



Supplement of

The Mediterranean climate change hotspot in the CMIP5 and CMIP6 projections

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Supplement

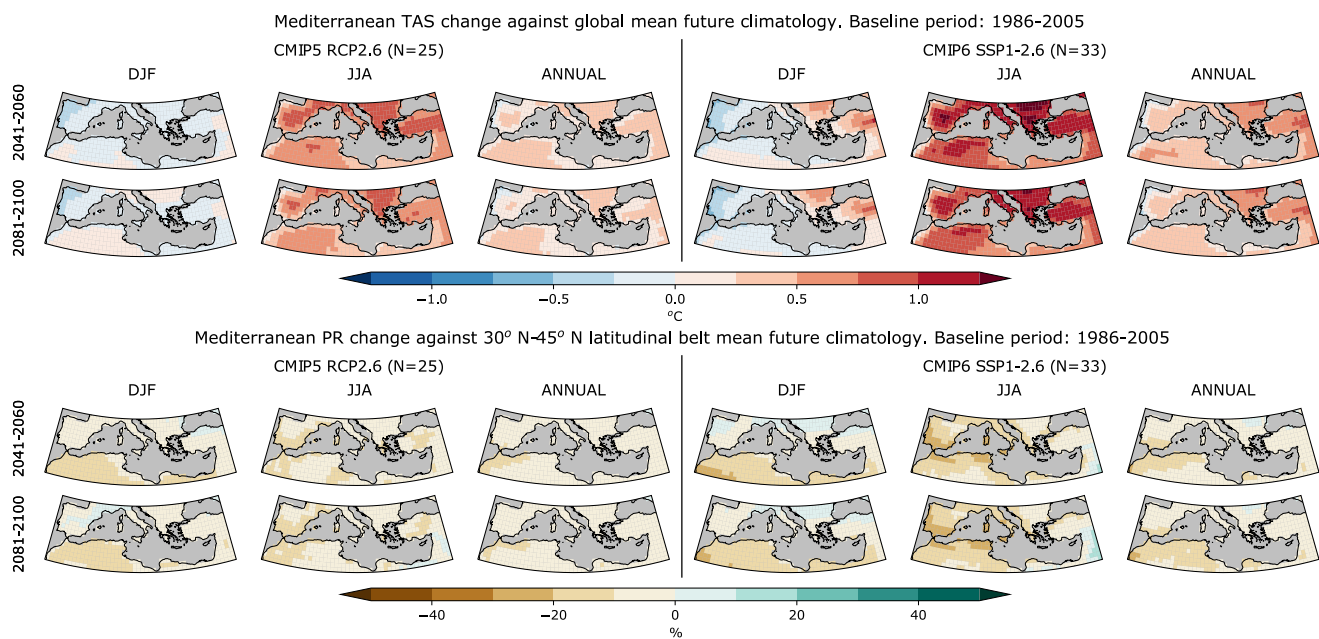
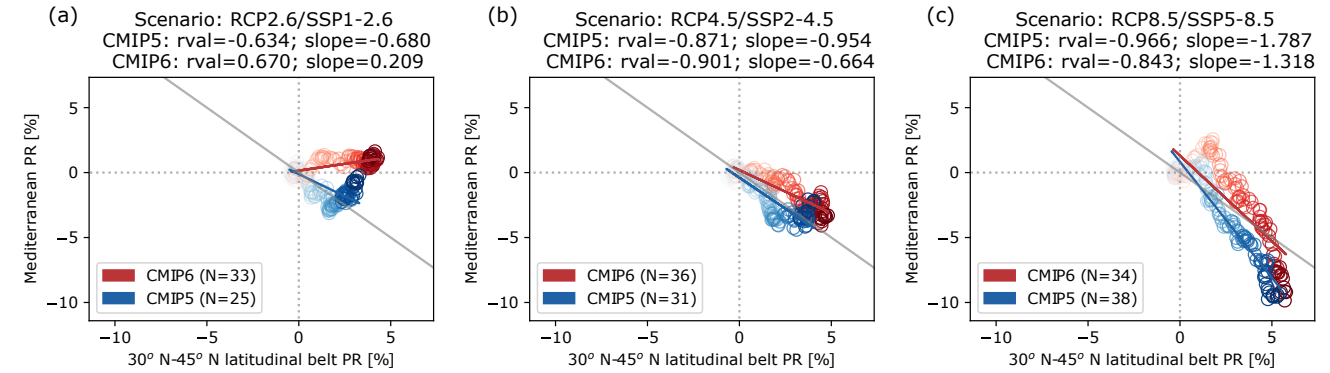


Figure S1. same as Fig. 1 but for scenario 2.6

Mediterranean vs 30° N-45° N latitudinal belt DJF precipitation.
10yr rolling means 1960-2100, Baseline: 1986-2005



Mediterranean vs 30° N-45° N latitudinal belt JJA precipitation.
10yr rolling means 1960-2100, Baseline: 1986-2005

