# Impacts Land-Use/Land-Cover Change on Terrestrial Ecosystem Carbon Budgets


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# Objectives

- Extract Vegetation Structure and composition with remote sensing
- Understanding impacts of landscape vegetation structure on the flow of energy into the ecosystems.
- Estimate impacts of LCLUC on carbon budget
- Develop an education program for 8-12$^{th}$ grade students in collaboration with Morehead Planetarium Science Center, UNC Chapel Hill

# Hypothesis

Land-cover/land-use changes have significant impacts on terrestrial ecosystem carbon cycling as a result of changes in both ecosystem composition and structure.

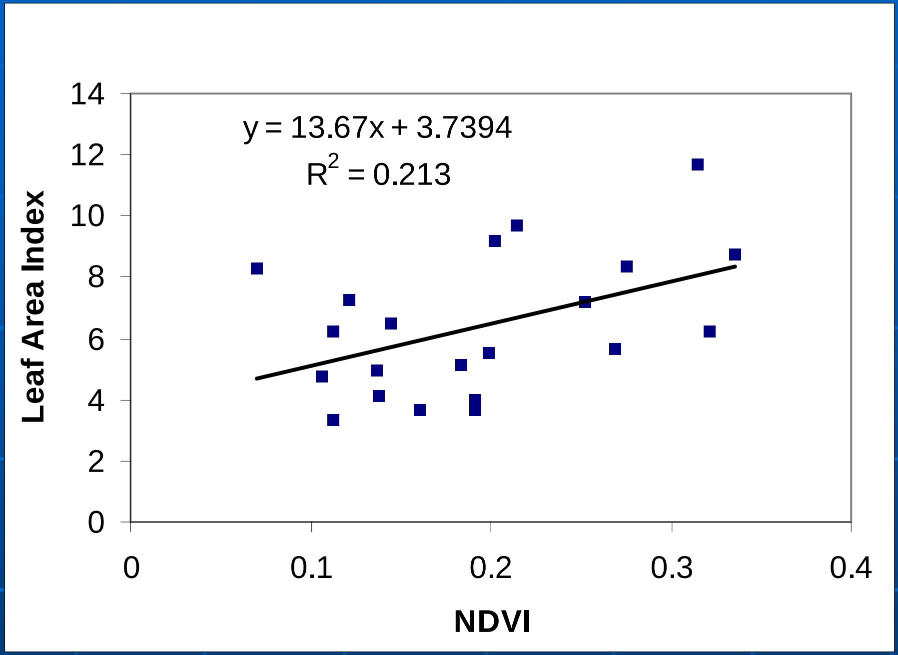
# Research Questions

- How can landscape structure be characterized with remotely sensed images?
- How does complex landscape structure influence our ability to model energy flow into the ecosystem across spatial and temporal scales?
- What is the impact of LCLUC on terrestrial ecosystem carbon flux?

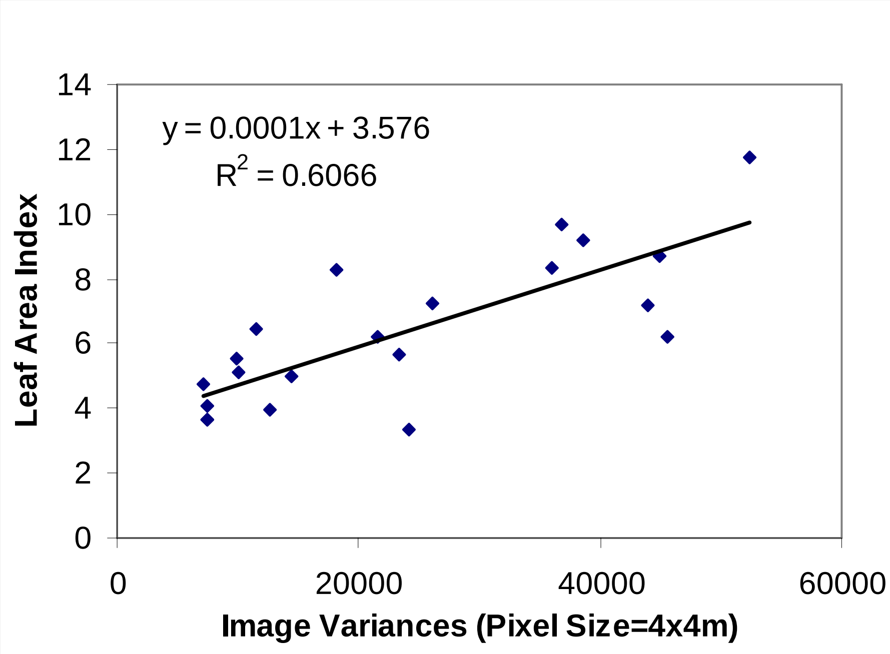
# Remote Sensing of Vegetation Structure

