Downscaling of future scenarios of temperature and precipitation across Europe based on quantile-quantile corrections of EURO-CORDEX projections

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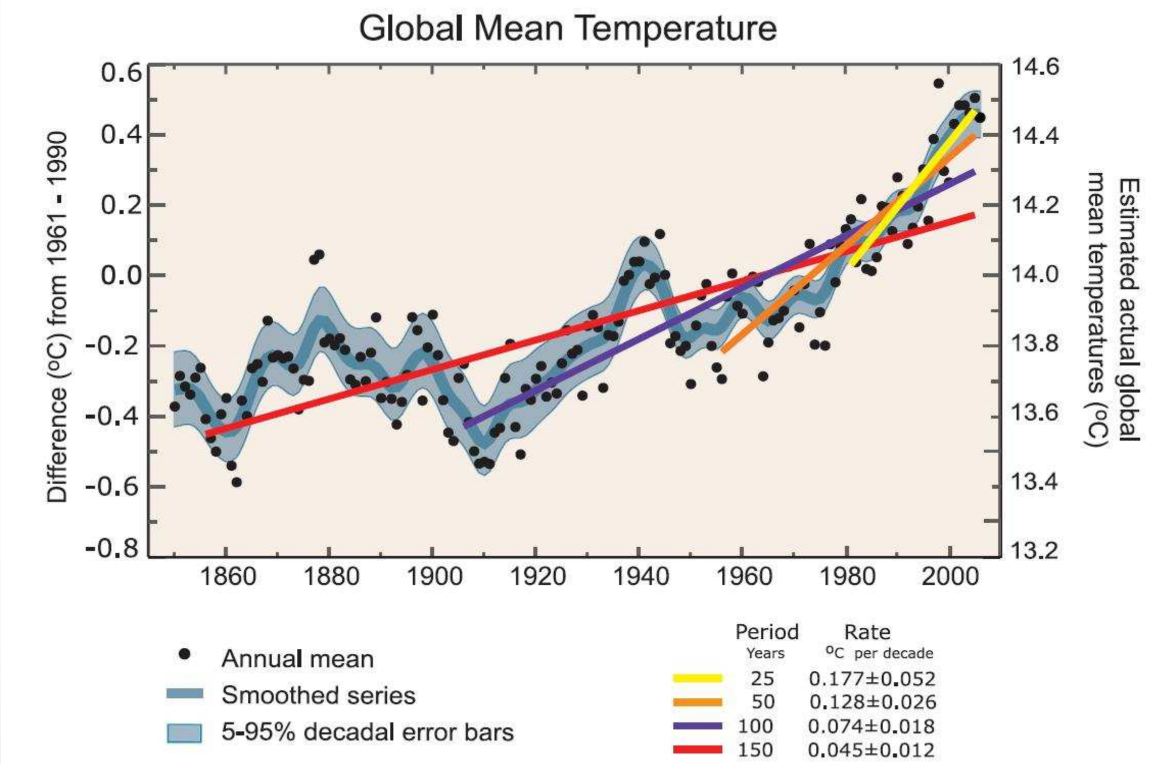
1. Motivations and objectives

Climate change: current evidences



- Global mean surface air temperature has risen by about 0.74ºC (1906-2005)
- 11 of the 12 warmest years on record have occurred in the past 12 years
- Important regional variations
- Redistribution of rainfall and other variables

Extreme weather events

Summary for Policymakers (IPCC)

⇩ cold days and nights (99%) h

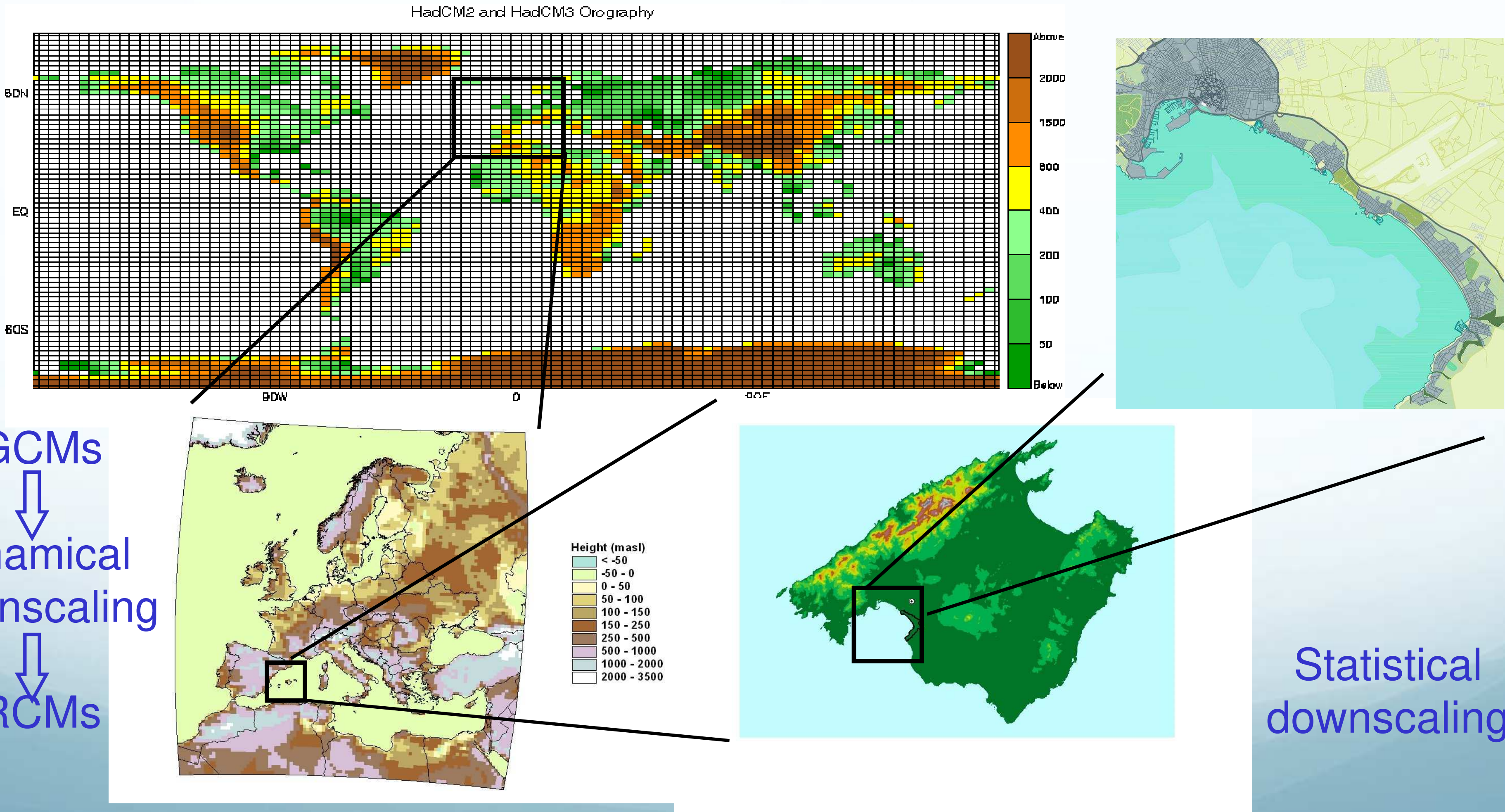
⇧ days and nights (99%) frequen

⇧ and/or intense heavy rainfall events (90%) Longer and/or more intense droughts (66%) hurricane activity (50%) (westerr

⇧ north pacific and north atlantic)

