All Team PINEMAP meeting

April 21, 2016

Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP) is a Coordinated Agricultural Project funded by the USDA National Institute of Food and Agriculture, Award #2011-68002-30185

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

Upcoming dates

- Executive committee meeting 4/22 10:30am ET
- Modeling summits 4/25 3pm ET
- Annual meeting in Athens: Tuesday 5/24 am – Thursday 5/26 lunchtime

Meeting deadlines

- Meeting May 24-26 (Tuesday am – Thursday lunchtime)
- Annual meeting registration deadline has passed (extenuating circumstances? Please email Grace ASAP)
- Poster registration through 5/15. Link on intranet landing page
- Hotel block drops 4/25! Fewer rooms reserved for 5/25, so please reserve early if possible

Final meeting preparation

- If you are a 1st or 2nd order integrative paper author, come prepared to participate in:
  - Presentations of the 1st set of integrative papers,
  - Workshop sessions to develop 2nd level integrative papers
- Questions? Contact Grace or Tim

Overview of Tier II data and analysis

Jason G. Vogel with contributions from many, many others

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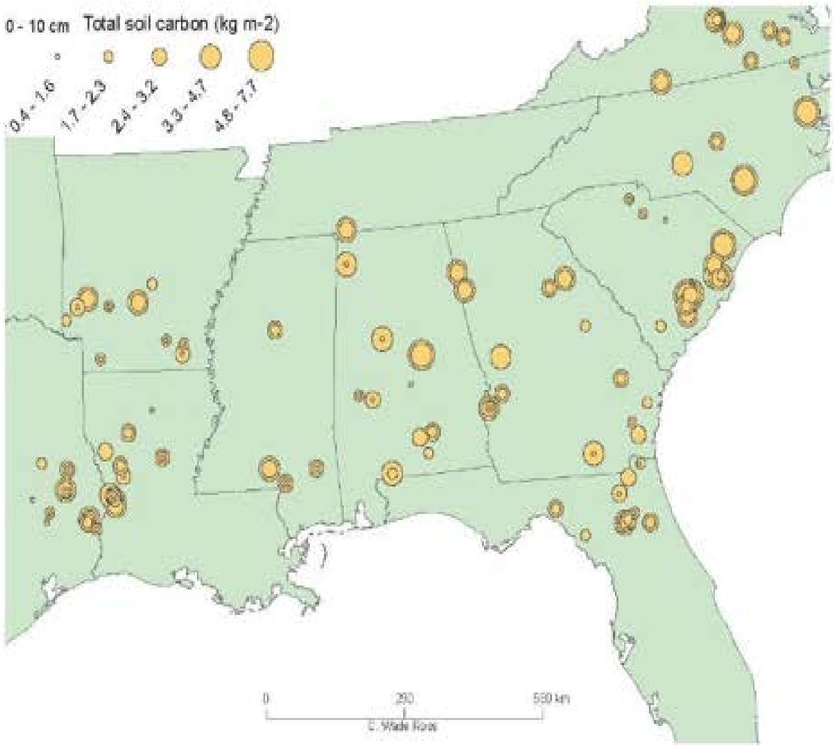
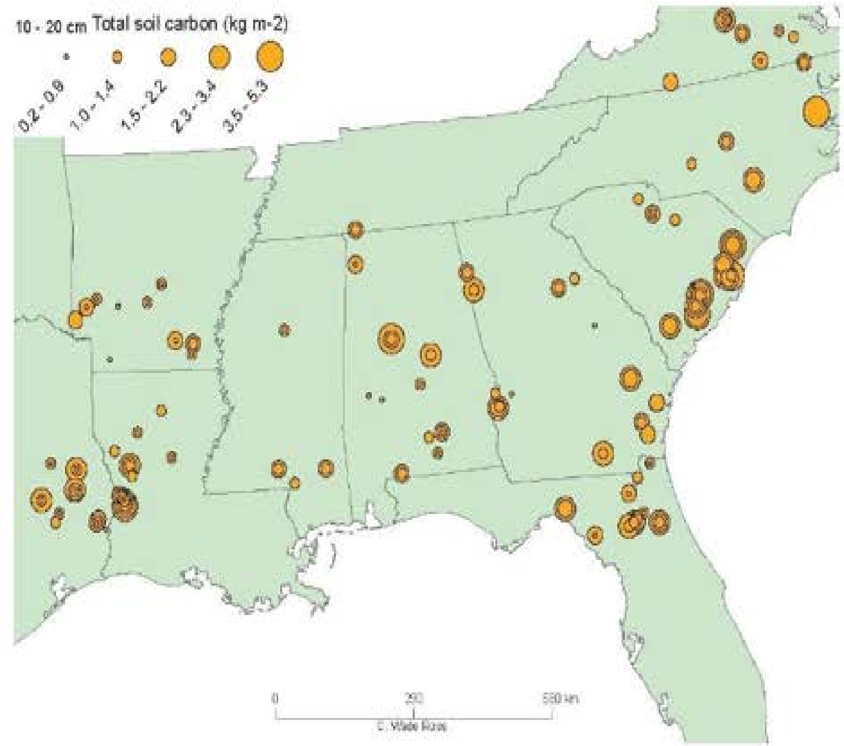
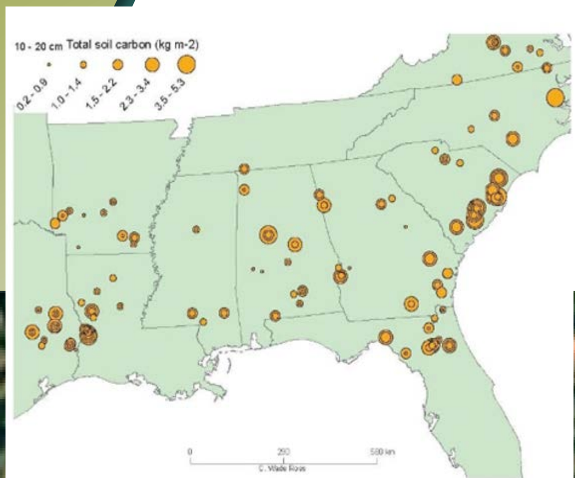
Tier II site distribution and Soil Carbon





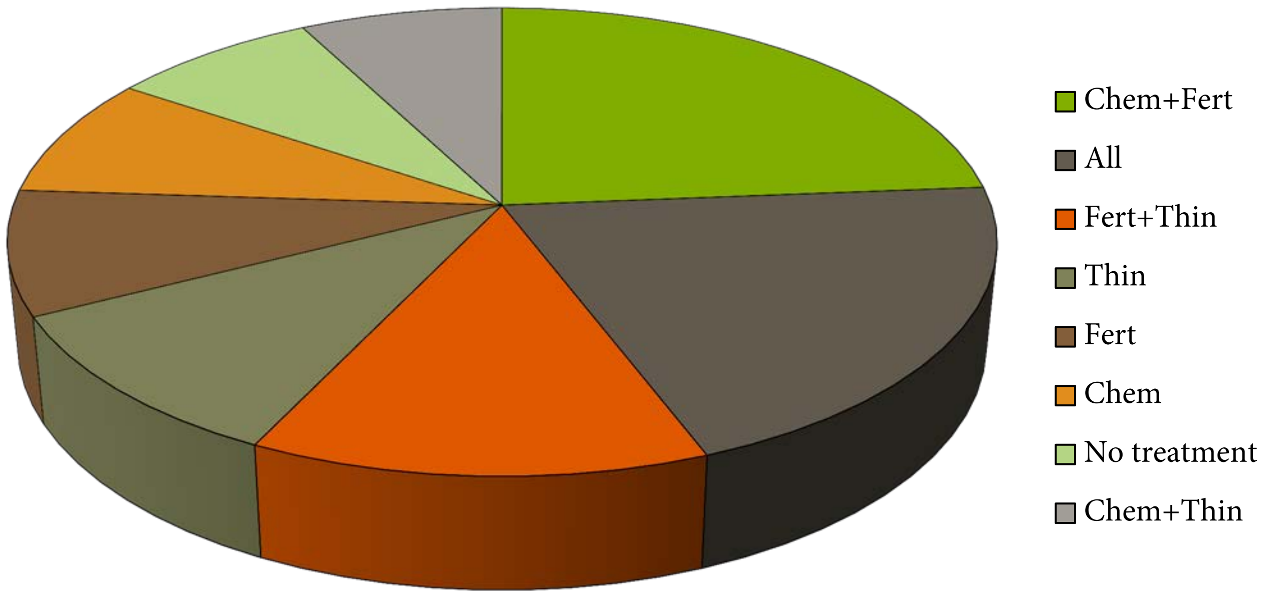
Wade Ross

One replicate plot per treatment type



Silvicultural Treatments in Network

Silvicultural treatments among 332 treatment combinations: Chemical competition control, Thinning, Fertilization

