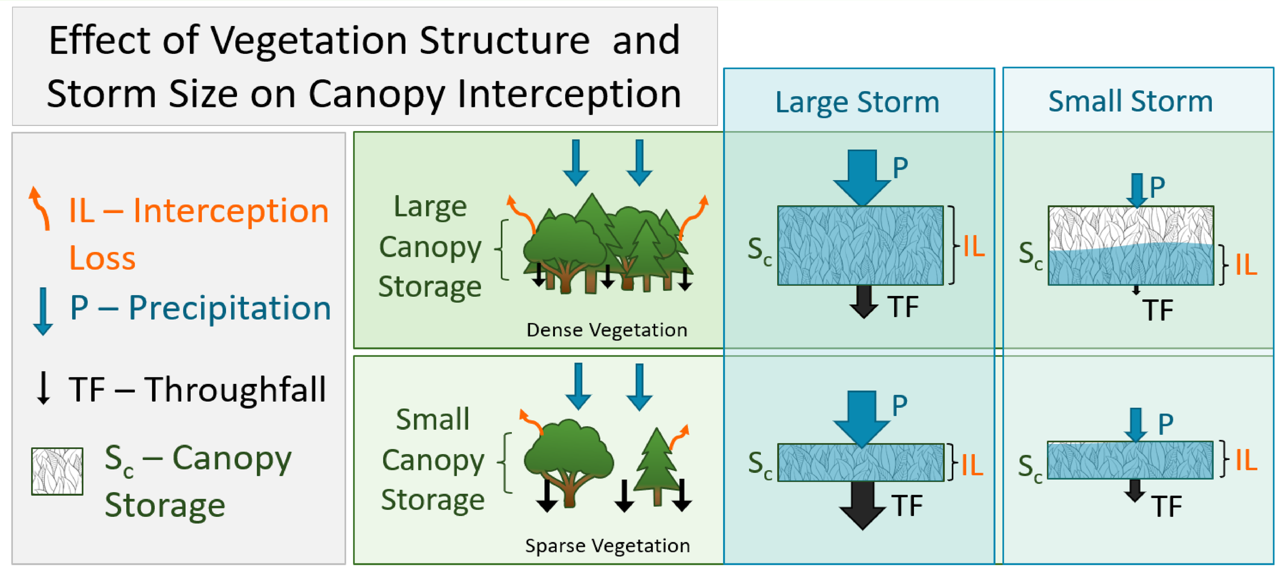
EXPERIMENT STATION
College of Agriculture, Biotechnology & Natural Resources

# Improving Predictions of Global Canopy Interception Losses by Leveraging Remotely Sensed Canopy Structure Data

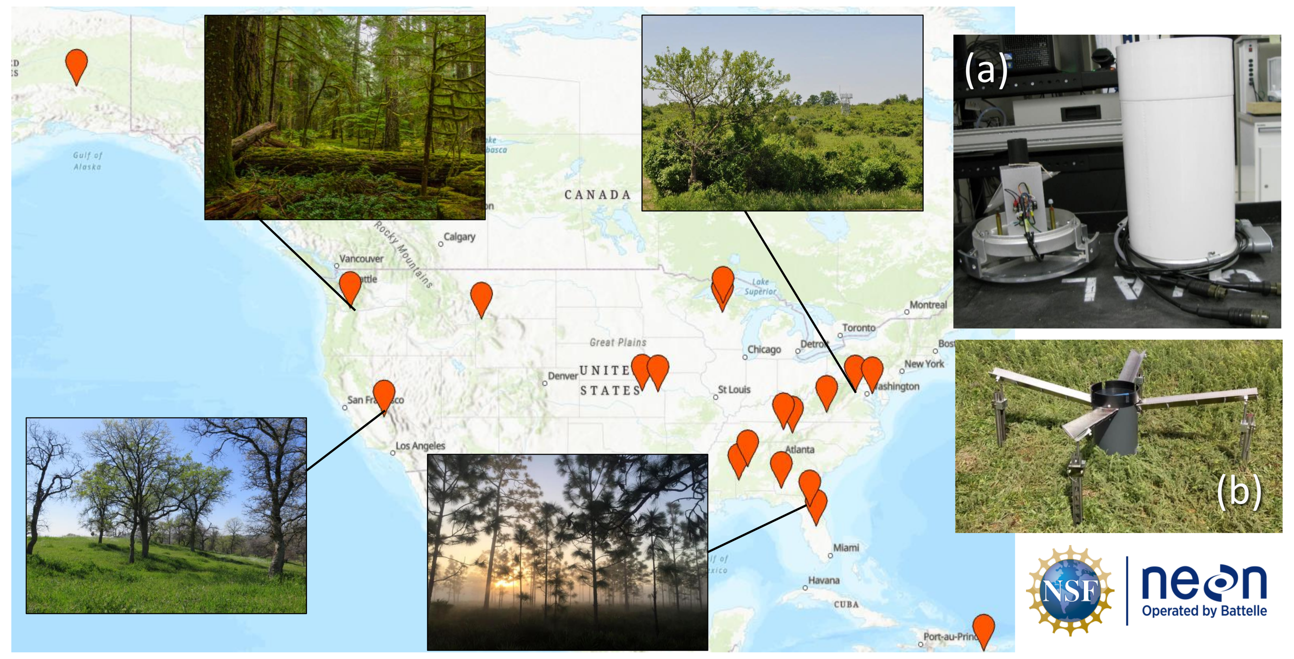
Abigail G. Sandquist[1], Scott T. Allen[1], Gabriel Barinas Sanchez[2], Steven P. Good[2]
[1]University of Nevada Reno, [2]Oregon State University

