EVALUATING MODEL-SIMULATED VARIABILITY IN TEMPERATURE EXTREMES

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Climate Extremes in Observations and Global Climate Models

Climate Extremes in Observations and Models

Climate extremes indices defined by joint CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI)*(http://etccdi.pacificclimate.org)*

Box 2.4, Table 1: Definitions of extreme temperature and precipitation indices used in IPCC. After Zhang et al. (2011). The most common units are shown but these may be shown as normalized or relative depending on application in different chapters.

Index	Descriptive name	Definition	Units	Figures/Tables	Section
TXx	Warmest daily Tmax	Seasonal/annual maximum value of daily max temperature	ºC	Box 2.4, Figure 1, Figures 9.37, 10.17, 12.13	Box 2.4, 9.5.4.1, 10.6.1.1, 12.4.3.3
TNx	Warmest daily Tmin	Seasonal/annual maximum value of daily minimum temperature	ºC	Figures 9.37, 10.17	9.5.4.1, 10.6.1.1
TXn	Coldest daily Tmax	Seasonal/annual minimum value of daily maximum temperature	ºC	Figures 9.37, 10.17, 12.13	9.5.4.1, 10.6.1.1, 12.4.3.3
TNn	Coldest daily Tmin	Seasonal/annual minimum value of daily minimum temperature	ºC	Figures 9.37, 10.17, 12.13	9.5.4.1, 10.6.1.1
RX5day	Wettest consecutive five days	Maximum of consecutive 5-day precipitation	mm	Figures 9.37, 12.26, 14.1	9.5.4.1, 10.6.1.2, 12.4.5.5, 14.2.1

Percentile-based threshold indices

SILLMANN ET AL.: CLIMATE EXTREMES INDICES IN CMIP5

Table 1. Core Set of 27 Extreme Indices Recommended by the ETCCDI. The Index R1mm Marked With * is Defined by ETCCDI for a User Specified Threshold Which is Set to 1 mm for This Study

Label	Index Name	Index Definition	Units
TN10p	Cold nights	Let TN_{ij} be the daily minimum temperature on day i in period j and let $TN_{in}10$ be the calendar day 10^{th} percentile centered on a 5 day window. The percentage of days in a year is determined where $TN_{ij} < TN_{in}10$	%
TX10p	Cold days	Let TX_{ij} be the daily maximum temperature on day i in period j and let $TX_{in}10$ be the calendar day 10^{th} percentile centered on a 5 day window. The percentage of days is determined where $TX_{ij} < TX_{in}10$	%
TN90p	Warm nights	Let TN_{ij} be the daily minimum temperature on day i in period j and let $TN_{in}90$ be the calendar day 90^{th} percentile centered on a 5 day window. The percentage of days is determined where $TN_{ij} > TN_{in}90$	%
TX90p	Warm days	Let TX_{ij} be the daily maximum temperature on day i in period j and let $TX_{in}90$ be the calendar day 90^{th} percentile centered on a 5 day window. The percentage of days is determined where $TX_{ij} > TX_{in}90$	%

Exceedance rate of the 10^{th} and 90^{th} percentile of daily minimum and maximum temperature → percentage of days exceeding these thresholds

→ Can be robustly estimated for limited temporal and spatial data availability, thus good spatial coverage in observational based datasets (e.g., HadEX2, GHNDEX)

