Carbon emissions from wildfires in larch forest ecosystems of Northeast Siberia

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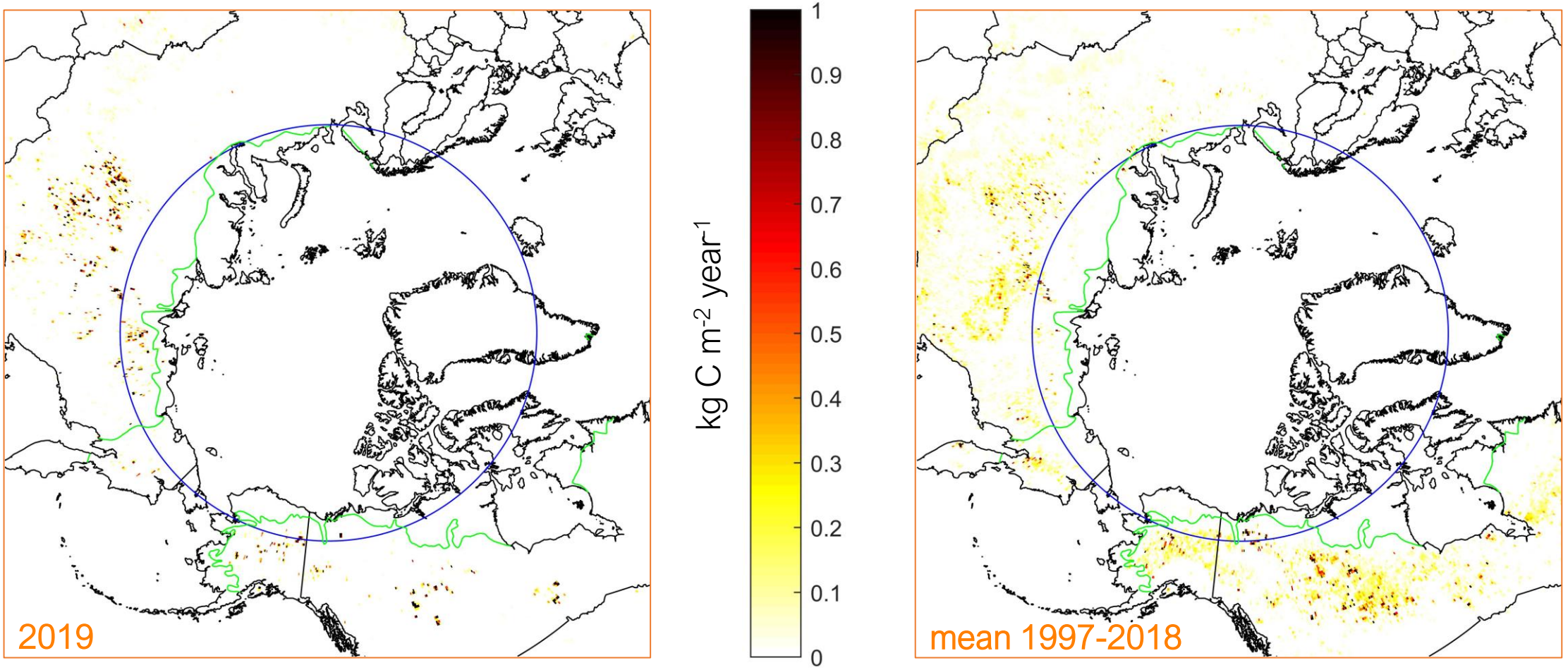
EGU2020: Sharing Geoscience Online

BG3.17 The Role of Fire in the Earth System

B. Izbicki, E.A. Kukavskaya, M.C. Mack, T.C. Maximov, R.E. Petrov, B.M. Rogers, R.C. Scholten, T. Shestakova, G. van der Werf, D. van Wees and S. Veraverbeke

Wildfire Smoke Swirls Over Russia (VIIRS – Suomi NPP), accessed on May 4th, 2020 from NASA's Earth Observatory

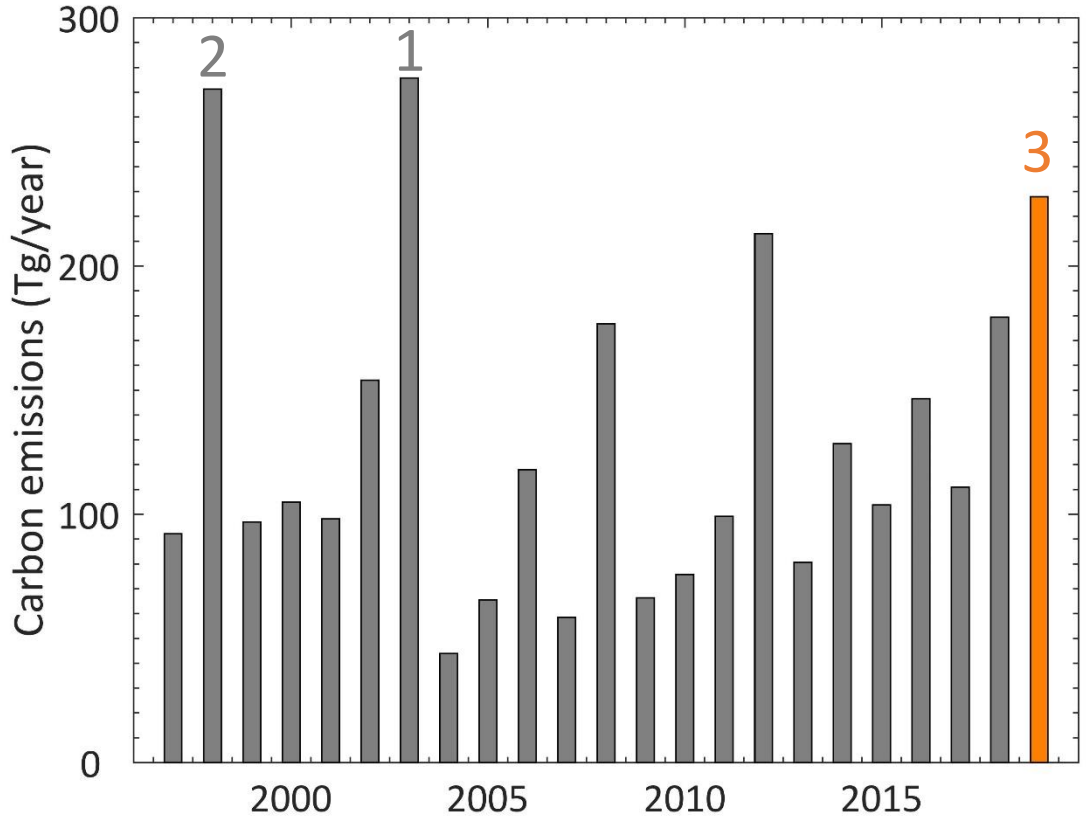
2019 fire season



Global Fire Emissions Database
van der Werf *et al.* (2017)

