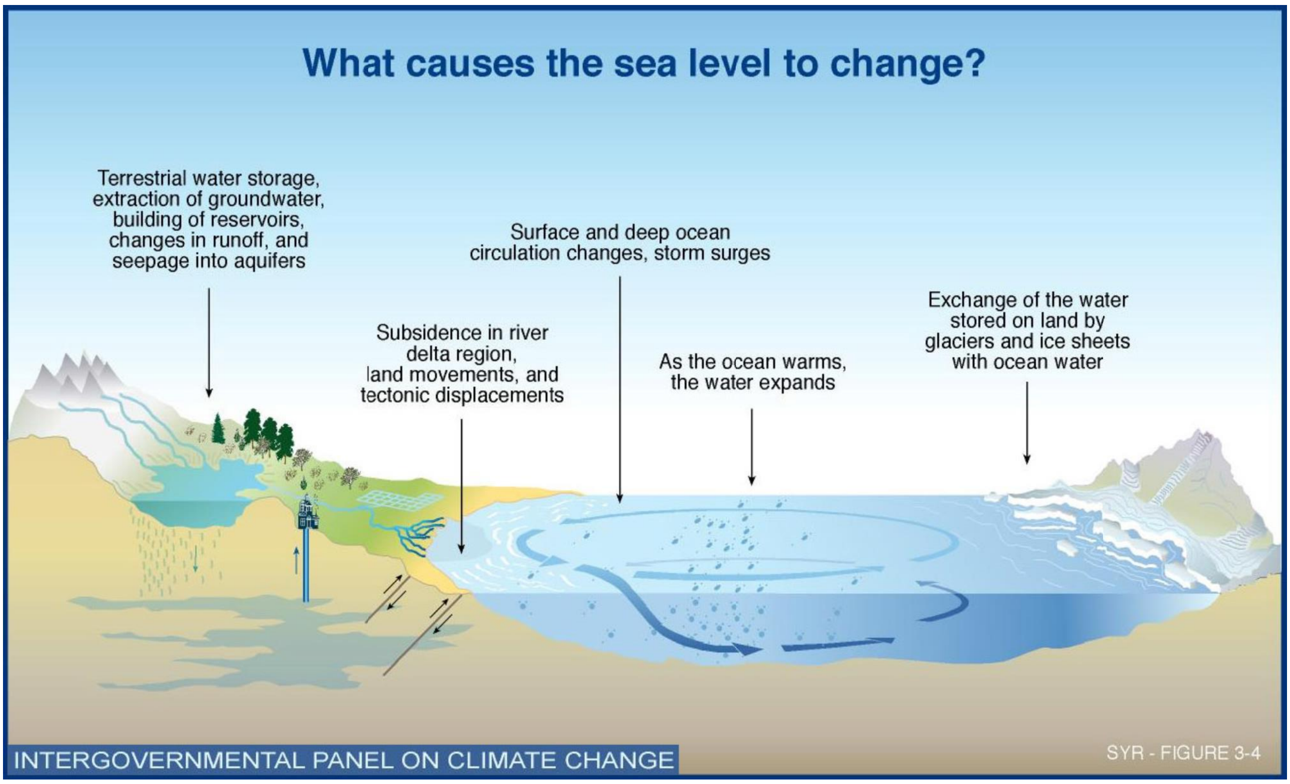
Year	2050	2085	2050	2085
Scenario	G	G	W	W
dTg	+1.0	+1.5	+2.0	+3.5

Reference
1981-2010

NOTE:
- Follows from CMIP5 plume
- Not very extreme
- Linear interpolation for years in between



Step 2: The contributions



Implementation

How are the Global Temperature Pathways implemented in the two scenarios?

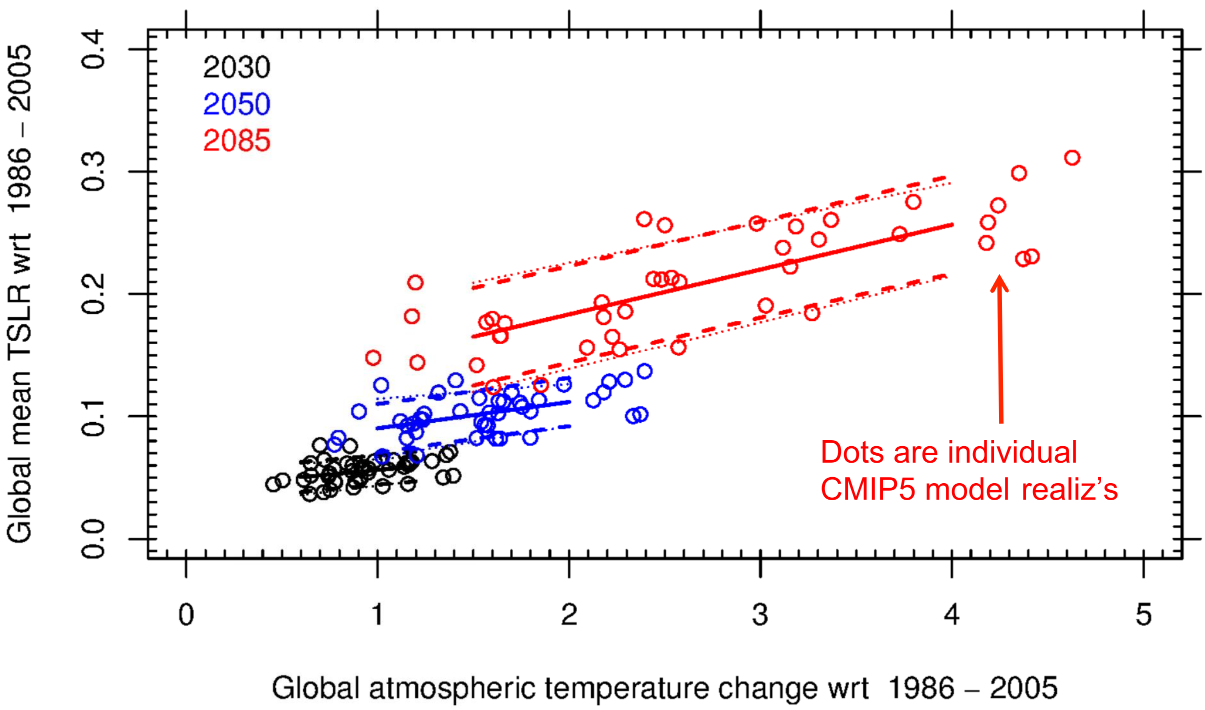
Use “sliding” regressions of 30-year mean AOGCM-output on 30-year mean dTglob

