CLIMATE PROJECTIONS FOR THE BALTIC SEA REGION

Erik Kjellström

Baltic Stakeholder Conference – Climate Change in the Baltic Sea

26 September 2022

Changing forcing conditions

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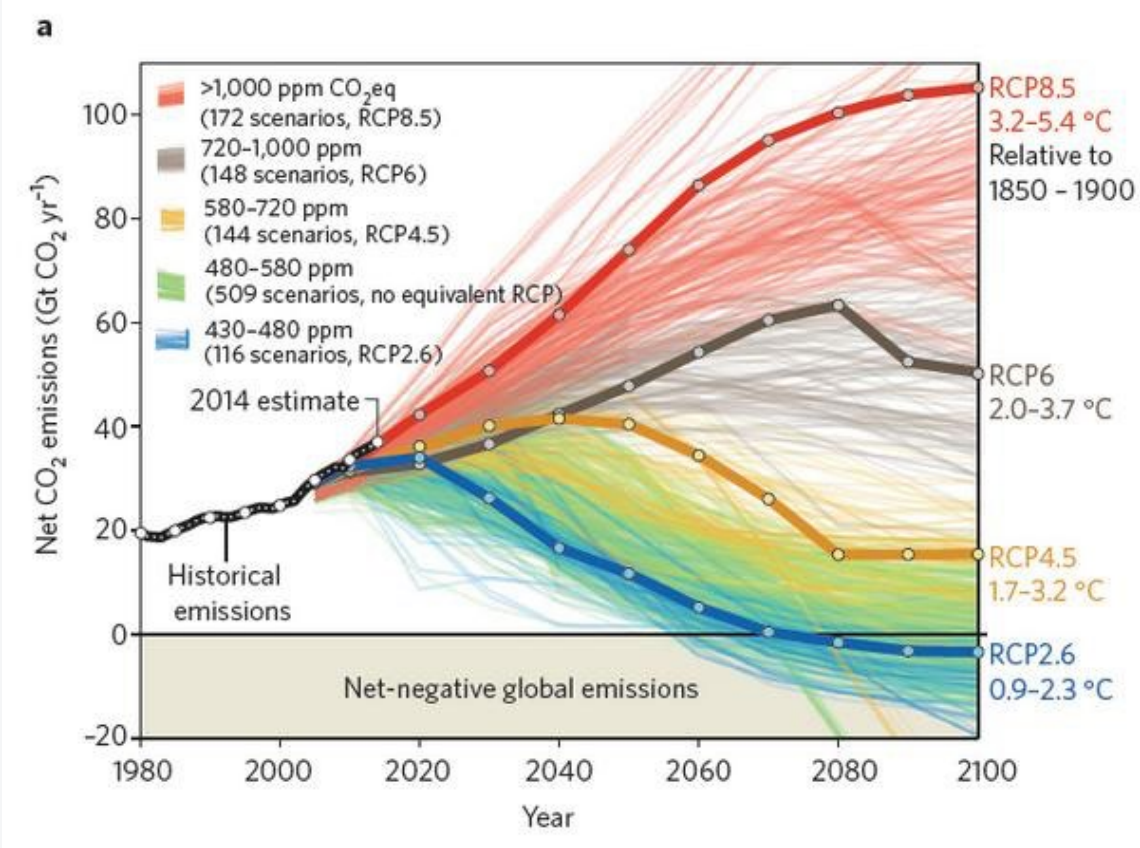
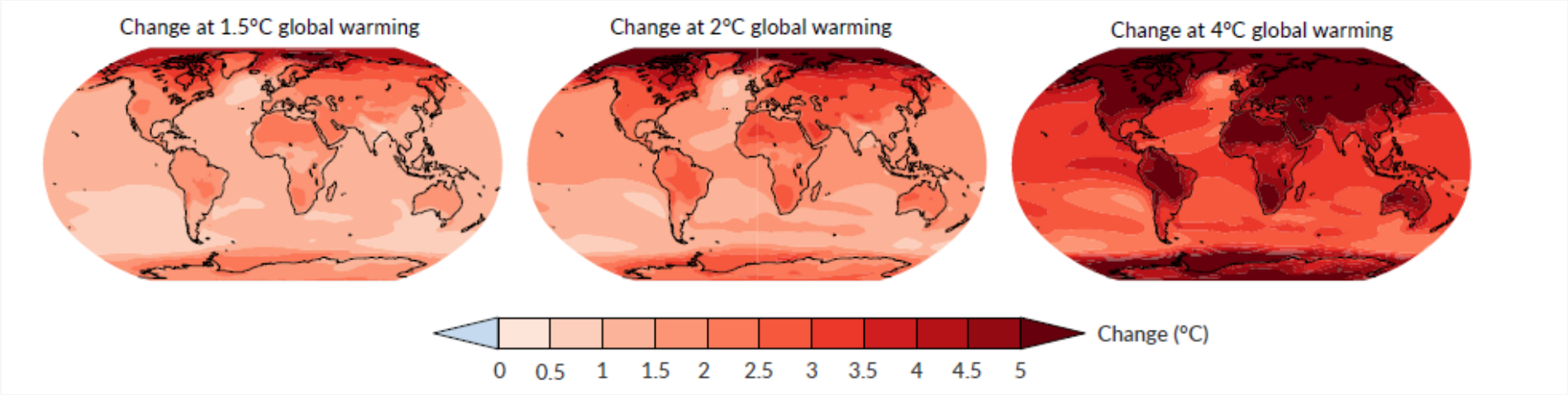
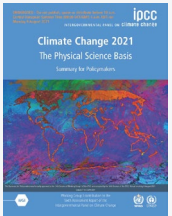


- Many scenarios
- Representative concentration pathways (RCP)
- RCP8.5 large increase in carbon emissions
- RCP2.6 likely requires carbon dioxide removal

