

Near-Term Imperatives for Comprehensive Climate Policy

**SilverLining Recommendations for
the Biden-Harris Administration
Plan for Climate Change and
Environmental Justice**

DECEMBER 2020



SilverLining
ENSURING A SAFE CLIMATE

EXECUTIVE SUMMARY

Climate change poses near-term risks to the safety of the United States and the world that are not adequately understood and are not addressed by measures for reducing greenhouse gases alone.

Climate change is already causing substantial suffering and great economic loss, with the greatest impacts on the most vulnerable members of society. These effects are projected to escalate, risking “tipping points” for catastrophic, abrupt changes in the next few decades, before even the most aggressive CO2 mitigation measures would take effect.

This dangerous condition demands better monitoring and forecasts than we have today. It also requires exploration of the most promising options for rapidly reducing warming. The U.S. is among a handful of nations with the capabilities to help the international community make progress on these problems quickly.

To keep people safe and natural systems stable while the world transitions to a carbon-neutral economy, it may be necessary to reduce warming in the next few decades. This requires a climate portfolio that extends beyond CO2 mitigation and removal to address powerful short-lived warming agents and even warming (heat-energy in the earth system) itself.

SilverLining applauds the Biden-Harris administration for its profound commitment to climate change and environmental justice and bold plans to address them. We offer our recommendations to aid in that effort:

For International Cooperation:

- **Rejoin the Paris Agreement, ratify the Kigali Amendment, and reaffirm international commitment more generally to climate safety**
- **Call for a United Nations Intergovernmental Panel on Climate Change (IPCC) expert meeting on near-term abrupt change risks and rapid climate interventions and a future IPCC Special Report**
- **Support assessment of solar climate intervention by the Montreal Protocol Scientific Assessment Panel**
- **Expand international access to climate models, data sets, and computing to accelerate scientific cooperation, particularly for research in climate intervention**
- **Facilitate engagement by developing countries in scientific research on climate intervention**
- **Support international efforts to reduce short-lived climate forcers**

For National Security:

- **Include climate change as part of the national security portfolio**
- **Significantly expand Department of Defense (DOD) climate and weather observation and prediction capabilities to secure infrastructure, fortify operations, and support readiness**
- **Increase collaboration and information sharing with civilian science agencies in climate and weather observation and prediction**
- **Drive toward five-year assessment of solar climate interventions to prevent strategic surprise and respond to international efforts**

EXECUTIVE SUMMARY (CONT.)

For the U.S. Domestically:

- **Substantially increase investments in climate research and earth system prediction**
 - » **Weather and climate prediction, including a possible “Operation Warp Speed” for climate prediction**
 - » **Observations, including investment in “shovel-ready” programs and enhanced operational capabilities to monitor key systems (e.g., Arctic, hurricanes)**
 - » **Advance warning systems for abrupt changes, with an immediate focus on permafrost and development of a model for other abrupt changes**
 - » **Evaluation of natural climate experiments, including observation and study of the climate effects of COVID-19, wildfires, and volcanoes**
 - » **Expansion of computing for climate research, including overall capacity, acceleration of cloud and exascale computing, and enhancements to the technology workforce**
- **Establish a national climate intervention research effort to assess the benefits and risks of methods to rapidly reduce warming**
 - » **Build capabilities to inform assessment of solar climate interventions within five years, accelerating relevant research efforts in National Oceanic and Atmospheric Administration (NOAA), Department of Energy (DOE), National Science Foundation (NSF), National Aeronautical and Space Administration (NASA), and other agencies**
 - » **Establish an interagency effort through the U.S. Global Change Research Program (USGCRP), with NOAA as lead agency for assessment**
 - » **Promote international cooperation and access to scientific tools and data**
 - » **Increase scientific research capacity within vulnerable communities**
 - » **Promote engagement of women and people of color in climate intervention research**
 - » **Support public engagement through agency and interagency programs**
- **In U.S. emissions-reduction efforts, prioritize areas with the potential for substantial mitigation to reduce warming and/or projected greenhouse gas emissions in the next 10-20 years**
 - » **Methane from natural gas, agriculture, and waste**
 - » **HFCs, other ozone depleting substances, and black carbon**
 - » **Greenhouse gas removal, including industrial, biological and mineralization approaches**
 - » **Refrigeration and air-conditioning**
 - » **Data centers and computing**

THE PROBLEM

NEAR-TERM CLIMATE RISK THREATENS GLOBAL SAFETY

The Biden-Harris administration describes climate change as “an existential threat to humanity,” acknowledging an unprecedented threat to the safety of world’s people and sustainability of its ecosystems.

