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Boundaries and Agency in Climate Uncertainty:
Encountering Traditional Knowledge at the Edges of Science

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List of Abbreviations

CDA: critical discourse analysis
IPCC: Intergovernmental Panel on Climate Change
IR: International Relations
Sci-Centre: the centre of the science discourse
Sci-Edges: the edges of the science discourse
SSK: sociology of scientific knowledge
STS: science and technology studies
TEK: traditional ecological knowledge
TK: traditional knowledge
TK-Info: the "traditional knowledge as information" discourse
TK-World: the "traditional knowledge as worldview" discourse

1. Introduction

Following much public debate and amidst ongoing political turmoil, it is now widely accepted that climate change is already occurring as a result of the anthropogenic elevation of greenhouse gas levels in the atmosphere (IPCC 2007b; Oreskes 2004). The Arctic region is at the frontlines of experiencing the effects of climate warming (ACIA 2005). For this reason, it has attracted increasing international attention from scientists wishing to better understand the effects of this phenomenon. This is a threat whose scale and scope are in many ways unprecedented; it therefore has the potential to call into question some of the foundational ontological and epistemological claims of science.

Indigenous peoples in the Arctic are experiencing climate change in their daily lives, mediated through the perspective of their own traditional worldviews (Krupnik and Jolly 2002). Traditional knowledges are multiple and diverse, varying considerably among places and peoples. Nonetheless, in the North some general shared characteristics are often discussed, especially in contrast with Western science. While science generally views the world in terms of causality and linearity, indigenous worldviews seek to understand in terms of analogy and cycles (Bielawski 1997, 478). Traditional knowledge treats human-environment and human-human interactions in the same way, and there tends to be "no distinction between nature and society"; understanding of the environment and animals is fundamentally linked to the understanding of self (Nuttall 1998, 85). The dichotomy between humans and nature is a construct of Western, not indigenous, societies. Because science shares many of the underlying beliefs and assumptions that have led to the current climate crisis, it is even more important to carefully consider and question science itself. At the same time, the legitimacy of science's dismissal of other ways of knowing the world is coming into question. When science encounters other ways of knowing, differences and similarities are highlighted. By critically examining previous attempts to mediate traditional knowledge and science as they contend with climate change in the Arctic (analyzing written publications resulting from these efforts, as well as conducting qualitative interviews with the original researchers), I address the question, **What does the intersection of traditional knowledge and science have to teach us about science?**

I assert that both the positivist and postmodern tendencies within social sciences may be inadequate to fully address this topic. Climate change exists somewhere between the

material and discursive worlds. It makes materially evident the warnings of environmentalists and the effects of current global power relations. But 'climate change' is itself a concept created discursively by scientists, researchers, policy-makers – *humans* – by weaving together multiple events, observations, predictions and beliefs; it cannot be directly seen, but is instead the result of making the material world discursive. Without the discursive elements of science, all the same things would be happening, but by tying multiple human-nature interactions together, attributing causality, and making predictions about the future, this phenomenon called climate change has been created:

> "The real threat of global warming exists in a future that has not yet come to pass. The links between the exhaust of my car and the extension of the Sahara desert exist only in computer simulations. What should we make of that?" (Pickering 2005, 39).

New materialism[1] is a growing philosophy that merges ontology and epistemology, and allows a return to the materiality of the world without discounting the imagined and constructed discursiveness of it in the process. It offers new possibilities for encountering climate change by looking at the spaces in between the purely social and the purely natural, between the political and the ecological. I use it both as the philosophical basis for my research and analysis, as well as asking the question, **how might a new materialist philosophy help to bridge the dichotomy between science and traditional knowledge?**

Although the effects of climate change will impact people locally, its causes are global. This is a critical time on local, societal and global scales: climate change must be addressed. Traditional or indigenous knowledge is increasingly being used in various combinations with conventional science in understanding processes and changes happening in the Arctic, and as a possible source of adaptation mechanisms for coping with change (Bielawski 2005a, 955). The threat of climate change suggests potential avenues toward solutions are ignored at the peril of indigenous and non-indigenous peoples alike (Krupnik and Jolly 2002, 356). This includes the possibility of creating new hybrid ways of knowing the world that cross boundaries such as spatial scale, discipline and worldview. In spite of

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[1] I join Myra Hird (2004) and Iris van der Tuin (2006) in labeling this philosophy "new materialism". Emerging within diverse streams of feminist thought over the past 20 years, it is more than a critique (as much classical feminist philosophy is). Instead, it is a creation, and as such, I see it as just as applicable and useful for situations in which gender and sex difference are not explicitly discussed, as for those in which they are. In my reading of new materialist philosophy, I also draw from Karen Barad's (2003) concept of "agential realism", Donna Haraway's (1991) "situated knowledge" and "cyborgs", Andrew Pickering's (1995) "temporal emergence" and "dance of agency", and Nancy Tuana's (2006) "interactionist ontology", although none of these scholars explicitly label their theories as new materialist.

this, attempts at integration often act to reinforce the dichotomy[2] between science and traditional knowledge rather than bridge it. An ongoing history of colonization of indigenous land, knowledge and culture, and the dominant position of the positivist scientific epistemology, add complex elements of power and politics to the matter. **In encountering traditional knowledges and climate change, is the dominant position of science reinforced or challenged?** I end with a discussion of how these dynamics of power interweave with different types of knowledge, and the relevance of different perspectives on the uncertainties of climate change to international relations and concepts of human and international security.

1.1 Traditional Knowledge, Science, Climate Change and Power

There is a great deal of debate about the terminology used to describe traditional/indigenous/local (ecological/environmental) knowledge, and every author has a preferred term for diverse reasons. To emphasize and/or politicize this knowledge as belonging to a specific group of people or ethnicity, terms such as "indigenous", "native", or "aboriginal" knowledge are used, each differing slightly in who they refer to (Berkes and Folke 1998, 4; Bielawski 2005a). Although indigenous knowledge has particular ethnic implications, it remains the broadest of these terms, in that it can be used to represent "the dynamic contributions of any community to problem-solving, based on their own perceptions and conceptions", encompassing whatever identification, categorization and classification of phenomena this may involve (Bielawski 2005a, 950). Indigenous knowledge is also the term most widely used in development studies and at international scales (e.g. Agrawal 1995). Other authors choose to use "practical knowledge" or "local knowledge" to achieve the reverse effect, emphasizing that this is knowledge stemming from a close connection to the environment and removing ethnicity from the equation; for example, a focus on practical knowledge "does not assume a cultural or temporal boundary" (Pálsson 1998, 53).

Most common in the North has been the term "traditional knowledge" (TK), which generally means knowledge that has a long historical continuity, having been passed down through generations (Berkes and Folke 1998, 5), although whether this term implies

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[2] It is possible that structuring my research around this initial presumption of a dichotomy between traditional knowledge and science reinforces/creates this very dichotomy. I have tried to keep this danger at the front of my mind throughout my research and analysis, to allow me to study and look for solutions to this problem without contributing to it.

knowledge specific to indigenous peoples (Nuttall 1998), or if it is more a synonym for local knowledge in that it does not imply holders are members of any particular group (Huntington 2005, 30), varies among authors. Traditional ecological knowledge (TEK) refers to the subset of traditional knowledge which deals specifically with interactions with the surrounding environment (Bielawski 2005a, 950).

Nadasdy (1999, 4) discusses how the words 'traditional', 'ecological'/'environmental' and 'knowledge' each carry a number of underlying assumptions. 'Traditional' can imply something fixed and unchanging, contrary to the flexibility and fluidity so integral to the lived nature of oral histories (Abram 1996, 172-178). Berkes and Folke (1998, 5) address this issue by explaining that "the word traditional is used to refer to historical and cultural continuity, recognizing that societies are constantly redefining what is considered 'traditional'". Furthermore, 'ecological' or 'environmental' are words firmly rooted in a "Western worldview that sees human beings as distinct from the rest of the world, a dichotomy that is wholly foreign to most indigenous worldviews" (Nadasdy 1999, 4). Thus, the very insertion of the word environmental in the naming of TEK distorts it, creating a dichotomy where there was none before.

Regardless of how well a term is redefined, it retains a good deal of its cultural baggage[3]. Keeping in mind the power implications inherent to naming, and taking the position that knowledge is inseparable from the context of culture and worldview that creates it, I use the term traditional knowledge[4], or 'TK', to refer to both the worldview and philosophical framework (ontology and epistemology, discussed below) of indigenous peoples as well as the actual pieces of information generated.

While recognizing the work of authors such as Linda Tuhiwai Smith (1999) and Oscar Kawagley (2006) as providing important analyses of similar issues and questions from indigenous perspectives, I am looking reflexively from the perspective of Western society, in order to explore what the intersections of traditional and scientific knowledge can teach

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[3] All naming is a form of power, and therefore can become a form of oppression. Abram (1996, 102) explains at length how once something is named, the word takes on a life of its own, replacing the actual thing in subsequent interactions.

[4] Although in many ways I agree with Bielawski (2005, 950) that indigenous knowledge is a better term with less historical and cultural baggage, 'traditional knowledge' is the term I found most commonly used in the context of climate change in the Arctic, and for the purposes of my study, it makes sense to use the term most commonly used by the texts and researchers I am encountering.

us about possibilities for our[5] own epistemology. My goal is not to study the ways that traditional knowledge is incorporated, to whatever level of equality, into the discourse of science. Neither is my purpose to extract ideas from traditional knowledge for the betterment of science, and in doing so romanticize, misunderstand, steal or taint what remains of cultures that have already suffered much in the name of colonization. Rather, my aim is to focus on options for the colonizer society, beyond the constraints of science as our only legitimate epistemology, as it is currently constructed in opposition to traditional knowledge systems. Through studying how science relates to and interacts with the 'otherness' of traditional knowledge we can become more aware of our own epistemology (McCarthy 1996, 68) and begin to make sense of the complex tangle of science and society, objectivity and subjectivity. Thus, all of the researchers and texts I study come from a Western scientific background, although their perspectives, approaches and objectives vary.

Just as there is not one 'traditional knowledge', there is no single scientific world and no one homogenous entity that can be labeled 'science' (Smith 1996, 201). Our general idea of what science *is* emerged in the Enlightenment as a promise of forward progression that would bring freedom from prejudice, domination, superstition and brutality, and alongside rationality, has formed the heart of "Western Civilization" ever since (McCarthy 1996, 85). The search for universal laws and truths that would apply to all things equally has "summarily defined what, in principle, science is" (McCarthy 1996, 86). As such, science is part of the positivist philosophical tradition, valuing objectivity and replicability, using hypothesis testing and measurement (usually requiring specialized instruments) to explain causation and improve prediction, and quantifying variability and uncertainty while making generalizations.

For centuries the facts, outcomes and findings of science were generally taken as order (Latour and Woolgar 1979, 33): sense-making of the chaotic natural world. The last 50 years have seen a number of challenges to positivism, especially in the social sciences. Spreading in popularity is the view that "science – the institution once seen as standing well outside and above society – is itself a thoroughly social and human enterprise" (McCarthy 1996, 109). Latour and Woolgar's (1979) anthropological study of daily life in

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[5] I will use 'we' and 'our' to refer generally to the dominant Western colonizer society and worldview, as this is a group, as a woman of European descent, of which I am part.

a scientific laboratory began a trend of reflexive social studies of scientific methodology, which has lead to the emergence of the numerous critiques of science and technology studies (STS) (see Lykke 2002) and the sociology of scientific knowledge (SSK) (see Pickering 1995). Feminist science scholars such as Sandra Harding (1991) have suggested that the natural sciences are best analyzed as part of the social sciences and that the self-reflexivity of the social sciences should serve as a model for all science.

Science is in many ways a diverse and ever-evolving institution, and ecology, molecular chemistry and quantum physics certainly vary greatly in practices and theory. Smith (1996) identifies two distinct camps within science based on how they view the natural world. The first, the "Newtonian" or linear camp sees nature as a system based on periodic order, and seeks to understand it through defining boundaries, identifying variables, and measuring change and trends over time; complexity and uncertainty are acknowledged, but predicting future states remains the focus (Smith 1996, 208). This type of science includes disciplines such as biology, statistics and economics, all of which play important roles in climate change sciences and share a strong reliance on mathematical modeling and quantification of uncertainty (see Pollack 2003). The "Chaos" (non-linear) camp of science, on the other hand, views the world as complex and dynamic, where change is non-random but not predictable; small changes in initial conditions matter greatly as they move through the system, and patterns observed over very long or very short amounts of time may be different than they appear (Smith 1996, 209). When non-linear science engages in modeling, it aims to "simulate the world rather than explain it" (Smith 1996, 214), and chaos theory does in fact form part of the theoretical basis of the General Circulation Models used in climatology. The IPCC defines chaos as a type of uncertainty inherent to the system being studied, well recognized as being a part of meteorology and "increasingly used in treatments of climate change" (Manning *et al*. 2004, 126).

The uncertainties of climate change pose a very material challenge to science. At the heart of the Newtonian scientific worldview is the assertion that change can be understood and explained. Things can change in predictable, systematic ways, and it is this type of mechanistic change based on fixed laws (which may or may not be known) that most science relies on. Trends, patterns, generalizations, and models all function on the assumption that even if change is complex, with enough knowledge it is decipherable and

predictable. In one way, uncertainty has always been a part of science – in fact, it is hard to imagine science, with its desire for answers and understanding of how things work, existing without uncertainty:

> "Has science been debilitated by uncertainty? To the contrary, the successes of science [...] arise from the ways that scientists have learned to make use of uncertainty in their quests for knowledge. Far from being an impediment that stalls science, uncertainty is a stimulus that propels science forward. Science thrives on uncertainty." (Pollack 2003, 5)

However, there are other types of uncertainty besides this optimistic view of it as driver of scientific inquiry. The IPCC identifies two broad classes: "statistical" uncertainty occurs when specific values or parameters are not precisely known, while "structural" uncertainty occurs when it is not known if all relevant variables have been included, or functional relationships are not understood (Manning *et al*. 2004, 2). This second type of uncertainty has long been poorly represented: it is much harder to quantify than statistical uncertainty, since what is being evaluated is by its nature unknown.

There is little doubt that climate change poses a formidable threat and challenge to human civilization. But what is less discussed is that climate change is actually a phenomenon of uncertainty, witnessed by changes in patterns themselves, increased variability, and non-uniform change. This third type of uncertainty arises as an inherent characteristic of the world, rather than statistical and structural uncertainty which reside in our ability to understand it. Although the shift in terminology from 'global warming' to 'climate change' is an improvement, the word change does not necessarily imply this type of uncertainty and unpredictability. Uncertainty is an important component of climate change and a potential crack in the ontological and epistemological foundations of science, and I examine it in more detail as a theme in my discourse analysis below.

Besides the material challenges of climate change, science also faces a number of discursive challenges, centered around issues of knowledge and power. As well as the growing recognition that science is socially created, there is also increasing pressure for science to be socially accountable and relevant (Heininen 2004, 15). Science provides the theory, but it is within the political realm that much of the practical uses of research will play out. When science encounters traditional knowledge, the political element of science cannot be ignored: the politics of naming discussed above only scratch the surface. Existing power dynamics are reinforced by ignoring that knowledge itself is constructed through power relations: that "power creates knowledge" as well as the reverse (Agrawal

1995, 430). Whose epistemology is used will affect what is found in the natural world as well as how it is described and understood. What gets to count or not count as knowledge, and who gets to decide, are key locations of power. Although there is much debate and discussion about the terminology regarding traditional versus indigenous versus local, on the term 'knowledge' many authors are strangely silent, even though the meaning of this word is far from clear. When speaking of knowledge, are we speaking of information and specific practices, or are we speaking of ways of knowing, epistemologies, and associated ways of living or being; in other words, worldviews? When science and traditional knowledge meet, the result can be colonization (see Nadasdy 1999), integration (Usher 2000), preservation (see Agrawal 1995) or recognition of inherent value (Cruikshank 1981). These outcomes are not mutually exclusive, as I will discuss.

One of the reasons that the TK-science dichotomy remains is that efforts to increase the validity and status of traditional knowledge in modern society have often resulted in reinforcing the dichotomy, especially in cases where TK is associated with specific ethnicities (Agrawal 1995, 420). This is not just knowledge anyone can have about the place they live; there are important identity and political aspects associated with it. As the perceived value of having access to TK has increased, indigenous people, speaking from the claim that their historical connection to the land has not been lost through the dichotomies of modernity, have asserted what rights they could from the ownership of this knowledge. Traditional knowledge is thus closely tied to issues of control of resource management, local empowerment, cultural preservation and identity, and self-determination (Nuttall 1998). In some cases, the situation extends even into the legal arena, through questions of intellectual property rights (Bielawski 1997, 480; Correa 2001). Practical problems such as low education and employable skills, health problems, poverty, alcoholism, and mistrust of government or academic researchers from the South are all the legacy of colonialism in the North and can act as barriers to creating research partnerships (Bielawski 1997, 479).

Extraction of the parts of traditional knowledge seen as most comparable to science and most relevant and useful to environmental management has become common in response to demands that Western society incorporate TK into policy affecting indigenous communities. The focus here is on finding real, practical ways of implementing policies that call for the inclusion of traditional knowledge (Usher 2000, 184); the agenda is driven

by the lack of a real comprehension between these two knowledge systems, and the rigid timelines of resource management. However, traditional knowledge has also become a key area of interest in climate change sciences, not only as a useful source of information but because it provides a different, more holistic perspective and approach that incorporates humans and culture into environmental systems (Berkes 1998; Bielawski 1997). Although the general tendency has been a one way flow of legitimization, through the incorporation and validation of traditional knowledge *into* the rational scientific framework (Nuttall 1998), there seems to be a growing awareness that this is a form of colonization. Nadasdy (1999) discusses how the distillation of traditional knowledge into categories that reflect the assumptions of science, and its compartmentalization based on the artificial division of the world into disciplines, results in the concentration of power in political and scientific centres, rather than the hoped for empowerment of indigenous communities. Seemingly well-intentioned goals of preserving indigenous knowledge come with similar dangers of missing or distorting the essence of traditional knowledge (Agrawal 1995, 428-429).

Huntington (2005) discusses how this very question of what traditional knowledge is, may in fact be more a reflection of the various and differing disciplinary perspectives and interests that researchers bring with them than anything actually inherent to traditional knowledge itself. In other words, perhaps the problem is not with understanding traditional knowledge, but with calling so many particular aspects and manifestations of numerous cultures' worldviews by a single term, as if it were a single definable entity (Huntington 2005, 29). He stresses the need to be clear and explicit that categories such as TEK (which deals with the ecological elements of TK) are created not by the broader knowledge base and worldview of traditional knowledge, but by the researchers themselves. However, the question of "knowing the other" presents its own challenges, and requires careful consideration of motives to avoid inappropriate appropriations or continuation of the cycle of colonial domination (Kuokkanen 2003). Haraway (1991, 193) addresses this issue when she describes the need for an awareness of subjectivity that allows a way to "see together without claiming to be another". In her proposed "feminist objectivity", "the scientific knower seeks the subject position not of identity, but of objectivity; that is, partial connection" (Haraway 1991, 193), thus achieving a passionate detachment that is neither totalizing nor relativistic.

