

Continuing Project

Assessing & Mapping Regional Variation in Site Productivity

CAFS.19.75

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Presented by:

Rachel Cook and Cristian Montes

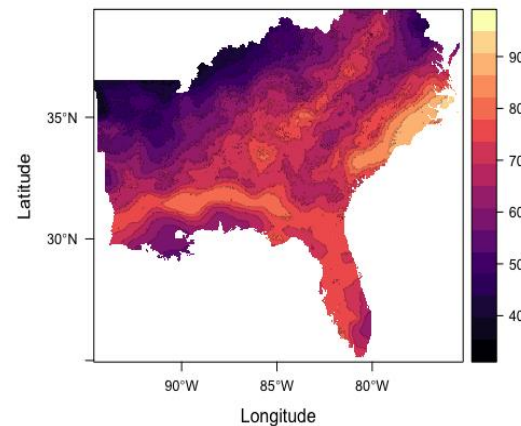
North Carolina State University and University of Georgia



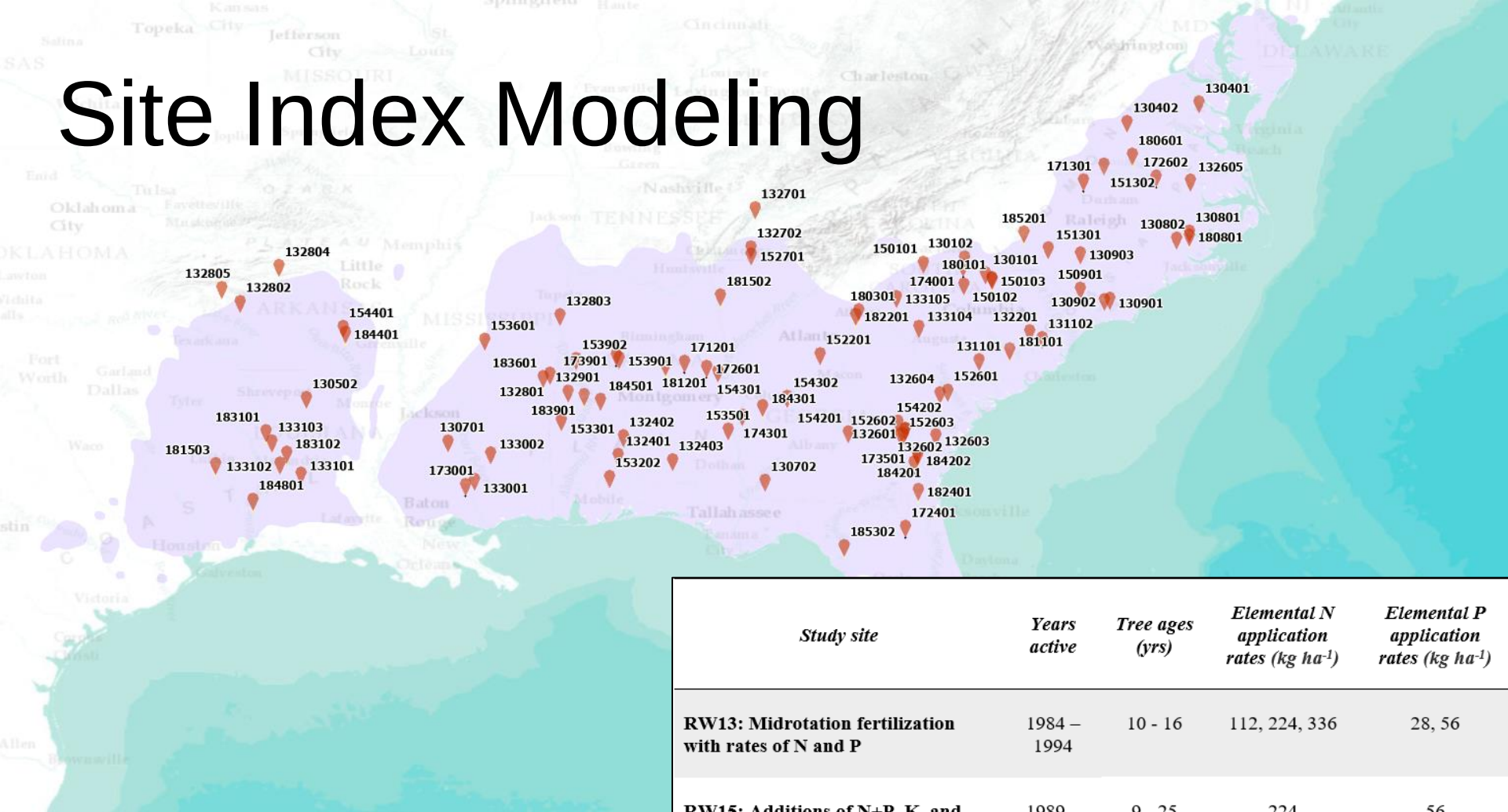
What drives site productivity and how do we make predictions?

