modextreme

agriculture facing extreme climatic events

Climate Scenarios for extreme events

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Future climate extremes

- In order to look at extremes, we need regional models due to their higher resolution
- We cannot know in advance, which model is ”right”
- We therefore need to explore the spread of available results





Regional Models

- Regional climate models are embedded into global coupled-model simulations to obtain higher spatial resolution, typically down to 8-12km grid distance.
- They can potentially output all meteorological variables in all grid points and levels, at all time steps. Typically, daily time resolution is used, sometimes hourly.
- Both emission scenario, driving global model and regional model add variability to the results.






Regional Model Output

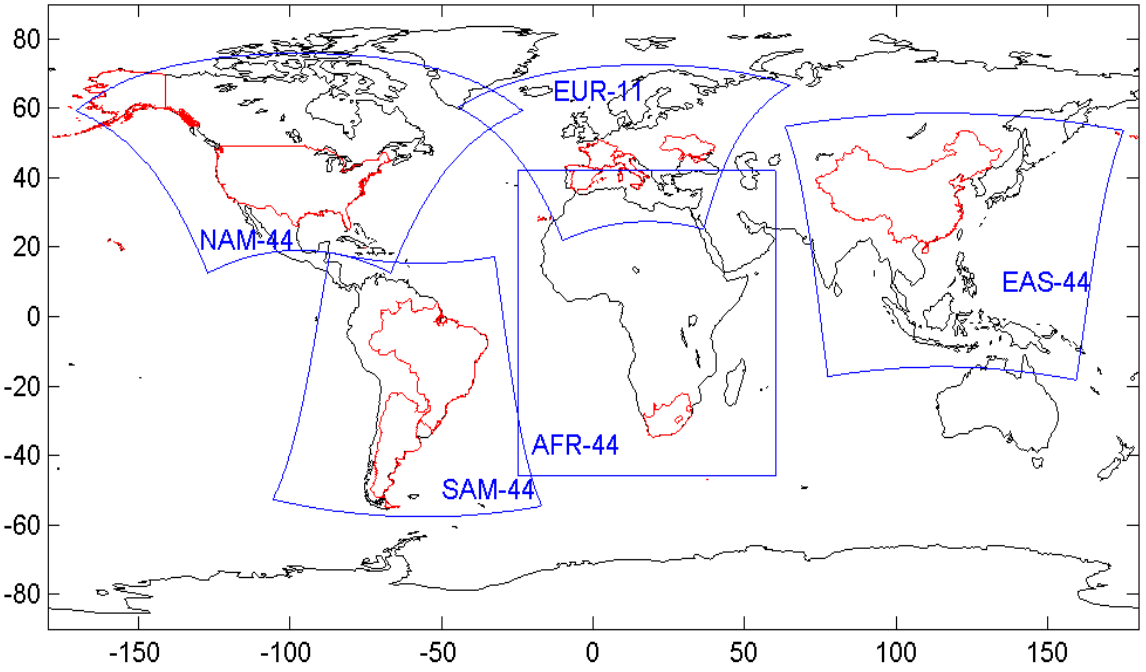
- Regional climate models are embedded into global coupled-model simulations to obtain higher spatial resolution, typically down to 8-12km grid distance. The Euro-CORDEX project aims at collecting 12km simulations covering the entire European area
- For all simulations, there are gridded daily data for daily maximum and minimum temperature plus precipitation on a common grid, both non-corrected and bias corrected.
- Other fields, e.g. incoming solar radiation, actual and potential evaporation etc. are available, but cannot be bias corrected





Sources of climate change data

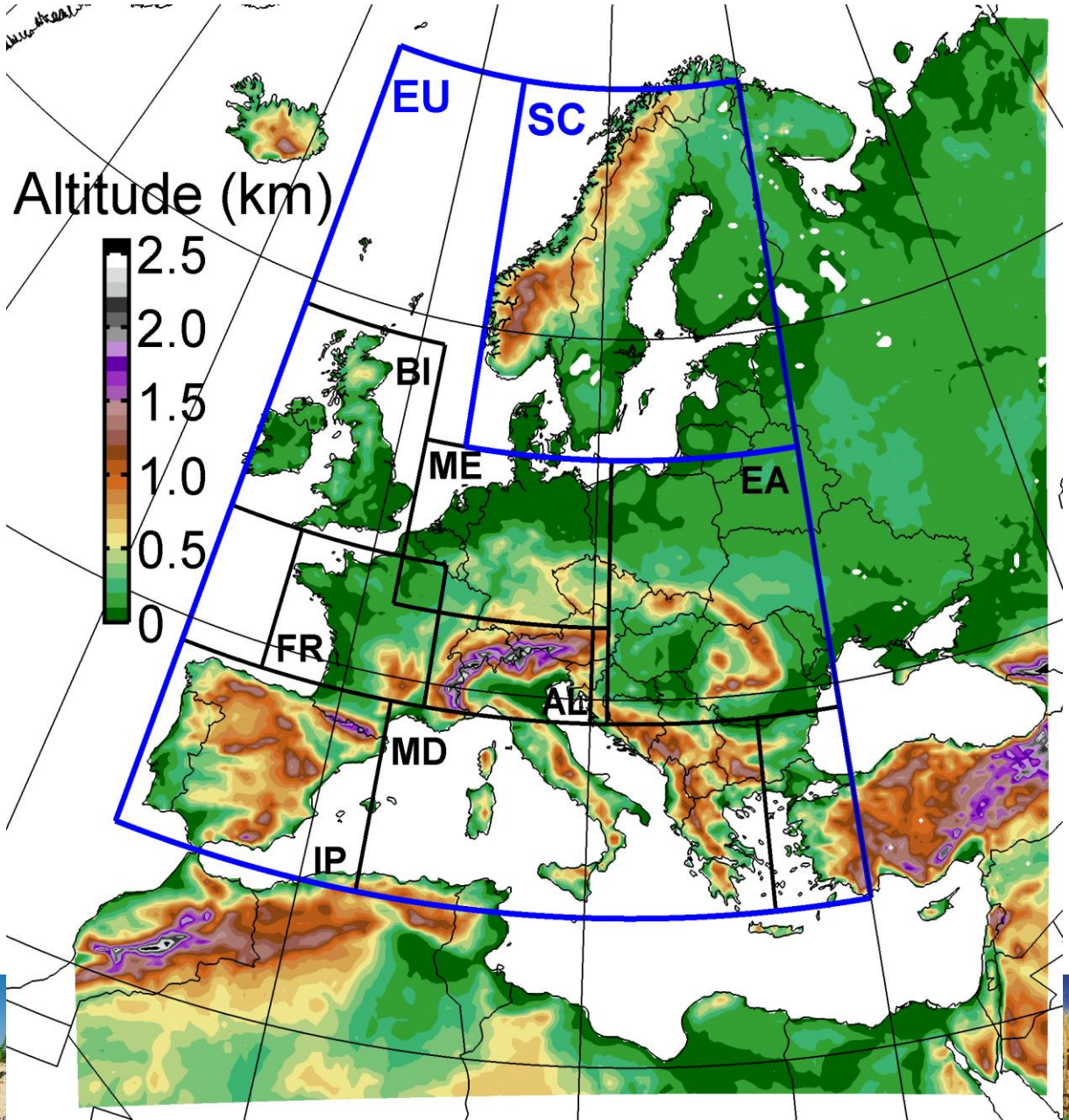
- CORDEX (http://www.cordex.org)
- Regional models covering land areas of the World







