The Mobilisation of Antarctic Research

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Acronyms and Abbreviations

AAD	Australian Antarctic Division
AAT	Australian Antarctic Territory
ANT	Actor network theory
APECS	Association of Polar Early Career Scientists
ASOC	Antarctic and Southern Ocean Coalition
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATS	Antarctic Treaty System
Brexit	British exit from the European Union
CEP	Committee for Environmental Protection
COMNAP	Council of Managers of National Antarctic Programs
CRAMRA	Convention on the Regulation of Antarctic Mineral Resource Activities
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EU	European Union
HASS	Humanities and social sciences
IGY	International Geophysical Year
IPY	International Polar Year
Madrid Protocol	Protocol on Environmental Protection to the Antarctic Treaty
NAP	National Antarctic programme
SCAR	Scientific Committee on Antarctic Research
STEM	Science, technology, engineering and maths
STS	Science and technology studies
Treaty	Antarctic Treaty
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Abstract

This dissertation is concerned with how Antarctic research is made possible through complex and interdependent networks, institutions, and relations. It investigates the experiences, challenges, and concerns of a selection of Antarctic researchers and the conditions that enable them to conduct their research in addition to their participation within the Antarctic research community. Informed by material semiotic approaches, it is concerned with the enactment of Antarctic research through institutional and material structures and relations. Antarctic research becomes performed through a complex apparatus of interdependent networks. The issues and concerns raised allowed me to explore the materiality of research practices in the Antarctic, broader geopolitical contexts, knowledge practices and temporal implications for anticipated Antarctic futures.

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Chapter 1
Introduction

As the only major landmass uninhabited by humans, the impenetrably icy continent of Antarctica has been a source of great curiosity, inspiring heroic endeavours of exploration. From the very outset of its history of human engagement though, this former *terra nullius,* beyond the sovereignty of nations and empires, also became a site of scientific investigation. This was formalized in 1959 with the signing of the Antarctic Treaty, which designated Antarctica as a place for peace and science. Administered through an international framework, this stimulated a much more systematic and coordinated phase of scientific activity, now pursued by research institutions across the world through multiple national facilities established on the barren and inaccessible landscapes of Antarctica. Isolation, inclement weather, and an international governance regime present challenges and opportunities for engagement with the continent. This dissertation is about the processes through which Antarctic research is made possible. Adopting an anthropological mode of inquiry, I explore the practice of Antarctic research by considering the material and structural relations that come to enable such research, and the communities of practice and technocratic structures through which knowledge is produced.

Considering the mobilisation of Antarctic research is a complex challenge requiring us to ask how research is *enabled* through interconnected structures, relations, and practices. It depends on international accords, governing institutions, material infrastructures, disciplinary expertise, and coordinated activity. Such concerns are not without precedent - social scientists have turned their attention to the investigation of scientific knowledge production for some time, considering for instance, scientific revolution*s* (Kuhn, 1962), biological laboratories (Latour & Woolgar, 1979; Knorr Cetina, 1995), high energy physics (Nothnagel, 1996), marine microbiologists (Helmreich, 2009), planetary scientists (Messeri, 2011), climate scientists (Skrydstrup, 2013), and 'limit' biologists (Helmreich, 2016).

This dissertation begins with an inquiry into the material relations and practices that enable Antarctic research. I employ an approach informed by John Law's conception of material semiotics (2009) to describe the enactment of Antarctic research. I address the historic geopolitical contexts that govern and manage human engagement with Antarctica, including the technocratic structures through which knowledge is produced. I then explore the embodiment of science within the Antarctic Treaty System (ATS) and its subsequent politicisation, and trace how Antarctic research emerges through heterogeneous relations between humans and nonhumans of all kinds across networks that

span the globe. I illustrate how technoscientific objects describe and translate the Antarctic environment into past histories, present truths and anticipated futures where Antarctic research is enacted, translated, practiced and embedded in the material relations that help produce it.

The next chapter addresses Antarctic knowledge production and practice. Antarctic knowledge can be seen to be produced through specific epistemic and institutional structures and is grounded in time, space and place. I discuss how epistemics are a useful conceptual tool for analysing the institutional arrangements that shape Antarctic knowledge production. I illustrate the interconnections between knowledge, language and representation within Antarctic research communities, and how they can become a point of contention. Knowledge and language become implicated in hierarchies with the power to include or exclude certain practitioners.

My final chapter explores the many temporalities of Antarctic research through an exploration of time, uncertainty and the future. I discuss how our ability to model and imagine the future is inextricably linked to societal stability and has temporal implications for foresight in a changing climate and in times of political uncertainty. Uncertainty emerges in Antarctic research in numerous ways through global geopolitics, climate change and funding contingencies. I illustrate how anticipation of the future emerges as we organise ourselves in the present, in relation to our past and to our unknown futures (Nielsen, 2011), always moving between multiple temporalities. We see an enrolment of technologies of anticipation within Antarctic research to meet the demands for predictive science where time and risk emerge together in abstraction elusive to management practices.

This dissertation contributes to the body of social science work on human engagement with Antarctica, drawing on Science and Technology Studies (STS) and anthropological theory. It seeks to understand the ways in which research in and on Antarctica is made possible, and it does so through an ethnographic project that solicited commentary from expert practitioners. Materiality, knowledge, and temporality represented the key themes to emerge from analysis of the extensive interview materials, around which this dissertation is shaped.

Chapter 2
Methods

"Human experience is endlessly interesting because it is endlessly unique." (Bernard, 2011: 458)

Antarctica is a place socially, culturally, politically, and scientifically constructed in many spaces across the world. Antarctic research becomes enacted by disparate and mobile individuals, fragmented groups and communities of researchers working in locales away from the Antarctic. My 'fieldwork' involved emailing potential participants, organising times and equipment, booking rooms and conducting semi structured interviews with those who responded to my requests. Much has been written about the nature of ethnographic research with emphasis placed on the necessity of going into the 'field' as the defining characteristic (Hastrup & Hervik, 1994). However, as Amit (2000) argues, anthropological experiences and conceptions of fieldwork are highly varied, fluid and more nuanced than traditional emphases on the 'field' and distinctions between 'home' versus 'away' would have us believe. Amit (2000: 11) goes on to argue that "it is the circumstance which defined the method rather than the method defining the circumstance" where for this research, semi-structured interviews with broadly defined 'Antarctic researchers' ex-situ from the Antarctic became my ethnographic fieldwork. I am concerned with the lived realities and experiences of Antarctic researchers, the day to day research practices, much of which take place in research institutes and universities around the world.

The methods employed for this research consist of semi-structured interviews with Antarctic researchers forming my primary data complemented by literature analyses, in addition to observations from my own Antarctic fieldwork during a postgraduate course the year before and participation within a multidisciplinary Antarctic research centre within the University of Canterbury; Gateway Antarctica. Semi-structured interviews were carried out with 13 Antarctic researchers, spanning across disciplines including marine biology, microbiology, glaciology, geopolitics, history and social science research. Semi-structured interviews allowed for fluidity of conversation and the freedom to respond organically to interview responses, Galletta (2013: 45), for example, describes semi-structured interviews as a "repertoire of possibilities".

Interviews took place within meeting rooms at the university in Christchurch, in a research laboratory in Wellington, over Skype, and over the phone. Interviews were roughly 90 minutes, with the shortest interview 45 minutes and the longest two interviews almost two hours. The interviews were audio-recorded using a dictaphone. I then produced verbatim transcripts of the interview recordings, which amounted to a total of 179 pages of verbatim transcribed data. Transcribing the

interviews myself took an extraordinary amount of time but did mean that I became very familiar with the transcripts during the process, making notes and identifying commonalities before I came to analysing and coding the data more formally, I became grounded in the data.

Analysing Primary Data: Finding Themes

I identified themes and common threads using a combination of deductive and inductive coding, anticipating some themes and allowing the transcripts to inform others. My identification of themes in the transcripts was heavily influenced by a grounded theory analysis approach that was originally developed by Glaser and Strauss ([1967] 2008). In grounded theory approaches through familiarity with, in this instance, the interview transcripts one becomes grounded in the text (Bernard, 2006) and "coding is analysis" (Miles et al., 2014: 72). I coded my texts using a combination of abstractions and empiricisms. For example, if participants were discussing a loss, expressing uncertainty, making a prediction, or describing a challenge, these were coded as such. In other cases, where direct reference was made to, for example, funding, language or governance, these too became codes accordingly. I also began *memoing* during the transcription process as I coded. Memoing involved making notes as thoughts and ideas emerged about my themes and possible connections between them (Bernard, 2011).

Challenges, Concerns & Obstacles

I initially intended to explore the production of scientific knowledge on the Antarctic but decided to broaden this for a number of reasons. Firstly, I did not want to recreate the binary that too often separates the social sciences from the natural sciences for I believed that, within Antarctic research, the lines were blurred (a point I will return to in chapter four). Secondly, I wanted to interview a number of political scientists and governance experts, who were interested in my work, and a focus specifically on the natural sciences may not have allowed this. Furthermore, differing disciplinary subjectivities meant the language of my research was less attractive to natural scientists (another point explored in chapter four). Of the over 50 researchers I approached at least 80% were natural scientists, but of those interviewed only one third were natural scientists, which in itself necessitated a change of direction. I will provide an example:

Early on, I was describing my research to one of my natural science colleagues at university. I discussed how I was planning to look into the production of scientific knowledge in the Antarctic and explore the material relations that enable the science and scientific practice. They listened attentively,

nodding occasionally. When I finished my explanation a few moments passed, when finally they said 'it sounds like you are suggesting that it [the scientific method] is wrong'. This told me a number of things. First, the differential intelligibility of the very idea of social studies of science would be a barrier to enticing natural scientists to participate in my research and, secondly, I suspect that I was likely to encounter a similar miscommunication with other natural scientists. In her PhD thesis, Jessica O'Reilly (2008) alludes to some of the difficulties of undertaking social research in an area where traditionally positivist natural sciences have held court. I too encountered similar frictions. I had thought about this divide, of epistemological and ontological clashes but did not think it something so close to the surface, something I would encounter so readily. Latour's *Pandora's Hope* (1999: 2-3), opens with Latour, speaking after a conversation in which he was asked the question "Do you believe in reality?" at a conference. Speaking about that conversation and about a separation at the conference between 'scientists' and 'science studies', he says:

> *This division itself, announced by the organisers, baffled me. How could we be pitted against the scientists? That we are studying a subject matter does not mean that we are attacking it. Are biologists anti-life, astronomers anti stars, immunologists anti-antibodies? I was a bit vexed to be excluded so casually… Then I realised I was wrong. What I would call "adding realism to science" was actually seen, by the scientists at this gathering, as a threat to the calling of science, as a way of decreasing its stake in truth and their claims to certainty… This distance between what I thought we had achieved in science studies and what was implied by this question was so vast that I needed to retrace my steps a bit*.

The above quote speaks to wider epistemological separations within academia generally, but also more specifically within the Antarctic research community and reflects some of my own experiences and observations as well as those revealed in some of my interviews. Thus, I decided it would be problematic to recreate a binary between the positivist natural scientists and humanities and social science scholars. Therefore, Antarctic research and researchers in the broadest sense became my focus. This study intends to provide insight into the many ways of both doing Antarctic research and being an Antarctic researcher, exploring the enablers and disablers, both human and nonhuman, through which Antarctic research takes place and knowledge is produced.

Selection & Recruitment

Sampling was a combination of opportunistic and snowball sampling, with researchers approached initially via email with over 50 approaches made in total. Antarctic research

is disciplinarily diverse, and participants were selected for the experience and research interests on Antarctica. An attempt was made to capture researchers from a wide array of backgrounds, experiences and expertise spanning many academic disciplines. Table 1 gives an overview of participants, their area of research and affiliation and, the pseudonyms by which they will be referred throughout the dissertation. Recruitment of participants was less successful than anticipated as mentioned above which has directed and constrained the research, in addition to the length of time taken to transcribe the interviews which meant further participants were no longer sought sooner than expected. All of my interviews took place in English, and I acknowledge a bias in my sample towards researchers from the Anglosphere as they were more readily accessible to me. Further, I acknowledge that there is also a bias towards humanities and social sciences researchers who more readily responded to my topic of inquiry, I suspect, due to our more closely aligned disciplinary subjectivities as well as perhaps an appreciation for the sometimes difficult task of attracting research participants.

Table 1: Research participants and their affiliation

Pseudonym	**Area of research**	**Affiliation**
Emmanuel	Social sciences	University
Francis	Humanities	University
Morgan	Biology	Antarctic research institute
Robin	Social sciences	University
Johannes	Glaciology	University
Lou	Social sciences	University
Lindsey	Biology	University
Kerry	Social sciences	Antarctic research institute
Jo	Humanities	University
Alex	Social sciences	University
Matias	Biology	Antarctic research institute
Maja	Social sciences	University
Karsten	Social sciences	University

Ethical Considerations

Ethnographic research often captures personal information, views, and opinions, some of which may be compromising (Herbert, 2014). Therefore it is of paramount importance that the rights of participants are protected and considered throughout the life of the research project (DeWalt &

DeWalt, 2011: 211). Research participants have the right not to be harmed, to anonymity, to confidentiality and to privacy (DeWalt & DeWalt, 2011; Miles et al., 2014). My research involved interviewing Antarctic researchers in their professional capacity and sought their educated thoughts on matters that are well within their fields of expertise, with no personal information sought. My research qualified as low-risk, was approved by the Human Ethics Committee (HEC) at the University of Canterbury (reference HEC 2016/74/LR) and is consequently bound by its guiding principles (see HEC, 2014).

Participants were selected for their connection to Antarctic research. Informed consent was gained prior to research participants involvement during which process they agreed to participate, acknowledging what participation involved and their rights throughout the research project. Participation in my research was entirely voluntary and consent could be subsequently withdrawn at any time during the research. Once transcribed, participants were given the opportunity to review and verify their transcripts. Participants' identity and that of their institutional affiliations has been kept confidential during this research through the use of pseudonyms in the dissertation and any other publications.

Chapter 3
Materiality

Antarctica has a rich history of research endeavour. Motivations for engagement with the Antarctic have changed considerably, from mapping new territories to be obtained during colonial eras of exploration, to geophysical and taxonomic classification and resource exploitation, to concerns of peace and militarisation, and to the present agenda of conservation and environmental protection. Scientific inquiry dominates and justifies human habitation in the Antarctic and has become the rationale for large expenditure on national Antarctic programmes (O'Reilly, 2008). Antarctica is used as a 'laboratory' for scientific research into climate change to an extent not seen on any other continent and, accordingly, research agendas share commonalities (Herr & Hall, 1989; O'Reilly, 2008). Due to its remoteness, its inclement weather and the high costs associated with undertaking *in-situ* research, the Antarctic is arguably a place premised for collaborative, co-ordinated and interdisciplinary research, i.e. the Antarctic lends itself to place-based and international research efforts over discipline-based and national research. Antarctic research (and Antarctic researchers) inform(s) environmental, in particular climate-change-related, policy and management strategies for Antarctica, it is therefore important to understand the networks in which Antarctic knowledge is produced and how such knowledge practices inform debate, governance and further research.

