# Original Request (27 August 2025)

"I have noticed and made records of planes or drones spraying the sky in my area.

Since I have not been advised, would you please confirm that your experiments are indeed taking place over Leigh (Greater Manchester) and the names of the materials that have been used to date."

[redacted]

23 September 2025

Dear [redacted],

**Environmental Information Regulations 2004 ("EIR") Request**

We are writing in response to your recent request for information to the Advanced Research + Invention Agency ("**ARIA**") dated 27 August 2025 in which you asked:

*"I have noticed and made records of planes or drones spraying the sky in my area.*

*Since I have not been advised, would you please confirm that your experiments are indeed taking place over Leigh (Greater Manchester) and the names of the materials that have been used to date."*

**Response to EIR request**

We can confirm that no ARIA-funded outdoor experiments have been carried out, or are currently planned to take place, in or around the Greater Manchester area. As such, the information you have requested is not held by ARIA.

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**.

Yours sincerely,

ARIA

You can ask us to review our response. If you want us to carry out a review, please let us know within 40 working days by emailing eir@aria.org.uk.

If you are still dissatisfied after our internal review, you may complain to the Information Commissioner's Office (ICO) for further investigation who can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF.

# Annex 1: Exploring Climate Cooling

Opp space: Future Proofing Our Climate and Weather

Programme: Exploring Climate Cooling

# Exploring Climate Cooling

**Motivated by the possibility of encountering damaging climate tipping points, and backed by £56.8m, this programme aims to transparently explore – under rigorous oversight – whether any climate cooling approaches that have been proposed as potential options to delay or avert such tipping points could ever be feasible, scalable, and safe.**

## Our goal

To gather critical missing scientific data to better understand potential climate cooling approaches and their impacts.

By investing in careful research today, we can build the fundamental scientific knowledge to make wiser, better-informed decisions about our future.

## Why this programme

Climate change could cause global temperatures to increase by several degrees by the end of the century, which could lead to climate tipping points – abrupt changes in the Earth system that, if crossed, could have devastating and essentially irreversible consequences.

We don’t know when a tipping point might happen, or how long it would take to feel the effects if it did; significant uncertainties remain regarding the probability and potential impacts of any given tipping point.

If faced with a climate tipping point, our understanding of the options available remains limited. This knowledge gap has driven increased interest in whether there are approaches (also known as “climate interventions”) that could actively reduce temperatures globally or regionally over shorter timescales.

Yet, in the absence of robust data, we currently have little understanding of whether such interventions are scientifically feasible, and what their full range of impacts might be. This programme aims to gather such data so that we can better understand these approaches and their potential effects.

## How we’re doing it

As a publicly funded, non-profit agency, our research efforts are grounded in transparency, responsible stewardship, and a commitment to broad public benefit.

The programme will explore more than one potential climate cooling approach in order to be comprehensive and to allow a range of potential options to be explored thoroughly and objectively.

Successful outcomes from this programme include assessing the feasibility and risks of these approaches, as well as setting the standard for how research in this field can be conducted responsibly and inclusively. The programme will not fund, and does not support, the deployment of any climate cooling approaches.

Read the programme thesis

Read the accessible version of the programme thesis

# FAQs

Why is ARIA funding this programme?

Are you funding any outdoor experiments? What do they involve?

What else are you funding (beyond outdoor experiments)?

What experiments do you expect to take place outside the UK?

How will I know if an experiment is planned to take place in my local area?

Why are outdoor experiments necessary if lower risk methods, like modelling and indoor testing, are available?

What oversight measures are in place?

Have any outdoor experiments funded by ARIA taken place yet?

Are these experiments legal?

Are these experiments safe for humans and animals?

Will your experiments change the weather or seasons?

Will your experiments stop plants and crops from growing?

Are you funding activities to block the sun?

Will any of the experiments release toxic materials into the atmosphere?

