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Laboratory of Tree-Ring Science
DEPARTMENT OF GEOGRAPHY

Past, Present, and Future Climate Change and Forest Dynamics in a High-Elevation Whitebark Pine Ecosystem, Wyoming, U.S.A.

Presented by: Maegen Rochner
University of Tennessee Department of Geography

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Introduction

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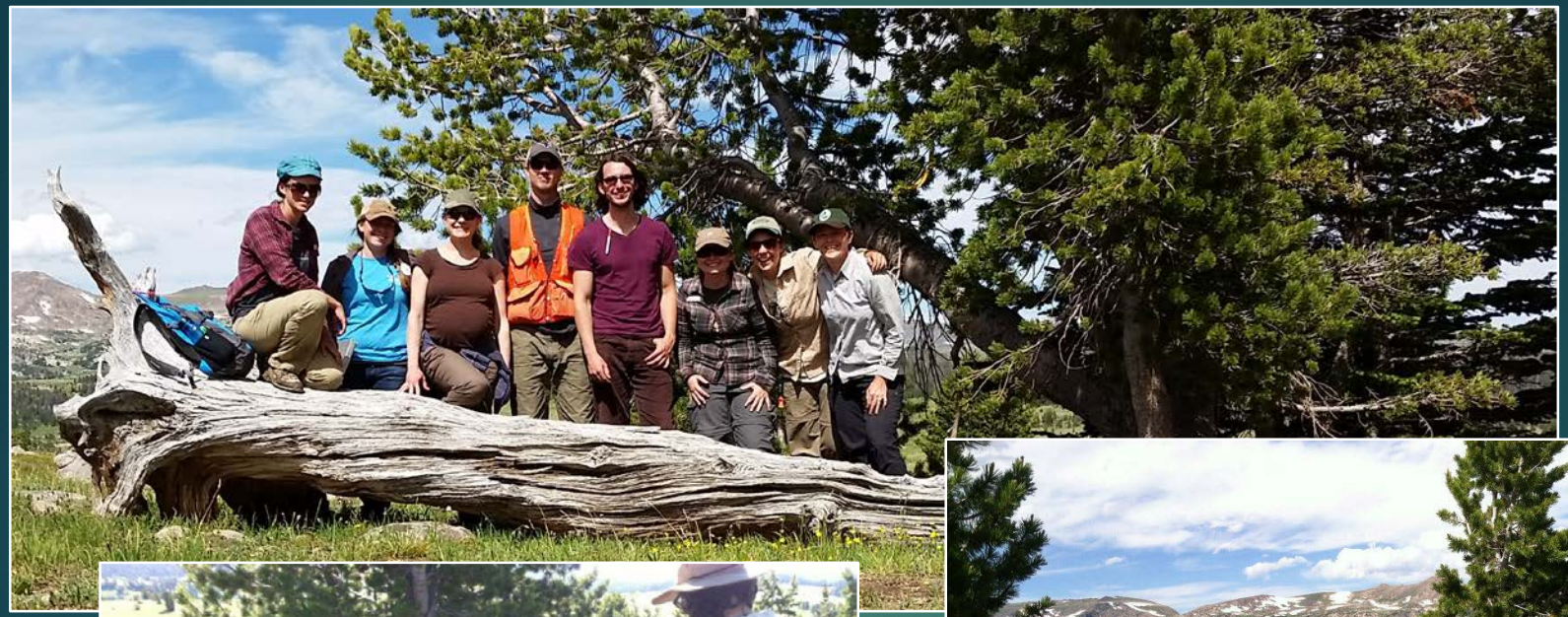

Research Objectives

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- To investigate late Holocene climate change
  - Medieval Warm Period (AD 900–1350)
  - Little Ice Age (AD1350–1850)
  - Maunder Minimum (AD 1645–1715)
- Evaluation possible analogues to modern climate change

Study Site

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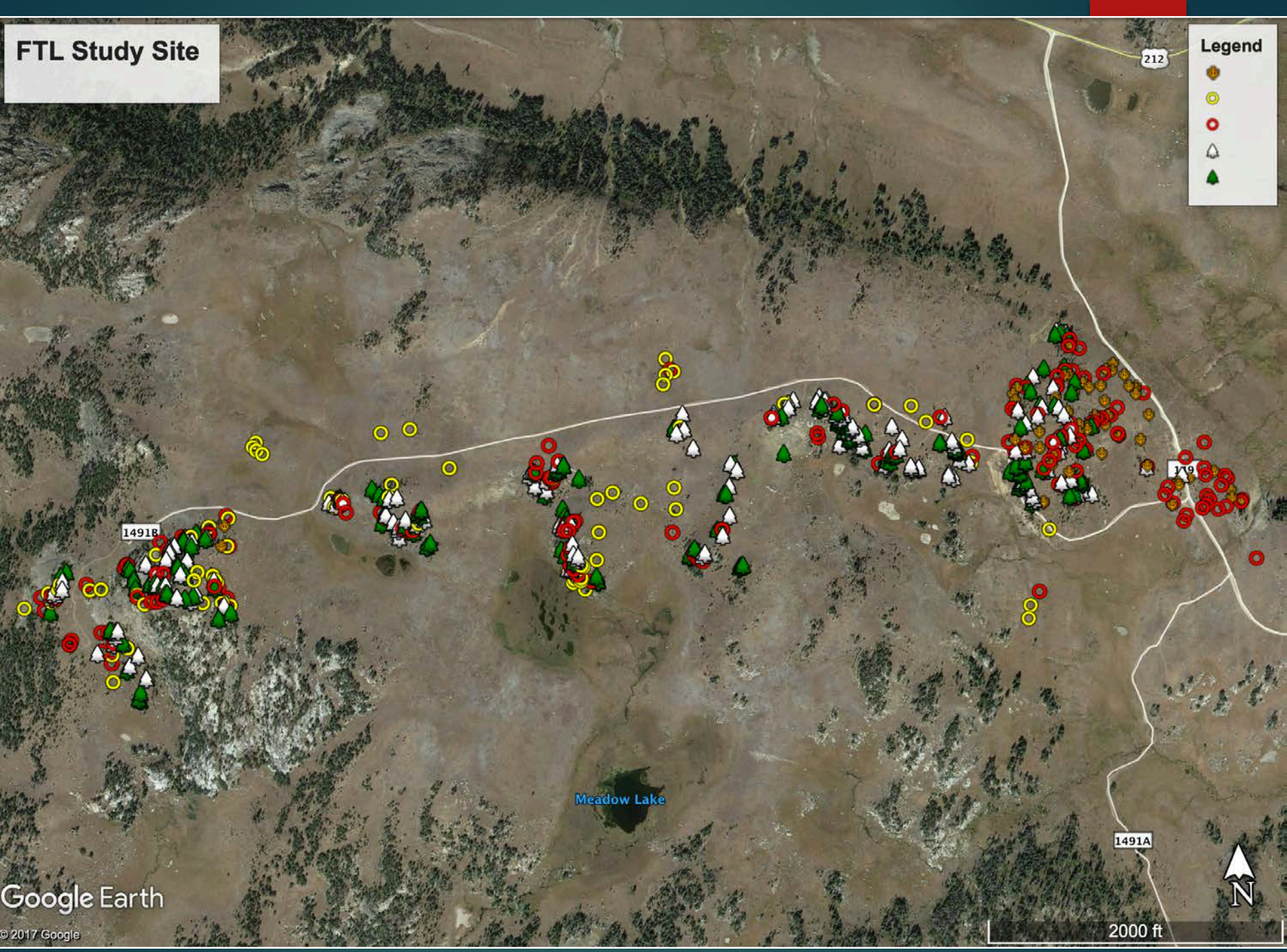
Google Earth image


