

# The plural of anecdote is not data:

Rigorously testing a boreal forest chronosequence

ESA 2009

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# Why we care: inferences

- Chronosequences used for soil development, succession, carbon cycling, you name it
- Many authors have pointed to problems with such studies
  - Too much variability!
- But we *would* like to draw larger temporal and spatial inferences about slow-moving processes

APPARENT ACCUMULATION OF NITROGEN  
IN SOIL UNDER RADIATA PINE:  
MISLEADING RESULTS FROM A CHRONOSEQUENCE

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TURVEY

THE CHRONOSEQUENCE CONCEPT AND SOIL  
FORMATION

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ABSTRACT

The effects of time as a soil-forming factor is to recognise four out of five soil-forming factors are between soils of different

3133

NOTE / NOTE

Is there a middle way between permanent plots  
and chronosequences?

Randall W. Myster and Michael P. Malahy

Abstract: Although permanent plots have proven critical to studies of vegetation dynamics, their logistic limitations have led to the wide use of chronosequences as an alternative. Here, we test whether or not an assumed, simplistic assumption  
Ecology Letters, (2008) 11: 419-431

IDEA AND  
PERSPECTIVE

Testing the assumptions of chronosequences  
in succession

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Miyajishi<sup>2</sup>  
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Abstract  
Many introductory ecology textbooks illustrate succession, at least in part, by using certain classic studies (e.g. sand dunes, ponds/bogs, glacial till, and old fields) that substituted space for time (chronosequence) in determining the sequences of the succession. Despite past criticisms of this method, there is continued, often uncritical, use of chronosequences in current research on topics besides succession, including  
ECOSYSTEMS (2009) 8, 147-153  
DOI: 10.1007/s10021-002-9206-5

ECOSYSTEMS  
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MINIREVIEW

Soil Carbon Dynamics after Forest  
Harvest: An Ecosystem Paradigm  
Reconsidered

Ruth D. Yanai,<sup>1\*</sup> William S. Currie,<sup>2</sup> and Christine L. Goodale<sup>3</sup>

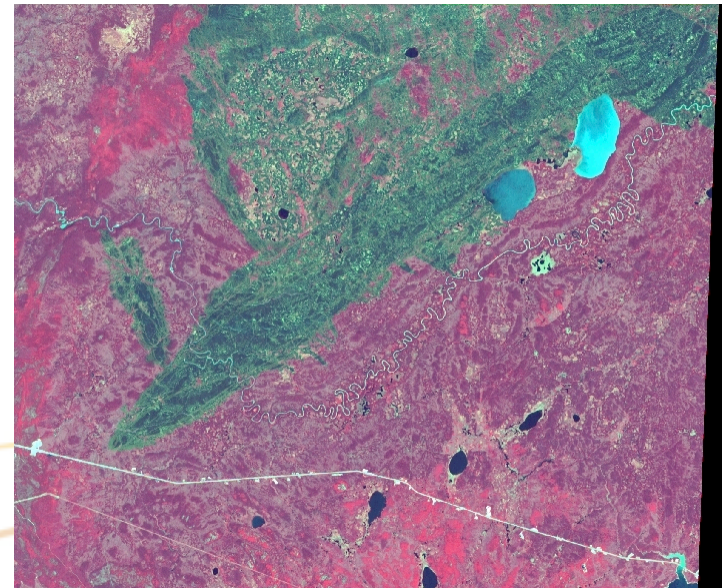
# Why we care: prioritizing

- Field research is (typically) extremely resource-limited
- High variability
- Prioritization is important
- Poor prioritization ->

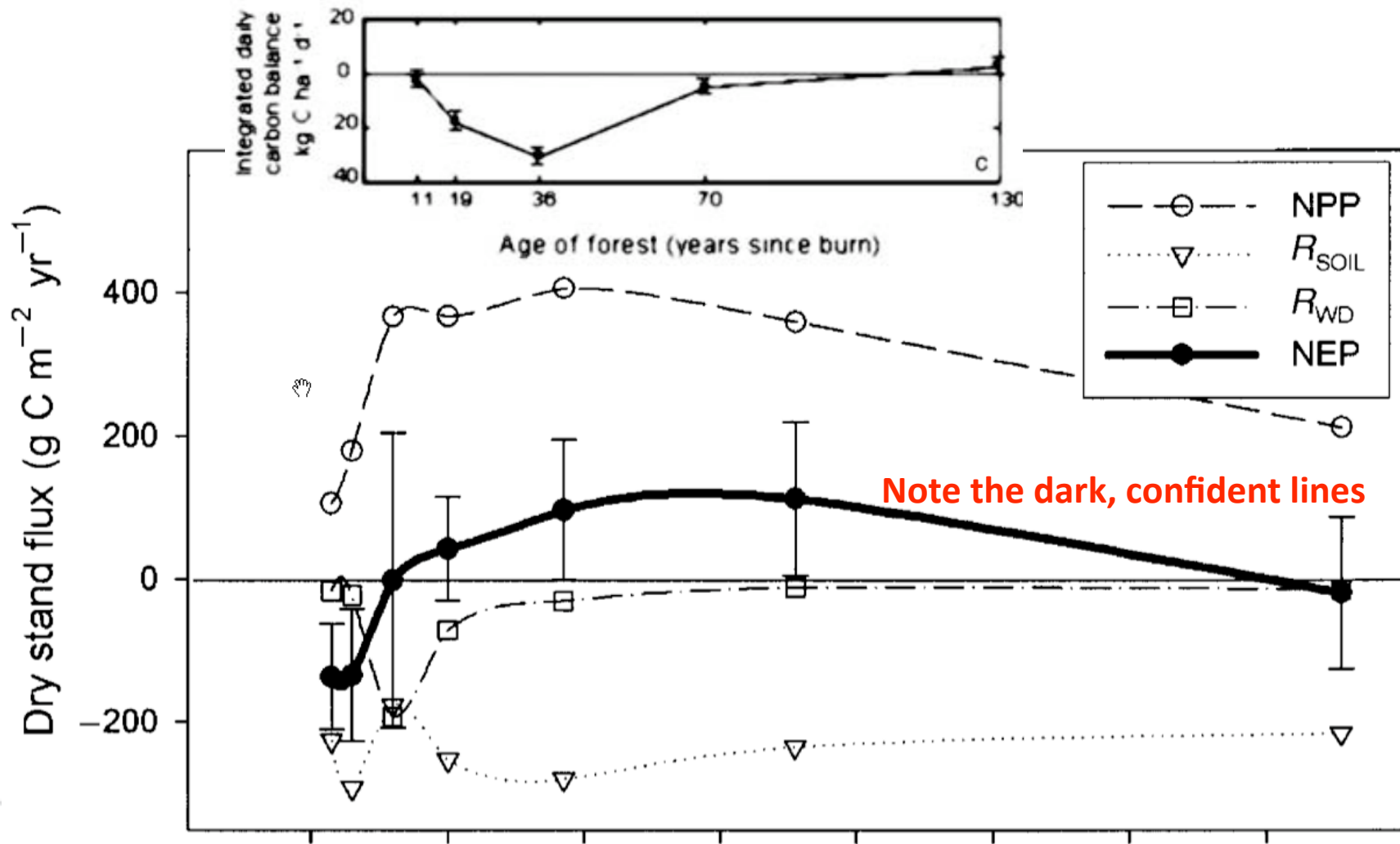


# Study region

- Northern Manitoba boreal forest
- Black spruce
- Few people; lots of wildfires
- Even-aged forests of known origin

