Comparison of statistical and dynamical downscaling methods in representing temperature extremes

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Outline

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2. Data
3. Methods
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Outline

Objectives

- To compare statistical and dynamical downscaling methods in terms of the biases in temperature percentiles. Do they depend on the observations considered?

- To analyze the different changes that percentiles will suffer in the 21st century depending on the Global Circulation Model (GCM) and the regionalization method.

Objectives

The area of study is the Iberian Peninsula.

Results presented for the 5th percentile of Tmin ($5p_{Tmin}$) and the 95th percentile of Tmax ($95p_{Tmax}$).

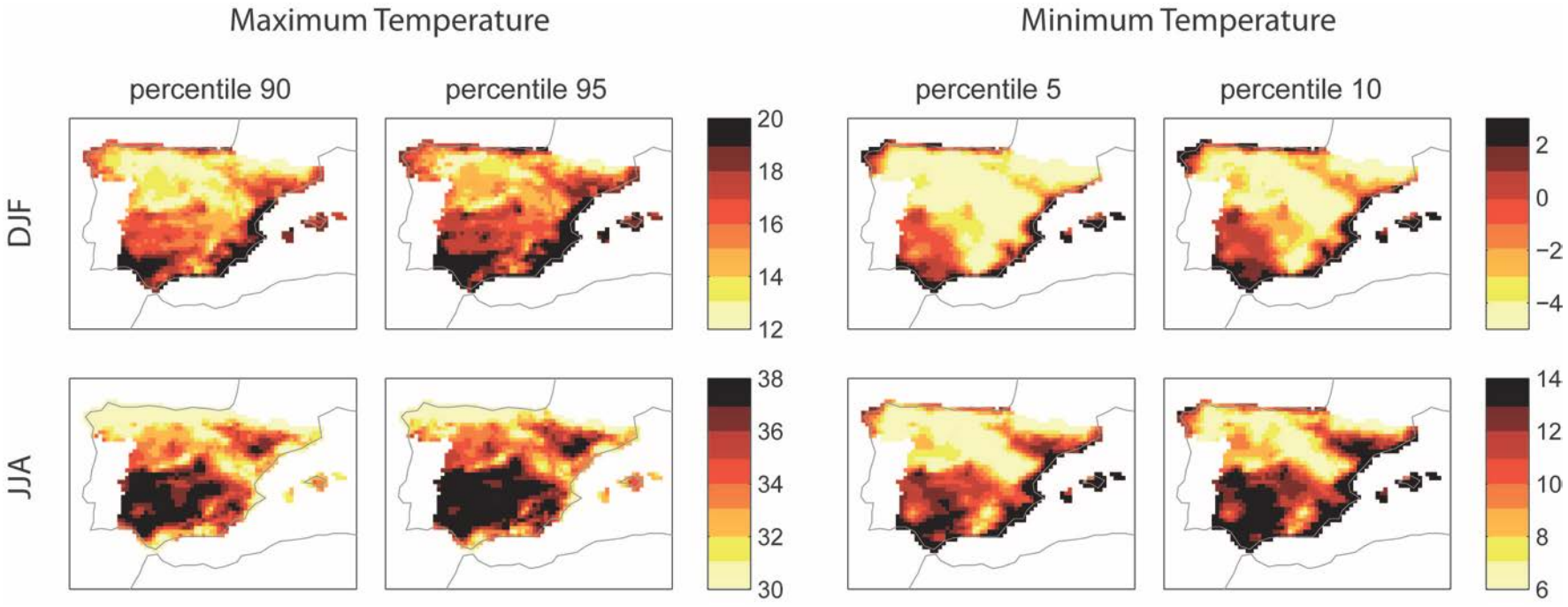


Fig.1: *Extreme percentiles for maximum (90th and 95th) and minimum (5th and 10th) temperature in winter and summer.*

Outline

Data

Observations:

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

E-OBS (Haylock et al.,2008; Hofstra et al., 2009): the state-of-the-art daily high resolution gridded observational data for Europe with 0.25º resolution, developed within the ENSEMBLES project (http://ensembles-eu.metoffice.com).

Data

Observations: Spain02 and E-OBS.

Dynamical Downscaling

ENSEMBLES Project

http://ensembles-eu.metoffice.com

Statistical Downscaling

esTcena National Project

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

Data

Observations: Spain02 and E-OBS.