FTL Study Site
Legend
212
1491B
Meadow Lake
1491A
N
2000 ft
Google Earth
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Study Site

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Hypotheses

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- ***(1)*** *The whitebark pine and Engelmann spruce remnant logs represent an open woodland that thrived during the MWP, but was killed during the LIA.*
- ***(2)*** *Establishment dates for living trees at the FTL site should post-date the end of the Maunder Minimum, and especially the LIA, and establishment patterns in these trees should reflect where snow and ice melted first, most likely along an elevational gradient.*
- ***(3)*** *During the 20th century, growth of living whitebark pines will have significant relationships with climate variables that were characteristic of climate conditions during the MWP (i.e. warmer temperatures and drier conditions).*

Methods I

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Methods II

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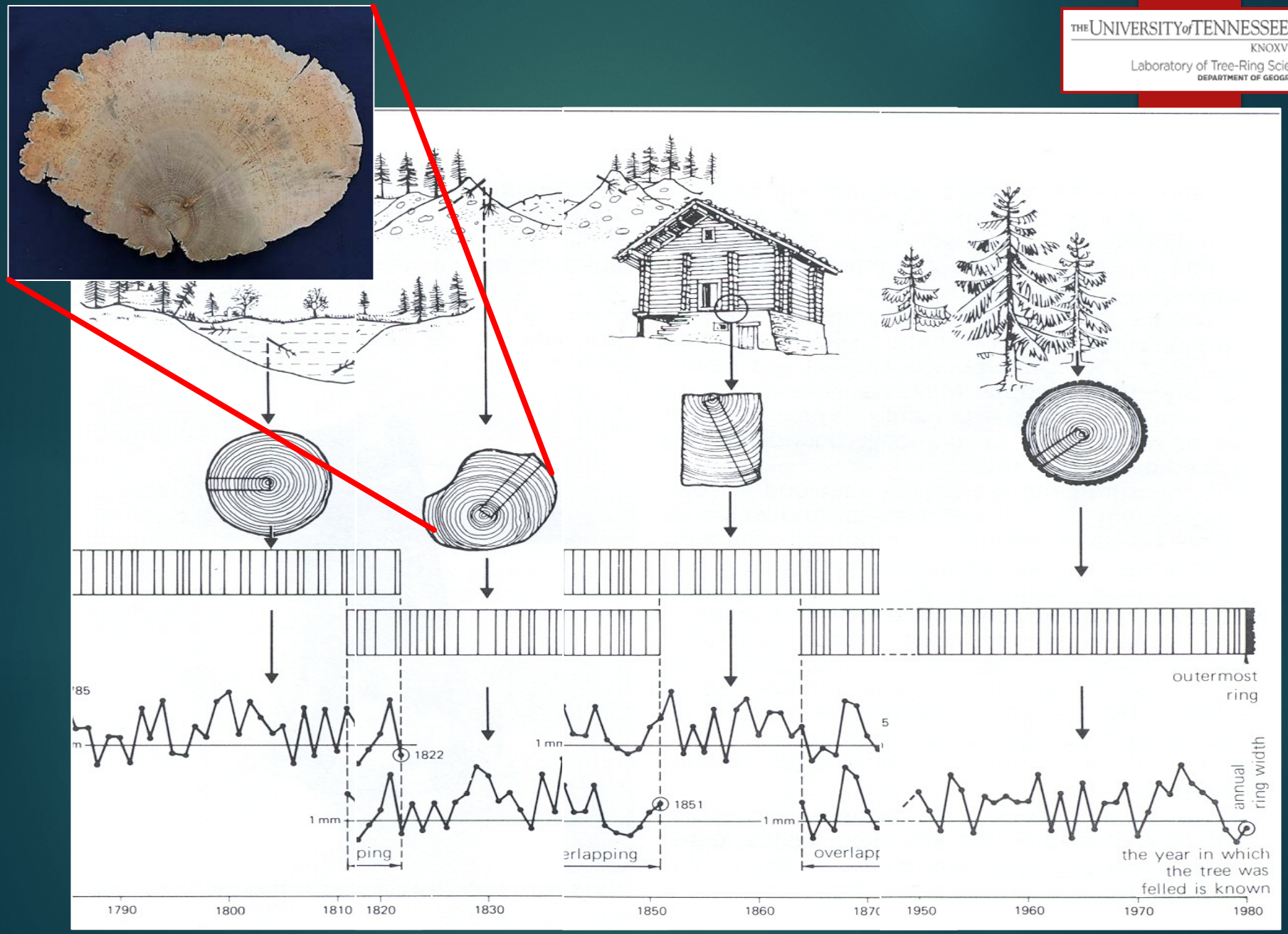
- **H1:** Remnant Tree Mortality
  - Dendroarchaeology
    - Statistical internal and external crossdating (COFECHA)
    - Development of "floating" detrended chronology (ARSTAN)
    - Mt. Washburn (AD 937–1998) and Sylvan Pass (AD 1388–1983)
    - Anchored in time
- **H2:** Living Tree Establishment
    - Ring counts and establishment dates
    - Standardized pith estimators
    - Chronology development (COFECHA and ARSTAN)
    - Stem Mapping and Frequency Distribution Graphs in Excel


1822
1851
1 mm
outermost ring
annual ring width
the year in which the tree was felled is known
1790
1800
1810
1820
1830
1850
1860
1950
1960
1970
1980

