Decadal Prediction Skill for Daily Temperature and Precipitation Extreme Climate Events

Carlos Delgado-Torres*, Markus G. Donat, Albert Soret, Nube González-Reviriego, Pierre-Antoine Bretonnière, An-Chi Ho, Núria Pérez-Zanón, Margarida Samsó Cabré, and Francisco J. Doblas-Reyes

Barcelona Supercomputing Center (BSC), Barcelona, Spain

***carlos.delgado@bsc.es**

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

ASPECT
FACILITATING SEAMLESS CLIMATE ADAPTATION

This presentation participates in OSPP
EGU
Outstanding Student & PhD candidate Presentation contest

Motivation and Objectives

The occurrence of extreme climate events in the coming years is modulated by both global warming and internal climate variability. Anticipating such events in advance may help minimize the impact on climate-dependent sectors and society. Trustworthy predictions are essential to develop strategic planning to adapt, build more resilience to their risk and anticipate their impacts ahead of time. Predictions of variations in the occurrence frequency and intensity of extremes in the forthcoming years can potentially be provided by decadal climate predictions.

We evaluate the multi-model forecast quality of the CMIP6 decadal hindcasts (DCPP; retrospective decadal predictions) in predicting a set of indices measuring different characteristics of temperature and precipitation extremes for the next five years. In addition, we compare such skill with that for predicting mean temperature and precipitation. We also assess the impact of model initialization by comparing the skill of the decadal hindcast with that of the historical forcing simulations (HIST; retrospective climate projections).

Data and Methods

- Variables: mean temperature (TAS) and precipitation (PR)
- Extreme indices:
  - TN10p: percentage of days when minimum temperature is below the 10th daily percentile.
  - TNn: minimum of daily minimum temperature.
  - TX90p: percentage of days when maximum temperature is above the 90th daily percentile.
  - TXx: maximum of daily maximum temperature.
  - R95p: sum of precipitation in days where daily precipitation exceeds the 95th percentile of daily precipitation.
  - Rx5day: maximum 5-day consecutive precipitation.
- DCPP multi-model: 133 members from 13 forecast systems
- HIST multi-model: 134 members from the same forecast systems
- Evaluation period: 1961-2014
- Forecast period: years 1-5
- Reference period: 1981-2010
- Reference datasets: BEST (daily minimum and maximum temperature), REGEN (daily precipitation), GHCNv4 (monthly temperature), and GPCC (monthly precipitation)

DCPP multi-model forecast quality

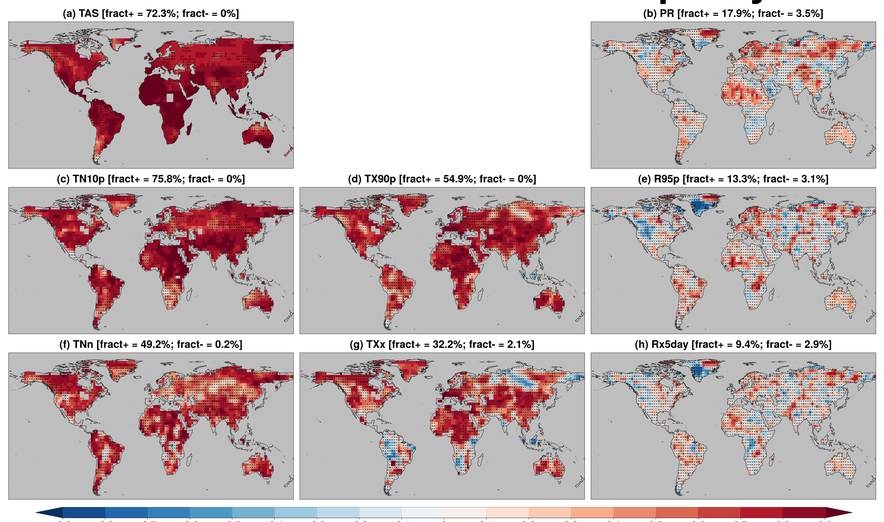

Figure 1. Anomaly correlation coefficient obtained with the DCPP multi-model ensemble. Crosses indicate statistical significance at the 95% confidence level.