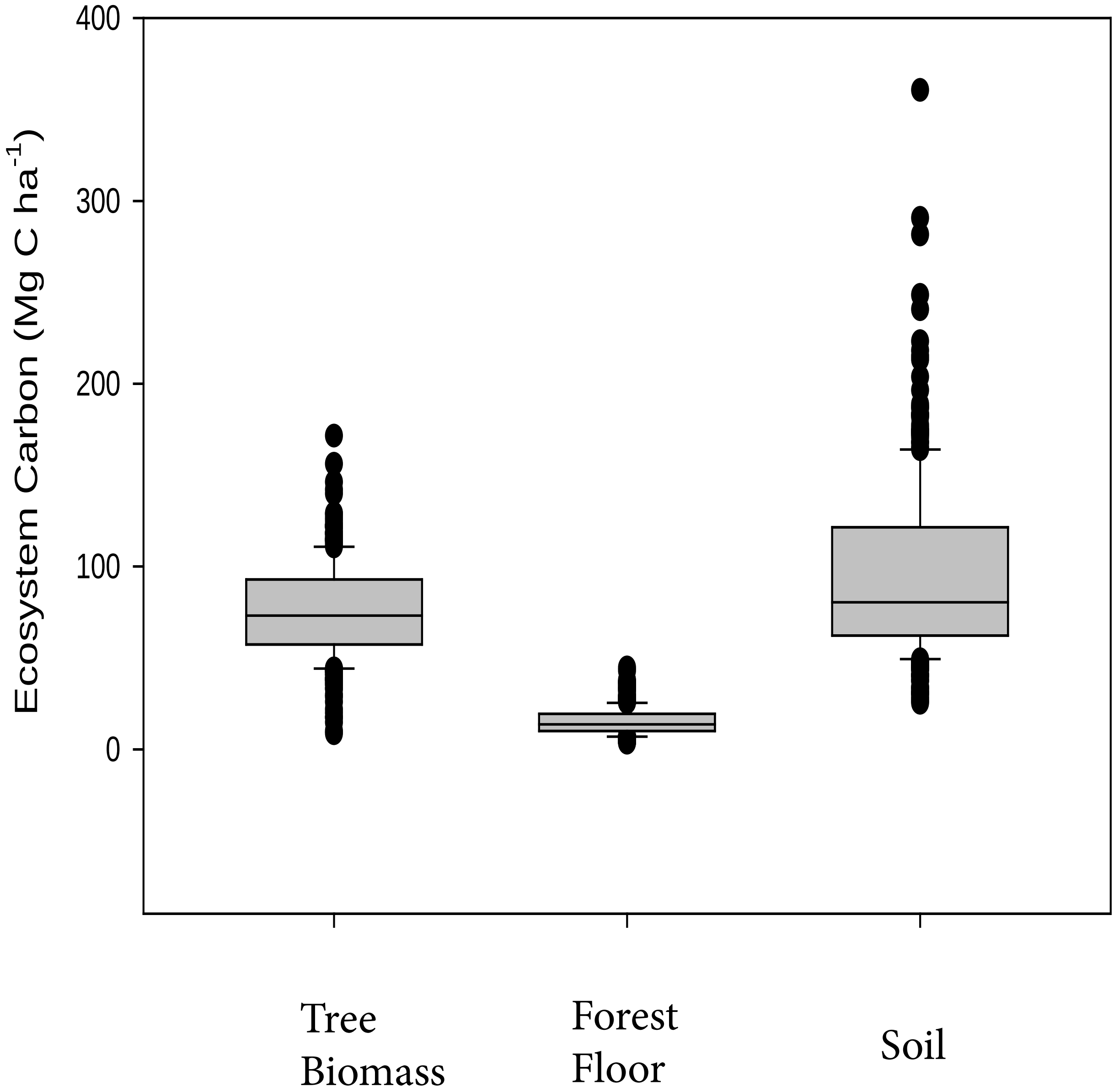


Data Summary

	Mean	Median	Range
Stand Density Index	744	757	0-1283
Age (years)	16	17	4-29
Tree biomass C	76	73	9-171
Forest Floor C (Mg C ha^{-1})	15	14	2-41
Understory C (Mg C ha^{-1})	0.73	0.43	0-18.3

Fertilizer Treatment Breakdown

Fertilization type (kg ha^{-1})	Mean	Median	Max	No. of Treatments	Treatment (%)
N	277	200	1492	206	62
P	51	28	198	207	63
K	18	<1	183	69	21
B	0.58	<1	86	55	17
Ca	4	<1	106	27	8
S	4	<1	165	16	5
Mg	2	<1	4	14	4
Cu	0.20	<1	11	13	4
Mn	0.63	<1	55	11	3
Zn	0.09	<1	3.9	9	3
Fe	0.90	<1	38	8	2



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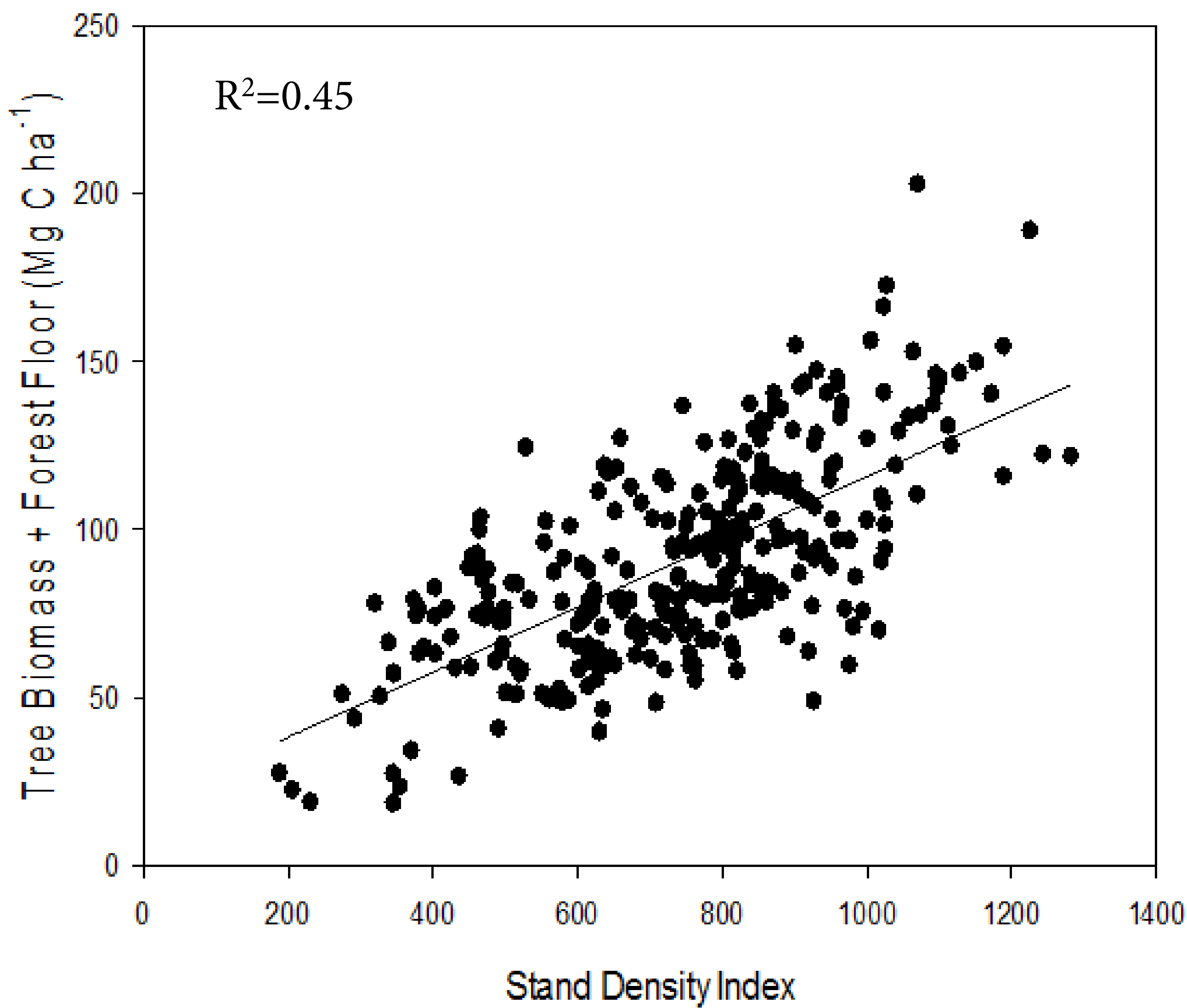
Dependent variables

- Tree Biomass Increment
- (Aboveground biomass+Coarse Roots)/Stand age

- Forest C increment= (Tree Biomass + Forest Floor + Understory + Fine Roots (<2 mm) + Coarse Woody Debris)/Stand Age

