Exploring WRF configuration sensitivity over the Euro-CORDEX domain.

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OUTLINE

1. Introduction
2. Objectives
3. Data and methods
4. Results
5. Conclusions

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INTRODUCTION

Santander Meteorology group is contributing to de EUROCORDEX project, among many other groups.

Contributions:

- 0.44 deg and 0.22 deg domains ERA-INTERM run 1979-2010 (WRF 3.3.1)

- 0.44 deg domain ERA-INTERIM run 1979-2010 (WRF 3.4 with wind correction*)

- 1 year (2001) sensitivity analysis to convective parametrization

* Jimenez and Duhia 2011.

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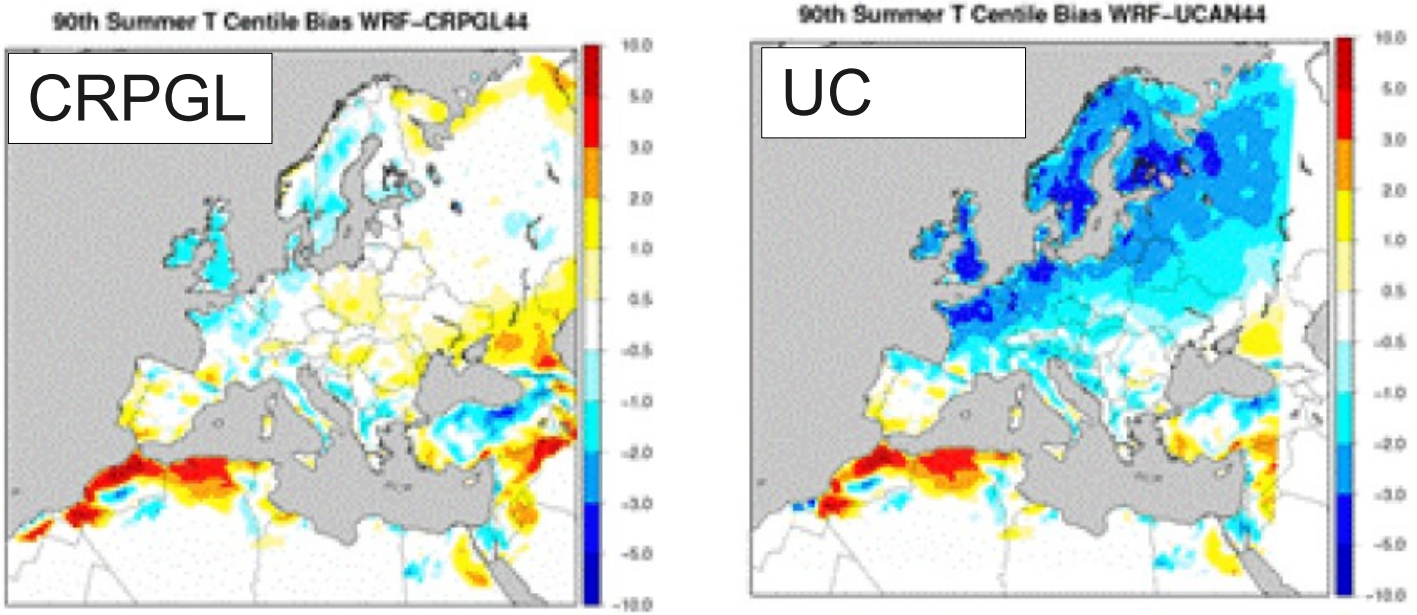
RESULTS

In the EUROCORDEX heat wave paper (1), a large difference was found between the WRF run carried out by our group (UC) and the Centre de Recherche Public Gabriel Lippmann (CRPGL)



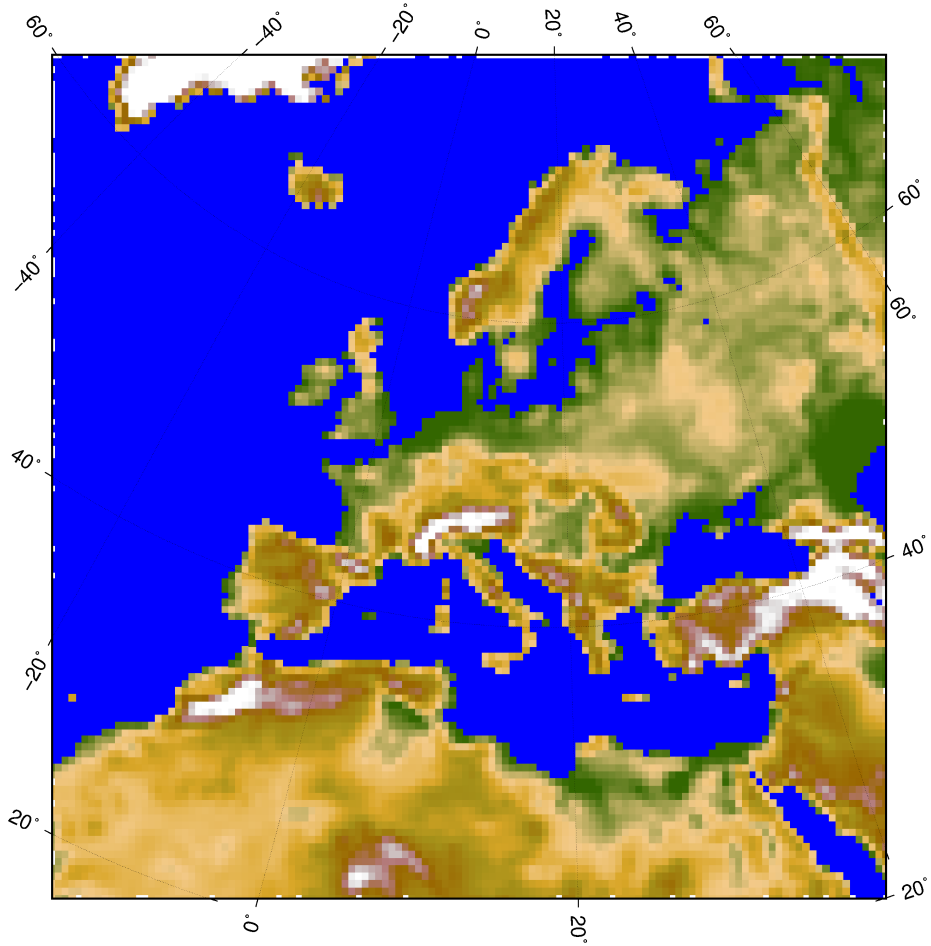
(1) Vautard, R., A. Gobiet, D. Jacob, M. Belda, A. Colette, M. Déqué, J. Fernandez, M. Garcia-Diez, K. Görgen, I. Güttler, T. Halenka, K. Keuler, G. Nikulin, M. Patarčić, M. Suklitsch, C. Teichmann, K. Warrach-Sagi, V. Wulfmeyer (2012): *The simulation of European heat waves from an ensemble of regional climate models within the EURO-CORDEX project*, Clim. Dyn., submitted

OBJECTIVES

- After a few tests, the responsible of the difference was found to be the change from the Grell-Devenyi convection scheme (UC) to the Kain-Frisch (CRPGL).

- The objective of this study is to explore the causes of the large sensitivity of summer temperatures to the convection scheme.

Eurocordex 0.44 domain



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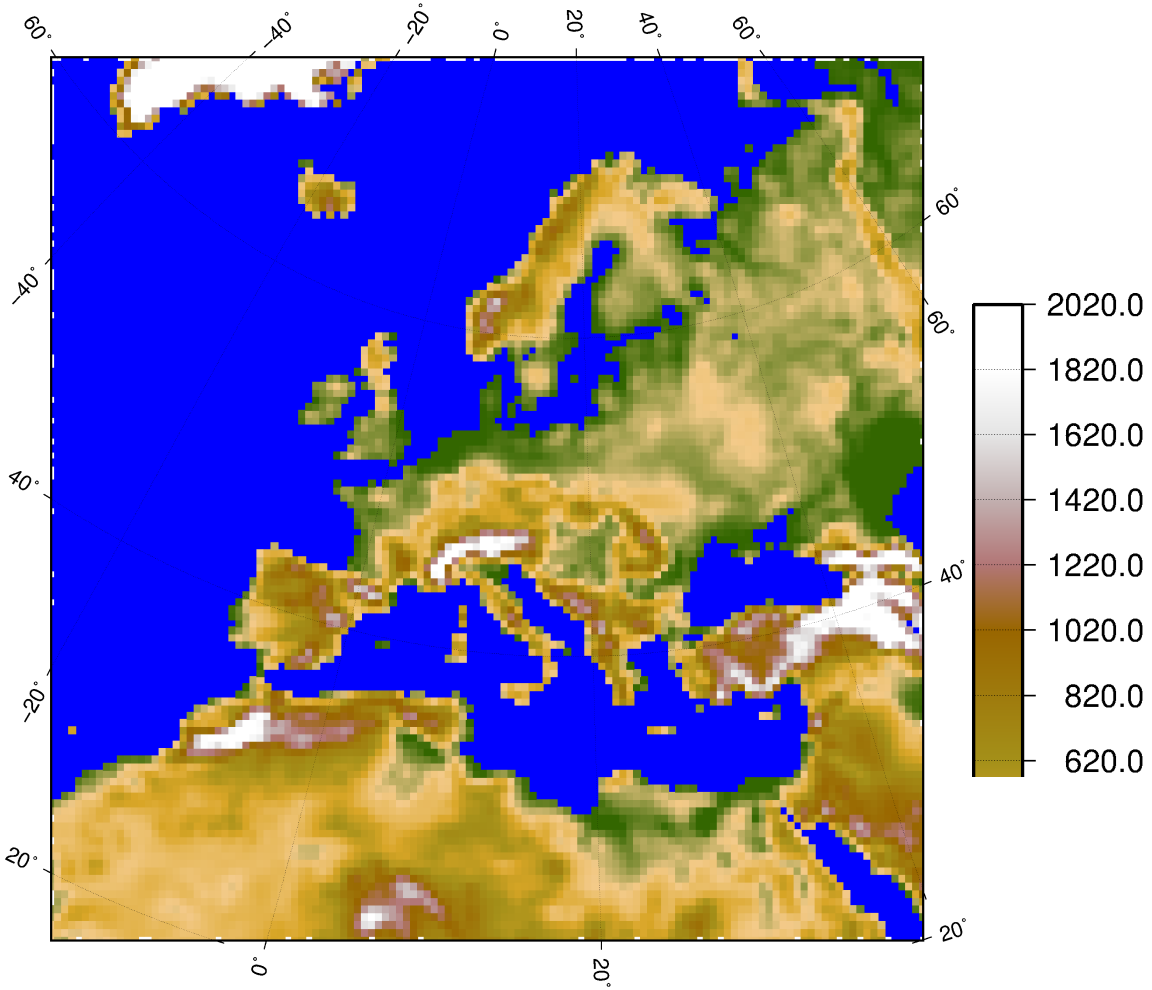
DATA AND METHODS