- Mapping tree crown size and density with Ikonos imagery
- Mapping LAI with Ikonos and Landsat Imagery
- Mapping forest successional stages with multitemporal Landsat imagery

# Remote Sensing LAI: Spatial vs. Spectral Information

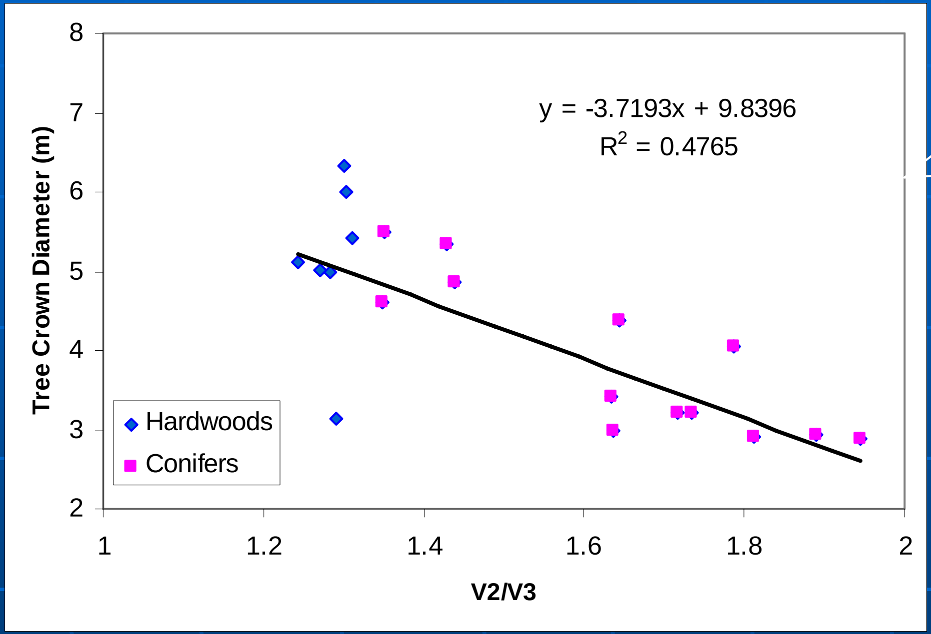



Relationships between LAI and NDVI vs. between LAI and image variance derived from Ikonos image for stands in the Duke Forest area.



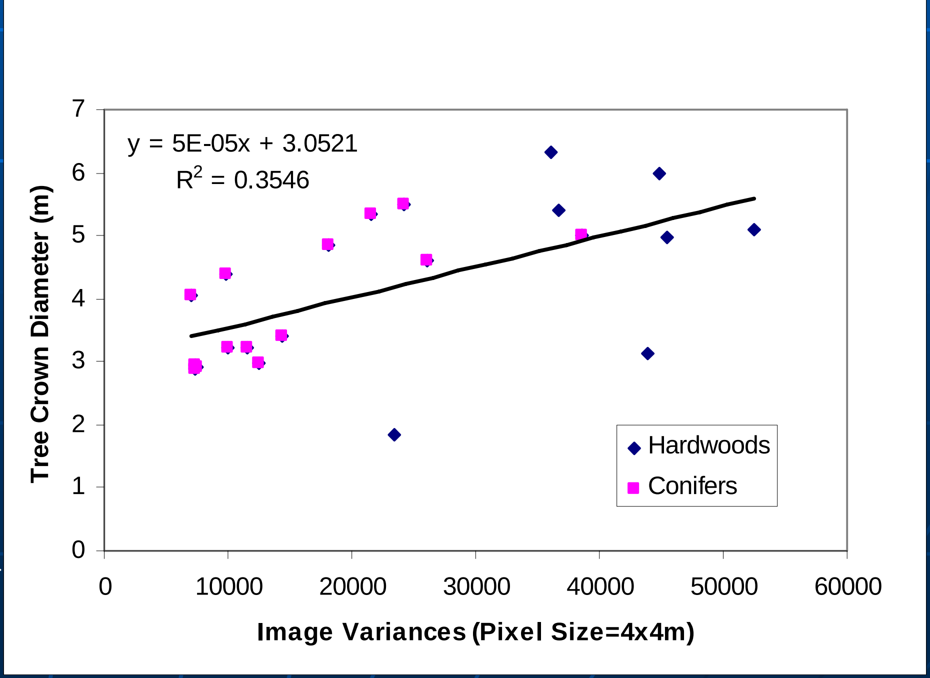

Spatial information is much more useful than traditionally used spectral information in mapping LAI

