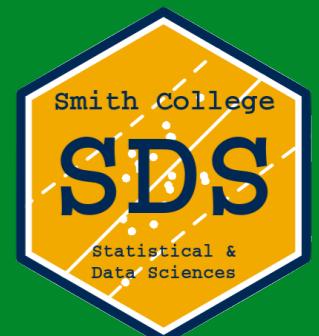


Statistical Models for Forest Ecology

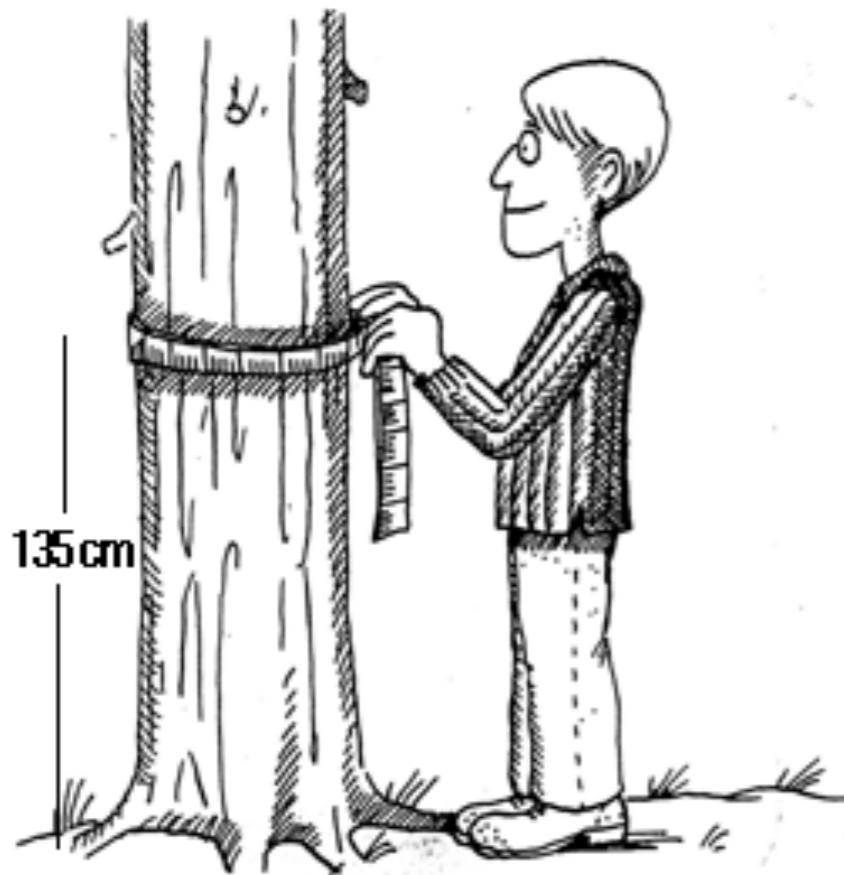


Prof. Albert Y. Kim
Environmental Science & Policy Lunchbag
Wednesday, September 30, 2020

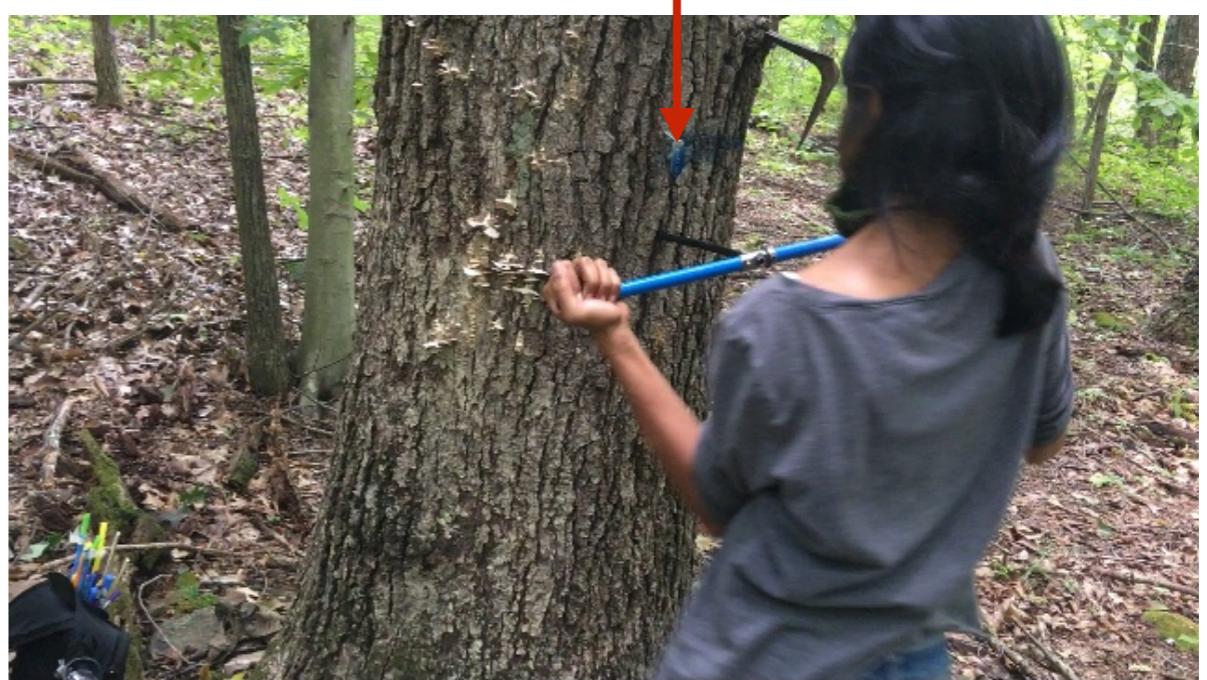


Diameter at Breast Height (dbh)

After species & location, one of the most informative variables about a tree is dbh



135cm off the ground



for 🤔: Just whose breast height are we talking about?

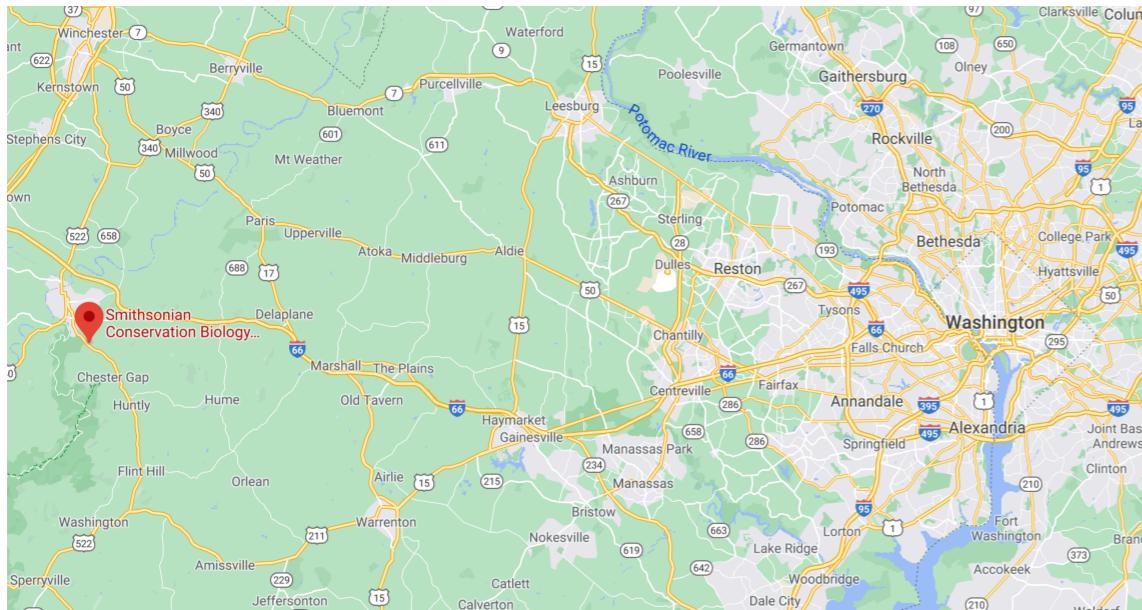
**Question 0: What data did
we collect and how?**

Liriodendron Tulipifera i.e. Tulip Poplar



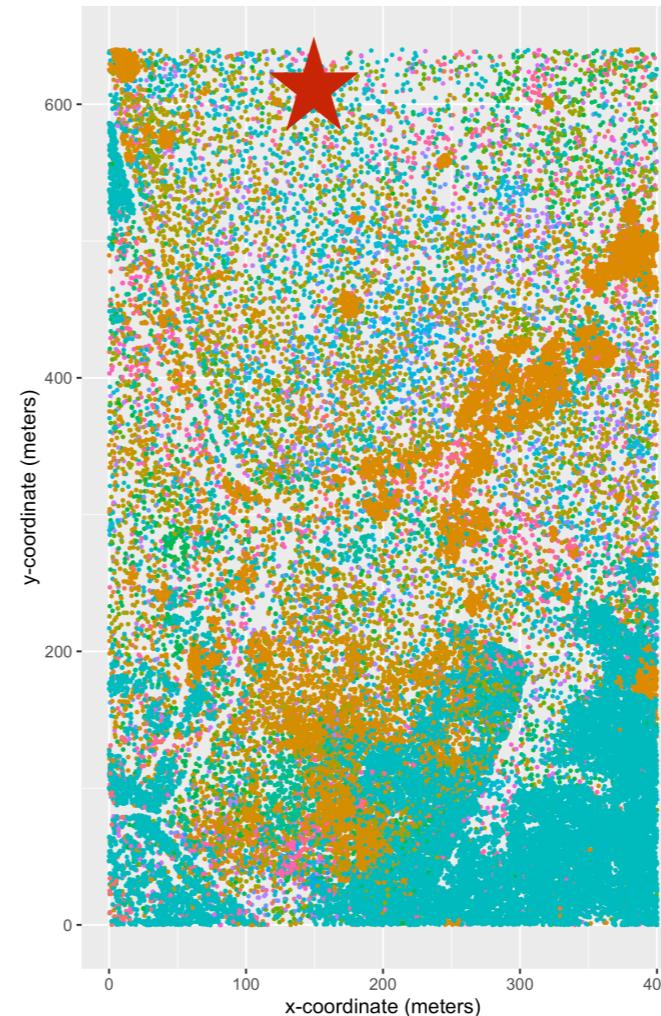
State tree of Indiana, Kentucky, & Tennessee.

