Comparison of past and future, high and low extremes of precipitation and river flow for the Mediterranean as projected using different statistical downscaling methods

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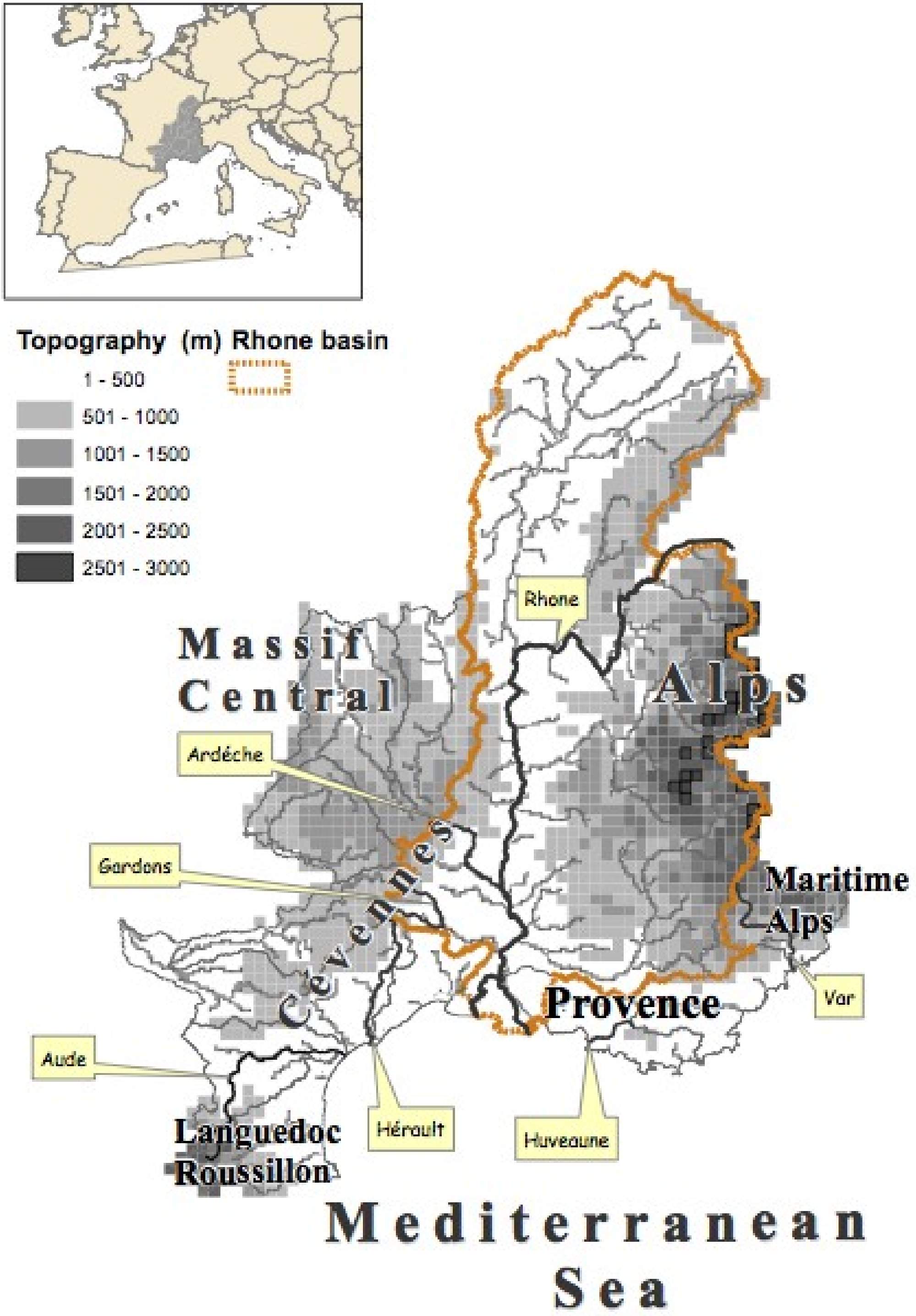
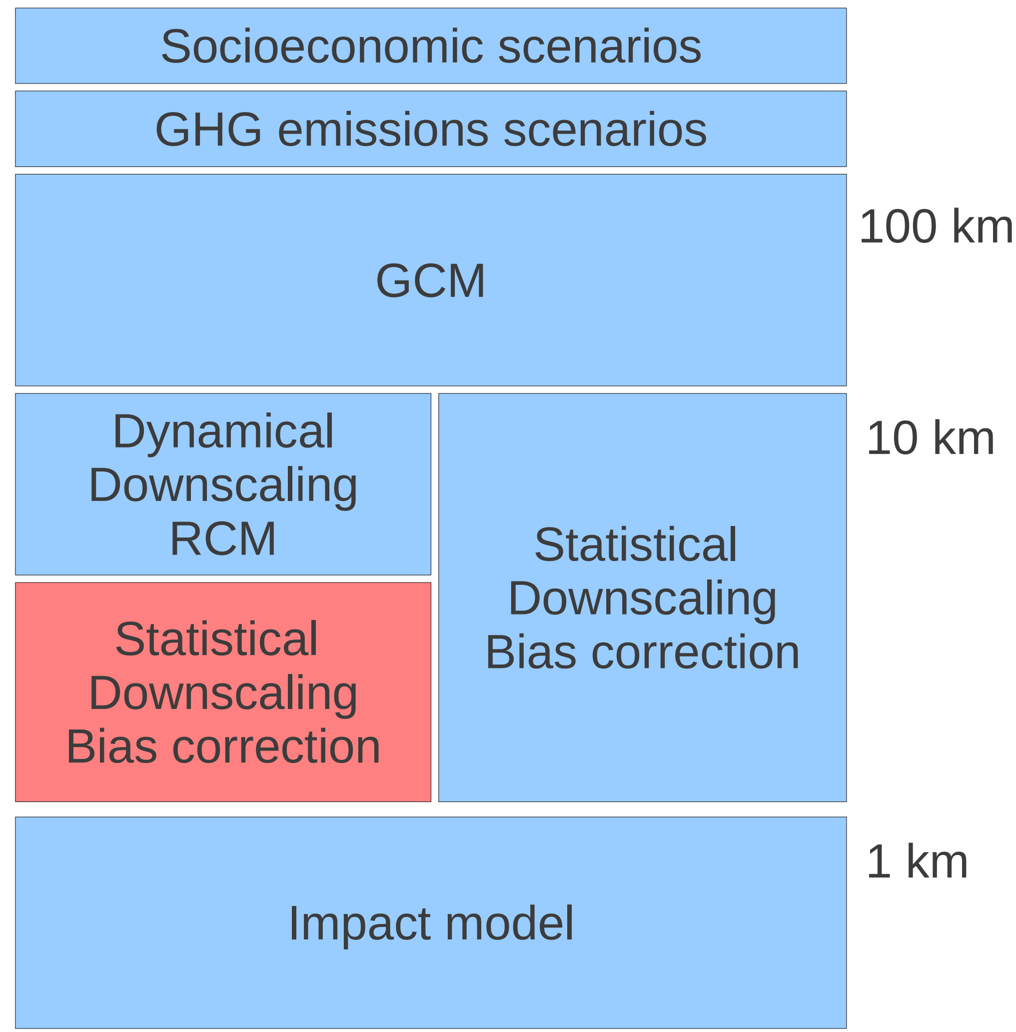
Area of study