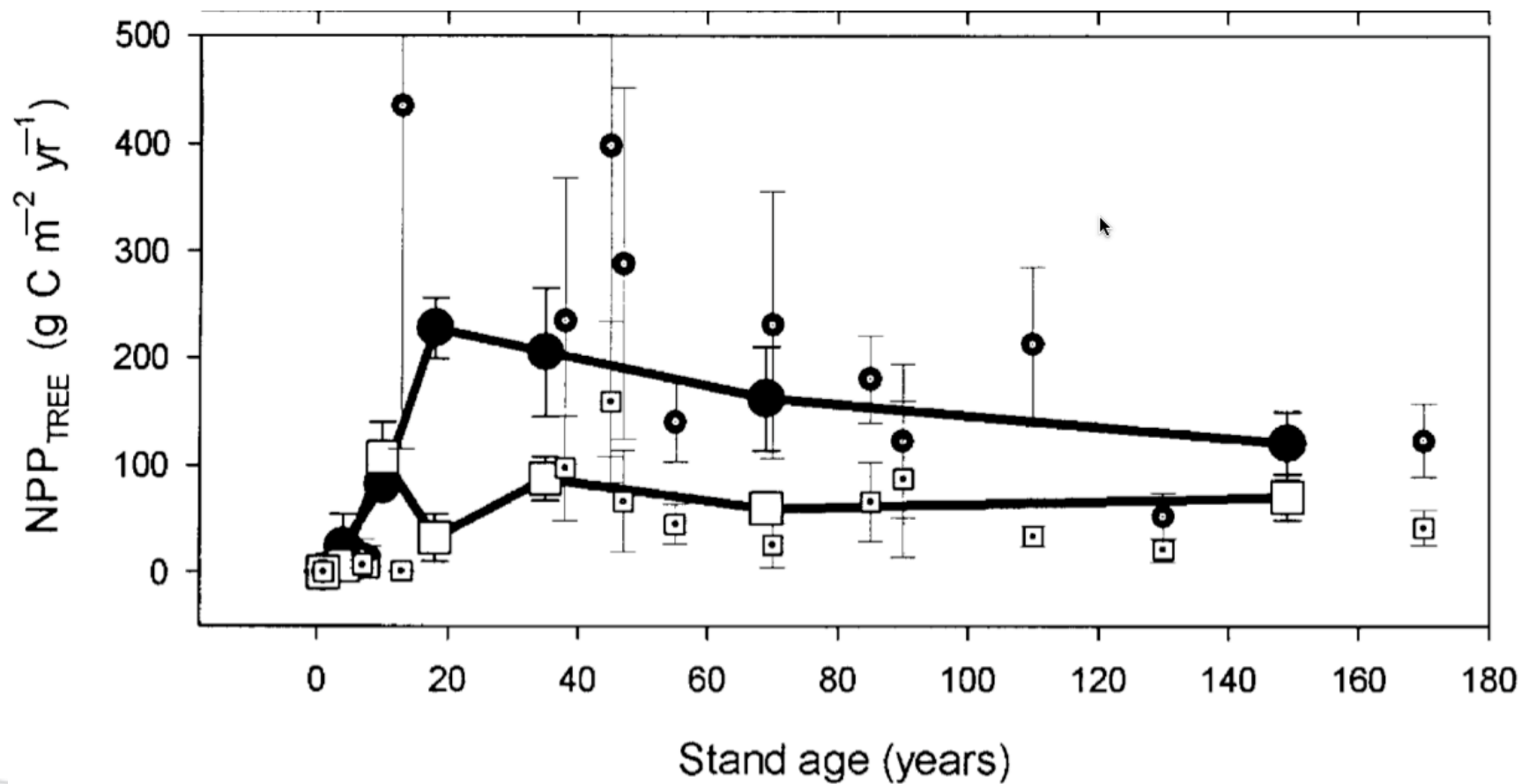


# Results



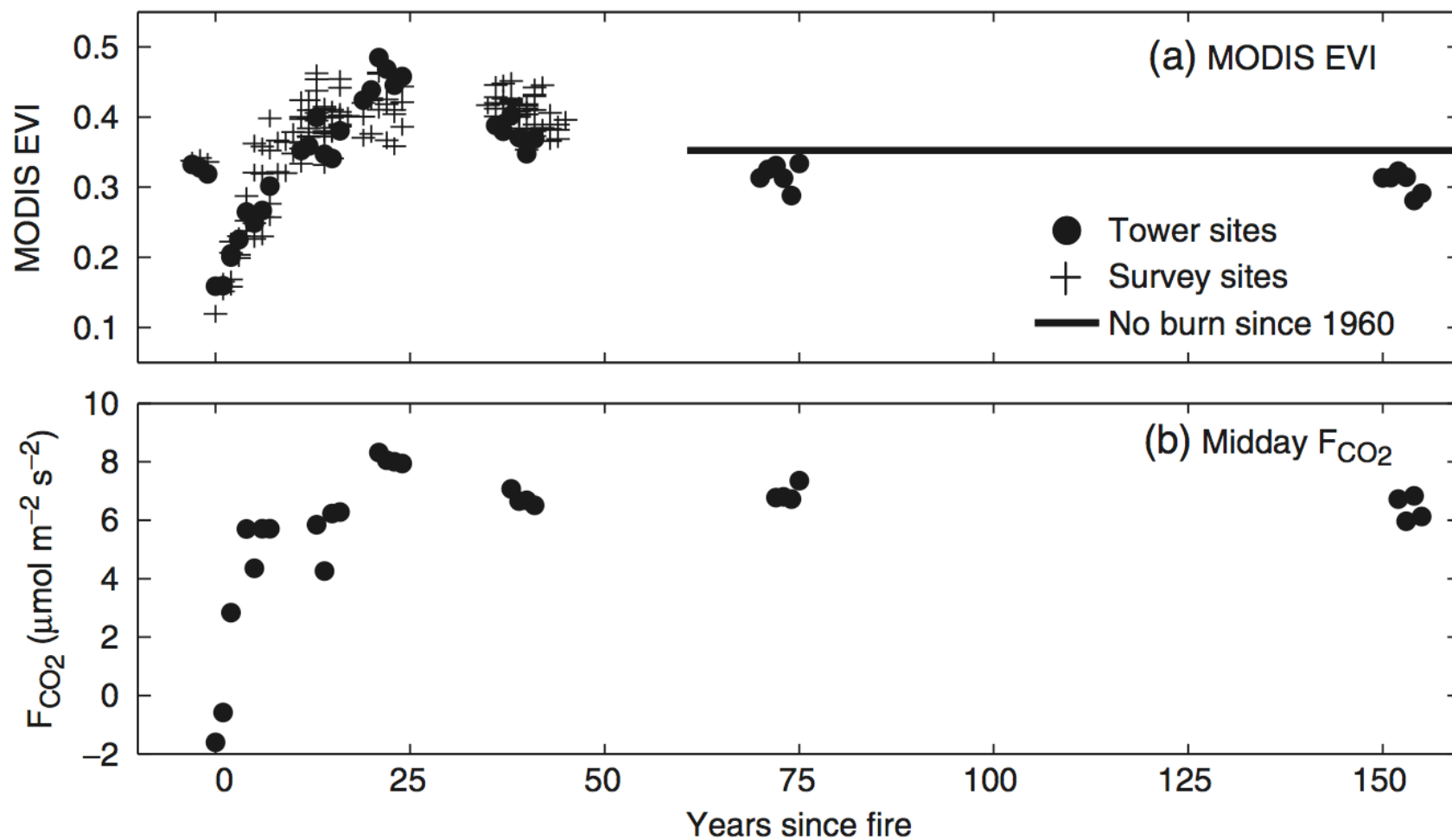
Litvak, M., S. Miller, S. C. Wofsy and M. L. Goulden (2003) *J. Geophys. Res.-Atmos.* **108(D3):8225**.  
 Bond-Lamberty, B., C. Wang and S. T. Gower (2004). *Global Change Biol.* **10(4): 473-487**.

