

Climate Change 2013: The Physical Science Basis

Working Group I contribution to the IPCC Fifth Assessment Report

Latest findings in climate science & their relevance for regional climate change

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(IPCC CLA, Chapter 14)

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Overview

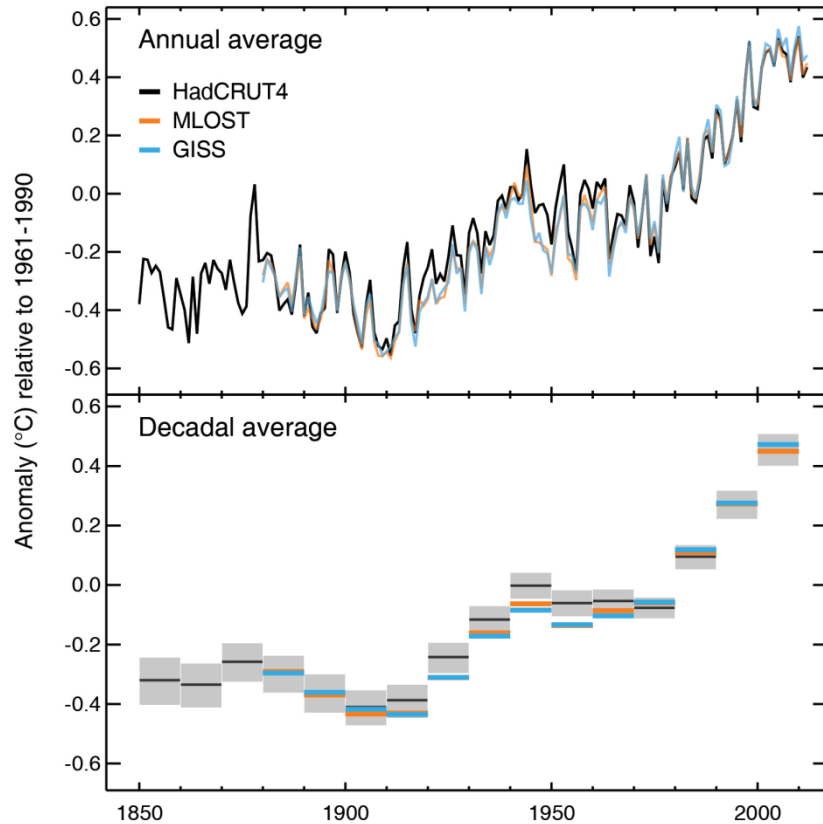
- AR5 basic message
 - Observed changes
 - Detection and attribution
 - Projections
 - Climate change commitment
- Regional climate change in an AR5 perspective
 - What is new from WGI?
 - A preview on WGII?

Observed changes

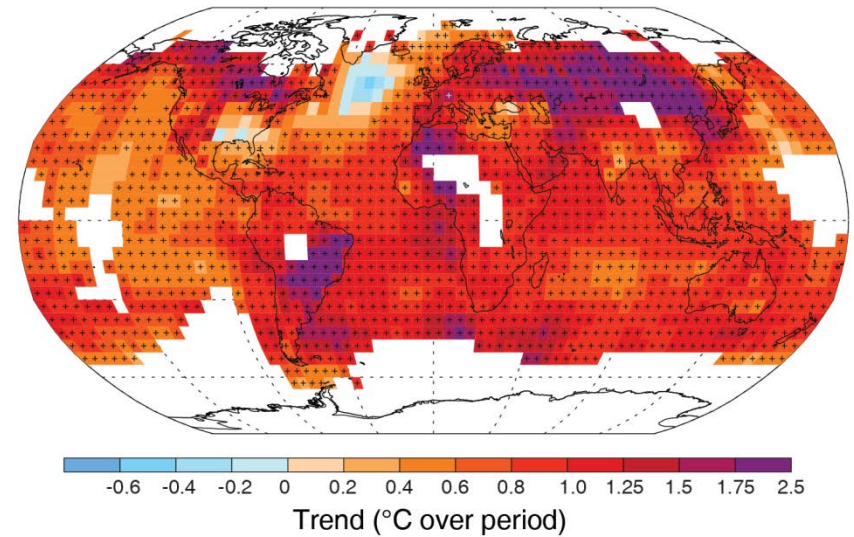
Observed change

Temperature

(a) Global surface temperature timeseries



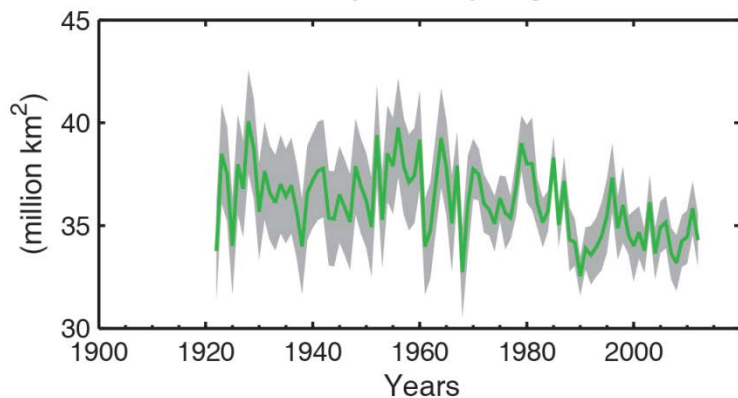
Change in global surface temperature 1901–2012



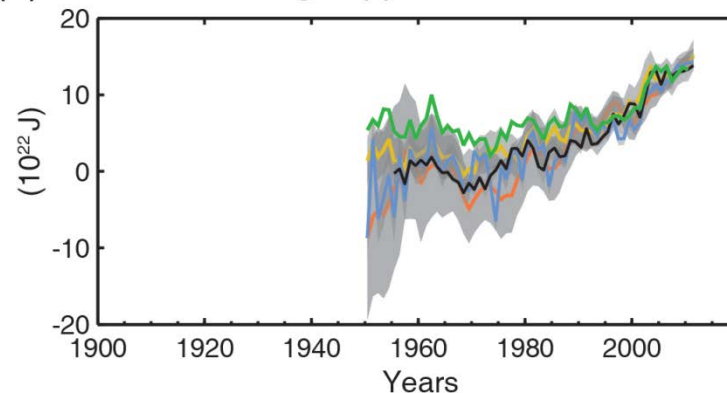
Observed change

Snow, sea ice, ocean heat content, sea level

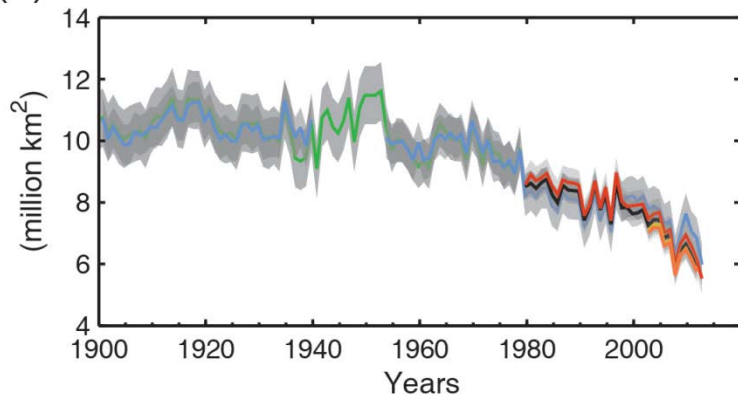
(a) Northern Hemisphere spring snow cover



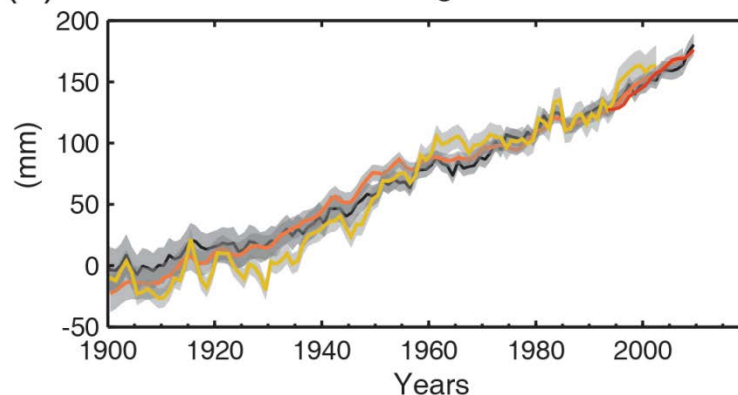
(c) Global average upper ocean heat content