# Estimating Tree Crown Size from High Spatial Resolution Optical Images

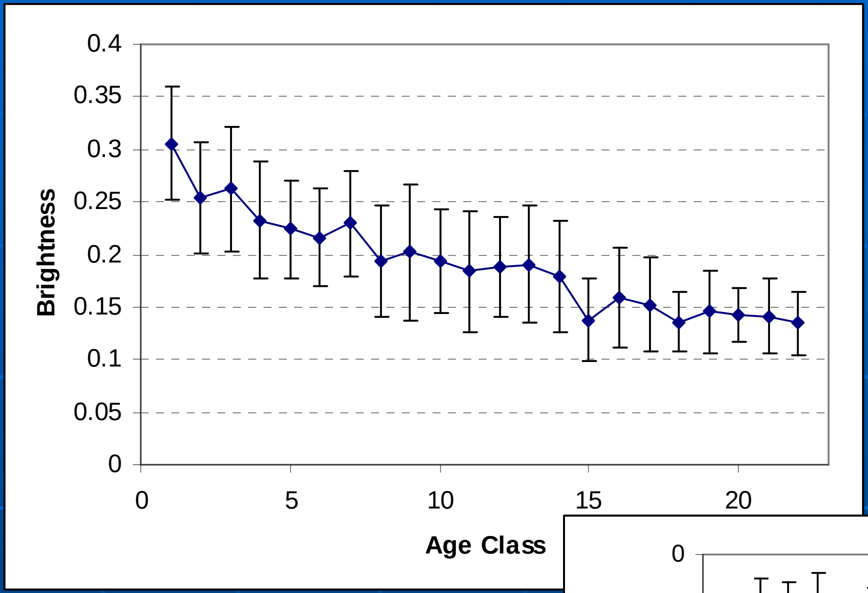


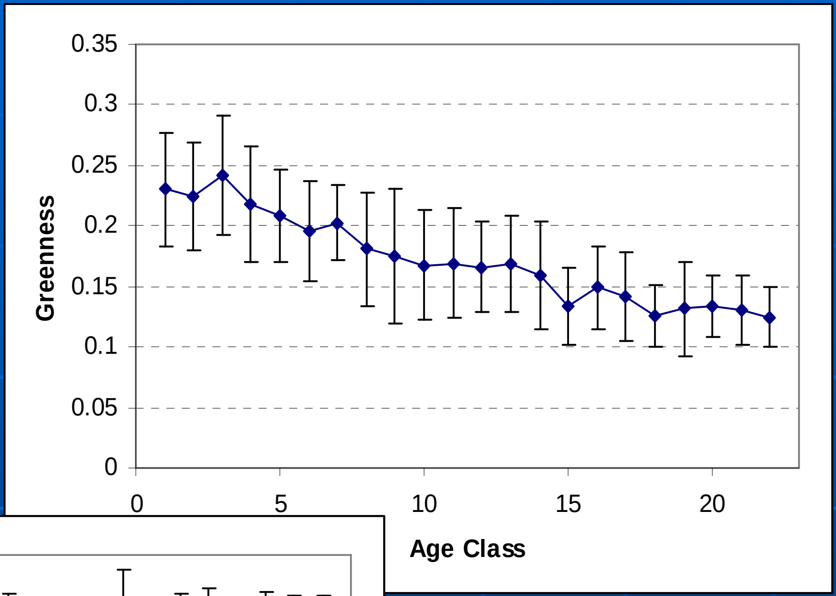

Tree crown size vs. the ratio of image variance of 2x2 m to 3x3 m spatial resolution from Ikonos image.