- French Mediterranean basins.
- High variability.
- Densely populated.
- The Cévennes area is well known due to the intense events that take place in the region.
  - Sept. 2002: 700 mm in one day on the Gard basin.
- The southern part is also affected by long dry spells and occasional droughts.



Methodology

- Impact studies usually follow a top-to-bottom approach.
- There is a cascade of uncertainty.
  - The main uncertainties are the socio-economic scenarios and the GCM
  - The uncertainties related to the final steps of downscaling are often neglected.
- We compare 3 different downscaling methods.

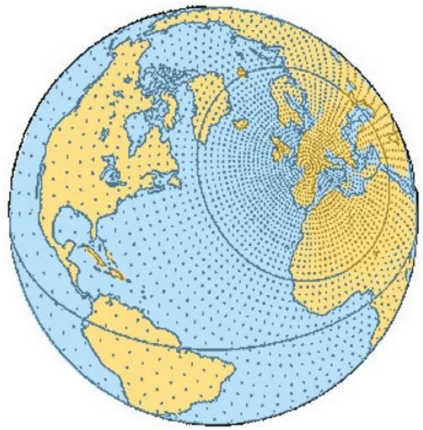


Downscaling techniques

- Anomaly (delta-change)
  - A monthly factor of change is obtained from the climate simulation and it is applied to observed series.
  - It is very simple and widely used.
  - It cannot take into account changes in climate variability.
- **Quantile mapping**
  - The model distribution is corrected using the observations, for each percentile.
  - It is considered that the model rightly simulates to which percentile each value of the corrected variable belongs, but it is not able to determine the value associated to each percentile.
- **Weather typing**
  - Boé et al. (2007, 2009).
  - Two large scale predictors: SLP and surface temperature.