2 simulations covering the year **2001** using both Grell and KF



WRF configuration	
Domain	127x124 points
Time step	300 s
Horizontal resolution	0.44 deg
Vertical levels	50
Boundary data.	**ERA-INTERIM**

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RESULTS

- Provided the namelist used by CRPGL, differences between their configuration our were tested individually.

- Convection scheme was found to be responsible of most of the difference found in summer temperatures.

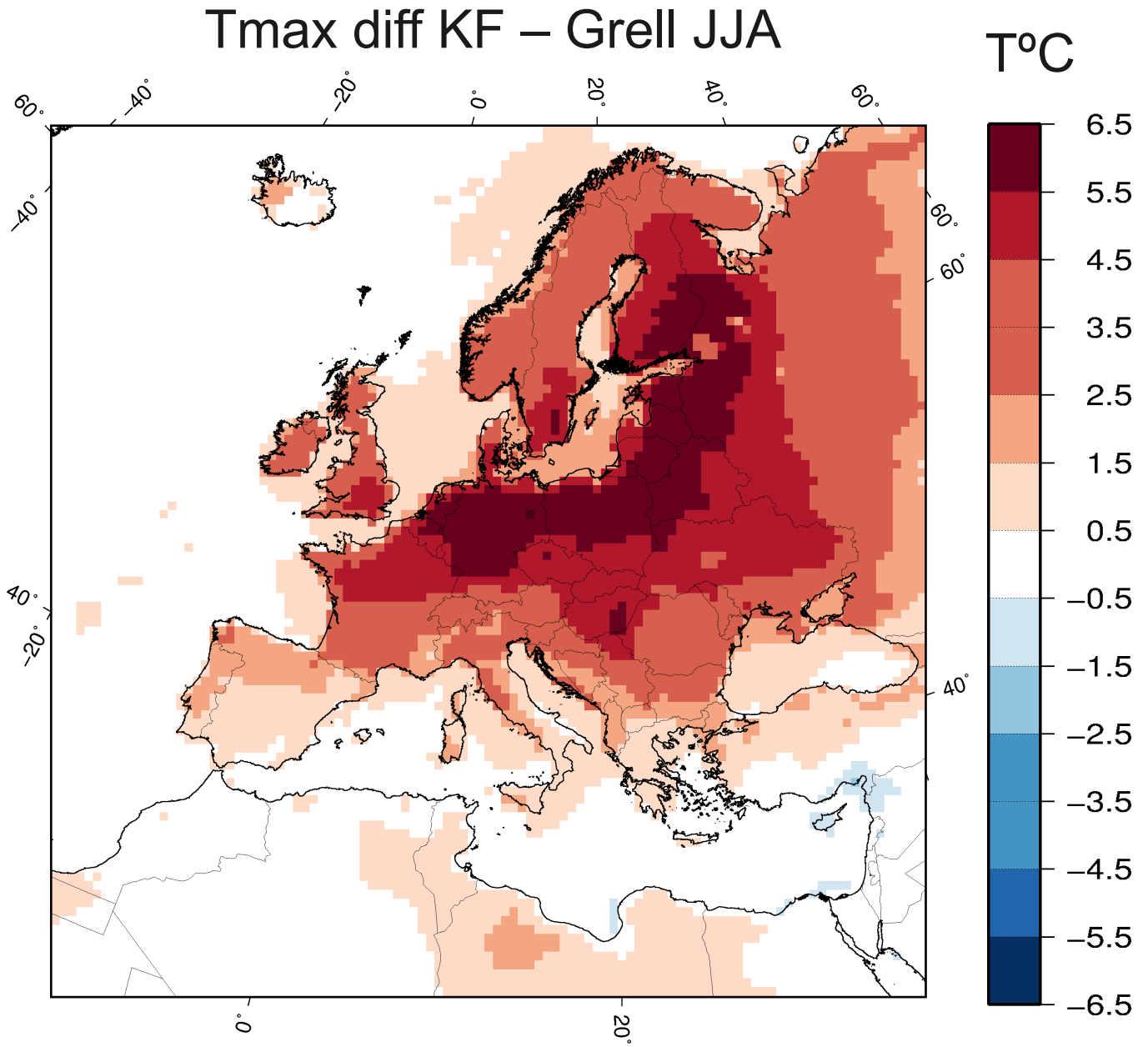
  UC → Grell-Devenyi (ensemble)

  CRPGL → Kain-Frisch (mass-flux)

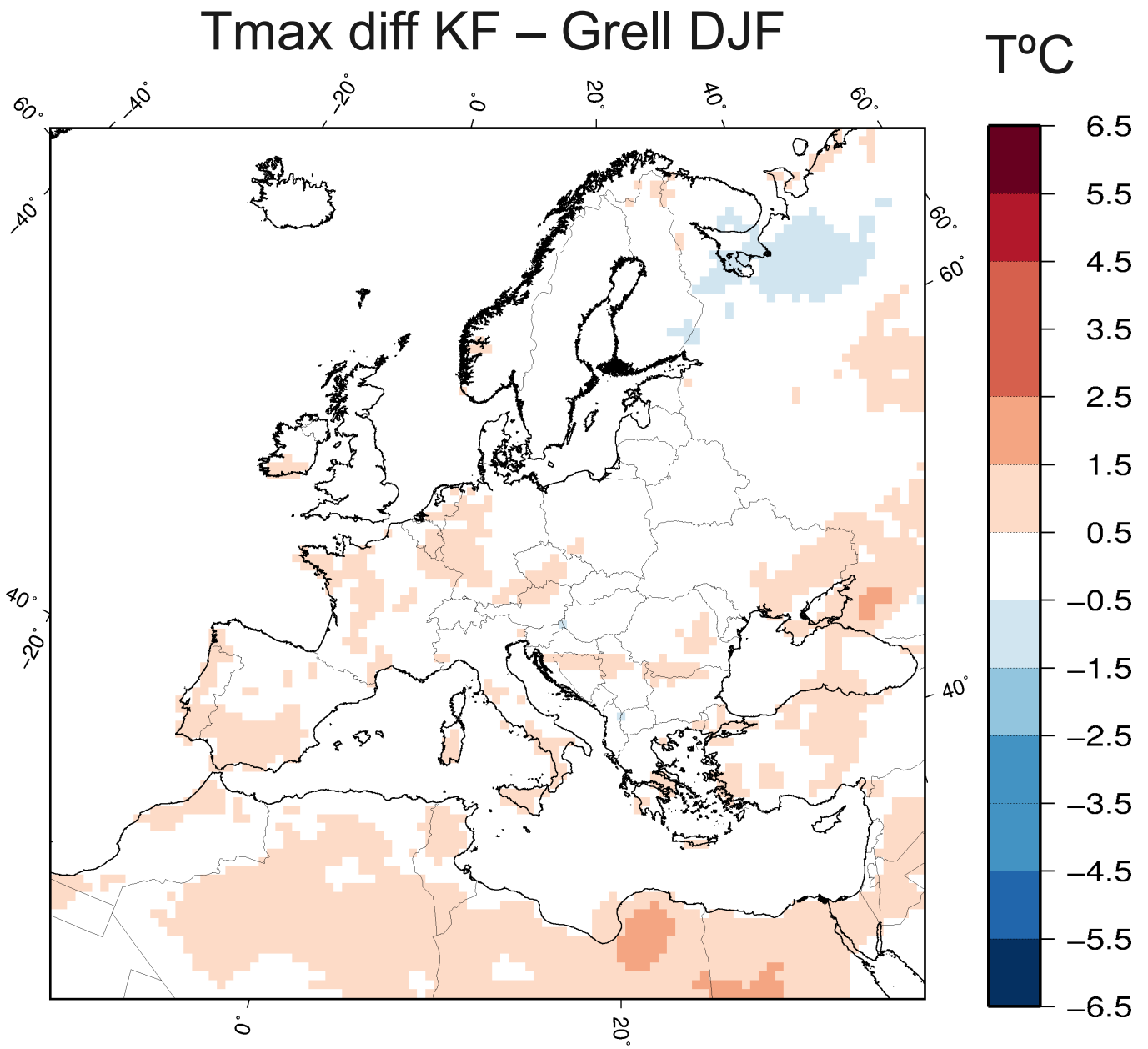
- Kain-Frisch is able to do shallow convection.

