Towards a near-global modified Climate Extremes Index for observations and global climate models

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1. Introduction

The **Climate Extremes Index** (CEI, Karl et al. 1996) combines 5 components, each measuring the percentage of an area experiencing much above or below normal conditions in:
- Maximum temperature
- Minimum temperature
- Rainfall
- Proportion of total rainfall from heavy rain days
- Annual number of wet and dry days

Gallant and Karoly (2010), hereafter GK2010, introduced a daily modified CEI where below normal extremes are subtracted from above normal extremes for each component, to give information on the direction of change.

We introduce a new modified CEI based on a suite of extreme indices, known as ETCCDI indices. This new index will allow the construction of a near-global index that can be easily updated. Thanks to its computational efficiency, this index also facilitates the analysis of climate models.

2. Method & data

Observational data: GHCNDEX dataset (Donat et al. 2013)
Model data: Pre-calculated ETCCDI indices for 5 CMIP5 models (Sillmann et al. 2013 and references therein)

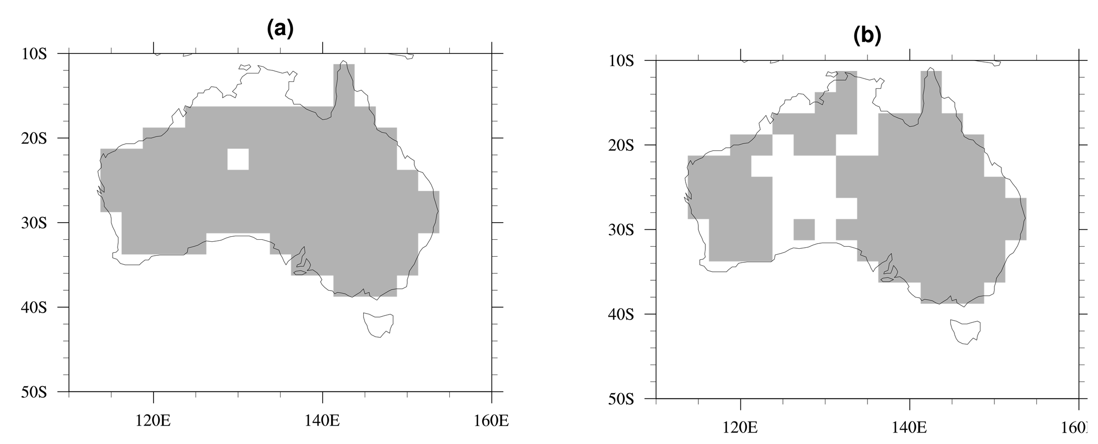

Figure 1 Coverage masks used for (a) the temperature component with lowest coverage and (b) the rainfall component with lowest coverage.

ETCCDI indices:
27 standard indices recommended by the Expert Team on Climate Change Detection and Indices. The ones used here are (Zhang et. al. 2011):

- **Cool days** (TX10p) and **warm days** (TX90p): Percentage of days where maximum temperature is below/above 10th/90th percentile respectively
- **Cool nights** (TN10p) and **warm nights** (TN90p): Percentage of days where minimum temperature is below/above 10th/90th percentile respectively
- **Annual contribution from very wet days** (R95p): Annual total rainfall due to rainfall above 95th percentile
- **Simple Daily Intensity Index** (SDII): Ratio of annual precipitation over total number of wet days
- **Annual contribution from wet days** (PRCPTOT): Annual total rainfall

Maximum temperature component: Percentage area where frequency of warm days (TX90p) > 90th percentile - percentage area where frequency of cool days (TX10p) > 90th percentile
Minimum temperature component: Same for minimum temperature (TN90p and TN10p)
Mean rainfall component: Percentage area where a standardised rainfall anomaly derived from PRCPTOT is above the 90th percentile - percentage area where it is below the 10th percentile
Heavy rainfall component: Percentage area where proportion of rainfall due to heavy rainfall > 90th percentile
Wet/dry days component: Percentage of area where annual number of wet days (WD) > 90th percentile - percentage area where annual number of dry days (DD) > 90th percentile
WD and DD are derived from SDII and PRCPTOT
EmCEI: Combination of all components

