Norwegian Centre for Climate Services

“Climate in Norway by 2100”

Basis for climate adaptation in Norway

Professor I. Hanssen-Bauer, Head of NCCS; Presentation in Riga 31.03.2016

NCCS is a cooperation between:

Meteorologisk institutt

uniResearch

Norges vassdrags- og energidirektorat NVE

Overview:

- Background info on the Norwegian Centre for Climate Services (NCCS)
- "Climate in Norway by 2100"
  – a climate report for Norway
- Contact with key users
- NCCS initiated research

Background for establishment of NCCS

- Official Norwegian Reports NOU 2010:10

http://www.regjeringen.no/pages/14545340/PDFS/NOU201020100010000DDDPDFS.pdf

- White paper on climate adaptation in Norway, 2013: «Stortingsmelding 33 (2012-2013)»

Norwegian Centre for Climate Services is a cooperation between:

- Norwegian Meteorological Institute
- Norwegian Water Resources and Energy Directorate (NVE)
- Uni Research (Univ. in Bergen)

- The Norwegian Environment Agency is represented in the board

Roles for the NCCS

- **Mission: Provide decision makers in Norway with information relevant for climate adaptation**
- Assessing and tailoring present knowledge is crucial
- Initiate research whenever needed
- Include other actors/institutions when necessary
- Which scenario we should adapt to is a political decision, but NCCS can offer advice…
- Design values for the future are decided by the responsible authorities, but NCCS coordinates and contributes to the basic calculations

Important user categories - 1

- Governmental institutions and authorities:
  - National to municipality level
  - Roads, railways, coastal infrastructure etc.
- Sectors/Industries, e.g.:
  - Energy
  - Buildings
  - Health
  - Primary industries

Important user categories - 2

Climate impact research

- Physical nature
- Ecosystems
- Society

M-406 | 2015

Klima i Norge 2100

Kunnskapsgrunnlag for klimatilpasning oppdatert i 2015

NCCS report no. 2/2015

Foto: Anne Olsen-Ryum, www.hasvikfoto.no

Redaktører

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Norwegian Meteorological Institute

NVE

uni Research

UNIVERSITAS BERGENSIS

HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

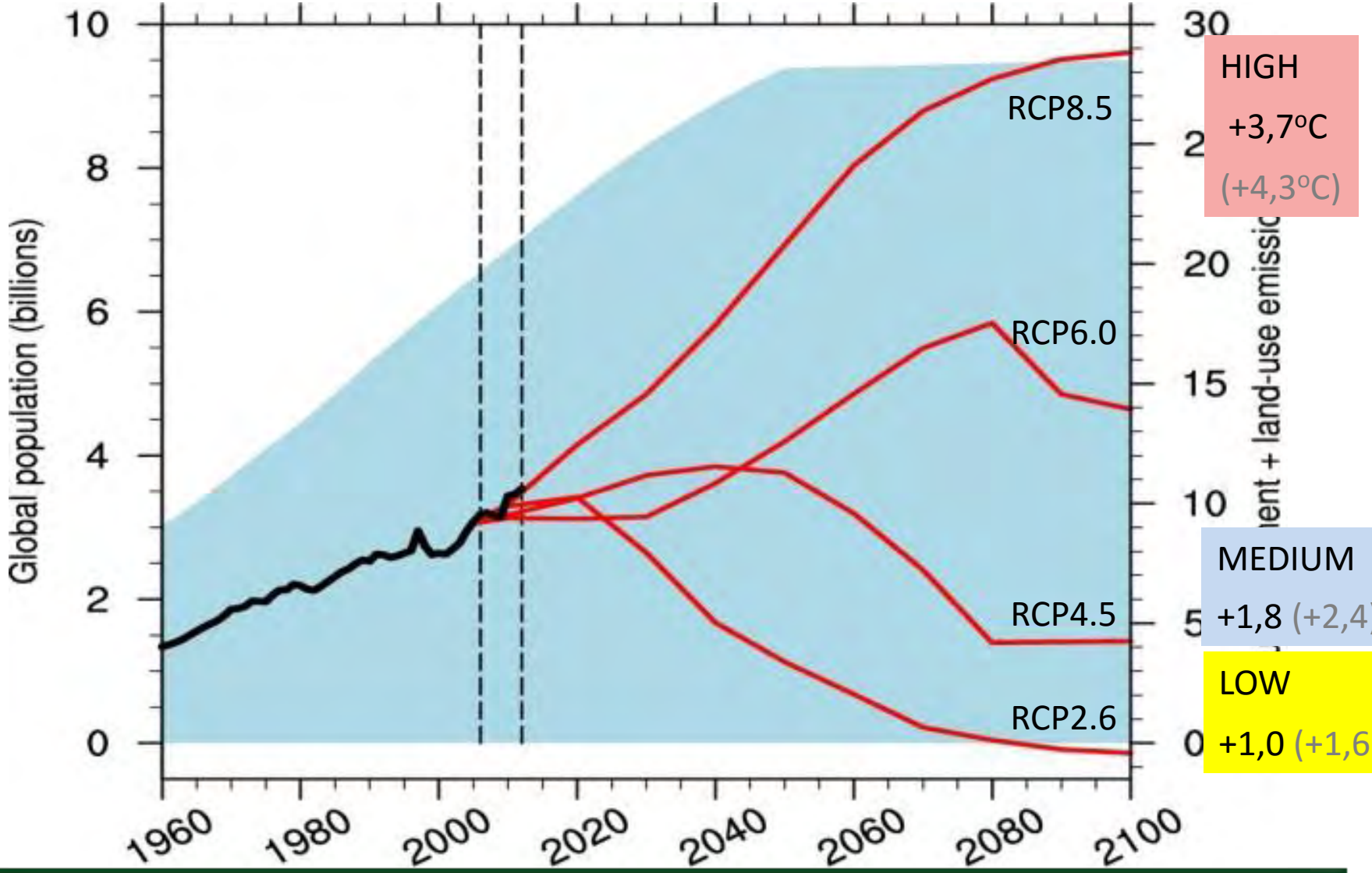
NERSC Nansensenteret

Kartverket

Some facts concerning “Klima i Norge 2100”

- Client: The Norwegian Environment Agency
- Aim: Form a common basis for climate adaptation
- 37 authors/co-authors representing 7 institutions
- 7 experts commented on/reviewed the manuscript
- A special report on sea level was initiated and used as basis for the sea level projections
- Both historical climate development, present climate and modelled future climate is included
- The following slides summarises methods and results for the future climate

Emission scenarios



Climate modelleing

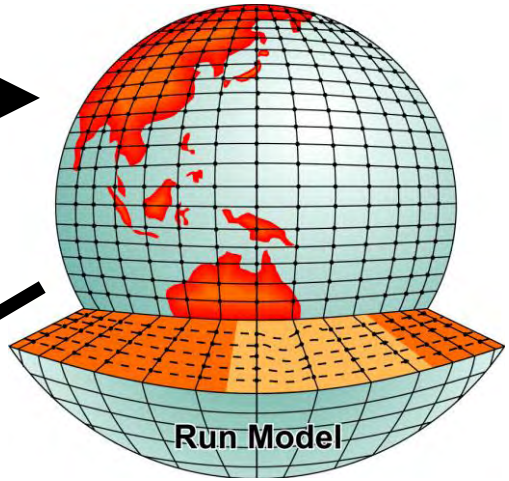
Physical equations

$$\frac{\partial \rho}{\partial t} + \vec{V} \cdot \nabla \rho = 0$$

$$\rho \frac{D\vec{V}}{Dt} = \rho \vec{f} - \nabla p + \frac{1}{3}\mu \nabla\left(\nabla \cdot \vec{V}\right) + \mu \nabla^2 \vec{V}$$

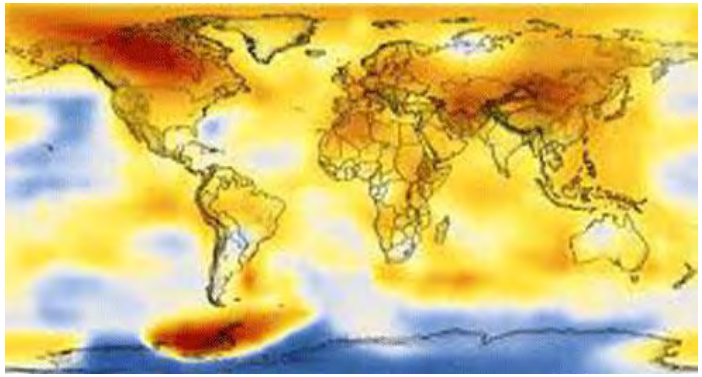
$$\rho \frac{D}{Dt}\left(e + \frac{1}{2}\vec{V} \cdot \vec{V}\right) = \nabla \cdot \left(\overline{\overline{T}} \cdot \vec{V}\right) + \rho \vec{f} \cdot \vec{V} - \nabla \cdot \vec{q} + Q$$

