



ReKliEs-De

Regionale Klimaprojektionen Ensemble für Deutschland

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Brandenburgische
Technische Universität
Cottbus - Senftenberg

3



POTSDAM-INSTITUT FÜR
KLIMAFOLGENFORSCHUNG

4



5

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



6

UNIVERSITÄT HOHENHEIM

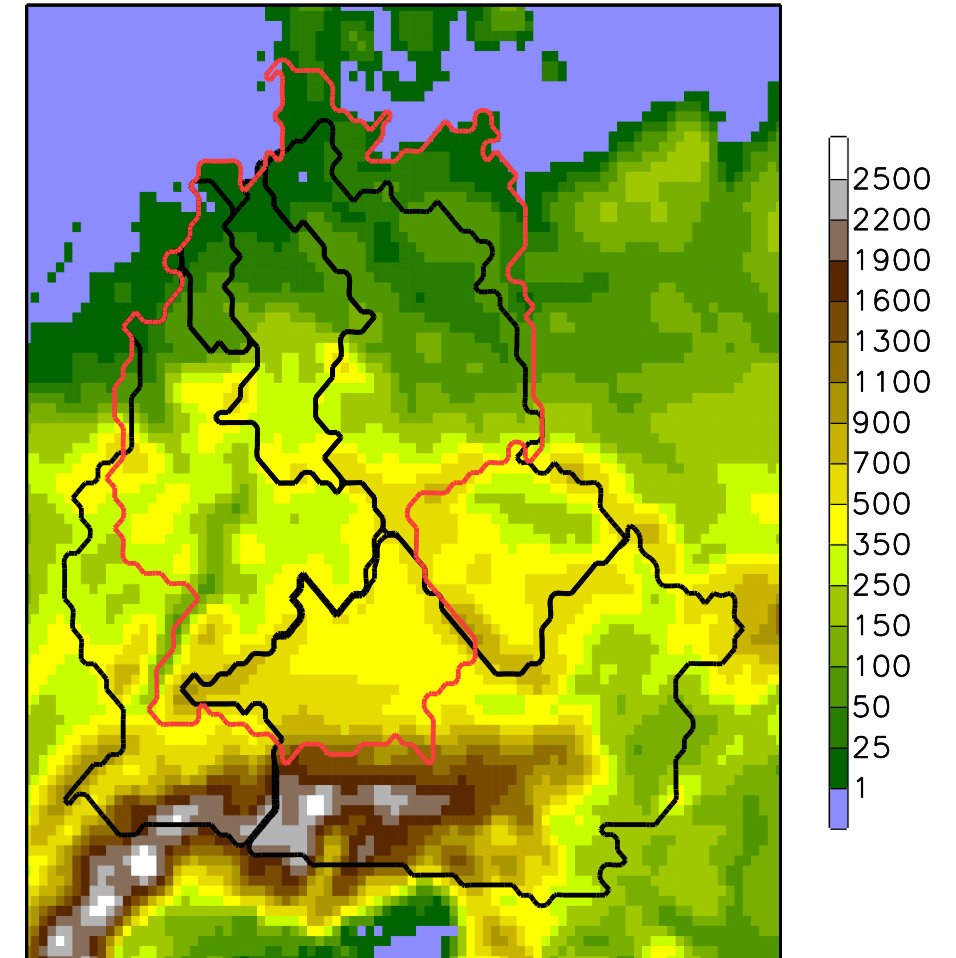


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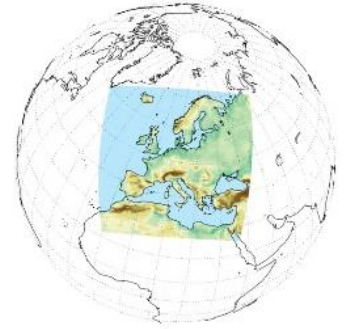
Funded by:



- The overall goal of ReKliEs-De is to derive climate change information on high spatial resolution (12 km) for Germany and the large river catchments draining into Germany
- Scientific basis for the new German adaptation strategies
- Consistent and user-tailored information
- Systematically complemented EURO-CORDEX with dynamical and statistical simulations



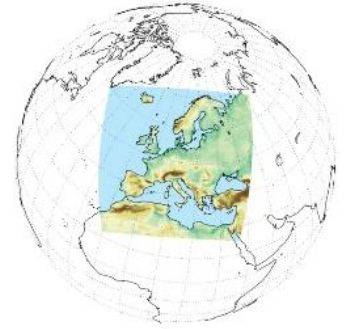
EURO-CORDEX simulations (May 2017)



GCM / RCM RCP	CCLM	REMO	WRF	WR'13	STARS	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		
MPI-ESM-LR RCP8.5	EURO CORDEX	EURO CORDEX	EURO CORDEX			EURO CORDEX		
CNRM-CM5 RCP8.5	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-INERIS RCP8.5			EURO CORDEX			EURO CORDEX		

Simulations
RCP2.6 = 9
RCP8.5 = 16

EURO-CORDEX simulations (May 2017) + ReKliEs-De



GCM / RCM RCP	CCLM	REMO	WRF	WR'13	STARS	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		
MPI-ESM-LR RCP8.5	EURO CORDEX	EURO CORDEX	EURO CORDEX			EURO CORDEX		
CNRM-CM5 RCP8.5	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-INERIS RCP8.5			EURO CORDEX			EURO CORDEX		



Simulations

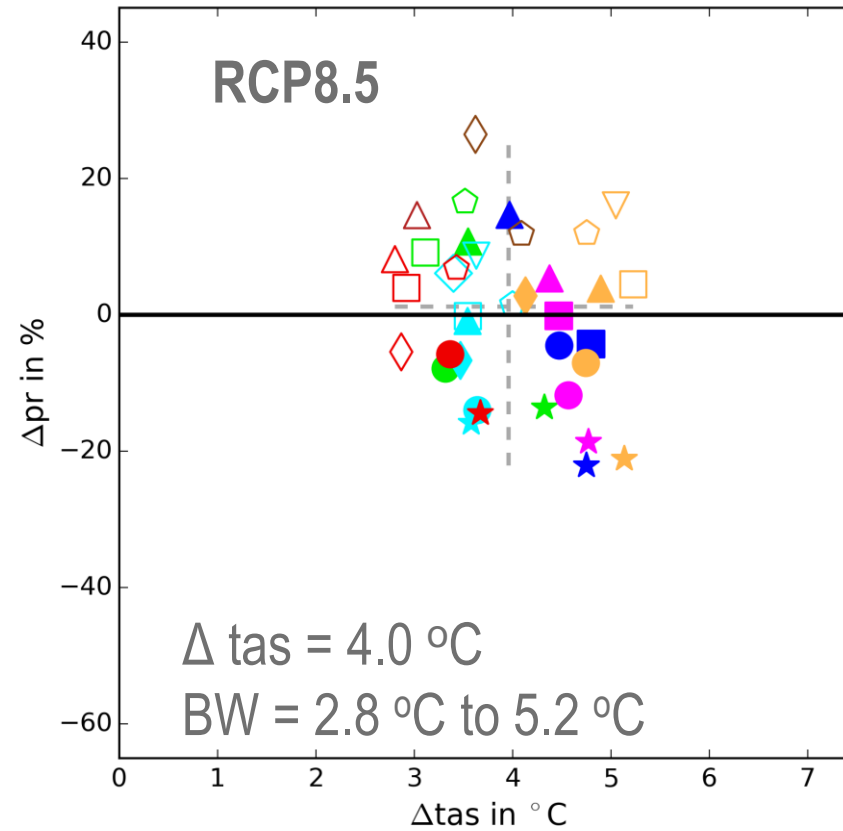
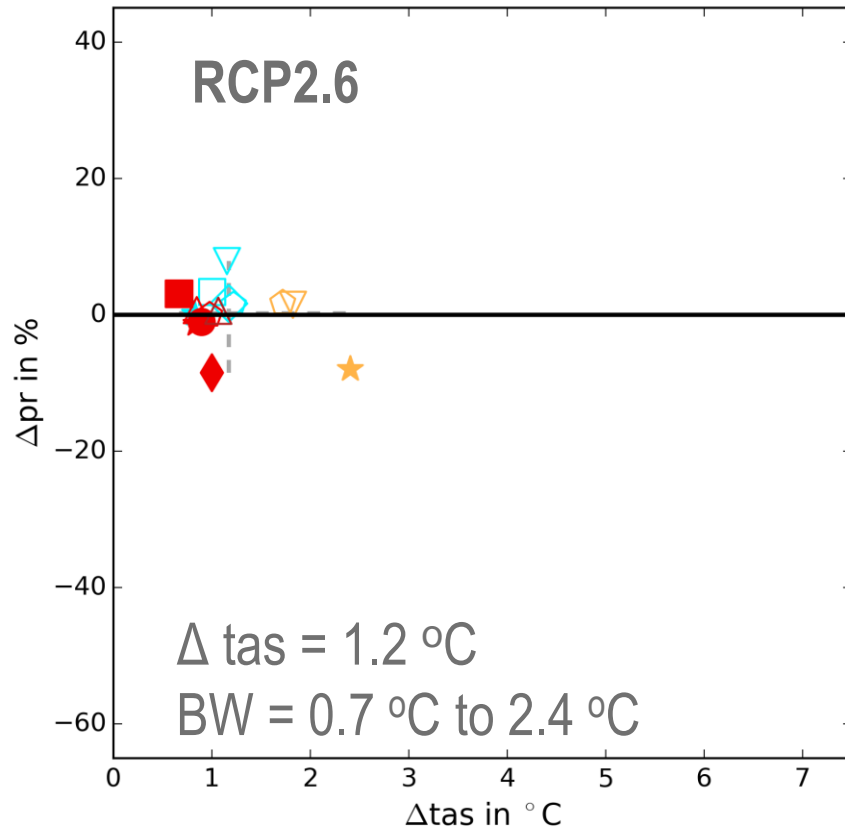
RCP2.6 = 9 + 6

RCP8.5 = 16 + 21

- Scenario RCP2.6 and RCP8.5
- Temperature
- Precipitation
- Reference period 1971 -2000
- Climate change in 2021-2050 and 2071-2100
- 24 different indices (ETCCDI)



Annual temperature change (2071 - 2100) - (1971 - 2000)



