Preliminary results from Tier III studies

et al. + Rodney Will

Science Presentation

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USDA United States Department of Agriculture National Institute of Food and Agriculture

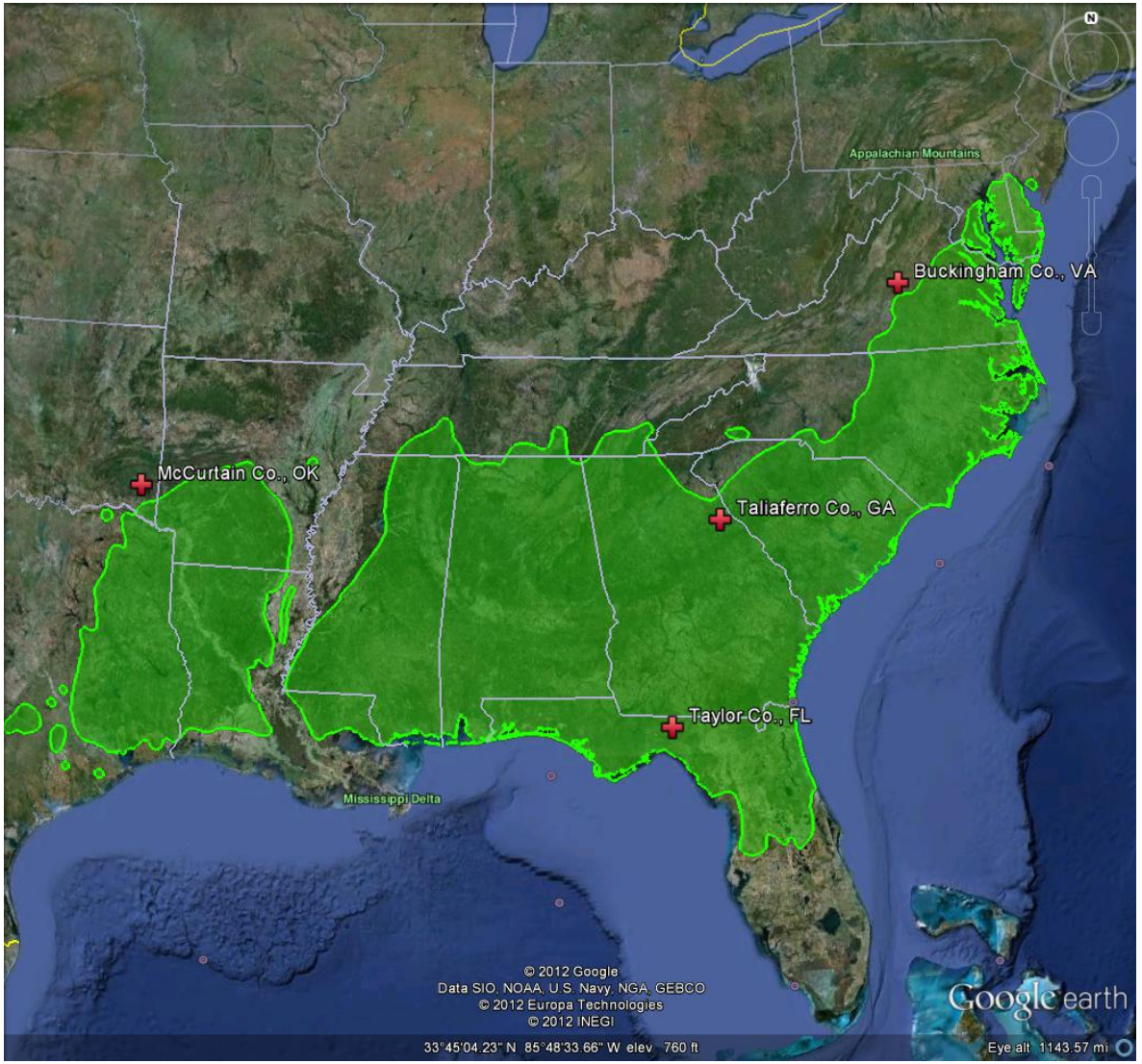
Aim 1

Tier I – existing growth & yield monitoring sites measure regional variation in productivity (500 existing sites)

Tier II - existing silvicultural experiments measure effects of management factors on carbon, nutrient, and water cycles (~140 existing sites)

Tier III – "rainfall-exclusion" treatments in factorial design with fertilization to measure response to changes in water and nutrient availability (4 new sites)