Tools for exploring climate change impacts

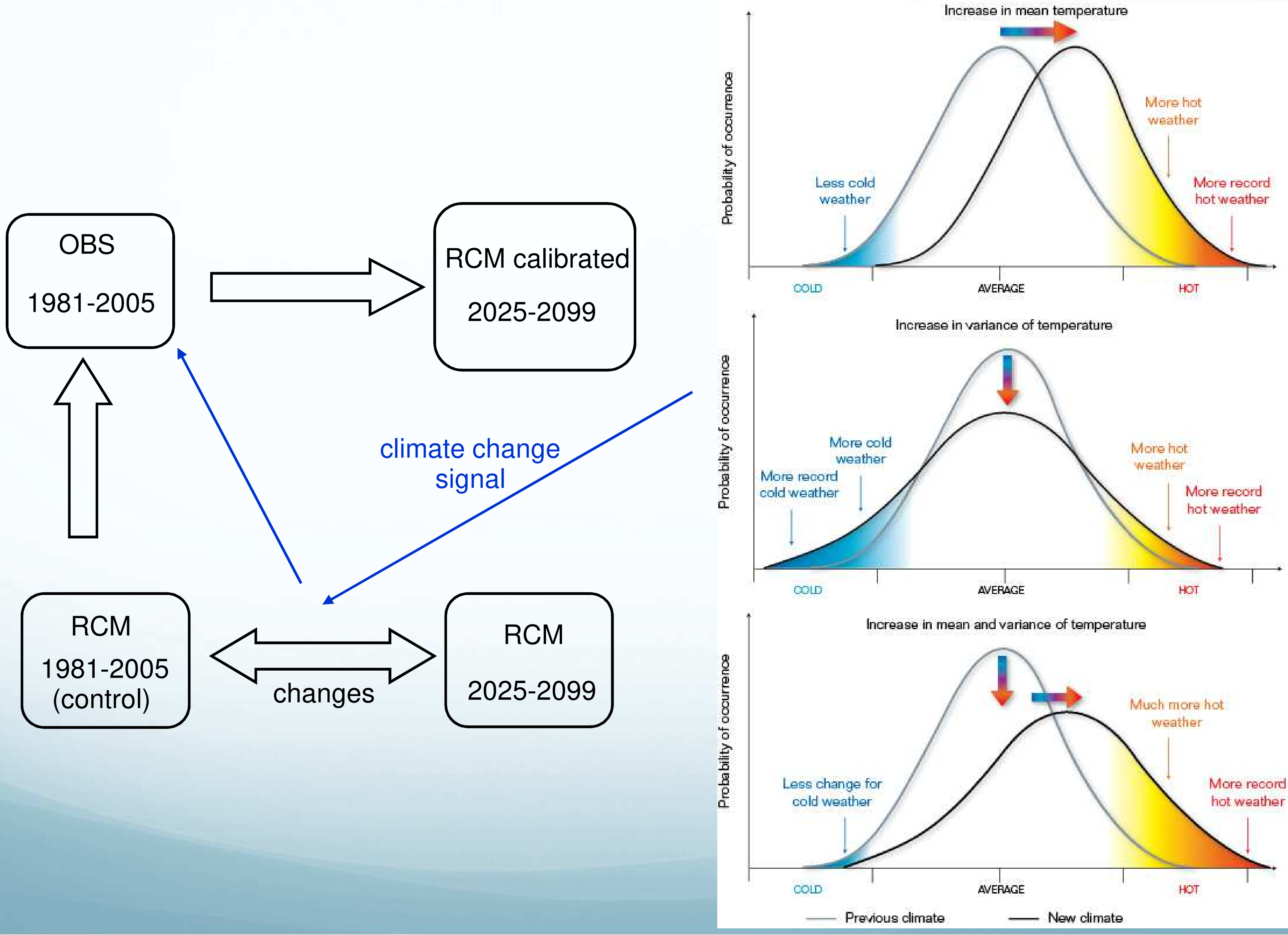
- GCMs → RCMs
  - Regional scales: Dynamical downscaling. Regional Climate Models (RCMs)
  - Local scales: Statistical downscaling and model calibration from RCMs



GCMs
⇩
Dynamical Downscaling
⇩
RCMs

Statistical downscaling

Statistical downscaling of RCM outputs



Statistical downscaling of RCM outputs: Quantile-Quantile adjustment *(Amengual et al. 2011)*

$$\boxed{p_i = o_i + g\overline{\Delta} + f\Delta'_i,}$$

$$\Delta_i = s_{\mathrm{fi}} - s_{\mathrm{ci}}$$

$$\overline{\Delta} = \frac{\sum_{i=1}^{N}\Delta_i}{N} = \frac{\sum_{i=1}^{N}(s_{\mathrm{fi}} - s_{\mathrm{ci}})}{N} = \overline{S_f} - \overline{S_c}$$

$$\Delta'_i = \Delta_i - \overline{\Delta}$$

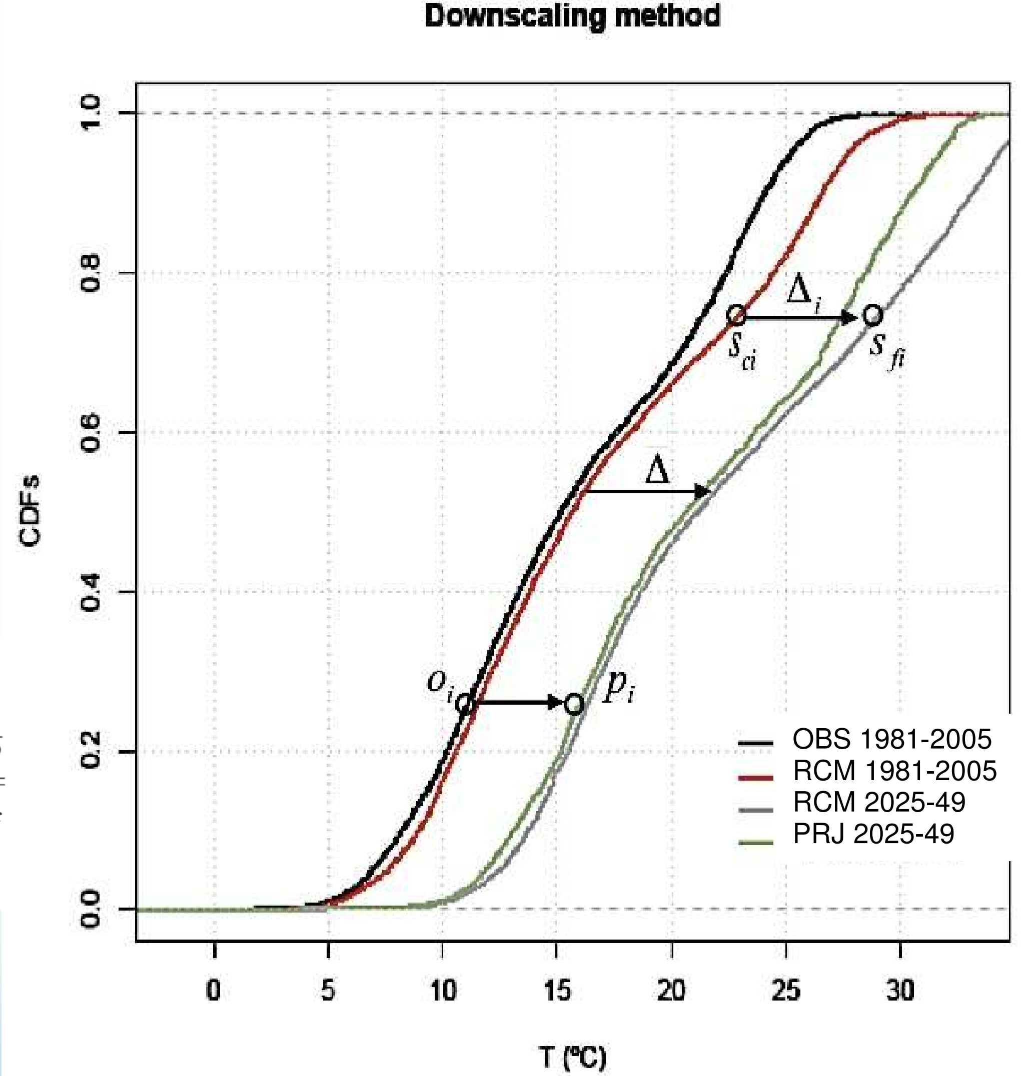
$$g = \frac{\left(\sum_{i=1}^{N} o_i\right) \Big/ N}{\left(\sum_{i=1}^{N} s_{\mathrm{ci}}\right) \Big/ N} = \frac{\overline{O}}{\overline{S_c}}$$

$$f = \frac{\sigma_O}{\sigma_{S_c}} = \frac{\mathrm{IQR}|_O}{\mathrm{IQR}|_{S_c}}.$$

