Statistical Models for Forest Ecology

Prof. Albert Y. Kim

Environmental Science & Policy Lunchbag

Wednesday, September 30, 2020

Smith College SDS Statistical & Data Sciences

Diameter at Breast Height (dbh)

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

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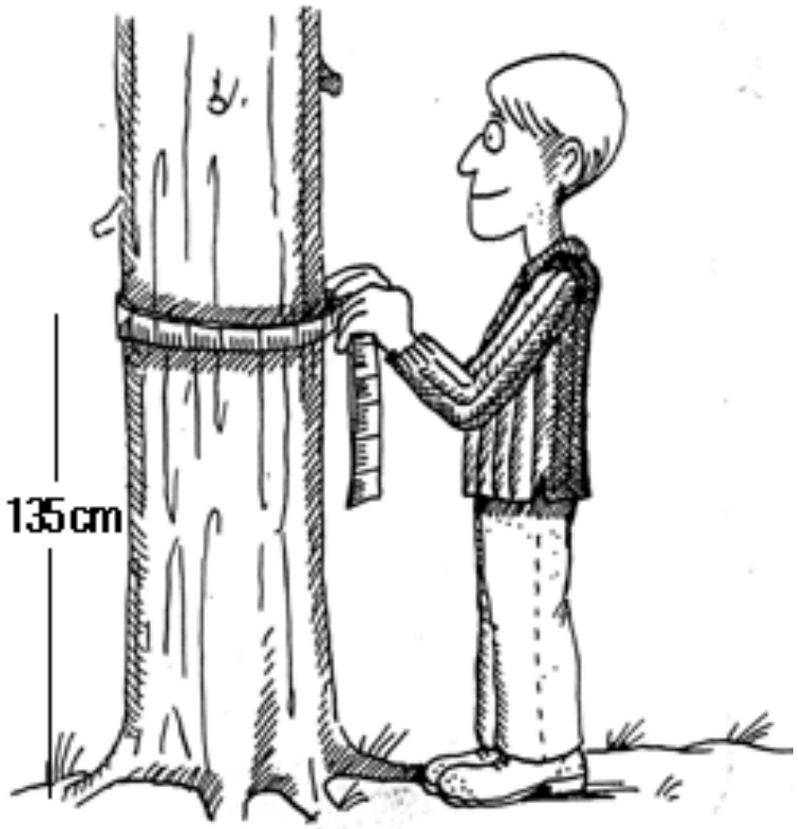

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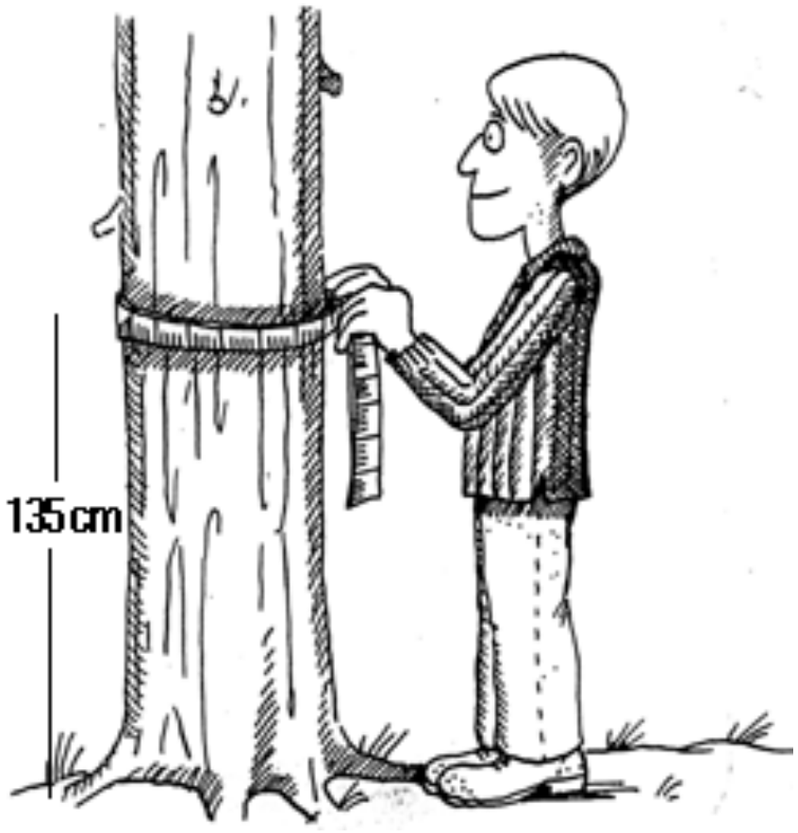

135cm off the ground

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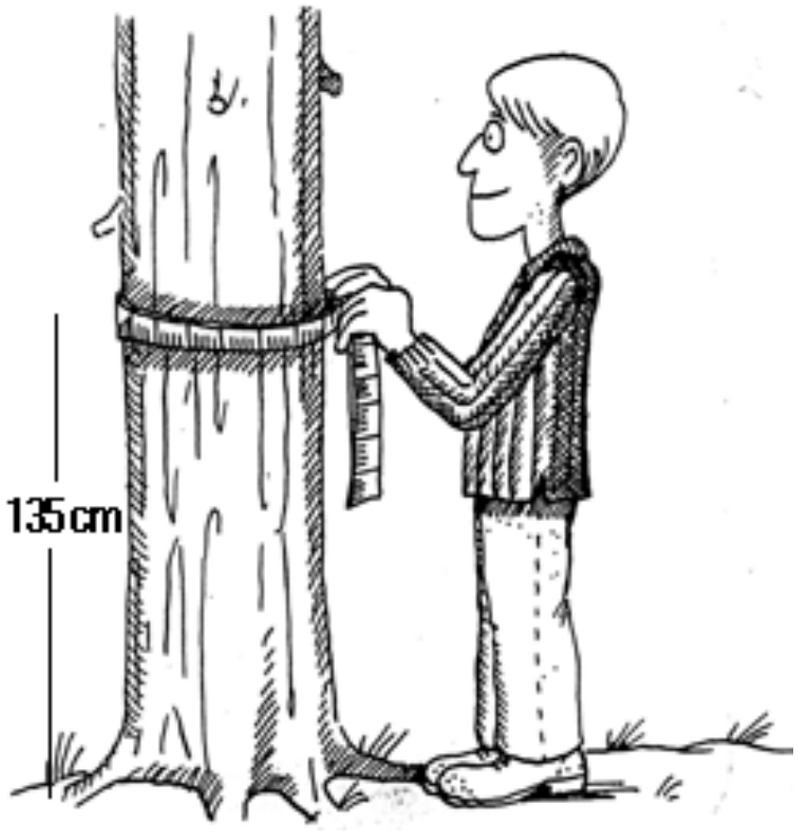

135cm off the ground

🥥 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

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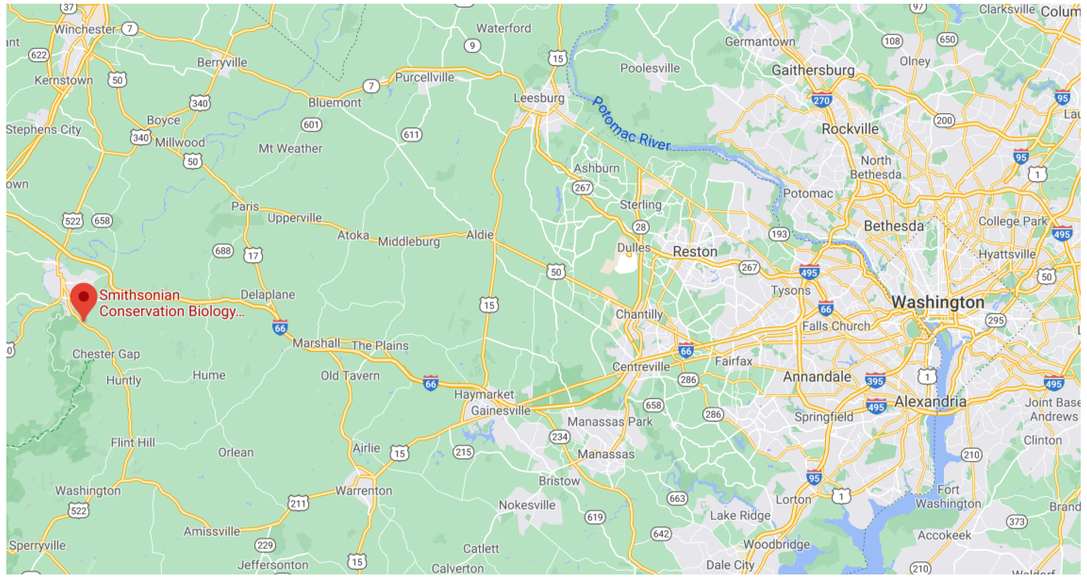

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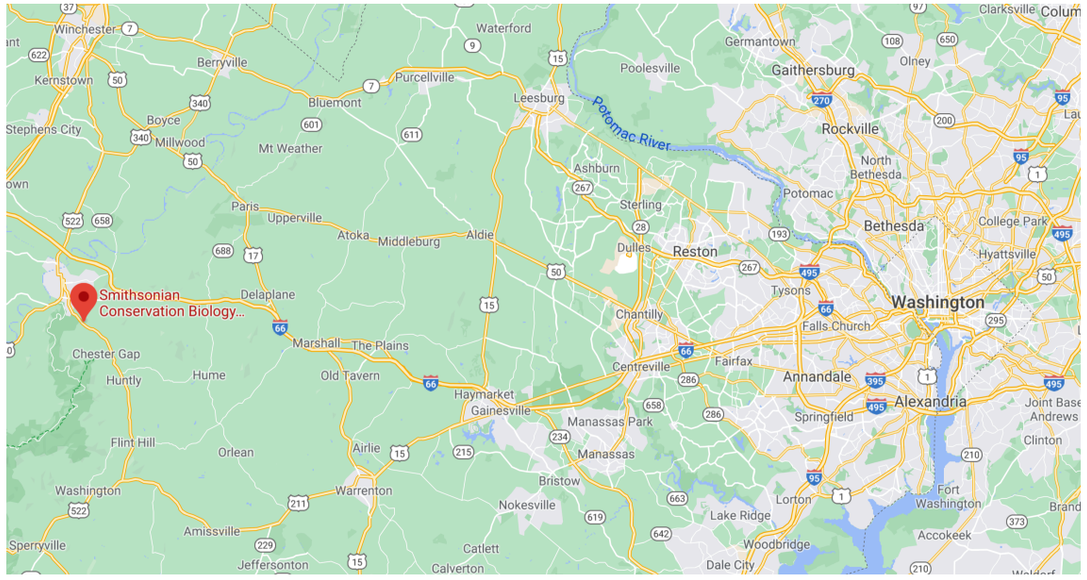

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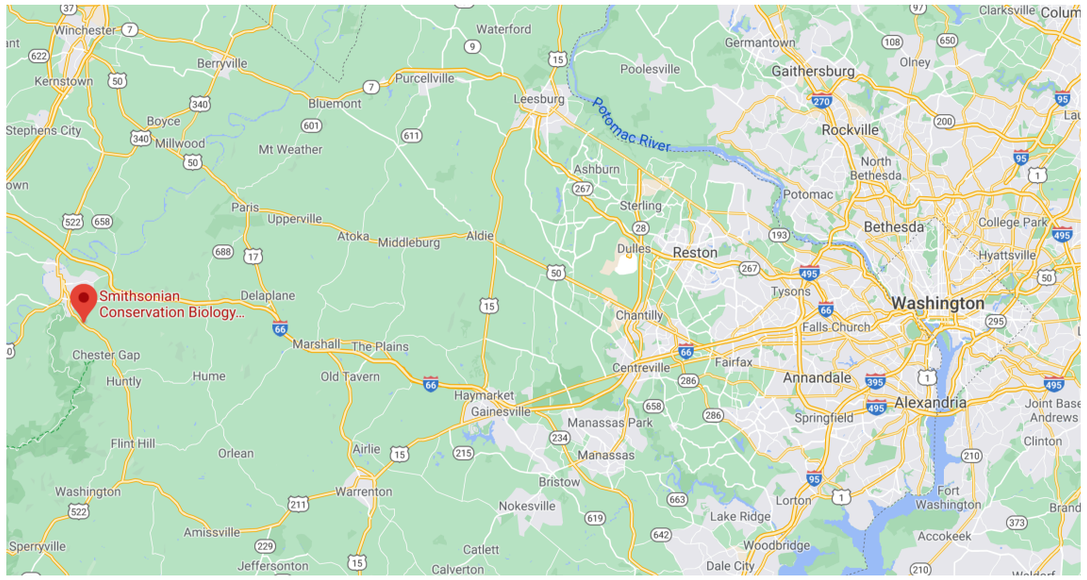

