From: [redacted]
Date: Tue, 17 Feb 2026 at 17:26
Subject: Formal Complaint and Request for Disclosure Regarding Solar Radiation Modification Activities
To: complaints@aria.org.uk <complaints@aria.org.uk>

Dear Sir or Madam,

I am writing to formally register a complaint regarding solar radiation modification and atmospheric aerosol activities being funded and/or conducted under the remit of the (ARIA).

I, do not consent to geoengineering activities conducted above my head, including any form of atmospheric aerosol spraying or interventions intended to reduce or alter sunlight levels. Activities of this nature affect the shared environment and public health and therefore require full transparency and accountability.

I am currently on a two-year waiting list to see an asthma specialist. I have noticed that during periods when I understand geoengineering or atmospheric intervention activities may be taking place, my asthma symptoms appear to worsen significantly. This has caused me considerable concern about potential respiratory impacts and the need for full disclosure regarding what substances, if any, are being released into the atmosphere. This has also had huge negative mental effects on myself.

I am requesting clear and direct disclosure of the following:

1) The precise nature and scope of the geoengineering or solar radiation modification activities being funded or conducted.

2) The full chemical composition of any aerosols or substances being released into the atmosphere.

3) The environmental impact assessments and public health risk assessments undertaken.

4) The legal authority under which these activities are being carried out.

5) The statutory basis on which ARIA considers itself exempt from Freedom of Information obligations, if applicable.

Given the scale and implications of atmospheric intervention, I believe the public has a right to full disclosure regarding what is being released, why it is being released, and under what legal and regulatory framework.

I expect a substantive written response addressing each of the above points, and I request that your reply be provided within 20 days in accordance with applicable response protocols.

Yours faithfully,

[redacted]
Sent from Outlook for Android

[redacted]

3 March 2026

Dear [redacted],

Complaint and Environmental Information Regulations 2004 Request

We are writing in response to your recent email to the Advanced Research + Invention Agency ("**ARIA**") dated 17 February 2026 in which you said:

> *"I am writing to formally register a complaint regarding solar radiation modification and atmospheric aerosol activities being funded and/or conducted under the remit of the (ARIA).*
>
> *I, do not consent to geoengineering activities conducted above my head, including any form of atmospheric aerosol spraying or interventions intended to reduce or alter sunlight levels. Activities of this nature affect the shared environment and public health and therefore require full transparency and accountability.*
>
> *I am currently on a two-year waiting list to see an asthma specialist. I have noticed that during periods when I understand geoengineering or atmospheric intervention activities may be taking place, my asthma symptoms appear to worsen significantly. This has caused me considerable concern about potential respiratory impacts and the need for full disclosure regarding what substances, if any, are being released into the atmosphere. This has also had huge negative mental effects on myself.*
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> *2) The full chemical composition of any aerosols or substances being released into the atmosphere.*

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I expect a substantive written response addressing each of the above points, and I request that your reply be provided within 20 days in accordance with applicable response protocols."

Response

We note your request includes a complaint and a request for information.

Firstly, in relation to your complaint, ARIA is not funding the deployment of climate cooling approaches. The Exploring Climate Cooling programme is funding 5 projects which will carry out carefully-controlled, outdoor experiments, with the goal of building an evidence base to support the effective governance of emerging climate cooling approaches. No such experiments have yet taken place in the UK. When sites are provisionally selected for these experiments, public engagement with the communities local to the experiment sites will be undertaken prior to any experimental work starting.

For more information about the Exploring Climate Cooling programme, including details of the funded projects, teams, amount of funding and locations, please see our website: Exploring Climate Cooling. For your convenience, we have enclosed a copy of this information at **Annex 1**.

We have concluded that no further action is required at this stage in relation to your complaint.

Secondly, we are treating your request for information in accordance with the Environmental Information Regulations 2004 ("EIR").

We have provided responses to your specific requests below.

1. The precise nature and scope of the geoengineering or solar radiation modification activities being funded or conducted.

ARIA's Exploring Climate Cooling programme is funding 5 outdoor experiments:

- One project will explore the efficacy of rethickening arctic sea ice using seawater.
- Two projects will explore the effects of seawater spray on cloud reflectivity.
- One project will explore the effects of electric charge on cloud reflectivity.
- One project studies how milligram quantities of mineral dusts age in the stratosphere. In this controlled experiment, none of these materials will be released; all are returned to the ground for analysis by scientists.

You can find details of the projects being funded by ARIA's Exploring Climate Cooling programme on ARIA's website: Exploring Climate Cooling | Funded projects. For your convenience, the relevant extract of the website is attached at **Annex 2**.

At present, only one of these outdoor experiments has commenced: Re-thickening Arctic Sea Ice (RASI). This project includes controlled, small-scale experiments in two locations in Canada, and is not carrying out any outdoor experiments in the UK. Further details about this project can be found on ARIA's website: Exploring Climate Cooling | Re-thickening Arctic Sea Ice. For your convenience, a screenshot of the relevant section is attached at **Annex 3**.

2. The full chemical composition of any aerosols or substances being released into the atmosphere.

Subject to meeting ARIA's governance requirements, two experiments (in the UK and Australia) will spray natural seawater into the sky to measure its effect on cloud reflectivity. Any cloud effect will be tiny, brief (dissipating within 24 hours), and the effect on the cloud should not be noticeable to the human eye (although you will be able to see the seawater spray itself). Another experiment will launch weather balloons or drones into the stratosphere (in the US and/or UK) with secured milligram amounts of natural mineral dusts. All the materials will be returned to the ground for recovery and analysis by scientists. Crucially, no materials will be released into the atmosphere.

3. The environmental impact assessments and public health risk assessments undertaken.

Details of environmental and other assessment requirements can be found on ARIA's website: Exploring Climate Cooling | Oversight + Governance. For your convenience, an extract of the relevant section of ARIA's website is included at **Annex 4**. In addition, at **Annex 5**, we have attached a document which gives further details of the governance principles and requirements of the Exploring Climate Cooling programme.

At present, assessments have been finalised for one outdoor experiment: RASI. Further details about this project (including the community engagement activities, research licences and the Nunavut Impact Review Board's screening reports) can be found on ARIA's website: Exploring Climate Cooling | Re-thickening Arctic Sea Ice, and at **Annex 3**.

Please find enclosed at **Annex 6** a copy of the Environmental Impact Assessment conducted in relation to RASI.

4. The legal authority under which these activities are being carried out.

Section 2(1) of the Advanced Research and Invention Agency Act 2022 authorises ARIA to, or commission or support others to, conduct scientific research; develop and exploit scientific knowledge; and collect, share, publish and advance scientific knowledge.

All ARIA projects must adhere to all applicable laws, and must respect the rights of indigenous peoples. For projects that propose to conduct activities that may require particular permissions, or compliance with particular regulatory or project management practices (e.g. outdoor experiments), ARIA will exercise its adaptive funding mechanism to review specific plans before funding is released for that component of the project.

5. The statutory basis on which ARIA considers itself exempt from Freedom of Information obligations, if applicable.

ARIA is not included in Schedule 1 (Public Authorities) to the Freedom of Information Act 2000. ARIA's exemption from the Freedom of Information requests was debated extensively and agreed to by both Houses of Parliament during the passage of the Advanced Research and Invention Agency Act 2022. Ultimately, it was agreed that the exemption would help reduce the administrative burden on ARIA's small team.

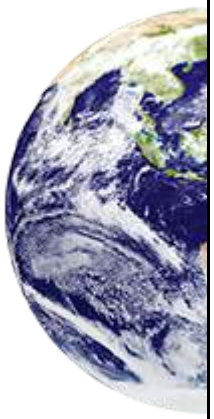
However, ARIA is committed to building in public – we engage with the scientific community through workshops and public calls for feedback. We publish all opportunity spaces and programme theses before launching solicitations, and publicise all awarded research projects. Further information about ARIA's work is available on our website: https://www.aria.org.uk/.

Yours sincerely,

ARIA

Advanced Research + Invention Agency ARIA

Annex 1: Exploring Climate Cooling webpage



Opportunity space: Future Proofing Our Climate and Weather

Programme: Exploring Climate Cooling

Exploring Climate Cooling

This £56.8m programme aims to build a robust evidence base to explore – with independent oversight – if climate cooling approaches could ever be feasible, scalable, safe, and governable.

Our goal

To build an evidence base to support the effective governance of emerging climate cooling approaches. We are funding transparent, public-good research — from ethics to real-world experiments — so the world can make better-informed decisions about this field.

Why this programme

Cutting emissions is the only sustainable solution to the climate crisis. However, ever-rising global temperatures are driving a surge of interest in approaches designed to cool the climate on timescales faster than decarbonisation.

This new field is evolving fast, attracting venture capital and giving rise to new private companies. Yet our understanding of the impacts, risks, governability, and even the basic feasibility of these approaches is poor.

We lack the deep technical and societal understanding required to govern this field responsibly: to reduce risk in a way that is ethical, legitimate, and inclusive.

How we're doing it

Our international research portfolio is comprehensive, funding everything from computer modelling, to ethical frameworks, and observations of natural analogues of climate cooling approaches (like volcanoes). Where essential questions cannot be answered by models, we also fund a limited number of small-scale, carefully controlled outdoor experiments, with stringent requirements for safety, respectful engagement, and transparency.

The world has a critical window of opportunity to build this evidence base, ensuring that robust safeguards can be developed while this field is still at a nascent stage. We are committed to sharing our results openly for the common good, and to working in partnership with others with the same goals.

Read the programme thesis

Read the accessible version of the programme thesis

Explore the funded projects

We're funding 22 research teams uniting specialists across diverse disciplines – from atmospheric physics, chemistry, and climate modelling to chemical engineering, systems analysis, and oceanography, alongside crucial expertise in governance and ethics – reflecting the programme's holistic approach.

Discover more

Meet the programme team

Mark Symes

Programme Director

Mark is an electrochemist with a 15-year career developing sustainable fuels in the drive towards net zero. He joined ARIA from the University of Glasgow, where he is Professor of Electrochemistry and Electrochemical Technology.

George Horner

Technical Specialist

George has a background in atmospheric physics, holding a PhD from Imperial College London, where he was researching how clouds evolve over time and how they may be impacted by aerosol particles.

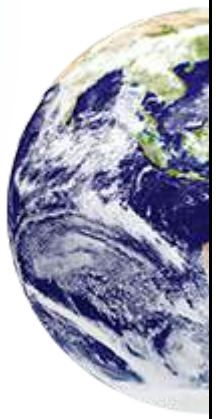
Mike Farrar

Programme Specialist

Mike is a condensed matter physicist by training and joined ARIA from his postdoc in Oxford, where he conducted research on novel photovoltaics. Prior to this, he was responsible for the set-up of several high volume, thin-film deposition operations across the globe for the world's largest electronics original equipment

Advanced Research + Invention Agency ARIA

Annex 2: Exploring Climate Cooling | Funded Projects



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Projects will utilise a range of methodologies, including modelling, observations and monitoring, indoor testing and – where strictly necessary and in accordance with our oversight and governance principles – small scale, controlled outdoor experiments.

The programme will also fund projects exploring the broader societal aspects of this scientific research, including methods for public engagement, public attitudes to the field, and governance.

This research explores the crucial governance and ethical dimensions that must accompany any scientific investigation of climate cooling approaches. It includes work on potential governance frameworks, the development of engagement toolkits with Arctic and UK communities, understanding public perceptions in South Asia and the Philippines, and building research capacity across the Global South – all help ensure that this research field evolves inclusively and responsibly.

Strategic Foresight on Climate and Geopolitics: Toward governance of earth cooling approaches

Project Lead: Matthias Honegger, Centre for Future Generations

Award: £1.25 million over 17 months

Key team members and approximate budget breakdown: Matthias Honegger, Cynthia Scharf, Centre for Future Generations (£420k) | Trish Lavery, Australian National University Futures Hub (£150k) | Rafal Kierzenkowski, The Organisation for Economic Co-operation and Development (OECD) (£220k) | Danielle Young, University of Leeds (£460k)

Understanding if and how earth cooling approaches could be responsibly governed is critical in light of accelerating climate impacts and the risk of unwise use. This team will explore how these approaches could be responsibly governed at the global level in various

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

How to speak about climate cooling? Co-creating an engagement toolkit in the Arctic and the UK

Award: £360k over 45 months

Key team members and approximate budget breakdown: Ine Steenmans + Chloe Colomer, University College London (£314k) | Cody Skahan, University of Oxford (£23k) | Albert van Wijngaarden, University of Cambridge (£23k)

Emerging climate cooling approaches raise profound ethical and societal questions. Meaningful dialogues are therefore a prerequisite for ensuring that research on, and governance of, these approaches will be just and inclusive. This is especially true in the Arctic, a region where the voices of people who will be amongst the most impacted are often left out of conversations because of ongoing and historical power imbalances. This team will explore how people want to speak about climate cooling, and how they form and change their views over time. It will move beyond social opinion research by co-designing engagement programmes with local communities and rightsholders across the Arctic and in three UK locations. Beyond the aim of empowering communities to participate more fully in governance, research, and decision-making around these new scientific approaches for cooling the earth, the learnings from these engagements will be captured in a practical, open access toolkit that can be used for future engagement projects around climate cooling.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Project Lead: Athar Hussain, COMSATS University

Award: £574k over 3 years

Key team members and approximate budget breakdown: Athar Hussain, COMSATS University (£532k) | Thomas Fischer, University of Liverpool (£5k) | Sajida Kousar, International Islamic University (£8k) | Hassaan Sipra, The Alliance for Just Deliberation on Solar Geoengineering (£9k) | Muhammad Mumtaz, Fatima Jinnah Women University (£20k)

This project provides a comparative analysis of potential climate response pathways – evaluating the implications in South Asia of marine cloud brightening (MCB) against carbon dioxide removal efforts and conventional mitigation approaches. This analysis combines climate science, governance research, direct stakeholder engagement, and policy analysis, deepening our understanding of potential climate cooling technologies within the ethical, governance and social context of South Asia. This work will empower decisionmakers and communities in South Asia to develop inclusive, effective, and locally-grounded climate action strategies.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

PULSE Project: Public Understanding, Leadership, and Social Ethics in the governance of earth cooling technologies in communities impacted by volcanic activity in the Philippine context

Project Lead: Lorena Sabino, University of the Philippines Los Baños, College of Forestry and Natural Resources

ward: £148k over 2 years

unique perspectives, exploring the understanding, ethical viewpoints, and governance concerns surrounding such technologies directly within these communities through focused research. Gathering these insights is crucial for grounding abstract global discussions about SAI in lived reality, and ensuring that the voices of those most vulnerable to both climate change and potential interventions are central to the conversation. This work will help develop ethical, inclusive governance frameworks and foster informed climate leadership in the most affected regions.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Ethics and Governance of Earth Cooling Research: From concepts to implementation

Project Lead: Ignacio Mastroleo, National Scientific and Technical Research Council (CONICET)

Award: £453k over 2 years

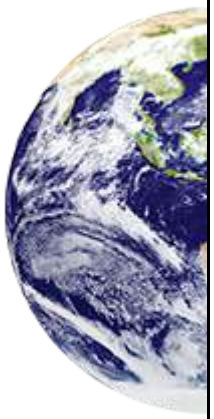
Key team members: Ignacio Mastroleo, Timothy Daly, María Inés Carabajal, National Scientific and Technical Research Council (CONICET) + Inter-American Institute for Global Change Research (IAI)

Researching potential Earth cooling approaches raises profound ethical and societal questions that require careful consideration and robust governance frameworks, especially ensuring diverse global perspectives are included. This project focuses on building research capacity and developing ethical frameworks, particularly within the Global South. This project will build a Latin America/Caribbean-UK research network that will address fundamental questions regarding the governance of these approaches, as well as nurturing a new community of experts in the region. The work will explore societal implications, ethics frameworks for managing trade-offs and the breadth of opinions, co-production of knowledge and regional governance, particularly in the Latin America/Caribbean context.