## Introduction

**We use field-measured precipitation and throughfall data from diverse vegetated sites to determine whether canopy structural traits can predict event-based interception losses (IL),** towards identifying new approaches to predict spatiotemporal variations in IL.

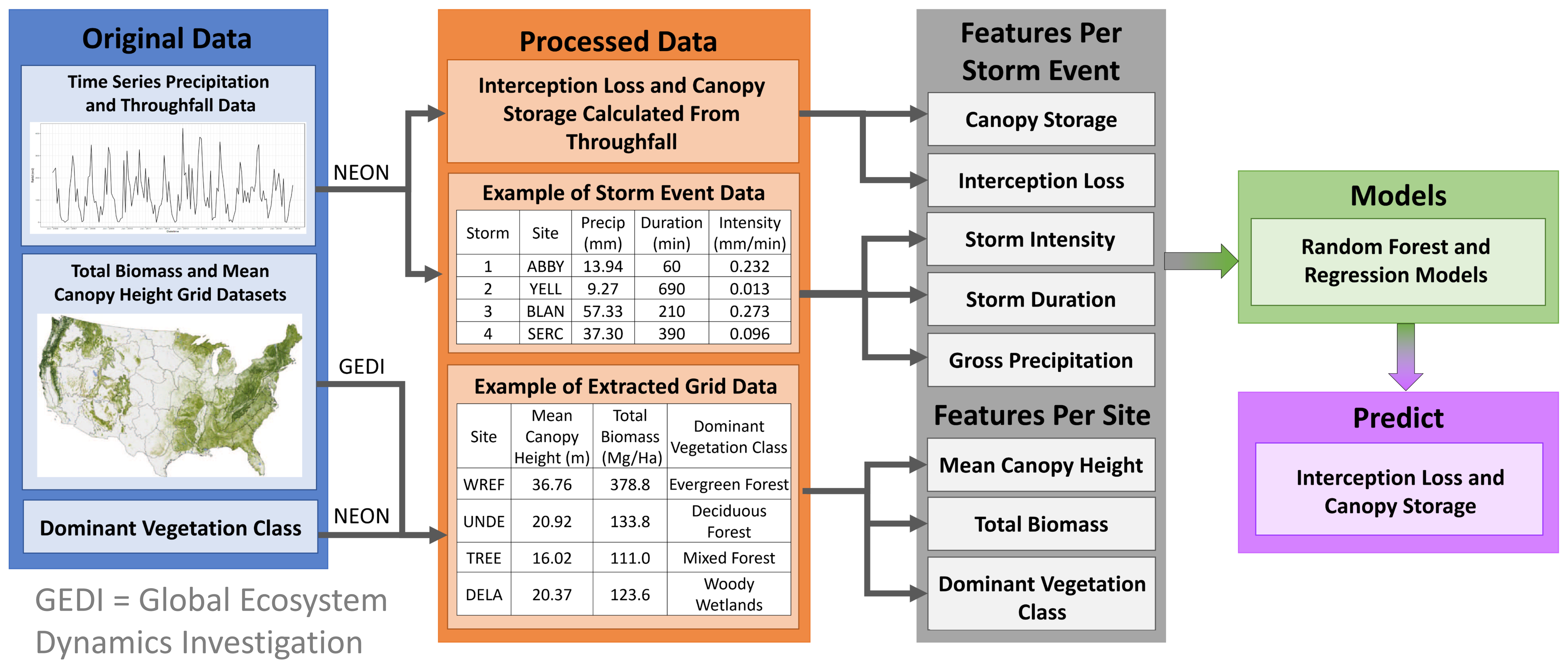



Orange pins show the sites from the National Ecological Observatory Network (NEON)[1] used in this study. Each site has a gross precipitation tipping bucket (a), and up to five throughfall tipping buckets (b). We use 30- and 1-minute timeseries precipitation and throughfall data collected from January 2016 to July 2022.