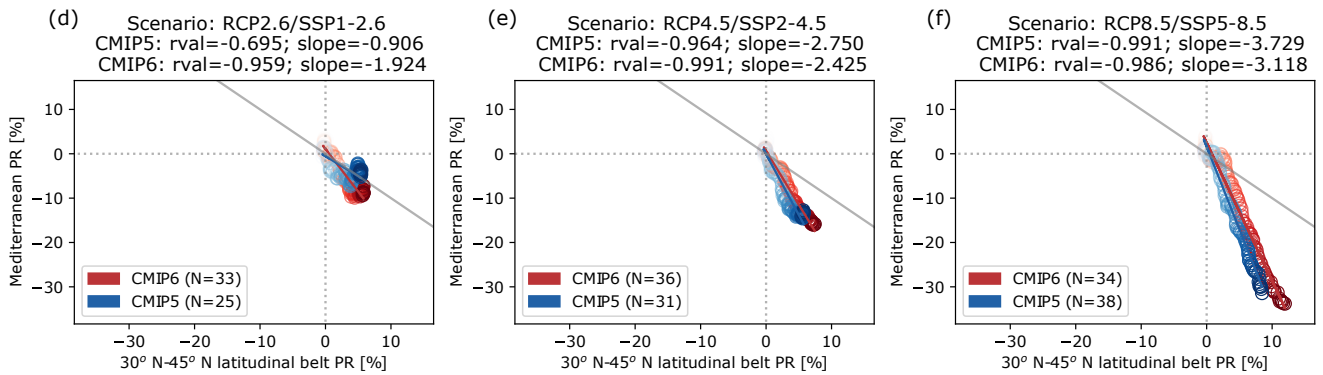


Figure S2. Same as Fig. 2 but plotting the Mediterranean precipitation change against the 30° N-45° N latitudinal belt precipitation change.

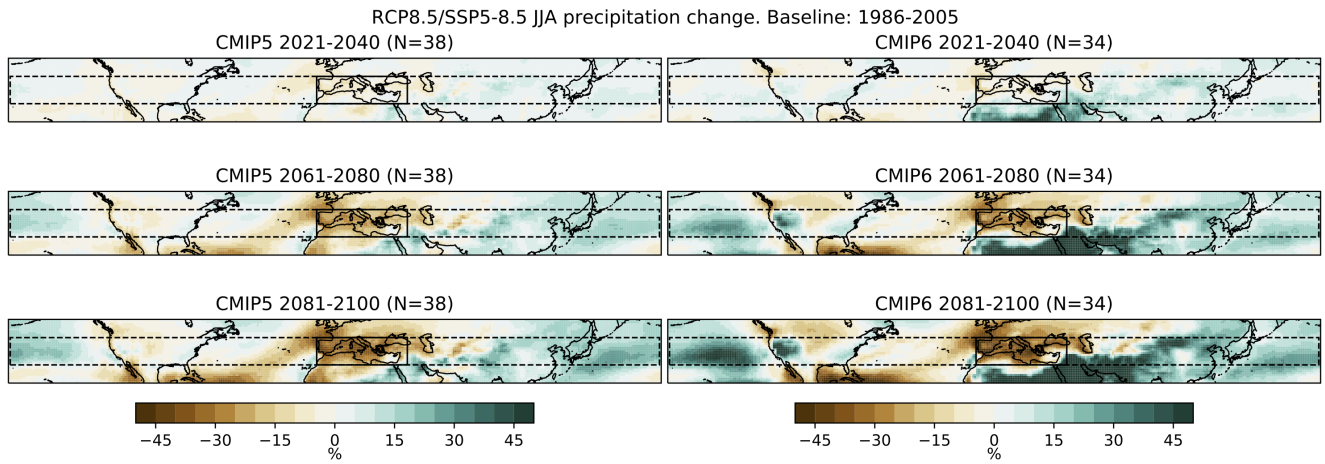
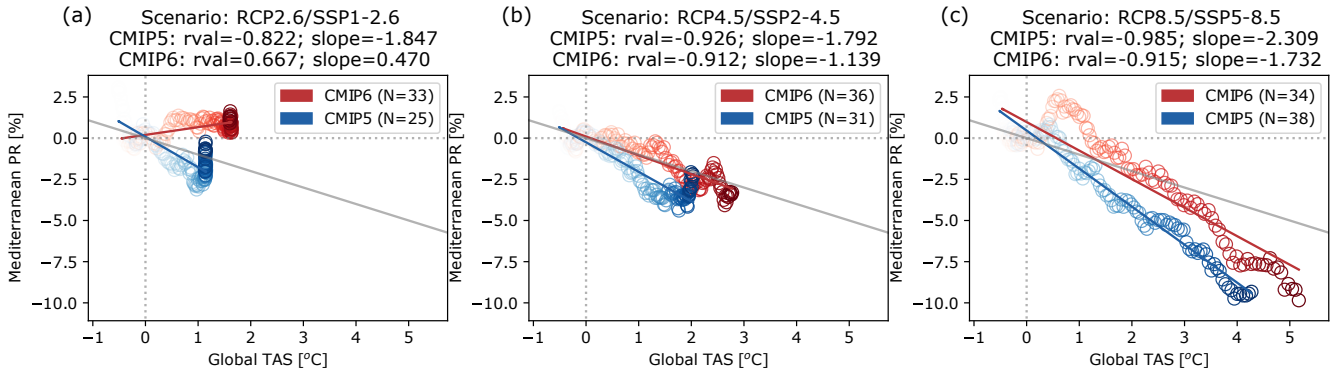


Figure S3. Summer precipitation differences for the future periods 2021-2040, 2061-2080 and 2081-2100 with respect to the baseline period 1986-2005, as projected by CMIP5 (left) and CMIP6 (right) multi-model means. The dashed line encloses the 30° N-45° N latitudinal belt and the solid line the Mediterranean region.