Previous funding calls in this programme

The projects we are funding have been selected from teams and individuals who applied to our previous funding calls for this programme. You can read more about these calls below.

Exploring Climate Cooling: Full proposals



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Funded projects

Our 22 funded research teams unite specialists across diverse disciplines – from atmospheric physics, chemistry, and climate modelling to chemical engineering, systems analysis, oceanography, and radiative transfer, alongside crucial expertise in governance and ethics – reflecting the programme's holistic approach. This group shares a deep commitment to objective research conducted transparently and responsibly, aiming to navigate the complex ethical dimensions and establish best practices within this field.

Projects will utilise a range of methodologies, including modelling, observations and monitoring, indoor testing and – where strictly necessary and in accordance with our oversight and governance principles – small scale, controlled outdoor experiments.

The programme will also fund projects exploring the broader societal aspects of this scientific research, including methods for public engagement, public attitudes to the field, and governance.

Leveraging advanced computer simulations and theoretical models, these projects will investigate the potential effects of various climate cooling approaches on global and regional climate systems, including sensitive areas like the Arctic and monsoon regions. This foundational research is crucial for improving our understanding of the feasibility and potential risks associated with these approaches.

GRID-CC: Global to Regional Impacts Downscaling for Climate Cooling

Project Lead: Andy Parker, The Degrees Initiative

Award: £2m over 3 years

Key team members and approximate budget breakdown: Andy Parker, The Degrees Initiative (£940k) | Babatunde Abiodun, Christopher Lennard, University of Cape Town (£770k) | Daniele Visioni, Cornell University (£290k)

Understanding the potential regional implications of earth cooling approaches is crucial, particularly for communities in the Global South which may be disproportionately affected. Yet, research capacity is often concentrated elsewhere. This project directly addresses this capacity gap by empowering researchers in the Global South. Through computational work, this project will build an open-access repository of detailed Global South climate data that will enable researchers to develop more accurate modelling of the global and regional impacts of these approaches. This project will create new research tools and hold expert convenings to help

Ecological Impact Assessment of Earth Cooling Experiments in the Arctic (Eco-ICE)

Project Lead: Amanda Burson, British Antarctic Survey

Award: £4.9 million over 4 years

Key team members and approximate budget breakdown: Amanda Burson, Jeremy Wilkinson, Louise Sime, Kate Hendry, Rhiannon Jones, Clara Manno, Florence Atherden, Rachel Cavanagh, Simeon Hill, British Antarctic Survey (£4.3m) | Neven Fučkar, University of Oxford (£270k) | Dorothee Bakker, University of East Anglia (£140k) | David Schroeder, Danny Feltham, University of Reading (£130k)

Fragile polar ecosystems are critical to the global climate system, yet the potential ecological consequences of climate interventions at the poles are poorly understood. Through laboratory experiments and computer modelling, this project will provide an independent impact assessment of potential climate interventions in the Arctic marine environment. The team will develop physical, climate and ecosystem models with direct input from bespoke biogeochemical and biological laboratory experimentation. This independent assessment by experts in modelling and ecology is critical to provide a thorough and balanced evaluation of potential climate interventions in the Arctic. The project will provide best-practice guidance for the ecological risk assessment of future proposed interventions within the polar marine environment.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Award: £257k over 3 years

Key team members and approximate budget breakdown: Amadou Coulibaly, Abdoulaye Ballo, Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR/IFRA) | Sabina Abba Omar, University of Cape Town (at no cost to the project)

The West African Monsoon is a vital climate system supporting agriculture and water resources for millions. Understanding how potential earth cooling approaches might affect this sensitive system is crucial for regional stability and food security. This research directly addresses this need by exploring potential impacts on critical rainfall patterns, including wet and dry spells. Using advanced climate models, observational data, and scenarios from established model intercomparison platforms (such as GeoMIP), the study aims to address critical gaps in understanding how earth cooling approaches might influence regional climate systems and how they might interact with existing climate vulnerabilities. The project will provide actionable insights, helping the region understand how these approaches might mitigate adverse climate impacts while avoiding unintended consequences.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Space Reflector Baseline Survey

Project Lead: Morgan Goodwin, Planetary Sunshade Foundation

Award: £400k over 14 months

Key team members and approximate budget breakdown: Morgan Goodwin, Jeff Overbeek, Planetary Sunshade Foundation (£275k) | Daniele Visioni, Cornell University (£85k) | Chantal Cappelletti, University of Nottingham (£40k) | Saptarshi Bandyopadhyay (NASA Jet Propulsion Laboratory, California Institute of Technology, at no cost to the project)

concepts might warrant further study based on their modelled efficiency, scalability, and potential side effects, fostering collaboration between the space engineering and climate modelling communities.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

An assessment of the feasibility of a space-based solar reflector

Project Lead: Colin McInnes, University of Glasgow

Award: £342k over 1 year

Key team members and approximate budget breakdown: Colin McInnes, Matteo Ceriotti, University of Glasgow (£161k) | Onur Çelik, Delft University of Technology (£156k) | Derek Bennet, AAC Clyde Space (£25k)

Highly speculative technologies like space-based solar reflectors require careful, early-stage assessment. This team is exploring the technical feasibility of space-based approaches to cooling the earth. This project is a desk-based study exploring the initial engineering steps and challenges involved in a hypothetical small-scale space mission to test the feasibility of a space-based sunlight reflector. This purely conceptual work is aimed at understanding the requirements for such a mission. Its purpose is to inform whether, and how, further research into this specific Earth cooling approach might proceed, ensuring resources are directed effectively based on sound engineering principles.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Project Lead: Heri Kuswanto, Institut Teknologi Sepuluh Nopember

Award: £345k over 3 years

Key team members: Heri Kuswanto, Kartika Fithriasari, Institut Teknologi Sepuluh Nopember

Responsible decisions about potential climate interventions like Stratospheric Aerosol Injection (SAI) depend on reliable, trusted data about their potential impacts, but current computer simulations have uncertainties. This project aims to significantly improve the accuracy and trustworthiness of the simulation outputs of these approaches. Using advanced statistical and machine learning techniques applied to climate model outputs, this project looks to ensure that impact predictions, especially crucial regional assessments, are robust and unbiased. This foundational modelling work is vital for building confidence in the science and enabling genuinely informed decision-making by policymakers and the public.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Simulating the effects of earth cooling approaches on the Dynamics and Thermodynamics of Monsoon and Precipitation Extremes

Project Lead: Byju Pookkandy, The Energy and Resources Institute

Award: £140k over 2 years

Key team members: Byju Pookkandy, Kaagita Venkatramana, The Energy and Resources Institute (TERI)

Reliable and predictable rainfall is fundamental to societies in both India and the UK, underpinning agriculture, water security, and protecting communities from floods and droughts. This research provides essential foresight into how proposals for earth cooling

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Defining the minimum scale of an SAI test: A fundamental first step towards an outdoor experiment

Project Lead: Doug MacMartin

Award: £445k over 2 years

Key team members: Doug MacMartin, Daniele Visioni, Cornell University

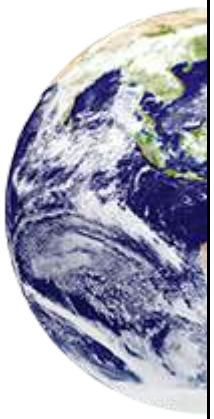
Making informed decisions about potential future climate interventions like Stratospheric Aerosol Injection (SAI) requires reliable predictions of their effects. Currently, a major uncertainty – precisely how cooling aerosol particles would behave when released high in the atmosphere – significantly limits the accuracy of these predictions. This project addresses this critical knowledge gap through theoretical modelling and analysis, as it aims to determine the minimum scale for a potential outdoor experiment that could provide the real-world data needed to substantially reduce this uncertainty. Identifying this minimum threshold is essential foundational work. It paves the way for designing any future research in the most responsible, efficient, and low-impact manner possible. Understanding this scale is also crucial for proactively developing the appropriate governance and oversight frameworks that would be necessary before any such small-scale atmospheric research were to take place.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Previous funding calls in this

The projects we are funding have been selected from teams and individuals who applied to our previous funding calls for this programme. You can read more about these calls below.

Exploring Climate Cooling: Full proposals



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Projects will utilise a range of methodologies, including modelling, observations and monitoring, indoor testing and – where strictly necessary and in accordance with our oversight and governance principles – small scale, controlled outdoor experiments.

The programme will also fund projects exploring the broader societal aspects of this scientific research, including methods for public engagement, public attitudes to the field, and governance.

These projects focus on gathering crucial real-world data about existing atmospheric processes, such as how soot affects clouds and how particles released in volcanic eruptions behave in the atmosphere. The goal is to enhance our ability to study the climate safely and effectively, and to ensure that we have the tools to understand both natural phenomena and the potential impacts that climate cooling approaches might have.

De-risking cirrus modification

Project Lead: Sebastian Eastham, Imperial College London

Award: £3.6m over 36 months

Key team members and approximate budget breakdown: Sebastian Eastham, Marc Stettler, Ed Gryspeerdt, Imperial College London (£740k) | Benjamin Murray, University of Leeds (£1.4m) | Blaž Gasparini, University of Vienna (£310k) | Takemasa Miyoshi, RIKEN (£270k)

High-altitude cirrus clouds have an overall warming effect on our climate, but how their formation is influenced by existing atmospheric particles (like dust or soot) remains a significant uncertainty in climate science. Improving our understanding of these natural processes is crucial for refining climate models and for establishing the knowledge needed to assess the potential risks and

The team will use a combination of computer modelling and analy ey will also conduct observational flights using research aircraft to directly measure how particles alr e, and the additional effects of aircraft engine soot, currently affect cirrus cloud properties. By observing and measuring these existing atmospheric processes, the team are looking to improve our fundamental understanding of cirrus cloud formation, providing essential baseline knowledge to help us understand if deliberately thinning cirrus clouds could ever offer a safe, predictable mechanism for cooling.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Ice-Nucleating Particles in the Upper Troposphere: Advancing Cirrus Control and Experimental Science Strength "INPUT:ACCESS"

Project lead: Thomas Whale, University of Leeds

Award: £1.3m over 36 months

Key team members and approximate budget breakdown: Thomas Whale, University of Leeds (£770k) | Alexandre Baron, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado (£475k) | Joshua Schwarz, National Oceanic and Atmospheric Administration (NOAA) Chemical Sciences Laboratory (at no cost to the project) | Sebastian Eastham, Imperial College London (£63k)

Cirrus clouds have a significant impact on Earth's temperature, yet prediction and modelling of their formation is challenging and constitutes a key uncertainty in climate models and projections. Lack of knowledge of the concentration and nature of the tiny particles suspended in the atmosphere on which cirrus clouds form, known as ice nucleating particles (INPs), is a major contributor to this uncertainty. This project aims to address this knowledge gap by developing new methods to observe and analyse these naturally occurring INPs high in the atmosphere.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

StratoGuard - Global Monitoring of Climate Engineering using Micro High-Altitude Balloons

Project lead: Steve Tate, Voltitude

Award: £600k over 33 months

Key team members and approximate budget breakdown: Steve Tate, Richard Nash, Paul Stevens, Voltitude Ltd (£575k) | Chris Stopford, University of Hertfordshire (£25k)

Improving our ability to monitor the Earth's climate, particularly in remote regions, and developing the tools needed to safely observe and measure potential future climate interventions are crucial needs for both climate science and the responsible assessment of climate cooling approaches.

Project StratoGuard focuses on creating low-cost, lightweight micro-balloons (under 4kg, <5m diameter) equipped with sensors, capable of navigating the stratosphere above 55,000 feet for up to 30 days. This capability would support affordable, detailed, and sustained climate data collection across the globe. It would also enhance the capability for sophisticated and cost-effective monitoring of any future outdoor climate intervention activities. With test launches planned from 2026 and potential global launch capabilities (subject to local approvals), this project seeks to miniaturise core technologies for global sensing using small, safe balloons, operating in full compliance with existing regulatory frameworks. The overarching goal is to provide a vital new tool for comprehensive climate observation, as well as providing a monitoring capability essential for responsible research and assessment of potential climate interventions.

Project lead: Matt Watson, University of Bristol

Award: £4.3m over 48 months

Key team members: Matt Watson, Arthur Richards, Tom Richardson, University of Bristol

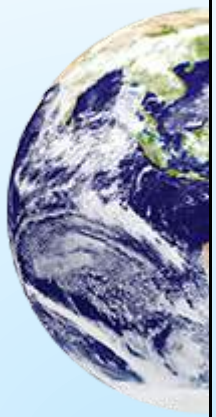
Natural events, particularly volcanic eruptions, release tiny particles (aerosols) into the atmosphere and offer invaluable real-world opportunities to study processes relevant to climate science and potential climate interventions, such as how aerosols affect clouds and the Earth's energy balance. However, safely and rapidly collecting data from these events is challenging. This project aims to address this by developing advanced, automated drone technology specifically designed for observing and analysing emissions from active volcanoes.

The team will design, build, and test lightweight, easily operationalised drones capable of flying safely at high altitudes (10 km). Following initial test flights in the first year, the plan is to use the drones to study emissions from selected, regularly erupting volcanoes – Volcán de Fuego (Guatemala), Soufrière Hills (Montserrat), and Lascar (Chile). The team have flown in all three countries in the past under suitable permits. By analysing these natural volcanic emissions in situ, the research will investigate how tiny cloud droplets form and how natural aerosol layers affect radiation. A key goal is to develop a rapid-response capability using these drones, enabling the scientific community to safely gather crucial data from future significant volcanic eruptions, thereby improving our understanding of natural climate processes.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

The projects we are funding have been selected from teams and ideas submitted to previous funding calls for this programme. You can read more about these calls below.

Exploring Climate Cooling: Full proposals



Opportunity space: Future Proofing Our Climate and Weather

Programme: Exploring Climate Cooling

Exploring Climate Cooling

This £56.8m programme aims to build a robust evidence base to explore – with independent oversight – if climate cooling approaches could ever be feasible, scalable, safe, and governable.

Funded projects

Our 22 funded research teams unite specialists across diverse disciplines – from atmospheric physics, chemistry, and climate modelling to chemical engineering, systems analysis, oceanography, and radiative transfer, alongside crucial expertise in governance and ethics – reflecting the programme's holistic approach. This group shares a deep commitment to objective research conducted transparently and responsibly, aiming to navigate the complex ethical dimensions and establish best practices within this field.

Projects will utilise a range of methodologies, including modelling, observations and monitoring, indoor testing and – where strictly necessary and in accordance with our oversight and governance principles – small scale, controlled outdoor experiments.

The programme will also fund projects exploring the broader societal aspects of this scientific research, including methods for public engagement, public attitudes to the field, and governance.