Material semiotics is used here as a framework within which to explore the materialities of Antarctic research and how networks of Antarctic knowledge are produced. Materiality matters. Antarctic research is enabled through specific sets of agreements, institutions, histories, policies, relationships and funding. Historically, geopolitical contexts have produced specific modes of human engagement that influence access, operations and research in and on the continent. The relationship between Antarctica and science has been carefully constructed over the last century with "machineries of knowledge construction" (Knorr Cetina, 2007) employed in empirical processes through which Antarctic knowledges and subjectivities are embedded and produced. The materiality of science and the production of scientific knowledge has been considered a subject to be studied, from the pioneering work of Thomas Kuhn's (1962) 'The Structure of Scientific Revolutions' to Bruno Latour and Steve Woolgar's (1979) 'Laboratory Life' and the discipline of Science and Technology Studies (STS) that has subsequently grown around it. Antarctic research is dominated by positivist scientific inquiry, with quantitative methods of inquiry preferred over qualitative research methods; it is a place where objectivity and quantitative methodologies have come to be expected and demanded of research (O'Reilly, 2008).

Material Semiotics

Early sociologies of science and the more recent STS seek to "better understand the power of actors and normative influences on the practices of science" (Rodger et al., 2009: 662). Actor-Network Theory (ANT) has been employed as an analytical tool for describing this "enactment of reality" (Law, 2009: 141) through webs of heterogeneous relations between actors of all kinds, including human, non-human, living, non-living, objects, institutions, regimes, scales, geographies, systems, machines and technologies, with actor-networks embedded in empirical practice (Law, 2009). ANT and other material semiotic approaches do not distinguish between the agency of human and non-human actants, but consider all actions to be relational (Latour, 1996). In *The Structure of Scientific Revolutions*, Kuhn (1962) argues that science is taught in a particular way leading to a particular kind of science being enacted and, as a result, we end up at with an amalgamation of scientific practices that come to constitute paradigms (Kuhn, 1962), or cultures of knowledge (Knorr Cetina, 2007). Early sociologists of science and scientific knowledge described the *Social Construction of Scientific Facts* (Latour & Woolgar, 1979), identifying how science is enacted and how, through processes of translation, we arrive at empirical scientific truth which resembles facts, devoid of the social (Latour & Woolgar, 1979). However, within STS we see a paradigm shift as the focus on materiality and practice challenged previous understandings of knowledge as socially constructed (Asdal, Brenna & Moser, 2007).

'Science' can be understood as a product of heterogeneous material relations (Latour & Woolgar, 1979). Material semiotic approaches have been undertaken by many researchers to analyse the enactment of the material relationality of given research areas, offering, for example, sociologies of translation for a scallop fishery (Callon, 1986a), the electric car (Callon, 1986b), wildlife tourism in the Antarctic (Rodger et al., 2009), or an analysis of how Atlantic salmon has become enrolled in regimes of domestication (Lien & Law, 2011). Scientists are understood to participate and produce scientific cultures, which may be treated as cultures of normative practice.

In an Antarctic context, significant logistic and operational challenges, in addition to the influence of global geopolitics and national interests, have enabled certain kinds of research while simultaneously stifling others. The processes through which research is enabled begin well before any researcher reaches the Antarctic continent. Antarctic research is multifaceted and complex with many layers of epistemological influence (as will be explored further in chapter four). This research seeks to understand the role of matter and meaning for understanding the enactment of research practices and the subjectivities they produce for practitioners within Antarctic research. It also discusses how

research practices inform and are informed by paradigmatic shifts and competing epistemological influences and how we arrive at a specifically Antarctic subjectivity.

Geopolitical History

The rules of engagement with the Antarctic were outlined in the 1959 Antarctic Treaty and its associated agreements, including the 1991 Protocol on Environmental Protection (Madrid Protocol) and its supporting annexes. The Treaty reflects the global Cold War geopolitics of the time, whereby the global political order was configured by the rivalry between superpowers and the ideological battle over democracy, capitalism, and socialism. For example, the Treaty bans militarisation, establishes a condominium with regard to sovereignty and territorial rights in the Antarctic, enables inspections of national Antarctic research facilities and vessels and, encourages international scientific cooperation as central to Antarctic engagement, thus cementing 'science' as the raison d'être in the Antarctic (Dodds, 2010; Elzinga, 2013) and embodying science within the governance system. The Treaty becomes enacted through participatory practices within the system and through the creation of policy through webs of relations connecting various state actors. The provisions of the Treaty have led to the often cited phrase that Antarctica is a continent for 'peace and science', and it is the interpretation and operationalisation of this rhetoric that continue to influence Antarctic research.

Understanding the historic geopolitical contexts through which the Antarctic Treaty was conceived and developed into the Antarctic Treaty System is crucial for assessing contemporary governance issues in the Antarctic (Dodds, 2010; Dodds & Collis, 2017) and the enactment of new modes of human engagement as expertise shift as knowledge builds. Engagement with the Antarctic can be divided into a number of significant phases: beginning with 'Colonial' Antarctic exploration during the early 20th century, the International Geophysical Year (IGY) leading to the signing of the Antarctic Treaty in 1959, and new concerns about the exclusive nature of Antarctic governance arising during the 1980s prior to the signing of the Madrid Protocol in 1991. The values pursued during these different periods of time significantly influenced how Antarctica is governed and managed. They also influenced what kind of research would be undertaken on the continent. As Dodds and Collis (2017: 51) argue: "the metaphorical and material power of the 'Antarctic frontier' is not something buried in the past; it continues to underpin contemporary manifestations of polar geopolitics". The interplay between temporalities and their manifestations in and on the Antarctic are explored in greater depth in chapter five.

Power relations and the mechanisms through which they are upheld within the ATS are multiple. Elzinga (2017: 107) discusses how "the IGY's sublimation of political rivalry into scientific

competition and cooperation was distinctive". Dodds and Collis (2017: 51) describe the Antarctic Treaty and ATS as a "form of colonial-scientific governance", while O'Reilly (2017) speaks of "technocratic governance" and "epistemic technocracy" to describe a "mode of governance whose political technologies rely on the form (the discursive habits) and matter (the literal substance) of scientific practice" (O'Reilly, 2017: 6). Here we see an interplay between political legacy and scientific knowledge and expertise recreating, participating in and enabling a form of hegemonic governance. "Politics is seen as a form of practice which comes into existence through a large number of material arrangements and technical objects" (Asdal et al., 2007: 44). Technoscientific governance for the Antarctic involves an ideal of science-informed policy that takes into account scientific knowledge and expertise, thus legitimising the governance regime where the bureaucratic rituals and procedures of policy creation are enacted by various actors within webs of heterogeneous relations in the wider Antarctic research and policy communities and within national governments (O'Reilly, 2017).

Geopolitical discourses in the Antarctic have moved from settler colonialism to scientific internationalism through the Treaty which "masked rather than resolved underlying tensions and ambitions, and reinforced unequal power relations and patterns of domination, albeit through scientific-political and technical discourses and practices" (Dodds & Collis, 2017: 59). Moreover, the 'scientific criterion' for becoming a consultative party to the Antarctic Treaty further perpetuated the politicisation of Antarctic science and, as Elzinga (2017: 106) argues, "science acquired symbolic value as political capital", a point I will return to shortly.

The persistence of colonial legacies and the privileged status original signatories to the Treaty continue to enjoy have been heavily critiqued (Dodds & Collis, 2017; Hemmings, 2017; Dodds, 2010; 2017a; Elzinga, 2013) and, as Dodds and Collis (2017: 52) contend, "colonial institutions, discourses, and practices are part of the here and now and not confined to a distant historical epoch", a privileging which serves both to enable certain research and researchers whilst simultaneously disabling others. Authority becomes established and subsequently reinforced through assemblages of technocratic experts and diplomats who create policy through the ritualised processes of Antarctic Treaty Consultative Meetings (ATCMs), intersessional discussions, hallway conversations and drafted documents which in turn inform practice on the ground in the Antarctic (O'Reilly, 2017). Antarctic futures are formed through these policy making processes (O'Reilly, 2017). A more thorough account of the geopolitics of the Antarctic Treaty is outside the bounds of this dissertation and has already been provided by Dodds (2010; 2017a), Dodds & Collis (2017), Elzinga (1993a; 2013; 2017), and Hemmings (2017).

The equity and legitimacy of the ATS has been questioned virtually since its inception. Many scholars (Hemmings, 2014; 2017; Dodds & Collis, 2017; Elzinga, 2013) criticise the fact that decisions for the future of the continent are made by a select few, excluding much of the global south, most notably illustrated through the raising of the 'Question of Antarctica' at the United Nations by the Malaysian government in 1983 (see Beck, 2006a for further detail and significance). The governance structures of the ATS perpetuate such inequity by allowing or disallowing membership through the enactment of historical policies outlined in the Treaty. States that have historically held a privileged position within the ATS fear a diminishing of their power and influence within the order that they created and from which they have benefitted (Hemmings, 2017). Thus, the enactment of the historical order continues as national interests are articulated at meetings of experts from signatory states. Furthermore, the Antarctic interests of many non-Western states, in particularly Asian states, are viewed as "intrinsically suspicious" (Dodds & Collis, 2017: 64) and, as Hemmings (2017: 507) notes, "science is international and value-free until it isn't one of us doing it".

The idea of 'Polar Orientalism' (Dodds & Hemmings, 2013), which I will discuss in greater depth in chapter five, draws attention to the many ways in which Asian and non-Western interests provoke suspicion from the Western world about their Antarctic interests and activities (Dodds & Hemmings, 2013; Hemmings, 2017; Dodds & Collis, 2017). The ATS has becomes an increasingly complex and multifaceted governance regime and, as Elzinga (1993a: 91) argues, "science does not go unaffected by its embodiment in an international regime having distinct political purposes".

The Politicisation of Science

"*Science in its own right is never enough to motivate a mobilisation of resources and efforts on the scale seen in Antarctica*" (Elzinga, 2017: 104).

The embodiment of science within the ATS plays a pivotal role in the functioning of the governance regime (Elzinga, 1993a; 1993b; 2017; Hemmings, 2017; Herr & Hall, 1989), and has been termed the "currency" of the Antarctic (Herr & Hall, 1989) as well as "symbolic capital" (Elzinga, 2017: 107). Whilst Article II of the Antarctic Treaty inscribes "freedom of scientific investigation", thus assigning science its central role, it is the "substantial scientific research activity" referred to in Article IX that is often interpreted as the 'scientific criterion' enabling certain states' Antarctic involvement whilst disabling others through the material practices of actually enacting (substantial) science in Antarctica. Elzinga (2013: 194), for example, discusses how science (and the scientific criterion) came to be used as a "political tool to restrict membership in the system", leaving the original signatories with an effective monopoly over the Antarctic (Elzinga, 1993a), where claimant states have justified

their privileged status under the guise of scientific objectivity (Dodds & Collis, 2017). Elzinga (1993a: 79) goes on to argue that "there is a vast gap between the ideal of disembodied science… and the embodiment of research within the "*realpolitik*" of the ATS" (original emphasis). The ATS is where authority, expertise and power are exercised over the Antarctic. An Antarctic research base therefore came to take on symbolic meaning bolstering the rights of those within the claimant community and providing a mechanism for inclusion vs. exclusion (Dodds & Collis, 2017; Elzinga, 2013). It should be noted that the 'scientific criterion' position has subsequently softened, and an early interpretation of Article IX as requiring a research station in order for a state party to apply for consultative status is not necessarily the case anymore (Elzinga, 1993a, 2013).

Among those Antarctic researchers interviewed opinions varied on the significance of the peace and science rhetoric inscribed within the Treaty. Robin, who has spent an entire career engaged in Antarctic affairs, working across multiple states, feels:

> *From its inception, the one thing that giving science such a central role in the Antarctic system did was politicise it. Because it made it the thing you did in order to have influence and by which you are recognised as having influence and it was the basis for all those Para Antarctic institutions that developed like SCAR… part of my concern about the sort of nationalistic trend is that that will alter the nature of the politicisation that it will mean that the Antarctic science is even more a kind of a spear holder for the national interest in Antarctica, we shall see, it's happening slowly. At the level of individual scientists, I don't think it is very well developed, I don't think nationalism is very well developed, I think it's really at the level of the kind of institutions*.

Kerry who heads an Antarctic organisation, however, opines that

> *The rhetoric that the continent is set aside for peace and science is more important to the governance arm of the system not to the science or the research arm in my view.*

Discussion of the politicisation of science in the Antarctic does not negate the quality of the science nor suggest it is not valuable. On the contrary, "for science to be able to function in its symbolic mode, it has to be accepted as quality science within an international scientific community. Scientific credibility is needed to underwrite political credibility within the ATS" (Elzinga, 1993a: 96). The quality of science need not be eroded by its position as political capital; quality science and political science are not mutually exclusive, but rather serve to demonstrate commitment to the Treaty (Roberts, Howkins & van der Watt, 2016a).

Scientific research in the Antarctic has become increasingly international and, where in the past Antarctic research was ad hoc and there was much duplication, presently research is more directed and coordinated, with the roles of the Committee for Environmental Protection (CEP) and the Scientific Committee on Antarctic Research (SCAR) more established and understood (Elzinga, 1993a, 2017). There are many examples of scientific internationalism and collaboration through the sharing of equipment, personnel and logistics in the Antarctic, but there are no truly international stations. In this sense, international scientific collaborations are grounded in the material practices and encounters in the Antarctic and through relations between scientists, researchers and National Antarctic Programmes (NAPs) rather than state governments. Elzinga (2013), Hemmings (2011) and the Antarctic and Southern Ocean Coalition (ASOC, 2014) have been critical of stations still flying national flags. In 2011 Hemmings penned a piece titled *'Why did we get an International Space Station before an International Antarctic Station?'*, which is critical of states' (both new and old Antarctic players) commitment to national autonomy over international scientific cooperation. Elzinga (2013: 193), too, analyses this mismatch between an ideal of scientific internationalism and a reality of vested national interests. Scientific internationalism often operates as scientific competition at the state level with the actualities of scientific internationalism enacted in the field. In the Antarctic, we see '*Science as the continuation of politics by other means'* (Elzinga, 1993b), operating and threatening to undermine international cooperation.

Intentionality & Commitment

The institutional dimensions of research networks are important enablers. Institutional motives are revealed in the Antarctic through different modes of human engagement via scientific exploration, from early concerns over mapping and taxonomic categorisations during the 19th and early 20th centuries, and changing over time to more conscious efforts around environmental and conservation provisions presently (Elzinga, 2017). "Research programs are entrenched in institutions" (Elzinga, 1993a: 77), and these institutions, in particularly NAPs become gatekeepers either allowing or disallowing access to the continent for certain research. The epistemic and institutional structures within which Antarctic knowledges are produced are explored in the next chapter.

"It is not altruism and scientific internationalism that has been a key element in the ATS. Rather national interests remain as both enabling and constraining factors" (Elzinga, 2013: 203). The material reality of Antarctic research requires large scale mobilisation of actors and capital. NAPs are themselves constrained within, for example, national agendas and funding cycles. The intentions and ongoing commitment of nations to the Antarctic Treaty came up repeatedly during the interviews.

Kerry and Lou, both with significant engagement with the ATS, had quite different interpretations of the operation of the ATS in its current form. Kerry continues seeing a strong commitment to the Treaty, while Lou was more critical, believing:

> *There are gaps… if one tries to take a fairly objective view and an assessment of what's working and what's not working in the governance and policy system you could identify a number of things: the slow pace of decision-making and reaching agreement on things is obvious, the liability annex took 13 years to negotiate and has not yet entered into force even, where are we now, 12 years after we agreed the liability annex, I think still less than half the parties have taken the necessary action to bring it into force, so that's frustrating, it doesn't tend to demonstrate intent on the part of countries to commit to the system.*

Lou draws our attention to the abstraction of time and the differences in time between policy creation and agreement within the ATS and the time to align and adopt policy at domestic levels in order to bring policy to life. In this instance, negotiation of the liability annex (Annex VI to the Protocol on Environmental Protection) began in 1992 by legal experts on liability as intersessional work and was discussed at regular ATCM sessions first in 1998 in Tromsø (Vidas, 2002). The liability annex was then agreed upon and adopted at the 2005 ATCM, but has not yet entered into force as Lou discusses. There is tension amongst actors where individual delegates and researchers negotiate, draft and achieve consensus within the system for a policy to remain in limbo while national governments align policy, decide whether their national interests are threatened and assess the risks. Thus, there is a frustration expressed and tensions apparent in light of differing timescales: policy debate and creation time and political and bureaucratic government response time (Helmreich, 2016). Within the ATS, consensus operates as both, an enabler of participation and inclusivity and a disabler of pace, as networks of vested national interests threaten to spill over into the Antarctic via commercial and national interests in, for example, the fishing industry. These tensions between urgency and slow pace were a recurring theme through my interviews and will discussed further in chapter five.

