

# THE RHETORICS AND NETWORKS OF CLIMATE CHANGE

by

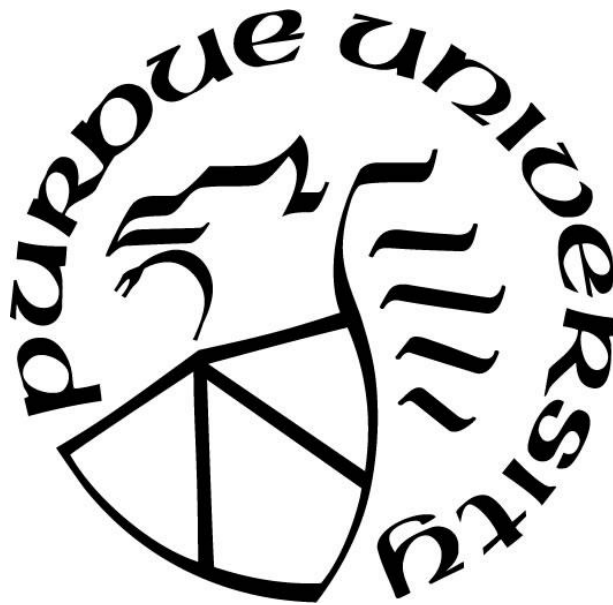
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**A Dissertation**

*Submitted to the Faculty of Purdue University*

*In Partial Fulfillment of the Requirements for the degree of*

**Doctor of Philosophy**



Department of English

West Lafayette, Indiana

August 2023

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*Dedicated to Holly, who got me through*

## ACKNOWLEDGMENTS

It would be hypocritical of me to write an entire dissertation about the power of networks without acknowledging the support of the people within my own.

This dissertation began as a project in a seminar taught by Bradley Dilger. He gave me advice and guidance, and connected me to my very first participant. He then went on to be my advisor as the project grew and took on a life of its own. Without his guidance, suggestions, (constructive) criticism, and encouragement, this project would not be what it is today, and I'm grateful for the time and work he's put into seeing me succeed.

I'm also grateful to the rest of my dissertation committee. Jennifer Bay was a guiding force not only in this project, but also in several others that emerged from seminars and our work in Purdue's Professional Writing program. Her knowledge of rhetorical theory has helped me keep this project anchored in the field. Richard Johnson-Sheehan helped me turn a seminar paper into my first solo publication, and his extensive knowledge of both technical communication and environmental rhetoric has been invaluable to me as this dissertation took form. Denise Tillery's work has been foundational for me in the area of networks, social media, and climate change communication, and so I was honored that she took time from her busy schedule across the country to offer feedback.

I owe my sanity to the support of Dilger's Disseminar Crew, a ragtag collection of graduate students and early-career scholars who meet regularly to review drafts of work, practice presentations, and generally turn what can be a solitary and back-breaking academic endeavor into one that, if not joyful, is at least tolerable, with glimmers of hilarity. Rebekah Sims, Derek Sherman, Marisa Yerace, Kailyn Shartel Hall, Adrianna Deptula, and Ghada Seifeddine have all listened to me share parts of this project in various stages of its development and offered valuable feedback. I owe special thanks to Allegra Smith, who—in addition to doing everything the other Disseminarians did—used her connections to put me in touch with what would eventually become my cluster of participants from NASA. Networking for the win!

For the past few years, I have worked with the Distributed Work research team, part of the Corpus and Repository of Writing (Crow). This team includes Dilger, Michelle McMullin, Hadi Riad Banat, Ola Swatek, and Anuj Gupta, all of whom have been exemplary models of ethical

research and scholarship. I've learned a lot from them, and I look forward to where our research is heading next.

My cohort at Purdue has also been supportive: Kimberly Broughton, Mattie Bruton, Jianfen Chen, Eliza Gellis, Kaden Milliren, Mason Pellegrini, and Jane Smith. We've had each others' backs for the past five years, and I appreciate all the support and camaraderie that they've provided.

During my time at Purdue, I have been a member of two separate writing groups (not concurrently, that would be crazy). Thanks to Ryan Murphy, Kaden Milliren, Jane Smith, Tony Ricks, Tracy Clark, and Adrianna Deptula for helping keep me on track.

Purdue's Rhetoric and Composition program has wonderful faculty who let me use their seminars to test out and work through ideas that eventually found their way into this project in some form or other. This dissertation would not be what it is—and I would not be the scholar I have become—without the input and support of professors like Thomas Rickert, Michael Salvo, Pat Sullivan, and Irwin Weiser.

Thanks to Sweta Baniya, who took a wide-eyed first-year PhD student under her wing and got him his first publication.

Thanks also to Lauren Cagle, who introduced me to Denise Tillery. Networking, for another win!

I am also appreciative of past advisors and professors whose work continues to inspire: Kristin Matthews, Trent Hickman, Phil Snyder, Brett McNelly, Dennis Perry, and Frank Christianson have all had an impact on the way I research, write, and teach.

My PhD journey would have been much more difficult without the support of my former supervisors Jessica Luevano and Nina Scott, who were excited when I told them I was thinking of going back to school, even if it meant resigning from my job.

The encouragement of friends like Angela Weech, Mickey Crockett, and Brent Behrens has helped me not get too disconnected with the rest of the world.

Finally, and perhaps most importantly, there are two other groups I need to thank.

First, my participants. Their willingness to lend their time to my study is what made the study possible in the first place. They think carefully about their online writing in ways that I can only aspire to.

Second, my family. My parents, Mike and Brook, never questioned me when I told them I wanted to quit my full-time job to go back to school for a degree in Rhetoric and Composition,

something neither of them had ever heard of. They helped me move from California to Indiana and have encouraged me from start to finish. I couldn't ask for better friends than my siblings, Drew and Chellē. We're a tightly knit group, and I'm lucky to have them. I'm also blessed with a set of parents-in-law, Calvin and Claire Baker, that came along early in my PhD journey. They were supportive from the start, and they accepted me into their family without reservation.

One in-law deserves special thanks. At one point, I intended for this study to go international. I had hopes to interview Spanish-speaking climate scientists in the Caribbean and Central America. My Spanish is fluent, but not flawless, and so Emmanuel Castro, brother-in-law extraordinaire, helped me translate my recruitment materials. For a variety of reasons I discuss later in this dissertation, I never got to use the materials, but his help is greatly appreciated.

Finally, principal among family members, the one who deserves all the Thanks (with a capital "T") that I can muster, is my wife Holly. She was there on the good days, and she was there on the tough ones when I questioned why I was doing this in the first place. She offered feedback, encouragement, support, and, in general, made life better just by being in it. Not to mention that she has a keen editorial eye and saved me from a few embarrassing typos. Any errors that remain were almost certainly added after she read this.

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## ABSTRACT

Science by its very nature is a networked discipline. Experiments and research build off of past experiments and research. Labs are collaborative spaces where many individuals work together with an array of technologies and other infrastructural elements. Much of the work of network building in science is done online as scientists communicate with each other and with the public on platforms like Twitter. But how do science communicators work in these online, digital spaces to build their networks and communicate? What kinds of rhetorical choices do science communicators make when they share research or reach out to connect with others? How do social media, networking, and other technologies influence those choices? What kinds of networks are created in these online, public discussions? In this study, I draw from actor-network theory and assemblage theory methodologies to begin answering these questions. Using snowball sampling, I recruited 12 climate science communicators from three network clusters: Purdue scientists, scientists whose work was highlighted by the nonprofit Black in Environment, and science writers for NASA. Drawing from choices I observed in the Twitter writing of participants, I then spoke with each participant in a discourse-based interview, inviting them to reflect on the choices they made as they wrote online.

The resulting conversation indicated the nonhuman (such as technologies) and human influences on their online discourse. Our discussions also revealed how participants used rhetorical strategies around identification and emotion to better appeal to their specific audiences. With identification, they not only asked themselves how an audience might react to their writing, but also engaged in internal dialogue with their imagined audiences and used conversational language. With emotion, participants emphasized the importance of humor and positivity as strategies by which to make online spaces more appealing and welcoming. This study offers four takeaways from the data: (1) science communicators should be aware of and take control of the networks that surround them; (2) public science communication should still be specific and directed at smaller audiences; (3) science communication—especially in online public spheres like Twitter—should not shy away from engaging with emotion; and (4) those of us who teach writing can (and should) teach writing as a networked process.

## CHAPTER 1. INTRODUCTION: NETWORKED CLIMATE COMMUNICATION

On June 16, 2021, Laura Bowling, professor of hydrology at Purdue University, tweeted a response to fellow Purdue professor and frequent collaborator, Linda Prokopy. Prokopy's original message shared a tweet from the United Farm Workers about the likelihood of farm workers to die because of heat, noting the seriousness of the issue (Prokopy, 2021). Bowling's response (see Figure 1) added more information about the issue, noting the "reduced hours available for safe farm work" (Bowling, 2021b). Bowling's tweet caught my eye because I had seen the same graphic elsewhere for related research (Weech, 2022): the Indiana Climate Change Impacts Assessment (INCCIA) was a series of reports put together by a group of scientists, public figures, and others that examined the specific effects of climate change in Indiana and how local Indiana industries—from farming to tourism and beyond—would need to work to mitigate those effects. Bowling herself was the lead author of the agriculturally focused report that I had researched, a report that contained multiple data visualizations presented within frames shaped like the state of Indiana (Bowling et al., 2018).

Here, then, in one tweet, is an example of the ways that scientists engage in networked communication: Prokopy shares a tweet from the United Farm Workers and links to a related article; Bowling responds to Prokopy's tweet by sharing information from the INCCIA report; research and data from two separate sources come together in these two tweets, which are linked together by Bowling. But there is more to this network than is just evident in the tweet. In a conversation with Bowling, I asked about the source of the original graphic—how it had been put together for the INCCIA report. Bowling responded,

We had a graphics artist who was hired to do some of the artwork. I worked collaboratively with the INCCIA's coordinator to agree on what the content should be in some of the various graphics. I had done the analysis and had all the statistics. And then we would have conversations like, "Okay, that's way too much. We need to reduce how much we're going to show in this one." So we would negotiate what level of detail we would show in our various illustrations, and then she specifically worked with the designer to come up with the graphic. (L. Bowling, personal communication, May 24, 2022)