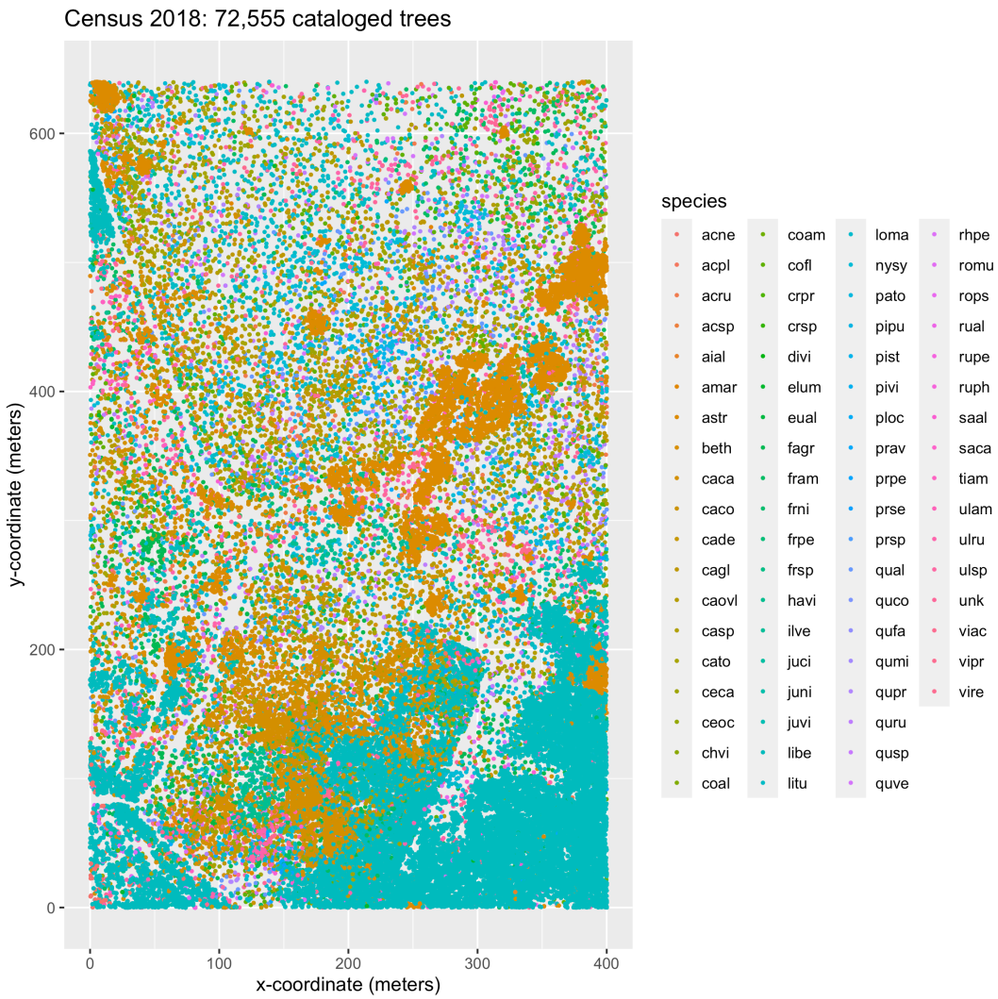

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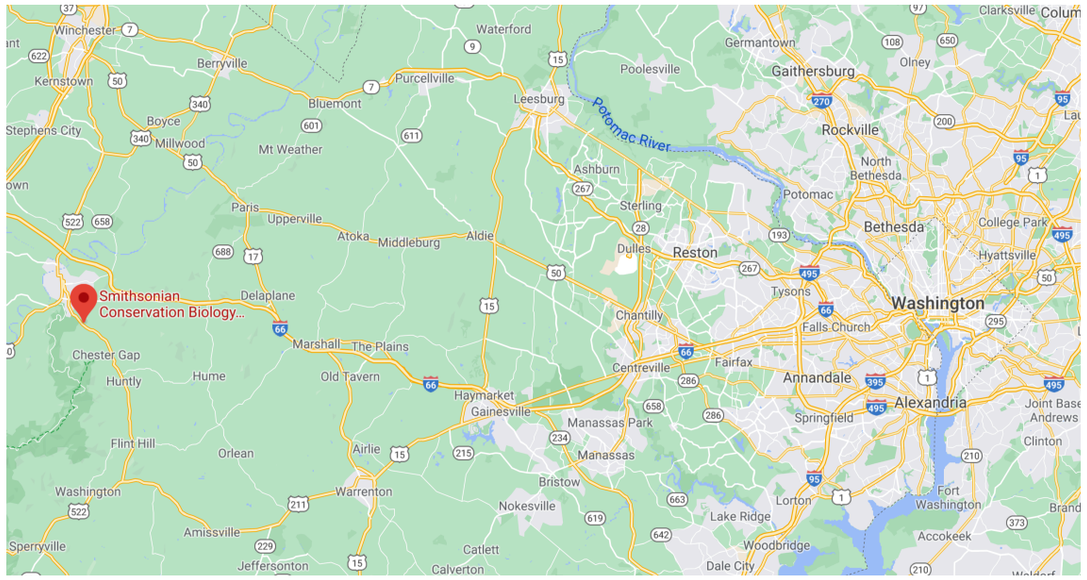

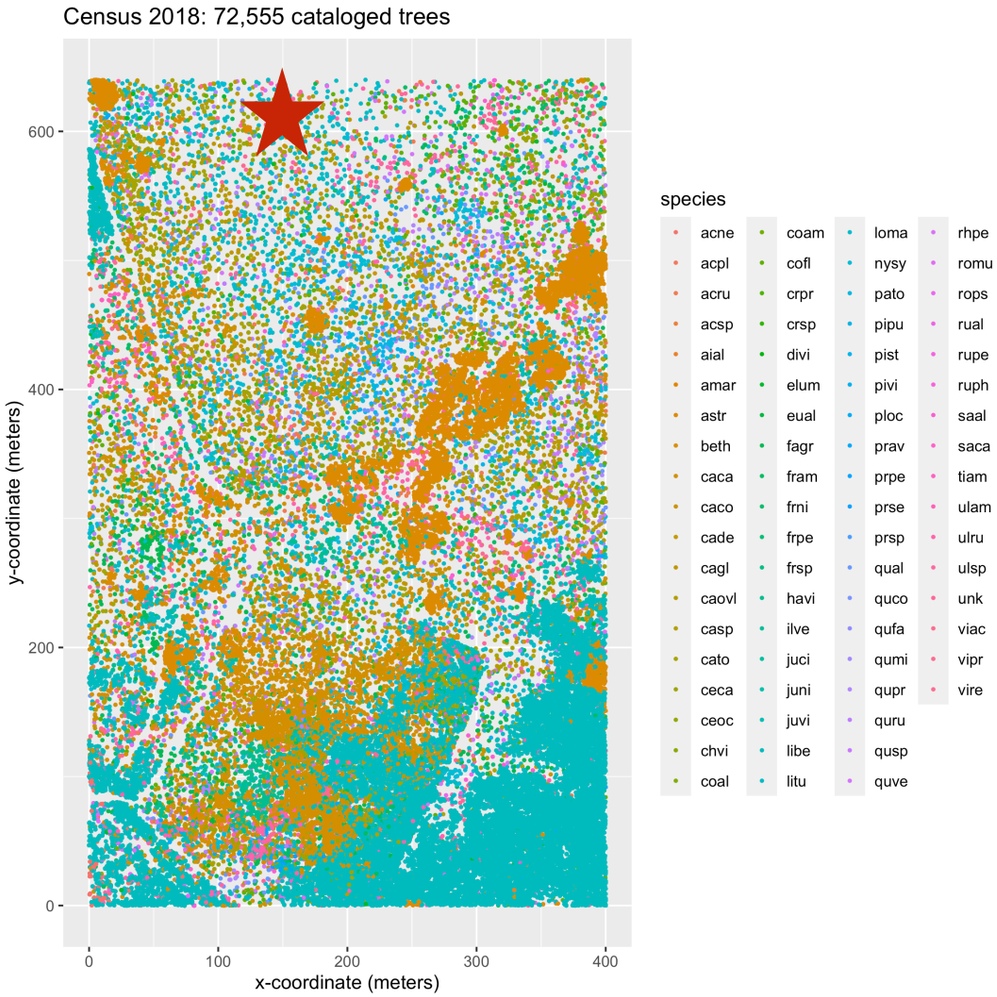

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Tag 082422

1. Measure diameter w/ dendroband + calipers

2. Share Data on GitHub

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SCBI-ForestGEO / Dendrobands — Unwatch 5 | Star 0 | Fork 0

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master — Dendrobands / data / scbi.dendroAll_2020.csv — Go to file

rudeboybert Replace text month coding with integer month coding for 2019 & 2020. F... — Latest commit aa41236 on Jul 3 — History

4 contributors

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	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
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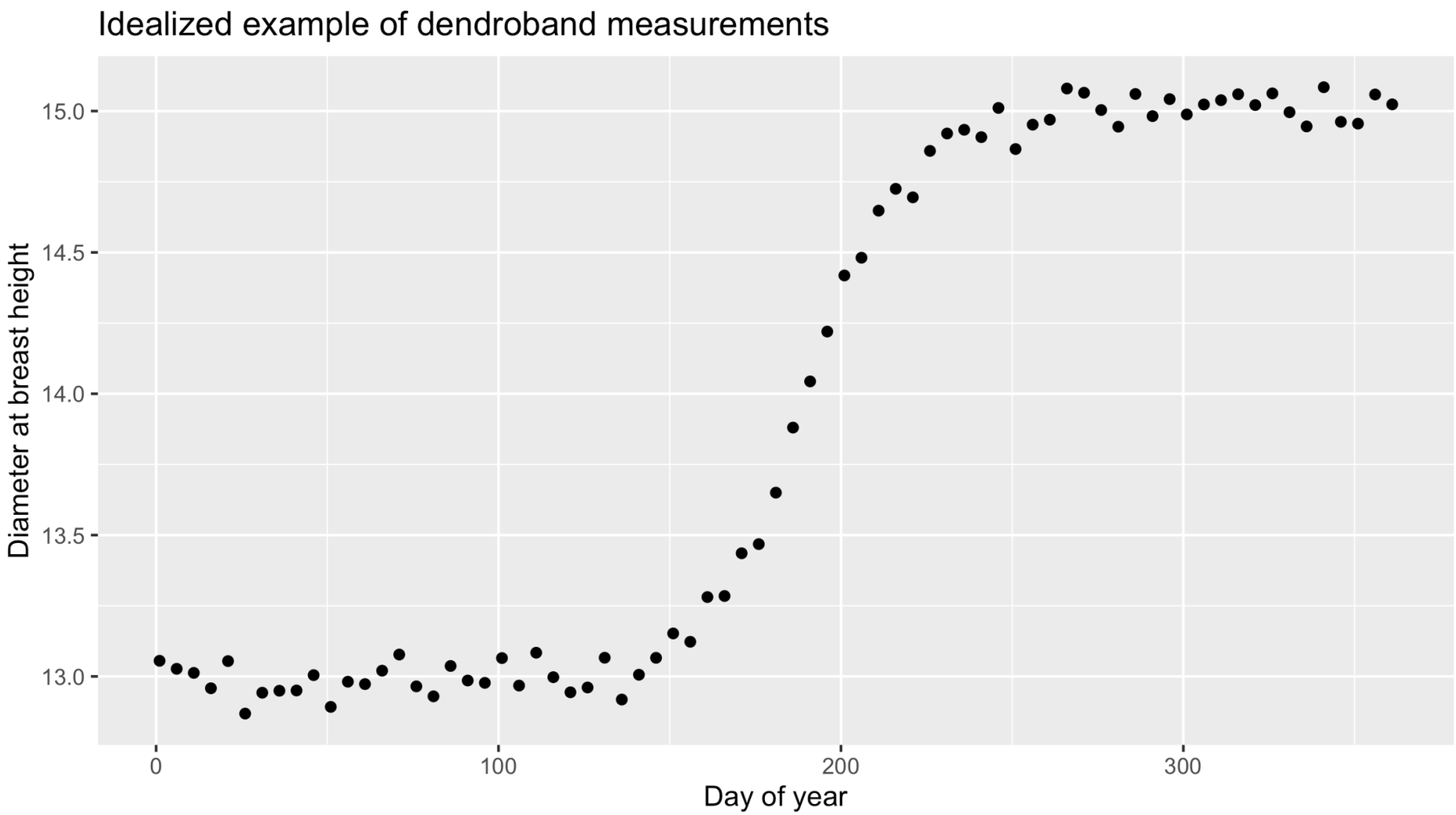
3. Load data into statistical software



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

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

Models

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

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Models in general:

- y = outcome you want to explain
- x = input info
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- y = dbh
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- x = day of year where Jan 1st = 1
- f = function connecting y & x
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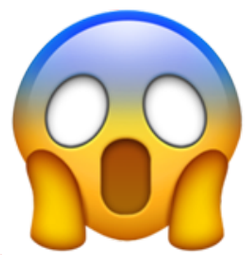
$$dbh = \frac{L + (K - L)}{1 + 1/\theta \cdot \exp\left(-r(doy - doy_{ip})/\theta\right)^{\theta}} + \epsilon$$



McMahon (2014)

Model for dbh

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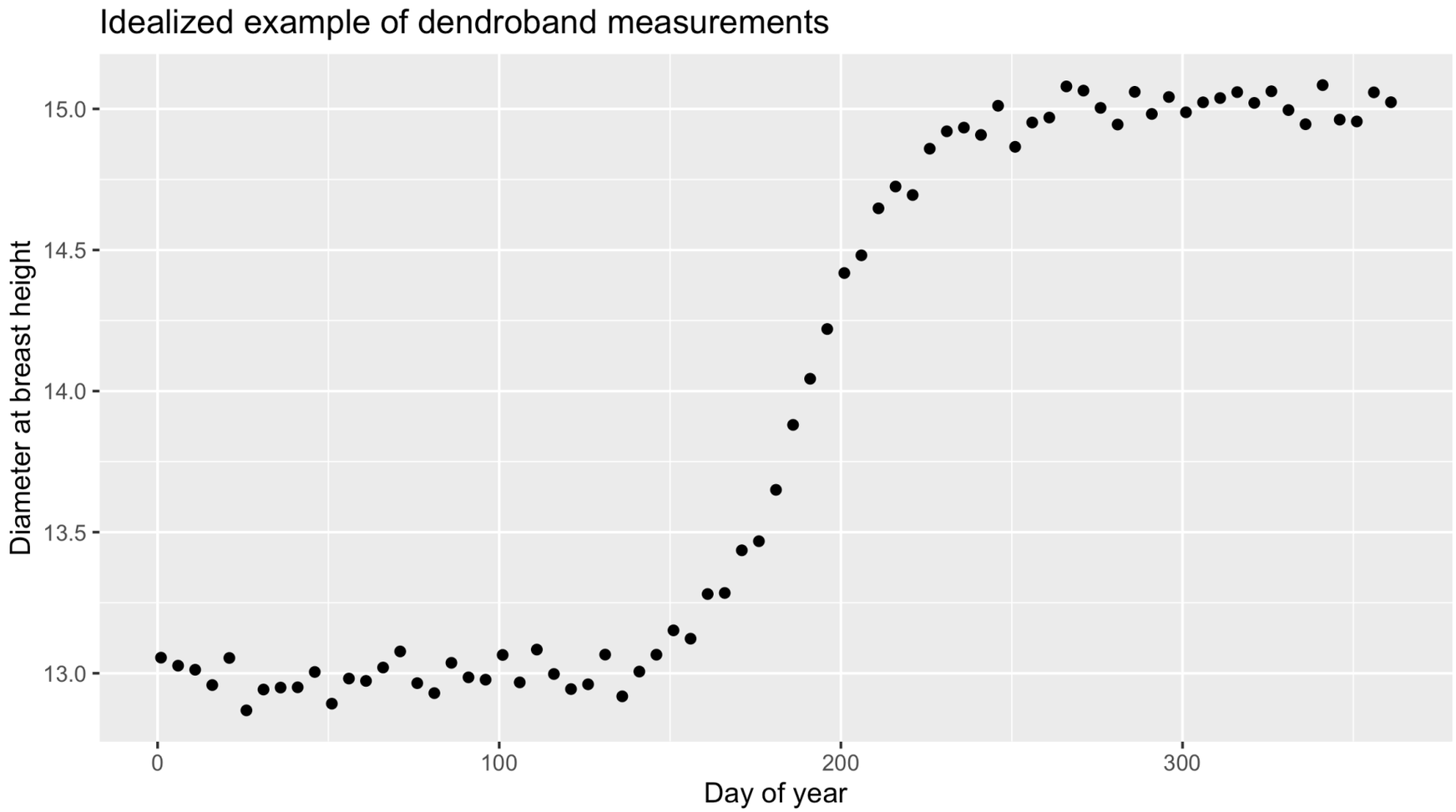

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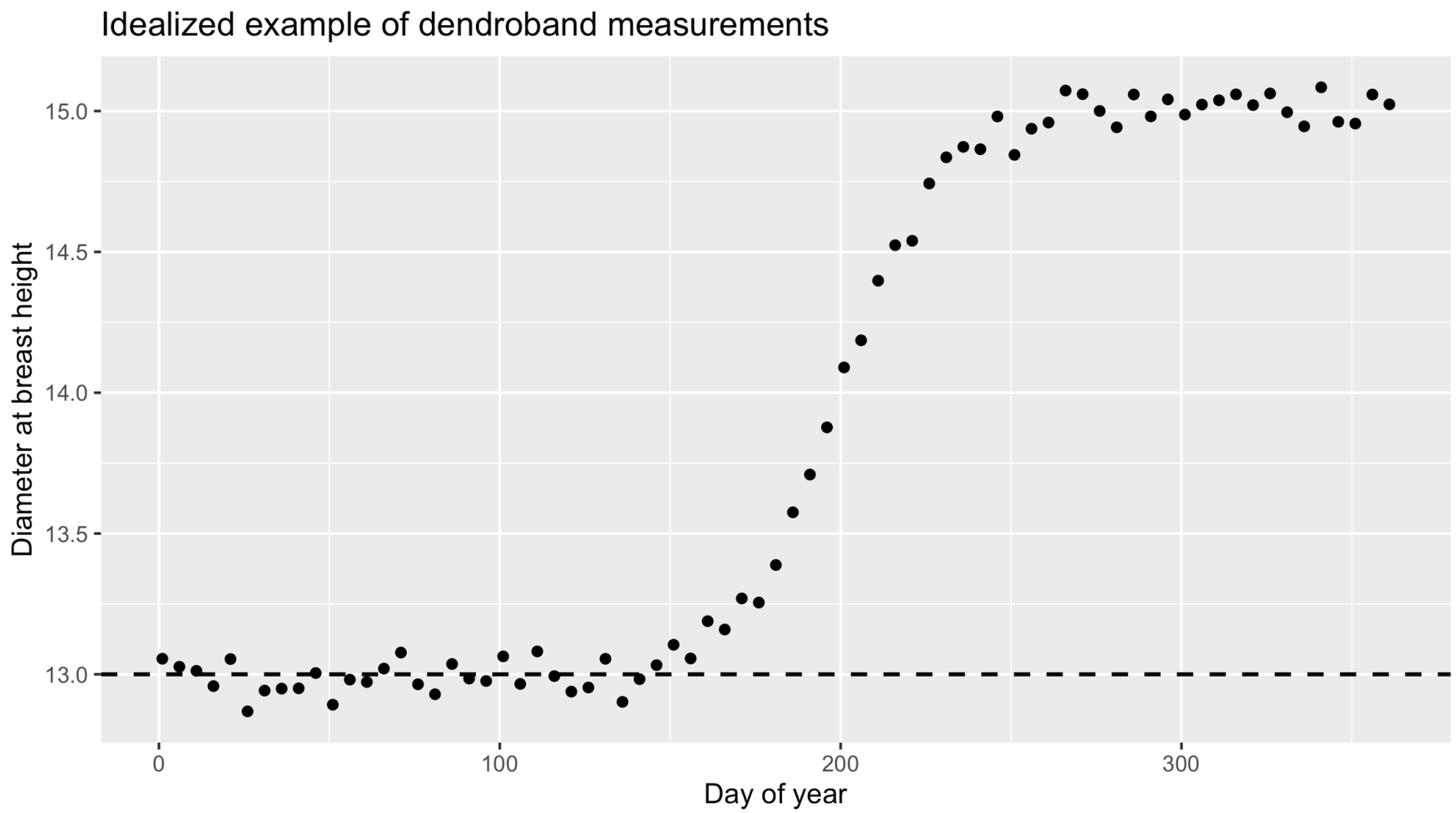

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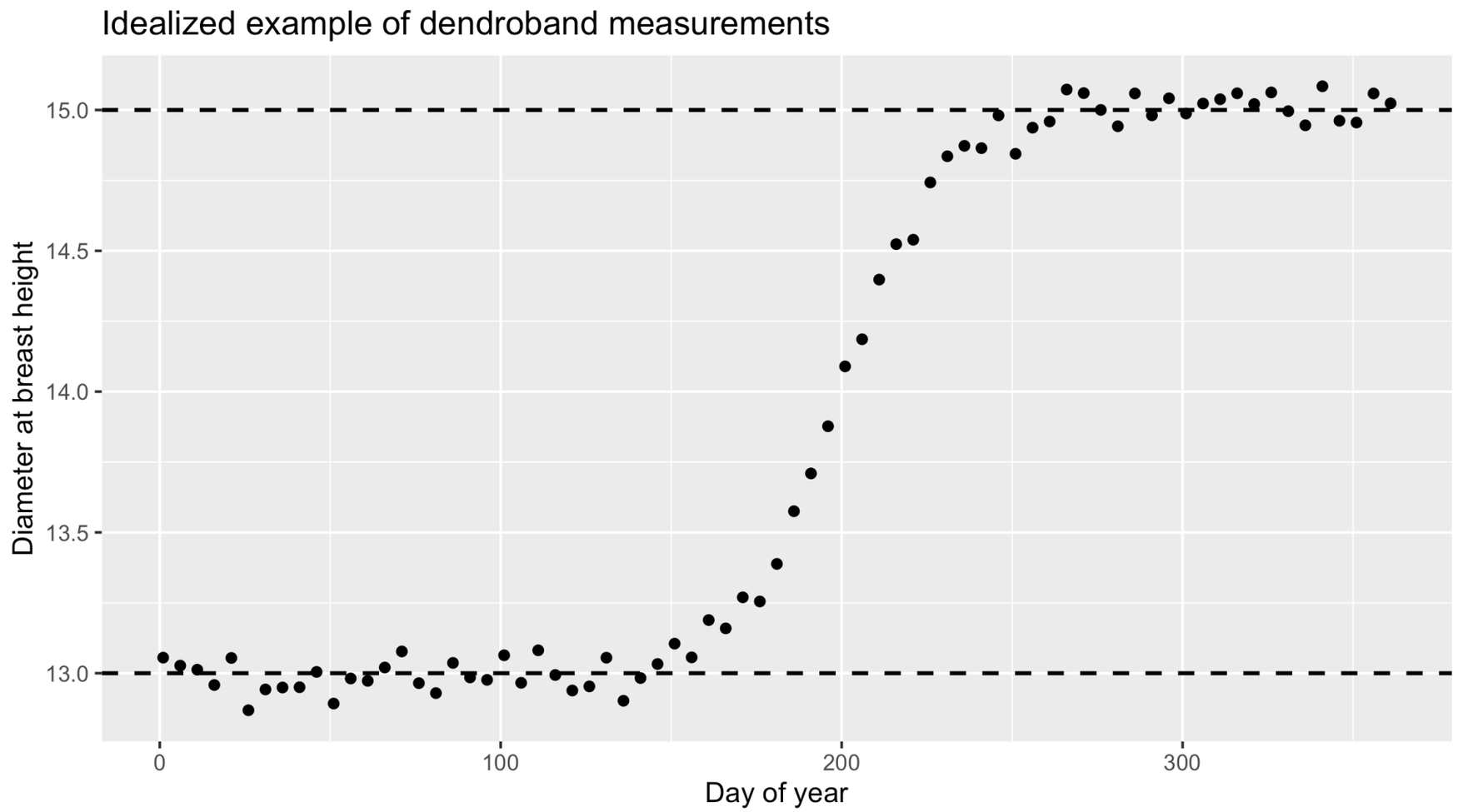