Is ARIA funding the Stratospheric Aerosol Transport and Nucleation project?

Are you looking to deploy these approaches?

# 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 here.

**Read the Oversight Committee's note on the announcement of the Exploring Climate Cooling projects, published 7 May 2025, here.**

# 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.

*∗All projects are subject to final contract negotiation.*

## 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 future scenarios. They will start by outlining scenarios variously shaped by growing climate impacts, geopolitical challenges, the need for ongoing mitigation efforts, and the public's views. Their research will survey existing debates in both academic and policy circles, and discuss with policy makers and civil society organisations the risks, benefits and uncertainties they expect. Based on these scenarios, the project aims to develop foundational governance ideas to help ensure future decisions are socially and scientifically informed.

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 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.

We will publish the complete grant agreement for this project, including its key milestones, as soon as it is finalised.

## Evidence-based Assessments to Guide Perceptions, Governance, and Ethical Frameworks for South Asia: Comparing Marine Cloud Brightening strategies vis-à-vis carbon dioxide removal and mitigation efforts

**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

**Award:** £148k over 2 years

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.

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

## 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 ensure that researchers in these regions have the evidence base to support scientifically-robust decision-making surrounding potential Earth cooling strategies.

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

## 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

## Investigating the Impacts of Earth Cooling Approaches on the Variability and Wet-Dry Spell Dynamics of the West African Monsoon

**Project Lead:** Amadou Coulibaly, Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR-IFRA)

**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.

We will publish the complete grant agreement for this project, including its key milestones, as soon as it is finalised.

## 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) | Jeff Overbeek (via Ethos Space, at no cost to the project) | Saptarshi Bandyopadhyay (NASA Jet Propulsion Laboratory, California Institute of Technology, at no cost to the project)

To make informed choices about potential climate cooling strategies, society needs a clear understanding of possible options, including less-studied approaches like space-based reflectors. This theoretical study brings together leading space engineering teams with expert climate modellers to address a critical knowledge gap. This team will model six different conceptual designs for space reflector approaches and

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.

## Towards Robust and Unbiased validation of SAI Simulations (TRUSS)

**Project Lead:** Heri Kuswanto, Institut Teknologi Sepuluh Nopember, Indonesia

**Award:** £345k over 3 years

**Key Team Members and approximate budget breakdown:** 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.

## 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 and approximate budget breakdown:** Byju Pookkandy, Kaagita Venkatramana, The Energy and Resources Institute (TERI)

Stable 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 could potentially disrupt these vital precipitation patterns – affecting everything from the timing of seasonal rains in India to the intensity of precipitation extremes. By analysing detailed climate simulations from established model intercomparison platforms (such as GeoMIP) specifically designed for earth cooling scenarios, the study will pinpoint why these changes might occur, disentangling the complex factors driving rainfall. This computational analysis will deliver crucial, regionally-specific evidence to help evaluate the potential risks these approaches may pose to indispensable water cycles and resources.

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 and approximate budget breakdown:** 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.

## 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 benefits of any future proposals to deliberately modify cirrus clouds. This project aims to gather vital real-world data on these natural cirrus cloud processes and how they are already being affected by the presence of aircraft engine soot.

The team will use a combination of computer modelling and analysis of existing satellite data. They will also conduct observational flights using research aircraft to directly measure how particles already present in the atmosphere, 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.

**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.

Operating out of Colorado, USA, the team will develop and operate a specialised balloon-borne collector designed to gather naturally present INPs from the upper troposphere where cirrus clouds form. These collected samples will then be brought back for detailed laboratory analysis in the UK. This focused monitoring and observation work will generate critical information about the types and concentrations of particles involved in natural cirrus formation. This data is essential for improving the accuracy of climate projections and enhancing our ability to monitor natural atmospheric processes, providing a crucial baseline for climate science.

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 capability essential for responsible research and assessment of potential climate interventions.

