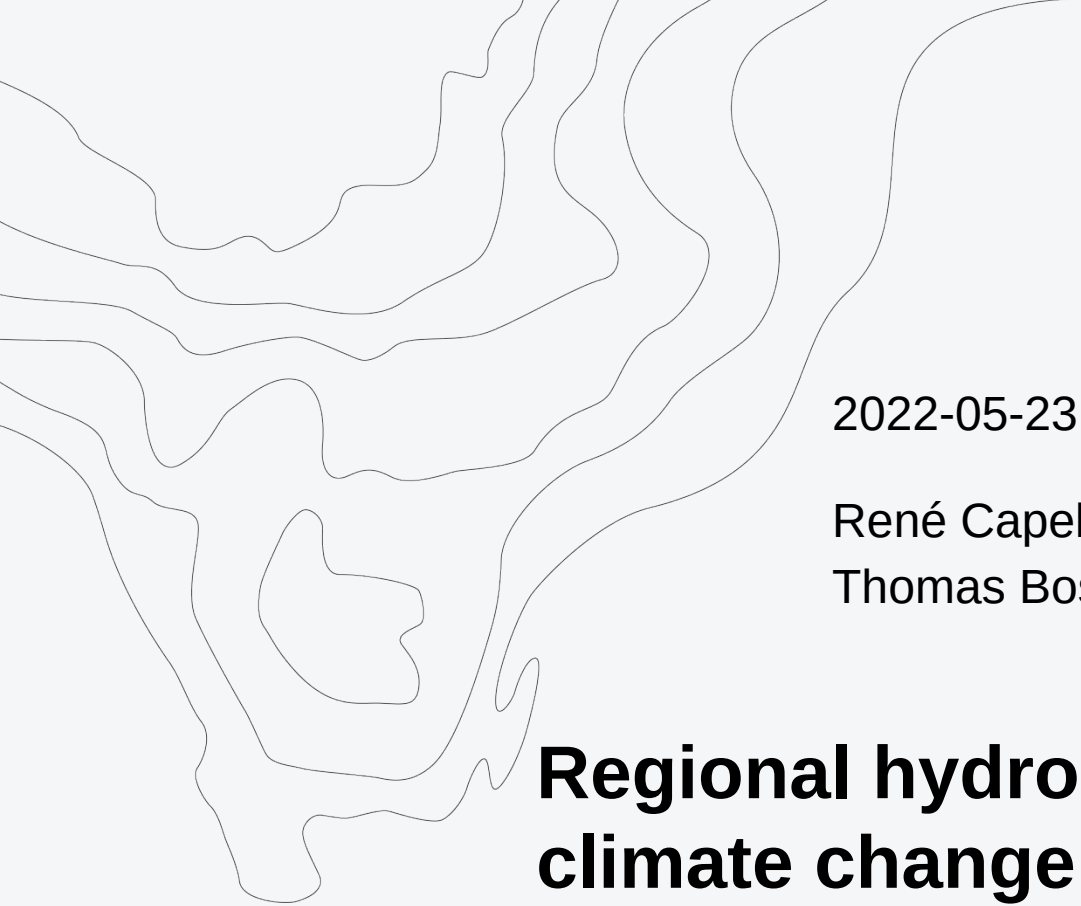

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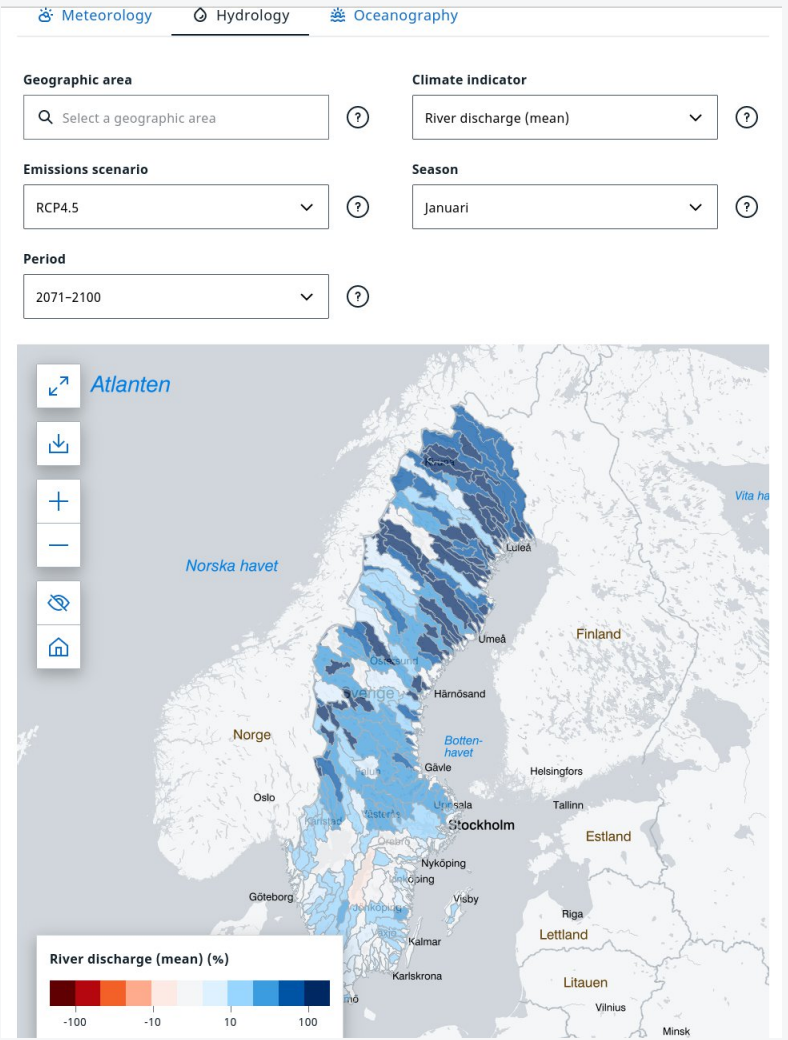
# Regional hydrological response to climate change across Sweden - Impact modelling and communication

# Climate Change Scenario Service

- Primary target audience: regional planners in Sweden
- Multi-disciplinary web service
- Climate impacts indicators (CIIs)
  - Discharge, mean and for range of return periods
  - Runoff
  - Soil moisture
  - Snow water equivalent
  - Precip + Temperature
- Spatially aggregated to ~250 river basin sections
- RCPs preserved, ensemble aggregated
- Robustness and ensemble spread to communicate uncertainty

