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Probabilistic Change of Wheat Productivity and Water Use in China

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Impacts of climate change on agriculture are a major concern worldwide, but uncertainties of climate models and emission scenarios may hamper efforts to adapt to climate change. In this paper, a probabilistic approach is used to estimate the uncertainties and simulate impacts of global warming on wheat production and water use in the main wheat cultivation regions of China, with a global mean temperature (GMT) increase scale relative to 1961–90 values. From output of 20 climate scenarios of the Intergovernmental Panel on Climate Change Data Distribution Centre, median values of projected changes in monthly mean climate variables for representative stations are adapted. These are used to drive the Crop Environment Resource Synthesis (CERES)-Wheat model to simulate wheat production and water use under baseline and global warming scenarios, with and without consideration of carbon dioxide (CO_2) fertilization effects. Results show that, because of temperature increase, projected wheat-growing periods for GMT changes of 18, 28, and 38C would shorten, with averaged median values of 3.94%, 6.90%, and 9.67%, respectively. There is a high probability of decreasing (increasing) changes in yield and water-use efficiency under higher temperature scenarios without (with) consideration of CO_2 fertilization effects. Elevated CO_2 concentration generally compensates for the negative effects of warming temperatures on production. Moreover, positive effects of elevated CO_2 concentration on grain yield increase with warming temperatures. The findings could be critical for climate-change-driven agricultural production that ensures global food security.