Stand Density Index vs. Tree Biomass + Forest Floor Carbon



Analysis Approach

$$Y = a_0 + SO \times SDC \times TN \times TP + SDI \times Th \times UB \times SA + Pcp \times Temp \times rH + \epsilon$$

Managed Nutrition ($SO \times SDC \times TN \times TP$)
Soil Order=Order (class variable)
Soil Drainage Class=SDC (class variable)
1=Very Well drained
2=Moderately Well drained
3=Somewhat poor to Very Poorly
Total Nitrogen Added=TN
Total Phosphorus Added=TP

Managed Vegetation ($SDI \times Th \times UB \times SA$)
Understory Biomass=UB
Thinning=T (1,0) (class variable)
Stand Density Index=SDI
Stand Age=SA (removed if looking at increment)

Unmanaged Site Characteristics ($Pcp \times Temp \times rH$)

Precipitation=Pcp

Max. Temperature=Temp

Min. Relative humidity=rH

Analysis approach

- GLMselect procedure in SAS v.9.1
  - General linear model selection
  - Classification variables (soil order, drainage class) are split and enter model independently of others within a group
  - Creates model from training data and then splits this main data and cross validates parameter estimates with subset of data.
- Examined multicollinearity using variable inflation factor
- Graphing of relationships, correlation analyses, influential points

Variables dropped because……

High collinearity as indexed with variable inflation factor (VIF) or low explanatory power…..

- Average Solar Radiation
- Average specific humidity and relative humidity maximum
- Minimum average temperature
- Treatments with N>1250 kg ha^{-1}. This is about 12 plots and reduces the VIF for N to less than 5.

Variables dropped because

Of incomplete information…

- Chemical control (understory biomass used as a stand in)
- Site preparation information

….too many possibilities (this needs more work)

- Timing of nutrient application (just cumulative amounts for N and P)

….Poor data coverage

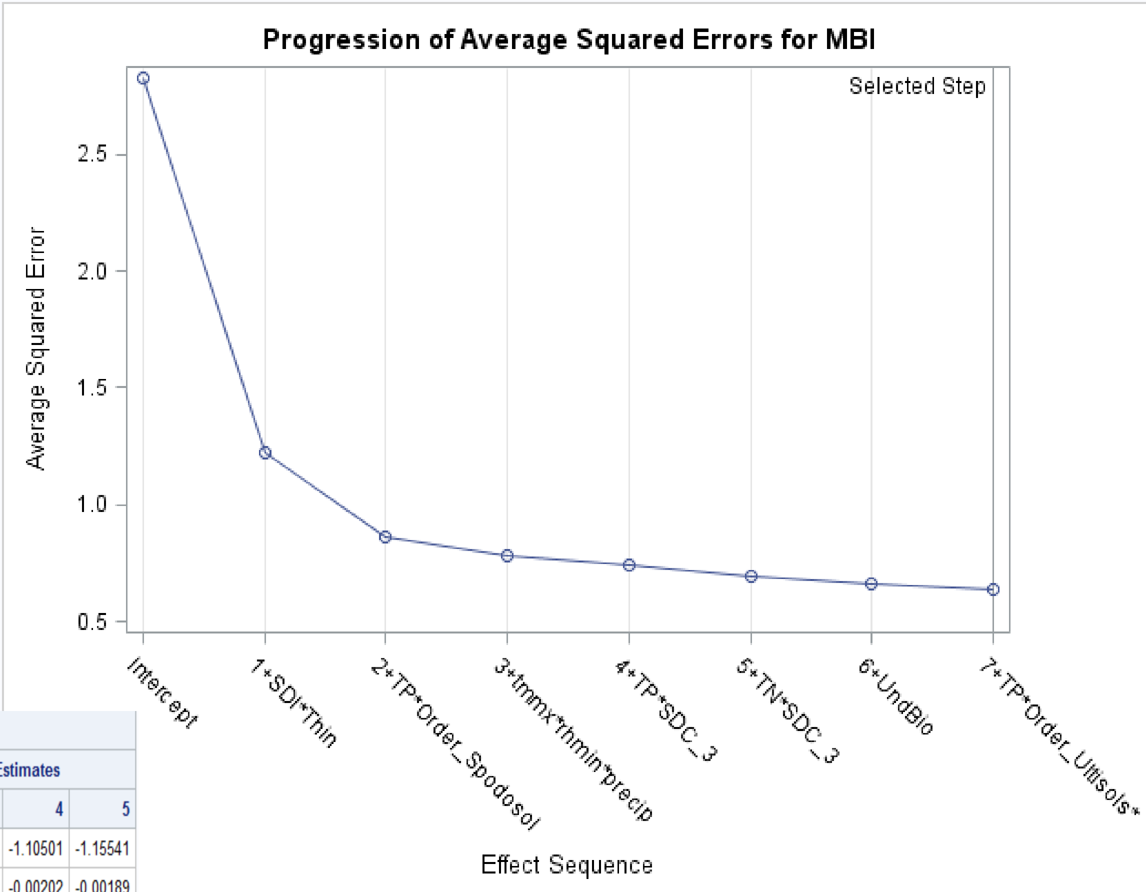
- Infrequent elements (e.g. B, K, Ca, micronutrients)

Nitrogen and Phosphorus

- 63% of treatments had N and P added.
- 8 treatments had only P and 1 treatment only N
- There are no comparisons for N and P only treatments
- Correlation between N and P application ($r=0.80$, $p<0.01$)

Stand biomass increment

Root MSE	0.81058
Dependent Mean	4.65778
R-Square	0.7748
Adj R-Sq	0.7683
AIC	178.47569
AICC	179.26706
BIC	-112.07002
C(p)	44.87070
PRESS	201.06184
SBC	-79.52647
ASE	0.63658
CV PRESS	201.51115

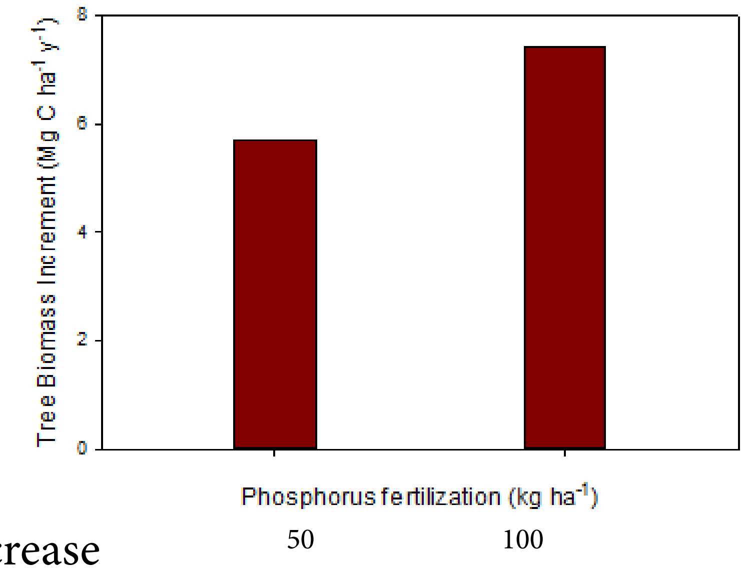


Parameter Estimates

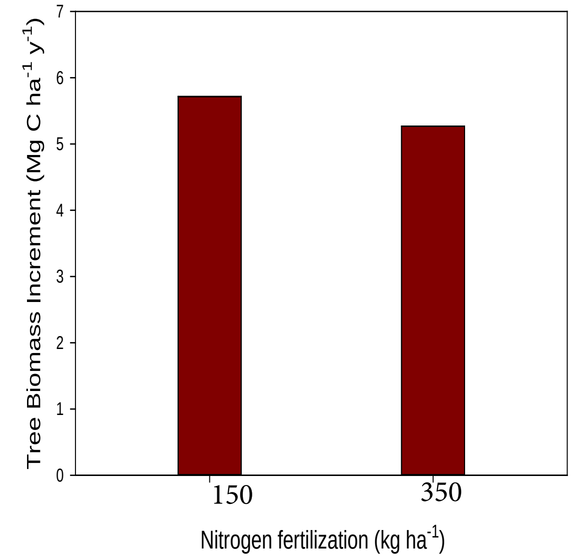
Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|	Cross Validation Estimates 1	2	3	4	5
Intercept	1	-0.879998	0.578154	-1.52	0.1291	-0.76660	-0.68142	-0.58381	-1.10501	-1.15541
TN*SDC_3	1	-0.002244	0.000519	-4.32	<.0001	-0.00215	-0.00249	-0.00280	-0.00202	-0.00189
TP*Order_Spodosol	1	0.015658	0.002127	7.36	<.0001	0.01553	0.01731	0.01331	0.01611	0.01609
TP*SDC_3	1	0.018346	0.002966	6.18	<.0001	0.01786	0.01906	0.02150	0.01851	0.01572
TP*Order_Ultisols*SDC_2	1	0.006035	0.001801	3.35	0.0009	0.00786	0.00446	0.00668	0.00659	0.00469
tmmx*rhmin*precip	1	5.2983412E-8	1.3483444E-8	3.93	0.0001	0.00000	0.00000	0.00000	0.00000	0.00000
UndBio	1	-0.150068	0.037985	-3.95	<.0001	-0.14510	-0.22297	-0.14522	-0.13512	-0.14114
SDI*Thin 0	1	0.004761	0.000249	19.09	<.0001	0.00487	0.00463	0.00466	0.00471	0.00484
SDI*Thin 1	1	0.004198	0.000293	14.31	<.0001	0.00425	0.00394	0.00416	0.00427	0.00429