When knowledge is viewed in this way, it seems clear that if science defines the rules, it will inevitably win. Even when researchers aim to treat traditional knowledge as an equally valid source of knowledge, the framework in which the comparisons are made often remains that of science. Traditional knowledge is first and foremost a complete philosophical framework (worldview), as well as the practical information that comes from it (Nuttall 1998, 72), but is still often treated "as a set of discrete intellectual products which are completely separable from the cultural milieu that gives them meaning" (Nadasdy 1999, 5). Despite appeals to stop viewing traditional knowledge as simply another form of data to be integrated into the framework of scientific resource management or climate change research, by and large the goals of documentation, understanding (from a scientific perspective) and integration remain. While it may seem politically expedient and beneficial to all to find easier ways of incorporating TK into decision-making processes previously based exclusively on science (Usher 2004), the categories researchers choose may "reflect more about their own societies than those which they propose to study" (Cruikshank 1981, 71); in fact, this notion is at the foundation of my research design. The Arctic Climate Impact Assessment chapter on indigenous knowledge is a prime example. The authors identify the "often neglected topic" of linking indigenous and scientific observations of climate change and their interpretations:

> "Part of the problem is in determining how indigenous knowledge can best be incorporated into scientific systems of knowledge acquisition and interpretation. Part of the problem is in finding ways to involve indigenous communities in scientific research as well as in communicating scientific findings to indigenous communities. And a large part of the problem is in establishing the trust necessary to find appropriate solutions to both goals." (Huntington and Fox 2005, 94)

Note, however, that the authors do not mention that part of the problem may be the scientific framework itself. Science remains the playing field on which climate change is being dealt with, and as long as its dominant position remains unchallenged a form of neo-colonialism will continue.

All knowledge systems have a worldview that provides a comprehensive understanding of reality, the world, and the universe (Berkes *et al*. 1998; Bielawski 2005b). When very different worldviews such as rational science and spiritual traditional knowledge meet, challenges can be difficult to overcome. In fact, Berkes (1999, 182) asserts that "perhaps the most fundamental lesson of traditional ecological knowledge is that worldviews and beliefs do matter". A spiritual component involving "non-dominant, respectful human-

nature relationships" is found in almost all traditional knowledge systems (Berkes 1999, 163). The Yupiaq worldview described by Kawagley (2006, 14-16) illustrates just how much indigenous worldviews differ from science: the natural, spiritual and human realms each provide an essential support and must remain aligned and in constant communication to maintain balance and wellness in all parts. In contrast, science not only ignores spiritual elements, it has since the time of Galileo explicitly defined itself by their exclusion (Bielawski 2005a, 953). Where traditional knowledge might use a spiritually based explanation for an observation, science will always look for a rational and testable one. When the analysis remains within the positivist epistemology of science, important elements of other epistemologies may be noted, but often with a sort of awkwardness. What to do with the non-perceptual elements of traditional knowledge beyond acknowledge them? They simply do not fit within the scientific framework and worldview. Although long known to exist and often mentioned, very little headway has been made in actually addressing this "problem of the sacred" (Trudel 2006, 5).

1.2 Philosophical Considerations: An Introduction to New Materialism

In assessing the challenges and politics of the meeting of traditional and scientific knowledge, it is necessary to begin at the basic metaphysical level of what exists and how we can know about it (ontology and epistemology). Marsh and Furlong (2002) argue that all social scientists (and I would add, natural scientists as well) have a distinct ontological and epistemological position originating in their worldview that, whether acknowledged or not, shapes how they approach their subject. Ontology is basically "a theory of 'being'" that asks questions such as "whether there is a 'real' world 'out there' that is independent of our knowledge of it"; ontology defines what the basic units of existence are understood to be. Epistemology refers to "what we can know about the world and how we can know it" (Marsh and Furlong 2002, 18-19): theories of knowledge and ways of knowing. It deals with the question of whether it is possible to objectively identify relations between things, and if so, how?

Broadly, "essentialist" or "foundationalist" traditions which see the world as real and independent of knowing it include positivism and empiricism (Marsh and Furlong 2002, 18). This is the theoretical basis of most natural sciences, including climate change research. The focus is on identifying causes and explanatory factors through direct observation (Marsh and Furlong 2002, 19) which allows predictions and interventions in

systems to be made. Furthermore, the knowledge produced is "generalizable to other contexts because it is universal" (Taylor 2001a, 11). Emphasis is placed on the importance of separating empirical questions from normative ones, the goal being objective, bias- and value-free research unaffected by the personal opinions or worldviews of the scientist (Marsh and Furlong 2002, 22; Taylor 2001a, 11). The positivist traditions evaluate themselves based on three main criteria: reliability refers mainly to measurements and how consistent they are; validity refers to the generalizations made and how accurate they are at describing the currently studied system (internal validity) as well as how applicable they are to other situations (external validity); and replicability means other researchers arrive at the same or similar results by following the described methods (for which objectivity is an essential requirement) (Taylor 2001b, 318).

The positivist traditions contrast with the grouping of "anti-foundationalist" traditions associated more closely with the social than the natural sciences, which view phenomena as socially constructed and include interpretist positions such as critical theory, postmodernism and poststructuralism (Taylor 2001a, 11). These positions represent a shift towards seeing all knowledge as necessarily partial, situated and relative (Taylor 2001a, 12). Part of this shift is due to the growing acknowledgement that understanding is different than explanation (McCarthy 1996, 87), resulting in a focus on meaning of behaviour rather than causation (Marsh and Furlong 2002, 20). It also involves a general acceptance of complexity within which multiple truths may remain valid: "Truth is unattainable because reality itself is not single or static, and reality is also inevitably influenced and altered by any processes through which a researcher attempts to investigate and represent it" (Taylor 2001b, 319). Interpretists often focus on the importance of language, seeing it not as a transparent or neutral medium, but rather as central to constructing social meanings (Marsh and Furlong 2002, 28, Taylor 2001a). The knowledge that comes out of these traditions is seen as situated, in that it refers to the specific contexts of the location and actors involved at the time the research took place, and contingent (provisional) rather than stable, enduring truth (Taylor 2001b, 319). The research methodology is self-reflexive about its place in and effects on the world it studies. Reflexivity has spread with the rise of postmodernism, bringing an awareness of historicity and metaphysical considerations to previously exempt disciplines such as international relations (IR) in the case of the "Third Debate" (Patomäki and Wight 2000, 222; Sylvester 2006, 202), and many disciplines are in various stages of encountering, accepting,

rejecting, or reacting to postmodern arguments. However, it remains conspicuously absent from other disciplines, especially more pragmatic or applied studies and the natural sciences.

Barad (2003, 804) argues that both positivism and social constructionism share an ontology in which there are "two distinct and independent kinds of entities – representations and entities to be represented": this representationalism presupposes that something exists that is separate from and prior to description. The only real argument then is if what is being represented is a real part of the natural world or a social creation. This "asymmetrical faith in our access to representations over things" creates another dichotomy that need not exist (Barad 2003, 806). Haraway (2004, 330) too rejects both social constructionism and positivism, describing it as a case of "neither-nor [...] It is not nature. It is not culture". Pickering (1995, 5) similarly identifies the representational idiom that casts "science as, above all, an activity that seeks to represent nature, to produce knowledge that maps, mirrors or corresponds to how the world really is" and thus is most concerned with realism and objectivity of representations. New materialism is not representationalist, overcoming the empiricist-interpretist argument by considering the stick itself rather than focusing on either the material or the discursive ends (van der Tuin 2006, 11). It does this by "rebalancing our understanding of science away from a pure obsession with knowledge and toward a recognition of science's material powers" (Pickering 1995, 7). Barad (2003, 802) also emphasizes the need to shift focus to "matters of practices/doings/actions", just as Haraway (2004, 330) is interested in "ways of getting at the world as a verb".

I see the key innovations and offerings of new materialism as: i) its ability to bridge and dissolve dichotomies; ii) its post-humanist relinquishment of agency as the sole property of humans; iii) its non-disciplinarity; and iv) its focus on intra-actions through which both matter and discourse come into existence. These overlapping ideas are not mutually exclusive points but rather form a collage[6], a field in which I situate my current research as well as a lens through which I look at the meetings of traditional knowledge, science and climate change.

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[6] Christine Sylvester (2006, 218-219) advocates a type of analytical thinking she calls a "feminist gaze", which allows us to see and think differently through "juxtapositions and collage techniques that visually open up unexpected sights of analysis".

One of the ways that postmodernism seems to get stuck is that, while it identifies dichotomies such as mind/body and culture/nature as privileging one side while subordinating the other, it generally does not offer many solutions. What to do with dichotomies beyond identifying and rejecting them? Perhaps this is one of the reasons that philosophy has moved through and past postmodernism: it is a more useful tool for exposing underlying structures of oppression than a solution, often raising more questions than it answers (Fontana 2001, 161). A key to understanding new materialism is how it not only avoids creating or reinforcing dichotomies, it is actually able to bridge and/or dissolve them, beginning at the roots of its philosophy: "The separation of epistemology from ontology is a reverberation of a metaphysics that assumes an inherent difference between human and nonhuman, subject and object, mind and body, matter and discourse" (Barad 2003, 829). As an alternative, Barad calls for an "onto-epistem-ology" which studies "practices of knowing in being". Dichotomies, real or not, do matter; even though they are discursive, they have undeniable effects on our current world, and thus it is not enough to simply reject them. Because new materialism bridges and dissolves dichotomies such as traditional knowledge/science without erasing or ignoring differences, it is very useful in dealing with relations in which power imbalances exist.

How does onto-epistemology work in practice? The key to understanding what happens when ontology and epistemology are no longer separate is the concept of interaction, or to use Barad's (2003) term, "intra-action". That which is interacting comes into being through this interaction, so it is really int*ra*-action, oneness: "Knowing is a matter of part of the world making itself intelligible to another part. Practices of knowing and being are not isolatable, but rather they are mutually implicated" (Barad 2003, 829). All knowing is personal and originates through action (Tsoukas 2003, 415): "The world makes us in one and the same process as we make the world" (Pickering 1995, 26). New materialism's focus on relationships and interactions rather than things aligns it closely with traditional knowledge, which is predominantly "knowledge that resides in doing" (Bielawski 2005a, 951).

Barad (2003, 814) is explicit in defining her concept of agential intra-action as one of causal relationships, placing herself clearly apart from interpretist epistemologies which focus on meaning rather than causality. In her truly non-foundational onto-epistemology, causality must be at play, since nothing exists independently of the phenomena which

bring into existence both the material and the discursive. The primary epistemological (and, ontological) unit *is* the phenomenon (Barad 2003, 815), or in Haraway's words, "objects are boundary projects" (1991, 201). Through intra-action, reality is locally determined, properties constituted, boundaries differentiated, and meanings created (Barad 2003, 821): "We do not obtain knowledge by standing outside of the world; we know because 'we' are of the world. We are part of the world in its differential becoming" (Barad 2003, 829).

While the physical sciences traditionally focus on the material world "from which all traces of humanity have been expunged" and the social sciences look at the residue of the material world – "a social world from which the material world has been magically whisked away by linguistic conjuring tricks" (Pickering 2005, 31), what is increasingly important and revealing is to look at the zone of intersection between people and things (Pickering 2005, 30). This is where overcoming disciplinary boundaries becomes essential, as "the knowledge that is too often missing and is often desperately needed is at the intersection between things and people" (Tuana 2006, 1). By allowing both the human and nonhuman world to be seen at once, new materialism does just this; it is an "interactionist ontology" which "rematerializes the social and takes seriously the agency of the natural" (Tuana 2006, 1).

New materialism is applicable to both the natural and the social sciences, to human and nonhuman phenomena (Hird 2004). This is rare in the modern academic world, witnessed by the lack of postmodern biologists and the backlash against sociobiology and biological determinism in the social sciences. New materialism gains inspiration from the natural sciences and uses this inspiration to form a critique of their methods: Hird (2003, 2004) draws from biology and Barad (2003) from physics, using examples from these disciplines in constructing their theories. Positivist (top-down), interpretist (bottom-up) and realist epistemologies in social sciences all see the social world as ontologically distinct from the natural world, and however they may differ in their conceptions of the human side, they view the nonhuman as predictable, without agency, and not reflexive (see for example Marsh and Furlong 2002, 24). New materialism offers the hope of bridging this dichotomy in academia. As Hird (2004, 145) puts it, "new materialism refers to a significant shift in the natural sciences that emphasizes openness and play within the living and nonliving world, contesting previous paradigms which posited a changeable culture against a stable

and inert nature". In fact, with her bold suggestion of truly cross-disciplinary theorizing that could encompass the most discursive studies of human social structures and the intricacies of molecular chemistry or genetics, the kind of paradigmatic shifts that are needed to reconceptualize the world may be emerging (Hird 2003, 4.6). Northern studies is an area of research in which multi-disciplinarity has flourished (Heininen 2004, 19), as what unites it is not theoretical traditions but the actual area of the Circumpolar North, where human and land are still intimately connected and which global influences such as climate change have increasingly shown to be inescapably linked to the rest of the world.

Thus, in new materialism, humans are no longer "at the center of the action and calling the shots", but are instead "inextricably entangled with the nonhuman" (Pickering 1995, 26). This relinquishment of our sole right to agency is central to post-humanism, as is rejecting the human-nonhuman dichotomy as a preordained condition (Barad 2003, 808). Barad (2003, 811) uses the term "agential realism" to rework concepts such as discursive practices, agency and causality to account for the nonhuman equally with the human, as well as the "fullness of matter's implication in its ongoing historicity" (Barad 2003, 811). Haraway (1991, 199) offers a conceptualization of nature as a "witty agent", a trickster that will continue to prove us blind if we believe it to be too predictable or knowable. Her "material-semiotic actor" highlights the active role of the object of knowledge as a "meaning-generating" agent (Haraway 1991, 200).

By restoring voice and agency to the nonhuman world that is not merely a reflection of our own, new materialism reconceptualizes agency itself. As Gram-Hanssen (1996, 93) says, nature "does not speak for itself, nor does it totally disappear through human theorizing". It is an 'other' with its own form of subjectivity and agency, and we can neither know it from its own perspective nor remove our own perspective from our knowing of it. The common understanding of agency involves action or intervention made with intention of producing a specific result, an attribute humans have long claimed as a defining feature of humanity. In contrast, Barad (2003, 818) redefines it as "not an attribute but the ongoing reconfigurings of the world": in Pickering's (1995, 6, emphasis in original) words, it is "the idea that the world is filled not, in the first instance, with facts and observations, but with *agency*. The world […] is continually *doing things*". This is helpful in coming to terms with what it really means for nonhuman entities to possess agency: if we realize that our concept of agency is coloured by how we as humans experience it, we can start to see that

this is but one viewpoint, and far from the only one. My working concept of agency as applicable to the nonhuman as well as the human world involves two key elements: that something acts in a way that influences the outcome of the situation it is in, and that it does this with something equivalent to intention – agency must be more than the residual of the inability of that which is affected to change the outcome.

2. Methodology and Methods

Studying science from within a scientific framework poses some interesting challenges. Because my research focuses on exploring and questioning the very nature of science and positivist onto-epistemologies, I use qualitative methodology and an inductive, multidisciplinary approach to explore alternatives to positivism. Qualitative research can allow a field to expand its breadth of knowledge beyond the findings of the dominant positivist paradigm (Riley and Love 1999:165). Latour and Woolgar (1979, 37) discuss how in order to study science, one generally needs to be somewhat creative with one's methodology, finding a theme to help construct a pattern among your observations. I use new materialism as my guiding theme in navigating the boundaries and shadows of science. While the research *method* indicates the tools used in data collection and analysis (for example, discourse analysis or qualitative interviewing), *methodology* describes the intellectual process that lies behind the research process, promoting careful consideration of the relationships between "epistemological assumptions, ontological perspective, ethical responsibilities, and method choices" (Ackerly *et al*. 2006, 6). Below I discuss my methodology, which is based on both critical theory and new materialism, as well as research design, interviewing method and how I analyzed the texts using a discourse analysis framework.

Critical theory asserts that research cannot, and should not, try to isolate itself from the world it exists in and affects. This is where critical theory becomes important and useful. Critical theory unites "diverse strands" of IR including Marxism, historical materialism, feminism, and postmodernism (Jacoby 2006, 158) in order to question how knowledge is produced and challenge dominant positivist theoretical branches which focus on rationalism and objectivity:

> "Traditional social science seeks to overcome the dilemmas of our times by imposing order and achieving certainty. The development of classifications and rules is intended to assure us that society is progressing towards a definitive resolution of the time-honored questions posed by the political sphere in a way that is rational and under our control. By contrast, critical social science celebrates the uncertainty of the political sphere by virtue of its boundless nature and thus its possibilities for change" (Jacoby 2006, 172-173).

Critical theory is concerned not only with describing or explaining the phenomena it studies, but also contributing to the transformation of that which it researches (Ackerly and True 2006, 243); in other words, it has normative goals (Fairclough 2001, 230), is aware of

its historical and sociological context, and seeks practical solutions for change (Ackerly and True 2006, 253).

A number of aspects of my research mesh well with the framework of critical theory. Four key theoretical practices that critical feminist methodologies exhibit are "skeptical scrutiny, inclusionary inquiry, choosing a deliberative moment, and conceptualizing the field as a collective" (Ackerly and True 2006, 256). This involves self-conscious examination of one's own assumptions, philosophical basis, research agendas and discipline, and situating one's research within academia and the world (Ackerly and True 2006, 258). The political and colonial past and present of science's interactions with other ways of knowing such as traditional knowledge are problematic and politically charged. Because of its fundamental questioning of metaphysical assumptions, critical theory is ideally suited to cross-cultural research such as my own (Jacoby 2006, 158). Choosing the right research topic at the right time amid a complex and constantly changing world highlights the importance of asking the right questions. In the context of the current and global threat of climate change, the meeting of traditional knowledge and science epitomizes a deliberative moment. Awareness that all stages of the research process involve choices of inclusion and exclusion highlights the importance of giving critical attention to all aspects of research design and facets of the research problem (Ackerly and True 2006, 256). In this way, my choice of qualitative methodology is as much a choice of the most appropriate method of inquiry as it is a conscious step toward a revised vision of academic research and societal worldviews. Critical theory fits well with a new materialist perspective, in which change through research is seen as inevitable, as intra-actions form the basis of all phenomena, and in their questioning and problematizing of science, STS and SSK can be viewed as critical disciplines.