There is broad agreement on the potential for catastrophic effects from climate change if the earth continues to warm over the 21st century, motivating commitments to eliminate emissions by the middle of the century. However, impacts are projected to escalate prior to 2050, before even the most aggressive CO2 mitigation and removal measures would take effect. Recent observations indicate that some changes are occurring faster than anticipated, moving critical ecosystems (e.g. permafrost, ice sheets, forests) closer to abrupt changes that could accelerate warming beyond humans’ ability to address it.

Today, there are critical gaps in our ability to predict near-term impacts and abrupt changes, as well as in our portfolio of responses to address them. This poses grave risks to the world’s safety, security, and prosperity and an imminent threat to its most vulnerable people.

PROTECTING VULNERABLE COMMUNITIES REQUIRES NEAR-TERM RESPONSES TO WARMING

The Biden-Harris administration recognizes that “vulnerable communities are disproportionately impacted by the climate emergency and pollution” and pledges to “develop solutions for environmental injustices affecting communities of color, low-income, and indigenous communities.”

Many of the most vulnerable in society live in locations and conditions that are relatively more exposed to climate change. These communities are disproportionately harmed by climate impacts while simultaneously facing strong disadvantages in adaptation capacity. They are experiencing climate impacts today, including increased death from heat exposure and disease, drought, flooding, displacement, loss of income, food and energy insecurity, and related social and political instability.

Vulnerable communities face even more devastating consequences with even modest increases in warming. Between now and 2050, a period when climate models project relatively similar levels of warming for most emission scenarios, climate impacts are predicted to lead to tens of millions of deaths, a billion or more displaced, and enormous levels of suffering. We do not have the tools to reduce impacts, remediate harms, or ensure protection from abrupt changes for vulnerable communities within this period.

THE WORLD LACKS OPTIONS FOR REDUCING WARMING RAPIDLY IF NEEDED

Rapidly alleviating heat stress on the earth system could reduce impacts on vulnerable communities and the risk of catastrophic abrupt changes, but today we lack options that could reduce warming within the next few decades.

One currently available approach is reducing the emission of powerful short-lived greenhouse gases and warming agents (“short-lived climate forcers”) such as methane and refrigerants. This area is underinvested and highly imperative. Much work is needed to determine how rapidly these could be reduced and the extent of the effect on climate, such that this activity alone is not sufficient to counter the risks of near-term warming.

A 2015 report from the National Academy of Sciences found that one of the most promising ways to reduce warming within a few years is one of the ways nature can cool the Earth—increasing the reflection of sunlight from clouds and particles (aerosols) in the atmosphere (“solar climate intervention”).^{1,2} An accidental form of this effect occurs today when pollution particles (e.g. sulfates) mix with clouds and make them slightly brighter. Globally, this “cloud-aerosol” cooling effect is estimated to be between 0.5 and 1.1°C and will diminish as emissions decline—one of the greatest near-term uncertainties in climate.³ The most prominent form of this type of intervention is based on observation of volcanoes large enough to release material into the stratosphere, such as the eruption of Mount Pinatubo in 1991 that temporarily cooled climate by nearly 1°C and caused a significant increase in Arctic ice.

Early research suggests that optimized methods to leverage these effects could reduce climate impacts versus likely projections for future warming, with the greatest benefits realized in the most vulnerable parts of the world.⁴ But much is unknown, and a great deal of research is needed to determine whether and how such interventions could be undertaken safely and effectively.

