

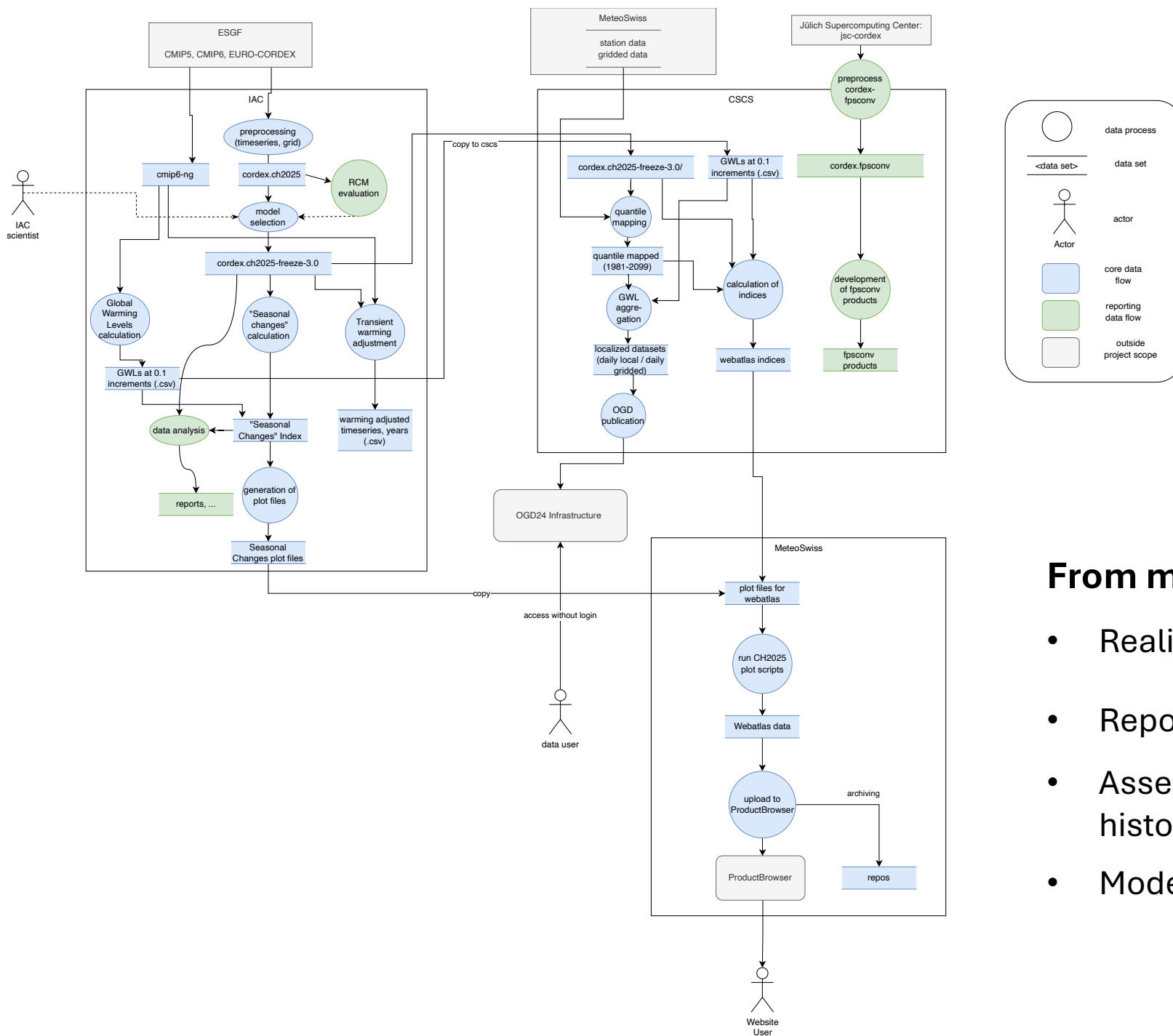


Model evaluation of EURO-CORDEX CMIP5 for Climate CH2025

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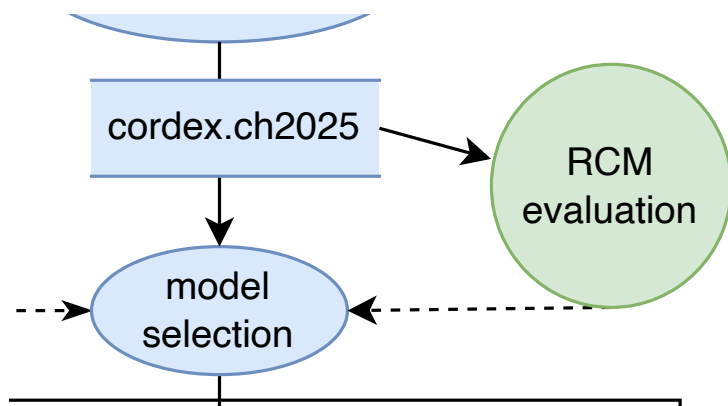




