

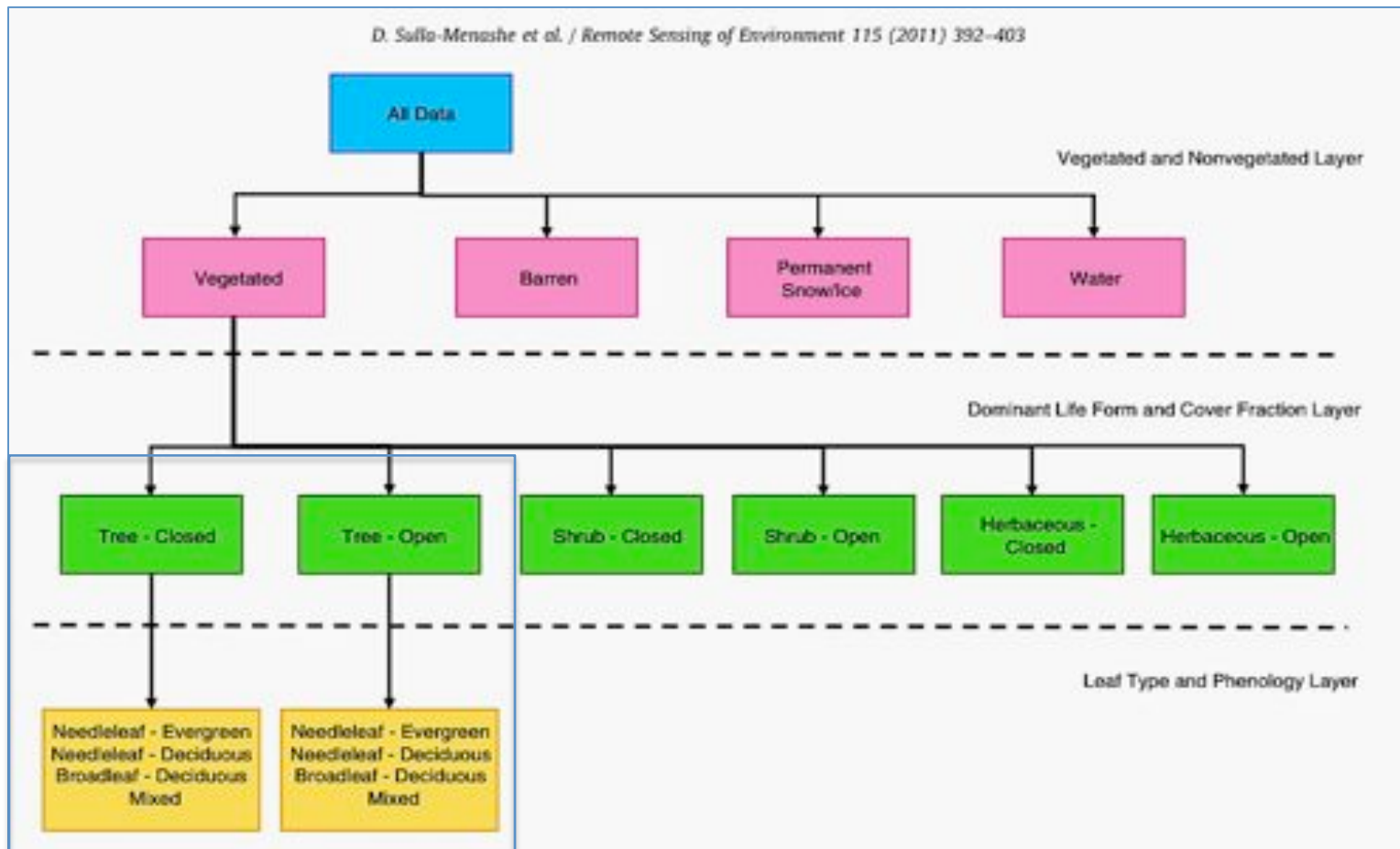
# ***Using MODIS to Monitor Dynamics in Land Cover & Phenology at Seasonal to Decadal Time Scales***

*Land Cover Type, Land Cover Dynamics  
Refinements & Science Data Analysis*

Mark Friedl, Damien Sulla-Menashe, Koen Hufkens,  
Xiaoman Huang, Eli Melaas, Surajit Ray, Luis Carvalho, Bin  
Tan, Robert Wolfe, Curtis Woodcock, Jeff Morisette,  
Andrew Richardson

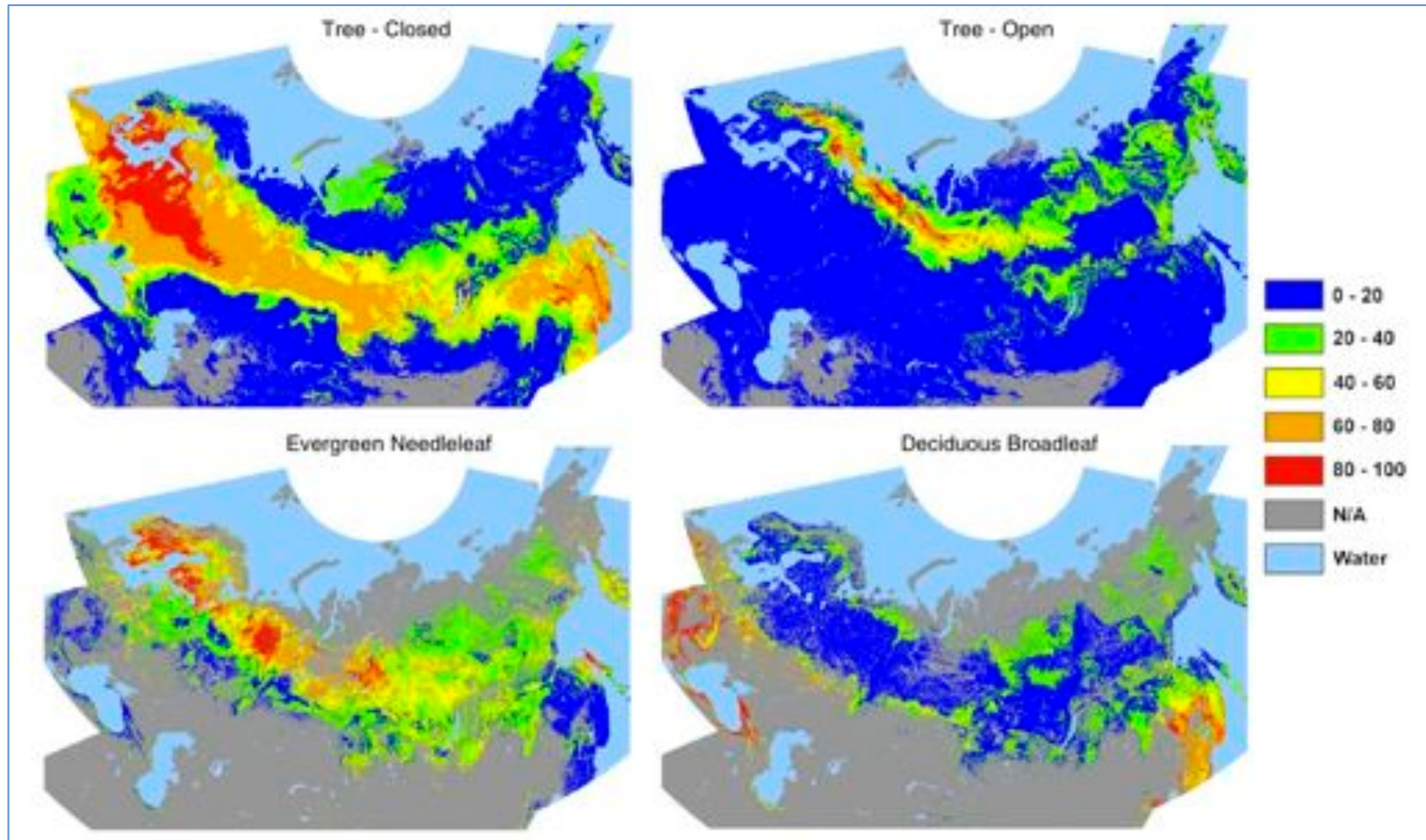
Boston University, NASA GSFC, USGS, Harvard University

