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Global drought changes under high levels of warming

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Global warming is expected to considerably change the hydrological cycle, with higher temperatures resulting in higher potential evapotranspiration (PET), as well as in changes in the spatial and temporal distribution of precipitation, including more frequent and persistent dry periods. Therefore, coherent information on plausible future drought conditions is needed for decision-makers and water managers in order to make informed decisions and to adapt to likely changes.

In this study, performed within the framework of the FP7 HELIX project, we evaluate how drought conditions may develop globally during the 21st century under high levels of warming. To this end, we analysed a set of six high resolution (0.5°) global simulations for the high end emission scenario RCP 8.5 over the 1976-2100 period.

Changes in different drought parameters, such as frequency, duration, severity, peak and onset, were assessed globally by means of the Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI). Relative standardized indicators were computed for a 30-years baseline period (1976-2005) of the original CMIP5 historical simulations, and compared to three 30-years periods (2006–2035, 2036-2065 and 2066–2100) of Representative Concentration Pathway (RCP) 8.5 simulations. To compute the relative SPI (SPEI), Gamma (log-normal) distributions were estimated for the reference and for the future periods. The fitted distributions were then used to calculate the probability difference between future and present standardized values.

More frequent, persistent and severe droughts are projected under these conditions, mainly driven by the increase in potential evapotranspiration. Highest increases from the baseline period in most of the drought related parameters (frequency, severity and duration) are projected mainly in southern Europe, Africa, Australia and tropical South America, with higher magnitudes in arid and semi-arid areas. Projected changes in SPEI are stronger than in SPI due to the considerable effect of the temperature rise on PET and therefore on drought-related parameters. Some regions like Canada, Northern Europe, Russia, China, Central India, Eastern Tanzania and Kenya and Southeastern South America show a slight reduction in drought frequency caused by higher precipitation that compensates the effects of increased evapotranspiration. Although there is a good agreement between different model runs, higher uncertainties are observed in tropical and artic regions.