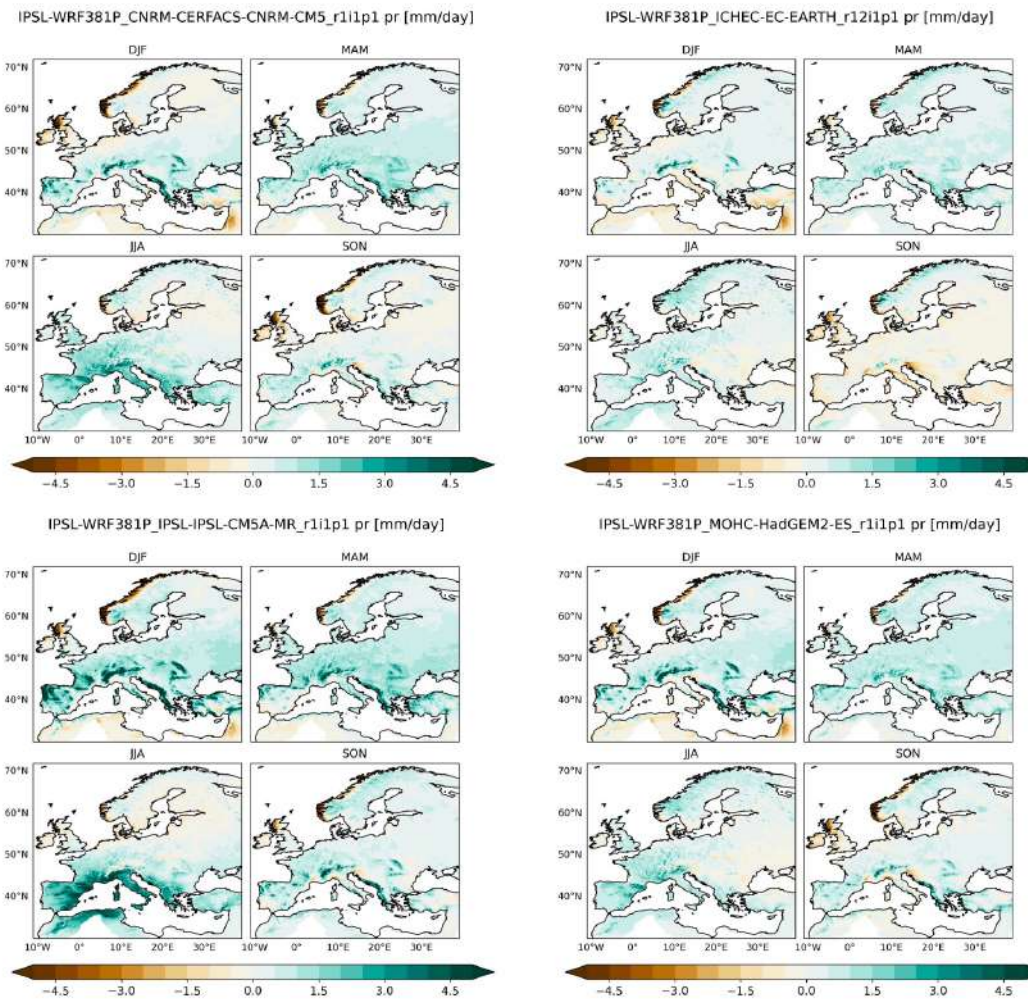
From model output to climate scenarios

- Realistic historical simulations
- Report unphysical behavior
- Assess mismatches with observed historical warming trends
- Model diversity

Realistic historical simulations



CMIP5 EURO-CORDEX simulations tend to be too cold, wet, and windy compared to observations [e.g., Vautard et al. (2021)]



Seasonal mean precipitation difference from observations over Europe



Full RCM evaluation

- Emphasis on heatmaps / maps
- Primary variables: mean, maximum, and minimum temperature, mean precipitation

Evaluation of CMIP5 EURO-CORDEX: 2 m Temperature

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Table of Contents

Heatmap: Difference from observations	2
Maps: Annual mean difference from observations over Europe	3
Heatmap: RMSE by season and region	4
Heatmap: Historical linear trend	5
Maps: Historical linear trend of annual mean over Alps	6
Heatmap: Historical linear trend difference from observations	7
Maps: Historical linear trend difference from observations of annual mean over Alps	8
Heatmap: Change in mean values between 1991-2020 and 2070-2099	9
Maps: Change in annual mean between 1991-2020 and 2070-2099	10
Heatmap: Change in mean values past to present difference between RCM and driving GCM	11
Heatmap: Change in mean values present to future difference between RCM and driving GCM	12
Timeseries: Annual mean 1971-2099, grouped by GCM	13