Mediterranean vs Global DJF precipitation.
10yr rolling means 1960-2100, Baseline: 1986-2005



Mediterranean vs Global JJA precipitation.
10yr rolling means 1960-2100, Baseline: 1986-2005

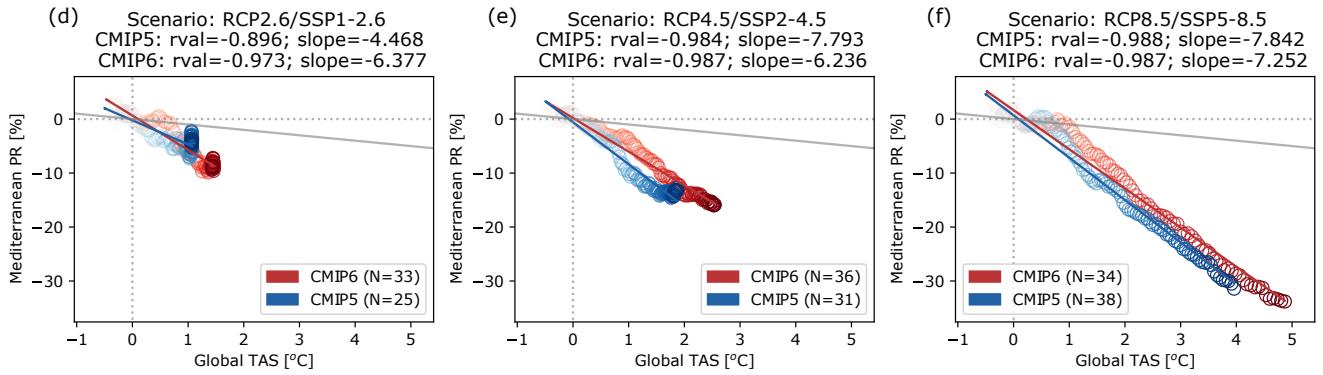


Figure S4. Same as Fig. 2 but plotting the Mediterranean precipitation change against the global temperature change.

