Exploring Ice and Snow in the Cold War

Julia Herzberg, Christian Kehrt, and Franziska Torma

In 1962 the American missile and aircraft manufacturer Martin Marietta published an advertisement promoting Antarctica's first nuclear power plant. This small reactor was designed to supply power for approximately one thousand scientists at the US Antarctic Station McMurdo and support a comfortable modern lifestyle that expelled every last trace of the hostile Antarctic environment outside: "Last night in Antarctica, nuclear power lit the bulb, heated the room, fried the eggs, boiled the coffee, kept the scientific instruments running, burned the toast."[1] Small nuclear power plants for ships, submarines, or polar stations are typical components of Cold War–driven approaches to building military infrastructures in remote and often extreme environments around the globe.[2] The hubris of employing technology to overcome obstacles of ice and snow on a global scale, and becoming independent of seasonal weather and climate, is characteristic of the dominant attitude toward nature during this era. Robust military technologies, such as icebreakers, airplanes, and snowcats, as well as federal financial support for expensive expeditions enabled the massive assault on and conquest of the poles during the Cold War. The polar regions were Cold War laboratories in which it was possible to test new technologies and develop ways for scientists and soldiers to work under extreme climatic conditions.[3] Knowledge of ice and snow, and of how to technologically control these remote and hostile environments, was certainly of scientific value. However, more importantly, it was also of military and geostrategic significance.

This volume focuses on the multiple meanings, functions, and uses of cold environments and addresses the question of why ice and snow became an important topic during the Cold War. It explores questions of interest to historians of science and technology, cultural and environmental historians, and scholars in the field of Cold War studies. The time frame ranges from the prehistory of the Cold War in the 1930s to the last of the Cold War years, so as to better illustrate continuities and changes during this era. It considers cold regions as special environments that make political, cultural, scientific, and environmental processes visible in a condensed and place-bound way.

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Dramatic stories about ice and snow, melting glaciers, and vanishing and cracking ice sheets constantly feature in the news today, along with warnings about impending environmental disasters. These stories and warnings are directly related to pressing societal problems of climate change, rising sea level, and environmental destruction.[4] In his introductory essay on cryo-history, Sverker Sörlin asks what kinds of narratives and stories can be told by considering ice and snow not merely as natural but as social categories that are intrinsically linked to human society, history, and politics on a global as well as a local level. Cryo-history in this sense goes beyond the history of science and adopts a broader and culturally richer perspective by focusing on the histories of changing human-nature relations. Related stories do not only include science and scientists—for example, the development of glaciology as a modern discipline—but also cultural and anthropological narratives, local knowledge, and both regional and long-term perspectives.

Environmental histories of the Cold War are opening up a new field of research.[5] As this volume shows, many pressing questions of global importance have their roots in the Cold War.[6] But to tell new stories about global environmental issues goes beyond disciplinary and national boundaries and requires bringing together multiple, often unconnected fields and approaches, including the history of science and technology, international relations, and military and environmental history. During the Cold War the earth began to be considered from the perspective of the planet as a whole for the first time, as several recent landmark studies on global environmental history show.[7] John McNeill has pointed to the crucial role of the sciences in connecting the Cold War and the environment in complex and manifold ways.[8] Science became absolutely central to the perception of Cold War problems and offered expert solutions. At the same time, it was a placeholder in the realm of Cold War politics to secure knowledge about and provide access to environments and spaces of strategic value.

The history of the polar regions and of polar expeditions as well as the role of glaciers and cold climates is a blossoming and interdisciplinary field of research. The International Polar Years and their contribution to global knowledge production is a particular topic of interest.[9] Matthias Heymann has investigated the role of Greenland during the Cold War,[10] while the cultural geographer Mathew Farish focused on northern American Arctic landscapes in order to enable a better understanding of the people who lived there and the use made of these environments during the Cold War.[11] Yet one of the main shortcomings of current Cold War scholarship is the US-centric approach and a lack of contributions on the Soviet Union and other Eastern Bloc states, as well as on Eastern and Western Europe.[12] This situation is slowly beginning to change. We know more about ice and snow in the Soviet Union thanks to the work of scholars like Paul Josephson, John McCannon, Andy Bruno, and

Julia Lajus. However there is still much to be learned about Eastern European, Russian, and Soviet activities in the Arctic and Antarctica.[13] Knowledge of ice and snow not only emerged among the superpowers, in the United States and the Soviet Union, but also in Switzerland, Bouvet Island, and the Kazakhstan mountains. These multipolar sites of knowledge and associated transnational knowledge flows challenge geographies of the Iron Curtain.[14] Sverker Sörlin's focus on Hans Ahlmann as an actor who bridged the East-West divide is revealing.[15] Further work on the international expeditions, institutions, and networks that emerged after World War II is necessary, as well as studies on the activities of countries like India, China, Chile, Malaysia, and South Africa in the polar regions. But there is also a surprising lack of studies of European countries such as Switzerland, Austria, France, or East and West Germany, which have long histories of scientific interest in ice and snow, whether with regard to alpine or polar regions, especially in the period after World War II.

The Polar Regions as Sites of Knowledge

In 1950–51 the French geographer Jean Malaurie witnessed the construction of a large US air base at Thule in northwestern Greenland.[16] In the tradition of Knud Rasmussen's Thule Expeditions, Malaurie studied and collected geographic, social, and demographic data of the world's "most northerly inhabitants" at a time when these Arctic cultures and landscapes were drawn into the middle of Cold War conflicts.[17] Malaurie critically described the encounter of these archaic hunter cultures with the modern lifestyle and technology of the US military as a cultural shock that threw these "harpoon men into the atomic age."[18] The US military relocated the inhabitants of Thule further north and, in the course of Operation Blue Jay, transformed the site of the former settlement Pituffik into a hypermodern $800 million station, with cinema, radio telecommunication, radar, and a three-kilometer-long landing strip for the bombers and reconnaissance planes that flew from Thule straight into the heart of Soviet Russia. As the aviator and polar explorer Bernt Balchen wrote in a memorandum for the US Air Force, the topography of Thule was favorable from a military perspective.[19] It had a natural harbor and was accessible by icebreaker; there was an area mostly free of permafrost that was suited for the construction of a landing strip. Thule is close to the Greenland inland ice sheet and was the starting point for several expeditions and camps that used the location as a site for testing the construction of military infrastructures and acquiring new knowledge of ice and snow in order to live, fight, and build in these environments. Within a short time the US Army Corps of Engineers transformed Thule into one of the biggest strategically important air bases. As Nikolaj Petersen has pointed out, "the construction of the Thule base in

1951–1952 signaled the beginning of the polar strategy."[20] Thule became an important node in the global front lines of the Cold War; its central location between the United States and the Soviet Union made the Arctic highly appealing to US military experts, who hoped to control the vast spaces of the Arctic by integrating it into their air force network.[21] World War II had already demonstrated the strategic importance of the Arctic with its Northern Sea Route and weather data. Its military significance increased during the Cold War and necessitated the massive exploration of Arctic spaces.[22] US plans for the Arctic culminated in a futuristic Cold War fantasy of creating a gigantic secret missile base underneath the Greenland ice sheet that could target sites in the Soviet Union.[23]

While the United States treated Greenland as an empty space to be controlled by modern technology, especially radar stations and airfields, in fact it was neither empty nor uninhabited: there were local Inuit hunter cultures close by, members of which had regular contact with the US military. In her anthropological case study on Inuit responses to and experiences and memories of Arctic militarization in Greenland, Sophie Elixhauser shows that the US military presence had a long-term effect on the lifestyles, memories, and cultures of local Inuit in the Ammassalik region in eastern Greenland. Contact and the exchange of expert knowledge between local cultures and the military are highly complex and have only recently come to the fore in postcolonial, cultural, and anthropological studies.[24]

Knowledge of Ice and Snow

Glaciology as a modern scientific discipline and the systematic investigation of glaciers (for example, using photogrammetric methods) dates back to the late nineteenth and early twentieth centuries.[25] Glaciologists systematically investigated the structures and transformations of ice and snow and their layers, density, volume, and age in both Alpine environments and the polar regions, gaining new insights into earth history, weather patterns, ocean currents, and ice ages. The discipline was also applied to solving more practical problems of avalanche protection and the construction of houses, weather stations, roads, and airstrips in icy regions. As early as 1912–13, the German scientist Alfred Wegener was already pursuing glaciological questions during his second Greenland expedition with the Dane Johann Peter Koch, where they studied snow and firn accumulation in pits. Wegener's interest in Greenland's ice sheet culminated in his 1930–31 Greenland expedition, during which he hoped to gain insight into weather and climate conditions and the dynamics of the inland ice, as well as the laws of snow and firn formation.[26]

Systematic scientific knowledge about ice and snow was developed during the interwar period, with Switzerland at the forefront of efforts to better understand the nature and causes of snow avalanches. This is highlighted by Dania Achermann's chapter on the institutionalization of snow and avalanche research. The Swiss example is revealing because it can help to understand continuities and changes from the interwar period to the Cold War, as well as forms of knowledge transfer and circulation across national and regional borders. Swiss expertise in glaciology is rooted in avalanche research and precaution in the Swiss Alps. In the interwar period the first ice and snow laboratories were established, and new methods were developed to systematically collect scientific data regarding ice and snow behavior, density, layers, and formation. The Swiss scientist Henri Bader drew on his expertise in crystallography in the standard book *Der Schnee und seine Metamorphose,* published in 1939 (the English translation, *Snow and Its Metamorphism*, was commissioned by the US government in 1954).[27] The goal was to better understand the formation of snow avalanches in Alpine contexts. The new discipline combined laboratory methods with field science approaches in order to gain insight into the nature of ice and snow, a fragile subject of study that quickly lost its defining characteristics if transferred to a traditional laboratory. Thus special ice and snow laboratories with controlled conditions to directly observe ice and snow formation were necessary. It is also relevant in the Swiss case that international cooperation was limited by national concerns, especially during World War II.

