

Illustrating regional exposure to changing climate: towards an interactive tool for mapping vulnerability

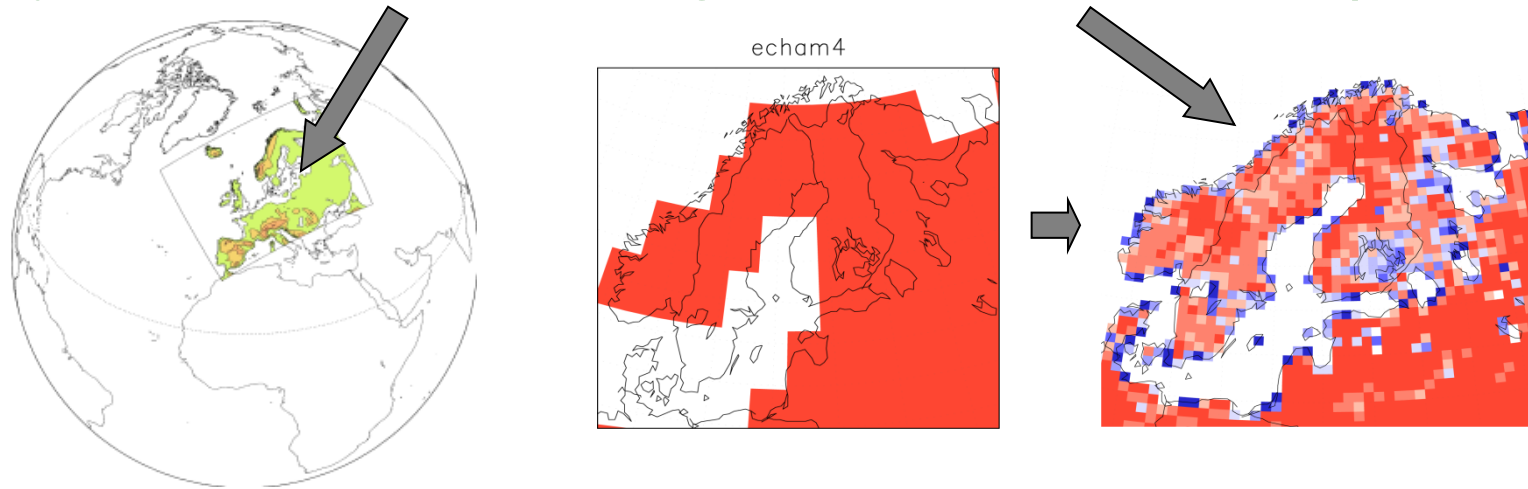


**Nordic Climate Change Adaptation Workshop
Norrköping, 3-5 September 2009**

Stefan Fronzek and Timothy R. Carter, Finnish Environment Institute
with contributions with CARAVAN partners



Daily climate data from Regional climate models (RCMs)



- Rossby Centre RCM RCA
- A1B emission scenario
- nested in ECHAM5-r3 General Circulation Model (GCM)
- 1951-2100, 25 km resolution
- variables to be used:
 - precipitation
 - min, mean and max temperature
 - surface snow amount