2019 fire season in Siberia

Siberia 2019	~230 Tg C
Amazon 2019	~145 Tg C
SE Australia 2019/2020	~130 Tg C



Global Fire Emissions Database
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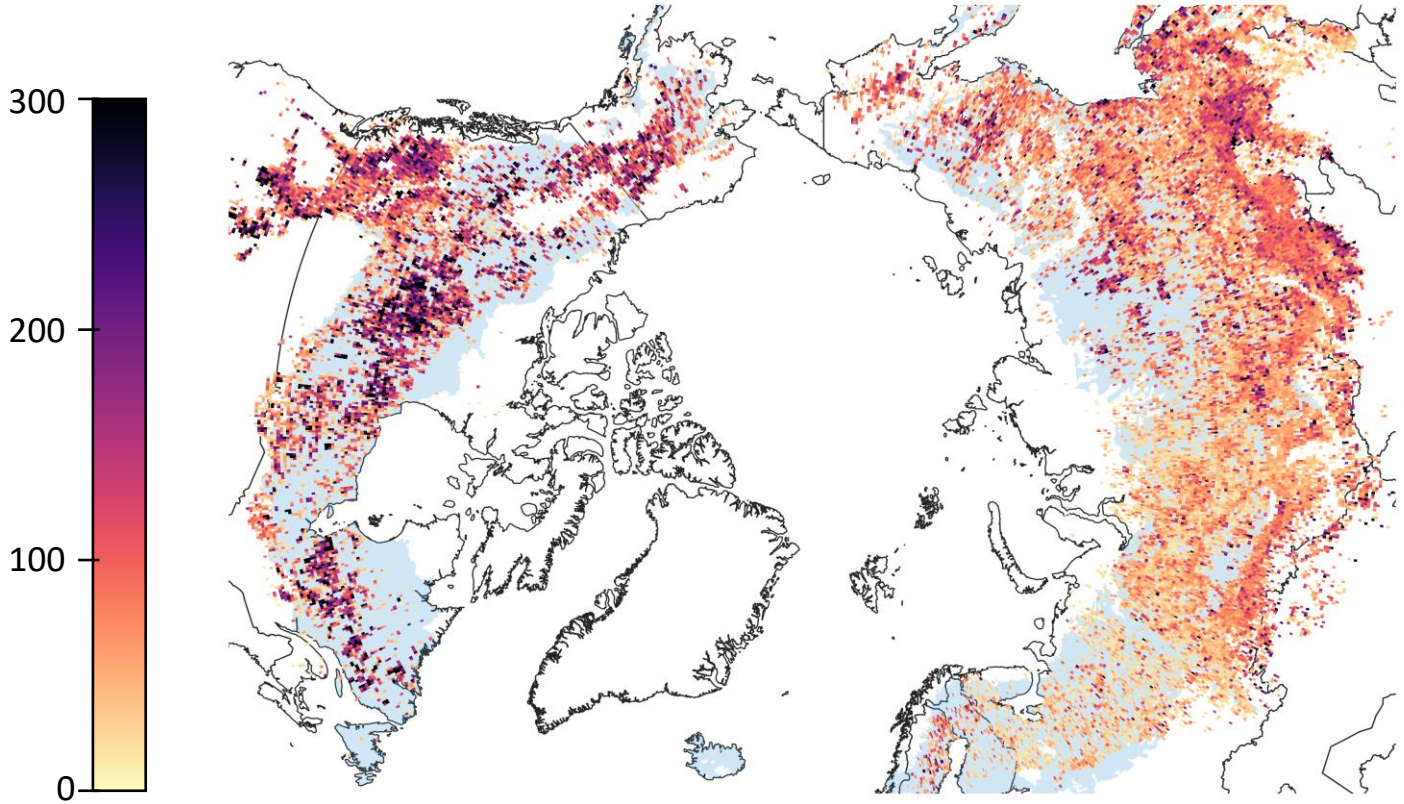
Why Siberia ?

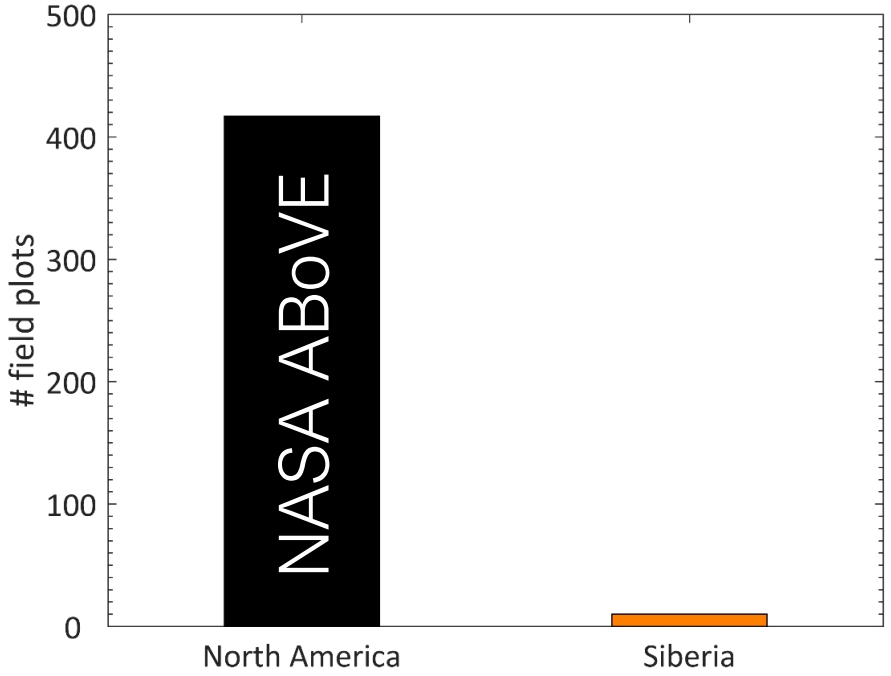


Fire Radiative Power (Mwatts)

Rogers *et al.* (2015)

Boreal biome

Dinerstein *et al.* (2017)



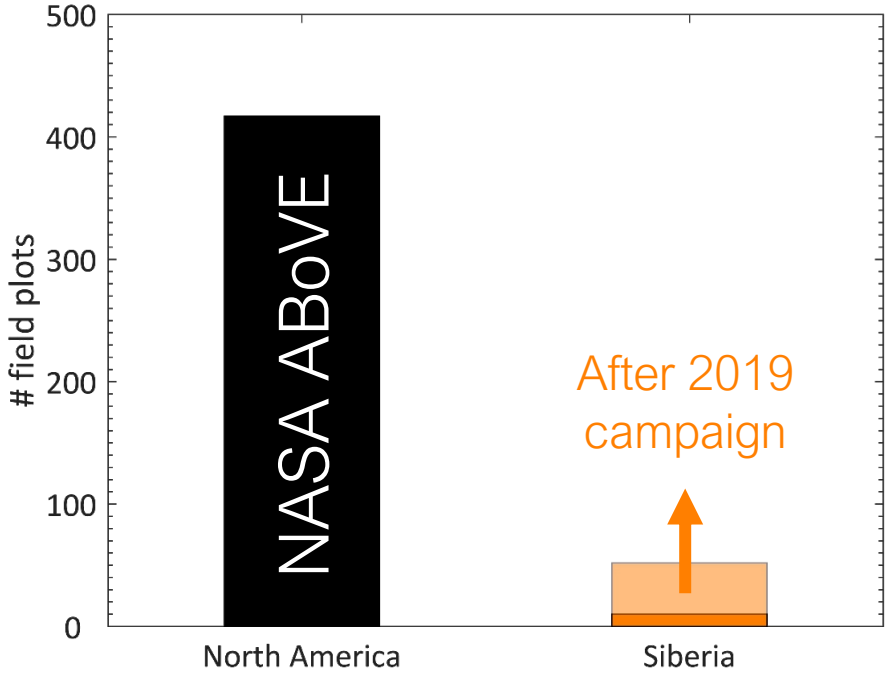
Why Siberia ?

