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Projected changes in meteorological drought risk under future climate change scenarios

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Potsdam Institute for Climate Impact Research

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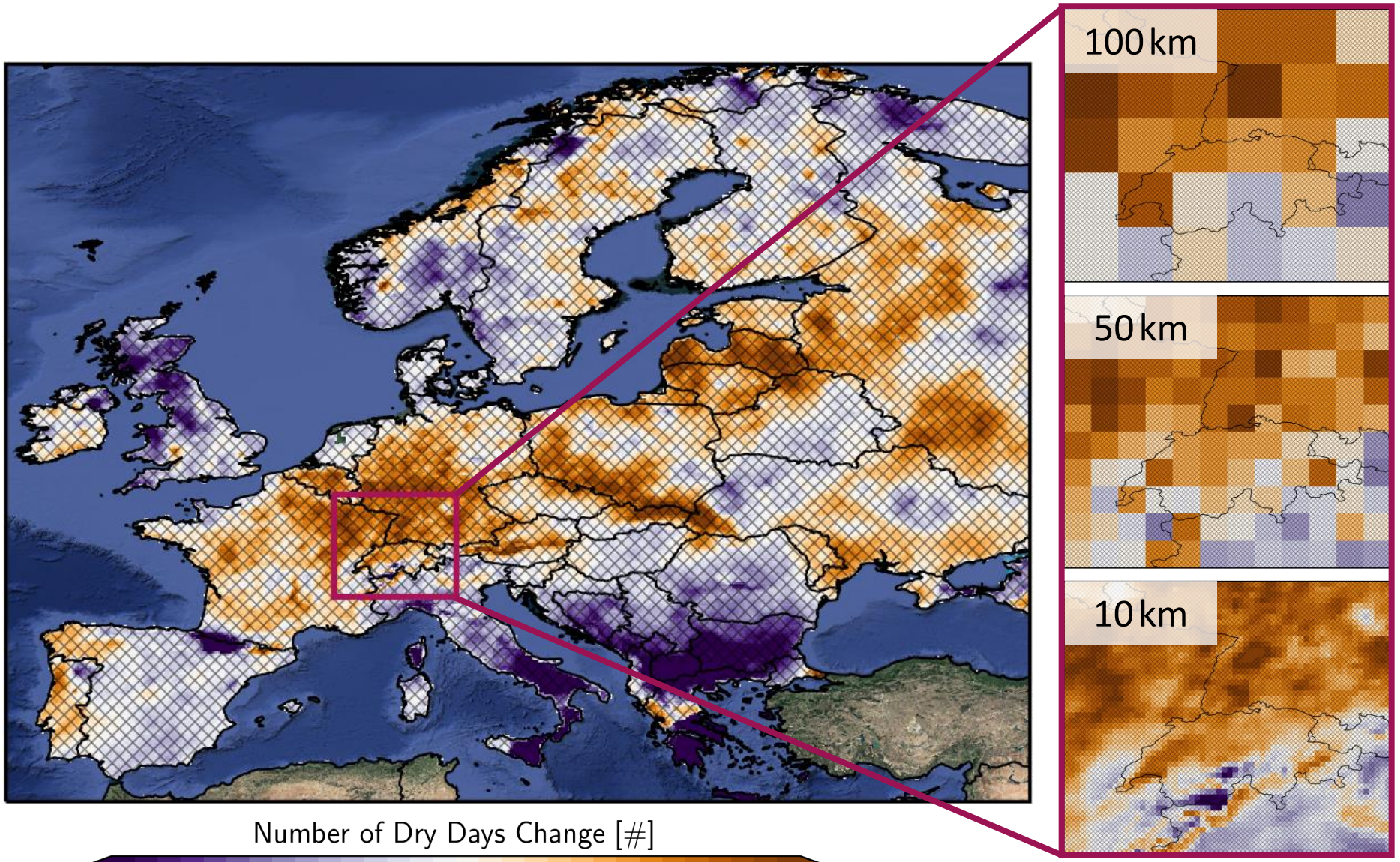
Motivation



