MAPPING EVERGREEN FORESTS IN THE PAN-TROPICAL ZONE USING MULTI-TEMPORAL MODIS IMAGES IN 2005

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Abstract

Evergreen forests (both broadleaf and needleleaf trees) in the tropical zone play an important role in climate, carbon cycle and biodiversity. There is a need for rapid monitoring of the spatial extent and temporal dynamics of evergreen forests. Frequent cloud cover in the tropical region makes it a challenging task to map evergreen forests.

The Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the Terra and Aqua satellites provide daily observation of the globe. The MODIS sensor has 36 spectral bands, and seven of these 36 bands are primarily designed for the study of vegetation and land surface: blue (459–479 nm), green (545–565 nm), red (620–670 nm), near infrared (841–875 nm, 1230–1250 nm) and shortwave infrared (1628–1652 nm, 2105–2155 nm). The red and NIR_1 (841-875 nm) bands have a spatial resolution of 250-m, and the other five bands (blue, green, NIR_2, $SWIR_1$, $SWIR_2$ bands) have a spatial resolution of 500-m. The MODIS Land Science Team provides a suite of standard MODIS data products to the users, including the 8-day composite MODIS Land Surface Reflectance Product (MOD09A1). There are forty-six 8-day composites in a year. Each 8-day composite (MOD09A1) includes estimates of land surface reflectance for the seven spectral bands at 500-m spatial resolution.

Three vegetation indices are calculated: Normalized Difference Vegetation Index (NDVI) (Tucker 1979), Enhanced Vegetation Index (EVI) (Huete et al. 1997), and Land Surface Water Index (LSWI) (Xiao et al. 2002), using Blue, Red, NIR_1 (841–875 nm) and $SWIR_2$ (1628–1652 nm) spectral bands. The vegetation indices data products are available to the public (http://www.eomf.ou.edu).

$$NDVI = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}} \quad (1)$$

$$EVI = 2.5 \times \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + 6 \times \rho_{red} - 7.5 \times \rho_{blue} + 1} \quad (2)$$

$$LSWI = \frac{\rho_{nir} - \rho_{swir}}{\rho_{nir} + \rho_{swir}} \quad (3)$$

We have recently developed a simple and novel mapping algorithm to map evergreen forests (Xiao et al. 2009). The algorithm is based on the temporal profile analysis of Land Surface Water Index (LSWI). The LSWI-based mapping algorithm was applied to map evergreen forests in the pan-tropical zone ($30^oN - 30^oS$) in 2000-2009, using MODIS 8-day Land Surface Reflectance (MOD09A1) data in 2001 (Xiao et al. 2009).

In this paper, we apply the same LSWI-based mapping algorithm to map evergreen forests in the pan-tropical zone using MODIS images in 2005. We also use the Phased Array type L-and Synthetic Aperture Radar (PALSAR/ALOS) data (500-m mosaic) in 2007-2008 to evaluate and refine the MODIS-based maps of evergreen forests in the pan-tropical zone. We compare the MODIS-based evergreen forest map in 2005 with the FAO Forest Resource Assessment 2005. Our results further demonstrate the potential of this simple LSWI-based mapping algorithm for identifying and mapping evergreen forests in the tropical zone at moderate spatial resolution.

Reference

Huete, A.R., Liu, H.Q., Batchily, K., & vanLeeuwen, W. (1997). A comparison of vegetation indices over a global set of TM images for EOS-MODIS. *Remote Sensing of Environment, 59*, 440-451

Tucker, C.J. (1979). Red and Photographic Infrared Linear Combinations for Monitoring Vegetation. *Remote Sensing of Environment, 8*, 127-150

Xiao, X., Biradar, C., Czarnecki, C., Alabi, T., & Keller, M. (2009). A simple algorithm for large-scale mapping of evergreen forests in tropical America, Africa and Asia. *Remote Sensing, 1*, 355-374

Xiao, X., Boles, S., Frolking, S., Salas, W., Moore, B., Li, C., He, L., & Zhao, R. (2002). Observation of flooding and rice transplanting of paddy rice fields at the site to landscape scales in China using VEGETATION sensor data. *International Journal of Remote Sensing, 23*, 3009-3022