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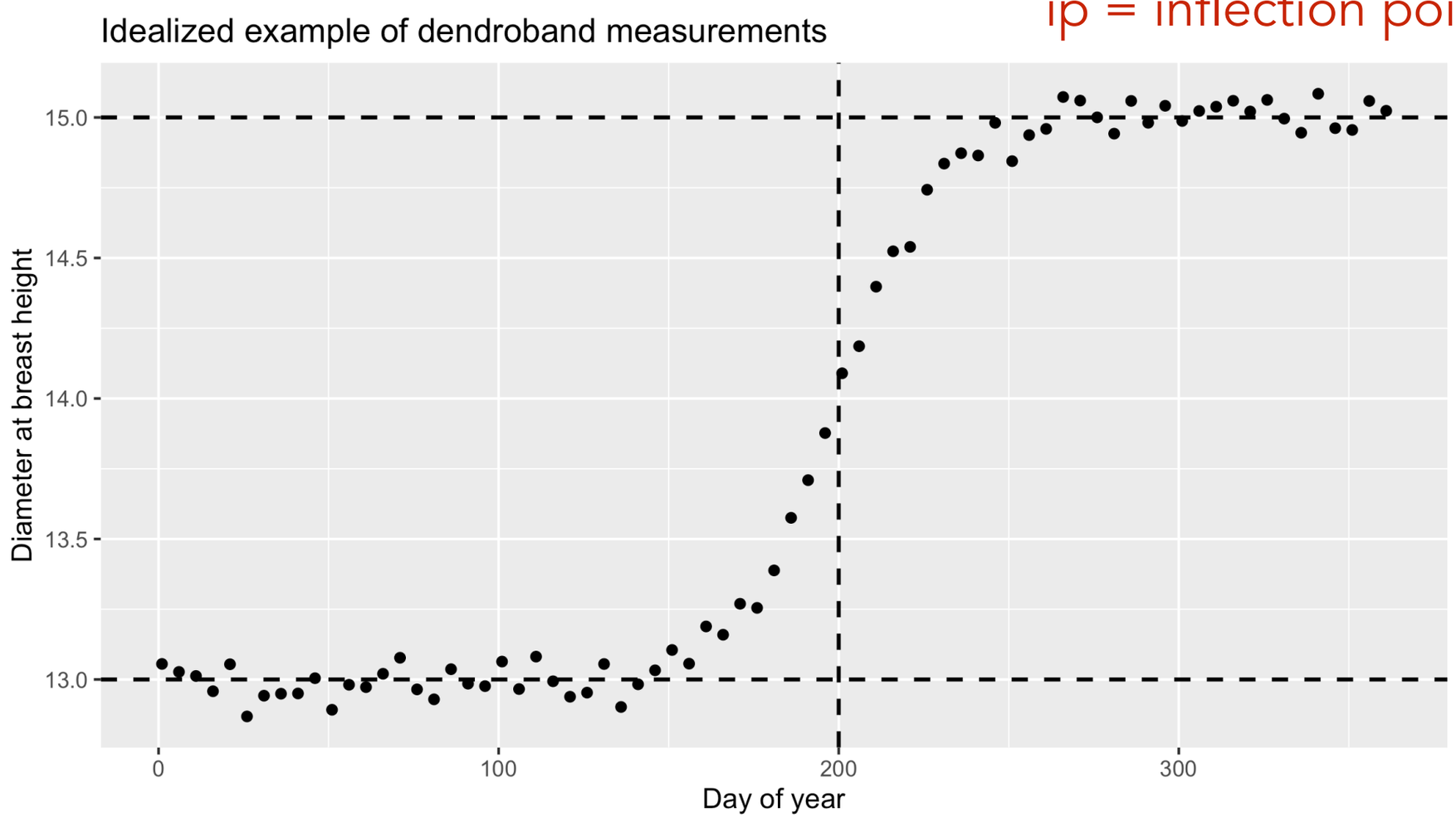
ip = inflection point



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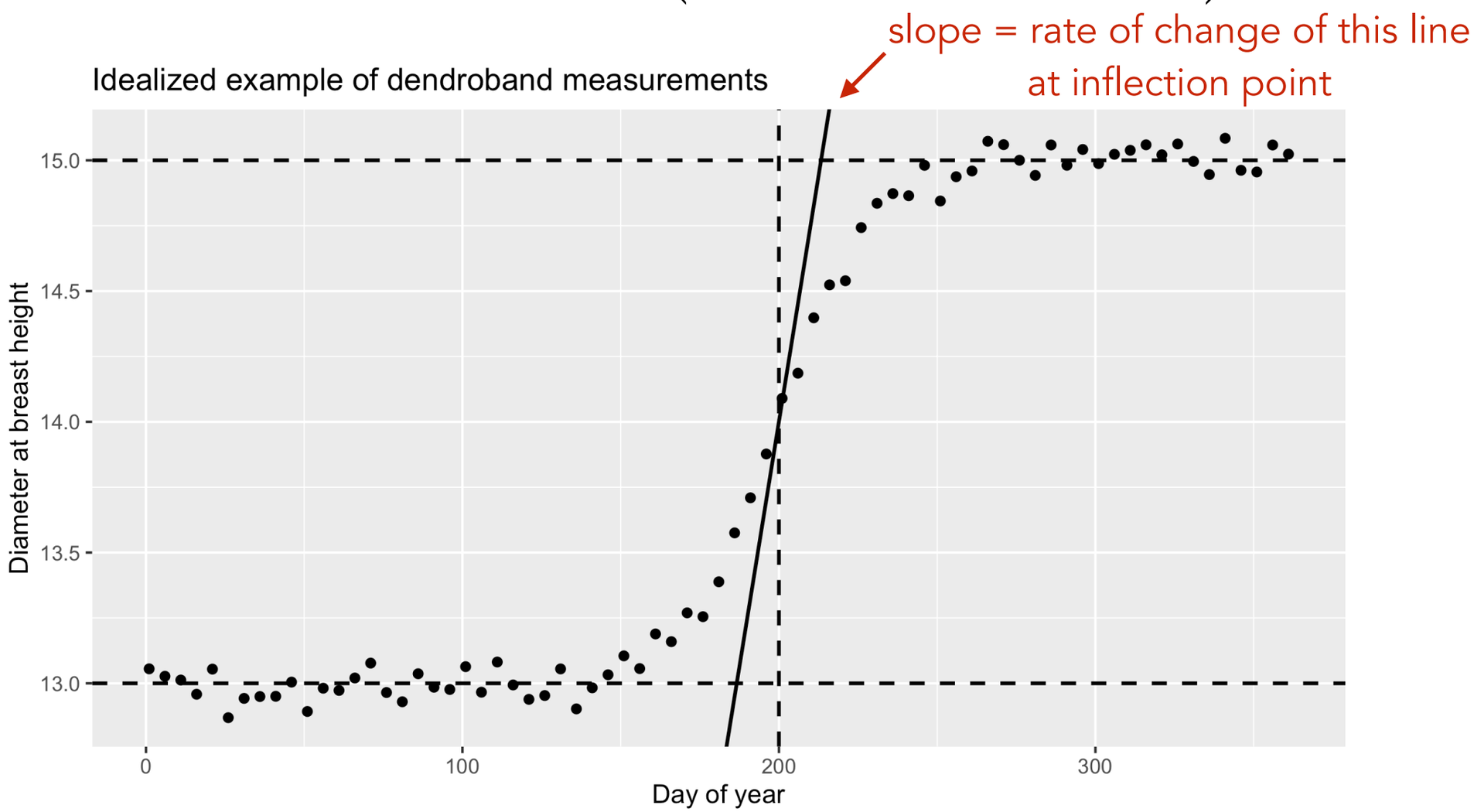

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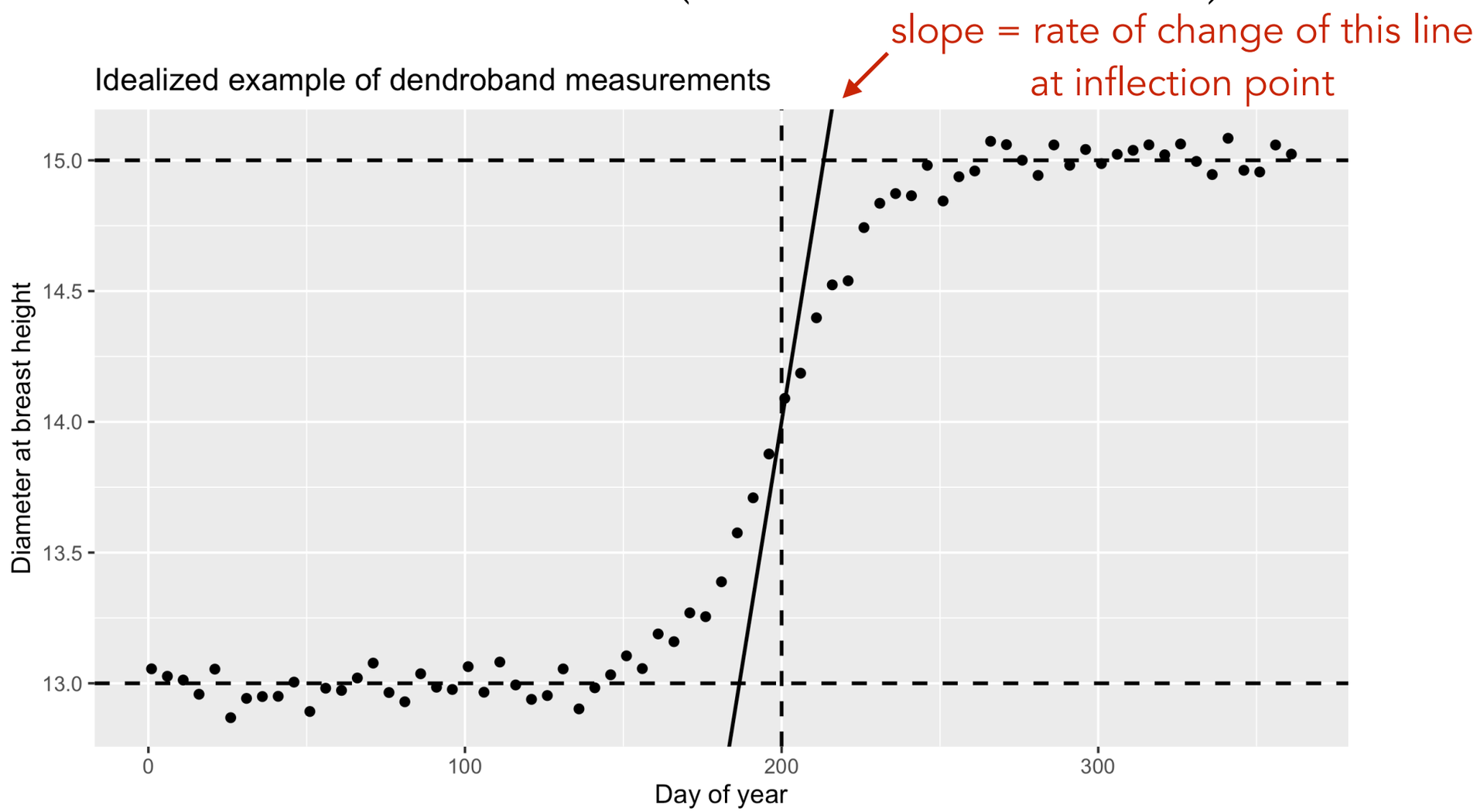

Ignoring θ, let's put it all together…

Model for dbh

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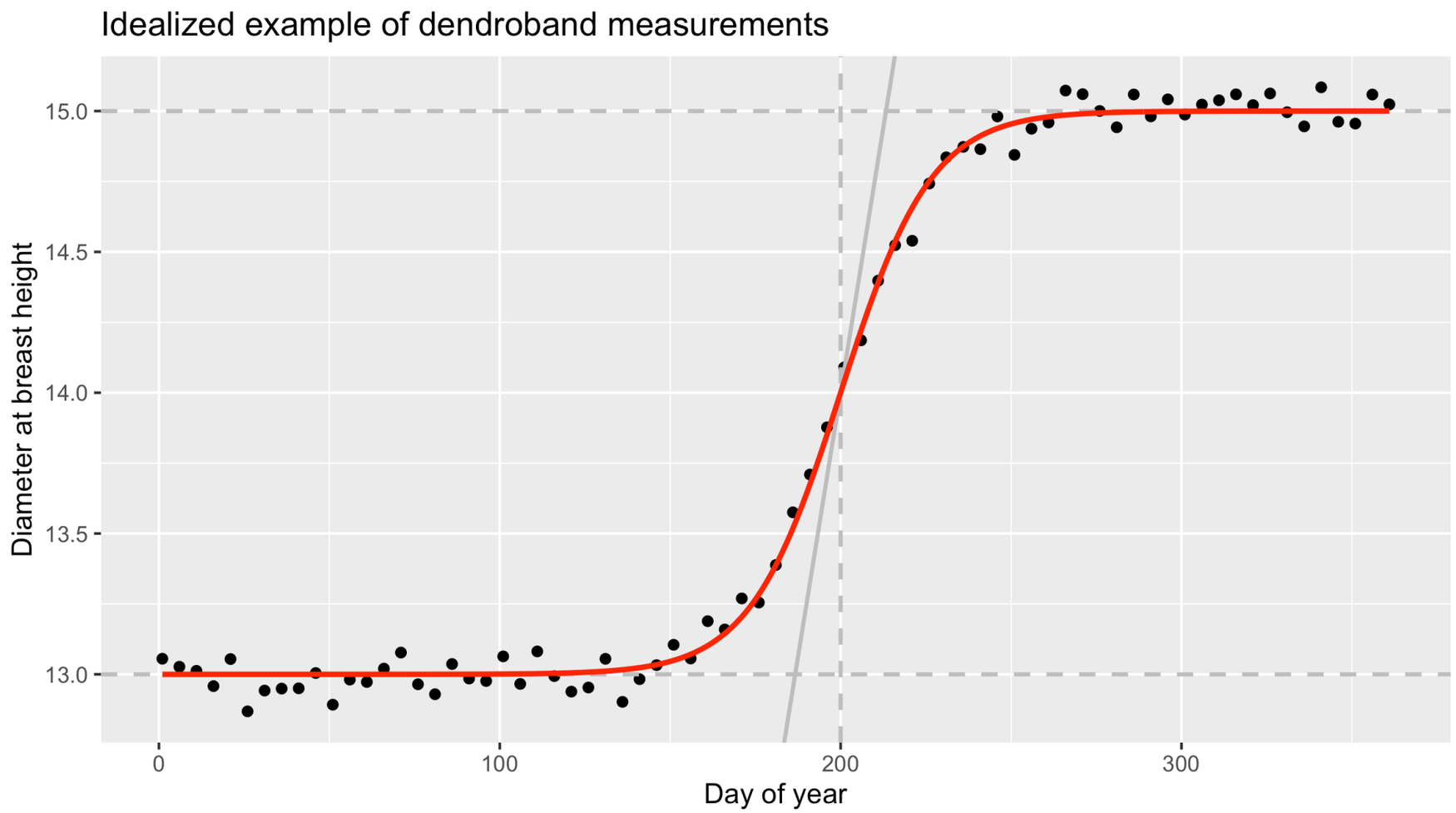

