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Recovery of Black Carbon Concentrations in Burned Forests

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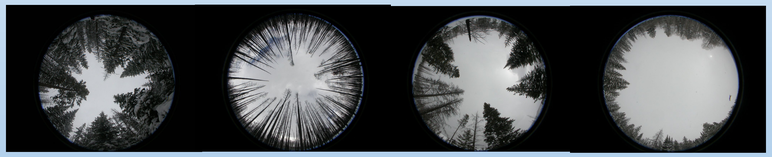
Problem

- As climate warms, snowpacks are declining, while forest fires are increasing across the western US.
- As burned forests disintegrate following fire, they shed black carbon (BC) and burned woody debris into snowpack below, reducing snow albedo, and with increased insolation on the snowpack surface, increase solar energy absorbed by snow during snowmelt following forest fire.
- Solar radiation is important for snow melt, and even small increases black carbon concentrations in snow reduces snow-water storage, advances the timing of snowmelt and snow disappearance date following fire.
- **Goal:** This study aims to quantify BC deposition on snow in burned forests over the postfire recovery period and relative to burned forest class including, high severity burned forest, moderate severity burned forest, open meadow, and unburned forest (Figure 1) in the Triple Divide Region of Western Wyoming.



Hypothesis

- Black carbon concentrations in snow will be greatest in high severity and moderate severity burned forests immediately following fire.
- Black carbon concentration in snow will recover over decades following fire to resemble that of the open meadow or unburned forest snow.

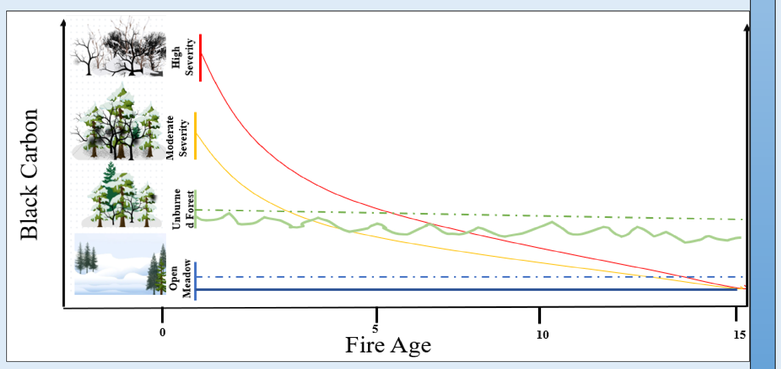


Figure 1: Conceptual model of postfire recovery of black carbon concentrations relative to burned forest classes over years since fire

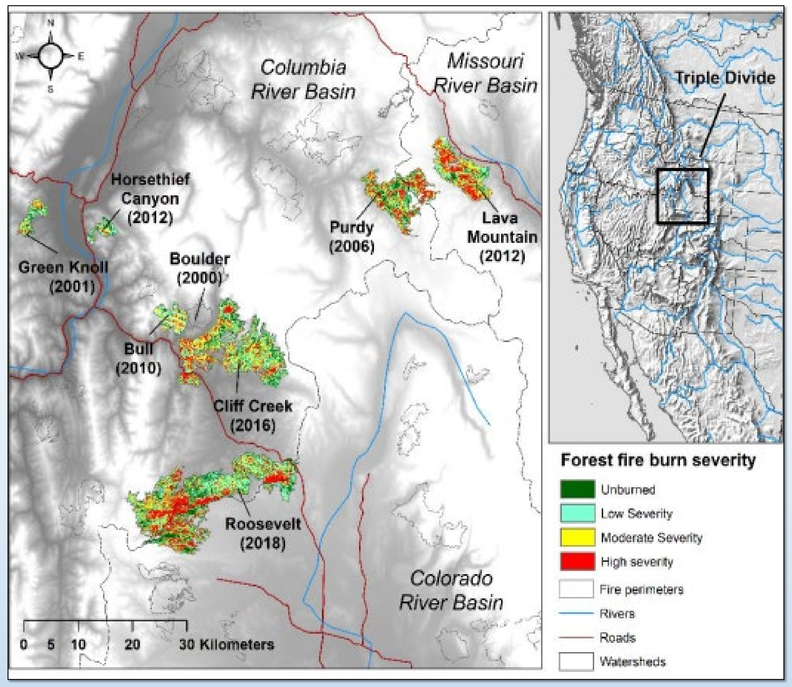


Figure 2: Snow samples were collected from a chronosequence of eight burned forests in the Triple Divide Region of Western Wyoming, the headwaters of the Columbia, Colorado, and Missouri Rivers. Map from Gersh et al., 2022

Methods

Field Sampling:

- Snow surface samples (0-3cm) and near surface samples (0-30cm) were collected in four forest classes (high and moderate severity burned forest, unburned forest, and open meadow) from a chronosequence of eight forests burned 1-20 years prior to snow sampling.

