Focus Article

Artful climate change communication: overcoming abstractions, insensibilities, and distances

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Edited by Mike Hulme, Domain Editor and Editor-in-Chief

This article considers how visual and sonic art creates encounters through which audiences can experience climate change. Building on reviews published in WIREs Climate Change on images, films, drama, climate science fiction, and other literary forms, we examine how audio and visual art addresses the enduring problems of climate change communication. We begin with three of these problems: climate change's often abstract nature, the distances in time and space between those who cause climate change and the places its effects are felt, and forms of human–environmental relations that shape how climate is understood. We reflect on how, through a combination of vision and sound, art creates sensory experiences that tackle these challenges. In querying how our artistic examples bring about environmental engagements, we combine an analysis of the representations and narratives of these works with an appreciation of their aesthetic form—in short, how these art pieces activate emotional and experiential responses. While we recognize the limits of what art can do, especially the gallery-based forms of work we study here, we argue that spending time exploring the encounters that art creates helps us to understand what it brings to the communication of climate change. It also demonstrates how lessons learnt about sensory experience, affect, and emotions might be more widely applied to the analysis of cultural forms—from literature to films—and their role in climate change communication.

How to cite this article:
WIREs Clim Change 2017, 8:e472. doi: 10.1002/wcc.472

INTRODUCTION

Far beyond the descriptive, prospective, retrospective/reflective and prescriptive, climate communication is increasingly asked to be narrative, interpretative and even contemplative. (Ref 1, p. 15)

In her review of the current landscape of climate change communication and its future demands (in this journal), Susanne Moser presents a series of possible avenues for thought and action.[1] She calls for an intensification of inter- and transdisciplinarity, extending existing calls by asking for further insights from the arts and humanities (see also Ref 2). She issues challenges for the production of novel and even experimental situations in which scientists, communication practitioners, and audiences might come together in ways that enhance cross-group learning. Throughout her article, she cements the foundations of the 'cultural turn' in climate change communication, which not only encompasses the value and study of 'cultural'

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Conflict of interest: The authors have declared no conflicts of interest for this article.

forms, such as art, literature, and films, but also which, in doing so, acknowledges the important role of emotions and affect in understanding and practicing climate change communication.[3,a] For Moser, the embrace of culture as both an important sphere of action and knowledge as well as a specialist form of production (literature, art, film etc.) holds a crucial place in the practices of science communication. Indeed, in her conclusion, she notes that what should be queried are the 'roles varied cultural expressions such as music, poetry, and theatre play in communication and engagement around climate change' (Ref 1, p. 13). Other scholars, including within this journal, demonstrate the value of such a cultural turn, making a case for further attention to visual art (and indeed its more-than-visual elements) as part of a wider attention to climate visualization and imagery.[4,5]

In this paper we take this querying of cultural value forward. We review the possibilities audio-visual art offers to some of the key challenges faced by climate communicators. Setting aside, until the conclusion at least, concerns with audiences and the connection of scientists and communicators, we want to focus on the sonic and visual elements of art works and what they can 'do.' We are concerned with how the sensory and affective dimensions, together with the works' narrative and representational content, might enable responses to the key climate communication challenges. We shape our arguments by addressing three of the central barriers that have been identified to climate change communication. We are specifically interested in how the natural, social, and political characteristics of climate pose challenges associated with climate change's often abstract nature, the distances in time and space between those who cause climate change and those places and peoples effected most intensively by it, and forms of human–environmental relations that shape how climate is understood[3] It is well recognized in this journal and elsewhere that creative practices—from literature and film to performance and, recently, contemporary art—can extend and enhance practices of climate change engagement.[6–12] Building on the groundwork laid by this recent work, we wish to delve more deeply into the forms and methods of encounters with climate change that audio-visual art practices offer. Our principal line of questioning concerns how art's sonic and visual elements develop environmental encounters that, we argue, offer responses to some of the challenges climate change poses for communicators. While there are many forms of art, including participatory and dialogic art, that might more directly address concerns with climate 'action,' here, we turn our attention to the *sensory* dimensions of audio-visual work to explore how environmental encounters engage their audiences on emotional and experiential registers.[13]

