Selecting CMIP6 models to assess the impact of climate change on energy demand over Europe

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CONTEXT

Despite the improvements of CMIP6 models compared to earlier generations of CMIP phases such as CMIP5 or CMIP3 in terms of representation of physical processes (Jiang, 2021) the uncertainty of future climate projections is still quite large (Peatier, 2022). All these uncertainties and a large number of climate simulations make the use of these simulations in impact and adaptation studies for the different socio-economic sectors very difficult, in particular when these simulations are directly used as input for impact models at the beginning of a decision chain. Therefore, it is very important to select a subset of climate simulations in order to be usable in terms of computing and storage costs and to reduce their related uncertainties.

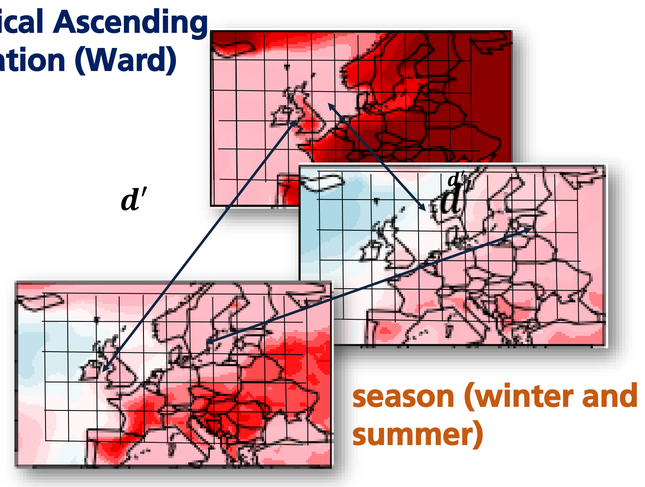
The aim of the study: Selecting a subset of 10 simulations from the CMIP6 multi-model ensemble to assess the impact of climate change on the energy demand in Europe for the energy sector.

METHODOLOGY OF SELECTION

1st step

- **Classification of CMIP6 models according to the average warming in the future**

Hierarchical Ascending Classification (Ward)



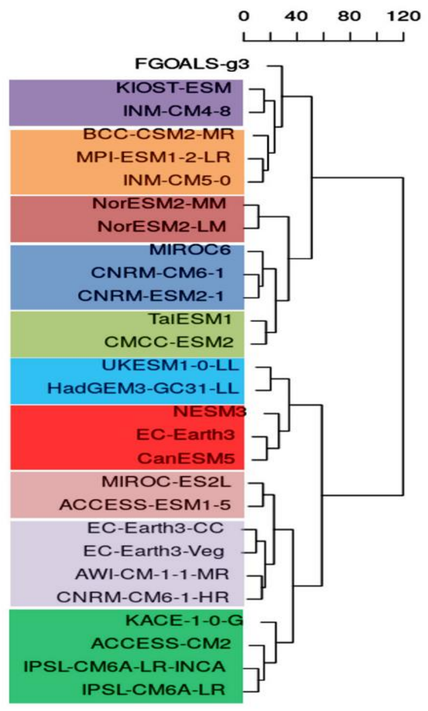


Figure 1 : Model classification tree for the CMIP6 models based on average future warming. Left-branching patterns are more similar in terms of all four metrics, and right-branching patterns are more dissimilar.

2nd step

- **Choose the best performing model in each group from the first classification**

4 **Criteria**

- Bias
- RMSE
- Spatial correlation
- Interannual variability

1st classification: Average temperatures

2nd classification: Maximum and minimum temperatures

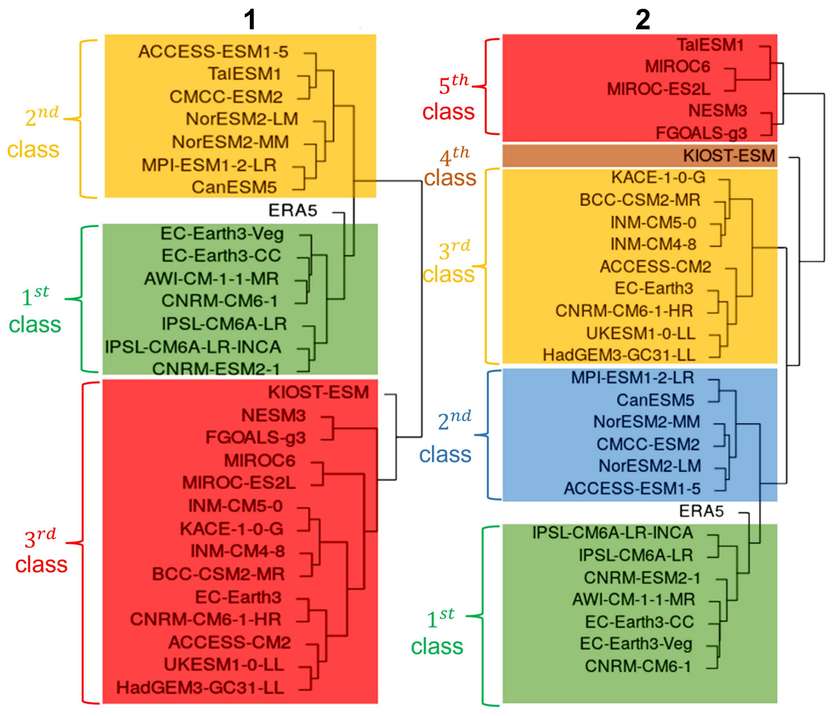
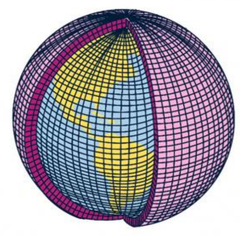


Figure 2 : Model classification tree for the CMIP6 models based on historical performance. 1) for daily average temperature. 2) for daily max and min temperatures. Left-branching patterns are more similar in terms of all four metrics, and right-branching patterns are more dissimilar.

