Reconstructing tundra fire regimes to inform a management-oriented ecosystem model

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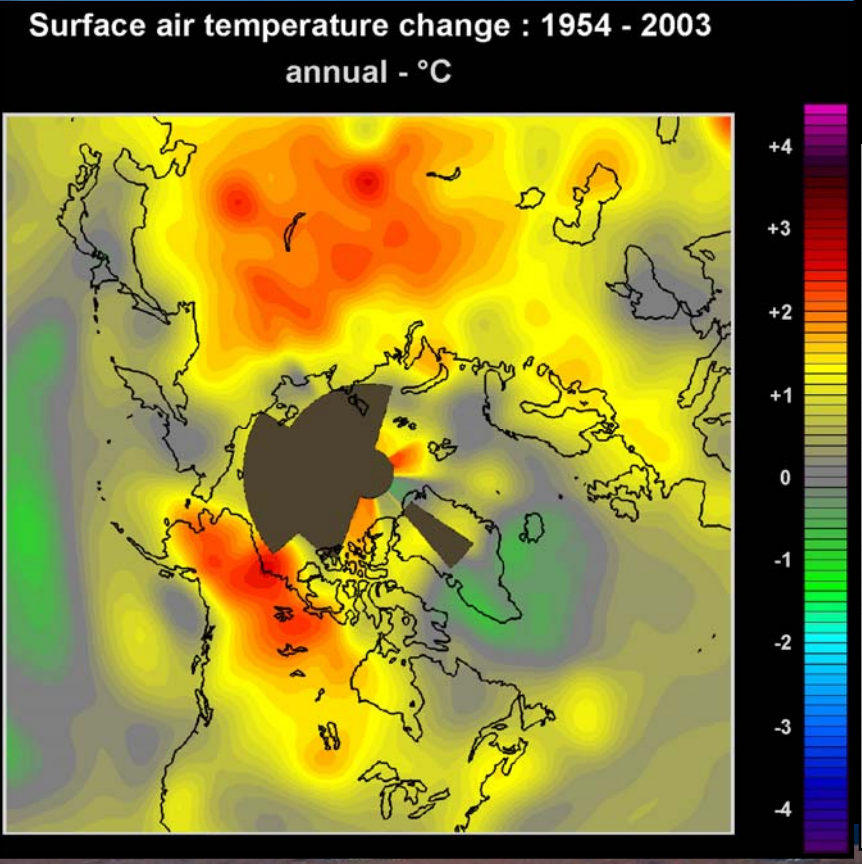
Joint Fire Science Program

Research Supporting Sound Decisions

Photo: Shan H. Pilot



Shrub expansion:

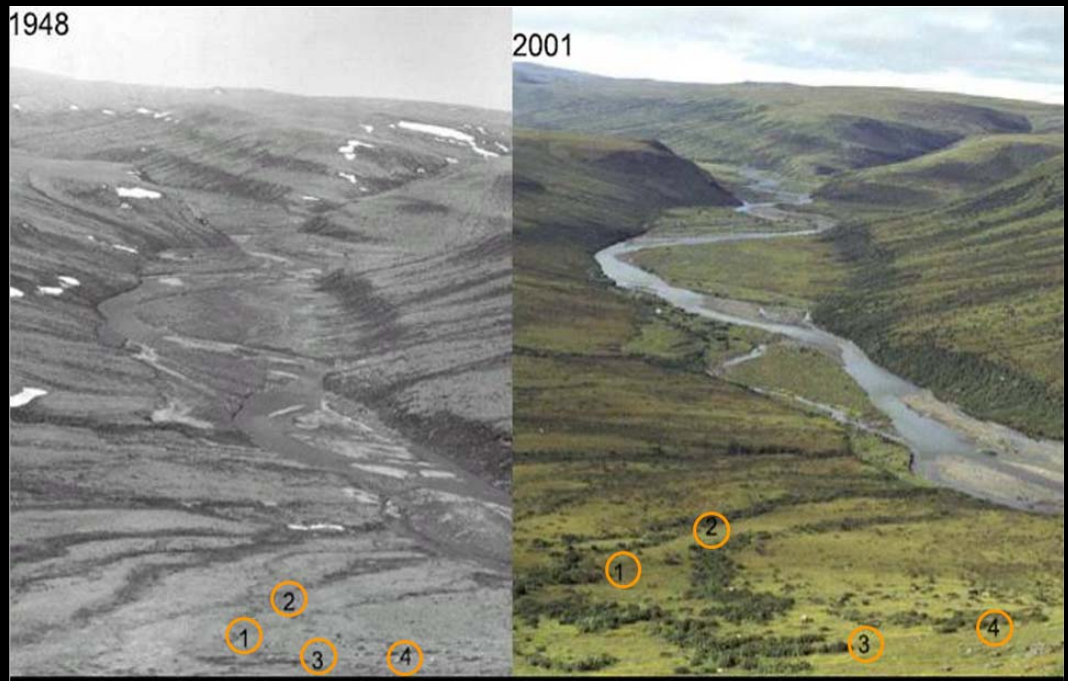
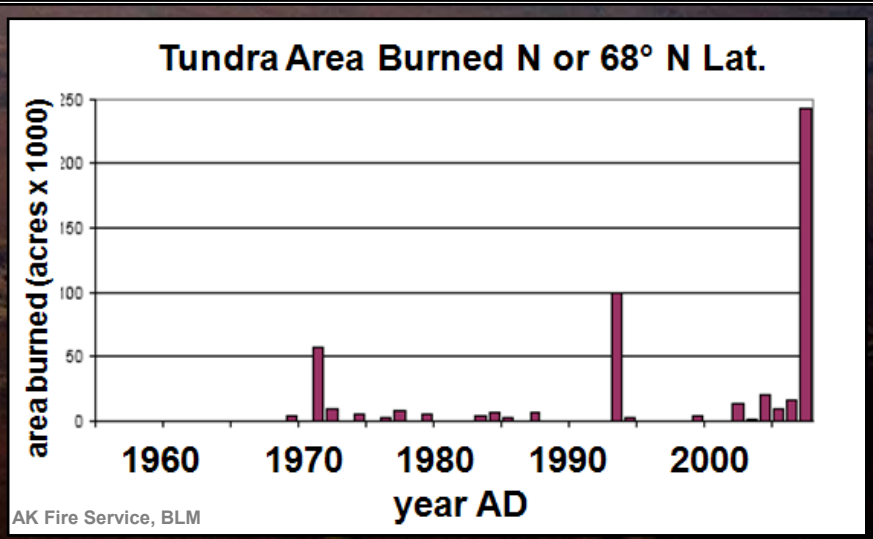


Fig. 4. from **Stow *et al.* 2004.** Remote sensing of vegetation and land-cover change in arctic tundra ecosystems.