Observed Climate Change

2001-2020 vs. 1981-2000

- E-OBS v24.0e
- Annual accumulation
- 90% Significance level

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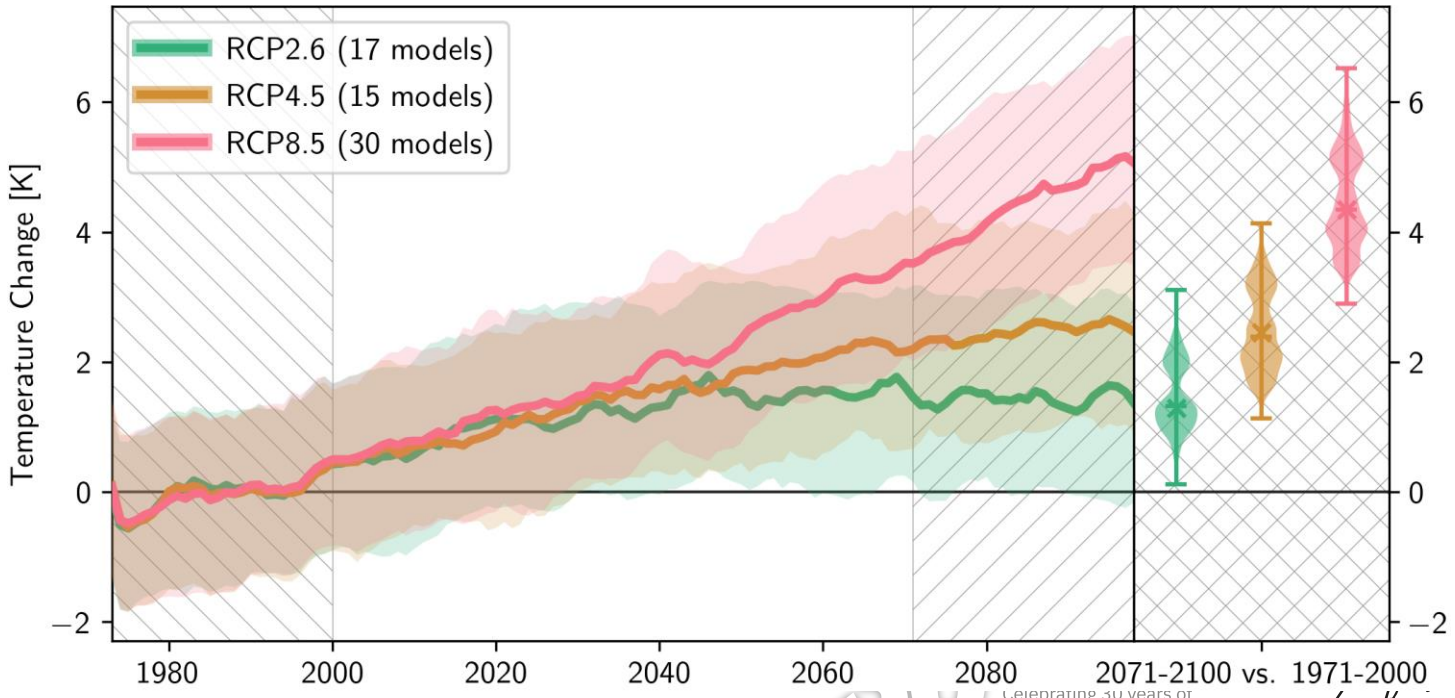
Regional Climate Projections

- Ensemble of 62 high resolution regional climate model simulations
- CORDEX-EUR11 framework: Europe @12.5km
- Daily temperature and precipitation

GCM/RCM	ALADIN53	ALARO-0	CCLM	HIRHAM5	RACMO22E	RCA4	REMO2009	REMO2015	WRF331F	WRF361H	WRF381P
CanESM2			X					X			
CNRM-CM5	X	X	X	X	X	X		X			
EC-EARTH			X	X	X	X		X		X	
CM5A-LR								X			
CM5A-MR						X			X		X
MIROC5			X					X			
HadGEM2-ES			X	X	X	X		X		X	X
MPI-ESM-LR			X			X	X			X	
NorESM1-M				X		X		X			
GFDL-ESM2G								X			



