

Some Remote Sensing Inferences for Southern Pine Stands in AR

An Exploration of Lidar vs NAIP3D, Various Model
Types, and More ...

April 21, 2026

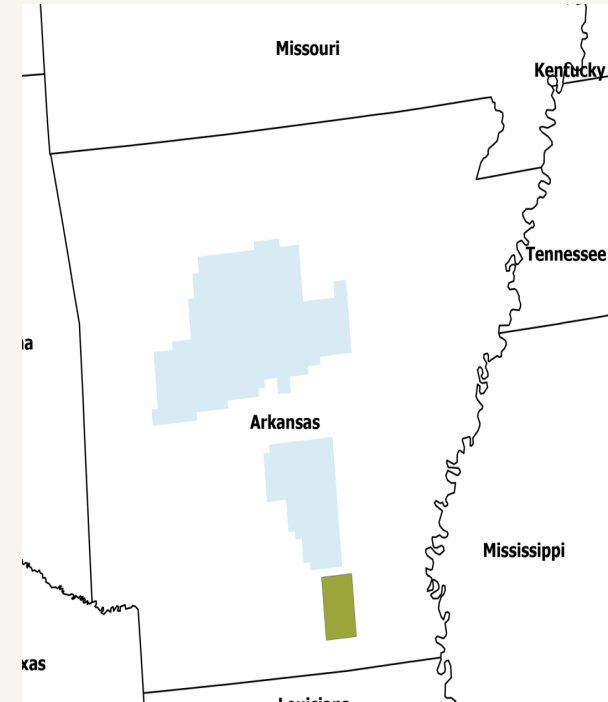
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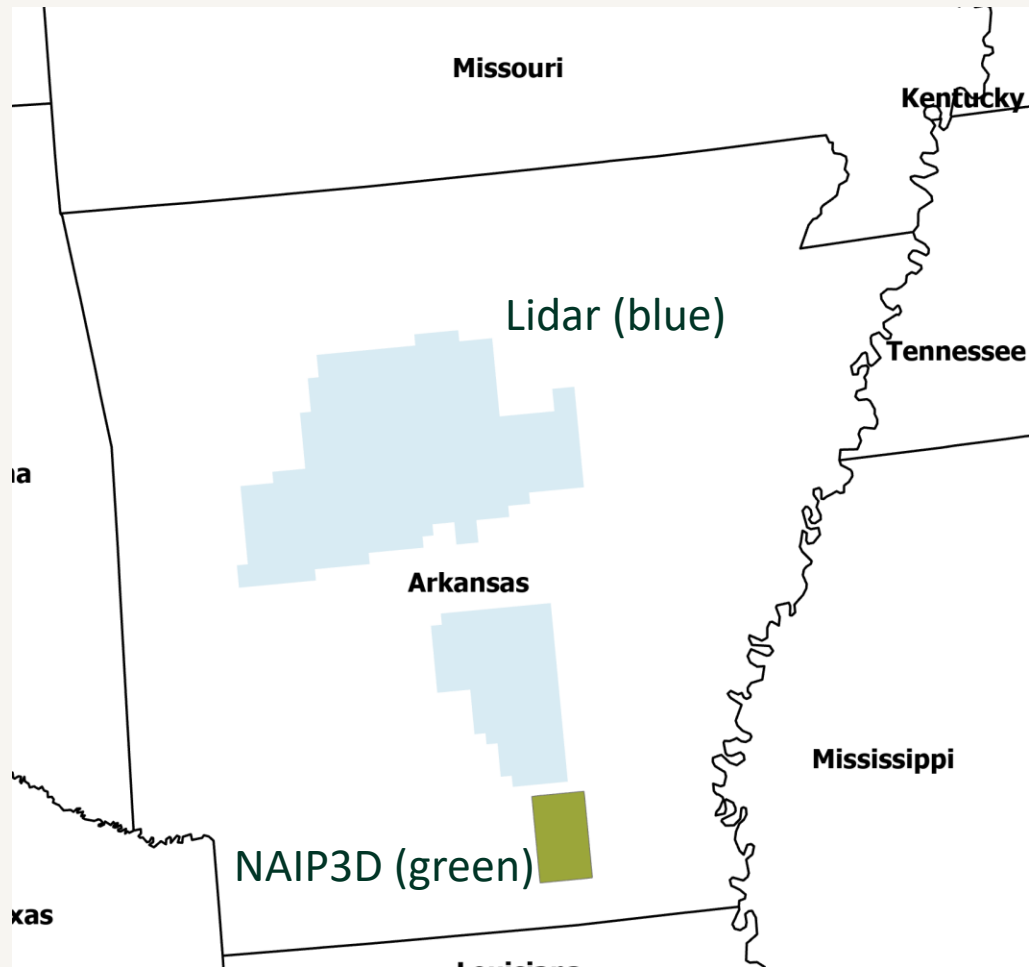
Forest Planning and Biometrics