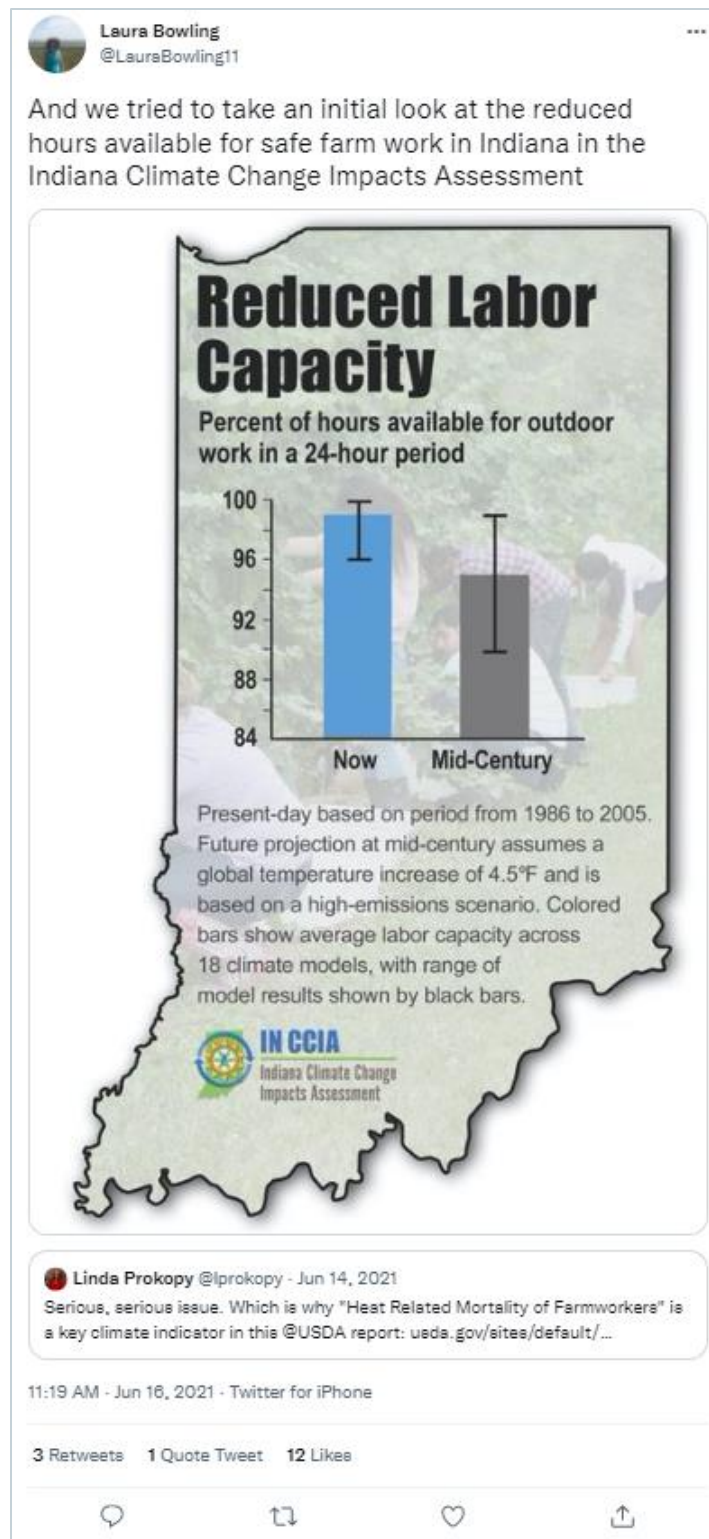


Figure 1: Tweet by Laura Bowling (2021b) responding to tweet by Linda Prokopy. She includes a graphic from an Indiana Climate Change Impacts Assessment report (Bowling et al., 2018).

In discussing the graphic, Bowling identified two other nodes in this network: the coordinator of the INCCIA and the graphic designer who created the image itself. And this is just a fraction of where this network could expand. We could look at the original tweet from the United Farm Workers or the link that Prokopy shared in her own tweet. We could delve deeper into the INCCIA report and see scientists engaging in networking by connecting with each other, with data, and by making visible other connections.

Science by its very nature functions as a networked discipline. Experiments and research build off of past experiments and research. Labs are collaborative spaces where many individuals work together with an array of technologies and other infrastructural elements. Indeed, it may even be that the networks themselves carry as much persuasive weight as any amount of scientific data. In the first chapter of *An Inquiry into Modes of Existence* (2013), Bruno Latour shares an anecdote that emphasizes the power of networks in scientific communication. Latour describes a situation in which industrialists ask a climatologist why they should believe his claims about the climate crisis. Rather than responding with details about climate science itself, the climate scientist describes the extensive network of climate science research: the vast number of researchers, technologies, systems, studies, principles of peer review, and data models. The climatologist then compares this network with the network of climate science doubters, noting that in the doubters' network there is "no competent researcher in the field who has the appropriate equipment" (p. 3). Thus, rather than citing scientific evidence as the base by which others should believe his research, the climatologist instead bases the reliability of his claims on the immense network of human and nonhuman agents arrayed to create such research. Here, it is the *network* that is most convincing. Networks themselves are rhetorical: they are formed through connection, context, and discourse.

In his answer, Latour's climatologist does not mention social media, but he might as well have done so. More and more, social media provides a clear demonstration that scientists are part of a network. On platforms such as Twitter, scientists consistently share their research while simultaneously linking their readers and followers to other institutions, other scientists, and other research that bolsters their own. And they do this while also engaging a large, public audience. This ever-growing network of individuals, technologies, institutions, infrastructures, and discourse is of particular interest in the field of rhetoric, where we research emergent discourse in all its forms. Researchers of these emergent public, online discourses and networks need appropriate methods that might reveal new knowledge about the nature of that discourse.

## 1.1 Research Questions and Methodologies

In this project, I sought to uncover how science communicators build networks while communicating online. As the effects of climate change continue to increase and impact our world, I chose to focus specifically on communication of research surrounding climate science and the networks that climate science communicators built as they interacted online. I focused on three research questions:

1. What rhetorical choices do scientists and professionals (specifically, climatologists) make when they communicate their research and work to a broader, more public audience via social media and other online platforms?
2. How do social media, networking, and other technologies influence those choices?
3. What kinds of networks (with other scientists, professionals, public institutions, corporations, and other entities) do these scientists and professionals create in these online, public discussions?

In choosing these questions, I hoped to uncover influences and strategies by which communicators created their online networks, and I also hoped to talk with these communicators to understand better why they chose the strategies they did.

I chose to base my study specifically around the writing that communicators posted on Twitter. Social media is a prime place to see social networks develop and evolve. Twitter in particular—with its public-facing nature, its defined mechanisms for connecting to other people, organizations, and websites—is a prime site for such an investigation. Indeed, past network studies in science communication have noted this as well, choosing Twitter as a research site (Cagle & Tillery, 2018; Mehlenbacher, 2019; Mehlenbacher & Mehlenbacher, 2021).

I should note that I gathered all my data (both from Twitter and from interviews) before Elon Musk purchased Twitter in late 2022. The platform has undergone changes since then, and it continues to change on what seems like a daily basis. Musk's decidedly political angle and his insistence on trimming down potentially important staff has caused many users to opt for other social media platforms (Sweeney, 2022). That said, as of this writing (June 2023), none of this study's participants have deactivated their Twitter accounts, and all are still posting on a regular basis.

My study offers a mixed-methodology (and a resulting mixed-methods) approach by which researchers can investigate communication across networks. From a methodological standpoint, I

draw from both actor-network theory (ANT) and assemblage theory. Actor-network theory is a methodology that studies the associations between actors or nodes in a network, identifying who or what those actors are and how they operate within that network (Callon, 1986, 1999; Farias et al., 2019; Latour, 1987, 2005b; Law & Mol, 1995). The associations that ANT studies focus on emphasize the contextual, relational nature of these networks—no single node exists in a vacuum. Furthermore, ANT studies tend to acknowledge the intricate lattice that makes up the networks. Spinuzzi (2008a) simplifies the ANT outlook as one focused on the idea of “splicing,” the idea that these various nodes in a network are joined together as a result of a myriad of political and cultural contexts: “a spliced or rhizomatic understanding,” Spinuzzi writes, “rejects simple cause-effect relationships; unlike dialectics, [ANT] assumes multiplicity rather than immanent unity in everything and understands change as not necessarily developmental” (p. 81).

That said, ANT studies have their shortcomings: they often have trouble identifying the links among nodes (Latour, 2005b); the expansive nature of the networks themselves is also a difficulty for ANT studies (Law, 1999), and ANT studies often tend to overemphasize the nonhuman at the cost of the human (Kaptelinin & Nardi, 2006). ANT, however, is a versatile and adaptable methodology (Mol, 2010), and as such it is not uncommon for researchers to pair ANT with other methodologies (see Batova, 2018; Read & Swarts, 2015; Spinuzzi, 2008 for three examples).

For my own purposes, to emphasize the importance of human agency and decision that underlies much network creation, I have turned to assemblage theory. Assemblages are groupings of individuals and things, intertwined and rootlike (Bennett, 2005; Deleuze & Guattari, 1987; Deleuze & Parnet, 1987). Assemblages come from the French *agencement*, a word that Deleuze and Guattari use to indicate both the action of creating the assemblage and the assemblage itself (DeLanda, 2016). Thus, an essential component to the interlinked networks of existence is the action of linking, an action driven by the agency of the components of that network.

These two methodologies—ANT and assemblage theory—underpin the methods of this study. From ANT, I draw on the idea that connections between nodes leave discernible traces that can be studied. The traces I begin with are the posts that science communicators write on Twitter. I use snowball sampling (Coleman, 1958; Heckathorn, 2011; Spreen, 1992), a method developed in medical and social science that follows connections within a network to discover more

connections. From Twitter posts, I found other potential participants, looking to create three distinct (but still interconnected) groupings—or “clusters,” as I call them—of participants.

From assemblage theory, I draw on the idea that the human elements within this network have agency and can influence the development of that network. To do this, I engaged in a discourse-based interview (DBI) with each participant. DBIs are interviews that look at specific discursive artifacts written by the interviewee and invite the interviewee to reflect on the creation of that artifact (Odell et al., 1983). Here, my aim was to use these interviews to uncover the knowledges and strategies that go into the creation of networks on Twitter and the communication of climate science through those networks.

## 1.2 A Few Terms, Defined

Before moving into a summary of each chapter of this dissertation, I want to briefly discuss the definitions of a few important terms that I use throughout.

### 1.2.1 *Network*

Although the literature about networks is extensive (see Chapter 2 for more), I offer a simple definition of the term here. **Networks are a collection of nodes, connectors, or actors that connect to and interact with one another.** Networks are composed of humans, animals, plants, weather systems, technologies, and any number of other potential nonhuman things. The connections in a network can be physical (like power lines crisscrossing a city’s electrical grid) or ephemeral (like a friendship).

### 1.2.2 *Social Network and Social Media*

These days, the term *social network* tends to mean the specific technologies and applications that individuals use to socialize online (Facebook, Instagram, Twitter, Reddit, etc.). But in sociological studies such as those by Granovetter (1973) or Centola (2020), social networks are the **interlaced connections between people that form social structures**. Social networks are myriad and overlapping. Any one person belongs to multiple social networks simultaneously: I am a member of my family, I attend Purdue University, I live in Lafayette, Indiana. Online tools like Facebook and Twitter are themselves social networks. Furthermore, social networks are connected

to other social networks. The Purdue Climate Change Research Center Twitter account follows the accounts of other Climate Centers across the Midwest and the country, for example, each of which represents a social network within the individual institutions where those centers are based. All that said, when I use the term *social network*, I use it in the way that sociologists use it, referring to the larger social structure and not necessarily to the specific technological application. When I refer to **specific technological applications themselves**—including Twitter, Facebook, etc.—I use the term *social media* or *social media platform*.

### 1.2.3 *Climate Science Communicators*

The participants in my study come from a variety of backgrounds. Some of these communicators are scientists with years of research in their fields, whether those fields be forestry, climate science, anthropology, or hydrology. Some communicators are burgeoning researchers. And some participants represent the National Aeronautics and Space Administration (NASA), writing articles for NASA websites and maintaining NASA social media accounts. All of my participants, however, **use their position and platform to address questions of climate change and climate science**. When I use the term *climate science communicator*, these are the individuals I refer to.

