Carbon accounting of ponderosa pine forests across the interior western U. S. based on tree-ring and forest inventory data

UA SCIENCE

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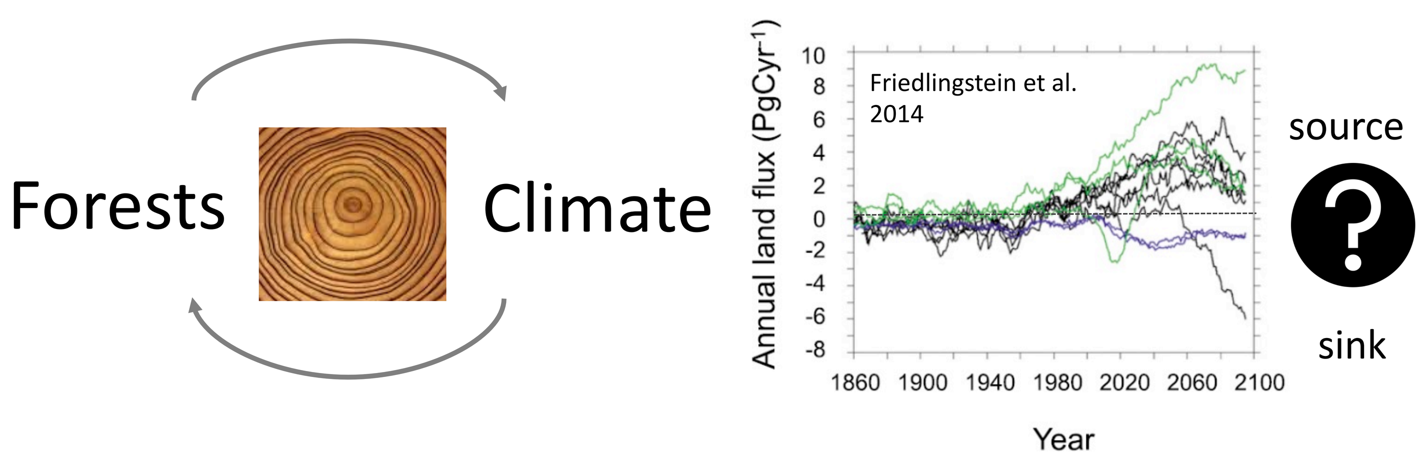
1. Motivation

Feedbacks between forests and climate lead to high uncertainty about the future land carbon sink.



We take an **ecological forecasting** approach to model and quantify uncertainty around the forest-climate feedback. We apply ecological forecasting principles (data fusion, model validation, uncertainty quantification), to *build a carbon forecasting system from a forest carbon monitoring system*.

2. Data Fusion

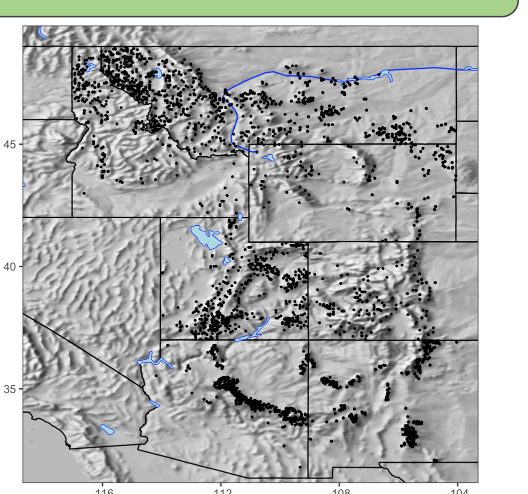
Enhancing a large monitoring network with models to build a forecasting system.

Tree Ring Data

>900 trees
annual resolution
climate response
temporal depth

Forest Inventory and **Analysis (FIA)** program

>15,000 trees
covariate data
tree size
stand competition



Pinus ponderosa

Presented Here: results from AZ, including 518 cored trees & 5794 non-cored trees

Data Assimilation (Bayesian State-space model)