An indication of the relative intentions and commitment of given Antarctic states can be seen through the levels of investment in infrastructure. These material indicators of logistical accessibility, are readily transformed into symbols of power, prestige and influence. The Australian government provides a useful example. The recent U-turns by the Australian government first on the climate science job cuts at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Dodds, 2017b), and more recently regarding the closure of the permanent research station on Macquarie Island (Frydenberg, 2016a; 2016b), show a concern for prestige, influence and reputation. The job cuts

at CSIRO and the closure of Macquarie Island facilities drew international headlines and condemnation from the wider climate science and Antarctic communities (Open Letter to the Australian Government, 2016). The government's decisions were particularly audacious and *awkward* (to use Dodds', 2017b term) as they were occurring in the months after the Paris Climate Change negotiations of late 2015. In both instances, the government has since changed its position, with fewer jobs losses than initially earmarked (Dodds, 2017b; Gough, 2016) and a $50 million upgrade announced for Macquarie Island, which is no longer facing closure (Frydenberg, 2016b). In both instances concerns over funding were initially cited, with the implication that funding was an issue, until Australia was no longer seen as a leading player (a) in climate science, (b) in combatting climate change and (c) in East Antarctica, i.e. the Australian Antarctic Territory (AAT) (Dodds, 2017b). A tension is revealed here as Dodds highlights in the case of CSIRO as "an organisation struggling over a number years to reconcile public service science with the pressures imposed by national government and a broader trend towards the privatised science regime" (Dodds, 2017b:25). Similar assertions could arguably also be made about the Australian Antarctic Division (AAD). Far from institutional autonomy, we see here how political motivations, intentions and commitments from governments enable Antarctic and climate research but also how those same governments are scrutinised by an international community who wield power through their outrage, their words, and their mobilisation (see Open letter to the Australian Government, 2016).

Access

Logistic & Infrastructural Support

Antarctic research is politically determined. Elzinga & Bohlin (1993) and Elzinga (2013) for example describe the impact of an organisations institutional motives operating within polar science and associated networks. For example, NAPs are the gateway institutions that provide access to the continent. It is therefore crucial that researchers have a relationship with an NAP in order enable their research. In turn, this accords NAPs a certain level of power over researchers by giving them the opportunity to vet the research to ensure it fits within their programme and capabilities and aligns with predetermined institutional motives. For example Johannes, a glaciologist describes the limited agency of the researcher within the logistical planning process where the NAP "decide what is required once they decide to support us."

Antarctic science is grounded in the material realities of the Antarctic, notably its distance from home countries, low temperatures and inclement weather. Logistical support in the Antarctic is therefore a fundamental enabler of in-situ Antarctic research, which in most instances is coordinated

solely by NAPs. The mobilisation of resources; infrastructure and personnel, provides scientists with the ability to collect data and samples, monitor sites and enact scientific practices in the Antarctic. Antarctic science is very much situated and embodied in the practices and liveability of the Antarctic continent, for which it relies on NAP operations, expertise and support. The physical location of NAP bases impacts research directions and abilities and is factored into research and experimental designs. Johannes for example discusses how research projects are constrained and designed to take place within the vicinity of the national Antarctic base. However, there is a desire to go further and improvements logistics and support capacity could enable this.

The location of a base, the infrastructure and logistic support inform the science that is practiced and influence how the scientists are able to practice it. Furthermore, readily available specialist and banal facilities inform scientific practice in the Antarctic what Messeri (2011: 111) calls the "technological sublime and the technological mundane". Morgan, a marine biologist discusses the ease with which experiments can take place as a result of laboratory space in the Antarctic:

> *We'll collect animals and we'll do experiments on them really quickly because they're as close to the condition they're in the sea as you can get and the laboratory we've got… is designed so you can do that.*

When I enquired about the kinds of materials needed to enact Antarctic research, Morgan rattled off this list which very quickly gives a sense of the scale of the mobilisation of Antarctic research:

> *We need the base, we need the boating facilities at the base, we need the diving facilities at the base, we need a really good aquarium and we need laboratories associated with that, so genetics, genomics laboratories, physiology, chemistry laboratories. For some of the work we need access to a larger ship because we need to go and look at different sites in the Antarctic... We need key personnel in all those areas; we need a good diving officer to support the diving, we need a good boatman as well to help us run the boats. Back [home] …we need the aquarium… we need the cold facilities… to run experiments there, we need again a suite of laboratories, we need funds to send our samples off for analysis in the genetics and the genomics labs, we need a whole bunch of facilities for the kind of smaller scale stuff that we do.*

Antarctic science requires a mobilisation of relations between all kinds of actors across many scales, localities and bureaucracies. It is a "choreography" (Law & Lien, 2012) of practice between international agreements and policies, scientists and support personnel and their respective expertise,

the field equipment, logistics support and the pathways for samples and data back to home institutions and, all ordered amongst the agencies of the ice, ocean and wind and, of Antarctica itself.

Information Access & Support

Aside from logistical support to access the continent itself, many Antarctic researchers work ex-situ where access and enablers take a more normative form. For example in the form of archives, artefacts, data, equipment, flights, funding, galleries, information, laboratories, language proficiencies, libraries, meetings, museums, papers, people, samples, support and time. Antarctic researchers who do not need to travel to Antarctica do not require the same relationship to an NAP nor scrutiny from them. The same question I asked Morgan earlier, about the kinds of materials needed to enact Antarctic research, I asked Robin who describes research requirements as follows:

> *I just need not to be disturbed in a way and I don't need any hard equipment, and I have 1000 books on the Antarctic... so what I need is time, my own time, but what I also need is access and openness to sources of information about policy decisions and that's something that isn't necessarily easy to get, varies with government agencies' commitment to public disclosure and it's also about contacts. I mean you raise a really valid point and this is one of the issues that came up in the SCAR review about priority research areas because one of the questions they were asking different constituencies within SCAR was what do you need by way of resources and humanities and social scientists have quite different needs really from somebody who needs tent on the snow and you know expensive electronic equipment.*

Here attention is drawn to the differing enablers of Antarctic research for different disciplinary subjectivities and settings. 'Access' requires different practices and differing bureaucracies, with for example access to information, openness and archives enabling for example historic Antarctic research. The differences in disciplinary subjectivities within the wider Antarctic research communities is explored further in chapter four.

Funding was much discussed by all research participants and was a significant cause of consternation for researchers. It readily shifts from being an enabler to being a disabler, affecting researchers' capacities to plan and envision their research into the future. Morgan discusses funding challenges:

> *At the moment, it's all funding, getting funding to do the research is crippling us. It used to be, up until about the 2000s it was facilities, we didn't have good enough*

facilities to do some of the things we wanted to do, and now we have got good enough facilities to do the things we want to do, but we haven't got the money to employ people to do it, we haven't got the money to pay for the consumables and things like that, so at the moment it is purely funding to do the research and to pay the salaries of the people involved, so we've got big funding cuts, we're making people redundant, we've got to go out and win grants for all of our science and actually if you look at the track records of winning grants to work in the Antarctic, it's poorer than it is for working outside the Antarctic and I think that's because the referees in the research councils don't see the questions in the Antarctic, especially in biology as being as important as the questions outside the Antarctic, so it's much harder to win money for that.

Funding networks are vast and within which research projects are brought into being or left in abstraction. Seeking funding involves an array of ideas, documents, expertise, deadlines, decisions, emotions, rituals and procedures holding the power to allow or disallow research. Of all those interviewed (with the exception of Robin who largely requires time), funding is what translates ideas into research projects and was discussed as the fundamental enabler of research.

Technologies

Specialist technologies are plentiful in Antarctic science, enabling scientific practice in ever more innovative ways. Technoscientific innovations came up repeatedly and were described in most instances as great enablers of improved research. Morgan, a marine biologist describes for example the changes in technology and what this means and has meant for their Antarctic research:

Technology has made a big difference… there's a whole new swathe of different experimental approaches, the theoretical side and understanding of how ecosystems function is changing rapidly, there's a lot of technical change and in terms of things like our ability to observe things, the photographic side, the camera side's improved massively and the improvement in the quality of the images you can get is changing what we can do a lot. I mean all of those sorts of things are just much better than they were.

Johannes on the other hand discusses how technological changes have allowed the visitation of new sites and repeat measurements of old sites with improved accuracy. The Antarctic environment is described and becomes translated into data through use of technoscientific objects. There are numerous technologies enrolled in scientific practice. In the Antarctic, scientific practice is enacted and performed through the use advanced technologies as well as the more mundane such as tents

and vehicles. Antarctic science is materially heterogeneous and embodied in the relations between scientists, technoscientific objects and the Antarctic environment. Science "is shaped or constructed by human beings who deploy cultural and material tools to solve problems… [where] scientific experimenting is about lining heterogeneous components up for long enough to *enact* materials that can be detected, inscribed, and transcribed" (Law, 2010: 178 original emphasis). In the choreography of Antarctic science, many components need to line up within networks of relations spanning the globe.

Johannes also discusses new capabilities through technological advancements and the networks of actors involved to ensure that access to, in this instance, satellite data continues:

> *For my work it's mainly data access from various space agencies to get the data we like, that also requires collaboration and application writing, proposal writing, but that is also in-kind support if you like, so there is no money flowing, but data flowing which is money for us pretty much, but for our work, yes that's equally important.*

In Antarctic research, commercial, national and international frameworks are often entangled. For example, the satellite data Johannes' research relies on provides a good example. The data is collected, stored and transferred through commercial, international and national pathways. Morgan too discusses access to equipment. For Morgan's research, the technology is not new, but the layers of bureaucracy to gain access to it are:

> *To get use of those now I have to get somebody in the University interested in doing a joint piece of work whereas 10 years ago I could have just gone and paid for the time on the machine and got one of my students do it, it doesn't happen anymore that way.*

Thus, Antarctic research is performed through a delicate navigation between networked relations and ritualised procedures through which researchers gain access to data, people, funding and to Antarctica.

Conclusion

"*The power and ability to represent, translate and shape reality is neither centred in formal political institutions, nor in science. On the contrary, realities are created and enacted in many different locations, practices and relations, and the connections between them, and the coherence of what has been created, is not a given. The question of which enactments prevail and become more real is thus*

an empirical question of the nature and character of the connections – and the boundaries – between different locations, practices and enactments" (Asdal et al., 2007: 36).

Antarctic research is a choreography of practice (Law & Lien, 2012), weaving relations between funding bodies, archives, personnel, bureaucracy, technocracy, universities, institutions, policy and governments. The geopolitical history of the Antarctic has set the scene for human engagement with the continent, enabling and disabling certain research and participation. Science is embodied within the fabric of the ATS, and there is a resultant politicisation of science within the regime with nationalisms and competing institutional motives manifest in Antarctic research. Access to the continent itself in order to practice science sees a mobilisation of actors across overlapping scales and temporalities. The materiality of Antarctic research varies enormously depending on differing disciplinary subjectivities with funding a fundamental enabler, translating and making tangible research ideas and projects. The networks of heterogeneous relations in Antarctic research are multifarious, operating in localities across the globe and within international spaces and, become enacted through different and overlapping knowledge practices and across multiple temporalities.

Chapter 4
Knowledge

Knowledge became a recurring theme across my interviews; it was something possessed, gained, disseminated, valued and lost. Antarctic research is a busy and complex space of multifarious disciplinary subjectivities, epistemologies and languages. Antarctica is enacted through disparate research communities spanning the globe, who collectively have much in common as we see the construction of an Antarctic specialist subjectivity. Therefore, epistemic approaches help to address the practices and institutions through which Antarctic knowledge is produced across scale, place and time. There are disciplinary and linguistic tensions that emerge through dominant framings and interpretations of a continent for science and at international meetings through the language challenges of only four Antarctic Treaty languages. Certain knowledges and values become privileged through the epistemic structures of Antarctic governance and research. Antarctic knowledge is practiced and produced through multifarious and complex networks and relations.

Epistemics

Epistemic cultures are *"those amalgams of arrangements and mechanisms – bonded through affinity, necessity, and historical coincidence – which, in a given field, make up* ***how we know what we know****. Epistemic cultures are cultures that create and warrant knowledge"* (Knorr Cetina, 1999: 1 original emphasis).

Thinking in epistemic terms when addressing the production of scholarly and scientific knowledge concerning Antarctica is useful. Epistemics are a conceptual tool for analysing the institutional arrangements that shape knowledge production. There are a number of inter-related heuristic epistemic concepts that I will introduce and draw on as tools for understanding knowledge production in Antarctic research. Epistemic community and technocracy are more specific inflections that can be considered sub-sets of the broader epistemic culture. Foucault ([1969] 2002: 211) defines 'episteme', as "the totality of relations that can be discovered, for a given period, between the sciences when one analyses them at the level of discursive regularities". This suggests that knowledge formations are predicated upon particular epistemological assumptions and are grounded within a given period in history. Building on the concept of episteme, Haas (1990: 55) develops the idea of 'epistemic communities', which are defined as "a professional group that believes in the same cause-

and-effect relationships, truth tests to assess them, and shares common values." The Antarctic research community is made up of many epistemic communities with many overlapping and shared values. For groups of Antarctic policy makers and the Antarctic governance regime, the focus shifts from constituency (the community of researchers) to its governing form (the political and technological apparatus that makes their practice possible) which O'Reilly (2017: 7) terms an "epistemic technocracy", drawing attention to the political arrangements within which Antarctic epistemic communities are produced. The notion of epistemic communities direct our attention to the relations among practitioners, in contrast to the formal structures of possibility to which they are subject, which O'Reilly's epistemic technocracy directs us to. Epistemic communities struggle to account for the embedded practices and institutions within which given epistemic knowledges and information are created and produced in addition to the material agencies within the process (O'Reilly, 2017). Furthermore, O'Reilly (2017) discusses how the agency of actors and their capacity for influence within epistemic communities is not equal and where such ideals of shared and agreed upon knowledges lead to practices of inclusion and exclusion, relevant to disciplinary boundary-making. Epistemic cultures, developed by Knorr Cetina (1999; 2007) is a broader, more inclusive concept that captures both aspects emphasised by Haas and O'Reilly and in addition, has a material semiotic approach which I have also adopted for this research. Knorr Cetina (2007: 362) defines epistemic cultures as "the cultures of knowledge settings" and their "capacity to produce knowledge" (Knorr Cetina, 1999: 167). She argues that within STS, "if the focus in the early studies was on knowledge construction, the focus in an epistemic culture approach is on the construction of the machineries of knowledge construction" (Knorr Cetina, 2007: 363) and thus includes the object and material worlds and their agencies, as with material semiotic approaches, drawing attention to the understanding of both knowledge and culture as practice (Knorr Cetina, 2007). An epistemic culture approach is therefore useful for addressing knowledge production within Antarctic research because it incorporates the multifarious ways to practice research; including the different contexts, spaces and material realities. Epistemic cultures is therefore the preferred formulation for this research because it is best suited tool for analysis of a project based on interviews with members of cross-cutting epistemic communities who reflect on the technocratic apparatus that enables their work.