In contrast to the Soviet Union and many European countries, the United States had little scientific experience of polar exploration and needed new knowledge in order to build military infrastructures, defense lines, air bases, and radar and weather stations in extremely hostile environments.[28] In World War II the US Air Force depended on the know-how of experienced European polar explorers for teaching pilots survival skills in Arctic environments. The science of glaciology only began to be fostered in the United States as a consequence of the new Cold War–driven interest in the polar regions. The earth sciences and geophysics blossomed all over the world in the Cold War, especially during the International Geophysical Year (IGY) 1957–58. In view of the flourishing of this research field, one scholar asks, "How was it that, for all the earth science disciplines, the postwar decades were probably the most productive periods in their histories?"[29] The answer to this question, at least from a Cold War perspective, is clear: geophysical data were necessary for atomic warfare involving intercontinental ballistic missiles, U-boats, and heavy bombers.[30]

As Janet Martin-Nielsen shows in her article on Henri Bader, the United States was driven by military concerns during the Cold War. The US Army, and its Snow, Ice and Permafrost Research Establishment (SIPRE) in partic-

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ular, pushed ice and snow studies. SIPRE was founded in 1949 and directed by Bader himself. To obtain systematic, regular data beyond that collected during expeditions, a permanent station had to be erected and, if possible, integrated into an expanding network of weather stations around the globe. The Soviet drift station, for example, made it possible to study ice and the changing weather and water conditions over an extended period of time.

While the study of ice and snow gives basic insight into climate patterns and the role of polar ice sheets in climate history, Janet Martin-Nielsen shows that US endeavors were mainly driven by an engineering approach. Ice and snow had to be controlled in order to build airfields, military infrastructures, and radar and weather stations. Indeed, building military infrastructures around the globe in remote but strategically important extreme and hostile environments was a characteristic feature of the Cold War. This engineering approach is also emphasized in Ingo Heidbrink's study of ice and snow as construction materials in Greenland, which looks more closely at the Camp Century site erected by the US Army Corps of Engineers in 1959. Like in McMurdo, a small nuclear reactor was temporarily established at Camp Century and publicly promoted. A further shared characteristic was the lack of knowledge exchange with local people. For Heidbrink it is characteristic of the United States to treat these areas as if they were *terra nullius,* unclaimed land in which the military could do as they wished. The behavior of the natural environment was also largely ignored; technological control of the environment did not take into account the powerful ice sheet dynamics that ultimately destroyed Camp Century.

The Politics of Cooperation and Confrontation

Scientific cooperation and the exchange of data and ideas, as well as the transfer of methods, instruments, technological artefacts, and scientists across national borders, are characteristic of polar exploration, although the results are often interpreted as mere national achievements.[31] As John Krige has pointed out, the process of establishing US hegemony during the Cold War was largely dependent on transnational knowledge flows that secured hegemony via open knowledge and cooperation.[32] In this context the questions that remain to be answered are how different nations within the Eastern and Western Blocs profited or suffered from their cooperation with the Cold War superpowers and whether flows of knowledge across the Iron Curtain were possible. During the Cold War scientists organized international committees and unions such as SCAR, the Scientific Committee on Antarctic Research founded in 1958, in order to continue the international research conducted in Antarctica during the International Geophysical Year 1957–58.[33] Sixty-seven nations around the globe had pursued earth science investigations into the planet during the International Geophysical Year. The IGY enhanced scientific cooperation across national and ideological boundaries and provided insight into global weather and climate patterns, ocean currents, and snow and ice covers. But such global geophysical data were also of immense strategic value.

From a political perspective, the exploration of Antarctica has a strong resemblance to the space race during this period. Both shed new light on the geostrategic dimension of these realms. Roger Launius shows that the Antarctic Treaty (1959), like the Outer Space Treaty (1967), has to be understood in the context of Cold War rivalries and emphasizes the political role of science in the appropriation of spaces that were outside national borders and territories. Both treaties are landmarks not only in the history of international relations and the governance of global commons but also in the history of the Cold War. Both treaties established a regime that is based on peaceful international scientific cooperation and nuclear-free zones during the height of the early Cold War. At the same time, these achievements came in the midst of a growing nuclear arms race; Antarctica was also appealing as a possible nuclear test site, and its oceans and ice caps were considered as sites for storing nuclear waste.

A study of a single site over an extended period of time can illustrate the variety of geopolitical interests struggling for control over the polar regions. Peder Roberts and Lize-Marié van der Watt trace the history of Bouvet Island in the Southern Ocean. During the interwar period it was a Norwegian whaling station, although the United Kingdom attempted to contest the Norwegian claim to the island. In the 1950s South Africa, which later took part in the IGY and was a founding member of the Antarctic Treaty System (ATS), became interested in Bouvet Island and tried to cooperate with Norway to construct a weather station in the context of what was to become the IGY network. While these actors were not at the center of Cold War conflict, the island was also of geostrategic relevance for the Soviet Union; at this early stage the Soviet interest in Antarctica was covert and not part of the early IGY plans and negotiations.

However, the significance of ice and snow during the Cold War was not limited to the polar regions. Just as in the Swiss Alps, problems resulting from avalanches and the needs of a growing tourist industry motivated the development of high-risk areas in both Western nations and in the Soviet Union and its satellite states. The example of the Kazakhstan mountains is typical of a self-confident approach to nature. Here, the Soviet state was not interested in military infrastructure, but rather the high modern development of a mountain region for tourism and the prestigious Winter Olympics. Glaciological knowledge and avalanche prevention were considered key to developing these regions in Central Asia under Soviet rule. As Marc Elie shows, nature was conquered and tamed by modern science and technology, exposing the expanding cities in cold regions to severe risks and environmental destruction.

Cultures and Narratives of Ice and Snow

The laboratory is a recurring trope in narratives of ice, snow, and cold regions.[34] On the one hand, scientific study of the polar regions was informed by modern laboratory methods for collecting data—for example, measuring oxygen isotopes or even radioactive fallout to date the age of ice cores and snow layers. On the other hand, the laboratory metaphor also has a broader political dimension, insofar as scientific expeditions have to be considered in the context of geostrategic conflicts and interests that were channeled and realized by and through the sciences and scientists.[35] Sebastian Vincent Grevsmühl shows that Antarctica with its peculiar physical features was perceived as "the largest laboratory in the world" and a unique site for researchers in many disciplines. Field sciences like geology, meteorology, and glaciology merged with the laboratory sciences and with cultural narratives: the polar regions were considered to be a "natural laboratory" with "pure" environmental conditions untouched by humans for thousands of years.[36] In addition, Antarctica was used as a laboratory for mimicking the conditions of space exploration. The medical and psychological effects on astronauts in outer space could be tested and compared with the experiences of scientists who overwintered in Antarctica.

Stories about ice and snow can also be told in a broader cultural and transnational framework, as Carolin F. Roeder and Gregory Afinogenov show in their contribution about the Soviet yeti craze. During its peak in the late 1950s, the craze had become an international cultural phenomenon at the intersection of public media and fringe, amateur and pseudoscience. While the yeti was a transnational phenomenon, the Soviet approach was distinctive because of the way it brought lay audiences and amateurs together with members of the Academy of the Sciences. The yeti fad can be compared to the space travel craze during the same period. Science became more popular and received increasing levels of state support and media coverage. After a while, the Soviet science establishment distanced itself from the phenomenon; the re-emergence of interest in the yeti in the late 1980s can be seen in the context of a growing public interest in occult phenomena.

Ekaterina Emeliantseva Koller focuses on the closed city of Molotovsk-Severodvinsk, an important production site for nuclear submarines in the Soviet Union. She shows how people in the Brezhnev era took the harsh climate in their stride as a source of symbolic capital and as a central component of community cohesion and self-identification. Narratives about the cold became a central element in the city's foundation myth, which took up Stalinist narratives about heroic Soviet citizens' conquest of nature in the Arctic. Authorities and inhabitants used the cold to legitimize and receive bonuses and higher wages. They successfully established the image of Molotovsk-Severodvinsk as a unique "Far North" area, even though the climatic conditions were not exceptional when compared to settlements in the surrounding area.

