

Statistical Models for Forest Ecology



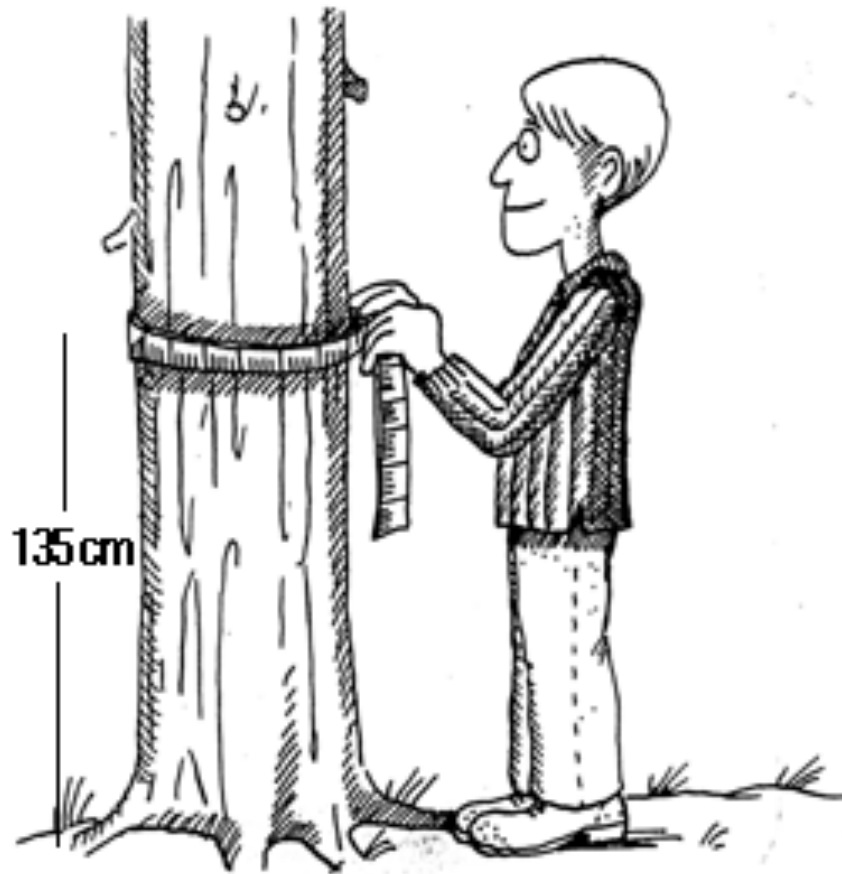
Prof. Albert Y. Kim
Environmental Science & Policy Lunchbag
Wednesday, September 30, 2020



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?

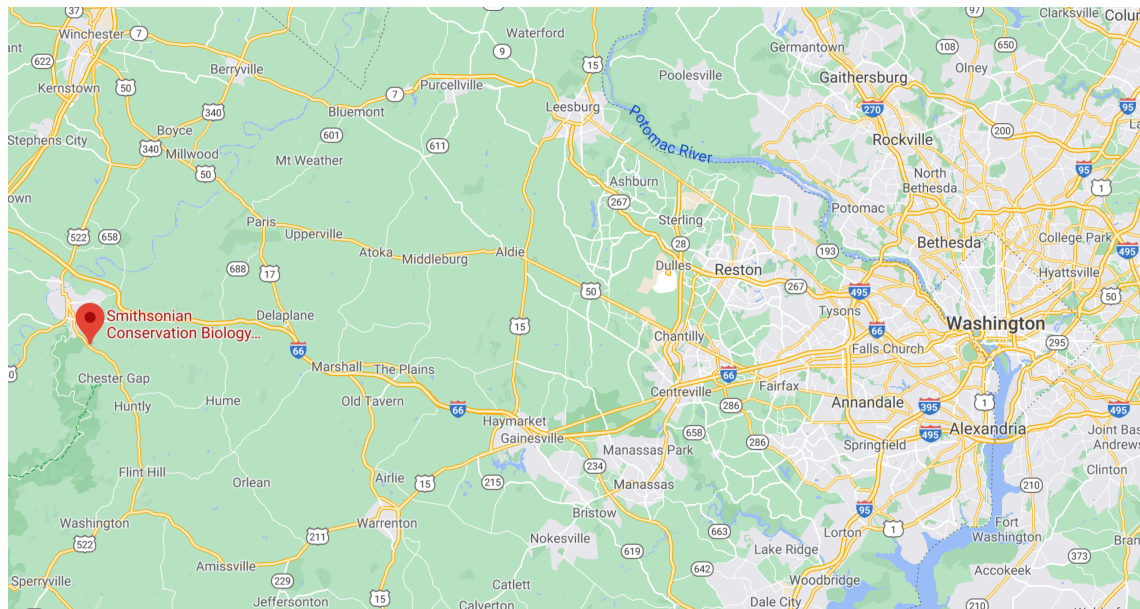
**Question 0: What data did
we collect and how?**

Liriodendron Tulipifera i.e. Tulip Poplar



State tree of Indiana, Kentucky, & Tennessee.