- **Will tundra area burned increase?**



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

Photo: Shan H. Pilot

Paleo Evidence of Frequent Tundra Fires

OPEN ACCESS Freely available online PLoS one

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

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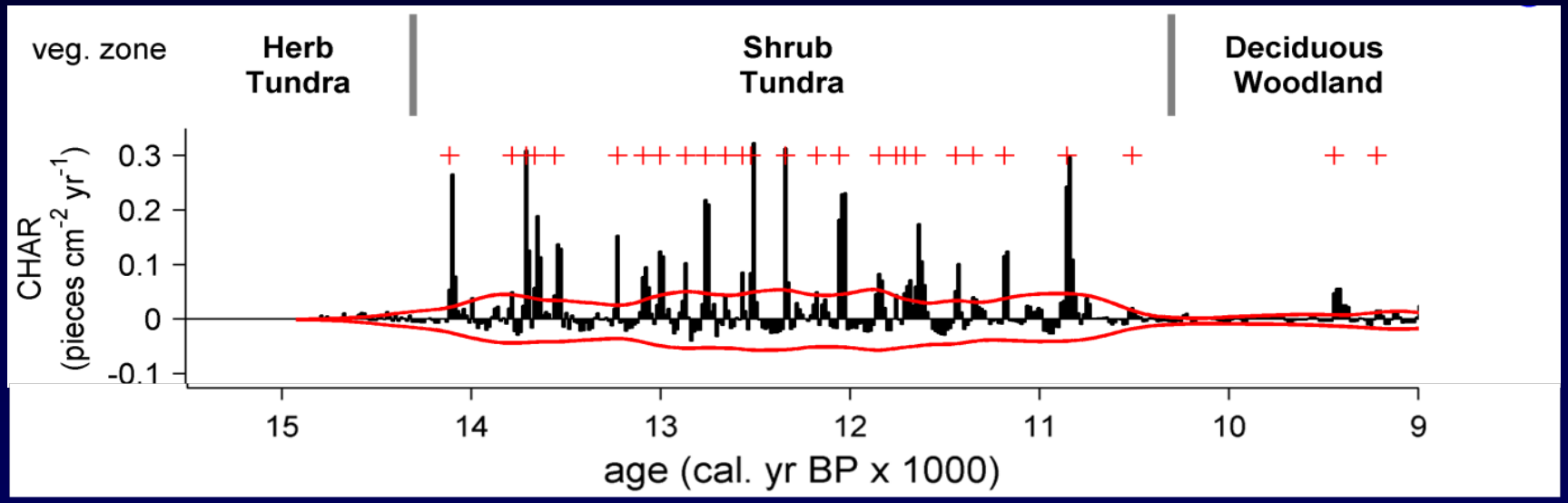
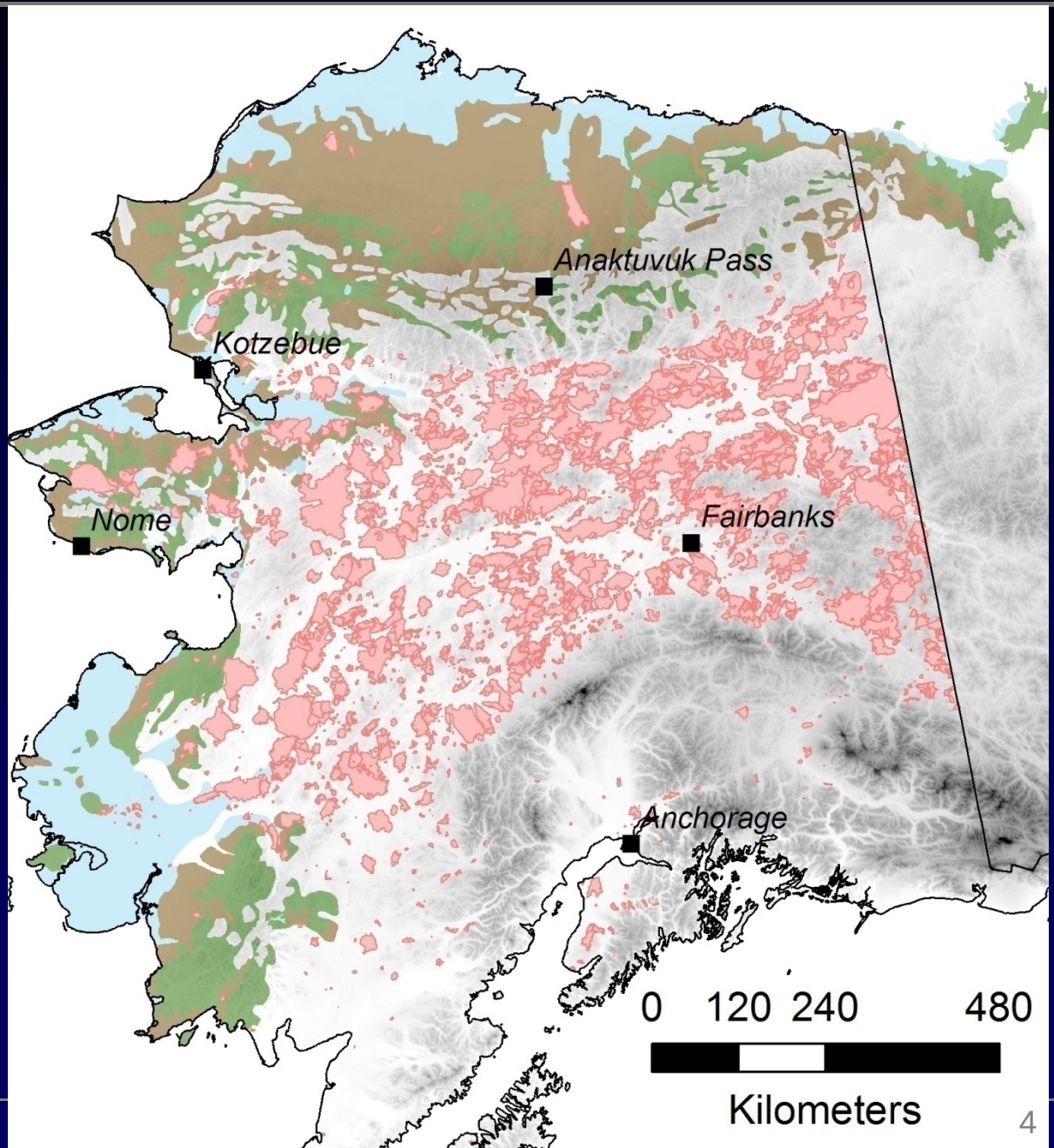


- **Tundra fire frequencies could increase with shrub abundance and climatic warming**

I. Background

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"



Management Needs

- **Cannot comply with national initiatives** requiring knowledge of historic fire-return intervals (LANDFIRE and FRCC)

