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Chapter 8

Laboratory Metaphors in Antarctic History: From Nature to Space

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Introduction

A 1970 special issue of the *Bulletin of the Atomic Scientists* edited by Philip Smith, deputy head of the Office of Polar Programs (NSF), declared that Antarctica has been "a conspicuously successful model as a laboratory for human and international relations."[1] The Antarctic Treaty (AT), signed in 1959 by twelve countries actively engaged in scientific Antarctic programs during the International Geophysical Year (IGY), is generally considered as having provided a robust legal framework in achieving this utopian dream of global scientific brotherhood.[2] As a so-called legal laboratory, Antarctica not only figured as the "precedent for the Treaty on Outer Space"[3] but also provided key arguments regarding legislation of the deep sea via the mobilization of a unique legal reasoning known to legal scholars as "the Antarctic analogy."[4] Thus, it provided important legal rules for yet other remote and perilous environments that were, at the beginning of the 1960s, still ill-defined.[5]

Besides this important role as legal and political laboratory during the Cold War,[6] the seventh continent saw also a great diversification of laboratory visions that were developed in close conjunction with a broader scientific inquiry into the Antarctic region. The geophysical sciences tempted, since the IGY, to establish Antarctica as a "geophysical laboratory" pointing at the very specific geophysical conditions one can find only on the Antarctic continent, in its atmosphere and its surrounding oceans. Life scientists, in particular human biologists, but also behavioral scientists, physiologists, and psychologists promoted immediately after IGY the Antarctic region as a "natural human laboratory," exploring various impacts of extreme isolation and confinement on human nature. Space advocates finally discovered during the 1960s the Antarctic continent as a veritable "space laboratory," promoting the frozen South as a fertile testing ground for space equipment and infrastructure as well as human suitability tests for long-term space missions. These divergent and sometimes competing laboratory visions show that today, literally every branch of science is involved in some way or another in Antarctic affairs. There is almost no scientific discipline that does not mobilize at least one of those multiple laboratory visions to describe or even justify its own research interests in what is quite tellingly referred to as the "largest laboratory in the world."[7]

The legal framework alone—albeit its important insistence on the heuristic value of analogical reasoning—is however not sufficient to explain the emergence of this great variety of laboratory visions, which were mostly established at the height of the Cold War. In a qualitative case study of articles on Antarctica published in *National Geographic*, Jason Davis argued that the metaphor of the "Antarctic laboratory" was introduced in the 1930s. He further stressed that during the 1970s one may observe the emergence of a true global dimension of Antarctic affairs and a decade later the firm integration of environmental discourses in the description of Antarctic research.[8]

My objective is to critically nuance those observations with reflections on the actual implications of using laboratory metaphors in connection with the Antarctic setting in order to find out what they can tell us about scientific activities in Antarctica, especially during the Cold War. In particular the fact that the natural sciences frequently underline the pure and immaculate character of the Antarctic region associated with the common metaphor of the biggest "natural laboratory" in the world, pointing thereby at the unique physical conditions one may only find "south of 60° South Latitude," merit close scrutiny.[9] This chapter also expands to the Antarctic region previous research conducted by Matthew Farish on the important "geographic triad of arctic, desert and tropic that defined American military research on 'natural environmental settings' during the twentieth century."[10]

From a methodological point of view, this implies mainly two aspects. First, my analysis asks for granting a certain importance to the mobilization of metaphors within scientific discourse. As I argue in this chapter, metaphors can acquire a structural and normative function within a specific scientific domain, and they can migrate, often with important modifications, between different disciplines. Moreover, and this is my second methodological assumption, not only metaphors but also spatial dimensions have a profound influence on scientific and cultural practices. That notions like "place" and "space" indeed matter has become the concern of many scholars not only in geography but also in sociology, anthropology, history, and cultural studies.[11] This chapter provides evidence for a historical analysis of the Antarctic region as a unique "laboratory" and a very specific place and space of knowledge production where the history of laboratories and the history of landscapes intimately merge.[12] One aspect in particular, the great difficulty to replicate elements of outer space conditions on earth, gave rise to a potent laboratory vision during the Cold War and the space race: Antarctica as a space laboratory.

After a short introduction to the use of metaphors in science, I trace in a more reflexive first part the master metaphor of the Antarctic, the so-called natural laboratory, back to its historical origins and its particular environmental setting: the mountains. This short excursion to the metaphor's historical roots is indeed necessary to identify the continuities but also the discontinuities that exist between early laboratory metaphors and their later counterparts. It may also help to grasp the problematic relationship of fundamental categories like "nature" and "laboratory," the "field sciences" and "laboratory sciences."

In a second part I provide concrete examples of one laboratory vision in particular, the "space laboratory," which is tightly connected to another laboratory metaphor, the "human laboratory." Space research and psychological research, I argue, emerged during the Cold War within the Antarctic context mainly because of their immediate relevance for national security and military dominance in "hostile" environmental settings. Indeed, Antarctica, far removed from Cold War rivalries in the Arctic, benefited at the height of the Cold War from the relative remoteness and a less tense geopolitical setting with no indigenous population present.

In the concluding remarks I explain how these historical developments are reflected in the use of different laboratory metaphors and why paying close attention to historical trajectories of metaphors may reveal new crucial insights into the nature of scientific research in "extreme" environments, especially within the polar context.

One main lesson that may be taken from this chapter is that one can observe at many historical stages an important interconnectedness between the scientific working environment and the actual objects of study. This concordance not only blurs the line of any sharp distinction between the laboratory and the field, but it also is in more general terms a more accurate account of the very nature of the multiple "marginal" and "extreme" geographies that become visible, as we will see, especially during the Cold War period and which helped shape the contours of the Cold Car.

Why Consider Metaphors?