One particular tulip poplar



Census 2018: 72,555 cataloged trees



Tag 082422

25.6 ha = 35.85 soccer fields

1. Measure diameter w/ dendroband + calipers

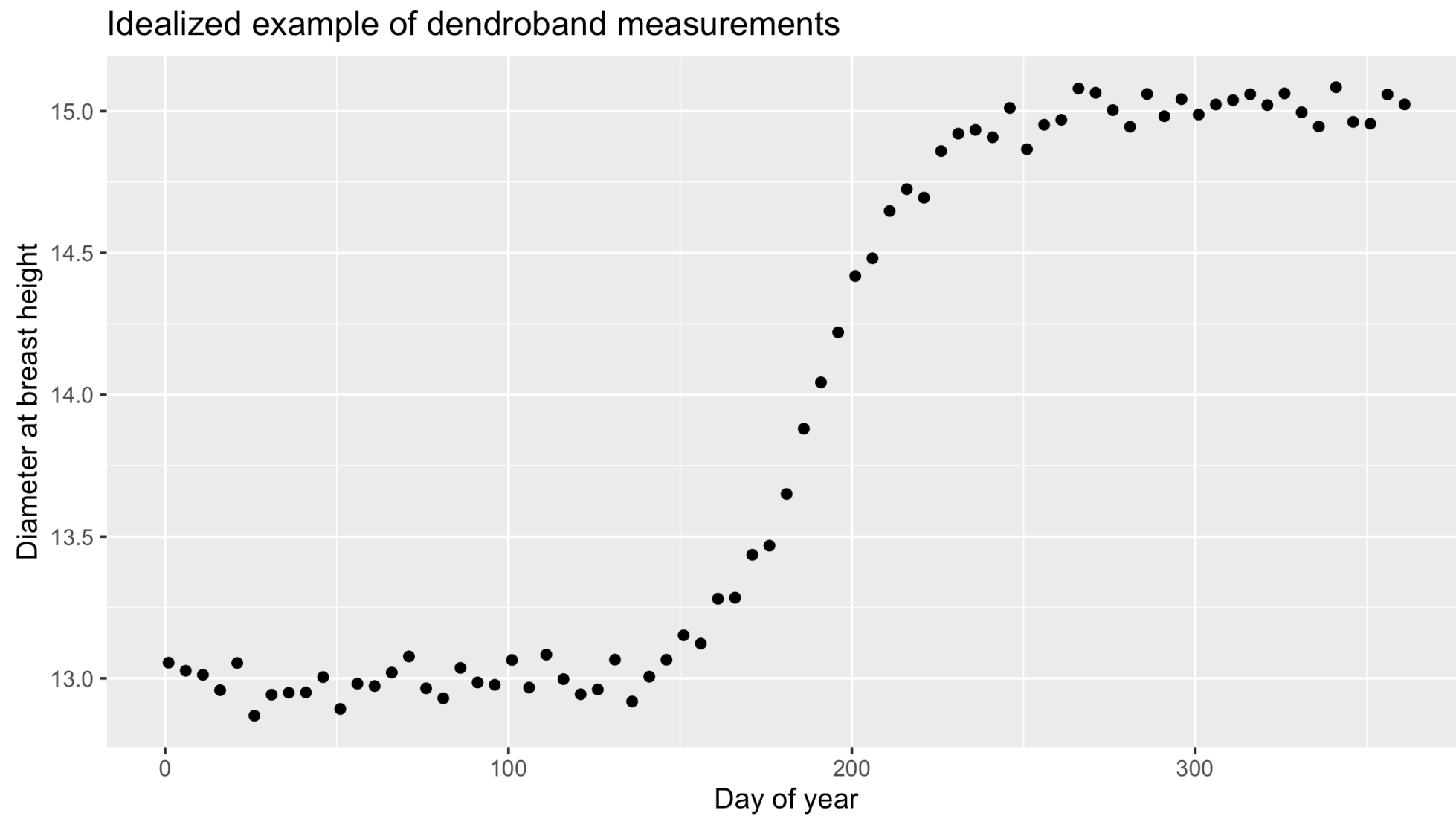


2. Share Data on GitHub

The screenshot shows the GitHub interface for the repository **SCBI-ForestGEO / Dendrobands**. The repository has 5 stars and 0 forks. The file **scbi.dendroAll_2020.csv** is selected, showing a commit by **rudeboybert** with the message "Replace text month coding with integer month coding for 2019 & 2020. F...". The file is 190 KB and contains 1280 lines of code. The CSV data is displayed with columns: tag, stemtag, survey.ID, year, month, day, biannual, intraannual, sp, quadrat, lx, ly, measure, codes, and notes. The first four rows of data are shown, with the 'tag' column, the date columns ('year', 'month', 'day'), and the 'measure' column highlighted with red boxes.

	tag	stemtag	survey.ID	year	month	day	biannual	intraannual	sp	quadrat	lx	ly	measure	codes	notes
1	10469	1	2020.01	2020	3	11	1	0	litu	109	9.7	1	NA	RE	window too large to measure
2	10587	1	2020.01	2020	3	11	1	0	litu	113	2.6	13	61.41	NA	NA
3	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

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

Models in general:

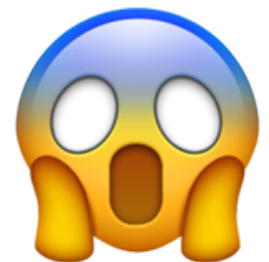
- y = outcome you want to explain
- x = input info
- f = function connecting y & x
- epsilon = error

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

Model for dbh from dendrobands

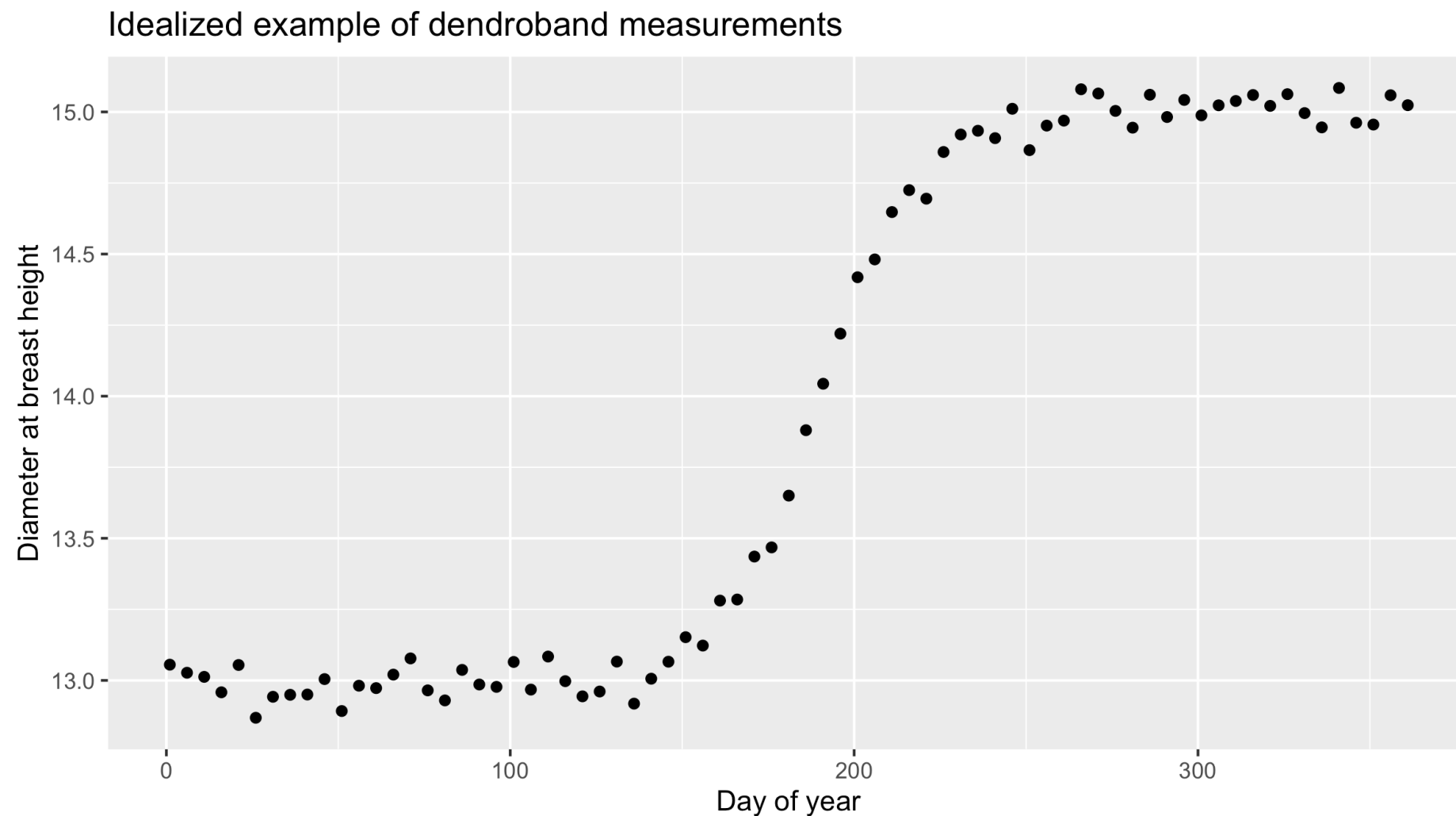
- y = dbh
- x = day of year where Jan 1st = 1
- f = function connecting y & x
- epsilon = measurement error, etc

