WORKSHOP 01

Effects of Geography, Weather Variability, and Climate Change on Potato Model Uncertainty

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I. Introduction

Over the past several years the AgMIP community has assembled various crop modeling teams, or pilots, with the objective of improving the assessment of climate change impacts on agriculture and food security. The initial pilot objectives include evaluation, inter-comparison, and improvement of models for specific commodities including wheat, maize, rice, and sugarcane. The present study summarizes inter-comparison results from the AgMIP potato crop modeling pilot and includes an assessment of the variation, or uncertainty, among multiple models when compared against common datasets. Projected changes in yield and water use in response to climate change were also summarized for multiple potato production regions.

II. Materials and Methods

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Nine potato modeling groups representing eight crop models participated in the study. Experimental data was obtained from field plots from Bolivia, Burundi, Denmark, and the United States. Model calibration and simulations were conducted in two phases, partial calibration (P1), in which only a minimum set of information needed to run the models for each site was provided to modelers, and full calibration (P2) in which modelers had access to complete yield and time-series data. Simulation were run for a single year corresponding to the experimental data and thirty historical weather-years at all four sites for both phases. For P2 only, factorial combinations of changes in daily air temperature (T), rainfall (W), and CO_2 levels (C) were explored at each of the four locations.

III. Results

Results for P2 phase were summarized for brevity. Model predictions significantly differed from one another in response to inter-annual weather variability, and uncertainty was higher for low- (Bolivia, Burundi) versus high-input managed sites (Denmark, United States) (Fig. 1). Variability was highest for resource use (e.g. water, nitrogen) responses compared with dry matter values. Uncertainty increased with T and declining W but remained constant for changes in C levels. A minimum of five partial, or three fully, calibrated models was required for a modeling ensemble to keep variability of predicted tuber yields below that of measured field variation. Relative yield change in response to climatic factors, as predicted by the median nine-model response, again varied for lower-input versus high-input managed sites (Fig. 2). Responses to increasing C were positive, but simulated yield declined with increasing T, particularly under dryer conditions (Fig. 2).

IV. Discussion

These are the first reported results to quantify uncertainty for tuber/root crops and suggest that, as consistent with other AgMIP pilots, using an ensemble approach will reduce uncertainty in potato model predictions as compared with using a single model. No individual model was found to be consistently better or worse than any other model across the locations and climate factors evaluated. Ensemble predictions suggested that warming temperatures in excess of 3°C would offset positive CO_2 responses at all locations studied. Uncertainty largest when simulating water and nutrient stress, and high temperatures, and thus, these areas represented topics to address for further model improvement.

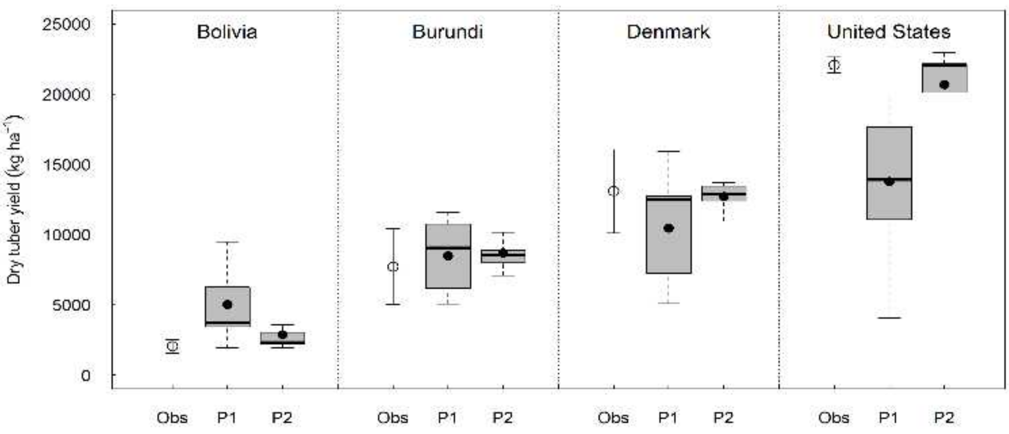

Fig. 1. Box-plots of potato yield for four contrasting locations. Observed (open circles) and simulated (filled circles) means and median values (solid line) as indicated for partial (P1) and fully (P2) calibrated models.

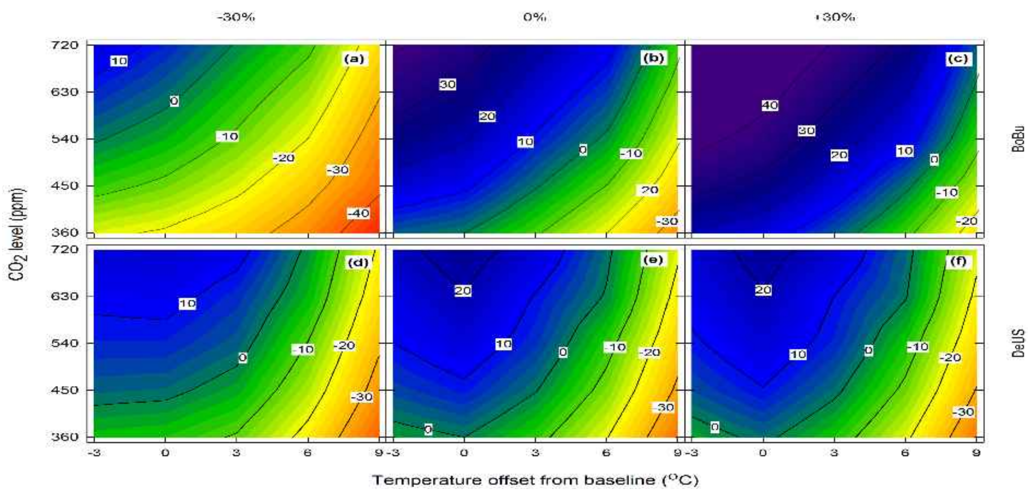

Fig. 2. Relative change in tuber dry yield from historical CO_2, temperature, and rainfall values averaged across low (Bolivia-Burundi, BoBu) or high (Denmark-United States, DeUS) locations.