### 1.2.4 *Climate Change*

Finally, I want to address the term *climate change*. This is a term that encompasses **all the effects of a changing ecosystem as a result of human activity**. The term itself is generally credited to Republican strategist Frank Luntz, who, in a crucial memo, suggested that politicians opt for the term *climate change* rather than *global warming* because the former is less frightening to potential voters (Luntz, 2002). The term caught on across party lines, but in recent years we have seen individuals and publications choose to use the terms *climate crisis* or *climate emergency* when they talk about these effects. For example, in 2019, *The Guardian* updated its style guide, noting that “climate change is no longer considered to accurately reflect the seriousness of the overall situation” (Zeldin-O’Neill, 2019). That said, there still seems to be some back-and-forth with the terms. Some of the discussions with my participants actually touched on this issue, and they generally suggested that they preferred *climate change*. NASA writer Sofie Bates noted that

*climate change* already is a very loaded term. But I think climate crisis is even more loaded, for someone who doesn't believe it's a crisis. Most people, I think, can recognize that the climate is changing whether they want to use that word or not. (S. Bates, personal communication, February 11, 2022)

I acknowledge that the term itself has political origins that carry with them some baggage. While there still seems to be a lack of consistent guidance across various style guides, I still opted here to use the term *climate change* rather than use other terms. I did this for two reasons: first, as Bates expressed, while the situation is indeed a crisis, I believe that choosing the more measured language can build more bridges between climate scientists and those who doubt the human origins of climate change. Second, and perhaps more importantly, this is the language my participants used in their tweets and in their interviews, and I choose to draw from their language here.

### 1.3 Chapter Overview

Chapter 2 begins by further defining and examining the concept of the network, building on the definition I offer above. I also discuss how influence spreads across networks, changing behavior through weaker connections or through stronger ones (Barabási, 2002; Centola, 2020; Granovetter, 1973; Oliver et al., 1985). I offer six salient features of networks that make them viable objects of study and tie them to my methodologies and methods. Chapter 2 then moves into a more detailed study of those methodologies: actor-network theory (ANT) and assemblage theory. As described above, ANT and assemblage theory both rely on an understanding of networks as rhetorical; networks emerge from specific contexts and decisions, and they often form around language (Latour, 2013). In pairing the two methodologies, I suggest a methodological approach that can give us both a distant view of a network while also analyzing elements of that network more deeply, and I offer social media as a useful site in which to examine networks. Online interactions can demonstrate how humans are both constrained by and work around systems of power using language, and public online spaces such as those on Twitter make the formation of and communication across networks visible. I conclude the chapter by reviewing relevant studies in climate science communication, focusing in particular on three studies that look at how scientists use Twitter (Cagle & Tillery, 2018; Mehlenbacher, 2019; Mehlenbacher & Mehlenbacher, 2021).

In Chapter 3, I describe in more detail my methods and how using snowball sampling and discourse-based interviews work to unite ANT and assemblage theory methodologies. As discussed above, snowball sampling uses participants to find other participants (Coleman, 1958;

Goodman, 1961). Once I identified a participant through Twitter, I used principles of snowball sampling and looked at other individuals with whom the participant interacted or was connected to on the site; then I investigated whether or not those individuals (1) were climate science communicators and (2) used Twitter to share research. In my pilot study (which I include as Chapter 4 of this dissertation), I found that, if I wanted to have more diversity among my participants, I would need to actively seek them out. Thus, instead of a pure snowball sample, I created three clusters of participants: five Purdue professors, three Black scientists whose work had been highlighted by @BlackinEnviron (the Twitter account of a nonprofit organization that boosts the voices of Black environmental scientists), and four NASA science writers. Once I reached out to and recruited participants, I engaged in a discourse-based interview with each. I analyzed a series of around 20 tweets per participant, looking for places where I saw choices about writing and networking being made, and I asked participants to reflect on those choices.

When I initiated this project, I ran a pilot study with my first three participants. These participants—Jeffrey Dukes, Marissa Tremblay, and Jessica Evans—were the start of two of my later clusters. I recruited these participants through my own networks, and—as detailed above and in Chapter 3—I analyzed 20 (or so) tweets from each participant, building discourse-based interviews that invited participants to think about the choices made when they wrote those tweets. I also built a series of maps of these networks, something I had originally planned to do with the larger study but soon realized was a larger project all its own. The results of the pilot study indicated that (1) much like the assemblages I discussed above, communicators saw networks as both the thing they were doing and the thing they were building—it was both the verb and the noun, so to speak; (2) the networks that these communicators were building and their reasons for doing so were heterogenous; (3) science writers were aware of context and audience when they network; and (4) mapping the networks did indeed show connections between participants that were not otherwise evident. I prepared the study as a standalone article, but because the results pointed at the viability of the study as a whole, I have included the study in full as Chapter 4 of this dissertation.

In Chapter 5, I share the results of the study. The data I gathered consisted of two types: first, data from the tweets themselves. This includes networking tools like tags, hashtags, and links, as well as rhetorical strategies by which communicators both networked (e.g., when they would use conversational language to address specific individuals) and communicated research (e.g.,

when they shared publications—either their own or those written by other researchers). The second type of data emerged from the discourse-based interviews, when participants described the influences behind choices they made, their reasons for using specific language or images, and the connections they sought to make with others.

Chapter 6 discusses several conclusions I draw from the data. First, the chapter discusses the influences and limitations—both nonhuman and human—that go into the communication that these participants do on Twitter. Whether that influence be how charged their phones are or what a supervisor or colleague will think of a tweet, participants showed that they were thinking about these things as they wrote. The chapter also discusses the purposes and reasons for which participants wrote and the fact that their choices were deliberate. In this chapter, I also spend time discussing how participants engage in a type of Burkean identification. Kenneth Burke (1969) suggested that, to persuade an audience, rhetors need to *identify* with that audience. Burke suggests that this is more than just putting ourselves in our audiences' shoes. Instead, identification requires that the writer in some ways *becomes* the audience. The networked rhetorics we see participants engage in throughout this study indicate that sense of becoming—and indeed, networked communication does link someone to their audience intrinsically so that the two of them become more than the sum of their parts. I also suggest in this chapter that participants are aware of the importance of affect and emotion. Studies in both social theory and in psychology have suggested that when humans make decisions, they do so using emotion first and rationalizing the decision later (Masumi, 2010; Zajonc, 1980), and the participants of this study indicated that they understood this. They stressed the importance of positivity and humor, among other emotions, and how those emotions were more useful than more pessimistic, dour tones. Chapter 6 also includes a discussion of how participants address questions of climate justice and diversity in their tweeting.

Finally, the chapter concludes with four takeaways, suggesting ways by which communicators can more effectively engage in networked communication by (1) taking more control of their networks, (2) carefully directing even their public communication, and (3) engaging with emotion. The fourth takeaway is meant for teachers of communication and writing, suggesting that writing is a networked process and can be taught as such. By recognizing the power of communication through networks, rhetors can ethically influence behavior in ways that can lead to mitigation of the effects of climate change and the injustices and suffering that results.

## CHAPTER 2. LITERATURE REVIEW: OF BUTTERFLIES AND NETWORKS

### 2.1 Of Seagulls, Butterflies, and Tornadoes

In the mid-20th century, while using a laboratory computer to run statistical weather predictions, meteorologist and mathematician Edward Norton Lorenz (1963) began to notice that the predictions sometimes varied greatly depending on which decimal point he or the computer would round to in the initial equations. Additional experimentation showed that tiny variations in one part of an equation—as small as thousandth and ten-thousandth percentiles—could lead to massive, unpredictable variations elsewhere. The conclusions of these experiments led Lorenz to state that “one flap of a sea gull’s wings would be enough to alter the course of the weather forever” (p. 431). In extremely complex systems (like weather), even the smallest of variables can have major, unpredictable impacts. About a decade later, in a speech to the American Association for the Advancement of Science (AAAS), Lorenz would change the central analogy of the concept from seagull to butterfly (2000), and the principle became known by its much more recognizable term: *the butterfly effect*.

I open this chapter with a brief discussion about the butterfly effect because, in spite of its origin in and importance to chaos theory, both the principle of the effect itself and the story of its inception have implications to my work here: the theoretical butterfly effect would be impossible without the connections that networks provide, and we wouldn’t have the insight into Lorenz’s thoughts without his willingness to reflect on his own creative process. Lorenz’s original description connecting a seagull to weather assumes that there *is* a connection there. It may not be direct: one flap of a wing may not immediately result in a change in weather pattern, but that one flap sets eddies and currents into motion that interact with other eddies and currents, each node in this network passing along or (to borrow a term from actor-network theory) *translating* that motion in different ways, until eventually the changes accumulate and associate with other nodes in a way that results in altered weather. In a complex network like a climate, even smaller actors like a seagull or a butterfly *can* effect change in the network through those connections, and those connections can be unpredictable. A simple signature on a piece of paper can lead to the building of an automobile manufacturing plant, which leads to thousands upon thousands of cars that release countless pollutants into the atmosphere. These greenhouse gases warm the climate, air currents

move differently, and extreme weather results. In complex networks—the ones in which we spend every day of our lives—the smallest actions have consequences.

The second note of interest here is the fact that Lorenz *changed his analogy* from seagulls to butterflies. More interesting is the reason *why* that analogy was changed. Through a series of interviews, physicist Robert C. Hilborn (2004) sought to figure out how and why Lorenz made that change. Lorenz himself told Hilborn that he was out of the country and unreachable for a time before giving his 1972 talk to the AAAS. During this time, Lorenz claims, his talk was titled in his absence. The likely culprits were Philip Merilees, then-convenor of the AAAS session Lorenz was going to speak, and Douglas Lilly, an atmospheric researcher whose office was close to Merilees's. Merilees told Hilborn that he was “aware of the sea gull metaphor” but “thought the butterfly might be more appealing” as an image (p. 425). He also notes attention to alliteration: “butterflies in Brazil” and “tornadoes in Texas.” Lilly suggests that, in conversations between himself and Merilees, he also may have suggested discussing title ideas, and that he was influenced by the 1941 George R. Stewart novel *Storm*, which in one passage expresses similar ideas of something small setting larger weather patterns into motion. Finally, in a note added to his article in proof, Hilborn mentions meteorologist Joseph Smagorinsky as another possible origin of the butterfly metaphor. Late during Hilborn's study, Lorenz remembered having read a paper by Smagorinsky that describes how a butterfly's wings could amplify to an unpredictable point.

While the butterfly effect assumes a network of connections between elements of a complex climate system, Lorenz's own process of writing about the butterfly effect emerges from a complex system of its own made up not only of other scholars, but, as Hilborn indicates, also includes creative works:

- Merilees: a colleague, credited with generating the title of Lorenz's talk
- Lilly: another colleague, who indicates that he also helped discuss title ideas
- Stewart's *Storm*, a novel wherein a passage describes weather patterns emerging from small, seemingly inconsequential events or things
- Smagorinsky, a meteorologist who suggested that butterfly wings could have unforeseen results

- Pierre Duham, a 19th-century French physicist who described how the flight of a grasshopper could change the course of a storm<sup>1</sup>
- Ray Bradbury's "The Sound of Thunder,"<sup>2</sup> a science fiction short story in which a time traveler accidentally steps on a butterfly and thereby changes the course of history

The fact that Hilborn does not decide on a single one of these as *the* deciding factor in Lorenz's change is telling. Tracing a cause to its effect—say, a flap of a butterfly's wings to a tornado—is one thing; tracing in the other direction—the tornado back to the butterfly wings—is entirely different. In fact, tracing these complex networks in any direction is difficult, especially as networks get more complicated. I could go into even more influences on Lorenz that led to his writing about the principle—the computer he used, laboratory conditions, graduate researchers assisting him, and so forth. There are innumerable actors in Lorenz's network that could be listed here, but the attempt to find those connections, as Hilborn does, is worthwhile and illuminating.

