IMPACT2C: Quantifying Projected Climate Impacts Under +2 ºC Warming

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Climate Service Center Germany (GERICS)

- **Founded in 2009** by the German Federal Ministry of Education and Research
- Since June 2014 **scientific organizational entity** of Helmholtz-Zentrum Geesthacht
- Financed by **programme-oriented funding** of Helmholtz Association
- Director is **Prof. Dr. Daniela Jacob**
- Based in Hamburg's **Chilehaus**
- **Interdisciplinary team** of natural scientists and socio-economists (approx. 40 staff members)

Chilehaus Hamburg

www.climate-service-center.de
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IMPACT2C – aim and approach

Research questions

1. What are the potential climate impacts in Europe in a 2 degree (compared to pre-industrial) warmer world?
2. What are the differential impacts between 1.5, 2, and 3 degree C worlds?
3. Are there any hotspot areas in Europe which may be particularly negatively or positively affected by multiple climate impacts?

Sectors

Water, ecosystems, agriculture, health, air quality, energy, tourism, coasts (SLR), cross-sectoral impacts.

Quantifying uncertainty

Multiple climate models, and multiple impact models.

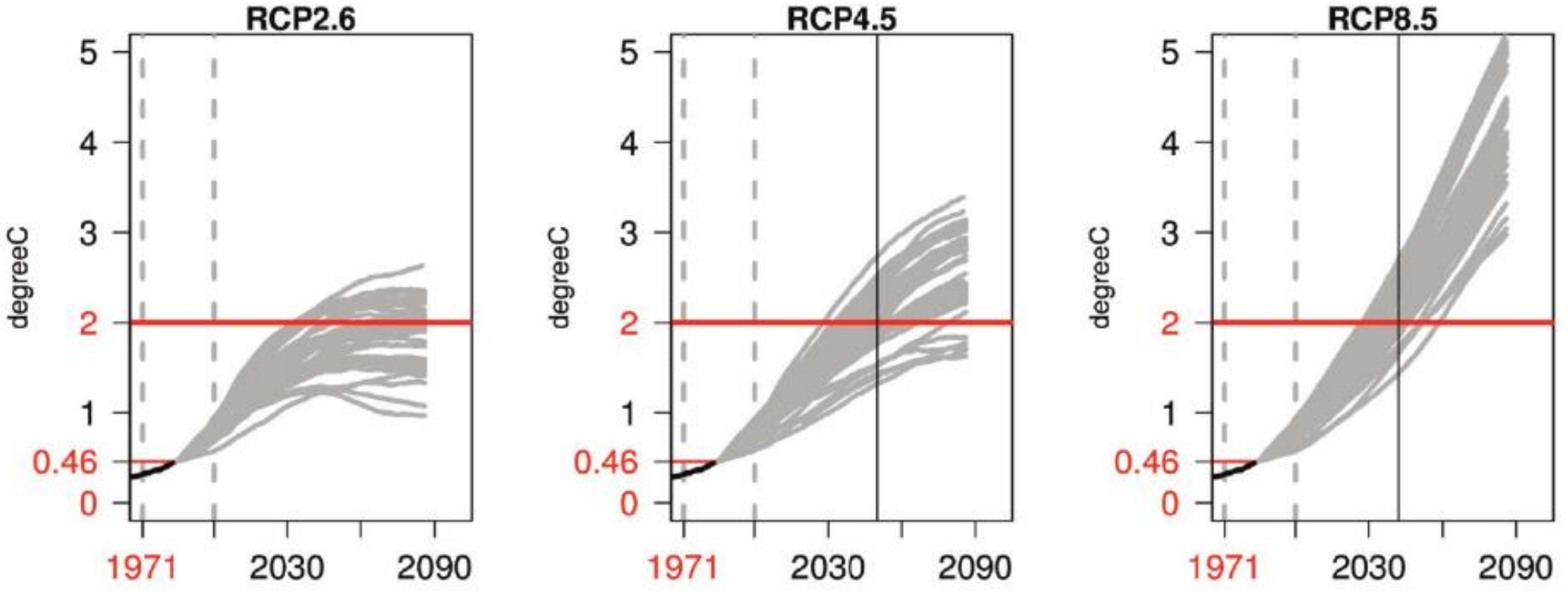
What do we mean by +2 ºC?

- ‘Pre-industrial’ period 1881-1910 (GISS LOT1, HadCRUT3, NOAA NCDC
- Base period 1971-2000
- Temperature threshold periods (1.5, 2, 3 ºC), determined by year in which GCM 30 year running mean crosses the temperature threshold starting from base period warming

When might we reach +2°C?

Evolution of global temperature. Observed historical (black line) and future projections from different GCMs (CMIP5) . Time series are smoothed using a 30-year running mean. The 2°C threshold is marked in red.

Pre-industrial time: 1881-1910; baseline period: 1971-2000



RCP4.5 ~2050
RCP8.5 ~2040

Source: Vautard et al. 2014

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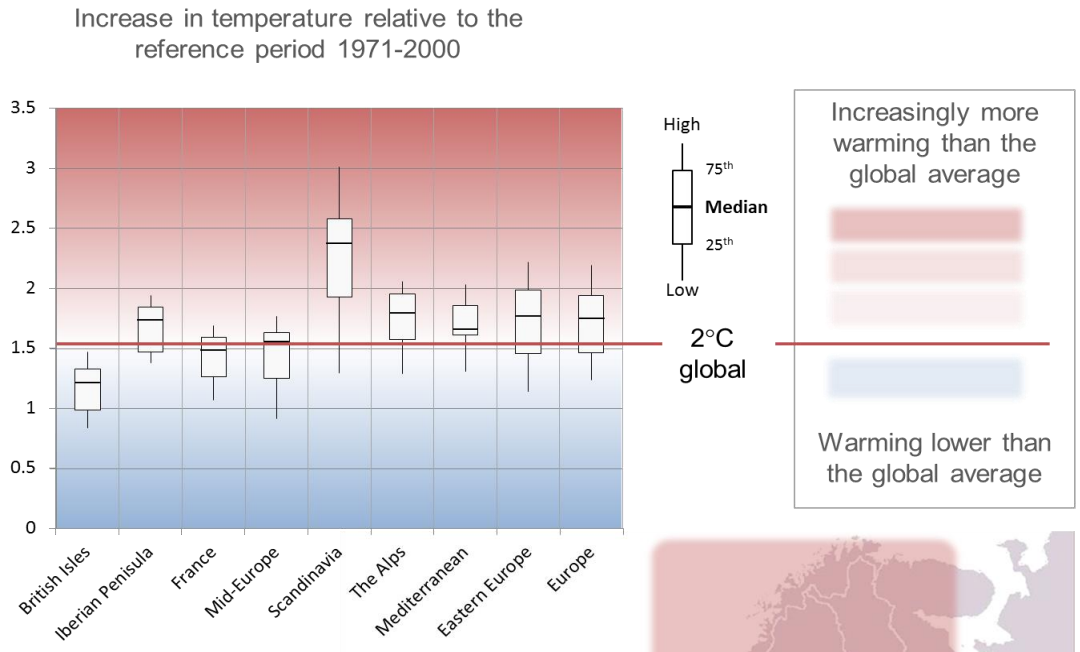
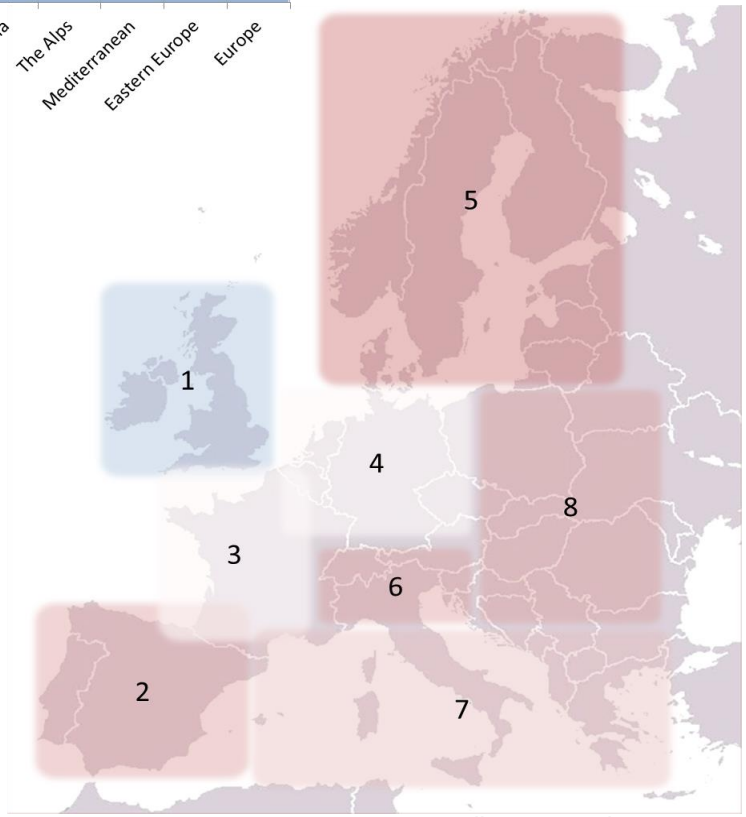
What does +2 ºC global warming mean for Europe?



1 – British Isles
2 – Iberian Peninsula
3 – France
4 – Mid Europe
5 – Scandinavia
6 – the Alps
7 – Mediterranean
8 – Eastern Europe



- Most regions in Europe warm more than global average; exceptions are British Isles, France, Germany and surrounding area;
- Most pronounced warming in the north and east in winter and in the south in summer;
- More precipitation in the north and more severe heavy precipitation extremes in most of Europe.

Results for 12 EURO-CORDEX simulations (EUR-44)
For the RCP4.5 scenario.
Source: Cathrine Fox Maule and Ole Bøssing Christensen, 2014.

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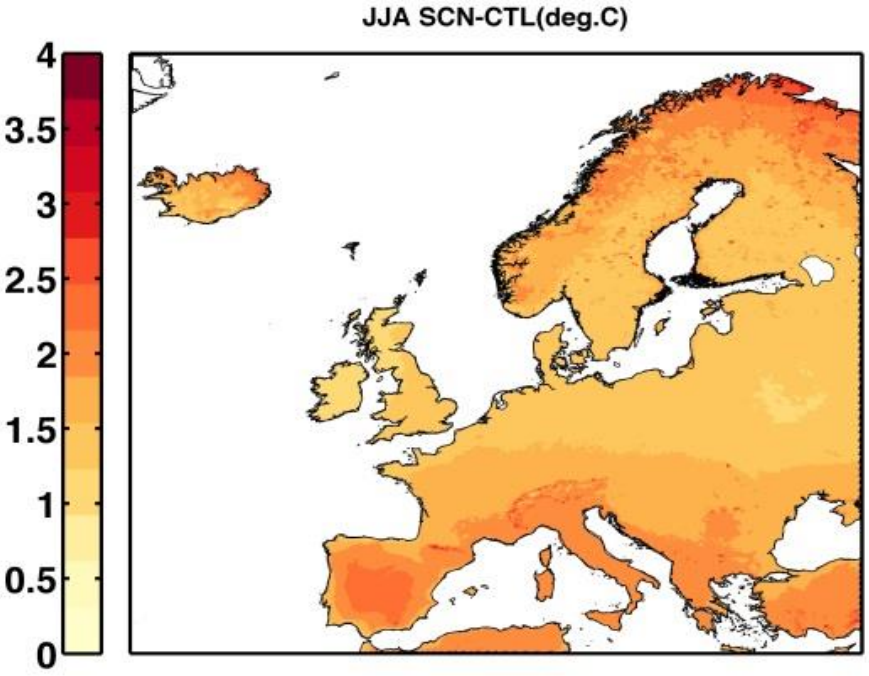
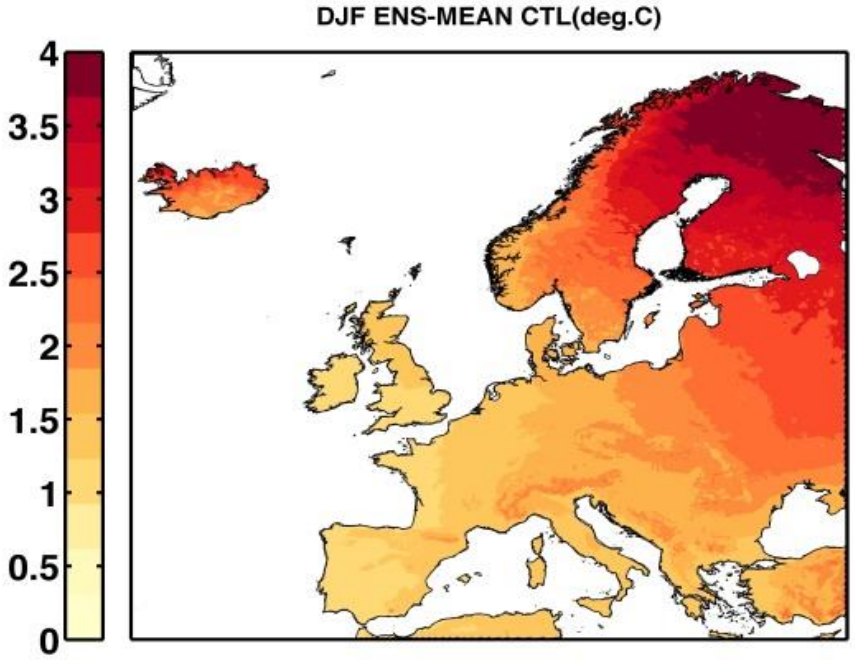
Seasonal mean temperature changes in Europe in a +2 ºC world

- Enhanced summer heat in Mediterranean regions (+3 ºC)
- Enhanced winter warming in Northern and Eastern Europe (+4 ºC)
- Robust agreement among climate models





***Source*: Sobolowski et al. In prep.**

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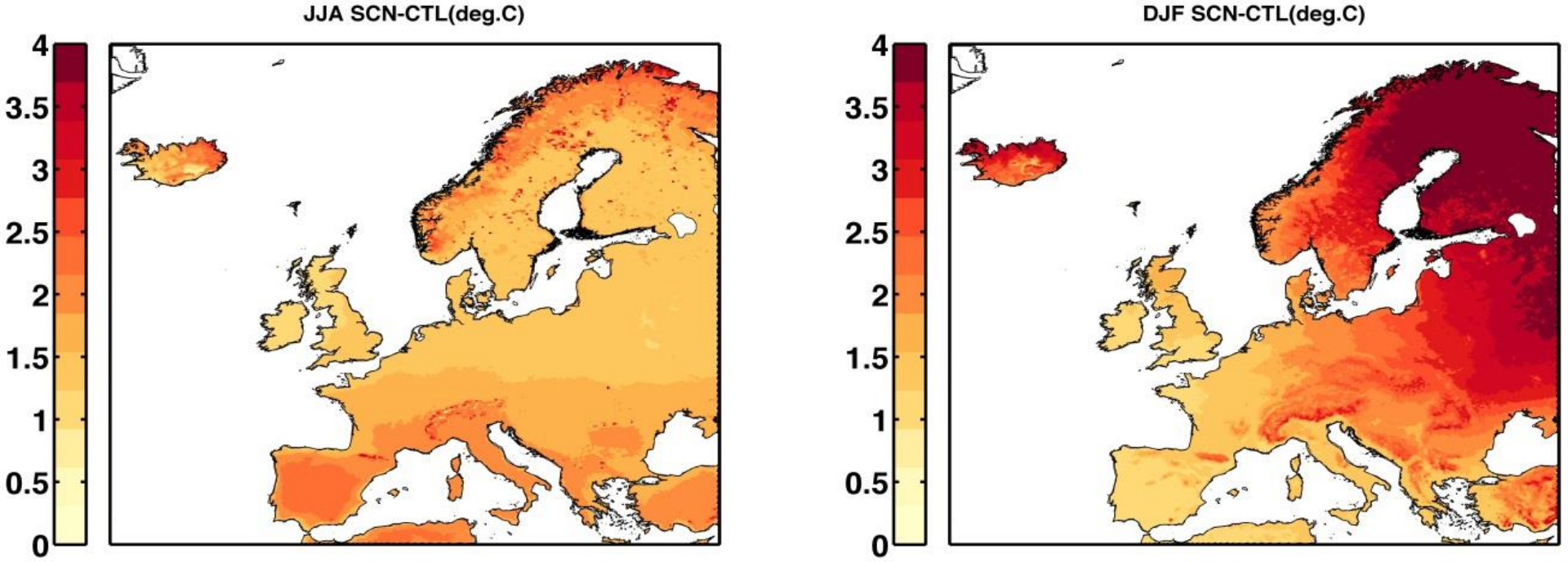
Daily maximum and minimum temperature in Europe in a +2 ºC world