Indicators of exposure of the agricultural sector to climate change

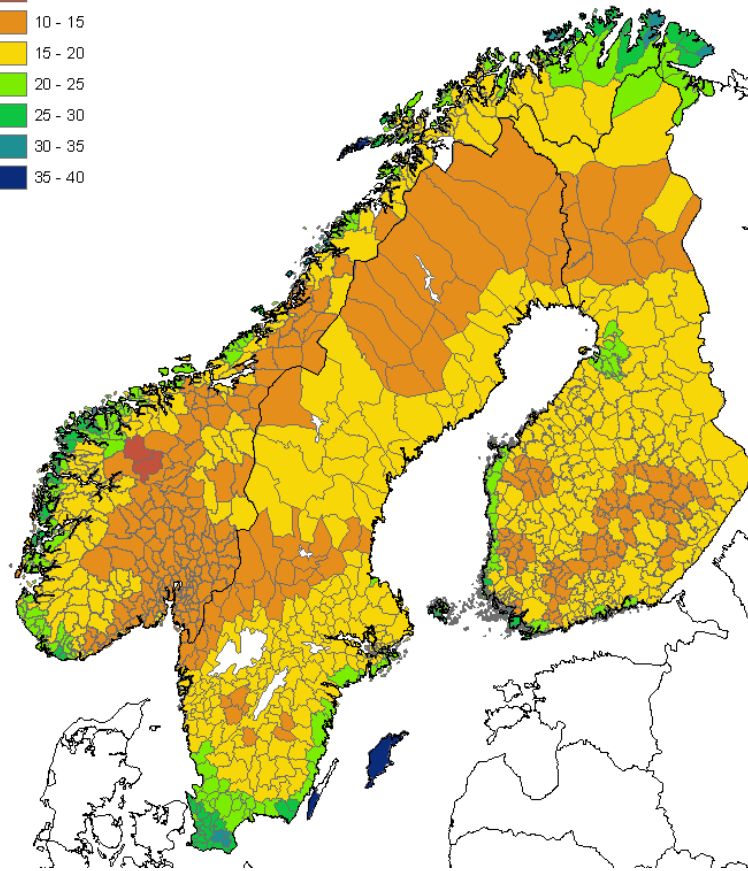
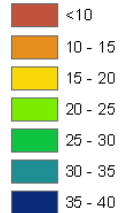
Changes between 2021-2050 and 1971-2000 of:

- Spring/autumn precipitation (PR_MAM, PR_SON)
- Length of the growing season (GSL)
Number of days between the first occurrence of at least 6 consecutive days with mean temperature (TG) $> 5^{\circ}\text{C}$ and the first occurrence after 1 July of at least 6 consecutive days with TG $< 5^{\circ}\text{C}$.
- Frequency of freezing point days (FPD)
Days with a daily minimum air temperature $< 0^{\circ}\text{C}$ and daily maximum temperature $> 0^{\circ}\text{C}$, i.e. days during which the air temperature crosses the 0°C threshold.
- Surface snow amount (SNW)

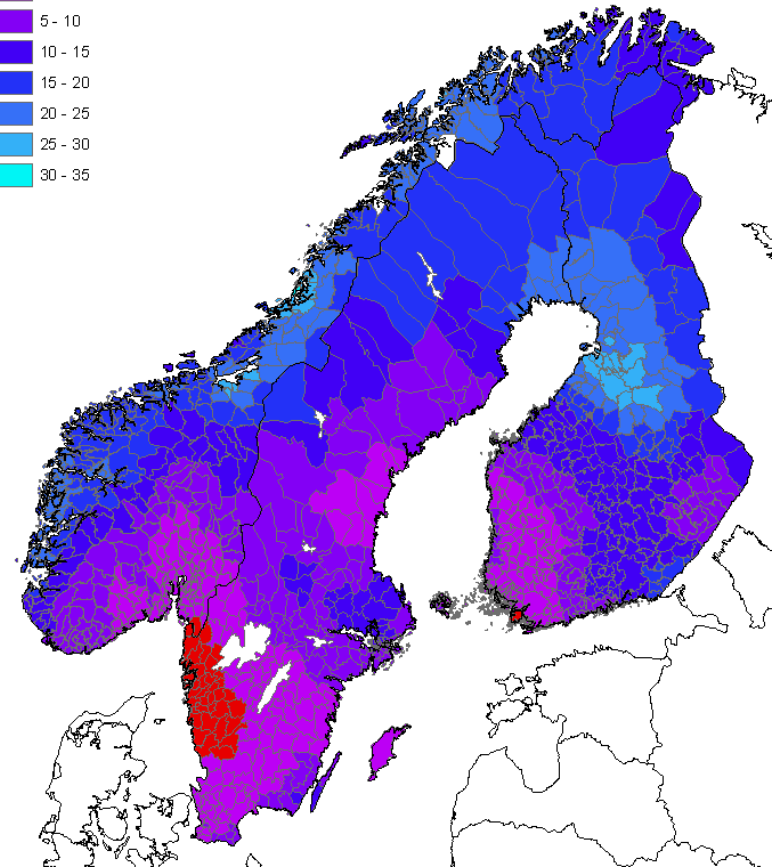
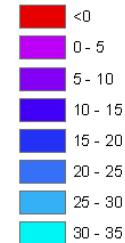