I open this chapter with a discussion on the butterfly effect and its networking implications to show how even complex networks can—and should—be studied. Communication networks like Lorenz's influence the way scientists write and talk about their work, which then influences how other scientists and the public perceive what they do. Today, *the butterfly effect* as a term is part of English vernacular. Studying how networks influence these kinds of events can help us understand why and how we make decisions within those networks, and how we might use those decisions to influence the networks around us.

In the sections that follow, I describe salient features of networks: what they are and why they matter. I then describe two possible methodologies by which we can study networks and how they can complement each other: actor-network theory (ANT) and assemblage theory. From there,

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<sup>1</sup> It should be noted that Hilborn is not accusing Lorenz of any kind of plagiarism here. The idea of small things effecting big changes is a common one and has been around for a long time. Hilborn does seem to be indicating that meteorologists had been thinking in these terms far earlier than 1963, and that perhaps Lorenz was just thinking along similar lines.

<sup>2</sup> Hilborn acknowledges the possible influence of Ray Bradbury's 1952 story in which time travelers step on a butterfly in the past and in so doing drastically change the present; however, in Hilborn's conversations with Lorenz, the latter says that he wasn't aware of Bradbury's story. That said, it is entirely possible that the story's popularity somehow filtered into Lorenz's thinking in some way. We don't have to have seen *The Empire Strikes Back* to be familiar with the ubiquitous line "I am your father."

I then discuss social media as a site where the discursive nature of networks is made visible, and thus is a perfect locale for research into how networks function. Finally, I conclude this chapter with an overview of current work on climate science communication and how this study into social media communication of climate science will contribute to that ongoing discussion.

## 2.2 Networks

Networks have influenced our ways of thinking for centuries. In its earliest coinage, the word *network* referred to literal “net” work: using tools to crisscross physical threads and wires in a netlike fashion. In other words, the work that goes into creating a net, like a fishing net. This variation of the word (“net work”) appears as early in the 16th-century Tyndale translation of the Bible. By the following century, the word had expanded its meaning into descriptions of living things: natural scientists described netlike structures within biological tissue as “networks.” In the 19th century, writers like Coleridge and Emerson were using the term in a way that indicated social connotations (“Network, n. and adj.,” 2019). Networks were no longer just physical things—wires and threads or biological tissue—but were now also metaphorical connections between people and things, living and unliving. As electrical and telecommunications technology developers committed more and more to link people and things together, *network* also began to be applied in a technological sense as well. All that said, the word has not lost its metaphorical connotation: we still speak of “networking” when it comes to someone going out and making connections with other people.

Talk of “networks” has also extended into cultural theory. Michael de Certeau and Donna Haraway, for example, brought networks into their discussions of geography, of situated knowledge, of cyborgs. De Certeau (1984) describes a form of postmodern geography, built from grassroots discourse, “networks” of “moving, intersecting writings” that create a “manifold story” (p. 93). These intersections allow a kind of equitable triangulation that incorporates perspective into mapmaking. Thus, not only do we have a birds’ eye view of a city’s streets, but we also have a people’s-eye view of unmapped shortcuts through buildings, subway systems, and so forth. Similar to de Certeau’s maps, Haraway’s (1988) idea of “situated knowledge” incorporated an “earthwide network of connections” through which individuals can “translate knowledges among very different—and power-differentiated—communities” (p. 580). Both de Certeau and Haraway value the connections that humans make with one another, the ways in which their stories link

across boundaries to create networks of varied lived experiences, and the ways in which these connections can empower individuals who live in situations where their stories and knowledges are traditionally overlooked by people in power.

These networks, however, go beyond linking humans with other humans; they also link humans to other organisms and nonliving things, infrastructures, technologies. Haraway (1998) describes a hybridized biological-technological “cyborg” that, she says, needs “connection” (p. 151). The world this cyborg lives in is “dispersed and interfaced in nearly infinite, polymorphous ways” (p. 163). In linking biology and technology, Haraway illuminates the fundamental ways in which we are connected to each other and to our surrounding infrastructures. These infinite interfaces are the stuff of networks, and the cyborg is connected to its world through these connections. There is no division between human and technology—the two are interrelated, interweaved.

Considering the history and the theoretical work that has gone into the word, I define a **network** as a collection of nodes (also referred to as connectors or actors—more on that below) that connect to each other in some way. The nodes can be human, nonhuman organisms, or nonliving things; and the connections between the nodes can be tangible or ephemeral. Tangible connections could include infrastructural connections like power lines, fingers touching keyboards, and so on. Ephemeral connections could include family relationships (some of which started as tangible connections but have evolved with some sense of distance), acquaintanceships, or ideas. Whether tangible or ephemeral, the connections between these nodes allow different nodes in the network to exercise influence—great or small—over other nodes in the network, and that influence is often passed along from node to node. Also of note: these nodes are not centered in a single place but rather are distributed across distances both local and global (Spinuzzi, 2008b).

Networks can be all-encompassing. Albert-László Barabási (2002) noted that the “subtle paths” that connect us ultimately connects everyone and everything: “We are all connected,” he wrote. “Nothing is excluded from this highly interconnected web of life. [...] It requires only one link per node to stay connected” (p. 17). In other words, even if I know only one person, that one person knows other people, who know other people. It is feasible that someone far from my local networks may communicate some kind of information that will eventually make its way to me, even though I have never met that person. These all-encompassing networks also include nonhuman nodes. For example, atmospheric pollution connects to and affects everyone—we all

breathe air, and if a local coal power plant pollutes the air, it affects nearby residents. And those who study pollution and its effects on people, livestock, and crops, are connected to those same residents *through the nodes of the pollution itself*. We are all connected, a vast network of existence.

The ways in which the nodes of a network form connections can be purposeful or random. In examining the ways that information technology has changed human interaction, Yochai Benkler (2006) described what he called a “networked information economy” and “networked public sphere.” In noting that this new societal framework enables individuals to do more for themselves and enables easier connection to do things with others, Benkler also notes that this framework enables individuals to come together into “formal organizations that operate outside the market sphere” (p. 253). Although Benkler’s description of networks sometimes verges on utopic, his discussion of the ways people organize themselves is particularly useful. These organizations sidestep the complete chaos one might expect from unstructured networking because they center around “high-visibility nodes” (p. 253). When people connect with these nodes, the visibility of the nodes becomes even greater, and information is passed from the high visibility node through these individuals to other nodes. Barabási also commented on the influence of these nodes:

Popularity is attractive. Webpages with more links are more likely to be linked to again, highly connected actors are more often considered for new roles, highly cited papers are more likely to be cited again, connectors<sup>3</sup> make more new friends. Network evolution is governed by the subtle yet unforgiving law of preferential attachment. (2002, p. 64)

The “preferential treatment” that Barabási describes here can result in certain “hubs” connecting to more nodes than others, and exercising much more influence, or even dominance (p. 68). Eventually, most nodes in a network end up connecting to a high-visibility node (Benkler’s term) or connector (Barabási’s), either directly or indirectly through connections with others. I do not work for NASA, but I know people who do, and I follow NASA’s Twitter accounts. I am still connected, albeit indirectly. To draw an image from Latour (1993), these popular nodes in a network are like busy train stations, with countless other nodes (or actors) connecting to them,

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<sup>3</sup> Barabási uses the term *connectors* to mean nodes that have a higher-than-average number of connections to other nodes.

sometimes continually, and sometimes only in passing. Latour's analogy is also appropriate in that the power of a specific node's influence can change over time. Indeed, nodes themselves are always evolving (Ronfeldt, 2007; Weber, 1947).

All of that said, network influence is not limited to these high-visibility nodes. In an influential paper, sociologist Mark S. Granovetter (1973) differentiates between *strong* and *weak* ties within networks. While there is no doubt that strong ties—such as those between close friends and family members—can be influential within a group, Granovetter notes that for larger movements, a greater number of weak ties—such as those between acquaintances—allows for more connection and influence on a greater scale. In other words, we have a limited number of close (strong) friends and family members, whereas we have a much greater number of distant (weak) acquaintances. Influence can be spread over greater distances, to more people, if those distant connections are invoked.

Later sociological studies have elaborated on how weak ties effect change among networks. Oliver, Marwell, and Teixeira (1985) put forth the idea of the critical mass. In physics, a critical mass refers to the minimum amount of nuclear fuel needed to keep a nuclear reaction going, a quantity of molecules that is high enough and dense enough (one might say, with a strong enough network) that one molecule's reaction results in more molecules reacting continually. In sociology, Oliver, Marwell, and Teixeira took the idea of the critical mass and applied it to social networks. Their study notes that the critical mass is the number of nodes (in this case, people) in a network that need to adopt a behavior for the rest of the nodes in that network to adopt that same behavior. A later study by Marwell, Oliver, and Pahl (1988) added that the density of social ties impacts how quickly this critical mass can be reached. In other words, while Granovetter's weak ties are useful in disseminating information or behavior across larger groups of networks, within a network, that same information or behavior will spread faster through close ties, and at some point that information or behavior will reach critical mass and the rest of the population of the network will adopt it. Think, for example, of Facebook. When it launched in the mid-2000s, it faced steep competition from other social media platforms like MySpace. But as more people adopted it, it became more and more common. Eventually, enough people adopted the use of Facebook that people within their networks looked unusual for *not* adopting it themselves. And the reverse happened for MySpace: once people started leaving MySpace, the total number of users rapidly cratered.

In a recent study, Damon Centola (2020) added the important distinction that not all information or behaviors transfer through networks in the same way. Building off Granovetter's work, Centola noted that the types of information or behaviors that transfer best across weak ties are what he calls "simple contagions" (p. 37). Comparing the dissemination of information or behaviors across networks to disease, Centola indicates that the easier it is for a behavior to be adopted, the weaker the tie needed for that behavior to transfer from one individual in a network to another. More complex behaviors require stronger ties or—alternatively—multiple sources of weak ties. The reason for this is that complex information or behaviors typically have costs associated with them: financial, reputational, psychological, etc. "The more risk that is associated with a mobilization effort," Centola observes, "the more that success depends upon close-knit networks to establish trusted relationships and provide social reinforcement for participation" (p. 91). Centola also discusses that the increasing interconnectedness of our world through information technology has led to a decrease in strong ties and an increase in weak ties, thus making it *harder* for behaviors to spread. Instead, we see simple information shared across weak ties like memes or jokes. That said, Centola does note that, even in online communities, people have "instinctively found, and in many cases created, clustered networks of social reinforcement that can sustain real changes in behavior" (p. 141). Centola suggests that careful attention to networking strategies and purposeful designing of social networks (both in the sociological sense as well as in the sense of technology and social media) can help spread beneficial information and behaviors more quickly and more effectively.

The fact that Centola argues that networks can be designed means that choices are made when networks are formed, and choices are made in the ways that actors exercise influence over other actors. Bruno Latour (2013) described the fundamental organizational act as one of discourse: he offers a hypothetical story of Peter and Paul, who say to each other that they will meet at a specific time. The discourse they use forms a tie between the two of them, organizing them together, and thus affecting not only the two of them, but their surroundings, their meeting place, to the materials needed in their meeting. The act of organization is one of speech. As Fairhurst and Cooren (2004) noted,

Organizing is synonymous with the positioning and inserting of speech acts nested within episodes and initiated and closed by other speech acts. [...] Language in use organizes as it situates actors in relation to other actors, contexts, goals, and objects. (p. 143)

In other words, we make choices when we build networks. Our choices are often discursive ones—we choose what to say to others to connect with them—and those choices are deeply influenced by contexts, both our own and those of our interlocutors. Thus, the networks that emerge from these choices are rhetorical by nature.