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



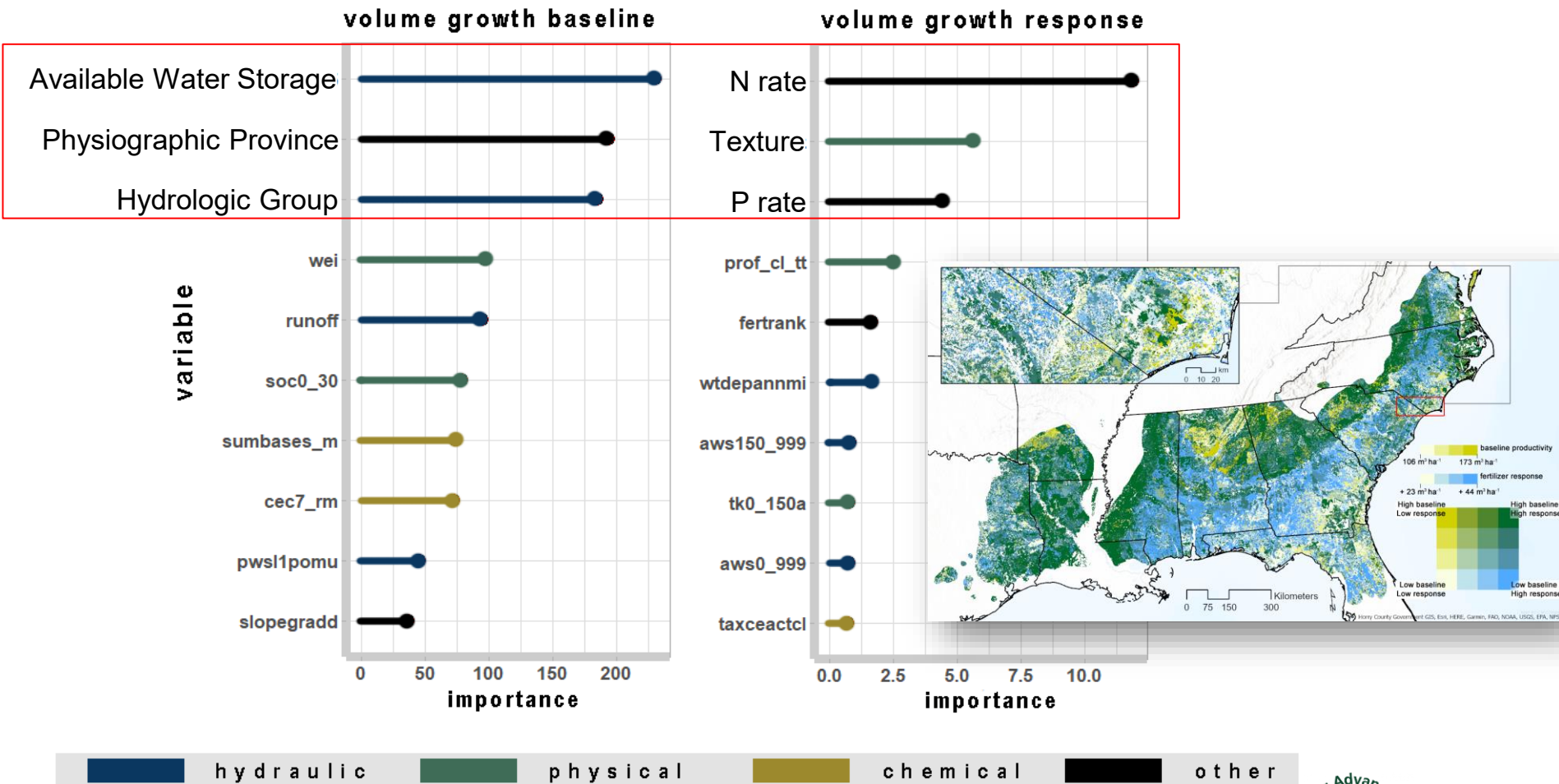
We have *a lot* of historical and contemporary field study research...

... especially related to fertilization:



<i>Study site</i>	<i>Years active</i>	<i>Tree ages (yrs)</i>	<i>Elemental N application rates (kg ha⁻¹)</i>	<i>Elemental P application rates (kg ha⁻¹)</i>
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		Depth Code (inches)		Drainage		Modifier 1: Nature of Surface		Modifier 2: Nature of Subsoil		Modifier 3: Limitations (A or B Horizon)		Geo Code		Physiographic Province	
A	Clay	0	unknown (0-20)	E	Excessively Drained	d	Dark surface	a	Alfic	w	Ponded Water	Pa	AF	Atlantic Coastal Plain Flatwoods	
B	Fine Loamy	1	0 – 5	D	Somewhat Excessively Drained	y	Silty	m	Mica	f	Floods (fluvic)	Al			
C	Coarse Loamy	2	5 – 10	W	Well Drained	e	Eroded	x	Mixed	l	Lamella	Dw			
D	Spodic	3	10 – 20	M	Moderately Well Drained	g	Gullied	k	Kaolinitic	s	Root limited (densic, lithic, paralithic) (<10, 10-20, 20-40 in)	Lb	GF	Gulf Coastal Plain Flatwoods	
E	Silty	4	20 – 40	S	Somewhat Poorly Drained	r	Rocky	p	Plastic/smectitic/vertic	t		Ws			
F	Deep Subsoil (Grossarenic, > 40 in)	5	40 – 80	P	Poorly Drained	o	Other or NA	i	Siliceous (sandy)	u		Am			
G	Deep Sand (> 80 in)	6	None within 80 in	V	Very Poorly Drained			o	Other or NA	v	Root limited 40-80 in	Au	SC	Southern Coastal Plain	
H	Histosol/Organic									q	Restrictions within 40 inches (fragic, cemented, plinthic)	Ct			
										c	Alkaline, calcareous	Fl			
										n	Salt affected (natric)	Ch	WG	Western Gulf Coastal Plain	
										o	Other or NA	Vk			
												Yg			
												Jk	LP	Mississippi Valley Loess Plain	
												Cb			
												Wx			
												Md	BP	Blackland Prairie	
												Bb			
												Ba			
												Av	SH	Sandhills	
												Sa			
												Cs			
												Ms	PD	Piedmont	
												Fs			
												Lo			
												Gg	MT	Mountains	
												Le			
												Sh			
												St	AA	Alluvium	
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NSF