WCRP CORDEX

ReKliEs-De
Regionale Klimaprojektionen Ensemble für Deutschland

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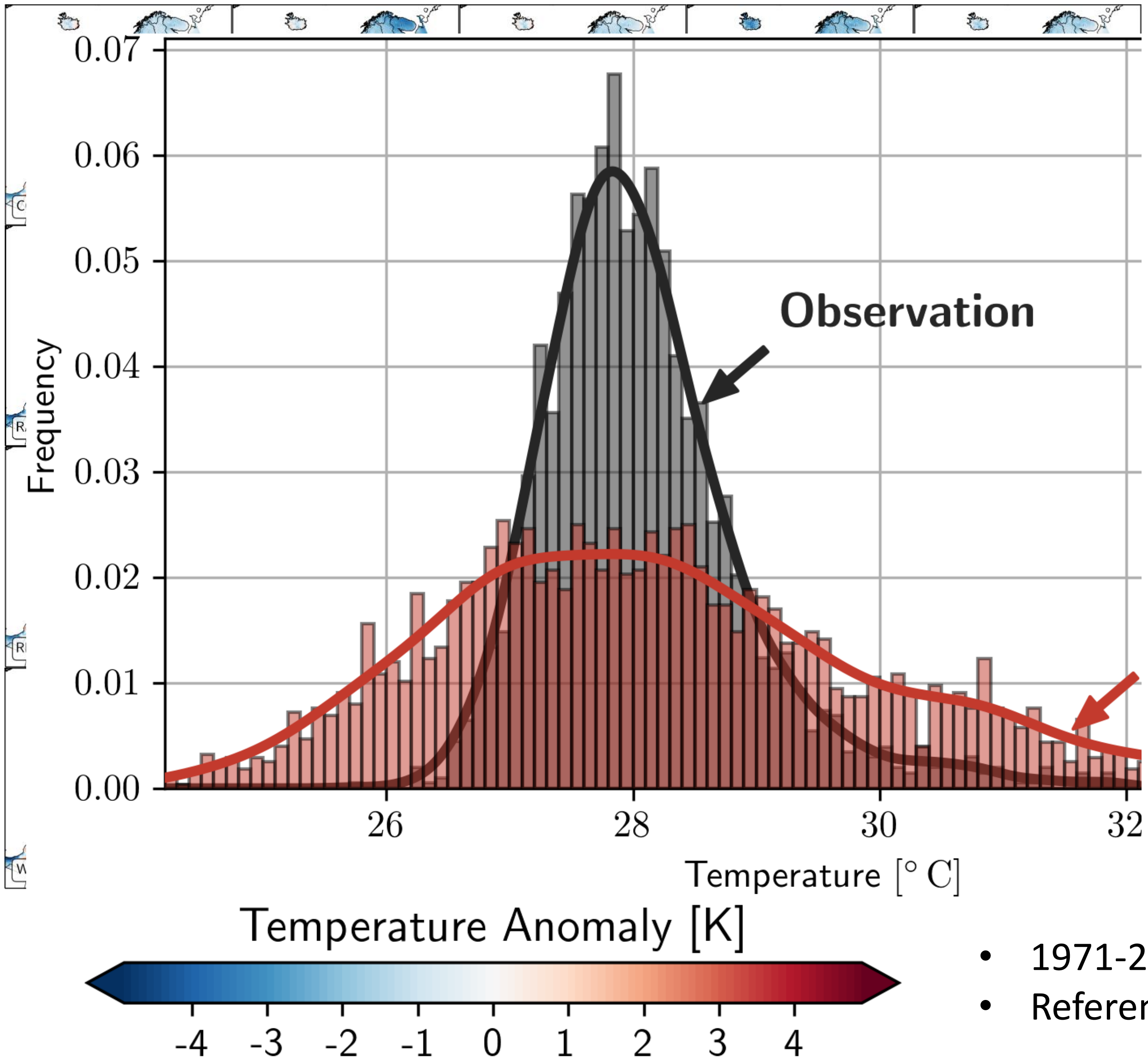
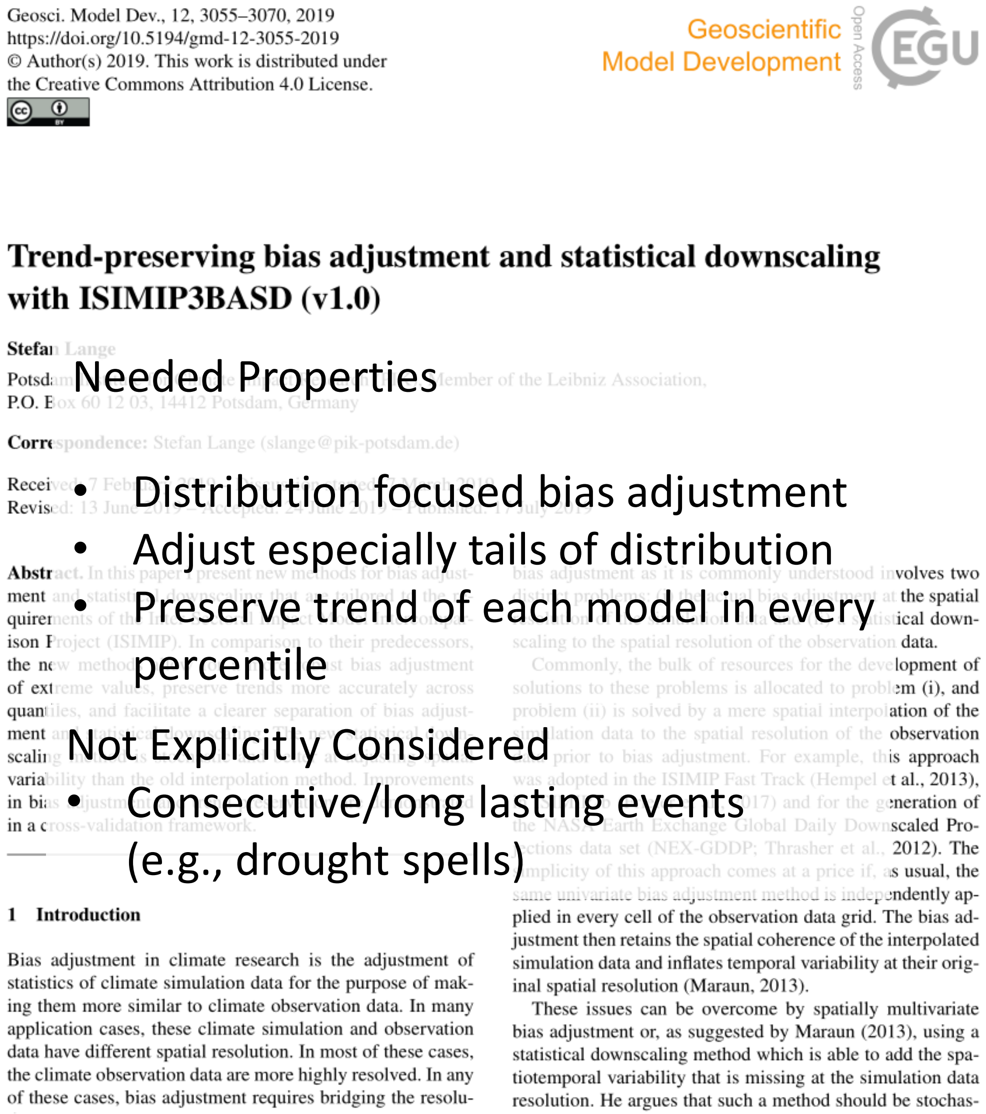
Bias Adjustment




Geosci. Model Dev., 12, 3055–3070, 2019
https://doi.org/10.5194/gmd-12-3055-2019
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Geoscientific
Model Development
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Trend-preserving bias adjustment and statistical downscaling with ISIMIP3BASD (v1.0)

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1 Introduction

Bias adjustment in climate research is the adjustment of statistics of climate simulation data for the purpose of making them more similar to climate observation data. In many application cases, these climate simulation and observation data have different spatial resolution. In most of these cases, the climate observation data are more highly resolved. In any of these cases, bias adjustment requires bridging the resolu-

plied in every cell of the observation data grid. The bias adjustment then retains the spatial coherence of the interpolated simulation data and inflates temporal variability at their original spatial resolution (Maraun, 2013).