# Land Cover Type: Refinements



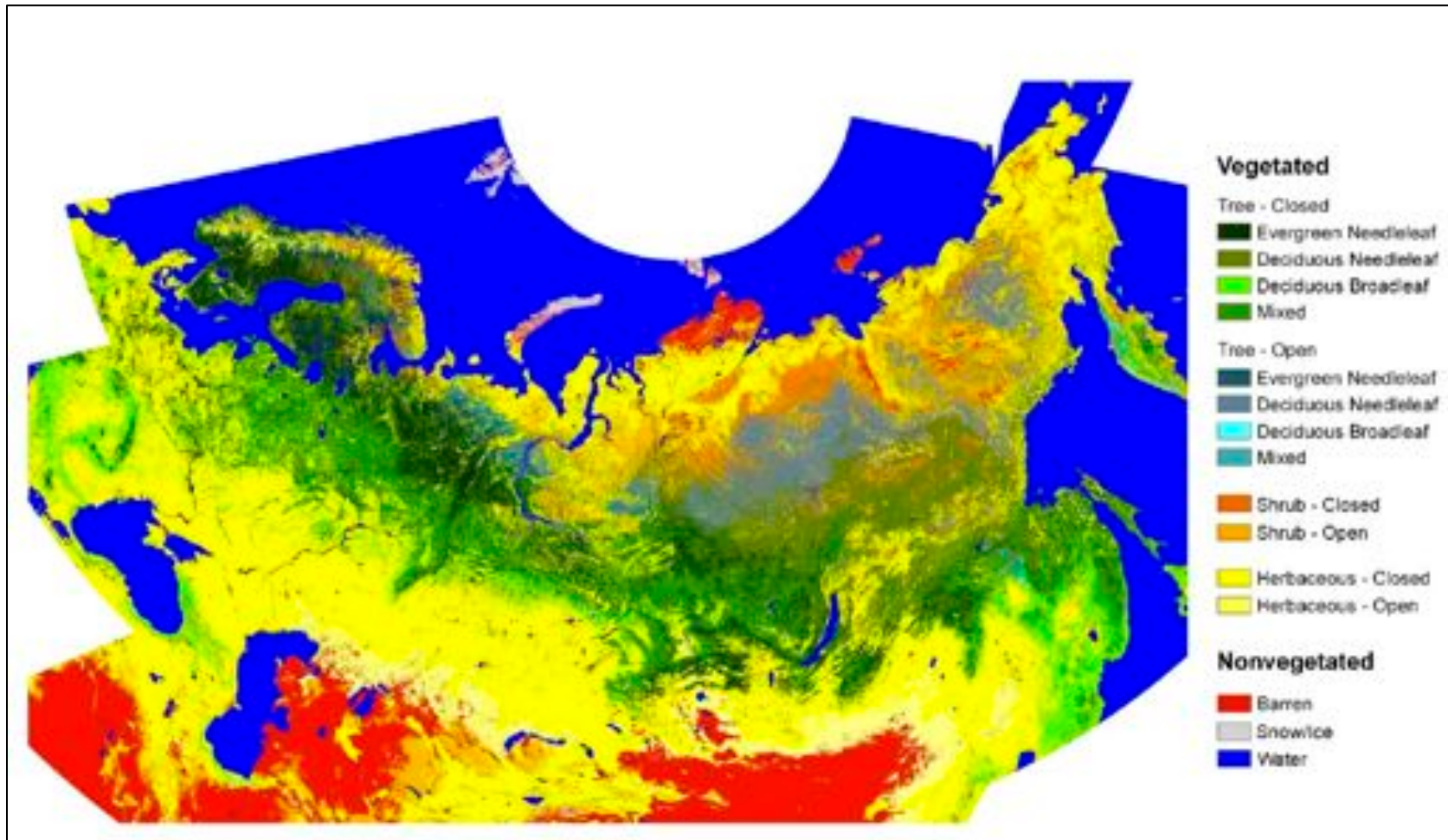
*Prototype Hierarchical Classification*

# Land Cover Type: Refinements



*Incorporating Potential Vegetation Prototype for Northern Eurasia*

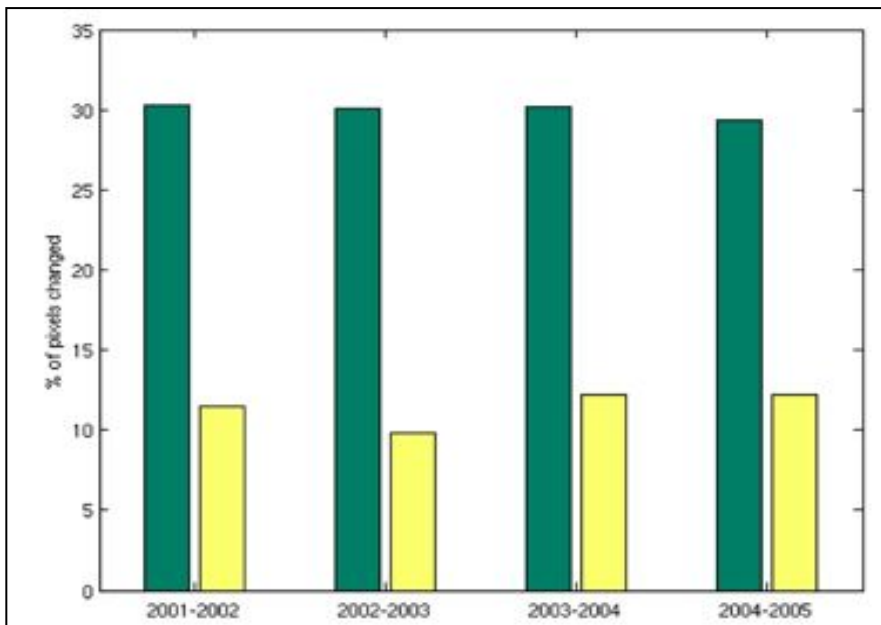
# Land Cover Type: Refinements



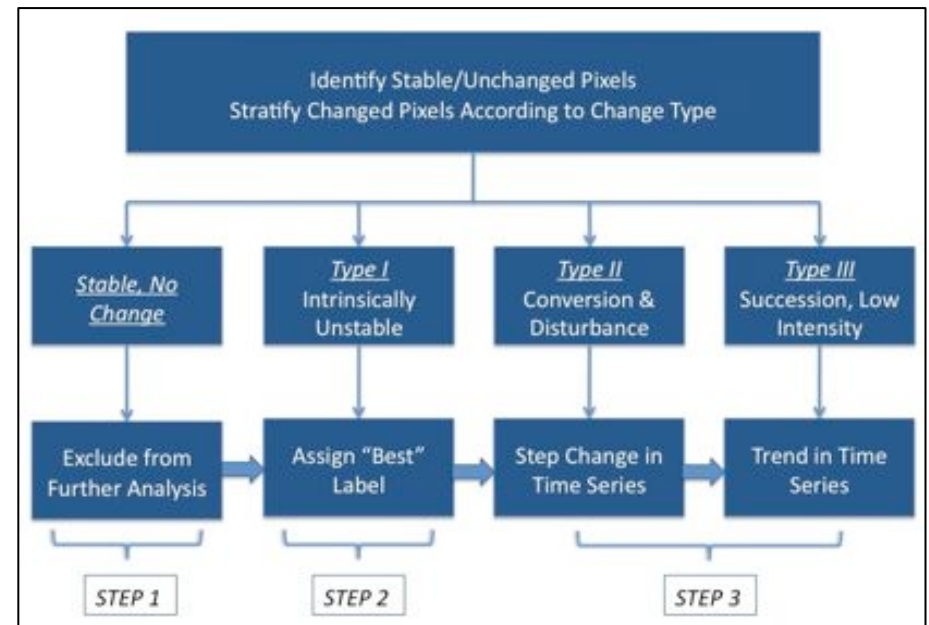
*C6 Prototype Classification (wetlands, land use not shown)*