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# Impact model chain

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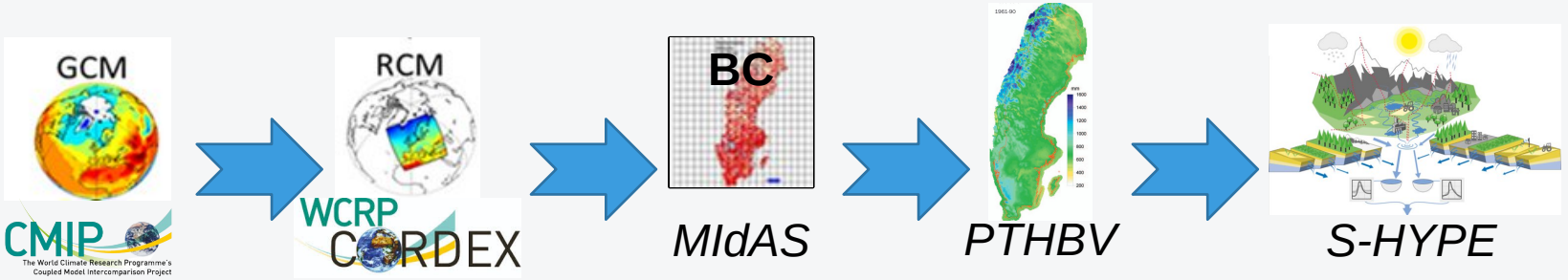
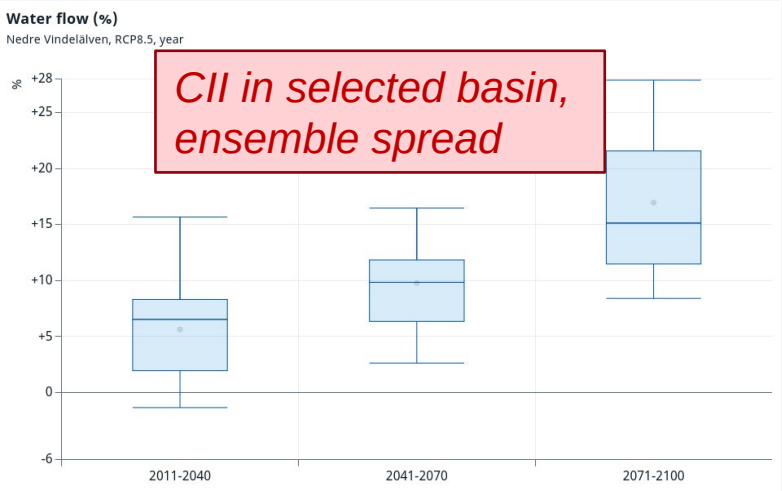
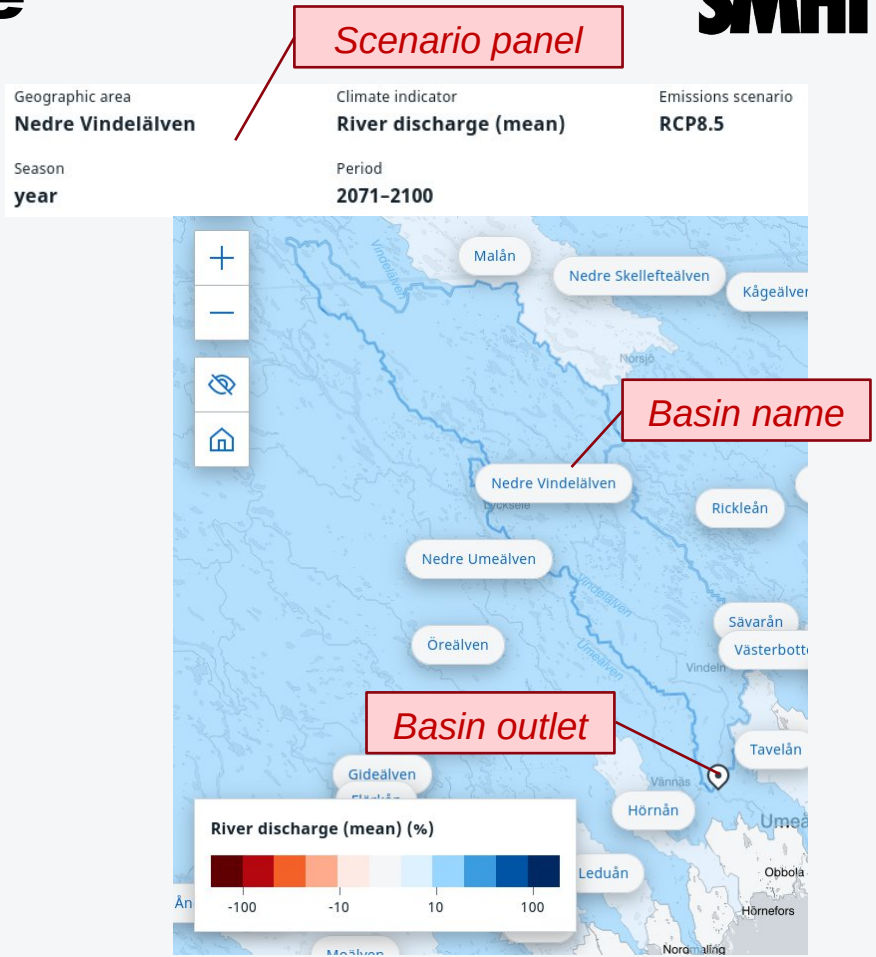



