A multi-scenario view of impacts on climate extremes and indices with a multi-variable ensemble of regional climate projections for Portugal

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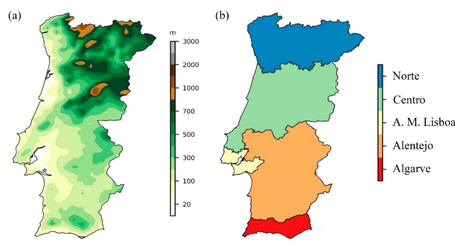
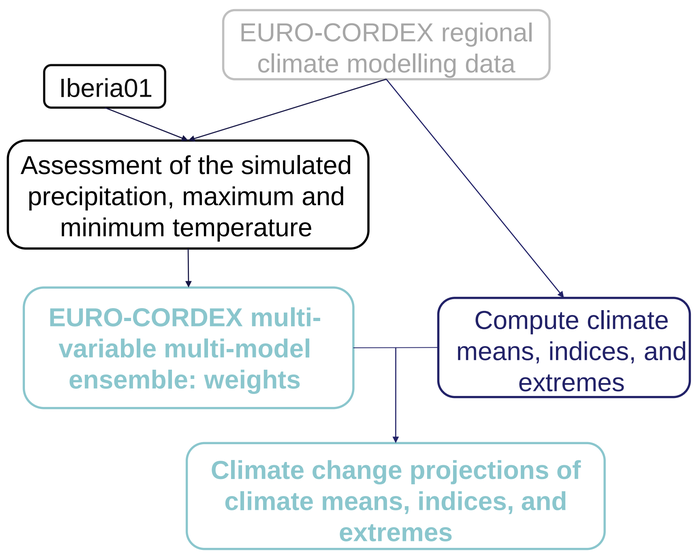
Goals

Characterisation of climate change projections based on a set of relevant variables: Climate means, extremes, and indices are explored from highly- to non-mitigated emission scenarios based on a multi-variable constrained ensemble of EURO-CORDEX

Establishing a baseline for future studies to delve in sectorial impact modelling, such as water resources, agriculture, forests, wildfire danger, and coastal areas, with the purpose of translating physical impacts into social and economic ones, both with and without adaptation measures.



Data and Methods



EURO-CORDEX regional climate modelling data

45 EURO-CORDEX simulations (13 selected)
RCP2.6, RCP4.5 and RCP8.5
2011-2040, 2041-2070 and 2071-2100

daily total precipitation; 2-m maximum and minimum daily temperatures; daily mean 10-m wind speed; daily maximum 10-m wind gust

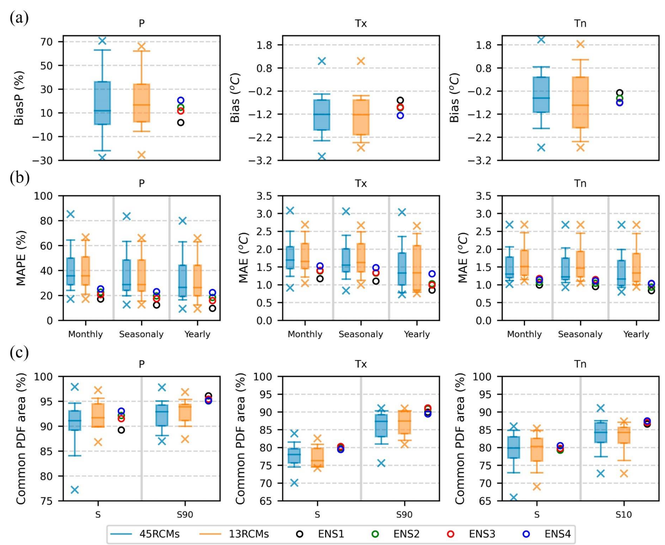
Iberia01 observations

daily total precipitation, 2-m maximum and minimum temperatures, from 1971 to 2000 at 0.1º horizontal resolution

Model evaluation metrics

The set of error metrics used are mean bias, mean absolute error, root mean squared error, normalized standard deviation, spatial correlation, Willmott-D Score, Perkins skill score, and Yule-Kendall skewness. This set allows the analysis of mean values but also measure the differences between PDF distributions.

