

Results of statistical downscaling of COSMO-CLM convection-permitting simulations with PCA-derived weather patterns



**Michael Haller, Susanne Brienen, Stefan Krähenmann,
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- Convection-permitting simulations in Project „Network of Experts“
 - Dynamical downscaling from 12 km to 2.8 km for Germany
- Statistical downscaling approach
 - Methods
 - Application to climate projection ensemble

Project „Network of Experts“ (NoE)

→ Network of several agencies in the frame of the German Federal Ministry of Transport and Digital Infrastructure (BMVI)

→ Integrates the knowledge and abilities available within the departmental research institutes

→ Datasets and analysis methods for observations and climate projections for Germany for the assessment of specific climate impacts on the transport infrastructure network

■ Local information of extreme events are essential for adaption strategies for traffic infrastructure

○ Convection-permitting simulations (CPS) in high resolution are performed



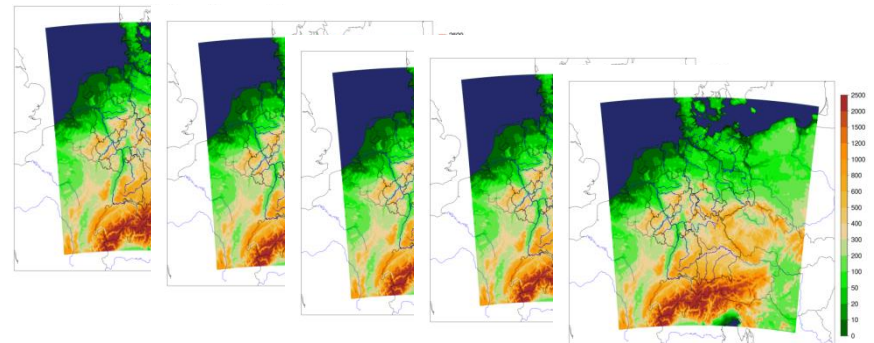
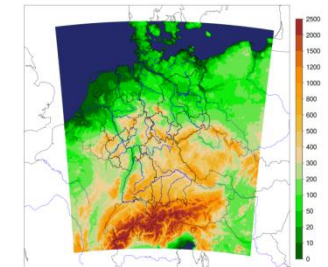
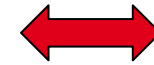
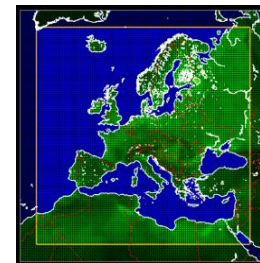
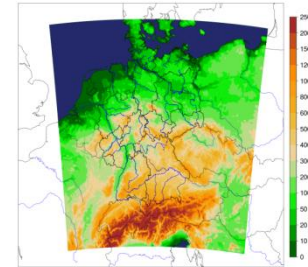
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Work concept in NoE

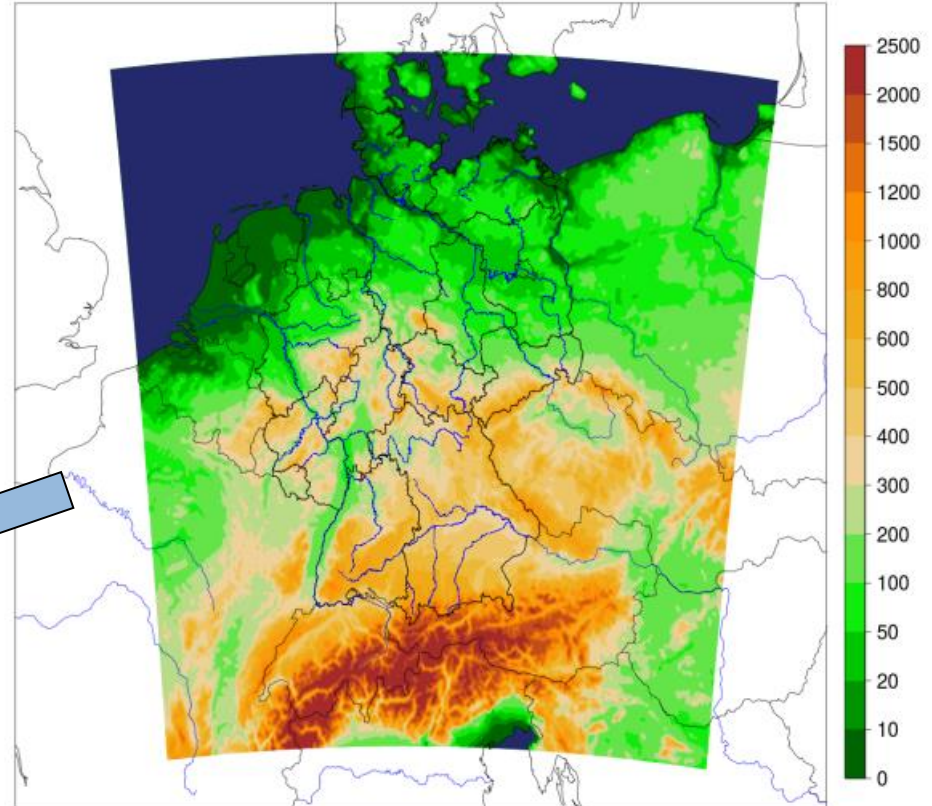
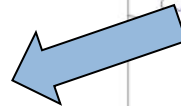
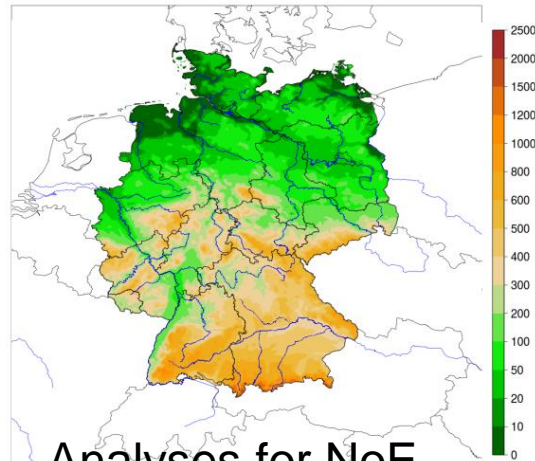
- Climate projections on high-resolution for Germany / Central Europe, based on EURO-CORDEX
- Test and apply statistical downscaling approach to EURO-CORDEX member for historical and future time periods
- Apply to EURO-CORDEX ensemble members to span a high-resolution data set of climate projections