Deciduous Needleleaf Forest (*Larix*)

Boreal biome

Dinerstein *et al.* (2017)

Bartalev *et al.* (2003)



2 fires in larch ecosystems around Yakutsk

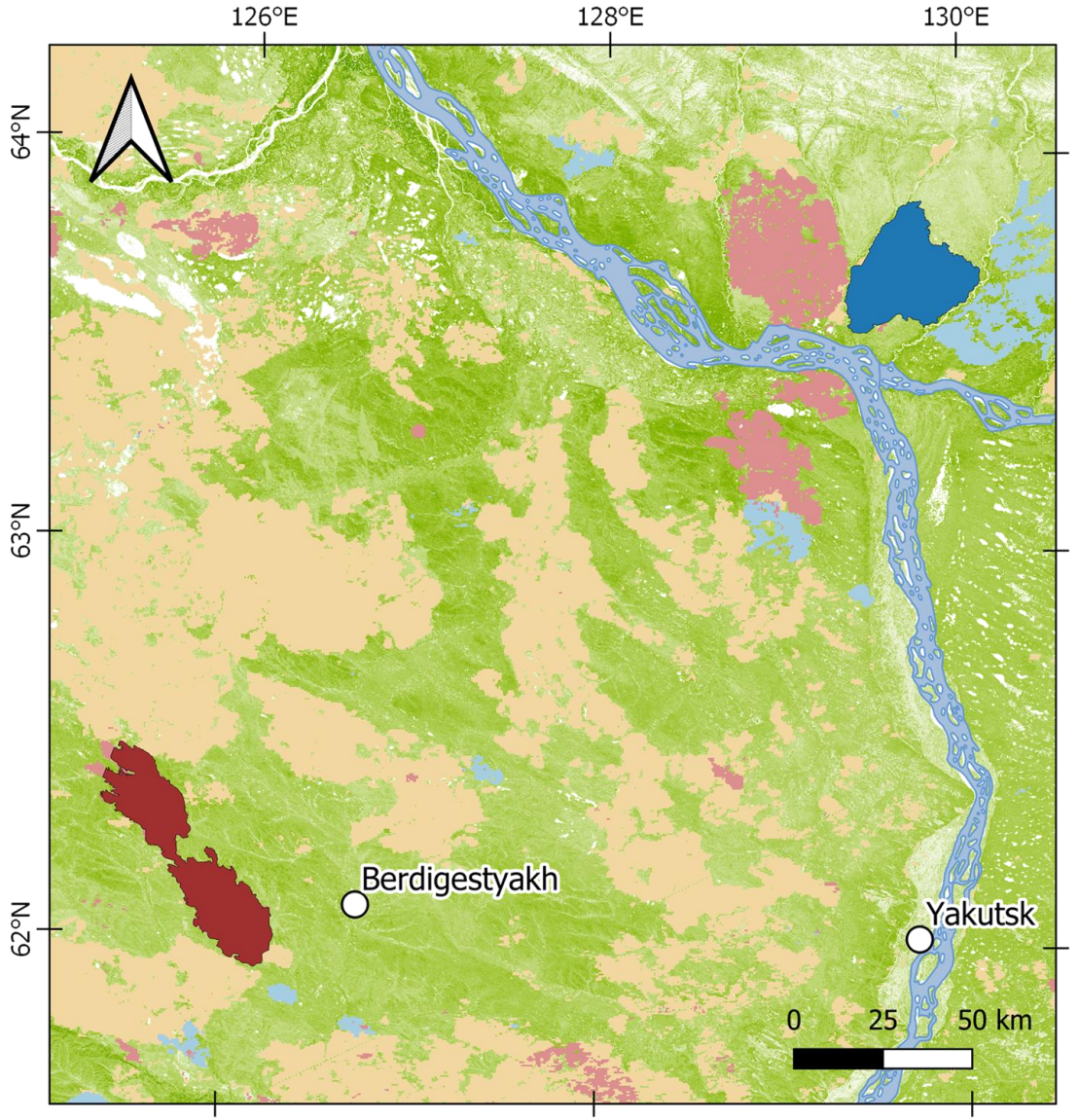
Burned area

2017

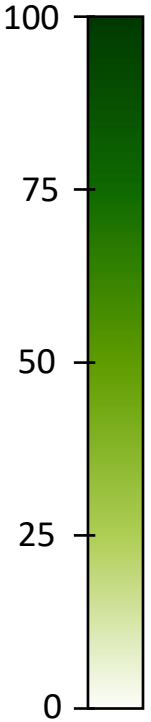
2018

2001-2016

MCD64monthly burned area product, Giglio *et al.* (2018)



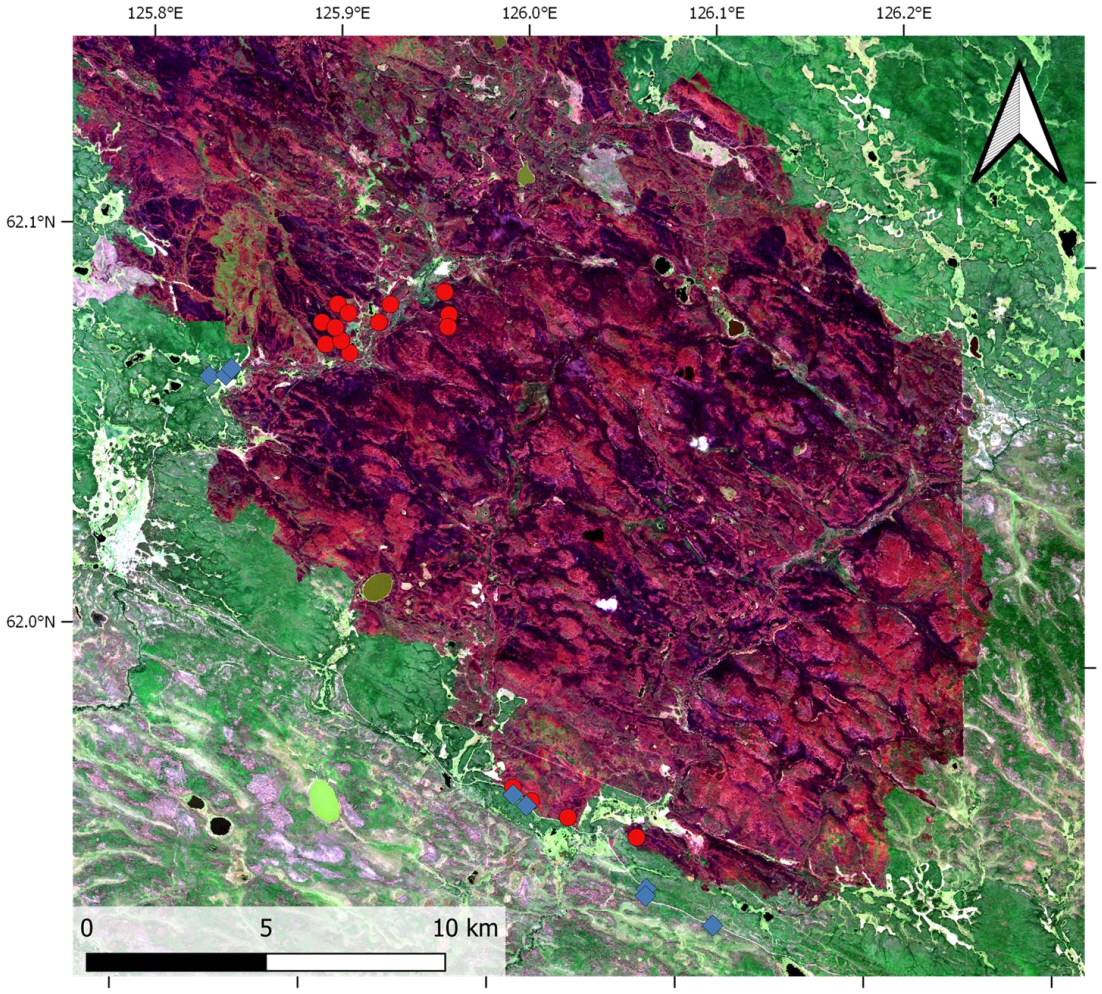
Tree cover (%)