## Methods

We identified storm events from the NEON precipitation time series, and calculated gross precipitation, duration, intensity, and canopy interception values for each storm. The NEON dominant vegetation class and GEDI vegetation metrics are associated with each event by site. This resulted in a dataset of 1906 storms across 23 sites to input into the random forest and regression models, with the goal of predicting canopy interception.




Example of Storm Event Data

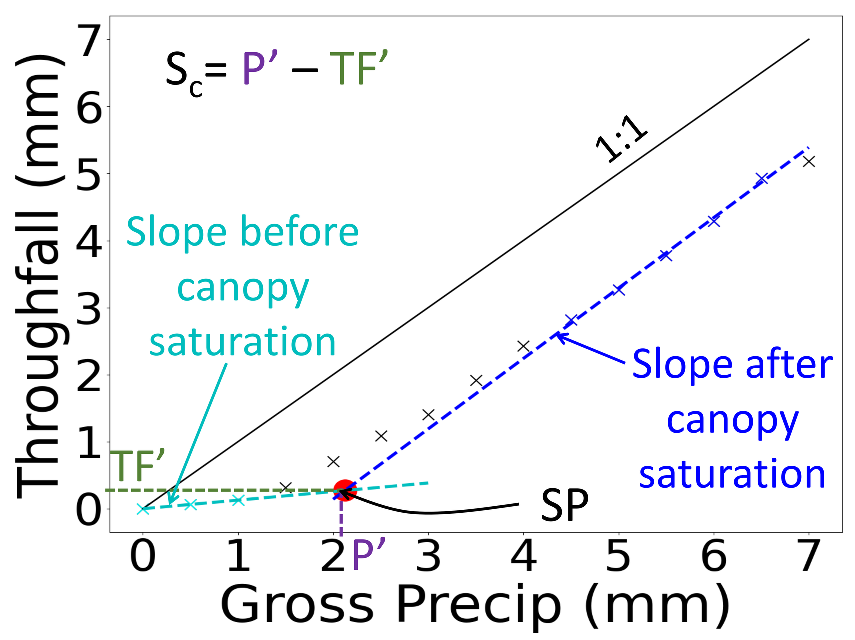
| Storm | Site | Precip (mm) | Duration (min) | Intensity (mm/min) |
|---|---|---|---|---|
| 1 | ABBY | 13.94 | 60 | 0.232 |
| 2 | YELL | 9.27 | 690 | 0.013 |
| 3 | BLAN | 57.33 | 210 | 0.273 |
| 4 | SERC | 37.30 | 390 | 0.096 |

Example of Extracted Grid Data

| Site | Mean Canopy Height (m) | Total Biomass (Mg/Ha) | Dominant Vegetation Class |
|---|---|---|---|
| WREF | 36.76 | 378.8 | Evergreen Forest |
| UNDE | 20.92 | 133.8 | Deciduous Forest |
| TREE | 16.02 | 111.0 | Mixed Forest |
| DELA | 20.37 | 123.6 | Woody Wetlands |

GEDI = Global Ecosystem Dynamics Investigation

The preliminary method we use to estimate canopy storage ($S_c$) for each storm event uses one-minute precipitation and throughfall NEON data over the first 7 mm of rainfall. The intersection of the two lines fit to points before and after the canopy is saturated is the saturation point (SP), shown by the red dot. The difference between precipitation and throughfall at the saturation point (P' and TF') is the estimated canopy storage for that storm event.




