

Interactions of climate, vegetation, and fire during the Holocene: insights to future change



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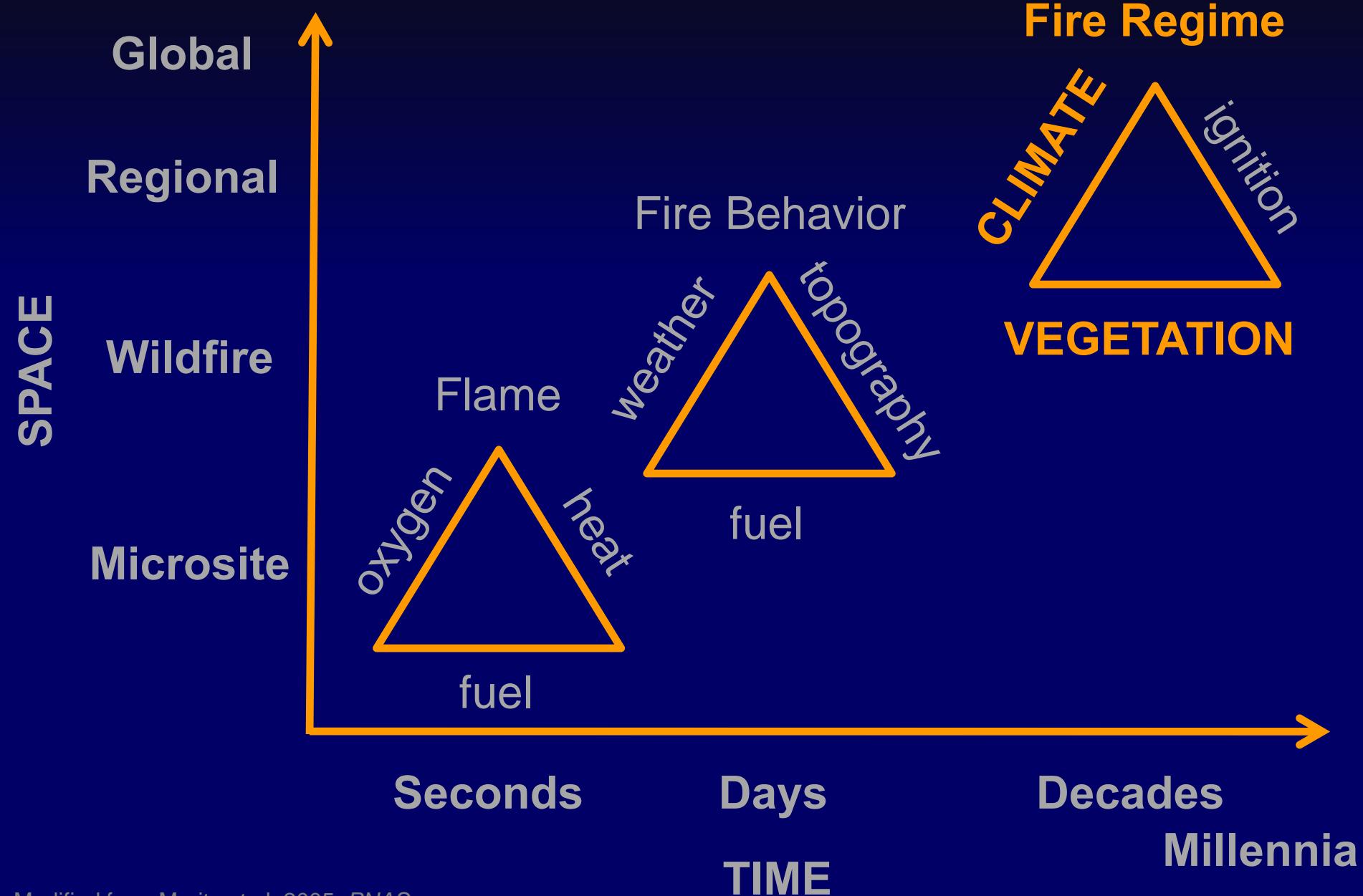
Fire and Climate Change

“As a result of climate change, we are in essence conducting a global experiment such that future wildland fire activity is highly uncertain.”

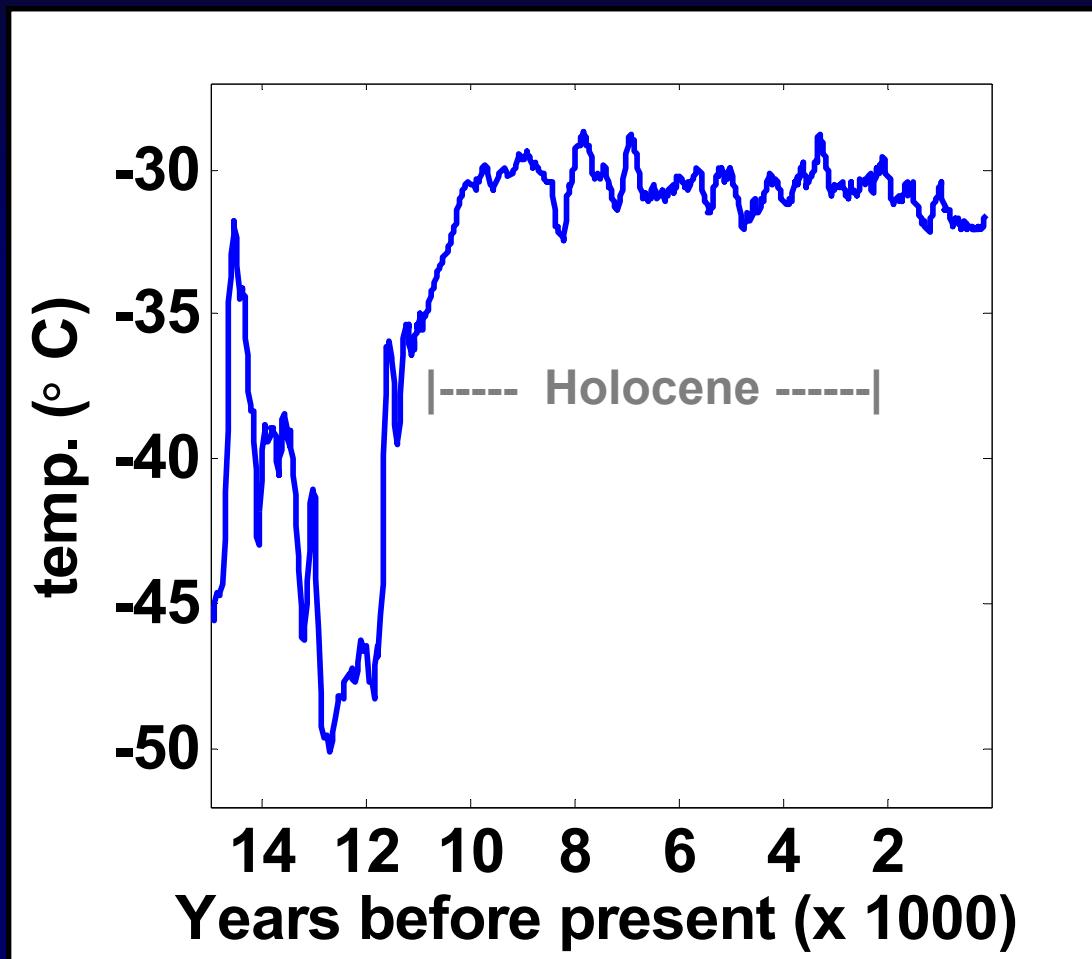
– Flannigan et al. 2009



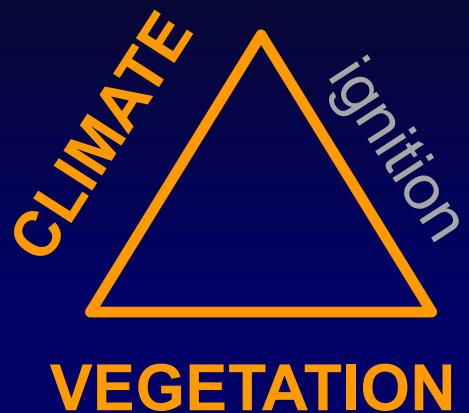
Conceptual Framework



Conceptual Framework



Fire Regime



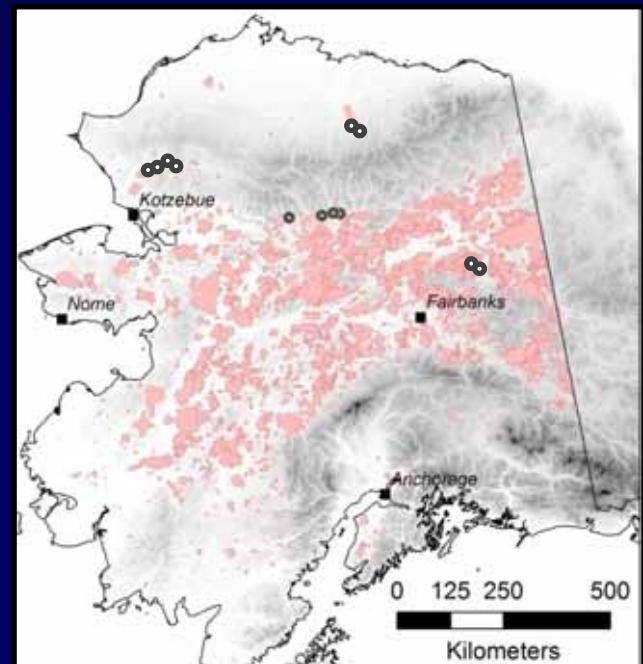
Overview

1. Climate-vegetation-fire interactions

- Reconstructing fire history
- Insights from Alaska
- Context for ongoing change

2. Conceptual challenges

- Defining regimes and detecting change



Reconstructing the past

pollen:



macrofossils:

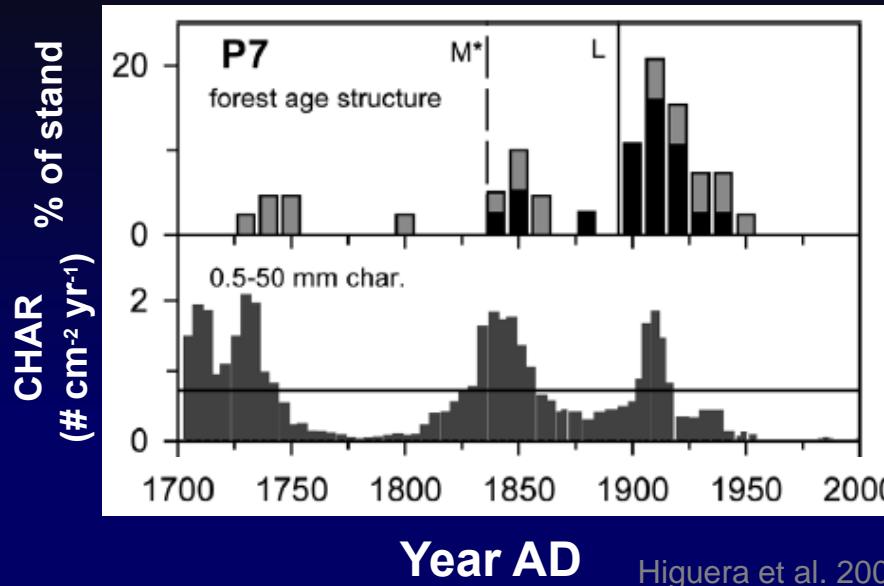


charcoal:



Fire history from continuous sediment records

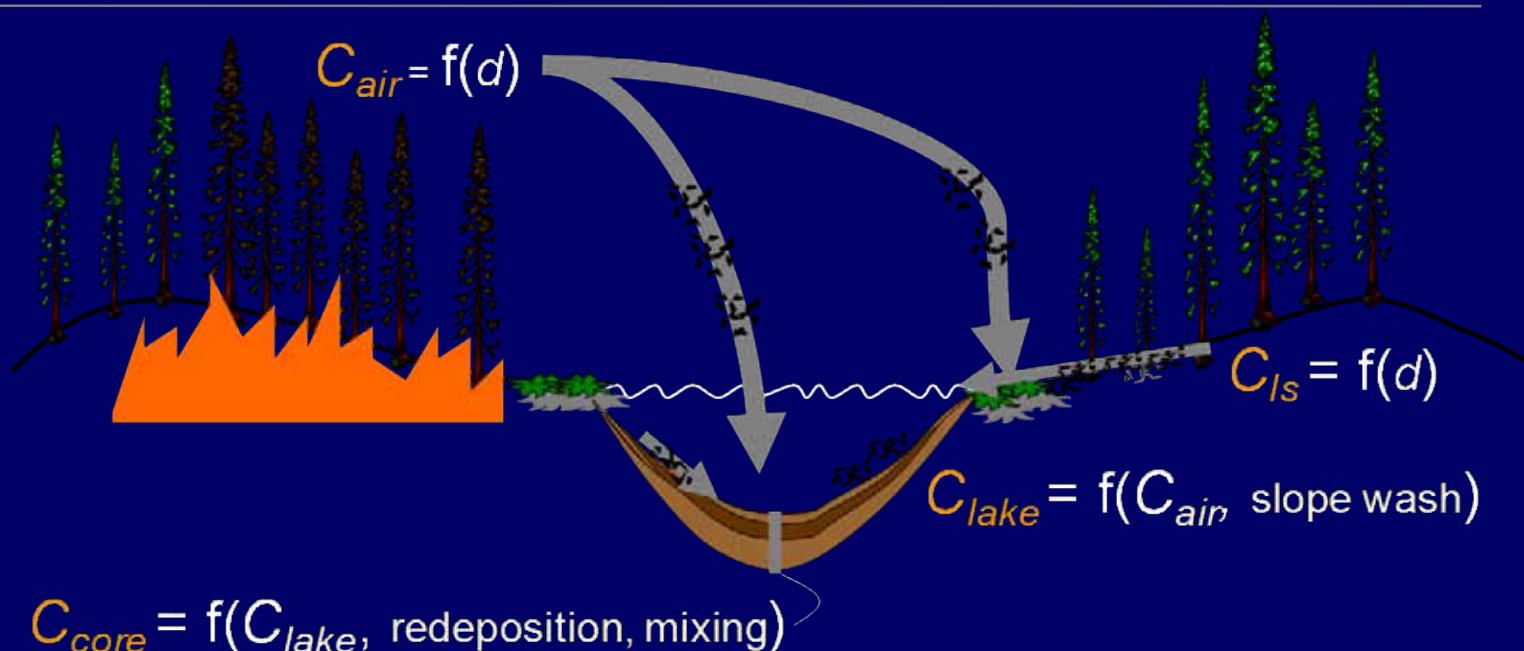
Empirical support:



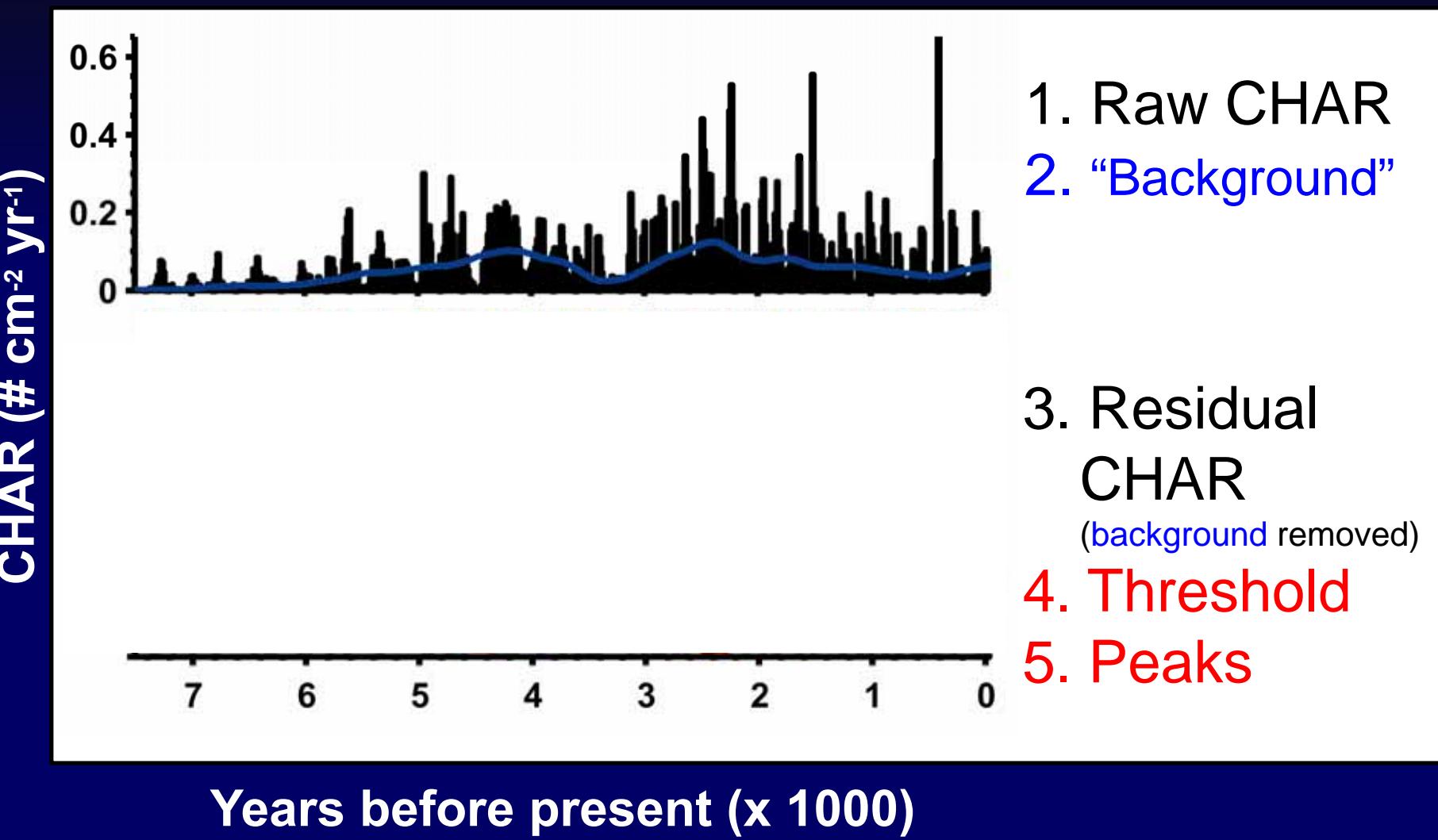
Stand age & fire scars

Charcoal accumulation

Theoretical support:

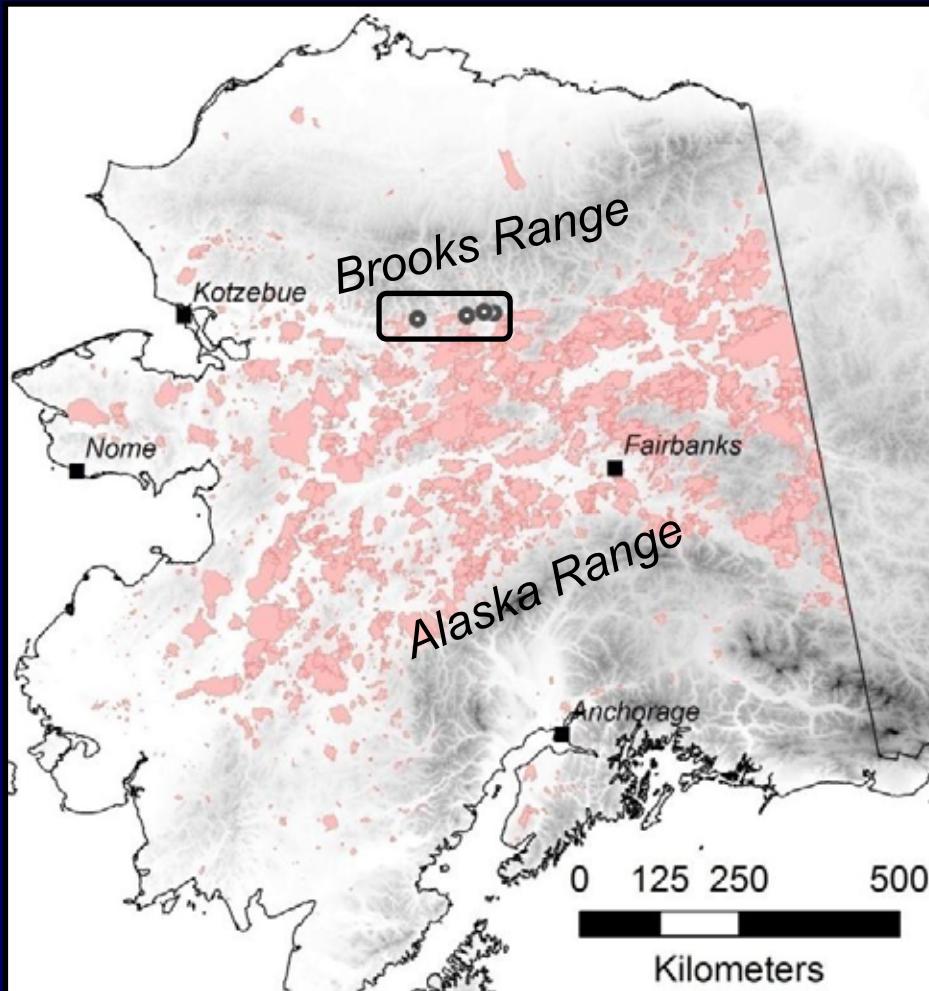


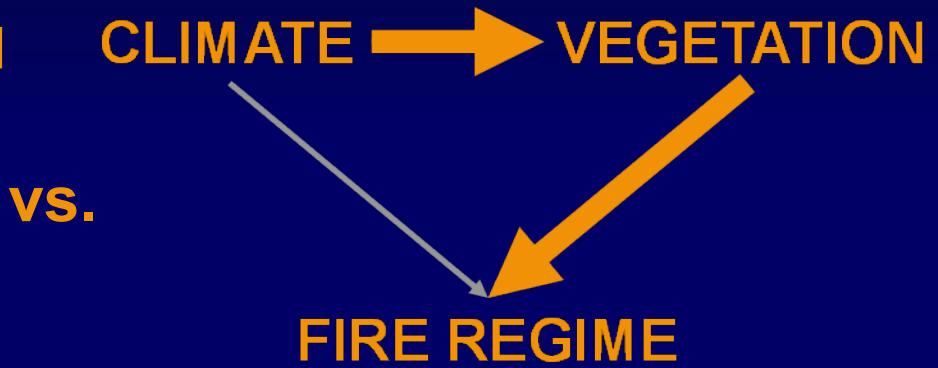
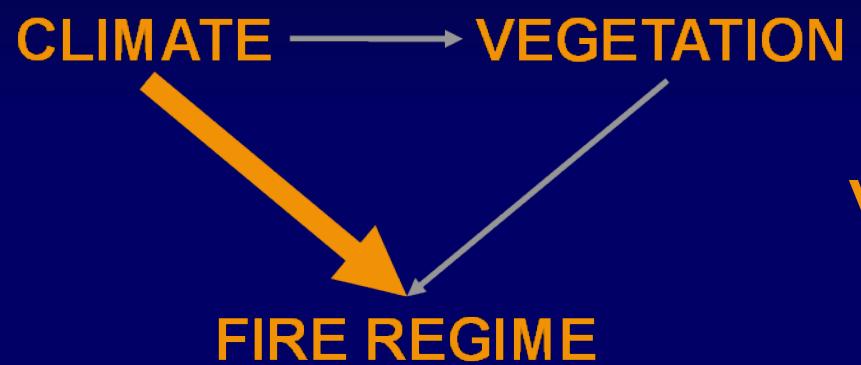
Fire history from continuous sediment records



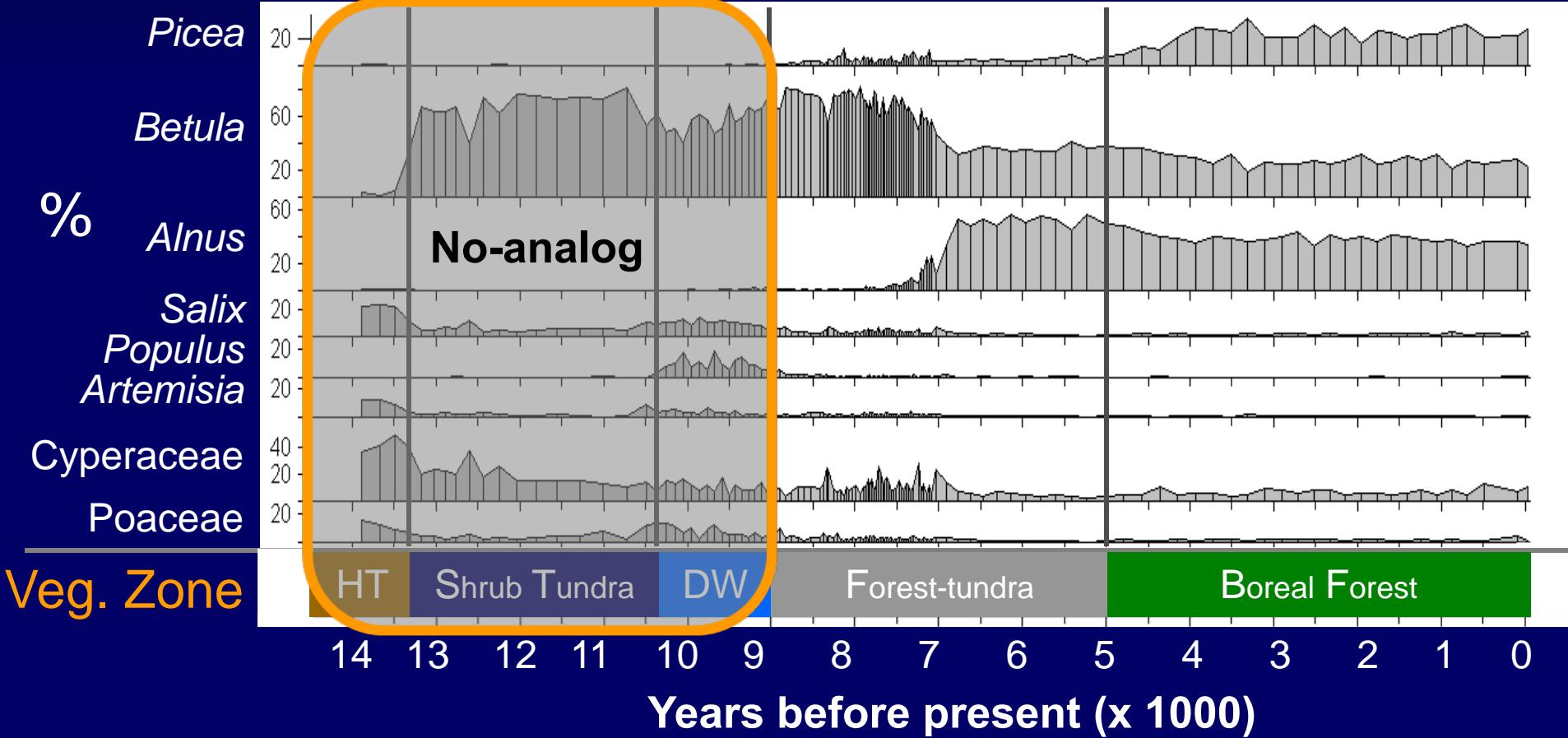
Climate Change and Fire Regimes

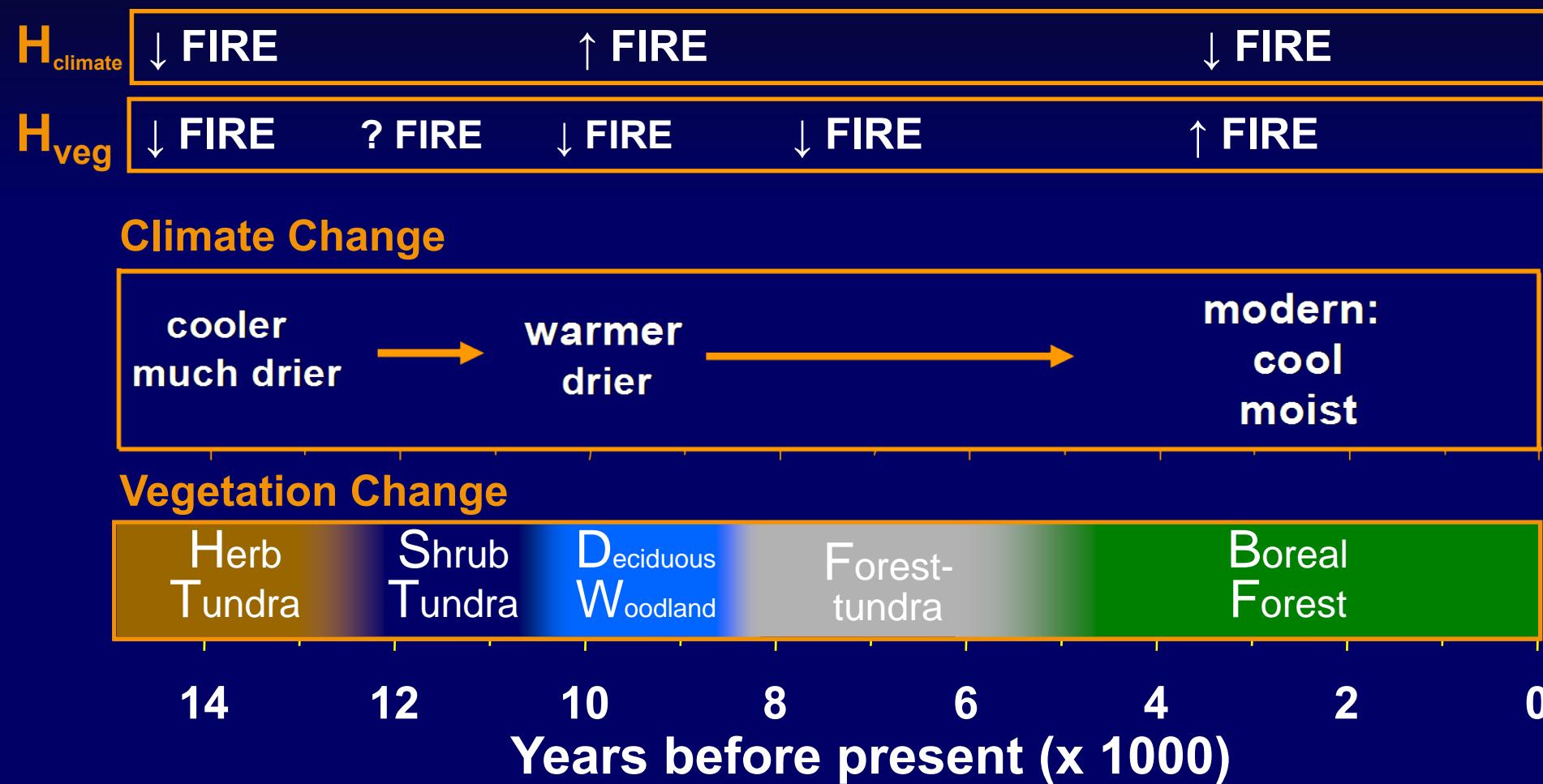
Vegetation mediates the impacts of climate change on fire regimes

