# Integrating Landsat, ASTER and MODIS data for Forest Change Detection

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Forest changes from disturbance, regeneration and conversion affect timber industry, terrestrial ecology and global carbon sequestration. Monitoring forest changes and understanding their consequences are the primary goals for the environmental and global change studies (Casperson et al., 2000; Barford et al., 2001).

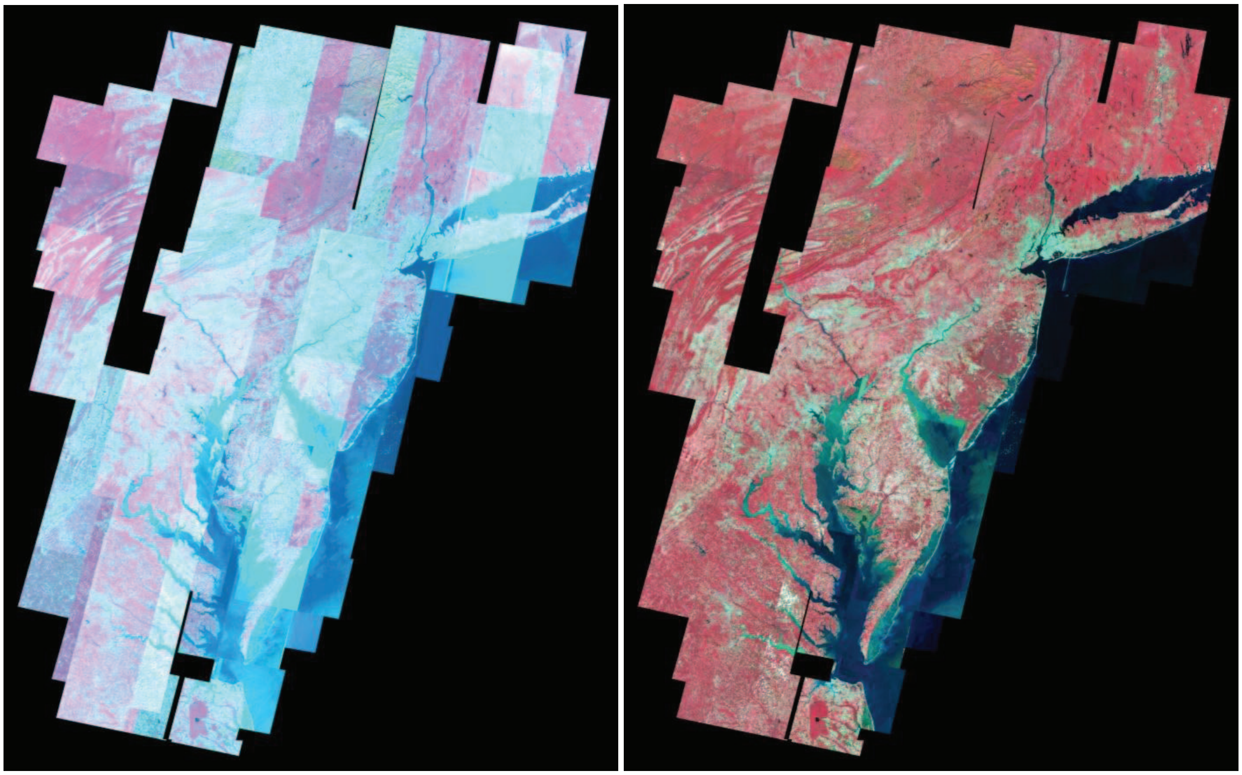
Remote sensing data have long been used for monitoring forest changes. The Landsat series satellites have been provided earth observation data record continuously since early 1970s. It's critical for the forest change monitoring to receive Landsat data without interruption. Masek etc. (2006, 2008) used Geocover Landsat data (Tucker et al., 2004) to built forest disturbance and regrowth for the North America for the period 1990-2000 through the Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS). However, the SLC-off problem in Landsat 7 since early 2003 and long pasting designed lifespan of Landsat 5 are threatening continuous Landsat data record before new Landsat 8 starts operation. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) aboard EOS/TERRA have spatial resolutions and bandwidths similar to Landsat TM/ETM+. They are good candidates for filling Landsat data gaps. In this study, we extend the algorithmic capabilities of the LEDAPS approach to include ASTER data and update the forest changes for the period 2000-2005.

In the previous studies, forest changes were computed based on the change of the disturbance index (Cohen and Goward, 2004; Masek et al., 2008). Due to the ecological complexity of different regions and the lack of standardized Landsat data, the thresholds of disturbance index need to be adjusted and verified region by region or even scene by scene. The seasonal variation due to different acquisition dates among different scenes is a major challenge for disturbance index based approach.