- CMIP-5 GCM – CORDEX RCM ensemble
- RCPs 2.6, 4.5, and 8.5
- 16 member ensemble
- Bias correction with quantile mapping method MIdAS ((MultI-scale bias AdjuStment; Berg m.fl., 2021) to gridded reference forcing data (PTHBV)
- S-HYPE hydrological impact model: Process-based, regionalised parameterisation, ~40,000 sub-basins, operationally used and trusted, performance published in separate web service (vattenwebb.smhi.se)

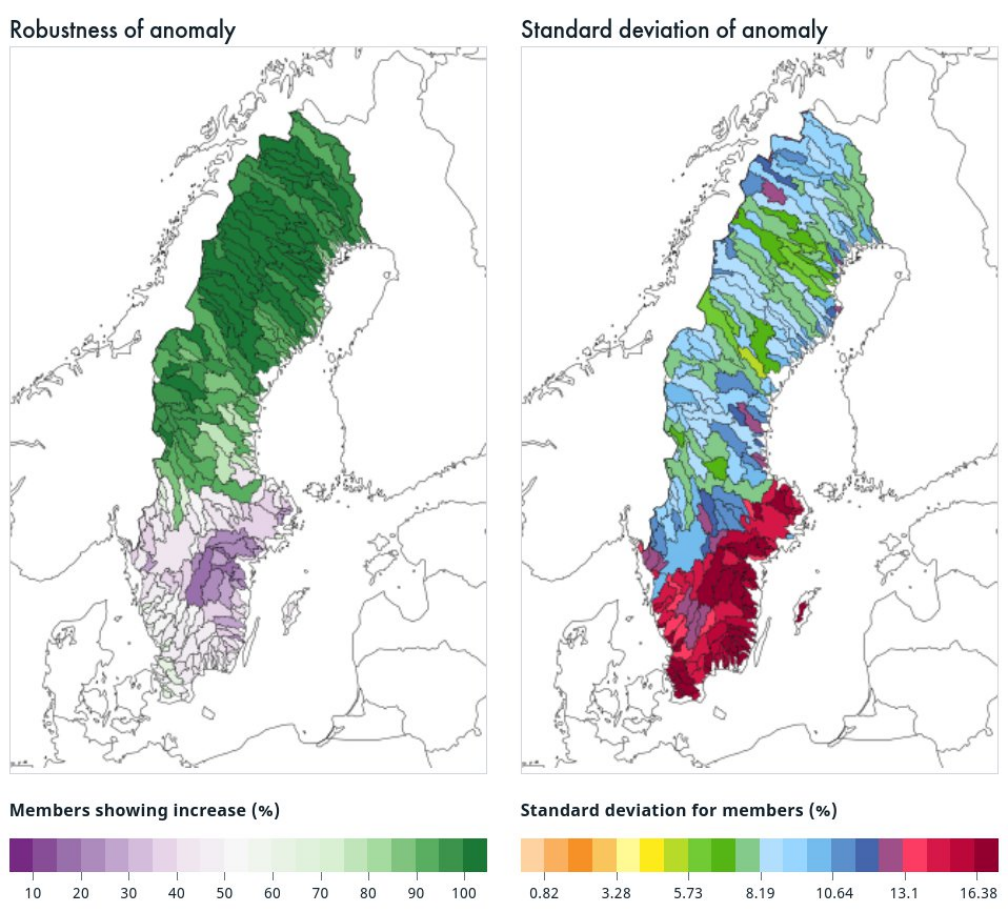
# Service user experience

- Select scenario combination and CII
- Select river basin section
- Map view to provide regional context
- CII impacts as boxplots for selected basin



# Service user experience




- Evaluation of climate change impact
  - Robustness:
    Do ensemble members agree on direction?
  - Standard deviation in CII:
    Is change signal stronger/weaker than ensemble spread?