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



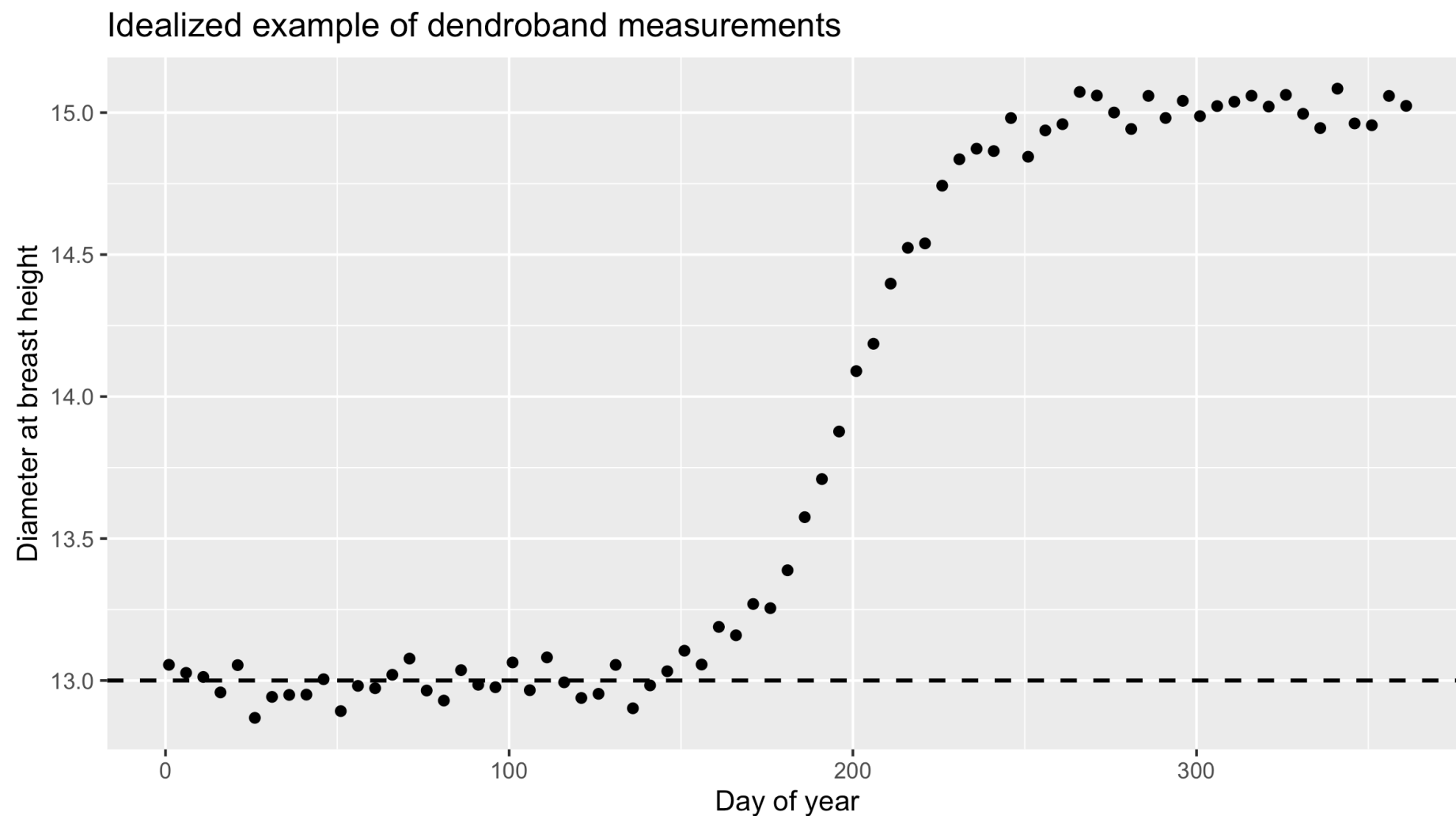
Model for dbh

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



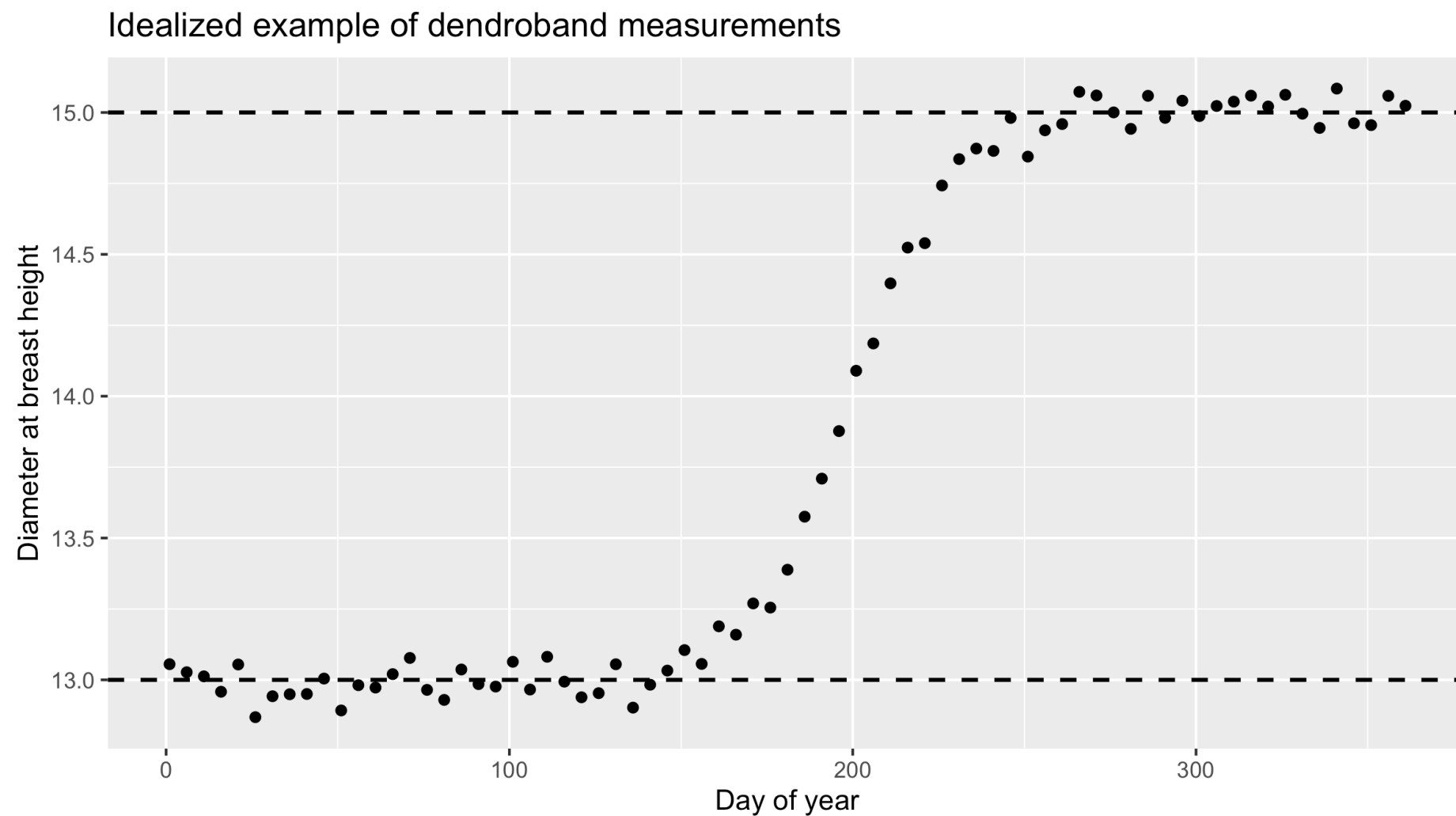
Model for dbh

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



Model for dbh

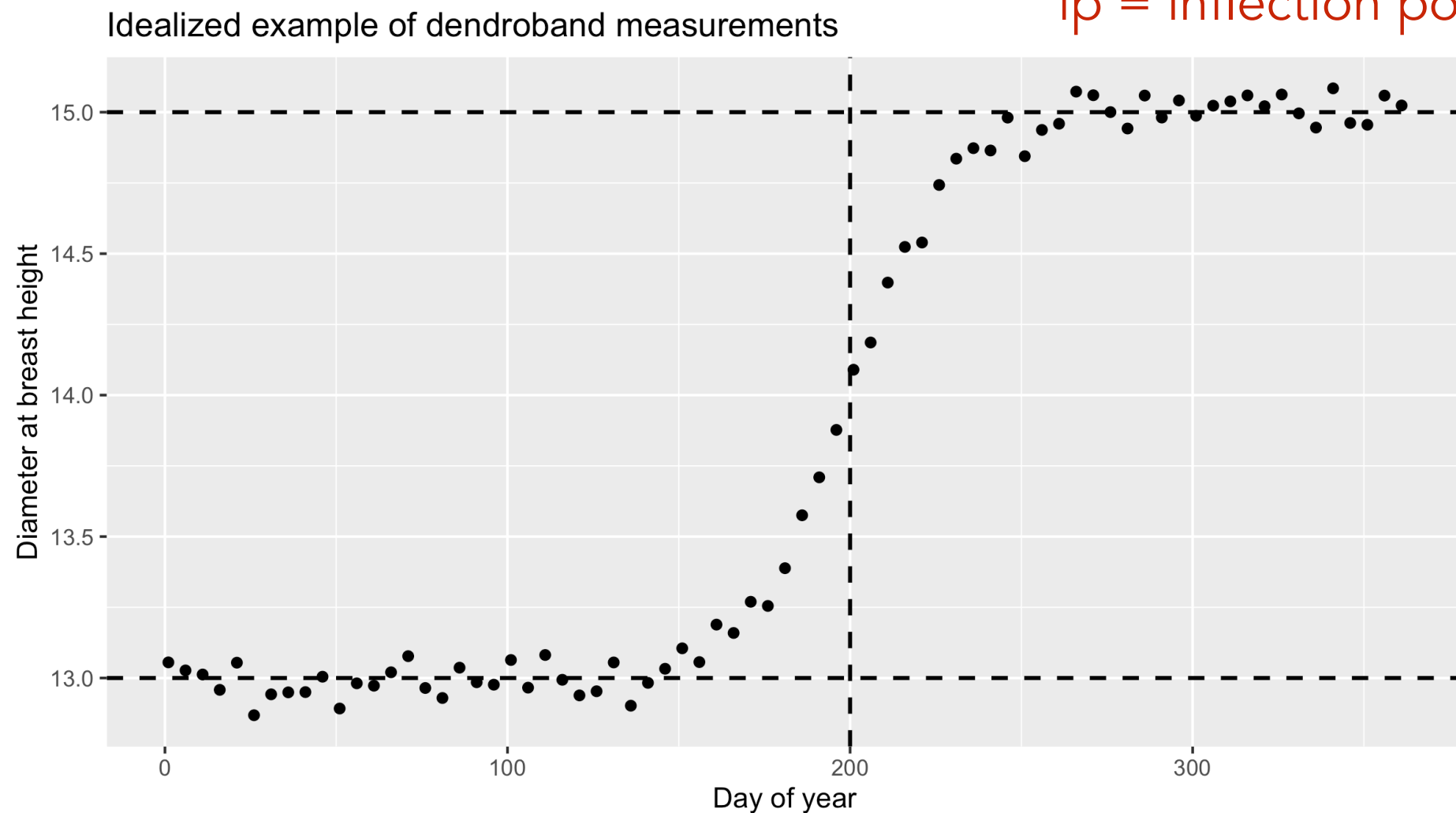
$$dbh = \frac{L + \boxed{K} - L}{1 + 1/\theta \cdot \exp\left(-r(doy - doy_{ip})/\theta\right)^\theta}$$