Appendices

Taylor Diagrams	15
Maps: Seasonal mean difference from observations over Europe	17
Maps: Historical linear trend of seasonal mean over Alps	30
Maps: Historical linear trend difference from observations of seasonal mean over Alps	43
Maps: Change in seasonal mean between 1991-2020 and 2070-2099	56

References

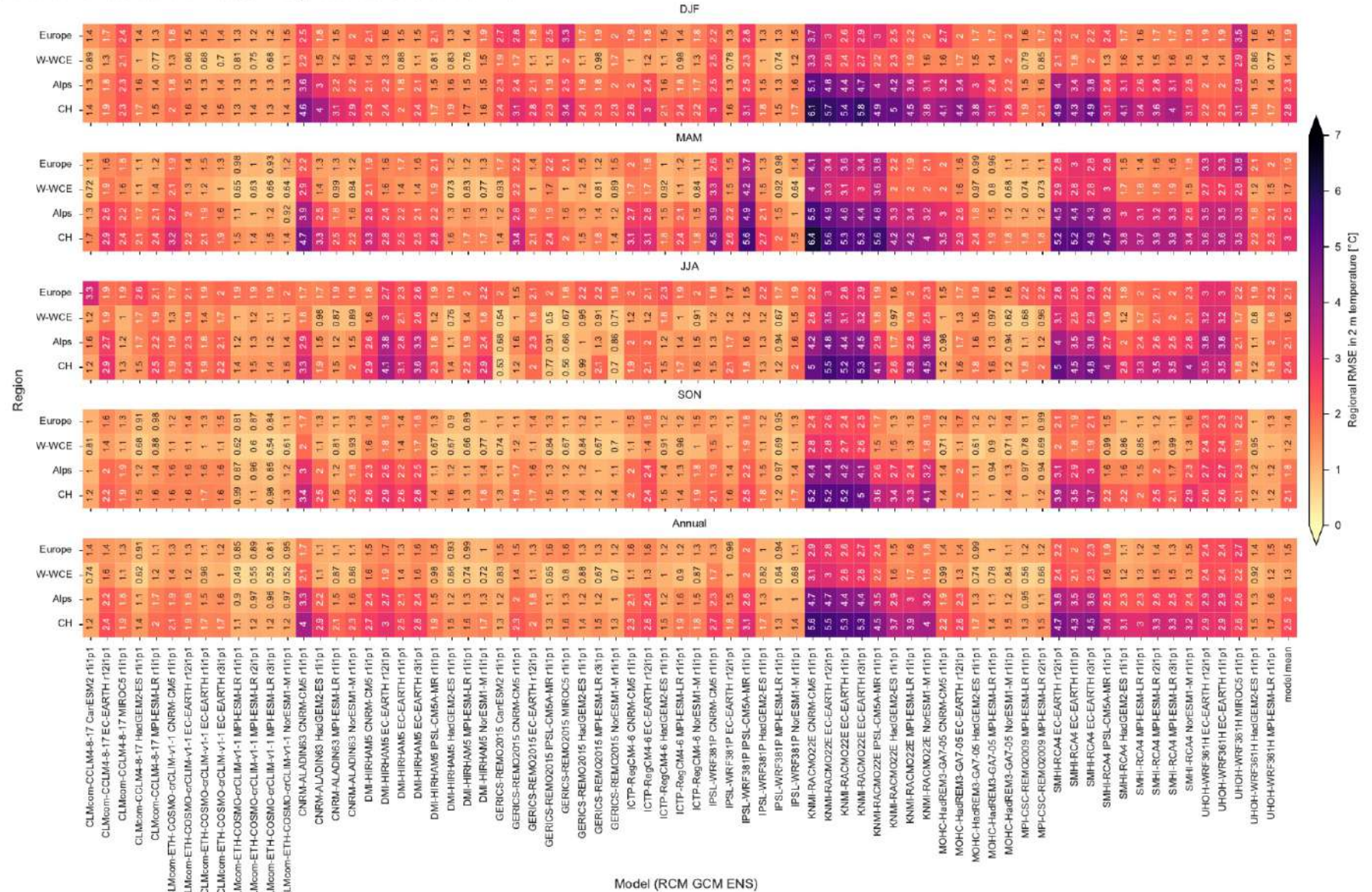
We acknowledge the World Climate Research Programme's Working Group on Regional Climate, and the Working Group on Coupled Modelling, former coordinating body of CORDEX and responsible panel for CMIP5. We also thank the climate modelling groups (see Figure 2.7 of Climate CH2025 Scientific Report: <https://www.klimaszenarien.ch>) for producing and making available their model output. We also acknowledge the Earth System Grid Federation infrastructure an international effort led by the U.S. Department of Energy's Program for Climate Model Diagnosis and Intercomparison, the European Network for Earth System Modelling and other partners in the Global Organisation for Earth System Science Portals (GO-ESSP).