- Scenarios include not only CO_2 but also other GHGs, aerosols, land use

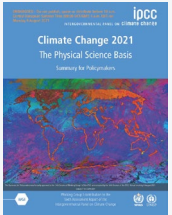
Strong warming in northern Europe

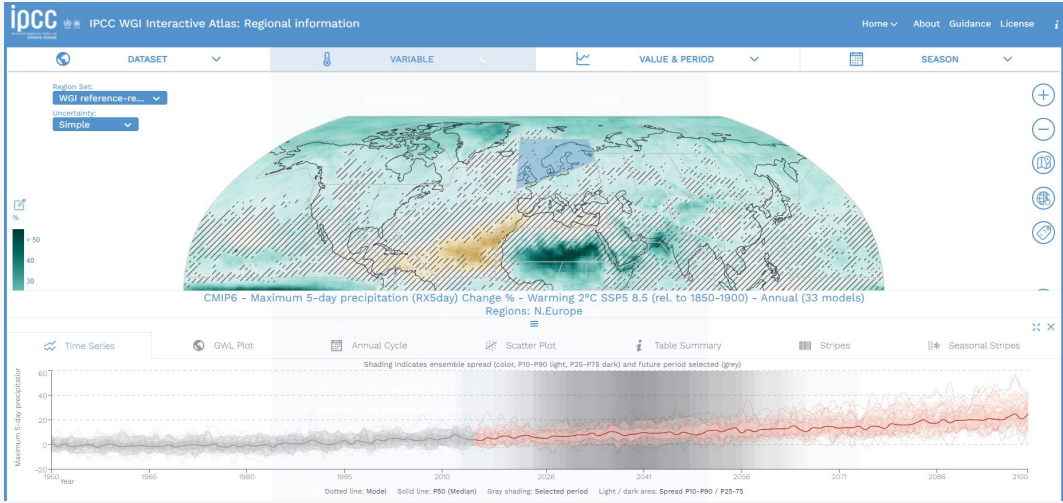




More precipitation in northern Europe

- A warmer atmosphere can hold more water vapor
- Leads to more evaporation
- More intense precipitation
- Increasing risk or drought
- Larger variability in precipitation
- Larger differences between ”wet” and ”dry”





IPCC(AR6 WGI): Atlas
Change in maximum 5-day precipitation

Resolution in climate models

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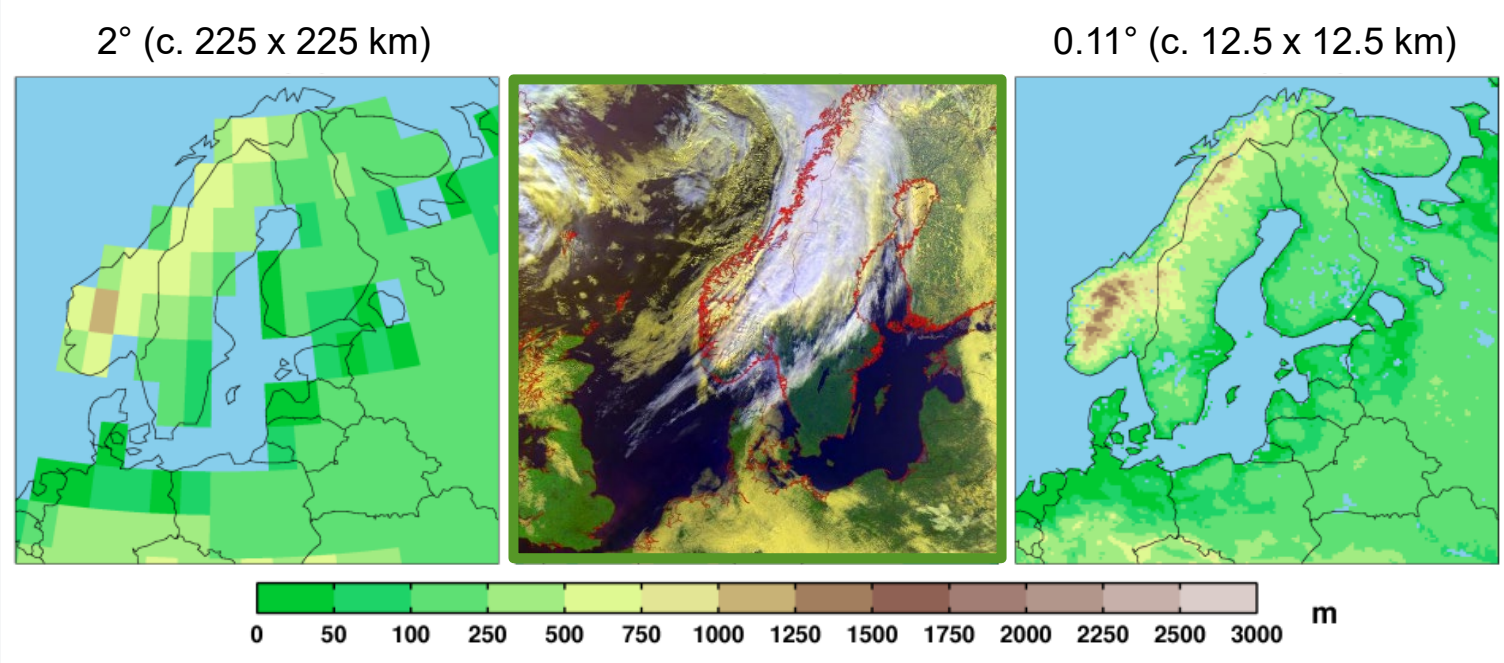

