EGU24-8388, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-8388
EGU General Assembly 2024
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The Future of Hot-Dry Events in the World's Breadbasket Regions

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We use a 50-member large ensemble of the CMIP6 version of the MPI-ESM1.2-LR model to examine the future of hot-dry compound events at 1.5 and 2°C of global warming. By targeting the largest maize production areas (breadbasket regions) and their corresponding growing seasons, we tailor our analysis to food production, indicating potential future threats to global food security. Our results suggest a notable shift in the extremes associated with maize harvest failure in the breadbaskets between 1.5 and 2°C of global warming, highlighting the value of mitigating climate change and the future need to adapt to climate challenges in the agricultural sector.

Our analysis shows a significant increase in the likelihood of these extremes during maize growing seasons across almost all examined regions and variables. In particular, the occurrence probability of heat events and hot-dry compounds at least doubles in most regions when the world warms from 1.5 to 2°C. Locally, cumulated heat excess increases everywhere, while the spatial extent of heat consistently expands across all regions in contrast to the relatively stable pattern we find for precipitation as we transition from one level of global warming to another. We additionally explore spatial compounding, where multiple breadbasket regions experience simultaneous extremes in the same growing season, exacerbating global food security challenges. Scenarios that were virtually impossible in the past, such as hot-dry events affecting at least three regions simultaneously, take on non-zero probabilities in a world that is 1.5 or 2°C warmer. The probabilities of simultaneous heat and hot-dry compounds in a 2°C warmer world significantly exceed those in a 1.5°C warmer world, to the extent that there is little to no overlap between the corresponding ensemble spreads.