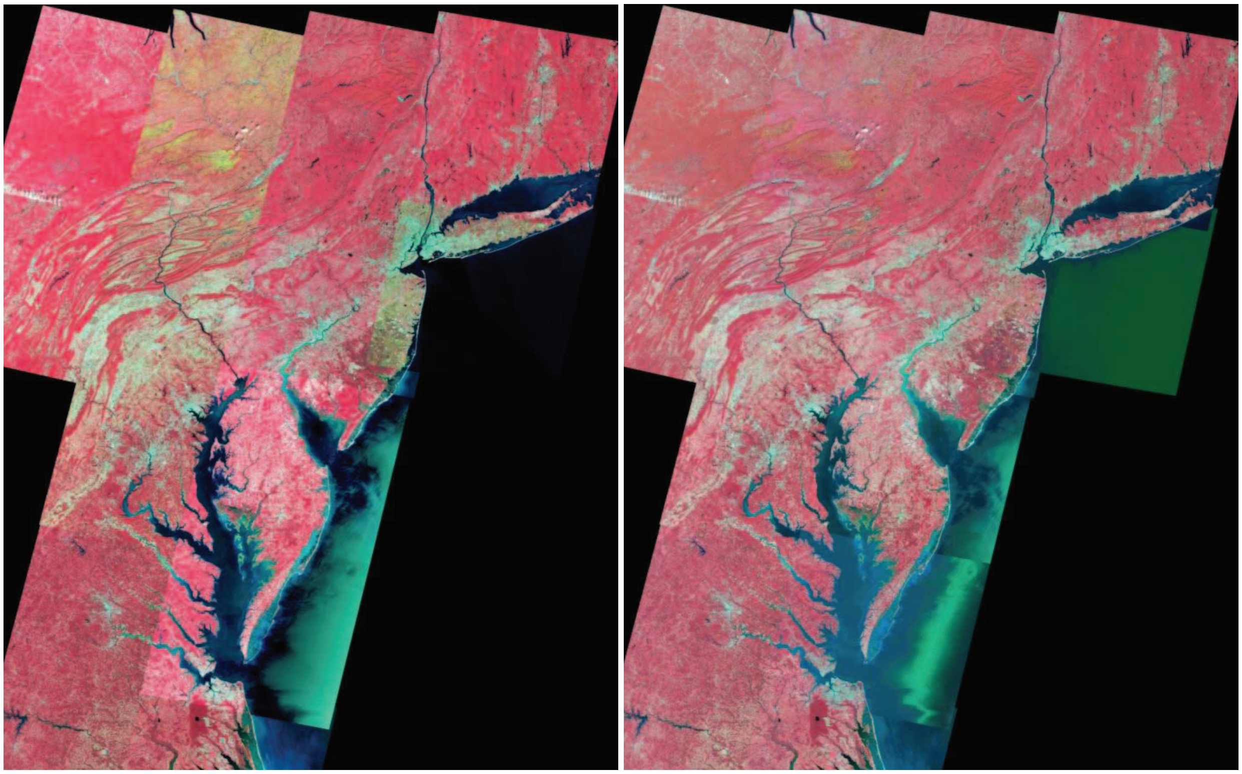
In this study, we developed a suite of algorithms to merge information from different satellite data and make them consistent both radiometrically and geometrically. The ASTER data were co-registered and orthorectified to match GLS (Global Land Survey) 2000 Landsat data using our Automated Registration and Orthorectification Package (AROP) (Gao et al., 2009). Both ASTER and Landsat data were normalized to the MODIS data through our data normalization process (Gao et al., 2009). This process first creates a cluster map using an unsupervised classifier ISODATA, and then reprojects Landsat/ASTER data and cluster map to the MODIS projection and spatial resolution. The pure and homogeneous MODIS pixels are selected as samples for each cluster. Linear relations between Landsat/ASTER data and MODIS reflectance are built from the selected samples. These relations are finally applied to the Landsat/ASTER data and produced the normalized MODIS-like product in Landsat spatial resolution. The input Landsat/ASTER data can be in digital numbers (DNs), top-of-atmosphere (TOA) reflectance and surface reflectance. As we use consistent MODIS data product as a reference, the output is always the MODIS-like product, which makes the direct comparison between Landsat and ASTER data become possible.

Figure 1 shows mosaics of the normalized ASTER (b) and Landsat scenes (d) in mid-Atlantic region using MODIS nadir BRDF-adjusted reflectance (NBAR) as a reference. In both cases (b and d), DNs were used as direct inputs. ASTER mosaic includes 196 scenes from different acquisition dates. Fig. 1a shows the different seasonality (vegetation phenology) of TOA reflectance from different ASTER scenes. After normalization, the phenology differences among different ASTER scenes in Fig. 1b are greatly reduced. Similar to the phenomena for the ASTER data, Landsat mosaics in Fig. 1c also show clear differences in phenology among 14 different scenes even after atmospheric correction (through LEDAPS). The mosaic of the normalized Landsat in Fig. 1d reduced the phenological differences for vegetation. In this example, both ASTER and Landsat normalization used MODIS NBAR data on the day 265 (September 21) as reference. Based on the standardized ASTER and Landsat reflectance, we can create disturbance index and detection forest changes seamlessly.

Next, we will evaluate the normalization approach and the LEDAPS disturbance algorithm using both leave-on and leave-off Landsat and ASTER data and expand our algorithms to the North America for the period of 2000-2005.



(a) ASTER TOA reflectance (196 scenes) (b) Normalized ASTER reflectance (2004-265)



(c) Landsat surface reflectance (14 scenes) (d) Normalized Landsat reflectance (2000-265)

Figure 1. The normalized ASTER (b) and Landsat (d) mosaics remove seasonal vegetation variations from TOA reflectance (a) and surface reflectance (c) by using MODIS NBAR as a reference (DOY 265).

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