

Storylines to synthesize the range of future plausible climates over France for hydrological studies

Motivation

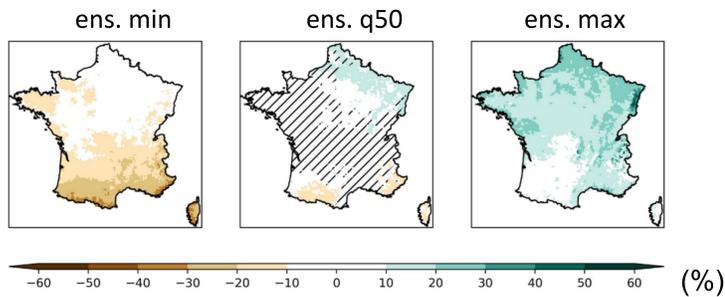
The precipitation response to global warming over metropolitan France is highly uncertain. To capture the range of the possible futures, a large ensemble of projections should be considered. How can we synthesize it for hydrological studies?

Data

An ensemble of 17 bias-corrected 12-km-resolution EURO-CORDEX projections that have been selected to be consistent with the range of changes in mean temperature and precipitation of the CMIP6 ensemble over France [1].

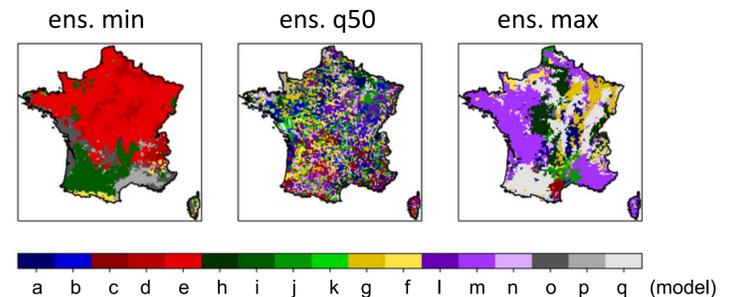
1. The probabilistic approach based on ensemble distribution products

Annual precipitation changes, RCP8.5, (2070-2099) vs. (1976-2005)



Multi-model averaging lead to a weak response that does not correspond to any model simulation and cannot be used to force hydrological models.

Model used to compute the distribution products by grid point



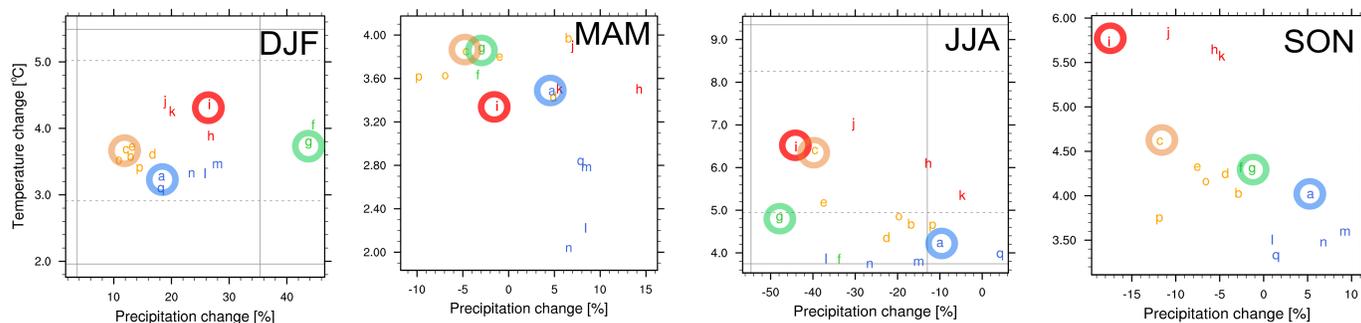
2. The possibilistic approach based on storylines

The request from water resource managers : choose 4 simulations illustrating the most contrasting futures possible.

Input data: mean temperature and precipitation changes over France, end of the century, RCP8.5, 4 seasons.

Methodology [2]: Hierarchical clustering (Euclidian distance + minimum variance criterion) and selection of one projection per cluster (experts/users co-construction).

Mean changes over France, RCP8.5, (2070-2099) vs. (1976-2005)

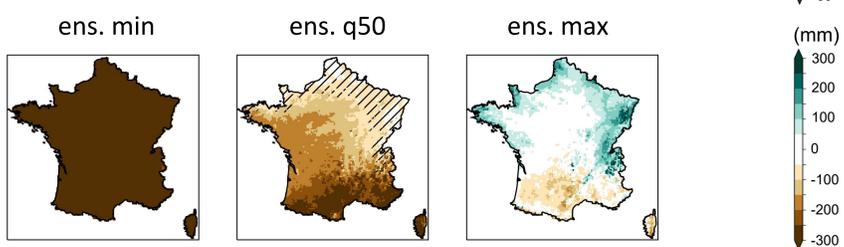


a	CNRM-CM5	ALADIN63
b	CNRM-CM5	HadREM3-GA7-05
c	EC-EARTH	HadREM3-GA7-05
d	EC-EARTH	RACMO22E
e	EC-EARTH	RCA4
f	IPSL-CM5A-MR	HIRHAM5
g	IPSL-CM5A-MR	RCA4
h	HadGEM2-ES	ALADIN63
i	HadGEM2-ES	CCLM4-8-17
j	HadGEM2-ES	HadREM3-GA7-05
k	HadGEM2-ES	RegCM4-6
l	MPI-ESM-LR	CCLM4-8-17
m	MPI-ESM-LR	RegCM4-6
n	MPI-ESM-LR	REMO2009
o	NorESM1-M	HIRHAM5
p	NorESM1-M	REMO2015
q	NorESM1-M	WRF381P