3. Results: Examples for Australia

A) Comparison to Gallant and Karoly 2010

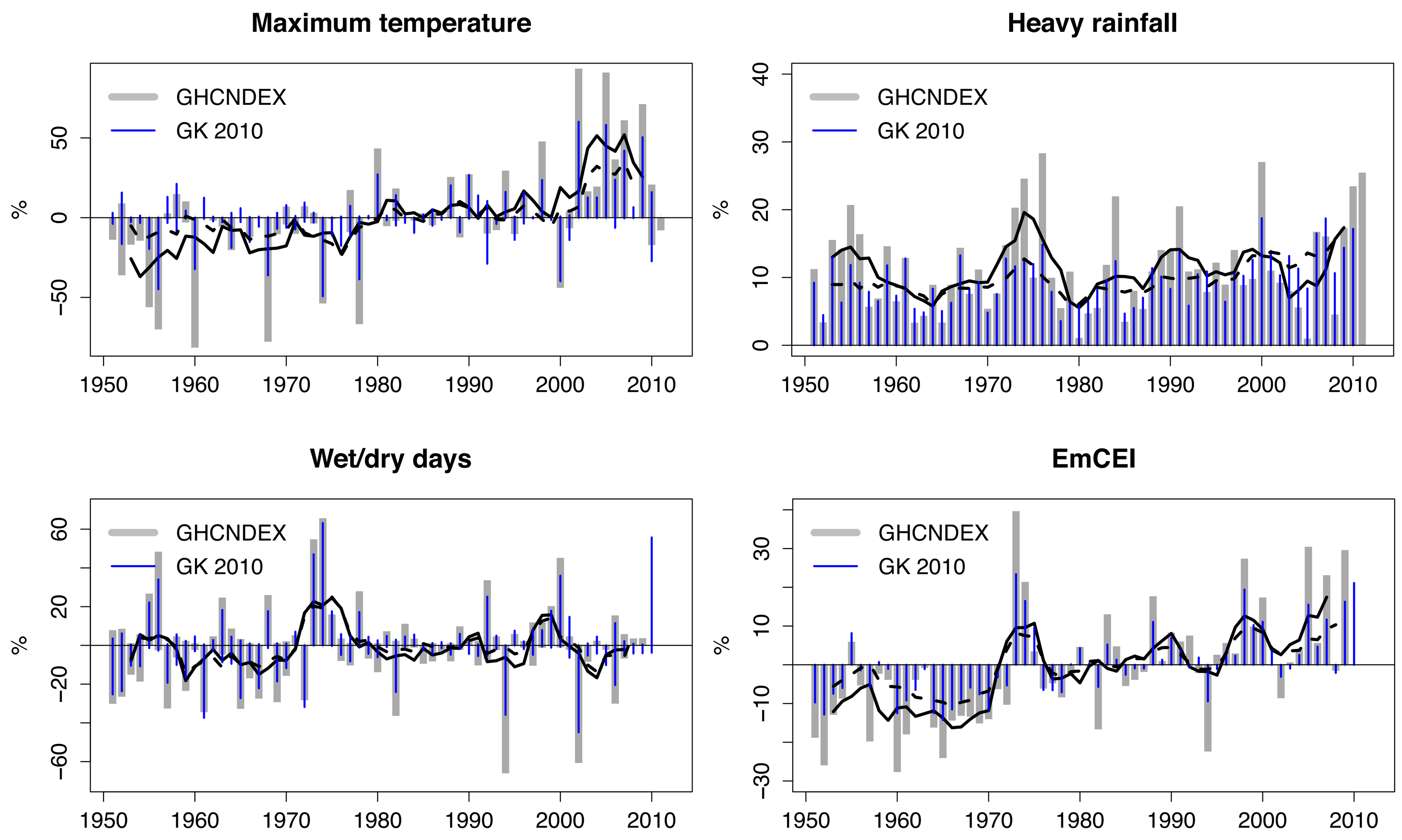

Figure 2 Maximum temperature, heavy rainfall and wet/dry days components of the observational EmCEI compared to the dmCEI from GK2010 for Australia. The ETCCDI based modified CEI (EmCEI, all components combined) is also shown. The full and dashed black line correspond to the 5-year running average for the EmCEI and the daily modified CEI from Gallant and Karoly 2010 respectively.

