Norwegian Centre for Climate Services

Future climate scenarios for Norway

Professor I. Hanssen-Bauer, Head of NCCS; Presentation in Riga 20.05.2016

NCCS is a cooperation between:

Meteorologisk institutt

uni Research

Norges vassdrags- og energidirektorat NVE

Overview:

- Methods and data
- Scenarios and time slices
- Results
- Contact with key users
- Challenges

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Klima i Norge 2100

Kunnskapsgrunnlag for klimatilpasning oppdatert i 2015

NCCS report no. 2/2015

Redaktører

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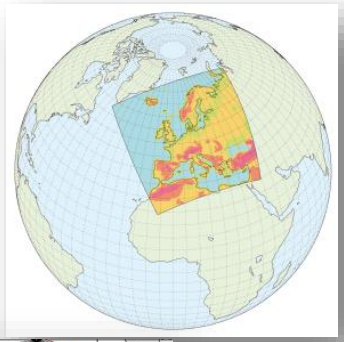
INSTITUTE OF MARINE RESEARCH

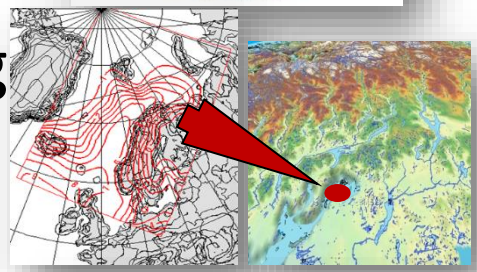
NERSC Nansensenteret

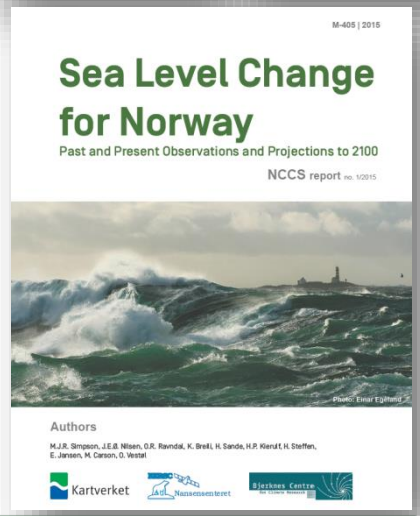
Kartverket

"Downscaling" of climate projections

- Temperature, precipitation and wind from Regional Climate Models (Euro CORDEX)
  - Applied only models with res. 12x12 km^2
- Temperature: Also Statistical Downscaling
  - Input directly from global models
- Sea level
  - Input directly from global models
  - Local effects (dynamical, gravitational, land rise) are included
  - A special report is written on this:





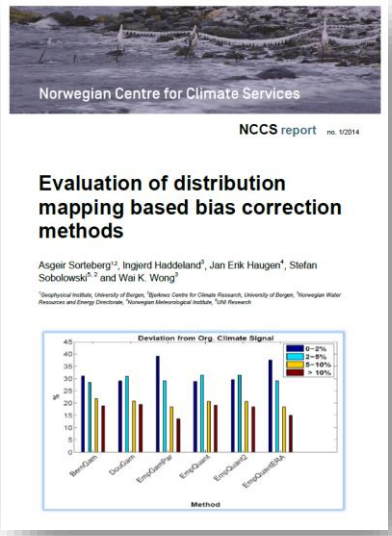


RCM with 12x12 km^2 : 10 GCM/RCM-combinations

Institutt	Global klimamodell	Ensemble medlem	Regional klimamodell
Climate Limited-area Modelling Community (CLM-Community)	CNRM-CERFACS-CM5	r1i1p1	CCLM4-8-17
Swedish Meteorological and Hydrological Institute (SMHI), Rossby Centre	CNRM-CERFACS-CM5	r1i1p1	RCA4
SMHI	IPSL-CM5A-MR	r1i1p1	RCA4
Royal Netherlands Meteorological Institute (KNMI)	ICHEC-EC-EARTH	r1i1p1	RACMO22E
Danish Meteorological Institute (DMI)	ICHEC-EC-EARTH	r3i1p1	HIRHAM5
SMHI	ICHEC-EC-EARTH	r12i1p1	RCA4
CLM-Community	ICHEC-EC-EARTH	r12i1p1	CCLM4-8-17
SMHI	MPI-ESM-LR	r1i1p1	RCA4
CLM-Community	MPI-ESM-LR	r1i1p1	CCLM4-8-17
SMHI	MOHC-HadGEM2-ES	r1i1p1	RCA4

Post-processing of RCM-data

- Temperature and precipitation:
  - Daily values interpolated to 1 x 1 km^2 grids
  - Bias adjustment (quantile mapping), using observationally based daily T- and R-maps with 1 x 1 km^2 resolution
- Hydrological variables:
  - R & T from the 1 x 1 km^2 grids were used as input in a hydrological model
  - Runoff, evaporation, snow conditions, soil water etc. was calculated

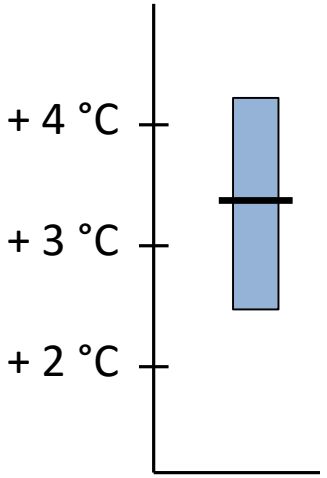


Statistical downscaling and sea level

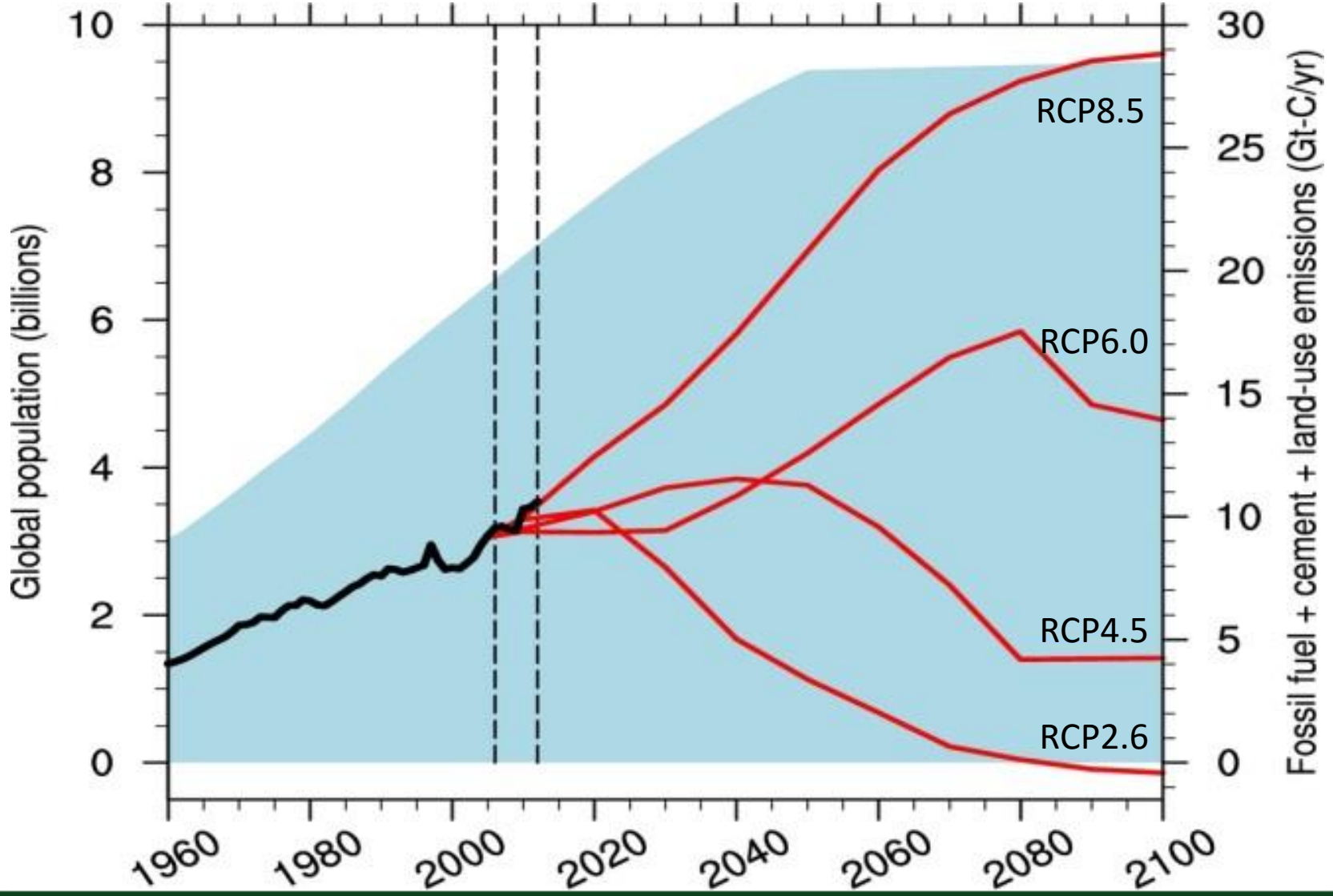
- Input directly from global models
- About 100 models available from IPCC AR5 were applied