Outline

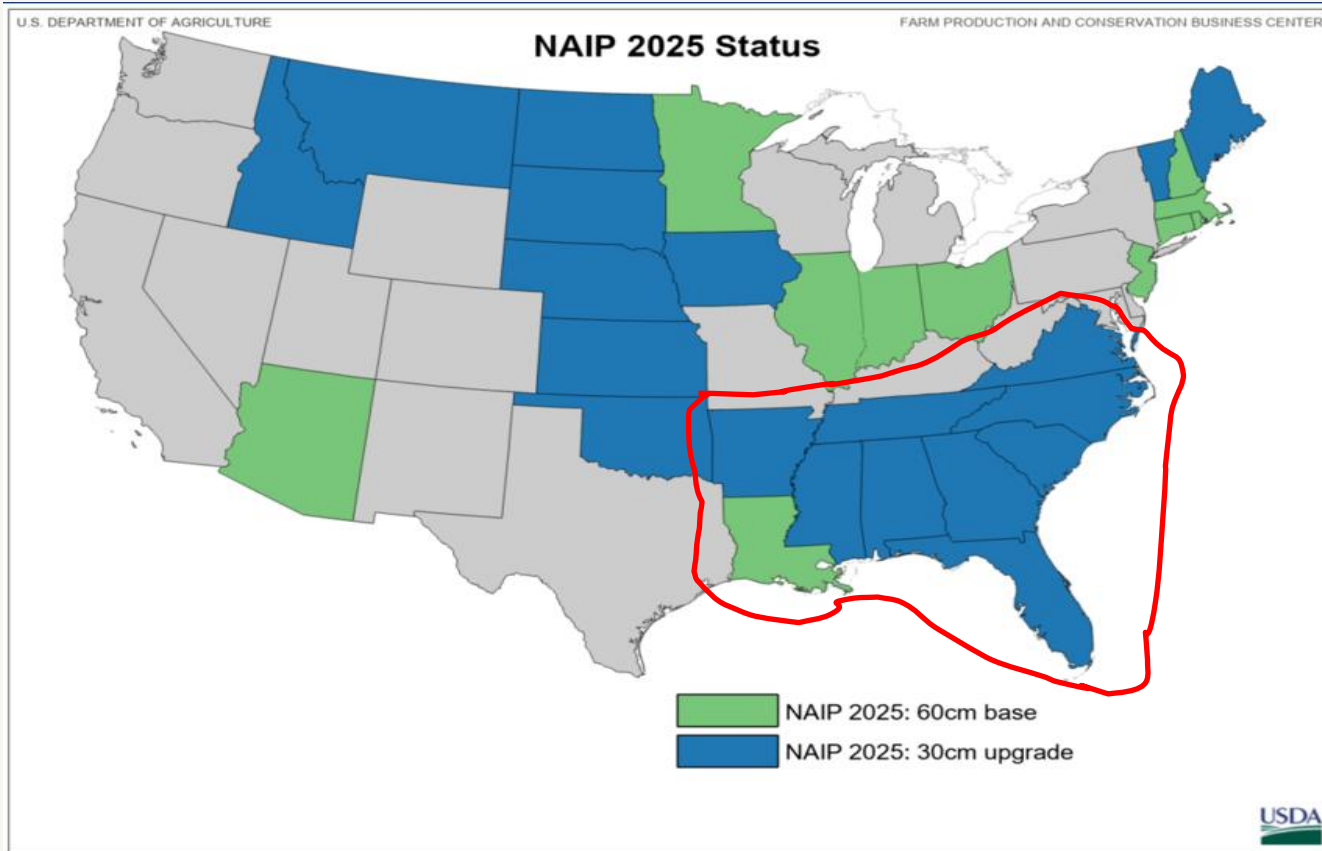
1. Study Area
2. Lidar vs NAIP3D
3. Research Questions
4. Validation
5. Results
6. Summary



Arkansas
Study Areas:
NAIP3D
Lidar



Southern NAIP3D

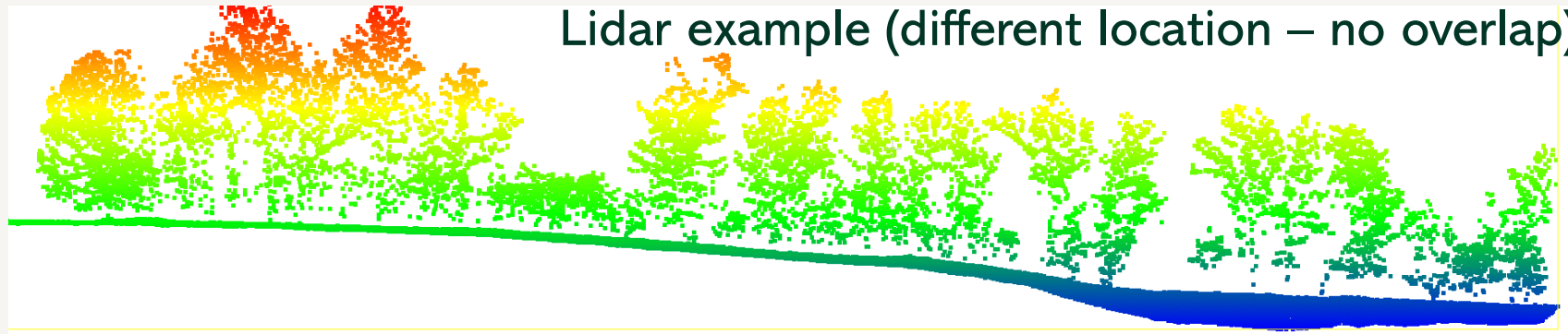


NAIP3D vs Lidar Point Cloud

NAIP3D example (older 2023 vintage)

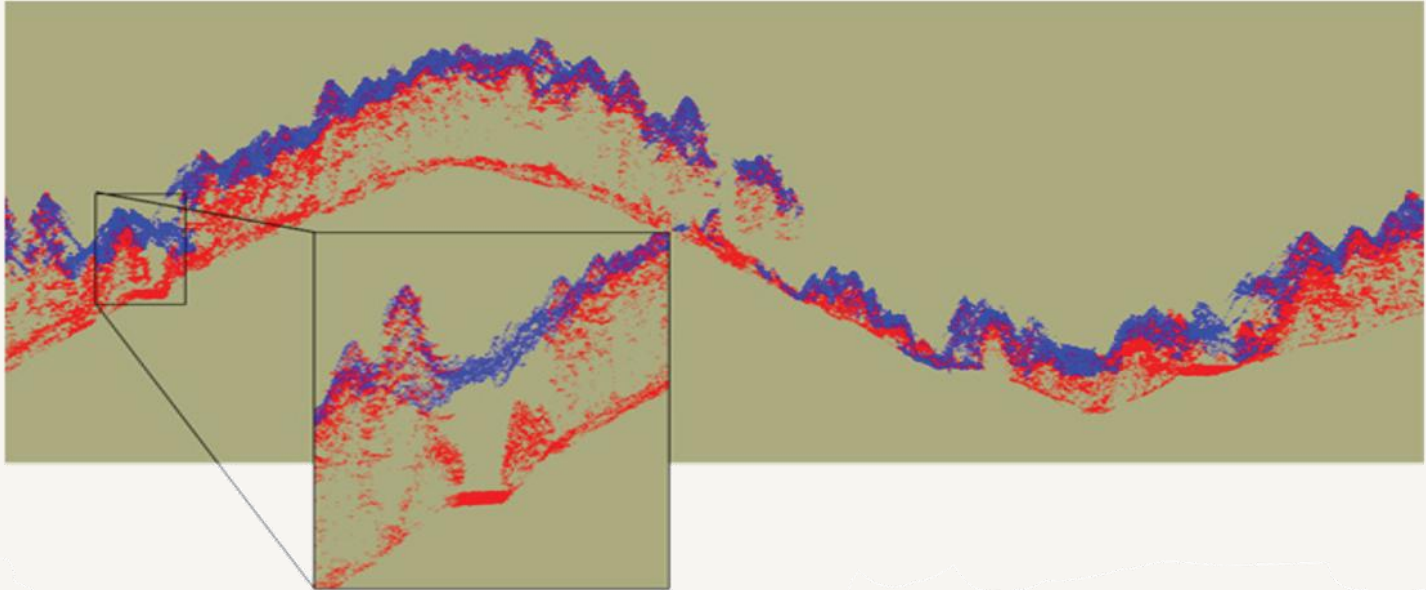


Lidar example (different location – no overlap)



NAIP3D vs Lidar Point Cloud

PNW Example...

