Airspace: Antarctic Sound Transmission

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ABSTRACT
This paper investigates how sound transmission can contribute to the public understanding of climate change within the context of the Poles. How have such transmission-based projects developed specifically in the Arctic and Antarctic, and how do these works create alternative pathways in order to help audiences better understand climate change? The author has created the media project *Sonic Antarctica* from a personal experience of the Antarctic. The work combines soundscape recordings and sonifications with radio-style audio interview excerpts. This work will be examined in the context of the other sound transmission science and art works.

Keywords
radio, Antarctica, soundscape, sonification, audification, climate.

1. INTRODUCTION
The Poles are on the front lines of climate change. Known as the planet's refrigerators (DeRosa, 2008), they circulate cold air that drives many of the weather systems in the Northern and Southern hemispheres. The Arctic has experienced unequivocal warming leading to accelerated melting over the past ten years. However, by 2002, the Antarctic became a focus in the politicized mainstream media global warming debate because the research showed that overall the continent was cooling. [1] Lacking an understanding of the science and looking for proof against global warming for political purposes, some members of the mass media began to use the findings of Antarctic climate scientists to claim that global warming was false.

Through a series of interviews with climate scientists in Antarctica, the author discovered that the politicization of the global warming issue combined with the difficulty of communicating the complexity of climate science to the general public has contributed to a lack of public understanding of climate change. Several scientists interviewed by the author expressed the need for a greater understanding of climate change among the general public. For example, Dr. Peter Doran of the Earth and Environmental Sciences Department at the University of Illinois at Chicago spoke with the author at length about the difficulty of non-scientists, particularly in the media, in understanding the complexities of climate science. He said:

"…in Chicago I get called up by the local media sometimes, when it's cold, and they say 'Oh, well, I thought global warming was happening.' The point I make in response is that we don't say one day is global warming and the next day isn't, it's all sort of a mixture. Some stuff is anthropogenic, some stuff is human-caused and some stuff is natural, and you can't tease them out. They're all blended together." [2]

According to Doran, however, this information should not have been misinterpreted by the media as evidence that anthropogenic global warming was not happening. Dr. Doran experienced firsthand the misleading reports in the mass media distorting the findings of climate scientists. In an interview with the author he said:

"We wrote an article in 2002 for Nature and it was immediately misused by some of the spokespeople of the Republican Right like Rush Limbaugh, Ann Coulter, and Michael Crichton. All three of those used our paper in the wrong way, and that was one thing. I understand that's what they do, but it was also misreported in some of the media. Then it got picked up and there was this broken telephone effect and it become sort of the poster child of 'Look, this proves that global warming isn't happening,' but it was all from misinterpretation from the beginning, and no one went back to look at the original paper." [3]

With all the checks and balances that have to occur before a scientific article hits the mainstream press, how could such a drastic misinterpretation have happened to Doran's research? Dr. Doran stated that part of the problem in the media was limited resources and the expertise needed to translate the science to the public. He said: "There is some great scientific reporting out there—The New York Times, The San Francisco Chronicle and others, but other, smaller papers don't have science reporters on staff and they don't have the tools to be able to translate from the science to the public. The scientists don't have the tools to be able to translate to the public, and so we've got this language barrier. That's getting better and better all the time, which is a good thing, but I think we need to solve that language barrier." [4]

One thing Dr. Doran stated was helping to break down the language barrier was the action of scientists contacting the media directly with their findings. Doran admitted that scientists talking directly to the media creates controversy within the scientific community, but he said that the political pressures on scientists, especially those involved in climate science, have made scientists

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more willing to speak out. He said: "I think that 10 years ago scientists were reticent to come out and speak about their science, but I think more and more the message is getting though that there' s war going on essentially. Especially in the last about eight years or so, there has been this war on science, and we've become less trusted. So we've had to take to the street to get our message out there. I think more and more people (scientists) are becoming comfortable with it." [5]

Doran himself became a model for other scientists by publishing a groundbreaking editorial about the misuse of his research on the opinion pages of The New York Times (NYT Doran reference). He was one of the first climate scientists in recent history to make such a prominent public stand. Although he initially struggled with a fear of being identified as a science 'popularizer', a label that within some circles of the scientific community is interpreted to mean one is not doing serious science, he explained his reasons for writing the editorial:

"I thought that it was time to set the record straight, and you can't do that in the scientific literature, people don't read science papers, so you have to go out to the public and straighten this out. I was initially going to submit to the Chicago Tribune, and the guy at my university that handles the media said 'Well, why don't you try the Times?', and I'm glad he made that suggestion because it got to a bigger audience. Then the response was great. I really got a lot of great response immediately." [6]

Responses to Doran's article came mostly in the form of emails, and he said that although he received some negative emails, the vast majority of responses to the article expressed gratitude to him for making this statement of clarification in the public forum.

