

# **WHAT CAN CLIMATE RESEARCH TELL US ABOUT FUTURE SKIING CONDITIONS?**

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NORDIC SUSTAINABILITY ARENA

ÅRE, 7/3 2025

**What we have already seen**

# Observed changes in Sweden and Europe

**SMHI**

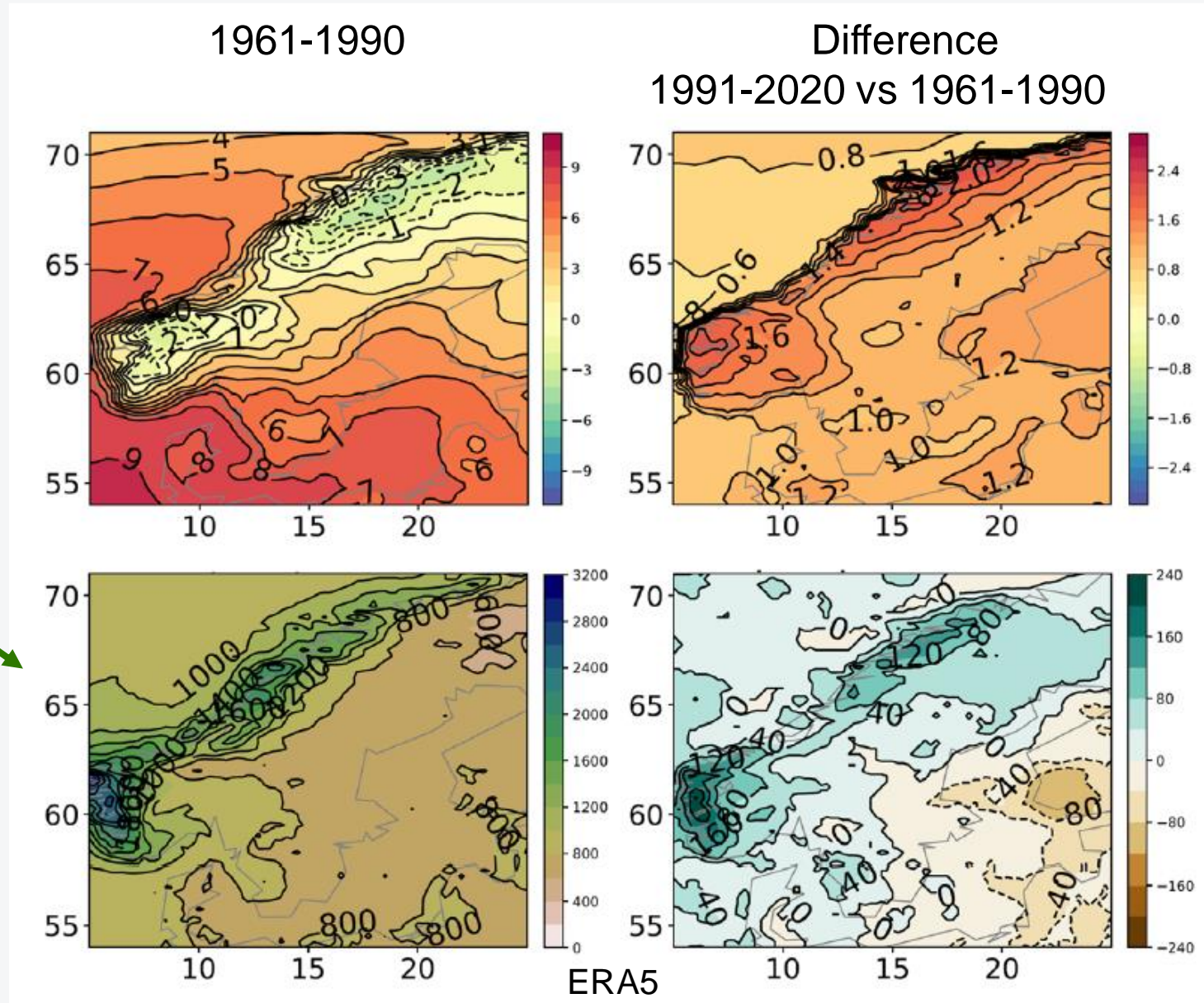


- Higher temperatures in all seasons
- Changing temperature extremes
- Longer summer season
- Shorter winter and snow season
- Precipitation:
  - more (in Scandinavia)
  - less (parts of southern Europe)
- Changing risk of flooding and drought

# Strong impacts in mountain areas

- Large increases in **temperature** and changes in **precipitation**
- Large differences in changes between west and east of the Scandinavian mountain chain

