Scaling photosynthesis in Amazonian ecosystems: from forest to savanna, from seasons to extreme events

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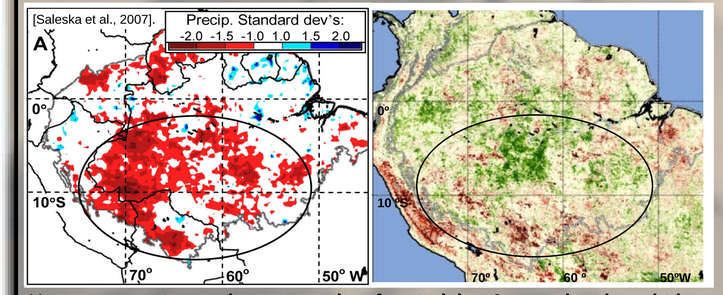
Motivation

Remote sensing methods offer potentially powerful insight into the response of vegetation to climatic variability, a particularly pressing question in Amazonian forests in light of recently observed contrasting responses to two widespread droughts in 2005 and 2010. While widespread increases in MODIS Enhanced Vegetation Index (EVI) (a photosynthetic "green-up") of forests were observed during the intense drought of July, August, September 2005, the pattern was reversed in 2010 when there were widespread EVI declines during a similarly intense drought in the same months.

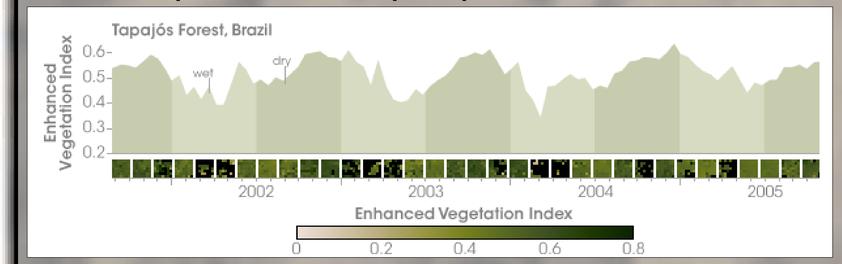


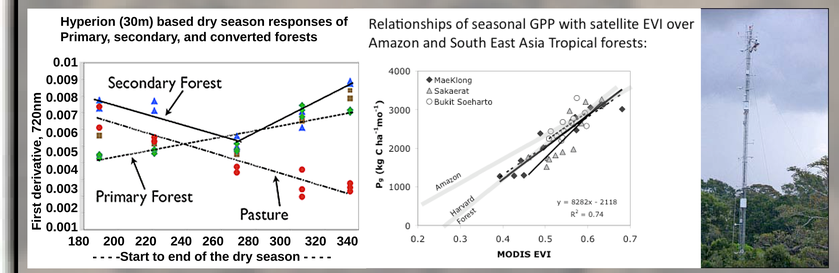
*updated to C5 from Saleska et al. [2007]

However, **remote sensing approaches for studying Amazonian drought have also been criticized as vulnerable to atmospheric aerosol and cloud artifacts**, calling into question the reliability of these results.

Here we introduce a **new 3-year project** that aims to simultaneously address the scientific question of vegetation response to climate, and the quality and reliability issues of remote sensing methods. The various approaches to be used in this project to integrate long-term *in-situ* and remote sensing observations of Amazonian ecosystems are presented along with some preliminary examples that highlight leaf- and canopy-scale optics with gas exchange measures.

Seasonality in Amazon Forests from MODIS, Hyperion, and Eddy Flux Tower (30m to >1km footprints)

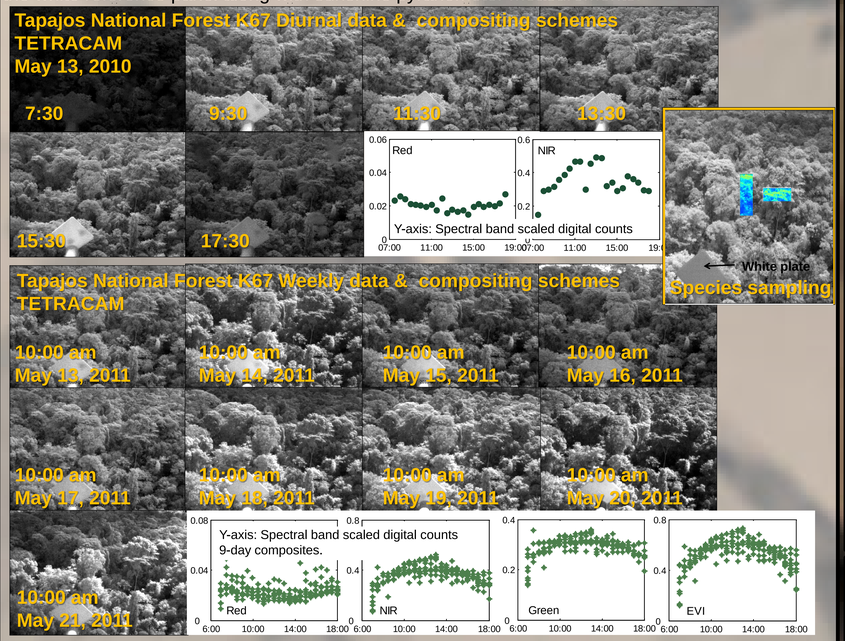


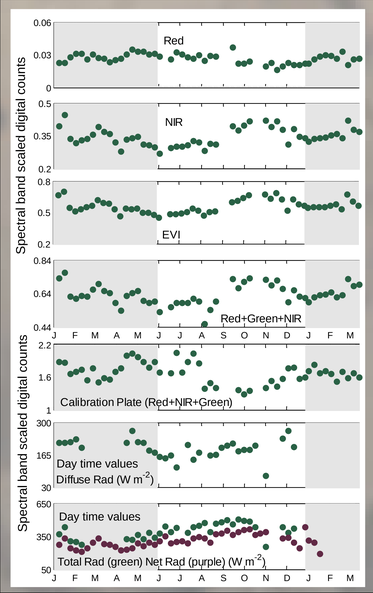


Hyperion data with 30m cloud & aerosol screening confirm continuous greening from start to end of dry season (left), while eddy covariance Pg is tightly related with MODIS EVI and Hyperion results.

