The Multi-MIP regional distillation dilemma

Results from the Spanish PNACC-2012 Programme

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EURO-CORDEX crowd
Questions

- Do old MIPs contain useful information on CC? Hopefully, yes. If so...
- How to combine them with the newest MIPs?
- How to combine ensembles of opportunity?
Questions

• Do old MIPs contain useful information on CC? Hopefully, yes. If so...

• How to combine them with the newest MIPs?

• How to combine ensembles of opportunity?

• How many models should we (or end-/next-users) consider in an ensemble?
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simulation domains

PROMES / MM5 / WRF
Lambert Conic Conformal @ 25Km

REMO
Rotated lat-lon @ 0.22°

http://proyectoescena.uclm.es
Multi-MIP projections

CMIP3

CGCM3–r1
HadCM3Q0
HadCM3Q16
HadCM3Q3
BCM–r1
CNCM3–r1
ECHAM5–r3
Multi-MIP projections

CMIP3
- CGCM3–r1
- HadCM3Q0
- HadCM3Q16
- HadCM3Q3
- BCM–r1
- CNCM3–r1
- ECHAM5–r3
- ECHAM5–r2

CMIP5
- CanESM2–r1
- CNRM–CM5–r1
- CSIROMk360–r1
- EC–EARTH–r1
- EC–EARTH–r12
- EC–EARTH–r3
- GFDL–ESM2M–r1
- HadGEM2–ES–r1
- IPSL–CM5A–MR–r1
- MIROC5–r1
- MPI–ESM–LR–r1
- MPI–ESM–LR–r2
- NorESM1M–r1

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Multi-MIP projections

CMIP3
- CGCM3–r1
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- BCM–r1
- CNRM–CM5–r1
- ECHAM5–r3
- ECHAM5–r2
- HadGEM2–r1
- IPCM4V2–r1
- CanESM2–r1

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- CNRM–CM5–r1
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Multi-MIP projections

Empirical-Statistical Downscaling
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Multi-MIP projections

CMIP3
- CGCM3–r1
- HadCM3Q0
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- ECHAM5–r2
- HadGEM2–r1
- IPCM4V2–r1
- CanESM2–r1

CMIP5
- CNRM–CM5–r1
- CSIROMk360–r1
- EC–EARTHR–r1
- EC–EARTHR–r12
- EC–EARTHR–r3
- GFDL–ESM2M–r1
- HadGEM2–ES–r1
- IPSL–CM5A–MR–r1
- MIROC5–r1
- MPI–ESM–LR–r1
- MPI–ESM–LR–r2
- NorESM1M–r1

Hidden dimensions:
Resolution (0.44, 0.22, 0.11)
Scenario (SRES, RCPs)

+53 raw GCM projections

Grand ensemble:
253 projections

Empirical-Statistical Downscaling
Simple (naïve?) approach:
- All MIPs pooled together
- Only pr and tas considered
- Near future period (2021-2050)
- Relative to 1971-2000
- Seasonal delta changes
- Averaged over Spain (excl. Canary Is.)
Multi-MIP projections

Spain JJA (2021-2050 vs. 1971-2000)

- CMIP3 (21)
- CMIP5 (30)
- EURO–CORDEX (77)
- ENSEMBLES (19)
- ESCENA (19)
- esTcena (30)

Fernández et al. (2016) Work in progress …
Multi-MIP projections

Spain JJA (2021-2050 vs. 1971-2000)

- 011 (32)
- 022 (68)
- 044 (45)
- Coarse (GCM) (51)

Fernández et al. (2016) Work in progress …
Multi-MIP projections

Spain JJA (2021-2050 vs. 1971-2000)

Fernández et al. (2016) Work in progress …
Multi-MIP projections

Spain JJA (2021-2050 vs. 1971-2000)

- EC–EARTH (21)
- ECHAM (53)
- HC MetOff (33)
- Other (89)

Fernández et al. (2016) Work in progress …
Uncertainty cascade

Raw GCM Temperature delta change (Spain)

Inspired by Ed Hawkins' Climate Lab Book
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Uncertainty cascade

Downscaled Temperature delta change (Spain)

Potential of downscaling to narrow uncertainty

Inspired by Ed Hawkins' Climate Lab Book
Delta method caveats

Spain JJA (2021-2050 vs. 1971-2000)

The delta method assumes that model errors are preserved in a changing climate. This is NOT true.