SMHI

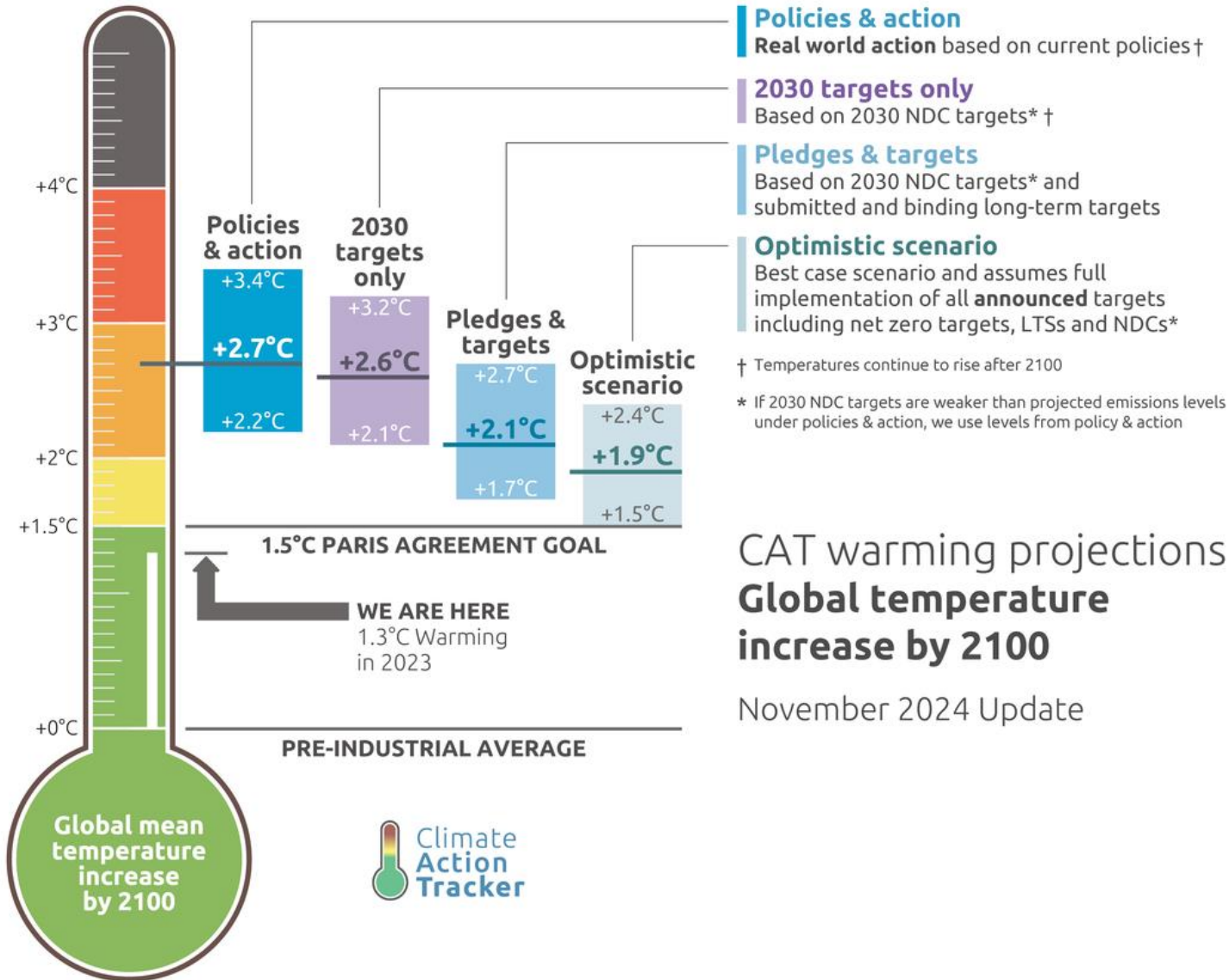


**What lies ahead of us**



# We will not stay below +1,5°C

SMHI

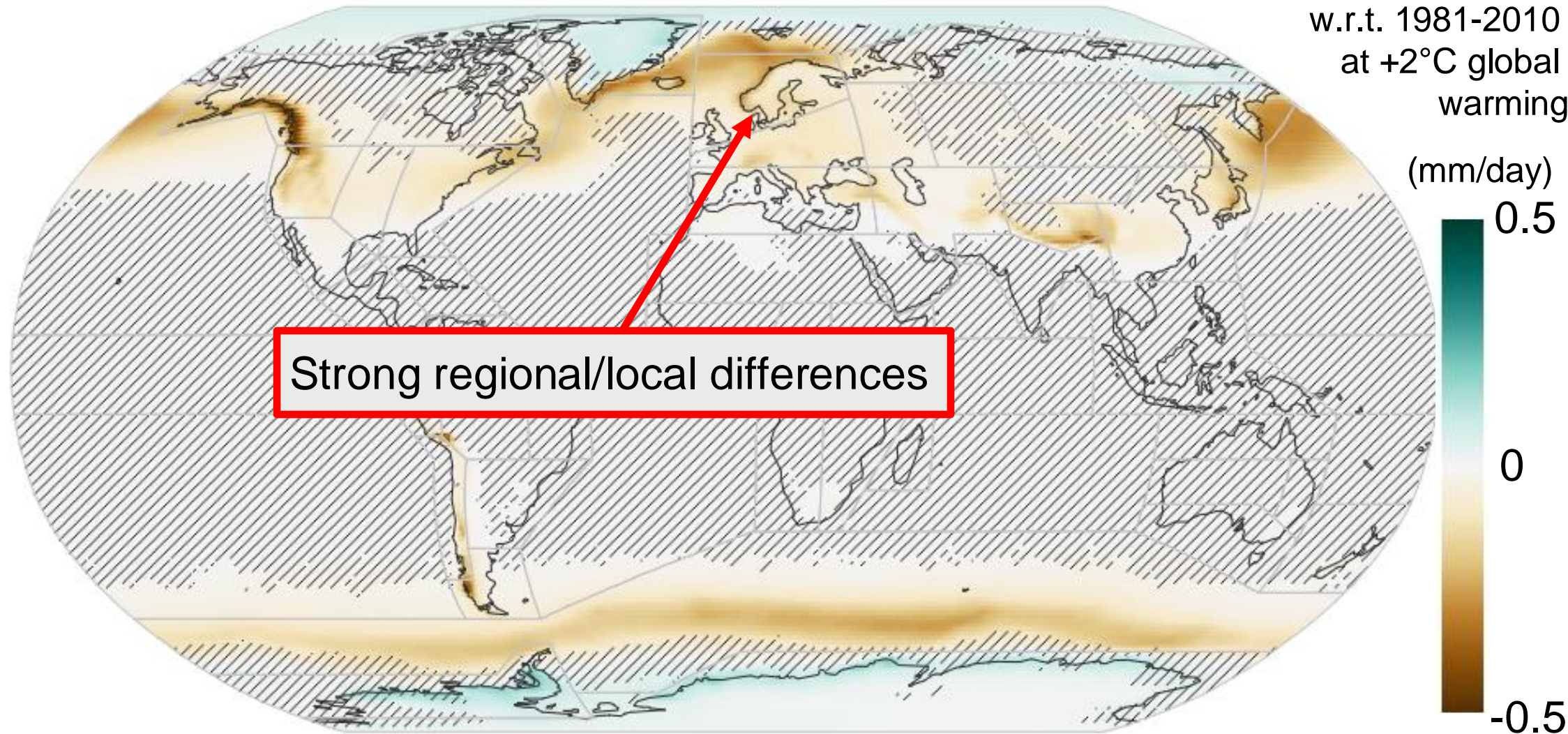


Accumulated CO<sub>2</sub> emissions over time largely controls global warming:

**Every gram matters!**

We can anticipate **warmer, wetter and drier** conditions with **changing extremes**