Center for Advanced Forestry Systems

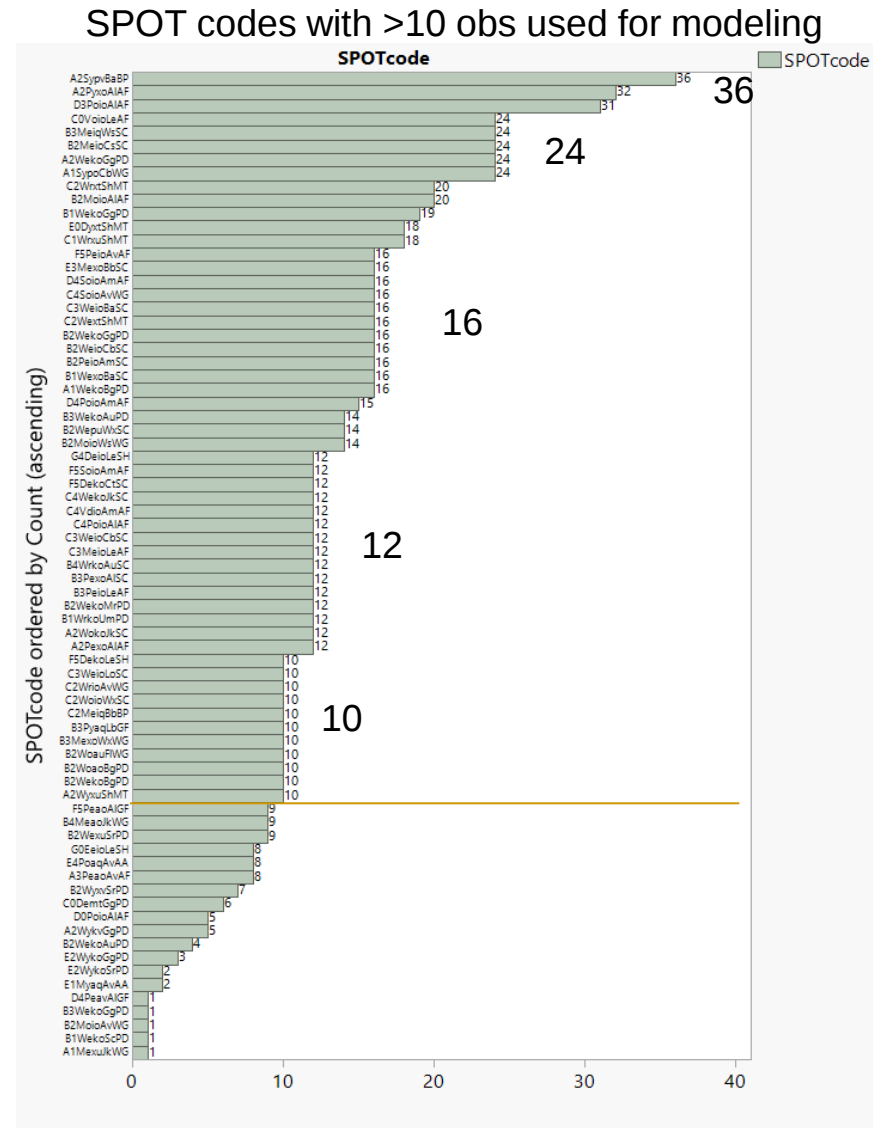
Classification based on:
Site Productivity Optimization of Trees
“SPOT” codes

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)



*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](https://doi.org/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



PRISM Climate Group at Oregon State University

prism.oregonstate.edu/normals/

PRISM CLIMATE GROUP

Northwest Alliance for Computational Science and Engineering

Home Normals Comparisons This Month Prior 6 Months Recent Years Historical Past Projects Explorer FAQ

What's new at PRISM

30-Year Normals

The normals are baseline datasets describing average monthly and annual conditions over the most recent three full decades. They are our most popular datasets. The current PRISM normals cover the period 1991-2020.

Long-term average datasets are modeled with PRISM using a digital elevation model (DEM) as the predictor grid. Given their importance, the normals were subjected to extensive peer review. See [PRISM datasets](#) for more information; the data available from this page is "Normal1m" (normals). For information on when the grids were most recently updated, see [calendar of PRISM data updates](#).

PRISM normals are available for Alaska, Hawaii and US Pacific Island possessions, Puerto Rico, US Virgin Islands, Jamaica, and western Canada from the [Projects](#) page.

Any known issues with the PRISM normals datasets are documented in the [Known Issues](#) section.

Spatial resolution needed: ☒ 4km (approx. 1MB per data file; 300KB per full-size image) ☐ 800m (18-350MB per data file; 5MB per full-size image)

Climate variable:

Temporal period: ☒ annual values ☐ monthly values for

[Download Full-Size Image](#) [Download Data \(.bil\)](#) [Download All Normals Data \(.bil\)](#) [Formats available](#)
[View/Download Metadata](#) [Download Data \(.asc\)](#) [Download All Normals Data \(.asc\)](#) [Terms of use](#)

30-yr Normal Precipitation: Annual

Period: 1991-2020

Annual Precipitation (in.)