Global

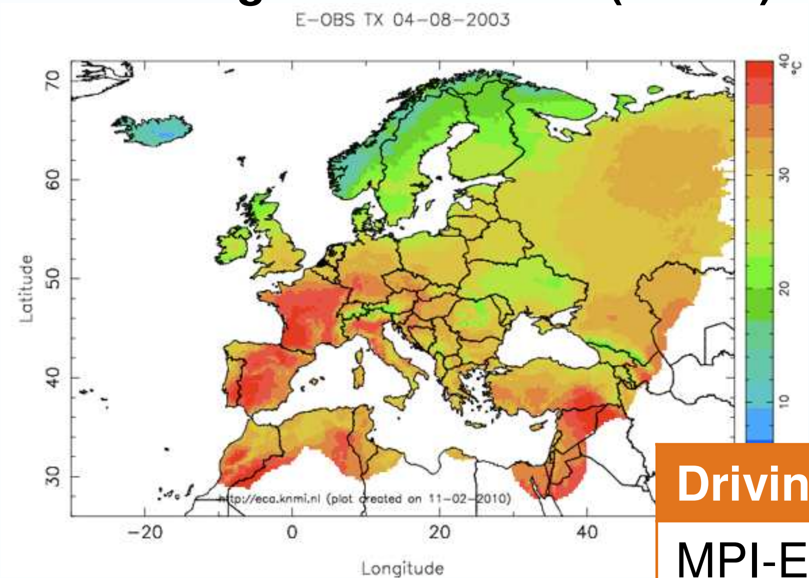
$$f = \frac{\sigma_{O'i}}{\sigma_{S_c'i}}$$

Local



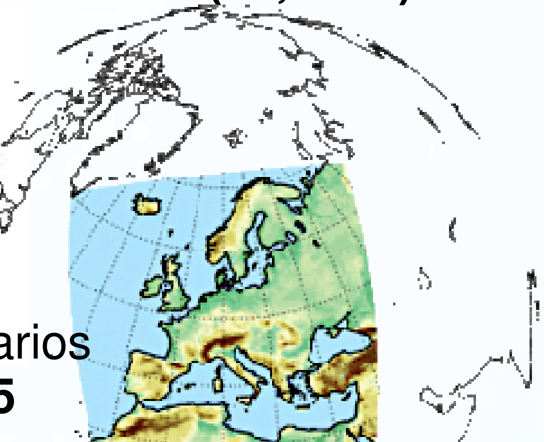
2. Database and methodology

E-OBS gridded dataset (25 km)



EURO-CORDEX (12,5 km)

WCRP CORDEX



Future regional scenarios
rcp4.5 and **rcp8.5**

Driving GCM	RCM	Institute
MPI-ESM-LR	CCLM4-8-17	CLMcom
HadGEM2-ES	CCLM4-8-17	CLMcom
CNRM-CM5-LR	CCLM4-8-17	CLMcom
EC-EARTH	CCLM4-8-17	CLMcom
EC-EARTH	RACMO22E	KNMI
HadGEM2-ES	RACMO22E	KNMI
EC-EARTH	HIRHAM5	DMI
NorESM1-M	HIRHAM5	DMI
CNRM-CM5	ALADIN53	CNRM

- Validation task

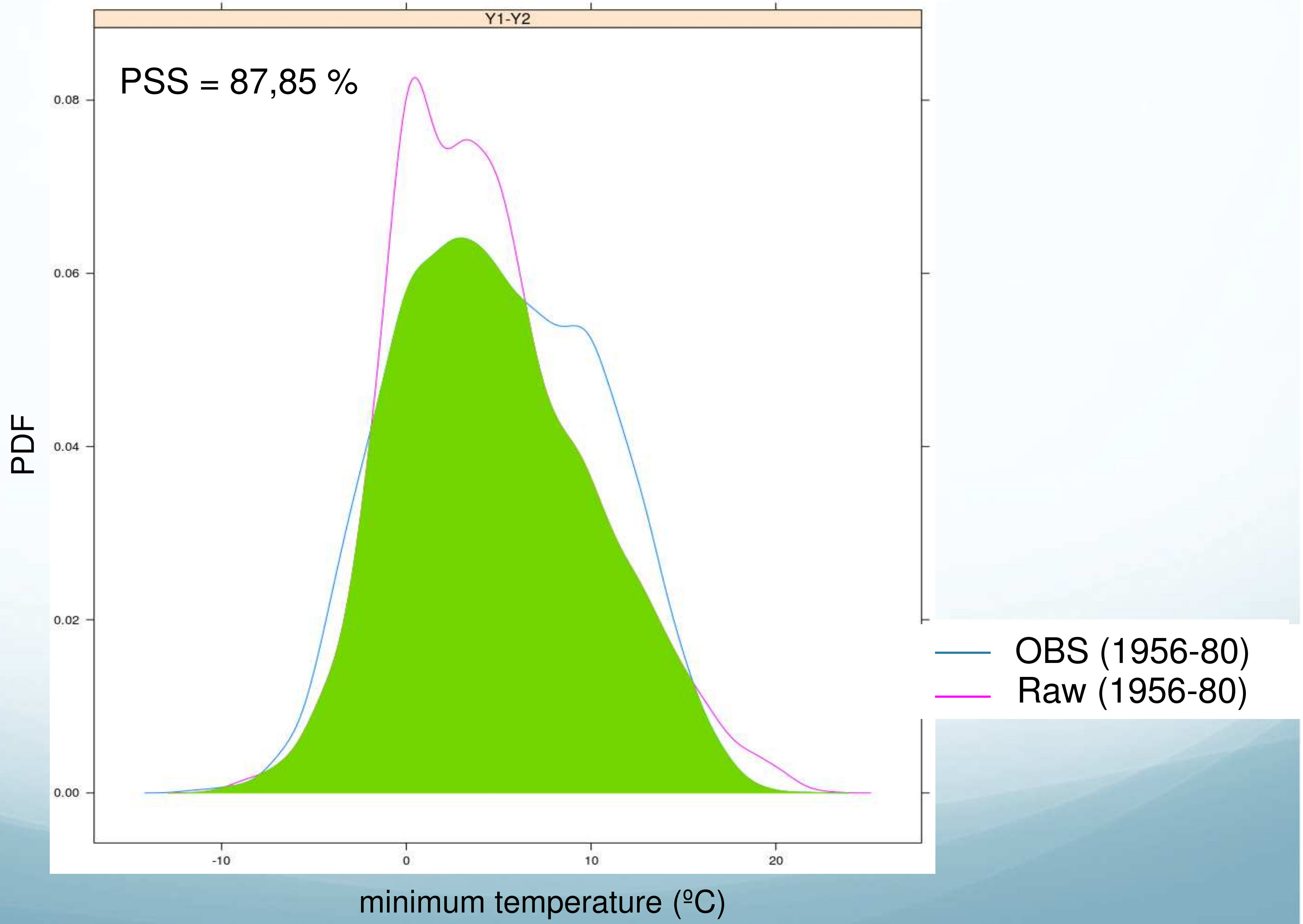
1. evaluation between rav
   1956-1980 interval. Co