- Daily max. temp. 3-4 ºC over S, SE, Europe
- Daily min. temp. 3-6 ºC in more northerly latitudes



***Source*: Sobolowski et al. In prep.**

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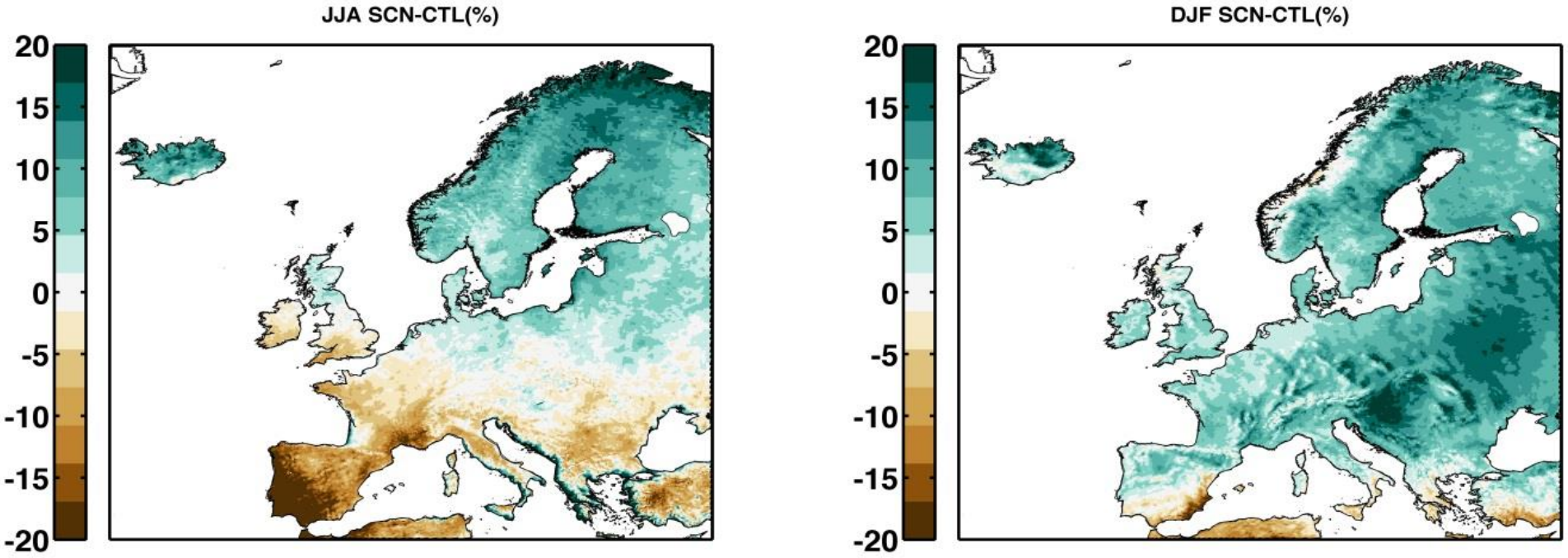
Mean precipitation changes in Europe in a +2 ºC world

- Increases in winter ppt. of +10-20% over central and northern Europe
- Decreases in summer ppt. of -10 to -20 % for central and southern Europe
- Results not as robust as for temperature based indicators



***Source*: Sobolowski et al. In prep.**

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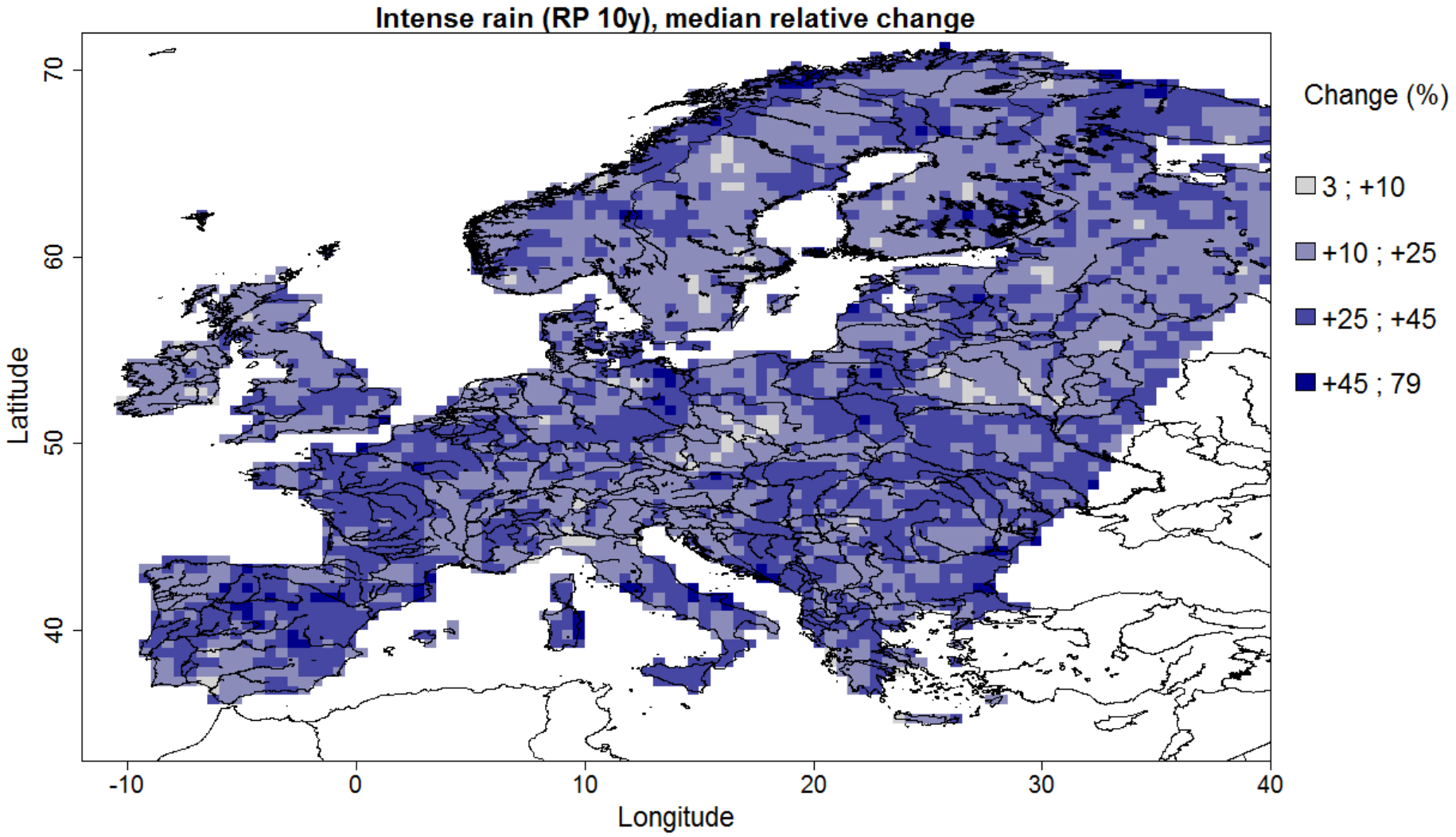
Intense rainfall (1 in 10 year RP) in Europe in a +2 ºC world



***Source*: Roudier et al. 2016**

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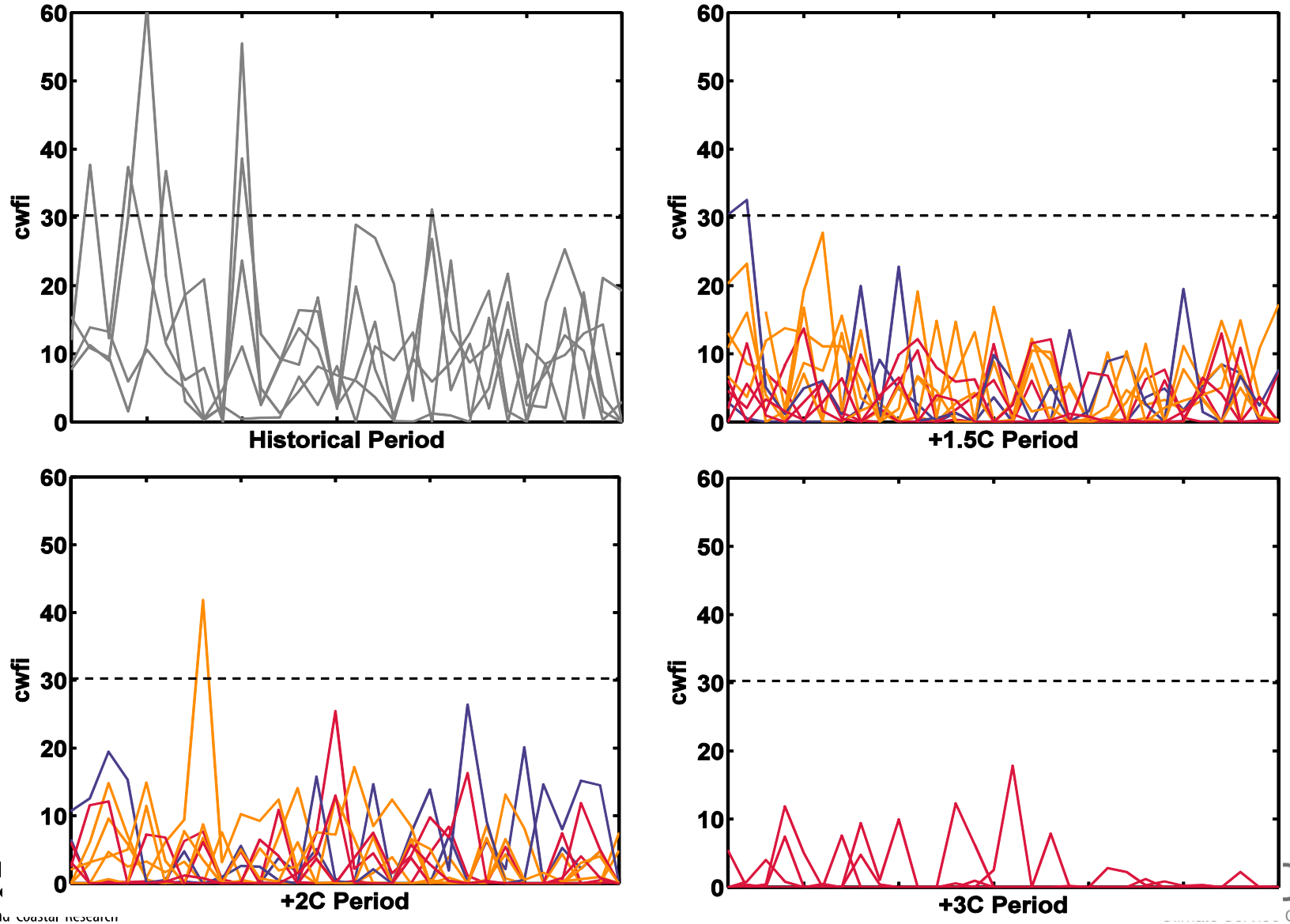
Cold day duration index (southern Finland)

The number of days where, in intervals of at least 6 consecutive days the daily minimum temperature is five degrees lower than the long term mean minimum temperature. The dashed line indicates the historical 95th percentile. stefan.sobolowski@uni.no



***Source*: Sobolowski et al. In prep.**

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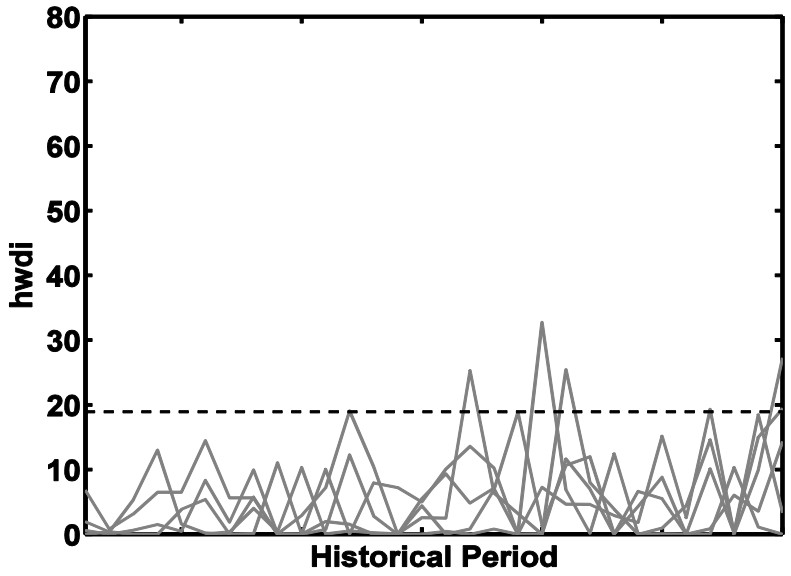
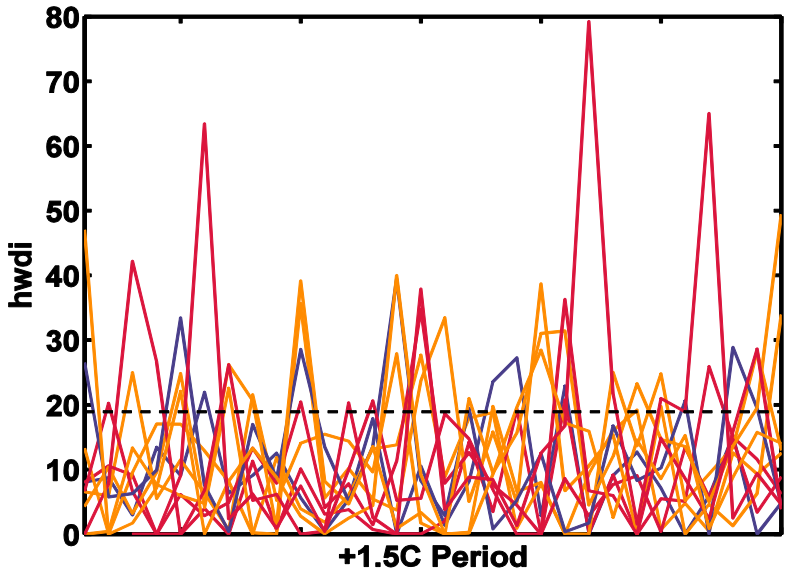
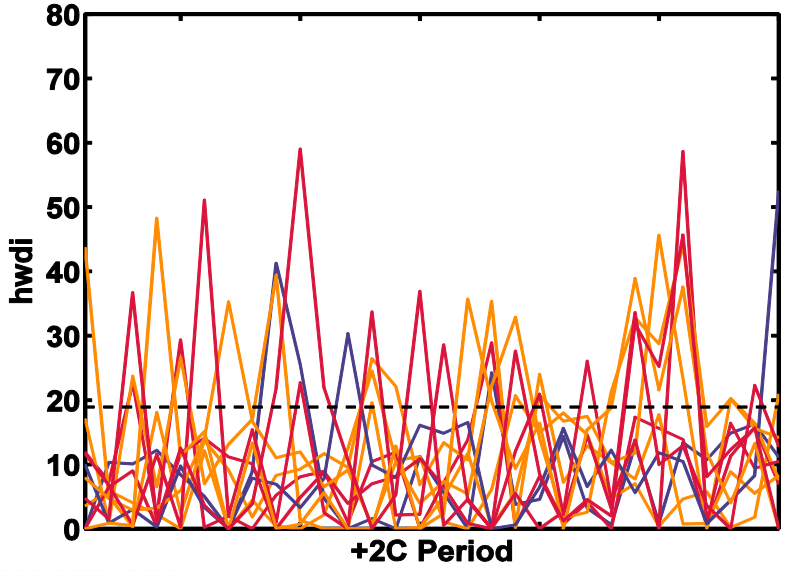
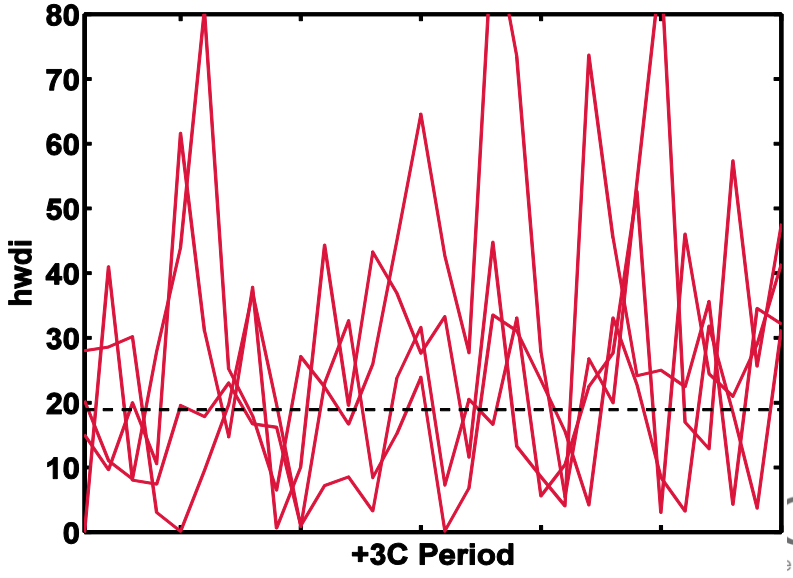
Heatwave duration index (central France)