# Climate model project less snowfall ... SMHI in most places



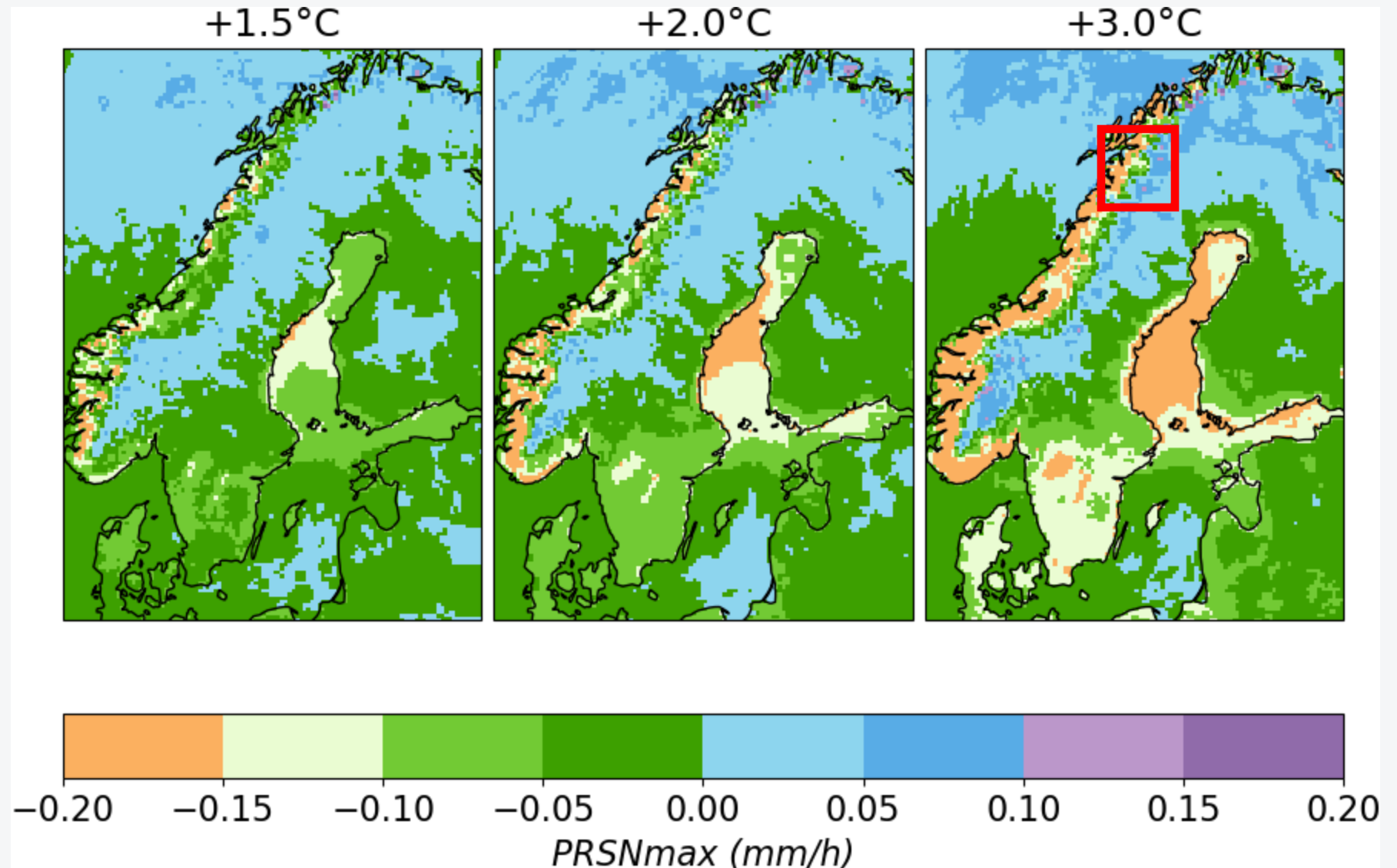


# Less intense snowfall – and more?

SMHI

Change in maximum  
intensity of snowfall  
December-March  
vs 1971-2000

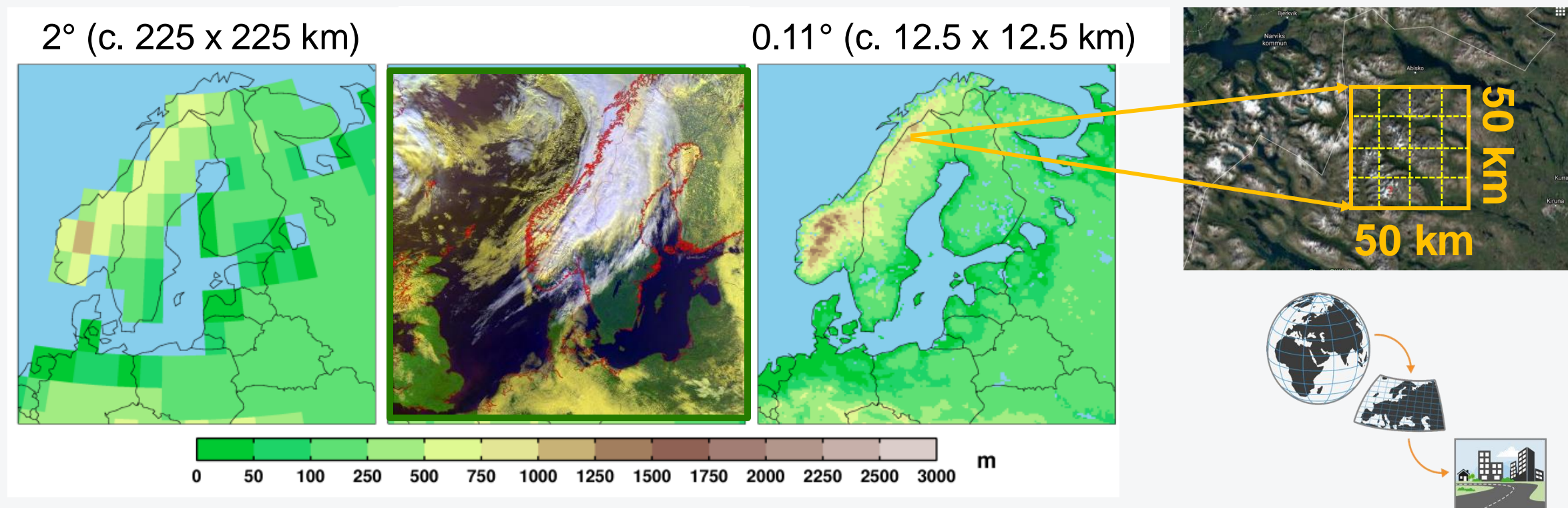
- Decreases in many locations
- Increases in some (cold enough) northern and/or high altitude areas





# Coarse scale climate models

- Typical resolution in global climate models: 80-300 km
- Resolution in regional climate models for Europe/Sweden: 12.5 km km