The warming appears in most of Europe, excepting the south.

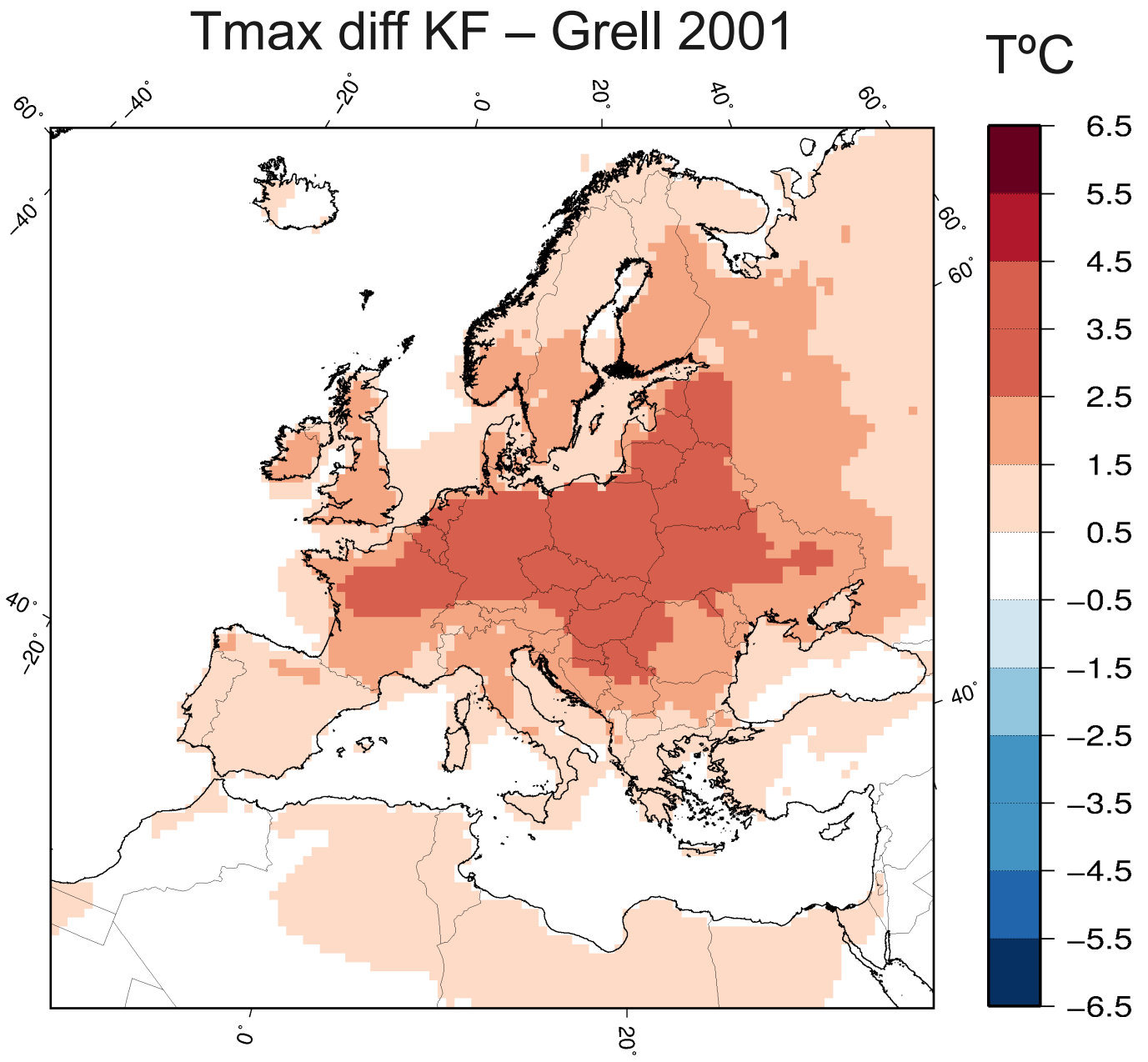
Little difference is found over Africa.



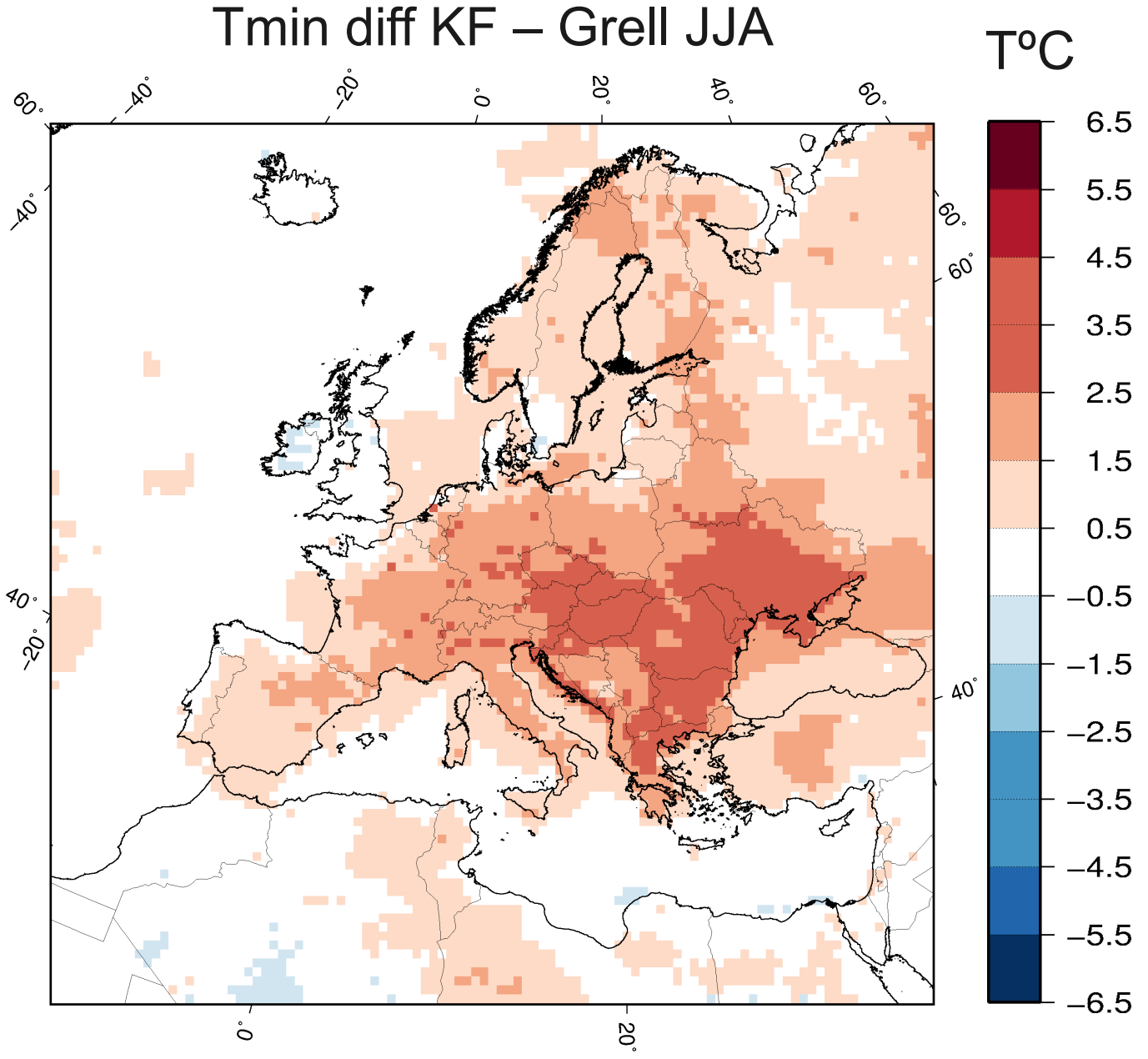
The difference appears only in the warm season.



But if averaging the whole year, this difference prevailing, and thus affecting the climatology of mean temperatures.



It does also appear in minimum temperatures, but is significantly smaller, and different pattern.



RESULTS

The following are candidates to explain this surprisingly large temperature shift.

1. Differences in the amount of rainfall in spring-summer, leading to a more moist soil in the simulation using Grell.

2. Differences in the cloud cover.

3. Differences in the entrainment, or the diffusión of the heat when when stabilizing the troposphere after a convective event.

or more...