One particular tulip poplar



25.6 ha = 35.85 soccer fields

Census 2018: 72,555 cataloged trees



species
acne
acpl
acru
acsp
aial
amar
astr
beth
caca
caco
cade
cagl
caovl
casp
cato
ceca
ceoc
chvi
coal
coam
cofl
crpr
crsp
divi
elum
eual
fagr
fram
frni
frpe
frsp
havi
ilve
juci
juni
juvi
libe
litu
loma
nysi
pato
pipu
pist
pivi
ploc
prav
prpe
prse
prsp
qual
quco
qufa
qumi
quru
qusp
quve
rhpe
romu
rops
rual
rupe
rugh
saca
tiam
ulam
ulru
ulsp
unk
viac
vipr
vire



Tag 082422

1. Measure diameter w/ dendroband + calipers

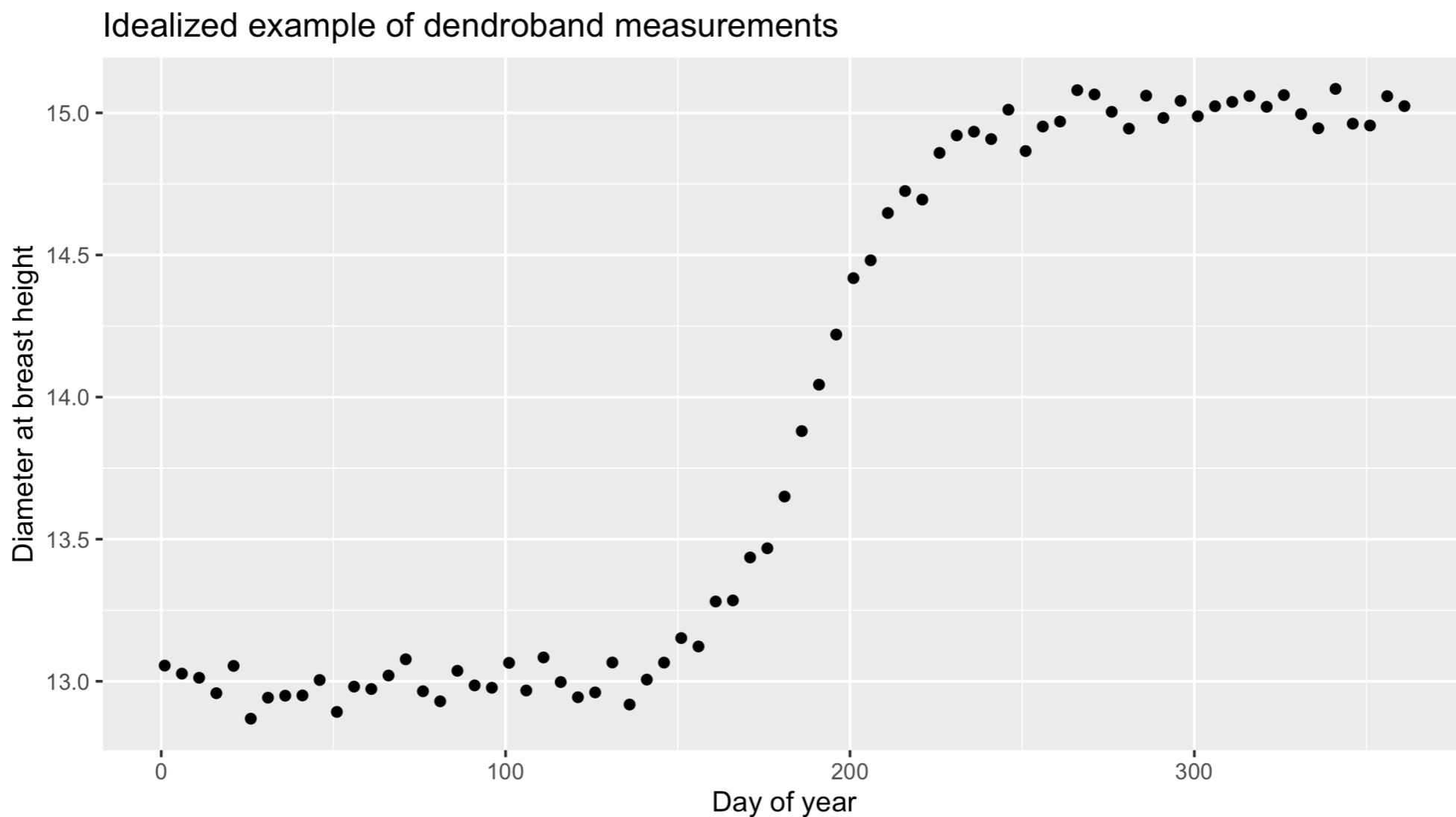


2. Share Data on GitHub

The screenshot shows a GitHub repository page for 'SCBI-ForestGEO / Dendrobands'. The repository has 5 stars, 0 forks, and 3 issues. The 'Code' tab is selected. A specific file, 'Dendrobands / data / scbi.dendroAll_2020.csv', is displayed. The file was last committed on July 3 by 'rudeboybert'. It has 4 contributors. The file contains 1280 lines (1280 sloc) and is 190 KB. The data is presented in a table:

1	tag	stemtag	survey.ID	year	month	day	biannual	intraannual	sp	quadrat	lx	ly	measure	codes	notes
2	10469	1	2020.01	2020	3	11	1	0	litu	109	9.7	1	NA	RE	window too large to measure
3	10587	1	2020.01	2020	3	11	1	0	litu	113	2.6	13	61.41	NA	NA
4	10609	1	2020.01	2020	3	11	1	0	cagl	111	19.5	2.9	81.03	NA	double-checked

3. Load data into statistical software



**Lesson 1: Numbers are
numbers, but data has
context.**

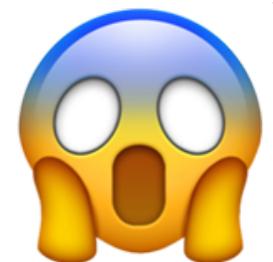
**Question 1: How can we
model within-year tree
growth?**

Models

$$y = f(x) + \epsilon$$

$$dbh = f(doy) + \epsilon$$

$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-r(doy - doy_{ip})/\theta\right)} + \epsilon$$



Models in general:

- y = outcome you want to explain
- x = input info
- f = function connecting y & x
- ϵ = error

