Beyond boreal forests: Holocene fire history in Alaskan tundra ecosystems

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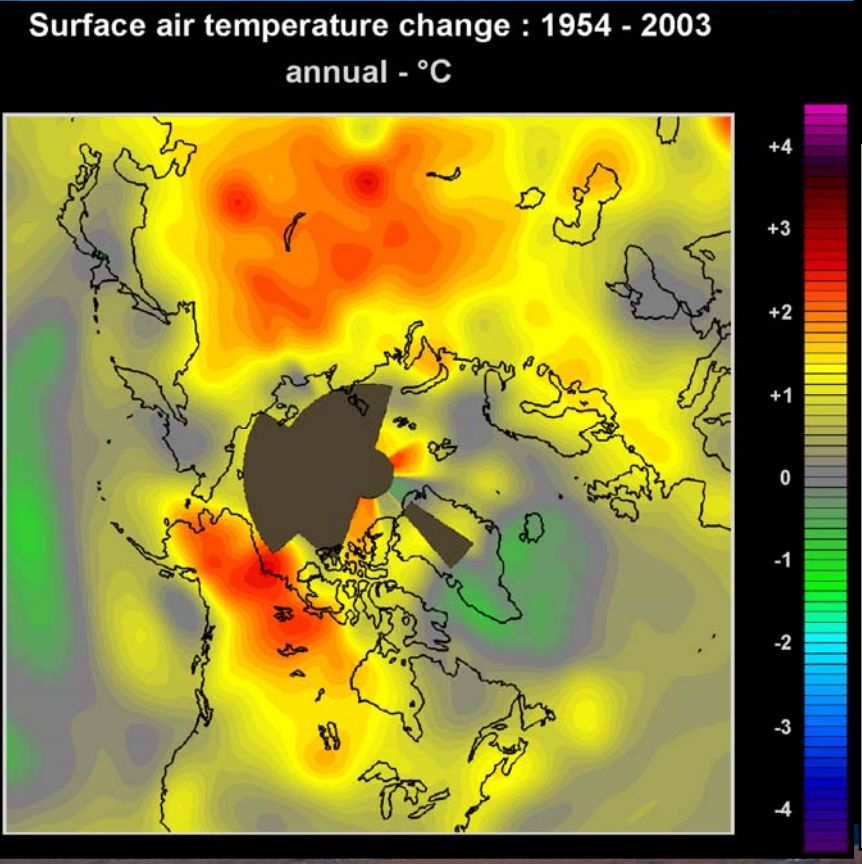
Joint Fire Science Program
Research Supporting Sound Decisions

Photo: Dale Woitas, AFS, BLM



Shrub expansion:

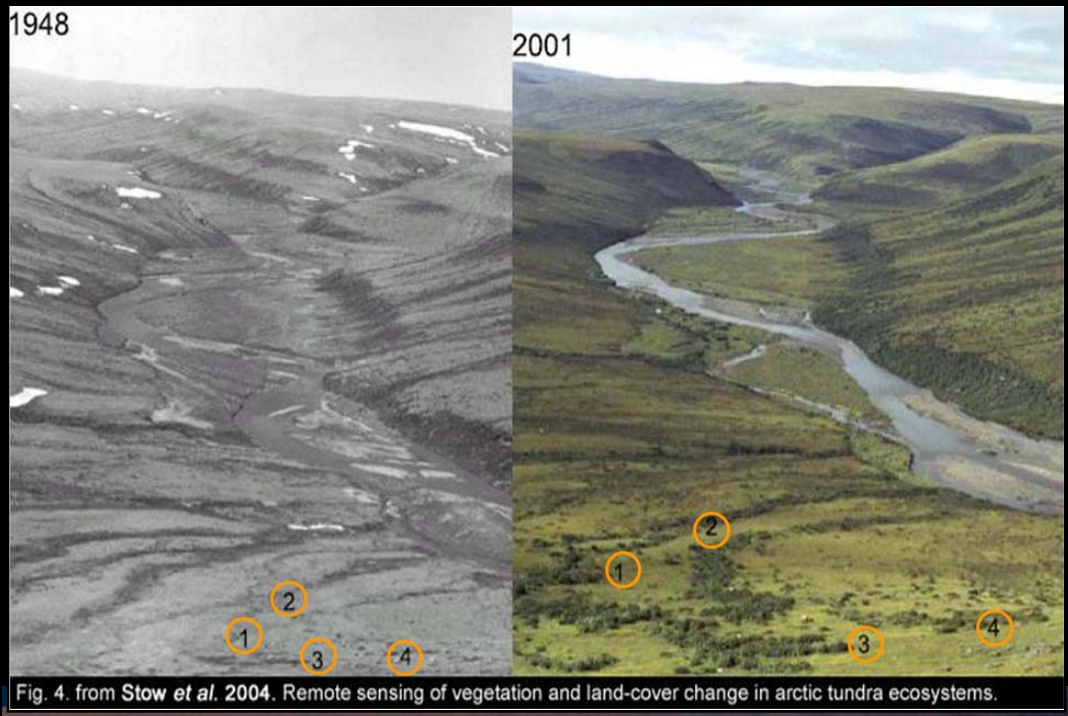
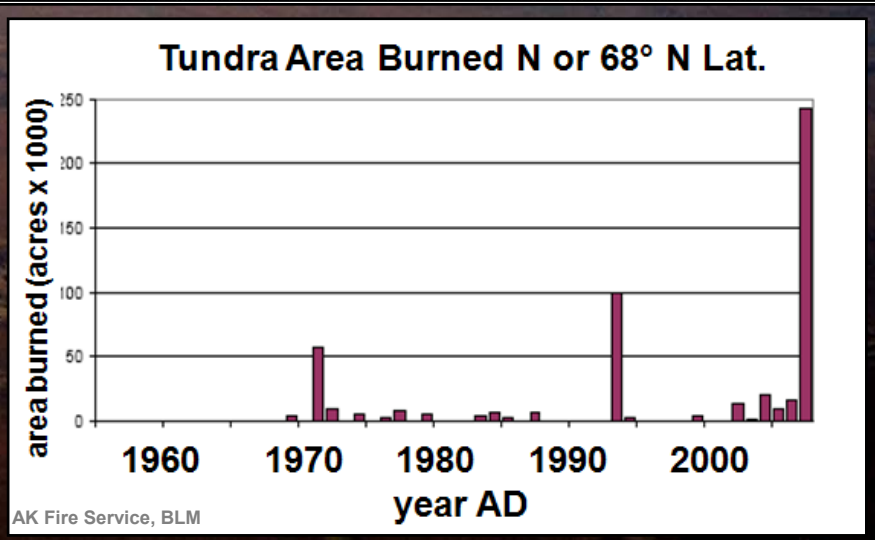


Fig. 4. from **Stow *et al.* 2004.** Remote sensing of vegetation and land-cover change in arctic tundra ecosystems.

- **Will tundra area burned increase?**



W. Chapman , U of IL: http://arctic.atmos.uiuc.edu/CLIMATESUMMARY/2003

Photo: Dale Woitas, AFS, BLM

Paleo Evidence of Frequent Tundra Fires

- **Tundra fire frequencies could increase with shrub abundance and climatic drying**

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Frequent Fires in Ancient Shrub Tundra: Implications of Paleorecords for Arctic Environmental Change