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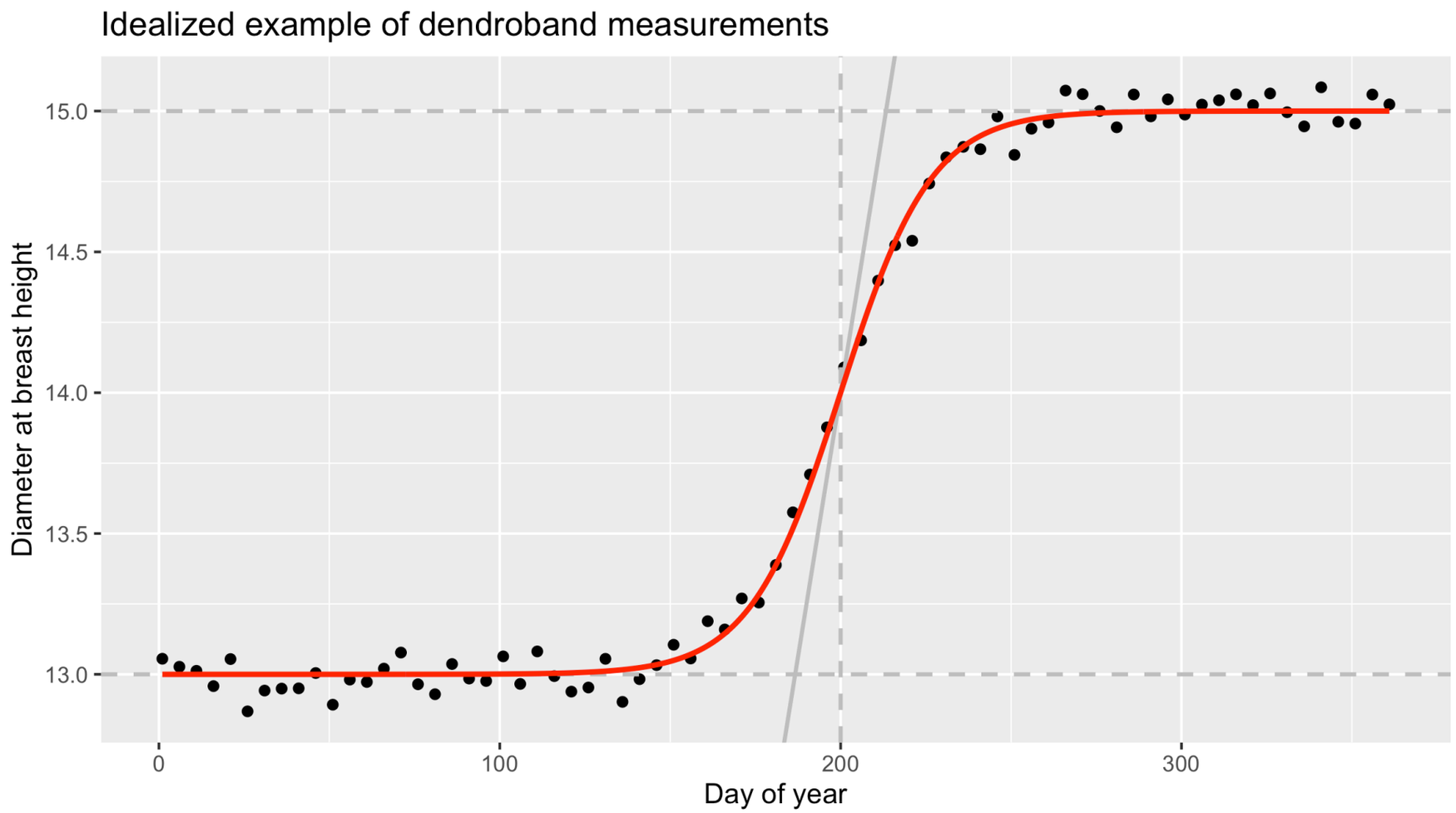
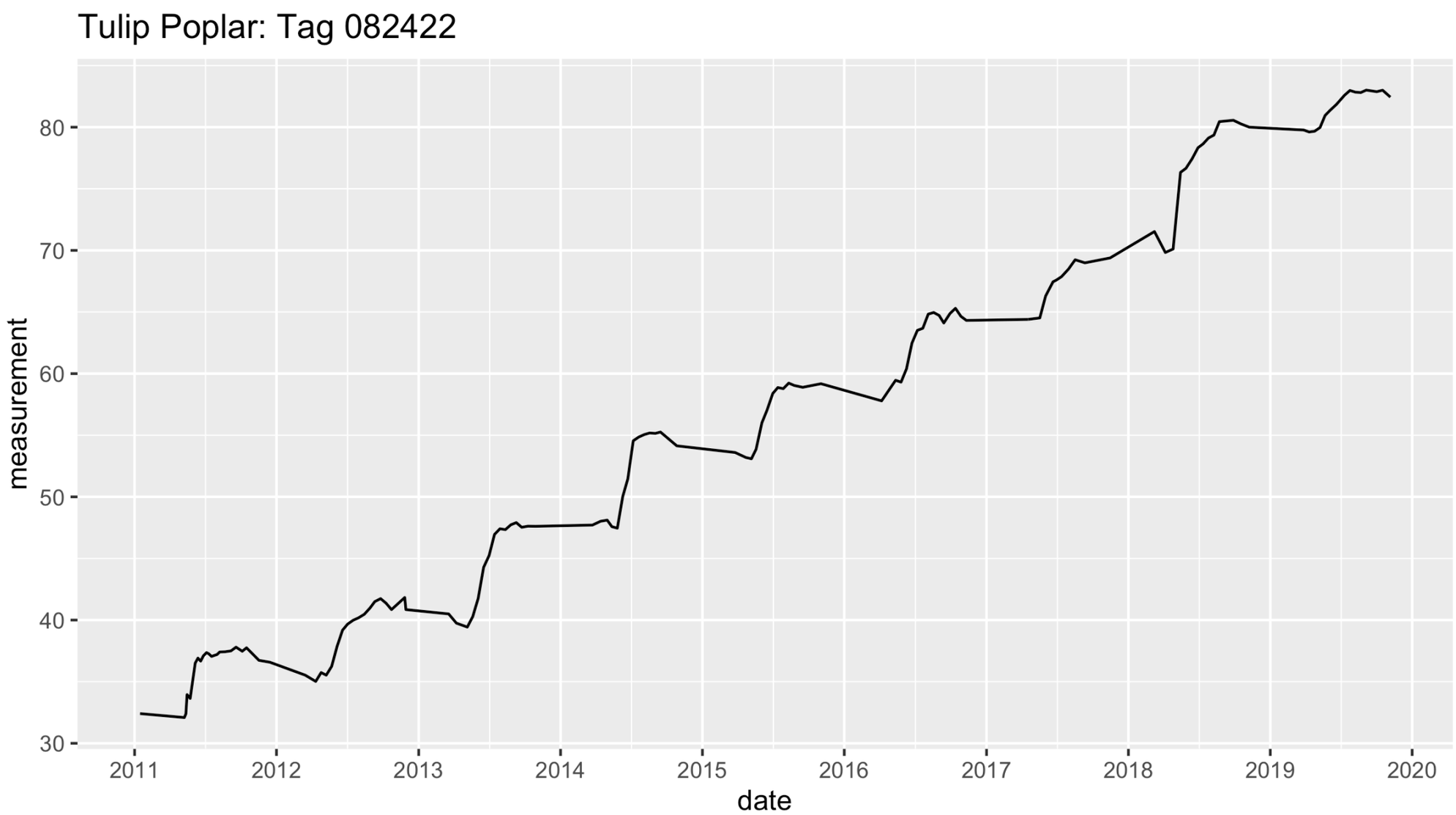


But remember, you need a model that works for ALL 🌲🌳🌴

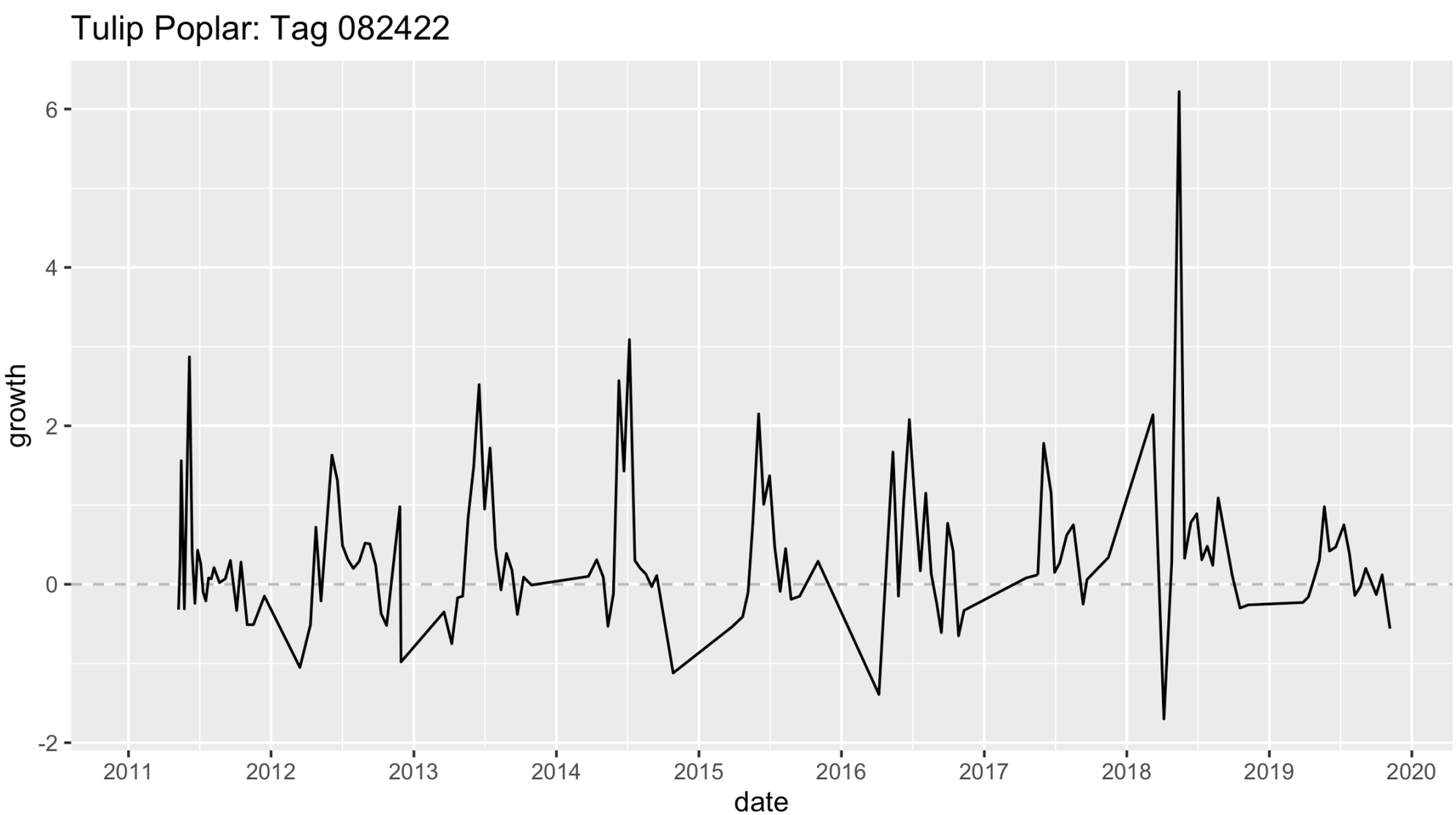
Lesson 2: Statistics is *not* math, rather statistics *uses* math