Biomass Increment Model: N and P effects

30% increase



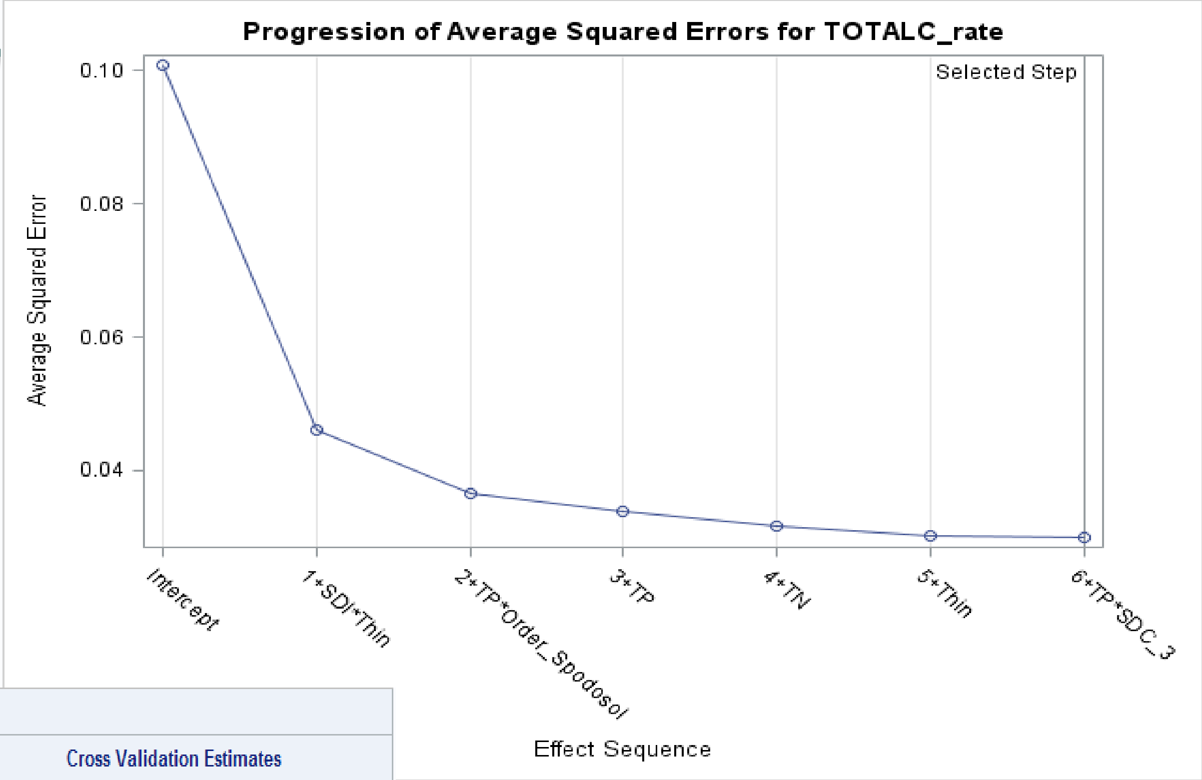
7% decrease



- Scenarios
  - Phosphorus 50 to 100 kg ha^{-1}
  - Nitrogen 150 to 300 kg ha^{-1}
- Constants
  - Spodosol
  - Drainage Class 3 (somewhat poor-very poor)
  - Understory Biomass=0.5 Mg C ha^{-1}
  - Climate (Gainesville, Florida)
  - Stand Density=740
  - Unthinned

Forest Carbon Increment

Root MSE	0.17529
Dependent Mean	1.77468
R-Square	0.7039
Adj R-Sq	0.6964
AIC	-702.63444
AICC	-701.98462
BIC	-990.59721
C(p)	34.23054
PRESS	9.14331
SBC	-962.35859
ASE	0.02987
CV PRESS	8.98240

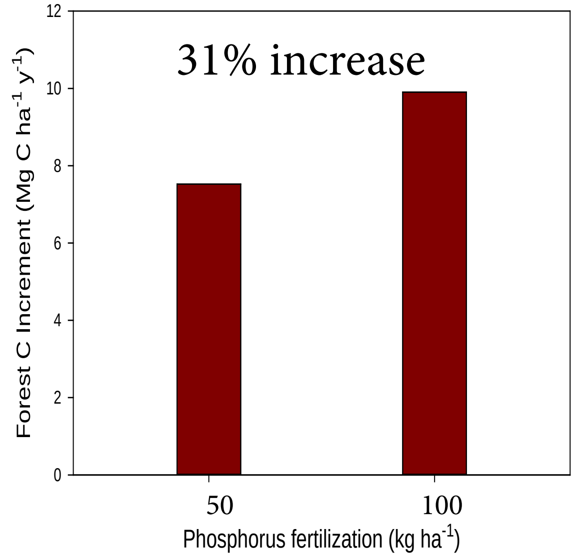


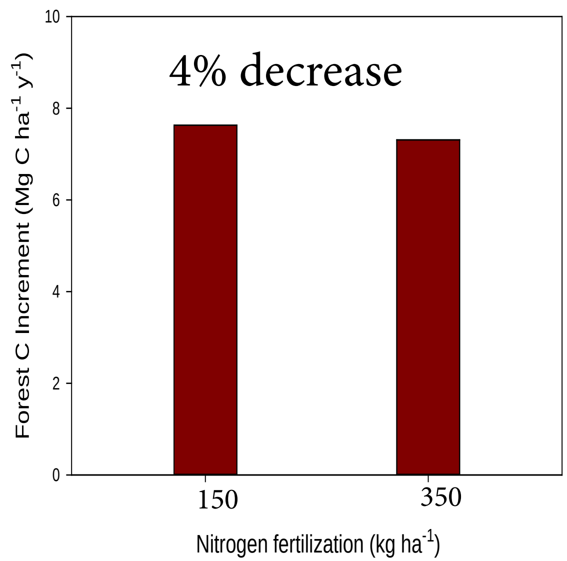
Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|	Cross Validation Estimates 1	2	3	4	5
Intercept	1	1.062978	0.054452	19.52	<.0001	1.045448	1.098143	1.053337	1.069918	1.047626
TN	1	-0.000289	0.000073608	-3.92	0.0001	-0.000295	-0.000317	-0.000320	-0.000264	-0.000258
TP	1	0.002346	0.000461	5.09	<.0001	0.002483	0.002569	0.002357	0.002329	0.002061
TP*Order_Spodosol	1	0.002416	0.000460	5.25	<.0001	0.002410	0.002532	0.002496	0.002379	0.002261
TP*SDC_3	1	0.000735	0.000386	1.90	0.0581	0.000358	0.000685	0.000738	0.000848	0.001007
Thin 0	1	0.293512	0.083162	3.53	0.0005	0.250675	0.286699	0.363489	0.297026	0.262741
Thin 1	0	0	.	.	.	0.000000	0.000000	0.000000	0.000000	0.000000
SDI*Thin 0	1	0.000595	0.000076275	7.80	<.0001	0.000673	0.000559	0.000535	0.000570	0.000645
SDI*Thin 1	1	0.000751	0.000078633	9.55	<.0001	0.000767	0.000703	0.000780	0.000733	0.000773

