

# A 5°C Arctic in a 2°C World

CHALLENGES AND RECOMMENDATIONS FOR IMMEDIATE ACTION  
FROM THE JULY 21-22, 2016 WORKSHOP

Briefing Paper for  
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# Summary

The Columbia Climate Center, in partnership with World Wildlife Fund, Woods Hole Research Center, and Arctic 21, held a workshop titled *A 5 °C Arctic in a 2 °C World* on July 20 and 21, 2016. The workshop was co-sponsored by the International Arctic Research Center (University of Alaska Fairbanks), the Arctic Institute of North America (Canada), the MEOPAR Network (Marine Environmental Observation, Prediction, and Response), and the Future Ocean Excellence Cluster. The goal of the workshop was to advance thinking on the science and policy implications of the temperature change in the context of the 1.5 to <2 °C warming expected for the globe, as discussed during the 21st session of the Conference of the Parties of the United Nations Framework Convention on Climate Change at Paris in 2015. For the Arctic, such an increase means an anticipated increase of roughly 3.5 to 5 °C. An international group of 41 experts shared perspectives on the regional and global impacts of an up to +5 °C Arctic, examined the feasibility of actively lowering Arctic temperatures, and considered realistic timescales associated with such interventions. The group also discussed the science and the political and governance actions required for alternative Arctic futures.



Inuit elders teach kayak building and paddling. Baffin Island, Canada

## Key Outcomes of the Workshop

- 1** Arctic Change is a reality. The Arctic is already changing faster than the rest of the globe is.
- 2** Changes are already felt on many fronts and affect not only Arctic residents but also billions of people living outside the Arctic.
- 3** Through our global emissions of carbon dioxide and other greenhouse gases (GHGs), society has committed the Arctic to substantial future warming with concomitant dislocations. For all emissions scenarios, warming and substantial ice loss are projected for the next 20 to 30 years, along with other major physical, biological, and societal changes.
- 4** If mitigating actions are not implemented immediately, the Arctic will continue to change dramatically from being white, ice-covered, and stable to a new state of instability with difficult-to-predict interactions, (abrupt) changes, and global responses.
- 5** The Arctic is already responding to the rapid changes: Arctic societies need support for strategic adaptation—including relocation—now. Arctic people are being forced to adapt in the absence of necessary policy and infrastructural frameworks.
- 6** Enhancement of the emerging pan-Arctic observing system and the addition of early warning components, along with development of Arctic system models, are required to keep our fingers on the pulse of Arctic change.
- 7** To avert massive environmental impacts beyond the time frame of a few decades, it is critical to immediately scale up implementation of alternative energy production, as well as decarbonization of the energy system. We also should greatly increase efforts in research and development and subsequent deployment of carbon dioxide removal (CDR) on a global scale.
- 8** An Arctic coalition with a unified voice in the global arena is needed to promote measures that keep the Arctic's vital functions intact, including its capacity to provide global services such as reflectivity of solar radiation, storage of carbon in permafrost, or storage of glacial ice that prevents sea level rise.