To sum up, I'd like to draw from this discussion six salient features of networks:

1. Networks are collections of nodes or actors that link to each other in some way.
2. Nodes can be human or nonhuman.
3. Connections can be tangible or ephemeral.
4. Nodes with more connections often have more influence.
5. That said, weak ties can also be influential, especially when communicating simple information and behaviors.
6. Networks are rhetorical: we make choices and use language to connect with other people and things.

This last point is of particular importance. It is also worth noting that in truly complex networks, there are nodes that use their own connections to defy and counteract the power of the larger, more influential nodes (Delpini et al., 2013). The choices that go into forming (and resisting, in these cases) networks mean that we can study how to improve these choices or how to better resist the influence of bad actors.

I should also note that these bad actors can use choices of their own to create and influence networks. Liza Potts, Rebekah Small, and Michae Trice have written in a variety of contexts about how individuals can coopt digital spaces (Potts et al., 2019; Trice, 2019; Trice et al., 2019; Trice & Potts, 2018). Their research shows how the GamerGate community spread from 4chan to other social media platforms like YouTube, Twitter, and Reddit, all the while engaging in aggressive harassment of women throughout the gaming and gaming criticism industries. The authors describe the ways that the GamerGate community coopts the tools and rules of the platforms they use (Trice et al., 2019), how the community insulates its members from outside opinions while also complaining about social justice (Potts et al., 2019), and how the community generally used Twitter tools to test how a variety of interconnected messages might resonate across audiences (Trice & Potts, 2018). In their work, we see the “dark side of digital composing” at work by bad actors who see themselves as agents of a cultural war (Ridolfo & Hart-Davidson, 2019).

Knowing that these bad actors are using principles and tools of digital rhetoric to grow their networks and spread their messages, it is ever more important for those of us who oppose this threat to understand how those networks work and to use them to our own ethical ends. As I have discussed above, if networks arise out of rhetorical choices, and if the choices that create networks arise out of discourse, then there should be evidence of that discourse (writing, records of speeches, etc.) that we can research in more depth. But *how* can we go about doing this research? And *where* are the best sites for this kind of research? In the two sections that follow, I suggest some possible answers. First, I describe two methodologies that can be used to study networks: actor-network theory (ANT) and assemblage theory. These are by no means the only methodologies available to researchers interested in network studies, but in the context of social media and scientific communication, and in the context of my own particular research questions, I have found these two to be particularly useful. Second, I examine social media as a site where we can readily find traces of the discourse that goes into creating networks and study them. In combining this methodology with this site, I hope to uncover not only useful tactics and strategies by which communicators can work in these specific contexts, but also useful insights into social networks themselves.

### 2.3 How to Study Networks: Actor-Network and Assemblage Theories

Before diving into the methodologies themselves, it is important to point out one additional feature of networks that I have yet to mention: networks are both a structure *and* a process (Lipnack & Stamps, 1994). Networks are not stable (Ronfeldt, 2007)—nodes are always gaining and losing connections to other nodes, shifting alliances, gaining or losing influence. Because of this, a network is not a stable thing, but rather a thing that is always *becoming*. This feature of networks is essential in understanding the ways by which actors in networks are constantly allying, or splicing (Spinuzzi, 2008b), with each other in actor-network theory, or how assemblages function as both noun and verb (DeLanda, 2016). Networks are not only the structured collection of interlaced nodes; they are also the ways those nodes are forming and reforming themselves. Exploring how networks form and the agency behind that formation is a key feature of both ANT and assemblage theory.

It is also worth noting that I see ANT and assemblage theory as methodologies in the sense that they guide the “why” of my research, as opposed to the “what” or the “how.” **Methods** are

what I do (and will be discussed in Chapter 3). **Methodologies** are why I choose the methods I do. ANT and assemblage theory deeply influence the choices I make regarding data collection and analysis procedures, and as such, I refer to them as *methodologies* rather than simply theories. Keeping that in mind, we can now begin to discuss the methodologies themselves.

### **2.3.1 Actor-Network Theory**

Actor-network theory (ANT) is a “family of conceptual and methodological sensibilities” that emerged from science and technology studies in France during the late-20th century (Farias et al., 2019, p. xx). Generally associated with the work of Bruno Latour, Michel Callon, John Law, and Annemarie Mol (among others), ANT has a generally “empirical-ethnographic interest” that has spread into study of networks in myriad settings (Gad & Bruun Jensen, 2010, p. 74). As a methodology, ANT offers an adaptable framework that can be used to analyze similarly adaptable and shifting networks (Mol, 2010). Each node in the network is an individual actor that exercises influence on the nodes to which it connects. The actors in these networks are “spliced” together and are constantly mediating and transforming each other, “delegating actions” in which each actors’ actions impact the greater network as a whole (Spinuzzi, 2008b, p. 22). Nor are these actors necessarily human: ANT places equal importance on the influence of both human and nonhuman actors in a network (Callon, 1986; Farias et al., 2019; Law & Mol, 1995; Law & Singleton, 2005).

ANT methodology bases itself on two main assumptions: first, that actors (human and nonhuman) in a network interact in fluid ways, and a sense of a network can be gleaned by studying these interactions (Latour, 1999, 2002, 2005a); and second, that these interactions can be studied through traceable associations that the interactions leave behind (Latour, 2005b). Latour has noted that these associations are “unpredictable and heterogenous” (Latour, 1987, p. 202); in other words, the associations echo the networks themselves—they form around imminent exigencies based on available infrastructures and power structures. Each association has its own context that merits analysis. Such analysis of these actors and traces, how and why they associate, and how they affect other actors and associations is the key aim of ANT studies. In addition, ANT studies work from a standpoint that does not presuppose a social order; instead, ANT studies trace the associations and describe whatever order might be found (Latour, 2005b). In other words, while one might approach a network with the intent to study it, an ANT researcher would (theoretically) approach

a situation by asking “Is there a network here to study?” and then answer the question by choosing a starting place and following traceable associations to map connections to possible actors.

How, then, might researchers carry out a study using ANT methodology? Callon (1999) suggested that when investigating complex networks, one task ANT researchers should undertake is to disentangle the actors from each other. In this way, the researcher can better illuminate the role each actor plays within the network and its connections to other actors in the immediate context. Additionally, Latour (1987) offered five potential pathways by which researchers might undertake to utilize ANT methodologies:

1. How causes and effects are attributed
2. What points are linked to which other
3. What size and strength these links have
4. Who the most legitimate spokespersons are
5. How all these elements are modified (1987, p. 202)

Each of these potential areas of focus could be seen as emphasizing the rhetorical nature of networks and the interaction of the actors that form them. Associations evolve based on situational context: places, power structures, backgrounds of individuals, technologies in use, and so forth. The traces, or “inscriptions,” that these associations leave behind are often discursive in nature (Spinuzzi, 2008b, p. 17)—whether that is a piece of writing or some other multimodal element, and analyzing these pieces of discourse created by actors within a network can give valuable insight into the network itself. Indeed, if we allow at even some level that discourse, once uttered or written, is separated from the person who uttered it (Barthes, 1967), we could even consider these discursive traces to be actors themselves, especially in a context such as social media, where posts may take on a life of their own, independent from the original authors. As Cagle and Tillery (2018) have demonstrated, textual artifacts such as hashtags and hyperlinks are crucial actors when it comes to the dissemination of information during scientific events. Indeed, the interactions and the technology that make up social media make possible substantial reconfigurations about what we think of as an actor, and such reconfigurations invite new, adaptive ANT methodologies (Gerlitz & Weltevrede, 2019).

### 2.3.2 ANT in Action: A Preliminary Analysis

Because network analysis using an ANT framework can be complex, I depart here from the theory-focused nature of this review to offer an example of how ANT can lend perspective to an analysis of networks. Much of the research for this dissertation was born out of analysis of a series of 2019 tweets by Jeffrey Dukes, then director of the Purdue Climate Change Research Center. Until late 2020, these tweets continued to be Dukes's pinned tweets at the top of his Twitter page. These tweets were some of the first I gathered in my data collection, and Dukes was the first participant I recruited. My discussion here is limited, centered on one researcher, but in these tweets, as we trace the connections that Duke makes with other actors—researchers, media outlets, online resources, and organizations (both research and governmental)—we can gain insight into the network itself. I structure this brief analysis around Latour's (1987) five potential aims of ANT discussed above. Reducing ANT to these five aims risks oversimplifying the methodology and its potential, as well as risks disregarding some of the adjustments ANT researchers have since made to the methodology.

Latour wrote that ANT studies can help us, first, to discover **how causes and effects are attributed**. In other words, ANT can help us discover the reasons and contexts underlying the creation of a network. In addition, ANT can help us see the effects that nodes of a network have on other nodes. For example, in one of his January 2019 tweets, Dukes (2019b) acknowledged the help of Purdue's College of Agriculture in putting together a series of scientific reports which he shared in earlier tweets (see Figure 2). In this way, Dukes not only acknowledges the extended network that went into the creation and sharing of climate reports, but also brought a new node into the existing social media network by creating a link to @PurdueAg. The Agricultural Department shifts from being a behind-the-scenes actor in the network to now being a visible actor on its own. There are two layers of cause/effect happening here: first, @PurdueAg helped create (cause) the reports (effect) that Dukes shared; and second, Dukes's mentioning them in the tweet (cause) made them a visible part of the network (effect).



Figure 2: Tweet by Jeffrey Dukes (2019b). Here, Dukes tags a number of other organizations, thanking them for their contributions to the Indiana Climate Change Impacts Assessment.

The second potential avenue of research for ANT that Latour described is that of discovering **what points are linked to which other**. Many ANT scholars do this using mapping (for example, Potts & Jones, 2011; Read & Swarts, 2015). There is value in simply seeing what elements make up a network. If we do not catalog and map these elements, some of them may remain unseen or unnoted. Conversely, if we do catalog and map them, we may find surprises that we did not expect. Throughout Dukes's January 2019 tweets, he utilized tags, hashtags, and retweets throughout the month and in so doing connects to a variety of individuals and organizations (Table 1). Some of what is here is not surprising: the majority of the connections Dukes made in these tweets is with other research organizations and individual researchers, either by tagging them or simply by retweeting their findings. Also included in Dukes's network, however, are a handful of media outlets and reporters, governments and government officials, and even a few resources he offered his followers if they look to engage in the conversation themselves.

Table 1: A list of the types of individuals and institutions linked to in Jeffrey Dukes's January 2019 Twitter feed. Research organizations and individual researchers make up the majority of links.

| Type                                         | Number |
|----------------------------------------------|--------|
| Research organizations                       | 14     |
| Individual researchers                       | 9      |
| Government/civic institutions                | 4      |
| Media outlets and reporters                  | 3      |
| Nonprofit organizations                      | 3      |
| Individual academics, writers, and advocates | 3      |
| Information resources                        | 2      |
| Government officials                         | 1      |

Third, ANT methodology can also analyze networks to see **the size and strength of their links**. This aim examines power structures, influences, and how stronger links in networks influence less stronger ones. Similarly, this aim may also investigate how nodes that have seemingly less influence resist the influence of more powerful nodes. Indeed, some links may be incorporated into a network based on their size alone, the way that a corporation may seek a celebrity endorsement on their product. Such analysis of size and strength are also useful in the ways that science utilizes social media. For example, in a chain of tweets from January 2019, Dukes (2019a) made a point to link to news coverage of the reports from the Indiana Climate Change Impacts Assessment, of which he is a part. He sends his followers to a webpage that continues to be updated (*Past News | Purdue University Indiana Climate Change Impacts Assessment*, 2020). The site serves as an archive of links of news reports, but the goal here is not necessarily for Dukes's followers to read every report. Such a task would be unlikely, since the website links to 440 articles from a total of 295 media outlets. The articles come from five countries outside of the United States and over 30 states within. Some of the links are broken, indicating again that by linking this page, the emphasis is on the size of the network and its influence rather than the details of the articles themselves. Once again, like Latour's climatologist, the persuasiveness here is less because of the science and more because of the vast nature of the network involved.