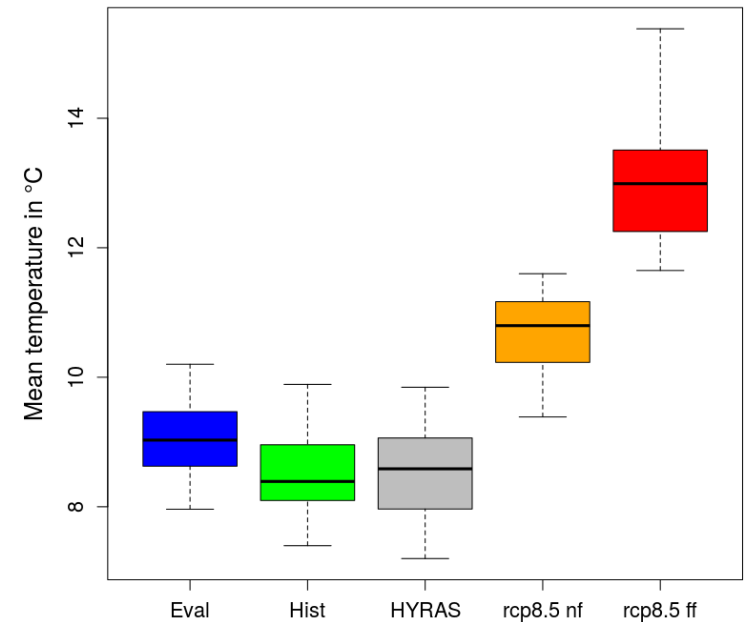
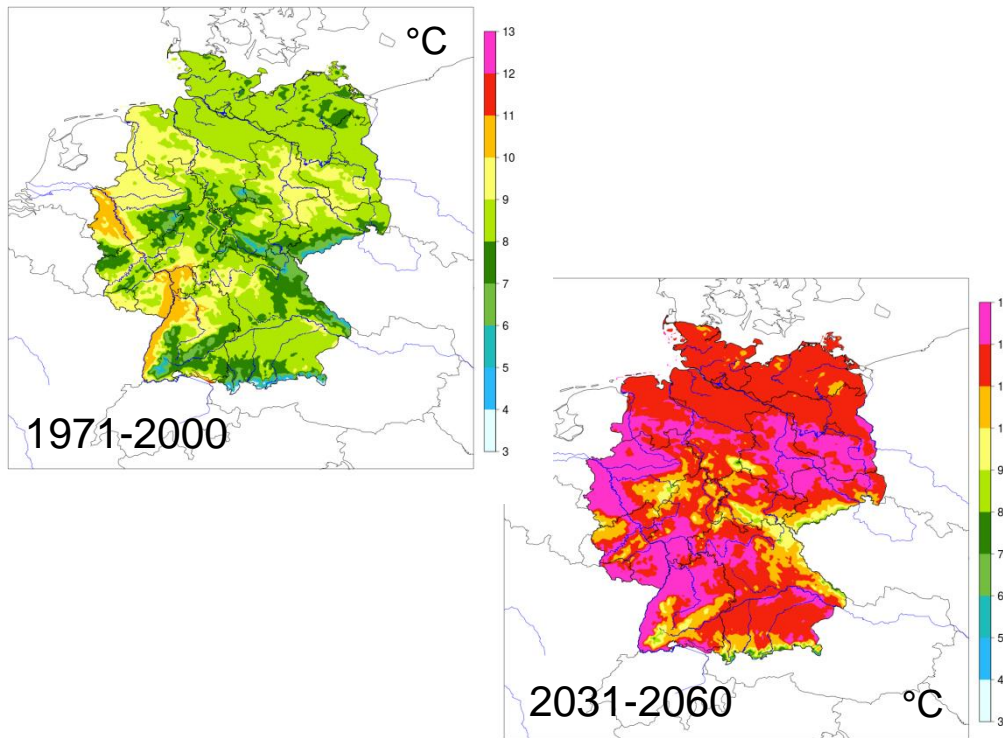
Dynamical downscaling simulations

COSMO-CLM Version	COSMO 4.8 CLM 18 (INT2LM Version 1.19)		
Resolution	horizontal: 2.8 km	vertical: 50 layers	
Model domain	COSMO-DE plus eastern river catchments 461x481 grid points		
Climate scenario	RCP 8.5		
Time periods	1971–2005	Historical run	MIROC5 - CCLM
	1971–2000	Evaluation run	ERA-40/ERA-Interim
	2006–2100	Scenario run	MIROC5 - CCLM
	Focus time periods	„Near Future“ (2031-2060)	MIROC5 - CCLM
		„Far Future“ (2071-2100)	MIROC5 - CCLM
Relevant variables	Temperature, dew point temperature, precipitation, wind, pressure, radiation		

- 461x481 grid points
- „COSMO-DE-plus“/GER-025:
extended to the east to
include river catchments
- Horizontal grid: 0.025°