Dynamical Downscaling

ENSEMBLES Project

http://ensembles-eu.metoffice.com

Label	Model	Acronym	Institution
D1	CLM	ETHZ	Swiss Institute of Technology
D2	HadRM3 Q0	HC	UK Met Office
D3	RACMO	KNMI	Koninklijk Nederlands Meteorologisch Instituut
D4	REMO	MPI	Max Planck Institute for Meteorology
D5	PROMES	UCLM	Universidad de Castilla la Mancha

Statistical Downscaling

esTcena National 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)

Data

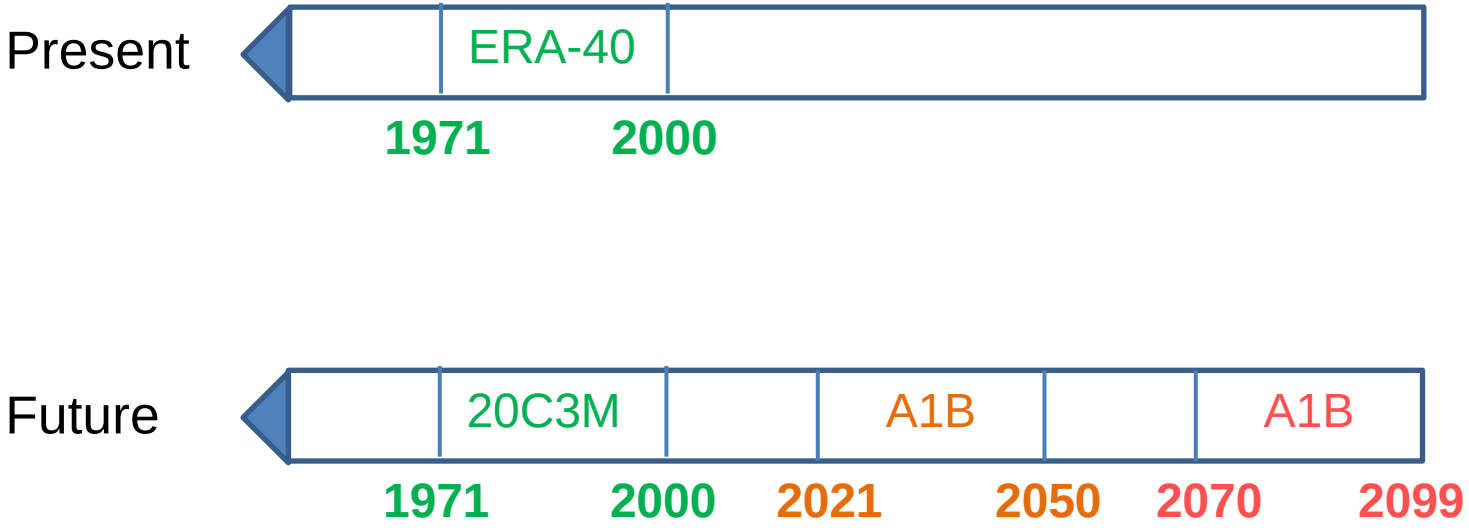
Observations: Spain02 and E-OBS.

Dynamical Downscaling

ENSEMBLES Project

Statistical Downscaling

esTcena National Project



Outline

Methods

- **Present time:**

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

Reference: Spain02, E-OBS

Bias correction:

Seasonal mean correction

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

x= data
m= RCM
o=observations
s = season depending on day i
σ = standard deviation

