

CLIMATE CHANGE IN SWEDEN WITH IMPACTS FOR REINDEER HUSBANDRY

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Reindeer herding in Sweden ...

SMHI

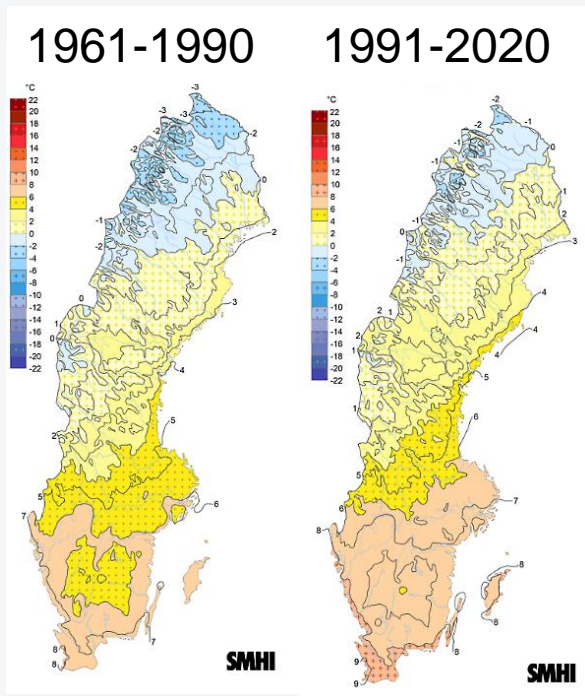


- 51 reindeer herding communities covering half of Sweden
- Adapting to changing weather conditions and availability of food by moving between pastures



... and some challenges

- Climate change
- Land use changes
- "Green transition"

