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Agricultural droughts in CMIP6 future projections

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Changes in climate have affected frequency and characteristics of extreme events and natural hazards. To improve understanding of possible changes of agricultural droughts in the future, we explore drought characteristics in long term future projections of Earth System Models (ESMs) participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6) for different future scenarios based on three Shared Socioeconomic Pathways (SSP). To quantify the intensity of agricultural droughts, the 6-month Standardized Precipitation Evapotranspiration Index (SPEI6) with a 65 year reference period is applied to simulations of 18 ESMs.
Drought related atmospheric variables of the simulations are validated with reanalysis datasets including ERA5 and CRU.
For three future scenarios the projected SPEI6 distributions are analyzed globally and regionally to estimate and characterize the changes in agricultural drought in the future based on multi-model means of change rates, distributions and relative area covered by certain event types. We quantify the change of drought index values for 42 IPCC AR6 WG1 reference regions individually with a focus on those with most harvest area. For higher emission scenarios we find, in agreement with other studies, negative trends in water budget and SPEI in most of them, particularly in the Mediterranean and other arid regions. Increasing reference evapotranspiration emerges as the dominant driver for more extreme drought conditions in these regions. What is considered as the driest 2.3% months during 1950-2014 is projected to be the new normal or moderate condition in arid regions by 2100, following a high emission future scenario (SSP 5-8.5). For this scenario, 20% of the harvest regions surface is considered to be under extreme drought conditions during northern hemisphere autumn. Under a low emission scenario (SSP 1-2.6) with an expected global warming of 1.8°C it would be less than 10%.