Continuing Project

Assessing & Mapping Regional Variation in Site Productivity

CAFS.19.75

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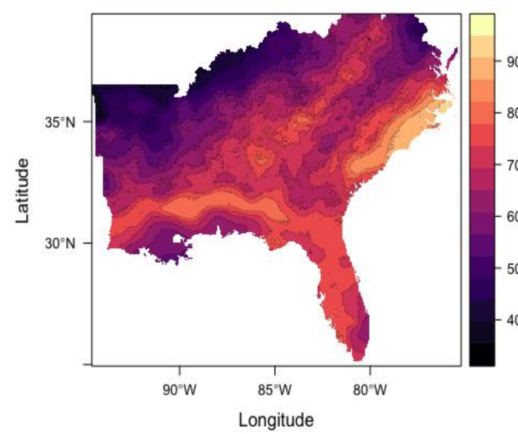
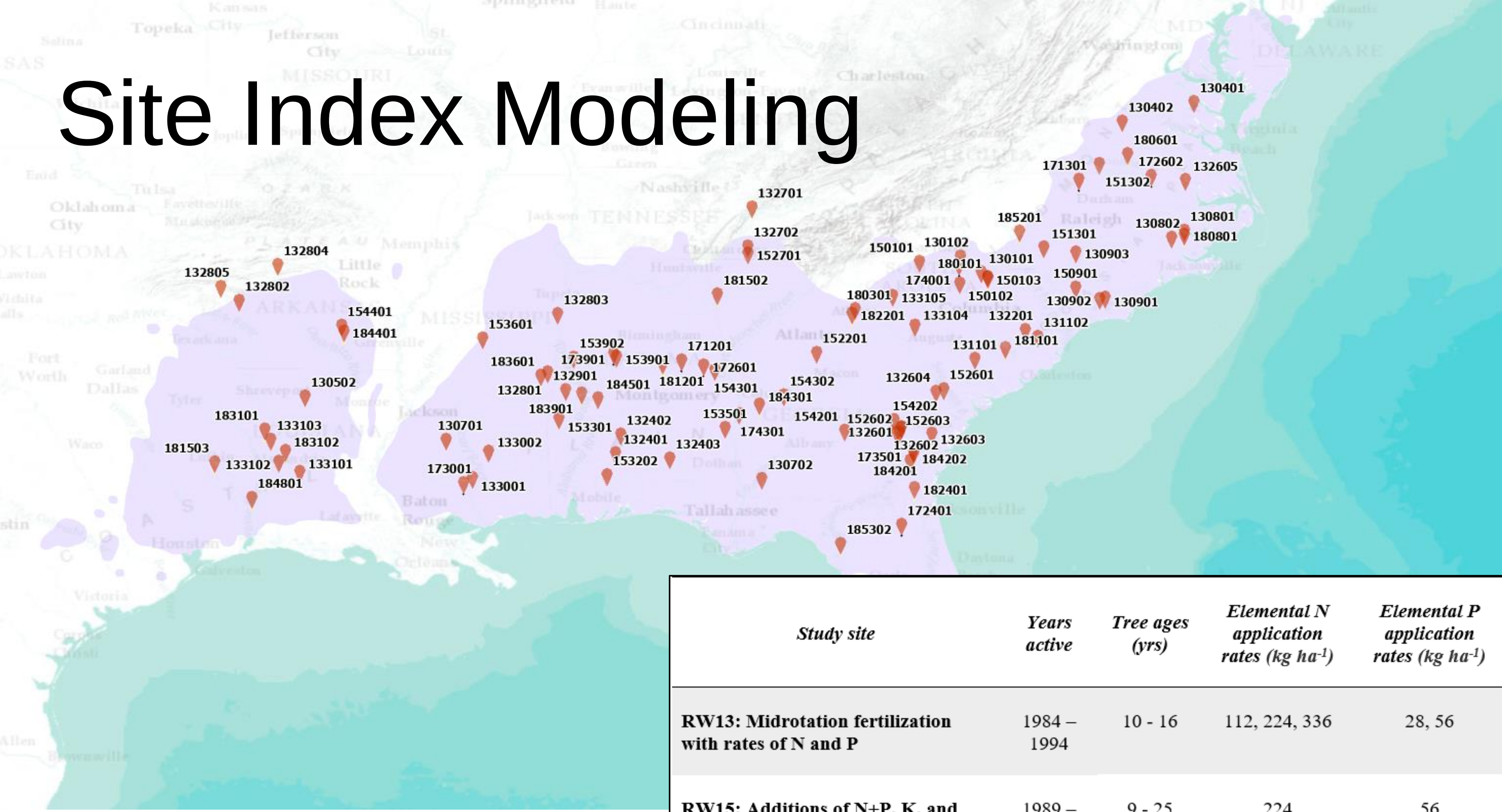
What drives site productivity and how do we make predictions?

Objectives

1. Develop a consistent and biologically meaningful metric of potential site productivity
2. Relate soils, geology, and environmental variables to predict site productivity
3. Map across major forest regions