Model for dbh

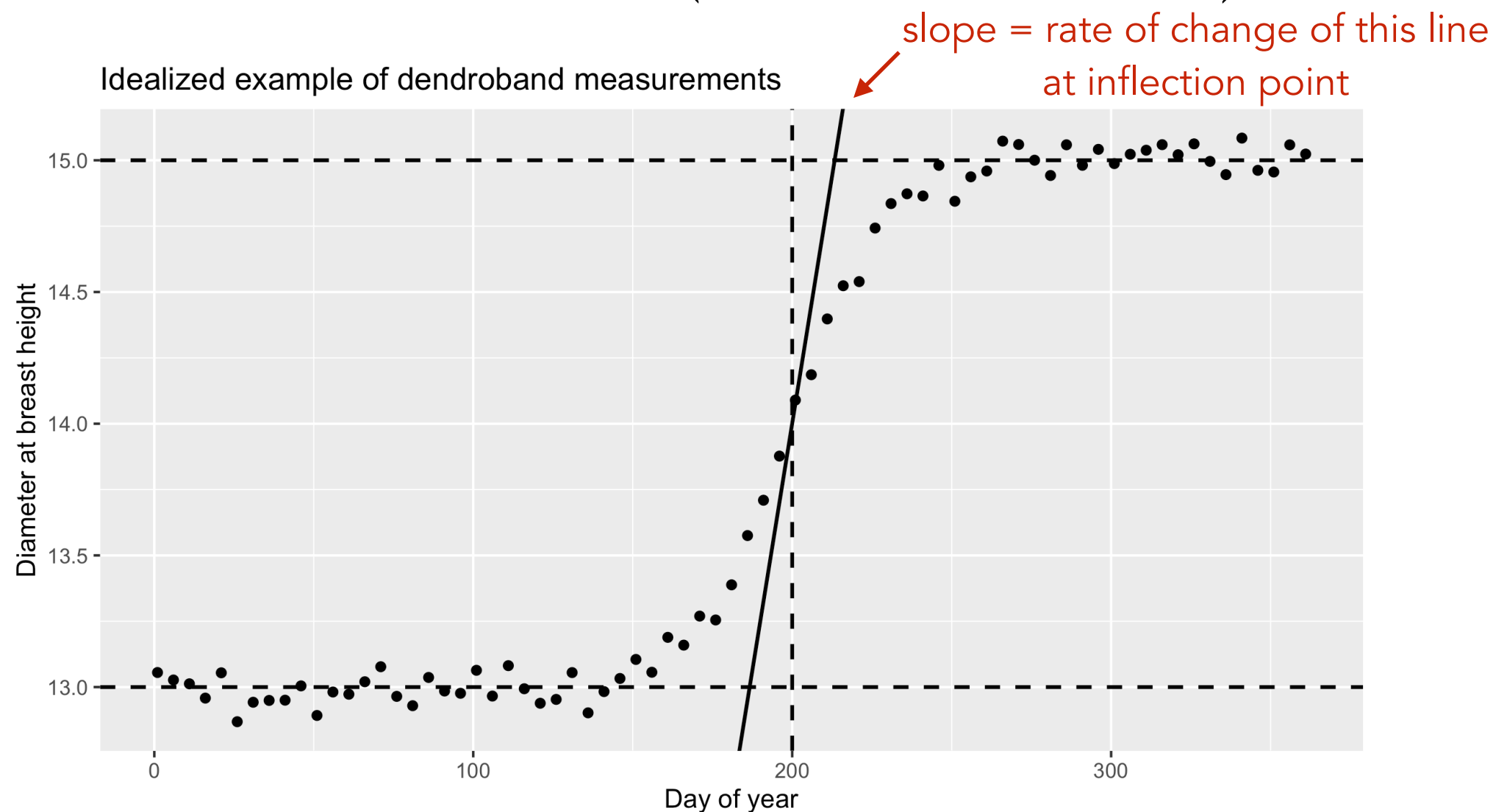
$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-r(doy - \boxed{doy_{ip}})/\theta\right)}^\theta$$

ip = inflection point



Model for dbh

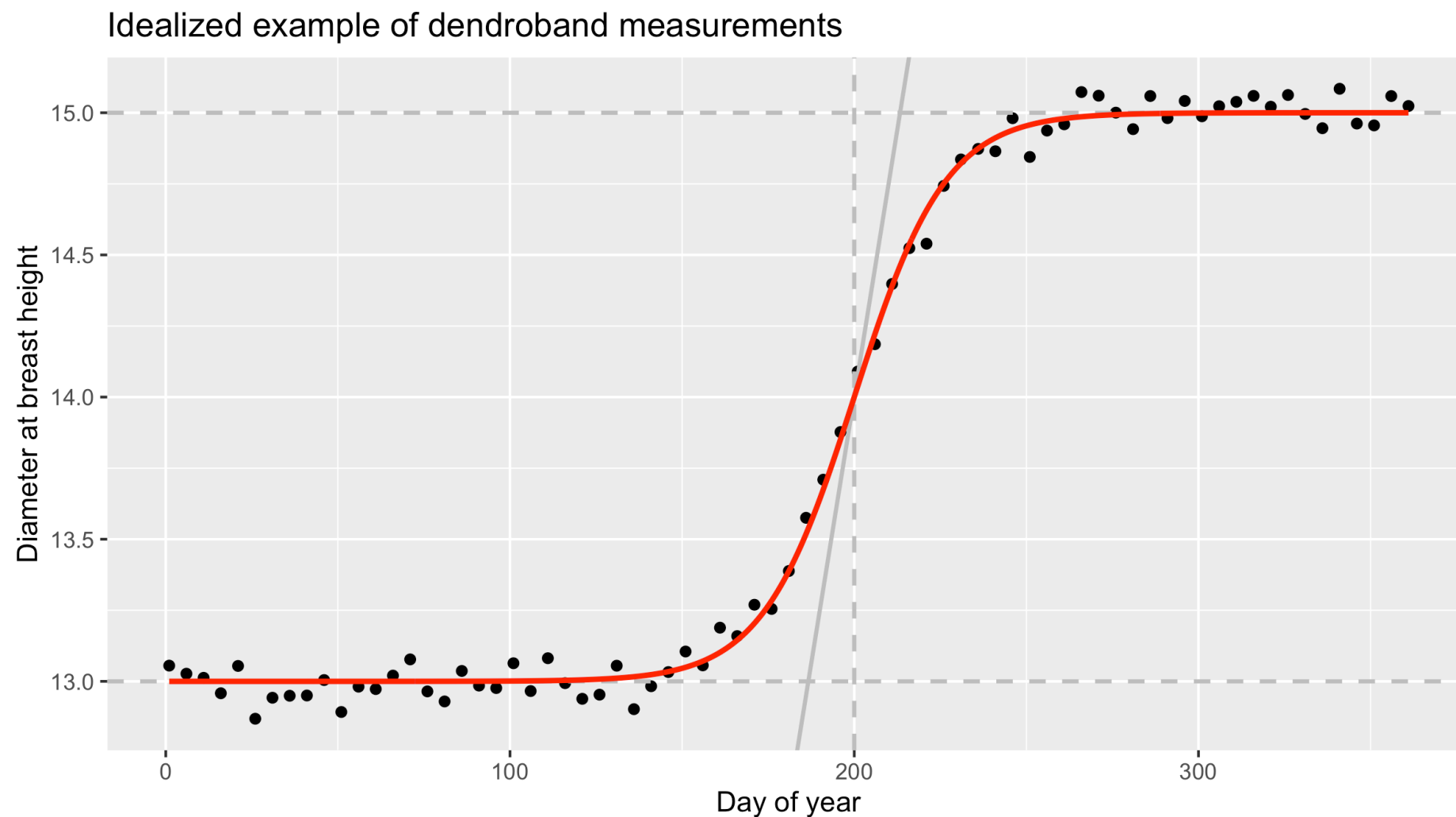
$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-\boxed{r}(doy - doy_{ip})/\theta\right)^\theta}$$