These issues can be overcome by spatially multivariate bias adjustment or, as suggested by Maraun (2013), using a statistical downscaling method which is able to add the spatiotemporal variability that is missing at the simulation data resolution. He argues that such a method should be stochas-

Needed Properties

- Distribution focused bias adjustment
- Adjust especially tails of distribution
- Preserve trend of each model in every percentile

Not Explicitly Considered

- Consecutive/long lasting events (e.g., drought spells)

- 1971-2000
- Reference: E-OBS v19.0e

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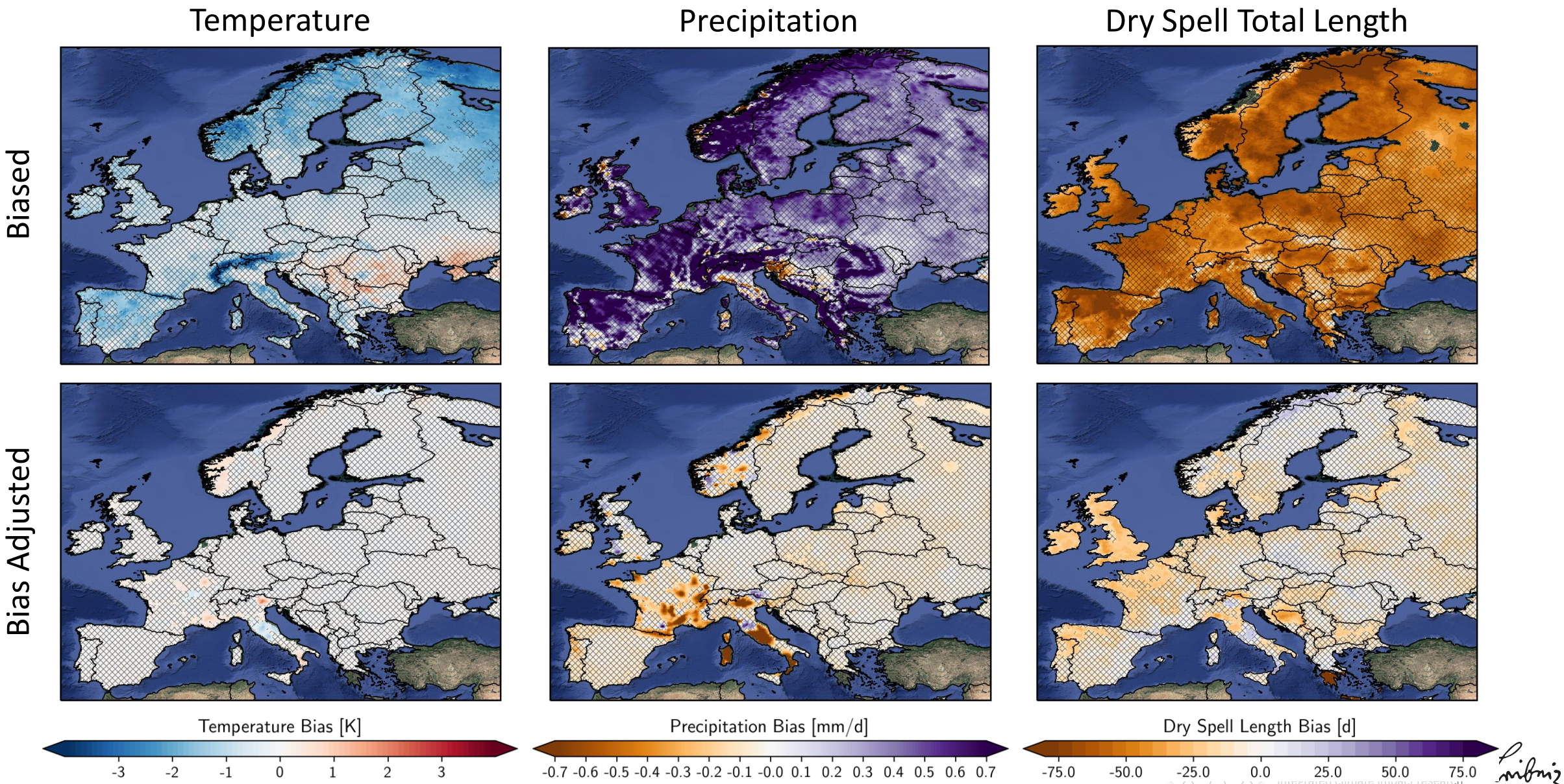
Bias Adjustment - Evaluation