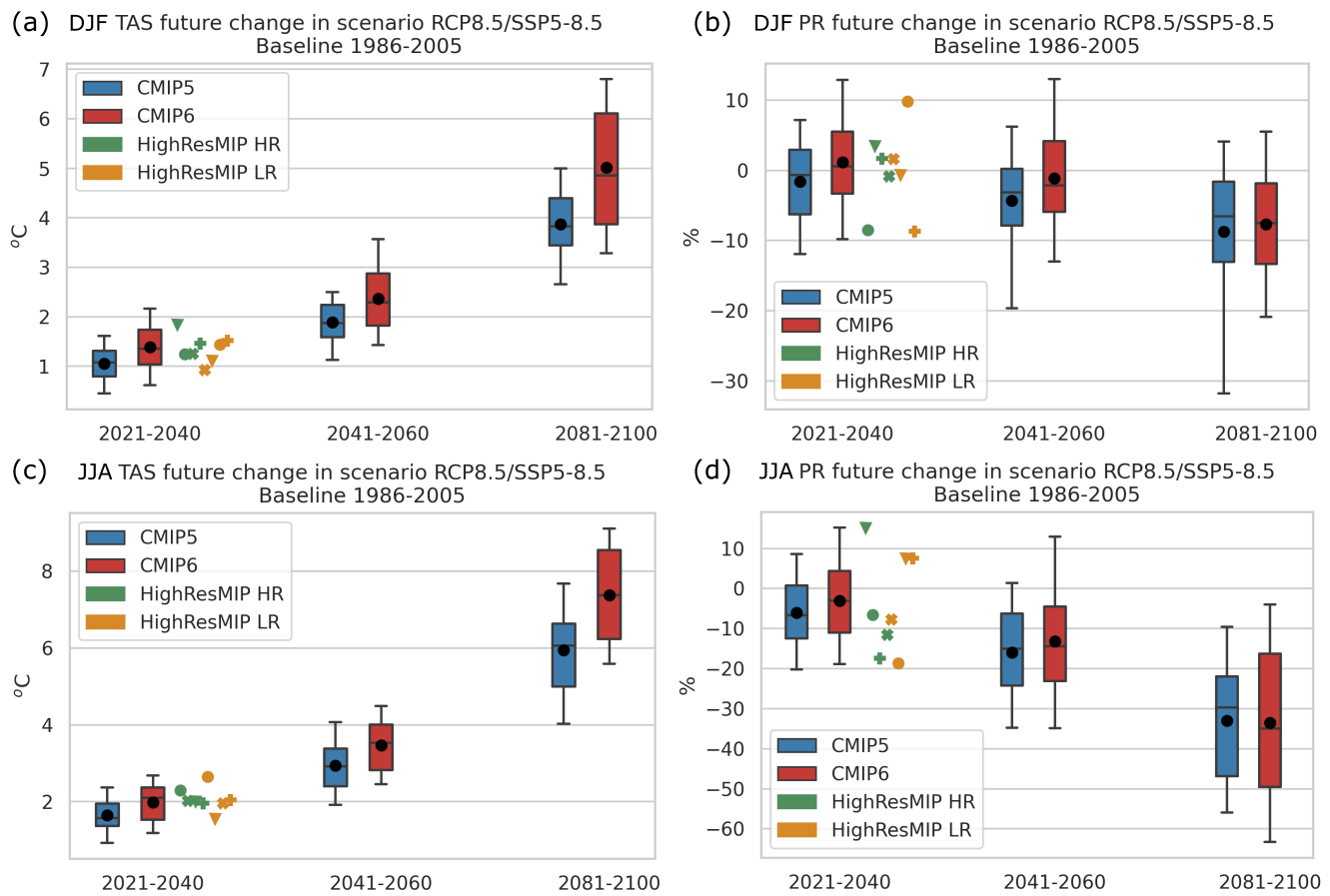


Figure S5. Winter (a, b) and summer (c, d) temperature (a, c) and precipitation (b, d) projected changes for the near, mid and long-term periods with respect to the baseline period, for multi-model-ensembles CMIP5, CMIP6 and HighResMIP. In the box plots, the black horizontal line represents the median and the black dot is the mean. The interquartile range (IQR) and whiskers are defined by the 25th-75th and 5th-95th percentiles, respectively. HighResMIP models are displayed as markers, enabling for a comparison of the HR (green) and LR (orange) models within the experiment. The same markers are used for two different resolution runs of the same model (see Table S1)

Table S1. HighResMIP markers used in Fig. S5 to highlight differences in resolution from the same model.

Marker	LR/HR Models
▼	CMCC-CM2-SR5 / CMCC-CM2-VHR4
✱	CNRM-CM6-1 / CNRM-CM6-1-HR
+	EC-Earth3P / EC-Earth3P-HR
●	HadGEM3-GC31-LL / HadGEM3-GC31-HM

CMIP5 & CMIP6 TAS changes over JJA & DJF
Baseline period: 1986-2005

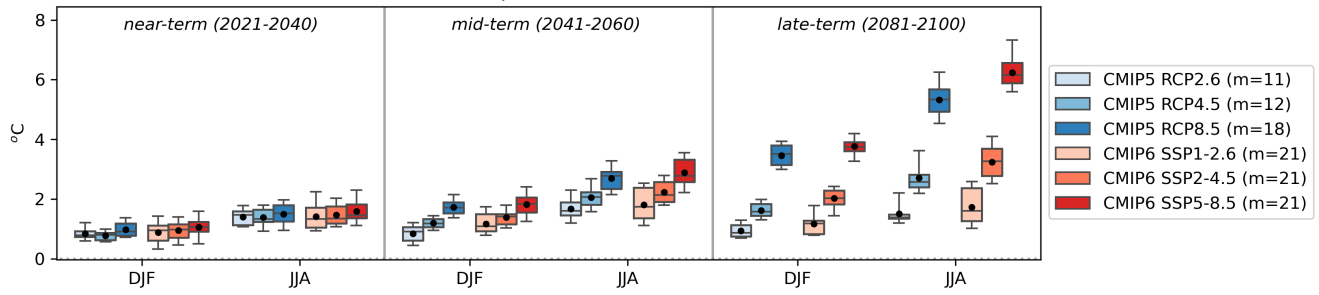


Figure S6. Same as Fig. 3a but computed with a subset distribution of CMIP5 and CMIP6 members with ECS between 2.6 and 3.3

