Biases in simulation of rice phenology model under warmer climate: Compared with four models in five Asian countries

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Climate-induced crop yields model projections are constrained by the accuracy of the phenology simulation in crop models. Here, under the support of the Belmont Forum Project, we collect and use phenology observations from 775 trials with 19 rice cultivars in five Asian countries to compare the performance of four rice phenology models (growing-degree-day (GDD), exponential, beta and bilinear models) when applied to warmer climates. For a given cultivar, the difference in growing season temperature (GST) varied between 2.2 and 8.2°C in different trials, which allowed us to calibrate the models for lower GST and validate under higher GST, with three calibration experiments. The results show that in warmer climates the bilinear and beta phenology models resulted in gradually increasing bias for phenology predication and double yield bias per percent increase in phenology simulation bias, while the GDD and exponential models maintained a comparatively constant bias. The phenology biases were primarily attributed to varying phenological patterns to temperature in models, rather than on the size of the calibration dataset. Additionally, results suggest that model simulations based on multiple cultivars provide better predictability than using one cultivar. Therefore, to accurately capture climate change impacts on rice phenology, we recommend simulations based on multiple cultivars using the GDD and exponential phenology models.

Key words: Climate change, rice phenology, crop growth model, biases