Seasonality in the Amazon and Response to the 2005 Drought

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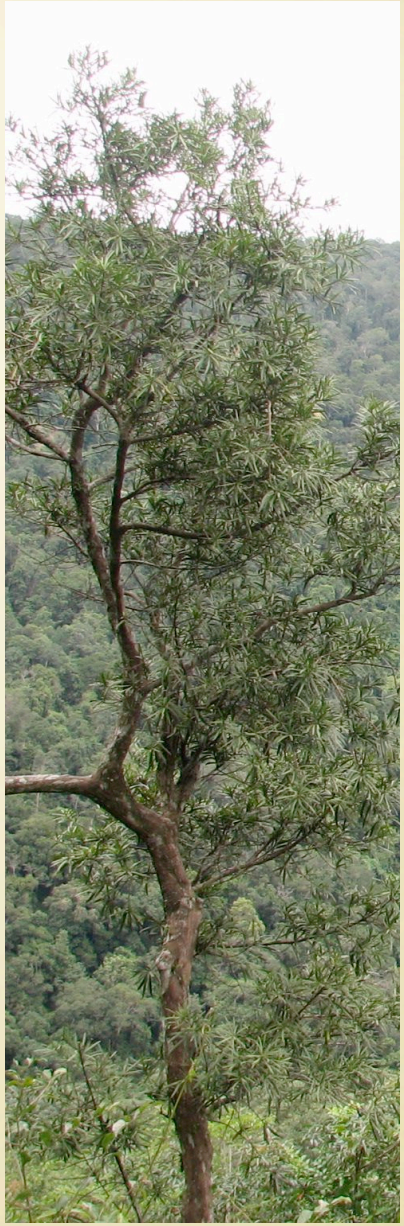
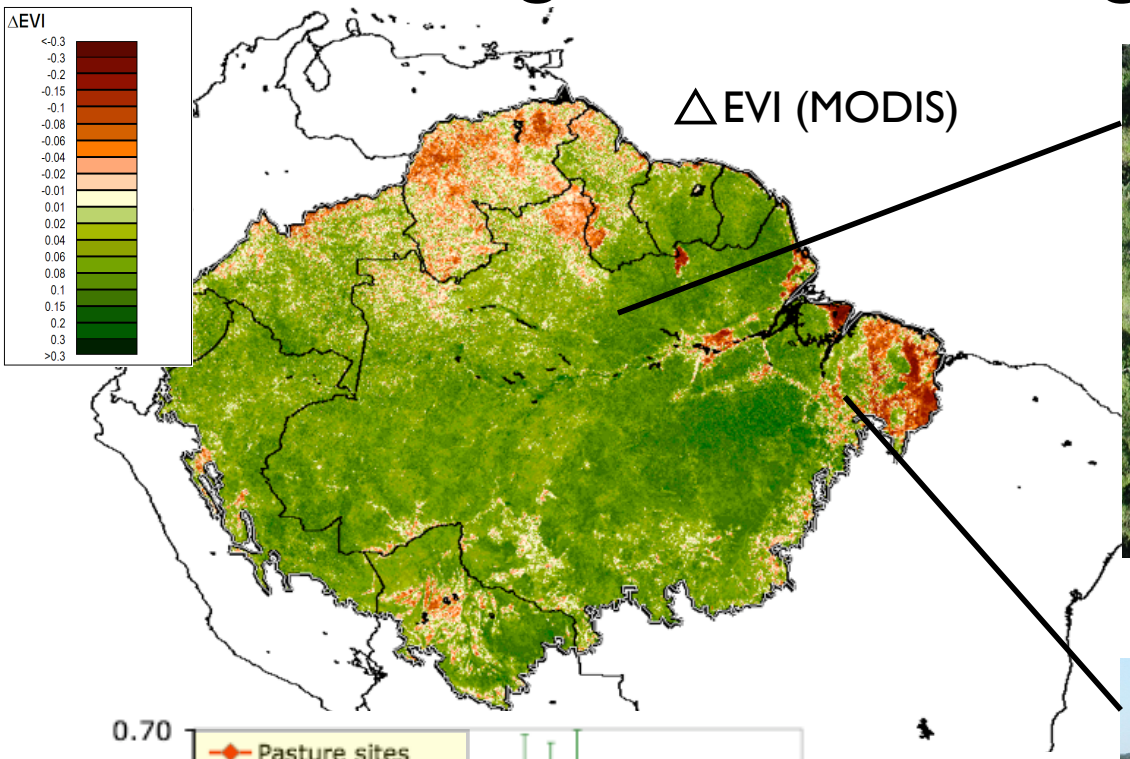
Phenology

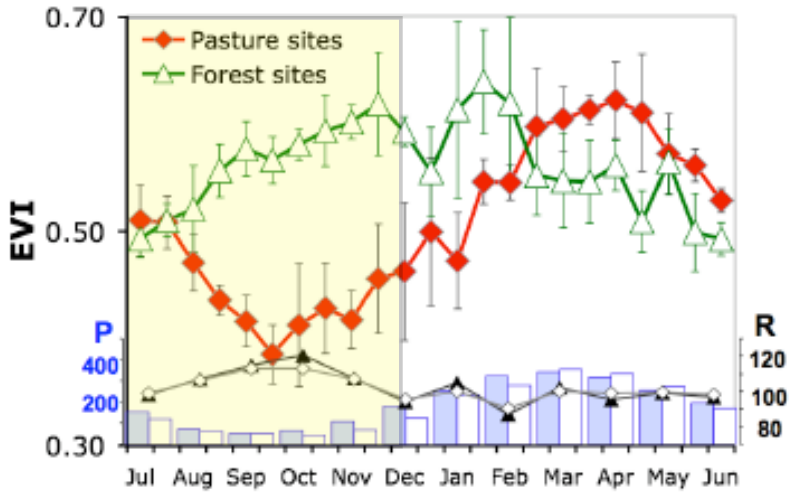
- Phenology “reflects” the interactions (responses, feedbacks) of organisms with their environment,
- Phenologic variations depict a canopies’ integrated response to environmental change and influence local biogeochemical processes, photosynthesis, water cycling, soil moisture depletion, and canopy physiology,
- Phenology is an important indicator of climate change, global change, and disturbance (anthropogenic signal),
- Phenological data and models are used in agricultural production, drought monitoring, wildfire risk assessment, and treatment of pollen allergies.



Seasonal change in satellite vegetation ‘greenness’