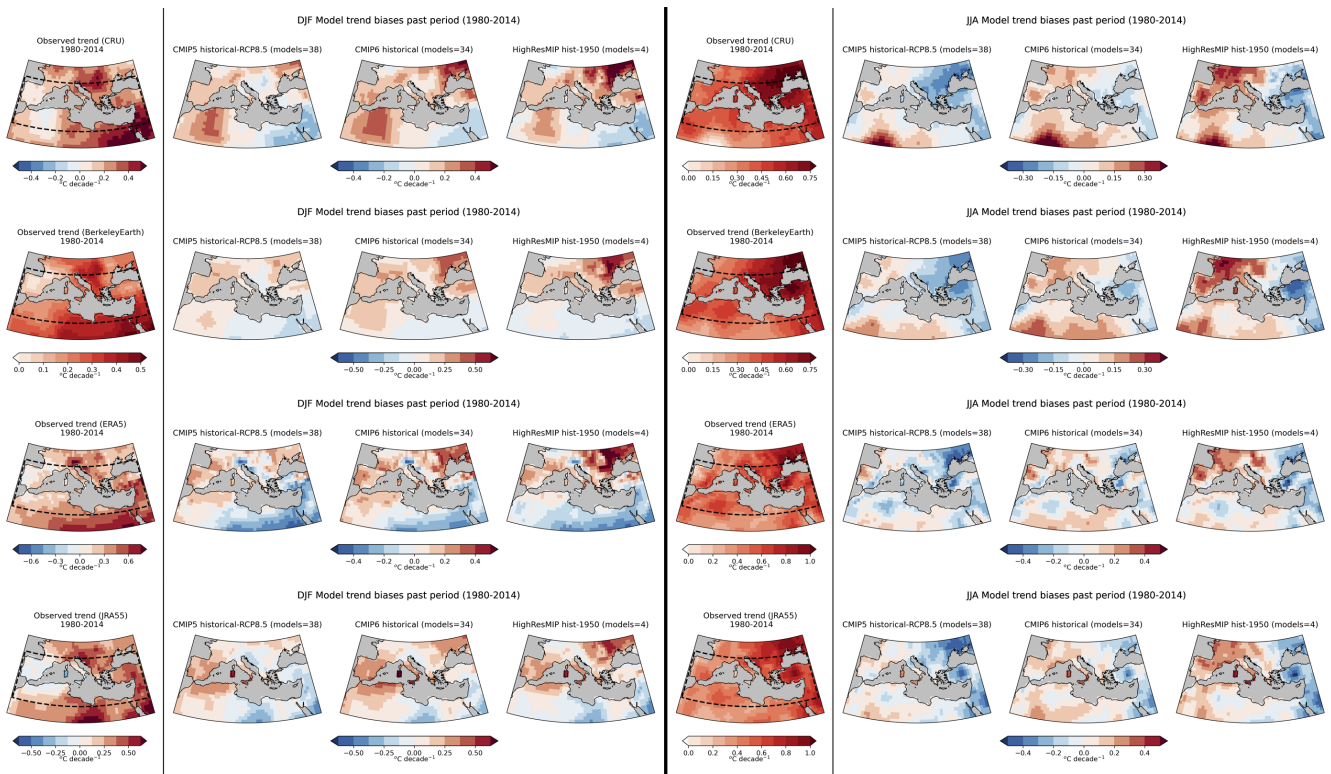


Figure S7. Historical period TAS trend biases against observational references (rows) for CMIP5, CMIP6 and HighResMIP multi-model means during winter (left) and summer (right).