# Land Cover Type: Science Data Analysis

Interannual rates of change in MCD12Q1



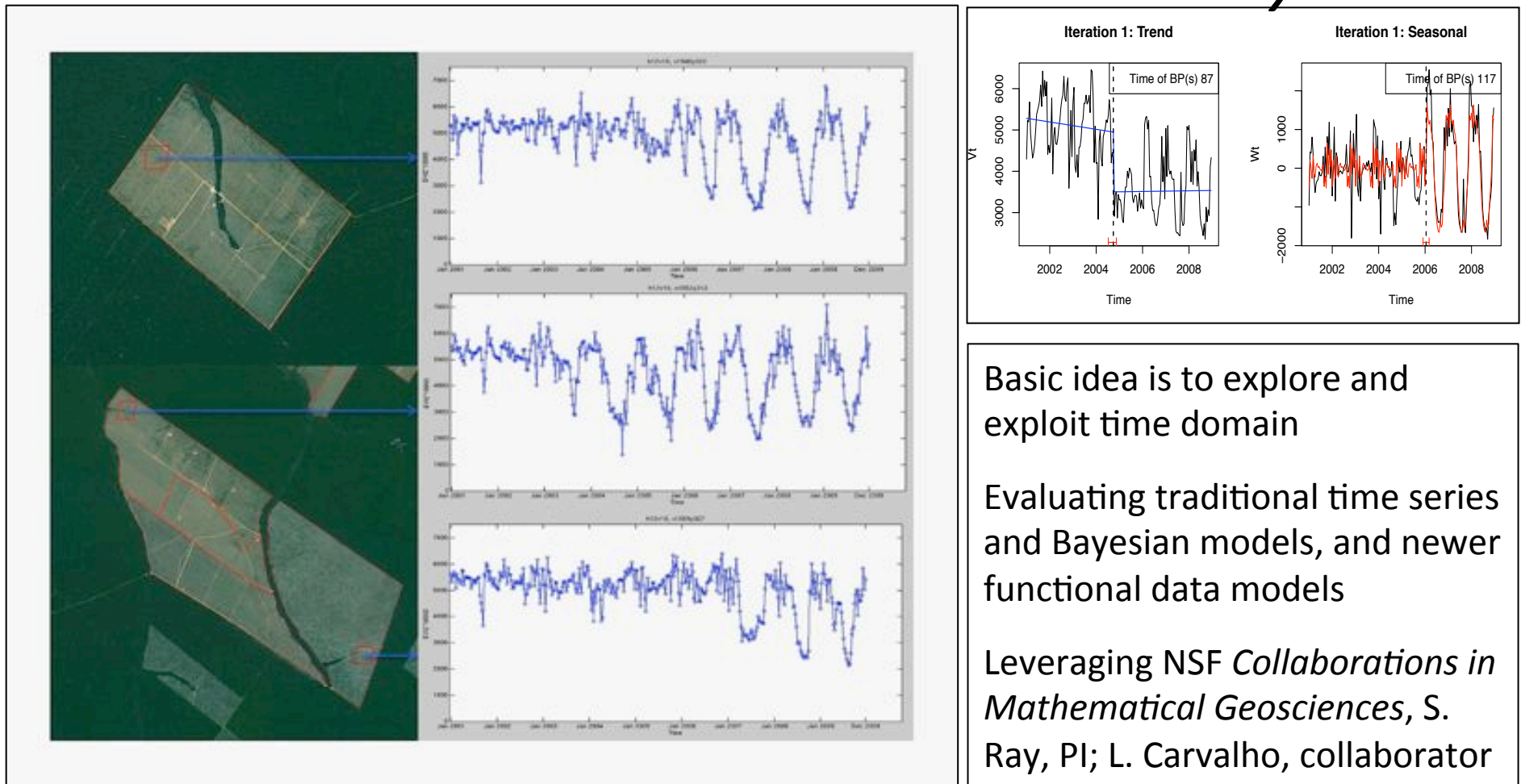
Conceptual stratification of change pixels



*Identification and characterization of change*

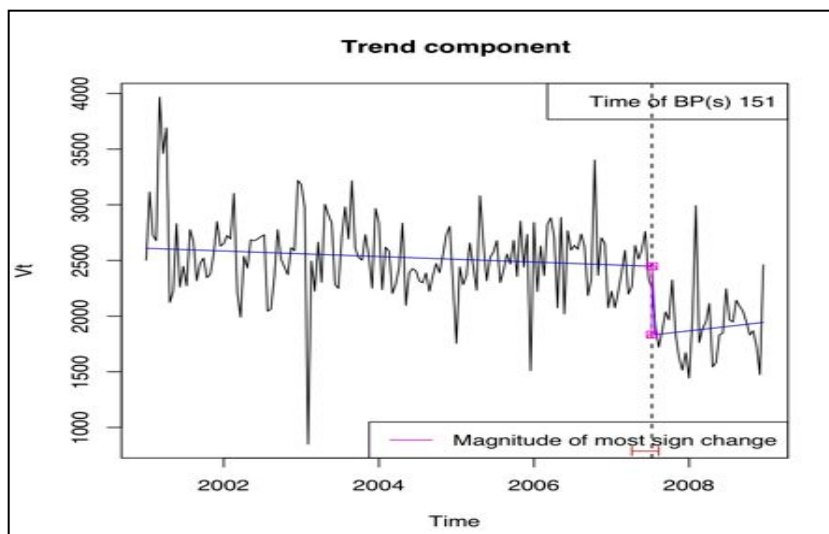
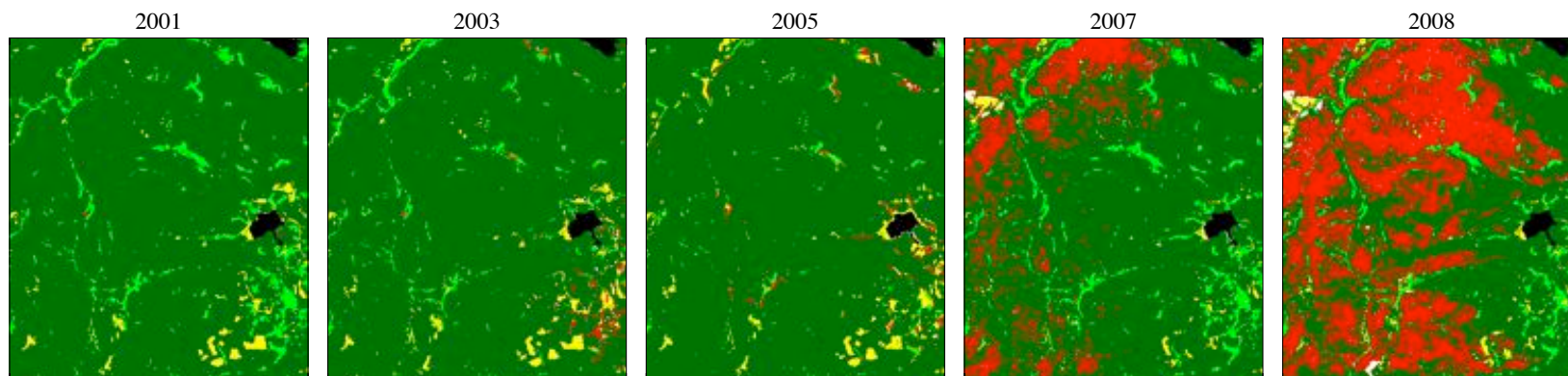
# Land Cover Type: Science Data Analysis