Numerical models



Super computers

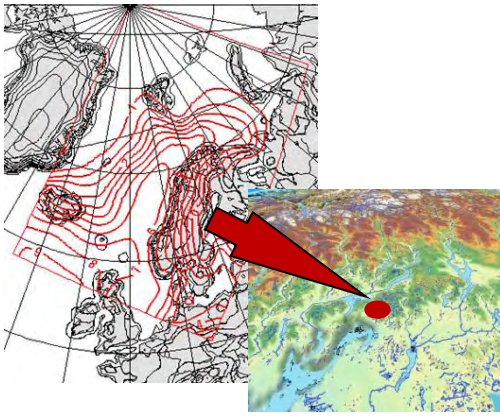
Resultat



"Downscaling" of climate projections

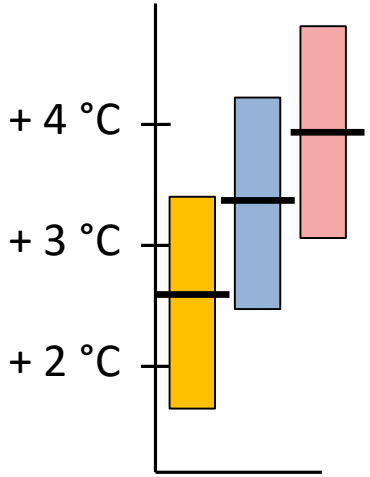
- Most variables deduced from results from regional climate models (Euro CORDEX)
  - We applied models with res. 12-12 km^2
  - Few results for "low scenario"→ excluded
  - Results from 10 models post-processed for high and medium
  - T and R used as input in hydrological model

- Temperature: also statistical downscaling
  - Takes input directly from global models
- Sea level
  - Takes input directly from global models
  - Local effects (dynamical, gravitational, land rise) are added



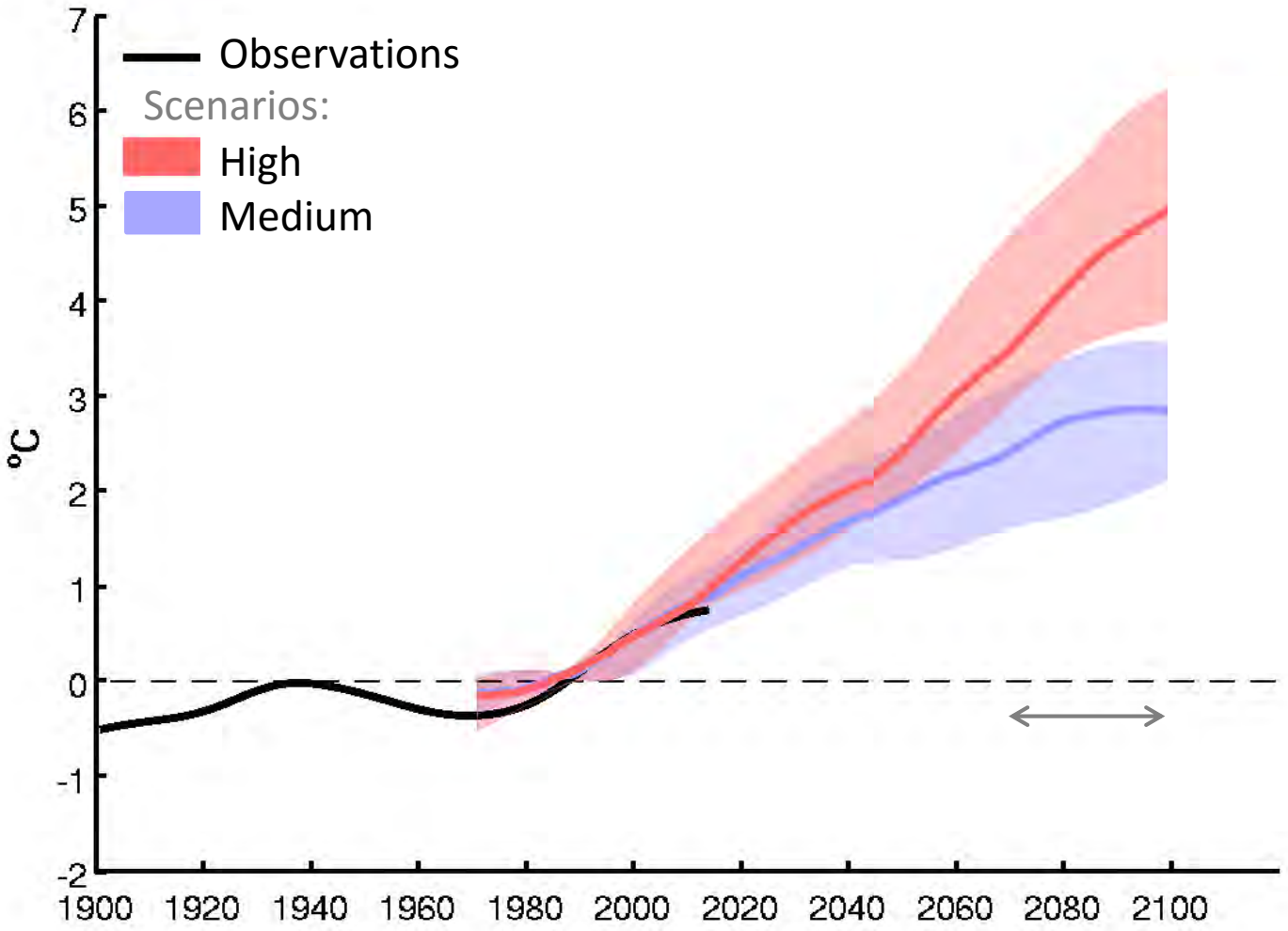
Uncertainty

- Uncertainty is in general larger on small spatial- and time-scales than on larger scales
- Uncertainty is connected to
  - Natural variations
  - Simplifications and errors in Climate models
  - Emission scenarios



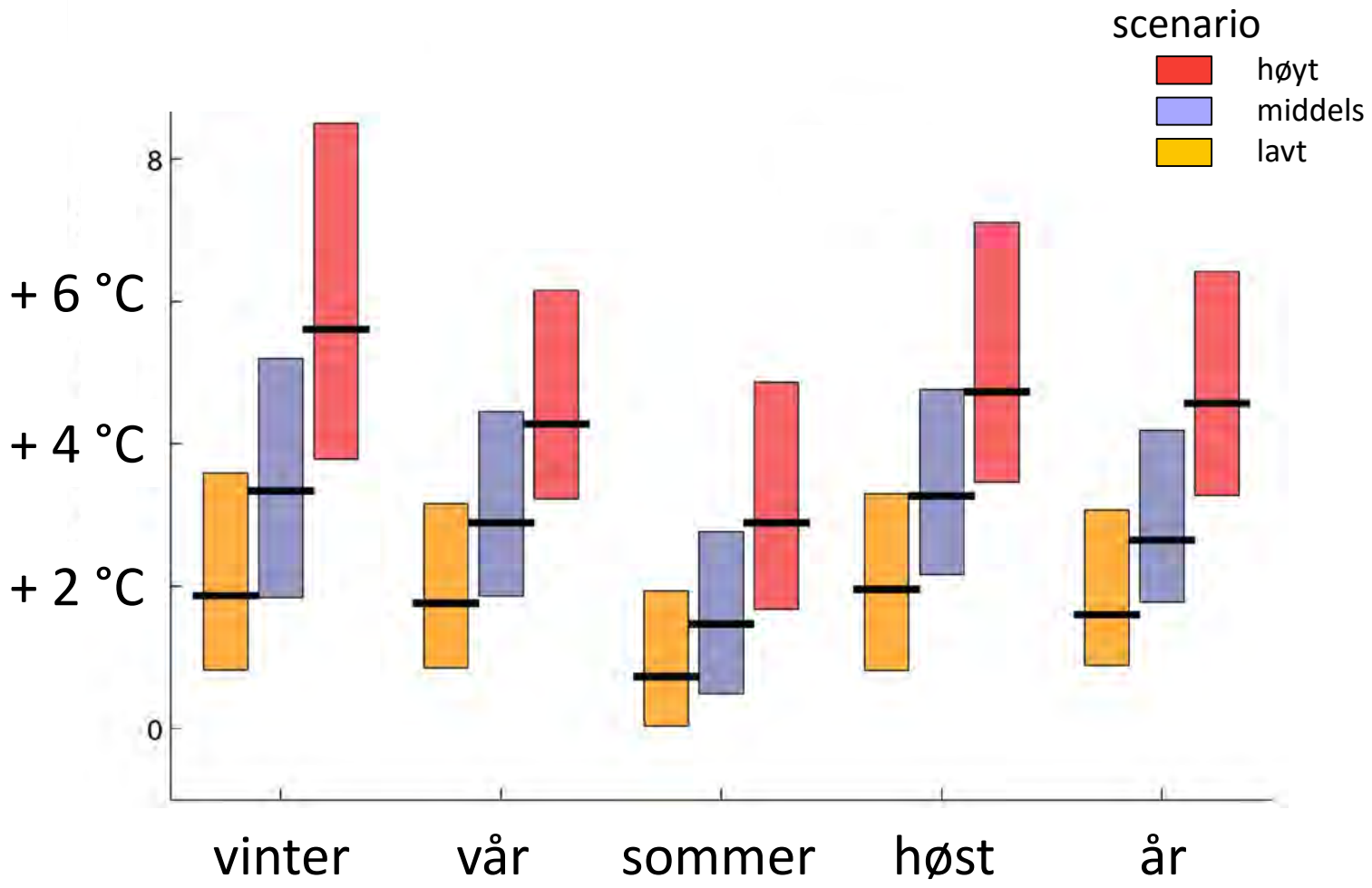
- For meteorological and hydrological variables the given uncertainty interval include 80% of the modelled values