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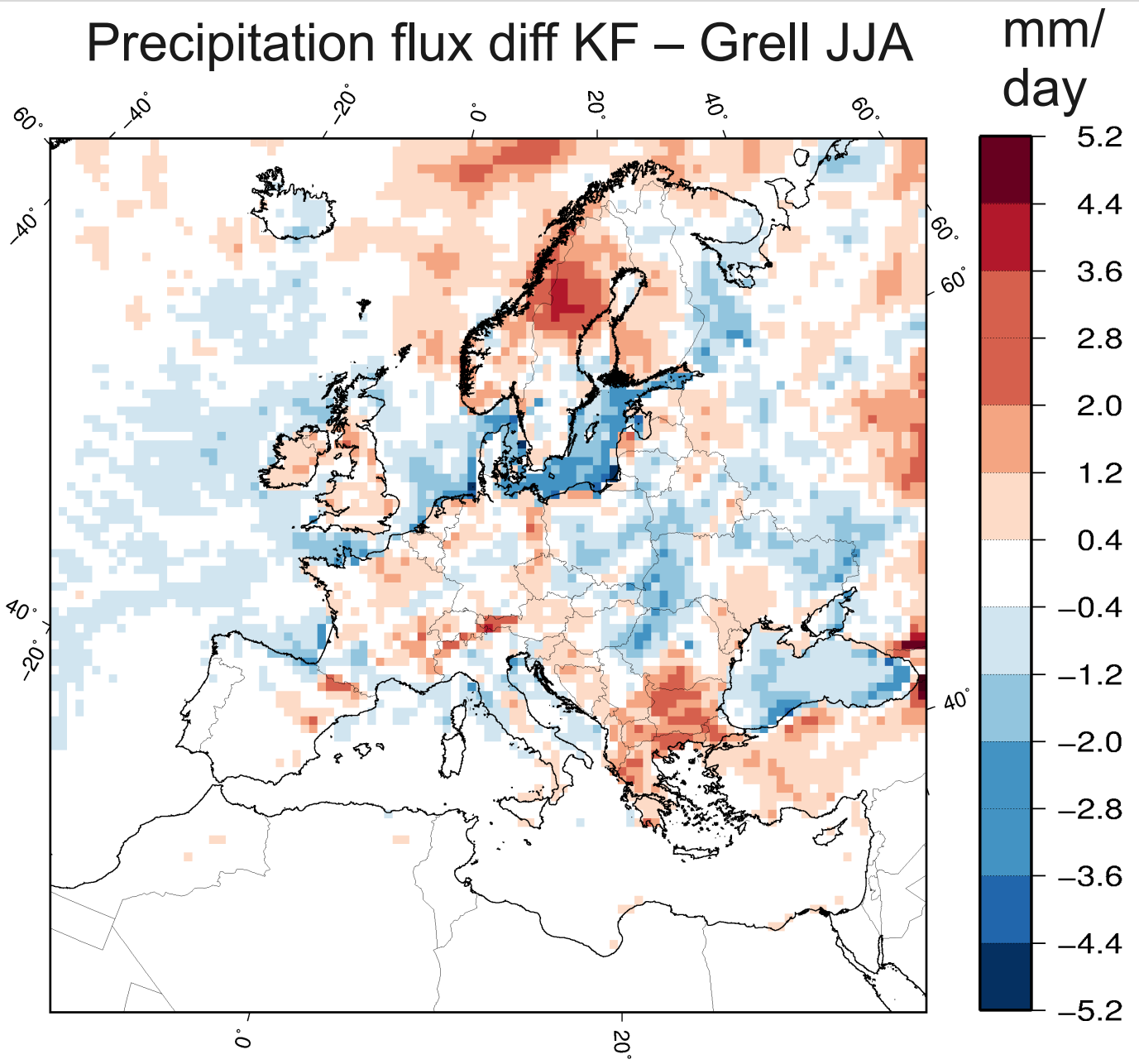
There are not large differences in precipitation, neither in spring or summer. Only noisy differences related to internal variability.



RESULTS

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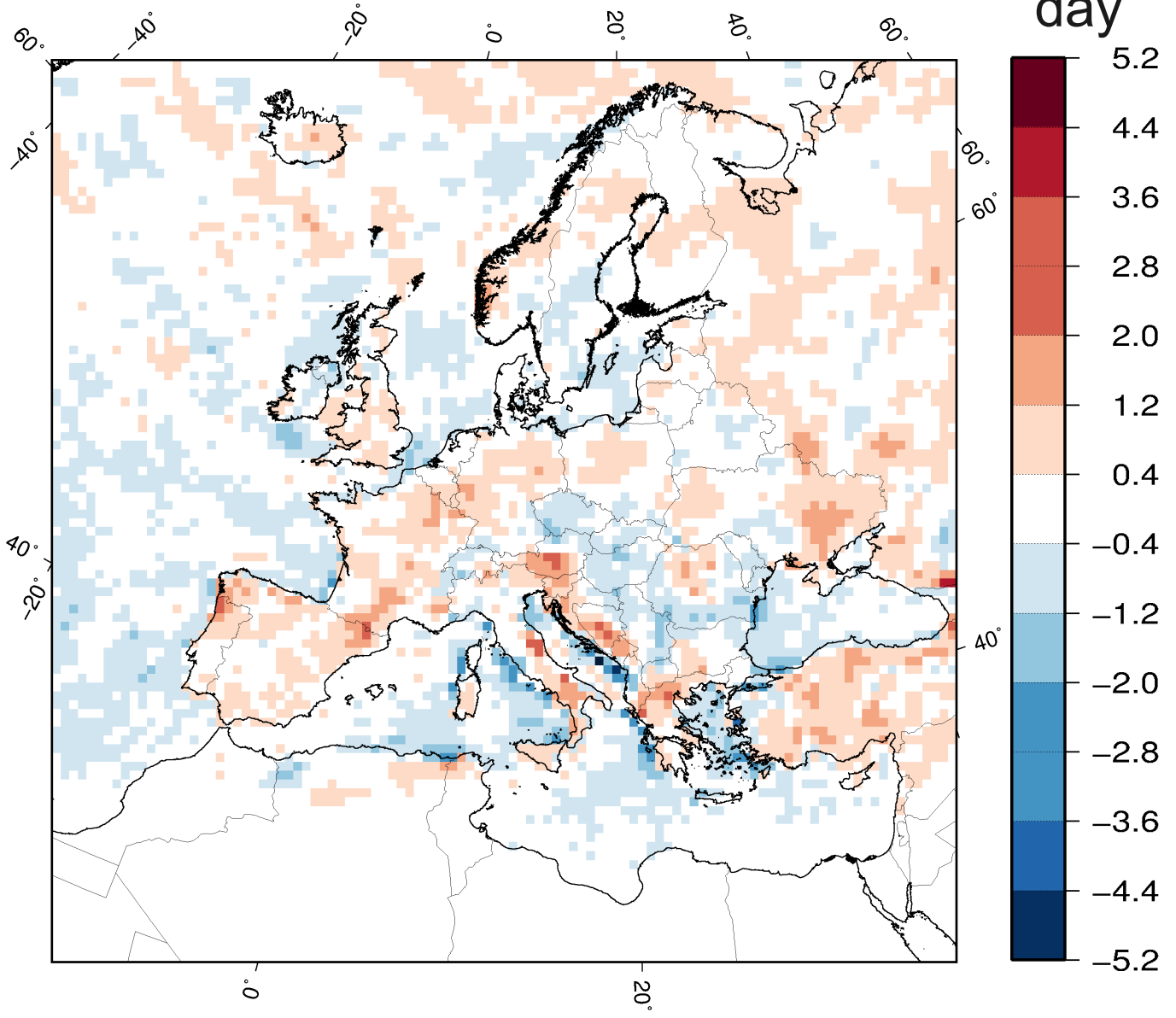
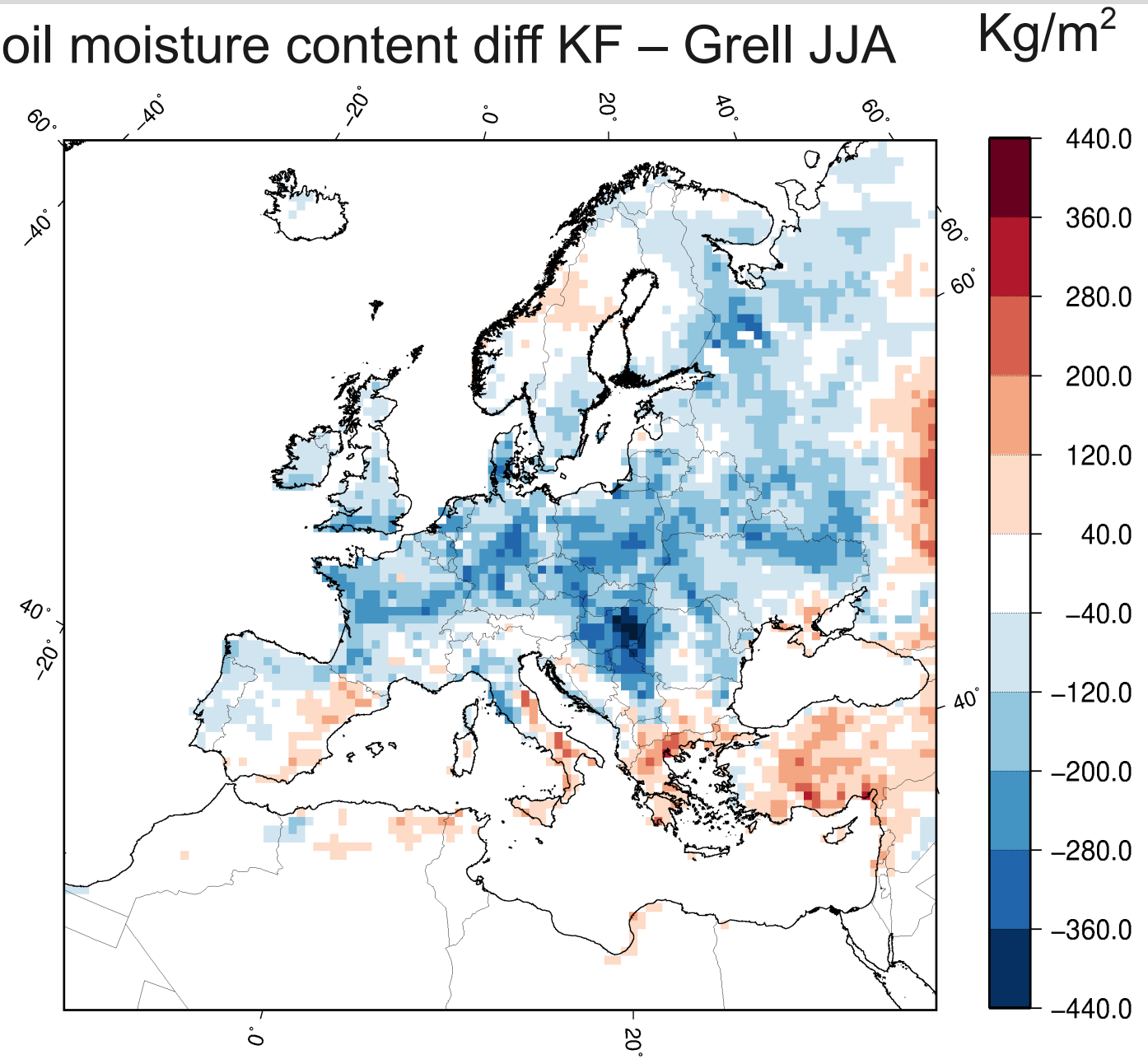
Precipitation flux diff KF – Grell MAM