One of the outcomes of postmodern arguments in political science and IR is the development of critical realism, which "provides an alternative 'problem-field' which embeds the social within the material without reducing one to the other" (Patomäki and Wight 2000, 223); here parallels to new materialism are seen, in the rebalancing of the material and discursive. Critical realism "attempts to acknowledge much of the interpretist critique, while retaining a commitment to causal explanation" (Marsh and Furlong 2002, 31). Privileging epistemological questions over ontological ones and "deriving ontological arguments from epistemological ones" has created a situation in which the only reality we

can refer to is the reality we can know (Patomäki and Wight 2000, 219). Although realists share a foundationalist ontology with positivists, they do not privilege direct observation as the only way of gaining information about the world. Rather, they believe in "deep structural relationships between social phenomena which cannot be directly observed" (Marsh and Furlong 2002, 20). Critical realism identifies the need to understand "both the external 'reality' and the social construction of that 'reality'" (Marsh and Furlong 2002, 31). Patomäki and Wight (2000, 217) argue that both positivism and postpositivism define the 'real' either in terms of what is experienced (positivism) or in terms of language or discourse (postpositivism), but what both of these require is a human to either experience or speak the world into existence; an inherent anthropocentrism because "a world prior to the emergence of humanity is a condition of possibility for that emergence". In other words, both are representationalist. Critical realism says there is a real world out there which is independent of our knowledge of it, but we simultaneously construct our conception and understanding of it through discourse that also has real political outcomes (Marsh 2002, 160). This parallels the non-representationalist argument made by new materialism; however, because critical realism remains foundationalist; it does not take the next step. Although the external world is seen as constraining or facilitating what we can or do construct, there is no mention of the reverse: what, if any, effects our discourse has on the world. Thus, although critical realism comes a long way in emphasizing the importance of interactions, unlike new materialism it remains applicable only within the social sciences.

Critical theory helps to move from a universalizing, progression-motivated, positivist stance to one that embraces the flow, change, uncertainty, and interaction of new materialism. However, it remains focused on the human world, which it treats as separate from the natural world. This is why I am using a combined theoretical framework I term 'critical new materialism'. With critical new materialism I mean that research has inevitable unpredictable effects resulting from the ongoing intra-actions of myself and my research with the world and people I am studying. With awareness I can actively strive not toward ultimate truths or ideal solutions, but toward outcomes that I believe to be positive.

> "It is not a matter of peeling away layers of lemon skin hermeneutically, to get a deeper and truer pip. It is about deeply looking at the lemons we see, and their surrounds, and asking the clichéd question: 'What's missing from this picture?' From that methodologically inductive spot our research task is to recognize and theorize how the colors, lines, compositions, and implied

narrative would have to change – do change – with various additions to the painting." (Sylvester 2006, 210-211).

It is about balancing the idea that change is possible and truth is always multiple, with the belief that the current reality as it appears and is experienced *does matter*. In a new materialist critical theory, intra-action is the point of origin of all phenomena, both human and nonhuman, and thus neither structure nor agency, neither the material nor discursive world, is given precedence.

2.1 Research Design

In qualitative research, sample sizes are not only necessarily small, but are understood to be situated and contingent. There has been a great deal of literature published over the past 25 years on traditional knowledge, and there are many and diverse researchers from far-ranging geographic areas and academic disciplines who work on this topic in some way. Becker (1998, 119-120) discusses the importance of identifying correctly what population has actually been sampled, so as to avoid claiming to speak for a larger group than was studied when developing concepts or theories. It is important to note that there is a broader range and scope of definitions, understandings, and methods of mediating science with traditional knowledge than I cover in this study. In choosing my sample, I narrowed the scope considerably by focusing only on traditional knowledge as it is related to climate change in the North. Taylor (2001a, 14) discusses how generalizability of results can be achieved by studying a fairly narrow but "uniquely important" topic that is of high current relevance (echoing Ackerly and True's (2006, 256) "deliberative moment"). I believe that the topic of climate change provides this form of relevance and applicability in my research.

I chose my texts during the process of conducting an extensive review of the literature on traditional knowledge/science. I chose texts that came from both peer reviewed journals (3 articles) and edited volumes (2 texts) (Appendix A). In three cases I chose the texts first, based on the degree they addressed my research topic, and then contacted the authors. In two cases I asked the researcher which text they felt best exemplified their work on the topic and used that. I attempted to interview at least one author of each text in my sample (Appendix B). In the case of Riedlinger and Berkes (2001), I was unable to contact Dyanna Jolly (formerly Riedlinger), and Fikret Berkes declined to be interviewed. Igor Krupnik's schedule was too full during my interviewing period for us to schedule an interview. I still

include these texts in my analysis because both are very relevant to my research topic. Furthermore, in Riedlinger and Berkes (2001) the lead author is female, which adds to the gender balance in my sample[7], and Krupnik (2002) contributes an anthropologic perspective different from the other texts. My sample includes researchers from a diverse array of backgrounds, spanning native studies, ecology, history, anthropology, political science, philosophy of science, English, polar studies, wildlife management, and biology. Participants were currently (or have previously been) employed within academia, at governmental and non-governmental research institutes, independently employed, or retired, spanning three countries on two continents.

Jacoby (2006, 158) discusses the need to integrate fieldwork into critical theory, as "studying the very problematic and controversial 'other' cannot be merely textual": I include interviews in my discourse analysis as another attempt to rebalance the material and the discursive[8]. Choosing interviewing as a method of data collection implies "taking experience seriously as an element of knowledge" (Jacoby 2006, 161), and tangibly incorporates interaction and people, their feelings and experiences, into the larger frameworks and discourses studied.

In the classic (positivist) interviewing method, the answers already exist inside the passive subject of the respondent, who interacts in an asymmetrical manner with the "objective", active interviewer (Gubrium and Holstein 2001, 13). However, the postmodern trend in interviewing sees the interview as a site and process of meaning production (Gubrium and Holstein 2001, 14) where active subjects are behind both the respondent and interviewer (Gubrium and Holstein 2001, 15). Following this latter style, I analyze the discourse co-created through interaction between two active subjects, myself and the researcher (Fontana 2001, 166). By using the interview to shift my participants, who are usually the 'objective' scientists, into a more subjective role, I hope to get a broader view of the discourse around traditional knowledge and science.

When the respondent is no longer seen as simply a vessel out of which pure answers and truths flow, issues of voice and varying subject positions arise. We all have multiple

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[7] Although I contacted 5 female researchers (of 12 in total), I was only able to interview one.
[8] My combined use of interviews and texts is also a form of data triangulation, improving the overall rigor of my analysis (Taylor 2001b, 322).

potential standpoints, and it matters what "hat" both the respondent and the interviewer are wearing, and how these are perceived by the other (Gubrium and Holstein 2001, 23). Voice is not static and can switch between various subject positions during the course of an interview (Warren 2001, 84). For example, my participants are all researchers, but may also have various other public roles and personal standpoints. Here the identity of the interviewer also becomes important (Taylor 2001a, 17), and at times I felt my participants may have been speaking to me more as a student, than, for example, a peer.

In the tradition of postmodern interviewing, I was careful to pay attention to the "hows" (discourse) as well as the "whats" (content) of my interviews (Fontana 2001, 167). I had a prepared list of questions which I used as a guide for all interviews (Appendix C), but in keeping with the open semi-structured interviewing format, I allowed the respondent's answers to guide the flow of the interview. Warren (2001, 87) discusses the importance of remaining flexible and attentive throughout the interview process, open to emerging or evolving meanings that, among other things, "may render previously designed questions irrelevant in light of the changing contexts of meaning". When there was a pause and it seemed an appropriate time to move the conversation forward or in a slightly new direction, I would choose the next question based on its relevance to what we had just been talking about. Thus, the question order differed somewhat from interview to interview, and at times I re-worded questions so that my speech flowed more naturally, avoiding the tone of verbatim reading. Similarly, I omitted some questions from each interview when I felt that in answering other questions, the participant had already covered the topic. When a participant seemed to have more to say on a topic, or if a question led them in a different direction, I encouraged them to finish their train of thought, and ad-libbed questions to probe for depth or clarity. In general, my aim was for the interviews to resemble a conversation rather than the rigid question-answer format of a traditional interview.

Transcription is of key importance in discourse analysis as it inherently involves a process of selection, making it part of the analysis. There are various styles of transcription depending on the type of discourse analysis used, ranging from extremely detailed records of conversation that include emphasis, intonation, pauses, timing, gestures, etc., to transcripts which basically resemble written text (Taylor 2001a, 29-36). Since I am more concerned with topics, themes and vocabulary of the discourses, and how these discourses relate to broader societal and cultural contexts, my style of transcription was quite basic,

closer to written text. I transcribed the interviews verbatim, including all words spoken (such as repetitions, rewordings, and phrases characteristic of spoken language such as "yeah", "you know", etc.) in order to preserve the texture of the speech. My words and comments (such as affirmations like "yeah") were also included.

Interviewing a small number of researchers who work within the same academic field as the research I am conducting raises delicate issues of ethics and confidentiality. Since I am interviewing authors of published texts, anonymity is not an option. Also, publications coming from this research would be in the same field as the participants, and could be read by their colleagues, etc. For these reasons, I ensured that each participant was aware of my research plan, and obtained verbal (taped) informed consent to use their name in the publication. Furthermore, I verified and obtained consent for direct quotes to which the participant's name is attached. Shorter quotes I simply attribute to an "Interview Participant", and I do not include citations for one or two word phrases quoted directly from my sample texts or interviews, rather treating all such quotes as part of the sample.

2.2 Discourse Analysis Framework

Discourse analysis is the search for patterns within language in use (Taylor 2001a, 10). It provides tools to deconstruct what is assumed to be true and inevitable, and thus offers hope for finding new ways of understanding and approaching societal problems such as climate change. Neither dialogue nor language, discourse is not *what* is being said, but rather "that which constrains and enables what can be said" and acts to "define what counts as meaningful statements" (Barad 2003, 819), providing the boundaries on what can be said or even imagined. How things are said matters, as "meaning is not a property of individual words or groups of words but an ongoing performance of the world in its differential intelligibility" (Barad 2003, 821). Dryzek (1997, 8) similarly defines discourse as "a shared way of apprehending the world". In Foulcauldian terms, discourses are "historically variable ways of specifying knowledges and truths, whereby knowledges are socially constructed and produced by effects of power and spoken of in terms of 'truths'" – here the focus is on power, which is believed to be created and distributed through discourses (Carabine 2001, 275).

I use a modified form of critical discourse analysis informed by a new materialist onto-epistemology. Critical discourse analysis (CDA) uses Gramsci's idea of hegemonic

structures to analyze how dominant discourses have power over what people can say: people become both the producers of and slaves to discourse (Edley 2001, 190). In this way, discourses may become part of a social structure that acts as "legitimizing common sense which sustains relations of domination" (Fairclough 2001, 235). CDA also involves the assertion that the dominant discourse will always be contested to some extent (Fairclough 2001, 235). CDA begins with an issue rather than a text, and asks how language figures as an element (Fairclough 2001, 229). It is inherently interdisciplinary and aims at transdisciplinarity (the creation of new theories and methods) (Fairclough 2001, 230).

While critical discourse analysis sees society as structured, with power distributed via these structures, Foucauldian discourse analysis sees society and power as flowing and non-hierarchical (Taylor 2001b, 316), more like a set of "socially and historically constructed rules designating 'what is' and 'what is not'" (Carabine 2001, 275). In essence, CDA places more emphasis on structure (the material world) while Foucauldian discourse analysis places greater emphasis on the discursive nature of society and power. By incorporating elements of both, I hope to rebalance the material and the discursive in a critical new materialist discourse analysis model. To Fairclough's analytical framework for CDA, I add elements of Carabine's genealogic model as well as Dryzek's environmentally-informed critical model to form my framework for discourse analysis (summarized in Figure 1).

Choose a deliberative research problem and identify its discursive aspects

Identify obstacles to the problem being addressed
- history of the issue
- context within existing power/knowledge networks

Analyze the discourse
- **ontology** – what themes, categories and objects are present, are they part of larger/more permanent discourses or paradigms
- **syntagmatic elements –** relationships between various components of the discourse and how they are valued; what local structures are created within the text
- **interdiscursive analysis** – mixing and interacting of genres and discourses; inter-relationships between different discourses
- **linguistic analysis** – narrative style, verb tense, active vs passive voice, truth-claim modifiers, word choice, metaphors, rhetorical devices

Political Considerations
- **agency** – who has it within the discourse, who are the actors, and what are their motives
- what are the **effects** of the discourse? How does the discourse matter and relate to the material world?

Identify ways past the obstacles
- look for gaps, contradictions, paradoxes
- absences, silences, resistances and counter discourses

Reflect critically on the analysis – be aware of the limitations of the research, your data and sources, and possible effects of your research.

Figure 1: Analytical Framework for New Materialist Discourse Analysis
(Adapted from Carabine 2001, 281; Dryzek 1997, 18; and Fairclough 2001, 236-242).

In total I analyzed 9 texts and interview transcripts, using the above framework to identify the discourses that emerge regarding the traditional knowledge/science dichotomy and the role of climate change in shaping these interactions. In my analysis, I treat language as *both* "referential", a means of conveying information about something else, and "constitutive, a site of meaning creation" (Taylor 2001a, 15). This follows a new materialist premise that both the matter (the content of the language) and the discourse (the language process itself) are important. I treat all the texts and interview transcripts with equal weighting, and do not make direct comparisons between interview and text for specific researchers, i.e. I assume the previously published texts to have as much agency as the interview participant and myself. During the interview, I did not focus on the author's

intentions when writing the text, although I was asking questions on the same topic and on the process behind the published research. I also avoid direct comparisons between texts that are based on causal explanations such as genre (publication type, interview) or background of the author. I deal with each text as a cohesive unit, so where the author has included quoted text, I include it in my analysis. The text matters, it acts as a real unit once created and all parts of it form its discursive nature.

In addition to distinguishing the discourses present and analyzing the ontology and agency of actors within each, I looked at a number of themes within the texts. It is not the coding method but rather the theoretical basis that distinguishes discourse analysis (Taylor 2001a, 39), and thus categorization of data can be either deductive, through the use of theory and etic validation (which derives themes and support from a particular discipline) or inductive (phenomenological) emic validation, where themes emerge from within the data and validation is provided by participants themselves (Latour and Woolgar 1979:38). The inductive approach can privilege the text as more true than all other information on that subject, while the deductive approach can place too much emphasis on broad and monolithic discourses and miss the material of the actual texts and interactions. Thus, I use both etically (e.g. uncertainty and spirituality) and emically (e.g. humility, time) derived categories for my coding, looking beyond my texts for a broader notion of the discourses at play (Carabine 2001), but not allowing these to obscure my view of what is actually embodied in the text.

I analyzed the text for themes falling broadly into three areas. The first are centered around knowledge and discursive elements, and include certainty/uncertainty, spirituality, objectivity, knowledge, post-humanism (de-centering of human subject) and humility. The second grouping of themes looks at the material world, through agency, time and spatiality, disciplinarity, and ontology. The last category explores themes of intra-actions and interdiscursive relations: meetings of TK/science, politicization and power relations, comparing similarities and differences, and dichotomies (reinforcing or dissolving).

3. Results

Through close readings of the texts, I identified the vocabulary used when describing knowledge and ways of knowing. Certain words and ideas tended to be associated with traditional knowledge, and others generally used when speaking of science, and for the most part these were identifiable as separate discourses within the texts. This is not surprising, as the texts and interview topics were centred around this meeting of TK, science and climate change. I also analyzed the texts to identify how the relationship between these types of knowledge and ways of knowing is portrayed, and how the discourses might shape how and what happens when they meet.

3.1 The Three Discourses

The discourses of traditional knowledge and science both emerge through the existence of the other, each defined through comparison and opposition; in this way the dichotomy between them is reinforced. In all the texts, science is the discourse the authors are situated in and speaking from. Science is identified as a fundamental part of the Western worldview: we live in a world built by science, and are increasingly reliant on science and technology in our daily lives, removed from the natural world. A distinct science discourse was present in all the texts. This is science as experienced in Arctic research, in the biological, physical and social sciences related to climate change, and remains quite firmly within the Newtonian camp. This science discourse can be pictured as a spherical continuum, similar to the common conception of an atom: at the dense core, definitions are clear-cut and solid, but the further one moves from the centre, the more fuzzy things become (Figure 2). I will refer to the science discourse at times as though it were two discourses, Sci-Centre and Sci-Edges, as at these different ends of the continuum the discourse takes on quite different properties and meanings. Some texts are generally closer to the centre of the science continuum and others nearer the edges, and in the course of an individual text, the position might vary, but whenever the discourse becomes clearer about what science is, it always converges on the same foundational beliefs and core assumptions (Sci-Centre). When science encounters an 'other' such as traditional knowledge, the reaction is usually to move toward the safe and identifiable centre of the science discourse, and differences between science and TK are emphasized. This reinforces dichotomies and

borders between science, which is "known"[9], and traditional knowledge, which is "recognized" by its difference from science. For example, science is aimed at "explaining" and "predicting" while traditional knowledge is portrayed as not good at either: instead it "describes" and "observes". At Sci-Edges, where boundaries blur, the very distinction between different knowledges, traditional, Western/scientific, and personal/practical becomes unclear.
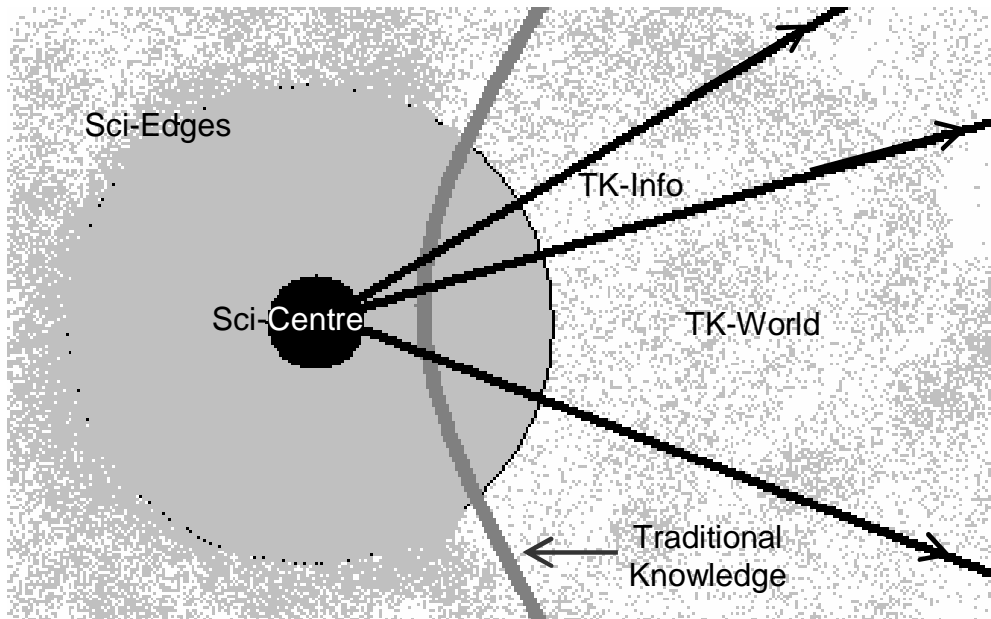

Figure 2: The Emergence of the Three Discourses. Science emerges as a coherent discourse easily identified at its centre (Sci-Centre). The lens of the Sci-Centre discourse splits traditional knowledge into two discourses, one in which it is viewed as information and observations (TK-Info) and one in which it is treated as a complete worldview (TK-World). Science is increasingly difficult to distinguish at its edges (Sci-Edges) but the politics of TK can still act to reinforce the dichotomy.

