The future of Arctic fires: Leveraging ongoing activities, new efforts, and international cooperation

ABC-iCAP Project
Technical Report 5

The future of Arctic fires: Leveraging ongoing activities, new efforts, and international cooperation

ABC-iCAP Technical Report 5

The future of Arctic fires: Leveraging ongoing activities, new efforts, and international cooperation
ABC-iCAP Technical Report 5

Citation
Paunu, V.-V. and J.L. McCarty et al., 2023. The future of Arctic fires: Leveraging ongoing activities, new efforts, and international cooperation. Arctic Black Carbon impacting on Climate and Air Pollution (ABC-iCAP) Technical Report 5. December 2023 vi+20pp.

Authors
Ville-Veikko Paunu[1], Jessica L. McCarty[2]

Contributor
Simon J. Wilson[3]

[1] Finnish Environment Institute (Syke)
[2] NASA Ames Research Center, USA
[3] Arctic Monitoring and Assessment Programme Secretariat, Norway

Layout and technical production
Burnthebook, United Kingdom (www.burnthebook.co.uk)

This project is funded by the European Union

The report was prepared as one of the deliverables under the project *Arctic Black Carbon impacting on Climate and Air Pollution (ABC-iCAP)*, funded by the European Union.

abc-icap.amap.no

Contents

Executive Summary

Fires in the Arctic region are gaining more attention and driving increased concern from the public, the scientific community, and policymakers. An increasing number of scientific projects, collaboration efforts, media coverage, and policy assessments have been and are being implemented and published regarding this emerging and important wildland fire phenomenon. In short, this increased activity comes from the recognition of increasing fire risk and activity close to, within, and impacting the Arctic. There is a need to integrate these numerous and expanding local, national, and international efforts to avoid redundant and overlapping efforts and to focus resources more efficiently. As a response, this report suggests short- and long-term goals to respond to the growing fire risk and fire danger in the Arctic. All efforts call for more integrated international collaboration and greater recognition of the importance for Arctic communities to be collaborators and leaders.

The three most critical and achievable short-term goals to move science-informed policy and management forward, and that should be accomplished within the next three to five years, are:

1. Develop and document adaptation and intervention strategies for Arctic and boreal fires

Information and data on adaptation and intervention options to reduce wildland fire risk and danger in the Arctic and boreal regions are not currently collected nor available in a centralized database. For knowledge to be shared in a centralized manner throughout the Arctic states, more information, details, and experiences from the effects of different intervention options, from local communities to policymakers, are needed. Further, this should be in a location for all to access, incentivizing the gathering of new information and production of lessons learned from shared strategies. This would be analogous to the BAT/BAP (best available techniques/practices) concept used with anthropogenic emissions and climate model intercomparison assessments.

2. Develop a Pan-Arctic and boreal fuel load spatial data product

In order to assess fire risk, quantify impacts of fires on climate and air quality, and to accurately model fires across a landscape, a comprehensive spatially- and temporally-explicit fuel load product is needed. Geospatial data of many fuel types are available, with many Northern regions having readily-available maps and fuel loadings by vegetation type and/or species and other regions having published but not readily-accessible data, but a comprehensive Pan-Arctic and Pan-Boreal high spatial resolution (≤ 30 m) fuel load product is lacking. A data fusion effort would be needed to stitch together and validate fuel loadings to create a unified and open-source product.

3. Extend the definition of fire season

Traditionally the fire season in the Arctic and boreal region has been defined by the growing season, beginning in May and lasting until September. In recent years this region has witnessed fires both earlier (starting in April) and later (continuing into November), with growing evidence of holdover fires, i.e., 'zombie fires', burning year-round in high latitude peat areas. We need to recognize the lengthening fire season to be able to develop appropriate adaptation and intervention strategies for community preparation, as well as wildland firefighting and land management response to a longer fire season.

Introduction

1

There is increased attention to wildfires in the Arctic region involving the public, scientific community and policymakers. An increasing number of scientific projects, collaboration efforts and policy assessments, with associated media coverage, have addressed the emerging and important wildland fire phenomenon. There are also numerous outreach initiatives, including many workshops, webinars, and reports. However, there is a lack of coordination between the activities, leading to fragmented work and networks.

In the past, the focus has been on the impact of fire on ecology, specifically forests, peatlands, and permafrost. Recently, there have been calls for a more holistic approach on Arctic fires, to streamline and integrate efforts to understand and prepare for the fires - both in a scientific context and for policy and fire management. Policy and fire management decisions will be done and applied on a national to local level, and local characteristics determine the best practices to deal with the fires. But there is potential and need to share knowledge and best practices across the Arctic, in addition to any cross-border fire fighting support.

This report is designed to provide a roadmap for collaborative research that can assist the Arctic Council and individual Arctic states with best management practices and policy development. Within this report, we aim to recognize the strengths and weaknesses of the current situation, while providing a first effort at naming potential solutions. The overarching context is that scientific endeavors in Arctic and boreal fires are always relevant to Arctic communities, fire and land managers, and policymakers. Ultimately, future activities related to Arctic wildland and prescribed fires will need to be collaborative and research and knowledge co-production efforts must follow suit.

