

Santander Meteorology Group

A multidisciplinary approach for weather & climate

Evaluation and projection of extreme temperature percentiles by means of statistical and dynamical downscaling methods

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Thanks to:

S. Herrera
M.D. Frías
J. Fernández
J.M. Gutiérrez





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**JOVEN
INVESTIGADORA**

1. Objectives
2. Data
3. Methods
4. Results
 - 4.1. Present
 - 4.2. Future
5. Conclusions

1. Objectives

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Objectives

- To compare statistical and dynamical downscaling methods in terms of the biases in temperature percentiles.
- To analyze the different changes that percentiles will suffer in the 21st century depending on the Global Circulation Model (GCM) and the regionalization method.

The area of study is the Iberian Peninsula.

Results presented for the 5th percentile of T_{\min} ($5p_{T_{\min}}$) and the 95th percentile of T_{\max} ($95p_{T_{\max}}$).

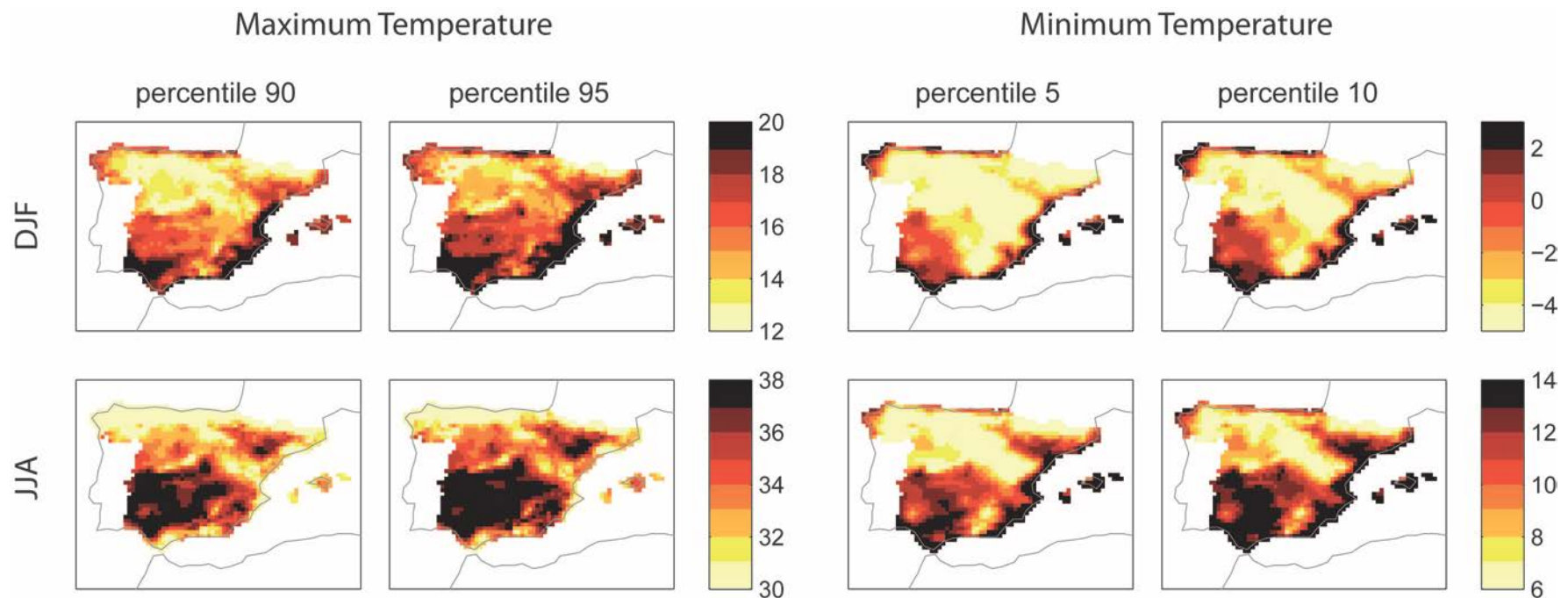


Fig.1: Extreme percentiles for maximum (90th and 95th) and minimum (5th and 10th) temperature in winter and summer.

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Observations:

Spain02 (Herrera et al., 2012): a new, public, gridded dataset for continental Spain and Balearic Islands with 0.2° resolution (1950-2008).

