Dynamical-statistical projections of annual and seasonal precipitation in Spain during the 21st century

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OUTLINE

- Motivation
- Datasets
- RCMs calibration technique
- Results
- Conclusions

MOTIVATION (1)

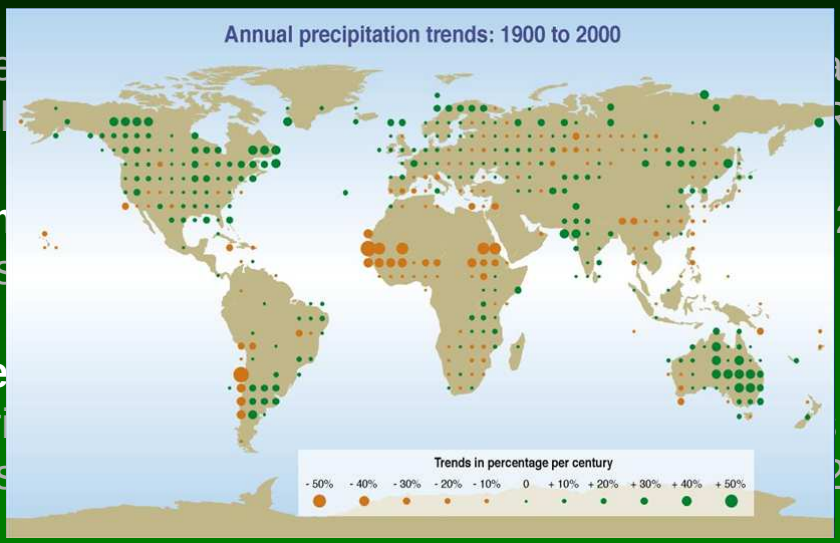
The **Mediterranean region** is a very sensitive area to the human-induced climate change (IPCC AR4)

Temperature increase during the period 1979-2005 lays between **2.5 – 3.5 ºC/century**

Precipitation decrease estimated at **5 – 20 %** during the period 1901-2005 (although changes less than 3% are obtained for the period 1979-2005)

Great concern for a "semiarid" country as **Spain**

MOTIVATION (1)



Great concern for a "semiarid" country as **Spain**

MOTIVATION (2)

GCMs project a **further precipitation decrease** during the 21st century in all seasons

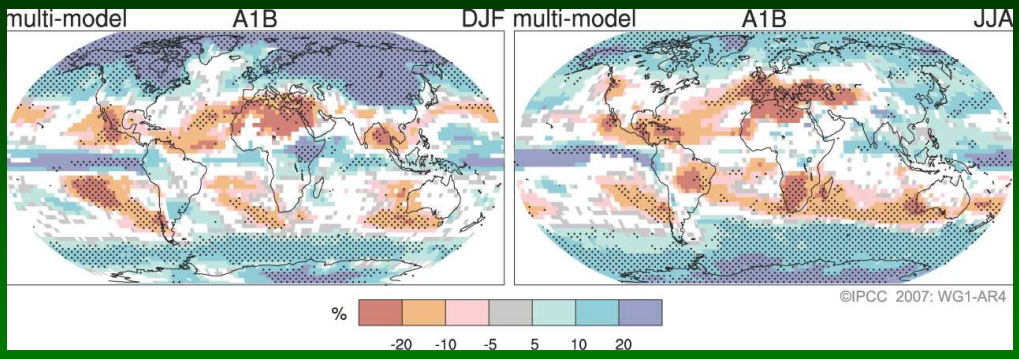
But … large spatial variability, whereas GCMs operate at about 100-300 km: **sub-regional tendencies** are needed

RCMs operating at higher horizontal resolution (20-40 km) are being nested within GCMs for specific regions of the world (**dynamical downscaling**)

Still insufficient to properly resolve the local scales and the projections are affected by model biases and errors: A novel technique for the **statistical adjustment of RCMs outputs at local scales** will be applied

MOTIVATION (2)

GCMs project a **further precipitation decrease** during the 21st century in all seasons



Still insufficient to properly resolve the local scales and the projections are affected by model biases and errors: A novel technique for the **statistical adjustment of RCMs outputs at local scales** will be applied