Regional Simulations over Europe



Previous analyses of changes in extremes

- ENSEMBLES and CORDEX
- Focus on Europe

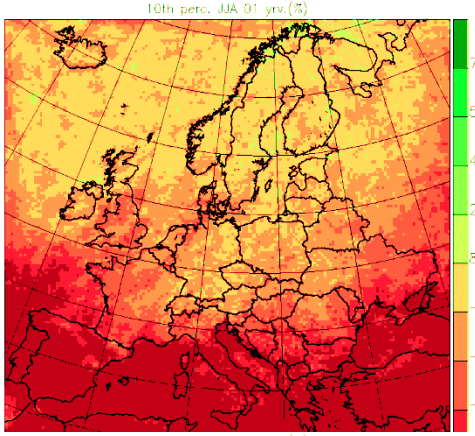


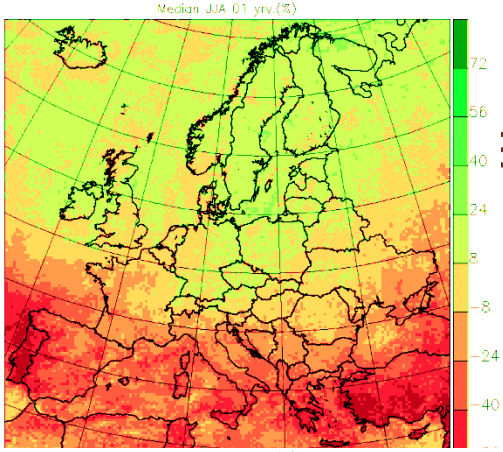


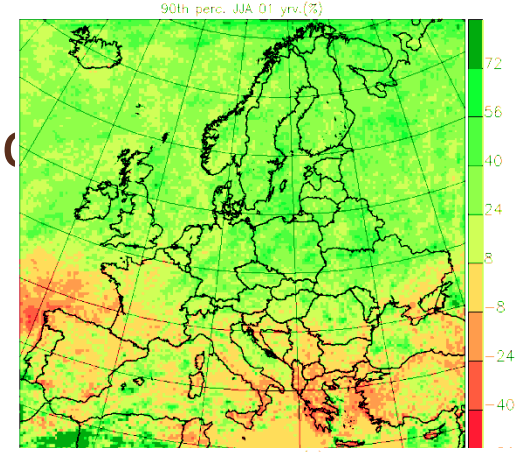

1 yrv

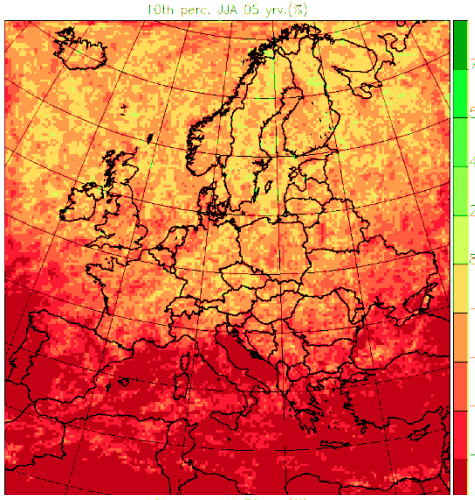
5 yrv

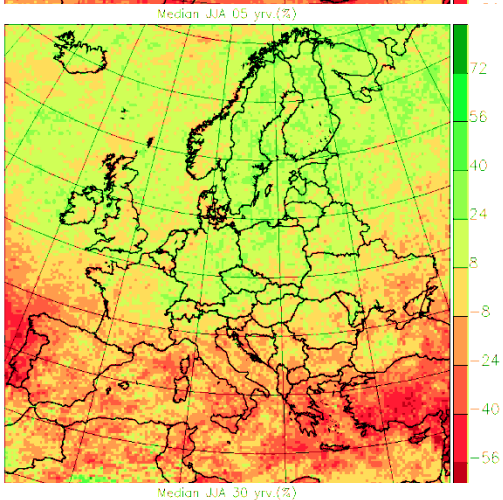
30 yrv

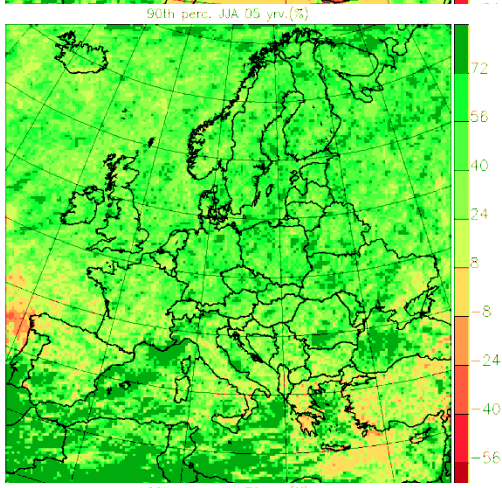


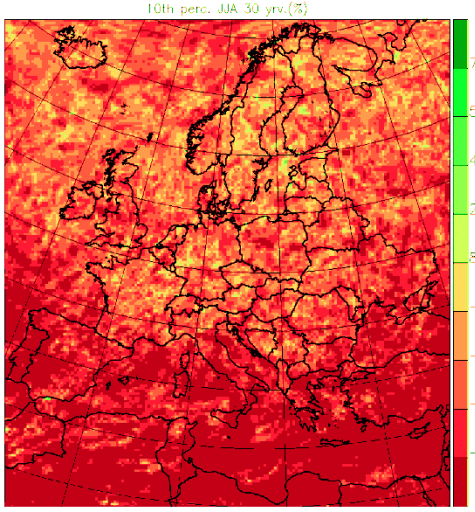


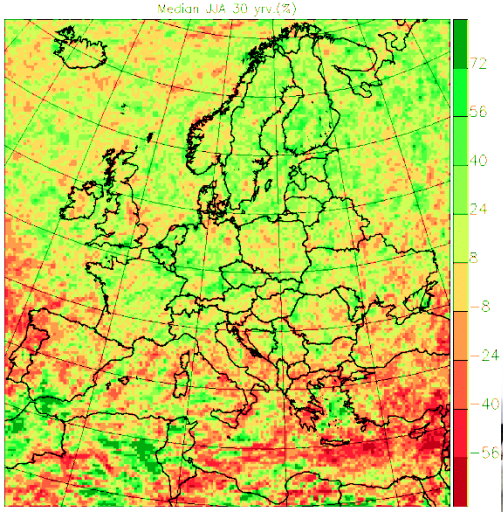


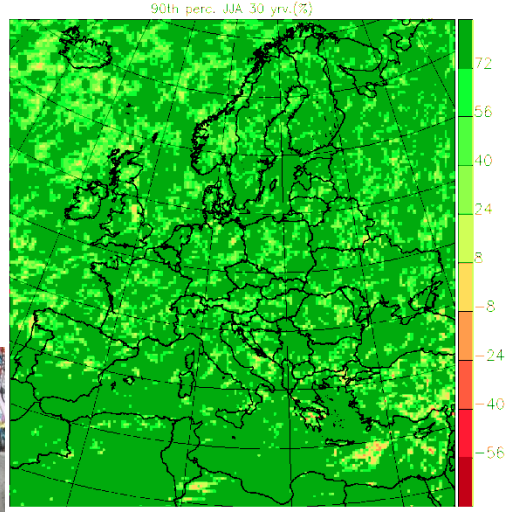




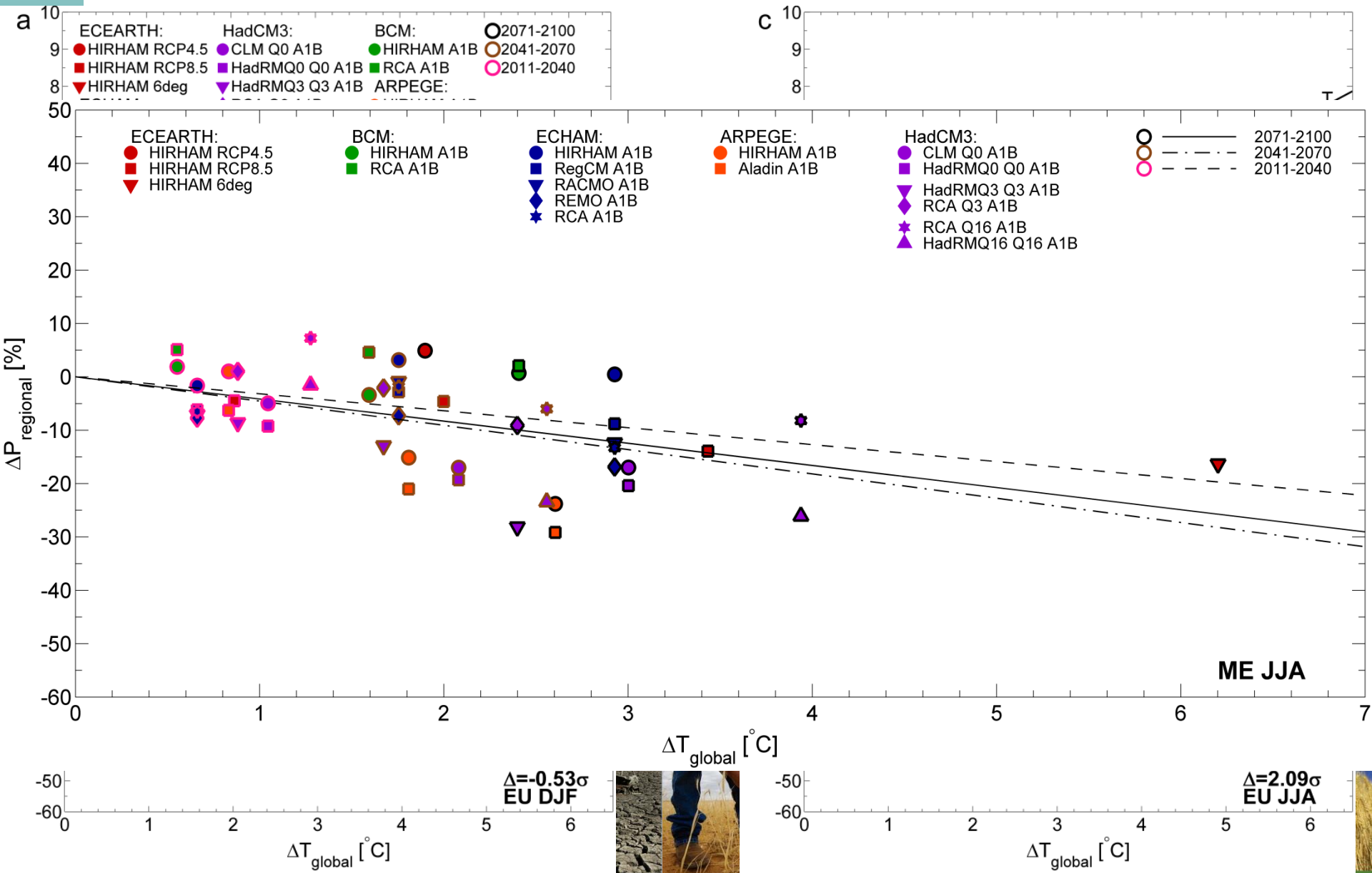






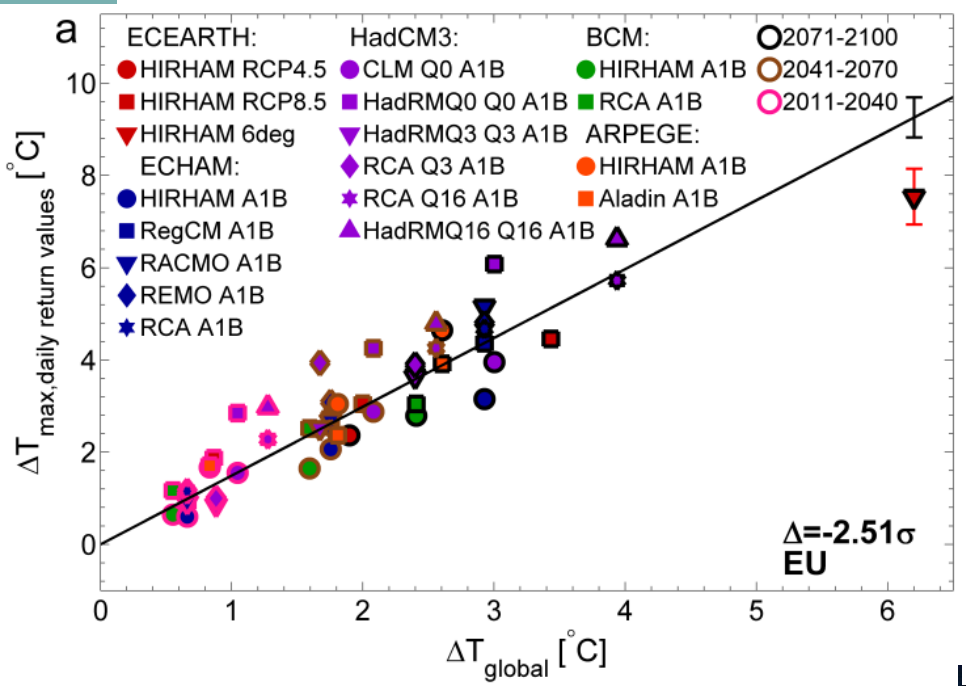


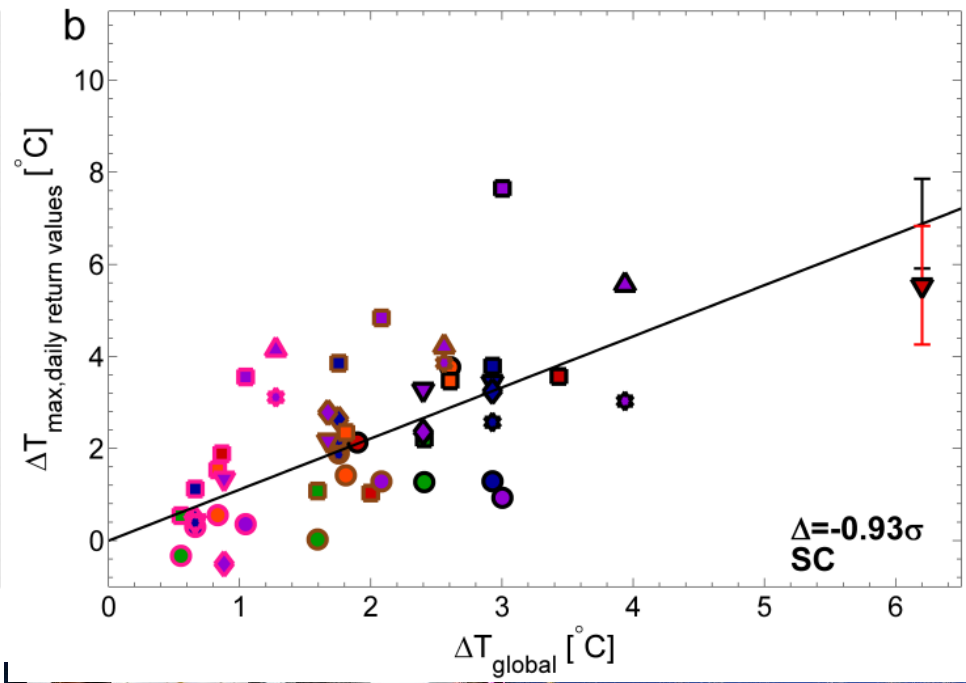