Data

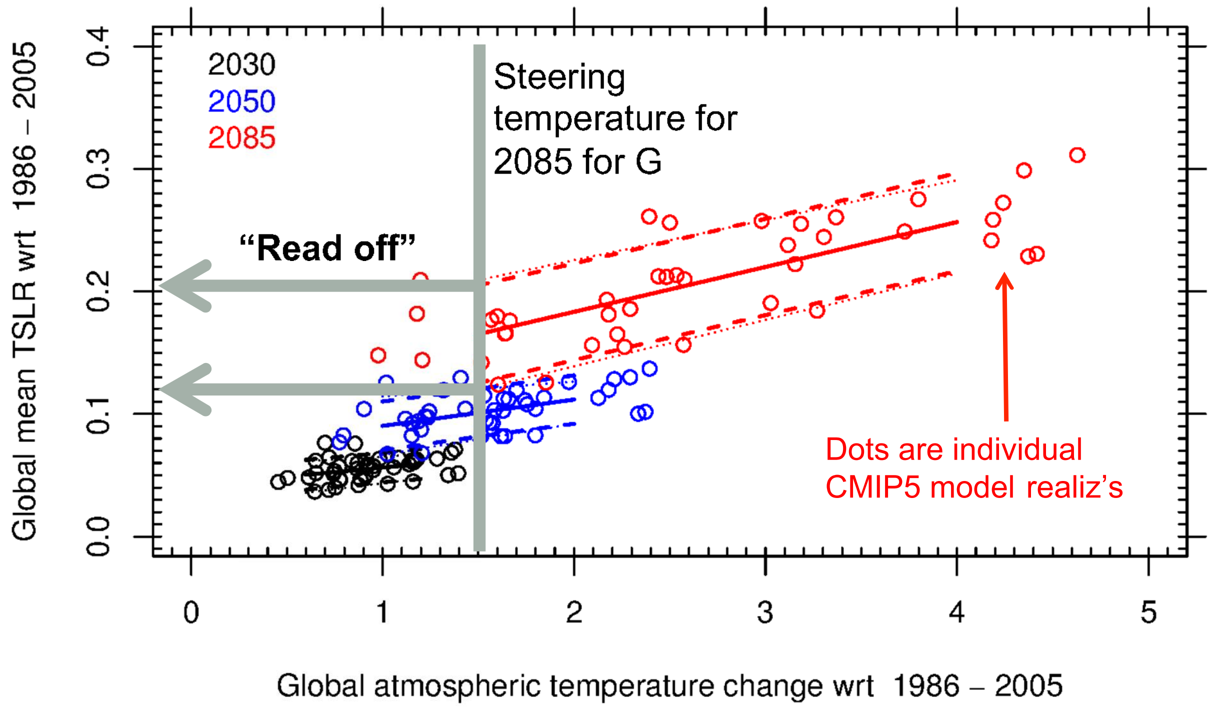
Model: CMIP5 RCP4.5 & RCP8.5: 42 models

Obs: tide-gauges and altimetry

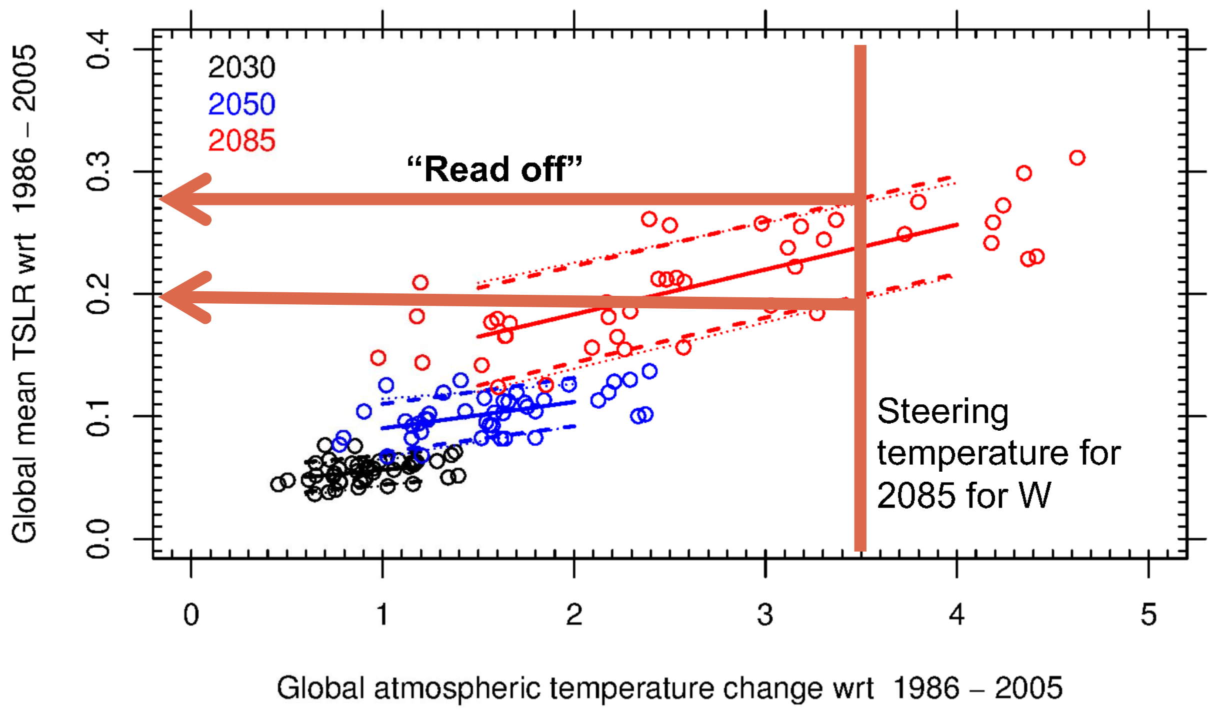
Sliding regression approach (example for global steric)



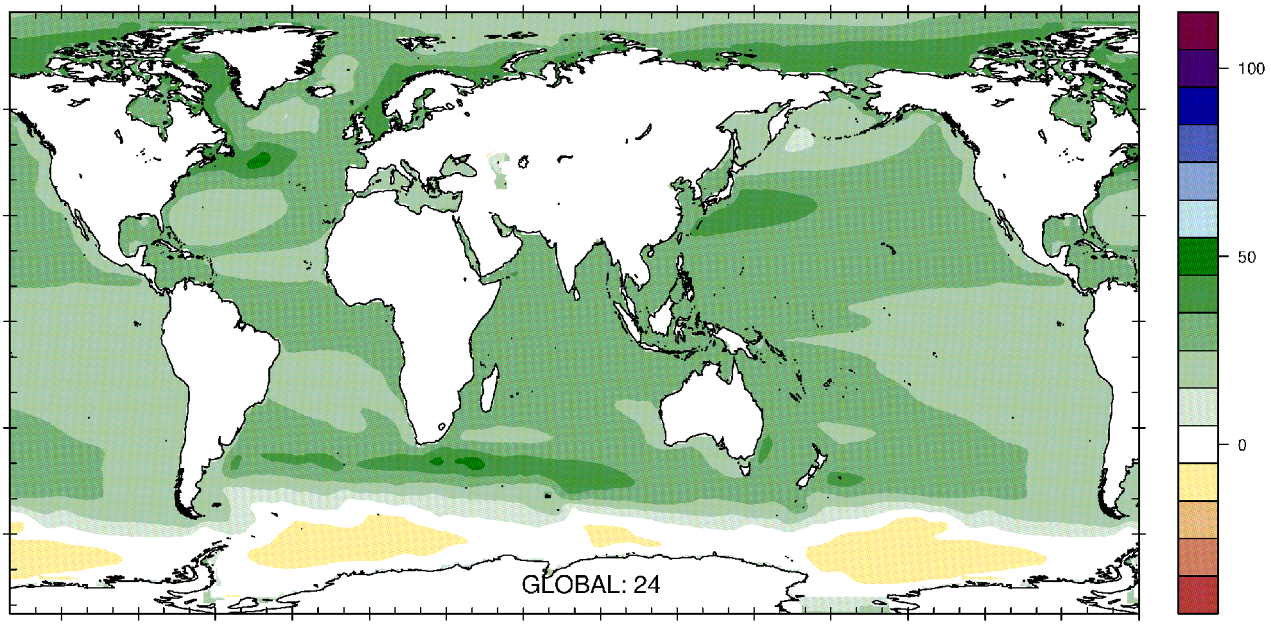
Sliding regression approach



Sliding regression approach

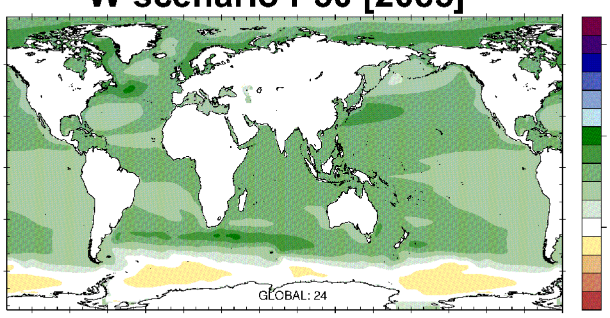


Steric/dynamic contribution, W-scenario (2085; P50)

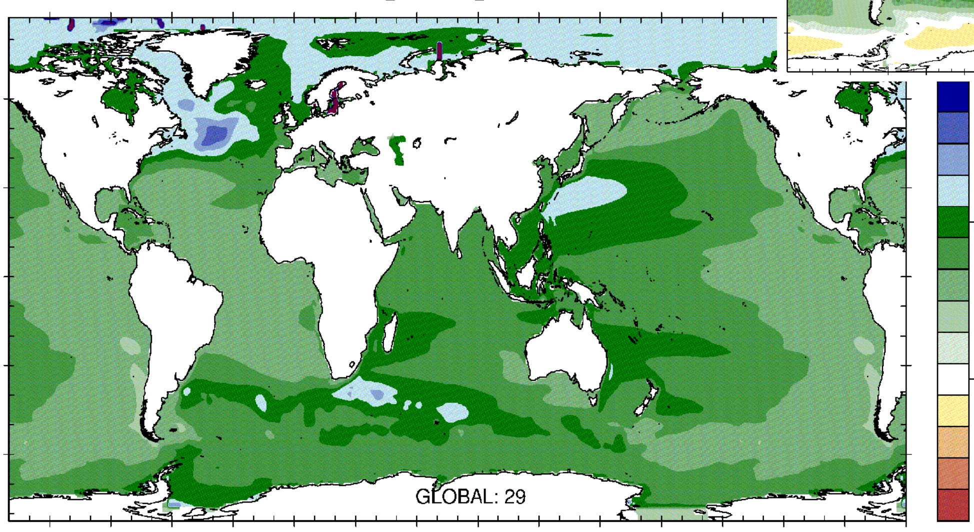


Uncertainty, W-scenario (2085)