Observations: Spain02 (Herrera *et al.*, 2012)

Dynamical Downscaling

ESCENA Project

<http://proyectoescena.uclm.es>

Statistical Downscaling

esTcena Project

<http://www.meteo.unican.es/en/projects/esTcena>

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Data**Observations:** Spain02 (Herrera *et al.*, 2012)**Dynamical Downscaling**

ESCENA Project

<http://proyectoescena.uclm.es>

Label	Model	Acronym	Institution
D1	WRF-A	UC	Universidad de Cantabria
D2	WRF-B	UC	Universidad de Cantabria
D3	MM5	UMU	Universidad de Murcia
D4	REMO	UAHE	Universidad de Alcalá de Henares
D5	PROMES	UCLM	Universidad de Castilla la Mancha

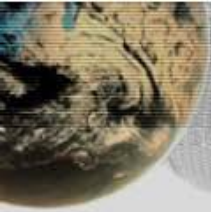
(Jimenez-Guerrero *et al.*, 2012, Dominguez *et al.*, 2012)**Statistical Downscaling**

esTcena Project

<http://www.meteo.unican.es/en/projects/esTcena>

Label	Downscaling Method	Predictor Variables
S1	Nearest neighbor (1 analogue)	T2m and SLP
S2	Linear regression with 30 PCs	T2m and SLP
S3	Linear regression with 15 PCs + Nearest grid box	T2m and SLP
S4	S3 conditioned on 10 WTs (k- means)	T2m
S5	Weather generator (Gaussian on 100 WTs)	T2m and SLP

(Gutierrez *et al.* 2012)



Observations: Spain02 (Herrera *et al.*, 2012)

Dynamical Downscaling

ESCENA Project

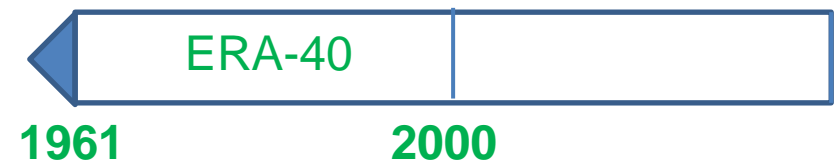
<http://proyectoescena.uclm.es>



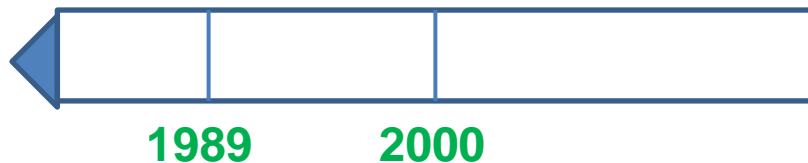
Statistical Downscaling

esTcena Project

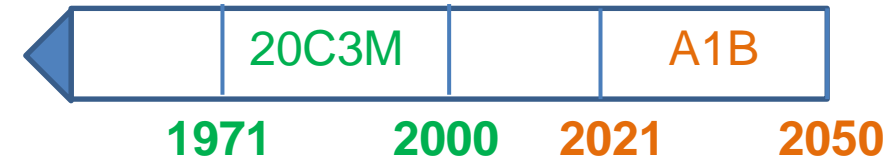
<http://www.meteo.unican.es/en/projects/esTcena>



Reanalysis



Scenarios



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• Present time:

Bias for the 95th percentile of Tmax and 5th percentile of Tmin

Reference: Spain02

Bias correction:

Seasonal mean correction

$$x_i^{m'} = (x_i^m - \overline{x_{s(i)}^m}) + \overline{x_{s(i)}^o}$$

x = data

m = RCM

o = observations

s = season depending on day i

σ = standard deviation

Seasonal standard deviation correction

$$x_i^{m''} = (x_i^m - \overline{x_{s(i)}^m}) \frac{\sigma_{s(i)}^o}{\sigma_{s(i)}^m} + \overline{x_{s(i)}^o}$$

• Future scenario:

Differences in percentiles: Delta Method

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5p_{Tmin} Bias wrt Spain02 (1971-2000)