Lead scientist of the Antarctic Long Term Ecological Research Group Dr. Andrew Fountain, whose work on Antarctic climate was also one of those misinterpreted by members of the mainstream media was also interviewed at length by the author. Like Doran, Dr. Fountain advocated scientists talking directly to the media. He explained how the attitudes within the scientific culture had changed over the years and defended his and Dr. Doran's activist approach:

"Oh, yes—this changed completely, because when I was started out in science it was 'keep your head low, stay out of newspapers.' You know, if newspapers come to you, fine. You don't go seeking publicity, that's a bad thing. Nobody wants a big blabbermouth. Now, with climate change, this whole edict in a sense has changed… Because in a sense science is really separated from public understanding, because science has gotten so complex and I think partly because of our culture. Now the funding agencies want to bring that back into the public arena, to at least make our results known and appreciated by the public. But now you put this climate change issue in front of everybody, and (for scientists) it's gone from 'this (going to the media) is something I should do' to 'this is my duty, to be involved and to get the word out.' As far as my research is concerned, this is what I'm seeing in the climate change debate, and that's a lot of actually what I do." [7]

The complexity of climate science makes climate change difficult for the layman to understand. The politicization of the climate change issue has caused a cascade of misinterpretations of scientific findings in the media, and the translation of scientific language to general language has become an increasing problem within the mainstream media due to lack of reporter resources and expertise. In the public climate change debate, the voices of scientists directly involved in climate research are important to help to break down the language barrier between science and the public. Technologies such as the web have made it possible for scientists to not only communicate with media professionals, but also to directly communicate with the public and get an immediate response. The next section will investigate the ways in which the structure and use of a specific form of media, radio, has influenced public perception of the Poles.

1. RADIO IN ANTARCTICA

The Antarctic and Arctic International Treaties and the long history of International Polar Years (IPY, 1882/1883, 1932/1933, 1957/1958, 2007/2008) have contributed to a public perception of the Poles as utopian science-villages of global cooperation and collaboration. Potentially, radio could make a contribution to this international collaboration at the Poles, but in the author's experience in US bases in Antarctica, radio is a highly regulated medium.

McMurdo Station is an Antarctic base founded by United States in 1956 that is currently operated by the global defense contractor Raytheon through the US National Science Foundation (NSF). Built on top of volcanic rock on the southern tip of Ross Island on the shore of McMurdo Sound, this science facility holds the largest community in Antarctica, up to 1,258 residents in what appear to be very temporary buildings. McMurdo is also a logistics base for half the continent. [8]

Although a limited amount of broadcast radio for news and entertainment is available to residents, the travel demands of the science and the unpredictable extremes of the weather make distributed radio communication much more prominent than broadcast radio. Every resident is issued a personal two-way radio and trained in local radio communication and in contacting one of several main radio dispatch locations around Ross Island. Residents also receive training in larger field radio systems with long-range capability. During a training session, the author's first experience with these systems was to use one of these radios to contact the communications office at the South Pole from a site near Williams Field on Ross Island, a distance of over 800 miles.

Figure 1. Antarctic researchers setting up a radio antenna to contact the South Pole Station.

Any significant travel, even on foot, without a radio is forbidden at McMurdo and the other US-operated bases including the South Pole. Researchers are expected to check in on a regular basis, and

if the radio check is not received by the home base within an allotted time, a search party is immediately deployed. McMurdo residents hold radios in the front pocket of a vest, a kind of "technical prosthesis", as electro-acoustic music pioneer Pierre Schaeffer calls radio In *Traite des Objets Musicaux.* [9] Schaeffer defines radio as the electro-acoustic chain that connects a human being to the environment. However, at McMurdo importance of the electro-acoustic chain between radio and human beings experienced by the author was not in how it connected residents to the environment, but in how the radio protected residents by connecting them to people who could save their lives in an emergency.

The author visited and made recordings at several communications sites and reviewed triangulation maps of the paths the radio signal takes in various situations: if interference was high in one area, or if a mountain was blocking transmission, the signal might be routed through transmitters on various outlying islands. The meaningless blank white places gained significance through their role in relaying life-saving messages.

Figure 2. Radio antennae at McMurdo Station.