## Hypotheses Tested

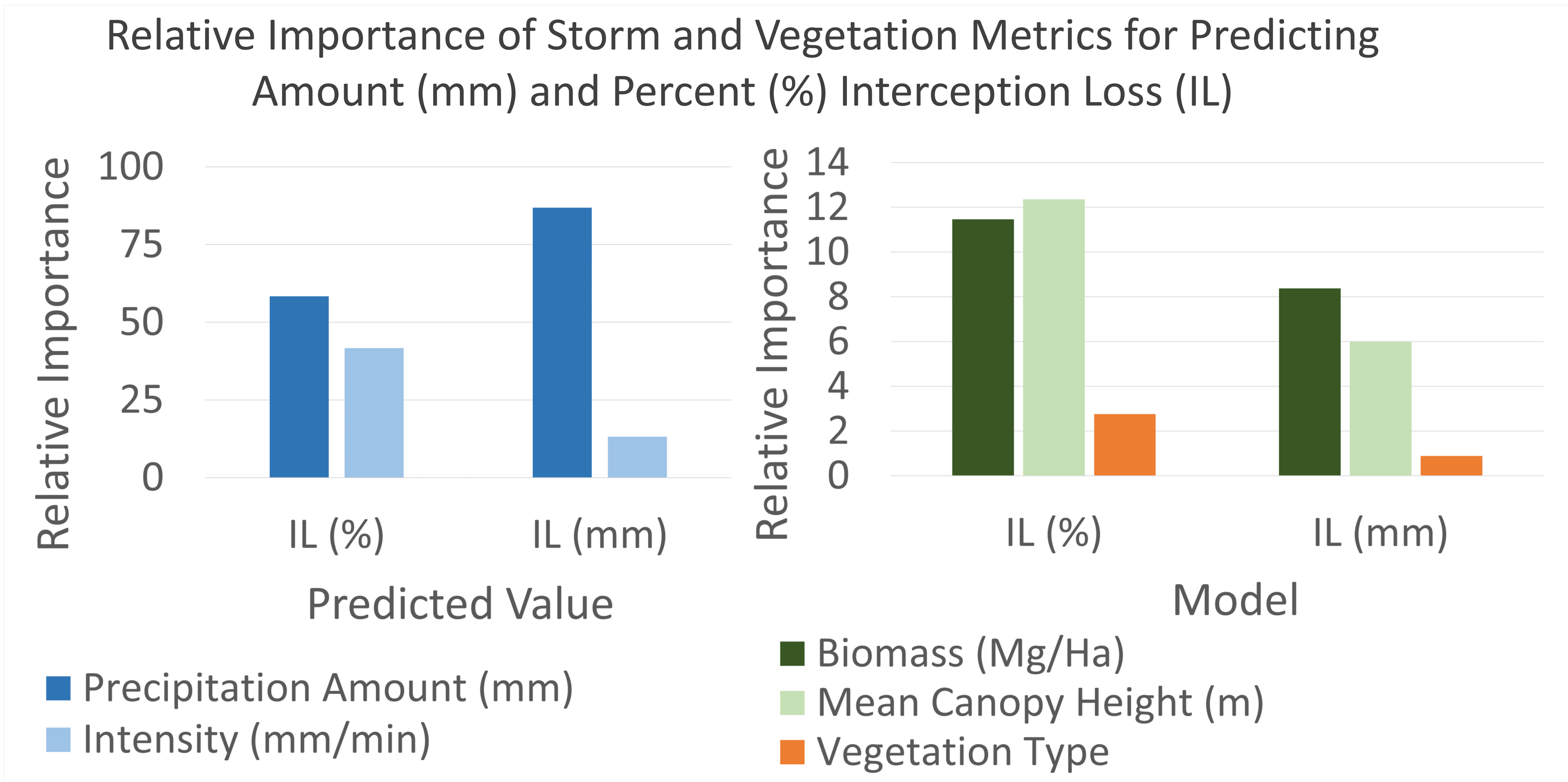
Canopy Storage ($S_c$) and Interception Loss (IL) are a function of biomass.

$S_c$ and IL are a function of biomass and vegetation type.

$S_c$ and IL are not a function of biomass or vegetation type.

## Which metrics are most important for predicting interception loss?

For random forest models predicting by-event amount and percent interception loss (IL), storm intensity is a more important metric for percent IL than for amount IL. All vegetation structure features are more important for percent IL than for amount IL. Biomass and mean canopy height are the most important vegetation metrics for predicting IL.