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

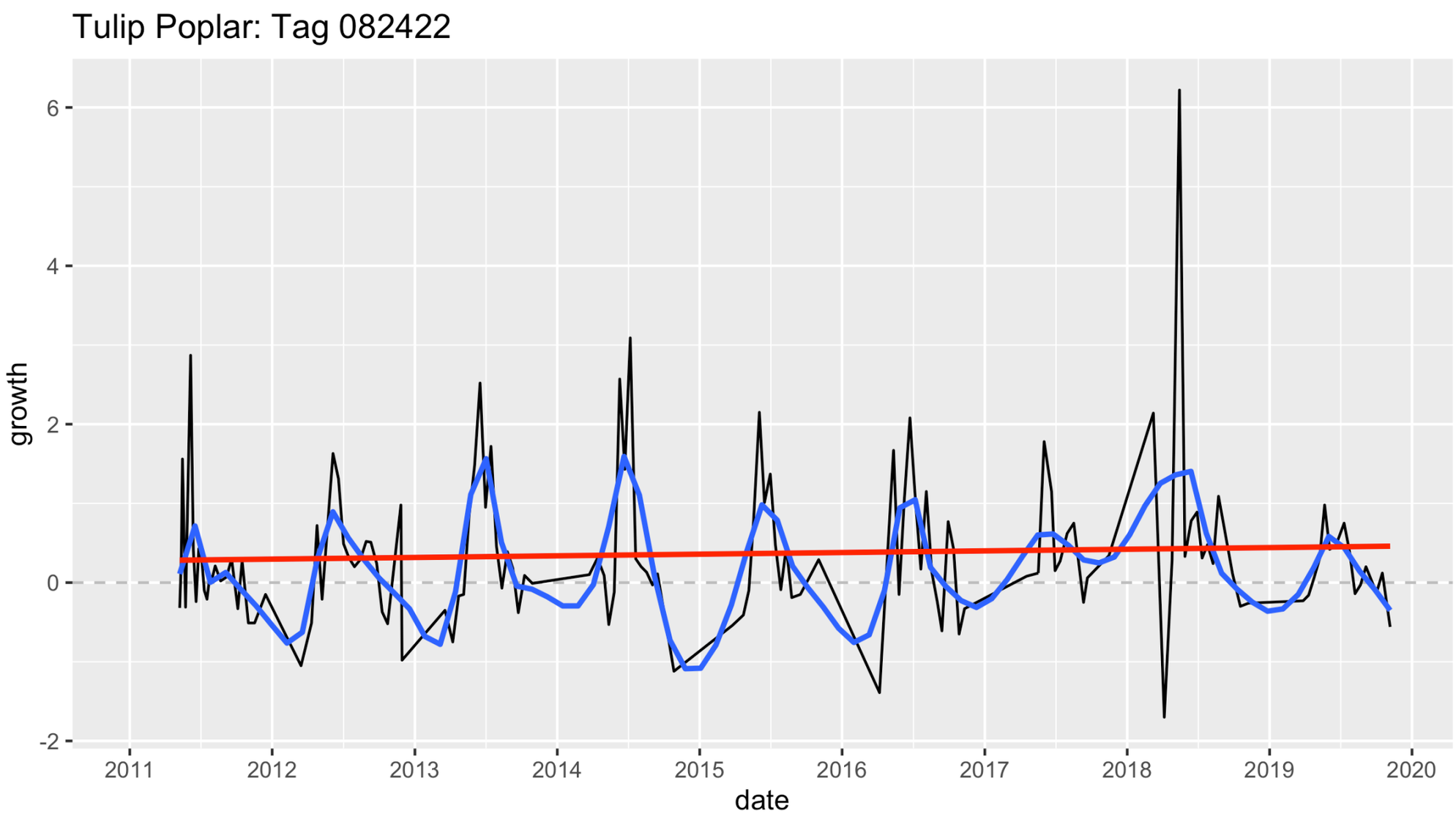
Observed Dendroband Measurements



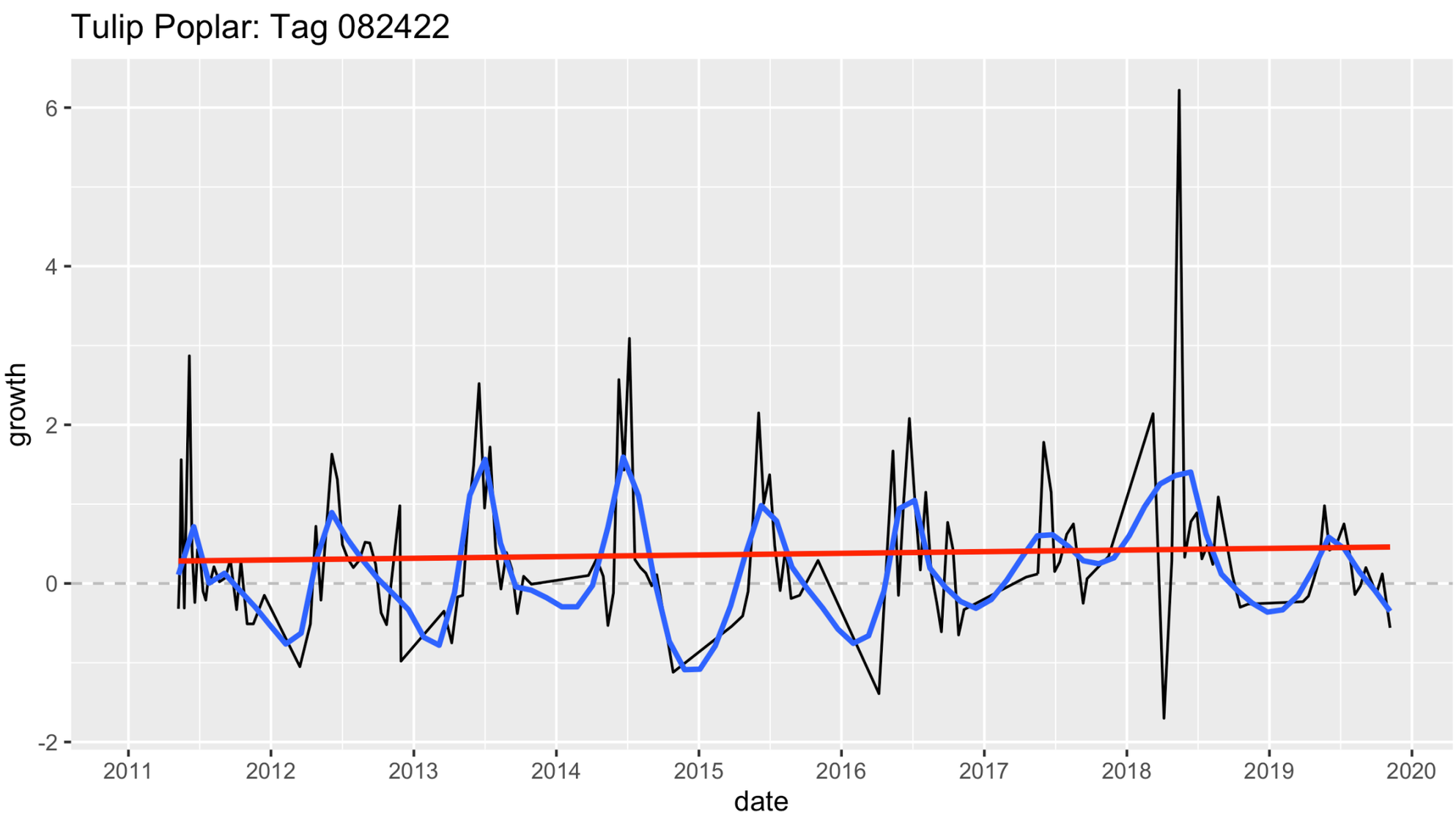
Growth = difference in measurements



Patterns


Tulip Poplar: Tag 082422
growth
6
4
2
0
-2
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
date

Patterns



Seasonal trend that repeats every year

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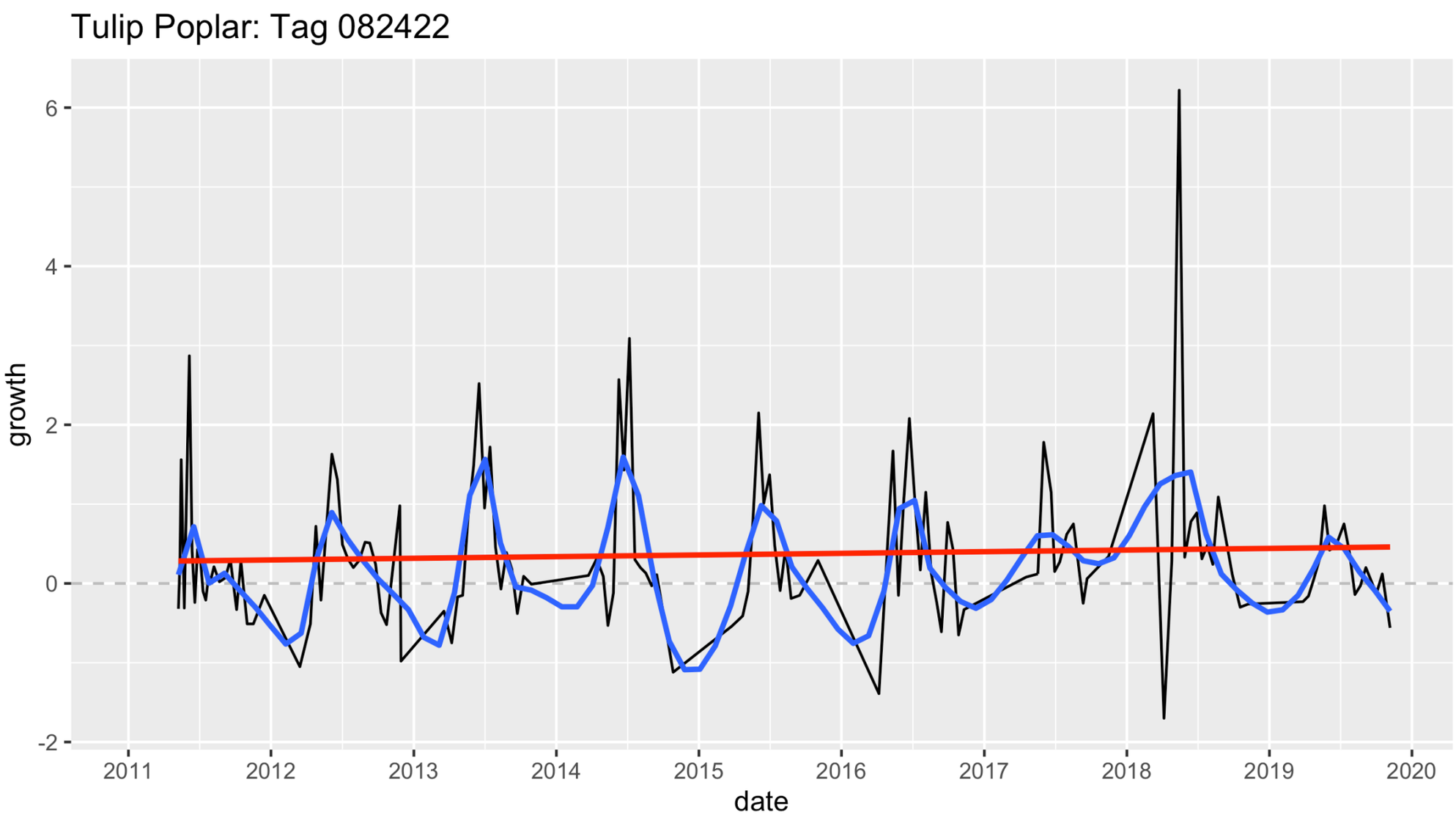
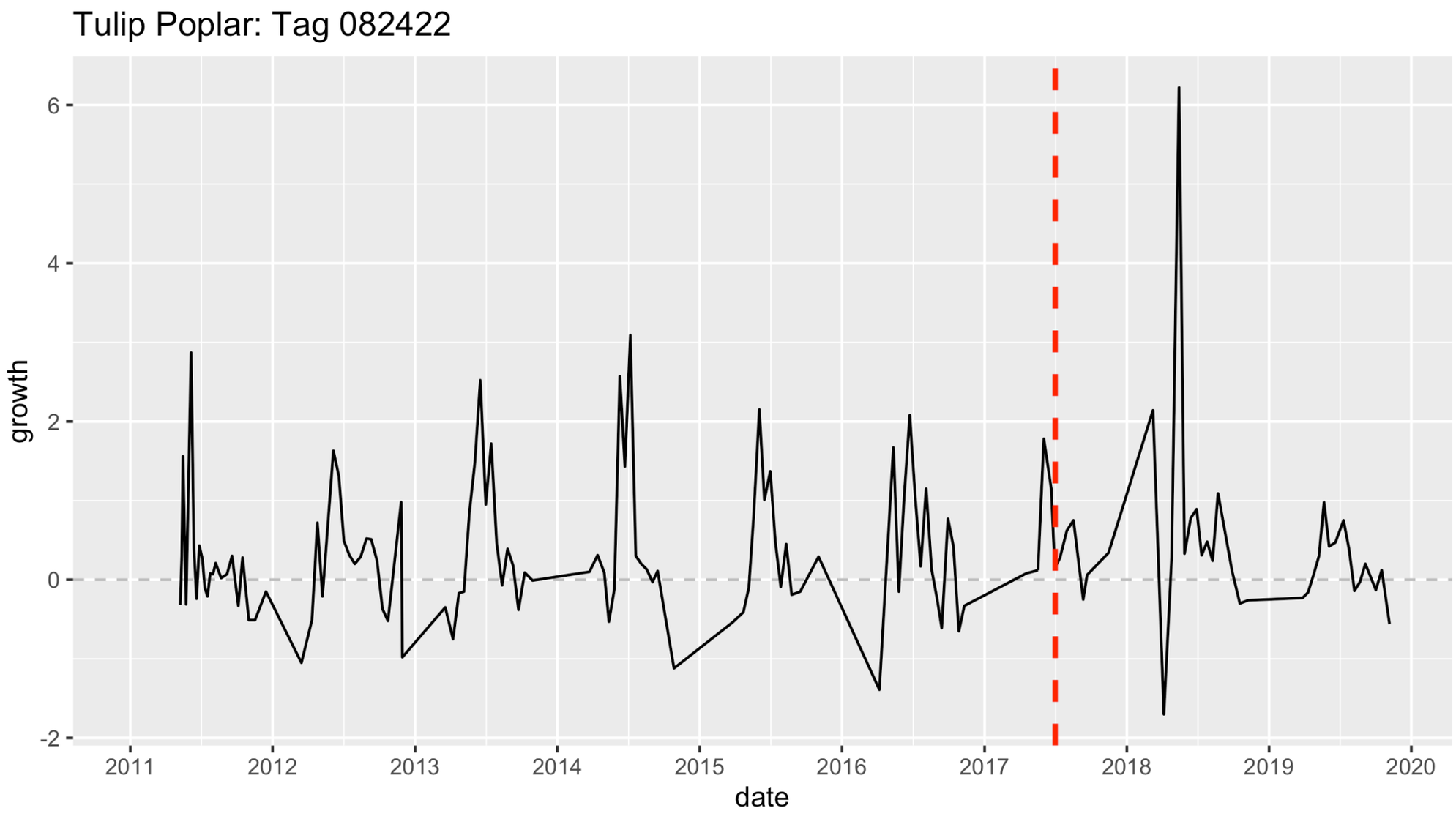


