Past to Future

Towards fully paleo-informed future climate projections

Utrecht University

Holocene fire disturbances of the terrestrial biosphere: European and circumboreal perspectives

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Background

- **Boreal forests** are among the regions most prone to a climate-driven **wildfire regime intensification**[1]
- **Paleoecological data** needed to understand long-term fire trends, interactions, and events
- Recent interest and new contributions enable novel analyses of **fire frequencies** and **synchronicity**, **intra-biome variability**
- Opportunity to produce paleo data that can be used for **data-model comparisons**

Methods

- **Charcoal particles** in lake or peat sediments can be used to **reconstruct fire activity**
- **Established statistical approaches**, e.g., peak analysis for **fire return intervals** (FRIs)[2], **regional composite curves**[3]
- Taken from **databases** + **manual** additions

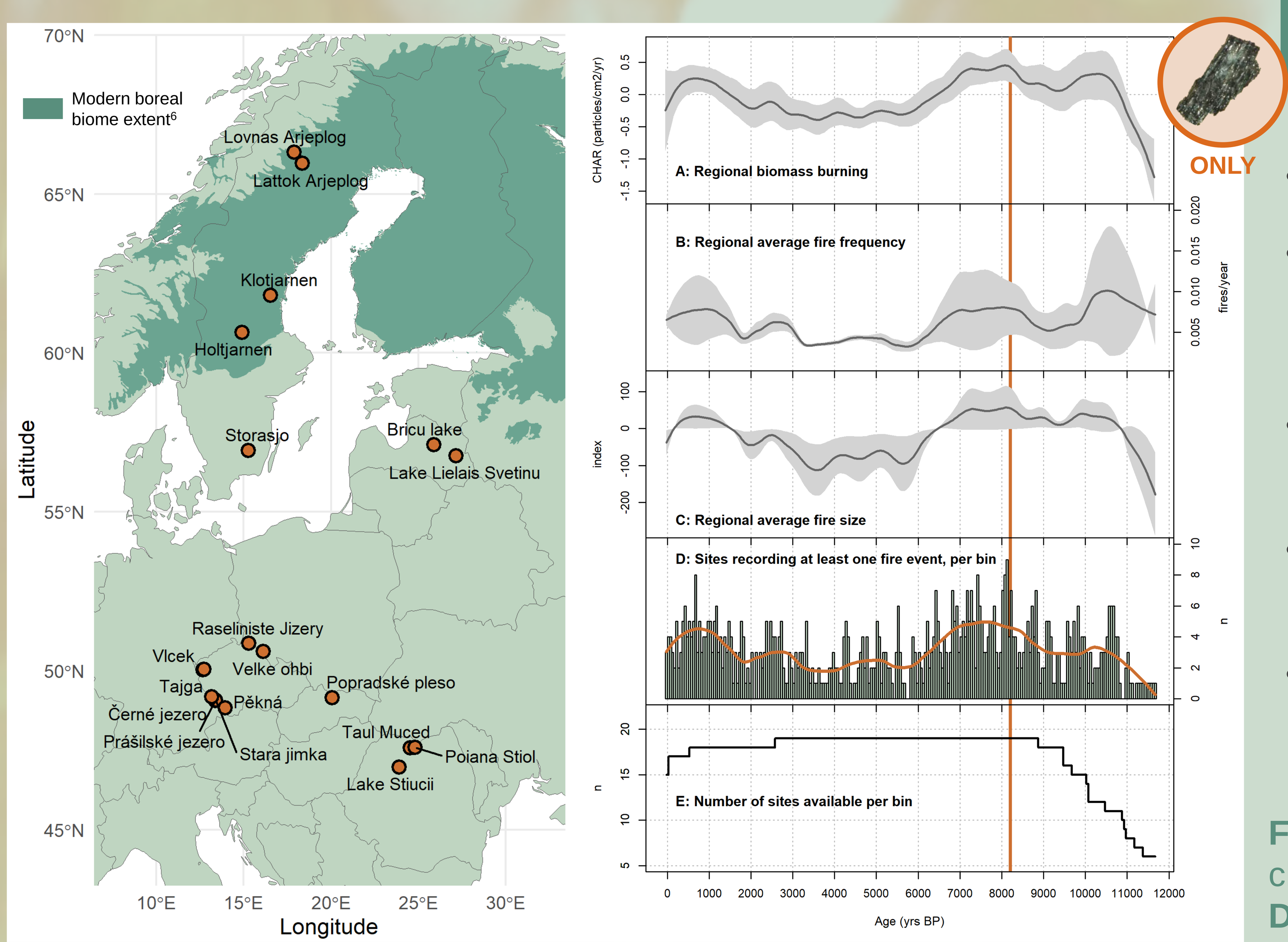
Macroscopic charcoal
Local to regional signal
Continuous sampling
High temporal resolution