Lengthening of the growing season and spring precipitation changes, 2021-2050 wrt 1971-2000 (SMHIRCA-EH5-A1B)

Lengthening of the growing season (days)



Precipitation change in spring (%)



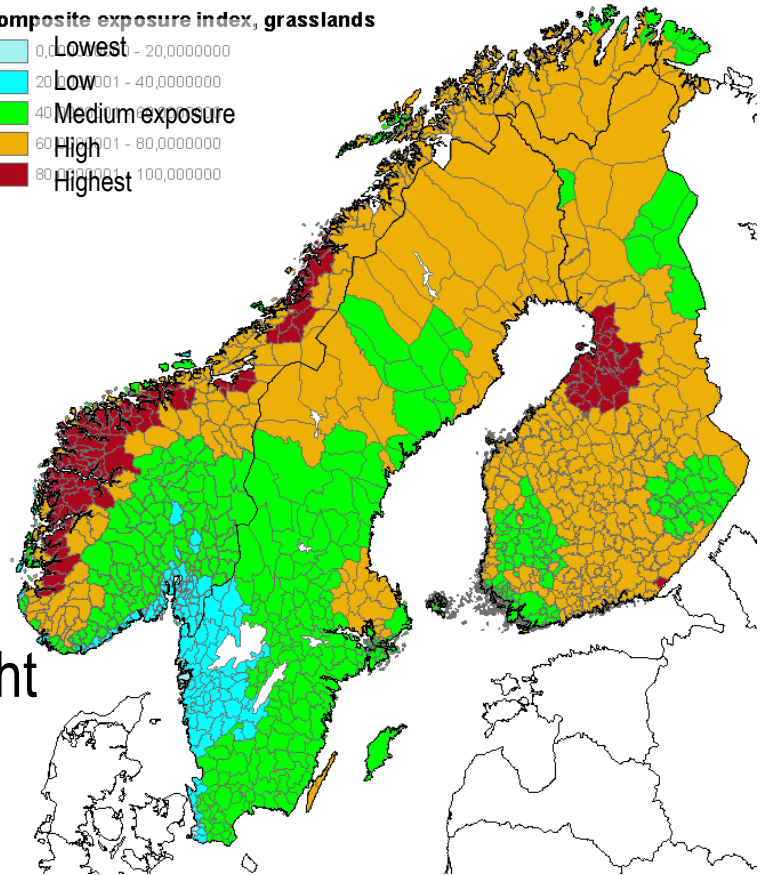
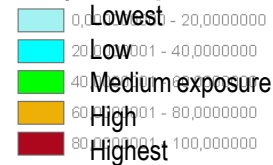
10.9.2009



Composite index of exposure for grassland

- PRMAM(+), GSL(+), FPC(-), SNW(-)
- Procedure to calculate composite indices:
 - Normalize individual indices
 - Combine by averaging over the normalized values, possibility to weight
 - Normalize the composite index, [assign (arbitrary) classes from low to high exposure]

