PERMAFROST PATHWAYS
Connecting Science, People, and Policy for Arctic Justice and Global Climate

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ARCTIC-BOREAL WILDFIRE TRENDS AND HEALTH IMPACTS

SCIENCE BRIEFING NOTES FROM PERMAFROST PATHWAYS AT WOODWELL CLIMATE RESEARCH CENTER

The Arctic is warming nearly four times faster than the global average, accelerating a host of environmental hazards and catastrophic impacts, including more intense and frequent wildfires at high latitudes where carbon-rich permafrost underlies much of the ground surface.[1] Fires in the Arctic-boreal region are not atypical; yet the combination of rising temperatures, increased lightning strikes, and reduced snow cover are contributing to higher ignition rates and longer burns with shorter intervals between each fire.

Permafrost Pathways scientists and policy experts are actively working with wildfire researchers and Indigenous knowledge-holders in the Arctic-boreal region and across the US to better understand both the immediate and long-term implications of these changing fire regimes.[2] Congressional leadership is ultimately necessary to support continued research and to advance strategies for mitigating harm arising from wildfire smoke. The following information is intended to provide context for this effort and to stimulate further discourse on potential solutions.

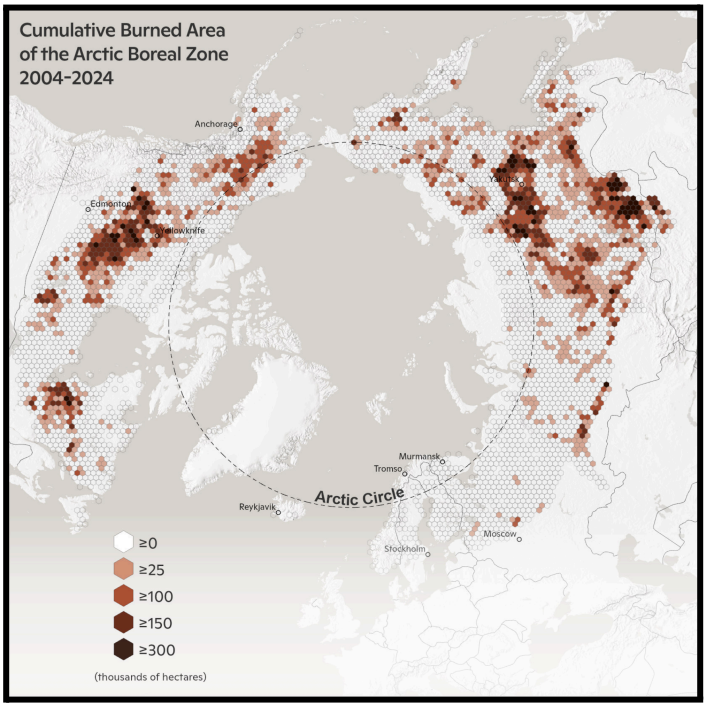
What are "Arctic-boreal wildfires"? *For purposes of this briefing, the authors use the term "Arctic-boreal wildfires" to refer to wildfires that ignite and/or burn in both the Arctic tundra and boreal forests. Boreal forests are found in high latitude environments where temperatures fall below freezing between 6 to 8 months out of the year. Home to coniferous tree species (pine, spruce, and fir) and broadleaf species (poplar, birch), these forests host 481 million hectares of the remaining primary forest, account for 30% of the global forested area, and store roughly 2/3rds of global forest carbon - primarily in their soils. The boreal forest region spans eight countries, including several Arctic nations: Canada, the US, Russia, Norway, Sweden, Finland, China, and Japan. Large tracts of these forests in US, Canada, and Russia are considered "unmanaged" and are therefore exempt from certain greenhouse gas reporting requirements.*

RECENT TRENDS FROM ARCTIC-BOREAL WILDFIRES (NORTH AMERICA FOCUS)

In recent years, fires in North American boreal forests across US and Canada have burned double the acreage since the mid-20th century. Researchers have accounted for a seven-fold increase in extreme boreal fires between 2003 and 2023, with 174 million hectares burned across in the Arctic-boreal region over the past 20 years.