>150 µm
<150 µm

Microscopic charcoal
Regional to continental signal
Non-continuous sampling
Low temporal resolution

P2F WP13

- **Title:** **“***Defining the states and variability of the terrestrial biosphere*”
- **Lead:** Thomas Giesecke (UU)
- **Tasks T13.1–3:** Ramesh Glückler (UU)
- **External partners contributing:**
  - Petr Kuneš (CUNI, Czech Republic)
  - Anneli Poska (TalTech, Estonia)



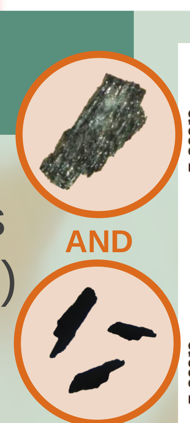
Fire synchronicity across Fennoscandia and Central Europe

- Using **19 high-resolution macroscopic** charcoal records (<45 years/sample)[9]
- Modern **boreal/hemiboreal regions** (Fennoscandia, Latvia) and sites with **boreal-like mixed forests** (Central Europe: Šumava Mts., Slavkov Forest, Sudetic Mts., Carpathian Mts.)
- Peak analysis yields a **mean FRI of 225 ± 124 years** across all sites (lowest: 61 years at Lake Lielais Svetinu, highest: 505 years at Lovnas Arjeplog)
- **Highest level of biomass burning** and **largest fire size** around **8200 years BP**; this also the interval with **highest synchronicity** (most sites record a fire event)
- Next step: Harmonizing age-depth models and **accounting for age uncertainty**, evaluating **regional differences** and smaller-scale synchronicities

Fig. 1: Left: Map of all included high-resolution macroscopic charcoal records. **Right:** Synthesized charcoal records. **A–C:** Composite curves for biomass burning, fire frequency, and fire size; **D:** Initial measure of synchronicity between sites (50-year bins); **E:** Extent of contributing records.

Circumboreal compilations of paleofire data

- Compiling **macro- and microscopic** charcoal records from various sources (Global Paleofire Database[4], Neotoma[5], manual additions[9])
- **Differing trends between boreal subregions** demonstrate limited usefulness of global or biome-wide composite curves, emphasizing **need for ecologically informed partitioning**
- Comparison to independent **ice core proxies**: Are there similarities?
- Follow-up **research potential:** Can state-of-the-art fire-vegetation models reproduce these differences across the boreal? If not, why?
- Next step: Merging records from Reading Paleofire Database[7], **more manual additions** from publications with non-deposited data