Seasonal standard deviation correction

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

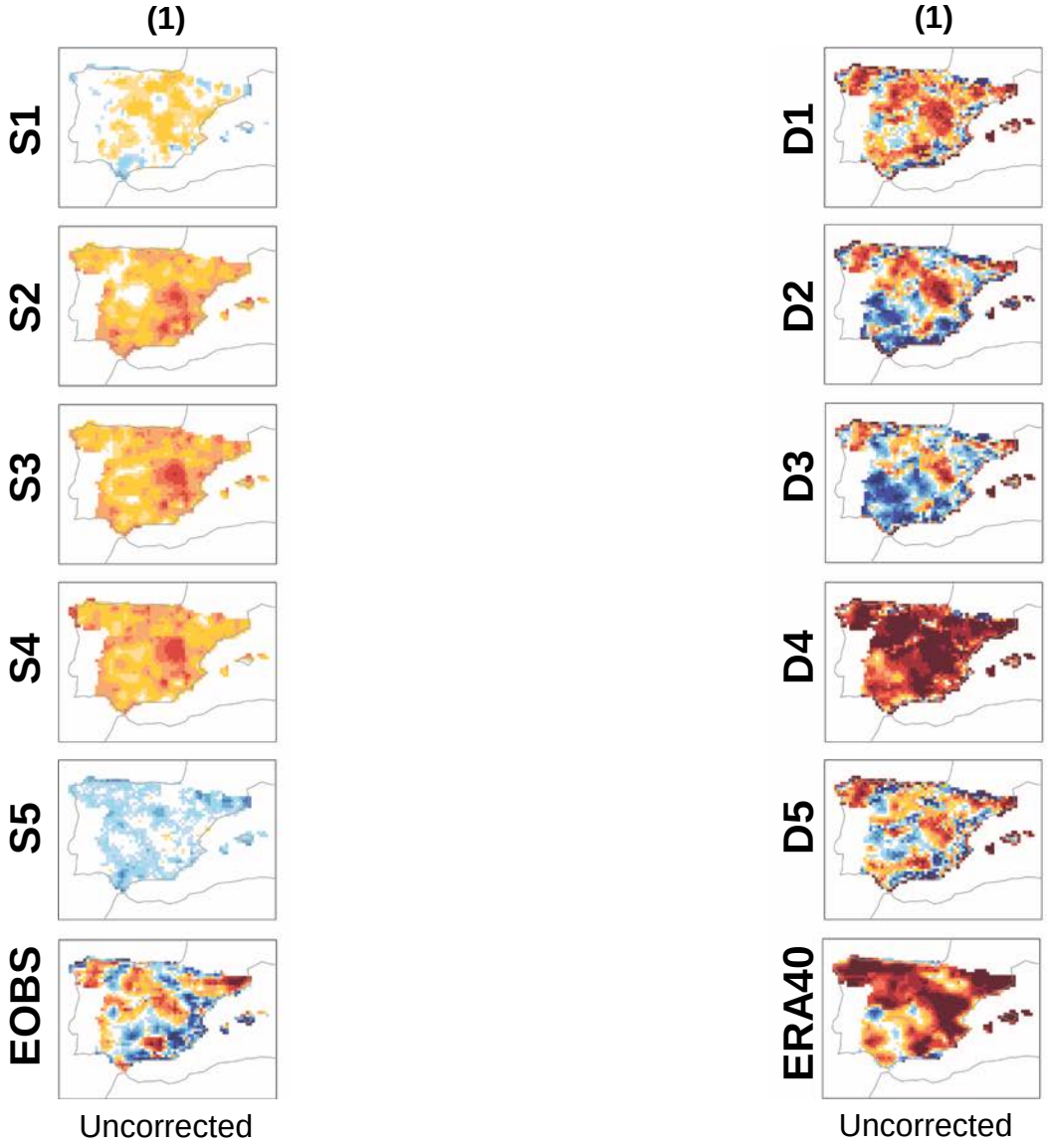
- **Future scenario:**

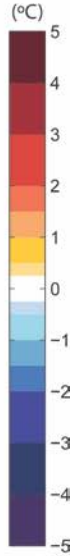
Differences in percentiles: Delta Method