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Heatmap: RMSE by season and region

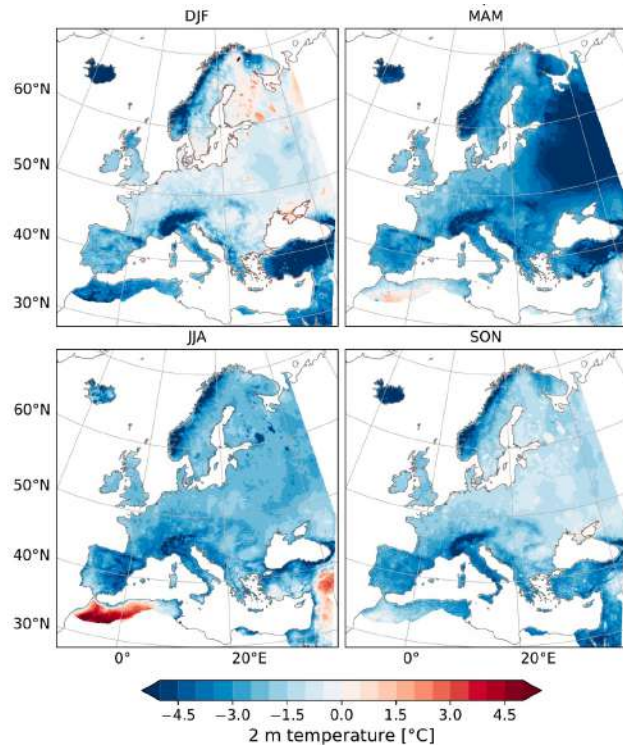
Root-mean-squared-error (RMSE) in 2 m temperature for each model simulation compared to observational estimates in different seasons (DJF, MAM, JJA, SON, Annual) in the reference period 1991-2020. Regions are Europe, West West-Central Europe (WWCE), PRUDENCE Alps (Alps), and Switzerland (CH). Observational estimates given by EObs on EUR-11 - v19.0eHOM until December 2018 combined with v27.0 thereafter - embedded with MeteoSwiss gridded data over Switzerland



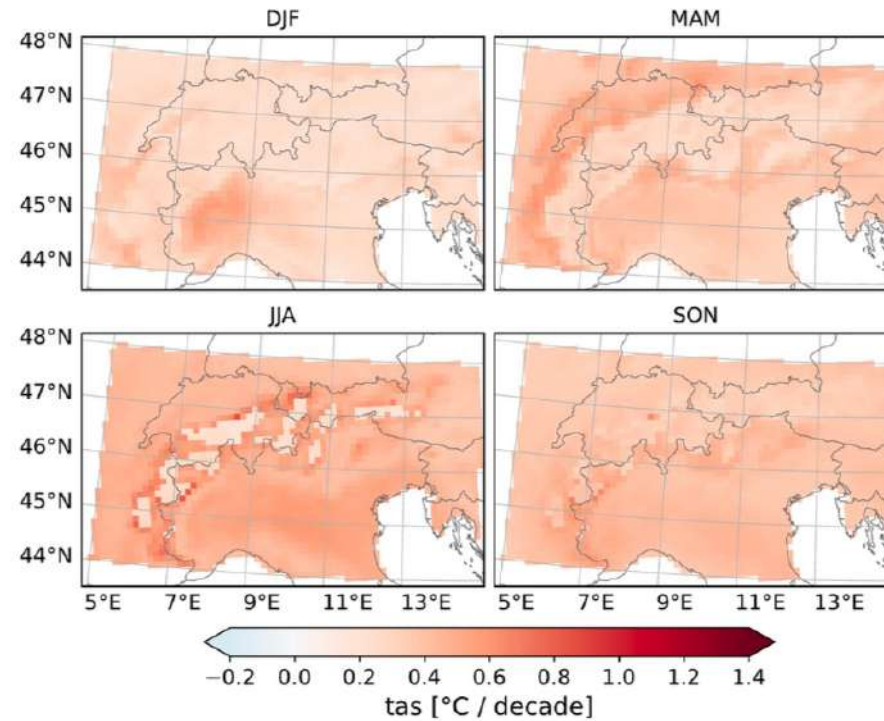
- One plot for a clear comparison of model biases
- All seasons + annual
- multiple spatial domains