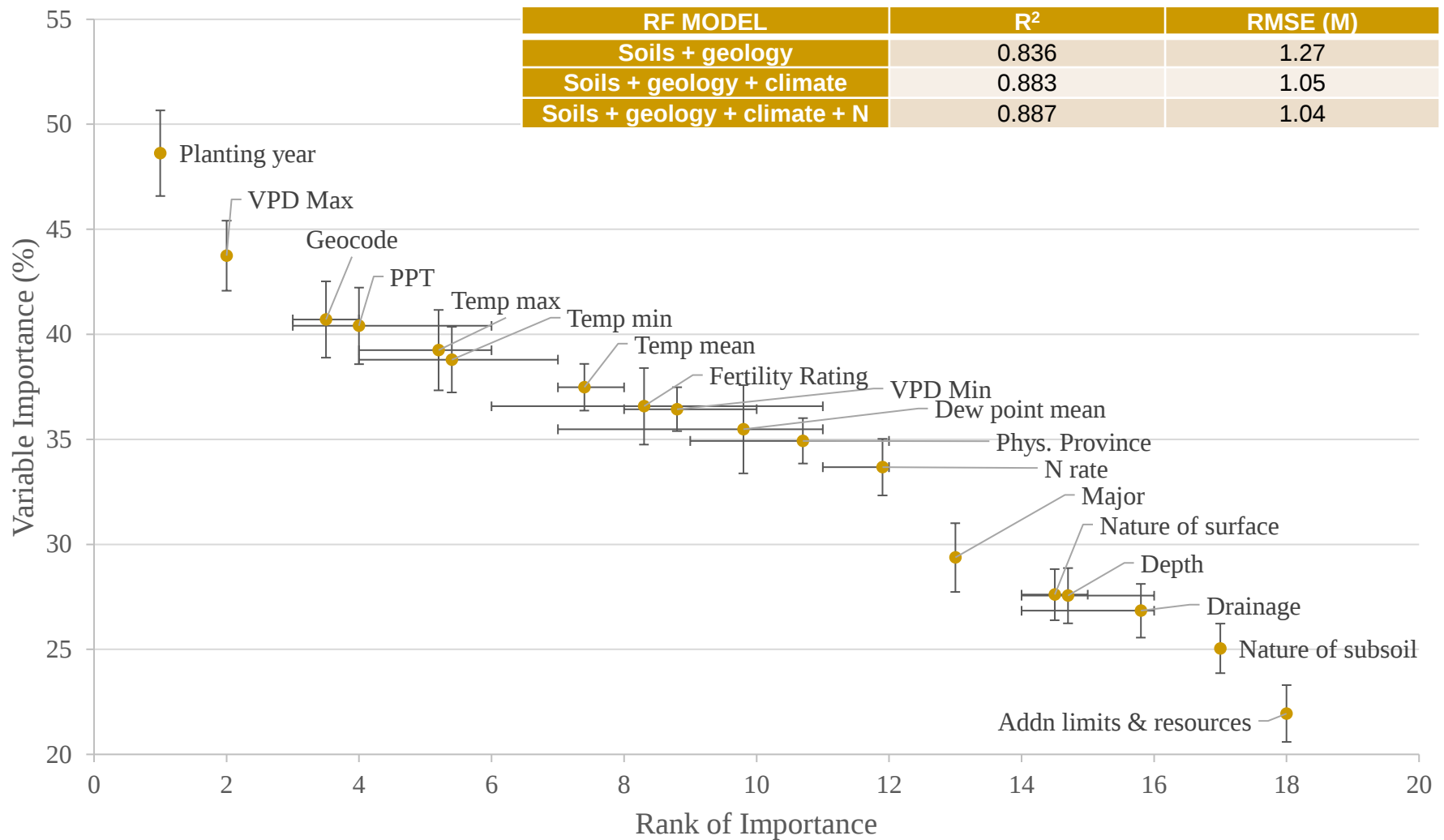
0	16-20	36-40	80-100
4-8	20-24	40-60	100-120
8-12	24-28	60-80	120-140
12-16	28-32	80-100	140-160
	32-36	100-120	160-180
		120-140	180-200

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Questions to prism-questions@prismclimate.org