Outline

Results: Present

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

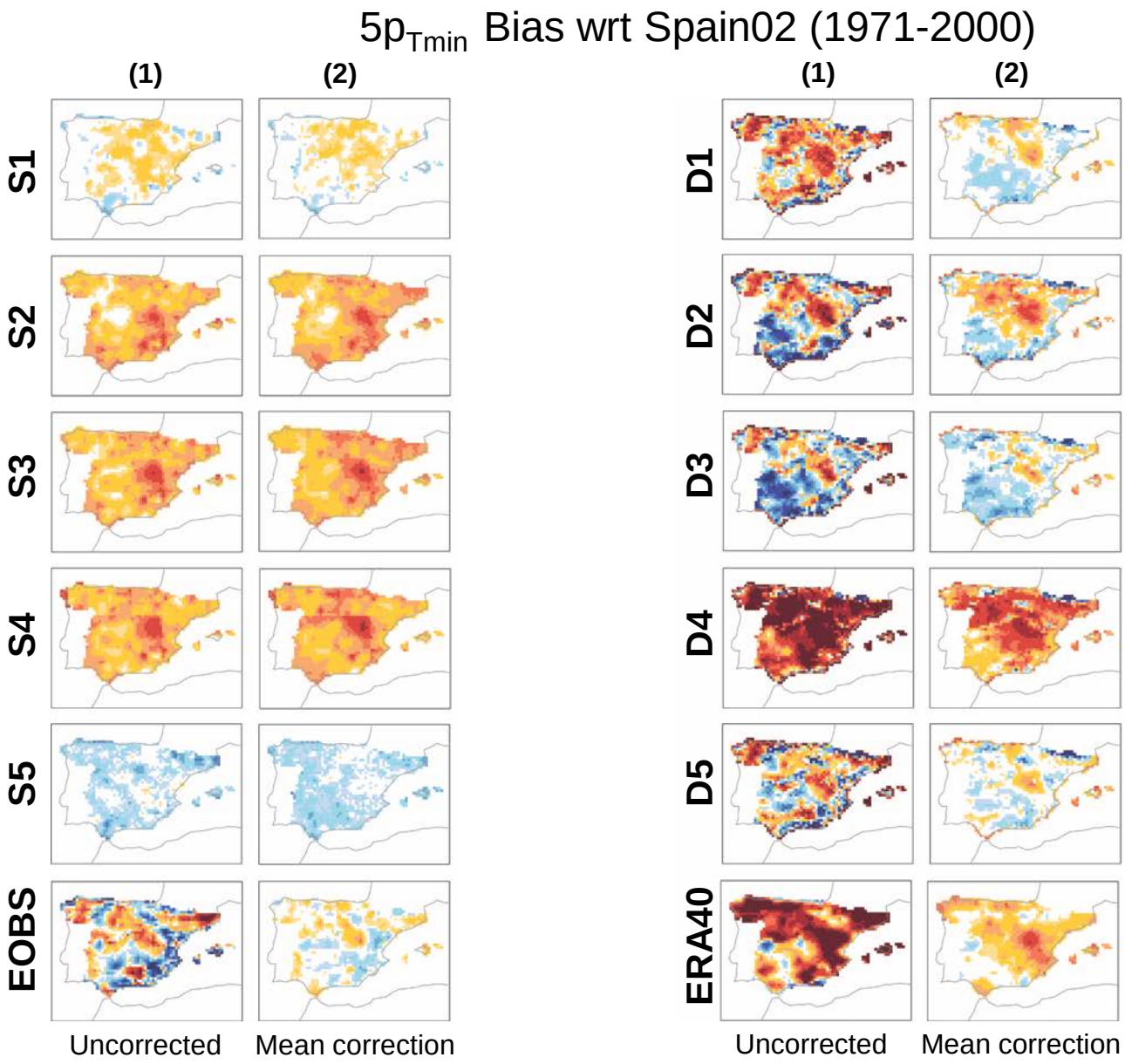


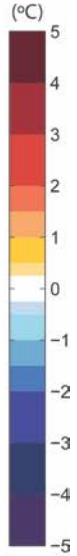


Label	Method
S1	1 Analog
S2	LR with PCs
S3	LR PCs + 1
S4	S3 on WTs
S5	Weather Generator
D1	CLM
D2	HadRM3Q0
D3	RACMO
D4	REMO
D5	PROMES

Fig.2: *Spatial bias distribution (ºC) for the $5p_{Tmin}$ in winter with respect to Spain02.*
(1) Bias without doing any correction to the model.