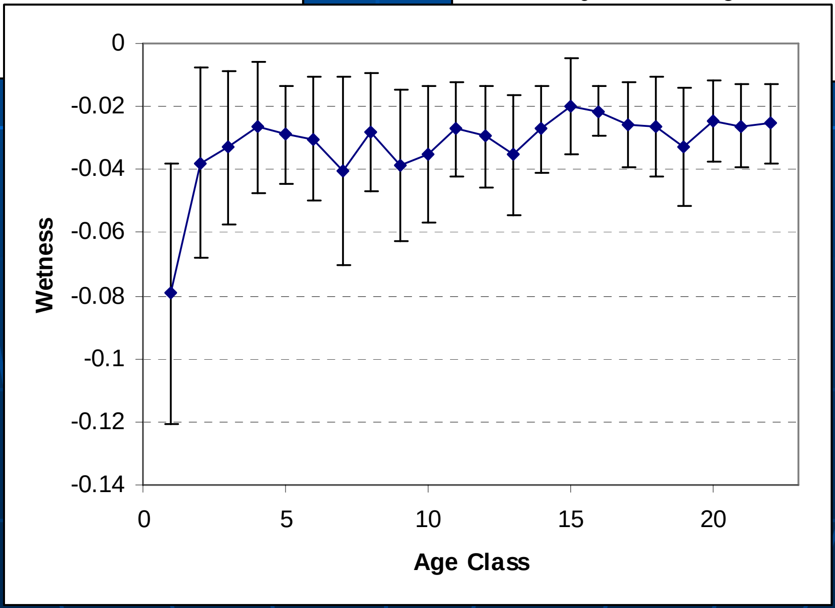
Tree crown size vs. image variance at a single spatial resolution (best fit) from Ikonos image



# Remote Sensing of Forest Successional Stages



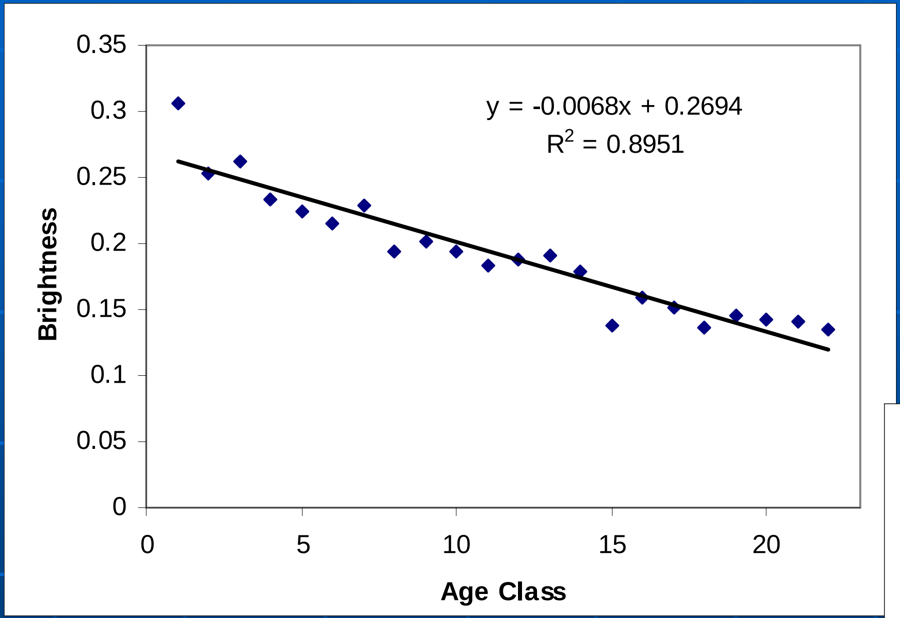



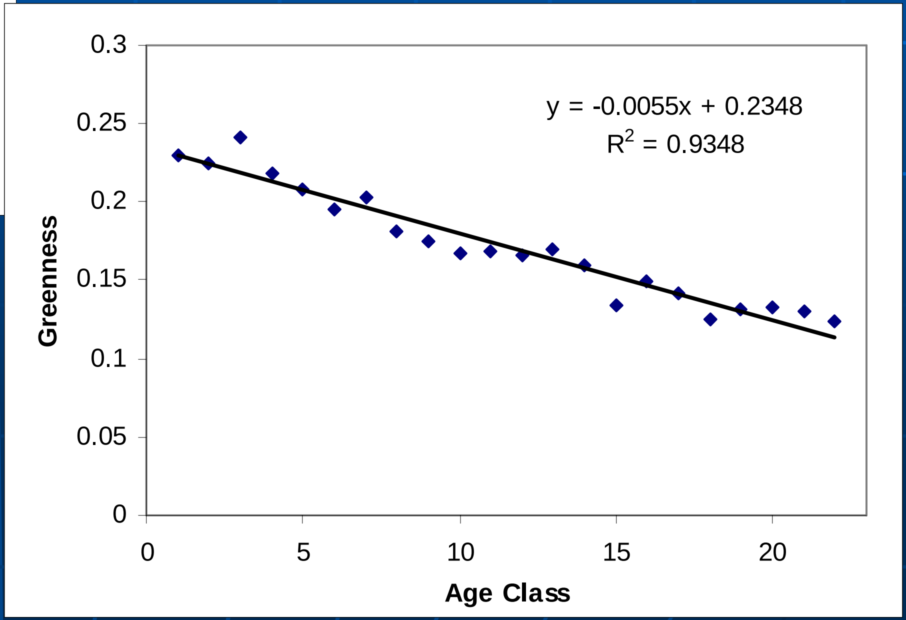




There are a lot of variations in brightness, greenness and wetness of Tasseled Cap transformation of Landsat TM image at a given age class.