We query the environmental encounters art creates through the lens of three well-recognized issues, which are generated though both the constitution of climate change as a phenomenon and the tendencies toward separation that contemporary western environmental relations exemplify.[14] By the latter, we mean particularly those relations that are based in a dichotomy between humans and nature, a dichotomy that ensures that a distance always remains between humans (especially those living in cities in the global north) and the environment within which they live and depend upon.[15,16] First, we explore how art can address the insensible nature of climate change. Insensible here means, quite literally, that which cannot be sensed, whether because it is beyond human sensory capacities, because the phenomenon itself does not take a sensory form, or because the space and time between humans and the phenomenon is so great that otherwise sensible traits are rendered insensible (indeed, with reference to particular issues of space and time, it has been suggested that talking about climate change can feel like defending the insensible [Refs 3,17,18]). Second, we examine the need to explore and overcome the abstractions and 'distances' in time and space that pose significant issues for climate change action and behavior change. We refer principally to the distance between the locations of climate change cause and effect. This is a global climate cartography (and temporality) based on huge distances between those who live, daily, with the effects of climate change and those to whom the causes of climate change can be attributed and whose responsibility mitigation measures are. Third, we reflect on the need to develop environmental relations other than those based on the separation (and dominance of) humans and the environment seek to develop in their place relations between humans and other forms of life based on entanglement. While, as Moser and others reflect, engaging people with climate change might be about of specific issues such as melting glaciers, it might also be about building connections between humans and nonhumans.[19–22]

We review these arguments through three case studies of audio-visual art works. Without claiming any kind of exceptionalism for these particular works, we propose the value of attentiveness to the modes of sound and vision that these works develop. These range from sonification practices to hybrid forms of scientific and artistic visualization. As such, we attend to the different forms of sensory

experience art practices offer, which work beyond narrative crosses and the symbolic and iconographic codes of the representation. Importantly then, the paper explores how visualization and sonification might develop other kinds of environmental encounters that work on bodies as well as minds in ways that can help in understanding, imagining, and even bringing about alternative climate relations and futures.

Aware of Moser's calls for further arts and humanities approaches to questions of climate communication, we mobilize here what might be thought of as an art historical mode of inquiry. As such, we orientate ourselves to the conditions of the production of these works and an analysis of their forms. The contemporary works we study are relatively cutting edge and include installation, art–science practices, and digital media works. While all the studies have participatory elements and are generally accessible to the public, they will not reach the broad audiences that newspaper imagery and feature films might. Our concern is neither to suggest that these art works will have mass effects nor to explore how they could but rather to focus on the possible effects they have in terms of their sensory and experiential qualities. We do this so that we might inform wider discussions on climate change and art that move beyond the visual and that appreciate other ways of engaging people with climate change communication. Furthermore, we fully acknowledge that unlike other studies that are more social science-oriented, our interest here has not been on audience reception.[4,5] We have not conducted the kind of audience research that investigates how experiences of these art works might interact with audiences' existing knowledge and pre-existing biases. This is not because we do not believe in the importance of these perspectives. Indeed, we take on board those critiques that challenge the figure of an embodied audience that senses with more individuated appreciations of audiences as socially and culturally located individuals with habits, biases, and so on. While we agree with such critiques, we nonetheless maintain that there is a place for foregrounding the experiential dimensions of audio-visual art works and their environmental encounters, not least because this is an area of analysis that has, to date, been relatively underexamined in the research on climate change communication.

From warming curves and diagrams to emotive pictures of the lost species and spaces of climate change (stranded polar bears, melting glaciers, and inundated tropical islands), the manifold possibilities and limitations of climate change visualizations in promoting understanding and action are well acknowledged.[3,17,18] This is why we focus less on the representational or even narrative elements of art works and more on their modes of sensing, particularly seeing and hearing. If visual arts practices are only now beginning to be studied in climate change communication discussions, then the sonic dimensions of art works, including the crucial intersection of sonic and visual elements, have received even less attention.[23–26] We approach this particular form of 'climate silence' by drawing on the emerging body of work that identifies how practices of sounding and sonification might engage that which is insensible to humans and can help to cultivate environmental dispositions and build relations between humans and nonhumans.[16,17,27] The paper proceeds to address each of the three climate change challenges identified above through artistic case studies before concluding by reflecting on some of the limitations of our proposals and indicating key directions for future research on artistic climate change communication (Figure 1).

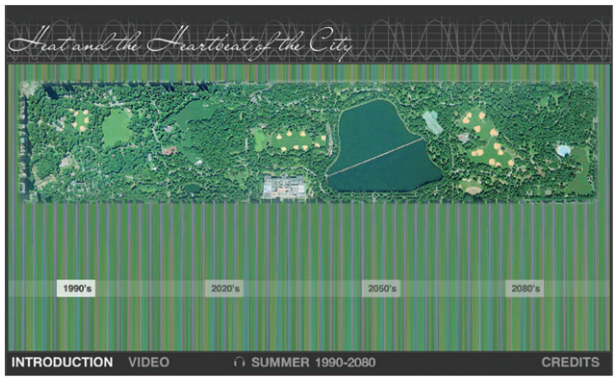

FIGURE 1 | Heat and Heartbeat of the City (2004) Andrea Polli, 'A kind of narrative, emphasizing a climate phenomenon that affects human life negatively and compressing a 90-year time scale involving millions of people into an individual experience of minutes' (Ref 33, p. 45). Source: http://www.andreapolli.com/centralpark/main.html.