Old-growth rainforest

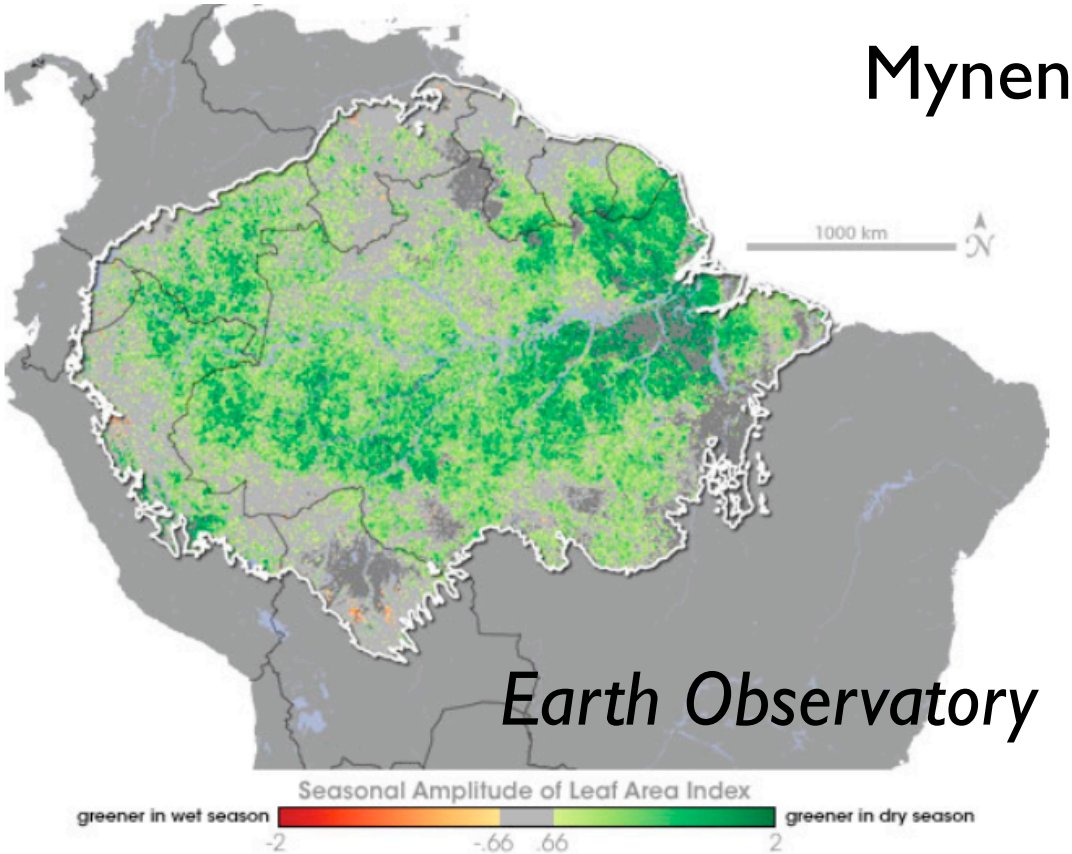


dry ‘sunny’ season

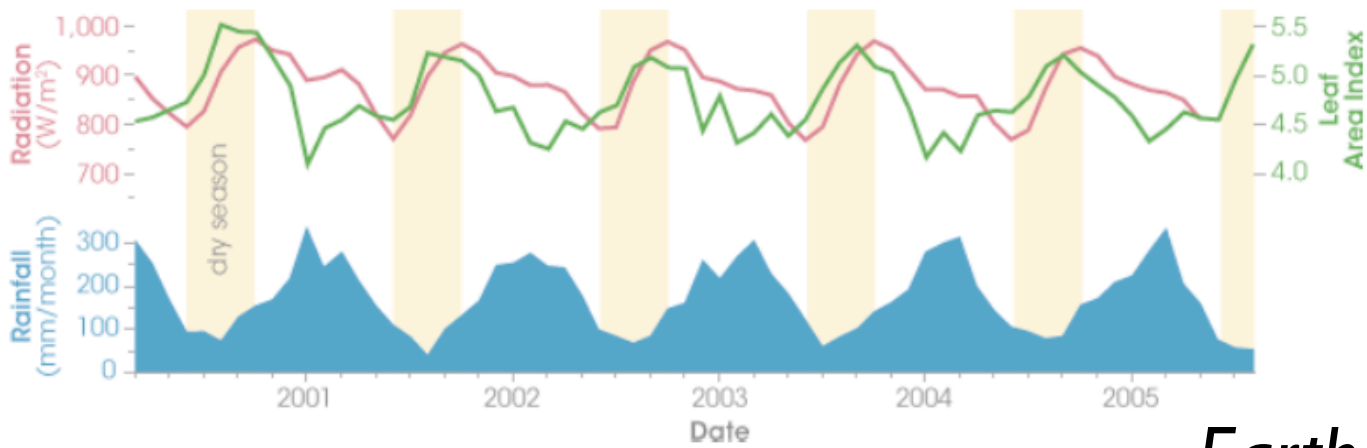
rainy season

Converted pastures in dry season

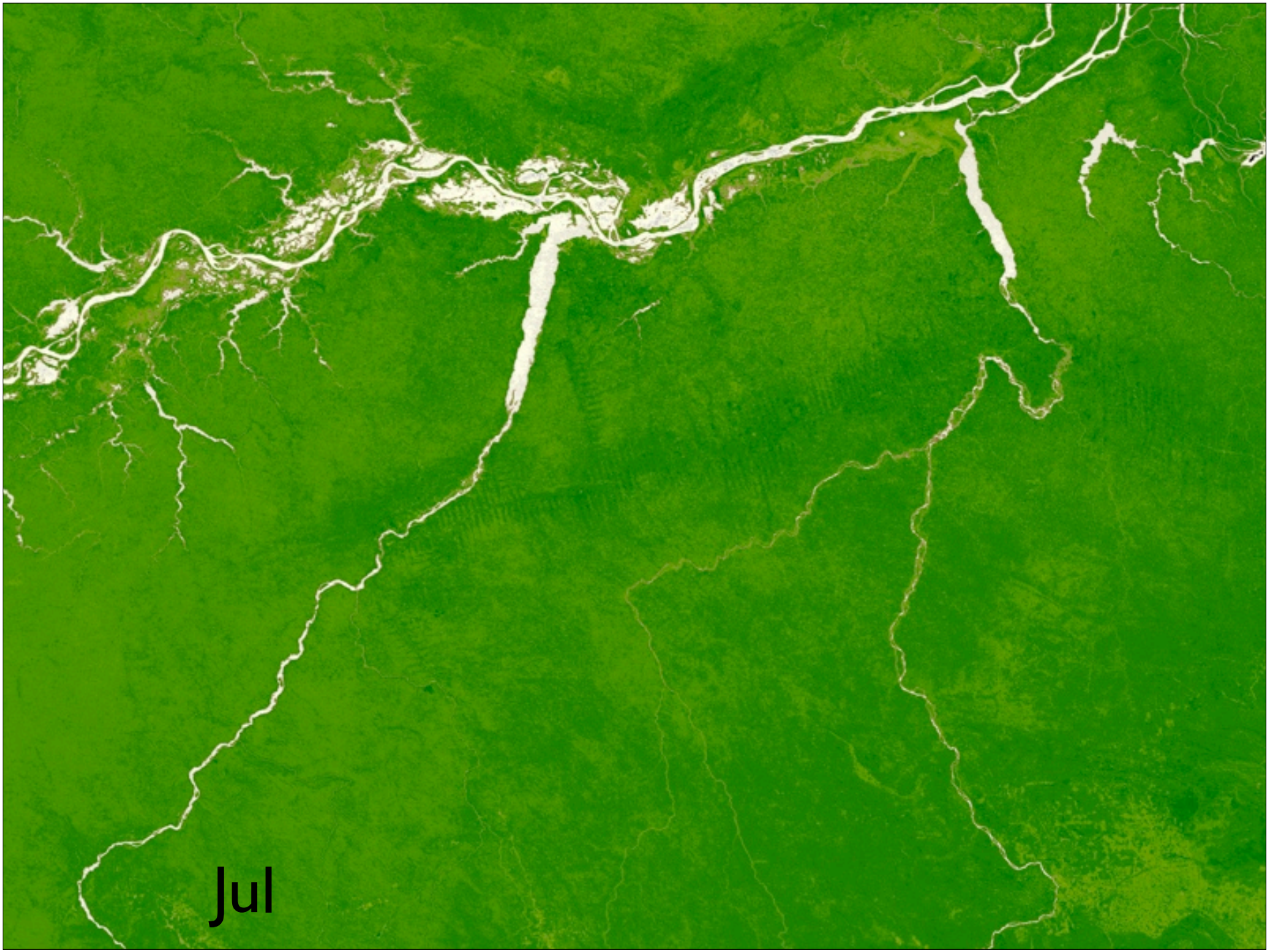
Myneni et al., 2007, PNAS

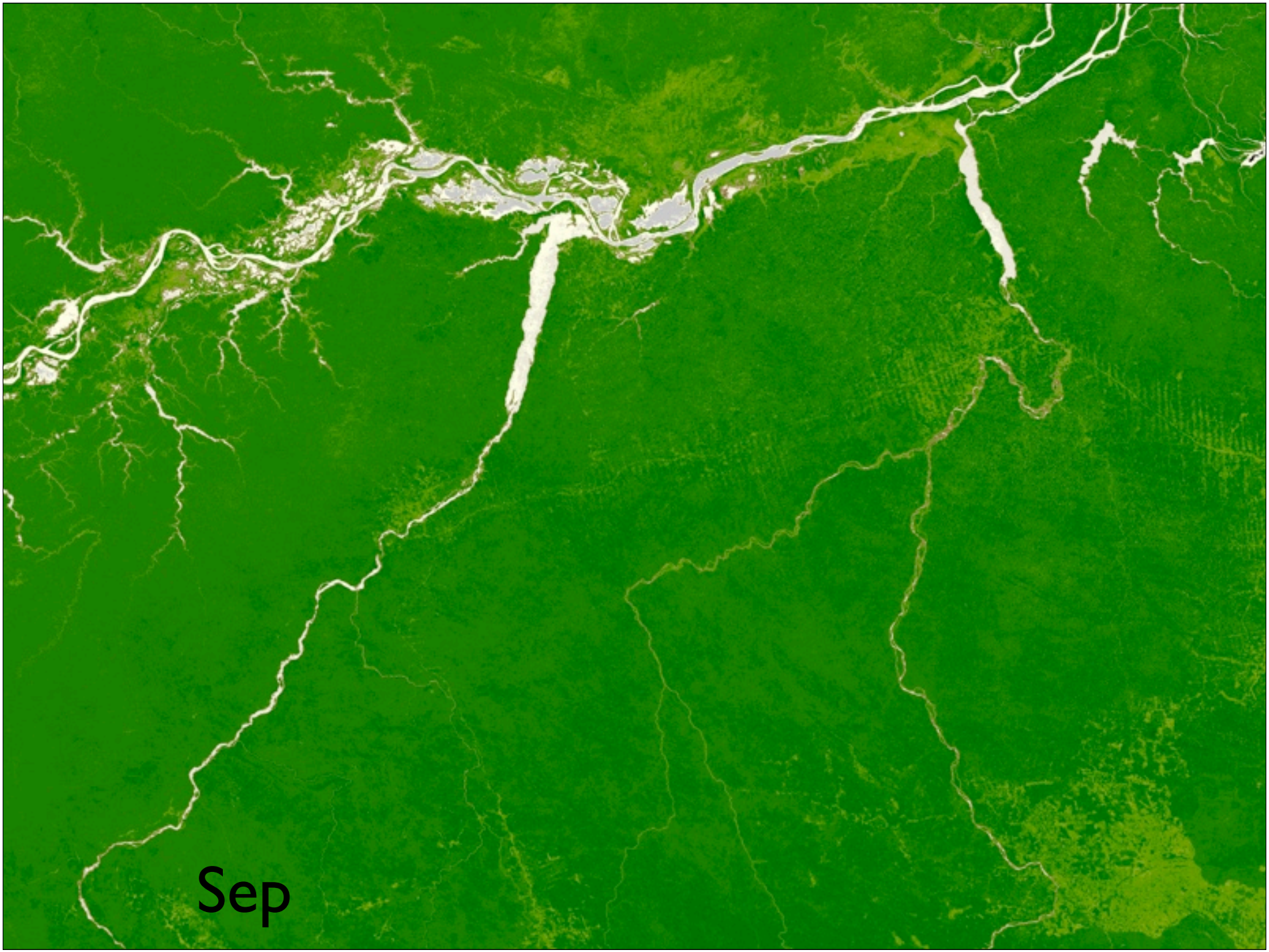


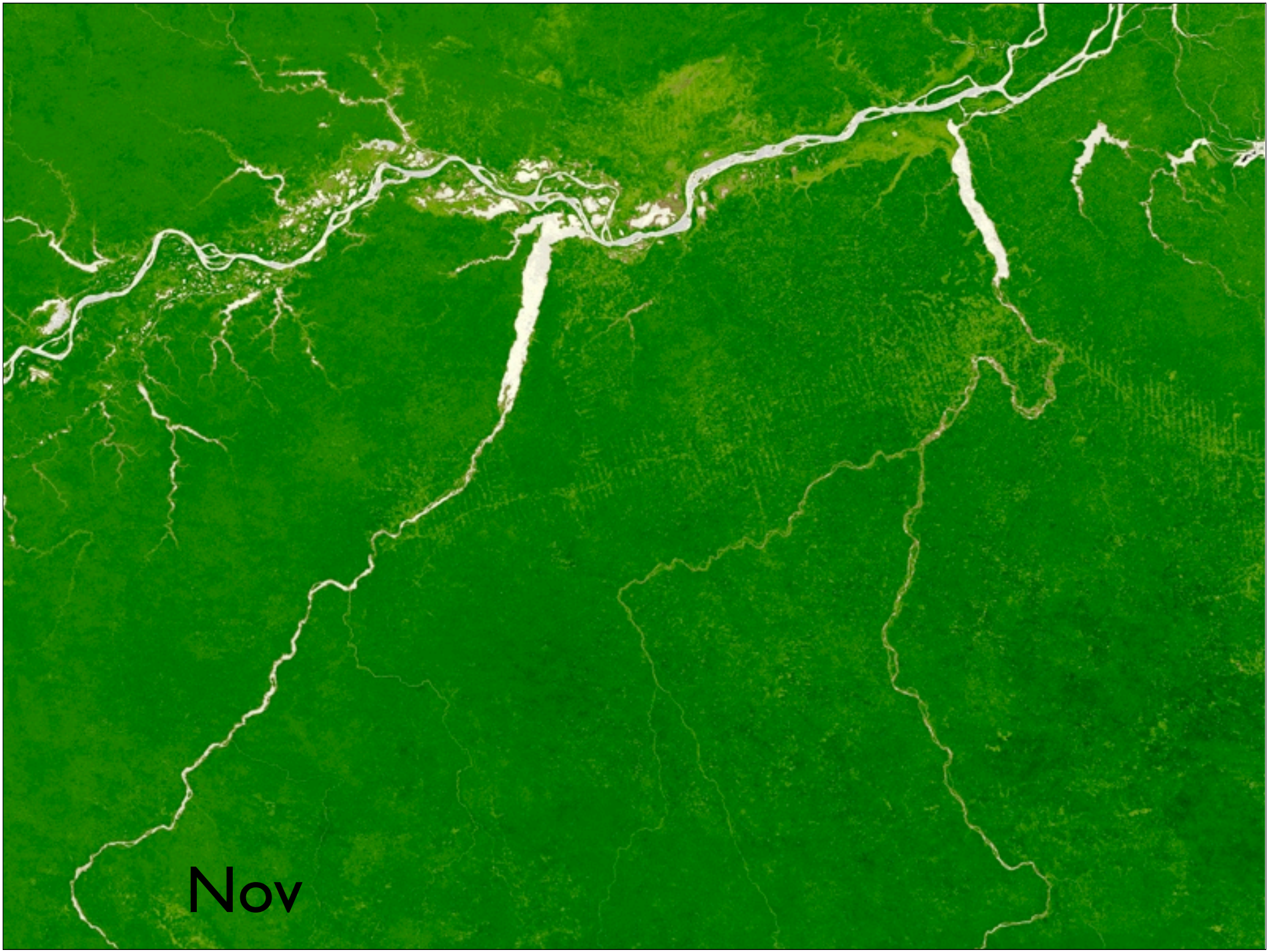
Earth Observatory



Earth Observatory

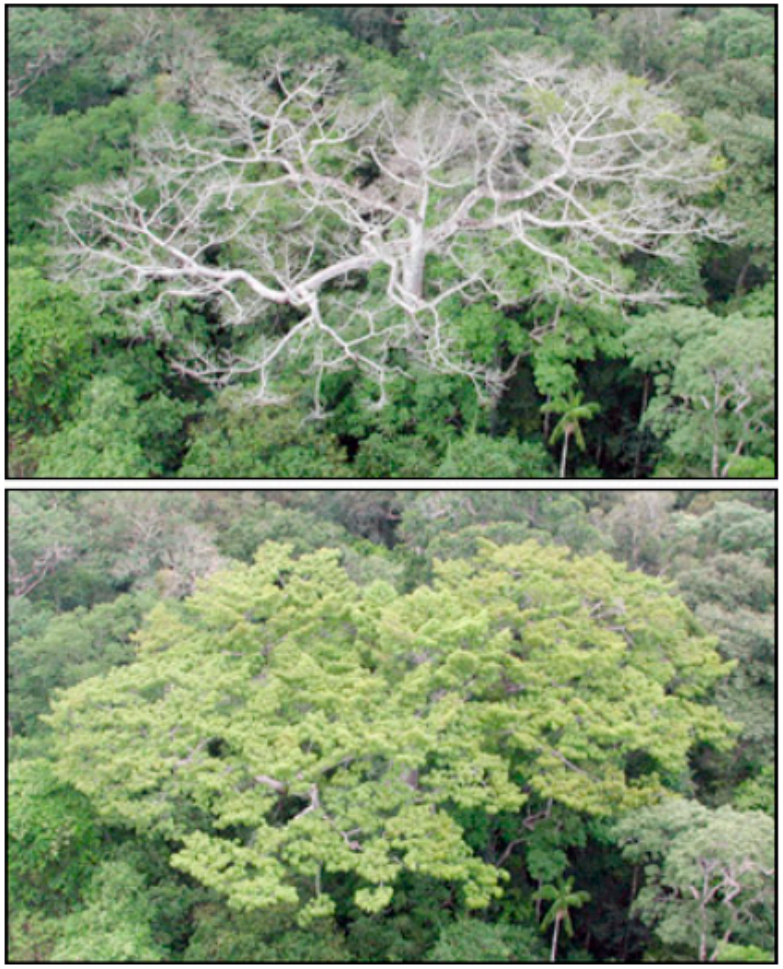

Jul


Sep


Nov

Leaf flushes of new growth with sunlight in the dry season (FLONA Tapajos, Brazil).

Photo by Tomoaki Miura



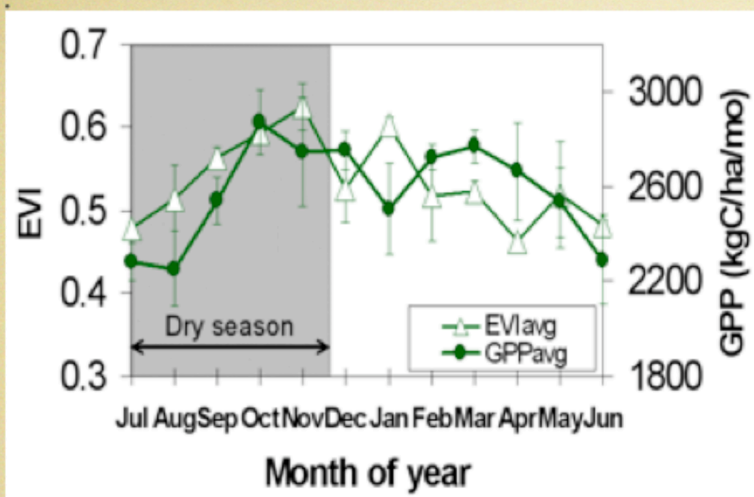
Sassan Saatchi, NASA JPL,
Earth Observatory

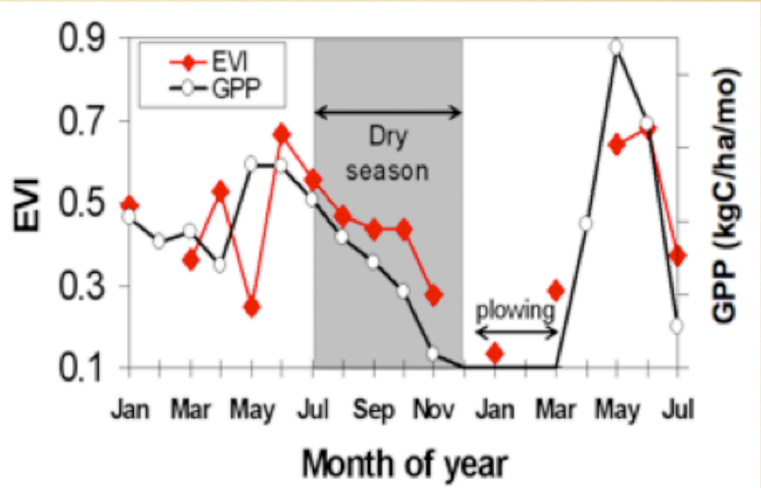