Furthermore, Knorr Cetina makes a case for the larger scale of "macro-epistemics" acknowledging that "not all places of knowledge… are bound spaces" (Knorr Cetina, 2007: 367) and may involve "macro actors". The Antarctic research community may be seen to share a macro-epistemic culture, with a shared focus on Antarctica, with knowledge produced across different locations on the continent as well as in the Southern Ocean. Antarctic climate scientists too could be seen to belong to the macro-epistemic community of polar and global climate scientists, with a shared

consensus about the risks posed by anthropogenic climate change. Macro-epistemics are better able to account for the many different scales and capacities that build knowledges and produce information, as well as the practices and machineries through which these processes take place. In the Antarctic, O'Reilly's (2017) 'epistemic technocracy' is useful because it more specifically directs our attention to the institutional infrastructure and governance of knowledge. Epistemic communities, whose deployment is more specific to analyses more concerned with the social than political approaches, draw attention to the shared values of professional groups, not dissimilar to disciplinary subjectivities. Epistemic cultures, highlight the settings, machineries and institutional arrangements of knowledge production through practice. Macro epistemics operate across an international scale and may be understood as "wider networks of knowledge generation" (Knorr Cetina, 2007: 361) and could include, for example, climate science communities and 'macro actors' such as the UNFCCC. Macro-epistemic cultures are made possible through the global assemblages of actors and institutions producing knowledge within micropractices (Knorr Cetina, 2007). An epistemic technocracy is more specific, referring to the governance arrangements where scientific and political expertise are shaped by and with one another, as is the case for the ATS. Epistemic technocracy is thus a useful term to be used in the Antarctic context (O'Reilly, 2017).

We may wish to identify numerous epistemic cultures concerned with Antarctica. At the governance level for example, Elzinga (2013: 208) describes how "the decision making cultures in which they [NAPs] are embedded differ considerably between countries" (Elzinga, 2013: 208). The Council of Managers of National Antarctic Programs (COMNAP) provides an epistemic technocracy for NAPs that transcend national interests, and the SCAR may be seen to provide an epistemic culture for the wider community of Antarctic researchers. The more specific interplay between scientific expertise and governance within the ATS may be considered an epistemic technocracy (O'Reilly, 2017). An epistemic approach offers many possibilities that can be developed and applied to a variety of concerns, for example in relation to community and in relation to technocracy. This repertoire of inter-related concepts allows us to consider the significance of communities, practices, structures, and spaces for research.

Certain knowledges come to be privileged by epistemic structures, "by sustaining or discouraging certain epistemic outcomes" (Knorr Cetina, 2007: 362). Thus, conceptualising Antarctic knowledge production using epistemic framings is a useful way to address the wider contexts and institutional dimensions within which the knowledge is practiced and produced. In the Antarctic research community, the rhetoric of peace and science has become a means and justification for the privileging of positivist scientific epistemologies for Antarctic research (Elzinga, 2017; Roberts et al.,

2016a). We may consider the politics of integrating specific kinds of epistemic community within the macro-epistemic culture of Antarctic research. Within SCAR, for example humanities and social sciences (HASS) have been incorporated within the system, an indication that the terrain is shifting. However, the group does not have the same standing as the natural sciences as Jo, an Antarctic humanities researcher discusses:

> *I think it's something that we're seeing over society generally and this kind of raising up of science and we see it in conversations about the importance of STEM… just that really pushing of science, technology, maths this is the future and I think it's ended up with something with a more narrow focus… In terms of Antarctica… I think that idea of peace and science has been used as more of a justification for that [privileging of the sciences] I know within SCAR certainly one of the difficulties we've encountered with trying to elevate the status of the humanities and social science group is people saying well it's a scientific committee why don't you go over to the humanities equivalent, which there isn't one and that's why the term social science can be really helpful even for someone in the humanities, I've used that to my advantage before.*

Here Jo, a humanities researcher, reveals an interesting insight into the fluid boundaries between domains and the possibility for researchers to make claim to typological identities in strategic ways, whilst also highlighting tensions encountered between academics of differing disciplinary subjectivities in addition to the institutional arrangements through which certain epistemologies become privileged.

When differing epistemic communities' boundaries rub up against one another, there can be a resultant friction between knowledge claims. This friction is perhaps best illustrated through the so called 'science wars'. This refers to a period of discursive controversy in which scientific positivist accounts of objectivity were challenged by constructivist accounts of science as social, political, situated and partial and, where the turn to practice and language took place (Asdal et al., 2007). It was argued that facts are created by scientists at specific times and in specific settings through practice (drawing upon Kuhn's idea of the paradigm) rather than truths about nature simply revealed or discovered, leading Haraway (1988) to speak of *Situated Knowledges*. STS scholars were critical of the "bifurcation of nature" (Whitehead, 1930) into nature/culture, human/nonhuman, subject/object and where nature became transformed and reduced to mere matters of fact (Whitehead, 1930; Latour, 2004). These epistemological differences, and in some instances suspicions, may be reinforced by disciplinary boundaries.

Figuring Antarctica as a metaphorical 'laboratory' adds further significance to the construction of Antarctica as the continent for science. The laboratory became a setting for many sociologies of science and gained importance as the space at the forefront of the scientific knowledge production effort as the "fact factories" (Knorr Cetina, 1995: 141) where many early sociologists conducted their fieldwork to understand "science in the making" (Asdal et al., 2007: 14) (see Knorr Cetina, 1995; Latour & Woolgar, 1979; Latour, 1983; 1987; 1988). Within STS "the laboratory has since achieved a position as the privileged, exemplary location in which to conduct studies of science, knowledge production and power" (Asdal et al., 2007: 9). Therefore, the metaphorical figuring of Antarctica as a laboratory is value laden, reifying and reinforcing a position of power and preference for the natural sciences. "A place is not "naturally" scientific, but must be established and maintained as such through social and political practice" (Messeri, 2011: 150).

Situated Knowledges

The peace and science rhetoric of the ATS sees a privileging of the natural sciences (Roberts et al., 2016a; Elzinga, 2016; 2017). Roberts et al. (2016a: 2) argue that "the implication is clear: unlike the rest of the world, with its complicated relations between people and nature, Antarctica is governed by an enlightened political order that acts both through and for science." The experiences of many of my research participants suggests the privileging of natural science epistemologies and practices has resulted in a subsequent marginalisation of those in the humanities and social sciences with many comments speaking to a frustration at having been overlooked (Lou; Alex; Maja; Jo; Francis; Emmanuel; Karsten). Karsten for example recalls a meeting with the Antarctic scientific research community in the lead up to the 4th International Polar Year (IPY):

> *It was the same patronising attitude from the natural science side… it's very good if we can bring in some social scientists into our projects but we'd be kind of, social scientists would be kind of servants or handmaidens you know, a secondary position in relation to some project or problem as defined by natural scientists and we said no we don't accept this… I remember these patronising attitudes one met at that time.*

The experience of Karsten is not unique amongst those interviewed, and I have had similar conversations during the course of undertaking this research. A situation not dissimilar to the one Latour faced at the beginning of *Pandora's Hope,* with Latour lamenting in 1999 that we have far to go. Fittingly, Latour (1999: 295) goes on to conclude that "the science wars are only the latest episode in this polemical use of objectivity – and not the last, I am afraid". The experiences of the Antarctic

HASS researchers interviewed suggest the preference for natural science is not only well established but has permeated through research communities and the general public alike.

"Two centuries ago, it was the liberal arts and humanities that were thought necessary for informed public debates... The eclipse of a public role for the humanities since the mid-20th century has been prompted by a continuing current of positivism within our culture, which has simultaneously defined quantity as the measure of reality and devalued traditional notions of the public relevance of a liberal education." (Frodeman, Mitcham & Pielke, 2003: 31).

Therefore, within the ATS is useful to understand how the institutions and epistemic structures shape the conditions of practice and knowledge production. Jo discusses some further frustrations:

> *I do also sometimes find it a bit difficult to get support for my project or get it kind of recognised as Antarctic research because it's not going down there and drilling ice cores, or collecting krill or what some of my other colleagues do, so that is also a challenge to doing this kind of research about Antarctica I would say, like people's preconceptions about what Antarctic research is… I've found it very hard… to get recognition that this kind of research is research… my institution has made life very difficult… it's some of the structural stuff that has made it really hard. It's pretty stupid, because it is Antarctic research.*

Maja, a social scientist simply states: "*everything is in the name of science*".

The Antarctic research community can be seen to share an epistemic culture, organising itself around an Antarctic commonality as evidenced through the biennial SCAR Open Science conferences in addition to the recent Horizon Scan which addresses future Antarctic research directions (which heavily lean towards the natural sciences, see Elzinga, 2016). The privileging of the natural sciences within the epistemic structures of Antarctic research communities, driven in part by policy demands for predictive science (as will be discussed in the next chapter), results in the false dichotomy of empiricism or constructivism and a valuing of certain research over others. The extent to which funding bodies and others in decision making positions subscribe, to or participate in (consciously or not), such privileging helps determine the kind of research pursued in and on Antarctica. The status of HASS disciplines on the periphery in Antarctic research affects researchers' capacities to image possible research projects in the future. Pessimism, as expressed by Alex, a social scientist, who considers Antarctic social science as "very peripheral", lacking a secure future, is contrasted by Jo's optimism:

I feel like in Antarctic humanities, it's just sort of beginning and there's a lot more opportunities for research and for contributing to wider projects as well, for really saying something that maybe other disciplines, particularly something empirical like science, can't say because of that ability to step back and look at the whole cultural context.

Antarctic fieldwork has become something of a rite of passage for Antarctic researchers (not unlike fieldwork for socio-cultural anthropologists as touched on in the methods) as Howkins (2010) postulates in *"Have you been there?" some thoughts on (not) visiting Antarctica*. Going to the places we study confers a certain legitimacy, especially it seems, on one's Antarctic research experience, which Howkins (2010) argues is undeserved. Roberts et al. (2016a: 6) discuss the prominence of explorers' narratives which "perpetuated a sense that Antarctica was a subject best pronounced upon by those who had experienced it directly". Within Antarctic research this becomes particularly apparent and speaks to a general interest in the continent (Howkins, 2010). Jo reflects on being asked the very question of "have you been there?":

What you do find a lot and I've talked to several of my colleagues about this, when they find out you do Antarctic research the first thing they ask is have you been or they assume that you haven't, if they are a scientist they assume that you haven't and then once you say well actually I have, you know that kind of, the level of respect accorded jumps up, and it shouldn't be like that because it has nothing to do with the research or the quality of the research, that's just like oh well I have therefore I know more… it's always that question have you been and if yes then people automatically think that you more qualified to talk about that place.

As Jo points out, the quality of the research is unaffected by having been there or not but rather symbolically functions as an indicator of group membership and a shared experience of a place with highly restricted access. The resultant insider/outsider dynamic favours the natural scientists who have greater representation in this exclusive club, keeping those in the HASS disciplines at the margins, as natural scientists' research more often requires a trip to the ice.

Leane (2011) argues that we are witnessing a *cultural turn in Antarctic Studies* with the breadth of research undertaken in both the humanities and social sciences at its greatest. In recent years, there have been a plethora of books published in the Antarctic HASS; *Antarctica and the Humanities* (2016), *The Technocratic Antarctic* (2017) and *Handbook of Antarctic Politics* (2017) to name a few and *The Polar Journal* continues to champion publications in Antarctic HASS fields (Elzinga, 2016; Steel, 2015). There is a political manoeuvring of a minority constituency, the Antarctic HASS (an

epistemic community) within what can be considered a macro-epistemic culture, SCAR. Whilst Roberts et al., (2016a) aptly title their chapter: *Antarctica: A Continent for the Humanities* and Elzinga (2016, 293) states: "the time for the Antarctic humanities has come", and thus, it appears a call to action is here.

Language

Academic & Epistemic

The epistemologies and disciplinary ways of knowing (our habitus) we develop have increasingly become barriers to interdisciplinarity. Epistemic communities as Haas (1990: 55) describes them share a "common vocabulary", while epistemic cultures can be seen to share a common goal or desired outcome through differing "capacities to produce knowledge" (Knorr Cetina, 1999: 167). The barriers to interdisciplinarity in Antarctic research are not unique. Antarctic research communities, however, are arguably well positioned by organising themselves as a place-based rather than discipline-based community through the construction of an Antarctic specialist subjectivity. There are commonalities in research agendas especially in the rubric of climate change. Karsten discusses the linguistic challenges posed by disciplinary differences:

> *Interdisciplinarity as far as being able to integrate from different disciplines has been rather difficult… Some kind of commonality is needed, either the object of research looked at from different angles or else some methodology or integrative concept… However once researchers from mutually differing disciplines joined together in pursuit of a common body of knowledge or goal, when it got down to the nitty-gritty, it was found that scientists from different areas tended to talk past each other. The ideal of integrating knowledge met many barriers.*

As mentioned previously and as argued by Elzinga (2016: 288), "many natural scientists felt that the "human dimension" could be accommodated as a kind of "add on" factor – a token acceptance of our existence". A similar feeling that prompted Latour (1999: 17) to claim that "scientists always stomp around meetings speaking about "bridging the two-culture gap", but when scores of people from outside the sciences begin to build just that bridge, they recoil in horror and want to impose the strangest of all gags on free speech since Socrates: only scientists should speak about science!" (Latour, 1999: 17). Academic and linguistic differences are further highlighted by the differential intelligibility of disciplinary sensibilities serving to make academic boundaries just that. Therefore, opening ourselves up to, and the ongoing facilitation of, interdisciplinarity (what Skrydstrup (2013b) terms: "epistemic trading zones") will be crucial to collectively tackling the many

issues life on earth is facing and the fostering of creative solutions. For Skrydstrup (2013b: 225), epistemic trading zones are about "genuine interdisciplinary encounters" and the ways in which exchanges across epistemic communities might help foster a dialogue that moves beyond any one discipline and toward a shared space of knowledge practice. Understandings of our world and tackling our shared challenges demand collaborative, multidisciplinary and interdisciplinary research, where intellectual barriers are broken and we are able to climb out of our academic silos and build bridges.

Within the natural sciences, disciplinary and epistemic boundaries are further being created through new technoscientific objects and machineries of ever more specialised knowledge production. Here, Morgan discusses barriers to interdisciplinarity within the sciences:

> *Science I think is becoming more factioned and fractioned… we're almost going to, you know, kind of Tower of Babel where people aren't even speaking the same languages as much anymore… if you look at big universities now, they've not only got more departments, but within the departments they've got more specialisations than they used to have… it also means that each of those areas now builds up its own language and its own way of thinking about things and although we have massive access to information and more meetings and more conferences and more interdisciplinary meetings, it is really hard to understand what somebody in an area of science even closely related to yours but not yours is doing and what they're thinking… which is another reason why you have to have 20 people now in a grant as opposed to 3 because you need somebody who is an expert in all of the different things you want to do. So I think it is, it's getting harder to do things that are tied together properly, it's hard to understand what other people are doing, you just have to trust them, to accept that they are good at what they do and they are genuinely doing something that's positive for the overall piece of science that you want to do.*

The machineries of knowledge production in the sciences are becoming increasingly complex, where the flow of knowledge is hindered by technological as well as epistemic barriers. The proliferation of ever more finely focused forms of specialization arguably now yields an imperative for integration. Lindsey gives an example of legal policy and scientific epistemologies in tension with one another, admitting:

> *When the minerals regime was being negotiated, I was more active then, in conservation movements and lobbying for the alternative for Environmental (Madrid) Protocol. But I must admit I found it incredibly difficult reading through drafts of treaties*

or whatever, all the legal language, very difficult to get my mind around and I think a lot of scientists are probably like that.

