Threshold Correction of Regional Climate Model Ensembles for Climate Extreme Assessments on the Country Level

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ReKliEs-De Regionale Klimaprojektionen Ensemble für Deutschland | HLNUG | PIK | Potsdam Institute for Climate Impact Research | btu Brandenburgische Technische Universität Cottbus - Senftenberg | DKRZ Deutsches Klimarechenzentrum | GERICS Climate Service Center Germany | DWD | Universität Hohenheim | Federal Ministry of Education and Research

Summary

Motivation: Raw data of regional climate model (RCM) simulations within Euro-Cordex have bias against observed temperature and total precipitation patterns for the historical period. This leads to an over/under estimation of especially threshold-based climatic indices, such as the number of hot days ($tasmax > 30°C$) or the number of very wet days ($pr > 20mm$), respectively.

Approach: The used concept to assess changes in climate extremes over Germany (ReKliEs-De domain) in absolute numbers based on a threshold correction. Thereby, every ensemble member is attributed to one single threshold. The adjusted threshold was found by choosing the respective value which belongs to the percentile of the fixed threshold ($tasmax > 30°C$ or $pr > 20mm$) in observation data. For the historical period (1971-2000) all simulations are in the order of about 5 hot and 5 very wet days after threshold correction.

Results: All RCP8.5 RCM simulations until 2041-2070 are consistently located in the same quadrant (Fig.2b upper-right). This stands for both increasing heat and rain extremes. In contrast to it, most of the ESD realizations simulate a decreasing frequency of very wet days. Consequently, the ensemble spread (only RCMs) seen in the PDFs is much smaller compared to the whole ensemble (RCMs and ESDs).

Conclusions: This assessment of projected changes in climate extreme values are very good commuticatable for a broader public community.

Space-Time Threshold Correction

- space-time percentile: OBS, *tasmax*, 1971-2000, ReKliEs-De, Python libraries
  - `Xobs = Xobs(d,y,x)` raw daily data (*tasmax*)
  - `XobsS = 30.` threshold ($tasmax > 30.0°C$)
  - `Xobs = numpy.ravel(Xobs[:,:,:])` space-time merging
  - `XobsP = scipy.stats.percentileofscore(Xobs,score=XobsS)` percentile
- threshold in RCM $XrcmS$ is attributed to the percentile $XobsP$ in observation data.
  - `XrcmS = numpy.percentile(Xrcm,XobsP)` threshold
- result: corrected threshold per RCM ↻ an adjusted spatial distribution of the number of hot days over the ReKliEs-De domain (analogue for $pr > 20mm$).

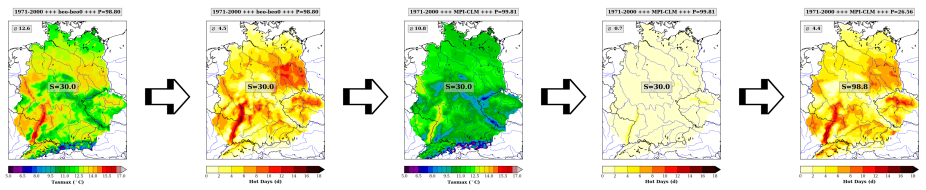


Fig.1: Flow chart of the threshold correction approach: *tasmax* (OBS) → $tasmax > 30°C$ (OBS) → *tasmax* (RCM) → $tasmax > 30°C$ (RCM) → $tasmax > XS$ (RCM).