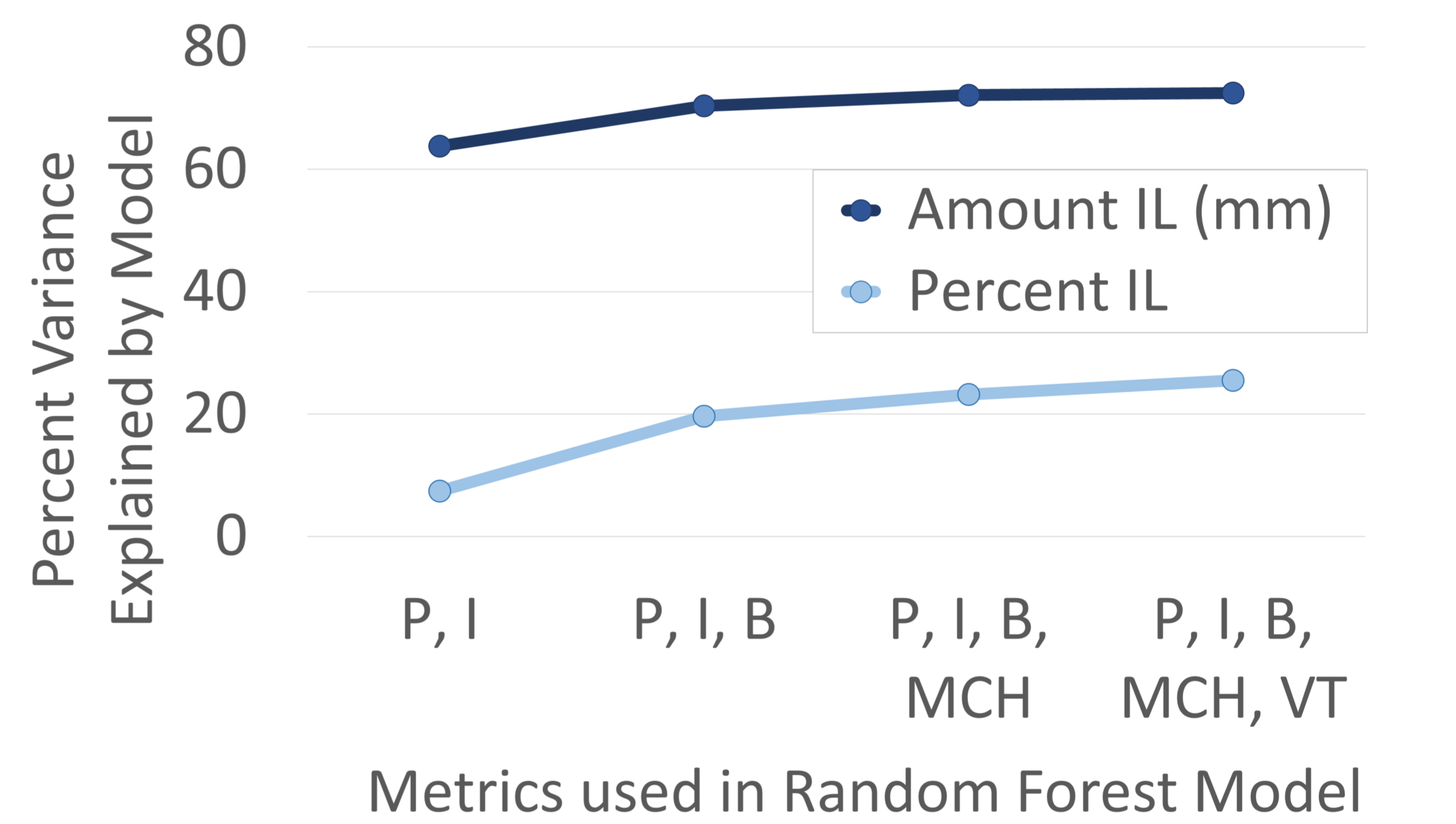



## Vegetation structure metrics improve interception loss predictions.

The performance of the random forest models improves significantly when vegetation structure metrics are included. Including Biomass and Mean Canopy Height result the greatest improvement in performance.

For percent IL, adding all vegetation structure metrics yields **over 3-fold improvement in model performance**.