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

Model for dbh

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

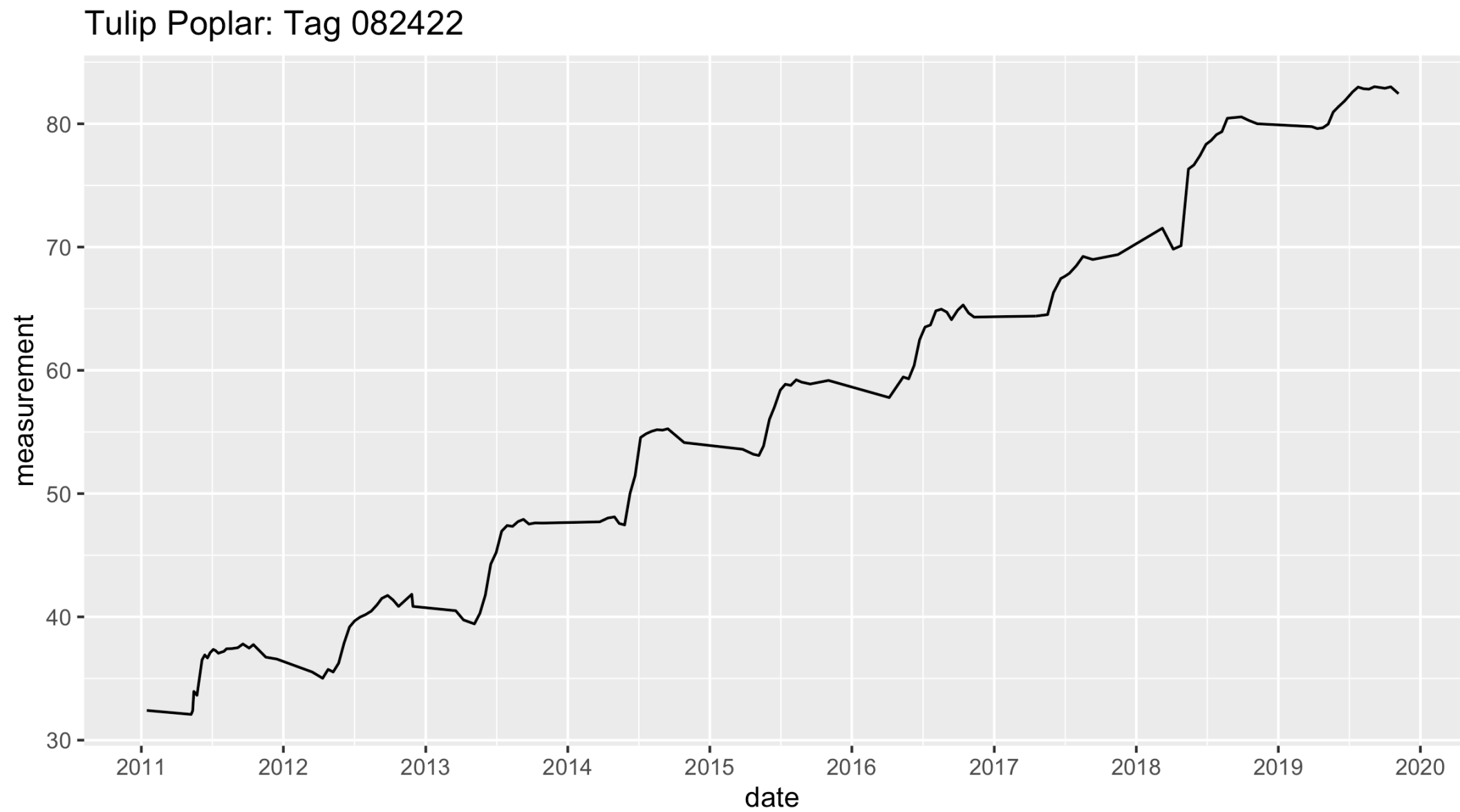


But remember, you need a model that works for ALL 🌲 🌳 🌴

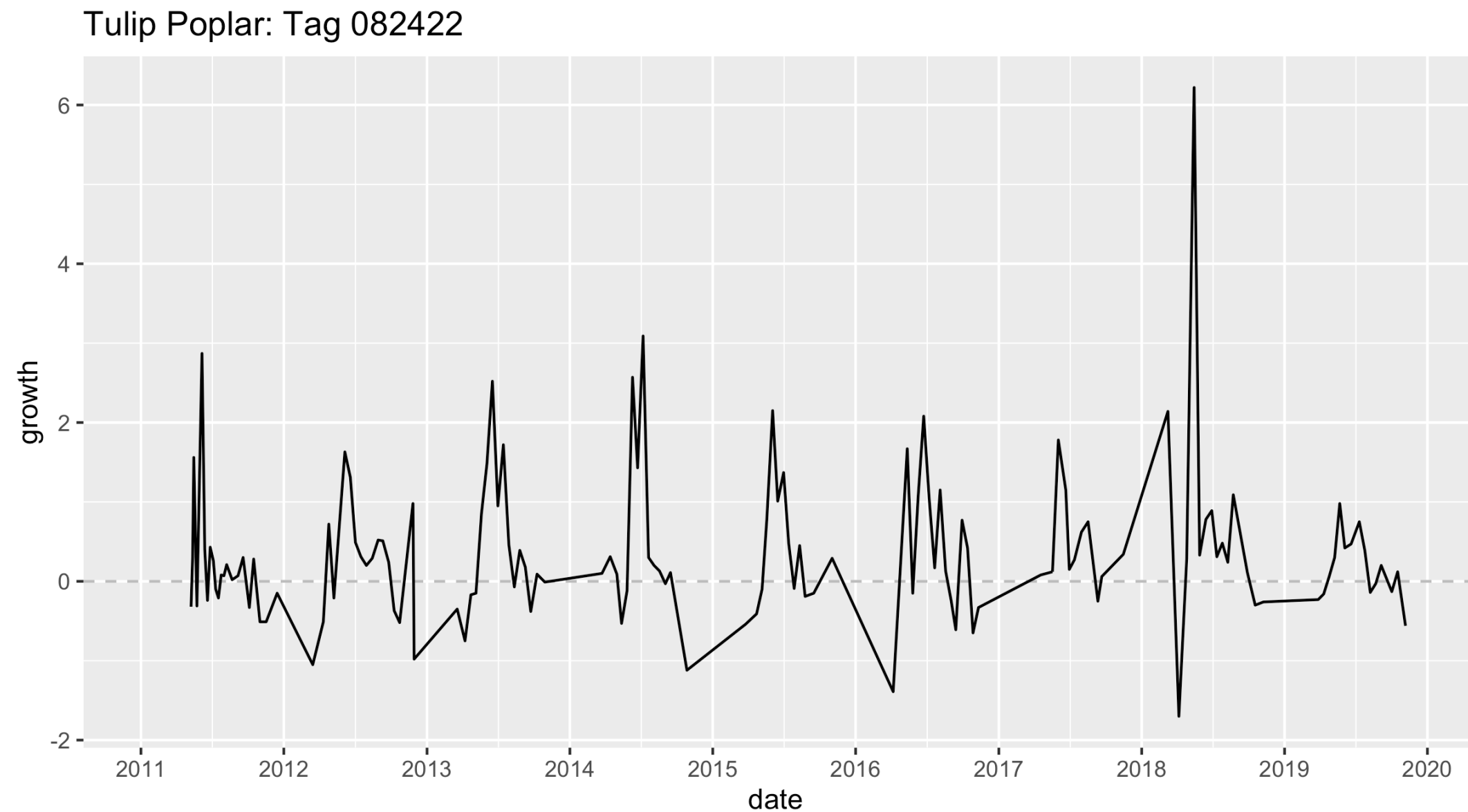
**Lesson 2: Statistics is not
math, rather statistics uses
math**