As Pascal Schilling's contribution on the transpolar expedition of Reinhold Messner and Arved Fuchs demonstrates, perceptions of the polar region changed during the 1970s and 1980s. While Messner and Fuchs inscribed their polar expedition into the stories and heroic myths of polar exploration in the late nineteenth century, they explicitly rejected and denied the technologies and approaches of the Cold War. Instead, Messner and Fuchs understood their trans-Antarctic trip as an exploration of the self and a personal, even spiritual, experience of nature, self, and body. While profiting from satellite communication and lucrative as well as extensive media coverage of their voyage, they rejected the modern science, technology, and military approaches that were developed during the Cold War period. They did not want to enter the US south polar station and enjoy the comforts of modern life. Instead they underlined environmental concerns and a new awareness that is typical for the 1970s and 1980s, when new actors entered the polar regions and questioned the established scientific and political actors that had hitherto shaped Antarctic politics. The expedition coincided with the de facto end of the Cold War: the fall of the Berlin Wall. In this period further new actors and environmental interests, and a new perception of wilderness and global environmental concerns, came to the fore. These concerns were expressed not only by scientists but also by new interest groups such as Greenpeace, who campaigned for making Antarctica a nature reserve—a world park—and criticized not only military, touristic, and technological approaches, but also the erection of scientific research stations.

The thematic and methodological scope of this volume extends beyond the common narratives of Cold War histories that consider the era mainly in terms of political confrontation between power centers. The contributions can be read as a narrative of adaption to cold environments in everyday lives and practices. The technologies (e.g., avalanche research, climate and weather observation) that were tested and developed in the polar regions changed the meaning and the nature of ice and snow in a general sense. Transport technologies and new ways of coping with the cold transformed local and global geographies and polar environments. From the Western point of view, faraway places (e.g., Greenland, Antarctica, the Artic) became part of everyday lives as a result of the practices dealing with these conditions, but also as a result of narratives about coping with these extreme environments and the popular images of polar travel and the "conquest" of ice and snow. Common histories of the Cold War are often narrated from a state perspective or scrutinized through the lens of international politics. By focusing on questions of how the

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exploration of ice and snow made icy peripheries centers of action, we focus on moments of exchange between local cultures, modern science, and Eastern and Western societies, as well as the people involved. The agents of our stories include the people who dealt and are dealing with extreme environments, be it the scientist from the Western or Eastern Bloc or the people who lived in these environments. From their perspectives, it is possible to appreciate how trajectories of knowledge gain momentum: examples of adaption show not only how science changed everyday lives in the context of local cultures, but also how (modern) scientists learned techniques of dealing with the cold from people who possessed genuine, and often tacit, local knowledge. A good example here is Alfred Wegener's Greenland experience. Wegner relied on indigenous knowledge of traveling and surviving in extreme environments and at the same time tried to introduce new means of transportation and communication that then shaped the Cold War period.

In this sense, modern approaches can be integrated into and compared with *longue durée* developments and older habits and ways of dealing with the cold. This sheds light on three major phases of human encounter with the cold; during the eighteenth and nineteenth centuries, the exploration of cold environments had empire- and nation-building functions. In tsarist Russia, for example, the scientific exploration of frost, ice, and snow became a means of integrating distant regions into the empire and carrying science, European morals, and the ideas of the Enlightenment to the peripheries of the realm. Its attempt to tame the cold through the sciences was also an attempt to present itself as a European state. In the Soviet Union of the 1930s, the exploration and appropriation of the Arctic delivered a message to its own people. The Soviet government used events like the rescue of the *Chelyuskin* crew in 1934 or the flight over the North Pole in 1937 as a tool to create an Arctic myth; this myth was supposed to unite a country that was terribly distressed by Stalinist terror and collectivization. The Arctic environments, which were closely connected to heroic tales of man versus cold nature, shaped identities within the communities that undertook these endeavors. The 1950s, however, threw light on a new emerging era, the third period at the heart of this volume. New technologies and the military turned the polar regions into sites of strategic concern and intense scientific research. They were Cold War environments in which new knowledge emerged and new forms of political cooperation and conflict were practiced and negotiated. The IGY and the modeling of the earth as a system led to the integration of polar environments into the globe as a whole, and the Antarctic Treaty System from 1959 defined Antarctica as a peaceful place without atomic weapons. The perception of the Arctic and of Antarctica as both being part of the global commons is central to this third phase and is based on the legacies, imaginaries, and knowledge that resulted from the Cold War years. Today these places are certainly still of military and geopolitical significance, but they are also places where new histories of cold and extreme environments emerge.

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25. See, for example, the photogrammetric work of Sebastian Finsterwalder (1862–1951) in the Bavarian and Austrian Alps. Finsterwalder was a professor of mathematics at the Technical University of Munich and crucial to the long-term measurement and monitoring, from 1889 to the present, of the Vernagtferner (Ötztal region) as a model glacier. See Kurt Brunner, "Die Karte 'Der Vernagt-Ferner im Jahre 1889' als erste exakte Kartierung eines Gesamtgletschers," *Zeitschrift für Gletscherkunde und Glazialgeologie* 29, no. 1 (1993).
26. Janet Martin-Nielsen, *Eismitte in the Scientific Imagination: Knowledge and Politics at the Center of Greenland* (New York: Palgrave Macmillan, 2013); Christian Kehrt, "The Wegener Diaries: Scientific Expeditions into the Eternal Ice," Environment & Society Portal digital exhibition (Munich: Rachel Carson Center for Environment and Society, 2013).

27. Henri Bader, *Der Schnee und seine Metamorphose: Erste Ergebnisse und Anwendungen; Systematische Untersuchung der alpinen Winterschneedecke* (Bern: Kümmerly & Frey, 1939).
28. See Ingo Heidbrink's contribution to this volume.
29. John Cloud, "Introduction: Special Guest-Edited Issue on the Earth Sciences in the Cold War," *Social Studies of Science* 33, no. 5 (October 2003): 629.
30. Ronald E. Doel, "Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA after 1945," *Social Studies of Science* 33, no. 5 (October 2003).
31. See Pascal Schillings, "First at the South Pole: The Production of Geographical 'Matters of Fact' during the Norwegian Antarctic Expedition, 1910–12," *Historical Social Research* 40, no. 1 (2015); *Die letzten weißen Flecken: Europäische Antarktisreisen um 1900.* Göttingen: Wallstein Verlag, 2017.
32. John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe (Transformations)* (Cambridge, MA: MIT Press, 2008).
33. Sidney Chapman, ed., *The Histories of the International Polar Years and the Inception the Development of the International Geophysical Year,* Annals of the International Geophysical Year (New York: Pergamon Press, 1959); Launius, Fleming, and DeVorkin, *Globalizing Polar Science*; Barr and Lüdecke, eds., *The History of the International Polar Years (IPYs).*
34. For an understanding of the laboratory metaphor as a reconfiguration of social and natural order, see Karin Knorr-Cetina, *Wissenskulturen: Ein Vergleich naturwissenschaftlicher Wissensformen* (Frankfurt am Main: Suhrkamp, 1999), 45–73; Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987). In the context of alpine expeditions and mountaineering, see Philipp Felsch, *Laborlandschaften: Physiologische Alpenreisen im 19. Jahrhundert* (Göttingen: Wallstein, 2007), 7; Charlotte Bigg, David Aubin, and Philipp Felsch, "Introduction: The Laboratory of Nature—Science in the Mountains," *Science in Context* 22, no. 3 (September 2009); see also Christian Kehrt, "Grönland im Kalten Krieg," *Technikgeschichte* 80, no. 3 (2013): 248.
35. Aant Elzinga, "Antarctica: The Construction of a Continent by and for Science," in *Denationalizing Science,* ed. E. Crawford (Dordrecht: Kluwer, 1993).
36. Kristian H. Nielsen, Michael Harbsmeier, and Christopher J. Ries, eds., *Scientists and Scholars in the Field: Studies in the History of Fieldwork and Expeditions* (Aarhus: Aarhus University Press, 2012).

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Cryo-history

Ice, Snow, and the Great Acceleration

Sverker Sörlin

At this moment of history that we are in, in the first decades of the twenty-first century, we can see an enhanced awareness of the significance of snow and ice. These fragile aggregation forms of matter appear to us now almost as a frost-clad owl of Minerva who flies at our planet's dusk. They vanish before our eyes. We hear it in the news. We see the polar bear images, and although they are certainly far from new—my oldest archival finding of the sweating white bear on his shrinking ice floe is from 1947, published in the Swedish daily *Dagens Nyheter*—they have indeed become more frequent. Sitting solemnly on the equator, the snows of Kilimanjaro—the prevailing, but vastly different, significance of the title of his short story might never have occurred to Ernest Hemingway—have become another symbol of the waning indicator species of a planet under severe pressure.[1]

The cryosphere, named by the Polish glaciologist Antoni Dobrowolski already in 1923 (and possibly conceived several years before that), in a volume entitled *Historja naturalna lodu* (Natural history of ice), has gone from the (contested)[2] name of a geophysical feature to a significant cultural phenomenon, one of the life-sustaining spheres—the atmosphere, the biosphere—that once they are known occupy a place in what it means to care for human life and human societies.