Methods III

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- **H3:** Climate-Growth Relationships
- Treeclim (R package)
  - Correlation Analysis (relationships)
  - Forward and backward evolutionary analysis (temporal stability)
- NOAA climate divisional data for the Yellowstone Drainage region of northwest Wyoming (NCEI 2016)
  - monthly average temperature (MNTM)
  - monthly maximum temperature (TMAX)
  - monthly minimum temperature (TMIN)
  - total monthly precipitation (TPCP)
  - monthly standardized precipitation index (SP01)
  - Palmer Drought Severity Index (PDSI)

Results I: Remnant Trees

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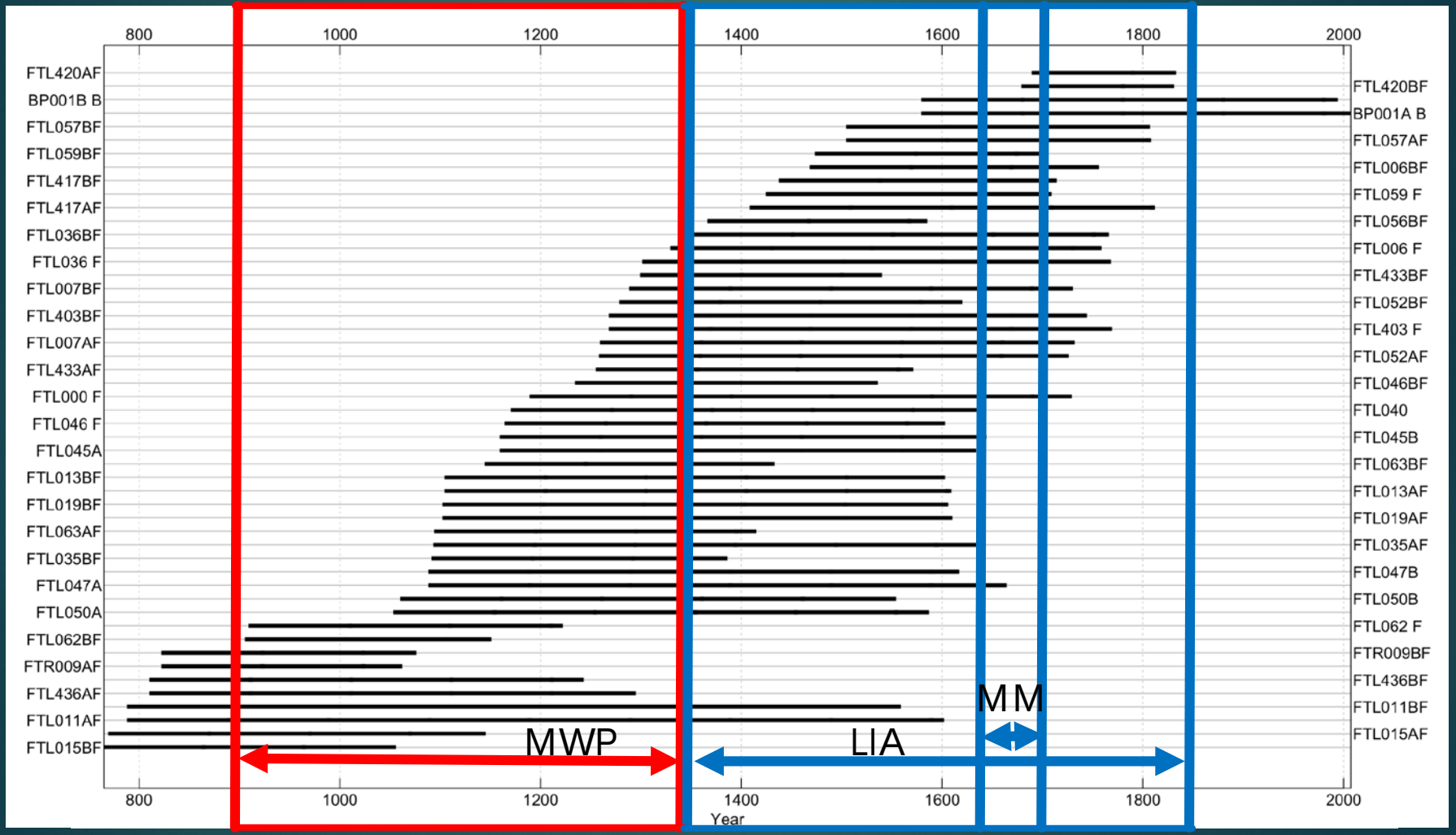