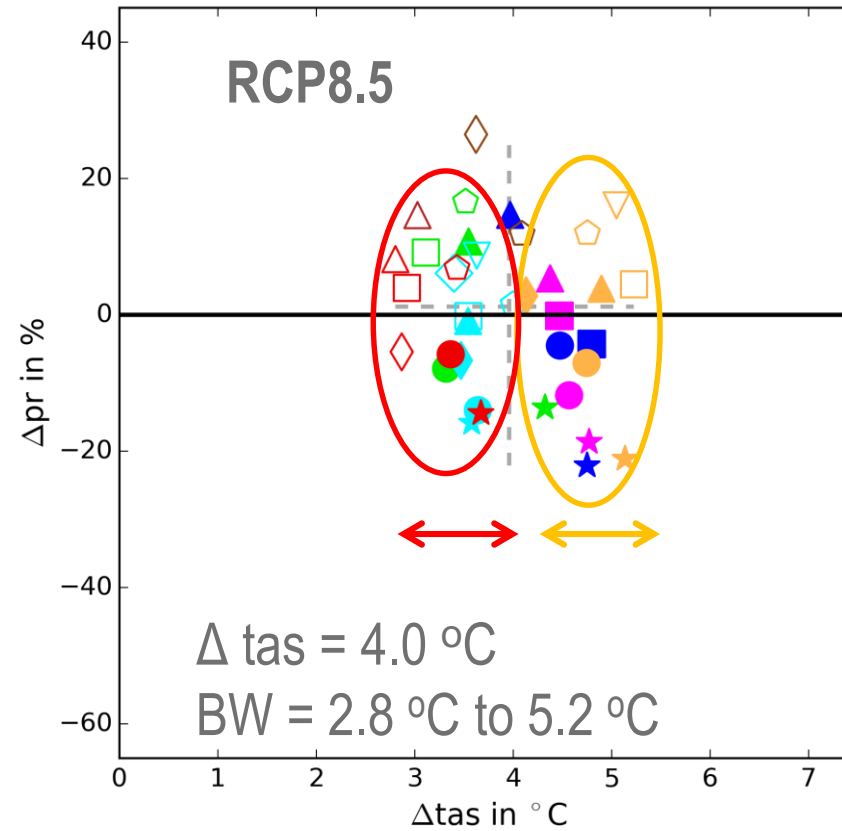
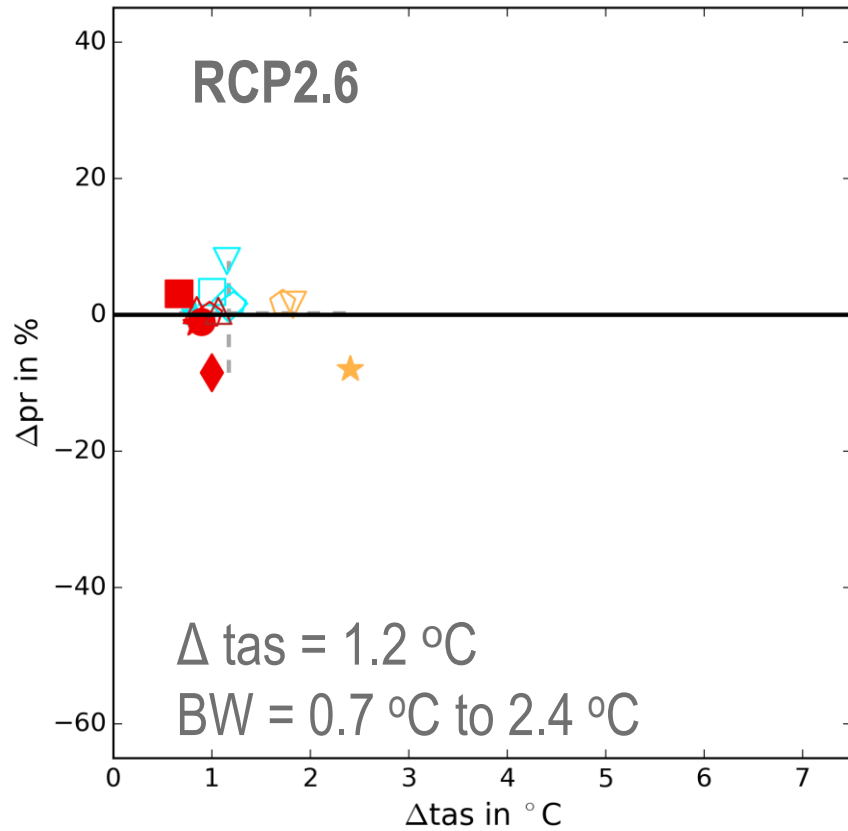
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| ▲ CA2_REM_R85 | ★ ECE_ST3_R85 | ■ MI5_CLM_R85 |
| ★ CA2_ST3_R85 | ● ECE_W13_R85 | ▲ MI5_REM_R85 |
| ● CA2_W13_R85 | ◆ ECE_WRF_R85 | ★ MI5_ST3_R85 |
| □ CN5_CLM_R85 | □ HG2_CLM_R85 | ● MI5_W13_R85 |
| ◇ CN5_RCA_R85 | ▽ HG2_RAC_R85 | □ MP1_CLM_R85 |
| ▲ CN5_REM_R85 | ◇ HG2_RCA_R85 | ◇ MP1_RCA_R85 |
| ★ CN5_ST3_R85 | ▲ HG2_REM_R85 | △ MP1_REM_R85 |
| ● CN5_W13_R85 | ★ HG2_ST3_R85 | ★ MP1_ST3_R85 |
| □ ECE_CLM_R85 | ● HG2_W13_R85 | ● MP1_W13_R85 |
| ◇ ECE_HIR_R85 | ◆ HG2_WRF_R85 | ◇ MP1_WRF_R85 |
| ▽ ECE_RAC_R85 | ◇ IP5_RCA_R85 | △ MP2_REM_R85 |
| ◇ ECE_RCA_R85 | | |

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|---------------|---------------|---------------|
| □ ECE_CLM_R26 | ▽ HG2_RAC_R26 | △ MP1_REM_R26 |
| ◇ ECE_HIR_R26 | ◇ HG2_RCA_R26 | ★ MP1_ST3_R26 |
| ▽ ECE_RAC_R26 | ★ HG2_ST3_R26 | ● MP1_W13_R26 |
| ◇ ECE_RCA_R26 | ■ MP1_CLM_R26 | ◆ MP1_WRF_R26 |
| ★ ECE_ST3_R26 | ◇ MP1_RCA_R26 | △ MP2_REM_R26 |

△ = EURO-CORDEX
 ▲ = ReKliEs-De
 color = GCM
 shape = RCM



Annual temperature change (2071 - 2100) - (1971 - 2000)



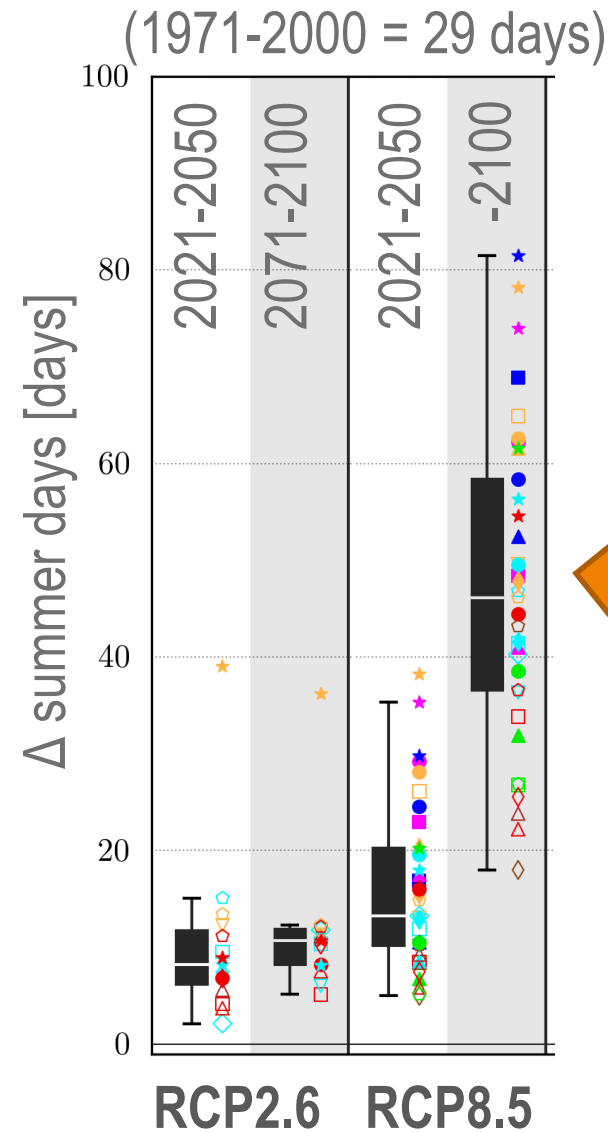
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| ★ CA2_ST3_R85 | ● ECE_W13_R85 | ▲ MI5_REM_R85 |
| ● CA2_W13_R85 | ◆ ECE_WRF_R85 | ★ MI5_ST3_R85 |
| □ CN5_CLM_R85 | □ HG2_CLM_R85 | ● MI5_W13_R85 |
| ◇ CN5_RCA_R85 | ▽ HG2_RAC_R85 | □ MP1_CLM_R85 |
| ▲ CN5_REM_R85 | ◇ HG2_RCA_R85 | ◇ MP1_RCA_R85 |
| ★ CN5_ST3_R85 | ▲ HG2_REM_R85 | △ MP1_REM_R85 |
| ● CN5_W13_R85 | ★ HG2_ST3_R85 | ★ MP1_ST3_R85 |
| □ ECE_CLM_R85 | ● HG2_W13_R85 | ● MP1_W13_R85 |
| ◇ ECE_HIR_R85 | ◆ HG2_WRF_R85 | ◇ MP1_WRF_R85 |
| ▽ ECE_RAC_R85 | ◇ IP5_RCA_R85 | △ MP2_REM_R85 |
| ◇ ECE_RCA_R85 | | |

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|---------------|---------------|---------------|
| □ ECE_CLM_R26 | ▽ HG2_RAC_R26 | △ MP1_REM_R26 |
| ◇ ECE_HIR_R26 | ◇ HG2_RCA_R26 | ★ MP1_ST3_R26 |
| ▽ ECE_RAC_R26 | ★ HG2_ST3_R26 | ● MP1_W13_R26 |
| ◇ ECE_RCA_R26 | ■ MP1_CLM_R26 | ◆ MP1_WRF_R26 |
| ★ ECE_ST3_R26 | ◇ MP1_RCA_R26 | △ MP2_REM_R26 |

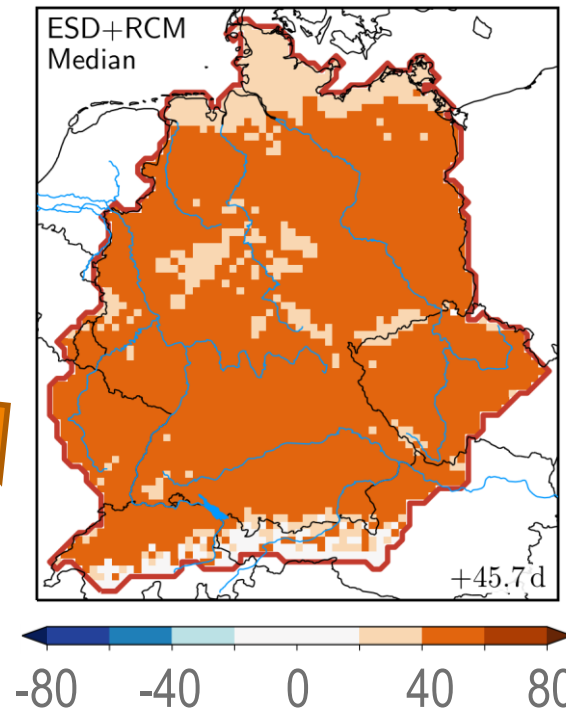
△ = EURO-CORDEX
 ▲ = ReKliEs-De
 color = GCM
 shape = RCM

