

Ethical Framework Principles for Climate Intervention Research

The American Geophysical Union (AGU), in partnership with scientific and policy stakeholders around the globe, proposes an Ethical Framework for Climate Intervention Research. This framework of Principles, first proposed in a [2022 AGU White Paper](#), builds on work such as the Oxford Principles, the Tollgate Principles and the Asilomar Conference Recommendations on Principles for Research into Climate Engineering but also draws from ethical guidance developed for other rapidly advancing areas of technologies. The Principles are designed to help guide governments, researchers, international organizations, NGOs, and the private sector that may be engaged in climate intervention research or policy in planning their work from an early stage. These Principles are important to ensuring public trust and societal legitimacy for such research by integrating more voices into the process, and by ensuring the direct undertaking of important ethical questions around justice, transparency, inclusivity, and respect.

This is a draft of the Ethical Framework Principles. The comment period closed in August 2023. Check back soon for an updated draft.

Development of the Ethical Framework Principles

Aggressive carbon emissions reduction must remain the primary strategy for reversing and addressing climate change. In advancing the principles, the supporters are not advocating for the use of climate intervention; however, we are living in a time of unprecedented urgency that requires enhanced climate intervention research and community engagement—this is work that must be guided by ethical principles.

Research aimed at understanding the benefits, limitations and impacts of possible climate intervention measures, including carbon dioxide removal (CDR) and solar radiation modification (SRM) techniques, shall consider issues of transparency, inclusion and climate justice practices. This research should also ensure a decision-making mechanism and process that includes public participation and consultation. In addition, the role of research is to anticipate unintended consequences and should be subject to robust governance and oversight structures whenever field research testing is proposed. More knowledge around potential climate intervention strategies is a necessary part of a comprehensive risk-management strategy to avoid a more severe global climate crisis and possible side-effects beyond the climate system.

Using AGU's unique global convening power, open dialogue and expansive reach, the below set of preliminary Ethical Framework Principles is the result of wide, diverse inputs received, including in regions most affected by the consequences of climate change.

These principles are presented broadly and organized in a modular format. The draft is designed to allow any necessary additional detailed guidance that may be needed to properly support CDR or SRM research, to allow for further debate and discussion and, importantly, for modifications to be made in the future as conditions and realities change.

¹ *Inclusivity is understood here to mean the practice or policy of providing equal access to opportunities and resources for people who might otherwise be excluded or marginalized such as those having physical or intellectual disabilities or belonging to other minority groups.*

The Ethical Framework Principles set forth recommendations in seven critical action areas:

SOCIETAL INTEREST / PUBLIC PARTICIPATION

Ensuring open and transparent communication with the public and the creation of engagement guidelines for feedback.

ENVIRONMENTAL JUSTICE

Discourse with the relevant, diverse, indigenous communities impacted by climate change and to be impacted by climate interventions with particular consideration of their equity and inclusion in the process as a whole.

DATA PRINCIPLES / TRANSPARENCY

Ensuring climate intervention research creates data in compliance with FAIR (Findable, Accessible, Interoperable and Reusable) principles.

SCALING

Ensuring that field experiments abide by local, regional, and international laws and regulations, and facilitating the creation of increased oversight and reporting requirements depending on the scale of proposed work.

GOVERNANCE AND MONITORING

Abiding by guidance for planning, coordination, and registering of field experiments; and ensuring validated monitoring, reporting and verification procedures are in place.

CARBON DIOXIDE REMOVAL (CDR)

Follow standards and reporting structure for CDR experiments and potential deployments along with a process for meeting those requirements.

SOLAR RADIATION MODIFICATION (SRM)

Follow standards and reporting structure for SRM experiments and potential deployments along with a process for meeting those requirements.

Vision Statement for Ethical Framework: Climate Intervention Research

The full range of climate intervention research is guided by ethical standards, principles, and practices that mitigate risk and add value in society, with appropriate communication, documentation, registration, inclusion, assessment and learning. These ethical standards are globally applicable with concrete local and regional use. Concurrent efforts to reduce emissions are not diminished in any way by climate intervention research.