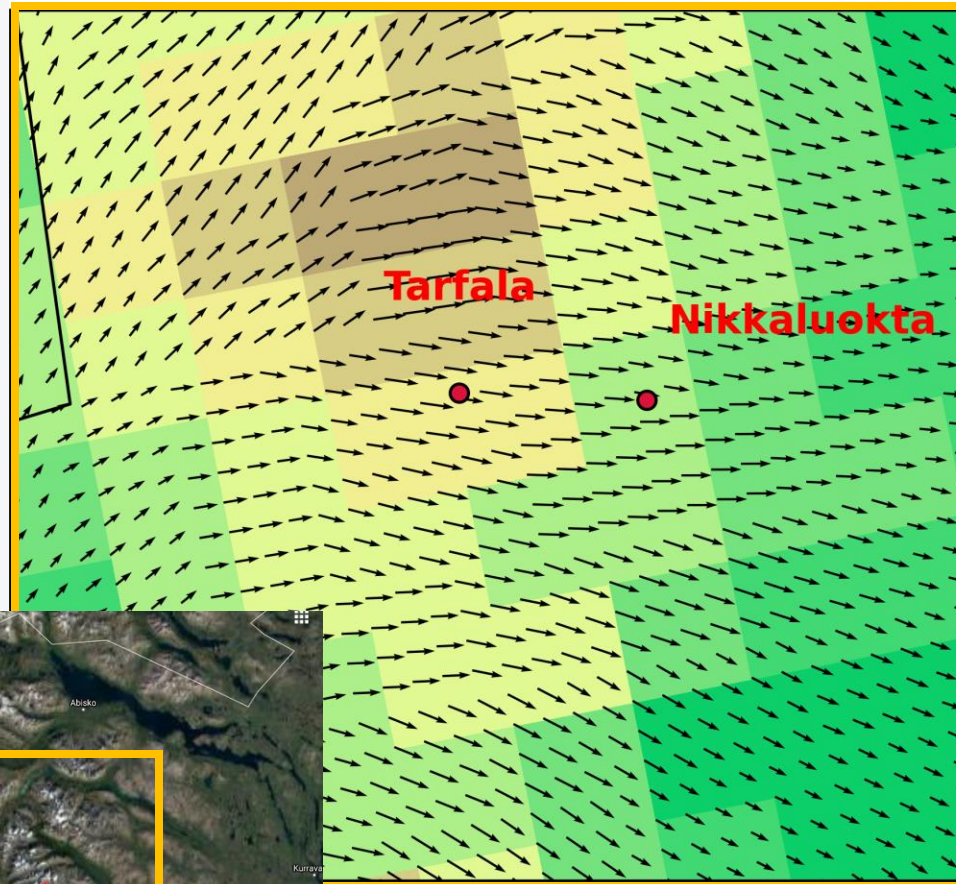




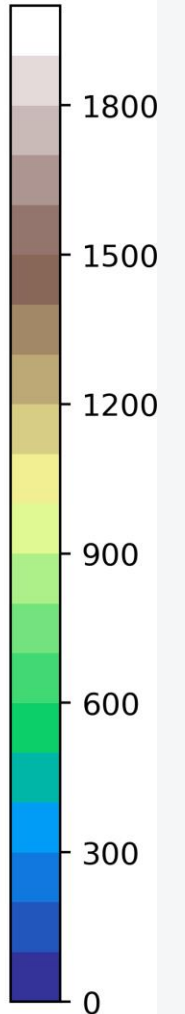
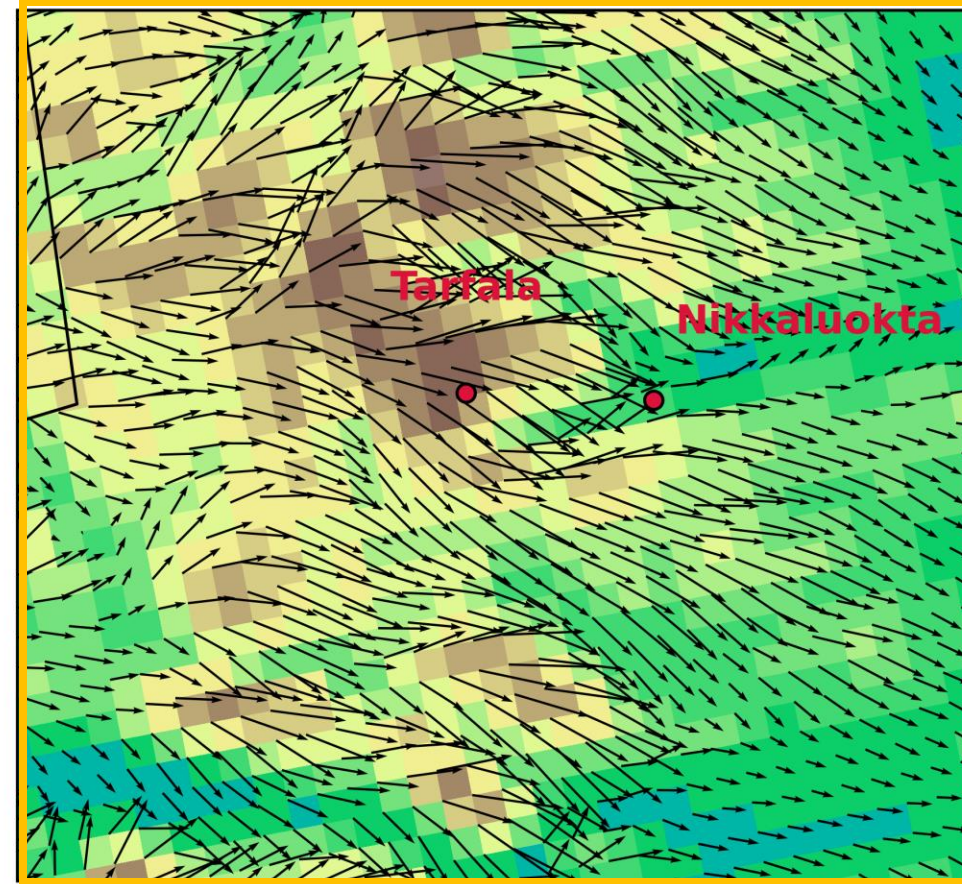
# A high resolution climate model

SMHI

Wind vectors and topography (m) - ALADIN  
2017-05-04 12:00



Wind vectors and topography (m) - AROME  
2017-05-04 12:00



15 m/s

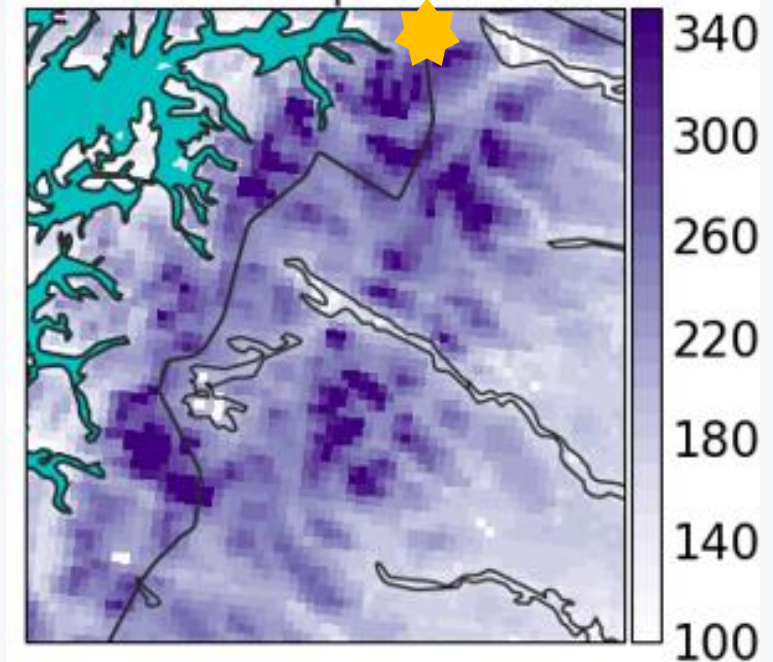
15 m/s



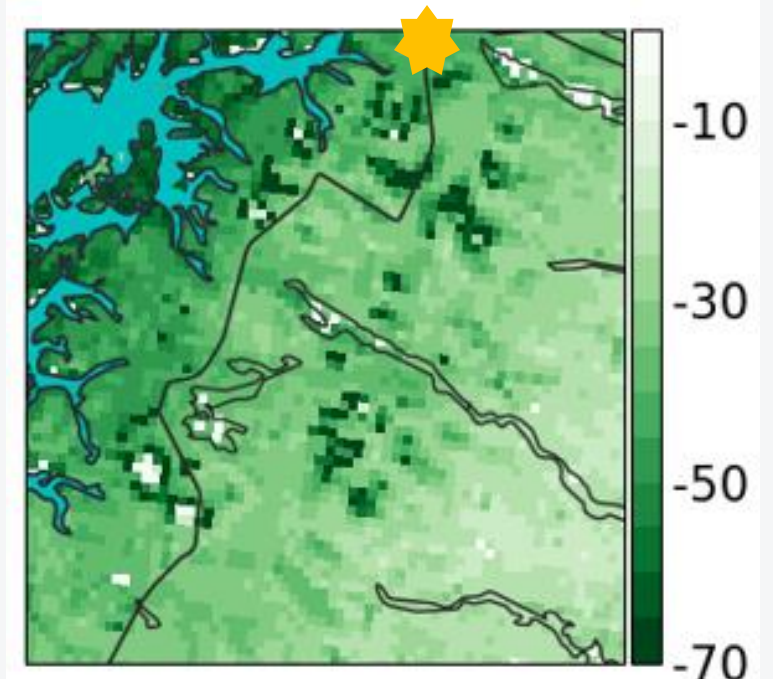
# Changes in Riksgränsen

- Warming in all seasons
- Increasing precipitation
- Less snow on the ground on an annual basis
- Fewer **days with snow on the ground**
- More periods with melting during winter