Models

RCM : SAMM



ARPEGE-Climat

SST

OPAMED8
Mediterranean

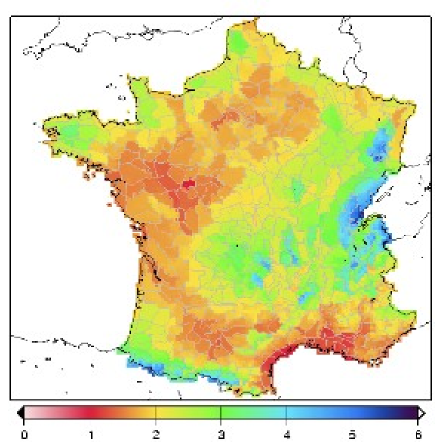
SST

Somot et al. (2008)
Glob. Plan. Change

Hydrological model : SIM

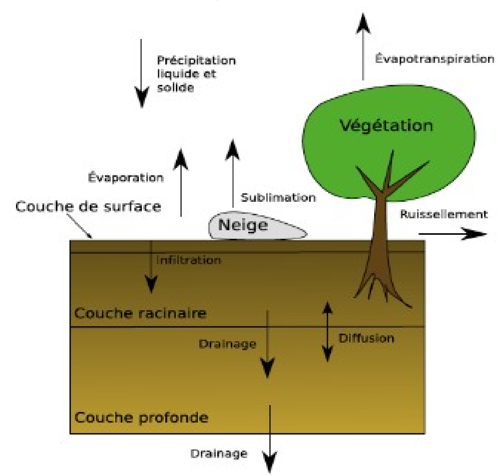
SAFRAN

Meteorological analysis
8 km



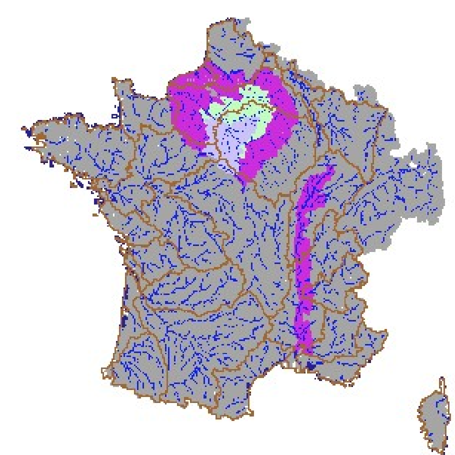
ISBA 3-L

Land-surface model
8 km



MODCOU

Routing and
underground



Habets et al. (2008)
JGR

Quintana-Seguí et al.
(2009) HESS

Objectives

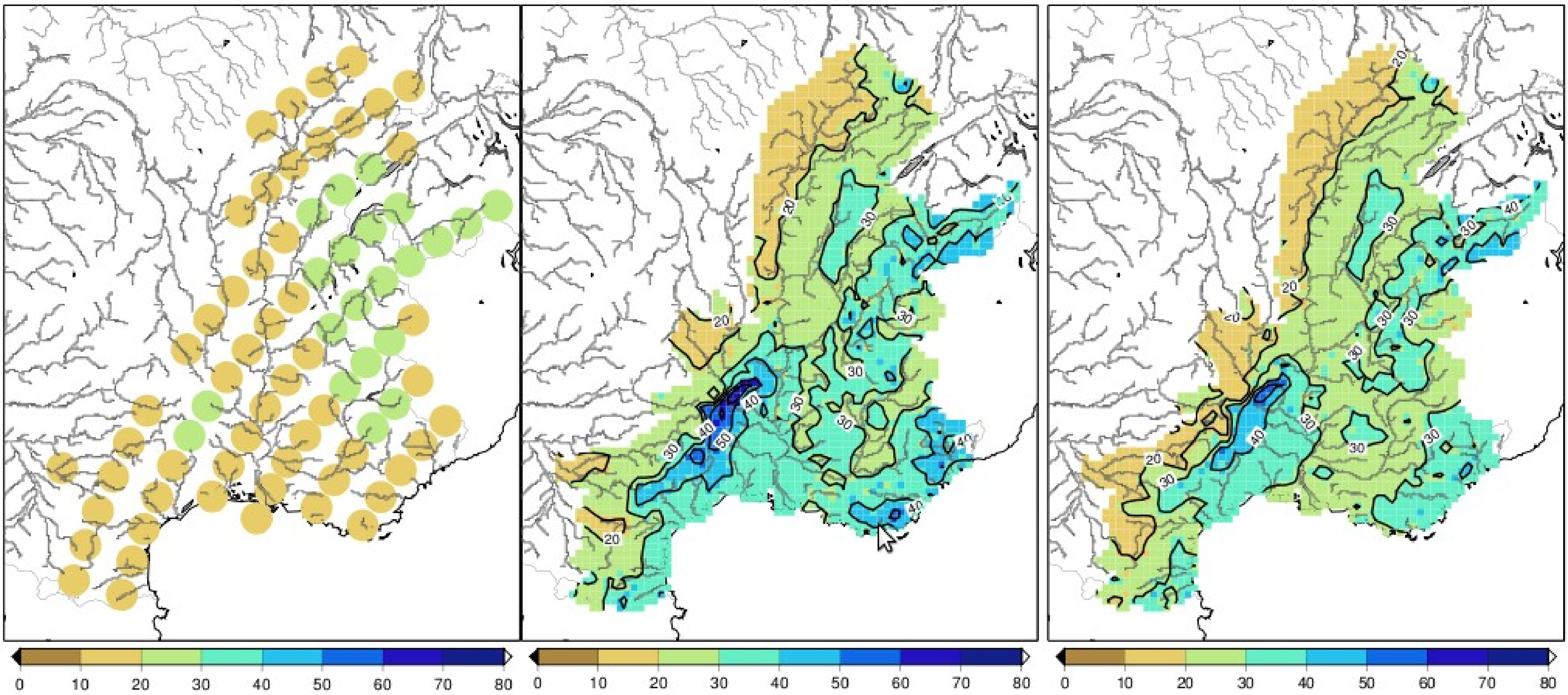
1. Evaluation of the impact of **downscaling methods** on the simulation of future **extremes** of both precipitation and river flow.
2. Analysis of the future extremes in this region, according to the climate simulation used.

