

CHARCOAL DEPOSITION AND SUMMER FINE-PARTICLE AEROSOLS CAPTURE RECENT EXTREME WILDFIRE YEARS IN BOREAL FORESTS

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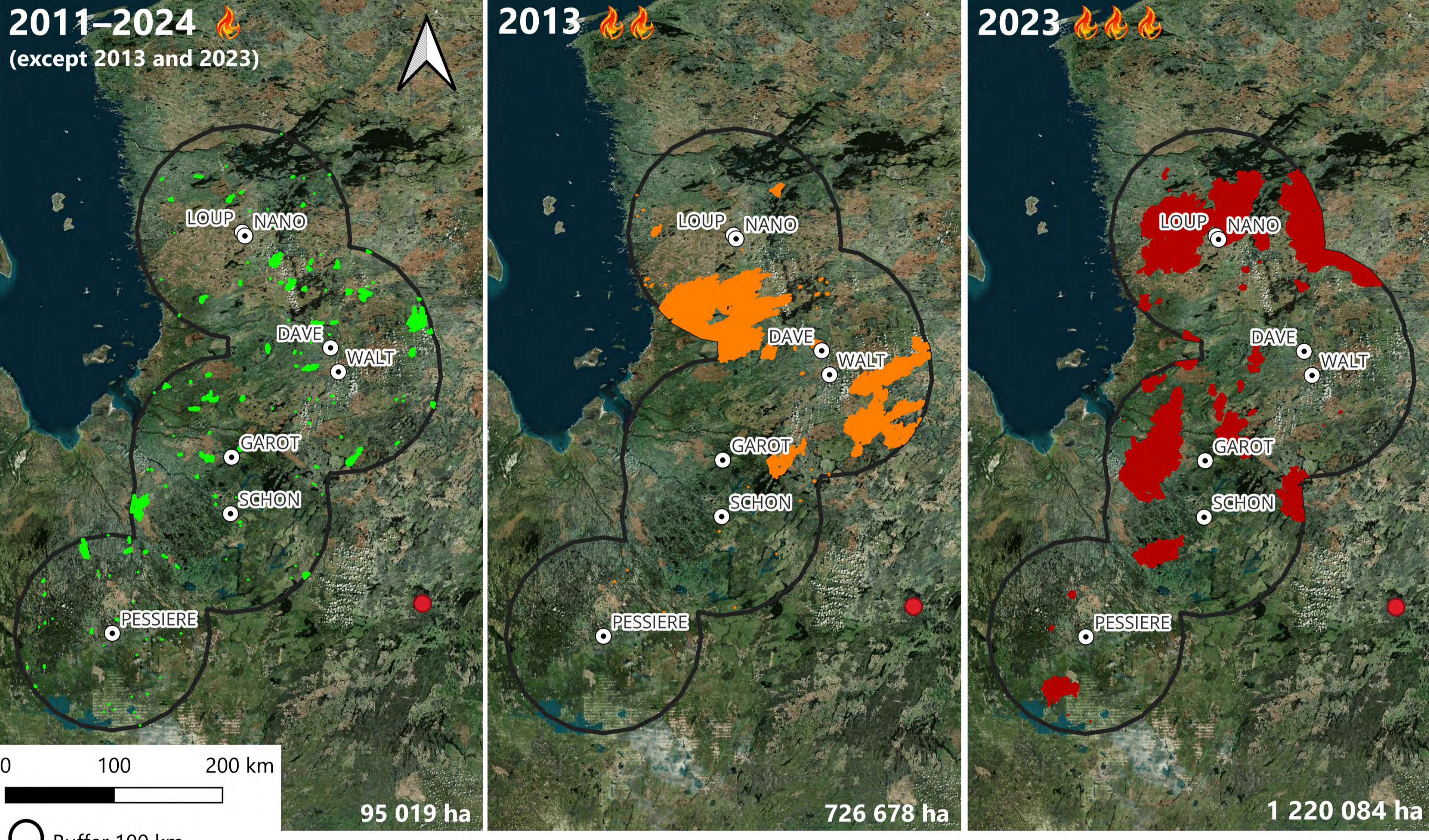
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1 ☀️ **2023** was among the warmest and driest years on record in Canada ^a (since 1950)
 🌡️ June temperature anomalies of **+ 3 to + 5°C** relative to the 1991-2010 climate normal
 🔥 ~**700 fires** burned **4.5 Mha** ^b in Quebec, surpassing the previous record in 1989 (2.3 Mha)
 ❤️ **Wildfire smoke causes respiratory diseases** and affects mental and cultural **wellbeing** ^c