- Calibration task

1. compute changes in C
   2005) and successive 2
2. shifts are corrected and

2. Database and methodology

- Validation task   <u>Perkins skill score (PSS) </u>*(Perkins et al. 2007)*

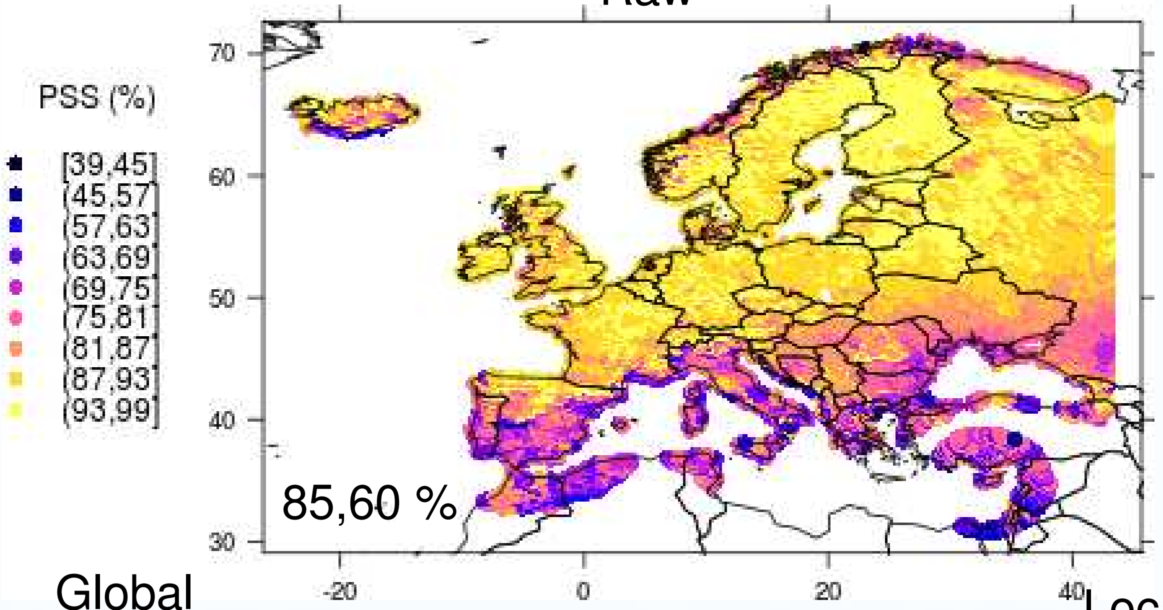


3. Results

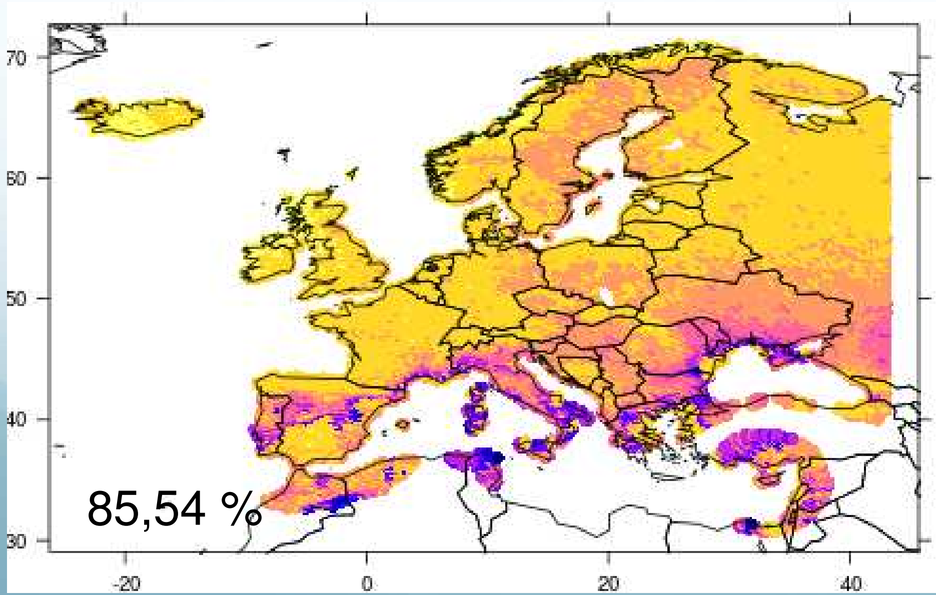
- PSS of the whole PDF for annual precipitation