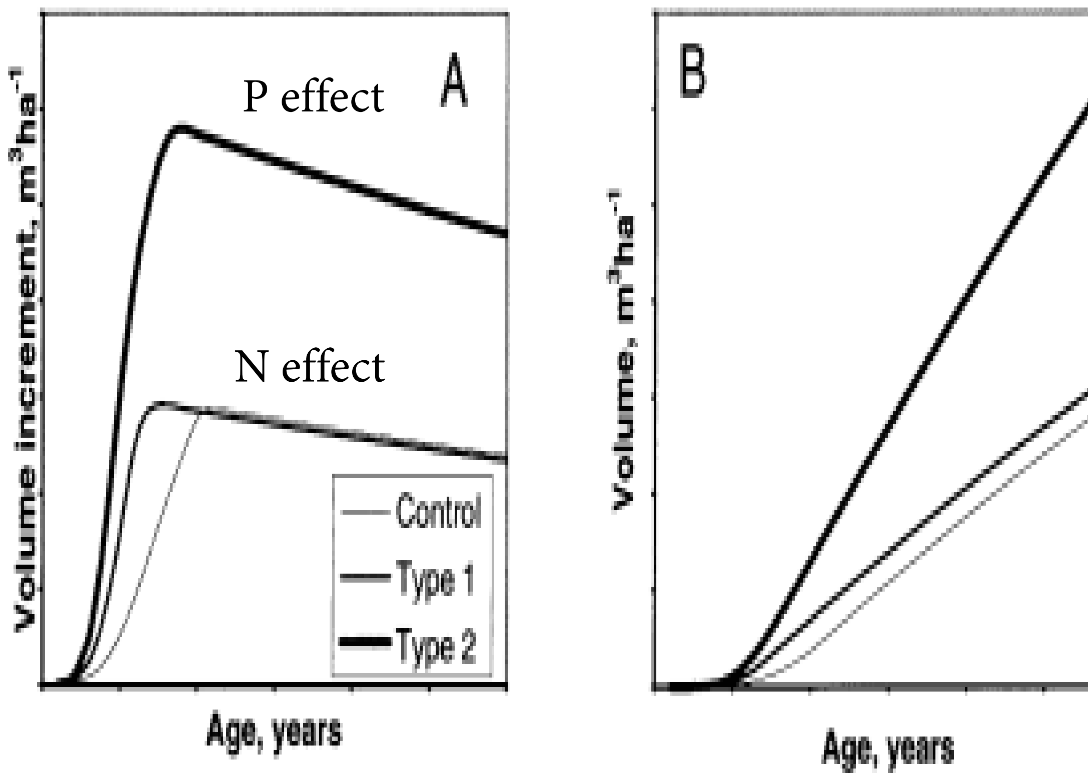
Forest C Increment model: N and P effects

- Scenarios
  - Phosphorus 50 to 100 kg ha^{-1}
  - Nitrogen 150 to 300 kg ha^{-1}
- Constants
  - Spodosol
  - Drainage Class 3 (somewhat poor- very poor)
  - Stand Density=740
  - Unthinned

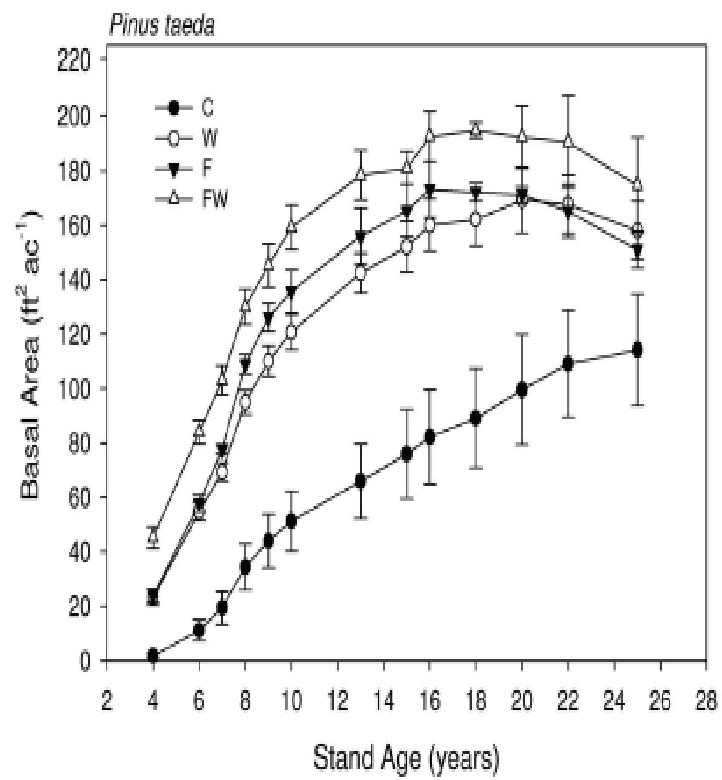




Type 1 vs. Type 2 response?



Snowdon 2002



Jokela et al. 2010

Summary (for this model configuration)

- Density management is the primary control on rates of C accumulation in trees and forest (sans soils) across the climate gradient.
- Climate has a very small effect on biomass increment
- Phosphorus has positive effects and interacts with drainage class; greater effect in poorly drained soils and Spodosols.
- Nitrogen is a slight detriment to forest C accumulation rate.
- There are forms of the models where a negative N effect "goes away" but <u>N is never a stand-alone positive effect.</u>

The effects of rainfall reduction and nutrient availability on net ecosystem productivity (NEP). Tier_3

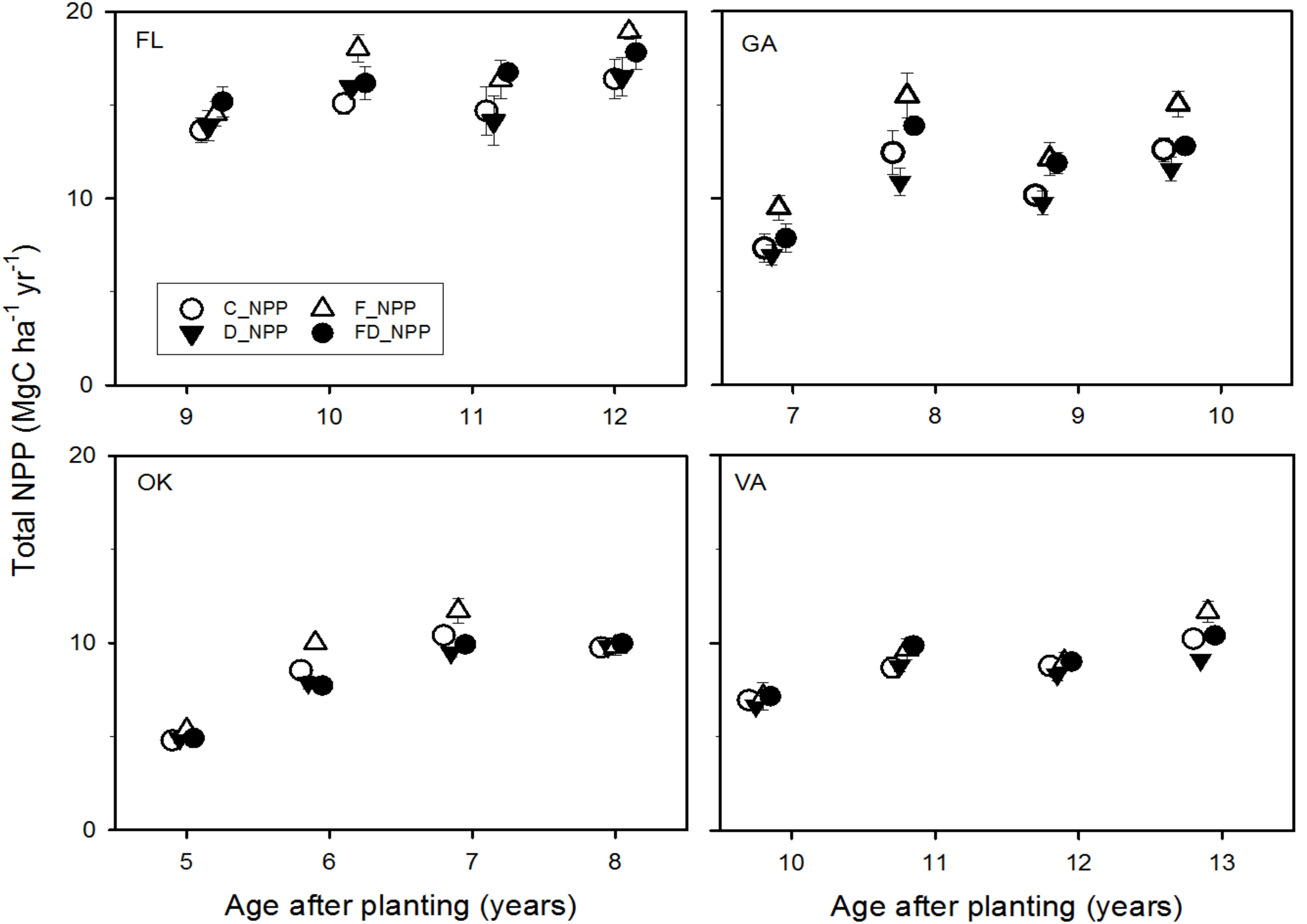
Bracho et al……….

$NEP = NPP - R_H$

NPP= Net primary productivity
biomass inventories.