Resolution in climate models and downscaling

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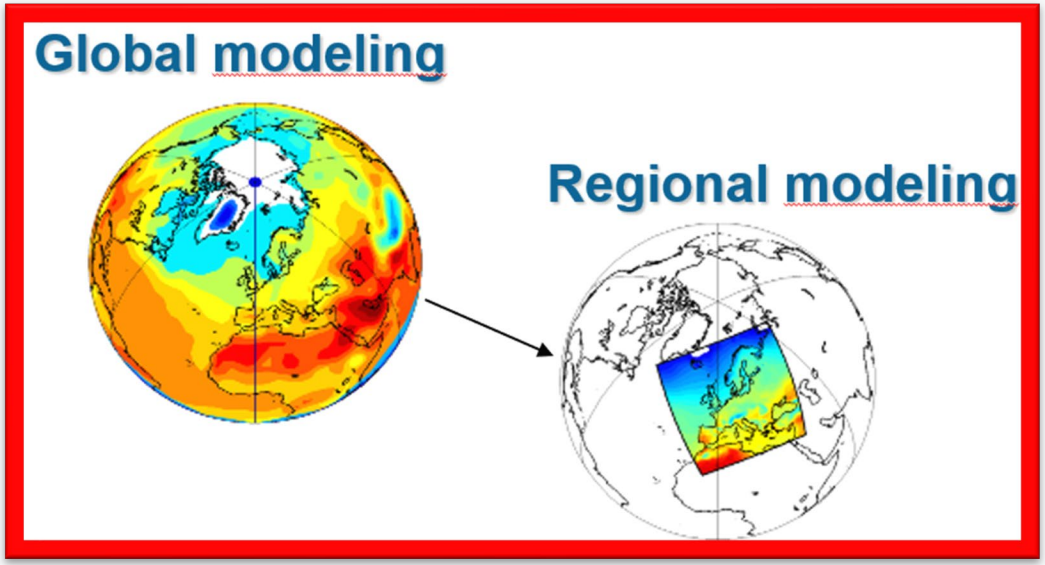
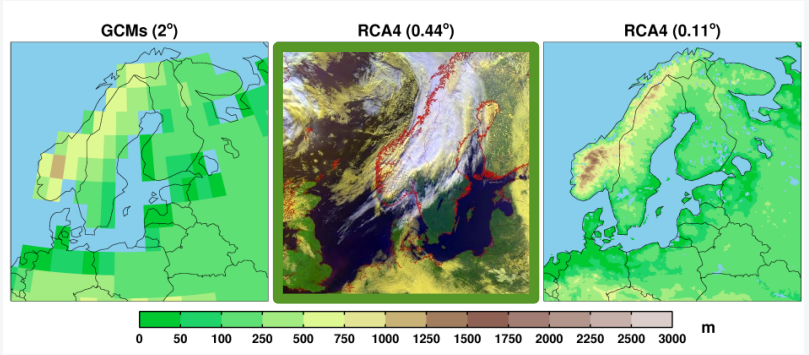
Typical grid spacing for GCMs: 125-300 km (CMIP5); 80-300 (CMIP6)

Grid spacing for EURO-CORDEX RCMs: 12.5 (50) km





Output from EURO-CORDEX RCMs

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- > 100 RCM projections
- 10 RCMs at 12.5x12.5 km
- Boundary conditions from 10 GCMs
- 3 RCP scenarios: 2.6; 4.5; 8.5
- 3 ensemble members for some GCMs

- Atmosphere (T, humidity, winds, pressure, clouds)
- Fluxes (rain, snow, evaporation, solar radiation, longwave radiation)
- Surface (soil T, humidity, snow cover)

- Data stored at least on daily basis – sometimes even hourly

RCP8.5	RCA4	crCLIM	REMO	RACMO22E	HIRHAM5	WRF381P	ALADIN63	RegCM4.6.1	HadREM3-GA7.05	GCM total
MOHC-HadGEM2-ES										9
ICHEC-EC-EARTH										16
CNRM-CERFACS-CNRM-CM5										9
NCC-NorESM1-M										9
MPI-M-MPI-ESM-LR										15
IPSL-IPSL-CM5A-MR										5
CCCma-CanESM2										1
MIROC-MIROC5										1
RCM total	10	9	10	8	8	5	4	5	5	65
RCP4.5	**RCA4**	**CcrCLM**	**REMO**	**RACMO22E**	**HIRHAM5**	**WRF381P**	**ALADIN63**	**RegCM4.6.1**	**HadREM3-GA7.05**	**GCM total**
MOHC-HadGEM2-ES										4
ICHEC-EC-EARTH										5
CNRM-CERFACS-CNRM-CM5										3
NCC-NorESM1-M										3
MPI-M-MPI-ESM-LR										3
IPSL-IPSL-CM5A-MR										2
RCM total	6	0	5	4	3	1	1	0	0	20
RCP2.6	**RCA4**	**CcrCLM**	**REMO**	**RACMO22E**	**HIRHAM5**	**WRF381P**	**ALADIN63**	**RegCM4.6.1**	**HadREM3-GA7.05**	**GCM total**
MOHC-HadGEM2-ES										6
ICHEC-EC-EARTH										5
CNRM-CERFACS-CNRM-CM5										3
NCC-NorESM1-M										4
MPI-M-MPI-ESM-LR										5
IPSL-IPSL-CM5A-MR										1
IPSL-IPSL-CM5A-LR										1
MIROC-MIROC5										1
NOAA-GFDL-ESM2G										1
RCM total	4	0	10	5	2	0	1	4	2	27
Total outside PRINCIPLES	13	0	17	10	5	1	0	0	0	46
PRINCIPLES total	7	9	8	7	8	6	6	8	7	66
Grand total	20	9	25	17	13	7	6	8	7	112

