

## Art in Extreme Environments; Reflections on space Research from the first Antarctic Biennale Expedition

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### Abstract

This paper examines emerging artistic engagements with scientific research on space, cultures of exploration and life in extreme environments, with a focus on Antarctica. Beginning with a case study of the first Antarctic Biennale (March 2017), the paper considers the responses of a transdisciplinary team of artists, philosophers and scientists to a two-week expedition to the Antarctic Peninsula. The Biennale's mission to valorize Antarctica's cultural significance was realized through an intensive daily program of artistic installations, performances, lectures and workshops. Structured by our collective encounter with the Antarctic landscape, these exchanges between disparate fields of research, methods of analysis and creative practices inspired three artists to new artistic projects that directly engage with the technologies and social dimensions of space research. The second section of this paper discusses each of these three works-in-progress and considers the potential of the arts to expand our understanding of the socio-cultural implications of space architecture, agriculture, and embodiment. Through these cases studies, the paper demonstrates that the arts raise surprising questions, reframe familiar ideas, inspire provocative alternative applications of technologies, and thus offer crucial methods for expanding understanding of the local and global significance of space research. Topics and questions raised by this paper offer directions for future research on matters including the importance of bringing space research down to earth; imagining earth itself as spaceship; the physical experiences and phenomenological embodiment of astronauts inside space habitats, spacesuits, ships, etc.; gender and social dimensions of space research culture; space agriculture and food aesthetics; eating well on earth; architecture for climate change and new environments; and using space research as a source of lessons for proximal extremes. In conclusion, the paper argues that lessons from the encounter between artists, philosophers and space researchers in Antarctica indicate that the arts offer a crucial resource for deepening understanding of the cultural significance of research *on* and *in* extreme environments.

**Keywords: extreme environments, visual arts, transdisciplinary methods, Antarctic Biennale, socio-cultural practices, spaceship earth**

### Acronyms/Abbreviations

Antarctic Biennale (AB)  
International Space Station (ISS)  
Self-Deployable Habitat for Extreme Environments (SHEE)  
International Association of Antarctica Tour Operators (IAATO)

### 1. Introduction

In March 2017 the Antarctic Biennale (AB), “an international socio-cultural phenomenon that uses artistic, scientific, and philosophical methodologies to address shared spaces such as Antarctica, the Ocean, and Outer Space”[1] ventured with 18 artists and 13 interdisciplinary experts to the Antarctic Peninsula to explore this remote place from fresh cultural

perspectives. The two authors—a space researcher - architect and a philosopher of science and art—were invited to participate in the AB expedition as interdisciplinary members and an art critic, and to discuss their perspectives on relationships between space and the Antarctic and the significance of art in extreme environments.

Antarctica is the most isolated, coldest, highest, darkest and driest place on earth, more extreme than any other terrestrial site. “It is crucial to our understanding of planetary systems and processes of climate change, glacier behaviour, ocean and atmospheric chemistry, meteorology, and the geophysical sciences more broadly—as well as for space research.” [2] At its coldest location, around the Russian research station Vostok where temperatures up to -80 degrees Celsius have been measured, temperatures in Antarctica are similar to those

found close to the equator on Mars. The Antarctic continent is covered with millions of years old ice and receives just slightly more rainfall than the Sahara Desert. It is the largest desert on earth as well the highest continent, with an average elevation of about 2,300 meters above sea level. Antarctica's harsh and unforgiving environment is the closest one can come to conditions of space on earth.

Antarctica has long been a place that challenged the human mind, inspiring efforts at comprehension and imagination that span the spectrum from subjective impressions and wild speculations to well corroborated scientific facts. The continent has fascinated adventurers and lured explorers into its frozen depths with the dream of being the first to set foot on the South Pole. Like the space race, the impulse to explore the southern continent has been motivated by national, economic and militaristic agendas as well as scientific curiosity. Meanwhile, the global socio-cultural significance of Antarctica and the research that takes place there has, until recently, developed only in the margins, through the creative pursuits of Antarctic workers and, more recently, a few artist residencies that have been established at scientific base stations—a similar situation to that of space research.