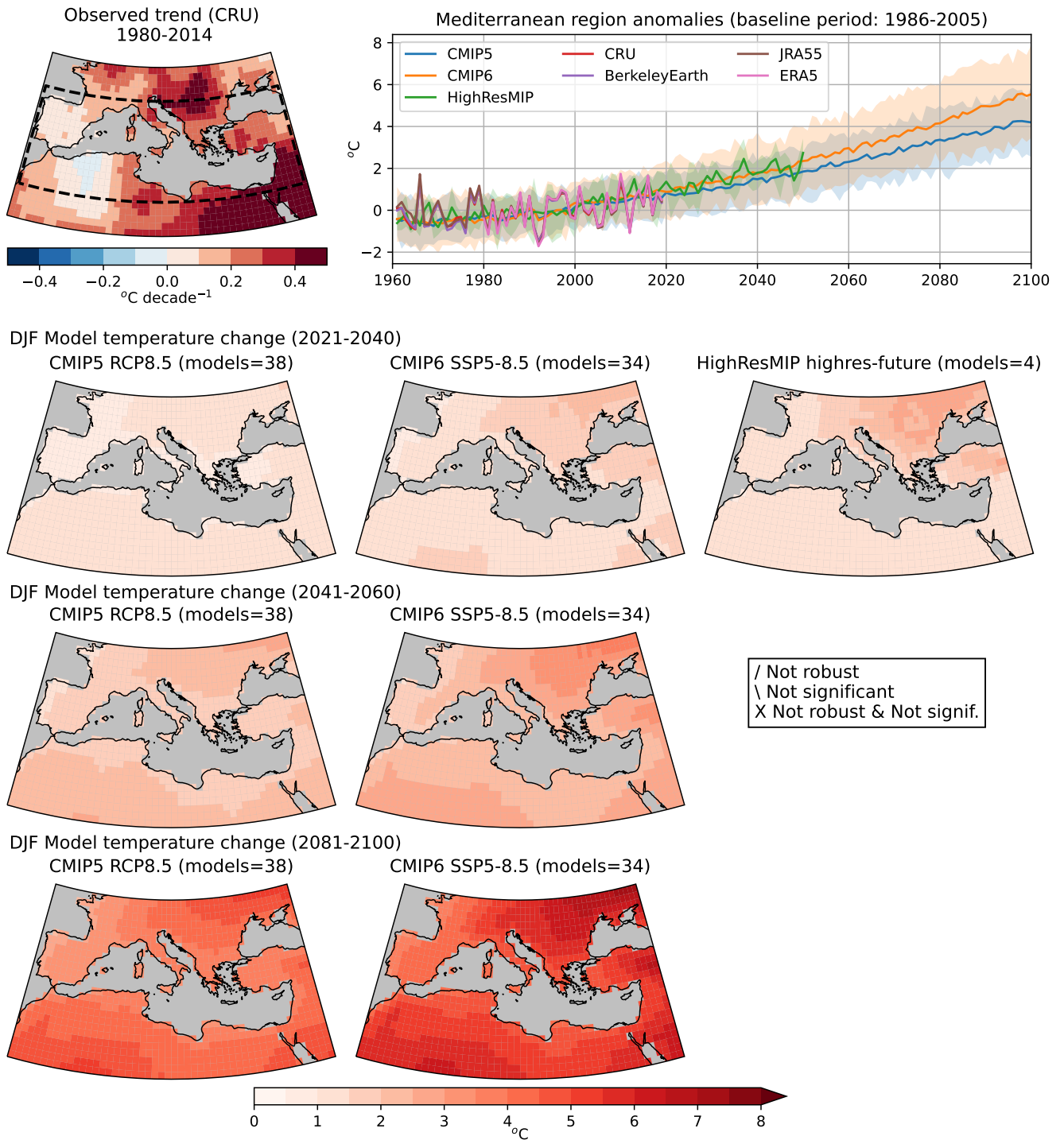


Figure S8. Same as Fig. 4 but for winter

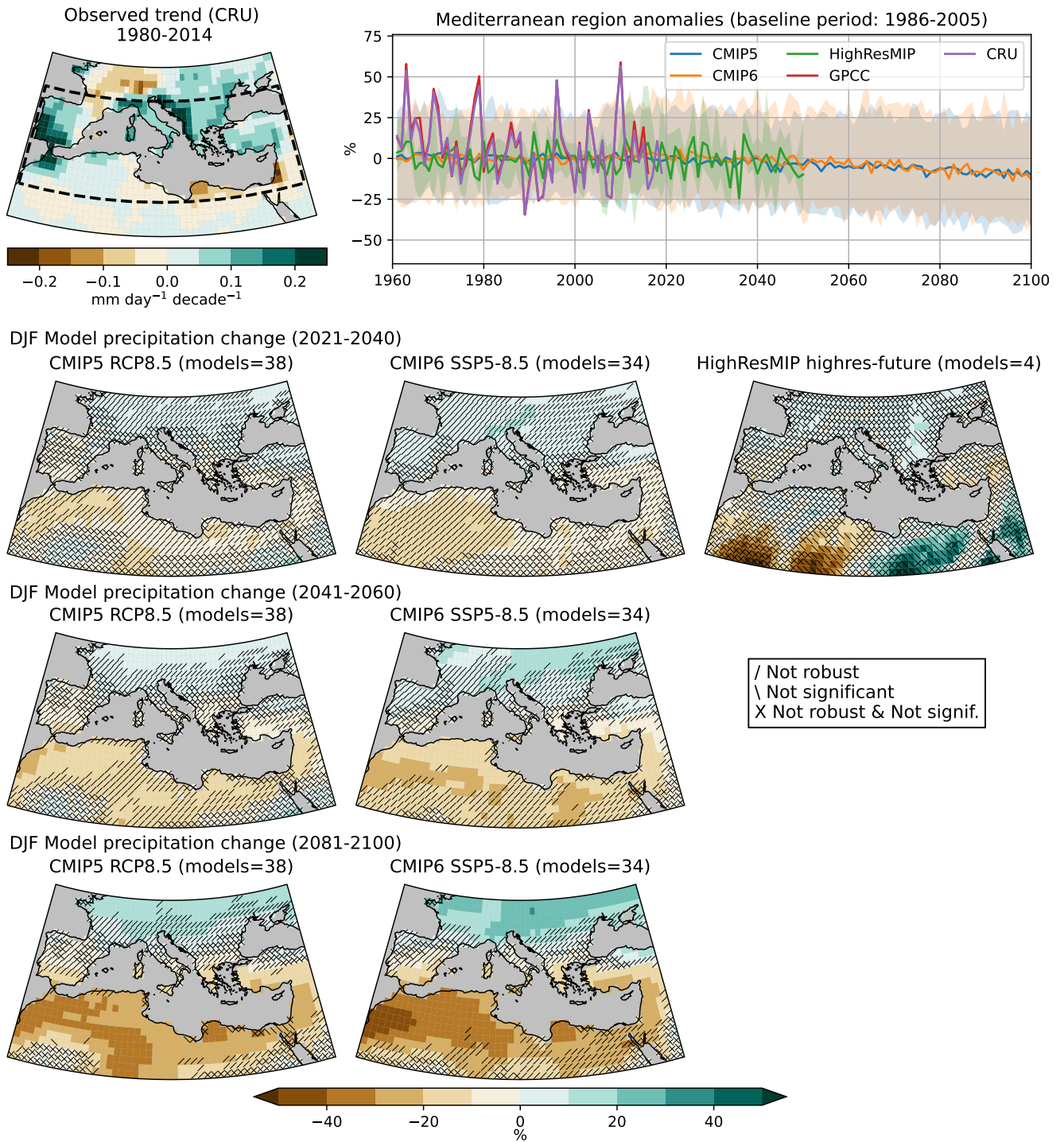


Figure S9. Same as Fig. 5 but for winter

1 Model performance over the historical period

The ensembles used in the present study contain many models and they all perform differently for different diagnostics. Fig. S10 shows the normalised RMSE from diverse diagnostics (rows) of all CMIP6 models (columns) for an historical period (1980-2014). The values are normalised by first subtracting the median RMSE of the single models to each model's RMSE, and secondly, dividing by the median RMSE (Gleckler et al., 2008) The boxes are diagonally split to show RMSE against JRA55 and CRU observational datasets. Negative values indicate a better than median performance, positive values worse than median performance.