Coupling of satellite data with in-situ networks (eddy-covariance flux towers)

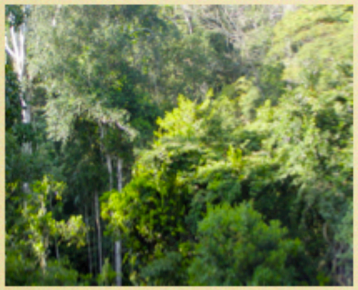
- **"Integration of in situ, airborne and space-based observations within the various societal benefit areas will be encouraged, as will the establishment of global, efficient, and representative networks of in situ observation to support process studies, satellite data validation....," (GEOSS)**

- Continuous measurements of flux (CO_2, H_2O, heat and momentum) data are powerfully suited for vegetation dynamics and for deriving relationships between carbon fluxes and key driving variables.

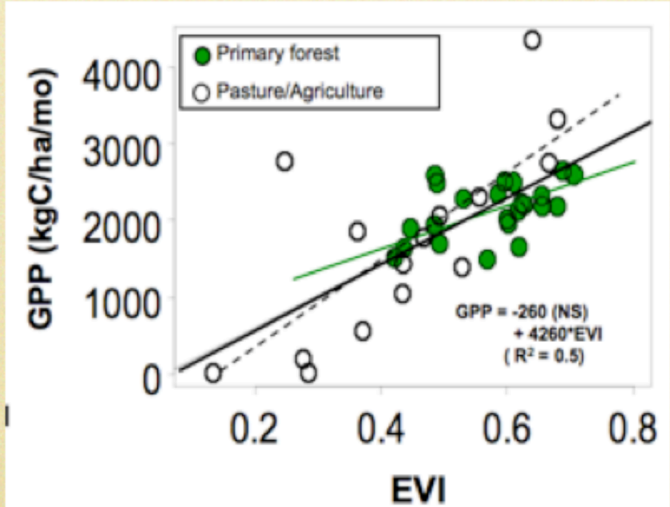
- Can test model/remote-sensing estimates of carbon-exchange and seasonality.