In cases where essential scientific questions cannot be answered by modelling or indoor experiments alone, these five projects will undertake carefully controlled outdoor experiments, allowing crucial real-world data to be gathered responsibly. These experiments will only proceed if ARIA's stringent governance requirements are met in full. An environmental impact assessment will be performed and made publicly available before any experiment starts, and experiments will have to be developed through engagement with local communities. All funded experiments will be time-bound and limited in size, scale so their effects dissipate within 24 hours or are fully reversible.

Re-Thickening Arctic Sea Ice (RASI)

Project Lead: Shaun Fitzgerald, Centre for Climate Repair

Award: £9.9m over 42 months

Key team members and approximate budget breakdown: Shaun Fitzgerald, University of Cambridge (£1.4m) | Geoff Evatt, University of Manchester (£0.63m) | Michel Tsamados, University College London (£0.63m) | Einar Ólason, Nansen Environmental and Remote Sensing Center (£0.4m) | Andrea Ceccolini, Real Ice (£3.5m) | Fonger Ypma, Arctic Reflections (£3.3m) | Edward Blanchard, University of Washington (£90k) | Steven Desch, Arizona State University (~£10k travel costs funded from Real Ice's share)

The RASI project is led by the University of Cambridge and includes a number of collaborating sub-teams looking at computer modelling, laboratory studies on ice mechanics, ecological studies and small, controlled outdoor experiments. Two separate sub-teams of researchers (Real Ice, Arctic Reflections) will conduct controlled, small-scale experiments in two locations in Canada. These experiments have been designed in close collaboration with local communities and in compliance with ARIA's stringent governance framework. The goal is to gather essential real-world data to rigorously assess if this intervention warrants further consideration.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Learn more about the research

Marine Cloud Brightening in a Complex World

Project lead: Daniel Harrison, Southern Cross University

Award: £1m (potentially rising to £5m with matched funding) over 5 years, contingent upon security an additional £10m of funding from other sources

Key team members: Southern Cross University | Commonwealth Science and Industrial Research Organisation | University of New South Wales | Freie Universität Berlin | Queensland University of Technology | Shaun Fitzgerald, University of Cambridge (contributing and funded via the REFLECT project)

processes involved, moving beyond basic principles to assess if, and how, MCB could work safely and effectively.

The research combines advanced computer modelling with the development and indoor testing of sea salt sprayers. If these findings suggest promise, and subject to meeting ARIA's governance requirements, the project plans to conduct small-scale, controlled outdoor experiments over the Great Barrier Reef in years 3 and 4 of the 5-year project. These outdoor experiments are strictly contingent on prior results, rigorous independent safety reviews, regulatory approvals, and continued co-design and partnership with Traditional Owner groups, local stakeholders, and the broader community of the Great Barrier Reef Marine Park. If approved, these controlled experiments could involve brightening clouds within areas up to 10 km × 10 km, with seawater spraying taking place over 5-6 weeks, for 6 to 8 hours per day. All activities will fully adhere to ARIA's robust governance framework, emphasising transparency, environmental risk minimisation by design, and community engagement. The overall goal is to generate crucial real-world data to determine the effectiveness and risks of MCB, and its potential for protecting vulnerable ecosystems at a regional scale.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

A REsponsible innovation Framework for assessing noveL spray tEChnology research To examine local albedo changes from marine brightening and its multi-scale impacts (REFLECT)

Project Lead: Hugh Coe, University of Manchester

Award: £6.1m over 3 years (initial phase)

Key team members and approximate budget breakdown: Hugh Coe, Robert Bellamy, University of Manchester (£2.1m) | Shaun Fitzgerald, University of Cambridge (£1.8m) | Dan Mace, Archipelago Technology (£0.9m) | James Haywood, University of Exeter (£1.1m) | Lindsay Bennett, University of Leeds (£22k) | Sami Romakkaniemi, Finnish Meteorological Institute* (£160k)

Marine Cloud Brightening (MCB) and Marine Sky Brightening (MSB) by increasing the reflectivity of clouds or the sky using tiny droplets of seawater – depend critically on technology to generate sprays of these droplets effectively. However, the technical feasibility and optimal methods for doing so are poorly understood. This project aims to address this gap by developing and responsibly testing the necessary spray technologies to determine if these approaches could be viable.

Over an initial three-year period, the team will undertake computer modelling, build bespoke sprayers based on the modelling results, and conduct indoor tests. A crucial part of this phase involves beginning collaborative engagement with local communities to co-design potential future outdoor experiments. Any small-scale, controlled outdoor experiments to test sprayer performance would only occur after this initial phase, contingent on further funding, successful co-design demonstrating community engagement and support, and strict adherence to ARIA's safety and governance protocols. These potential tests are expected to be undertaken in the UK (location to be determined). Initial tests, if approved, would be very limited, lasting only a few seconds and creating small plumes of seawater spray just a few hundred metres in size. Only if these initial tests prove successful and safe might later experiments explore brightening larger cloud areas, potentially up to 10 km long and a few hundred metres wide. These tests are inherently benign, replicating natural processes that generate sea spray over the ocean developing spray systems such as those that are already employed to cool crowds with fine mists of water and dampen construction sites to suppress pollution. The overall goal is to establish a robust and responsible experimental framework to assess the technical feasibility and optimal methods for MCB and MSB.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

BrightSpark – Cloud brightening with electric charge

Project Lead: Giles Harrison, University of Reading

ward: £2m over 36 months

Finding ways to influence cloud reflectivity is a key research challe using controlled electric charge, a natural atmospheric phenomenon, to influence water droplets in fo e to spraying seawater. The research aims to determine if carefully managed electrical charges could offer a safe and effective method for enhancing cloud reflectivity.

The team will investigate the fundamental science of how artificial charge release affects cloud and fog droplets. The project includes plans for very small-scale (on the order of 100 m × 100 m), controlled outdoor experiments in the UK during the third year of the project. These experiments are strictly conditional on demonstrating appropriate levels of community engagement, co-design, and adherence to ARIA's rigorous safety and ethical governance framework. The core goal is to gather foundational data to assess if this method is viable and safe enough to warrant further investigation.

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Natural Materials for Stratospheric Aerosol Injection

Project Lead: Hugh Hunt, University of Cambridge

Award: £5.5m over 36 months

Key team members and approximate budget breakdown: Hugh Hunt, University of Cambridge (£2.5m) | Frank Keutsch, Harvard University (£2.5m) | Sebastian Eastham, Imperial College London (£0.54m)

Stratospheric Aerosol Injection (SAI) is a widely discussed potential climate cooling method, but the most commonly proposed materials (sulfates) carry significant hazards in this context, including potential ozone depletion and toxicity. Addressing whether safer, alternative materials could ever be feasible or effective for SAI is therefore a critical, unanswered scientific question. This project will undertake fundamental research to investigate the properties and behaviour of innovative, non-toxic, non-sulfate materials in a very controlled manner.

performing controlled descent for recovery. **Crucially, no materials will be released into the stratosphere**; this approach effectively brings the stratosphere to the samples. Studying the recovered samples will reveal how stratospheric conditions affect their properties over time. This foundational science is essential to advance understanding of the potential impacts of SAI and for determining if less harmful alternatives to sulfates might exist (and if they might warrant further study in the context of SAI).

View the full grant agreement for this project, which outlines its objectives, milestones, and deliverables here.

Previous funding calls in this programme

The projects we are funding have been selected from teams and individuals who applied to our previous funding calls for this programme. You can read more about these calls below.

Exploring Climate Cooling: Full proposals

Advanced Research + Invention Agency ARIA

Annex 3: Exploring Climate Cooling | Rethickening Arctic Sea Ice

Re-thickening Arctic Sea Ice (RASI)

The Arctic is warming much faster than the global average, driving sea ice loss that threatens local ecosystems and accelerates global climate change.

While the only sustainable, long-term way to slow Arctic warming is through emissions reductions, the speed of Arctic warming has led to suggestions that deliberately thickening sea ice during winter might help to slow the melting and the rate of sea ice loss.

By bridging the gap between theoretical models, laboratory studies and real-world data collected through small-scale outdoor experiments, this project will investigate whether this approach could ever be feasible, scalable, and ecologically sound.

Overview

Led by Shaun Fitzgerald at the Centre for Climate Repair (University of Cambridge), the RASI project is supported by a £9.9m grant over 42 months. The consortium unites specialised field teams — Real Ice and Arctic Reflections — with a global network of research partners including the University of Manchester, UCL, the University of Washington, and NERSC, to combine rigorous scientific modelling with real-world Arctic experimentation.

Two separate sub-teams of researchers (Real Ice, Arctic Reflections) will conduct controlled, small-scale experiments in two locations in Canada. These experiments have been designed in close collaboration with local communities and in compliance with ARIA's stringent governance framework. The goal is to gather essential real-world data to rigorously assess if this intervention warrants further consideration.

Methodology

The outdoor experiments will take place in Nunavut, Canada, across three winter seasons (2026 to 2028). Using both above-ice and submersible pumps, the team will try to create thickened ice patches by pumping seawater from beneath existing ice and spreading it on top, where the frigid air freezes it quickly. Over the course of the project – and only if the early experiments suggest the approach is ecologically sound – later experiments will aim to cover areas up to 1 km^2 per experiment site. In the process, the RASI team will generate real-world data on variables that theory cannot yet predict – including whether this thicker ice lasts longer into the summer, how ice movement might be affected, and what the local ecological impacts of thickening might be.

In parallel, the RASI teams will look to reduce uncertainty around efficiency and scale. Data from outdoor experiments will feed into computer models to simulate interventions at scales that are not being physically tested. The RASI teams will model targeted interventions at natural choke points such as the Nares Strait – specifically, thickening ice arches. The goal is to understand if strengthening these specific areas could slow the flow of ice from the Arctic Sea into the warmer Atlantic, which is happening earlier and earlier in the year as the Arctic warms.

By collecting ice cores and water samples for study, the teams will look to improve our current understanding of whether sea ice thickening is ecologically sound. This real world environmental data will contribute to the wider programme, as scientists working on ecological modelling will then be able to simulate any ripple effects on the marine ecosystem, ensuring that the ecological cost-benefit analysis is understood before any large-scale activity is ever considered.

Research

The first phase of ARIA funded outdoor research begins in early 2026 at two locations in Nunavut, Canada. In both locations, the teams have secured Free, Prior and Informed Consent from the communities where this research will take place, ensuring engagement is meaningful, respectful and continuous. The researchers have secured the support and cooperation of municipal authorities, local Elders, and Hunters and Trappers Organizations (HTOs). Local residents have not only provided input into the experimental design but will also work alongside the researchers as part of the team.

In Cambridge Bay, Nunavut, the Real Ice sub-team will commence work in mid-January. Building on two years of engagement with local residents, and subsequent iterations of the experimental design, the team has been granted their formal permit to operate. The experiment site, located ~7km from the hamlet, was selected together with the Ekaluktutiak HTO, and their members will take part in the project.

(Real Ice team members in Cambridge Bay, Winter 2024-25, courtesy of Elise Imbeau)

In Qikiqtarjuaq, the Arctic Reflections sub-team will commence work in early February. They have the support of key local stakeholders and have been granted the formal permit to operate. Following a pivotal consultation with the local community in September 2025, the team moved their proposed experiment site to a new location to avoid disturbing seal birthing areas, acting directly on the advice of local Elders and the Hunters & Trappers Organization.

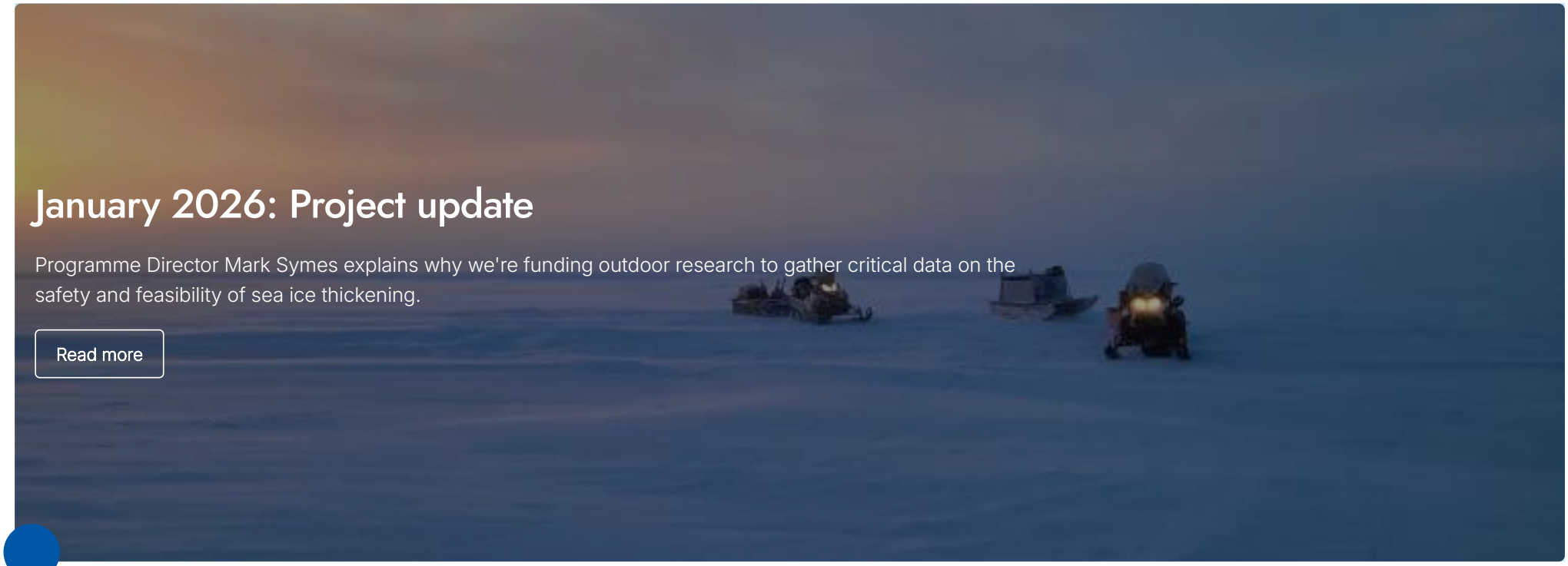
(Real Ice research site in Cambridge Bay, Winter 2024-25, courtesy of Centre for Climate Repair)

RASI's experiment and community engagement plans have been rigorously scrutinised by the programme's independent Oversight Committee and subsequently approved to proceed by ARIA's CEO. You can read the Committee's full recommendation here and the CEO's formal decision letter here.

Research is proceeding under Nunavut's well-established research permitting framework, which ensures research is ethical, responsible, and incorporates traditional knowledge.

Resources

Real Ice	Arctic Reflections
Community engagement summary, Winter 2025/26 [PDF - 484.73Kb]	Community engagement summary, Winter 2025/6 [PDF - 1.12Mb]
Nunavut Impact Review Board's screening report [PDF - 379.95Kb]	Nunavut Impact Review Board's screening report [PDF - 534.29Kb]
Scientific research licence for experiments from the Nunavut Research Institute [PDF - 908.81Kb]	Scientific research licence for experiments from the Nunavut Research Institute [PDF - 851.53Kb]
Letter to ECC programme team confirming completion of CEO conditions [PDF - 172.41Kb]	Letter to ECC programme team confirming completion of CEO conditions [PDF - 175.08Kb]
Independent legal assessment and permitting [PDF - 443.65Kb]	Independent legal assessment and permitting [PDF - 1.94Mb]



January 2026: Project update

Programme Director Mark Symes explains why we're funding outdoor research to gather critical data on the safety and feasibility of sea ice thickening.