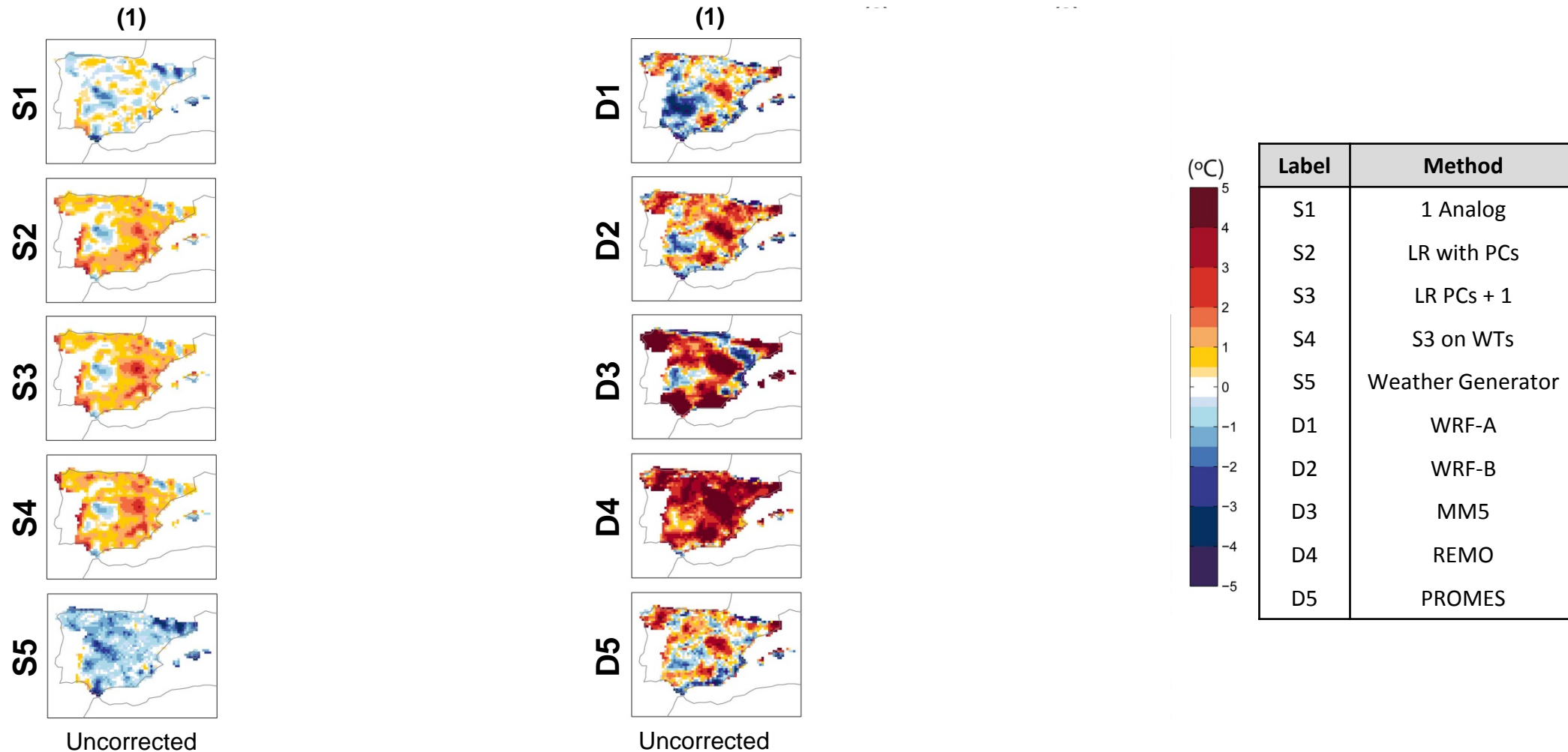


Fig.2: Spatial bias distribution (°C) for the 5p_{Tmin} in winter with respect to Spain02.

(1) Bias without doing any correction to the model.

5p_{Tmin} Bias wrt Spain02 (1971-2000)