- COSMO-CLM CPS 2.8 km historical and scenario time periods

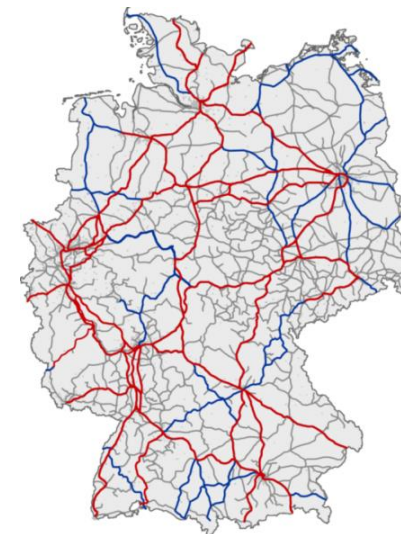
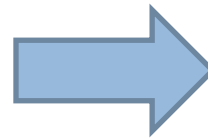
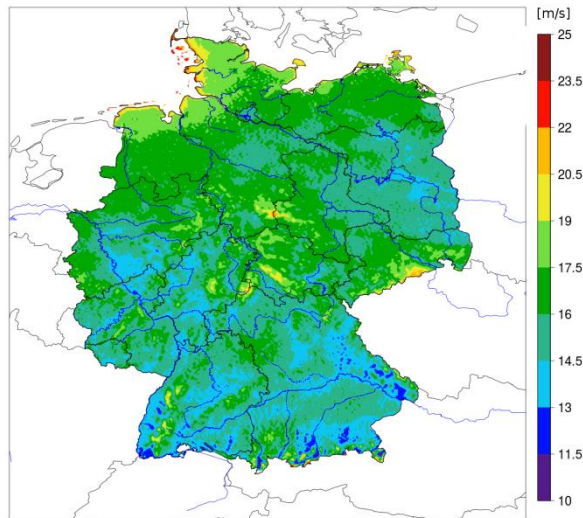


More about analyses of the dynamically downscaled runs in the next presentation by
Susanne Brienen, DWD

ure („End of century“)



- Climate data of NoE CPS runs are delivered to project partners
- Analyses of climate impact on traffic infrastructure
 - Impact of storms on railway track sections
- CPS-Data set based on only one GCM-RCM model
- For quantification of uncertainties climate model ensemble needed

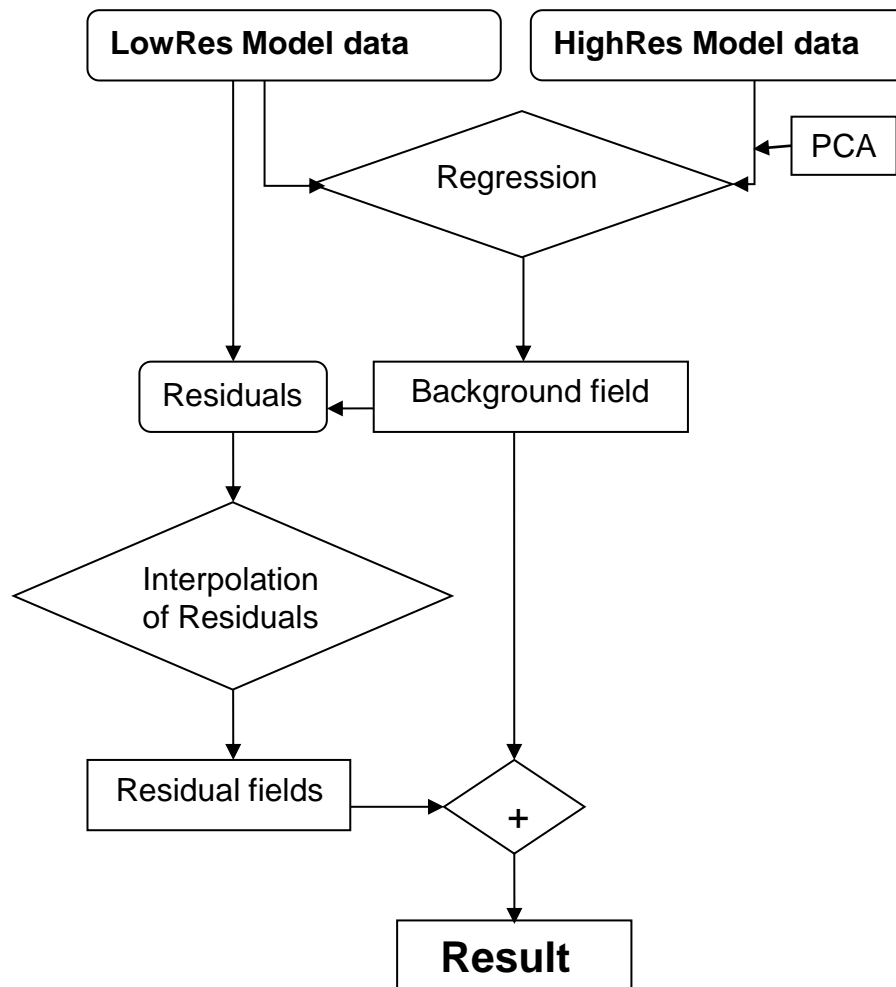


Railway network
Express rails

Statistical Downscaling

- Problem: Dynamical Downscaling technique takes much time and money
 - Building of CPS ensemble only possible for small domains and few models
- Our solution: Application of Statistical Downscaling technique
 - As Predictors serve Principal Component Analysis (PCA) derived weather patterns, taken from CPS high-resolution (HighRes) run

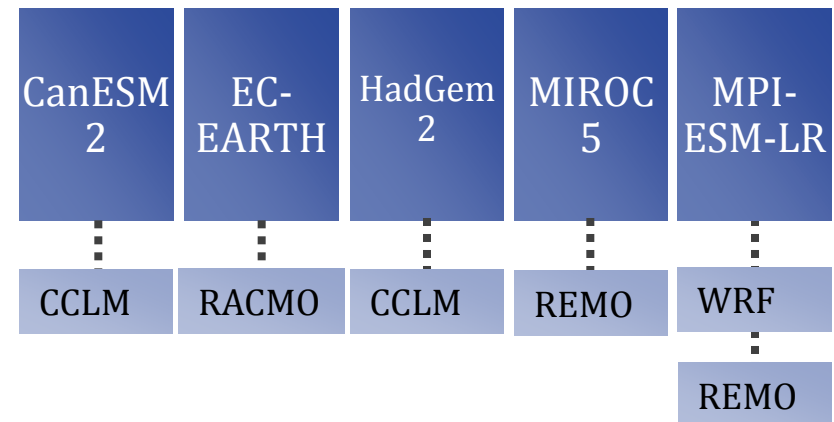
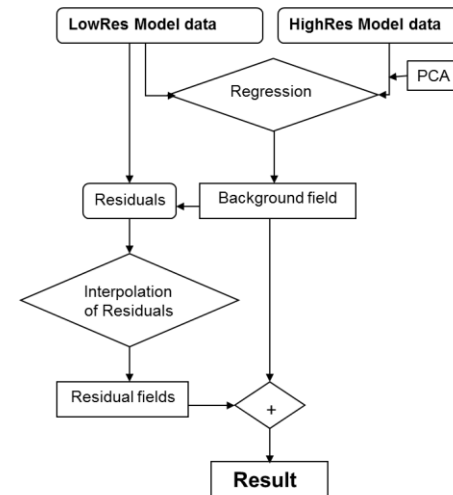
Statistical downscaling scheme



Krähenmann & Haller, in prep.