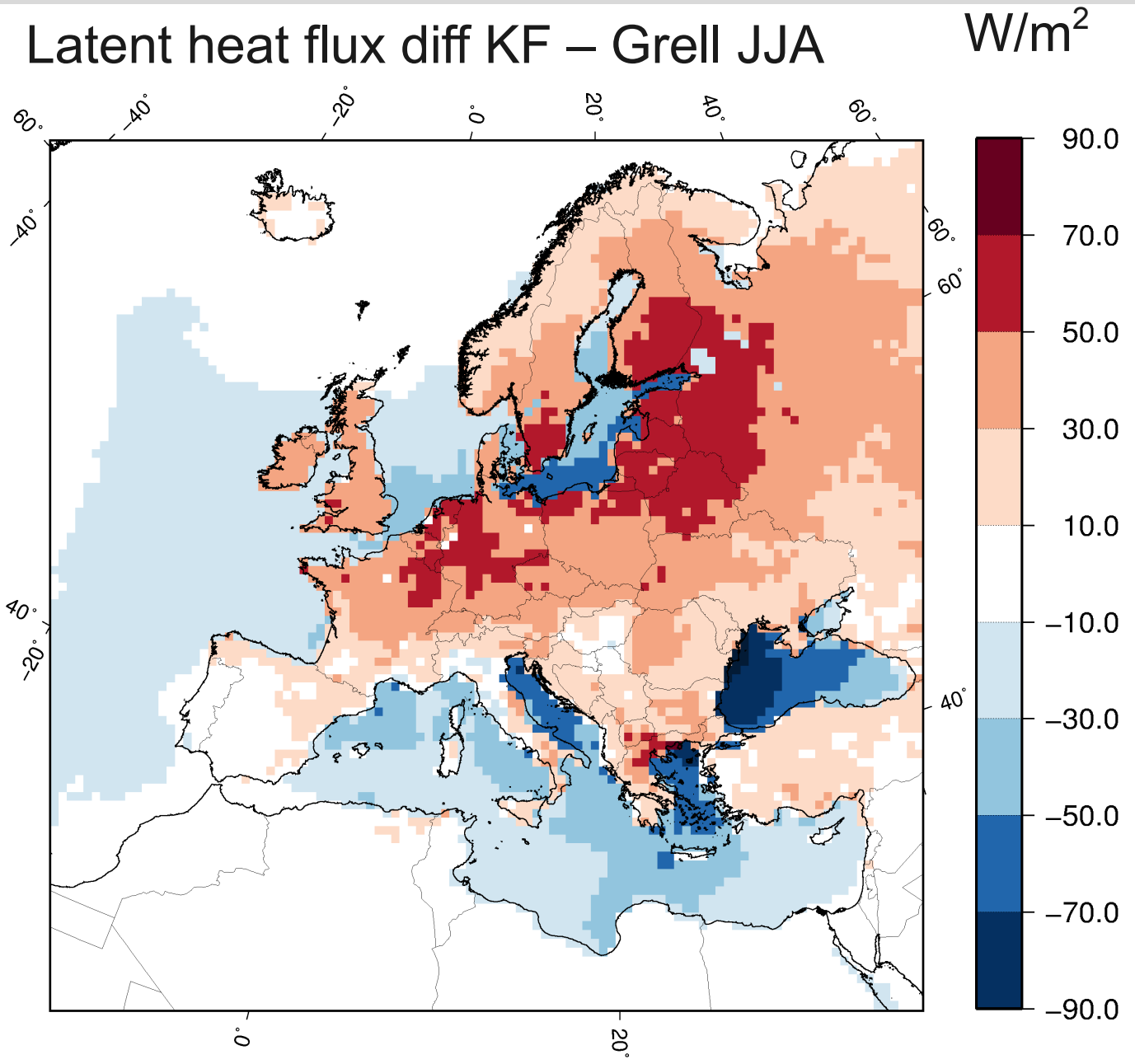
But the soil moisture content is clearly lower in the simulation using KF.

Soil moisture content diff KF – Grell JJA



Despite lower soil moisture, latent heat flux is larger in KF.

Latent heat flux diff KF – Grell JJA



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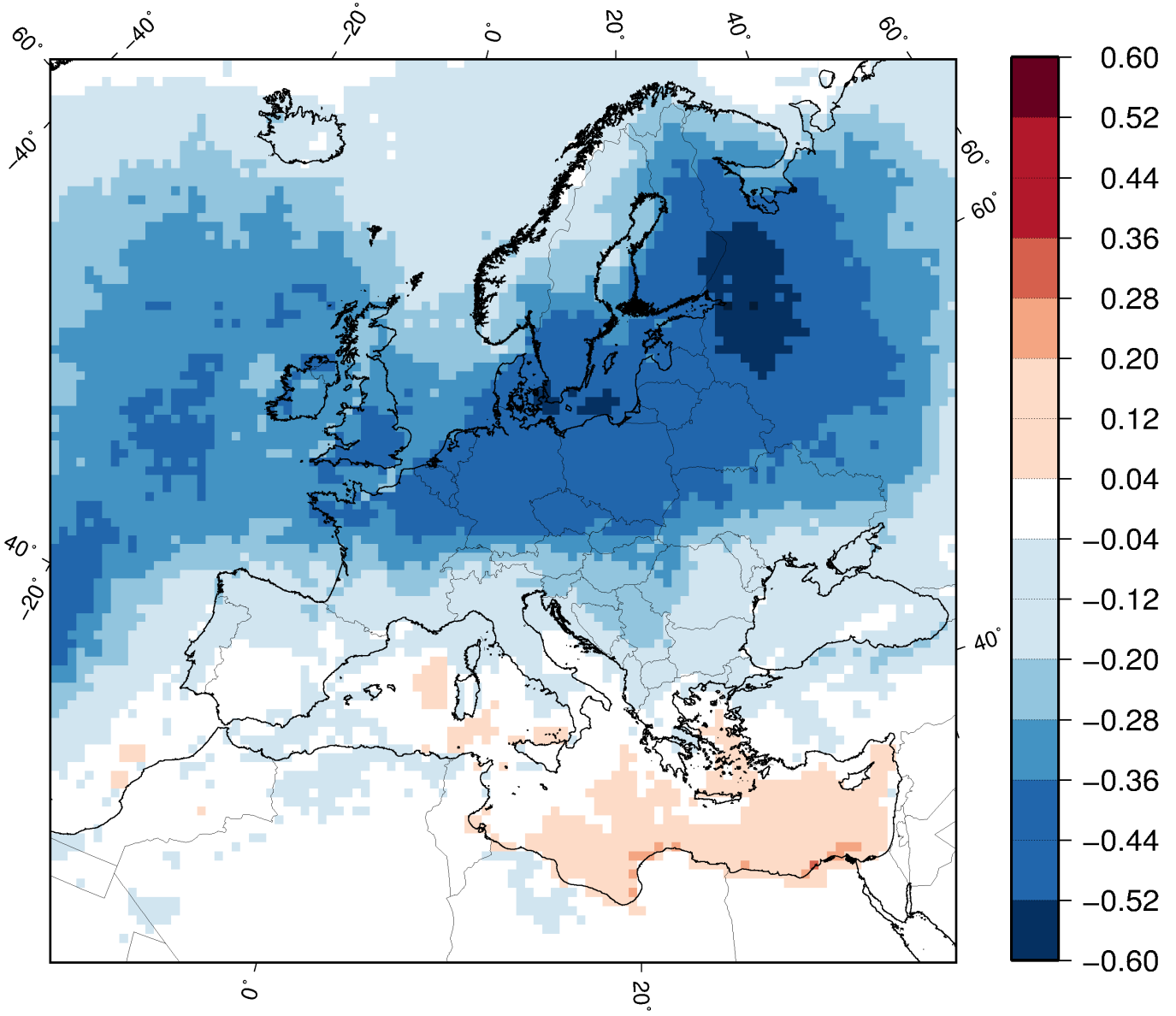
RESULTS

Grell is producing a more cloudy weather. Cloud cover seems to be a good candidate to explain the large difference found in temperatures.