Recent and ongoing activities (as of December 2023)

2

Many wildland fire monitoring and modeling scientific activities have a generally global focus, with the end goal of integrating deliverables into climate models and assessments. Comparatively, the Arctic still has low fire activity compared to more southern regions, though the boreal region has experienced extreme fire seasons in 2020 in Eurasia and in 2023 in Canada larger than temperate or tropical fire activity. Moving forward, the pan-Arctic, with the inclusion of the pan-boreal given its impact on the Arctic, needs specific attention to enhance the knowledge on wildland and prescribed fires in the region. There is a need to prevent duplication of effort. Here we list activities with Arctic focus. The text box below highlights just a few recent and ongoing multinational pan-Arctic and/or pan-boreal activities and is not meant to be comprehensive. More details on the activities can be found in the Appendix.

ABC-iCAP

This EU-funded Arctic Black Carbon impacting on Climate and Air Pollution (ABC-iCAP; https://abc-icap.amap.no/) project focused on sharing knowledge, raising awareness, engaging with stakeholders, expert analysis and building capacity related to black carbon in the Arctic. On Arctic wildfires, the project organized three webinars, which brought together Arctic fire researchers, Arctic indigenous representatives, and other experts, especially from (but not limited to) the Arctic Council Member States. The webinars (see project website for webinar recordings) showed that there was and is wide and increasing interest on the topic, with an audience consisting of scientists, government and academic representatives, and the press. The number of participants grew from the first webinar to the third, with the last event organized after requests from the participants. Participants also indicated the wish for the series to continue. As the project provided the resources to organize the event, the future of the webinar series is uncertain after the project. As the Norwegian Chairship has planned online events as part of their Wildland Fire Initiative, the webinars of the ABC-iCAP project can provide a template for such an effort. As part of the project, three research visits were organized between Finnish and US fire experts. The visits and research exchange were an example of needed pan-Arctic collaboration on Arctic fires. They also demonstrated how networking and collaboration building are often based on a few key individuals and their activities and contacts, as opposed to established structures.

HTAP

The Task Force on Hemispheric Transport of Air Pollution (TF HTAP or HTAP; https://htap.org/) is an ongoing mostly volunteer effort from countries that are Parties to the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP). A recent HTAP effort is a Multi-Model, Multi-Pollutant Modeling Study of Fire Impacts. The activity has a global scope, but there is emphasis on the Northern Hemisphere. It focuses especially on developing smoke and pollutant transport modeling. In autumn 2023 the activity held a joint workshop with the IGAC/BBURNED project on fire emission datasets. Timeline for the activity is 2023-2027. As part of the activity, several workshops have been held and more are planned to organize the work. The activity has an email list and an options paper open for contributions.

IGAC - BBURNED & PACES

This ongoing and mostly volunteer effort is an offshoot of the International Global Atmospheric Chemistry (IGAC; https://igacproject.org/) Project, which operates under the umbrella of the Future Earth (https://futureearth.org/) initiative. IGAC is mainly funded by U.S. and Japanese governmental scientific organizations. The BBURNED (Biomass Burning Uncertainty: ReactioNs, Emissions and Dynamics; https://igacproject.org/activities/bburned) project is led and supported by a consortium of mainly EU and US fire researchers, with a focus on experts from the atmospheric science community. The end goal is to improve emissions modeling and therefore, emissions estimates of past, current, and future fire events at local to global scales, as well as improve atmospheric chemistry process modeling. BBURNED engages and is co-led by the research groups of the three most common global fire emissions databases: GFED (https://www.globalfiredata.org/), GFAS (https://www.ecmwf.int/en/forecasts/dataset/global-fire-assimilation-system), and FINN (https://www2.acom.ucar.edu/modeling/finn-fire-inventory-ncar). BBURNED is a complementary project to PACES (Air Pollution in the Arctic: Climate, Environment and Societies, https://pacesproject.org/about). PACES is an additional IGAC project that started in 2016 and has participation across Europe, UK, North America, and Japan.

ACRoBEAR

The ACRoBEAR (Arctic Community Resilience to Boreal Environmental change: Assessing Risks from fire and disease; https://bag.leeds.ac.uk/projects/acrobear/) project studies the health risks imposed by wildfires in the high latitudes. This project is funded by the Belmont Forum (https://www.belmontforum.org/), and includes investigators from the UK, US, Canada, Sweden, Finland, and, until 2022, Russia. The project includes engagement with local and Indigenous communities, specifically in Alaska, Eastern Siberia and Sweden. The project will consider several climate scenarios. One goal is to produce a web-based dashboard system to support decision makers on adaptation measures and actions.

WMO VFSP-WAS Fire & Arctic Working Group

The World Meteorological Organization (WMO), Global Atmosphere Watch (GAW) Programme has a working group named the Vegetation Fire and Smoke Pollution Warning Advisory and Assessment System (VFSP-WAS; https://community.wmo.int/en/activity-areas/gaw/science/modelling-applications/vfsp-was). The VFSP-WAS aims to enhance the ability of individual countries to deliver timely and quality fire and smoke forecasts, observations, information and knowledge. This is done via an international partnership of research and operational communities, including a focus on building capacity to prevent fires and damage from them, developing fire management policies, fire and smoke observation and prediction facilitation. In 2024-25, the Arctic and Boreal will be a focus under the “Fire & Arctic Working Group”. Potential themes include Toxic organic contaminant transport & emissions; Biomass burning smoke aerosol modeling (reanalysis & forecast); Biomass burning smoke aerosol impact on cryosphere through deposition on snow/ice; and Smoke impacts on aerosol-cloud interactions (ACI). Members of the Fire & Arctic Working Group can include any representative from the WMO countries.