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

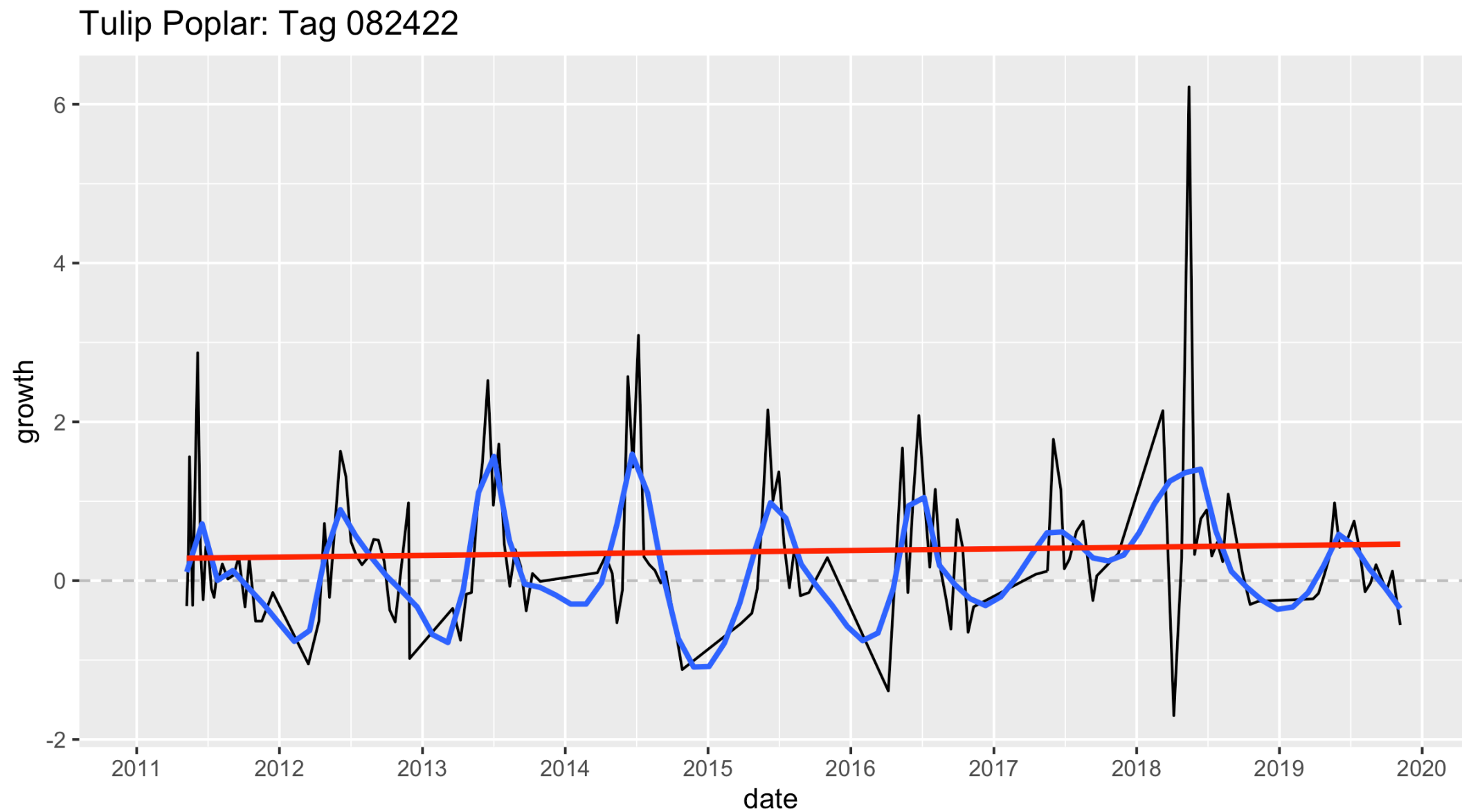
Observed Dendroband Measurements



Growth = difference in measurements



Patterns



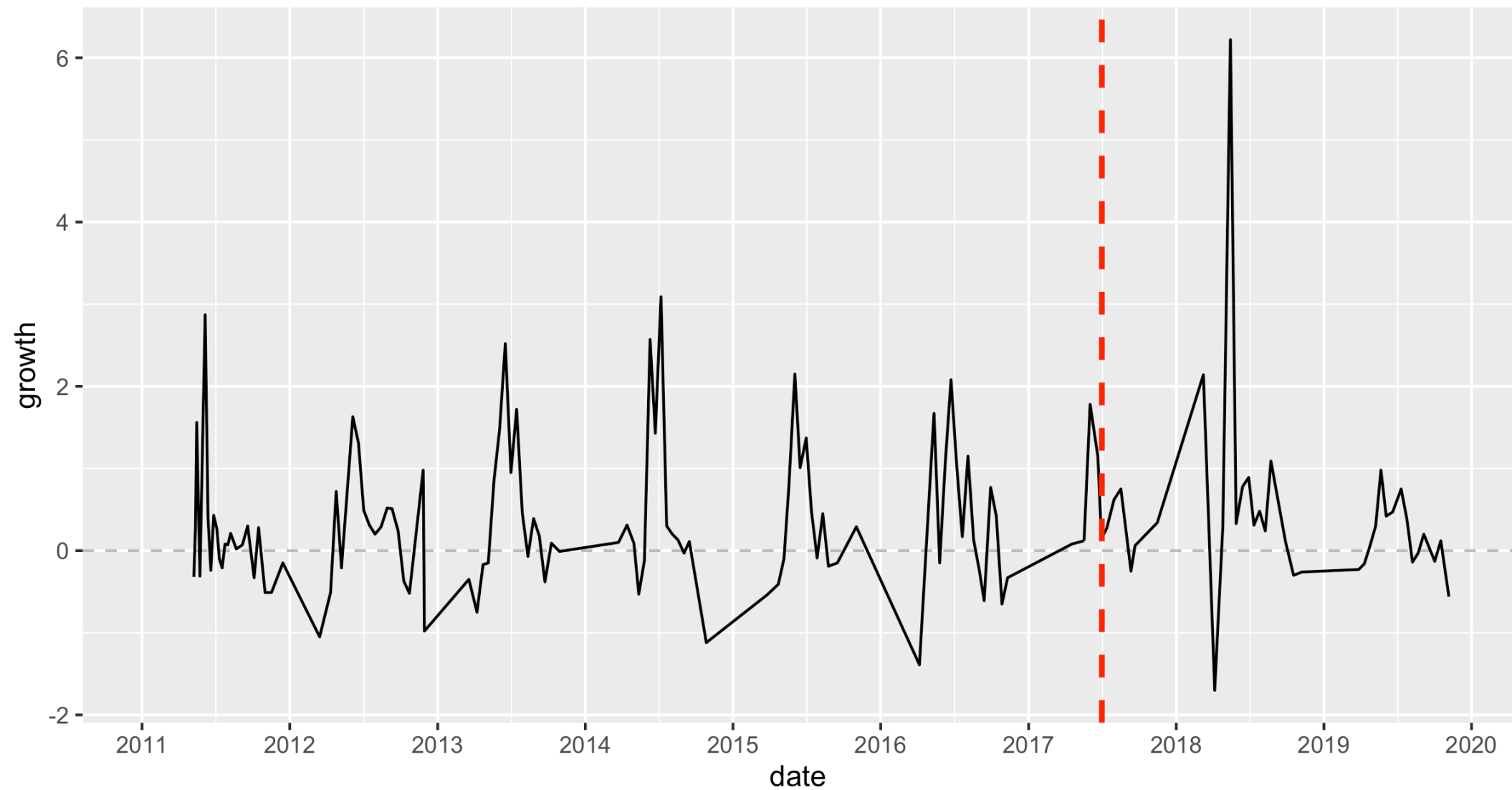
Seasonal trend that repeats every year

Overall (slightly increasing) trend

Effect of Climate Change