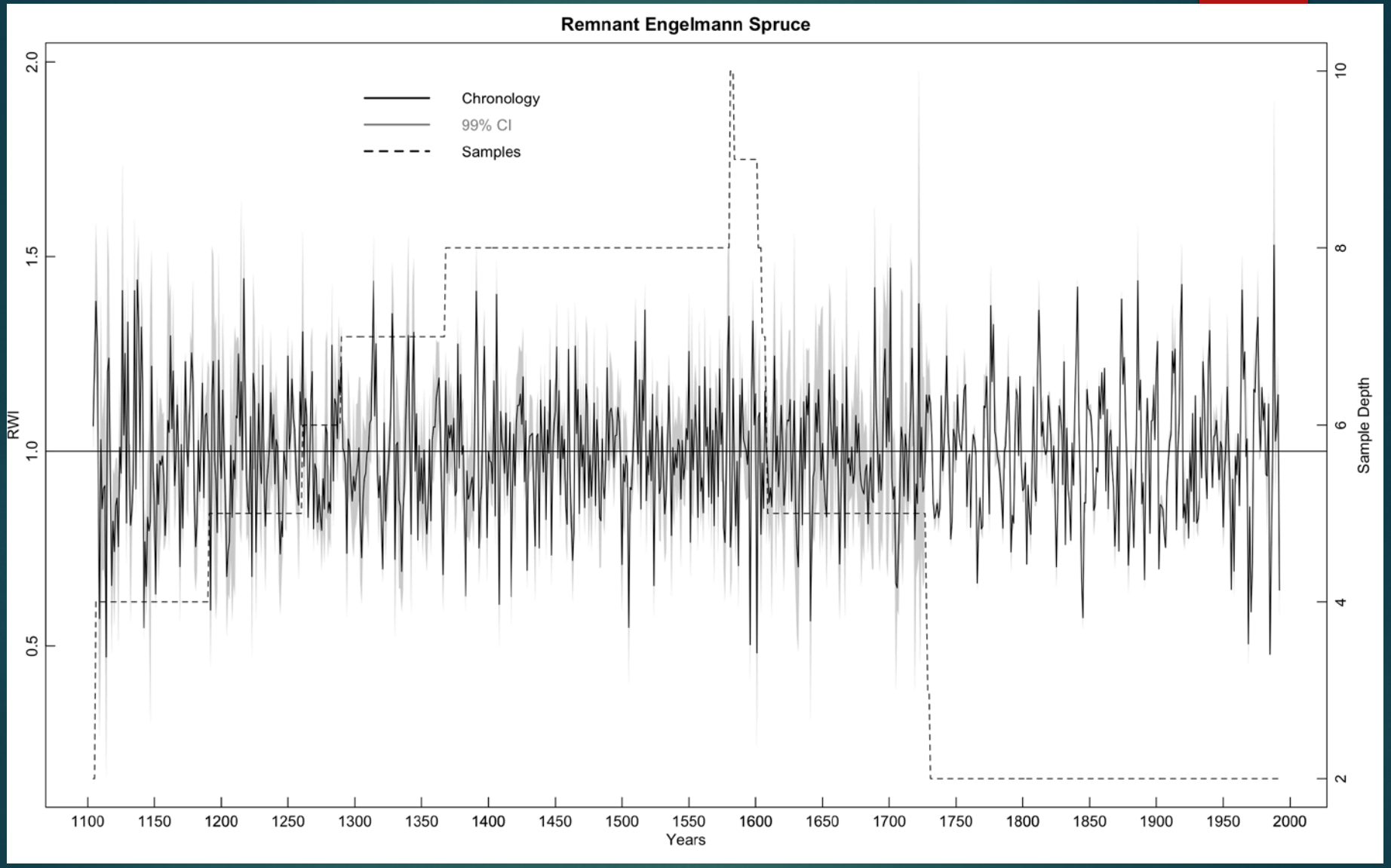

Remnant Engelmann Spruce AD 1100-2007 (r = 0.41, n = 895 years, t = 15.96, p < 0.0001)
average interseries correlation: 0.68 (p ≤ 0.0001), average mean sensitivity: 0.21

Remnant Engelmann Spruce AD 1100-2007 (r = 0.41, n = 895 years, t = 15.96, p < 0.0001)

Results II: Establishment

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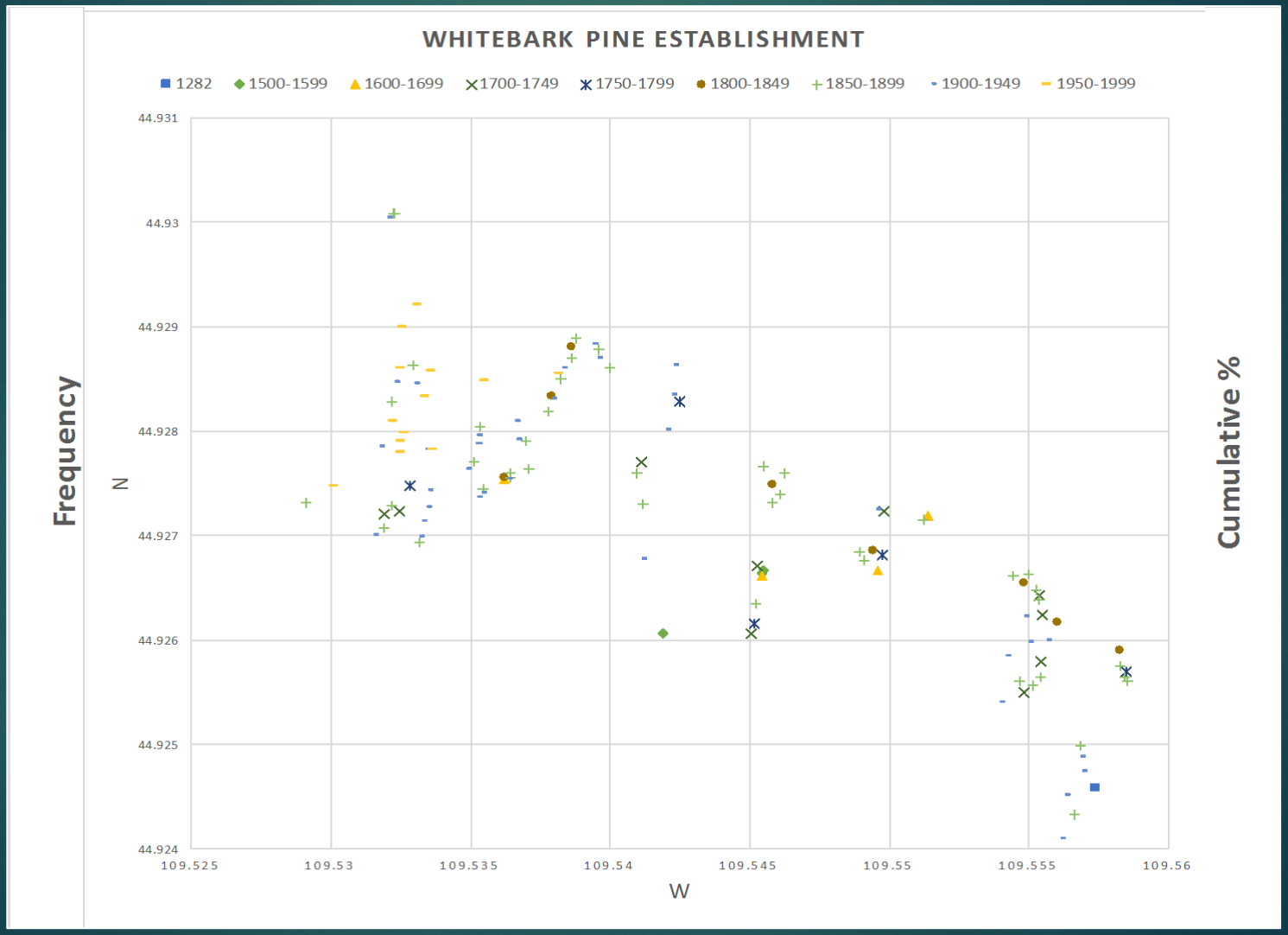