Composite exposure index, grasslands



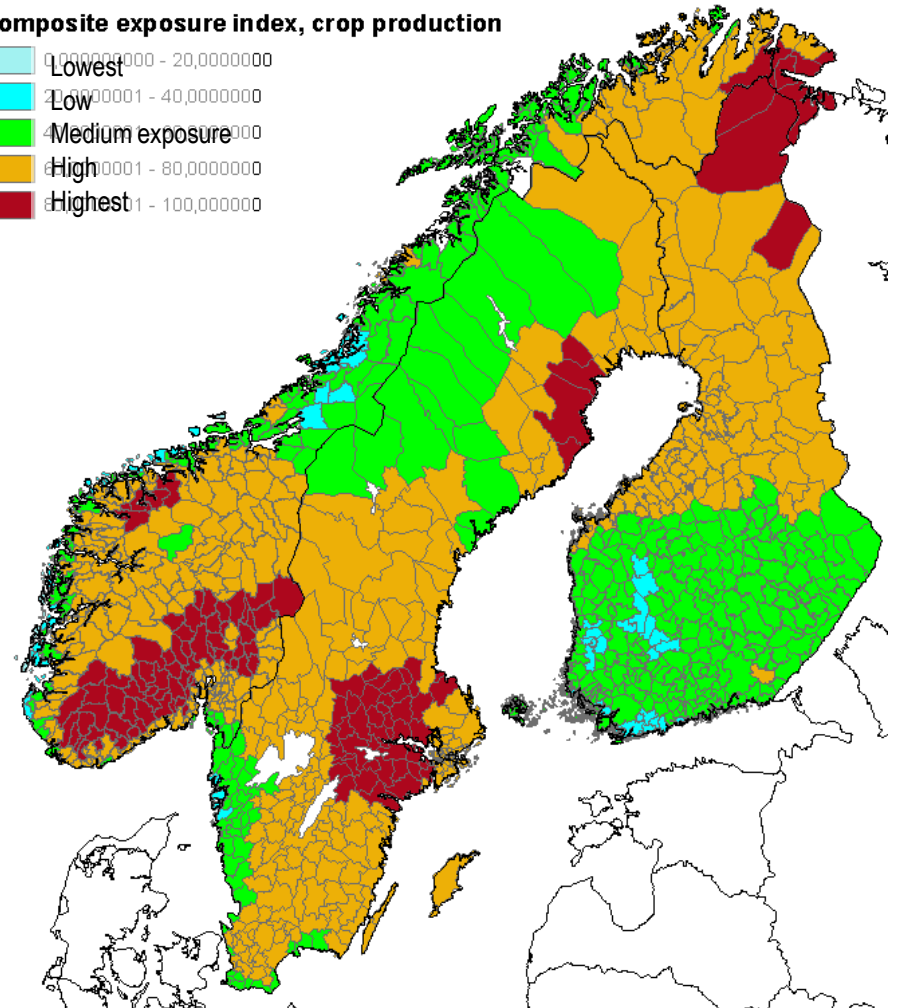
10.9.2009



Composite index of exposure for crop production

- PRSON(-), GSL(+), FPC(-)

Composite exposure index, crop production



10.9.2009

Proposed indicators of exposure to climate change for the elderly

Changes between 2021-2050 and 1971-2000 of:

Heat-
related

- **Heat wave duration index** wrt mean of reference period (HWDI)
Number of days where, in intervals of at least 6 consecutive days, $TX > TX_{norm} + 5^{\circ}C$.
- **Warm spell days index** wrt 90th percentile of reference period (HWFI)
Number of days where, in intervals of at least 6 consecutive days, $TG > TG_{norm}$.
- **Summer days** index (SU): Days with $TM > 25^{\circ}C$
- **Warm nights** percent wrt 90th percentile of T_{min} in reference period (TN90P)
- **Tropical nights** index (TR): Days with $TN > 20^{\circ}C$

Frost-
/snow
related

- **Ice days** (ID): Days with $TM < 0^{\circ}C$
- **Cold days** percent wrt 10th percentile of reference period (TG10P)
- **Surface snow** amount (SNW)

Prec.