Consequences of being historically too cold

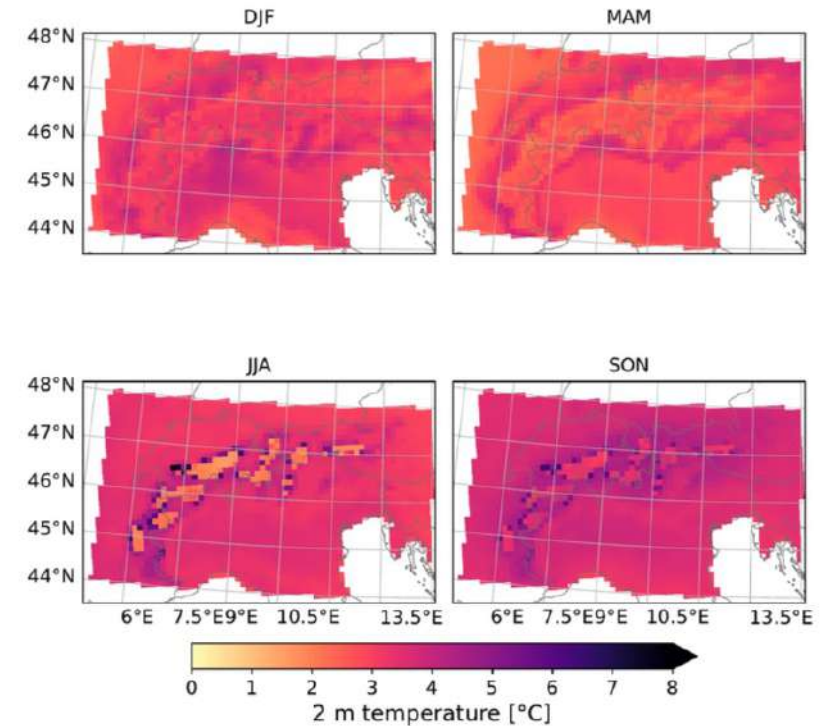
historical mean state colder than observed