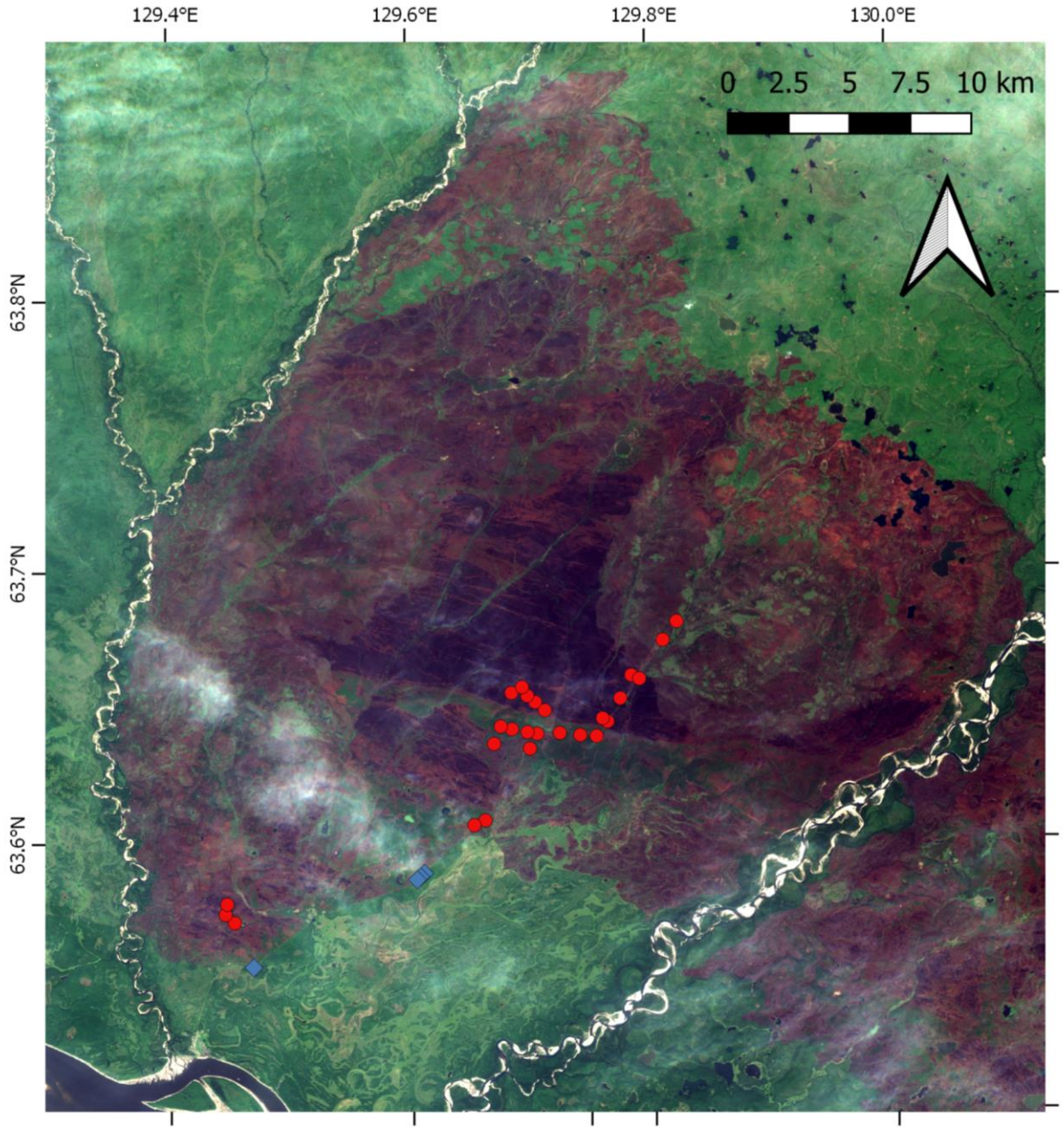
GFCC 30 m Tree Canopy Cover product for 2015, Sexton *et al.* (2013)