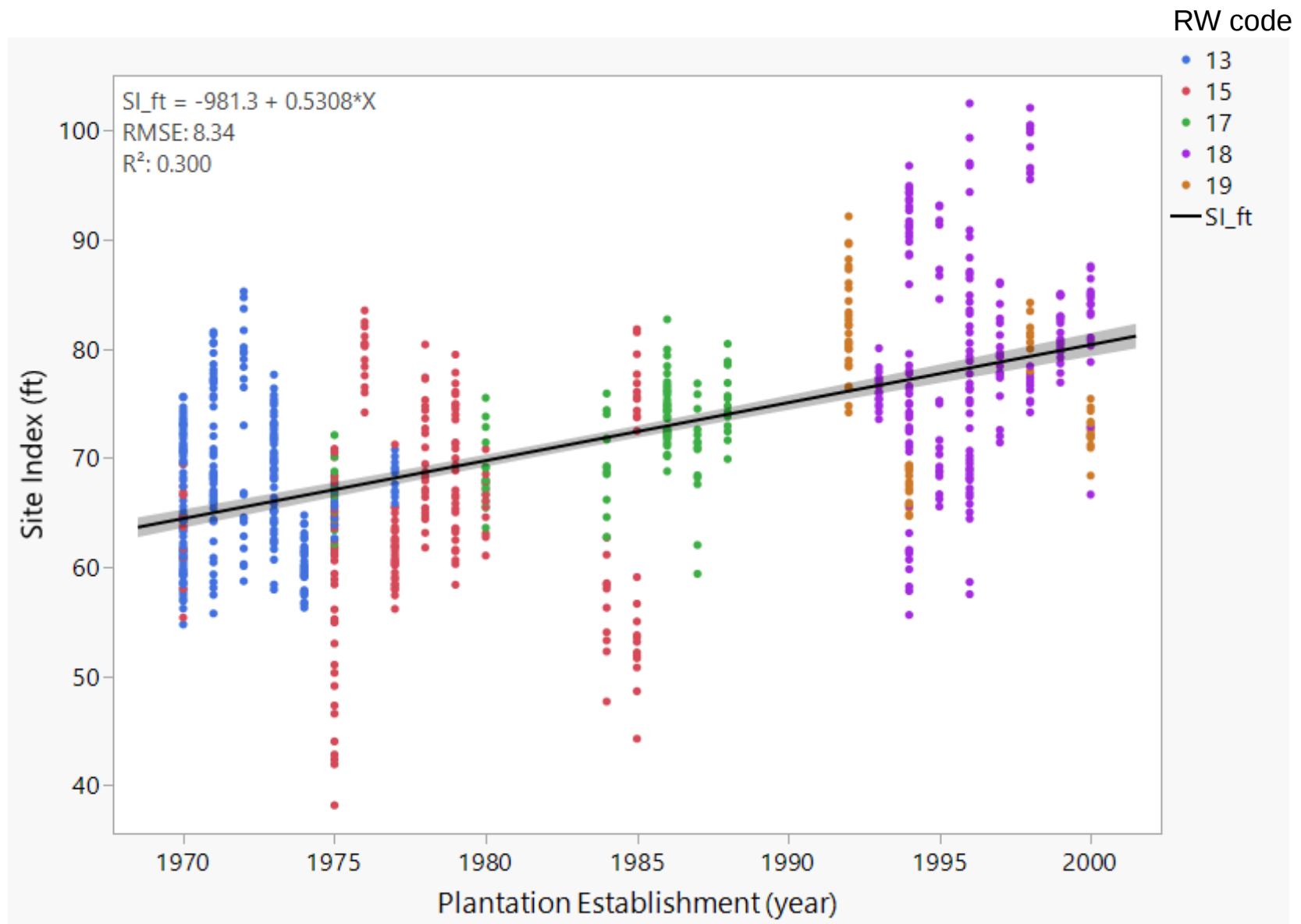
This website is supported by the USDA Risk Management Agency