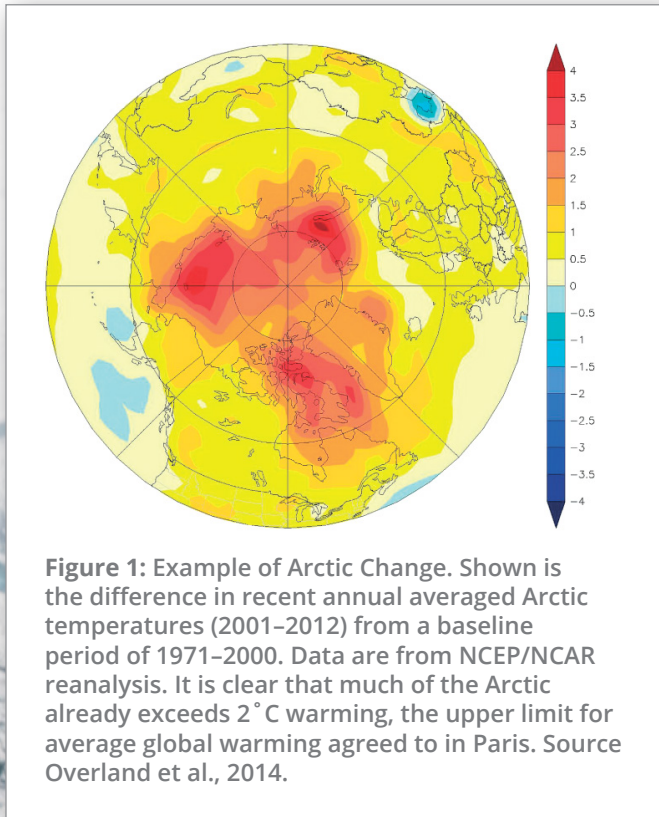


# Background

## Arctic Change Is a Reality

Except for the Low-Lying Island Nations, nowhere are the effects of human activities on our natural and human systems as visible as in the Arctic where surface warming is causing ice loss at sea and on land (Fig. 1). The retreat of Arctic sea ice and related increase in access to the Arctic and its resources, especially during the summer season, is just the most dramatic example of the kind of changes that are playing out in front of our eyes.

If the Paris Climate Agreement reached during the Conference of the Parties session 21 (COP21) in December 2015 were implemented and average global warming were halted at a level well below 2°C, preferably at 1.5 °C, the Arctic would have warmed by 3.75 °C to nearly 5 °C. It is because of this amplification of global climate change that the Arctic is under a higher degree of pressure. Major system change is already under way, and we have only years to take action to turn the trajectory around.



## Global Feedbacks

Changes in the Arctic, mostly triggered through influences from outside of the region, are affecting the Arctic itself, as well as billions of people at lower latitudes. The reason for the impact on such a large segment of the global population is the tight linkages among the various components of the Earth's system.

For example, the melting of the Greenland ice sheet is already contributing to global sea level rise. A complete meltdown of the Greenland ice sheet would result in a global average sea level rise of roughly seven meters. Even if only a relatively small fraction of the total potential sea level rise stored in the Arctic would be released, the impact on low-lying island nations, coastal areas of many countries, and important infrastructures such as sea ports would be significant (Fig. 2).

Feedbacks of Arctic change on the globe include ice-albedo feedback (loss of capability to reflect sunlight back into space), which corresponds to a quarter or more of the total driving force of global warming due to GHGs. As permafrost is thawing, stored carbon is being released, contributing to further warming. Slowing of the Gulf Stream Circulation would impact heat transport in the North Atlantic and the climate of the Northern Hemisphere. Mid-latitude weather patterns could be influenced by the changing Arctic.

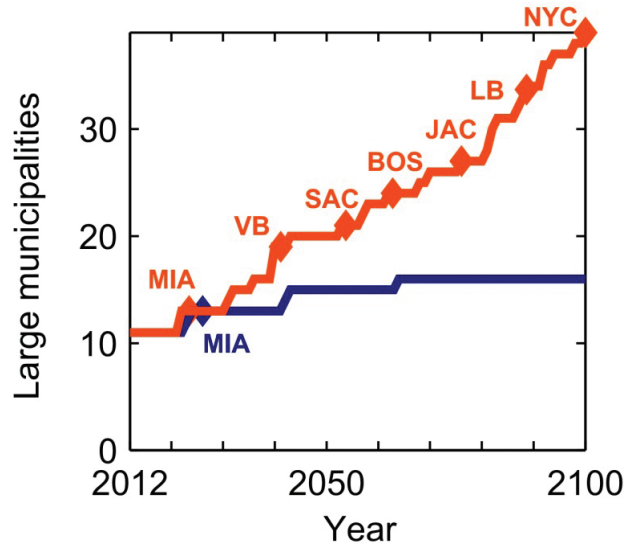
A supraglacial river drains meltwater runoff from the Greenland ice sheet.