DATASETS

SPAIN02 grid (REFERENCE/OBSERVED CLIMATE):
Regular 0.2º (aprox. 20 km) daily precipitation grid for 1961-2003 built by the University of Santander, using 2756 quality-controlled AEMET stations

ENSEMBLES project (RAW SIMULATED CLIMATE):
Daily precipitation data from 12 different RCMs run at 25 km resolution for the period 1951-2100 under the SRES A1B scenario. This data is interpolated to the 1445 land points of the previous grid

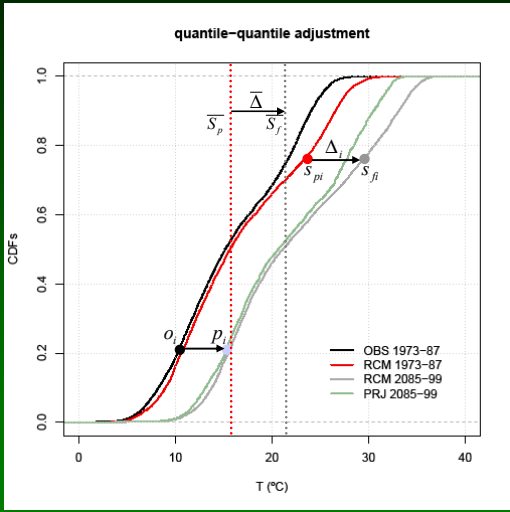
TIME WINDOWS:
1961-1980: Calibration Period
1981-2000: Validation Period
2011-2030, 2031-2050, 2051-2070, **2071-2090**: Projected Periods

DATASETS

Driving GCM	*RCM*	*Acronym*	*Institute*
ECHAM5	RCA3	C4IRCA3	C4I
ARPEGE	HIRLAM	DMI-HIRLAM5	DMI
ECHAM5	HIRLAM	DMI-HIRLAM5	DMI
BCM	HIRLAM	DMI-HIRLAM5	DMI
HadCM3	CLM	ETHZ-CLM	ETHZ
ECHAM5	RegCM	ICTP-REGCM	ICTP
ECHAM5	RACMO	KNMI-RACMO	KNMI
HadCM3	HadRM3Q0	METO-HC-HadCM3Q0	HC
HadCM3	HadRM3Q3	METO-HC-HadCM3Q3	HC
HadCM3	HadRM3Q16	METO-HC-HadCM3Q16	HC
BCM	RCA	SMIRCA	SMHI
ECHAM5	RCA	SMIRCA	SMHI
HadCM3	RCA	SMIRCA	SMHI

Table 1: List of transient RCM experiments driven within the ENSEMBLES European project for the 1951-2100 period. Note that all the models have a spatial resolution of 25 km and have been run under the A1B SRES.

RCMs CALIBRATION TECHNIQUE (1)



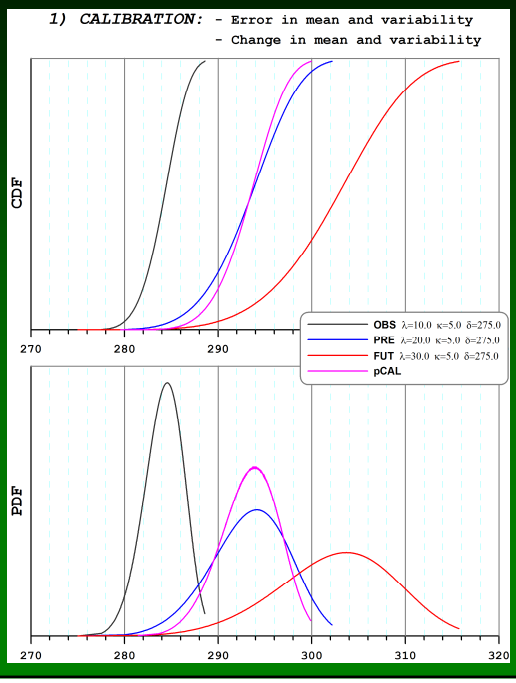
$$\Delta_i{}' = \Delta_i - \overline{\Delta}$$