# Projected impacts on hydrology across Sweden

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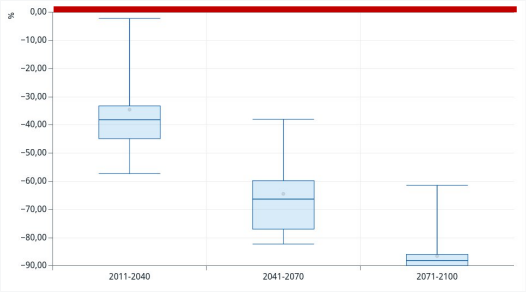
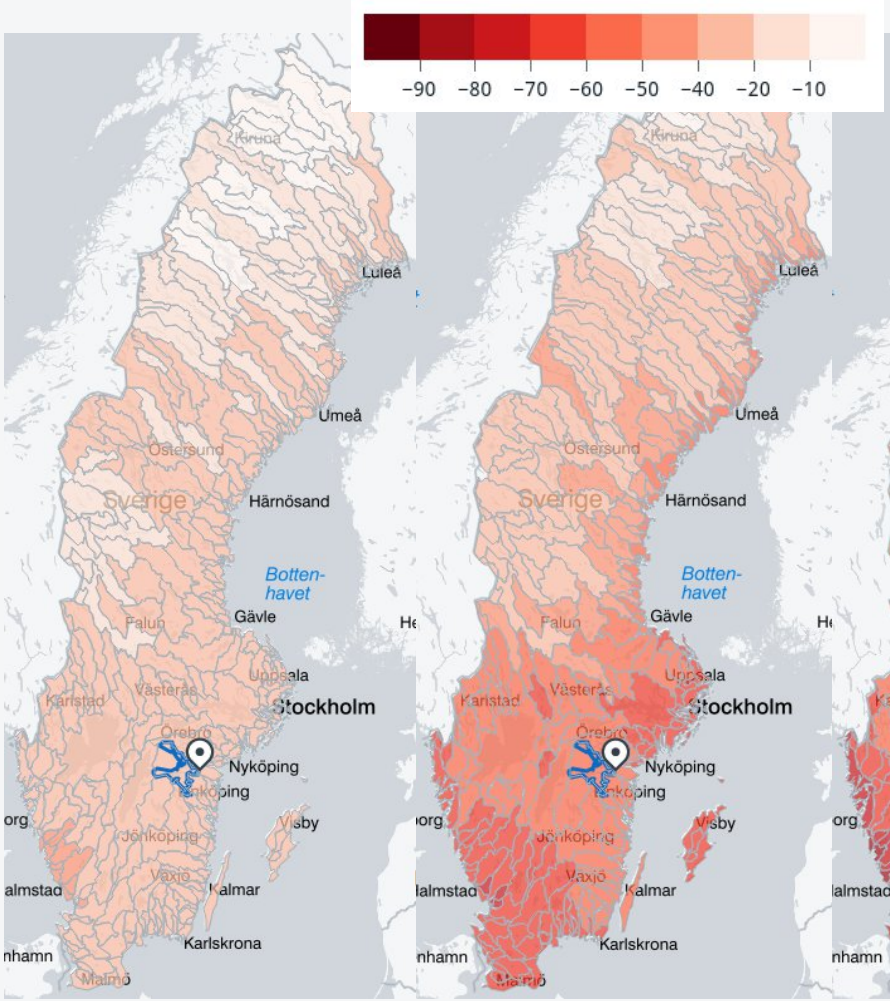
- Long latitudinal extent, covering a temperate to cold climate gradient
- Two web service examples which highlight changes with societal relevance
  - Maximum snow water equivalent
  - Summer soil moisture
- Two examples of SHYPE-modelled impacts at full spatial resolution
  - Köppen-Geiger climate classes
  - Discharge regime changes

# Diminished snow season

- Maximum annual snow water equivalent
- Change for RCP 8.5 and three future periods
- Major impact on hydrological cycle