Sillmann et al. 2013: Part 1. Model evaluation in the present climate, JGR

Climate Extremes in Observations and Models

Temperature Extremes – 1981 to 2000

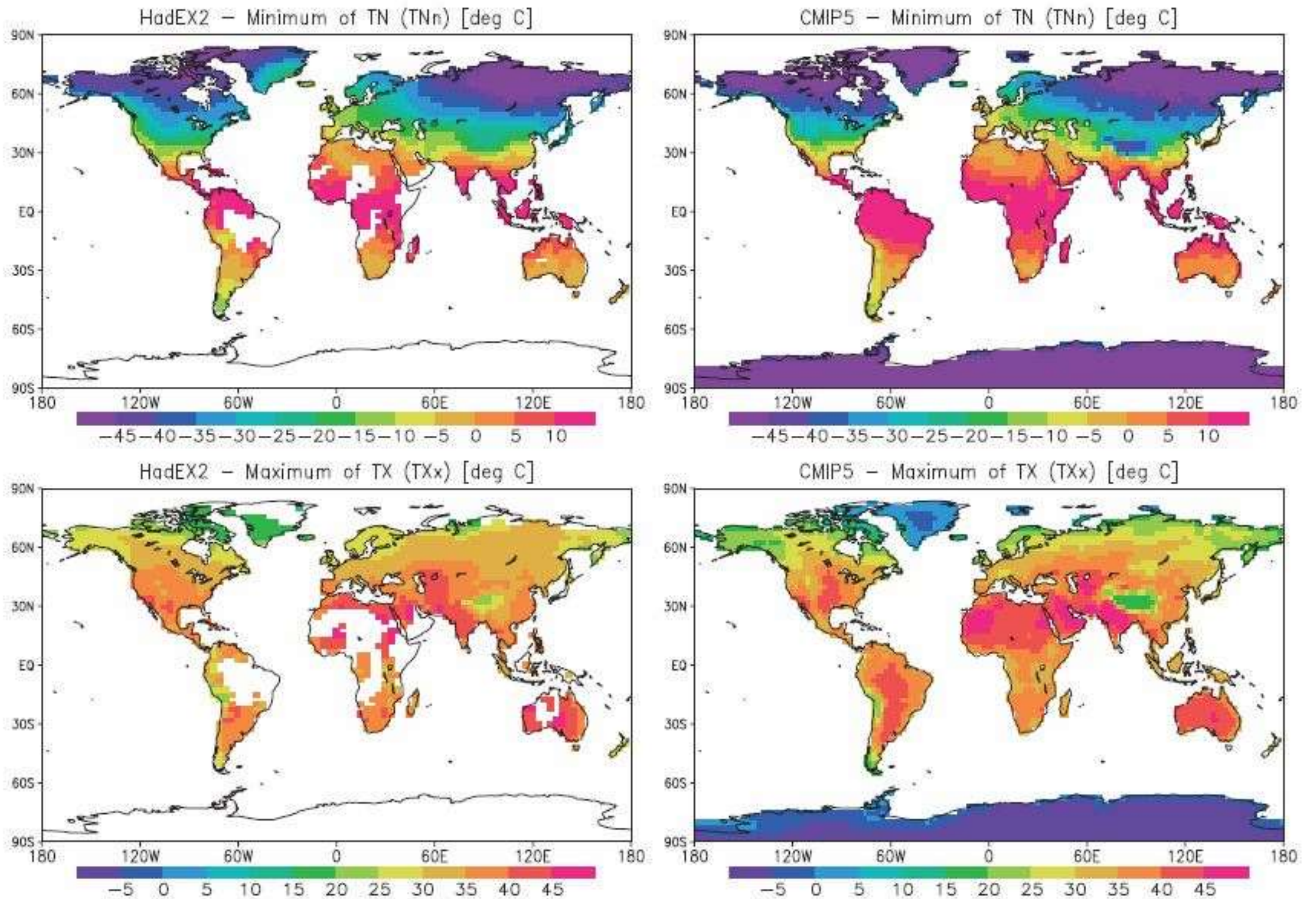


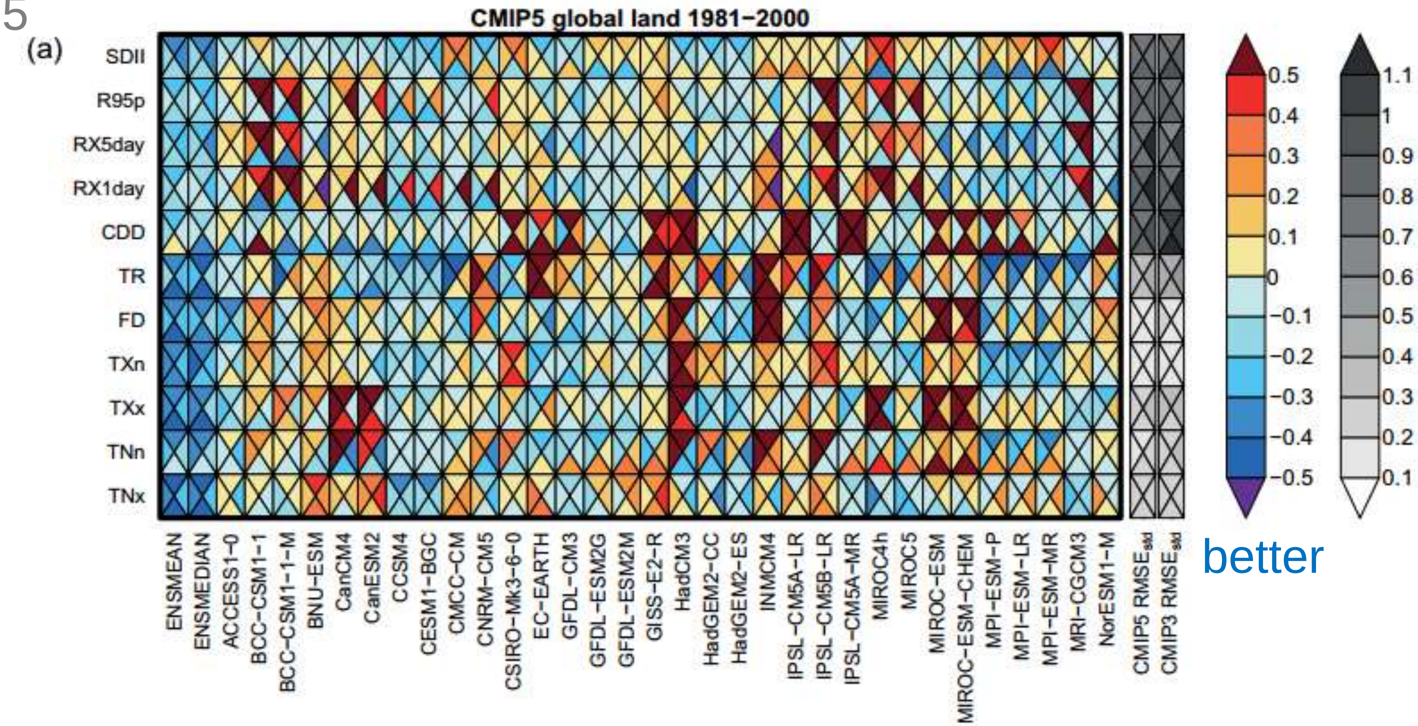
Figure 2. The 1981–2000 time mean of the annual minimum of TN (TNn, top panel) and maximum of TX (TXx, bottom panel) for HadEX2 and the CMIP5 multimodel ensemble median.

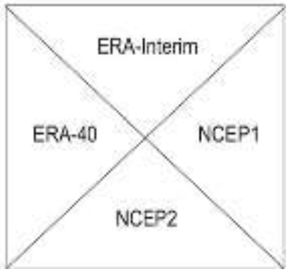
Sillmann et al. 2013: Part 1. Model evaluation in the present climate, JGR

Climate Extremes in Observations and Models

relative Root Mean Squared Errors (RMSE)