Higher temperatures



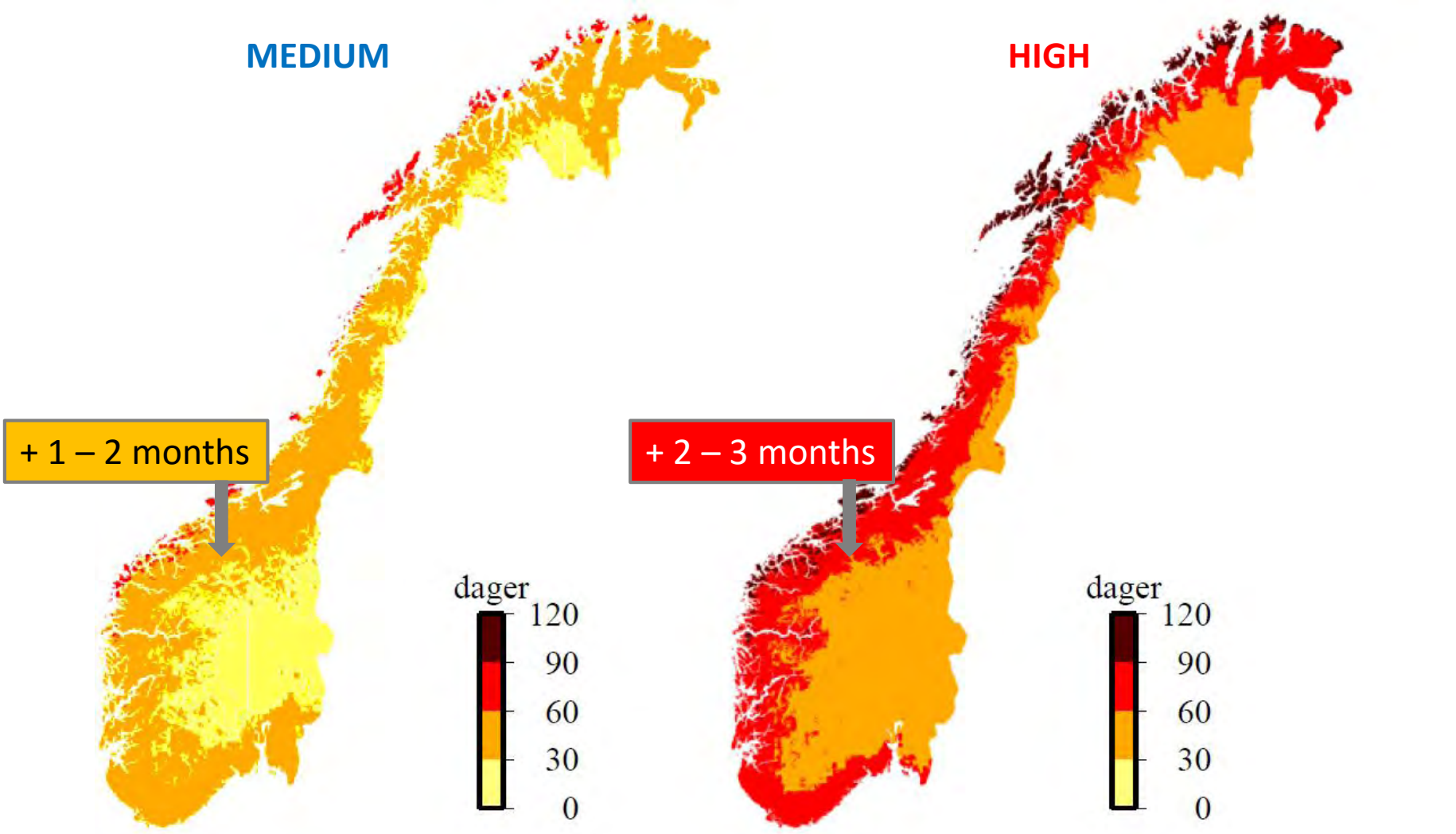
Change in temperature

from 1971-2000 to 2071-2100



Increased growing season

from 1971-2000 to 2071-2100



…improved conditions for agriculture ??