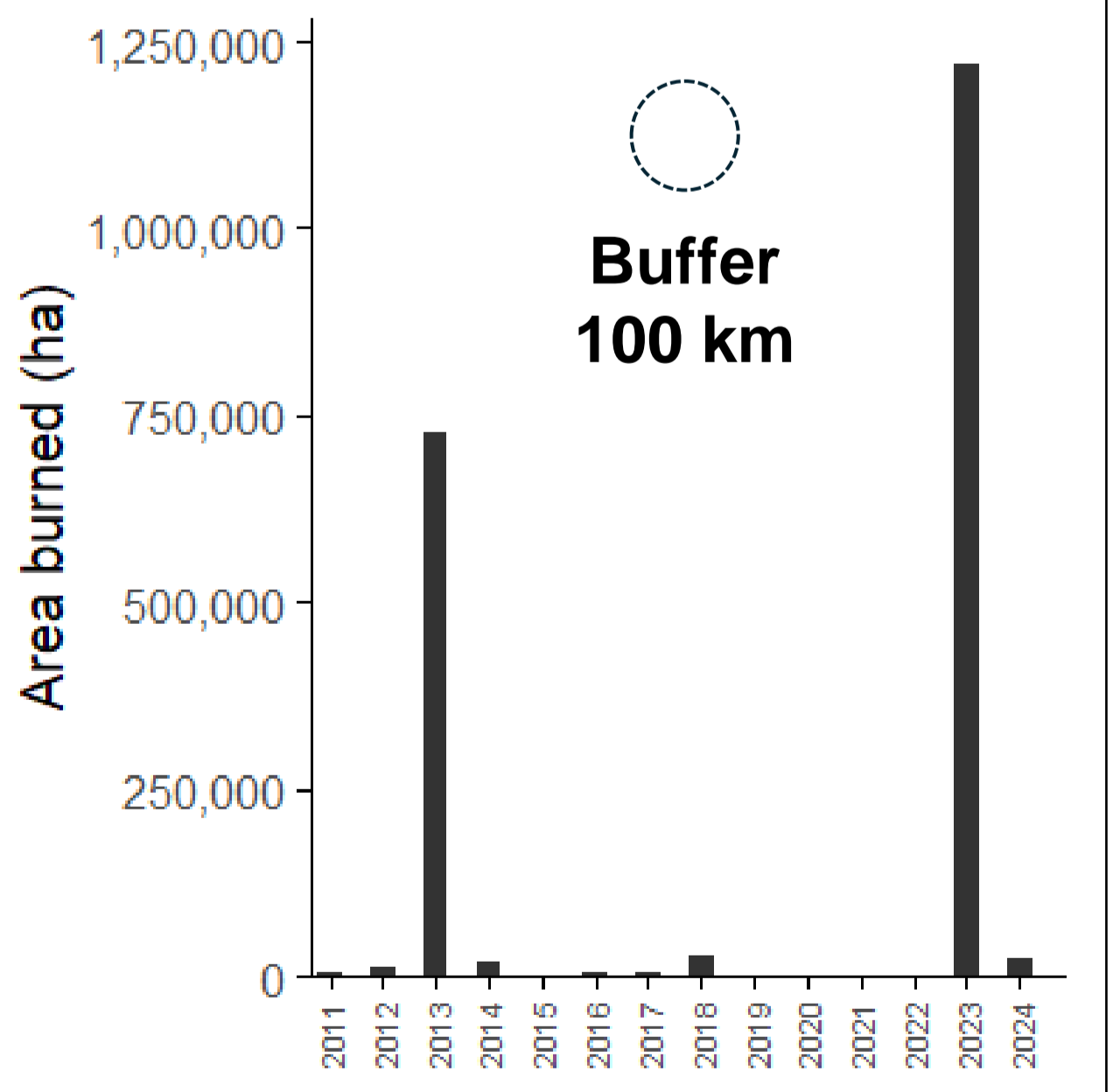
To what extent did lake-sediment charcoal deposition and regional fine-particle aerosols record the extreme 2023 wildfire season?

