Evaluation of temperature variability and change over Europe

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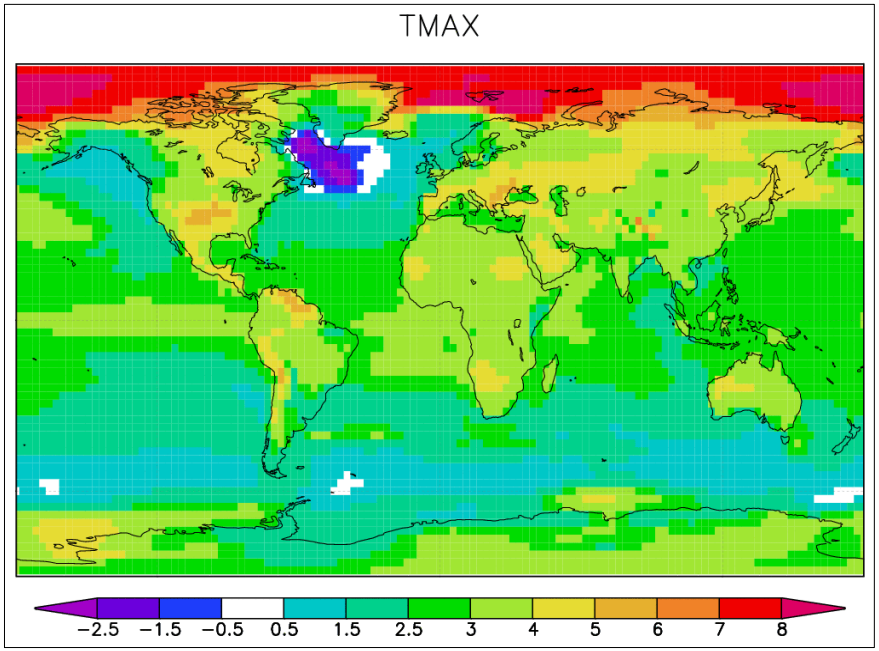
Toujours un temps d'avance