Projected changes in temperature

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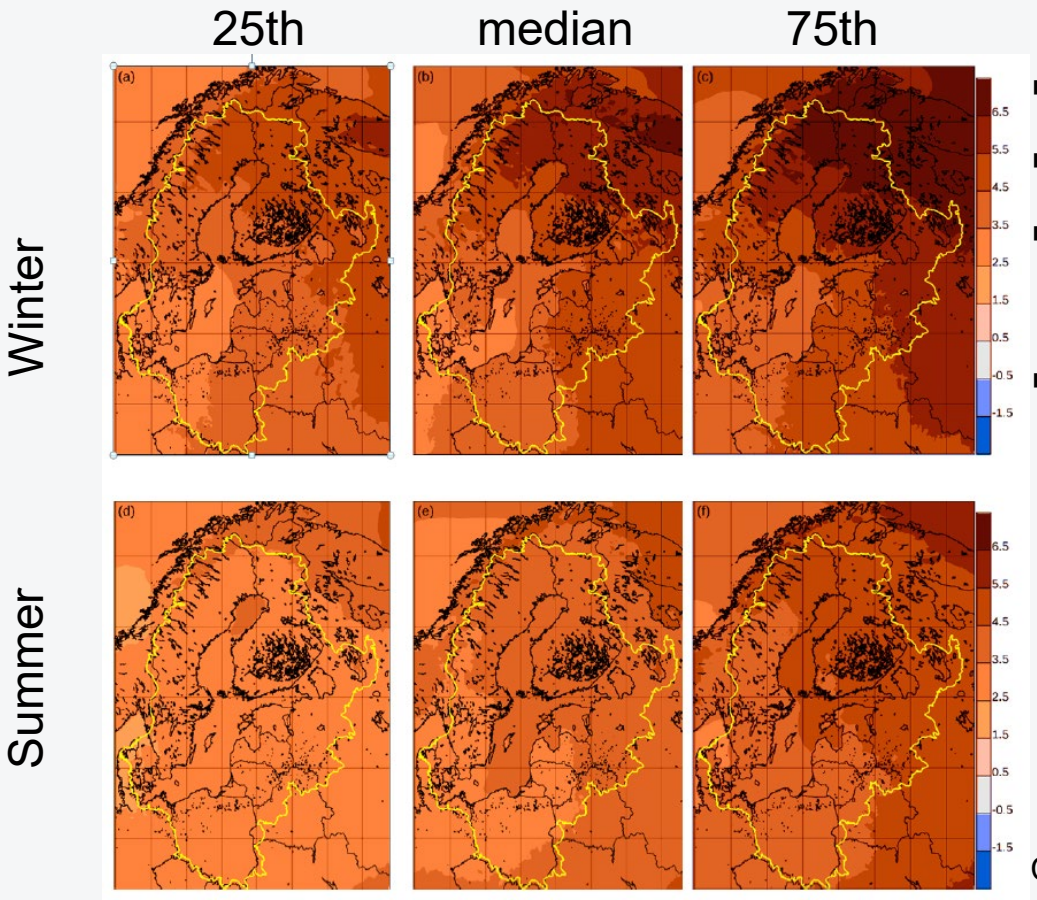


- Warmer in all seasons
- Largest warming in winter
- Largest warming in the north

- Differences between models

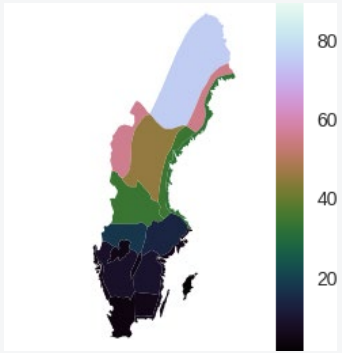
Christensen et al., 2022

Reduced frequency and intensity of cold snaps

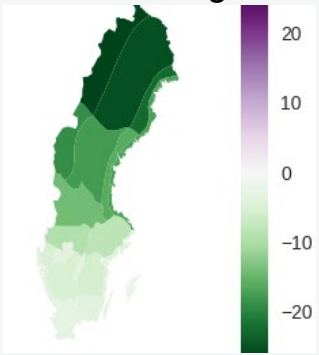
The temperature increase is largest for cold days in winter

Number of cold days (<-7°C) per year

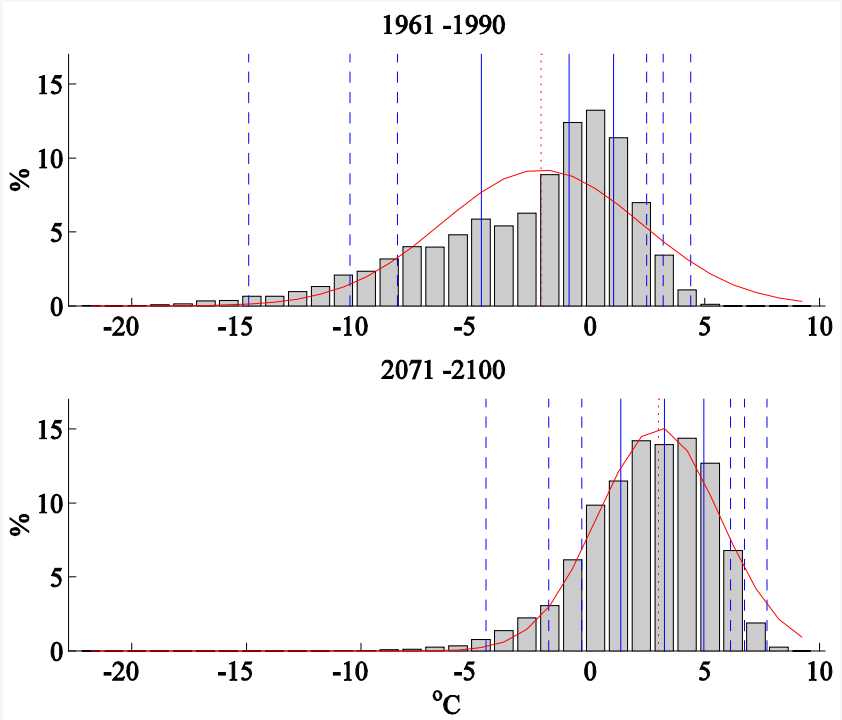
1971-2100



At +2°C global warming



An example for ”Stockholm”