The number of heatwave days per year (May-Sep) in intervals of at least six consecutive days which are at least 5 degrees over the climatological Tmax 5-day running mean. The dashed line indicates the historical 95th percentile. stefan.sobolowski@uni.no









***Source*: Sobolowski et al. In prep.**

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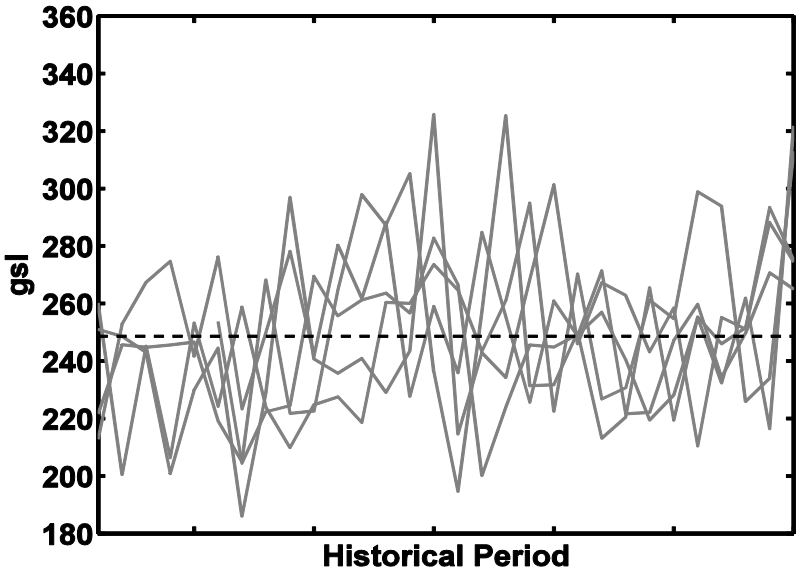
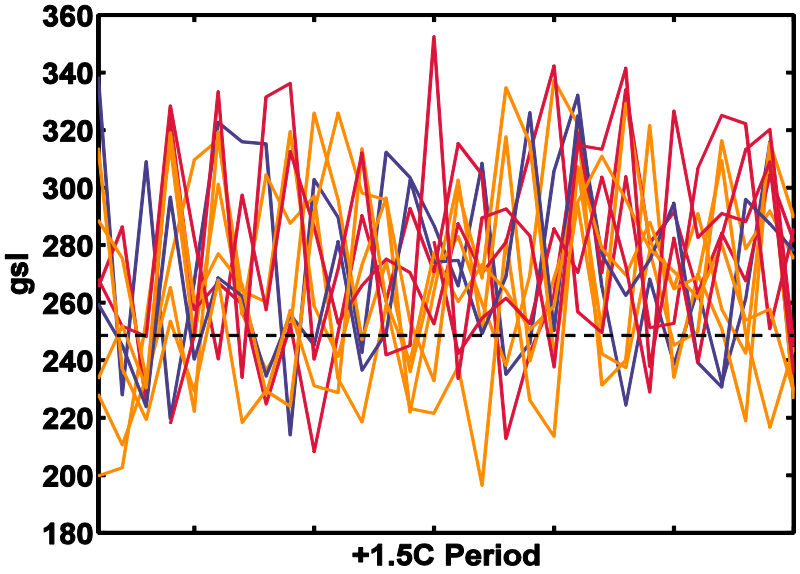
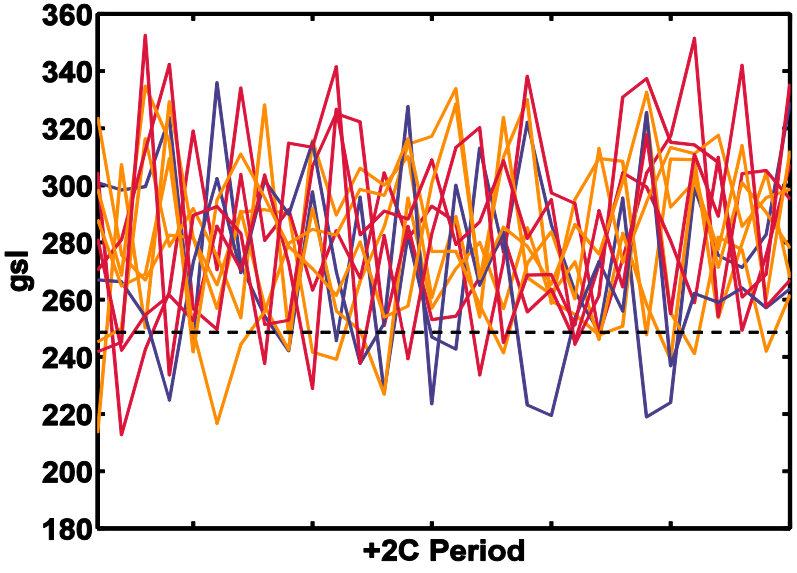
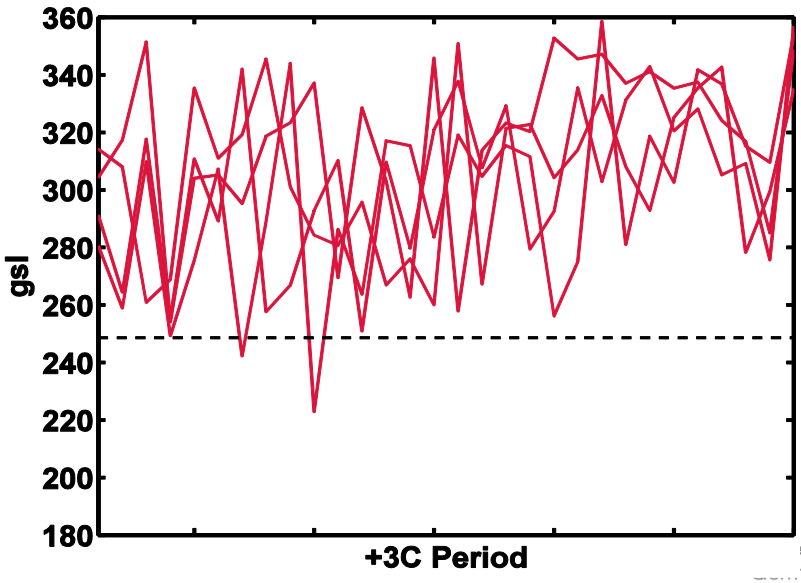
Growing season length (Brandenburg, Germany)

The number of days between the first occurrence of 5day where T > 5C and the last occurrence within a calendar year. The dashed line is the median from the historical simulations. stefan.sobolowski@uni.no









***Source*: Sobolowski et al. In prep.**

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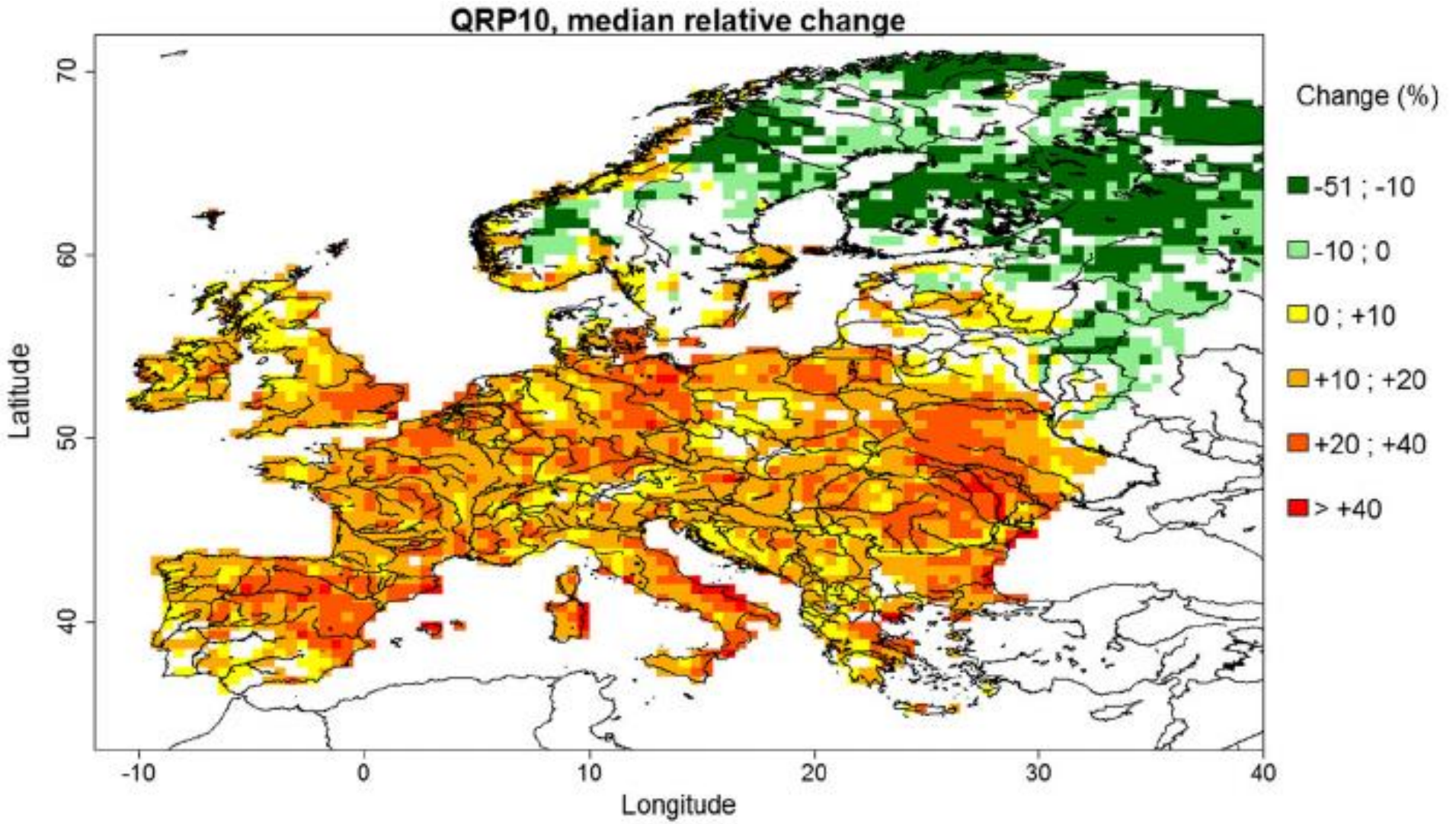
Floods – 1 in 10 year RP



***Source*: Roudier et al. 2016**

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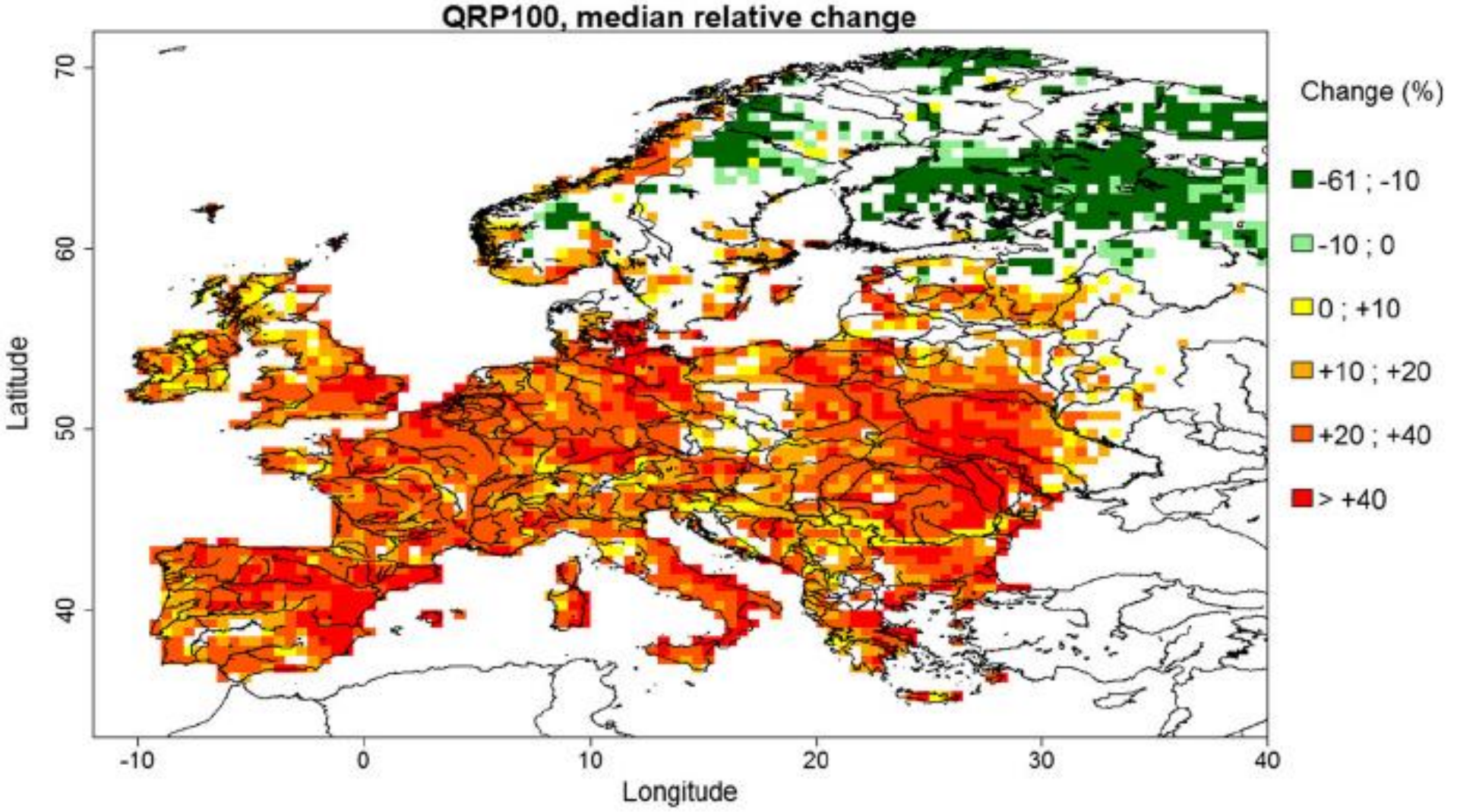
Floods – 1 in 100 year RP