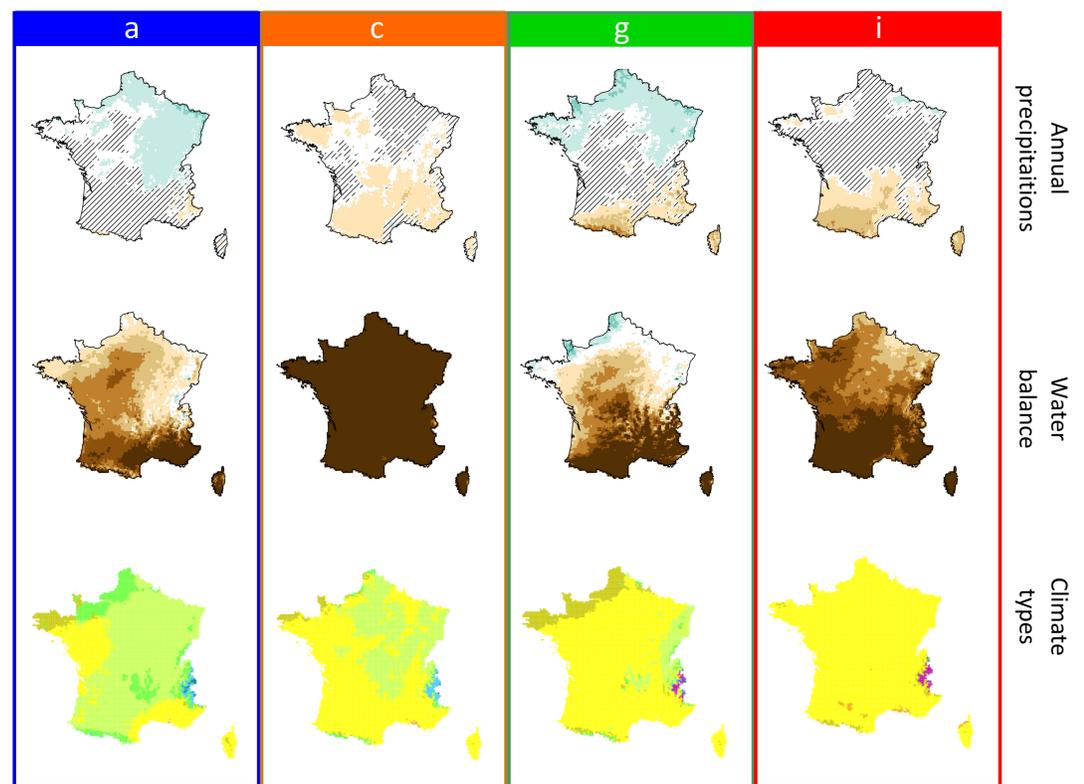
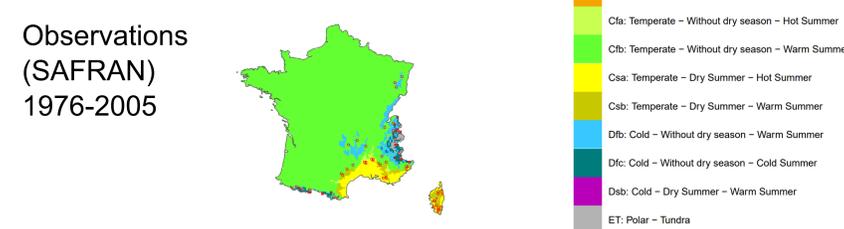
4 storylines (relative to the full ensemble)

- a: lesser warming and wetter
- c: drier all year (no recharging season)
- g: seasonally contrasted (wetter in DJF, drier in JJA)
- i: hotter and drier in JJA and SON

Climatic water balance changes (P - ETP)



Climate type maps (Köppen-Geiger classification)



- French national climate services are based on 17 bias-corrected EURO-CORDEX projections which do not agree on the simple sign of future annual precipitation changes.
- Water resource managers are requiring to narrow the ensemble down to 4 contrasted storylines.
- A hierarchical clustering method based on mean changes of temperature and precipitation was used to classify the projections, and one model from each group was selected (expert and users co-construction).
- The set of the 4 storylines broadly captures the ensemble mean pattern and the spread of main climatic parameters changes from the full ensemble.
- All storylines project warmer and drier summers spreading from south to north, leading to a generalization of the Mediterranean climate in France.
- Future work: to add new variables in the analysis (eg: other parameters, other periods, other scenario) and to test objective methods to select one model from each group.
- Storylines are subjective and their selection must be adapted to the user's needs.

[1] Soubeyroux, J.-M., Bernus, S., Corre, L., Drouin, A., Dubuisson, B., Etchevers, P., Gouget, V., Josse, P., Kerdoncuff, M., Samacoits, R., & Tocquer, F. (2021). Les nouvelles projections climatiques de référence DRIAS 2020 pour la métropole. <http://www.drias-climat.fr/document/rapport-DRIAS-2020-red3-2.pdf>
 [2] Monerie, PA., Sanchez-Gomez, E. & Boé, J. On the range of future Sahel precipitation projections and the selection of a sub-sample of CMIP5 models for impact studies. *Clim Dyn* 48, 2751–2770 (2017). <https://doi.org/10.1007/s00382-016-3236-y>
 [3] Ribes, A., Boé, J., Qasbi, S., Dubuisson, B., Douville, H., & Terray, L. (2022). An updated assessment of past and future warming over France based on a regional observational constraint. *Earth System Dynamics*, 13(4), 1397–1415. <https://doi.org/10.5194/esd-13-1397-2022>