Historical  
period  
(1986-2005)



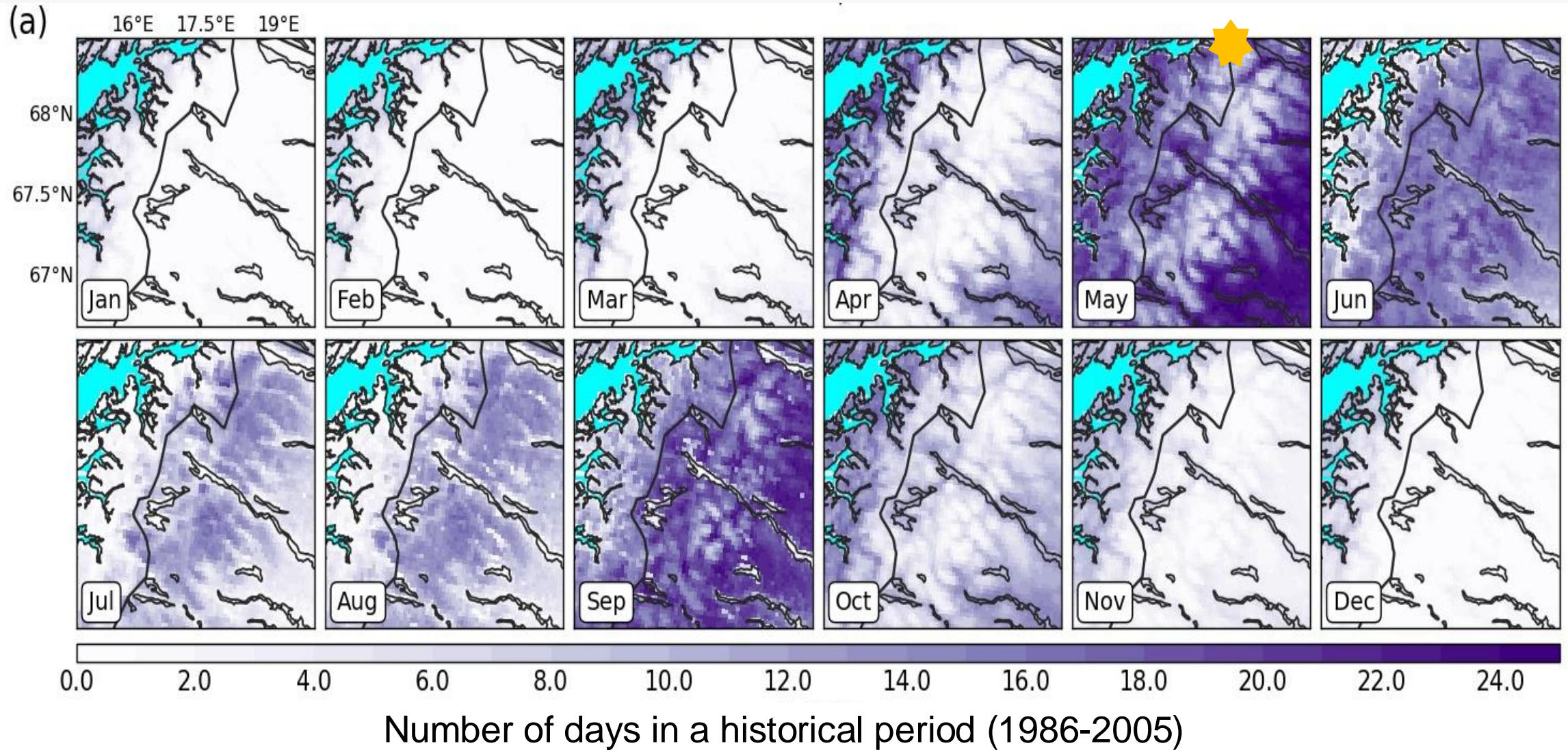
Change until  
the middle of  
the century  
(2041-2060)





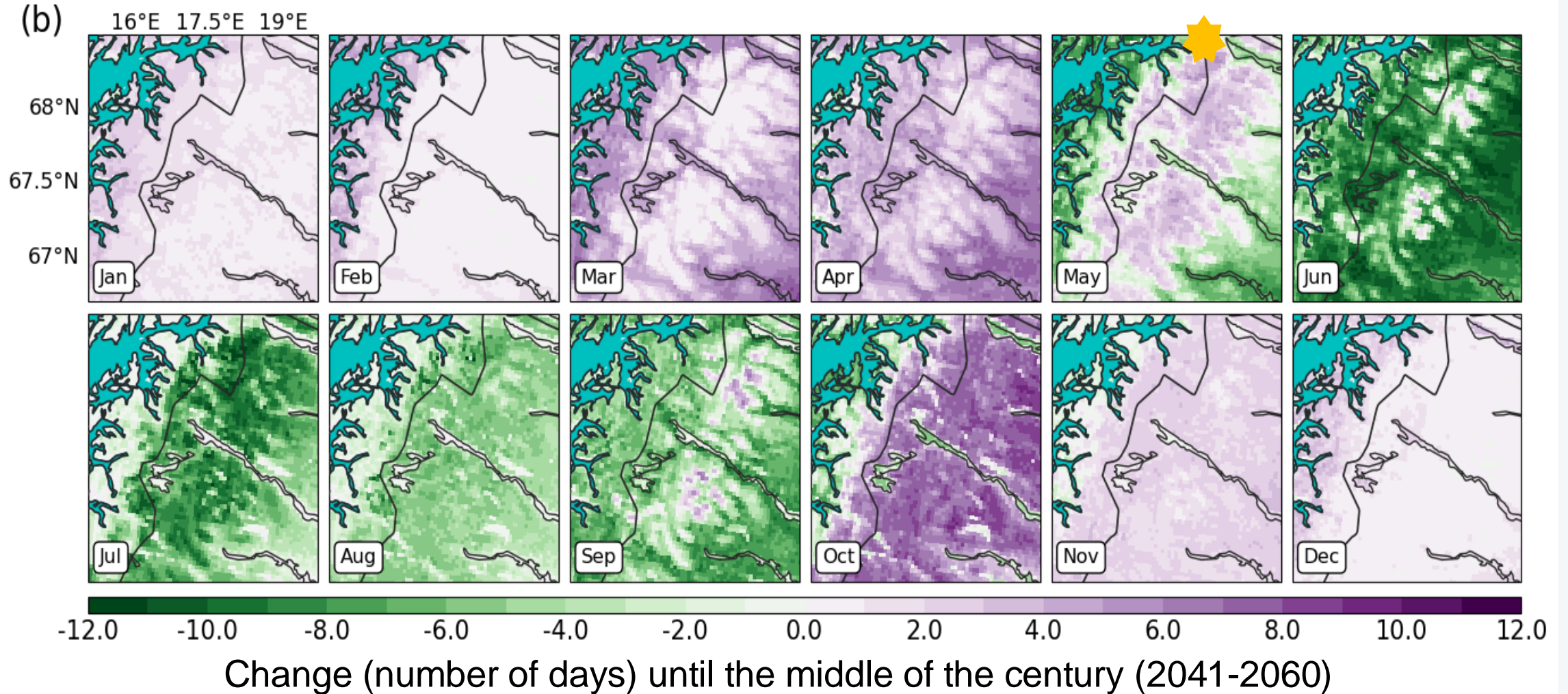
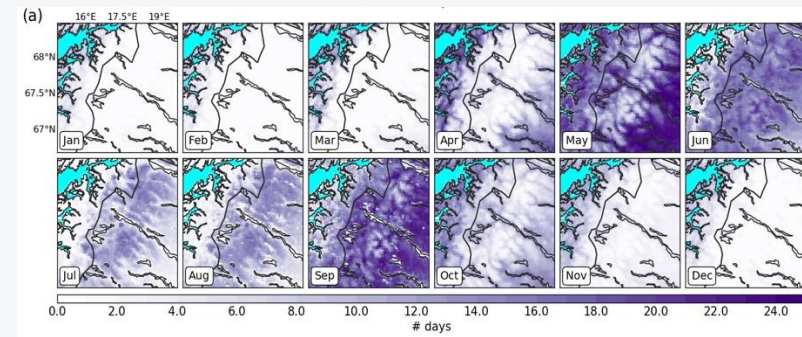
# Number of days with zerocrossings (temperatures both above and below 0°C during the same day)