W-scenario P50 [2085]



W-scenario P95 [2085]



Other contributions

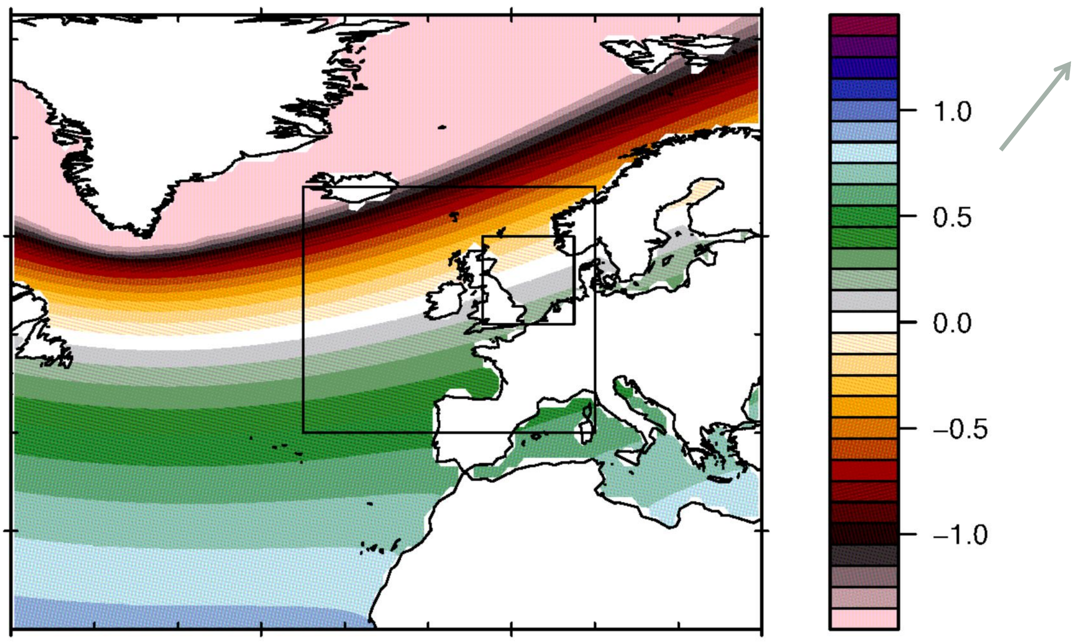
- Temperature regression approach also used for
  - Glaciers and small ice-caps (AR5, mixed)
  - Greenland Ice-Sheet (GIS) surface mass balance (Fettweis)
  - Antarctic Ice-Sheet (AIS) surface mass balance (AR5)
- Other terms taken *scenario independent*
  - GIS rapid dynamical changes (calving, basal melt etc)
  - AIS rapid dynamical changes
  - Landwater usage (Wada et al)

Step 3: Regionalization

- Mass attracts mass
- Three “influence” zones with different response to ice-loss
  - **Near-field**: sea-level less than global mean (may even decrease)
  - Medium: sea level equal to global mean
  - **Far-field**: sea level more than global mean
- “Fingerprint” fields
  - Glaciers and small ice caps
  - Large Ice Sheet contributions
  - Landwater

Fingerprints Courtesy: A. Slangen

Greenland (surface mass balance)

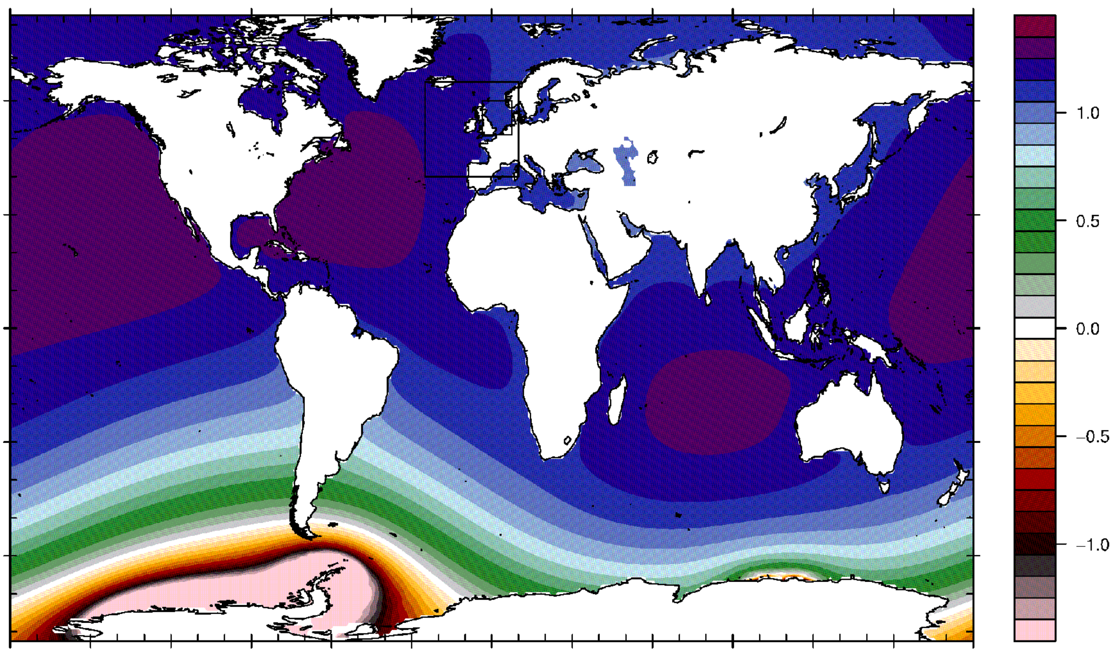


Fingerprints Courtesy: A. Slangen

$$SLR(t) \sim -71.5 \cdot \Delta T(t) - 20.4 \cdot (\Delta T(t))^2 - 2.8 \cdot (\Delta T(t))^3$$

Fettweis (2013)

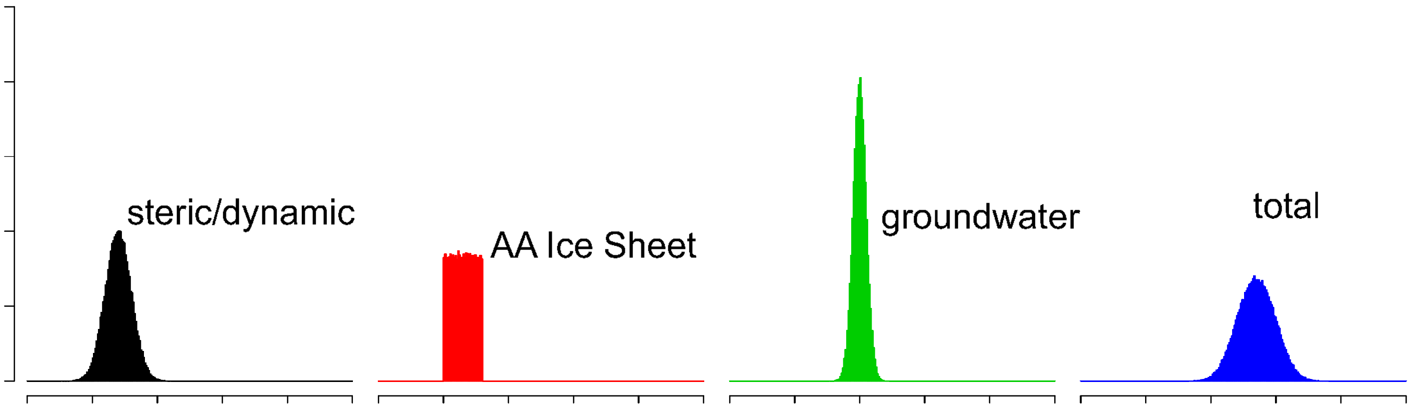
Antarctic (rapid dynamical changes)



As in AR5, but with higher upper-bound (Katsman, 2011)

Fingerprints Courtesy: A. Slangen

Step 4: Combining statistically (“Monte Carlo”)