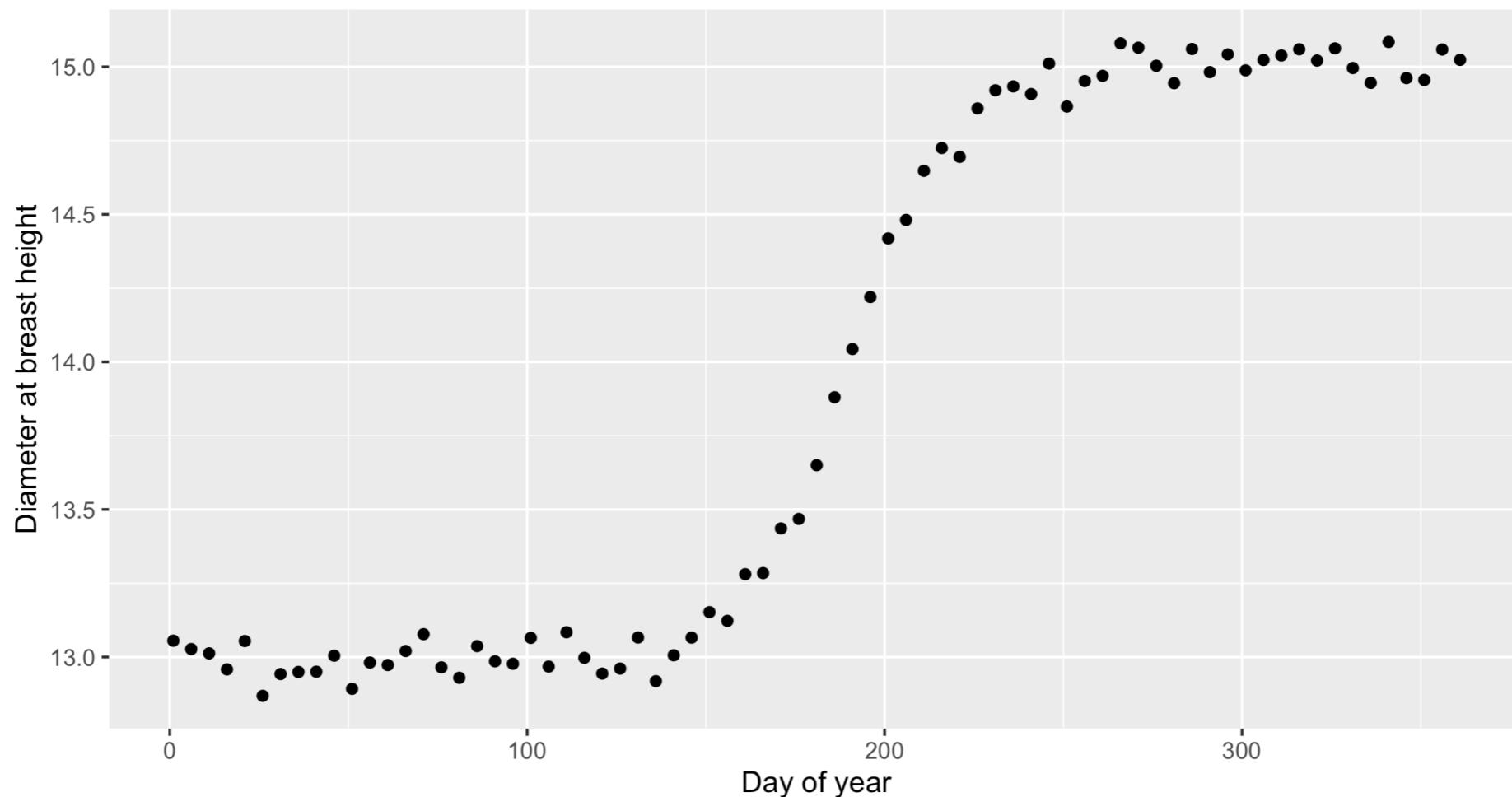
Model for dbh from dendrobands

- y = dbh
- x = day of year where Jan 1st = 1
- f = function connecting y & x
- ϵ = measurement error, etc

Model for dbh

$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-r(doy - doy_{ip})/\theta\right)^\theta}$$

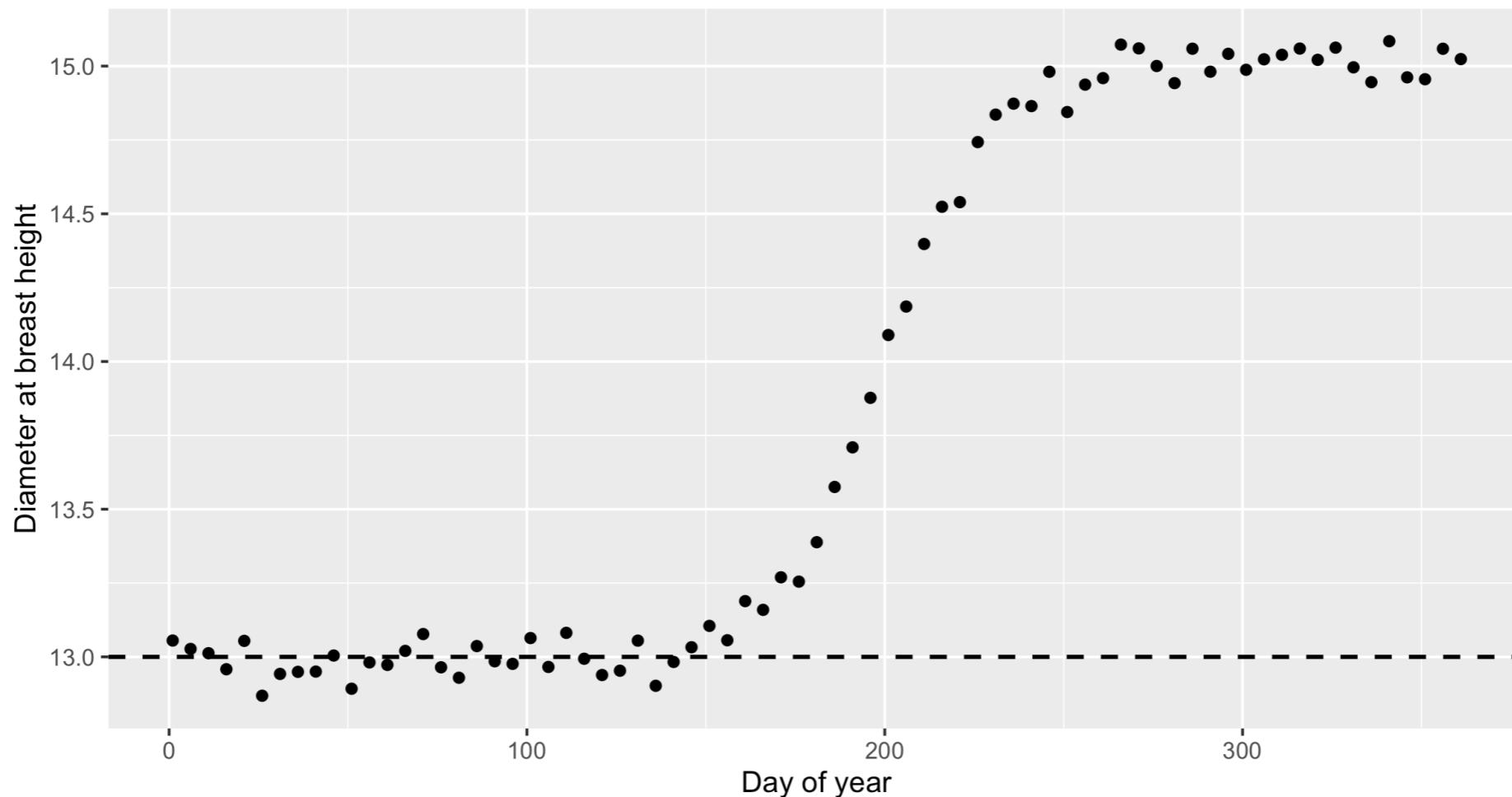
Idealized example of dendroband measurements



Model for dbh

$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp(-r(doy - doy_{ip})/\theta)}$$

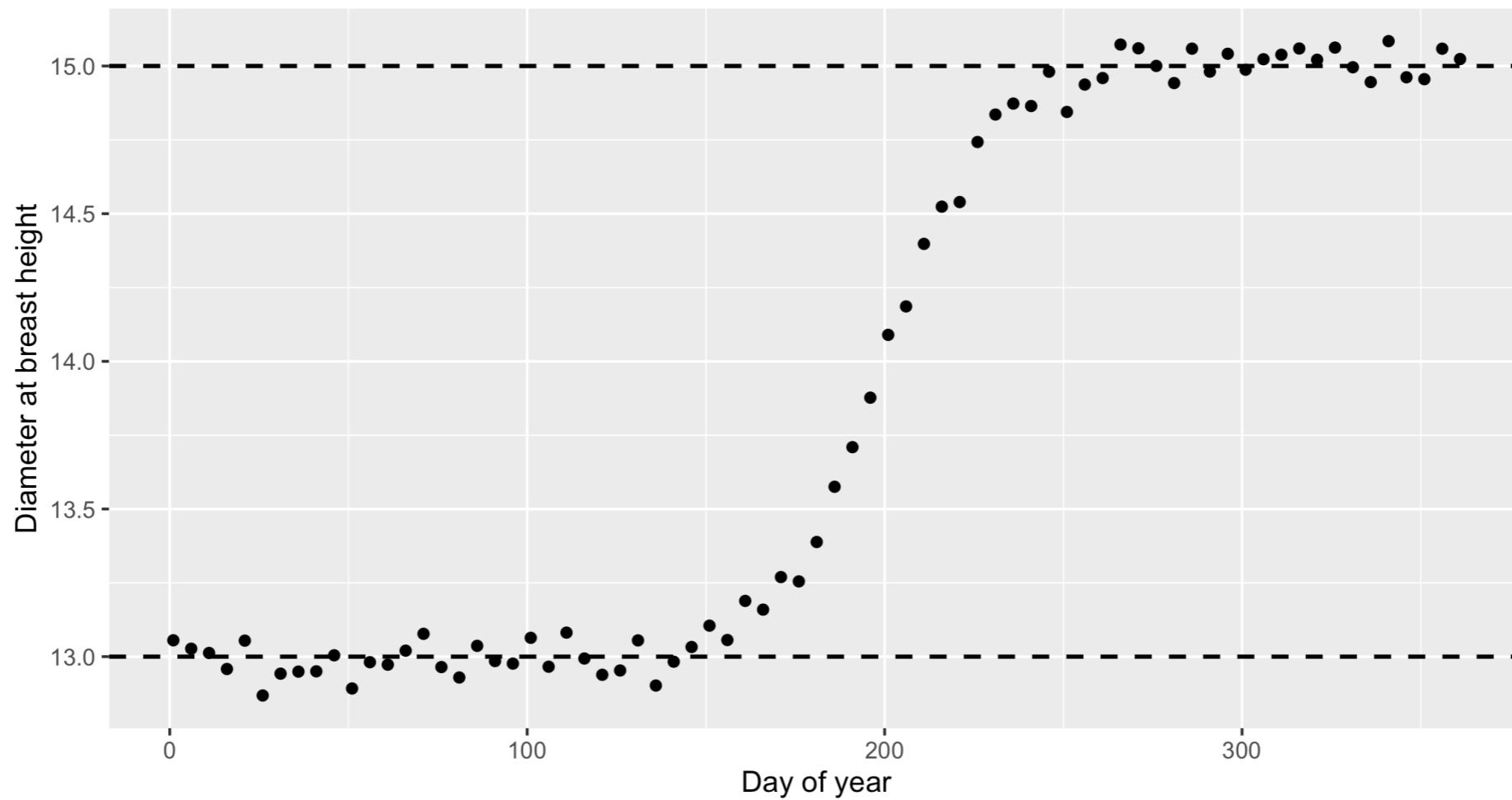
Idealized example of dendroband measurements