RENDERING SENSIBLE—HEARING AND SEEING HEAT

Entering the online visual–sonic interface, the audience is presented with an aerial mapping of Central Park, New York. It is with a deliberate sensory unease that the audience is invited to explore the interface based in the 'heart' of New York City and one of its the first sites for climate monitoring.[b] In selecting one of the four dates on the screen—1990s, 2020s, 2050s, and 2080s—a sound composition is activated. The tones played rise and fall, rising more often than falling. Modulating like ghostly, half-tuned radio transmissions, interspersed with sharp

blown out buzzes and underlain with occasional muted rhythmic hums, they build an atmosphere of discomfort, and their density and volumes accumulate to deeply unsettling registers. Accompanying the sounds is a graph that appears over the park along which a marker moves left to right, tracing a series of peaks and troughs. As the marker progresses, the parts of the park over which it has passed are stained a rusty brown, then gradually a deep red, before finally a vibrant, shocking pink. Chromatic unease is intensified and translated into pitches and frequencies, simultaneously agitating the ears and challenging the eyes, unsettling the imagination, invoking anxiety and trepidation.

As strings of facts and numbers, the abstractions of climatic predictions, tipping points, and thresholds can often feel distanced from the lived realities of those inhabiting economically developed, socially and racially elite demographics. If one response has been to generate a host of visualizations, from maps, graphs, and memes to photography and pictorial art, another response has been to turn to embodied experiences of climate change, to offer singular and collective accounts of the effects of climate change on the lives of humans and nonhumans[2,28,29] *Heat and the Heartbeat of the City* (2004, hereafter HHC) is a collaborative art–science project led by new media artist Andrea Polli,[c] which exemplifies how audio-visual encounters with climate change can challenge the latter's insensible nature in the global north. In this work, Polli tracks the correlation of climate trends and weather fluctuations with increases in hospital emergency room visits in New York. As such, she starkly highlights the very personal, and collective, long-term implications of environmental change on the bodies and health of populations. What HHC illustrates is how actual and predicated data on climate change can combine with the particulars of sonification (sonic compositions of data translated into sound) and visualization (in this case, a composite aesthetic involving basic scientific diagramming as well as photography) to mobilize the senses in the shaping of environmental understandings.

The insensibility of climate change and climate future cause a range of different dimensions. Principal are those invisible characteristics of climate change—the rise in carbon emissions and other heat-trapping gases (often colorless and odorless) or the geotectonic effects of fracking or nuclear power—which make it difficult to communicate this as an urgent issue. As Moser notes, 'the primary cause—the greenhouse gases emitted from fossil fuel use or during land-use conversion—is literally invisible and does not have direct and immediate implications' (Ref 19, p. 33, Ref 20). There is an issue with the sensible nature of climate change representations and how they are understood. Long-term trends in climate change have taken a while to emerge from the 'noise' of daily, seasonal, and interannual variability and are the result of systematic monitoring over decades rather than from bodily observable characteristics. It is not so much that the effects of climate change are invisible; rather that, relative to human perceptive capacities, factors accumulate too slowly for the scales and capacities of a human-sensing body in the context of the human life span to fully comprehend.[19,20] What we find compelling about audio-visual works is how they use sound and vision to enable our apprehension of environmental changes through an intersection of complex-sensing apparatus in ways that disrupt the characteristic ordering and sorting of the Aristotelian five senses (hearing, vision, touch, taste, and smell).

The possibilities arts practices offer for telling sensory stories of the world, which move beyond the deployment of vision alone to attune us to earthly processes and forms of life other than the human, have been documented.[30–32] In HHC, it is a hybrid mode of art–science visualization and sonification that is key to the environmental encounters it creates. Both sonification and visualization are based on temperature data gathered for over 90 days across the summer months throughout the 1990s as well as a series of projected data for the summers of the 2020s, 2050s, and 2080s (with each decade holding around 900 data values). As Polli explains, 'the sonifications focused on expressing the effects of days over 90° Fahrenheit, an uncomfortable temperature. If the number of consecutive days over 90° increased, I would attempt to create an "uncomfortable" change in the sound' (Ref 33, p. 44). In addition to 'translating' the sonic data 'into pitch, loudness and the speed of sounds' to form the sonic compositions, the team also visually transposed the data to combine scientific diagramming with symbolic coloration (blues and greens transform into pinks and reds) as temperatures intensify (Ref 33, p. 44). Days at which temperatures remained below 32° and which did not form in clusters were filtered into softer, clearer sounds. As more clusters of hot days emerged, the sounds grow loud and discordant. Velocity was added to the parameters to condense the 3600 data values into four interconnected 7-min-long compositions. To deepen the compositional timbre, precipitation data were also added into the score.