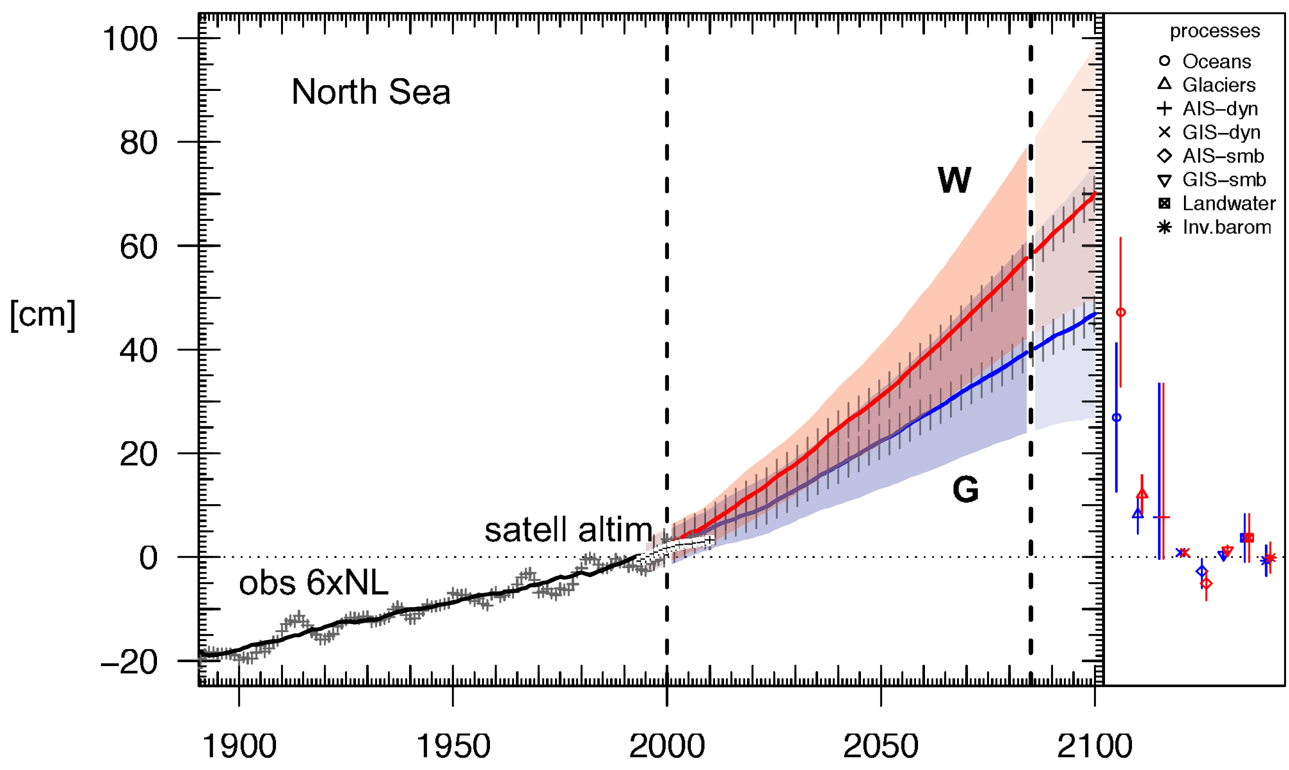


$$m_{tot}(t) \approx \sum_i m_i(t)$$

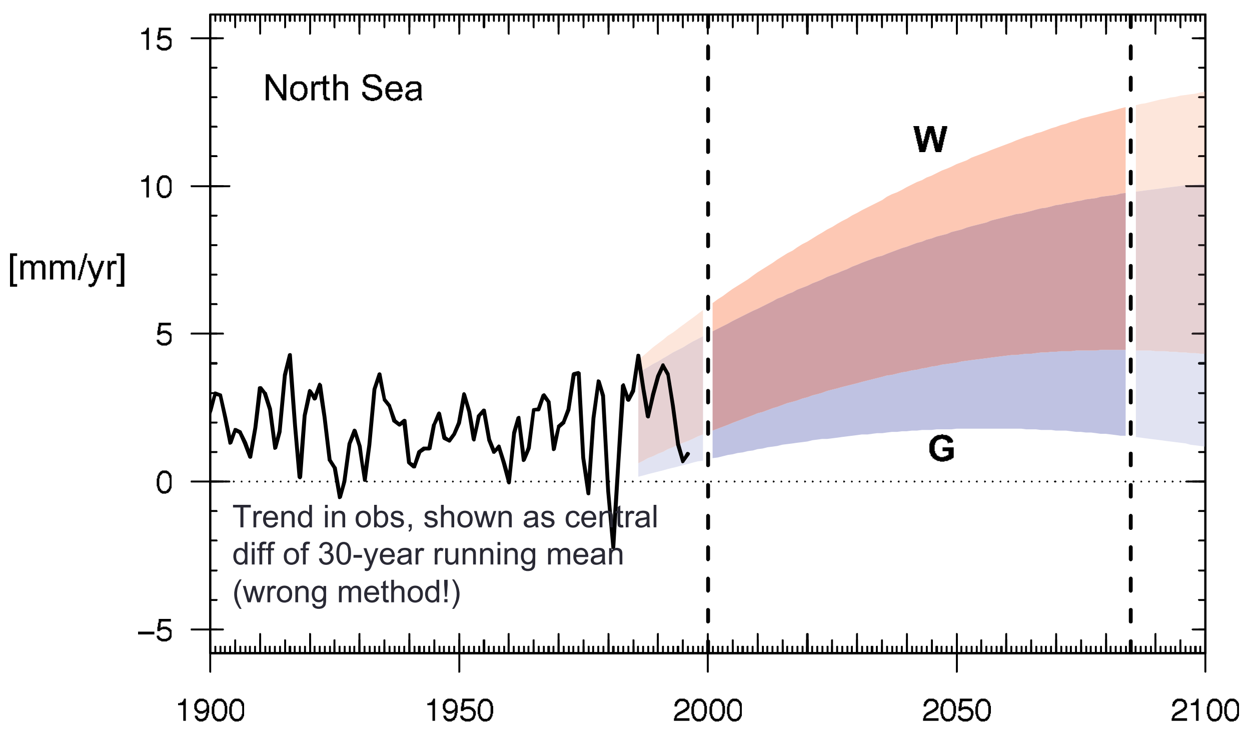
$$q_{tot}(t) \approx m_{tot}(t) + \mathrm{sgn}(\alpha_q)\sqrt{\sum_i [q_i(t) - m_i(t)]^2}$$

Results

Two scenarios (G and W)

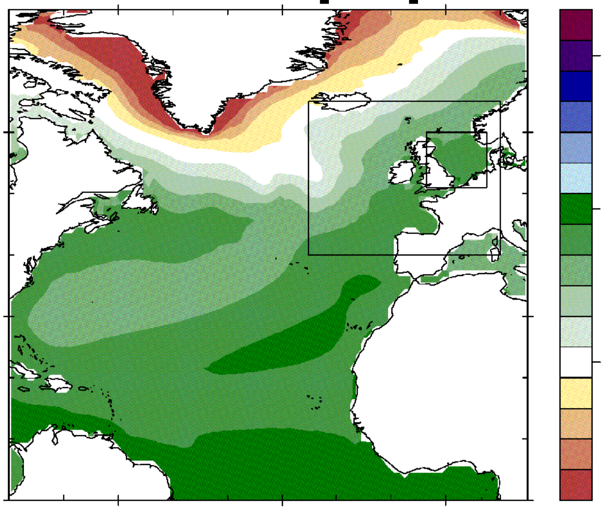


Sea-level trends mm/yr for the North Sea

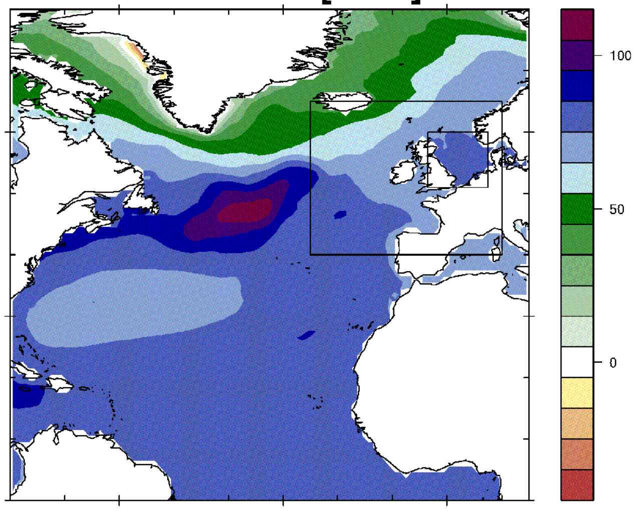


Regional consistency / differences

W-scenario P05 [2085]