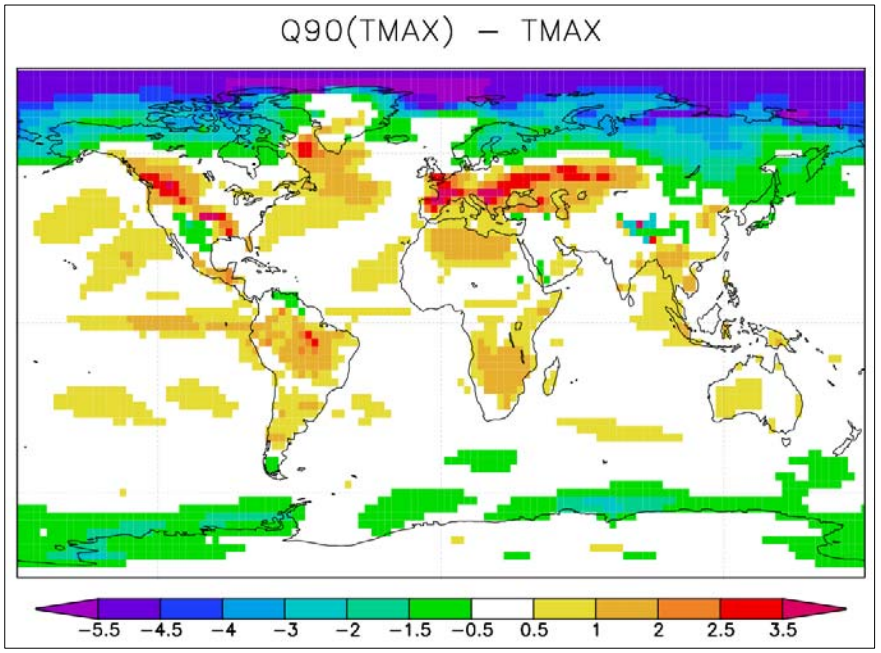
Motivations and objectives

- Cloud feedbacks are a major source of uncertainty for global warming projections (e.g. Dufresne and Bony 2008)
- But changes in temperature variability and extremes do not necessarily scale with global warming and is more relevant than changes in mean temperature (e.g. Schär et al. 2004)
- What are the biases (present-day climate) and uncertainties (future climate) in CFMIP/CMIP5 projections of temperature variability (including heat waves and cold spells) ?
- What is the contribution of regional cloud feedbacks ?
- How does it compare with other sources of uncertainties such as large-scale dynamics and land surface feedbacks ?

Southern Europe as a « hot spot » ?



SRES-A2 (2071-2100)
minus present-day (1971-2000)
climatology of JJAS mean
Tmax (K)



SRES-A2 (2071-2100)
minus present-day (1971-2000)
climatology of JJAS
Q90-Tmax (K)

Ballester et al., Climate Dyn., 2008

Partitioning of $T_{min/max}$ biases / anomalies

$$T = \sum_{i=1,n} f_i.T_i \text{ with } f_i \text{ frequency of regime i}$$

$$\Delta T = T_{sim} - T_{obs} \text{ (bias) or } T_{future} - T_{present} \text{ (CC)}$$

$$= \sum_{i=1,n} \Delta(f_i.T_i)$$

$$= \sum_{i=1,n} \Delta f_i.T_i + f_i.\Delta T_i$$

Bias / change of frequency of regime i => large-scale dynamics

Bias / change of T for regime i => regional feedbacks

Same method for « extreme probabilities »

$$P(T_{min}<Q) = \Sigma_{i=1,n}\, f_i.P(T_{min}<Q \mid i)$$

$$\Delta P(T_{min}<Q) =$$

$$\Sigma_{i=1,n}\, \Delta f_i.P(T_{min}<Q \mid i) + f_i.\Delta P(T_{min}<Q \mid i)$$

Bias / change of frequency of regime i => large-scale dynamics

Bias / change of $P(T_{min}<Q)$ for regime i => regional feedbacks

Need of daily data (CFMIP)

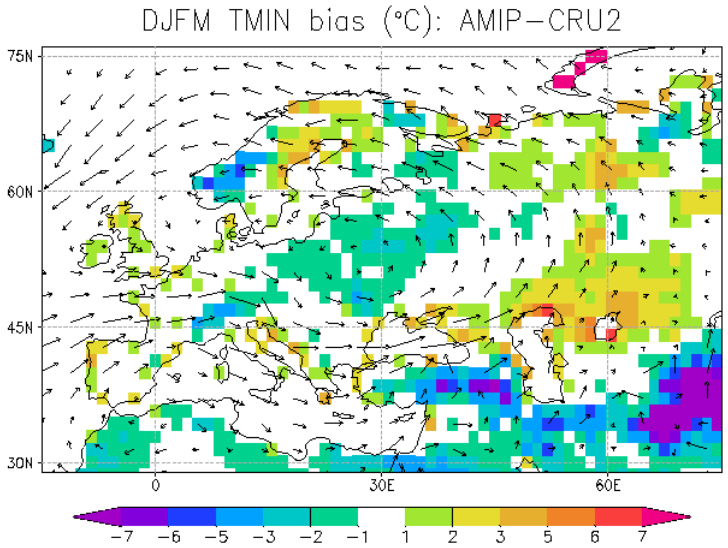
Daily data	Observations	Models
Z500	ECMWF (1958-2008)	Day or cfDay
Tmin, Tmax, RH	ENSEMBLES (1950-2006)	Day
Radiative (and turbulent) fluxes	ISCCP (1983-2000)	Day + cfDay
Low/Mid/High Cloud fraction	ISCCP (1983-2000)	Day + cfDay
OLR	NOAA (1979-2008)	Day
Snow and soil moisture	Off-line climatol. (1950-2006)	Day
SST	ECMWF (1958-2008)	Day