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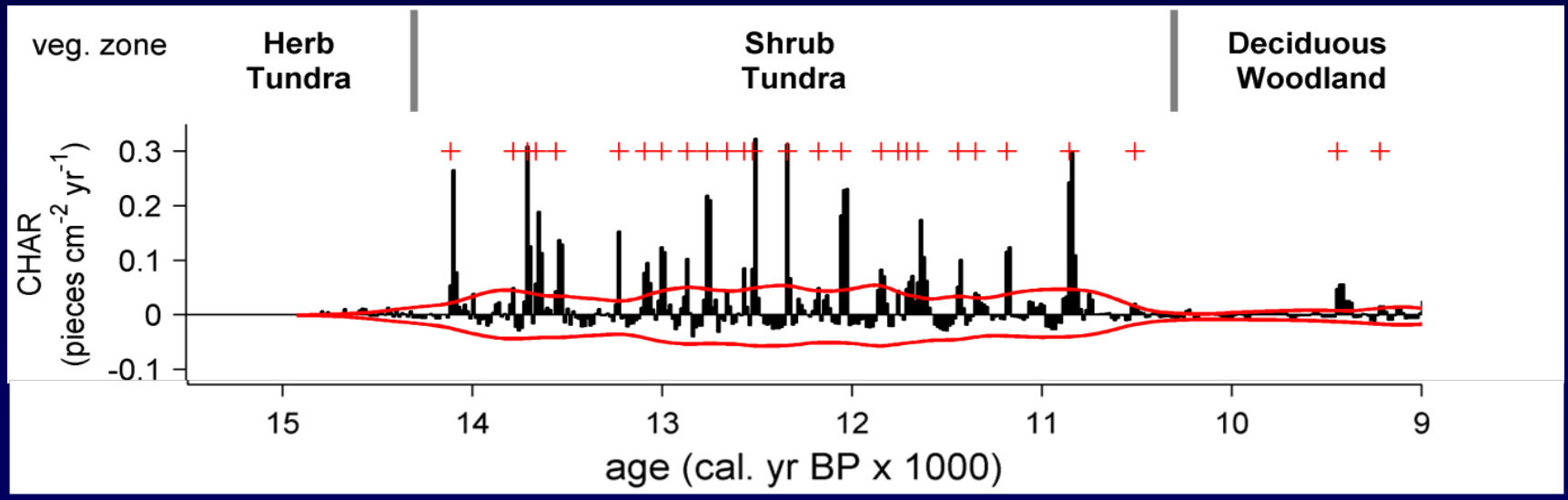
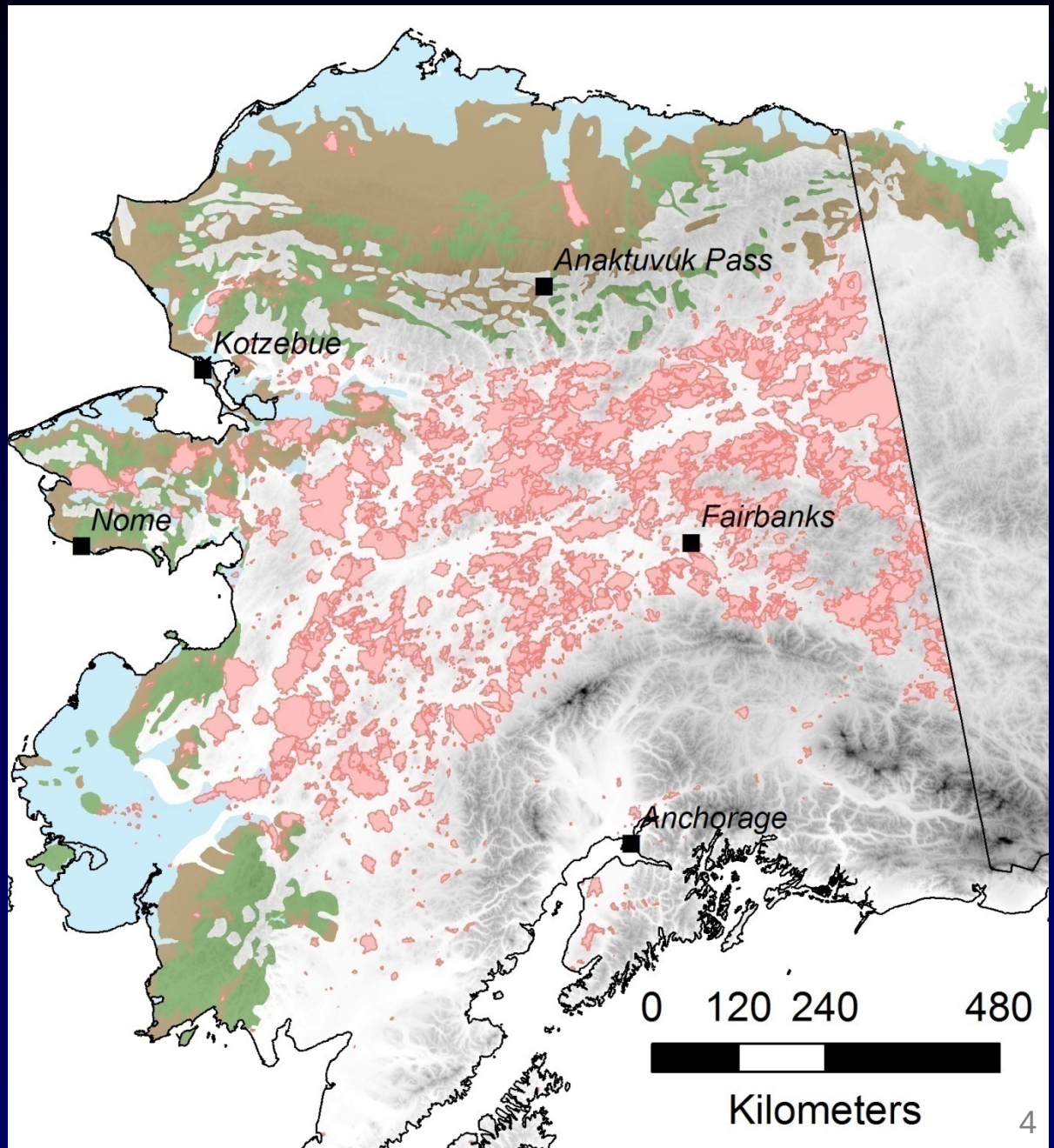


AK Fire History

- ≈ 90% area burned in boreal forest
- > 1.8 million ha burned in tundra
- 1332 citations: "boreal forest + fire"
- 139 citations: "tundra + fire"



II. Objectives

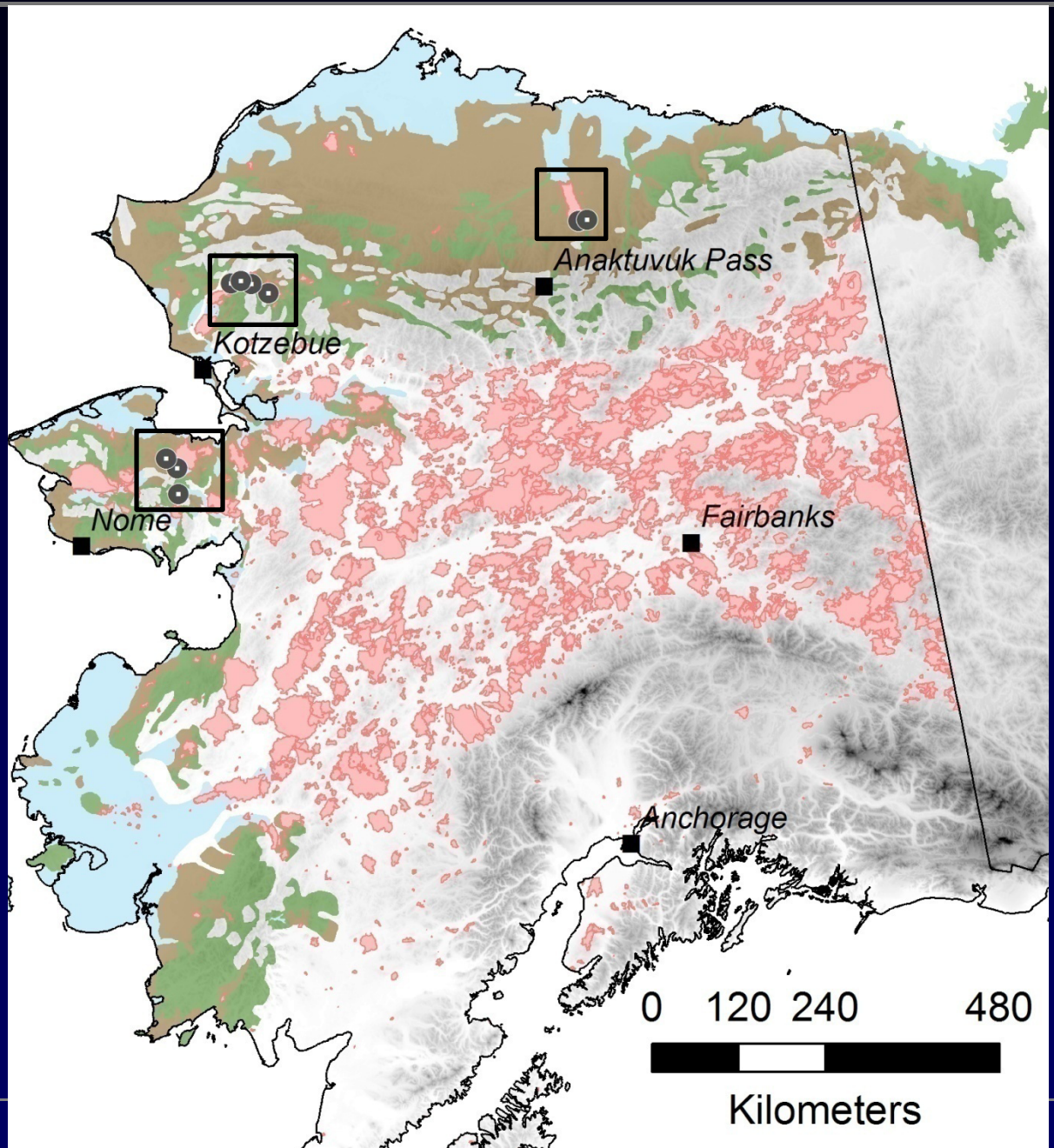
1. Quantify tundra fire history over the past 6000 years