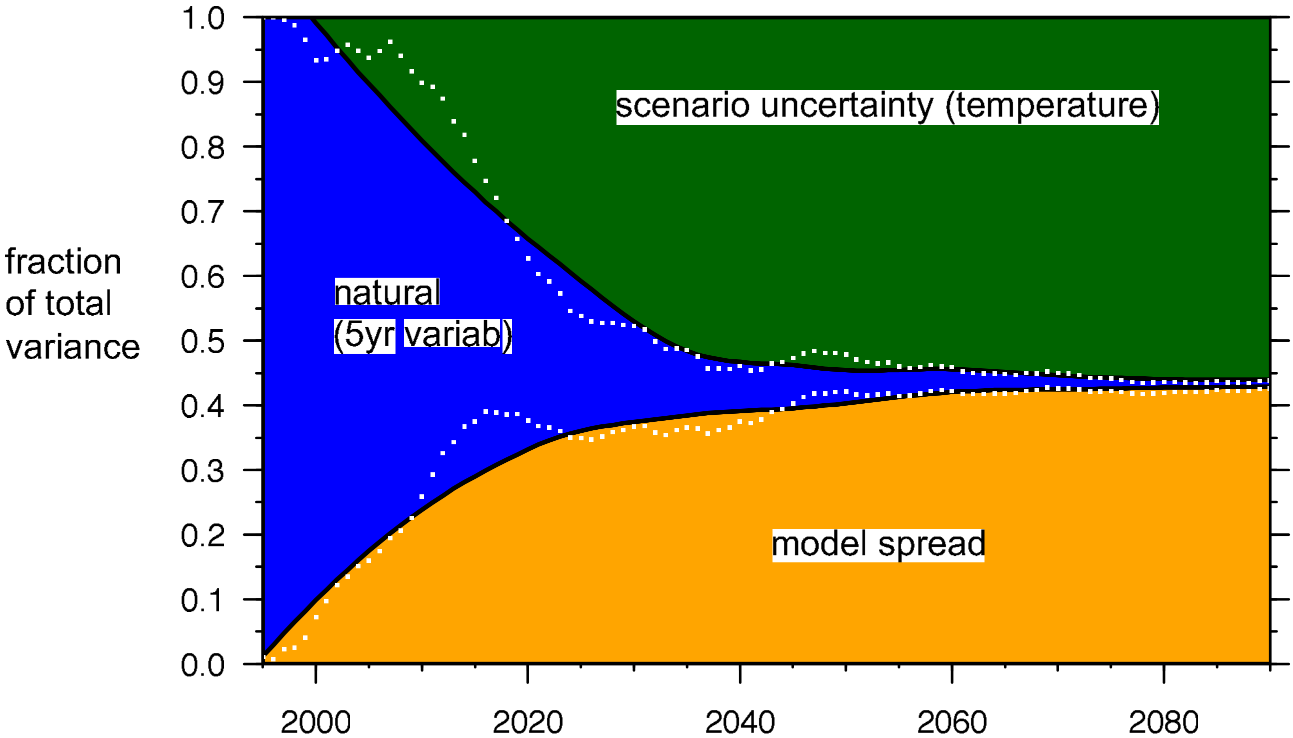
W-scenario P95 [2085]



Consistency North Sea area, but locally strong gradients (e.g. near Greenland and over N-Atlantic)

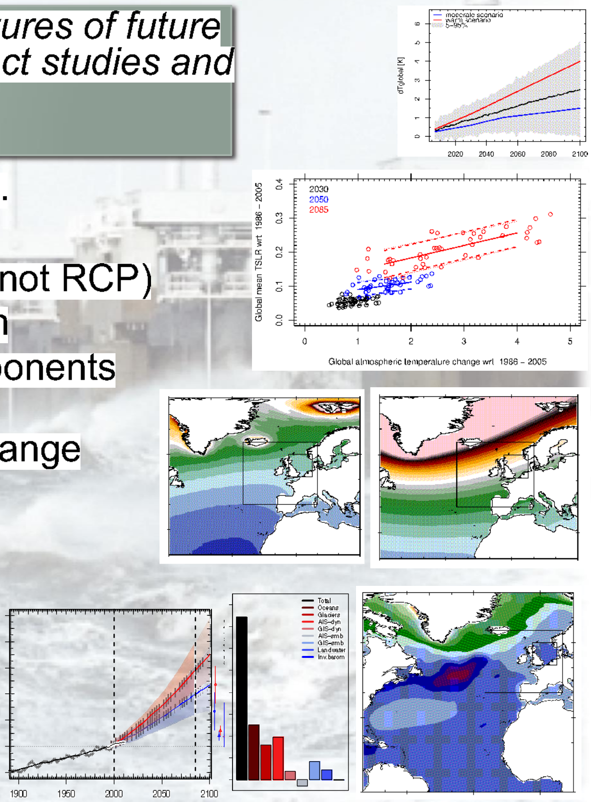
Bonus

Decomposing the uncertainty (North sea)



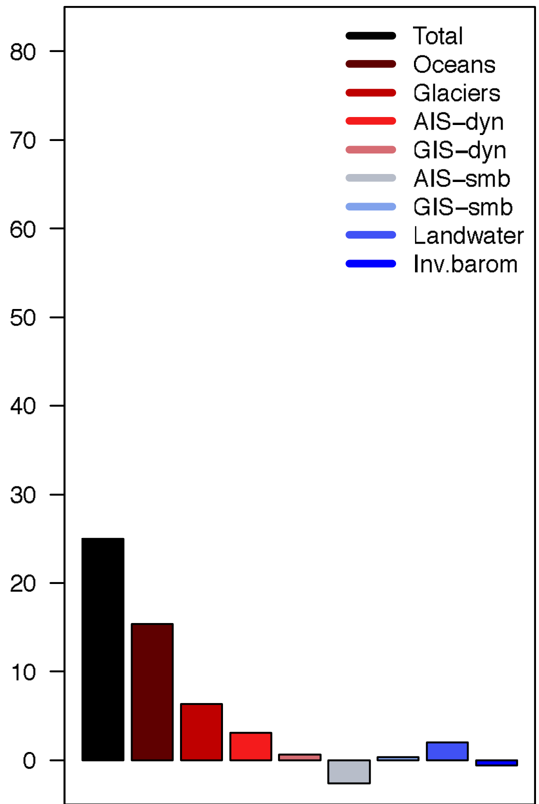
Conclusions

- **KNMI scenarios**: *consistent, plausible pictures of future climate, intended as a tool for climate impact studies and adaptation measures.*
- Used by government, companies, public, ...
- Temperature (dTglob) is steering variable (not RCP)
  - Sliding temperature regression approach
  - Fingerprints for ice- and landwater components to obtain regional response
  - For given dTglob express dSL as likely range
- Results consistent with AR5
- Ongoing: local acceleration or not?
- Need for new high-end scenarios?

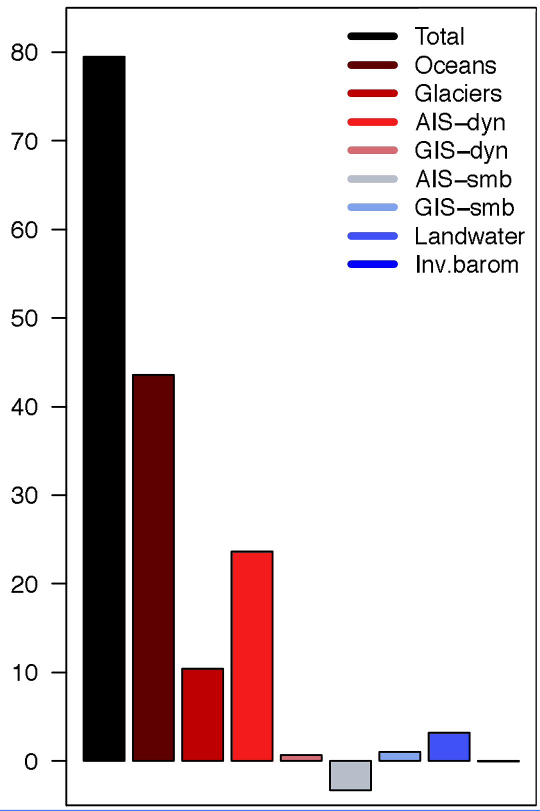


Bonus

Composition of the extreme ranges (low-L, high-H)