- As of September 2025, over 7.5 million hectares (almost 19 million acres) burned in Canada during the 2025 fire season. This is the second-highest annual burn extent for Canada in recorded history (after 2023).
- Over 1 million acres burned across Alaska during the summer of 2025, the highest since 2022. Several fires burned close to Fairbanks, making this the fourth summer in a row with over 100 hours of restricted visibility at Fairbanks International Airport due to smoke.

Due to human activity and natural climate shifts in the Arctic, the burned area across Alaska and Canada is expected to double by 2050.



Map by Greg Fiske, Woodwell Climate Research Center

[1] Permafrost refers to perennially frozen ground that underlies approximately 80% of the land in Alaska and 15% of exposed land surface in the Northern hemisphere. Permafrost soils contain nearly 1.4 trillion tons of carbon (twice the amount currently in the atmosphere). Due to warming Arctic temperatures and increasing wildfires in the permafrost region, 7% of near-surface permafrost has been lost in 30 years, and an additional 77% may be lost by 2100 under the highest GHG emission scenarios.

[2] Fire regimes can generally be defined in terms of fire frequency, seasonality, type, typical size and severity, and ignition types. Arctic-boreal fire regimes are complex and require multi-disciplinary research.

Carbon (GHG) emissions: Compared to wildland fires in other parts of the US, which are primarily fueled by vegetation, fires occurring in these high-latitude forests burn through carbon-rich soils (permafrost and peatlands, see map, below), which release a significant amount of greenhouse gases (GHG), including carbon dioxide and black carbon, into the atmosphere.

- Boreal forests have historically served as an important land-based carbon store; but between 2001 and 2020, over 30% of the Arctic-boreal region was found to be releasing more CO_2 – a shift that researchers have attributed to an increase in high latitude wildfires.
- On average, half of all annual CO_2 emitted from wildfires in the US originate from Alaska-based wildfires.
- Carbon emissions from Canadian fires in 2023 were 3-4 times higher than emissions from all other sectors in Canada, combined (and exceeded fossil fuel emissions from every country except China, the US, and India).
- Carbon release from Arctic-boreal wildfires continues long after fires are extinguished, accelerating permafrost thaw and associated emissions for decades.
- Less than 4% of the $3 billion spent in the US for federal fire suppression is directed to Alaska; yet, for every $13 dollars spent on managing fires in the Arctic-boreal, the US could prevent one ton of CO_2 emissions.

Infrastructure damage: Arctic-boreal wildfires often burn in less-densely populated areas of Alaska and Canada compared to those in the lower 48. These fires can still cause significant damage to surrounding infrastructure, including utilities critical for economic development and security. **Recall: Wildfires in the US are contributing to an estimated $400 - $900 billion/year in damages and economic losses (equivalent to 2-4% of the nation's GDP).**

Ecosystem degradation: Arctic-boreal wildfires are reshaping forest composition and local habitats–impacts that may undermine the capacity of boreal forests to effectively sequester soil carbon (and protect permafrost soils). Ash, charred organic matter, and the release of chemicals from burned vegetation (including heavy metals and nutrients) may also contaminate waters used for drinking and which serve as key aquatic habitats for food sources.

PUBLIC HEALTH IMPLICATIONS OF ARCTIC-BOREAL WILDFIRE SMOKE ON ALASKA & THE LOWER 48

The implications of Arctic-boreal fires on air quality are far from localized: Smoke from fires in Alaska and Canada can travel hundreds to thousands of miles, impacting the health and well-being of communities across the US. In the past few fire seasons, smoke from these northern fires has drifted to the lower 48, causing noticeable haze and raising concerns of local, regional, and national health authorities.