2. Infer climate-vegetation-fire relationships from pollen and independent paleocliamte records

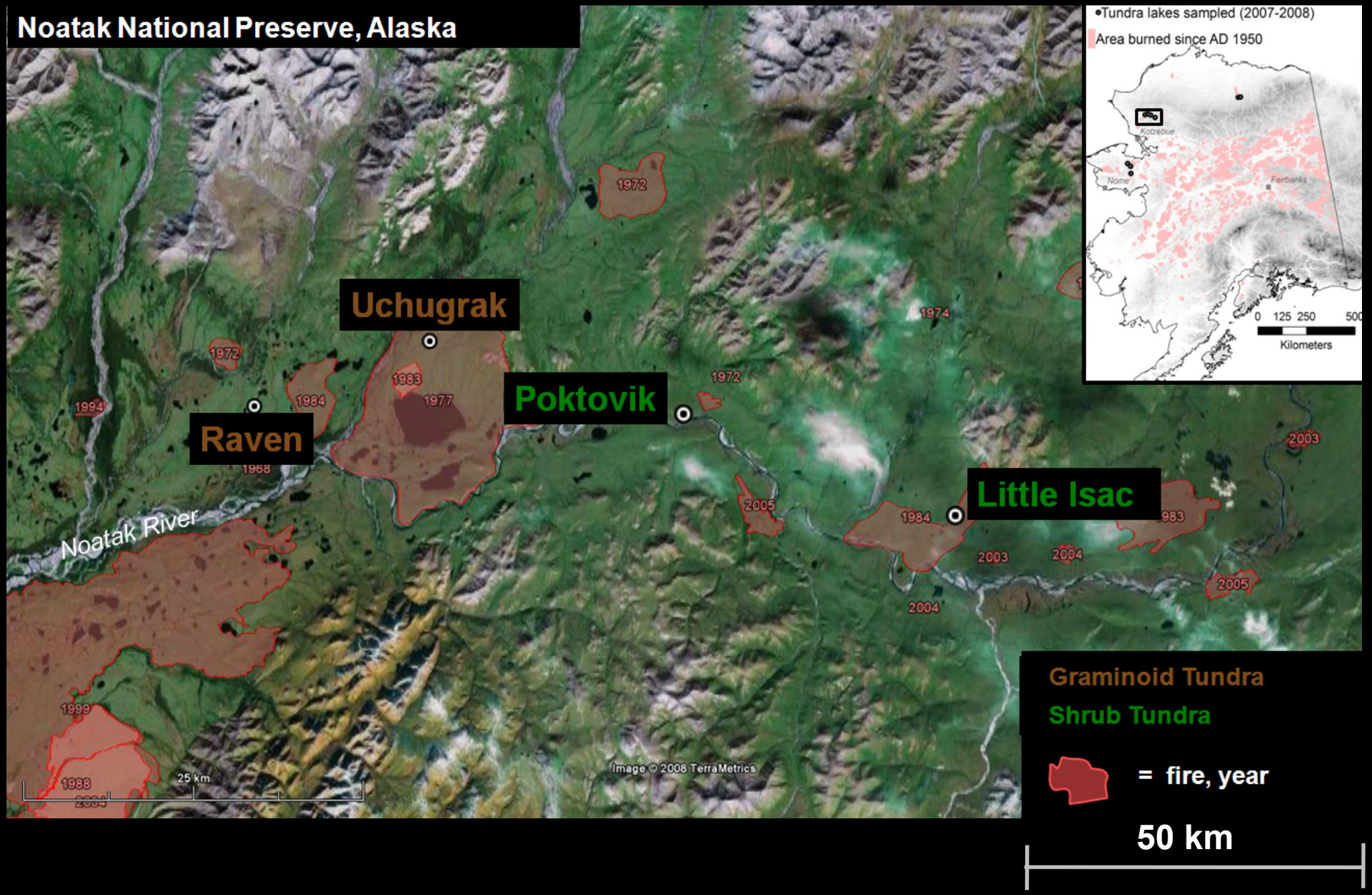
3. Inform ecosystem model (ALFRESCO) for assessing fire and fuels hazards in tundra under future climate / veg.

III. Study Design

- **Noatak NP**
  - **graminoid**
  - **shrub**
- Bering Land Bridge NP
  - **graminoid**
  - **shrub**
- Anaktuvuk River Fire



Noatak Study Area



Noatak Study Area

Graminoid Tundra:

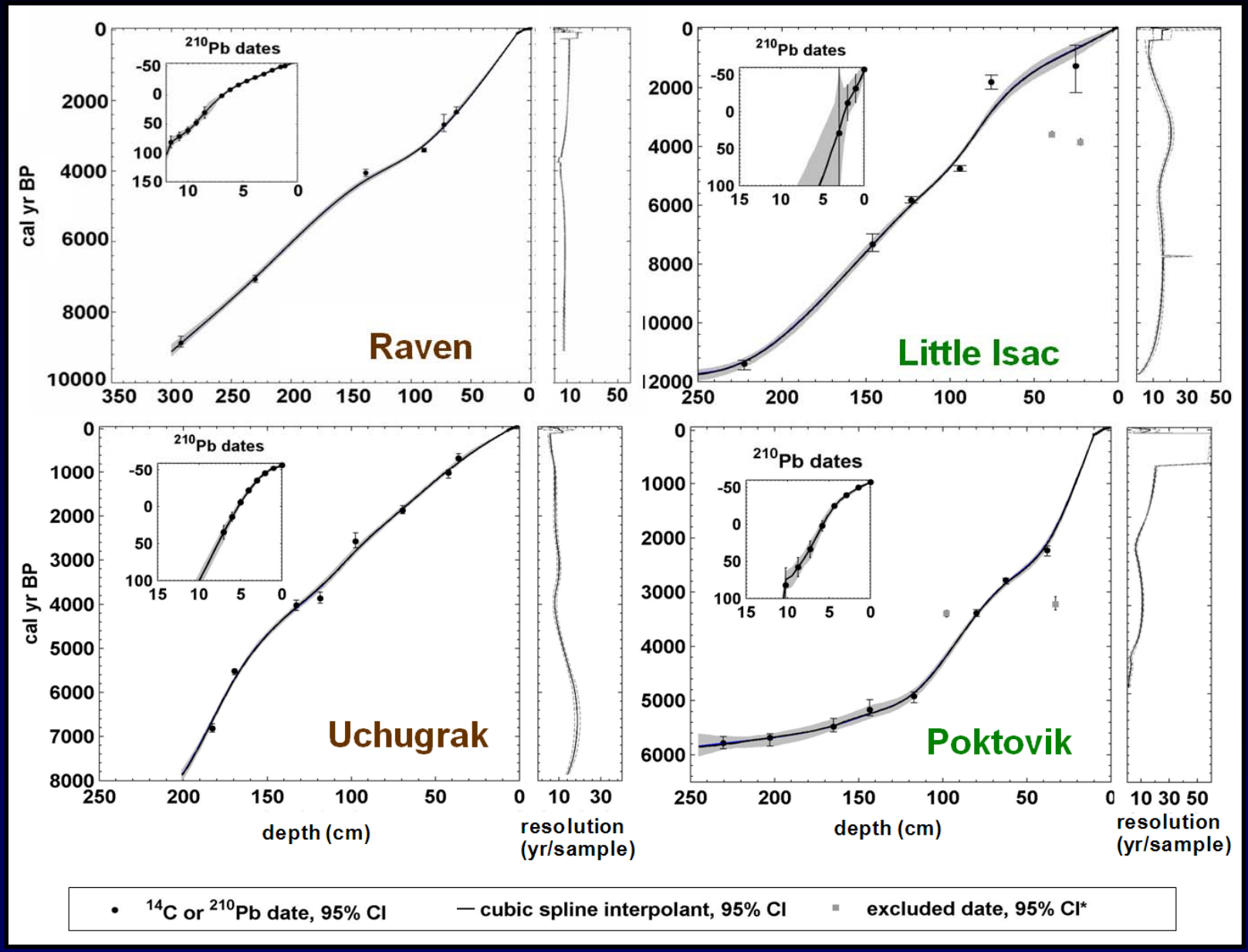
Cyperaceae , Poaceae, dwarf shrubs

Shrub Tundra:

Betula, Alnus, Salix

IV. Tundra Fire History

Age Models



age (cal. yr BP)

depth (cm)