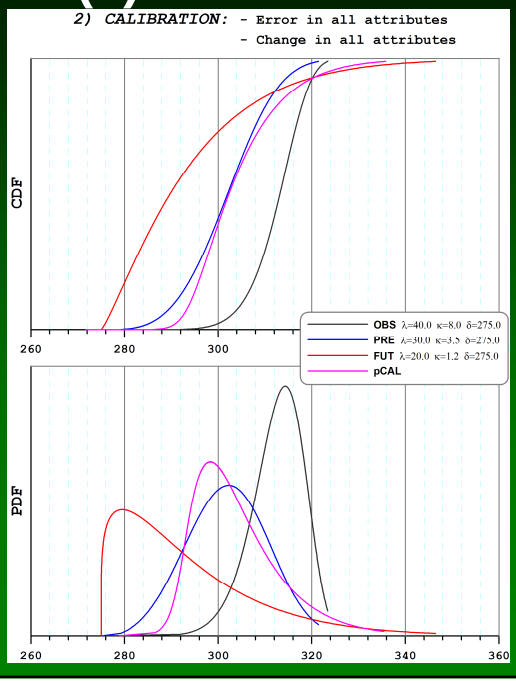
$$g = \frac{(\sum_{i=1}^{N} o_i)/N}{(\sum_{i=1}^{N} s_{pi})/N} = \frac{\overline{O}}{\overline{S_p}}$$

$$f = \frac{\sigma_O}{\sigma_{S_p}} = \frac{IQR|_O}{IQR|_{S_p}}$$

$$p_i = o_i + g\overline{\Delta} + f\Delta_i{}'$$

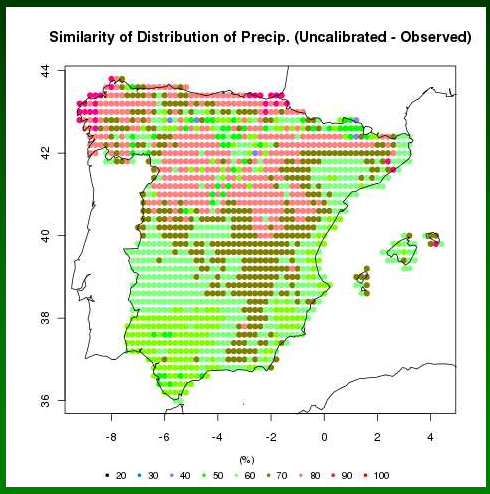
RCMs CALIBRATION TECHNIQUE (2)

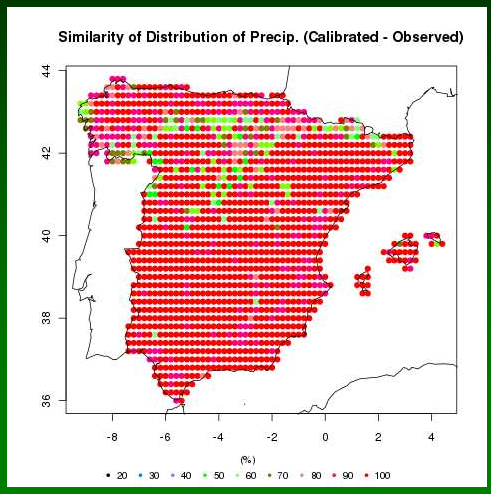




RESULTS (1)

Validation: Perkins Similarity of PDFs (ensemble mean)