1971-2000 vs. E-OBS v24.0e



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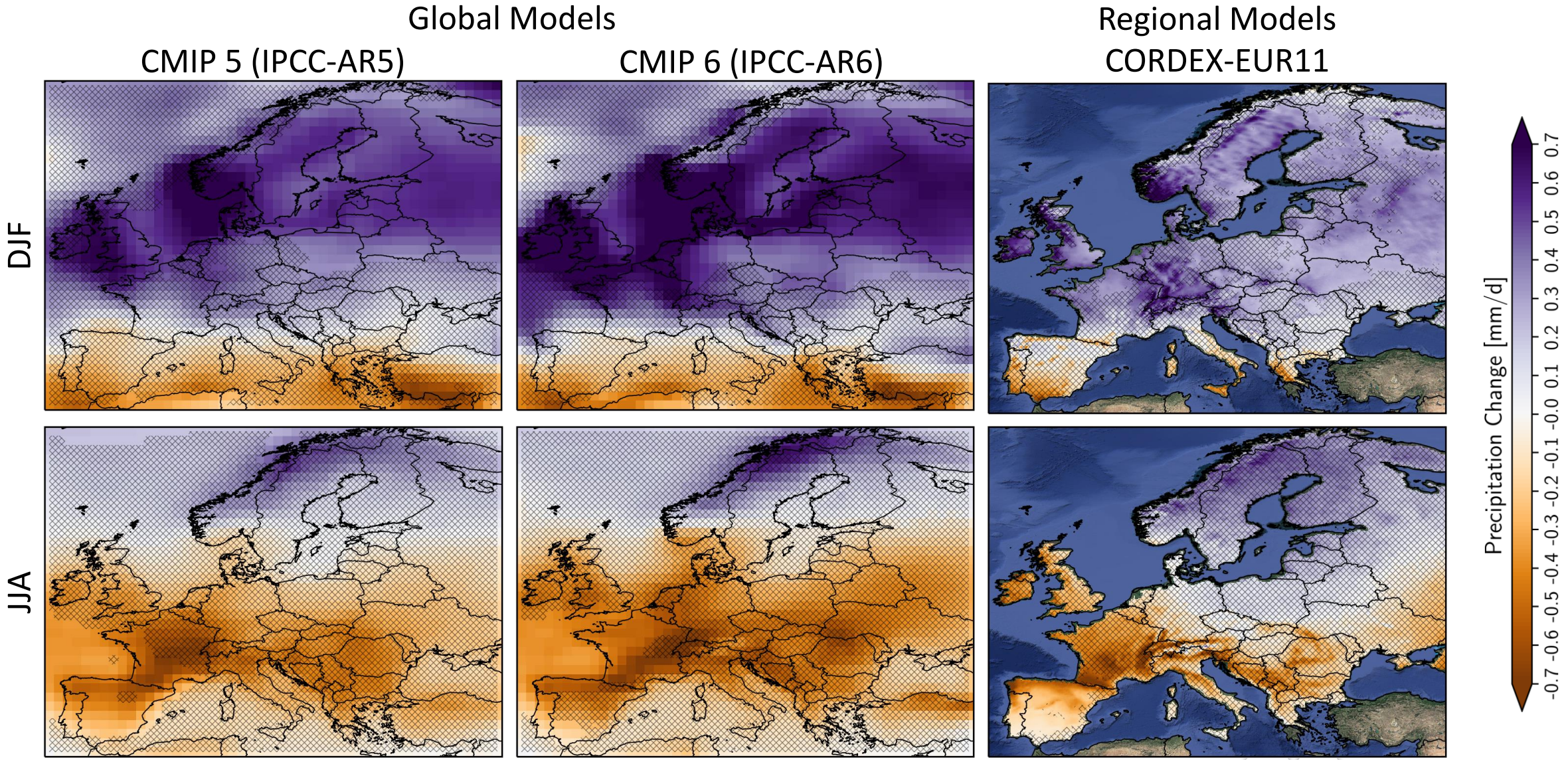
Regional Climate Projections – General Overview