Despite the many successful examples of international scientific cooperation with regard to the Poles, extreme systemic resistance to any form of international communication was highly prominent during the author's experience living in Antarctica. The communications specialists interviewed by the author at McMurdo were well aware of Ham radio operators, and found their listening relatively benign. However, during radio training given by employees of Raytheon, the author was cautioned about outsiders 'snooping' and told not to use the conventional radios for anything other than routine contact to maintain privacy and to control the public's perception of the Antarctic research. For example, in an emergency, residents were advised to use the satellite Irridium phone to communicate the details.

2. POLAR RADIO

Re-framing the broadcast radio paradigm in the Antarctic context is the subject of the *Polar Radio* project by Radioqualia and I-TASC (the Interpolar Transnational Art Science Constellation). The project's website identifies *Polar Radio* as Antarctica's first ever artist-run radio station. Their first station began FM broadcasts of new music, sound art, documentaries and live shows in December of 2006 in the Dronning Maud Land sector of Antarctica, the site of the South African base, SANAE IV, with plans to eventually broadcast in between several Antarctic bases.

While *Polar Radio* was inspired by the history of amateur radio broadcasting at the Poles for both science and communication with the wider world, its intention is to create an International radio network that is a platform for creative work. *Polar Radio* aims to promote discussion and collaboration amongst the researchers living in Antarctica, enable researchers to share information about their respective bases, make it possible for the many artists-in-residence and others at the bases to communicate their creative work to the wider population of Antarctica, and broadcast creative work produced both in and outside Antarctica through a continental radio network and through the Internet. [10]

The *Polar Radio* project is one example how sound transmission can be used to work against the restricted and confined uses and promote greater collaboration between nations and disciplines. An open radio project connecting to *Polar Radio* was proposed to the administrative staff at McMurdo by the author, but the idea was vehemently rejected as completely out of the scope of what was permitted. In casual conversation about the idea within the McMurdo community, it was revealed that a pirate radio station had been in operation in McMurdo intermittently over the past 15 years. The Raytheon staff clearly considered this pirate station a serious violation of the policies, suggesting that this station clogged important channels of communication and put residents in danger. Long-term McMurdo residents the author spoke to took a different view, applauding the efforts of the pirate radio station and the operator's ability to evade detection. These residents did not believe that the station posed a threat to their safety, citing that communications channels were limited to channels not used by the pirate station. Despite the McMurdo station management's best efforts, the operator of the station had not been found by the time the author left Antarctica, but if he or she had been, there would have been serious consequences.

3. LISTENING TO MCMURDO

In order to bring McMurdo residents from various backgrounds and disciplines together around the topic of sound, the author held open sound recording workshops at McMurdo called a 'sound walkabout.' The author's goals for conducting the workshop included sharing an enthusiasm for listening to soundscapes and learning about the Antarctic soundscape from people with different perspectives who had spent a significant amount of time living there. The workshop attracted a diverse interdisciplinary audience of about fifteen participants, from carpenters and physicists to architects and boiler technicians. Each participant brought a unique perspective and identified a special place they wanted to record. Although a variety of microphones and recording devices were provided for participants to use, some brought their own equipment, including homemade devices.

Soundwalking is a well-established interdisciplinary practice first described by acoustic ecologist Hildegard Westerkamp. [11] As sound scholar Brandon LaBelle states: "Without listening there is no communication, no exchange, and no understanding. It is a prerequisite for participation, intervention, and interactivity that one's input responds appropriately to the aesthetic-communicative intention of the media-defined setting, fulfills it, and completes it. Even in the age of networked media architectures, the practice and discipline of listening remains the origin of creative and intellectual sovereignty." [12]

Figure 2. Participants in the sound walkabout field recording workshop at McMurdo Station.

Participants in the sound walkabout workshop were representative of the highly interdisciplinary community at McMurdo and were given a chance to communicate with each other in an alternative way, through experiencing and sharing the sound environment of Antarctica. In informal interviews after the experience, participants spoke about being inspired not only by observing and interacting with the Antarctic soundscape, but by the rare opportunity to interact with people outside of their field. This interdisciplinary interaction is highly valued by many of the climate scientists interviewed by the author. For example, Dr. Andrew Fountain, the head of the Antarctic Long Term Ecological Research (LTER) project spoke of the importance of interdisciplinary interaction in advancing climate science:

"To really understand the system you can't rely on just atmospheric science because there's interactions with the ocean, the land the ice sheets—the biology in the oceans and on the lands. …this whole interdisciplinary world is critical for us to understand how the system is working. Until you really find that integration, you don't really understand the system. You understand a part of one component." [13]

The soundwalkabout workshop sought to expand the interdisciplinary experience beyond interdisciplinary science collaboration to create focused data-gathering interaction between people from many different disciplines and background. After the soundwalkabout workshop, the group decided to share their listening experiences with the larger community of McMurdo by hosting soundscape listening party at the local coffeehouse. This concert was highly attended and was standing-room-only. The author also shared the listening experience with audiences outside of Antarctica by regularly posting soundscape recordings on the blog *90degreessouth.org* and later by publishing the audio CD *Sonic Antarctica* including her own soundscape recordings.