Uncertainty

- For climatological and hydrological variables:
  - Median, 10 and 90 percentile for each scenario
- For sea level and storm surges:
  - Average, 5 and 95 percentile



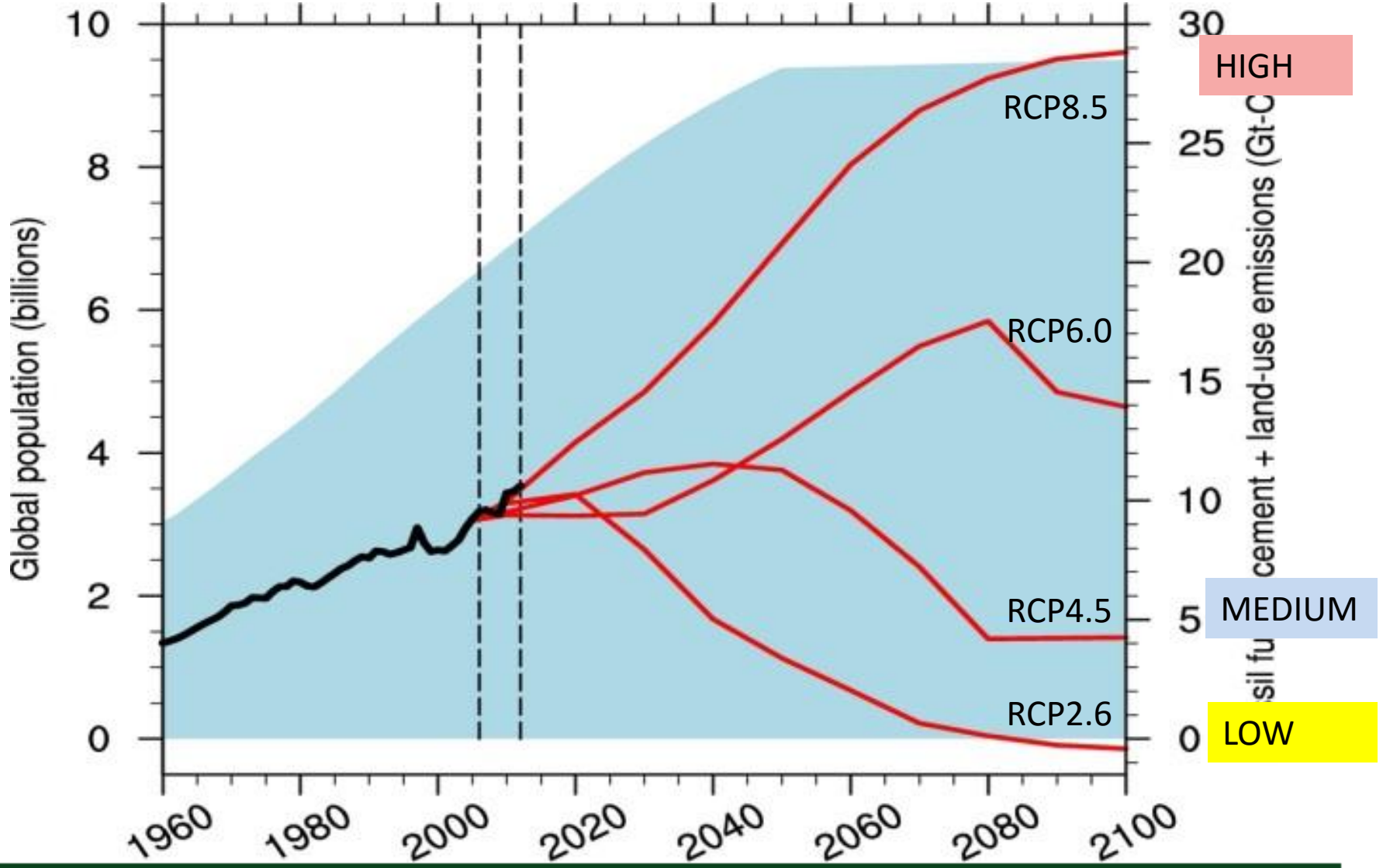
Emission scenarios



Scenarios

- The Norwegian Environment Agency wanted all scenarios, and especially the high and the low
  - "Stortingsmelding 33", 2013: The high scenario should be applied when risks for impacts are assessed…
  - The low scenario is our ambition and should thus be included
- We argued
  - RCP4.5 and RCP6.0 would not give very different climate during the present century. We suggested RCP4.5
  - For RCP2.6 only T (from statistical downscaling) and sea level could be given with indications of uncertainty

Emission scenarios



Time slices

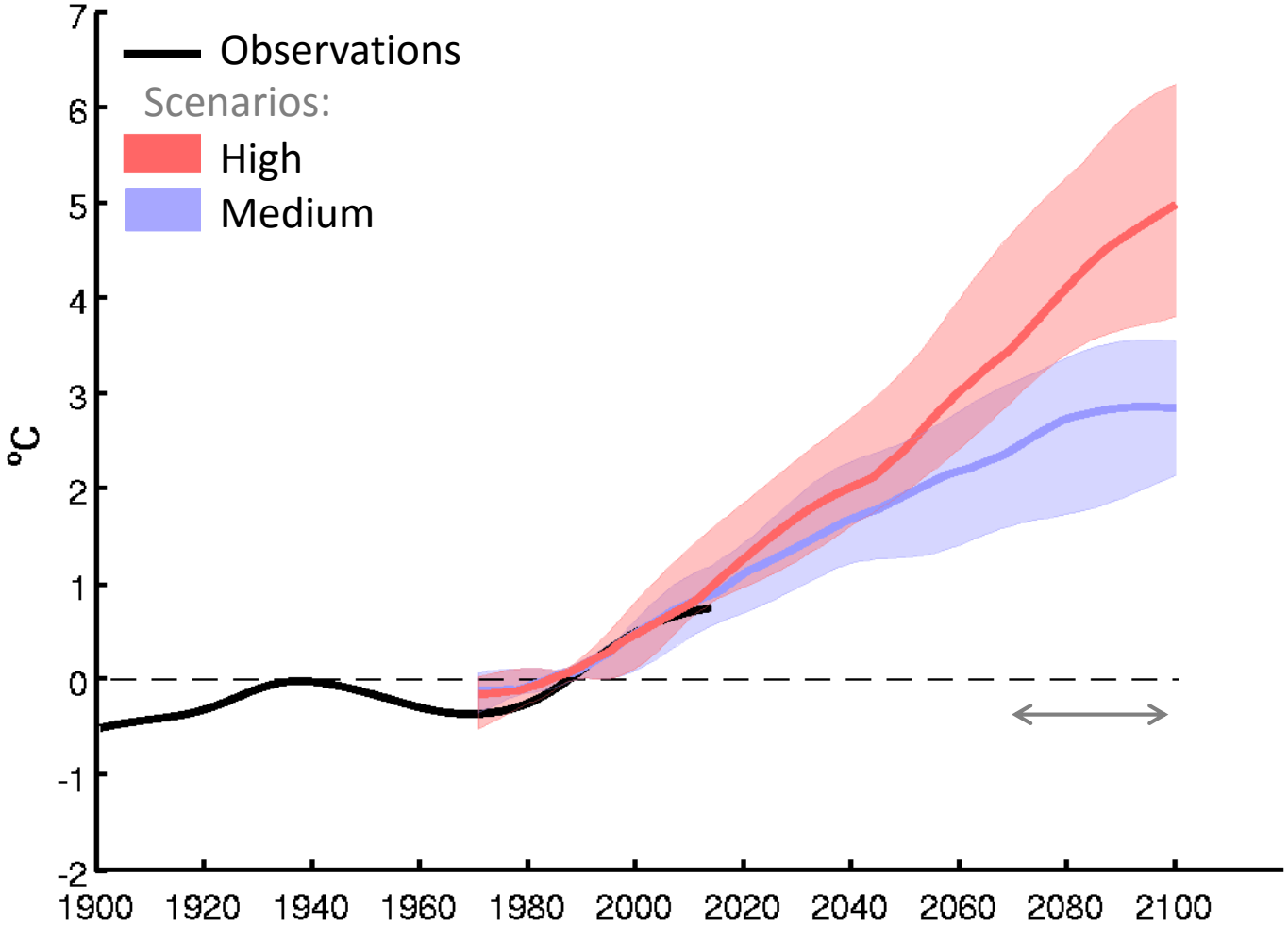
- The Norwegian Environment Agency wanted “the IPCC time-slices”, and specifically a “near future” time-slice
- We argued
  - IPCC use 20-year slices, but for local climate we need to use 30-year slices
  - For the near future, natural variability will dominate over climate change, and for short-time planning purposes it is better to apply updated climate info based on observations
- Conclusion:
  - Scenarios: 2031-2060 and 2071-2100. Control: 1971-2000