Tier III Locations



Tier III Descriptions

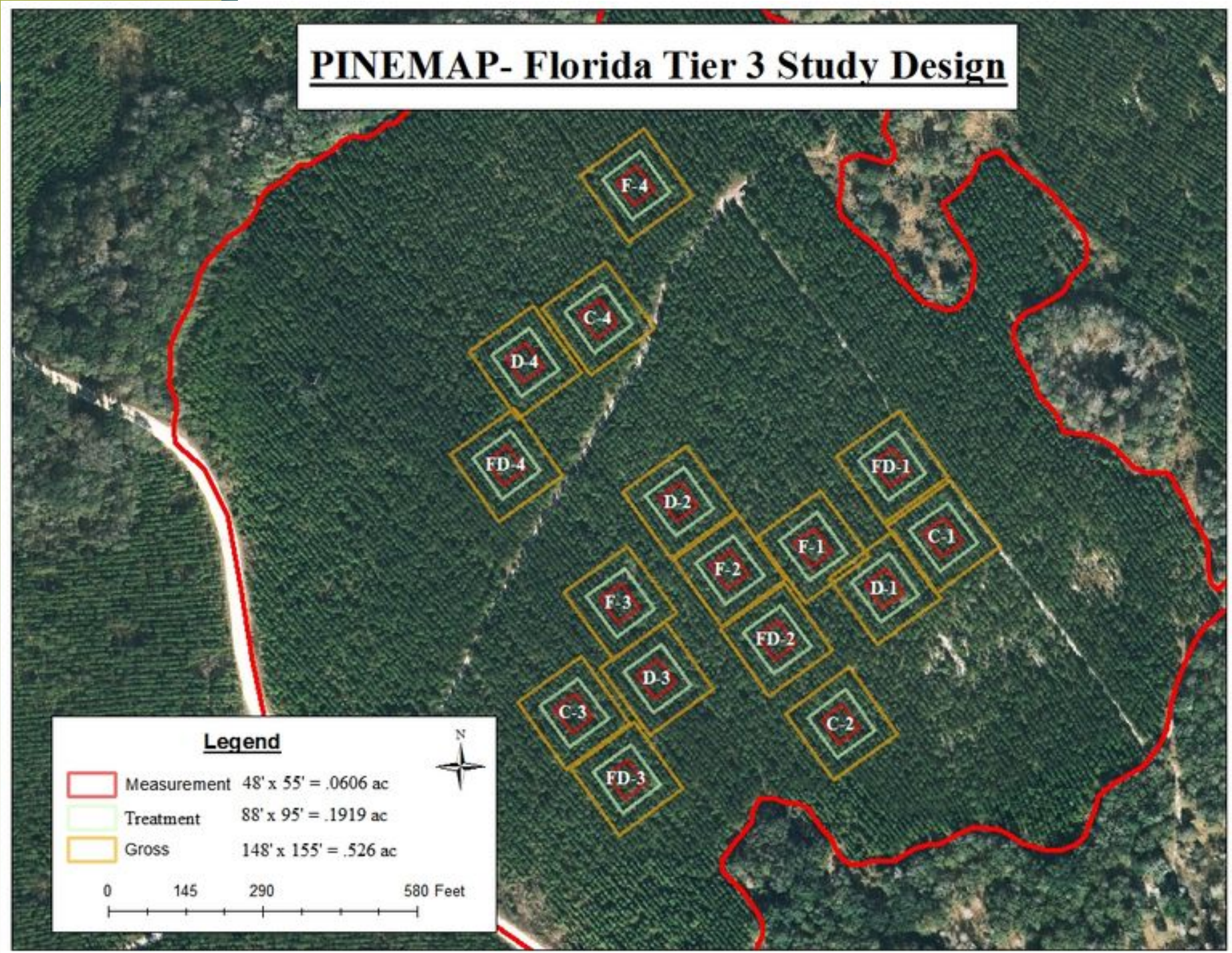
- Stands at or near crown closure
- Orchard mix of genetics appropriate for region
- Planting year
  - Oklahoma, 2008
  - Virginia, 2003
  - Georgia, 2006
  - Florida, 2004
- N = 4 at each site
- Gross plot size ~ 0.40 acres,
- Measurement plot size ~ 0.10 acres

Fertilizer inputs

- 200 lbs/ac N
  - 386 lbs/ac urea
  - 125 lbs/ac DAP
- 25lbs/ac P
  - 125 lbs/ac DAP
- 50 lbs/ac K
- Micornutrients (full suite)
  - 1 lb/ac elemental B

Rainfall reduction

- Reduce throughfall by 30%
- Avoid excessive trough widths
- Move excess water away off plots


PINEMAP- Florida Tier 3 Study Design
F-4
C-4
D-4
FD-4
D-2
F-2
F-3
D-3
C-3
FD-3
FD-2
F-1
D-1
FD-1
C-1
C-2
Legend
Measurement 48' x 55' = .0606 ac
Treatment 88' x 95' = .1919 ac
Gross 148' x 155' = .526 ac
N
0
145
290
580 Feet