## Urgency

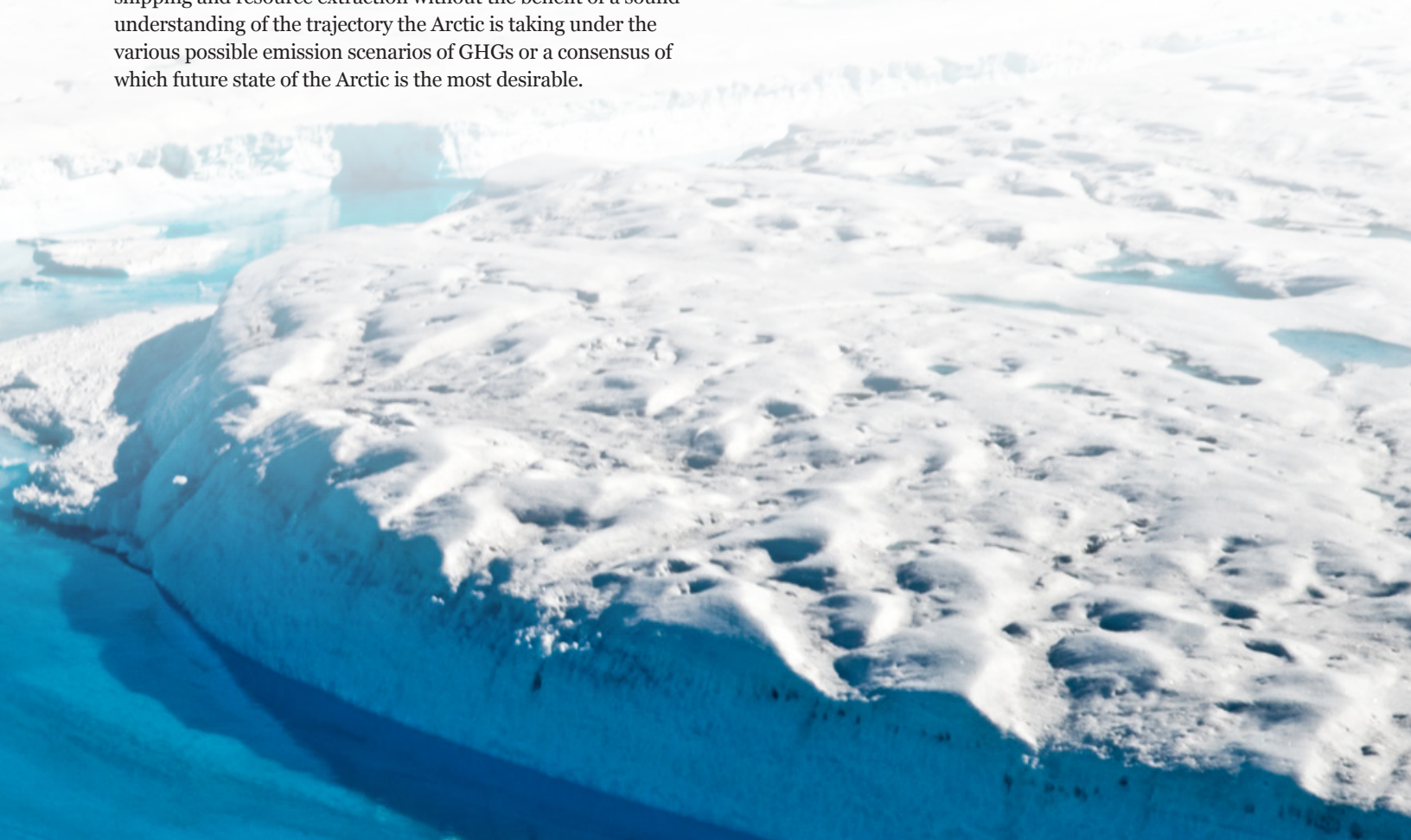
All of the above suggests that it is time for immediate action informed by the best science at hand. Time has run out on us, and we have embarked on what some call the “world’s biggest gamble.” (Rockstroem et al, 2016; Earth’s Future). To limit global warming to well below 2°C, the target of the Paris Agreement, action has to be taken now and significant changes have to be adopted on a global scale within the next years and in some cases be completed by 2050 (Fig. 3). However, it appears that after celebrating the victory of COP21, the world remains complacent and the necessary steps are not being taken at the pace required to implement the agreement (Rockstroem et al.; Earth’s Future, 2016 ). Society must make changes now for the sake of the Arctic and the planet of the next generation.

Without immediate action, the Arctic will continue to unravel, leading to an unstable future, difficult-to-predict interactions with global impacts, and dramatic changes from white, ice-covered, and stable to a new future of instability with abrupt, disruptive changes, difficult-to-predict interactions, and global chain reactions.