Seasonal trend that repeats every year

Overall (slightly increasing) trend

Effect of Climate Change



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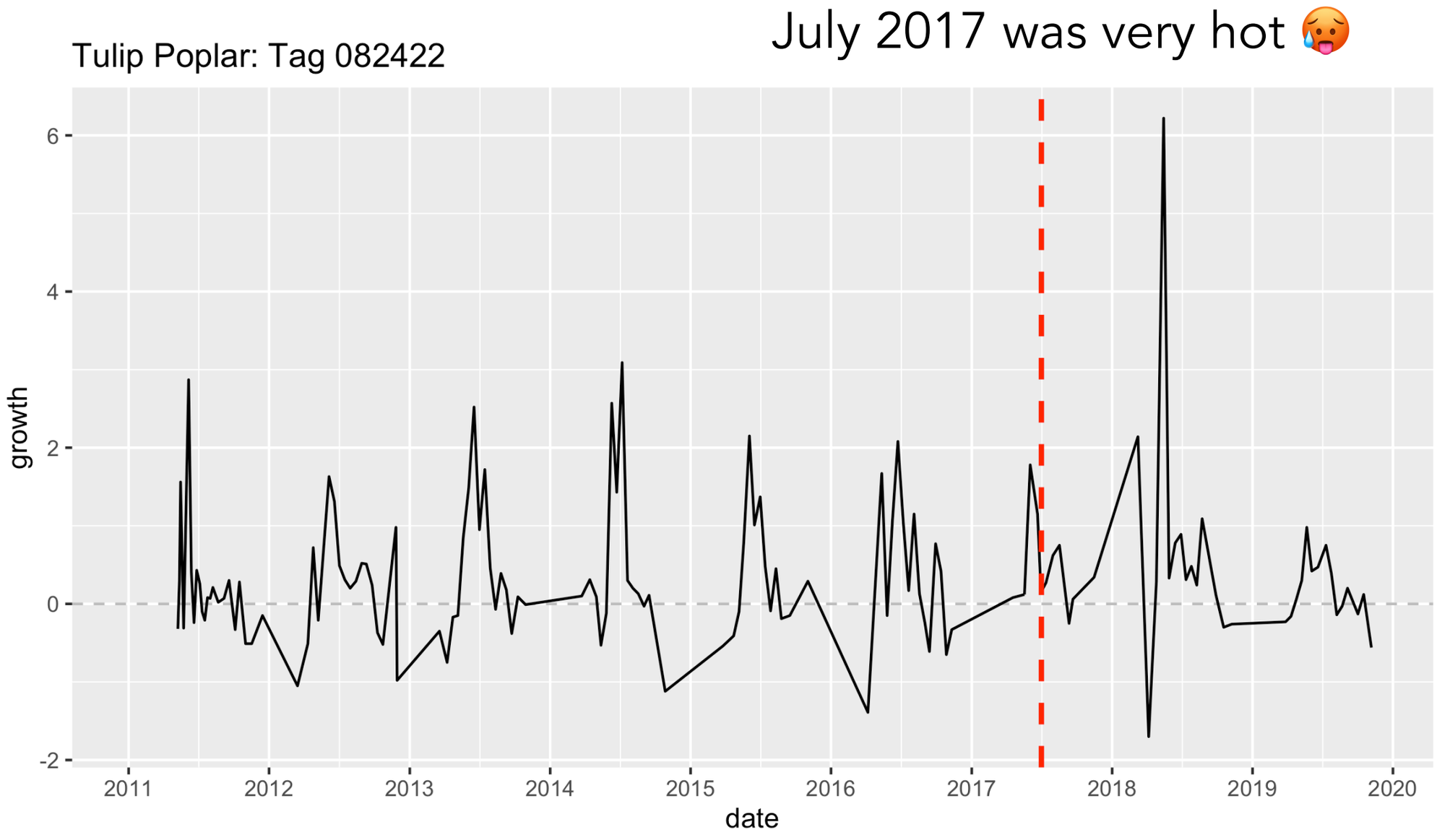
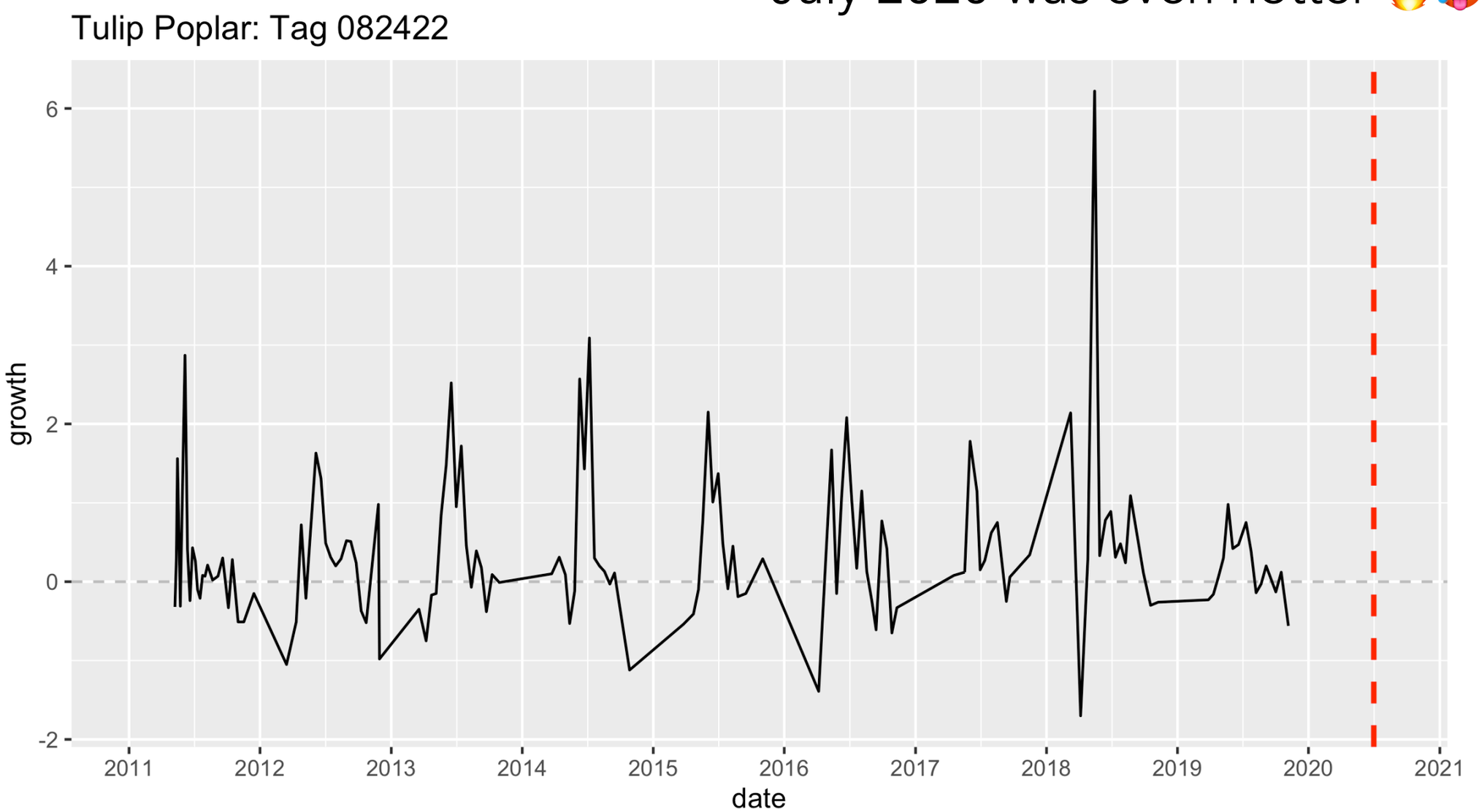


