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Global Warming Determines Future Increase in Compound Dry and Hot Days within Wheat Growing Seasons Worldwide

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Compound dry and hot extremes are proved to be the most damaging climatic stressor to wheat thereby with grave implications for food security, thus it is critical to systematically reveal their changes under unabated global warming. This study provides a comprehensive analysis of the changes in compound dry and hot days (CDHD) occurring within dynamic wheat growing seasons of 2015-2100 over dynamic wheat planting regions worldwide under SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5, including CDHD's frequency and severity. This study sought to fill the gap in knowledge by identifying the CDHD occurring within dynamic wheat growing seasons, clarifying the correlations between droughts and heats as well as their impacts on CDHD, and revealing the driven mechanism of global warming for the increase of CDHD.

Our results demonstrate a notable increase in CDHD's frequency and severity worldwide under all SSPs, such increase is sharper over southern Asia in winter wheat growing season, and southern Canada, northern America, Ukraine, Turkey and northern Kazakhstan in spring wheat growing season. As the top 10 wheat producer, India and America will suffer much more detrimental CDHD in their wheat growing season. Adopting a low forcing pathway will mitigate CDHD risks in up to 93.3% of wheat areas. Positive dependence between droughts and heats in wheat growing season is found over more than 74.2% of wheat areas, which will effectively promote the frequency and severity of CDHD. Global warming will dominate the increase of CDHD directly by increasing hot days and indirectly by enhancing potential evapotranspiration thereby aggravating droughts. This study helps to optimize adaptation strategies for mitigating CDHD risks on wheat production, and provides new insights and analysis paradigm for investigating future variations in compound extremes occurring within dynamic crops growing seasons.