IPCC AR5 WGI





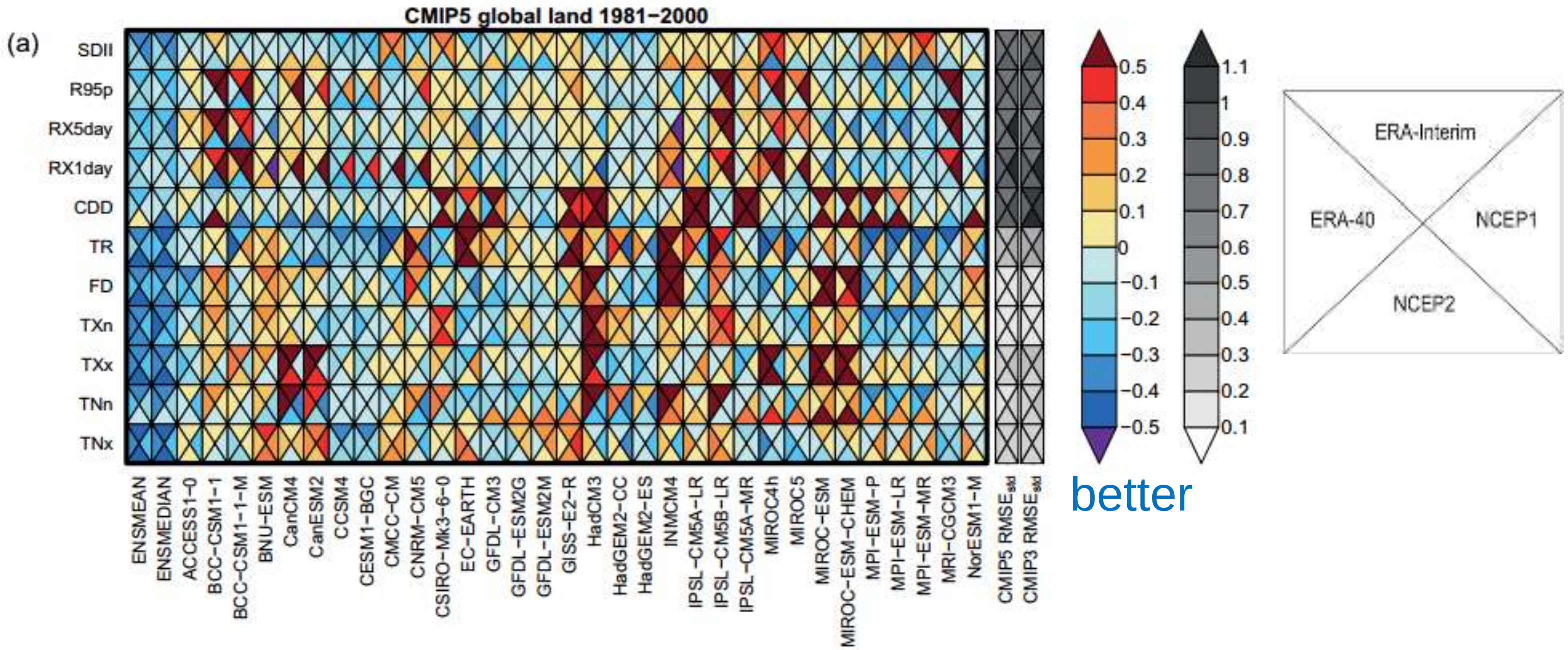
based on Sillmann et al. 2013: Part 1. Model evaluation in the present climate, JGR

Climate Extremes in Observations and Models

IPCC AR5 WGI

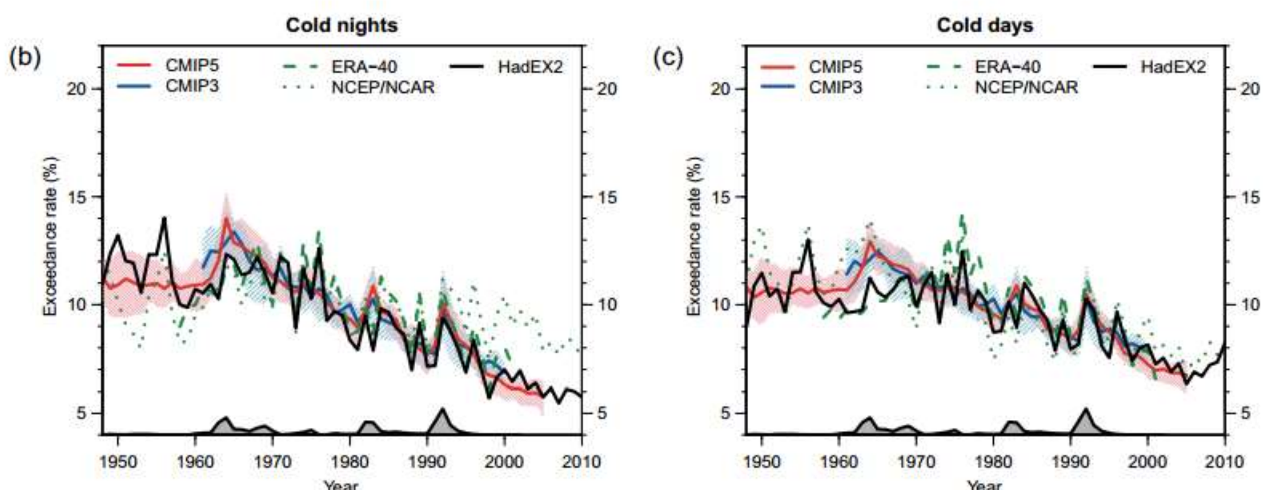
relative Root Mean Squared Errors (RMSE)

