CANOPY MODELING AND VALIDATION FOR ROW PLANTED CROPS OF KEY GROWTH STAGES

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1. INTRODUCTION

Leaf area index (LAI) can be used to infer processes (e.g., photosynthesis, transpiration, and evapotranspiration) and estimate net primary production (NPP) of terrestrial ecosystems [1, 2]. The variability of LAI can reflect various conditions affecting plant growth and development [3]. However, the LAI application is limited for its low inverted accuracy. The suitable LAI for the elongation stage is crucial for the huge ear, strong stem and root system [4]. Furthermore, the diseases will be alleviated with the suitable LAI for the elongation stage. So, the elongation stage is the crop key growth stage (KGS).

Crops are mostly planted as row structure in China. There are different canopy structures for row planted crops at different growth stages. The canopy appears row by row structure and then appears homogeneous for different growth stages. Now, there is no canopy reflectance model suitable both for the row structure canopy and for the homogeneous canopy. So, it is need to select the suitable canopy reflectance model for LAI inversion with high accuracy [5]. However, the criteria for switching structural model for crop canopy are related with the crop physiology, planting density, etc. that is to say, the time for model selection it not unique and this will add the difficulties for LAI inversion. In fact, the time for canopy structure switch is round the elongation stage. It is needed to propose the canopy reflectance model for the key growth stage (KGSM) for high LAI inversion.

2. MODEL MODIFICATION AND VALIDATION

We put the object on one row period for the similar structure of the row planted crop. For each period, four components (sunlit vegetation and soil; viewed vegetation and soil) can be computed based on the bidirectional gap probability model, and structure parameters (W (row width), H (row height), S (row spacing), etc.) and view and solar zenith/azimuth angles. At the same time, the equivalent radiance for vegetation and soil from direct illuminated light and from the diffused and multi-scatted light will be computed. The key growth stages model (KGSM) is the sum of the four component radiance which is the product of each component area and the corresponding equivalent radiance.

In order to validate the performance of the KGSM, we need the canopy reflectance data of key crop growth stages. However, it is difficult to obtain all field-measured CR data for the key crop growth stages because of the weather condition.

The computer simulated data can be used as standard data set to evaluate the performance of other CR models and to analyses the uncertainties of different models [6, 7]. At the mean time, the SAILH model [8, 9] is also used to evaluate the performance of the KGSM. The SAILH model was chosen because it is not only widely tested in the literature but also offers a good representation of homogeneous canopy with a limited number of input parameters and reasonable computation time. In order to validate the performance of the KGSM for typical row planted crops, a field campaign was carried out at Luzhou station (38°51.4′N, 100°24.6′E), in the middle of the Heihe drainage area, Gansu Province, China, from May to August 2008. The KGSM is validated based on the simulated canopy reflectance and the measured data.

3. CONCLUSION AND DISCUSSION

CR models provide the logical connection between the biophysical parameters of the canopy and resulting angular spectral radiation measurement. In order to accurately estimate LAI, the CR model must be adequately consistent to the real canopy. We consider the four component area and corresponding equivalent radiance. The proposed KGSM in this paper is suitable for crop key growth stages for row planted crop, concluding early growth stage and later growth stage. That is to say, KGSM is suitable both for the row structure canopy and the homogeneous canopy. Different from the ROW and SAILH model, there are wide application ranges for the KGSM.

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