Source: Roudier et al. 2016

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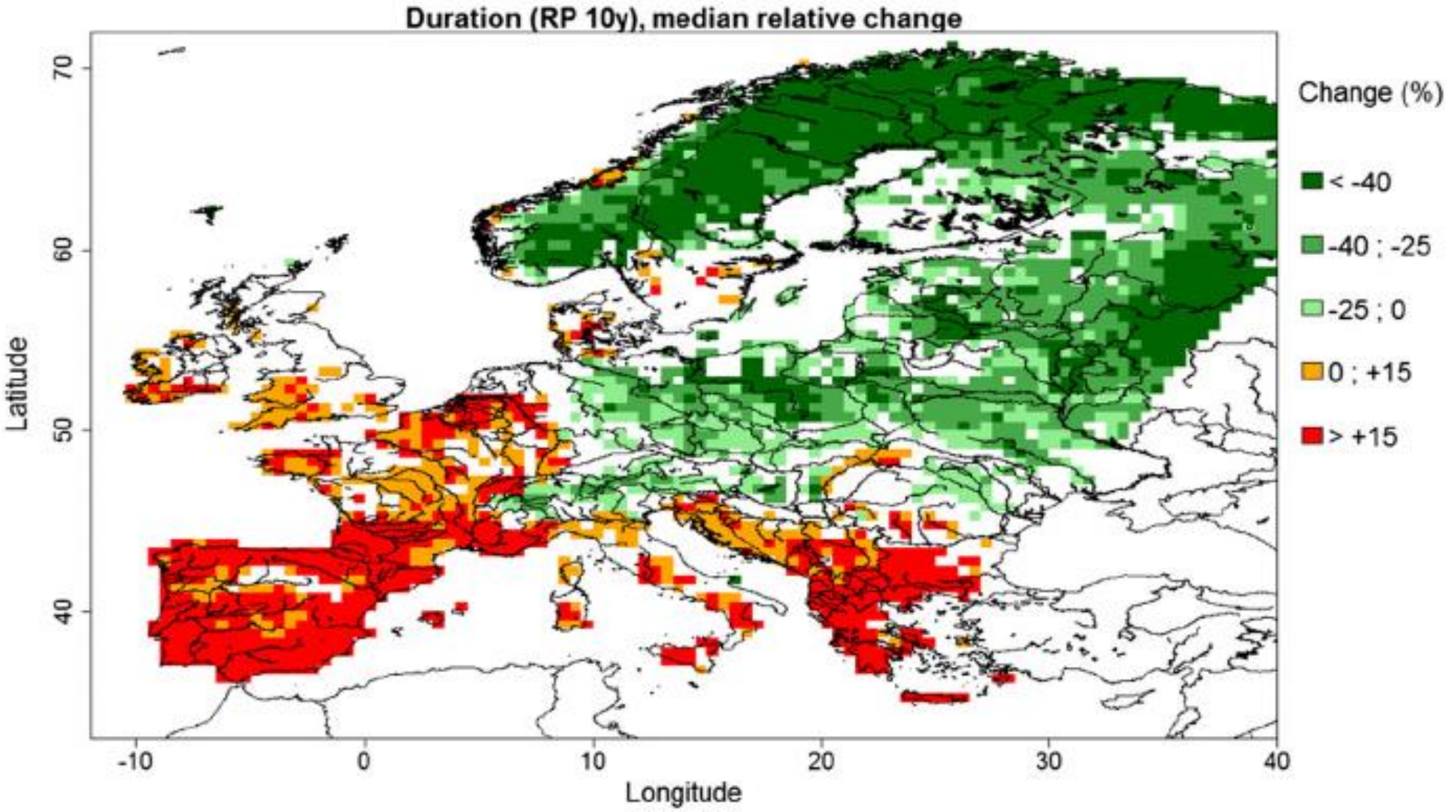
Hydrological drought - low flow duration



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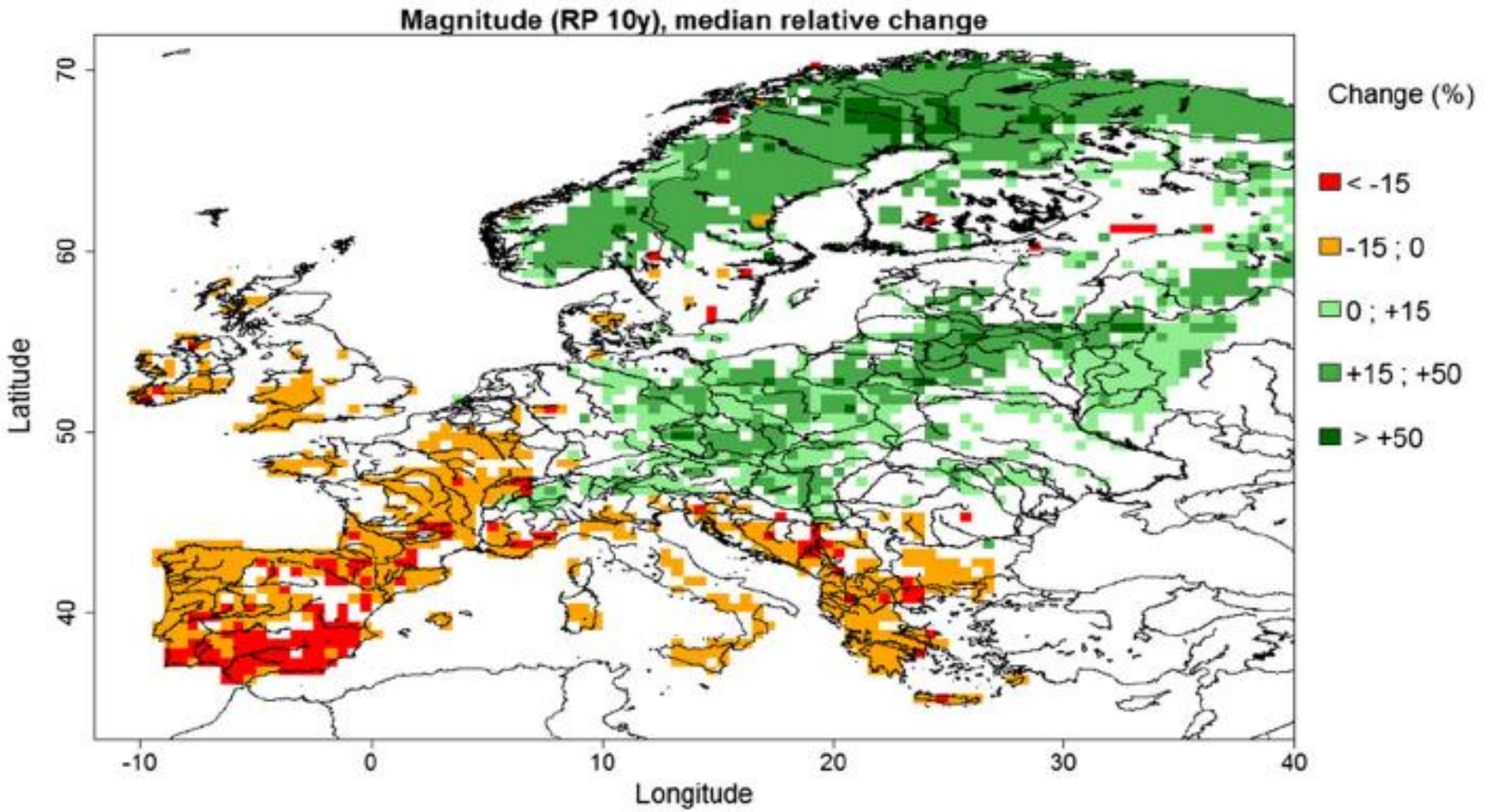
Hydrological drought – magnitude of low flow



***Source*: Roudier et al. 2016**

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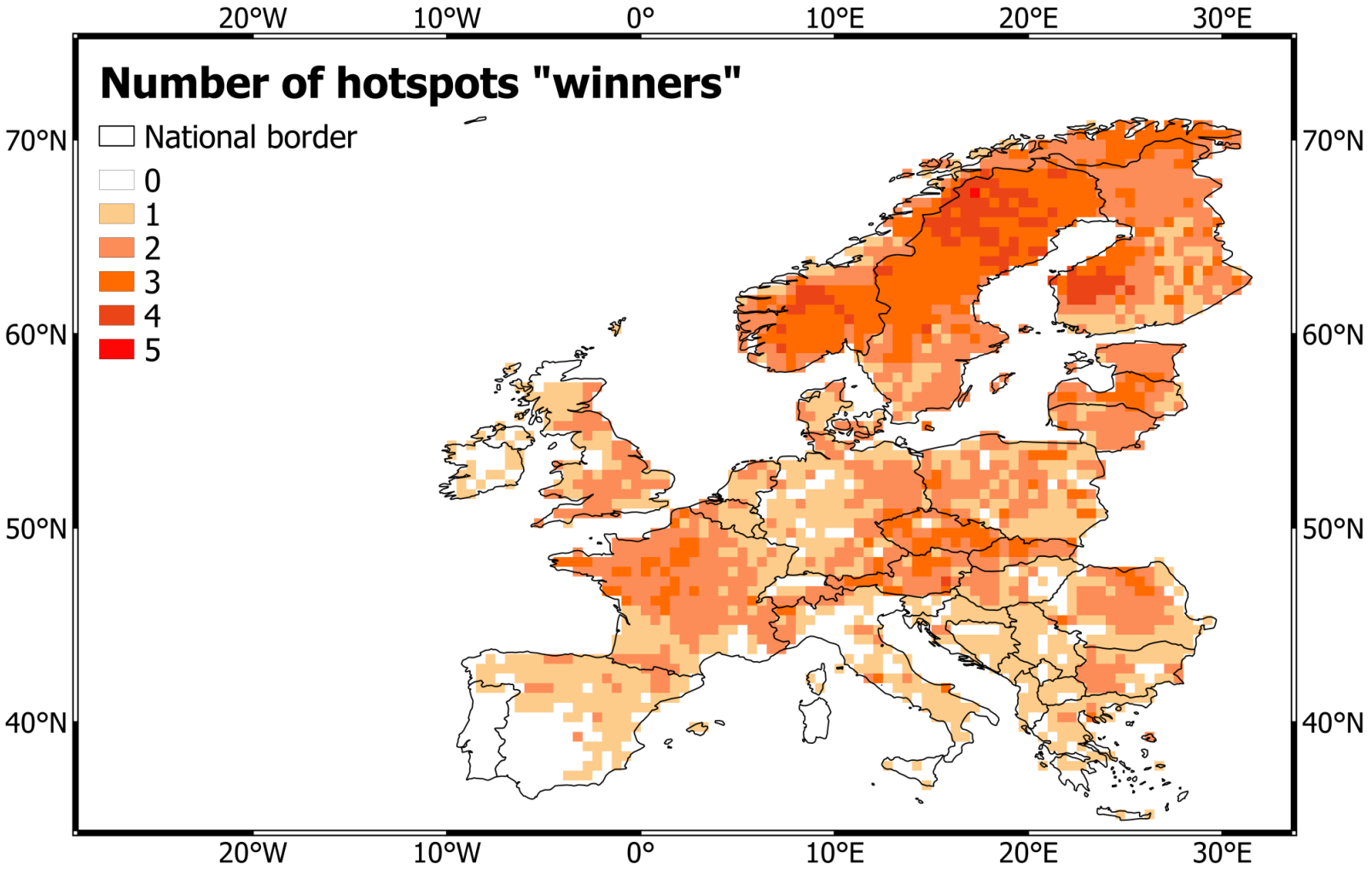
Multi-sector “winners” and “losers” in a +2º C world

Impacts: water (hydrological drought, floods, cooling water), agriculture (crop yield), ecosystems (NPP, SOC), tourism (summer and winter VaR)



Published in ‘Climate change, impacts and vulnerability in Europe 2016’ EEA 2016 (https://goo.gl/qZvavi)

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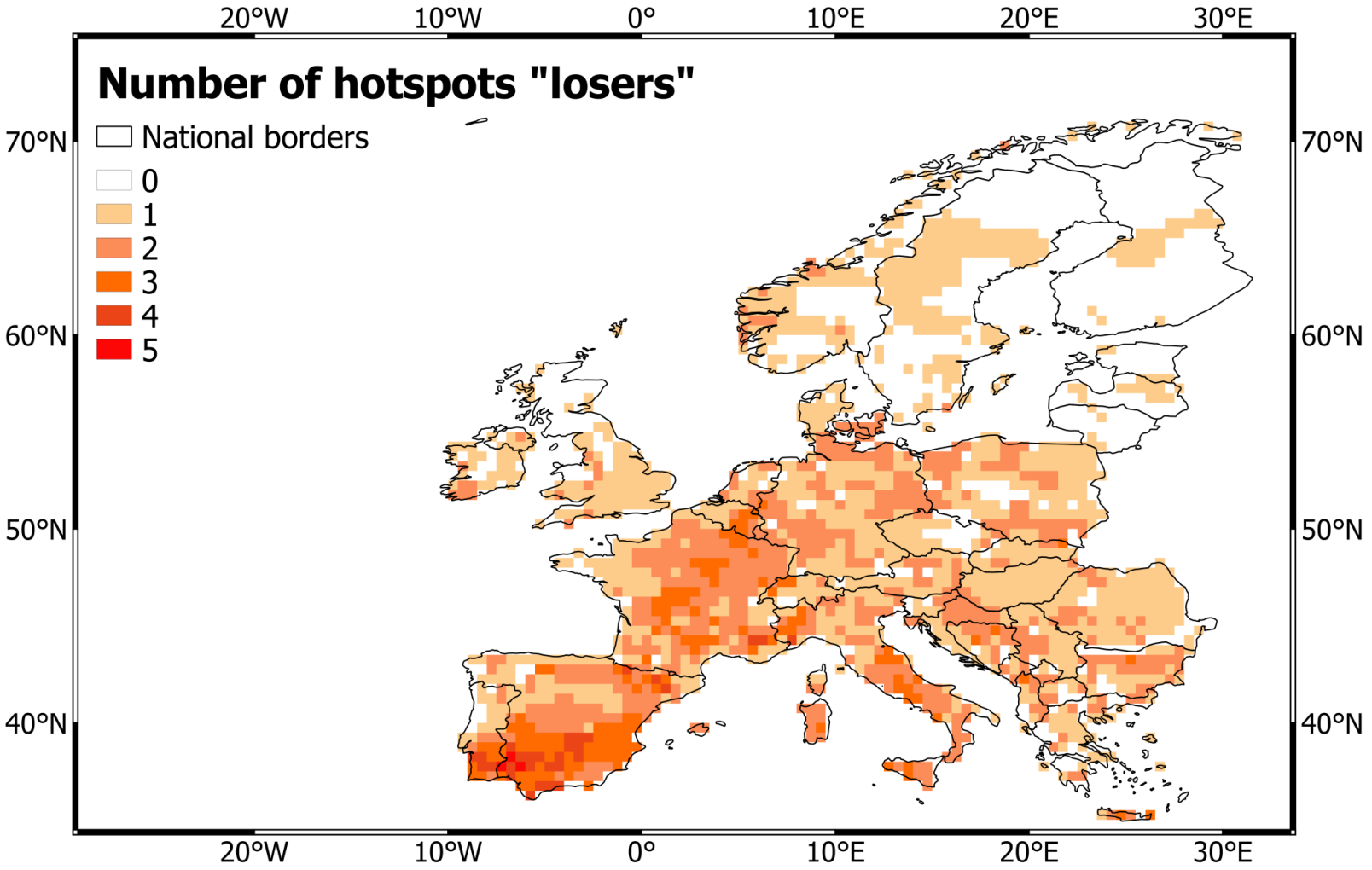