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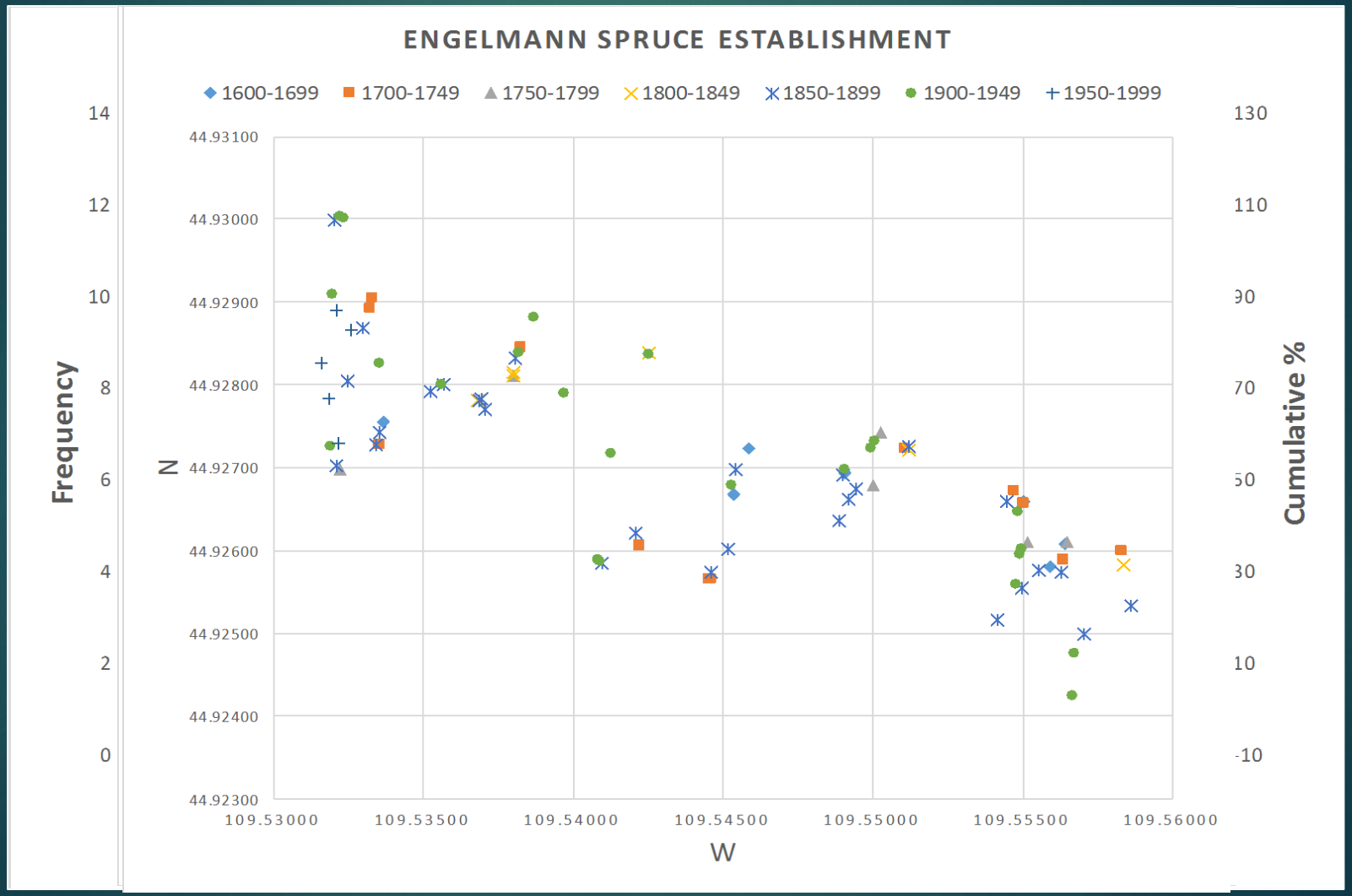

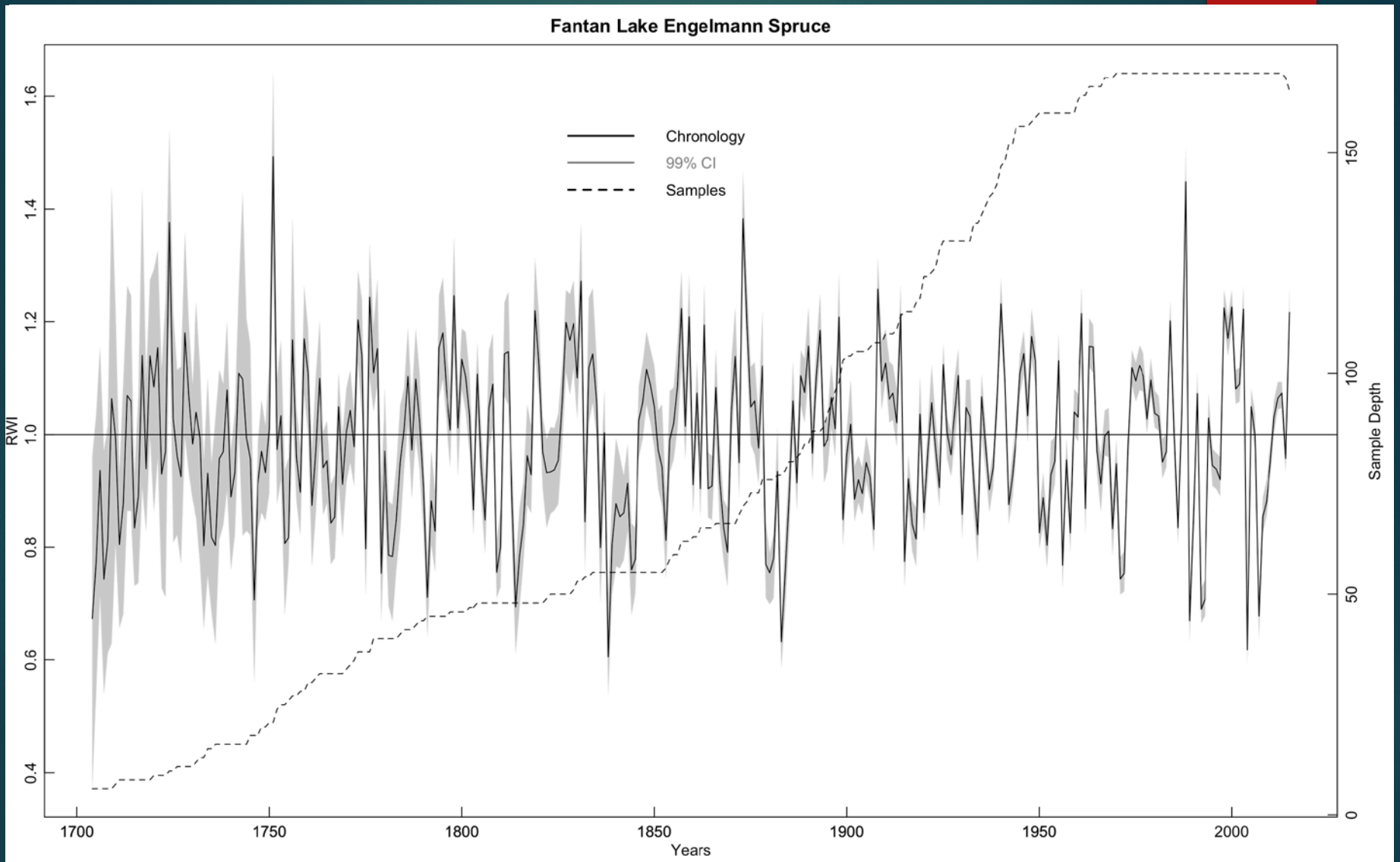

Living Engelmann Spruce AD 1615-2015

Average interseries correlation: 0.62 ($p \leq 0.0001$), average mean sensitivity: 0.24