Numerous case studies document the heuristic value of following metaphors throughout different historical and disciplinary contexts. For example, in history of science, Nancy Leys Stepan studied the metaphorical relationship established during the nineteenth century between race and gender. She showed that this metaphorical rapprochement had considerable political effects and that it played a fundamental role in the scientific orientation of many research programs. She argued in particular that the metaphorical assimilation of women and the problematic notion of "Negroes" was not recognized within all contexts as a metaphorical one, but was rather interpreted as a true similarity since the comparison was based on statistical, and therefore "scientific," foundations.[13] Other case studies critically analyzed the "information" metaphor, which was transposed during the 1950s from physics and cybernetics to molecular biology.[14] Finally, similar observations were made in the field of international relations, where metaphors, adopted especially from the field of game theory, proved particularly influential.[15] All of these case studies have in common that they show how metaphors, adopted from a wide variety of contexts, can intervene in an active way in shaping knowledge and politics. The choice of vocabulary is in other words rarely innocent, especially because metaphors effectively transpose political convictions from one context to another.

The great diversity of laboratory metaphors encountered within the Antarctic context, I argue, merit close scrutiny. Especially the master metaphor of the so-called natural laboratory (which is in some way the Antarctic equivalent of the "information" metaphor in biology) helps clarify some historical and epistemological implications by paradoxically combining nature, or the "natural," with the highly constructed, the laboratory. In particular, close analysis of the "natural laboratory" may advance our understanding why the popular distinction between laboratory sciences on the one hand and field sciences on the other represents within the Antarctic context, especially since the Cold War, a problematic separation.

From the "Laboratory of Nature" to the "Natural Laboratory"

Considering certain regions of nature as specific or even "natural" laboratories is an invention that arguably goes back to the age of the Enlightenment. Denis Cosgrove, for example, claimed that the identification of marginal places as experimental environments is a fundamental characteristic of modern science, exemplified most notably with the localization of astronomical observatories atop high mountains, a tradition that can be followed right up to the more recent "testing" of atomic bombs on "remote" Pacific islands.[16] It was precisely within the context of astronomy that the metaphor of the "laboratory of Nature" was coined by Swiss naturalist Horace-Bénédict de Saussure (1740–99).[17] A passionate scientific explorer of mountainous regions, Saussure introduced the term in his preliminary discourse of *Voyages dans les Alpes*, insisting on the very specificity of mountains, claiming that "all the phenomena of general Physics are revealed there with a greatness and a majesty."[18]

Three aspects of Saussure's travel account can help define the heuristic implications of this founding metaphor of the "laboratory of Nature." First, Saussure successfully attached qualities such as purity to the mountain. Mountains represented what one could henceforth call a "natural" state, a pure and immaculate milieu.[19] Second, the fact of being at high altitude allows for a global overview, the privileged point of view in establishing a "Theory of this Globe."[20] Mountains allow, in other words, objects of knowledge that cannot be observed elsewhere to become visible if certain material practices are closely followed, such as keeping a systematic agenda of the observations.[21] Third, the metaphor points at the conception of mountainous regions as a reduced model of the whole earth, a true "microcosm."[22] This notion relies not only on an analogy between latitude and altitude but also on the emergence of a new type of field science, famously promoted half a century later by Alexander von Humboldt, linking a great number of scientific disciplines from geology to meteorology and botany, all united in one whole "cosmic globality."[23] Saussure's mountain treaty represents therefore an early attempt to establish many important codified efforts—which would become commonplace only during the nineteenth century's "laboratory revolution"—more or less effectively within "nature," which meant in his case in a perilous, cold, and challenging environment.[24]

This transposition had obviously important consequences for what would have to be considered henceforth as "nature" or as "laboratory." On the one hand, Saussure's metaphor of the "laboratory of Nature" may be read in a literal way.[25] Nature, as an autonomous actor, produces out of itself large-scale experiments, and it requires solely the presence of the naturalist-explorer and his instruments to reveal "new truths" about the globe.[26] On the other hand, Saussure's metaphor may also be understood as a "natural laboratory," whereas "natural" would refer in this case to the fact that one may encounter "naturally" in the mountain milieu physical conditions that would otherwise have to be laboriously reproduced in an artificial way within the confines of a laboratory. In this second reading, mountains, and one may add for the twentieth century the polar regions, the abysses of the ocean, and even outer space, all qualify as what Karin Knorr-Cetina has labeled an "enhanced environment" where scientists may observe under more or less controlled conditions specific physical aspects that are produced in a "natural" (meaning spontaneous) way.[27] In other words, instead of reproducing nature within the confines of laboratory walls, it could be equally or even more convenient and appropriate to introduce key aspects of the laboratory to the "natural" environment.

Up to here, I have deliberately avoided using the notion of the "field," since here again, one must be cautious of the vocabulary employed in order to steer clear of anachronisms. As Robert Kohler has argued, the dichotomy between the "laboratory" and the "field" was only established during the mid-nineteenth century during the laboratory revolution, when the very notions of "laboratory" and "field" became mutually defining.[28] I argue that with the powerful rise of laboratory culture toward the end of the nineteenth century, the metaphor of the "laboratory of Nature," strongly attached to the naturalist tradition, started to fade and its intellectual twin brother, the metaphor of the "natural laboratory," started to become commonplace. Metaphors and their interpretation have, in other words, their own historicity, and employing the metaphor of the "natural laboratory" therefore makes sense only since the laboratory revolution. However, its origins are closely linked to the naturalist tradition and a specific environmental setting: the mountain. Yet many of those characteristics, as we shall see now, were successfully transposed to other "perilous" and "remote" regions, most notably Antarctica, that caught global scientific and political attention especially during the 1950s.

Antarctica as Unique Site for Scientific Investigation

Although the differentiation between the laboratory sciences on the one hand and the field sciences on the other was certainly a fruitful distinction, more recent developments especially since the 1950s in fields such as ecology, biology, and the earth sciences invite us to rethink the adequateness of such a distinction.[29] One of my aims is to show that within the context of the twentieth century, one has to consider Antarctica, and in some ways also the deep sea and outer space, as places where main properties of the laboratory sciences and the field sciences intimately merge. At the core of these geographies, we are confronted with places that are always both: "the *where* and [the] *what* of study."[30] The profound interrelationship and interconnectedness of the actual scientific working environment and the objects of study is clearly a strong sign for the problematic nature of a sharp distinction between the laboratory and the field. As a general characteristic of "extreme" places, it is also a more accurate account of the very nature of those "marginal" and "extreme" geographies that become visible especially during the Cold War period.