In light of our understanding of the profound geophysical importance of Antarctica, the historical and cultural significance of the continent captured the attention of the AB's founding artist Alexander Ponomorev and curator Nadim Samman. "We are here in Antarctica because it is a place that grabs the imagination, that seems both otherworldly and intensely connected to everything else in this planet," Samman reflected in an on-site interview. [2] The AB trip was conceived with the vision that artists, philosophers and thinkers would find a way to interpret Antarctica anew. An intensive program of artistic activities and intellectual exchanges were planned in advance, yet the intent was also to create a communal social situation that would yield new inspiration and spontaneous projects. Spending time together without internet, isolated from communication with anyone beyond the participants on-board, turned out to be crucial to the expedition's success. The AB was a workshop, a studio, a residency, a field research mission and an art exhibition at once. For the authors, as well as the artists whose work we explore below, the experience produced powerful shift in our perspectives on both space and Antarctica as otherworldly places with intensely personal and cultural implications for life 'back home.'



Fig. 1. Paradise Bay, Antarctic Peninsula, March 2017, credit: Barbara Imhof

## 2. Purpose of the paper

Much like space, Antarctica remains for most people a land of fantasy, fear and desire rather than cultural responses to direct exposure. With no indigenous human population of its own, Antarctica's culture is the product of its visitors. The continent is inhabited by 4-5000 research staff and visited by about 36,000 tourists per year under the auspices of the International Association of Antarctica Tour Operators (IAATO), the regulatory body responsible for implementing environmental regulations designed to protect the delicate ice continent from the direct impact of human hands. Nonetheless, Antarctica is significantly impacted by distant human activities, which created (and partially repaired) the hole in the ozone layer and continue to drive climate change, ocean acidification and warming, and the collapse of parts of Antarctic's ice sheet.

As with Antarctica, the effects of human activities in space are geographically inaccessible and often require specialized knowledge to comprehend, the way remote sites are represented and discussed in diverse contexts shapes public understanding and decision making. The authors begin from the premise that appreciating the socio-cultural significance of space and extreme environments is crucial to shaping research priorities and, more generally, to living better within the (limited) conditions of what Buckminster Fuller called "Spaceship Earth." [3] Fuller advanced the idea of Earth as a mechanical vehicle moving through space that requires maintenance, which will cease to function if we do not care for it well. [4] Spaceship Earth is also described as a whole system that is greater than the sum of its parts, a metaphor that has been important in the cultural imagination since the beginning of space exploration in the 1960s. As the arts can bring us new insights into complex matters and the Antarctic as an otherworldly place is a perfect location for reflecting on space exploration, the authors use the AB expedition as a case study for artistic exploration in extreme environments.

In the following we develop a framework for research on art and extreme environments. In section 3 we introduce three conceptual optics that allow us to draw analogies between space and Antarctica. In section 4 we discuss three productive constraints on living, working and creating in extreme environments, drawing examples from the AB. In section 5 we use this framework to examine three new artistic projects engaged with space research that emerged in response to exchanges aboard the AB. In section 6, we discuss the potential of this conceptual framework to facilitate analysis of the emerging hybrid field of artistic engagements with space and extreme environments and their socio-cultural implications. The paper concludes with a discussion of the topics raised by each of the new artworks and suggests directions for future research.

### 3. A Framework for research on Art and Extreme Environments: Space and Antarctica as Analogues

In this section the paper develops three optics through which to consider space and Antarctica as sites that are analogous to and related to one another in particular respects. Both sites are 3.1 *tangible extremes*, 3.2 *habitable extremes*, and 3.2 *shared extremes* collectively governed by international treaties designed to promote peaceful and scientific use—potentially including greater cultural and artistic use.