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Project outputs

IMPACT2C policy briefs

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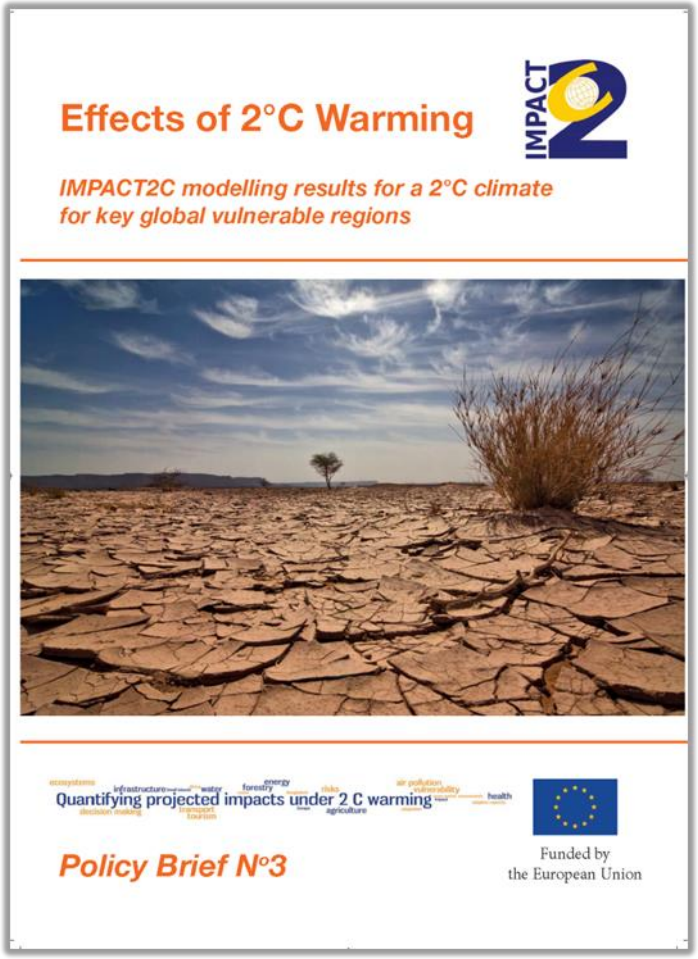
goo.gl/bBgzeQ



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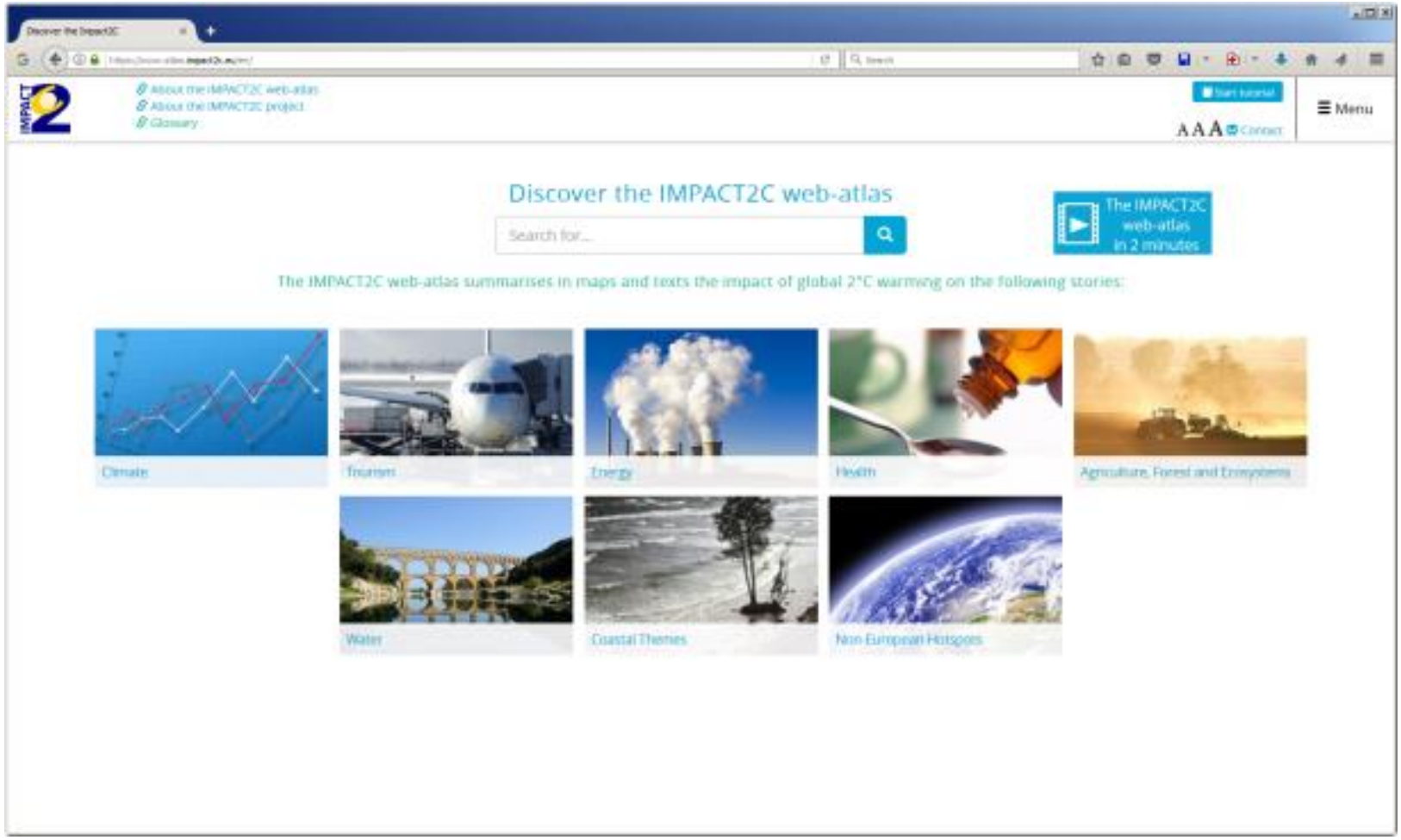
IMPACT2C atlas: www.atlas.impact2c.eu

By presenting a wide variety of potential climate change impacts, the IMPACT2C atlas aims to serve various audiences in gathering information for the development of recommendations on possible adaptation strategies on national and international levels



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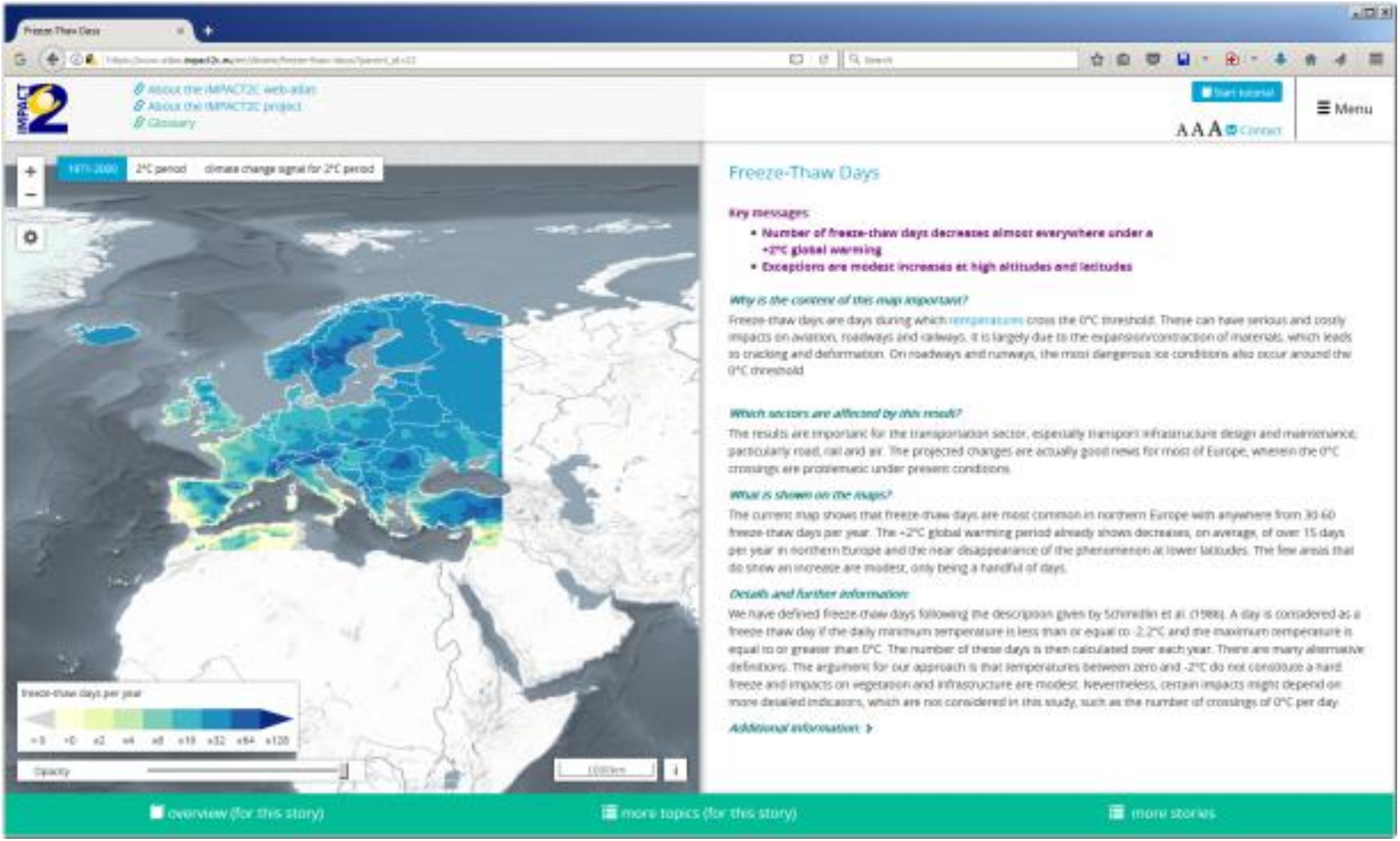
IMPACT2C Atlas example: freeze-thaw days (1971-2000 absolute)



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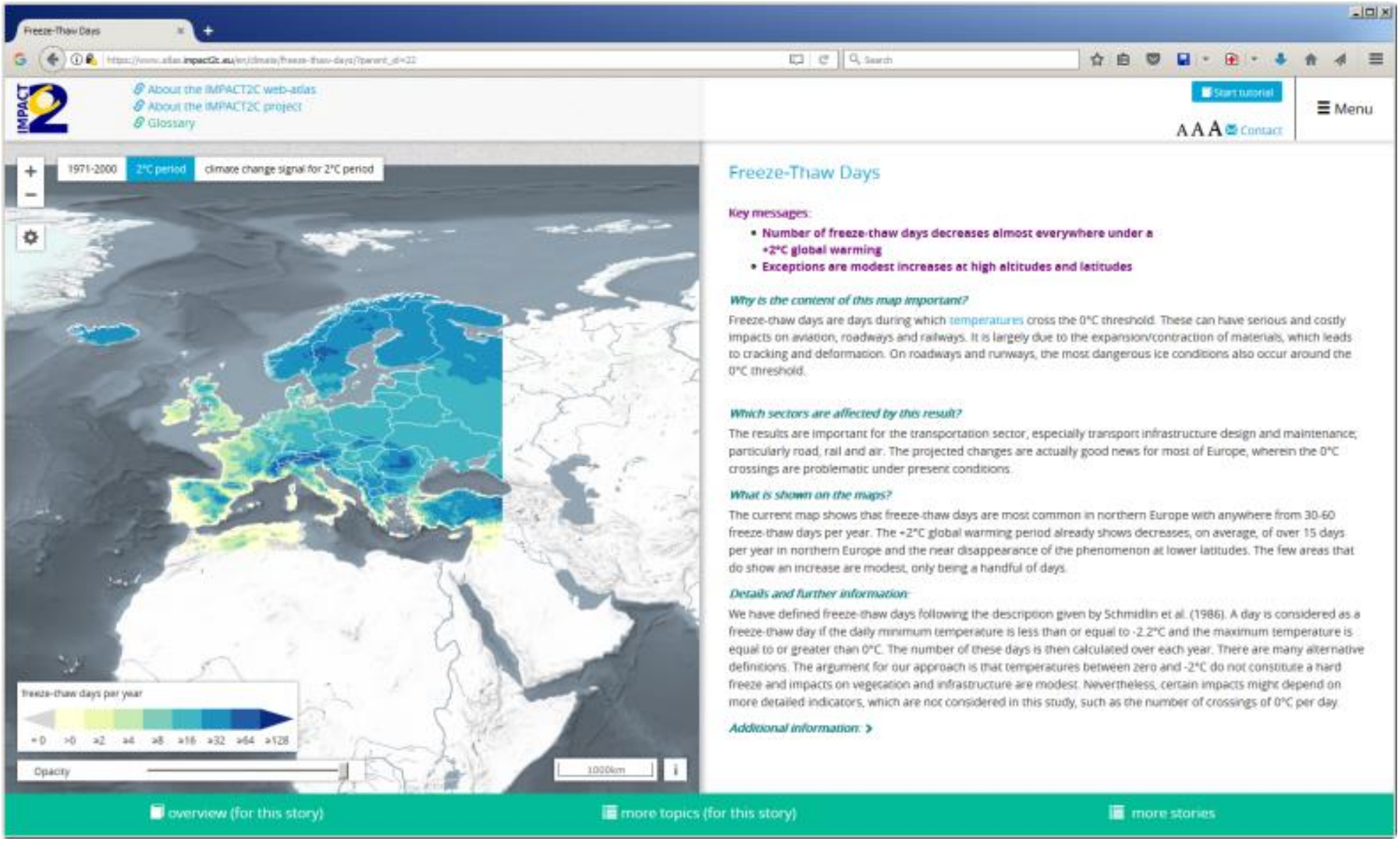
IMPACT2C Atlas example: freeze-thaw days (+2 ºC absolute)



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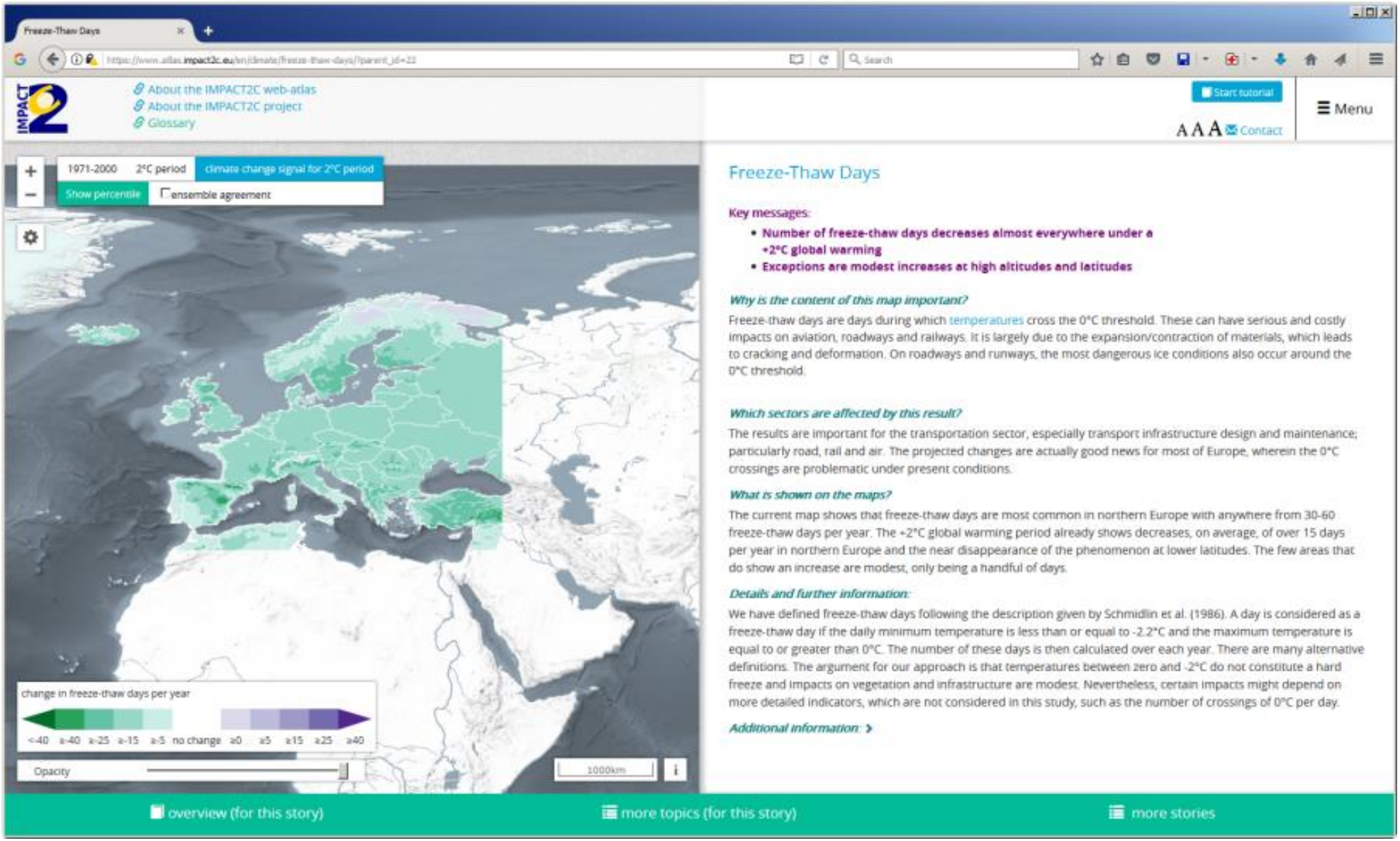
IMPACT2C Atlas example: freeze-thaw days (change in a +2 ºC world)