B) Models

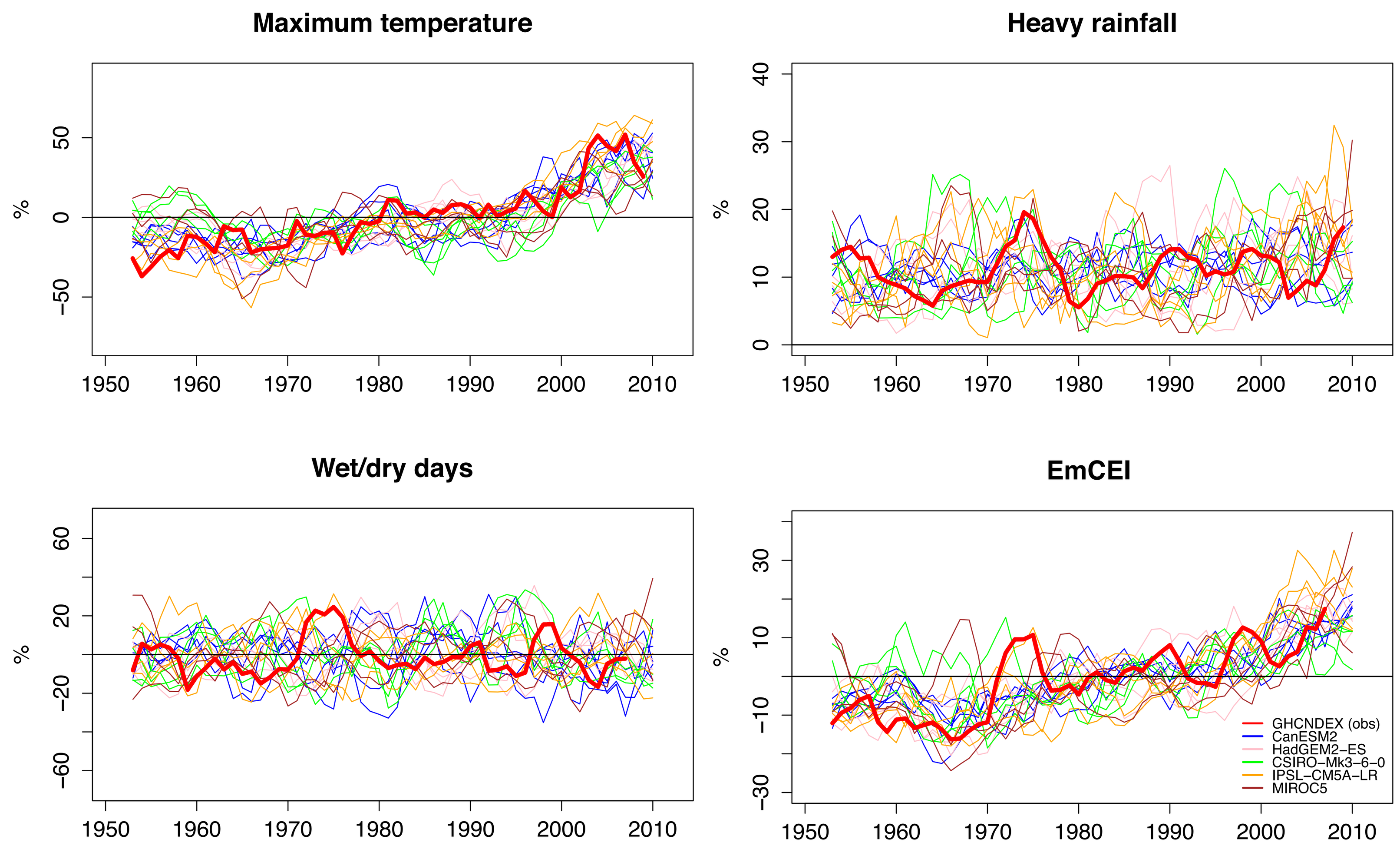

Figure 3 Maximum temperature, heavy rainfall and wet/dry days components as well as the combined EmCEI for 5 CMIP5 models are compared to observations (GHCNDEX, thick red line). 3 to 5 ensemble members per model are shown. The historical scenario was used for the period 1951-2005, complemented by the RCP8.5 scenario for 2006-2012.

4. Conclusions

This new Climate Extremes Index is able to reproduce the results of GK2010. However, for all components, the values of the new index are larger, likely due to the coarser resolution of GHCNDEX compared to the data used in GK2010.

The observations are all within the model spread, indicating that the use of climate models for this purpose is appropriate. In particular, the observed increases in the temperature components are reproduced by the models. Furthermore, the models seem to capture the variability in both temperature and rainfall components well.

Future work will look at expanding this analysis to other regions on the globe and to investigate the role of anthropogenic contributions to the observed results.

References

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