Arctic PASSION

Arctic PASSION (Pan-Arctic Observing System of Systems Implementing Observations for Societal Needs, https://arcticpassion.eu/) is a large EU-funded project with an Arctic focus. It includes North American as well as European partners. As part of the project, Shared Arctic Variables (SAVs) are developed. Finnish Meteorological Institute (FMI) leads the SAV work on Arctic wildfires. This SAV’s aim is to help with response and adaptation to the wildfire phenomenon in the Arctic environment. The goal is to have broadly shared benefits throughout the Arctic, and consider the needs of Indigenous peoples. The project held a series of workshops in Finland on the topic with Nordic Indigenous participants involved. There is a plan for a pilot service for improving the response to wildfires in the Arctic, and another on information emissions with improved forecasting.

National initiatives

- US: Wildland Fire Mitigation and Management Commission Report - https://www.usda.gov/topics/disaster-resource-center/wildland-fire/commission. The commission, co-chaired by the Departments of Agriculture, the Interior and the Federal Emergency Management Agency, was created in 2021 to give recommendations on how federal agencies could improve wildfire management. The commission produced two reports in 2023, with the second and final one containing 148 recommendations.
- Finland: Arctic Fire and Rescue Network of Knowledge (ArcResc Network) - https://sppl.fi/palvelut/asiantuntijatoiminta/hankkeet/arcresc/. The Ministry of Foreign Affairs Finland financed an ArcResc-project in 2021-2023. The focus was on international cooperation of rescue services in the Arctic region, i.e. the Arctic Council member states. Fire was one of the themes. The project resulted in the creation of ArcResc Network. So far the Network collects 12 fire and rescue services from Finland, Sweden, Norway, Iceland and Canada, and offers a platform for sharing ideas, information and knowledge, as well as cooperation development.
- Sweden: Nordic fire network https://skogsbrandnorden.org/. The network was established in 2020 by the committee of senior officials (EK-FJLS Executive) under the Nordic Council of Ministers for Fisheries, Aquaculture, Agriculture, Food and Forestry (MR-FJLS). Focuses on knowledge and experience sharing on managing wildfire problems in the Nordic countries.
- Canada: WildFireSat https://www.asc-csa.gc.ca/eng/satellites/wildfiresat/. Canada plans to launch the WildFireSat mission in 2029 to monitor Canadian wildfires from space to support wildfire management. This initiative is led by the Canadian Space Agency, Natural Resource Canada, and Environment and Climate Change Canada. It will also provide smoke and air quality information and carbon emission measurements. To align with the global fire community, Canada's WildFireSat often holds sessions in tandem with other international meetings, like the Global Wildfire Information System (GWIS) and Global Observations of Forest Cover and Land-use Dynamics (GOFC–GOLD) Fire Implementation Team Meeting (https://gofcgold.umd.edu/meetings/6th-global-wildfire-information-system-gwis-and-gofc-gold-fire-implementation-team-meeting); GWIS and GOFC-GOLD are supported mainly by NASA and the European Space Agency.

Activities under the Arctic Council (AC)

3

3.1 Norwegian Arctic Council Chairship's Arctic Wildland Fire Initiative

In autumn 2023, the Norwegian Chairship of the Arctic Council launched a Wildland Fires Initiative (https://arctic-council.org/news/norwegian-chairship-arctic-wildland-fires-initiative/). The initiative answers some of the challenges mentioned in the next chapter, especially on knowledge sharing and collaboration building. The initiative is aimed to engage the Arctic Council Working Groups, Indigenous Permanent Participants, Observers, and other relevant actors. Specifically, the initiative will create an information sharing platform. The initiative focuses on information sharing and building circumpolar collaboration. Currently, the plan for this initiative is to span throughout the Norwegian Chairship (2023–2025). The design and implementation of the initiative will be with Gwich'in Council International, Emergency Prevention, Preparedness and Response (EPPR), Conservation of Arctic Flora and Fauna (CAFF) and Arctic Monitoring and Assessment Programme (AMAP).

3.2 Ongoing and planned activities under the Arctic Council working groups

There are several activities planned and ongoing under the Arctic Council working groups, many closely linked to the Norwegian chairship's initiative. Gwich'in Council International leads two projects, with Conservation of Arctic Flora and Fauna (CAFF) and Emergency Prevention, Preparedness and Response (EPPR), on Arctic wildfires. The CAFF project focuses on the extent of fires in the Arctic and fire management. The EPPR project is on wildfire response and operational readiness. Arctic Contaminants Action Program (ACAP) has a project to understand how fire management affects black carbon and other emissions, and sharing the best practices identified. Arctic Monitoring and Assessment Programme (AMAP) planned work focuses on emissions and scenarios from Arctic wildfires, with climate, societal and health impact analyses, aimed especially at science-based policy development. AMAP and CAFF also have a planned project on ecosystem impacts of wildfires in the Arctic. More details on the activities are presented in a table in the Appendix.

International Cooperation: Identifying points of weakness and strength

4

International collaboration is crucial for sharing knowledge and best practices and building successful projects on fires in the Arctic. We have identified several points of strengths and weaknesses in the current situation to help find the areas for development.

Points of strength

- The community shares the commitment to open science, and to sharing experiences, data, and results, as well as to open discussion.
- There already exists robust satellite observations, models, data, long-term emission databases and studies, good fire ecology and fire regimes knowledge and understanding.
- There is an existing interest in the problem, increased awareness of it, and commitment to management.
- There is ongoing momentum on the topic.