Random Forest Variable Importance

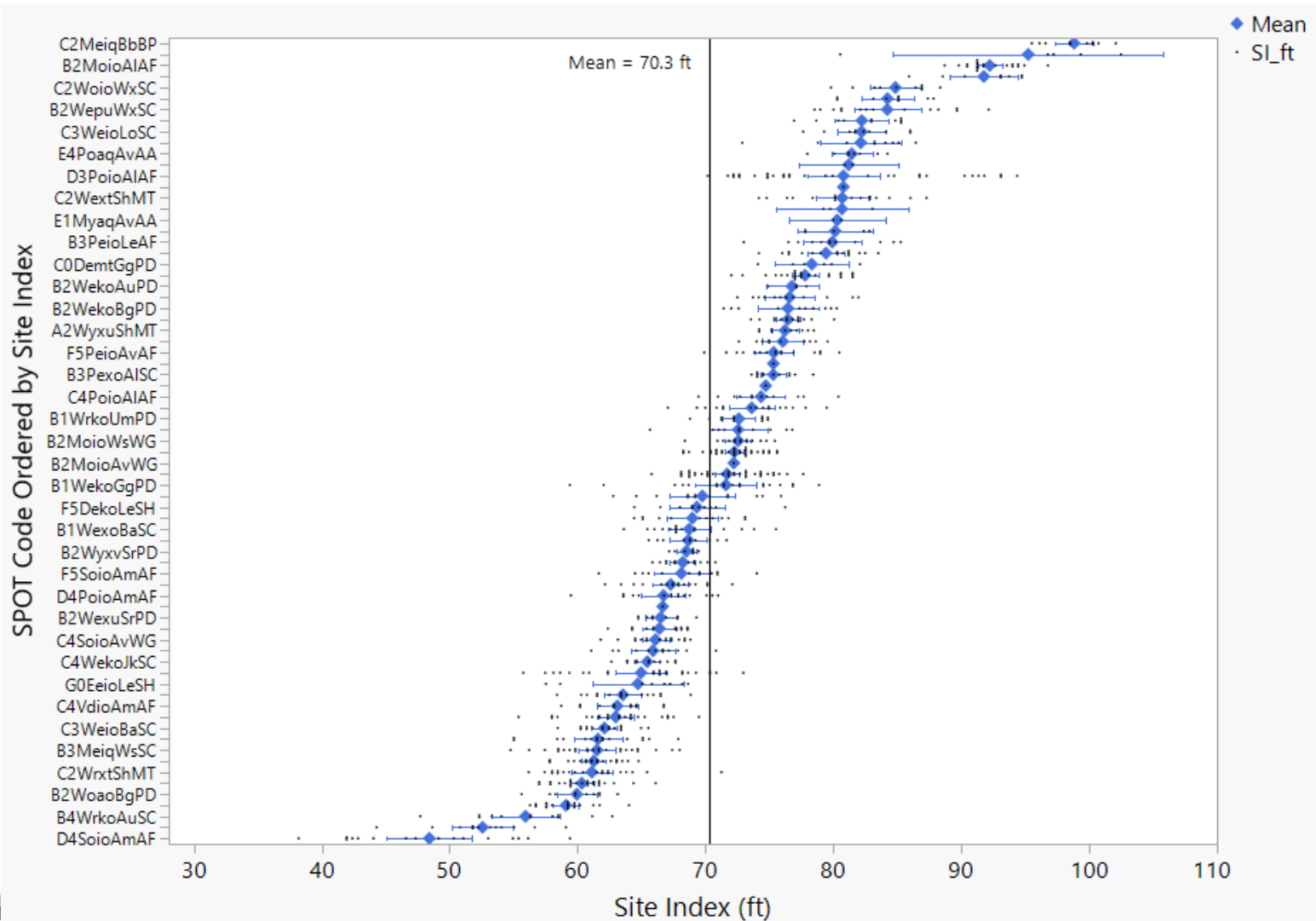


Range of rank after 10 model runs

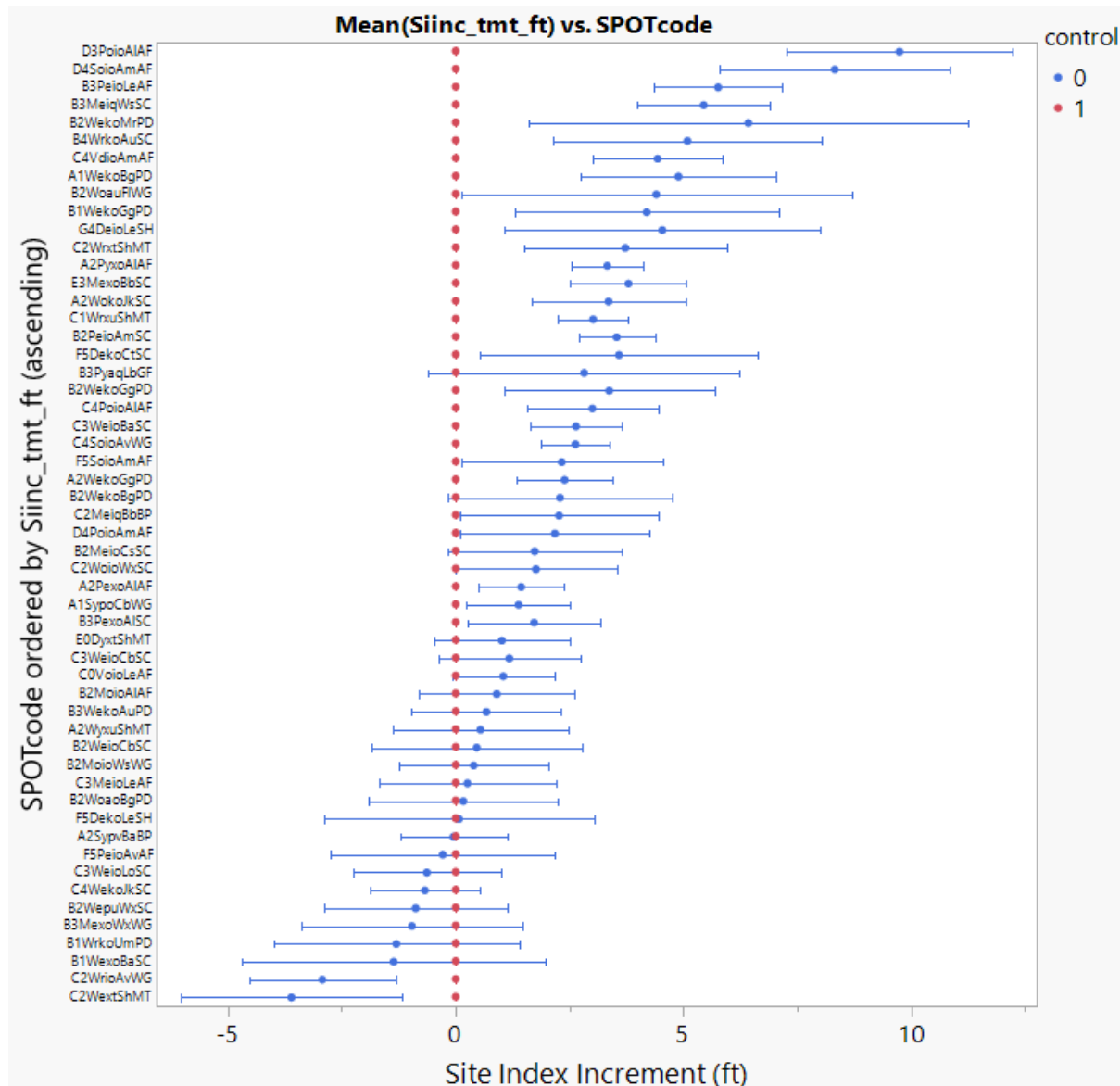