## *Time Series & Functional Data Analysis*



# Land Cover Type: Science Data Analysis

## *Time Series & Functional Data Analysis*

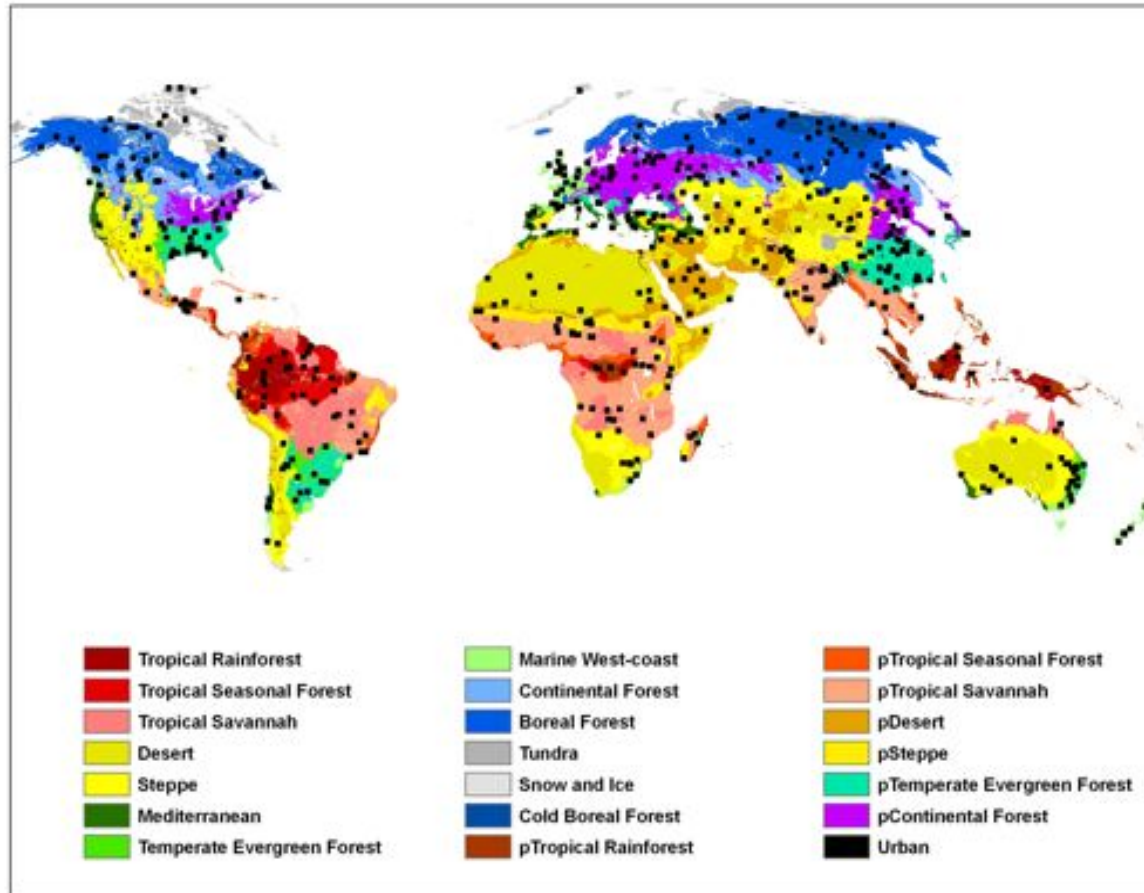


***Time series analysis of Mountain Pine Beetle infestation near Fraser, CO.***

***Above: Time series of Landsat-based maps of infestation (red = tree mortality); courtesy J. Hicke, U. Idaho.***

***At Left: Time series analysis using BFAST applied to MODIS EVI. The dashed vertical line indicates a detected break point in the time series.***

# Land Cover Type: Validation

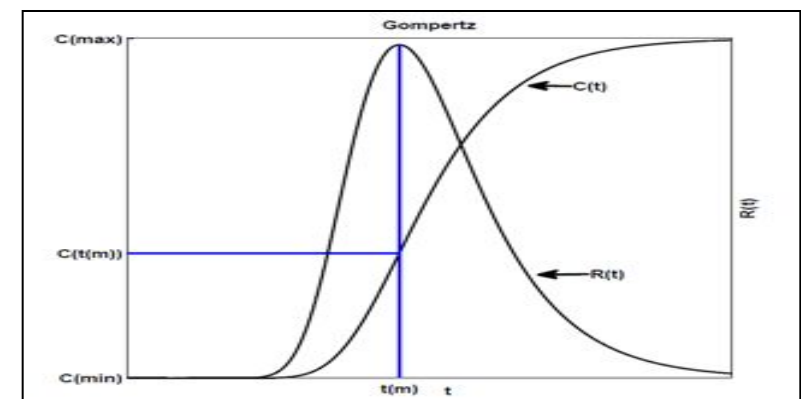
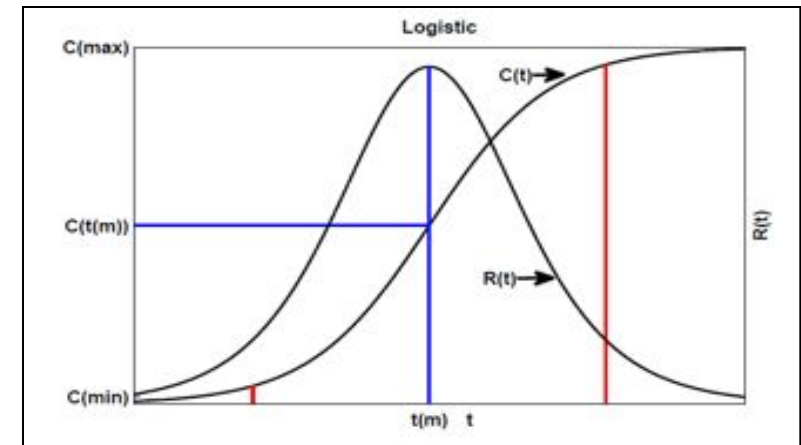
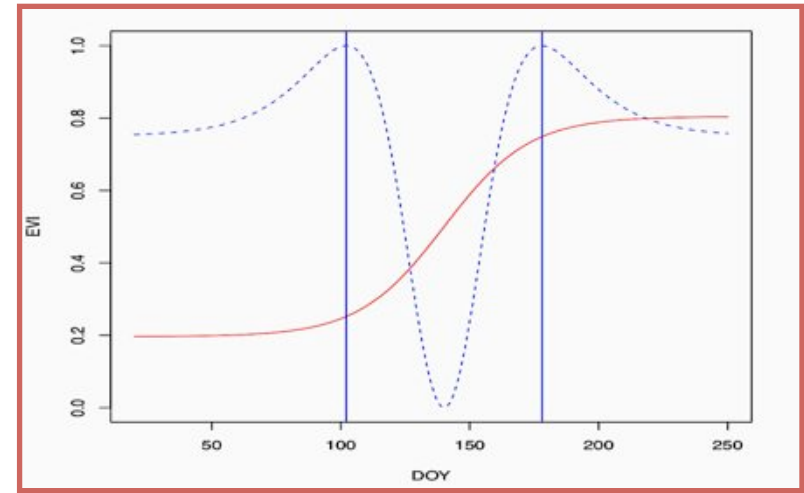


*Developing Database of 500 validation sites in collaboration with Curtis Woodcock, Martin Herold (GOFC/GOLD) and partially supported by NPP Cal/Val Team)*