This point can clearly be made in the context of Antarctic science, where the complex machinery of logistics and the highly specialized knowledge of techniques and infrastructures of survival are very difficult to separate from the strategies and technologies of scientific knowledge production. Here again, a closer look at the vocabulary can be helpful, since it is indeed a very peculiar gesture to associate the "natural" world with the laboratory. In fact, at closer inspection the metaphor of the "natural laboratory" reveals itself as an antinomy, since no scientific observation would be possible without the establishment and maintenance of a long chain of complex and costly logistics (which in many cases is carried out, for obvious reasons, by military personnel). Only the deployment of highly sophisticated infrastructures of life-support systems allows therefore for both, the survival of the staff and the use of fragile instrumentation.

Although the laboratory revolution gave rise to a culture of universal values in the sense that results and findings are supposed to be universally replicable—an insofar inherently placeless knowledge—it has become more and more evident that the actual physical location of various observing sites determines the nature and therefore also the very success of scientific observations.

A telling example is the vibrant field of ice coring, as studied by sociologist Morgan Jouvenet, where massive logistics mobilized within the field, as well as between the laboratories and the Antarctic continent, are key to scientific success.[31] Yet once the ice cores are extracted, flown or shipped back to the home countries, and cut up and chemically analyzed in the laboratories, the published results appear highly purified. Indeed, the field is mentioned only in the form of geographical and temporal coordinates, despite the fact that practically all researchers describe the actual field experience as something crucial to both their own mind-set and the building of a scientific community. Ice core science strives, in other words, for the production of universal, placeless knowledge, yet most of the results are not part of the usual legitimacy framework of laboratory science. Indeed, because of the complex logistics involved as well as the important financial needs mobilized, usually none of the experiments are reproduced. Thus, ice cores are rarely re-extracted at the same site. Moreover, during the chemical analysis in the laboratory, the sample is necessarily lost, making a reproduction of the experiment impossible.

The physical location on the Antarctic continent can also play out in other important ways. For instance, within the atmospheric sciences, it led to the important discovery of Antarctic stratospheric ozone depletion. Published in 1985 by atmospheric researchers of the British Antarctic Survey (BAS, a case that will not be further discussed here, although it gave rise, as I have shown elsewhere, to another important metaphor, the so-called Antarctic ozone hole), the discovery depended at least in part on the unique location of BAS's observation hut at Halley Bay, incidentally located below a region of greatly diminished stratospheric ozone at the time.[32] The legitimacy of the British findings in Antarctica relied, however, also in a fundamental way on the trustworthiness assigned to the observation instrument employed, the Dobson spectrophotometer, which regularly had to be calibrated against a standard instrument under highly controlled, laboratory-like conditions.[33] As both cases show, this complex interaction of fundamental elements from both sides of the "border zone" (mobilizing elements from the field sciences and the lab sciences) points to the fact that research conducted in Antarctica relies on fundamentally unique scientific sites with specific forms of social organization, scientific knowledge production, and scientific and political legitimization.[34] As I will argue in the following section, these characteristics came to bear especially in the case of the establishment of Antarctica as a "space laboratory" during the early 1960s.

Antarctica as Space Laboratory

One of the most interesting examples to illustrate the rich potential of Antarctic laboratory visions and their diverse implications for scientific research is NASA's attempt during the Cold War to establish Antarctica as a veritable space laboratory. In 1964, members of the Space Sciences Laboratory, an important branch of the Marshall Space Flight Center (MSFC) directed by the so-called father of the American space program, Wernher von Braun, contacted NSF's United States Antarctic Research Program (USARP) to obtain more information on the nature of the Antarctic program. More precisely, they requested information on the planning of various missions, logistical aspects, security measures, known effects of confinement, engineering considerations concerning life-support systems, and international cooperation.[35] The result of these early inquiries and the growing interest of the space community in polar research was an invitation, proffered by Philip Smith, the field planning coordinator at NSF of USARP, to visit several scientific bases on the Antarctic continent.[36]

Figure 8.1. The father of the US space program Wernher von Braun at the geographical South Pole in January 1967. Photo: NASA.

In January 1967, less than two and a half years before the famous Apollo 11 moon landing, five eminent members of the US space program set foot on the icy continent for a weeklong visit of seven Antarctic stations, the dry valleys, and several historical sites, such as Ernest

Shackleton's hut and a shelter and provisions depot erected in 1911 by Robert Scott's party at Cape Evans on Ross Island before their fateful journey to the South Pole (see figure 8.1).[37] Wernher von Braun and Ernst Stuhlinger, both from MSFC, arrived on New Years Day 1967 in Christchurch, New Zealand, to meet up with their colleagues Robert Gilruth and Maxime Faget of the Manned Spacecraft Center (based in Houston), as well as with Edwin Goodale, the local representative of USARP, and their host Philip Smith. On 3 January 1967, the group finally left Christchurch (without Goodale) with a military airlift to McMurdo Sound on the Antarctic continent.[38]

This visit would be of only marginal or anecdotal interest were it not for the important reasons that justified this highly exclusive tour. By letting their arguably most valuable personnel travel to Antarctica, NASA's associate administrators Robert Seamans and George Mueller expressed their high interest in the reconciliation of the two main directors, Wernher von Braun and Robert Gilruth, both with strong, not to say conflicting personalities.[39] This experiment of what psychologists would call forced socialization proved rather successful, however, at least for the time of the visit. That the Antarctic continent can be most appropriate for that type of experiment is exemplified by the fact that it may be perceived as a place, much like outer space, where strategies of mutual understanding coincide with strategies of survival.

The perceived potential of using Antarctica as a space laboratory is best documented in numerous reports and accounts that most of the participants published in various journals upon their return to the United States from down South.[40] They show that at the height of the space race, Antarctica was identified as a suitable testing ground and useful model to learn about lunar bases and possible Mars colonization. As Ernst Stuhlinger, the director of MSFC's Space Sciences Laboratory succinctly put it, "Very simply, the four of us wanted to go to Antarctica because this was as close to lunar conditions as we could get here on Earth."[41]

Stuhlinger's conclusion mobilizes one of the oldest and most persistent Antarctic motives, the analogy between Antarctica and outer space, a trope that can be traced back in fictional literature to early nineteenth-century Antarctic utopias.[42] The Antarctic analogy gained considerable currency—along with a fundamental new meaning—within juridical debate at the dawn of the space age.[43] This development was paralleled by numerous disciplines that picked up on other forms of the Antarctic analogy, most notably the early American space community, which saw in Antarctica a model for space exploration. That the Antarctic environment could emerge as a lunar analogue or as a simplified model of space exploration has diverse historical reasons, and the laboratory vision of Antarctica as a space laboratory evolved all along the Cold War. Yet one event in particular shaped the way the Antarctic continent would be perceived in the immediate aftermath of World War II: a U.S. Navy maneuver code-named Operation Highjump.