Model for dbh

$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp(-r(doy - doy_{ip})/\theta)}$$

Idealized example of dendroband measurements

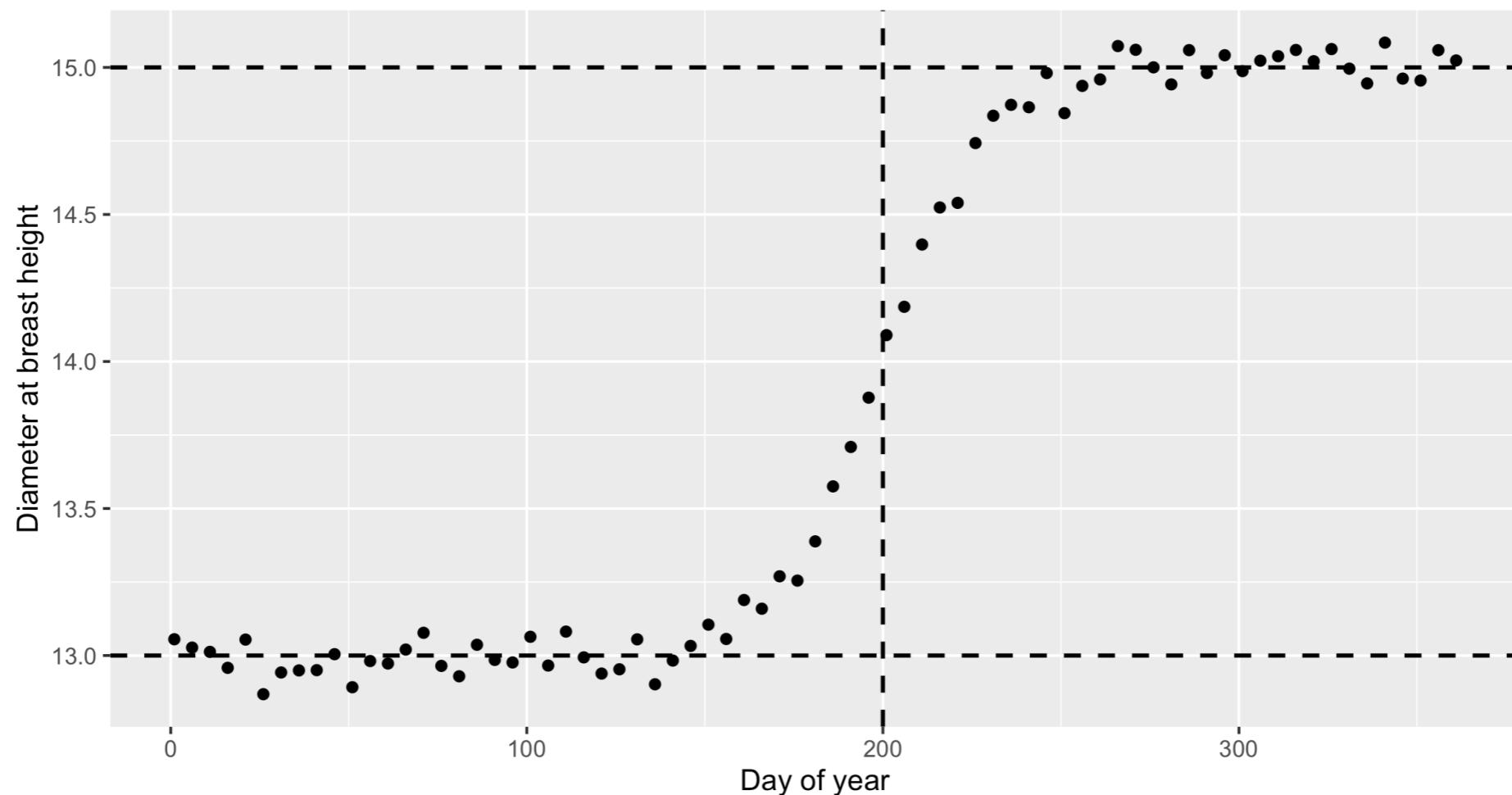


Model for dbh

$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-r(doy - \boxed{doy_{ip}})/\theta\right)^\theta}$$

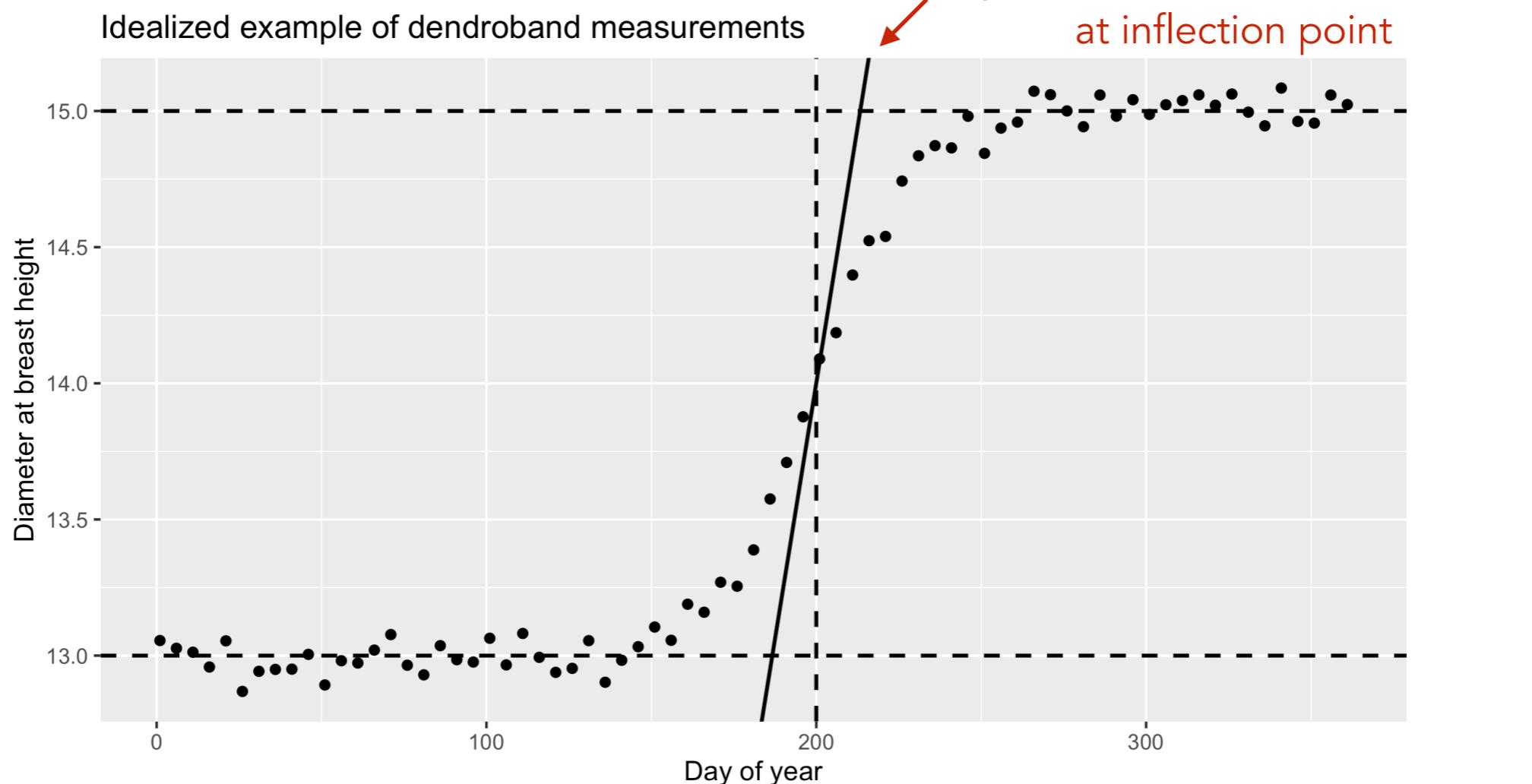
Idealized example of dendroband measurements