Where differing disciplinary epistemic communities may clash, epistemic cultures may shift the focus to addressing the bigger picture collectively.

"Strong academic boundaries also influence the scope of inquiry in as far as both the political regime and SCAR subscribe to the narrow English-speaking definition of 'science'" (Elzinga, 2017: 103). As Elzinga (2017) points out, the German 'Wissenschaft' is much broader describing the holistic process of knowledge production, from collection to dissemination encompassing the humanities and sciences, a point which Francis, an Antarctic humanities researcher, discusses:

> *In German… we are all Wissenschaftler, but we are Geisteswissenschaftler, humanities researchers, and Naturwissenschaftler, natural scientists, and… I am [a] Geisteswissenschaftler, and when I translate it… I am a humanities scientist, and they said that doesn't fit together, it's contradictory.*

There is power in language as "language participates in giving meaning to and shaping these boundaries, it is important whose definitions prevail" (Asdal et al., 2007: 29). Thus, there are arguably more philosophical discussions to be had within SCAR regarding terminology and epistemology.

Power in Language

The ATS operates in four languages: English, Spanish, French and Russian, the linguae francae at the time of negotiation of the Treaty. As discussed in chapter three, the geopolitical context leading to the signing of the Treaty continues to have a significant impact on the regime today, one of the most visible examples of this is through language. Many identified linguistic access within the ATS as an ongoing challenge (Elzinga, 2017; Kerry; Alex; Maja; Jo; Matias; Robin; Lou). Kerry, for example, describes challenges to participation at the ATCM:

> *I've seen smaller delegations struggle at the Treaty meetings because they don't speak one of the four Treaty languages and part of it isn't just about participation on the floor of the Treaty meetings but it's being able to talk to your colleagues on the margin in a way that's meaningful… it's even more difficult when the meeting is over, there's a series of intersessional contact group discussions set up and they're all in English… so you always see strongly those English as a first language countries and the countries who have, like*

Germany and things, strong English language abilities, they are the ones that are participating in the intersessional discussions, not the other countries.

One of the flow-on effects of such linguistic challenges and access is that much Antarctic scholarship is written from the same perspective and by people from a narrow group of countries as Robin discusses:

I think that's the kind of discussion we need to have from differing perspectives… most people writing about the Antarctic are Anglo-Saxons, Western Europeans, Australasians you know and it seems to me we actually need people from India and China to be writing books about the Antarctic which somebody translates… we need wider buy-in to create ownership of the Antarctic in its loosest sense and so don't see very much evidence of that happening but it could.

The lack of diversity amongst voices in the wider Antarctic research community and the subsequent potential for future scholarship is also noted by Robert et al. (2016: 6) who remark that "the fact so much of the material considered canonical is by white, male and native English-speaking voices is in itself indicative of the opportunities that remain for scholars". My participants, too, as discussed previously, are biased towards the Anglosphere.

Antarctic states, in particularly Consultative Parties (CPs), are often scrutinised in terms of how active they are within the ATS. Relative levels of activity are quantified in terms of papers within the ATS as well as scientific publications where both papers and publications are an indication of participation in the system (see Dudeney & Walton, 2012). However, as Karsten discusses, non-English speaking states are further disadvantaged within the structures of such approaches:

That's the other difficulty, if you're trying to make an assessment of the performativity in terms of research papers if they're written in long non-English or non-Anglo-American languages then they don't rate them in the same citation index.

Knowledge: Education, Outreach & Policy

The flow of knowledge between different groups within the wider Antarctic community and the global public was much discussed during my interviews. The possession of, loss of, the desire to gain and the dissemination of knowledge were frequently cited in reference to policy, education and outreach. For instance, many felt that the urgency of climate change research and data conveyed was at odds with the slow pace of policy uptake, with a lack of information flowing adequately between

scientists and policy-makers often cited (Johannes; Robin; Jo; Karsten; Lou). This is also a point Matias raises in reference to the gaps between policy and science and, advocating for a broader possession of knowledge within Antarctic epistemic structures and cultures in the future:

> *I'm a scientist and all my team members, all my students and everybody that works with me I really like for them to be very familiar with these three dimensions; the science, the education and outreach, and policy-making and how they work together… One of the major issues that we need to tackle now is that you don't have many people that have these different dimensions in one single person, usually you have a scientist who just does science, you have an educator that just does the education and you have the policymakers who just do the policy-making*.

Furthermore Matias and Jo both go on to implore Antarctic researchers to be involved with education, outreach and continued support for early-career researchers. For example, the importance and value of the Association of Polar Early Career Scientists (APECS) within the wider Antarctic and polar research communities was repeatedly mentioned (Matias; Jo; Kerry; Maja). Kerry similarly expresses the importance of support for early-career researchers to ensure knowledge flows into the future:

> *I just think we have to continue to do the best we can to educate early career people to ensure that they spread out and throw themselves into these areas where they can intelligently speak about the consequences and related changes in the Antarctic to the rest of humanity and continue to ensure that Antarctic research is acknowledged and supported still.*

The dissemination of knowledge between Parties within the ATS is identified as an area where improvements can be made. Matias, Kerry, Robin and Lou all agree that the quality of the knowledge and the quality of people at the meetings is crucial to the direction and functioning of the system in the long run. As Lou states:

> *There is a lag there and yet by the same token some of those governments are still investing in science and research that they want done on the issue of climate change, so I think the need for knowledge, the understanding that there is a need for knowledge is there, I think commitment to change from a policy and governmental perspective is still very much behind the eight ball… I'm not really seeing effective flow of science knowledge into those discussions… we need good quality information flowing and regularly and we need parties to be seized by what that information is telling them.*

The 'flow' of knowledge and information within the wider Antarctic research and governance communities was an often repeated phrase. This fluidity of knowledge within given networks was always discussed in terms of its potential. The Antarctic Environments Portal was set up as a means to address this flow and access of information between science and policy where SCAR could play a more active role (Elzinga, 2017). Here, Robin discusses further challenges to the flow of information between science and policy:

> *I think another factor in most of our societies is that there is very limited penetration by scientists into our parliaments… so I think there is a conceptual problem that they have in actually understanding the language within which climate change is described and I don't think that they're professionally well-equipped to understand risk as a concept… I think there is an internal problem that we've had, which is the rarefied language within which at least initially climate change and other complex issues were discussed although I don't think that's a fair criticism of most climate scientists today, I think one thing they've learned in the last 10 years is how to project simple stories without compromising intellectual rigour.*

Furthermore, the prevalence of discussions on education and outreach implies a "one way flow of knowledge and information… it presupposes that one group has all the answers while others lack them" (Hebdon, Lennon, Ludlow, Zhang & Dove, 2016: 389). Hebdon et al. (2016) go on to argue that we need a shift of power and focus that addresses the interest and stakes that different communities have in climate change mitigation.

Values

The values ascribed to Antarctica are multifarious and continue to evolve with time (Neufeld, O'Reilly, Summerson & Tin, 2014). The Antarctic Treaty refers implicitly to peace and the scientific value of Antarctica. The Madrid Protocol recognises values of environmental protection and conservation for Antarctica as well as explicitly acknowledging the "intrinsic value of Antarctica, including its wilderness and aesthetic values". There are numerous studies that have explored Antarctic values (Neufeld et al., 2014; Summerson & Bishop, 2011; Liggett & Hemmings, 2013; McLean & Rock, 2016). As Neufeld et al. (2014) have found, globally, many value Antarctica as a utopian wilderness, undisturbed by humans with high instances of a desire for environmental protection expressed. During discussions with my research participants, narratives of protectionism and of an environmental consciousness came through strongly (Kerry; Lou; Jo; Matias; Lindsey). Here Lindsey, an Antarctic biologist recalls the concern amongst researchers in the late 1980s as mining in Antarctica

was being discussed during negotiations around the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA):

> *I've got personal experience of it… when the minerals convention was being negotiated, I organised a petition of Antarctic scientists… who were saying we don't want the minerals convention ratified and it would have had… about 100... scientists who had had Antarctic experience… and only a handful of them would have said no, so the large majority were in favour [of signing], otherwise we wouldn't have put the thing together and presented it… Now whether it's still the case, I wouldn't be at all surprised that it is, I'm pretty certain it would be really, so that is an indication, quite a strong indication of attitudes I think.*

The evolution of Antarctic values and the motivations behind them need to be understood in the context of values within societies globally (Neufeld et al., 2014). As discussed in chapter three, the Antarctic Treaty was influenced by the Cold War geopolitics of the time, which we see reflected in the ATS today. Moreover, in the late 1980s environmental considerations came to the fore in the global psyche with demands for environmental protections for the Antarctic increasing (Elzinga, 2013; 2017; Neufeld et al., 2014). Furthermore, Neufeld et al. (2014) discuss how the different values that Antarctic Treaty Consultative Parties (ATCPs) bring to the system will continue to evolve over time and at different rates, a challenge to be continually negotiated and renegotiated in order to bring greater equity into the system.

Antarctica has come to represent climate change on a scale not seen on any other continent (O'Reilly, 2017). Antarctica is the "laboratory where climate change is depicted in real time… and over millennia" (O'Reilly, 2017: 147). As a result, Antarctic research communities (in particularly scientific) can be considered to share an epistemic culture through a shared consensus on climate change and a shared desire for mitigation. Unsurprisingly, thoughts and insights into climate change were implicit throughout my interviews.

Alex describes the situation thus:

> *You can't really learn about Antarctica and not be confronted with how it's threatening to change or how it has changed or how people fear it is going to change… you can't not have that and be working in or engaging with Antarctica and any way I think it's inseparable.*

Jo recalls conversations with colleagues regarding climate change:

This is one of the things I often talk about with my scientist colleagues as well, and they're saying but the facts you know the facts are there, we just need the facts. It's not the facts that we need it's actually looking at those value systems and what people think are important and how can you bring those kind of facts and that knowledge that we have about the world, to integrate it with those worldviews and you know to touch on those different values.

Here, differing epistemic communities may be seen to be in friction with one another where their understandings and ideas about causes of a shared and agreed upon problem (i.e. climate change inaction) differ. "Fostering pessimistic scenarios has become part of a global regime of anticipation featuring a new epistemology, which exerts power effects on the public and citizens" (Skrydstrup, 2017: 72). Understanding the epistemic structures within institutions through which climate change knowledges are disseminated is important. The urgency and concern about climate change expressed by those interviewed will be discussed further in chapter five.

The importance of HASS in Antarctic research and within wider climate change research is crucial. "It is not overstating the case to say that uptake and acceptance of this information by the human population is going to be of paramount importance in the next several decades. Research is urgently required to track current knowledge pathways, identify key actors and suggest improved routes for delivery." (Steel, 2015: 4). Robin provocatively suggests:

Scientists aren't necessarily very bright or aware about things which aren't science. So it may well be that some scientist believes that the most important thing in the world is them getting through a funding round so they can go down and study algal systems in a freshwater lake in the dry valleys, but I don't necessarily think that's a very good judgement about what the most important things are that we have to do in Antarctica right now, similarly, even in the area of climate change, we're dripping with data and it's not making the slightest bit of difference to government policy in most of our countries, I sometimes wonder whether more climate research should be in the hands of psychologists and sociologists to try and explain why the hell we are so reluctant to do anything about a clear and present danger and less to glaciologists and physicists.

Representing and communicating climate change is crucial for mobilising populations and governments alike to take seriously the imminent threats to life on earth. Where "trying to produce more and more precise facts can become an excuse for not making good use of the facts we already have." (Frodeman et al., 2003: 31). Climate change pedagogies, communication and dissemination of

knowledge are urgent, but they must move beyond the dominant framings and discourses of "fear and their dissolution" (Hulme, 2008: 5) and address the intimacy of the relationship between nature and culture. As Hebdon et al. (2016: 388) argue, "to be successful, pedagogies need to foster abilities to think ecologically and to discern how human agency is implicated in this "natural" disaster".

Media, Narratives & Representations

"The very designation of the Antarctic as the "continent for science" is of course a representation – a very powerful one, which resonates with the icescape itself, a giant white laboratory coat with its connotations of objectivity and impersonality." (Leane, 2011: 150)

Contemporary Antarctica is most often represented visually by images of glaciers, icebergs and penguins or through climate models of warming temperatures and has come to be the reluctant pin-up for global anthropogenic climate change through such representations. Mainstream media engagement with the Antarctic must move beyond a reduction of the continent to one-dimensional images of ice or charismatic megafauna if we are to see a meaningful engagement with the issues facing the continent. Lou, an Antarctic policy expect with years of experience advocating Antarctic issues, expresses:

> *Very little about the geopolitics of Antarctica is ever communicated, I've struggled for years to get seniors within (NAP) aboard to understand the importance of the governance regime, because it just isn't visible to so many people, it's a group of officials that go to a meeting once a year and talk, you know that's the perception.*

Robin goes further, addressing the complexities of Antarctic geopolitics whilst critiquing the prevalence of nationalist agendas in media engagement, and opines:

> *How would you persuade a New Zealand audience that their outrage about Japanese whaling is perfectly legitimate but they're going to go nowhere if they say 'the Japanese whaling in **our** waters', if they try to frame Japanese whaling in the Ross Sea as the Japanese sticking the finger up to New Zealand when only three other states in the world recognise New Zealand's claim to the Ross dependency. Now that's not something that lends itself to a kind of simple fluffy animal story*.
>
> […]
>
> *I get called most weeks by journalists wanting to do a story or to get background about some kind of story around policy, but now they already know the answer before*

they speak to you, they already know that China is the cause of the problem, and so what they really want is you as an authority to confirm the predetermined, right? And if you don't do, you find that story doesn't go anywhere… and if they don't provide something that fits within the expected framework they don't get to sell it and so it doesn't appear. So and I think that's quite an acute problem because a kind of infantilises the kind of Antarctic debate.

Here we see how narratives of Antarctic issues can become entwined within predetermined oriental framings of the world (Said, 2003 [1978]), giving rise to a 'Polar orientalism' (Dodds and Hemmings, 2013), a term I will return to in the chapter five.

The majority of researchers interviewed were cynical of the way in which the mainstream media has engaged with the Antarctic (Lou; Jo; Robin; Kerry), with differing sympathies. For representations of the Antarctic, there is a hierarchy of certain knowledges and an authority that particular representations gain (Hedbon et al., 2016; O'Reilly, 2017). For example, O'Reilly (2017) discusses the charisma of Antarctic climate change data and models, highlighting the authority anticipated climate change narratives gain such as for example the imagery showing the disintegration of the Larsen B ice shelf.

Conclusion

Antarctic knowledge is practiced and produced in multifarious ways. Knowledge flows across and between overlapping networks and becomes coded through different epistemologies, disciplinary subjectivities and academic languages. Understanding the epistemic structures and institutions through which Antarctic knowledge is practiced and produced will be important to address both disciplinary hierarchies and frictions and will aid future interdisciplinarity through the creation and facilitation of epistemic trading zones. Knowledge is situated. It is produced through specific institutional structures and machineries and is grounded in time and place. Epistemic cultures, highlight the settings, machineries and institutional arrangements of knowledge production through practice. There are numerous languages that emerge and operate within Antarctic communities, both academic and other and often come to operate as barriers to meaningful dialogue, participation and collaboration. Education and outreach are important tools for facilitating greater engagement and knowledge dissemination on Antarctic science, governance and climate change issues. There is a need to have conversations about the complexities of Antarctic issues that are in open dialogue and move beyond recreating hierarchies of knowledge possession or practice.

"The point is to embrace epistemic diversity and reflexivity while stimulating further thinking, multi-disciplinary consultation, and debate on future research agendas in our fledging field."