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

## Monitoring Aerosol Climate Engineering (MACE)

**Project lead:** Matt Watson, University of Bristol

**Award:** £4.3m over 48 months

**Key Team Members and approximate budget breakdown:** 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.

## 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 Arctic is warming much faster than the global average, leading to dangerous sea ice loss with far-reaching consequences. This project investigates whether deliberately thickening sea ice during winter could be a viable way to slow summer melt, reduce Arctic warming, and mitigate further ice loss. The research aims to provide critical data on the feasibility, scalability, potential ecological impacts, and overall effectiveness of this approach, which involves accelerating natural freezing processes using seawater from underneath the ice.

Researchers will conduct controlled, small-scale experiments in Canada across three winter seasons (2025-26 to 2027-28). The process involves pumping seawater from beneath existing ice and spreading it on top, where the frigid air freezes it quickly, creating thicker ice patches. Over the course of the project (and if the early experiments suggest the approach is ecologically sound), later experiments will aim to cover areas up to 1 km² per experiment site. The key questions are whether this thicker ice lasts longer into the summer, how it might affect ice movement, and what the local ecological impacts are. These experiments will be conducted in close collaboration with local communities and under ARIA's stringent governance framework, prioritising safety and environmental monitoring. 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.

## Marine Cloud Brightening in a Complex World

**Project lead:** Daniel Harrison, Southern Cross University

Queensland University of Technology | Shaun Fitzgerald, University of Cambridge (contributing and funded via the REFLECT project)

This project investigates Marine Cloud Brightening (MCB), a potential way to cool specific areas by enhancing cloud reflectivity using a spray of seawater. Building on their experience conducting previous small-scale outdoor experiments in partnership with local communities around the Great Barrier Reef, Australia, this team seeks to deepen our understanding of MCB. While the concept could potentially protect vulnerable ecosystems like coral reefs from heat stress, its real-world effectiveness remains uncertain. This research aims to address this critical knowledge gap by investigating the complex atmospheric dynamics and microphysical 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.

We will publish the complete grant agreement for this project, including its key milestones, as soon as it is finalised.

## 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)

∗Finnish Meteorological Institute are contributing to the modelling exercises in this proposal and are not involved in any outdoor experimentation

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.

We will publish the complete grant agreement for this project, including its key milestones, as soon as it is finalised.

## BrightSpark – Cloud brightening with electric charge

**Project Lead:** Giles Harrison, University of Reading

**Award:** £2m over 36 months

**Key Team Members and approximate budget breakdown:** Giles Harrison, Maarten Ambaum, Keri Nicoll, University of Reading (£1.75m) | John Mooney, Menapia Ltd (£170k)

Finding ways to influence cloud reflectivity is a key research challenge. This project investigates using controlled electric charge, a natural atmospheric phenomenon, to influence water droplets in fogs and clouds as an alternative 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.

**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.

The research combines laboratory studies and computational modelling with unique and contained material exposure experiments. In these experiments, tiny (milligram) amounts of materials that occur in natural mineral dust (such as limestone, dolomite, or corundum) will be secured onto supports inside the gondolas of specially adapted weather balloons. These balloons are likely to be launched from sites in the USA and/or the UK; the specific site will be determined in line with ARIA's requirements for community engagement. The balloons will carry the samples into the stratosphere for exposure periods ranging from hours to weeks before 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.

Electrochemical Technology.

"Decarbonisation is essential, but our current climate trajectory puts us at risk of triggering temperature-driven tipping points in the coming decades. This has sparked growing interest in approaches that could cool the Earth on short timescales, potentially delaying or avoiding such thresholds. However, we currently have very little understanding of whether these approaches would even work, or what their risks and impacts might be. This programme will explore critical unanswered questions as to the feasibility, scalability and safety of some of these proposed approaches. By investing in careful research today, we can build the evidence base needed to make wiser, better-informed decisions about the future."

**Mark Symes**
Programme Director