Results: Present





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S1	1 Analog
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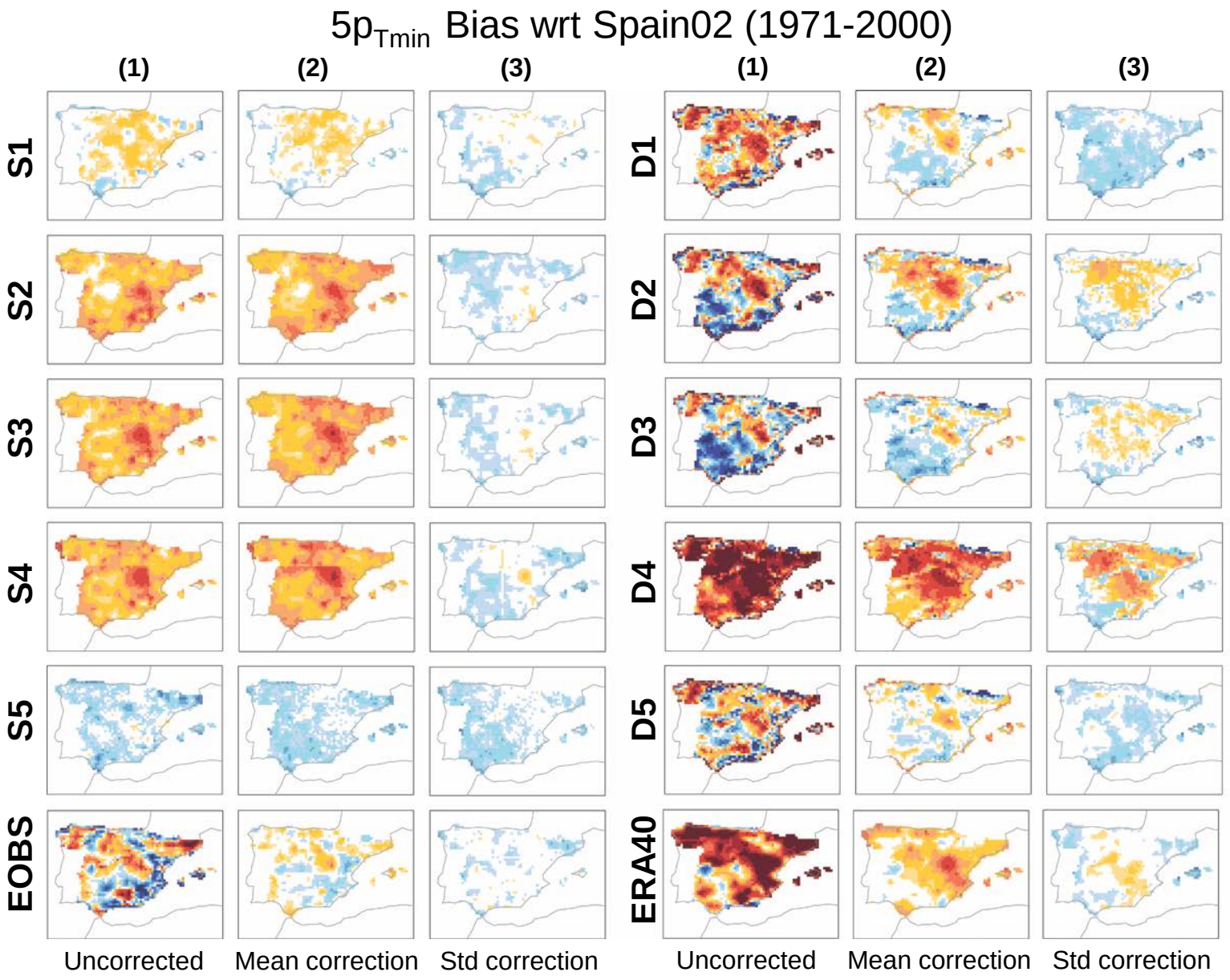
D4	REMO
D5	PROMES

Fig.2: *Spatial bias distribution (ºC) 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.

