Mapping incident Photosynthetically Active Radiation over Land from MODIS Data

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Incident Photosynthetically Active Radiation (PAR) is a key variable required by almost all ecosystem models, and some of which calculate biomass accumulation based on its linear relation to incident PAR. Current PAR products, generated from either satellite observations or GCM reanalysis, are of coarse spatial resolutions and inconsistent accuracy incapable of meeting the land modeling needs. For instance, because the high-resolution incident PAR over land is not a standard EOS product, the MODIS team has to disaggregate the NASA DAO 1° by 1.5° solar radiation product to generate 1km net primary productivity and net photosynthesis products. Therefore, there is a critical need for mapping incident PAR at a high resolution. In response to this critical need, we developed new algorithms for estimating incident PAR from the polar-orbiting MODIS data. Using our new algorithms, the first version of instantaneous and daily average PAR at 1km resolution over land surfaces over North America have been produced and made available to the public.

Estimating Instantaneous PAR

This algorithm is composed of two major steps: first, determination of the surface reflectance from the "clearest" observations over a temporal window, and second, calculation of incident PAR from the determined surface reflectance and top-of-atmosphere (TOA) radiance using the table look-up approach. Variations of the algorithm have been adopted in order to best suit the different characteristics of multiple sensors. An example is shown in Figure 1.

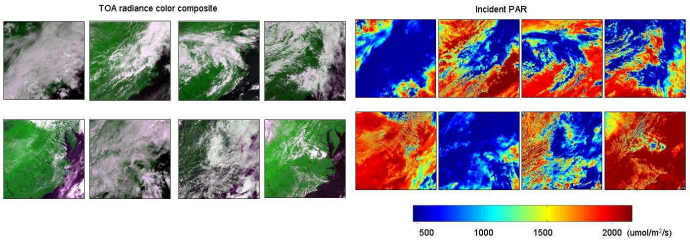

Figure1. True color composite MODIS imagery of greater Washington, D. C. area on 8 days (May 22, May 25, May 29, May 31, June 5, June 7, June 8, and June 10, 2003) and the corresponding retrieved incident PAR maps (right).

Temporal Integrating Algorithm

The idea of integrating the instantaneous PAR is to infer the PAR distribution function within the daytime. A sinusoidal curve is used to fit the distribution of PAR over a day. When multiple observations exist, the linear interpolation over time is employed to best capture the diurnal change of PAR.

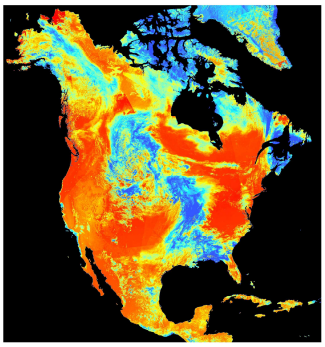

Figure 2. Daily incident PAR (June 6 2004)

Different Temporal Scale

Both instantaneous and daily PAR have been generated over North America. Figure 2 shows an example of daily PAR on Julian day 157, 2003. Monthly PAR are also calculated, as shown in Figure 3.

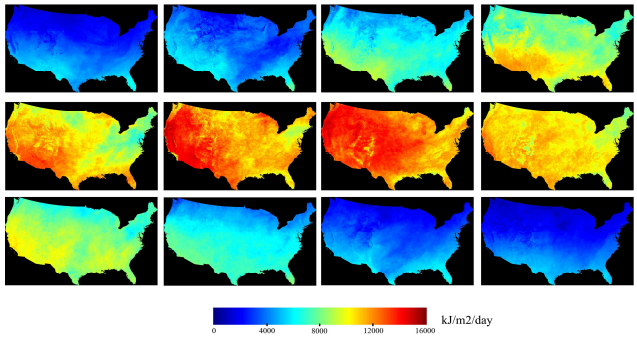

Figure 3. Monthly incident PAR derived from MODIS (2003).

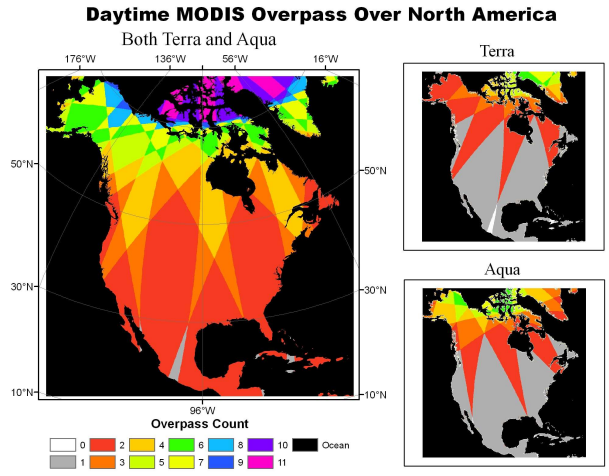

Figure 4. MODIS daily overpass over the North American

The overpass counts of MODIS increase with the latitude. At low latitudes where there are only one or two daily MODIS observations, PAR estimation from geostationary sensors (e.g., GOES) can be incorporated to improve the accuracy of temporal integration.

Product Distribution

We have produced incident PAR over North America for 2003 and made available to the public through the University of Maryland Global Land Cover Facility (GLCF: http://www.landcover.org)

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