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The hidden signature of temperature-moisture couplings in the heat sensitivity of global crops

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Rising air temperatures are a leading risk to global crop production and food security under climate change. Recent research has emphasized the critical role of moisture availability in regulating crop responses to heat and the importance of temperature-moisture couplings in the genesis of concurrent hot and dry conditions. Here, we demonstrate that the heat sensitivity of key global crops is dependent on the local strength of couplings between temperature and moisture in the climate system (namely, the interannual correlations of growing season temperature with evapotransipration and precipitation). Over 1970-2013, maize and soy yields declined more during hotter growing seasons where decreased precipitation and evapotranspiration more strongly accompanied higher temperatures. Based on this historical pattern and a suite of CMIP6 climate model projections, we show that changes in temperature-moisture couplings in response to warming could enhance the heat sensitivity of these crops as temperatures rise, worsening the impact of warming by ~5% on global average. However, these changes will benefit crops in some areas where couplings weaken, and are highly uncertain in others. Our results demonstrate that climate change will impact crops not only through warming, but also through changes in temperature-moisture couplings, which may alter the sensitivity of crop yields to heat as warming proceeds. Robust adaptation of cropping systems will need to consider this underappreciated risk to food production from climate change.