A New Language of Change

How could this rising significance of ice be understood? Why cryo-history? What is it? Why this interest in histories of ice and snow? This chapter is about these questions. The rising of the ice and snow as historical categories happened at the same time as we are developing a new language for the causes and effects that are involved. We are getting used to concepts such as the Anthro-

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pocene, a relatively new word in this articulation—since around 2000—but not a new idea; precursors can be found generations back in various articulations.[3] This language is only now gaining broad usage, including the concept "the Great Acceleration," which refers to the rapid growth of multiple entities, from the use of digital media and cell phones to the use of natural resources, the consumption of energy, and the emissions of carbon dioxide in the atmosphere leaving no doubt of the hegemonic influence that humanity exerts on the earth system.

The Great Acceleration concept was first introduced as a concept in an earth systems science conference in Berlin 2005[4] and then widely spread as part and parcel of the burgeoning Anthropocene thinking and research.[5] This language, especially the concept "Anthropocene" has permeated from the earth sciences and atmospheric chemistry into the social sciences and the humanities, where it has received support as well as critical debate and probing questions.[6] The humanities, especially the environmental humanities, have carried the concept far beyond its origins.[7] The idea that societies now operate under a new "human condition"[8]—deliberately invoking Hannah Arendt's notion—plays a key role in this new solemn "music of the spheres": geosphere, atmosphere, hydrosphere, lithosphere, and cryosphere.

So, it is time to link ice and snow as historical categories with the period of the Great Acceleration, which in turn almost precisely coincides with the Cold War, both starting right after World War II and coinciding with the rise of "the environment" as a seminal conceptual tool for assembling global attention, knowledge, and action on the increasingly problematic human-nature relationship.[9] We change our language as a sign of our changing perception of the world and where it is going. And as we do this, we start paying more and more attention to ice and snow. This is no coincidence, and I shall in this chapter make an attempt to answer the question why this is so.

An Old Language of Ice and Snow

As "ice" and "snow" are now embarking on a new career as words and concepts, it mustn't be forgotten that there is a somewhat older literature on ice and snow and things people did with it, such as skiing, trekking, building, or using its aesthetic properties—for example Ruth Kirk's vivid pictorial album *Snow* from 1977, with magnificent black-and-white photographs from the Californian Sierras, or Bernard Mergen's kaleidoscopic, poetic, imaginative *Snow in America* from 1997.[10] Both of these have an American focus, but you could as well get your literature from other parts of the world. The Australian poet Les Murray published a book of essays where he tells of the first skiing club in Australia (some claim in the world). It was started in the Kiandra gold fields in the Snowy Mountains and its members' skis made from the wood of mountain ash trees as they organized their first competition in 1862.[11]

Of course, they were Norwegians, and Scandinavia looms large in the narrative of ice and snow. One of the early Norwegian skiers is closely linked to the kinds of histories we sometimes tell in the history of science and environment. Carl Bjerknes, a noted mathematician, was the father of successful engineer Ernst Bjerknes, who ended second in the first Holmenkollen skiing games in 1888, and of Vilhelm Bjerknes, who founded the famous Norwegian school of meteorology and invented the Arctic front concept, so masterfully researched by Robert Marc Friedman (1989), and whose son in turn, Jacob Bjerknes, as a faculty member at UCLA, became a central figure in the research of the impact of a changing climate on snow and ice during the Cold War.[12]

The kinds of knowledge that have been employed about snow and ice cover a range of cultures and knowledge regimes. The late Yngve Ryd, a Swedish ethnologist who passed away in 2012, wrote a book on Sami words for snow. His chief informants were Anna and Johan Rassa, an old couple in Jokkmokk, a center of Sami society in Lapland. There are some 350 words covered in the book, which tell everything about the properties and qualities of snow in different seasons and elevations, sizes and shapes and speeds, and what sorts of sensations it gives to humans and reindeer and dogs. The elderly Rassas were more than eighty years old when the book was issued.[13]

This kind of information is also why we start to see the limitations of our existing knowledge. Previous research on ice and snow has, with the exception of people like Yngve Ryd or cultural historians like Kirk or Mergen, been by and large about the natural science of ice. Glaciers and snowfields have been conceived largely as extensions upward of the crust of the earth and as components of the complex physical chemistry of the earth and its climate. Gerald Seligman's pioneering work *Snow Structure and Ski Fields* from 1936 demonstrated that even the systematic natural science knowledge of these phenomena does not go back very far.[14] Seligman, who was an articulate enemy of Dobrowolski's cryosphere concept, covered the minute details of the smallest snow crystals—photographed by Seligman himself with equipment from his London supplier—to the major fluctuations of the largest glacier systems and the relations of glaciers to climate fluctuations, as well as the mechanics and dynamics of avalanches. When glaciology took a more firm institutional shape as an acknowledged sub-discipline of the geosciences, with the *Journal of Glaciology* (from 1947) as its key publication, it was in this tradition. More rarely did we see attempts to understand ice and snow as extensions of society into the geosphere, atmosphere, and biosphere, as arenas of culture and of human ingenuity.[15]

Bringing People to the Ice

This situation has changed decisively. The work by Mark Carey on climate change and Andean societies, *In the Shadow of Melting Glaciers,* makes the point very convincingly that there is an entire continent of work to be done on what snow and ice mean and have meant. His story is about glacier experts in the twentieth century, communities of carriers of knowledge and technologies, and how they interact with local communities who carry local knowledge. Carey demonstrates how there is a history of interaction between these knowledge traditions and an even longer history of local adaptation to glaciers.[16] Further north in the Americas, Julie Cruikshank's work shows that in the analysis of glaciers there is a history of encounters of knowledge traditions that goes back for centuries, in her case in the Pacific Northwest, where the Tlingit met with French Enlightenment scientists, Lapérouse and his mathematics-infused experts.[17]

Some of the historical work has surfaced as a subcategory of the history of geology, geography, or natural history, but again only rarely did snow and ice as categories in this work become fully historicized. The framing story was, typically, the role of glaciers in the discovery of terrestrial time, and especially the discovery of the Ice Age, Karl Schimper's concept. Since the groundbreaking work by two European scholars, Jean de Charpentier (1786–1855), a German-Swiss mining engineer who developed his first ideas of glacial retreat in the 1820s and 1830s, and Louis Agassiz (1807–1873), a Swiss geologist who spent his later career at Harvard University and published *Études sur les glaciers* (Studies of glaciers) in (1840), commonly seen as the breakthrough of Ice Age theory, glaciology as a scientific enterprise was closely related to the understanding of geographical change in historic times. Glaciers told stories, if not of deep time, at least of a time that was deep enough to make it relevant for a whole range of scientific disciplines.[18]

Glaciers played a role in national narratives in several countries, from the nineteenth century, often with science in a key role. In Scandinavia, natural historian Georg Wahlenberg, a post-Linnaean botanist and plant geographer at Uppsala, visited several glaciers on his extensive travels in Lapland and regarded them as indicators of the virtues of the hardening Nordic climate in the very first decade of the nineteenth century.[19] This was an early interest in glaciers and has been mostly overlooked, probably because he had no idea of ice as a link to terrestrial deep time. Climate control was a preoccupation of imperial Austria and included the study of glacial motion.[20] Glaciers played a role in "Victorian imagination" in the United Kingdom.[21] The Antarctic ice served as a counterpoint to the red interior in the national lore of Australia.[22]

Most, if not all, the earlier attempts to write historically about snow and ice, say before the foundation of the Intergovernmental Panel on Climate Change

(IPCC) in 1988 and the acknowledgment of climate as a major global issue, lacked the framing narrative that we now have: that the loss of glaciers and the shrinking annual snow cover signify a major historical event in and of itself, that they herald even deeper changes in the future, and that these changes are not limited to the ice-clad zones but will affect the entire world. It may be worthwhile to compare the interest in oceans, deserts, or the tropical rainforest, where significant historical work has more of a lineage, in particular within imperial and colonial history.