42 burned sites

12 unburned sites

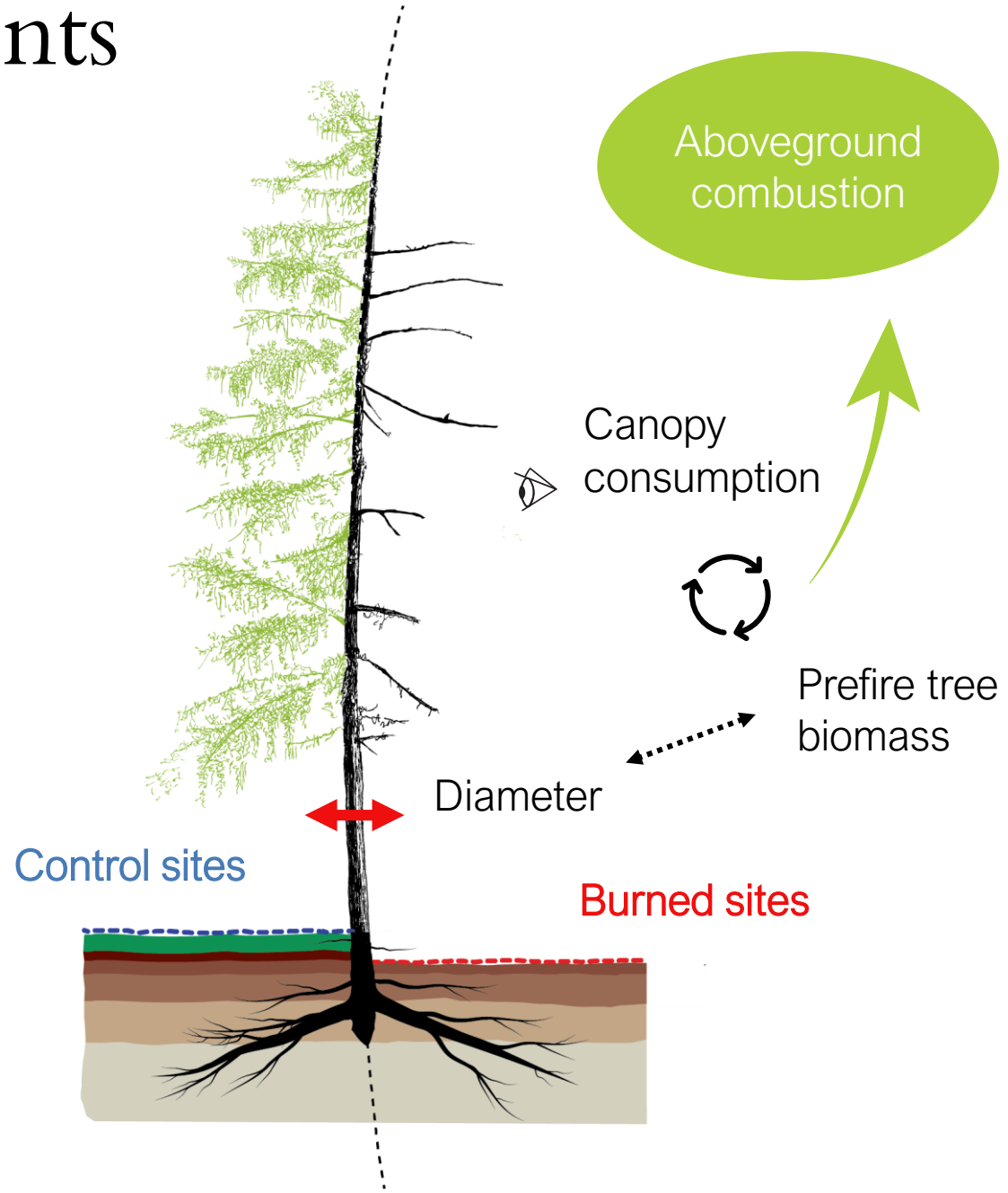


Copernicus Sentinel data [May, 2020], processed by ESA



Copernicus Sentinel data [May 2020], processed by ESA

Aboveground measurements

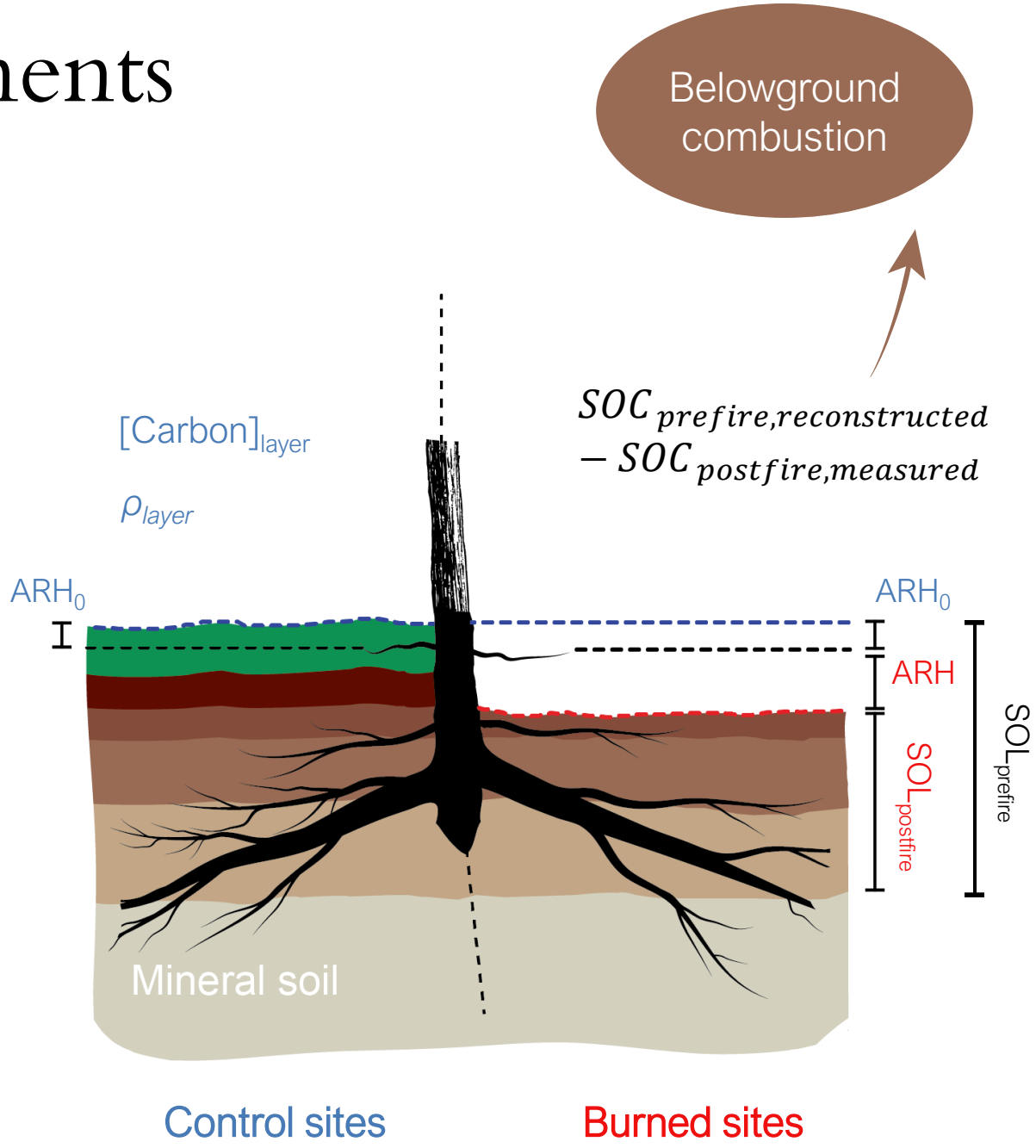


Belowground measurements

ARH: Adventitious root height

SOL: Soil organic layer (depth)

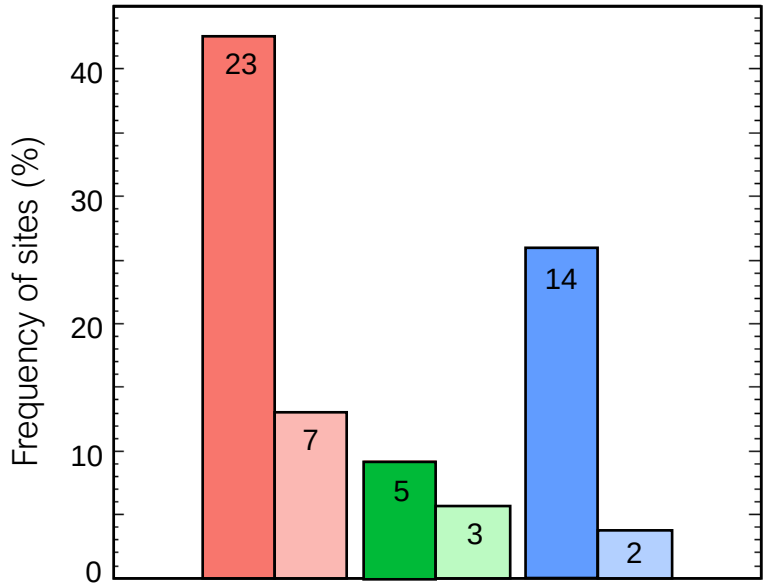
SOC: Soil organic carbon (stocks)