ReKliEs-De: Number of summer days

Tmax > 25 °C



Median Δ (2071-2100) RCP8.5

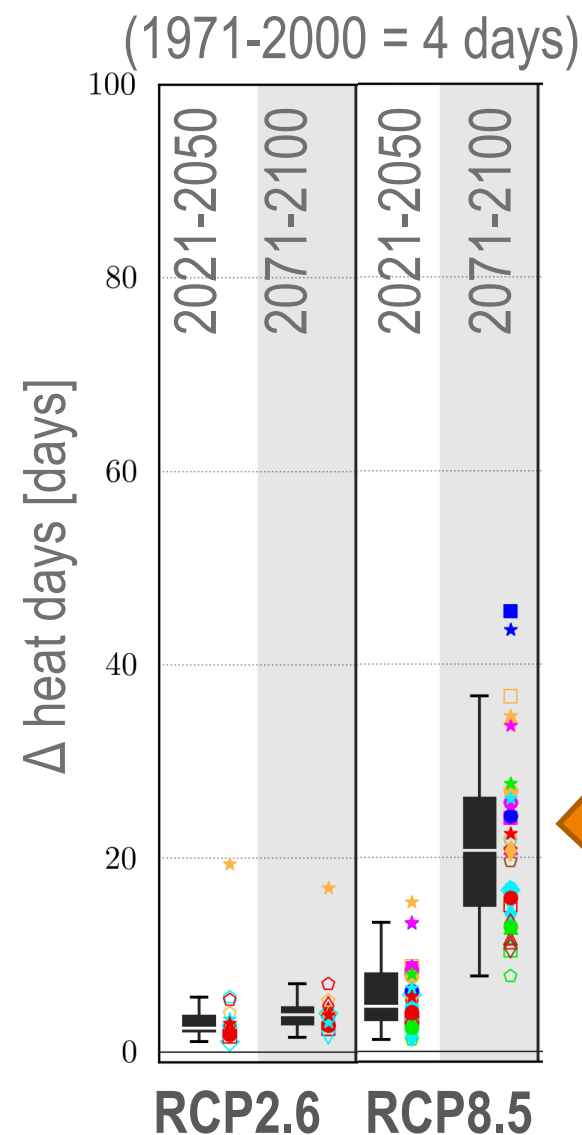


- CA2
- CN5
- ECE
- HG2
- IP5
- MI5
- MPI
- CLM
- CLM
- CLM
- CLM
- CLM
- CLM
- ◇ HIR
- ▽ RAC
- ▽ RAC
- ▽ RAC
- ◇ RCA
- ◇ RCA
- ◇ RCA
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- W13
- W13
- W13
- W13
- W13
- W13
- W13
- ◇ WRF
- ◇ WRF
- ◇ WRF

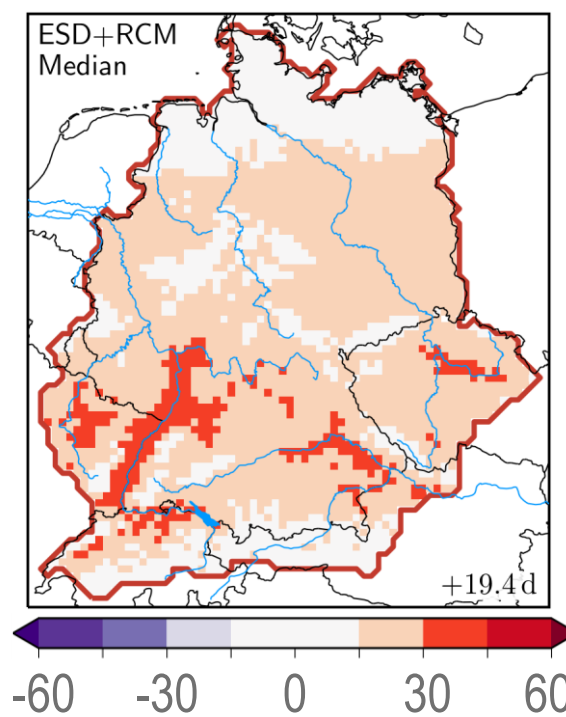
Change 2071-2100	Climate Variable	RCP 2.6	RCP 8.5
↑	Annual mean temperature (°C)	1	4
↑	Number of summer days (Tmax > 25°C)	10	46

ReKliEs-De: Number of heat days

Tmax ≥ 30 °C



Medin Δ (2071-2100) RCP8.5

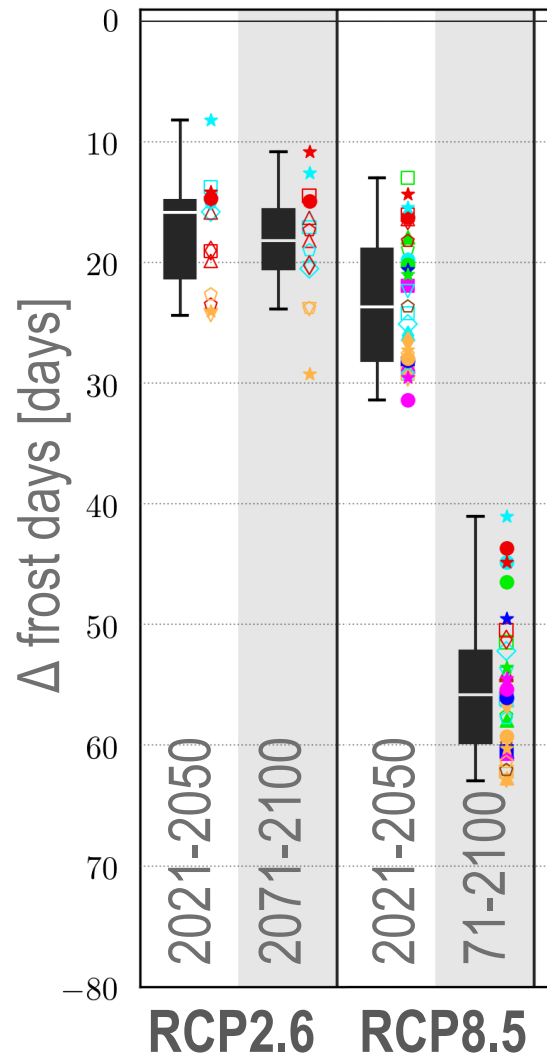


- CA2
- CN5
- ECE
- HG2
- IP5
- MI5
- MPI
- CLM
- CLM
- CLM
- CLM
- CLM
- CLM
- ◇ HIR
- ▽ RAC
- ▽ RAC
- ▽ RAC
- ◇ RCA
- ◇ RCA
- ◇ RCA
- ◇ RCA
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- W13
- W13
- W13
- W13
- W13
- W13
- W13
- ◆ WRF
- ◆ WRF
- ◇ WRF
- ◇ WRF
- ◇ WRF
- ◇ WRF

Change 2071-2100	Climate Variable	RCP 2.6	RCP 8.5
↑	Annual mean temperature (°C)	1.2	4
↑	Number of heat days (Tmax ≥ 30°C)	4	19

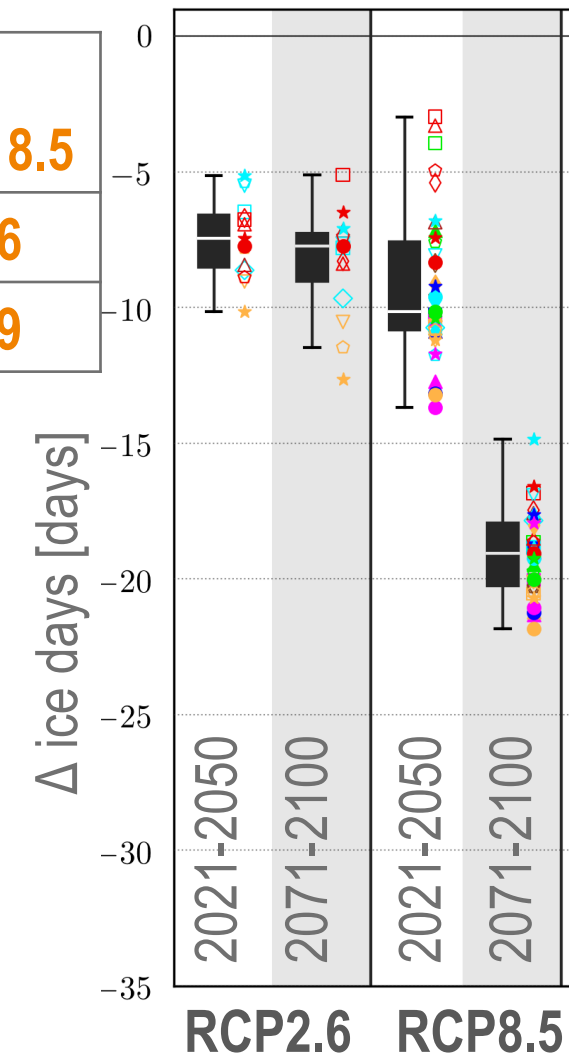
ReKliEs-De: Number frost days and ice days

(1971-2000 = 93 days)



Change 2071-2100	Climate Variable	RCP 2.6	RCP 8.5
↓	Number of frost days ($T_{min} < 0^{\circ}C$)	-18	-56
↓	Number of ice days ($T_{max} < 0^{\circ}C$)	-8	-19

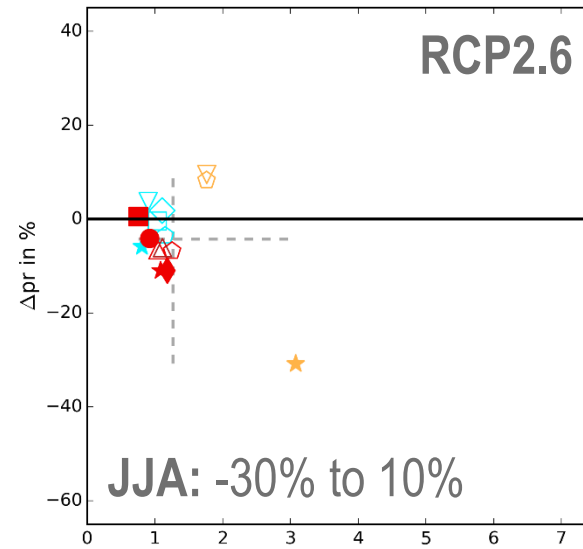
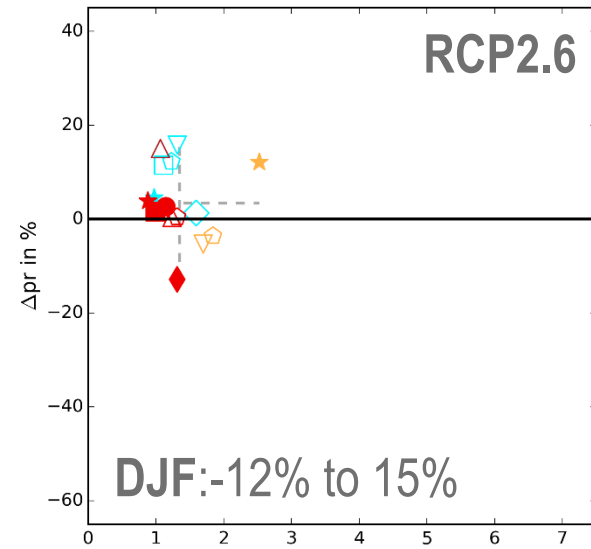
(1971-2000 = 25 days)