Results III: Climate-Growth

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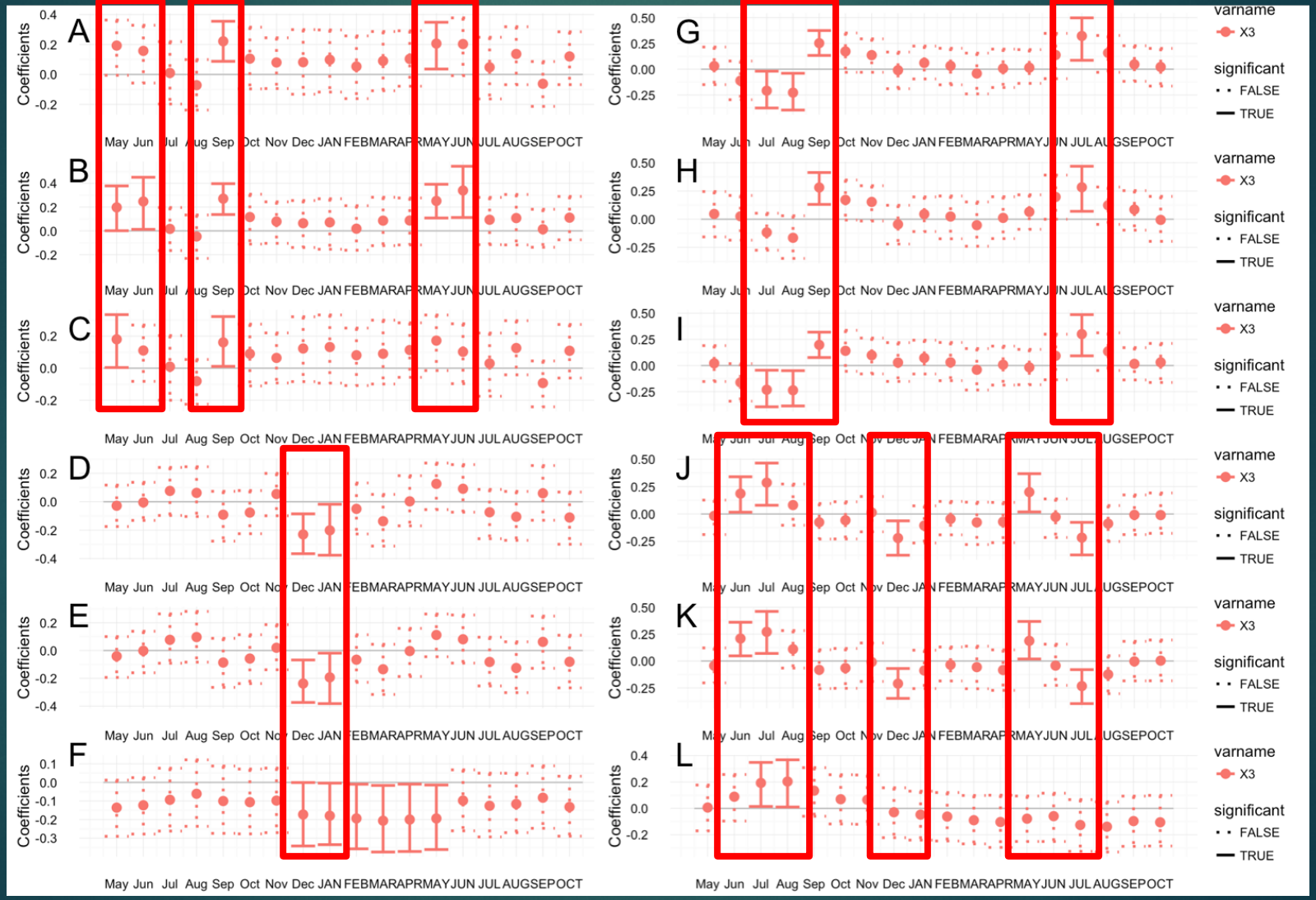