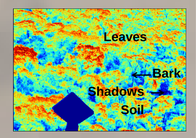
Half-hourly "local" remote sensing (spectral) images of vegetation (TETRACAM) and full-sky radiometer images of incoming radiation fields enable new sampling schemes for compositing to daily and weekly values as well as to capture canopy structure – interactions with light. *(a hyperspectral camera will be mounted in 2011)*

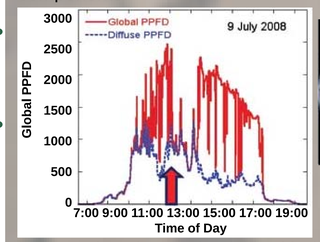
We are developing a scheme to transform the spectral digital counts into image reflectances using the white reference panel along with sunshine pyranometer measurements.

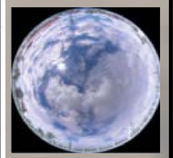




Examples of diurnal observations separated into direct and diffuse canopy reflectances and direct and diffuse irradiances onto a panel reference for light interaction analysis on canopy greening. Time series for eight day average spectral band scaled digital counts (uncorrected) for the Tetracam. The images include soil, leaves, shadows, bark soil and all forest components

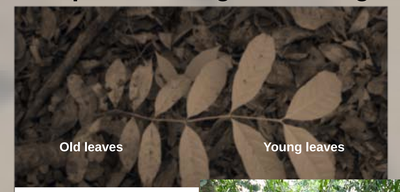


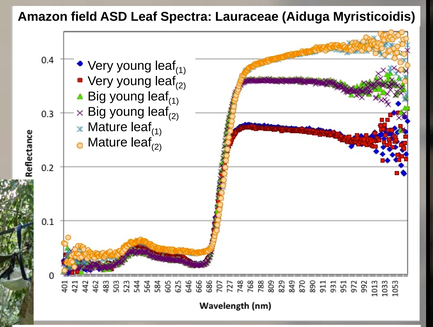


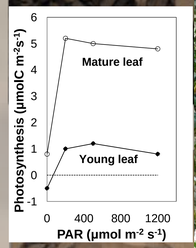


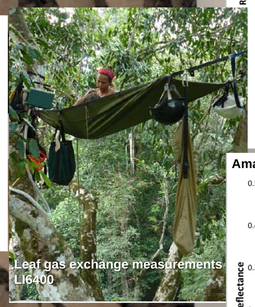
Images show increasing NIR with decreasing Red scaled digital counts from onset to end of dry season, following dry season leaf flushing and leaf (phenology) development.

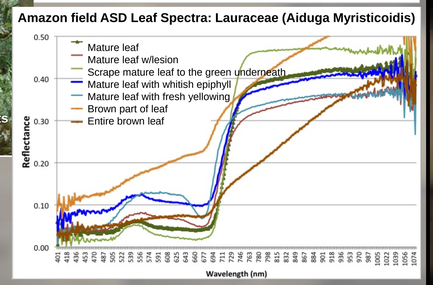
Leaf spectral and gas exchange measurements





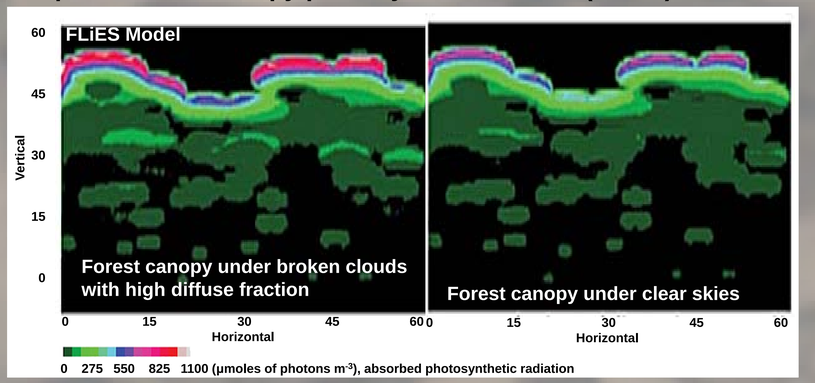






Leaf scale optics and photosynthesis exhibit strong 'seasonal' variations, irrespective of LAI changes due to litterfall and flushing.

Scaling up tropical forest characteristics and radiation components 3-D canopy photosynthesis model (FLiES)



Our results will further be integrated into a parameterized and sophisticated 3-D canopy photosynthesis model (FLiES) in order to scale up tropical forest characteristics and radiation components (including aerosol-, cloud-, and subcanopy-influenced effects of diffuse radiation fraction and angular distribution). These initial results suggest that integrating imagery from satellites and towers, and linking these to ecosystem fluxes will provide a powerful tool for understanding the dynamics of vegetation-climate interactions in tropical Amazônia.

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