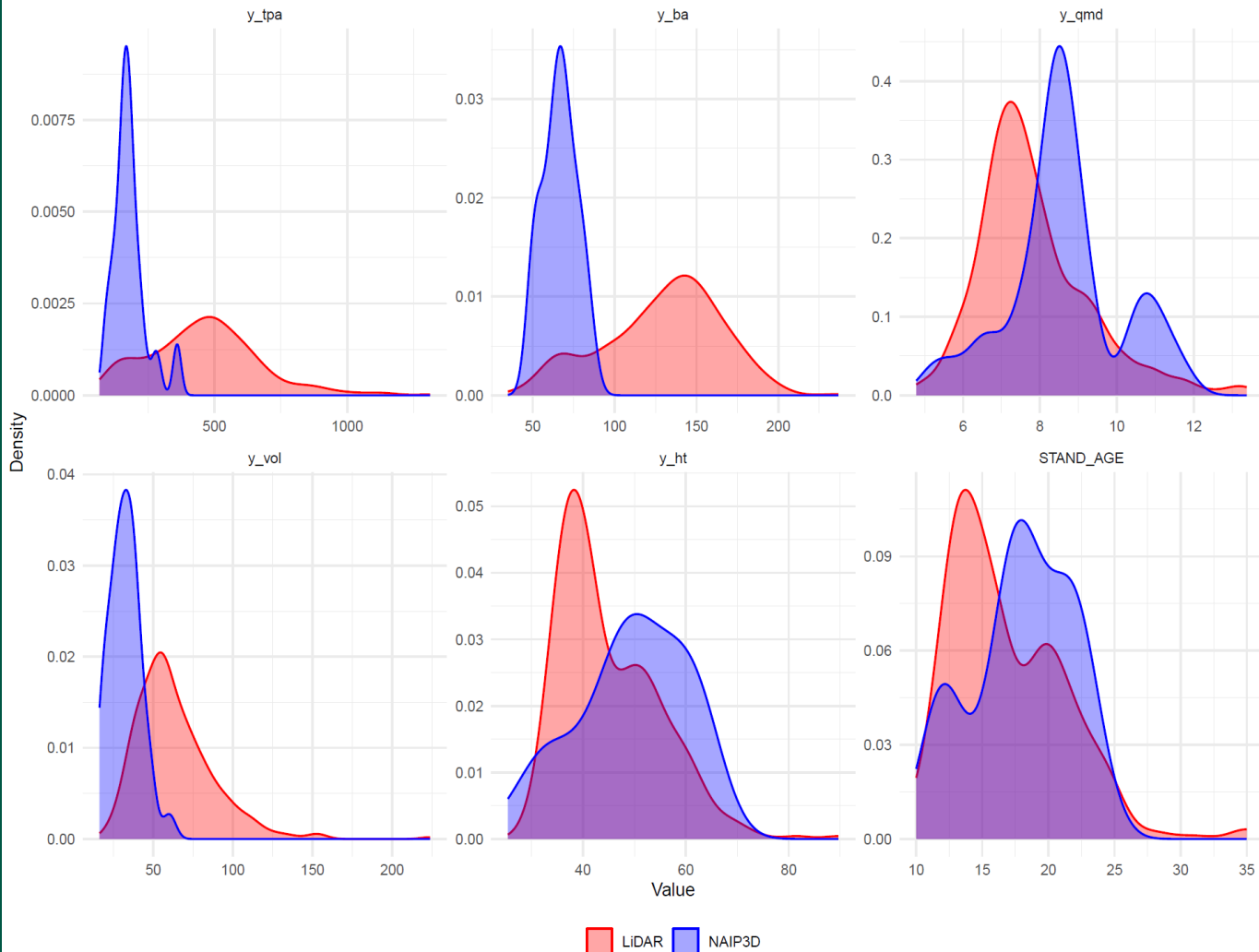


Quick look:

- Cruise plots
- Stand level data
- Lidar – 300+ stands
- NAIP3D - 37 stands

DIFFERENT!!

