WINTER WHEAT YIELDS ASSESSMENT USING DATA ASSIMILATION METHOD COMBINED MODIS-LAI AND SWAP MODEL

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1. INTRODUCTION

Crop growth models such as WOFOST (World Food Studies) or SWAP (Soil Water Atmosphere Plant), which simulates in detail photosynthesis and crop development, can be a useful tool for yield assessment. For successfully application of these models need sufficient input parameters, covering crop characteristics, field management, soil properties and weather conditions etc, which can be obtained by field measurement. However, it is impractical to collect all the parameters at regional and larger scale due to economical or other limits. Remote sensing can provide ground information that the model needed such as weather, crop and land use etc, with a high temporal and spatial resolution. Especially, LAI is commonly used as connection point to relate model simulation with remote sensing data, for improving the accuracy of crop yield assessment at regional scales. Unfortunately, due to clouds or mixed pixel effect etc, remotely sensed crop parameters such as LAI, FPAR etc. generally mis-estimate the actual crop conditions. Directly integrate these data with crop model may leads to even poorer results compare to single model simulation without remote sensing. Researchers have developed several methods to fix the problem, such as relate LAI with NDVI using some empirical function, or retrieval LAI using some radiative transfer model. Our experiment show, although the MODIS LAI product (MOD15A2) underestimated the leaf area at least 50% of winter wheat in North China, the phenological trends of the MODIS LAI paralleled well with ground measured LAI. In this paper, we adopted a SCE (Shuffled Complex Evolution) algorithm [3], to assimilate the phenological information about winter wheat extracted from seasonal series of MODIS-LAI product into SWAP

model. The objective of this paper was to evaluate the improvements of assimilation MODIS LAI derived phenological information into SWAP for regional winter wheat yield assessment.

2. STUDY REGIONS AND DATA COLLECTION

The study region is Hebei province, North China, which contributes 11% of China's winter wheat yields in 2008. We pick up the sown region from land use data, and regard the dryland as the winter wheat acreage during growing seasons in this research, because of winter wheat acreage occupied average of 88% crop region of autumn sown in Hebei province. During the whole growing seasons, we performed 7 field experiments at GuCheng station, in Hebei province dating from November 3, 2007 to June 20, 2008, and gathered soil and crop parameters for SWAP model calibration. We've collected three years agro-meteorological data about 23 meteorological stations in Hebei and surrounding provinces in order to enhancing the accuracy of interpolation results. The MODIS-LAI data products (MOD15A2) downloaded from the Goddard Earth Sciences (GES) Distributed Active Archive Center (DAAC), which are produced from TERRA/MODIS data, synthesis of a scene for every 8 days so that there are 46 scenes every year. All these data we collected cover the whole Hebei province and surrounding stations dating from 2006 to 2009.

3. METHODS

Primarily, we perform a sensitivity analysis using OAT (one-factor-at-a-time) method [5] on SWAP model and screened three initial parameters which have a great influence on both LAI and yields. These three inputs are date of crop emergence, the temperature sum from emergence to anthesis and initial total crop dry weight. After that we extracted the phenological transition days at the 23 meteorological stations surrounding area with a mean of 25 pixels through 1 to 177 days of each year. Then we assimilate MODIS-LAI phenological information into SWAP model using SCE algorithm which have an ability to re-initializing model inputs (the three selected in former step) to get a better assessment of yield. Finally, in order to get the yield results about the whole Hebei province, we interpolate the yield at the 23 stations using kriging method based on land use data of Hebei province. To evaluate our method, we compared 3 yields data from 2007 to 2009, which are official yield reported by Department of Agriculture of Hebei province, model simulation results with and without assimilation of MODIS-LAI phenological information.

4. RESULTS AND DISCUSSION

Results indicate that, running model assimilated with MODIS-LAI phenological information, the yields are closer to official yields than the method without assimilation. However, the accuracy of this method cannot satisfy the needs for operational application at regional or provincial scale. The reason is that it is not enough to represent the whole Hebei province by 23 meteorological stations, and the

method that interpolate the yield results need further validation. This study focus on the feasibility to assimilate MODIS-LAI derived phenological information into SWAP model for regional winter wheat yield assessment. In the future research we are going to interpolate the meteorology data into 25 × 25 km grids at first and then running the system by pixels of the land use data of Hebei province.

5. REFERENCES

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