# Spatial replication (1)



Bond-Lamberty, B., C. Wang and S. T. Gower (2004). *Global Change Biol.* **10**(4): 473-487.

# Spatial replication (2)



# But note the difference

“these stands comprise a  
chronosequence”

$$s = f(cl, o, r, p, t, \dots)$$

$$s = f(T_{cl, o, r, p, \dots})$$

$$F \in \{cl, o, r, p, \dots\}$$

≠

$$\int_c^d \frac{\delta s}{\delta F} dF \approx 0$$

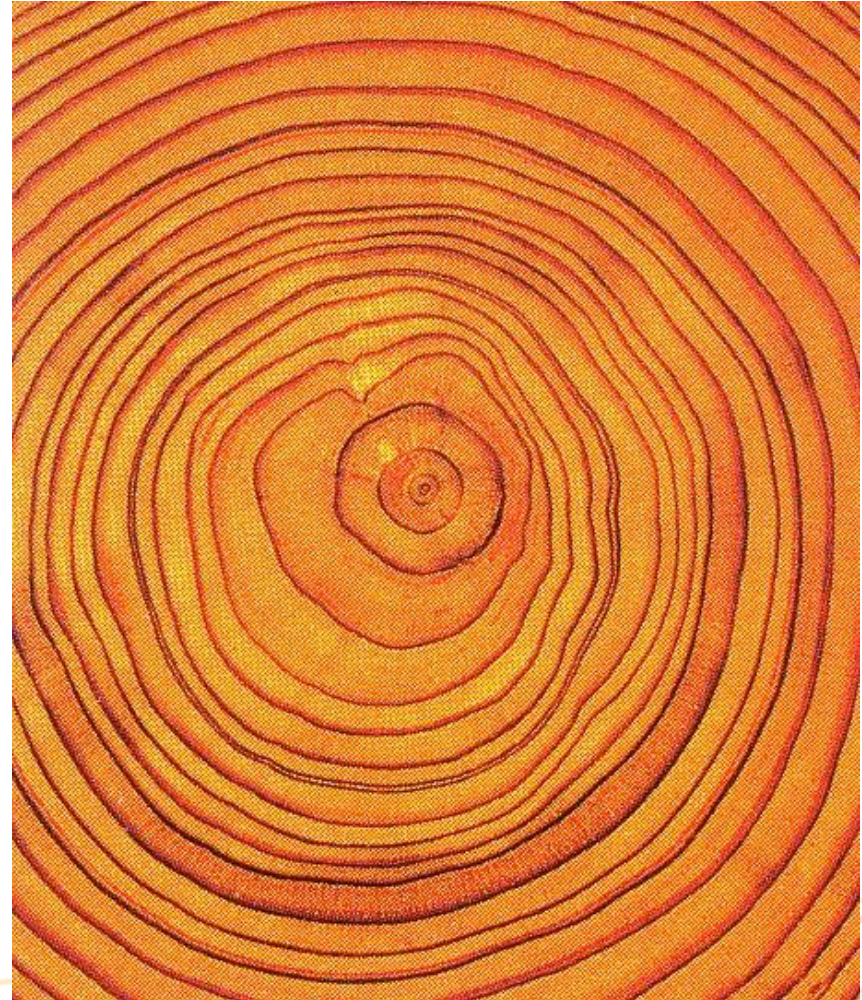
“these stands are  
representative of the  
surrounding landscape”