Points of weakness

- There is a need for more formalized international connections. There should be a formalized process to create and maintain the connections. For example, the ABC-iCAP project facilitated transatlantic science/research visits. However, these were still very much based on established scienctific collaborations between indivduals.
- Fragmented activity landscape. There are many initiatives around the globe, but they are not always coordinated.
- There are few examples (and results) of mitigation of Arctic fires (with limited geographical scope).
- There is a need for greater understanding of the local (and national) laws and regulations regarding fires (such as those relevant to prescribed and cultural burning).
- How can North American and European cooperation (on Arctic and boreal fire science, policy, and management) be funded? There is a lack of funding instruments that can provide resources for joint projects or knowledge exchanges.
- The focus to date has been on individual topics (such as air pollution), instead of a holistic approach to fires. There is a need for more cooperation and perhaps joint products between Arctic Council working groups, which may require working groups to become more responsive in terms of deliverables (concise policy-relevant science communications in addition to long-term/longitudinal reports).
- Training the next generation. Some Arctic Council working groups have trouble reaching and including early-stage scientists.
- Individual countries should institute a process to allow early-career scientists and Indigenous experts to apply/be recruited to international cooperation, with possibilities for sustained longer-term engagement in relevant fields of work.
- There is a challenge to connect new relevant work with the Arctic Council working groups. The current process includes publication of peer-reviewed articles which then hopefully are found by Arctic Council working groups.

Short- and long-term considerations and recommendations

5

While recent and ongoing research and international collaboration, including with Indigenous and local communities in the North, has advanced our understanding of current and future Arctic and boreal fire risks, much is still left unanswered. Paramount is the need to understand and accept that the Arctic and boreal landscapes and the climate have changed and are rapidly changing. Below is a short list of both short-term (2-3 years) and long-term (5-10 years) monitoring and knowledge generation needs for improving Arctic fire management and policies.

Short-term (2-3 years)

1. Create a process and open-source database to monitor adaptation and intervention strategies to extreme Arctic and boreal wildland fires (accomplished in 1-2 years, with ongoing updates).

   A centralized and open-source repository is needed for knowledge to be shared in a centralized manner throughout the Arctic states, more information, details, and experiences from the effects of different intervention options and with inputs from local communities to policymakers. Further, this should be in a location for all to access, incentivizing the gathering of new information and production of lessons learned from shared strategies. This would be analogous to the BAT/BAP (best available techniques/practices) concept used with anthropogenic emissions and climate model intercomparison assessments.

2. Create a spatially-explicit Pan-Arctic and pan-boreal fuels product, including climate- and management-driven species distribution of coniferous and deciduous trees.

   Geospatial data of many fuel types are available, with many Northern regions having readily-available maps and fuel loadings by vegetation type and/or species and other regions having published but not readily-accessible data, but a comprehensive Pan-Arctic and Pan-Boreal high spatial resolution (≤ 30 m) fuel load product is lacking. New fuel products are not necessarily needed at the moment. This inherent data fusion effort would be needed to stitch together and validate fuel loadings to create a unified and open-source product that could then be dynamically updated or refined for country- or local-scale purposes.

3. Expand the definition of the fire season and fire activity for official monitoring and scientific modeling

   Traditionally the fire season in the Arctic and boreal has been defined by the growing season, beginning in May and lasting until September. In recent years the Arctic and boreal region has witnessed fires both earlier (starting in April) and later (continuing into November), with growing evidence of holdover fires, i.e., 'zombie fires', burning year-round in Northern peat areas. We need to recognize the lengthening fire season to be able to develop appropriate adaptation and intervention strategies for community preparation as well as wildland firefighting and land management response to a longer fire season. Human-caused fires in the spring and fall, including northern agricultural landscapes, will likely lengthen the fire season and this should also be considered.

4. Improve public-facing communication and education on linkages of pan-Arctic and boreal to larger population centers in the temperate regions.

   Large cities in North America, Europe, and Asia have been impacted by extreme smoke events caused by extreme fire seasons in the boreal. These are not anomalies, but rather an illustration of how northern ecosystems are linked to and can impact southern ecosystems. The state-of-the-science illustrates clearly that emissions from industrial and energy production areas in the temperate regions often impact the boreal and Arctic - wildfire smoke is no different. Further, by communicating the role of prescribed and cultural burning to reduce fire risk (i.e., "good fire") and the impacts of extreme wildland fires (i.e., "bad fires") on regions outside the North, there is a potential to create global understanding and "buy-in" into improving the situation.

5. Improve fire mapping with new satellite datasets

   New, moderate to high spatial resolution satellite data has become available for fire mapping. Harmonised

Landsat Sentinel-2 offers data from 2015 onwards on 20-30 m resolution, with additional access to some open-source commercial satellite imagery. The challenge in utilizing these products is the amount of data produced, and it would require substantial computing power and (expert) work to improve the fire mapping in just the Arctic and boreal regions. While machine learning and potentially AI could improve speed of fire mapping, human experts are still needed to produce a large quantity of high-quality and rigorously assessed training and validation data for any algorithms.

Long-term (5-10 years)

1. Improve ecosystem and climate models to reflect increased fire risk across the Arctic and boreal

   The summer 2023 fires in Quebec demonstrated that current landscape, ecosystem, and climate models are too conservative in their estimation of fire risk in the deciduous-dominated boreal forests for eastern Canada. Transition to deciduous forests in eastern Canada is not decreasing fire risk because fire weather and ongoing warming due to climate change cancel out the reduction of fuel flammability associated with deciduous trees. The same could be true for the Nordics and Alaska in the future. Further, new novel Arctic fire regimes like Greenland will need different modeling approaches that may not be able to rely on existing modeling approaches.