Oklahoma Tier III from Google Earth

Tier III Measurements

- Tree and stand growth
  - Annual measurements
  - Dendrometer bands
- Stand carbon
- Soil carbon
- Soil CO_2 efflux
  - Treatment effects
  - Separating Rh and Ra
- Tree water use
- Canopy size and light interception
- Leaf-level physiology

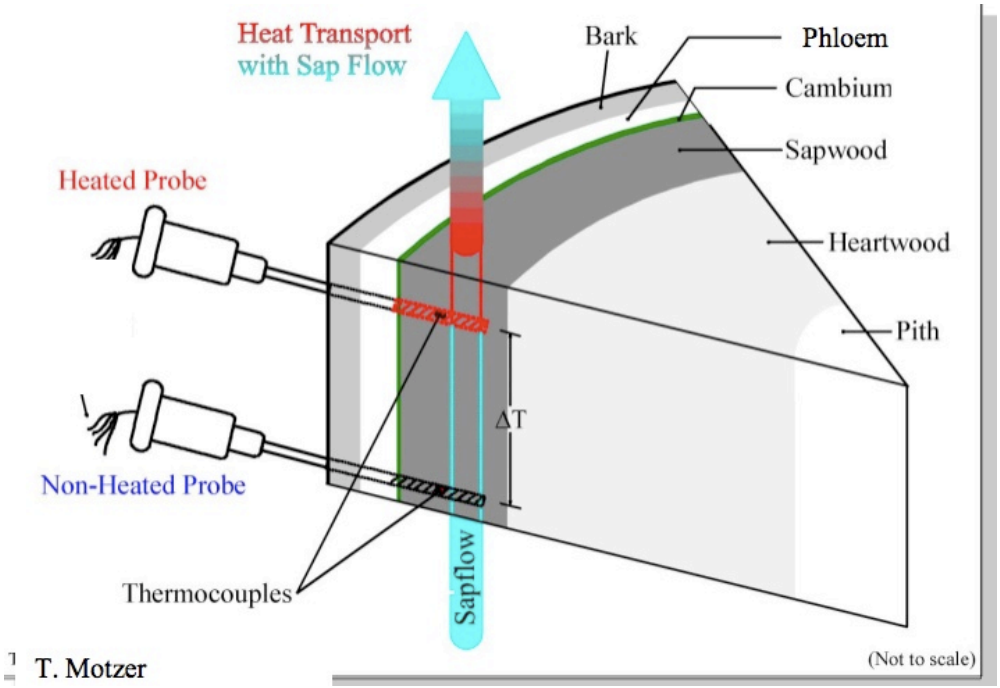
Tier III Research – this presentation

- Tree and stand water use
- Separating Rh and Ra
- Fertilizer uptake efficiency

Sap flux to measure tree water use

Objective: measure how the treatments affect tree and stand water use

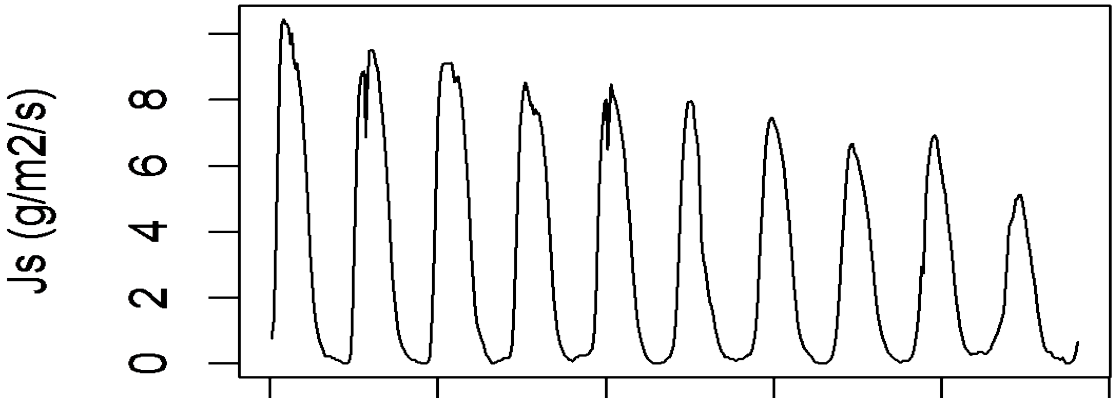
Sap flux to measure tree water use

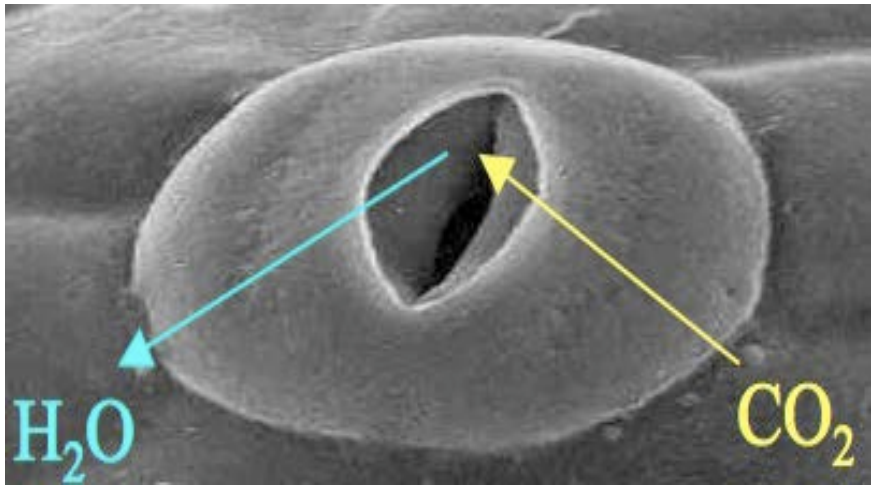


- Estimates water transport in outer sapwood of tree from dissipation of heat.
- Sensor is 20 mm in length, installed in outermost sapwood.
- Five sets of probes per plot

Slide courtesy of Ward et al.

Sap Flux Density (J_S) Data





Slide courtesy of Ward et al.