ip = inflection point



Model for dbh

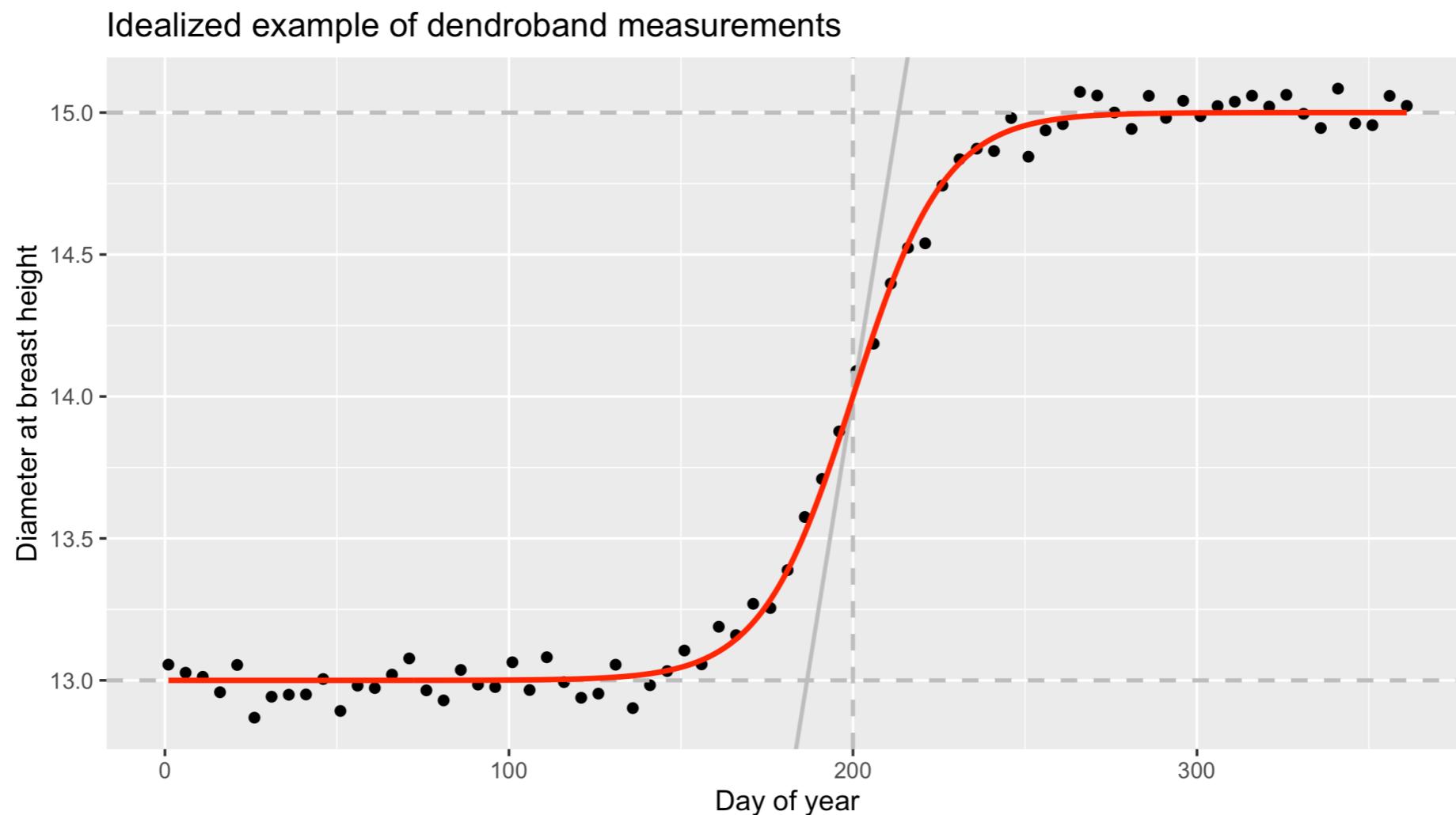
$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-\boxed{r}(doy - doy_{ip})/\theta\right)^\theta}$$



Ignoring θ , let's put it all together...

Model for dbh

$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp(-r(doy - doy_{ip})/\theta)}$$