Assessment of the multi-variable constrained ensembles



Climatological error measures of EURO-CORDEX RCMs (45 models in blue and 13 models in orange) and of EURO-CORDEX multi-model ensemble common precipitation (left), maximum (middle) and minimum (right) temperature over Portuguese mainland (1971-2000). *(from Lima et al. 2023 – Part I)*

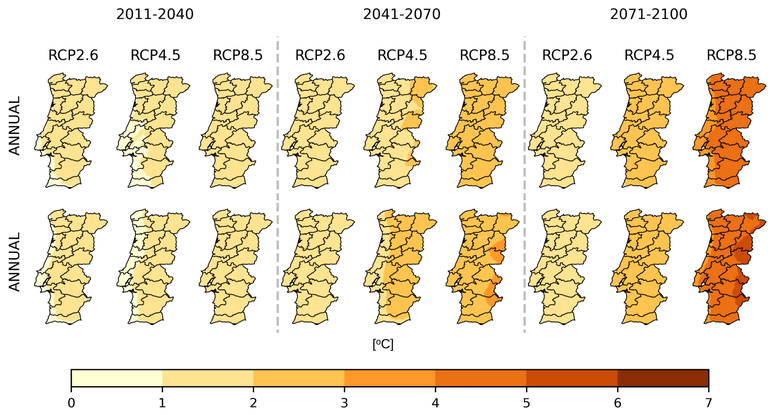
$$ENS3 = \sum_{m=1}^{M} V_m\left(0.5w_{p_m} + 0.25w_{tx_m} + 0.25w_{tn_m}\right)$$