Ethical Framework: Draft Principles Climate Intervention Research and Scaling

RECOMMENDED PRINCIPLES AND PRACTICES

1. Comply with local, national, regional, and international laws, regulations, and practices governing climate intervention experiments.
2. Anticipate outdoor and scaling implications (environmental and societal) when conducting indoor experiments and simulation modeling.
3. Ensure review by an appropriate Institutional Review Board (IRB) in advance of outdoor experiments (CDR, SRM, and other climate altering technologies).
4. Comply with established systems for registration of climate intervention experiments.
5. Provide communities potentially impacted by any outdoor experiments (CDR, SRM, and other climate altering technologies) with notification and the opportunity for meaningful engagement in experiment planning and implementation.
6. Build mechanisms for post-intervention impact monitoring, “near miss” reporting, and after-action reviews into climate intervention experiment design and implementation.
7. Ensure climate intervention experiments address all five forms of environmental justice: distributive justice, intergenerational justice, procedural justice, corrective justice, and ecological justice.
8. Follow leading practices for open science, including storage and sharing of climate intervention research data, consistent with FAIR principles and use of trusted repositories.

Table 1: Ethical Framework Principles Overview

PRINCIPLE	DESCRIPTION
Principle 1	Guiding Principles
Principle 2	Protecting Societal Interests, Public Participation and Representation
Principle 3	Environmental Justice
Principle 4	Data Principles, Data Sharing and Transparency
Principle 5	Guidance on Scaling for Outdoor Testing
Principle 6	Guidance on Governance, Monitoring and Compliance
Principle 7	Carbon Dioxide Removal (CDR) Technology Specific Guidelines
Principle 8	Solar Radiation Modification (SRM) Technology Specific Guidelines

Table 2: Climate Intervention Ethical Framework Principles: Summary Elements

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 1	Guiding Principles	<ul style="list-style-type: none"> • Climate intervention experiments (indoors and outdoors) should not be conducted without appropriate attention to ethical standards, principles and guidelines. • Recognizing that in many cases there are no equally good ways to do the research or collect the data without outdoor experiments, climate intervention outdoor experiments should not take place until there is an adequate scientific basis on which to justify such activities, along with appropriate consideration of environmental, community, and other potential impacts. • Climate intervention research and scaling must be conducted in accordance with all applicable local and regional laws and regulations and in compliance with a publicly endorsed code of conduct. • Climate intervention should not be presented or used as a substitute for emission reductions.

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 2	Protecting Societal Interests, Public Participation and Representation	<ul style="list-style-type: none"> • The public should be provided with timely information about climate intervention research, especially outdoor experiments, and communities in the vicinity of any planned outdoor experiments should be given notice in advance, with the opportunity to comment. • Care should be taken to identify and invite public comment from regions where the experiments are being conducted, as well as those who may be impacted. • Project plans for climate intervention experiments should include plans for post project monitoring (publicly communicated), including monitoring for potential adverse impacts. • Any planned outdoor experiments should exhibit due diligence to prevent and mitigate potential environmental harm. • Engagement with vulnerable and marginalized populations should be based on norms and procedures co-developed with the involved communities.

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 3	Environmental Justice	<ul style="list-style-type: none"> • Concepts and values advancing environmental justice are determined through discourse with relevant, diverse communities. • The ways in which environmental justice are to be realized are designed with explicit attention to historical injustices. • Consideration of transparency, inclusion, fairness, equity or social issues within or beyond direct impacts of climate intervention experiments should be addressed in advance with relevant impacted communities. • Project sponsors should understand, anticipate and be prepared to address five forms of environment justice:² <ul style="list-style-type: none"> ○ Distributive justice ○ Intergenerational justice ○ Procedural justice ○ Corrective justice ○ Ecological justice

² Environmental justice definitions and resources for addressing are provided separately.