Also the spatial pattern clearly fits with the pattern.

Shallow convection?

Total cloud cover diff KF – Grell JJA



Emerging picture:

Kain-Frisch producing less clouds

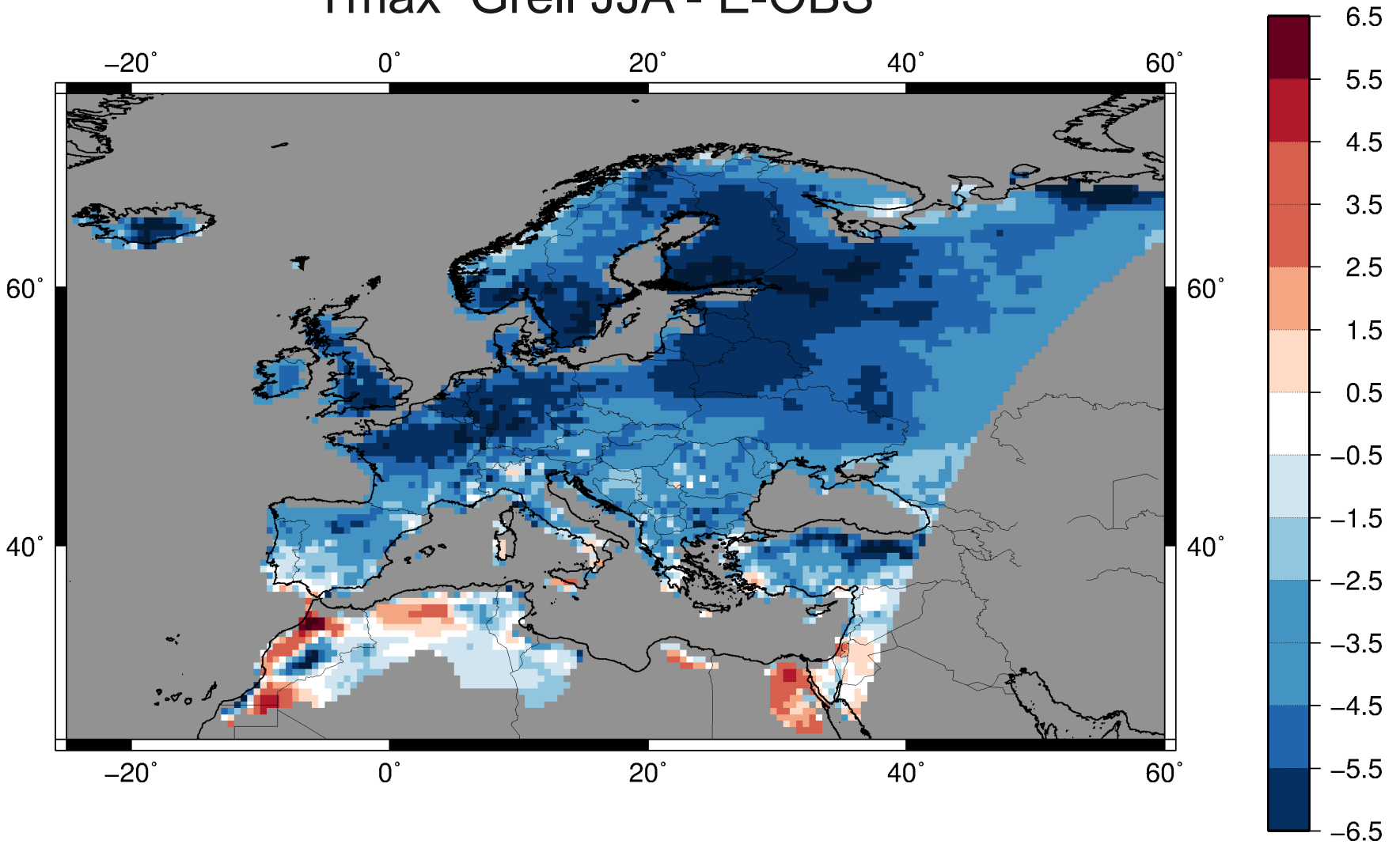
↓

Warmer temperatures

↓

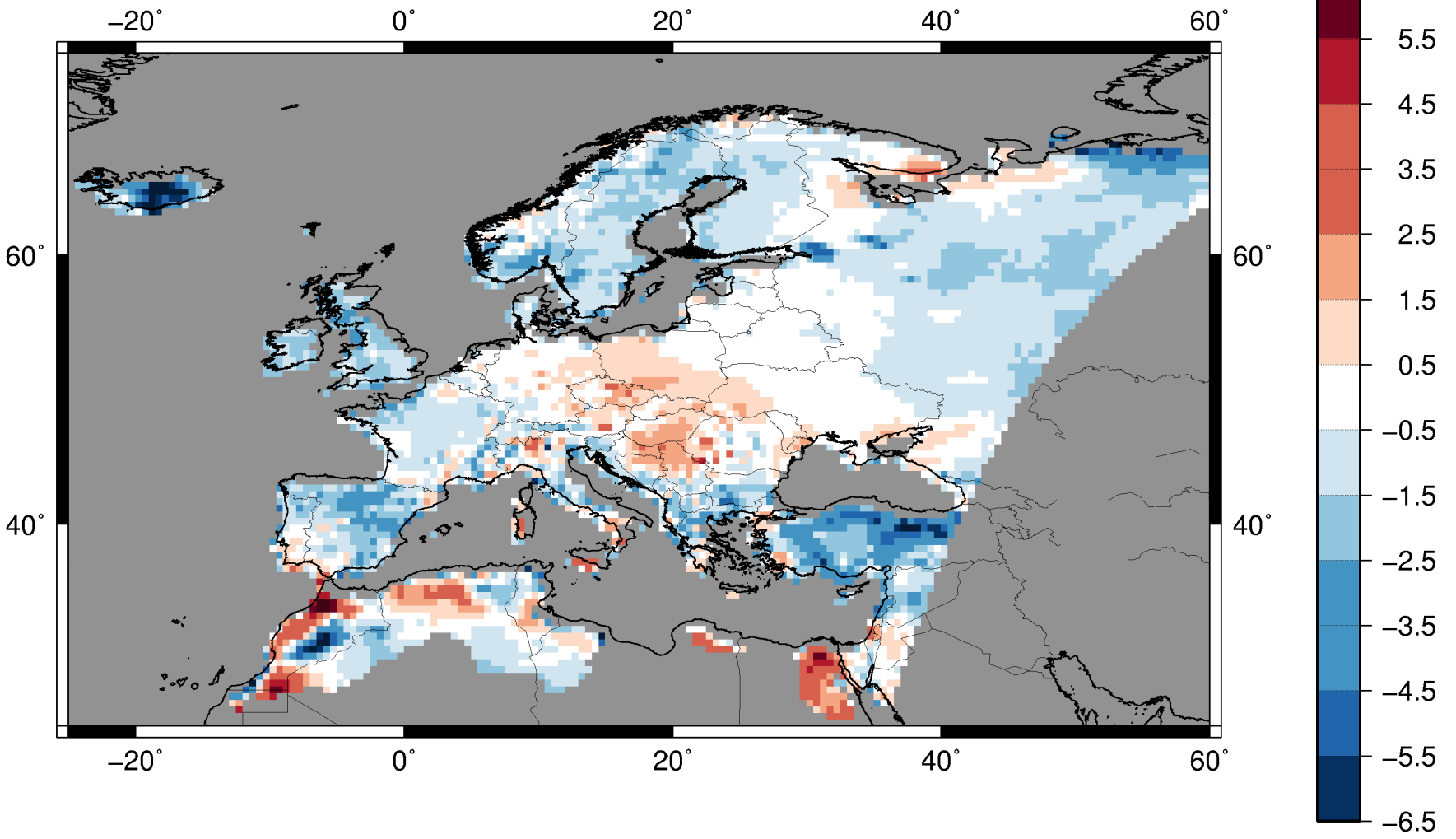
Less soil moisture content

Tmax Grell JJA - E-OBS



So, how does the temperature improve when changing to Kain-Frisch?

Tmax Kain-Frisch JJA - E-OBS



Wow!

Good job! We have really improved our 2m temperature field...

...but what if this is not enough?