- **Management decisions made in the absence of long-term fire-history records**

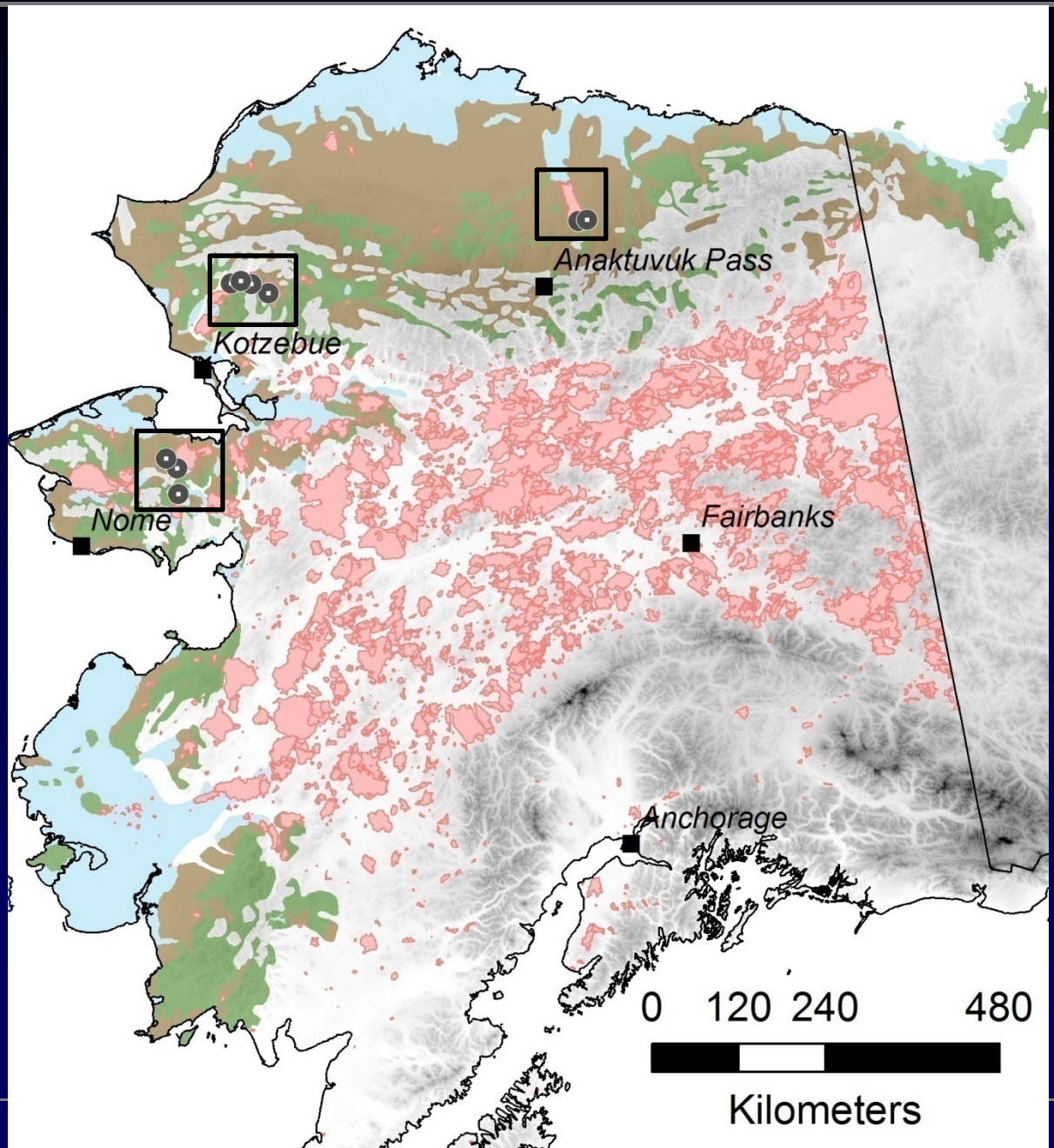
II. Objectives

A. Quantify tundra fire frequencies in two dominant tundra types in northwestern Alaska over the past 5000 years

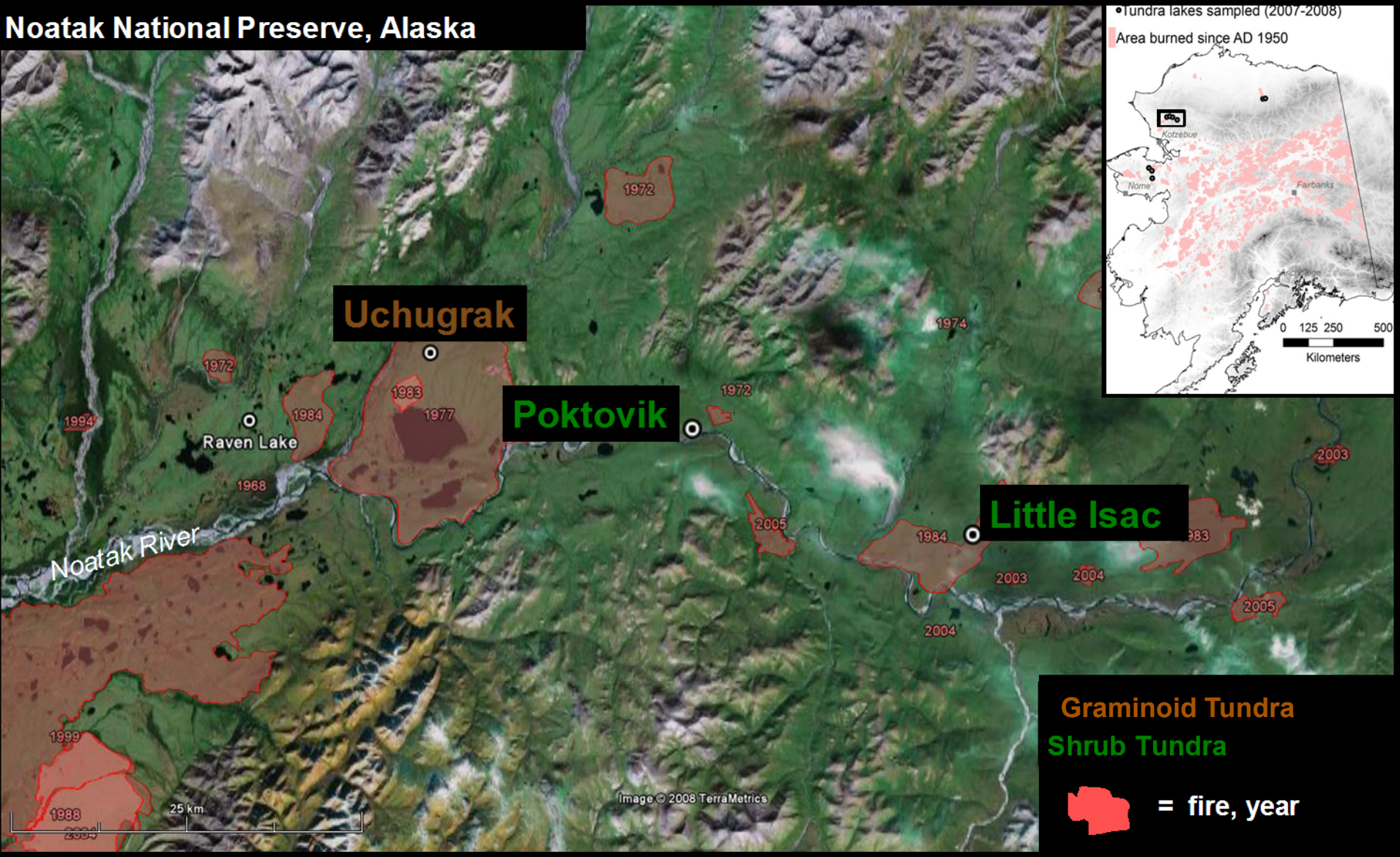
B. Integrate climate-vegetation-fire relationships into a management tool (ALFRESCO) for assessing fire and fuels hazards in tundra ecosystems