Field Measurement Distributions

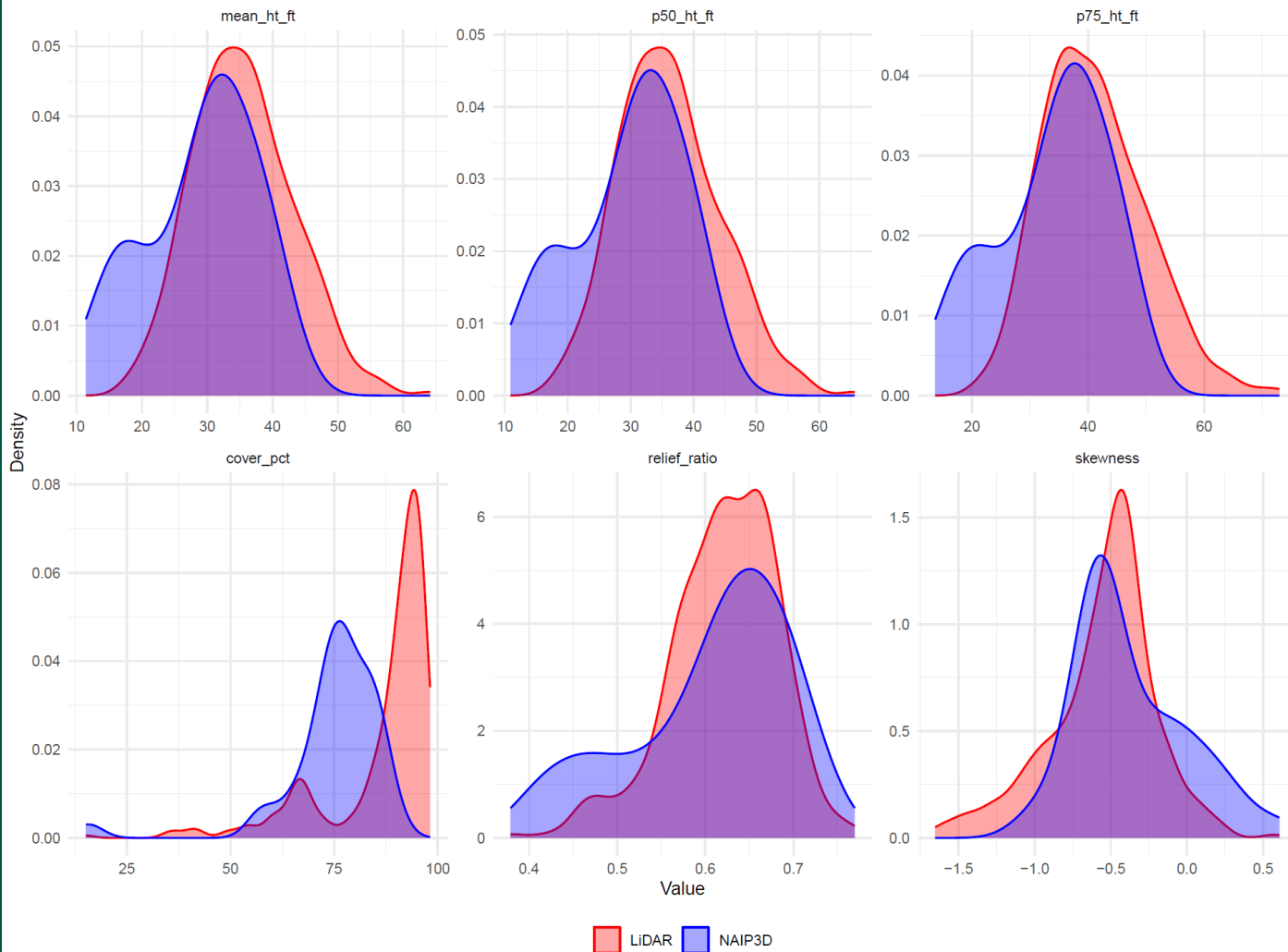


Quick look:

- Remote Sensing
- Cruise plots
- Stand level

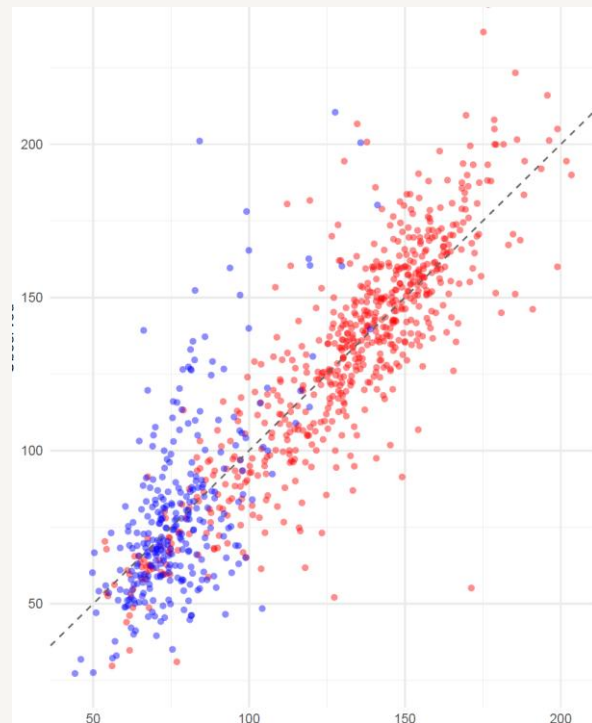
- Data Different!

Remote Sensing Metric Distributions (heights in feet)



Research Questions

1. (Lidar vs NAIP3D performance)
2. Stand vs Plot Scale Performance
3. Stand vs Plot Scale Models
4. Effect of Model type (kNN, OLS, RF, XGB)
5. SAE: Synthetic vs GREG vs Rand Effect



*Terminology

“Small area” estimation (SAE)

- subdomain, subgroup, local area, etc.
- Estimation at the stand scale in this context

Synthetic estimation (straight model prediction)

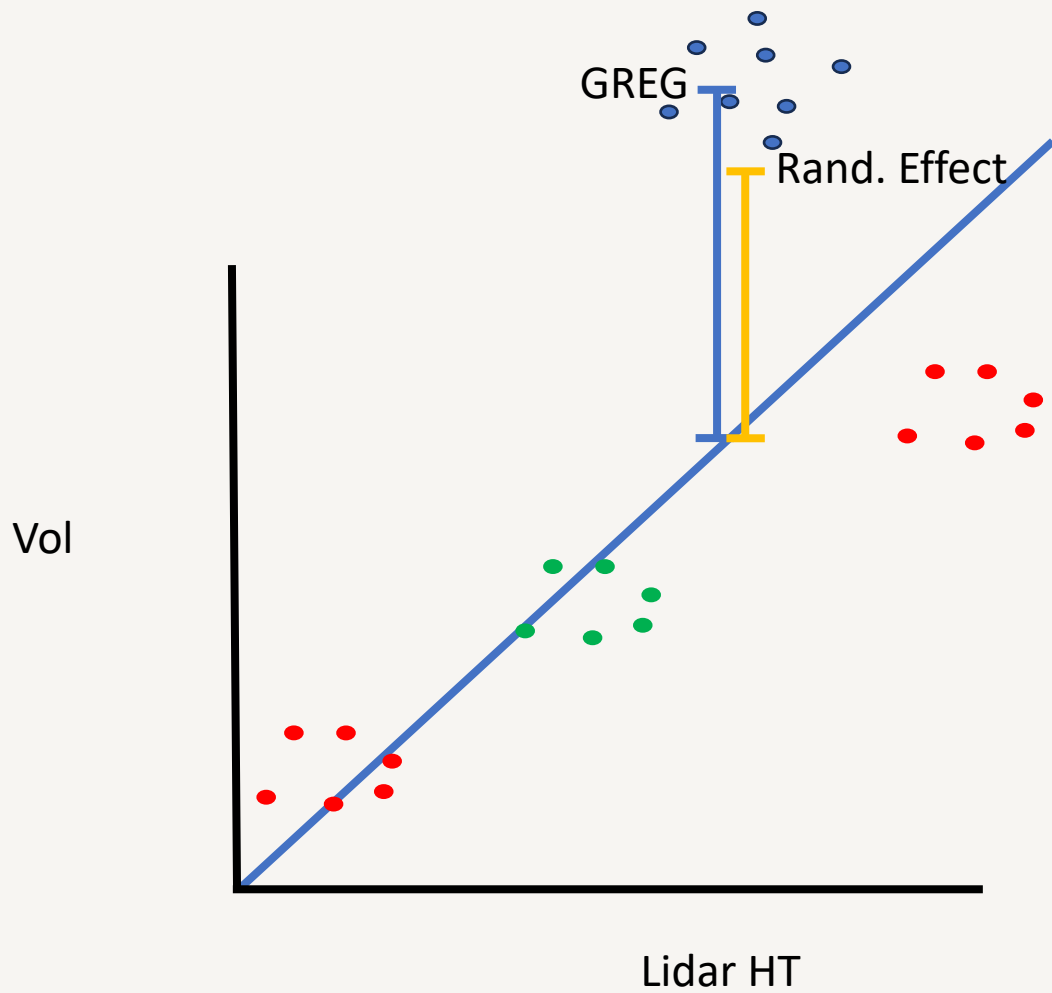
- Make predictions with a fitted model
- No attempt at survey sampling type inference

Generalized Regression Estimator (GREG) (adjust with sample)

- Like a fixed effect for each stand
- Survey sampling approach
- Leverages a model and a random sample for design-based estimation ...