- **Very heavy precipitation** days (R20MM): Days where $RR > 20$ mm

Scenario and time period

Select scenario

SMHI-RCA, ECHAM5, SRES A1B
SMHI-RCA, HadCM3Q3, SRES A1B
other RCM simulations, SRES A2
other RCM simulations, SRES B1
...

Select time period

period
present day
2011-2030
2021-2050
...

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Web-based vulnerability mapping tool

Scenario and time period

Select scenario
 SMHI-RCA, ECHAM5, SRES A1B
 SMHI-RCA, HadCM3Q3, SRES A1B
 other RCM simulations, SRES A2
 other RCM simulations, SRES B1
 ...

Select time period
 present day
 2011-2030
 2021-2050

Exposure and sensitivity

Select indices of exposure and sensitivity

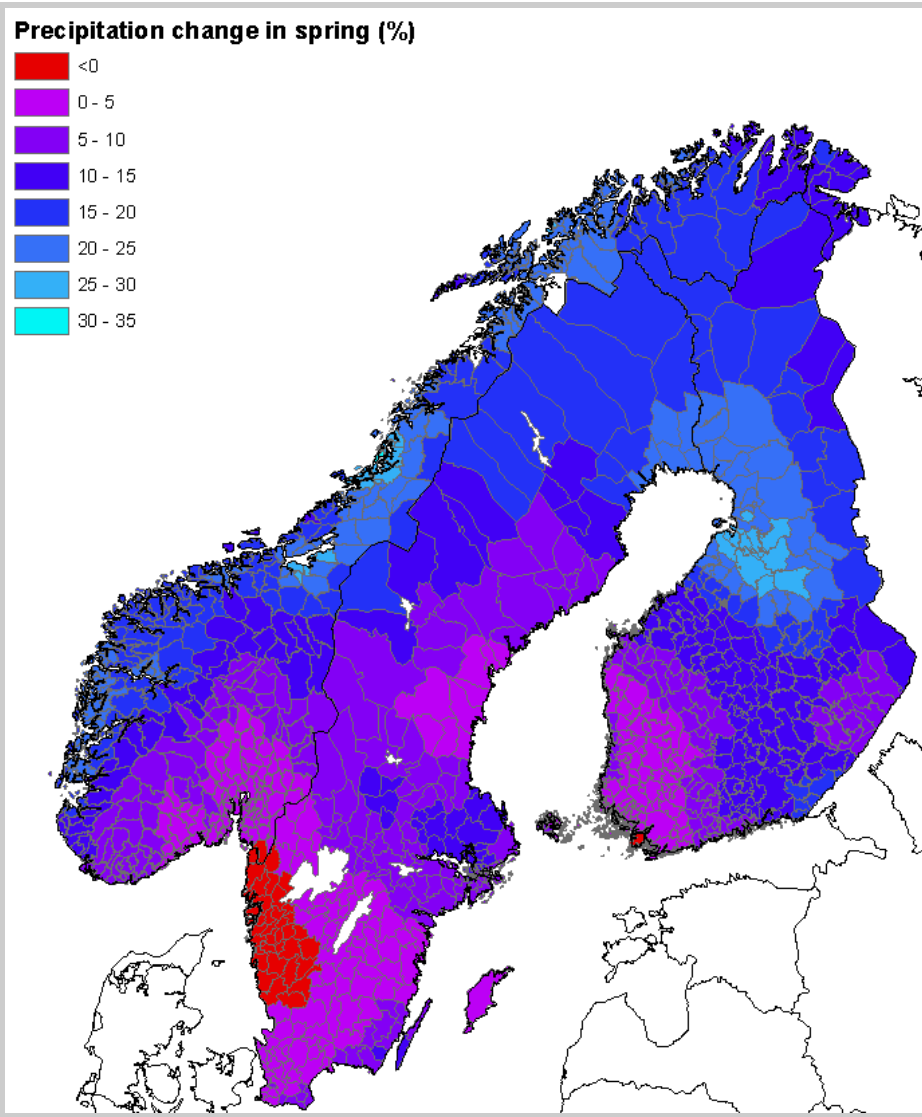
Spring temperature weight:

Autumn temperature weight:

Spring precipitation weight:

Autumn precipitation weight:

Update composite map of exposure and sensitivity ->



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Scenario and time period

Select scenario
 SMHI-RCA, ECHAM5, SRES A1B
 SMHI-RCA, HadCM3Q3, SRES A1B
 other RCM simulations, SRES A2
 other RCM simulations, SRES B1
 ...