Site Index Modeling

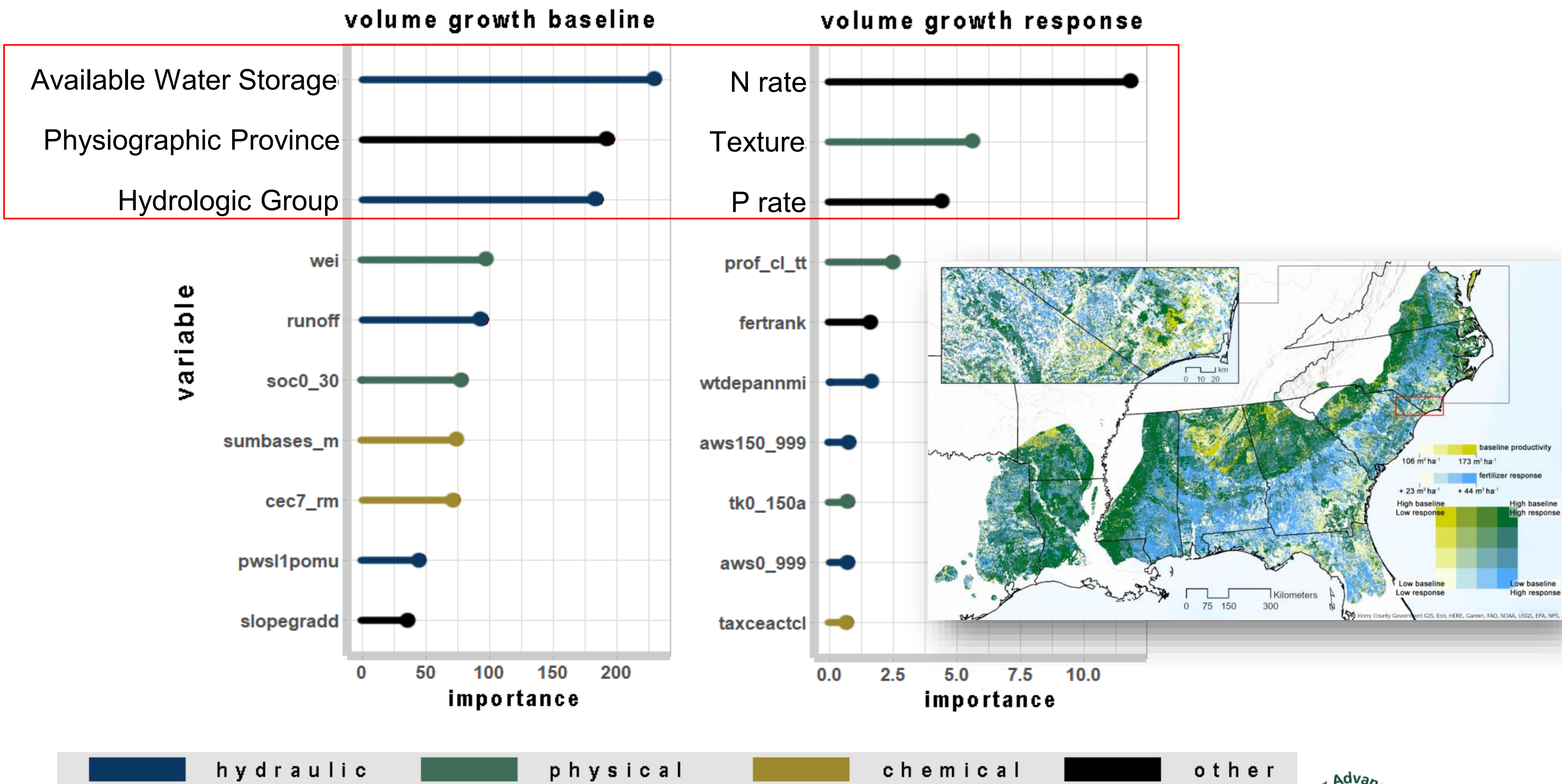


We have *a lot* of historical and contemporary field study research…

… especially related to fertilization:

Study site	*Years active*	*Tree ages (yrs)*	*Elemental N application rates (kg ha-1)*	*Elemental P application rates (kg ha-1)*
RW13: Midrotation fertilization with rates of N and P	1984 – 1994	10 - 16	112, 224, 336	28, 56
RW15: Additions of N+P, K, and micronutrients	1989 – 1999	9 - 25	224	56
RW17: Fertilization x vegetation control at midrotation	1996 – 2002	9 - 22	224	56
RW18: Optimal rates and frequencies of nutrient application	1998 – 2006	3 - 6	67, 134, 201, 269	7, 13, 20, 27
RW19: Thinning x fertilization response	2006 – present	12-16	224	28

2022 – Mapping response based on continuous variables



Major Soil Group	
A	Clay
B	Fine Loamy
C	Coarse Loamy
D	Spodic
E	Silty
F	Deep Subsoil (Grossarenic, > 40 in)
G	Deep Sand (> 80 in)
H	Histosol/ Organic

Depth Code (inches)	
0	unknown (0-20)
1	0 – 5
2	5 – 10
3	10 – 20
4	20 – 40
5	40 – 80
6	None within 80 in

Drainage	
E	Excessively Drained
D	Somewhat Excessively Drained
W	Well Drained
M	Moderately Well Drained
S	Somewhat Poorly Drained
P	Poorly Drained
V	Very Poorly Drained

Modifier 1: Nature of Surface	
d	Dark surface
y	Silty
e	Eroded
g	Gullied
r	Rocky
o	Other or NA

Modifier 2: Nature of Subsoil	
a	Alfic
m	Mica
x	Mixed
k	Kaolinitic
p	Plastic/ smectitic/ vertic
i	Siliceous (sandy)
o	Other or NA

Modifier 3: Limitations (A or B Horizon)	
w	Ponded Water
f	Floods (fluvic)
l	Lamella
s t u	Root limited (densic, lithic, paralithic) (<10, 10-20, 20-40 in)
v	Root limited 40-80 in
q	Restrictions within 40 inches (fragic, cemented, plinthic)
c	Alkaline, calcareous
n	Salt affected (natric)
o	Other or NA

Geo Code
Pa
Al
Dw
Lb
Ws
Am
Au
Ct
Fl
Ch
Vk
Yg
Jk
Cb
Wx
Md
Bb
Ba
Av
Sa
Cs
Ms
Fs
Lo
Gg
Le
Sh
St
Lm
Sc
Bg
Um
Sr
Mr
Ui