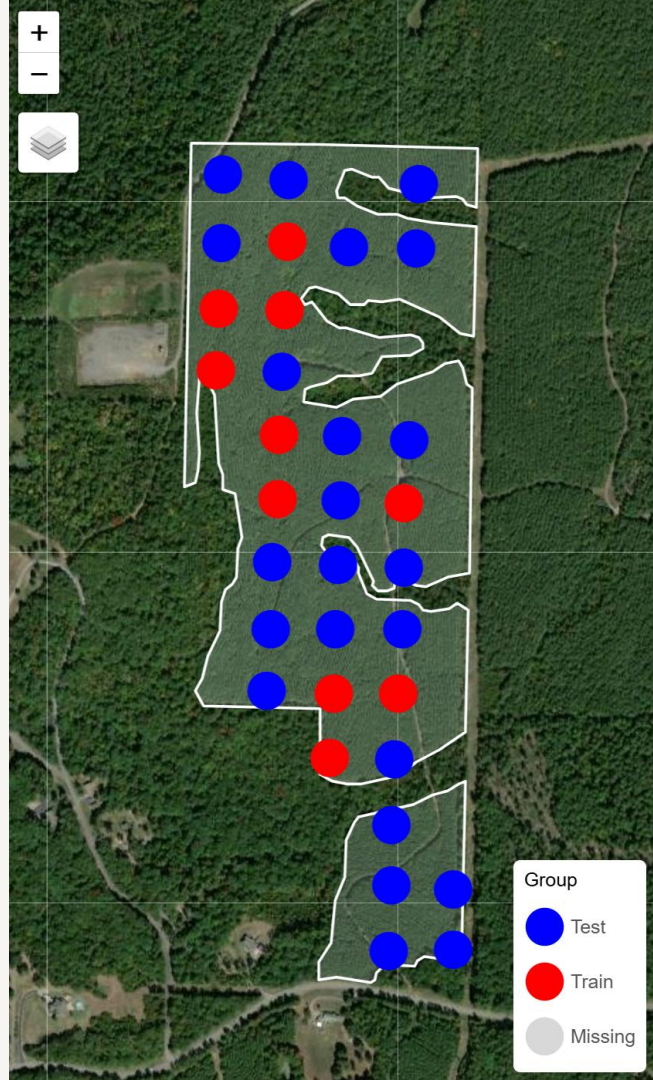
Random effects model in SAE context (nuanced sample-based adjustment)

- Group effect estimate “adapts” to data
- Depends on sample size and within / between group variability
- Can “shrink” back to model prediction



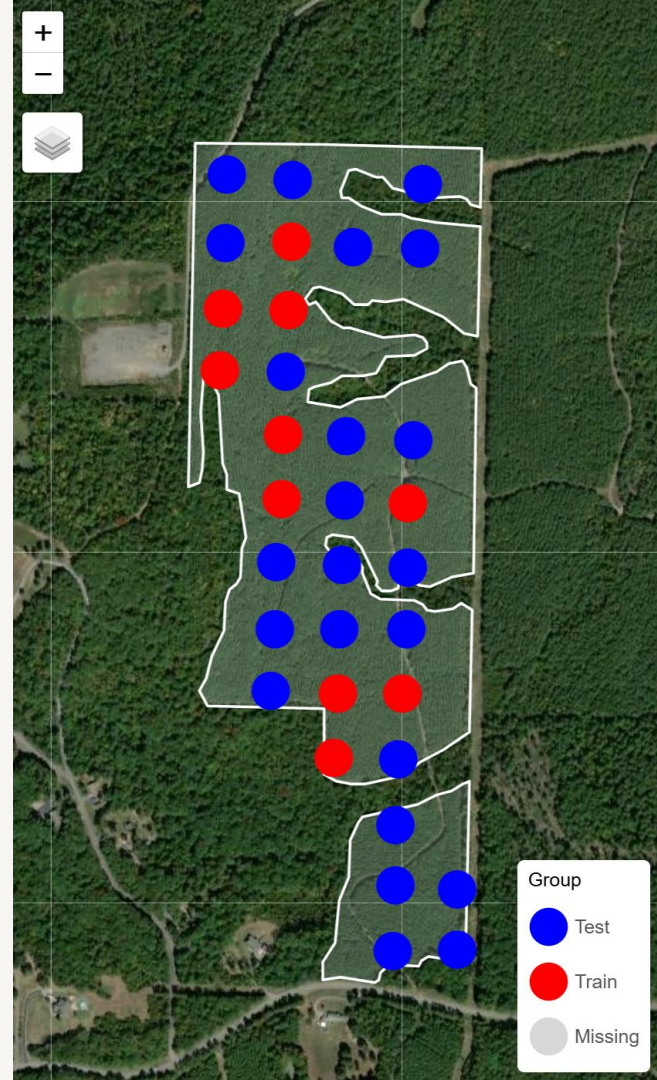
Validation – True Synthetic

1. K-folds cross validation (5-fold)
 - A. 80% **stands** train
 - B. 20% **stands** test(otherwise results too optimistic if plots from same stand included in predictions)
2. Holdout approach
 - 10 plots -> train
 - 15 plots -> test
3. Compute errors (15 test plots / stand)



Validation - SAE

1. Holdout approach (25+ plot stands)
 - **10 plots -> train**
 - **15 plots -> test**
2. Compute errors (15 test plots / stand)



Research Questions (Again)

1. (Lidar vs NAIP3D performance)
2. Stand vs Plot Scale Performance
3. Stand vs Plot Scale Models
4. Effect of Model type (kNN, OLS, RF, XGB)
5. SAE: Synthetic vs GREG vs Rand Effect