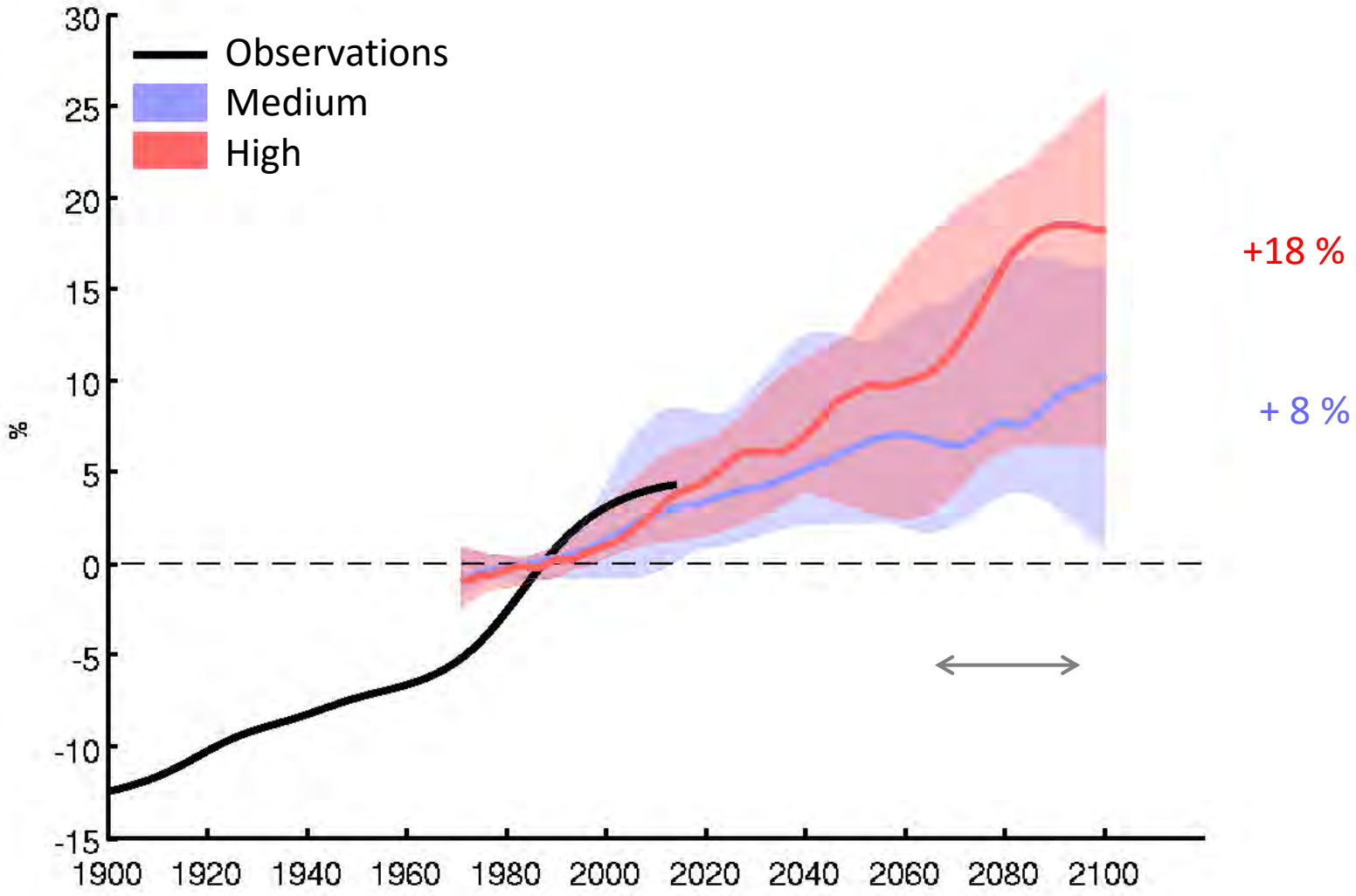
Photo: Einar Egeland

Photo: Arild Andersen/Bioforsk

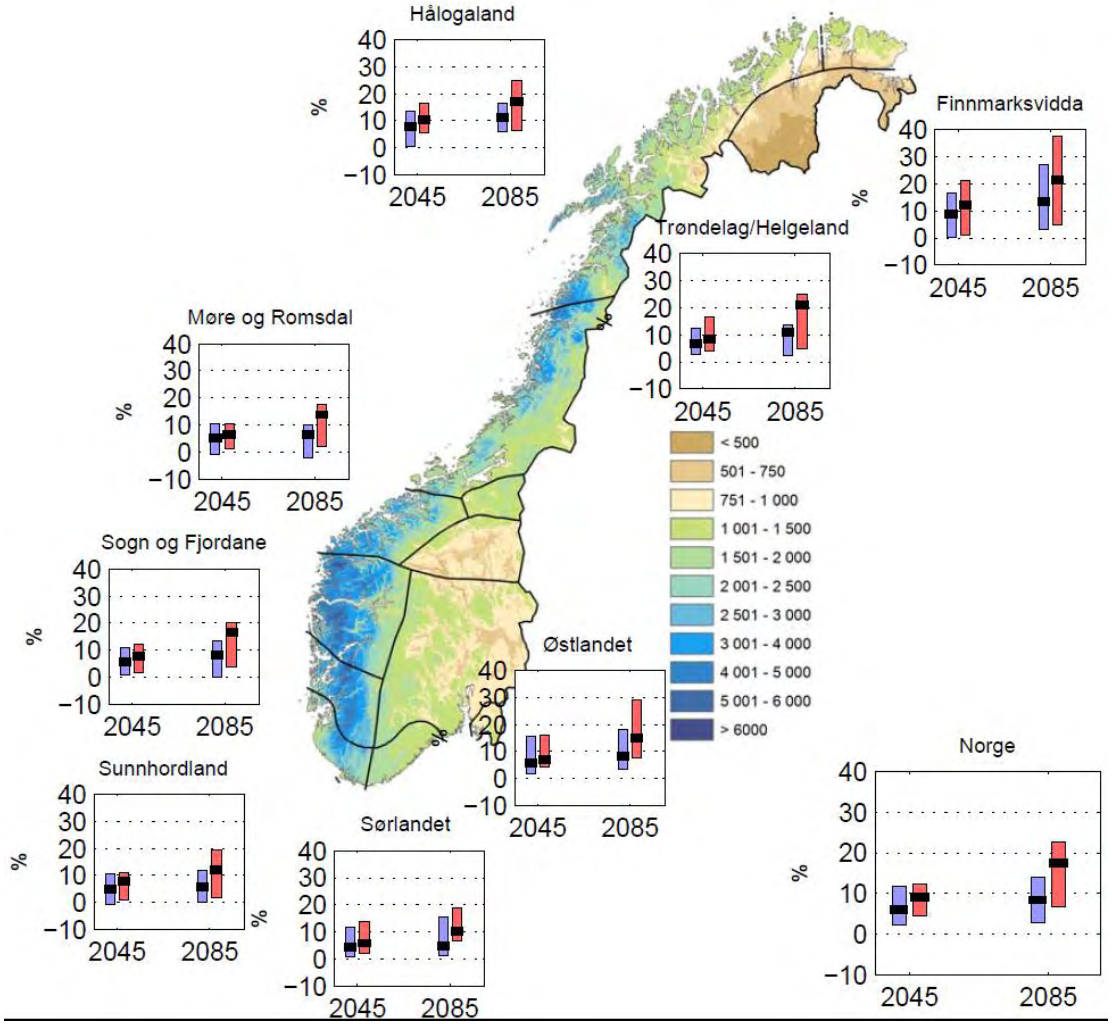
Photo: G. Volker/Wikipedia

Photo: Jafar Razzaghian/Bioforsk

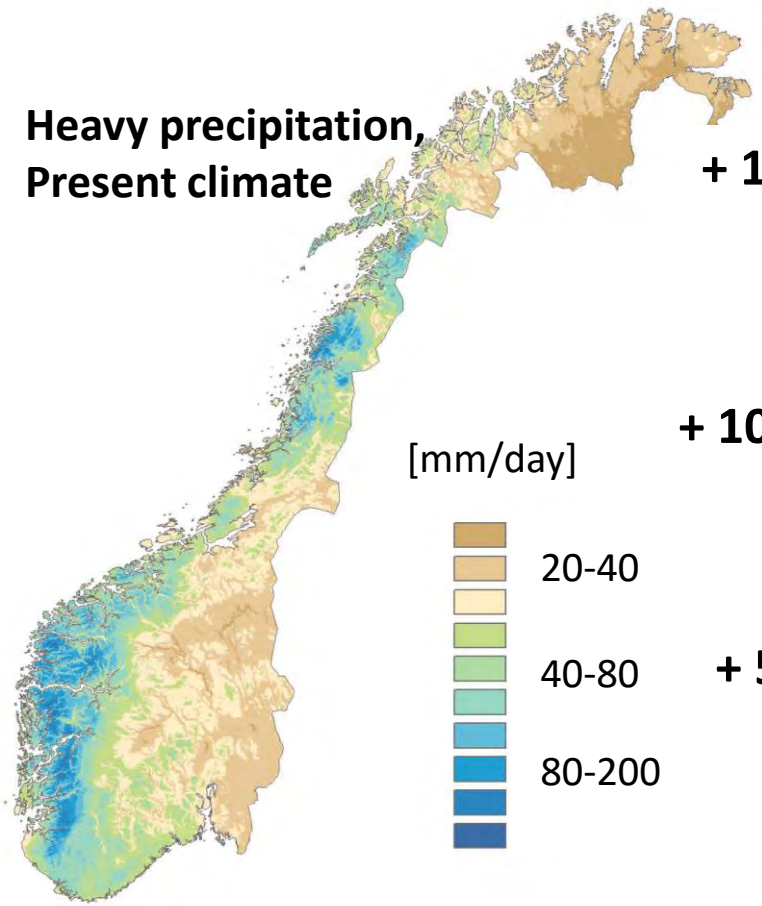
More precipitation

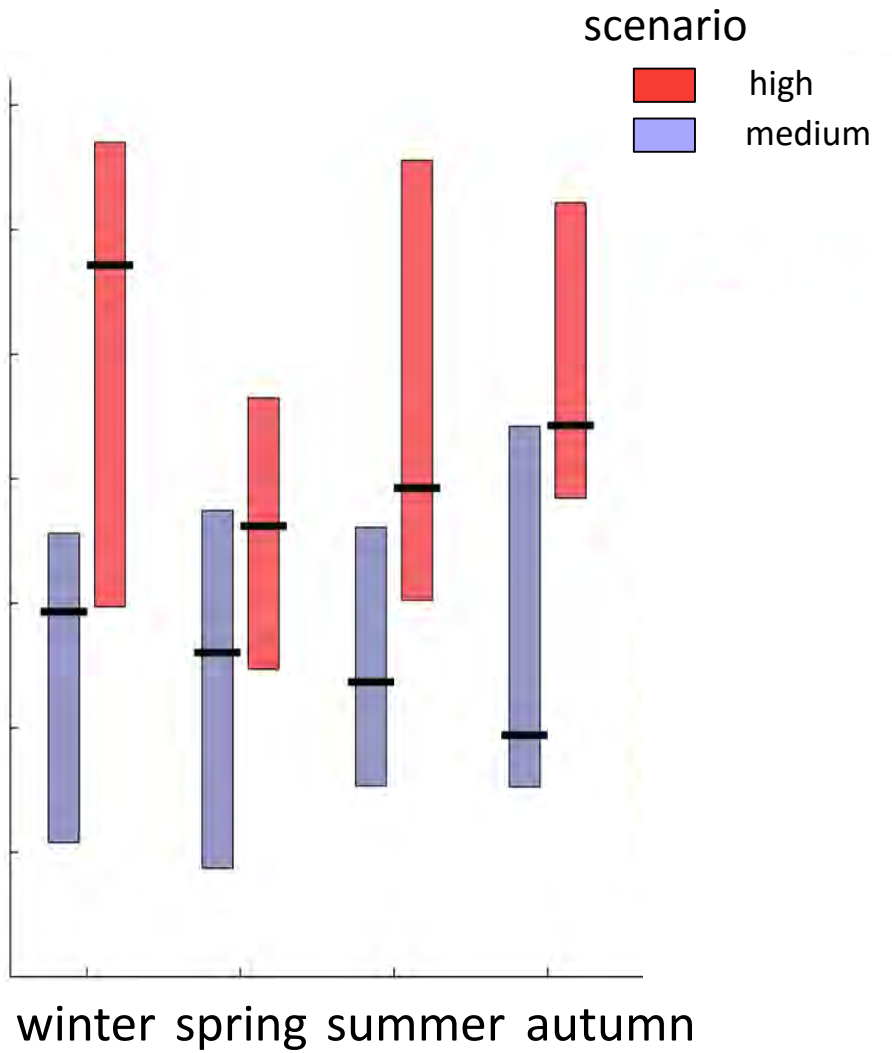


Changes in precipitation by region



Frequency of days with “heavy precipitation”





Modelled 3-hour rainfall

- Heavy rainfall cause the problems…
- We have investigated 3-hour rainfall from Euro CORDEX
- Change during 100 years under high scenario:
  - «2 x a year» (median): + 20%
  - «5-year return value» : + 28%
  - «200-year return value»:+ 38%