Site Index improving 0.5 ft per year



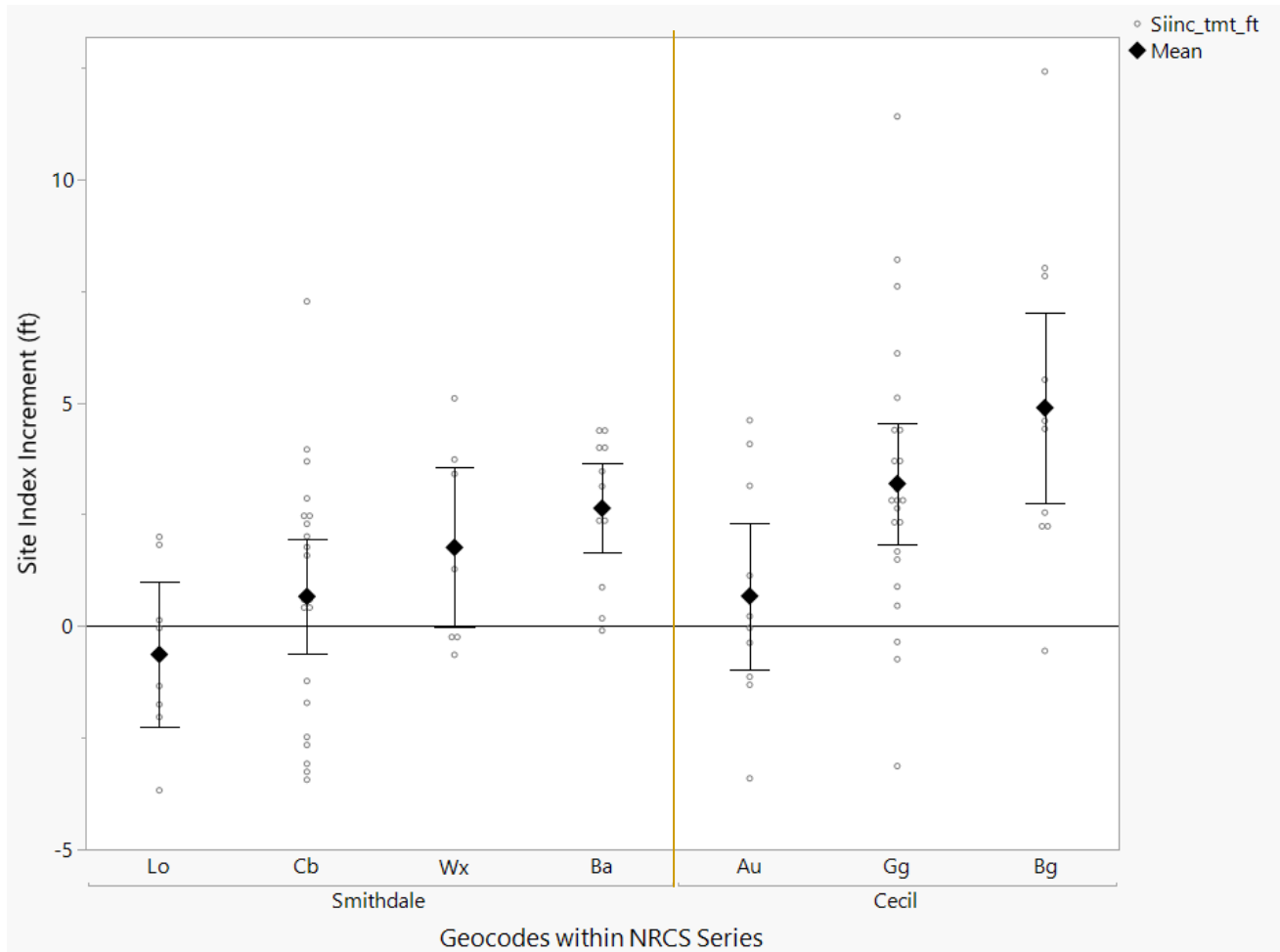
Site Index Distribution by SPOT code (ft)