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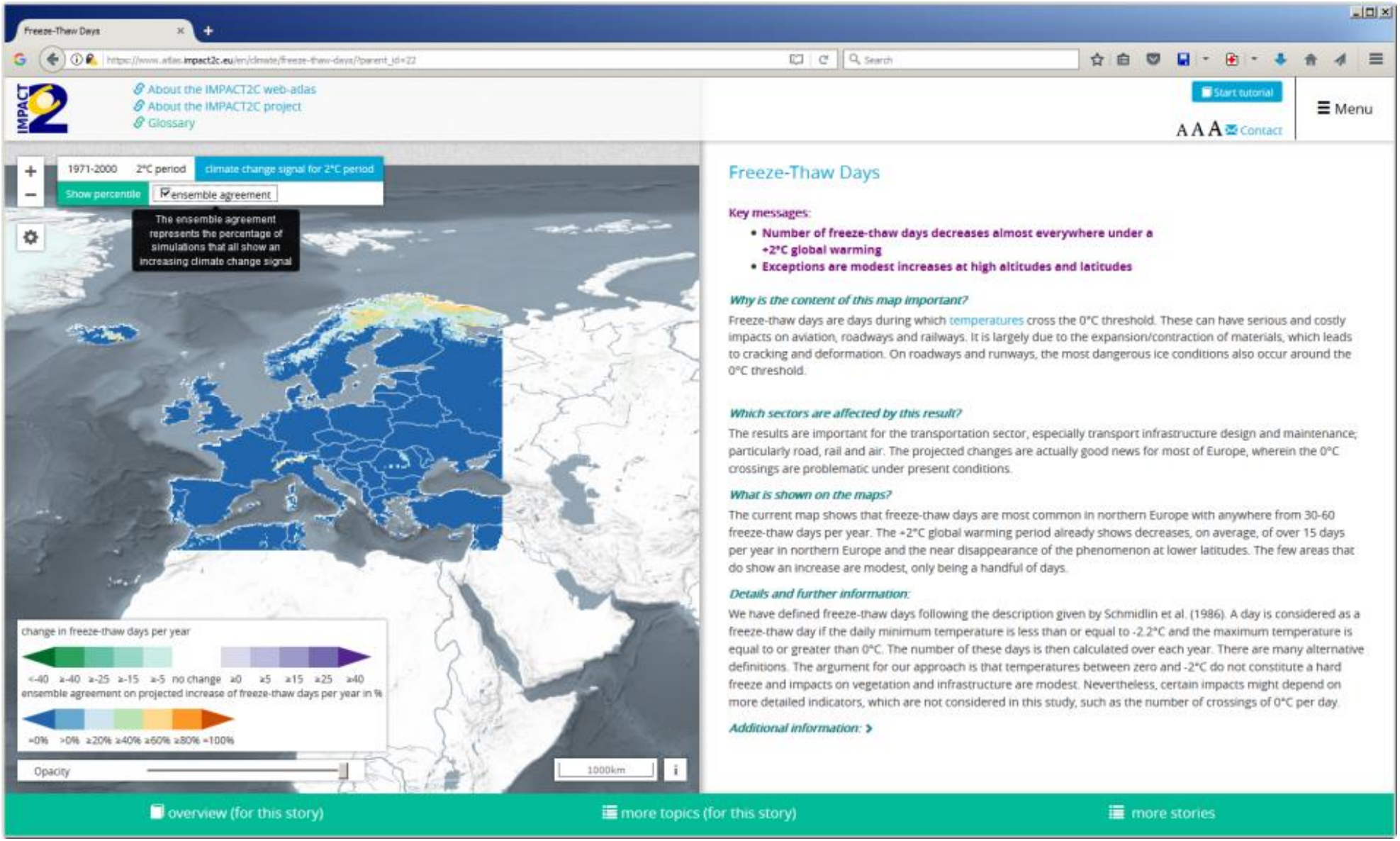
IMPACT2C Atlas example: freeze-thaw days (model agreement in a +2 ºC world)



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Using climate information in the transport sector

- Climate risk screening and risk analyses
- Testing current design standards against climate change - new updated standards needed?
- Examining current business goals and objectives and how a changing climate may affect the ability to meet these → climate risk management in the transport sector.

Using climate information in the transport sector

Phenomenon	1st threshold: harmful impacts possible	2nd threshold: harmful impacts are likely	3rd threshold: harmful impacts are certain
Wind (gust speed)	>= 17 m/s	>= 25 m/s	>= 32 m/s
Snowfall	>= 1 cm/day	>= 10 cm/day	>= 20 cm/day
Rain	>= 30 mm/day	>= 100 mm/day	>= 150 mm/day
Cold (mean daily temp.)	< 0 °C	< -7 °C	< -20 °C
Heat (mean daily temp.)	>= 25 °C	>= 32 °C	>= 43 °C
Blizzard	When threshold values of wind, snowfall, and cold are realised simultaneously		

***Source*: adapted from Leviakangas and Saarikivi, 2012**

Acknowledgement

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Thank you

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Spare slides

We are…

Project Coordinator:
Dr. Daniela Jacob
Climate Service Center Germany

Researchers from **29** different **institutions** and **16** different **countries**

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ACMAD

Global Climate Forum

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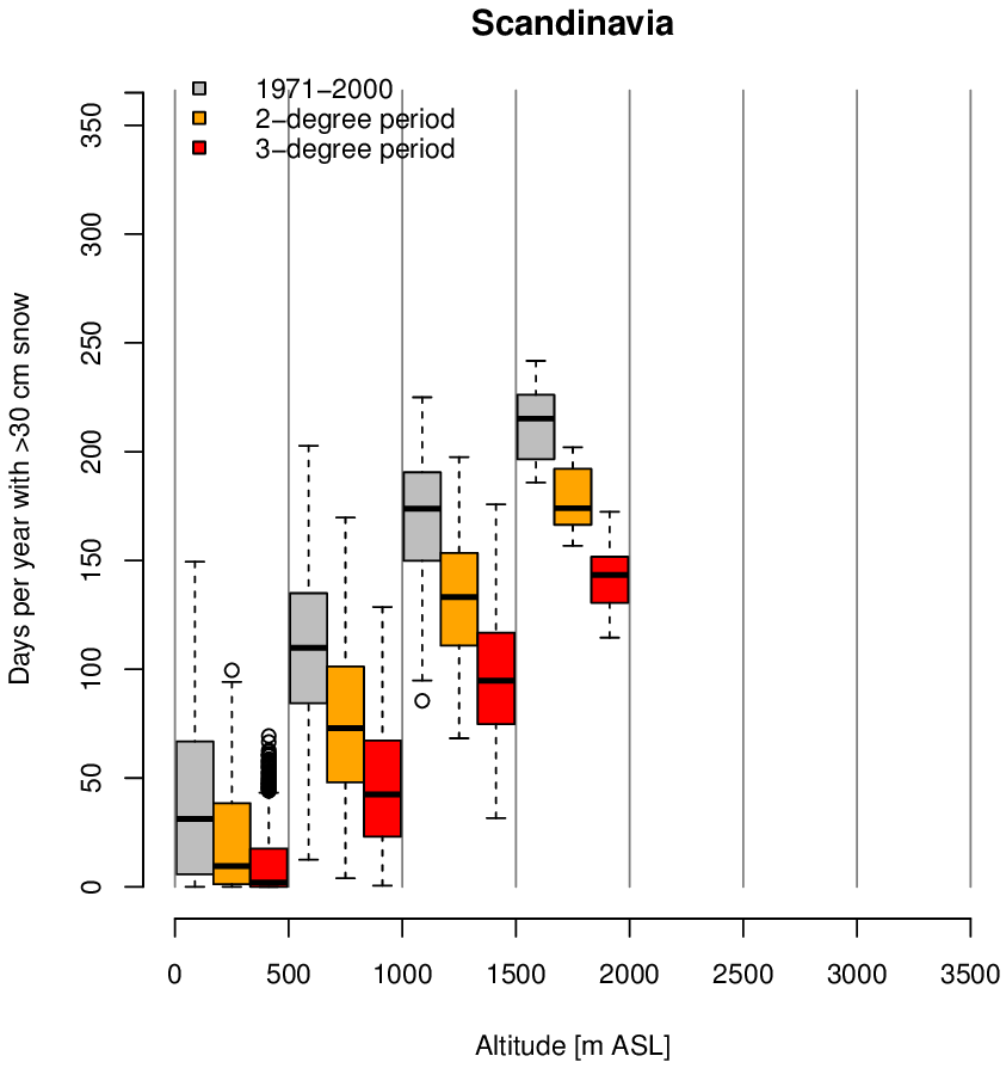
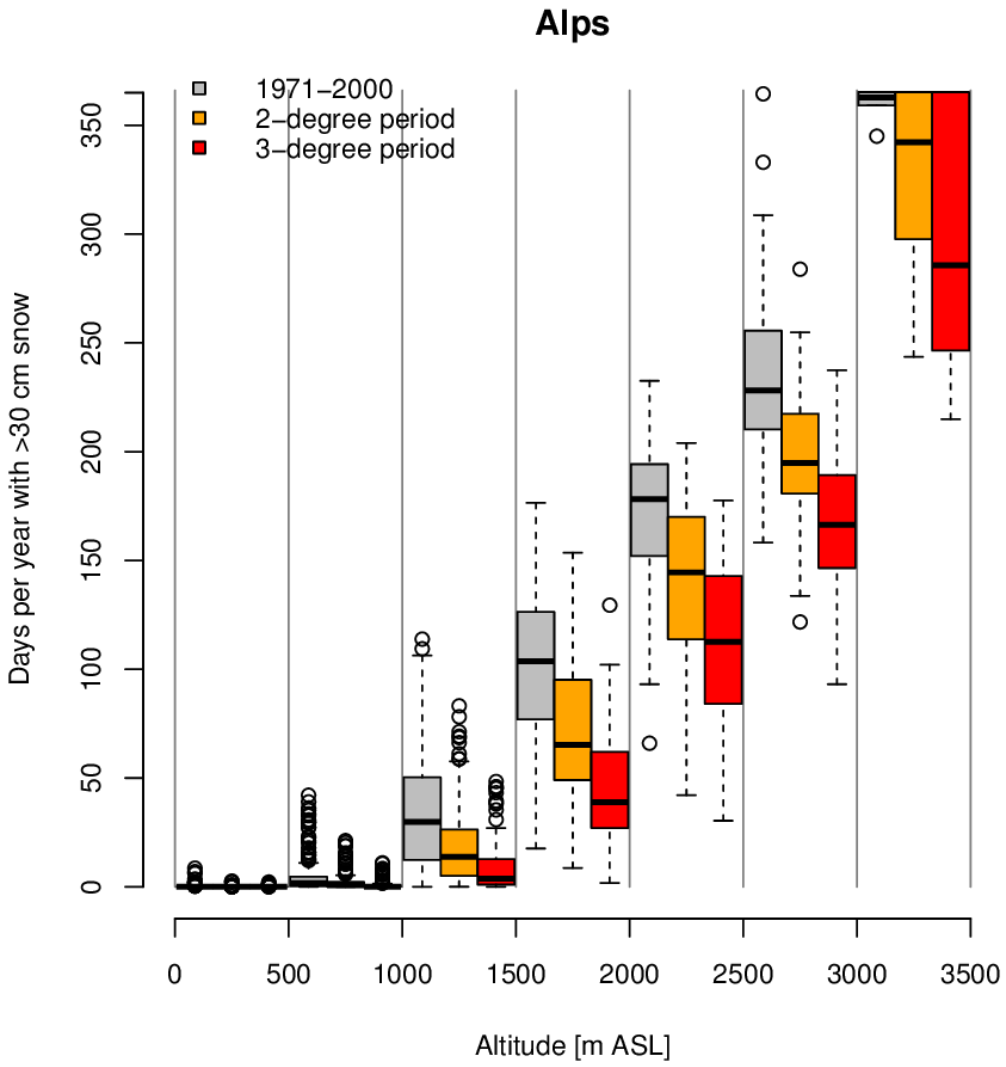
Number of days with >30 cm snow per year





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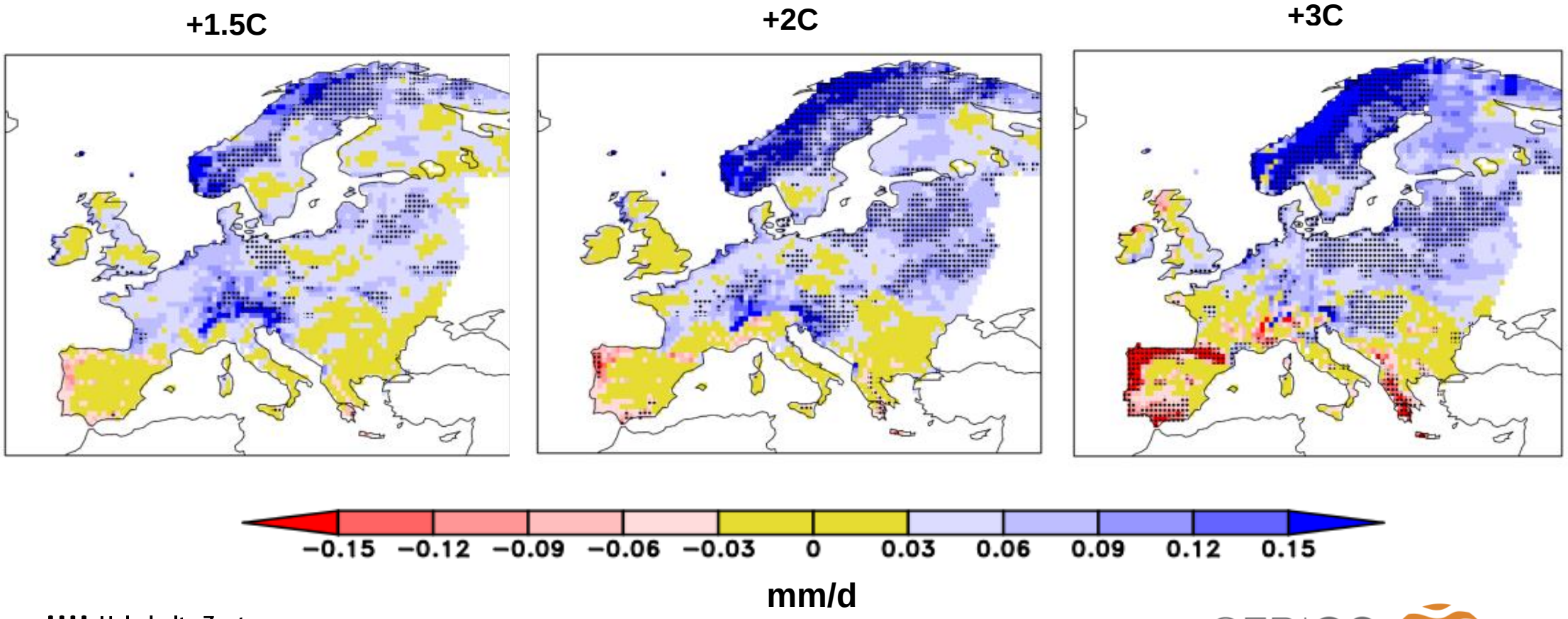
Water