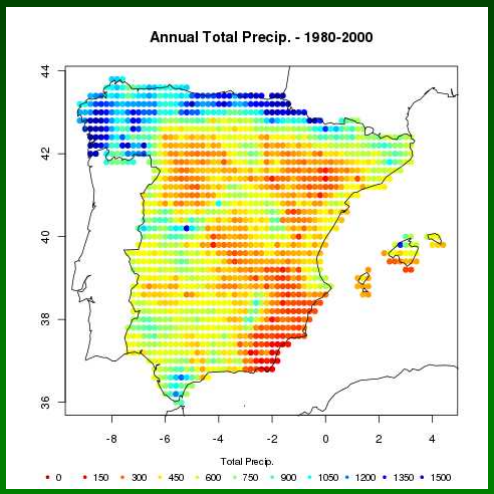




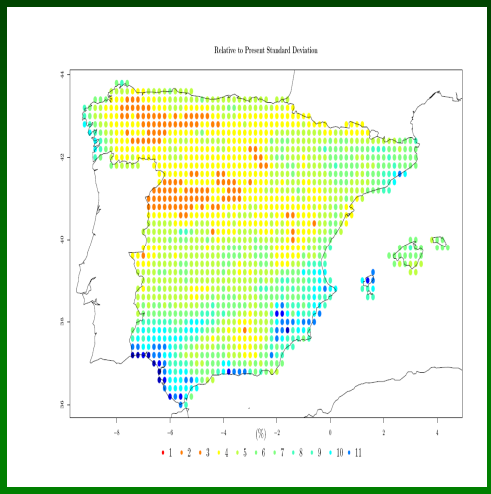
RESULTS (2)

Validation period (PRESENT)

Annual mean precipitation



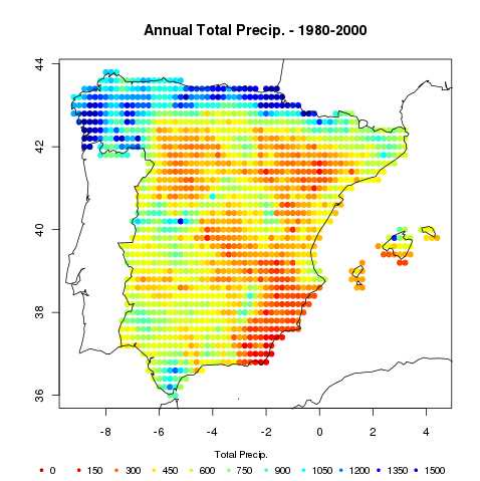
Spread among the 12 RCMs



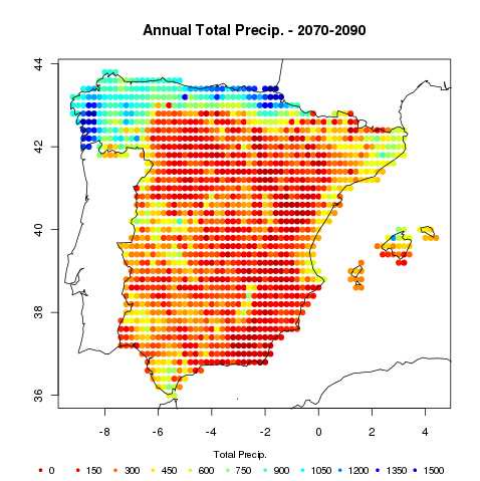
RESULTS (3)

Changes in annual mean precipitation

1981-2000

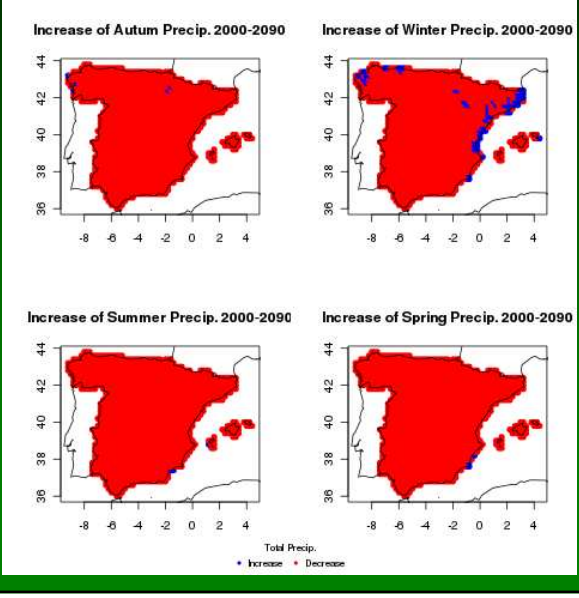


2071-2090



RESULTS (4)