Select time period
 present day
 2011-2030
 2021-2050
 ...

Exposure and sensitivity

Select indices of exposure and sensitivity

Length of the growing season weight: 1

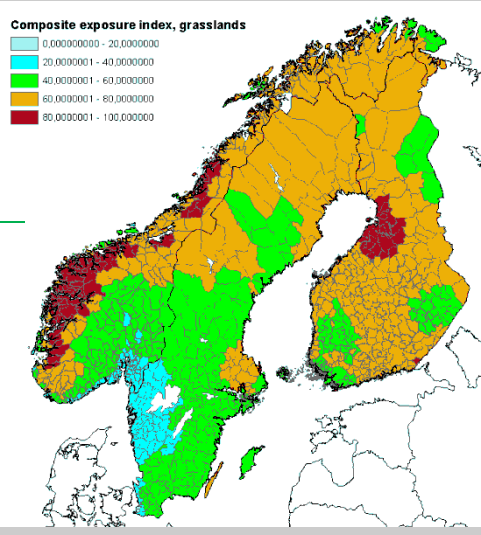
Frequency of freezing point days weight: -1

Spring precipitation weight: 1

Autumn precipitation weight: 0

Surface snow amount weight: 1

Update composite map of exposure and sensitivity ->



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Web-based vulnerability mapping tool

Scenario and time period

Select scenario
 SMHI-RCA, ECHAM5, SRES A1B
 SMHI-RCA, HadCM3Q3, SRES A1B
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 ...

Select time period
 present day
 2011-2030
 2021-2050

Exposure and sensitivity

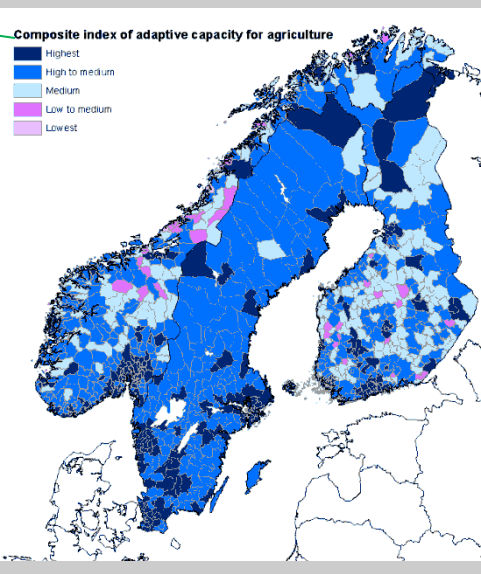
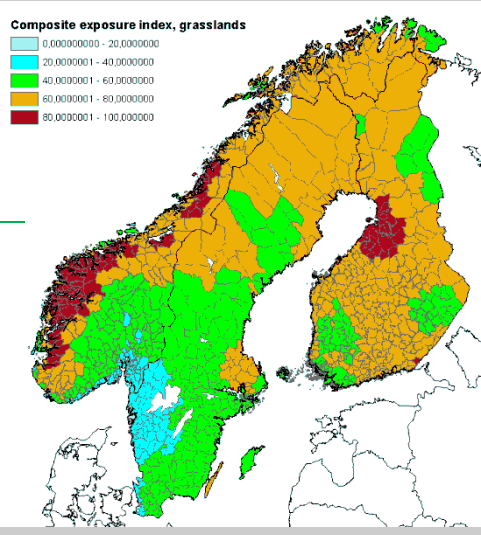
Select indices of exposure and sensitivity