Climat./Hydrol. time series

- Median, 10- and 90-percentiles
  - Temperature, precipitation, run-off
  - Annual and seasonal values
  - For the entire country
  - For regions defined by climatology/ hydrology
  - For counties

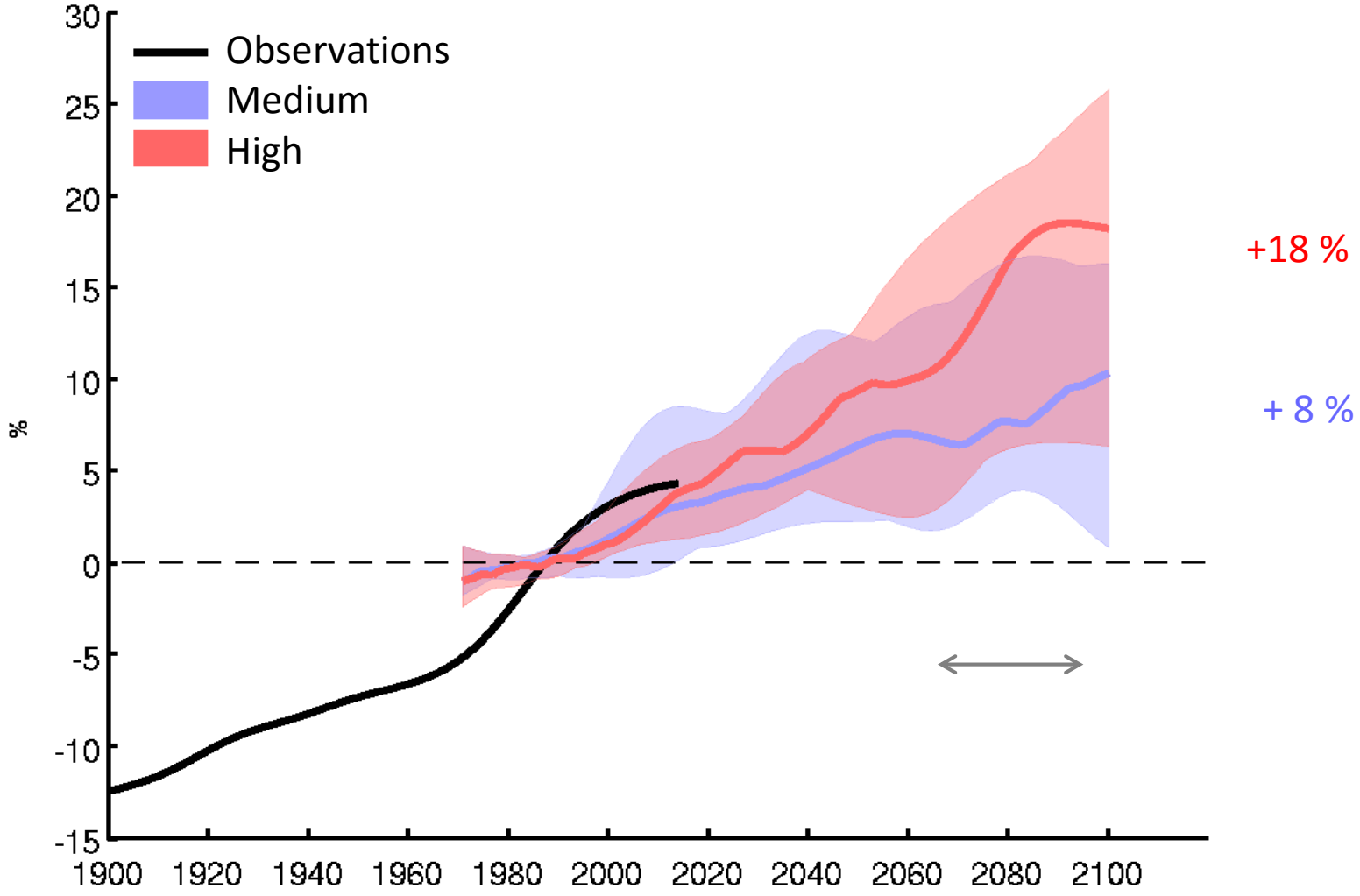
Annual temperature, Norway

deviation from 1971-2000



Precipitation, Norway