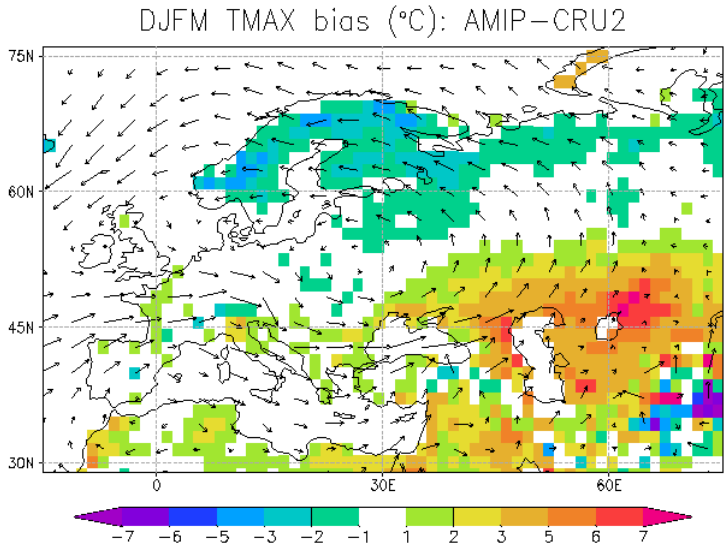
Summary

- Evaluation of temperature biases and changes over Europe using a weather regime cluster analysis for both winter (DJFL) and summer (JJAS)
- Comparison of various sources of errors (present-day climate) and uncertainties (future climate):
  - Large-scale dynamics (frequencies of weather regimes)
  - Cloud feedbacks
  - Land surface feedbacks (soil moisture in summer, snow cover in winter)
- Need of daily model outputs (CFMIP, possibly CMIP5, Z500)
- 18-month postdoc starting in January 2011

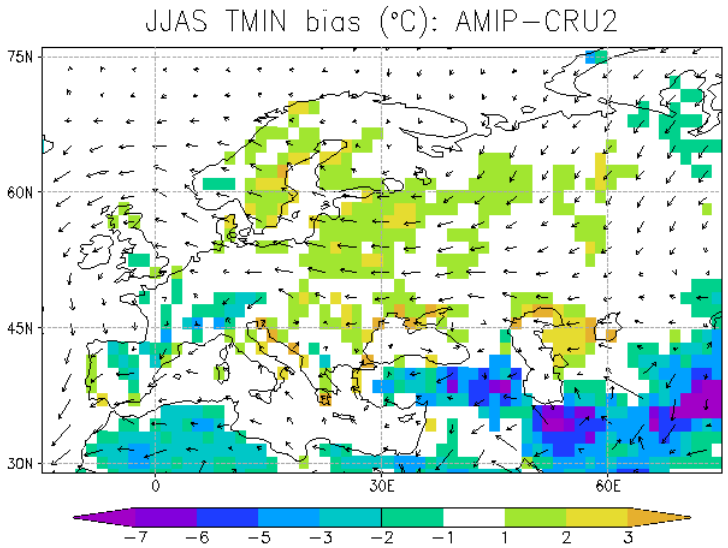
Tmin and Tmax biases in ARPEGE-Climat v5.2