*Ensemble spread, Motala Ström*



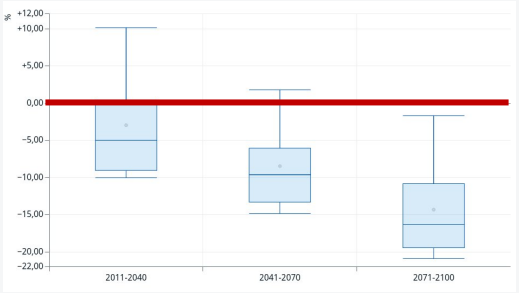

*2011 to 2040*

*2041 to 2070*

*2071 to 2100*

# Drier summers

- HYPE Soil moisture for July
- Change for RCP 8.5 and three future periods
- Less robust than snow
- Change in seasonal pattern with high impact on several societal sectors




*Ensemble spread, Motala Ström*


*2011 to 2040*


*2041 to 2070*


*2071 to 2100*

# Projected climate classification (Köppen-Geiger)

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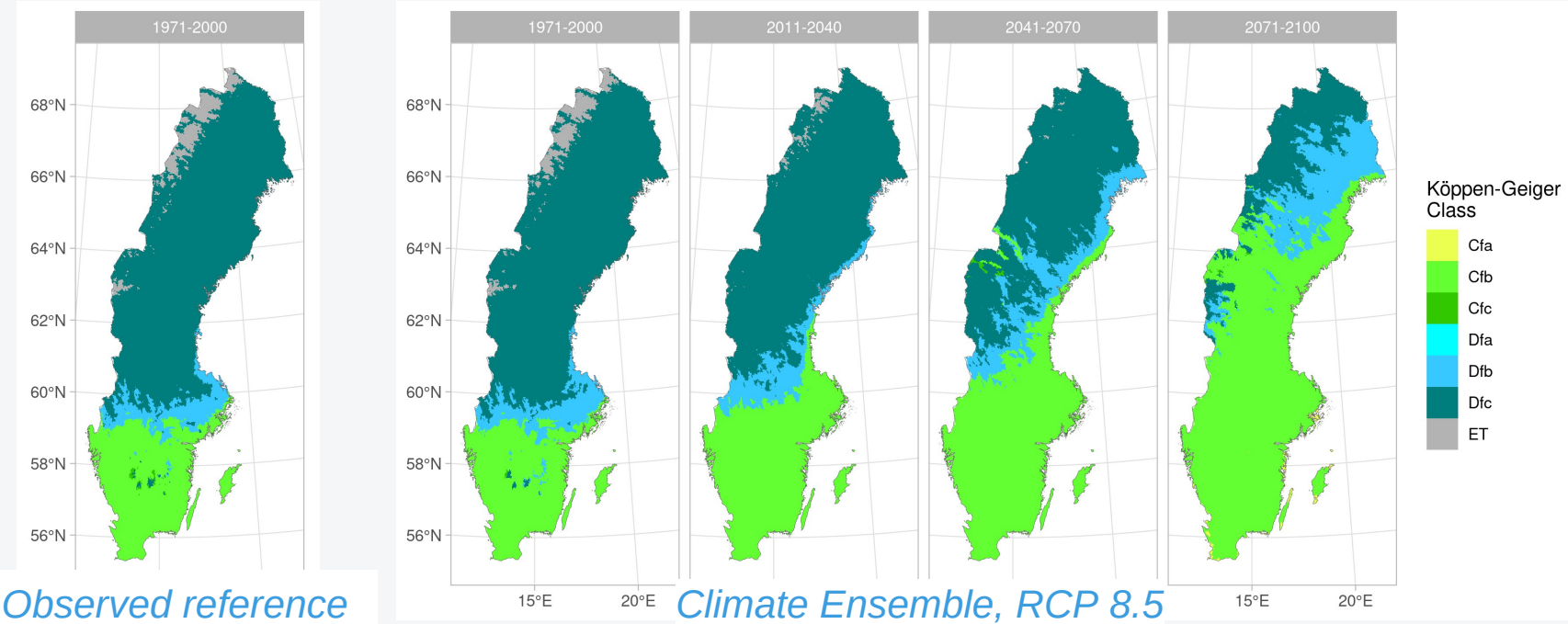
- Based on all ensemble members with bias correction to
- Massive loss of Subarctic climate (Dfc) projected
- Tundra climate (ET) vanishes from mountain range