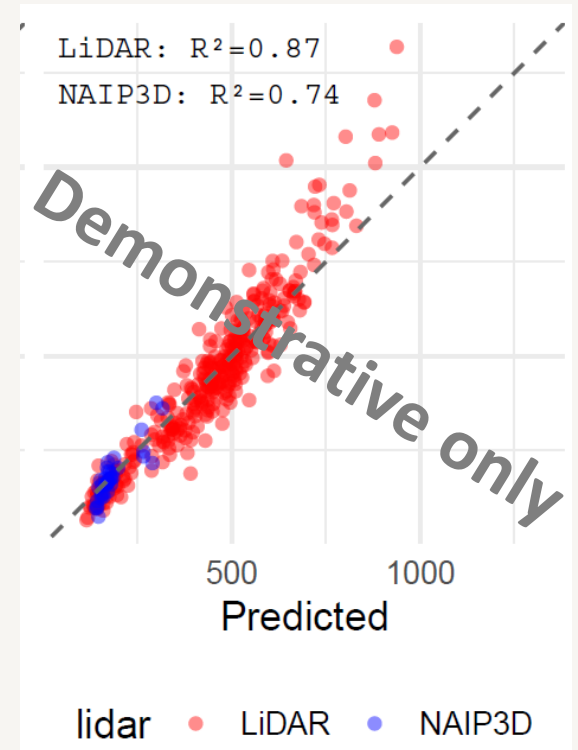
5-Fold CV & Holdout



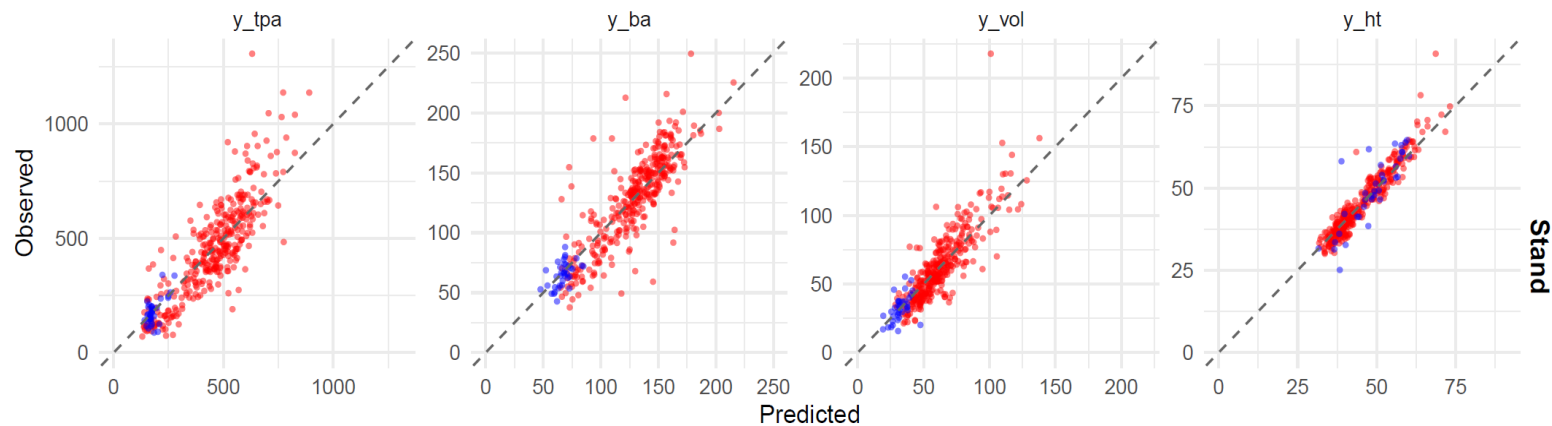
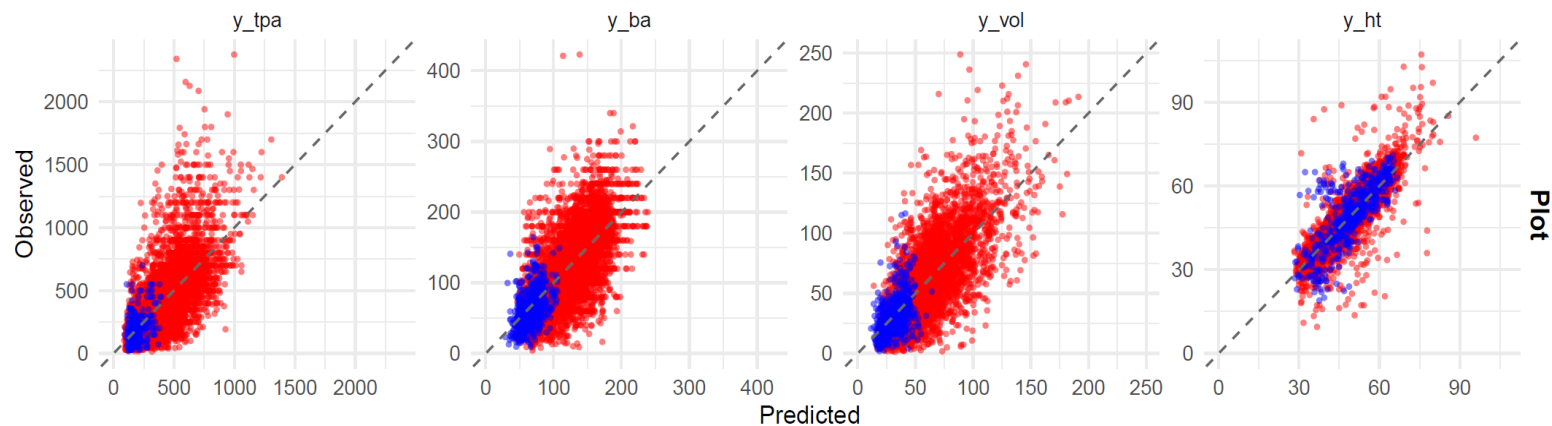
Holdout only

(Q1: NAIP3D vs Lidar)

- Not a separate section
- Embedded into Q2 – Q5 results
- ~Encouraging
- Hard to evaluate
 - Range is limited
 - Few stands
 - Low values of Vol / BA

