

Evaluating effects of climate changes on Midwest agroecosystems using a climate-crop coupled model

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Abstract

(1) Our general project objective is to understand and quantify how critical ecosystem structure, functioning, and climate feedbacks in major terrestrial ecosystems of the Midwest (i.e., agroecosystems consisting mainly of corn and soybeans) will change at the regional scale under climate change, directly addressing Focuses 1, 4, and (to a lesser degree) 3 of the RFP.

(2) The research activity will be carried out at Iowa State University (lead institute) and Saint Louis University (subcontractor institute). The region of interest for the study is the U.S. Midwest, focusing on agroecosystem of the region.

(3) We hypothesize that climate change effects on U.S. Midwest agroecosystem functioning and their mutual feedback, from sub-seasonal to decadal scales, can be understood and quantified more completely by use of high-resolution, crop-specific, and climate-ecosystem coupled regional models. The climate change factors to be considered in this project include air temperature, precipitation/soil moisture, and atmospheric CO₂ concentration while agroecosystem structure and functioning consist of crop yields, dry mass, photosynthesis, water and CO₂ fluxes.

(4) We will use our new coupled regional climate-crop model developed under past NIGEC funding to downscale global climate model scenarios created for the next IPCC assessment report. Our model includes physiological processes unique to each of the main crops (e.g., corn, soybean) that comprise the dominant agroecosystems of the U.S. Midwest. This modeling system allows realistic simulation of Midwest ecosystem structure and functioning interactively with regional climate as constrained by global climate changes produced by increases in atmospheric CO₂. The factor separation methodology will quantify contributions from individual climate change variables separately and synergistically on ecosystems from tissue to system levels. Stringent field significance tests, which treat climate and ecosystem variables as spatially correlated *fields* rather than independent point values, will allow us to clarify the relationship between climate variables and ecosystem function with a new level of confidence.

(5) The research aims at understanding critical processes governing climate-ecosystem interaction and reducing uncertainty in climate change impacts on U.S. Midwest agroecosystems. The deliverables to the public upon successful completion include improved modeling tools for refined climate change-ecosystem response studies, and quantified ecosystem impacts that include ecosystem feedback to the regional climate. Deliverables also include scientific papers published in peer-reviewed literature that will advance our understanding of climate change and ecosystem functioning in the Midwest.