2. Improve identification of human-caused ignitions to create region-specific interventions

   Human-caused fires in the boreal and Arctic regions are important sources of fire risk near many Northern communities. In particular, human ignitions early in the fire season and late in the fire season can cause unexpected fire spread (e.g., Spring 2023 fire in Halifax, Canada). Open burning in northern agricultural landscapes are also important sources of black carbon emissions. Remote sensing is limited in providing insight into fire ignition types, as well as a limited satellite-based lightning products and a global lightning detection and monitoring network in the High Northern Latitudes. We must improve ignition source typology based on observations moving forward to improve fire modeling, fire risk assessments, fire emissions, and fire response.

3. Finer spatial resolution maps of peat and permafrost for the pan-Arctic and boreal

   Here, the problem is not that there are no products of Northern peat and permafrost, but that the peat and permafrost are rapidly changing and many of the current products are at coarse spatial scales designed to be used for modeling and assessments. High resolution (10-30 m) products are necessary to improve local to country-level modeling and risk assessments, and to improve pan-Arctic emission estimates. Further, for BAT-like assessments, these products must include locations of historically dried peat and areas of new and planned infrastructure in permafrost areas.

4. Improve data stewardship (FAIR and CARE) but with data sovereignty and security at the forefront

   FAIR (Findable, Accessible, Interoperable, Reusable; https://www.go-fair.org/fair-principles/) and CARE (Collective benefit, Authority to control, Responsibility, Ethics; https://www.gida-global.org/care) data standards should not only be adopted but also properly implemented for all public-facing products and models created by Arctic Council working groups, including those shared between the working groups. Data sovereignty and security issues for Arctic states and Indigenous Permanent Participants is an important consideration that will continue for the Arctic. Crucial information on infrastructure, demographics, and important cultural knowledge may not want to be shared or could be weaponized. Resulting data products and models should follow the FAIR approach of open data, but we need to be amenable to CARE data sovereignty and security issues and adapt to those realities.

5. Using science and knowledge generation to support wildland fire response and evacuations

   Ultimately, the short-term and long-term goals listed above would support and improve wildland fire response, evacuations, and community adaptation and resilience in our changing climate and shared future of increasing Arctic fires. Engagement with working groups, policymakers, and emergency responders in a collaborative manner will be necessary to both transfer scientific and technological results and improvements but also to refine science efforts to meet realities on the ground. The timeline of this effort will be based on both domestic and pan-Arctic community building that engages all levels of wildland and prescribed fire responders to scientists. Some successful blueprints exist across many Arctic states (e.g., ArcResc in Finland) and Arctic Council working groups and efforts (EPPR and the Norwegian Chairship effort).

Appendix

Ongoing and coming projects on Arctic fires under Arctic Council working groups

[Table]: Arctic fire projects-table, the AC working group activities (not the external ones).

	CAFF[2]	EPPR[2]
Sphere of impact	Management & mitigation of impacts Sharing knowledge systems	Operational readiness and response Economic development
Objective(s)	Understand extent and impacts of wildland fires; Understand good practices for wildland fire management (to achieve social, ecological, cultural goals) from Western science and IK perspectives. Share practices and ongoing work and learnings.	Document and understand good practices for international cooperation agreements, targeting operational activities. Improve coordinated response by Arctic States and Permanent Participants and promote international cooperation. Create template for discussion of MOU for Arctic fire collaboration (response, training).
Activities	Map the extent and distribution of fires across the Arctic (look at data across jurisdictions and map key elements), currently and in the past. Review practices from states/different jurisdictions to compile how they manage fires. Invite PPs to document use of fire for management and impacts. Assess who is doing what work/projects around fire in the Arctic. Joint with EPPR Workshop to bring together fire ecologists, knowledge holders, and operational staff to share and discuss project work and deliverables across and within working groups.	Compile and assess instruments (agreements, MOUs, policies) that enable cross-border responses. Interview users, designers, and policy makers for what elements worked, recommendations for change, and what was most useful. Draft a template to include necessary elements for consideration when discussing cross-border fire response. Joint with CAFF Workshop to bring together fire ecologists, knowledge holders, and operational staff to share and discuss project work and deliverables across and within working groups.
Deliverables	Map(s) of the extent and distribution of fires across the Arctic. Compilation of guidelines and best practices for Arctic fire ecology and forest management. Compilation, to be updated annually, of work on Arctic fire ecology and fire-related Indigenous knowledge products.	Compendium and assessment of instruments and best practices. Template with clauses relevant for wildfire response (including but not limited to operational and training response). Summary of how each Arctic state manages operational response and what, if any, interagency/state agreements are in place. Summary of standard practices/training by state.
Audience	Public –understand how fires impact the Arctic Ecologists – better understanding of management practices and options, including from Indigenous perspectives Policy makers –understand scope of issue and levers of impact Academics –understand current work and gaps PPs –enable knowledge transmission	Policy makers Operational fire managers Government resource managers and planners Local fire crews and communities PPs –enable co-production of knowledge
Priorities	Data compilation and standardization Ecological, management, social, cultural impacts, and knowledge transmission	Understanding context for international cooperation on fire response, and drafting template to advance discussion
Partners	GCI CAFF Secretariat Natural resource agencies & departments of Interior, Resource Management, Forestry Knowledge holders Academics GIS specialists	GCI EPPR Secretariat Wildland fire experts and managers (operations division) Law & policy specialists Training branches
How work is intended to be used	Reduce threats of catastrophic wildfires Increased options for mitigating and managing fires depending on desired outcomes Support cross-border conversations about management Advance Arctic conversation because extent of impact in Arctic is known	Enable cross border responses to fire, bringing more resources to bear and creating economic opportunities for crews that understand and are trained in Arctic fire response Create the framework for joint responses when fires cross borders Proactively have mechanism for sharing resources Enable international cooperation, training, and contracting of wildland fire resources across state boundaries
Timing	Project approved September 2019 Steering Committee established Nov 2019 PSI Funding application submitted Feb 2020 (currently on hold)	Project approved January 2020 Steering Committee to begin early summer 2020