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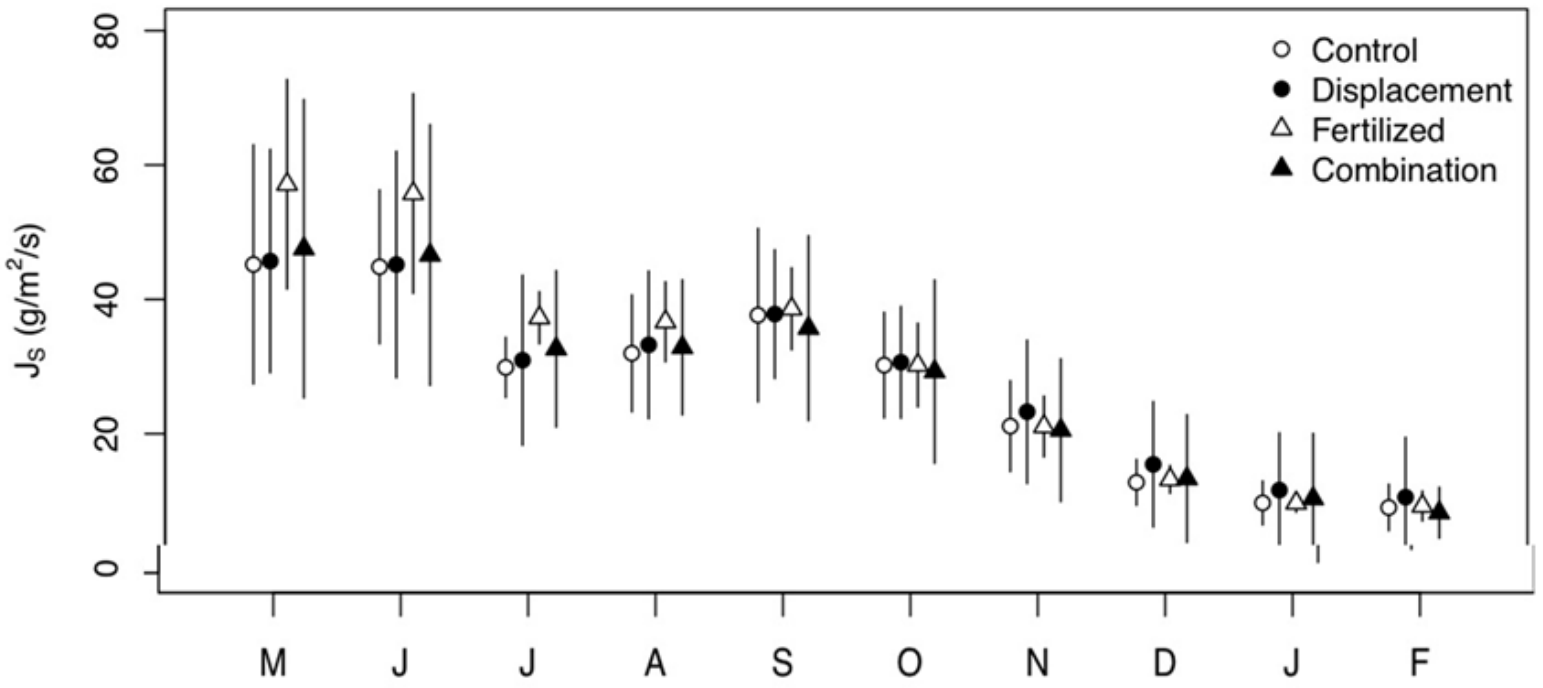
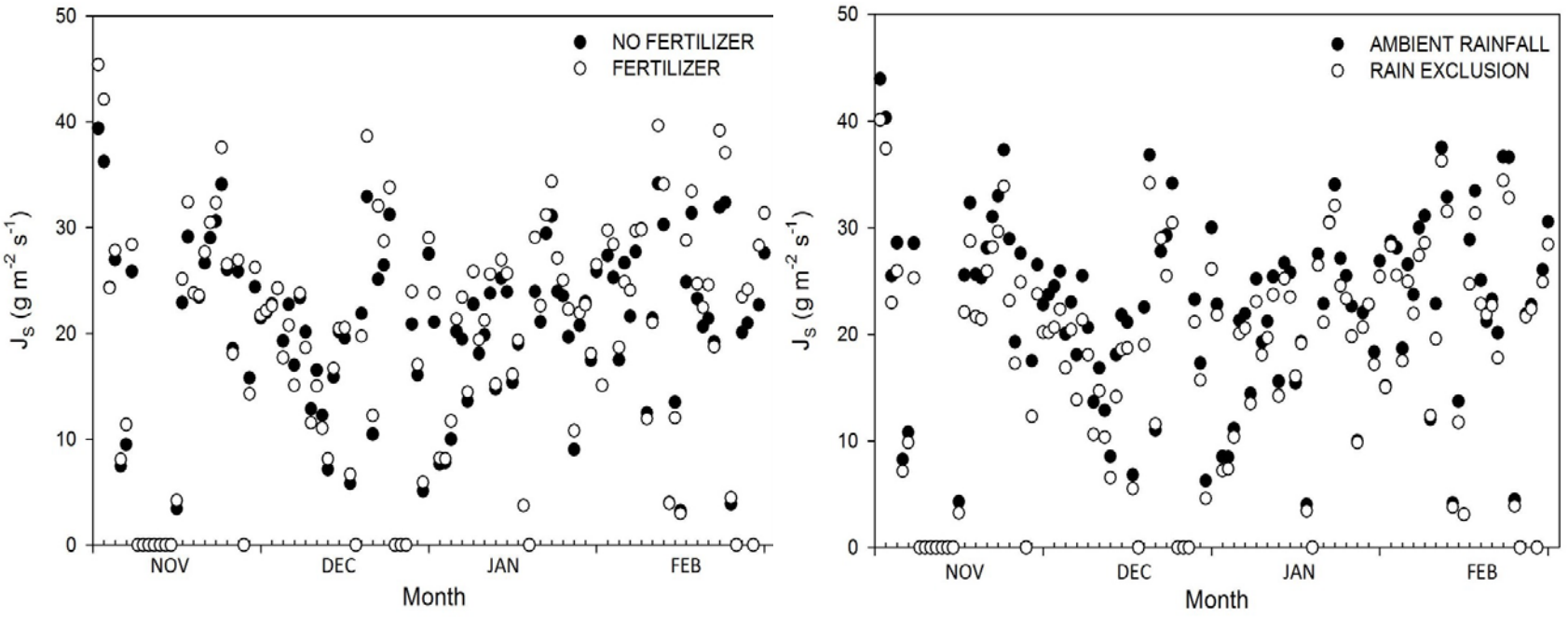


Greater sap flux density with fertilization at the Virginia site

Data courtesy of Ward et al.

Sap Flux Density (J_S) Data



Greater sap flux density with fertilization and ambient rainfall at the Georgia site

Data from courtesy of Lisa Samuelson and Stan Bartkowiak

Separating autotrophic and heterotrophic respiration

Objective

Provide a partitioning coefficients of R_S into R_H and R_A in order to quantify C storage in managed loblolly pine forests

Slide courtesy of Heim et al.

How is NEP Defined?

$$NEP = GPP - R_{total}$$

NPP estimates are being used not GPP

$$GPP = NPP + R_{above} + R_{auto}$$

$$NEP = NPP + R_{above} + R_{auto} - R_{total}$$

$$NEP = NPP + \cancel{R_{above}} + \cancel{R_{auto}} - \cancel{R_{above}} - \cancel{R_{auto}} - R_{hetero}$$

$$\boxed{NEP = NPP - R_{hetero}}$$

Slide courtesy of Heim et al.