1 Age class=10 yeas

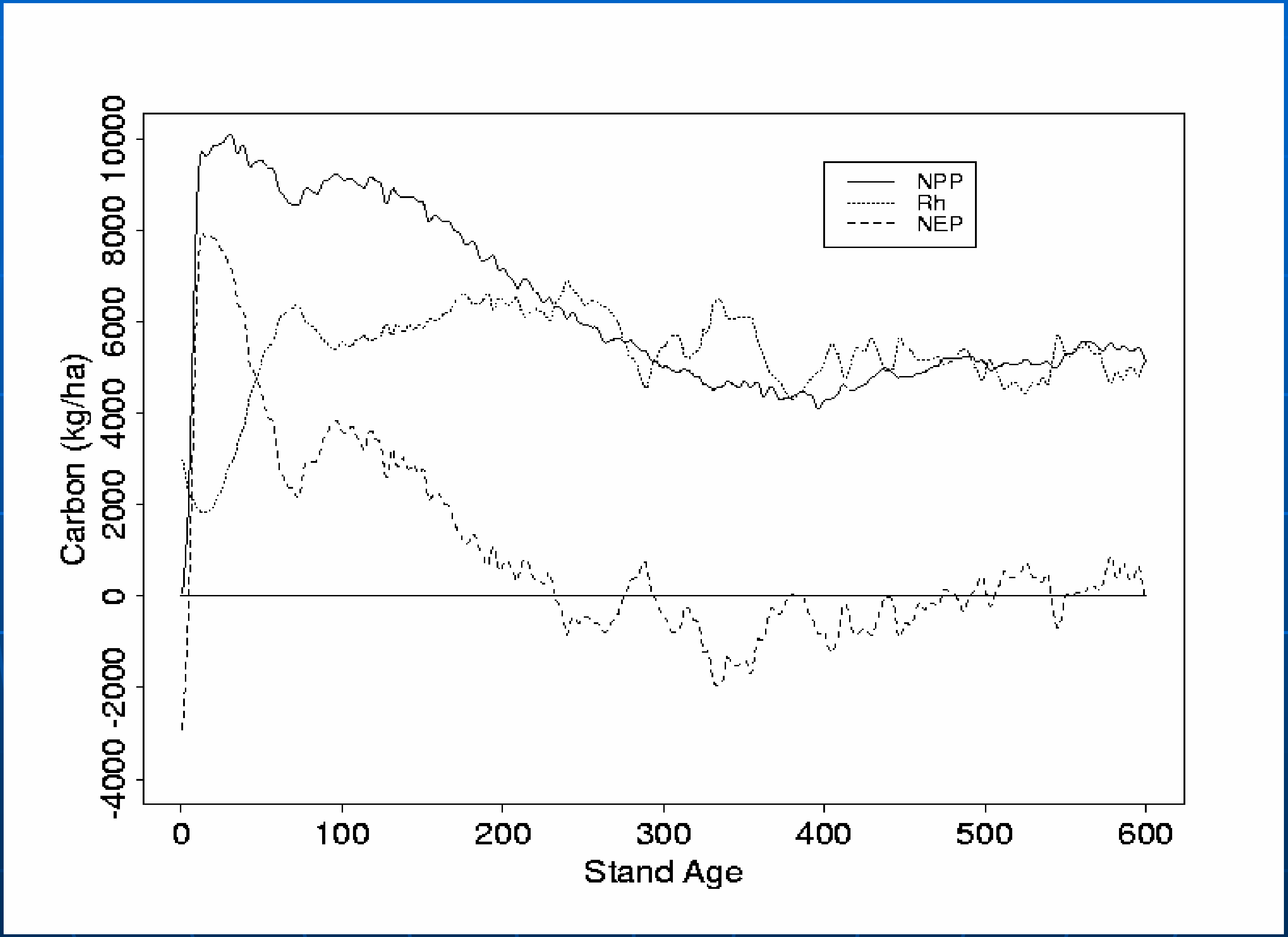
# Remote Sensing of Regional Mean Successional Stages