Muted historical temperature trends tied to snow accumulation

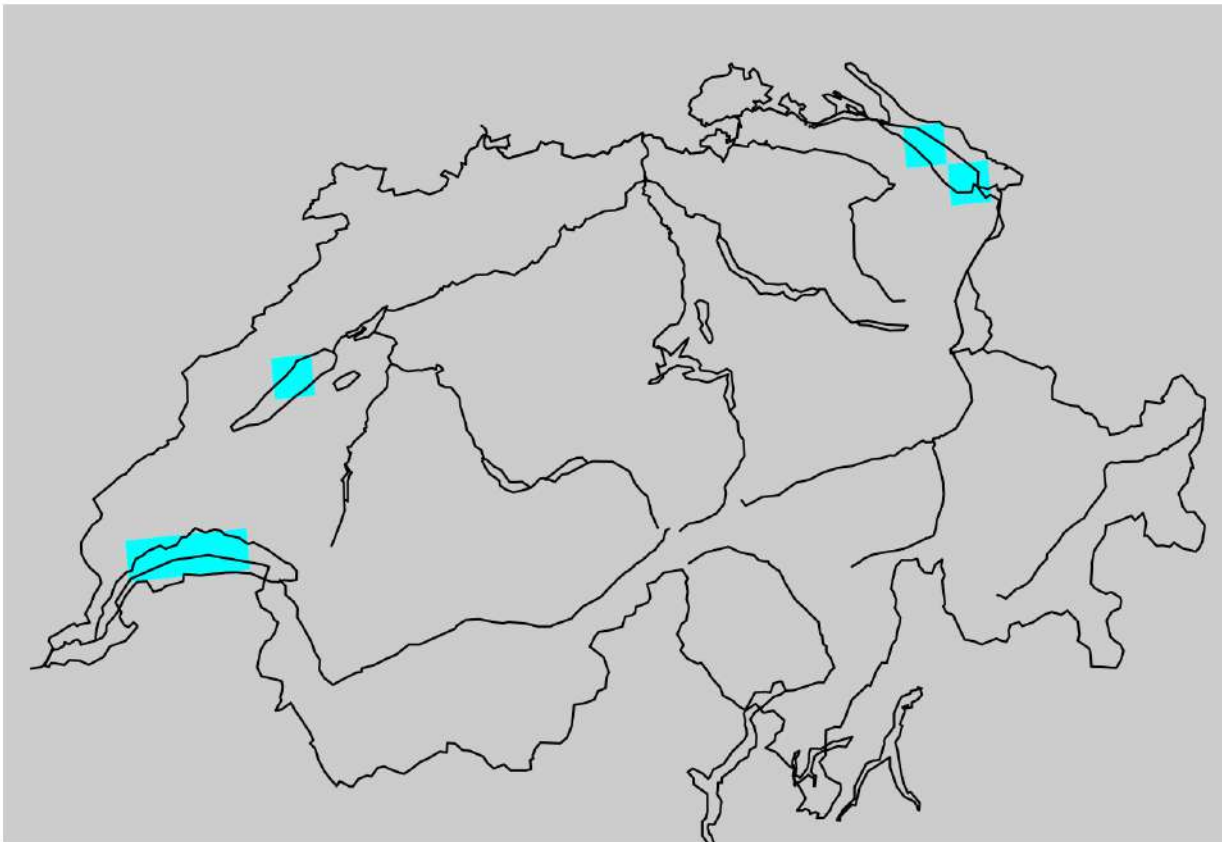


Hard to justify levels of end of century warming in RCP8.5



Report unphysical behavior

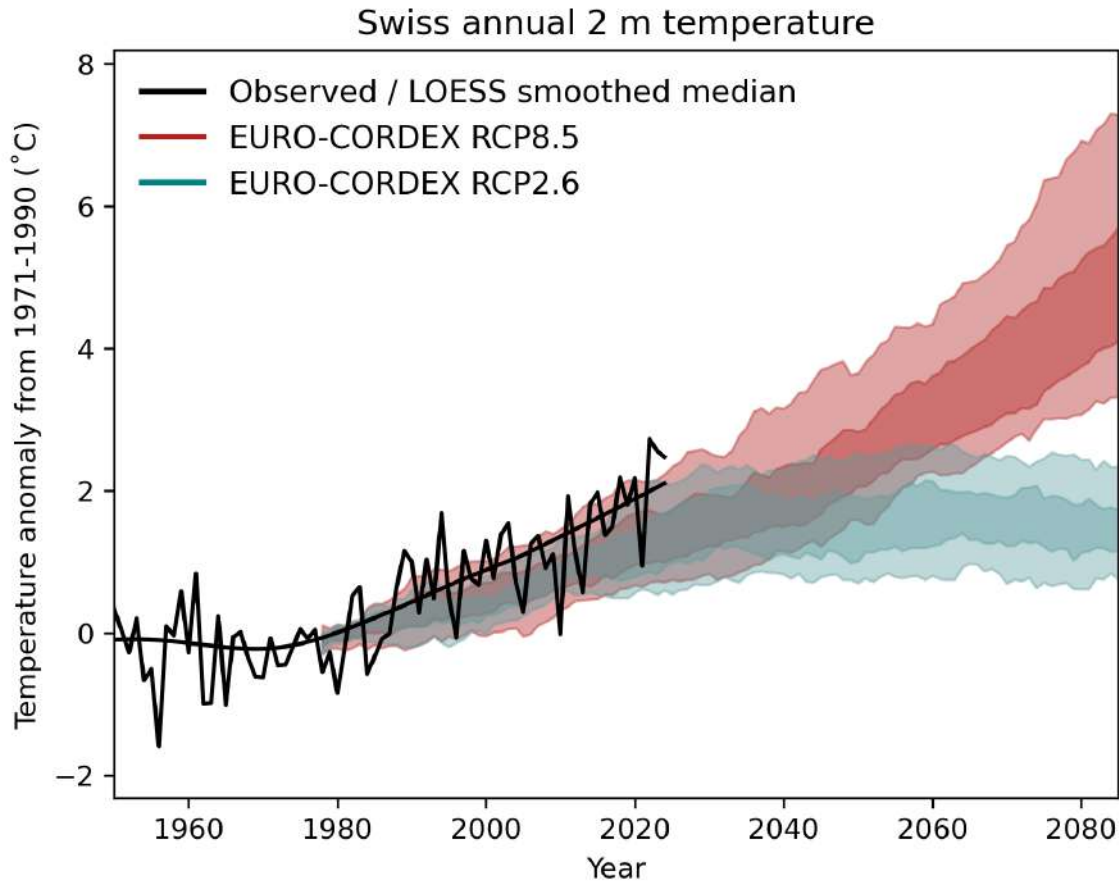
COSMO CLM EUR-11 gridpoint mask



Gridpoint storms found over Swiss lakes

- Precipitation > 2400 mm/day \rightarrow mask these grid points for precipitation
- Most models have some grid point storms, but only one has them over Switzerland (Swiss lakes)