- We focus on these two 30-yr periods:
    - End of the 20th century: 1970-1999.
    - Middle of the 21st century: 2035-2064.
- Continuation of previous study:
    - Quintana Seguí et al. *Comparison of three downscaling methods in simulating the impact of climate change on the hydrology of Mediterranean basins*. Journal of Hydrology. 2010; 383:111-124.
    - Significant differences in the mean of river flows obtained using different downscaling methods.

Precipitation

Comparison between SAFRAN (obs) and the RCM and the downscaled data.

PQ95 1970-1999



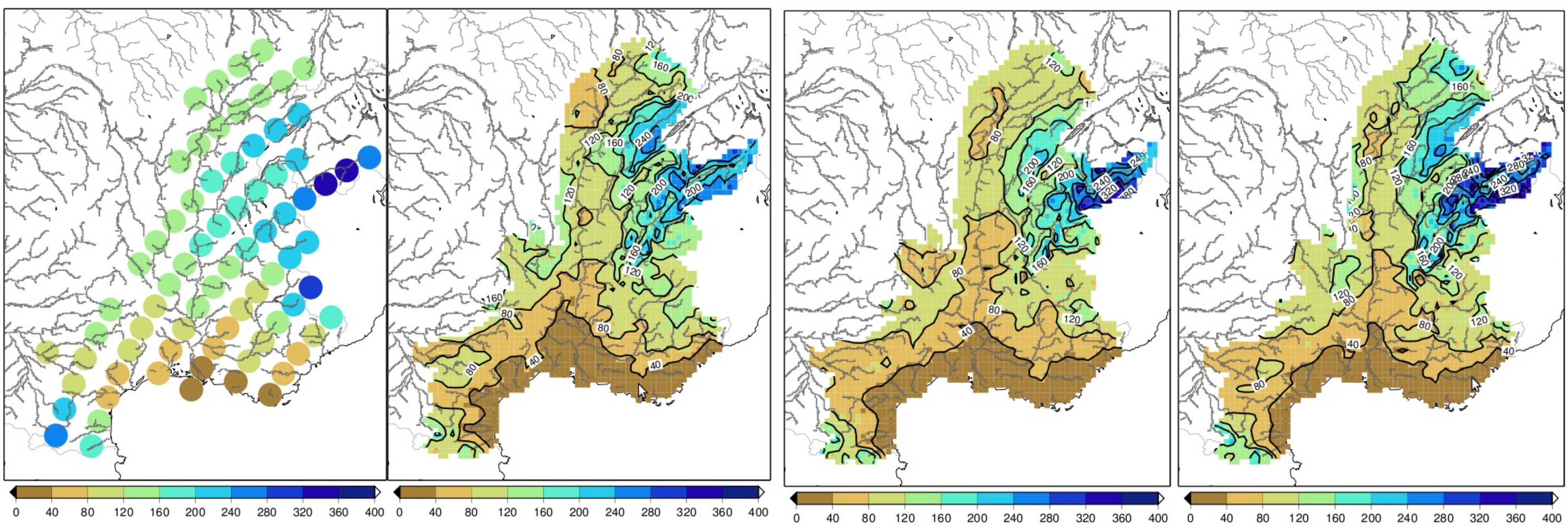
(a) SAMM 1970 (b) SF 1970 (c) WT 1970

Results

Comparison between SAFRAN (obs) and the RCM and the downscaled data.