(Elzinga, 2016: 290)

Chapter 5
Temporality:
Time, Uncertainty and the Future

"The world we are living in is, in many respects, an illusion. Or, to put it more precisely, it is founded on illusions. That is, much that is conventional, taken-for-granted, the 'way things are' does not stand up to close examination. The affluent Western world has become entranced by its wealth, its success and its ever more compelling technological prowess. But it pays little more than superficial attention to the consequences of its spiralling demands, to the ways it constantly transfers costs elsewhere and 'elsewhen' into the ever-receding future. Short-term thinking has become the norm and it protects us from ever taking seriously our collective attempts to consume the future."

(Slaughter, 2004: xxi)

Contemporary discussions of Antarctica and Antarctic research invariably yield insights into hopes, predictions and concerns for the future. There are many temporalities at play in and on the Antarctic; ice cores that produce a proxy of climate conditions millennia ago, historic sites and monuments of previous eras of Antarctic exploration, contemporary bases and field sites, modern universities, research centres and international meetings across the globe that construct and dissect Antarctica in multifarious ways, to the models and minds that predict an Antarctic yet to become. I use 'temporality' here to refer to the interconnections between time, history and chronology, where temporality is "seen to encompass a pattern of retensions from the past and protentions for the future" (Ingold, 2000: 194). Antarctic research communities and individuals within such communities have uncertain futures; from individual job and funding security, to organisational upheavals, national regime changes, to regional and global trends, actions and inactions. Discussions, perceptions and future predictions penetrate across the many scales that Antarctic researchers are situated within, where future anxieties do not care for disciplinary boundaries. The anxieties, hopes and ambitions of some of those researching the Antarctic have been gathered during my interviews and, echoing Liggett, Lamers, Tin and Maher (2014: 348) "future scenarios… draw a near unanimous and sobering picture"; that in changing political and ecological climates, existing management practices are insufficient to achieve comprehensive protection for both Antarctica and the rest of the planet. Antarctic futures, like those elsewhere, become constructed through multifarious temporalities where time cannot simply be understood as chronological and linear pertaining to the past, present and

future (Nielsen, 2011; Pink & Salazar, 2017) but demands a much more nuanced understanding of how time interrupts and intersects through different temporalities.

Historically, futures have been imagined from an anthropocentric viewpoint; that is, one in which futures were made and shaped by human agencies alone and where nature and the natural world were merely a backdrop for human society (Granjou, Walker & Salazar, 2017). However, in the Anthropocene (a term I will return to shortly), this is changing; the very way in which we conceive of futures must attempt to comprehend temporalities beyond dualistic understandings of a culture separate from nature, and account for the more-than-human worlds we cohabit and co-create (Haraway, 2008) and where anticipated crossings of human-induced "biophysical thresholds" (Granjou et al., 2017: 9) potentially spell catastrophe for us all. The ability to anticipate and know the future has been a feature and fascination of civilisations through the ages where forecasting has taken many forms (see Adam & Groves, 2007 for more), allowing us to plan and prepare for what is yet to come. Anticipating the future always involves moving between multiple temporalities as we organise ourselves in the present in relation to our past and to our unknown futures (Nielsen, 2011), and where understanding the interdependencies of time and space is crucial to imagining, shaping and making futures. As Adam and Groves remark; "engagement with the future is an encounter with a non-tangible and invisible world that nevertheless has real and material consequences" (Adam & Groves, 2007: xv). The relative stability or rapidity of societal change significantly alters relations to the future (Adam & Groves, 2007; de Jouvenel, 1967) and future anticipations too affect the way in which we act and respond in the present in combination with our past experiences, epistemologies and ontologies. Forecasting provides a means for creating structural security through knowledges and knowledge practices which know and interpret the yet to come and make visible the invisible (Adam & Groves, 2007).

Critical views predominate in futures literature, and my research findings are in line with the work of others exploring futures both generally (Slaughter, 2004; Anderson, 2010; Salazar, Pink, Irving & Sjöberg, 2017) and in an Antarctic context specifically (Tin, Liggett, Maher & Lamers., 2014; Salazar, 2015; 2017). Such concerns over potential futures are real, are experienced far and wide, and demand to be considered thoughtfully. Antarctic researchers tend to be passionate Antarcticans, and there is apparent consensus about protecting the continent they study, evidenced through numerous expressions of an environmental consciousness and ideals of protectionism for the continent (see Neufeld et al., 2014 and chapter four for more). The resultant concerns and uncertainties of both a changing physical environment and changing political and funding environments are causing measurable and tangible anxieties for the professional and personal lived realities of the Antarctic

researchers sampled. I did not set out to capture thoughts and perceptions on the future, but such is the nature of the Antarctic that long-term thought, planning and consideration are part and parcel of engagement with the Antarctic. Antarctica is changing, and whether or not the instruments charged with governing, protecting and managing it are flexible enough to respond as the planet and the continent changes has been subject to much debate (Tin et al., 2014; Hemmings, 2017; Elzinga, 2017; O'Reilly, 2017; Dodds, 2010). This chapter will explore the numerous Antarctic futures offered through manifestations of concern and uncertainty, hope and ambition within Antarctic research, through external global geopolitics, internal factors within the ATS, funding and climate change. I will conclude with a discussion of the many predicted Antarctic futures, through the use of models and simulations, experiences in and with the Antarctic and to the many desired Antarctic futures.

External Global Geopolitical Concerns

In chapter three I discussed how, aside from processes linked to Antarctic governance, global geopolitics have significantly influenced Antarctic research agendas, directions and funding through various enabling and disabling factors. Where chapter three addressed historical geopolitical influences, this section explores geopolitical concerns yet to be fully realised, global geopolitical trends and the nature of operating within uncertainty.

In 2016 a number of significant political events shook research communities across the world (Blyth & Matthijs, 2017). The ramifications and consequences of these events have yet to play out in full, and the uncertainties of two in particular, came up repeatedly during my interviews: the United Kingdom leaving the European Union (EU), i.e. Brexit, and the Trump presidency in the United States. While the prevalence of these two events during my interviews does speak to the Anglosphere bias of my research participants, the events are globally significant and speak to worrying trends towards the political right, to new manifestations of nationalisms and the rise of populism as we begin to see a second wave of cold war geopolitics globally (Inglehart & Norris, 2016; Blyth & Matthijs, 2017; Gusterson, 2017) already influencing the Antarctic and Antarctic research, as will be discussed. Of the Antarctic researchers I spoke with, there was clear and collective anger in response to the above events and about the uncertainty both globally and for the Antarctic as the many vulnerabilities of new known unknowns are yet to reveal themselves. Whilst the implications of Trump's election were described with language such as "going backwards" and "wildcard", and Brexit inspired the use of "bonkers," the note of real concern and anxiety was not possible to miss across all those interviewed.

Lou, with 30 years' experience in Antarctic policy at various levels representing numerous countries said:

I worry about what's going to happen… under a Trump administration where we may well see a significant reduction both on climate change research more generally but also in Antarctic research… those changes I think are worrying rather than giving hope… there are real challenges and Antarctic science is expensive, it's not cheap to do it and often an easy thing for governments to pull back on to save money. So yeah generally I'm concerned about what the future holds, for the system generally, for science and for the place, for Antarctica itself.

Similarly, Kerry who heads an Antarctic organisation discusses anticipated challenges for the ATCM:

There's a huge amount of change… when new political parties take over in a country, the US is a very good example right now… if Trump and his Republican Party decide to cut science funding then that will certainly have a drop-down effect on the National Science Foundation's ability to do Antarctic science, because Antarctic science is expensive.

Both Lou and Kerry express concern about potential future changes for Antarctic research resultant from a change of political regime and the US. In the present, they do not anticipate that Antarctic research will continue to be funded into the future by a regime in the business of climate change denial and because the cost of Antarctic research is high.

The unknowns of Brexit too are causing consternation amongst a number of those interviewed. Morgan, a senior researcher at a prestigious Antarctic research institute commented:

Brexit is going to make a difference... I was on two groups developing grant applications for the EU before Brexit and now I'm not involved in either of them because all the partners are worried having a Brit on it is going to make it less successful… I think that it is going to get harder, there are all sorts of questions about the UK government, [they] have promised to replace funds that are lost from Europe, how they're going to do that at the moment we don't know... the current feel that we get from the government is they want their science to be supportive of industry and that's harder in the Antarctic than it is elsewhere… it'll depend a lot more I think on the flavour of the government in the UK in the future and where they put their emphasis. There's a general decrease in our ability to do things because of the way the politics has gone in Antarctic science in the UK over the last 10 years and it might be that where we're going is better for the UK plc (public

limited company) in general but at the moment for the people who are, if you like, career Antarctic scientists, especially biologists, it's a lot worse than it was.

Political change has resulted in significant unknowns for Morgan having already been asked to leave two research projects because of the uncertainties of the Brexit vote, who then extrapolates that funding environments, in particularly for Antarctic research will likely be worse in the future because the science does not readily support industry in the UK. Kenward (2016) notes similar concerns as he discusses the early manifestations of uncertainty and doubt resulting from the Brexit vote for research communities within the UK and the friction it is already causing across some research communities within the wider EU.

The most recent US election of an administration of climate change denialists is a significant blow to an international community collaborating over climate change issues. The troupe of climate scepticism, denial, alternative facts and fake news have all been employed by the US government in response to the risks posed by anthropogenic climate change. As Latour (2015: 149) states "the deniers' success is not to win any argument, but simply to make sure that the rest of the public is convinced that there *is* an argument. How could the poor helpless climatologists ever win in such a kangaroo court where the point is not to reach a verdict (the verdict has been reached in the IPCC report already anyway)." At the time of writing, the US has officially pulled out of the Paris Climate Accord, further illustrating the relationship between political instability and the production of uncertainty (Nielsen, 2011). As Beck (2006b: 330) discusses (albeit 11 years earlier, still applies): "whoever believes in not-knowing (like the US government) increases the danger of climate catastrophe".

Societal stability is directly linked to our abilities to forecast and as a result heavily influences our relationship with the future (Adam & Groves, 2007). In the *Communist Manifesto* for example, Marx and Engels (2012 [1848]) describe the parallels between the new modes of production of industrial society and the coproduction of uncertainty that accompanies such rapid expansion and change: "constant revolutionising of production, uninterrupted disturbance of all social conditions, everlasting uncertainty and agitation distinguish the bourgeois epoch from all earlier ones" (Marx & Engels, 2012: 77 [1848]). Here, Marx and Engels draw attention to the development of the relationship between constant societal change and uncertainty, a point that de Jouvenel also discusses in detail:

"The fewer changes we anticipate, the more we can continue to rely on our knowledge for the future. If society tends on the whole to conserve the present state of affairs, our present knowledge has a high chance of being valid in the future. On the other hand, the future validity of our knowledge

becomes increasingly doubtful as the mood of society inclines toward change and the changes promise to be more rapid" (de Jouvenel, 1967: 10).

The responses to the instability and uncertainty caused by Trump and Brexit and situated within the wider context of a changing climate are illustrative of how "political transformations affect subjective capacities for future orientation" (Nielsen, 2011: 398), whereby it is difficult to contend with research ambitions when the very future of the structures and values that enable the research may be in jeopardy. Morgan's comments further draw our attention to another area of uncertainty in Antarctica: commercial interest.

Commercial Interest

Commercial interests and activities in the Antarctic are increasing and presently involve tourism, fisheries and biological prospecting (Hemmings, 2017). Commercial interests are not new phenomena in the Antarctic. However, it is a new blurring of boundaries between science as a public good and profitable science that risks further exposing vulnerabilities within the ATS that have yet to be resolved and threaten to challenge notions of Antarctica as a continent of peace (Hemmings, 2017). As discussed in the two previous chapters, the values that are attributed to and pursued in the Antarctic are reflective of concerns within wider global society, initially through concerns about militarisation and resource extraction to environmental concerns and protection of the continent. The concerns around increasing commercial interest are concerns about access, influence and the potential for changes in power dynamics within the system, which have further potential to influence long term decision making within the ATS. Commercial interests bring another set of values altogether. For instance, Robin worries:

> *I think it's [increasing commercial interest] going to have a profound effect because it will mean that the kind of values which are being pursued by the separate Antarctic programs and which are then melded together internationally, the kind of values framework will have changed rather dramatically… The question is whether scientific cooperation remains feasible… for states and also whether the focus on science is now a sufficiently robust glue to hold the Antarctic Treaty system together and I'm not so sure on the second point that it is.*

Johannes, a glaciologist notes his reliance on data from international satellites, the many international collaborations they facilitate and the uncertainties of continued access, acknowledging that:

More and more countries… try to get sensors up into space and so it's more and more commercialised so there are more and more commercial sensors, so there is a lot of data available but of course much of the data are not necessarily useful for our purpose… we need satellites which keep measuring surface elevation, we need satellites which keep measuring ice flow and ice flow variability, but these are also satellites and technology which is very hard to commercialise so it needs a commitment also from governments to invest money to keep that type of technology going so this is important… we cannot take it for granted that the data keeps flowing… we have to work on that.

Where Robin has concerns about the potential control and lobby within the system that commercial interest and influence may have in the future, for Johannes, commercial usage would provide a means to secure access and ongoing flow of data, where government investment is viewed as less secure.

There are ongoing issues surrounding the acquisition of Antarctic data from multiple platforms – in, above and outside Antarctica and where the boundary is drawn. Interpretative flexibility of Article III of the Treaty which states "scientific observations and results from Antarctic shall be exchanged and made freely available" has the potential to add another layer of complexity. Ironically, as Elzinga (2017) notes, much of the Cold War surveillance technology (for example satellites and remote sensing) is now enrolled in science in the Antarctic.

Nationalisms

"National science programmes do all sorts of valuable science for us, but until our governments really get serious about climate change, the thing they do ***par excellence*** *is fly the national flag."*

(Hemmings, 2017: 508, original emphasis)

The rise of new nationalisms globally are a worrying site for many researchers particularly those expert in Antarctic policy where this new wave and shape of nationalisms are exposing fragilities in the Antarctic governance regime (Hemmings, Chaturvedi, Leane, Liggett & Salazar, 2015; Hemmings, 2017). There is a rich body of critical scholarship on Antarctic nationalisms that I will not survey in depth here (see Hemmings et al., 2015; Dodds, 2017b for more). Nationalisms in the Antarctic were discussed during a number of interviews, with many expressions of concern about their potentially destabilising effects (Robin; Maja; Lou; Karsten). For example Lou discusses:

The shift towards nationalism, heavily towards nationalism in a number of countries, in Europe, the US and elsewhere, the desires of some players like Russia and China to either state or reinstate themselves as global leaders from a nationalist perspective is concerning, particularly when you think in Antarctica that that was kind of the very thing that the treaty system was set up to overcome in the first place, was individual territorial claims, we've gone from a very nationalistic approach to Antarctica to a much more global engaging system and I think if we start to see a disintegration of that where countries are actually looking at their own domestic interests of being in the Antarctic or not, then I think it could be undermining.

This is an irony not lost on Hemmings (2017: 513) who describes the ATS as a "Cold War management tool". Robin too discusses concerns if new nationalisms manifest in the Antarctic:

The Antarctic system depends upon the suppression of aggressive autonomy because it depends upon collaboration and so if the nationalism runs away in Antarctica, even at a much lower level than what alarms you elsewhere in the world, my concern is that it undercuts international collaboration.

Enduring colonial legacies in the Antarctic in the contemporary world has lead Dodds (2017b) to refer to '*Awkward Antarctic nationalism*' and what he calls the present "awkwardness of being a claimant state in Antarctica" (Dodds, 2017b: 16). He illustrates the interconnections between the historic colonial legacy of a state with contemporary views on colonialism and the awkward task of mediating between them. "There is no one 'post-colonial Antarctic'; rather it is means of recognizing that colonialism is never fixed in the past, and that the past must be invoked to make sense of the present" (Dodds & Collis, 2017: 65). There are multifarious temporalities at play within the technocratic structures that govern the ATS.