# Land Cover Dynamics: Refinements

- Model identification
  - Assessment of VI dynamics
- Input selection
  - Testing different VI's (Fall vs Spring)
- Filtering snow
  - Key source of variance in greenup dates



# Land Cover Dynamics: Refinement & Validation

## Webcam Monitoring of Phenology

Supports model development

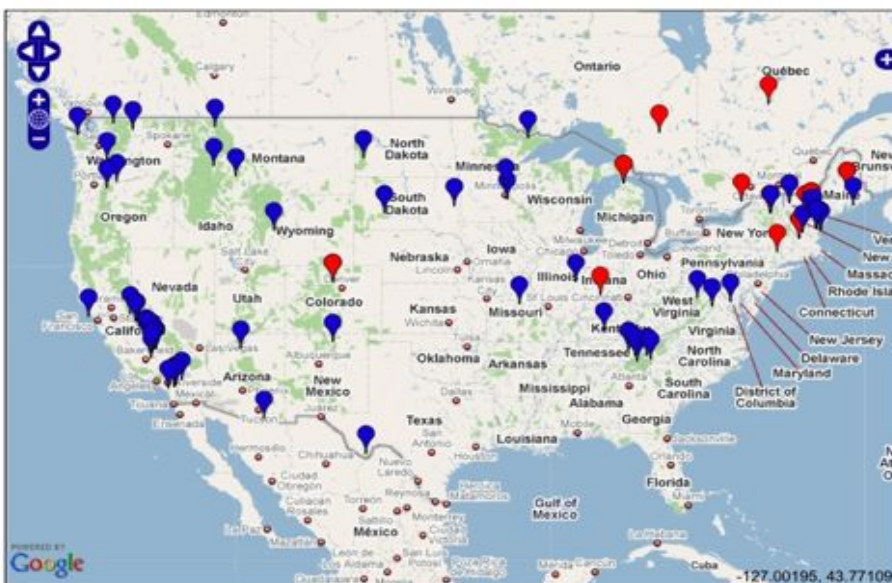
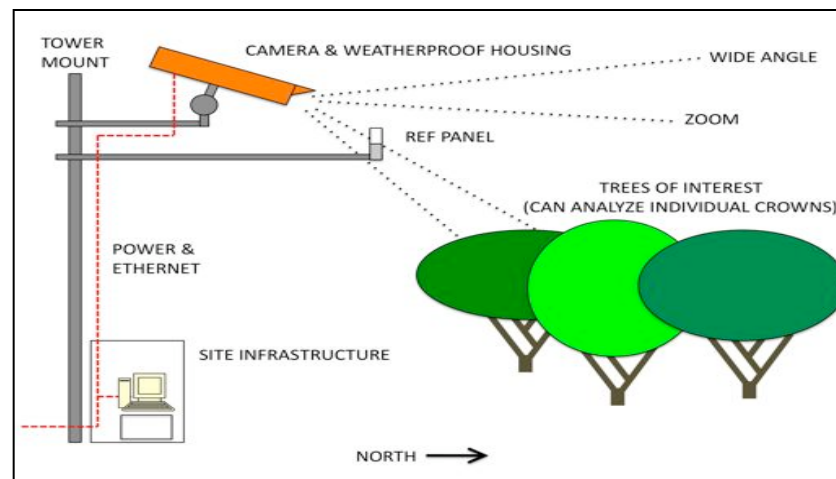
Error characterization and validation

Leveraging NSF Macrosystems Biology

*Continental-Scale Monitoring, Modeling and*

*Forecasting of Phenological Responses to*

*Climate Change; Richardson, PI*



Harvard Forest Webcam Mon Apr 07 12:31:41 2008 EST Exposure: 137  
Camera temp 37.0 °C Air temp 6.5 °C  
RH 0% Pressure 992.0 mb



Harvard Forest Webcam Sun May 11 12:01:40 2008 EST Exposure: 127  
Camera temp 46.5 °C Air temp 16.0 °C  
RH 0% Pressure 971.0 mb



Harvard Forest Webcam Thu Jun 12 13:31:42 2008 EST Exposure: 171  
Camera temp 51.5 °C Air temp 22.0 °C  
RH 0% Pressure 984.0 mb



Harvard Forest Webcam Sun Aug 24 12:01:43 2008 EST Exposure: 169  
Camera temp 55.5 °C Air temp 24.0 °C  
RH 0% Pressure 982.0 mb



Harvard Forest Webcam Thu Oct 30 12:31:39 2008 EST Exposure: 127  
Camera temp 33.5 °C Air temp 3.5 °C  
RH 0% Pressure 986.0 mb



# Land Cover Dynamics: Refinement & Validation

## PhenoCam Vegetation Indices

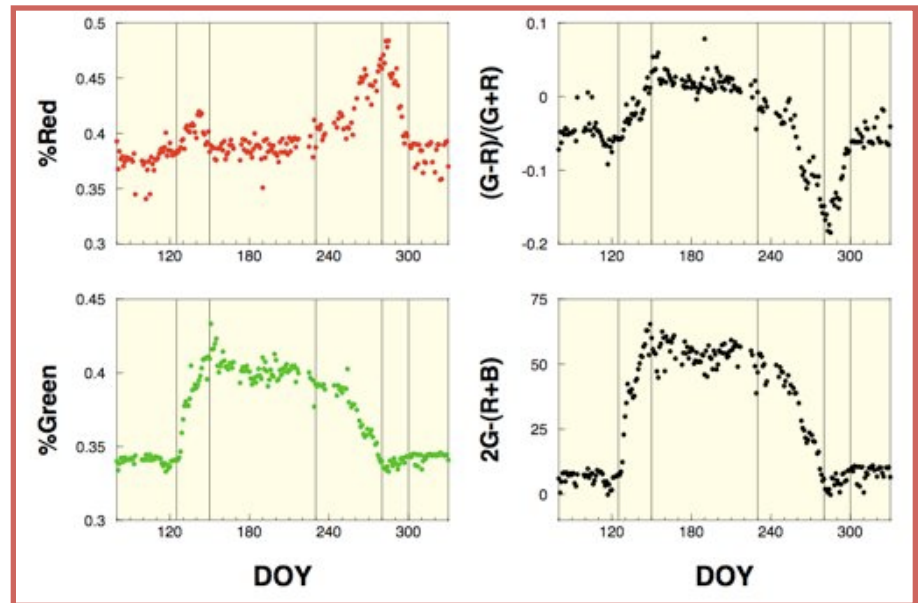
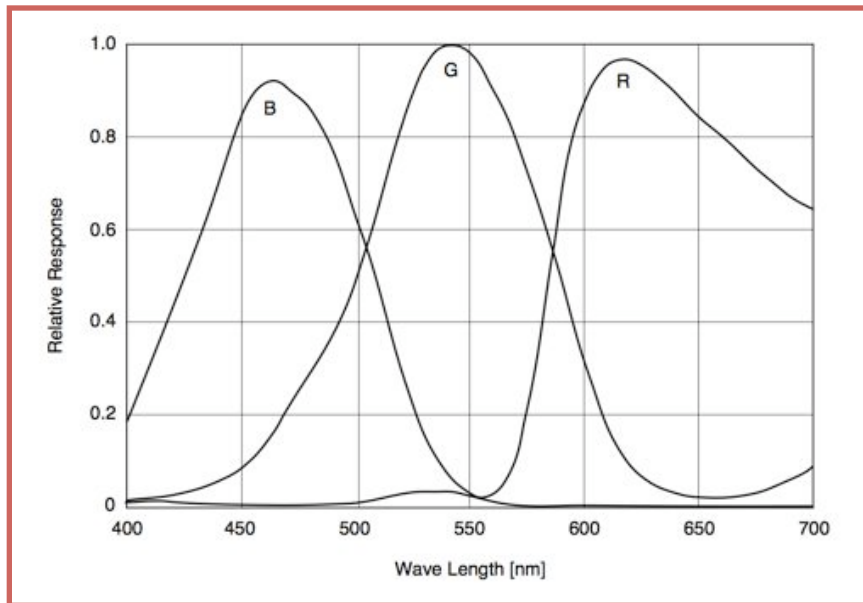