WE DO NOT HAVE THE INFORMATION WE NEED TO ENSURE SAFETY

Understanding climate is among the most complex problems in science. Climate models are the primary tool for predicting impacts and assessing responses. Models face well-known limitations in their ability to represent complex, high-risk phenomena, such as tipping points and feedbacks, that will require concerted effort and alternative forms of analysis to overcome. There are substantial gaps in the type of data that could improve the accuracy of models, including observations of key systems like Arctic sea ice, clouds, and permafrost. Climate models also require vast computing resources, whereas today these are highly constrained, limiting the quality and quantity of simulations, the accuracy of predictions, and our ability to make effective decisions.

RECOMMENDATIONS

As ambitious efforts are undertaken to build a clean energy future and achieve carbon neutrality, concerted efforts must be made to predict near-term climate impacts and abrupt changes, as well as to support international cooperation on measures for protecting vulnerable communities and avoiding catastrophic impacts.

INTERNATIONAL COOPERATION

The Biden-Harris administration is a strong proponent of international engagement and has committed to rejoining the Paris Accord and to “taking it to the next level.”

While global efforts to reduce greenhouse gases are both imperative and underway, the international response to climate change has been, and may continue to be, inadequate to ensure a safe climate in the context of near-term climate risks.

While scientific assessments suggest that climate interventions may have the potential to rapidly reduce warming, we do not yet understand their potential impacts and risks, creating a challenge for international decision-making. A paper co-authored by Sue Biniiaz, senior fellow for climate change, U.N. Foundation, and Dan Bodansky, author of *International*

¹ Also known as “solar radiation modification” (SRM) or “solar geoengineering.”

² National Research Council. (2015). *Climate Intervention: Reflecting Sunlight to Cool Earth*, The National Academies Press, Washington, DC. <https://doi.org/10.17226/18988>

³ Intergovernmental Panel on Climate Change. (2013). *Climate Change 2013: The Physical Science Basis*, Fifth Assessment Report of the Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/report/ar5/wg1/>

⁴ Romaric C Odoulami et. al. 2020. “Stratospheric Aerosol Geoengineering Could Lower Future Risk of ‘Day Zero’ Level Droughts in Cape Town,” *Environmental Research Letters*. <https://iopscience.iop.org/article/10.1088/1748-9326/abbf13>

Climate Change Law, commissioned by SilverLining, recommends an approach to international decision-making centered on scientific assessment of safety and reviews the capabilities of existing international institutions to support it.

The Biden-Harris administration should rejoin the Paris Agreement, support the phasedown of climate warming refrigerants under the Kigali Amendment, and reaffirm U.S. commitment to climate safety. It should promote consideration of near-term climate risks through an international decision-making process that is both cooperative and based in science that considers “two safeties,” the safety of a warming climate and the safety of responses, including climate interventions.

The United Nations Intergovernmental Panel on Climate Change (IPCC) is the international forum with responsibility and scientific expertise for assessing climate. The IPCC Fifth Assessment Report (AR5) acknowledged the limitations of its coverage of abrupt change risks, and this remains a critical problem for international decision-making. The report also included only very limited coverage of solar climate interventions. Modest expansion of coverage for both areas is anticipated in the forthcoming AR6 report.⁵

Given the enormous, global near-term risks to vulnerable communities and natural systems, the Biden-Harris administration should seek coverage of abrupt change risks and climate interventions by the IPCC, including an IPCC Expert Meeting and a future IPCC Special Report.

The Montreal Protocol on Substances that Deplete the Ozone Layer is an agreement that protects the health of the ozone layer in the stratosphere. All of the world’s countries are signatories and all actions are governed through rigorous science-based processes supported by expert scientific and technical assessment panels. Having prevented catastrophic global ozone loss and put the Antarctic ozone hole on the path to recovery, it is the most successful global environmental effort ever undertaken. In conjunction with its efforts to reduce certain ozone-depleting chemicals (recently expanded to include some non-ozone-depleting short-lived forcers), it is also the most effective environmental effort in reducing greenhouse gases. In November 2019, the parties to the Montreal Protocol gave guidance to its Scientific Assessment Panel to include “solar radiation management research” in its 2022 Scientific Assessment of Ozone Depletion report, to address possible impacts on the abundance of stratospheric ozone and indirect risks, such as heating and circulation changes in the stratosphere.