Cold War Infrastructures and Logistics

The U.S. Navy's Operation Highjump (1946–47), the biggest logistics operation ever held by a single country in Antarctic history, had proved that large military operations can be successfully held under even extremely harsh environmental conditions. With the operation involving forty-seven hundred naval and marine personnel, thirteen ships, and twenty-three aircraft, no individual expedition sent to Antarctica has ever demanded similar complex logistical achievements.[44] With days becoming shorter in the North and ice conditions treacherous in Greenland, the US Navy turned to Antarctica so as not to lose any time in testing its polar military equipment and training its military personnel.[45] By staging the large-scale military exercise down South, the Navy benefited also from a far less controversial setting, avoiding the potential geopolitical conflict that could easily arise in the North.[46] Although aerial photography and cartography figured among the operation's high-priority objectives, the actual geopolitical aim was not so much establishing the cartographic basis for an Antarctic claim—since this would have involved leaving other strategic areas under the exclusive control of other countries—but rather demonstrating that large-scale military operations were viable and that they would allow in principle for a US military control of the entire continent.[47]

Logistics, in other words, figured at the very heart of the early American geopolitical Cold War strategy for the Antarctic region, and it is precisely for the same reason that the Antarctic region attracted considerable interest from the American space community. Wernher von Braun had already picked up the idea of modeling space travel on Antarctic expeditions while writing in the late 1940s the manuscript of his famous "Marsprojekt."[48] The great Antarctic expeditions and especially the most recent Operation Highjump inspired his visions of future Mars exploration and space travel in general. The same role of Antarctica as a reduced model for space travel resurfaced in several reports after NASA's gathering at the South Pole. Rodney Johnson (from NASA's Manned Mission Program) and Philip Smith (NSF) suggested in two reports they coauthored that one could model the entire space program on the US Antarctic Program, very much in the way Wernher von Braun believed that "Antarctic activities offer lessons for the whole procedure of space exploration."[49]

Operation Highjump was during the early Cold War period clearly the absolute reference line for any American large-scale exploration initiative. However, contrary to IGY, which was staged ten years later, the operation's success was not mainly due to scientific advancements. Aerial photography, one of the mission's highest priorities, had missed its ambitious goal, with only a quarter of the territory mapped as originally planned. Half of those photographs lacked even ground control, an indispensable aspect for accurate cartography. However, at least eighteen new mountain ranges were discovered, and large parts of the Antarctic coastline could be mapped in the end.[50]

Paul Siple, designated senior War Department observer and technical adviser to the officer in charge, Admiral Byrd, regretted (as did many other participating scientists) the fact that during Operation Highjump many opportunities for science were lost. His "Antarctic Plan for Scientific Exploration," issued as one of the last chapters of the *Army Observers' Report of Operation Highjump*, therefore urged to move on from "adventurous exploration" and finally begin systematic "scientific exploitation" by organizing joint research "administered by the United Nations Organization" or an "English speaking condominium," prefiguring later diplomatic developments that would lead to the Antarctic Treaty.[51]

It was not fundamental science but more practical and operational aspects that made up the bulk of Operation Highjump's achievements. A large panoply of locomotion techniques were tested for the first time and used regularly thereafter (see figure 8.2). Icebreakers made their first appearance in Antarctic waters, and airstrips were put in place for large aircraft that were launched from aircraft carriers. Meteorological observations allowed producing twice-daily synoptic weather maps, which were crucial for planning aerial observations such as airborne geological studies of the Antarctic bedrock. Numerous domains profited substantially from this unique large-scale military intervention in Antarctica. Basic knowledge associated in some way or another to moving and especially, as I will show in the following section, maintaining soldiers in extreme cold were in this sense the actual important outcome of the polar exercise. It was, in other words, mainly through the success of engineering, the fact that one could find ad hoc solutions for travel and especially survival in the most forbidding of all continents, that Antarctica could be firmly established during the Cold War as a space laboratory.

Figure 8.2. A bulldozer preparing a path during Operation Highjump to lay Marston matting and facilitate unloading of ships. Photo: US Navy, no copyright.

Antarctica as Human Laboratory

The general conclusion, which figured in all reports of the NSF-NASA Antarctic delegation, that there was no other continent on earth as close to lunar conditions as Antarctica echoed very well in another domain that was in a particular way closely linked to logistics: medical studies. Already in 1962, two American military psychologists, William Smith and Marshall Jones, found in a comparative study between astronaut candidates and Antarctic personnel that the "Antarctic situation, taken as a whole, is about as similar to the astronauts as we are likely to find on earth."[52] Antarctica, as the (now fading) "last real frontier on Earth," as Wernher von Braun called it, allowed not only for the transfer of knowledge from one pole to the other (as also effectively demonstrated during Operation Highjump), but the frame of the Cold War permitted also for a large generalization and transferability of Antarctic knowledge to other domains and environmental settings. It meant, with the beginning of what Paul Siple called the "scientific age" in Antarctica, successfully transferring the frontier metaphor from Antarctica to outer space. With the technologies and large-scale logistics since Operation Highjump finally at hand, the complete exploration of the white continent was only a matter of time. With what one could call the "end of terrestrial geography," a new powerful frontier emerged: outer space.[53]

As at the beginning of the 1960s medical knowledge on spaceflight conditions was still extremely sparse, scientists had to rely on experiments conducted in so-called analogue environments, such as submarines, simulators, or the polar regions. NASA therefore initiated in the 1960s physiological and psychological studies on the Antarctic continent, exploring the effects of extreme isolation and confinement. Within the American context, this was a research domain of great interest in particular to the US Navy, since psychological knowledge was imperative to establishing selection criteria for submarine personnel. For this reason of expertise and as the main logistics partner in Antarctica, the Navy was also solicited during IGY to establish screening procedures for military and civil personnel. Indeed, the potentially severe effects of confinement and isolation were dramatically experienced during an incident that occurred in the austral winter of 1956 directly preceding IGY. One of the winter staff developed a "frank and florid psychosis," as the psychologist captain J. E. Nardini, chief of the newly established Navy Medical Neuropsychiatric Research Unit (NMNRU), later recorded in his official report.[54] With the Antarctic base confronted with the problem of the impossibility of an evacuation and in the absence of any adequate tools to separate the sick member from the rest of the group, the working schedule at the base was considerably disrupted by the incident. This potentially dangerous disruption of everyday affairs at Antarctic bases led, with the creation of the NMNRU in June 1959 in San Diego (see figure 8.3), to the establishment of systematic physical and psychological research, standardized screening procedures, and research on selection methods.