As a hybrid object, the art–science piece combines visualization and sonification in ways that

are technical and emotive, sensory, factual, and predictive. Its very hybridity registers the complexity and uncertainty of our climate futures, as well as collaging space and time, bringing distant events into the proximate spaces of the here and now. Decades of time are compressed into an x-axis rendered as wide as a computer screen, and space becomes narrowed to that of temperature, registered in the amplitude and magnitude of the lines on the graph; the numerical value is given as the bar that marks the advancing front of the composition and in the shifting of colors of the park landscape. The result is an environmental encounter, the forms of which render climate change and its effects sensible and embodied in disconcertingly multisensuous and multiscalar ways. Visualization and sonification do not function in isolation; rather, together, they confront sound and sight to chart the rise in temperature correlative to hospital admissions and in doing so enable a registering of the uncertainty of coming futures. Rendering the uncertain sensible in auditory and visual ways is unsettling, bringing to audiences a future of yet unfelt, unrealized climactic threat.

RENDERING PROXIMATE—REMAPPING DISTANCES

While the popular visual logics of climate change are dominated by representations of emaciated polar bears, melting ice caps, and retreating glaciers, some artists are seeking to challenge these with alternative audio-visual geographies.[34,35] For audiences removed from environmental frontlines, the effect of such visualities is to situate climate change (and its effects) in space and time other than those of the everyday somewhere 'out there.' Given the concerns environmental scientists and activists alike share over dangerous gaps between environmental knowledge and action caused in part (many posit) by such distancing, we look to art for alternative environmental logics.[1,19,20,36] Using artist Katie Paterson's piece *Archive of Vatnajökull* (*the sound of*), we reflect on how the experiences of visual and audio art might remap complex environmental spacings (Figure 2).

Distance—meaning here both spatial and temporal separation—is a compounding problem in tackling climate change. The litany of challenges (cognitive, political, and psychological) that separation poses is extensive. It might be considered to obfuscate 'the cumulative and collective nature of both causes and actions that would lead to any (detectable and attributable) changes in the atmosphere.'[29] This is exacerbated by the geographic and social separation between those who are at the frontlines of climate change and those at a 'privileged' a discordance between global conflicts and crises versus local immediacies, needs, and precarities[19,20,37] As psychologists have repeatedly argued, 'direct experience and immediate demands trump vicarious experiences or abstract data almost every time' (Ref 19, p. 34, Refs 20 and 38). Furthermore, when action is pursued, the lag between mitigative acts and beneficial changes can be significant (seen in the incongruous temporalities of environmental crisis and policy intervention for instance). Against these lags, the sensory regimes of art works can enable a remapping of the complex spatialities and temporalities of climate change, rescaling those distances that are seen as barriers to understanding and, potentially, to action.

FIGURE 2 | *Archive of Vatnajökull* (*the sound of*), 2007–8, Katie Paterson. Installation view PKM Gallery, Seoul, 2011. Photograph: Hong Cheolki. Call this number between June 6th and 13th, 2007 and you would have heard an abstract series of cracks, pops, and creaks. The book, mounted in a case on the plinth, contains the numbers of the 10,000 callers who did ring in and were connected to one of Europe's largest ice extents and one of the key sites in the monitoring of global warming and its effects.

If at its most basic, vision was once understood as the 'sense of separation', offering a distanced view over the world, touch and hearing have been understood as configuring sensory proximities through their promotion of different kinds of phenomenological intimacy between audiences and the sounded world.[24,39,40] Katie Paterson's soundings and visualizations create both junctures and disjunctures with those more standard imaginaries of ice melt and glacial ruination and in doing so challenge some of the traditional distancings of climate change. In 2007, Paterson installed an underwater microphone (hydrophone) in Jökulsárlón, an outlet glacial lagoon of Vatnajökull—the largest and most voluminous glacier in the south of Iceland. The microphone was

connected to an amplifier, which was in turn connected to a mobile phone, reachable from any location in the world. The piece *Archive of Vatnajökull* (*the sound of*) was designed by Paterson to forge a link between the caller-listener and the real-time movements of the glacial environment over the course of a week in the Icelandic summer (June 6–13). Audible through the speaker were the cracks, groans, and drips of ice shifting and thawing. The choice of *Vatnajökull*, an area colloquially referred to as ground zero for the effects of global warming, as a site for exploration was significant. From the early 1900s, the glacier's positive mass balance went into a steady decline.[41] In modeling simulations based on Intergovernmental Panel on Climate Change scenarios, it had been predicted that *Vatnajökull* would reduce by 50% by the next century and completely disappear by 2200.[42]