Fourth, ANT can be useful for **identifying the legitimate spokespersons of a network**. While networks allow for each node to influence other nodes in a variety of ways, and while discourse is an important function of the relationships between nodes, the nature of each network privileges the discourse of some individuals more than others. In some networks, this can lead to the dehumanization and oppression of other individuals in the network (as we see repeatedly in

historical interactions between colonizer and colonized, for example), but there may be other cases as well. Regarding Dukes's January 2019 tweets, I have already noted that Dukes connects more often to other researchers and research organizations. These are the voices he privileged, suggesting that these are the legitimate spokespersons for climate science. He did lend space to other voices, of course—reporters and writers—but even these other voices merely support the research network. Not once over the course of the month did Dukes link to or respond to specific individuals or organizations who doubt climate science, not even to counter their message. They may still be nodes in the network, but they are not directly connected to these tweets, and thus they remain silent, and—within this particular network, at least—their message of doubt is silent.



Figure 3: Tweet by Jeffrey Dukes sharing “good news” about American understanding of climate change (2019c)

Finally, the fifth potential pathway for an ANT study as described by Latour is the examination of **how elements in a network are modified**. Networks are constantly shifting and evolving, sometimes because of human decision, sometimes because of outside forces. Whether human-driven or not, the shifts in a network can reveal trends or insights about the network itself, about the contexts surrounding it, and about the actors within it. An example of such a change in a network can be seen through a tweet that Dukes (2019d) made in late January 2019 (Figure 3). He notes “good news” and links to a recent poll suggesting that more and more Americans believe that climate change is real and that such change may lead to “productive action.” The link to the

poll adds a new actor to the network, but more interesting is Dukes's language. It is a small change, but his positivity here adds a greater sense of optimism into the network. All of the previous reports and research that Dukes connected to throughout the month now have a stronger sense of leading to something positive. Indeed, with the addition of any new actors within a network (such as the poll Dukes links to), a network will change. New actors add new influences, new affects, new discourse, new links to actors within the network and new links to additional actors beyond. These shifts create new traces to be examined, new contexts to be studied. The nature of networks is to change; studying networks is a study of these changes.

This is only a brief analysis of one set of tweets from one researcher, but my hope is that it demonstrates how ANT methodology can be helpful in the analysis of public, scientific discourse through social media. We see how Dukes in these tweets connects to other organizations, websites, and discourse. The messages about climate change that transmit across this network are constantly translated for the needs of each node, to be used in each specific context, while still maintaining connections to other nodes. Thus, these nodes present a unified—if diverse and contextual—front for the publics that may encounter them. That said, ANT methodology is not without its criticisms. In the section that follows, I will discuss some of its drawbacks.

### **2.3.3 ANT Limitations**

Despite its usefulness as a methodology in rhetorical scholarship, ANT is not without its shortcomings. Latour (Latour, 2005b) himself acknowledged that “being connected is not enough”; that more important than the connections are “the work, and the movement, and the flow, and the changes”; and that, while ANT can be useful in discovering and describing these changes, it often also has difficulty in precisely and accurately figuring out “what the link is” (pp. 141–143). Connections between nodes in a network are often difficult to pin down, especially connections between nonhuman participants. Think again of the butterfly's wings and the tornado—while there may be a connection there, pinning down every node between the two is a herculean task. When such traces are difficult to find, how thorough can an ANT study be?

Additionally, Kaptelinin and Nardi (2006) have noted that ANT tends to overemphasize the nonhuman at the cost of the human. As an example, they describe a cell phone, which alerts its user when it is low on batteries, perhaps through a sound or an icon, or simply by turning itself off when the battery level is too low. In ANT methodology, the cell phone is an actor at the same level

as human users in the network. Kaptelinin and Nardi suggest that such a viewpoint does not take into account the fact that the cell phone is a technology with a user interface designed by humans for human usage. They also argue that ANT methodology would pay less attention to the fact that, ultimately, regardless of the cell phone's action, the human is the one who decides to charge the cell phone. The phone itself does not have agency to do so. To better understand the functioning of sociological networks, they argue that researchers should focus on human decisions.

Related to this is the fact that, as previously noted, ANT methodology does not presuppose connections between any potential nodes in a network, nor does it presuppose a structure of the surrounding network (Latour, 2005b). While there is value to letting the network dictate how a researcher follows connections—one of my participants, I discovered after interviewing her, was connected to other participants in ways that I did not anticipate, thus surprising me with an unexpected network structure that I hadn't anticipated—there are drawbacks. In my own research, as my pilot study in Chapter 4 will describe, I found that tracing networks of scientists in the US Midwest can result in leaving out scientists who come from different racial, and ethnic backgrounds. Following networks wherever they lead may limit examination of important, diverse human actors within networks who aren't directly connected to the node where the research begins. Latour would have us follow a network as the network dictates, but sometimes a researcher may benefit from jumping to entirely different nodes or even different networks.

A tendency to smooth out diversity in ANT-inspired network descriptions also arises from the size and complexities of networks themselves. If everything is connected to everything else, then ANT studies could theoretically be as expansive as all of human (and even nonhuman) experience. The need to parse down ANT studies into workable reports, articles, or books can result in descriptions that are often homogenized and simplified, rather than heterogenous and complex (Law, 1999). Knights and Murray (1994; Vidgen & McMaster, 1996) argue that such thin descriptions of networks can fail to adequately acknowledge or examine the workings of power, how it exercises influence and control across such networks. If too much time is spent describing the network itself, and if the section of network chosen for analysis is too large, more time can be spent in description than in analysis itself. Depth can be lost, and true understanding of the workings of the network can be misread or even missed entirely.

I would argue, however, that even though some descriptions emerging out of ANT may be thin, that does not necessarily have to be the case. Latour, acknowledging the expansive nature of

networks, has noted that ANT studies tend to be more useful when they focus on the “very local, very practical, very tiny” cross-sections of networks (1999, p. 17). It does make sense: analysis of smaller portions of networks allows for deeper, more fully explored research of those networks. Limiting themselves to such smaller portions may help researchers from biting off more than they can chew, so to speak. It may also allow for more time to discover different actors within the network, particularly those powerful or influential parts of an infrastructure that often remain hidden. Star and Ruhleder (1996) have noted that one salient feature of infrastructures is that they are often difficult to discern unless they break down; a deeper analysis of a smaller network may allow more opportunity for researchers to discover such hidden infrastructural actors and other influences on the network itself. Latour’s (1987) description of the pathways ANT studies might take allows for the analysis of the workings of power within a network: he notes that ANT studies examine the “size and strength” of links, as well as address the question of a network’s “legitimate spokespersons” (p. 202). When suitably scaled, then, an ANT study *can* be detailed and *can* address questions of power, contrary to what some critics suggest. Indeed, Foltz (2021) recently argued that “expanding the unit of observation from single lines and nodes to clusters of actants and relationships allows for better macrolevel analysis” (p. 14). Looking at networks from this distance can provide valuable insights.

On the other hand, Latour (2005b) has also at times argued against attempting to analyze or explain ANT networks at all, beyond just describing them:

Either the networks that make possible a state of affairs are fully deployed—and then adding an explanation will be superfluous—or we ‘add an explanation’ stating that some other actor or factor should be taken into account, so that it is the description that should be extended one step further. If a description remains in need of an explanation, it means that it is a bad description. (p. 137)

Latour’s discussion here comes from what seems to be a view of pure empiricism, without any attempt by researchers to impose any of their thoughts or opinions on their observations. They observe and they describe in as much detail as they can. As long as those descriptions are thorough, then explanations and analyses become superfluous—the description and the network itself make the findings clear. That said, what defines “as much detail” in Latourian terms? By necessity (article word counts, book page limits, audience attention spans, etc.), something has to be left out, turning what should be a thick description into a thin one.

But thin descriptions of larger networks are not necessarily shortcomings in and of themselves. In his recent book *Network Sense*, Derek Mueller (2018) describes methodologies of

thin description and distant reading to get a “network sense” of an academic discipline, in this case the discipline of rhetoric and composition. With a network like this, which reaches out across university departments across the United States and beyond, with thousands of published pages of scholarship annually, and hundreds of scholars producing it, sometimes thin description is the best method “for grasping patterns latent in the accumulating textual materials usually produced by multiple authors in different times and places. We cannot hold it all in our heads, except distantly, thinly” (p. 164). While Mueller is not writing of ANT or networks in particular here, his argument could be mapped onto larger studies carried out through ANT methodologies. Where Law (1999) acknowledges that such descriptions emerging out of ANT studies may be problematic, there is still value to be found in thin descriptions and distant reading, in seeing overviews of networks so vast that we can only really get a sense of them. There is value even in just perceiving how vast and influential a large network can be. If our methods are sound, we might glean valuable information from that network sense.

ANT offers an adaptable methodology that can be used for detailed, focused examinations of smaller networks, or thinly described, distant readings of broader networks. It can offer both of these because of what Mol (2010) argues is one of its strengths: its adaptability. And ANT is not only adaptable by itself: Law and Mol (1995) note that when dealing with network studies, “the best strategy is usually impure. It’s a *mixture of different strategies*. Not one alone” (p. 285, emphasis in original). Thus, depending on the study, ANT can also be paired with other theories and methodologies to help foment a richer analysis. Past studies have drawn concepts from economic theory (Batova, 2018), network analysis (Read & Swarts, 2015), and activity and genre theory (Spinuzzi, 2008b), among others.

ANT’s versatility, then, makes it a valuable methodology for studying the interconnected nature of agents, both human and nonhuman, within a multiplicity of settings. As I mentioned earlier, networks themselves are rhetorical, emergent, assembled. They arise within specific contexts, specific exigencies, and more, they create their own contexts and exigencies for further development. It is no wonder, then, that scholars of rhetoric have been drawn to ANT as a methodology. While much of Clay Spinuzzi’s work has centered around genre and activity theory, he has also written about the usefulness of ANT for a “political and rhetorical view of networks” that “foregrounds the continual recruiting of new allies—both human and nonhuman—to strengthen the [...] network” (2008b, p. 16). ANT methodology has been used in technical and

professional communication to examine networks in a variety of rhetorical situations: for example, technical communication audience analysis (P. B. Gallagher, 2019), workplaces and professional partnerships (Baddour, 2022; Pang et al., 2018; Shin et al., 2015; Spinuzzi, 2008b), veterinary and medical practice (Kessler & Graham, 2018; Swarts, 2008), disaster response (Potts, 2009), research laboratories (Read & Swarts, 2015), human-technology interaction (Foltz, 2021; Waldherr et al., 2019), and citizen-scientist interactions (Walker, 2016). And it has, of course, been useful in social media studies as well (Cagle & Tillery, 2018).

### 2.3.4 *Assemblage Theory*

Because of ANT's tendency to view networks as existing, static structures, and because ANT sometimes deemphasizes human agency involved in the formation of those networks, for my purposes, I am drawing some concepts from assemblage theory to supplement my ANT standpoint. Connecting ANT with assemblage theory is a natural move: Bruun Jensen (2019) connected the networks described in ANT studies with *rhizomes*, the interconnecting networks of roots that serve as one of the central metaphors of Deleuze and Guattari's *A Thousand Plateaus* (1987). According to Deleuze and Guattari, rhizomes are characterized in the way that they connect to each other, in their heterogeneity, in their multiplicity, in the ways in which connections can rupture and reconnect, and in the ways in which they resist easy tracing while also encouraging mapping connections. A rhizome, then "has no beginning or end; it is always in the middle, between things, interbeing, *intermezzo*. [...] the rhizome is alliance, uniquely alliance" (Deleuze & Guattari, 1987, p. 25).