Figure 8.3. The main buildings of the Naval Medical Neuropsychiatric Research Unit (NMNRU) in San Diego, officially established 1 June 1959. Photo: US Navy, no copyright.

NASA's interest in these studies was, since the 1960s, focused on the analysis of physical and especially psychological capacities of astronauts during long-duration spaceflight.[55] In Antarctica, a psychopathological incident could prove very dangerous; during long-term space travel, it could mean the potential death of the astronauts and the end of an extremely costly mission. Yet the historical and geopolitical context of analogue studies had radically changed since World War II. As the doyen of Antarctic psychological research Eric Gunderson and his colleague Paul Nelson illustratively declared in 1966, "Knowledge acquired in the Antarctic setting may have application in other unusual or restricted environments, such as radar and tracking stations, long-range nuclear submarines, lunar colonies, orbiting laboratories, or undersea experimental stations."[56]

This development shows particularly well that the Antarctic analogy, promoted within the context of the "human laboratory" of scientific research on confinement and isolation, was introduced to avoid failure and "malfunction" of the potentially weakest element: the human actor. Crew selection procedures became therefore, for the simple reason of survival, a key element of Antarctic logistics. In a second step, control had to be gained over the efficiency of personnel working in the confined and isolated environments of the new geographies of the Cold

War, ranging from nuclear submarines that were hiding in austral waters to radar stations of the 1950s newly established aerial defense line (DEW Line) in Greenland, Alaska, and Canada.[57] Space research was neatly integrated in the 1960s into this global American strategy of the conquest of literally all spaces with the help of medical knowledge gained in Antarctica. The military nature of all knowledge acquired in the human laboratory also revealed important tensions. If Antarctica as a reduced model and analogue space allowed the interconnection of multiples spaces, the potentially widespread application of this knowledge exposed a certain confusion regarding the status of the research itself, allowing no more to differentiate clearly between military and civil research. When Eric Gunderson was asked again in 1967 to conduct a study, co-financed by the US Navy and NASA, on "factors of compatibility" at five Antarctic stations, it was pretty clear that his new insights could be transposed to the entire civil and military spectrum of isolated and confined environments that flourished during the Cold War.[58]

Conclusion

Systematic study of environmental impact on people, as conducted within the "human laboratory," was clearly not new. During the nineteenth century, mountainous regions but also manned balloons figured already as emblematic places of high-altitude research, exposing explorers and scientists to dangerously low levels of oxygen and severe cold.[59] However, at the turn of the century, mountaintops started to lose their scientific attractiveness, and considerable attention was starting to be directed toward other "remote" geographies, most notably the seventh continent, which, praised as the "last frontier" on earth, figured as the symbol of the radically unknown, the very last piece of unexplored land nation states could lay their hands on. As we have seen all along this chapter, many key attributes that had made up Saussure's "laboratory of nature" were transferred during the twentieth century in a highly successful way to the Antarctic region, the new "natural laboratory" of science. As an antonym of what the politician and jurist Thomas Berger has called a "humanized landscape," Antarctica acquired especially during the 1960s the status of the last untouched and pure continent, the baseline against which global pollution and global environmental changes could be measured.[60] In this sense, Saussure's "theory of the globe" was at the height of the Cold War no longer a question of a synoptic, mountaintop overview, but rather of the Antarctic, polar perspective.

The historical basis for this development was the military "conquest" of the Antarctic continent, achieved most visibly during Operation Highjump in 1946–47, with the conclusive demonstration that large-scale logistics could maintain military operations in the most extreme of all terrestrial environments. Operation Highjump laid the practical, so to speak engineering basis that opened the seventh continent, most famously during IGY, to systematic scientific research. Antarctica's "space laboratory" and the closely linked "human laboratory" helped acquiring knowledge within the field for the conquest of all crucial geographies of the Cold War: the deep sea, the polar regions, and outer space. The analogue qualities that were attached to Antarctica relied, however, on the fact that the strategies, technologies, and resources mobilized for surviving in the forbidding environment could no longer be separated from the tools and strategies of knowledge production. Being able to survive in Antarctica meant, at the height of the Cold War, knowing how to survive in all relevant geographies of the Cold War, be it a submarine, a radar station, an underwater habitat, or even a hypothetical lunar outpost. Although similar studies were conducted for instance in Alaska (for example, at the Arctic Aeromedical Laboratory), Antarctica's remoteness offered a geopolitically less controversial geographical setting.[61] Finally, and maybe most importantly, declaring Antarctica as a "natural laboratory" meant that the various limits and barriers that the environment imposed on the scientists represented at the same time a unique opportunity for science itself.

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Notes

1. Richard S. Lewis, "Introduction: Antarctic Research and the Relevance of Science," *Bulletin of the Atomic Scientists* 26, no. 10 (1970): 4.

2. Recent research has, however, shown that prior to the Antarctic conference there was nonetheless considerable opposition to the Soviet Union in joining the Antarctic Treaty negotiations; see Simone Turchetti et al., "On Thick Ice: Scientific Internationalism and Antarctic Affairs," *History and Technology* 24, no. 4 (2008).

3. Lewis, "Introduction: Antarctic Research," 4.

4. The "Antarctic analogy" in international law has its own rich bibliography. One of the most useful starting points is to consult the work of the two legal scholars who coined the notion in Philip C. Jessup and Howard J. Taubenfeld, *Controls for Outer Space and the Antarctic Analogy* (New York: Columbia University Press, 1959).