*Observed reference*

*Climate Ensemble, RCP 8.5*

# Projected climate classification (Köppen-Geiger)

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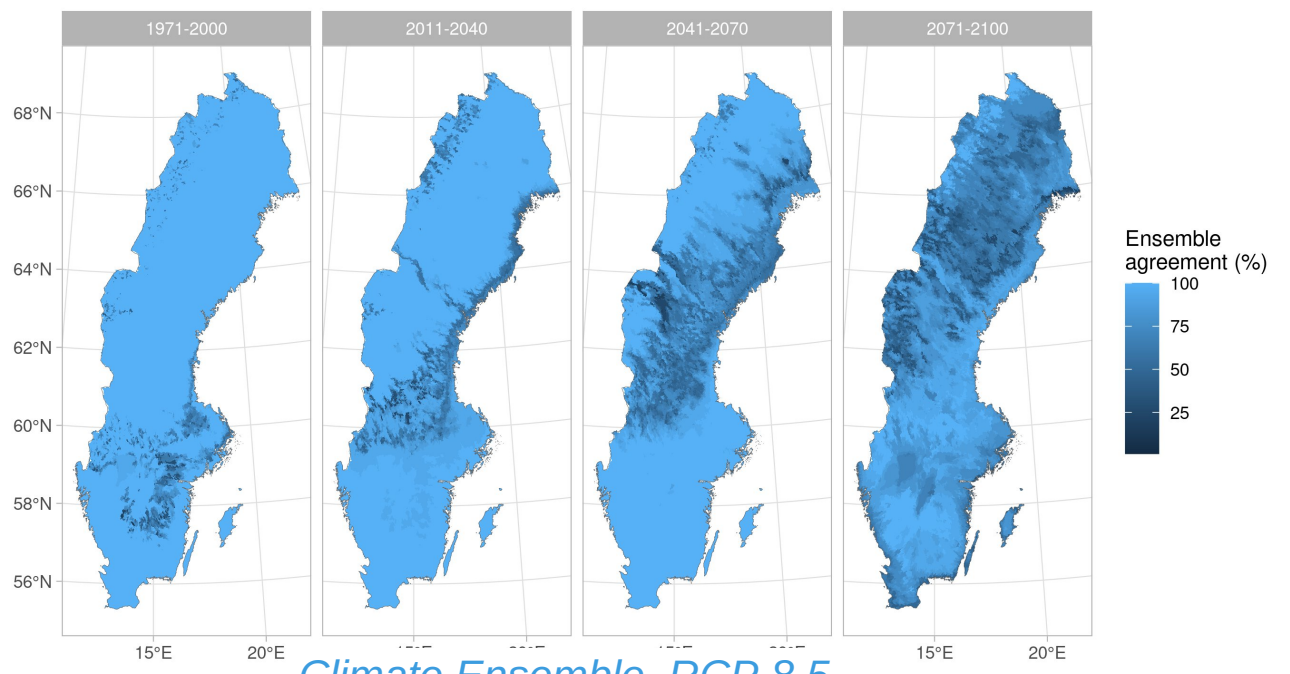
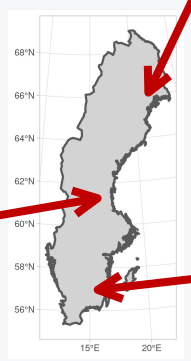
- Ensemble agreement, ensemble members separately
- Variation on climate zone frontiers
- Decreasing agreement with time indicating increasing ensemble spread

