Biophysical crop simulation models are normally forced with precipitation data recorded with either gauges or ground-based radar. However, ground-based recording networks are not available at spatial and temporal scales needed to drive the models at many critical places on earth. An alternative would be to employ satellite-based observations of either precipitation or soil moisture. Satellite-based observations of precipitation are currently not considered capable of forcing the models with sufficient accuracy for crop yield predictions. However, deduction of soil moisture from space-based platforms is in a more advanced stage than are precipitation estimates, therefore these data may be capable of forcing the models with better accuracy. In this study, a mature two-source energy balance model, the Atmosphere Land Exchange Inverse (ALEXI) model, was used to deduce root zone soil moisture. The soil moisture estimates were used in turn to force the state-of-the-art Decision Support System for Agrotechnology Transfer (DSSAT) crop simulation model. The study area consisted of a mixture of rainfed and irrigated cornfields. The results indicate that the model forced with the ALEXI moisture estimates produced yield simulations that compared favorably with observed yields and with the rainfed model. The data appear to indicate that the ALEXI model did detect the soil moisture signal from the mixed rainfed/irrigation corn fields and this signal was of sufficient strength to produce adequate simulations of recorded yields over a 10 year period (2000-2009).

This study involves the use of the Decision Support System for Agrotechnology Transfer (DSSAT) crop model to simulate corn yields under various forcing scenarios. First, the model was run using observed precipitation and model-generated soil moisture dynamics. Next, the modeled soil moisture was updated using estimates derived from satellite-based TIR imagery and the Atmospheric Land Exchange Inverse (ALEXI) model. We selected two climatically different locations to test the concept. Bell Mina, Alabama – South Eastern United States, representing humid subtropical climate and Nabb, Indiana – Mid Western United States, representing humid continental climate. A temporal correlation analysis of the soil moisture values from both DSSAT and ALEXI were performed and validated against the Land Information System (LIS) soil moisture dataset at Belle Mina. The results clearly show strong correlation (R = 73%) between ALEXI and DSSAT. At Nabb the correlation between soil moisture estimations from ALEXI and rainfed DSSAT was 53%. Additionally, one of the major outcomes of the study was the successful application of the Principle of Maximum Entropy (POME) in the real-world scenario to develop a soil moisture profile. Further, multiple experiments were conducted for each location: a) a DSSAT rain-fed 10 year sequential run forced with deymet precipitation; b) a DSSAT sequential run with no precipitation data; and c) a DSSAT run forced with ALEXI soil moisture estimates alone. The preliminary results of all the experiments are quantified through soil moisture correlations and yield comparisons. In general, the preliminary results strongly suggest that DSSAT forced with ALEXI can provide significant information especially at locations where no significant precipitation data exists.
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