$$s(T) \approx \iint s(T)$$

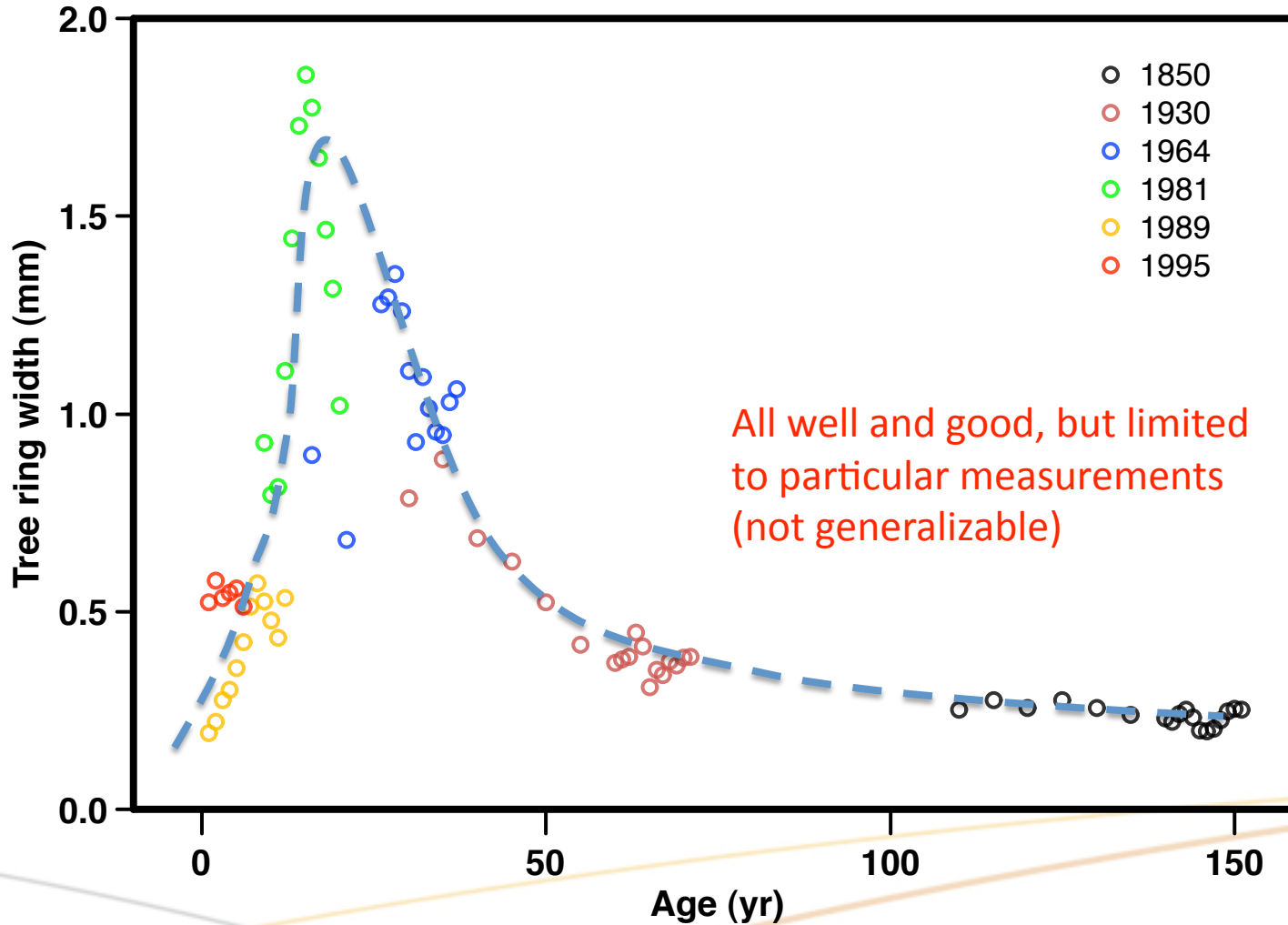


# Pseudo-temporal replication

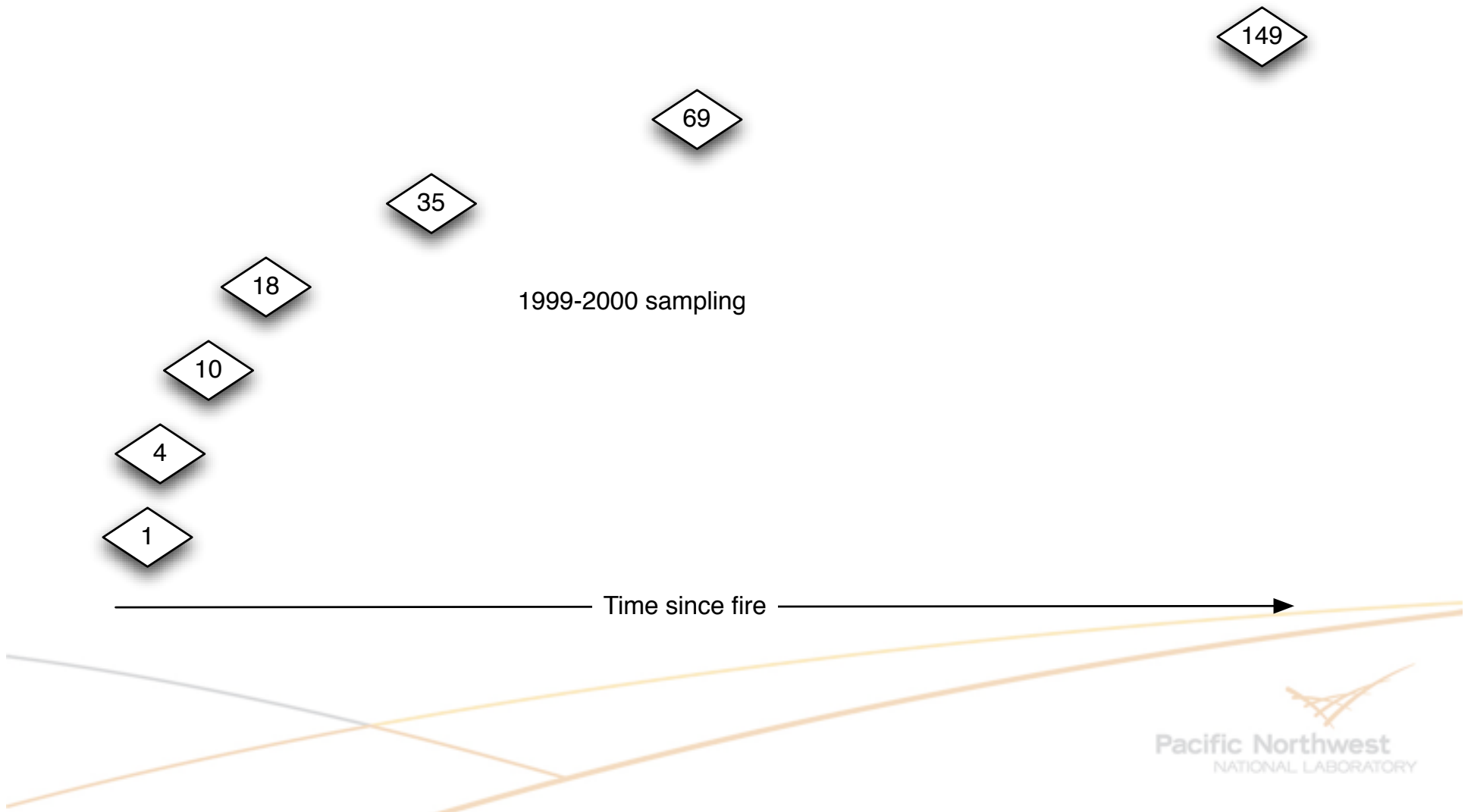
- Integrative measurements
  - Tree rings
  - Peat cores