After the phone line to the glacier was disconnected, further gallery installations of the work were curated, which included sound recordings of the site, a neon sculpture of the glacier's phone number, a book of 10,000 telephone numbers from listeners who called in during the week-long connection, and three photographs of the glacier in a traditional landscape style (Figure 3). The different forms of the work (the live listening event of the melting glacier, the artifacts of the 'live' performance, the photographs, and the sound recordings in the gallery space) came together to prompt the question: what happens when an audience can listen to as well as look at a landscape?

It is fair to say that, on the surface, Paterson's work undertook a conventional aesthetic rendering of climate change, evoking global warming and glacier melt to reproduce narratives of 'glacier ruination.'[43] This was more acute in the gallery where the recordings were framed by three 'classic' arctic landscapes, with striking, empty, white expanses.[43] Without a doubt, there is much to be discussed about what is lost and gained in the gap between the 'live' listening event and the encounter with the archive, whether in a gallery, online, or through secondary texts such as this one (see Refs 44 and 45) as Cameron and Neilson's work on the spatial and temporal challenges of the display of climate change point out.[44] Although it is too simplistic to suggest that the original experience was somehow more 'real' and the later recordings less 'authentic,' it is important to acknowledge the differences between the experience of directly listening to the glacier from a mobile phone from anywhere in the world and listening on a set of headphones in a gallery, standing next to a case with a set of images in it underneath a neon tube sign of the phone number. This, however, does not do the nuances of the work justice.

FIGURE 3 | *Archive of Vatnajökull* (*the sound of*), 2007–8, Katie Paterson. Installation view Ingleby, Edinburgh, 2014. Photograph: John McKenzie. The three images that accompany the installation and that also surround the sound files online offer a very particular visual framing of the recordings. The pops, creaks, and muted ice slides become set against the visualization of a white icy environment.

While it is not difficult to conceive of how the phone connection collapsed distance, the proximity developed through the work's sonic dimensions is more multifaceted than first presumed. First, if to look is to be presented with images of white, static expanses of ice, then to listen, especially 'live,' is to be confronted by the glacier as a constantly mobile and dynamic entity. To listen on the phone is to be invited into proximity: for a week, 10,000 people heard in real time the glacier melt and in that listening were afforded an intimacy with the minute expansions and contractions of its kinetic form. To listen thus offers a tuning into the ongoing, and very shifting, nature of earthly processes.[46] That is to say, while the intensified fact of ice melt was a frame of reference brought to the work by the audience, the act of listening rendered proximate earth surface processes and their ongoing nature. Second, the acousmatic (sound that is heard where the source is unseen) element not only developed these dynamic intimacies but additionally required the audience to create an imaginative connection between what was being heard and the environments in which the sound was created—environments that became all the more lively and heterogeneous for being imagined.[24]

The sonic and visual elements of the *Archive of Vatnajökull* (*the sound of*) thus engenders for its audiences a proximate encounter with an ice sheet and a set of processes that are distant in space and time but which are also ongoing and incremental rather than singular and spectacular. In its modes of

audibility, the work demands that the audience listens differently and becomes aware of that which is not human and not animal but other again. What emerges is an environmental encounter that demonstrates how sound can be employed to sense more-than-human environmental change, bringing human and nonhuman bodies into proximity with events over vast geographical registers.

RENDERING ENTANGLEMENTS

When reading across the climate change literature, it can seem like climate change knowledge, if not in crisis, is certainly undergoing significant critiques not only of what is known about the environment but also how it is known and who can participate in the making of that knowledge.[1,2,45,47,48] Two key imaginaries of the emerging 'new' climate knowledge are interdisciplinarity and critiques of expertise.[2,49] In practice, both these imaginaries usher in a broadening of the knowledge about climate change, making space for other ways of knowing and other knowledge makers. In both cases, one of the challenges that remain, however, is that knowing about and understanding climate change does not inevitably lead to activity on climate change.[1,50–52] An emerging set of responses from across science, social science, and the arts and humanities has focused on how opening out different forms of knowledge might develop new forms of environmental connection. Such connections are as much about shifting the knowledge forms of scientific experts as they are about the population of the global north, who are often understood to live in some form of insulation not only from climate frontlines but also from the physical wilderness more generally, thus ensuring that environmental changes remain unnoticed or are dismissed as unimportant.[19–21] In what follows, we explore how art practices might enable us to appreciate different ways of knowing the environment and how doing so might forge environmental relations based on connections of entanglement rather than those of separation, domination, and distance (Figure 4).