Decadal Predictions vs Climate Projections

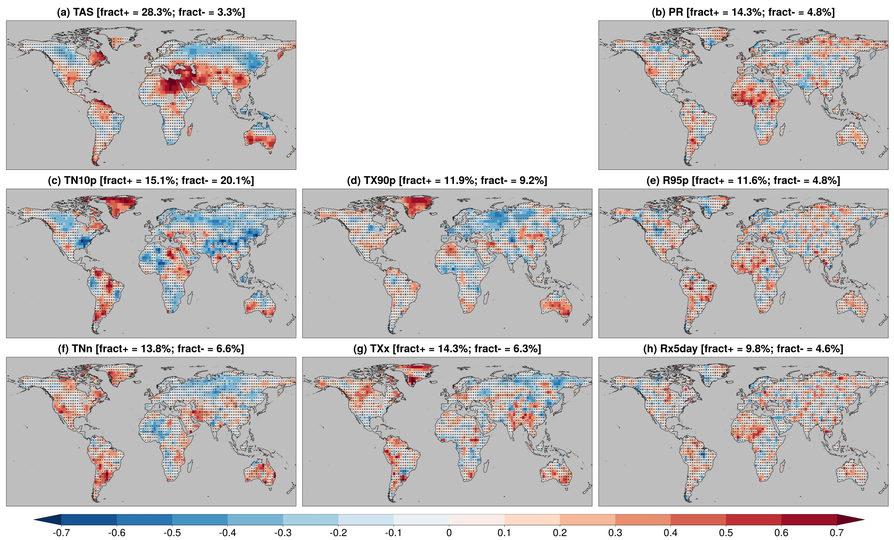

Figure 2. Residual correlation. Red colors indicate that DCPP capture more observed variability than HIST, meaning the opposite otherwise. Crosses indicate statistical significance at the 95% confidence level.

Conclusions

- The decadal predictions skillfully predicts mean and extreme temperature indices at multi-annual frequency over most of the globe.
- The skill is lower and limited to some regions for mean and extreme precipitation.
- There is a generally higher skill in predicting the mean variables than the extreme indices.
- The skill for both extreme temperature and precipitation is higher for the moderate extremes (TN10p, TX90p and R95p; related to frequency) than for the most extreme extremes (TNn, TXx and Rx5day, related to intensity).
- The comparison between the decadal predictions and historical simulations shows a region-dependent impact of initialization on the skill.
- The added value due to initialization is higher for the mean variables than for the extreme indices. Besides, such skill differences differ between indices, especially those representing extreme temperature.

This forecast quality assessment is essential when providing a climate service based on decadal predictions so that the user is informed on the trustworthiness of the forecasts for each specific region and extreme event.

Acknowledgments

This study is a contribution to the Horizon Europe ASPECT project (Grant 101081460). CDT acknowledges financial support from the Spanish Ministry for Science and Innovation (FPI PRE2019-509 08864 financed by MCIN/AEI/10.13039/501100011033 and by FSE invierte en tu futuro). MGD is grateful for support by the AXA Research Fund. We acknowledge the use of the climdex.pcic, startR, s2dv, CSTools, multiApply, and ClimProjDiags R-language-based software packages, all of them available on the Comprehensive R Archive Network (CRAN). The authors thank all the modeling groups for making the simulations available through the Earth System Grid Federation system ESGF).

Publication

Delgado-Torres, C., Donat, M. G., Soret, A., Gonzalez-Reviriego, N., Bretonnière, P.-A., Ho, A.-C., Pérez-Zanón, N., Samsó Cabré, M., and Doblas-Reyes, F. J. (2023). Multi-annual predictions of the frequency and intensity of daily temperature and precipitation extremes. Environmental Research Letters, 18 034031. https://doi.org/10.1088/1748-9326/acbbe1