PDJJA 1970-1999

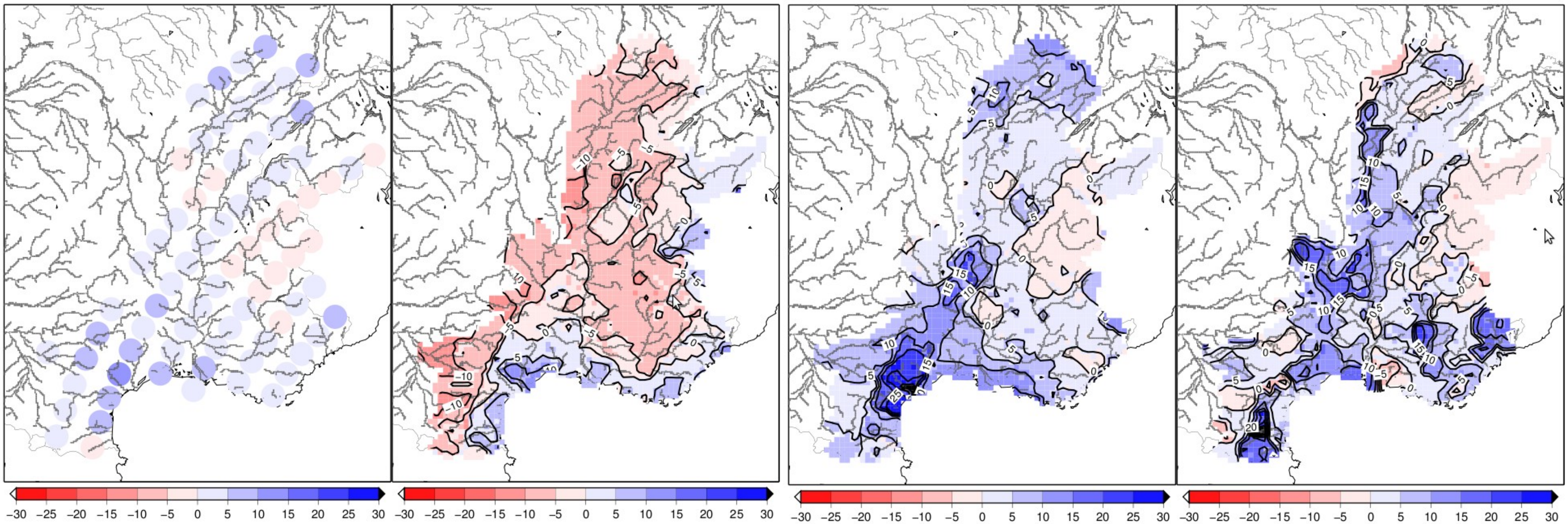
PDJJA = driest summer at each grid point (June, July, August).