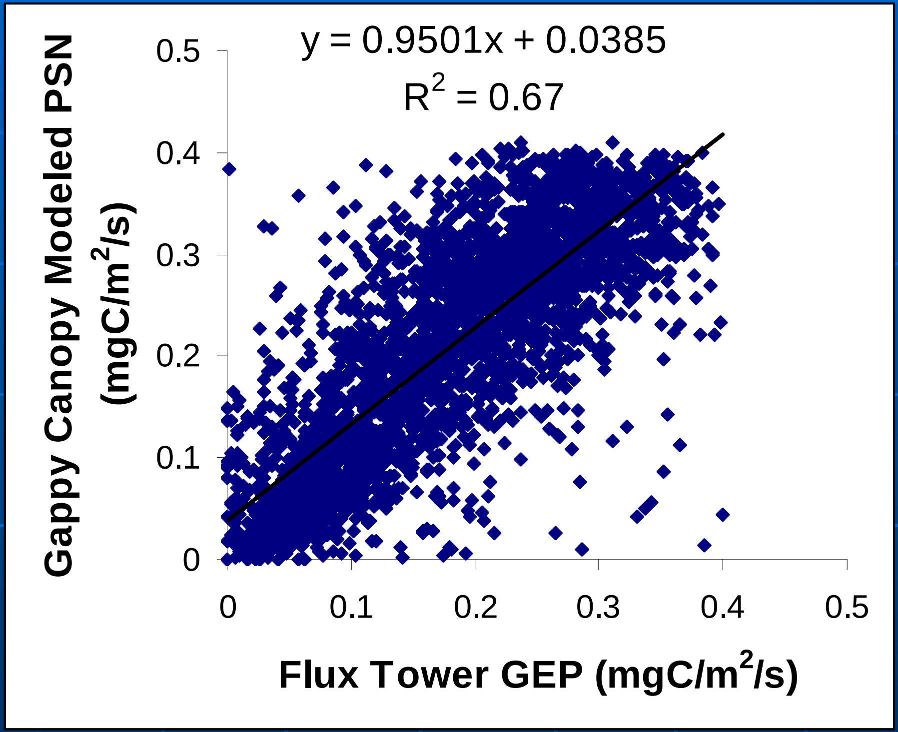

Over a regional scale, brightness, greenness of Tasseled Cap transformation of Landsat TM images can predict the successional stages well.

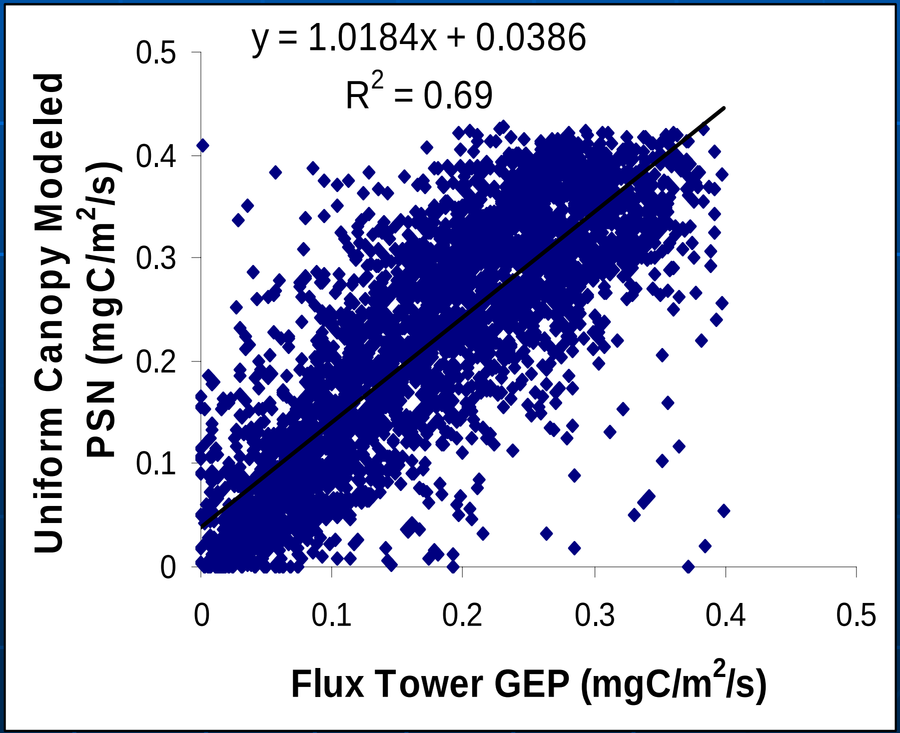
# Successional Stage and Carbon Budget




Forest ecosystem carbon budget strongly depends on successional stage as modeled by IntCarb.