	ACAP[2]	AMAP[1,2,3] (SLCF)
Sphere of impact	Support efforts to improve air quality and minimize climate change and its impacts.	Assessment of climate and air quality impacts of wildfires as a basis for science-based policy development.
Objective(s)	Understand the impacts of fire management practices on emissions of black carbon and other pollutants from wildland fire and share best practices.	Estimating emissions associated with wildfires; developing scenarios for wildfire emissions; analysing the causes of wildfires; assessing climate change impacts on wildfires and associated climate feedbacks; Assessing societal impacts; smoke modelling in connection with air quality/human health impacts; Improvement of observing systems.
Activities	Compile information on practices for wildland fire management across Arctic States. Assess the impact of various practices on emissions. This would include emissions resulting directly from management practices (for instance from a controlled burn), from wildland fires that occur (or are prevented) in areas where management practices are undertaken, and fires that occur in areas where no management is undertaken. This information could be used to help improve air pollution and GHG inventories and modelling and could also help to determine best practices for limiting emissions from wildland fires.	Generating and analysing map fire occurrence mapping (NB: using ongoing satellite remote sensing and GIS work); fire attribution and risk assessment; GIS-based work to identify fuel characteristics and calculate resulting emissions; Modelling of climate and air quality impacts, including smoke modelling. MOdelling plumes, includiong intercontinental transport of PM/BC and other associated air pollutants
Deliverables	Report on how various management practices impact emissions of black carbon and other air pollutants. This report could include recommendations for best practices in fire management to limit air emissions.	AMAP assessment products; fire mapping and analyses (GIS- based); Emissions models (scenarios - building on ABC-iCAP project work); Smoke transport/impacts; real-time plume tracking/modelling
Audience	Policy makers – understand how various management practices can be used to limit emissions. Scientific community – improve knowledge and use information on emissions from different management practices to refine and update emissions estimates, climate models, etc. Public – understand how wildfires and their management impact air quality, health, and climate	Scientific community; Policy- and decision-makers
Priorities	Determining best practices for limiting emissions of black carbon and other air pollutants from wildland fires and fire management measures.	Data compilation and analysis, incl. GIS-based analyses
Partners	AMAP EGBCM CAFF EPPR	AMAP Secretariat AMAP Climate Expert Group AMAP Short-lived climate forcers Expert Group ICCI IIASA Remote sensing agencies (e.g., NASA, NOAA, ESA, IKI)
How work is intended to be used	Reduce impacts of fires on air quality and climate change. Provide recommendations for best practices to manage emissions from wildland fires according to local conditions.	Provide input to AMAP assessments to understand the causes and implications of wildfires for climate and air quality, including related societal impacts. Develop science-based advice for policy-makers. Parts of the AMAP work will feed into joint AMAP-CAFF project work on 'Understanding climate change impacts on Arctic ecosystems and associated climate feedbacks'.
Timing	The project is in a conceptual stage and is still in the scoping process. We are hopeful that we will be able to begin work in 2023.	2023-2025, and beyond, building on work reported in AMAP 2021 assessment products

	AMAP CEG（updates and Societal Impacts）	**AMAP/CAFF project**
Sphere of impact	Assessment of Arctic climate change	Climate change impacts on Arctic ecosystems and associated climate feedbacks
Objective（s）	Tracking trends over time in key Arctic climate change indices; Assessing societal impacts of Arctic climate change	
Activities	Preparation of biennial updates on climate indices; Assessment of societal impacts of Arctic climate change	Potentially: Combining AMAP information on fire occurrence and characteristics with CAFF informaiotn on vegetation（fuels）to support modelling of emissions/ climate impacts and consequent feedbacks on changes in vegetation and fire regimes, etc.
Deliverables	Climate change indices update: Arctic wildfires - scientific journal article	Planned journal special issue article on: Trophic interactions and future climate feedbacks from the Arctic - Changes in trophic interactions: phenology, predator/prey, etc. - key biodiversity-ecosystem-climate feedbacks such as insect outbreaks, wildfires, etc.
Audience		
Priorities		
Partners	AMAP （Article coordinating lead: M. Parrington）	AMAP CAFF
How work is intended to be used		Basis for informaing policy-making
Timing		