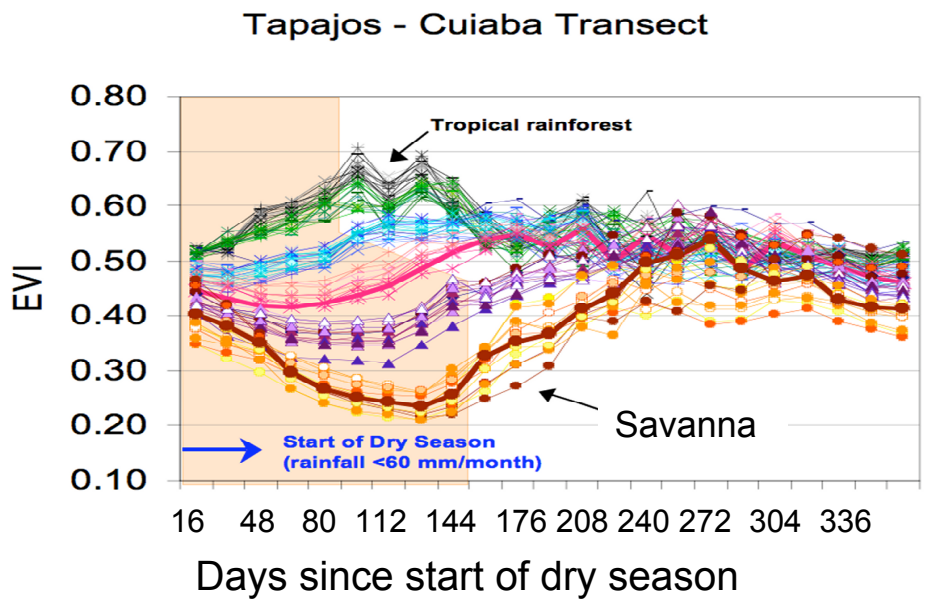




Tapajos Forest



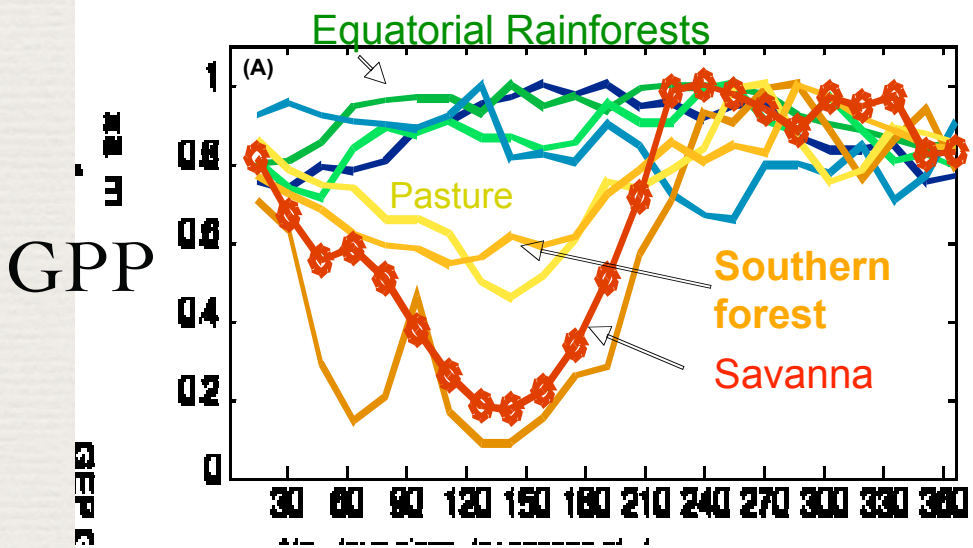
Huete et al., GRL 2006



MODIS satellite data

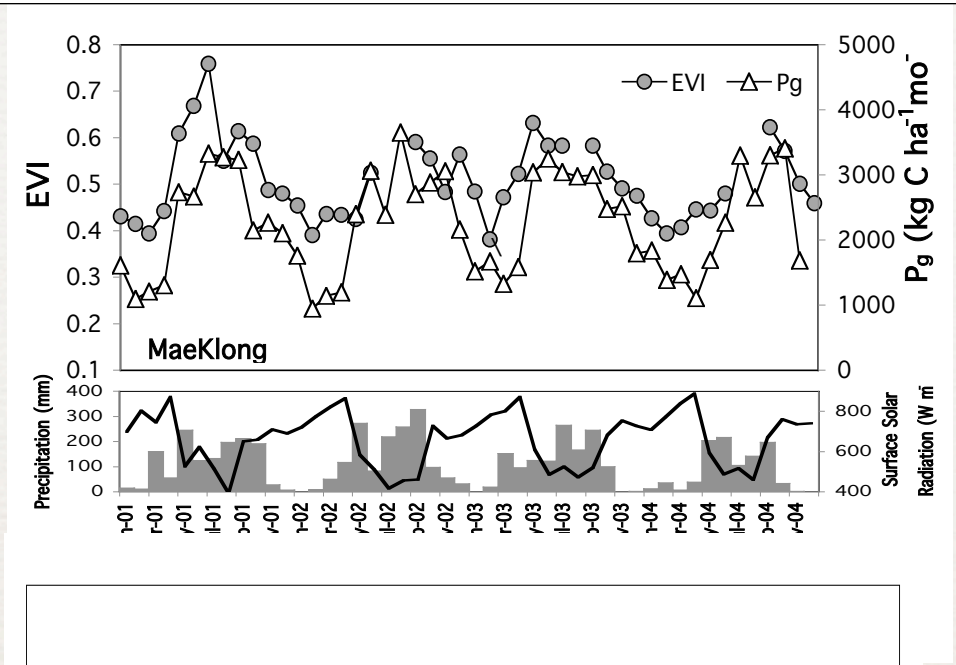
(shifted to start of dry season)

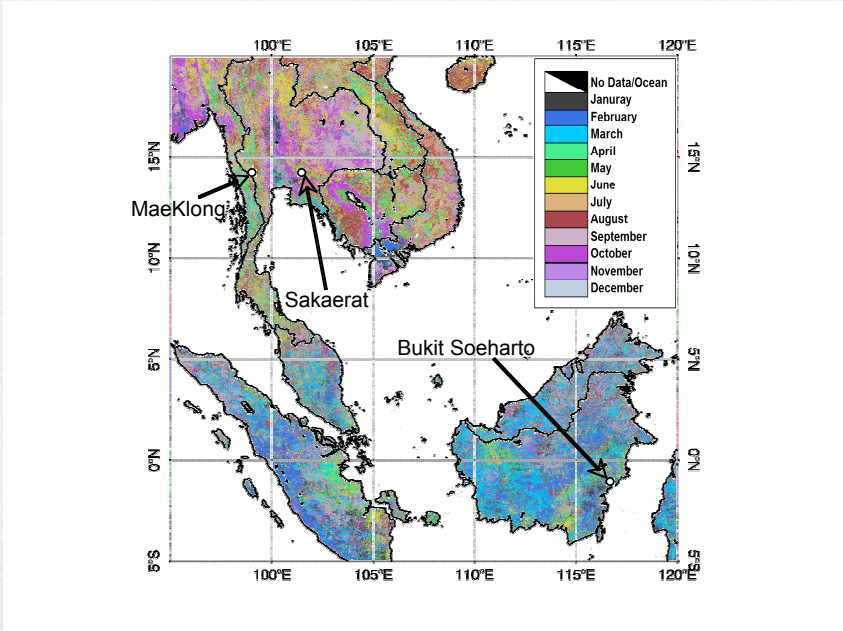
Ratana, P
Huete, et al

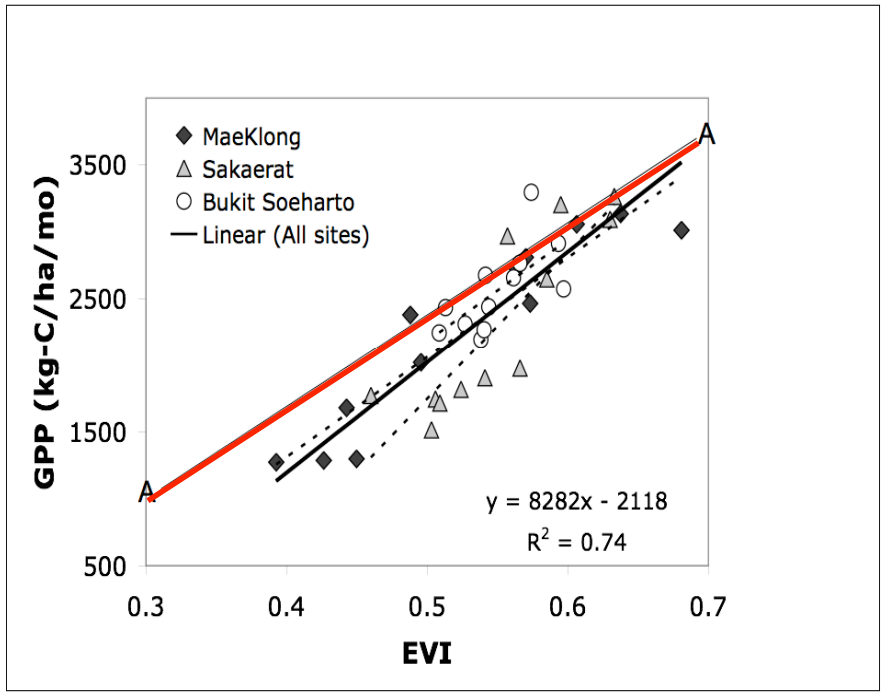


Tower-based flux data

Restrepo-Coupe et al.