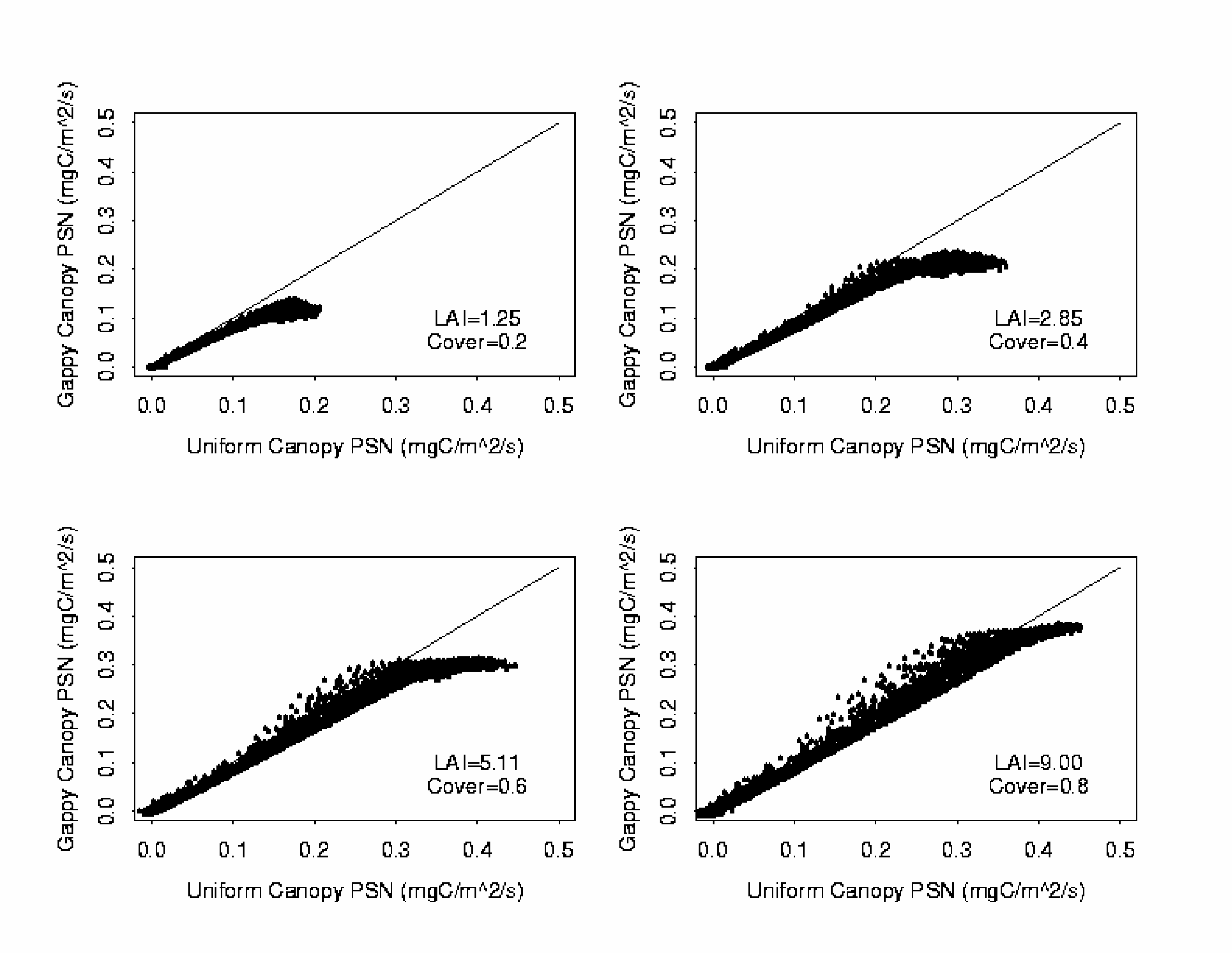
# Impacts of Canopy Structure on Terrestrial Ecosystem Carbon Fluxes



