Evaluation of Regional climate models: how much can we trust in gridded observational data sets?

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Motivation: We need to estimate uncertainty

Accurate Climate Change projections demand assessing uncertainties, arising from:

- the coarse spatial resolution of global climate models (RCMs)
- uncertainties in the parametrization schemes
- the unpredictable evolution of socioeconomic factors: scenarios
- Etc.

A fairly common approach is the use of ensembles of simulations

Motivation: We need observational database

- A common way to validate (estimate the uncertainty) climate models is through their skills reproducing present climate
- The present climate is "known" through observations
- Observations are gridded (extrapolated) using statistical tools
- How much uncertainty do "observational databases" include?

What makes a model better?

- How can we know which is the "best model" of the ensemble?
- Is the best model the closest to the observational database?
- Is it better to weight the model according to their skill to reproduce "observations"?

Simulations

Two independent ensembles were employed:

ESCENA project (Jiménez-Guerrero et al. 2012 submitted)

- 5 Members (1998-2008)
- $\sim$ 25 km
- Driven by ERA Interim

PHYSICS ensemble (Jerez et al. 2012 submitted)

- 8 Members (1970-2000)
- MM5
- 30 km over the IP
- Driven by ERA40

Observational databases

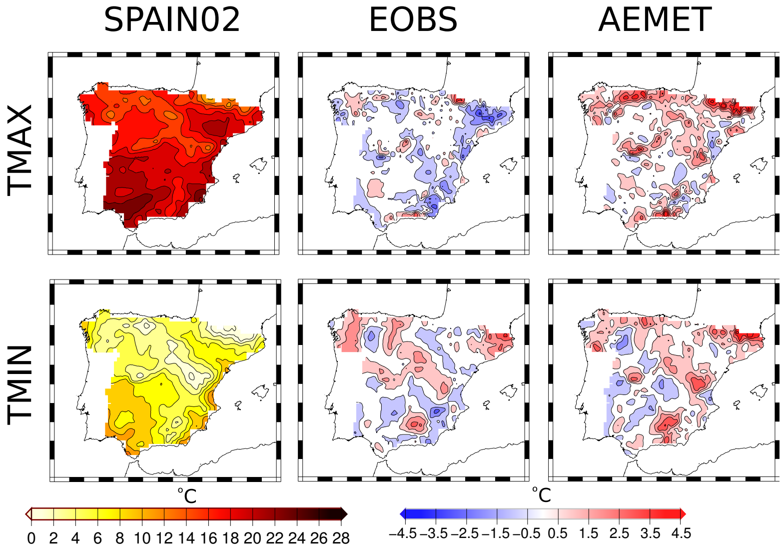
Three gridded observational databases over Spain have been compared:

- E-OBS
- SPAIN02
- AEMET gridded

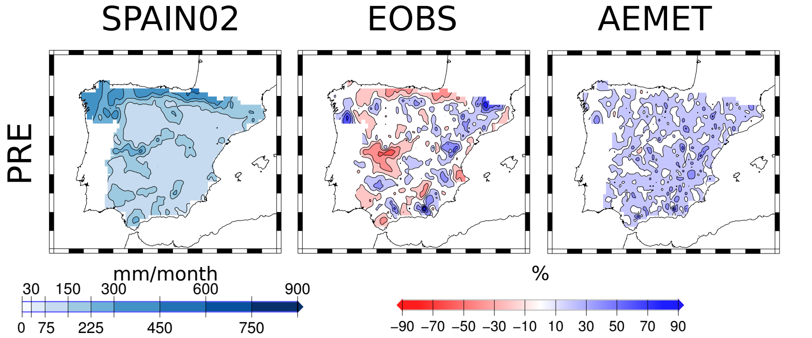
Which share:

- Overlap period: 1950-2008
- ∼ resolution
- Variables: daily TMAX, TMIN and PRE

Temperature biases in Spring (1950-2008)

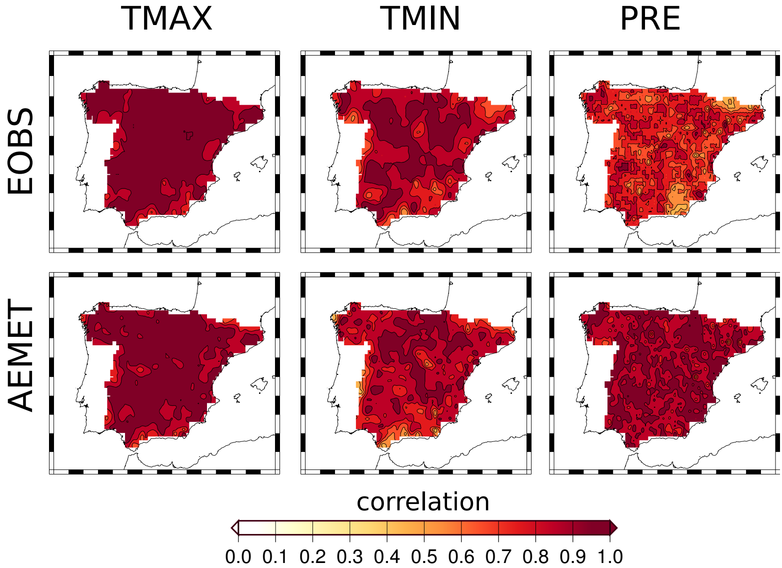


Precipitation biases in Spring (1950-2008)