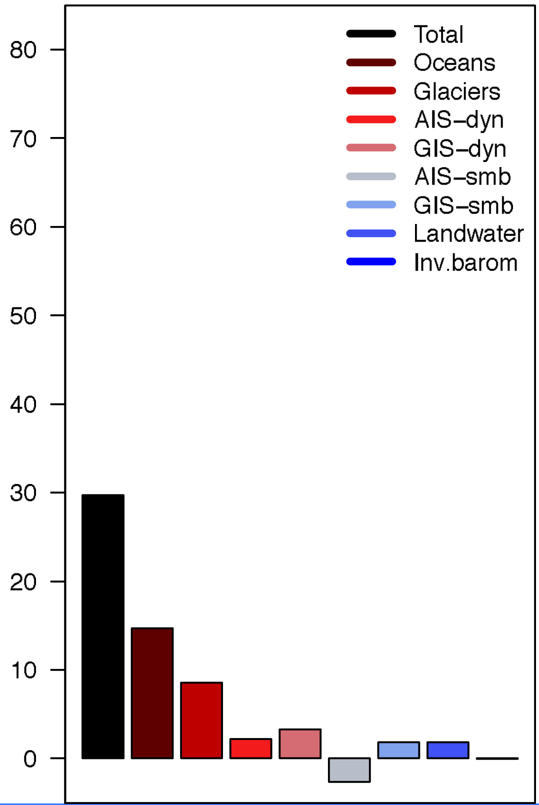


North Sea 2085

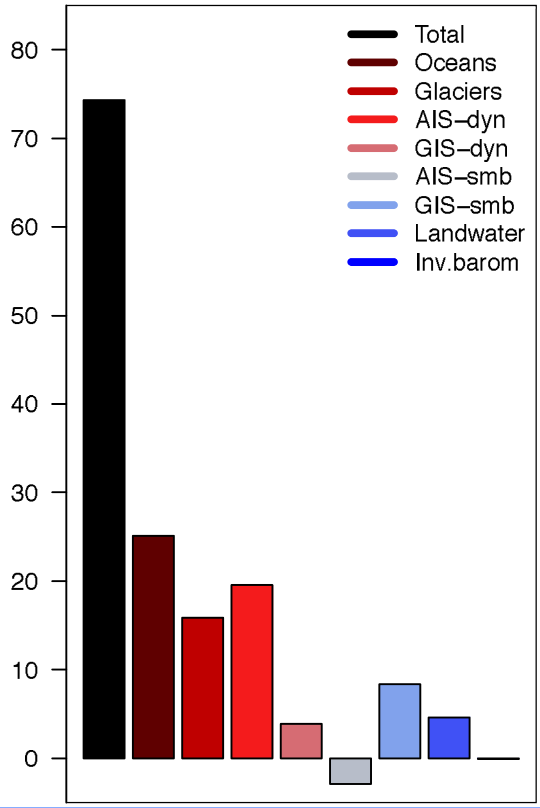


Bonus

Composition of the extreme ranges (low-L, high-H)

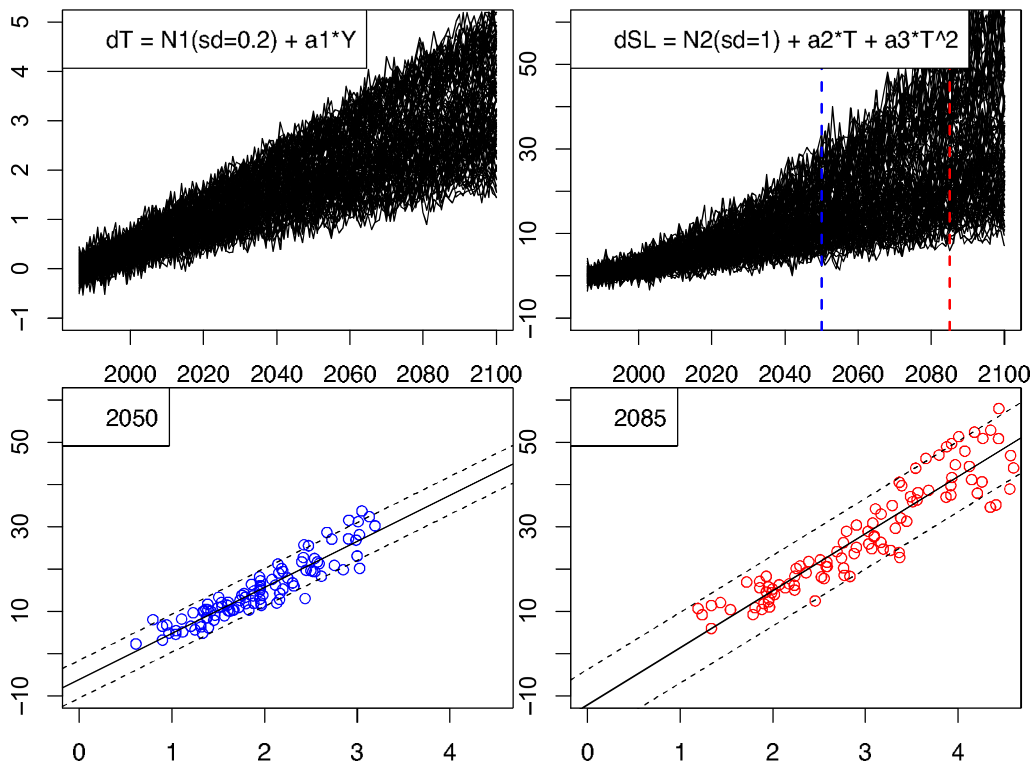


Global 2085



Bonus

Approach too linear? (example with synthetic data!)