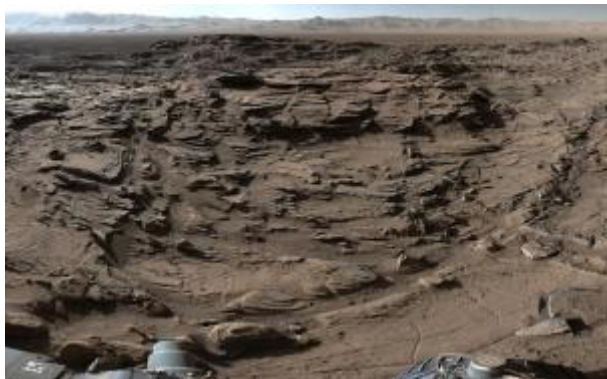


Fig. 2 Image taken by the NASA Curiosity rover, 2016

#### 3.1. Tangible Extremes

Space to most of the people seems to be a vast place above us, which one can imagine but neither feel or touch with one's own hands. Antarctica is likewise out of reach for most people—and indeed must remain so if we are to avoid negative environmental impacts. Yet in Antarctica, there are opportunities to “touch space”. Martian rocks can be found close to the Transantarctic Mountains because the geology and the environmental conditions allow these fallen rocks to be preserved for millions of years. This direct encounter is a reminder that planet Earth is a part of the universe and anything humans can touch can be considered a piece of outer space

already; there is no absolute ‘outside.’ Likewise, the air and water in our oceans is material that Antarctica shares with distant shores. In times of climate change and ongoing exploitation of terrestrial resources, it might be useful to eliminate the conceptual separation of earth and space and understand that there is only one universe and geophysical system that all life is part of. This system is delicate and human survival on and off the planet is dependent upon our careful negotiation of it. Making geographically distant and extreme environments tangible is crucial to situating ourselves imaginatively and behaving responsibly within the universe. Even without going there, Antarctica, space and other sites may be made *more* tangible through artistic and cultural activities.



Fig. 3 AB Artist Julius von Bismark tasting ice, Paradise Bay, Antarctica. Image taken by Dehlia Hannah, 2017

#### 3.2. Habitable Extremes

Lake Vostok in the middle of the Antarctic continent lies 3000 metres below the ice surface. Scientists and engineers have been drilling down expecting to find a subsurface lake home to ancient life forms. Even as we build space stations and design architectural prototypes for living on Mars and elsewhere, going to space has also always been a search for life. The impulse to discover other life forms and possible human habitats drives humans to explore our solar system as well as the deepest recesses of our own planet. The traits we need to sustain



ourselves far away from our home planet can be recognized and trained in Antarctica.



Fig. 4 Ice tent by AB artist Gustav Dusing. Image by Dehlia Hannah, 2017

In light of climate change, war, industrial pollution, population growth, forced migration of human and others species, the development of megacities, etc. the authors argue that we have indeed created extreme conditions on earth already. The protected ‘here’ of terrestrial ground and the harsh unforgiving environment beyond our earth’s atmosphere are converging, and in the future the world’s population will have to face more extreme environmental changes. This may lead to inhabiting fewer places with even more dense populations, or we might create safe places in locations we cannot imagine living permanently today, e.g. underwater, at higher altitudes, or in more unstable regional climates as well as political conditions. Crowding, which is a significant concern aboard ships, submarines, and space ships, is also becoming an issue for example in mega-cities. Psycho-social issues familiar from life in space and other isolated, extreme, and confined habitats are becoming part of our everyday life. In addition to issues of shelter and community, humanity will face issues of food security, which may also be addressed through technological methods of food production and storage developed for extreme environments. From the search for life in extreme

environments to the design of new habitats on Earth or other planets, we must constantly revisit the question of what passes—architecturally, biologically, socially, and aesthetically—for a habitable environment.

### 3.3 Shared extremes: Globally governed research spaces

Like the International Space Station, Antarctica is governed by international treaties and offers a permanently inhabited shared research space for a global community. Both places foster international collaboration for common goals and peaceful uses, enabling scientific research to continue in times of political uncertainty and emphasizing the urgency of environmental protection, perhaps most importantly, actions to mitigate climate change. Numbers of research stations in Antarctica and Space are compared in Table 1 in order to demonstrate their similarity as exemplary institutions of political cooperation. Basic rules for collaboration and environmental protection are compared in table 2.