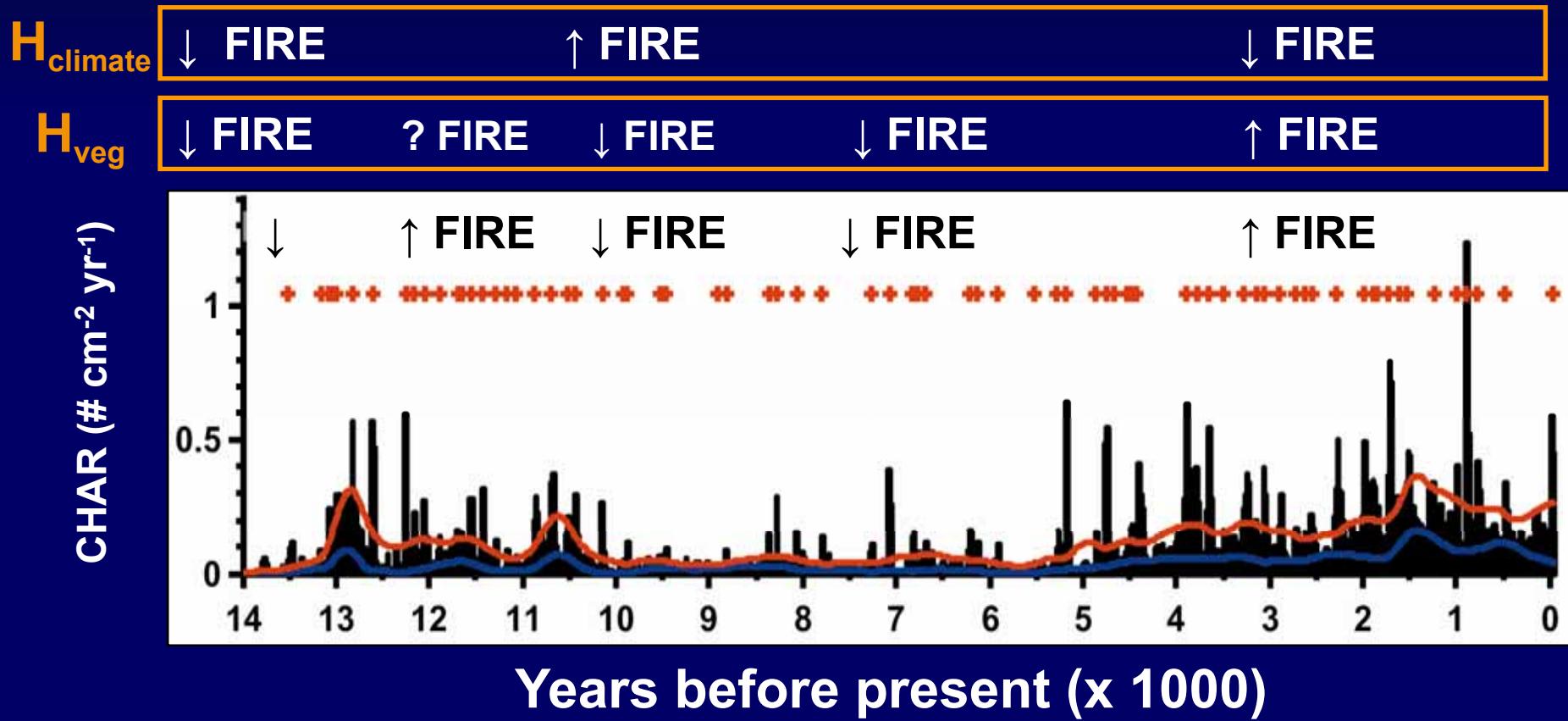


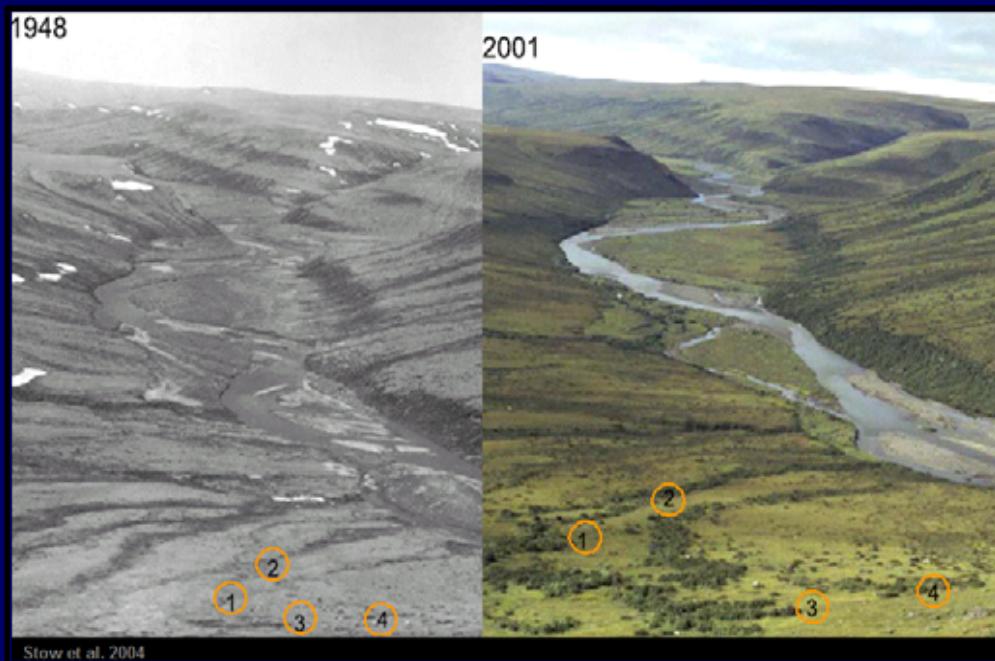
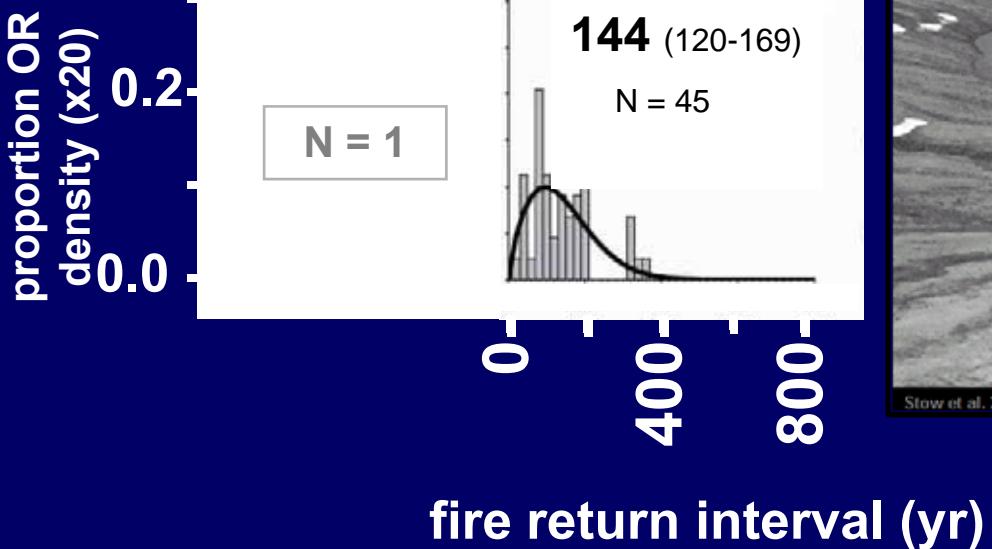
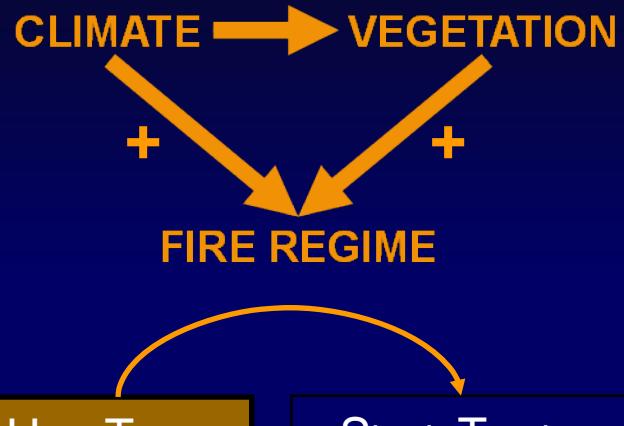


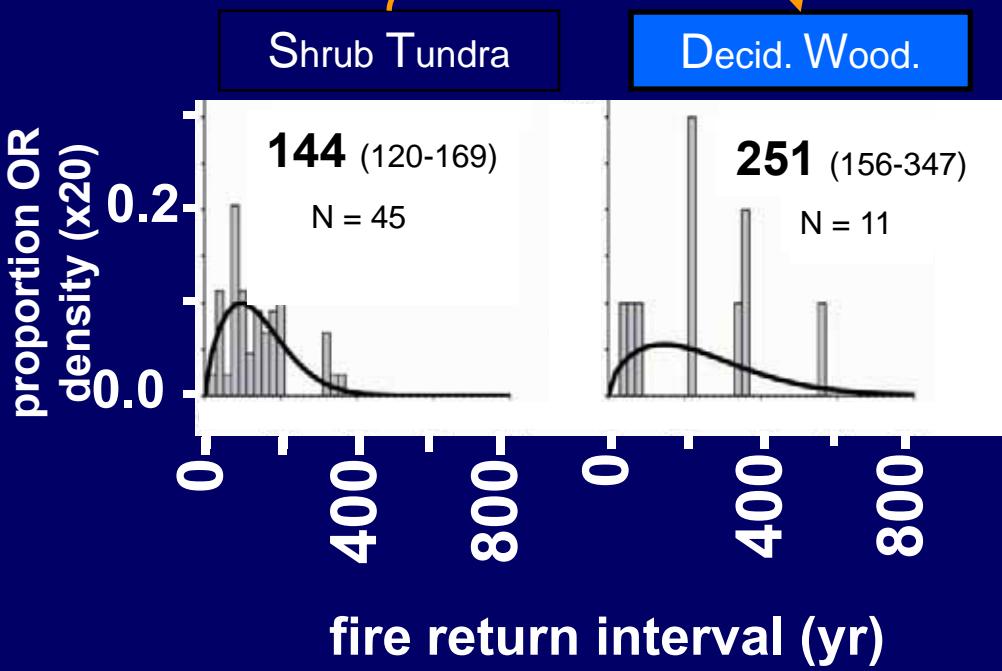
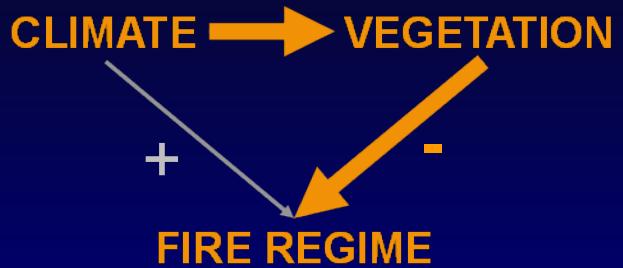
Climate Change