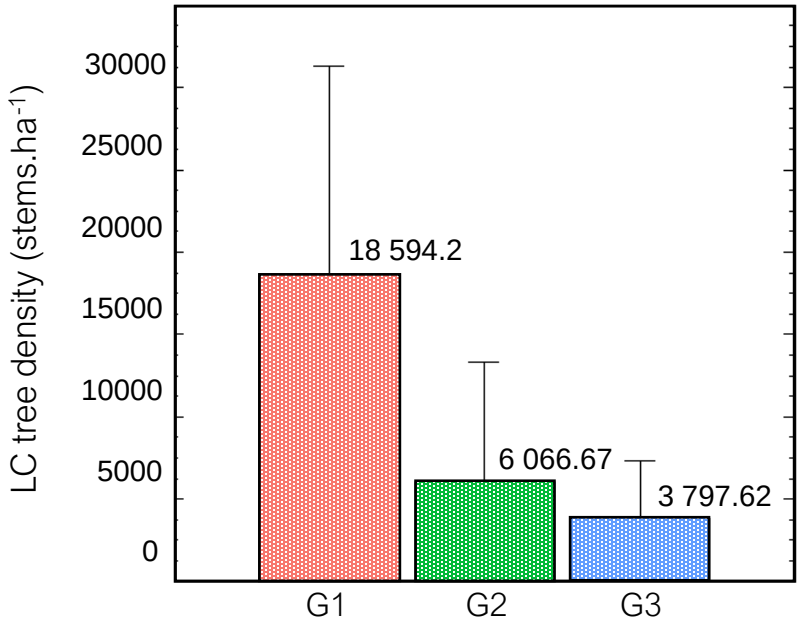


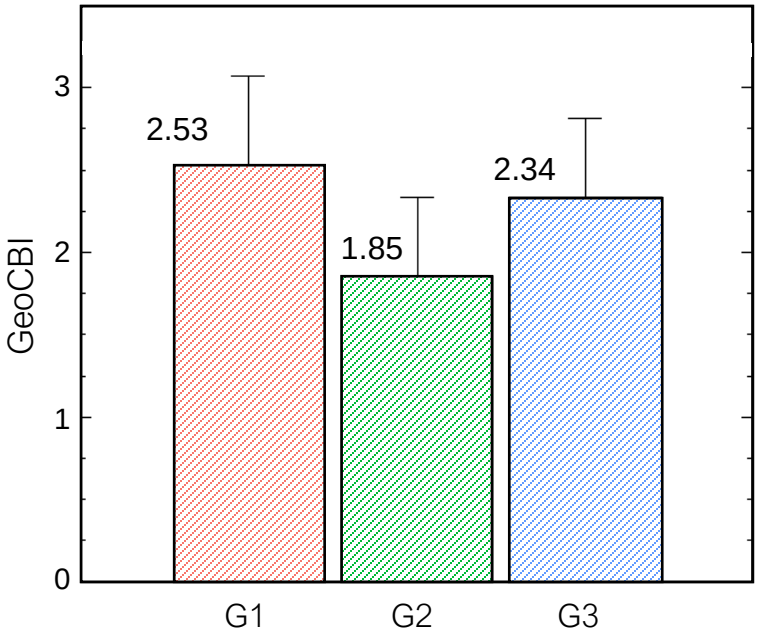
Larix Cajanderi dominant & dense plots

Mixed *LC* / *Pinus Sylvestris* & open plots

Larix Cajanderi dominant & open plots

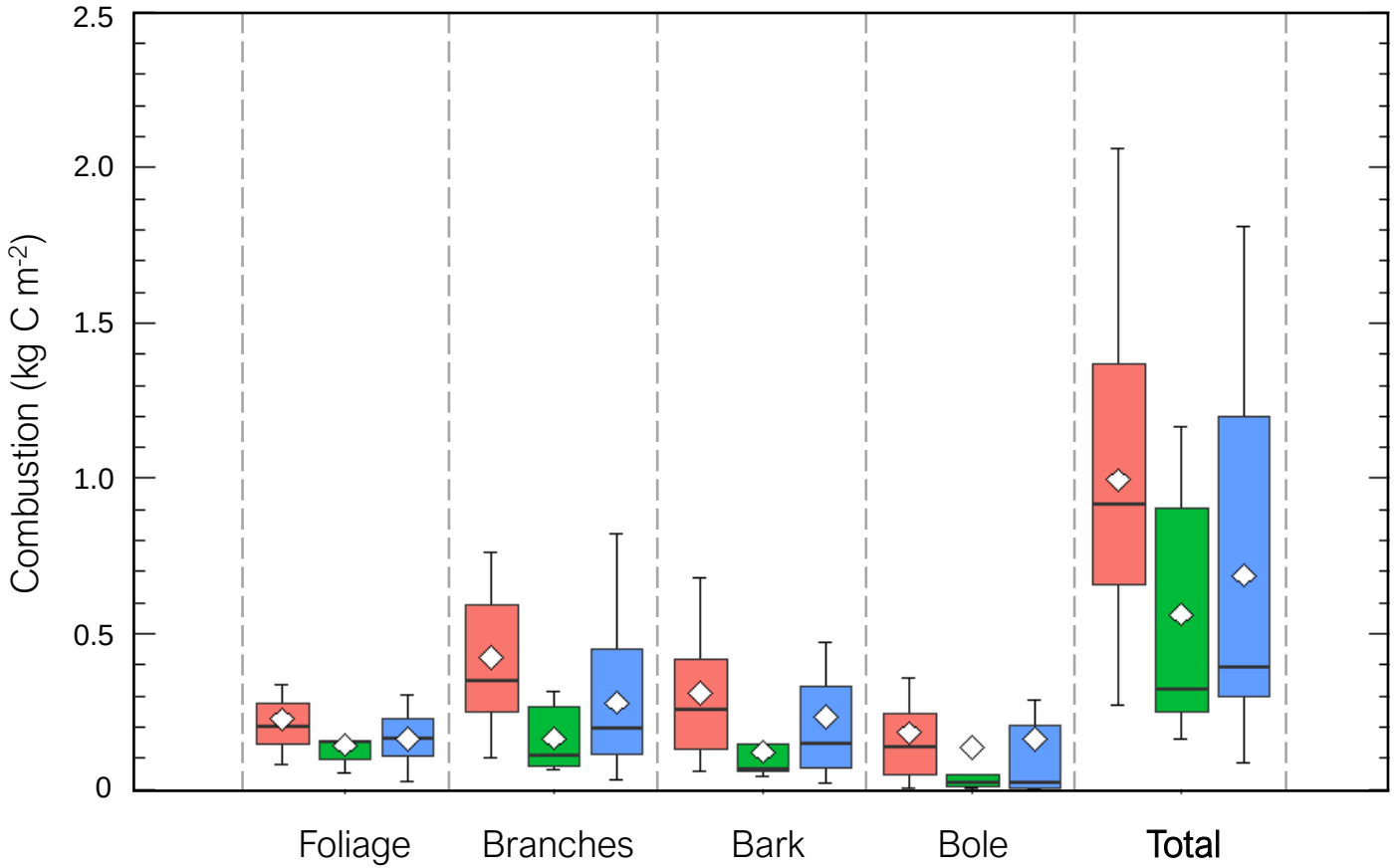






Aboveground combustion

➢ Overall mean : **0.97 ± 0.81 kg C m^{-2}**



Group 1: *Larix Cajanderi* dense sites

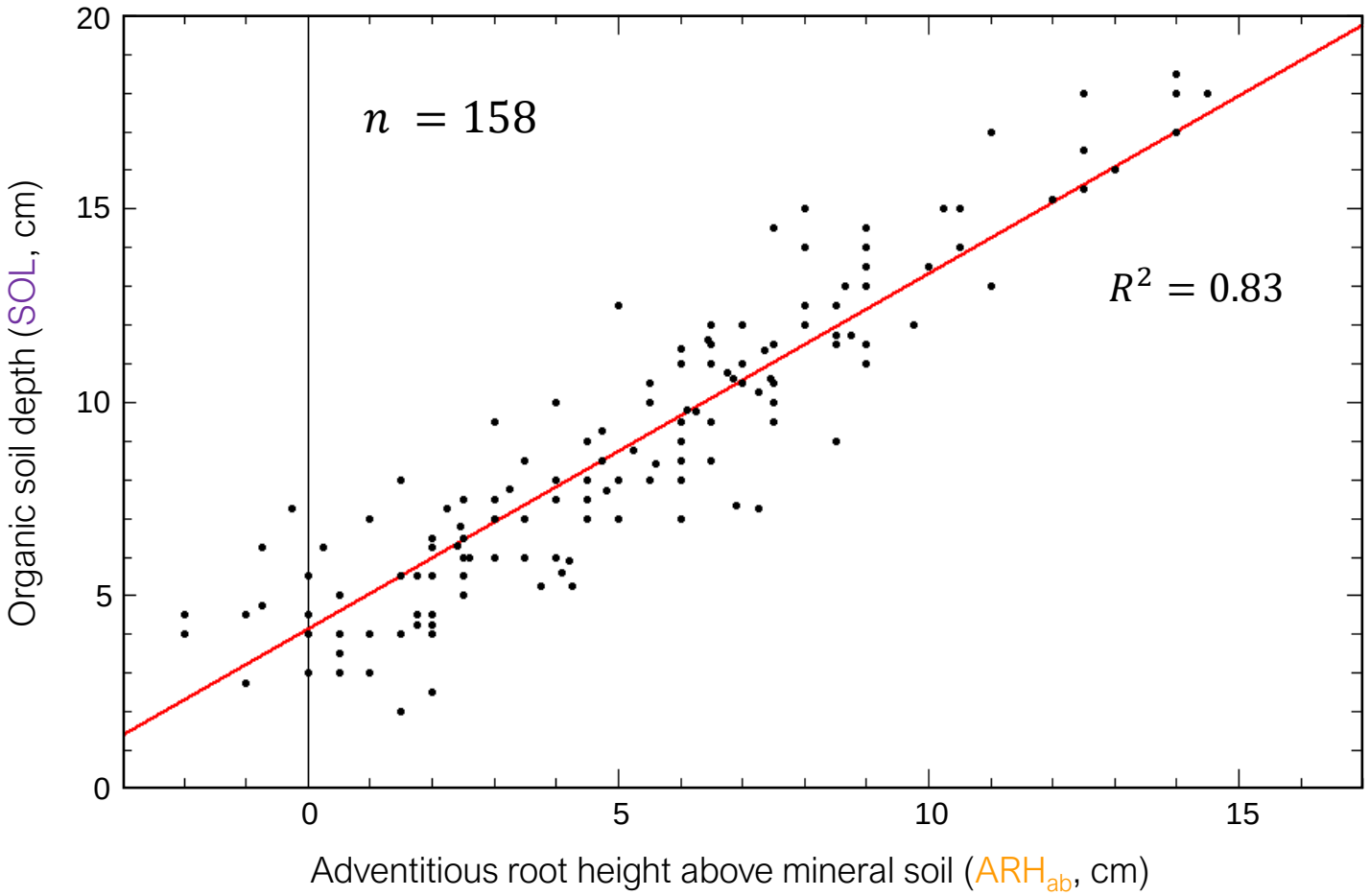
Group 2: Mixed *Larix Cajanderi*/*Pinus Sylvestris* open sites

