

User tailored results of a regional climate model ensemble to plan adaptation to the changing climate in Germany

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ReKliEs-De
Regionale Klimaprojektionen Ensemble für Deutschland

Introduction

High resolution climate information from a multi model ensemble is required for the development and the planning of measures to adapt to climate change (e.g. German Adaptation Strategy). Using a multi model ensemble is essential to develop information on possible ranges of future climate change for climate impact research and as background information for policy and economy. The BMBF project ReKliEs-De provides consistent, user-tailored information for federal agencies as well as climate impact and adaptation research. To achieve this, a national coordinated effort was undertaken to examine the EURO-CORDEX simulations on 12 km horizontal resolution for Germany and systematically complemented them by further simulations with both dynamical and statistical downscaling methods. Since the end of the Project in December 2017, some simulations have been withdrawn and new additional simulations are available.

GCM/RCM RCP	CCLM	REMO	WRF	WR'13	STARS till 1950	RCA4	RACMO	HIRHAM5
EC-EARTH RCP2.6	EURO CORDEX					EURO CORDEX	EURO CORDEX	EURO CORDEX
HADGEM2-ES RCP2.6						EURO CORDEX	EURO CORDEX	
MPI-ESM-LR RCP2.6		EURO CORDEX				EURO CORDEX		
MIROC5 RCP2.6		EURO CORDEX						
IPSL-CM5A-LR RCP2.6		EURO CORDEX						
GFDL-ESM RCP2.6		EURO CORDEX						
MPI-ESM-LR RCP8.5	EURO CORDEX	EURO CORDEX	EURO CORDEX			EURO CORDEX		
HADGEM2-ES RCP8.5	EURO CORDEX					EURO CORDEX	EURO CORDEX	
EC-EARTH RCP8.5	EURO CORDEX					EURO CORDEX	EURO CORDEX	EURO CORDEX
Can-ESM RCP8.5								
MIROC5 RCP8.5								
IPSL-INNERIS RCP8.5						EURO CORDEX		
NorESM1 RCP8.5								EURO CORDEX

Table 1 shows the simulations performed within ReKliEs-De (dark blue), which systematically complement the existing EURO-CORDEX simulation (light blue). The output of the ReKliEs-De simulations is conform with the EURO-CORDEX definitions and will be published in the ESGF (Earth System Grid Federation).

Temperature and precipitation change

The mean annual precipitation and temperature change 2071-2100 minus 1971-2000 averaged over the ReKliEs-De domain shows an increase in temperature between 2.8 and 5.3 K for RCP8.5 and between 0.5 and 2 K for RCP2.6. A precipitation decrease and increase between -25 and +30 % was found for RCP8.5 and between -10 and +10 % for RCP2.6. For the annual mean temperature change all RCMs show a similar increase as their forcing GCM (same color).