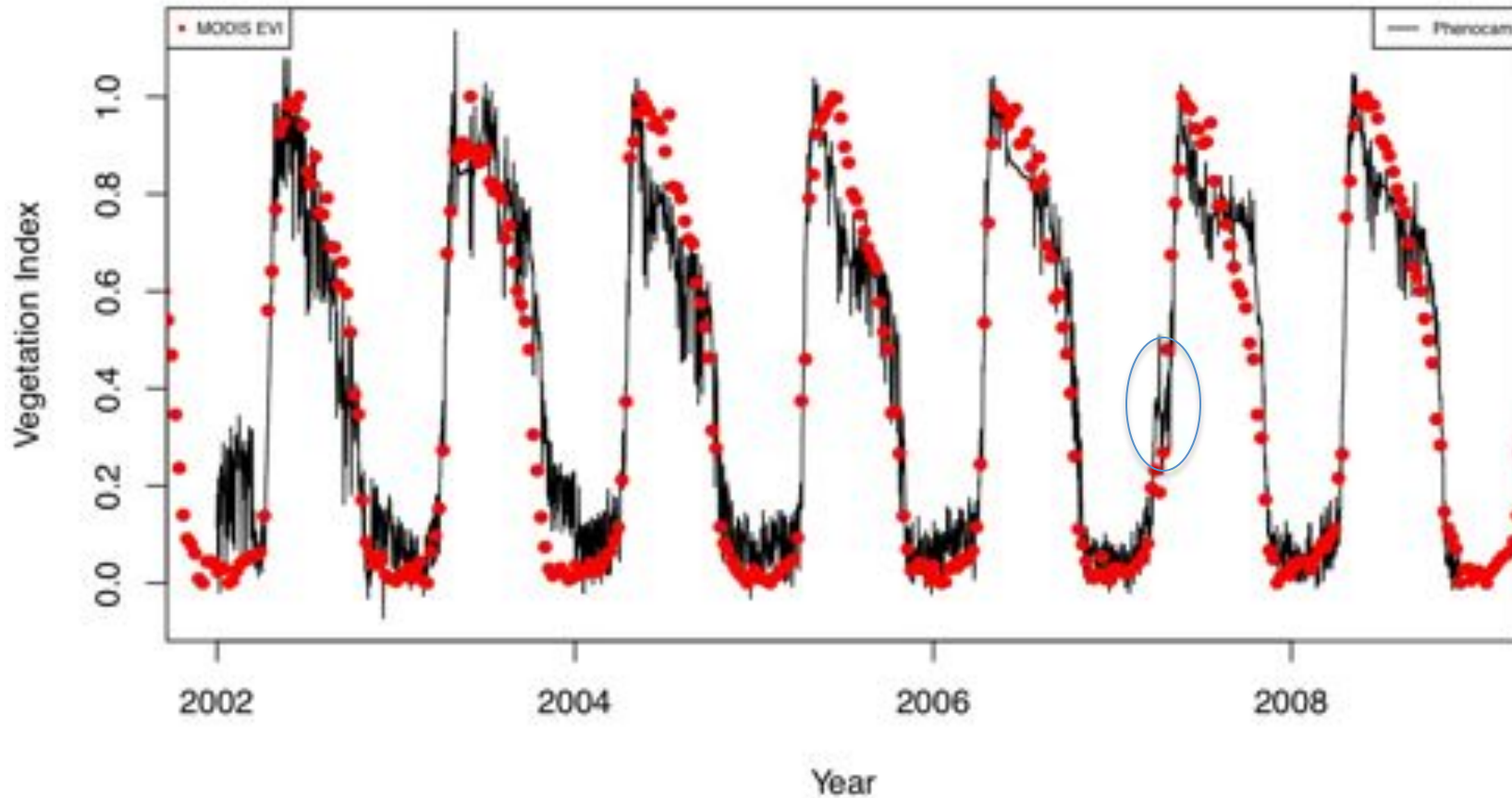
Image analysis (RGB channel extraction) to quantify phenological dynamics

– Richardson et al., 2007, *Oecologia*; Richardson et al, 2009, *Ecological Applications*



# Land Cover Dynamics: Refinement & Validation

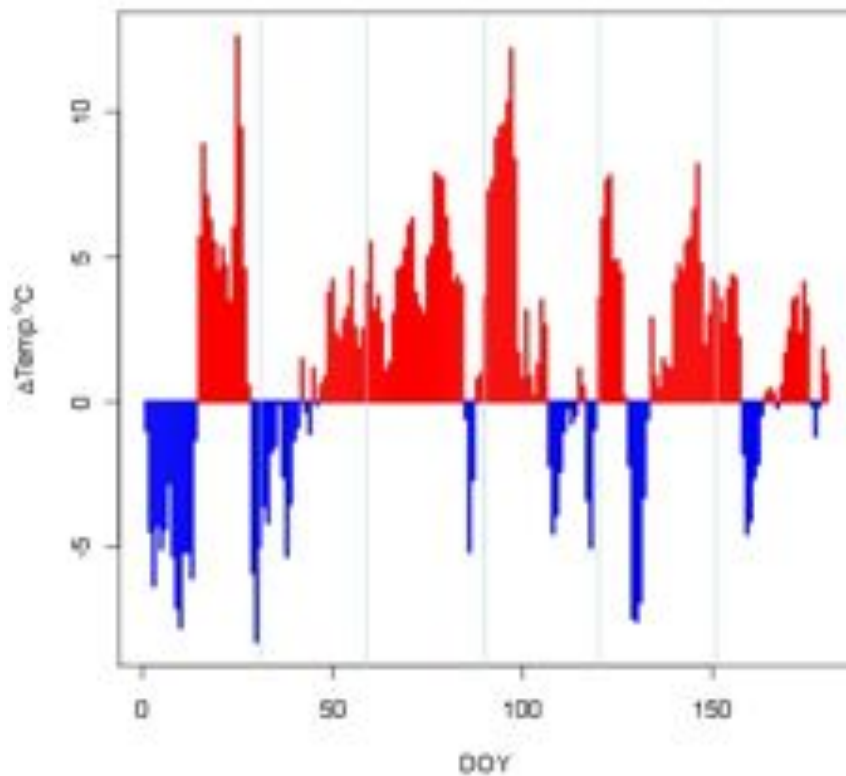
*Phenocam vs MODIS (Mammoth Cave, Ky)*



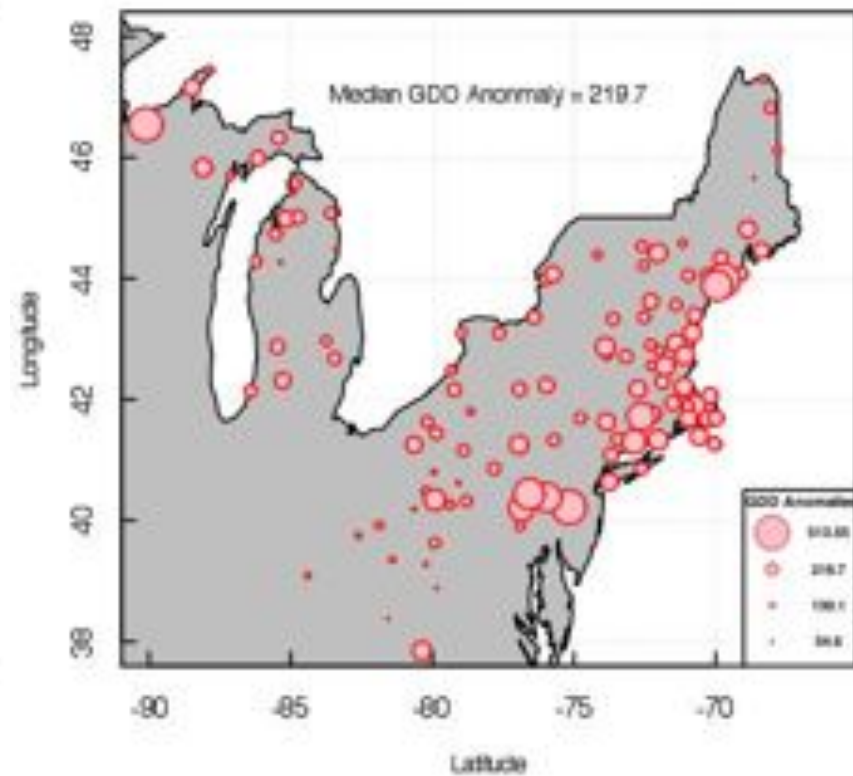
*Clear phenology, modest noise level, strong covariance w/MODIS*