Geochemical analysis:

- Black carbon concentrations in snow samples were analyzed in the Portland State University Snow Laboratory using, a Cetac Autosampler, Peristaltic Pump, Apex Ultrasonic Nebulizer, and a Single Particle Soot Photometer (SP2).

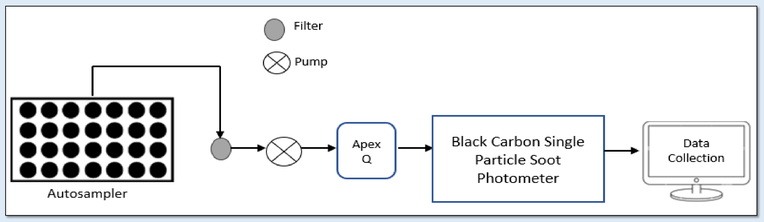


Figure 3: PSU Snow Laboratory SP2 system for testing snow sample.

Next Steps: SNICAR radiative transfer modeling of snow albedo associated with measured BC concentrations.

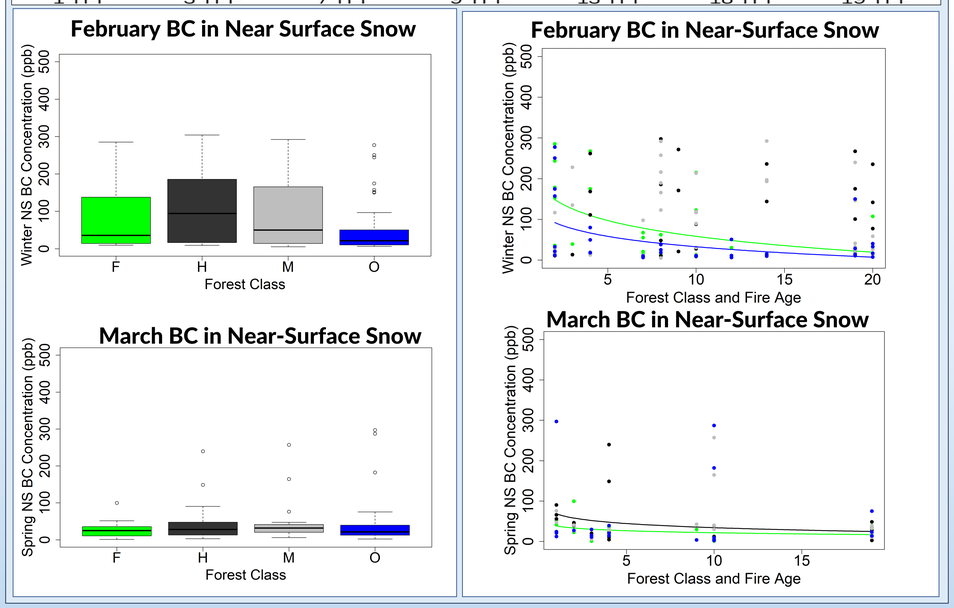


Figure 4: Black carbon concentrations in snow collected in high and moderate severity burned forests, unburned forest, and open meadows across a chronosequence of eight forests burned from 1-20 years prior to sampling.

Results/Discussion

- February winter samples were elevated during periods of no snowfall, and March spring samples were diluted during periods of fresh snowfall.
- BC concentrations are greatest in high and moderate severity burned forests but spill over beyond the forest fire perimeter into nearby unburned forests and open meadows.
- BC concentrations in high and moderate severity burned forests persist across the 20 year postfire recovery period likely due to associated prefire antecedent insect associated mortality.

Conclusions

- BC deposition from burned forest canopies in snow extends beyond the burned forest perimeter, and in some sites persists for decades following fire.

Acknowledgments

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