Temperature anomaly (K) w.r.t. the coldest simulation during the reference period.
Should we put more trust in the delta of a model with very low T bias during the evaluation period?
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Uncertainty cascade

Downscaled Temperature delta change (Spain)

Potential of downscaling to narrow uncertainty

Inspired by Ed Hawkins' Climate Lab Book
GCM-RCM consistency

A1B delta

single-GCM / multi-RCM

Turco et al. (2013) “Large biases and inconsistent CC signals in ENSEMBLES …” CC 120:859
What to expect from DS?

CCLM4.8.17

Forcing GCM

CNRM-CM5

EC-EARTH

MPI-ESM-LR

JJA pr
% change
in 2021-50
wrt 1971-00
Credibility limits?

CCLM4.8.17

Forcing GCM

CNRM-CM5

EC-EARTH

MPI-ESM-LR

HadGEM2-ES

JJA pr % change in 2021-50 wrt 1971-00

http://www.meteo.unican.es
Credibility limits?

JJA pr % change in 2021-50 wrt 1971-00

RCA4 011
RACMO 011
RCA4 044
RACMO 044
CCLM4.8.17

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RCM uncertainty questions

- How to separate uncertainty (spread) due to unrealistic process modeling from genuine modeling uncertainty?
- How to discard (underweight) unrealistic GCMs/RCMs (and their associated extra uncertainty range)?
- Is the answer to the above application dependent? Can we trust tas/pr from a model which lacks realism in other variables?

- Huge spread
- Is M best for precip?
- Can D be trusted for autumn (SON) soil moisture?
Multi-physics ens. E-CDX-WRF

- Watch out for error compensation!

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EURO-CORDEX Multi-model

How different is this picture when considering a multi-model instead of a multi-physics ensemble?

García-Díez & Fernández (2016) Work in progress ...
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EURO-CORDEX Multi-model

How different is this picture when considering a multi-model instead of a multi-physics ensemble?

Not easily comparable across models.

García-Díez & Fernández (2016) Work in progress ...
Tack!

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Soil moisture

Total cloud cover

Temperature

SW radiation

Precipitation

- Is there a “best” model configuration?
- See also:
  - Solman & Pessacg (2012)
  - Jerez et al (2012)

Multi-MIP projections

Year

Delta (w.r.t. 1961-1990)

tas (K)

1960 1980 2000 2020 2040

294.0 294.5 295.0 295.5 296.0 296.5 297.0

0 0.5 1.0 1.5 2.0
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High resolution RCMs

Hi-res 0.11° Euro-CORDEX simulations took ~100x the computing power of the standard 0.44° CORDEX resolution.

Where should we look for added value in hi-res simulations?

Casanueva et al. (2016) “Daily pr statistics in the EURO-CORDEX RCM ens … ” CDyn early view
Casanueva et al. (2016) “Towards a fair comparison of SD and DD in the …” Clim Change
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Fair comparison of SD vs DD

Casanueva et al. (2016) “Towards a fair comparison of SD and DD in the … ” Clim Change
Casanueva et al. (2016) “Towards a fair comparison of SD and DD in the … ” Clim Change
Delta method caveats

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Boberg & Christensen, 2012

Jerez et al, 2013
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GCM-RCM consistency

20C3M

A1B delta

multi-GCM / single-RCM

single-GCM / multi-RCM

Turco et al. (2013) “Large biases and inconsistent CC signals in ENSEMBLES …” CC 120:859