H1. Charcoal deposition increases markedly during extreme wildfire years (e.g., 2023)
H2. Charcoal deposition covaries with regional summer fine-particle concentrations

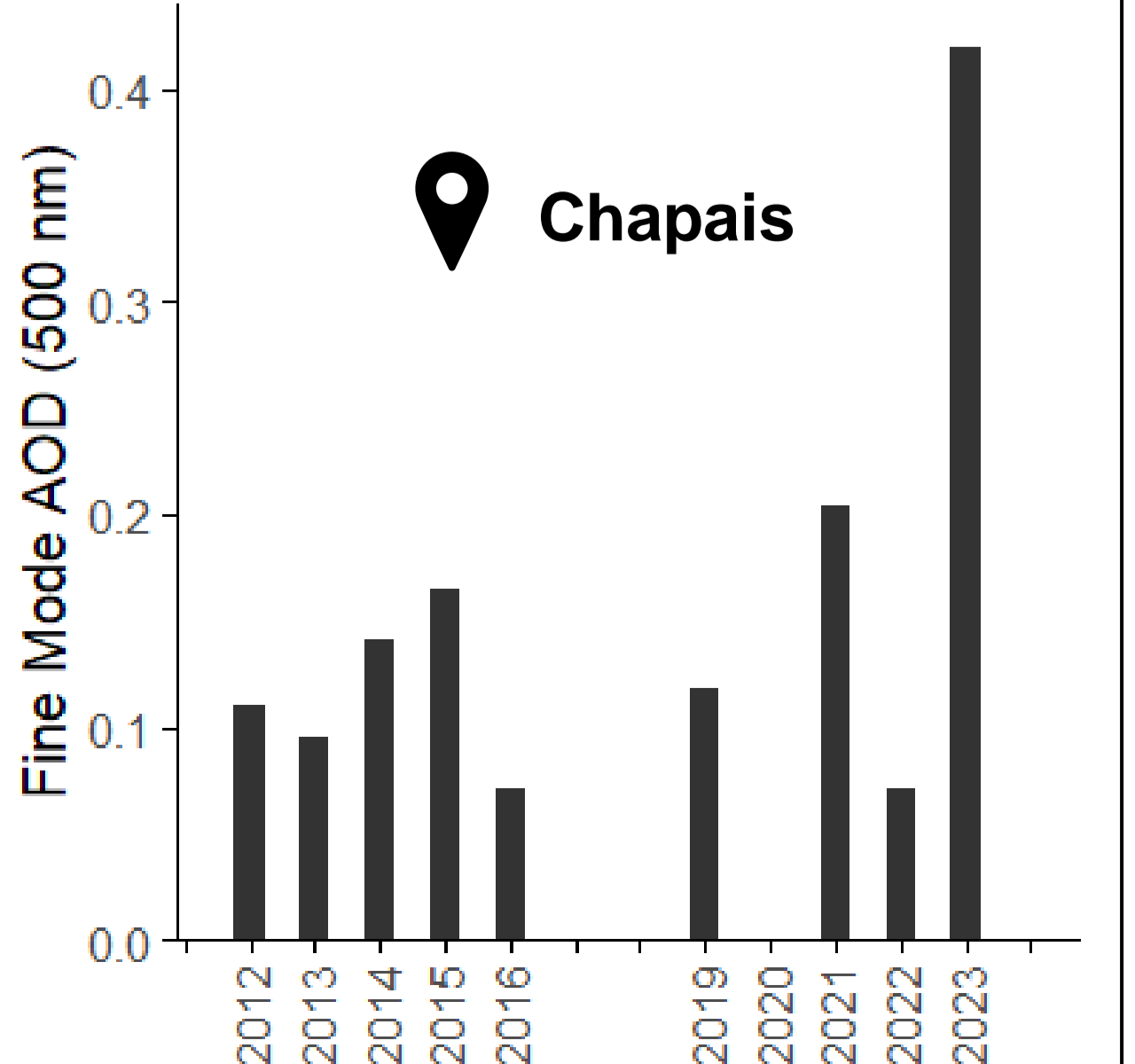
2 **418-km gradient** across Eeyou Istchee James Bay (Cree territory)
Black spruce on moss/clay and **jack pine** on lichen/sand
 Traps in **7 lakes** (49–53°N) to quantify annual charcoal deposition (**2011–2025**)
 Vertical tube-and-bottle traps at **~1 m depth** ^d
AERONET fine-particle mode = fraction of combustion-derived aerosols



Historical fires (2011-2024)