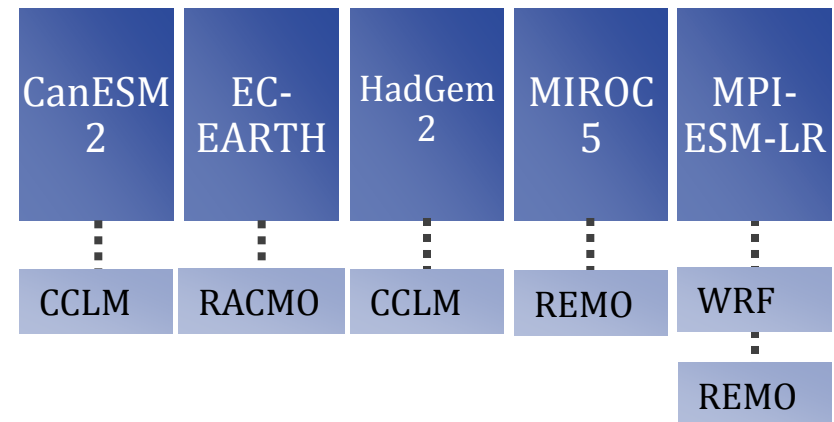
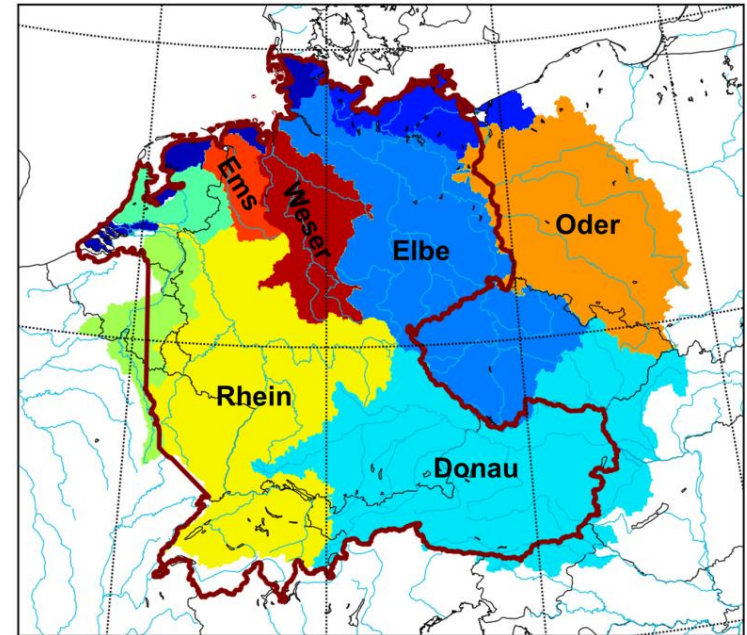
Statistical Downscaling

- Calculation of reduced climate model ensemble by method of Dalelane et al. (2018)
 - 6 out of 20 Members in RCP8.5-ensemble
- LowRes data set: Bias-adjusted 12 km EURO-CORDEX data
- HighRes data set: evaluation run with COSMO-CLM with 2.8 km grid width
- Calculations done for area surrounded by red line
- Variables: temperature, precipitation



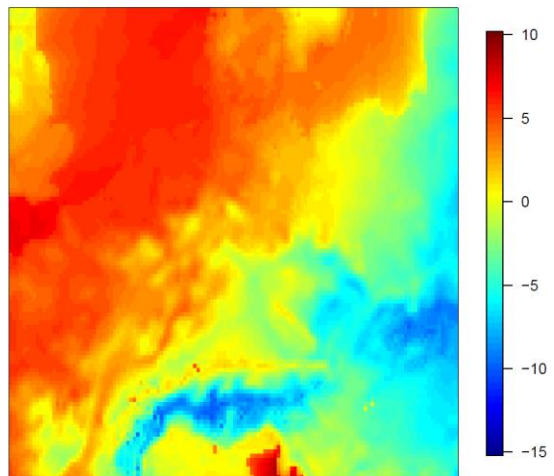
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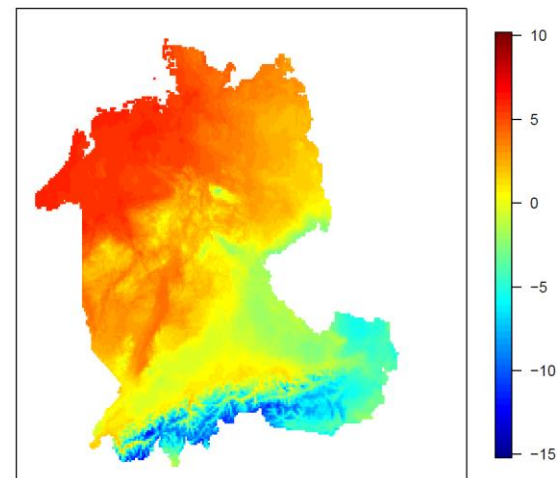
Statistical downscaling scheme: Example

MPI-M-MPI-ESM-LR CLMcom-CCLM4-8-17 (tas, 1950-11-30)