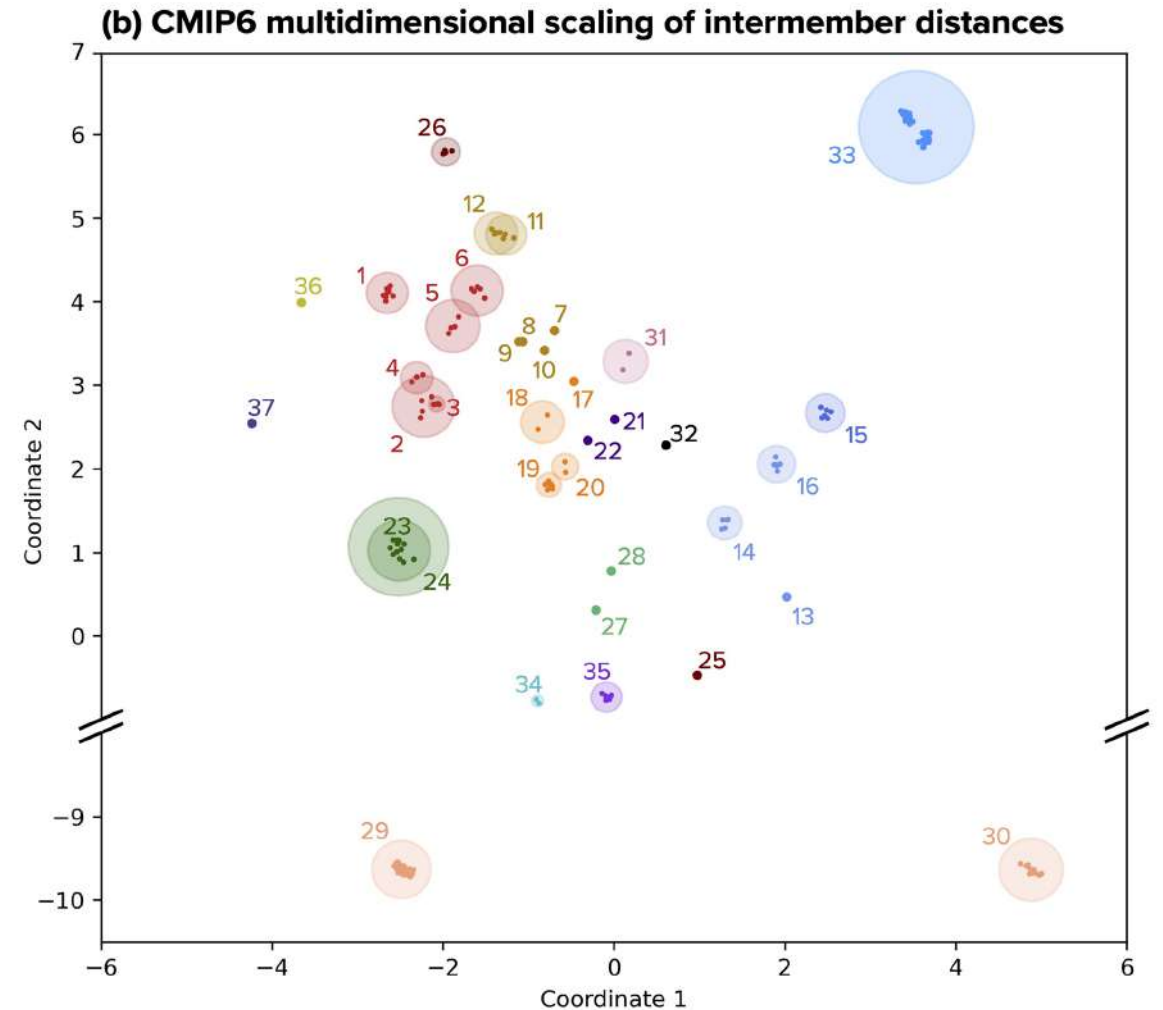
Assess mismatches with observed historical warming trends



- Swiss warming is currently outpacing many EURO-CORDEX projections
- Internal variability and time-invariant aerosol loading contribute [e.g., Boé et al. 2020, Taranu et al. 2022, Schumacher et al. 2024]
- Creates issues when attempting to provide a seamless transition from past observations to future projections

Model Diversity

- model diversity is required for meaningful estimates of uncertainty in multi-model ensembles
- Tuning to the same observational datasets eliminated some emergent constraints between CMIP5 and CMIP6 [e.g., Simpson et al. 2021]
- Other considerations in the development process of the models
 - Processes dependent on absolute temperature
 - Known discrepancies (model ensemble does not capture observed behavior), i.e., trends in Tropical SST pattern [Simpson et al. 2025]