- CA2
- CN5
- ECE
- HG2
- IP5
- MI5
- MPI
- CLM
- CLM
- CLM
- CLM
- CLM
- CLM
- ◇ HIR
- ▽ RAC
- ▽ RAC
- ▽ RAC
- ◇ RCA
- ◇ RCA
- ◇ RCA
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- △ REM
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- ★ ST3
- W13
- W13
- W13
- W13
- W13
- W13
- ◆ WRF
- ◆ WRF
- ◇ WRF
- ◇ WRF
- ◇ WRF

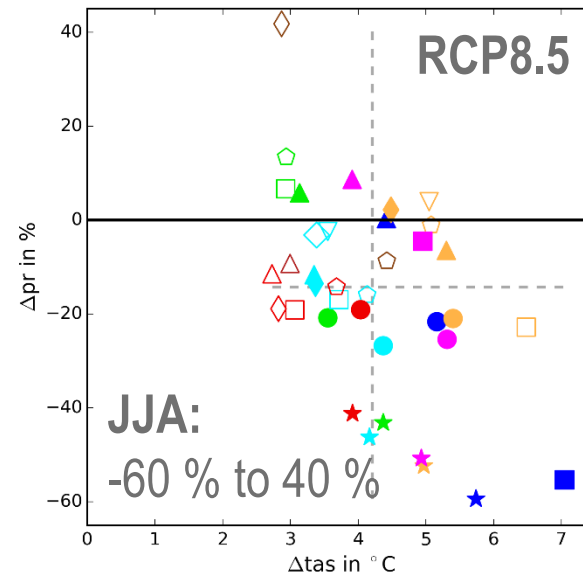
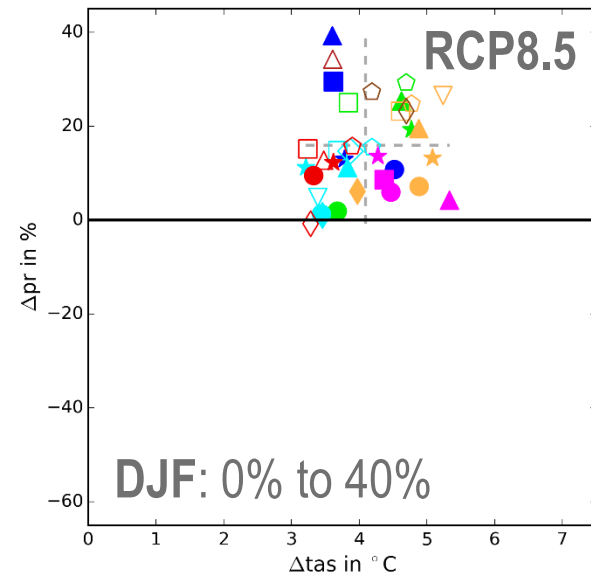


Seasonal precipitation change [%] (2071 - 2100) - (1971 - 2000)



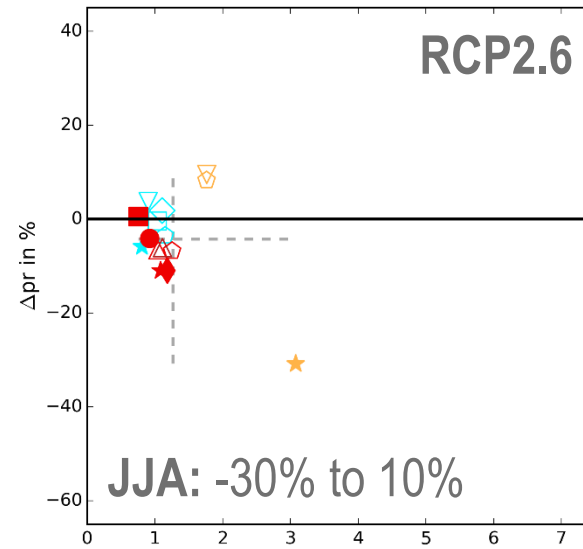
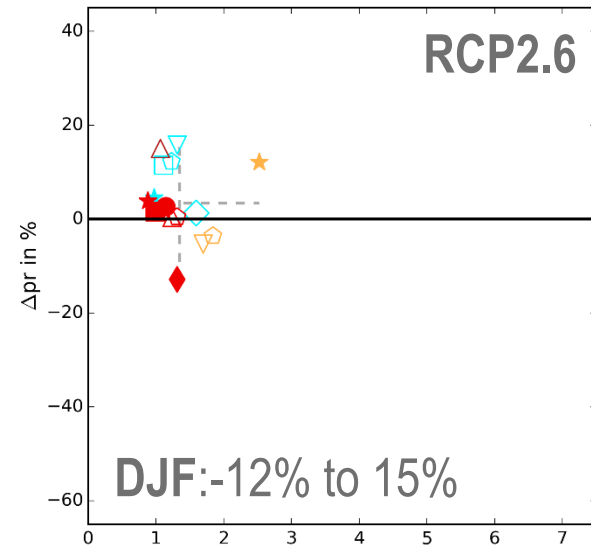
mean 1971-2000:
pr DJF= 225 mm
pr JJA = 258 mm

- | | | |
|---------------|---------------|---------------|
| □ ECE_CLM_R26 | ▽ HG2_RAC_R26 | △ MP1_REM_R26 |
| ◇ ECE_HIR_R26 | ◇ HG2_RCA_R26 | ★ MP1_ST3_R26 |
| ▽ ECE_RAC_R26 | ★ HG2_ST3_R26 | ● MP1_W13_R26 |
| ◇ ECE_RCA_R26 | ■ MP1_CLM_R26 | ◆ MP1_WRF_R26 |
| ★ ECE_ST3_R26 | ◇ MP1_RCA_R26 | △ MP2_REM_R26 |



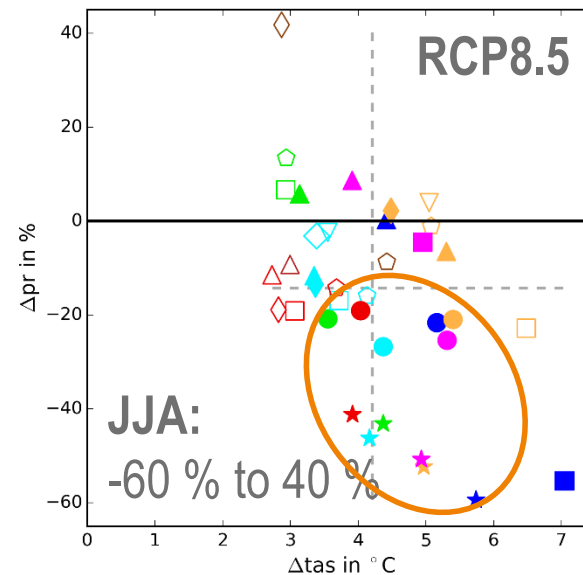
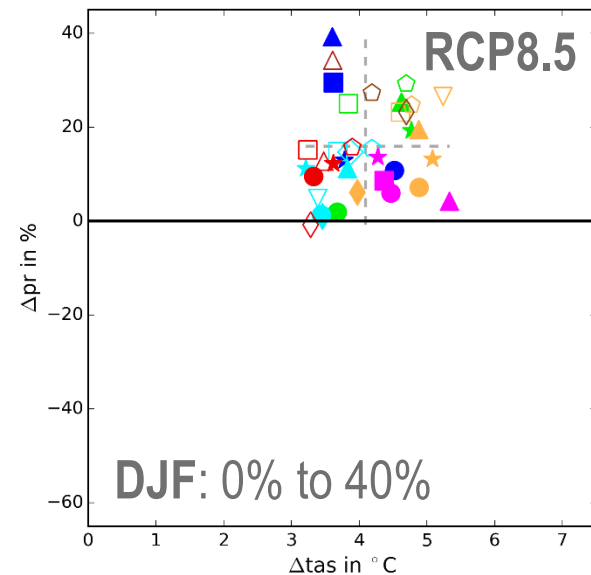
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| ▲ CA2_REM_R85 | ★ ECE_ST3_R85 | ■ MI5_CLM_R85 |
| ★ CA2_ST3_R85 | ● ECE_W13_R85 | ▲ MI5_REM_R85 |
| ● CA2_W13_R85 | ◇ ECE_WRF_R85 | ★ MI5_ST3_R85 |
| □ CN5_CLM_R85 | □ HG2_CLM_R85 | ● MI5_W13_R85 |
| ◇ CN5_RCA_R85 | ▽ HG2_RAC_R85 | □ MP1_CLM_R85 |
| ▲ CN5_REM_R85 | ◇ HG2_RCA_R85 | ◇ MP1_RCA_R85 |
| ★ CN5_ST3_R85 | ▲ HG2_REM_R85 | △ MP1_REM_R85 |
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| □ ECE_CLM_R85 | ● HG2_W13_R85 | ● MP1_W13_R85 |
| ◇ ECE_HIR_R85 | ◇ HG2_WRF_R85 | ◇ MP1_WRF_R85 |
| ▽ ECE_RAC_R85 | ◇ IP5_RCA_R85 | △ MP2_REM_R85 |
| ◇ ECE_RCA_R85 | | |

Seasonal precipitation change [%] (2071 - 2100) - (1971 - 2000)