SMHI



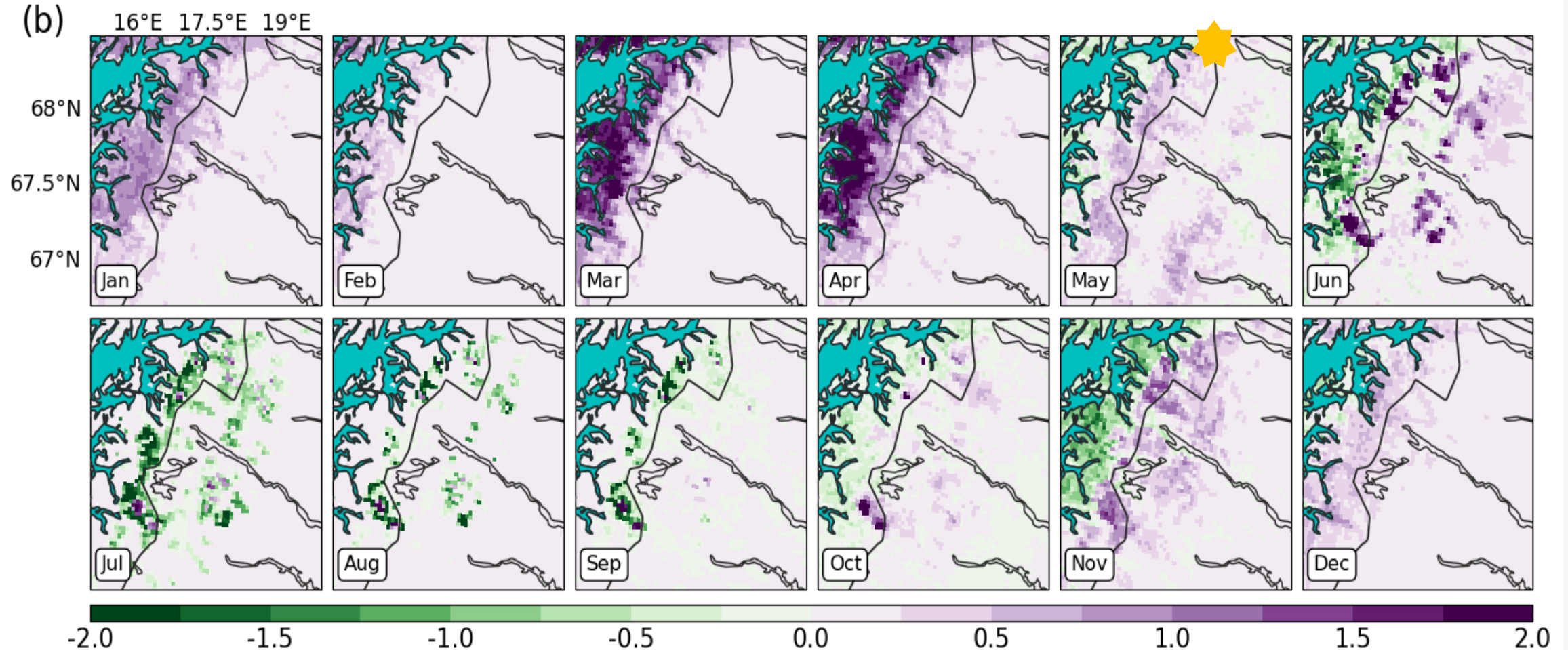


# Days with zerocrossings



# Rainy days with snow on the ground

SMHI



Change (number of days) until the middle of the century (2041-2060)



# **Impacts to be expected**

# Impacts on alpine skiing?

- Estimation of "snow scarce conditions" based on a "snow reliability index" (starting from % of the skiing resorts surface areas with >20 cm of snow)
- Historical climate + future change
- With/without artificial snow making

nature climate change

Article

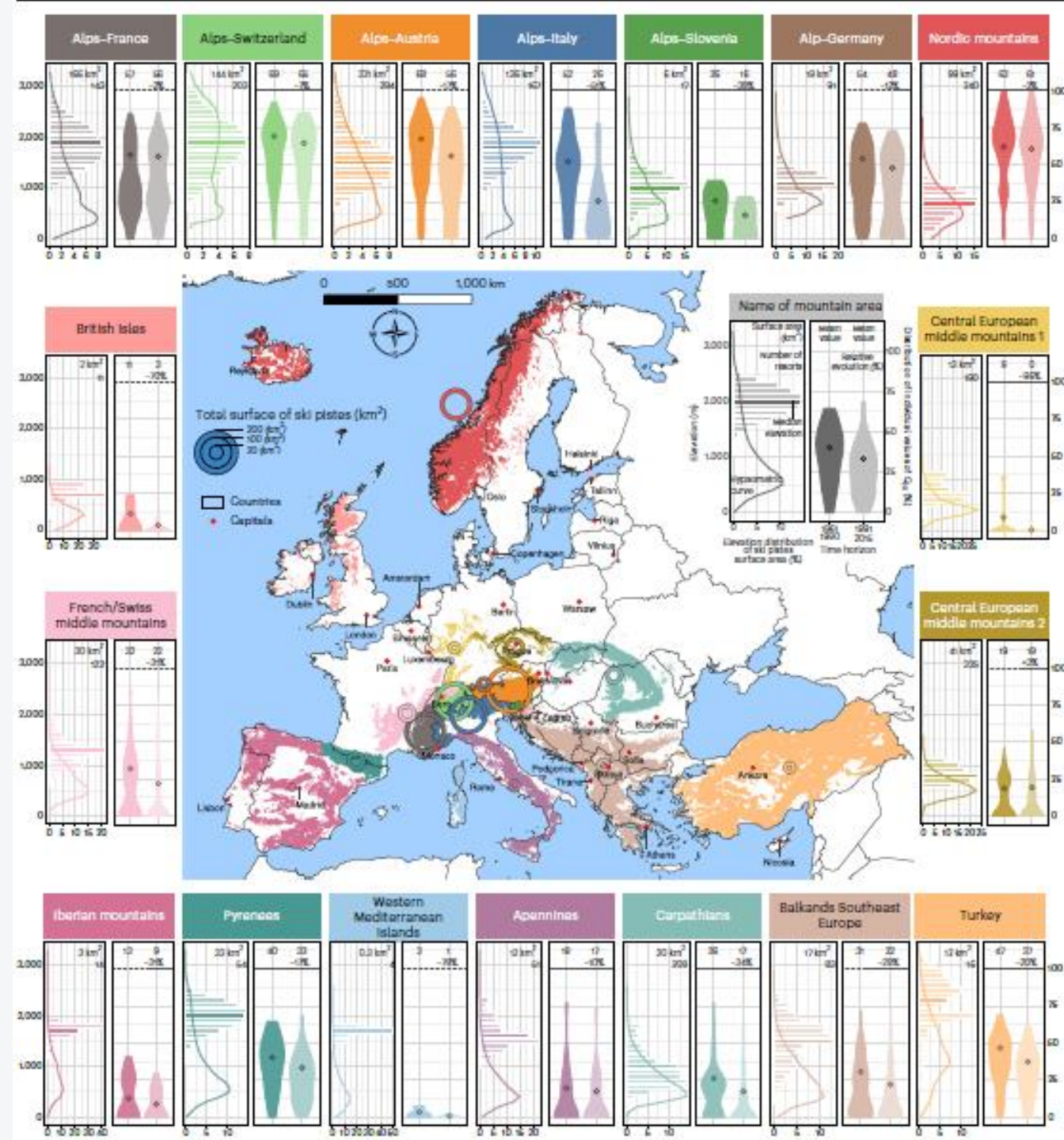
<https://doi.org/10.1038/s41558-023-01759-5>

