Integrated Remote Sensing and Crop Yield Modeling: Reliability and Uncertainty Analysis

Xianzeng Niu *, Eric W. Warner, Gary W. Petersen, and William E. Easterling
The Pennsylvania State University, University Park, PA 16802.

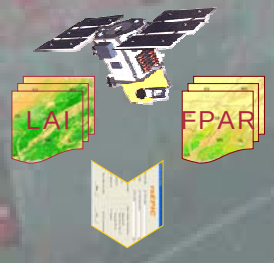
Introduction

Input data uncertainty is one of the important sources of crop yield model errors. Remotely sensed plant biophysical characteristics, such as green leaf area index (LAI) of vegetation and fraction of photosynthetically active radiation (FPAR) from the Moderate Resolution Imaging Spectroradiometer (MODIS), provide great opportunities to improve model performance.

Objectives

➢ To compare model error/reliability in crop yield simulations between a remote sensing driven and a traditional crop model;

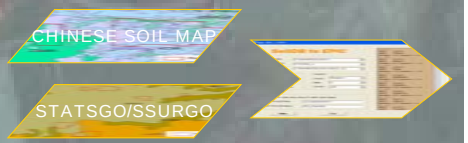
➢ To evaluate the effect of remote sensing data on uncertainties introduced by using input data from different data sources.



Methods

❖ Model. A remote sensing driven crop yield simulation model, rsEPIC (Fig.1), was developed for corn/rice yield simulations.

❖ Locations. Five corn fields were selected in Sangamon County, IL, USA, and four rice fields were chosen in Gaoyou, Jiangsu, China.



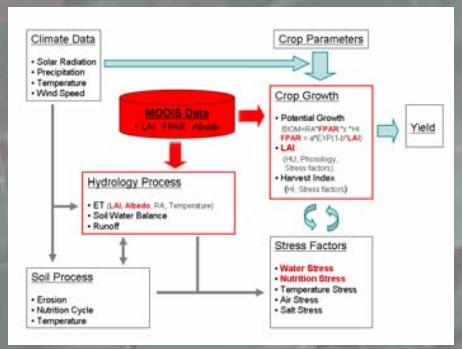


Figure 1. Diagram of a remote sensing driven crop model - rsEPIC

❖ Ground data. Yield and management data of 2005 were obtained from local farmer-networks in both locations. Soil data included a fine-scale field survey (FS) and a coarse-scale soil maps (MS). Weather data included observations from local stations (W2) and model simulations (W0).

❖ MODIS data. The 8-day products of MODIS LAI & FPAR data for both sites were downloaded from the MODIS Land team website spanning the time period of April 19 – Nov. 5, 2005.

Conclusions

➢ Model accuracy in corn/rice yield simulations was greatly improved by incorporation of MODIS LAI & FPAR data into a physical crop model;

➢ A remote sensing driven crop model, rsEPIC, was about 10% more reliable than a traditional model, EPIC, for most of combinations of input data sources;

➢ Incorporation of MODIS LAI data also greatly reduced the model output uncertainties caused by using soil data at different spatial scales.

Results

Model accuracy

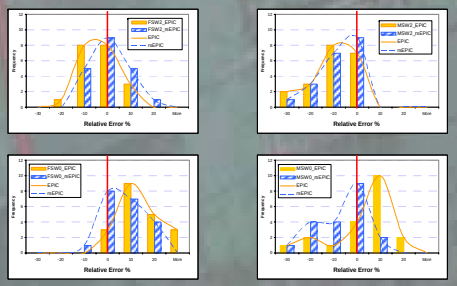


Figure 2. Histogram of relative error (*RE*) in simulation of rice yields by rsEPIC and a traditional physical crop model - EPIC. The accuracy of rsEPIC was better than traditional EPIC as indicated by the shift of the *RE* central distribution toward zero.

Model reliability

SOILS	WEATHER	EPIC	rsEPIC
FIELD	OBSV	100	100
	MODEL	80	95
MAP	OBSV	80	90
	MODEL	85	95

Table 1. Model reliability was presented as the probability (%) that the absolute *RE* < 20%. The rsEPIC was more reliable than EPIC in rice yield simulations for most combination of data sources. The more generalized input data, the greater improvement.

Model uncertainty

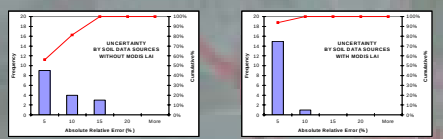


Figure 3. Distribution of differences of absolute relative error in simulation of corn yields in IL between using soil data generated from SSURGO and STATSGO database. The soil-data-induced uncertainty was reduced by rsEPIC (right) as indicated by a sharp “L” shaped distribution.

Acknowledgment

This study was funded by NASA ‘s Office for Earth Sciences through the REASON Program. Grant EOS/03-0000-0610.

* e-mail: xxn101@psu.edu