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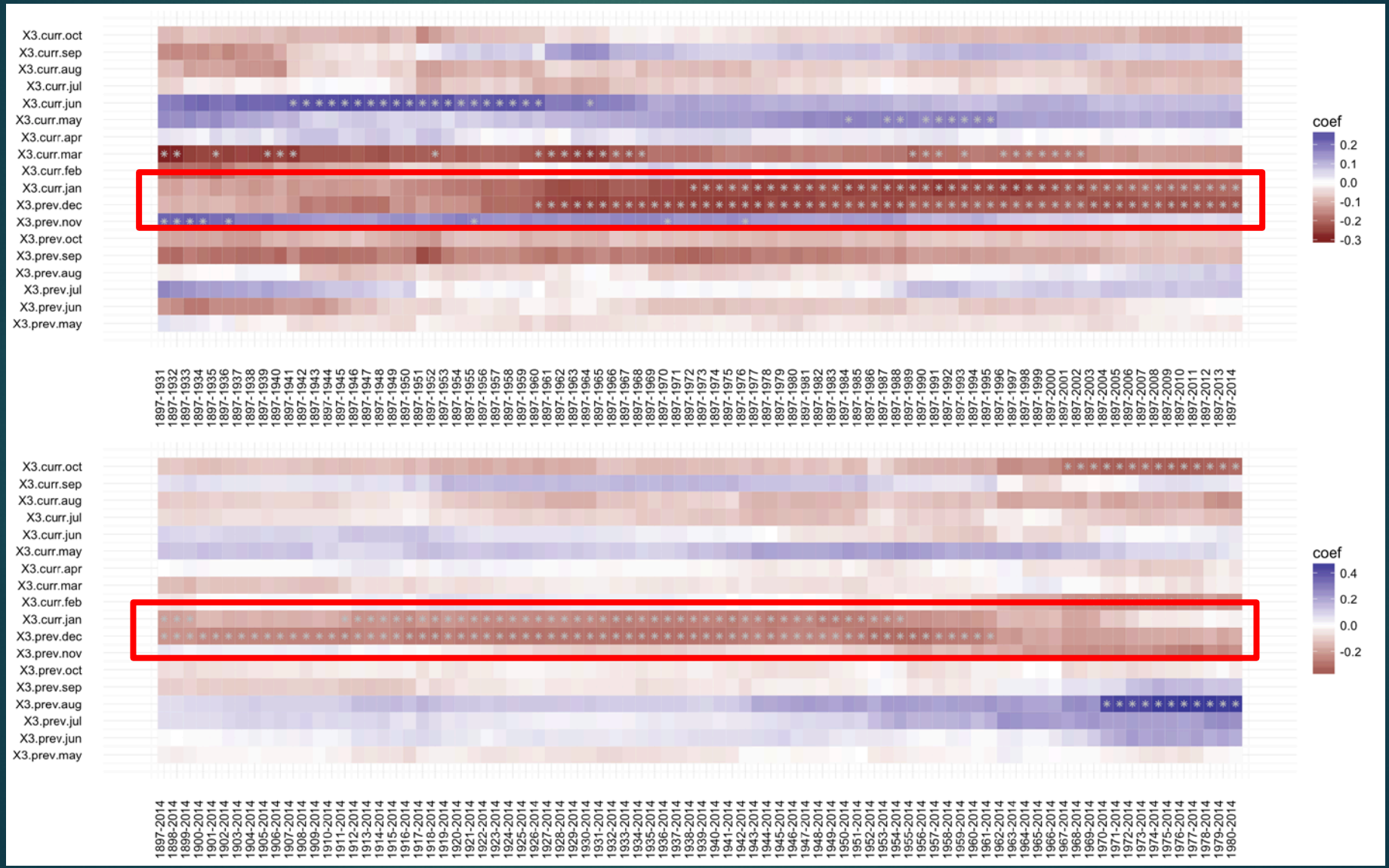

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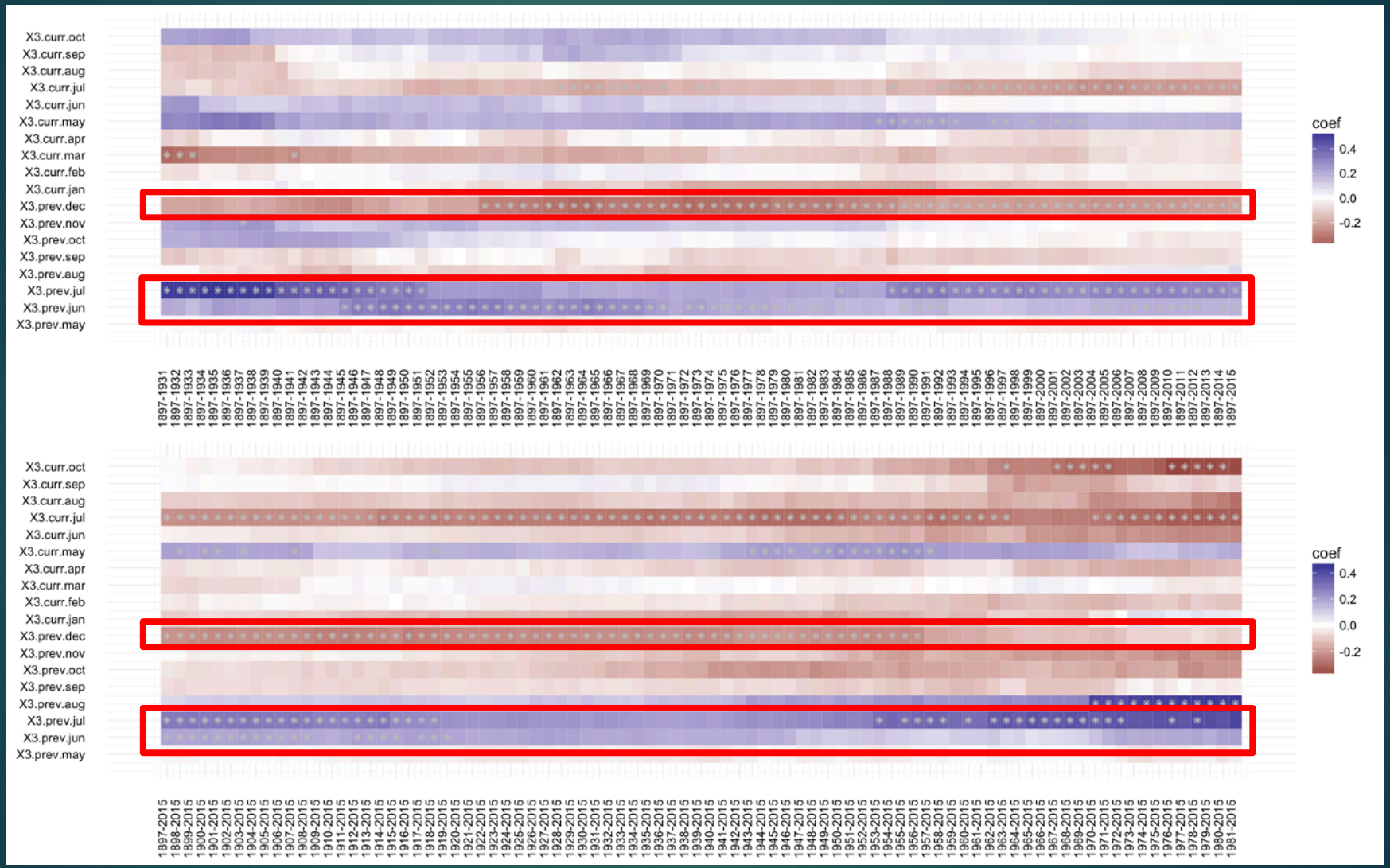