R_H= Heterotrophic respiration
Root severing collars

NPP Tier 3 sites



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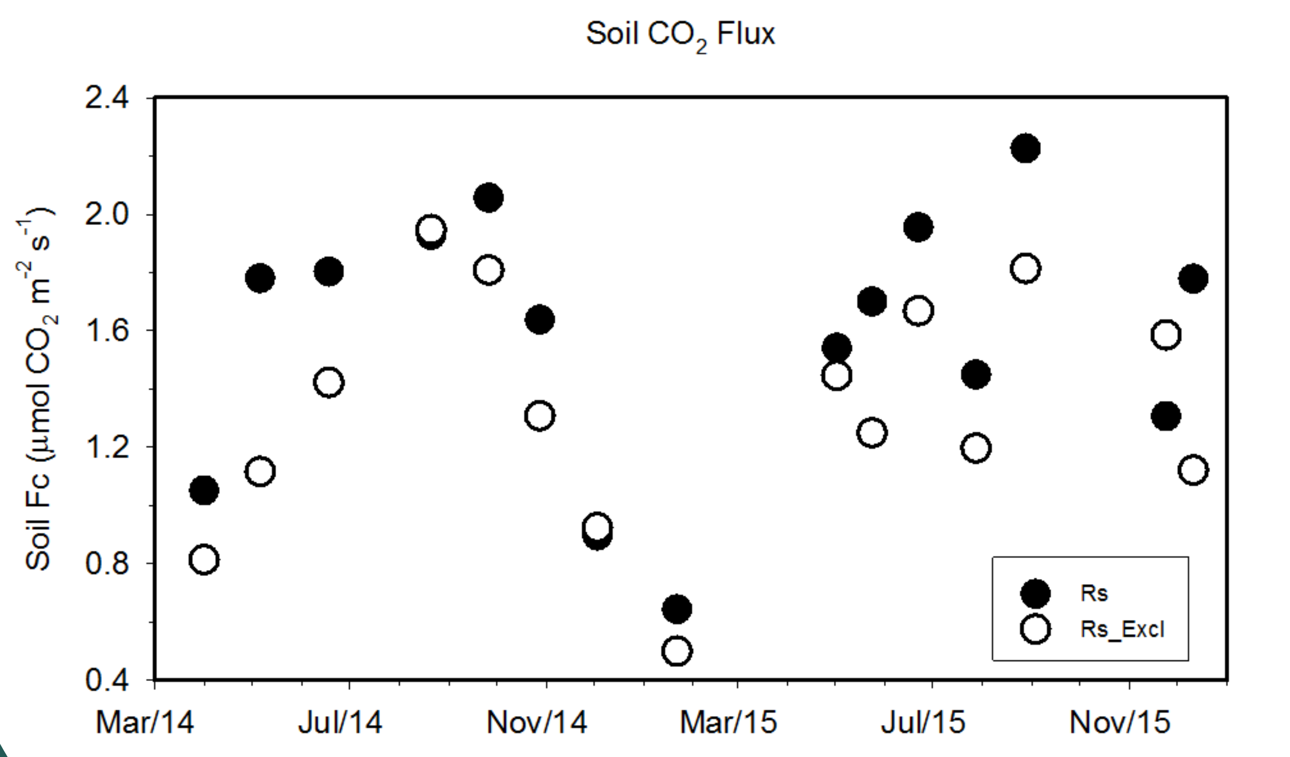
Heterotrophic component (R_H)

Soil respiration measurements (R_S & R_H):

All Tier3 sites with at least one year of paired R_S & R_H.
Soil temperature (Ts) & soil moisture (VWC)



Soil Respiration (Rs)

Model Soil respiration by treatment Rs=f(Ts, age, VWC)

Analysis of Variance (CONTROL)					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	68.82951	22.94317	132.10	<.0001
Error	299	51.93055	0.17368		
Corrected Total	302	120.76006			

Root MSE	0.41675	R-Square	0.5700
Dependent Mean	0.99155	Adj R-Sq	0.5657
Coeff Var	42.03038		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.32112	0.18999	1.69	0.0920
Ts	1	0.07063	0.00467	15.11	<.0001
age	1	-0.04034	0.01494	-2.70	0.0073
VWC	1	-1.75118	0.40738	-4.30	<.0001

SOIL TEMPERATURE

$$Ts_{daily} = f(Tair_{daily})$$

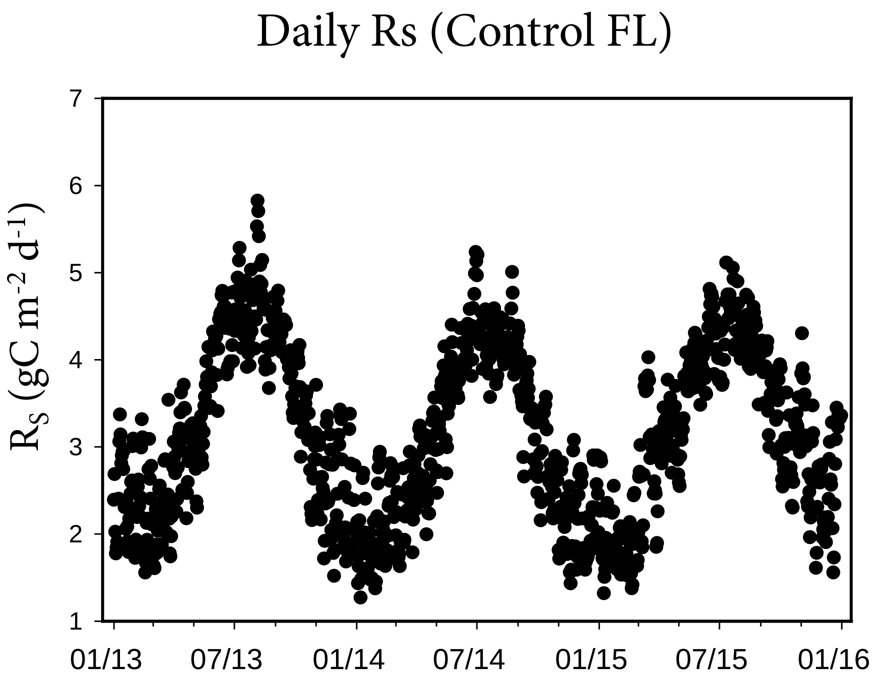
studyID=VA_Tier3. Treatment=Control

Analysis of Variance				
Source	Sum of Squares	Mean Square	F Value	Pr > F
Model	15.45724	15.45724	442.79	<.0001
Error	2.54835	0.03491		
Corrected Total	18.00559			

Root MSE	0.18684	R-Square	0.8585
Dependent Mean	2.73997	Adj R-Sq	0.8565
Coeff Var	6.81903		

Parameter Estimates				
Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1.81686	0.04889	37.16	<.0001
daily_Tair	0.05520	0.00262	21.04	<.0001

Soil C fluxes



Annual Soil respiration, 2013 (gC m^{-2} yr^{-1})

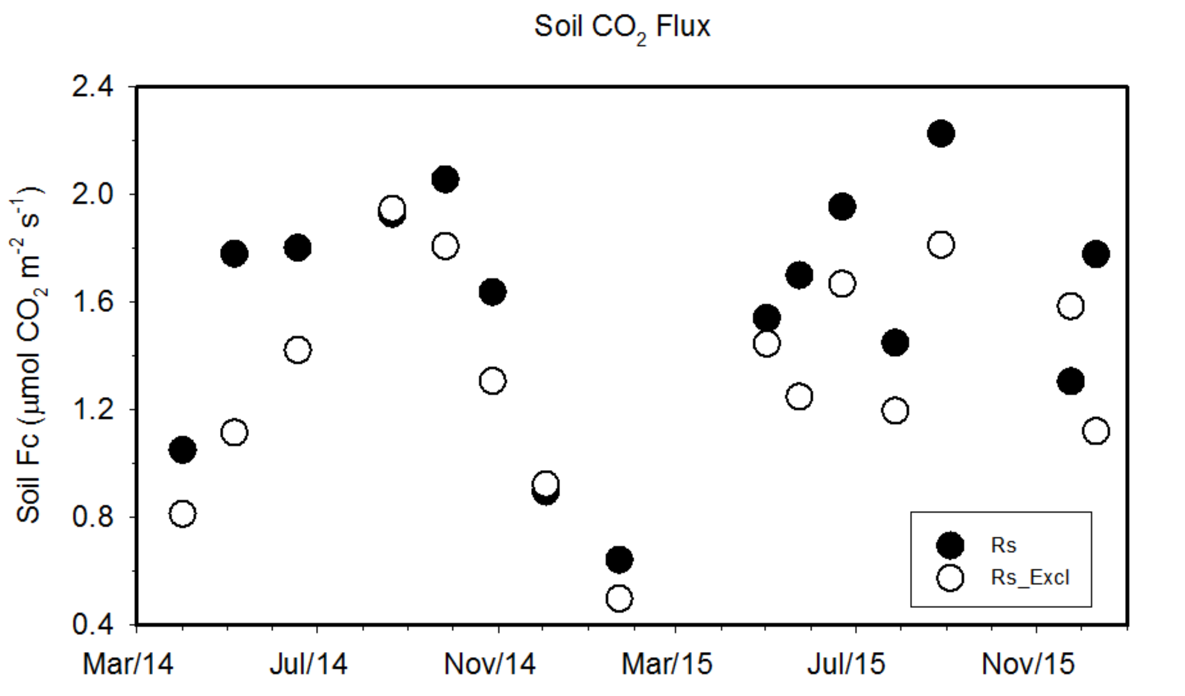
SITE	Control	Drought	Fertilized	F * D
FL	1189.00	902.30	977.18	988.0
GA	952.21	771.51	734.17	759.44
OK	1045.44	882.31	740.86	857.45
VA	804.87	707.52	727.94	688.22