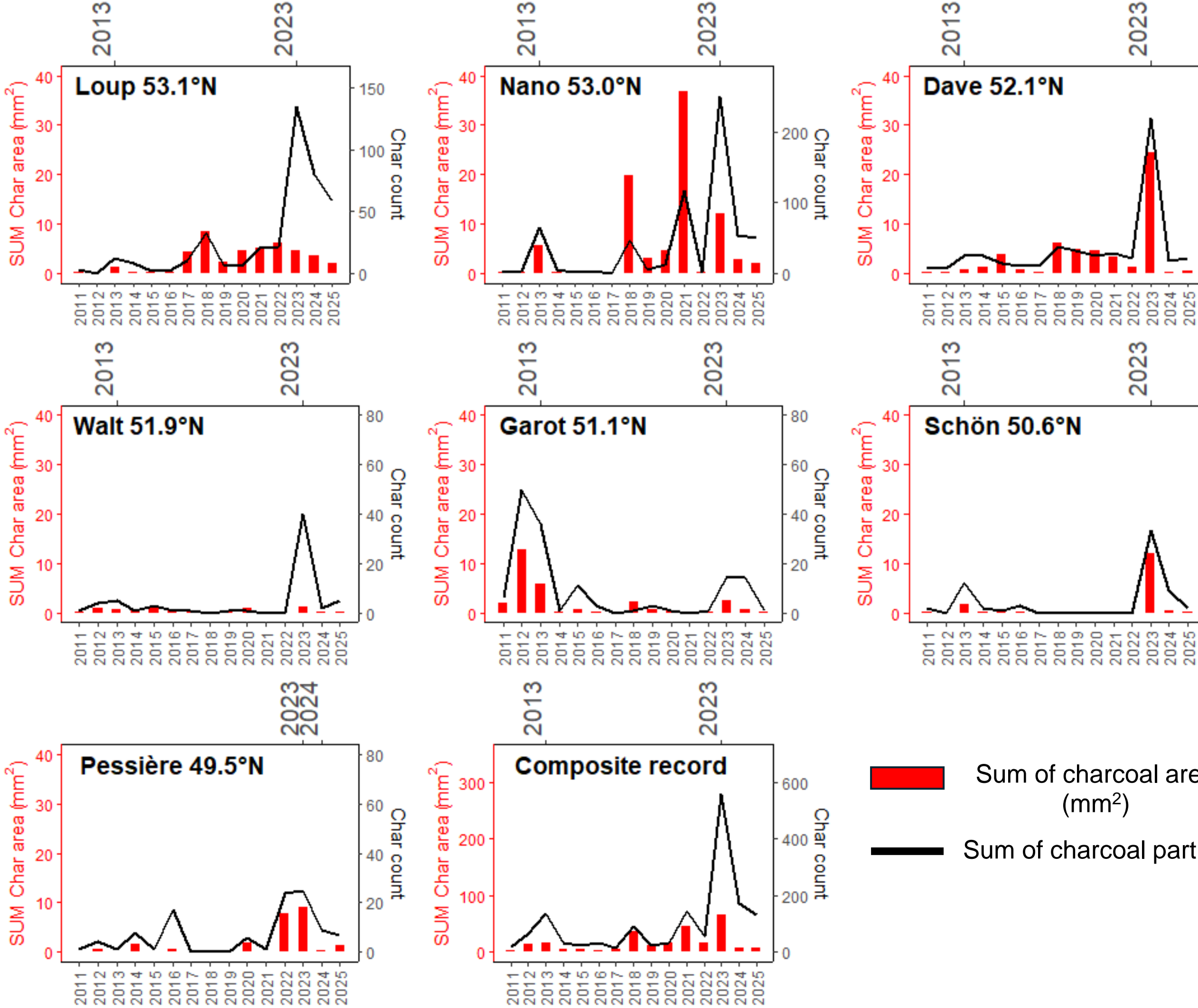


Regional fine-particle aerosols JUN-JUL-AUG

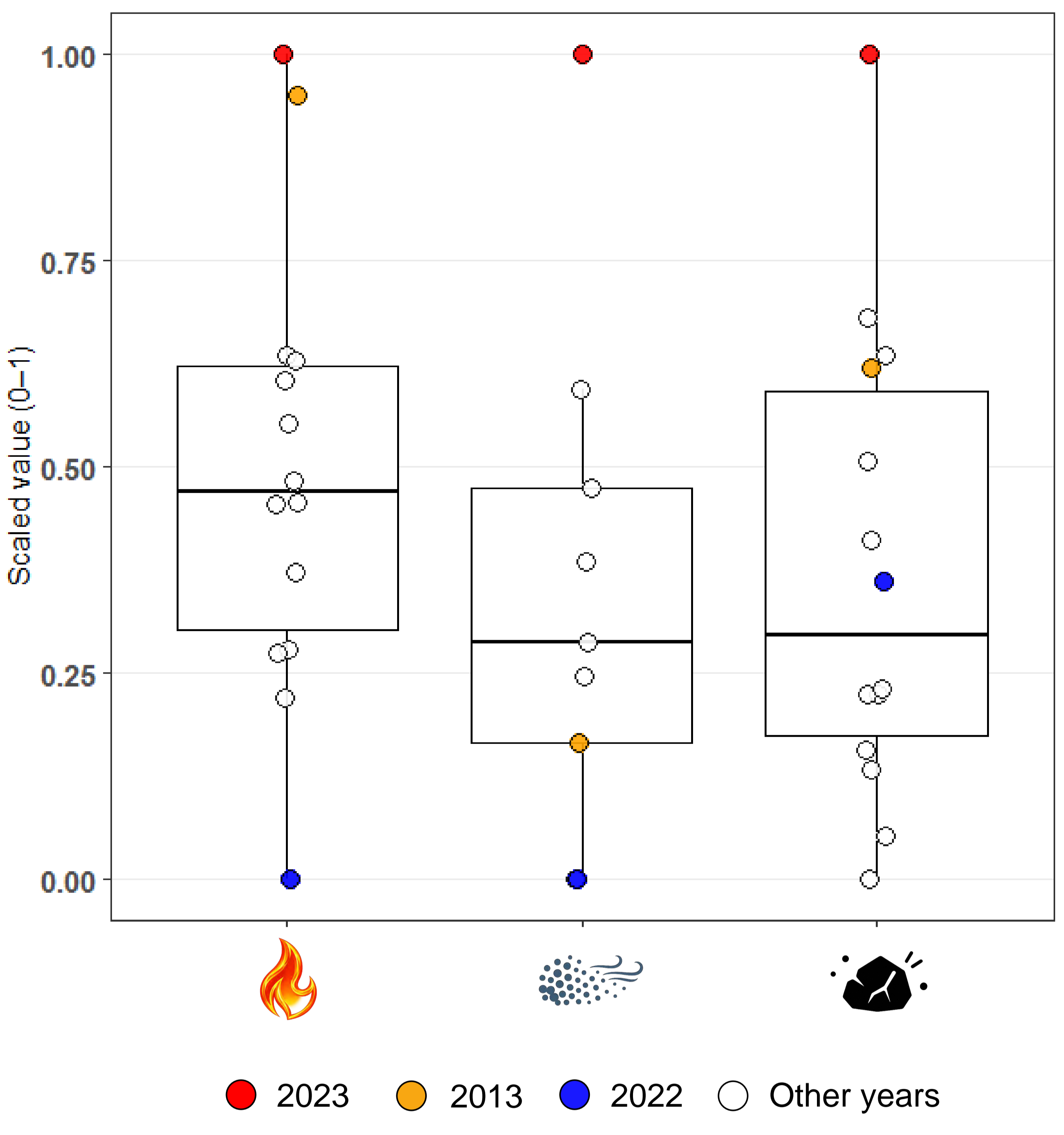


3 Two seasons of high/extreme fire activity: **2013** and **2023** 🔥
 🌫️ Highest **summer fine-particle** concentrations in **2023**
 🌫️ Highest **number** (6/7 lakes) and **area** (4/7 lakes) of charcoal particles in **2023**