Read more

FAQs for RASI

How does ice re-thickening work?

What is the specific goal of these experiments?

Doesn't the salty water melt or damage the ice that's already there?

Who is doing the research?

Where and when will the experiments happen? Why were these locations chosen for the experiments?

How are local communities, and local knowledge, incorporated into this research?

Will these experiments impact the local environment and wildlife?

Who gave permission for these experiments?

ow are you ensuring these experiments are ethical and safe?

When will the results of these experiments be made public?

How are these experiments different from deployment?

How do you measure the impacts of these experiments?

Why does Arctic sea ice matter for the global climate?

How does losing Arctic Sea Ice impact local communities?

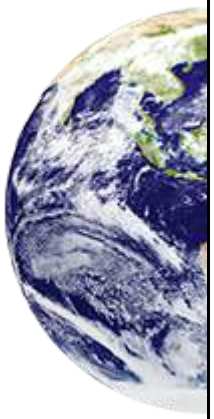
Can re-thickening sea ice solve climate change on its own?

Is the plan to scale these experiments up in the future?

What can these small scale experiments tell us about larger-scale impacts?

Advanced Research + Invention Agency ARIA

Annex 4: Exploring Climate Cooling | Oversight and Governance Webpage



Opportunity space: Future Proofing Our Climate and Weather

Programme: Exploring Climate Cooling

Exploring Climate Cooling

This £56.8m programme aims to build a robust evidence base to explore – with independent oversight – if climate cooling approaches could ever be feasible, scalable, safe, and governable.

Programme oversight + governance

We're committed to responsible stewardship, transparency, accountability + good governance. All funded research in this programme must comply with the following governance principles:

- **Deliver valuable + transformational knowledge.** We aim to select and design for research that will address the most pressing critical scientific questions surrounding approaches for actively cooling the climate.
- **Minimise risk.** All experiments should be designed to reduce direct risk as far as possible.
- **Engage with, and respect key communities**.
- **Communicate proactively and be transparent, open, and honest** at both the programme and project level, including around levels and sources of funding, intentions, how the research is conducted, outputs, and impacts.

- **Be cognisant of the broader implications of research + integrate systems thinking** into research on approaches for actively cooling the climate.
- **Learn, adapt and be responsive**. Success will require a willingness to adapt to lessons learned during the programme and to changing circumstances.

Our goal is to build the open scientific knowledge base the world needs to make better-informed decisions

To ensure this, all our funded teams have signed a binding Intellectual Property (IP) Pledge. This legal commitment ensures:

- All experimental data is made public for scrutiny by the global scientific community.
- All patents are free for research. Any team member must provide a royalty-free licence for anyone to use their patents for research purposes.

Oversight Committee

To ensure rigorous and responsible governance, this programme benefits from an independent Oversight Committee composed of international experts and chaired by Piers Forster. The Committee advises ARIA leadership and plays a crucial role in scrutinising outdoor experiment plans, providing expert recommendations, and may advise against funding experiments unless certain modifications are made. While ultimate funding decisions rest with ARIA, the Oversight Committee has the authority to comment publicly and independently on experiment funding decisions and on other matters related to the programme and the wider field.

The committee focuses on:

- Supporting effective oversight of the programme's outdoor experiments and guiding transparent communication of findings.
- Shaping international norms and standards for the responsible governance of such experiments.
- Contributing constructively to the wider international discussion on potential governance mechanisms for climate cooling approaches.

Learn more about the Committee's remit, members, and work

Meet the Oversight Committee

Our independent oversight committee brings together international experts in climate science, climate engineering, ethics, and governance. Together, this group is supporting the effective oversight and governance of outdoor experiments, and is helping to

Piers Forster

Chair

Piers Forster is a highly cited atmospheric scientist with over 30 years of experience researching the causes and impacts of climate change, as well as mitigation and adaptation approaches and their connection to national and international climate policy. He is founding Director of the Priestley Centre for Climate ...tures and Professor of Physical Climate ...hange at the University of Leeds.

Jessica Seddon

Secretary

Dr. Jessica Seddon's work on environmental governance focuses on how new sources of data can be used to enable new (more sustainable) ways of interacting with the environment around us. She is currently Senior Fellow and Director of the Deitz Family Initiative on Environment and Global Affairs at the Yale Jackson School of Global Affairs and a co-founder of The Institutional Architecture Lab.

Arunabha Ghosh

Member

Dr. Arunabha Ghosh is an internationally recognised public policy expert, author, columnist, and institution builder. He is the founder-CEO of the Council on Energy, Environment and Water, and has led CEEW to the top ranks as one of Asia's leading policy research institutions and among the world's 20 best climate think-tanks.

Elena Kavanagh

Member

Dr. Elena Kavanagh is an Indigenous Rights Scholar at University College Cork, Ireland, and a Research Affiliate at the Centre for the Study of Existential Risk (CSER) at the University of Cambridge.

Jack Stilgoe

Member

Dr. Jack Stilgoe is a professor in science and technology studies at University College London, where he researches the governance of emerging technologies.

Shuchi Talati

Member

Dr. Shuchi Talati is a climate technology governance expert and founder of The Alliance for Just Deliberation on Solar Geoengineering (DSG). DSG is a nonprofit organisation working towards just and inclusive deliberation about research and potential use of solar geoengineering.

Jan McDonald

Jan McDonald is Professor of Environmental and Climate Law at the University of Tasmania, Australia. Jan's research explores the legal frameworks required to responsibly govern the research, development and deployment of both solar radiation management and marine carbon dioxide removal technologies.

Oversight Committee publications

Note on the announcement of the Exploring Climate Cooling projects, (7 May 2025) [PDF - 66.16Kb]

RASI: Oversight Committee's full recommendation (9 December 2025) [PDF - 151.07Kb]

RASI: Reply from and the CEO's formal decision letter (18 December 2025) [PDF - 94.91Kb]

Governance of outdoor experiments: how it works in practice

We prioritise transparency, public engagement, and risk minimisation. Project teams planning an outdoor experiment must navigate a formal, multi-stage approval process. This ensures no funding for an outdoor experiment is released without rigorous technical analysis and meaningful community engagement. Here are the key stages:

1. Preparation: planning + engagement

2. Robust scrutiny: multi-level, independent

Recommendation: approve, improve, or deny

Advanced Research + Invention Agency ARIA

Annex 5: Exploring Climate Cooling | Oversight and Governance Document

Exploring Climate Cooling

Programme oversight and governance

Updated January 2026

What are ARIA's core principles for governance of this programme?

ARIA will not fund experiments where the activities proposed are prohibited by domestic or international law or that violate indigenous rights, including those outlined in the UN Declaration on the Rights of Indigenous People. Project teams will be required to show how their tests comply with all applicable laws.

The governance measures that ARIA has put in place for this programme have been designed with the following principles in mind:

- **Deliver Valuable & Transformational Knowledge.** We aim to select and design for research that will address the most pressing critical scientific questions surrounding approaches for actively cooling the climate.
- **Minimise Risk.** All experiments should be designed to reduce direct risk as far as possible.
- **Engage With, and Respect Key Communities.**
- **Communicate Proactively and be Transparent, Open, and Honest** at both the programme and project level, including around levels and sources of funding, intentions, how the research is conducted, outputs, and impacts.
- **Be Cognisant of the Broader Implications of Research + Integrate Systems Thinking** into research on approaches for actively cooling the climate.
- **Learn, Adapt and be Responsive.** Success will require a willingness to adapt to lessons learned during the programme and to changing circumstances.

Measures to try and uphold these principles are discussed in the programme **thesis**. In particular, we are:

- Working with and refining a detailed framework for approving funding for outdoor experiments in order to be transparent about our decision-making, ways of minimising risk and engagement with communities (see Figures 1-3 below).
- Opening the funding opportunity to a global pool of researchers in order to support a wider set of perspectives on critical questions.
- Maintaining a policy of transparent reporting of findings and open IP (when applied to climate intervention) in order to ensure that the knowledge gained is available for public benefit.

The programme's independent oversight committee (see below) is a mechanism intended to strengthen governance of the programme.

However, ARIA acknowledges that this is a complex and ethically-challenging research field and that circumstances unforeseen by the proposed governance measures may arise. By applying the principles above, ARIA will continue to iterate and update the programme's governance mechanisms in order to adhere to the principles above.

The role of the oversight committee and its relationship to the project teams

The programme oversight committee will have three main roles prioritised in this order:

1. Supporting ARIA's leadership in the effective oversight and governance of the outdoor experiments conducted as part of this programme, including producing guidance to ensure transparent and objective communication of findings.
2. Shaping the development of internationally-accepted and responsible norms and standards for oversight and governance of outdoor experiments of approaches for actively cooling the Earth.
3. Identifying constructive ways to contribute to the wider international discussion on possible governance mechanisms for these approaches.

The programme oversight committee is a panel of experts (including international members) that is independent of the project teams and the programme director and that makes recommendations directly to ARIA's leadership. Roughly half of the members of the

oversight committee were in place in time to contribute during the selection of projects by ARIA's leadership and the programme team. Additional members will continue to be appointed to the committee at the recommendation of the existing oversight committee members (and with the approval of ARIA's leadership) as the need arises. This flexible intake approach allowed for independent oversight during project selection, whilst also allowing the precise expertise of the committee to be tuned to best suit the projects that have been selected.

The initial members of the committee (see biographies below) were identified by ARIA on the basis of their expertise and international standing across a wide range of areas relevant to climate science and climate engineering. Potential members were then invited to join the committee by ARIA's leadership after meeting with the programme director and ARIA's CEO. These initial members have been appointed for the duration of the programme (5 years). Members appointed subsequently will be appointed for the remaining duration of the programme by invitation from ARIA's leadership, at the recommendation of the existing members of the committee and after consulting with the programme director. At the outset, the committee will have the opportunity to deliberate on and refine its terms of reference, for approval by ARIA's leadership.

Members of the committee will be paid at a fixed rate by ARIA in order to ensure that they can dedicate sufficient time to programme oversight. Remuneration will not be dependent on the progress of the project teams or on the delivery of particular recommendations regarding these teams, supporting the committee's independence. Budget will be available to allow the committee members to join in-person ARIA meetings and workshops.

The names, affiliations and biographies of the current members of the committee, together with information on their specific roles on the committee and any potential conflicts of interest are supplied below.

It is expected that the oversight committee will discuss the development of plans for outdoor experiments with the project teams and programme director, but it will be the responsibility of the project teams to develop suitable technical and non-technical plans. The oversight committee will not be involved in any direct management or day-to-day decision making for any of the projects. This approach is designed to give project teams access to the expertise of the oversight committee members (promoting the development of plans and pre-experiment activities in line with best practice), whilst allowing the oversight committee members to maintain a high level of objectivity regarding individual projects.

Budget and additional expert support services contracted by ARIA will be available to project teams to allow them to design and undertake the necessary pre-experiment public engagement and co-design activities. At the point at which project teams require additional budget in order to actually perform the outdoor tests, they will go through a formal "outdoor experiment funding approval" process, whereby their technical and non-technical plans and pre-experiment activities will be assessed, and approval for release of funds for the outdoor experiment (or series of linked experiments) will be either granted or refused by ARIA's leadership on the basis of the materials that the project teams submit for consideration.

Outdoor experiments will only be funded if they meet the criteria outlined in the programme thesis in the section "A Suggested Framework for Outdoor Experiments". Two key figures from the thesis are reproduced below for ease of access (Figures 1 and 2, which are called Figures 2 and 3 in the programme thesis). Further context on these figures is given in the programme thesis.

All ARIA projects must adhere to all relevant applicable domestic and international laws, and must respect the rights of indigenous peoples. For projects that propose to conduct activities that may require particular permissions, or compliance with particular regulatory or project management practices (e.g. outdoor experiments), ARIA will exercise its adaptive funding mechanism to review specific plans before funding is released for that component of the project.

An overview of the outdoor experiment funding approval process (and the role of the oversight committee in that process) is summarised in Figure 3. The decision trees in Figures 1 and 2 feed directly into this process, by informing which experiment proposals progress as far as seeking funding through the mechanism summarised in Figure 3. This figure also shows the relationship of the oversight committee to ARIA's leadership, the ARIA board committee for ethics and social responsibility (which has visibility across all of ARIA's programmes), the programme director, and to individual project teams. It is important to note that while ARIA's leadership makes the final decision on any given outdoor experiment, no project that violates applicable domestic or international laws or the recognized rights of indigenous peoples would be funded.

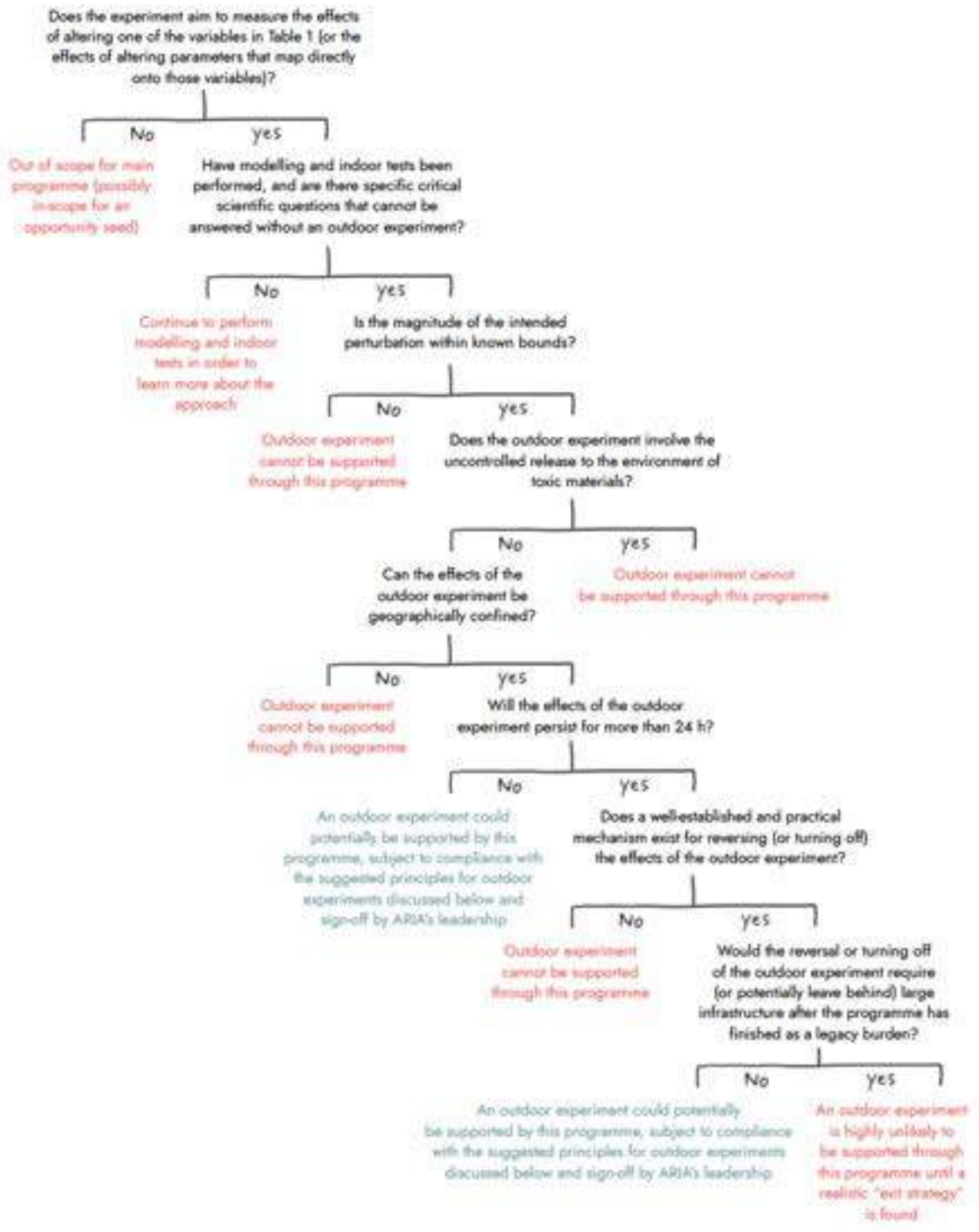


Figure 1: *The suggested outdoor experiment technical consideration decision tree (called "Figure 2" in the programme thesis). Table 1 refers to Table 1 in the Programme Thesis.*