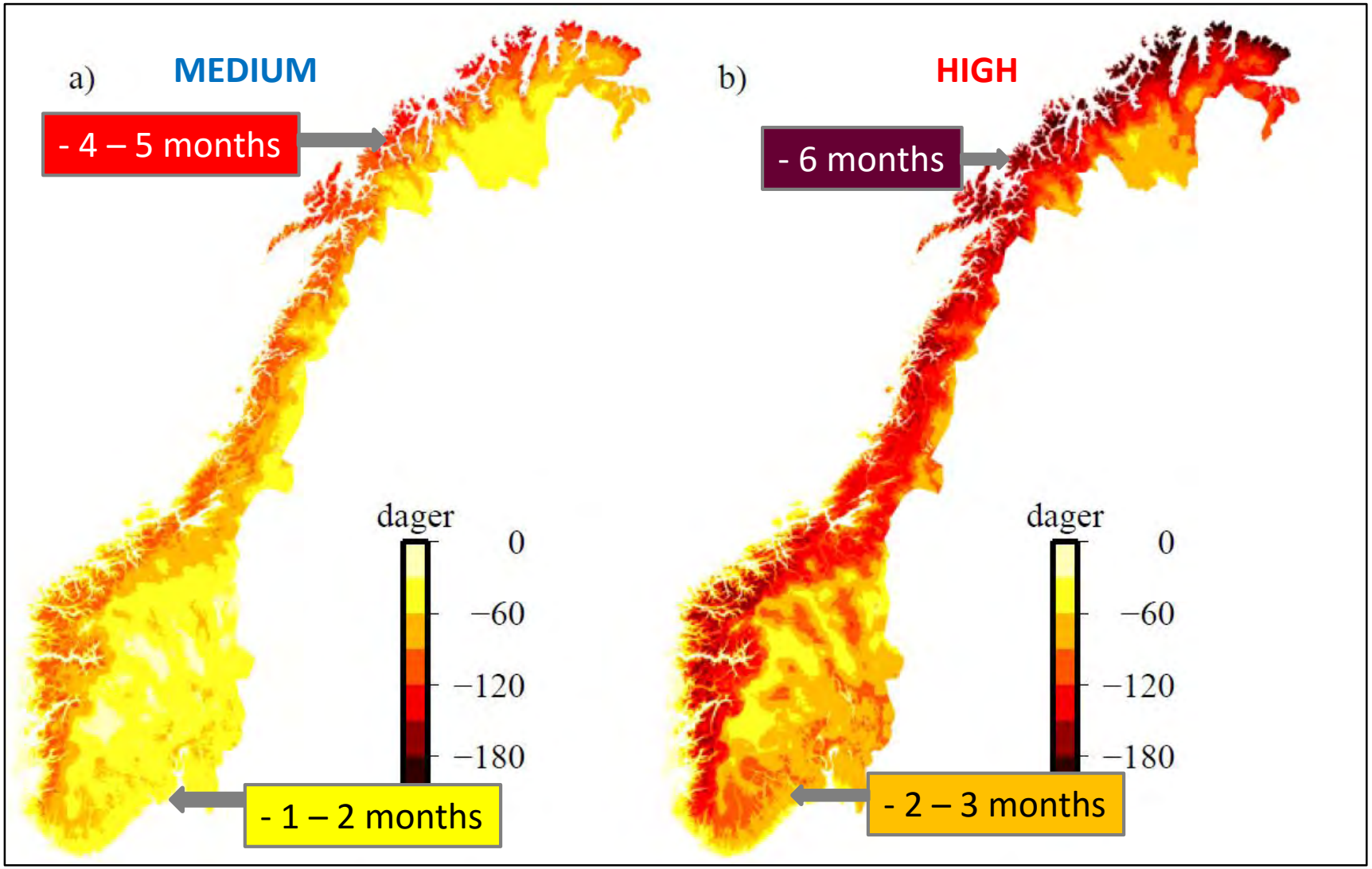
Tinn 2013 Foto: Robert Saunes

Edland 2013 (Foto: ARKIVFOTO)