HIRHAM5

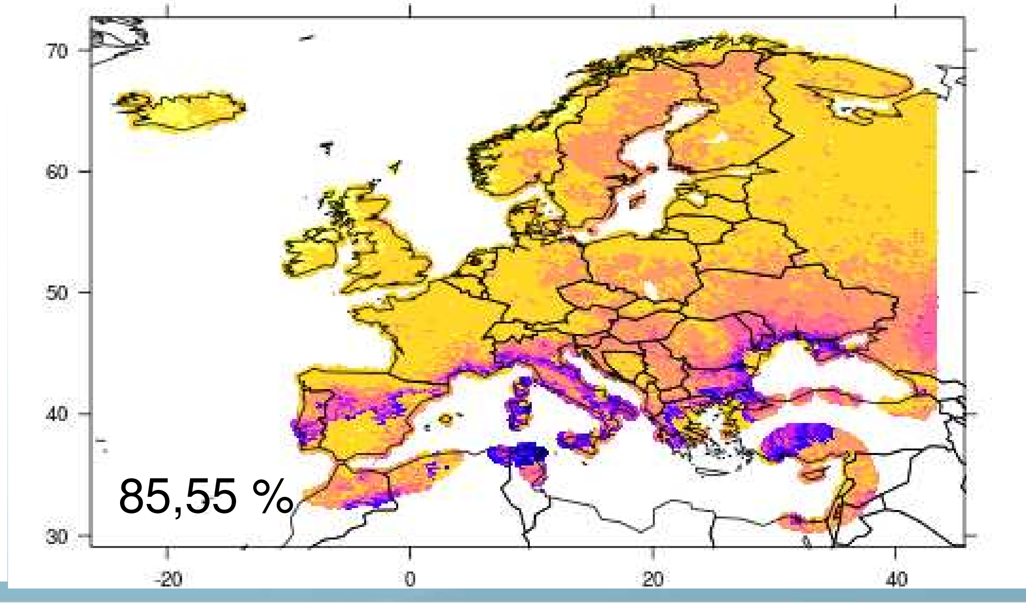
Raw



Global



Local

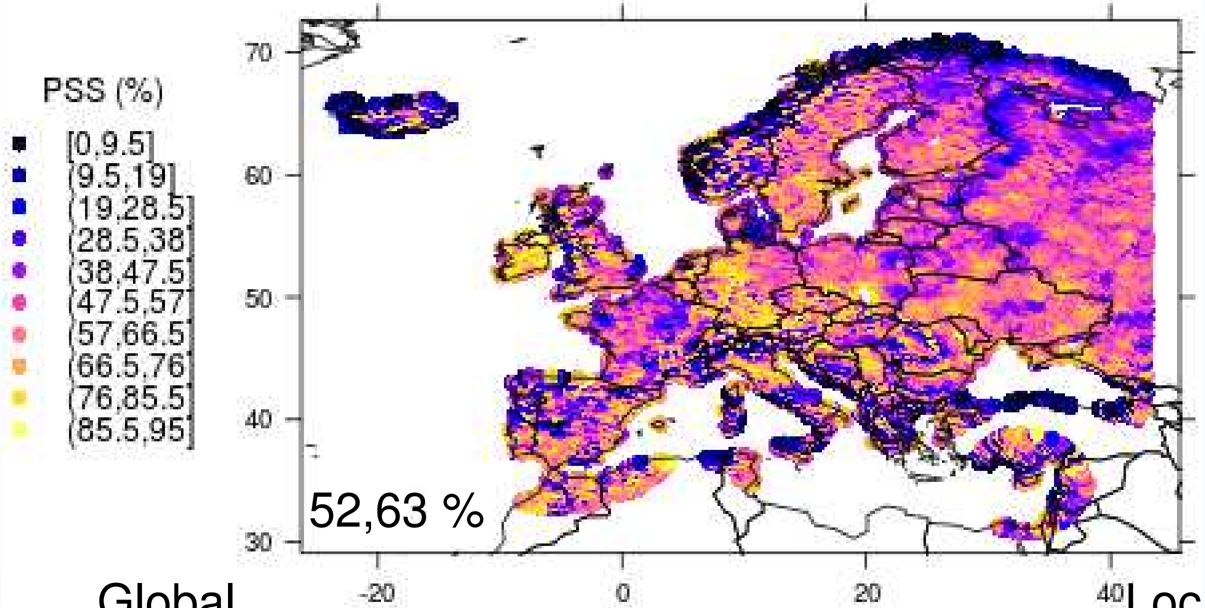


3. Results

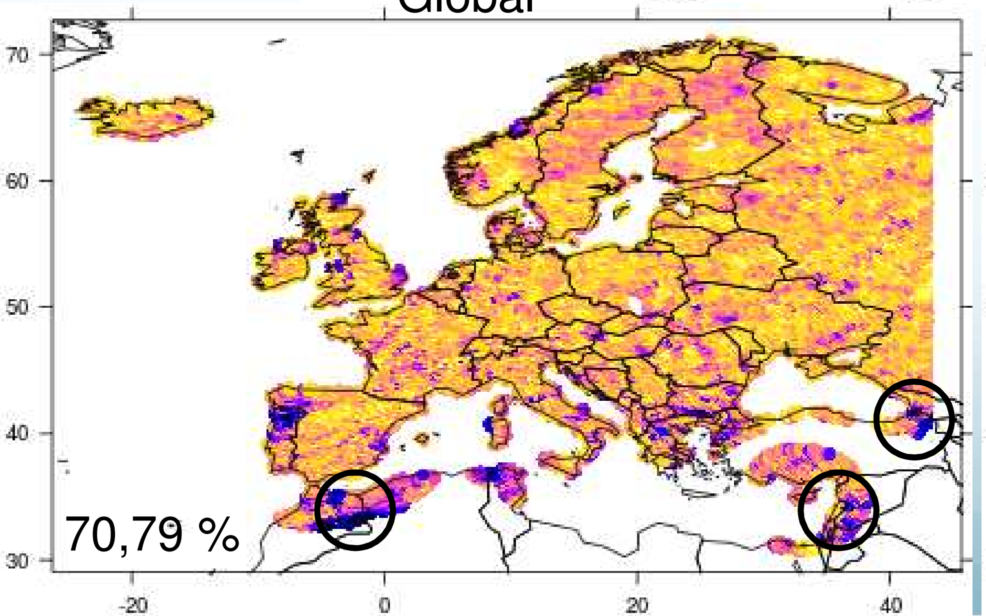
- PSS over P_{99} for annual precipitation