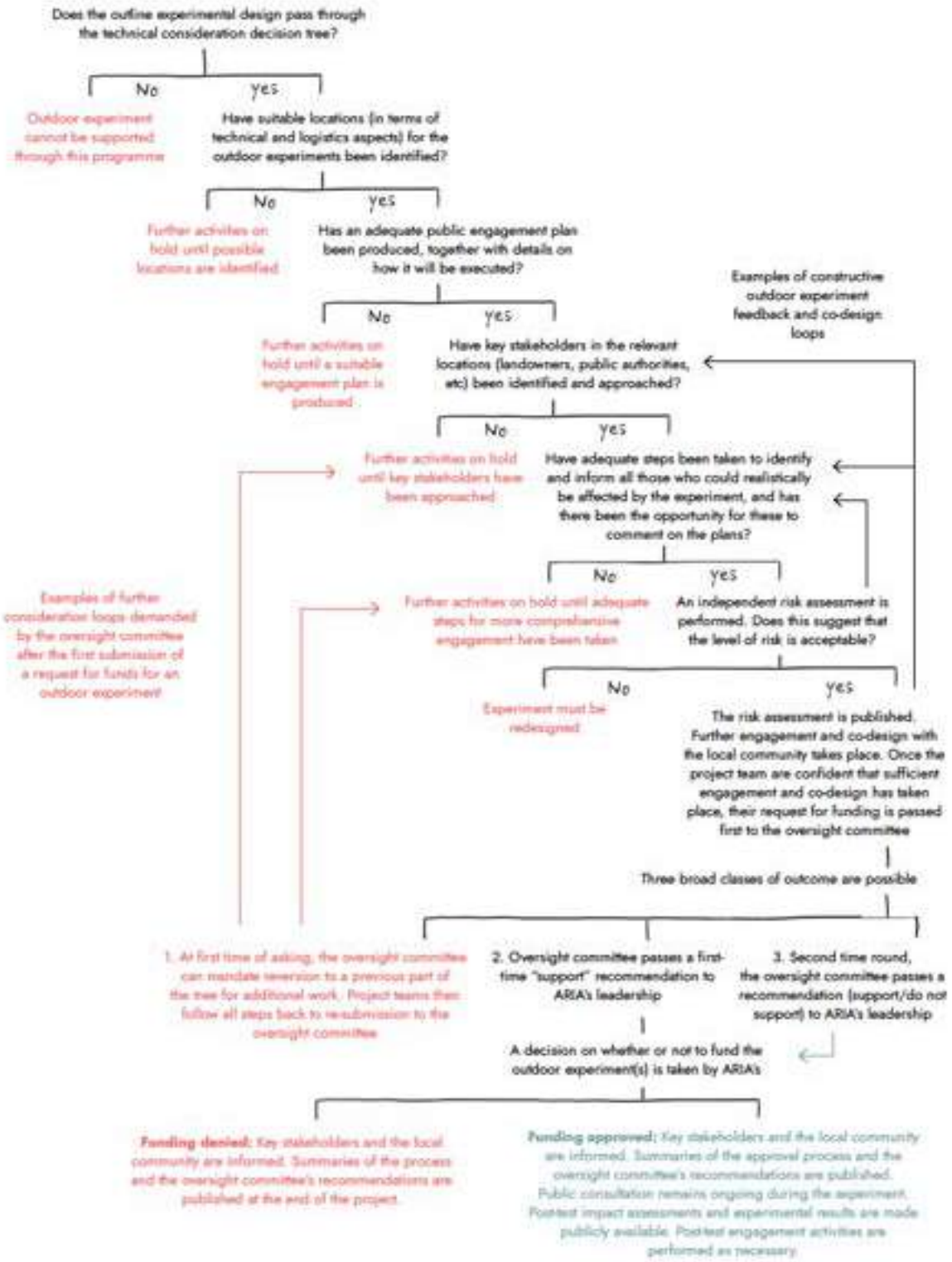


Figure 2: *The suggested outdoor experiment funding approval decision tree (called "Figure 3" in the programme thesis). This figure is to be used in conjunction with Figure 1 above.*

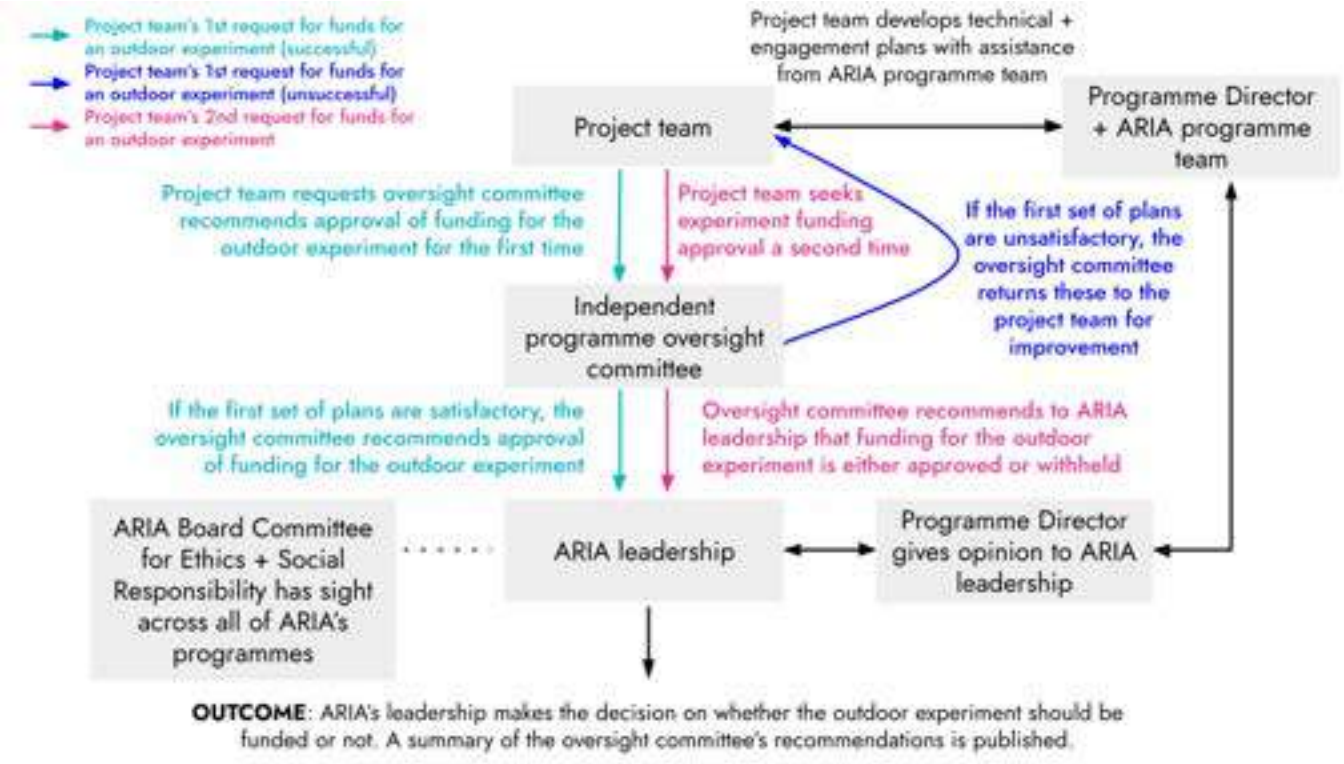


Figure 3: *The relationship of the oversight committee to ARIA's leadership, the ARIA board committee for ethics and social responsibility, the programme director, and to individual project teams, together with an overview of the process by which the oversight committee can insist on alterations to project teams' plans for outdoor experiments, and how subsequent decisions will be taken.*

At the outset of the outdoor experiment funding approval process, project teams will submit materials describing their plans and activities-to-date related to the outdoor experiment to the oversight committee, who will be able to scrutinise both the technical and non-technical aspects of these materials. The programme oversight committee will then make one of three recommendations to ARIA's leadership:

1. If the committee is thoroughly satisfied with the project team's plans and pre-experiment activities, then a recommendation will be made to ARIA's leadership that funding for the outdoor experiment (or series of linked experiments) should be approved (teal arrows in Figure 3).

2. If the committee is mostly satisfied with the project team's plans and pre-experiment activities, then a recommendation can be made to ARIA's leadership that funding for the outdoor experiment should be approved contingent on certain minor clarifications or amendments being made (teal arrows in Figure 3).
3. If the oversight committee is dissatisfied with the project team's plans and pre-experiment activities, then the oversight committee will have the power to refuse funding approval for any outdoor experiment (or series of linked experiments) on its own initiative at the first time of asking. Should this occur, the committee will be able to request alterations to a project team's plans and/or request that additional activities are performed prior to the start of an outdoor experiment (blue arrow in Figure 3). The project team will then be obliged to address these concerns and re-submit their updated materials to the oversight committee, with three outcomes then possible (pink arrows in Figure 3):
    a. The committee is now thoroughly satisfied, and recommends to ARIA's leadership that funding for the outdoor experiment is approved.
    b. The committee is now mostly satisfied, and recommends to ARIA's leadership that funding for the outdoor experiment can be approved contingent on certain minor clarifications or amendments being made.
    c. The committee remains dissatisfied, and recommends to ARIA's leadership that funding approval for the outdoor experiment is not granted.

The ultimate decision as to whether any individual outdoor experiment (or linked series of experiments) can be funded by ARIA therefore rests with ARIA's leadership. A summary of the committee's recommendations on any particular outdoor experiment (or linked series of experiments) will be made public on the ARIA website before the experiment takes place (in the cases where funding approval is ultimately granted), or at the end of the project in cases where funding approval is not granted. This summary will be prepared by the committee members, in consultation with the programme director.

When making recommendations as to whether any individual outdoor experiment (or linked series of experiments) can be funded by ARIA, the oversight committee will consider the following criteria:

- Is there sufficient scientific value in the proposed experiment and in the knowledge that could be gained by performing it to merit an outdoor experiment?
- Does the design of the experiment minimise risk sufficiently (e.g. to experimenters, the local environment and ecosystem, to property, etc)?

- Has sufficient meaningful engagement with the local community and key stakeholders taken place, and is there sufficient evidence of experimental co-design with these groups?
- Has there been sufficient consideration of the potential broader societal ramifications of the experiment?

Current membership of the oversight committee

The following international experts are the current members of the oversight committee. The committee is chaired by Piers Forster. While the current makeup of the committee provides expertise across a range of climate fields and geographies, ARIA and the oversight committee intend to add to the membership of this committee as the programme progresses and additional perspectives are needed.

As of September 2024, committee members are paid for their participation at a rate of £575/day. ARIA expects that participation will be ~1 day/month.

Committee Membership (April 2025)

Piers Forster (Chair)

Piers Forster is a highly cited atmospheric scientist with over 30 years of experience researching the causes and impacts of climate change, as well as mitigation and adaptation approaches and their connection to national and international climate policy. He was principal investigator for some of the first publicly funded research on geoengineering, the UK's Integrated Assessment of Geoengineering Proposals over 2010-2015.

Piers is a fellow of the American Geophysical Union and has played leading roles authoring Intergovernmental Panel on Climate Change (IPCC) reports, including its Special Report on 1.5°C and its latest

IPCC 6th Assessment Report. He has sat on the UK Government's Climate Change Committee since 2018 and has served as the Committee's Interim Chair since 2023.

He is founding Director of the Priestley Centre for Climate Futures and Professor of Physical Climate Change at the University of Leeds. The Priestley Centre was founded in 2016 to support interdisciplinary research, innovation and teaching on climate and foster strong working relationships with policy makers, businesses and the third sector to support climate actions that deliver wide societal and ecosystem benefits.

Declared conflicts of interest: The University of Leeds are recipients of funding from the ARIA call. Piers Forster was not involved in the proposals or funding decisions. A contract of work between Stardust Solutions and the Priestley Centre was agreed in late 2025, which funds some of Piers Forster's time. This contract funds a postdoc that will work with Professors Dan Marsh and Piers Forster. The work is designed to test the effectiveness of sunlight reflection technology and the impact of any physical and chemistry side effects. The plan is to publish both positive and negative results as the work progresses. The work is not under a non-disclosure agreement.

Jessica Seddon (Secretary)

Dr. Jessica Seddon's work on environmental governance focuses on how new sources of data can be leveraged to enable new (and more sustainable) ways of interacting with the environment around us. Her career spans academic, programme leadership, and strategic advisory roles in the U.S., India, and internationally, focused on institutional design for integrating science into policy and social initiatives. Dr. Seddon is currently Senior Fellow and Director of the Deitz Family Initiative on Environment and Global Affairs at the Yale Jackson School of Global Affairs and a co-founder of The Institutional Architecture Lab.

Jessica worked with the ARIA programme team on the initial design of the governance approach including formation of the Oversight Committee, on which she served as Interim

Chair. As Secretary, Jessica works as a bridge between the ARIA programme team and the Oversight Committee to facilitate some of the operational aspects of the Committee's relationship with ARIA. This includes, inter-alia: conveying questions and agenda requests from the programme team to the Oversight Committee, consolidating and conveying advice from Oversight Committee to the programme team, and supporting the programme team on governance-related questions as they arise.

Declared conflicts of interest: none

Arunabha Ghosh (ordinary member)

Dr Arunabha Ghosh is an internationally recognised public policy expert, author, columnist, and institution builder. He is the founder-CEO of the Council on Energy, Environment and Water, and has led CEEW to the top ranks as one of Asia's leading policy research institutions and among the world's 20 best climate think-tanks. He played a formative role in creating the International Solar Alliance, and was a founding board member of the Clean Energy Access Network. Co-author/editor of four books and with experience in 54 countries, he previously worked at Princeton, Oxford, UNDP (New York), and WTO (Geneva). The Asia Society honoured him with the 2022 Asia Game Changer Award, for his and CEEW's "incredible work, which is making a real difference for India and for the planet".