Length of the growing season weight: 1
 Frequency of freezing point days weight: -1
 Spring precipitation weight: 1
 Autumn precipitation weight: 0
 Surface snow amount weight: 1

Update composite map of exposure and sensitivity ->

Adaptive capacity

Employment in primary sector (3x)
 Proportion of aging work force (1x)
 In-migration (1x)
 Dependency rate (1x)



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Scenario and time period

Select scenario
 ECHAM5, SRES A1B
 HadCM3, SRES A2
 HadCM3, SRES B1

Select time period
 present day
 2011-2030
 2021-2050

Exposure and sensitivity

Select indices of exposure and sensitivity

Spring temperature weight:

Autumn temperature weight:

Spring precipitation weight:

Autumn precipitation weight:

Update composite map of exposure and sensitivity ->

Adaptive capacity

Select indices of adaptive capacity

Primary sector employment rate weight:

Percentage elderly working population weight:

Children and elderly as percent of working population weight:

Net in-migration weight:

Income weight:

Employment growth in major sectors weight:

Update composite map of adaptive capacity ->

Vulnerability maps still to be constructed based on exposure, sensitivity and adaptive capacity

Outlook

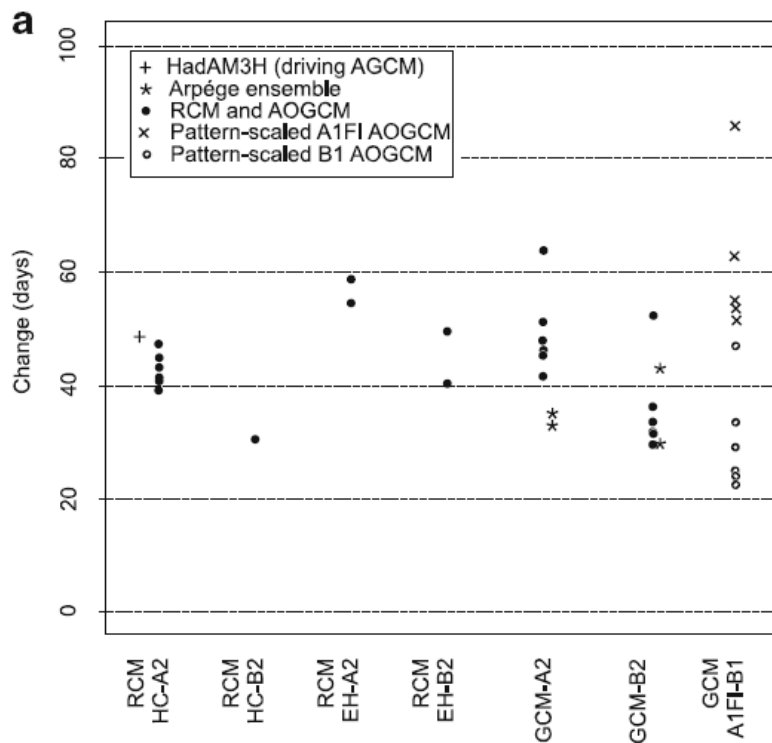
- Considering exposure to climate change vs. changed climate
- Incorporating indicators of sensitivity – e.g. results from hydrological or crop simulation models
- Present uncertainties (e.g. ensemble of climate of projections)





Change in growing season length

Fig. 4 Regionally-averaged changes in **a** the length, and **b** the start (*bottom*) and end (*top*) of the thermal growing season in northern Europe (see footnote 3) for different groups of climate scenarios from RCM, AGCM and AOGCM simulations for the period 2071–2100 compared with the baseline (1961–1990). All scenarios are applied as delta changes to the CRU baseline temperatures