Furthermore, as touched on briefly in chapter four, the increasing interest and participation in Antarctic science and governance of Asian states in particular, as well as other non-western states, has been met with suspicion (Hemmings, 2017; Dodds & Hemmings, 2013). 'Orientalism' in the Antarctic as Hemmings (2017) illustrates, takes many varieties but is invariably framed through the rubric of the 'rise of China' (note Robin's experiences with journalists in chapter four). Here, Robin discusses manifestations of 'Polar Orientalism' in the Antarctic:

You see for example scientists or science managers arguing at appropriations hearings to get money for their national programme that they are falling behind country X. Well country X is invariably China, and… what you begin to see them saying is that it's

essential that we do the science, whereas I would have thought the objective need is for the science to be done, I mean why would it matter in fact whether the breakthrough in science say climate change is done by a Chinese scientist rather than an American or a New Zealander or whatever, I mean if the science project has the confidence in the intrinsic merits of science, which is part of what's underpinned the role of science in the Antarctic Treaty system in the eyes of the scientists, then surely it shouldn't have this hypocritical stance which seems to suggest that some practitioners of science in the Antarctic are inferior, well why would the Chinese Antarctic program be inferior, or even if they're not inferior, their breakthroughs are undesirable. That's back to a kind of Cold War mentality… and I think that's corrosive in the long run where we begin to see this adversarial relationship right at the heart of the Antarctic communal project that is Antarctic science.

This idea of states competing through science is also evident in the Australian narrative of a 'race' to discover the first one million year old ice core (Dodds, 2017b). There a rise of neo-colonial nations in the Antarctic challenging the current hegemon (Dodds & Collis, 2017), where traditional Antarctic states fear future marginalisation, which can be expressed both through explicit and more inconspicuous forms of nationalism and orientalism. Dodds & Collis (2017: 52) illustrate the complex temporal arrangements and relations between the many Antarctic pasts, presents and futures:

"The past is very much in evidence in the present, stubbornly persisting through such categories as hierarchies of knowledge, experience and language, which enable white, Euro-American, and Anglophone worlds to emerge as hegemonic; even if postcolonial and International Relations (IR) scholars are increasingly grappling with the etymologies of 'China/Asian' rising powers and its implications for a post-colonial encounter shaped by spatial divisions between North and South".

Internal ATS Concerns

Globally, many value Antarctica as a utopia (Neufeld et al., 2014: 248), protected environmentally, largely untouched by humans, and aesthetically stunning; Antarctica is often cited as 'the last great wilderness'. Such idealism is not in the minds and experiences of those interviewed. As discussed in chapter four, the many values inscribed on the continent externally in addition to those brought into the system by the numerous players are changing over time, are reflective of an evolution of values within global society more broadly speaking, and are reflected through the evolution of the Antarctic Treaty System (see Neufeld et al., 2014). However, as will be discussed, the incorporation of values into the Antarctic governance regime is not fluid and continues to reflect the global hegemon

of the Cold War era in which the Antarctic Treaty was negotiated. As a result, many see this inequity as a threat to the very legitimacy of the system both presently and crucially into the future too should the status quo remain (Hemmings, 2014; 2017; Dodds, 2010; 2017a; Dodds & Collis, 2017; Elzinga, 2013).

While manifestations of nationalism globally present new challenges in the Antarctic and around its governance, the ATS has yet to adequately deal with shortcomings in relation to equity within the regime itself threatening to undermine the regime's legitimacy (Dodds & Collis, 2017; Hemmings, 2017). As discussed in chapter three, equity within the Antarctic governance regime has been much debated, the legal instruments and norms were set by the global hegemon of the 1950s and the modus operandi remains fixed (Hemmings, 2017). The need for the regime to become more responsive to current global politics with an incorporation of a wider array of global values is necessary if it is to receive greater commitment, investment and legitimacy (Hemmings, 2017; Tin et al., 2014). However, as Hemmings (2017: 510) discusses; "the sense of entitlement that the earliest Parties still feel they have" reifies unequal power dynamics within the system whereby the previously 'traditional' Antarctic states (i.e. the original 12 Treaty signatories) "perceive their profiles and influence to be in relative decline" (Hemmings, 2017: 510). Lou discusses future challenges for the ATS as follows:

> *The challenge is to have an adequate and effective governance regime that is contemporary, addressing the issues that need to be addressed, that it has charged itself with addressing by establishing the regime in the first place and that there is sufficient commitment from governments either through research funding or support to the International governance regime Secretariat, sending people to meetings to make it effective into the future, that's the challenge. There is a risk, I think that it just slowly becomes a more and more moribund organisation because of that lack of commitment, lack of interest on the part of governments, so something has got to change in order to generate that long-term or that desire to see the system operate in the long-term and I'm not seeing it at the moment… governments pulling funding back, British Antarctic survey going into something of a decline, arguments over contributions at meetings, lack of an adequate agenda, all of those are indicators to me that the system just isn't quite doing what it really should be doing so that's the challenge.*

There are many temporal implications highlighted through Lou's comments. For instance the use of the word, moribund, the etymology of which suggests a terminal decline, illustrates an understanding and experience of the system functionally operating during a time in which there was greater commitment on the part of governments. Lou further extrapolates future likelihoods of

governments 'pulling funding back' through an understanding of present signals to anticipate the future. Moreover, Lou demonstrates how a normative understanding of the role of the ATS both in theory and in practice and, in the past and presently, has led to the conviction that it is not fulfilling this role: 'what it really should be doing'.

Matias too, illustrates temporalities at play, discussing present and potential future challenges for the ATS:

> *What we do in the Antarctic will be an example to the rest of the world and I think the Antarctic Treaty will go on being very stable but things could deteriorate very quickly if the lobby of the fossil fuels continue and says shall we explore it or not the minerals in the Antarctic, I think it won't happen … I'm hopeful and I think things will be alright, but it I think it's the political part of the puzzle that we need to be more conscientious of it will be the hardest challenge.*

For Matias, the assertion that the ATS 'will be an example to the rest of the world' provided the system is not undermined by the pursuit of commercial values shows an awareness of the potential power the fossil fuel lobby wield and the destabilising effect this could have on the ATS, should it become susceptible in the future. Matias, like Lou alludes to future political challenges illustrating the interplay here between the real and the ideal.

Kerry sees challenges to the ATS too:

> *I think the biggest challenge facing the governance arm of the Antarctic Treaty system is ensuring that the systems and organisations outside of the Antarctic understand the critical issues relating to the Antarctic, we need to make sure that areas outside the Antarctic that are having policy decisions made for them understand what impact indirect human activity is having on the Antarctic… I think we've been very bad as a community to do that, the Antarctic community is very insular we have our own little ways of doing things and terminology and we try to keep that to ourselves and we go to the meetings and we walk away and we don't feed that into the other arms of the governance system, the global governance system so I think we have to do better at that.*

For Kerry, the challenges to the ATS are external and about the networks of relations between the internal institutional structures within the Antarctic community and those externally whose decisions could impact the Antarctic. Kerry alludes to an insider/outsider dynamic within the ATS and the language the community has built up as a barrier to the flow of information to external governance

structures. Moreover, for Kerry the assumed implication is that external decisions made without an appreciation or consideration for the Antarctic will adversely impact Antarctica.

There appears to some agreement amongst those interviewed and the literature that the ATS is not operating at its potential, where there is an understanding of ideal and desired ATS operations and understandings of its real operations. "Current environmental management practices and regulatory mechanisms will not be sufficient to address the environmental challenges in a warmer and busier Antarctic in the twenty-first century and beyond" (Liggett et al., 2014: 348). Here we see how "the future emerges as anticipation inscribed in the present" (Nielsen, 2011: 398).

Funding & Research Directions

As touched on in chapter three, a significant enabler of Antarctic research is funding. Funding can be a significant cause of consternation for any researcher, impacting abilities to make potential projects tangible and capacities to practice research into the future. Funding emerged as a recurring theme during my interviews.

Johannes explains:

> *Funding is of course critical, we cannot do it without funding and… we would like to do more but quite often… there are restrictions to funding.*

Similarly, Morgan states:

> *Getting funding to do the research is crippling us… I don't have the ability now to ask what I think are fundamental questions in the Antarctic.*

Francis too, expresses:

> *What I also need all the time is funding and it's always from one year to the next so I don't know if I can continue… it's really tiring and I'm sometimes a little bit frustrated and getting a little bit cynical.*

Thus, the temporal implications of an uncertain and contestable funding environment are significant. Uncertainties and the often accompanying frustrations become extrapolated into the future, impacting upon research directions (Johannes; Alex; Francis; Morgan), scope (Johannes; Morgan), length of a project (Morgan; Johannes) and individual researchers' future careers (Francis; Alex).

Funding is also a central focus of the uncertainties expressed over Trump and Brexit as well as how funding environments are changing. As mentioned earlier, Brexit has already affected involvement in upcoming research projects for Morgan, drawing attention to the human dimension and experience within broader geopolitical contexts. In order to secure funding there are many bureaucratic imperatives to be negotiated, as Lindsey discusses:

> *The scientists want to attract funding from the National funding agencies and to do that nowadays it's got to be shown to be internationally relevant, you know all the usual things, multidisciplinary, international research, team research, focused on important questions which are recognised as important by the science community… and if you don't do those things you won't get the money hence they go through this exercise.*

Lou feels:

> *A lot of bureaucracy and administration is absorbing those costs when that could be spent on science.*

Such funding environments are by no means unique to the Antarctic research community but will have an impact on the future directions of Antarctic research.

Future directions of Antarctic research have been rigorously discussed since scientific exploration on the continent became inscribed in the Antarctic Treaty (Hanessian, 1960; Hambro, 1974), when new levels of environmental regulation came in with the Madrid Protocol (Herr et al., 1990; Elzinga, 1993a) and most recently through the SCAR Horizon Scan leading to the Antarctic Roadmap, which sets out a vision for the future of Antarctic research over the next 20 years by identifying 80 priority areas for future research (see Kennicutt et al., 2014; 2015 for further detail). The Horizon Scan was carried out by researchers for researchers, specifically addressing research ideals in abstraction. The COMNAP Antarctic Roadmap Challenges (ARC) projects directly builds upon the Horizon Scan research to explicitly address the questions of how to *enable* the research set out during the Horizon Scan (Kennicutt, Kim & Finnemore, 2016). New partnerships to secure and enable future Antarctic research have been discussed and public-private partnerships may be sought to address research and funding requirements, whereby the ATS will need to be open to working with new stakeholders.

Therefore, there is an acknowledgment that knowledge, abilities, technologies, materials, resources, access, and logistical support as discussed are all important enablers for the performance and realisation of Antarctic research. However, it is ultimately funding that becomes a mechanism for participation or non-participation.

Climate Change

"Researching environmental futures requires us… to destabilize the disciplinary patterns of the social construction of reality in order to confront the autonomous and outside reality of the future… [and] to become more attuned to the fact that humans and societies do not own and shape "their" future alone. Environmental futures are definitively "more than human" futures." (Granjou et al., 2017: 8)

"Species interdependence is a well-known fact—except when it comes to humans. Human exceptionalism blinds us." (Tsing, 2012: 144)

The Polar Regions are warming faster than any other and have come to represent climate change. As a result, we see Antarctica situated and constructed as a place of climate change (O'Reilly, 2017: 14) through multifarious knowledge practices, representations and narratives (see O'Reilly, 2017 for further discussion). As discussed in chapter four, Antarctic research communities can be considered 'epistemic communities' for climate change knowledge with shared values and agreed upon sets of knowledge. The uncertainties of climate change were implicit during large portions of my interviews and explicit during all discussions about Antarctic futures where concerns are dual: for the Antarctic itself, and for elsewhere where anthropic industrial practices continue to directly impact the Antarctic environment. "Modern society has become a risk society in the sense that it is increasingly occupied with debating, preventing and managing risks that it itself has created" (Beck, 2006b: 332).

The Anthropocene, a term that has been much problematized (Latour, 2015; Helmreich, 2016; Bonneuil & Fressoz, 2015; Haraway, 2015), draws our attention to the influence that humans are having on planetary changes, "the final rejection of the separation between Nature and Human that has paralysed science and politics since the dawn of modernism" (Latour, 2015: 146). The prominent discourse of futures of climate fear and catastrophe are linked with neoliberalism and the emergence of a "world risk society" (Beck, 2006b; Hulme, 2008). "Climate science lost its innocence with the Hockey Stick and… the business of going public with science irrevocably means politicising science" (Skrydstrup, 2017: 77).

The science-policy gap was repeatedly mentioned during my interviews, where the pace and uptake of scientific knowledge within policy both within the ATS and globally was a cause of considerable concern. Johannes discusses:

It's almost scary how slow it is, I mean and also how this knowledge is taken up and ignored, largely ignored… it's the timescale I think… even 10 years, thinking 10 years out is difficult, I think it's the problem of the timescales, of the climate, I mean by definition climate is the mean state of our weather or environmental conditions… over say several decades and to change climate or to see climate change it takes long.

Johannes draws our attention back to time. We see a collision between the numerous different timings at play; cultural time, political time, geological time and climate time. There is a discrepancy between scientists' discussions of geological and climate time, which centre on for example, the atmosphere, sea level rise and associated probabilities; science time, with an absence of a human dimension. On the other hand, there is 'real time' operating at a much more urgent pace with for example unprecedented flooding across disparate parts of the world and larger and more intense storms. Here, we see natural disasters set within a wider framework in which scientific investigation follows frequencies and probabilities of a predictable nature and in which scientific funding is itself implicated within social, political and bureaucratic timings. With vastly different epistemologies, scales and temporalities at play, Helmreich (2016: 115) calls for a need to "calibrate geological time to social time". Time and the climate become formalised within computer models and simulations, but what do these formalisms mean in human terms? O'Reilly (2017: 148) argues that climate change narratives "rely on multiple temporal shifts that can obfuscate the stories and cautionary tales being told".

Johannes and Matias both discuss the need to keep documenting and collecting good quality data on climate change in the Antarctic. Johannes discusses:

From a science point of view, I mean what the political conclusion is, this is up to the policy makers of course, but the only thing what we can really try to do is that we enhance the knowledge in a way that we have, that we find a better basis for decisions, that we can predict better the changes and the consequences, I think this is what is really really urgent.

Johannes situates the research and policy as separate but interconnected through the epistemic technocracy of the ATS. Johannes expresses hope that improved data will lead to meaningful policy action and the contribution the research has towards this goal.

A number of the Antarctic researchers interviewed expressed a sense of pride about their research and firm belief in the contribution their science is making within the wider context of climate change information and the need for a continued effort in the Antarctic, ensuring good quality data

keeps flowing. For example, Matias an Antarctic scientist working with a prestigious Antarctic research institute makes this prideful assertion:

> *I think what's the most important, is that… you feel special… it takes a lot of time to collect the samples, so when you finally publish the paper, by the media interest and the implications on policies that it has, all the scientists I mean particularly me and my colleagues in my team we feel very privileged to go to the Antarctic to collect samples, you feel that you are doing something for the planet you're not doing something that people don't care [about], you feel that the rest of the world cares. So, when you come from an Antarctic trip, you know the media is very interested in what you found out, why it's important, all these issues are really relevant like sea level rise, climate change is it really happening in the Antarctic… so we repeat the message almost every year adding everything that we are finding out there that year.*

Matias' prideful assertion at the privilege of helping making a contribution highlights the human dimension of the individuals behind Antarctic research. Matias expresses hope for the future and the tangible practices that will make a positive change for our shared futures.