Rjukan 2015 Foto: Hans-D. Fleger

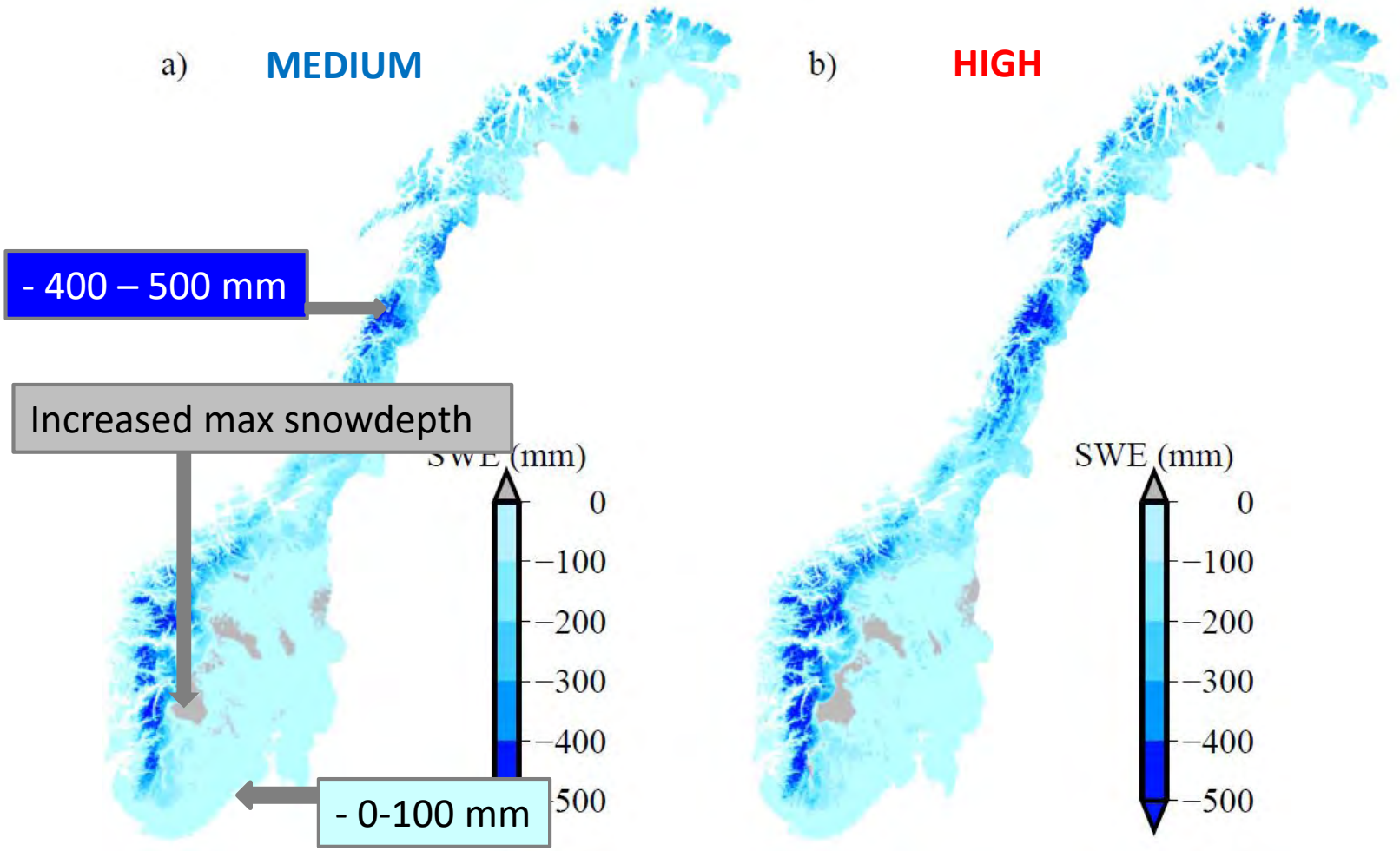
Length of snow season

Changes from 1971-2000 to 2071-2100

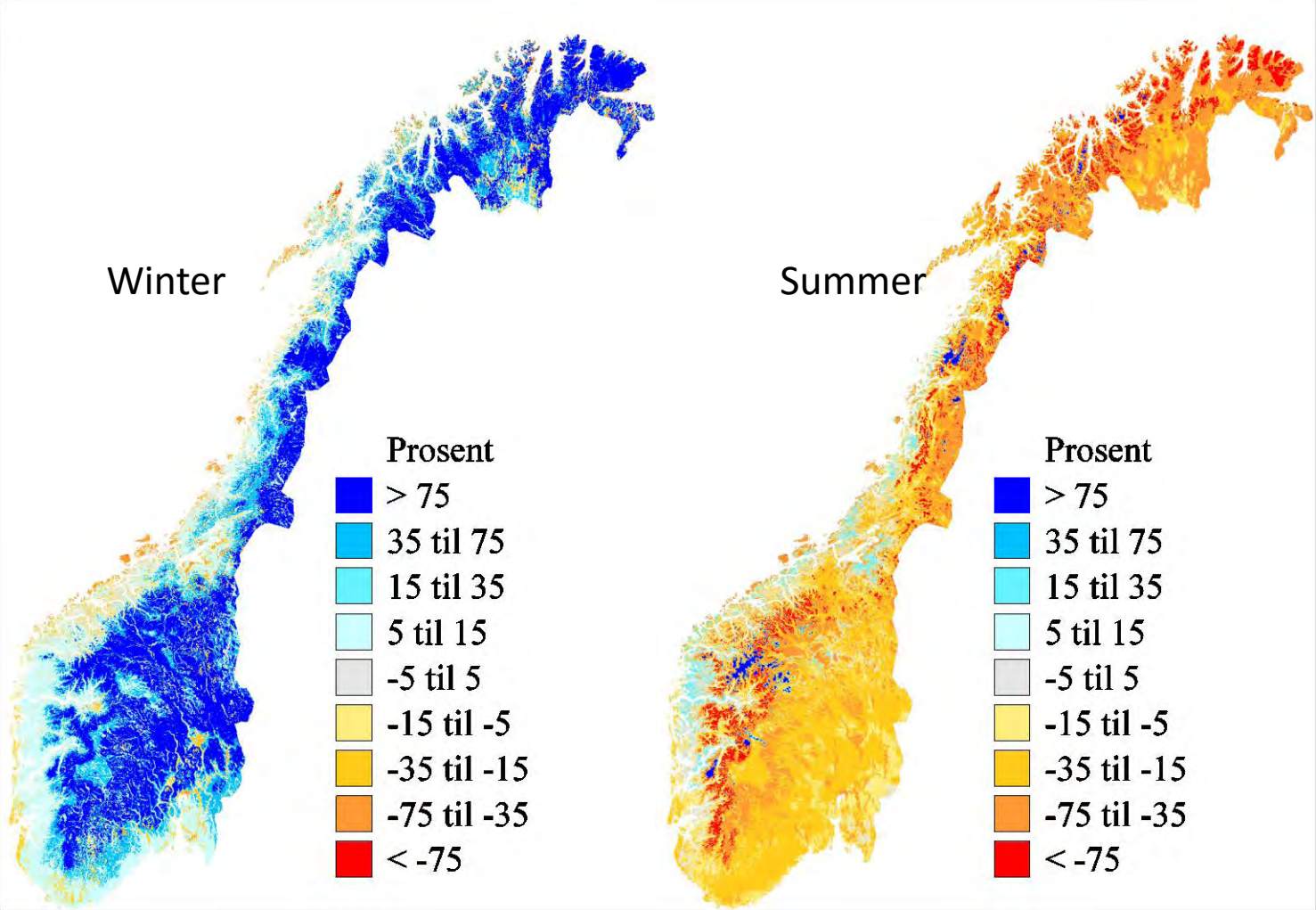


Average winter snow maximum

Changes from 1971-2000 to 2071-2100

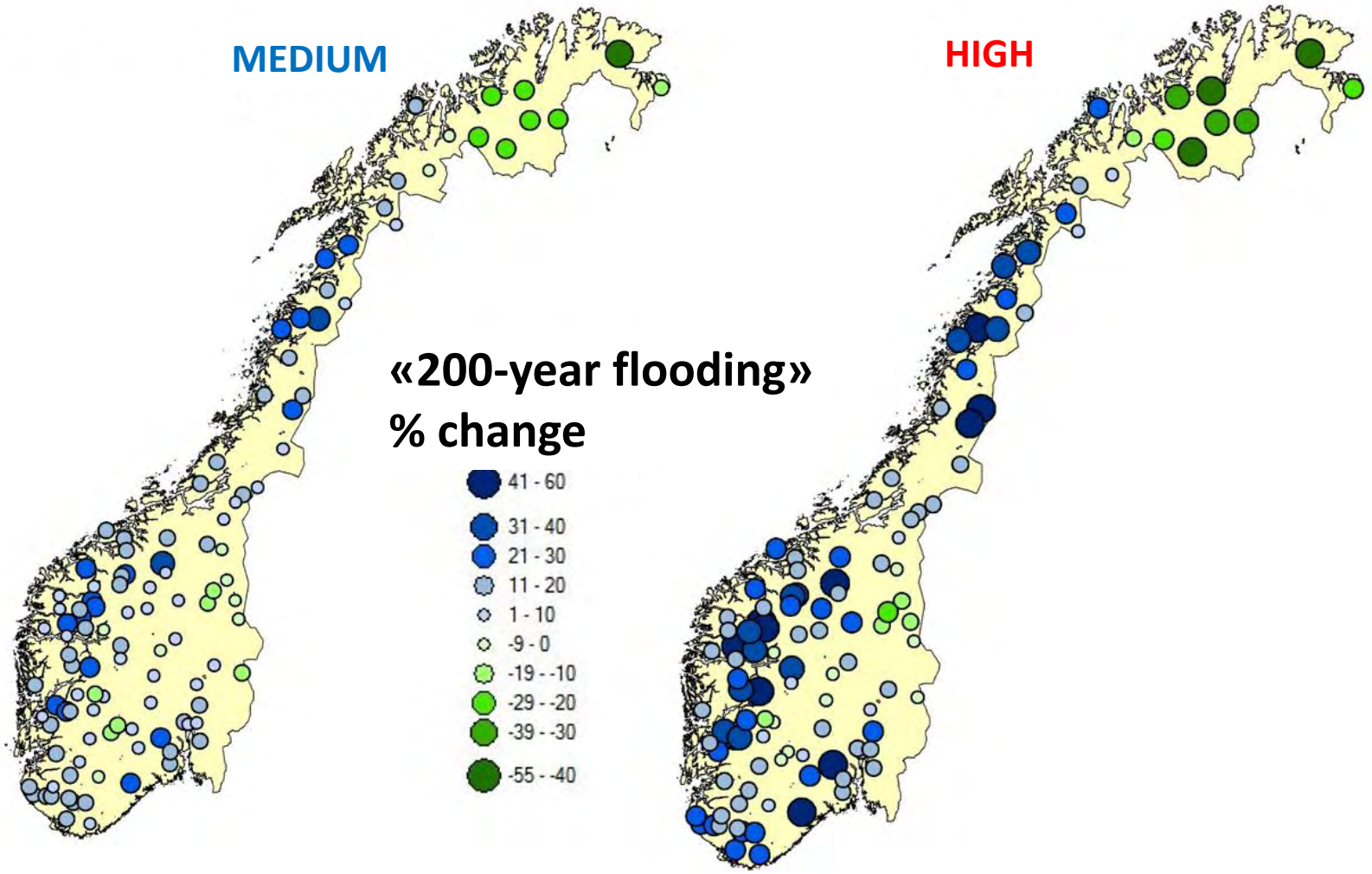


More water in the rivers in winter – less in summer



Floods: larger here and smaller there

Changes from 1971-2000 to 2071-2100



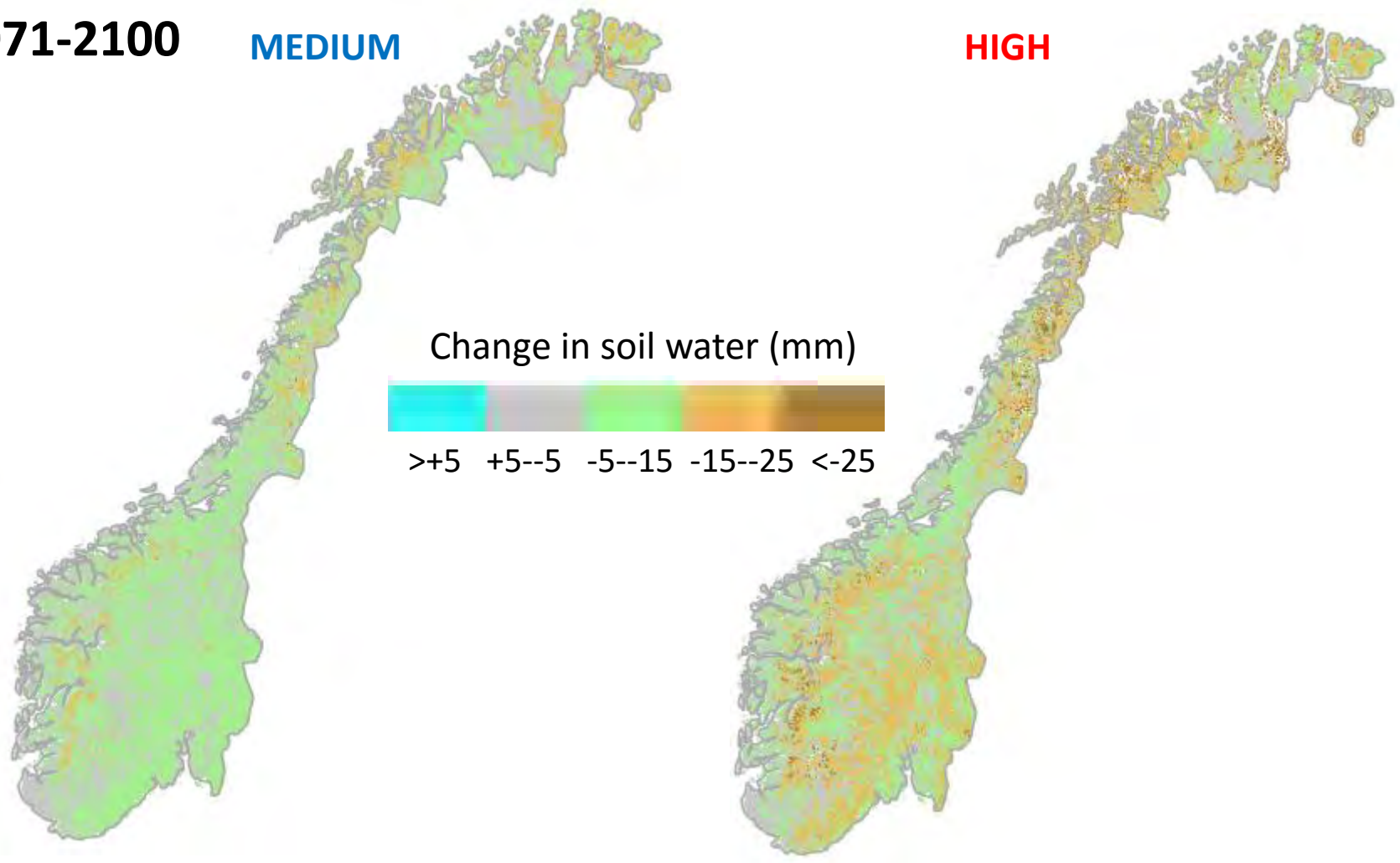
Landslides and avalanches in the future

- Climate and hydrology are important:
- More heavy rainfall in steep terrain ➔ increased risk for landslides connected to flash floods
- Floods in small water sheads ➔ increased erosion ➔ increased risk for quick clay slides
- Higher temperature + increased winter precipitation ➔ reduced risk for dry snow avalanches most places, but increased risk for wet snow/slush avalanches

➔ Be aware!!!