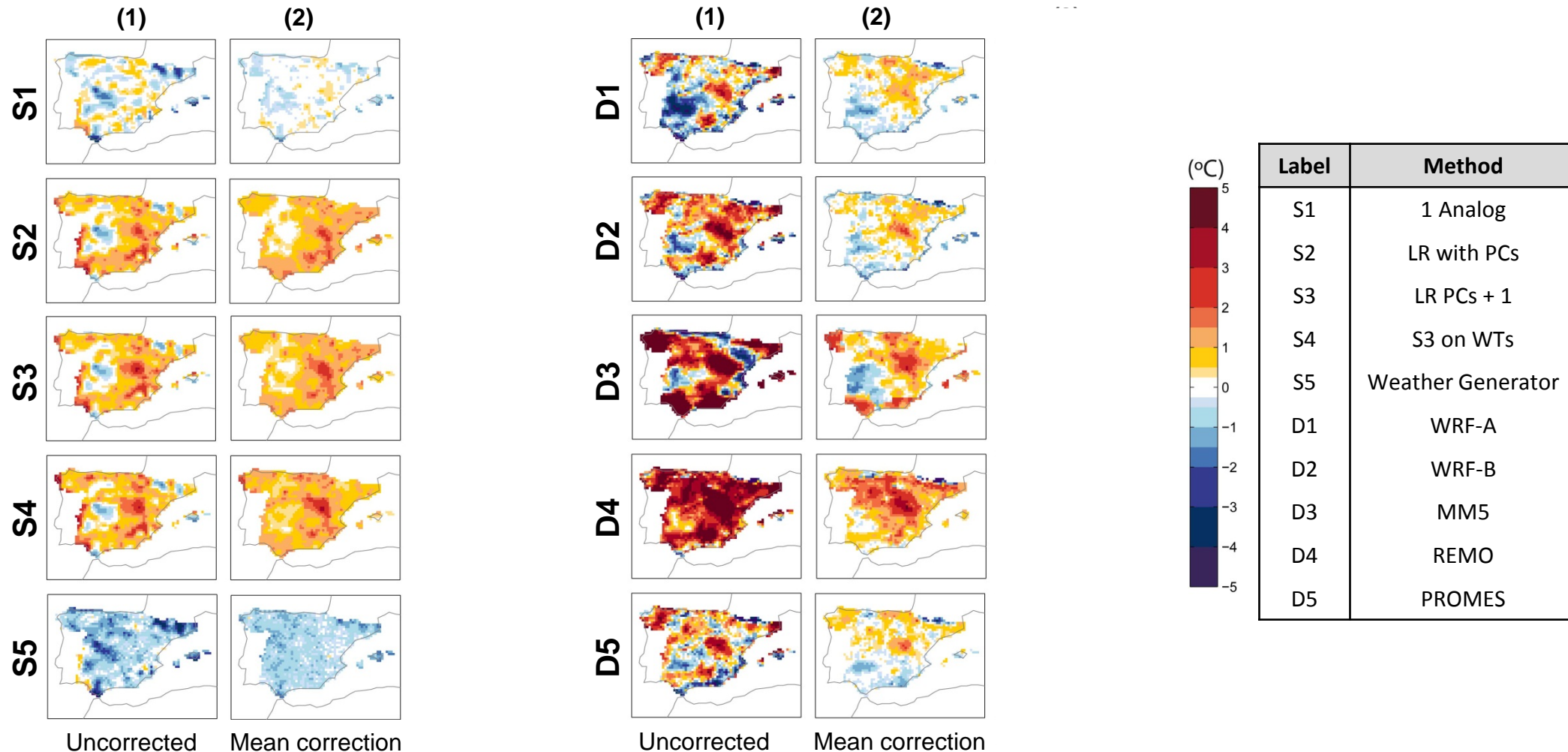


Fig.2: Spatial bias distribution (°C) for the 5p_{Tmin} in winter with respect to Spain02.

(1) Bias without doing any correction to the model.

(2) Bias when the correction in the seasonal mean is done.

5p_{Tmin} Bias wrt Spain02 (1971-2000)