Snow and ice have indeed been studied, for example as a special aspect of transportation, or as aid or obstacle in war. In recent years it has occasionally been understood as historically important, for example as a key element in the rise of the Arctic as a theater of war in the immediate post–World War II decades.[23] Some of this latter work has appeared in "Special Feature: Arctic Science" of the *Journal of Historical Geography* (2014), which features several articles about historical aspects of ice. Also, a recent book by Janet Martin-Nielsen problematizes science work on ice in Greenland's Eismitte; her work falls within the larger framework of study of the Greenland ice cap conducted at the University of Aarhus. Related work for Canada and the United States has been conducted by Matthew Farish.[24]

Other work picks up on the local popular perceptions and practices of or on ice. In this category we find notably work by anthropologists such as Julie Cruikshank's, on the relation to glaciers among the Tlingit in the Pacific Northwest.[25] Several broad interdisciplinary projects were conducted as parts of the International Polar Year 2007–9 and have continued since. One of them, SIKU, involved both Arctic residents in Greenland and northeastern Canada and anthropologists in a very hands-on effort including common fieldwork and resulted in a diverse volume entitled *Knowing Our Ice*[26] and in a magnificent recent volume, *The Meaning of Ice.*[27]

Interesting recent work is also assembled in a volume edited by anthropologists Kirsten Hastrup and Morten Skrydstrup, *The Social Life of Climate Change Models: Anticipating Nature.* It is mostly Hastrup's chapter on the navigational practices of Inuit in northwestern Greenland, Skrydstrup's report from his fieldwork on ice core drilling, also in Greenland, and Hildegard Diemberger's paper on predictability of the snow and ice region of Tibet that deal fully with ice, but throughout the book glaciers and sea ice are discussed.[28]

While this slightly personal sample is already a lot, there is more work out there, and more still is coming. But, considering the contemporary debates about anthropogenic climate change, we must draw the conclusion that we have still been too modest. The histories we tell of ice and snow and the growing interest in them are momentous. They heralded more than I imagined. This is probably why we are now seeing this surging interest in ice and snow and the quest for a new integrative narrative of humans and the rapidly chang-

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ing environment—indeed in cryo-history—as a historiography emerging in our time, because it has acquired relevance and a stature that these pursuits did not carry in the past.[29]

The Sea Ice Minimum as an Event

The evidence that ice and snow are becoming increasingly important not just as topics of historical analysis but for the perception of a planetary condition seems to me now broad and manifold. But if we are looking for a particular moment that, albeit symbolically, may serve as a sign that the attention was turning around—a crystallization point, to use the language of ice formation—I suggest we should pay attention to the 2007 Arctic sea ice minimum.

In October of that year, the National Snow and Ice Data Center (NSIDC) of the US National Oceanic and Atmospheric Association (NOAA) declared that the melting season had ended and that a record low had been reached at a level that was not only far below the average of the last decades of observing sea ice, but also way below the lowest coverage area that any models had predicted.[30] It was at the beginning of the International Polar Year, and the news came just as a European Science Foundation conference on climate change had started. I was among the participants, and the buzz was enormous. Speakers changed their talks, images were quickly fetched from the web to illustrate the phenomenon, and a discussion immediately broke out on whether we could trust the models and the predictions when they seemingly had so grossly underestimated the forces of change.[31] At the conference there was concern but also some kind of paradoxical excitement, as if this could prove climate change to be more true, in a more forceful way, and at a higher pace than the barely visible day-to-day change that could only be reported in illusive statistics. The already ongoing speculations of an ice-free Arctic—an old trope[32]—immediately intensified.

How could these sentiments be understood? It may be useful to think of the sea ice minimum as more than just a neutral geophysical observation. It was rather an event, since it caught massive attention and captured the imagination of many people. It has also become a reference point, and it acquired its own icons. The data showed that the extent of sea ice in the Arctic Ocean had reached 23 percent below previously recorded low levels (2005) and 39 percent below the average over the period 1979–2000.[33] Instead it has been suggested that it can be construed as a "media event," a special moment, or "happening" that draws significant attention in various forms and outlets of media. The concept was originally developed by Elihu Katz (1980), who emphasized its national character, but with globalizing media and societies, media events have tended increasingly to become transnational, even global, and they tend also not to be isolated to politics in the limited sense.[34] They occur around major sports and entertainment occasions, celebrity deaths (the Kennedy assassination, the Diana phenomenon), and natural and environmental disasters (the 2004 Indian Ocean tsunami, Hurricane Katrina in 2005).

For a few days in October 2007 eventization centered on ice. In a thorough analysis Miyase Christensen, Annika Nilsson, and Nina Wormbs have suggested that the optimal framing of the sea ice minima, in 2007 and also an ensuing one in 2012, is to see them as constituting minor events, or "moments" in the larger meta-event of climate change. The latter, grand and global as it truly is, has many media sites where it can be visualized, mediatized, and thus manifested, beyond (the weak and vague) personal experience that the ordinary citizen has of climate change and beyond pale statistics. The melting Greenland ice cap at Illulissat is one such example, and the summer ice-free Arctic Ocean is another.[35]

The sea ice minimum 2007 came precisely at a moment when climate change was assuming a prime position on the global political agenda. Why was it perceived as so significant? It was not only the recorded ice-cover low that was important; at least as important was the fact that the minimum grossly exceeded almost all the modeled expectations. Models had started to become extremely interesting. Paul Edwards and others had already many years earlier started working on the roles of climate models, how they are constructed, and how they are used both within science and in a wider social realm.[36] In his synthetic volume, *A Vast Machine,* he argues that we could understand modeling as a large technological system (LTS), referring to the concept by Thomas P. Hughes, and that we should pay attention to the infrastructural dimensions of this enterprise.[37]

But even this carefully researched book somehow overlooks the fact that the models, as they predict, also pave the way for mediated events that can only happen in relation to the anticipated, almost preordained as it were, reality that the models themselves have produced by providing them with their fateful context. The record low was of course a low, and it was sensational, but even more sensational was the fact that it was a low that was lower than the lowest modeled low. *That* was the scary news. It was more than a variation, it was ominous, it was nature speaking back: "You think you can model my change? I could change even faster!"

Indeed, there was a scientific language for that as well: that of "tipping points," "cascades," and linked processes of change. A revolutionary worldview, rather than one of gradual change, an old trope indeed in the geosciences with roots to Georges Cuvier and beyond, but quite unusual when it came to the models that we had just started to learn that we should trust and that had started to circulate not only scientifically but in popular notions aided by books such as Malcolm Gladwell's *The Tipping Point* (2000).

But if one looks carefully, there were some models that had extreme values that allowed for the 2007 minimum, not as an average but as a single-year value. This was also what it was: a single-year event; nobody knew at the time what the following years would bring. The obvious thing to do would have been to wait and see if it was repeated. But such detailed and boring remarks were drowned out by the hype and speculation. Furthermore, as already noted, it took only until 2012 for the 2007 low to be broken yet again.

The information on the minimum was not reaching the large audiences, since it was an entirely different narrative that was taking shape and that formed the core of the event, that gave it the event-like character: that here was cryo-history in the making. The ice was playing the role of the ominous, yet objective, truth teller from the ends of the earth, at the same time re-invoking yet another trope with a venerable history, namely that truths of global significance arrive from distant core geographies: the heart of Africa, the steppes of Asia—or the cold void of the polar regions. When Big Narrative is out, disturbing details are not always visible on the front stage. Events like clarity as much as they need narrative—preferably with a certain, slight ring of environmental determinism to it, although of course this time it is the humans that are behind it all, isn't it?

The politics of the minimum was also interesting. A lot of groups, paradoxically including the modelers and scientists who had failed in their predictions, had a lot to gain from high attention on the Arctic. The fact they were proved at least somewhat wrong could be interpreted to mean that they needed to work even harder to get models that could measure up to the alarming level of the planet itself. Arctic residents, concerned citizens, and political actors such as the European Union also could gain from the attention. Perhaps even the oil and resource industries and the Arctic coastal states—that is, both those who had an interest in stopping oil and gas activities in the Arctic Sea and those who wanted them to continue had stakes in a record sea ice minimum.

Slow Ice, Slow Glaciers

Against this reading of a contemporary event, which happened rapidly, as a "tipping point" of attention and speculation, I wish to draw a contrast with the more long-term and considerably slower prehistory of sea ice and glaciers as climate indicators—those ups and downs of ice and snow that were denied revolutionary potential.

The truth is that sea ice minima have appeared earlier, but in more marginal circumstances and sometimes as predictions, or historical hypotheses, rather than as empirical facts. In the 1950s an ice-free Arctic Ocean was predicted by the year 2000 by American and Canadian scientists, and the trope circulated fairly widely in the news media.[38] In the 1920s scientists saw reason to believe that the Arctic Ocean had been free of ice for long periods in the past. Glaciers started to be used as climate indicators in the nineteenth century, and a broad and institutionally organized cryospheric research took shape in the twentieth century.[39] Climate change may, in retrospect, have appeared obvious, but such an interpretation was in the past rarely put forward as a serious alternative for the immediate future on the human timescale of decades, generations, or centuries. Instead, it was not until the final decades of the century, and for a global audience only in the early years of the twenty-first, that this happened, and then it happened rapidly. This should interest us, precisely because an ice-free Arctic was not turned into an event.