Projected changes in precipitation

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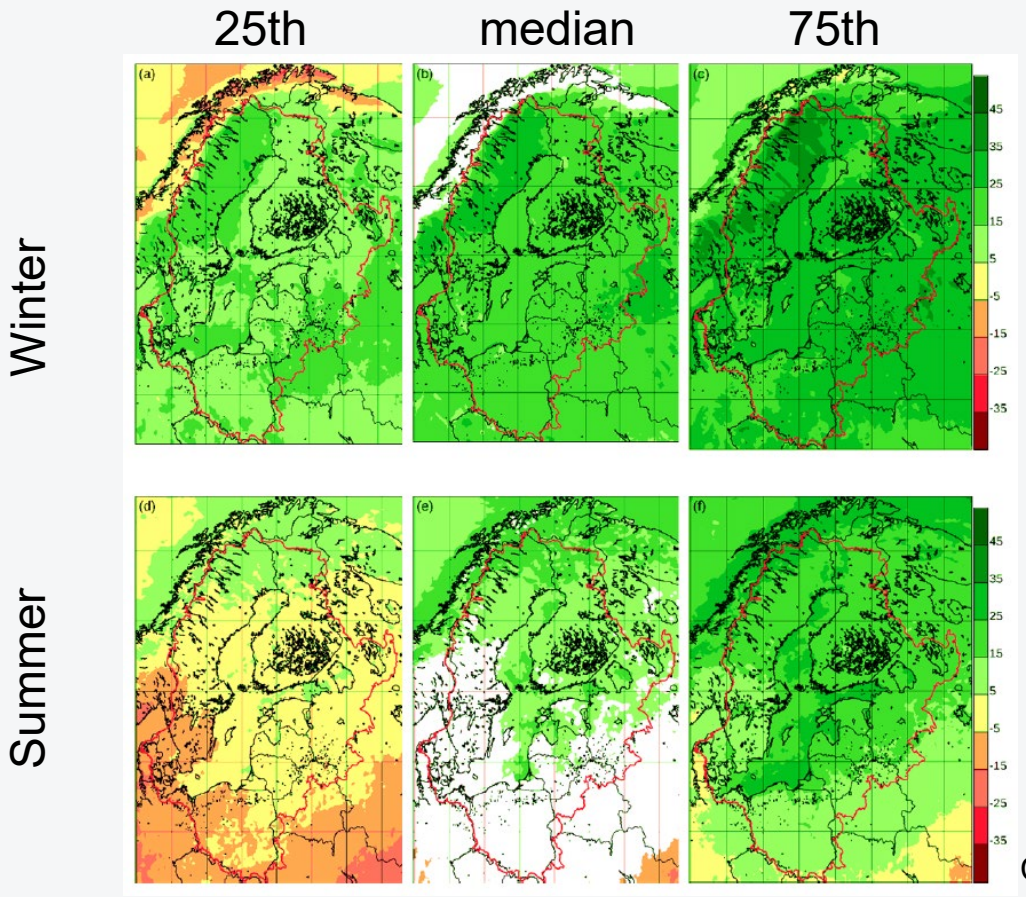

- Generally more precipitation
- Wetter in winter
- Wetter in the north in summer
- Unclear more/less precipitation in summer in the south

- Differences between models

Christensen et al., 2022

Changes in temperature and precipitation

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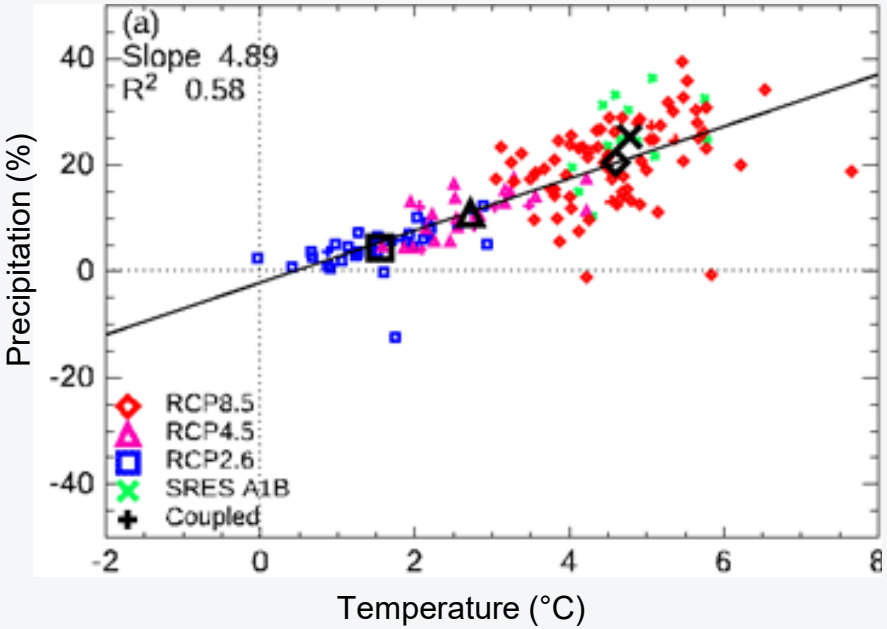
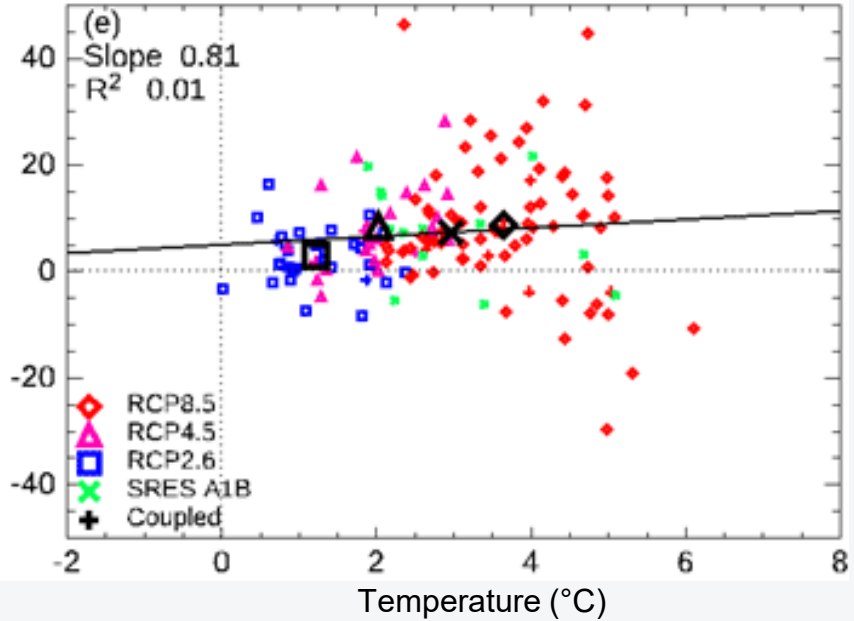
Winter (DJF)



Summer (JJA)