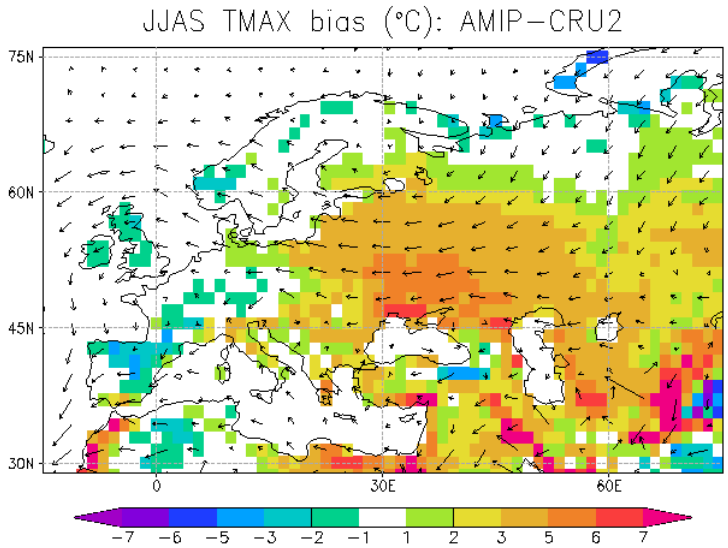
DJFM





JJAS





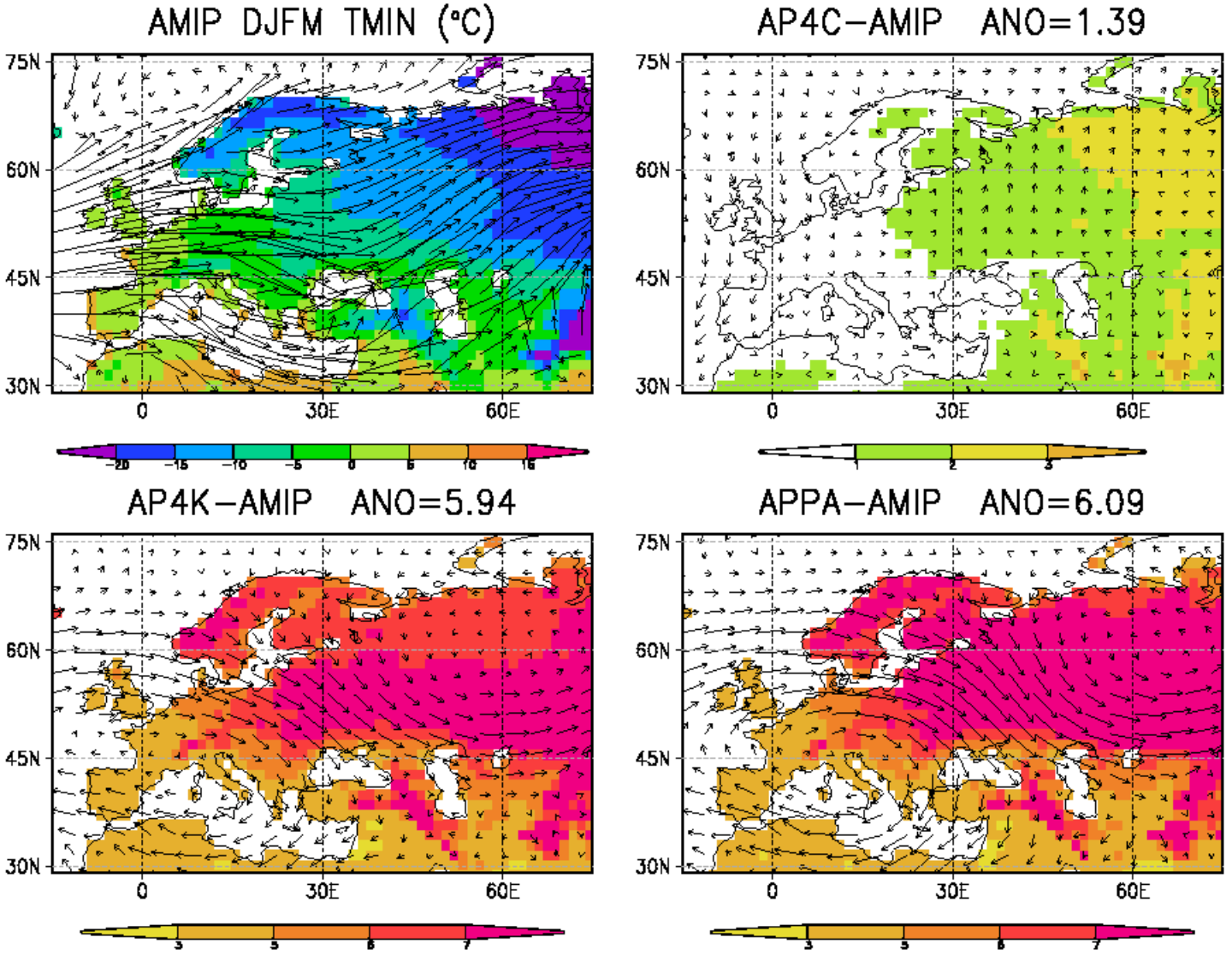
DJFM Tmin response in ARPEGE-Climat v5.2