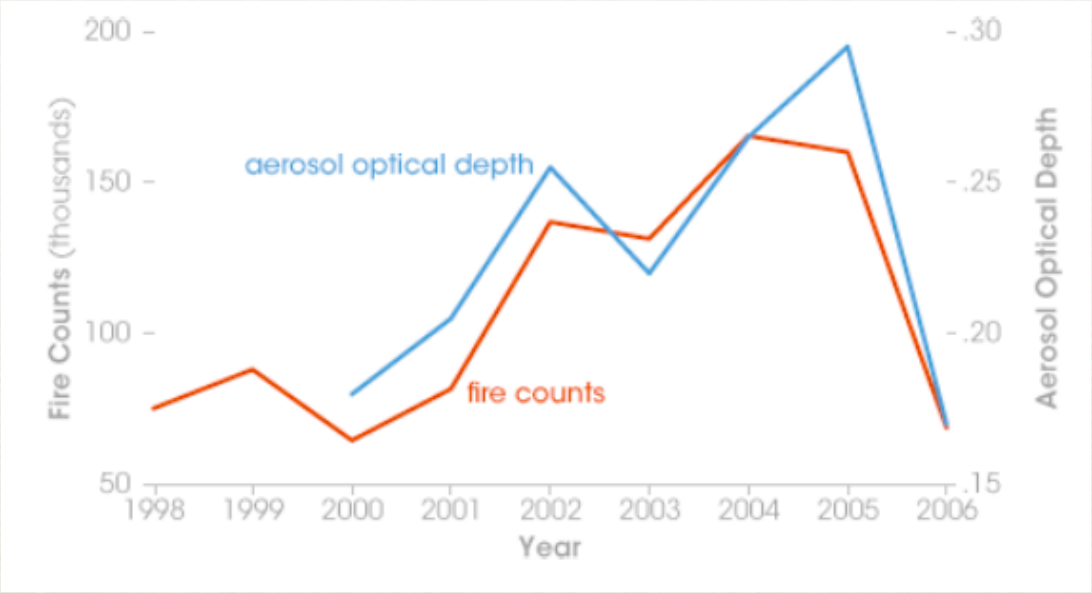




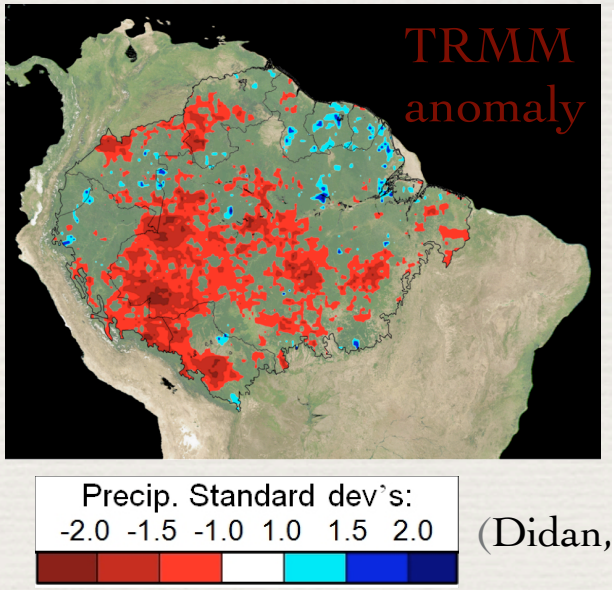
Huete et al. 2008 AgForMet

Pan-tropical correspondence

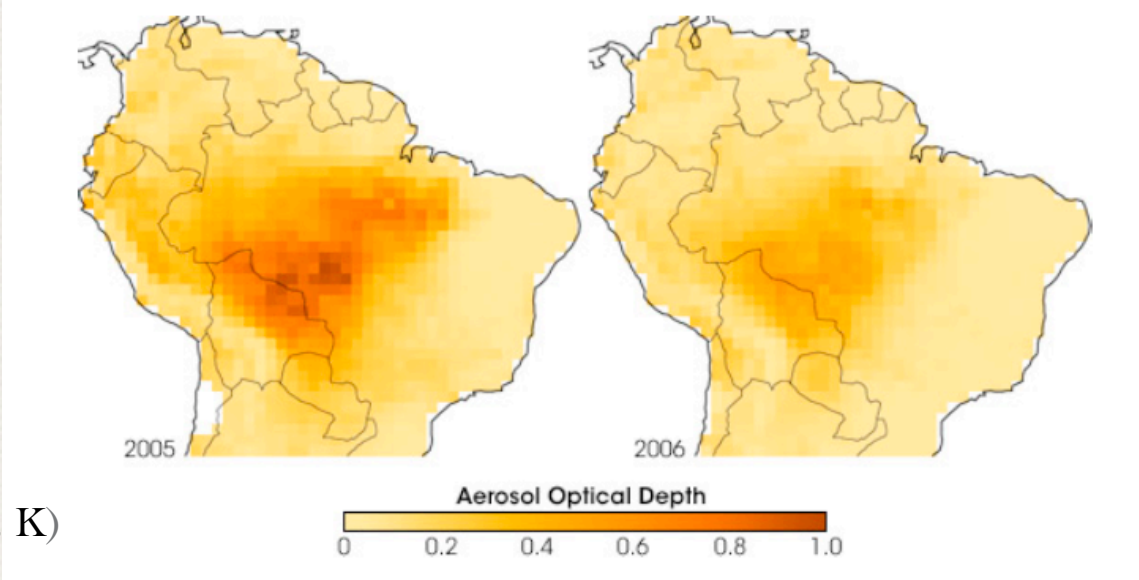
2005 Amazon Drought



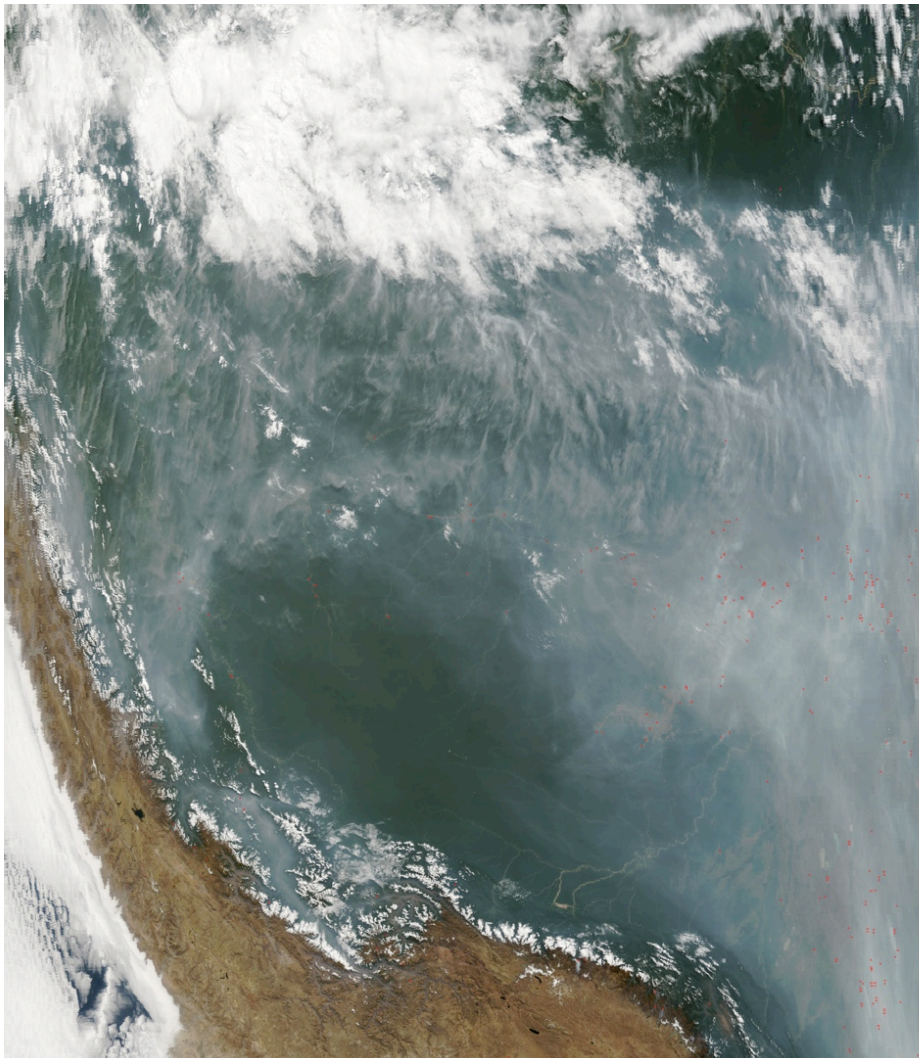
(*Robert Simmon, based on data from Ilan Koren and Karla Longo.*)



(Didan, K)



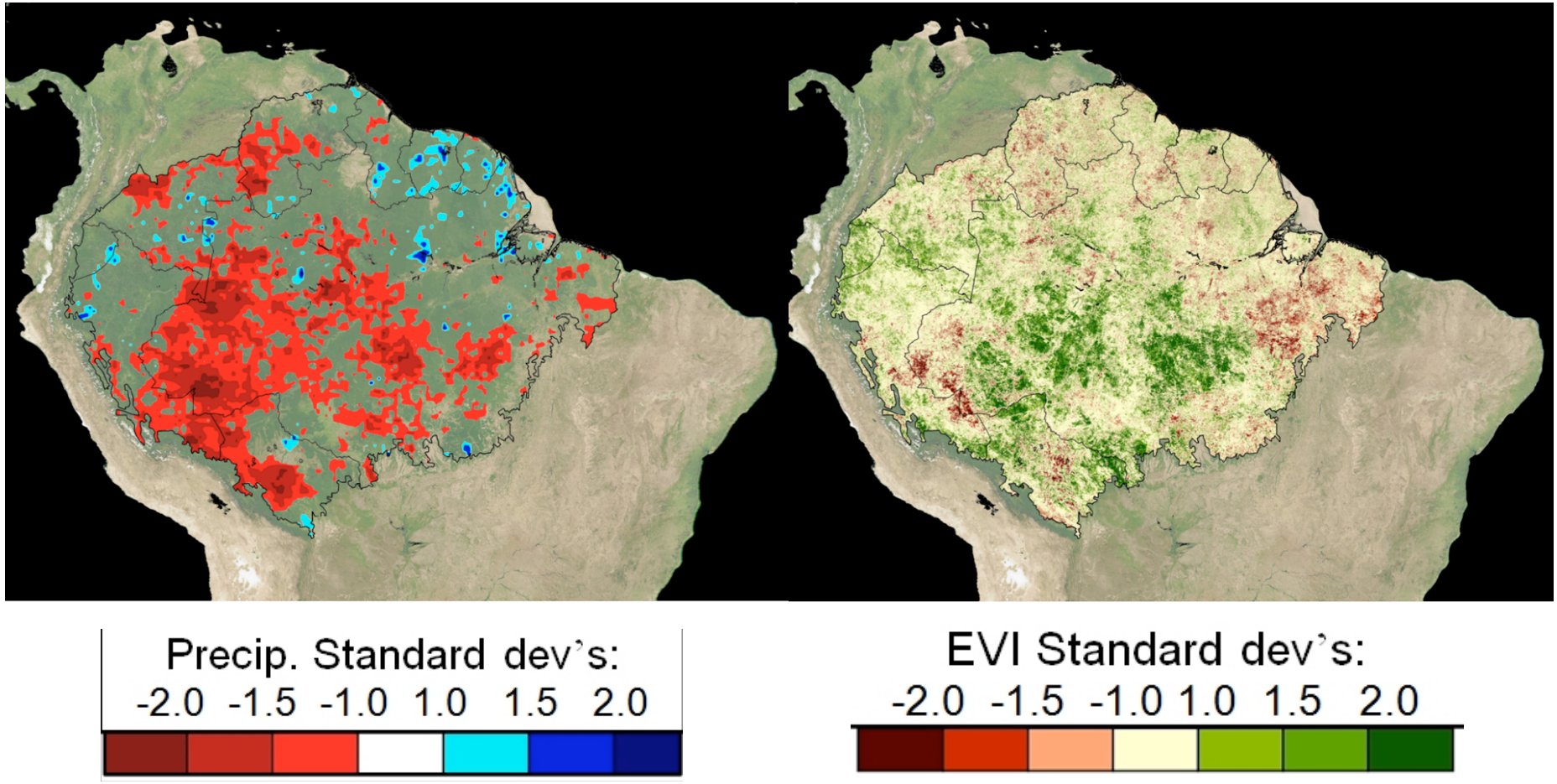
Forest converted pastures



Fires in the Amazon, as observed with MODIS satellite, August 2005

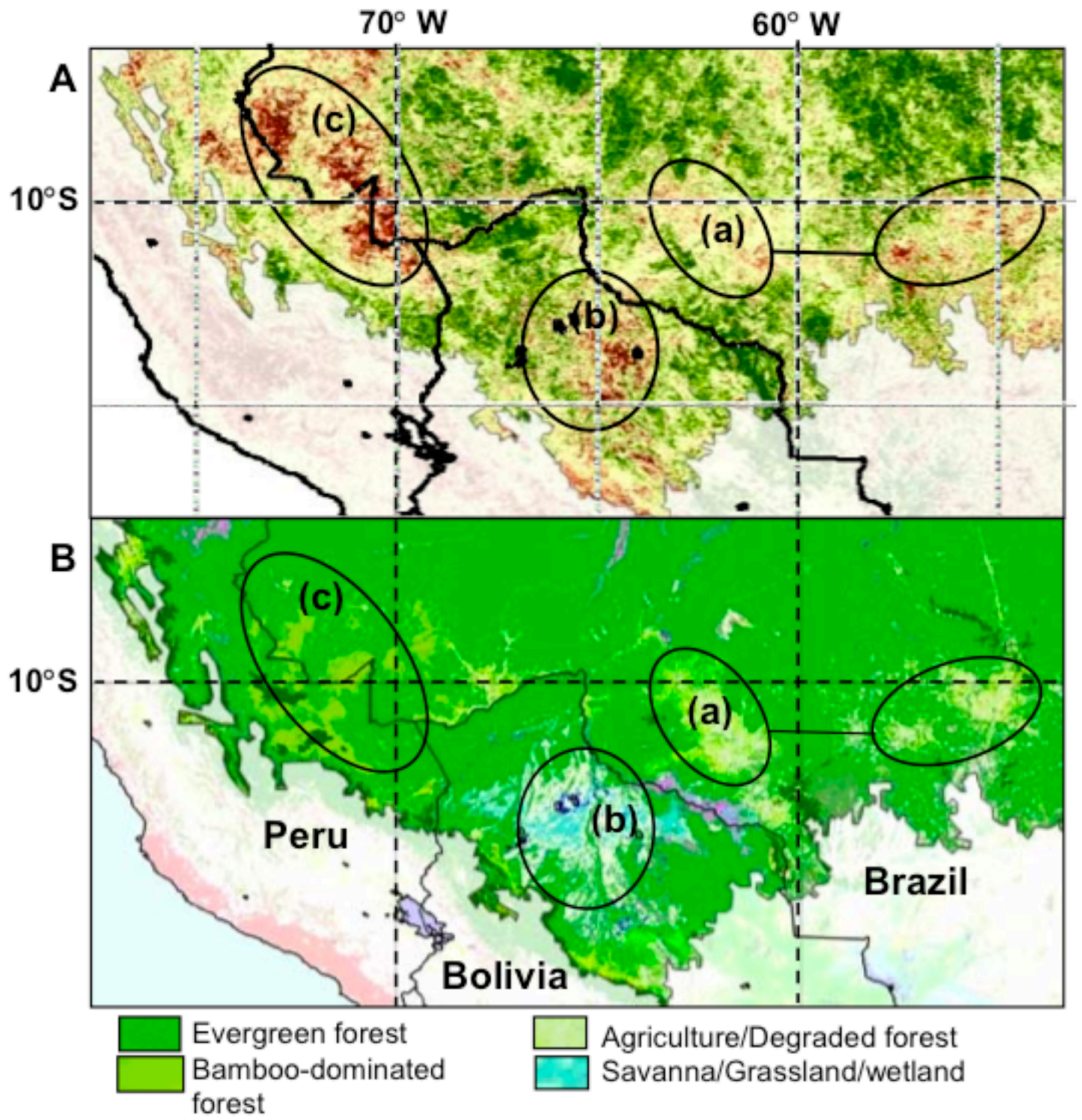
MODIS rapid response system, http://rapidfire.sci.gsfc.nasa.gov/