Assessment by the Montreal Protocol Scientific Assessment Panel is an important step forward in science-based governance for solar climate intervention. The Biden-Harris administration should reiterate U.S. support for the Montreal Protocol Scientific Assessment Panel and support careful review of the Montreal Protocol as a model for addressing near-term catastrophic earth system risks and a gold standard for effective global environmental governance in the service of public safety.

The U.S. has the world’s highest concentration of climate research expertise, infrastructure, and technology, and it provides scientific and analytic capabilities in climate research for stakeholders around the world. Increased investment in climate observation and prediction and U.S. research in solar climate intervention can promote international scientific cooperation on climate risk and climate intervention and participation by experts from the world’s most vulnerable communities.

The Biden-Harris administration should support science-based international decision-making that evaluates the safety of climate responses for the world’s most vulnerable. It should work with international partners to grow scientific capacity in vulnerable regions to support informed representation of their interests in decision-making on climate responses, including climate interventions.

⁵ Kelly Wanser, Executive Director of SilverLining, was a reviewer for AR6.

NATIONAL SECURITY

The Biden-Harris administration promises to “fully integrate climate change into our foreign policy and national security strategies,” while noting the importance of “helping developing countries better manage the adverse effects of climate change, including conflict, migration, and state fragility.”

Climate impacts pose substantial threats to global security by increasing instability in vulnerable countries, promoting conflict over scarce resources, and opening new theaters of operation, such as the Arctic. They also pose direct threats to national security in terms of military infrastructure and operational readiness.

National security stakeholders currently lack sufficient information on and prediction of climate to support defense investments, strategic and operational plans, and ongoing operations. They also lack measures that arrest or rapidly reduce warming to provide a wider portfolio of options for enhancing global and regional security and sustaining national strategic infrastructure and assets.

As climate impacts increase, other nations are beginning to invest in measures such as forms of weather modification and solar climate intervention, including large-scale weather modification efforts in China and solar climate intervention research in China, India, Europe, and developing nations. Currently, the U.S. lacks sufficient information to inform policy decisions about whether to cooperate in these activities or work to constrain them. This leaves the U.S. unable to assess and respond to climatic and geostrategic developments. Furthermore, better information and improved scientific understanding is likely to reduce tensions and support cooperative decision-making in these areas. U.S. leadership in understanding climate interventions is an important aspect of ensuring our future national and global security.

The Biden-Harris administration should make climate change part of the national defense mission. Climate prediction and intervention are critical for both military operations and global security. The DOD budget should include a substantial dedication of resources to climate observation, prediction, and response. The 2020 National Defense Authorization Act (NDAA) included language directing the Office of Naval Research to review capabilities and needs for observation and research in these areas. The administration should consider their recommendations and support expanded capabilities for observing and predicting cloud-aerosol, Arctic, and other systems. Relevant DOD agencies should support and partner with civilian institutions to rapidly improve short-, medium-, and long-term climate and weather prediction and to study and assess climate interventions.

U.S. DOMESTIC POLICY

“Just like we need a unified national response to COVID-19, we need a unified national response to climate change. We need to meet the moment with the urgency it demands as we would during any national emergency.” - President-elect Joe Biden (December 19, 2020)

The economic costs of climate impacts and extremes to the U.S. are staggering, including about \$180 billion for recent western wildfires and hundreds of billions of dollars in excess storms and flooding. Impacts are escalating. Uncertain risks and forecasts inhibit planning to protect communities and decisions about the timing and nature of climate responses.

INVESTMENT IN CLIMATE PREDICTION AND RISK ANALYSIS IS A NATIONAL IMPERATIVE

Dramatic improvements in public safety have been achieved through efforts to provide local communities advance warning of natural disasters like storms and wildfires. We need the same kind of early warning systems for seasonal-to-decadal predictions of climate impacts in order to design a portfolio of climate responses; to prioritize investments in climate mitigation, resilience, and adaptation; and to assess climate interventions.