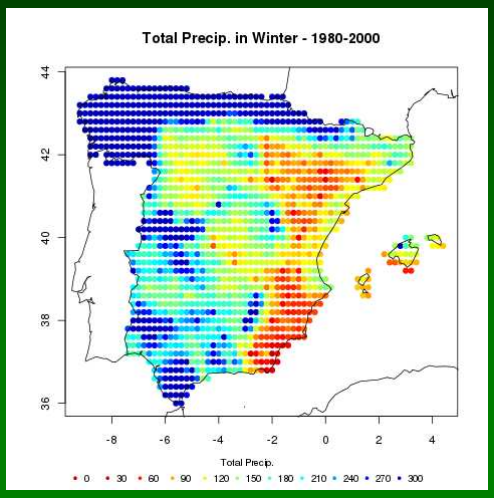
Changes in seasonal mean precipitation



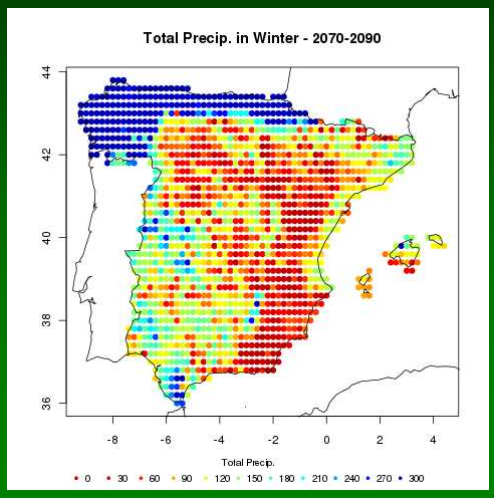
RESULTS (5)

Changes in seasonal mean precipitation

WINTER: 1981-2000



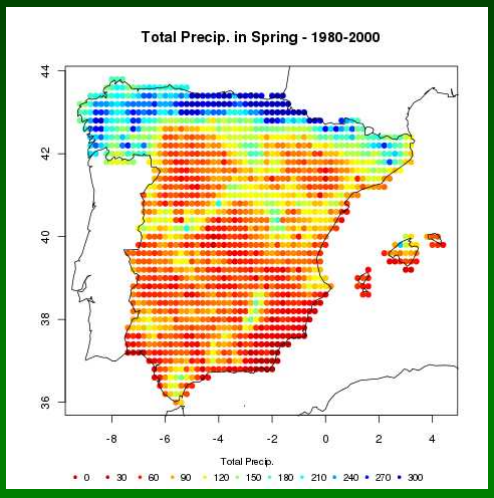
WINTER: 2071-2090



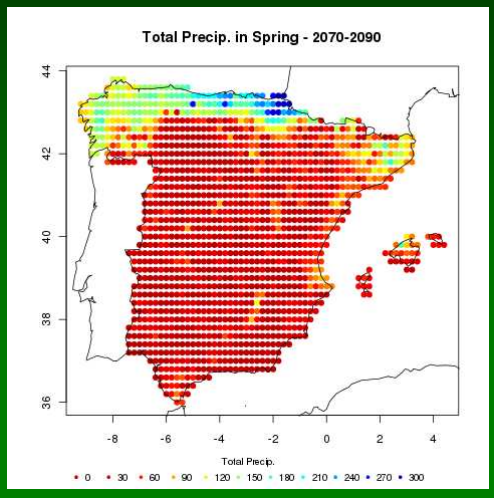
RESULTS (6)

Changes in seasonal mean precipitation

SPRING: 1981-2000



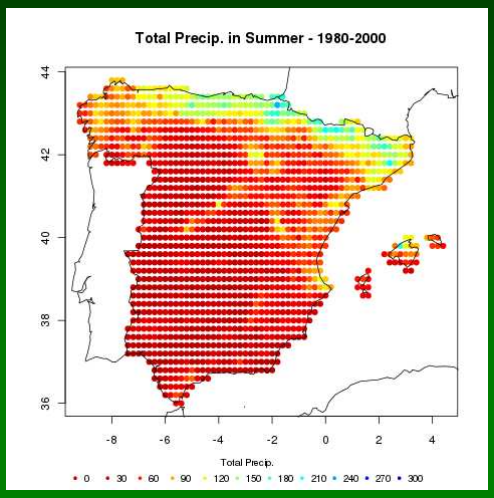
SPRING: 2071-2090



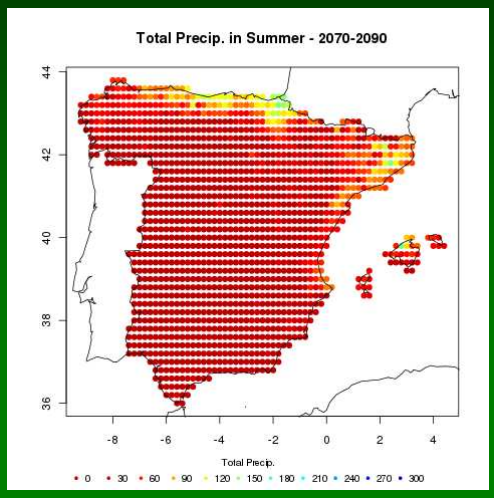
RESULTS (7)