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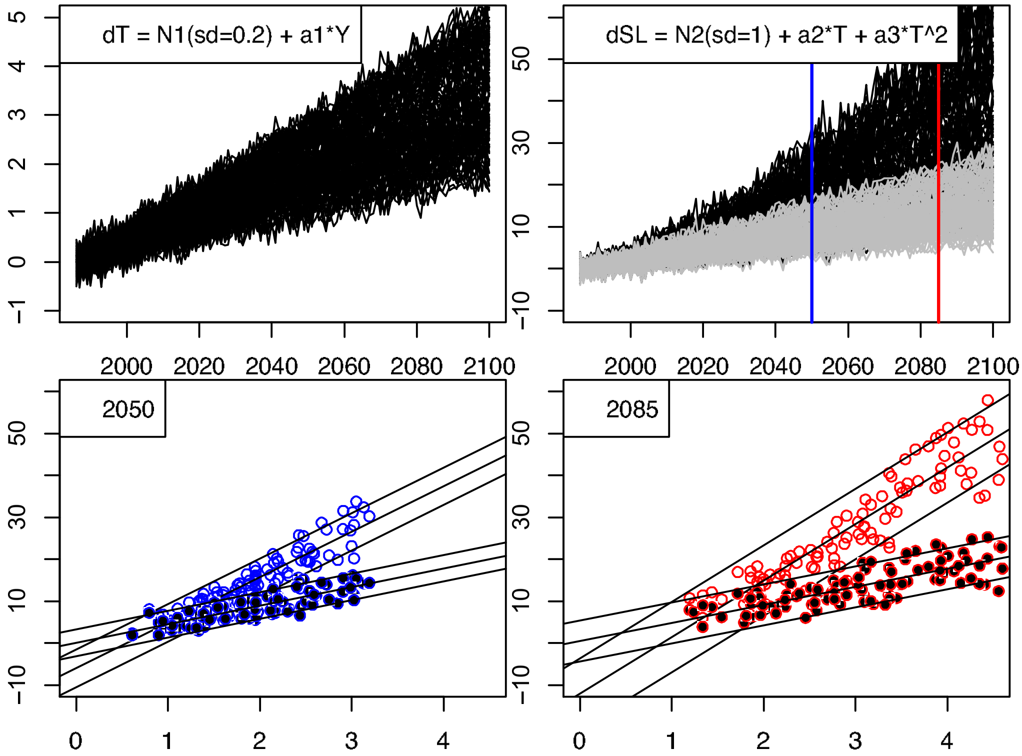
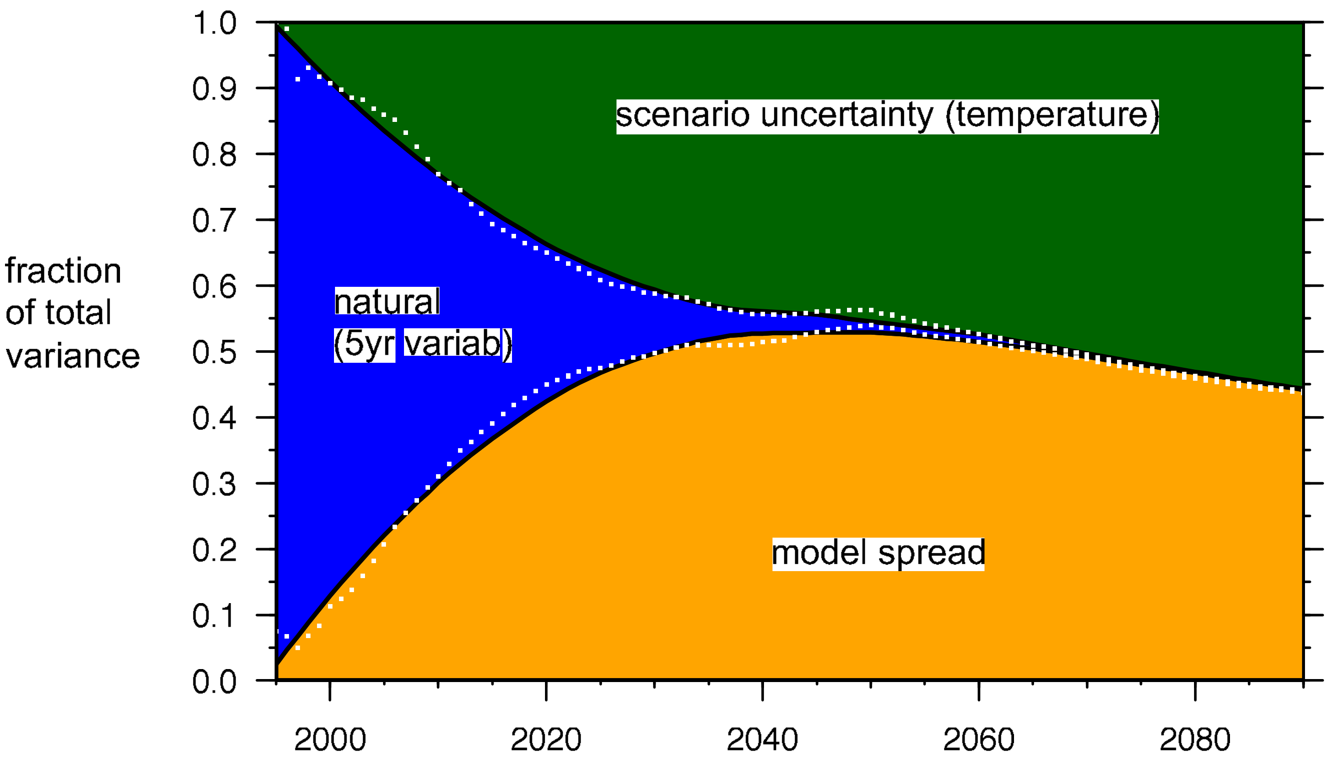


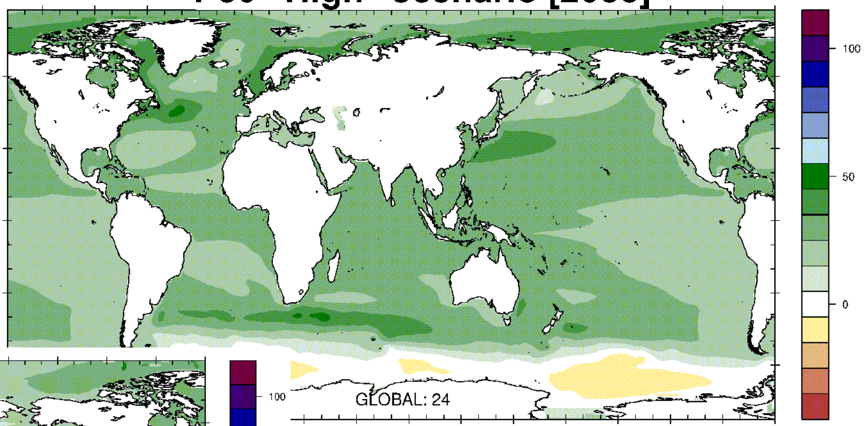
Linear term

Decomposing the uncertainty (global SL change)

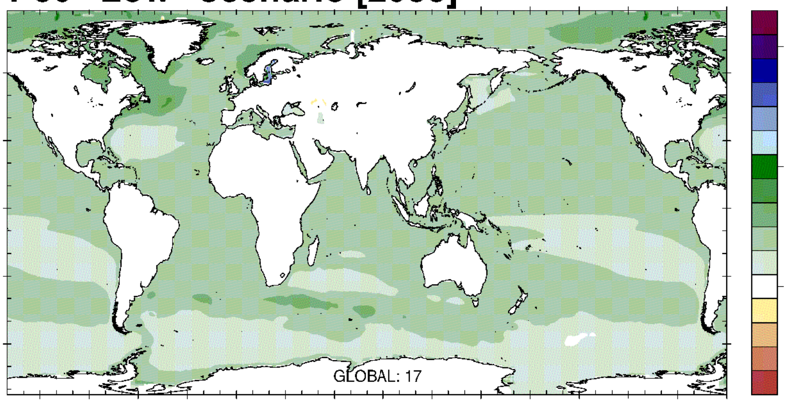


Results: 2085, steric contribution (pecularities)

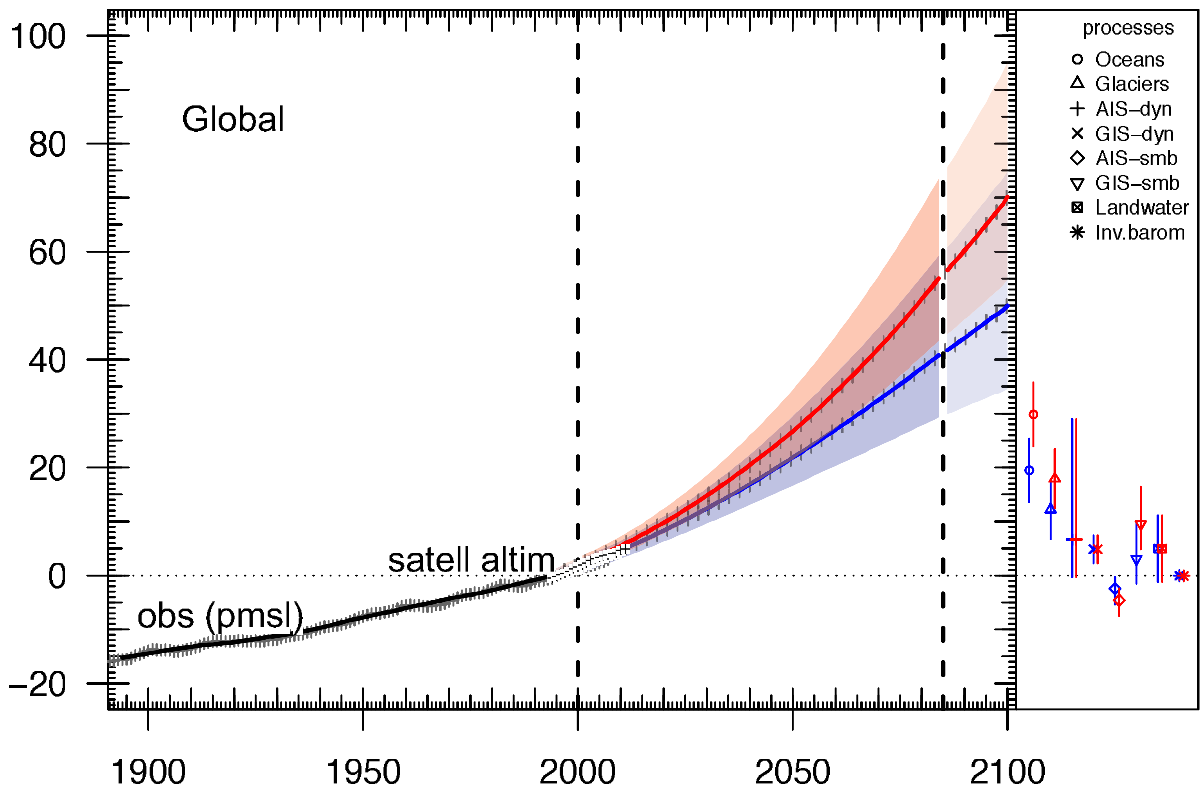
P50 "High" scenario [2085]