Table 1 Numbers of stations in Antarctica and space

	<b>Antarctica</b>	<b>Space</b>
No. of research stations	76 (44 permanently inhabited)	2 (ISS, permanently inhabited since 1998, Chinese Space Station Tiangong, partially inhabited only by Chinese)



Fig. 5 International Space Station in 350 km altitude, image courtesy of NASA

Table 2 International treaties as codes of conduct

	<b>Outer Space Treaty</b>	<b>Antarctic Treaty</b>
Establishment	10 October 1967	1 December 1959
No. of countries	104 (another 24 have signed the treaty but have not completed ratification)	12 (countries active in and around Antarctica)
Peaceful use	✓ Yes	✓ Yes

Other points	✓ Forbids any government from claiming a celestial resource such as the Moon or a planet	✓ <i>Freedom of scientific investigation</i> ✓ <i>Scientific observations and results from Antarctica shall be exchanged and made freely available</i>
Special clauses with regard to the environment	— No	✓ <i>Protocol on Environmental Protection to the Antarctic Treaty October 4, 1991 (protect environment, flora, fauna, wild life, all trash must be taken off the continent)</i>

in and of itself, however it is also of interest because these spaces can set examples for community behaviour closer to home.

By considering how space and Antarctica operate as *tangible extremes*, *habitable extremes*, and *shared extremes* this framework introduces three conceptual lenses through which to analyse the AB and other artistic engagements with extreme environments.

#### 4. Productive constraints on creating in extreme environments: lessons from the AB

After passing through the rough open seas of the Drake Passage and enduring seasickness (days 1-2 & 11-12), the AB program (days 3-10) included of daily landfalls at sites of natural and historical interest along the Antarctic Peninsula. Artworks were temporarily installed or performed on land, heightening participants' attention to the surrounding natural environment as the artists struggled to create their pieces amidst unfamiliar terrain, icy winds, aggressive fur seals, and the distraction of Antarctica's own extraordinary landscape. Between excursions, meetings of the Antarctic Biennale Vision Club were held onboard, at which thematic discussions focused on polar histories and mythologies, art and science, climate change, earth and space exploration, and the future of the AB. Even the interdisciplinary scholars and journalists (including the authors) the experience was far from one of passive spectatorship. On the contrary, the practicalities of attending an art exhibition could scarcely be more challenging. In addition to magnifying the significance of the artworks and the environment, these challenges functioned as *productive constraints* on the social and intellectual experience of the AB. The following considerations, derived from the authors' discussions at AB Vision Club, are broadly relevant to creative work that engages with space, remote or protected sites, and extremes.

##### 4.1 Social boundary of inside and outside in extreme environments

A life in extreme environments is a life mostly lived indoors. Between the inside and outside there is a defined boundary which cannot be opened up easily unless specific procedures are taken into account. Humans need to protect themselves against the icy and windy outside environment in Antarctica; even a walk in summer requires special gear. This has implications for the social life indoors, which, though not as physically cramped as a spaceship, is in certain ways more isolated due to the limited communication with others off of the ship or base station. Inside, an agreed set of standards is followed regarding how to manage the station and interactions amongst crew members. Codes of conduct—both official and implicit—also extend to interactions with wildlife



Fig. 6 AB artist Paul Rosero Contreras with *Arriba!* (cultivated cacao plant with greenhouse). Image by Dehlia Hannah, 2017

The status of space and Antarctica as spaces of international political cooperation is of significant socio-cultural interest. Engagement with rules and regulations governing Antarctica was a prominent theme for artists at the AB, for example for Paul Rosero Contreras and Julius von Bismark, both of whom designed special life support/environmental isolation units in order to carry exogenous species south of the 60<sup>th</sup> parallel without contaminating the continent. The way we regulate and negotiate collective use of *shared extremes* is of interest

and the dangerous topographical sites. To prepare the crew for a safe and convivial expedition, survival training and training for living with/as the crew is mandatory, *especially* before wintering over on an Antarctic base or space station. Although training time for visitors and workers in Antarctica is much shorter than for astronauts going to the ISS, the experience of emergency exercises, schooling for operational duties and science experiments is comparable. Aboard the AB, we became acutely aware that the time consuming activity dressing and cooperating for safety was important in producing social norms inside and outside, on board the ship and on land. This boundary presents an important node of cultural activity to attend to in extreme environments.