# Land Cover Dynamics Science Data Analysis: *Signatures of Climate & Ecosystem Dynamics*

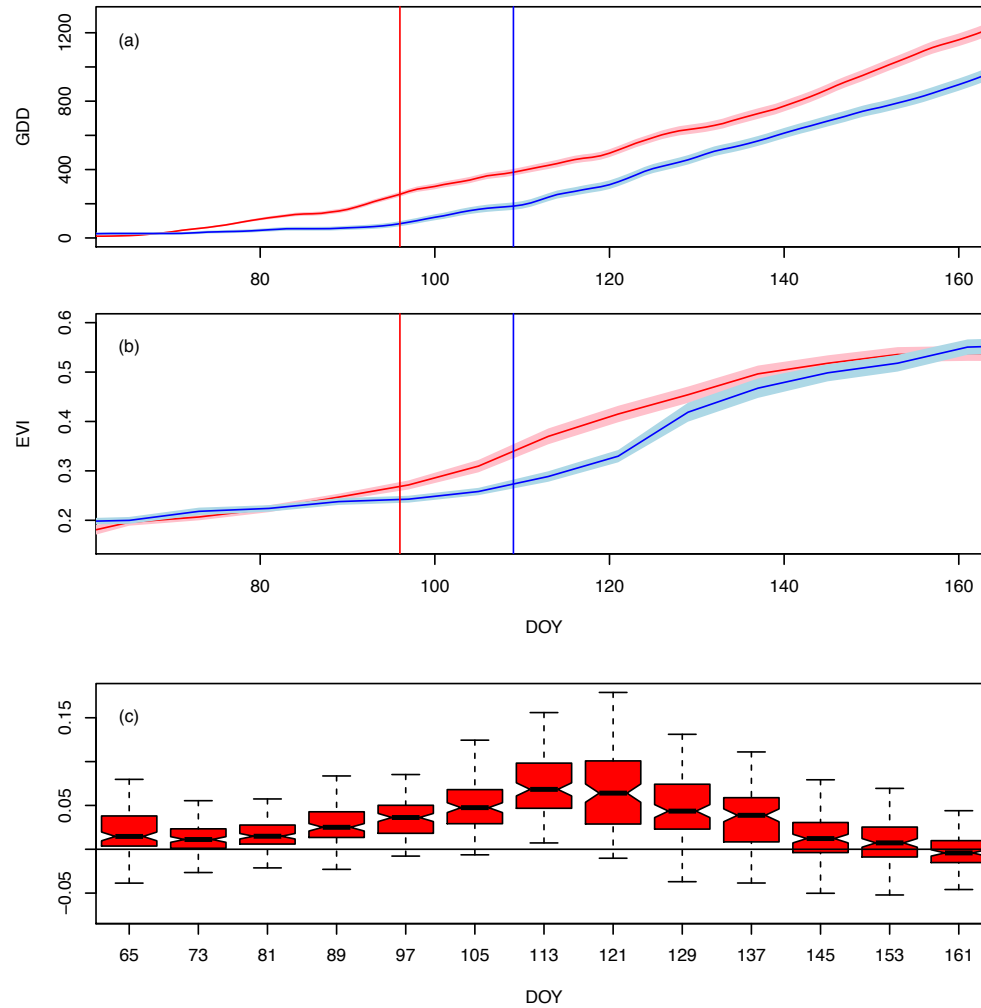
2010 Jan-June Temperature Anomalies



2010 Jan-June Growing Degree Day Anomalies

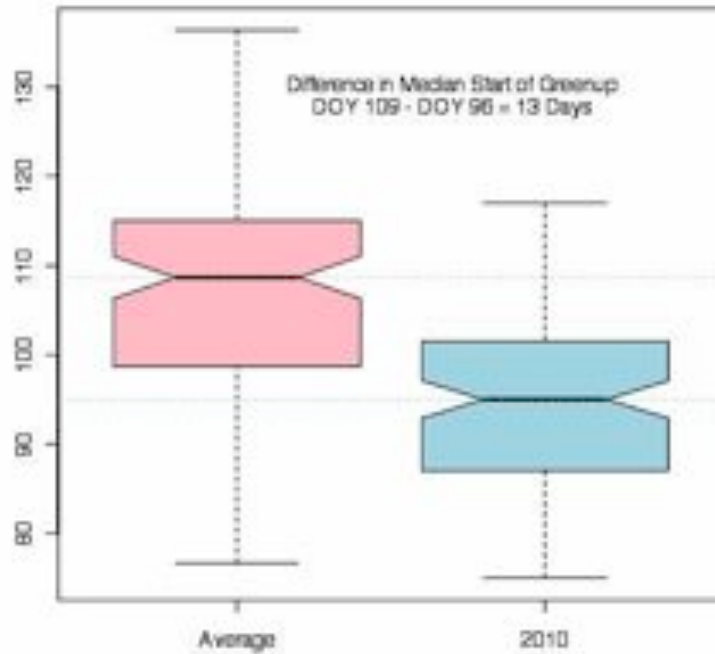


# Land Cover Dynamics Science Data Analysis: *Signatures of Climate & Ecosystem Dynamics*

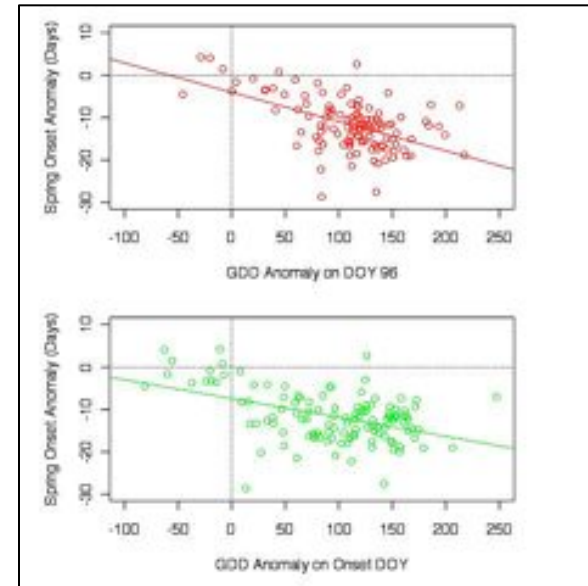


# Land Cover Dynamics Science Data Analysis: *Signatures of Climate & Ecosystem Dynamics*

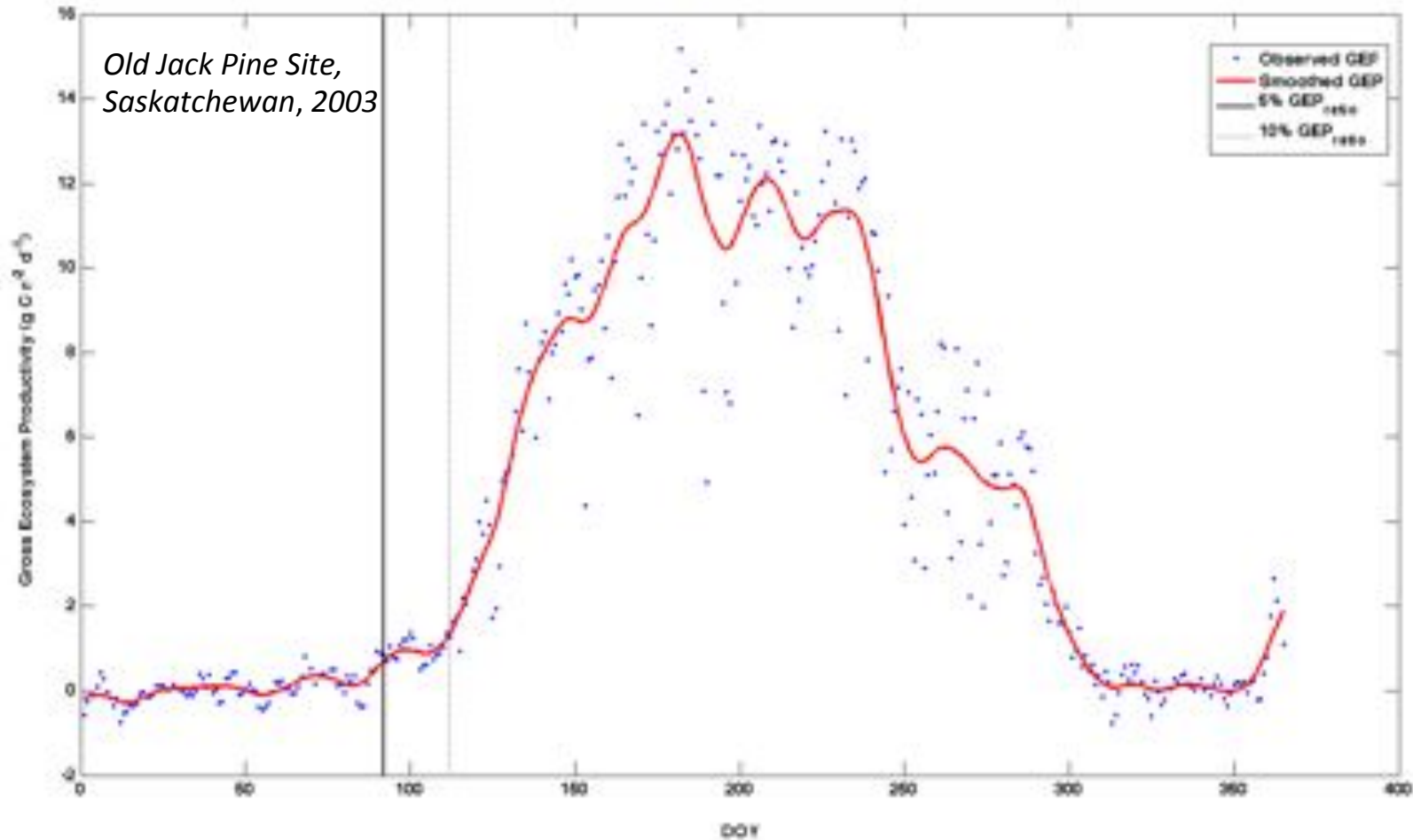
