INTEGRATING COARSE AND FINE RESOLUTION SATELLITE DATA TO MONITOR LAND COVER CHANGE THROUGHOUT AMAZÔNIA

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Abstract:
    This project addresses a key need to accurately monitor land cover change at repeated intervals throughout Amazônia. Spatially-explicit data on land cover dynamics in response to land use change are essential to extrapolate process-level understanding of carbon, nutrient, and trace gas fluxes over the larger region. Currently, monitoring efforts to quantify land cover change based on analysis of Landsat data are time-consuming, laborious, and data-intensive. Estimates from different analyses often yield conflicting results, highlighting differences in land cover definitions and methodologies applied by various researchers.
    We will collaborate with colleagues from the Brazilian National Institute for Space Research (INPE) to develop efficient, accurate, and repeatable methods for monitoring land cover dynamics throughout the region. The approach is to combine the use of moderately coarse resolution data from the MODIS sensor with high resolution Landsat data and field observations. We also plan to characterize land cover dynamics in terms of percentage tree cover within each grid cell rather than arbitrary, scale-dependent labels of "forest" and "non-forest"

Objectives of the project are:

1) develop and test methods to apply MODIS data for identifying locations of land use change. Through this approach, we aim to reduce the amount of high resolution data requiring time consuming analysis without sacrificing wall-to-wall coverage of the entire region.

2) examine an alternative approach to describe land cover dynamics in terms of subpixel percentage tree cover to circumvent the definitional differences in terms such as "forest", "nonforest", "degraded forest", "deforestation", and "regrowth." Through such an approach, we aim to improve the ability to identify subpixel changes in tree cover and provide estimates of forest area and change that are consistent in space and time.

3) Establish collaborative relationships and exchanges of methods and data between INPE, the University of Maryland, and the LBA-ECO team.

4) Provide subsets of 250m and 500m MODIS data and improved estimates of land cover dynamics throughout the region to the LBA community through the University of Maryland Global Land Cover Facility (linked to the LBA data distribution system).
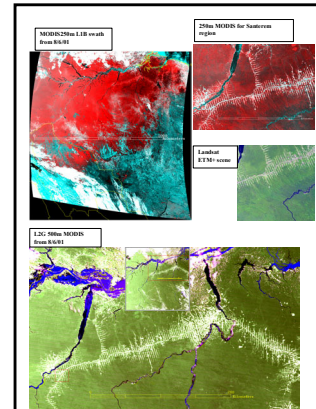
Approach:
    We will develop a nested strategy whereby MODIS data will be analyzed over the entire region to identify the likelihood that land cover change is occurring at a given location. The likelihoods can then be used to identify the Landsat scenes requiring analysis. In some locations selected through a sampling strategy that accounts for the practicalities of access on the ground, field observations will be carried out to aid analysis of the MODIS and Landsat data. We expect the analysis to yield an approach that can be applied operationally to more efficiently observe the entire region as opposed to wall-to-wall coverage of Landsat data. The approach will take advantage of the coarse spatial but high temporal coverage from MODIS and the higher spatial but lower temporal coverage of Landsat. The intent is to use MODIS data to indicate the likelihood of change rather than the precise spatial extent, the latter more appropriately addressed with Landsat or even higher resolution data. Preliminary investigation of MODIS data suggests that the large majority of deforested areas are clearly discernible in both the 250m and 500m bands, particularly the "fishbone" patterns along the highway (Figure 1).
    One of the approaches to identify change is through repeated estimates of percent tree cover at annual intervals to identify locations undergoing decreases or increases in cover: We will use the regression tree algorithms and training data sets developed in our previous work to estimate percent tree cover at regular intervals over the entire region. Input to the regression tree will be the 250 and 500m MODIS bands. We will examine the input data to determine which bands are needed for accurate estimation of percent tree cover. Differences in percent tree cover between intervals will be compared with Landsat and higher resolution data to determine the accuracy with which this approach can identify locations undergoing change. Based on the accuracies, we will provide a "likelihood of change" for each MODIS pixel.
    Figure 2 shows the application of the percent tree cover approach to very coarse resolution AVHRR data over the past 20 years. The method identifies the broad spatial extent of deforestation compared to the Landsat analyses carried out by the Tropical Rain Forest Information Center (TRFIC). Estimates of percent tree cover for 2000 derived from MODIS 500m data are shown in Figure 3.