Christensen et al., 2022

Changes in temperature and precipitation

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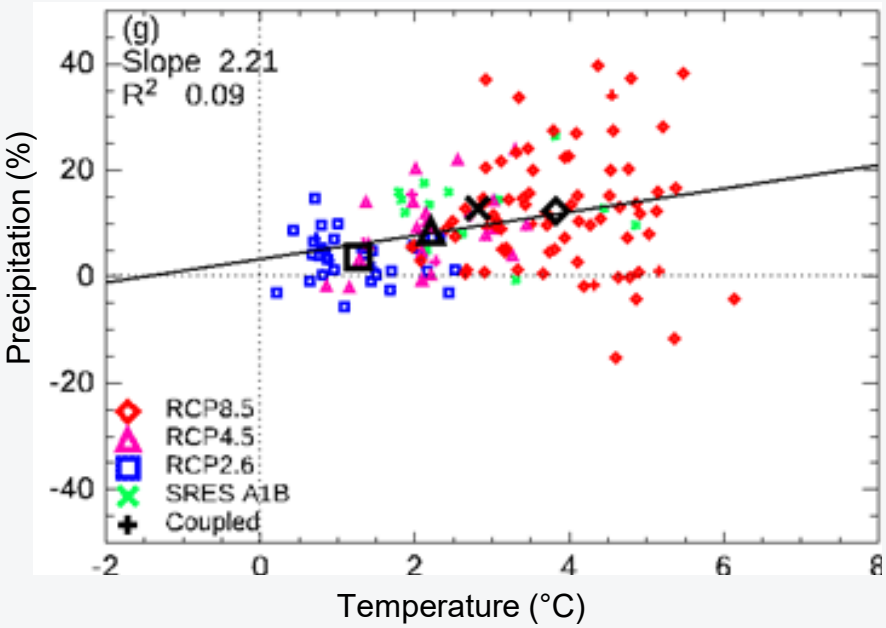
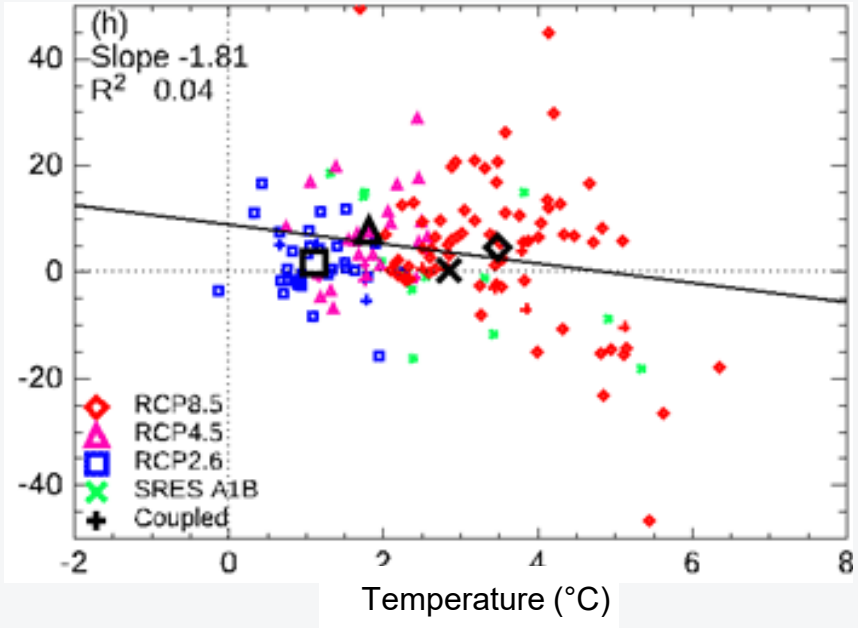
Summer (JJA) – north of 60°N



Summer (JJA) – south of 60°N



Christensen et al., 2022

Changes in temperature and intense precipitation

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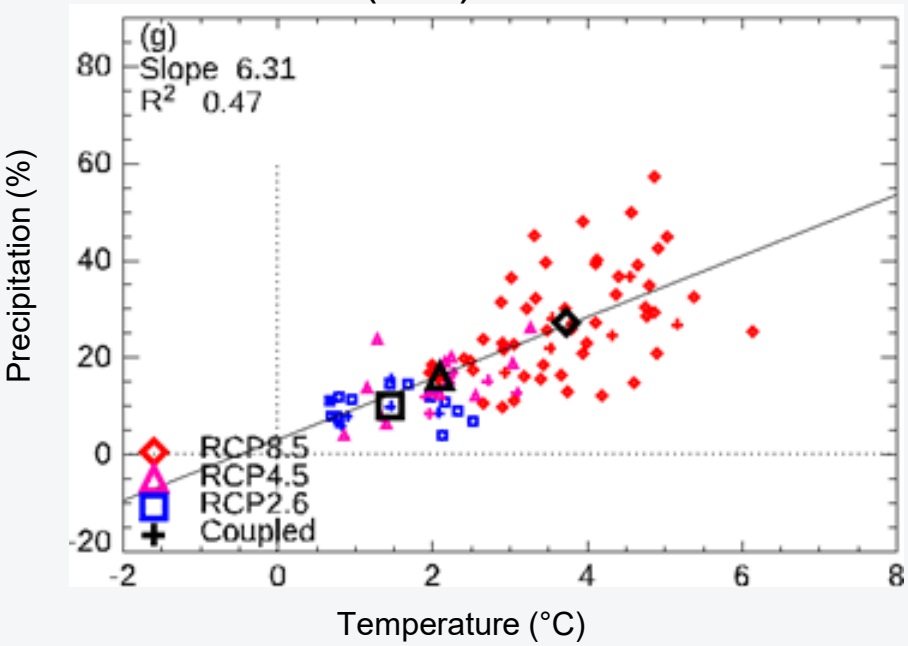
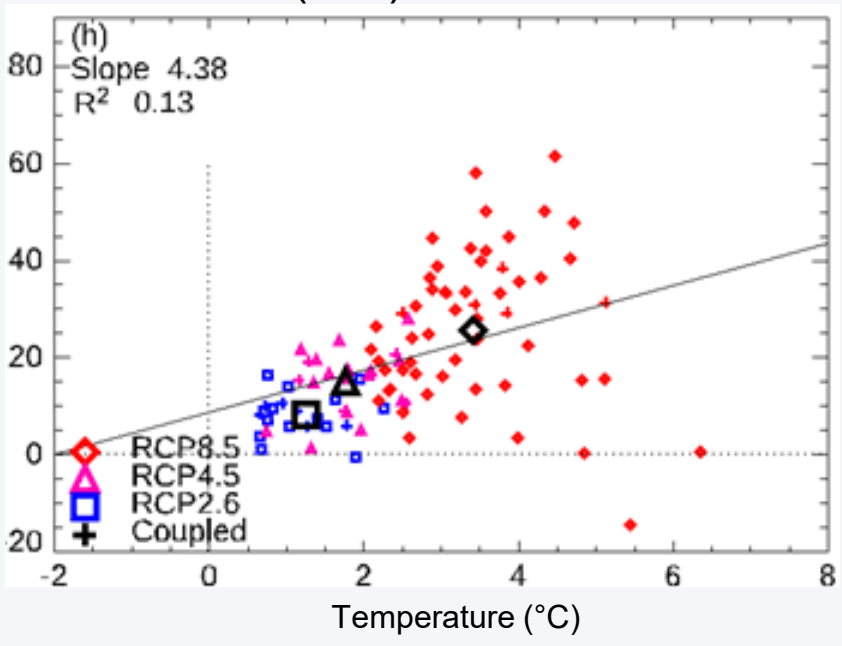
Summer (JJA) – north of 60°N