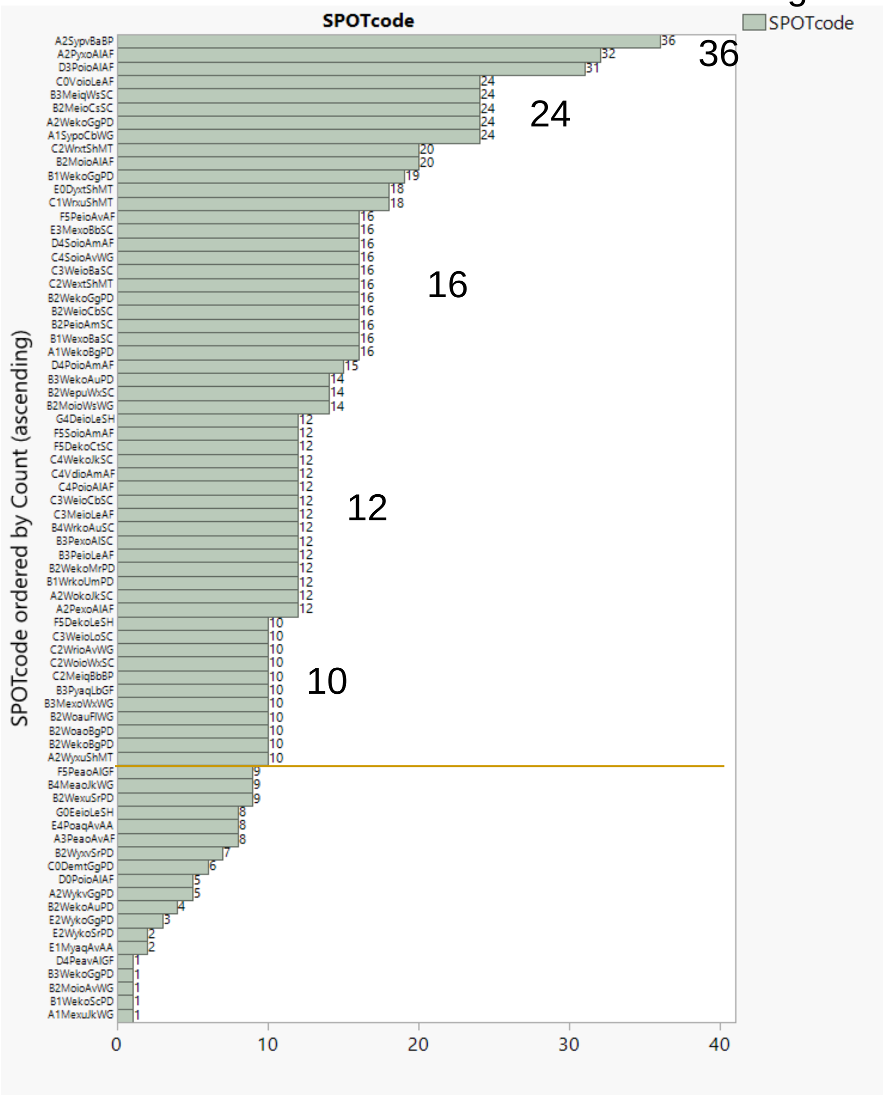
Physiographic Province	
AF	Atlantic Coastal Plain Flatwoods
GF	Gulf Coastal Plain Flatwoods
SC	Southern Coastal Plain
WG	Western Gulf Coastal Plain
LP	Mississippi Valley Loess Plain
BP	Blackland Prairie
SH	Sandhills
PD	Piedmont
MT	Mountains
AA	Alluvium

Classification based on:
Site Productivity Optimization of Trees “SPOT” codes

SPOT Code Coverage

- Soils in loblolly in native range
  - 35 million acres*
- Exact RW SPOT codes
  - 2.7 million acres (7% of total)
- SPOT code “scrabble”
  - 26 million acres (74% of total)