change in percent of 1971-2000 average

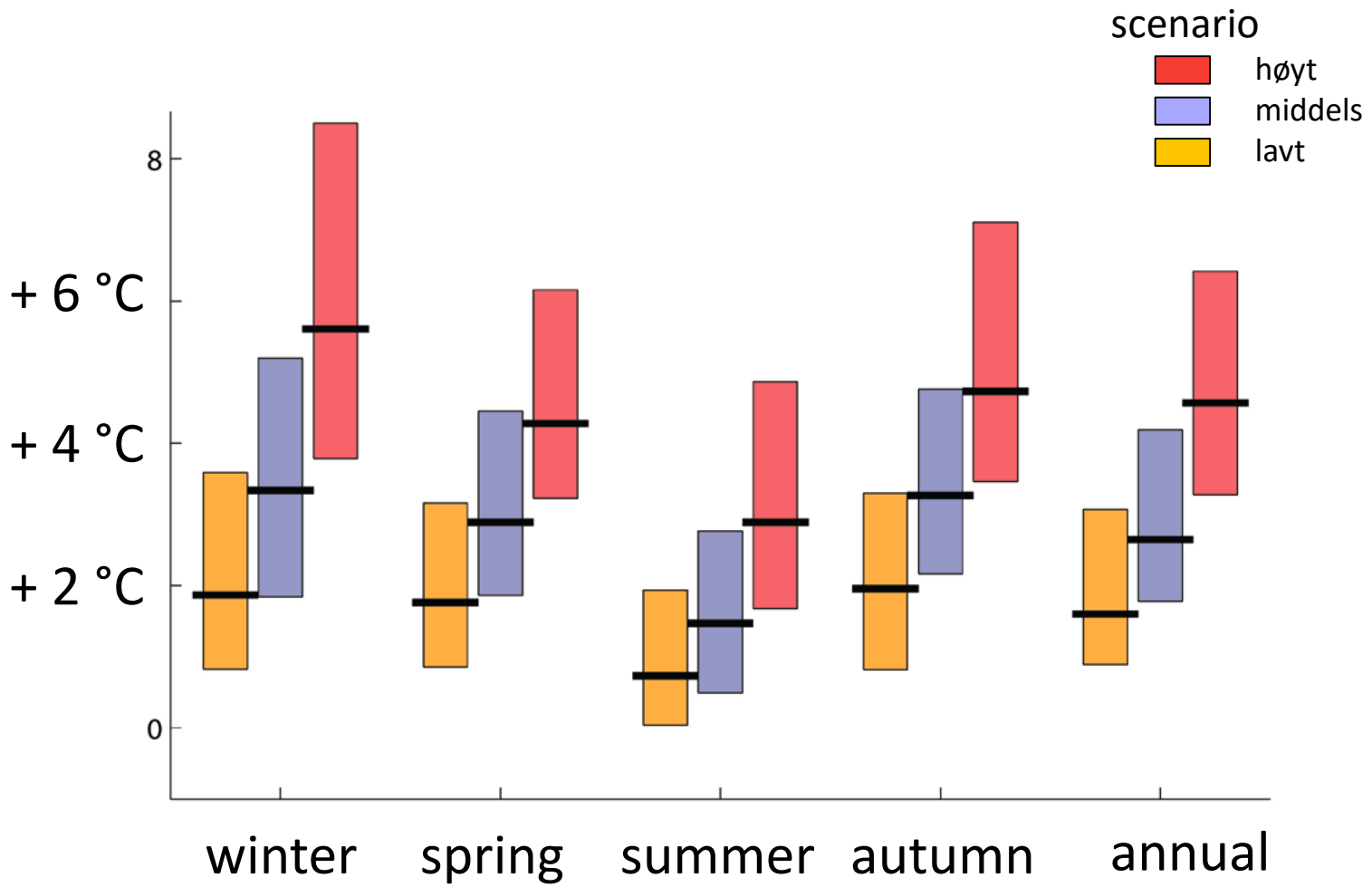


Climat./Hydrol. time slices

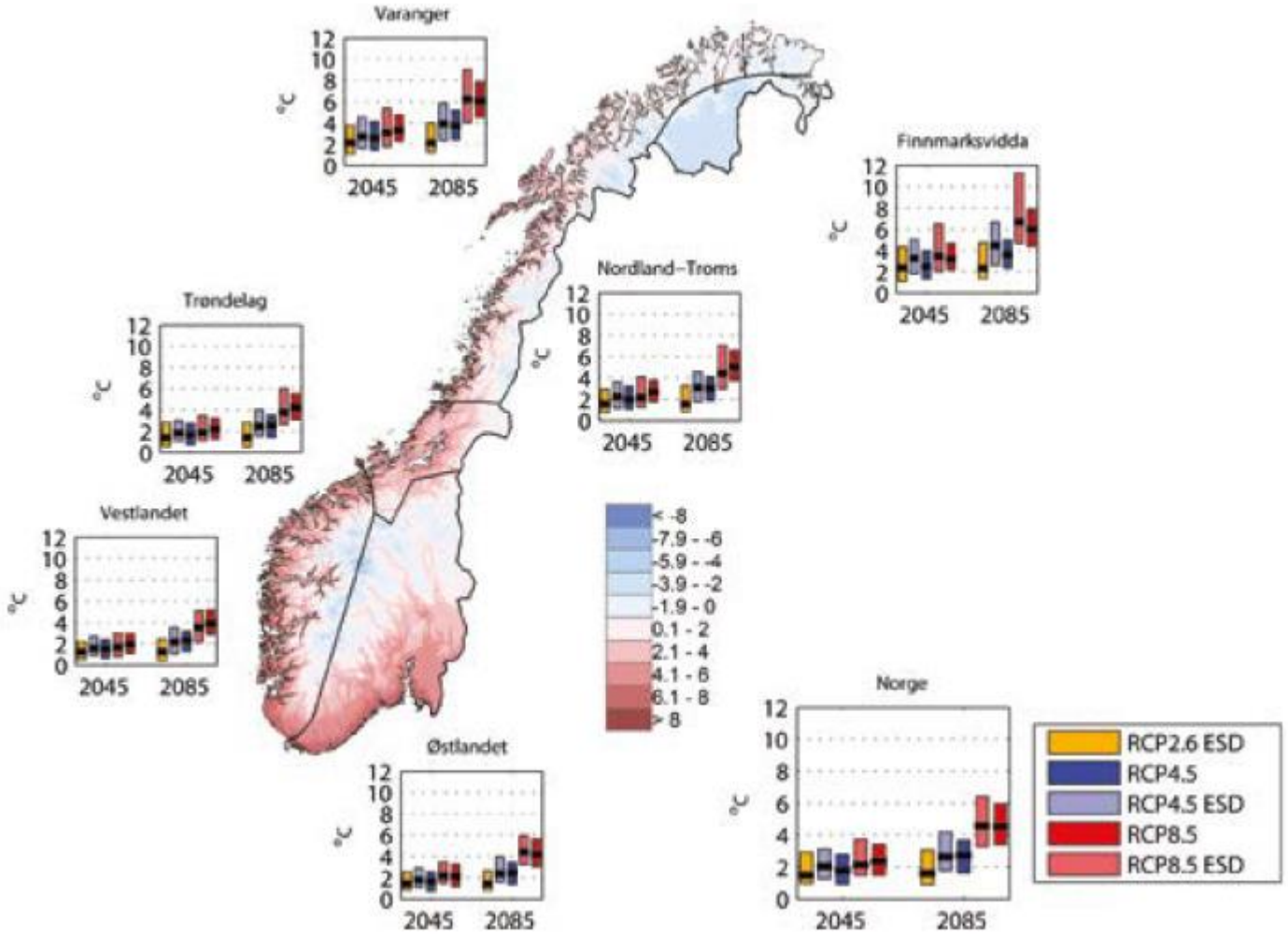
- Median, 10- and 90-percentiles:
  - Variables: Same as for time series
  - In addition: Number of days with “heavy precipitation” (R > 99,5 percentile in control periode)
  - The 99,5 percentile