	ABC-iCAP	Arctic Passion
Sphere of impact	Focus on emission of BC from Arctic/boreal wildfires and open burning impacting the Arctic	Pan-Arctic observing System of Systems: Implementing Observations for societal Needs. Focus on areas that are currently inadequately served such as wildfire and pollution risk reduction.
Objective(s)	Understand sources of black carbon and methane impacting Arctic climate; awareness building and knowledge sharing to support and align policy development.	Rise to the scientific and societal challenges of Arctic climate change through the co-creation of a comprehensive, coordinated, and coherent Arctic Observing System of Systems. Related to wildfires, the objectives are to provide a pilot service for improving the response to wildfires in the Arctic and in another pilot information on emissions from wildfires are provided and forecasts improved. In addition, wildfire Shared Arctic Variables (SAVs) will be defined to help to deal with the wildfire phenomenon in the Arctic environment. SAVs are supposed to have a broadly shared benefit and also consider the needs of indigenous peoples.
Activities	Exchange of information and coordiantion of work through research exchange visits (Finland/ USA); dissemination of information (3 webinars; resources made available through project website, etc.)	Providing analysis ready data access, clustering activities and workshops. Integrated Fire Risk Management (INFRA) pilot service (PS4) to improve the response to wildfires in high northern regions. In pilot service 5 (PS5), Local atmospheric pollution forecast service, information on emissions from wildfires are provided and forecasts improved. Awareness of the impact of wildfires on air quality is increased. Wildfire Shared Arctic Variables (SAVs) are defined for two regions: Finland and North America. Expert Panels are organized, SAVs, needs and requirements defined and implemented.
Deliverables	Stakeholder meetings; Webinar presentations (recordings available); Technical reports: (i) wildfire and open-burning emissions - examining differences between remote-sensing-derived and nationally-reported estimates and mapping future pathways for Arctic wildfires as a basis for scenario development; (ii) overview of groups working on wildfires, coordination proposals, etc. (to be delivered in 2023)	Deliverables related to wildfires are related to pilot services and defining Wildfire Shared Arctic Variables. In INFRA pilot service, there will be a web-based system to support fire management. It will include a risk map, combination of ground and satellite-based information for early identification of fires and short-term evolution maps of fire events. The platform for emergency management will enable risk analysis and emergency management.
Audience	Scientific community; Policy- and decision-makers	The audience for the whole project consists of indigenous peoples, service providers, policy and decision makers, organizational stakeholders, science organizations, scientific community, and public and private sectors. The pilot service 4 (PS4) is intended for example for first responders for wildfires. The pilot service 5 (PS5) is intended for environmental agencies, local people, modelers, users for Copernicus services, local, regional and private meteorological services, local authorities and private sector.
Priorities	Communicaiton products; harmonization of fire data compiled in different countries	Involving indigenous peoples knowledge and local knowledge in the observing systems. To align to priorities of EU's Arctic Policy (climate change, sustainable development and international cooperation).
Partners	AMAP Secretariat/IVL/SYKE/ FMI/ICCI/IIASA/ NASA, etc.	35 partners from 17 different countries. Indigenous communities and a huge number of collaborating partners involved. Related to wildfires, partners involved in PS4 are CNR, CAE, GCI (Gwich'in Council International), SNOW, FMI, CEMS, Copernicus EFFIS, CAFF and EPPS, and in PS5 JCR and CNR. FMI is involved In Wildfire SAVs and in convening the Wildfire Expert Panels.
How work is intended to be used	Informaiton dissemination activities targetting scientific community and policy-makers through virtual and in-person stakeholer dialogue meetings	Help people living and working in the Arctic, in decision making and in addressing scientific and societal challenges related to climate change. The pilot services will be to all on a free, full and open access basis. PS4 is intended to be used by emergency responders, indigenous peoples etc. It will help in pre-event, in event and in post event phases. The 'Windows of the Arctic' platform will contain an 'Arctic Window' for each pilot service, also the one for wildfire.The Wildfire SAVs benefit several users. Overall, the work will increase knowledge and co-operation with Arctic and wildfire observations related issues.
Timing	EU-funded project; Project work was completed by end of 2023	EU-funded project; Project runs to 2025 The project started on the 1st of July, 2021, and ends on the 30th of June, 2025, but the project deliverables and pilot services are planned to exist also after the project ends.