Tulip Poplar: Tag 082422

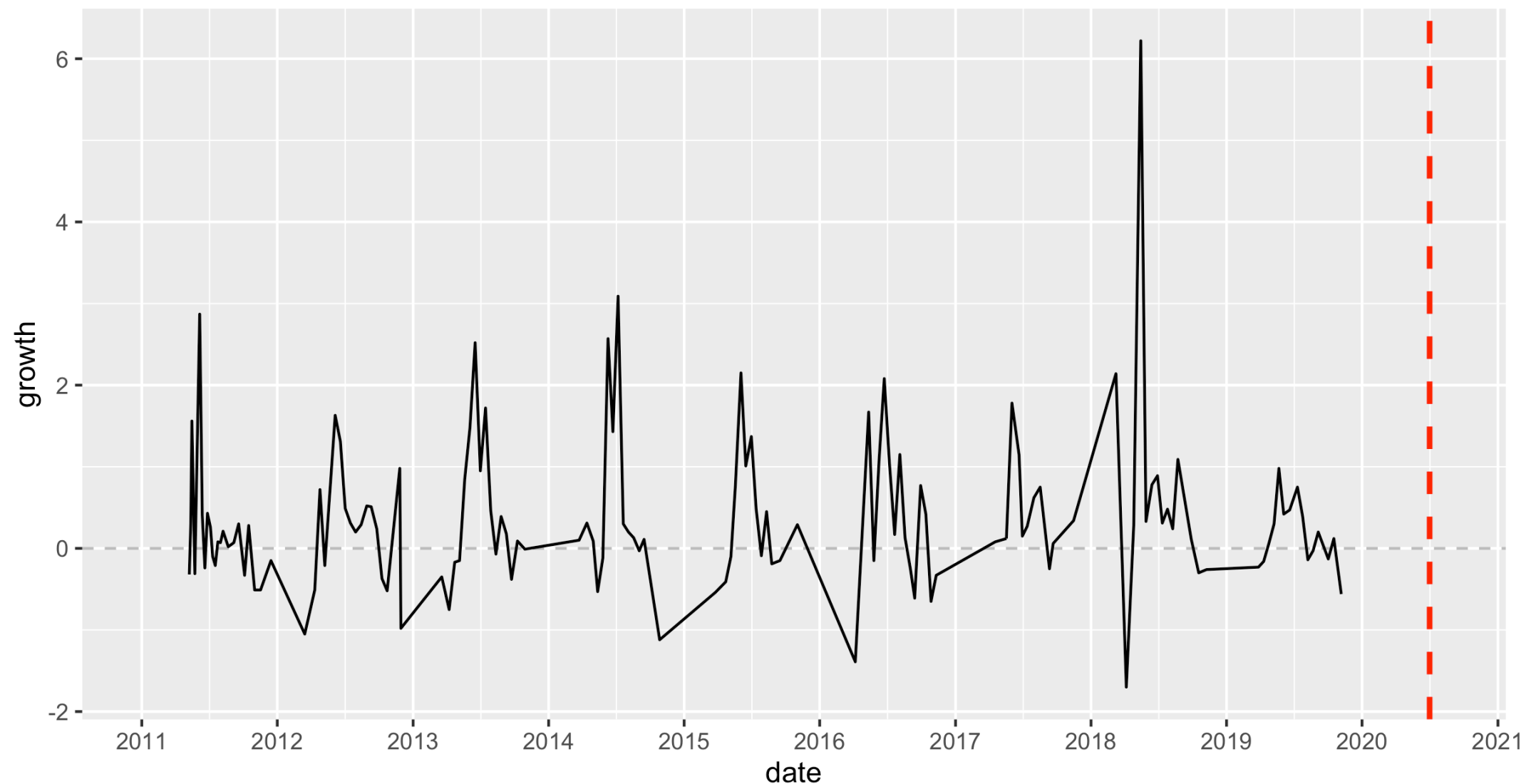
July 2017 was very hot 🥵



Effect of Climate Change

July 2020 was even hotter 🔥😓🔥

Tulip Poplar: Tag 082422



What other variables should we account for?

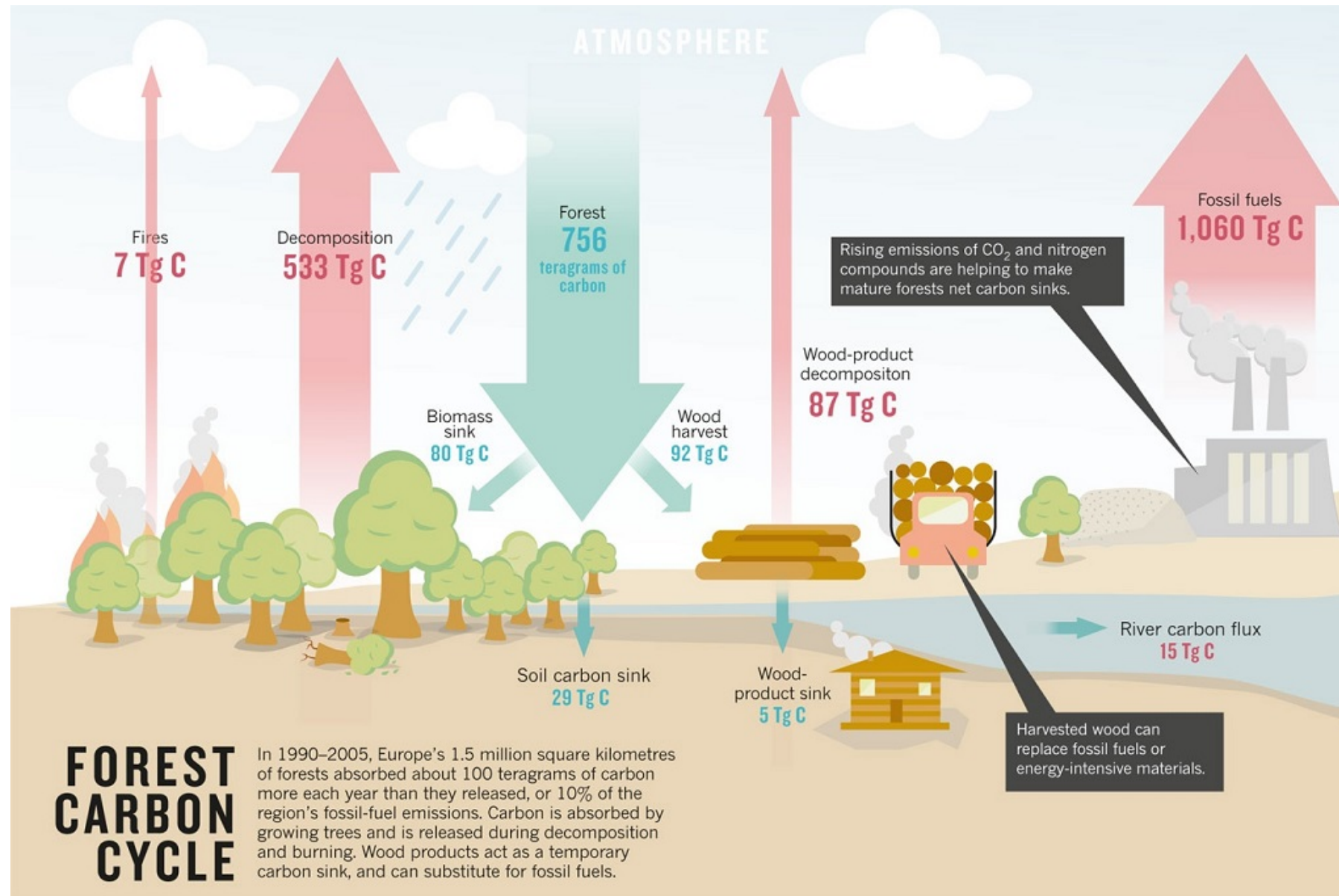
Drought? Humidity? Earlier springs?