SPOT codes with >10 obs used for modeling

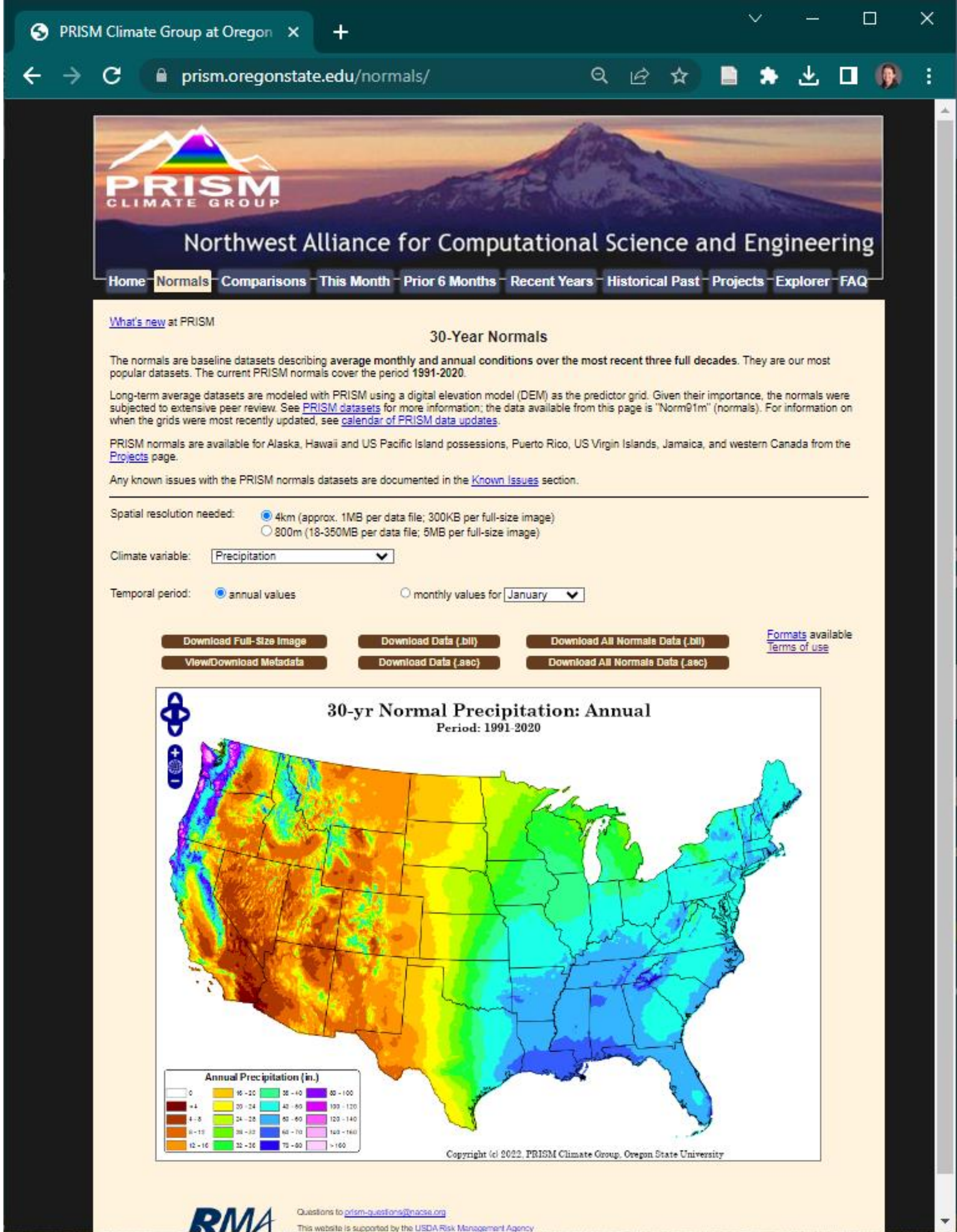


*Thomas, V.A., R.H. Wynne, J. Kauffman, W. McCurdy, E.B. Brooks, et al. 2021. Mapping thins to identify active forest management in southern pine plantations using Landsat time series stacks. Remote Sensing of Environment 252: 112127. doi: 10.1016/j.rse.2020.112127.