Fig. 7 AB expedition emergency training, March 2017, photo credit: Dehlia Hannah

#### 4.2 Relationship of the human body in the indoor defined environment

In an enclosed space the relationship of the human body to the indoor environment becomes important because of lack of alternative spaces. How can one move through this space? How is it perceived in its dimensions, materiality and kinaesthetic qualities? How much can such a space compensate for the limited access to the outside? How can it be designed so that limited sensual cues do not cause detriment to the human psyche or physiology, since humans normally inhabit environments with much more sensual stimuli? These questions are addressed by designers and architects on a functional and user-oriented level. At the AB, and in the new projects that emerged in response to discussions of space explorations, it became clear that this forms a rich site of artistic investigation. (See especially 5.2)

#### 4.3 Food for human survival and quality of life

A shared meal is, in most cultures, still the most important social act in our daily lives, showing hospitality and producing community cohesion. To survive, humans need oxygen, water and basic nutrition. Yet a tasty shared meal enhances physiological and psychological well-being of humans. For a sustainable settlement in extreme environments a greenhouse which produces the food for the crew is mandatory. Technologies that allow for optimized food production in a limited space are advancing through greenhouses and vertical farming techniques that deploy highly economized light spectra and carefully selected plants. Extra-terrestrial installations of such facilities, currently being prototypes and tested in Antarctica, will require a full loop of water, plant nutrition and waste products to be sustainable. At the AB, the psychosocial and nutritional aspects of food in extreme environments became a central topic of discussion, as the interdisciplinary team met regularly within the two available public spaces of the ship: the café/bar and the dining room. These discussions informed proposed new work that explores the social significance of food production for space and urban environments (see 5.3).

### 5. New Directions

In response to the experiences and discussions that took place on the AB three new projects are under development. Each engages with the themes of tactile connection, habitability and collective relationships with extreme environments and the technologies through which we access and gain knowledge thereof. Here we present brief descriptions of the works in progress and preliminary reflections on their potential for illuminating under-studied cultural aspects and socio-political implications of space research.



Fig. 8 SHEE habitat, photo credit: Bruno Stubenrauch 2015



*5.1 Zero-Orbit, by Julien Charrière and Nadim Samman: Circumnavigation of Earth in Self-Deployable Habitat for Extreme Environments (S.H.E.E.)*

*Zero-Orbit* is an ambitious proposal to deploy cutting edge space exploration technologies to re-examine our own planet with fresh eyes. A collaboration between AB artist Julien Charrière and AB curator Nadim Samman, the project proposes “A complete orbit of planet earth, traveling at surface level within S.H.E.E. (Self-deployable Habitat for Extreme Environments)” – a prototype living module developed by a six-partner consortium and co-funded by the European Commission in the Seventh Framework Programme for future Moon and Mars explorations deployments. [5] *Zero-Orbit* builds upon previous work by Charrière and Samman, including site-specific work in zones of nuclear contamination such as Bikini Atoll, in which bodily and photographic exposure to extreme environments constitutes a key component of the work. “Beginning in Strasbourg, [the team] will undertake a two-month long voyage by surface transport, confined within a 6m diameter habitat as [they] traverse roads, rail, and sea, before returning to the project’s launch site. [The] terranauts, solely communicating with the rest of human society via mission control at COMEX (Compagnie Maritime d’Expertises, France), will observe the globe’s alien industrial landscapes, transport corridors, creatures, and remaining wildernesses through the interface of the module’s array of cameras and sensors. Throughout, [they] will capture and edit video footage in real time and record daily logs [and] undertake a series of sample collection missions, facilitated with the module’s spacesuit application, under strict operational protocols directed by mission control. Immediately upon the orbit’s completion, the discoveries (samples), documentation (video) and analysis (writings) will be presented for inspection at a European museum or space agency.” [6]

The implications of this project are multifaceted. For the present, we wish to highlight the manner in which *Zero-Orbit*—quite literally—brings space research ‘down to earth’ and in doing so affords both a deeper understanding of the methods through which we may come to know other planets as well as the specific natural and human built infrastructure through which we occupy our present home. By looking at Earth through the windows of S.H.E.E. we are invited to view our own planet as a patchwork of extreme environments—some pleasant and comfortable, others difficult and inhospitable to the human species—but, above all, one with an atmosphere, gravitational field, hydro- and biosphere that is rare and precious within the broader universe.



