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The Impacts of Various Environments Factors and Management Strategies on Food Crops in the 21st Century Based on a Land Surface Model

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Environmental factors - characterized by increasing levels of CO_2, and changes in temperature and precipitation patterns - present potential risks to global food supply. To date, understanding of environmental factors' effects on crop production remains uncertain due to (1) uncertainties in projected trends of these factors and their spatial and temporal variability; (2) uncertainties in the physiological, genetic and molecular basis of crop adaptation to management practices (e.g. change in planting time, irrigation and N fertilization etc.) and (3) uncertainties in current land surface models to estimate the response of crop production to changes in environmental factors and management strategies. In this study we apply a process-based land surface model, the Integrated Science Assessment model (ISAM), to assess the impact of various environmental factors and management practices on the production of row crops (e.g., corn, soybean, wheat and rice) at regional and global scales. Results are compared to corresponding simulations performed with the crop model in the Community Land Model (CLM4.5). Each model is driven with historical atmospheric forcing data (1901-2005), and projected atmospheric forcing data under RCP 4.5 or RCP 8.5 (2006-2100) from CESM CMIP5 simulations to estimate the effects of different climate change projections on potential productivity of food crops at a global scale. For each set of atmospheric forcing data, production of each crop is simulated with and without inclusion of management practices (e.g. application of irrigation, N fertilization, change in planting time and crop cultivars etc.) to assess the effect of adaptation on projected crop production over the 21st century. In detail, three questions are addressed: (1) what are the effects of environmental factors and management practices on historical and projected crop production; (2) what are the impacts of different climate change projections on global crop production; and (3) What are the effects of environmental factors and management practices on historical and projected crop production. The major outcomes of this study will help to understand the uncertainties in potential productivity of food crops under different environmental conditions and management practices.