worse



better

Percentile - based threshold indices



Average magnitude of original percentile indices is independent of model deficiencies in simulating daily variability

based on Sillmann et al. 2013: Part 1. Model evaluation in the present climate, JGR

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RMetS
Royal Meteorological Society

Short Communication

Evaluating model-simulated variability in temperature extremes using modified percentile indices

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Bias-correction Methodology

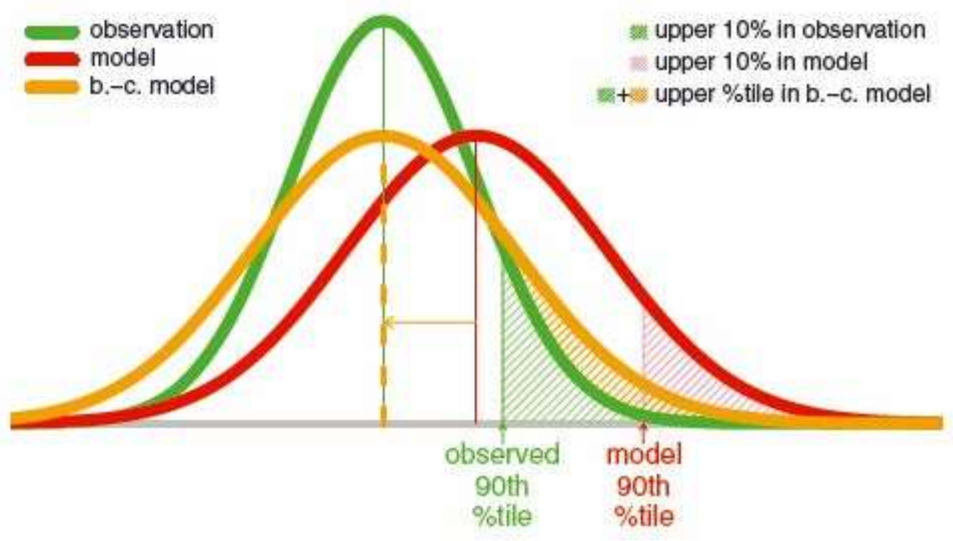
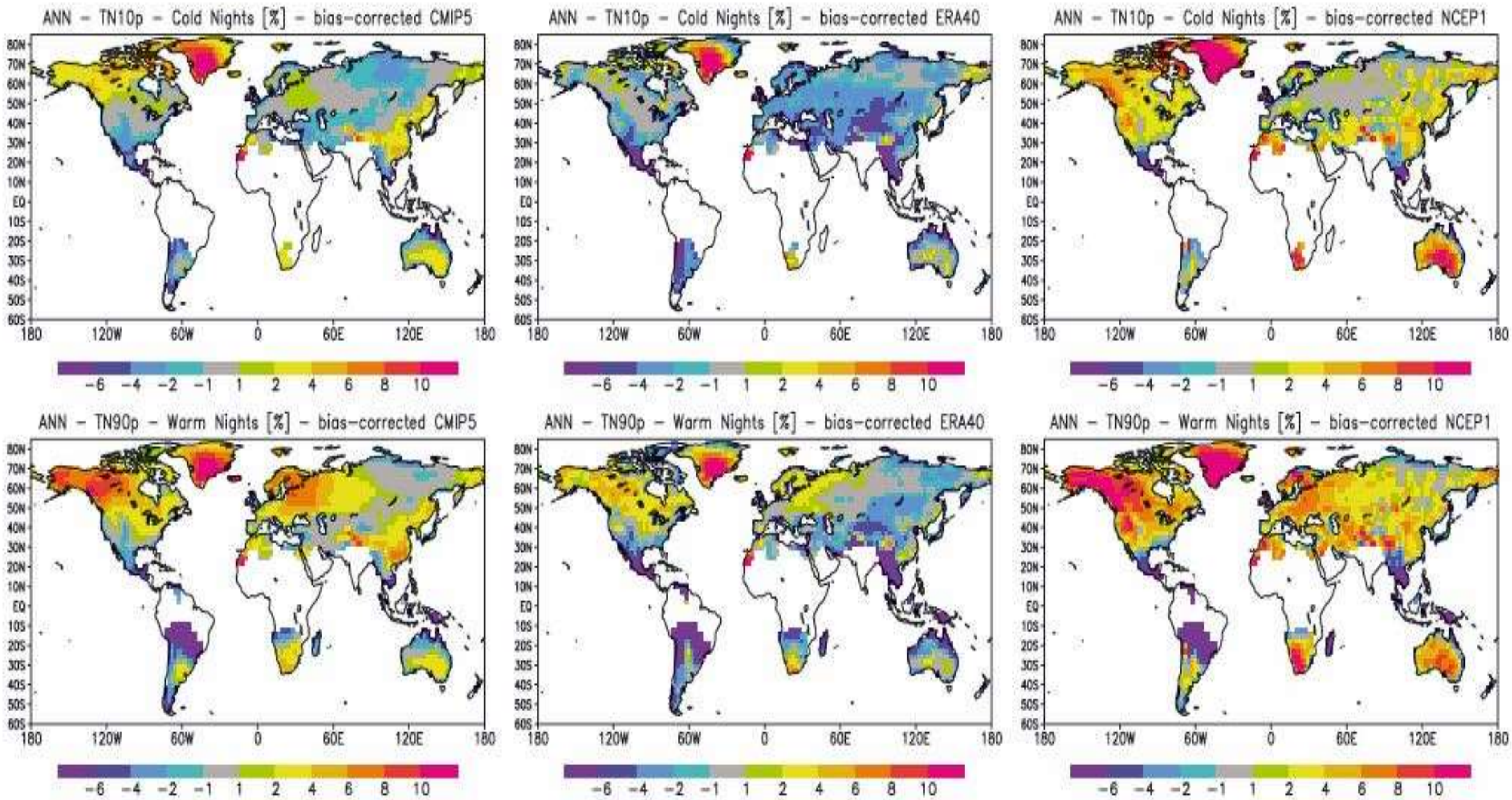


Figure 1. Schematic illustration of the bias-correction methodology where the green and red curves indicate an observed and modelled temperature distribution, respectively. Both distributions have the same exceedance rate above their respective 90th percentile thresholds (green and red shaded areas). When bias correcting the mean of the model temperature distribution (orange curve) and applying the observed 90th percentile threshold for the indices calculation, the exceedance rate in the bias-corrected (b.-c.) model gives an indication of the discrepancy between the variability of the observed and model temperature distribution (green plus orange shaded area).