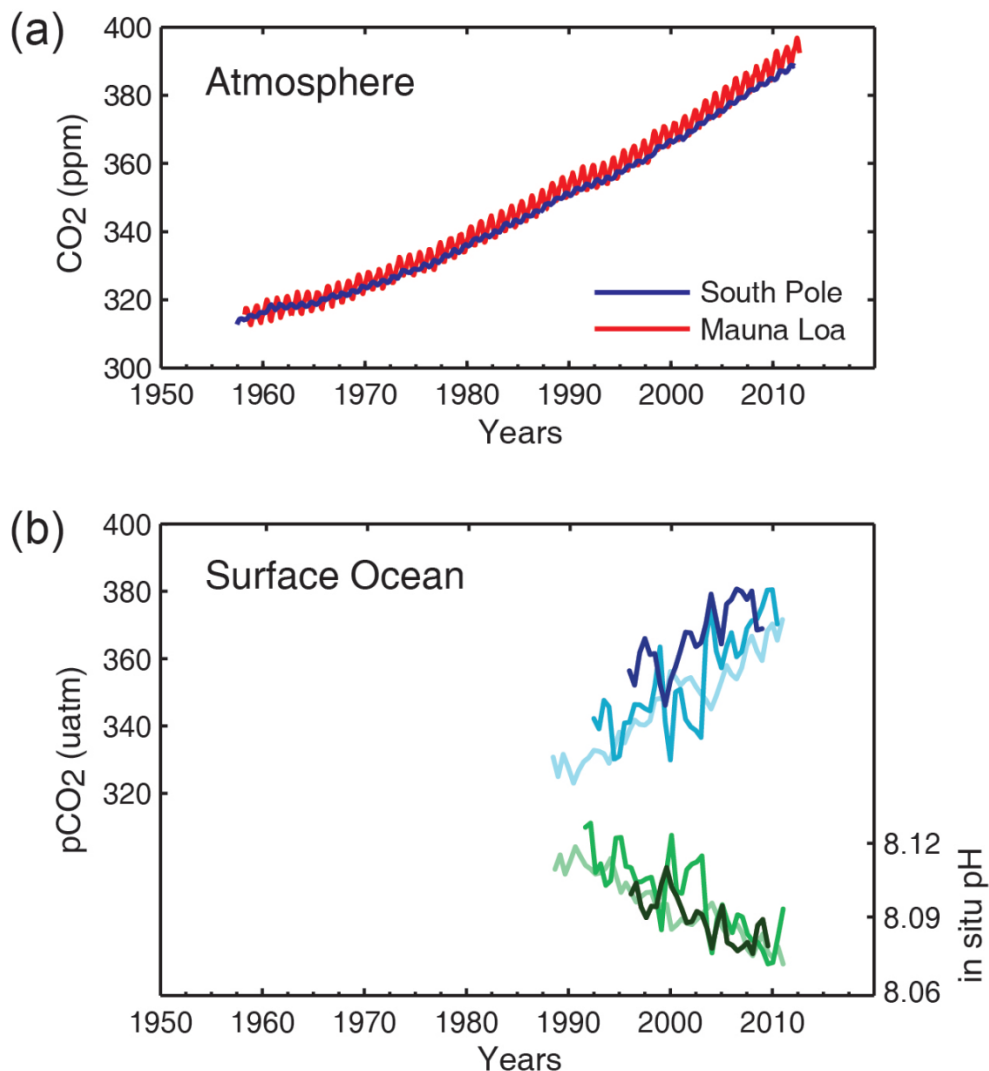
(b) Arctic summer sea ice extent



(d) Global average sea level



Observed change CO₂ in the atmosphere and the ocean



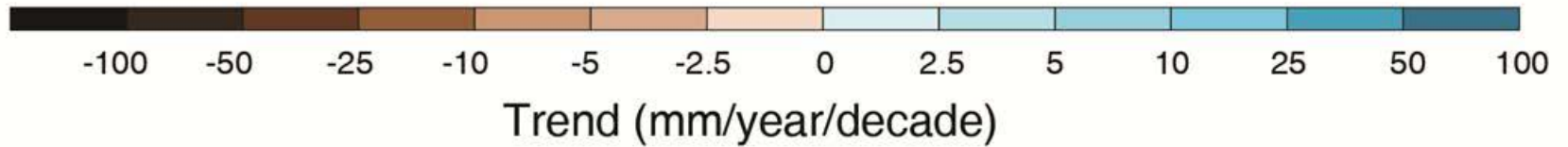
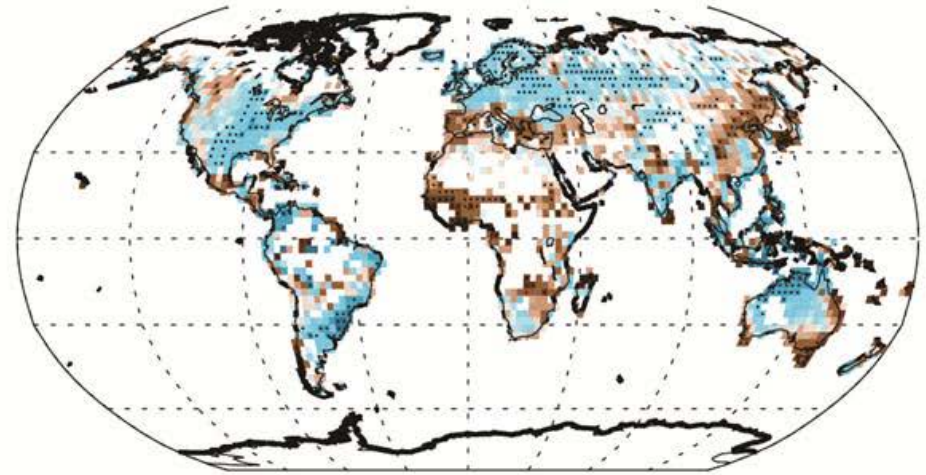
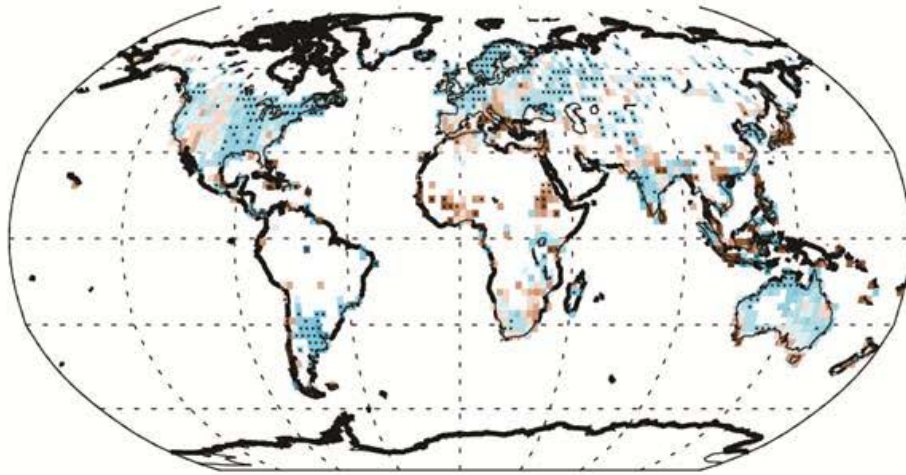
Observed change

Precipitation

Observed change in precipitation over land

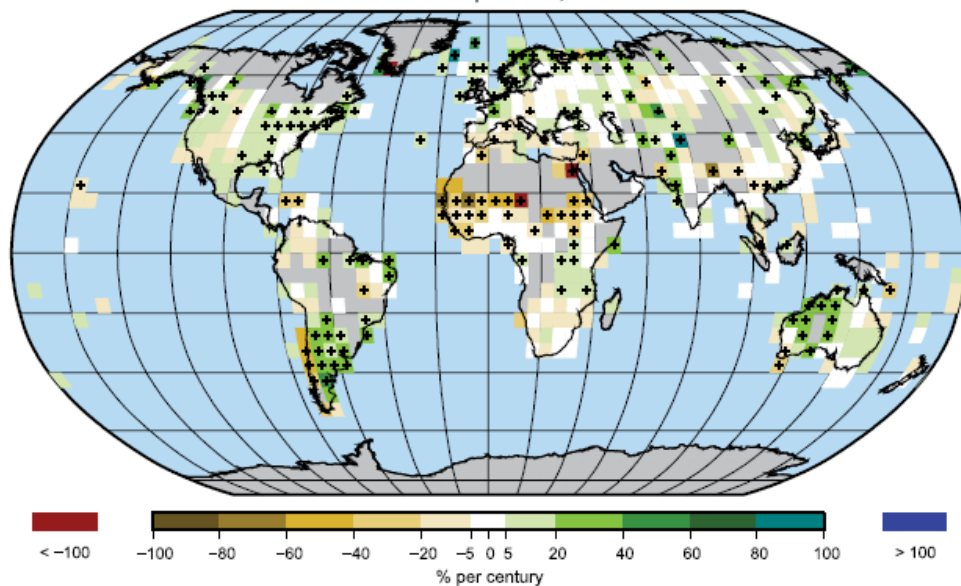
1901–2010

1951–2010

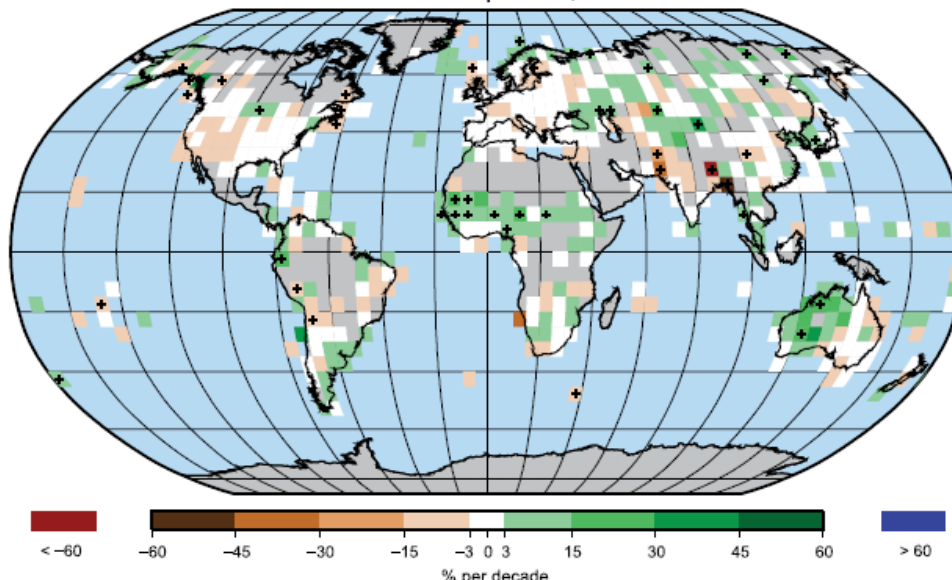


Observed change – AR4

Trend in Annual Precipitation, 1901 to 2005



Trend in Annual Precipitation, 1979 to 2005



Observed changes

- **Warming of the climate system is unequivocal,**
- **Since 1950, many of the observed changes are unprecedented over decades to millennia.**
- **The atmosphere and ocean have warmed**
- **The amounts of snow has diminished**
- **The amounts of ice has diminished**
- **Sea level has risen**
- **The concentrations of greenhouse gases have increased**
- **Ocean warming dominates the increase in energy stored in the climate system**

Detection and attribution

Detection and Attribution of Climate Change

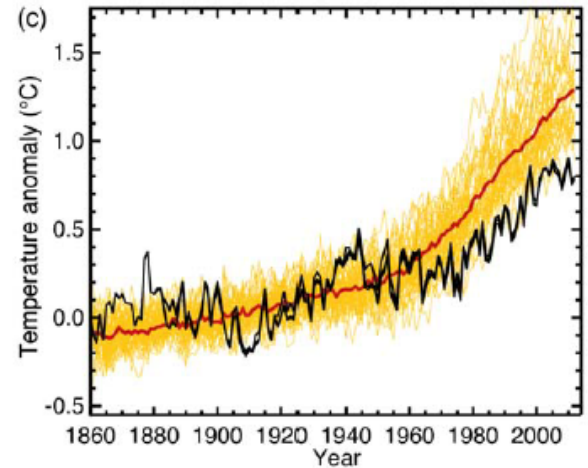
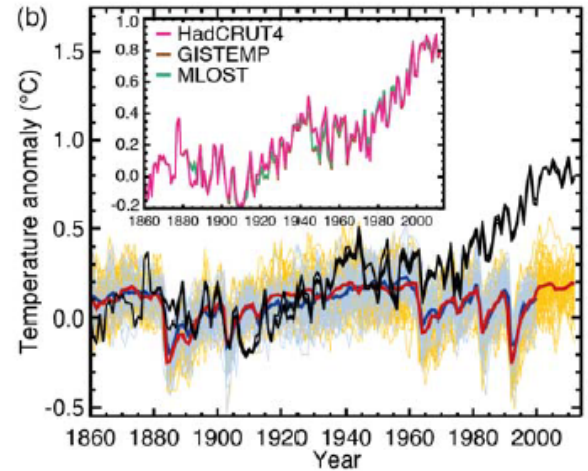
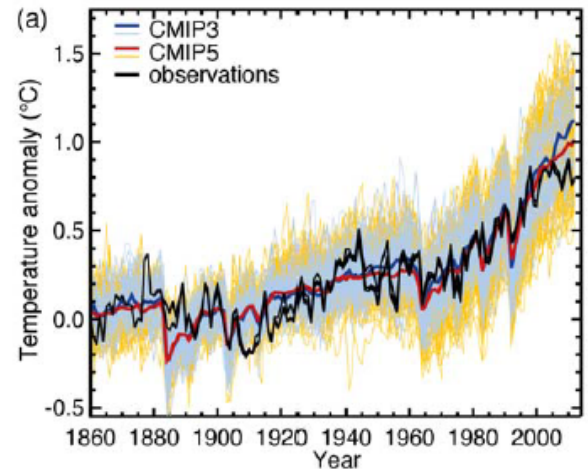
- Human influence has been detected in
 - warming of the atmosphere and the ocean,
 - changes in the global water cycle,
 - reductions in snow and ice,
 - global mean sea level rise,
 - changes in some climate extremes