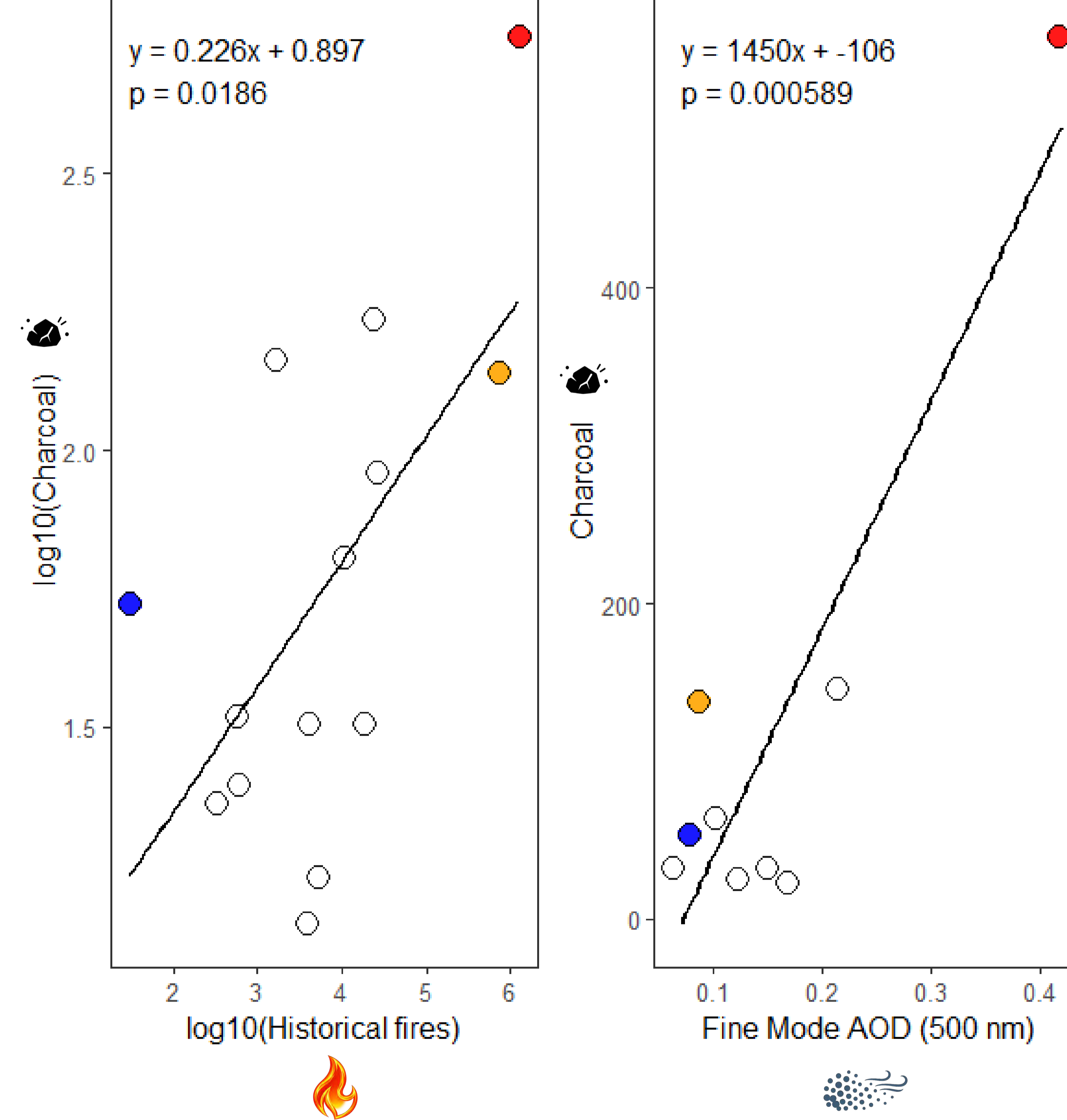
Charcoal deposition (2011-2025)



4 Distributions of annual area burned, summer fine-particle concentrations, and annual charcoal deposition (count)



5 Linear regressions between charcoal particles (count) and 1) historical fire activity and 2) aerosol concentrations



- 1 - High levels of charcoal and aerosols in 2023 highlight the synchronous sensitivity of both proxies to extreme wildfire years**
- 2 - High-magnitude charcoal deposition peaks provide clear sedimentary markers of extreme wildfire years**
- 3 - Regional aerosols could be influenced by prevailing westerly winds and by emissions from the Chapais sawmill**

^a - P. Jain et al., 2024. Drivers and Impacts of the Record-Breaking 2023 Wildfire Season in Canada (Nature communications)
^b - Y. Boulanger et al., 2024. The 2023 wildfire season in Québec: an overview of extreme conditions, impacts, lessons learned, and considerations for the future (Canadian Journal of Forest Research)
^c - W. Dodd et al., 2018. The summer of smoke: ecosocial and health impacts of a record wildfire season in the Northwest Territories, Canada (The Lancet Global Health)
^d - F. Oris et al., 2014. Charcoal dispersion and deposition in boreal lakes from 3 years of monitoring: Differences between local and regional fires (Geophysical Research Letters)