It is through the lens of Sci-Centre and the political resistance from indigenous people against further colonization that the discourses of both science and traditional knowledge are articulated (Figure 2). The TK discourse splits into two distinct discourses by how Sci-Centre sees and defines it: one that deals with the information generated by traditional knowledge (TK-Info), and one that attempts to address traditional knowledge as a complete worldview (TK-World). This is similar to the findings of Huntington (2005): the traditional knowledge discourse splits through its dealings with science rather than due to something in its own nature.

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[9] From this point on, if not otherwise cited, all single words or short phrases in double quotations are taken from the sample of 9 texts I analyzed.

TK-World includes a broader conceptualization of what traditional knowledge is, including references to the spiritual and holistic nature of traditional knowledge, and emphasizing its subtlety, complexity, and diversity. TK-Info focuses on the concrete side of traditional knowledge and the observations it produces. The science discourse is similar for both TK discourses; both TK discourses are created through their contrast as "not science". Most texts contain the science discourse with one of the traditional knowledge discourses dominant. In four texts, the TK-Info discourse was more prominent, and in three, the TK-World discourse dominated. However, the 'TK-Info' texts usually shift at least briefly into the TK-World discourse when describing the potential of traditional knowledge to broaden the horizons of science, because "science isn't perfect" (Interview Participant[10] 2007). In the 'TK-World' texts, the TK-Info discourse is sometimes mentioned, usually critically[11]. In the remaining two texts, where the science discourse was mostly Sci-Edges, the TK discourses were not so easy to identify. Both TK discourses can only exist when contrasted with Sci-Centre – at its edges, all three dissolve into interconnected experiences and interactions that shape individual ways of knowing the world. In the Sci-Edges discourse, the boundaries between traditional knowledge and science largely disappear.

In the TK-Info discourse, the focus is on what is produced, the body of knowledge or collection of facts and observations, rather than the means by which this knowledge was gathered or created. At times the TK-Info discourse acknowledges that traditional knowledge is in fact a knowledge system or worldview different from science. However, it is asserted that practical knowledge and observations can be extracted from this worldview without affecting the information itself. This focus on things and pieces of knowledge leads to an ontology which is rich in dichotomies: humans are ontologically separate from nature, and the social is distinct from the biological. This is closely aligned with the ontology of science, which is foundationalist and sees things as the basic unit of existence, seeking to understand through reductionism.

The TK-Info discourse is motivated by increased recognition of the value of traditional knowledge observations as data useful in decreasing uncertainty about natural phenomena, coupled with mounting political pressure to incorporate knowledge from indigenous people

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[10] To help preserve some confidentiality, for shorter extracts from interviews I have not identified the participant by name. A list of interview participants is provided in Appendix B.
[11] For this reason, I mostly refer to specific discourses rather than specific texts.

in northern communities. The Arctic is seen as part of a larger global context, of global significance as the "canary in the mine" of climate change. Within this context, the role of TK is to translate theoretical scientific ideas and models of climate change into what is materially happening on the local scale, and it is science's role to scale back up to the global. The importance of mediation between these two types of knowledge is highlighted by the assertion of one participant that it is at the regional level where prediction matters most to policy; understanding the causes of climate change must be global, personal experience of it is local but the ability to deal with it is societal. TK-Info argues that the benefits to both indigenous and scientific communities of using traditional knowledge as information outweigh potential negatives: in these "partnerships" which could "only be beneficial", each has a "role to play" and a certain level of commitment and investment is necessary on both sides to make the data more accessible and the analysis more cooperative. Traditional knowledge is a valuable source of information from which useful parts can be isolated and documented, a "valid approach" that is "listed alongside" various scientific methods such as experimentation, simulation, modeling, and remote sensing. Generally, the more reduced the concept of traditional knowledge (for example extracted observations treated as discrete pieces of data), the better it is seen to work with (and within) science, and similarities are emphasized. Here traditional knowledge is described as being replicable, practical and observation-based, just like science. The categories and framework are decided by science, and the observations are filled in by TK. Differences are viewed as a sign of uncertainty and thus are seen as challenges to be overcome in this discourse.

Unlike the narrow ontology of knowledge-as-observations of the TK-Info discourse, in the ontology of the TK-World discourse interactions and relationships are primary, similar to the intra-actions that form the basis of new materialism. This ontology allows for the legitimate existence and importance of elements that may not be fully known or knowable: even the ephemeral, such as spirit, can be an actor. When traditional knowledge is discussed as a worldview, including not only the body of knowledge but the ontology and epistemology that yielded it, the differences and difficulties in the meeting of traditional knowledge and science tend to be emphasized. TK and science are seen as having distinctly different, separate ontologies, and translation is cited as necessary before dialogue can occur. TK is seen as bodily, frequent, communal, alert for change, holistic,

intuitive and multifaceted because it is culturally based, and does not separate humans from nature.

In TK-World, there is a greater emphasis on the local spatial scale than in the science-driven, regionally and globally focused TK-Info discourse. Climate research is global, but traditional knowledge is local; knowledge is linked to the land rather than classified by disciplines as in science. Global level changes in politics and attitudes regarding development have important local effects; research agendas are described as set by science and driven by politics, at regional and global levels. Climate change is also not taken for granted as an actor in this discourse – there is more hesitation, and acknowledgement that it is itself a creation emerging from the discourse of science rather than traditional knowledge. Motivated by interest in how indigenous peoples observe and understand the world, knowledge is discussed as systems which in turn generate bodies of knowledge. Often paired with the concept of traditional knowledge as a worldview is an argument against its reduction to something that will fit within the framework of science. This argument is usually made from a political perspective and is in direct conflict with the methods of the TK-Info discourse:

> "In short, while in the last two decades much scientific interest has turned to mining Dene and Inuit knowledge for nuggets that science in the North has missed, the amount of effort devoted to the task yielded few research results of originality and good quality beyond common sense. It proved too difficult and seemed counter productive to many scientists, to extract specific bits of empirical data from indigenous knowledge narratives and to record these in the data cells that scientists were attempting to fill." (Bielawski 2003, 324)

Politics is seen as a barrier to truly understanding and learning from TK, reflecting the history of colonization of indigenous peoples. In the TK-World discourse, science is more openly acknowledged as also being a worldview that affects what we define as data. However, it is also just one specialized part of Western knowledge that is not intrinsically better than any other, and may in fact have more data than wisdom. The problem of the sacred or spiritual aspect of traditional knowledge is usually identified in this discourse and largely ignored by the TK-Info discourse.

At its expansive outer edges the science discourse blurs into traditional knowledge. When the Sci-Centre discourse meets traditional knowledge it splits it, but at Sci-Edges the TK-Info and TK-World discourses blend together. Science and TK are equally indistinct, the ontology based on practices rather than definitions. Some of the words attached to science

in the Sci-Edges discourse, such as "characterize", "describe", "relate", and "identify", are more similar to the traditional knowledge discourses than Sci-Centre. At its edges, science is more flexible and open to possibility, whereas strictly adhering to Sci-Centre is seen as limiting and a barrier to fully engaging with traditional knowledge. The very idea of one unified scientific method is identified as a mystification:

> "I don't have any sense that there really is a scientific method, I don't see two scientists coming to similar conclusions by the same route very often […] We couldn't have arrived at some of the astonishing things with that one sea ice project if we'd been highly methodologically oriented. If we'd been following an orthodox 'scientific method', our minds wouldn't have been open to a lot of the surprises that the whaling captains presented us with. So I guess I'm as reluctant to define science as I am traditional knowledge. They're both adaptive systems and people practice traditional knowledge as they practice science – in different ways." (Norton 2007)

Science is still recognized as a valid personal worldview but it is no longer depicted as the one true way of knowing. Science and traditional knowledge are described as not so different after all, witnessed by native elders who can operate within both. These are not so much of a different nature than a different focus and spatial scale: TK looks at detail and small, local scales, while science tries to generalize to larger scales. The primary focus of Sci-Edges is local, with careful descriptions of local history and important climatic or environmental events, as well as the local history of colonization, and secondarily situated within the more global context of climate change. Personal anecdotes and stories of the researcher are also more likely to be included.

The Sci-Edges discourse shares with TK-Info the hope of mutual benefit, "synergistic understanding" and increased confidence in the results by both the scientific and indigenous communities. Science, however, is also changed in the meetings, becoming more qualitative:

> "Gradually it became evident that a more fundamental revision in thinking about coastal sea ice was needed before quantitative evaluation of oceanographic or other predictors would make sense. […] Not until we had reconstructed the entire sequence of ice motions in both whaling seasons, however, did the importance of ice drift become obvious. Even then, evidence that ice floes so often reversed directions at first strained credulity. Whalers, however, confirmed that reversals in ice drift were common, and reminded us of their depictions of ice floes rotating and moving 'like a hinge' against or away from shorefast ice." (Norton and Gaylord 2004, 360-361)

Here, traditional knowledge confirms science, reversing the historic power dynamic. The role reversal can also be seen when what science usually measures is modified to match traditional knowledge rather than the reverse: "Our interest in following ice features of 0.1km or less in diameter over distances of ~100km matched the dimensions of subsistence

hunters' familiarity, but these were novel dimensions for specialists in remote-sensing imagery for this region" (Norton and Gaylord 2004, 349). Rather than using the authoritative, impersonal, passive tone of the TK-Info discourses, the Norton and Gaylord (2004) text begins as a narrative written by an actively involved first person, where ice, scientists and subsistence whalers are all actors. The study was motivated by practical concern about hunter safety on the part of scientists in the area, and a desire to make the current scientific technologies more useful and accessible to the community. The introduction at times has a normative tone ("repeat local sampling […] should be frequent enough to detect changes before they become catastrophic") and political ("the advocacy […] persuaded collaborators"). The authors become much less visible and are largely replaced by a passive voice through the methods and results sections, where the discourse moves closer to Sci-Centre. The authors then return in the discussion to translate the data into a narrative that makes sense ("during the storm, a surge probably lifted…") and is relevant ("this high-energy destruction would have threatened the lives of any crews…").

There is a strong theme in the Sci-Edges discourse of the need to withhold judgment of causality. Science is seen as a powerful tool, but like TK it can be misused or abused. For example, one participant pointed out that a lack of communication and objectivity can lead to people "seeing what they believe rather than believing what they see". Sci-Edges is inherently and necessarily multi-disciplinary; boundaries are erased by science relinquishing its power and instead focusing on solving specific, practical problems.

3.2 Intra-actions of the Discourses

Berkes (1999) identifies two threads in the dealings of traditional knowledge and Western society in the field of resource management. The first he labels political ecology, which considers how traditional knowledge is used in larger political and social systems and relations, and how the use of traditional knowledge "is political because it threatens to change power relations between indigenous groups and the dominant society" while being used as a tool to empower indigenous peoples (Berkes 1999, 164). The second thread is more philosophical, how traditional knowledge might challenge the current positivist-reductionist paradigm of Western science (Berkes 1999, 176). Elements of both the political and philosophical run through both the TK-Info and TK-World discourses, as I will discuss.

How traditional knowledge and science are seen to interact with each other is closely linked to the type of knowledge the author is referring to with the term TK. The TK-World discourse points out that science has a long history of ignoring, misunderstanding, misinterpreting, reducing, dismissing and discrediting TK; colonization is discussed at length, and valuing traditional knowledge on its own terms, including political empowerment, is the goal. Even 15 years ago, the attitude within the scientific community towards traditional knowledge generally involved ignorance, lack of interest, resistance or even hostility, and vestiges of these attitudes remain in the discourses today. For example, choice of word order such as: "…relationships between scientists and Native experts" (Krupnik 2002, 158) still assumes scientists are experts while Native "experts" requires qualification. Accompanying the indigenous movement towards political empowerment and cultural regeneration, the revaluing of traditional knowledge is a recent phenomena and remains very political. There is also pessimism in the TK-World discourse, speaking of political demands leading to incorporating and validating (TK "describes" while science "interprets"). Both "literal and cultural" translation problems are seen to contribute to lack of understanding and the tendency for science and traditional knowledge not to mesh.

The TK-Info discourse emphasizes collaboration and partnerships with science, and matching, comparing, complementing, linking, and exchange are common words used to describe the TK-science relationship. However, the relationship in this discourse generally remains one of extraction and utilization in some form. Awareness of the political sensitivity surrounding traditional knowledge can be seen in the great care taken when criticizing it in any way. When TK explains something in a different way from science, the scientific explanation still dominates but the TK one is "not necessarily wrong or silly". The TK-Info discourse is careful to qualify that it is not trying to "'validate' one set of observations in terms of the other" but validation still frequently comes up, in the form of traditional knowledge in some way conforming to science. For example, traditional knowledge explanations are said to gain credibility when they "sound like" holistic ecology.

Traditional knowledge becomes more valuable in the TK-Info discourse once its accuracy, consistency and precision have been tested and proven by science. The positivist assumption of this discourse that there is one true reality means that when there is disagreement between observations, the underlying source of disagreement must be sought.

Science usually prevails, either directly by questioning the credibility or validity of the observation, or indirectly, by calling for more study until the observation can be brought into agreement with scientific understanding. Despite science's claims to objectivity, people still ultimately decide what is convincing, what makes sense, and what will be dismissed: outlying data that seems "kind of weird" is "ignored" in the final analysis. When traditional knowledge is incorporated into science as information or data it too becomes susceptible to this level of validation and judgment of what can be true and what "from my point of view cannot be correct […] based on my science background" and thus is "rejected" (Interview Participant 2007). If only what fits the existing model is accepted, traditional knowledge may provide data, but is not likely to change science itself. This "fill in the blanks model", where traditional knowledge is treated as a source to pull information from and plug into a scientific framework, is identified as a major problem by the TK-World discourse.

At other times, traditional knowledge "validates" what science "quantifies". Things are often more complicated on the ground than they appear from remotely sensed data and scientific generalizations, and local expertise may be used to "ground truth" or contextualize scientific findings. For example, the impact of an unusually warm ice year on the community turns out to be less than might be expected based on ice charts, because different animals became available for hunting (Krupnik 2002, 171). One strand of the TK-World discourse, moving towards Sci-Edges, emphasizes how traditional knowledge experts epitomize the qualities of a scholar, such as "analytical perception, an inquisitive drive for continuous observation and recording, the eagerness to cross-check their data" and openness to other epistemologies (Krupnik 2002, 184); similarly, traditional knowledge is praised as an "accurate and sophisticated source for understanding" (Riedlinger and Berkes 2001, 322).

The demand for meaningful involvement of indigenous people and ideas in all stages of the scientific research process (often called community-based or participatory action research) is a common call today in the North. In the TK-World discourse, all stages of research are identified as involving various assumptions, omissions, and inclusions. It is hoped that perhaps traditional knowledge can be the one that "prioritizes" while science "provides". When the TK-World discourse is positive about the potential outcomes, words such as examining, considering, opening, and accommodating are used. Here it is a source for

understanding rather than just data. But in the TK-Info discourse, while traditional knowledge may offer insights that expand or broaden the scope of scientific inquiry, it is still seen as a starting point from which science can build, suggesting that it is not intrinsically good enough by itself. Traditional knowledge observations may lead to scientific questions, which may or may not eventually corroborate, or validate, the original knowledge. Similar to its role as an information source, here too traditional knowledge remains in a supporting role. The power dominance remains colonial, with science acting as a provider of findings to the community, and traditional knowledge asking questions and providing data to fill in gaps in scientific knowledge. In the Sci-Edges discourse, collaborating, interpreting, exchanging and strengthening are emphasized: the relationship is moving towards one of equal valuation of knowledge contributions based on their practical value rather than their theoretical basis or the power relations of the underlying paradigms.

How the meetings between traditional knowledge and science are conceptualized is closely related to the framework within which research is conducted. A good illustration of what happens when the framework remains scientific is found in Riedlinger and Berkes (2001, 324-325), where traditional knowledge is compared as an "approach" in a table alongside instrumental data (from weather stations), satellite imagery, archival data, and proxy data (ice cores). As these latter four are core methods of science, it is not surprising that differences stand out. For example, one column of comparison is "reliability", which refers to "the objectivity/subjectivity of data, and whether they can be independently verified" (Riedlinger and Berkes 2001, 323): not surprisingly, TK falls short, as this is science's way of evaluating reliability, very different from the importance traditional knowledge places on the identity of the knowledge holder. "Accessibility" is another category of comparison that relates to how much money, time or labour is needed to "extract and use the information" – in this category traditional knowledge stands out as the most difficult and time intensive, relative to the four other methods. Science is reductionist, so it is hardly a surprise that it is easier to isolate and extract pieces of information from these other four (scientific) methods than it is from TK. But what if, instead of all the categories of evaluation being derived from a scientific worldview, there was a category of, for example, 'relational integration': the difficulty or ease of understanding the data in the context of the world? I think traditional knowledge would shine through there! Furthermore, if such a table were truly reversed and created from a TK perspective, it would no longer be a table

at all, because traditional knowledge does not operate by categorizing piecewise in boxes, or understand through isolation and reduction. As one participant suggested, even our *imaginations* are so restricted by our worldview that we have great difficulty finding ways to conceptualize or comprehend the nature of traditional knowledge. By choosing the parts of traditional knowledge that will be used, extracting information from a broader worldview and calling that information traditional knowledge, science in the TK-Info discourse retains the power to decide what knowledge is.

In terms of power dynamics, science is generally seen as more likely to undermine traditional knowledge than the reverse. As the rate of technological growth continues to increase, indigenous people also begin to lose their connection with the land, and traditional knowledge is used less and no longer automatically transmitted to the next generation: it will not "remain intact for an indefinite time" (Krupnik 2002, 184). In the TK-World discourse, the need for rebalancing power dynamics between traditional knowledge and science is stressed. The options discussed include adding power to the side of traditional knowledge or taking it from the side of science, but there are no easy answers:

> "The circumstances aren't great yet for people to feel safe enough. You know, another generation of cultural regeneration, say, and people might be more confident in questioning some of their premises, and that would mean that the scientists would be less afraid of offending them. But I don't think we're there yet. People may be in individual cases, but I don't think we're there in terms of the literature and the existing paradigm." (Bielawski 2007)

Really addressing questions such as spirituality is impossible until indigenous cultures feel safer and more politically solid, and science is subsequently less worried about disrespecting them. One suggestion is long-term documentation projects carried out by indigenous people themselves that give communities autonomy and power in the research process. As Cruikshank (1981, 86) suggests, "the focus should not be on 'getting information before it is too late'" but instead, on preservation of the culture and mechanisms of knowledge creation themselves. Calls that traditional knowledge should be preserved through documentation occur in various contexts in TK-Info and TK-World, but in order to preserve one thing, it must be clearly distinct from another; a dichotomy must first exist (Agrawal 1995, 428). Thus, the goal of preservation makes the least sense at Sci-Edges, as traditional knowledge must first be seen as distinct from Western knowledge before preserving it becomes a meaningful endeavor. In the Sci-Edges discourse, it is suggested that the spiritual elements of traditional knowledge may have been less affected

by modernization than the more practical, tangible elements, pointing to the nature of TK being more than what it produces, and suggesting a deeper resilience than is seen in TK-Info.