Today, we face major gaps in climate model representations of critical parts of the earth system leading to under-

representation of near-term risks to safety and longer-term sustainability. Improvements in climate and weather prediction and risk analysis are essential for decision-making that can help minimize damage and maximize safety. This requires major investments in climate observations, models, scientific research, and computing infrastructure.

U.S. federal funding for climate research has been steady in dollar terms over the past two decades, but at about \$2.6 billion annually, it is drastically underfunded relative to the magnitude of the problem and the value of better information. Prioritizing investments in research will be critical to build the knowledge base necessary to prevent catastrophic impacts and reduce extreme weather effects on communities and ecosystems and is likely to grow in importance as climate change continues.

The Biden-Harris administration should dramatically increase investment in climate research, including the scientific, modeling, computing, and observational capabilities required to rapidly improve climate prediction and risk analysis, following the recommendations of the National Oceanic and Atmospheric Administration (NOAA), Department of Energy (DOE), National Aeronautical and Space Administration (NASA), and other U.S. science agencies. It should expand the Interagency Council for Advancing Meteorological Services (ICAMS) to support an “Operation Warp Speed” for seasonal-to-decadal climate predictions and early warning indicators for major abrupt changes.

We endorse the recommendation made by the Center for American Progress that federal investment in climate and energy data and scientific research should double across the programs and activities of the 13 federal agencies that make up the U.S. Global Change Research Program.

THE CLIMATE EFFECTS OF UNPLANNED EXPERIMENTS REQUIRE CONCERTED STUDY

The COVID-19 pandemic disrupted economic activity in the U.S. and around the world, resulting in large effects on the environment, including unprecedented improvements in urban air quality and effects on weather, climate, and atmosphere. The reduction in emissions resulting from COVID-19 has resulted in a massive unplanned experiment in one of the areas of greatest uncertainty in the prediction of weather and climate: “cloud-aerosol effects.” Close study of “cloud-aerosol effects” might help to improve predictions of weather and climate and the proposed climate intervention based on these effects, marine cloud brightening.

Similarly, unprecedented fire activity and extreme meteorological conditions have injected massive quantities of material into the atmosphere, including the stratosphere, with unprecedented atmospheric and climatic effects that require study. Similar benefits are possible with timely and directed observation of volcanoes.

The Biden-Harris administration Climate Plan should include investment in observational and scientific resources for understanding the climate effects of unplanned experiments. In particular, it should provide dedicated funding for the NOAA Oceanic and Atmospheric Research (OAR) Division for observations, research, and computing, to understand the climate and weather effects of the reduction of emissions associated with COVID-19 and other events, as well as emissions from western wildfires.

CLIMATE INTERVENTION RESEARCH IS A NATIONAL IMPERATIVE

Climate interventions to rapidly reduce warming, such as increasing the reflection of sunlight from the atmosphere, may be an important part of a portfolio of climate responses to ensure safety, an area in which the U.S. would benefit from scientific and technical leadership or face challenges if it falls behind. Investments in “insurance policy” interventions to reduce warming globally or regionally—for example, to reduce the force of hurricanes or increase precipitation—may play a role in promoting safety for vulnerable populations, protecting economic sectors, and other aspects of adapting to climate change.

There is ongoing bipartisan support for research in solar climate intervention, driven by the lack of information to inform policy, emerging international activity, and gaps in critical areas of related science. Specifically, DOE’s Environment and Earth Systems Division and NOAA’s OAR Division both have support from congressional sponsors for continued

or increased funding for solar climate intervention and related research. In conjunction with improvements to climate prediction and risk assessment in general, assessment of the risks and benefits of climate interventions requires technology research, small-scale field experiments, and dedicated programs that require authorization.

The Biden-Harris administration’s budget proposal should maintain and expand existing funding in NOAA and DOE for research on cloud aerosol effects, for stratospheric chemistry observations and models—including chemistry baselines of the stratosphere—and research to assess risks of climate interventions. Authorizing legislation to support this funding also should be pursued.