Change in Average Fields

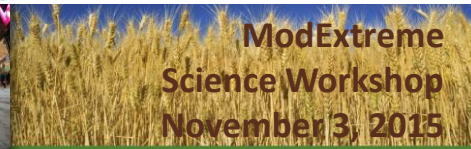


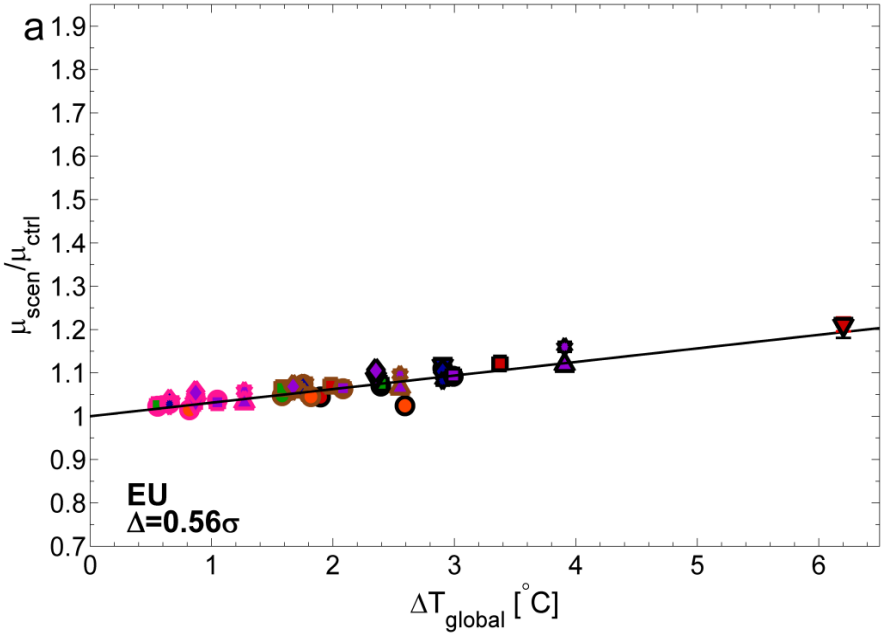
Change in Extremes

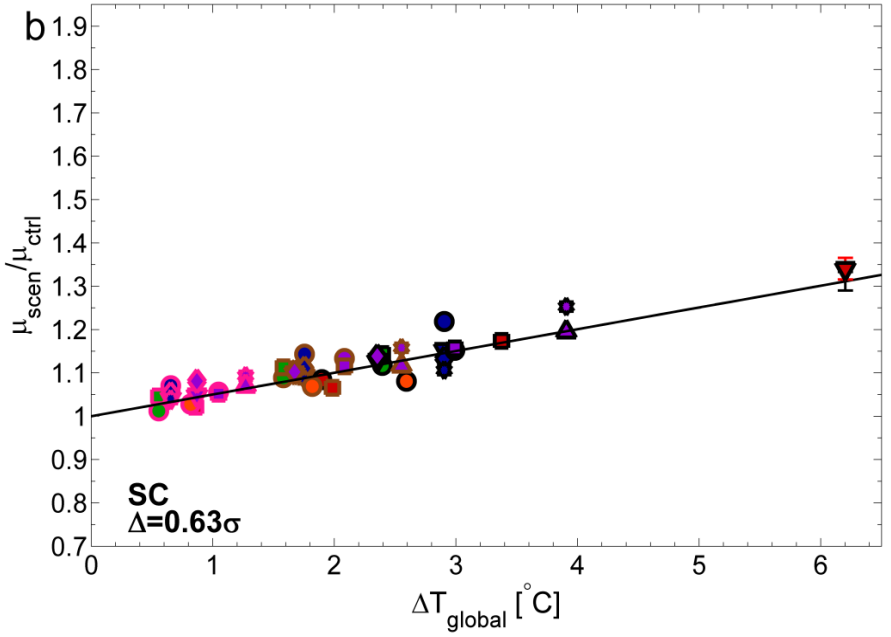
30-y return value of Daily Max. T

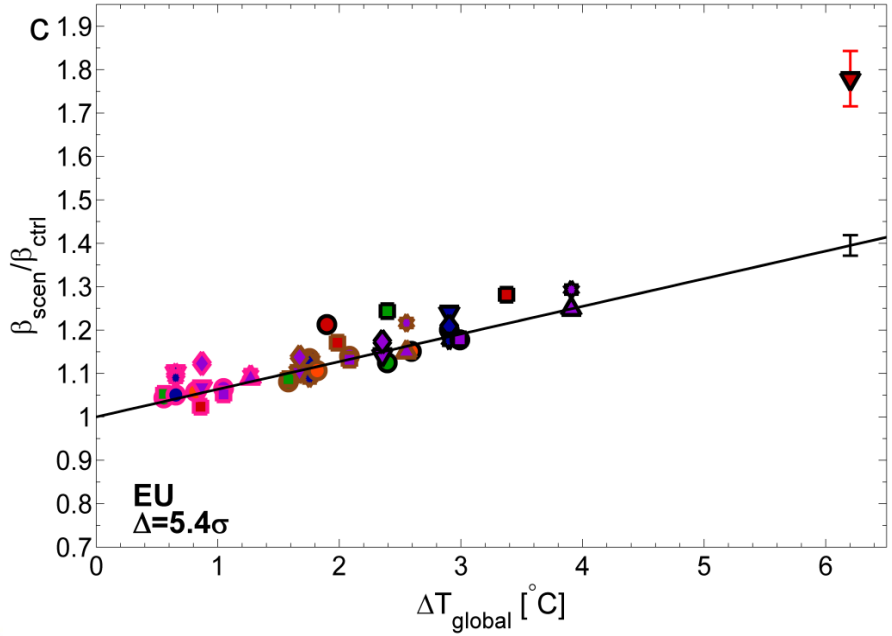


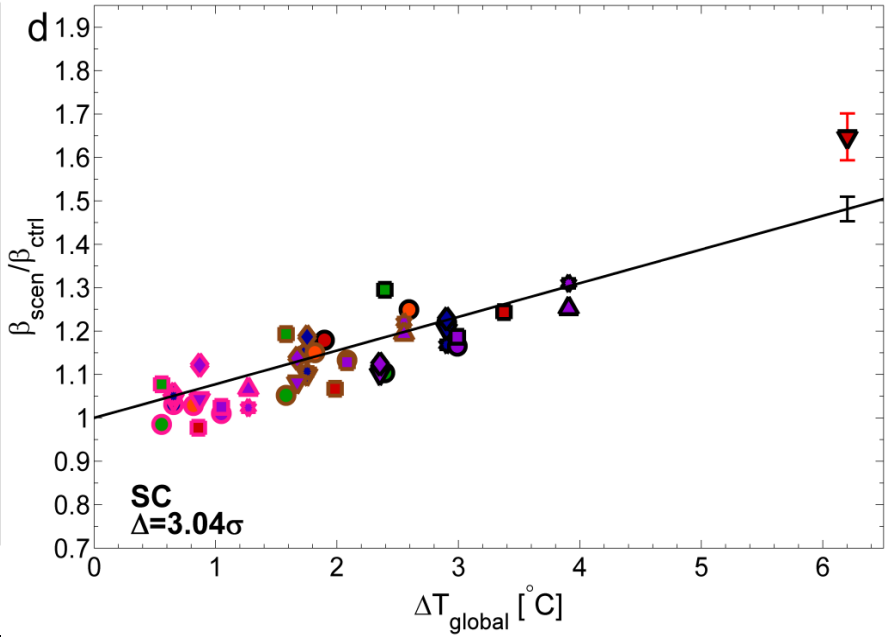





a
μ_{scen}/μ_{ctrl}
EU
Δ=0.56σ
ΔT_{global} [°C]


b
μ_{scen}/μ_{ctrl}
SC
Δ=0.63σ
ΔT_{global} [°C]


c
$\beta_{scen}/\beta_{ctrl}$
EU
Δ=5.4σ
ΔT_{global} [°C]


d
$\beta_{scen}/\beta_{ctrl}$
SC
Δ=3.04σ
ΔT_{global} [°C]


ModExtreme
Science Workshop
November 3, 2015

MODEXTREME

- CORDEX results, bias corrected towards observed time series