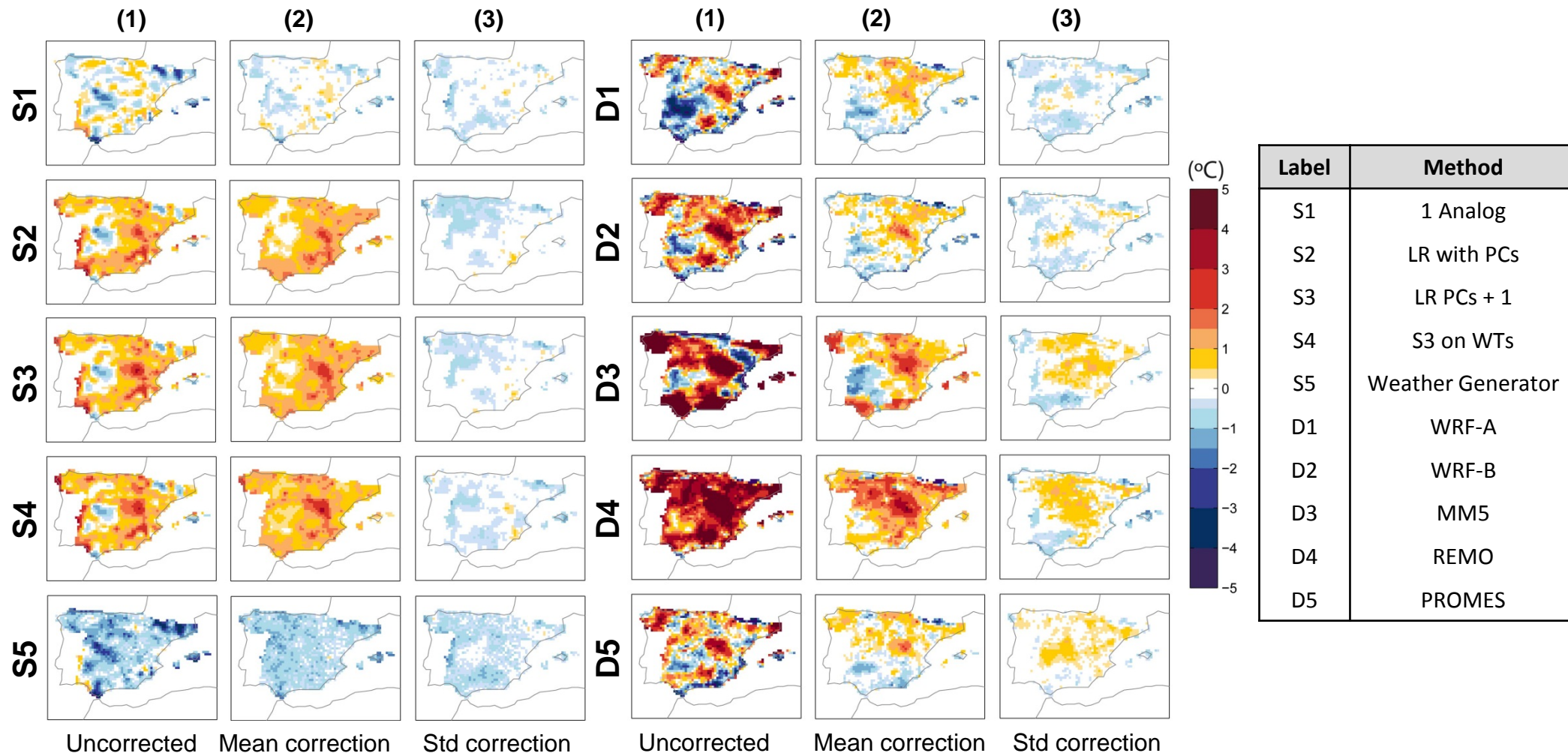


Fig.2: Spatial bias distribution (°C) for the 5p_{Tmin} in winter with respect to Spain02.

(1) Bias without doing any correction to the model.

(2) Bias when the correction in the seasonal mean is done. (3) Bias when the second order correction is done.

95p_{Tmax} Bias wrt Spain02 (1971-2000)