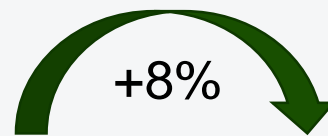


Annual mean temperature



+1,1°C

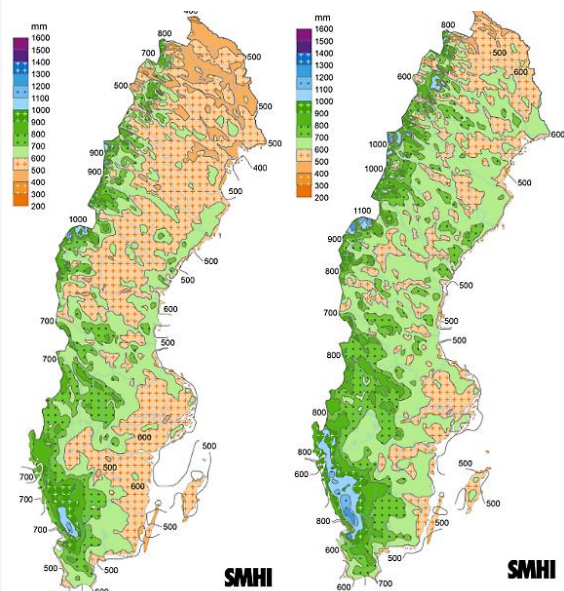
SMHI



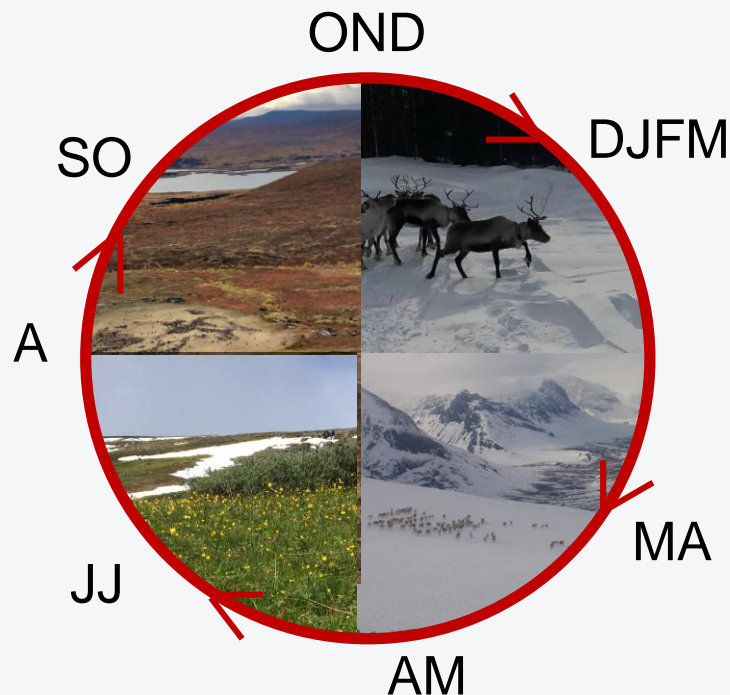
+8%

Annual precipitation

1961-1990 1991-2020



Co-production of relevant climate information



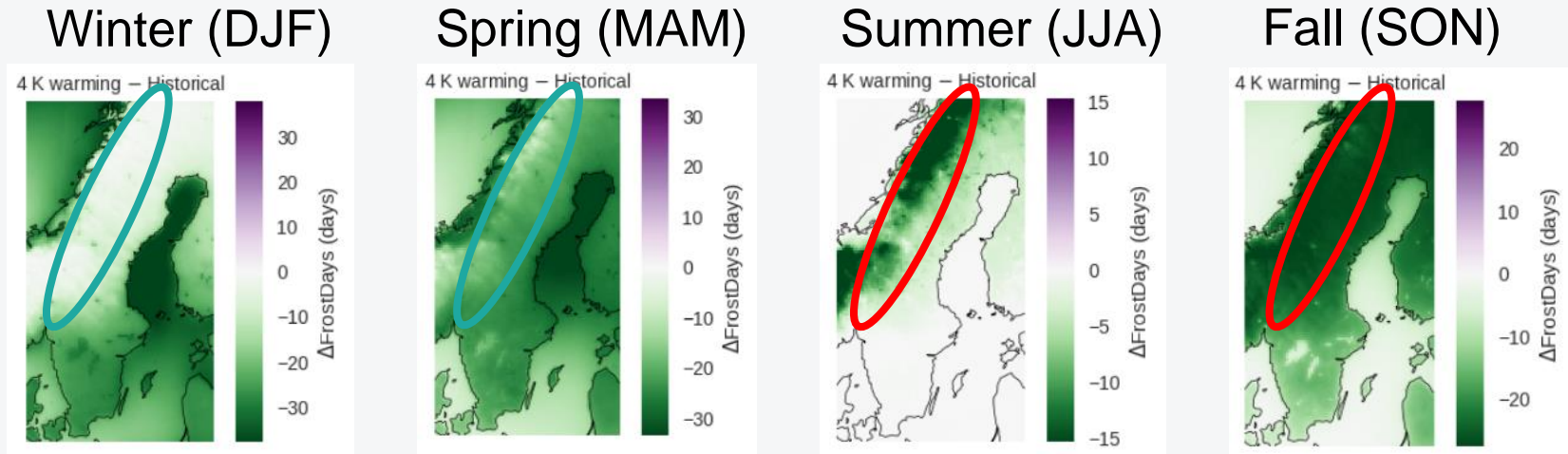
- Dialogue between reindeer herders and climate scientists
- Identifying a set of climate change indicators
- Based on ~60 EURO-CORDEX simulations analysed at a range of global warming levels

Analyzed climate indicators

- Start and end of vegetation period (**tasmean**)
- Warm days (**tasmax** > 20°C)
- Heat waves (consecutive days with **tasmax** > 20°C)
- Zerocrossings (**tasmin** < 0°C & **tasmax** > 0°C)
- Frost days (**tasmin** < 0°C)
- "Warm snowfall" (**prsn** > 0 and **tasmean** > -2°C)
- Snowfall amount (**prsn**)
- Maximum snowfall intensity (**prsn**)
- Effective precipitation (**pr** - **evap**)
- Number of dry days (**pr** = 0)
- Longest consecutive period of dry days (**pr** = 0)

Less frost days ($T_{\min} < 0^{\circ}\text{C}$)