Heterotrophic respiration (R_H)

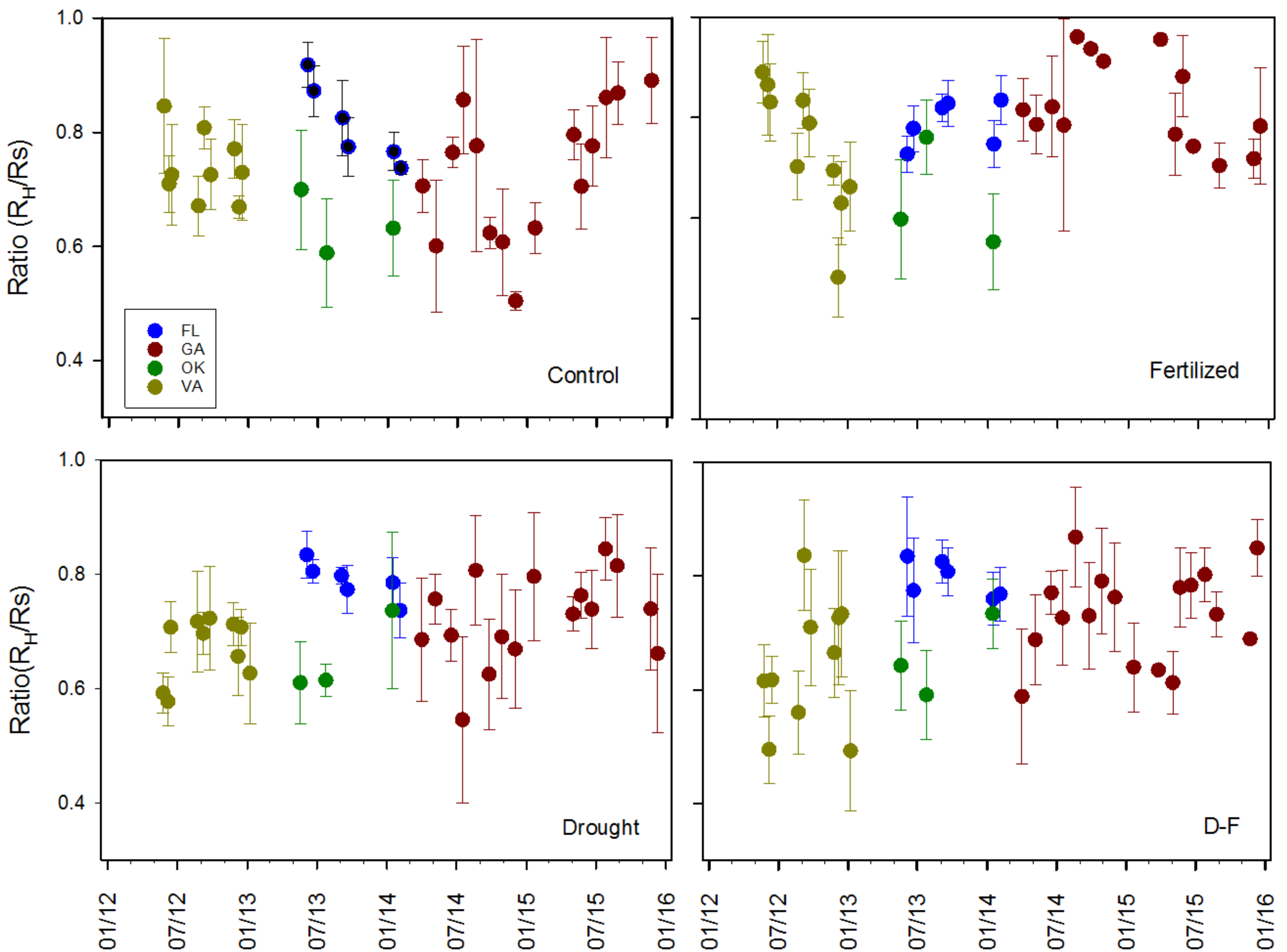
R_H - Root severing collars

Paired Rs & R_H measurements after 60 days of installation:

Ratio (R_H:R_S)



R_H:Rs



Ratio (R_H/Rs)
Ratio(R_H/Rs)
1.0
0.8
0.6
0.4
FL
GA
OK
VA
Control
Fertilized
Drought
D-F
01/12
07/12
01/13
07/13
01/14
07/14
01/15
07/15
01/16

Ratio=f(Ts age)

Treatment=CONTROL

Root MSE	0.13231	R-Square	0.1279
Dependent Mean	0.73857	Adj R-Sq	0.1115
Coeff Var	17.91491		

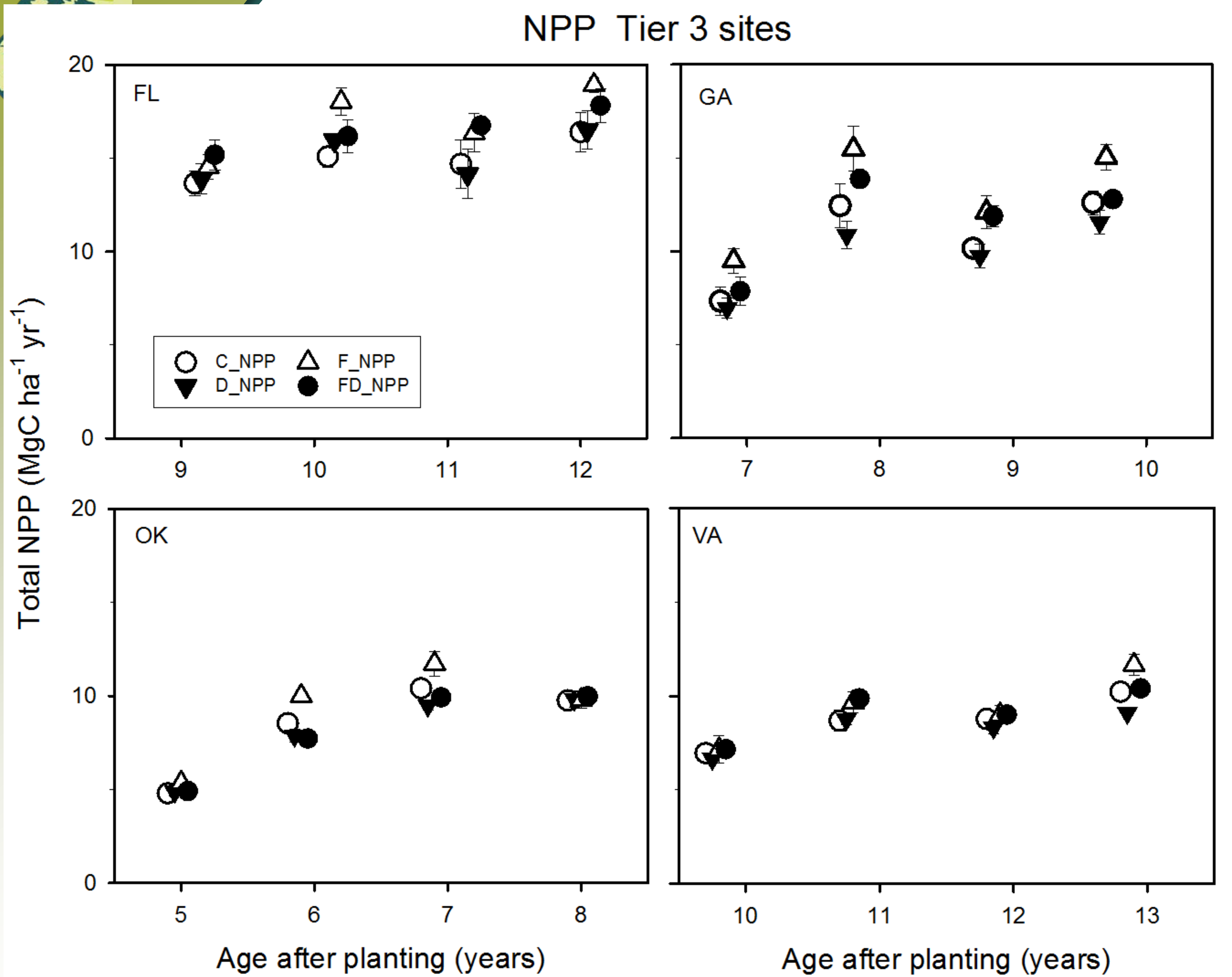
Parameter Estimates				
Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.38605	0.09734	3.97	0.0001
Ts	0.00664	0.00213	3.12	0.0023
age	0.02488	0.00914	2.72	0.0076