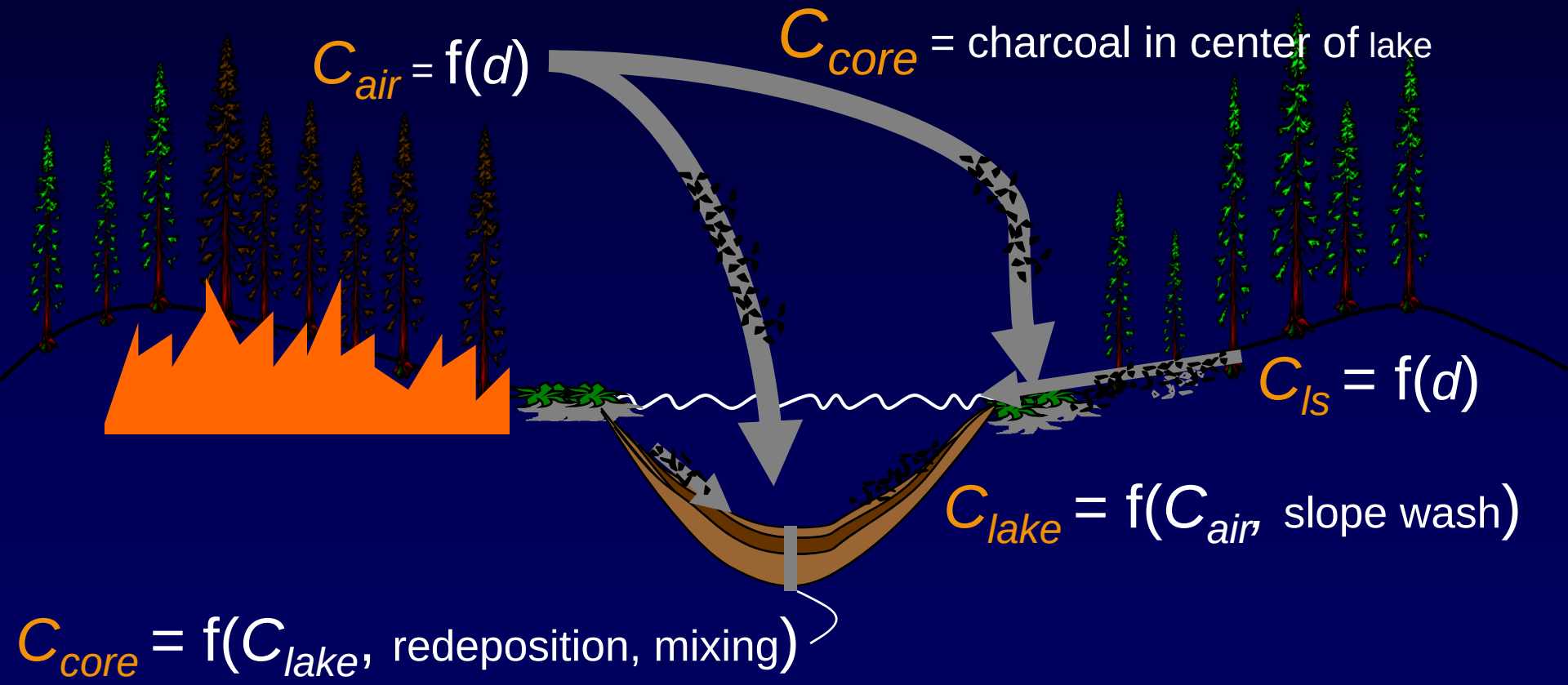
Fire History from Sed. Charcoal

C_{air} = airborne fallout of charcoal

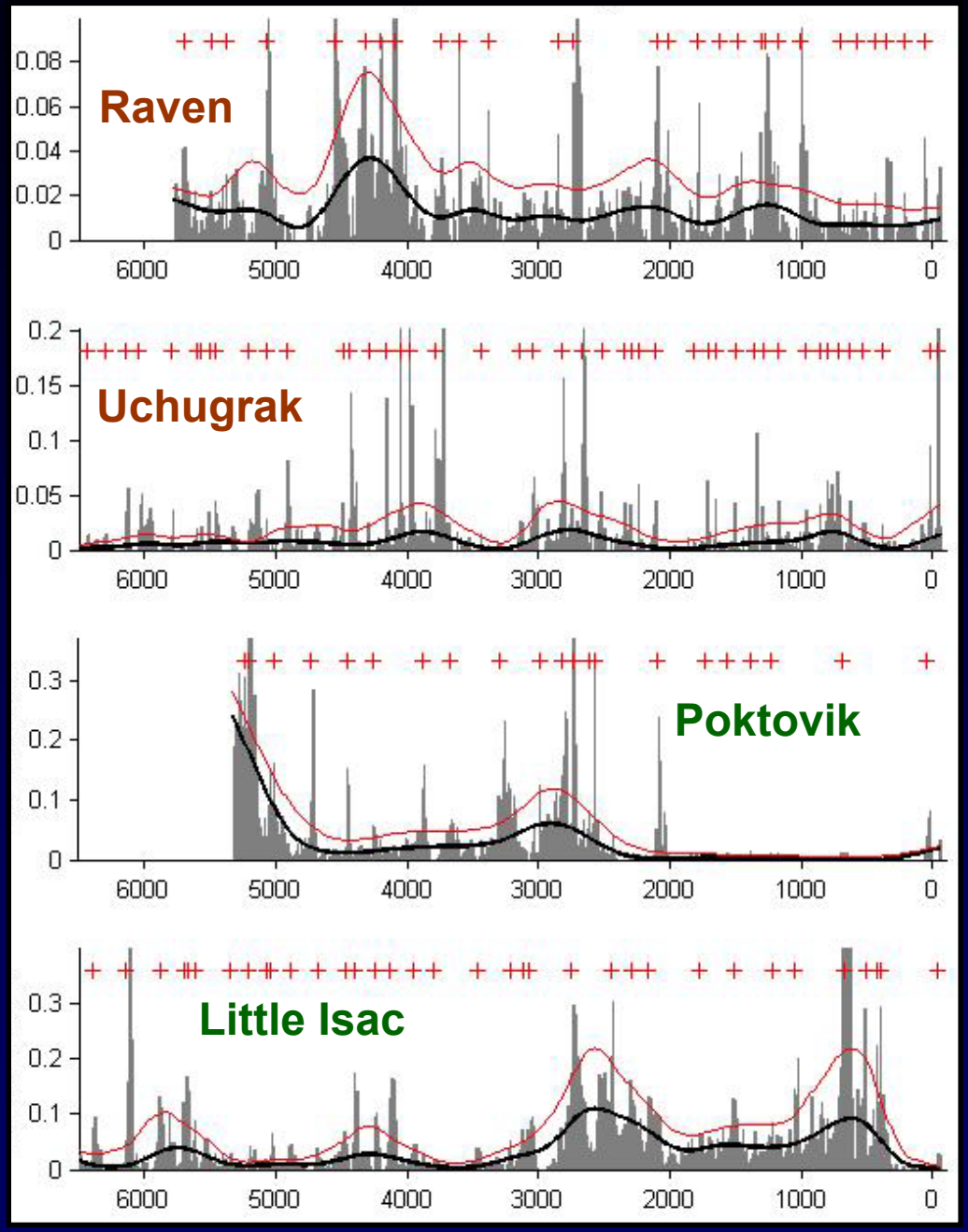
C_{ls} = charcoal on landscape surface

C_{lake} = charcoal on lake surface

C_{core} = charcoal in center of lake

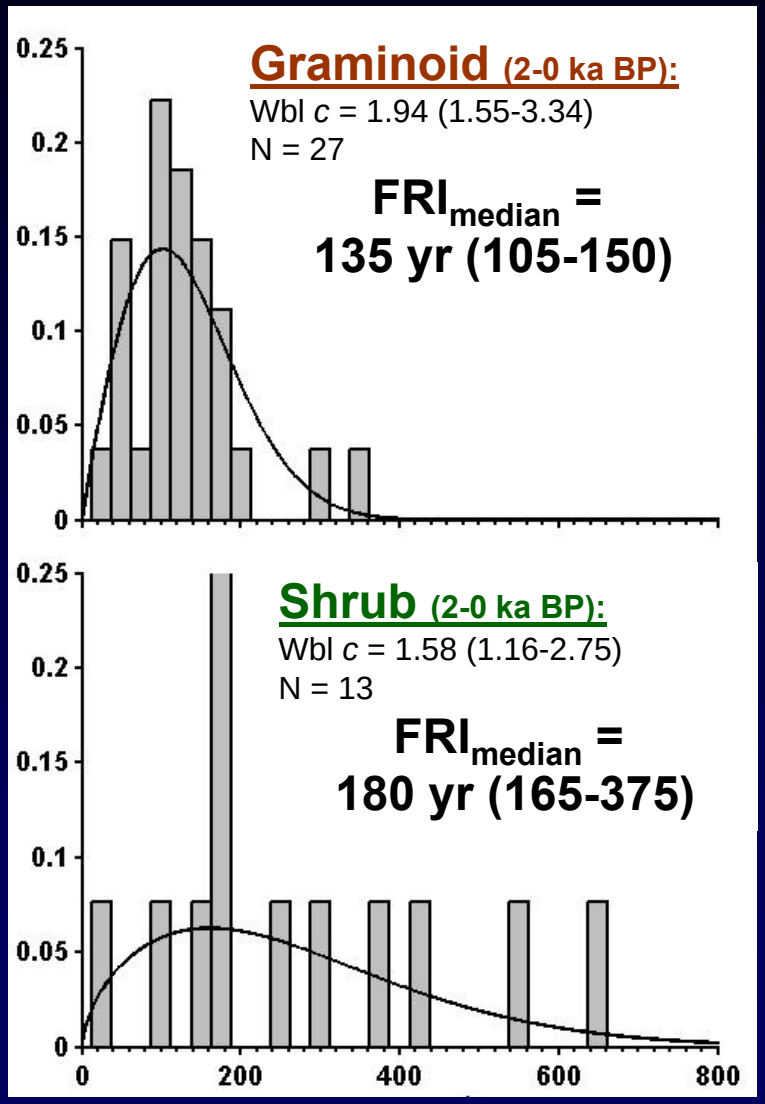


Higuera et al., 2007, Quaternary Science Reviews. Peters and Higuera, 2007 Quaternary Research



1. Tundra burns

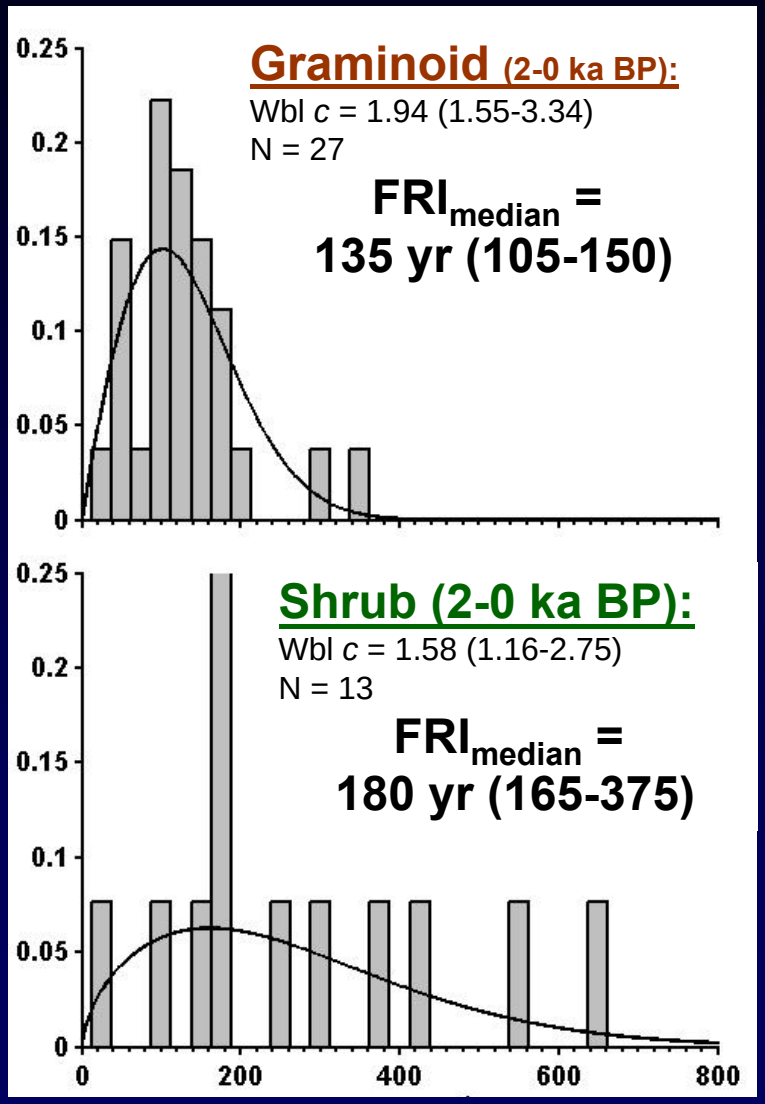
- Records appropriate for peak identification
- Recent large fires detected



2. Location matters:

- vegetation

Fire regimes of the last 2000 years

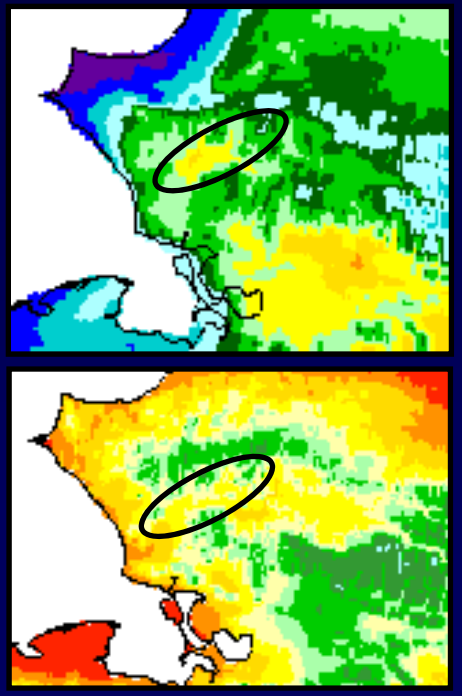


2. Location matters:

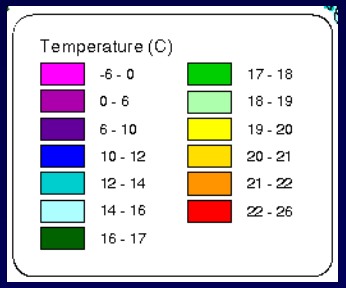
- vegetation

  and/or

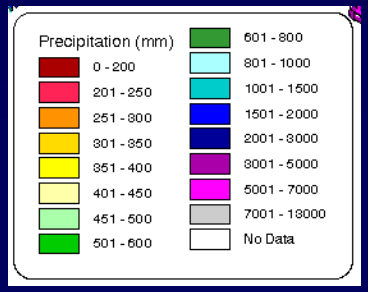
- climate



July max Temp.