Attribution

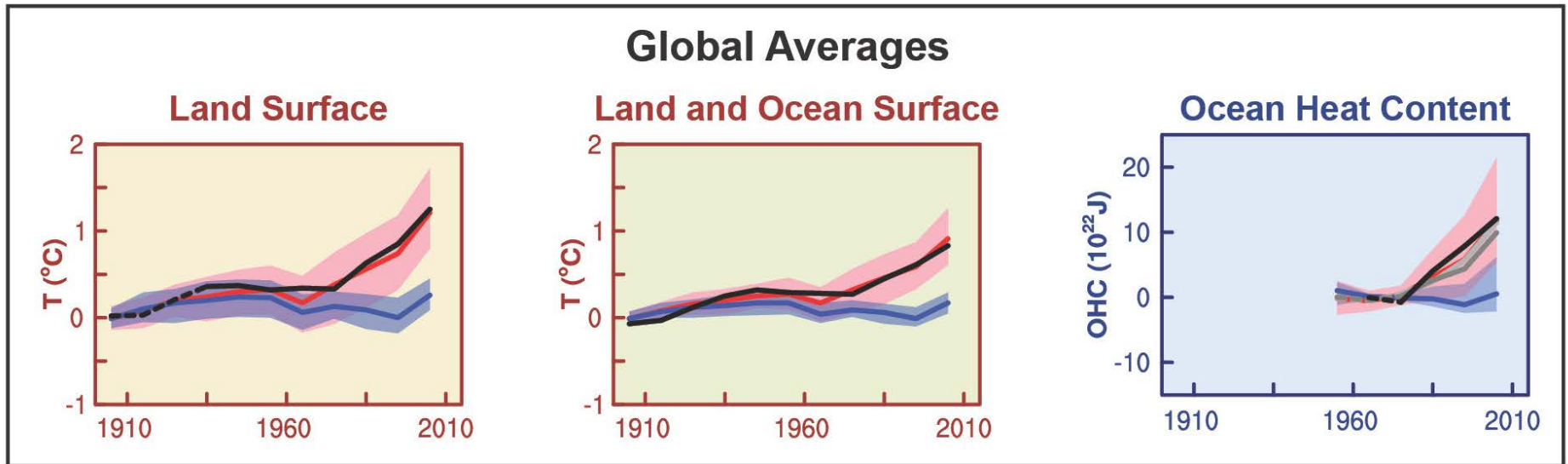
Natural + Anthropogenic

Natural

Anthropogenic



Detection and Attribution of Climate Change

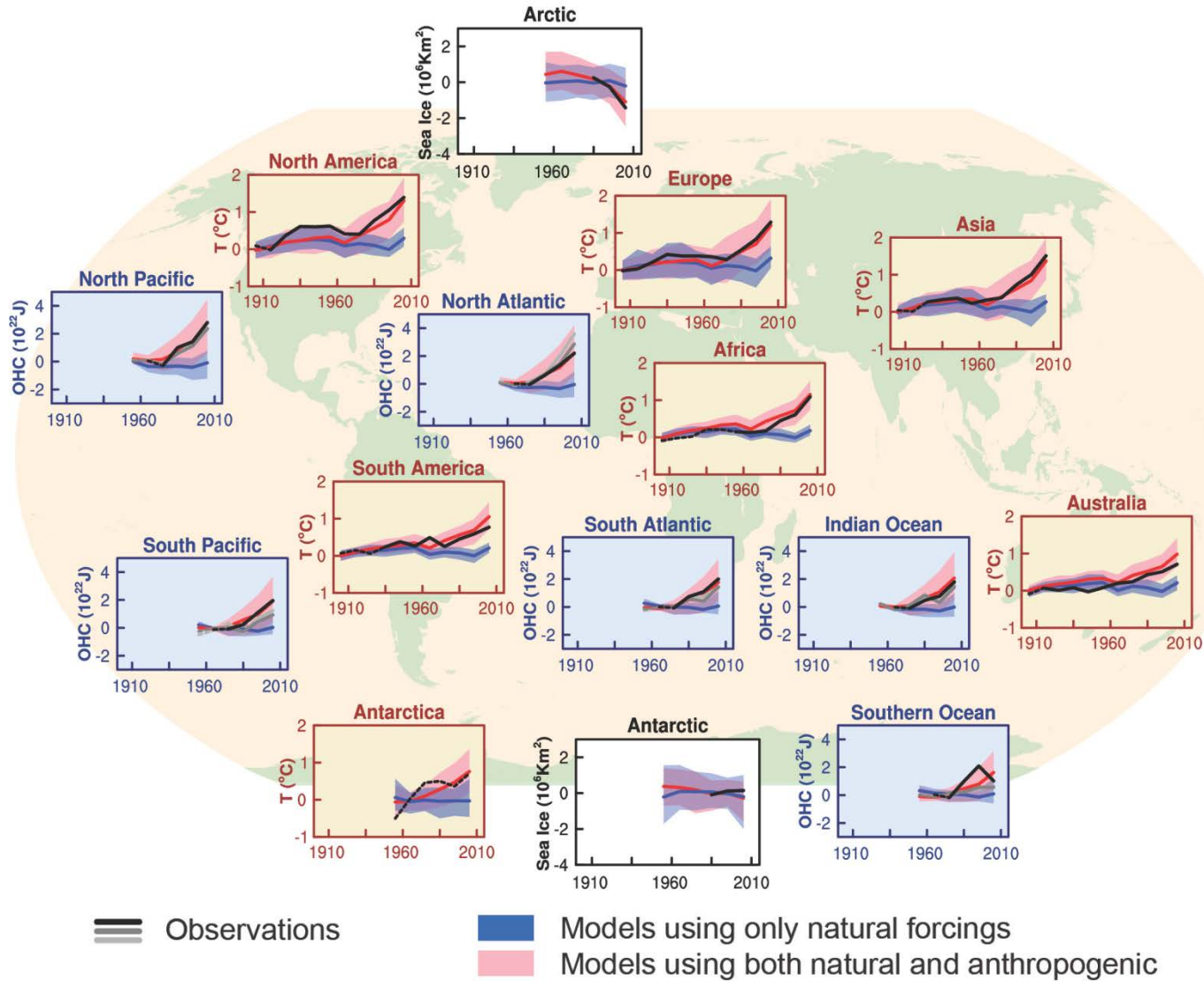


≡ Observations

■ Models using only natural forcings

■ Models using both natural and anthropogenic

Detection and Attribution of Climate Change



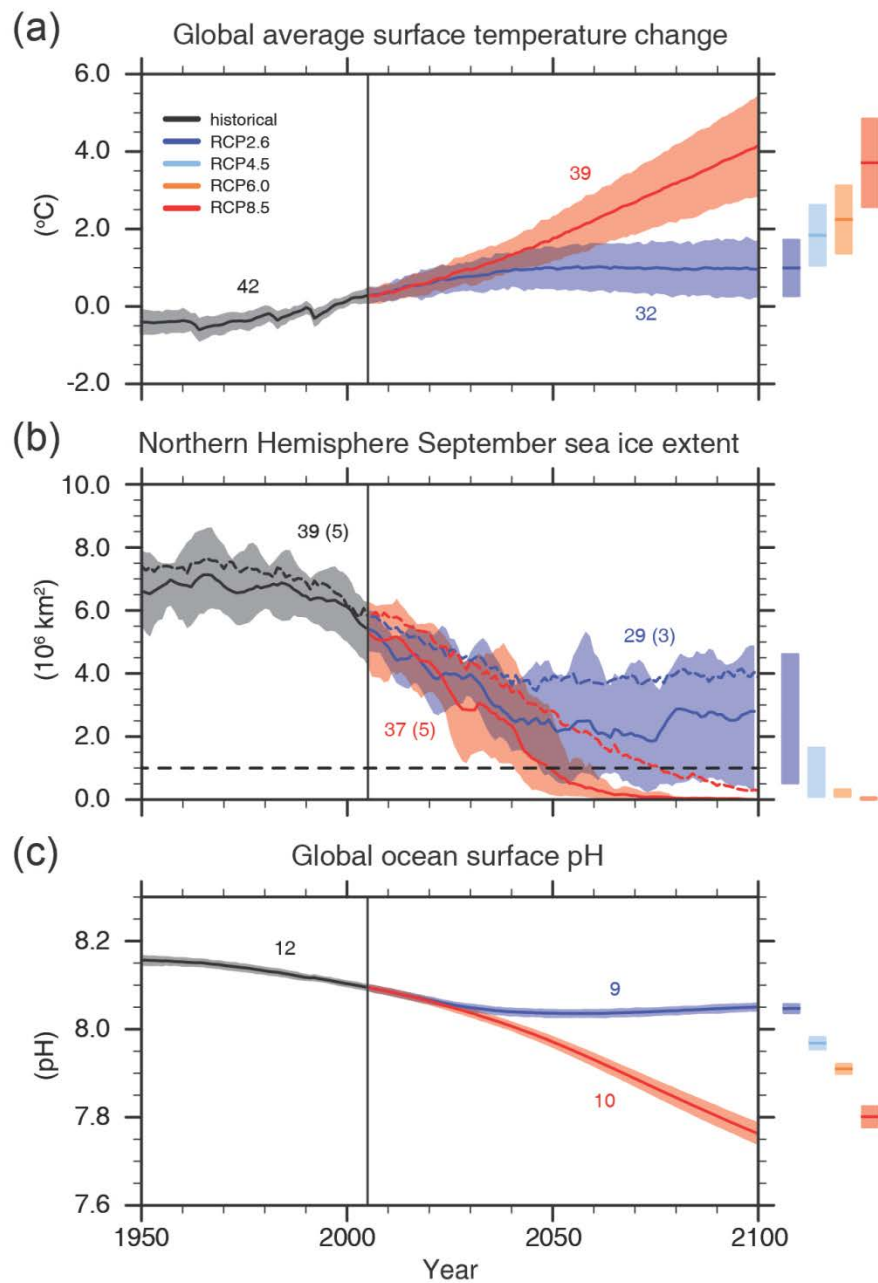
Projections & commitments

Projections

- Continued emissions of greenhouse gases
 - will cause further warming
 - changes in all components of the climate system.
- Limiting climate change will require
 - substantial and sustained reductions of greenhouse gas emissions