R_{hetero} Respiration from microbes

Separating autotrophic and heterotrophic respiration

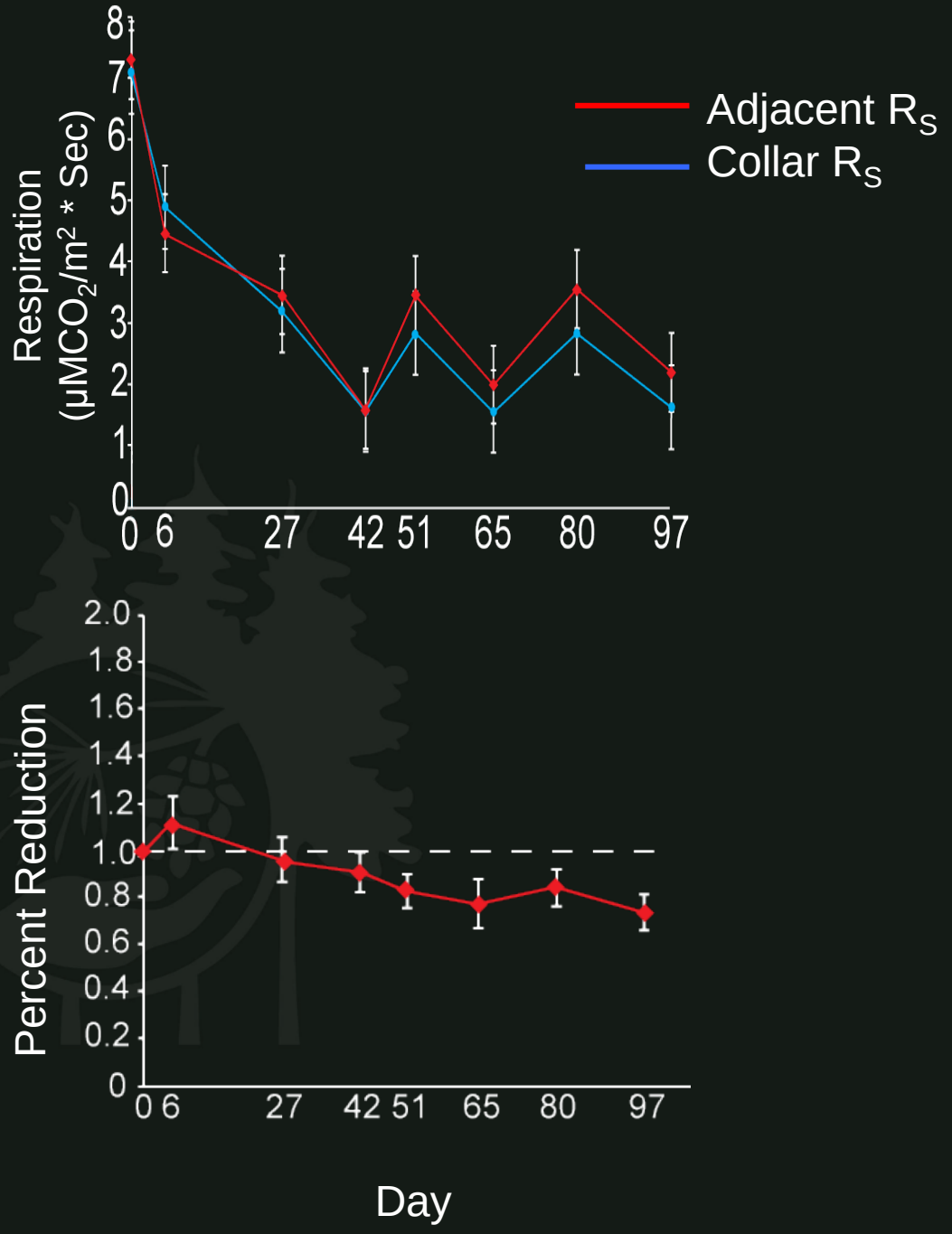
- Root severing collars driven flush to the ground
  - In order to drive R_A to zero, where $R_S=R_H$
- 3 subsamples per plot
- At each subsample efflux was measured in and adjacent to the collar using a LiCor 6200
- Along with soil moisture and temperature
- Measurements were taken every 2 weeks from beginning of June to beginning of September

Slide courtesy of Heim et al.

Slide courtesy of Heim et al.