## Climate change exacerbates snow-water-energy challenges for European ski tourism

Received: 24 July 2022

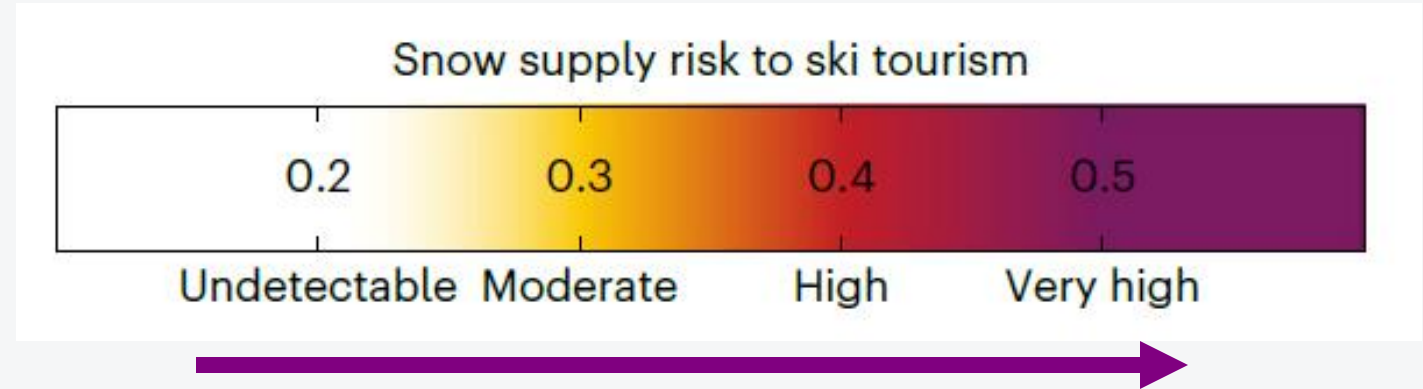
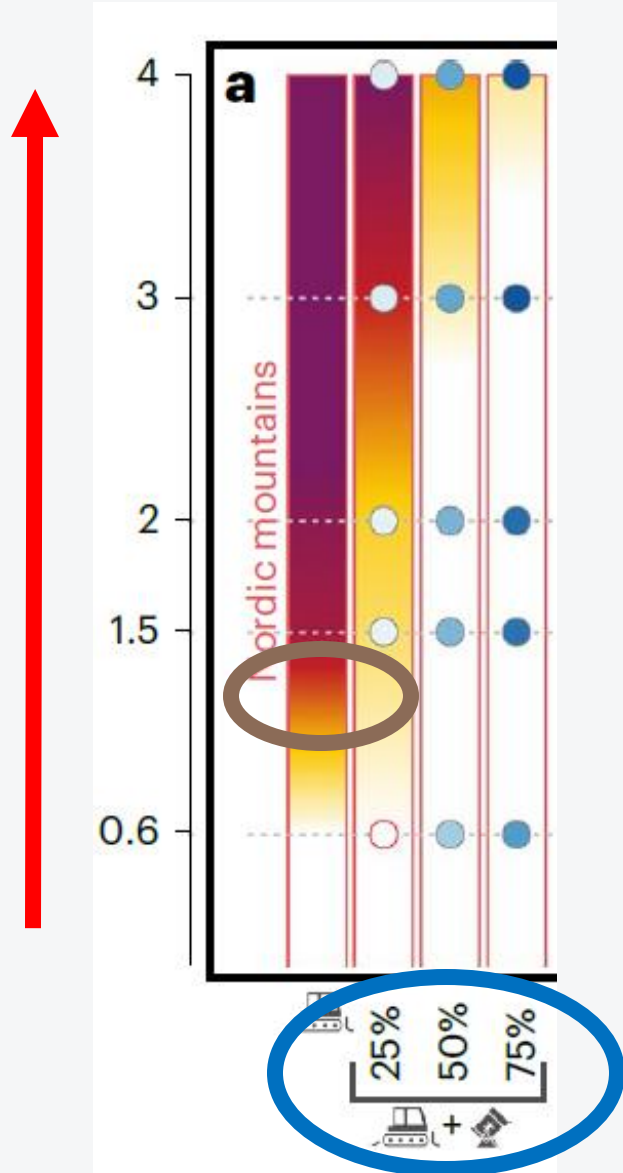
Hugues François<sup>1,6</sup>, Raphaëlle Samacoïts<sup>1,2,6</sup>, David Neil Bird<sup>3</sup>,  
Judith Köberl<sup>3</sup>, Franz Prettenhaler<sup>3</sup> & Samuel Morin<sup>4,5</sup>✉