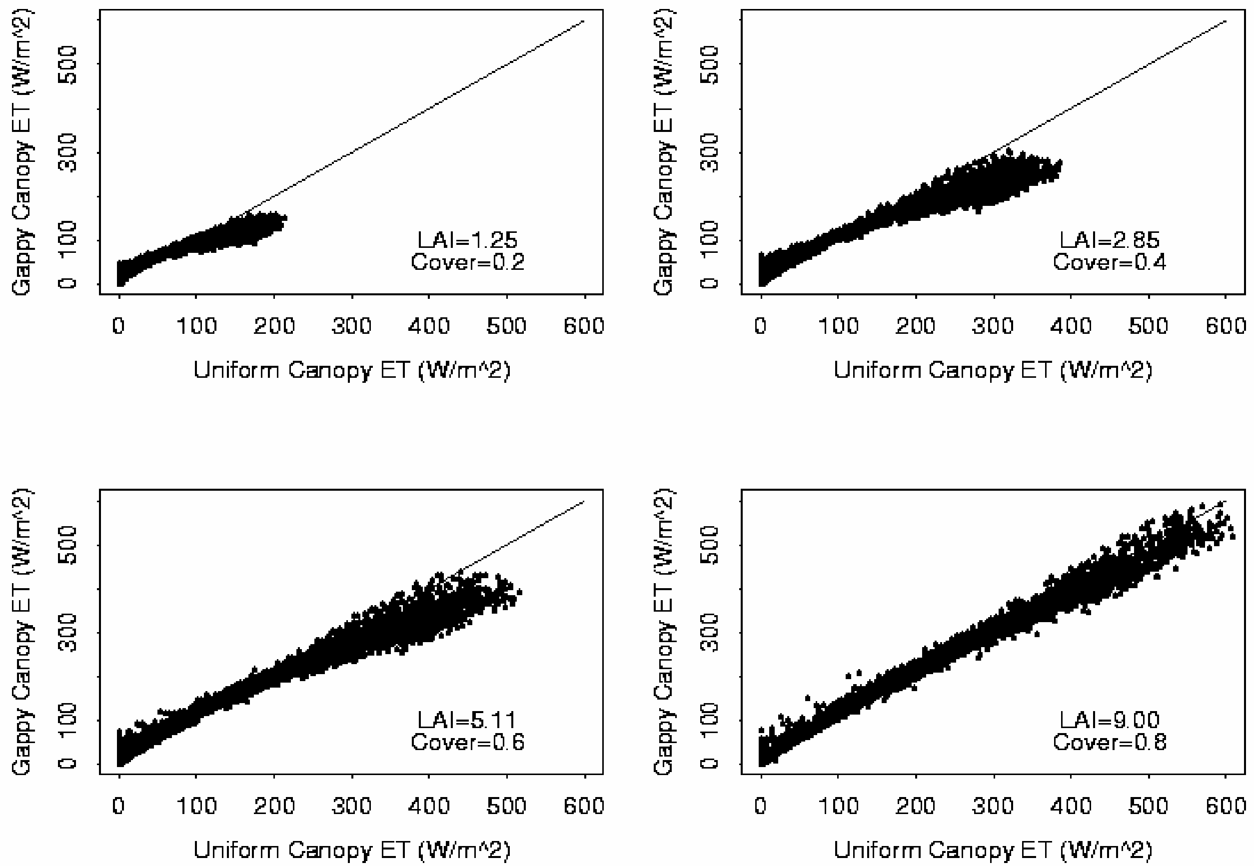

Gappy canopy representation does not make significant different from uniform canopy representation for a closed canopy loblolly pine stand in Duke Forest.

# Canopy Structure and Carbon Assimilation




Sensitivity Analysis: Impacts of canopy structure on carbon assimilation

# Canopy Structure and Evapotranspiration




Sensitivity Analysis: Impacts of canopy structure on evapotranspiration

# Net Primary Production

- Modeling light absorption over the landscape: landscape clumping index

- Modeling Regional Carbon Assimilation

$$NPP = \varepsilon \times APAR \times f(E)$$

$$APAR = IPAR \times (1.0 - \exp(-K\Omega_R L))$$

$$\varepsilon = (A_c \varepsilon_c + A_d \varepsilon_d + A_h \varepsilon_h) / A$$

# More Expected Results

- Historical Land-Cover/Land-Use Change maps for Piedmont North Carolina
- Algorithm to map leaf clumping index using directional information of remotely sensed data
- Understanding of the impact of spatial vegetation structure on terrestrial ecosystem carbon budget.
- Quantitative understanding of carbon fluxes over the landscape as a result of LCLUC