Arunabha advises governments, industry, civil society, and international organisations around the world. In October 2024, the Government of India appointed him to the Commission for Air Quality Management. He currently co-chairs the World Economic Forum's Global Future Council on the Energy Nexus (and previously co-chaired the GFC on Clean Air). He served on the Government of India's G20 Finance Track Advisory Group and advised the Sherpa Track for India's G20 Presidency in 2022-23. In 2022, the UN Secretary-General appointed him to the High-level Expert Group on the Credibility and Accountability of Net-Zero Announcements by Non-State Actors. In 2020, the Government of India appointed him

Co-Chair of the energy, environment and climate change track for India's Science, Technology and Innovation Policy (STIP2020).

Dr Ghosh has been a member of the UN Committee for Development Policy since 2019 (nominated by the UN Secretary-General; Vice-Chair 2023-25). He co-convened the Our Common Air Commission. He is a member of several international expert advisory groups: Global Commission on the Economics of Water; High-Level Group of Economists, constituted by the French president for the One Planet Lab; and the Senior Consultative Group for the Energy Transition Accelerator.

He writes monthly columns across various platforms. A frequent speaker, he has hosted or featured in several documentaries, and his 2019 TED Talk on air quality (Mission 80-80-80) has crossed 280,000 views. He was a World Economic Forum Young Global Leader. He holds a D.Phil. from Oxford.

Declared conflicts of interest: none

Jack Stilgoe (ordinary member)

Dr Jack Stilgoe is a professor in science and technology studies at University College London, where he researches the governance of emerging technologies. He is part of the UKRI Responsible AI leadership team (www.rai.ac.uk). He worked with EPSRC and ESRC to develop a framework for responsible innovation that is now being used by the Research Councils. Among other publications, he is the author of 'Who's Driving Innovation?' (2020, Palgrave) and 'Experiment Earth: Responsible innovation in geoengineering' (2015, Routledge). He is currently chairing an oversight committee for public dialogue on geoengineering research for the Natural Environment Research Council (NERC). He previously worked in science and technology policy at the Royal Society and the think tank Demos. He is a trustee of the Royal Institution.

Declared conflicts of interest: Jack is an employee of University College London, where one of his colleagues, Cian O'Donovan, is part of The Liminal Space, the consultancy that ARIA has contracted with to support teams funded by the Exploring Climate Cooling programme in developing their public engagement plans. He recused himself from advising ARIA on The Liminal Space's proposal.

Shuchi Talati (ordinary member)

Dr. Shuchi Talati is a climate technology governance expert and founder of The Alliance for Just Deliberation on Solar Geoengineering (DSG). DSG is a nonprofit organisation working towards just and inclusive deliberation about research and potential use of solar geoengineering. She is a contributing author to the American Geophysical Union's Ethical Framework for Climate Intervention Research, Experimentation, and Deployment. Dr. Talati was the co-chair of the Independent Advisory Committee to oversee SCoPEx, an effort to provide oversight for the proposed solar geoengineering experiment by Harvard University. She most recently served as a Presidential Appointee in the Biden-Harris Administration at the U.S. Department of Energy where she focused on creating just and sustainable frameworks for carbon dioxide removal. Dr. Talati has previously held roles in academia and civil society advising on policy and governance for emerging climate technologies, including as a Visiting Scholar at the Kleinman Center for Energy Policy at the University of Pennsylvania, an AAAS/AIP Congressional Science Fellow in the U.S. Senate and the Fellow on geoengineering research governance and public engagement at the Union of Concerned Scientists. Dr. Talati has a BS in environmental engineering from Northwestern University, an MA in climate and society from Columbia University, and PhD from Carnegie Mellon in engineering and public policy.

Declared conflicts of interest: A member of The Alliance for Just Deliberation on Solar Geoengineering is part of the team for the project entitled "Evidence-based Assessments to

Guide Perceptions, Governance, and Ethical Frameworks for South Asia," providing support on policy analysis, ethical framing and stakeholder engagement. Shuchi Talati was not involved in the review of the project proposal and will not be involved in oversight of this component of the project.

Jan McDonald (ordinary member)

Jan McDonald is Professor of Environmental and Climate Law at the University of Tasmania, Australia. Jan's research explores the legal frameworks required to responsibly govern the research, development and deployment of both solar radiation management and marine carbon dioxide removal technologies. Jan has previously worked for the United Nations Development Program in the Pacific and consulted on a range of projects to local, state and national governments in Australia, Vanuatu and the Solomon Islands. She is a Fellow of the Australian Academy of Law and co-founder of the Australian Forum for Climate Intervention Governance.

Declared conflicts of interest: none

Elena Kavanagh (ordinary member)

Dr Elena Kavanagh is an Indigenous Rights Scholar at University College Cork, Ireland, and a Research Affiliate at the Centre for the Study of Existential Risk (CSER) at the University of

Cambridge. Her broader areas of expertise include international law, Indigenous rights, human rights, and international relations, with a strong emphasis on ethical research approaches with a geographical focus on the Arctic. Elena's current research also engages with emerging global governance challenges. She examines how Indigenous knowledge and rights frameworks can inform debates on climate interventions, artificial intelligence, and the governance of outer space, particularly in relation to Free Prior and Informed Consent (FPIC), ethics, and participatory rights.

Elena completed her PhD in Law at University College Cork, where her doctoral research explored Indigenous language rights in the Arctic. During her academic work, she also engaged in field-informed research and training at the University of Lapland (Finland) and Nord University (Norway), specialising in Arctic governance, Sámi rights, and the operation of international human rights regimes in circumpolar and global contexts.

In addition to her academic work, Elena holds several international leadership roles. She currently sits on the Advisory Board of Directors of the Arctic Youth Network (Canada), serves as Chair of the Humanities and Social Sciences Working Group within the Network for Arctic Researchers in Ireland (NARI), and is the President of APECS—Ireland, where she supports early-career researchers engaging in polar and Indigenous scholarship.

***Declared conflicts of interest:** Elena sits on the Advisory Board of Directors of the Arctic Youth Network, a coalition-building grantee of the Climate Emergencies Forum (CEF), an initiative led by Renaissance Philanthropy, an ARIA Activation Partner.*

Emeritus Members

Nana Klutse

Prof. Nana Ama Browne Klutse is a distinguished Ghanaian known for her expertise in climate modelling, climate change impacts, adaptation, and mitigation strategies, particularly in Africa. She has been involved in various high-profile research projects and has contributed significantly to global climate assessments, including her work with the Intergovernmental Panel on Climate Change (IPCC) as the Vice Chair of the Working Group I. She is a full professor, researcher and the Head of the Department of Physics at the University of Ghana. She focuses on climate variability, climate

change modelling, Solar Radiation Management, and the impacts of climate change on society for her research and often addresses how climate change affects sectors such as agriculture, water resources, and health in Africa. Prof. Klutse has also been an advocate for integrating indigenous knowledge systems with scientific research to develop more comprehensive and context-specific climate adaptation and mitigation strategies. Her work aims to inform policy decisions and promote sustainable development in the face of climate change challenges. She has received various awards and recognitions for her contributions to climate science and her efforts to improve understanding and action on climate change in Africa.

Nana Klutse was an oversight committee member from August 2024 until August 2025

Advanced Research + Invention Agency ARIA

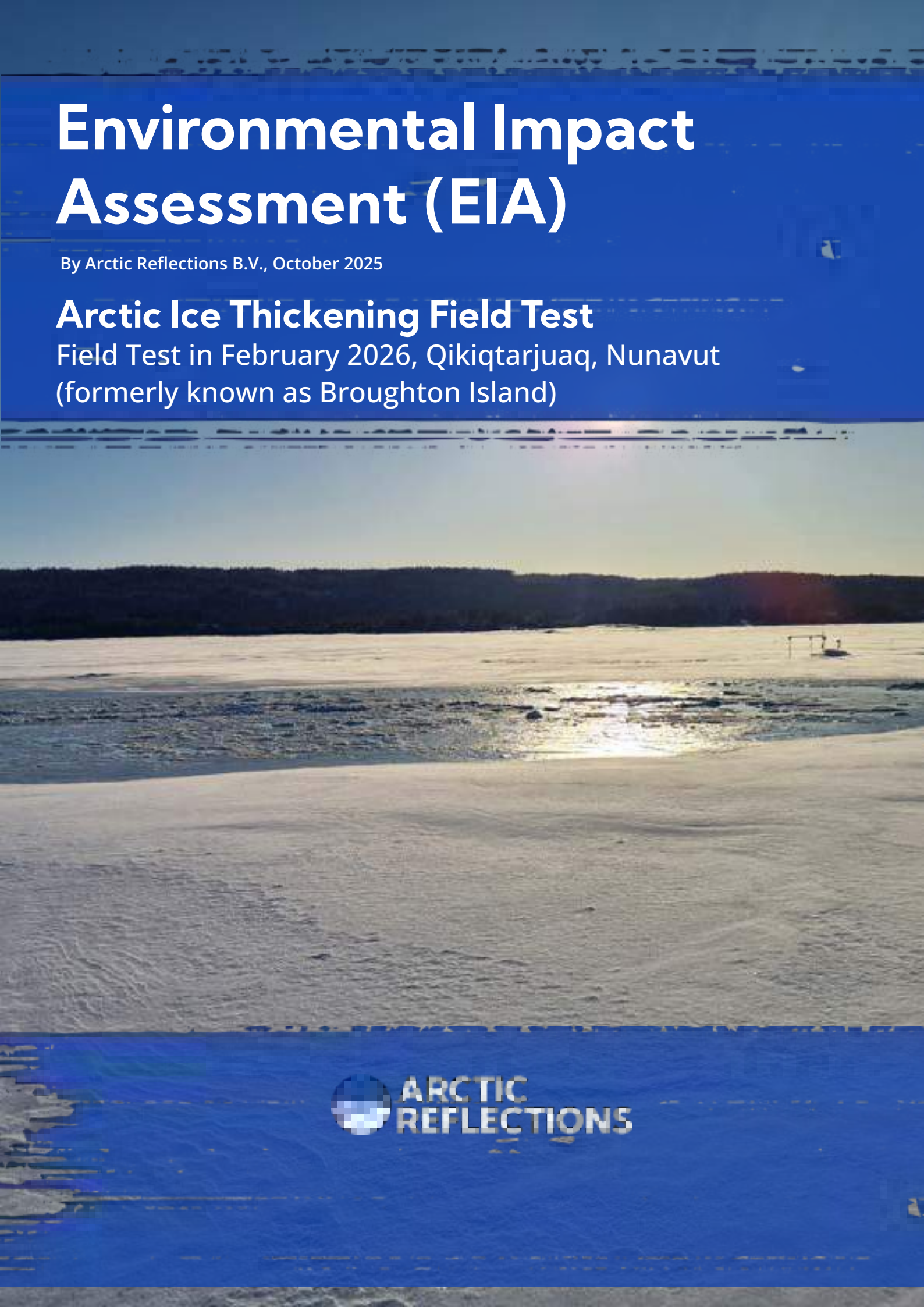
Annex 6: Environmental Impact Assessment | Arctic Ice Thickening Field Test

Environmental Impact Assessment (EIA)

By Arctic Reflections B.V., October 2025

Arctic Ice Thickening Field Test

Field Test in February 2026, Qikiqtarjuaq, Nunavut (formerly known as Broughton Island)



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We contribute to Sustainable Development Goals

1. Introduction and Purpose

This Environmental Impact Assessment (EIA) evaluates the potential environmental effects associated with the Arctic Ice Thickening (AIT) field test to be conducted directly off the southeast coast of Qikiqtarjuaq (Nunavut) in February. The purpose of this field test is to evaluate the scientific and technical feasibility of using AIT to thicken sea ice in order to enhance its seasonal persistence, reflectivity, and potential cooling effect. The overall goal is to assess whether AIT can contribute to mitigating Arctic sea ice loss and related ecosystem impacts caused by global warming.
The main body of this document will provide a summarized overview of potential impact and relevant mitigation measures. Annex I will provide a detailed overview for each species used to compile the summarized overview. This EIA was informed by a broader Environmental Risk Assessment of the Arctic Reflections' sea ice thickening methodology in the Canadian Arctic (M. Teunis, 2023).

2. Project Overview

Three tailor-made skid barges equipped with pumps will be towed to the site by snowmobiles. The pumps, mounted on lifting frames, will extract seawater from below the ice and discharge it onto the surface to promote controlled ice thickening. Two alternating crews of five to eight people each will conduct the operations over approximately four weeks. The first crew will install scientific instruments, commission the pumps, and initiate ice thickening. After 2.5 weeks, the second crew will continue the process, complete the thickening phase, and carry out cleanup and storage of the equipment. Scientific instruments will remain in place to monitor melting throughout the spring and summer seasons, after which they will be recovered.

3. Site Description and Baseline Conditions

The field test will take place off the southeast coast of Qikiqtarjuaq, located on the east coast of Baffin Island in Nunavut. We identified 2 zones within which our field test could take place. Following an in-person joint meeting with the Hunters and Trappers Organization (HTO) and the Hamlet of Qikiqtarjuaq on September 10th, 2025, we jointly decided to designate a new Zone 3 (south-east of Qikiqtarjuaq) as the preferred location for our upcoming field test. Zone 3 has been selected because the likelihood of disturbing wildlife is lower compared to the previously indicated Zones 1 and 2. Zone 2 will not be considered anymore. Zone 1 will remain only as a fallback option, to be considered solely in extraordinary circumstances and only if the HTO determines just before the start of the field test that Zone 1 takes preference over Zone 3. Figure 1 shows these three zones. For reference, we have included a rectangle within each zone to illustrate the size of the final 1 km^2 site relative to the overall zone. The exact location within this zone will be chosen just before the start of the field test in collaboration with the HTO, to avoid areas where animals are known to gather while staying clear of community travel routes.

The Qikiqtarjuaq region is part of the Qikiqtaaluk (Baffin) region and falls within Inuit Nunangat. The area is characterized by landfast sea ice in winter, rugged fjord coastlines, and proximity to the Davis Strait. The local community of Qikiqtarjuaq has a population of approximately 600 people, with livelihoods closely tied to traditional harvesting and marine resources (Kanatami, 2023, pp. 5-6). The area supports species including ringed seals, bearded seals, polar bears, Arctic char, seabirds, and occasionally narwhals and bowhead whales during open-water seasons. The nearest sensitive habitat

features include polynyas and floe-edge ecosystems located farther east, outside the operational area (Copernicus Climate Change Service, 2021). (Qikiqtani Inuit Association, 2018, p. 33)

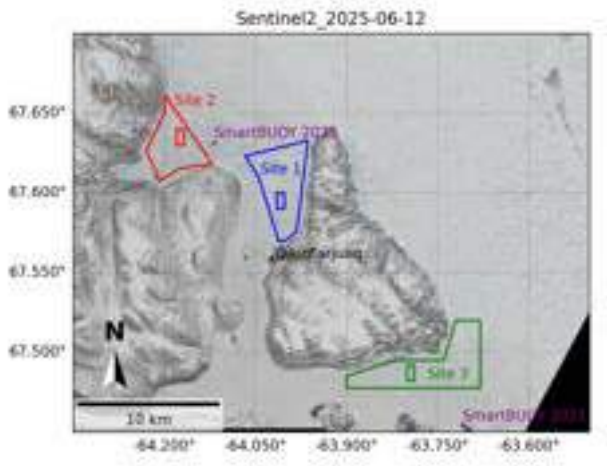

Figure 1: Potential field test sites zones, zone 3 being the preferred location

4. Analysis of Potential Environmental Impacts

4.1 Physical Environment

The physical disturbance from the AIT test will be minimal given its small (1 km^2) footprint. Pumping seawater onto sea ice can be compared to constructing temporary ice roads in terms of physical impact. All activities are conducted during the winter season when the sea ice is stable and thick. No sediment disturbance is expected since pump inlets will be limited to a maximum depth of 50 cm below the ice surface, with local water depths easily exceeding 10 meters. No long-term alteration of the seafloor or hydrodynamic processes is anticipated. The thickened ice will eventually melt during summer, ensuring no lasting physical modification to the environment

Figure 2 Water depth (in meters) at the southern side of Qikiqtarjuaq, the location of our preferred field test zone 3.