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 4	Data Principles, Data Sharing and Transparency	<ul style="list-style-type: none"> • Climate intervention data should be properly preserved in discipline-specific or generalist trusted repositories to ensure compliance with FAIR principles, i.e., data are Findable, Accessible, Interoperable, and Reusable.³ • Climate intervention outdoor scaling experiments should publicly reveal funding sources. • Information about the context in which the climate intervention data was generated should be made explicit when sharing data, including from indoor experiments and simulation models, so that relevant values and perspectives represented in the scientific process for generating the data can be known and acknowledged. • Provide pre-registration for outdoor experiments and share negative results.
Principle 5	Guidance on Scaling for Outdoor Testing	<ul style="list-style-type: none"> • All outdoor scaling experiments would abide by local, regional, and international governance laws and requirements. • All anticipated climate intervention experiments should address risk assessment requirements and review standards to be applied at various stages of potential testing or deployment. • All outdoor experiments or scaling will be covered by an institutional review board (to be determined) before deployment. Project sponsor is responsible for scheduling the proposed climate intervention IRB review.⁴

³ Explanation of FAIR data principles is provided separately.

⁴ Additional guidance on Institutional Review Boards to be provide separately. In some cases, a recognized and validated external review board may be appropriate.

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 6	Guidance on Governance, Monitoring and Compliance	<ul style="list-style-type: none"> • Researchers and project sponsors should apply an incremental, proportional, step-by-step approach to the design of outdoor experiments that employ leading scientific methods and that anticipate adverse impacts and to include plans for monitoring for potential adverse impacts in pre- and post-outdoor trials. • Researchers and project sponsors should identify the appropriate local or regional or international governing bodies for its work in advance of outdoor scaling. • Mechanisms should be established to register climate intervention experiments in advance of outdoor trials and to monitor outdoor experiments where there is not voluntary registration. • Researchers, project sponsors, and their home institutions share the responsibility to ensure that outdoor experiments, pilot stage scaling or implementation trials meet the Ethical Framework requirements as outlined either in these modules, the Asilomar Principles, the Oxford Principles or the Tollgate principles, plus any established local regional, national or international requirements, including institutional review boards, prior to deployment.

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 7	Carbon Dioxide Removal (CDR) Technology Specific Guidelines	<ul style="list-style-type: none"> • Carbon Dioxide Removal (CDR) technologies should have specific ethical standards that address the ways that CDR research and interventions are conducted. • Deployment of CDR technologies should be designed to have as close to a carbon-neutral footprint as possible (separate from the mitigation gains achieved). • CDR researchers, project sponsors and their home institutions share the responsibility to ensure that outdoor experiments, pilot stage scaling or proposed implementation meet the Ethical Framework requirements as outlined either in these modules, the Asilomar Principles or the Tollgate principles, plus any established local regional or national and international requirements for institutional review boards, prior to deployment. • All proposed CDR outdoor research or pilot trials reviews will include an explanation of environmental monitoring techniques to be deployed, and whom to contact in the event of an outdoor research-related injury to the environment. Pre-trial reviews will include contact information for the research or sponsoring team for questions, concerns or complaints. Communities likely to be impacted by CDR experiments should have advance notice and opportunities for input.

PRINCIPLE	DESCRIPTION	RECOMMENDATIONS / KEY DETAILS
Principle 8	Solar Radiation Modification (SRM) Technology Specific Guidelines	<ul style="list-style-type: none"> • SRM researchers, project sponsors, and their home institutions share the responsibility to ensure that outdoor experiments, pilot stage scaling or proposed implementation meet the Ethical Framework requirements as outlined either in these modules, the Asilomar Principles or the Tollgate principles, plus any established local regional or national and international requirements for institutional review boards, prior to deployment. • All proposed SRM outdoor research or pilot trials reviews will include an explanation of environmental monitoring techniques to be deployed, and whom to contact in the event of an outdoor research-related injury to the environment. Pre-trial reviews will include contact information for the research or sponsoring team for questions, concerns, or complaints. Communities likely to be impacted by SRM experiments should have advance notice and opportunities for input.

Table 3 References

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