(a) SAMM 1970 (b) SF 1970 (c) QM 1970 (d) WT 1970

2035-2064 vs 1970-1999

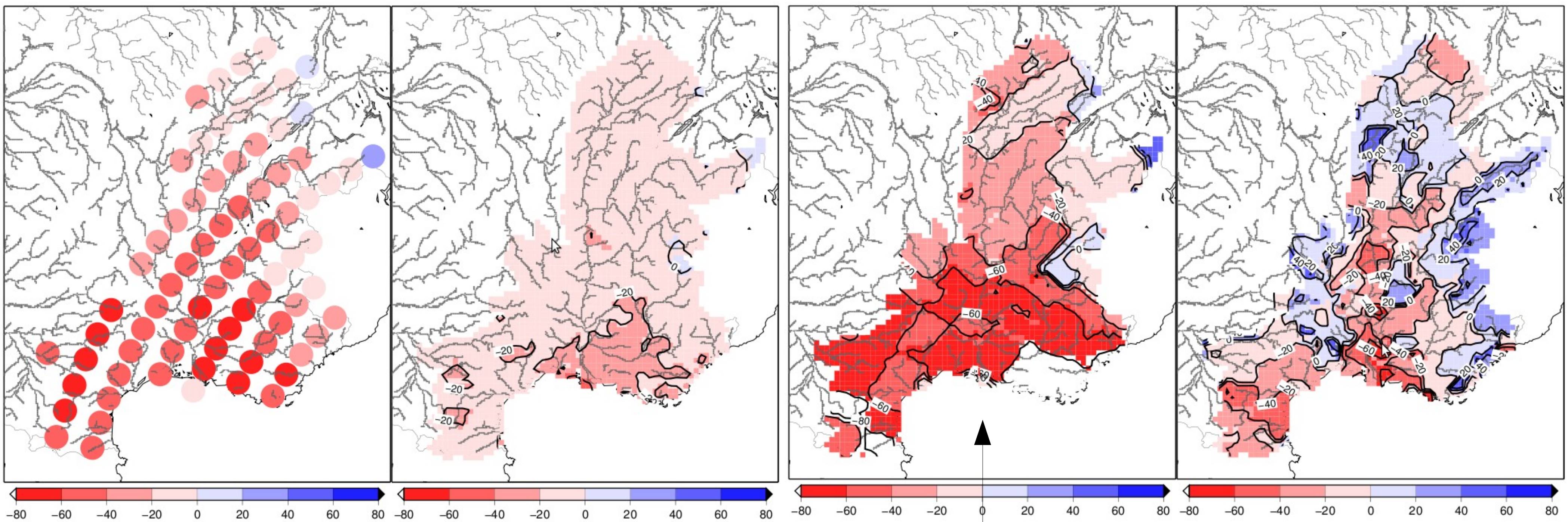
Anomaly of PQ95



(a) SAMM (b) AN (c) QM (d) WT

2035-2064 vs 1970-1999

Anomaly of PDJJA



(a) SAMM (b) AN (c) QM (d) WT

Important differences !

Precipitation: main results

- Compared to SAFRAN, both QM and WT are able, in general, to reproduce the extremes of precipitation.
- The differences in the anomalies of the indices are sometimes important.
- The main differences are found for low precipitation.

River flow

Comparison of the simulations to the observations

R2 Coefficient of determination.

Control run, model forced with obs

Model force with downscaled RCM data.

Daily high flow with 10-yr return period.

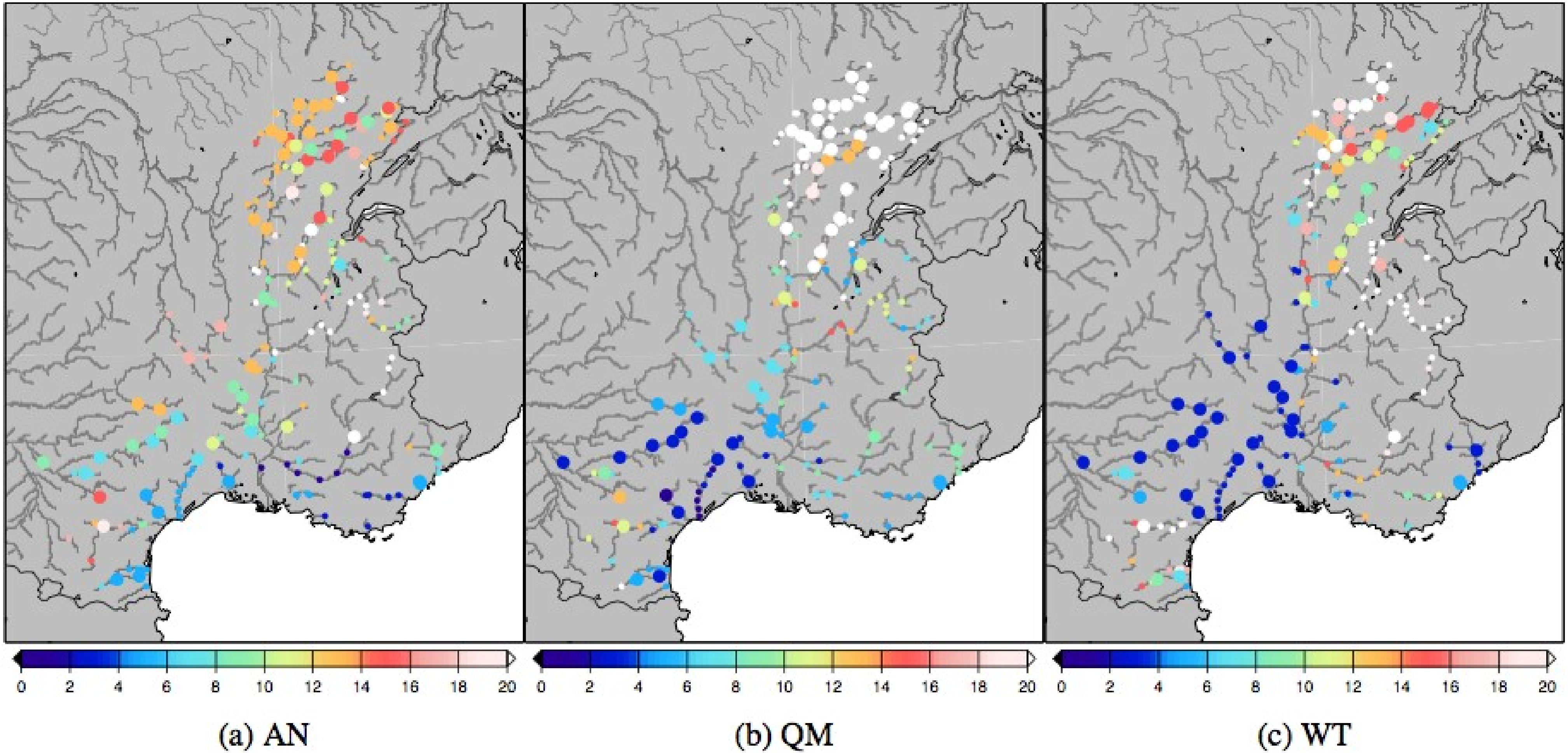
Monthly low flow with 5-yr return period.