Central to the TK-World discourse is the call to value traditional knowledge equally alongside science without needing it to conform to the standards set by science. Adopting a critical realist perspective is suggested as a way to get there, based on the ontology that a real world exists prior to knowledge of it, but with many avenues of inquiry possible to gain information about that reality. This rebalances the power between science and traditional knowledge on the philosophical level, as whatever different strategies they employ to understand the world or different conclusions they come to about it, the world remains. The TK-World discourse also attempts to bridge the conceptual gap between traditional knowledge and science. Using an active, present tense, first person, and tending to be more narrative in style, much care is taken to avoid succumbing to the authoritative dominance of scientific research and writing. Many truth claim modifiers are used, carefully qualifying that this is an "attempt" to give the " briefest of glimpses" into the multiple, unique, complex and subtle nature of traditional knowledges, and that summarizing or generalizing is "doomed to misconception if not inaccuracy" (Bielawski 2003, 312). Extensive quotations from indigenous people themselves may also be used, for example: "This section reviews some individual comments by the project participants and other local elders and lets the voices of the Yupik people be fully heard", but also carefully qualifying that it does not claim to provide a full summary (Krupnik 2002, 171). I think a danger exists here, however, if it only *appears* that indigenous voices are being heard while the underlying framework or power dynamic remains scientific. The need for understanding to develop at the human-scale, where the people involved work together to find ways to really communicate with each other, is also highlighted:

> "Each of those bodies of knowledge, the body of knowledge that Western science method yields, and the body of knowledge that aboriginal knowledge built up over several thousand years yields, each have things to offer the other, but for each topic, not even question but for each topic, ideally […] the carriers of the knowledge, the experts, find a way to communicate with each other. You know think if there are two circles they end up with a common area in here, within which is the questions they're looking at. And questions are value-laden, so there are values involved in it, but they get to something like that […] the Research Problem […] Then they would discuss what we call theory in Western science and what other people would call by whatever name they would have for essentially the overarching sense-making system of the world, of their world. And then you would proceed through the steps of

figuring out what are the data and what data do you need, do you need it over time, do you need it over area, and so on." (Bielawski 2007)

There is a wealth of information already present, both within traditional knowledge and within science, but much of its potential is said to be missed because research agendas remain driven by policy and money and restricted by time.

Because the view of TK (as observations) in the TK-Info discourse is quite static, the greatest threat to traditional knowledge is seen to come from climate change. Examples are given of traditional knowledge that no longer applies to the current world: as change gets faster, traditional knowledge could become less relevant. In the TK-World discourse, where traditional knowledge is a dynamic and evolving way of generating new knowledge and making sense of the world, science itself, or continued colonization in general, is highlighted as the main threat. Even in indigenous communities, acculturation and scientific education can result in science being used to reinforce or validate traditional knowledge and elders' knowledge.

4. Discussions

4.1 Science Fraying at the Edges

Because of the atomic nature of the science discourse and the splitting of the TK discourse based on its encounters with the core of science, defining and boundary creation are of high importance in these texts. Defining is inherently a foundationalist practice, because it assumes that there is something real that can be defined. Defining is also at its heart political, as "boundaries are interested instances of power, specific constructions, with real material consequences" (van der Tuin 2006, 8). The desire for boundaries that demarcate separation is closely linked to the reductionism of positivist science; defining or studying something becomes easier the more isolated it is from its surroundings or context. Thus, the farther and more obviously different traditional knowledge is from science, the easier it is to identify and accept. For example, one participant described the relative ease of defining traditional knowledge in a remote indigenous community whose traditional culture and practices of subsistence have remained relatively unchanged by influence from Western society. In another text, the villages studied were very isolated and culturally preserved, their worldview relatively intact. It can be easy to distinguish similarities and differences between TK and science when they are spatially separated and/or the observer is detached, but on the ground, where the two are actually meeting, mixing and coexisting in practice, the lines are harder to draw. A line on a map representing a boundary may look clean and crisp, but actually stand in that place on the land and it disappears entirely.

Although in two of the texts, defining science is given approximately equal space, thought, and subtlety, in the remainder science is not defined or discussed in much detail. Science is "what scientists do", pointing to the ideological nature of science and the power of scientists to determine knowledge and truth. Statistics clean up the ambiguities and scientists clean up the rest through the narrative interpretation of findings. The lack of attention to defining science reveals a tendency for science to not be very self-aware or reflexive. But not all is well within the science discourse: "The epistemological core of science, the values in which it is ultimately rooted, may be a mirage; *often* it is empty" (Nowotny *et al*. 2003, 191, emphasis in original).

In the TK-Info discourse the question of defining traditional knowledge is generally treated in considerable detail, often emphasizing the complexity and politics involved. Although

the TK-World discourse emphasizes the blurring of the human/nature dichotomy, and speaks of "ever-shifting and ephemeral" boundaries of ice-edges, ecosystem types and indigenous territories, the TK/science dichotomy is still reinforced. Political implications of who gets the power of having traditional knowledge cause differences to be emphasized, and much care is taken describing traditional knowledge worldviews, often in the words of indigenous peoples themselves or by comparison to science. At other times, when trying to break down political barriers to communication or understanding, the texts draw attention to ways that traditional knowledge is not so different, with phrases like "in the way of people everywhere".

When science gets out of the lab and into the field, at the edges where science meets communities on the frozen tundra, people creep back into the discourse. Arctic science in particular is described as dwelling on the edges, different from other sciences. Far from funding sources and the urbanization of Western society, these scientists live and work in close proximity with indigenous communities and the Arctic land. Arctic science shifts away from the Sci-Centre discourse as it becomes more pluralistic and participatory and opens to traditional knowledge. Unlike the TK-Info or TK-World discourses, in the Sci-Edges discourse far less attention is paid to defining and boundary setting – both traditional knowledge and science are hard to define, but defining is not seen as something to "really worry about". It is only when we look at traditional knowledge and science through the reductionist and boundary-creating tendencies of Sci-Centre that they seem so different, but at the edges of science, traditional knowledge and society, it becomes much less clear where traditional knowledge ends and personal knowledge begins, where science ends and TK begins.

Moving away from Sci-Centre to where science and traditional knowledge meet society, it becomes less easy to draw the boundary between what is traditional knowledge and what is personal knowledge. The question arises of how traditional knowledge differs from "what any of us knows about our surroundings" (Interview Participant 2007). As one participant put it, "I have my own TK passed on from generation to generation, for the land where I live, so I like to think that I have a far wider view than just being constrained in my thoughts by normal science". Two participants spoke about mediating their own experiences of climate change, scientific worldview, and knowledge passed down from

their parents ("my mother was right"). All spoke of observations accumulated over their lifetime linked to their surroundings:

> "I think if I had to say a general trend, I'd say the summers seemed like they'd been at times a little bit warmer, and the winters have not been quite as cold, but again there's a considerable amount of variability. So there's a good example of scientific coloring of the world. How much do I trust my own observation in those things and how much do I say, oh well, nice observations pal but do you have the data to back it up? In this case, I think personally I'd want to see the data because I know that my own view can be colored by recent phenomena taking precedence over more distant ones, and there's a general view that there's climate change going on so that becomes a convincing explanation for anything." (Huntington 2007)

While climate change science is globally situated, personal knowledge is like traditional knowledge, local and spatially specific. It is at this human scale that it makes most sense to us. However, in the discourse of Sci-Centre, knowledge becomes legitimate through the scientific method; things can be known because they are published, not because they are experienced. Science becomes a barrier between individuals and the world. Researchers' anecdotal evidence or what scientists expect based on their experiences does not fit comfortably within the bounds and constraints of the Sci-Centre discourse. The interpretations and opinions of individual researchers get relegated to a "comments" column in a table (Huntington *et al.* 2004, 21), or are otherwise carefully segregated from the 'facts' and empirical observations. This is the scientists' personal equivalent of traditional knowledge, but they must first convert it into 'real' science by running it through the scientific method, sterilizing it of bias and calibrating it with measurements, before it is considered valid.

Another theme that emerges is that science itself has its own form of 'traditional' knowledge. In the Sci-Edges discourse, it is discussed how historically, Arctic scientists would seek out elders' advice, and individual interaction meant the TK/science dichotomy was much less than it is today. It was not until fairly recently, as science became more "equipment dependent" and "laboratory mystical", that the dichotomy became greater. The widening gap between traditional knowledge and science is in part attributed to the decline of the "natural history" style of science, and the widening gap between humans and nature. One participant described traditional knowledge as "based on living in the system and making observations and learning from those observations". This contrasts to scientists who spend less and less time actually in the field: the original explorers spent years in the Arctic, decreasing in the 19th century natural science tradition to around a year or a few months, until now, when many researchers "go out and they're back within a week and

they've done all their sampling by helicopter or icebreaker and they've never missed a hot meal and they've never really lived in the environment" (Interview Participant 2007).

The history of traditional knowledge within science itself is marked as at risk of being lost. Especially at older research institutes, the long time depth of inter-generational, oral natural history knowledge linked to the landscape is now threatened by the increasingly fast collection and accumulation of data due to modern technology. Participants noted that there are limits to how much information the human mind can deal with, and practical observation and understanding are now frequently displaced by technical understandings. This illuminates the narrative element of science that is rarely acknowledged but always present: the sense-making stage, where the scientist tells the story of what the data means, emphasizing some parts, justifying omissions and error, and forming a coherent story. Because science seeks to understand through studying parts of the whole, these pieces of understanding must eventually be re-integrated to be practically useful. Traditional knowledge conceptualizes relationships rather than isolated parts, and thus is much more than the collection of observations or data that the TK-Info discourse would treat it as; it is "fully developed scenarios" which already make sense and have meaning without the additional analysis and interpretation that scientific data requires.

In science's ongoing battle with uncertainty, the common cry is that more information is needed, and desire to increase certainty is a main driver of the TK-Info discourse. But as we are increasingly "challenged organizationally and intellectually to deal with greater amounts of information" (Interview Participant 2007), the question becomes just how much data we can actually process into a coherent understanding. A number of the texts pointed to the problem of scientific knowledge being missed or lost amidst the abundance of data already out there. One respondent lamented the loss of time depth and history in science due to this abundance of data: studies published even 40 years ago are almost never cited, never mind all the knowledge dating further back, particularly in biology and natural history. The traditional knowledge of science is being lost, and limits of time, access and capacity mean that scientists unwillingly "reinvent the wheel" more and more frequently.

4.2 Boundaries and Objectivity

The more one tries to solidify a definition, the more subtleties and complexities arise. In understanding the Sci-Edges discourse, I draw upon the feminist science studies scholar

Donna Haraway (1991), who offers an interesting way of viewing and working with the dichotomies of modernity. Haraway (1991, 313) describes how Western society is based on a number of dichotomies, such as mind/body and nature/culture, that contribute to domination: the dichotomy between local knowledge and scientific knowledge can be understood as one manifestation of the dichotomies of modernity. As Pálsson (1998, 51) describes, "for several centuries, Western discourse has tended to radically separate scientific understanding and everyday accounts", seeing a definite and distinct separation between how we experience the world (subjectively) as individuals, and the objective accounts of reality that science offers. This pervasive aspect of the Western worldview is absent from nearly all indigenous worldviews, which are holistic, non-hierarchical and interconnected (Bielawski 2005b, 963). In his examination of dichotomies, Latour (1993, 34) describes how the paradox of modernity is that the process of hybridization constantly blurs the boundaries, creating hybrids out of supposedly discrete entities. We need only look to climate change for abundant examples of hybrids – the phenomenon itself is a blatant transgression of the supposed boundary between human and nature. Despite this, few question the continued reliance on positivist science as the underlying paradigm in studying and seeking solutions to this threat, even though it distinguishes between 'human' spheres such as economics or politics and 'nonhuman' spheres such as species distributions and weather patterns. New materialism addresses these dichotomies through its non-representationalist metaphysics, and Latour's hypothesis that we in fact have never been modern (i.e. dichotomies have always been a delusion) can be read as just one step away from new materialism: the situation he describes is very much one of intra-actions through which matter and discourses become themselves. Disciplinarity that divides the world into that which is studied by the natural or physical sciences, and that which is studied by the social sciences or humanities, seeks to clarify dichotomies, but the world constantly fights back: in fact, it is the interactions between nature and culture (what Latour calls hybridization) that actually forms "the world we know and are of" (Tuana 2006, 14). This is not the world we think we *should* know or the world we *want* to know, but the world we *do* know, the world we live in right now.

Rather than a return to a prior state of presumed innocence before the creation of dichotomies such as humans/nature and mind/body, Haraway (1991) discusses the potentials of cyborgs, which, similar to Latour's hybrids, are already everywhere, whether we accept them or not. At boundaries and edges, cyborgs proliferate, occupying the spaces

between dualities such as traditional knowledge and science. Differences still exist and are not erased, but the boundaries that classify dichotomies and define separation are no longer clear. Finding ways of erasing boundaries without disregarding differences is crucial to overcoming existing power imbalances between Western and indigenous ways of knowing. As Pálsson (1998, 64) suggests, while "it may be tempting either to submit to the populist notion that privileges the indigenous or to contribute to the opposite enterprise, the reproduction of the master narrative of science", perhaps a wiser and more productive approach would be to "search for an egalitarian discursive framework".

One of Sci-Centre's core defining features is its claim to objectivity. In the TK-Info discourse, traditional knowledge is full of people: elders, holders of traditional knowledge, communities. At Sci-Centre, the passive formal tense of writing removes actual people from the scientific method – people are replaced by publications, research, experiments, and instruments. When scientists do allow themselves to be seen, they do things like "contributing to the development of knowledge" and "engaging" in "rigorous review" rather than the consulting and conversing among hunters and sharing of information attributed to traditional knowledge. Peer review and independent testing are meant to remove the need for this personal level of validation from science. Even when discussing advantages and challenges of comparing observations, the authors are absent: "The comparisons have turned out to be more difficult to make *than was assumed* at the offset" (Huntington *et al*. 2004, 20, emphasis mine). This is the classic scientific way of speaking about analysis and results: the difficulties encountered are an attribute of the material studied and would have been encountered by anyone following the rules of scientific inquiry (the claim of replicability). The authors only enter in the first person tense briefly, when discussing possible failings of the study: "It is worth noting that our retrospective and opportunistic approach […] gives us greater latitude in having a number of studies to draw on, but constrains us in that we have not been able to direct specific studies…" (Huntington *et al*. 2004, 22). In the TK-Info discourse, replicability is also sometimes referred to as a similarity, but achieved in different ways – science through objectivity and generality, and traditional knowledge by providing knowledge on what to expect relevant to survival.

On the question of objectivity, the TK-World discourse is markedly different from Sci-Centre, circling around to meet the edges of science: humans are equally involved in the

creation of knowledge in both science and traditional knowledge: "Knowledge systems, or ways of knowing the world, provide the boundaries that either constrain or enhance the process of asking questions, observing, testing, and understanding" (Riedlinger and Berkes 2001, 319). Formulating hypotheses is identified as the most crucial part of the research process in determining what you will find: the questions you ask are influenced by culture, and science is no exception. Therefore, how science understands the world may be constrained by its worldview. Objectivity is a subject of tension at Sci-Centre, because at some point it must be admitted to be an ideal rather than an absolute: personal judgment always comes into the picture. Here there is an acknowledgement in the texts that both traditional knowledge holders and scientists equally choose what to observe, basing their choice on personal needs or disciplinary goals, respectively. In the Sci-Edges discourse, personal judgment is seen as playing an important role and should be applied when considering any findings, whether it be how far an indigenous hunter can actually see or how finely a scientist can discriminate between lines on a remote sensing chart.

By following the rules and conventions of objectivity and "naked" unadorned writing, the scientist retains a powerful but transparent role in results published as 'scientific findings' and 'facts':

> "And so he is endowed with the remarkable power to establish the facts. He bears witness: he is objective; he guarantees the clarity and purity of objects. His subjectivity is his objectivity. His narratives have a magical power – they lose all trace of their history as stories… the narratives become clear mirrors, fully magical mirrors, without once appealing to the transcendental or the magical" (Haraway 1997, 24).

In fact, at Sci-Centre, science demonstrates many of the characteristics of an ideology. Ideologies are representations that contribute to our identity and who we think we are, "largely unconscious structures that express both how we actually live and how we imagine we live" (McCarthy 1996, 42). Ideologies tend to speak as though they are truth, presenting their arguments in a totalizing way that is above question. Science gains its power through its demarcation as a special and separate epistemology and methodology. It decontextualizes itself from its origins within the social systems and worldviews which created it, as well as from the problems, solutions and technologies that continue to shape it (Nader 1996, 3). In this way it takes on a privileged status in which it is defined by the ideal conditions and rules it claims to follow (its ideology) more than what it really *is* in practice. Science cleverly relegates any opposing epistemological stances to that of mere anecdote or trivia, subjective and therefore inferior to the 'true' objective knowledge

provided by science, while simultaneously covering its own basis in society, history and culture. Ideologies often portray their way as being for the good of all, call all *opposing* ideas ideological and therefore false (McCarthy 1996, 31-39). They work to hide things, from those being oppressed and even from those reinforcing and benefiting from them, thus skewing power dynamics between groups in an almost invisible way by working on a subconscious level that may escape notice by most, at least for a while (McCarthy 1996, 33).

The claim to objectivity is key to science's ideological nature and as such, has long been a topic of concern as scientists continually try to detach their own subjectivity from their studies, and critique by those who question whether it is ever really possible (see Harding 1991, Haraway 1991). Are scientists really all that different from regular people, or are they "locked up in a particular natural or cultural world, driven by genetic make-up, ecological context, superstitious beliefs, or local concerns" (Pálsson 1998, 51) just like the rest of us? If all people, including scientists, bring an inevitable subjectivity to everything they do or perceive, is it perhaps better to acknowledge this than hide from it? This is Haraway's (1991, 188) argument when she introduces her "feminist objectivity", which she names "situated knowledge": if we clearly acknowledge our embodied subjectivity, we can actually be more objective than when we deny any bias or body and act as a "conquering gaze from nowhere". When bias is inevitable, it is best to be aware of it and open and honest about it. This seems to be the basis behind Sci-Edges emphasis on personal judgment.

When traditional knowledge is said to lose its meaning when removed from its context, it seems to be the antithesis of scientific objectivity and replicability. But in TK-World, pure or theoretical knowledge must always be linked to something practical, making subjectivity not only inevitable, but necessary for sense-making. Whereas science's universalism is derived from its claims to objectivity, TK is simply not designed or intended to be taken out of its cultural, lived context: when observations are extracted to fit within a scientific framework, the subtleties of their relative meanings are lost. Traditional knowledge seems to fall within Haraway's logic, as it places much importance on who is providing the knowledge or making the observation; awareness is crucial to the sense-making process. The subjectivity of TK also allows it freedom to be more overtly political,

whereas science hides its political power behind claims of objectivity while holding its dominant position in Western society as the source of truth and "facts".