4.2 Biological Environment

The biological environment includes ice-dependent mammals (ringed and bearded seals, polar bears), Arctic cod, seabirds, and microorganisms inhabiting the sea ice. Operations are planned for February, prior to the ringed seal pupping season (March–April) and before the peak biological productivity period (April–June). Disturbance to wildlife is expected to be temporary and localized. Noise from pumps and snowmobiles may cause avoidance behavior in nearby seals or polar bears, though mitigation measures will minimize this risk. The impact of artificial light will be minimal, as operations occur primarily under natural daylight conditions. No significant effect on fish populations or plankton communities is anticipated. Arctic char typically winter and spawn in lakes (Fisheries and Oceans Canada, 2023, p. 18) and Arctic cod spawn in deeper ice-covered offshore areas and the site is distant from known spawning grounds (e.g., Franklin and Darney Bays). (Geoffroy, 2023, p. 7).

4.3 Socioeconomic and Cultural Environment

Qikiqtarjuaq is an Inuit community with active subsistence hunting and fishing, primarily targeting seals, Arctic char, occasionally polar bears and seasonally narwhals (Qikiqtani Inuit Association, 2018, p. 29). The field test area lies outside the main local harvesting routes, reducing potential overlap. Noise and human activity could temporarily disturb seals, potentially affecting harvest

opportunities, though this risk is minimal. The project will employ local wildlife monitors and engage community representatives to ensure culturally appropriate and environmentally sensitive operations, consistent with Inuit Tapiriit Kanatami's policy recommendations emphasizing Inuit participation in climate action initiatives (Inuit Tapiriit Kanatami (ITK), 2019, p. 4).

5. Mitigation Measures

- Select field site with input from Inuit wildlife monitors to avoid seal concentrations, denning sites, or key travel routes.
- Use high-flow rate pumps to minimize operational duration and noise.
- Restrict artificial lighting; operate mainly in daylight.
- Cease all operations if polar bears or other wildlife are observed nearby.
- Provide polar bear safety training for personnel.
- Prohibit any approaching or disturbance of wildlife by team members.
- Remove all non-essential equipment and waste after operations to avoid pollution.
- Always take the exact same route to and from the field test location to minimize disturbance caused by snowmobiles

6. Residual Impact Assessment

Due to the limited area and the timing of field test operations in February, no significant impact is expected. The most important mitigation is to minimize the disturbance of seals. Other than that, we think that the impact of our field test can best be compared with the impact of creating an ice road.

Biophysical resource	Potential impact	Proposed Mitigation	Residual impact	Predicted significance
Sea ice	Extended lifetime of sea ice	Limit to max 1 km2	• low magnitude • localized geographic extent • frequent occurrence • short-term duration • fully reversible	Not significant
Sea water	Disturbance of sediment while pumping	Use of pumps with short water inlet pipe (< 0.5m) while water depth > 10m	• low magnitude • localized geographic extent • frequent occurrence • short-term duration • fully reversible	Not significant
Pinnipeds	Disturbance of ringed seals	• Exact field test area to be chosen based on topical information and advice from wildlife monitors, staying away from seal concentrations • Wildlife Monitors will continuously assess the proposed field test area and advise on any wildlife concerns • Avoid resting and foraging areas while travelling to and from field test area and always use the same route • Minimize use of artificial light / operate in February when there is daylight • Minimize use of artificial noise: use high flow rate pumps to reduce pumping time and limit vehicle movements • Operate in February before birthing period • Team will be instructed to stay away from wildlife and not feed, hunt, trap or disturb them	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant

Polar bear	Disturbance, negative human-bear encounters	• Exact field test area to be chosen based on topical information and advice from wildlife monitors, staying far away from known dens • Wildlife Monitors will continuously assess the proposed field test area and advise on any wildlife concerns • Activities will cease if polar bear observed in proximity of the field test site and will only resume after the bear has left the area • Team will receive polar bear training • Minimize use of artificial light / operate in February when there is daylight • Minimize use of artificial noise: use high flow rate pumps to reduce pumping time and limit vehicle movements • Team will be instructed to stay away from wildlife and not feed, hunt, trap or disturb them	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant
Fish	Disturbance of Arctic Cod	• Avoid pumping near known spawning areas. Known spawning areas in Canadian Arctic are Franklin and Darney Bays • Field test operations in February. By late spring (after operations) juvenile cod can be found in shallower waters	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant
Whales	Disturbance of whales	• Field test operations in February when whales are not present	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant
Birds	Disturbance of birds	• Field test operations in February when migratory birds are not present on the sea ice	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant
Phytoplankton and Zooplankton	Disturbance of algae growth and disturbance of zooplankton	• Operations in February avoid disrupting the critical bloom period • Minimize artificial light • Conduct measurements for future reference	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant
Impact on harvesting	Disturbance of seals	• See mitigation to prevent disturbance of seals in this table	• low magnitude • localized geographic extent • infrequent occurrence • short-term duration • fully reversible	Not significant

7. Conclusion

The environmental impact of the proposed Arctic Ice Thickening (AIT) field test off the southeast coast of Qikiqtarjuaq is expected to be minimal. The activity is temporary, small in scale, and conducted during a period of low biological activity. With the mitigation measures in place, no significant adverse effects are anticipated on the physical, biological, or cultural environment. Continued collaboration with local Inuit organizations and wildlife monitors ensures that the project aligns with community values and respects Inuit rights under the Nunavut Agreement and UNDRIP.

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Annex I: Detailed overview per species

Potential Impacts on Pinnipeds around Qikiqtarjuaq (February – March)

Ringed Seals: Small pinnipeds (~1.5 m, 68 kg in winter) that depend on thick blubber layers for insulation and energy during the breeding season. They are key prey for polar bears and subsistence species for local communities. They primarily feed on arctic cod and crustaceans. Pupping starts at the end of March, but most born in April. To be found mainly to the Northwest of Qikiqtarjuaq year-round (Nunavut department of Environment, 2010, p. 52) (Qikiqtani Inuit Association, 2018, p. 70).

- Bearded Seals: Larger seals (~2.4 m, up to 340 kg in winter) that rely on benthic prey like crabs, shrimp, and clams. They birth pups on moving sea ice later in the year (April-May). Bearded seals can be found to the Northwest and to the South of Qikiqtarjuaq. The latter being the preferred location of our field test, but there they can only be found between August and November (Nunavut department of Environment, 2010, p. 26) (Qikiqtani Inuit Association, 2018, p. 70).
- Harbour Seals: not present in February-March (Qikiqtani Inuit Association, 2018, p. 71)

- Harp Seals: not present in February-March (Qikiqtani Inuit Association, 2018, p. 71)

- Hooded Seal: not present in February-March (Qikiqtani Inuit Association, 2018, p. 71)

- Walrus: not present in February-March (Qikiqtani Inuit Association, 2018, p. 71)

Potential Impacts of Operations:

1. Disturbance from Noise and Human Activity:

• Noise Stress: Seals are highly sensitive to sound. This could cause seals to flee their resting or foraging areas, leading to increased energy expenditure.

• Displacement: Disturbance might force seals away from preferred habitats near Qikiqtarjuaq, affecting their access to prey and increasing competition in less suitable areas.

• Artificial Light:

• Behavioral Disruption: Artificial lighting during winter could disturb seals' natural behavior, such as resting or hunting. Light may also attract or repel prey species, indirectly affecting seals' foraging success.

• Impact on Ice Habitat:

• Habitat Alteration: Pumping water onto sea ice could change ice thickness and dynamics, potentially impacting seal breathing holes and access to sub-ice habitats.

• Breeding Site Risk: February is before the birthing period for bearded seals, but altering ice conditions later in winter could impact future habitat suitability for denning and pupping later in the year.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Qikiqtarjuaq												
bearded seal	X	X	X	X	X	X	X	X	X	X	X	X
harbour seal (rare)			X	X								
harp seal	X	X	X	X	X	X						X
hooded seal	X	X	X	X	X							X
ringed seal	X	X	X	X	X	X	X	X	X	X	X	X
walrus	X	X	X	X	X	X						

Figure 3: Observations of seals and walruses Qikiqtarjuaq [5] (Qikiqtani Inuit Association, 2018, p. 64)

Figure 4: Ringed Seal near Qikiqtarjuaq (arrow pointing at Qikiqtarjuaq) (Nunavut department of Environment, 2010, p. 52)

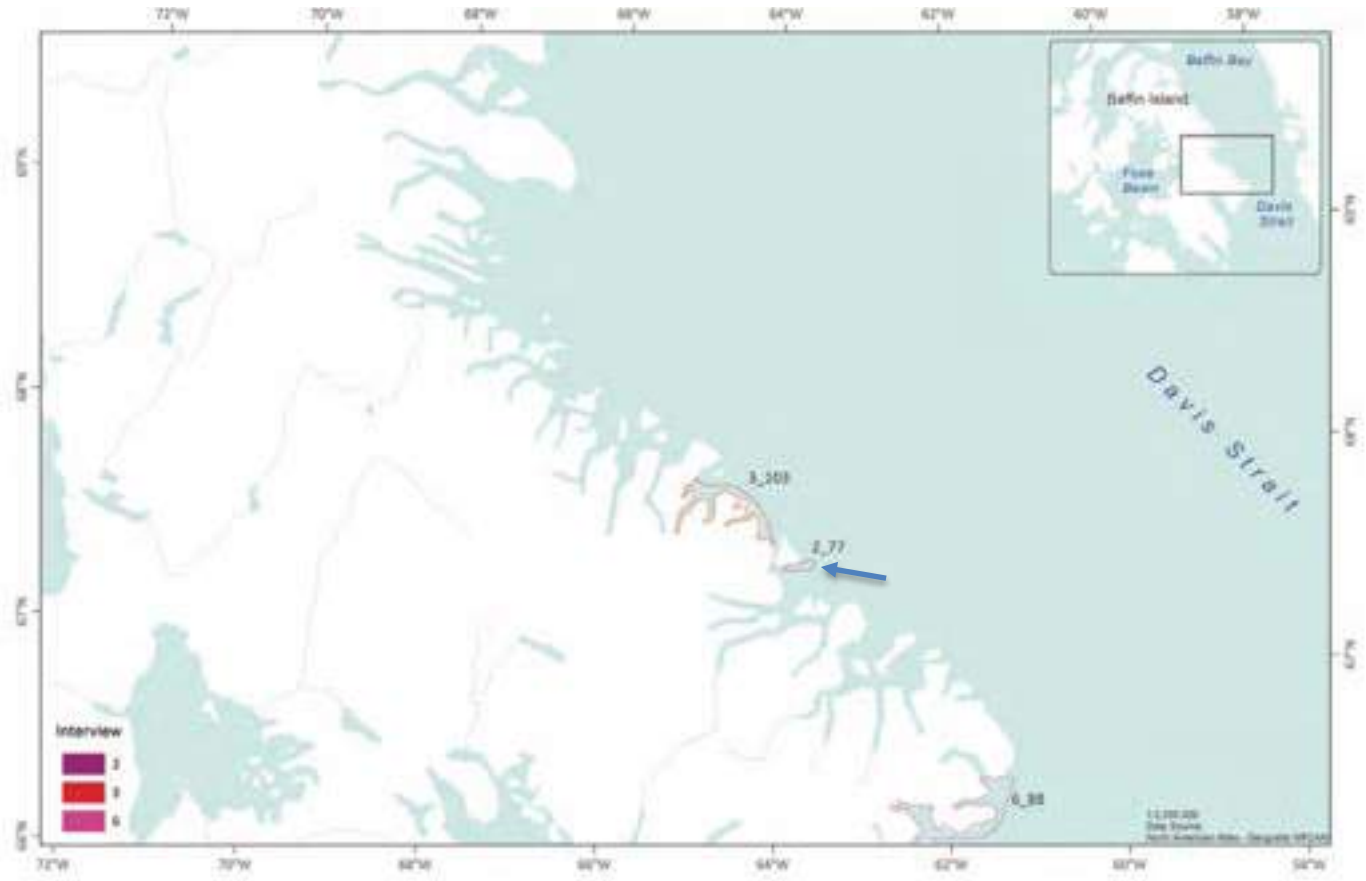

Figure 5: Bearded Seal near Qikiqtarjuaq (arrow pointing at Qikiqtarjuaq) (Nunavut department of Environment, 2010, p. 26)

Table 7: Bearded Seal - Areas of Occupation

LABEL NUMBER	INTERVIEW CODE	SPECIES	MONTHS	COMMENTS
2_77	QIK_2_0310	Bearded Seal	Aug-Nov	
3_103	QIK_3_0310	Bearded Seal	Sep-Oct	
6_88A	QIK_6_0310	Bearded Seal	Aug-Sep	

Figure 6: Table showing presence of Bearded Seal to the south of Qikiqtarjuaq (area 2_77) (Nunavut department of Environment, 2010, p. 27)

Conclusion

Operations near Qikiqtarjuaq in February could potentially affect ringed seals; however, these animals are primarily found northwest of Qikiqtarjuaq and not in the southern area where our preferred field test Zone 3 is located. Other pinniped species are not present near the planned operations site.

To minimize any potential impact, a series of mitigation measures will be implemented, focusing on avoiding known resting and foraging areas. Wildlife monitors will be engaged to provide real-time observations and guidance on selecting the precise field test location. They will continuously monitor the area during operations and promptly alert the team to any seal-related concerns. All team members will be instructed to avoid disturbing seals or other wildlife. Conducting operations in February enables the use of natural daylight—reducing the need for artificial lighting—and ensures that activities take place before the ringed seal birthing season. In addition, the use of high flow rate pumps will help shorten pumping duration, further limiting potential disturbance.

Species	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕙᓚᐃᖅ Upirngasaaq	ᐅᐱᕙᓂᖅ Upirngaaq	ᐊᔾᔨᖅ Aujaq	ᐅᑭᐊᓯᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	January to mid-March	mid-March to third week of May	end of May to mid-July	end of July / beginning of August to mid-September	end of September to November	end of November to end of December
Ringed seal	breathing holes (maybe at floe edge but harvesting is not done there. Ice too rough)	breathing hole; birthing lair; pupping starts at the end of March, but most born in April	present	present	present	present
Bearded seal	breathing holes (maybe at floe edge but harvesting is not done there. Ice too rough)	breathing hole; birthing lair; pupping starts at the end of March, but most born in April	floe edge; skins best this time of year for boots	present	present	present

Figure 7: Table showing Ringed and Bearded seal distribution around Qikiqtarjuaq based on IQ (Qikiqtani Inuit Association, 2018, p. 71)

Potential Impacts on Polar Bears around Qikiqtarjuaq (February–March)

Polar Bears (Ursus maritimus): Apex predators of the Arctic that rely on sea ice for hunting, mainly targeting ringed seals. Females den from November to late March/ early April, with average litter sizes of 1-3 cubs, and typically breed in late April or early May. Polar bears can be found along the entire Baffin, Devon, and Ellesmere islands coastlines. They have their cubs in dens before ringed seals give birth. Polar bear hunt ringed seal pups in their dens, or out on the open ice (Qikiqtani Inuit Association, 2018, p. 76).