- PCA selection of models for various relevant extremes






Model selection

- We choose to select up to 4 models per area, one central and 3 to span the variation within a set of 8 indices based on precipitation: Average precipitation plus

RX1day	Highest precipitation amount in one-day period.	-	●
RX5day	Highest precipitation amount in five-day period.	-	●
SDII	Simple daily intensity index	Mean of precipitation (RR) on days when rain occurred (days when RR ≥ 1mm).	●
R10mm	Heavy precipitation days	Count of days where RR (daily precipitation amount) ≥ 10 mm.	●
R20mm	Very heavy precipitation days	Count of days where RR (daily precipitation amount) ≥ 20 mm.	●
CDD	Consecutive dry days	Maximum length of dry spell (RR < 1 mm).	●
CWD	Consecutive wet days	Maximum length of wet spell (RR ≥ 1 mm)	●





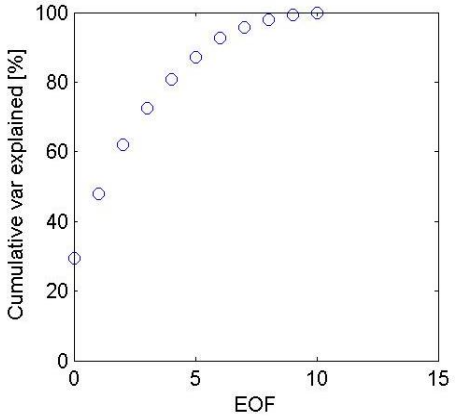
Model selection

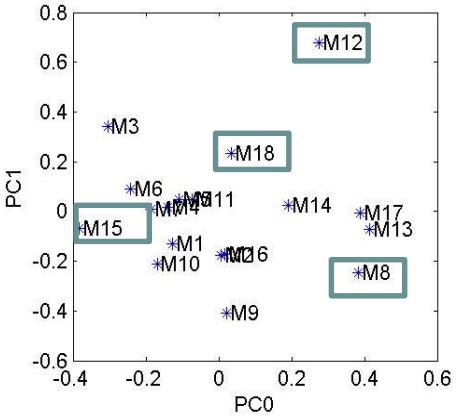
- Principal Component Analysis in index/model space: Identify which models and which indices follow each others, and which are independent.
- Select one central and 3 others spanning the independent directions subjectively
- Selected simulations for SW Europe: ECEARTH-HIRHAM (central), CERFACS-RCA, ECEARTH-RACMO, MPIESM-CCLM
- For Ukraine: CERFACS-RCA, ECEARTH-RACMO, HadGEM-RCA, MPIESM-CCLM