At +4°C global warming relative to 1971-2000



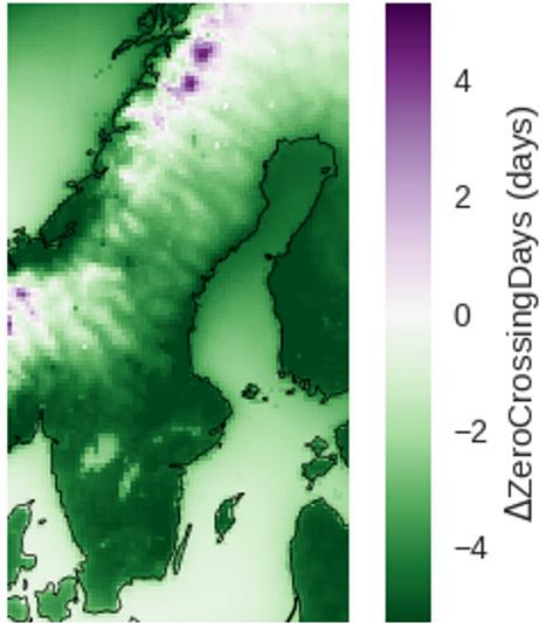
Small or no change in DJF or at high elevation in MAM

Large change in JJA (notably at high elevation) and in SON

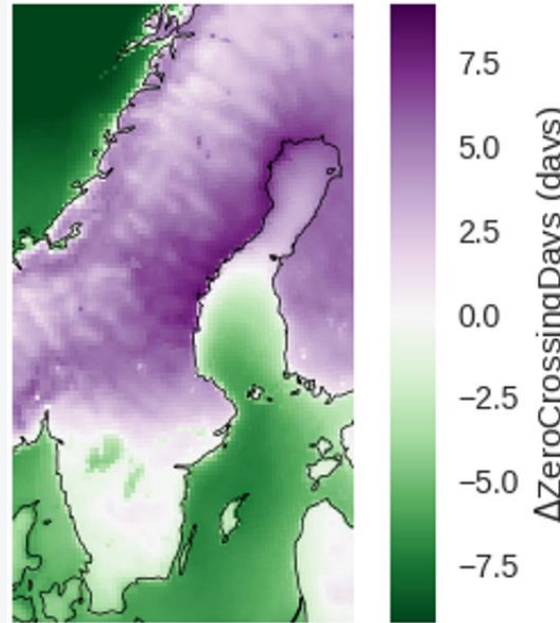
Changes in days with zerocrossings

At +2°C global warming relative to 1971-2000

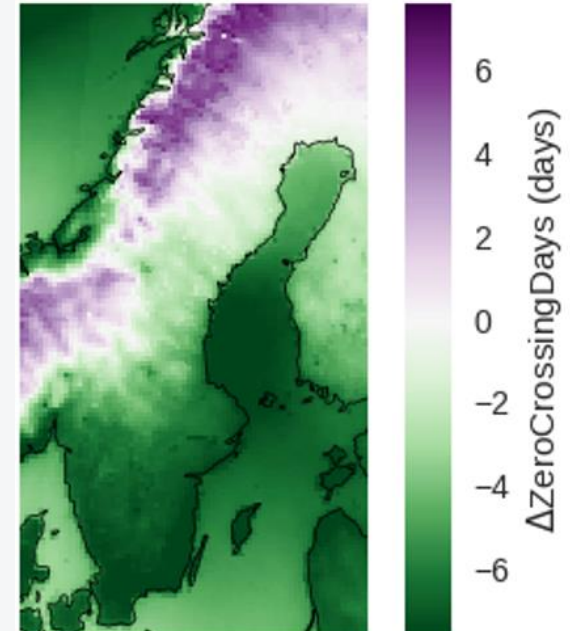
Fall (SON)



Winter (DJF)



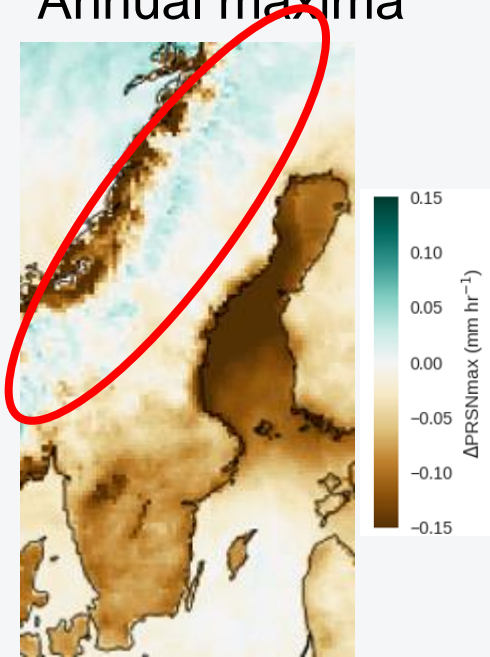
Spring (MAM)