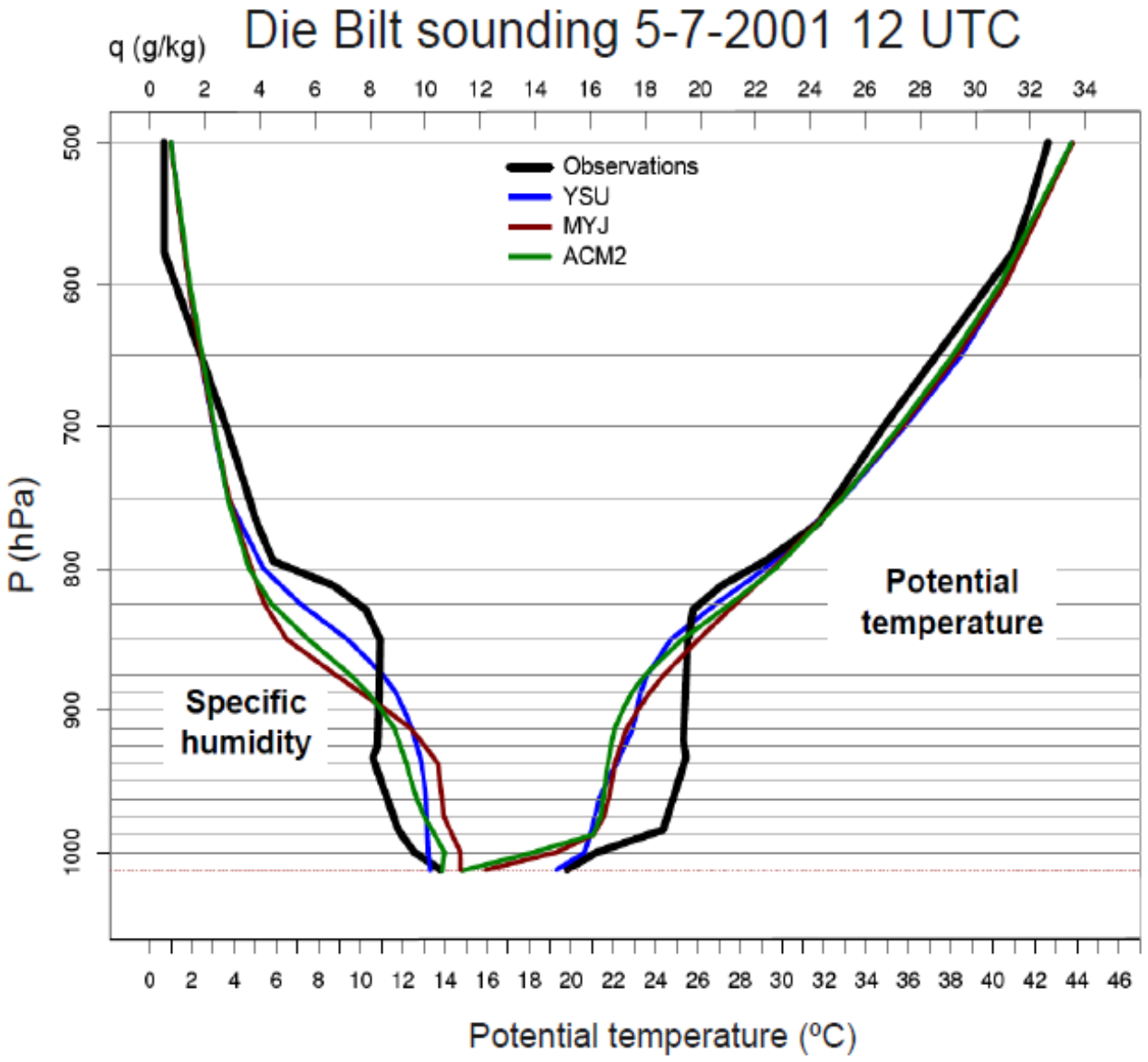
We don't know if there are other fields wrong. There are very few observations of many important fields and parameters. ¿Could we be just compensating different errors to get a correct temperature?

The impossibility to evaluate every field and parameter of the model leads to ensemble approaches to asses uncertainties.

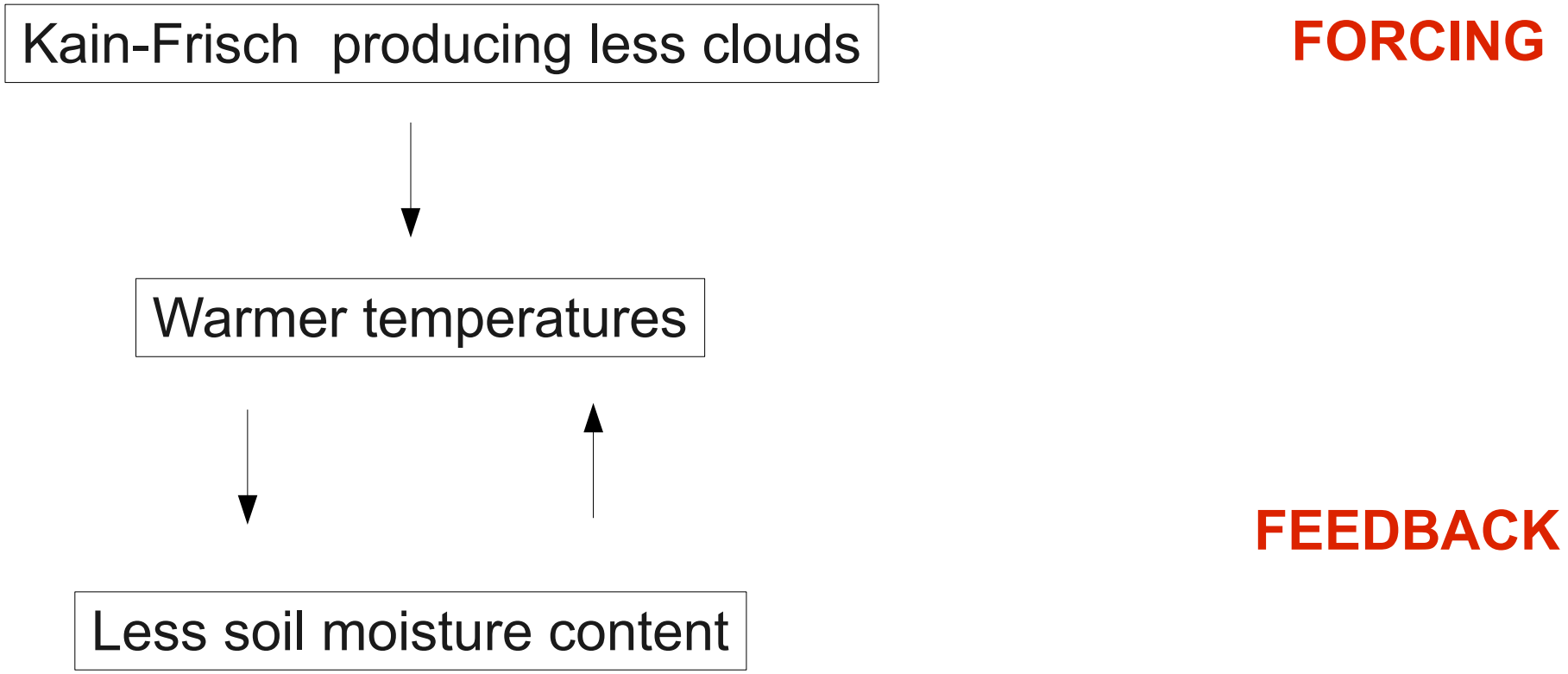
Example of “0 bias”, but because of wrong reasons.

Daily reforecasts of 2001 with 3 PBL schemes (Garcia-Diez et al. 2012, QJRMS)

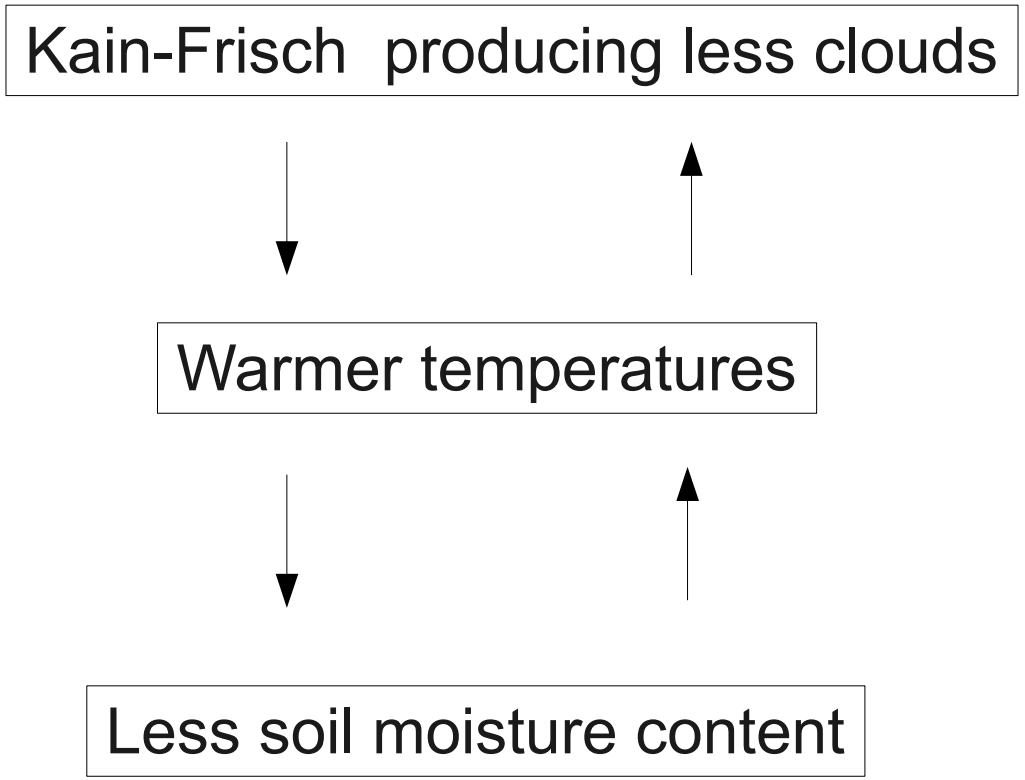
Vertical profile completely wrong!