Projections

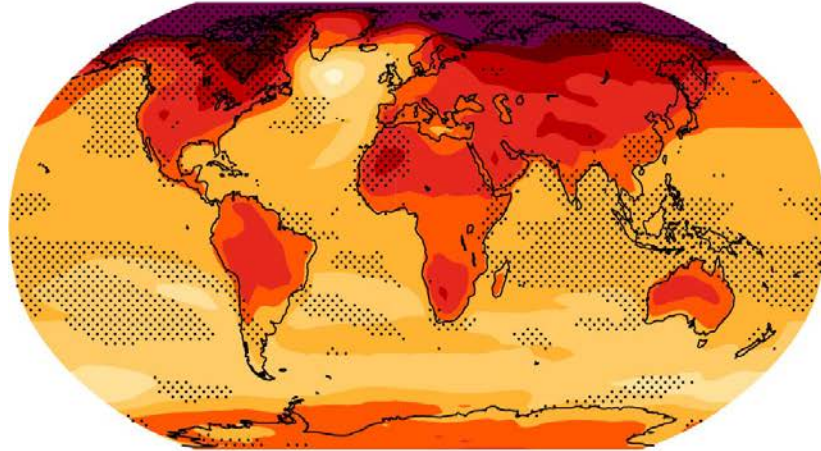
Temperature Sea ice Ocean pH



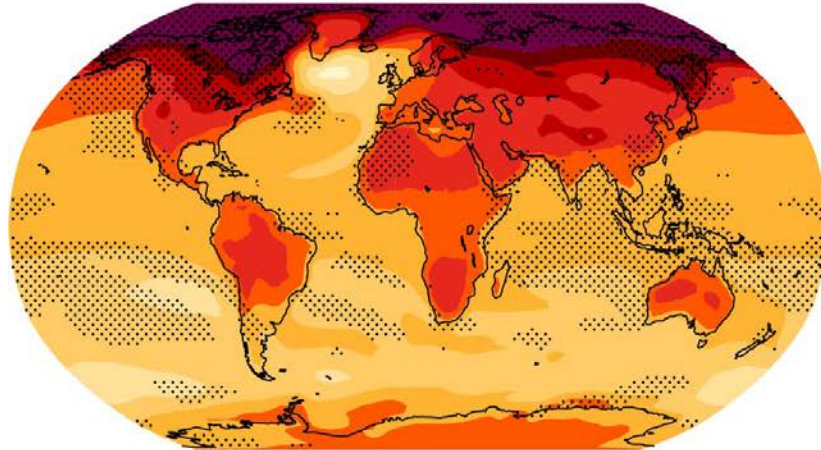
Spatial structure of surface warming

temperature scaled by global T ($^{\circ}\text{C}$ per $^{\circ}\text{C}$)

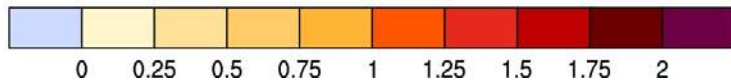
CMIP3 : 2080-2099



CMIP5 : 2081-2100

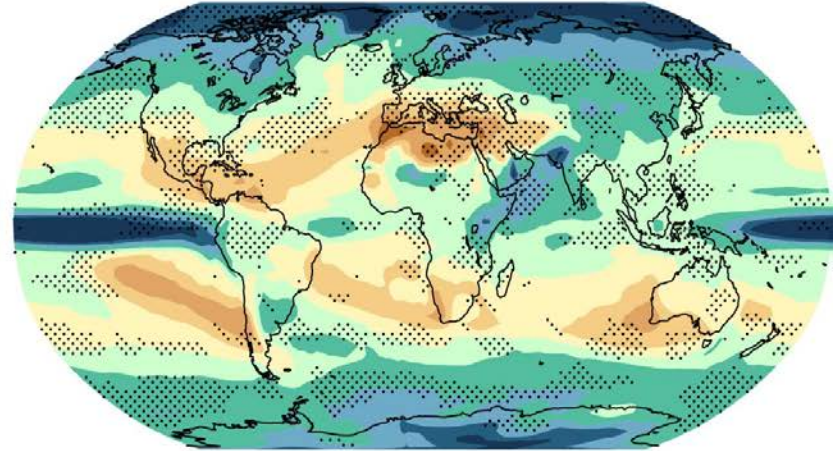


($^{\circ}\text{C}$ per $^{\circ}\text{C}$ global mean change)

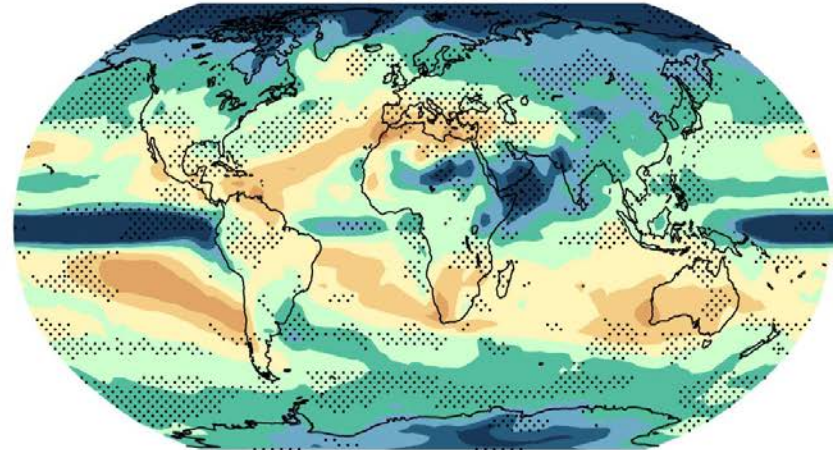


precipitation scaled by global T (% per $^{\circ}\text{C}$)