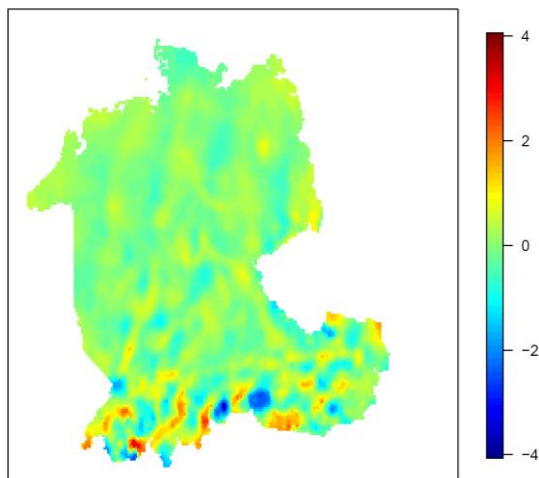
Low resolution field

MPI-M-MPI-ESM-LR CLMcom-CCLM4-8-17 (tas, 1950-11-30)



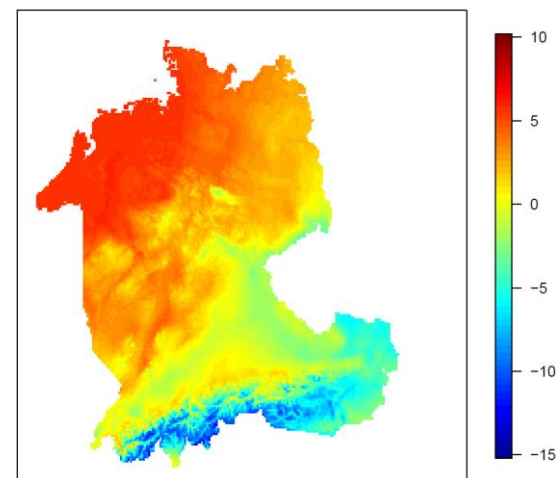
High resolution field

Resids MPI-M-MPI-ESM-LR CLMcom-CCLM4-8-17 (tas, 1950-11-30)



Residual field

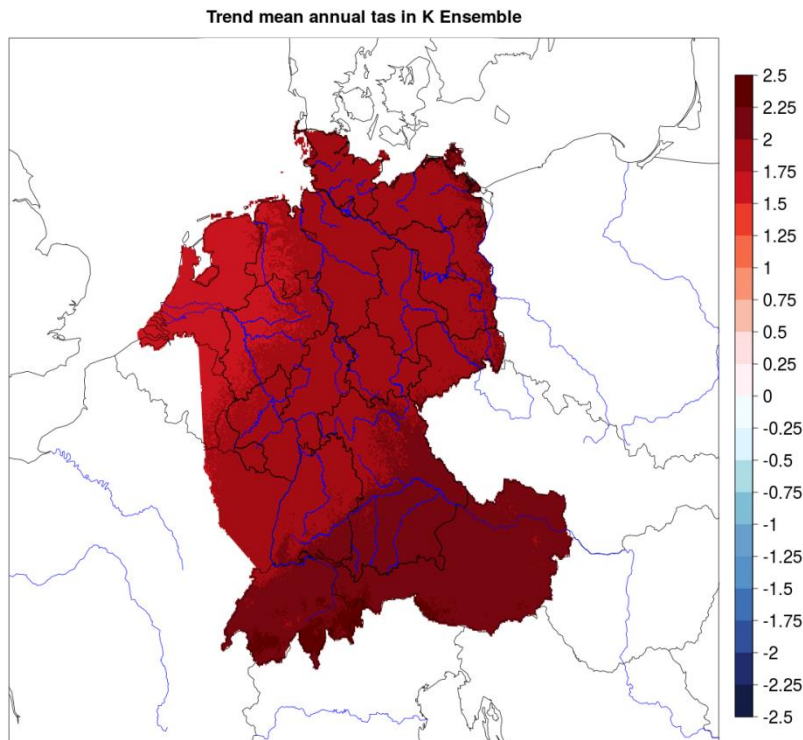
MPI-M-MPI-ESM-LR CLMcom-CCLM4-8-17 (tas, 1950-11-30)



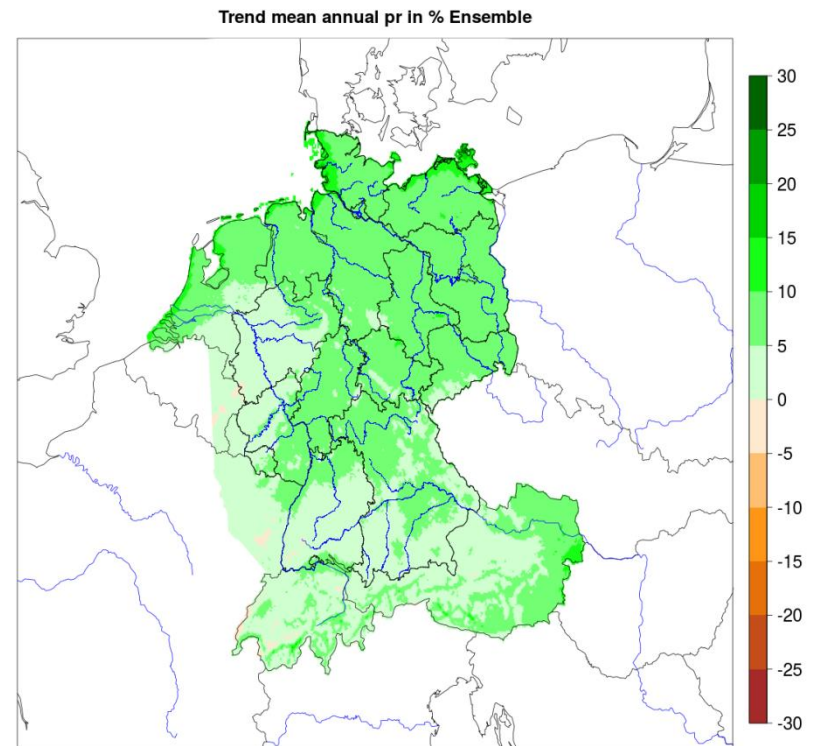
End result

Statistical Downscaling: Results

→ Ensemble changes of mean values of temperature and precipitation (2031-2060 to reference period 1971-2000)