2071-2100 vs. 1971-2000 RCP8.5/SSP5-8.5 90% Significance Level

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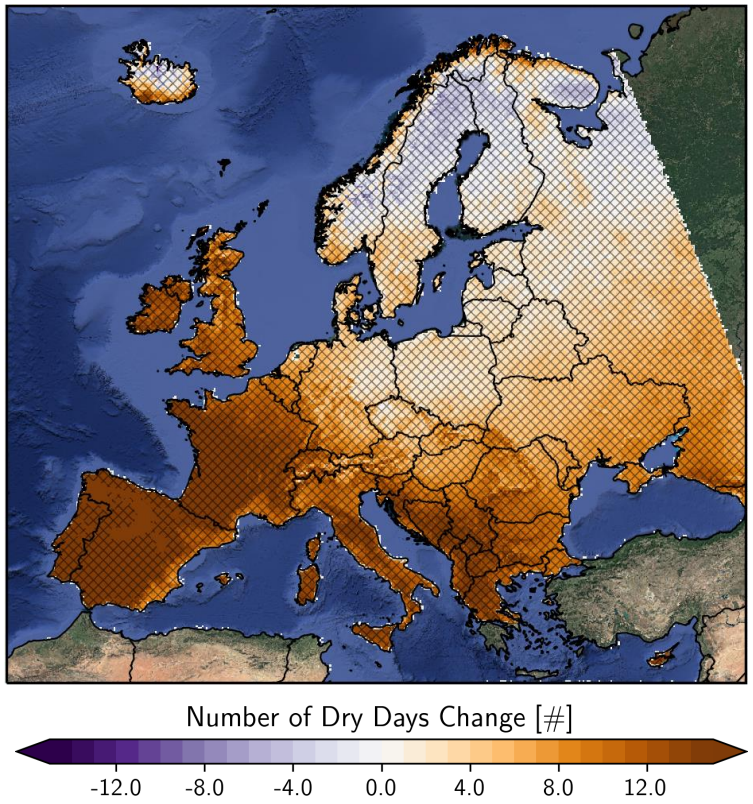
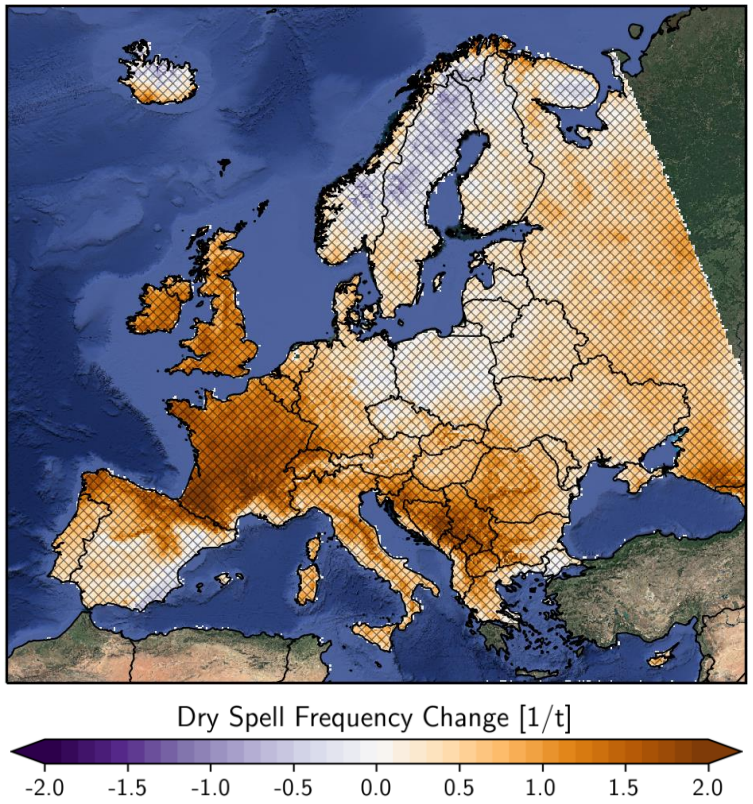
Regional Climate Projections – Drought Spell Change

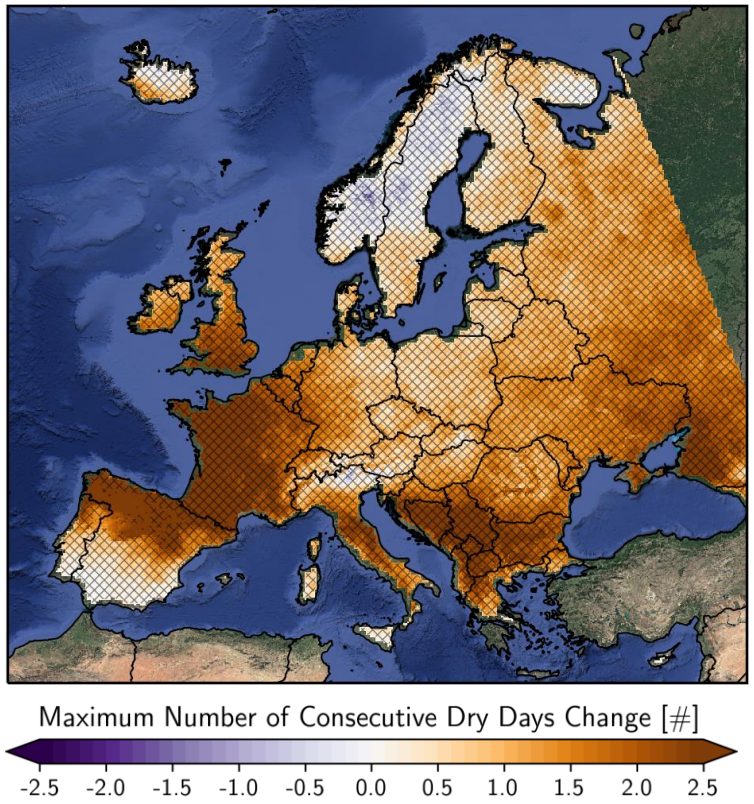
Dry Days



Dry Spell Frequency



Length of Most Severe Drought



2071-2100 vs. 1971-2000
CORDEX-EUR11 RCP8.5
Annual Changes
90% Significance Level