High flows :	**QJXA10**			
Simulation	**Bias (%)**		R^2	
SF	-18	*7*	0.7	*0.7*
QM	-26	*4*	0.4	*0.5*
WT	-44	*-22*	-0.2	*0.0*
Low flows :	**QMNA5**			
Simulation	**Bias (%)**		R^2	
SF	6	*18*	0.0	*0.0*
QM	-3	*7*	-0.1	*0.0*
WT	-5	*8*	-0.2	*0.0*

Stations simulated well by the model according to NSE (> 0.5)

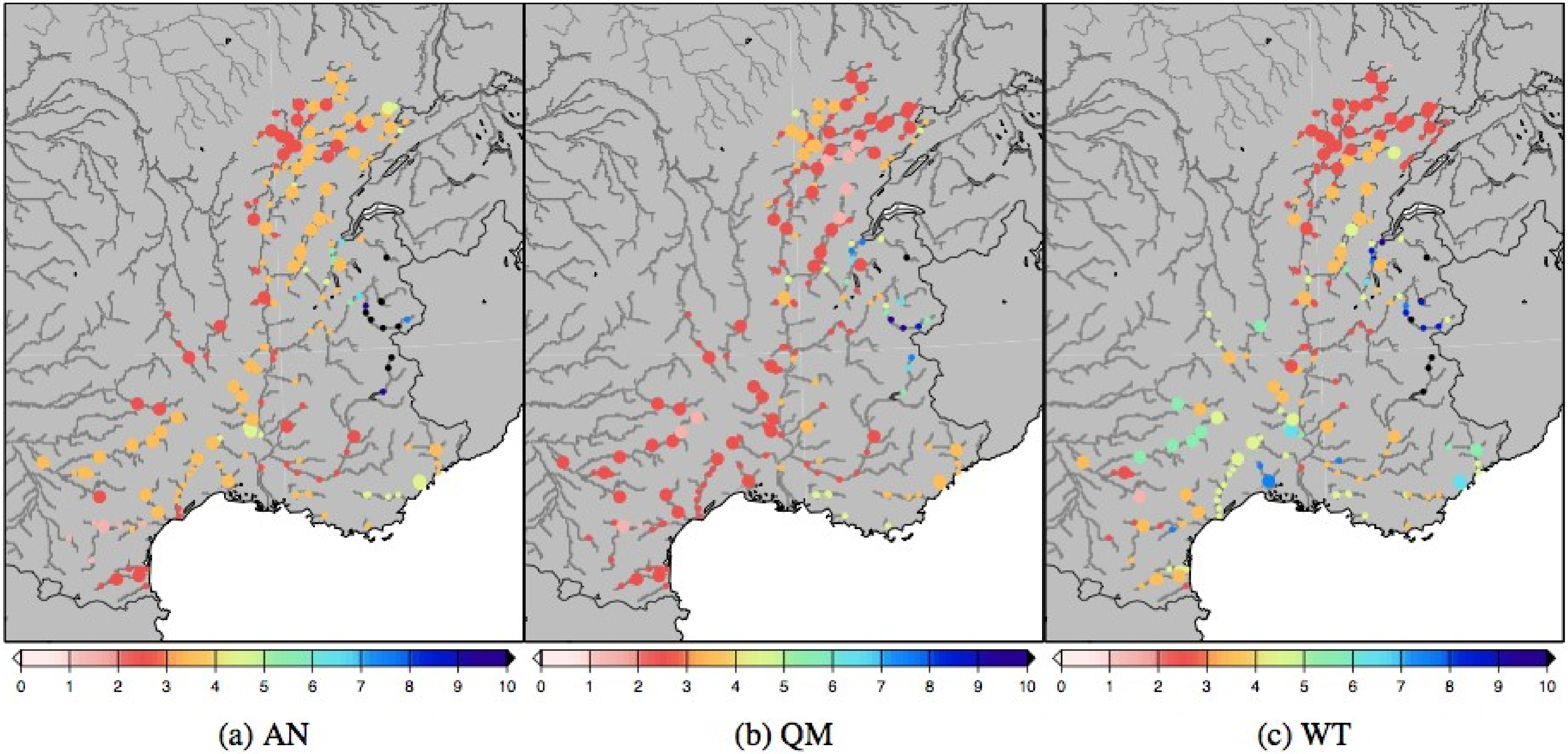
Stations simulated poorly by the model according to NSE (> 0.5)

2035-2064 : return period of the 1970-1999 QJXA10



Return period in years, calculated for 2035-2064, of the discharge corresponding to the QJXA10 of 1970-1999. Values smaller than 10 indicate a decrease of the return period.