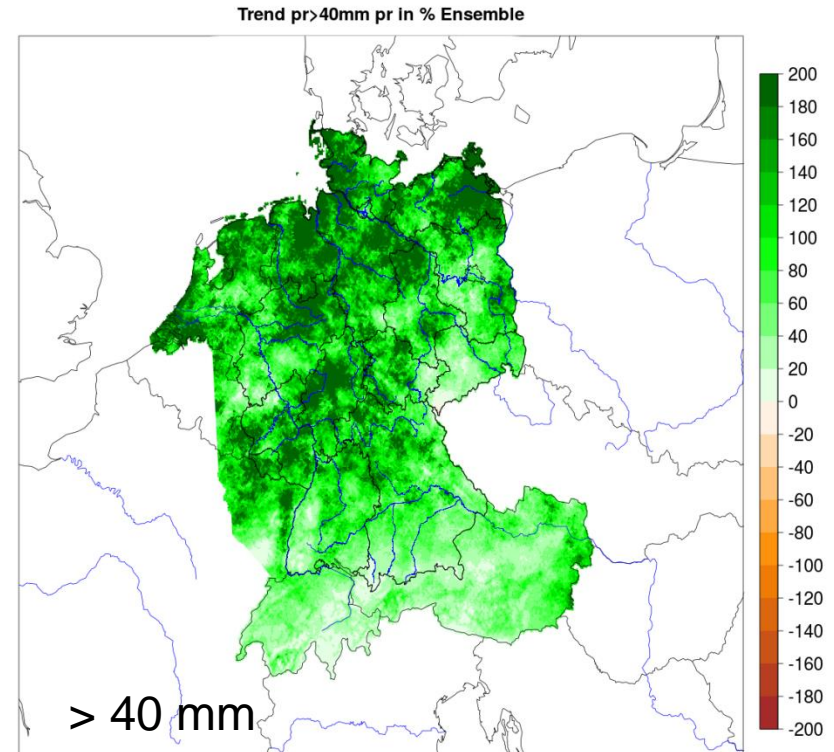
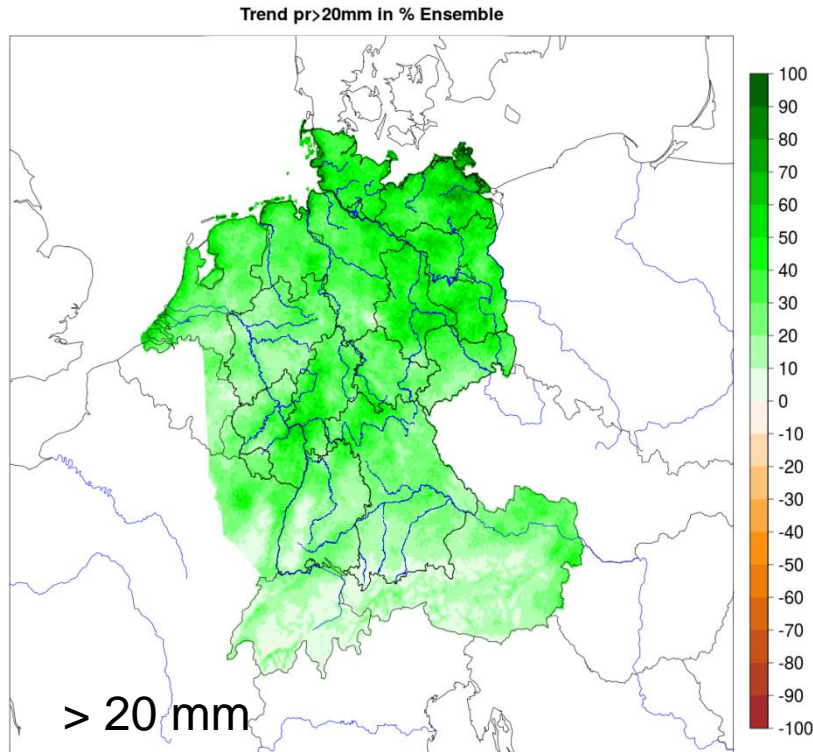
Mean ensemble trend of mean temperature in K



Mean ensemble trend of mean annual precipitation in percent [%]

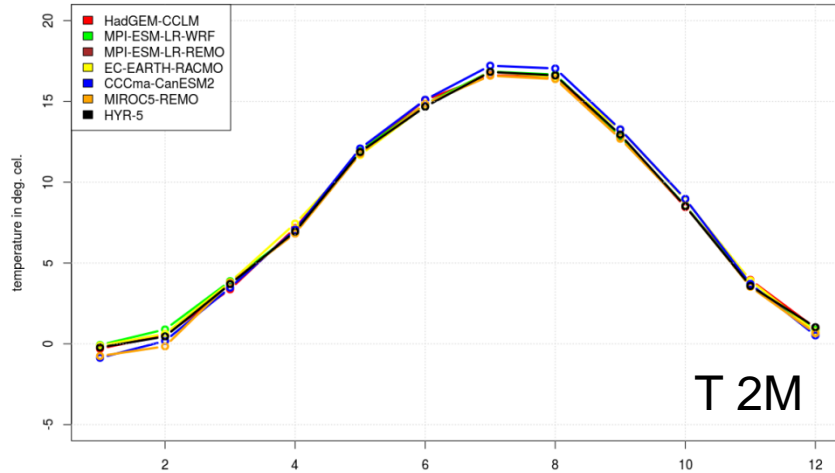
Statistical Downscaling: Results

- Ensemble changes of extreme values of precipitation (2031-2060 to reference period 1971-2000)