5. See especially Chris Collis and Klaus Dodds, "Assault on the Unknown: The Historical and Political Geographies of the International Geophysical Year (1957–8)," *Journal of Historical Geography* 34, no. 4 (2008).

6. See Roger D. Launius's contribution to this volume.

7. See, for example, Jean Rivolier et al., eds., *Man in the Antarctic: The Scientific Work of the International Biomedical Expedition to the Antarctic (IBEA)* (New York: Taylor & Francis, 1988), XXV.
8. Jason Davis, "National Geographic Magazine's portrayals of Antarctica," in *Steps of Foundation of Institutionalized Antarctic Research*, ed. Cornelia Lüdecke (Bremerhaven: Alfred-Wegener-Institut für Polar- und Meeresforschung, 2007), 38–39.
9. There are several (more or less arbitrary) definitions of the geographic designation of the "Antarctic region." I chose to adopt the official definition from Article VI of the Antarctic Treaty. A digital version of the original document from 1959 is accessible (as are many other historical legal documents) on the website of the Secretariat of the Antarctic Treaty. Conference on Antarctica, "The Antarctic Treaty," 1 December 1959.
10. Matthew Farish, "The Lab and the Land: Overcoming the Arctic in Cold War Alaska," *Isis* 104, no. 1 (March 2013): 5–6.
11. For discussions in the history of science and allied disciplines, see Adi Ophir and Steven Shapin, "The Place of Knowledge: A Methodological Survey," *Science in Context* 4, no. 1 (1991); Crosbie Smith and John Agar, eds., *Making Space for Science: Territorial Themes in the Shaping of Knowledge* (New York: St. Martin's Press, 1998); David N. Livingstone, *Putting Science in Its Place* (Chicago: University of Chicago Press, 2003). For a more recent general overview, but oriented toward cultural studies and sociology, see Jörg Döring and Tristan Thielmann, eds., *Spatial Turn: Das Raumparadigma in den Kultur- und Sozialwissenschaften* (Bielefeld: Transcript, 2008).
12. Two general historic, political, and social studies that provide important arguments why especially the Arctic may not be considered as being equivalent to the Antarctic are as follows: Peter Beck and Klaus Dodds, *Why Study Antarctica?*, CEDAR Discussion Paper Series 26 (London: Royal Holloway, University of London, 1998); Stephen J. Pyne, *The Ice* (Seattle: University of Washington Press, 2003). Scientists obviously often use the argument of the very uniqueness of the Antarctic region to underline the relevance of their own work.
13. Nancy L. Stepan, "Race and Gender: The Role of Analogy in Science," *Isis* 77, no. 2 (June 1986).

14. Especially American scholars have paid close attention to these issues. In molecular biology, for example, biologists did not understand the full implications in adapting the mathematical notion of information developed by Claude Shannon and Norbert Wiener; see Lily E. Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford: Stanford University Press, 2000); Evelyn F. Keller, *Refiguring Life: Metaphors of Twentieth-Century Biology* (New York: Columbia University Press, 1995); Evelyn F. Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge, MA: Harvard University Press, 2002). On the information metaphor in cybernetics, see Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Enquiry* 21, no. 1 (1994); see also for a broader overview A. Dahan and D. Pestre, eds., *Les science pour la Guerre (1949–1960)* (Paris: Editions de l'EHESS, 2004).

15. See Rens van Muenster and Casper Sylvest, eds., *The Politics of Globality Since 1945* (New York: Routledge, 2016), xiv–xv.

16. Denis Cosgrove, "Images and Imagination in 20th Century Environmentalism: From the Sierras to the Poles," in *Bipolar*, ed. K. Yusoff (London: Arts Catalyst, 2008), 22; on observatories as specific sites of modern science, see Maria Lane, "Astronomers at Altitude: Mountain Geography and the Cultivation of Scientific Legitimacy," in *High Places: Cultural Geographies of Mountains, Ice and Science*, ed. D. Cosgrove and V. della Dora (New York: I. B. Tauris, 2009).

17. Horace-Bénédict de Saussure, *Voyages dans les Alpes, précédés d'un essai sur l'histoire naturelle des environs de Genève*, 4 vols. (Neuchâtel: L. Fauche-Borel, 1779), vol. 1, viii. Some ideas developed in the following passages on Saussure and the mountain draw on the special issue Charlotte Bigg, David Aubin, and Philipp Felsch, eds., "The Laboratory of Nature: Science in the Mountains—Mountains in Science, from the Late Eighteenth to the Early Twentieth Century," *Science in Context* 22, no. 3 (2009).

18. Saussure, *Voyages dans les Alpes* 1, viii.

19. Ibid., ix.

20. Ibid., ii.

21. Ibid., xi. Research notebooks have attracted already some important scholarly attention; see, for example, Frederic L. Holmes, Jürgen Renn and Hans-Jörg Rheinberger, eds., *Reworking the*

Bench: Research Notebooks in the History of Science (New York: Kluwer Academic Publishers, 2003).

22. See David Aubin, "The Hotel That Became an Observatory: Mount Faulhorn as Singularity, Microcosm, and Macro-Tool," *Science in Context* 22, no. 3 (September 2009).

23. Charlotte Bigg, David Aubin, and Philipp Felsch, "Introduction: The Laboratory of Nature—Science in the Mountains," *Science in Context* 22, no. 3 (2009): 318.

24. On the institutionalization of laboratory science during the second half of the nineteenth century, see, for example, David Aubin, "Orchestrating Observatory, Laboratory, and Field: Jules Janssen, the Spectroscope, and Travel," *Nuncius* 17 (2002).

25. Donald Davidson argues—against Max Black's so-called interactionist theory of metaphor—that metaphors may only be read in a literal way. Davidson claims that the conventional denotation of a word that is employed in a metaphorical way is the only meaning that counts, which implies that its meaning is no longer a question of semantics, but of pragmatics. His main claim therefore reads, "Metaphors mean what the words, in their most literal interpretation, mean, and nothing more"; Donald Davidson, "What Metaphors Mean," *Critical Inquiry* 5, no. 1 (1978): 32. Although this certainly holds true for many active metaphors, Davidson's definition is nevertheless too rigid, since the metaphorical significant may itself rely on another context of meaning that has to be incorporated into the analysis. For a critical discussion, see Philipp Sarasin, *Geschichtswissenschaft und Diskursanalyse* (Frankfurt am Main: Suhrkamp, 2003), 209–10.