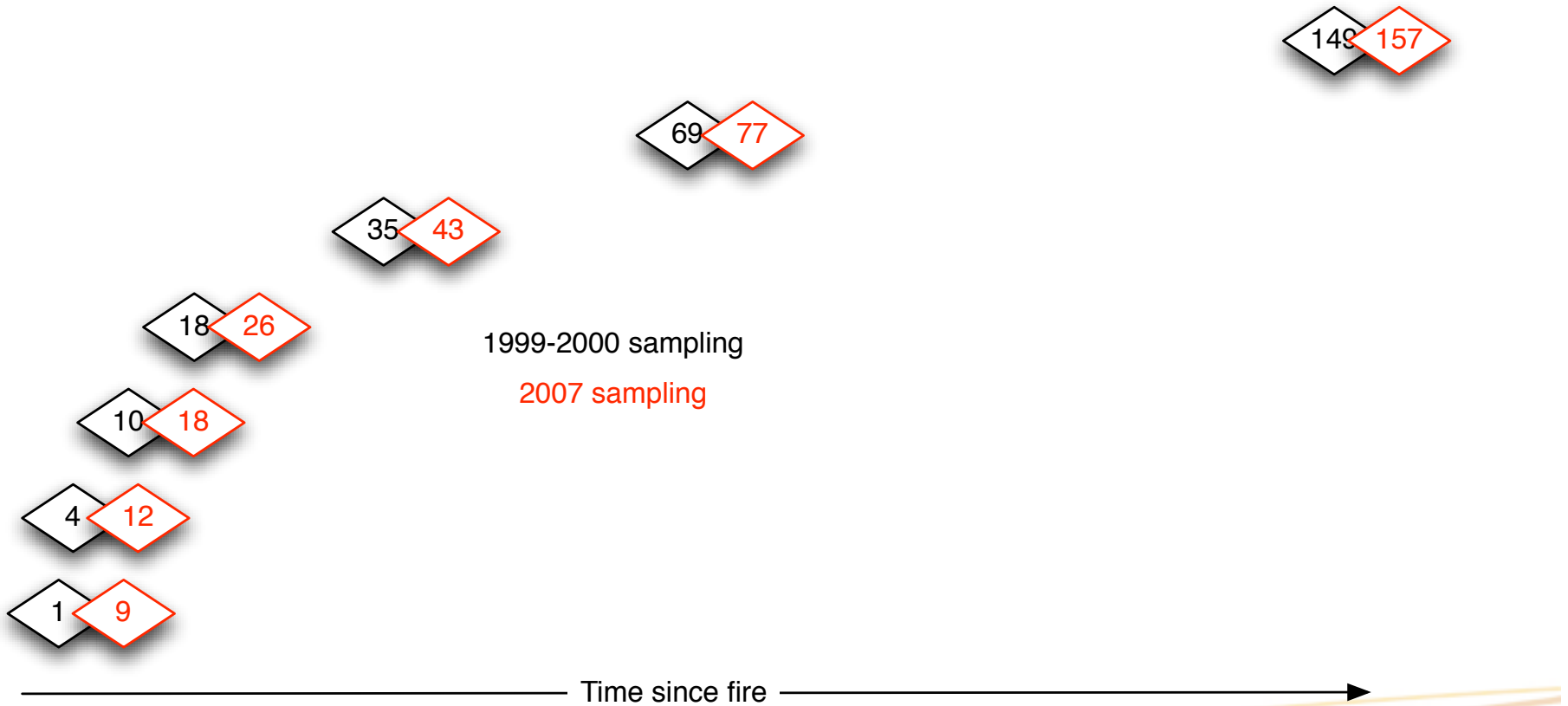
# Tree cores



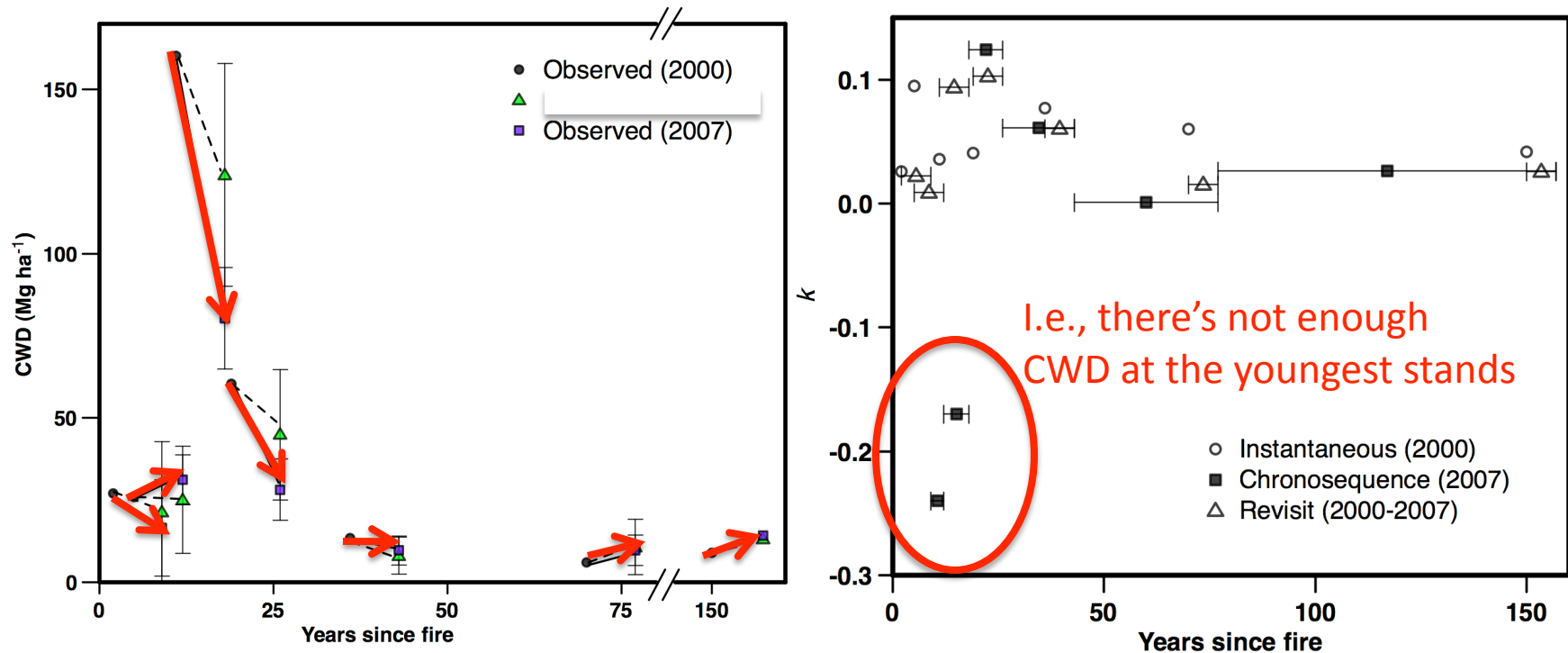
# True temporal replication



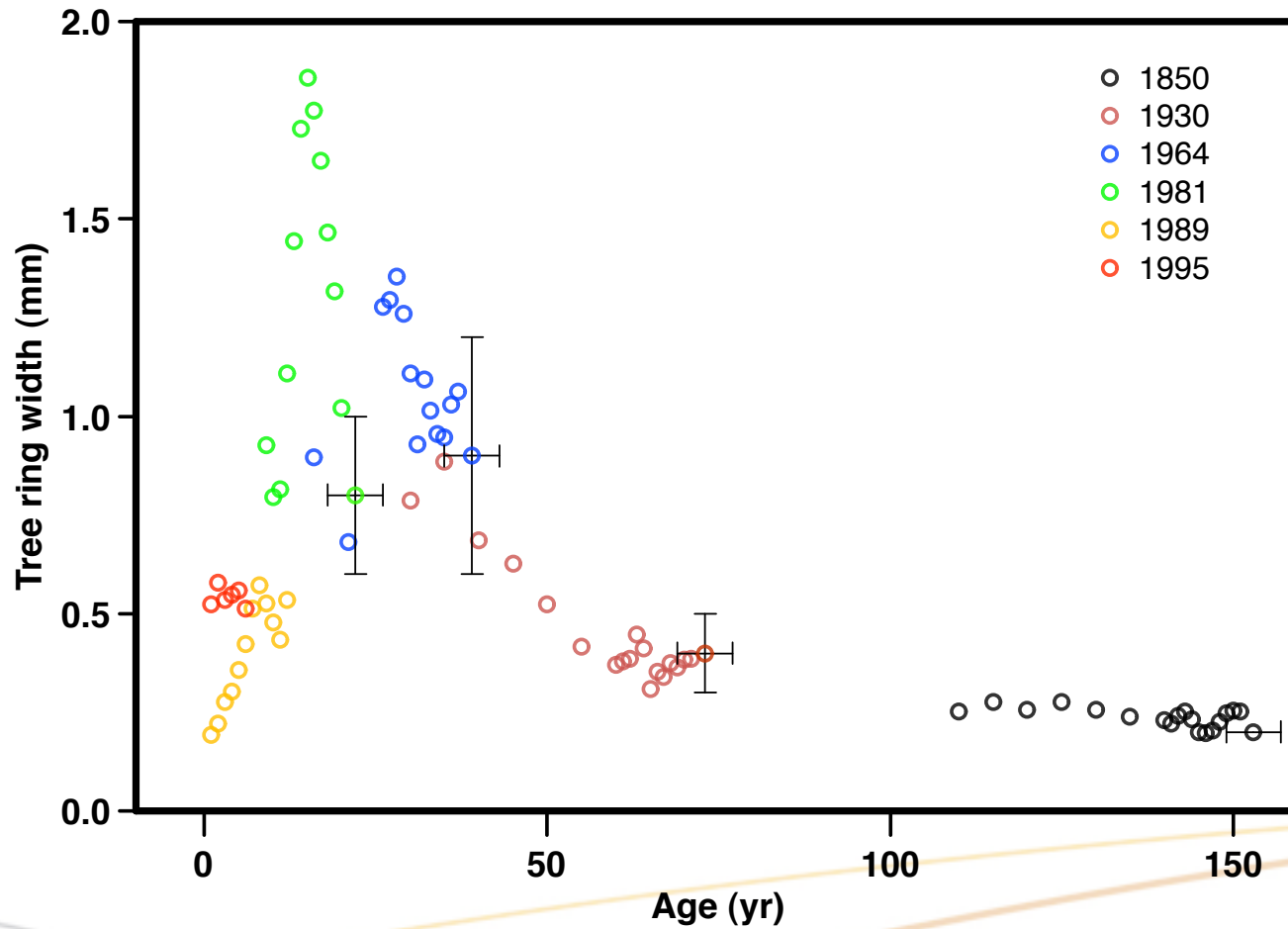
# True temporal replication



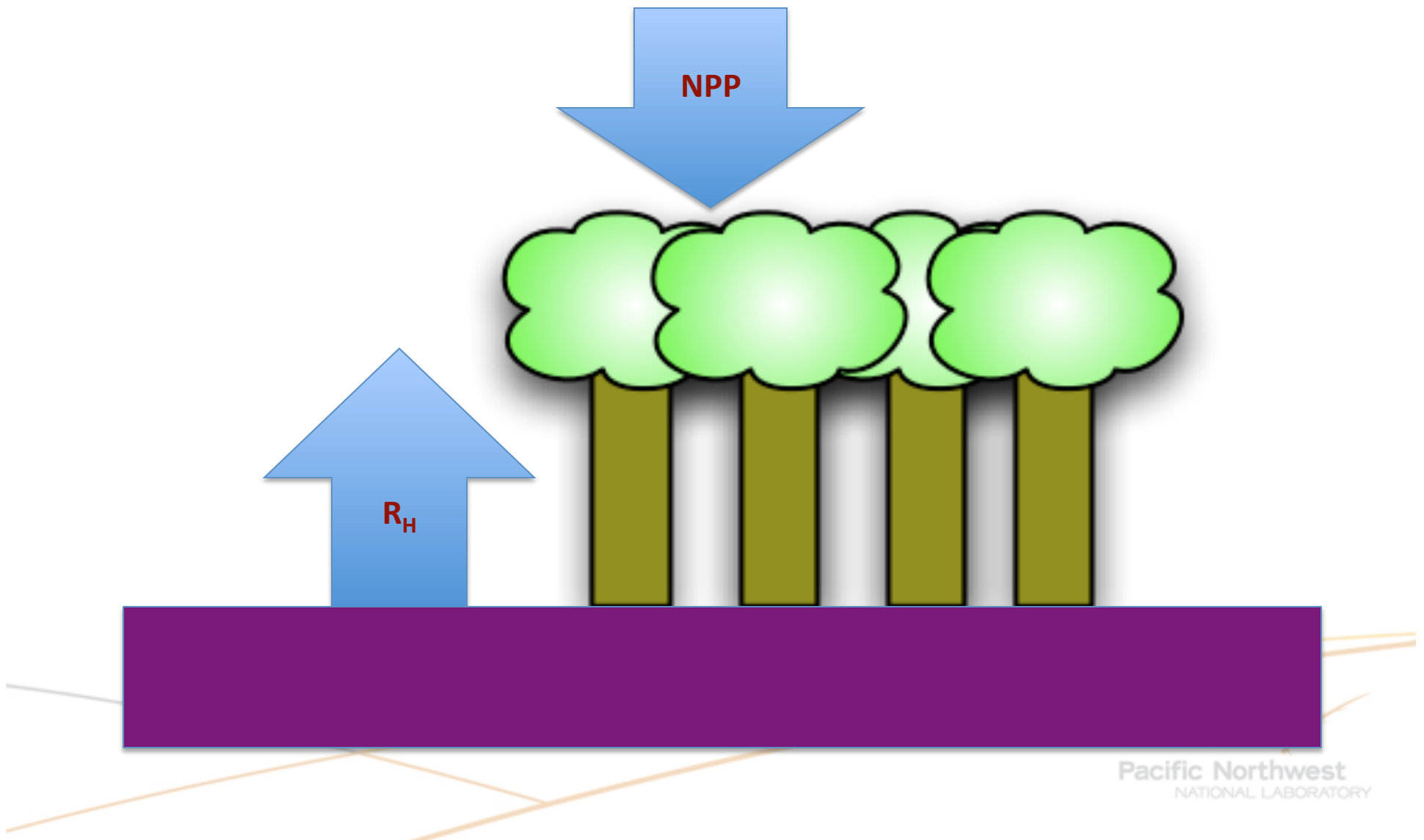
# Temporal replication—CWD



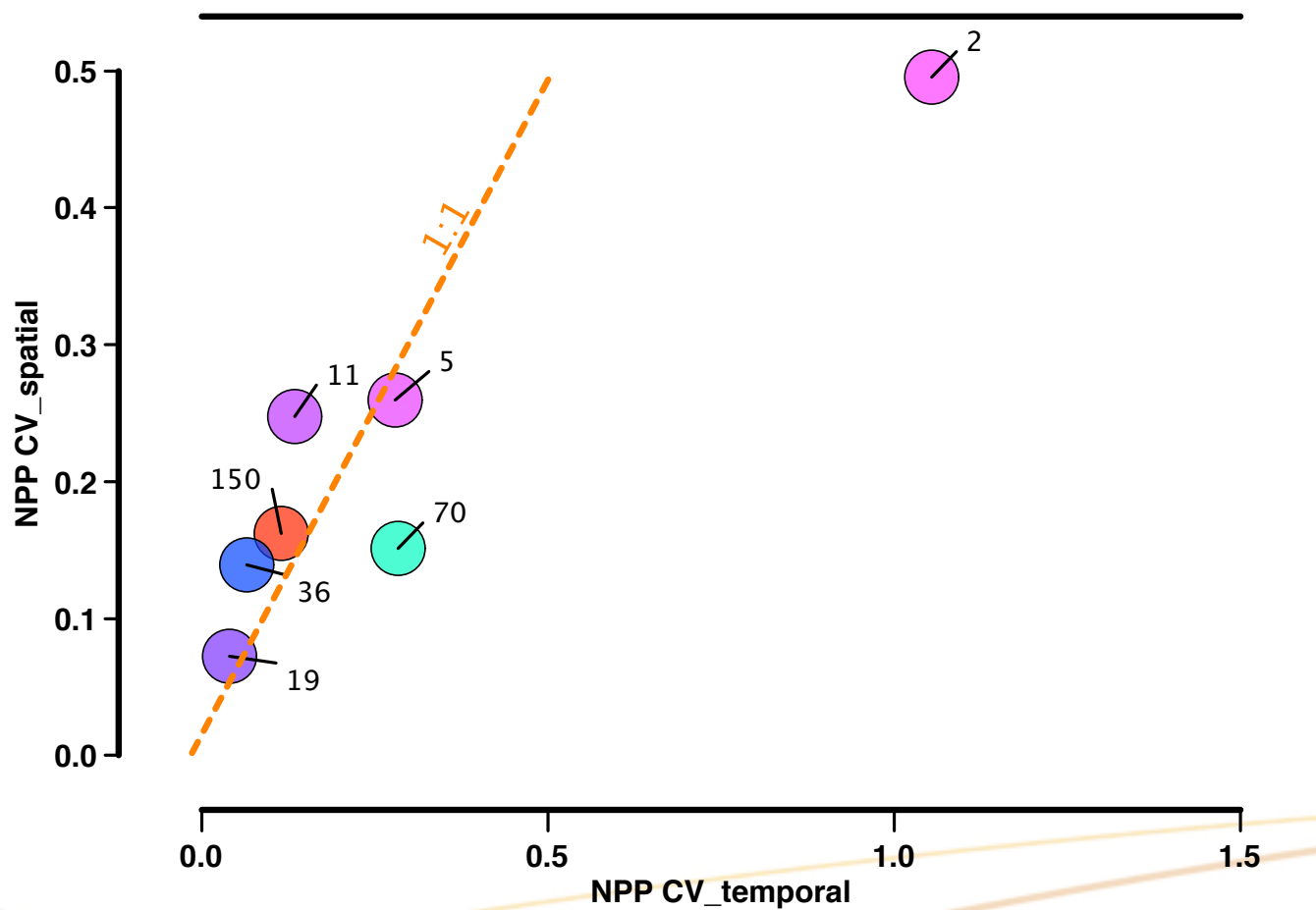