Climate

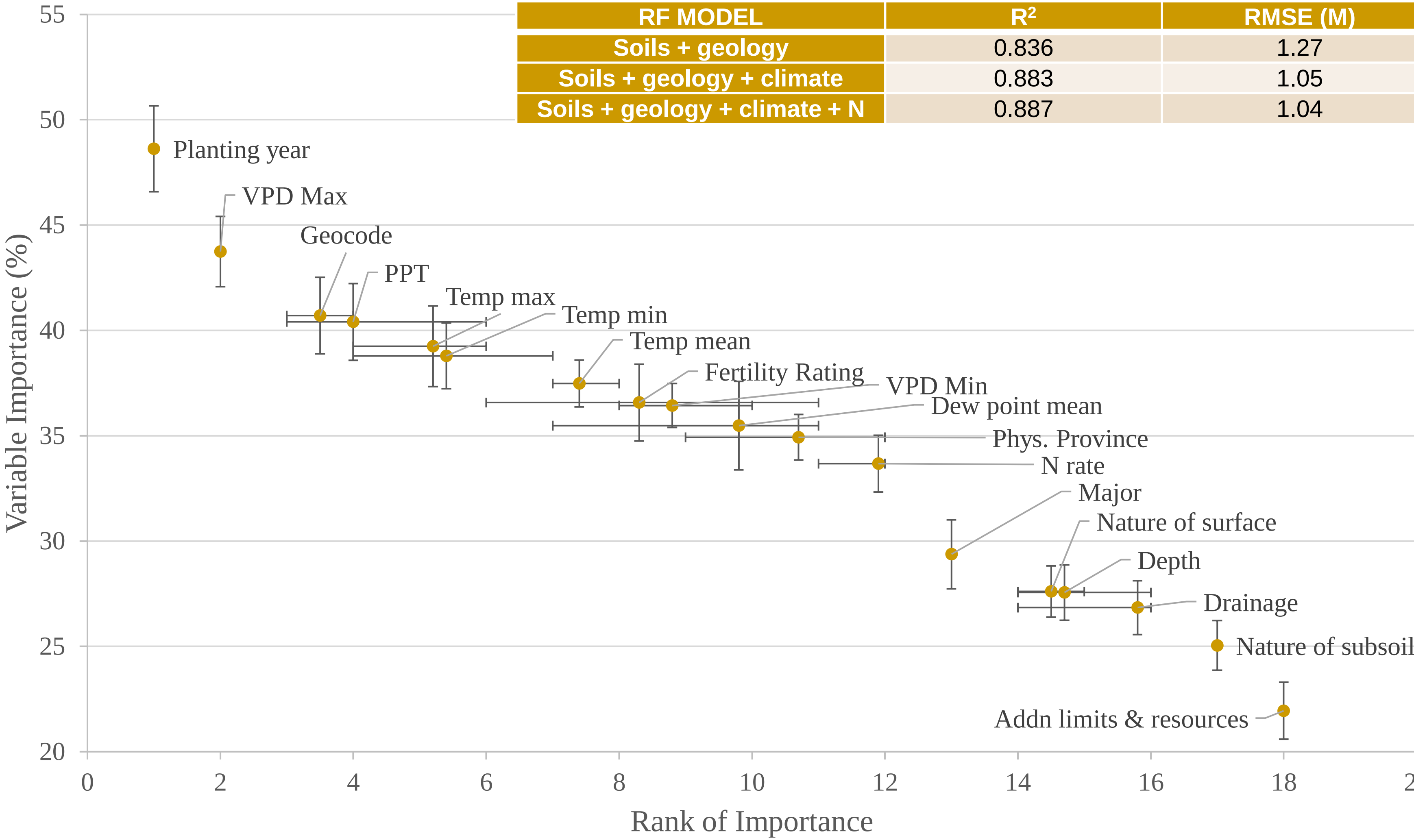
- 30-yr averages
- 800 m resolution

VPD Max
VPD Min
PPT
Temp max
Temp min
Temp mean
Dew point mean



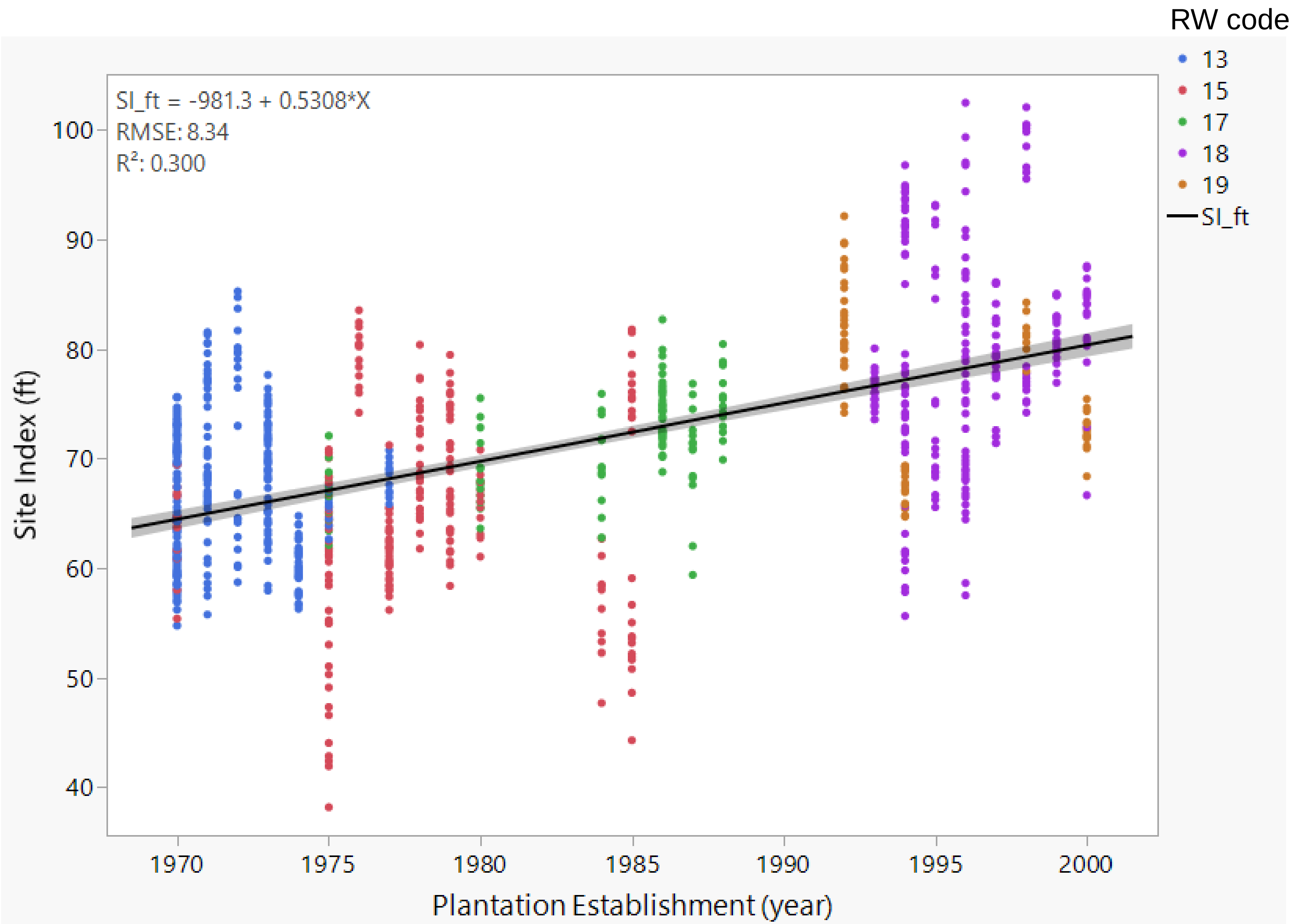
Random Forest Variable Importance

RF MODEL	R^2	RMSE (M)
Soils + geology	0.836	1.27
Soils + geology + climate	0.883	1.05
Soils + geology + climate + N	0.887	1.04