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

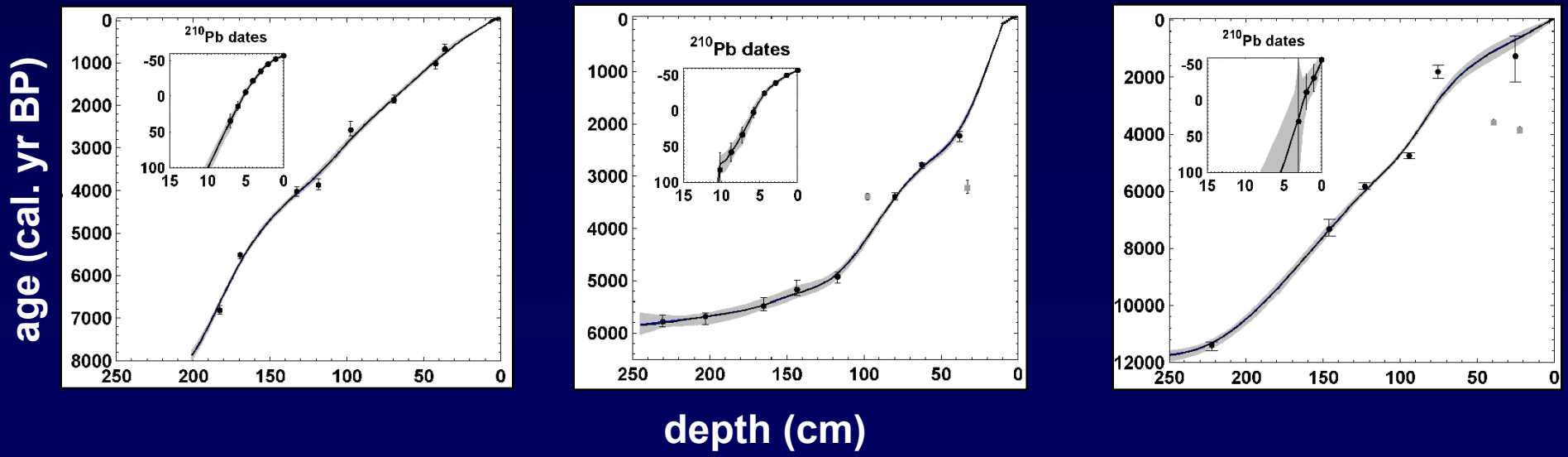
IV. Noatak Fire History

Age Models

Uchugrak Lake

Poktovik Lake

Little Isac Lake



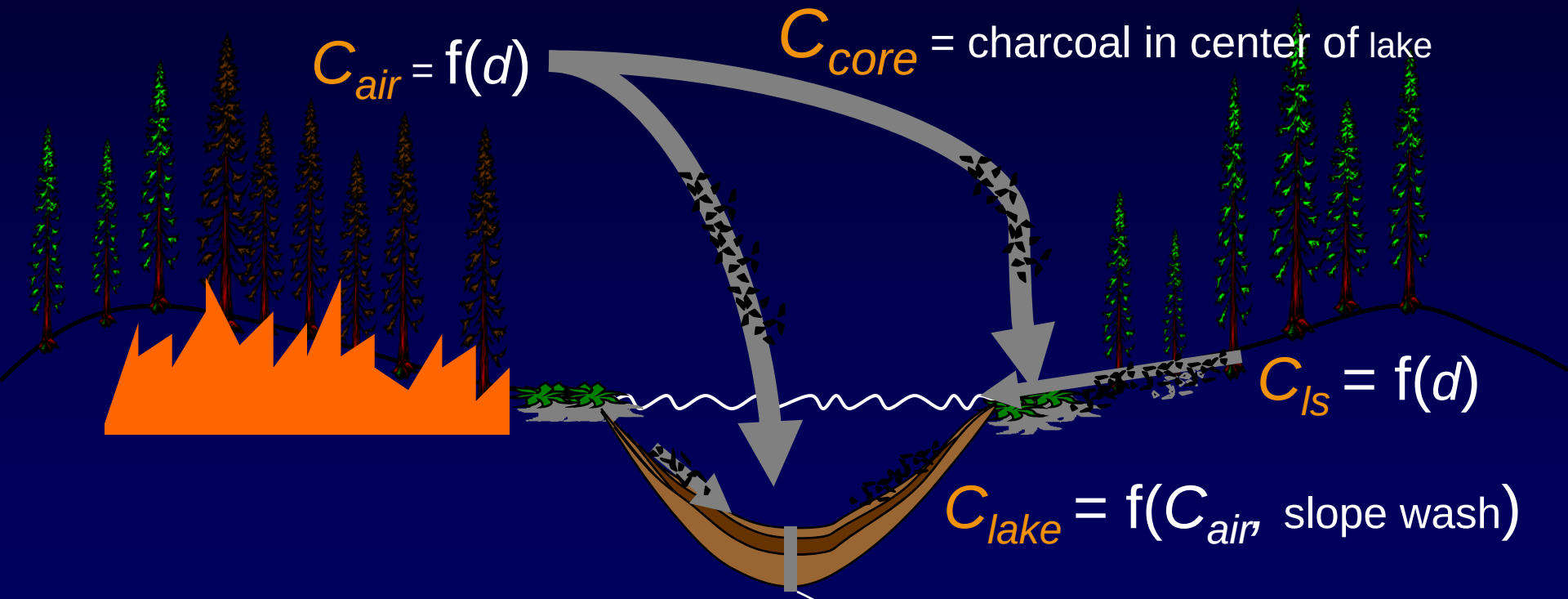
Fire History from Sed. Charcoal