Site Index Fertilizer Response by Spot Code



Site Index Fertilizer Response: Geology matters within NRCS soil series

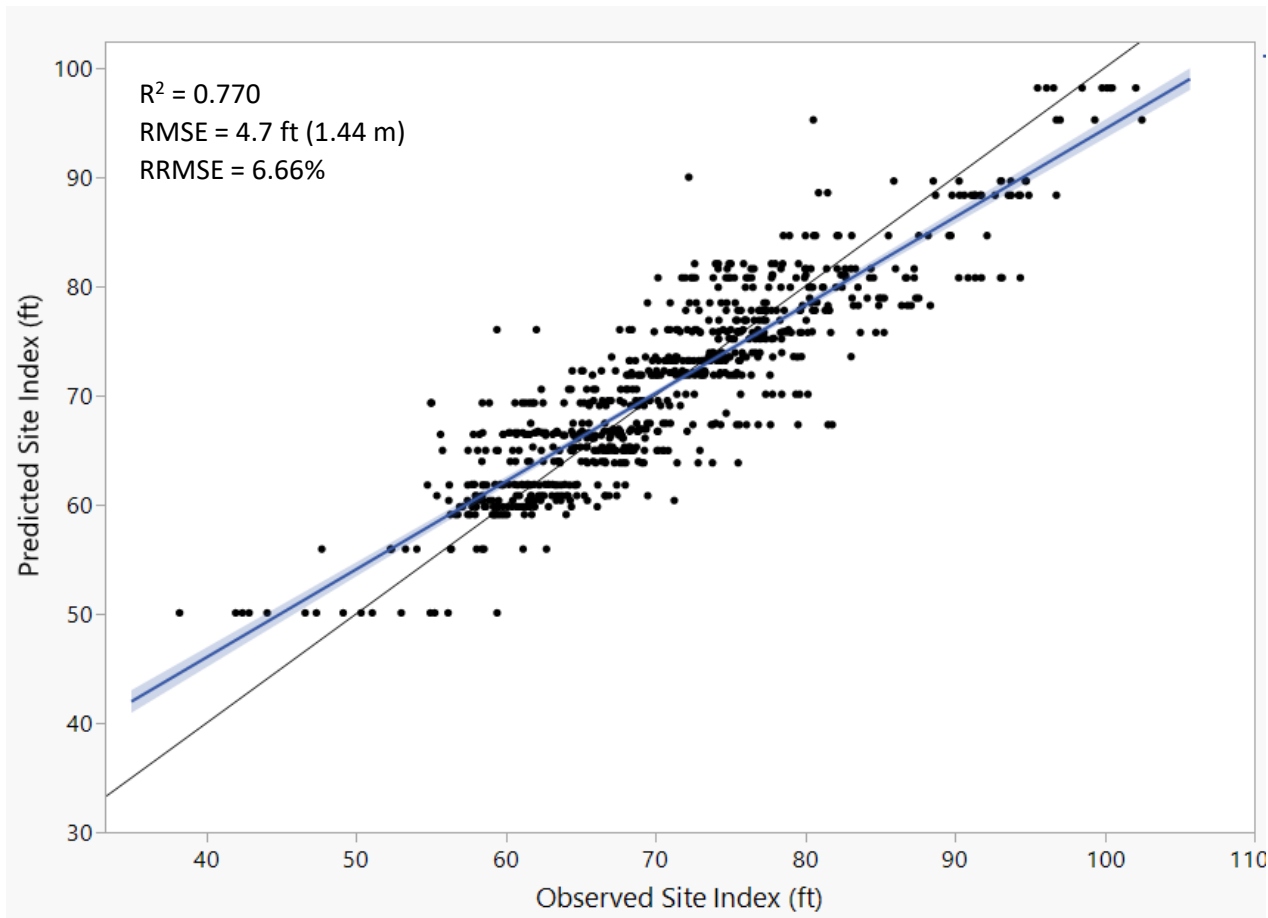


95% Confidence Intervals



SPOT model for site index predictions

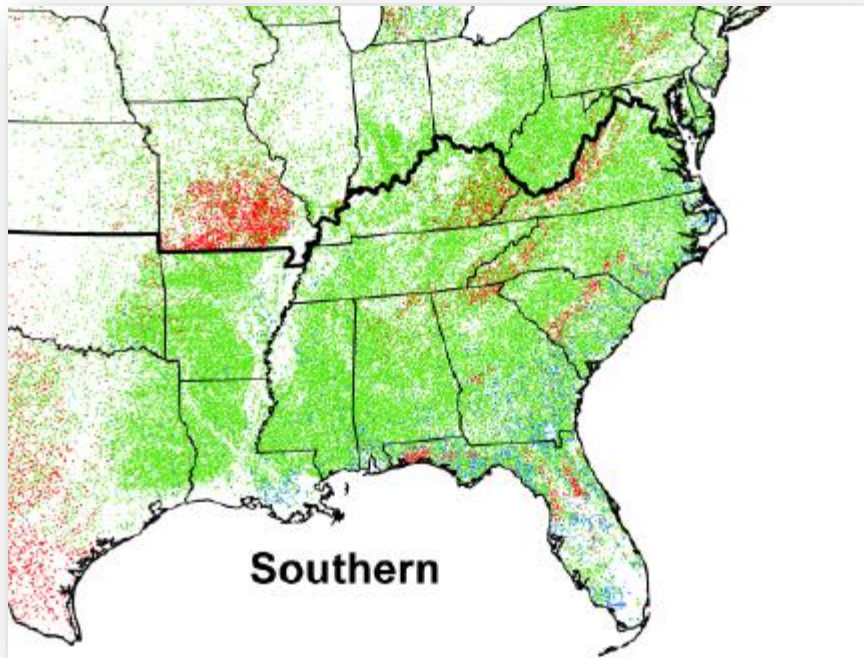
$SI_m \sim \text{Major code} + \text{Drainage} + \text{Depth} + \text{Surface}$
 $+ \text{Subsoil} + \text{Addn limitations} + \text{Geocode} + \text{Phys Prov}$



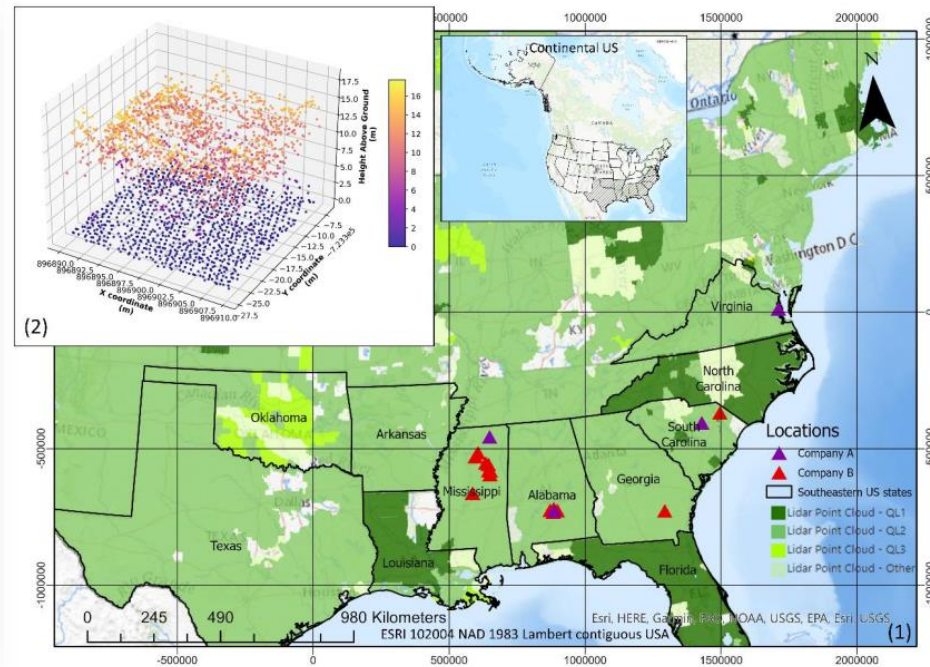
Next Steps: More Data!

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