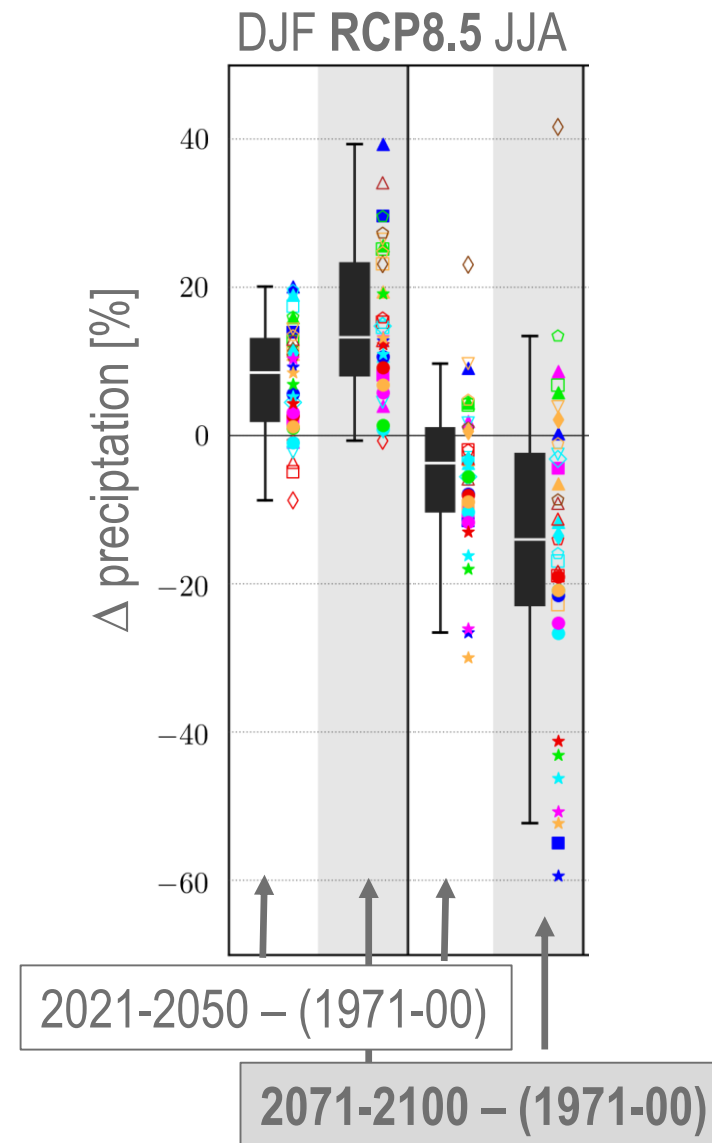
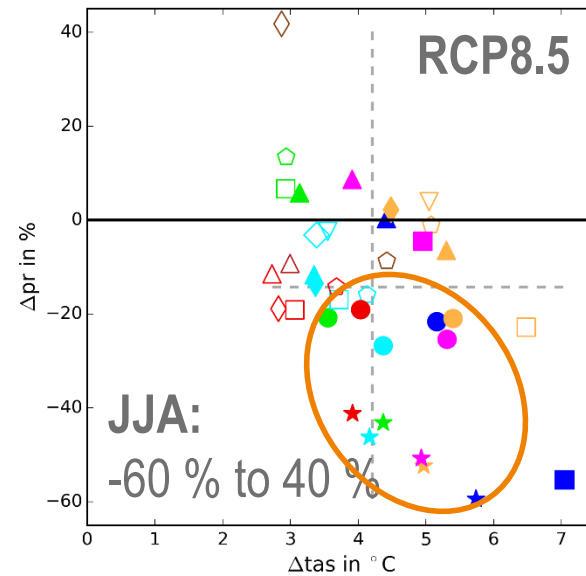
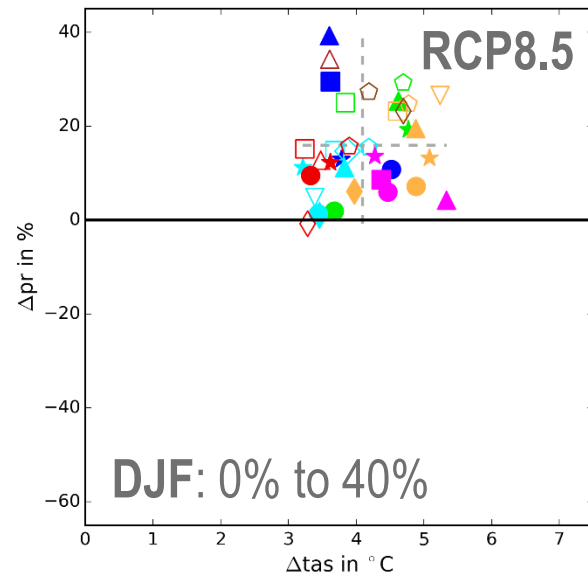
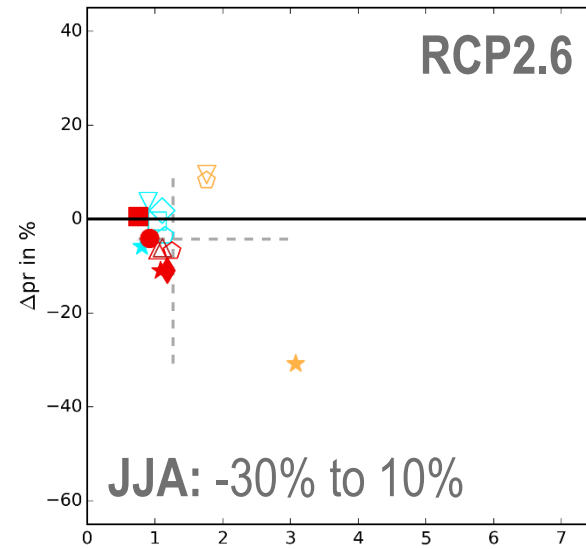
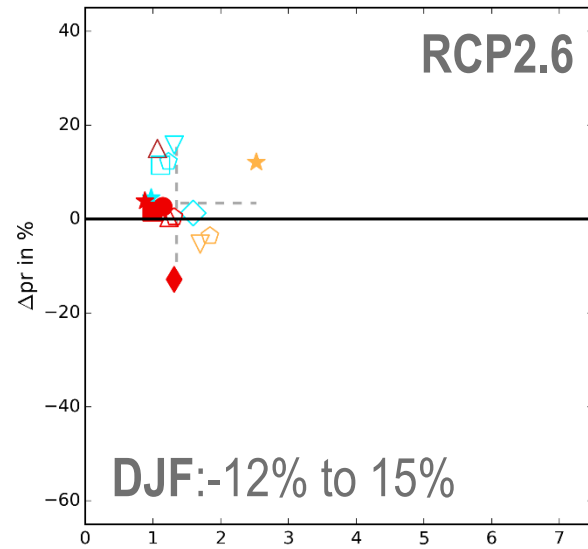
mean 1971-2000:
pr DJF= 225 mm
pr JJA = 258 mm

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|---------------|---------------|---------------|
| □ ECE_CLM_R26 | ▽ HG2_RAC_R26 | △ MP1_REM_R26 |
| ◇ ECE_HIR_R26 | ◇ HG2_RCA_R26 | ★ MP1_ST3_R26 |
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| ◇ ECE_RCA_R26 | ■ MP1_CLM_R26 | ◆ MP1_WRF_R26 |
| ★ ECE_ST3_R26 | ◇ MP1_RCA_R26 | △ MP2_REM_R26 |



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| ▲ CA2_REM_R85 | ★ ECE_ST3_R85 | ■ MI5_CLM_R85 |
| ★ CA2_ST3_R85 | ● ECE_W13_R85 | ▲ MI5_REM_R85 |
| ● CA2_W13_R85 | ◇ ECE_WRF_R85 | ★ MI5_ST3_R85 |
| □ CN5_CLM_R85 | □ HG2_CLM_R85 | ● MI5_W13_R85 |
| ◇ CN5_RCA_R85 | ▽ HG2_RAC_R85 | □ MP1_CLM_R85 |
| ▲ CN5_REM_R85 | ◇ HG2_RCA_R85 | ◇ MP1_RCA_R85 |
| ★ CN5_ST3_R85 | ▲ HG2_REM_R85 | △ MP1_REM_R85 |
| ● CN5_W13_R85 | ★ HG2_ST3_R85 | ★ MP1_ST3_R85 |
| □ ECE_CLM_R85 | ● HG2_W13_R85 | ● MP1_W13_R85 |
| ◇ ECE_HIR_R85 | ◇ HG2_WRF_R85 | ◇ MP1_WRF_R85 |
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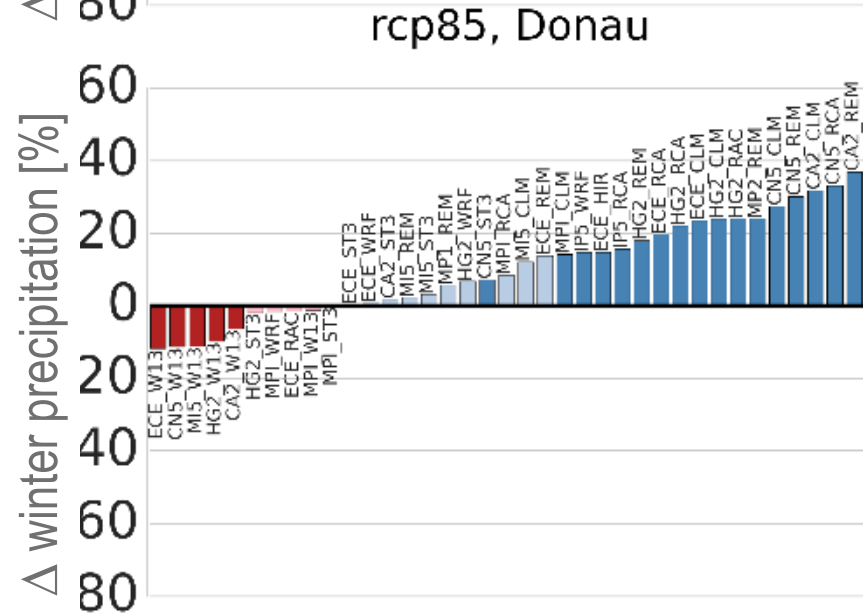
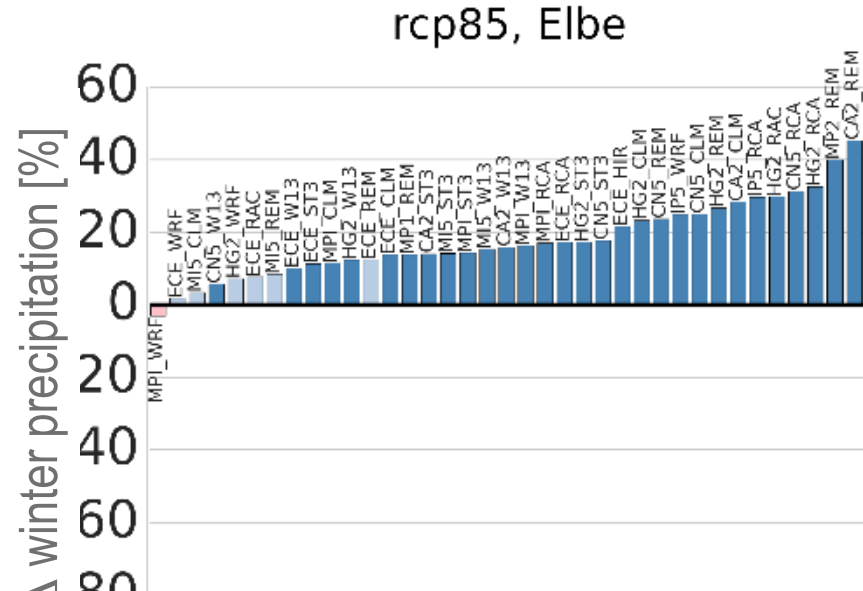
Seasonal precipitation change [%] (2071 - 2100) - (1971 - 2000)



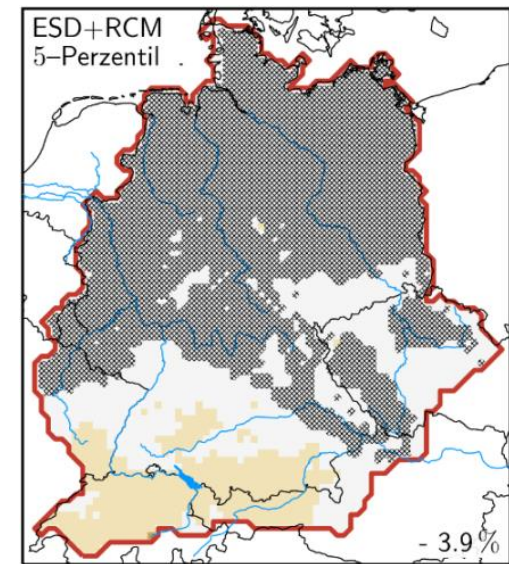
mean 1971-2000:
pr DJF = 225 mm
pr JJA = 258 mm

Winter precipitation change [%] (2071 - 2100) - (1971 - 2000)