Accepted: 6 July 2023



# Increasing snow supply risk

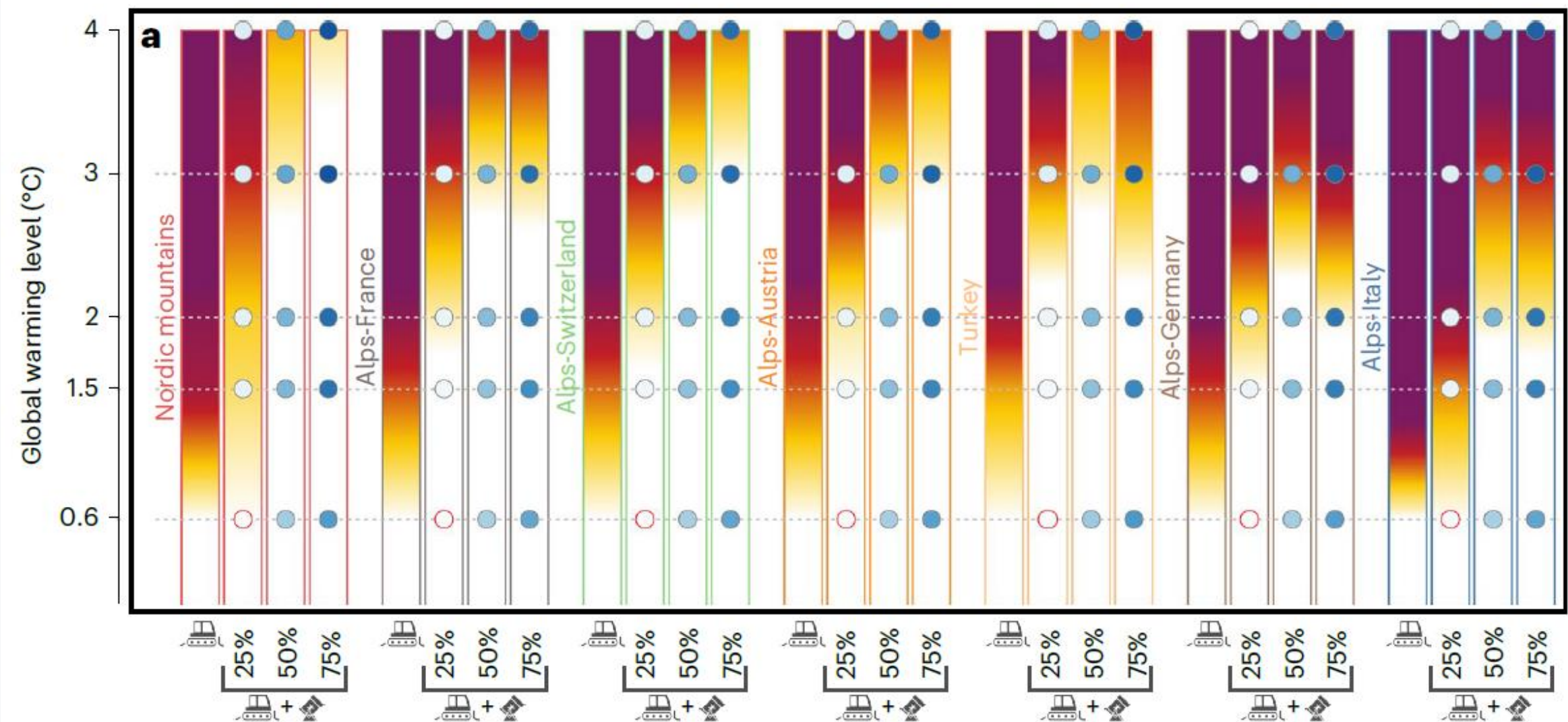
SMHI



- Increasing **risk** with increasing **global mean temperature**
- Already today at c. 1.3C global warming moderate to high risk in the Nordic region
- **Artificial snow production** can alleviate the situation even at high degree of global warming

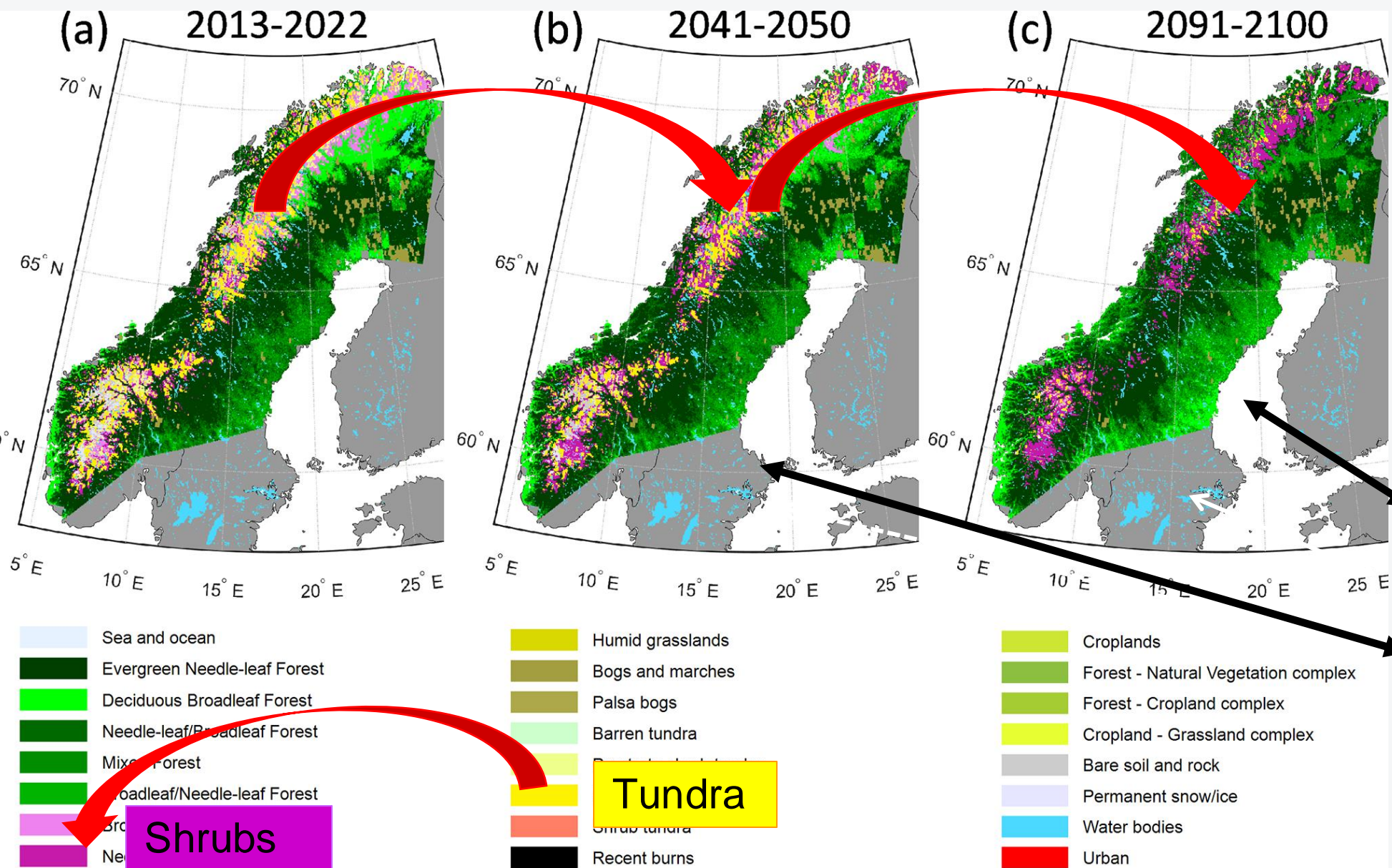


# Differences between regions



# Potential impacts on vegetation

SMHI



High-resolution  
climate model +  
dynamic  
vegetation model

Under very high  
emissions

Under higher  
emissions than  
today

(Lagergren et al., 2024)



# Expected changes in the mountains

**SMHI**

- Shorter and milder winter season
  - Generally less snow on the ground
  - Intense snowfall events still to be expected
  - More common with rain and melting
- Glaciers continues to melt
- Permafrost thawing
- Trees climbing upwards on mountain slopes
- Strong impacts on natural ecosystems and society
- Climate change adaptation will be needed
- Snow scarce conditions increasing risk for skiing

