Managing our climate and weather through responsible engineering

v1.0

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CONTEXT

This document describes an early opportunity space from which we believe one or more funding programmes can emerge. We’ve sketched out some of our early thinking to spark your interest, and invite you to imagine relevant potential programmes with us, or suggest new directions.

We’ll publish updated versions of this document as our thinking evolves. Sign up here to receive those updates and learn about any funding opportunities that emerge from this opportunity space.

An ARIA opportunity space should be
+ important if true (i.e. could lead to a significant new capability for society),
+ under-explored relative to its potential impact, and
+ ripe for new talent, perspectives, or resources to change what’s possible.

SUMMARY

If an abrupt alteration in a climate system were to unfold, we would have no tools to mitigate the effects. Through research, we could understand the science behind how we might intervene to responsibly manage the climate and weather. For more on our approach, read our Q&A.

BELIEFS

The core beliefs that underpin/bound this area of opportunity.

1. Climate tipping points (abrupt changes to the Earth’s climate) like the melting of large ice sheets or sudden changes in ocean currents have happened in the past. The next one could be imminent but we have no options for how we might intervene on the timescales required to avert disaster.

2. Through carefully-considered engineering solutions it may eventually be possible to actively and responsibly control the climate and weather at regional and global scale.

3. Modern computing allows us to model the climate with unprecedented precision, providing a basis for increasingly confident prediction and validation of research-scale climate control experiments. Coupled with the imperative to address the consequences of anthropogenic climate change there is a unique combination of push-pull factors pushing us to explore the development of a new climate control R&D community.
OBSERVATIONS

Some signposts as to why we see this area as important, underserved, and ripe.

April 1815 — Mount Tambora erupted in Indonesia. Huge quantities of dust + aerosols were released into the atmosphere. In the year following: the average global temperature dropped by 0.4–0.7 °C; Europe experienced its coldest summer in the last 250 years. Famine + economic disruption followed.

Current trends in global temperatures driven by human activity suggest we're on course to exceed 1.5 °C above pre-industrial levels within 10-20 years, and 3–4 °C by 2100.

The buffering capacity of the oceans will lead to a significant time lag between emission and maximal warming effect.

Mark's (incomplete) risk register of potential climate tipping points, assuming 3-4 °C warming above pre-industrial levels by 2100. In many cases, the likelihood and potential effects of such events are only poorly constrained. Likelihood and impact scales: 1 = very low; 5 = very high.

<table>
<thead>
<tr>
<th>EVENT</th>
<th>LIKELIHOOD</th>
<th>EFFECTS</th>
<th>IMPACT</th>
<th>MARK'S RISK RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Antarctic ice sheet melts</td>
<td>1</td>
<td>Global sea levels rise by ~1.5m by 2100 and 5m by 2500</td>
<td>5</td>
<td>Extreme</td>
</tr>
<tr>
<td>Atlantic overturning circulation collapses</td>
<td>3 (by 2060)</td>
<td>NW Europe cools by 10°celsius</td>
<td>4-5</td>
<td>Very high</td>
</tr>
<tr>
<td>Methane release from permafrost</td>
<td>2-4?</td>
<td>Dramatically accelerated heating</td>
<td>4</td>
<td>High</td>
</tr>
<tr>
<td>Dieback of Amazon rainforest</td>
<td>5 (by 2050)</td>
<td>Global precipitation patterns disrupted</td>
<td>3</td>
<td>Medium</td>
</tr>
<tr>
<td>Yellowstone Supervolcano erupts</td>
<td>1</td>
<td>Mass extinction in volcanic winter</td>
<td>5</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Any trials of climate and weather control technologies should rely on close engagement with governments, policy makers and the public. Governance and policy are likely to become major geopolitical issues.

Could we develop the capability to intervene, prevent, rather than only react?

The development and testing of hardware for controlling the weather and climate remains massively underserved.

Very few trials of any technologies for weather or climate control have taken place.

What technological options are there that are workable, scalable, ethical and for which the benefits outweigh the drawbacks?

What civil engineering and improved land use solutions might there be for controlling the climate at local and global scale?

Surely there are more options than just stratospheric aerosol injection or cloud brightening?
We are already conducting passive climate engineering experiments. In 2020, new rules led to an abrupt drop in global sulfur dioxide emissions from shipping. Sulfur dioxide forms aerosols that reflect sunlight, producing a net cooling effect.

By 2050, the effect of removing sulfur dioxide from shipping fuel has been predicted to increase global temperatures by roughly the same amount as two additional years of carbon dioxide emissions at current rates.

The economic cost of extreme weather events is significant (and rising), and the potential economic gains of developing technologies for control of the climate and weather are likely to be considerable.

In contrast, total global spend on climate engineering research over the last fifty years has been minimal.

The resolution and accuracy of climate and weather prediction models has increased dramatically in recent years.

1970s
Resolution = 500 km

Today
Resolution = 1-10 km

Progress in simulation and monitoring capabilities will allow for increasingly robust evaluation of the most effective and responsible options.

With a trusted, reliable, and responsible climate and weather control toolkit, interventions could be accurately predicted beforehand at both local and global scales, opening up possibilities for proactive management and mitigation strategies.

What role could financial institutions and markets play in climate control? Could ‘climate cooling credits’ incentivise progress?

The scale of such ‘unintentional’ climate interventions provides perspective for small, carefully-controlled trials of climate and weather management methods.

Additional warming expected as a result of lowering sulfur content of shipping fuel.

What possibilities would that open up? Mitigating severe weather events like droughts and hurricanes? Stopping the Arctic ice cap from melting? Greening the deserts? Terraforming other worlds?
ENGAGE

We invite you to shape our efforts by providing feedback and surfacing breakthrough ideas related to this opportunity space. Our next step will be to formulate a programme that directs funding across research disciplines or institutions toward a focused objective. We also plan to open up seed funding for researchers whose bold aspirations are unlikely to be funded elsewhere.

Sign up for updates and share your feedback here—we will read anything you send.

If you require an accessible version of this document and/or form, please contact us at info@aria.org.uk