Changes in snowfall

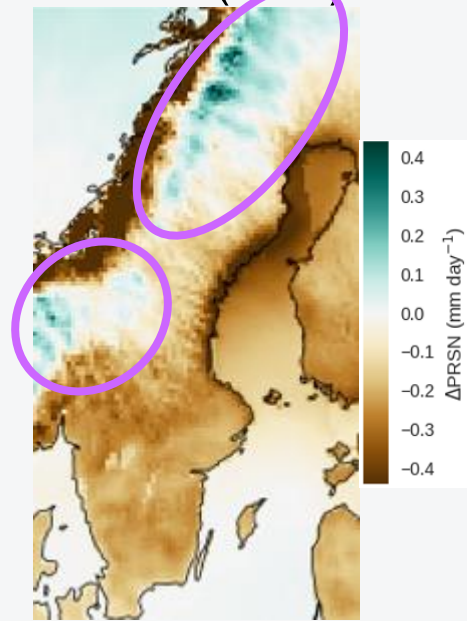
At +2°C global warming relative to 1971-2000

Annual maxima

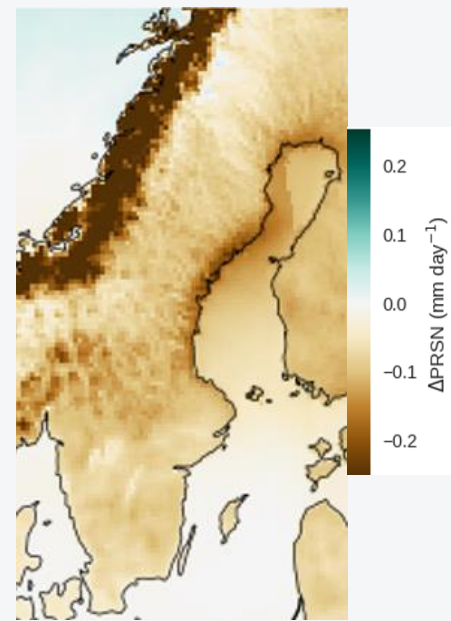


- Increase in cold areas in winter
- Intense snowfall may increase

Winter (D.J.F)