Summer (JJA) – south of 60°N



Christensen et al., 2022

Changes in temperature and wind speed (all land points)

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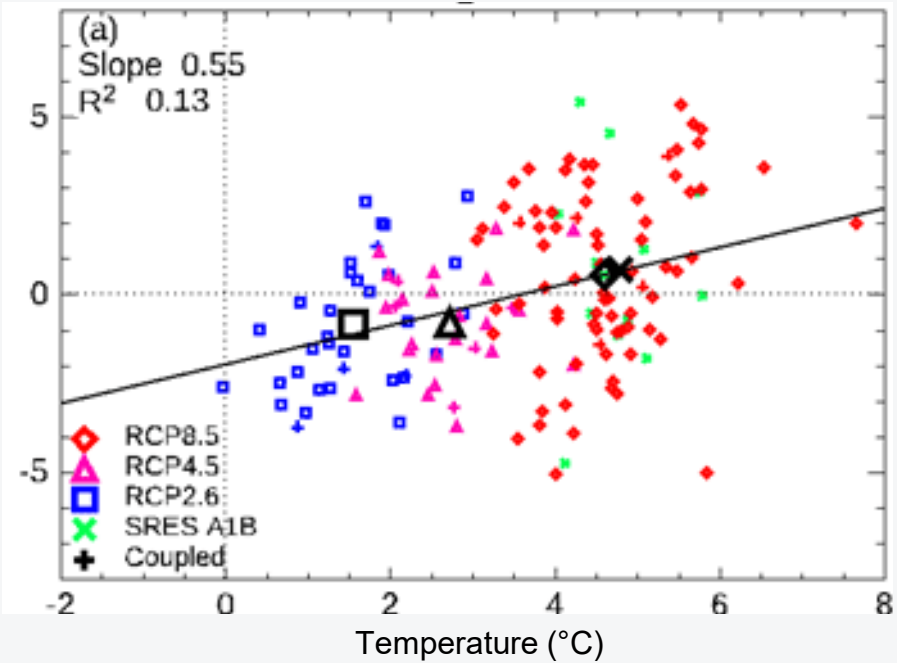
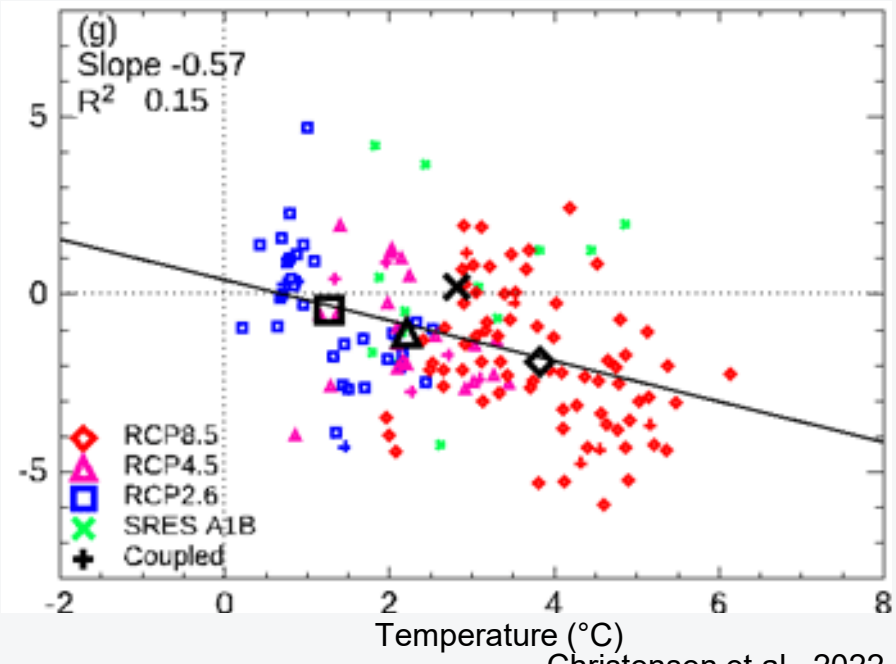
Winter (DJF)