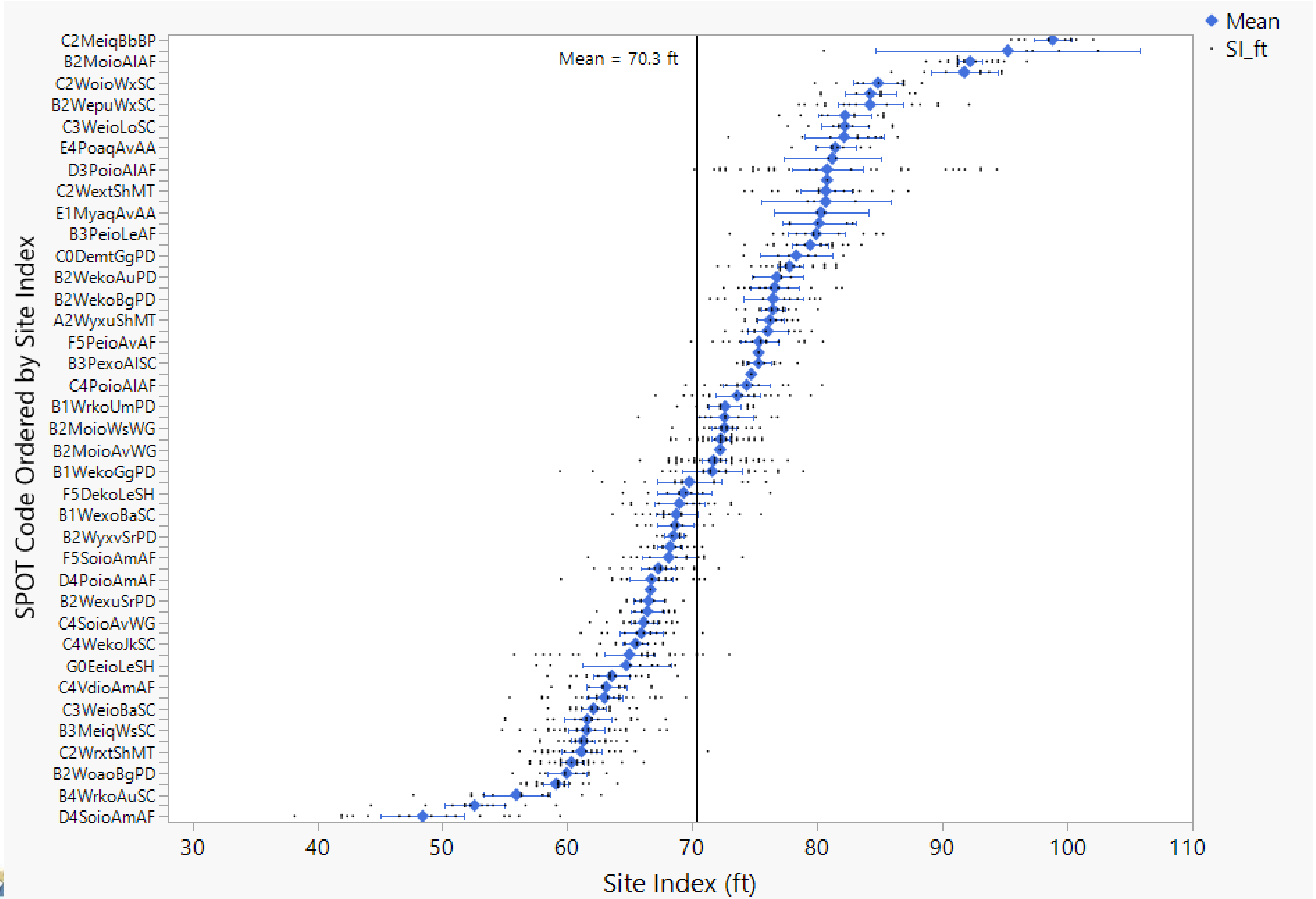


Range of rank after 10 model runs

Site Index improving 0.5 ft per year

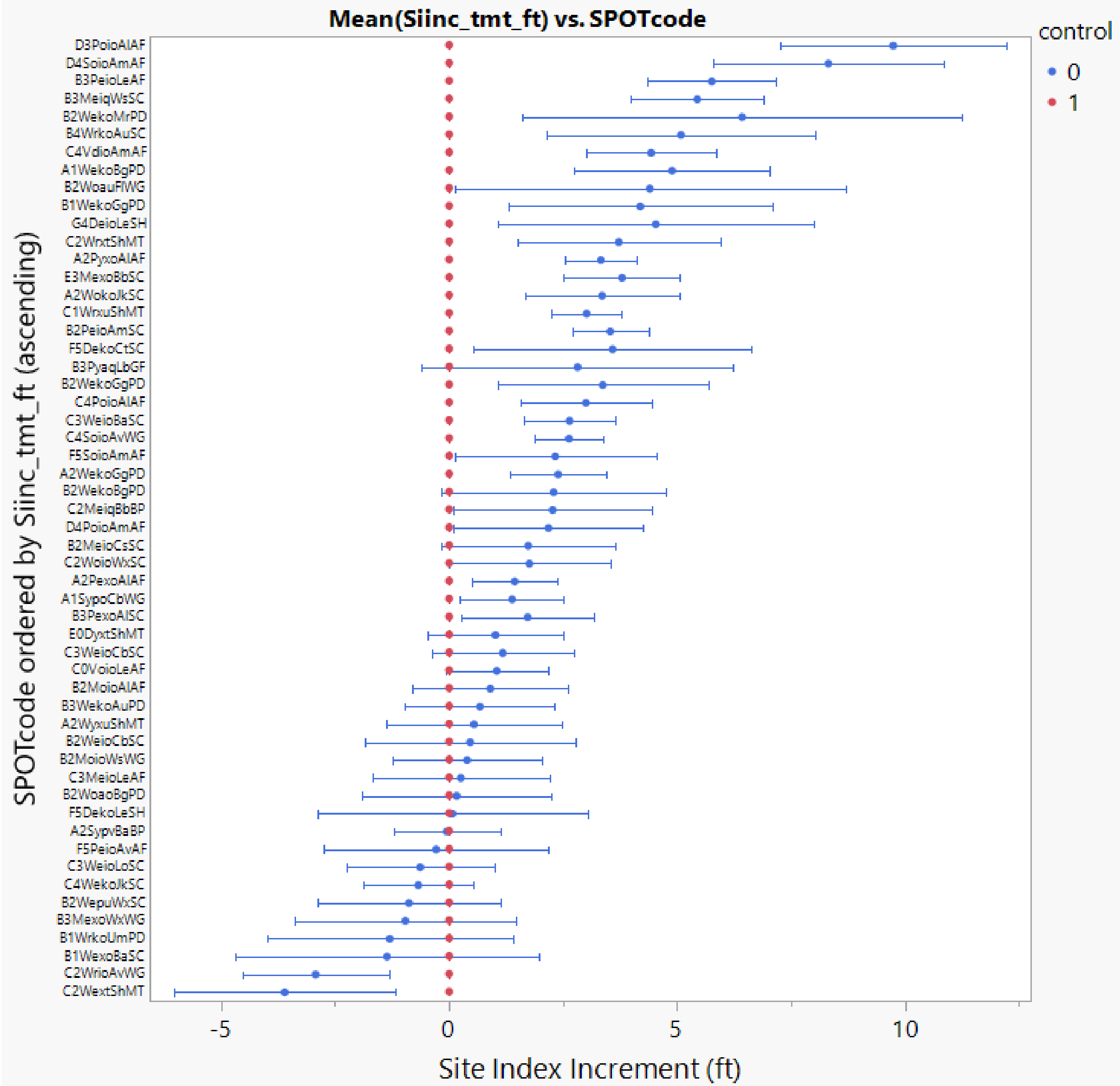


Site Index Distribution by SPOT code (ft)