- **H.R. 5519, The Atmospheric Climate Intervention Act, for example, is a bipartisan bill to establish a program in NOAA to support assessment of the safety and risks of solar climate interventions.**
- **The NAS is soon to complete a study to develop a research agenda and governance recommendations in this area toward a coordinated national program of research that should be used as one source of guidance for the new administration.**

To address near-term risks, the administration should establish a national climate intervention research effort to inform assessment of solar climate interventions within five years, supporting research efforts in NOAA, DOE, NSF, NASA, and other agencies and interagency coordination through the USGCRP. Such an effort should promote international cooperation and access to scientific tools and data, increase scientific research capacity within vulnerable communities, and support public engagement through agency and interagency programs.

WOMEN AND PEOPLE OF COLOR MUST PLAY A VITAL ROLE IN CLIMATE INTERVENTION RESEARCH

Climate research has a vibrant community of female scientists, but the far smaller field of research in climate interventions has been dominated by men over the past few decades. In recent years, however, many women have emerged in the field, including in positions of leadership on scientific assessment panels, as conference chairs and keynotes, and, in at least one case, as an all-female research team. Both climate research and climate intervention research also suffer from a lack of representation of people of color, exacerbating the problem of under-representation of vulnerable communities and limiting perspectives.

The Biden-Harris administration should promote opportunities for women and people of color in scientific and technical research in climate and climate intervention and their representation in climate policy and decision-making for climate intervention.

AGGRESSIVE MITIGATION EFFORTS IN AREAS WITH HIGH NEAR-TERM LEVERAGE ON WARMING MUST BE A PRIORITY

In climate mitigation efforts, close attention should be paid to areas with the potential for substantial mitigation to reduce warming and/or projected greenhouse gas emissions in the next 10-20 years. Today, a number of these areas are underinvested relative to their potential contribution to climate safety.

The Biden-Harris administration should prioritize aggressive emission reductions of anthropogenic, short-lived climate forcers including methane from natural gas, agriculture and waste; HFCs in refrigeration; ozone depleting substances; and black carbon. It should invest in research in carbon removal including both industrial, biological, and mineralization approaches. It should also prioritize investments in, and incentives for, energy efficiency and clean energy in areas with very high near-term growth projections including refrigeration and air-conditioning⁶ and data centers and computing⁷.

⁶ Montreal Protocol Report of the Technology and Economic Assessment Panel. (September 2020). Decision XXXI/7 - Continued provision of information on energy-efficient and low-global-warming-potential technologies (Volume 2). <https://ozone.unep.org/meetings/43rd-meeting-open-ended-working-group-parties-montreal-protocol/pre-session-documents>