More realistic picture:



Or even:



FEEDBACK

FEEDBACK

Different models can lead to different equilibrium points and different temperatures without a clear forcing or “cause”. Beware of our tendency to “thinking in linear”.

Question for discussion:

¿How can be distinguish a forced error from a system with equilibrium points differing from observation?

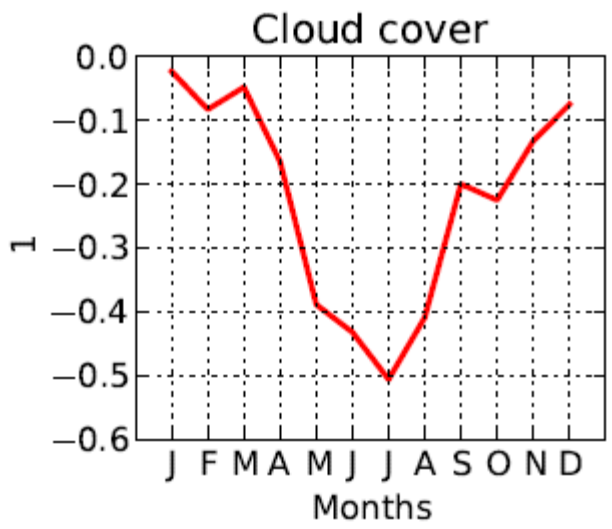
RESULTS

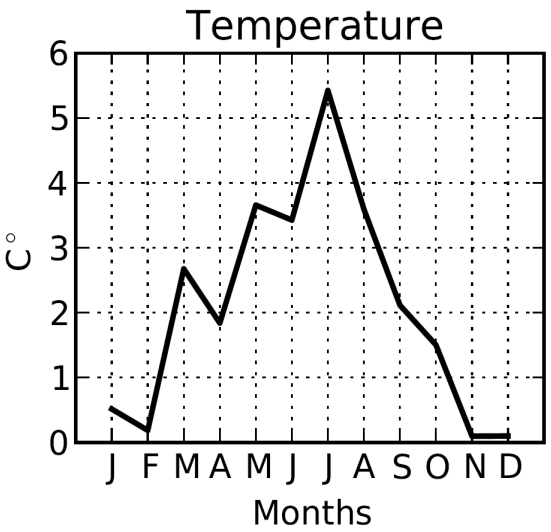
If some of the deviations precedes the others, this could be a symptom of a forced error.

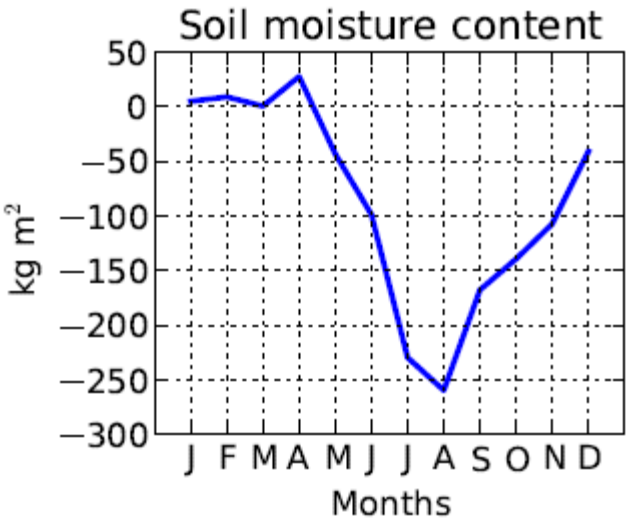
In our case, only soil moisture difference appears to have a lag of 1 moth compared with cloud cover.

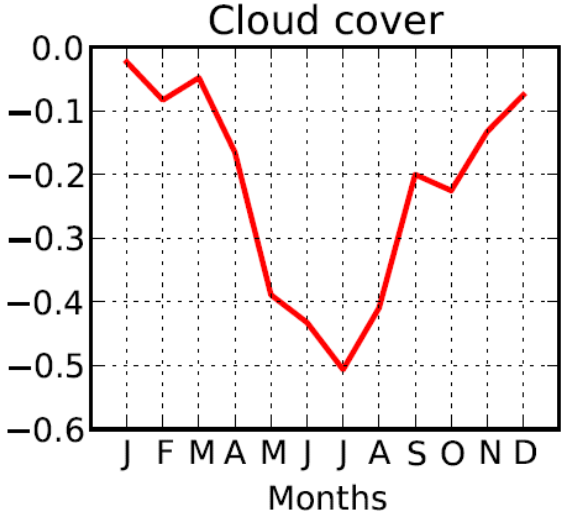
Temperature and cloud cover differences do not show lag, at least at monthly scale.

Diff KF - Grell



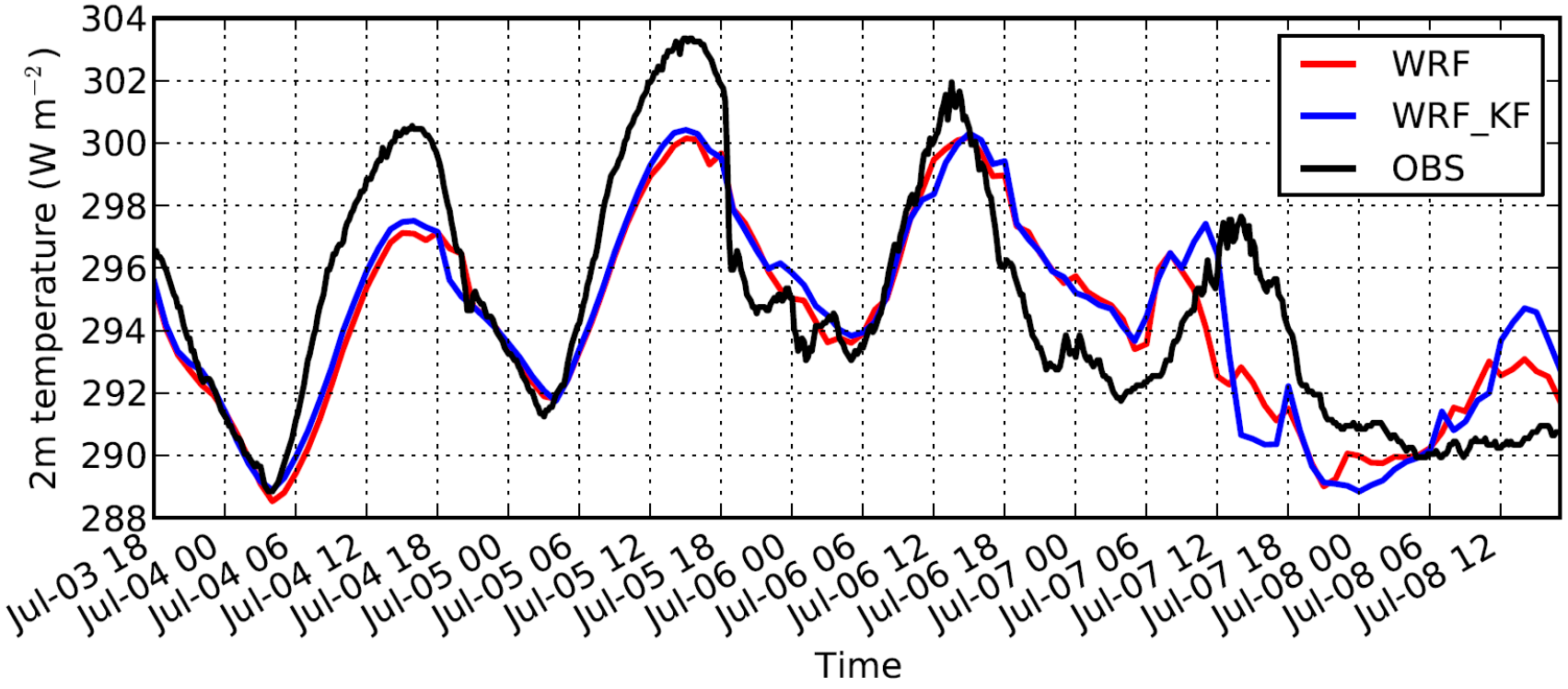






RESULTS

If Kain-Frisch was also tested in the re-forecast way, but in then the difference does not appear → Needs spin up to build up



Cabaw, Netherlads, July 2001

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CONCLUSIONS

- The large difference in summer temperatures between the EUROCORDEX-WRF run uf UC and CRPGL is related to the convection scheme.

- WRF with Kain-Frisch is giving temperatures much closer to observations.

- The difference is not caused by different precipitation, but seems to be related to differences in the cloud cover. Need validation for this cloud cover.

- The difference appears to be amplified by a feedback with soil moisture, and does not appear if simulations are restarted every day.

CONCLUSIONS

• Finally, despite the significant improvement, is very difficult to say that one configuration is better than the other one (From a physical process realism perspective, seeking climate change prediction skill)

• Procedures:

- Ensembles
- Scenarios

• Need to agree in a criteria to decide when a model is “too wrong” to include it in the assessment. ¿What processes are essential for a useful projection?

Thank you

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