- Projected change in mean annual total runoff
- 5 HMs (E-Hype, Lisflood, LPJmL, VIC, WBM)



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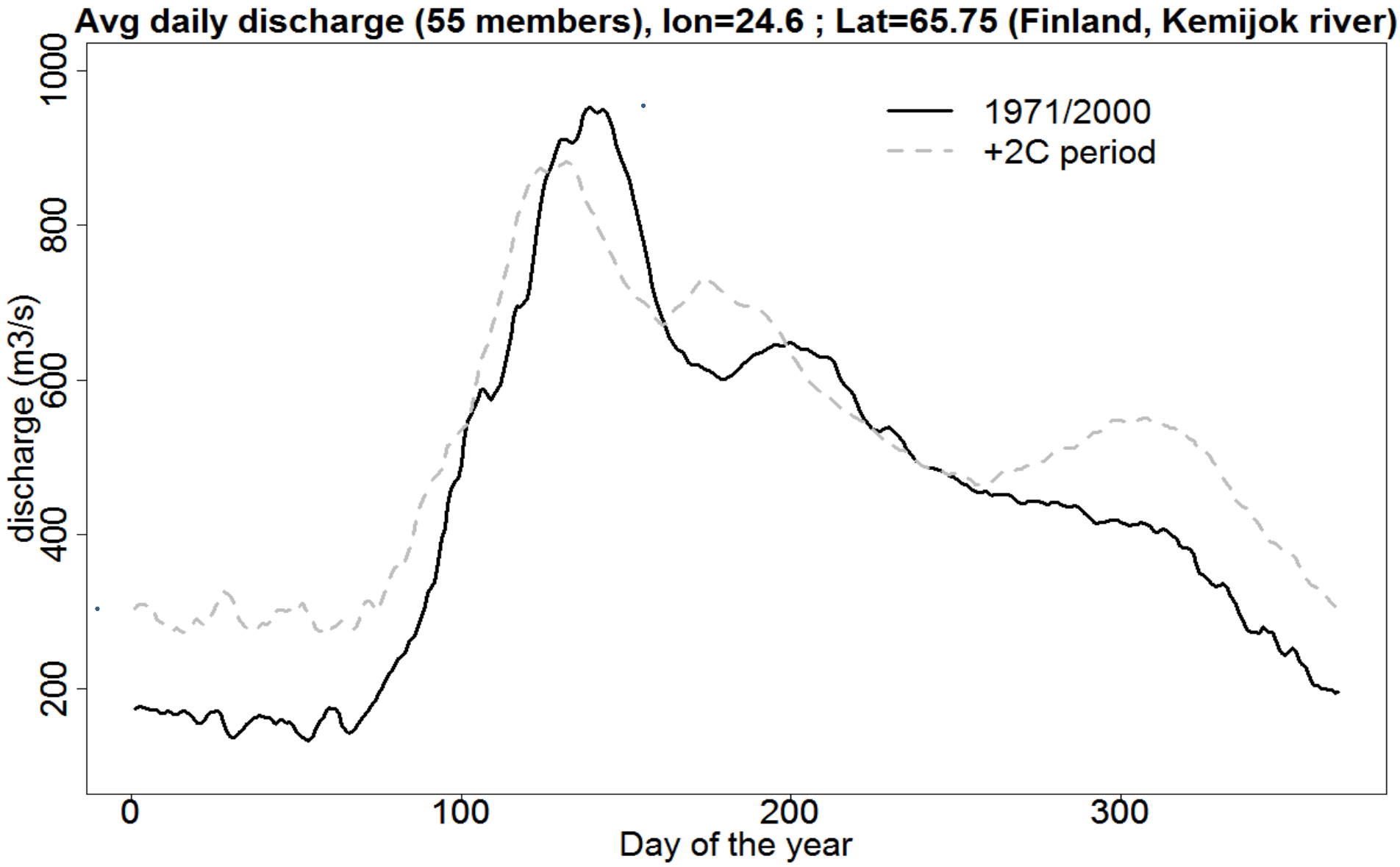
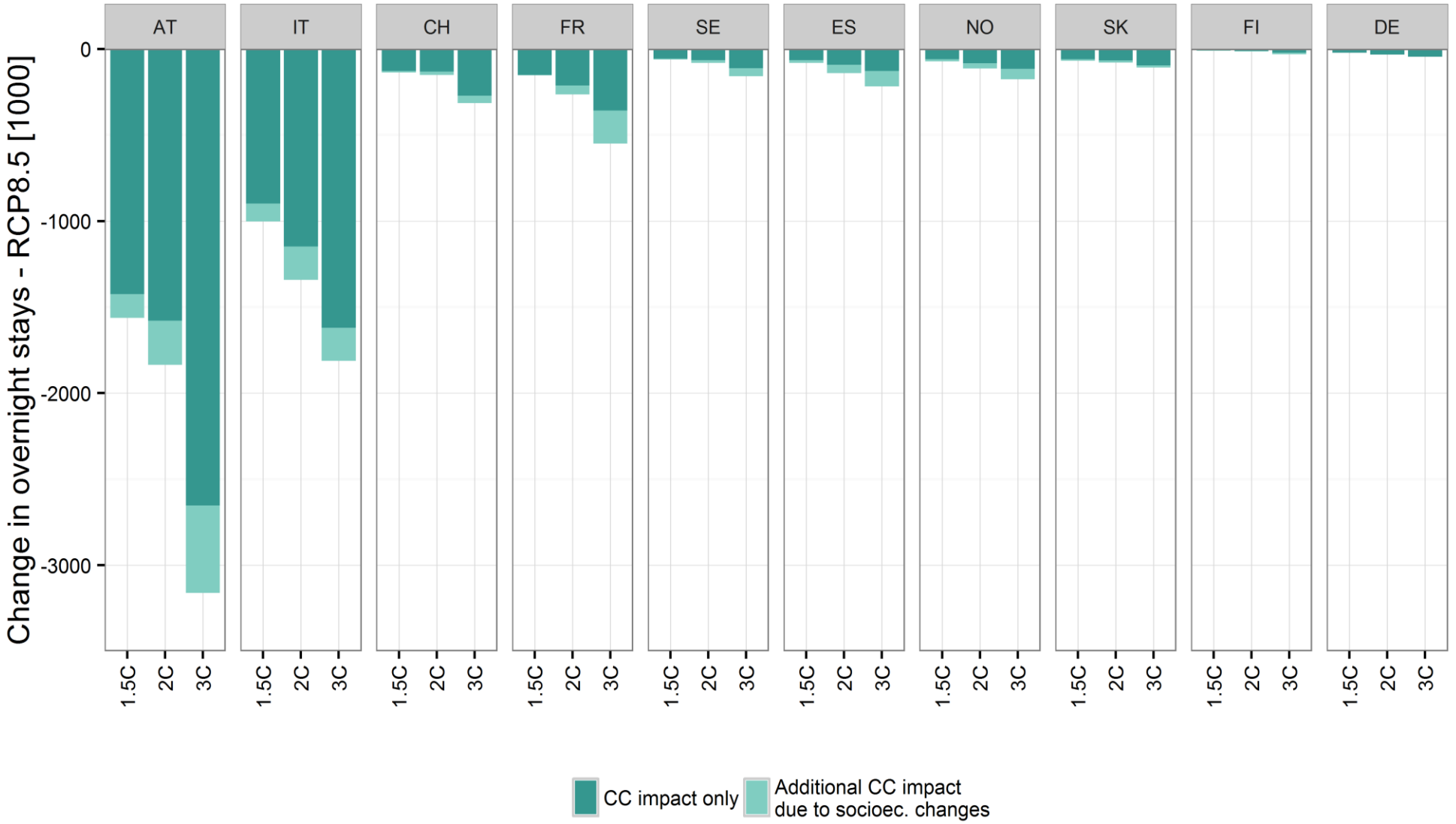
Example in Finland



Winter tourism demand

- Natural snow conditions in Europe
- Weather value at risk (VaR) resulting from adverse weather conditions
- VaR is change in number of overnight stays
- Regression model between number of overnight stays and a snow index (fraction of days SWE >= 120mm)
- VIC and E-Obs (1958-2010)
- VIC and RCP8.5 simulations
- Socio-economic factors: GDP per capita, population

Winter tourism demand



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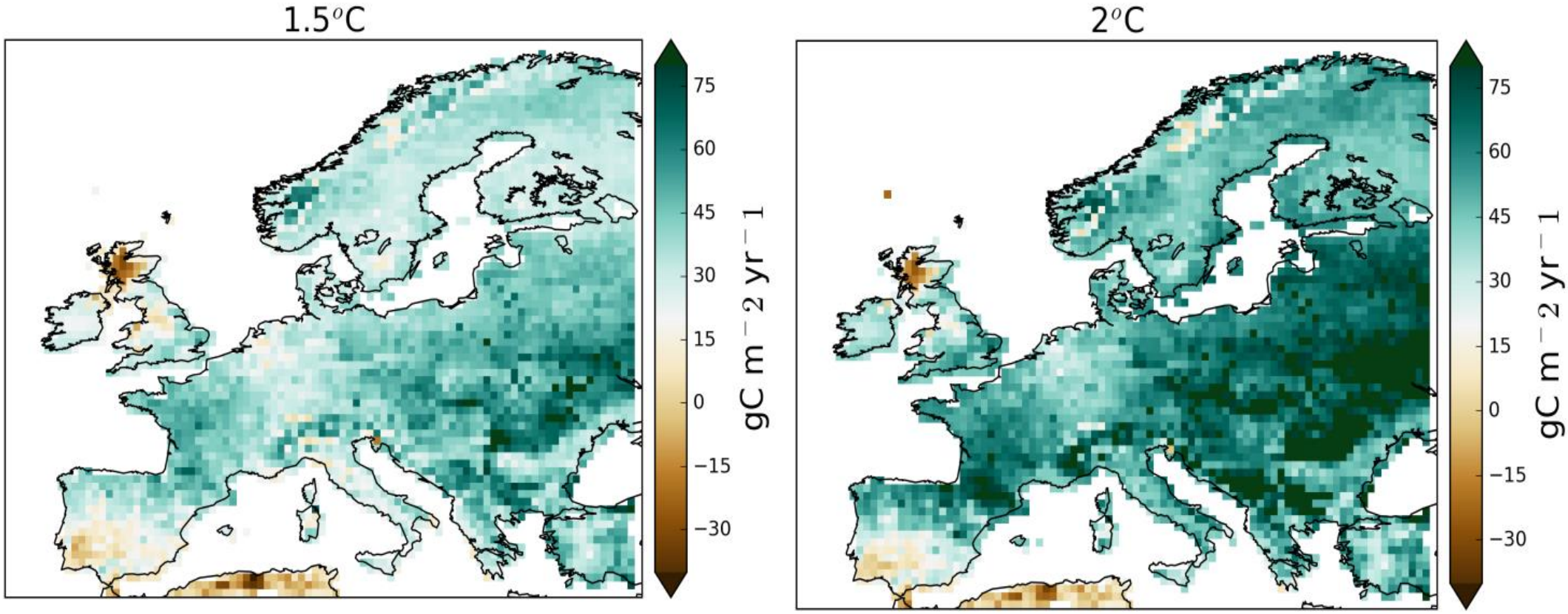
Ecosystems

- Projected change in NPP
- CLM4.0-CN, LPJmL



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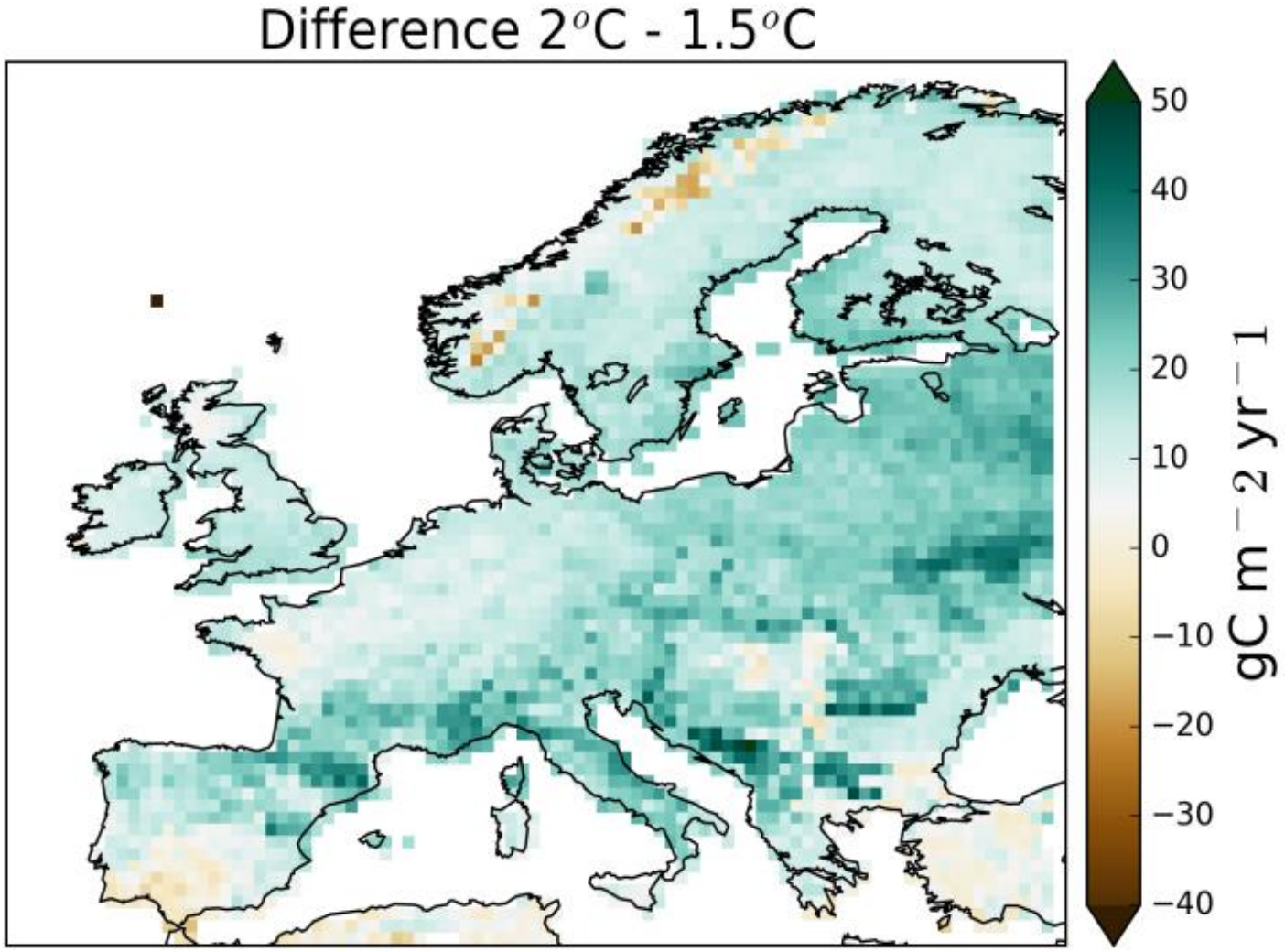
Ecosystems (NPP)