"We are not dealing here with indisputable "matters of fact," but with "matters of concern" to be disputed. It is a question of knowing "uncomfortable facts" about pressing issues that concern the very soil on which every body resides" (Latour, 2015: 150).

Technologies, Models & Simulations

The demand for predictive science is increasing (Skrydstrup, 2017; Granjou et al., 2017) and, as a result in Antarctic and climate science the "machineries of knowledge production" (Knorr Cetina, 2007) are also becoming technologies of anticipation. The challenges lie in managing uncertainty and risk. In order for governments to attend to future risk, risk must be brought into the realm of the manageable. "Contemporary political decision-making is a forward-looking process, which therefore produce a demand for science-based predictions" (Skrydstrup, 2017: 72). Hence, models and simulations become tools for expert extrapolation, risk mitigation and management. These operate with and through multifarious temporalities in Antarctic research. Here we see the past used in the present to extrapolate an anticipated future, which will in turn (in theory) help us in the present to make decisions about that very future. We are therefore no longer talking about a real world, but a proxy, a constructed, predicted and anticipated world.

Johannes explains anticipated future research:

> *For glaciology I think it's quite clear that… new data strategies and getting more data, getting better ground validation data so at least the same maybe the faster pace we will get a better understanding how the ice sheet really works, we will have better models, so probably in 10 years' time we will be at the stage where meteorology is maybe today, that we are able to predict the change on the Antarctic ice sheet depending on how the ocean and the weather is changing, so I think this is kind of the route that we're going*.

Moreover, here Johannes predicts when they may be able to better predict. Johannes goes on to state:

> *What we really need to try to achieve is that we really get better at telling what's going to happen, that we get more accurate at how will the planet look like in 50 years' time or in 20 years' time.*

Morgan discusses the losses of knowledge perceived with the increasing use of models:

> *I don't think we're there with the models to have the same overall breadth and depth that you would get from somebody who had spent a lot of time understanding how organisms function as a physiologist. We might get there in 10 years' time, where you can literally do most of it on a computer but I think there's lots of caveats there. It's much harder to see where the problems with your data are if you've not actually done those sorts of experiments, and before somebody who's running those models hasn't done any of those experiments and doesn't understand the limitations of what the experiments are telling you whereas like I say 25-30 years ago there were people who had done literally thousands of experiments on groups of marine animals and you could go and talk to them about how muscles work in this way and they could tell you, whereas now you can't.*

Morgan has an understanding of the time required to gain an intimate knowledge physically working with given groups of animals and running experiments. Morgan therefore sees a decline in this intimate knowledge as the popularity of and demand for predictive aspects of science using models increases. Here, the implication is that moving towards the use of proxies and codes, one may lose their grounding in the present and knowledge of the very subjects which they aim to study.

"The main ethical motivation and financial justification for this globalised research effort in climate is to allow better understanding and prediction of our climate in order to manage it in better ways for "societal benefit"" (Peterson & Broad, 2009: 71).

Conclusion

Human engagement with the Antarctic spans multiple temporalities. Time, uncertainty and the future emerged as prominent themes throughout my interviews. Our conversations moved fluidly between knowns and unknowns, fears and triumphs, empiricisms and abstractions. Anticipation of the future always involves moving between multiple temporalities as we organise ourselves in the present in relation to our past and to our unknown futures (Nielsen, 2011). Antarctica is changing and the current governance policies and structures in place will not be flexible enough to respond to both a changing political environment and a changing climate. Forecasting allows us respond in the present to our anticipated futures, but societal and political instability and change lead to the production of uncertainty. In the Antarctic, commercial interests and new waves of nationalism threaten an already vulnerable regime, creating anticipated future political challenges. Antarctic researchers operate within these modes of uncertainty. We are living a risk society. Anthropogenic climate change threatens the very future of our planet. As a result, climate scientists are more often called upon to conduct their research in the anticipatory mode, using models and simulations to predict a future yet to come and to bring the unknown into the realm of the known and manageable (Granjou et al., 2017). The machineries of knowledge production in Antarctic science are increasingly technologies of and for anticipation. Granjou et al. (2017) present a strong case for the use of foresight to address environmental and political concerns over hindsight, while Nielsen (2011: 398) argues for "a view on anticipatory action which takes seriously those 'possible worlds' which, although not yet realized, inform people's everyday actions". We must acknowledge our responsibility and "response ability" (Haraway, 2008: 88) in collectively shaping our more-than-human preferred futures.

"Social learning, if it occurs at all, is often slow, crude and can be very expensive. It appears that our species, while familiar with foresight, often fails to employ it until forced to do so. In other words we seem to require some sort of painful 'learning experience' before we will trust our foresight capabilities and act in timely and effective ways." (Slaughter, 2004: 250)

Chapter 6
Conclusion

Research efforts in the Antarctic require a very deliberate mobilisation of materials, resources and personnel, a choreography performed in multifarious ways across the world. Antarctica becomes imagined, enacted and practiced across universities, international meetings, and by domestic governments. The geopolitical history of the Antarctic is saturated with competing nationalisms, and today national agendas are threatening to spill over into the Antarctic as we see a rise of populism within neoliberal globalisation. There is a friction that emerges from Antarctic research. The icy continent is a place designated for the peace and ideally apolitical science but these ideals are at conflict with the reality of a highly politicised and internationally fragile space. The mismatch between scientific knowledge and policy change are a great source of frustration as time interrupts and intersects, weaving between the different epistemic structures of Antarctic engagements. Ice cores describe the Antarctic continent millennia ago, models predict an Antarctic 10, 20, 50 years from now, and all taking place within the here and the now as we decide and align ourselves and our management practices in relation to these predicted futures. We seek to bring the risk of operating in Antarctica and the Antarctic continent itself into the realm of the manageable. Power, hierarchy and uncertainty are recurring themes throughout this dissertation. Antarctic researchers have to navigate the technocratic structures which determine the conditions and possibilities of their practice.

Materiality

Antarctica has a rich history of research endeavour that has taken many forms since human engagement with the continent first began. Engagement with the Antarctic is deliberate, one does not stumble upon the icy continent by chance. Material semiotics provide a framework for exploring the materialities of Antarctic research and how networks of Antarctic knowledge are produced. Material semiotics is suitable for conceptualizing the complex assemblages of Antarctic research, including technoscientific objects, expertise, and political and governance structures. The relationship between Antarctica and science emerges through the machineries of knowledge construction, where research becomes enacted through multiple webs of heterogeneous relations and empirical practices in which it is embedded. My research has sought to understand the role of matter and meaning with regard to the enactment of research practices and the subjectivities they produce for practitioners. Modes of engagement with the Antarctic became formalised through the 1959 Antarctic Treaty, and henceforth the continent has been constructed as a place of international cooperation and scientific

internationalism, peace and science. Science became embodied within the very fabric of Antarctic engagement, the 'currency' of influence in Antarctica and has consequently been politicised within the system.

The geopolitical context within which Antarctic engagement was negotiated is significant for the subsequent structures and institutions that have emerged and become the ATS, a form of colonial and technoscientific governance. Colonial legacies remain present through the privileged status original signatories continue to enjoy. The Antarctic Treaty is a noble ideal, sublimating international political rivalry into international scientific cooperation and collaboration. The roots of entrenched national interests remain deep as, for instance, highlighted by the fact that there is still no truly international Antarctic research station. International scientific collaborations in the Antarctic are grounded in the material practices and encounters through relationships between individual researchers, especially as Antarctic research requires a large-scale mobilisation of resources, materials, personnel, expertise, policy and governments.

In this dissertation I have sought to show how Antarctic knowledge is practiced and produced through specific epistemic and institutional structures and is grounded in time, space and place. The intentions and motivations of the institutions involved in Antarctic knowledge production and practice are complex. There are discrepancies in time between policy creation and government response, serving to slow down decision making processes within the ATS, much to the frustration of Antarctic researchers and policy makers alike. Logistical and infrastructural support are fundamental enablers of Antarctic research. The physical location of Antarctic bases and the relationships with NAPs, impact research participation, design and practice. Antarctic science thus becomes a choreography of practice between policy, expertise, logistics, materials, and equipment. Access emerges as an important enabler of Antarctic research, and includes access to the continent itself, to people, and to information. Technoscientific objects describe and translate the Antarctic environment into past histories, present truths and anticipated futures. Antarctic research is enacted, translated, practiced and embedded in the material relations that helped produce it.

Knowledge

Epistemics are a conceptual tool for analysing the institutional arrangements that shape knowledge production. There are numerous epistemic knowledge practices within Antarctic research that make up "*how we know what we know*" (Knorr Cetina, 1999: 1). Epistemic communities constitute groups that share sets of knowledge, values and agreed upon means to assess them. An epistemic technocracy draws our attention to the political arrangements within which epistemic

communities are produced. An epistemic cultural approach employs the tools of material semiotics and is concerned with the machineries of knowledge production and their construction. In this dissertation I have sought to show how certain knowledges come to be privileged by epistemic structures, including the communities of practice and the technocratic structures through which knowledge is produced. For example, within SCAR, the institutional arrangements highlight tensions between different epistemic communities of researchers. The peace and science rhetoric of the Antarctic Treaty has seen a privileging of, and a preference for natural sciences and a resultant marginalisation of the humanities and social sciences. Antarctica has become figured as laboratory, a metaphorical figuring that reifies a position of power to the natural sciences. The personal experiences of these epistemic structures for a number of those interviewed results in frustrations. Antarctic fieldwork, much like fieldwork for socio-cultural anthropologists, functions as a rite of passage, of group membership and implied commonalities, but many Antarctic researchers do not experience the ice, and the legitimacy conferred serves to exclude.

Antarctic researchers organise themselves as a place-based community. Arguably, this positions Antarctic research well for collaboration and interdisciplinarity, but interdisciplinarity subjects researchers to many barriers. Academic languages result in differential intelligibility of research making academic boundaries just that. The increasing complexity of technoscientific machineries has meant that even branches of the natural sciences that are closely related speak different languages. These epistemic barriers need to be addressed head on, and SCAR would be well positioned to facilitate such epistemic trading zones.

The differential treatment of Parties within the ATS and also the privileging of signatory states over non-signatory states was cause for further concern and remains an ongoing challenge. There are only four linguae francae in the Antarctic Treaty System, with intersessional discussions largely taking place in English. Therefore, meaningful participation and engagement is accessible only to those with reasonable English language abilities. We see a flow-on effect into Antarctic research whereby much that is written about the Antarctic is by native English speaking voices.

Education, outreach and communication of Antarctic issues were important topics of concern. The dissemination of Antarctic knowledge and, in particularly climate change knowledge, to the wider public and policy makers was seen as a fundamental obligation for Antarctic researchers. Antarctic values are complex and continue to evolve with time. Expressions of protectionism and an environmental consciousness are commonplace within Antarctic research communities and within the global community with reference to the Antarctic. Concern about climate change, and urgency for climate change action, featured strongly in all of my interviews with Antarctic researchers. Antarctic

representations in the media are a point of concern as debates seem to be fit within predetermined framings where Antarctica is represented as a one-dimensional space of penguins and icebergs.

Temporality

There are many temporalities at play in an Antarctic context. They construct and dissect Antarctica or predict an Antarctic yet to become. Antarctic futures become imagined through a range of temporalities, where time cannot simply be understood as pertaining to the past, present and future but demands a more nuanced understanding of how time interrupts and intersects through different temporalities. Futures have historically been imagined as shaped by human agencies alone, with nature merely a backdrop for human society. In the Anthropocene, a time of unprecedented human-induced climatic change, this cannot be the case. We organise ourselves in the present in relation to our unknown futures, but political and societal stability affects our subjectivities and our capacity to think into the future. The prevalence of the concerns over Brexit and Trump speak to the bias in my sample towards Antarctic researchers from the Anglosphere but also serve to ground this research in 2017 and the global political uncertainties of the present.

Increasing commercial interest in the Antarctic blurs boundaries between science as a public good and profitable science, exposing vulnerabilities within the ATS that have yet to be resolved. New nationalisms in the Antarctic will potentially have a destabilising effect on the system, one of the very things it was set up to address in the first place. There is an ongoing *awkwardness* of being a claimant state in Antarctica, highlighting the continued colonial legacies within the system and multiple temporalities operating within the ATS. 'Polar Orientalism', which views with some suspicion the motives for Antarctic engagements of Asian states in particularly, and of other Eastern states, has manifested itself within the Antarctic and Antarctic research. One of the many challenges that have been identified within the ATS relates to a certain imbalance of power between ATCPs and non-consultative parties, which has been inscribed in the ATS from its inception and risks its legitimacy into the future. Here, "the future emerges as anticipation inscribed in the present" (Nielsen, 2011: 398) and highlights the tension between a noble ideal and reality. Funding contingencies are a significant stress for researchers too, rife with uncertainties into the future.

As mentioned previously, climate change came through repeatedly during my interviews. There is concern about the pace with which the scientific knowledge is being generated as compared to the pace with which the knowledge is being taken up by policy. There is a mismatch between the numerous timings at play, where policy change does not reflect the urgency expressed. The demands for predictive science are increasing, and as result we see the increasing use of technologies of

anticipation. A key challenge relates to the management of uncertainty and risk. In order for governments to attend to future risk, risk must be brought into the realm of the manageable. Time, uncertainty and the future are recurring themes and concerns in Antarctic research, where engagement with preferred Antarctic futures today will help shape engagement into the future.

Research Contributions & Future Directions

This research illustrates the frank and human side of experience within these broader contexts, and provides insight into how researchers experience the technocratic apparatus within which they research through ethnographic and anthropological methods and analyses. While the utility for generalisation is limited, this research speaks to the configurations, contestations, and experiences of Antarctic research. Semi-structured interviews provide a snapshot, a glimpse into the realities and experiences, of a select number of Antarctic researchers. There many ways to describe the Antarctic and many ways to be an Antarctic researcher, just like there are multifarious imaginings of Antarctica, depending on whose perspectives – individuals', nation states', institutions' – one considers, Antarctica is many things to individual researchers as it is many things to individual nations and to nations collectively. Antarctica is not static but in a state of becoming and is shaped and situated through different knowledges, epistemologies and ontologies. Antarctica is one thing whilst simultaneously many others. Antarctica is a convenience (intergovernmental cooperation over science) and an inconvenience (harsh and isolated). Antarctic descriptions transcend all three tenses as it becomes predicted, modelled, manipulated, speculated, imagined and preferred. Antarctica is numeric and linguistic. Antarctica is the litmus test for the rest of the world, for global change, and its future is inextricable from climate change, entangled within narratives of the Anthropocene and practices of climatic anticipation. "To state the fact and to ring the bell is one and the same thing" (Latour, 2014: 4). Antarctic futures are made and shaped through epistemic communities and an epistemic technocracy of the ATS, but all states have a stake in Antarctica's future, and soon they will all need to have a voice too. Antarctica is a place premised for interdisciplinary encounters, a place-based international research community with a communal project at its core. We must reassess the relationships between nature and culture through thinking with climate change, cultural change and global change through epistemic trading zones, redrawing and dismantling intellectual boundaries. We need meaningful engagement with the future today, to make visible to invisible as we collectively shape and make our preferred Antarctic futures.

"To withdraw inside the narrow limits of nation-states is the surest way to threaten the safety and livelihood of those same nation-states, and even, for some low lying countries, to risk their existence altogether." (Latour, 2016: 2)

"Half of our politics is constructed in science and technology. The other half of Nature is constructed in societies. Let us patch the two back together, and the political task can begin again… It is up to us to change our ways of changing." (Latour, 1993: 144-45)

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