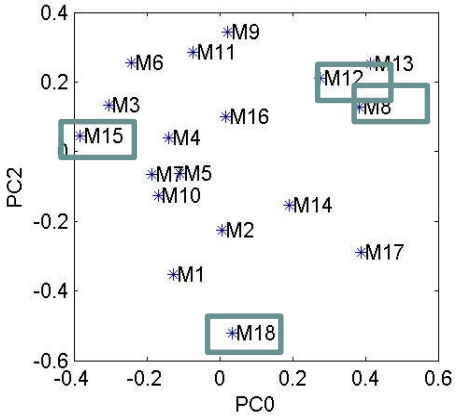


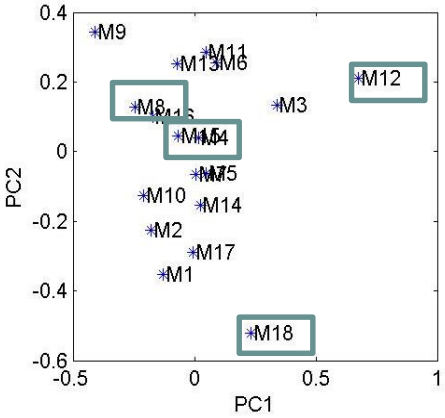


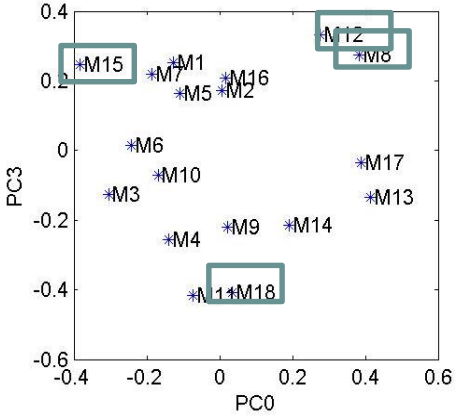

Choice of models for South Africa





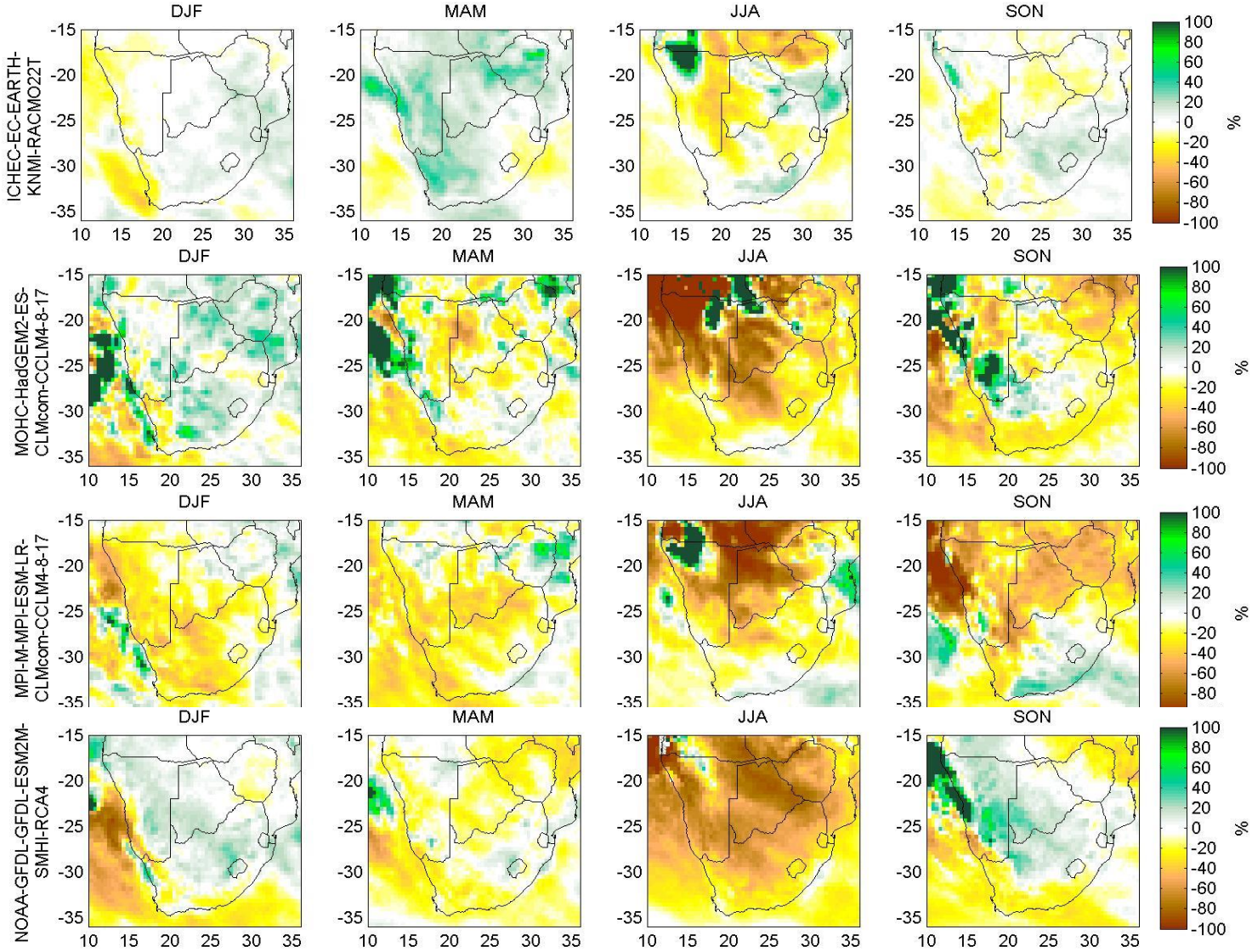






M1: CanESM-CanRCM
M2: CanESM-RCA
M3: CERFACS-CCLM
M4: CERFACS-RCA
M5: CSIRO-RCA
M6: ECEARTH-CCLM
M7: ECEARTH-HIRHAM
M8: ECEARTH-RACMO
M9: ECEARTH-RCA
M10: IPSLCM-RCA
M11: MIROC-RCA
M12: HadGEM-CCLM
M13: HadGEM-RACMO
M14: HadGEM-RCA
M15: MPIESM-CCLM
M16: MPIESM-RCA
M17: NorESM-RCA
M18: GFDLESM-RCA