The urgency of a structured transition to the desired future state of the Arctic is exemplified by the facts that coastal erosion threatens the livelihood of those living in villages that are literally falling into the sea, general degradation of infrastructure is occurring due to thawing permafrost, and it is more difficult to navigate land and ocean for access to food and other resources. Additionally, there are already investments in infrastructure for shipping and resource extraction without the benefit of a sound understanding of the trajectory the Arctic is taking under the various possible emission scenarios of GHGs or a consensus of which future state of the Arctic is the most desirable.



**Figure 2:** Projected threats to coastal municipalities in the contiguous United States. RCP8.5 projections shown in orange and RCP2.6 in blue. Includes municipalities >100,000 in current population living below projected zero emission commitments (ZECs) plus high tide plotted as a function of commitment year. Cities >350,000 are labeled individually: MIA, Miami, FL; VB, Virginia Beach, VA; SAC, Sacramento, CA; JAC, Jacksonville, FL; BOS, Boston, MA; LB, Long Beach, CA; NYC, New York, NY. From Strauss, B. “Rapid accumulation of committed sea-level rise from global warming,” *PNAS*, vol. 110 no. 34, 13699–13700 (2013).





# Need for Immediate Action

## WE SEE THE NEED FOR IMMEDIATE ACTION IN THE FOLLOWING AREAS:

### (a) Enhanced National and International Efforts in Understanding and Projecting Arctic Futures and Their Impacts

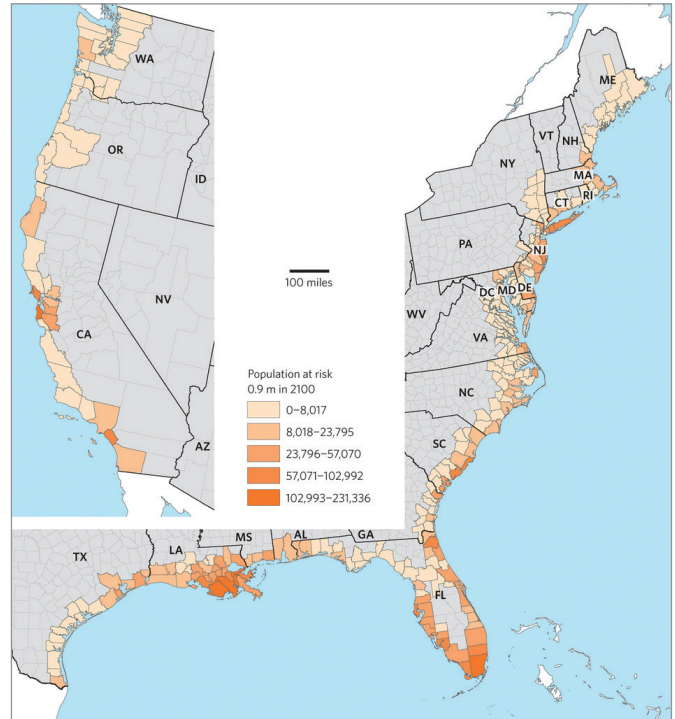
The Arctic system is moving toward a new state with much less ice on land and on the ocean (EOS article). However, scientific understanding of potential trajectories the system might take toward such a new state is still inadequate. Many uncertainties persist in our understanding of the interaction between the Earth system and the Arctic subsystems along these trajectories. National and international resources for outcome-driven research that can be applied by stakeholders/actors to guide policy actions are needed in order to keep pace with the rapidly unfolding change in the Arctic and its global impacts.

### (b) Dialogue Platform on Desired Future State of the Arctic

There is no “one Arctic.” Rather, there are different and potentially diverging views on what the desired state of the future Arctic should be, depending on the interests of individual stakeholders or actors. This raises the question: Who determines which Arctic is desirable? Given the opportunities for easier maritime and terrestrial access to territory and resources emerging in a warmer Arctic with less ice and permafrost, and the desire of a group of stakeholders to take advantage of them, a dialogue has to be initiated about which future Arctic states we are aiming for and whether these states are (still) achievable.