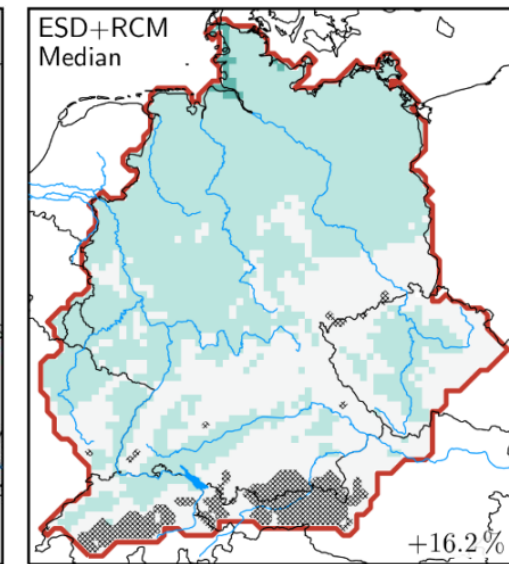
mean 1971-2000: pr DJF= 225 mm



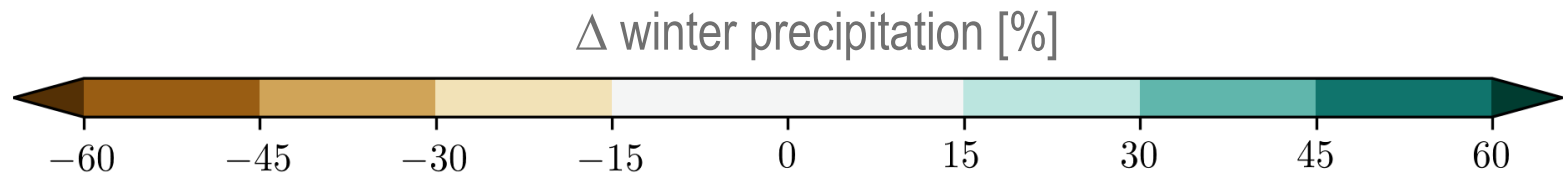
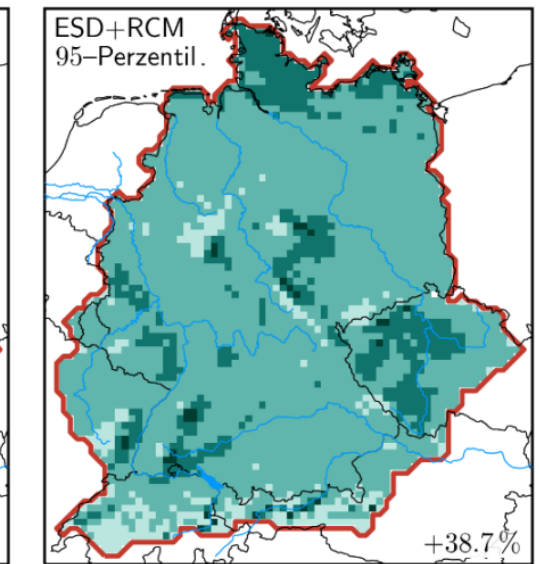
5.percentile



median



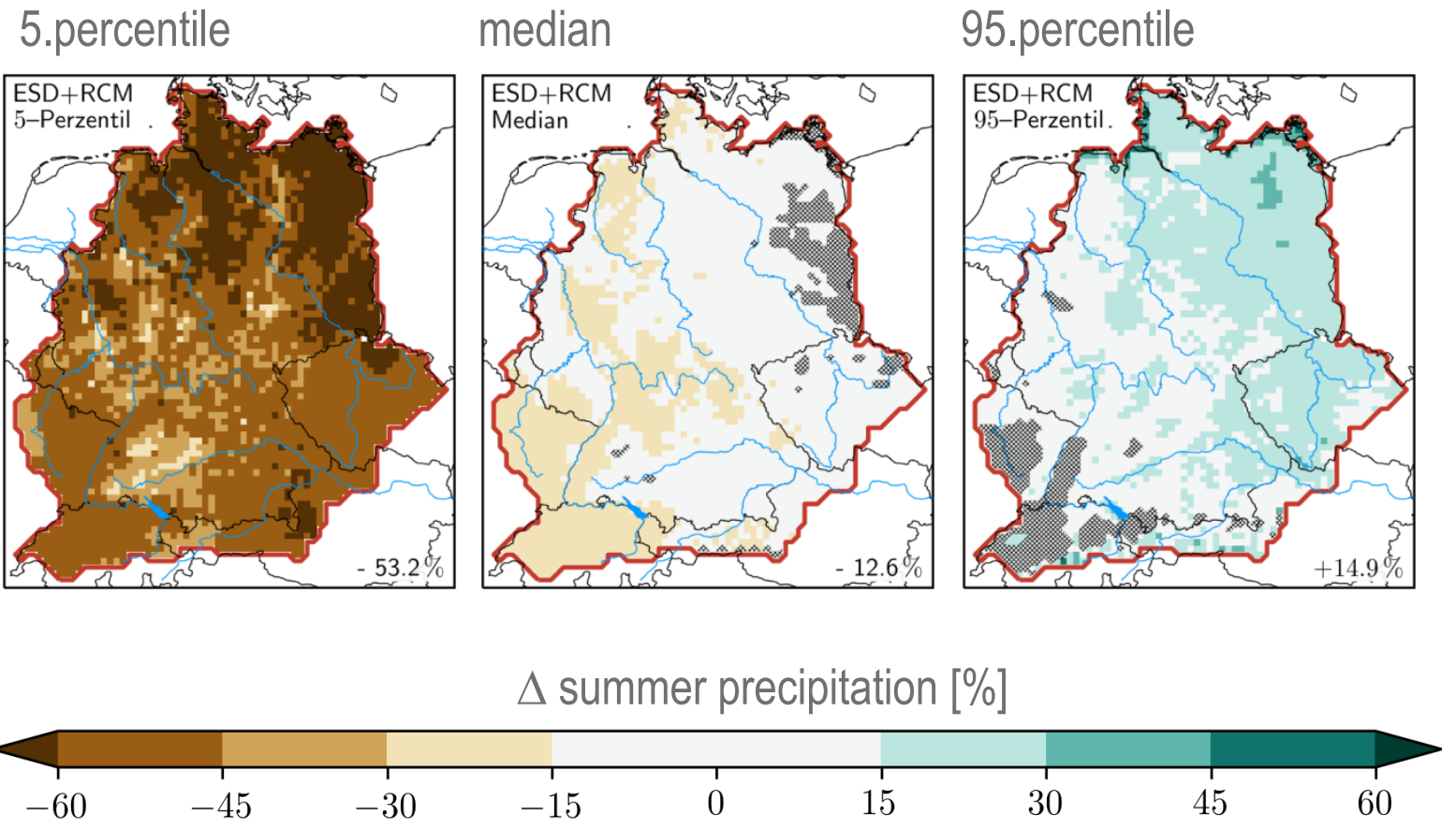
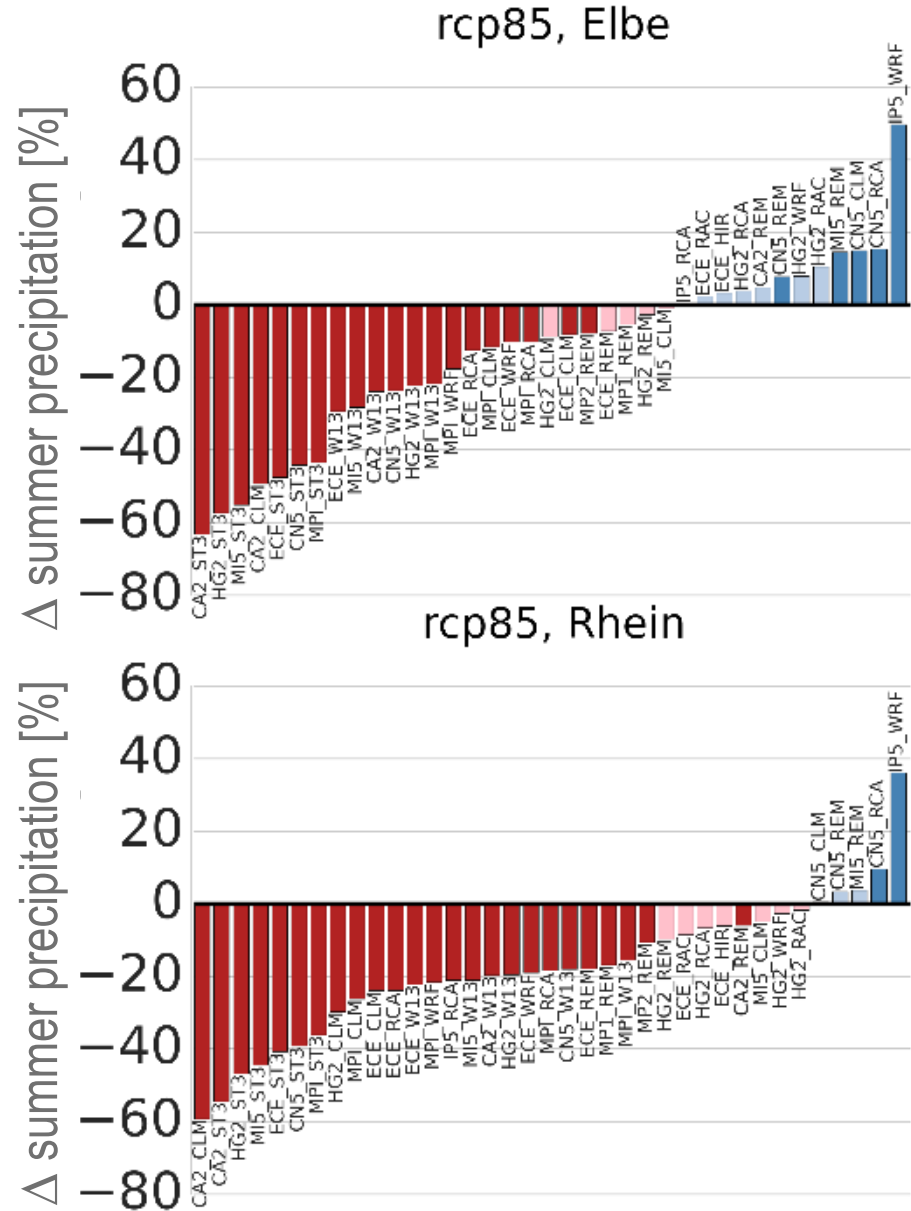
95.percentile