Differences in climate change



Extremes Indices: full list

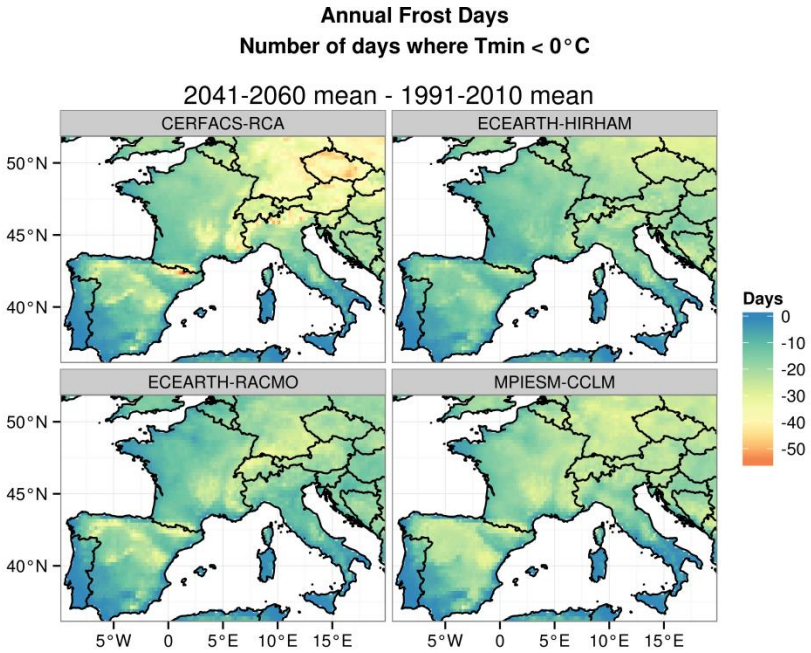
Standard Indices: Temperature			Standard Indices: Precipitation		
1	**FD**	**Frost days (Tmin < 0°C)**	8	RX1day	Highest precipitation amount in one-day period.
2	**SU**	**Summer days (Tmax > 25°C)**	9	RX5day	Highest precipitation amount in five-day period.
3	TR	Tropical nights (Tmin > 20°C)	**10**	**SDII**	**Simple daily intensity index**
4	**GSL**	**Growing season length**	12	R10mm	Heavy precipitation days (RR > 10mm)
5	WSDI	Warm Spell Duration Index	12	R20mm	Very heavy precipitation days (RR > 20mm)
6	WSDImax	Length of longest Warm Spell	**13**	**CDD**	**Consecutive dry days**
7	CSDI	Cold spell duration index	**14**	**CWD**	**Consecutive wet days**

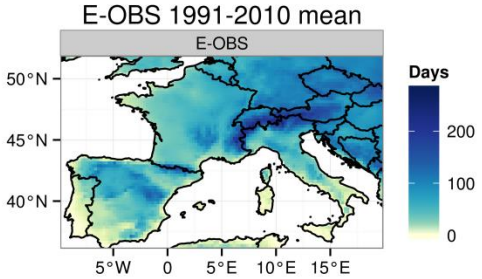
Phenological Indices: Cold Temperatures			Phenological Indices: Extreme Heat		
15	S.EM.CRIT.8	Sowing-emergence critical days (< -8°C)	22	TMAX.40	Ceiling temperature for development (Tmax > 40°C)
16	S.EM.CRIT.3	Sowing-emergence critical days (< -3°C)	23	TMAX.45	Ceiling temperature for development (Tmax > 45°C)
17	EM.AN.CRIT.2	Emergence-flowering critical days (< -2°C)	**Phenological Indices: Grasslands**		
18	LASTFROST.0	Final frost day (0°C)	24	GSL.GRASS	Growing Season length for Grasses/Clover mix
19	LASTFROST.8	Final frost day (-8°C)	25	VHOT.DAYS	Very Hot Days (Tmax > 35°C)
20	LASTFROST.3	Final frost day (-3°C)			
21	LASTFROST.2	Final frost day (-2°C)			* **Bold** Indicates the six "core" indices