C_{air} = airborne fallout of charcoal

C_{ls} = charcoal on landscape surface

C_{lake} = charcoal on lake surface

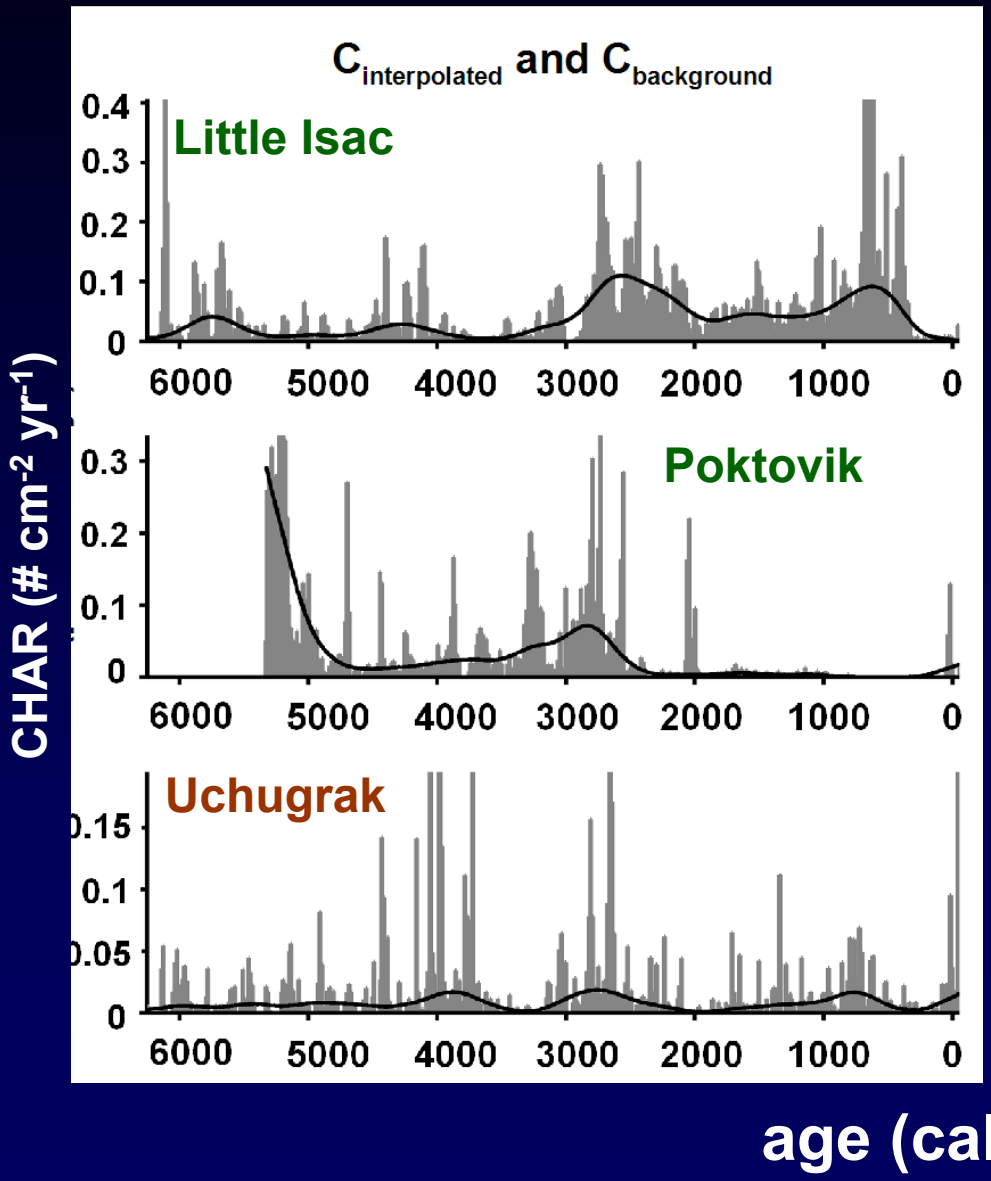
C_{core} = charcoal in center of lake



$C_{core} = f(C_{lake}$, redeposition, mixing$)$