Ideologies are often most evident in situations involving conflict or struggle over right or power (McCarthy 1996, 30), and both sides of the climate change debate (both the 'listen to the science!' advocates and the 'don't worry, do nothing' naysayers) can be characterized as operating ideologically, at least in part: "Today's ideological practices typically wear the garb of rationality or science, or they mask themselves in forms of political practicality" (McCarthy 1996, 46). Rather than advocate an ideology-free world (as Marx and others did in the past), we can instead expose and problematize the ideologies of today, placing them in historical context, and opposing them if necessary (McCarthy 1996, 46). The Arctic, where science meets different epistemologies under uncertain circumstances, is an ideal place to problematize our own ideologies. Climate change is an arena where borders and boundaries are becoming blurred, and the solidity of science begins to crack under the unprecedented weight of uncertainty as we urgently seek answers and solutions. The ideological element of science acts as a hindrance to seeing new possibilities or valuing other knowledges. By stripping science of its ideological claims and the power it gleans through them, it can be recognized as simply one of many ways of knowing (Nader 1996, 12). If objectivity is not really possible, and perhaps not even desirable, then questioning and reflexive self-examination can transform science from a dictator of truth into a useful tool. Traditional knowledge has gained attention, especially in the Arctic, but in the texts it is thought to have more influence at a local and personal level than nationally or internationally. But as cyborgs and hybrids remind us, it is at the boundaries and edges that change begins, and with the increasing challenges of climate change, these marginal influences can spread. Most of the texts agree that there is not much chance of traditional knowledge drastically changing science or posing much threat to science's position of power as the dominant discourse of Western society. While this may be true, the question that remains is, what might Western society be losing by not fully exploring what the traditional knowledge-science borderland has to offer, especially when addressing climate change?

4.3 Science Exploding from the Centre

Differences in how traditional knowledge and science come to know the world are closely linked to how they differently perceive time[12]. Traditional knowledge is relational in its dealings with time. Rather than speaking of history in years, as science does, TK compares "before" with "now", and significant phenomena are marked by how many times they have happened in an individual's memory and lifetime. This is information not directly transferable outside the context of the speaker, again illustrating the importance of context in understanding traditional knowledge. If, on the other hand, holders of traditional knowledge are allowed to interpret their own observations themselves (such as in community-based monitoring), their interpretations may be quite different from science's. For example, the reluctance of TK to judge what is normal is seen in the hesitation to place too high an importance on recent warm winters: "Both men stressed repeatedly that they did not consider those conditions as 'extremes', since they have seen it before" (Krupnik 2002, 180). Traditional knowledge thinks in terms of cycles that alternate rather than averages and extremes, and thus the idea of "normal", so common in the Western worldview, is an abstract concept that is rarely used. Traditional knowledge is diachronic, concerned with the way things and relationships develop through time, and moves at the same pace as the constantly changing world in which it exists. It follows that measuring time accurately is not a big concern, replaced by a narrative, story-telling style. For example, forecasting weather is "a lifelong and a twenty-four-hour passion" (Krupnik 2002, 172). Knowledge is lived and inseparable from living, gained not by imposing constructions of measured linear time onto the world, but through watching the world unfold. The world dictates time in its own cyclical way, not bound and restricted by the limits of a project study periods as science is.

Science[13], on the other hand, is synchronic, concerned with collecting large amounts of information from the particular points in space and time research happens to be carried out,

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[12] In this and subsequent sections, I speak of the philosophical underpinnings of traditional knowledge as I have come to understand them while analyzing the texts. It is not my intention to characterize and classify the true nature of traditional knowledges and worldviews or speak for any of the indigenous groups whose knowledge this is. Instead, I want to critically examine how TK *appears* when looked at through the lens of science, to see what this reflects back about *science* - my discussions of TK are meant to be read as a reflexive tool for shining light back on science itself.

[13] When discussing the philosophy of science, I am again referring to how it emerged in the science discourse in the texts and interviews I analyzed, and do not mean to generalize all sciences, some of which see things very differently than I discuss here.

and extrapolating from there - hence its focus on "production". Whether looking from a distance (remote sensing), looking back (reconstructing and retrospective analysis), looking within (manipulation and experimentation) or looking forwards (predicting and modeling), the science discourse attempts to understand the world from where it is right now, by trying to understand the current site and object of study as well as possible. This inherently assumes the world follows unchanging laws, and that even change can be predicted and understood. Science is consequently very good at measuring time and developing technology and understanding based around this ability, and values averages, developing technologies geared towards working "in most cases".

In traditional knowledge, empirical observations are validated through experience, and respected experts are usually elders because they have the most experience; TK does not adhere to science's faith in gathering information all at once. Reliability in traditional knowledge is linked to the personal success of the individual it comes from: what works survives and what does not is replaced. The TK-Info discourse emphasizes that there is a greater motivation to be certain when survival is at stake. The scientist is not usually staking whether his family will go hungry or not on his probabilities and trends, which is why traditional knowledge puts greater emphasis on unusual or anomalous events than science: when survival is at stake, if something happens once, it matters.

> "The holders of traditional knowledge are literally staking their lives on the accuracy of their information. That's a pretty good test, and I think there are probably relatively few scientists who would stake their lives on their findings. We discuss things in 95% probability and we're pretty pleased with that, but frankly I would want a lot better than a 19 out of 20 chance before I put my life on something." (Huntington 2007)

This causes traditional knowledge to be detail-focused and specific, with all observations considered equally important. TK is not so concerned with what *usually* happens as what *actually* happens moment to moment.

At the centre of the science discourse, prediction is identified as something science is good at, contrasted with traditional knowledge which predicts poorly. For prediction to be possible, change must be mechanistic, and this is how it is viewed at Sci-Centre: "I'm used to looking at the world and natural phenomena as things that are susceptible to explanation by natural causes" (Interview Participant 2007). This theme is present in both TK discourses, but is only seen as a real concern by the TK-Info discourse. In TK-World it is pointed out that in some indigenous societies, talking about the future is not necessarily a

"productive, worthwhile or appropriate thing to do" (Interview Participant 2007). For example, Krupnik (2002, 176) quotes a Yupik hunter's views on prediction:

> "You can never make a good forecast for tomorrow if based upon today's weather. Better go out and check it in the evening. Make a guess and check it next day: it is better to see whether it is correct or not." (Chester Noongwook, 2001)

With the long time depth of traditional knowledge, there is space and room for a dynamic world to be comprehended and described as people live their daily lives, while the lack of time depth that characterizes science is linked to the assumption of predictability. There are many parallels between this TK concept of time, and new materialism. In Pickering's (1995, 24) temporal emergence, because actions occur in real time, each subsequent step is not predictable and does not invite causality or explanation, because each action/actor can be linked to the previous in an endless backwards chain.

Yet, even science is admitted to change over time, making consistency of data over long time periods difficult to attain. This is one of the reasons that the TK-Info discourse looks to traditional knowledge as a potential "source of climate history" that could provide "important baseline data against which to compare change" (Riedlinger and Berkes 2001, 318). This appears as a fundamental misunderstanding (or misuse) of traditional knowledge by science, because what meaning can a baseline have if change is viewed as ongoing and time cyclical, as in indigenous worldviews? Science's desire to establish baselines illustrates its attitude toward change well. Baselines fix a stable point in linear time, against which change itself can be measured. In describing time, traditional knowledge uses phrases such as "early days", "every summer", "long, long time ago", "before I was born" and "one time" that do create a sort of baseline to which current experiences can be compared. However, it is personal, relative, fluid and ever-evolving – it is not what science is looking for.

In the TK-World discourse, there is less certainty about science's ability to predict. For example, "scientists are still unable to predict ice distribution and condition" nearly as well as community members, who understand the complex relationships involved (Riedlinger and Berkes 2001, 317). Reducing uncertainty requires that some variables be held constant, but the TK-World discourse questions if this is possible in an ever-changing world. Most participants brought up the problem of the unpredictability of the weather, joking that "nobody expects the weatherman to be right" because the weather itself is a

"fundamentally unpredictable phenomena" and noting that the field of meteorology most closely resembles traditional knowledge in the sense that "prediction is lousy". Here the science discourse moves toward Sci-Edges, where both traditional knowledge and science are discussed as being poor at prediction.

Closely linked to prediction is uncertainty: if the future is uncertain, accurate prediction cannot be expected. Uncertainty could be called the key concern of the science discourse: it is the gravity which gives it purpose but also the force behind the desire for more data, which threatens to blow it apart from within. In the TK-Info discourse, uncertainty emerges as a major barrier in bringing together traditional knowledge and science. In science there is much thought and effort put into the question of uncertainty, witnessed by the development of quantitative statistical methods to measure error and probability. The lack of a way to quantify uncertainty in traditional knowledge increases the dichotomy with science:

> "In traditional knowledge there is as yet no measure of uncertainty and the problem that is generating is the belief by some that all traditional knowledge is perfect, and the absolute viewpoint of hardcore scientists that because of uncertainties, no traditional knowledge is any use. So there is a polarization of attitudes based on uncertainties, and the way different communities view uncertainties." (Callaghan 2007)

But even in science, certainty about the past is always greater than certainty about the future, where errors can multiply in a "geometric progression" to form a "pyramid of uncertainties" when trying to model the effects of possible future climates. The question of uncertainty is a complex one.

Throughout the texts, climate change is seen as a phenomenon of uncertainty. It is described as "destabilizing", likely to decrease predictability and increase variability and unusual fluctuations, and characterized primarily by changing patterns. In this way, climate change highlights science's weaknesses:

> "I think it [climate change] poses several new challenges to science, one of which is trying to capture something that is this complex. Science, I think, in general has been spectacularly successful at dealing with single causality, dealing with separating things and identifying chains of causation or chains of interaction. I think it's been far less successful in dealing with very complex cases of multiple interaction and feedback." (Huntington 2007)

Throughout the texts, the world is spoken of as "alive and lively", "inherently highly variable", "dynamic", and "constantly changing". There is "so much we don't know about the natural world" and all participants agreed that it is *not* fully knowable. One reason

given for this is the chaos theory, where "very small differences in initial conditions can lead to very different outcomes" even in purely deterministic systems like mathematics (Interview Participant, 2007).

> "No matter what question you solve in science there'll always be a lot of other questions generated, and it will only be a matter of time before we answer those questions again, but that will generate more questions too, so science understanding is infinite, but at the same time there are some questions where science can't make progress, and science merges into philosophy and the creation of life and the creation of the universe and what happens after death, all that sort of stuff has to be at the boundaries of science and philosophy but in terms of the natural world that we can see and measure, then we should, sooner or later we should be able to answer the questions we address to those systems. It's a progression towards a fuller understanding but we will never get there." (Callaghan 2007)

It is the human capacity for understanding that is seen to limit us, not the nature of the world itself. Returning once more to science's foundational belief in replicability, it requires that both the actions of the researcher and the responses of what is being studied remain constant. Not only must people be consistently objective, but the natural world must follow static rules and act without agency. All the texts remain well within the scientific discourse in attributing agency to humans alone. We may be limited by the structure of the vastly complex world, but only so far as our agency to adapt and develop technologies to meet this complexity fails.

A fundamental tension running through the discourse of science and climate change is the repeated acknowledgements that complete knowledge of the world is unattainable, while at the same time this is implicitly what science is attempting to do when it tries to understand climate change. Again, the harder one tries to fix definite boundaries, this time on what is known and what there is to know, the more elusive they become. In the words of Patomäki and Wight,

> "There can be no a priori assumption that the scientific endeavor could ever come to an end. For as one phenomenon is explained by a deeper level, that deeper level itself becomes a new phenomenon that requires explanation. Equally, as deeper layers are revealed and understood, the knowledge we gain of them may necessitate that we revise our understandings of the original phenomenon. Science is seen to proceed through a constant spiral of discovery and understanding, further discovery, and revision, and hopefully more adequate, understanding." (Patomäki & Wight 2000, 224)

The increasingly uncertain world of global climate change means changes in what can be expected, non-uniform change on a scale that is quite literally as big as the entire earth and atmospheric system. Reductionism that aims to understand each individual part, then synthesis of all this knowledge, seems an unrealistically lofty goal: *the goal of science in*

the context of climate change essentially becomes the goal of complete understanding of the entire world and everything in it.

The paradox of seeking to understand the entire world leads to the never-ending calls within the science discourse for more data. But eventually, all scientific data must be synthesized, summarized, analyzed and understood by people or it remains useless: contrary to the common conclusion in many scientific papers, perhaps what is needed is not more data, but more wisdom. Riedlinger and Berkes (2001, 326) quote a former Inuit Circumpolar Conference president speaking at a UN convention on climate change: "Your science cannot tell you how fast climate change will happen and your science cannot tell you what and when the surprises will be – just that they will happen". More data will not help because of human limits to dealing with it, evidenced by the loss of traditional scientific knowledge, data that sits unused in storage, and the forgotten wisdom missed by the decreasing time-depth of literature reviews. Still, science continues to be thought of as a progression towards fuller understanding. The endpoint, however, is a rapidly moving target. It is somewhat ironic then, that Sci-Centre sees climate change as the main threat to traditional knowledge due to TK's lack of predictive power, while glossing over the formidable challenge it poses to science.

When it comes to climate change, it seems to me that an onto-epistemological framework that sets itself in constant battle with uncertainty is doomed to fail. Is the problem that the world will always change at a rate faster than we can gain understanding, or is it perhaps that we are not actually progressing as we think, but instead simply flowing along with the world much as traditional knowledge is? Contrary to the boundary-drawing and limit-testing tendencies of science, traditional knowledge does not presume to attempt full understanding of the complexity of the world. TK focuses on describing relationships rather than isolating parts of the whole; unlike science, it comprises already synthesized information that is narrative and linked to time and memory. It is what any of our worldviews would be were we able to see the world holistically, integrated and intact, before disciplinarity and specialization carved up our epistemology: it is understanding through living. Science is but one facet of society, never intended to give us a full comprehension of the world. When we focus too closely on one part of a system, we can lose perspective and think we have the answer when we do not; the problem with science's predictions and extrapolations from the present moment is that the world is always

changing. Despite science's best attempts at complex mathematical modeling to try to understand climate change, "If traditional ecological knowledge can do a better job just by being more a collection of holistic observations, then that may just be the best we can do" (Norton 2007). Phenomena such as climate change test our ability as a society to move beyond disciplinarity. In some ways, multidisciplinary studies offer the potential of shifting science back towards a more narrative and holistic way of understanding the world. A characteristic of conventional science is that it must rely on research from many disciplines in order to understand a complex system such as the social-ecological-physical phenomenon of climate change. The question becomes one of holism versus reductionism: science asks, if you cannot explain the mechanisms by which something works, do you really understand it? But as it is daily and bodily that we will experience climate change, the reverse question also becomes pertinent: if you cannot piece the explanations of the parts back together into a coherent and livable understanding of the world, what do you really know?

Just as traditional knowledge pays attention to and remembers what people perceive as important, science too measures what it believes to be most valuable. In the TK-Info discourse, the science/TK dichotomy is reinforced around the issue of quantifying uncertainty, but the question of *why* traditional knowledge is not good at prediction and places little emphasis on quantifying uncertainty is missed in the discourses. It is hinted in the TK-World discourse that the apparent difference in predictive power may reflect a difference in the subjects of TK and science, in other words, a difference in how they see the world. Perhaps traditional knowledge is not good at prediction *because it fundamentally does not believe that predicting the future is possible.* Although science strives for accurate prediction, it still often falls short, and although uncertainty is quantified through probabilities and confidence intervals, the fact remains that putting a number on something does not actually decrease it. By generalizing the variability of reality through averages and trends, science obtains *seemingly* greater certainty, especially in the eyes of a layperson, but the variability remains unchanged: "convergence among models is not the same as reducing uncertainties" (Manning *et al.* 2004, 33). In its drive to reduce uncertainty, science can end up masking the uncertainty that still exists. One participant discussed the scientific practice of discarding outliers believed to be caused by measurement error or lack of precision. Here a difference in the ontologies of TK and science is highlighted, as science believes in trends, graphs and statistical tests, while TK

believes in dinner: an outlier may be the difference between feeding one's family or not. Rather than fighting what it views as an inherently changing, animate and dynamic world, traditional knowledge accepts uncertainty, and focuses on how to live with it. Thus, traditional knowledge tends to work through narratives and stories about *how* things are, rather than theories and explanations of *why* things are. New materialism also accepts the uncertainty of the world by using phenomena as its onto-epistemological base unit, thus removing the need for either the observed world or the observer to be static, and in fact assuming they are not. While science strives for universals, both traditional knowledge and new materialism are relative and relational: experience and knowledge are "coterminous", meaning "they arise and develop simultaneously" (McCarthy 1996, 4). Knowledge, the subject and the object all become what they are through intra-action.

A recurring theme in the texts is that one of the key lessons traditional knowledge has for science is humility. Humility and respect come from viewing the world as a web of interconnected relationships between equal realms of existence, where nothing is self-sufficient so there is no basis on which to claim superiority. At the simplest level this can begin with an individual scientist realizing and marveling at the extent of indigenous expertise. Science's assumptions about the world often lead to arrogance: it is always just on the verge of knowing, and with more information it will reveal the processes behind nature's mysteries. Science also tends to assume not only that is it right, but that everyone else also believes it to be:

> "I remember one colleague on a project in one town, they were building a new hospital there and somebody said 'We used the results of your study to figure out where we should put our hospital', and the poor guy was just horrified because now this is a multimillion dollar decision being based on some findings, not that they'd done a lousy job, but he just, he knew the level of uncertainty they'd dealt with. And yeah, fortunately talking to the person who'd said this, they said 'Well look, we knew, we knew it wasn't 100% reliable or anything but it was better than the other information that we had'. Which I thought was a pretty good answer; it seemed to relieve him quite a bit. But, you know, part of it again is at least trying to follow that idea of some humility about what we can expect." (Huntington 2007)

Sometimes basic common sense is the best mediator of when science is functioning as a useful guide, and when other tools and ways of knowing may be more helpful.

If, as discussed above, there are limits to our understanding of the world, should there not also be limits to what we demand of it? Humility causes traditional knowledge to be less eager to push limits:

"I think in Western society in particular we're often trying to push the limits. See how many fish can we take, can we take a few more, can we take one or two more than that, can't we take that last one. Rather than saying, you know, let's take it easy. If we think we can take 50 fish, let's take 30. That satisfies our needs, let's just stop there and leave a little extra just to have it. Just a sort of safety, a margin of error. I think we in Western society tend to try to get away with much smaller margins of error that way." (Huntington 2007)

Because traditional knowledge accumulates over a long period of time, respect is able to develop in parallel with knowledge, as "generations of accumulated respect" (Interview Participant 2007). Values are not stripped from knowledge as they are in science through the pursuit of objectivity. Science amasses information so quickly that it is not always mindful of the implications of current actions, causing us to arrogantly think we have the answers when we do not. One participant gave the example of antibiotics transitioning from a miracle breakthrough of modern medicine to a crisis of antibiotic resistance in only 70 years, which on the evolutionary timeframe of the earth, is "not even a blip". Traditional knowledge operates on a much longer timeframe, lending caution to the limits of knowledge, and humility about our place in the fabric of life; it suggests that it is not up to us to determine what is normal or extreme, but to just watch and to pay attention. Humility is a valuable lesson for Western society and science, but an important source of this humility is found in TK's spiritual dimensions: "Our relationship with the spiritual world is based upon acceptance of things that can neither be seen nor touched" (Dene Kede 1993, quoted in Bielawski 2003, 317).