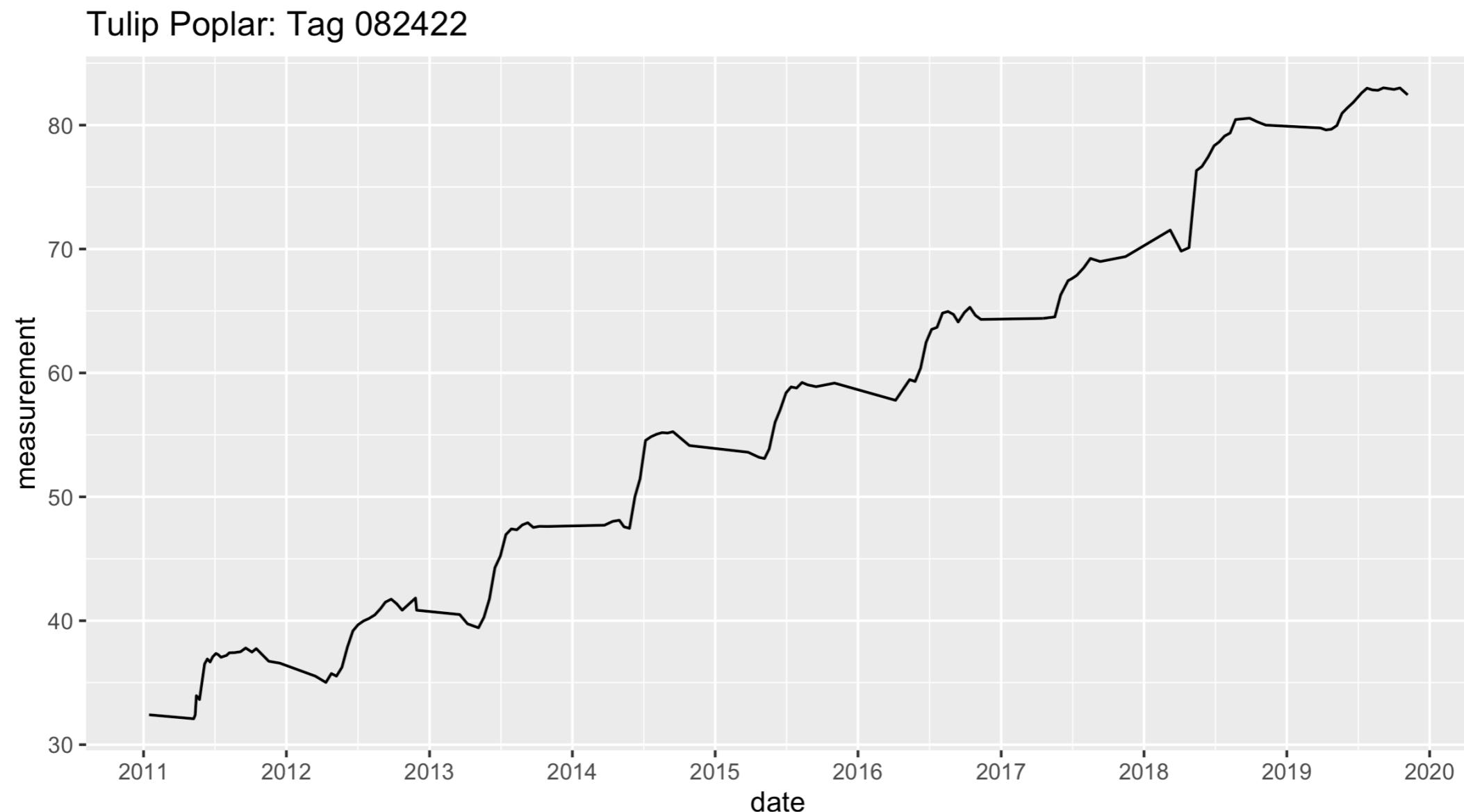


But remember, you need a model that works for ALL 🌲🌳🌴

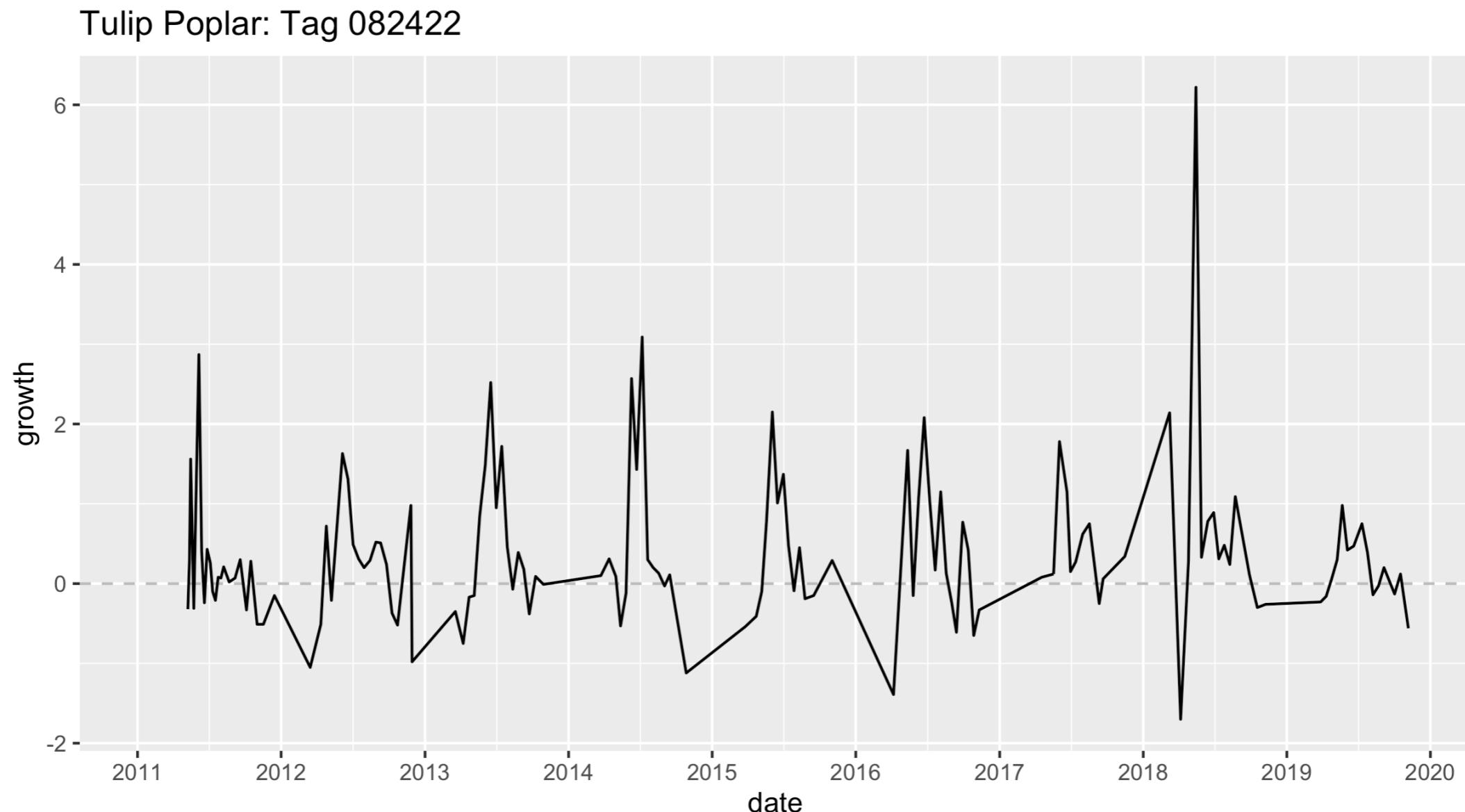
**Lesson 2: Statistics is not
math, rather statistics uses
math**