min. 7 days below 0.1mm

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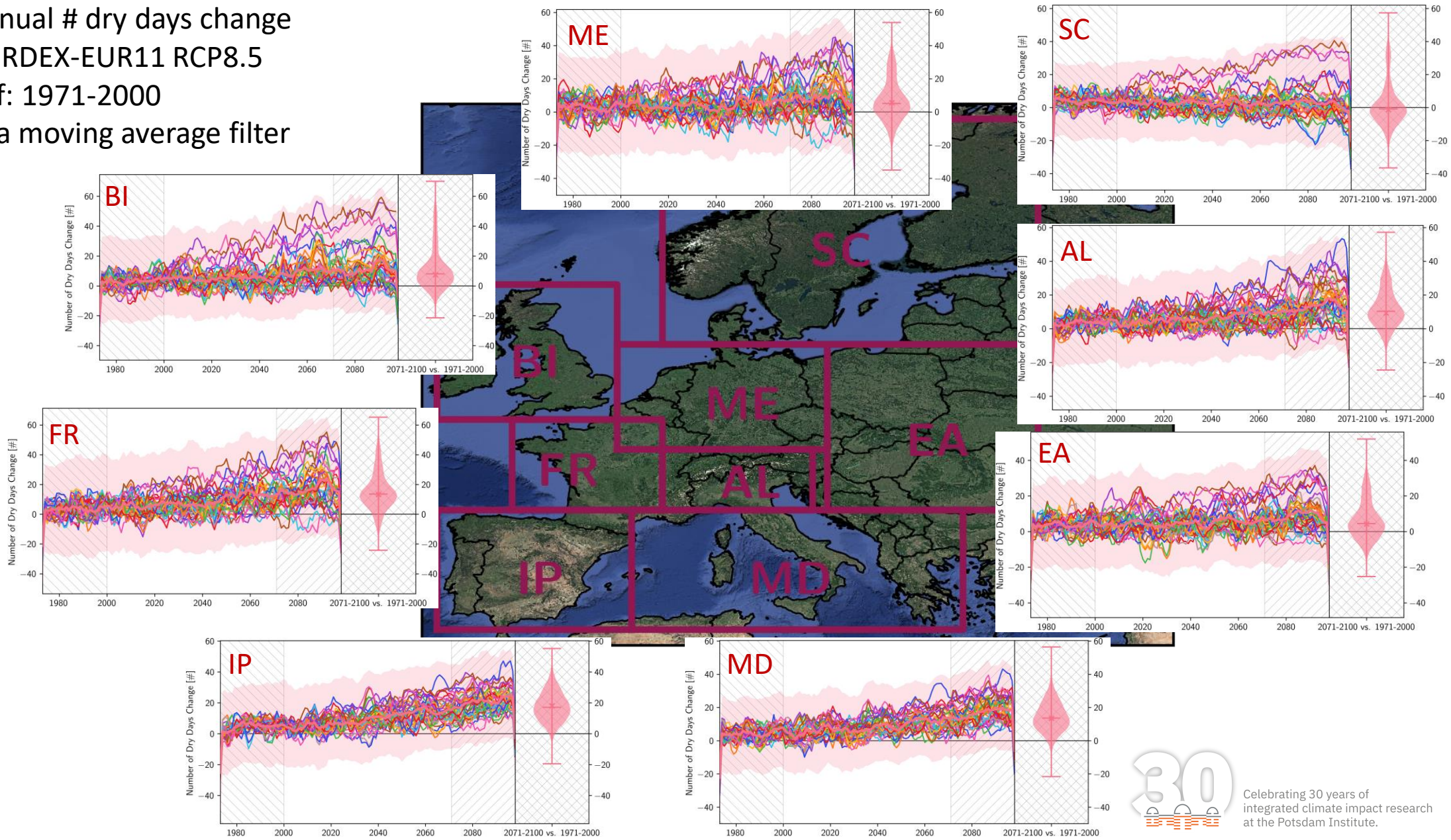
Regional Climate Projections – # Dry Days Change Time Series

- Annual # dry days change
- CORDEX-EUR11 RCP8.5
- Ref: 1971-2000
- 10a moving average filter