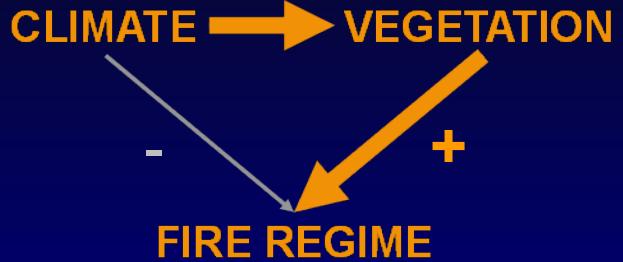






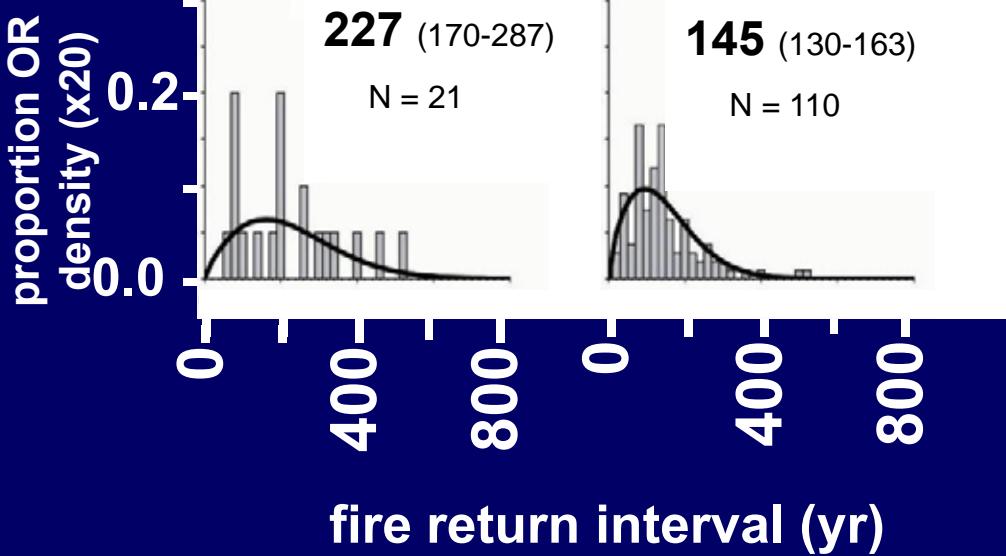






Forest-tundra

Boreal Forest



Forest-tundra

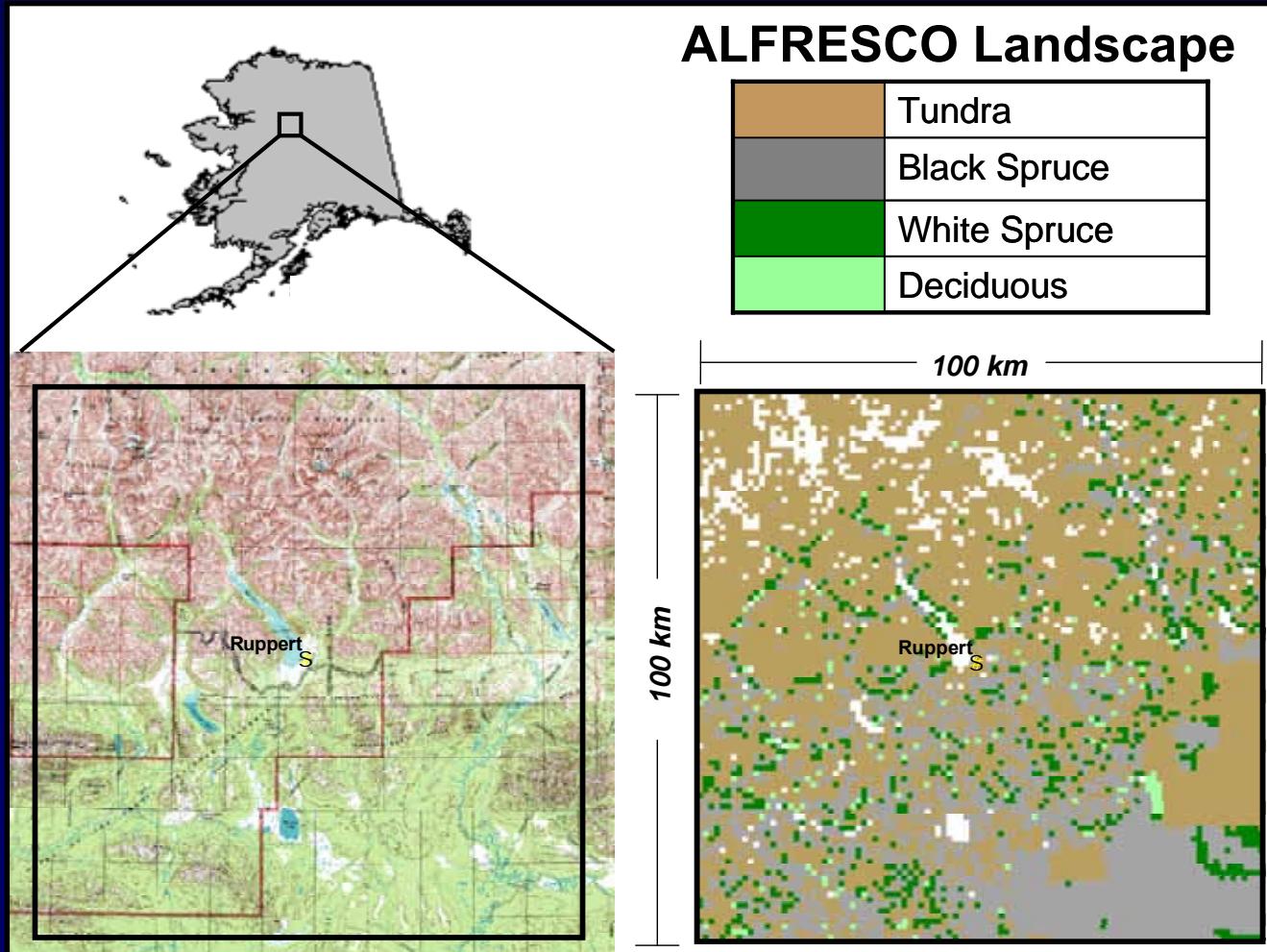


Boreal Forest



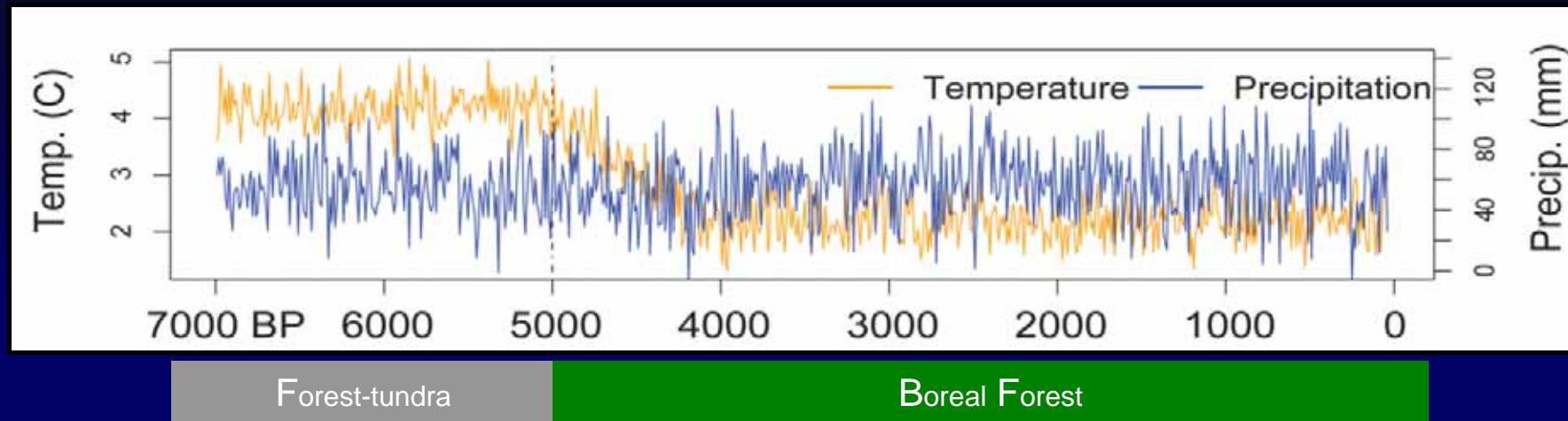
Modeling climate-veg.-fire interactions:

$\text{fire} = f(\text{climate}, \text{vegetation})$

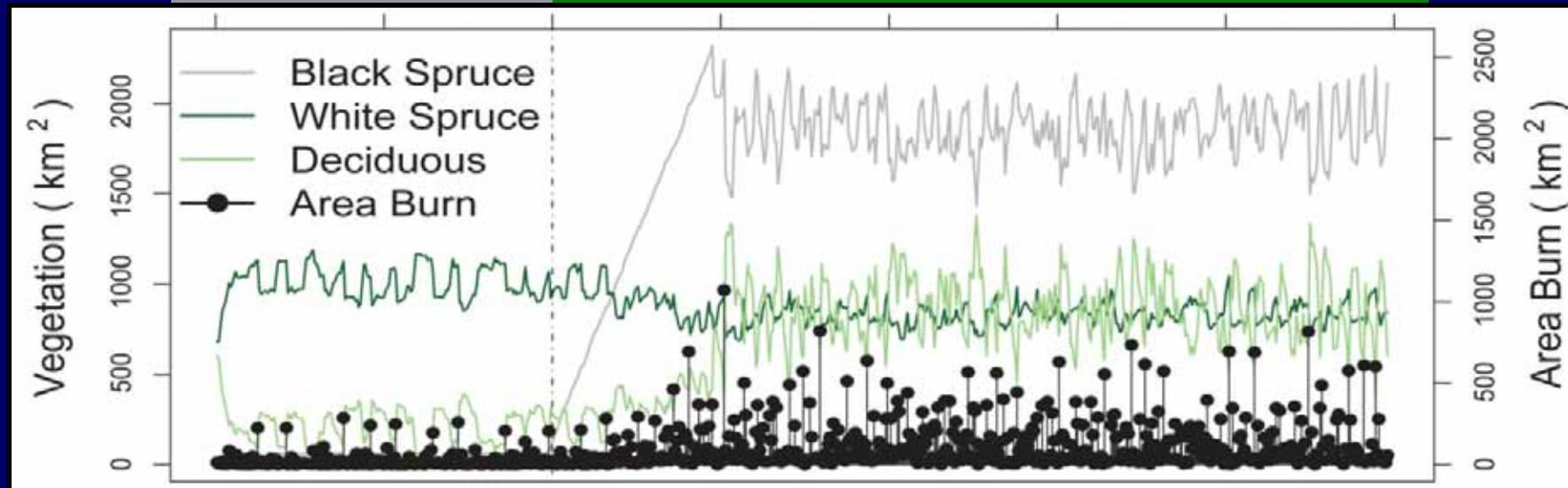


Veg. and climate change required for data-model match

climate

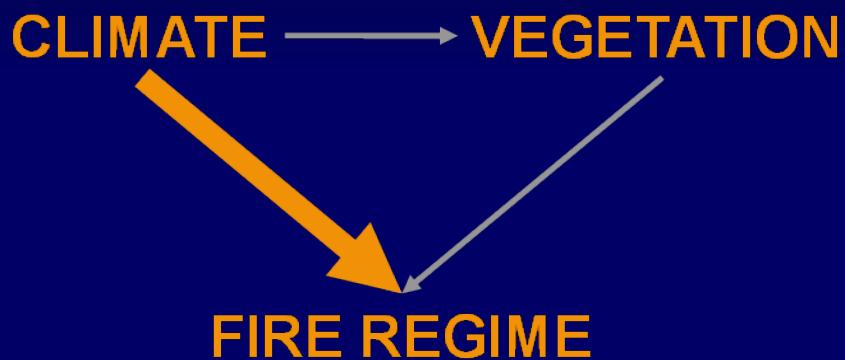


veg. & fire

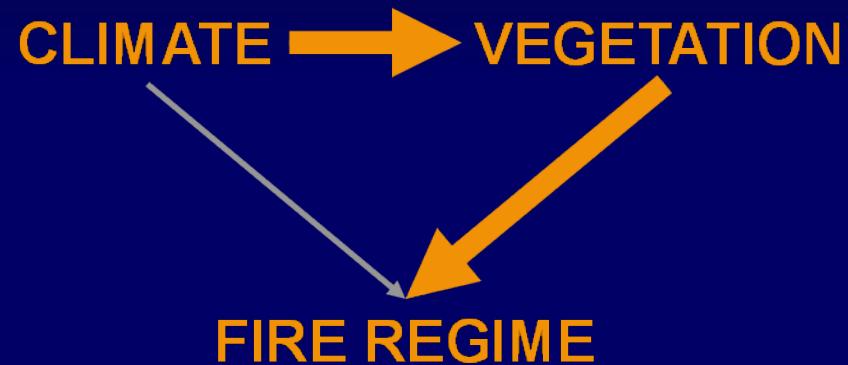


Simulated years before present

As in the past, future fire regimes determined by:



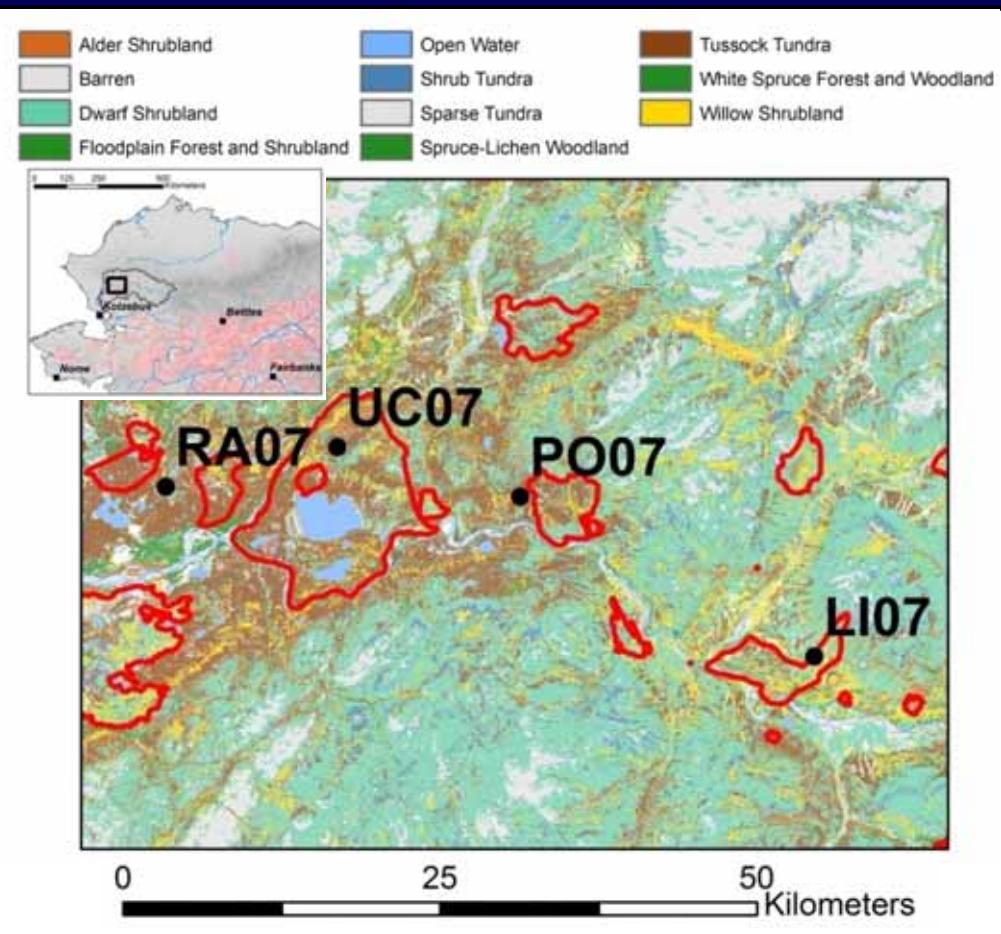
&



- *If fire is limited more by the abundance and/or continuity of fuels, then vegetation change can be more important than climate change.*

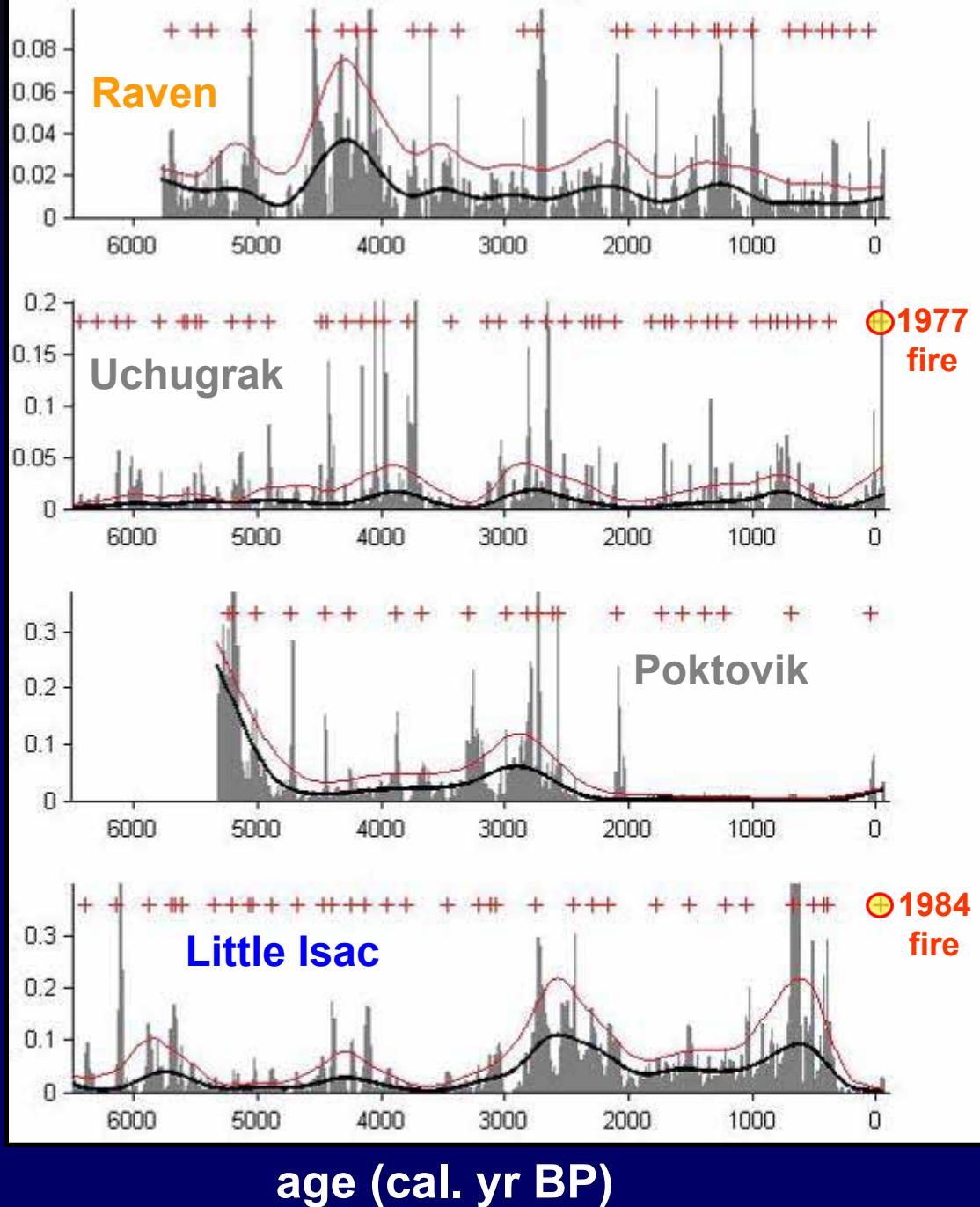
Western Brooks Range, Alaskan tundra

Locally-mediated response to climate change



Raven Lake

CHAR (# $\text{cm}^{-2} \text{yr}^{-1}$)



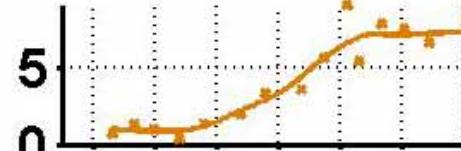
Tundra burns

- Records appropriate for peak identification
- Recent large fires detected

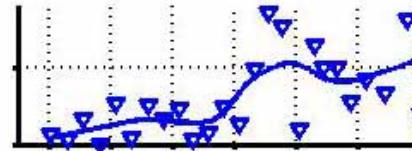
% pollen

Picea

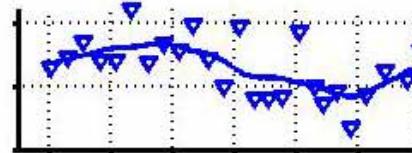
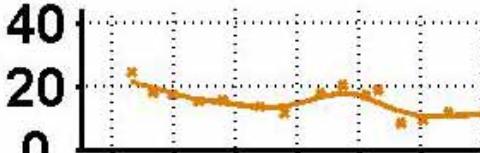
Raven



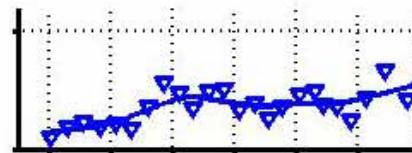
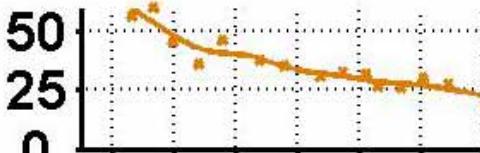
Little Isac



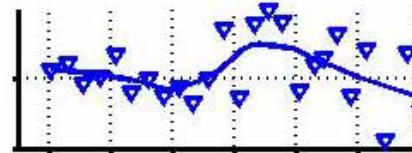
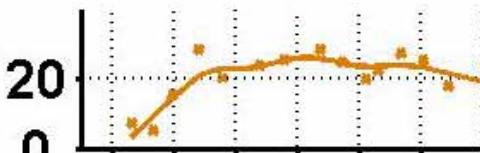
Betula



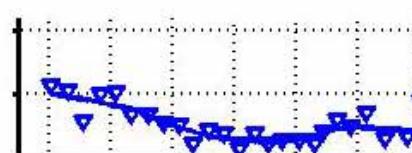
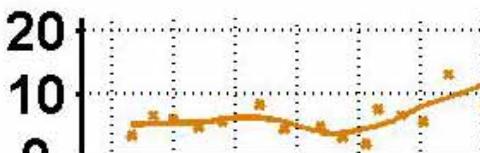
Alnus



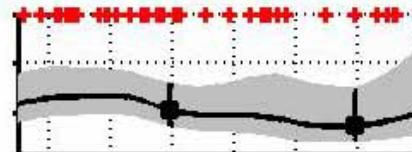
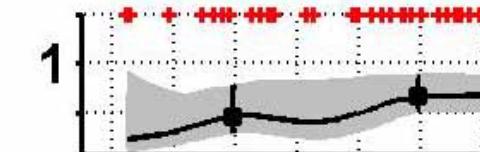
Cyperaceae



