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A 2000 year drought dataset for present-day and 2K temperature increase

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There is growing evidence that climate change will alter global water availability. Here, we investigate how hydrological droughts are affected under 2K global warming. Due to the extreme nature of hydrological drought, we need longer timeseries to accurately estimate distributions of drought characteristics. Within the HiWAVES3 project we aim to quantify the changes and teleconnection in extreme droughts events, using the new HiWAVES3 large ensemble simulations.

The fully coupled dynamical model EC-Earth was used to then generate 2000-year simulation of meteorological variables, both for a present-day climate and a 2K warming scenario. The present-day period is defined as the period in the model in which the global mean near-surface temperature (GMST) is equal to that observed for the period 2011-2015.

For the global simulation of discharge, for both scenarios, we use the global hydrological model PCR-GLOBWB 2, that includes human water interactions. The model produces discharge for the 2000-year period at a daily temporal resolution and 0.5-degree spatial resolution.

Comparing drought characteristics for present-day and 2K warming show a significant negative trend in the low flow regime over the 21st century for large parts of South America, southern Africa, Australia and the Mediterranean. In 40% of the world increases in droughts are projected, while decreased drought impacts are mostly found in the snow-dominated climates. The mean global area in drought, shows a substantial increase going from 11.7 to 20 %. We observe that the changes in the extreme drought (>100-year return periods), are likely to show a stronger response to 2K warming.

This study shows that global drought impacts will increase under a 2K global warming scenario. Furthermore, we show that the approach of large ensemble climate and hydrological modelling provides improved estimates of the risk of extreme drought events. The use of these new large ensemble simulations allows for novel analysis of drought characteristics and teleconnections across the globe. We recommend that the large ensemble approach for any future assessments of the impact of climate change on future drought characteristics.