*Onset of "greenup"*



*Greenup anomaly vs GDD anomaly*



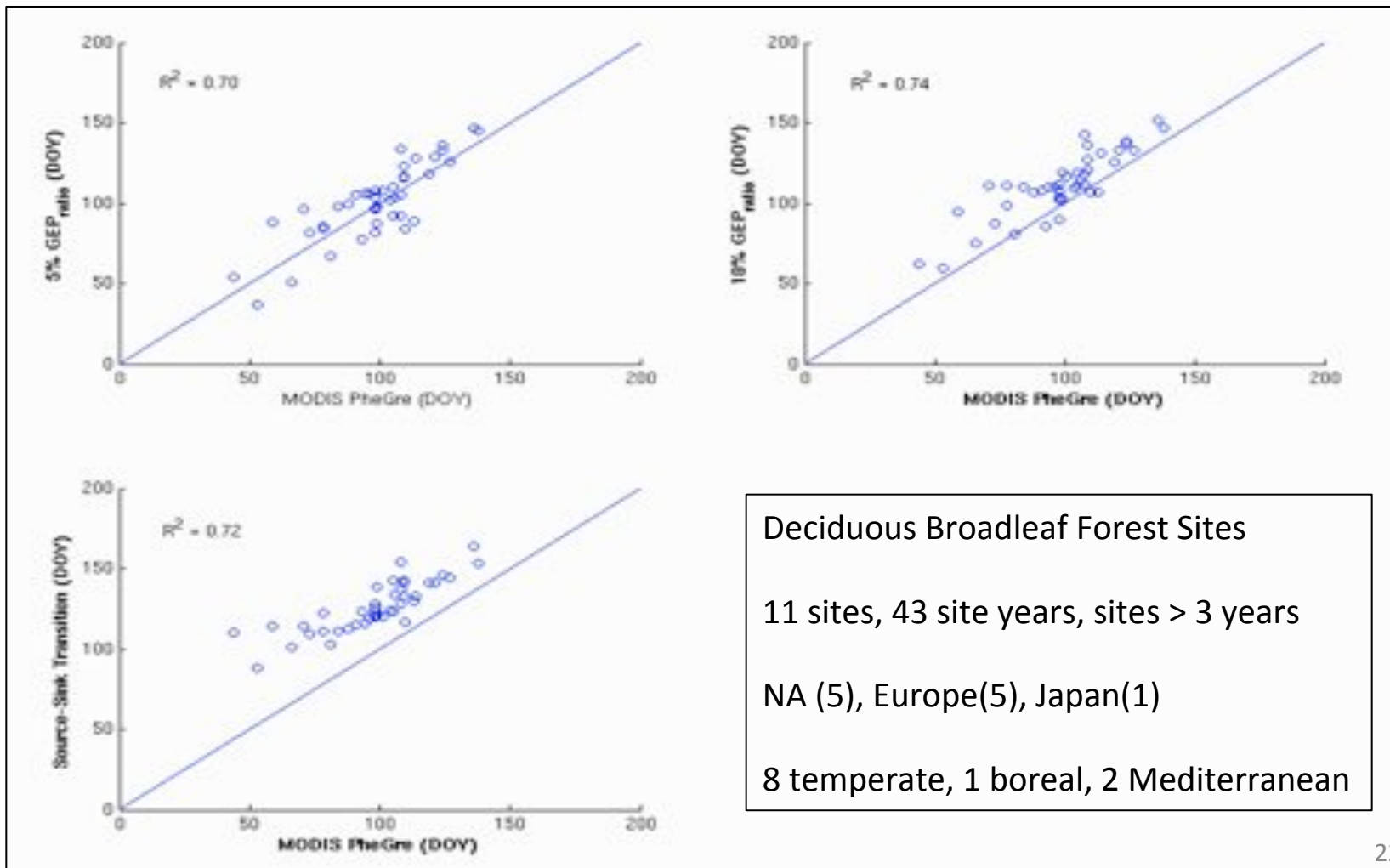
# Land Cover Dynamics Science Data Analysis: *Signatures of Climate & Ecosystem Dynamics*



*Estimate start of growing season from fluxes – compare with MCD12Q2*

# Land Cover Dynamics Science Data Analysis: *Signatures of Climate & Ecosystem Dynamics*

*Compare timing of flux phenology from FluxNet with timing of greenup from MODIS*



*Questions?*