Geophysical Research Abstracts
Vol. 12, EGU2010-250, 2010
EGU General Assembly 2010

Climate Change and Regional Agricultural Production Risk in China: A New Super-ensemble-based Probabilistic Projection

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Abstract. A warming trend has become pronounced since the 1980s and is projected to accelerate in the future. Concerns about the vulnerability of agricultural production to climate change are increasing. However estimates of climate change impacts are plague with uncertainties from many physical, biological, and social-economic processes. Among the urgent research priorities, more comprehensive assessments of impacts that better represent the uncertainties are needed. Here, we develop a new super-ensemble-based probabilistic projection system to account for the uncertainties from CO2 emission scenarios, climate change scenarios, and biophysical processes in impact assessment model. We demonstrate the system in addressing the probabilistic changes of maize production in the North China Plain in future. The new process-based general crop model, MCWLA [Tao, F., Yokozawa, M. Zhang, Z., 2009. Modelling the impacts of weather and climate variability on crop productivity over a large area: a new process-based model development, optimization, and uncertainties analysis. Agric. For. Meteorol. 149, 831–850], is used. MCWLA accounts for the key impact mechanisms of climate variability and is accurate over a large area. We use 10 climate scenarios consisting of the combinations of five GCMs and two emission scenarios, the corresponding atmospheric CO2 concentration range, and 60 sets of crop model parameters derived using the Bayesian probability inversion and a Markov chain Monte Carlo (MCMC) technique, representing the biophysical uncertainties from crop models. The resulting probability distributions indicate expected yield changes of -9.7% to -9.1%, -19.0% to -15.7%, and -25.5% to -24.7%, during 2020s, 2050s, and 2080s, respectively. We also investigate the temporal and spatial pattern of changes and variability in maize yield across the region. Besides the new findings on the probabilistic changes of maize productivity in the North China Plain, our study demonstrated an advanced super-ensemble-based probabilistic projection approach in addressing the impacts of climate variability (change) on regional agricultural production and the uncertainties.