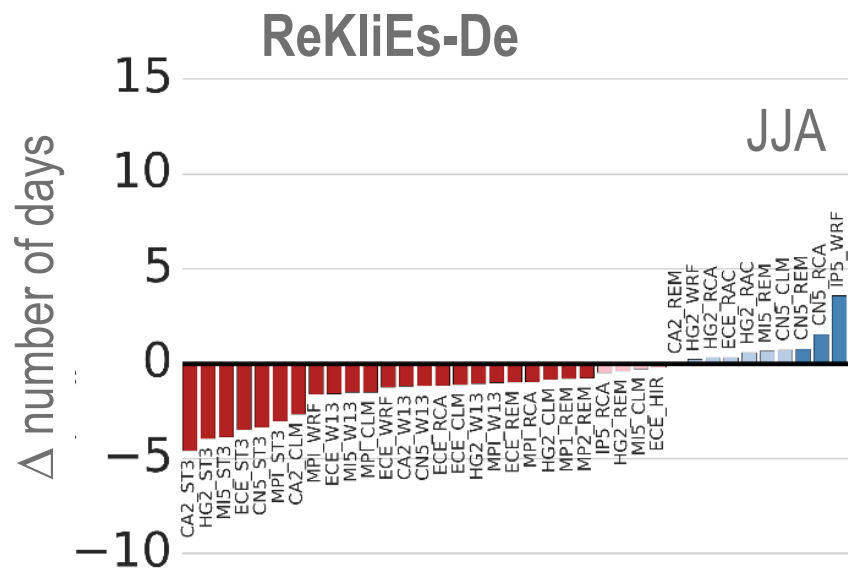
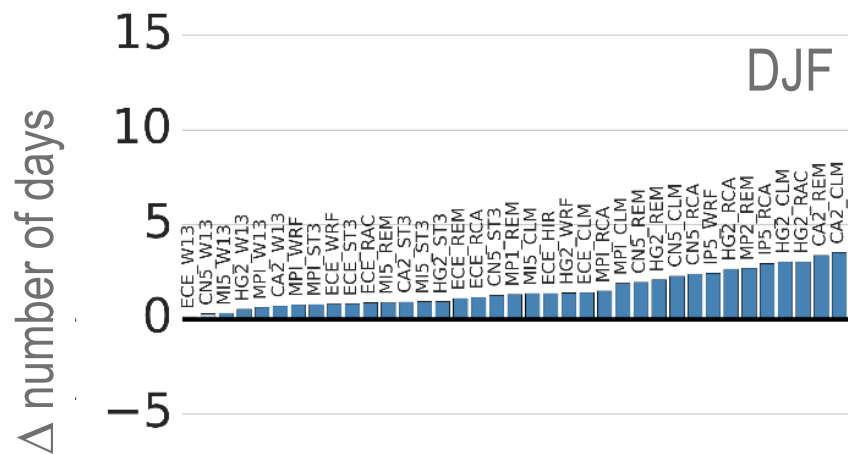


Summer precipitation change [%] (2071 - 2100) - (1971 - 2000)

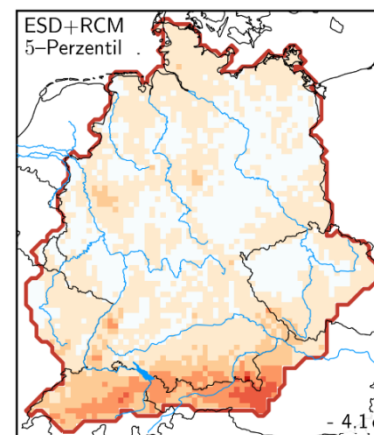
mean 1971-2000:pr JJA = 258 mm



Number of precipitation days ≥ 10 mm/day (2071 - 2100) - (1971 - 2000), RCP8.5

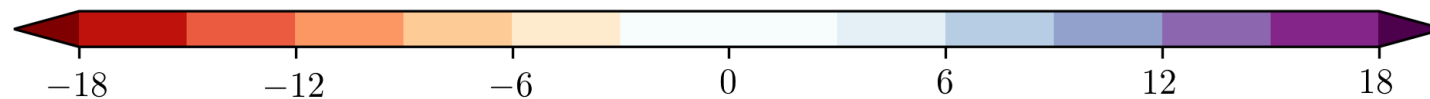


5. Perzentile

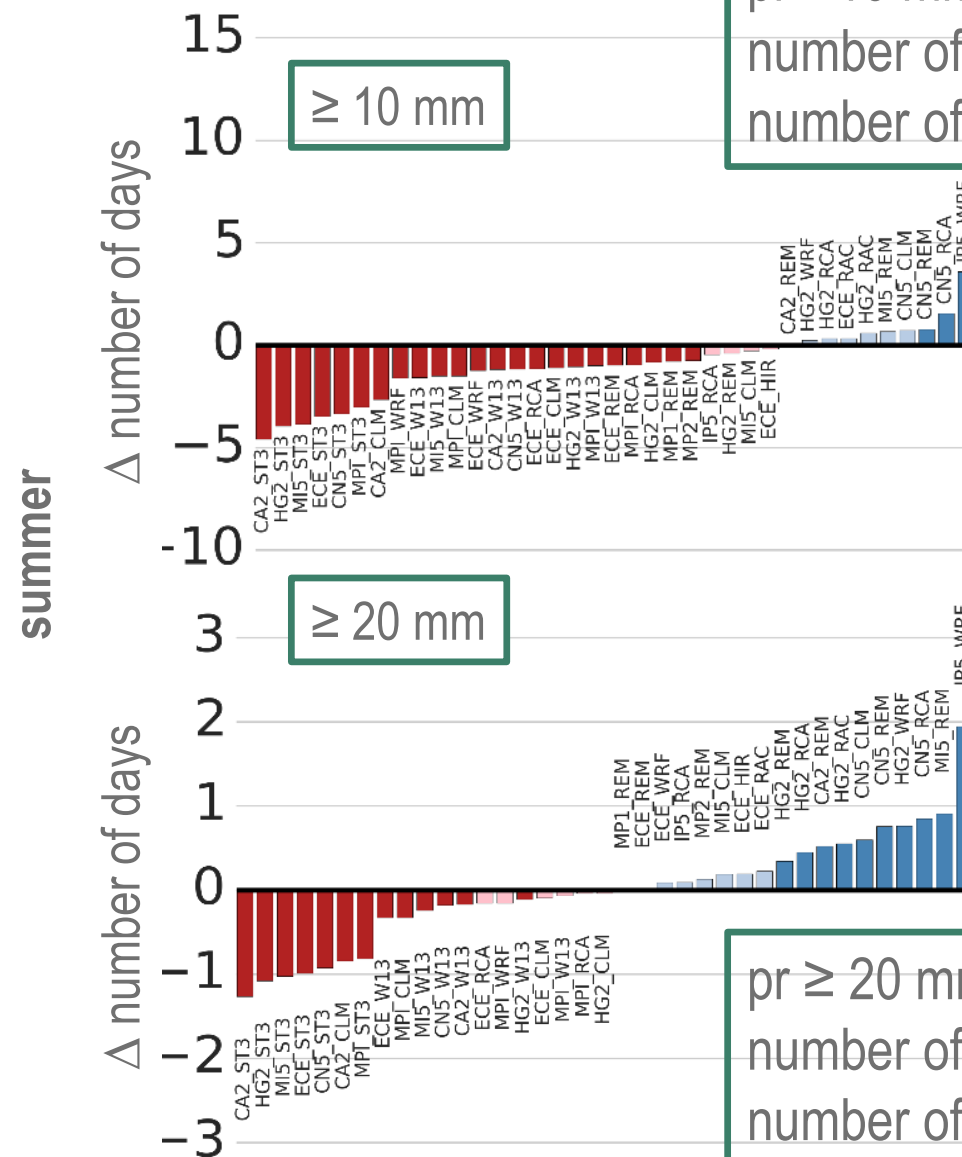
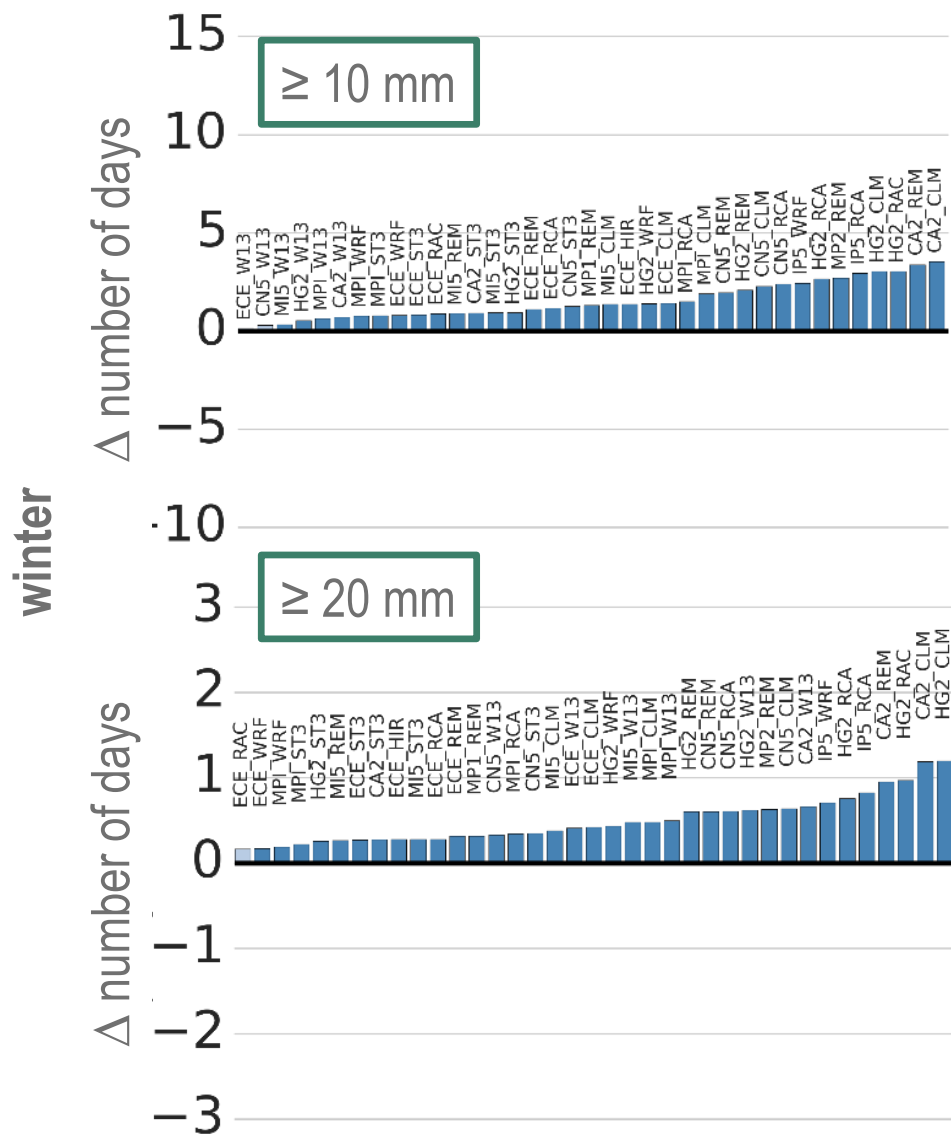


mean 1971-2000:
number of days DJF= 5
number of days JJA = 7

Δ number days pr ≥ 10 mm



Number of precipitation days ≥ 20 mm/day (2071 - 2100) - (1971 - 2000), RCP8.5, ReKliEs-De

