Present-day biases and future changes in intra-seasonal variability of European temperatures

A pilot study with CNRM and IPSL models

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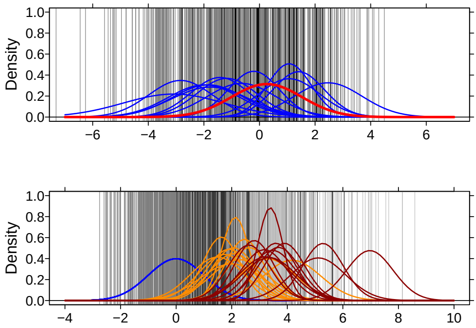
Motivations

European temperatures in CMIP3 models (DJF).



ERA-40 1961–2000 2046–2065 2081–2100

Understanding...

- Present-day biases, both in mean state & variability (extremes).
- Uncertainties in future projections (sensitivity to enhanced radiative forcing).

How?

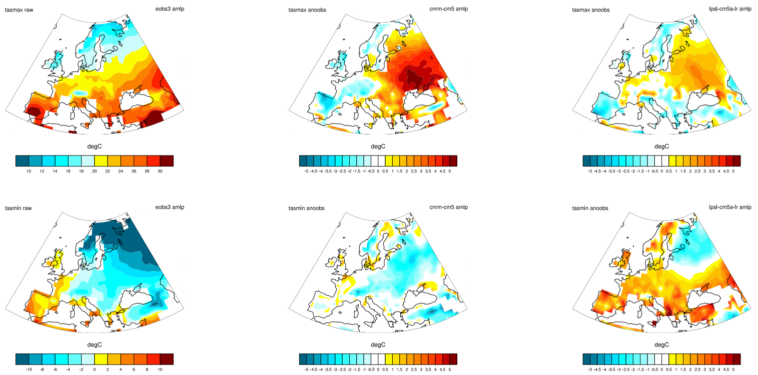
By decomposing biases / changes into dynamical (weather regimes) and physical contributions.

CNRM & IPSL in CMIP5

Up to now (now = May 2011): only AMIP-type experiments

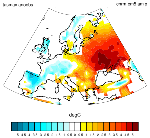
Mean seasonal temperature biases: *amip* vs. E-OBS over 1979–2008.

	E-OBS (raw)	CNRM-CM5 (bias)	IPSL-CM5A-LR (bias)
JJAS *tasmax*			
DJFM *tasmin*			



Breaking-up present-day temperature biases

$$\Delta T = \bar{T}^m - \bar{T}^0 = \sum_k f_k^m t_k^m - \sum_k f_k^0 t_k^0 = \underbrace{\sum_k \Delta f_k \cdot t_k^0}_{Inter-class} + \underbrace{\sum_k f_k^0 \cdot \Delta t_k}_{Intra-class} + \underbrace{\sum_k \Delta f_k \cdot \Delta t_k}_{Residual}$$



amip−ref
CNRM-CM5
JJAS *tasmax*

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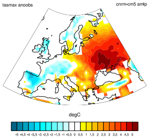

amip−ref
CNRM-CM5
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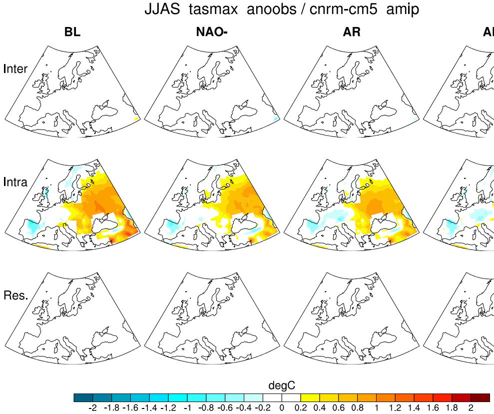

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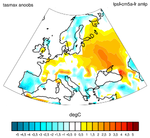
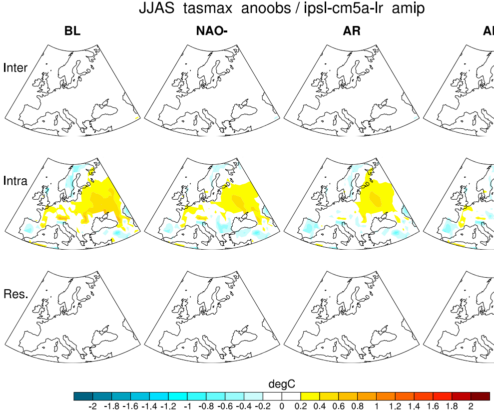


amip−ref
IPSL-CM5A-LR
JJAS *tasmax*



So?