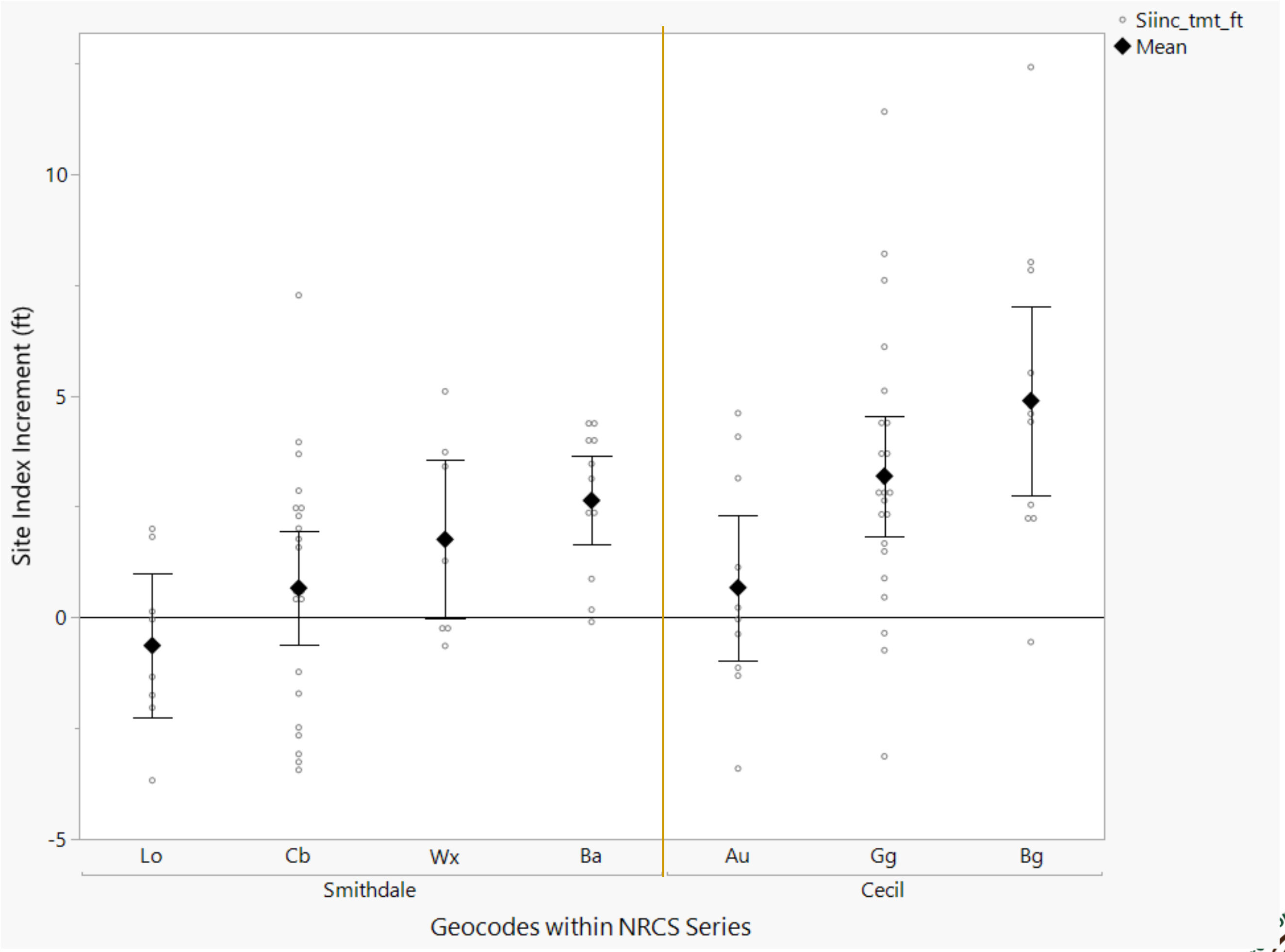
Each error bar is constructed using a 95% confidence interval of the mean.

Site Index Fertilizer Response by Spot Code



Where(tmt = (0, 1, 11, 12, 17, 21, 23, 31, 32, 33, 100, 110, 111, 112, 119) & more)
Each error bar is constructed using a 95% confidence interval of the mean.

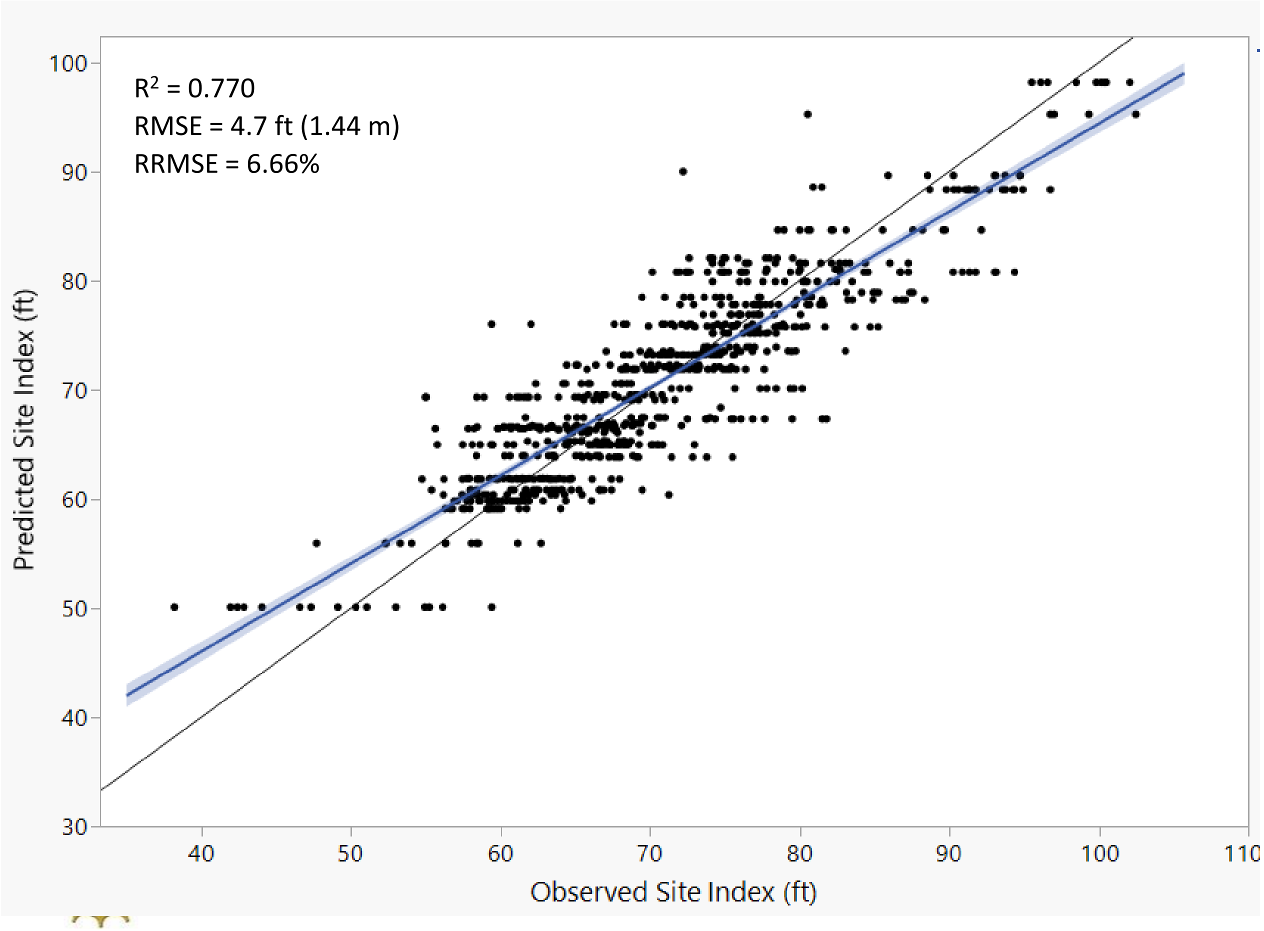
Site Index Fertilizer Response: Geology matters within NRCS soil series