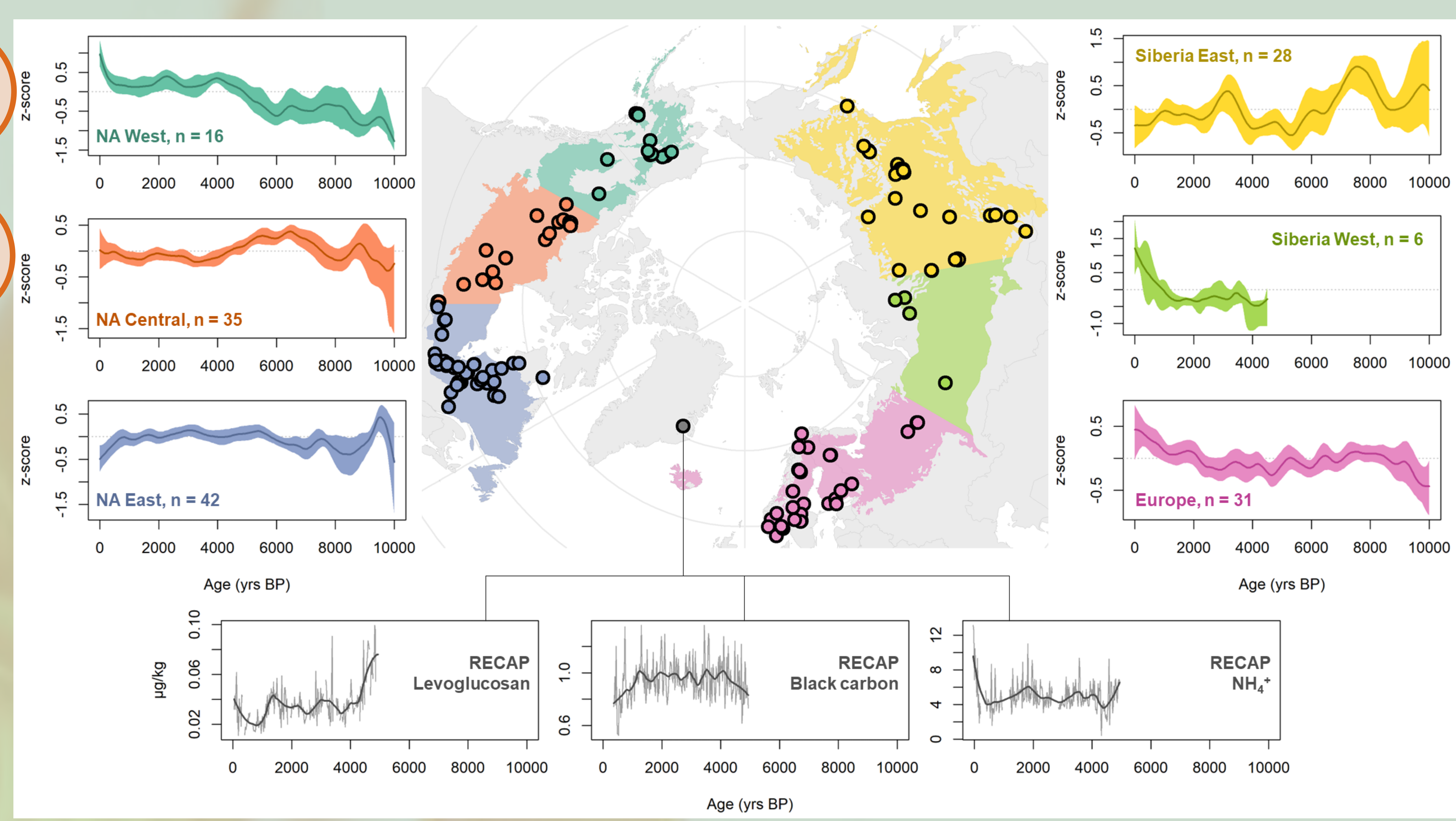


Fig. 2: Composite curves for biomass burning for boreal subregions. Plots on the bottom show fire proxies analyzed in the RECAP ice core from eastern Greenland[8].

What’s next?

- These are **early-stage results**: continuing to add and analyze paleo data
- Both projects enable potential **data-model comparisons**
- From next year: Focus on European post-LGM **vegetation dynamics** under rapid and gradual climatic changes; collaboration with **WP18**

References

1: Cunningham et al. 2024 (Nat. Ecol. Evol.); **2:** Higuera et al. 2009 (Ecol. Monogr.); **3:** Power et al. 2008 (Clim. Dyn.); **4:** Power et al. 2010 (Palaeo3); **5:** Williams et al. 2018 (Quat. Res.); **6:** RESOLVE Ecoregions 2017; **7:** Harrison et al. 2022 (ESSD); **8:** Segato et al. 2021 (Clim. Past); **9:** For complete list of references to all records, please inquire

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