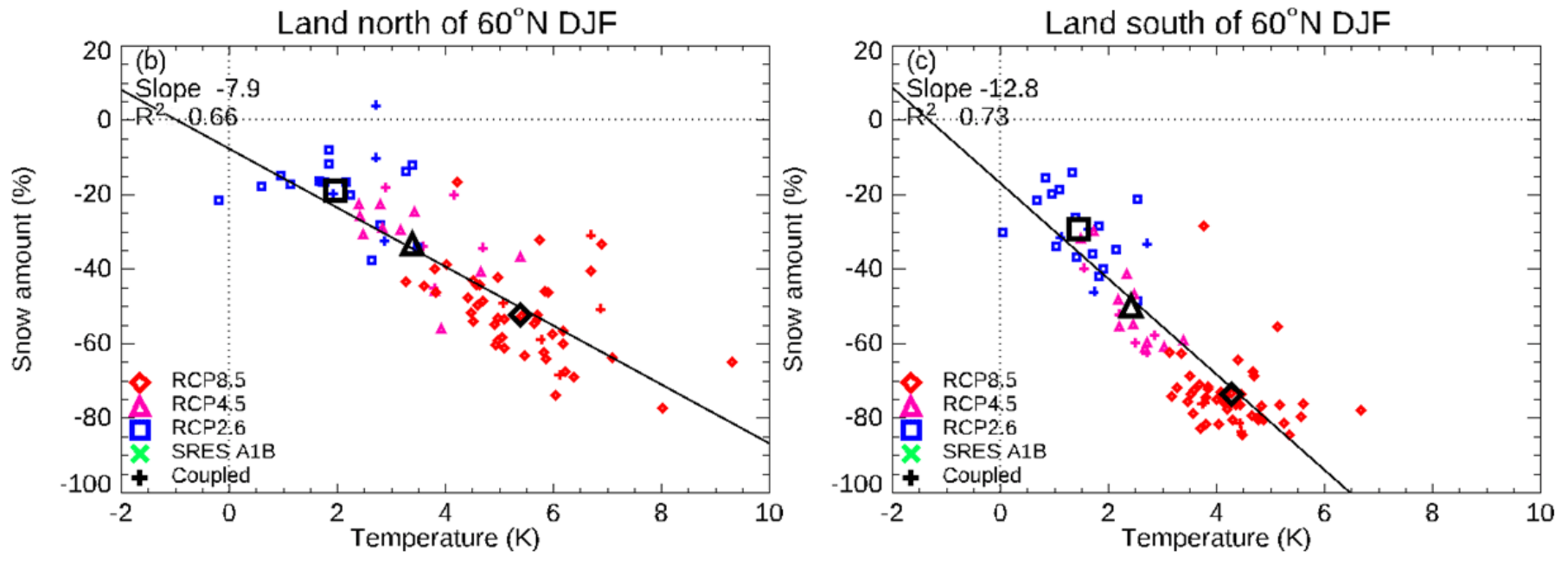


Summer (JJA)



Christensen et al., 2022

Changes in temperature and snow amount (all land points)



Christensen et al., 2022

Changing hydrological conditions

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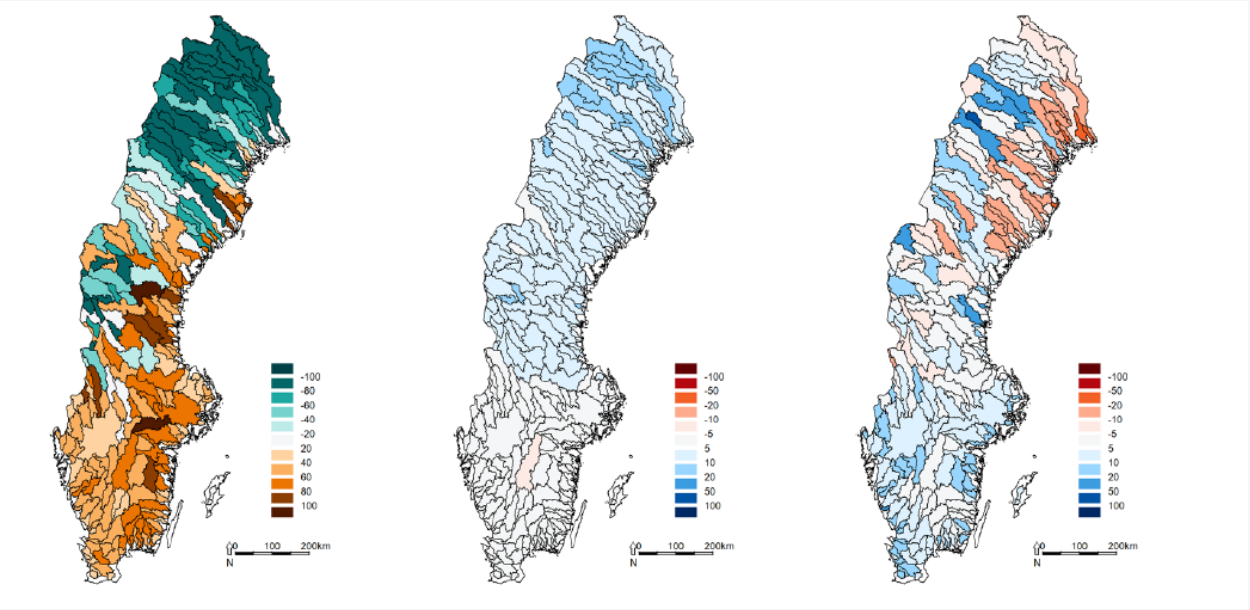
Numer of days with low discharge

Average discharge

10-year flood



- Generally more precipitation
- On average wetter conditions (especially in the north)
- Larger risk for flooding except in areas where spring snow melt is reduced
- Potential for drier conditions in the south
- Larger differences between ”wet” and ”dry”

Projected changes in discharge for 2041-2070 relative to 1971-2000 in RCP4.5

Kjellström, E. et al., 2022. Klimatinformation för samhällets klimatanpassningsarbete. Klimatologi 64, SMHI, SE-60176 Norrköping. ISSN: 1654-2258, 85 pp. (In Swedish)

Conclusions

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- Projections show continued warming of the region
- Leads to shorter winters and longer summers
- Changing variability
- More precipitation in winter and in the north in summer, uncertainty about changes in the south
- Increasing risk for drought
- More heavy/intense precipitation extremes
- Less snow and ice
- Large uncertainty in changes in wind speed

Christensen, O.B., Kjellström, E., Dieterich, C., Gröger, M. and Meier, H.E.M., 2022. Atmospheric regional climate projections for the Baltic Sea Region until 2100. Earth Syst. Dynam., 13, 133-157, DOI:10.5194/esd-13-133-2022.