Effect of Climate Change

July 2020 was even hotter 🔥🥵🔥



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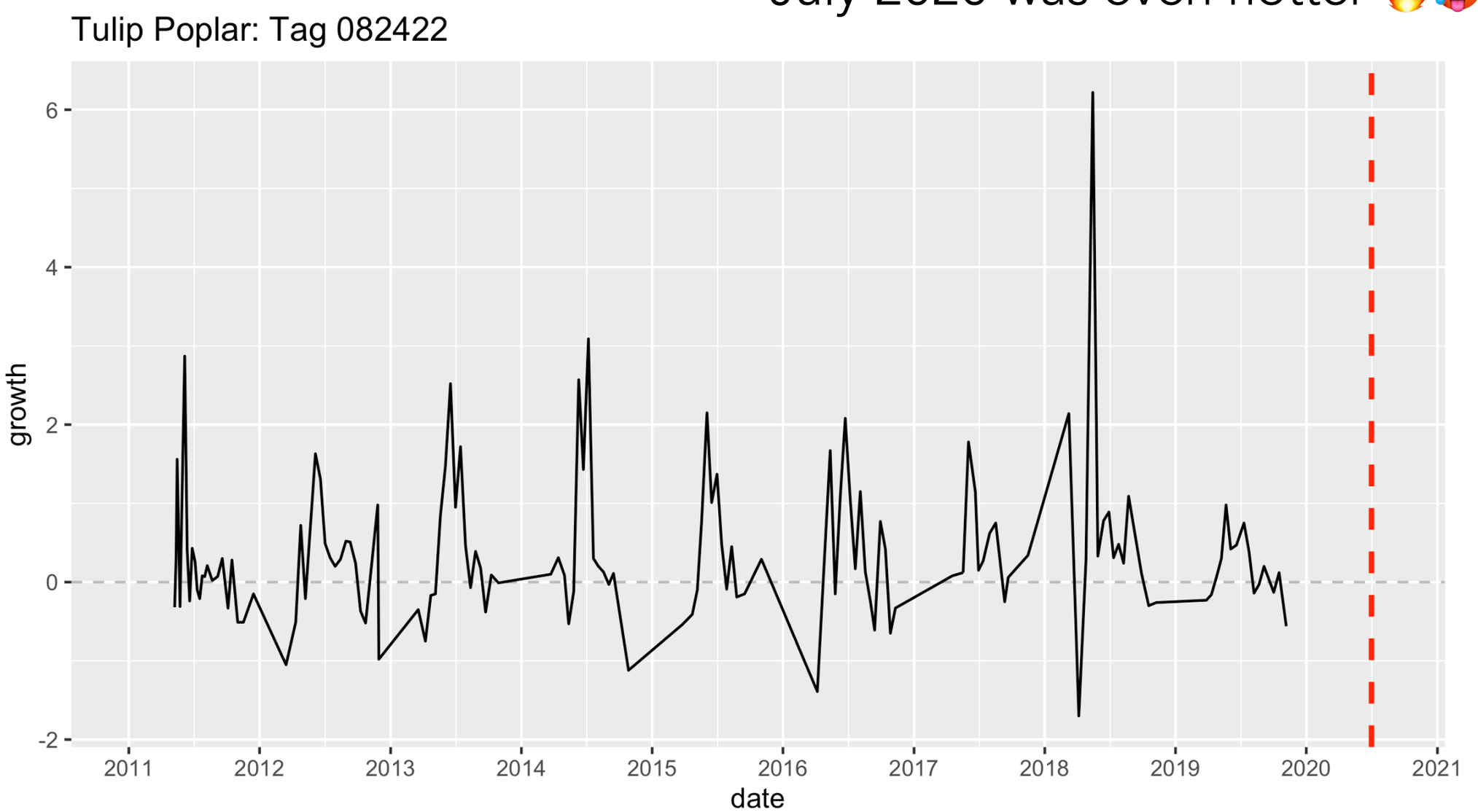
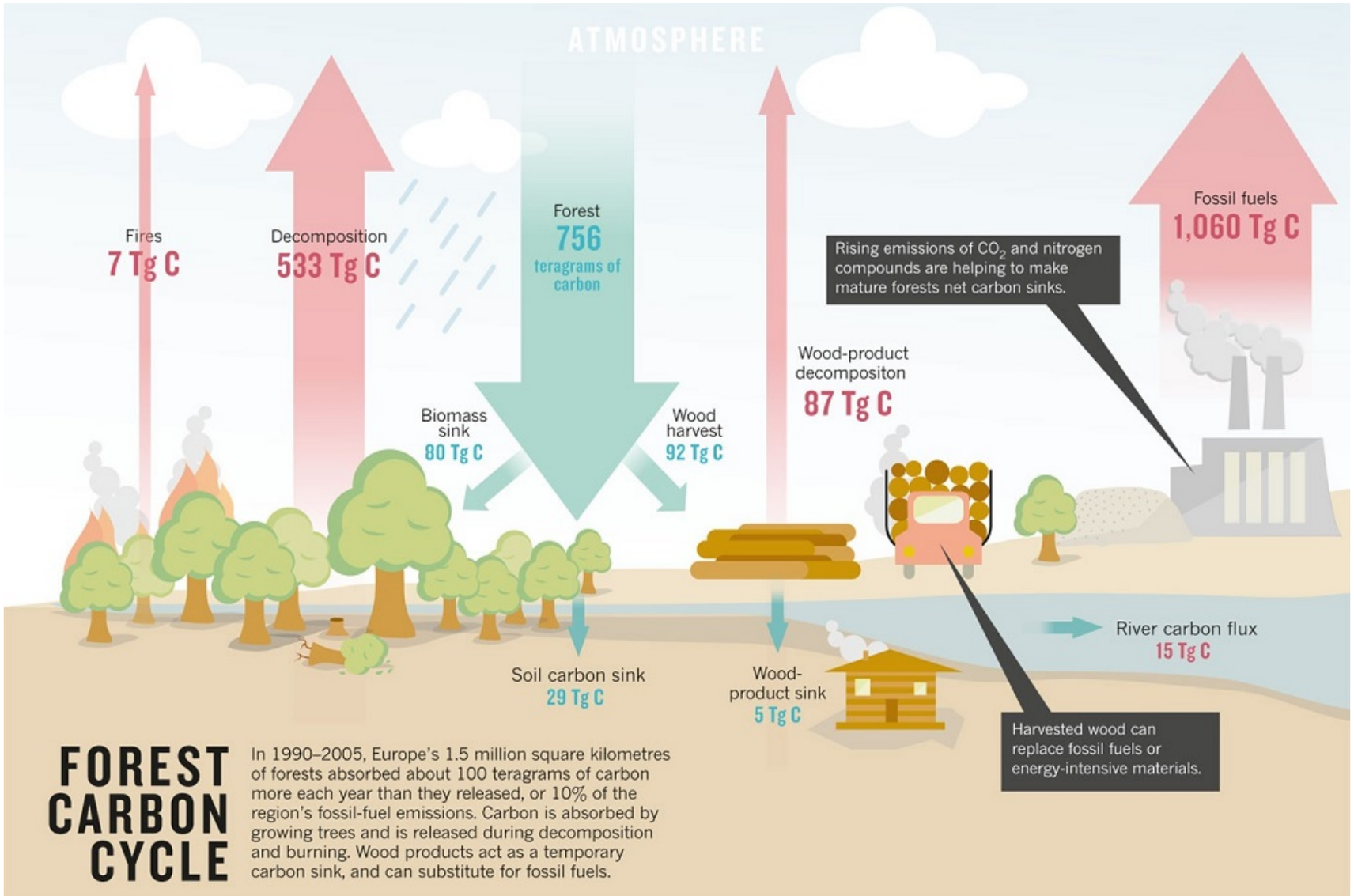


What other variables should we account for?
Drought? Humidity? Earlier springs?
Smoke from CA, WA, OR forest fires? etc…

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"

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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

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

[Link to Science Article]

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 carbon[3], but accurate assessments of its potential are limited by uncertainty and variability in carbon accumulation rates[2,3]. To assess why and

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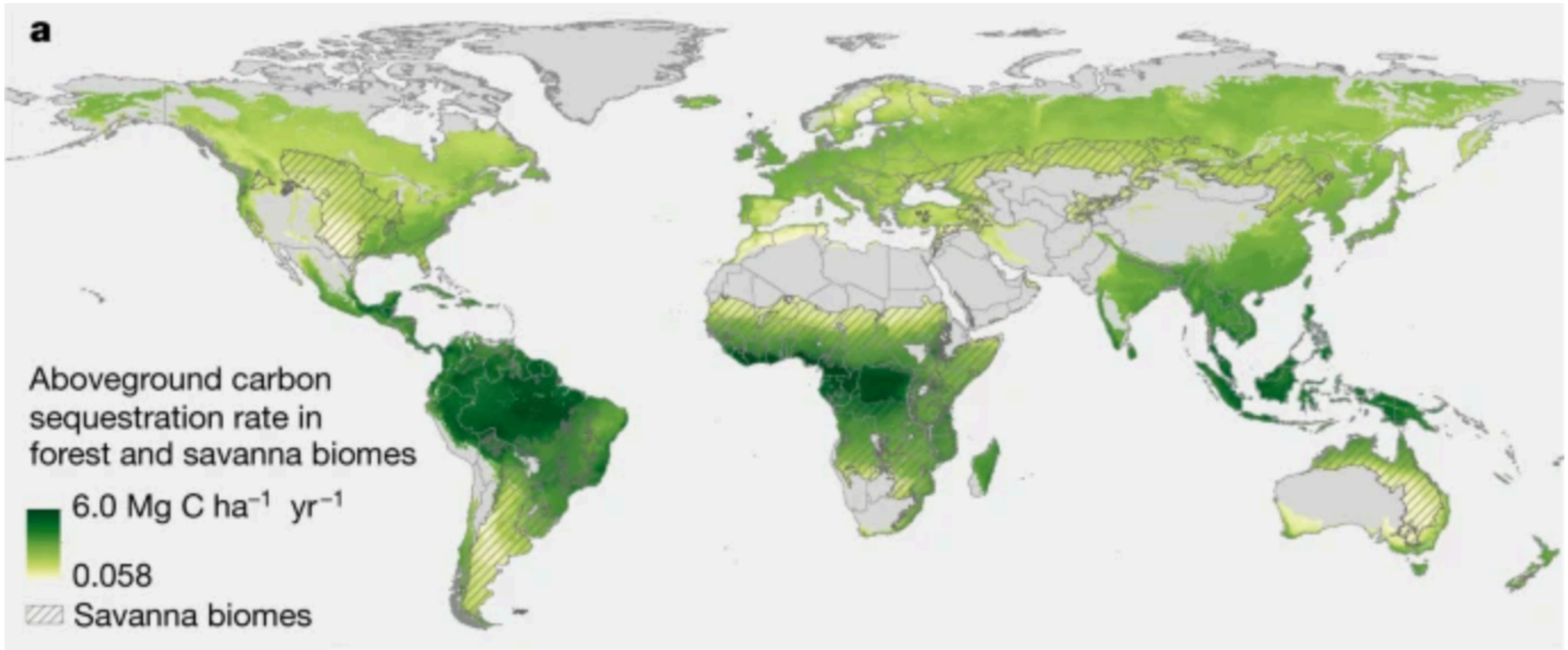
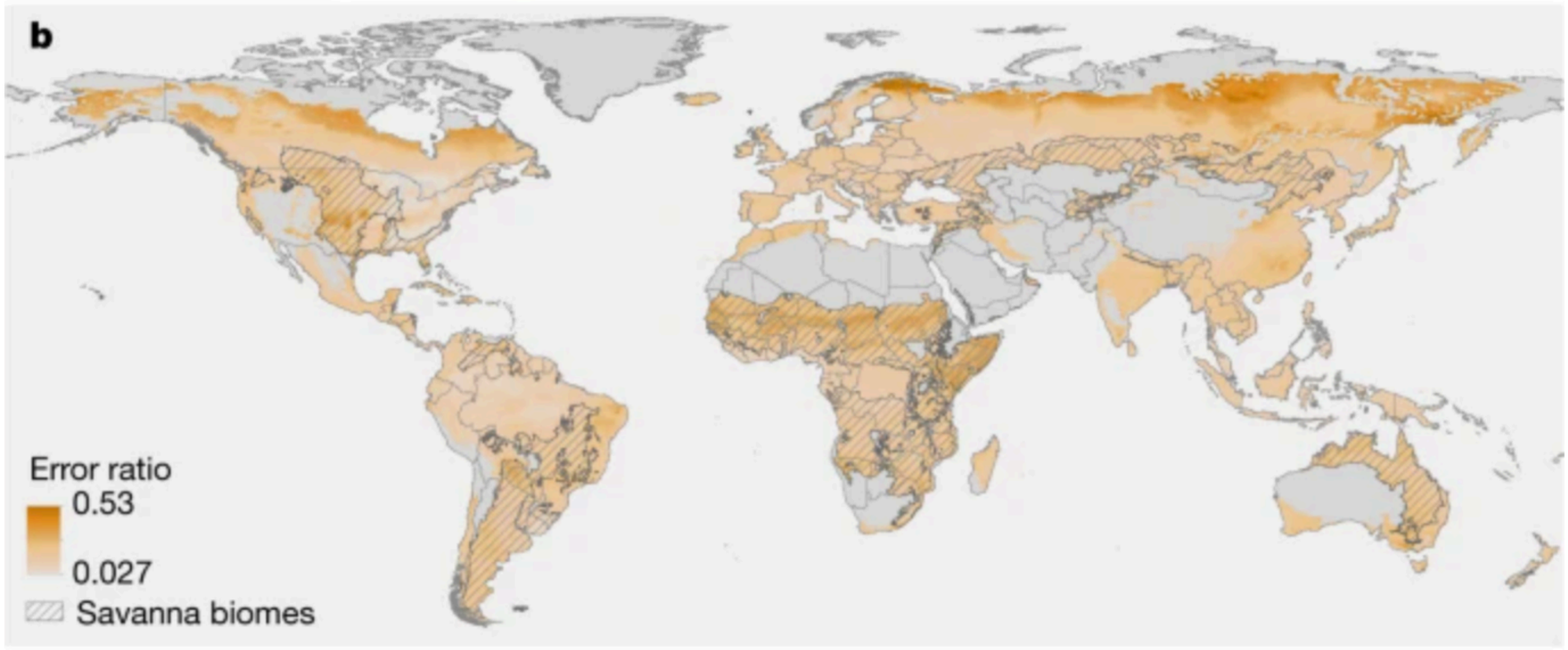
Predicted/forecasted carbon accumulation



All predictions/forecasts have errors too…



Thanks!

Slides on Twitter
@rudeboybert