Ann. Precip.



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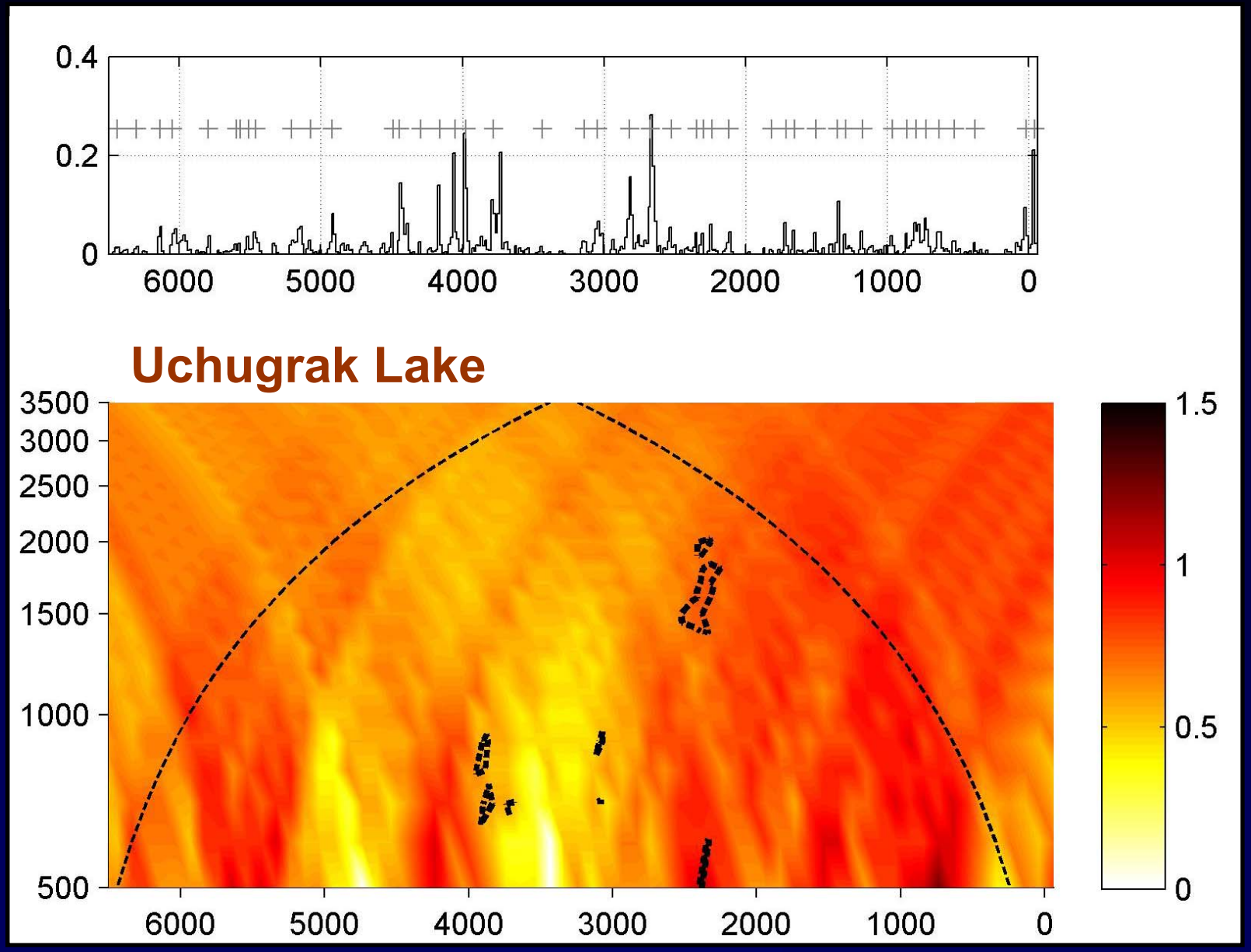
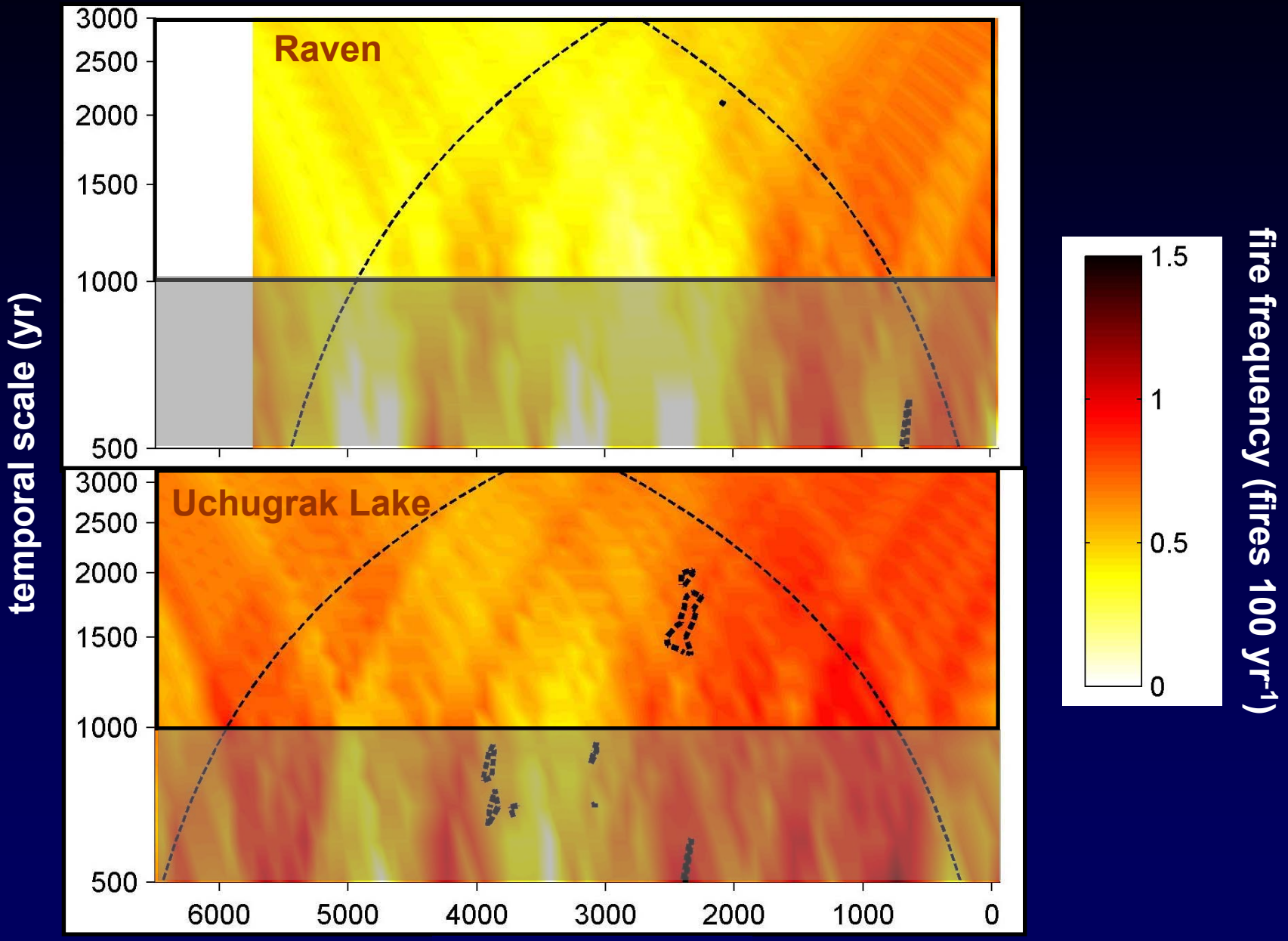
Temporal Scales of Change