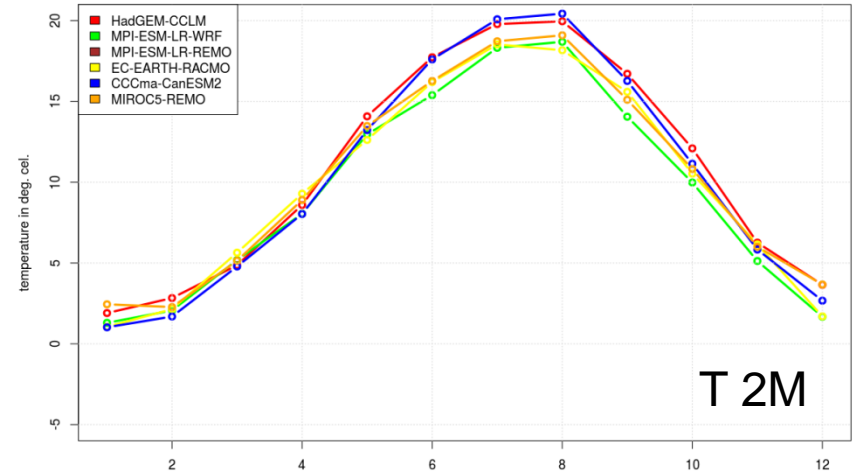


Mean ensemble relative change of number of days
in percent [%]

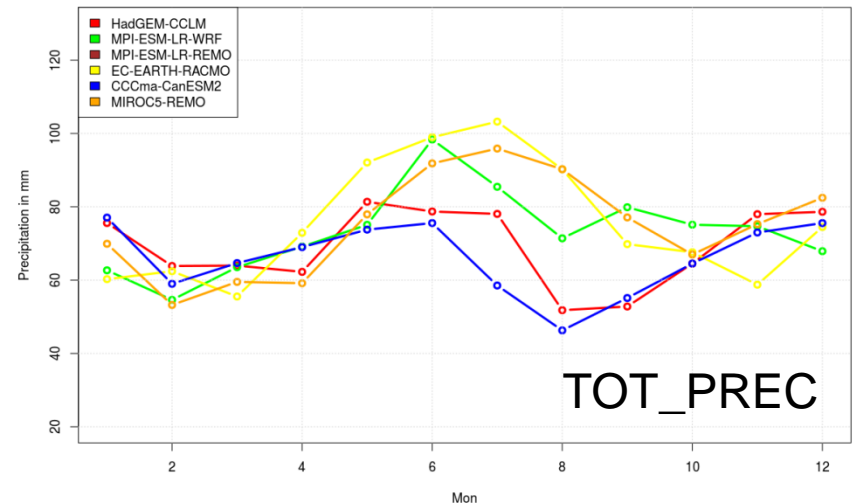
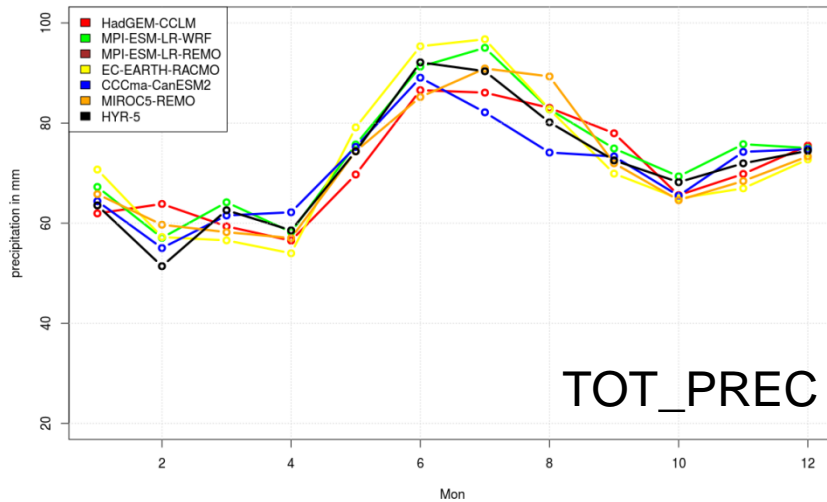
Statistical Downscaling: Annual cycle