HIRHAM5

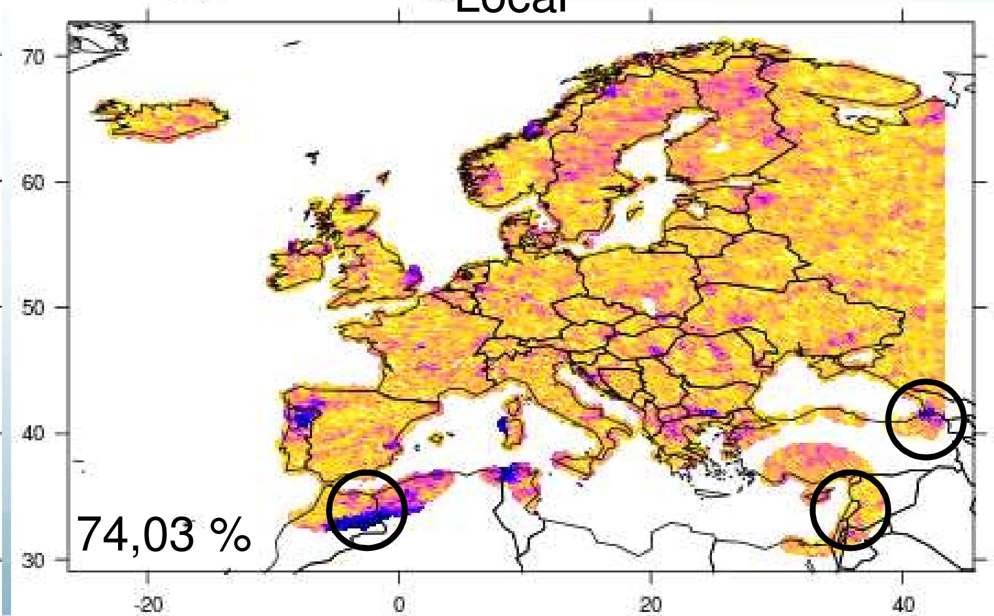
Raw



Global



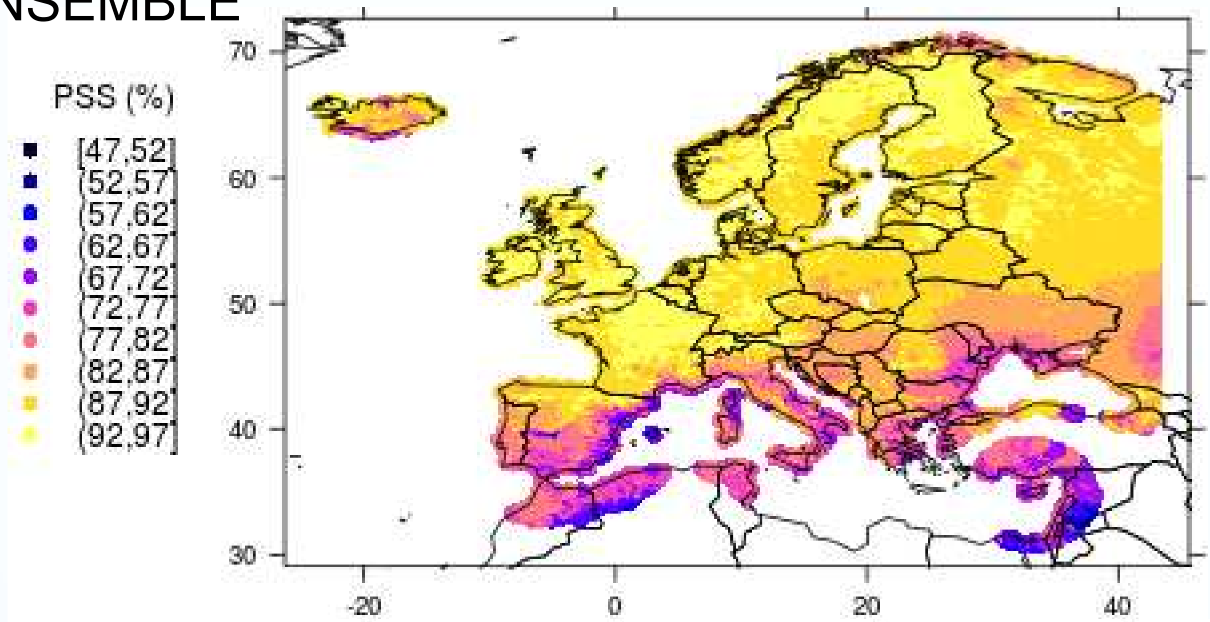
Local



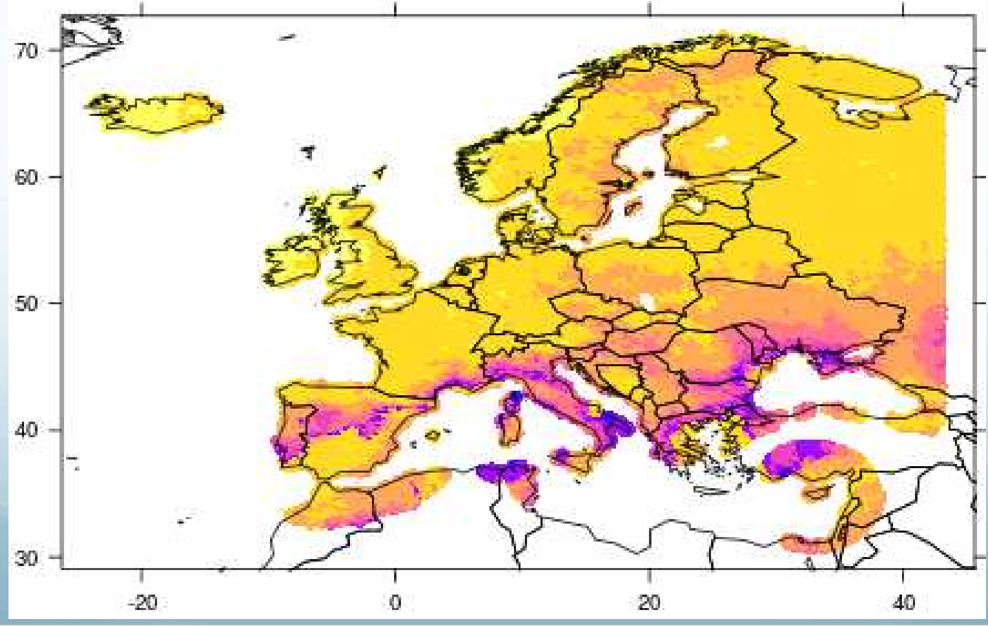
3. Results

- PSS of the whole PDF for annual precipitation

ENSEMBLE



← Raw
86,29 %



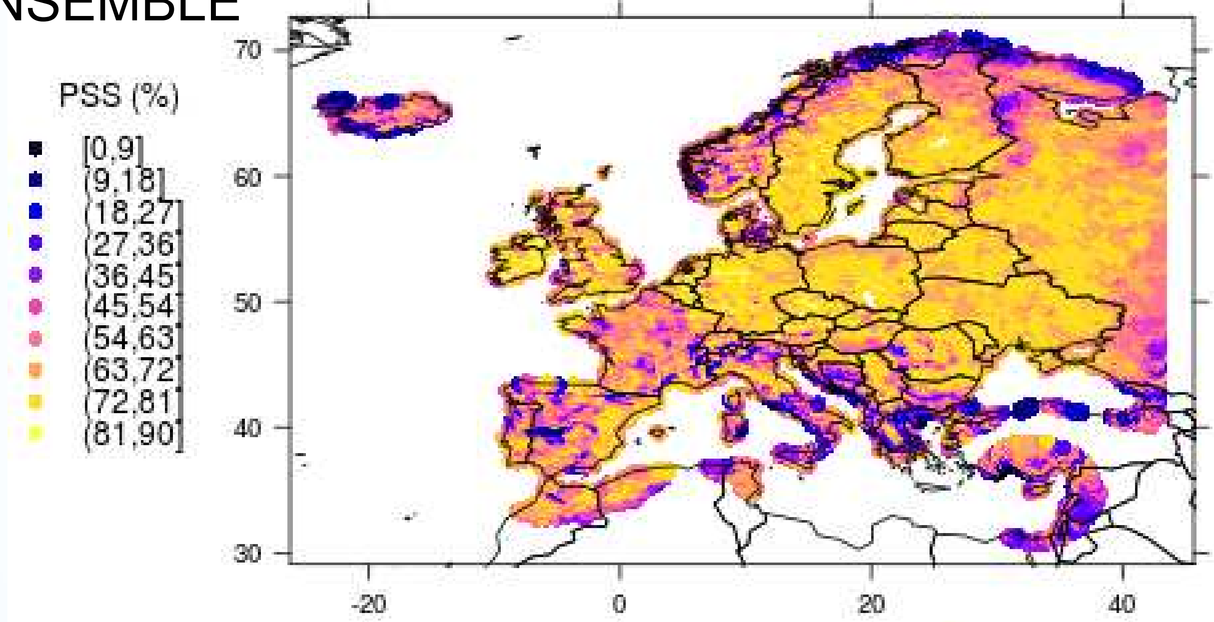
←Local
86,10 %

Global
86,14 %

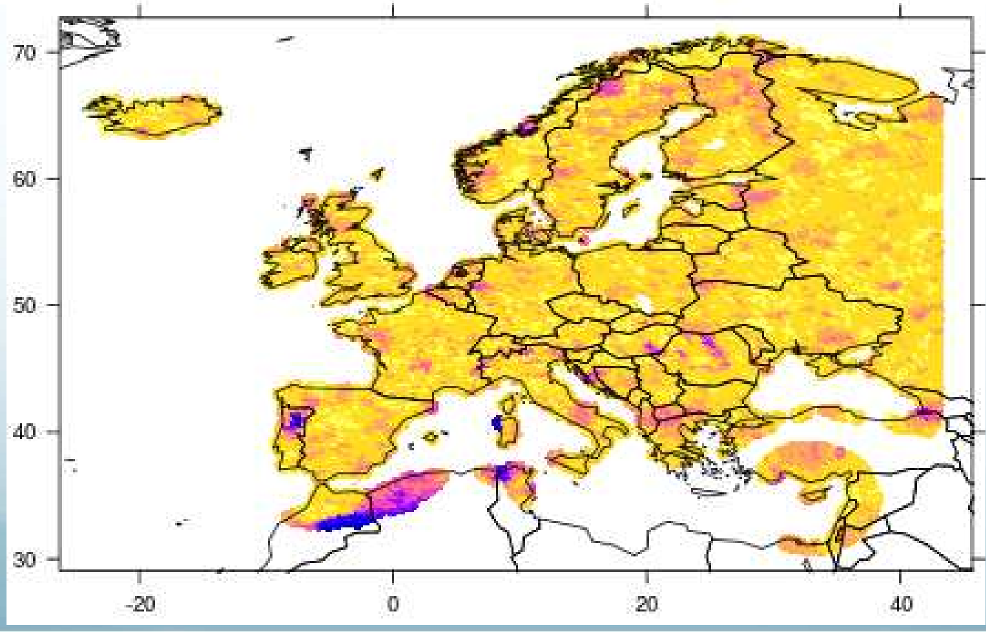
3. Results

- PSS over P_{99} for annual precipitation

ENSEMBLE



← Raw
63,99 %



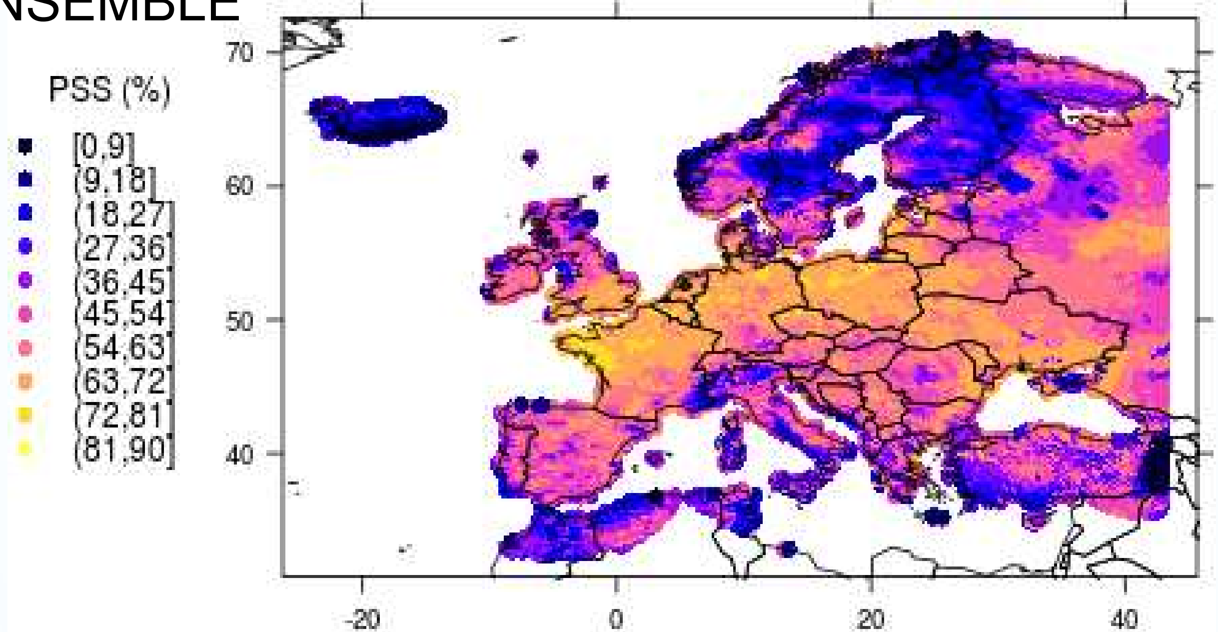
←Local
74,29 %

Global
71,87 %

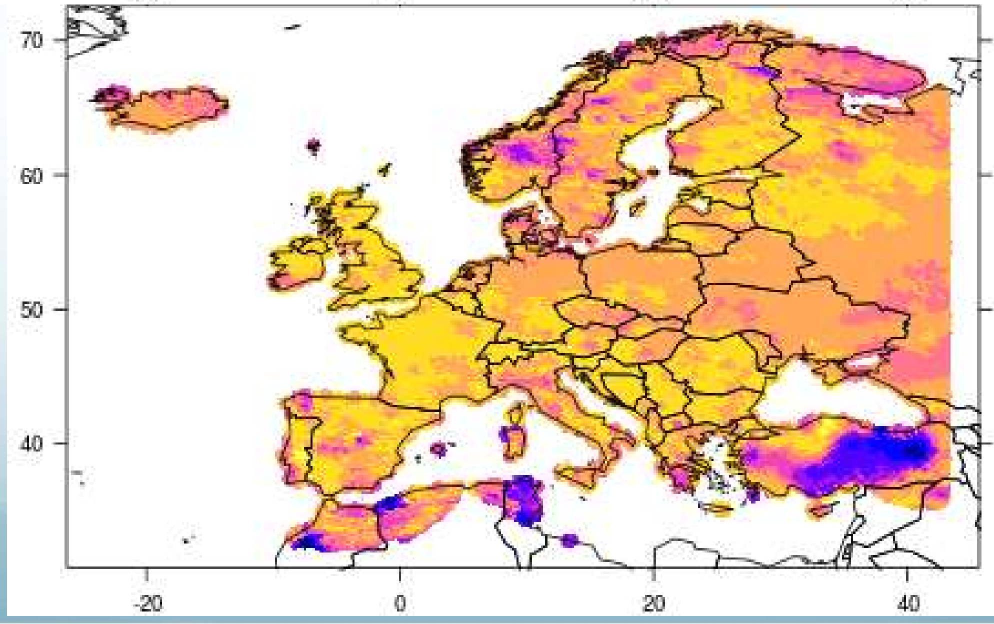
3. Results

- PSS under P_5 for minimum temperature in winter

ENSEMBLE



← Raw
49,17 %



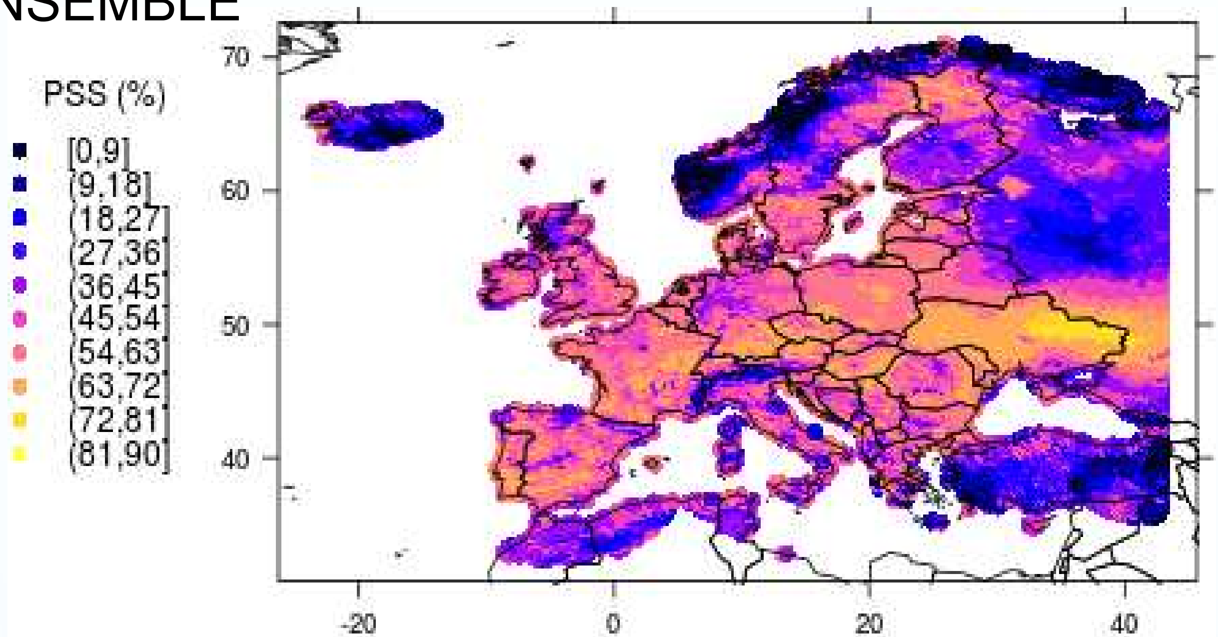
←Local
67.07 %

Global
66.14 %