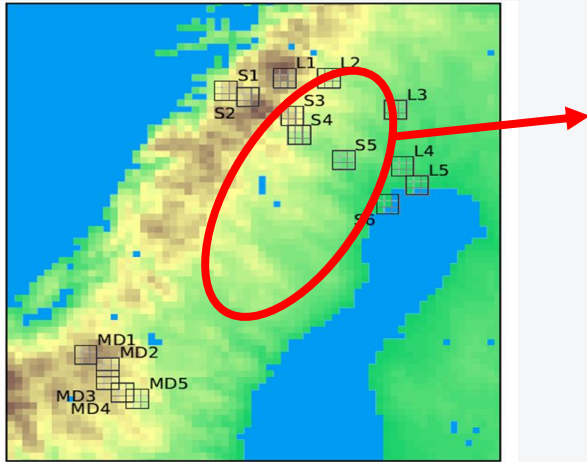


Annual mean



Calculation of climate indicators

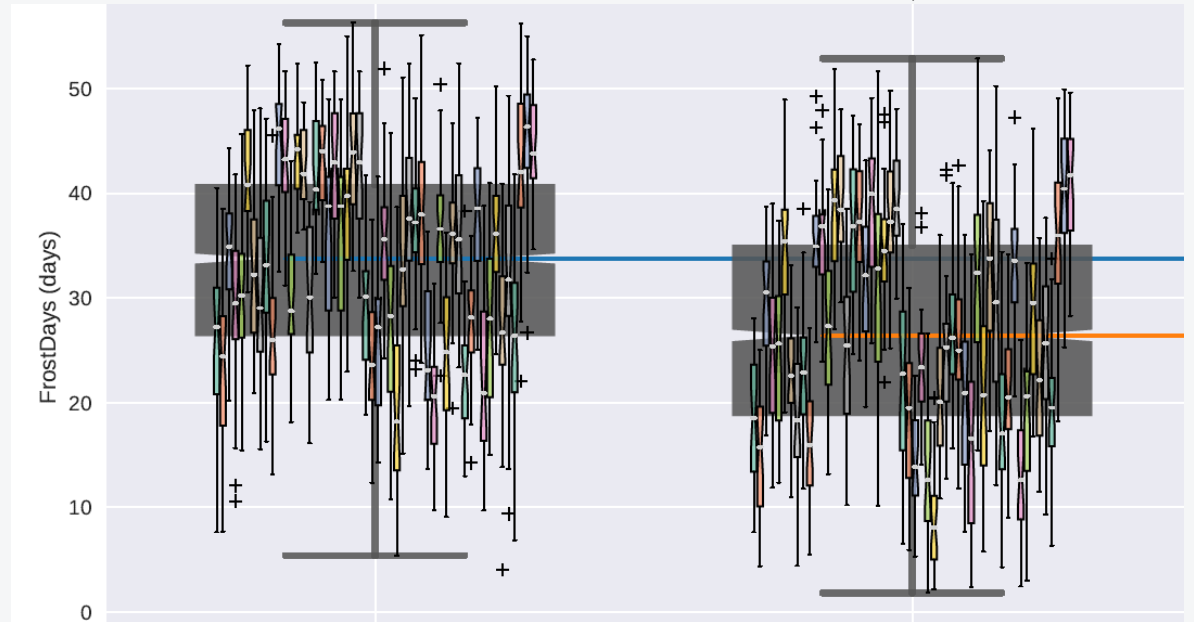
- Daily data
- No bias adjustment
- Relevant areas and seasons



Number of frost days in September and October

1971-2000

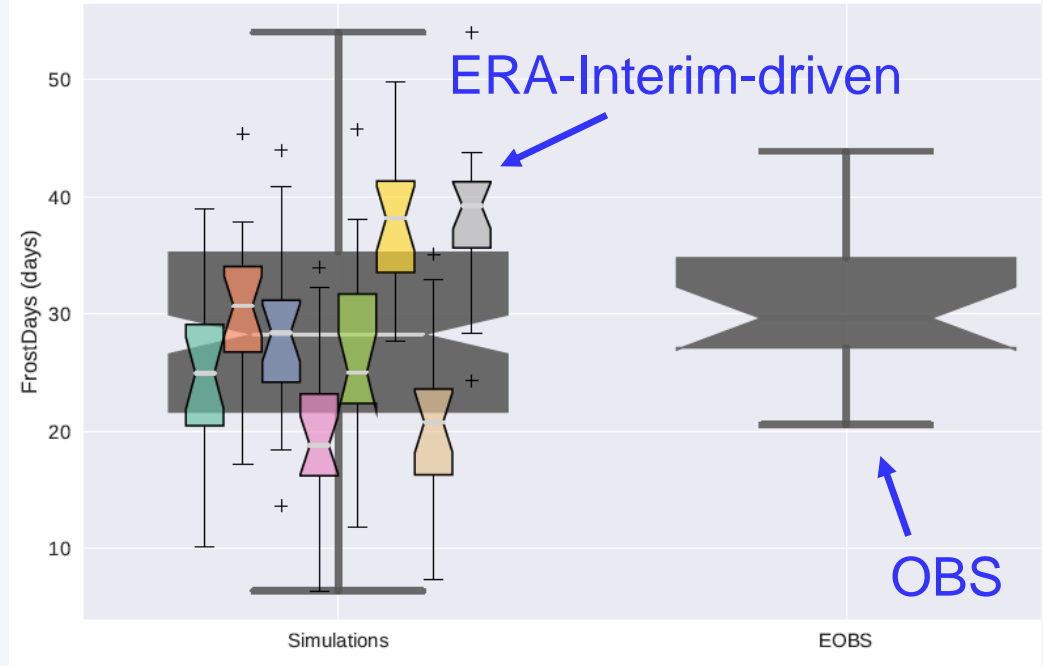
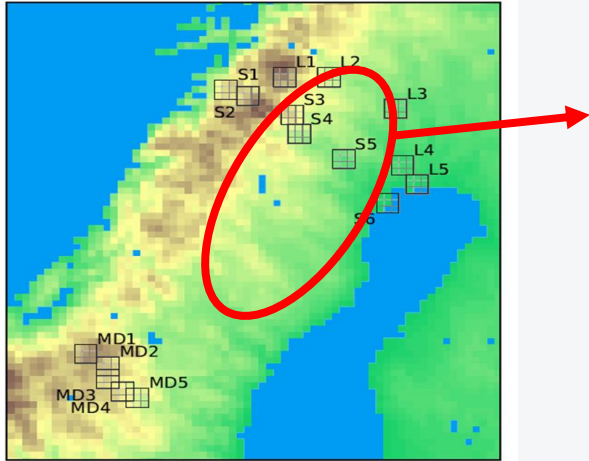
+1,5°C