2035-2064 : Return period of the 1970-1999 QMNA5



Return period in years, calculated for 2035-2064, of the discharge corresponding to the QMNA5 of 1970-1999. Values smaller than 5 indicate a decrease of the return period.

River flow: main results

- Compared to the observations:
  - The model is better for high flows than for low flows.
  - The scores obtained with WT were surprisingly poor.
  - The scores of future river flow obtained with AN were more comparable to the other variables than initially expected.
- Anomalies
  - **There are important differences between methods when we compare the results station by station**: <u>uncertainty</u>.
  - But if we look at the whole picture, the results are similar.
    - More floods on the region of the Cévennes.
    - The old QMNA5 will become more frequent.

Conclusions and future work

- **The differences obtained using different statistical downscaling methods are important.**
- Our study is limited, we did not assess all the uncertainties.
- Paper under review (NHESS).
- We are developing a model similar to SIM on the NE of the Iberian Peninsula (including the Ebro river) and working on downscaling methods to apply in this area.
  - Poster: EGU2011-11961 in session NP3.7 (yesterday).
    - Downscaling technique.
  - Poster: EGU2011-6700 in this same session (today, 17:30-19:00).
    - Hall A at board number A190.
    - Distributed model on the NE of the Iberian Peninsula.

Thank You!
Danke!

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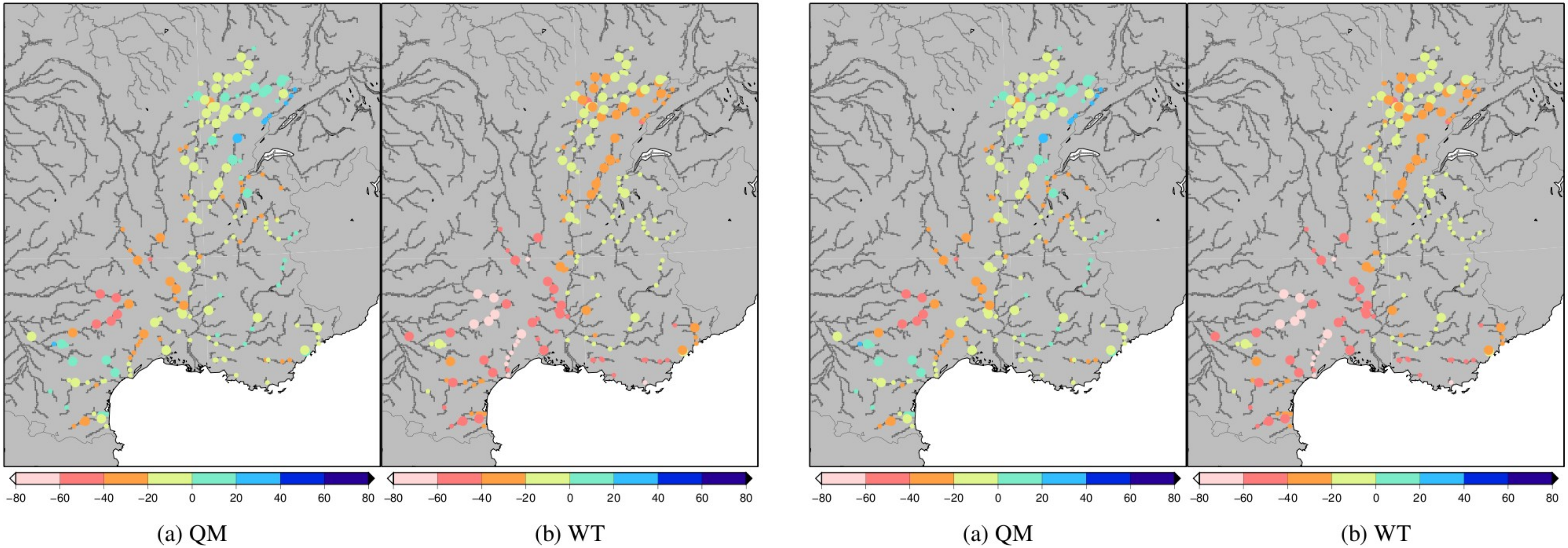
River flow

1970-1999 : downscaled data vs safran

QJXA10
Daily high flow 10-yr return period

QMNA5
Montlhy low flow 5-yr return period



- Control run: SIM forced by SAFRAN (observations)
- We compare the runs forced with downscaled data vs the control run (%).
- The model simulates better the high extremes than the low ones (not shown).
- The results with WT are surprisingly bad.