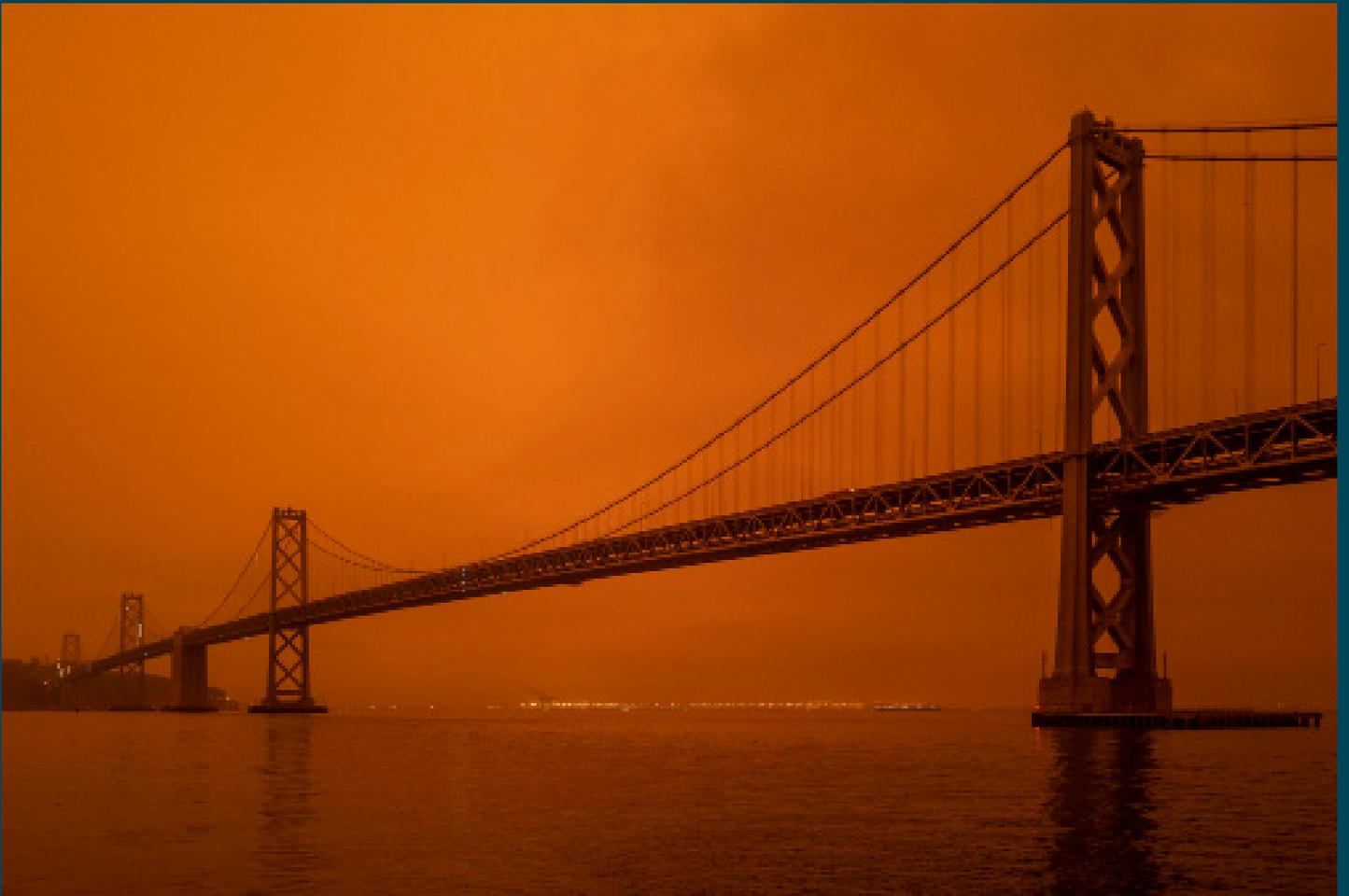
⁷ Massnet et al. Recalibrating Global Data Center Energy Use Estimates. *Science*. (February 28, 2020). pgs: 984-986. <https://science.sciencemag.org/content/367/6481/984>

≡ TOWARD THE FUTURE

Alongside essential and ambitious efforts to reduce greenhouse gases, a comprehensive climate plan for the United States must include rapid, concerted efforts in climate prediction and climate intervention to ensure safety in the next few decades. This is essential “emergency medicine” that will help protect communities and sustain ecosystems as the world moves toward a bright and sustainable future with the opportunity for shared security and prosperity for all.

ADDITIONAL RESOURCES

- *Ensuring a Safe Climate: A National Imperative for Research in Climate Intervention and Earth System Prediction* (2019), SilverLining <https://www.silverlining.ngo/safe-climate-report>
- *Understanding Our Future: Frontiers of Climate and Energy Data and Research* (2018), Center for American Progress, <https://www.americanprogress.org/issues/green/reports/2018/09/12/457762/understanding-our-future/>
- *Climate Intervention: Reflecting Sunlight to Cool Earth* (2015), National Academy of Sciences, <https://www.nap.edu/catalog/18988/climate-intervention-reflecting-sunlight-to-cool-earth>



ABOUT SILVERLINING

SilverLining is a non-profit organization dedicated to ensuring that society has sufficient options to address near-term climate risk. We engage with the research community, policymakers, technologists, civil society, and people from all walks of life to help advance research and innovation in efforts to ensure a safe climate.

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