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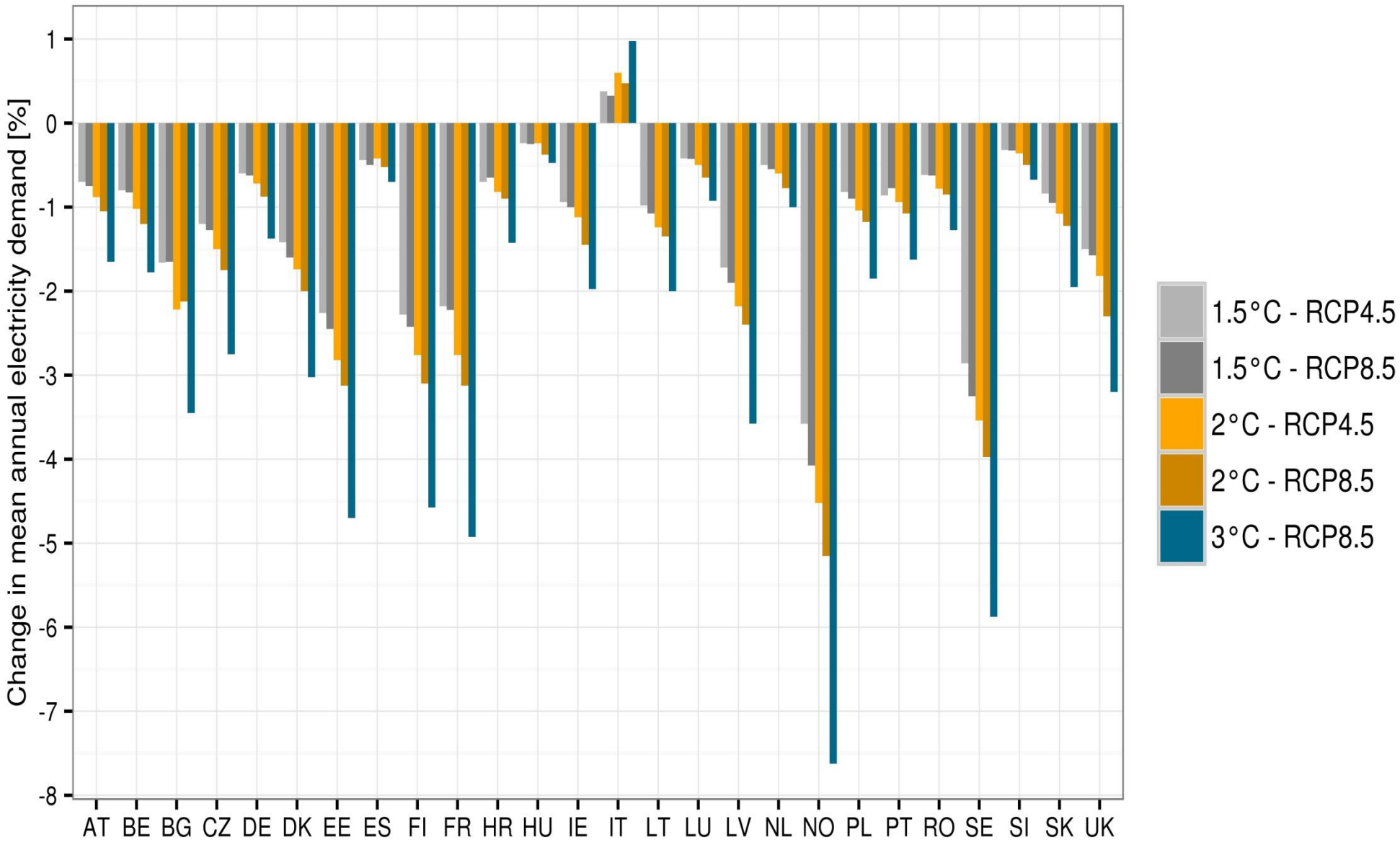
Electricity demand

- Temperature related impact on electricity load
- Load data corrected for non-climate factors e.g. weekday effects, summer holidays, industrial production
- Regression between corrected historical load data and daily mean temperature
- Historical relationship used with RCPs

Electricity demand



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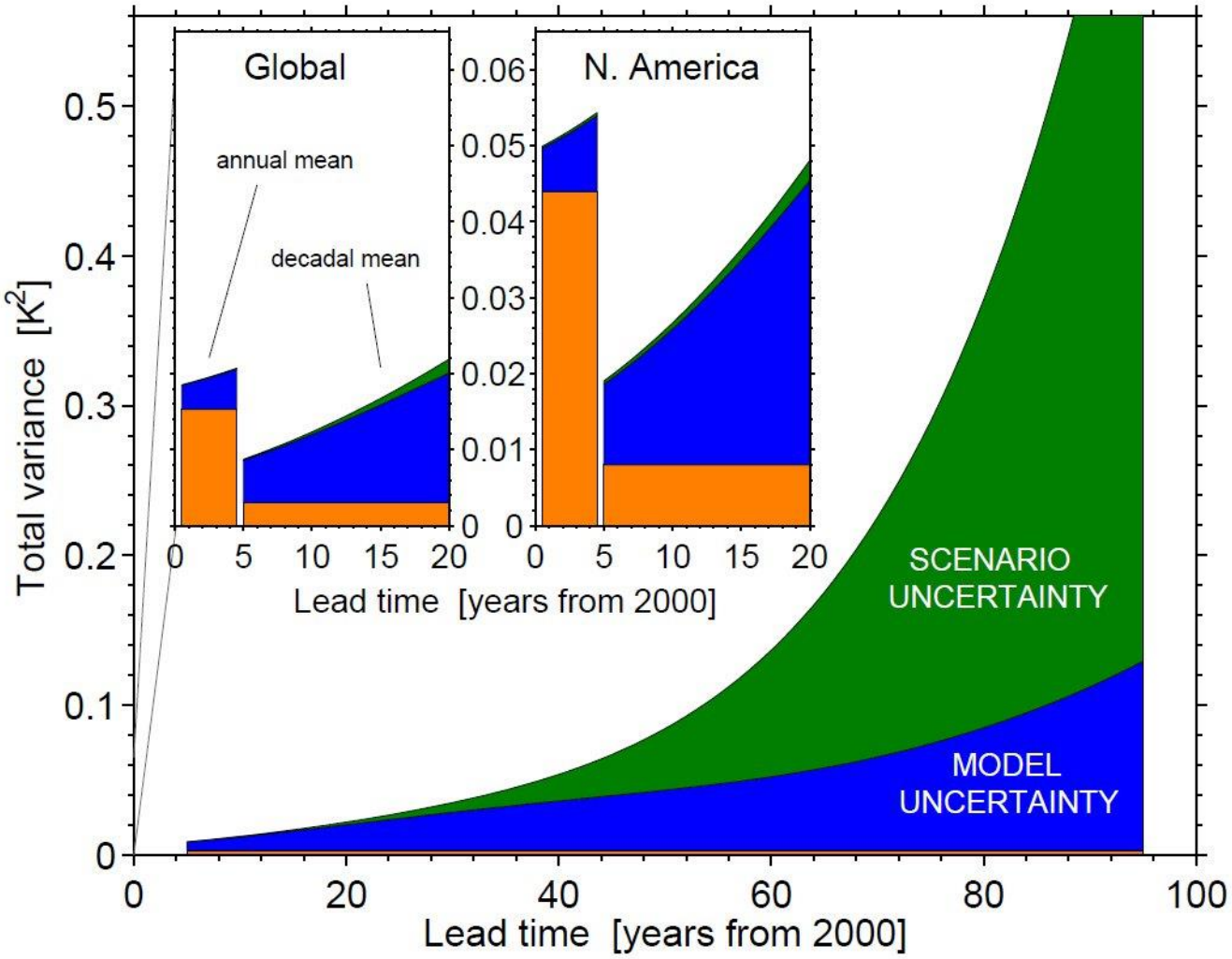
Sources of uncertainty in climate model projections



Source: Hawkins & Sutton 2009

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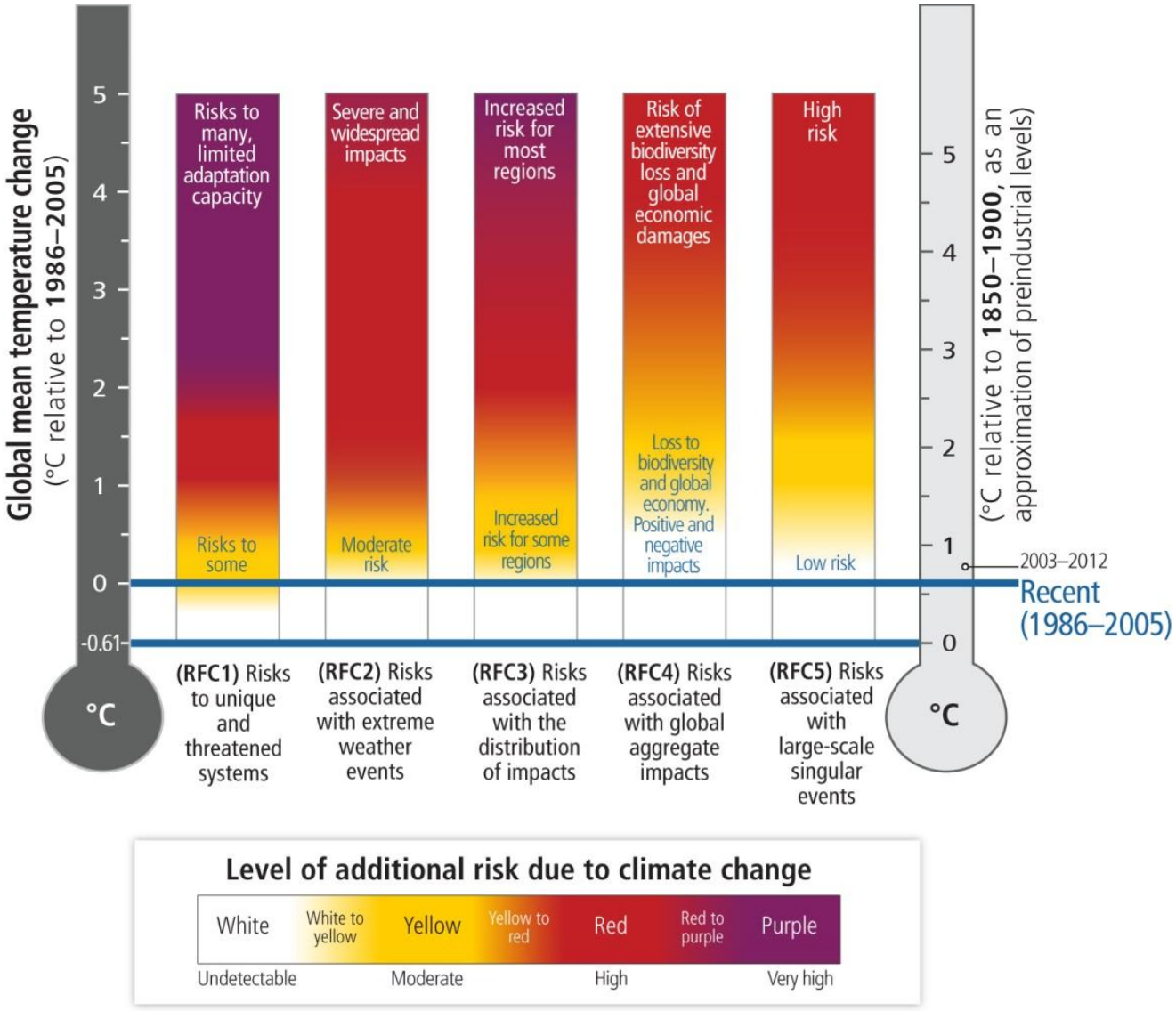
Reasons for concern, informing climate policy goals



Source: Oppenheimer et al. 2014

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Key findings

❖A global warming by 2C substantially affects a wide range of sectors and regions throughout Europe.
❖Some regions or sectors will benefit from a future warming, but some will experience disadvantages.

❖To assess the impacts of climate change on specific sectors, cross-sectoral relationships have to be included into the analysis.

❖In most regions of Europe, the projected regional warming is more pronounced than the global mean warming.
❖Projections for annual mean precipitation show wetter conditions in northern Europe and drier conditions in southern Europe.

❖Under a 2C global warming, a European-wide increase in the frequency of extreme events is expected.
❖Heatwaves are projected to double while extreme precipitation events tend to become more intense.

❖A limitation to 2C global warming will not stop sea-level rise due to the delayed reaction of the oceans. Therefore costs due to coastal flooding will incur even with adaptation measures.

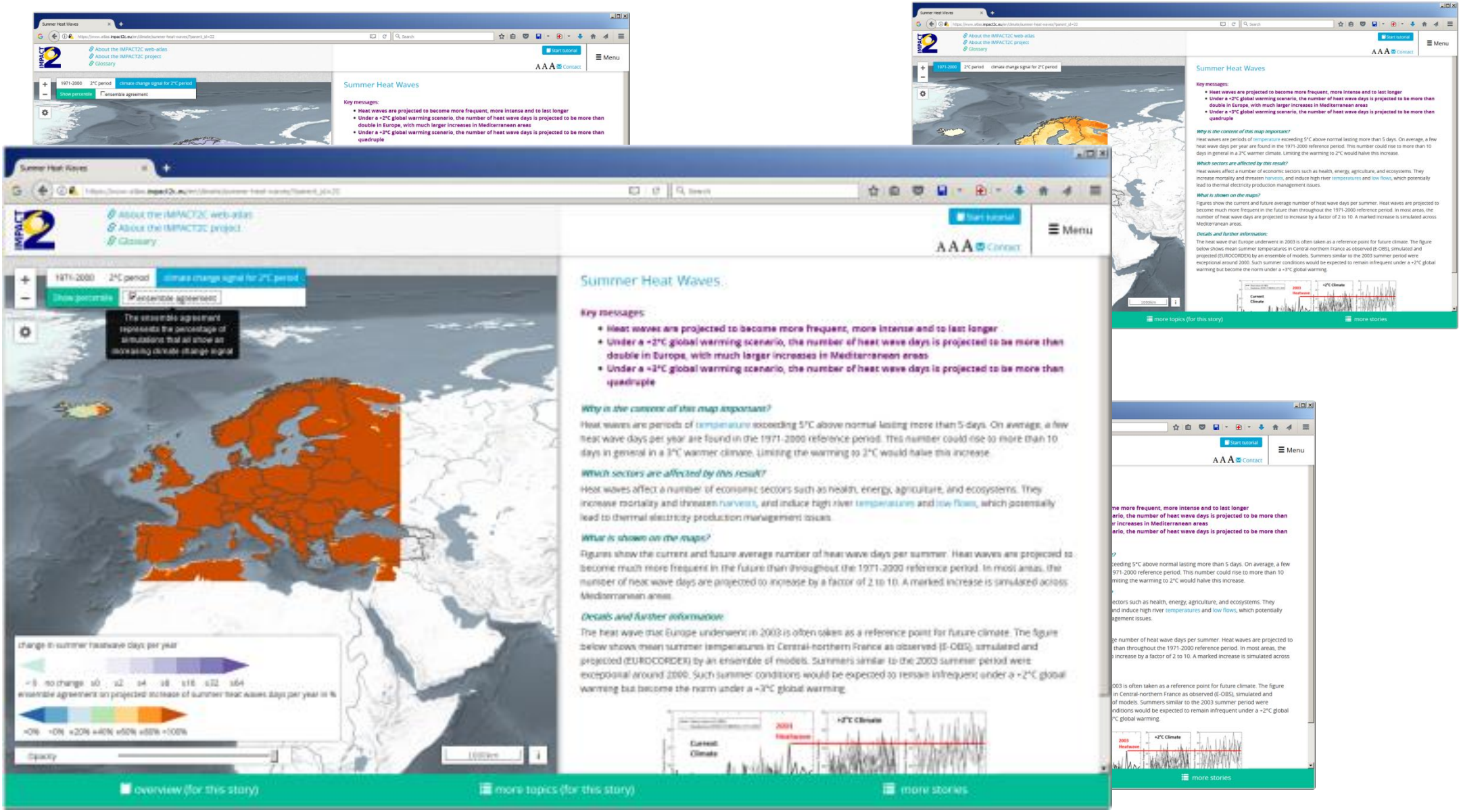
❖Bangladesh and the low-lying islands like Maldives are expected to feel the consequences of climate change, due to the continuous rise of sea-levels enhancing the risk for storm surges and flooding.

❖For West and East Africa, the warming is above the global temperature increase.
❖West Africa could experience a modest increase in rainfall, whereas for East Africa no clear trend is projected .

Summary

Based on the evidence presented:

- Some appreciable changes in climate impacts at 1.5C
- Differential impacts between 1.5C and 2C worlds, are, on the whole, not considerable for Europe, more pronounced at 3C
- Find out more: www.impact2c.eu
- Online atlas available at: www.atlas.impact2c.eu



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