**Question 2: How can we
model the effect of climate
change on growth?**

Observed Dendroband Measurements

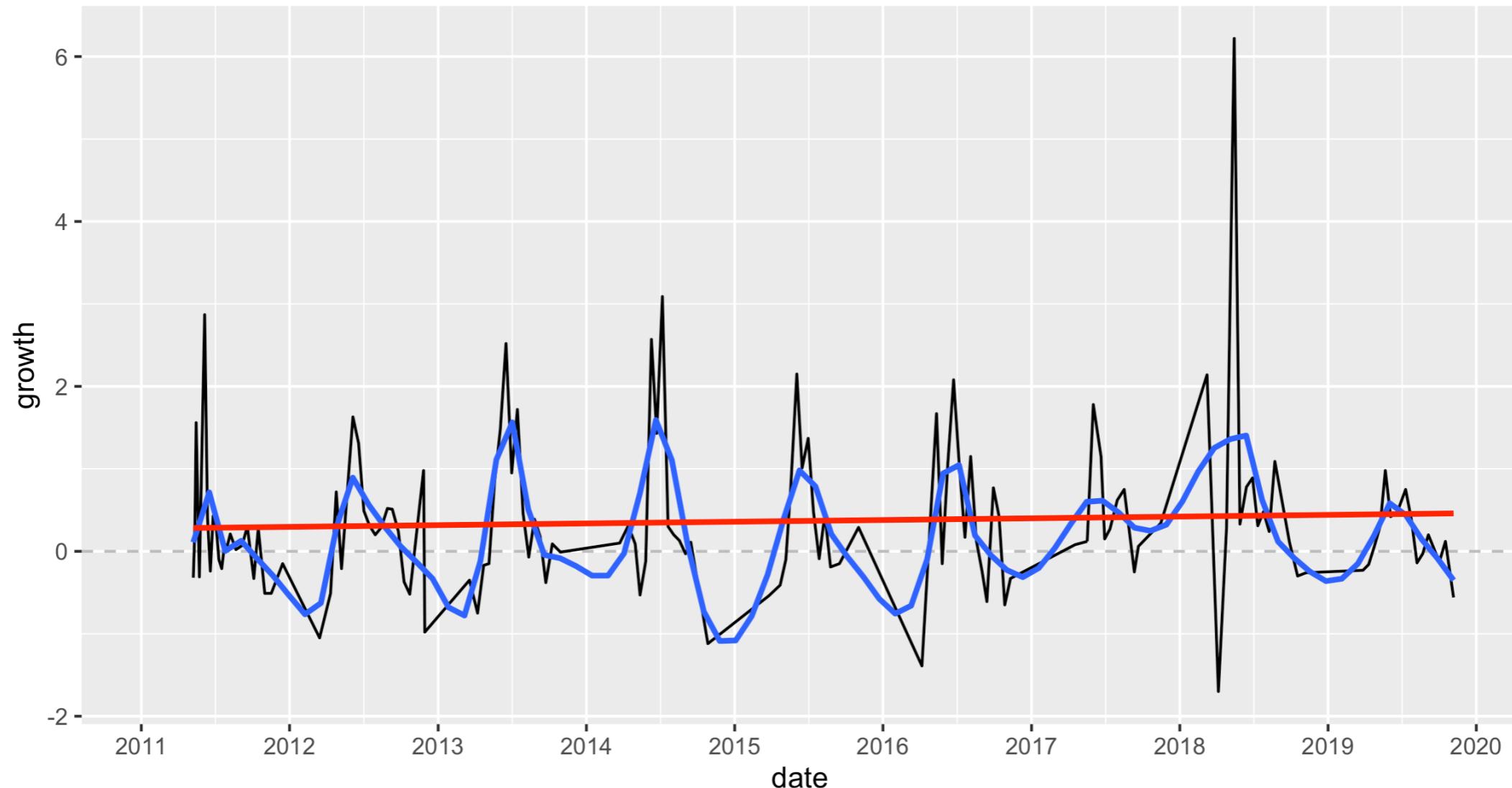


Growth = difference in diameter



Patterns

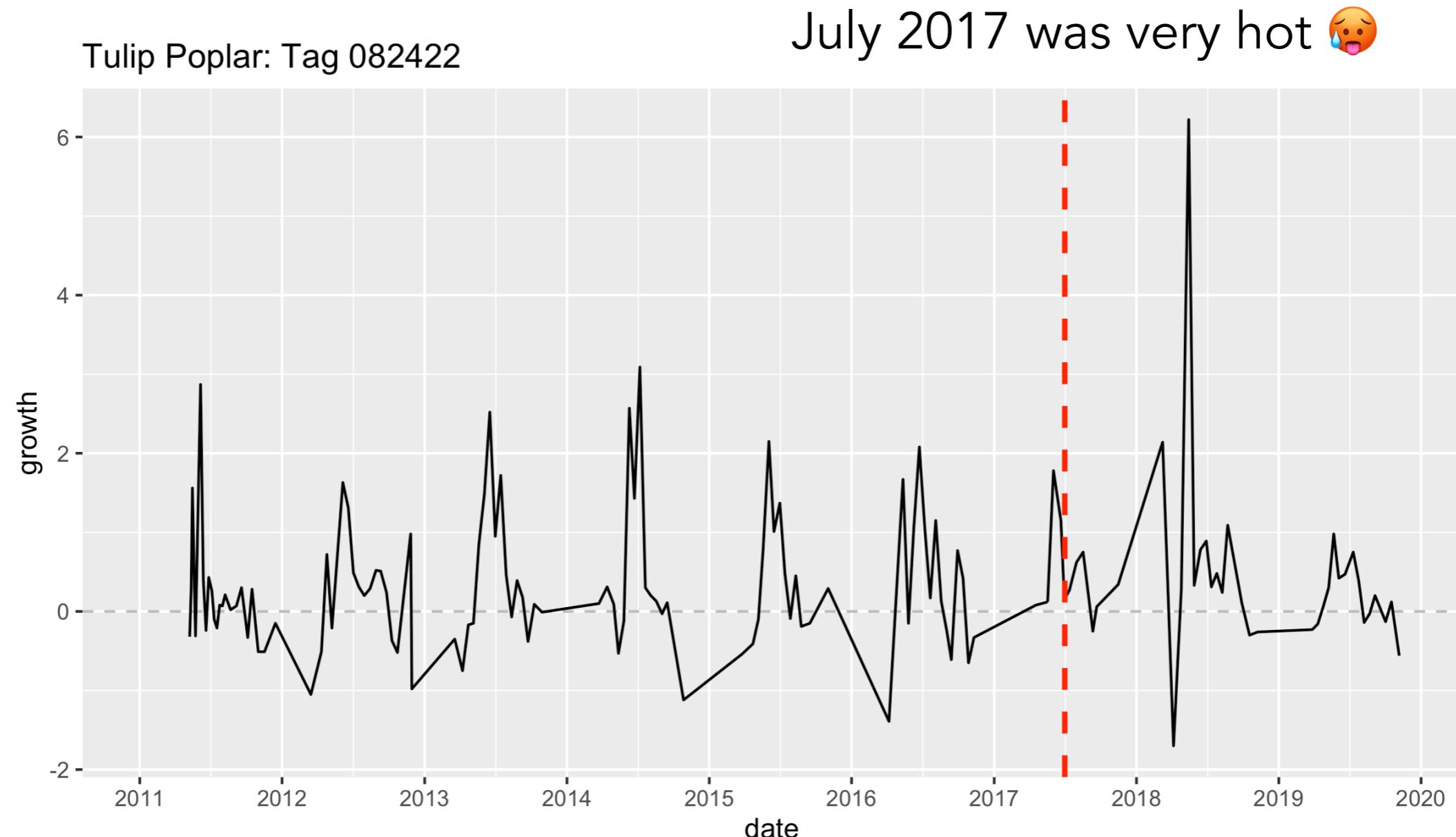
Tulip Poplar: Tag 082422



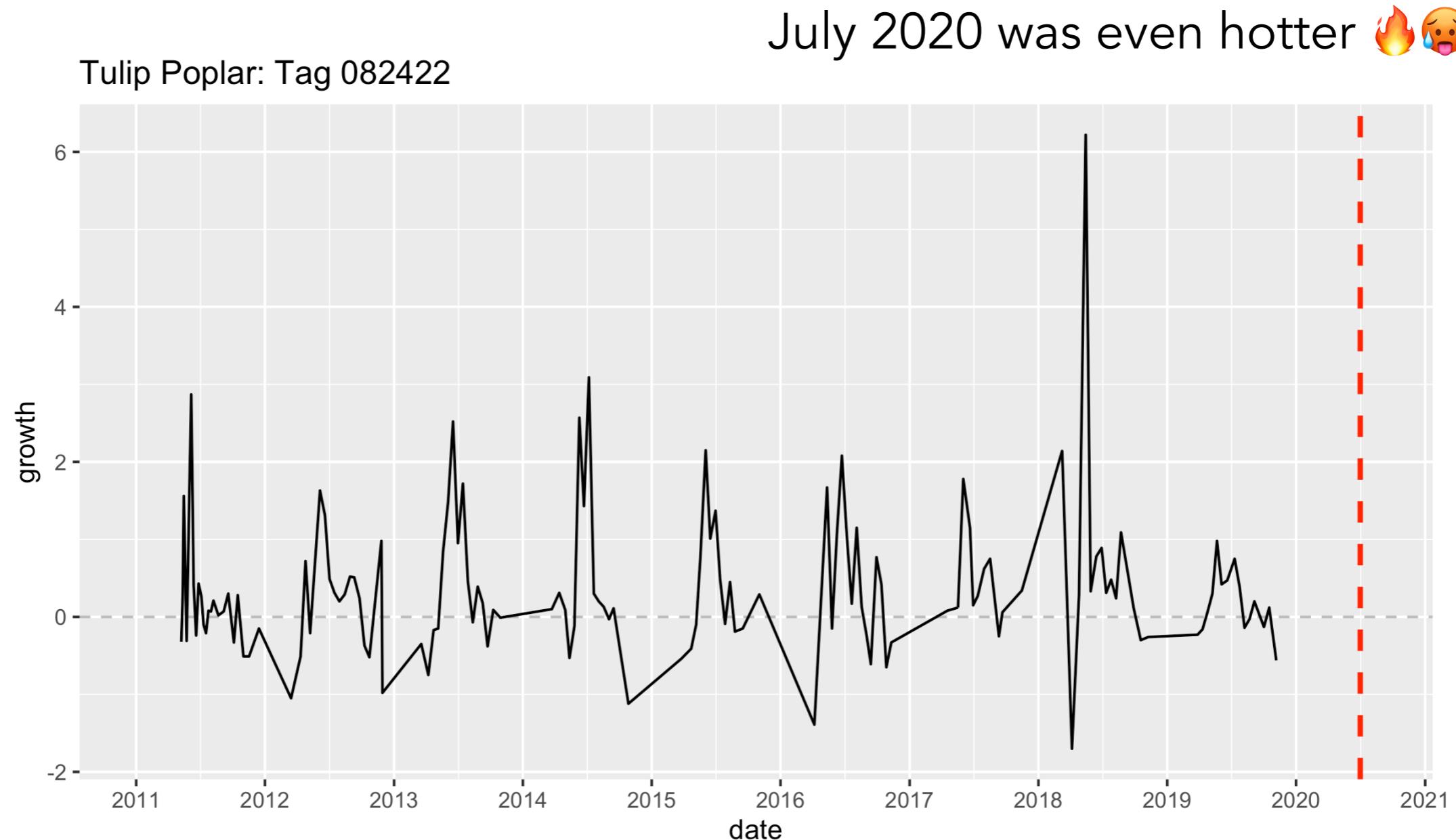
Seasonal trend that repeats every year

Overall (slightly increasing) trend

Effect of Climate Change



Effect of Climate Change



What other variables should we account for?

Drought? Humidity? Earlier springs?

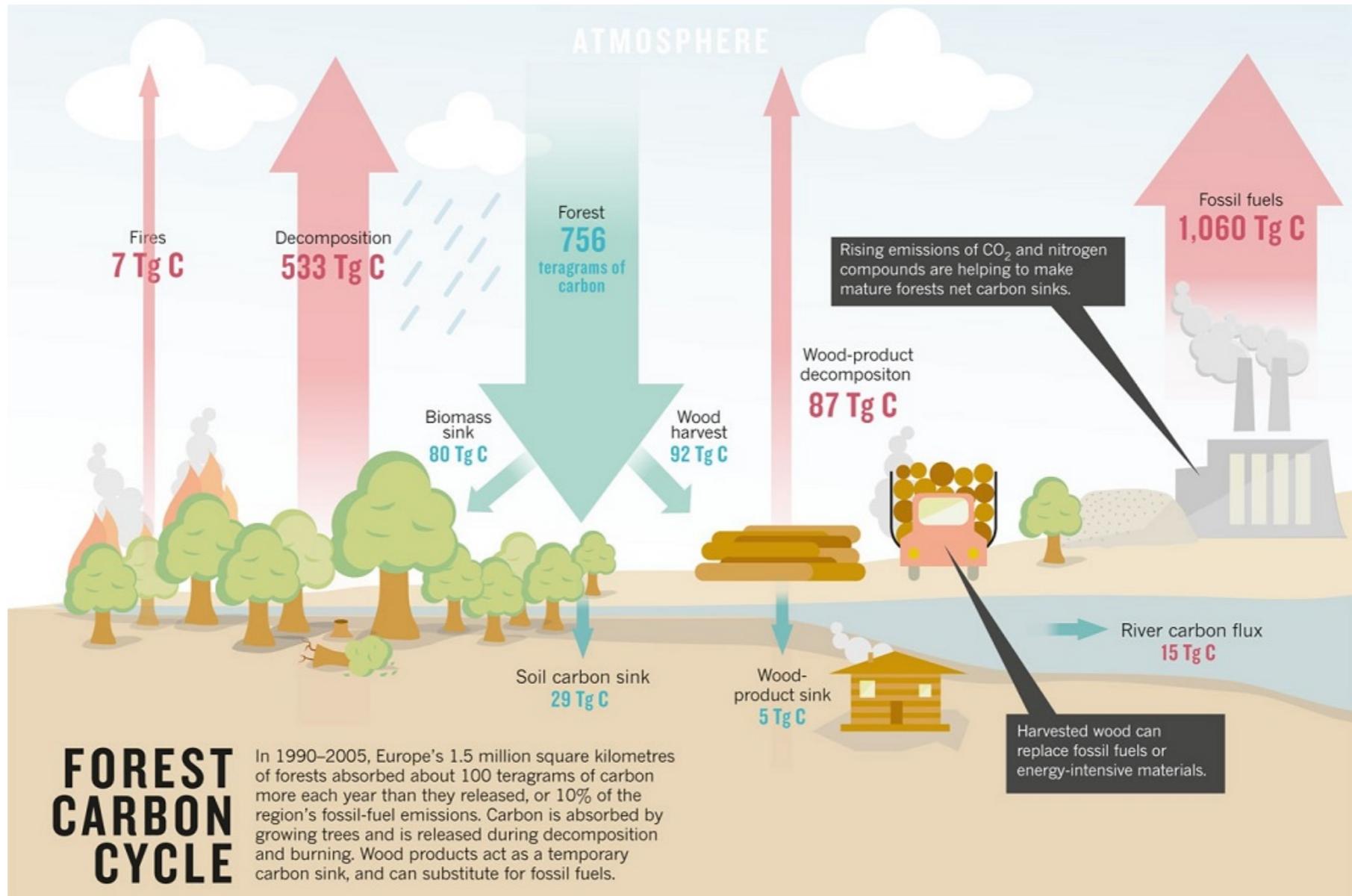
Smoke from CA, WA, OR forest fires? etc...