Poaceae



Fire frequency
(fires 100-yr⁻¹)

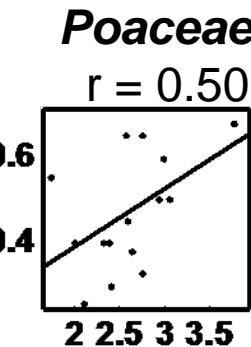
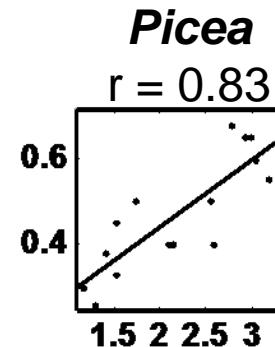


age (cal. yr BP x 1000)

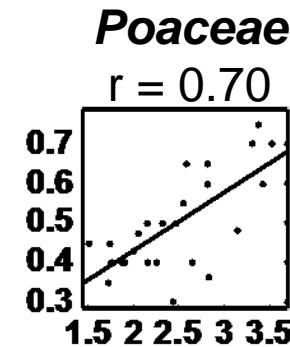
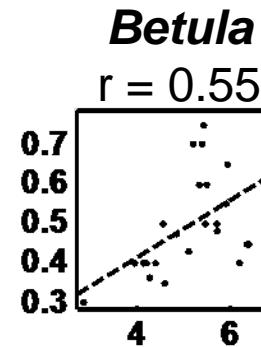
Coherent pattern

Site-specific patterns

Raven

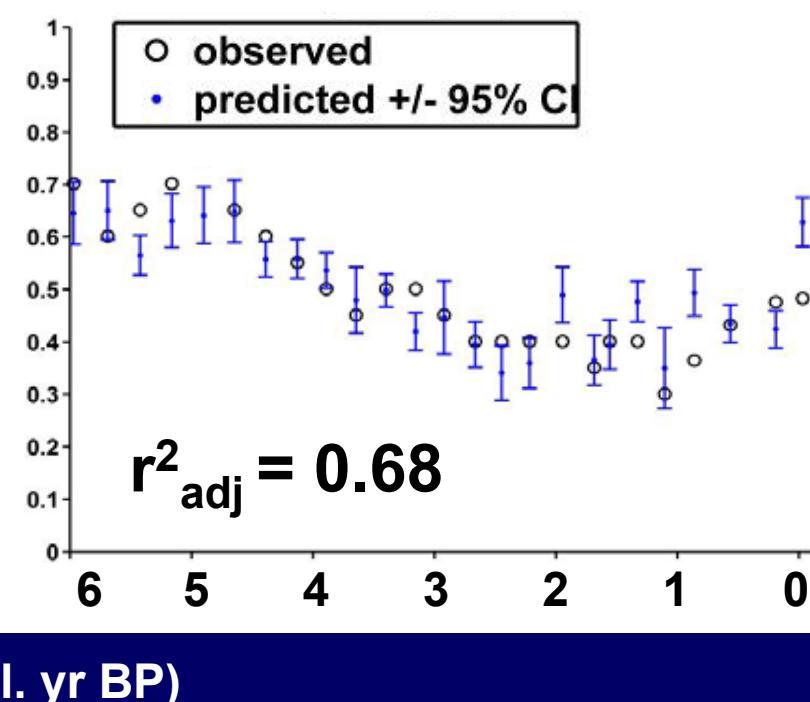
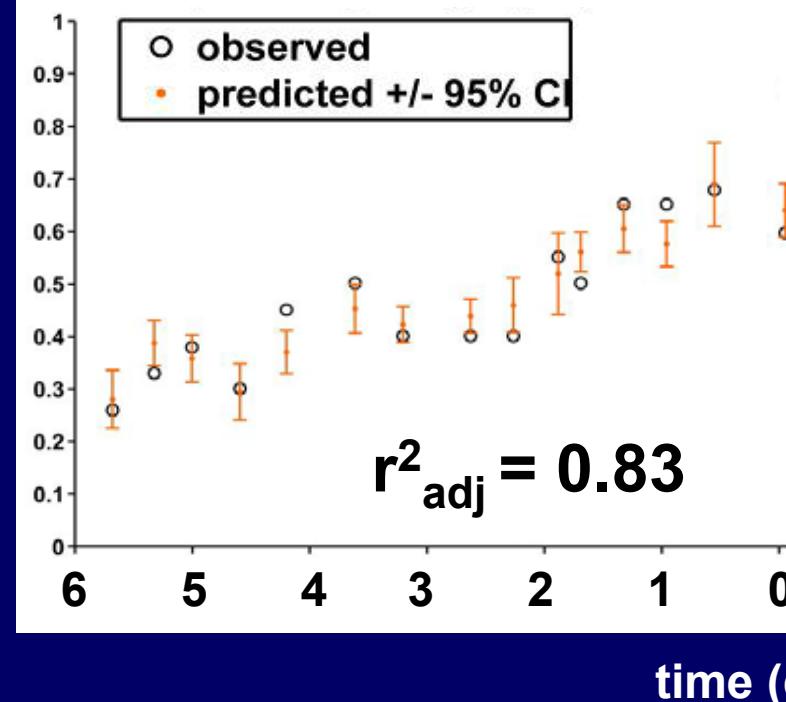


Little Isac

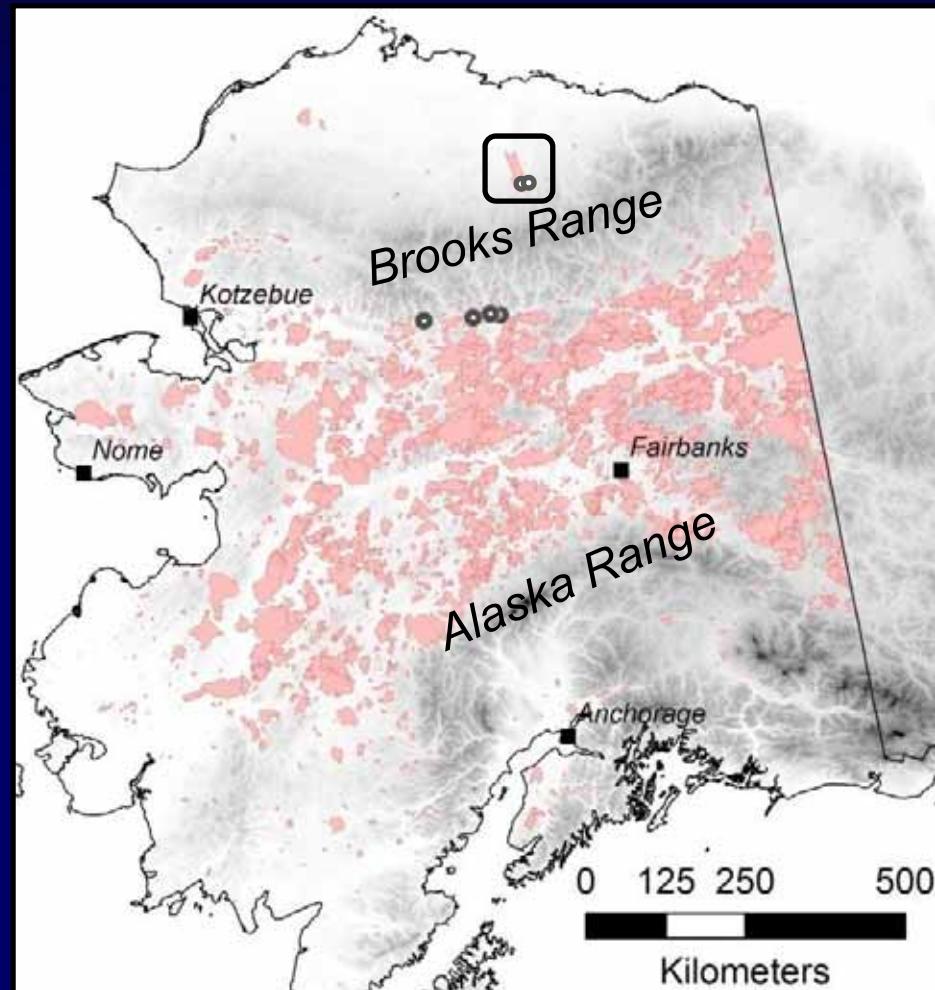


Square root-transformed pollen percentage

2000-yr fire frequency (fires 100 yr⁻¹)