- Wildfire smoke contains large quantities of fine particulate matter ($PM_{2.5}$) that penetrate into the lungs and bloodstream, substantially exacerbating risks of respiratory and cardiovascular illness.
    - *E.g.,* high levels of $PM_{2.5}$ originating from 2023 Canadian wildfires were associated with substantial increases in people seeking emergency care for asthma in New York City.
- Smoke from wildfires across the circumpolar Arctic-boreal region led to an estimated 21,000 excess deaths each year between 2001-2020 (including 8,000 deaths in non-Arctic countries).
- Arctic wildfires are also known sources of atmospheric mercury and volatile organic compounds–exposure to which has been linked to neurological and cardiovascular complications.
- Children, elderly, and those with existing health conditions are most at risk. Wildland firefighters also face significant exposure to smoke; however, long-term health effects are not well-documented.

Health impacts of smoke are not confined to physical health symptoms: Studies confirm mental health impacts related to displacement and smoke exposure following wildfires, which can lead to more cases of anxiety and post-traumatic stress disorder. Smoke also compromises visibility, creating heightened risks for travelers; rural communities that rely on air transportation for transit, food, and resources; emergency transport vehicles; and those evacuating wildfire zones.

PRIORITY POLICY ACTIONS FOR ENHANCED ARCTIC-BOREAL WILDFIRE MANAGEMENT/RISK MITIGATION

Permafrost Pathways researchers recognize the importance of consulting with public health experts to most effectively address the consequences of smoke exposure from Arctic-boreal wildfires on communities. As this smoke is ultimately a consequence of intensifying wildfires in the Arctic-boreal region, Permafrost Pathways also recommends national coordination for improved wildfire management and response. Accordingly, Permafrost Pathways respectfully offers the following recommendations for government consideration:

Priority 1. Increasing support for federally-led and Arctic-inclusive wildfire science research, via:

- Ensuring that portfolios of DOI's Office of Wildland Fire Management, BLM's Fire Service, and other federal protection agencies named in Alaska's wildfire management policies are sufficiently resourced in FY26+;
- Endorsing legislative proposals that include dedicated funding for research into regionally-focused wildfire

modeling, mapping, and early warning and detection technologies, and other mitigation tools;

- Maintaining the US federal government's position as a leader in Arctic science research, including in Earth System Model development, and other programming of NSF and NOAA; and
- Supporting a policy of enhanced wildfire suppression in carbon-rich permafrost zones, including across Alaska's National Wildlife Refuge System.

Priority 2. Removing barriers to community-led wildfire risk management and resilience, via:

- Dedicating resources to enable the design and implementation of co-produced and up-to-date Community Wildfire Protection Plans (CWPP) that account for natural sources of carbon, including permafrost soils;
- Differentiating "cultural burning" from "prescribed fire" to reinforce Indigenous stewardship rights and Tribal sovereignty and to appropriately exempt Tribal fire programs (Good Fire) from prohibitive regulations;
- Permanently authorizing Indigenous communities to conduct culturally prescribed burning on wildfire-prone federal lands via co-stewardship agreements with public land agencies, issuance of research grants, and statutorily-backed collaborative programs;
- Amending national disaster relief and emergency assistance frameworks to include wildfire (and smoke) and compounding events that damage public infrastructure, natural landscapes, and sites of cultural significance.

Priority 3. Accounting for expansive and long-term [public & ecosystem] health impacts of Arctic-boreal wildfires, via:

- Improving accounting of warming-induced GHG emissions from natural carbon stores/sources (boreal forests and permafrost zones) to inform carbon budgets and national GHG inventories.
- Prioritizing the protection of public health and carbon in national and pan-Arctic wildfire management governance policies.
- Dedicating resources for federally-funded research into the near- and long-term health impacts of wildfire smoke exposure.
- Participating in pan-Arctic wildland fire governance dialogues and future coordinated frameworks, including those developed in partnership with Canadian decision-makers and Arctic Indigenous leaders.

Other: Continue implementing identified improvements for cohesive and coordinated national wildland fire management and response, including suggestions for modernizing workforce development and firefighter safety measures.

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