Amazon rainforest ‘resiliency’ to intense drought in 2005



- Rainforest were highly resilient to short term climatic anomalies

Saleska, Didan, Huete, Rocha (2007), *Science*

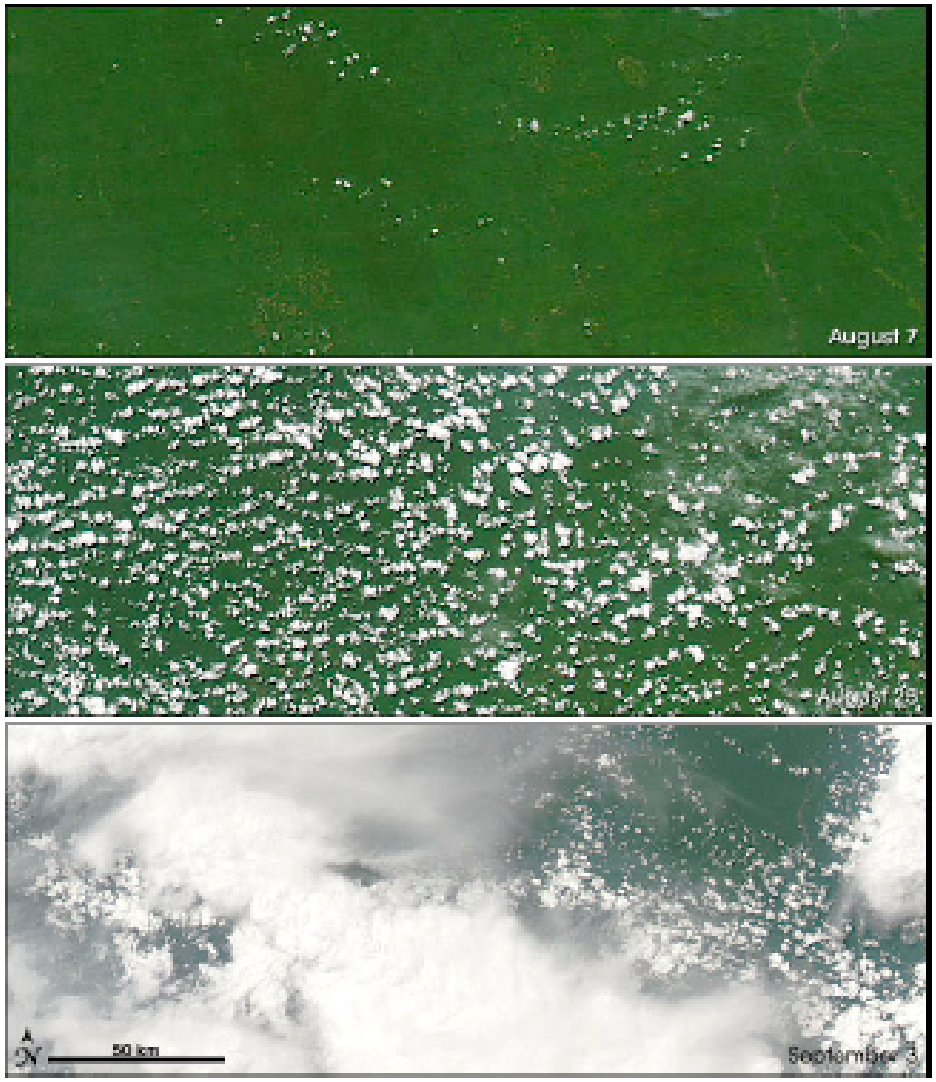


Close-up of EVI anomaly- showing areas with no increase in EVI

a) Deforested & converted areas;

b) savanna wetland and Bolivia lowlands; and

c) bamboo-dominated area

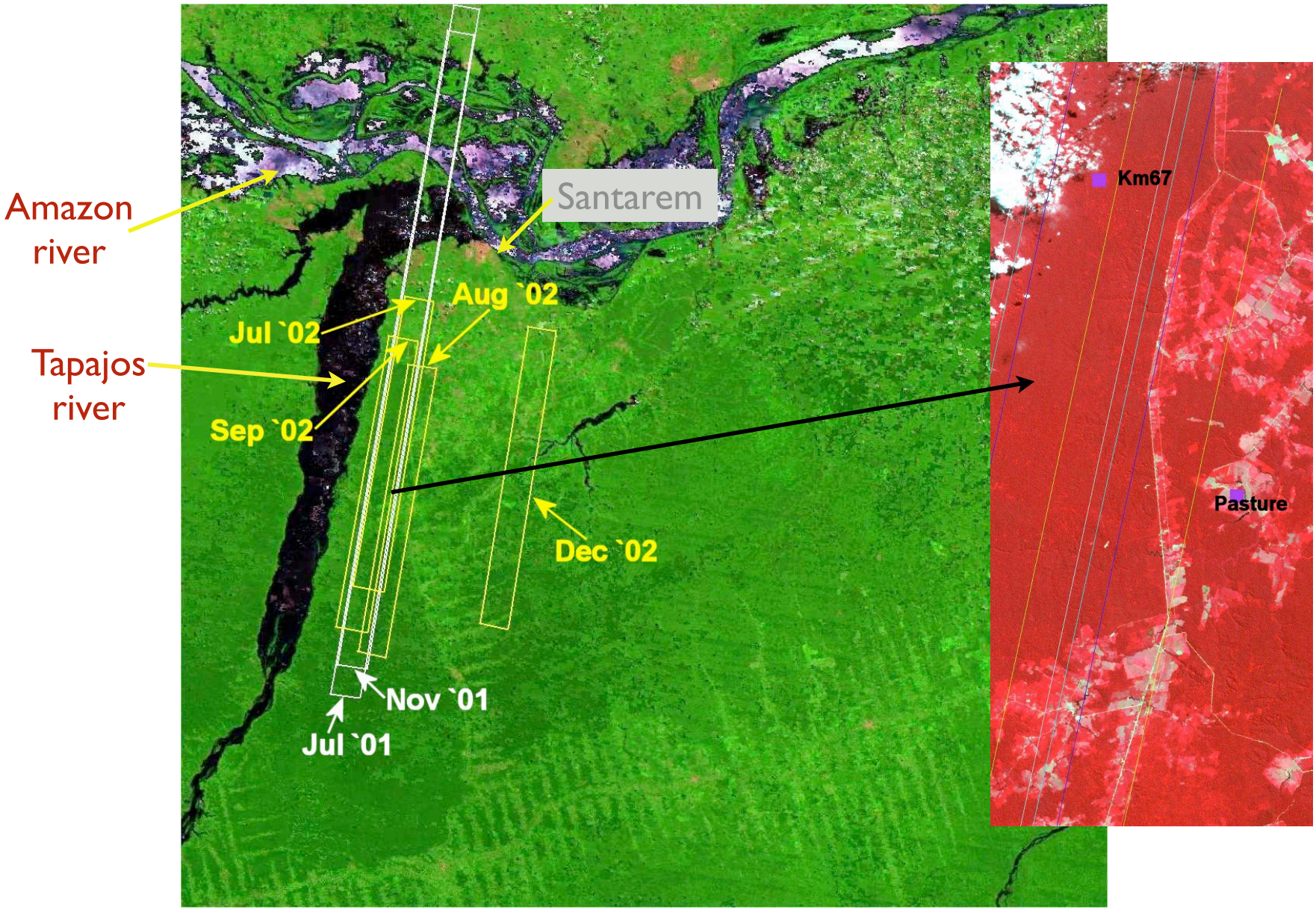


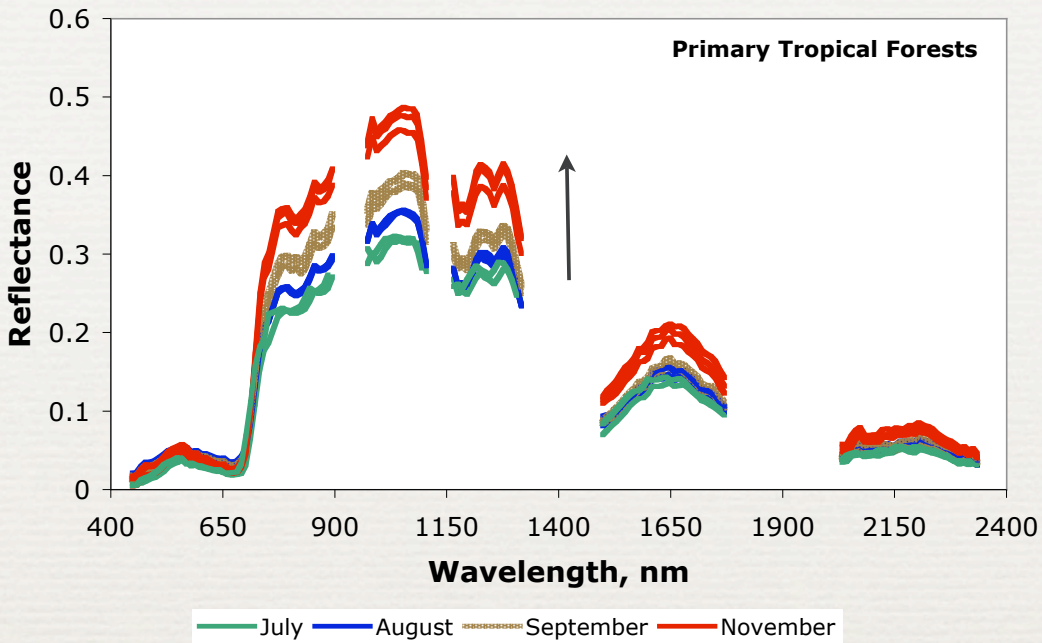
Fu et al., 2004

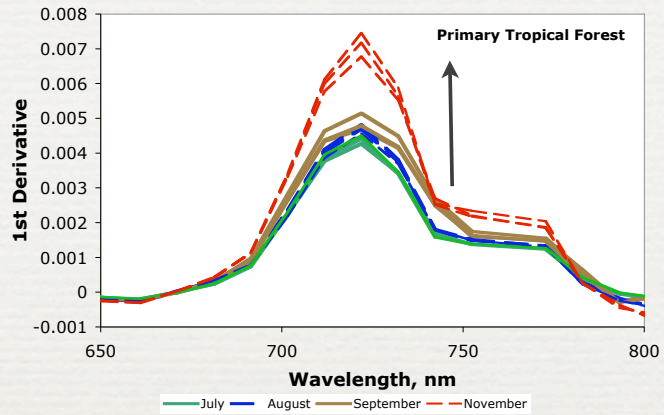
These satellite images show the progress from dry season to wet season. During the height of the dry season there are few clouds and little moisture above the forest canopy (above, top). As the trees grow leaves and photosynthesis increases, the humidity above the canopy increases, leading to popcorn-like clouds (middle). The energy released by the condensation of water vapor into water droplets drives convection and creates thunderstorms (lower). (NASA images from the MODIS Rapid Response System.)