area mean & interannual variability

RCMs come with biases

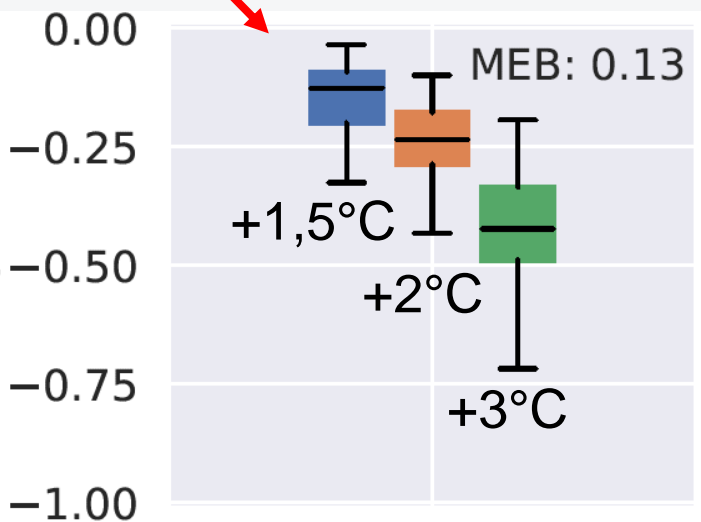
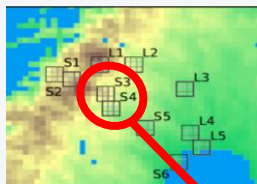
Number of frost days in September and October



area mean & interannual variability

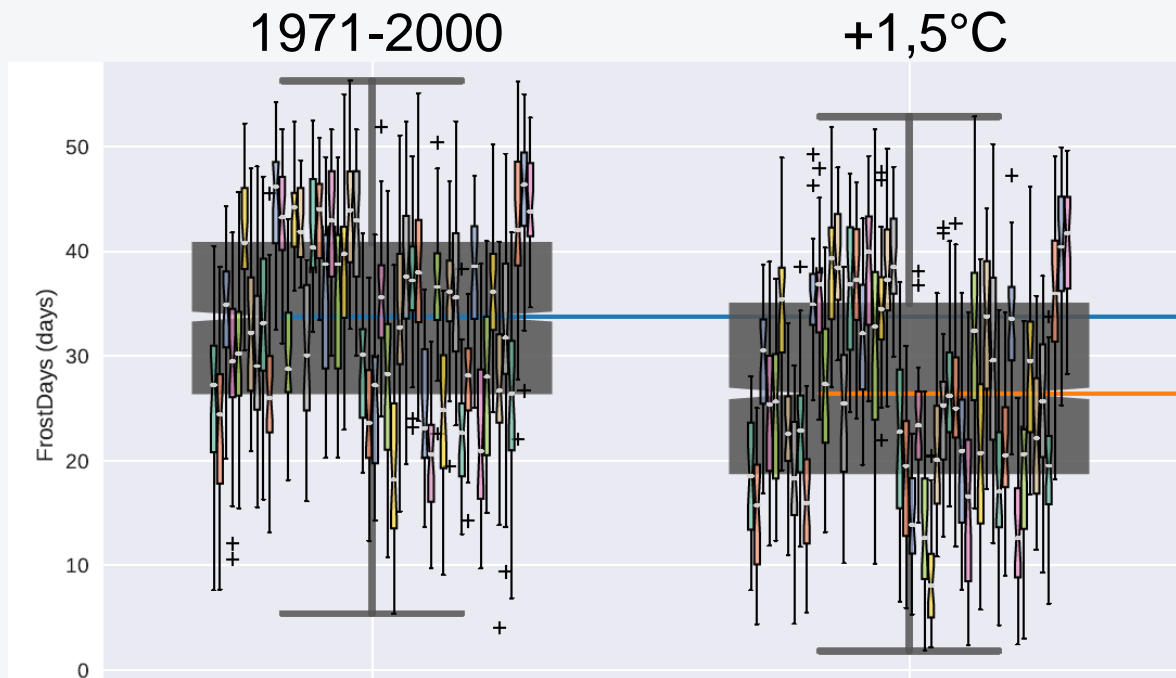
Focus on tendencies and relative changes