Percent Reduction of R_S within in Collar

- Over time autotrophic respiration (R_A) ceases
  - loss of the C supply due root severing
- Maximum reduction of R_A occurs approximately 65 days after the root collars have been installed
- Percent decrease in the autotrophic component across all treatments ranged from 20% - 40%
- R_H accounts for 60 – 80% of the total respiration
- Across all plots R_H is 74% of total R_S



Fertilizer N uptake efficiency

Thomas Fox, Brian Strahm, Jay Raymond

Virginia Tech

Fertilizer N uptake efficiency

- **Nitrogen limits productivity**
- **Fertilization with urea (N)**
- **Fertilizer N uptake efficiency generally low**
- **Volatilization losses can be substantial**
- **Better understand of the fate of applied fertilizer N to improve management**

Questions: Fertilizer N uptake efficiency

- **N uptake efficiency of urea vs. enhanced efficiency fertilizers (EEF's)?**

- **Differences between winter-summer fertilization?**

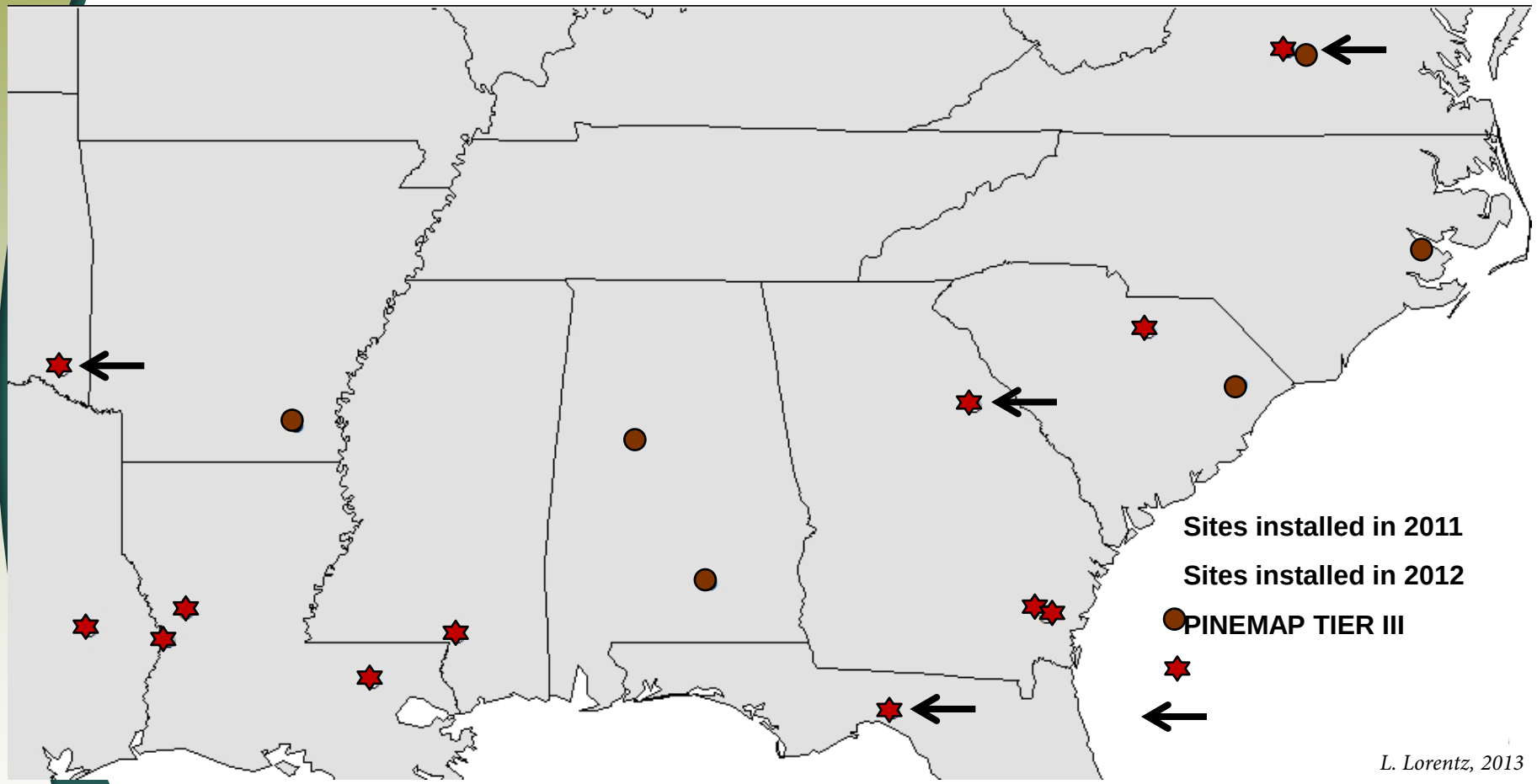
- **How much fertilizer N is lost via volatilization and leaching?**

- **How much fertilizer is retained by the understory?**
  - VA and GA TIER III PINEMAP