Role in integration and synthesis:
    The ability to map and monitor land cover change is one of the essential ingredients for meeting the goals of LBA-ECO: to understand how forest conversion, regrowth, and logging influence carbon storage, nutrient dynamics, and trace gas fluxes. Addressing these questions in the second phase of the LBA involves extrapolation of process-level understanding, largely the focus of the first phase of LBA-Ecology, over the larger region. Spatially-explicit, wall-to-wall data on the type, extent, and dynamics of land cover change at repeated intervals throughout the region is key to understanding the ecosystem responses. The report of the Review Committee on the LBA-Ecology Program dated February, 2001 strongly identifies this need. We aim to develop a nested approach, whereby coarser resolution data (250 and 500m) with daily coverage from MODIS will be used to identify probable locations undergoing landcover change. Identification of these locations can then be used for targeted analysis with higher resolution Landsat data, very high resolution IKONOS data, and *in situ* observations in some locations. With such an approach, the repeated monitoring of land cover dynamics is more tractable, automated and efficient than the use of high resolution data alone. We also aim to characterize land cover dynamics as subpixel percentage tree cover so that results can be compared directly without the binary labels of "forest" or "non-forest." This fully-scalable approach will facilitate extrapolation of results from process-level studies to the regional scale.

Examples of MODIS and Landsat data for portion of Amazon Basin

FIGURE 1

Using Continuous Fields to Detect Forest Cover Change

Percent tree cover ~1985   Percent tree cover ~1997
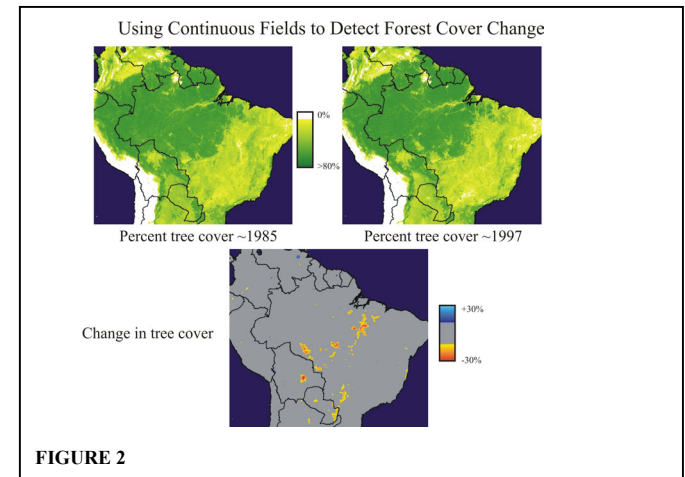
Change in tree cover

FIGURE 2

Example of MODIS 500 m for Rondonia, Brazil --
Global data soon to be available per MODIS tile at EDG, available per continent at glcf.umiacs.umd.edu
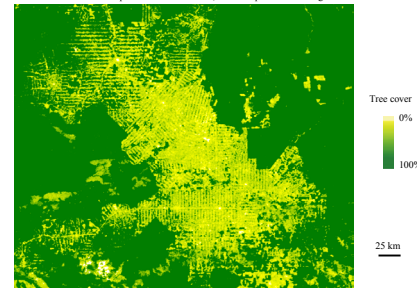
Tree cover
0%
100%

25 km

FIGURE 3

Estimated Percent Tree Cover Derived from MODIS 500m Data for 2000