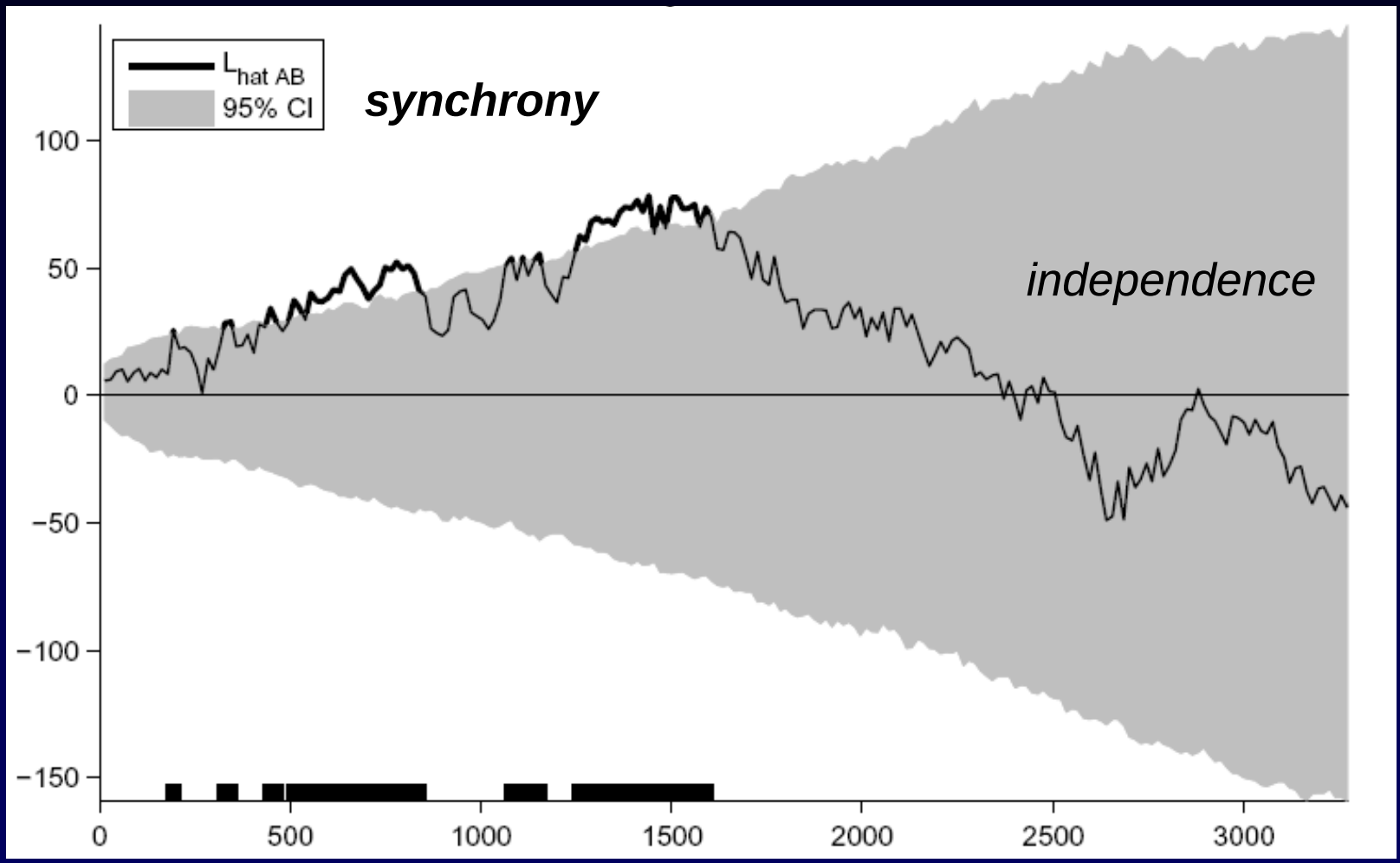


Temporal Scales of Change



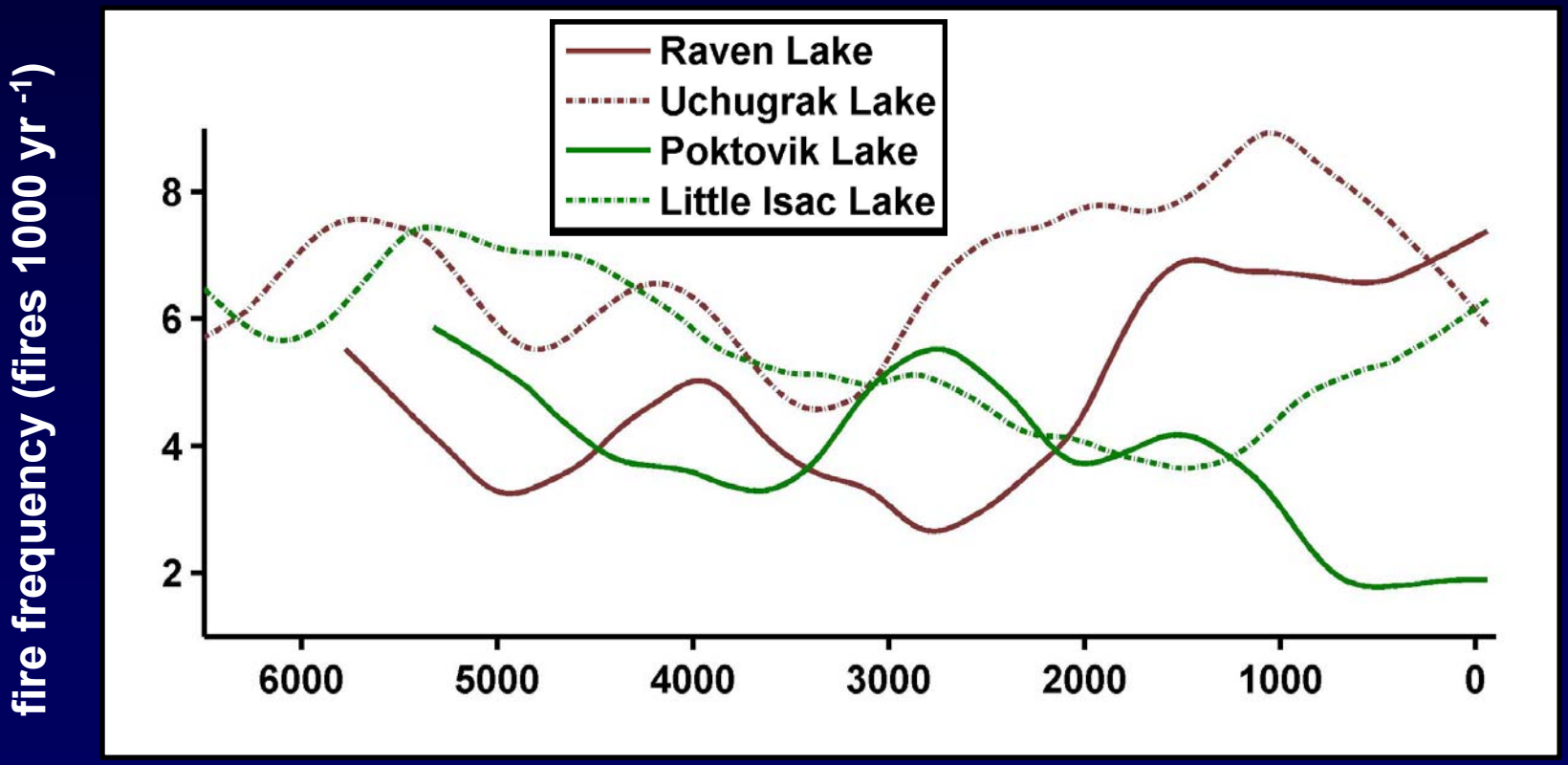
Millennial-scale synchrony

Raven-Uchugrak: 6.5-0 ka BP

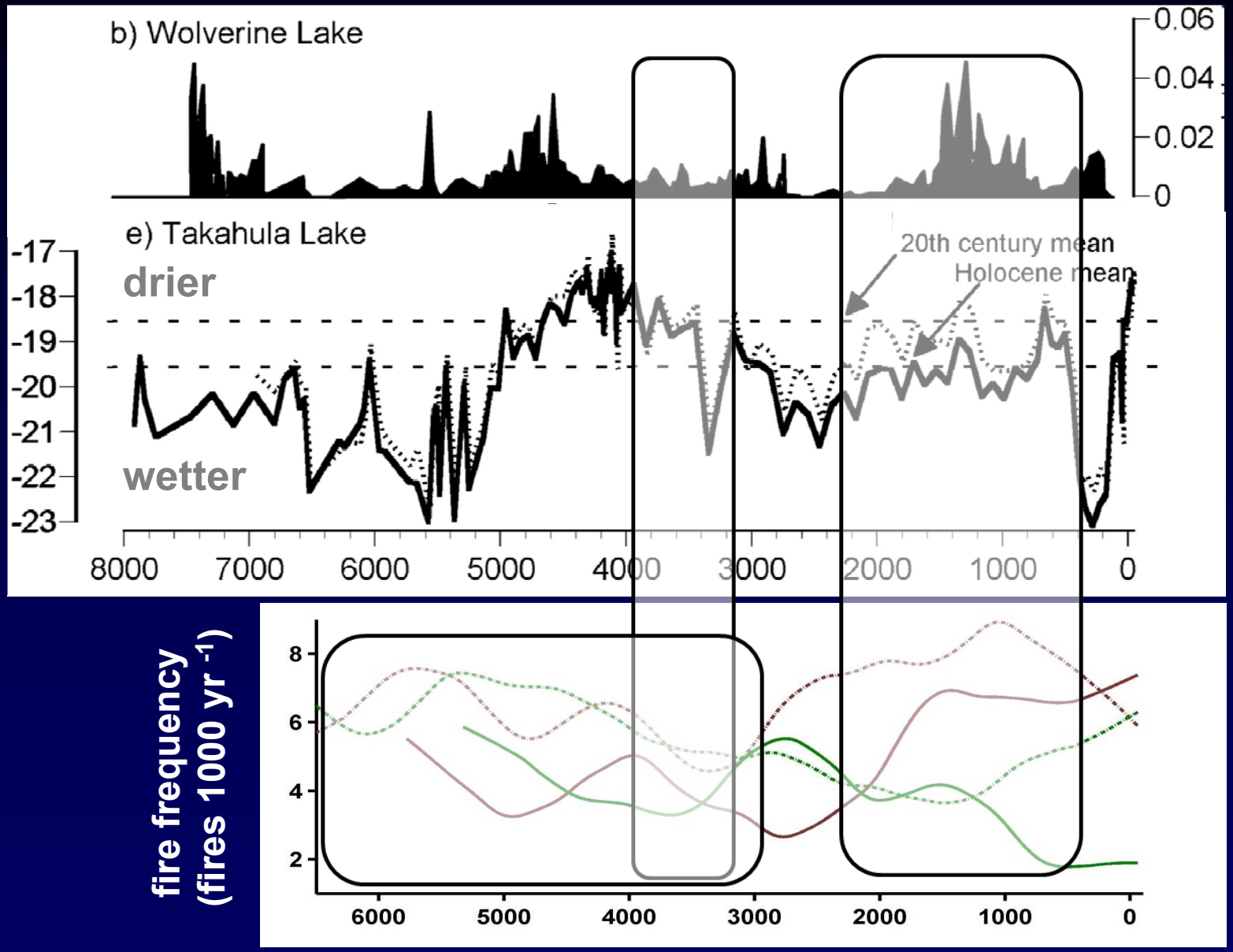


2. Synchrony suggests climatic controls:

- Raven-Uchugrak: 6.5-0 ka BP
- Poktovik-Little Isac: 6.5-0 ka BP
- Raven-Uchugrak-Little Isac: 6.5-3.0 ka BP



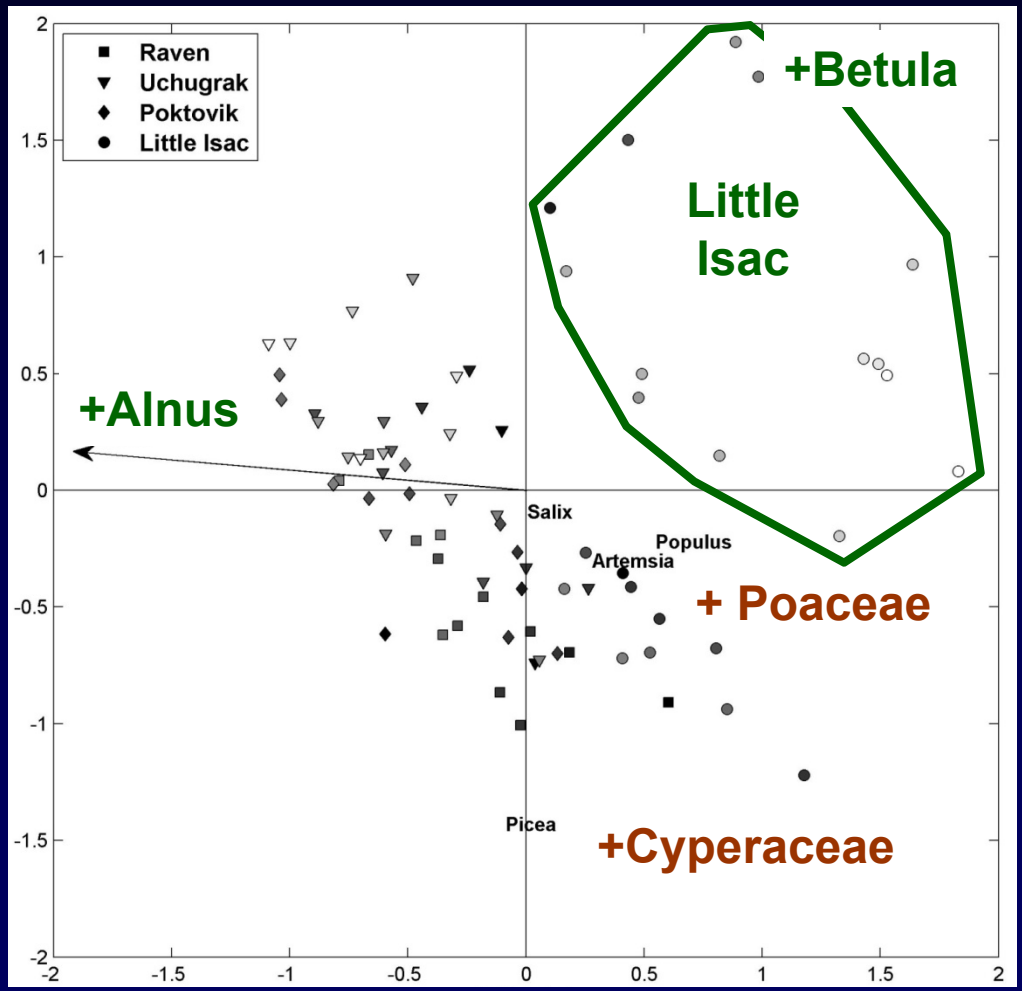
Brooks Range Relative Moisture



Mann et al. 2002, QSR; Clegg and Hu in review

4. Role of vegetation dependent on climate:

- shrub tundra more flammable in drier climate



V. Conclusions

1. Sediment charcoal reveals that tundra can burn as frequently as boreal forest

2. Synchronous changes and paleorecords suggest climate and possibly vegetation drivers of tundra fire regimes

3. Tundra fire regimes should be sensitive to ongoing environmental change

Acknowledgements and Questions

Funding: Joint Fire Science Program and the National Park Service.

Field Assistance: Denali National Park fire personnel

Lab Assistance: Triet Vuong and Jennifer Schwarz

Poktovik Lake, 11:30 pm, June 19th