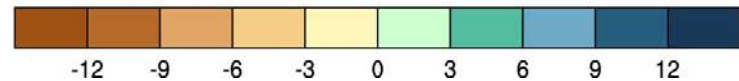
CMIP3 : 2080-2099



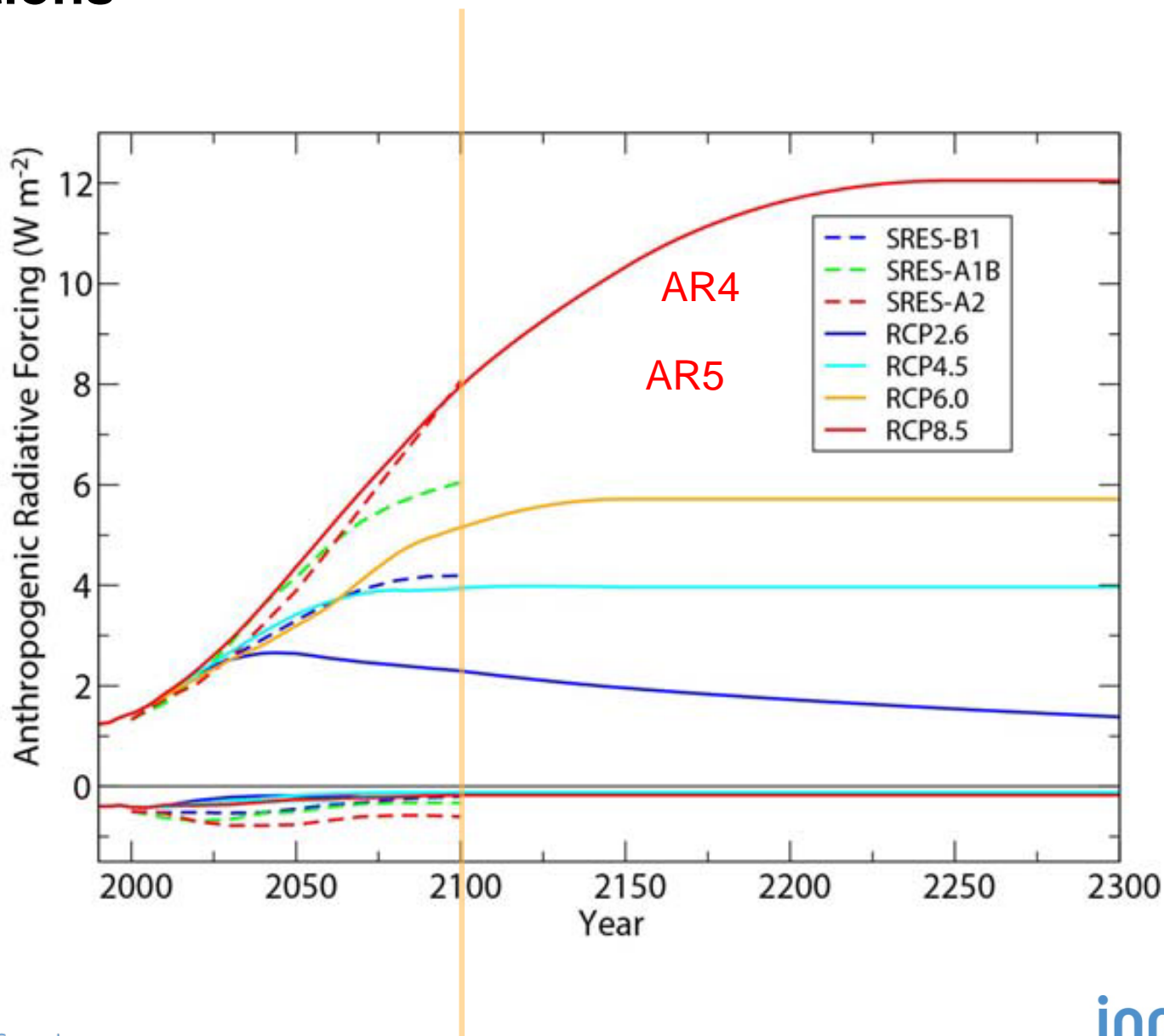
CMIP5 : 2081-2100



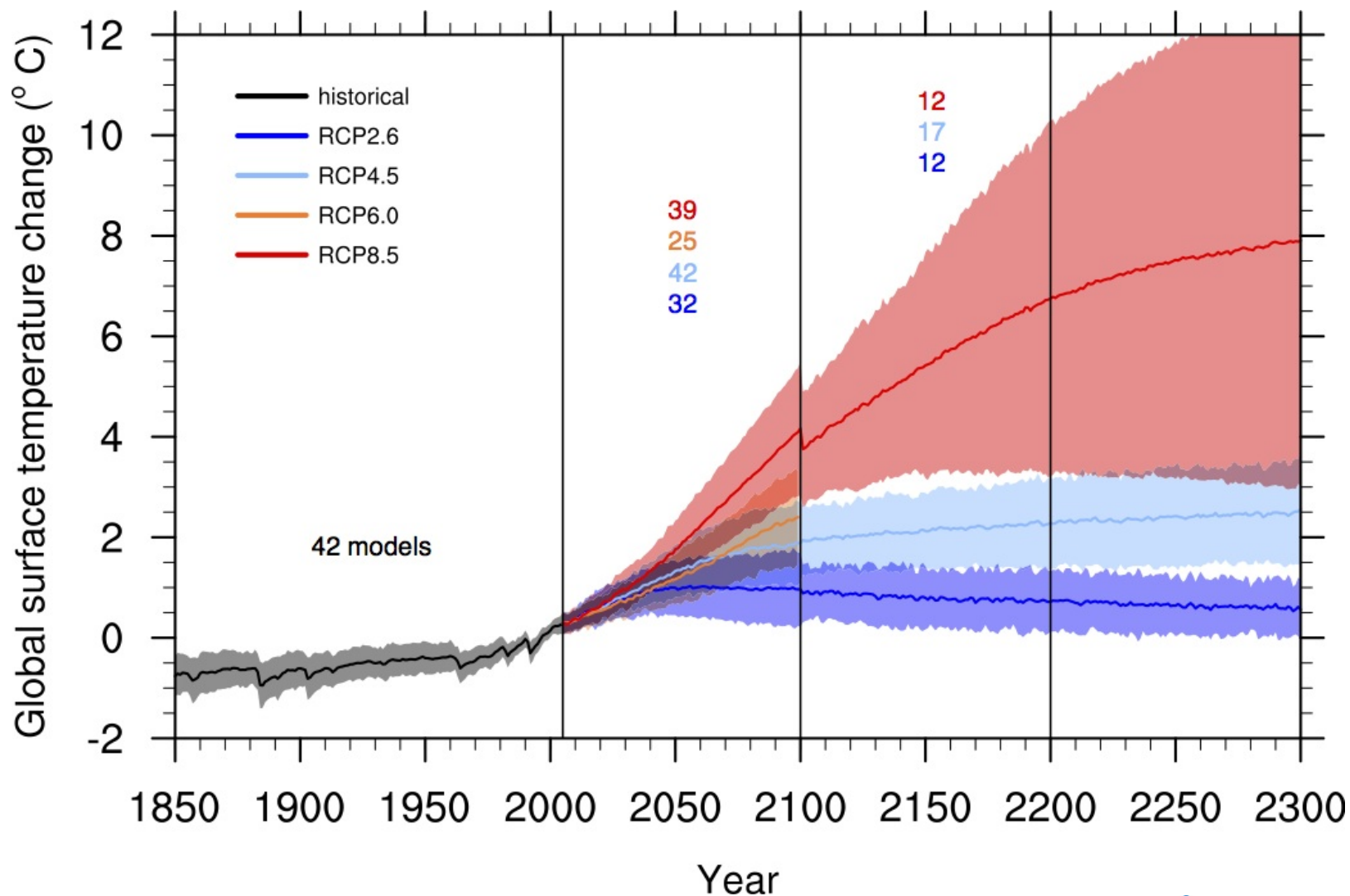
(% per $^{\circ}\text{C}$ global mean change)



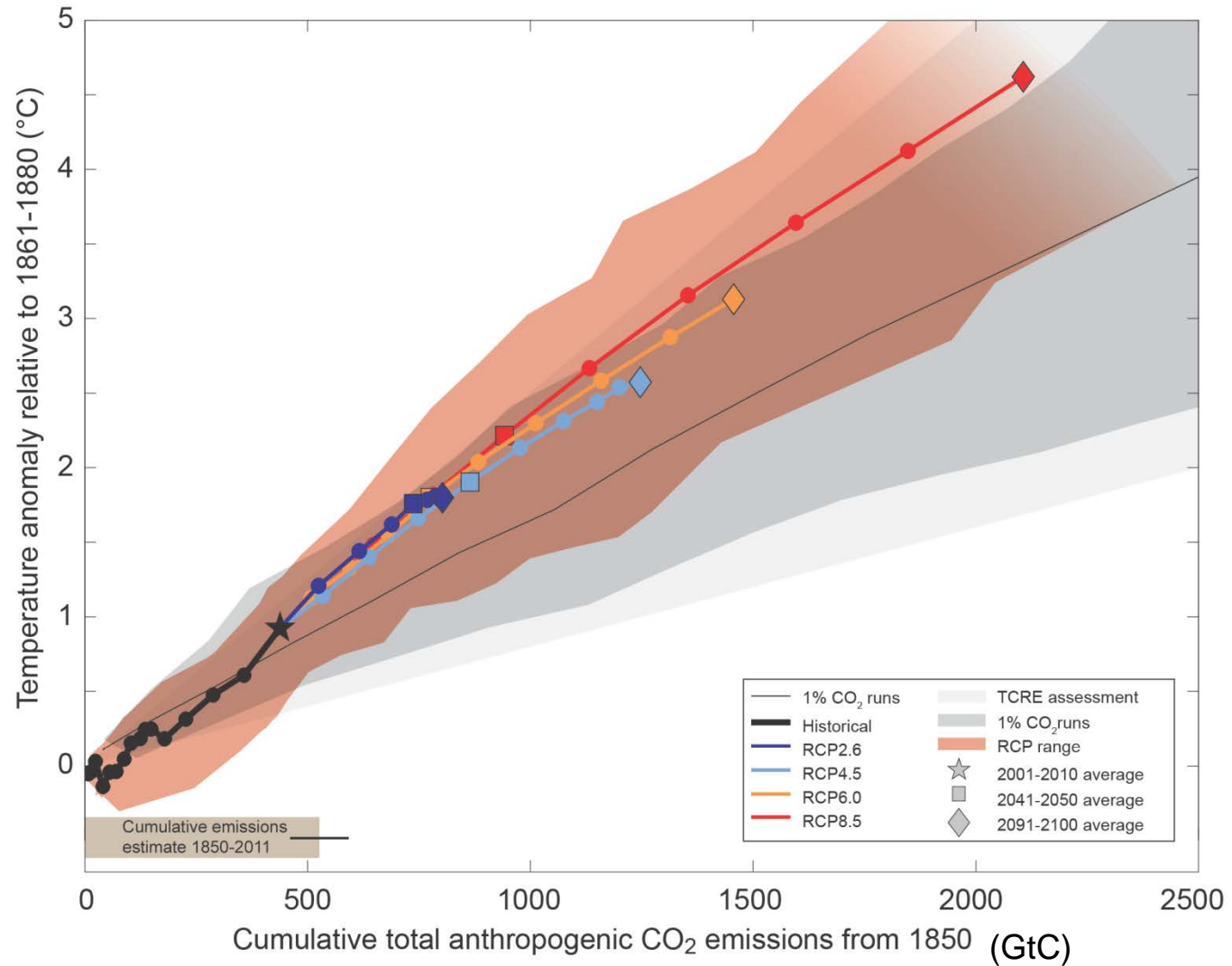
Projections



Projections

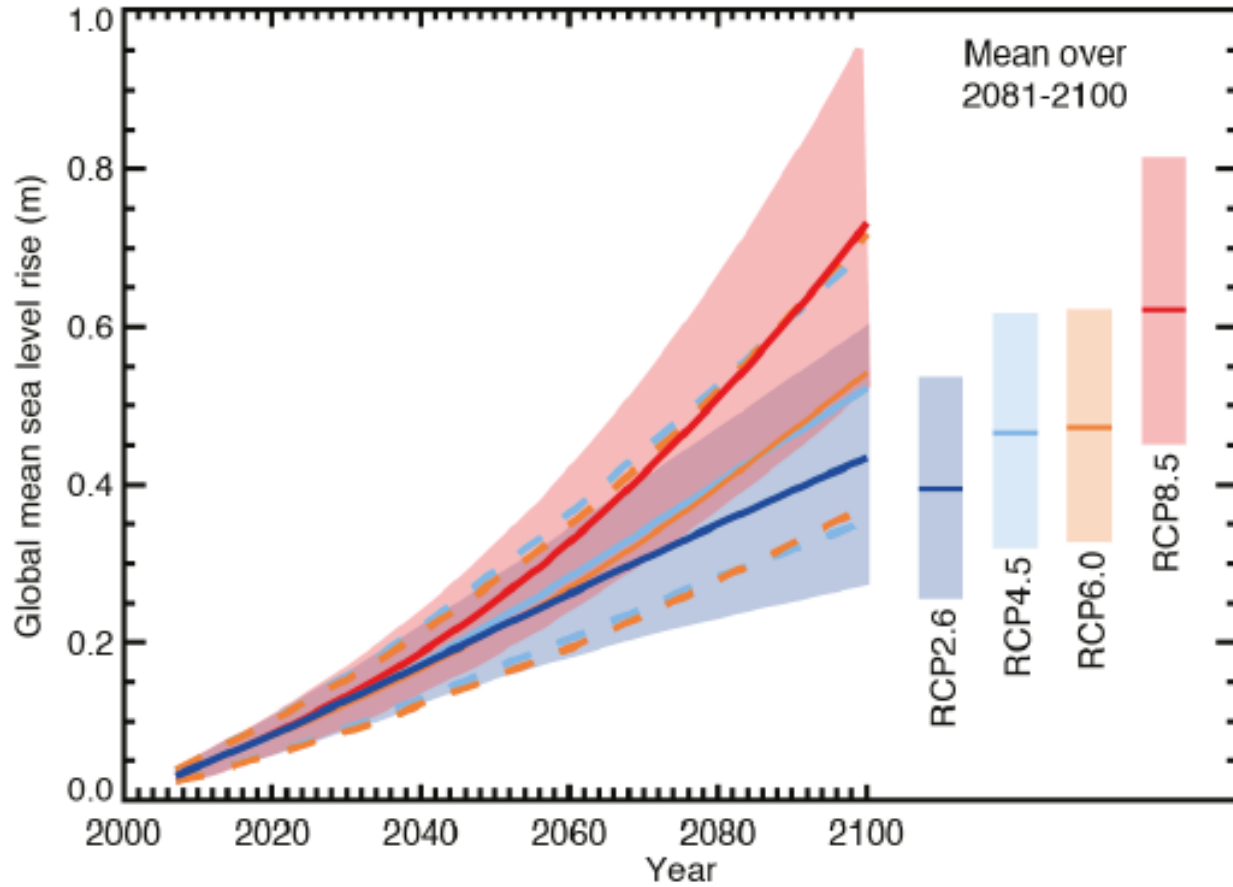


Climate Change Commitment



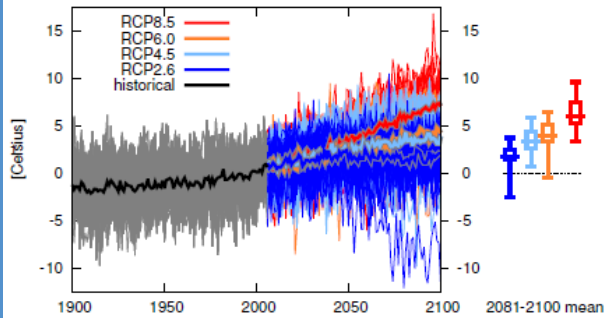
Future sea level

Global sea level rise

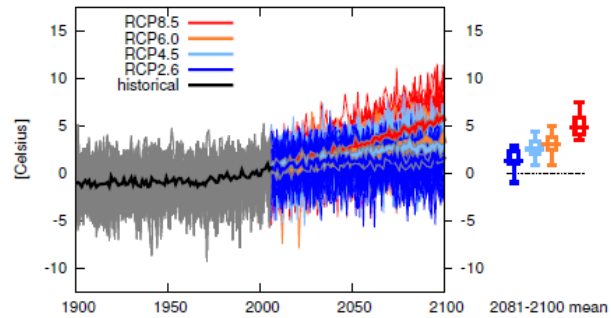


Regional examples

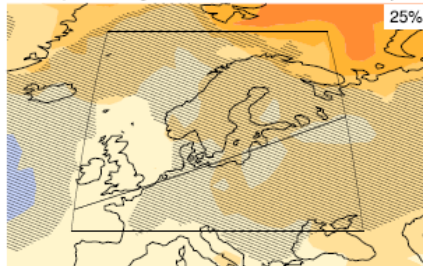
Temperature change North Europe December-February