Just to demonstrate one example of this earlier work we could look at Swedish oceanographer Otto Pettersson's theory, proposed in a series of papers of long-term variations in the circulation of the oceans caused by changes in "tide-generating force," which in turn varies with the declination and proximity of the sun and moon to the earth and reaches maxima every seventeen hundred years, roughly 3500 BC, 1900 BC, 250 BC, and AD 1433 (a remarkably exact date).[40] We must here leave aside the details of Pettersson's analysis and just focus on what he has to say about an ice-free Arctic Ocean. According to Pettersson, an ice-free Arctic would occur repeatedly during periods of climate optima when tidal forces brought more warm water into the Arctic. In essence, breaking these long ice-free periods was not easy.

British meteorologist and climatologist C. E. P. Brooks's rendering of Pettersson's theory as late as in his 1949 edition of *Climate through the Ages* (originally published in 1926) is totally open to the thought that the Arctic Sea was free of ice for very long periods of time, hundreds of years. Brooks writes, "The final stage [of a long period of ice-free conditions] came about 500 BC when for some reason the Arctic ice-cap last became firmly established, apparently very extensively, after a few centuries of heat and drought." As for reasons, he speculates about sunspots or volcanic activity, and of course he has just referred to Pettersson's tidal forces. He connects existence of an ice cap also to storminess in Europe in quite sophisticated ways. But by and large one gets the impression that still at the middle of the twentieth century you could come away with quite wide-ranging statements about ocean ice.[41]

But the overriding message is of course that with ideas like these, putting enormous explanatory pressure on astronomical explanations, the idea that human climate forcing should play any role is exotic. At about the same time as the second edition of his book was published, Brooks also published repeatedly on the total incredibility of Guy Stewart Callendar's climate-forcing hypothesis first presented in his famous 1938 paper. Brooks says:

> This argument [Callendar's] has rather broken down in the last few years, however, for the rise of temperature seems to have reached its crest and have given rise to a fall. The possibility that changes in the amount of carbon dioxide have been responsible for some small part of the climatic changes of geological time seems to remain open however.

In other sources his skepticism to human climate forcing is even more outspoken, and in this he shared the majority view among scientists around 1950.

My take on Pettersson and Brooks—and they were not the only ones interested in Arctic ice conditions—is that this understanding, full of earth history theories and empirical findings about the past presence and non-presence of ice in the Arctic Ocean, is still evidence of the contrary to what I refer to as cryo-history: that ice was not yet made part of human history. The ice was an extension not of humans but of the earth and its caprices, and possibly the earth system (before that term of course). Ice was a natural category altogether, not a social one.

Glaciers demonstrate a parallel pattern useful for historical research into the science politics of climate change. Glaciers as physical phenomena fascinated nineteenth-century British scientists like John Tyndall and Charles Darwin[42] and were masterfully interpreted as agents of change by Alpine geologists. Glaciers were also of much interest in the Scandinavian countries, where they were chiefly regarded as a kind of nature's ruins, the remnants left of the great Ice Age, which had formed and molded the Scandinavian peninsula and created the basic parameters of human settlement through soils, moraines, and land elevation, and laying the foundations for agriculture and even forestry with U-shaped river valleys good for timber floating. As scientific as this glacial research was, it had a somewhat providential interpretation: the economic success of, in this case, Sweden could be attributed to its glacial past.[43]

Quite naturally glaciers became patriotic assets, which enhanced their scientific interest and vice versa.[44] Axel Hamberg, who spent a lifelong career researching the glaciers of the Sarek massif in remote Lapland, could quite readily rely on royal and parliamentary support for his massive publications and pictorial representations of glaciers. Tourism and alpinism reinforced this trend. But beyond the mapping and the morphology there was really quite little work on the dynamics of glaciers. But there was of course the big enigma: Why had there been a big ice cap and now only scattered glaciers remained? Why had there been an Ice Age at all, and why had the ice retreated?

The question was addressed famously by the physical chemist Svante Arrhenius, but it was a geologist, Arvid Högbom, who was himself from the north and had done fieldwork in the glacial regions like most geologists, who had originally formulated the question and aroused Arrhenius's interest. Carbon dioxide was a hypothesis in the quest for an overarching explanation as to why Ice Ages could happen and why one could not rule out the possibility that it could happen again. Arrhenius indeed suggested increased human production of carbon dioxide to prevent this from happening.[45]

Sea Ice and Strategic Concerns

Work on sea ice was particularly active at an early stage in Russia and the Soviet Union. Given her several thousand kilometers of Polar Sea coast and a long-standing interest in a Northeast Passage, sea ice was always a major concern. From around 1900 Russians started collecting sea ice data in a systematic way, and a long series of expeditions into polar waters were conducted, aided by world-leading ice-breaking technology, which remained a central priority for the Bolshevik government. In the 1920s the USSR formed major research institutes for polar science in both Leningrad and Moscow. Soviet scientists collaborated intensely with Norwegian colleagues, based in the lively maritime and oceanographic research community in Bergen,[46] and Norway turned out to be another significant provider of knowledge and data about sea ice. This was based on the work of Fridtjof Nansen with the Fram expedition in the 1890s and the subsequent Maud expedition in the 1920s. In the latter, the work on sea ice was led by Harald Ulrik Sverdrup, who, as director of Scripps Oceanographic Institute in La Jolla, California, from 1937 to 1948, and then as the first director of the Norwegian Polar Institute from 1948, rose to become a major actor in Arctic science planning and, subsequently, Cold War science politics.[47] His main work was on sea ice, but he also collaborated with Swedish geographer Hans Ahlmann on terrestrial glaciers in Svalbard in the 1930s. Thus, through widely networked science politics actors and school builders, such as Ahlmann and Sverdrup, and their colleagues in the earth and marine sciences in Bergen, for example Björn Helland-Hansen, Scandinavian ice research served as a nexus of knowledge brokering between both the Western sphere and the Soviet Union.[48]

This, however, does not diminish the fact that the scientific study of sea ice in the twentieth century reflects distinct national and economic interests,[49] as so much polar science does.[50] If Russia/USSR took the lead, followed by the Norwegians, with scattered contributions from other countries,[51] the Cold War saw a distinct rise of interest in Arctic ice research in the United States and Canada. This was linked to strategic considerations and the US-founded Arctic-related research labs and institutes related to all major branches of the armed forces in Alaska and elsewhere. The US Navy established the Arctic Research Laboratory in Barrow, at the northwest tip of Alaska, to pursue "basic research in the Arctic." Separately the US Air Force created the Arctic Aero-

"Ice and Snow in the Cold War: Histories of Extreme Climactic Enviornments"
Edited by Julia Herzberg, Christian Kehrt, and Franziska Torma. http://berghahnbooks.com/title/HerzbergIce

medical Laboratory at Ladd Air Force Base outside Fairbanks, Alaska, with a mission to aid operations in hostile environments (including investigations of acclimatization and survival as well as physiological studies of indigenous Alaskans). These included outsourced labs in Europe (one in the north of Sweden[52]) and massive research efforts on the Greenland ice cap.[53]

The strategic and military component of sea ice research was significant even before the Cold War, and charts and statistics were compiled by many countries.[54] In the Cold War, sea ice research was also linked to ideas of climate change and predictions, and speculations of a seasonally ice-free polar sea started to appear.[55] This was based on geographical lore, which in turn entered modern sea ice science.[56]

A Career in Cryo-science

At the beginning of this chapter I asked the question, why cryo-history? The answer so far has been mainly a review of themes and topics in recent historiography and how they are linked to contemporary concerns such as climate change and the Anthropocene. I have indicated that cryo-history can be seen as part of the emerging environmental humanities. The scale has mostly been large. In reality, however, ice is a scalable concept, and cryo-history works well from the individual and local scales all the way up to the planetary and the atmospheric, and from these back down again to effects on the ground, where, as in our time, ice is melting and livelihoods are affected. Agency will be found at all levels of this scaling: among hunting Inuit and Sami in the Arctic, among imperial surveyors and geologists in Austria and the Himalayas, in national environmental and climate policies, and among communities of modelers and climate scientists. On the largest scale, there is agency in the ice and snow themselves, just as there is in winds and clouds.[57]

Indeed, several scales could be seen through the microcosm of one individual actor. How the story of ice and snow materialized in one scientific life, before the new framing of cryo-history had happened, I would like to briefly illustrate with a summary presentation of the climate science conducted by Stockholm geographer Hans Ahlmann. He was later to become a leading name in glaciology and climate change theory. In the 1910s and 1920s he started his long period of work in Scandinavia in the North Atlantic with some fairly vague notions of glacial dynamics. He followed in the wake of predecessors like Axel Hamberg, Fredrik Svenonius, and other Swedish glaciologists, and he was determined to find out more about the behavior of glaciers. When he left his active research career in 1950 to assume the post as Sweden's ambassador to Oslo, he had investigated sites around Scandinavia, Spitsbergen, Iceland, and Greenland and had built a permanent glacial observatory in Swedish

Lapland. He became "Professor Ice" in the media and personified the kind of natural science history of ice that until recently was the only one that existed.[58]

Throughout his career Ahlmann's local data collection from individual glaciers was linked to wider issues of climate change and its possible causes—rather than their effects, which he considered basically benevolent. His work coincided almost perfectly with the period of North Atlantic warming that caused quite a discussion at the time and was very rarely, if at all, interpreted as caused by any human climate forcing. Instead, Ahlmann came to play an influential role as a descriptor of the warming phenomena and also to some extent exerted a brief moment of influence as to the explanatory factors.