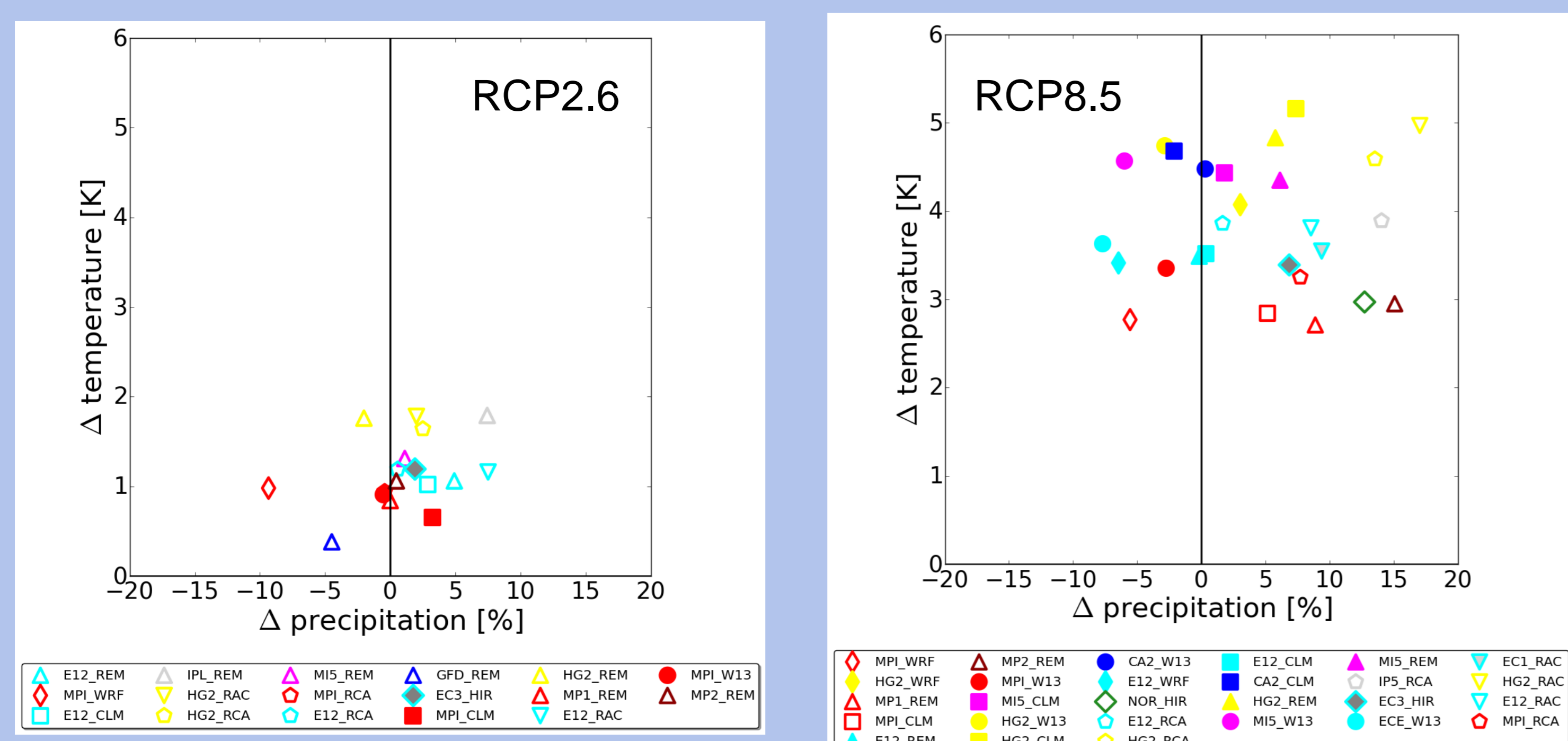


Figure 1 shows the mean annual change between 2071-2100 and 1971-2000 for temperature and precipitation of each model averaged over the ReKliEs-De domain (RCP2.6:left, RCP8.5 :right).