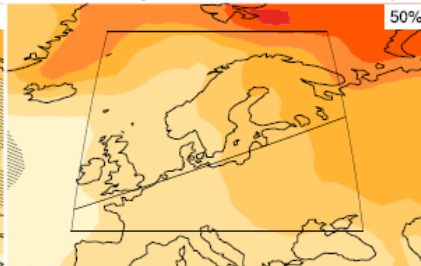
Temperature change Central Europe December-February



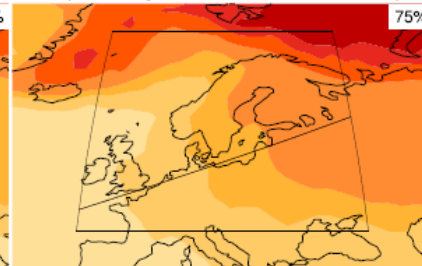
Temperature change RCP4.5 In 2016-2035: December-February



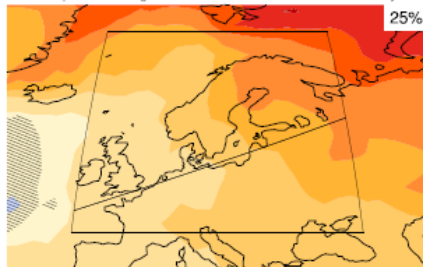
Temperature change RCP4.5 In 2016-2035: December-February



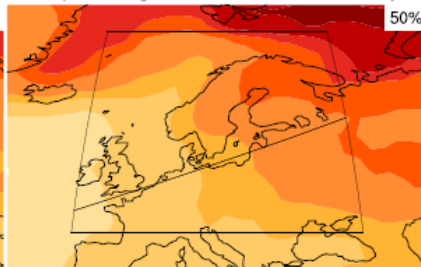
Temperature change RCP4.5 In 2016-2035: December-February



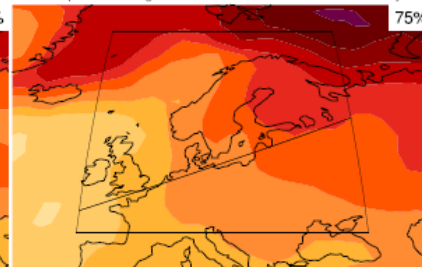
Temperature change RCP4.5 In 2046-2065: December-February



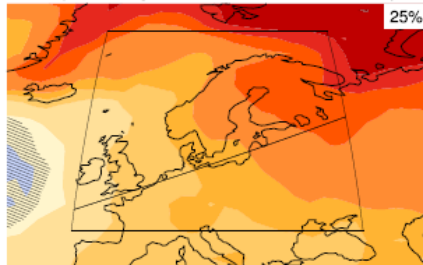
Temperature change RCP4.5 In 2046-2065: December-February



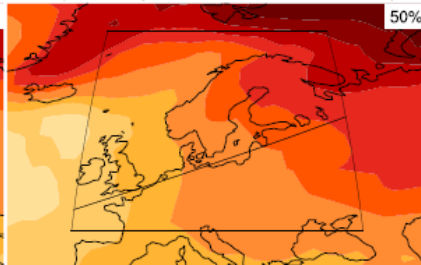
Temperature change RCP4.5 In 2046-2065: December-February



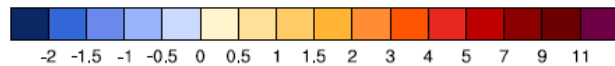
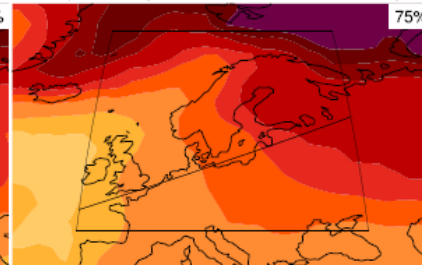
Temperature change RCP4.5 In 2081-2100: December-February



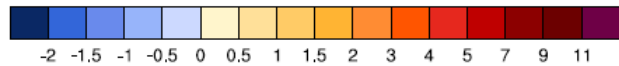
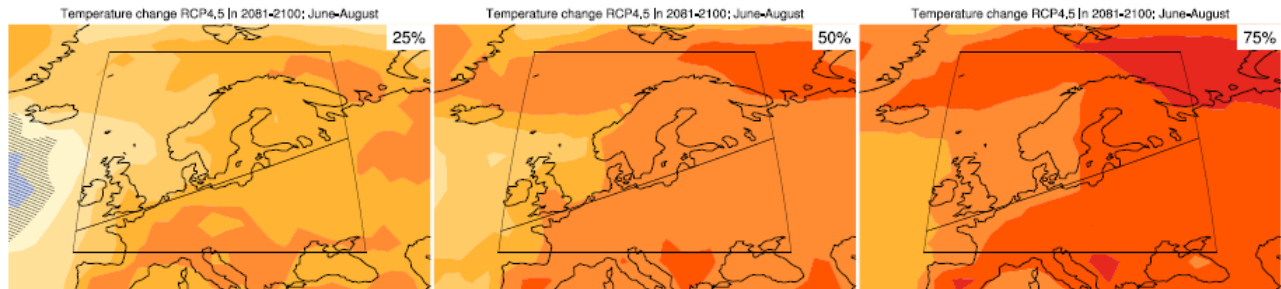
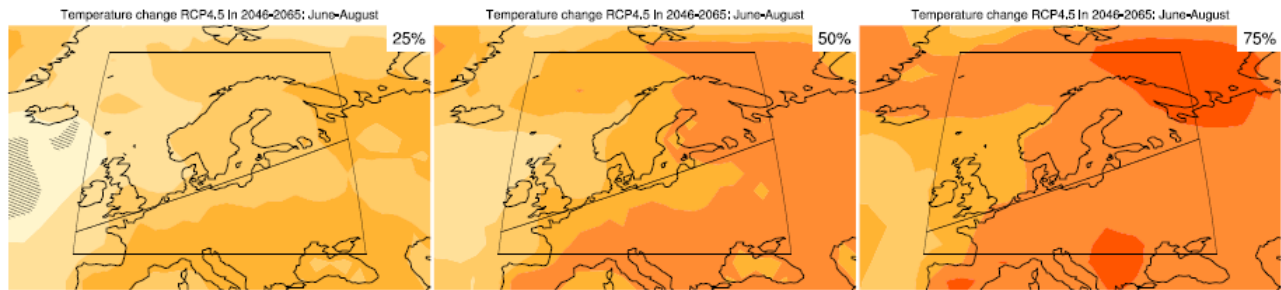
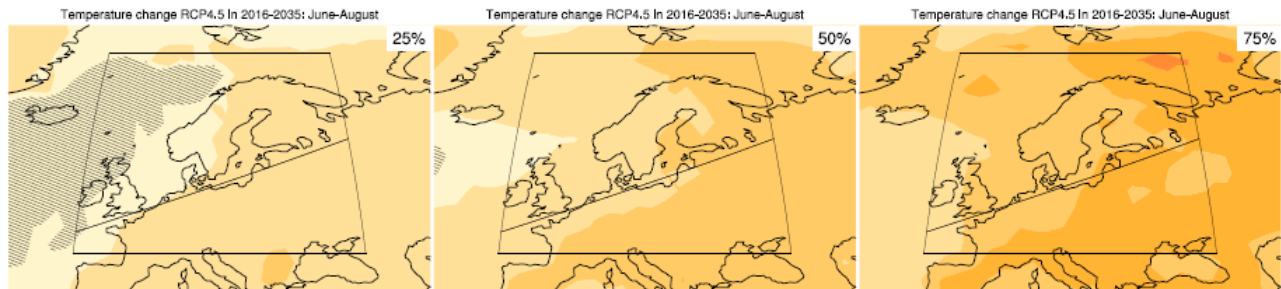
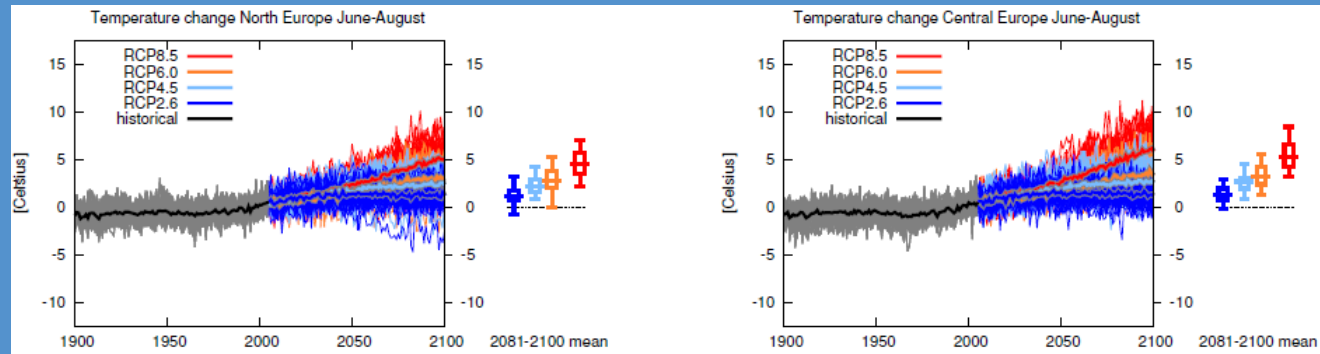
Temperature change RCP4.5 In 2081-2100: December-February