Assemblages, like actor-networks, are rhizome-like: interweaving and complex. In language that feels very similar to Spinuzzi's (2008b) description of the way that actors in networks *splice* themselves together, Deleuze emphasized assemblages as "alliances" and "alloys" joined together in a "multiplicity" whose "only unity is that of co-functioning" (Deleuze & Parnet, 1987, p. 69). Assemblages are groupings of individuals and things, "living" and "throbbing" and constantly changing, "a web with an uneven topography" (Bennett, 2005, p. 445). Bennett's choice of the term "web" draws a clear parallel between assemblages and networks, but assemblages are more than just the thing itself.

The French word in Deleuze and Guattari from which "assemblage" is translated is *agencement*, which DeLanda (2016) noted, has two connotations: first, the idea of the *action* of

fitting disparate parts together, as well as the *result* of that action. In other words, Deleuze and Guattari's concept of assemblage is both verb and noun, the act of assembling and the assemblage itself. The parts that are brought together do not need to be uniform in any way, and in fact, they rarely are. The different parts come together and create something entirely new out of their union. And from that union emerges new collective ways of expression, a "collective assemblage of enunciation, of acts and statements, of incorporeal transformations attributed to bodies" (Deleuze & Guattari, 1987, p. 88). Assemblages, then, are actions, they are things, and they are by their very nature discursive.

These assemblages of enunciation are particularly useful in rhetorical studies, and especially in technical and professional communication. Assemblage theory has been invoked in describing and theorizing the discipline of technical communication as a whole (Meloncon & Schreiber, 2022) or in the actual technical communication that the discipline studies (Johnson-Eilola & Selber, 2022). Assemblages are key components in scholarship about disaster response (Baniya, 2022), online grant writing (J. R. Gallagher et al., 2021), media studies (Hondros, 2016; A. Reid, 2010), and entrepreneurship (Pellegrini & Johnson-Sheehan, 2021). Assemblages are also invoked when discussing the potential for mapping connections (Angeli, 2018) and gaps (Sánchez, 2020) between people and things.

How can assemblage theory complement what I'm doing with ANT? While ANT can help me see the connections between actors, assemblage theory emphasizes the ways that assemblages grow, shrink, and change. What assemblage theory also offers is the concept of agency. Bennett (2005) describes the potential of assemblages

to become otherwise than they are, to press out of their current configuration and enter into new compositions of self as well as into new alliances and rivalries with others. Within the terms of this imaginary, there are various sources or sites of agency, including the intentionality of a human animal, the temperament of an architectural form, the propensity of a family, the style of a corporation, the drive of a sound-field, and the decisions of molecules at far-from-equilibrium states. (p. 447)

In other words, assemblages—and the assemblages within those assemblages—have the capacity to move and to change, and that capacity affects the rest of the assemblage. Such agency may result in changes that parts of the assemblage may be unaware of, or even disapprove of (Pellegrini & Johnson-Sheehan, 2021), but nevertheless, the agency remains. For my purposes, recognizing the agency of individual actors and smaller assemblages within the larger networks of climate science

communication and researching the choices and changes resulting from that agency may give us insight into how alliances are made in these contexts.

For a researcher, the pairing of ANT and assemblage theory may go something like this: In ANT, actors leave traces of their connections. These traces are often discursive and can be studied. Such discourse should reflect the ways in which actors within the network, or parts within the assemblage, utilize discourse both to express points of view of the general assemblages as well as utilize discourse to *continue the formation and evolution* of the assemblage itself. In other words, the discourse studied by scholars reveals the rhetorical choices that actors make as they form and reform their networks. And through discussions with the human actors in the network, we can get closer to discovering the motivations and choices behind the formations of that assemblage. In this way, pairing ANT with assemblage theory can give us a distant view (thin description) of a network while also providing a deeper examination (thick description) of that network's creation.

In a conversation I had with Jeff Dukes about the tweets I discussed above, he discussed the context of those tweets in more detail. He and his collaborators had been working on the Indiana Climate Change Impacts Assessment (INCCIA) at the time, putting out reports about the different ways that climate change was affecting Indiana communities and industries. Dukes noted that

we'd done a decent chunk of our assessment reports at that point. And I wanted to do something to highlight the overall Indiana Climate Change Impacts Assessment exercise and provide people with an in to [...] access a bunch of reports from one thread. (J. Dukes, personal communication, February 16, 2021)

Dukes here describes how he uses Twitter to grow the assemblage, to make connections between different human and nonhuman links—he purposefully gives people he is connected to a way to connect to other parts of his network. By putting in one thread a link to the different INCCIA reports and articles highlighting the work of the INCCIA and the PCCRC, the assemblage grows and changes. Without his choice of making those connections more apparent on Twitter, such growth and change may not have been possible, at least not in this specific manner. It is Dukes's agency that enables the change. And those choices were elaborated on through our conversation.

For this study, I have engaged in discourse-based interviews (DBIs) as a semi-structured method by which I could have these conversations with participants. In this way, I hope to examine more deeply how they use their agency to build and adapt the networks that they are part of. I will discuss discourse-based interviews in more detail in Chapter 3.

## 2.4 Where to Study Networks: Social Media as a Site of Network Action

Network studies suggest that everything is connected to everything else. Both ANT and assemblage theory posit the importance of both human and nonhuman actors and their connections with each other, which brings us to the question: if ANT and assemblage theory provide potential methodologies that we can use to study social media, the question still remains: where can we study networks? Where are the spaces and sites that lend themselves to network study? For this study, I see social media as an ideal place to conduct this work. Foucault (1998) saw links between individuals and their locations. He described the ways in which humans were classified by systems of power within the spaces they occupied. Such classifications emerged from and resulted in “relations of proximity between points,” these points occurring in the spaces where humans reside:

Real places, actual places, places that are designed into the very institution of society, which are sorts of actually realized utopias in which the real emplacements, all the other real emplacements that can be found within the culture are, at the same time, represented, contested, and reversed, sorts of places that are outside all places, although they are actually localizable. (Foucault, 1998, p. 178)

Foucault’s preoccupation here was with physical spaces and architecture; however, his description of emplacement could just as easily transfer to online, virtual spaces. Networks and communities form as readily online as they do in the physical world, sometimes with even more ease, and there are still power structures and infrastructures that regulate and influence the formation of such spaces.

Not only do physical and virtual spaces facilitate the networking of human and nonhuman actors, but discourse itself also facilitates networked connections. Bakhtin (1981) describes the sociality of language in a way that resonates with the features of networks. For Bakhtin, “the word in language is half someone else’s,” and we appropriate language to make it our own and express ourselves. Before this moment of appropriation, language “exists in other people’s mouths, in other people’s contexts, serving other people’s intentions: it is from there that one must take the word and make it one’s own” (p. 293–294). Language is almost always borrowed; we are able to communicate because we use words and expressions that others have used before us. This is even more true in an online environment, where traces of borrowed language may be easier to follow: we share memes, articles, pictures, copy and paste text, retweet.

Indeed, social media itself is nothing *but* discourse, from the writing that we create and share across it down to the very code that determines what a page looks like, how it runs, how it

interfaces with other machines and people. Gregory Ulmer (1994) has written about hypermedia extensively, noting that from the beginning it was organized in networked, associational ways. Research in these digital spaces requires navigating these associations. For these researchers, which Ulmer calls *chorographers*, their goal is to gather “dispersed information into an unstable set [...] held together by a *pattern* that is the trace of understanding or learning” (p. 213). To Ulmer, electronic rhetoric is interconnective, associative, intuitive, mnemonic. The rhetorical canon of memory is revitalized because digital spaces store indefinitely what we write in them. They are characterized by remix (think again of retweets or creative use of memes). Social media—the contemporary descendent of the hypermedia of the 1990s that Ulmer described—is all of these things as well, and as such, is a perfect site for research into this kind of networked communication. Not all networks are social media, *but all social media are networks*.

And social media is *designed* with this in mind. In discussing networks at large (i.e., not social media networks), Damon Centola (2020) noted that a key to influencing the adoption of more complex behaviors is conscious designing of networks. I would argue that for us to more effectively design social networks (and social media that helps extend those networks into online spaces), it is important to understand how people use online spaces to network.

Technical communicators and professionals are already sharing the work they do via Facebook, Instagram, Twitter, LinkedIn, and other social media sites. This fact has not been lost on scholars of technical communication, who have undertaken detailed studies of these digital spaces. Some of these have approached these spaces from ANT methodological standpoints (Cagle & Tillery, 2018; Pang et al., 2018; Potts & Jones, 2011; Shin et al., 2015). Potts and Jones (2011) even diagram the relationships between human and nonhuman actors via Twitter. At the center of their diagram is the application itself, which branches out and connects to hashtags, the communities built through hashtags, separate networks of participants, replies to other tweets, retweets, direct messages, external links, and the users themselves. I would add that the map could be even more complex: the application itself also connects to FCC regulations, programmers, business executives, advertisers, power grids, informational infrastructures, etc. The complexity and vastness of online networks provides a site for innumerable studies that could each reveal more details about the workings of the networks themselves and the actors within them.

Other studies have shown the viability of approaching the internet and social media as assemblages. Years ago, Benkler (2006) wrote about the relationships he saw developing online.

Through electronic networks, individuals enter and leave different social groups. For example, it is easy for someone to use the hashtag #climatechange without fully engaging with organizations that actually use their resources to combat climate change. The hashtag itself is a loose connection, a weak tie, and those who use it connect with each other fleetingly. In his observations of mid-2000s internet usage, Benkler did not have the data or experiences that we have seen since 2006: online communities *have* developed and deepened. Individuals make lifelong friends; networks of like-minded people who support and validate each other are formed. People even find romantic partners. And these online communities are always in flux, always growing and shrinking. Pellegrini and Johnson-Sheehan (2021) even make a direct analogy between assemblages and the internet, which is constantly adding and subtracting elements, sites, users, while territorializing and deterritorializing spaces: “The internet is an assemblage of assemblages that has both organic elements [...] and mechanistic elements” (p. 194). Assemblage theory is a perfect methodology to use in sites like these, and we have seen scholars of technical communication take up the challenge (Baniya, 2022; Hondros, 2016; A. Reid, 2010).

Thus, while networks are not exclusive to social media, social media cannot exist without them. On public social media feeds, we can see and study the discourse that goes into the making of these networks. Twitter, for example, is a site where a multitude of actors connect and interact. Some of these actors are human (e.g., Twitter programmers, Twitter users) and some are nonhuman (e.g., word count limit, code, infrastructures and technologies that allow access to the platform). The actors in this network constantly connect or disconnect from others by using tags, hashtags, direct messages, links, and other methods. Much of the networking done on Twitter is done with writing, and much of that writing is public and generally searchable. These discursive artifacts can be examined by researchers to see the process of network and assemblage-building happening. From these observations we can draw conclusions about the choices that go into that discourse and the networks that form from them. That said, “social media” itself is a vast landscape. There are numerous platforms, private and public, that come from areas around the globe. For a feasible study, I have chosen to narrow my scope to science communication on social media, and specifically to science communication about climate change.