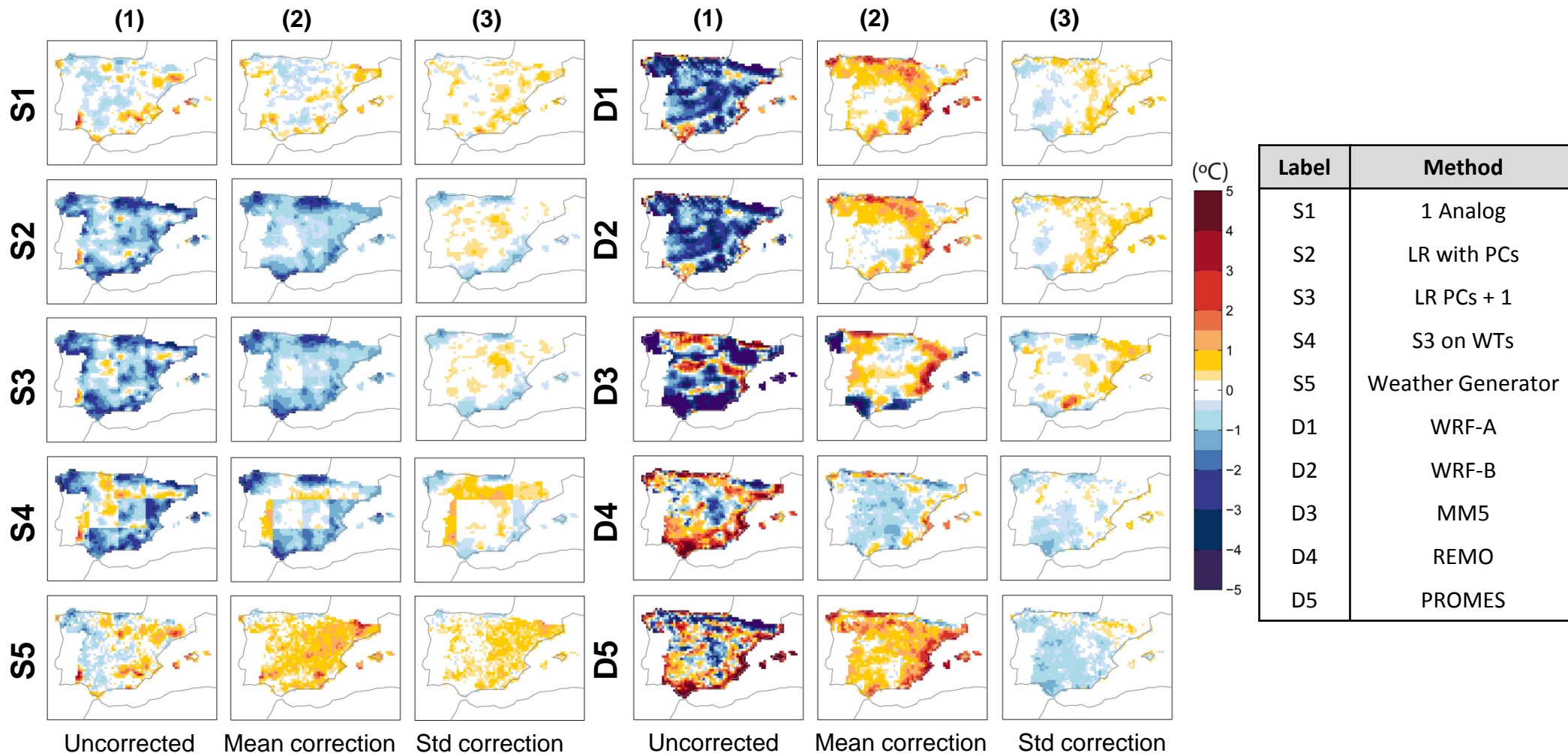


Fig.3: Spatial bias distribution (°C) for the 95p_{Tmax} in summer with respect to Spain02.

(1) Bias without doing any correction to the model.

(2) Bias when the correction in the seasonal mean is done. (3) Bias when the second order correction is done.