Already in the 1920s, during his work in Norway and even more on the Lapland Kårsa Jökel (*jökel* being an ancient term for glacier in Norse languages) in Sweden, Ahlmann found solid empirical evidence of glaciers shrinking in correlation to the warming trend. He did not rush to tout this news. He was a cautious man and played his cards carefully, busy also with ongoing other lines of research in Libya and Rome and on the growth of the urban region of Stockholm. But in the late 1930s he had evidence enough from the entire North Atlantic region, and he could present his theory of polar warming based on glaciers as indicators. As a small celebrity on the fugitive element, he went on lecture tours—for example, in the United States in 1947 and 1952—and wrote news articles and gave interviews about the warming and the enigma it presented. The media coverage was large, in ways that was not totally dissimilar from ice events in recent years.

But there was a significant difference: Ahlmann would not buy into any human climate forcing theory. His own explanations, which he admitted he could not really draw to any binding confirmation, was that for unexplained reasons warmer air was transported from the equatorial regions and caused warming. The Arctic amplification—a later term—was tremendous, and the annual average temperatures in Spitsbergen grew with as much as seven degrees Celsius.

In the self-imagery of glaciologists who count themselves as followers of the Ahlmann tradition, or school, of whom I have interviewed several,[59] there is no doubt that these are scientists who privilege their empirical observations. They provide records of historical climate. The glaciological research station at Tarfala in northernmost Lapland, which Ahlmann founded in 1946 with some of his students, prides itself on having the longest series of observations of a glacier anywhere. By now they are of course adherents of the prevalent orthodoxy, but not long ago there was still an Ahlmannian skepticism around the site. The Tarfala site and its records have, fairly late, been drawn into cryo-history and are now one of its providers of basic facts, raw materials, although as physical geographers they did not work much on societies and the people.[60] They also provide quite a bit of the raw materials that humanists and social scientists need as we now go about doing cryo-history, even of the Cold War.

Through the Looking Glass of Time

Ahlmann rose to become a political figure of sorts. Not only was he a diplomat in his later years, he had increasingly played a role as science adviser and as a networker among scientists and politicians in the Scandinavian countries. He saw Arctic research as a bridge-building activity between the Soviet Union and the Western countries. He had scientific reasons for this, as he could expand his pool of data, but his aims were also political. He was a cofounder of the Swedish friendship society with the USSR in 1934, also the year of his first visit to the country. He returned several times, importantly in 1945 to be part of the Academy of Sciences 220th anniversary celebrations, also a tribute to the Soviet victory in the war. He learned a lot about Soviet Arctic science and was quite impressed.

At the same time he had big plans for extended work on the Greenland ice cap and on Antarctica. He consistently supported Norwegian positions and interests, opposed the Germans, and was sometimes skeptical of American interests, for example in Iceland. He wanted the Danes to join the Scandinavian camp and to host a major Nordic research effort on Greenland. When he learned that they cared more for their own colony and even ventured to both join NATO and get close with the United States in Thule, he was disappointed. He cultivated intensely his Icelandic connections, not least through his student Sigurdur Thorarinnsson, who was not only state geologist on Iceland but also a literary figure who translated between Icelandic and Swedish and, like Ahlmann, was skeptical toward the Americans and their bases. Nonetheless Ahlmann went to the Pentagon and advised the Americans if need be. The US trip in 1947 was planned by his friends and colleagues Carl-Gustaf Rossby and Harald Ulrik Sverdrup, both centrally located in the science of the American war effort. Why, precisely, this need to speak to the American military as the Cold War was just coming up?

Glacial work was for Ahlmann not just an issue of climate dynamics, it was also a "cryo-arena," to bring countries and politics together to favor Nordic cooperation, to sustain a unity that had been broken by unfavorable politics. Glaciers were, among other things, a special matter that bound scattered lands in the North Atlantic together. Glaciers were a political category. They belonged in the Cold War as part of an attempt to create an alternative to the Cold War dualism, one that failed, but nonetheless.

In this sense Ahlmann and his school of glaciology form a key chapter of the kind of cryo-history that starts to unfold in our time, with empirical examples from multiple times and geographies. These scientists and their field assistants in many countries of local people, Icelandic farmers and Lapland Sami of both sexes, are Northern Hemisphere counterparts to the people Mark Carey found in his Andean pursuits. When we study them today we can see them as belonging in a cryo-history that can be subsumed under a wider *problematique* of climate change and humanity in a new human condition under the Anthropocene. But it is one of the ironies of history that Ahlmann himself did not draw any such conclusion. He kept his glaciers squarely outside the human realm. They obeyed nature's laws, they did not listen to any commands from human civilization—their dynamics were not anthropogenic. This means that there were many dimensions of the waning snow and ice that Ahlmann was not aware of, indeed could not see.

In the first decades of the twenty-first century, in times of swiftly changing perception of global climate, the 2007 sea ice minimum stands out not as merely a scientific fact. It comes forth as a tipping point event—but with what long-term effect? What time does it take for ice to melt compared to the time required for basic societal and cultural perceptions to change? Will we be able to change, or is climate change also a normalizing phenomenon, with a tendency to absorb variation and vulnerability and present itself as normality?

Ultimately, we will do well to ask questions about temporality. What happens when we are looking at snow and ice through a looking glass of time? What do we see?

Through the looking glass we may, as did once an Oxford mathematician who wrote about a little girl called Alice, find a wonderland of forgotten ideas—and of hopes and deceptions. And we will find ruins, not just of a bygone Ice Age but of failed policies, a grotesque version of a rationality that we professed but seemed unable to practice. But we may perhaps also find stories of ethics, responsibility, and global and local connections, and we may uncover new ways to understand the world we live in—and ourselves.

How We Tell the World

As I have argued in this chapter, we are already pursuing a broader historical reading of ice and snow—a cryo-history—that speaks to major issues of environmental and global change, social and planetary temporalities, and the geopolitics of climate. This means that we can tell stories that will form part of a social science and humanities understanding of what has come to be called the era of the Anthropocene, where environmental and climate change is more deeply embedded in the understanding of history—and the future.[61]

We can look back at more than a century of attempts to enroll ice as an object of study in a range of science fields and an established tradition of researching the records of changes in the physical properties of ice. In this tradition new work is constantly produced and is becoming ever more refined.[62] But the new work is the work that unites the physical history of planetary and local change with the histories of people, places, societies, economies, values, knowledge, art, literature—how we tell the world as historians and sense-making humans. If there was once "eternity in a grain of sand," we now try to find some of the main truths about ourselves in crystals of ice.

Much of this work can be seen as part of a broader movement toward the environmental humanities. This emerging field, which has grown rapidly in the last decade, puts the human experience at the center of environmental and climate change. Ice and snow make up some of its core elements. They fit the environmental humanities bill ideally: they are fugitive and vulnerable, they link the human and the natural worlds, they link the scientific and the vernacular, and they draw a lot of attention from news, media, and the arts. The environmental humanities correspond in the human sciences to what earth systems science represents in the sciences.

At the core of both the sciences and the humanities is environmental change. They are both cognizant of the tremendous change in multiple dimensions that marked the Cold War and have been termed the Great Acceleration, which in turn is a fundamental understanding of the Anthropocene. This should be emphasized, since it links snow and ice even further to the Cold War. These elements have been a part of the human experience for eons of time, but they have become acute and important for societies around the world, and central to world events, only in the past few generations. Their "natural history" is a couple of centuries old. Their historiographical career is so recent that we almost have no word for what we are talking about—hence cryo-history and this attempt to contextualize it as a dimension of the environmental humanities.

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2013), and *Science, Geopolitics and Culture in the Polar Region* (Ashgate, 2013). He is a coauthor, with Libby Robin and Paul Warde, of *The Environment—A History of the Idea* (Johns Hopkins University Press, 2018).