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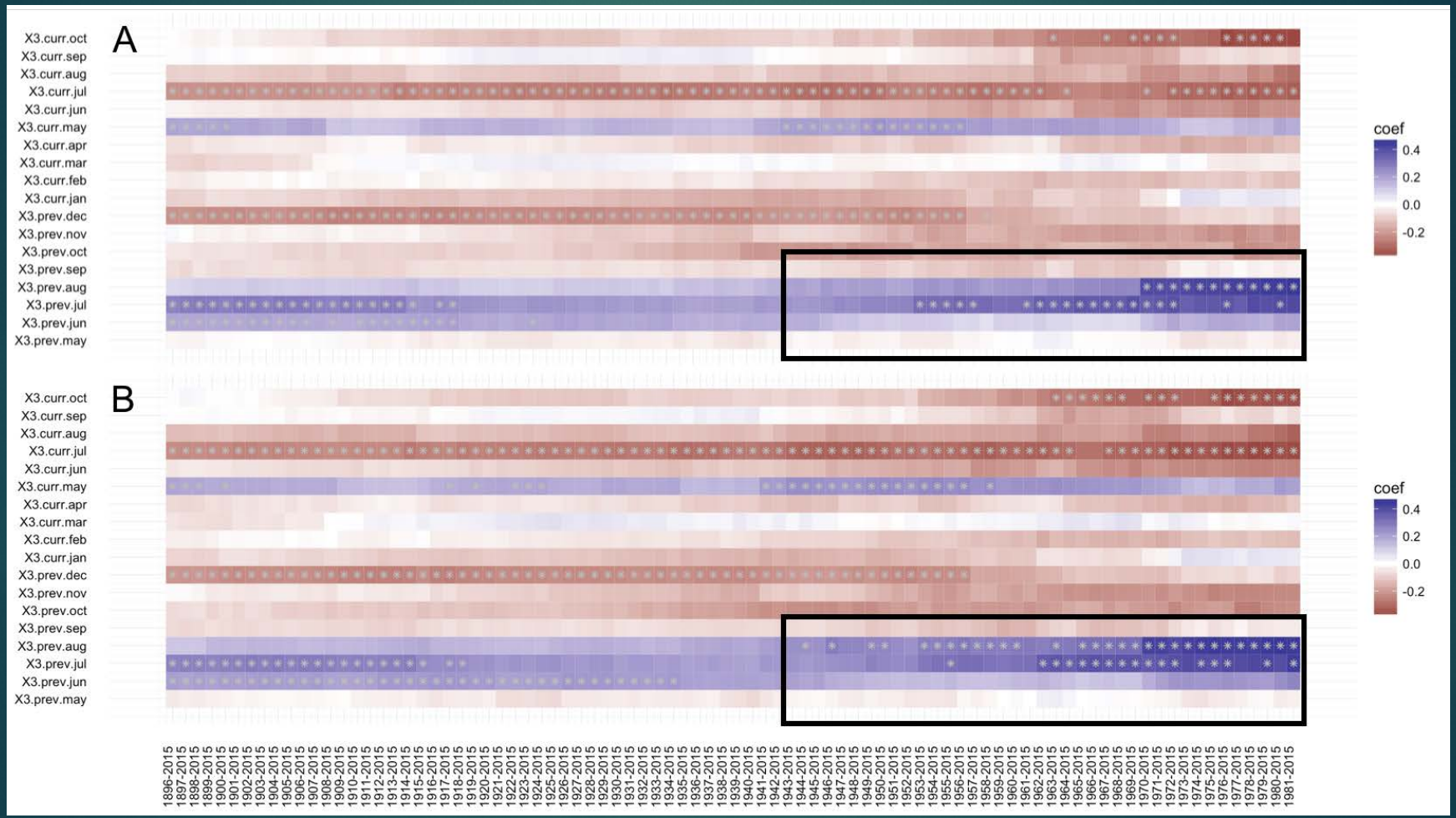

Conclusions & Discussion

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- Remnants can be dated
- LIA = mortality event
- Most living trees post-date LIA
- No spatial establishment patterns
- Shift in climate response from growing season length to previous summer conditions
- The influence of summer moisture

Continued Work

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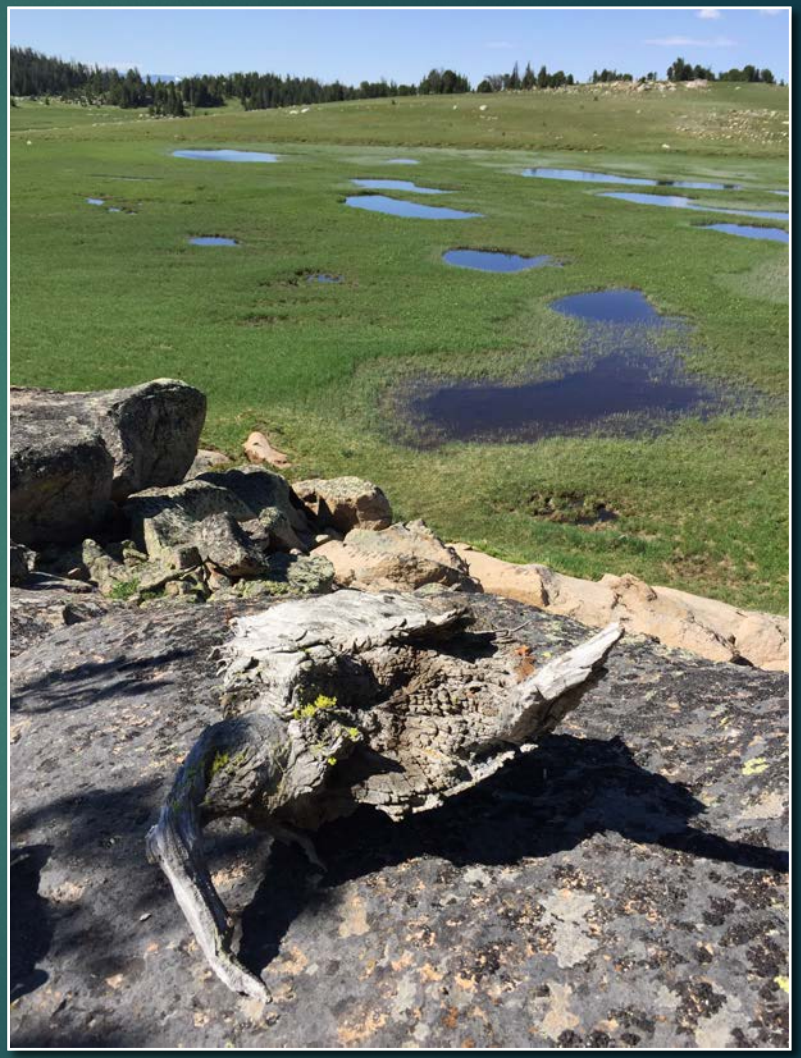
- Potential of remnants
  - Climate reconstruction
  - BC Barrier!?



Continued Work

- Fire!
- Insects!

Questions?

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- Thank you!

Acknowledgements

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