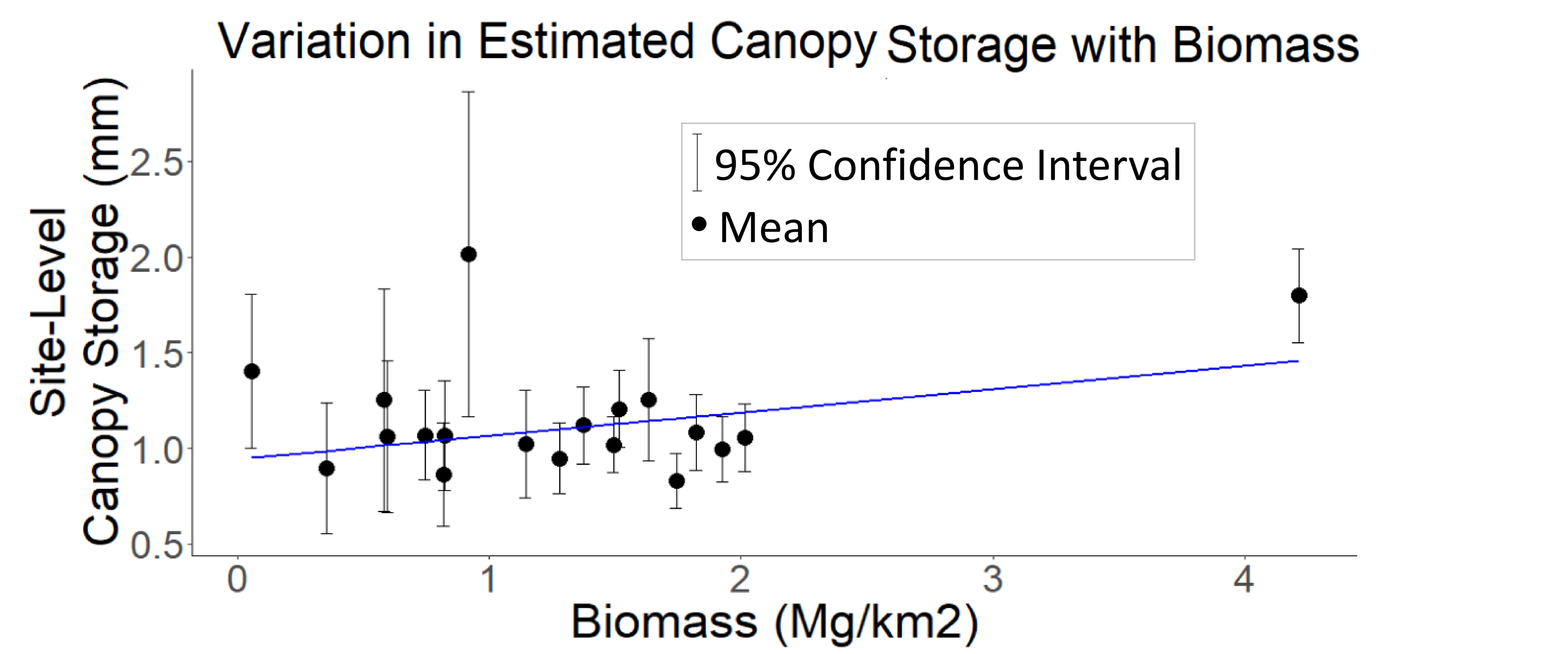
P = Gross Precipitation, I = Storm Intensity
B = Biomass, MCH = Mean Canopy Height,
VT = Vegetation Type (Needleleaf, Broadleaf, or Shrub)




## Canopy Storage is a function of biomass.

A linear regression model shows estimates of site-level canopy storage have a statistically significant positive relationship with biomass ($p = .034$).

The slope is 0.12280 mm of canopy storage per $Mg/km^2$ of biomass.




## Continued Work

Ongoing efforts include developing a more complex algorithm for determining the saturation point when estimating event-level canopy storage, including jack knifing broken-stick regression analysis.

We will also expand the models to include additional storms as NEON data continues to be collected and consider more spatiotemporal variation in vegetation structure metrics.

## Key Takeaways

Canopy storage roughly increases with total biomass.

Interception loss varies with vegetation structure and storm conditions.

Percent interception loss is a function of biomass and mean canopy height.

## Application

Relationships from this study can be expanded to predict canopy interception in areas without field measurements based on remotely-sensed vegetation structure data.

This can be leveraged to improve global canopy interception loss estimates.

## Acknowledgements

This material is based upon work supported in part by the National Aeronautics and Space Administration under Grant No. 80NSSC20M00043.

## References

1. NEON (National Ecological Observatory Network). Ecosystem structure, RELEASE-2022 (DP3.30015.001). https://doi.org/10.48443/hd92-rr80. Dataset accessed from https://data.neonscience.org on August 12, 2022.
2. Dubayah, R.O., S.B. Luthcke, T.J. Sabaka, J.B. Nicholas, S. Preaux, and M.A. Hofton. 2021. GEDI L3 Gridded Land Surface Metrics, Version 2. ORNL DAAC, Oak Ridge, Tennessee, USA.