### (c) Adaptation to Arctic Change

All components of the Arctic system are adjusting to change—physically, biologically, socioeconomically, and socioculturally—through ad hoc, unstructured responses. We urgently require a strategic adaptation program that is a stakeholder-driven process, including research on the best adaptive strategies and their means for implementation. Resources for moving from research to implementation should be made available on national and international levels. A key focus should be the empowerment of local actors to put in place effective adaptation actions and build resilience at the community level. Attention needs to be paid to soft infrastructure (for example, building codes, governance, relocation assistance), as well as hard infrastructure (for example, ports, roads). Knowledge and technology transfer and the growth of communities of practice involving Arctic and non-Arctic organizations and governments can enhance the success of such efforts.



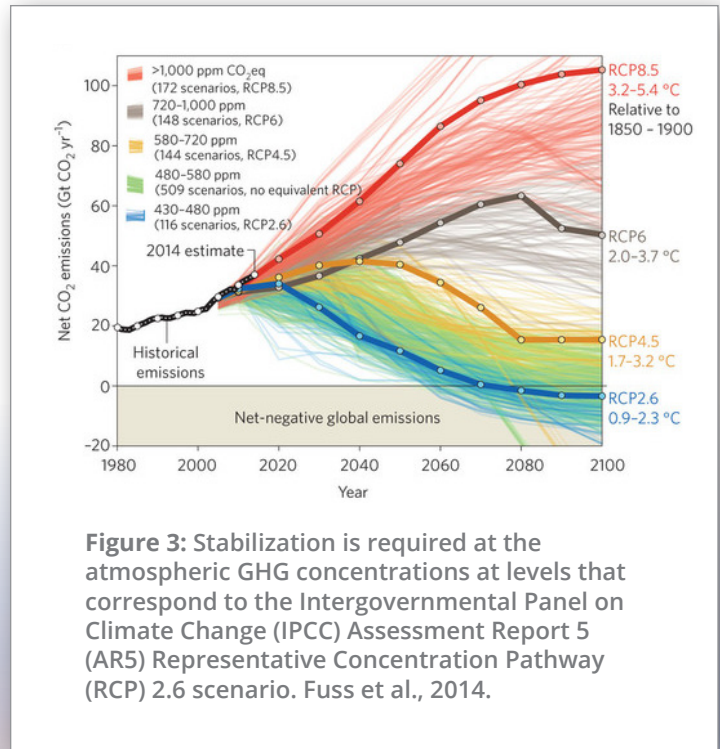
Projected flood risks following 3 feet (0.9 meters) of sea level rise by 2100 in the southeast U.S. Credit: University of Georgia, Nature Climate Change “Millions projected to be at risk from sea-level rise in the continental United States” Hauer, M., J. M. Evans & D.R. Mishra, Nature Climate Change (2016).

### (d) Continuity and Enhancement of Arctic Observations

We have to keep our fingers on the pulse of this rapidly changing and highly vulnerable region. A flexible, long-term, internationally coordinated Arctic Observing System that encompasses all domains of the Arctic system and is seamlessly integrated into a global observing system is required. The system should be a hybrid to serve both the scientific community and a broader group of stakeholders including Arctic peoples. Elements of such an observing system are in place and mechanisms to sustain and enhance it, including community-based observations, have been identified or are under way (e.g., SAON, AOS: Arctic Observing Summit; EU H2020; national efforts). A common feature of all Arctic observing initiatives is that they are underfunded and their long-term operation is insecure. This results in lapses in operation of major observing components, creating gaps in our picture of Arctic Change. These challenges are amplified by the loss of perennial (multiyear) sea ice that has long served

as a drifting platform for instrumentation. International coordination of support for an Arctic Observing System is urgently needed to avoid truncation of ongoing observations and to permit the acquisition of new information needed for structured responses to Arctic change. A key element of successful observing efforts is mutual agreement on an open, collaborative marine scientific research and operational observations regime in the high Arctic and over the (extended) continental shelves.

The present design of the Arctic Observing System should be augmented by an early warning component; in other words, by assuring that variables that are seen as indicators of imminent changes of the system are in place and that their signals are translated into messages directly useful for decision makers on the appropriate time scales. In some instances this requires real-time delivery of information from remote sensor locations to user communities. An Arctic Observing System cannot measure every parameter at every location. Thus realistic Arctic system models are required to obtain a consistent synthesis of all data.