Process Model

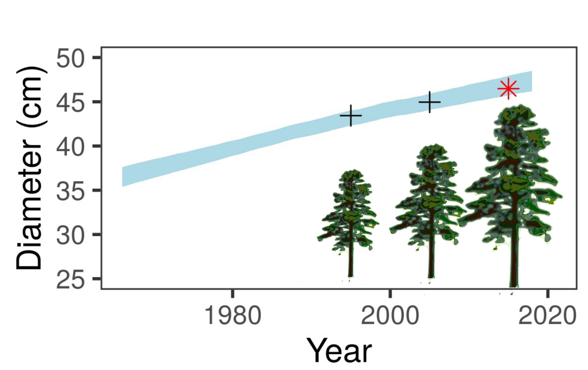
inc_t = f(DBH, competition, climate, site quality, two-way interactions)

$DBH_t = DBH_{t-1} + inc_t$

Increment Data Model $y_{i,t} \sim normal(inc_{i,t}, \tau_{inc})$

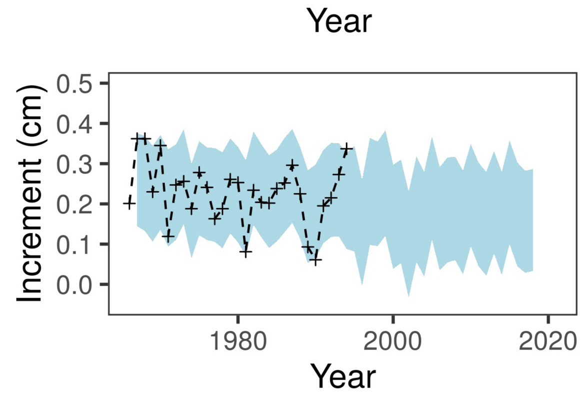
Diameter Data Model $z_{i,t} \sim normal(DBH_t, \tau_{dbh})$

Estimate true **DBH** + uncertainty



*Ongoing USFS surveys are an opportunity to continuously validate and update models

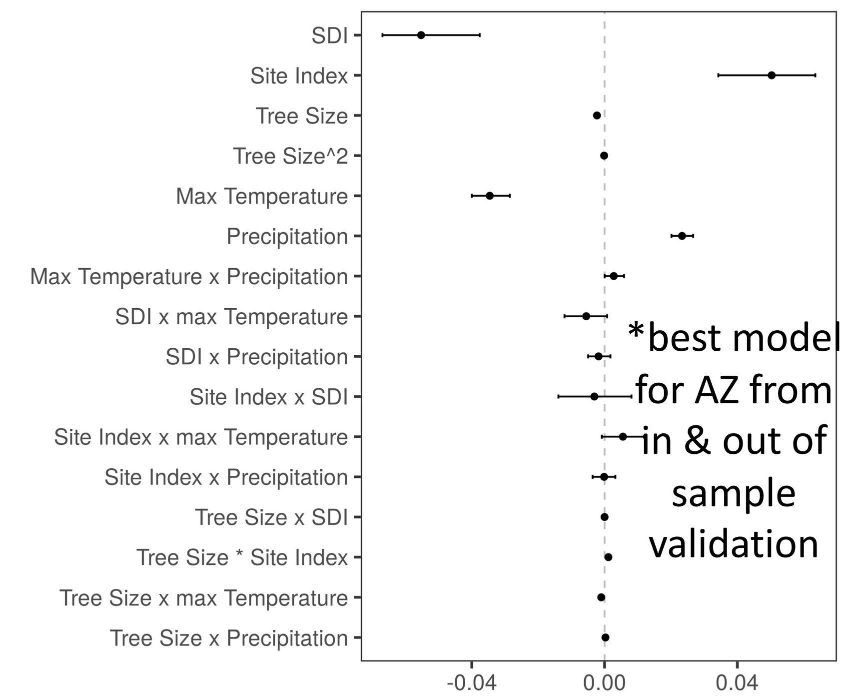
Estimate true **increment** + uncertainty