Results: Present



Label	Method
S1	1 Analog
S2	LR with PCs
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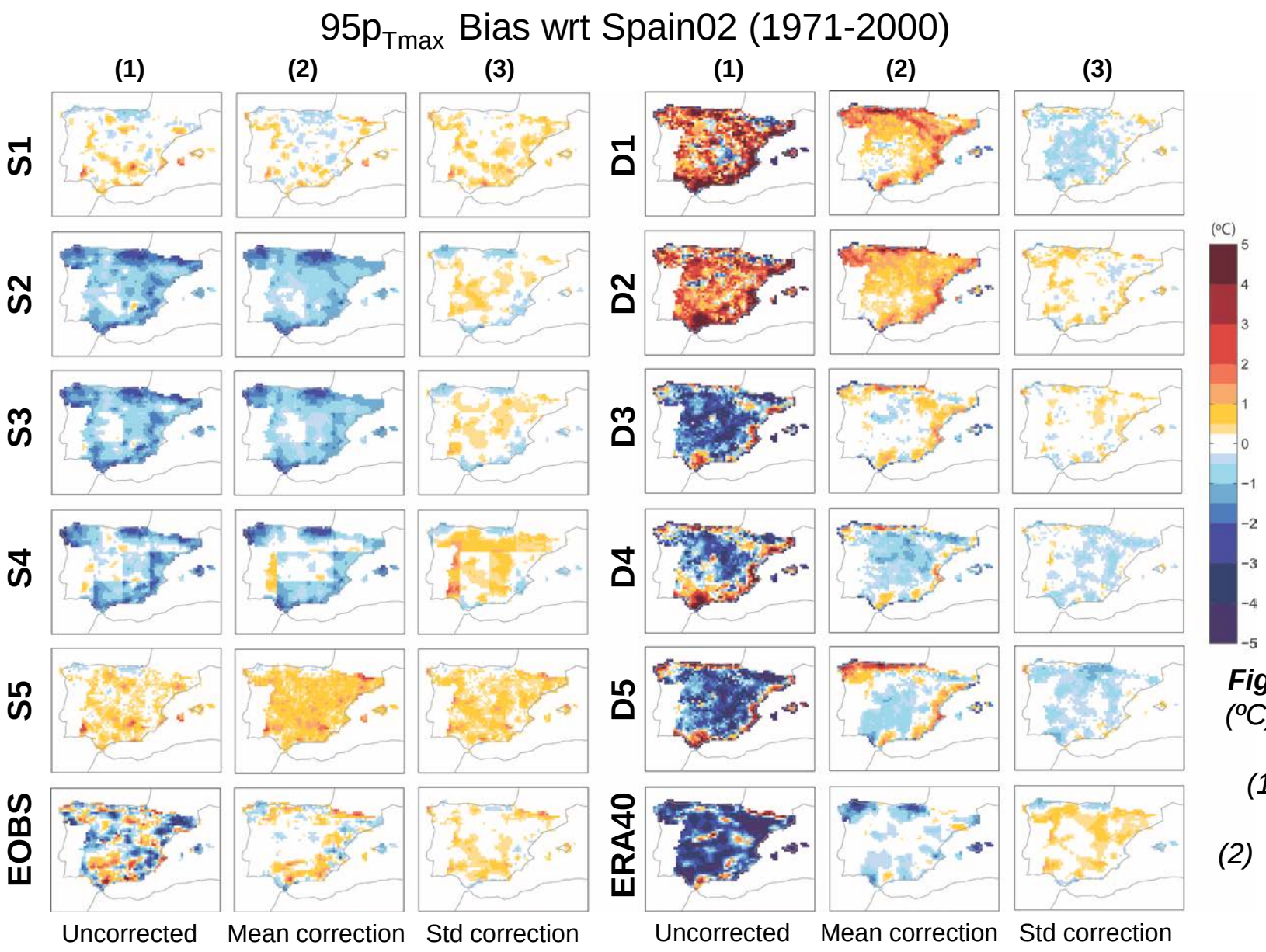
S4	S3 on WTs
S5	Weather Generator
D1	CLM
D2	HadRM3Q0
D3	RACMO
D4	REMO
D5	PROMES

Fig.2: *Spatial bias distribution (ºC) 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.

Results: Present



Label	Method
S1	1 Analog
S2	LR with PCs
S3	LR PCs + 1
S4	S3 on WTs
S5	Weather Generator
D1	CLM
D2	HadRM3Q0
D3	RACMO
D4	REMO
D5	PROMES

Fig.3: *Spatial bias distribution (ºC) 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.