Changes in seasonal mean precipitation

SUMMER: 1981-2000



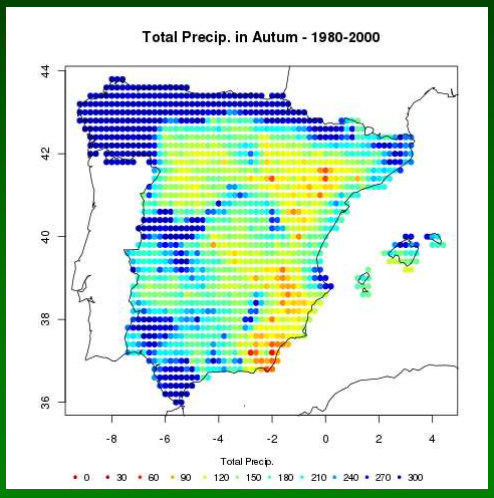
SUMMER: 2071-2090



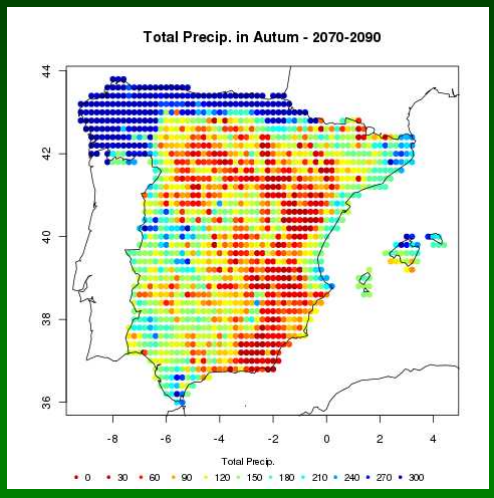
RESULTS (8)

Changes in seasonal mean precipitation

AUTUMN: 1981-2000

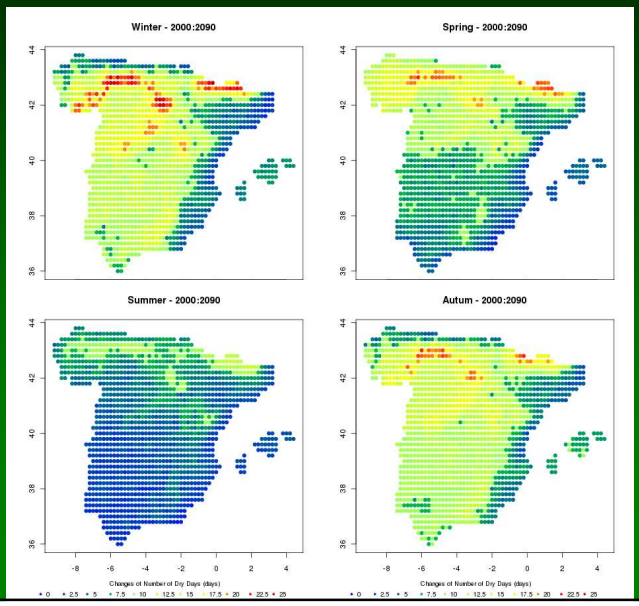


AUTUMN: 2071-2090



RESULTS (9)

Increase in number of dry days: 2071-2090 **vs** 1981-2000



CONCLUSIONS

Precipitation downscaling in a sensitive and topographically-complex area as Spain is a **great challenge**

Combination of dynamical (**RCMs**) and statistical (PDFs **calibration**) techniques has been shown to **better represent** the local climates

Preliminary results (ensemble mean) show a **significant decrease of annual and seasonal precipitation** in almost all zones during the century

Further analyses are needed regarding the ensemble-contained **uncertainty** and future projections of **extreme events**

Similar projections of daily max, mean and min **temperatures** are **underway**