Results



40 climate models

10 models

Models	Climate sensitivity
INM-CM4-8	1.8
MPI-ESM1-2-LR	3.0
NorESM2-MM	2.5
CNRM-ESM2-1	4.8
CMCC-ESM2	3.5
UKESM1-0-LL	5.4
CanESM5	5.6
EC-Earth3-Veg	4.3
ACCESS-ESM1-5	3.9
IPSL-CM6A-LR	4.6

COMPARISON OF PERFORMANCE

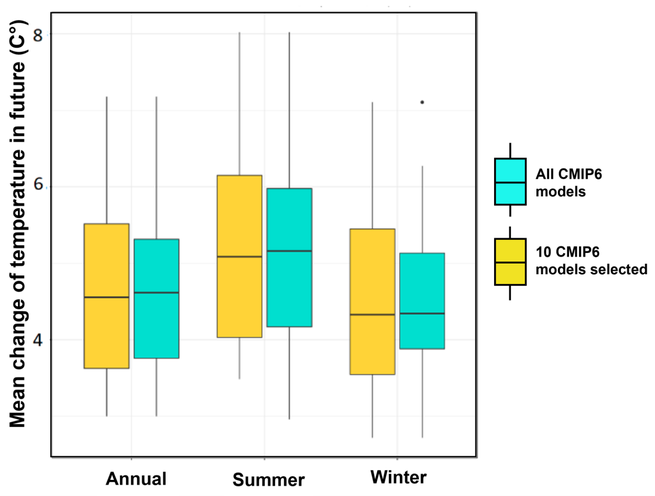


Figure 3 :Distribution of average future warming at the horizon 2071-2100 compared to 1981-2010

The process of the CMIP6 models selection allowed us to :

✓ keep a distribution of the average future warming similar to that of the initial set.

✓ keep the most performing models with respect to ERA5.

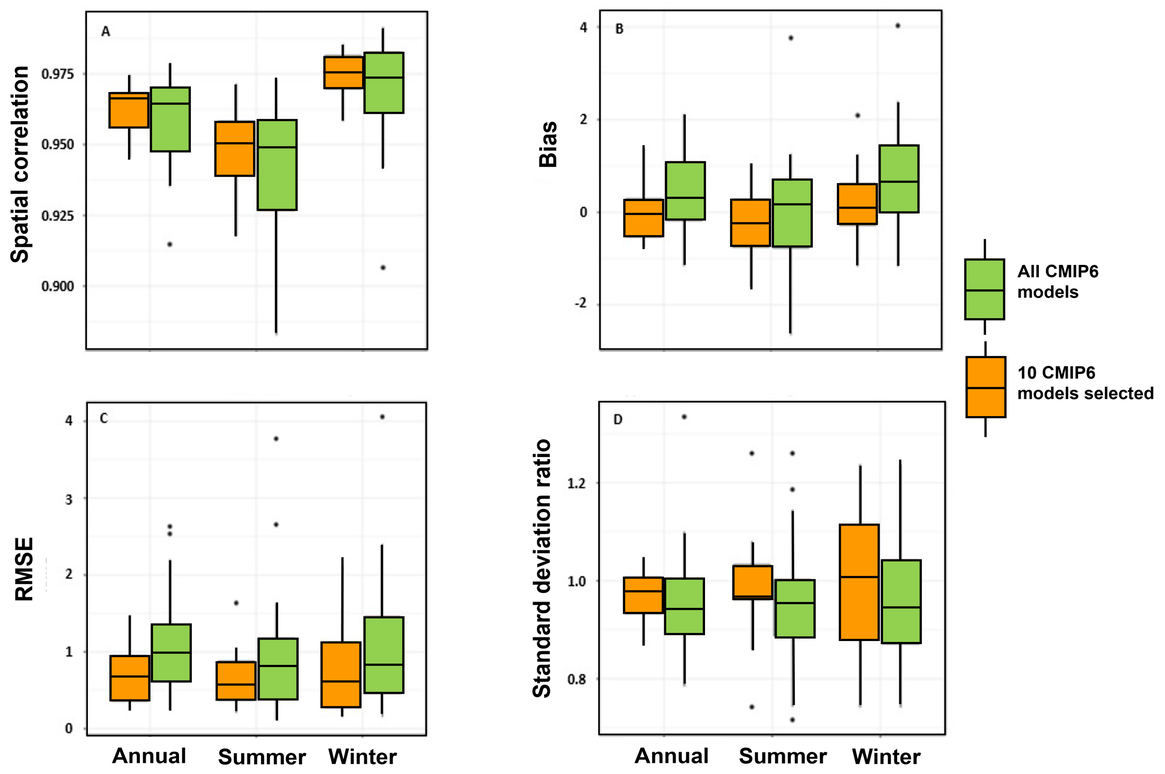


Figure 4 : Distribution of A/spatial correlation, B/ Bais, C/ RMSE and C/ Interannual temperature variability ratio of all CMIP6 models compared to ERA5 before and after selection in the European domain

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