Fig. 9 *Zero Orbit* sketch of terrestrial transport of SHEE, image credit: Julian Charrière and Nadim Samman

*Zero-Orbit* addresses the themes of tangibility, habitability, and cooperative responsibility by enacting space research on Earth. In addition to inviting us to view the world through different scientific instruments and artistic media, however, the project also takes us inside the space research station and focuses our gaze on the social and psychological conditions of cooperation on a human level. At once a long duration artistic performance and a para-scientific research expedition, *Zero-Orbit* promises expand our understanding of how we work, play and tolerate one another under conditions that stretch our capacities for cooperation. In this respect, the project presses to the extreme relationships and practices of collaboration put into training at the AB and during wintering-over at Antarctic research stations—a microcosm of global challenges.



Fig. 10 Inside the SHEE habitat – crew quarter, photo credit: Bruno Stubenrauch 2015

### 5.2 Sculptural and spatial investigation of S.H.E.E., by Juliana Cerquiere-Leite

The second artwork we consider, by Juliana Cerquiere-Leite, offers a radically different engagement with the Self-deployable Habitat for Extreme Environments or S.H.E.E., one which deepens our understanding of *tangible extremes* by focusing attention on the body's relationship to its immediate physical surroundings. As her contribution to the AB, Cerquiere-Leite created an installation aboard the ship in which participants could swing in specially designed chairs while watching a series of films; the work was designed to moderate the feeling of seasickness, while at the same time heightening our awareness of the ship itself as a powerful technology that mediates our passage to Antarctica.



Fig. 11: Measuring SHEE: Juliana's hand inside the deployed SHEE habitat, photo credit: Juliana Cerquiere-Leite, 2017

The artist now proposes a sculptural investigation of an extreme environments living module, which invites us—rather than turning our gaze upwards and outwards—to consider more carefully what it feels like for our bodies to be immersed in the unfamiliar, confining architectures

necessitated by space research, an intimate study of our phenomenological embodiment that also calls attention to the gendered and culturally specific dimensions of perception that may be intensified under extreme conditions.

“The name SHEE –pronounced like the female pronoun– suggests the ability to accommodate life, mining a tradition of characterizing ships, buildings and aircraft as female, facilitators of the (often characterized as male) act of exploration, rescue and territorial conquest,” writes the artist. “In order to produce this new sculpture I will construct a life-sized... replica of this habitat in its compacted state ...I will use this replica as a mold and maneuver my body inside, tactilely exploring all reachable spaces and surfaces. As I do so I'll pour ‘emergency-orange’ colored plaster between myself and the objects I am able to touch. The plaster will produce casts of the negative spaces between my female body and the life-supporting objects and structures around me, simultaneously defining my adapted positions and my folded surroundings. ...Instead of moving the fixtures within SHEE out of my way to make space for my body, I will adjust myself to the available topography composing myself instead of what surrounds me, aiming to interact with my environment without making space. When I have inhabited as much of SHEE as possible I'll have completed the casting process. The entire card and fabric replica will then be disassembled and peeled away from the plaster, leaving only an index –a map of a specific interaction– in the shape of a large plaster sculpture.” [7]

Ironically, experiencing the vast openness of outer space necessarily involves intense feelings of confinement. The sculptor's excavation of the actual living space of the extreme environments habitat offers a visceral image of how astronauts may actually move within their artificial confines. The project raises many questions: how does it feel to live in such a confined space in the absence of gravity? Is it possible to imagine the physical boundaries of the habitat disappearing, such that we might feel our way through space itself? How does it feel to move inside the habitat as compared to underwater, inside of a spacesuit, a submarine, or the maternal womb? The sculpture that emerges from this project will embody many of the tensions that attend the astronaut's personal and bodily experience of exploration, which reflect at once the broad environment encountered and the architecture, clothing, and life-support systems that are required to be present there.





Fig. 12 Artwork INTRANSITIVE by Juliana Cerquiere-Leite, at Regina Rex, 221 Madison St. NYC, February 28 - April 3, 2016.

