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Prediction of Evapotranspiration and Yields of Maize: An Inter-comparison among 29 Maize Models and Future Plans

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Introduction

Crop yield can be affected by crop water use (evapotranspiration, ET) and vice versa, so when trying to simulate one or the other, it can be important to simulate both well.

Method: To determine how well 29 maize growth models can simulate ET, an inter-comparison study was initiated under the umbrella of AgMIP (Agricultural Model Inter-Comparison and Improvement Project) using eddy covariance data from Ames, IA as the standard for comparison (Kimball et al., 2019).

Results

In the first “blind” phase for which only weather, soils, phenology, and management information were provided to the modelers, estimates of seasonal ET varied from about 200 to about 700 mm (Fig. 1), and even after receiving all information, ET estimates still varied by a factor of two or more. Much of the variability among the models was due to differing estimates of potential evapotranspiration. The ensemble median values were generally close to the observations, but a few of the models sometimes performed better. The best models varied widely in complexity in spite of having similar prediction accuracies. Models that are widely used tended to perform better, leading us to speculate that a larger number of users testing these models over a wider range of conditions likely has led to improvement. User experience and skill were also a factor in determining the accuracy of model predictions. In several cases, different versions of a model were better, such as an older soil evaporation routine was better than a newer default routine in the DSSAT family.

Future plans

However, there were several issues with the observed data, so a second round of inter-comparisons was initiated and is underway using eddy covariance data from Mead, NE and lysimeter data from Bushland, TX. Besides the ET data, these datasets feature several within-season observations of growth and soil moisture measurements at several depths.

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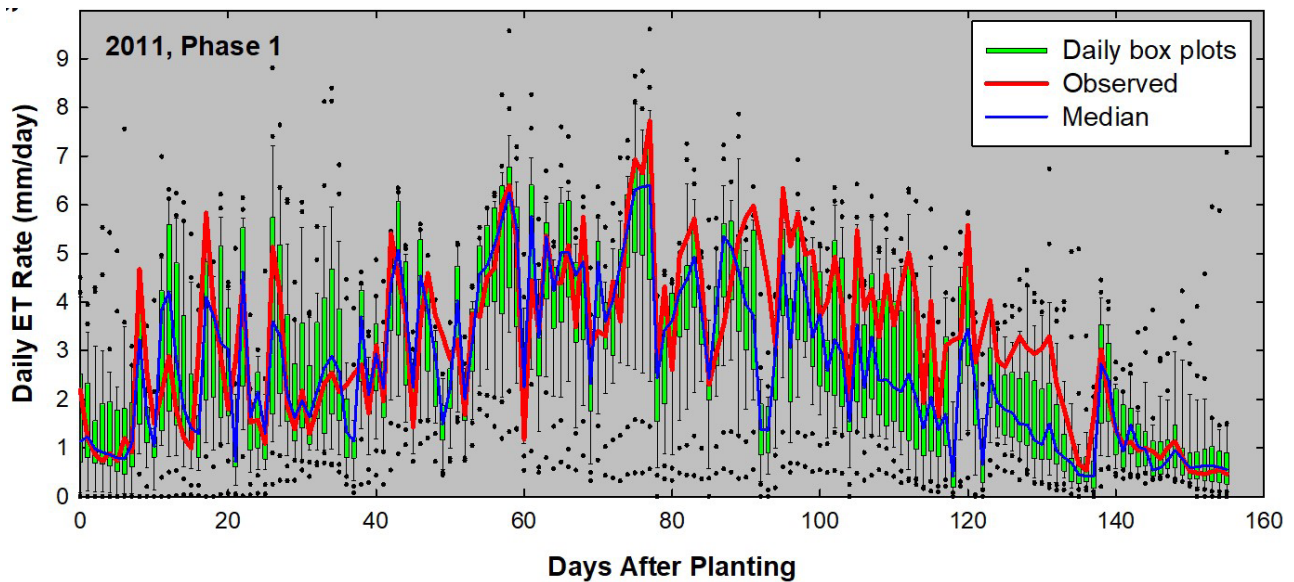


Figure 1. Box plots of daily evapotranspiration (ET) where the lower and upper limits of the box indicate the 25th and 75th percentile of ET values simulated by 29 maize growth models, respectively, the lower and upper whiskers indicate the 10th and 90th percentiles, and the points are outliers. Observed values and the median values from the 29 models are also shown. The simulated values in this plot came from Phase 1, a “blind” test whereby the modellers were only given weather, phenology, management, and soils information, but no crop response data.

Keywords: Water Use, growth, yield.

References:

1. Kimball BA, et al. (2019) Simulation of maize evapotranspiration: an inter-comparison among 29 maize models. *Agric. For. Meteorol.* 271:264-284.