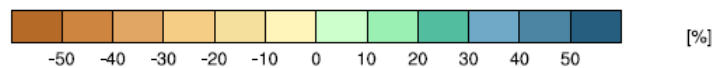
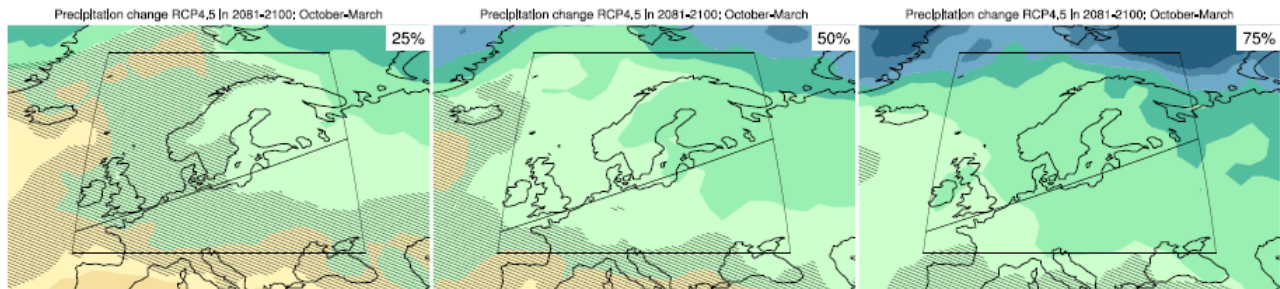
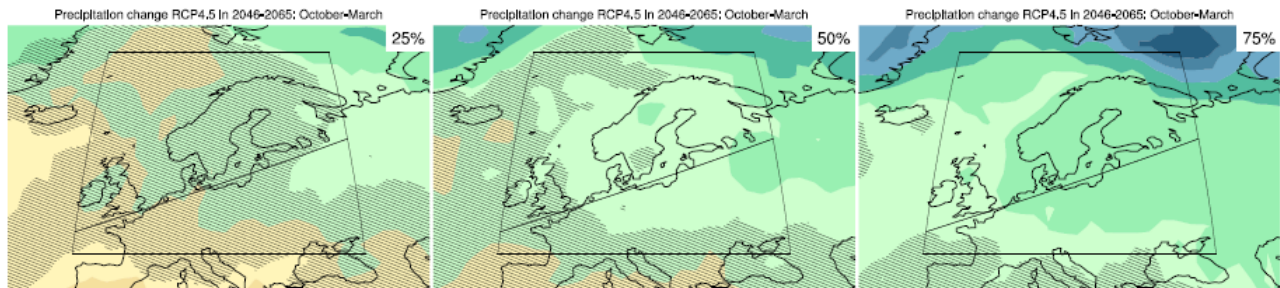
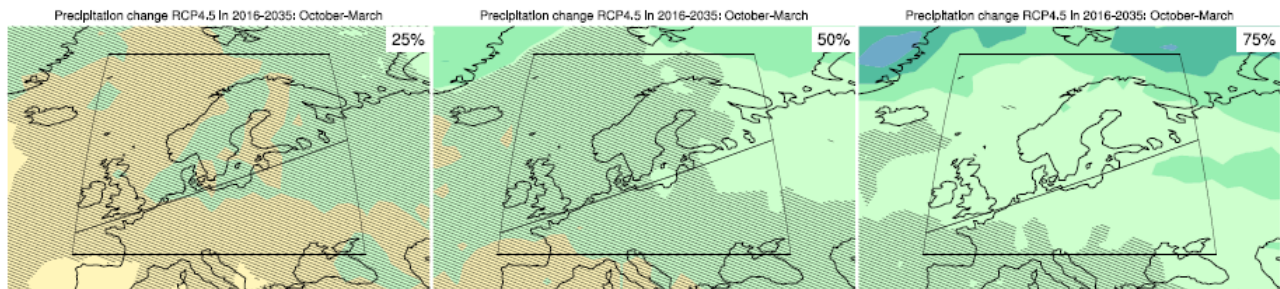
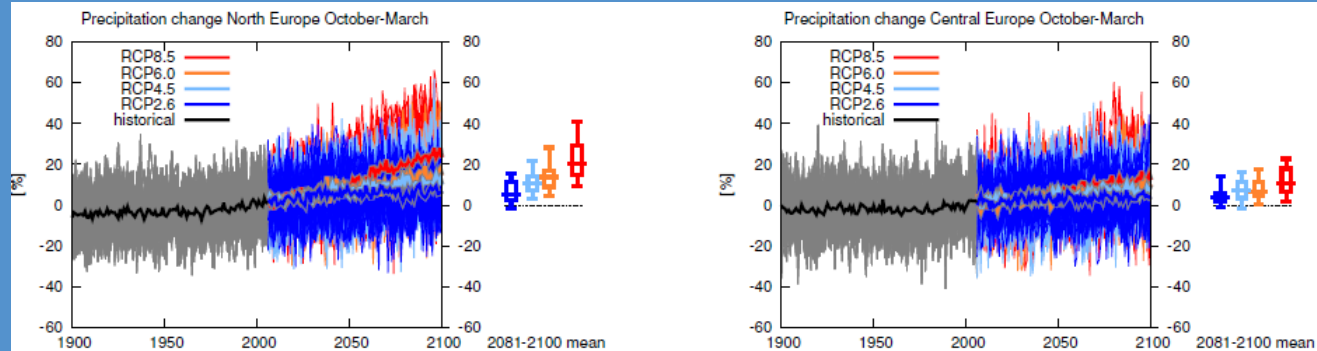
Temperature change RCP4.5 In 2081-2100: December-February

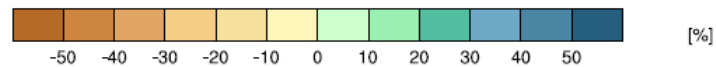
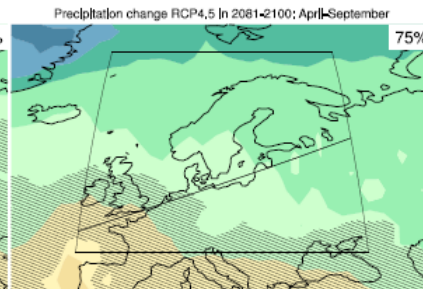
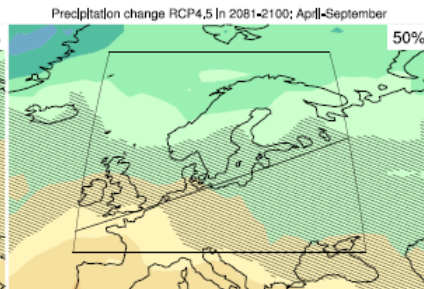
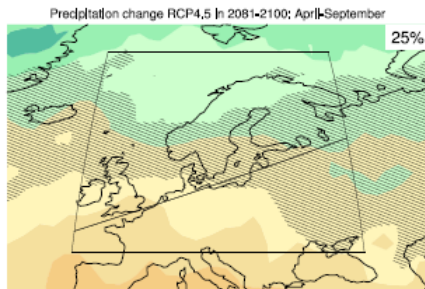
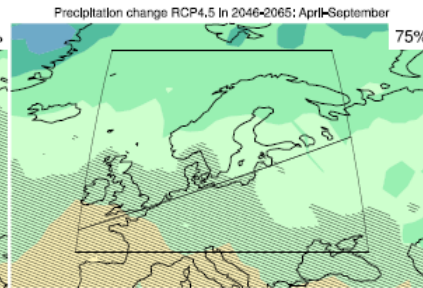
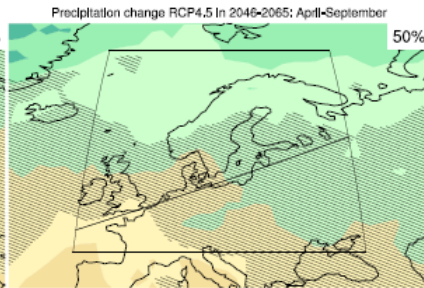
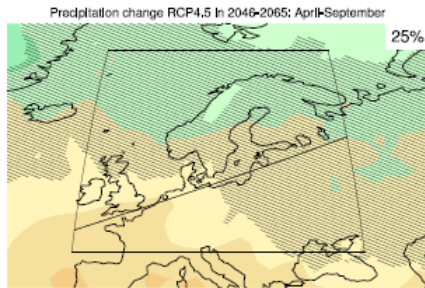
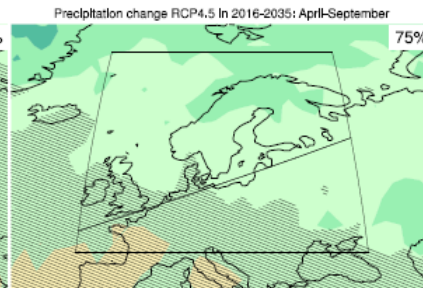
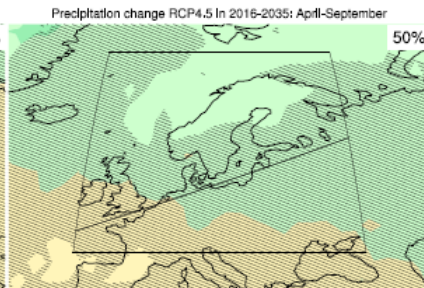
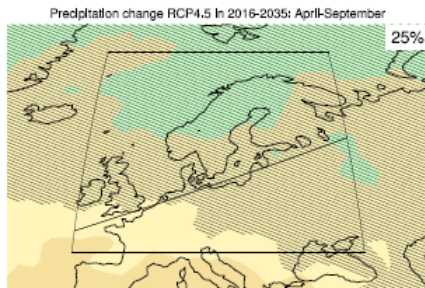
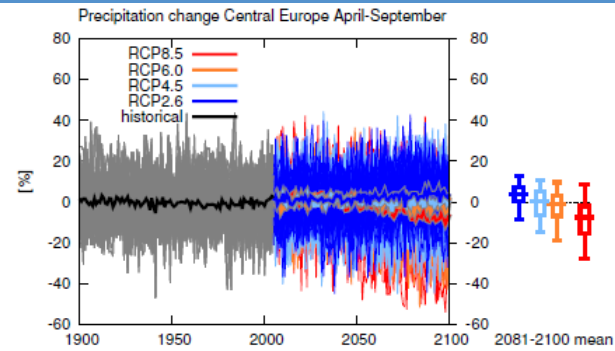
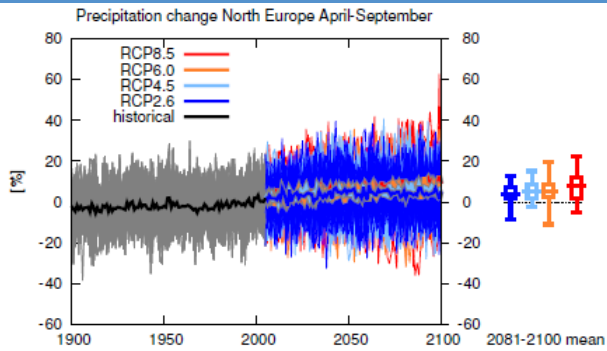


[°C]