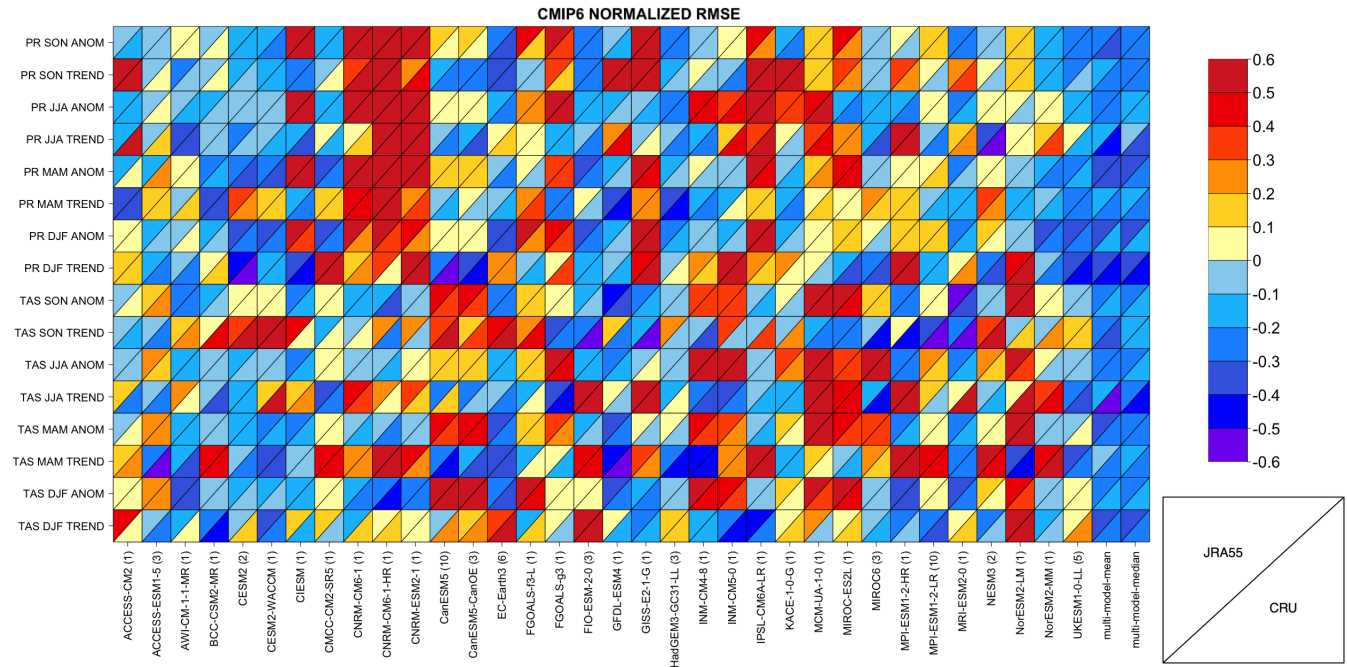


Figure S10. Seasonal normalized root mean squared error of TAS and PR anomalies and trends over the Mediterranean (rows) between each CMIP6 model (columns) and observational references for 1980-2014. Each cell is divided in two triangles to display the RMSE against JRA55 and CRU. The last two columns show the RMSE of multi-model ensemble mean and median.

Each models' performance is very different along the diagnostics. Some models perform better over most of the diagnostics, some seem to perform well for some diagnostics or variables and bad for others, and some perform worse than the RMSE median for most diagnostics. There are models that apparently share characteristics as some diagnostics yield similar results for models from CCCma and CNRM-CERFACS. Differences between models from the same institutions usually are the grid resolution, the ocean model or the chemistry of both the atmosphere and ocean, to name a few (ref*). The potential dependency between models raises another concern when dealing with multi-model ensemble projections. Dependent models bear the risk of producing unbalanced mean projections as more weight could be given to a certain way of modelling the climate.

15 Interestingly, the multi-model-mean and multi-model-median performances are better than the single model performance median. Showing that while there are models that perform better than the ensemble mean, it is still better to use the mean than single models when considering multiple diagnostics. The fact that the multi-model ensemble performance is consistently better for all diagnostics shows how single model errors partly cancel off (Tebaldi and Knutti, 2007). Arriving at a better representation of the climate by combining different models is one of the pillars behind the Coupled Model Intercomparison Project.

20 Project.

The comparison between the CMIP5, CMIP6 and HighResMIP models is shown in Fig. S2.10S11. The multi-model means from CMIP5 and CMIP6 show very similar RMSE values, on average, across diagnostics. The HighResMIP ensemble is too small to compare it's multi-model mean to both CMIPs.

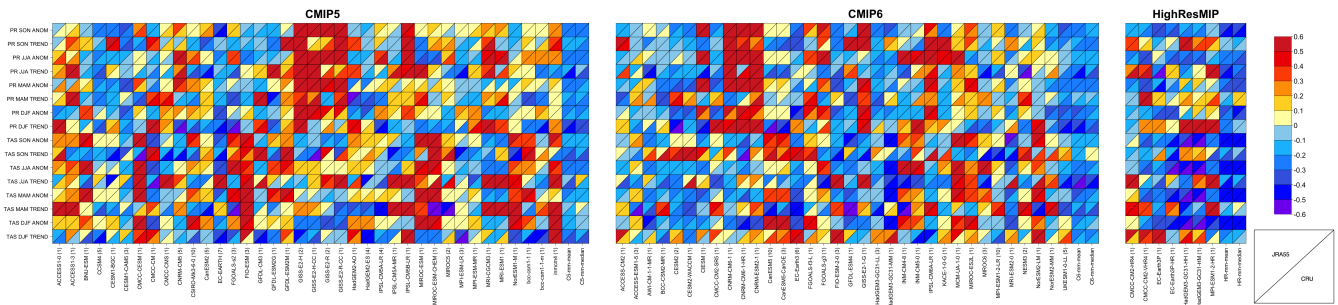


Figure S11. Same as Fig. S10 but normalising RMSE using the complete ensemble of models from CMIP5, CMIP6 and HighResMIP.