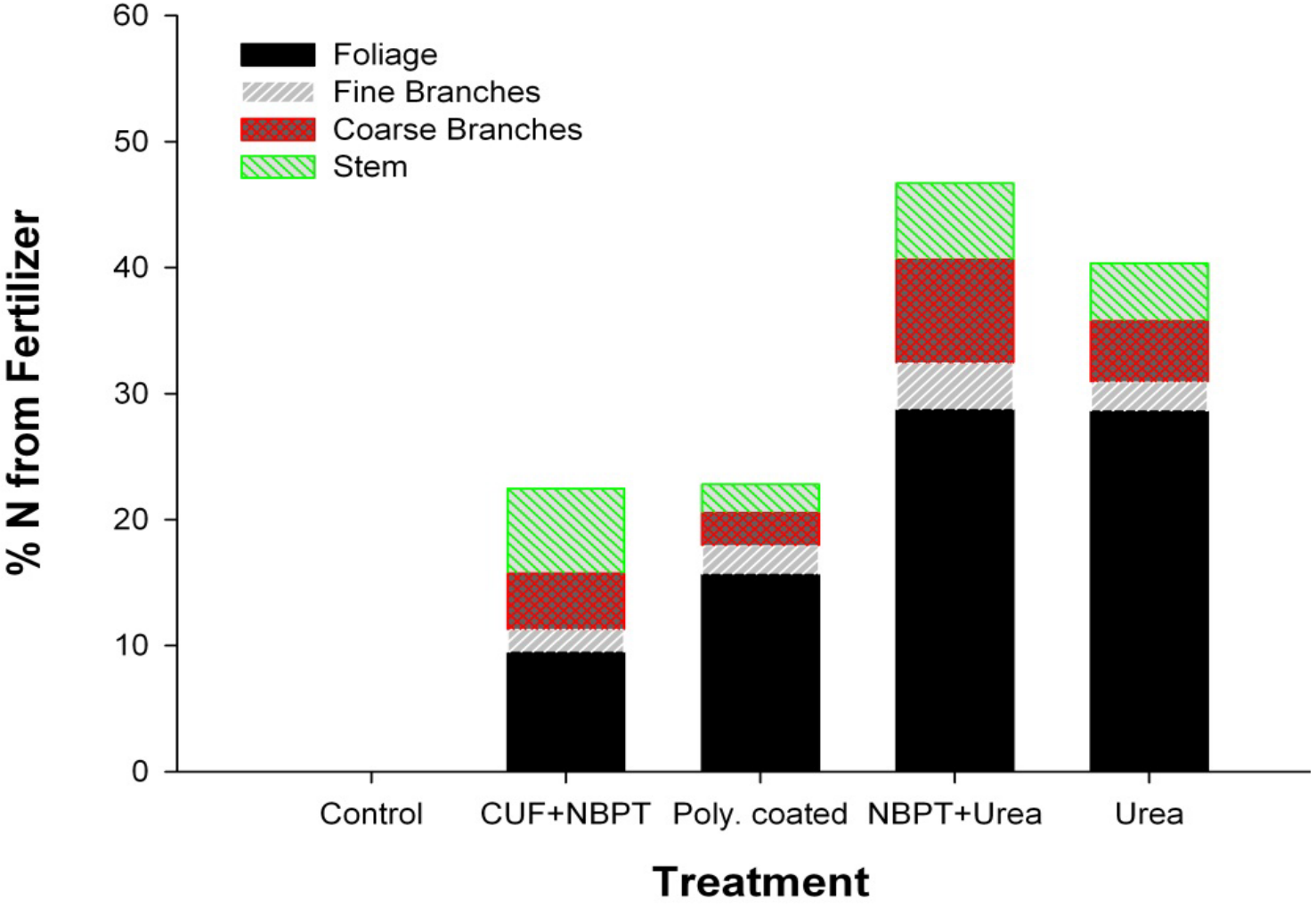
Experimental Overview

- **Use of the stable isotope ^{15}N (0.5 AP, ~370 ‰ ^{15}N)**
- **Site Number:** 18
- **Experimental Design:** RCB
- **Experimental & Observational Units:** 5
  - 100 m^2 circular plots
  - 1 harvested tree per plot
- **Treatments:** 5
  - Control, polymer coated urea, CUF+NBPT, NBPT+Urea, Urea
- **Application:** 224 kg N ha^{-1} and 28 kg P ha^{-1}
- **Sample system components, calculate ^{15}N recovered**

Site Locations



Preliminary ^{15}N Recovery - VA
Above Ground Biomass – Year 1 - Winter



Stated Outcomes of PINEMAP

- Increase carbon sequestration 15% above present by 2030
- Implement 25% increased efficiency of applied fertilizer N

- *Tier III research is working towards those outcomes!*