Results: Present

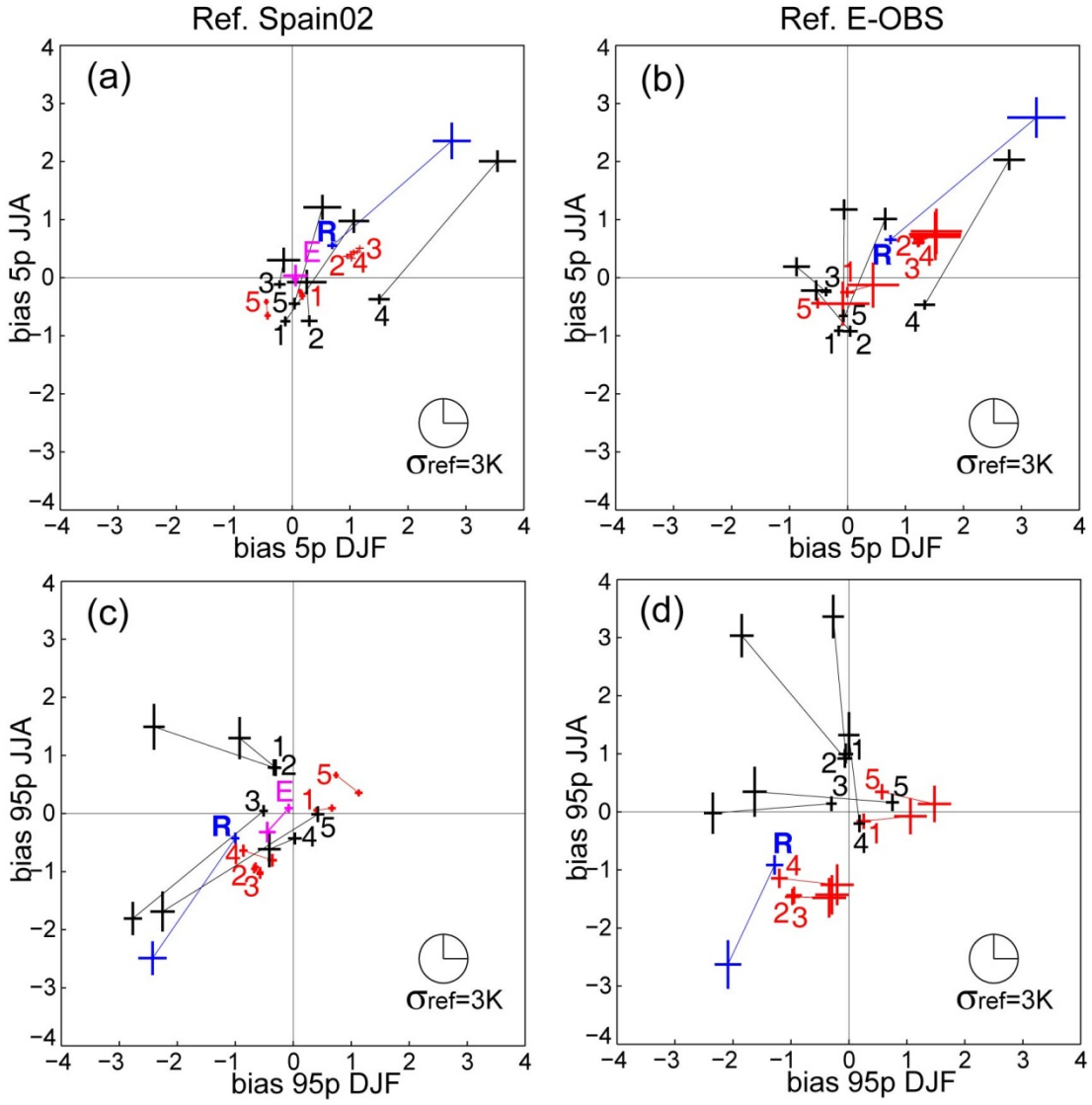


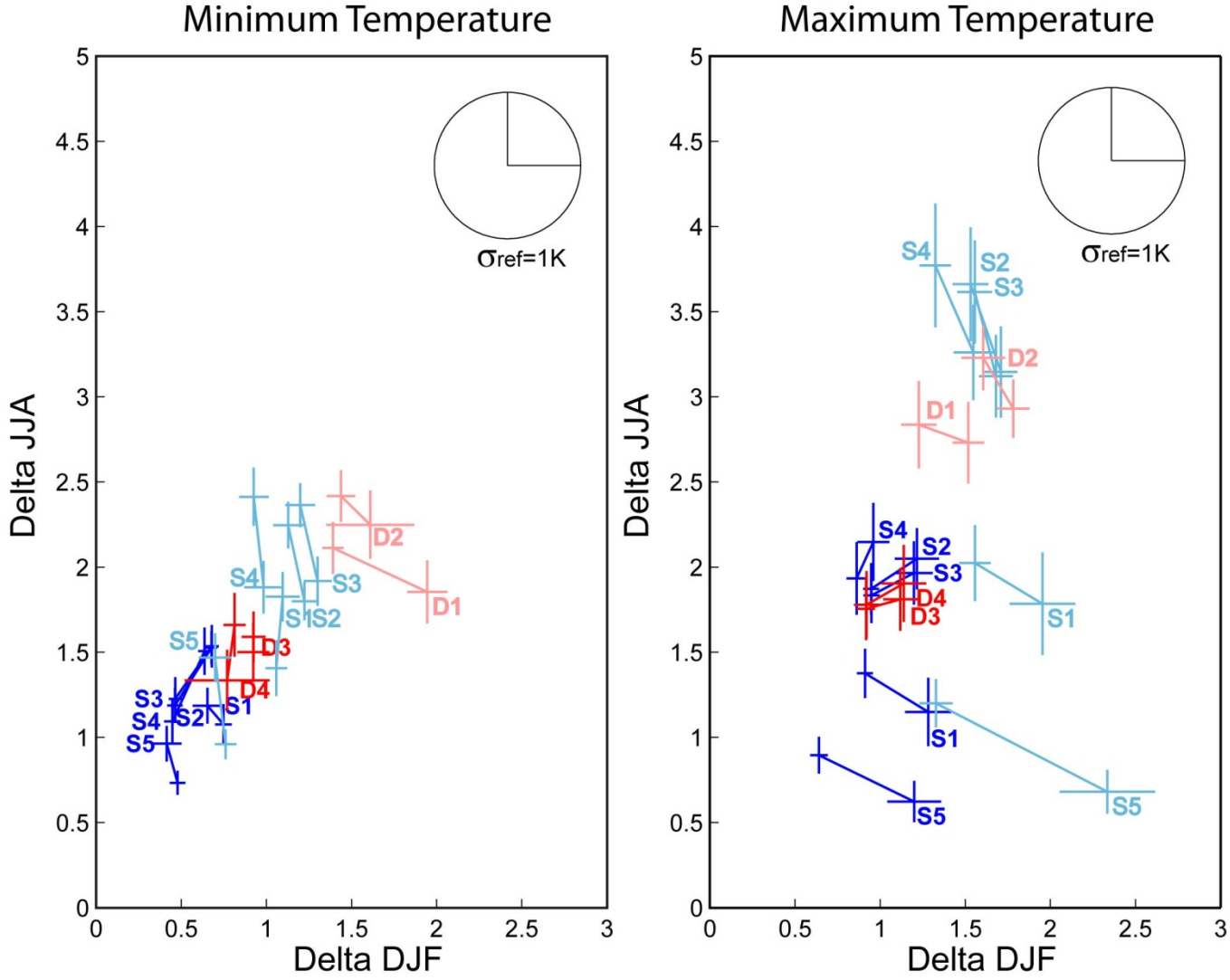
Fig.4: *Spatially averaged bias over the IP (ºC) with respect to Spain02 (left) and E-OBS (right), for the winter predictions (X axis) and those for summer (Y axis), for* $5p_{Tmin}$ *(up) and* $95p_{Tmax}$ *(low).*

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

Crosses indicate σ over the IP.

Black lines for dynamical models
Red lines for statistical methods
Blue lines for ERA-40 reanalysis
Pink lines for the difference E-OBSvsSpain02

Results: Future



Label	Method	Label	Method
S1	1 Analog	D1	CLM
S2	LR with PCs	D2	HadRM3Q0
S3	LR PCs + 1	D3	RACMO
S4	S3 on WTs	D4	REMO
S5	Weather Generator	D5	PROMES

Fig.5: *Spatially averaged increment over IP of Tmin and $5p_{Tmin}$ (left) and Tmax and $95p_{Tmax}$ (rigth), for winter (X axis) and summer (Y axis). Line graph's origin: increment for Tmin (left) and Tmax (right). Line graph's ending (labels): increment for the percentile.*

Crosses indicate σ over the IP.

Statistical nested into ECHAM5
Statistical nested into HADCM3Q0
Dynamical nested into ECHAM5
Dynamical nested into HADCM3Q0

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

Outline

Conclusions: Present

- ✓ Each method presents a different bias pattern in $5p_{Tmin}/95p_{Tmax}$
- ✓ After the correction, biases are very similar considering different observations.
- ✓ As expected:
  - Statistical methods present smaller biases than dynamical ones.
  - The spread over the IP is smaller when using Spain02 in the SD methods.
- ✓ For all the RCMs, the bias in $5p_{Tmin}/95p_{Tmax}$ is considerably reduced with the correction. The model spread over the IP is reduced with this correction.

Conclusions: Future

- ✓ Increments in **near** future projections are more sensitive on the GCM than in the downscaling method, being larger for HADCM3Q0 than for ECHAM5.
- ✓ Seasonality: larger increments for summer than for winter, for both Tmin and Tmax.
- ✓ Increments in **far** future are larger than in near future and depend more on the downscaling method than in the GCM (not shown).

Acknowledgements

- Data providers:

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

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- Hofstra, N., Haylock, M., New, M., and Jones, P. D.: Testing EOBS European high-resolution gridded data set of daily precipitation and surface temperature, Journal of Geophysical Research-Atmospheres, 114, 2009.

Thank you!

Dziękujemy!

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