USE OF MODIS ENHANCED VEGETATION INDEX TO DETECT SEASONAL PATTERNS OF LEAF PHENOLOGY IN CENTRAL AMAZON VÁRZEA FOREST

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Evasion of carbon dioxide and methane from Amazonian floodplains and associated lakes and channels has been shown to be an important component of the regional carbon budget, and efforts are currently underway to characterize carbon transformations on the floodplain using biogeochemical models. Seasonally flooded forests, which cover approximately 70% of the mainstem Amazon floodplain (várzea), supply large amounts of carbon through leaf-fall linked to the annual flood cycle. Knowledge of the timing of leaf-fall and green-up of várzea forests is necessary for biogeochemical modeling, but previously has been limited to a handful of field sites. This study explored whether time series of Enhanced Vegetation Index (EVI) data from the Moderate Resolution Imaging Spectroradiometer (MODIS) could be used to track seasonal changes in greenness of várzea forests.

MODIS 16-day composite EVI, NDVI (Normalized Difference Vegetation Index), and VI Quality Assurance (VI-QA) values for 2000-2005 were extracted for polygons corresponding to 21 closed-canopy forest sites along the Solimões-Amazon floodplain west of Manaus. Sites were clustered in three reaches near Cabaliana Lake, the Purus River confluence, and Badajós Lake, located respectively about 40 km, 180 km, and 280 km upstream of the Manacapuru gauging station. Sites were identified using SAR-based habitat maps, Landsat Thematic Mapper imagery, and aerial videography, and included high-, mid-, and low-levee communities. Number of MODIS pixels for each site ranged from 12 to 56. VI values were filtered to exclude pixels/dates with VI-QA values greater than 3. For each polygon, a cubic smoothing spline was fit to the median for all valid pixels on each date, and the resulting time series was examined in conjunction with river stage levels for the Manacapuru gauge.

All sites showed a regular seasonal variation in EVI, ranging from a mean low for all sites of 0.41 to a mean high of 0.61. The amplitude of variability in NDVI was about 50% that of EVI. Minimum EVI, corresponding to minimum leaf area, occurred in late May about one month preceding maximum river stage, and EVI peaked in mid-October, about 40 days before lowest river levels. The phase of the EVI curve was thus opposite to that of river stage and offset 30-40 days in advance. Variability in timing and amplitude of seasonal EVI within the three reaches was as great as the variability between reaches.

These results are in general agreement with field observations of leaf phenology at várzea stands near Manaus [1,2] and the Purus confluence [3]. We conclude that MODIS EVI is an appropriate surrogate for seasonal changes in greenness of várzea forests. However, it should be noted that 1) the seasonal EVI patterns noted here are similar to those reported for terra firme forest and attributed to seasonal variations in solar irradiance [4]; and 2) because the timing of the Amazon flood wave is fairly constant from year to year, the relationship of the EVI cycle to river stage could as well be attributed to another constant seasonal cycle such as solar irradiance. Therefore, future work will seek to clarify the relationship to flooding by comparing EVI cycles for várzea stands to closely adjacent terra firme stands, and by extending the analysis to sites along rivers with annual flood waves out of phase with those of the mainstem Amazon.

REFERENCES

[1] P. Parolin, "Phenology and CO2-assimilation of trees in Central Amazonian floodplains", *J. Tropical Ecology* 16: 465-473, 2000.
[2] J. Schöngart, M.T.F. Piedade, S. Ludwigshausen, V. Horna, and M. Worbes, "Phenology and stem-growth periodicity of tree species in Amazonian floodplain forests", *J. Tropical Ecology* 18: 581-597, 2002.
[3] T. Haugaasen and C. Peres, "Tree phenology in adjacent Amazonian flooded and unflooded forests", *Biotropica* 37: 620-630, 2005.
[4] A. Huete, K. Didan, Y. E. Shimabukuro, P. Ratana, S.R. Saleska, L.R. Hutyra, D. Fitzjarrald, W. Yang, R.R. Nemani, and R. Myneni, "Amazon rainforests green-up with sunlight in the dry season", *Geophysical Research Letters* 13, doi:10.1029/ 2005GL025583, 2006.