Soundscape recording is a kind of environmental data gathering, and that data becomes more valuable the longer it is collected. A longer-term establishment of in-depth workshops at McMurdo Station on creative radio production, in combination with the efforts of the *Polar Radio* project, might serve to begin to change the culture of primarily tightly controlled uses of radio in Antarctica as a whole to a more open paradigm that encourages collaboration using radio as a medium. A cultural shift towards collaboration using sound could have a positive effect on the scientific work being done at the Poles. In an interview with the author in the context of the LTER, Dr. Fountain spoke of the need for interdisciplinary collaboration to occur over long time periods:

"It actually takes a while, to learn what the other disciplines are, and to get used to each other's working style, such that we're comfortable working together. Really it was only after our first six-year (LTER project) that I think we really started to do interdisciplinary work. We were working cooperatively before that, and friendly, but not interdisciplinary. It was really only after I can see what glacier or weather effects are on the solids and begin to ask them questions and then being to interact with them on their studies and vice versa, have them interact with me on mine in kind of a knowledgeable way, in a way that's kind of comfortable for all of us to interact…For me, it's really broadened my view of what's happening…Now I have a much wider perspective of how glaciers are part of the whole system." [14]

The soundscape is a part of the whole system of an environment and the interdisciplinary practice of soundwalking provides an alternative pathway for understanding that system. The next section will provide examples of ways in which the author discovered data audification and sonification being used by scientists for Antarctic research.

4. SONIFICATION AND AUDIFICATION BY SCIENTISTS AT MCMURDO

While at McMurdo, the author had the opportunity to interview and work alongside two Antarctic scientists who were making seismic audifications and sonifications. Dr. Rick Aster was co-PI for the Mt. Erebus observatory with his colleague Dr. Phil Kyle. They were recording motions of the Earth's surface on the volcano at various points and using that information to understand how the seismic waves, the solid-earth equivalent of sound waves, bounce around inside the volcano and also how they are generated by eruptions. He was transforming signals from Mount Erebus with a lowest harmonic frequency of around 1 hertz. He would speed up the signals100 times to move the information into the audible band, and discovered musical sounds like horns and whale song. He and his collaborators Dr. Douglas MacAyeal at the University of Chicago and Dr. Emile Okal at Northwestern University discovered that these musical sounds come from iceberg tremor signals. In an interview with the author, Dr. Aster outlined what he found significant about these audifications:

"I'm a guitarist so I was very interested in the harmonic structure of this (seismic information)... So this of course is also one way for me to think about the science when I hear these sounds because we all have a spectrum analyzer in our heads, especially those of us who have played music for a while, and it's kind of fascinating to think about the analogous ways that nature makes sound and human beings make sound with musical instruments." [15]

Despite the technological pitch-shifting process required to bring the seismic vibrations into the audible range, as evidenced in this quote, Dr. Aster clearly believed the seismic audifications to be a part of the natural soundscape. Throughout the interview, he spoke about instrument analogues and how listening to the sound of the signal could tell scientists about the seismic structure:

"…The signals I've been studying from Erebus that are particularly musical are the iceberg tremor signals…they sound like horns and whales and swooshes and all kind of interesting, wind noise, all kinds of interesting sounds... as these icebergs grind against eachother, they basically produce a sequence of tens of thousands of tiny ice quakes…it's sort of like the macroscopic version of the squeaks you might get from a hinge or from pushing a heavy piece of furniture across a polished floor, that's the same type of thing, or the squealing of tires, because those are just a sequence of thousands and thousands of little stick-slip events." [16]

The unusual sounds discovered by Aster and MacAyeal inspired them to place seismic instruments on the iceberg which allowed them to gather more detailed information about the structure of its movement.

Another Antarctic seismologist, Dr. Robert Smalley, was interested in listening to seismic signals, but in this case not by audification, or pitch-shifting the vibrational information, but rather by transforming the information into the amplitude and pitch of computer-generated sine waves. Unlike Aster, who was interested in the scientific potential of interpreting the resulting seismic sounds, Smalley was interested in the public communication of the seismic data. He worked closely with the author while developing his sonifications and presented his experiments to the public alongside audifications by Aster and MacAyeal and soundscape recordings by members of the McMurdo community at the Sonic Antarctica concert organized by the author.