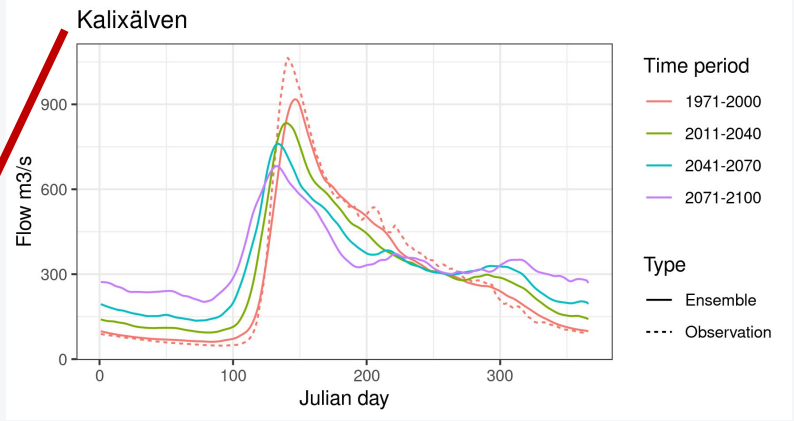


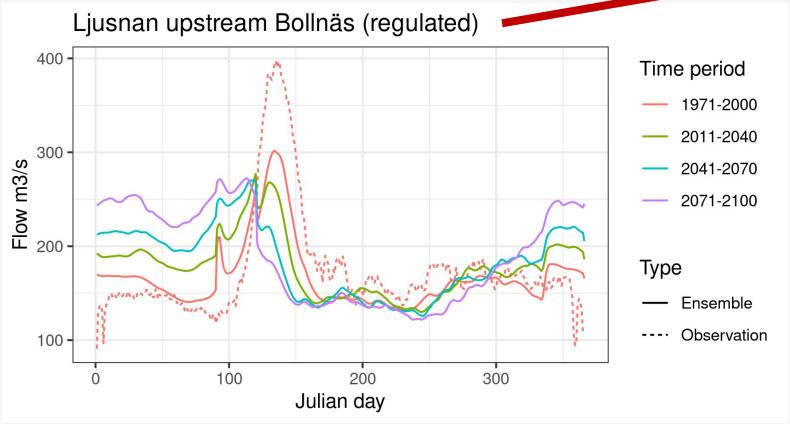

*Climate Ensemble, RCP 8.5*

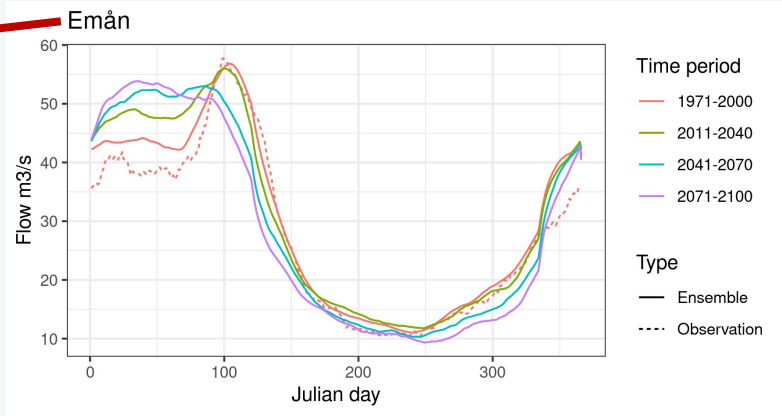
# Projected regime changes

- Spring flood loss and/or change in timing
- Increased winter flow even far north
- Prolonged summer low flows in the south



# Summary

- Global to regional impact model chain for hydrological CC impact assessment
- Condensed into spatially aggregated Climate Impact Indicators (CIIs) for user communication
- Hydrological impact model S-HYPE with regionalised parameterisation provides impact projections at high resolution
  - More detailed impact analyses possible, e.g. on eco-hydrological thresholds
- Scenario uncertainty estimate through ensemble robustness, other sources (e.g. through model structure) only qualitatively assessed

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**Thank you!**

*smhi.se/en/research/research-departments/hydrology*