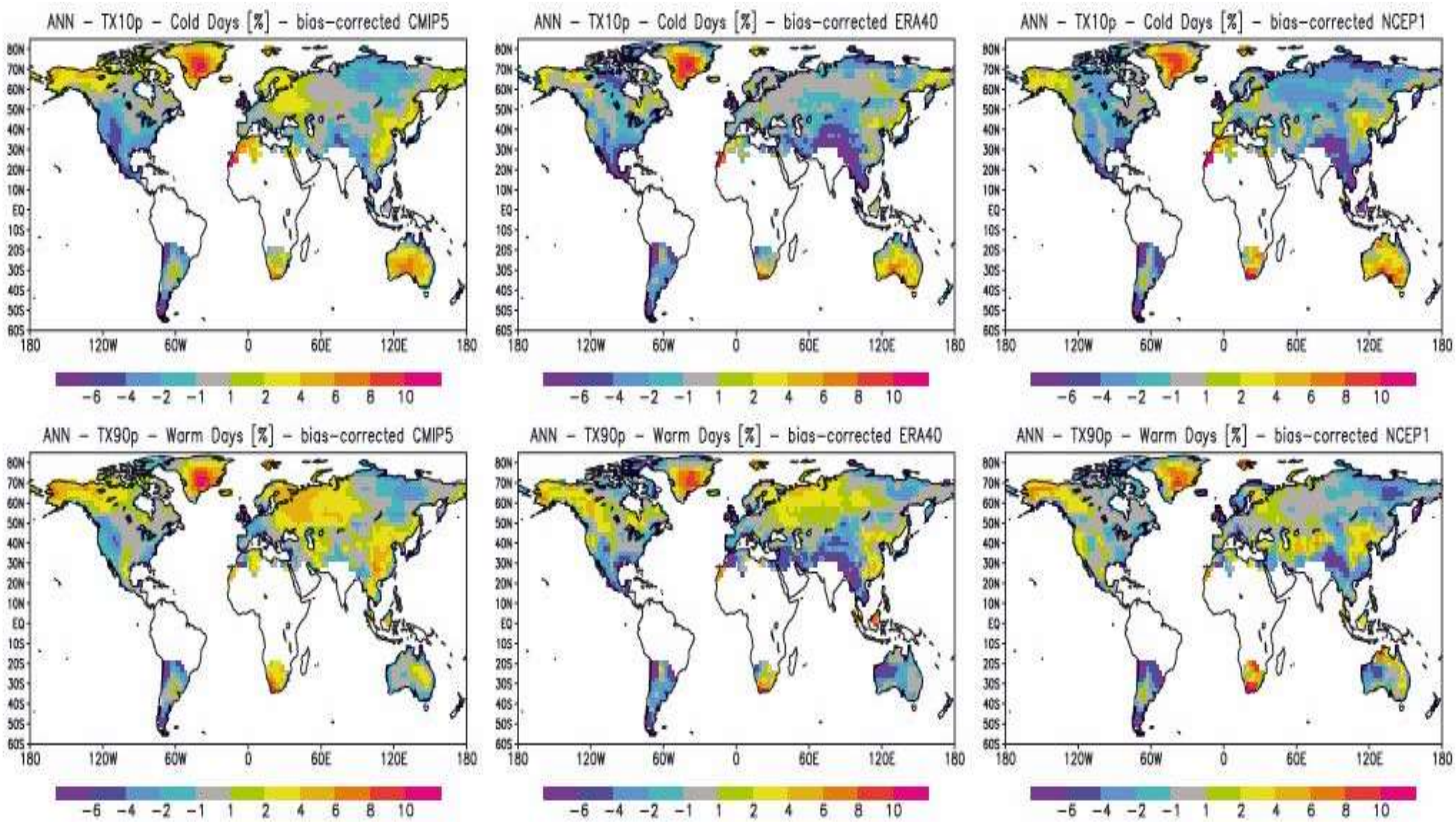
Percentile-based threshold indices

Bias-correction with GHCN-Daily

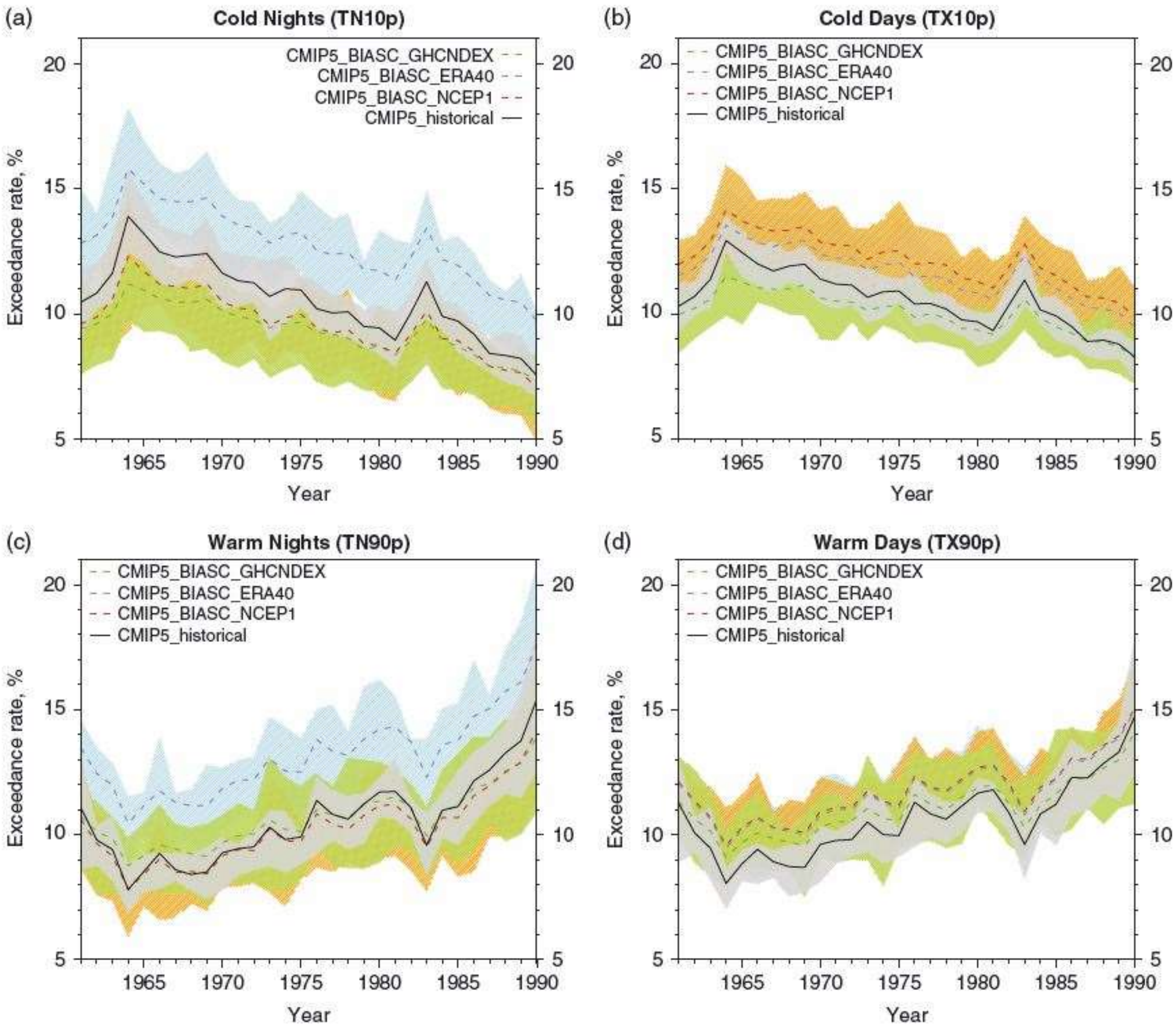


Percentile-based threshold indices

Bias-correction with GHCN-Daily



Bias-correction with GHCNDEX



Conclusion

- more effort is required to **fill the gaps in observation-based datasets** to improve the evaluation of simulated temperature variability by the current model generation, particularly with respect to the extremes

- observational datasets of extremes indices (e.g. ETCCDI) should contain **information about actual percentile values** (i.e., 10^{th}, 50^{th}, and 90^{th} percentiles)

- **bias-correction methodology accounts for biases in the mean state**, but shape of the distribution remains unchanged, which would imply that models underestimating temperature variability show a larger trend in exceedance rates, and models overestimating temperature variability would show a smaller trend with implication for the interpretation of future projections

Thank you!