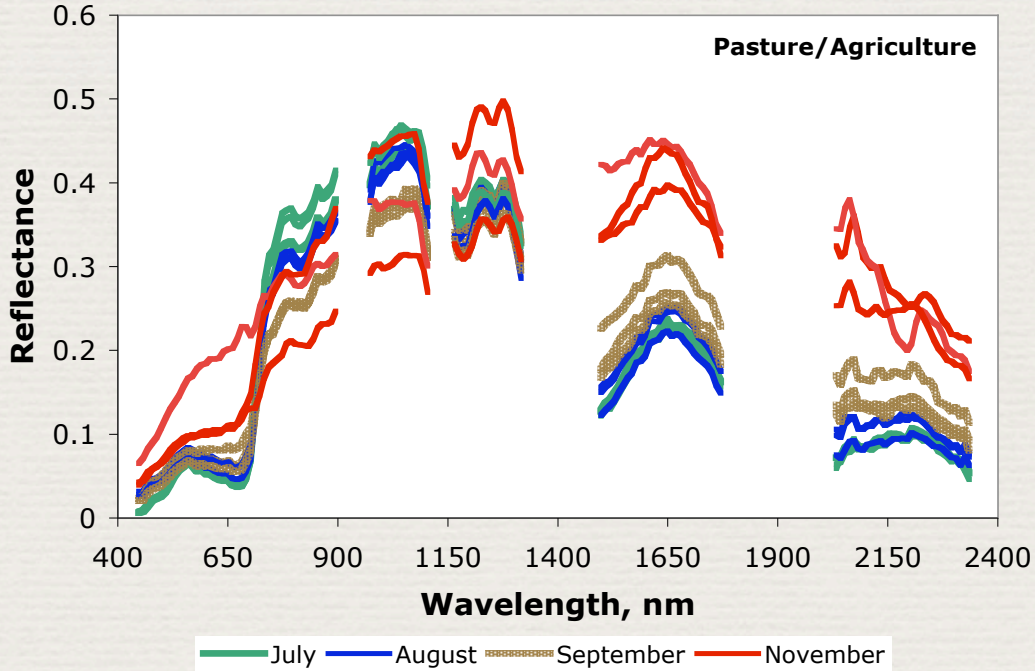
Earth Observatory

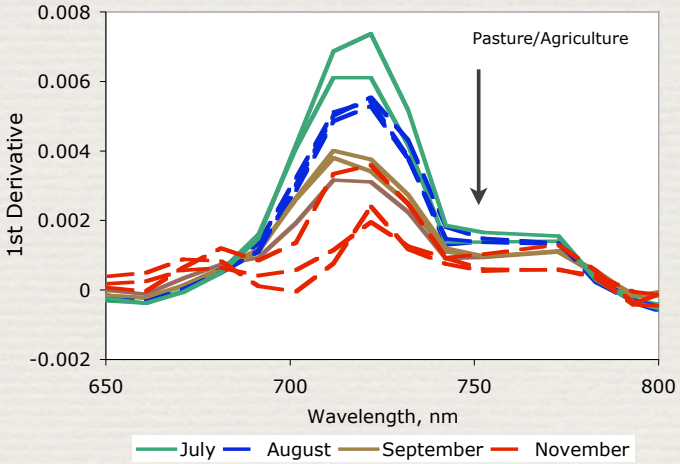
Fine resolution, hyperspectral remote sensing of Amazon seasonality




Primary Tropical Forests
Reflectance
0.6
0.5
0.4
0.3
0.2
0.1
0
400
650
900
1150
1400
1650
1900
2150
2400
Wavelength, nm
July
August
September
November

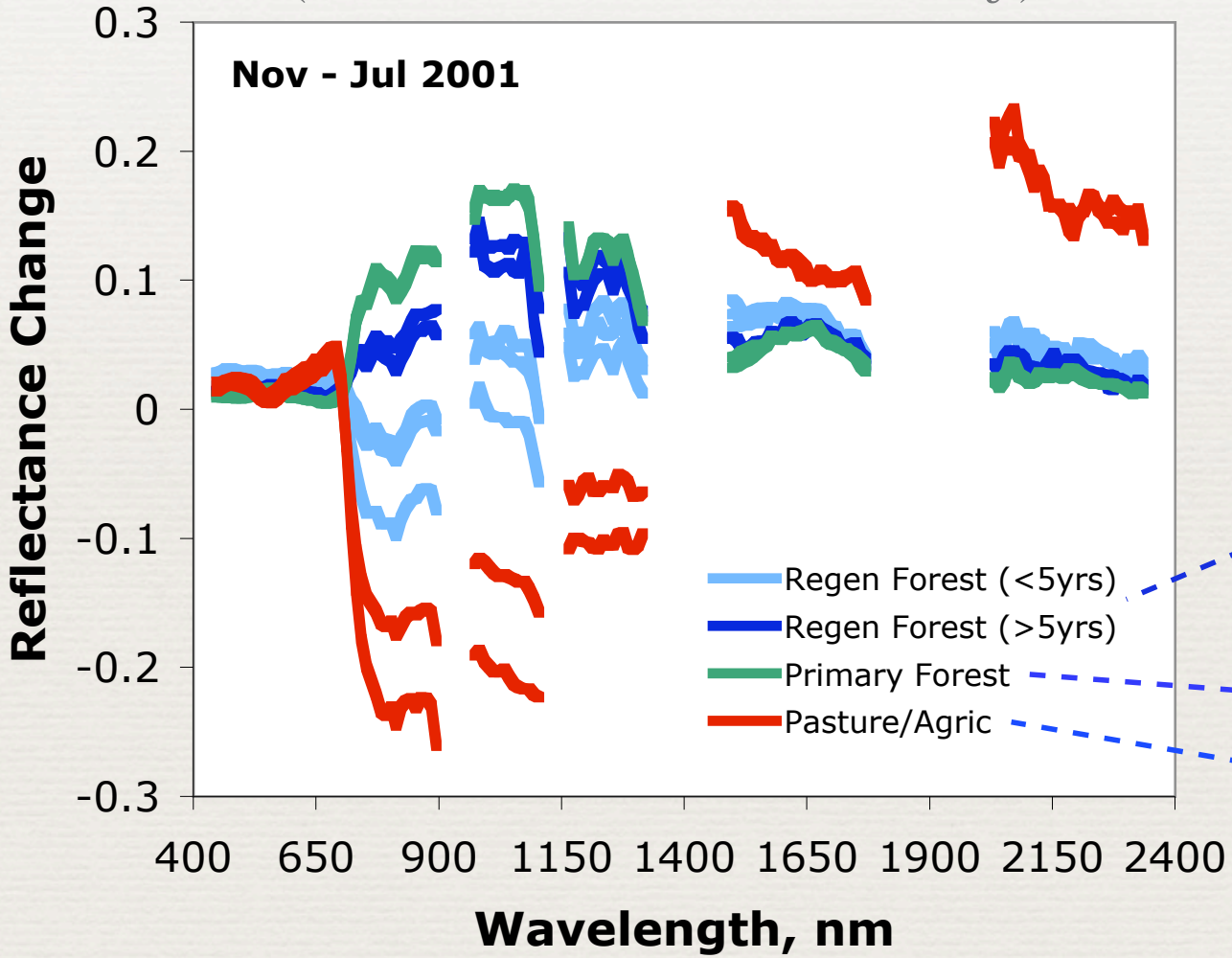

Primary Tropical Forest
1st Derivative
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
-0.001
650
700
750
800
Wavelength, nm
July
August
September
November

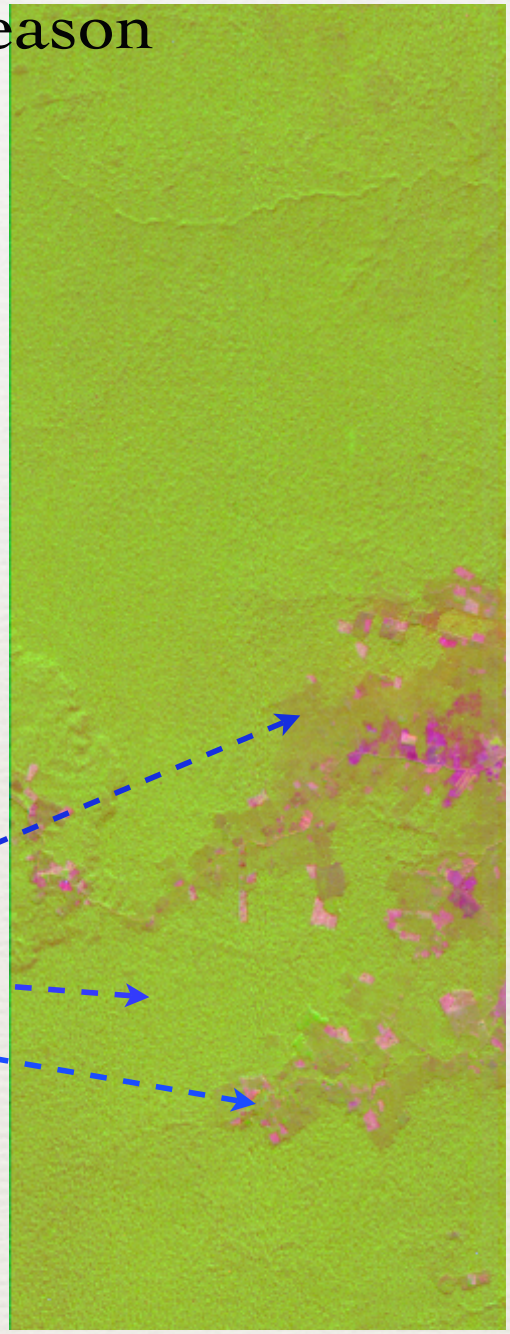

Pasture/Agriculture
Reflectance
0.6
0.5
0.4
0.3
0.2
0.1
0
400
650
900
1150
1400
1650
1900
2150
2400
Wavelength, nm
July
August
September
November

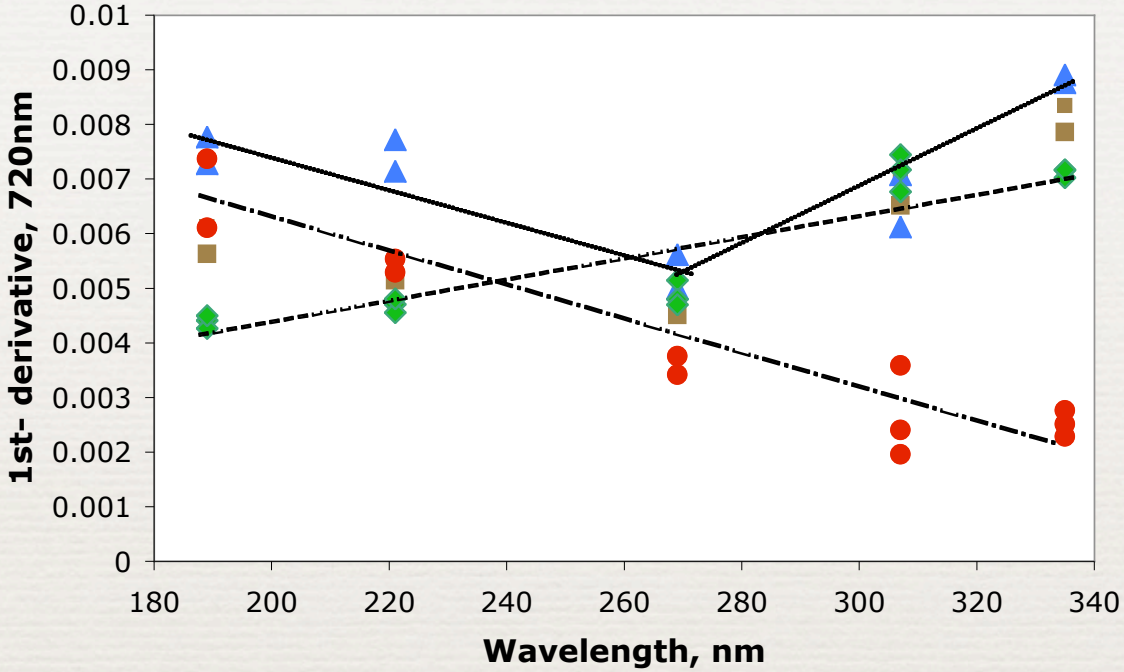

Pasture/Agriculture
1st Derivative
0.008
0.006
0.004
0.002
0
-0.002
650
700
750
800
Wavelength, nm
July
August
September
November