In 2010–2011, artist Christina Della Giustina spent a year in residence at the Swiss Federal institute for forest, landscape, and snow research outside Zurich.[d] Starting from the question 'how do changes in climatic conditions modify water cycle and water variability in trees,?' she sought to sonify and visualize data from the lab's world-renowned permanent plot sites, which has long been a key source of data for EU climate change predictions. Combining centuries of pre-existing data with contemporary live data streams, Della Giustina created an iteration of her ongoing audio-visual installation *You are Variations*. In the myriad visualizations and sonifications that constitute the work, we find an exemplification of how art can be understood to cultivate attentiveness

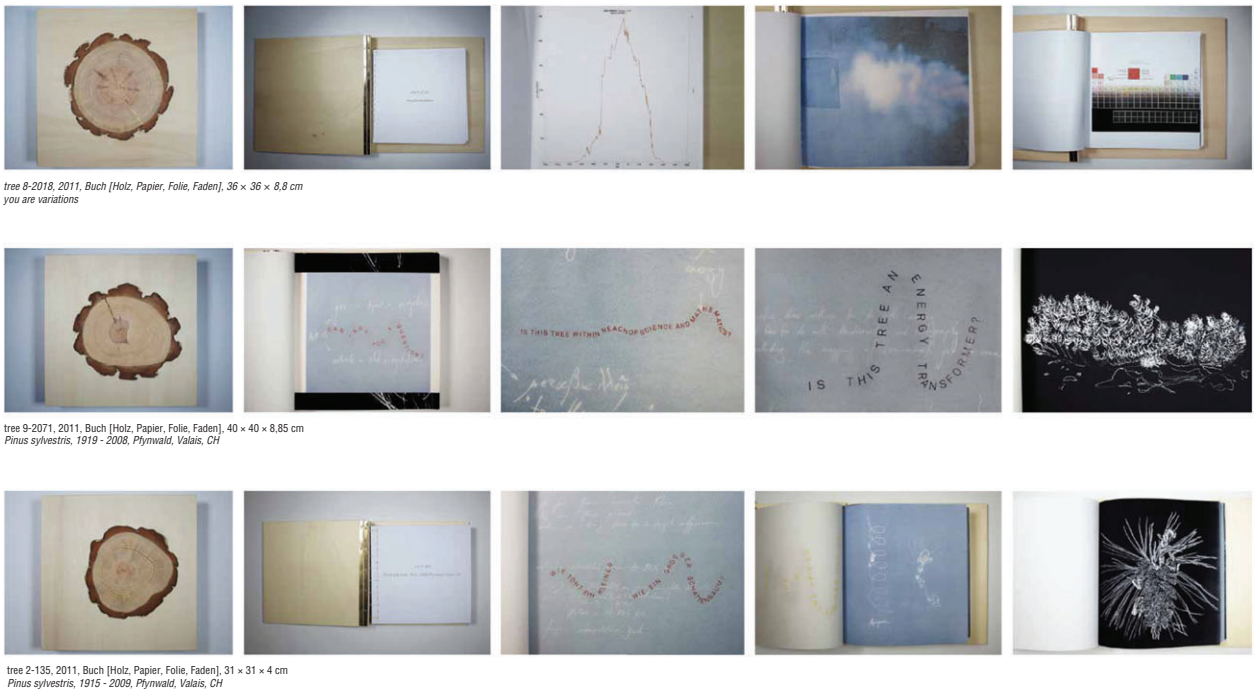

FIGURE 4 | You are variations (detail from artists' books), 2011–ongoing, Christina della Giustina.

in artists, scientists, and audiences alike to becoming affected by nonhuman others.