The integration of sonification and audification with soundscape recordings has great potential to serve both scientific research and scientific communication and is a rich area for further research. Like soundscape field recording, data sonification presents a rich area for blurring the disciplinary boundaries between art and science. Several audience members of the Sonic Antarctica concert at McMurdo expressed surprise at the sonifications and audifications, finding the sonifications extremely musical and the audifications very similar to the Antarctic wildlife recordings also presented at the concert. Other audience members talked about the feeling of being physically transported to the location where the sound was recorded. The next section discusses sonification of Antarctic data that has been done from an artist's perspective.

5. SONIFICATION AND AUDIFICATION OF ANTARCTIC DATA BY ARTISTS

While in Antarctica, the author collected a large amount of data from climate and weather scientists and later created a series of sonifications of this data. The data consisted of: ice movement data from various sites, weather balloon data from the South Pole and McMurdo, and data from climate monitoring weather stations in the Dry Valleys. The author combined these sonifications with excerpts from the audio interviews she conducted with scientists and soundscape recordings she made in Antarctica on the aforementioned audio CD called *Sonic Antarctica*. [17]

Other artists have explored ways in which Antarctic data may be translated into sound. In 2007, the artists' collective Mongrel produced the *Antarctic Data Jam* using weather data collected by weather monitoring equipment sent to the Antarctic by SoSLUG in conjunction with MediaShed and I-TASC. The group held workshops during which participants created sonifications from the data using open source tools and produced an audio CD with the contributions. The *Antarctic Data Jam* producers invited electronic musicians and artists, programmers, students and the general public to make songs, images, videos or noise with raw Antarctic weather data they provided. Guidelines for the project were very open, although they provided a piece of software people could use to translate the data to sound, participants were also invited to collect their own Antarctic sounds via the web and the only requirement was that the resulting pieces have some or all Antarctic sound or data content. [18]

While traditional radio is technically a "push" medium, sending signals out to receivers whether under the communications or broadcast model, the digital environment, whether experienced on an internet terminal or wireless device operates on the "pull" principle, only sending information if the receiver requests it. Through the digital, the paradigm of radio as broadcast is structurally and functionally transformed into radio as multi-user interactive space, and by emphasizing the input of community, projects like *Antarctic Data Jam* use this model as a basis for the work.

6. CONCLUSION

Due to the extreme climate of the Arctic and the Antarctic and the related fact that these places have a relatively low amount of human presence, the function of radio is very different there than in more populous areas of the Earth. In these remote spaces, radio is primarily a communications tool used for logistical operations with a small amount of communications with Hams and broadcast news radio for residents. This relatively blank slate provides an opportunity for media projects like *Polar Radio* to re-frame the paradigm of broadcast radio in the field.

In an interview with the author, Dr. Peter Doran stressed that there is a great need for longer-term records of Polar weather and climate data, and Dr. Andrew Fountain observed the need for longer-term interdisciplinary collaboration for understanding climate complexity. Seismologists Dr. Rick Aster and Dr. Robert Smalley have found audification and sonification useful to their scientific research as well as beneficial to raising public awareness. Projects like *Polar Radio* and *Sonic Antarctica* provide alternative pathways to help scientists forge interdisciplinary collaborations and communicate their research to the wider world in a new way. Once these pathways are open, they need to be extended in time. A multi-year soundscape recording and radio production series of workshops and concerts that include sonification could serve to enhance interdisciplinary collaboration and advance science in Antarctica.

Douglas Kahn has said that the annihilation of space and time is the goal of radio [19], and while the sound transmission projects discussed in this paper transcend a seemingly insurmountable distance, in content they are firmly grounded in the present time and the political and geographic dimensions of the Earth. *Polar Radio* focuses on possibilities for International collaboration in a place where strict boundaries lines are drawn while *Sonic Antarctica* draws connections between scientific and artistic disciplines through the Antarctic soundscape and sonification. Structurally, metaphorically and aesthetically, the projects discussed in this paper re-frame transmission from a polar perspective, giving a voice to both the people living in these remote locations and the rapid melting occurring there due to anthropogenic climate change.

In conclusion, because of the complexity of the information and the misinformation in mainstream media, there is a need for more public communication of weather and climate science. Sound offers a way for scientists to bring their messages directly to the public, by directly speaking to the public through recordings and radio transmissions and by collaborating on audification and sonification of scientific data. Listeners often respond to sound with emotion and empathy for the scientists' messages. Interdisciplinary collaboration is essential to the work of climate scientists in Antarctica, and radio and the Internet allow for communication and possibly collaboration across vast distances, especially near the Poles. For these reasons, the Poles offer an opportunity for innovative uses of sound transmission and this can contribute to the public understanding of climate change within the context of the Poles.

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