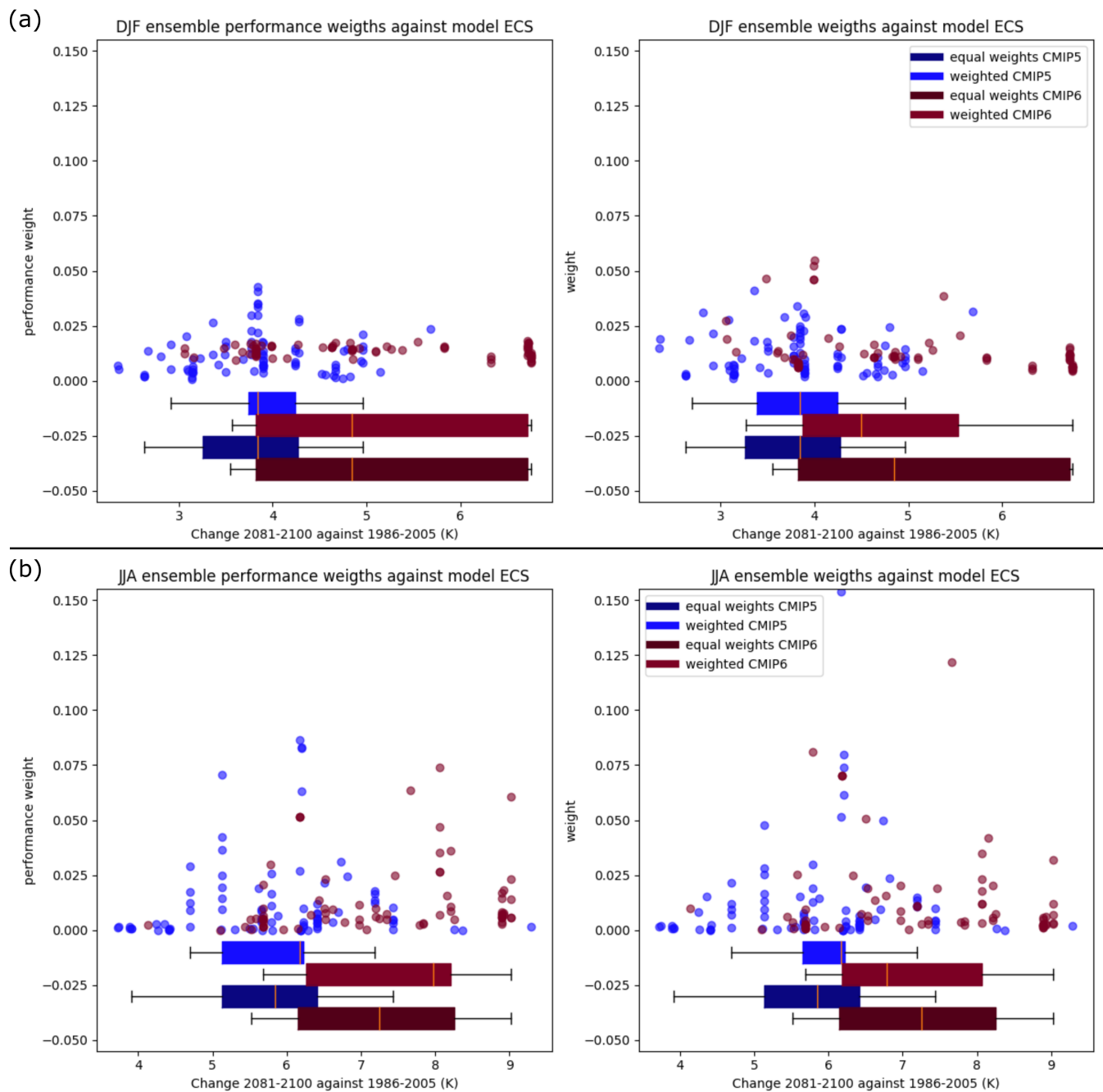


Figure S12. Scatter plots displaying the performance weights (left) and the full weights (right) against their member's 2081-2100 warming with respect to 1986-2005 for DJF (a) and JJA (b). The boxplots represent the long-term Δ TAS distributions for weighted (darker colour) and unweighted (lighter colour) from the CMIP5 (blue) and CMIP6 (red) ensembles.

References

- 25 Gleckler, P. J., Taylor, K. E., and Doutriaux, C.: Performance metrics for climate models, *Journal of Geophysical Research Atmospheres*, 113, <https://doi.org/10.1029/2007JD008972>, 2008.
- Tebaldi, C. and Knutti, R.: The use of the multi-model ensemble in probabilistic climate projections, *Ocean Model.*, 365, 2053–2075, <https://doi.org/10.1098/rsta.2007.2076>, 2007.