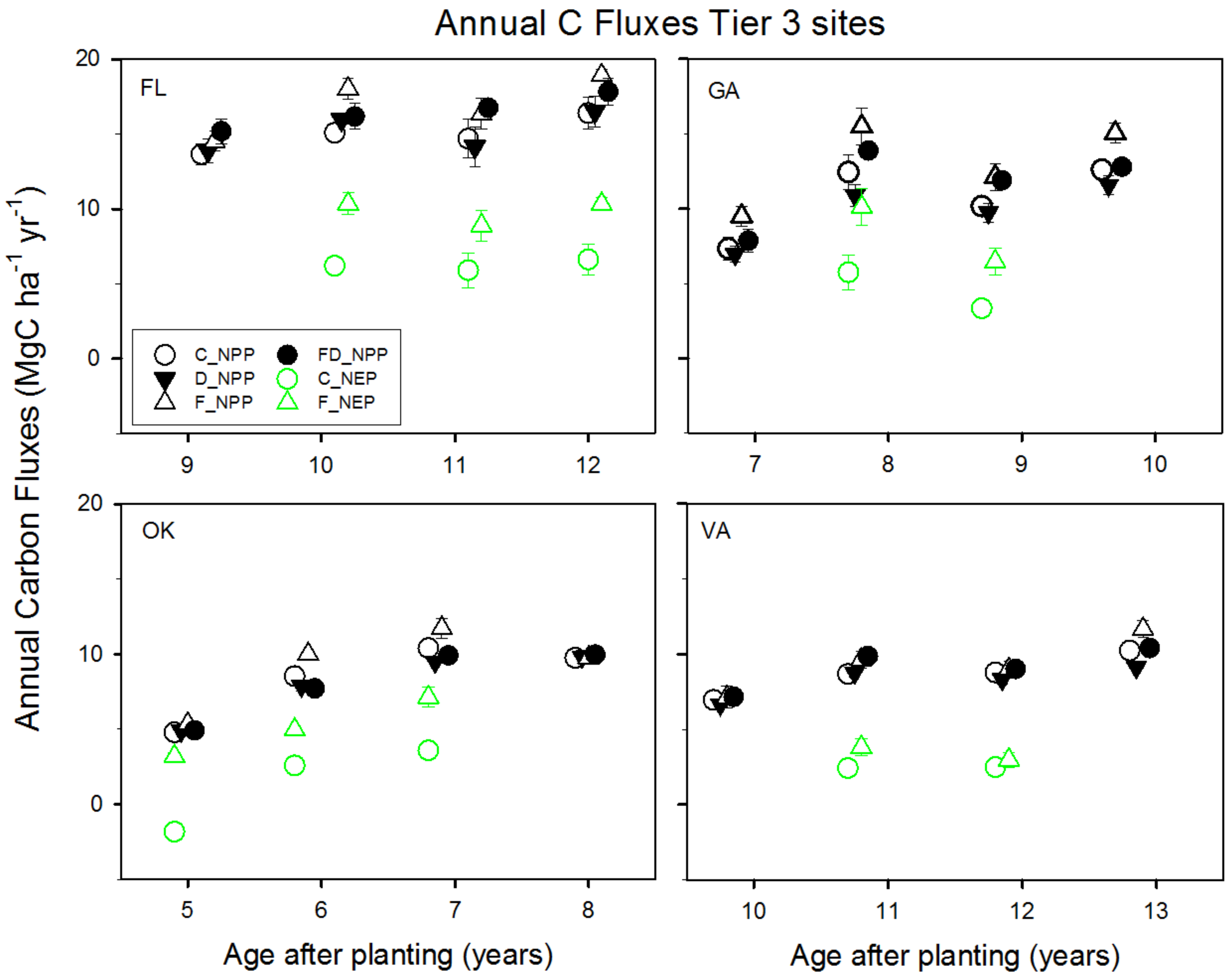
Treatment = FERTILIZED

Root MSE	0.13769	R-Square	0.2171
Dependent Mean	0.75706	Adj R-Sq	0.2010
Coeff Var	18.18719		

Parameter Estimates				
Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.38467	0.10456	3.68	0.0004
Ts	0.01018	0.00206	4.93	<.0001
age	0.02137	0.01016	2.10	0.0380

$$R_H = R_S * ratio$$


NPP Tier 3 sites
FL
GA
OK
VA
C_NPP
F_NPP
D_NPP
FD_NPP
Total NPP (MgC ha^{-1} yr^{-1})
Age after planting (years)
Age after planting (years)
National Institute of Food and Agriculture



Annual C Fluxes Tier 3 sites
Annual Carbon Fluxes (MgC ha^{-1} yr^{-1})
FL
GA
OK
VA
C_NPP
D_NPP
F_NPP
FD_NPP
C_NEP
F_NEP
20
10
0
9
10
11
12
7
8
9
10
5
6
7
8
10
11
12
13
Age after planting (years)
Age after planting (years)

Soil Respiration Modeling

Overview

- Step 1: Develop a region wide relationship between soil temperature and respiration
  - Focus on total soil respiration

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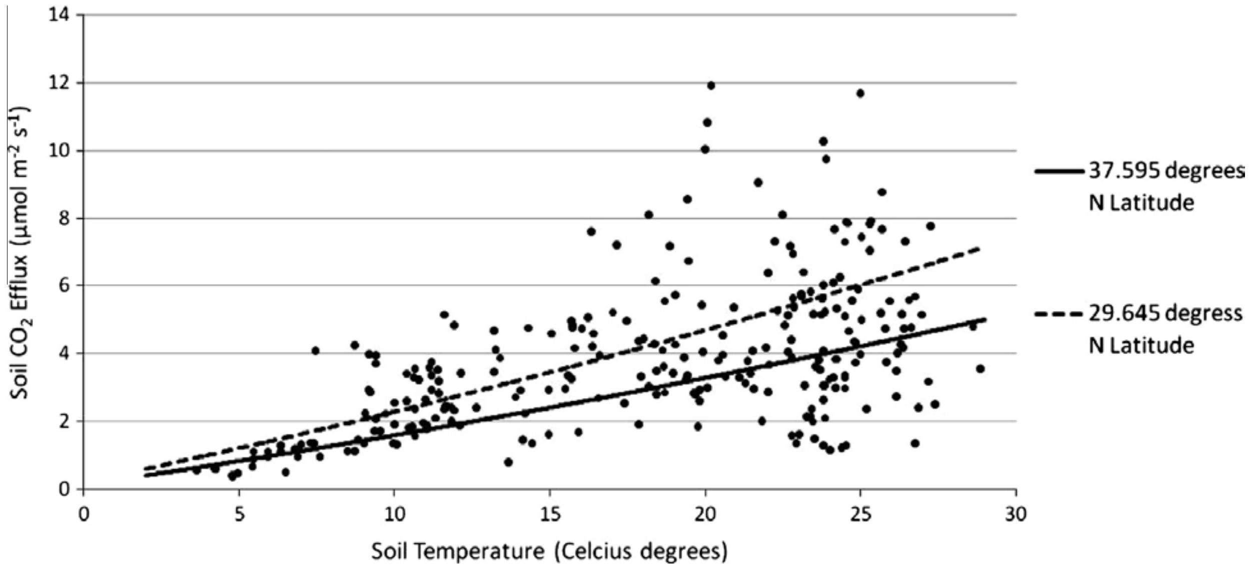

Overview

- Step 1: Develop a region wide relationship between soil temperature and respiration
  - Focus on total soil respiration
  - Concerns
    - Dependence on background productivity (initial tests suggest that SI is not a strong predictor of total soil respiration)
    - Dependence on soil moisture
    - Dependence on stand age
    - Dependence on soil properties
    - Space-for-time substitution
    - Acclimation of respiration to increased temperatures

Overview

- Step 2: Calculate monthly total soil respiration for each HUC simulated by 3PG
  - Challenges
    - Need to translate air temperature to soil temperature
  - Currently developing model

Overview

- Step 3: Calculate heterotrophic respiration for each month of the 3PG simulation
  - Use the autotrophic respiration produced by the 3PG model: Ra = GPP * (1-y)
  - Use the ration of aboveground to belowground biomass to calculate Ra_below (Ra_below = Ra *(below biomass/total biomass)
  - Add Ra_below to the total soil respiration
    - Rh = Rs + Ra_below

Overview

- Step 4: Calculate monthly NEP (NPP from 3PG – Rh)

Overview

- Needs from group
  - Tier 2 soil respiration vs. temperature to combine with the Templeton data.
  - Tier 2 and 3 soil temperature and atmospheric temperature data