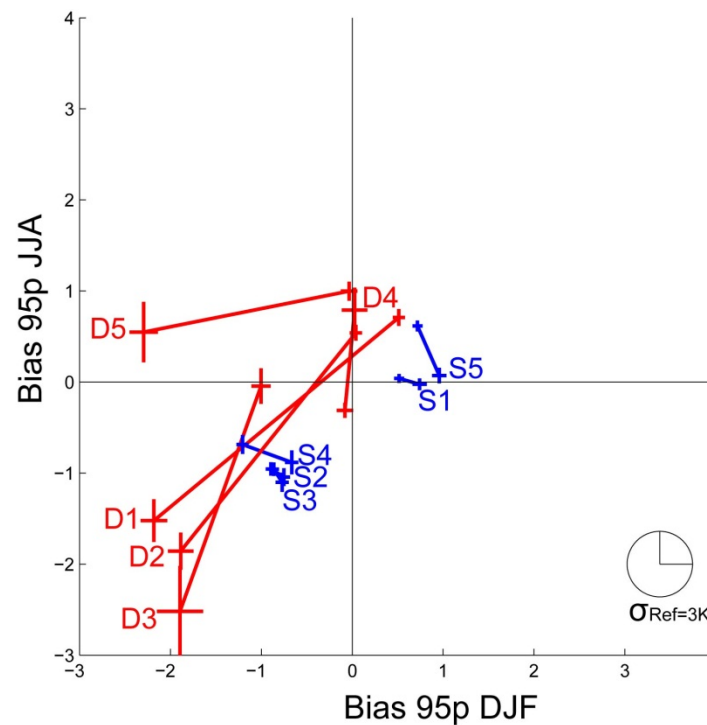
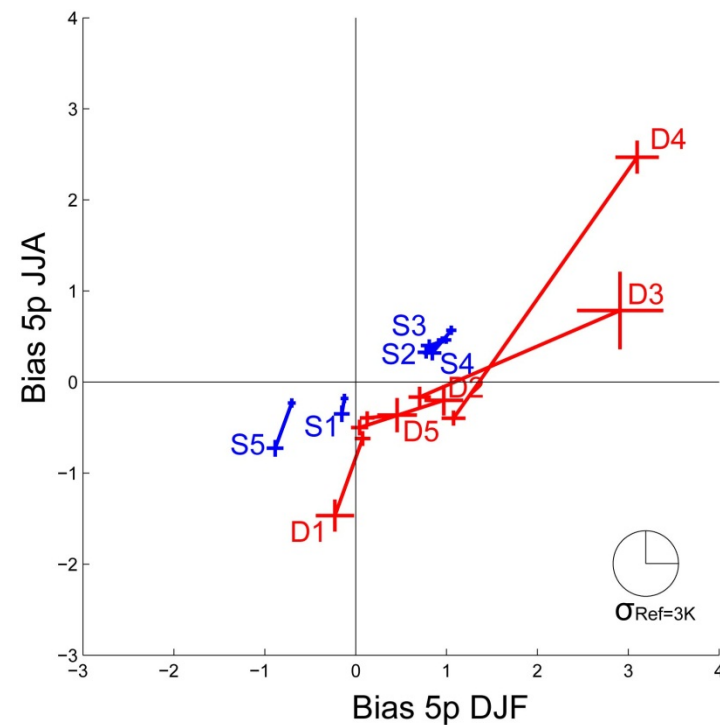
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Results: Present

Minimum Temperature

Maximum Temperature



Line graph's origin (**labels**): bias without doing any correction
Line graph's ending: bias when the correction in the seasonal mean is done.

Red lines for dynamical models
Blue lines for statistical methods

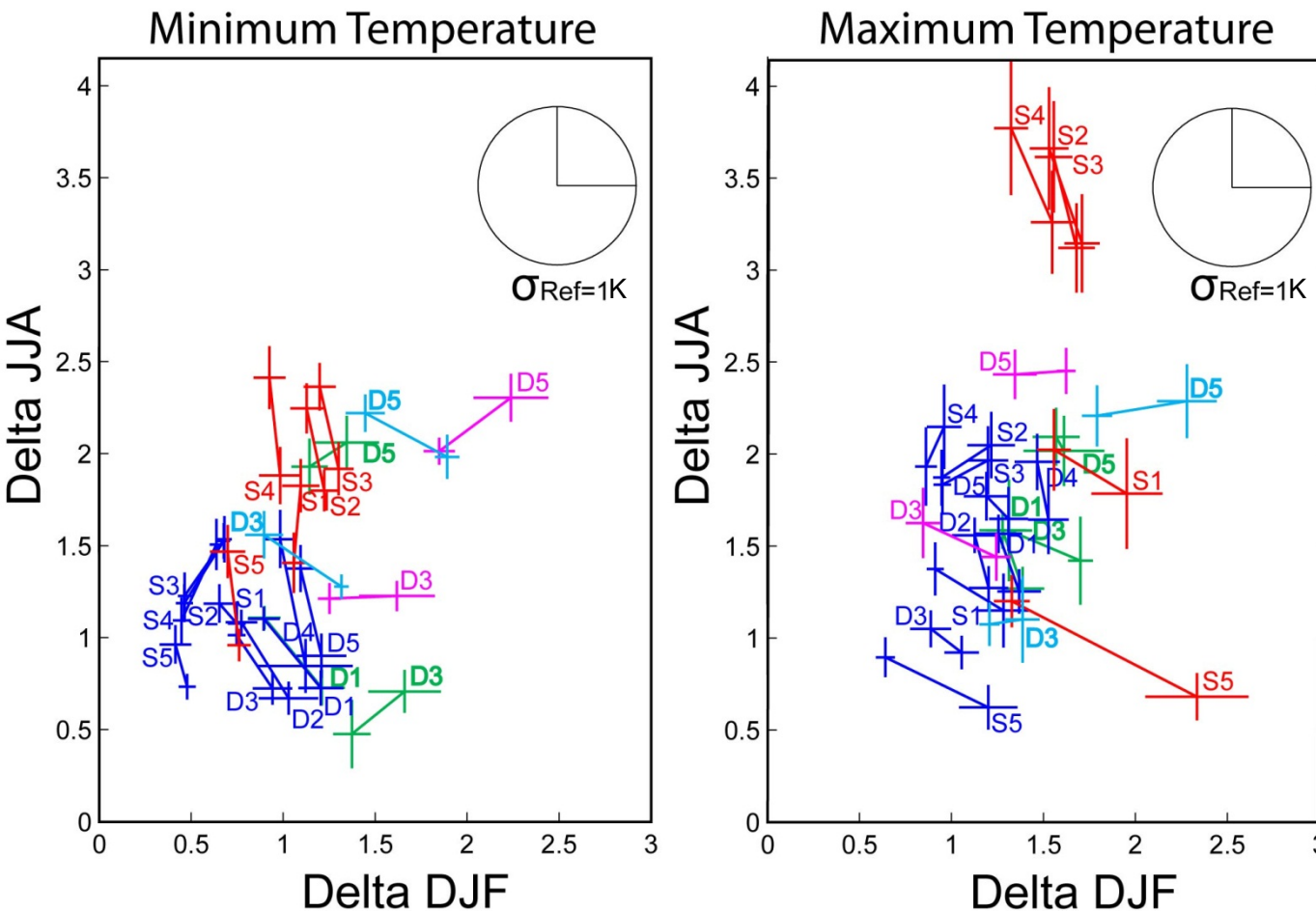
Crosses indicate σ over the IP.