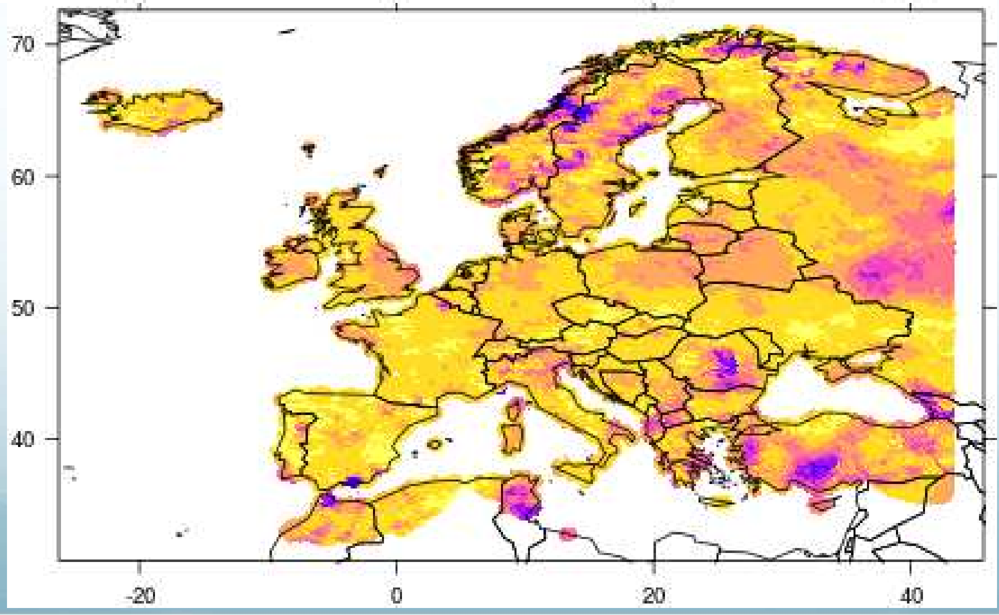
3. Results

- PSS over P_{95} for minimum temperature in winter

ENSEMBLE



← Raw
46,64 %



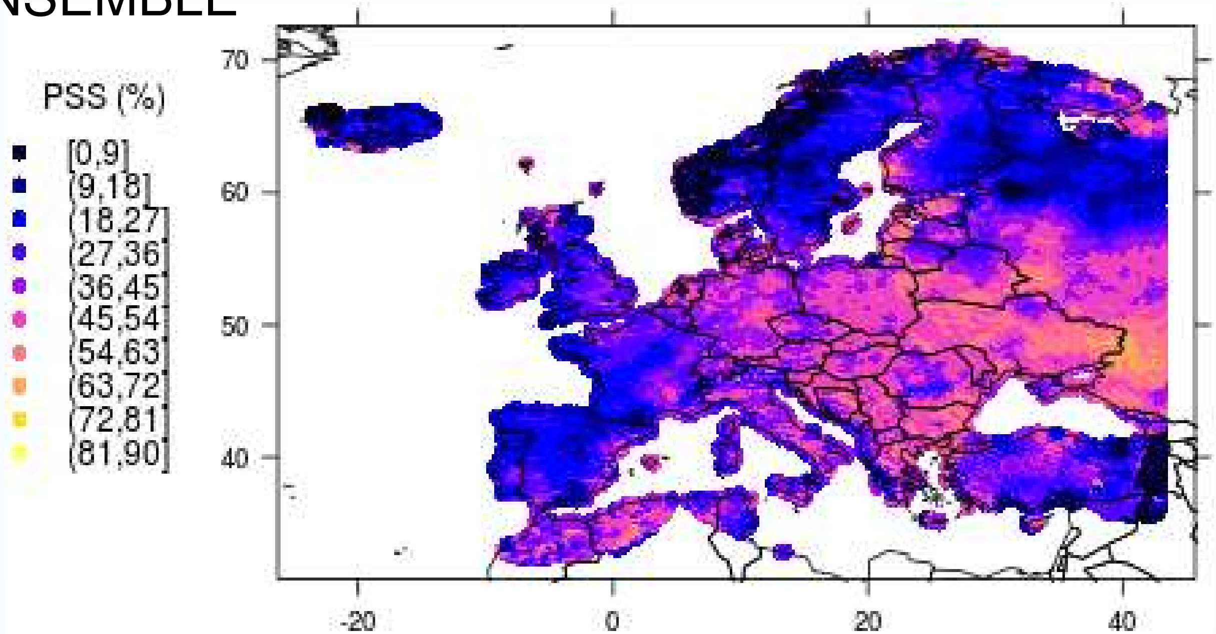
←Local
71,20 %

Global
70,23 %

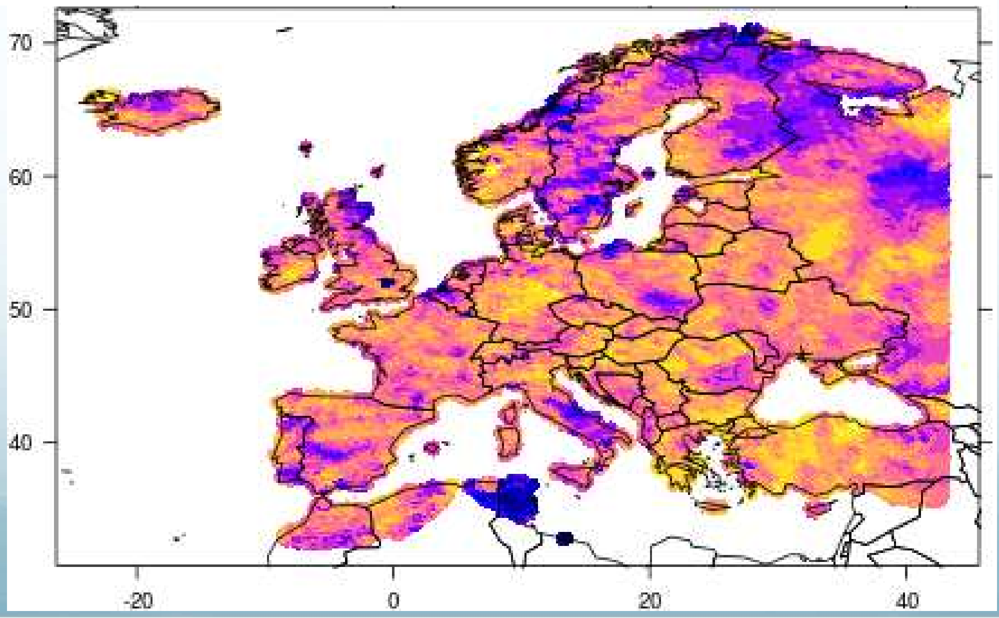
3. Results

- PSS under P_1 for maximum temperature in summer

ENSEMBLE



← Raw
36,03 %



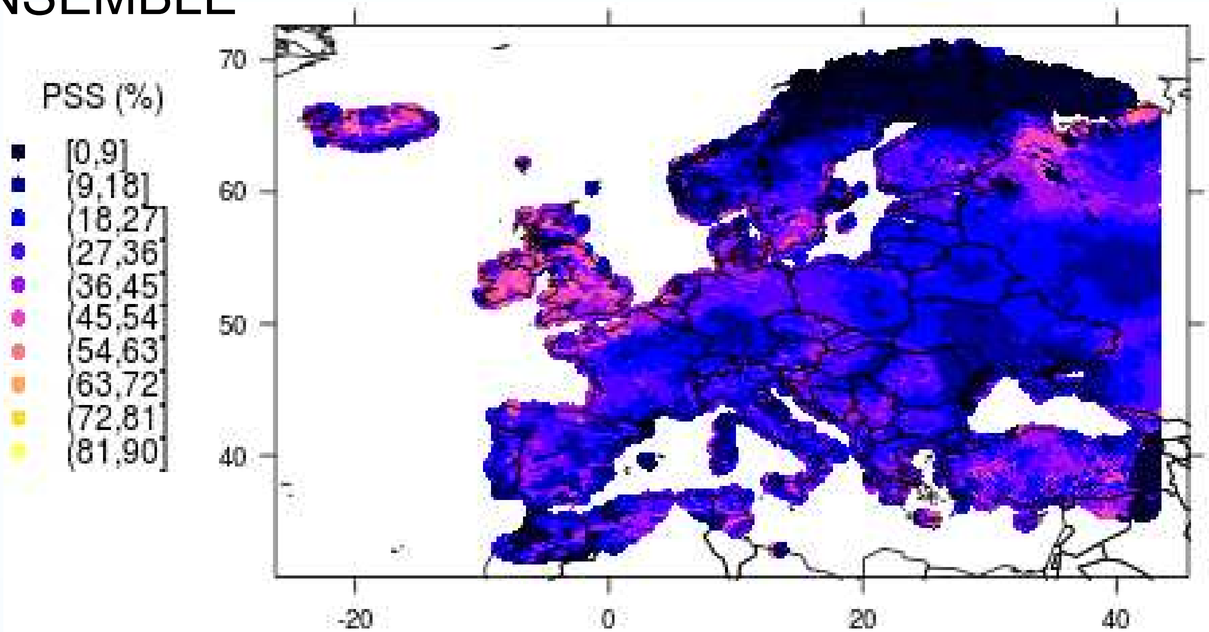
←Local
57,91 %

Global
57,57 %

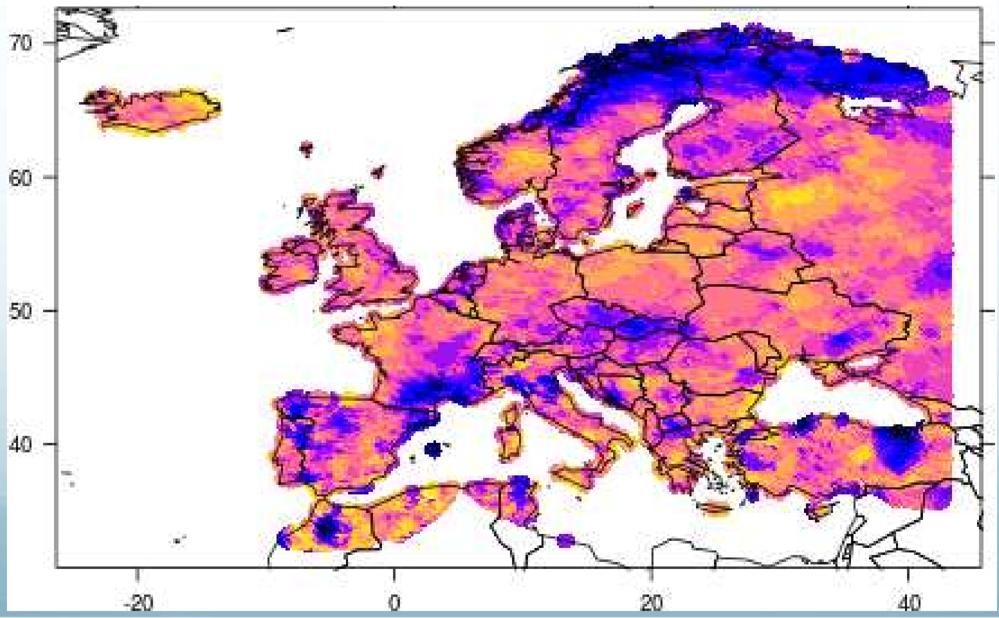
3. Results

- PSS over P_{99} for maximum temperature in summer

ENSEMBLE



← Raw
24,03 %



←Local
52,67 %

Global
51,27 %

4. Summary

Annual	PSS (%) whole PDF		
Variable	Raw	Global	Local
Pr	86,29	86,14	86,10
	PSS(%) over P_{99}		
Pr	63,99	71,87	**74,29**

Winter	PSS (%) under P_5				PSS (%) over P_{95}		
Variable	Raw	Global	Local		Raw	Global	Local
Tmin	49,17	66,14	**67,07**		46,64	70,23	**71,20**
Summer	PSS(%) under P_1				PSS (%) over P_{99}		
Variable	Raw	Global	Local		Raw	Global	Local
Tmax	36,03	57,57	**57,91**		24,03	51,27	**52,67**

5. Future work

1. Build a better annual calibration from seasonal calibration
2. Validate the method picking up even years for the training period and odd years for the calibration period in order to avoid the effects of climate change
3. Calibration task
4. Obtain results on future annual and seasonal temperatures and precipitation changes (both means and extremes)
5. These future scenarios will be used to feed the different impact studies/models.