**Lesson 3: “All models are
wrong, but some are useful”**

George Box

Where is this headed?

Forests as Carbon Sinks



Source: American Forests

From yesterday's presidential "debate"

On the topic of climate change...

Is the U.S. Really Planting a Billion Trees, as Trump Said?

Or maybe a trillion? Either way, it won't do much.

By Alissa Walker | @awalkerinLA | Sep 30, 2020, 12:20am EDT

f t SHARE



Proof that Donald Trump has in fact planted one tree, with French president Emmanuel Macron in 2018. (It died.) | AFP via Getty Images

MOST READ



Is the U.S. Really Planting a Billion Trees, as Trump Said?



To plant or not to plant?



Regrowing trees soak up carbon in Brazil's Atlantic Forest northeast of Rio de Janeiro. ROBIN CHAZDON

Plant trees or let forests regrow? New studies probe two ways to fight climate change

By [Gabriel Popkin](#) | Sep. 23, 2020 , 12:25 PM

Model for Natural Regrowth

nature

Explore our content ▾ Journal information ▾

nature > articles > article

Article | Published: 23 September 2020

Mapping carbon accumulation potential from global natural forest regrowth

Susan C. Cook-Patton , Sara M. Leavitt, [...] Bronson W. Griscom

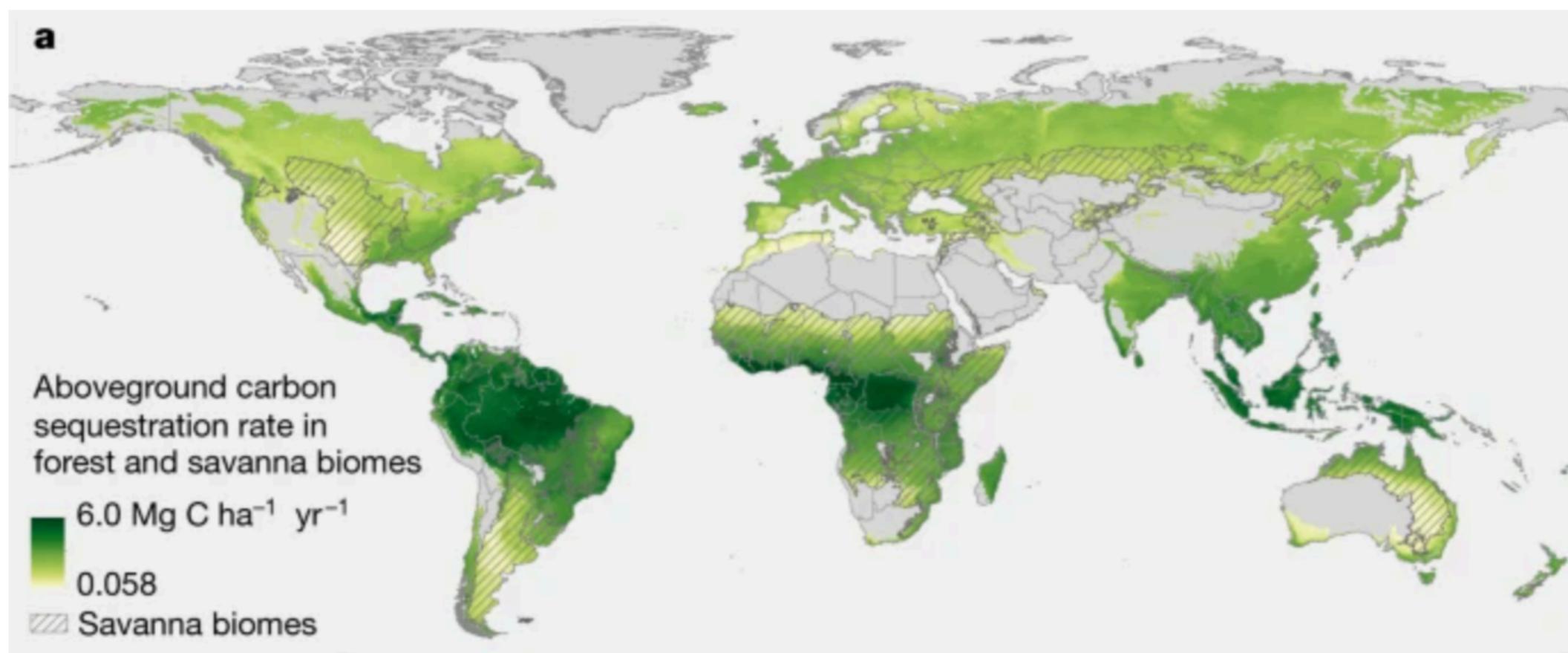
Nature 585, 545–550(2020) | Cite this article

4647 Accesses | 564 Altmetric | Metrics

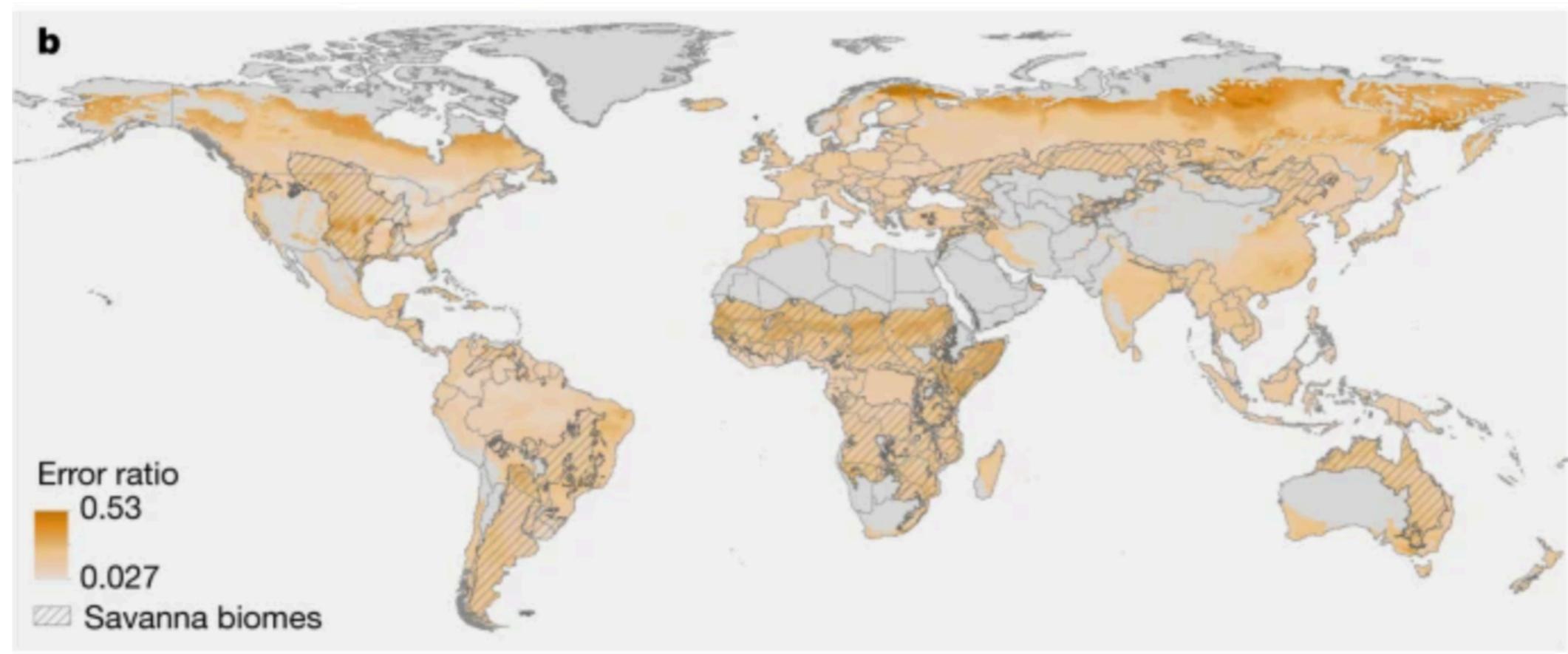
Abstract

To constrain global warming, we must strongly curtail greenhouse gas emissions and capture excess atmospheric carbon dioxide^{1,2}. Regrowing natural forests is a prominent strategy for capturing additional carbon³, but accurate assessments of its potential are limited by uncertainty and variability in carbon accumulation rates^{2,3}. To assess why and

Predicted/forecasted carbon accumulation



All predictions/forecasts have errors too...



Thanks!

Slides on Twitter
@rudeboybert