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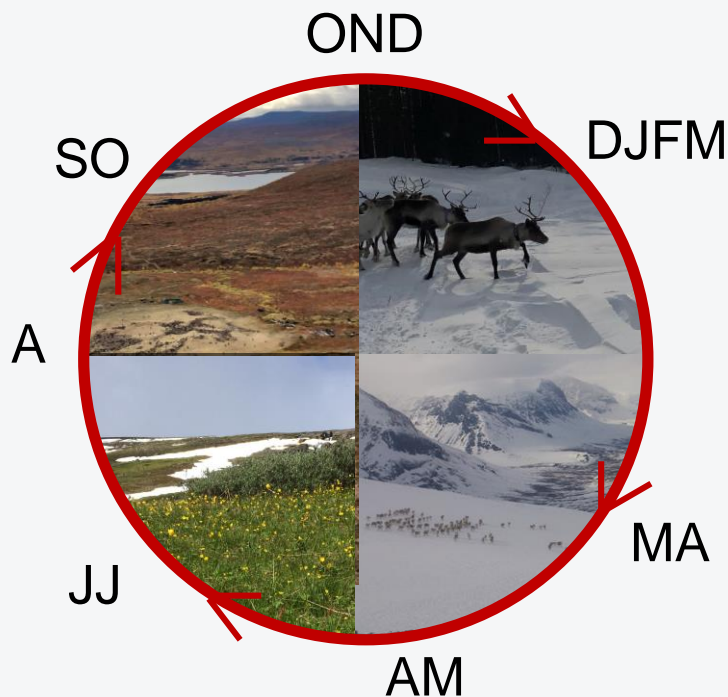
area mean & ensemble spread