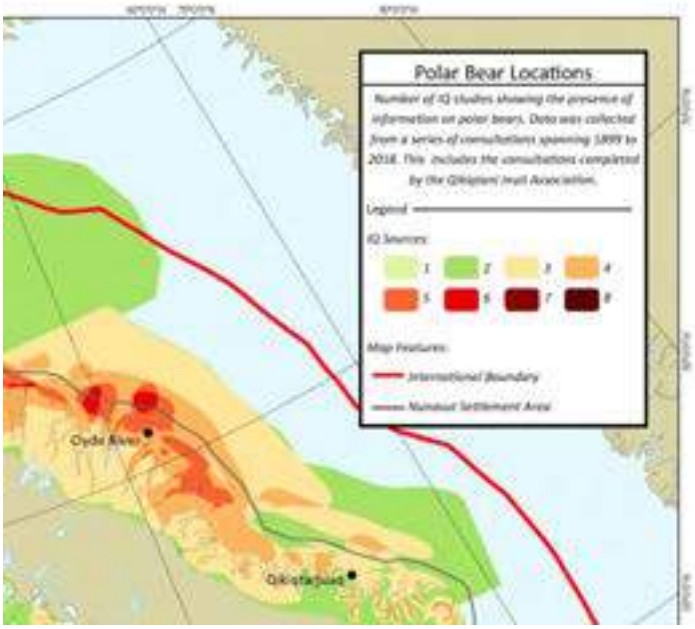

Figure 8 Location of polar bear based on Inuit hunting locations (Qikiqtani Inuit Association, 2018, p. 77)

Potential Impacts of Operations:

1. Disturbance from Noise and Human Activity:

o Denning Females: Noise from pumping and associated activities near denning areas can disturb pregnant females or mothers with cubs, potentially causing den abandonment, which could lead to cub mortality.

o Energetic Stress: Polar bears rely on conserving energy during winter. Human activity that forces movement or alters behavior can increase energy expenditure, reducing survival chances.

2. Artificial Light:

o Behavioral Disruption: Artificial light may disturb nocturnal hunting or resting patterns, potentially disorienting bears or altering their interaction with prey like ringed seals.

o Impact on Hunting: Light may also affect the visibility of prey species, influencing hunting success.

3. Impact on Habitat and Prey Availability:

o Prey Distribution: If ringed seals are displaced or their local populations are reduced due to operations, polar bears may struggle to find sufficient prey, increasing their travel distances and energy use.

4. Impact on Population and Reproduction:

o Den Site Disruption: Operations in or near key denning areas may harm the reproductive success of females by causing abandonment or physical disturbance of dens.

o Stress on Cubs: Disturbed females might fail to provide adequate care to cubs, affecting their survival.

Conclusion

Pumping operations, noise, and artificial light near Qikiqtarjuaq in February could impact polar bears, particularly denning females and hunting adults. The most critical concerns are disturbance to denning sites and disruption of hunting opportunities. Implementing mitigation measures will reduce these risks. The field test area will be selected based on current information and guidance from wildlife monitors, ensuring it remains distant from known dens. Wildlife monitors will continuously evaluate the site and provide advice on any concerns related to wildlife. If a polar bear is observed near the field test site, all activities will pause and only resume once the bear has left the vicinity. Additionally, the team will undergo polar bear safety training to ensure preparedness. We plan our

operations in February, so we can make use of daylight and minimize artificial light.

Potential Impacts on Fish Around Qikiqtarjuaq in February

In February, Arctic cod is the only fish species known to remain active under the sea ice near Qikiqtarjuaq. Arctic cod plays a critical role in the Arctic ecosystem, serving as a key prey species for marine mammals like seals and some seabirds. While Arctic char is a common species in the Arctic, they are not present directly in or under sea ice. They lack the necessary antifreeze proteins to survive the frigid saltwater temperatures and risk freezing. They therefore migrate to fresh water to overwinter or migrate to deep offshore areas. They spawn in September in lakes or rivers or streams connected to lakes.
Potential Impacts of Operations:
1. Direct Removal of Eggs or Larvae
- Risk: Arctic cod spawn during the winter, and their eggs and larvae may be present in the water column under the ice. Pumping seawater onto the ice risks unintentionally removing eggs or larvae from the local environment, which could reduce reproductive success in the immediate area. In general, it can be said that Arctic cod moves to deeper, ice-covered waters to release their eggs. The eggs and larvae then drift with the currents, eventually making their way into shallower coastal areas as they develop. By late spring and summer, juvenile cod can often be found in shallower waters
- Mitigation: Avoid pumping near known spawning areas or at depths where eggs and larvae are most concentrated. In the Canadian Arctic, spawning is suggested to occur near the Franklin and Darney Bays [(Geoffroy, 2023, p. 7).

2. Disturbance from Noise
- Risk: Arctic cod are sensitive to underwater noise, which can alter their behavior. Noise generated by pumping equipment could cause cod to flee, leading to energy loss and potential displacement from optimal foraging grounds.
- Mitigation: limit operating time by using high flow rate pumps

3. Changes in Prey Availability
- Risk: Pumping operations might disturb zooplankton, a primary food source for Arctic cod. Any significant disruption to the local zooplankton population could impact cod feeding opportunities, particularly during the resource-scarce winter months.
- Mitigation: Maintain careful placement of pumping equipment / use short water inlet pipe to reduce the disturbance of zooplankton populations near the sea floor.

Broader Considerations
- Localized Impact: Arctic cod populations are highly adapted to dynamic and harsh conditions, so localized effects are unlikely to significantly impact the broader population.
- Ecosystem Dependency: Since Arctic cod are a cornerstone species, any significant disruption to their lifecycle could cascade through the food web, affecting higher predators like seals and seabirds.

Conclusion

By implementing precautionary measures, the potential risks to Arctic cod during February pumping operations can be minimized, ensuring minimal ecological disruption near Qikiqtarjuaq. Spawning occurs between September and April, and peaks between January and February, when our field test location is planned. We should thus stay away from the known spawning areas in the Canadian Arctic are Franklin and Darney Bays (Geoffroy, 2023, p. 7). By late spring (after our operations) juvenile cod can be found in shallower waters

Potential Impacts on Whales around Qikiqtarjuaq (February–March)

Given the absence of belugas, bowhead whales, and narwhals in the Qikiqtarjuaq region during February and March, the direct impact of Arctic Ice Thickening operations on these species is expected to be negligible.

These whales typically migrate to areas with polynyas or less dense ice during the winter months, avoiding the stable, heavy ice found near Qikiqtarjuaq.

ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᓂᖏᓐᓄᑦ Upirngasaaq	ᐅᐱᕐᓂᖅ Upirngaaq	ᐊᔾᔨᖅ Aujaq	ᐅᑭᐊᓯᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
January to mid-March	Mid-March through third week of May	End of May to mid-July	Mid-End of July to mid-September	End of September to October / November	End of November and December
Not present. In deep water		Moving northward past Qikiqtarjuaq in mid-June	Seldom seen. Maybe be seen in Merchants Bay and Padle Fiord.		Not present

Figure 11 Beluga seasonal distribution near Qikiqtarjuaq (Qikiqtani Inuit Association, 2018, p. 48)

ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᓂᖏᓐᓄᑦ Upirngasaaq	ᐅᐱᕐᓂᖅ Upirngaaq	ᐊᔾᔨᖅ Aujaq	ᐅᑭᐊᓯᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
January to mid-March	Mid-March through third week of May	End of May to mid-July	Mid-End of July to mid-September	End of September to October / November	End of November and December
Not present. In deep water at floe edge in Baffin Bay	Migrating north in April	At floe edge; near Qikiqtarjuaq mid-June migrating northward	Migrating south along with other whales	Migrating south along with other whales; Gone by November	Not present; Offshore northern Davis Strait and southern Baffin Bay

Figure 10 Narwhal seasonal distribution near Qikiqtarjuaq (Qikiqtani Inuit Association, 2018, p. 54)

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᓂᖏᓐᓄᑦ Upirngasaaq	ᐅᐱᕐᓂᖅ Upirngaaq	ᐊᔾᔨᖅ Aujaq	ᐅᑭᐊᓯᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	early spring	late spring	summer	early fall	fall, early winter
Qikiqtarjuaq	Not present	Not present	Arriving in July	Present	Leave the area in September	Not present

Figure 9 Seasonal location of killer whale based on IQ (Qikiqtani Inuit Association, 2018, p. 58)

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᓂᖏᓐᓄᑦ Upirngasaaq	ᐅᐱᕐᓂᖅ Upirngaaq	ᐊᔾᔨᖅ Aujaq	ᐅᑭᐊᓯᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	early spring	late spring	summer	early fall	fall, early winter
Qikiqtarjuaq	Not present	Not present	Arrive in the area	Abundant in near shore waters, and fiords and inlets	Whales from the north passing by Qikiqtarjuaq. Leave before ice forms	Not present

Figure 12 Seasonal location of bowhead whales based on IQ (Qikiqtani Inuit Association, 2018, p. 60)

Potential Impacts on Birds around Qikiqtarjuaq (February–March)

The majority of marine related birds arrive on Baffin Island during Upirngasaaq (mid-March – beginning of May) and depart towards the end of Aujaq (mid-September).
The exceptions are the Black guillemot and thick-billed murre. They remain in Baffin Bay and Davis Strait year-round, keeping to open waters during the winter (Qikiqtani Inuit Association, 2018, p. 84).

Our operations in February and beginning of March (Ukiuq) will be on sea ice therefore no birds expected to be present.

	Upirngasaaq	Upirngaaq	Aujaq
Arctic Loon			
Arctic Tern		X	X
Black Guillemot*	X	X	X
Brant Goose		X	X
Canada Geese		X	X
Common Loon			
Red breasted Merganser		X	X
Dovekie		X	X
Eider duck*	X	X	X
Greater Snow Geese		X	X
Gulls		X	X
Harlequin duck		X	X
King Eider		X	X
Black-legged Kittiwake		X	X
Long-tailed Jaeger		X	X
Northern Fulmar		X	X
Long-tailed duck (Oldsquaw)		X	X
Red-necked Phalarope		X	X
Plovers		X	X
Razor Bill		X	X
Red knot		X	X
Ruddy Turnstone		X	X
Sandhill Crane		X	X
Sandpiper		X	X
Shorebirds		X	X
Thick-billed murre*	X	X	X
Tundra Swan		X	X
White-fronted goose		X	X
Yellow-billed Loon		X	X

*These birds remain year round wintering in open water areas

Figure 13 Common birds of Baffin Bay and Davis strait (Qikiqtani Inuit Association, 2018, p. 85)

Potential Impacts on Phytoplankton and Zooplankton

Sea ice is a crucial habitat for microorganisms such as phytoplankton and other microbes that form the base of the Arctic food chain. The spring and summer algae bloom, particularly from April to June, marks a vital period for Arctic marine life, with ice algae starting to bloom as early as April, followed by phytoplankton as the ice melts. These organisms support a wide range of species, from fish to marine mammals and birds.
The timing of our operations in February and beginning of March avoids disrupting this critical bloom period, which starts when the sea ice starts thinning.
Artificial light may disturb the natural cycle of zooplankton and krill and invertedly start their diel vertical migration (M. Teunis, 2023, p. 34). Minimizing artificial light will reduce this risk.

Potential Impacts on harvesting

As noted by the Nattivak Hunters & Trappers Organization, field test operations may mainly impact seal harvesting activities. Noise and human activity could potentially disturb seals, causing them to leave the area.
To minimize these impacts, mitigation measures will be implemented, including noise level reduction, avoiding key habitats, and the utilization of low-impact lighting to limit disturbances to seal populations.
To further mitigate risks, local wildlife monitors will be engaged during the flooding phase of the operations. The field test will avoid areas with known wildlife concentrations and key habitats, including seal dens. Additionally, the advice and expertise of wildlife monitors will guide the selection of the exact location for the Arctic Ice Thickening (AIT) field test.

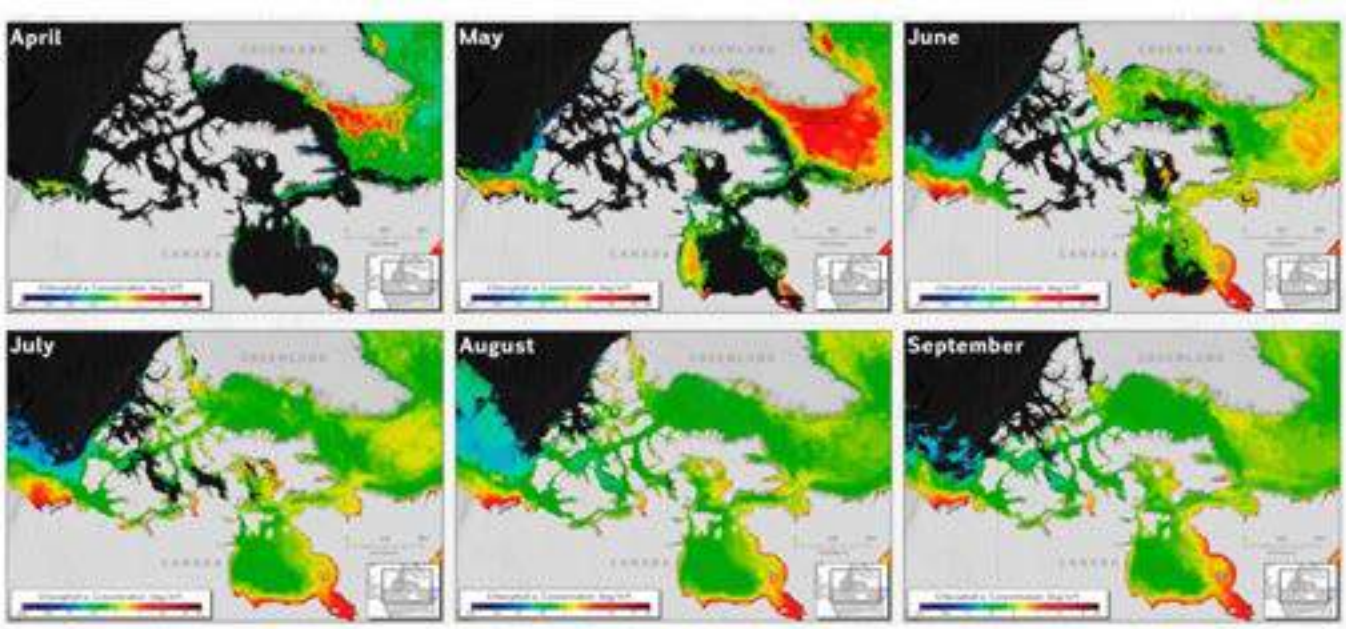

Figure 3.2 *Monthly average chlorophyll-a concentration in the Canadian Arctic based on satellite imagery (pelagic phytoplankton). Chlorophyll is the green pigment in phytoplankton, so areas with high chlorophyll concentrations are places where phytoplankton are growing (Oceans North Conservation Society et al. 2018).*