Increased soil water deficit in summer

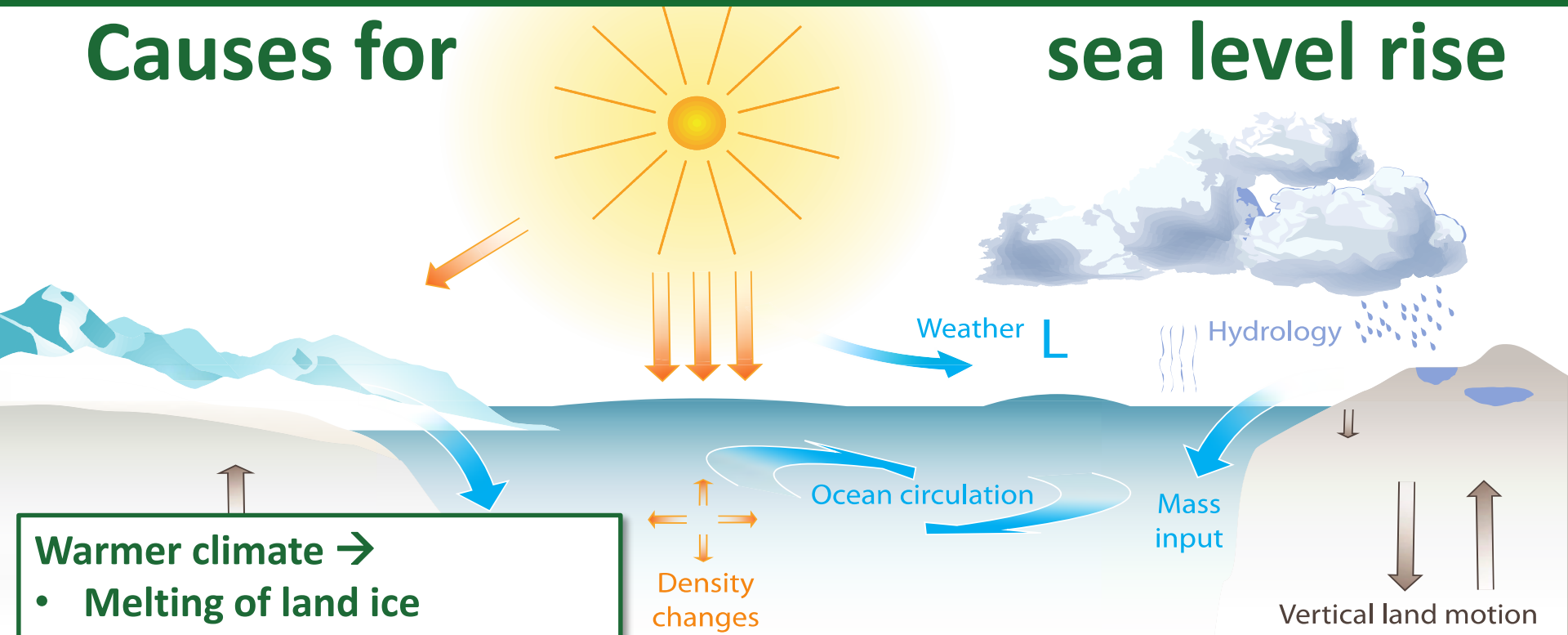
2071-2100



Increased summer soil water deficit

- Caused by
  - Larger increase in evaporation than in rainfall in summer
  - Changed precipitation distribution?
- Leads to
  - Increased risk for summer droughts
  - Increased risk for forest fire

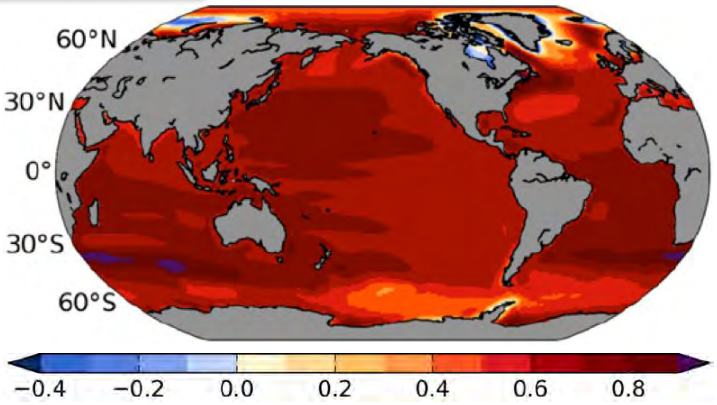
Causes for sea level rise

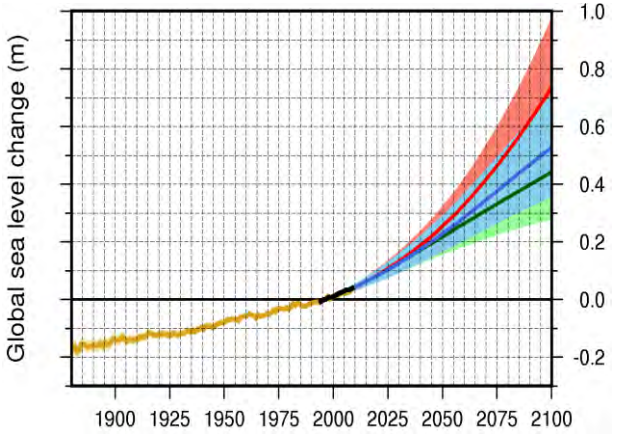


Warmer climate →

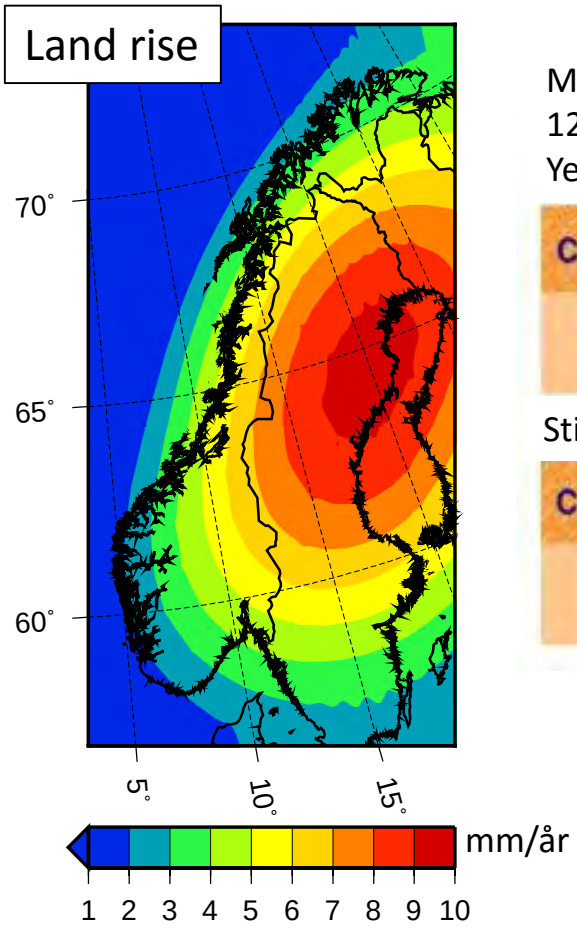
- **Melting of land ice**
- **Heat expansion of the ocean**

High emissions





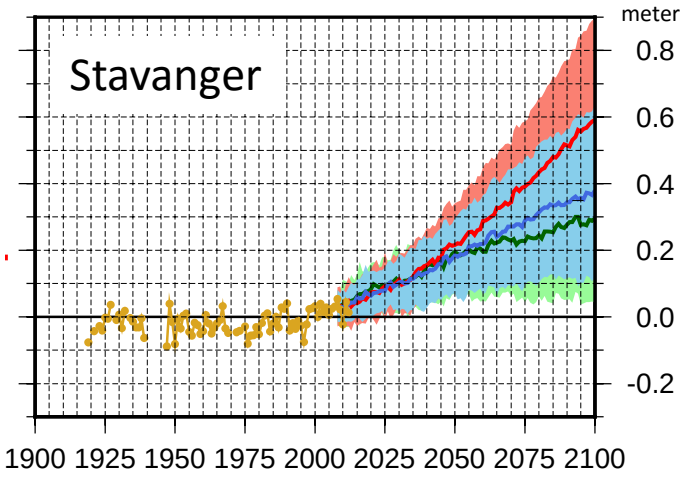
Land rise is important in Norway

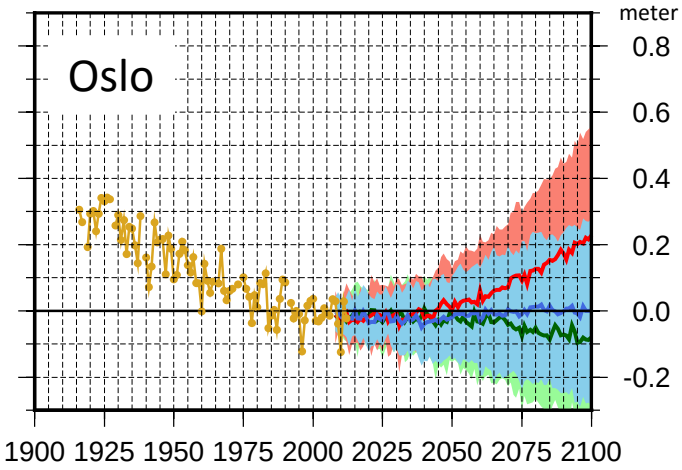


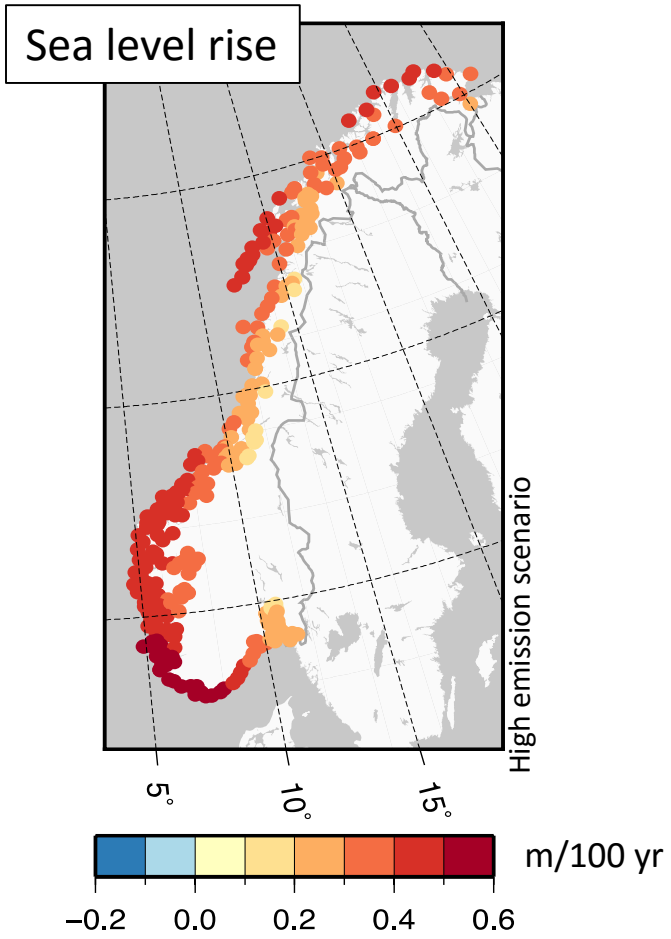
More than
12 000
Years b.p.:

Still:

Time development







Main message 1

Foto: Anette Karlsen/NTB scanpix

Foto: Hans Olav Hygen

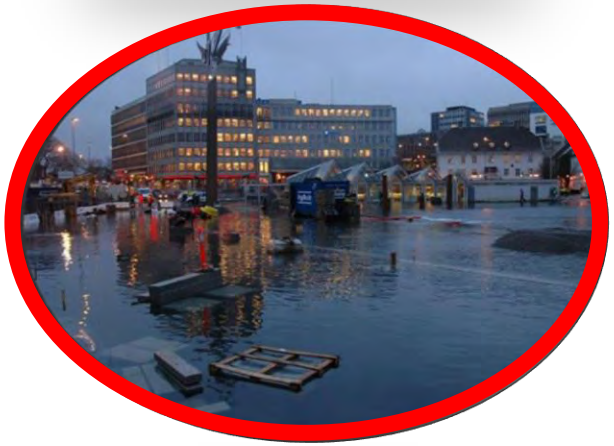
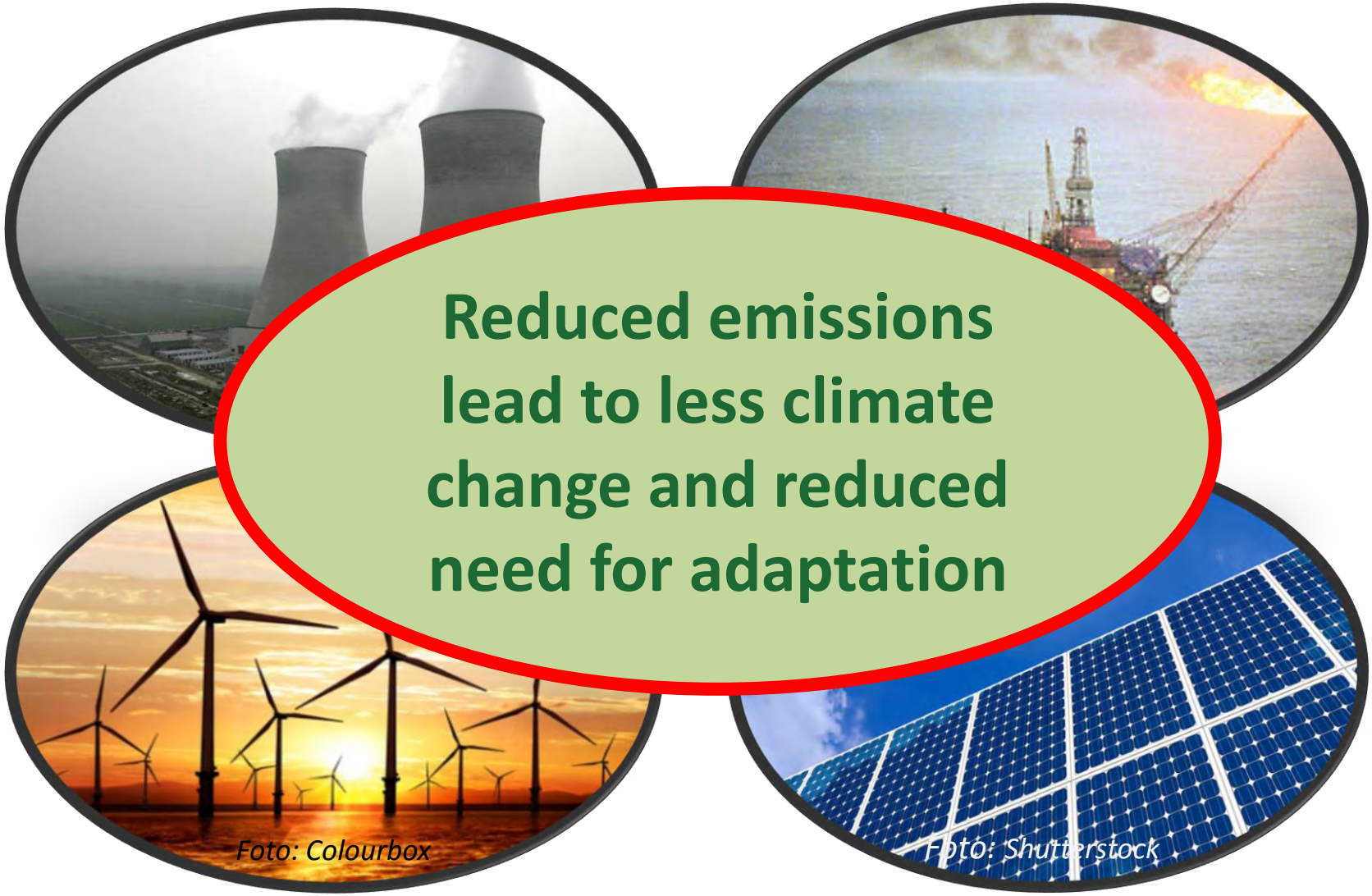


Foto: Ludvig Lorentzen

Helge Mikalsen/NTB scanpix

Foto: Erling Briksdal

Main message 2

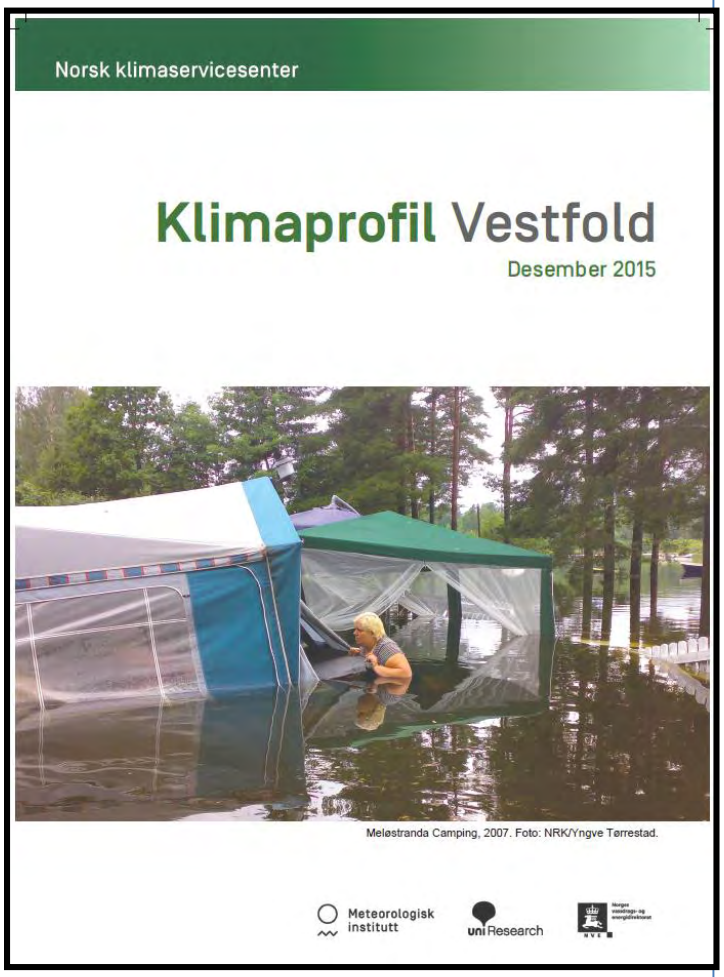


Contact with users

- The climate report was launched in a national “climate adaptation conference”
- Afterwards we have given more than 30 presentations of the report
- Results from the report are also used in *“Climate profiles”* which we develop for every county…

Climate profiles

- The climate profiles are developed in close contact with the counties
- The profile points out the specific challenges for each county
- Three are completed, ten more will be completed this year



Web-site

- All reports, “Climate profiles” and results are presented on our web-site: https://klimaservicesenter.no (regretfully only in Norwegian)
- There is also info on heavy precipitation, design values based on observations, climatology etc.
- A solution for downloading climate projections are being developed
- Historical meteorological data are freely available in Norway

«The climate watch»

- A three-level phone and e-mail service
- Users are also invited to comment on the NCCS web-site
- Important lesson from all contact with users:

There is a knowledge gap

On-going research initiated by NCCS

- «ExPrec Flood» (2015-2017): On heavy precipitation and flash floods
  - Involved users: Transportation sector
- «R-cubed» (2016-2019): An attempt to adjust GCM results for biases and then run the RCM
  - Involved users: Several sectors
- «PostClim» (2016-2019): Post-processing (including bias adjustment) of RCM results
  - Involved users: The agriculture sector and the municipality sector

Some final remarks on climate services

- **Our mission is to provide decision makers with information relevant for climate adaptation**
- This includes being a bridge between science and management
- Between observations and model calculations
- Between our past and future
- Between different scales in time and space
- Between different institutions, directories and ministries
- Challenging – but not impossible!


Thanks for your attention!
Meteorologisk institutt
uni Research
Norges vassdrags- og energidirektorat
NVE