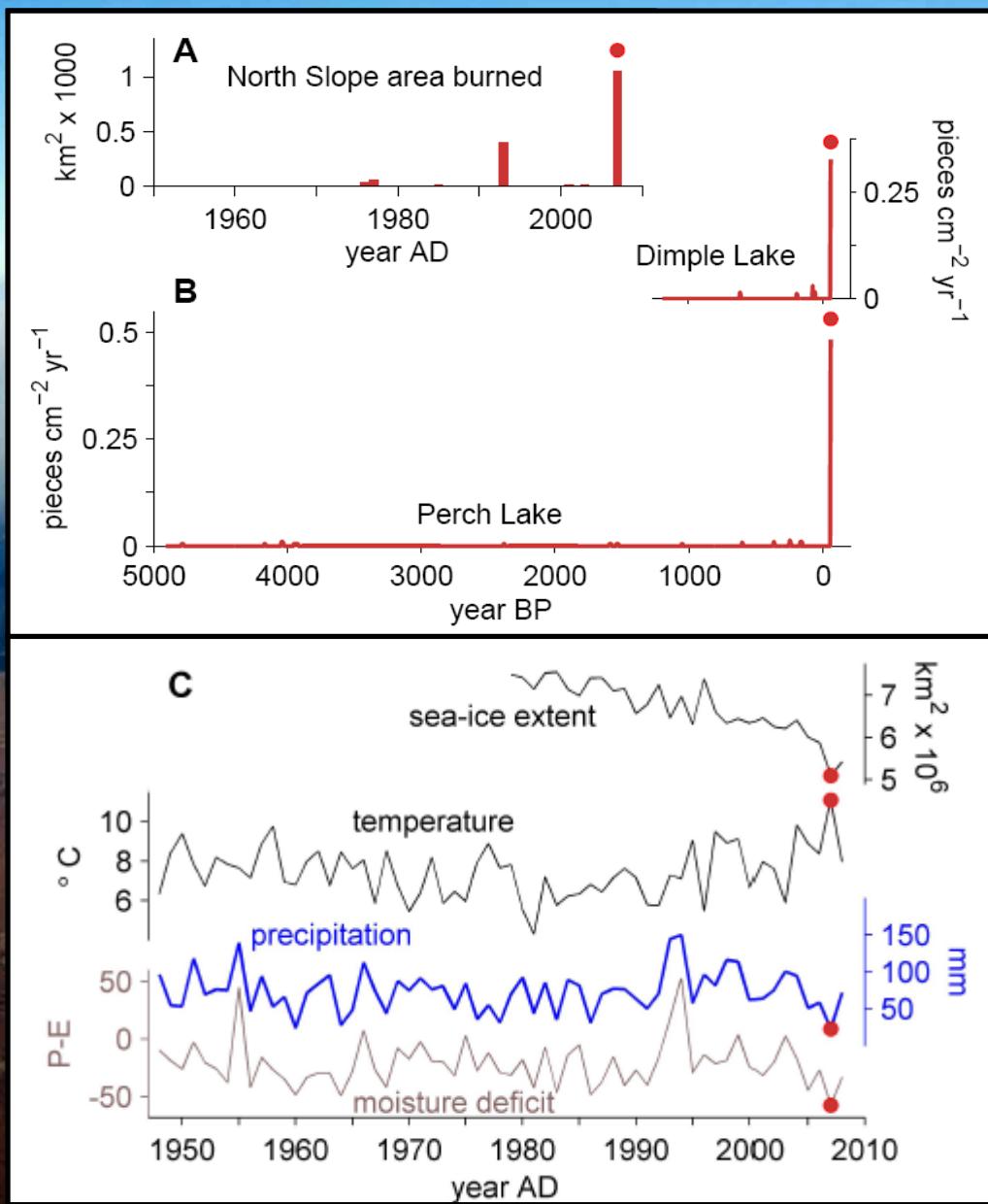


Context for ongoing change



Unprecedented Tundra Burning During Extreme Sea-Ice Retreat

F. S. Hu, P.E. Higuera,
J. E. Walsh, W. L. Chapman,
L. B. Brubaker, M. L. Chipman



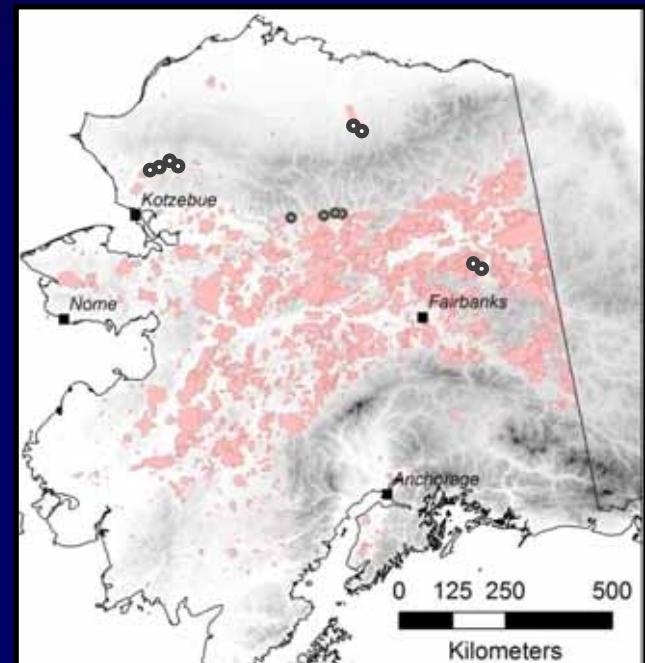
Overview

1. Climate-vegetation-fire interactions

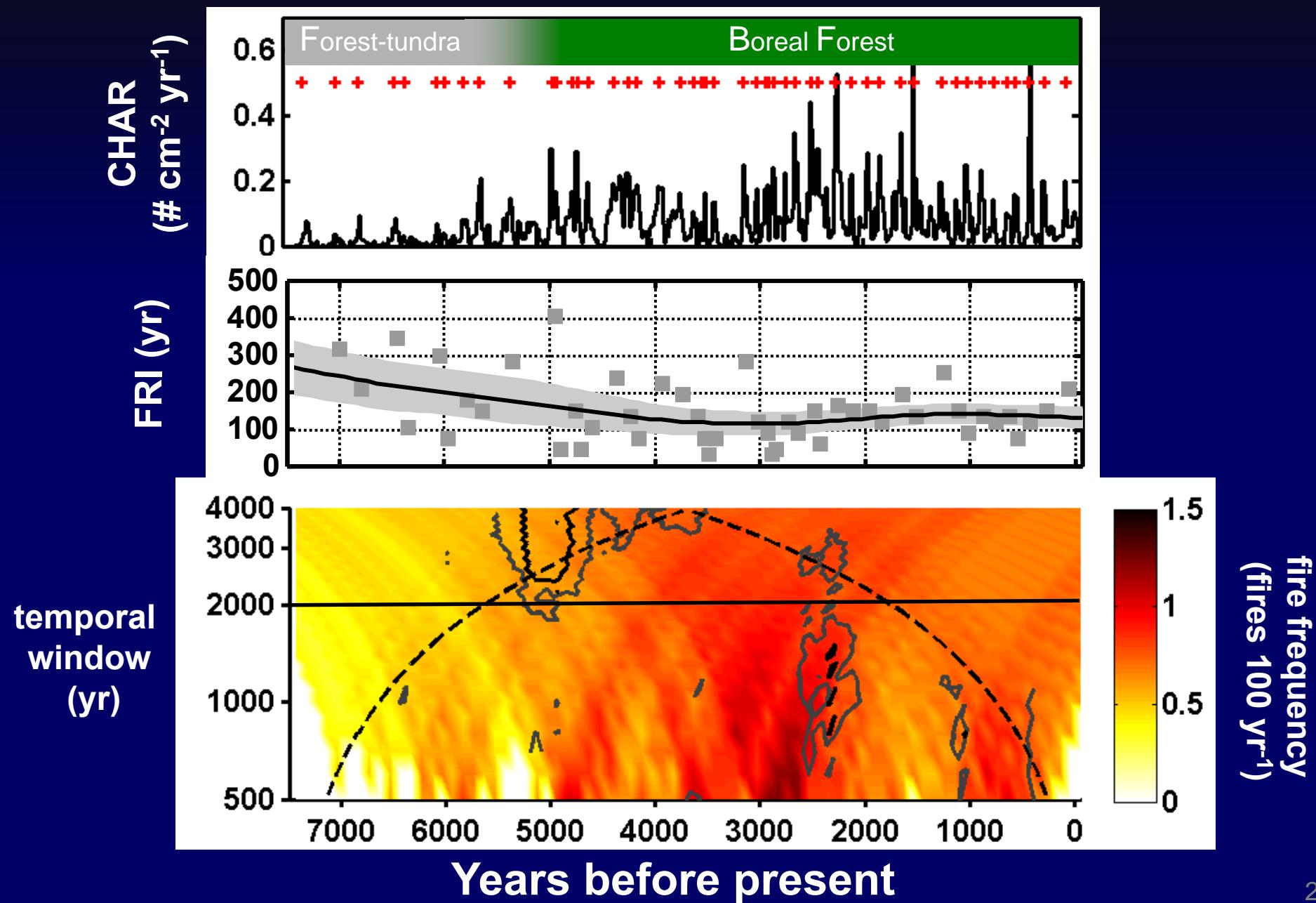
- Reconstructing fire history
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- Defining regimes and detecting change



Temporal scale of fire regimes



Temporal scale of fire regimes

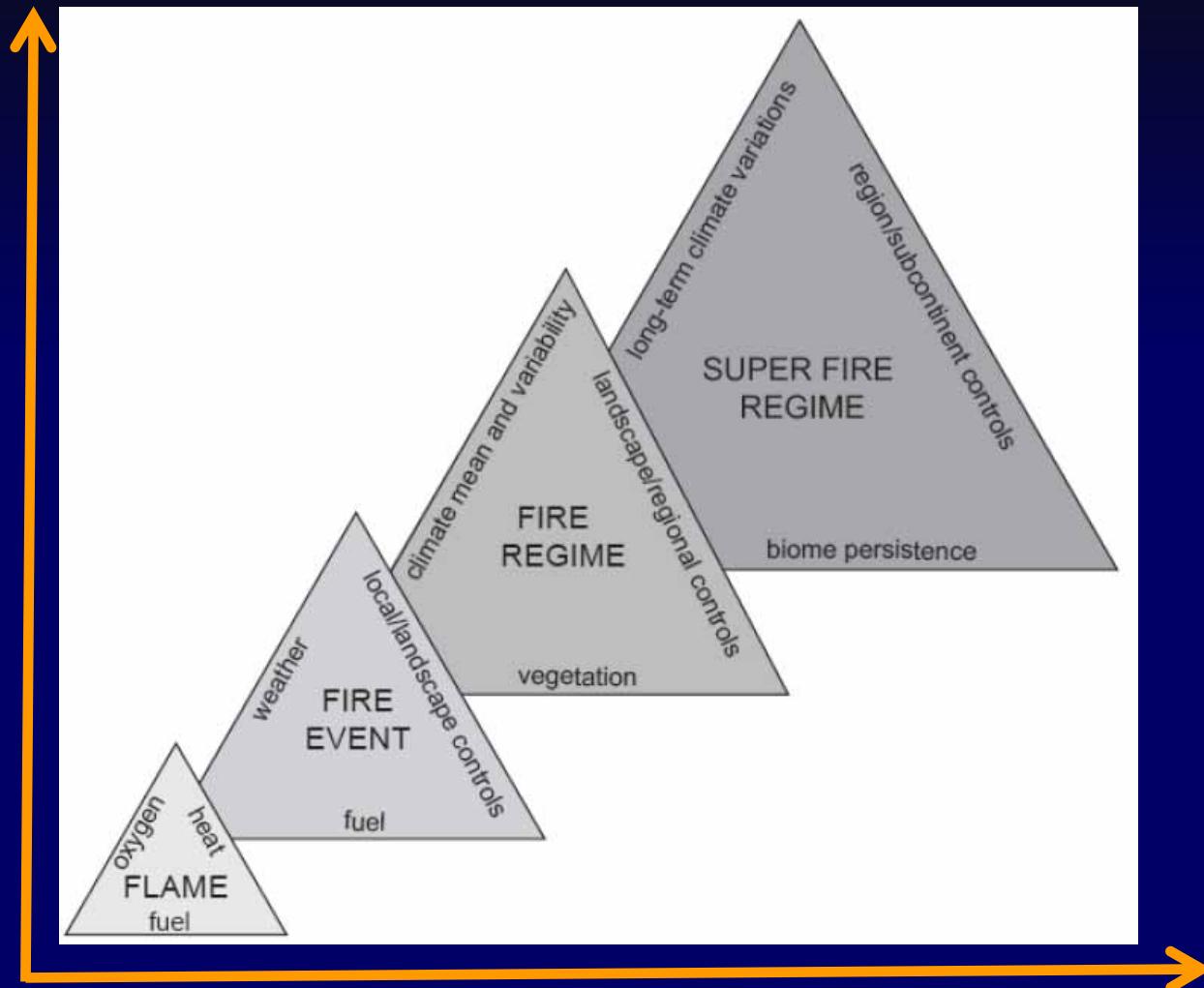
SPACE

Global

Regional

Wildfire

Microsite



Seconds Days Decades Millennia
TIME

Acknowledgments

Collaborators:

- Jennifer Allen, NPS
- Pat Anderson, U of WA
- Tom Brown, LLNL
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- Feng Sheng Hu, U of IL
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Mountains & Minds

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- Christy Briles
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- Ben Clegg
- Jennifer Leach
- Amy Lilienthal
- John Mauro
- NPS personnel
- Kate Shick
- Jason Smith
- Emily Spaulding

Questions?



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