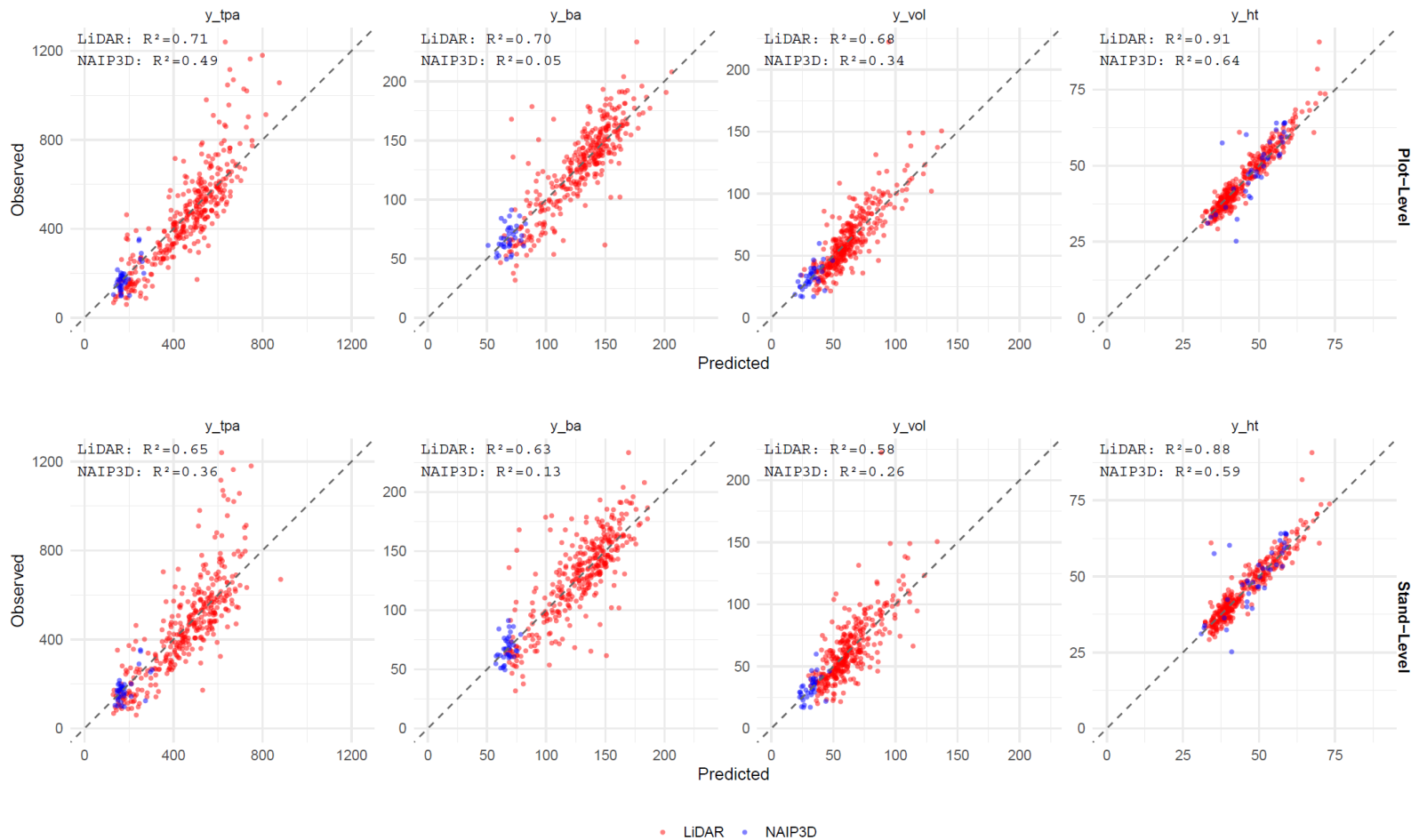


Q2: Plot vs Stand-Level Errors (RF, Plot-Model)

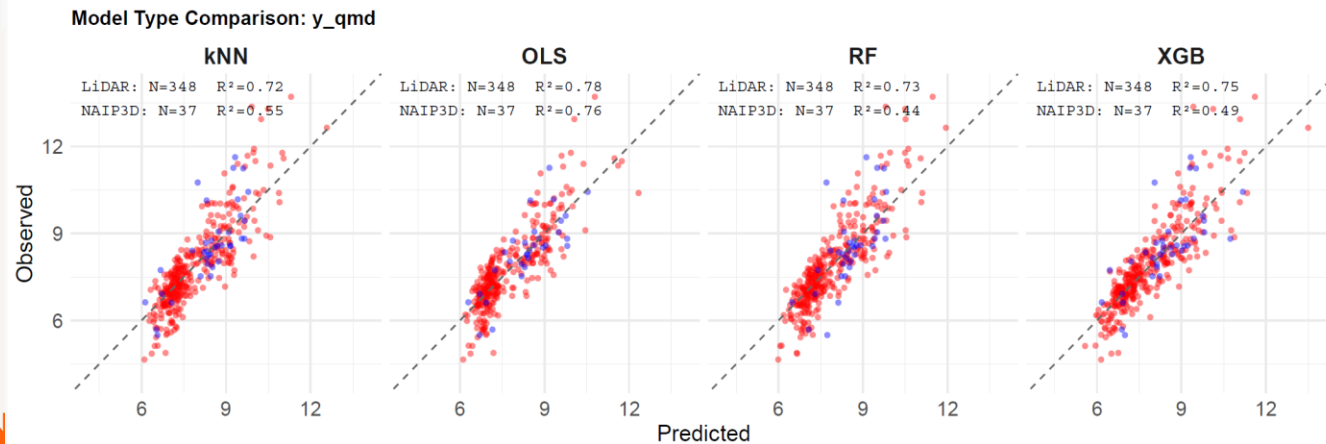
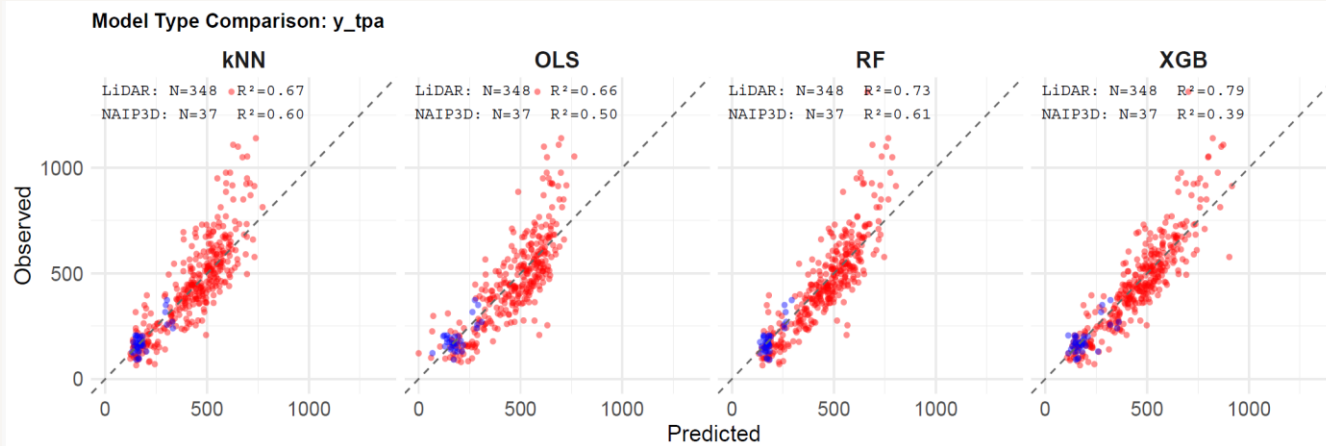


• LiDAR • NAIP3D

Q3: Plot vs Stand Models (RF, Stand Level Errors)



Q4: Model Types(Plot-Mod, Stand-Ag)



