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Unprecedented climate extremes in Sub-Saharan Africa and implications for maize production

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Sub-Saharan Africa is one of the most food-insecure regions in the world, and is particularly vulnerable to the impacts of extreme climate events and climate change. To gain a better understanding of the present-day likelihood of extreme seasonal temperature and rainfall events, and their joint occurrence, we apply the UNprecedented Simulated Extremes using ENsembles (UNSEEN) approach to a large ensemble of high-resolution initialised climate simulations in three countries of Sub-Saharan Africa: Tanzania, Zambia and South Africa. We assess the annual likelihood of unprecedented seasonal temperature and precipitation extremes during the maize growing season (October-April), as key variables for maize productivity , and investigate the large-scale dynamics of the climate system that govern their occurrence. We estimate that there is a 3-4% chance per year of exceeding the present-day seasonal temperature records in the maize growing regions of these countries, and a 1-3.5% chance per year of exceeding the present-day seasonal precipitation records. Conversely, whilst we find a 2% and 5% chance per year of subceeding the present-day seasonal precipitation records in Zambia and Tanzania respectively, we find a very low chance (0-1% per year) of subceeding the present-day seasonal precipitation records in South Africa. We also use the large ensemble to investigate the large-scale dynamics of the climate extremes, finding that high temperature extremes tend to be associated with El Niño and positive IOD/SIOD events and low temperature extremes with La Niña and negative IOD/SIOD events. The drivers of precipitation extremes, however, differ between the countries. In South Africa, high (low) precipitation extremes are associated with La Niña (El Niño) events but otherwise the influence on extremes of ENSO, and even more so the IOD/SIOD, is weak or not seen in the ensemble, which invites further investigation. To explore implications for growing maize in these regions, we convert our unprecedented seasonal temperature estimates to daily maximum temperatures and our seasonal precipitation estimates to monthly precipitation indices and compare to climatic thresholds for maize. Combined with projected changes to crop suitability in much of sub-Saharan Africa, our analysis suggests the need for significant adaptation strategies that build food system resilience in the near and longer term.