CTRL

4 CO2

+ 4K unif

+ 4K CMIP3



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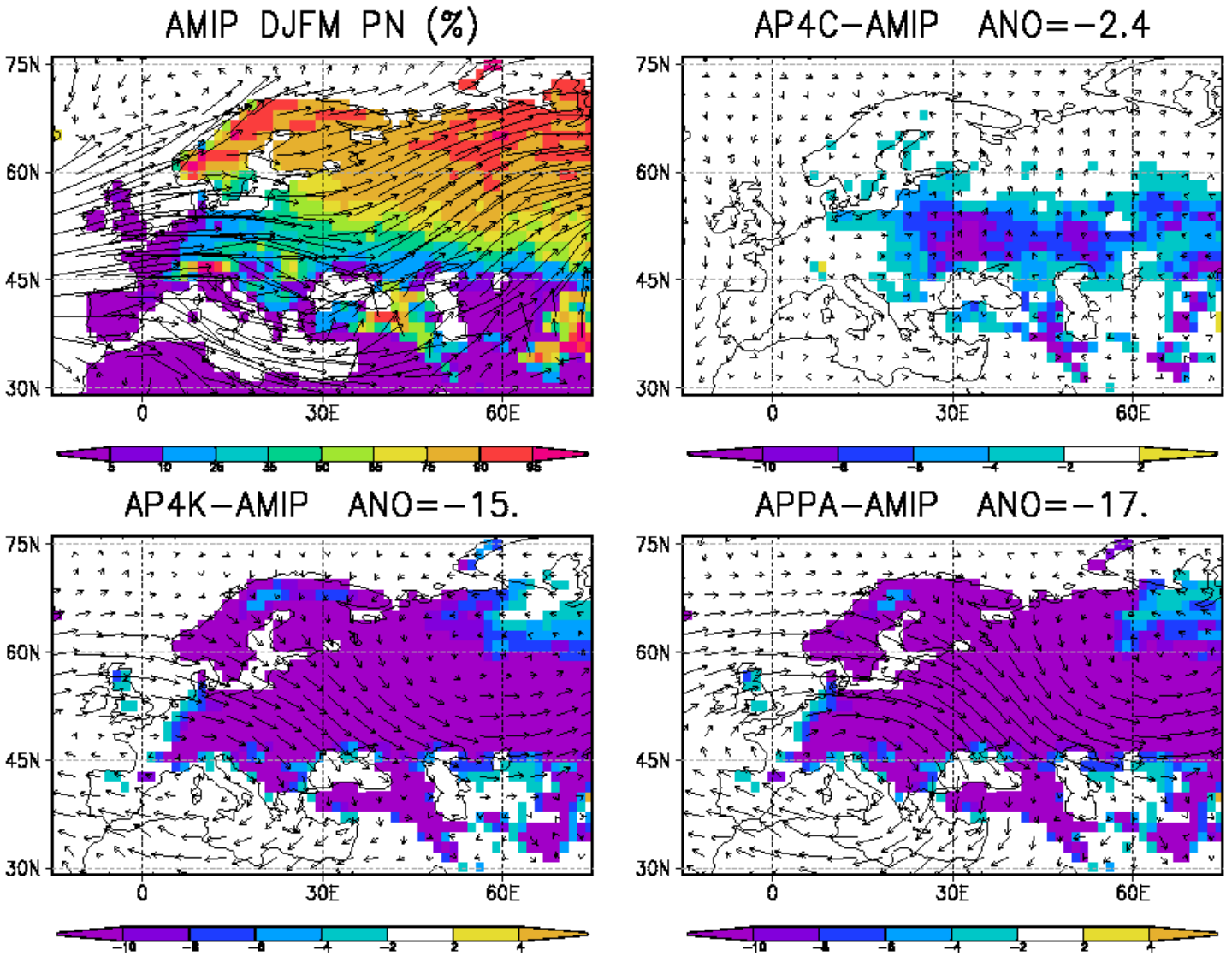
DJFM cloud cover / snow cover response