In December 2011, Della Giustina invited assembled scientists and visitors to meet *Anlus glutinosa*, *Carpinus betulus*, *Acer pseudoplatanus*, and *Pinus sylvestris*, four common tree species that populate European landscapes, through three artists' books and three sound installations. Within covers made from discarded specimens, each book collaged together three layers of heterogeneous visual material from a range of sources. This included high-resolution microscopic images, intricate pencil sketches, and a series of line graphs depicting a year-long story of tree health. The resultant combination united mathematical rigor with the spare forms of scientific diagramming and the intimacies of hours spent drawing pine cones, needles, and leaves from life. The images worked to bring awareness to how different modes of rendering sit next to and interleave with each other. This included the precisely computer-rendered graphical forms of line diagrams composed from millions of data points and the technicolor microscopic images of false color-stained plant cells that they bisect. These were overlaid by the sketched forms of delicate tendrils the artist had created from living specimens. The precision of the computer-generated line made stark the more hesitant touch of pencil on paper, the textures and gestures of the liveness of the artist's hand recorded in the slight miss marks, the varying weight of lines, or the fine feathering of overlapping pencil elements (see Ref 53 for a discussion of drawing as a process of cultivating intimacy).

Of the three sound pieces, two 12-min-long compositions were electronically composed and installed in vertical staircases that ascended the external walls of the lab, climbing through the thickets of pine around the site. Ascending the stairs, the audience began with soundings from the root/soil interface, moving up into the molecular exchanges in the stem before hearing the leaf–atmosphere interactions taking place at sunset at the top of the staircase. Despite their organic nature, the sounds heard were not, like Paterson's, field recordings created *in situ*, amplifications of actual environmental soundings made audible to the human ear; rather, they were, like Polli's compositions, a sounding of science, an aesthetic processing of data. Each piece was the result of a sonification of data being streamed from the permanent plot sites.

Della Giustina worked alongside scientists to develop a series of parameters that mapped biological and atmospheric characteristics onto functions of sound. For example, the atomic and molecular structures of the tree at a particular point (e.g., soil–root interface) became operations of rhythm, pulse, and pitch, while temperature readings gave the time signature of the piece, and the rate of evaporation–transpiration marked changes in the volume. Refining the parameters with Della Giustina, the collaborating scientists raised questions around 'fidelity to the data' and challenged some of the sonic renderings as being overly monotonous or as not 'sounding' like water or trees. These concerns revealed a compelling instigation of a sensory expansion, a valuation of becoming attentive to the trees studied in different interdisciplinary ways.

Like Polli and Paterson, the sonic and visual tactility of Della Giustina's work led her audiences on a spatial–temporal journey. The overlappings and intersections of the collection of soundings and visionings created a constellation of relations destabilizes registers of environmental understanding—the scientific and the artistic—to create novel environmental encounters. What evolve are multispecies explorations that decenter and deprivilege both the human subject and scientific forms of 'data,' situating them alongside and within rich assemblages of material from multiple sources. Visualizations and sonifications attune artists, scientists, and other audiences to different ways of engaging with the trees that are usually positioned as scientific specimens. Like the works discussed in the previous sections, this is not to privilege one way of knowing or to try to replace scientific understandings with other ones but to expand concerns with how the environment is known connected with. The result is a mode of encounter that opens out the spaces and practices of 'knowing' climate change to sensory engagements that, while clearly not necessarily excluded from more scientifically constituted methods, are certainly less privileged within them.

CONCLUSION: AND SO TO ACTION? TOWARDS THE ARTFUL COMMUNICATION OF CLIMATE CHANGE

This paper has presented three artistic case studies that enable a review of some of the specific ways that arts practices can engage the key challenges facing climate change communicators. It has reflected on the possibilities art practices offer to address issues faced by those concerned with climate change communication, namely, issues of insensibility, abstractions, and distancings. By drawing out transferable lessons from three artistic case studies, we hope to

have opened up space for further inquiry into what art can contribute, and how, to understandings of climate change. We explored how aesthetic experiences (e.g., of discomfort, of difference), developed here through visual and sonic methods, can cultivate particular ways of knowing and attentiveness toward things that are distant in space and time or simply not human. We reflected on how the modes of sensing—seeing, hearing, etc.—are associated with different kinds of spatial relation that may configure our relations to climate differently. We have also investigated how in the making, as well as in the consumption, of art different kinds of orientation toward the environment might be cultivated through a range of visualization and sonification practices, whether through graphs, microscopic images or drawings, environmental sounding, or sonification. Through these accounts, we have demonstrated how concerns with aesthetics, and hence with sensory experience, in the production and consumption of art works can offer valuable perspectives for those interested in climate change communication. We do not suggest that such accounts replace those which focus more specifically on representations, iconography, or narrative content; rather, we think that richer accounts and effects can be generated by thinking these things together. This is a movement beyond conceiving of art as 'picturing' the possibilities multiple forms of artistic practice offer in understanding, imagining, and even bringing about alterative environmental futures. Indeed, it is our contention that more complex accounts of cultural practices, which layer together representation, narrative, and symbolism with sensory, emotional, and affective dimensions, can offer much to climate change communications more generally.