Number of frost days in September and October



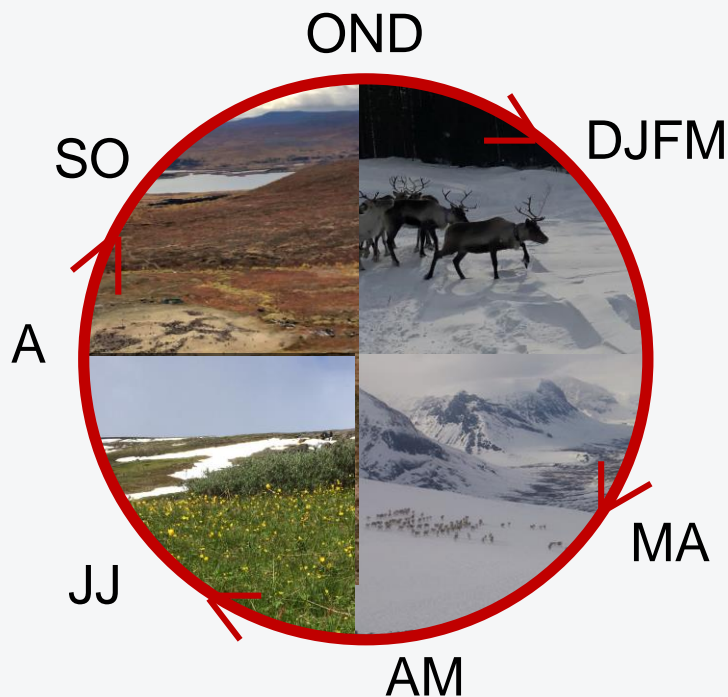
area mean & interannual variability

Simulated changes



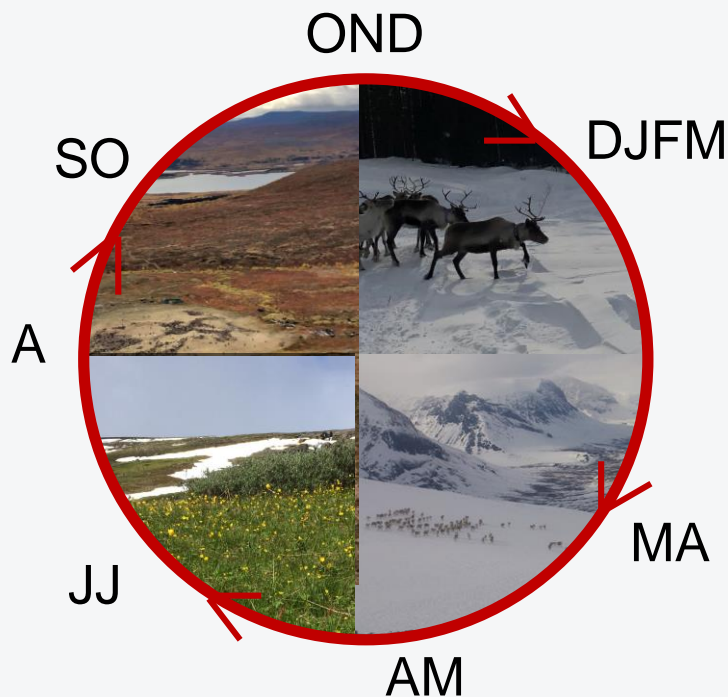
- Longer vegetation period
- More warm days
- Small change in P-E in summer
- Shorter snow season
- Less frost days
- More days with zero-crossings except in summer/early fall
- More days with "precipitation close to 0°C" in winter
- Less snowfall except in winter

Implications of climate change



- More heat-related problems in summer
- More problems with freeze-thaw cycles, rain-on-snow etc in the winter half of the year
- Modifications of seasonal migration patterns
- Shift of areas needed for grazing

Room for improvement



- Model resolution too coarse for representing complex orography
- Large biases in RCMs
- Indicators give crude representation of some phenomena
- Some variables lacking in model output

Thanks for your attention!

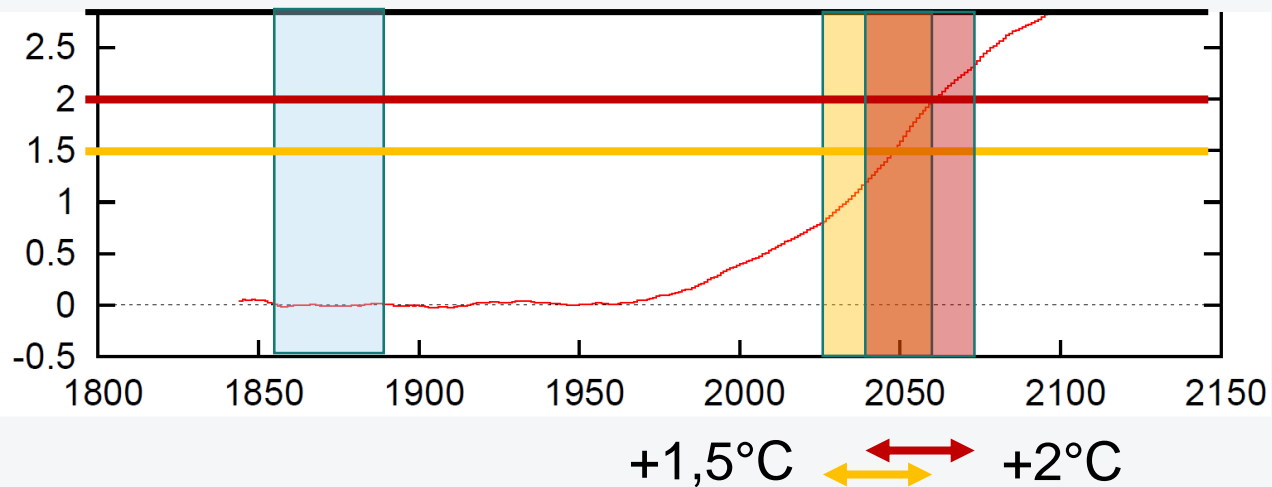
See also session D4:

STRANDBERG Gustav Tailored CORDEX data for the Swedish energy sector – a stakeholder focused approach

Kjellström et al., 2021 (in Swedish), <https://energiforsk.se/media/29543/forandringar-i-klimatet-som-paverkar-energisektorn-i-sverige-energiforskrappport-2021-745.pdf>

Calculation of warming levels

Running 30-year averages of global mean temperature



Note:

- *Periods are partly overlapping*
- *Climate is not stationary*