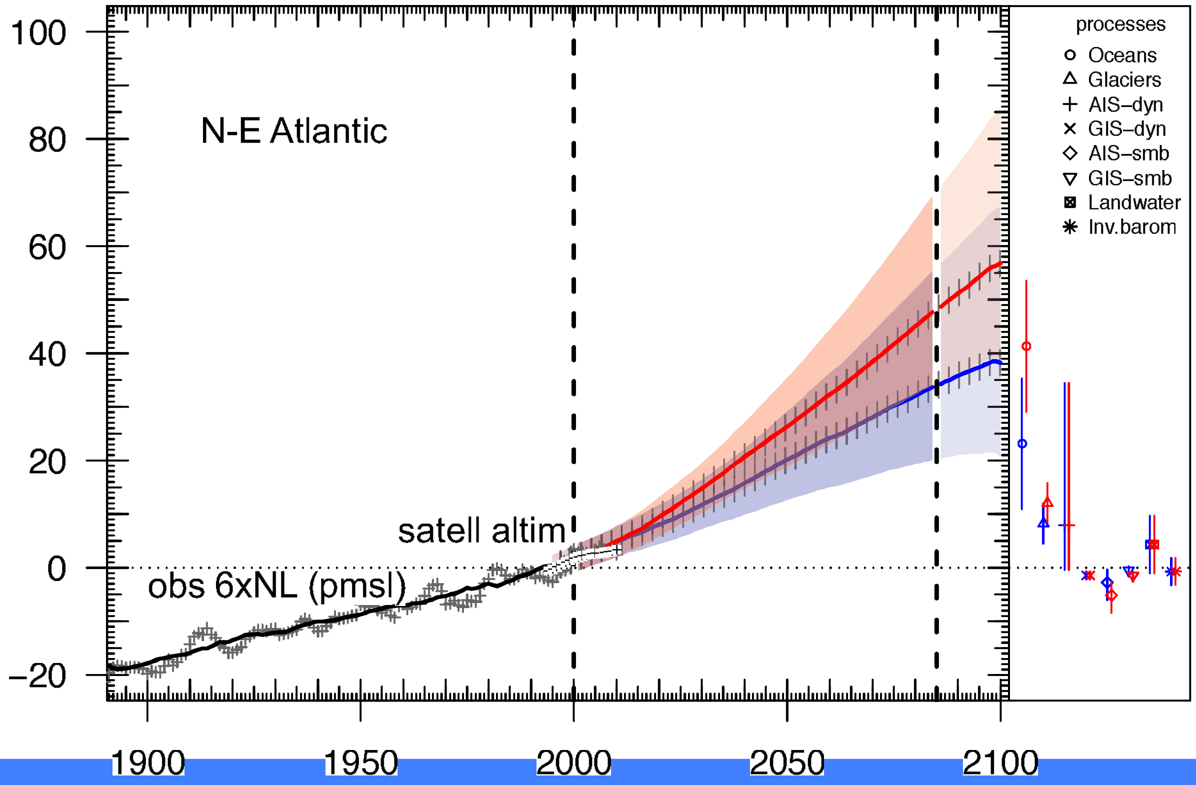
P50 "Low" scenario [2085]



What does it all end up to? (Global)



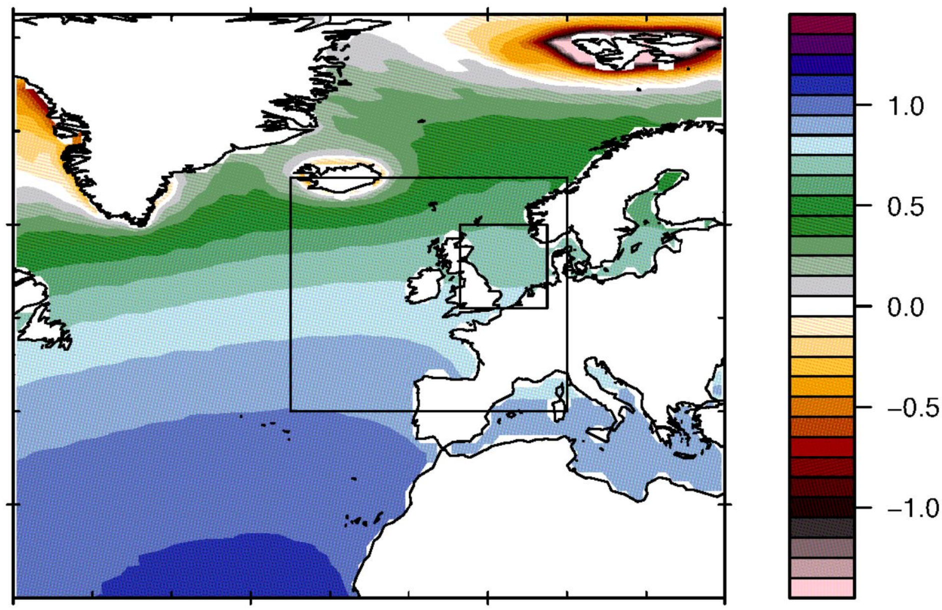
What does it all end up to? (NE-Atlantic)



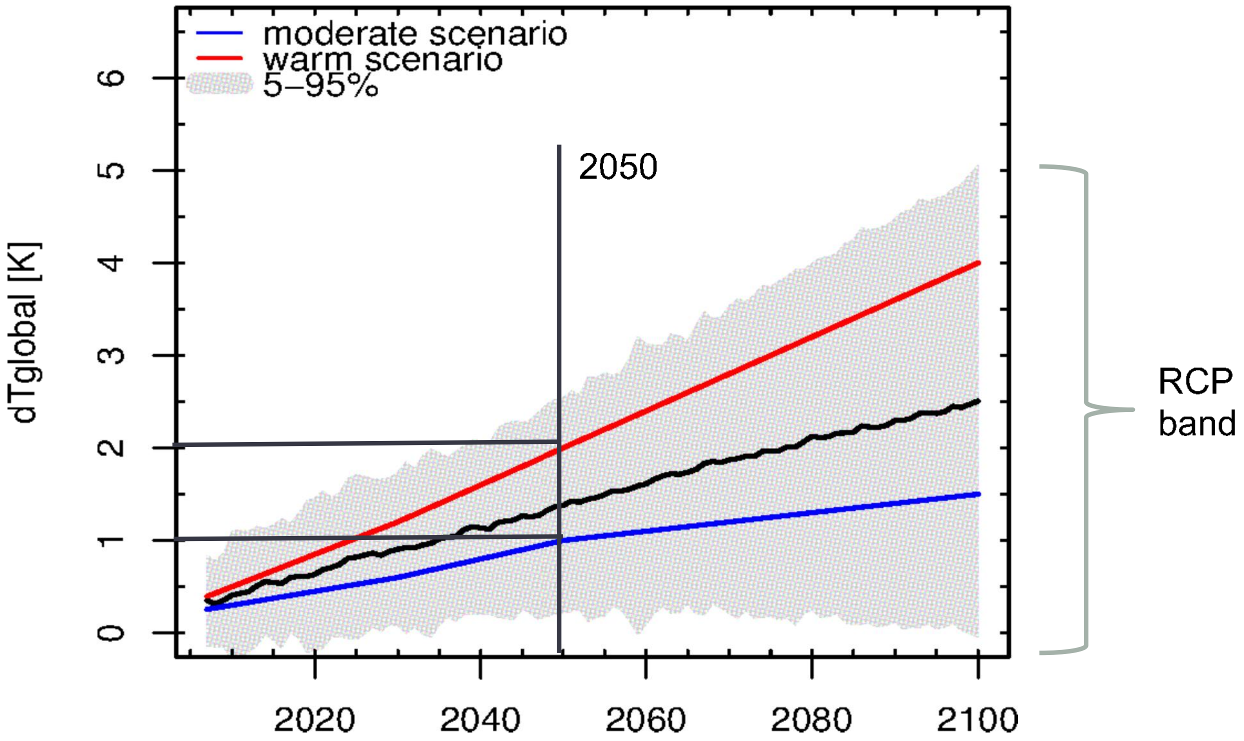
Glaciers and (small) ice-caps

$$\Delta_{gic}(t) = fI(t)^p, \quad I(t) = \int_{2006}^{t} [T(t') - \bar{T}]dt';$$

Fingerprint slowly evolving with time



Global Temperature Pathways



Global Temperature Pathways