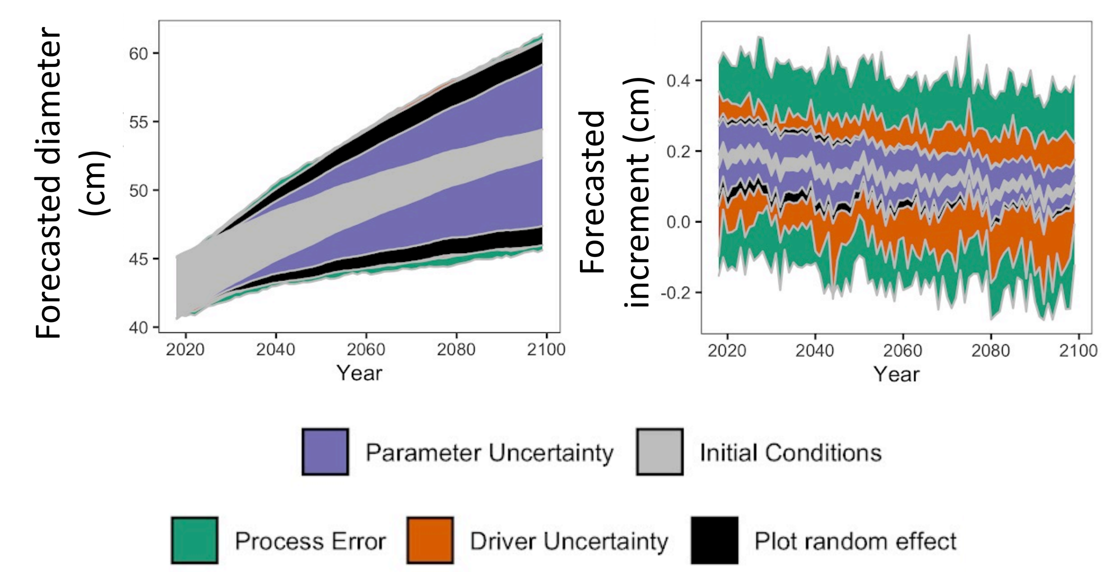
95% Confidence Interval
Observations
Validation data