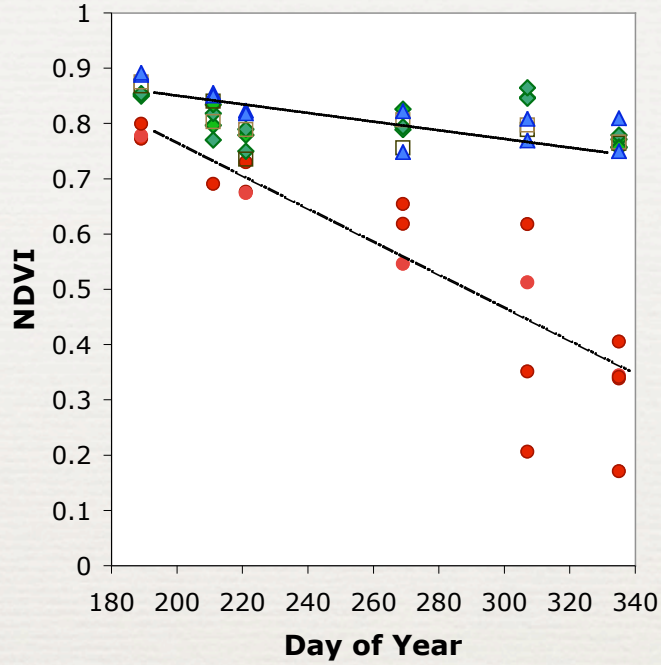
Vegetation dynamics through entire dry season

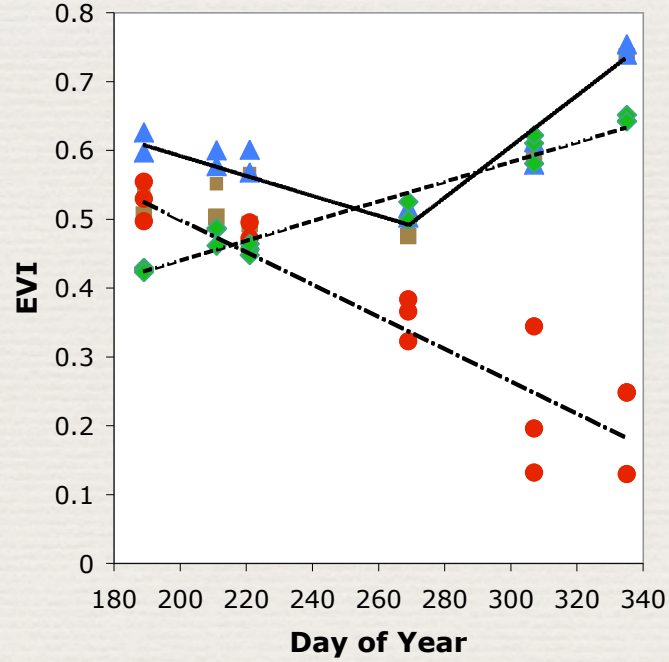
(Subtract November and July)



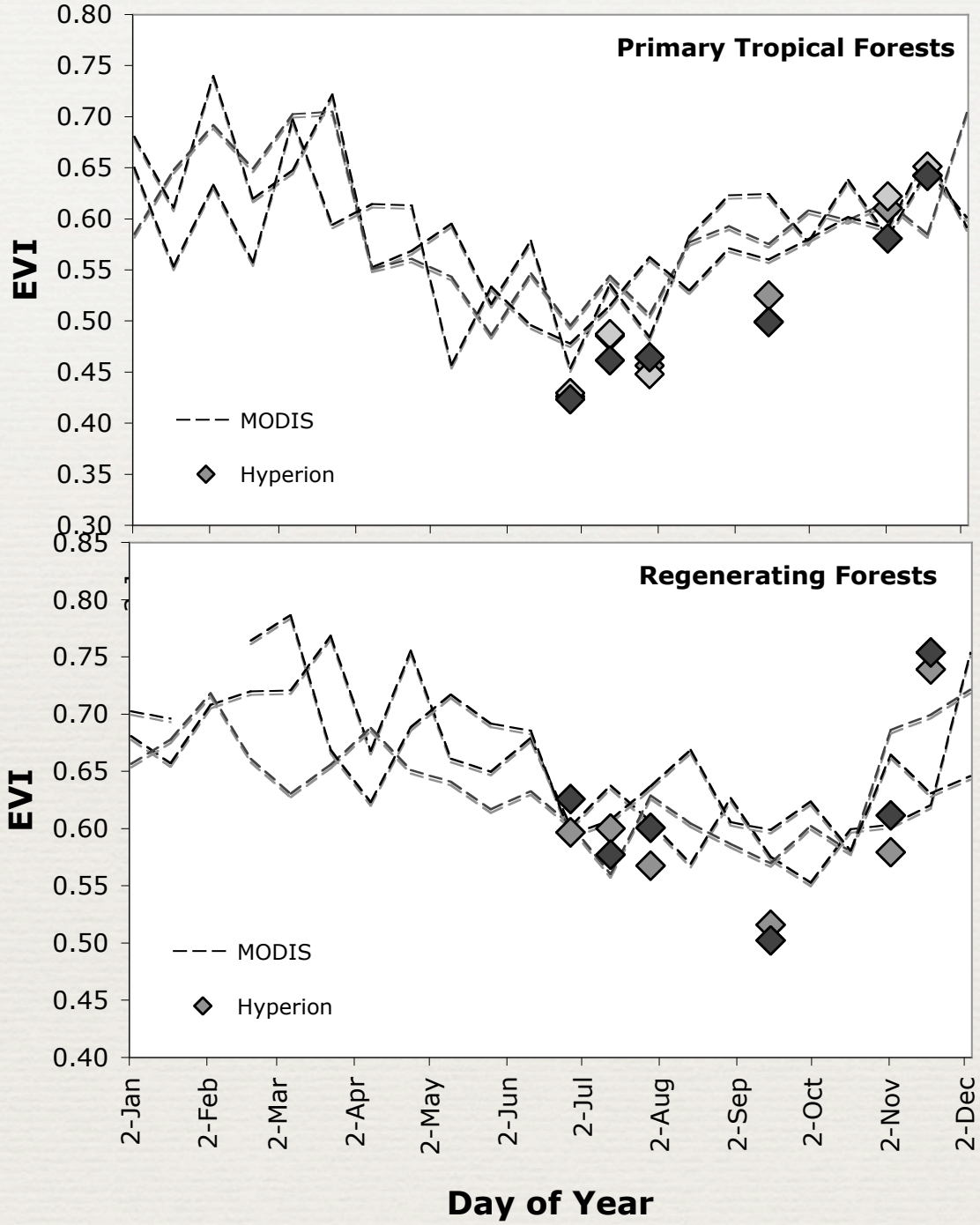






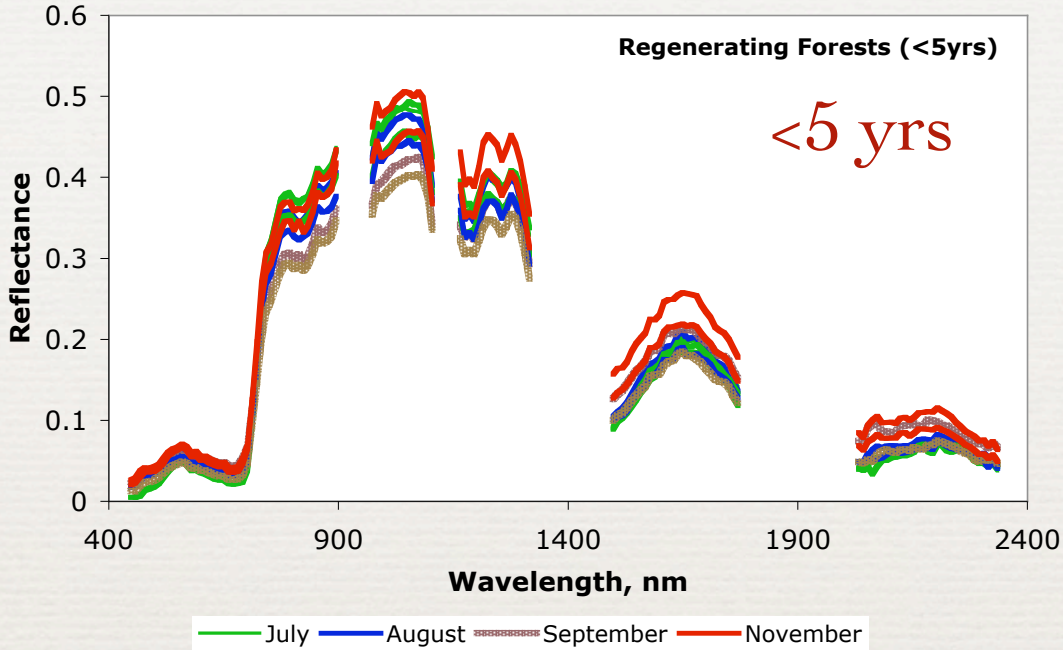


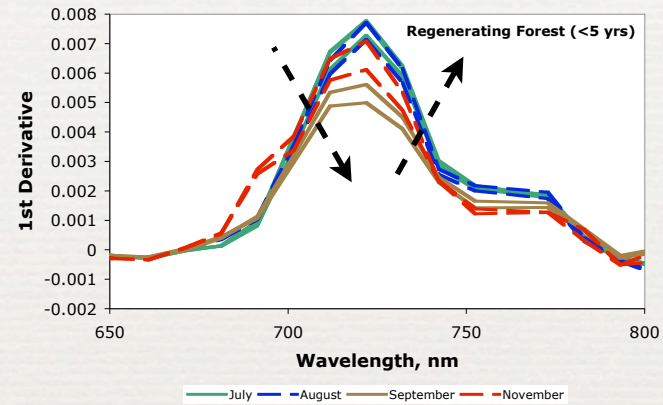
- Regenerating Forest, >5yrs
- Regenerating Forest, <5yrs
- Pasture/Agriculture
- Primary Forest


Primary Tropical Forests
Regenerating Forests
EVI
MODIS
Hyperion
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.85
2-Jan
2-Feb
2-Mar
2-Apr
2-May
2-Jun
2-Jul
2-Aug
2-Sep
2-Oct
2-Nov
2-Dec
Day of Year

Thank you

Regenerating Forests





- The balance of forested area worldwide is increasingly tilting to secondary forests.
- Barlow *et al*. (PNAS-2007) found large differences in species richness of major invertebrate, vertebrate, and plant taxa across primary and secondary forest sites in Amazonia.
- Many studies have demonstrated the difficulties in estimating C-emissions from secondary forests (Skole & Qi, 2001; Ramankutty et al., 2006)