**Figure 3:** Stabilization is required at the atmospheric GHG concentrations at levels that correspond to the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5) Representative Concentration Pathway (RCP) 2.6 scenario. Fuss et al., 2014.

Global emissions of carbon dioxide and other greenhouse gases have committed the Arctic to substantial future warming.





### (e) Shaping the Trajectory of the Arctic System

Future states of the Arctic are heavily dependent on future emissions pathways (Fig. 3). The main tool to influence the trajectory of the Arctic through mitigation is global modulation of atmospheric GHGs, especially CO<sub>2</sub>. Another principal tool is solar radiation management (SRM), i.e., the dimming of the incoming solar radiation. Because global GHG concentrations are determined by emissions, which emission scenario the world embarks on is critical for the future state of the Arctic. The best case outlined in the Paris Climate Agreement with a global temperature increase between well below 2 °C and 1.5 °C requires negative carbon emissions.


In principle, GHG concentrations can be shaped by application of carbon dioxide removal (CDR). CDR (re-extraction of CO<sub>2</sub> from the atmosphere) is widely seen as the preferred method to control future global warming. Its principal technical feasibility has been demonstrated on small scales (up to several tons per day in the Global Thermostat pilot experiment). In order to be applicable on the scale needed to keep global warming at or below 2 °C globally, a major global effort has to be launched in research, development, and implementation of CDR.

Solar radiation management (SRM) is a geoengineering option that would show cooling effects on a short time scale (a few years). However, during deployment of SRM, GHGs would continue to accumulate and if an SRM program were

stopped, warming would rebound quickly and strongly. SRM would not prevent or slow down ocean acidification due to marine carbon uptake, often referred to as the other climate problem. This would continue unabated, threatening marine ecosystems. Additionally, due to the lack of the basic research concerning technical and governance aspects of SRM, there are other uncertainties related to this technology such as possible shifts in precipitation patterns, to name just one example. Thus, SRM should be considered only in conjunction with CDR and as an absolute emergency measure in the case of catastrophic warming and not as a true alternative to CDR. SRM is not an alternative to decarbonization of the energy system to the point of zero or negative emissions. In general, geoengineering should not be seen as a “free pass” for further emissions but as a tool to keep the warming of the planet below the threshold considered as dangerous interference with the climate system.

### (f) Unified Arctic Voice for Global Action

COP 21 in Paris has shown that the unified voice of stakeholders can have significant impact on political decisions. There, the Low-Lying Island Nations (AOSIS; Alliance of Small Island States) were instrumental in setting the target for a global warming well below 2°C or even below 1.5°C. Global action is needed to influence major drivers of Arctic Change such as global atmospheric GHG concentrations. An Arctic coalition with a unified voice in the global arena is needed to promote measures to keep the Arctic's vital functions intact.



Late forming sea ice leaves the village of Shishmaref, Alaska vulnerable to powerful autumn storms and devastating coastal erosion. The community recently voted to relocate.



## WE RECOMMEND THE FOLLOWING COURSE OF ACTION:

- (a) Enhance and support research in projecting which future states of the Arctic are possible in principle, under which conditions they can be reached, and which impact they would have.
- (b) Design, initiate, and support a platform for a broad stakeholder dialogue on which future state of the Arctic we should strive for, drawing on existing local and regional platforms. The outcomes of the continuing dialogue have to inform decision-making processes in the context of the evolving Arctic trajectory.
- (c) Expedite research on adaptation of the Arctic to ongoing and expected environmental changes and provide resources for implementation of science-based adaptation strategies.
- (d) Ramp up technical and financial support for Arctic societies needing strategic adaptation solutions—including relocation and soft infrastructure support (building codes, zoning, and others).
- (e) Complete and sustain the emerging Arctic Observing System, augmented by early warning components and enhanced Arctic system models to closely track key components of the changing Arctic.
- (f) Unify the voices of the Arctic Nations and those global actors interested in the future of the Arctic in support of the science needed for immediate upscaling of efforts in global decarbonization and negative emissions schemes.
- (g) Deploy measures for deep decarbonization of the global energy system and accelerate the upscaling and deployment of technologies for negative carbon emissions. Unify the efforts for allocating resources to master this historic challenge.





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A polar bear (*Ursus maritimus*) navigates broken ice near Svalbard, Norway.





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