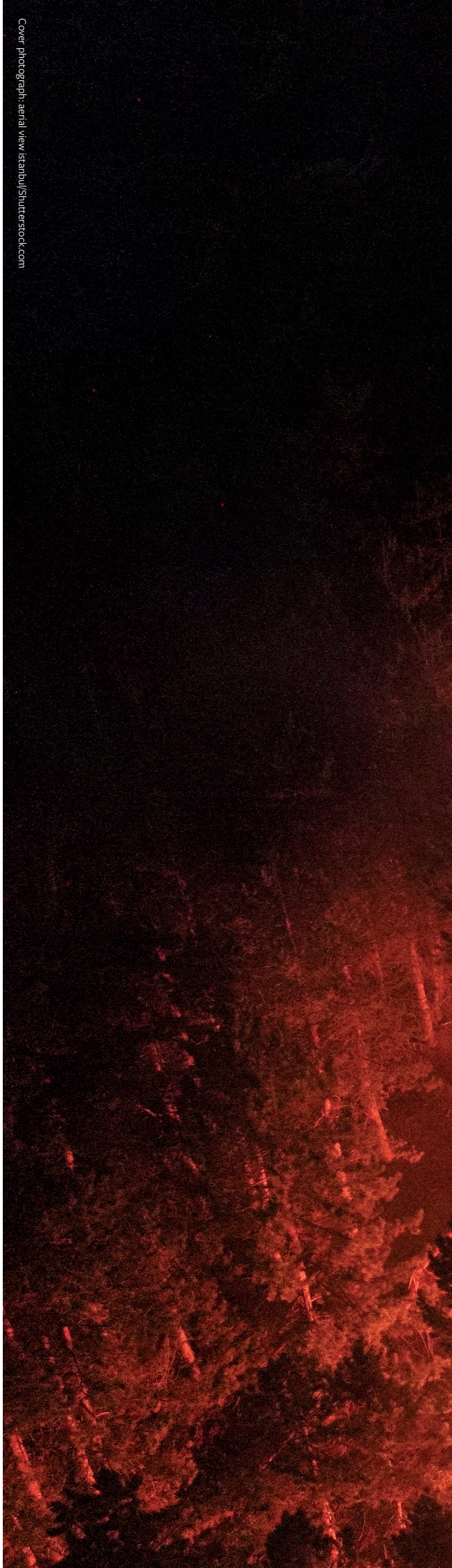
	PACES - ACRoBEAR	HTAP
Sphere of impact	The Arctic Community Resilience to Boreal Environmental change: Assessing Risks from fire and disease (ACRoBEAR) focuses on better quantifying health impacts of high latitude fires.	Multi-pollutant multi-model exercise focused on open burning planned for period 2023-2027. Global, with emphasis on Northern Hemisphere (UNECE Air Convention range)
Objective(s)	Predict and understand health risks from wildfire air pollution and natural-focal disease at high latitudes, under rapid Arctic climate change, and resilience and adaptability of communities across the region to these risks.	TF HTAP is an expert group organized in 2005 under the Convention on Long-range Transboundary Air Pollution (UNECE Air Convention), charged with improving understanding of the intercontinential flows of O3, PM, Hg, and POPs, their impacts on health and the environment, and the potential for mitigation inside and outside the UNECE. Fires are a source of all of the pollutants under the convention. Fire location, frequency, and intensity are changing in our changing climate, and becoming larger relative and absolute contributors to air pollution episodes.
Activities	Activities include a pan-Arctic health impact assessment of fire pollution health impacts, case studies based on health data during large fire events in Scandinavia, assessment and prediction of high latitude climate drivers for fire, assessment of community preparedness and resilience towards fire impacts. This is being achieved by ntegrating health data and knowledge, community knowledge and stakeholder dialogue, with satellite and in-situ observations, and numerical modelling.	Options paper exploring model inputs, harmonization of wildfire emission datasets for use in modelling applications; model development and application; source/receptor simulations; etc
Deliverables	Model simulations; datasets; journal article(s); stakeholder dialogue Web-based dashboard system targeted to decision-making needs that builds on improved and integrated scientific and community knowledge for understanding and mapping these risks historically and for identifying appropriate adaptation measures and actions under different climate and policy scenarios	Model simulations; datasets; journal article(s), possibly in special issue
Audience	Stakeholders; Arctic communities; scientific community.	Scientific community and LR HTAP secretariat
Priorities	Informing on community level health risks associateed with wildfires	Wildfire emissions datasets and model simulations
Partners	10 research organisations across 7 nations €2M funded under the Belmont Forum Climate, Environment and Health research action	ECCC (leading white paper development); modelling groups (volunntary scientific collaboration), IGAC-BBURNED (co-hosting the fire emissions workshop)
How work is intended to be used	Modelling to inform policy-making	Modelling to inform policy-making
Timing	The project runs 2020-2024.	White paper development 2023; modelling work in period to 2027 (timeline not yet defined)

	IGAC - BBURNED
Sphere of impact	Biomass Burning Uncertainty: ReactioNs, Emissions, and Dynamics. Focus on global and on atmospheric chemistry (IGAC=International Global Atmospheric Chemistry)
Objective(s)	BBURNED aims to better quantify the current understanding of the uncertainty and variability in biomass burning emission estimation, and determine how to more accurately represent atmospheric chemistry resulting from fire. We will be a conduit to coordinate and organize the international scientific community to improve understanding of the current and future impacts of wildfires, prescribed burning and agricultural fire on public health and climate by addressing the uncertainties in atmospheric chemistry processes influenced by biomass burning.
Activities	Hosting fire emissions workshop in Nov 2023 (co- with HTAP) with aim to write fire emissions report; co-organizing AGU conference session
Deliverables	Report on intercomparison of fire emissions; AGU conference session; special issue and journal article(s); IGAC newsletter article(s)
Audience	Scientific community
Priorities	Understanding and improving fire process uncertainties in the global atmospheric chemistry context (working groups on Emissions, Chemistry, and Modelling); early career researcher development; supporting researchers from developing countries
Partners	HTAP
How work is intended to be used	Coordination of fire-related work and information for scientific audience
Timing	Dec 2022 to Dec 2023 is a 1 year probationary period for this new IGAC activity. If fully approved after that, there is no end date.

[1] Arctic Council Preamble: Wildland fires are increasing in frequency, severity, and area across the Arctic, bringing challenges as well as opportunities and requiring greater collaboration, knowledge sharing, and partnership. GCI is leading two projects in CAFF and EPPR to advance work on wildland fires at the Arctic Council. Projects usually have a Steering Committee, objectives, and intended uses, summarized below. Projects are connected through their overarching goal of addressing wildland fires in the Arctic with a circumpolar focus. Knowledge sharing is a key component of both projects, and a workshop is planned to bring people working in ecology, management, and response together and review draft project deliverables.

[2] As the current Chair of the Arctic Council, Norway launched its Chairship 'Initiative on Wildland Fires' at the Arctic Circle Assembly in Iceland in October 2023. This initiative is linked to work on wildfires that is being conducted or planned by Arctic Council Working Groups as listed in this overview

[3] The content of the table reflecting AMAPs work includes activities currently under consideration; decisions on precise specifications of eventual work have yet to be made.



Cover photograph: aerial view Istanbul/Shutterstock.com

Funded by the European Union