Mapping High-Resolution Land Surface Radiative Fluxes from MODIS

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Land surface net radiation, calculated from shortwave and longwave radiative fluxes, is the key component of the surface energy budget that is the core of all land surface process models. There are currently several global radiative flux datasets derived from either satellite observations or GCM reanalysis, but the spatial resolution (usually >1°) and accuracy of these products are not satisfactory for high-resolution modeling and applications. The MODIS science team has to disaggregate NASA's 1°*1.5° reanalysis incident solar radiation to produce the 1-km net primary productivity (NPP) product. There are also other compelling reasons that we urgently need to produce high-resolution radiative fluxes.

We have developed a series of algorithms for routinely producing high-resolution land radiative fluxes from MODIS, including incident shortwave solar radiation (insolation) and photosynthetically active radiation (PAR), shortwave net radiation, longwave downward, upwelling and net radiation, and all-wave net radiation. Shortwave radiation under all-sky conditions can be estimated, but only clear-sky conditions for longwave radiation products will be considered. An empirical algorithm has been developed to estimate cloudy-sky longwave radiation. Therefore, the all-wave net radiation can be estimated under all-sky conditions. Because of two MODIS sensors and the orbit convergence, both instantaneous and daily integrated products can be generated. The flow chart is shown in Figure 1.

Most of these algorithms have been recently published in peer-reviewed journals. All of them have been validated using ground measurements and demonstrated to be suitable for global applications. In this presentation, I will first link surface radiation budget with global water cycle and carbon cycle, and then present the basic ideas of these algorithms and the latest validation results. The suites of algorithms have been described in the following papers:

1) Incident PAR/insolation:
    - Liang, S., T. Zheng, R. Liu, H. Fang, S. C. Tsay, S. Running, (2006), Estimation of incident Photosynthetically Active Radiation from MODIS Data, *Journal of Geophysical Research*, 111, D15208,doi:10.1029/2005JD006730.
    - Liang, S. T. Zheng, D. Wang, K. Wang, R. Liu, S. C. Tsay, S. Running, J. Townshend, (2007), Mapping High-Resolution Incident Photosynthetically Active Radiation over Land from Polar-Orbiting and Geostationary Satellite Data, *Photogrammetric Engineering and Remote Sensing*, 73(10), 1085-1089.
    - Wang, D., S. Liang and T. Zheng, (2008a), Estimation of daily-integrated PAR from sparse satellite observations: comparison of temporal scaling methods, *International Journal of Remote Sensing*, in press.

- Zheng, T., Liang, S. and Wang, K., (2008), Estimation of incident PAR from GOES imagery. *Journal of Applied Meteorology and Climatology*, 47, 853-868.

2) Clear-sky thermal radiation
   - Wang, W., S. Liang, J. A. Augustine, (2008e), Estimating clear-sky land surface upwelling longwave radiation from MODIS data, *IEEE Transactions on Geoscience and Remote Sensing*, 46(12), DOI: 10.1109/TGRS.2008.2005206.
   - Wang, W. & S. Liang, (2008f), Estimating High-Spatial Resolution Clear-Sky Land Surface Downwelling Longwave Radiation from MODIS Data, *Remote Sensing of Environment*, in press.

3) Cloudy-sky net radiation
   - Wang, K., S. Liang (2008c), Estimation of daytime net radiation from shortwave radiation measurements and meteorological observations, *Journal of Applied Meteorology and Climatology*, in press.

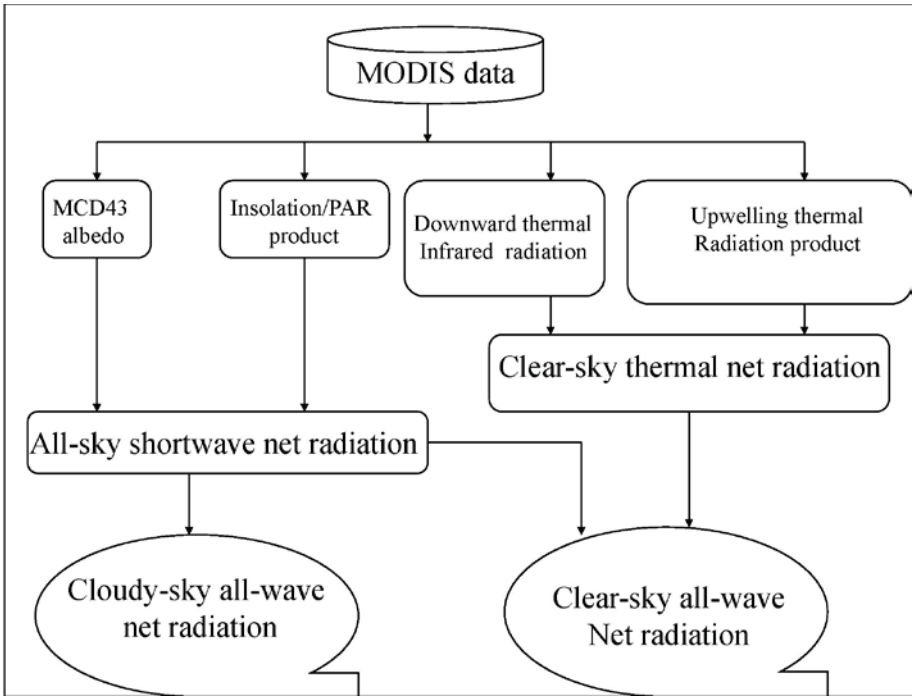

Figure 1 . Flowchart of the estimation of net radiation from MODIS