Fig.4: Spatially averaged bias over the IP ($^{\circ}C$) with respect to Spain02, for the winter predictions (X axis) and those for summer (Y axis), for 5p_{T_{min}} (left) and 95p_{T_{max}} (right).

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Results: Future



The increment is calculated as the difference between seasonal projections for A1B scenario (2021-2050) and 20C3M experiment (1971-2000).

Label	Method	Label	Method
S1	1 Analog	D1	WRF-A
S2	LR with PCs	D2	WRF-B
S3	LR PCs + 1	D3	MM5
S4	S3 on WTs	D4	REMO
S5	Weather Generator	D5	PROMES

Fig.5: Spatially averaged increment over IP of T_{min} and $5p_{T_{min}}$ (left) and T_{max} and $95p_{T_{max}}$ (right), for winter (X axis) and summer (Y axis).

Line graph's origin: increment for T_{min} (left) and T_{max} (right).

Line graph's ending (**labels**): increment for the percentile.

Crosses indicate σ over the IP.

Methods nested into ECHAM5

Methods nested into HADCM3Q0

Methods nested into HADCM3Q3

Methods nested into HADCM3Q16

Methods nested into ARPEGE

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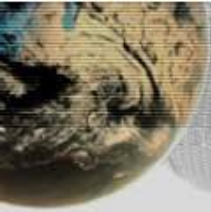
3. Methods

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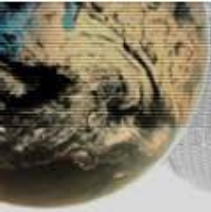
4.2. Future

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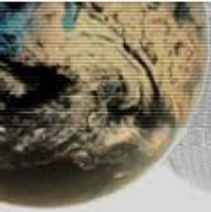
Conclusions: Present

- ✓ Each method presents a different bias pattern in $5p_{T_{\min}}/95p_{T_{\max}}$
- ✓ As expected: Statistical methods present smaller biases than dynamical ones.
- ✓ For all the RCMs, the bias in $5p_{T_{\min}}/95p_{T_{\max}}$ is considerably reduced with the correction. The model spread over the IP is reduced with this correction.



Conclusions: Future

- ✓ For statistical methods: increments in future projections are more sensitive to the GCM than to the downscaling method.
 - larger for HADCM3Q0 than for ECHAM5
- ✓ For PROMES: larger increments for the Hadley Center models.
- ✓ Seasonality: larger increments for summer than for winter, for both T_{min} and T_{max}.



Acknowledgements

- Data providers:

DMI repository for the ENSEMBLES Project research groups involved in esTcena Project.

AEMET and UC for the data provided for this work (Spain02).

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Thank you

Gracias

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downscaling methods, Natural Hazards Earth Syst. Sciences, submitted.