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Investigate the Effects of Compound Extreme Climate Events on Global crop Yield from 1982 to 2016

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In the context of global climate change, extreme climate events are becoming increasingly frequent. Extreme climate events constitute major risks to global food security. The simultaneous occurrence of multiple extreme climate events may have a much greater impact than individual extreme events in isolation. Here we quantitatively analyzed the impact of individual and combined extreme climate indices, including cold days (CD), warm degree days (WDD), precipitation, and compound hot – windy - dry (HWD), on the yields of three major crops (winter wheat, soybeans, and maize) globally by establishing a linear mixed-effects model. CD, HWD, and WDD are identified as the most significant driving factors causing yield losses in winter wheat, soybeans, and maize, respectively. During the planting to the jointing stage, per 10 days of CD account for a 3.2% reduction in winter wheat yield. During the jointing to heading stage, per 10 h of HWD and per 10 °C day-1 WDD result in a 7.5% reduction in soybean yield and a 2.7% reduction in maize yield, respectively. We quantified "yield shocks" and found that the regions experiencing yield shocks exhibit a similar spatial distribution to extreme climate indices. These extreme climate indices are likely to be the driving factors behind yield shocks for the three crops. Our findings indicate that multiple individual extreme climate factors, as well as compound heat-drought-wind (HDW) indices that have been overlooked in traditional risk assessments, impact the yield of the three major crops globally.