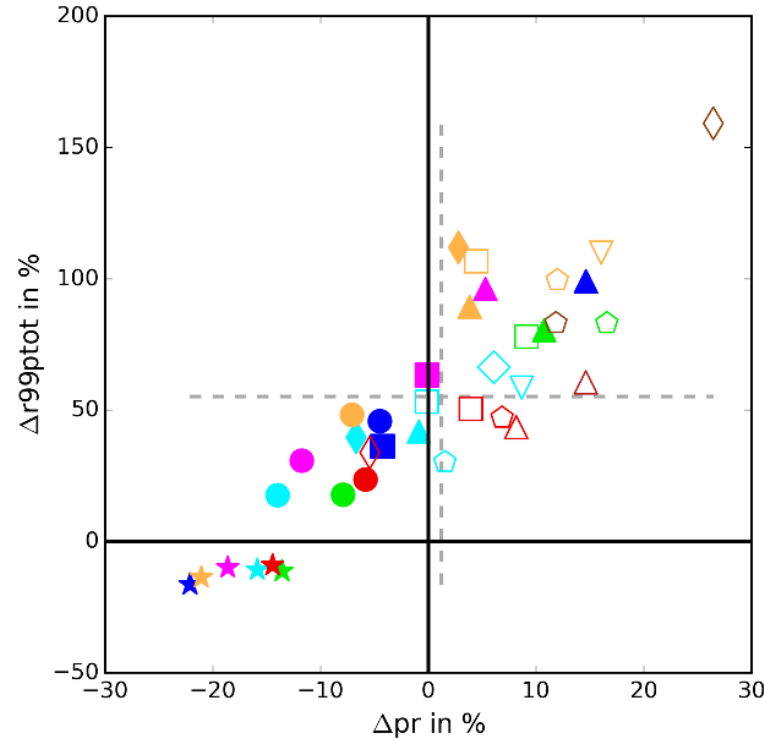
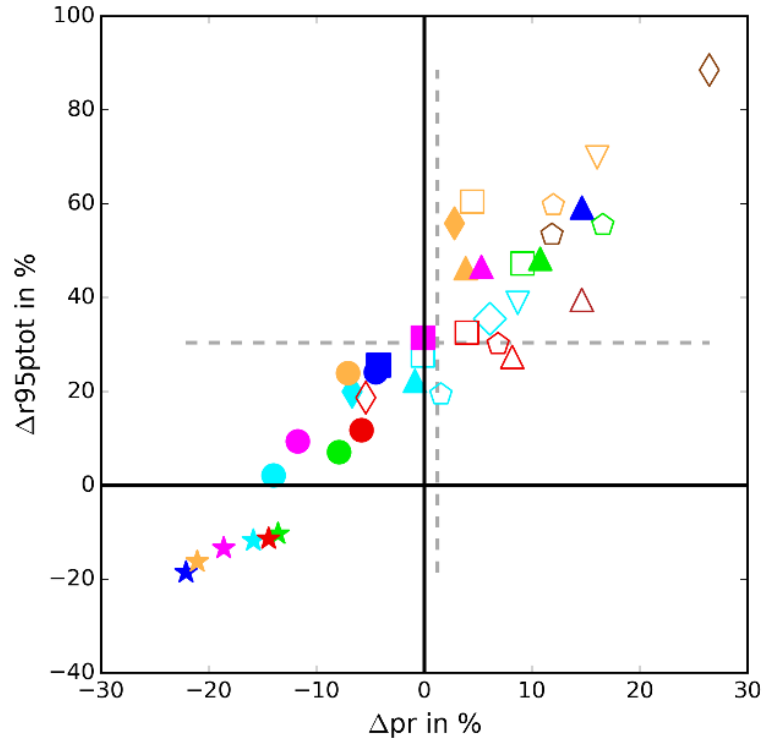


pr ≥ 10 mm 1971-2000:
 number of days DJF = 5
 number of days JJA = 7

pr ≥ 20 mm 1971-2000:
 number of days DJF = 1
 number of days JJA = 2

Annual change of the precipitation above 95. and 99. percentile [%] (2071 - 2100) - (1971 - 2000) ReKliEs-De, RCP8.5

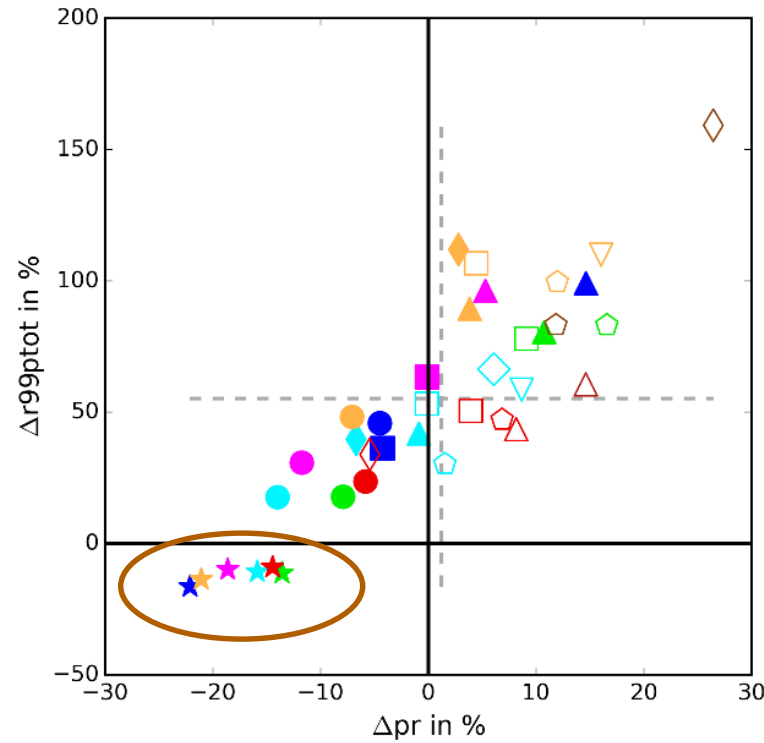
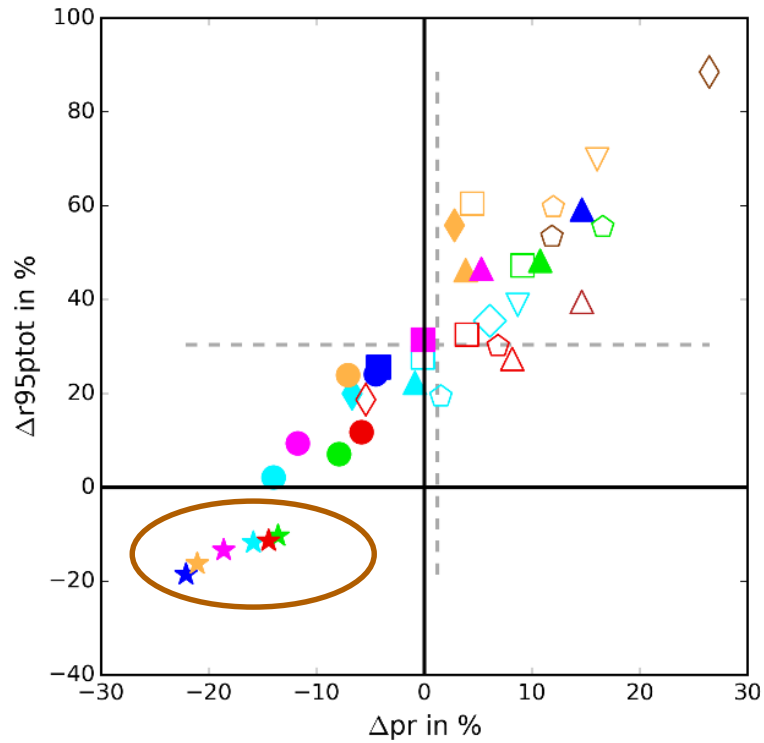
Mean 1971-2000:
 annual precip. = 900 mm/year
 pr 95. percentile = 178 mm/year
 pr 99. percentile = 57 mm/year



- | | | |
|---------------|---------------|---------------|
| ■ CA2_CLM_R85 | ▲ ECE_REM_R85 | ◇ IP5_WRF_R85 |
| ▲ CA2_REM_R85 | ★ ECE_ST3_R85 | ■ MI5_CLM_R85 |
| ★ CA2_ST3_R85 | ● ECE_W13_R85 | ▲ MI5_REM_R85 |
| ● CA2_W13_R85 | ◆ ECE_WRF_R85 | ★ MI5_ST3_R85 |
| □ CN5_CLM_R85 | □ HG2_CLM_R85 | ● MI5_W13_R85 |
| ◇ CN5_RCA_R85 | ▽ HG2_RAC_R85 | □ MP1_CLM_R85 |
| ▲ CN5_REM_R85 | ◇ HG2_RCA_R85 | ◇ MP1_RCA_R85 |
| ★ CN5_ST3_R85 | ▲ HG2_REM_R85 | △ MP1_REM_R85 |
| ● CN5_W13_R85 | ★ HG2_ST3_R85 | ★ MP1_ST3_R85 |
| □ ECE_CLM_R85 | ● HG2_W13_R85 | ● MP1_W13_R85 |
| ◇ ECE_HIR_R85 | ◇ HG2_WRF_R85 | ◇ MP1_WRF_R85 |
| ▽ ECE_RAC_R85 | ◇ IP5_RCA_R85 | △ MP2_REM_R85 |
| ◇ ECE_RCA_R85 | | |

Annual change of the precipitation above 95. and 99. percentile [%] (2071 - 2100) - (1971 - 2000) ReKliEs-De, RCP8.5

Mean 1971-2000:
 annual precip. = 900 mm/year
 pr 95. percentile = 178 mm/year
 pr 99. percentile = 57 mm/year







- | | | |
|---------------|---------------|---------------|
| ■ CA2_CLM_R85 | ▲ ECE_REM_R85 | ◇ IP5_WRF_R85 |
| ▲ CA2_REM_R85 | ★ ECE_ST3_R85 | ■ MI5_CLM_R85 |
| ★ CA2_ST3_R85 | ● ECE_W13_R85 | ▲ MI5_REM_R85 |
| ● CA2_W13_R85 | ◆ ECE_WRF_R85 | ★ MI5_ST3_R85 |
| □ CN5_CLM_R85 | □ HG2_CLM_R85 | ● MI5_W13_R85 |
| ◇ CN5_RCA_R85 | ▽ HG2_RAC_R85 | □ MP1_CLM_R85 |
| ▲ CN5_REM_R85 | ◇ HG2_RCA_R85 | ◇ MP1_RCA_R85 |
| ★ CN5_ST3_R85 | ▲ HG2_REM_R85 | △ MP1_REM_R85 |
| ● CN5_W13_R85 | ★ HG2_ST3_R85 | ★ MP1_ST3_R85 |
| □ ECE_CLM_R85 | ● HG2_W13_R85 | ● MP1_W13_R85 |
| ◇ ECE_HIR_R85 | ◇ HG2_WRF_R85 | ◇ MP1_WRF_R85 |
| ▽ ECE_RAC_R85 | ◇ IP5_RCA_R85 | △ MP2_REM_R85 |
| ◇ ECE_RCA_R85 | | |

Summary: Temperature change

Change 2071-2100	Climate Variable	RCP 2.6	RCP 8.5
↑	Annual mean temperature (°C)	1	4
↑	Number of summer days (Tmax > 25°C)	10	46
↑	Number of heat days (Tmax ≥ 30°C)	4	19
↓	Number of frost days (Tmin < 0°C)	-18	-56
↓	Number of ice days (Tmax < 0°C)	-8	-19

- Increase of band width in 2071-2100 for RCP8.5 :

Summary: Precipitation change

Change 2071-2100	Climate Variable	RCP 2.6	RCP 8.5
	JJA precipitation	-30% - +10%	-60% - +10%
	JJA number of wet days \geq 10 mm	-30% - +18%	-60% - +50%
	JJA number of wet days \geq 20 mm	-30% - +30%	-50% - +120%
	DJF precipitation	-15% - +18%	0% - +40%
	DJF number of wet days \geq 10 mm	-3% - +25%	+5% - +70%
 	DJF number of wet days \geq 20 mm	0% - +40%	+20% - +130%

- Increase in annual precipitation amount above 95. and 99. percentile (not STARS)
- Increase of band width in 2071-2100 for RCP8.5

- Public access: data, climate change indices, manuals, graphics, condensed Information, etc.



<http://reklies.hlnug.de>