Climate change assessment for Portugal

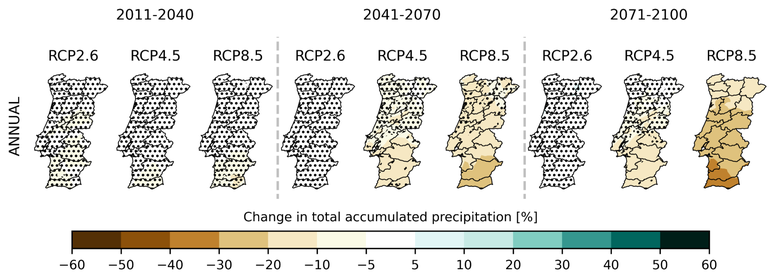
Changes in mean variables

Minimum temperature

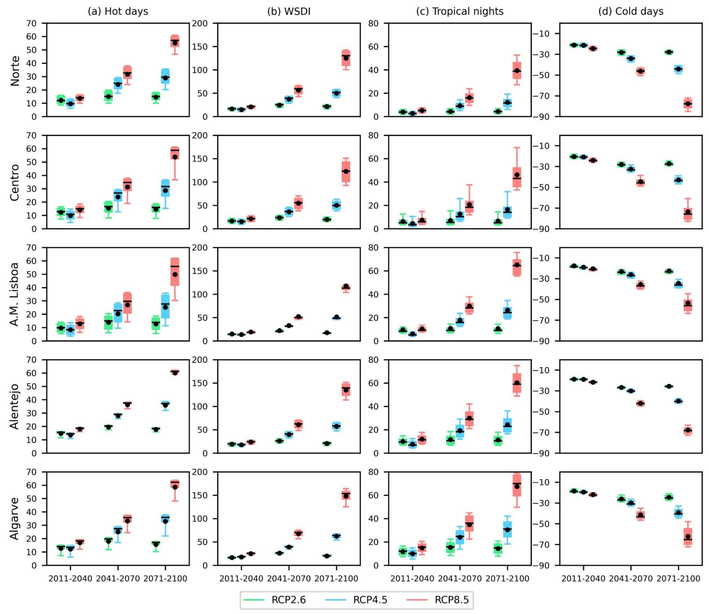
Maximum temperature



Precipitation

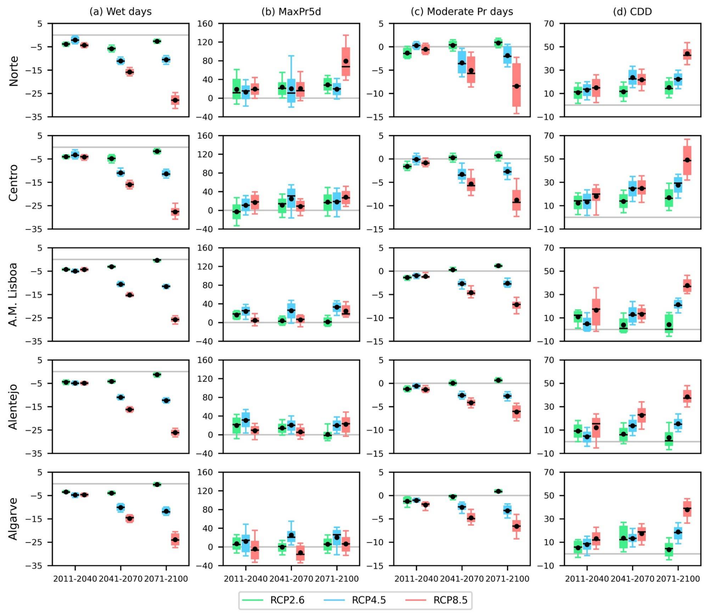


Changes in temperature indices



Future projected changes in (a) hot days [days/year], (b) WSDI [days/year], (c) tropical nights [days/year] and (d) cold days [days/year] for the different NUTS II regions (Norte, Centro, A.M. Lisboa, Alentejo and Algarve, from top to bottom). Three future periods are shown: 2011-2040, 2041-2070, and 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red). The black point represents the multi-model ensemble mean. Individual boxes span from the 25th to the 75th percentile, with the median represented by a straight line, and the whiskers span from 10th to the 90th percentile.

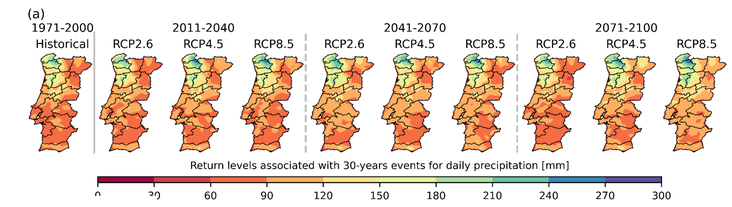
Changes in precipitation indices



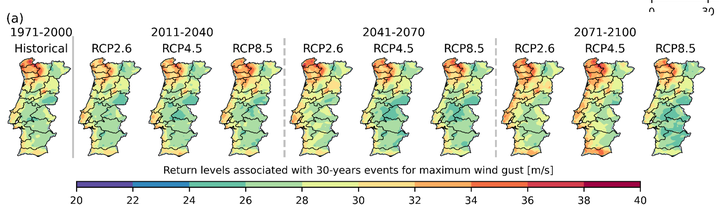
Future projected changes in (a) wet days [days/year], (b) maximum of 5-day accumulated precipitation [mm], (c) moderate precipitation days [days/year] and (d) CDD [days] for the different NUTS II regions (Norte, Centro, A.M. Lisboa, Alentejo and Algarve, from top to bottom). Three future periods are shown: 2011-2040, 2041-2070, and 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red). The black point represents the multi-model ensemble mean. Individual boxes span from the 25th to the 75th percentile, with the median represented by a straight line, and the whiskers span from 10th to the 90th percentile.

Changes in extremes

Precipitation



10-m Wind gust



Conclusions

- The **weighted multi-variable multi-model ensemble** is crucial to preserve the physical consistency among the sectorial modelling since impact models are dependent on climate information from more than one variable;
- The **projected warming and drying trends over Portugal** were shown to be stronger for high anthropogenic emission scenarios, confirming the importance of the human component on the overall climate change projections when compared to the natural variability of the climate system, even at the regional scale;
- As a result of the projected warming and drying trends, the **frequency, intensity, and spatial distribution of extreme climate events are also projected to change**;

➢ Such projected conditions are compatible with an increase in the frequency of occurrence of hazards driven by hydro-meteorological variability, such as droughts, heatwaves, and wildfires, severely impacting agriculture, forests, and water availability.

References

Lima DCA, Gil Lemos; Virgílio A. Bento; Miguel Nogueira; Pedro M.M. Soares (2023) A multi-variable constrained ensemble of regional climate projections under multi-scenarios for Portugal – Part I: an overview of impacts on means and extremes. Climate Services, 30 (100351). DOI: https://doi.org/10.1016/j.cliser.2023.100351.

Lima DCA, Virgílio A. Bento; Gil Lemos; Miguel Nogueira; Pedro M.M. Soares (2023) A multi-variable constrained ensemble of regional climate projections under multi-scenarios for Portugal – Part II: sectoral climate indices. Climate Services, 30 (100377). DOI: https://doi.org/10.1016/j.cliser.2023.100377.

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