Spirituality is one of the most direct disagreements between the two traditional knowledge discourses, one of the reasons the TK-Info discourse splits from the TK-World discourse in the first place. Because it defines traditional knowledge as information, the TK-Info discourse excludes spiritual or non-empirical elements as something the researchers "don't know about" and asserts that the observations retain their meaning and relevance "completely out of the spiritualistic context" (Interview Participant 2007). Because it is science defining traditional knowledge as what fits within the scientific framework, TK is defined as what fits. The TK-Info discourse is embedded in the disciplinarity of science and as one participant put it, it is not the job of biologists to get into spiritual debates with holders of TK; this is something that "someone else" should be looking at. Another participant claimed no understanding of how spirituality fits in, recognizing that while it likely plays a part in how traditional knowledge is produced, he just appreciates the parts that he can understand – the observations. Selective use of TK is simultaneously

acknowledged and justified by the need to understand climate change, and the benefits to both sides in the exchange of information on the observation level. Spirituality is carefully not disregarded, but is clearly marked as not relevant to science. Furthermore, at times in the TK-Info discourse there is skepticism as to whether spirituality is even that important to indigenous people, who in one participant's opinion seem more interested in "real concerns" such as money, and other practical issues: here pieces of TK are not only extracted, but the notion that there might be holistic, spiritual or contextual elements is rejected.

In the TK-World discourse, spirituality features prominently as the "only seemingly irresolvable contradiction" between science and traditional knowledge and is depicted as central to indigenous worldviews. For example, the commonly used term "environment" means decidedly different things to Western scientists and indigenous peoples:

> "In Western science, the term 'environment' typically excludes people. For both Dene and Inuit, however, environment includes people, land, animals, air, insects, water, fish, birds, plants, rocks, *and everything else we can perceive or imagine*" (Bielawski 2003, 313, emphasis mine)

Environment is not only inclusive of everything human and nonhuman, but includes all possible relationships, past and present, among these things, encompassing social interaction and spiritual knowledge. The worldview of traditional knowledge systems extends far beyond the scientific ontology of the world, into a "non-empirical" environment which is perceptual and intuitive, and simply cannot be defined in the terms of Western science. Fear of the unknown is also cited as an obstacle. For example, Bielawski quotes a story where an Igloolik hunter tried to explain to government biologists that polar bears, having intelligence equal to or greater than humans, were the ones who made the choice of when to allow themselves to be taken by hunters. The hunter told of a time he was following fresh bear tracks only to find them suddenly end,

> "and there on the tundra was a rectangular block of ice. Clearly, the polar bear, not wanting to be taken, had transformed itself into ice. The government biologists were bemused at this explanation, whereupon the old hunter told them that if they did not, or could not believe him, then they knew nothing about polar bears." (*The Arctic Sky*, MacDonald 2000, 18. Quoted in Bielawski 2003)

Where to go from there? In our interview, Ellen Bielawski read this quote aloud, commenting "there's something there. What is it?" The issue goes far beyond the political level, reaching deep into philosophy: "We need to talk to that hunter and all the hunters who agree with him and say, so what does it look like from your side, over to what we're doing? Because we're doing something that shapes reality and describes it too" (Bielawski

2007). In the TK-World discourse, it is pointed out that the history of science is closely entwined with religion and spiritual belief; the segregation of science happened relatively recently for societal and political reasons, making the lack of effort to address the question of spirituality even more unjustified. The only way to truly address this problem is for science to examine its own assumptions: "Perhaps with new scholarship showing that Western science is in itself a cultural artifact, not free of value or interpretation, some of this will change" (Bielawski 2003, 325). Practical obstacles in the structure of the research system also preclude addressing spirituality, with lack of time and the constraints of disciplinarity cited:

> "I think this is a really complicated question, this thing about spirituality and aboriginal knowledge. And I don't think we've even tried to really start to get a handle on it. Because I think to do that, we can't just have biologists talking to hunters. We have to help, have philosophers of many stripes involved, we have to have physicists involved, we have to have molecular biologists and we probably have to have nanochemists or something like that. You know, we can't just rule out traditional knowledge because there's a spiritual element."
> (Bielawski 2007)

Spirituality must be addressed before the gap between traditional knowledge and scientific worldviews can be bridged. Where scientific ways of knowing merge with others such as philosophy, and questions such as the meaning of existence are pondered, the barrier of spirituality becomes less formidable.

4.4 Spirituality and Nonhuman Agency

The spiritual element of traditional knowledge has valuable lessons of humility and acceptance of uncertainty that are ignored at science and society's peril. It is thus crucial that researchers not disregard this element of traditional knowledge, as in the TK-Info discourse, or shy away from questioning what its absence means in science. However, the high degree of political and cultural sensitivity surrounding spirituality is not easily overcome. Here, a Western-derived philosophy such as new materialism offers hope of bridging this formidable and politically imposing gap. Apart from its actual spiritual nature, *what is it that this spiritual element brings to traditional knowledge that is absent from science*? Beyond the spiritual meanings attached to explanations, what emerges is that traditional knowledge sees the natural world as possessing agency, while science fundamentally does not. "There is something there, what is it?" – the answer is agency. Traditional knowledge sees the world as constantly changing, an animate world full of surprises *because agency is synonymous with being*: "All nature is alive and everything has its own being" (Kawagley 2006, 21). The impasse discussed in the texts between scientists

and hunters over whether animals choose to be taken is usually attributed to spirituality, but at its heart, it is about agency. For example, the Cree also believe that it is animals, not people, who control the success of the hunt, and the hunter's role is to show respect to the animal in order to ensure future success in hunting (Berkes 1999, 80). Animals are believed to have spirits, just like people do: "they have spirits that are sentient; they are watchful and aware of people's behaviour" (Berkes 1999, 80). Consequently, if a hunter is disrespectful, the animal may not "decide to come back" to the traps for many years (Berkes 1999, 81). If the natural world has agency, then it is no longer expected to follow definite or predictable rules any more than humans do, and uncertainty becomes expected.

Sci-Centre bases itself on the assumption that when a world following static laws is observed by an objective observer, the results will also be static (i.e. predictable and replicable):

Correct theory * Static world + Objective observer = Predictable result.

When this equation breaks down, science assumes it to be a problem with the observer or with the theory, because only humans are granted agency and thus the ability to throw a wrench into the equation. The TK-Info and Sci-Centre discourses are clear that only the human world has agency. This points to one of the reasons disciplines in Western knowledge split: when humans are the main subject matter, as in the social sciences or international relations, outcomes are seen as inherently less certain or deterministic than in the natural sciences. The way in which the IPCC handles uncertainty differently in each of its three working groups highlights that they too attribute agency only to humans: the methods of Working Groups I and II ("The Physical Science Basis" and "Impacts, Adaptation and Vulnerability") were "judged to be inadequate" by Working Group III ("Mitigation of Climate Change") in dealing with the "specific uncertainties involved in this mitigation report, as here human choices are considered" (IPCC 2007a, 23). Human subjects add greater uncertainty through their agency.

Recall that the concept of agency I am using here has two requirements. First, for 'A' to have agency, something 'B' must be affected, and second, the resulting effect must be due to action or influence of 'A' which is more than the residual of 'B' not having the power to resist: something equivalent to intention is required of 'A'. So, although many of the texts depict the natural world as an influential and important actor, the second element is missing. Unexpected outcomes are attributed to *human* limitations: we do not understand

the structure well enough so nature only *appears* to have agency. Although at first, intentionality does not have an obvious counterpart in the material world (Pickering 1995, 18), looking at our own intentionality from another angle can help make sense of it:

> "Modeling is an open-ended process with no determinate destination. From a given model…an indefinite number of future variants can be constructed. Nothing about the model itself fixes which of them will figure as the goal for a particular passage of practice" (Pickering 1995, 19).

Although people have goals, these are really just the plane of practice (action) from which results emerge. Goals and intentions do not determine definitively what will actually happen, and furthermore, can and do shift and change depending on what *does* happen (i.e. what the material world does in response) (Pickering 1995, 20). In this way, the standpoint of post-humanism is inherently humble, as it removes us from our egocentric place as the sole agents at the centre of everything.

Time is key to understanding agency in new materialism. In a similar fashion to how traditional knowledge moves at the same pace as the world, new materialism sees time as iterative and cyclical. Discursive practices and the material world exist in an isochronous relationship of phenomena, inseparable from one another but also not reducible to one or the other (Barad 2003, 822); both are created in the same boundary-making process of intra-action. Pickering describes how the post-human space (which includes both human and nonhuman elements and agency) is temporally prior to anything that either the natural or social sciences may choose as an object of study; in this way, post-human objects of study emerge in an "unpredictably open-ended fashion" (Pickering 2005, 34). He uses the idea of "temporal emergence" to explain how nonhuman agency is manifested: "the contours of material agency are never decisively known in advance" and so scientists are continually engaged in a relationship of problem-solving, where understanding and solutions come through "tuning" between human and material actors that is repetitive and co-produced (Pickering 1995, 14-16). "Agency in all these instances emerges out of such interaction; it is not antecedent to them" (Tuana 2006, 6). In this sense, science itself can be thought of as the act of capturing material agency in a form that we as humans are able to understand (Pickering 1995, 7). The increasing variation and unpredictability of climate change can be seen as the agency of the world becoming more visible:

> "No one knows where this kind of dance of agency is going. This is the sense in which such assemblages are prior to the objects of the traditional sciences. The latter come late, and try to understand what the dance of agency has made visible." (Pickering 2005, 35)

Science can help make sense of things by creating objects of study through e*x post facto* disciplinary partitioning (after creation through intra-action), and may at times succeed in applying the rules derived to predicting future outcomes. Science is very good at predicting until it is not, but it is those instances where it fails that are most telling: here the nonhuman agency of the world becomes evident and the wisdom of the humility of traditional knowledge is highlighted. Without actually invoking spiritual explanations, new materialism accepts uncertainty through its relinquishment of agency as the sole possession of humans, and matter itself is seen as "a congealing of agency" (Barad 2003:818). The ontology seen in the Sci-Edges discourse is also primarily one of agency. Here, a four-way dance of agency involves the real-time flow of interactions between scientific researchers, instruments and technology, members of indigenous communities, and the natural world.

We tend to forget that the assumptions of science and their dominance of our worldview is a very recent development on the timeline of human history. The onto-epistemology of medieval Europe shared many characteristics with today's traditional knowledge. The world was seen as dynamic and alive, and the relationship between humans and nature conceptualized as empathetic, "nature that must be read like a book, not dismantled like a machine" (Everndon 1992, 43). With the Enlightenment and the scientific revolution (which share common roots with the Industrial Revolution, large-scale environmental degradation and the current climate change crisis itself) came the replacement of this knowable-through-lived-experience concept of nature with the belief that nature was only knowable through objective scientific study, a "non-experienced reality" (Everndon 1992, 53). Then followed a dramatic shift "from the fundamental assumption that the world is alive and that death is the anomaly to the assumption that death is the norm and life is the anomaly" (Everndon 1992, 90). Everndon argues this shift could not have been conceived, never mind accepted, until we effectively cut ourselves off from nature through the reinforcement of the human/nature dichotomy. If this dichotomy can again be dissolved, perhaps nonhuman agency can also be restored. Just as we have drastically changed our perspective on nature and our relationship to it in the past, so too is there hope we may do so again. The current climate change crisis may be just the motivation we need.

4.5 Knowledges Meet: Power and Practice

Although traditional knowledge may give us a partial and subjective glance into one way of understanding the world, science gives us no more. It too is a cultural product, just one

way of knowing the world that arose relatively recently, under specific cultural and historical conditions, and has no more claims to truth than any other onto-epistemology. At a basic level, reality and knowledge can be viewed as a process, "reciprocally related and socially generated" and accepted by a group of people (McCarthy 1996, 2). Berger and Luckmann (1966, 3) define knowledge as "whatever passes for 'knowledge' in a society, regardless of the ultimate validity or invalidity (by whatever criteria) of such 'knowledge'". This all combines to form an inter-subjective understanding of reality and a coherent view of the world. Haraway (1989/2000, 157) discusses how science can be seen as a narrative where the material and symbolic interweave and "natural sciences, like human sciences, are inextricably within the processes that give them birth". Far from being exempt from discourse, science happens in a world already known and experienced as something, and also constructs this world as it describes and seeks to understand it (McCarthy 1996:95). In order to understand how this happens and what results, the universalizing truth claims of science must first be deconstructed, for example, by uncovering how science uses frameworks to decrease confusion and background noise (Latour and Woolgar 1979:37).

In order for there to be a chance for true meeting of the potentials of traditional knowledge and science, the balance of power between them must be addressed. This is a crucial step before erasing dichotomies altogether, lest the more powerful side drown out the other in their merging. Re-balancing of power can occur through strengthening and empowering traditional knowledge, and/or opening science to honest self-reflection and critique. To date, more attention has gone to the former, the politically charged agenda of revaluing traditional knowledge, as evidenced in both the TK-Info and TK-World discourses. However, this will only get the dialogue so far, and misses the important philosophical implications discussed in the previous section.

When the motivation for integrating traditional knowledge and science is political, there can be too much historical baggage and not enough time. In the TK-Info discourse, the sense of urgency surrounding climate change is a central justification for treating traditional knowledge as observations and pieces of data rather than entering the lengthy process of recording, translating, interpreting and comprehending indigenous worldviews. But this simply cannot go on: "TEK researchers, insofar as they focus exclusively on the methodological difficulties of integrating distinct knowledge systems, help to obscure the

power relations that shape the production and use of the knowledge they study" (Nadasdy 1999, 15). In the TK-World discourse, it is noted that rushing the process of including TK in development plans, environmental impact assessments, or climate change research can lead to increased mistrust on the part of traditional knowledge holders about the motivations of researchers expressing interest in their knowledge. There are concerns of how the TK will be used in political circles and that it may end up being used against the interests of the community, even if it is not totally misunderstood or misrepresented. The desire to prevent the continued exploitation of traditional knowledge is very understandable, as noted also by Kuokkanen (2003, 8): "Asking for a full comprehension may not only prove impossible but may also represent a colonizing, totalizing attempt to subsume the other […] we cannot forget how historically, knowing indigenous peoples has been an integral part of colonization." Conversely, the politicization of traditional knowledge can also contribute to lack of credulity on the part of some scientists who feel that the emphasis being placed on it is due to a current political fad rather than merit.

The hope for the future seems to lie in slowing down and allowing space and time for a real meeting of these different worldviews. Most of the texts touched on the interaction between TK and science being more productive, open, easier and enjoyable at the personal level, but becoming more difficult at higher levels. One reason may be that at this human-scale, dichotomies and boundaries are less easy to maintain. When science is viewed in opposition to traditional knowledge as being what TK is not, it appears clear cut and uniform; but when questions call for closer examination of science itself, its assumptions become grey areas and it frays at the edges. When we start to see science as simply an approach, then it can be integrated into any number of different worldviews without the imposition of Sci-Centre's values of objectivity and reductionism. This is crucial, because neither traditional knowledge nor science alone is likely to be enough to deal with climate change, and both scientists and local communities are looking for answers:

> "I think either one alone can strengthen the quality of observations and usefulness of their observations but together they really make a difference, they're in a position to help one another out in many ways." (Norton 2007)

Science and traditional knowledges mix with personal experience and worldview as boundaries dissolve and hybrid onto-epistemologies emerge. At the level of individual interaction, what works best in the current context is likely to win out, rather than what is coming from the dominant paradigm.

In true community-based research where the community is involved in all stages of research, indigenous TK holders identify gaps in knowledge which they want science to fill, so that science can act as a resource for traditional knowledge as much as TK acts as a source of information and understanding for science. The question becomes how science can be relevant to communities on the ground. Most science happens because of real world demands (Smith 1996, 2002), resulting in what some term the "Mode 2" process of knowledge production. Mode 2 knowledge is "generated within a context of application"; trans-disciplinary in that it is "not necessarily derived from pre-existing disciplines, nor does it always contribute to the formation of new disciplines"; it is reflexive and dialogue-based rather than objective and ideological; and it blurs the borders between science, society and politics (Nowotny *et al*. 2003, 186-187). The Sci-Edges discourse resembles Mode 2 knowledge by allowing combinations of knowledge and practices from both science and TK. Although the framework may still appear to be science-oriented, it is porous, and traditional knowledge's worldview can enter and hybridize. When this occurs on a level playing field that does not privilege one worldview over another, science loses its ideological status as inherently better, more objective, or more able to discover the truth than any other onto-epistemology. This relinquishment of power also allows the Sci-Edges discourse to be less politically cautious with traditional knowledge than the two TK discourses.

Elaborating on the writings of Michael Polanyi, Tsoukas (2003, 425) describes tacit (practical) knowledge as knowledge in doing, which underlies even the most explicit theoretical (articulated) knowledge. He asserts that a false dichotomy has been created between tacit and explicit knowledge, when in fact they are not in opposition but simply two sides of the same coin (Tsoukas 2003, 412). This is essentially what new materialism suggests by dissolving dichotomies through focusing on intra-action rather than oppositions. In a way, traditional knowledge and science too can be viewed as two sides of the same coin: traditional knowledge seems more implicit, knowledge through doing and interaction, and Sci-Centre more explicit and theoretically based. But by focusing on the coin itself, the knower who must perform "skillful action" through "personal judgment" for any act of understanding to occur, the very concept of objective detached knowledge becomes nonsensical (Tsoukas 2003, 412). Thus, Tsoukas (2003, 425) argues that what is needed is to "re-orientate ourselves to how we relate to others and the world around us". Although 'scientists', 'researchers', 'government' and 'the public' are usually discussed as

though they were discrete and separate entities, the people that make up these groups actually cross between categories all the time (Smith 1996, 201). Through intra-actions, both traditional knowledge and science come into being, and it is through dialogue at the personal level that scientists and indigenous experts share and exchange data and resources. Part of what is gained is not the information itself, but the lessons and experiences that come from these interactions – this is relational knowledge that can only be accumulated through living, not all at once like science. Thus, it brings with it humility and respect.

In attempts to bridge the divide between traditional knowledge and science, what is often lacking is a thorough reflexive analysis of the foundational assumptions and methods of science itself. As long as science remains the basis for policy and societal action regarding climate change, we must critically question it in order to avoid repeating past environmental and cultural wrongs. Otherwise, the currently dominant positivist ontology and epistemology of the natural sciences will continue to obscure fully seeing and allowing the potentials of traditional knowledge. The reduction of TK to fit within scientific frameworks is negative for both science and traditional knowledge, and if it continues, represents a serious missed opportunity for society to expand its perspective and possibly find new ways of dealing with challenges like climate change. New materialism sheds light on the middle ground, always present but often obscured by power relations or disciplinary boundaries, that exists between a positivist focus on the material world and a constructivist focus on the social world. The practical matters, matter matters, the ideational and discursive matter, and in this way the middle ground expands to become all ground. The focus shifts from goals and outcomes to process and intra-actions, allowing more productive and open interplay between scientists, indigenous peoples, policy-makers, and other actors. Hopefully the emerging new stages of dialogue and decision-making in the North, such as the Northern Research Forum and the Arctic Council (see Heininen 2004) will provide fruitful ground for the development and expansion of new materialist frameworks in which science and traditional knowledge can both realize their potentials.