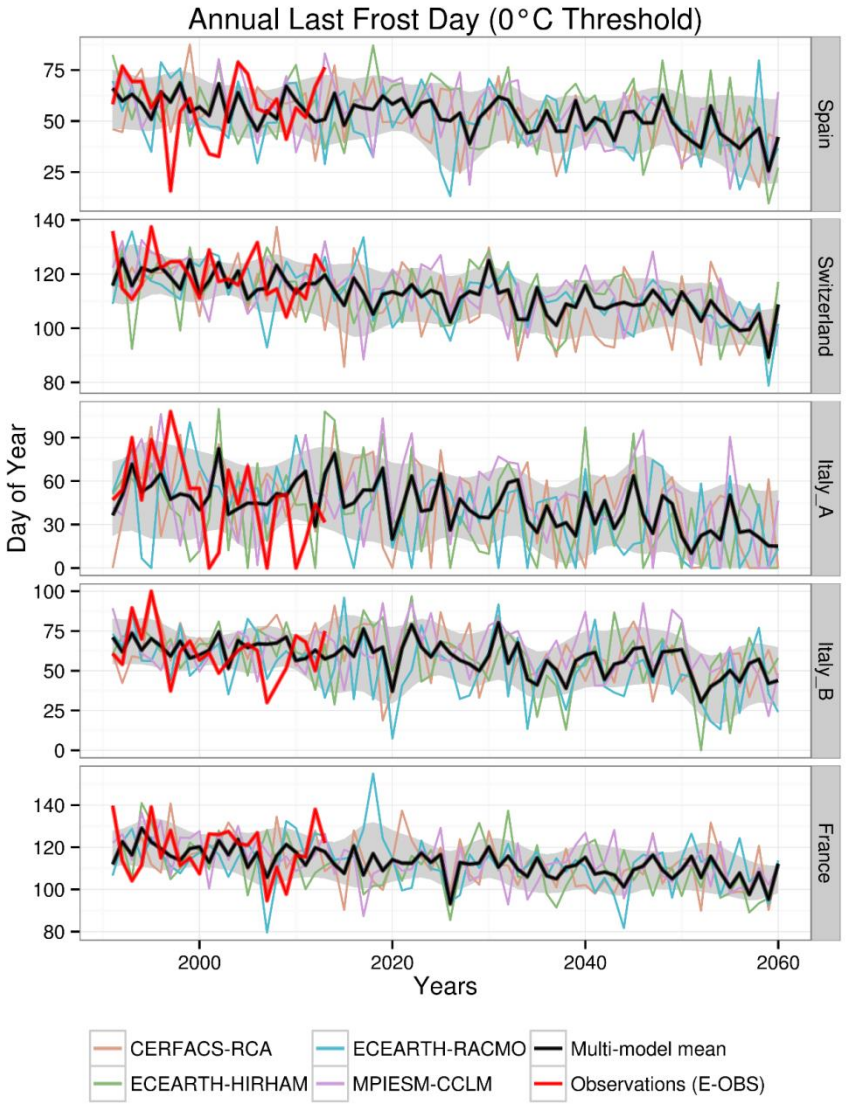




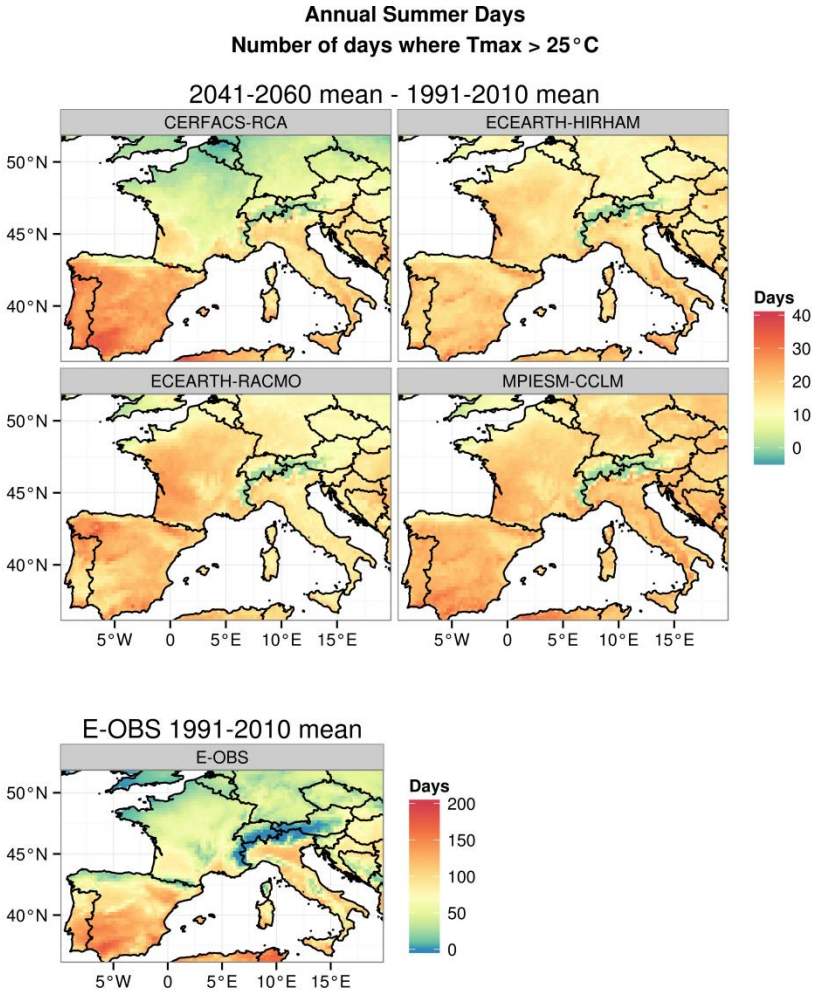

Indices from corrected model data

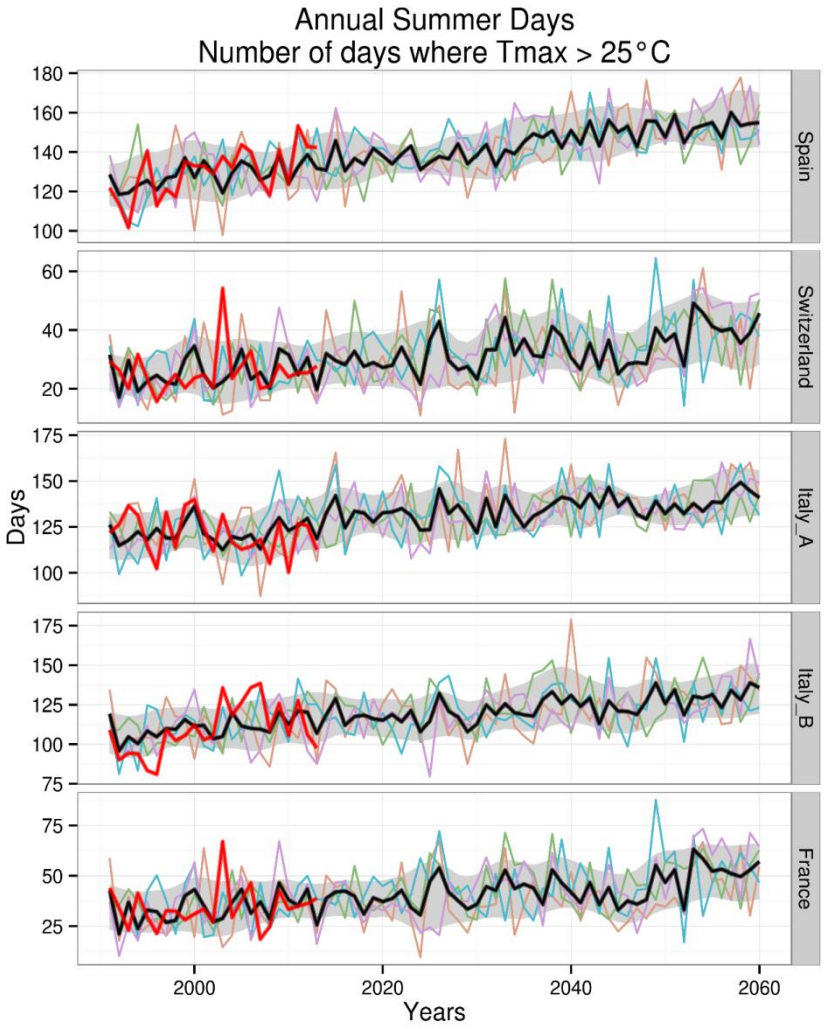






Indices from corrected model data





Conclusions

- Generally, there are large uncertainties in projections of extreme events. It requires careful analysis of large model ensembles to obtain robust results
- Such robust results do, however, exist. Extreme precipitation will probably increase in drying regions
- With principal-component analysis it is possible to estimate this span with fewer models