IV. Noatak Fire History

Peak Identification

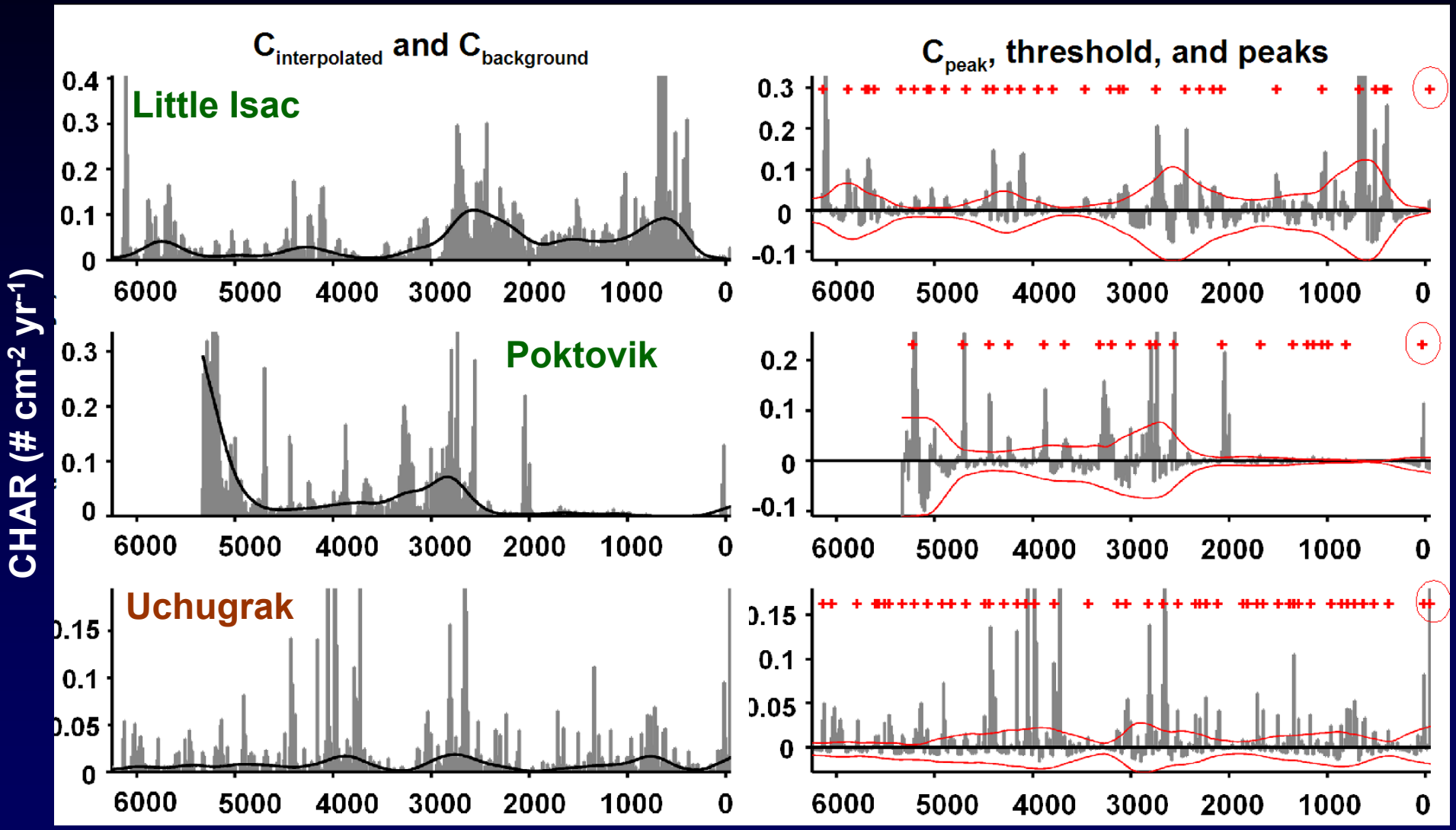


1. Tundra vegetation produces charcoal…

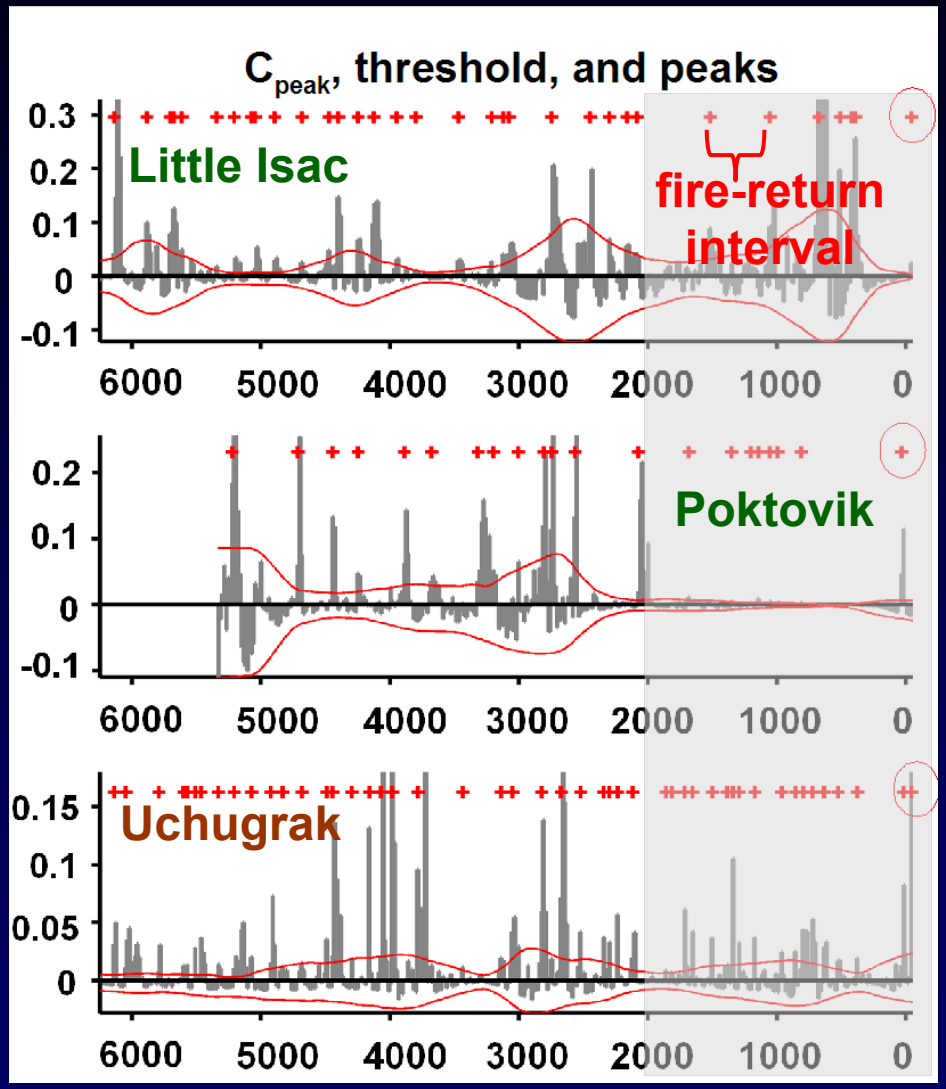
1.1 High-frequency variations = records appropriate for peak ID