New materialism offers a way of overcoming many of the obstacles of positivist science without resorting to an appropriation or devaluation of traditional knowledge and without the pitfalls of a purely social constructionist rejection of science that discounts the material world. It overcomes the barriers of both TK's politics and science's ideology by

encouraging a focus on practical, contextualized problems, individual intra-actions and knowing-in-doing. The Sci-Edges discourse is most similar to new materialism. It is not so concerned with deeper origins or meanings (discursive elements), whether they be of spiritual or philosophical nature, or discovering the true nature of the material, but with actual practices, processes, intra-actions and outcomes. My qualitative methodology was not able to determine the prevalence of the TK-Info and TK-World discourses, only that they each exist, and that they emerge through the slicing lens of Sci-Centre. Although the TK-World discourse speaks more of the philosophical (discursive) than the more practical (material) TK-Info discourse, it provides more concrete direction as to how to politically rebalance power relations. I see the most hope for realizing the potentials of all of our knowledges of climate change in combining the TK-World discourse with the new materialistic philosophy and pragmatic approach seen at Sci-Edges, where the very dichotomy between the two dissolves.

The Arctic is a political periphery, and in the case of the human-induced natural phenomena of climate change, it is portrayed as especially victimized, the area that is being affected first and hardest while remaining relatively powerless to do anything but try to adapt. However, the very circumstances that seem to contribute to its marginalization may also empower it to be a central hub in challenging the philosophical basis of science, and thus shifting the onto-epistemology of Western society:

> "Instead of taking the circumpolar North, or the Arctic, as a laboratory, or of claiming it as a distinctive region, it would be interesting to take the circumpolar wide organizations and fora as platforms for a wider discussion and common activities of, and by, both the residents and the actors from outside the region." (Heininen 2004, 18)

In the globally focused TK-Info discourse, climate change is portrayed as a teacher about nature, and the Arctic becomes, in part, a laboratory; in the more locally anchored TK-World discourse, climate change teaches us about ourselves, and here, I think, lies the undiscovered potential of the Arctic.

4.6 The Politics of Uncertainty

Climate change is portrayed as very political in the texts, and this is seen as a barrier to finding solutions. Science sets the agenda but that agenda is actually driven by politics and policy needs, not the environment. The political underpinnings of the TK-Info discourse can be seen in its complaint that traditional knowledge deals differently with uncertainty:

the problem is deciding whose truth wins, a major issue when power is at stake. Again looking to the basic level of naming,

> "Climate change as we label it in the Western system was just one variable that has always been part of people's perception of and questioning of the natural environment. So to even talk about climate change, we're already structuring the conversation in a Western scientific method." (Bielawski 2007)

How the nature of the world and uncertainty are viewed have direct policy implications. For example, the scientific desire for certainty may contribute to the rare application of the precautionary principle in modern society. In traditional knowledge, on the other hand, a precautionary tale may endure for decades or even centuries without actually being put to the test. An example is found in the case of the Chisasibi Cree in the James Bay area, where traditional knowledge about the dangers of over-hunting caribou survived as oral history for an 80-year period during which the community did not encounter a single caribou (Berkes 1998, 104-107). Admitting uncertainty about climate change need not equate to advocating political inactivity; instead, it decouples science from political goals by ceasing to demand certainty about a phenomenon so inherently uncertain:

> "I think that there is every reason to believe that we should be doing something very serious about curbing carbon emissions. Even if we curb emissions for the wrong reasons or even if we're not preventing some sort of catastrophe, it's good for us." (Norton 2007)

At Sci-Edges, decoupling the ability to act from the need to be sure allows the precautionary principle to become an easier path to choose.

Even once uncertainty is assessed, it must still be communicated to policy-makers and the general public. Decision-makers are often more comfortable with uncertainty than scientists, as they constantly deal with restrictive timeframes within which action must be taken one way or the other, regardless of how strong the evidence for a particular scientific hypothesis is (Manning *et al*. 2004, 23). However, there is a history of the public misunderstanding the uncertainties that form an integral part of the scientific process (Pollack 2003). Science has long tried to gain recognition of its validity, significance and necessity to everyday life and policy formation; when it actually succeeds, however, its success quickly becomes a curse if certainty and predictive power were exaggerated during the struggle (Smith 1996, 213). A clear example of this can be seen in the field of health sciences and epidemiology, where the political and advocacy elements of a science dealing with high complexity (causation of disease) combined with acute public and political interest has lead to the proliferation of 'junk science' and the silencing of legitimate

findings (Phillips 2007, Ungar and Bray 2005). A common concern among researchers, especially within the TK-Info discourse, is that a failure of science to accurately predict will result in the public losing their faith in science. Although it may be tempting to reinforce the ideological nature of science in the face of seemingly irrational and ideologically based opposition, as happened for years in the public media debate on climate change, ultimately this can weaken the position of science (Pollack 2003).

Sci-Edges issues a similar warning to retain a sense of agnosticism about the world and what is happening in it. Climate change is becoming a "convincing explanation for anything" (Interview Participant 2007) but this is dangerous to the integrity of the scientific process. There is good reason to be more realistic about uncertainty and not over-exaggerate the predictive power of models in order to gain political influence. In TK-World, science is seen as having a disproportionate amount of political power already, and needs to open to traditional knowledge and let go of its ideological power to determine truth. The TK-World discourse also suggests that climate change can be a catalyst for changing how science interacts with TK. If by encountering an other, science is forced to relinquish some of its ideological power, this may be positive for maintaining the scientific part of science that makes it a useful tool for understanding the world. Diversity leads to strength, and questioning science keeps it humble. In the politically charged arena of climate change, where both the public and policy-makers are increasingly demanding answers and guidance from science, the more science sticks to its goals of increased certainty and progression towards truth, the more its legitimacy will be threatened when it fails to meet these standards. And when dealing with a phenomenon like climate change, it seems doomed to fail more and more frequently. Accepting uncertainty is politically important, to maintain science's legitimacy as well as let go of its ideological power and open it to other knowledges. The political matters and the science matters, and it is crucial to resist sacrificing one for the other just because circumstances such as climate change seem too urgent.

4.7 Climate Uncertainty in International Relations

Political climate is dictated both discursively, through the interactions of multiple actors, and physically by circumstances outside direct human control (for example in geopolitics). At the 2007 United Nations Climate Change Conference in Bali, discussions were dominated by politics that related more to the existing economic and political relations of

the attending states than to the physical threats and challenges of climate change. But while political and discursive details are argued, the material consequences of climate change are uncertainly looming up around us. If the earth's climate is to become increasingly uncertain, with the rippling effects of these changes on biological and human systems even more uncertain, then the stages and circumstances of international relations are also likely to shift and change, possibly destabilizing old relationships or forcing the evolution of new systems and structures of relations.

Climate change is a complex and far-reaching phenomena. Its atmospheric mechanisms, shifts in weather patterns and extremes, and effects on living organisms, species distributions and ecosystems clearly fall within the environmental sector. But its causes, and the strongest arguments blocking action to curtail it, are largely economic, driven by a world economy dependent on oil, industrialized production and global trade of goods. Because its causes and effects span so many sectors and scales, in many cases, "we are eroding capacities to respond to change, at the same time as we are accelerating the speed and magnitude of change" (O'Brien 2006, 3). So-called "environmental issues" such as climate change actually "interact with social, economic, technological, political, and institutional dynamics and create new challenges for human security" (O'Brien 2006, 3). Although most debate around climate change has treated it as an environmental rather than a security issue (O'Brien 2006, 1), there are signs of change, as more actors on all levels recognize that "our increasingly unstable climate is no longer seen as primarily an environmental or economic issue" (Parry 2007, 20). Human security is experienced on the individual level, and encompasses a broader spectrum of potential referents and threats than traditional international security. Because of its potential for destabilization, and because it does span multiple sectors and scales, climate change is an interesting potential referent for an expanded concept of security.

Concepts such as human security can act to broaden the security agenda, and some in IR have argued for an expansion of what can be securitized (Buzan *et al*. 1998). A broader understanding of security can draw much needed attention to the importance and urgency of an issue, indicating that it "warrants a policy response commensurate in effort if not in kind with war" (Barnett 2003, 14). There are signs this is already occurring: in April 2007, the UN Security Council debated climate change, marking its recognition as a core international security issue (Parry 2007, 21). The traditional referent of security is the state,

where the primary concern is violent conflict and the military is the accepted response (Barnett 2003, 8). In this context, the analysis of climate change in relation to security becomes how it will impact state sovereignty and legitimacy by affecting its ability to respond to external forces (such as extreme weather events), causing large scale migrations of environmental refugees, and/or exaggerating existing inequalities that under some circumstances can lead to violent conflict (Barnett 2003). There is a danger that securitizing climate change will turn it into "a military rather than a foreign policy problem and a sovereignty rather than global commons problem" (Barnett 2003, 14). This is a valid concern, as militaries are major greenhouse gas emitters, and military spending takes money and attention away from environmental and social goals more directly relevant to human security (Barnett 2003, 13). In light of these types of pitfalls, a counter-argument to securitization (in essence an extreme form of politicization in which one issue is moved to the top of and beyond the regular agenda entirely) is that it is more preferable to move beyond securitization altogether (Buzan *et al*. 1998).

Still, the threats of climate change to human security are compelling. Questions of poverty, inequality and social justice are key elements of human security, and the impacts of climate change will be felt unequally throughout the social sector. The distribution of impact is likely to vary both geographically and socio-economically, exacerbating existing inequalities, with the greater burden resting on the poorer people, as was seen in New Orleans in the aftermath of Hurricane Katrina (O'Brien 2006, 2). Thus, responding to the impacts of climate change will be closely entwined with the fight against poverty (Parry 2007, 20). This is especially relevant to my current discussion because in the North, as in other parts of the world, poverty is found to a disproportionate degree in indigenous communities (AHDR 2004). Shifting the framing of climate change from environmental issue to human security can also help move the debate beyond scientific uncertainty: "Using scientific uncertainty as a reason for inaction is simply no longer a credible excuse" (O'Brien 2006, 2). Despite the reality of uncertainty and the importance of humility, science does already possess a great deal of important and highly relevant knowledge about the world. Putting it into practice in an integrated way that supports rather than trumps other ways of knowing is what is needed now. At the same time, Barnett (2003, 15) concludes that a grounding in science, such as that produced and reviewed by the IPCC, is necessary to avoid appropriation by conventional military security.

As can be seen especially clearly in the environmental sector, where so many (interrelated) issues compete for attention, focusing on one issue has the potential to cause more overall harm than good; narrowing the focus to one symptom, be it water pollution or species loss or desertification, misses the underlying causes and thus fails to reach real solutions. In fact, even issues that seem straightforward, such as military threats, usually have underlying causes that cross into other sectors, and thus securitization can be argued to exacerbate rather than help most problems, not only environmental ones. However, I think a unique argument can be made for securitizing climate change, if it is viewed holistically and critically as climate uncertainty, as traditional knowledges or new materialism view it. Recognizing the agency of the nonhuman world and the importance of intra-actions forces us to view our relationships and interactions with each other and the world as uncertain and constantly co-created. Securitizing climate change in this way can be seen as a radical suggestion, in that it could act to draw attention to where we most need to look: the roots of things.

In its sheer scope and magnitude, encompassing most human, biological and physical systems on the planet in some way, climate change can be almost overwhelming in its unity. Looking at climate change through the lens of security, however, can also help integrate multiple scales, linking "local (human security), national (national security) and global (international security) levels of environmental change and response" (Barnett 2003, 14) as well as integrating projects of mitigation and adaptation. On one hand, an issue that brings to the forefront the interconnectedness of the global bio-geo-physical system seems to call for globalized solutions. Attempts at global solutions can be seen in international arenas such as the Kyoto and Bali meetings, and organizations such as the IPCC. However, uncertainty about the resilience of existing systems and the possible destabilizing effects of climate uncertainty can also easily support an argument for devolution of power, as smaller systems are quicker to adapt to change. Most change ultimately must originate from the roots up, at the human and local level. Yet, insofar as human security is necessary for lasting national security, and traditionally it is threats to national security that are the greatest concern and focus of international security, the divide between these three levels may be somewhat artificial. I think that the most effective and lasting solutions will come through synergy of multiple scales, with global agreements and strategies partially directing and partially directed by human-driven local and regional action. This calls for an

alternative concept of security that does not privilege security at any one level over the others.

The most crucial element to any approach is a humility rooted in a thorough understanding and acknowledgment of the uncertainty that currently, and likely always will, underlie our knowledge and predictions about climate change and its effects. Without this, any political strategy is bound to fail when something unexpected (inevitably) happens. Furthermore, I believe that understanding uncertainty can help foster tolerance and cooperation, even at the state-level of security and international relations. If no one believes they are absolutely right, the perspectives of other sides are better heard and more easily accommodated.

5. Conclusions, Beginnings

The accumulation of traditional knowledge can be visualized as a slow moving cloud sprinkling rain, following the topography of the land as each falling drop becomes integrated and embedded in space and time. In contrast, scientific knowledge generation is more like a powerful hose positioned at one present moment: it sprays its water as far as it can reach and calls the circumference of its reach reality. Driven by its desire to increase certainty, at its centre science continues to divide the world into smaller and smaller units, and as more and more data is packed in, pressure builds up and threatens to explode. When the lens of Sci-Centre focuses on traditional knowledge, it cuts it and colours it based on its own philosophy and worldview (seen in the TK-Info discourse). The reaction of TK is to resist this continuation of colonization, attempting to regain power by emphasizing its differences from science, thus reinforcing the dichotomy (seen in the TK-World discourse). By naming traditional knowledge as something that Western society does not and cannot possess, the dichotomy-reinforcing political elements of the meetings of science and TK obscure the forms of knowledge available to us all. But, at the edges of science's reach, boundaries become blurred and science dwindles to a light mist that mingles with the waters of traditional knowledge. The 'traditional knowledge' of science and personal local knowledge point to the expansive grey middle ground that exists beneath the political struggles of acceptance or domination. New materialism offers a way of getting at that middle ground while also addressing power relations: borders become uncertain and differences can remain even while politically-charged boundaries of power are being erased.

The post-humanist onto-epistemology of new materialism provides an alternate framework to look at the whole landscape – the land, water, hose and clouds – not privileging any one element and seeing the interactions between all of the components as primary. It is a way for Western society to decolonize ourselves, and thus better engage in a non-oppressive dialogue with traditional epistemologies without appropriating or distorting them, while at the same time opening up new possibilities for dealing with climate change. The positioning of Arctic science, at the edges of science and at the centre of climate change, makes it a likely location for change to occur. Where science and traditional knowledge meet in the arena of climate change, the assumptions and weaknesses of science are revealed. While science values prediction highly, traditional knowledge sees it as a largely

fruitless endeavor, as the constantly changing world will always surprise us. In its attempt to predict the future, science is engaged in a never-ending battle with uncertainty, but increasing uncertainty is chiefly what climate change is. Even as climate change researchers work to accurately identify, gauge, quantify and communicate their levels of uncertainty, it may be a losing battle in a world where uncertainty continues to multiply. More data will not solve this problem, but a change in attitude towards uncertainty might. Traditional knowledge accepts uncertainty through its spiritual elements, but the essence of this revolves around restoring nonhuman agency. Aligning more closely with traditional knowledge systems than with science, new materialism explicitly recognizes the embodied and accountable nature of the observer in all knowledge claims and traverses academic disciplinary boundaries, offering a more holistic view of the world. And, by returning agency to the material world, it offers science a way of dealing with uncertainty similar to what spirituality does for traditional knowledge.

The physical and material challenges of climate change are likely to be great, regardless of what worldview we hold. (Still, it is important to remember that the impacts are likely to be experienced more severely by the underprivileged, and this includes many indigenous peoples.) How we react and adapt on all levels, from local to global, most certainly will depend greatly on our onto-epistemology. How might an acceptance of uncertainty help us to cope with climate change? Even when the changes we are witnessing are human-induced, the nonhuman world is always playing an equal role in the dance of agency, and we can never know what the true and best answer is. No matter how hard we try, we will never know the future and will never actually move beyond this present moment; however hard we may fight it, we are still moving with the world at the world's pace just as traditional knowledge is. The future is constantly co-created and emerging through our intra-actions with it. By changing our attitude and cultivating acceptance of uncertainty, we avoid engaging in a constant battle with the world that tries to simultaneously understand it and make (or keep) it the way we think it should be. Science has a history of imposing its theories onto the world with little regard for those places where the fit is clumsy at best, disastrous at worst. But instead of constantly trying to erase our mistakes and stick to the plan, we could embrace the flow of the world as it emerges. Knowing we have made mistakes, even while consciously trying to live and develop in ways that we believe to be better, we could still accept what already is. In the words of Pickering (2005, 41), "we could look for the beauty, very broadly understood, natural and social, in the outcomes of

our interactions with the environment, and we could try to work on and amplify that when we find it." By accepting the inherent uncertainty of the world and the partiality of our knowledge of it, post-humanism brings humility about our place in the agency-filled world. But it can also help us see beyond the fear of not knowing and the passion of political struggles, to the bigger picture of how science can coexist with multiple other ways of knowing. With each contributing what perspectives and wisdom it can offer, we could focus more on the present than on the future, which *is* uncertain, but then, as many oral traditions would remind us, it always has been.

Acknowledgements

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Appendix A: Publications used in Analysis

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Appendix B: Interview Participants

Bielawski, Ellen. In-person interview. Edmonton, AB, 26.03.07.
Callaghan, Terry. Telephone interview. Abisko, Sweden, 27.02.07.
Huntington, Henry. Telephone interview. Eagle River, Alaska, 05.03.07.
Norton, David. Telephone interview. Barrow, Alaska, 06.03.07.

Appendix C: Interview Question Outline

What is your current position? What discipline or disciplines do you describe yourself as working within?

(If not primary/sole author of the paper in question) I am interviewing authors of published papers and chapters on this intersection of TK, science and climate change. What was your role in the writing and publication of the paper _____?

How do you define traditional knowledge?

How do you define science?

In relation to climate change, in what capacity have you worked with using both TK and science together? For how long have you been working with TK?

Have you ever had any reservations or concerns about the use or validity of TK?

In your experience, what is the relationship between TK and science? What do you see as the main similarities or differences between them? What happens when they meet?

Some believe that using TK as a set of observations or a source of data overlooks that it is actually a holistic epistemology that includes elements such as spirituality which science deliberately excludes. What is your opinion on this?

How do you relate science to your personal worldview?

What is your personal experience with climate change?

Has climate change affected how you view the world?

Do you think the natural world has agency? Do you think it is possible to fully know or understand the world? Why/why not?

How do you deal with uncertainty and complexity as a person? Regarding climate change in particular and science in general?

What kind of phenomenon would you describe climate change as?

Do you think climate change poses any new challenges to science? Does TK have anything unique to offer our understanding of climate change?

In your opinion, when TK meets science in attempts to address and understand climate change, is the position of science as the dominant epistemology of Western society reinforced or challenged?