26. Saussure, *Voyages dans les Alpes* 1, iv.

27. See Karin Knorr-Cetina, *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge, MA: Harvard University Press, 1999), 26.

28. Robert Kohler, *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology* (Chicago: University of Chicago Press, 2002), 3, 98–99.

29. Margaret Pilkington, for example, proposes another distinction and argues that since the 1950s, ecology does not deal with a lab-field border anymore but rather with an experimental-observational border; see Margaret Pilkington, "The Ecologists Very Own Ecotone: Exploring the Lab-Field Border," *Journal of Biogeography* 31, no. 3 (March 2004): 516.

30. This analysis was initially proposed by Thomas Gieryn to describe the specific role of the city as a "truth-spot" within the Chicago school in urban studies; see Thomas F. Gieryn, "City as Truth-Spot: Laboratories and Field-Sites in Urban Studies," *Social Studies of Science* 36, no. 1 (February 2006): 28.
31. Morgan Jouvenet, "Des pôles aux laboratoires: les échelles de la coopération internationale en paléoclimatologie (1955–2015)," *Revue française de sociologie* 57, no. 3 (2016): 563–90.
32. Jon Shanklin, interview by Sebastian V. Grevsmühl, *British Antarctic Survey*, 29 April 2008. Shanklin is the coauthor of the famous *Nature* paper announcing annual stratospheric ozone depletion above the Antarctic continent; see J. C. Farman, B. G. Gardiner, and J. D. Shanklin, "Large Losses of Total Ozone in Antarctica Reveal Seasonal ClOx/NOx Interaction," *Nature* 315, no. 6016 (1985): 207–10. On the ozone hole metaphor, see Sebastian V. Grevsmühl, "Revisiting the 'Ozone Hole' Metaphor: From Observational Window to Global Environmental Threat," *Environmental Communication*, 12, no.1 (2018): 71–83..
33. The case of the ozone hole discovery and especially its visual history is discussed in detail in Sebastian V. Grevsmühl, "The Creation of Global Imaginaries: The Antarctic Ozone Hole and the Isoline Tradition in the Atmospheric Sciences," in *Image Politics of Climate Change: Visualizations, Imaginations, Documentations*, ed. B. Schneider and T. Nocke (Bielefeld: Transcript, 2014); Sebastian V. Grevsmühl, "A Visual History of the Ozone Hole: A Journey to the Heart of Science, Technology and the Global Environment," *History and Technology*, 33, no. 3 (2017): 333–44.
34. Contrary to the Arctic, Antarctica is a frozen continent surrounded by sea. The exceptionally harsh environmental conditions, coupled with its remoteness and inaccessibility (especially during austral winter), make it a truly unique site for scientific investigation. Many more reasons are given by Dodds and Beck in their working paper Beck and Dodds, *Why Study Antarctica?*
35. See Ernst Stuhlinger and Frederick L. Ordway, *Wernher von Braun, Crusader for Space: A Biographical Memoir* (Malabar, FL: Krieger, 1994), chapter 9.8, "Spacemen in Antarctica," 266; See also Philip M. Smith, "Lunar Stations: Prospects for International Cooperation," in *Lunar Bases and Space Activities of the 21st Century*, ed. W. W. Mendell (Houston: Lunar and Planetary Institute, 1985).

36. I refer to the interviews conducted by Dian O. Belanger for the Antarctic Deep Freeze Oral History Project; Philip M. Smith, "Interview with Philip M. Smith," interview by Dian O. Belanger, *Byrd Polar Research Center Archival Program*, Antarctic Deep Freeze Oral History Project, 8 December 1998 (Spec.RG.56.186, 21).
37. See Wernher von Braun, "A Space Man's Look at Antarctica," *Popular Science* 190, no. 5 (May 1967): 200.
38. Famous astronaut James Lovell had also asked for participation, but his request was turned down by NASA administrator Robert Seamans; see Robert Seamans, "Notes for Mr. Webb," 3 December 1966, in *Von Braun, Dr. Wernher, 1952–1977* (NASA History Office, HRC 13254, III/C/6). It seems that two other astronauts were granted permission a few years later to travel to Antarctica during a second voyage organized by Philip Smith in January 1970; see Smith, "Interview with Philip M. Smith," 21.
39. On the motivations of their visit, see also Sebastian V. Grevsmühl, "Antarctique et Espace: fin et suite de la géographie," *Information géographique* 74, no. 2 (2010): 120.
40. Von Braun, "A Space Man's Look at Antarctica"; Ernst Stuhlinger, "Antarctic Research: A Prelude to Space Research," *Antarctic Journal of the United States* 4, no. 1 (1969); Ernst Stuhlinger, "A Prelude to Space Research," *Bulletin of the Atomic Scientists* 25, no. 3 (1969); Philip M. Smith, "Prospects for International Cooperation on the Moon: The Antarctic Analogy," *Bulletin of the Atomic Scientists* 25, no. 7 (1969); Philip M. Smith, "International Cooperation in Antarctica—The Next Decade," *Bulletin of the Atomic Scientists* 26, no. 10 (1970); Tillman Durdin, "Antarctic Studies Said to Aid U.S. Space Program Research," *New York Times*, 15 January 1967, 87.
41. Stuhlinger, "Antarctic Research," 2.
42. On early polar utopias, see E. Leane, "Romancing the Pole: A Survey of Nineteenth Century Utopias," *ACH: The Journal of the History of Culture in Australia*, no. 23 (2004).
43. See Roger D. Launius's contribution to this volume. For an analysis of early Antarctic fictional literature as a genre of its own, see Leane, "Romancing the Pole." For references to the juridical "Antarctic analogy," see note 4 above. For an overview of the evolution of the Antarctic analogy, see Grevsmühl, "Antarctique et Espace."