Change in temperature

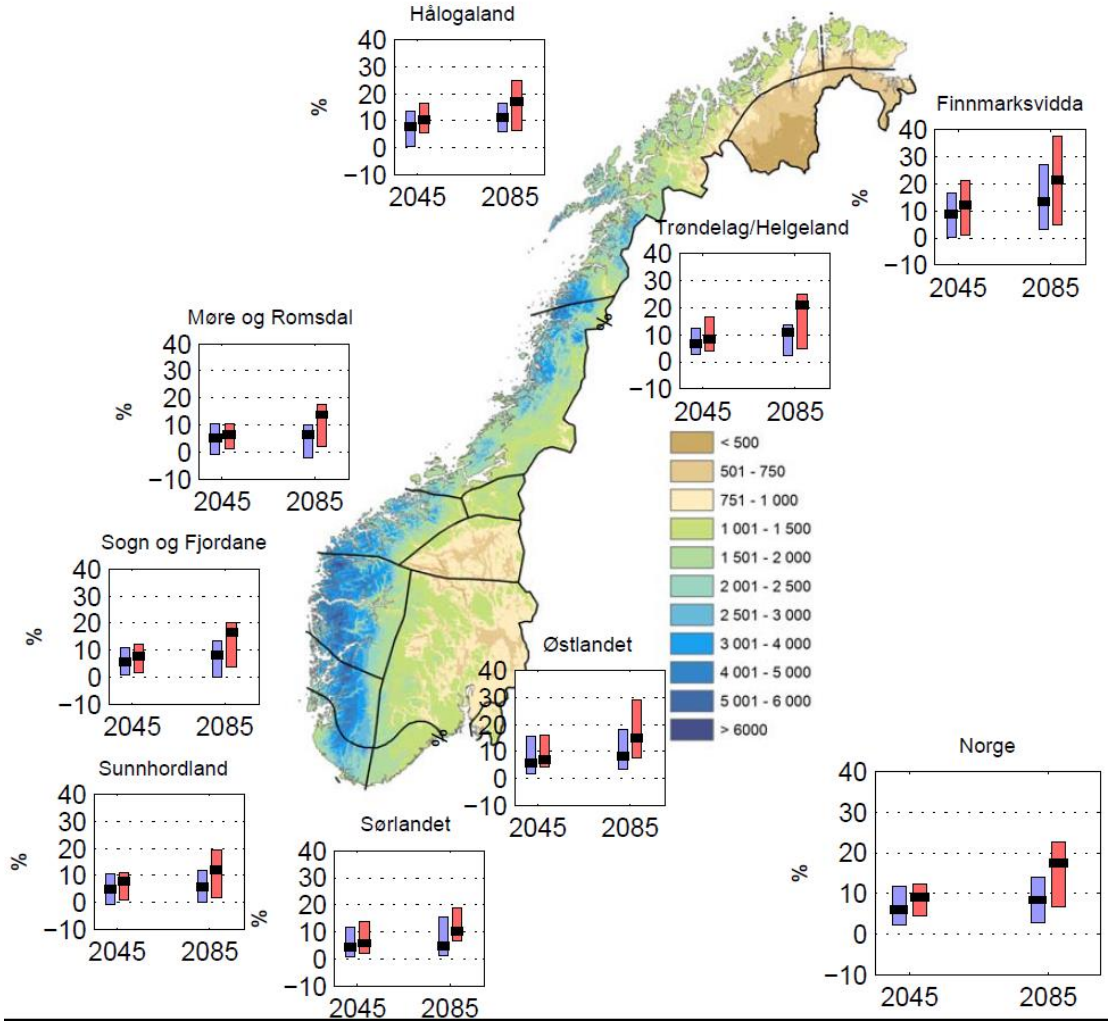
from 1971-2000 to 2071-2100



Changes in temperature by region



Changes in precipitation by region

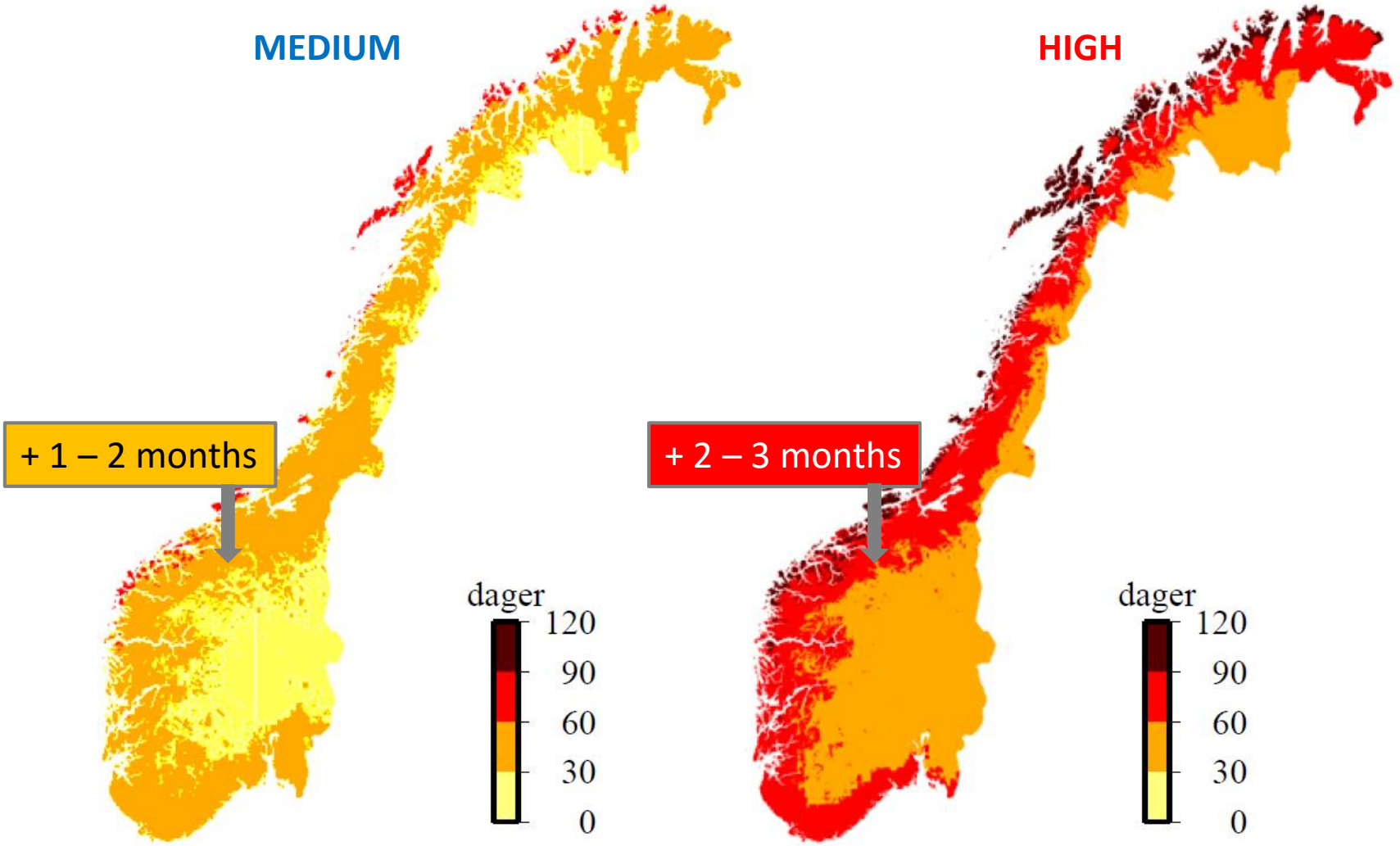


Climat./Hydrol. maps

- Change in median for medium and high scenario from 1971-2000 to 2071-2100
- Some also for 10- and 90-percentile
- Variables:
  - Temperature, “warm days”, growing season
  - Precipitation, runoff
  - Snow equivalent, snow season
  - “200-year flood”