Summary

- Methodology for decomposing biases / future changes in both mean and extreme temperatures into dynamical & physical contributions.
- First results for CNRM-CM5 & IPSL-CM5A-LR (*amip*):
  - ΔT almost exclusively due to intra-class contributions.
  - Intra-class ΔT can vary from one regime to another, and have to be linked to biases in radiative fluxes and processes.

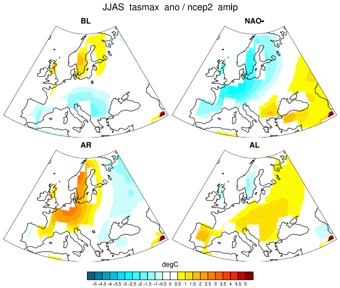
Prospects

- Better understanding of intra-class biases:
  - Estimating the dynamical part due to the WRs methodology.
  - Investigating surface energy budgets (clouds, albedo, snow etc.).
- Apply the methodology to all CFMIP2 models, and gather the multi-model information (e.g., highlight general features).
- Special issue: "only" CNRM & IPSL, submission in September?

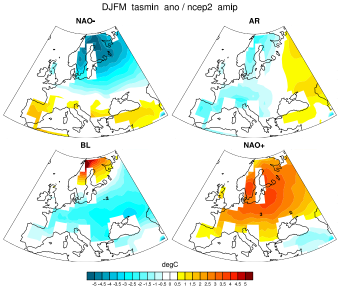
Intra-class mean temperatures t_k

- $t_k = \frac{1}{N_k} \sum_{i \in \Omega_k} T_i$, with Ω_k the N_k days spent in WR_k.
- Overall $\bar{T} = \frac{1}{N} \sum_i T_i = \sum_k f_k t_k$, with $f_k = \frac{N_k}{N}$ frequency of WR_k.

JJAS *tasmax*



DJFM *tasmin*

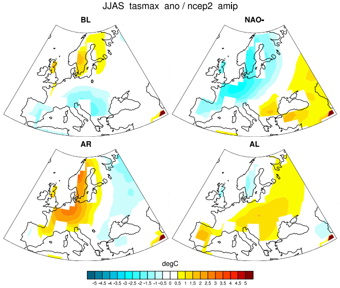


EOBS, 1979–2008, based on NCEP2 classification.

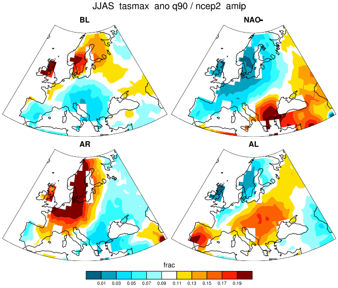
Days above/below $90^{th}/10^{th}$ temperature quantiles

- $p_k^{90} = \frac{n(T > T^{90})_k}{N_k}$, with N_k the number of days spent in WR_k.
- Overall $P^{90} = 10\% = \sum_k f_k p_k^{90}$, with f_k frequency of WR_k.

JJAS *tasmax*



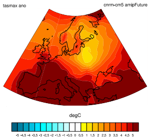
JJAS P^{90} (*tasmax*)



EOBS, 1979–2008, based on NCEP2 classification.

Breaking up future temperature increases

$$\Delta^{F-P} T = \sum_k \Delta f_k \cdot t_k^0 + \sum_k f_k^0 \cdot \Delta t_k + \sum_k \Delta f_k \cdot \Delta t_k$$



amipFuture—amip
CNRM-CM5
JJAS *tasmax*

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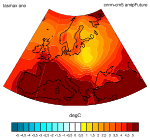

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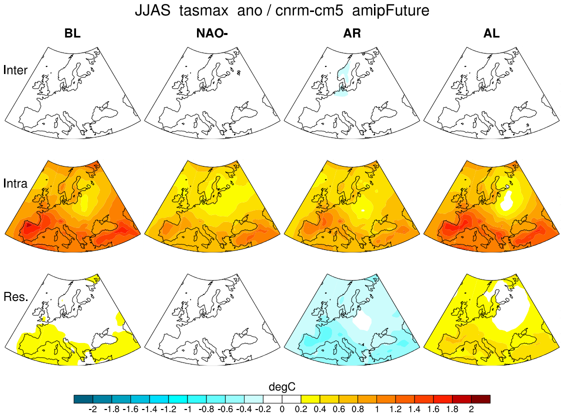

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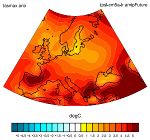

amipFuture−*amip*
IPSL-CM5A-LR
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