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



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

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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

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Article | **Published: 23 September 2020**

Mapping carbon accumulation potential from global natural forest regrowth

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

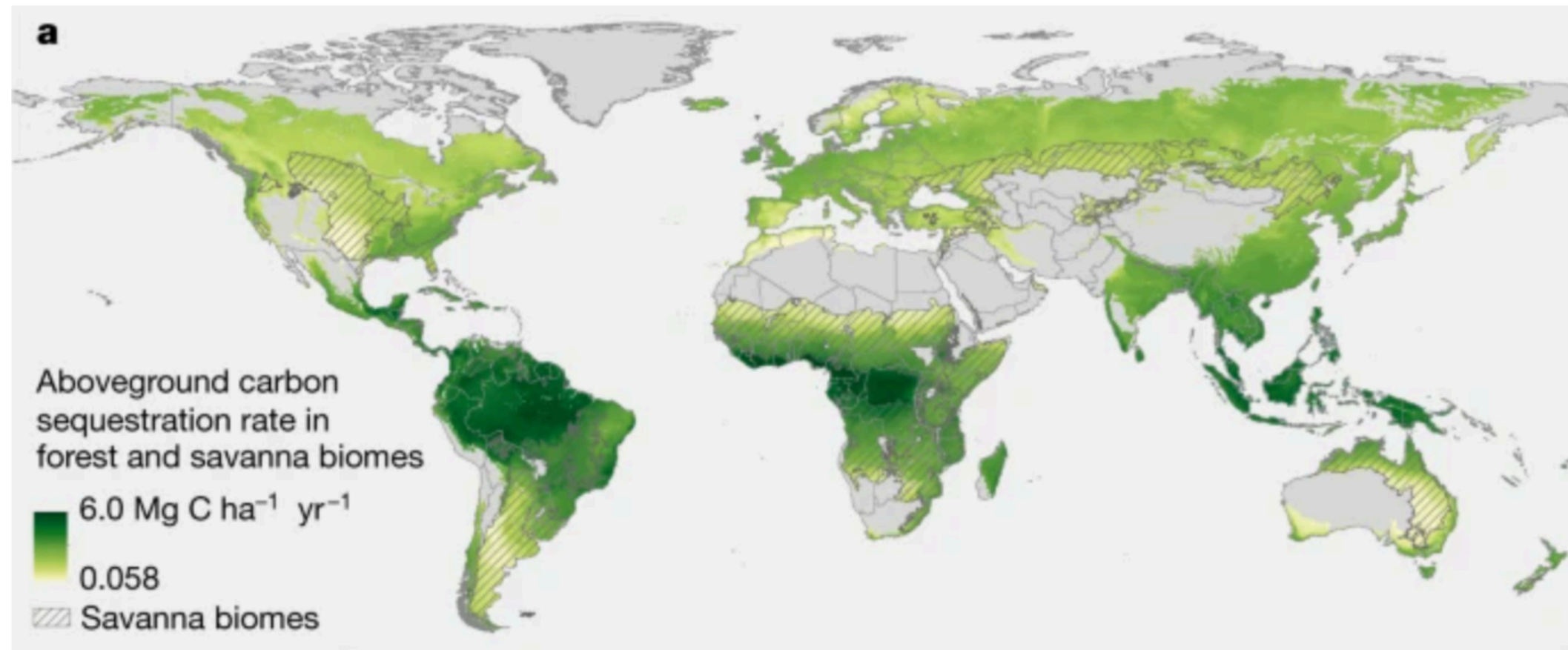
Nature **585**, 545–550(2020) | [Cite this article](#)

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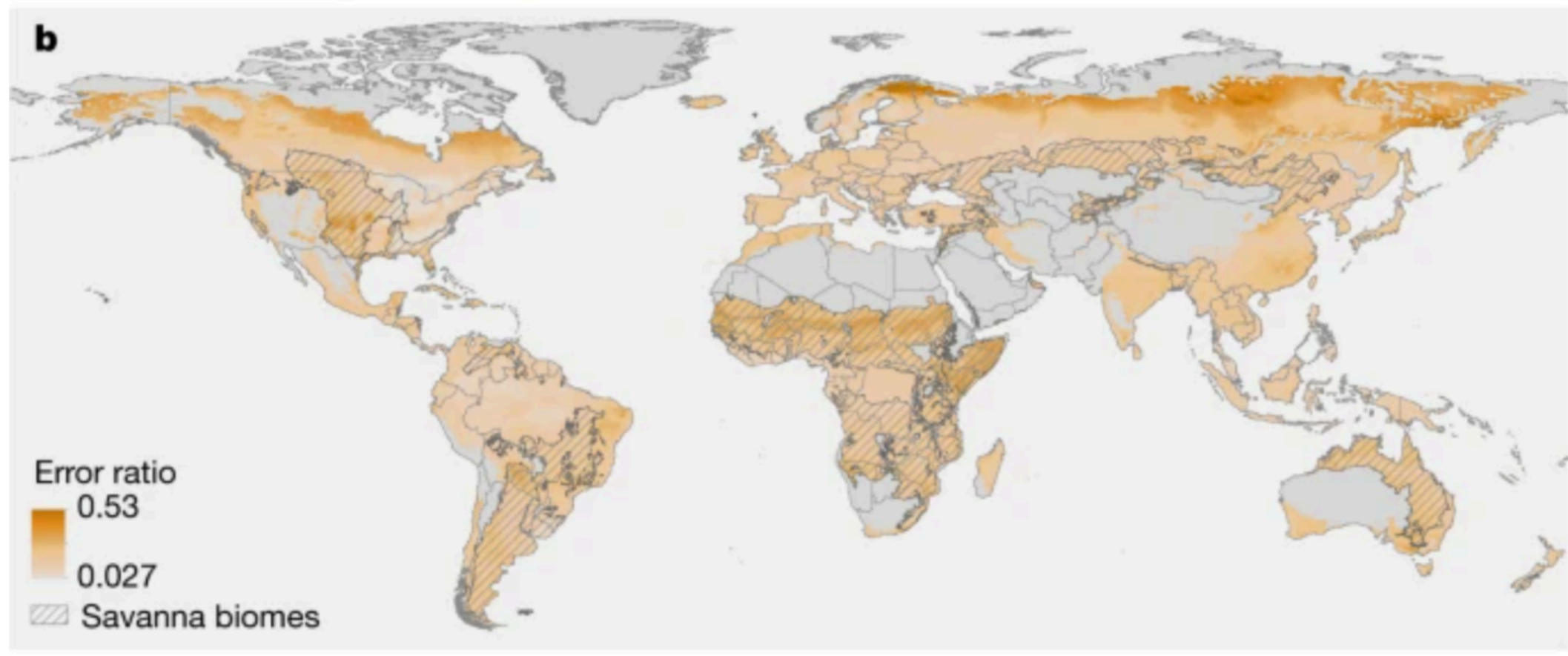
Abstract

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**