95% Confidence Intervals

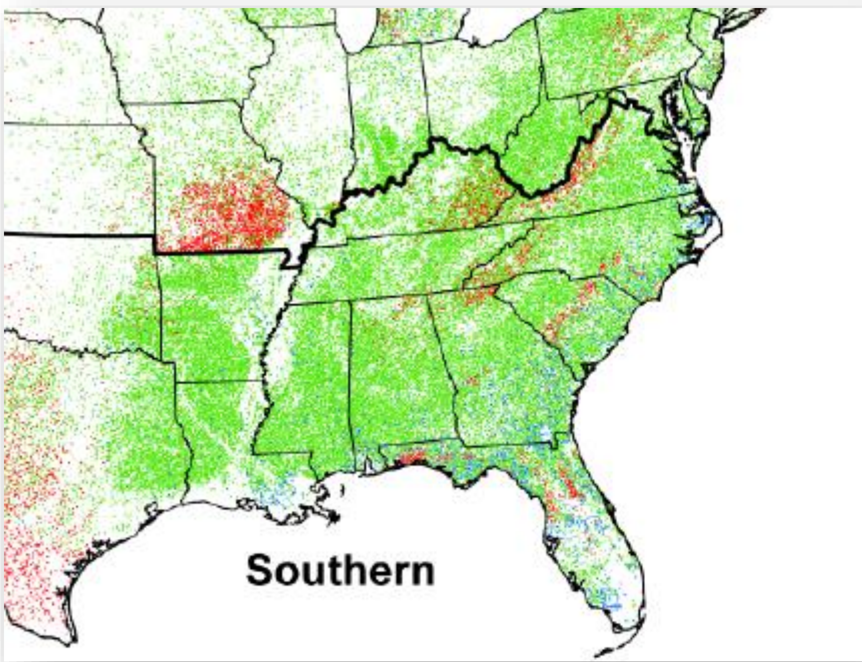
SPOT model for site index predictions

$$SI\_m \sim Major\ code\ + Drainage\ + Depth\ + Surface\ + Subsoil\ + Addn\ limitations\ + Geocode\ + Phys\ Prov$$

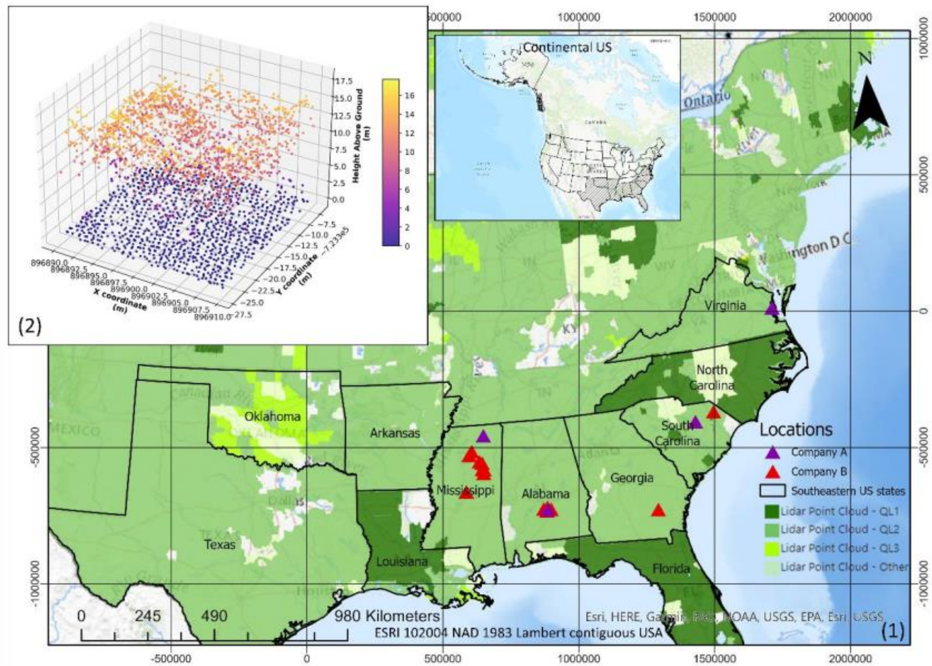


Next Steps: More Data!
USGS LiDAR for member plantations
& FIA data

FIA plot data



USGS LiDAR coverage



Method developed thanks to member inventory data contributions

Submitted:

International Journal of Applied Earth Observation and Geoinformation

Dominant height models from LiDAR validated with forest inventory, and age, can produce site productivity maps for loblolly pine (Pinus taeda L.) plantations in the southeastern US.

--Manuscript Draft--

Timeline - Updated

✓Year 1 (2020): Data gathering and compilation of forest soil map units and available stand data

- ✓ Year 2-4 (2021-2023): Spatial modeling and model comparisons of site productivity and drivers

Year 4-5: Develop web-based interface of base and potential site productivity (additional funding from International Paper and Forest Service – in progress)

Year 5: 1) Incorporate LAI into productivity modeling, 2) Collect USGS data across SEUS for large-scale site index mapping