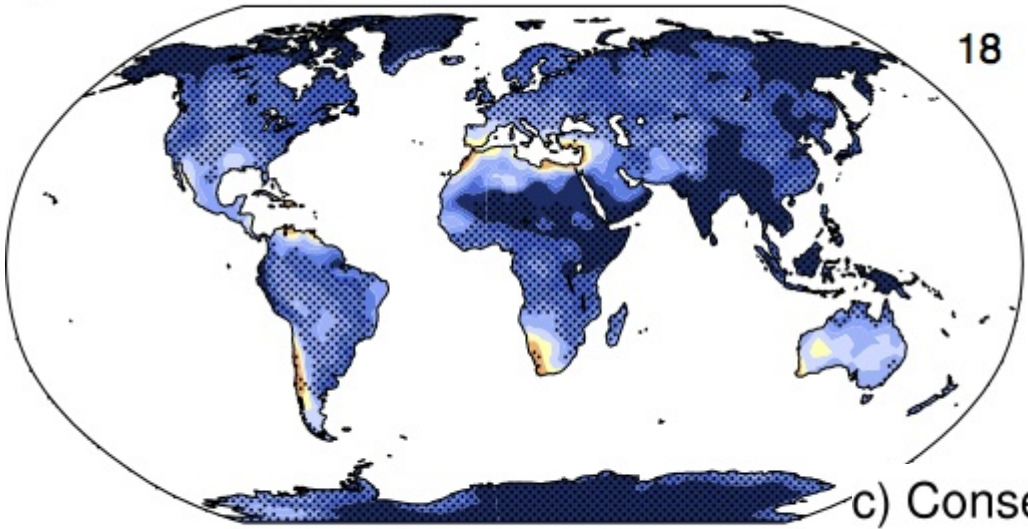
[°C]



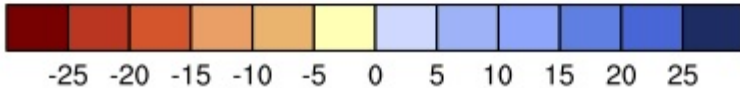
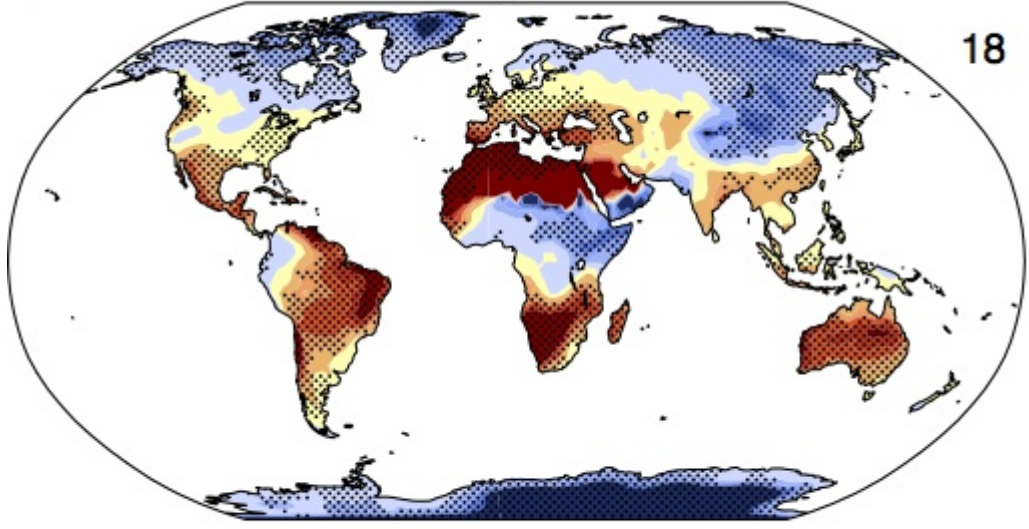


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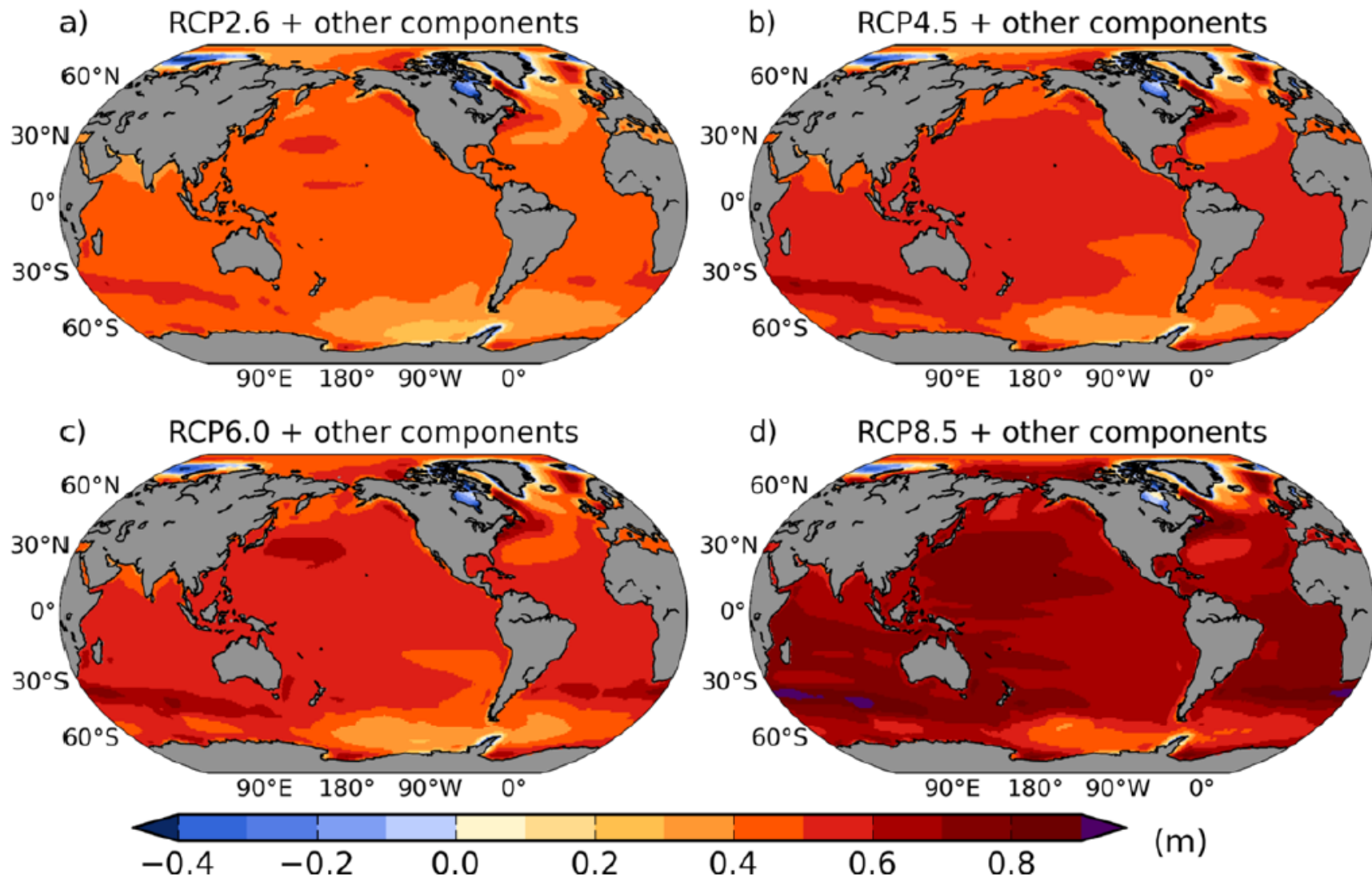
b) max. 5 day precip RCP8.5: 2081-2100



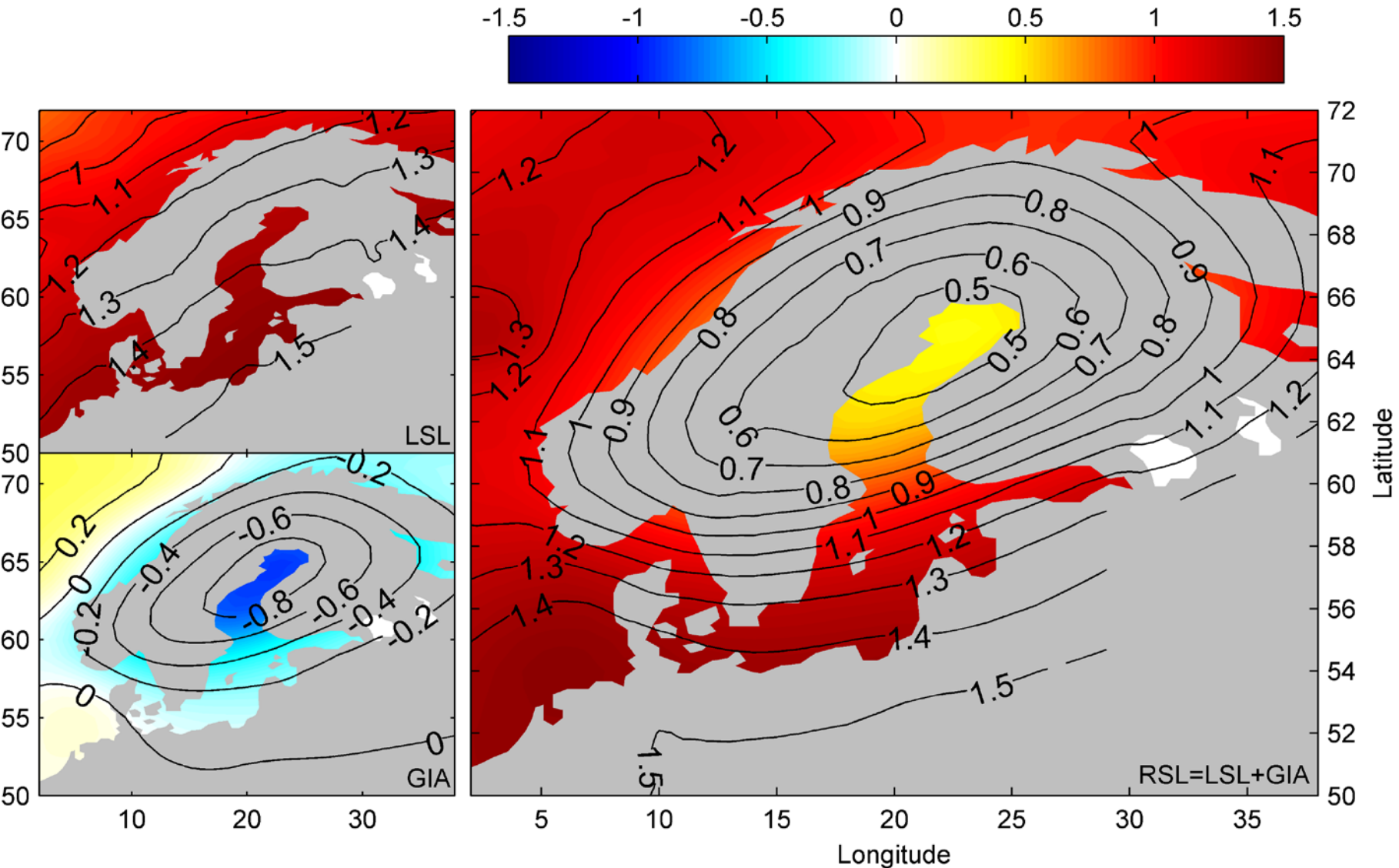
c) Consecutive Dry Days RCP8.5: 2081-2100



Regional sea level 2081-2100 rel. 1986-2005



High-end estimate (for $\Delta\text{GMSL} = 130\text{cm}$)



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Working Group I contribution to the IPCC Fifth Assessment Report

Further Information
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Acidification
The other CO₂ problem!