IV. Noatak Fire History

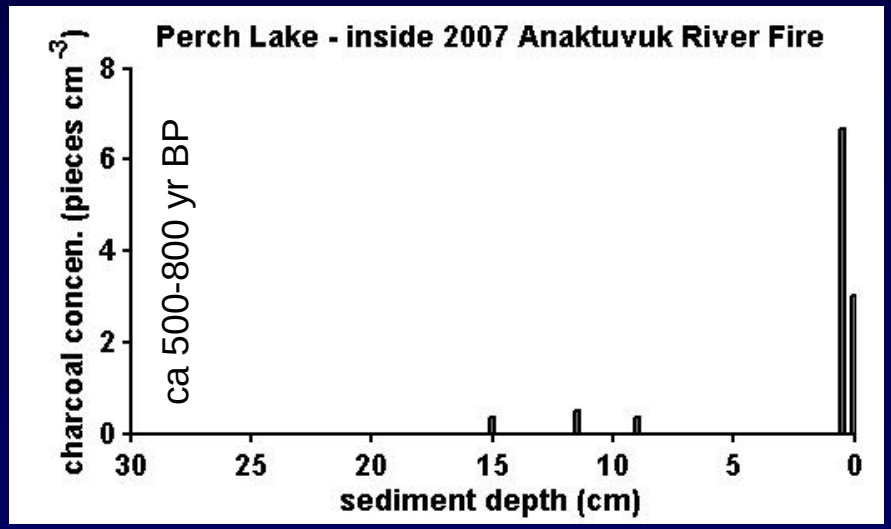
Peak Identification



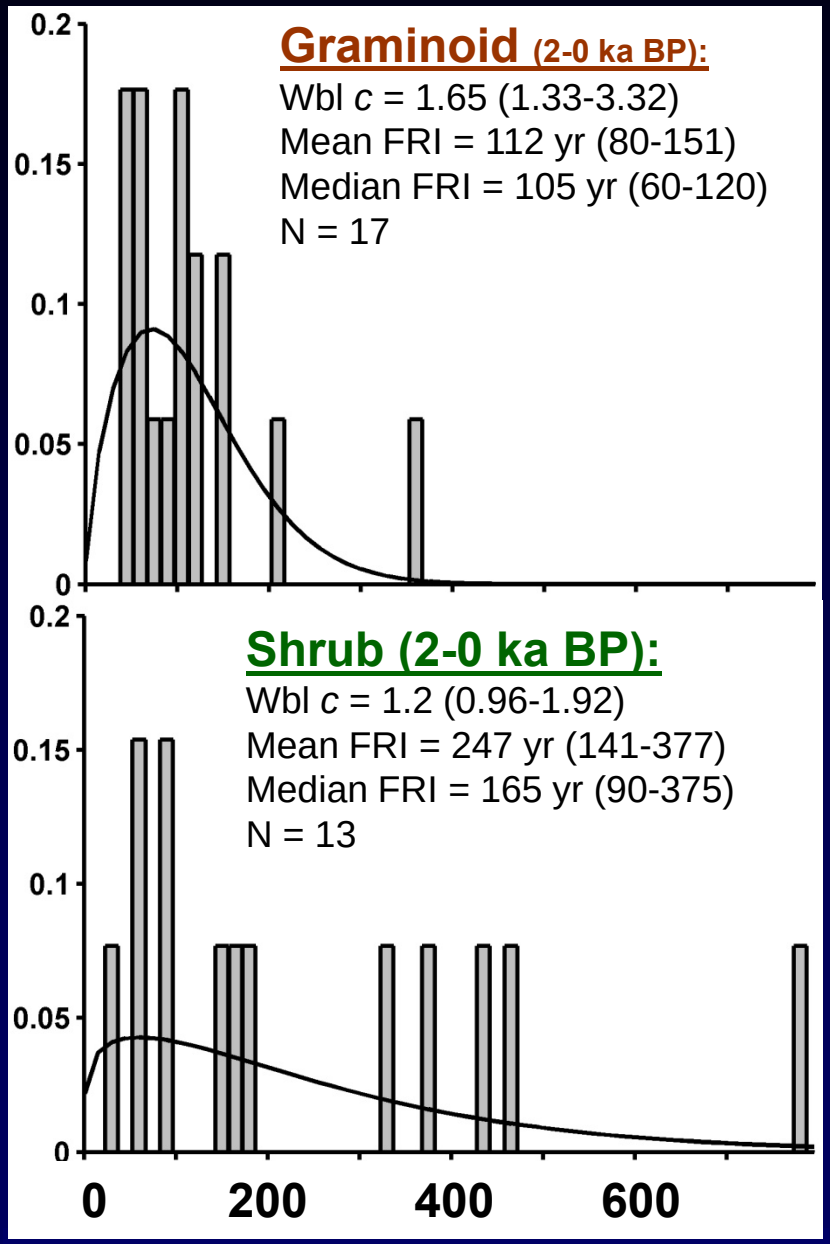
Peak Identification



2. Tundra fires leave detectable peaks

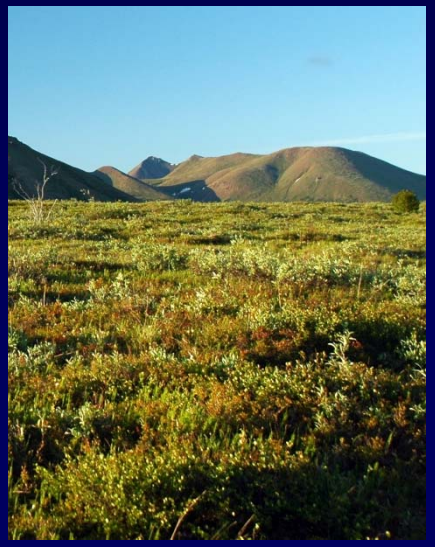


Between-site Differences

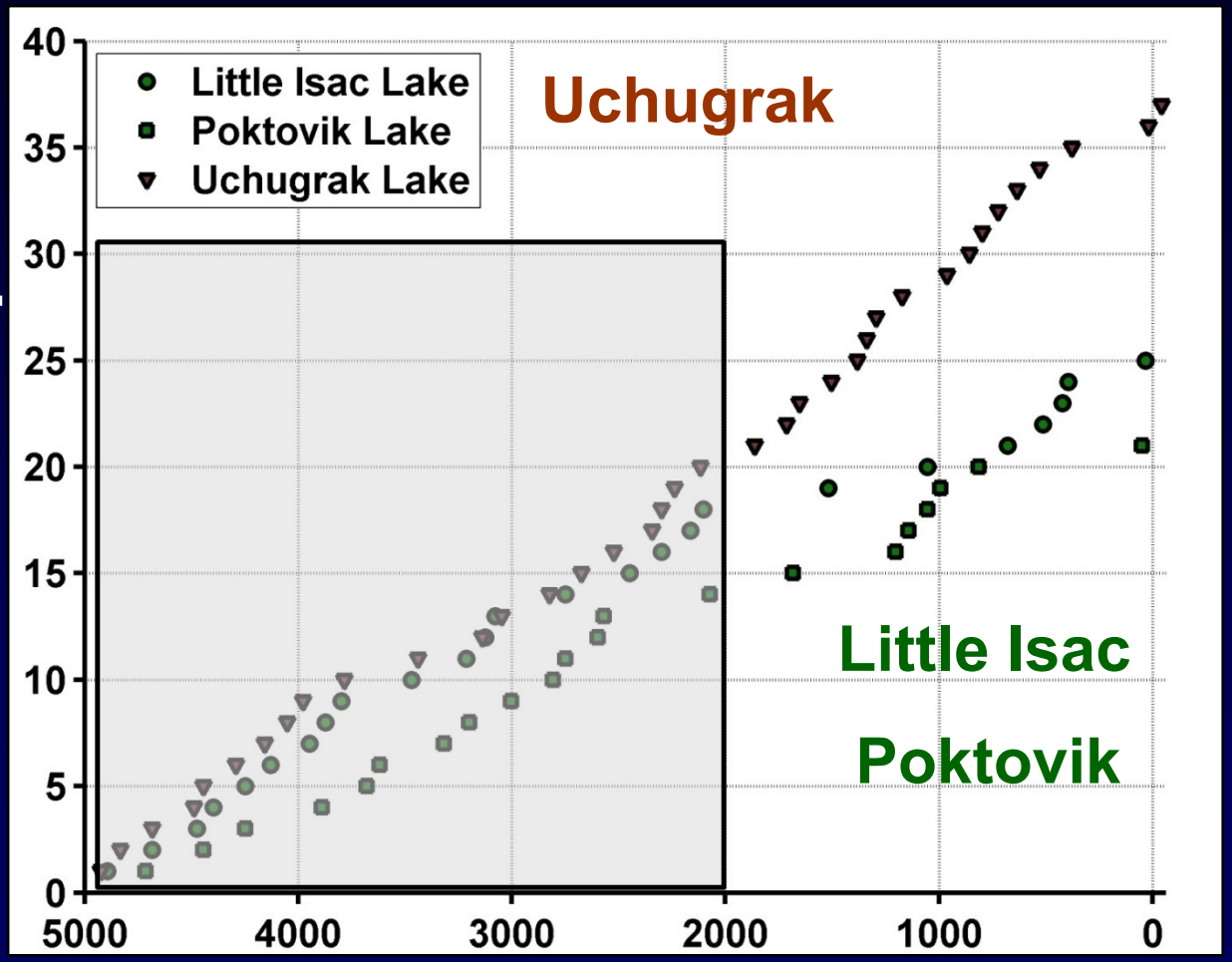


3. Vegetation matters:

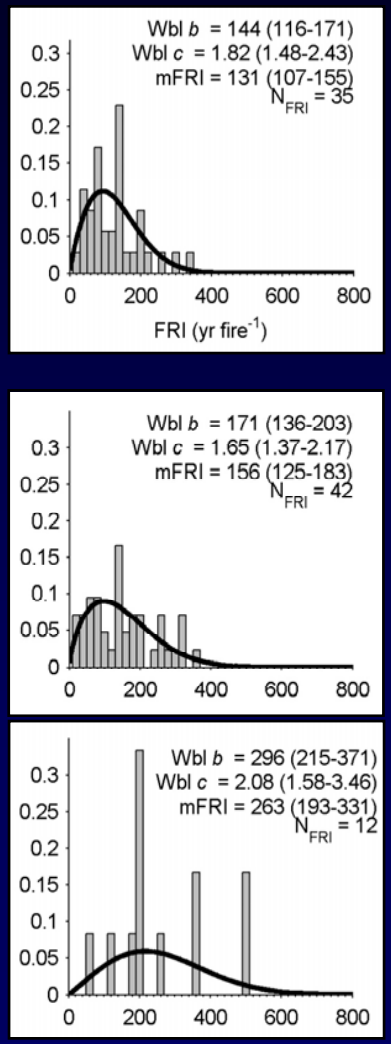
gramminoid site had significantly shorter FRIs than shrub sites *in the recent past*.

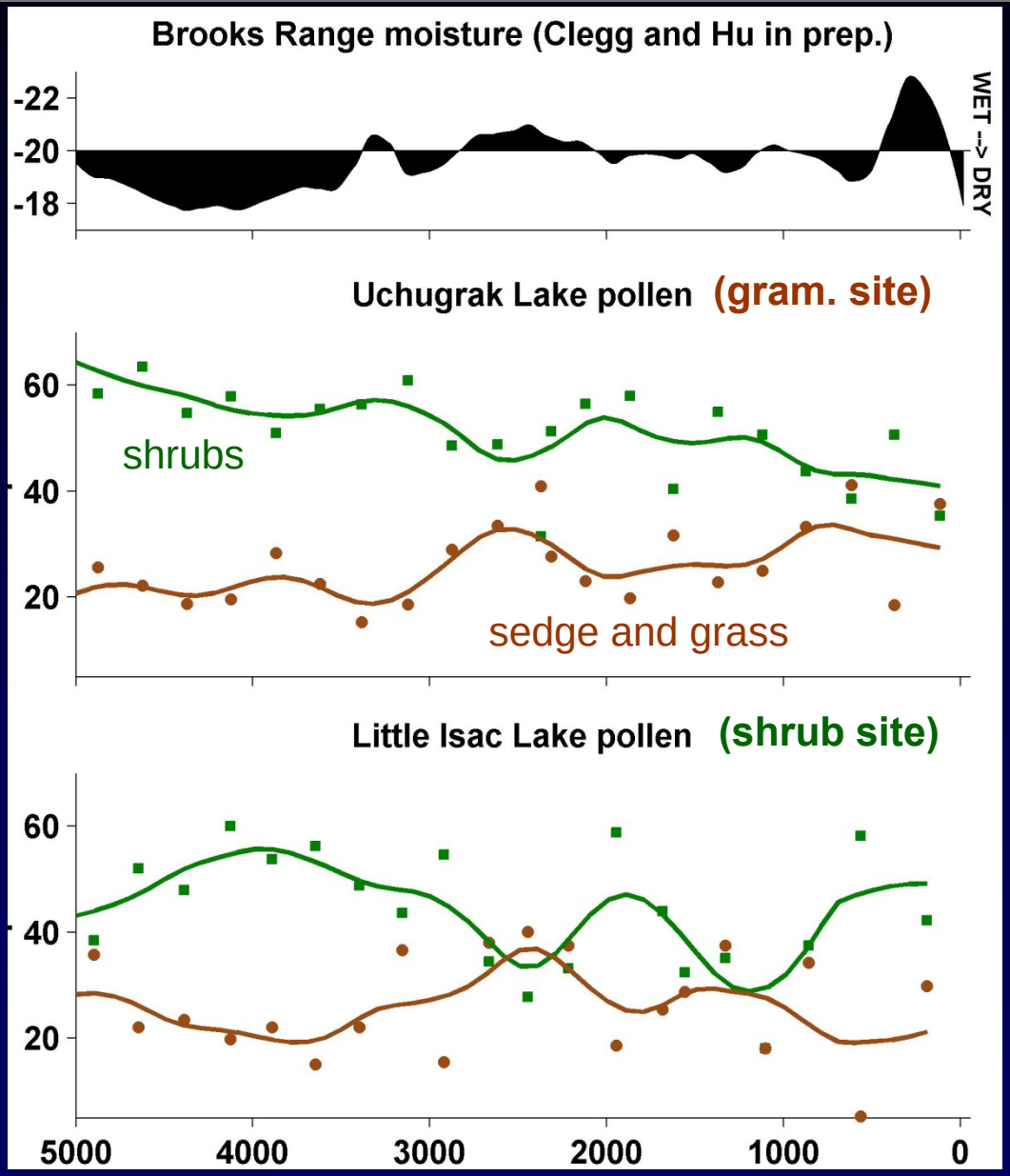


4. Differences over time suggest…



FRIs prior to 2 ka BP





4. Climate matters:

Mid-Holocene:

- ↓/≈ FRIs
- ↑ / ≈ shrubs
- ↓ moisture

Role of vegetation likely depends on climatic conditions

V. Summary

1. Sediment-charcoal records play a unique role in revealing tundra fire history

2. Tundra can sustain short fire return intervals (< 100 yr) and has burned frequently in the past

3. Fire frequencies differ between fuel types

4. Impact of fuels likely changes with climatic context

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 19