For more information on Climate CH2025



Questions? Feel free to reach out at anna.merrifield@env.ethz.ch



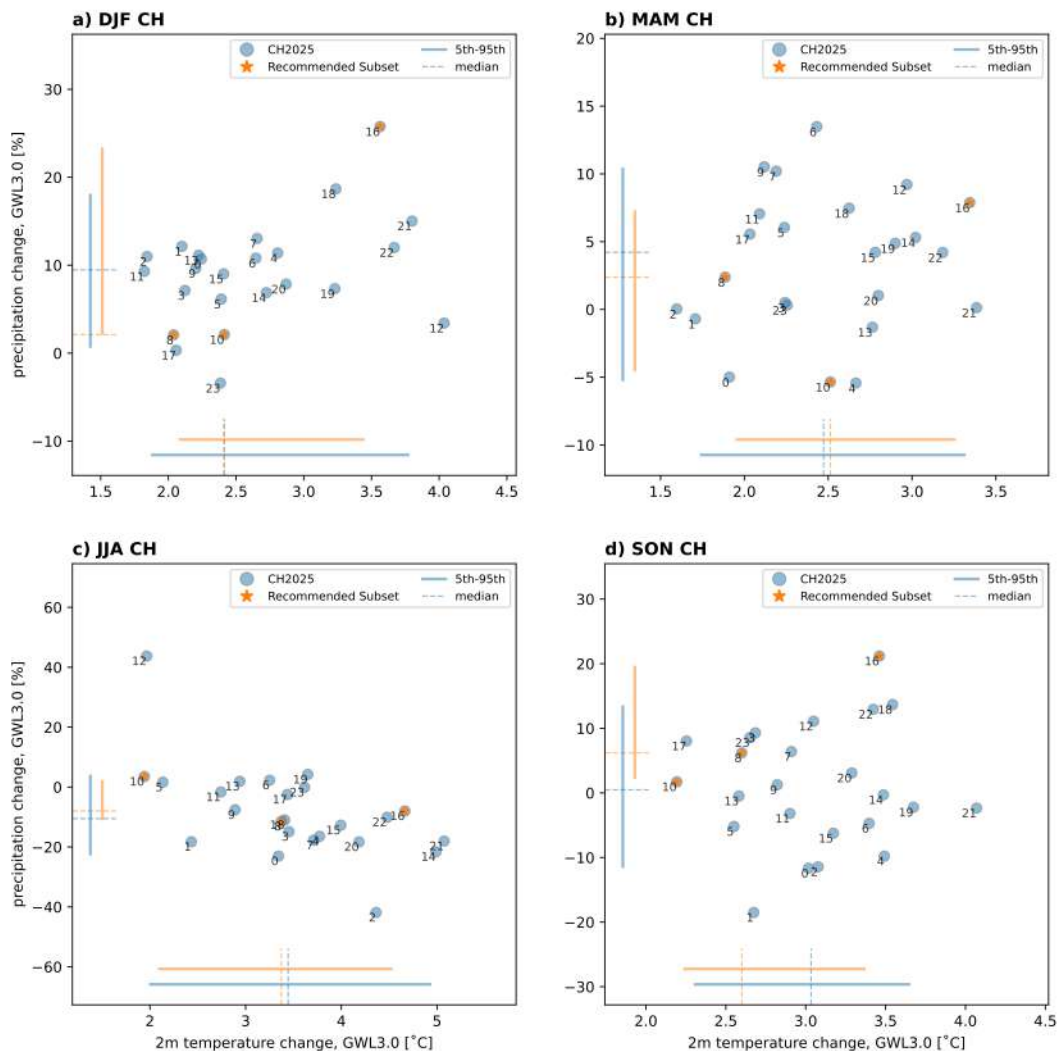
Strategies for Model Subselection

Model ranks

Region: CH

Case: A: Temperature

RCP 8.5



solutions	alternatives				
	tas (°C) [+]	tas_MAM (°C) [+]	tas_JJA (°C) [+]	tas_SON (°C) [+]	tas_DJF (°C) [+]
CLMCOM-CCLM4_ECEARTH_EUR11	21	19	21	20	26
CLMCOM-CCLM4_HADGEM_EUR11	5	15	3	4	6
CLMCOM-CCLM4_HADGEM_EUR44	9	18	9	6	8
CLMCOM-CCLM4_MPIESM_EUR11	24	28	29	24	22
CLMCOM-CCLM4_MPIESM_EUR44	29	31	26	29	23
CLMCOM-CCLM5_ECEARTH_EUR44	20	21	24	18	19
CLMCOM-CCLM5_HADGEM_EUR44	11	17	12	5	9
CLMCOM-CCLM5_MIROC_EUR44	17	12	19	15	16
CLMCOM-CCLM5_MPIESM_EUR44	25	30	27	27	17
DMI-HIRHAM_ECEARTH_EUR11	30	25	25	21	29
DMI-HIRHAM_ECEARTH_EUR44	27	24	20	23	31
ICTP-REGCM_HADGEM_EUR44	12	16	10	11	5
KNMI-RACMO_ECEARTH_EUR44	19	22	23	13	24
KNMI-RACMO_HADGEM_EUR44	6	10	14	7	1
MPICSC-REMO1_MPIESM_EUR11	28	29	30	26	20
MPICSC-REMO1_MPIESM_EUR44	22	20	31	31	18
MPICSC-REMO2_MPIESM_EUR11	23	26	22	19	28
MPICSC-REMO2_MPIESM_EUR44	31	23	28	25	27
SMHI-RCA_CCCMA_EUR44	1	3	1	1	7
SMHI-RCA_CSIRO_EUR44	14	13	6	9	21
SMHI-RCA_ECEARTH_EUR11	10	8	8	12	15
SMHI-RCA_ECEARTH_EUR44	8	1	7	14	14
SMHI-RCA_GFDL_EUR44	26	27	18	30	30
SMHI-RCA_HADGEM_EUR11	2	7	2	2	4
SMHI-RCA_HADGEM_EUR44	3	5	4	3	2
SMHI-RCA_IPSL_EUR11	4	6	5	8	11
SMHI-RCA_IPSL_EUR44	7	4	11	10	10
SMHI-RCA_MIROC_EUR44	13	2	17	16	3
SMHI-RCA_MPIESM_EUR11	15	11	13	17	13
SMHI-RCA_MPIESM_EUR44	16	9	15	22	12
SMHI-RCA_NORESM_EUR44	18	14	16	28	25

Legend:

- T₃
- T₂
- T₁
- ▨ alternative
- ⋯ flagged

@ climate scenarios CH2018