CTRL

4 CO2

+ 4K unif

+ 4K CMIP3



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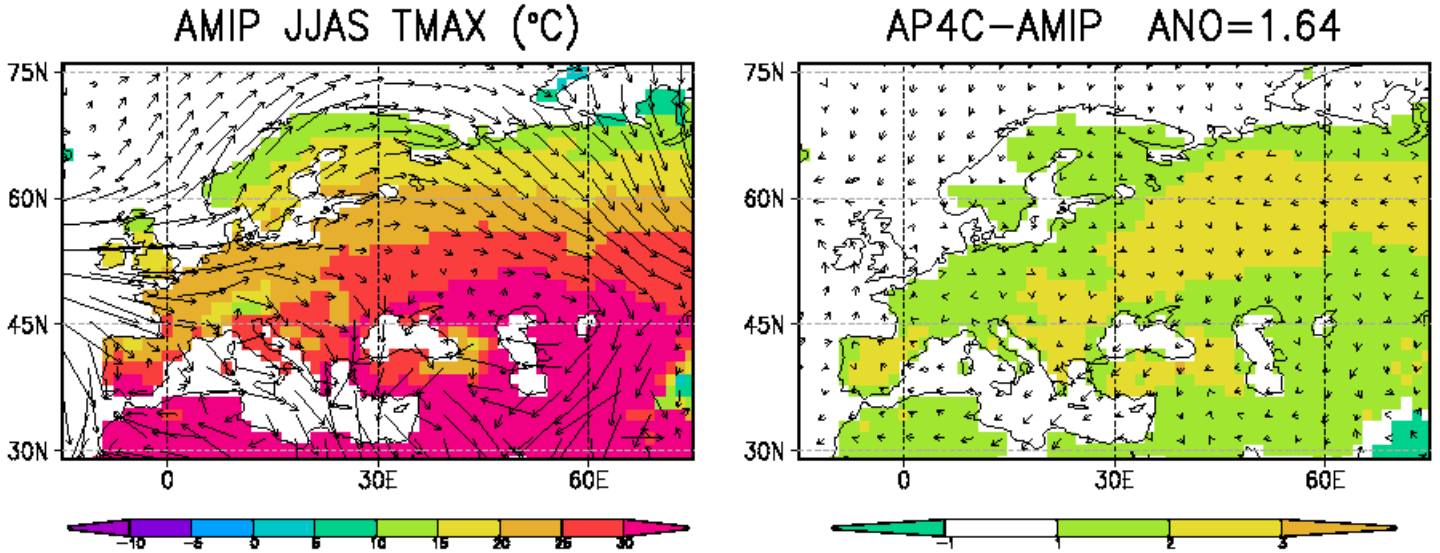
JJAS Tmax response in ARPEGE-Climat v5.2