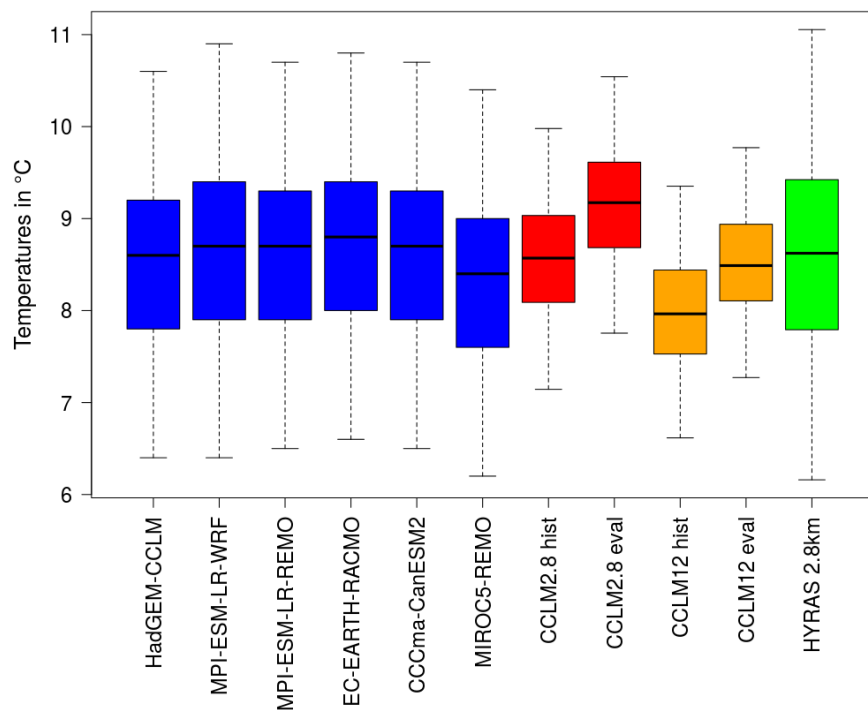
1971-2000



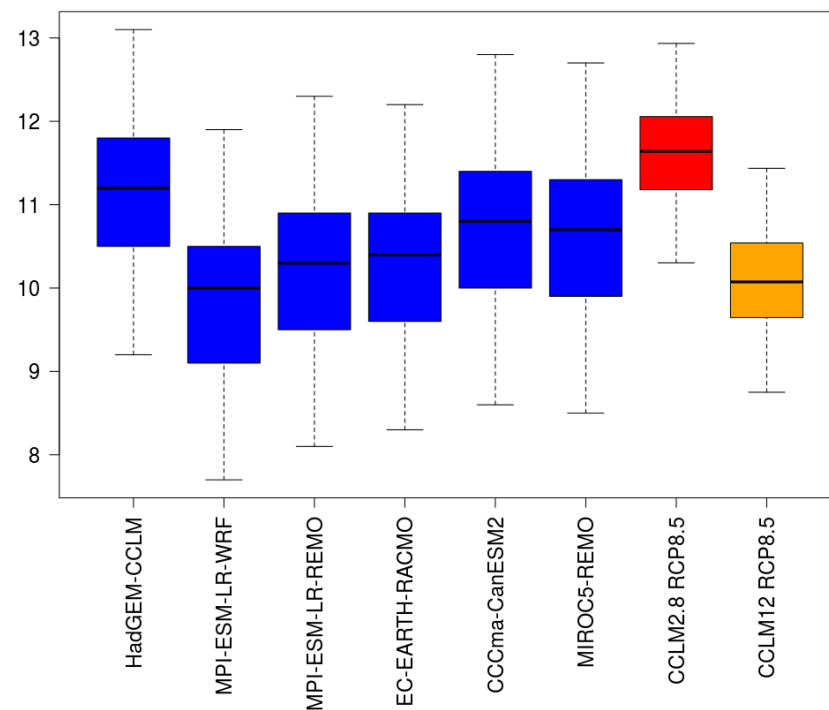
2031-2060



Mean Temperature at every grid point

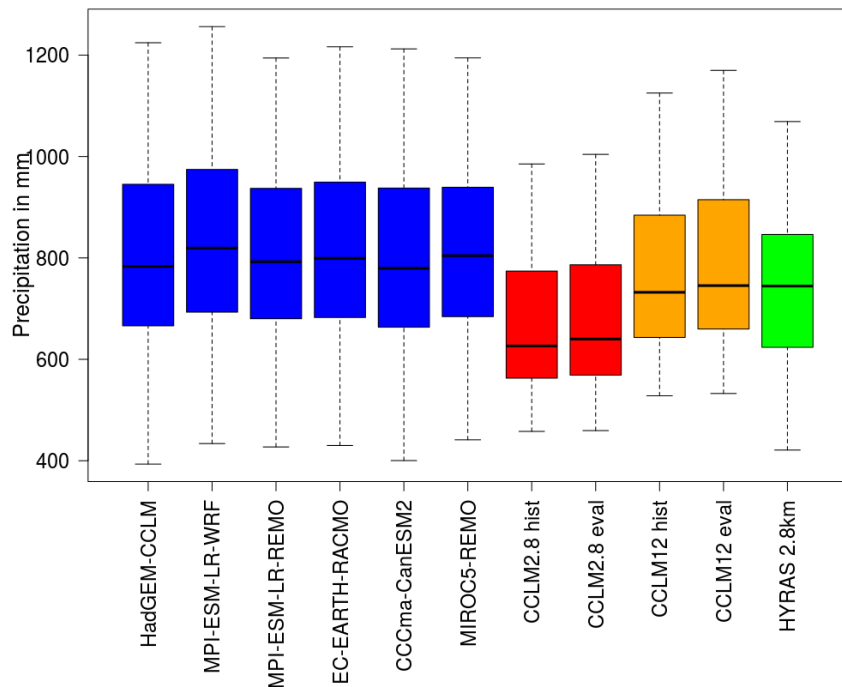


Historical time period 1971-2000

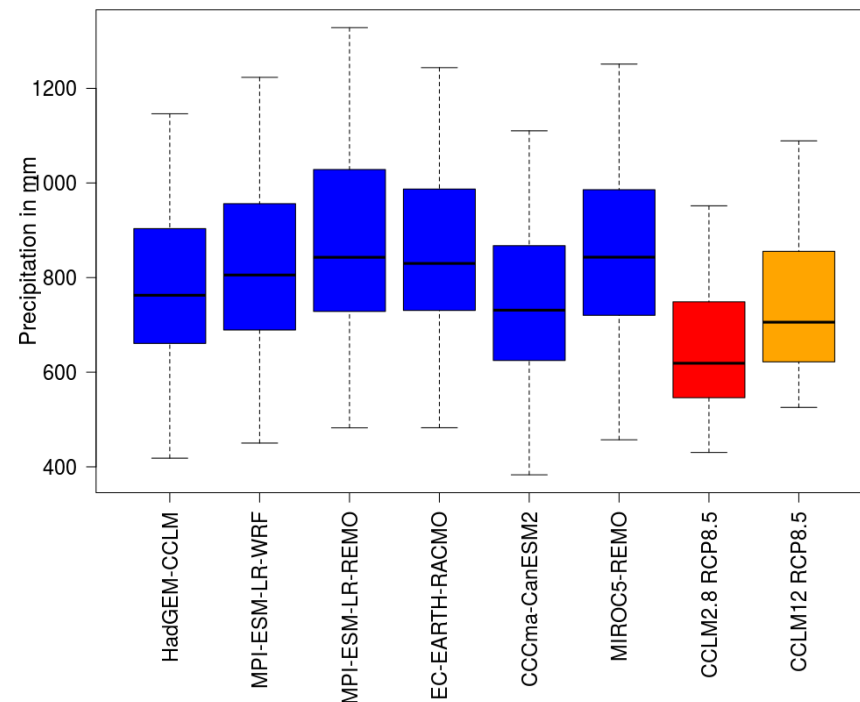


RCP8.5 Scenario 2031-2060

Mean yearly precipitation at every grid point



Historical time period 1971-2000



RCP8.5 Scenario 2031-2060

- Next phase of Network of Experts will start 2020
- Switch to ICON-CLM (on convection-permitting scale)
- New projections with very high time resolution for precipitation (5min)
- Extension of current analyses of the dynamically and statistically downscaled simulations
 - Some open questions to solve
 - Evaluation with hourly radar data
- COSMO-CLM CPS data set soon available on ESGF-node
 - <https://esgf.dwd.de/>

