Satellite Retrieval of Overstory and Understory Leaf Area Index in High Northern Forests

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Leaf area index (LAI), defined as one-half the total green leaf are per unit of horizontal ground surface area, is a crucial input parameter for global carbon cycle modeling. Since carbon fixed through net primary productivity has different residence times for different components, the LAI for overstory and understory vegetation in forest ecosystems need to be treated differently in carbon cycle modeling. Currently, satellite remote sensing is the only feasible technique to measure the LAI at a continental and/or global scale over a long periods of multiple years. However, there are no existing satellite products that provide simultaneous estimation of overstory and understory leaf area index (LAIo and LAIu) at present. Consequently, we proposed an integrating look-up table (LUT) method to remotely estimate the LAIo and LAIu for boreal forests, where are encountering rapider temperature change than other areas. In the newly proposed method, the understory normalized vegetation difference index (NDVIu) is first retrieved from multiple satellite observations by using a semi-empirical method. Then the LAIu is estimated from the retrieved NDVIu through searching a LUT generated by radiative transfer simulation for understory vegetation. In order to estimate the LAIo, a new land-cover map of forest types, which classifies the boreal forests as low, medium and high types, is generated by using a wall-to-wall canopy height product to replace the conventional global land-cover maps. The LUTs containing angles, LAIu, LAIo, and corresponding reflectance at red and near-infrared bands are generated for each forest type by running a radiative transfer model. Specifically, the forest landscape parameters are determined by an empirical forest structure model. Moreover, the retrieved NDVIu is used as an ancillary information to constrain the relationship between LAIo and canopy reflectance. The validation results showed acceptable accuracy based on our filed measurement at interior Alaska, America.

Keywords: Satellite Remote Sensing, Leaf Area Index, Northern Forests