Fronzek & Carter, 2007

Thermal suitability for grain maize

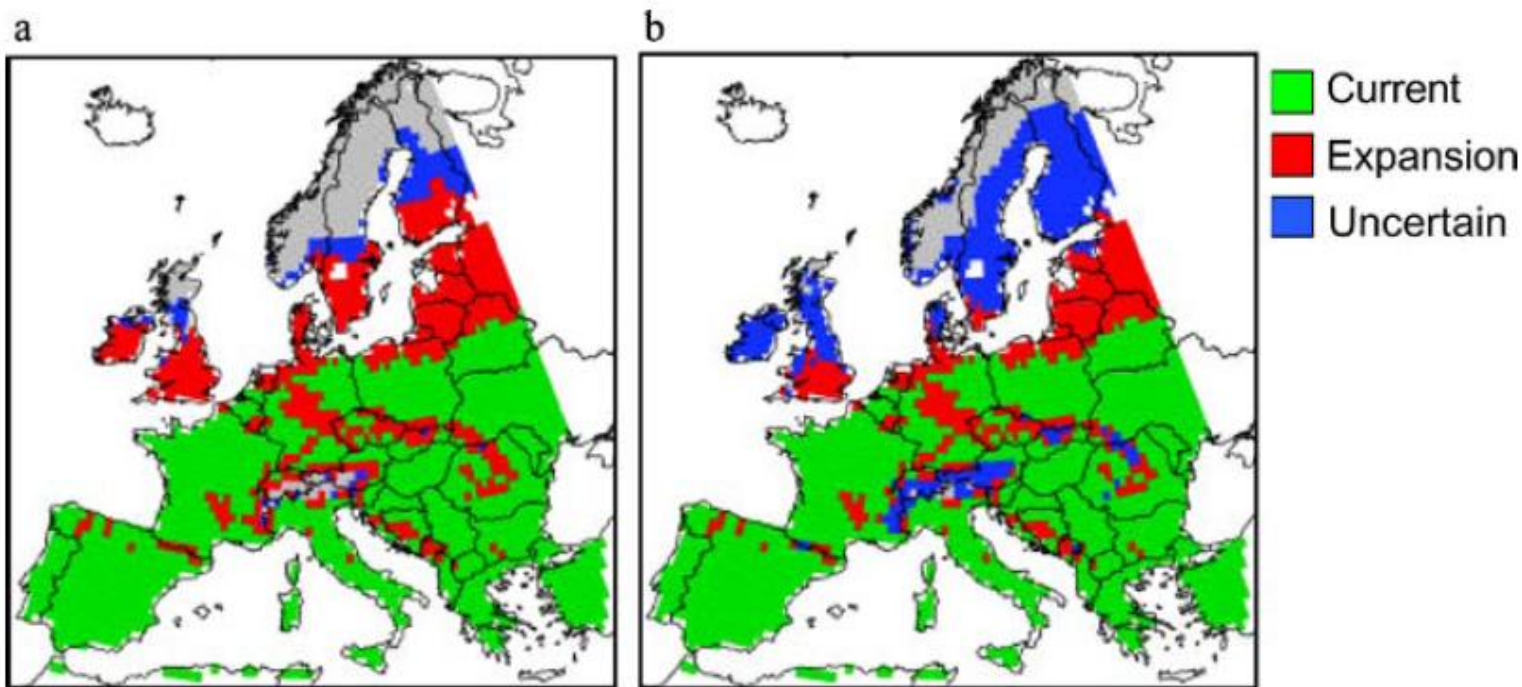


Fig. 4 Modelled suitability for grain maize cultivation during the baseline (1961–1990) and future (2071–2100) periods for: **a** 7 RCM scenarios driven by HadAM3H for the A2 emissions scenario and **b** 24 scenarios from 6 GCMs for each of the A1FI, A2, B1 and B2 emissions scenarios. *Green areas* show the suitable area for the baseline, *red* depicts the expansion common under all scenarios and *blue* the uncertainty range of the respective scenario group. *Grey areas* are unsuitable under all scenarios