Despite the values we find in these art practices, we want to briefly address some of the limitations with what we have presented here. This is not to say that the art works themselves are limited or have failed; indeed, as we have demonstrated, we think these are pieces that offer much with respect to key concerns with climate communication. Rather, we want to echo some of what Moser observed in her recent review concerning the limitations of climate change communication as it currently stands.[1] From within these, we find a series of stepping stones for further research and engagement on art and climate change.

Our key concern here is with regard to the 'oft-demanded, and rarely fulfilled request to evaluate communication's impact' (Ref 1, p. 4). As Moser notes, this constitutes 'one of the most important prospects for growth and advancement' (Ref 1, p. 4) and yet might well become one of the biggest missed opportunities for climate communication. In this paper, we have not set out to assess the broader impact of the works we studied nor would we argue that such works will ever likely have 'mass' appeal or reach a global audience. Rather, we have explored how these forms of work might affect those who encounter them and the artists and scientists who produced them. There is much work to be done in developing methods for arts evaluation more broadly and for the evaluation of climate change arts in particular.[30,54,55] Such methods would need to take account not only these kind of experiential dimensions but would combine these with research into the social–cultural location of individual audience members, including their pre-existing knowledge and biases. These are clearly large questions that need to be attended to as has been noted across the arts and science communication. It may be that fruitful combinations of methods and approaches can be generated by combining arts and humanities approaches to understanding the 'work' art can do alongside social science-based approaches that have, to date, been applied within science communication.

A second concern, and again, this is one shared with the wider field of climate communication, is around the need not just for explaining and educating but also for action to, as Moser states, 'move publics from mere awareness, concern and understanding, to an active engagement' (Ref 1, p. 10). With the awareness that 'knowledge itself is insufficient motivation to take action', a shift toward enabling and empowering' action has followed, but as Moser argues, it is 'far from clear even to the most motivated people what actions to take'(Ref 1, p. 7). Action is a tricky concept to untangle, especially within the constraints of academic publication. We are not claiming that the art works discussed here will move people toward action—either of direct action protest or of long-term behavior change—but we do think there are forms of creative practice that might. Other forms of encounter, which we have detailed elsewhere, are enabling action and are providing the space for organizing and collectivizing people into discussions about what action can consist of. We refer here to the evolving field of participatory and dialogic art that speaks to climate change (see Refs 56–58 for a series of examples) and which often feature community and site-specific practices taking up localized environmental issues—whether through story telling and gathering or the creation of living archives and artifacts of change.[59–62] We can also think of citizen science projects that engage with local communities as climate 'experts' and in so

doing disrupt more traditional senses of who makes climate knowledge and sanctifies climate futures.[63,64] These are forms of creative practice that have been proven, with respect to other issues (e.g., urban inequality, migration, education), to demonstrate practices and effects similar to the kinds of dialogic practices identified as key to furthering climate change communication.[1,47,48,64–66] Our investigation here sits alongside such practices, navigating 'action' through sensory, relational, and more intimate dimensions. We particularly reflect on the value of audio-visual art in the evolution of new relationships between humans and their environments, relations that, we suggest, hold within them much potential to respond to Moser's call for climate communication practices to 'open minds, deepen understanding, foster empathy and change attitudes' (Ref 1, p. 8).

It is this opening of minds, deepening of understanding, and fostering of empathy that this paper has sought to demonstrate art's capacity to do. In a communication landscape concerned with the possibilities of interdisciplinarity, with the need for interpretative, dialogic, and contemplative approaches to climate change, audio-visual arts offer one trajectory for investigation and instigation. It is our belief that arts practices such as these, and the ways in which they go to work on bodies and on the senses, can address 'climate silence[s]' to build alternative understandings and imaginings of, and in the best cases action on, global environmental change.

NOTES

[a] The literature on climate change, emotions, and affect has blossomed in recent years, key amongst which includes Ref 3.

[b] http://archive.turbulence.org/Works/heat/ last accessed November 24, 2016.

[c] New Media Art refers to those practices that encompass a range of work produced through the means of 'new media', so, for example, work produced for production and/or consumption through the internet, on computers, via social media as well as video games and robotic arts practices. The piece under discussion here was made through a collaboration between Polli, Cynthia Rosenzweig, David Rind, and Richard Goldberg from the Climate Impacts Group at the NASA Goddard Institute for Space Studies and Columbia University and documentary filmmaker Morgan Barnard and was enabled by sonification technologies Polli had designed with video artist and programmer Kurt Ralske.

[d] Author one carried out an ethnography of this year of residency and has continued to conduct ethnographic work with this artist.

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