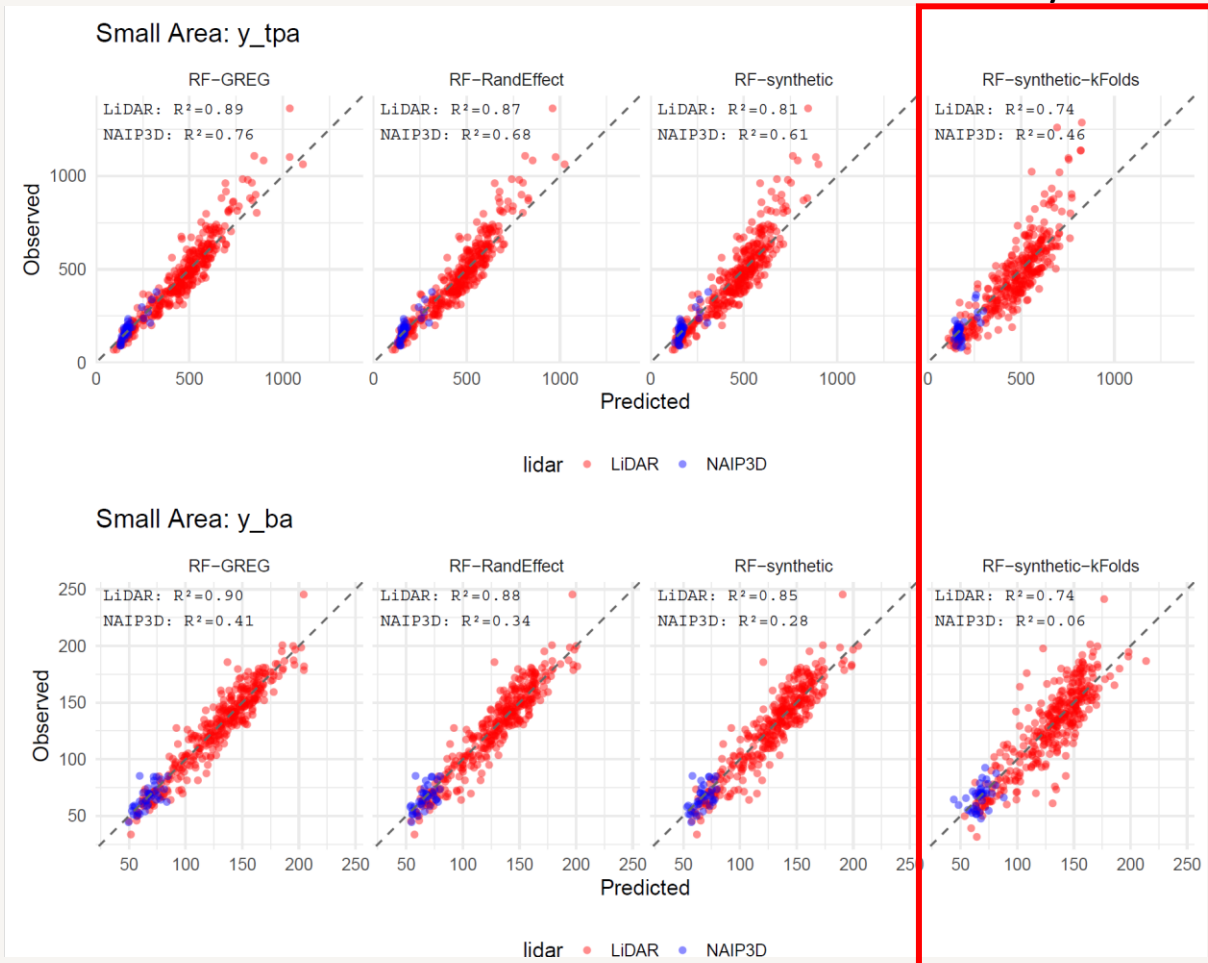
Source: ● LiDAR ● NAIP3D



Q5: Small Area Approaches

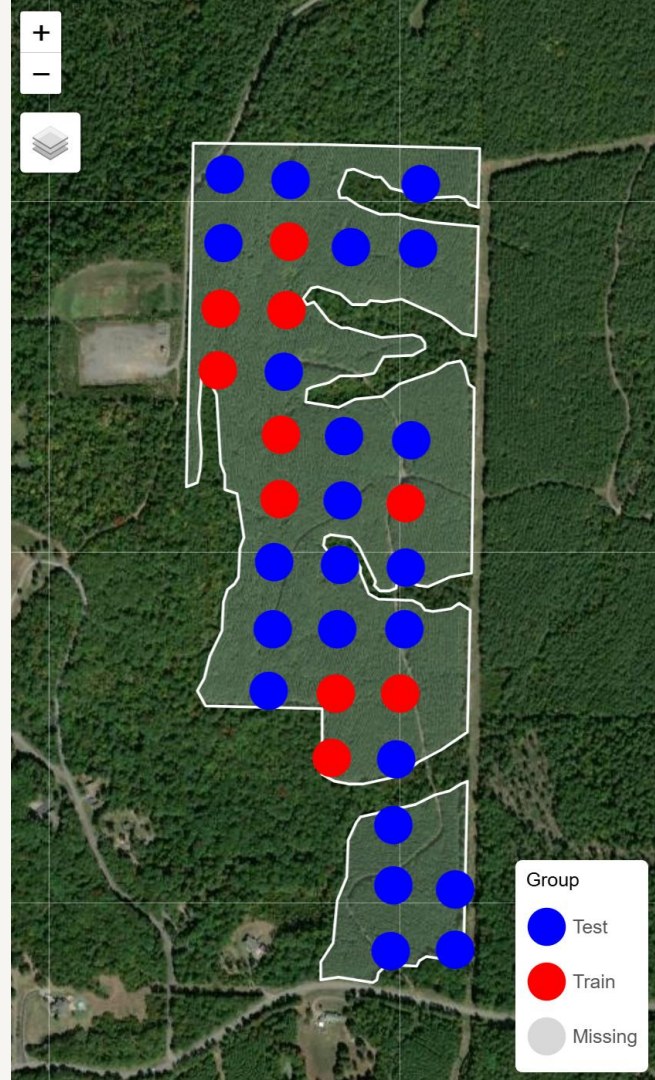
Random Forest
Plot-Level models
Stand-Aggregates

True Synthetic



Summary

1. (Lidar vs NAIP3D performance)
 - **Poor match BUT encouraging for NAIP3D**
2. Stand vs Plot Scale Performance
 - **Stand average much improved**
3. Stand vs Plot Scale Models
 - **Plot-scale models work better**
4. Effect of Model type
 - ~**Minor, depends on response**
5. Synthetic vs GREG vs Rand Effect
 - **GREG best for 10+ plots**





Thank You

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