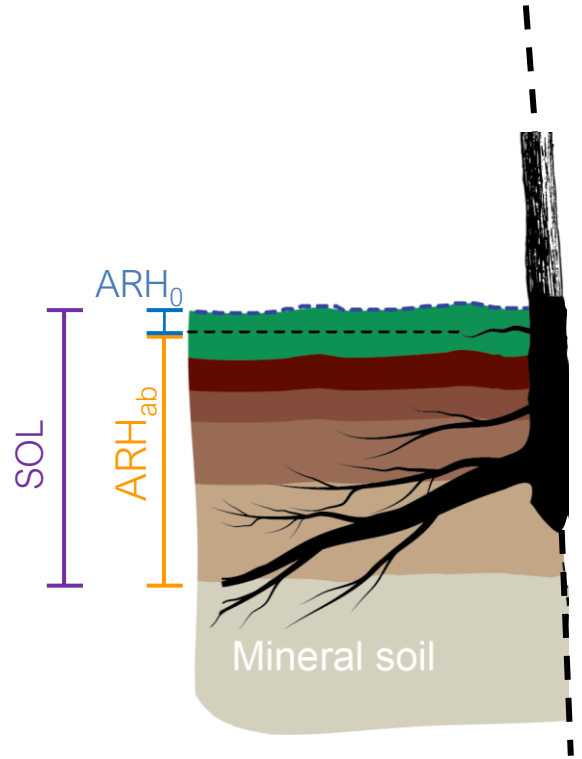
Group 3: *Larix Cajanderi* open sites

mean

Parameters used to reconstruct prefire SOC

$$SOL_{prefire} = 4.156 + 0.918 \times ARH_{ab}$$



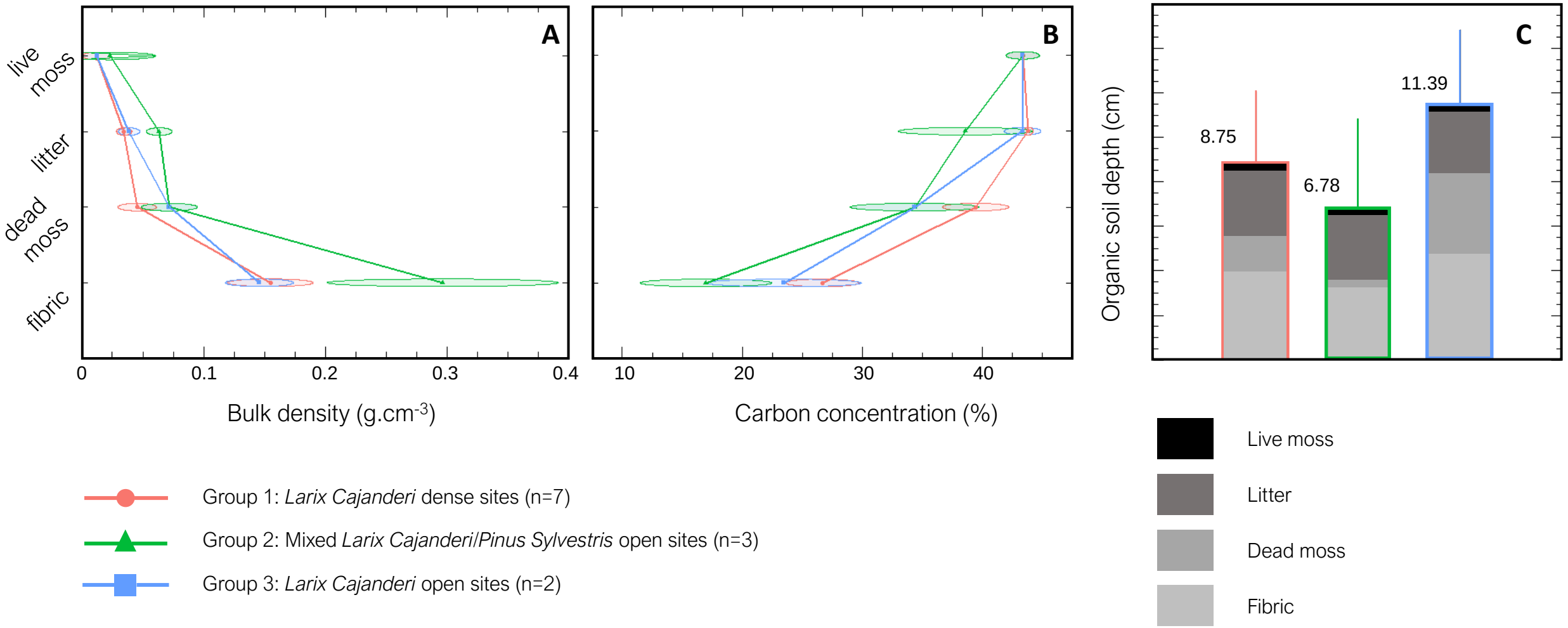


Control sites

- derived from measurements in unburned sites

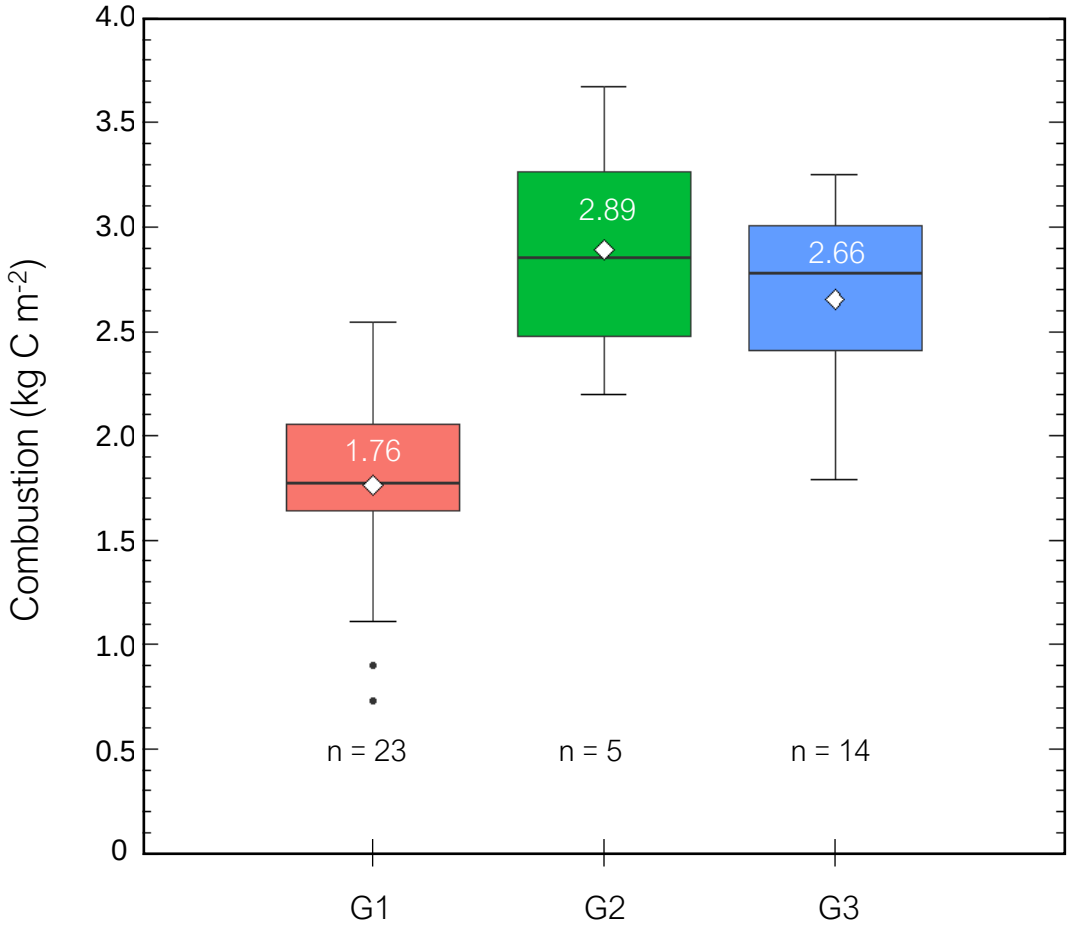
Parameters used to reconstruct prefire SOC

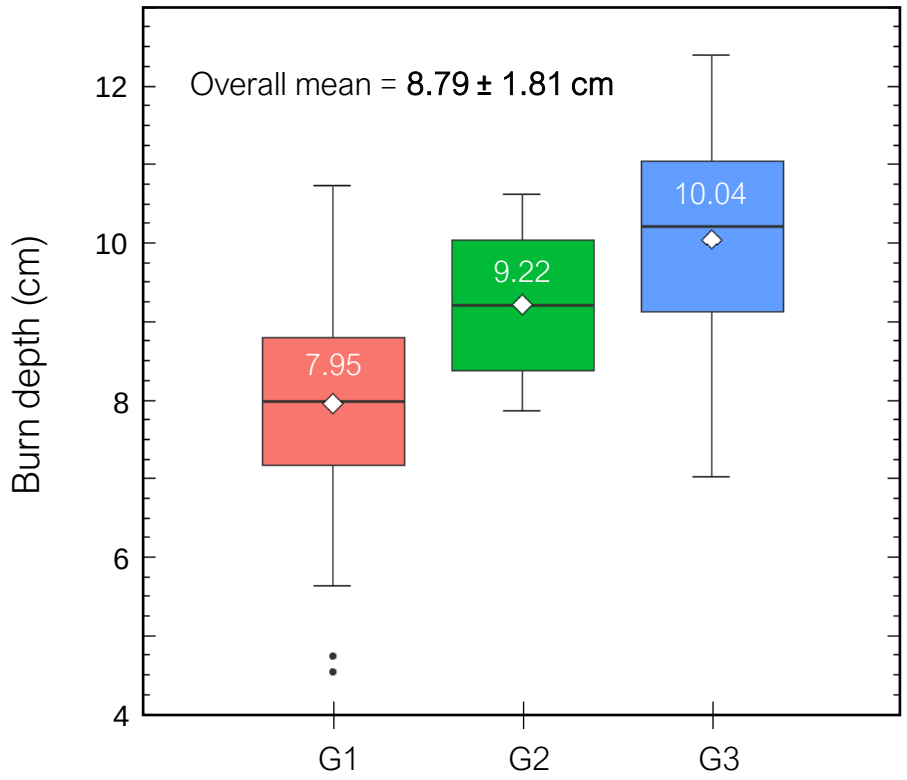
- derived from measurements in unburned sites



Belowground combustion

$$Combustion = SOC_{prefire} - SOC_{postfire}$$





- Group 1: *Larix Cajanderi* dense sites
- Group 2: Mixed *Larix Cajanderi*/*Pinus Sylvestris* open sites
- Group 3: *Larix Cajanderi* open sites
- mean

➢ Overall mean : **2.18 ± 0.68 kg C m^{-2}**

In summary

- Average combustion from field-sampled larch stands: **3.16 ± 1.05 kg C m^{-2}** (range from 1.26 to 6.12 kg C m^{-2})
- Approximately **70%** attributable to **organic soil combustion** (2.18 ± 0.68 kg C m^{-2})
- Dense and young stands (~60 years old) characterised by high fire severity (GeoCBI~2.5) and larger aboveground carbon combustion (G1 mean = 1.14 kg C m^{-2})
- Burn depth is thicker in older (>100 years old) and more open plots (G2 and G3) resulting in higher soil carbon losses

Future work perspectives

- Conducting an **uncertainty analysis** (Monte Carlo simulations with varied parameters and methodological choices for computing above- and belowground combustion)

- Investigating **drivers** of carbon emissions in both fire scars (plot-level attributes, prefire stand characteristics, fire attributes)

This study is part of the 'Fires Pushing Trees North' project funded by the Netherlands Organisation for Scientific Research (NWO)