CTRL

4 CO2

+ 4K unif

+ 4K CMIP3



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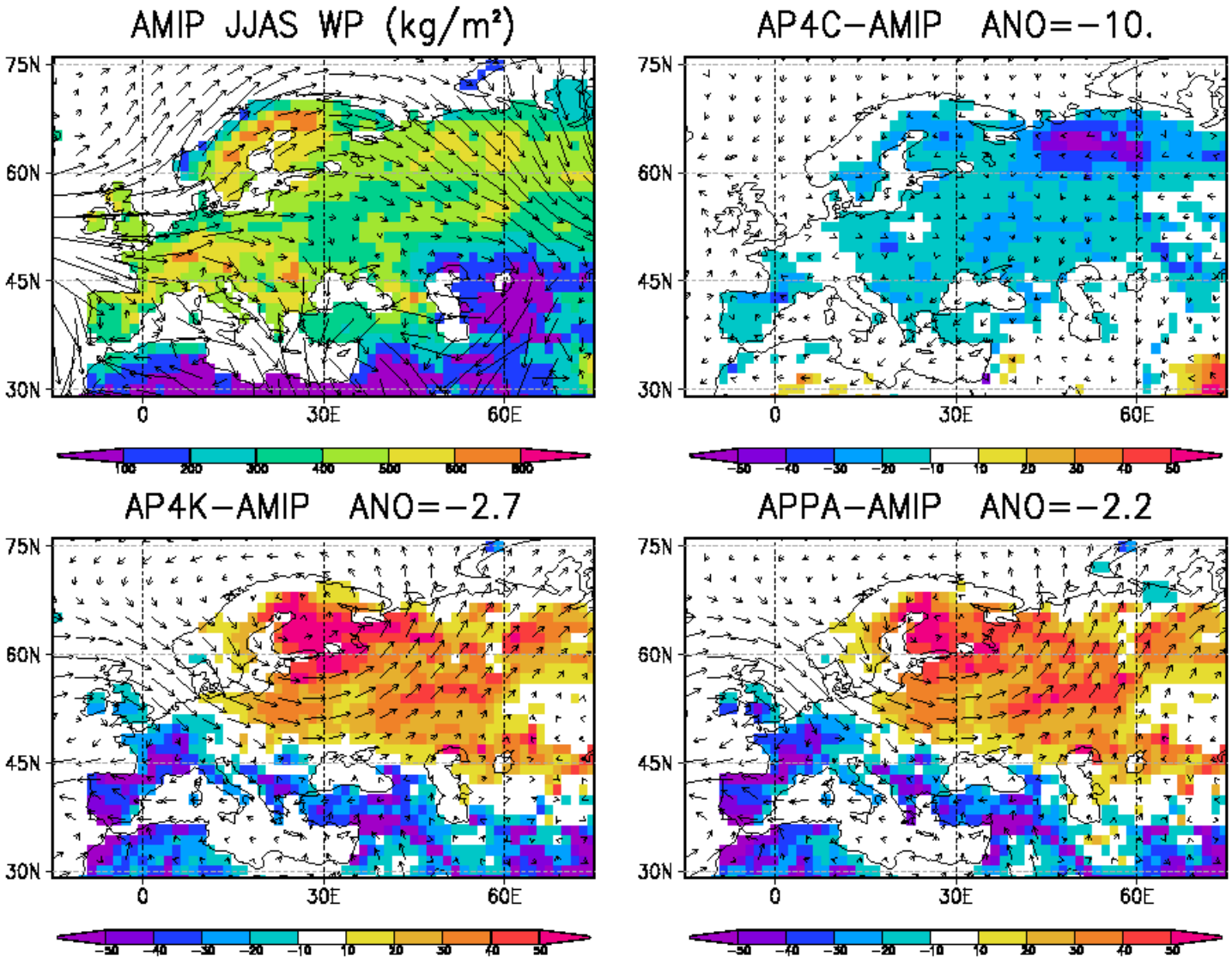
JJAS cloud cover / soil moisture response



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