Temporal correlation Spring (1950-2008)

- Motivation
- Data employed
- **Differences among observational databases**
- Uncertainties ranking models
- Conclusions

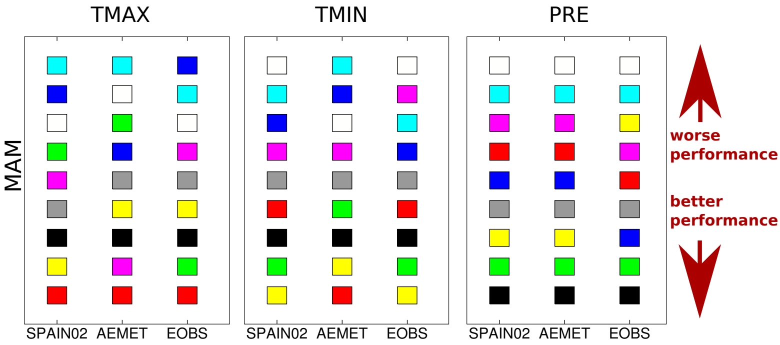


Assessing the skill of each model

- For the next ranking exercises, we focus on the spatial correlation of the climatological mean values of TMAX, TMIN and PRE.
- A similar assessment can be reproduced with analogous results for RMSE

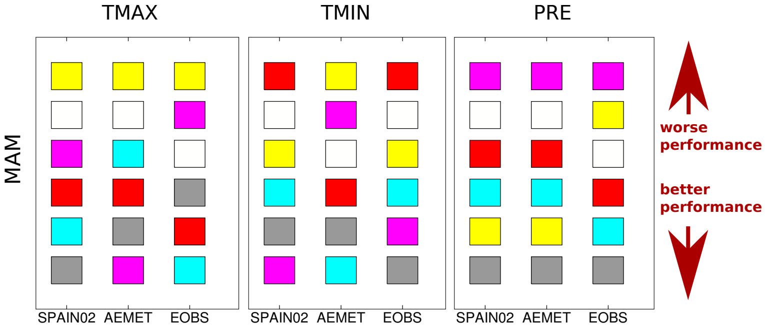
There is no "best" model (in the PHYSICS ensemble)

Only Spring results are shown. Each color represents an ensemble member



There is no "best" model (in the ESCENA ensemble)

Only Spring results are shown. Each color represents an ensemble member



Measuring the spreads

Fixed a database, there is a spread in the model ensemble...

Spread among models

$\Delta\mathrm{mod} = \frac{1}{N_{obs}} \sum_i \left[\max_i\{\rho_{i,j}\} - \min_i\{\rho_{i,j}\} \right] \forall j$ in models

... and fixed a model, there is a spread in the observations

Spread among databases

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If Δobs > Δmod, uncertainties in observational database are as important as in ensembles!

Spreads in the PHYSICS ensemble

		COR (× 100)		RMSE	
Var.	Seas.	Δ mod	Δ obs	Δ mod	Δ obs
TMAX	DJF	1.53	3.45	1.88	0.66
	MAM	1.42	3.73	1.49	0.95
	JJA	3.92	4.23	1.56	1.20
	SON	1.77	2.99	1.60	0.90
TMIN	DJF	1.86	4.71	1.51	0.46
	MAM	2.50	4.07	0.76	0.44
	JJA	1.87	4.50	0.46	0.56
	SON	1.32	4.49	0.94	0.53
PRE	DJF	3.83	1.71	10.73	9.97
	MAM	6.94	8.21	9.39	17.05
	JJA	16.6	3.64	51.94	11.81
	SON	11.09	6.99	17.06	15.87

Spreads in the ESCENA ensemble

		COR (× 100)		RMSE	
Var.	Seas.	Δ mod	Δ obs	Δ mod	Δ obs
TMAX	DJF	3.19	5.16	1.84	0.57
	MAM	3.52	3.27	1.85	0.58
	JJA	2.51	2.57	1.70	0.62
	SON	2.02	3.08	1.39	0.57
TMIN	DJF	4.02	4.89	1.12	0.41
	MAM	3.91	5.14	1.17	0.38
	JJA	4.54	5.55	2.28	0.64
	SON	3.56	4.77	1.84	0.45
PRE	DJF	7.74	4.95	38.69	10.84
	MAM	11.50	4.23	60.76	10.66
	JJA	8.74	4.46	53.03	9.85
	SON	10.55	6.79	46.78	16.30

Take home messages

- Observations are fundamental to validate climate models
- We should not forget the uncertainties inherent to these data sets
- A perfect model could not match perfectly observations
- Weighting models according to a given (unique) database is potentially dangerous