Temperature Indices

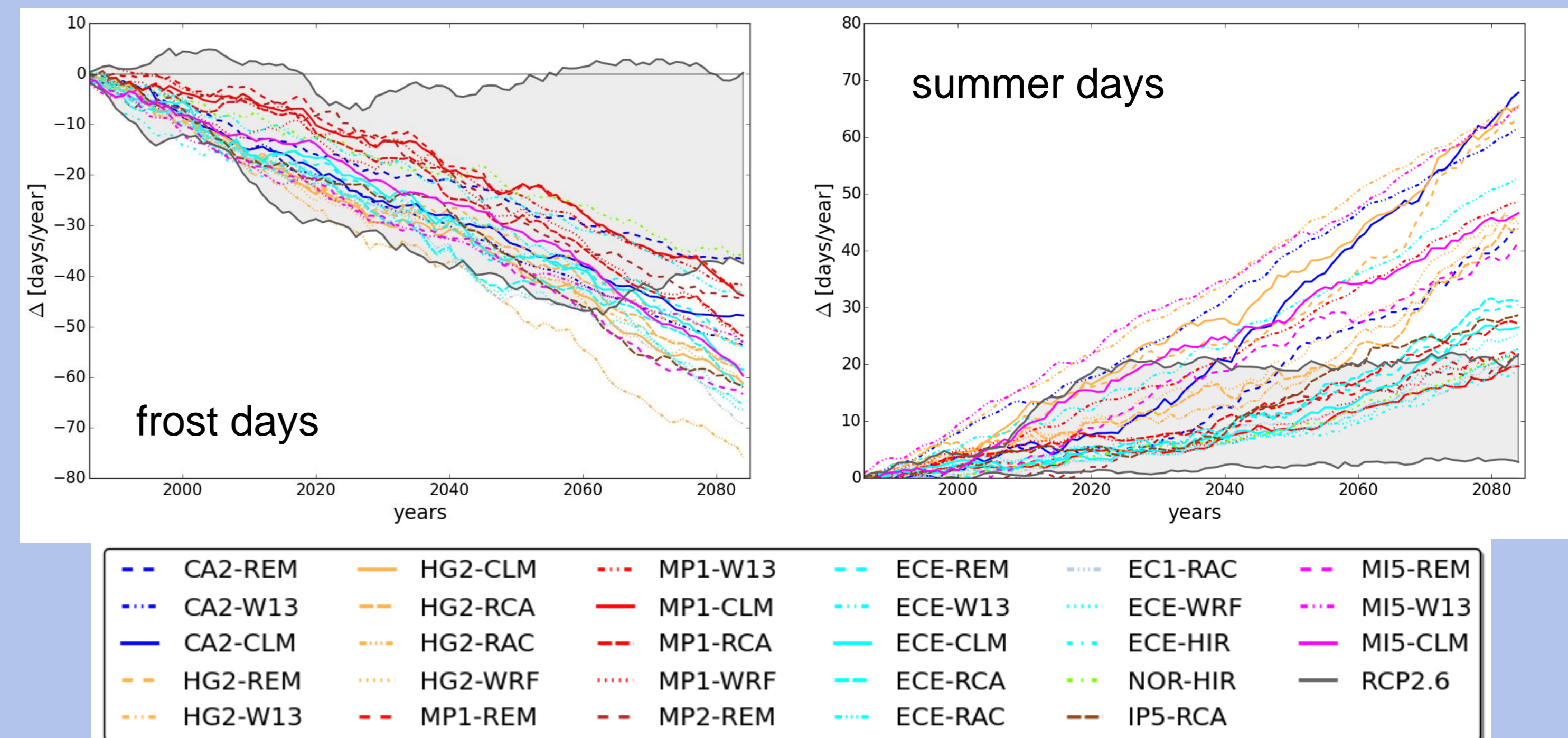


Figure 2 shows the 30-year „running mean“ 1986 - 2085 minus (1971 - 2000). The bandwidth between minimum and maximum change of the number of frost days $T_{min} < 0^{\circ}C$ (left) and summer days $T_{max} > 25^{\circ}C$ (right) is shown for rcp2.6 simulations (grey) and each colored line shows the change calculated by an EURO-CORDEX or ReKliEs-De simulation using RCP8.5.

At the end of the 21st century frost days decreases in RCP8.5 between - 30 and - 75 days/year, this is twice as large as in RCP2.6. Summer days increase in RCP8.5 between 20 and 70 days/year, which is 3 times larger than for RCP 2.6.

Precipitation Indices

The climate change signals for precipitation is not consistent, it increases and decreases except for RCP8.5: all models show an increase of dry days in summer and an increase in winter precipitation.