### 5.3 Artistic investigation of agricultural extremes in EDEN Greenhouse, by Paul Contreras Rosero

The third project under development as a result of encounters between artists and space researchers aboard the AB explores the aesthetics, technology and politics of food production for extreme environments. Paul Rosero Contreras's new work is an engagement with *EDEN-ISS*—A Ground Demonstration of Plant Cultivation Technologies for Safe Food Production in Space [9] – a specially designed closed-loop greenhouse system under development in Germany, which will be deployed to Antarctica for field testing. Responding to both the utopian promise of growing fresh vegetables in space and the travesty of continuing food waste and insecurity for much of the world's population today, Contreras proposes to share the aeroponic methods developed to grow food in space as part of a Do-It-Yourself kit to grown 'space-tomatoes' to feed urban communities here on Earth. The ultimate outcome will be a series of communal dinners in which "guest chefs will create special menus based on community grown space tomatoes and recovered food discarded by big distribution food markets," a form of social sculpture that juxtaposes methods of meeting nutritional needs ranging from community organizing to high-tech agricultural production.

The project also highlights the aesthetic impulse for growing fresh food in extreme environments. The growing techniques now being refined for growing space tomatoes have been widely used for illegal home cultivation of marijuana. Meeting basic biological needs represents only one dimension of creating and maintaining a habitable environment; meeting the needs for pleasure and sociality remain paramount for human well-being and, perhaps, basic survival. As though to press the point further, the artist proposes to create a special space tomato paste and canned soup—an art historical reference to Andy Warhol's *Campbell's Tomato Soup* (1962), the futuristic food of a previous era. Whatever nutritional properties they may have, the artist highlights the fact that space tomatoes and other agricultural innovations spurred by space research are ultimately cultural interventions in contemporary life nearby here on earth. This work expands our understanding of the role of food itself in and social conventions around eating in producing *habitable extremes* and *shared extremes*.



Fig. 13 EDEN ISS in Antarctica 400m south of the German Neumayer Station III, visualisation: LIQUIFER Systems Group 2017



Fig. 14 EDEN ISS Future Exploration Greenhouse, photo credit: Bruno Stubenrauch, 2017



Fig. 15 EDEN ISS greenhouse produce, photo credit: Paul Rosero, 2017



Fig. 16 Paul Rosero in the EDEN ISS facility; preparation trays, photo credit: Barbara Imhof, 2017

## 6. Conclusion

Artworks that engage with scientific research on and in extreme environments offer diverse opportunities for exploring cultural implications of space research. As the examples considered here demonstrate, such artworks are far from transparent in their meanings, and rather demand adept critical interpretation by art historians and philosophers, in collaboration with scientists and engineers. The interpretive framework that we introduced in section 3 enabled us to identify themes that emerged at the AB, which later inspired new artistic projects engaged with space research. By tracing the idea of *tangible extremes*, *habitable extremes* and *shared extremes* through the specific experiences of the AB, our attention was drawn to the significance of the social boundary between inside and outside, the phenomenological experience of being in enclosed spaces, and the role of food in producing a sense of community. This set of concepts and themes is not meant to be exhaustive, but rather to demonstrate how an abstract theoretical framework can enable us to move between very different sites and artworks, thus drawing

lessons about the cultural significance of space research from our experiences in Antarctica, for example.

The three new artworks we considered suggest directions for future research on the socio-cultural significance of space research. Specifically, these include bringing space research down to earth and experiencing earth itself from the perspective of a simulation terranaut, as described in Section 5.1 *Zero-Orbit*. Earth is presented through this artwork as an extra-terrestrial planetary body that needs to be explored in the same way as one would do Mars, from a secured and safe space habitat, with limited access to the outside world, only by virtual interfaces and carefully orchestrated Extra-Vehicular-Activities (EVAs). Secondly, as described in Section 5.2 *Sculptural and spatial investigation of S.H.E.E.*, an interpretation of the phenomenological embodiment of humans or astronauts in a limited space, with a focus on the gender and social dimension of space research culture and physical experiences. In extreme environments, on earth and in space, life is predominantly lived inside the narrow confines of a carefully designed habitat. Designing from the perspective of diverse bodily experience, focusing on the details of operations, and usability of the shape and geometry of an inhabitable envelope is of paramount importance. Juliana Cerquiere-Leite expresses this in a sculptural form and emphasizes the importance of the body in spaceships. Thirdly, Section 5.3 *Artistic investigation of agricultural extremes in the EDEN ISS Greenhouse* revolves around space agriculture and food. Common dinners are important social gatherings for spaceship crews. The daily schedule is structured around a meal together, most times dinner. This creates a community, enhances group cohesion and offers opportunities to solve interpersonal relationship problems. Food as essential eases the soul.

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