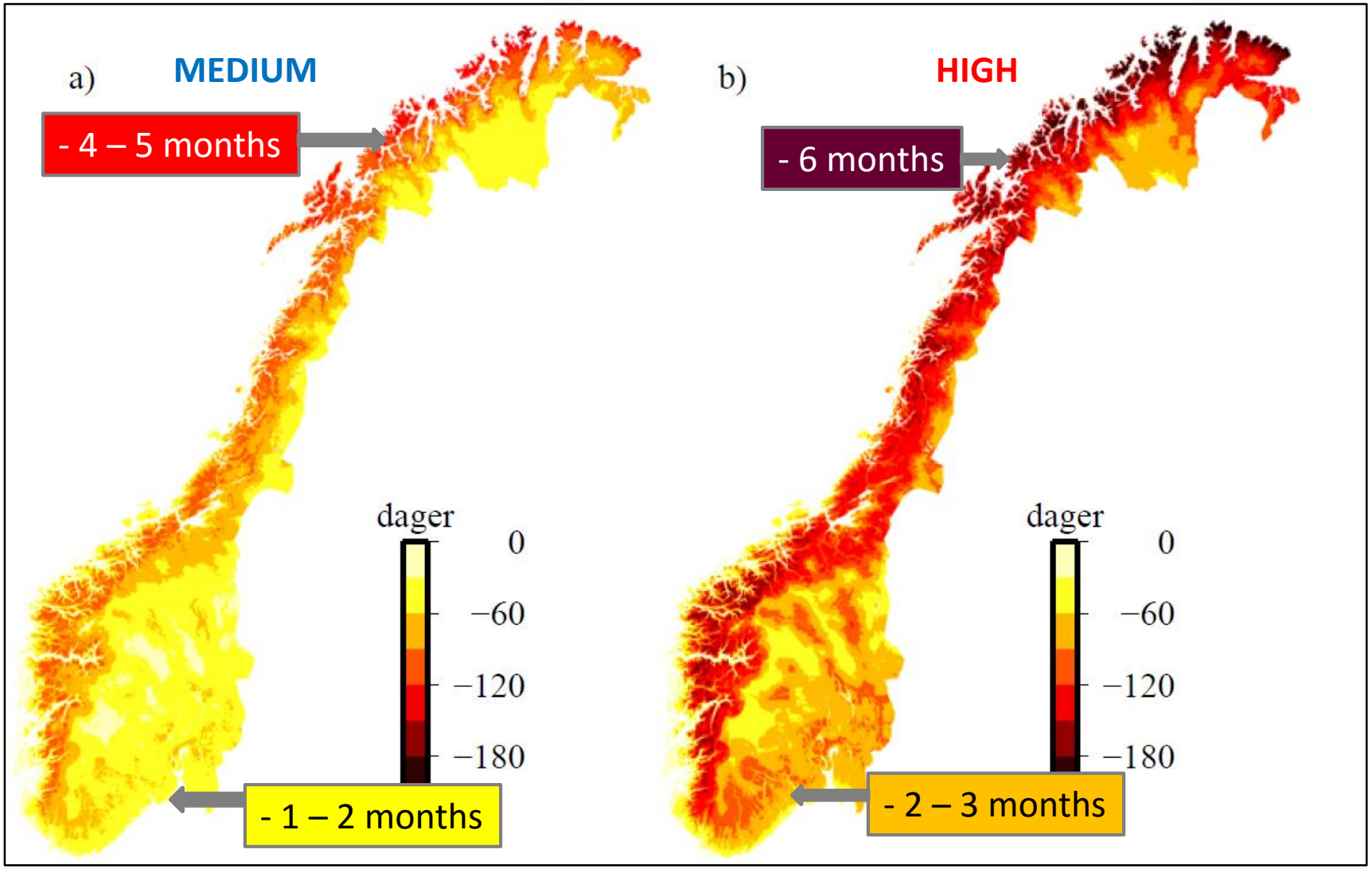
Increased growing season

from 1971-2000 to 2071-2100



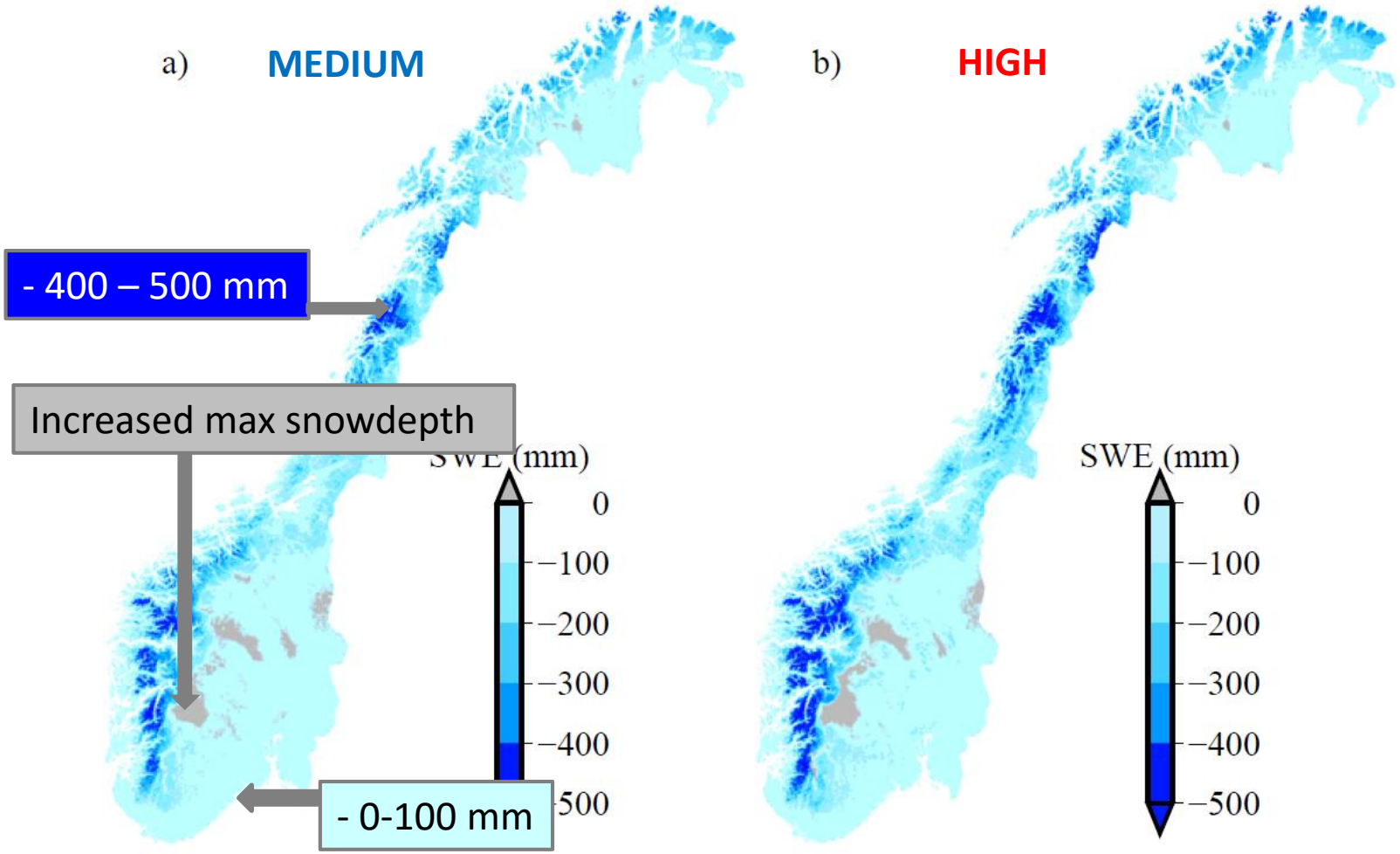
Length of snow season

Changes from 1971-2000 to 2071-2100

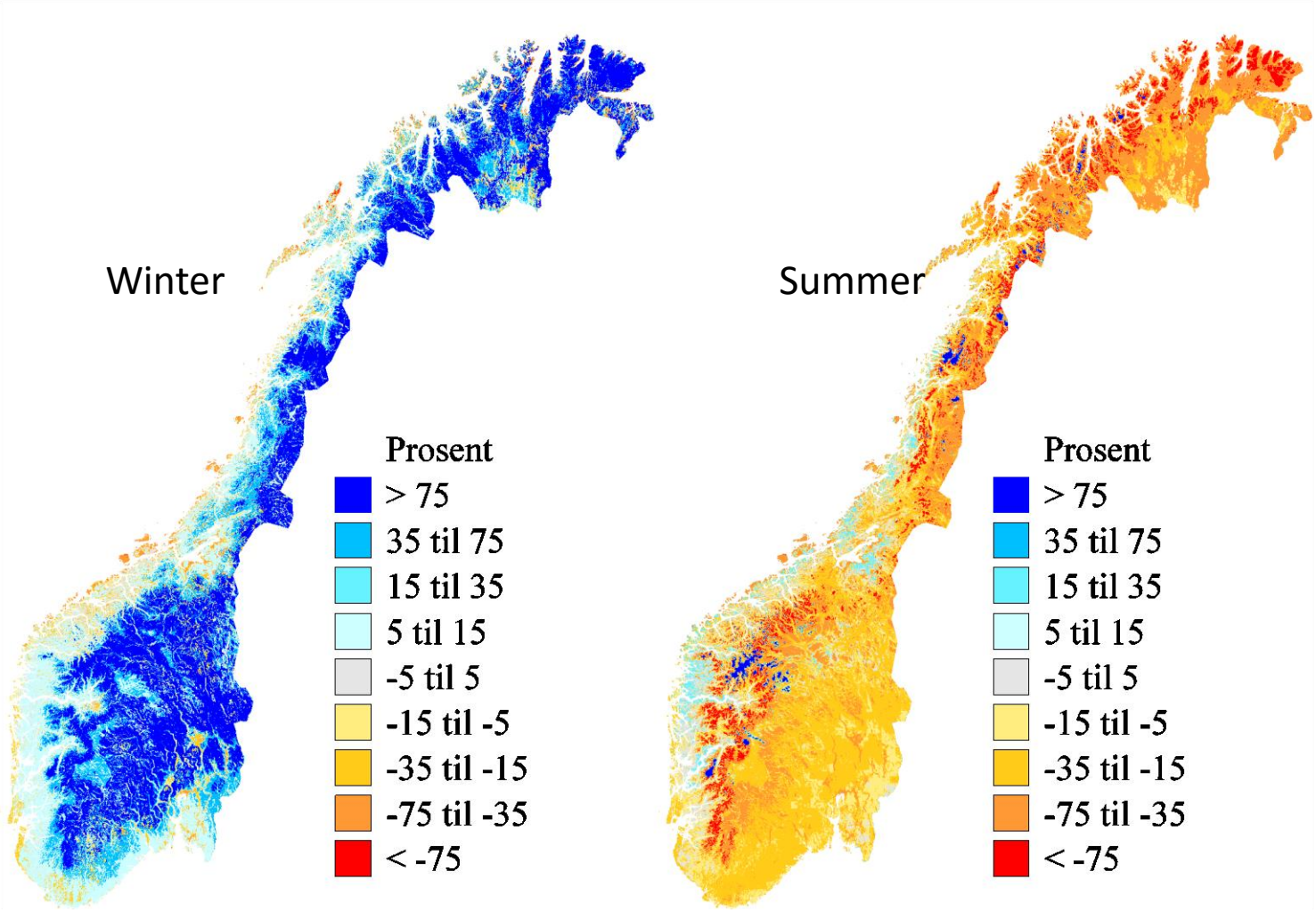


Average winter snow maximum

Changes from 1971-2000 to 2071-2100



More water in the rivers in winter – less in summer