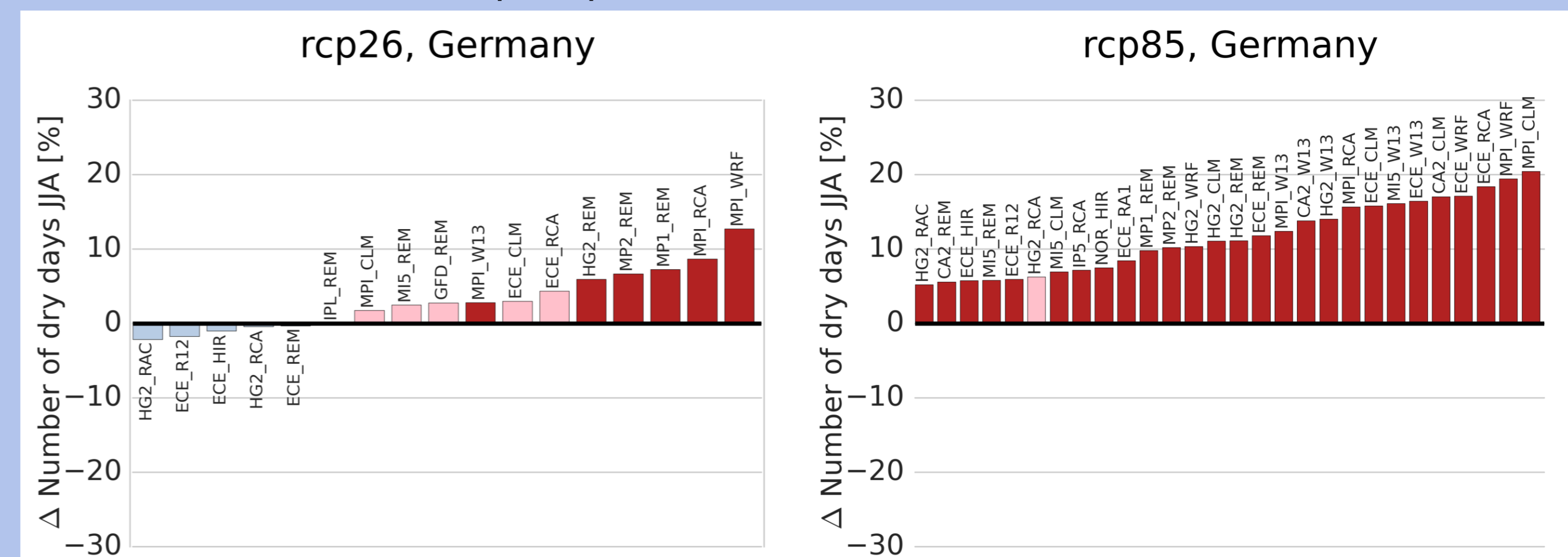


Figure 3 shows the mean change in dry days during summer between 2070-2099 minus 1971-2000 averaged over Germany. Increase in dry days in red and significant increase is dark red. The Mann-Whitney U Test is used to test the significance.

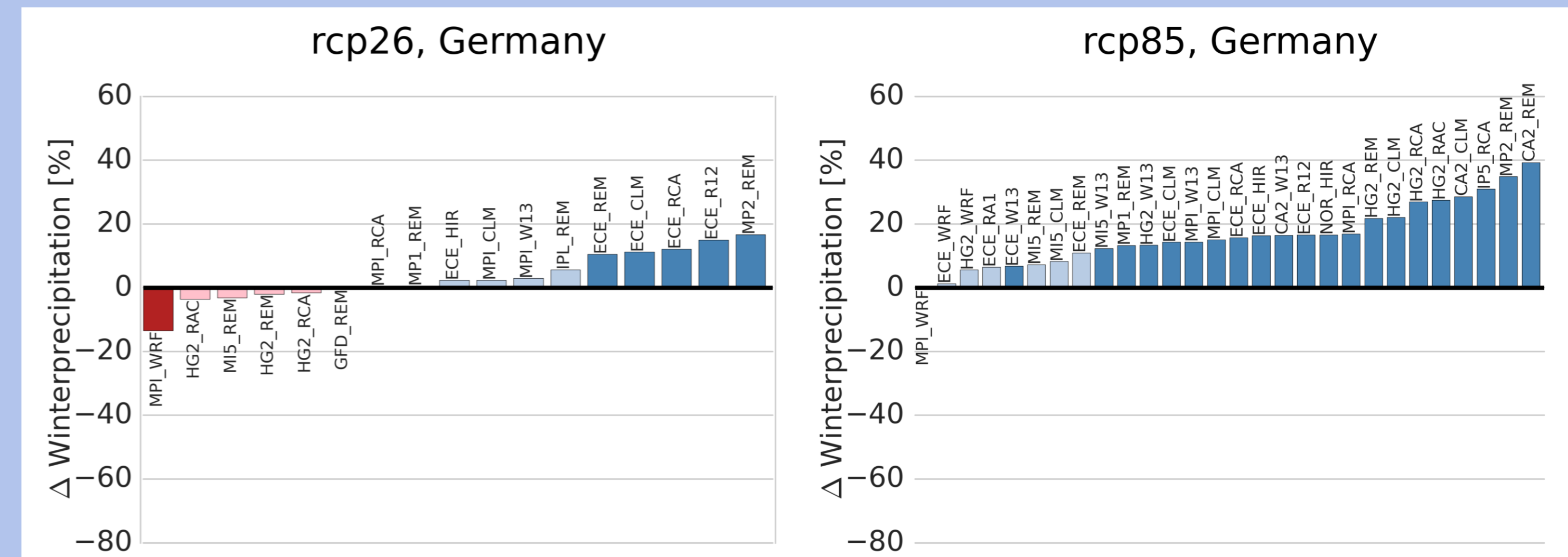


Figure 4 shows the mean winter precipitation change between 2070-2099 minus 1971-2000 averaged over Germany. Precipitation increase in blue and significant increase is dark blue. The Mann-Whitney U Test is used to test the significance.

Mitigation scenario versus. "business as usual"

(Ensemble size and members differ)

Climate Variable	RCP 2.6	RCP 8.5
Changes between 1971-2000 and 2071-2100		
Annual mean temperature ($^{\circ}C$)	0.5 to 2.5	2.5 to 5.5
Number of summer days ($T_{max} > 25^{\circ}C$)	2 to 18	17 to 68
Number of frost days ($T_{min} < 0^{\circ}C$)	- 45 to 0	-75 to -38
Annual mean precipitation (%)	-10 to 10	-25 to 30
Winter precipitation (%)	-15 to 15	0 to 40
Number of dry days in summer (number)	-2 to 15	5 to 20

Further information and results of project ReKliEs-De: <http://rekli.es.hlnug.de>