Climate Extreme Assessment for Germany

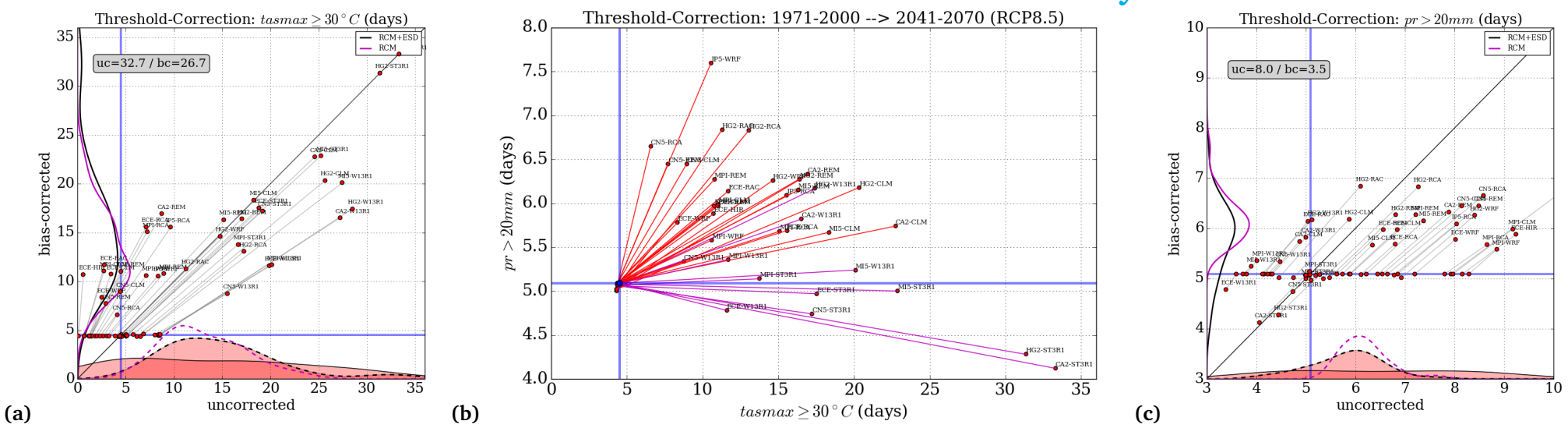
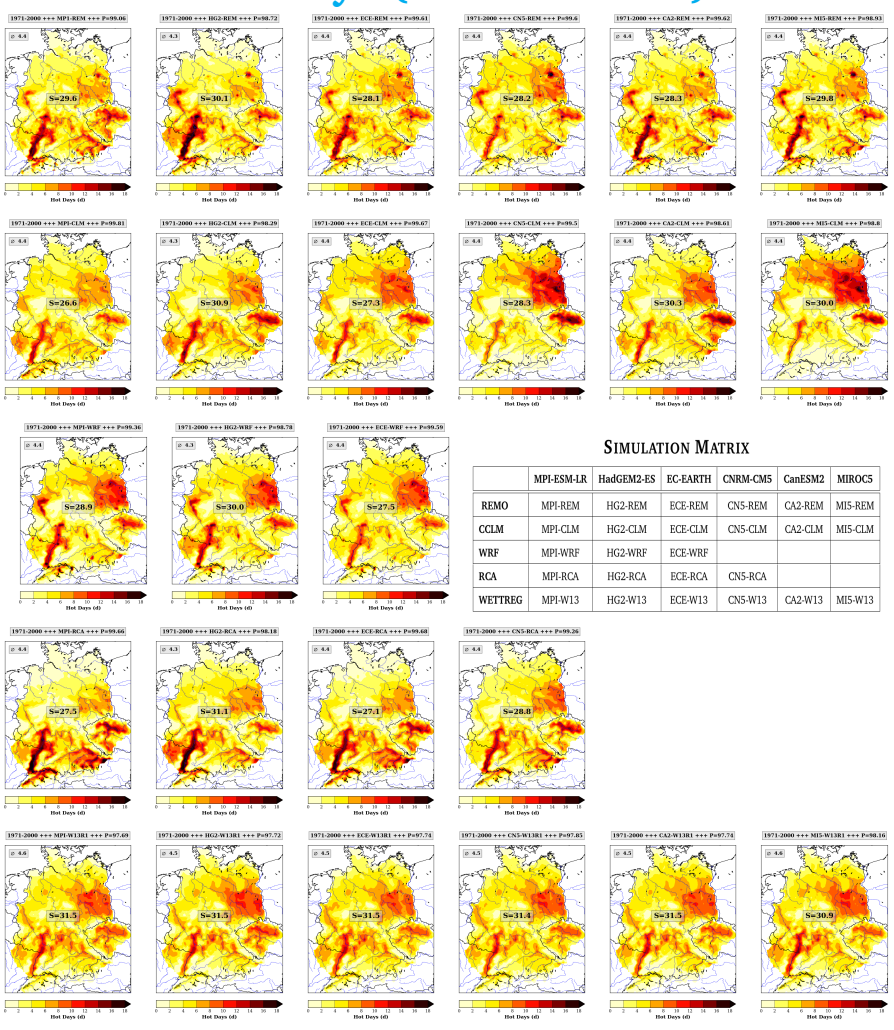


Fig.2: *middle:* Scatter plot of the projected number of hot days and very wet days using threshold corrected RCM (red) and ESD (magenta) simulations until 2041-2070 (RCP8.5). The blue cross marks the baseline period 1971-2000. *left/right:* Scatter plots of the projected changes and ensemble spreads in uncorrected and threshold corrected simulations. The PDFs indicate the distribution without ESD (magenta) and RCM-ESD (black).

Hot Days ($tasmax > 30°C$)



Simulation Matrix

	MPI-ESM-LR	HadGEM2-ES	EC-EARTH	CNRM-CM5	CanESM2	MIROC5
REMO	MPI-REM	HG2-REM	ECE-REM	CN5-REM	CA2-REM	MI5-REM
CCLM	MPI-CLM	HG2-CLM	ECE-CLM	CN5-CLM	CA2-CLM	MI5-CLM
WRF	MPI-WRF	HG2-WRF	ECE-WRF			
RCA	MPI-RCA	HG2-RCA	ECE-RCA	CN5-RCA		
WETTREG	MPI-W13	HG2-W13	ECE-W13	CN5-W13	CA2-W13	MI5-W13

Fig.3: Threshold corrected patterns of $tasmax > 30°C$ in historical GCM/RCM (horizontal/vertical) simulations.

Very Wet Days ($pr > 20mm$)

Simulation Matrix

	MPI-ESM-LR	HadGEM2-ES	EC-EARTH	CNRM-CM5	CanESM2	MIROC5
REMO	MPI-REM	HG2-REM	ECE-REM	CN5-REM	CA2-REM	MI5-REM
CCLM	MPI-CLM	HG2-CLM	ECE-CLM	CN5-CLM	CA2-CLM	MI5-CLM
WRF	MPI-WRF	HG2-WRF	ECE-WRF			
RCA	MPI-RCA	HG2-RCA	ECE-RCA	CN5-RCA		
WETTREG	MPI-W13	HG2-W13	ECE-W13	CN5-W13	CA2-W13	MI5-W13

Fig.4: Threshold corrected patterns of $pr > 20mm$ in historical GCM/RCM (horizontal/vertical) simulations.