3. Ecological Forecasting

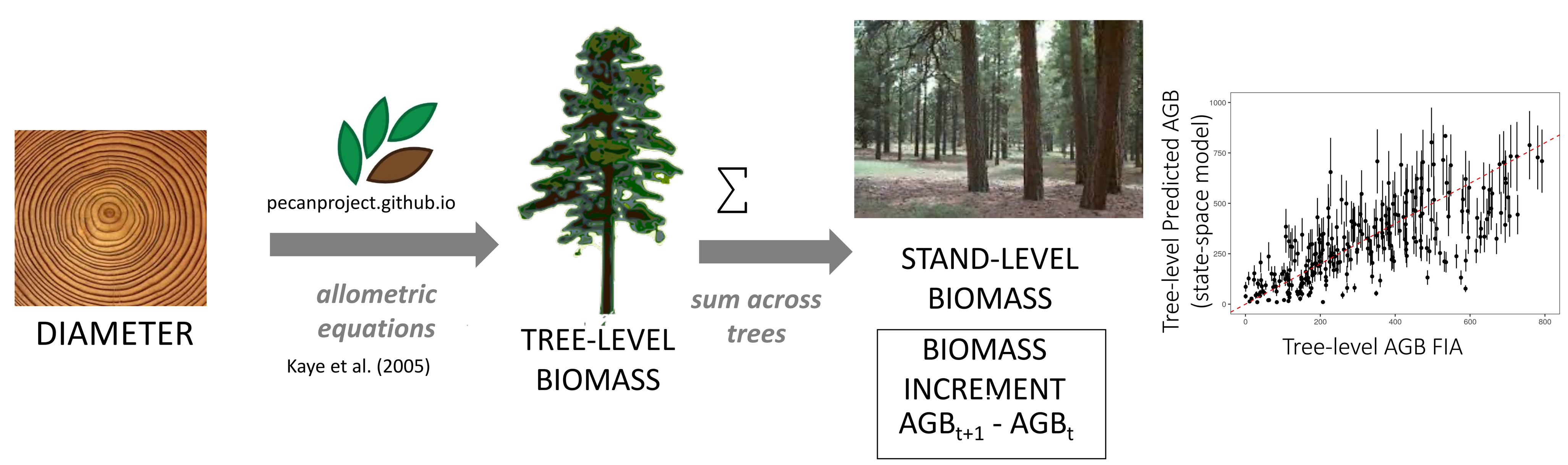
A). Estimate drivers of Tree Growth

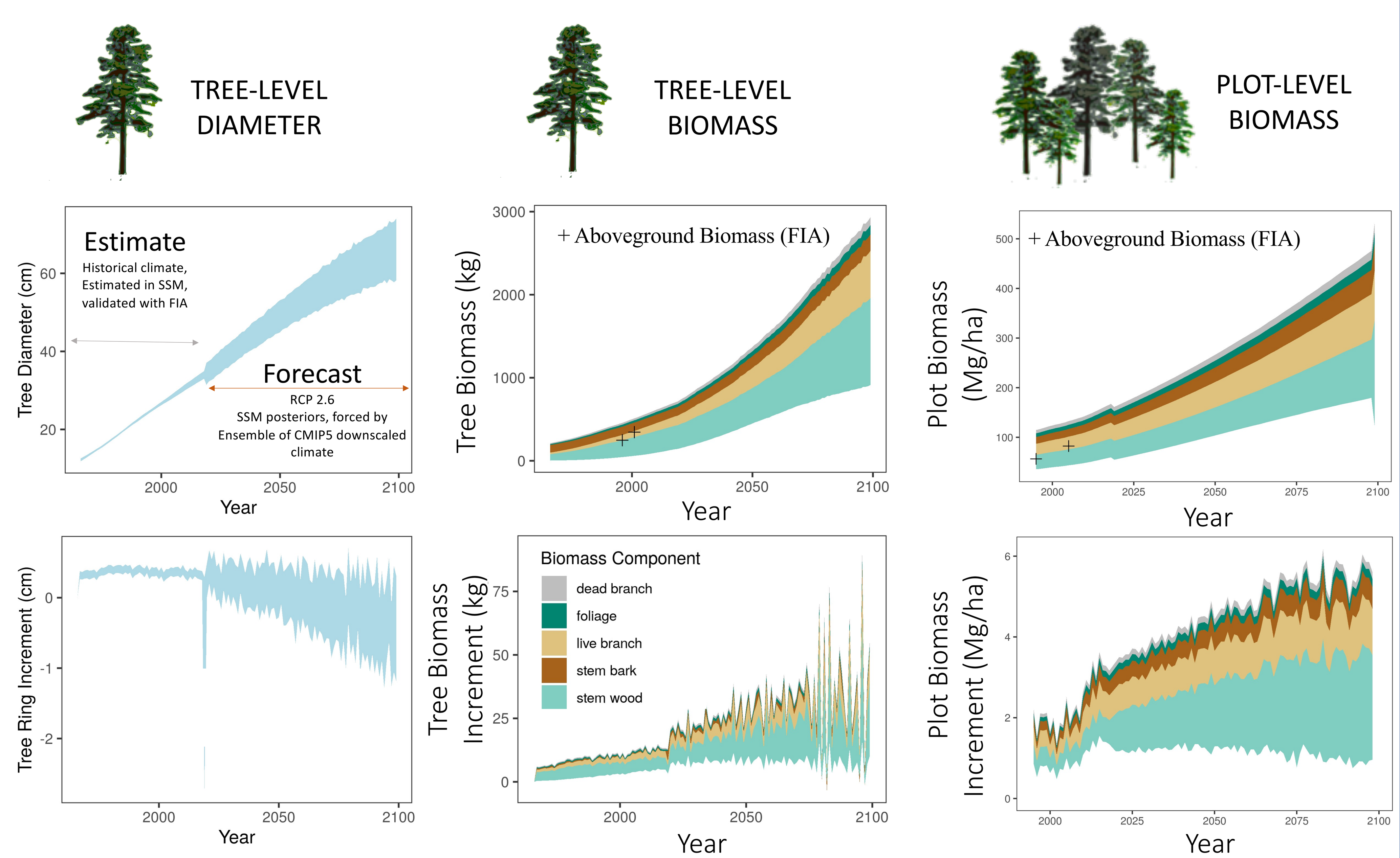


B). Use posteriors as priors to forecast diameter & partition uncertainty



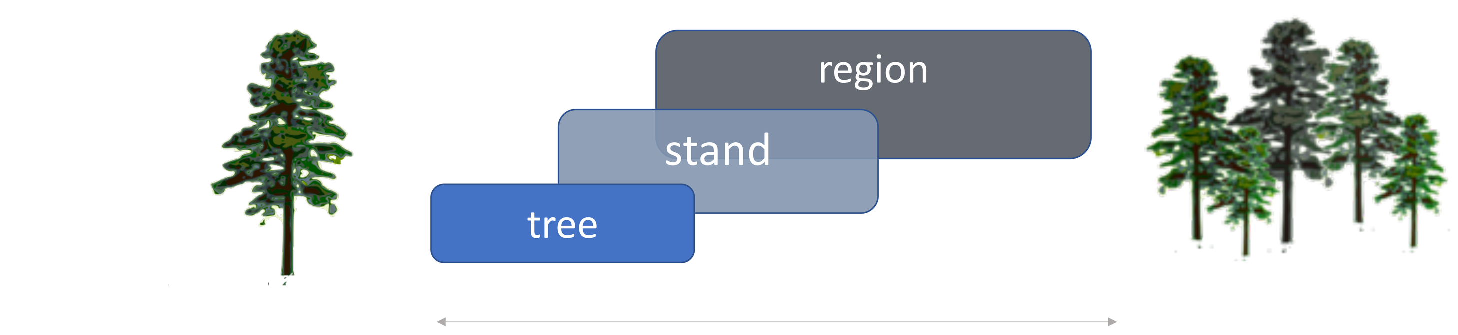
C). Estimate tree and stand-level biomass from diameter forecasts

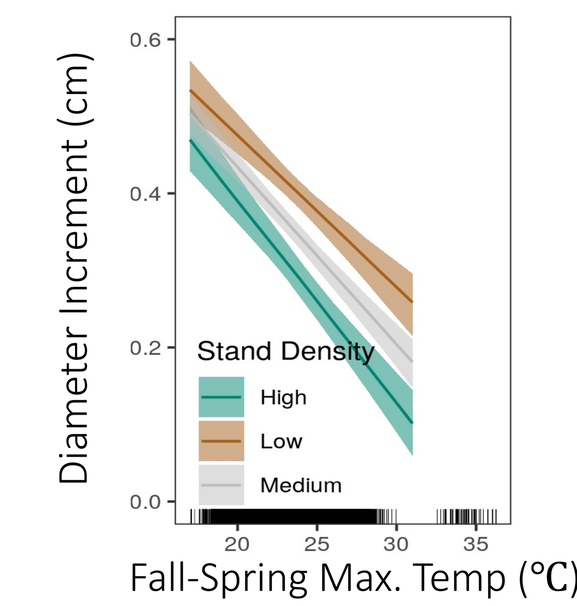




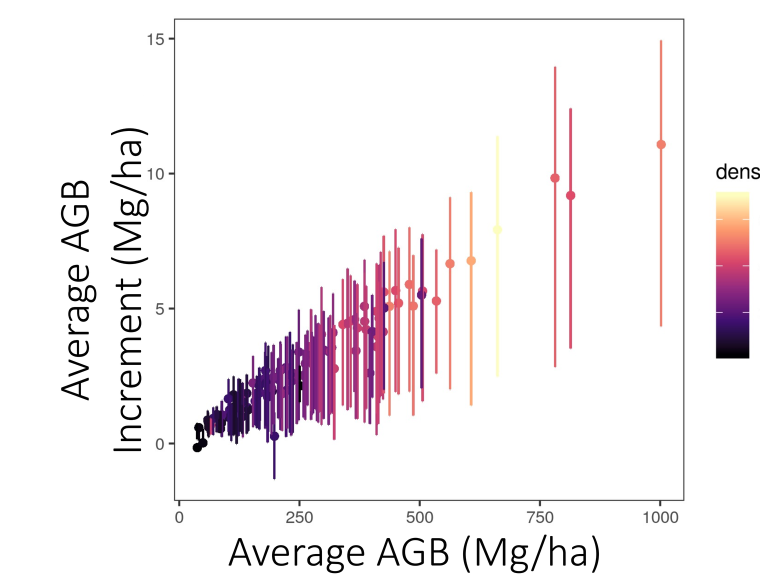
4. What we have learned…

Patterns & drivers of C cycling across spatial scales





Trees in denser stands in AZ have lower growth and stronger climate sensitivity



Denser stands have the highest biomass in AZ, but they have the largest flux uncertainties

Turning a monitoring system into a forecasting system: conclusions & next steps

- Bayesian fusion of tree ring and forest monitoring data allowed us to quantify cross-scale drivers (+ interactions) of forest biomass, and their uncertainties
- High allometric uncertainty, and driver uncertainties result in high forecast uncertainty, but ***more data across the region & improved allometric uncertainty quantification*** could reduce these uncertainties
- ***Including spatial variability in climate response*** could reduce uncertainty
- Incorporating new inventory data each year will constrain future AGB forecasts, turning the monitoring system into a forecasting system

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