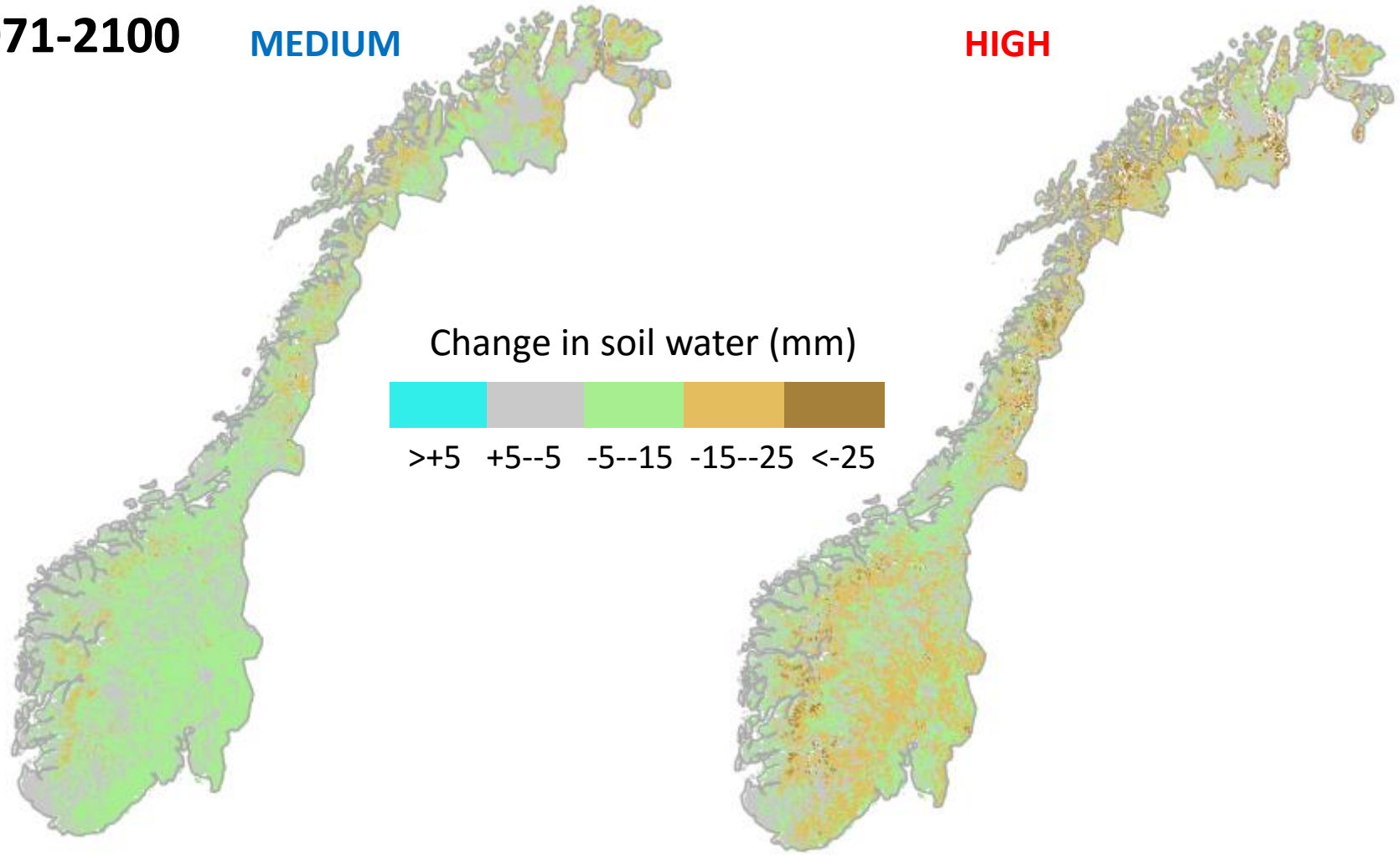


Increased soil water deficit in summer

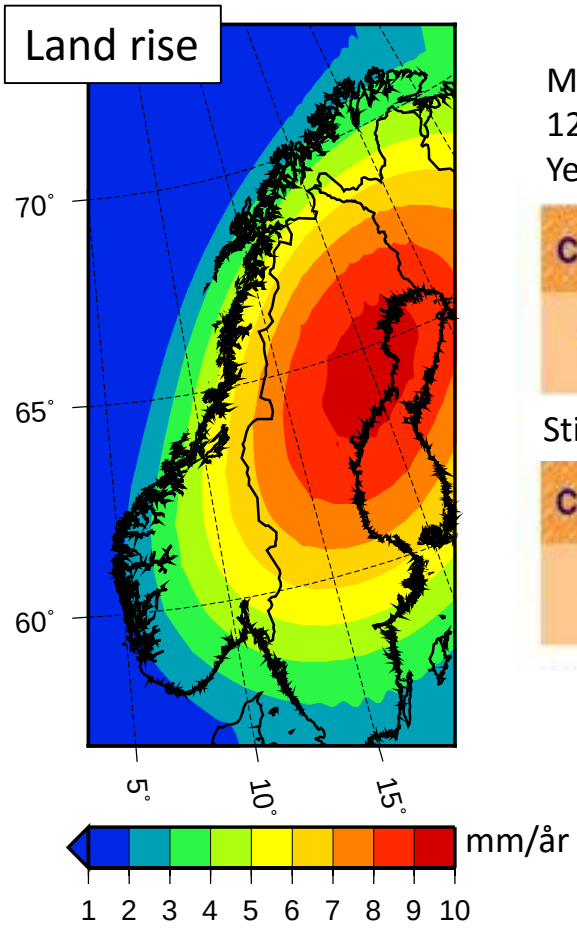
2071-2100

MEDIUM

HIGH

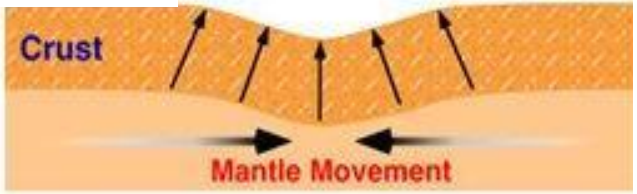


Sea level: Land rise is important in Norway

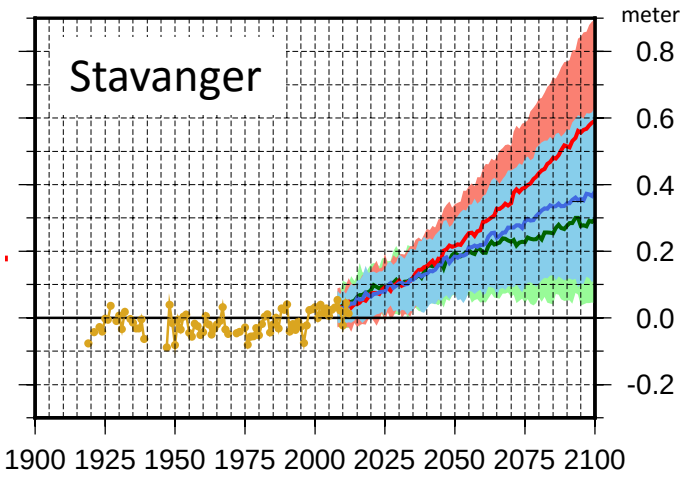


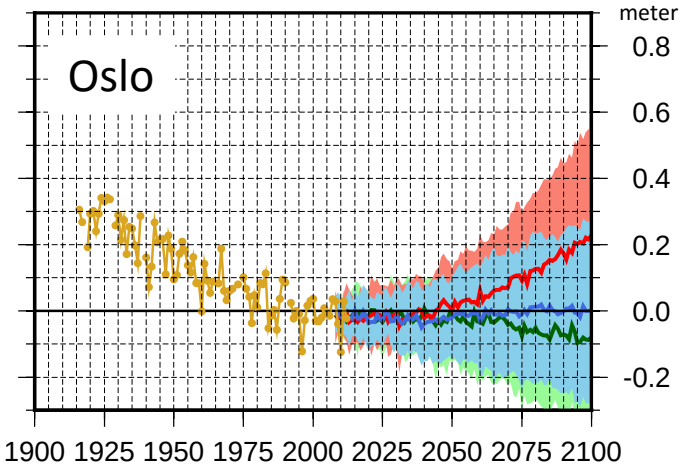
More than
12 000
Years b.p.:

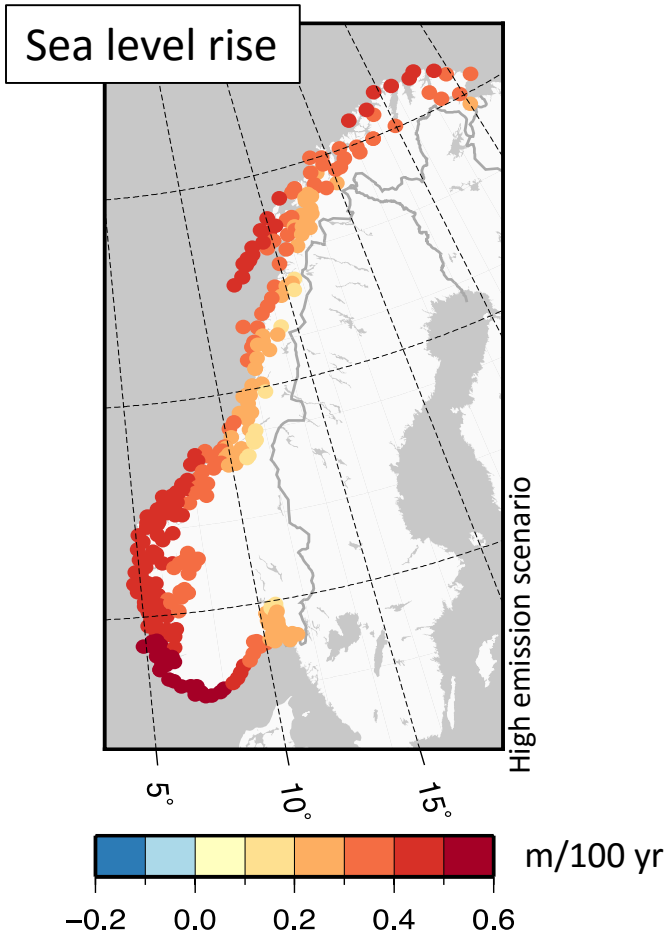
Still:



Time development







Sea-level

- Tables with median, 5- and 95-percentile for a number of time-slices, and for RCP2.6, RCP4.5 and RCP8.5 are given on the web for all coastal municipalities.
- The Directorate for Civil Protection has published a report with recommended design values for storm surges for the period 2071-2100.

Contact with users

- The climate report was launched in a national “climate adaptation conference”
- Afterwards we have given more than 30 presentations of the report
- Results are presented on our web-pages
- We produce “climate profiles” for counties
- We have close contact with the Norwegian Environment Agency
- …and with the Directorate for Civil Protection
- We cooperate with users in projects

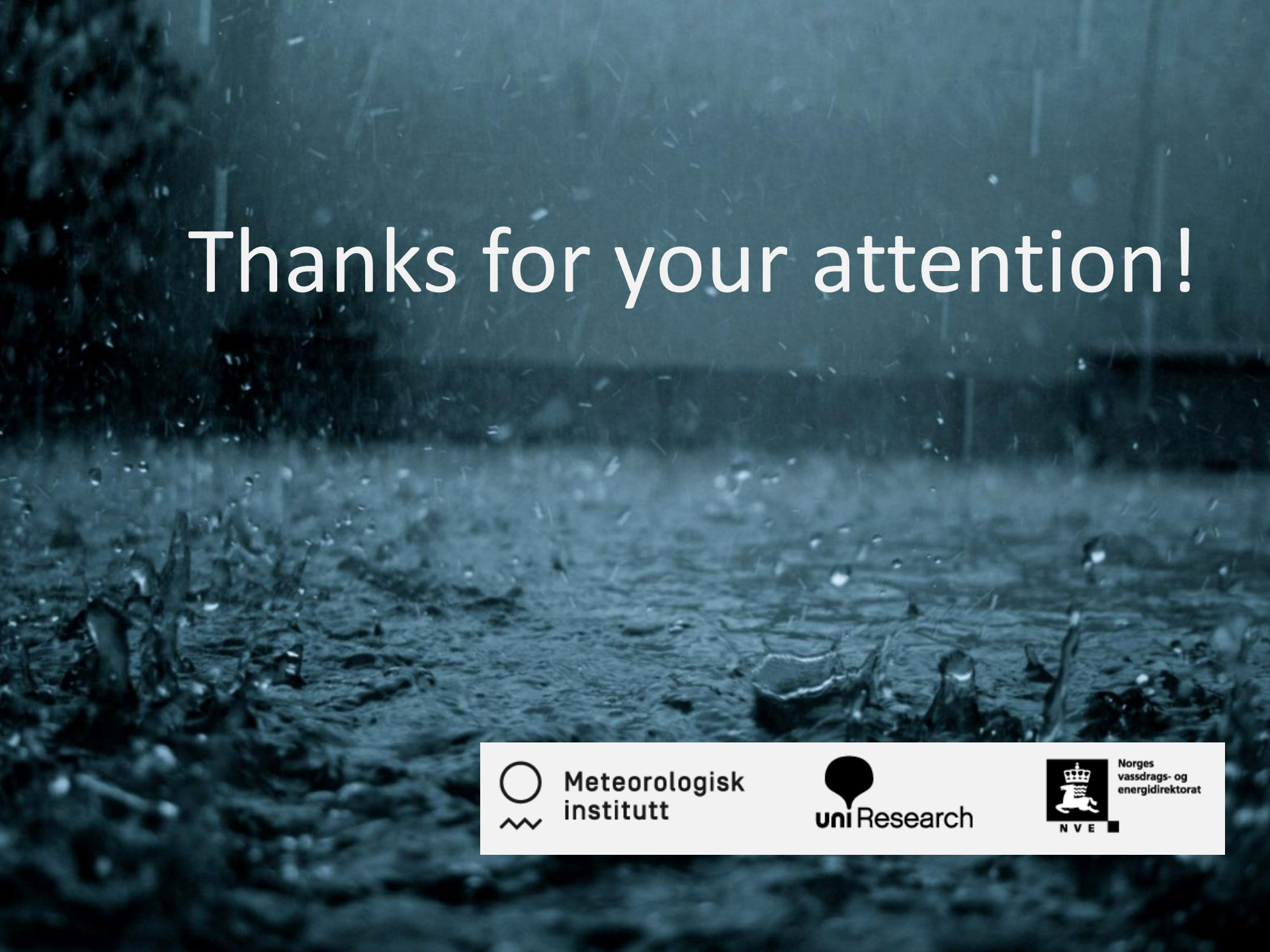
There is a knowledge gap

Some scientific challenges

- Practically all models have too zonal storm-tracks over the North Atlantic. Can we compensate for that?
- How to pick the “best” global model in “our region”?
- Bias adjustment is crucial for many purposes.
  - How do we maintain the climate signal, autocorrelation, spatial correlation and physical connection between variables during this process?

Practical and institutional challenges

- Updating information:
  - General update after IPCC main reports
  - How do we treat “break through scientific news” between the main reports?
- Costs/finances:
  - NCCS is financed year by year: Difficult to plan!
  - Ambition: Most products should be free of charge
  - Challenge: Limited resources and financing
- Many actors: Coordination is needed!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