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29. A brief digression here, to avoid doubt: the term has been used. And since one can't propose something that already exists, I wish to point out that the term "Cryo History" (when I first started using it in 2010–11) had, to my knowledge, only been known in the context of cold technologies to repair, restore, or rejuvenate metals and tools. There were firms for that in Germany, Japan, and the United States, at the least, and there were labs. They use advanced physics. There is also a certain biological hinge to the concept. On the University of Alberta website I found this (in January 2011): "'We like to meet at the end of January to filter out the people who are not really serious about cryobiology,' joked Locksley McGann, professor in the University of Alberta Department of Laboratory Medicine and Pathology, on the first day of a conference hosted by the university called Extreme Cryo 2008: 100 Years in the Cold." Cryo-history in this particular context means the forty years since the first low-temperature preservation of kidneys and other organs for transplantation. But I have found no evidence that professional historians have engaged with the term. This is, again, until I proposed it in my keynote talk at the Rachel Carson Center in Munich on 27 January 2011. Not much seems to be out there several years later, except a few papers that I wrote myself, such as Sverker Sörlin, "Cryo-history: Exploring Ice as Indicator of Change in Northern Environments and Societies," *American Historical Association,* 3 January 2014; Sverker Sörlin, "Cryo-history: Ice and the Emerging Arctic Humanities," in *The New Arctic,* ed. B. Evengard, J. N. Larsen, and Ø. Paasche (New York: Springer, 2015); Sverker Sörlin, "Do Glaciers Speak? The Political Aesthetics of Vo/ice," in *Methodological Challenges in Nature-Culture and Environmental History Research,* ed. S. Rutherford, A. Sandberg, and J. Thorpe (New York: Routledge, 2016).
30. "Arctic Sea Ice Falls to Third-Lowest Extent; Downward Trend Persists," *National Snow & Ice Data Center,* 4 April 2010. See also N. Wormbs et al., "Bellwether, Exceptionalism, and Other Tropes: Political Coproduction of Arctic Climate Modeling," in *Cultures of Prediction,* ed. M. Heymann, G. Gramelsberger, and M. Mahony (New York: Routledge, 2017).

31. I happened to be chair of the Swedish National Committee for the International Polar Year 2007–9, and I was also a member of the science committee for the European Science Foundation conference, held south of Stockholm, which assembled scientists and policy makers from around Europe and beyond.
32. J. K. Wright, "The Open Polar Sea," *Geographical Review* 43, no. 3 (July 1953); S. Sörlin and J. Lajus, "An Ice Free Arctic Sea? The Science of Sea Ice and Its Interests," in *Media and the Politics of Arctic Climate Change,* ed. M. Christensen, A. E. Nilsson, and N. Wormbs (New York: Palgrave Macmillan, 2013).
33. "Arctic Sea Ice Shatters All Previous Record Lows," *National Snow & Ice Data Center,* 1 October 2007.
34. Elihu Katz, "Media Events: The Sense of Occasion," *Studies in Visual Anthropology* 6, no. 3 (1980): 84–89; Nick Couldry, Andreas Hepp, and Friedrich Krotz, eds., *Media Events in a Global Age* (New York: Routledge, 2009).
35. Miyase Christensen, Annika E. Nilsson, and Nina Wormbs, "Globalization, Climate Change and the Media: An Introduction," in *Media and the Politics of Arctic Climate Change,* ed. M. Christensen, A. Nilsson, and N. Wormbs (New York: Palgrave Macmillan, 2013).
36. Clark A. Miller and Paul N. Edwards, eds., Changing the Atmosphere: Expert Knowledge and Environmental Governance (Cambridge, MA: MIT Press, 2001).
37. P. N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).
38. Doel et al., "Strategic Arctic Science," 70.
39. The word "cryosphere" itself derives from the Ancient Greek word κρύος (*cryos*, meaning "cold," "frost," or "ice") and collectively describes the portions of the earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (which includes permafrost). "Cryosphere," Wikipedia, retrieved 1 October 2017 from http://en.wikipedia.org/wiki/Cryosphere.
40. Otto Pettersson, "On the probable occurrence in the Atlantic current of variations periodical, and otherwise, and their bearing on meteorological and biological phenomena," *Rapports et Procès-Verbaux des Réunions de Conseil Permanent International pour l'Exploration de la Mer* 42 (1905); Otto Pettersson, "Climatic variations in historic and prehistoric time," *Svenska hydrogr. biol. Kommissionens skrifter* 5 (1914); Otto Pettersson, "Long periodical variations of the tide generating force," *Publication Circular Conseil Permanent International pour l'Exploration de la Mer* 65 (1915).
41. C. E. P. Brooks, *Climate through the Ages* (New York: R. V. Coleman, 1926; 2nd rev. ed., New York: R. V. Coleman, 1949), 372.
42. Bruce Hevly, "The Heroic Science of Glacier Motion," *Osiris* 11 (1995); Sandra Herbert, *Charles Darwin, Geologist* (Ithaca, NY: Cornell University Press, 2005).
43. Sörlin, *Framtidslandet,* 262–72; Sverker Sörlin, "Rituals and Resources of Natural History: The North and the Arctic in Swedish Scientific Nationalism," in *Narrating the Arctic,* ed. M. T. Bravo and S. Sörlin (Canton, MA: Science History Publications, 2002).
44. Much the way Achermann's contribution to this volume has shown was the case for snow in Switzerland and that Pey-Yi Chu has described for permafrost in the Soviet Union, suggested to cover half the area of the enormous country and which was given its own research institute in 1939. Pey-Yi Chu, "Mapping Permafrost Country: Creat-

ing an Environmental Object in the Soviet Union, 1920s–1940s," *Environmental History* 20, no. 3 (2015).
45. E. Crawford, *Arrhenius: From Ionic Theory to the Greenhouse Effect* (Canton, MA: Science History Publications, 1996); Sörlin, "Rituals and Resources of Natural History"; J. R. Fleming, *Historical Perspectives on Climate Change* (New York: Oxford University Press, 1998).
46. Julia Lajus, "Linking People through Fish: Science and Barents Sea Fish Resources in the Context of Russian–Scandinavian Relations," in *Science, Geopolitics and Culture in the Polar Region: Norden beyond Borders,* ed. Sverker Sörlin (Farnham: Ashgate Publishing, 2013).
47. Robert M. Friedman, *The Expeditions of Harald Ulrik Sverdrup: Contexts for Shaping an Ocean Science* (San Diego: Scripps Institution of Oceanography, 1994).
48. Julia Lajus and Sverker Sörlin, "Melting the Glacial Curtain: The Soft Politics of Scandinavian-Soviet Networks in the Geophysical Field Sciences between Two Polar Years, 1932/33–1957/58," *Journal of Historical Geography* 44 (April 2014).
49. Sörlin and Lajus, "An Ice Free Arctic Sea?"
50. Doel et al., "Strategic Arctic Science."
51. E.g., Uppsala meteorologist Fredrik Malmgren, "On the Properties of Sea-Ice," in *Norwegian North Polar Expedition with the 'Maud' 1918–1925: Scientific Results* 1, no. 5, ed. H. U. Sverdrup (Bergen: Geofysisk Institutt, 1927).
52. Doel et al., "Strategic Arctic Science."
53. Matthias Heymann et al., "Exploring Greenland: Science and Technology in Cold War Settings," *Scientia Canadensis* 33, no. 2 (2010); Martin-Nielsen, *Eismitte in the Scientific Imagination*; Ronald E. Doel, Kristine C. Harper, and Matthias Heymann, eds., *Exploring Greenland: Cold War Science and Technology on Ice* (New York: Palgrave Macmillan, 2016).
54. Sörlin and Lajus, "An Ice Free Arctic Sea?"
55. P. Siple, "Proposal for Consideration by the U.S. National Committee (UGY)," 1 May 1953, C1, USNC-IGY (Washington, DC: National Academy of Sciences Archives, 1953); Graham Rowley, *Cold Comfort: My Love Affair with the Arctic* (Montreal: McGill-Queen's University Press, 1996; 2nd ed., Montreal: McGill-Queen's University Press, 2006).
56. J. K. Wright, "The Open Polar Sea."
57. John Durham Peters, *The Marvelous Clouds*: *Toward a Philosophy of Elemental Media* (Chicago: University of Chicago Press, 2015).
58. A comprehensive presentation of Ahlmann's career as a geographer and glacial scientist is available in Sverker Sörlin, "Ice Diplomacy and Climate Change: Hans Ahlmann and the Quest for a Nordic Region Beyond Borders," in *Science, Geoplitics and Culture in the Polar Region: Norden beyond Borders,* ed. S. Sörlin (Farnham: Ashgate Publishing, 2013).
59. E.g., Sörlin, "Narratives and Counter Narratives of Climate Change."
60. Sverker Sörlin, "A Microgeography of Authority: Glaciology and Climate Change at the Tarfala Station, 1945–1980," in *Understanding Field Science Institutions,* ed. H. Ekerholm, K. Grandin, C. Nordlund, and P. Schell (Sagamore Beach, MA: Science History Publications, 2018), 255–85.
61. Pálsson et al., "Reconceptualizing the 'Anthropos' in the Anthropocene."

62. Leonid Polyak et al., "History of Sea Ice in the Arctic," *Quaternary Science Reviews* 29, no. 15–16 (July 2010).

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