44. Dian O. Belanger, *Deep Freeze: The United States, the International Geophysical Year, and the Origins of Antarctica's Age of Science* (Boulder: University of Colorado Press, 2006), 19–24; see also the account in Byrd's biography by Lisle A. Rose, *Explorer: The Life of Richard E. Byrd* (Columbia: University of Missouri Press, 2008).
45. Task Force 68, US Navy, *Army Observers' Report of Operation Highjump* (Washington, DC: s.n., 1947), 15.
46. Walter Sullivan, "Antarctica in a Two-Power World," *Foreign Affairs* 36, no. 1 (October 1957): 160; see also Gordon E. Fogg, *A History of Antarctic Science* (New York: Cambridge University Press, 1992), 166.
47. On US geostrategic strategies, see especially Turchetti et al., "On Thick Ice," 353. A similar argument was made in Christopher C. Joyner and Ethel R. Theis, *Eagle Over the Ice: The U.S. in the Antarctic* (Hanover, NH: University Press of New England, 1997), 37. The objectives of Operation Highjump are stated at the beginning of the US Army's report: "systematic long range air exploration" figures as the very first objective; see Task Force 68, *Report of Operation Highjump*, 1.
48. In a true science *and* fiction tradition, Wernher von Braun had conceived his project in two complementary parts, a fiction and an accompanying technical report justifying the feasibility of the first. However, only the second, technical part was finally published as Wernher von Braun, *Das Marsprojekt: Studie einer interplanetarischen Expedition* (Frankfurt am Main: Umschau, 1952); English translation, *The Mars Project* (Champaign: University of Illinois Press, 1953). As a distinct literary strategy, this had already been used by the young Kepler while writing his fiction *Somnium* (1609), which was accompanied by a substantial body of technical footnotes justifying the dream travel to the moon; see Johannes Kepler, *Kepler's Somnium: The Dream, or Posthumous Work on Lunar Astronomy*, trans. Edward Rosen (Madison: University of Wisconsin Press, 1967). Von Braun's Mars Project had a brief revival with NASA's "90-day report" following George Bush's Space Exploration Initiative in 1989, yet without any success; Robert Zubrin, *Mars on Earth: The Adventures of Space Pioneers in the High Arctic* (New York: Jeremy P. Tarcher/Penguin, 2003), 46–49.
49. Philip M. Smith and Rodney W. Johnson, "From the South Pole to the Moon: Parallels in Exploration," *Bulletin of the Atomic Scientists* 24, no. 10 (1968); Rodney W. Johnson and Philip

M. Smith, "Antarctic Research and Lunar Exploration," in *Advances in Space Science and Technology*, vol. 10, ed. F. I. Ordway (New York: Academic Press, 1970); von Braun's quote was taken from von Braun, "A Space Man's Look at Antarctica," 115.

50. Kenneth J. Bertrand, *Americans in Antarctica*, *1775–1948* (New York: American Geographical Society, 1971), 484–85. See also Belanger, *Deep Freeze*, 22.

51. Paul Siple, "Antarctic Plan for Scientific Exploration," in *Army Observers' Report of Operation Highjump*, Task Force 68 and US Navy (Washington, DC: s.n., 1947), 324–28.

52. William M. Smith and Marshall B. Jones, "Astronauts, Antarctic Scientists, and Personal Autonomy," *Aerospace Medicine* 33 (February 1962).

53. On the so-called end of terrestrial geography, see Grevsmühl, "Antarctique et Espace," 119. Outer space as "new frontier" emerged at the time, especially in John F. Kennedy's rhetoric; he used it as early as 1960 when accepting nomination for the presidency.

54. J. E. Nardini and R. S. Herrmann, "Navy Psychiatric Assessment Program in the Antarctic," *American Journal of Psychiatry* 119, no. 2 (August 1962): 97. Nardini was a leading specialist in this field, and he had worked previously on other stressful scenarios, such as war captivity; see J. E. Nardini, "Survival Factors in American Prisoners of War of the Japanese," *American Journal of Psychiatry* 109, no. 4 (October 1952); J. E. Nardini, "Psychiatric Concepts of Prisoners of War Confinement," *Military Medicine* 127 (April 1962).

55. See, for example, R. Trego et al., *Some Determiners of Interpersonal Climate in Relation to Long Distance Space Missions* (Fort Worth, TX: Texas Christian University, 1968); S. B. Sells and R. E. Trego, *Normative Studies of Personality Measures Related to Adaptation under Conditions of Long Duration Isolation and Confinement*, Final Report, Part I, IBR Technical Report 73-17 (Fort Worth, TX: Texas Christian University, 1973).

56. E. K. Eric Gunderson and Paul D. Nelson, "Criterion Measures for Extremely Isolated Groups," *Personnel Psychology* 19, no. 1 (March 1966): 67. For a similar study, see the technical report E. K. Eric Gunderson, *Small Group Structure and Performance in Extreme Environments*, Report no. 66-3 (San Diego: Navy Medical Neuropsychiatric Research Unit, 1966).

57. On the Distant Early Warning Line established in the 1950s in Alaska, Canada, and Greenland and climatic laboratories in the United States, see especially Matthew Farish, "Creating Cold War Climates: The Laboratories of American Globalism," in *Environmental*

Histories of the Cold War, ed. C. Unger and J. R. McNeill (New York: Cambridge University Press, 2010).

58. E. K. Eric Gunderson, *Group Compatibility in Restricted Environments*, Report no. 67-24, (San Diego: Navy Medical Neuropsychiatric Research Unit, 1967).

59. On high-altitude experiments, see, for example, P. Felsch, "Mountains of Sublimity, Mountains of Fatigue: Towards a History of Speechlessness in the Alps," *Science in Context* 22, no. 3 (September 2009); on scientific ballooning in nineteenth-century France, see, for example, Sebastian V. Grevsmühl, *La Terre vue d'en haut: l'invention de l'environnement global* (Paris: Seuil, 2014).

60. The notion of the "humanized landscape" was introduced for the Arctic region in Thomas R. Berger, *Northern Frontier, Northern Homeland*: *The Report of the Mackenzie Valley Pipeline Inquiry* (Vancouver: Douglas & McIntyre, 1988), 40–41.

61. On Alaska, see Farish, "The Lab and the Land." On the military role of the poles during IGY, see Jacob Hamblin, *Arming Mother Nature* (New York: Oxford University Press, 2013), in particular 90–92.