# Temporal replication—tree growth



# Should we replicate in space or time?

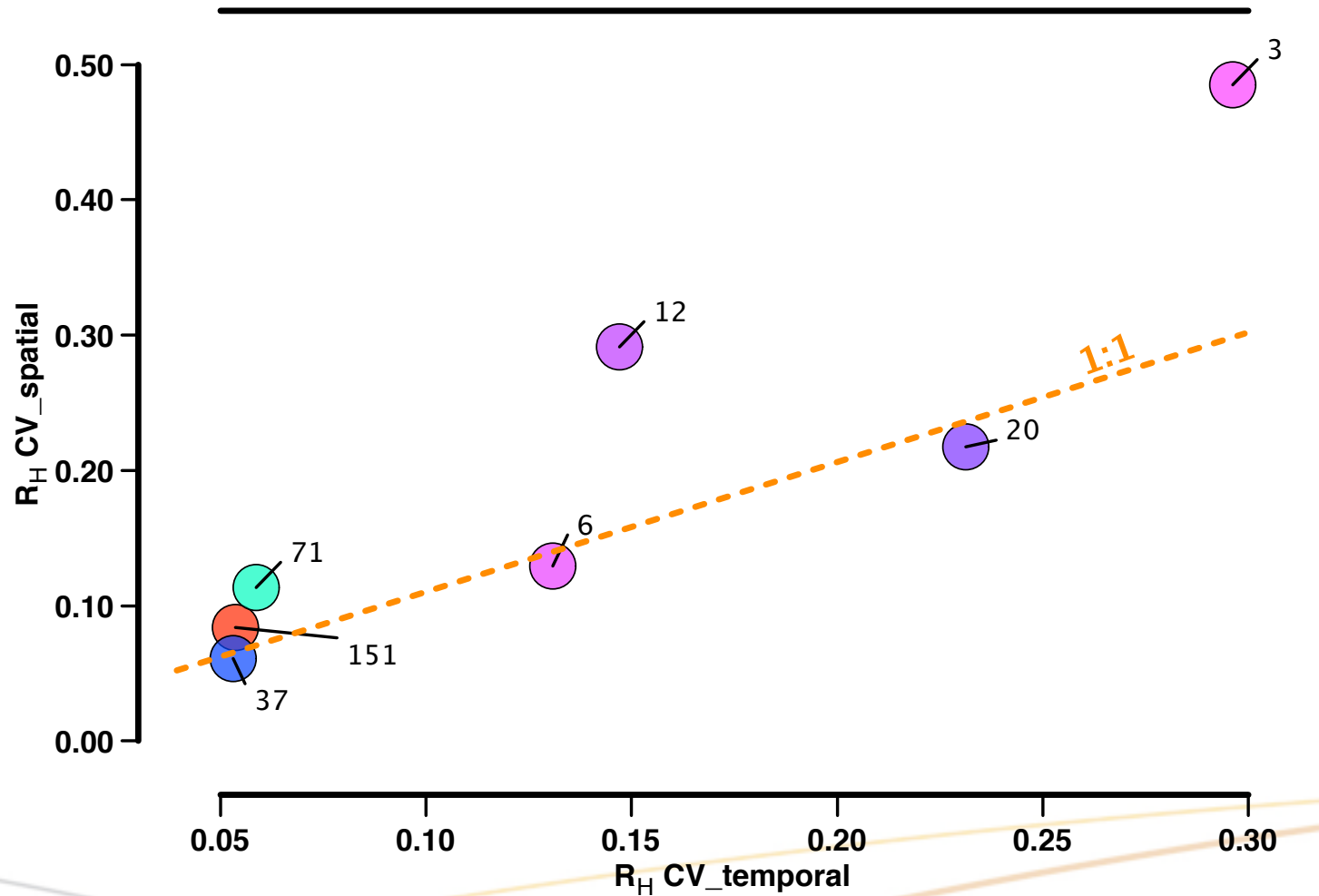


# NPP variability by stand age

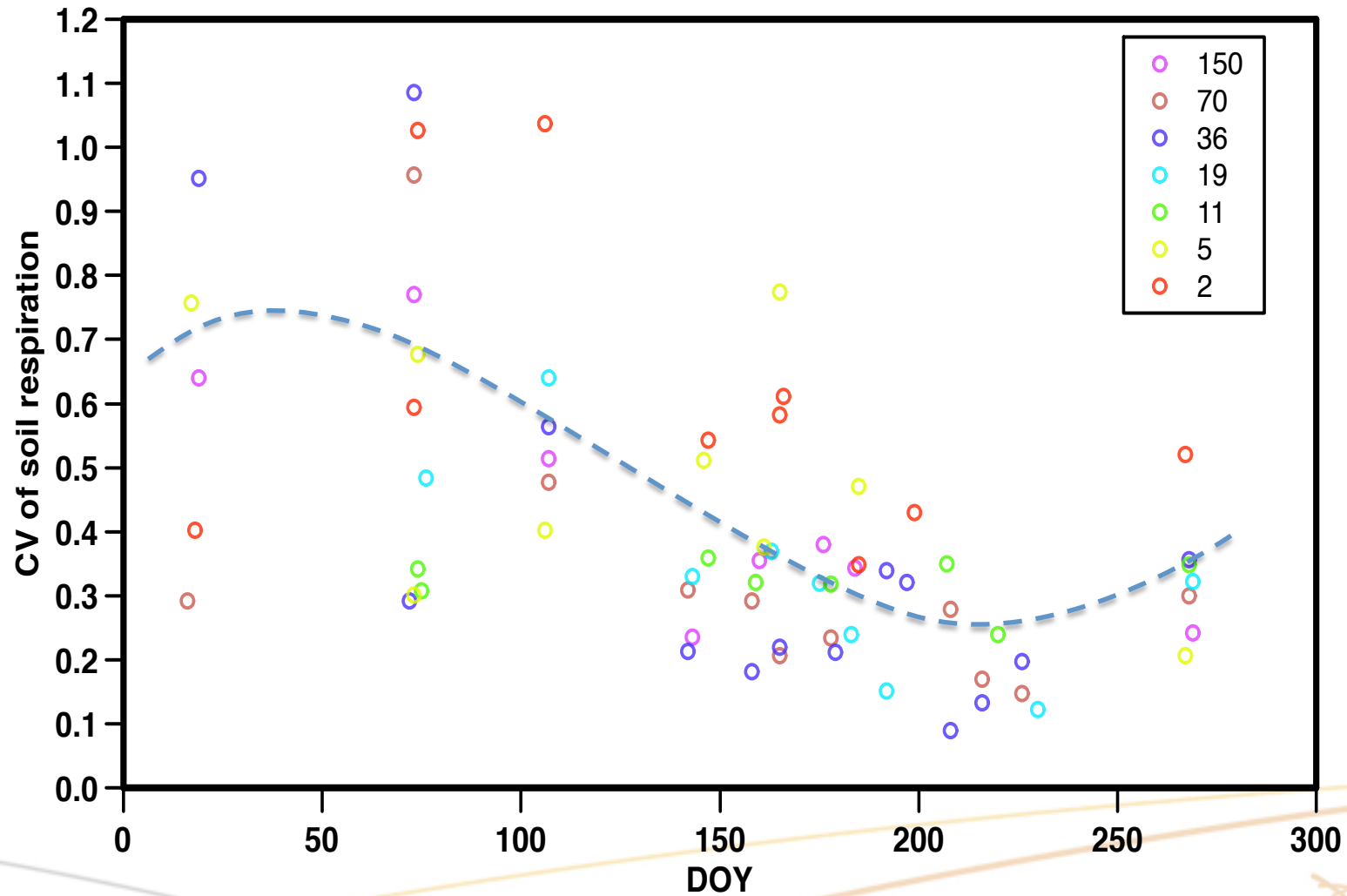




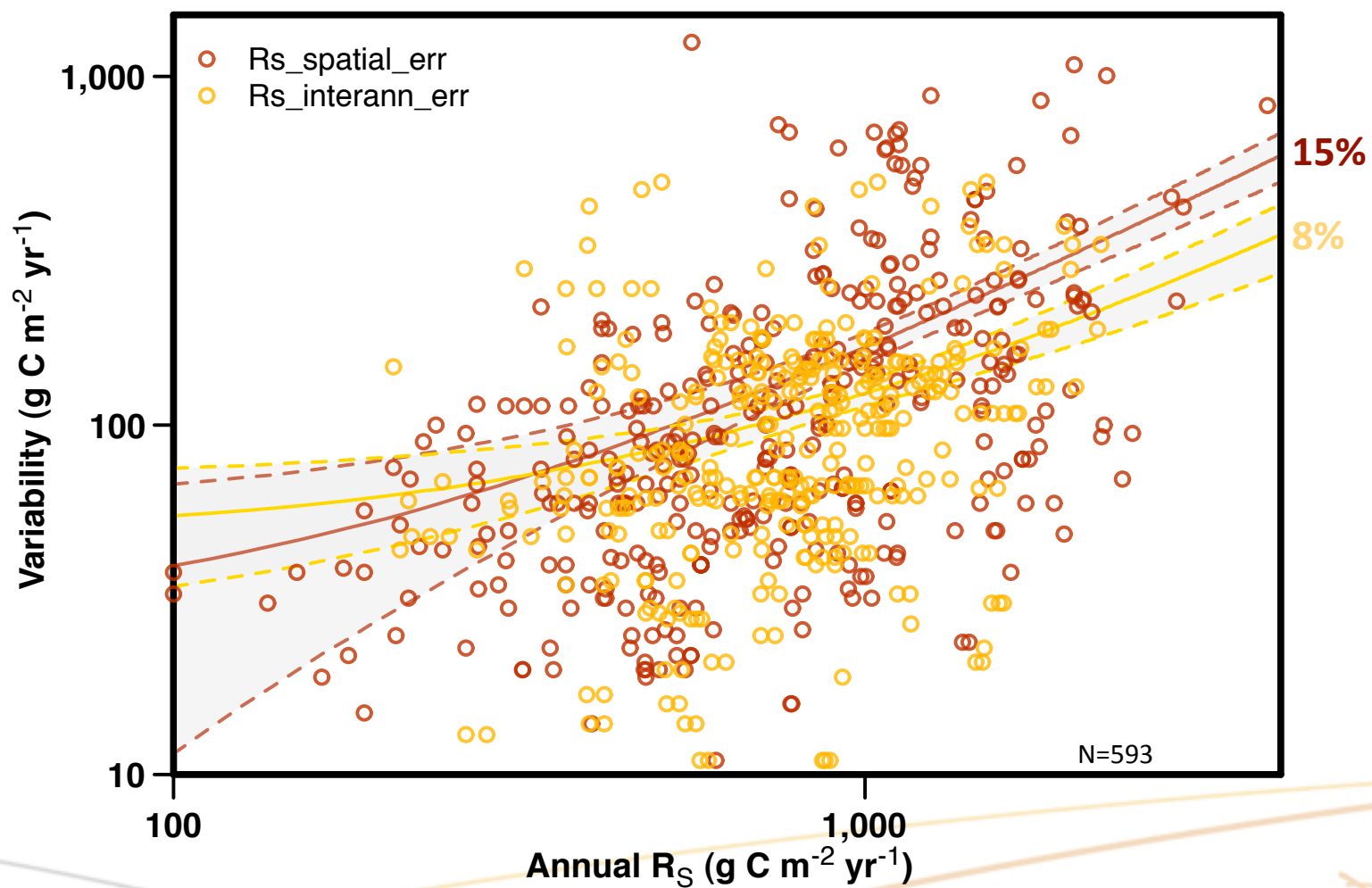
# Heterotrophic soil respiration



# Spatial variability varies



# Soil respiration (global)



# Conclusions

- We really need
  - ~~A time machine, or~~
  - ~~Patient, long-lived graduate students, or~~
  - Integrative measurements (maybe)
- A chronosequence is fundamentally a hypothesis: it can only be *disproven*, not proven
- Landscape inferences from standard replication
  - Give up the strict chronosequence claim
- Variability -> power calculations
  - Sampling may vary by, e.g., forest age
  - This lets us prioritize and use resources efficiently

# Thanks