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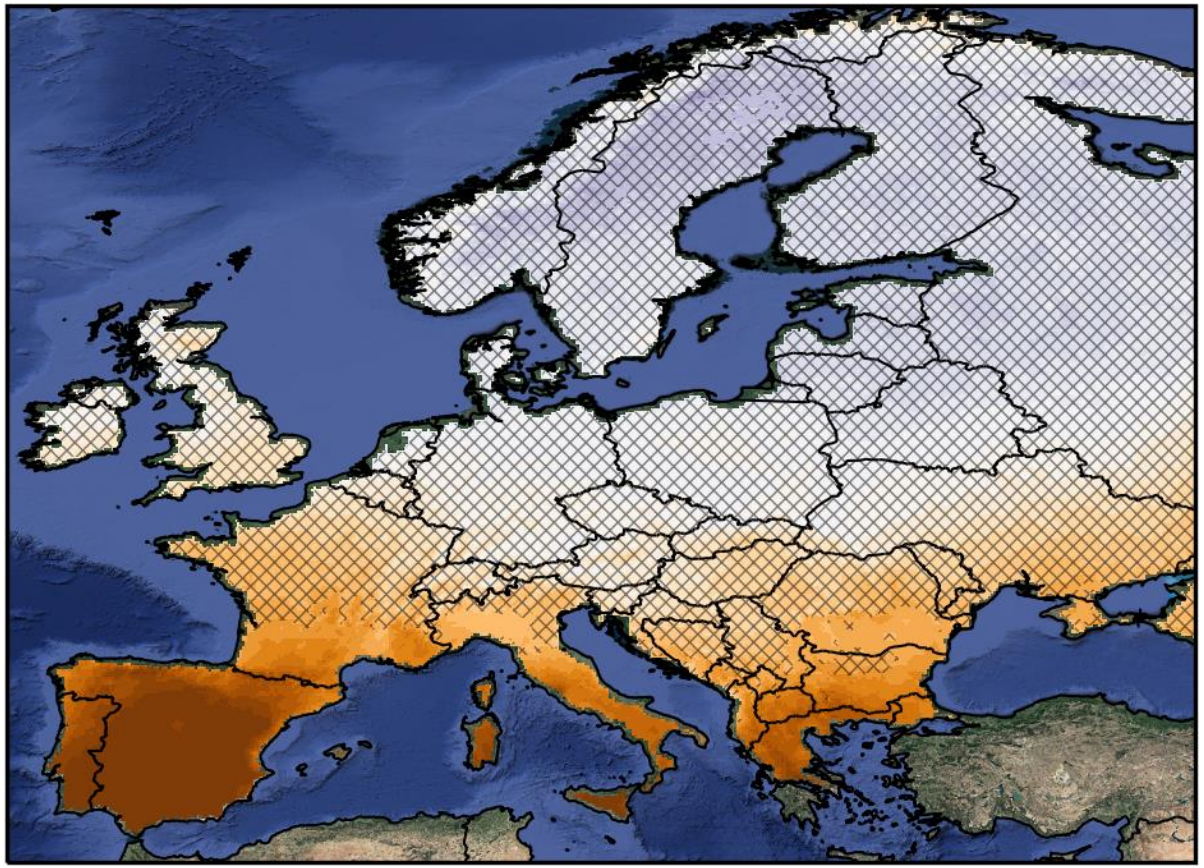
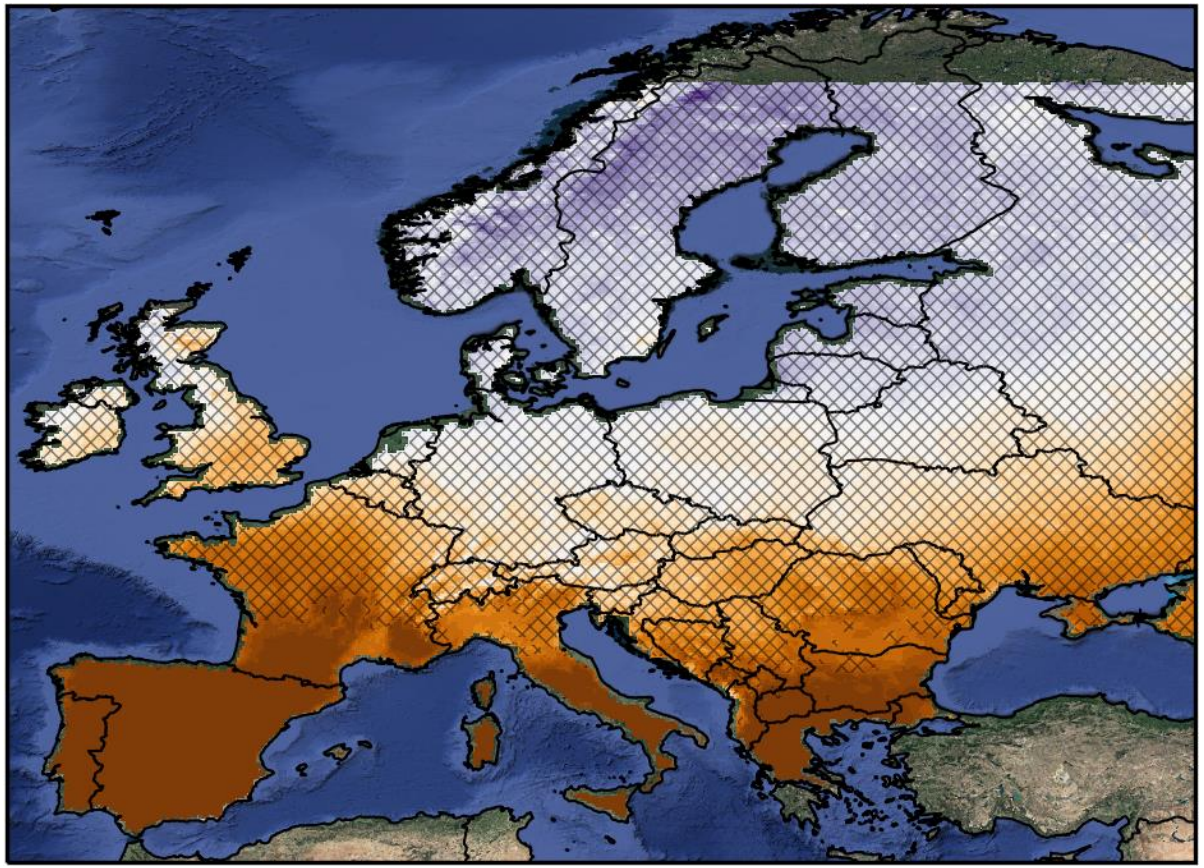
Regional Climate Projections – SPEI Change

SPEI – 3 Month



SPEI – 12 Month



Standardized Precipitation Evapotranspiration Index

-1.2 -0.8 -0.4 -0.0 0.4 0.8 1.2

Potential Evapotranspiration based on Hargreaves

2071-2100 vs. 1971-2000
CORDEX-EUR11 RCP8.5
Annual Changes
90% Significance Level

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Summary

- Ensemble of 62 high resolution regional climate model simulations are available for the project
- Bias adjustment reduces bias significantly, also for prolonged drought event
- North-South gradient in climate change signal, but different border between different ensembles
- Increase number of drought events and length of drought spells
- Precipitation related changes are uncertain with any ensemble (CMIP5, CMIP6 and CORDEX-EUR11)
  - High natural variability
  - High inter-model variability
- Strongest changes anticipated for France, Italy and Balkans
- Long-scale SPEI (>12 month) show stronger increase

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