## 2.5 Climate Science, Social Media, and Network Connections

The literature in technical and professional communication surrounding climate change rhetoric is extensive. Over 10 years ago, Johnson-Sheehan and Morgan (2008) drew attention to conservation writing as a growing arena within TPC. In the years since, such research has only expanded. Nicotra and Parrish (2010) presented a transdisciplinary collaboration between a rhetorician and a paleoclimatologist in which the authors drew on theories of temporal rhetorics to analyze discourses of climate change. In a similar spirit of transdisciplinarity, Cagle and Tillery (2015) put together an interdisciplinary literature review, finding traits in the literature of other disciplines that TPC researchers can use in their own writing about climate change, while also finding holes in that same literature that rhetorical studies might fill. Walker (2016) has examined scientific visualizations of climate change, examining in particular how those visualizations reach and impact a public audience. More than this, however, Walker also discussed how these public audiences create and share counterimages, alternative visualizations of their own experiences with and perceptions of climate change that fill in what they perceive as missing information and knowledge.

A common approach that rhetoricians use when researching climate change discourse is that of *framing*. In brief, framing is the act of selecting and omitting specific details of something being communicated to appeal more closely to an audience. Rademaekers and Johnson-Sheehan (2014) discussed traditional frames that climate communication uses. Such traditional frames often diminish scientific findings and amplify non-scientific or lobbyist voices despite scientific evidence. As an alternative, the authors offered six guidelines by which communicators might change traditional frames surrounding climate change communication, emphasizing “progress, science, ethics, truth, problem-solving, and adaptation” (p. 19). Weathers and Kendall (2016) examined how communicators may benefit from framing climate change as a crisis of public health, noting that audiences tend to accept and act on health threats. Howell, Capstick, and Whitmarsh (2016) wrote about focusing on the frames of adaptation and responsibility and how that focus will eventually help audiences accept arguments about how to mitigate damage caused by the crisis. Weems and Subramaniam (2017) suggested that climate crisis communicators focus their frames on the attitudes and responsibilities of the individual, rather than on attitudes and responsibilities of entire nations. The narrower focus makes real change feel like something that is not only possible, but also closer to home. Stephens and Richards (2020) discussed how they utilized

narrative framing as they built an interactive map of sea levels and coastal flooding. My own previous research (Weech, 2022) has looked at how stasis theory can be used to frame climate change communication.

One other area that I should address here is how researchers in TPC have addressed social media and the climate crisis. There are three studies I want to examine in particular. First, Ashley Rose Mehlenbacher (2019) has written about the ways in which social media genres have raised questions about expertise and how science, including climate science, is communicated online by scientists and nonscientists alike. More recently, Mehlenbacher and Mehlenbacher (2021) published a case study of scientists who created “rogue” Twitter accounts to sidestep a government gag order and publish research on climate change. Both of these studies are genre-focused: through the lens of genre theory, they look at the ways in which the chosen genre both sustains and undercuts their messages. More pertinent to my own study is a study by Cagle and Tillery (2018) which utilized ANT methodology to follow a single hashtag as it was tweeted, retweeted, and shared across various Twitter accounts. They concluded that such sharing of hashtags across networks has potential to inspire activism and change. True to ANT methodology, they view the hyperlinks and hashtags being shared as full actors within the network, and as such, having power and influence of their own on the rest of the network itself.

Cagle and Tillery’s study (2018) is a starting point for my own. Similar to them, I wish to utilize ANT methodology to trace the networks of public climate science communication—what do these networks look like? Who and what are the different actors involved? How do those actors exercise influence on each other? That said, I also want to dig into the specific choices those communicators make as they create their tweets. How do they go about writing these tweets? How do they see themselves connecting with their audiences? How do they work within the restrictions of the tools and institutions that surround them?

Thus, by combining elements from actor-network theory and assemblage theory, I can follow networks of climate science communicators on Twitter and subsequently ask them about the choices they make, thereby uncovering connections that are otherwise not evident and strategies by which other communicators can use to bolster their public messaging. And these strategies are useful beyond just what we see in Twitter. Social media networks can be representative of networks as a whole, and learning to better navigate and effectively persuade connections in our own networks can help us build a more ecologically sound and equitable world.

## CHAPTER 3. SNOWBALLS AND INTERVIEWS: A METHOD FOR STUDYING NETWORKED RHETORICS

### 3.1. Methodizing Networks

In the previous chapter, I suggested that there are six salient features of networks. To begin studying networks, it is important to remember that networks

1. are collections of actors that link to each other and through each other;
2. include human and nonhuman actors;
3. include connections between nodes that are both tangible (like physical, signed contracts) and ephemeral (like verbal agreements);
4. tend to favor nodes with stronger connections; these nodes have more influence than ones with weaker ties;
5. can also spread influence through weak ties, despite the favorable conditions for actors with more connections; this is especially the case when simple information and behaviors are being communicated;
6. are rhetorical. Actors in networks make choices and use language to connect with other actors.

I have already discussed these features in more detail in Chapter 2, and so here I will hone in on two of these features here that both complicate the task of studying networks and make it both possible and worthwhile. The first point, that **networks are collections of actors that link to each other and through each other**, suggests that literally everything in existence is part of one massive network. If everything is one big network, studying that network becomes a Sisyphean task, by its very definition impossible to complete. We must think of networks, then, in terms of smaller networks, grouped because of geography or purpose. In this age of technological networks especially, networks in which individuals are linked because of purpose—say, for example, climate-minded individuals who follow Greta Thunberg on Twitter—defy geography. Thunberg herself is Swedish, but a cursory glance at five of her Twitter followers lists individuals from Switzerland, Utah, Virginia, Michigan, and Pennsylvania. Consider the range here, even with the knowledge that Twitter’s algorithms ranks followers that I don’t know according to people who might already have a closer connection to me. Among Thunberg’s 5 million other followers are individuals from all walks of life. To study networks, to sketch out one approach, one must figure

out what constitutes the smaller network that one wants to study, and then find the nodes within that network to examine how those nodes interact.

For that reason, the fact that **networks are rhetorical** makes the selection of those subsets of actors and links possible. Actors in networks make choices about how to form those networks, and those choices are influenced by a variety of contexts, both human and nonhuman. Locales, technologies, other people, other intersecting networks: all influence the choices that individuals within a network make, which then go on to influence other networks, specific contexts influence the creation and evolution of those networks. Studying those choices and the impacts of those contexts on those choices can help give us insight into how and why those choices were made and thereby help us understand how we might in similar situations make choices to improve the lives and conditions of other people within networks.

In focusing on these two particular features, I am drawing from both actor-network theory and assemblage theory as methodologies. As I discussed in Chapter 2, ANT studies look for the traces between actors in a network and follow those traces to see where they lead. The traces are often discursive, writing-based artifacts that demonstrate how actors connect to each other. Because they are discursive, they can be studied. But sometimes those traces are not discursive, or perhaps those connections were furtive and fleeting, like a handshake at an academic conference. Unless someone took a picture of it, the traces of that handshake may only exist in the memories of those who took part, but even in memory form, those traces do exist. And those traces can be made explicit and examined more carefully by inviting actors in the network to articulate and reflect on them.

Assemblage theory adds the component of agency to the mix, suggesting that an individual's choices can influence the formation of that network. And if that is the case, then discovering how people make those choices—what influences them to make the choices they do—can be valuable. For this reason, it can be useful to have conversations with human actors in a network. These actors can shed light on why networks are made the way they are, how they leverage their networks for persuasion. They can even give insight into previously unseen

connections in a network, those handshakes and conversations that go otherwise unrecorded and leave no trace except in the memories of the participants.<sup>4</sup>

The challenge, then, is creating qualitative methods that do these things: (1) finding, and (2) defining what constitutes the network we are studying; in other words, figuring out the scope and site of the network or network segment we are analyzing. As discussed in Chapter 2, one challenge with network studies is that, if we let them, our scope can be unreasonably extensive when it comes to network studies. Our task also includes (3) identifying the actors within it: which human and nonhuman actors contribute sufficient weight and influence to the network to suggest examination, then (4) discovering, and (5) analyzing the choices that those actors made in the formation of that network. These last two tasks depend on analysis of the traces left by the network connections, whether that be looking at traces like Twitter threads or inviting actors to reflect on those choices. Additionally, (6) looking into the factors that influenced how and why those choices were made can give us additional insight into other actors and contexts that played a part in that network's formation.

In the sections that follow, I describe the mixed methods approach that I used for this study. The two methods in question, snowball sampling and discourse-based interviews, were used in tandem to trace connections in a network of communication about climate change. Snowball sampling, which gathers data by following traces in a network, much as pathologists track the progress of a virus through a community, allowed me, in the spirit of ANT, to trace connections between actors in this social media network, finding publicly visible connections between individuals and organizations as they shared information online. Discourse-based interviews base their questions in the language of the participant, looking specifically at what they wrote or said and asking about the choices they made in creating that language, with the intention of uncovering the tacit knowledge that participants use. Putting these two methods together creates an opportunity to meet the challenge mentioned above: I can better define and trace the network that I am studying, and I can discover and analyze the choices being made within that network.

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<sup>4</sup> The discovery of otherwise unseen links between actors in a network by conversing with people within the network is one of the findings of my pilot study, which I include as Chapter 4 of this dissertation.

### 3.2 A Recipe for Mixing: Add One Part Snow, One Part Discourse, Shake Well

By *mixed methods*, I specifically am using the simple definition of term as discussed by Alexander, Thomas, Cronin, Fielding, and Moran-Ellis (2016): any methods that gather and utilize more than two types of data. Mixed methods approaches can be useful in analyzing larger datasets, offering opportunities to investigate that dataset from multiple angles (Lawrence et al., 2019). Mixed methods studies offer opportunities for broader research projects, testing data in a variety of ways; these studies often create opportunities for researchers to confirm the results of their findings (Lanius et al., 2021). Much like the proverbial story of the blind men describing the elephant<sup>5</sup>, each element of data gathered offers a unique insight into what the data describes. In the case of this study, the data I seek both describes a network of climate science communication and the choices that are made within that network.

#### 3.2.1 Snowball Sampling

Drawing from an actor-network orientation, I use a variation on snowball sampling to find participants. Simply put, snowball sampling (Coleman, 1958; Goodman, 1961) uses participants to find other participants. Following the method strictly, one would ask a participant to name a certain number of other participants based on a specific criterion (for example, “Who are the five people you most frequently associate with?”). The list that is generated becomes the second stage of participants, who then undergo the same study as the first participant and at the end are asked the same question to find the third stage. The participant list and resulting dataset grow from there. Snowball sampling was developed to identify hard-to-reach or hidden populations (Heckathorn, 2011), and as such is often used by epidemiologists and other medical professionals to track the path of a virus in a community. This was notably seen during the HIV epidemic, and more recently during the COVID-19 pandemic.

While finding these hidden populations has been a useful and often-used category for snowball sampling, in a broader sense, this method is a particularly useful tool for analyzing social

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<sup>5</sup> You know the story: several blind men are asked to describe an elephant, so they each examine different parts. The one examining its legs says it’s like a tree, the one looking at its trunk says it’s like a snake. Taken together, the different descriptions offer a full picture of the elephant.

structures and networks in general (Spreen, 1992). Snowball sampling has been used in studies from fields as varied as science education (von der Fehr et al., 2018), statistics (K. Vincent & Thompson, 2022), sociology (Molina et al., 2022), architectural engineering (Posillico et al., 2022), and—of course—technical communication (Campeau, 2022; Gubala et al., 2020; Molloy, 2019). Crouse and Lowe (2018) note several benefits to snowball sampling in qualitative studies: first, the familiarity that snowball sampling requires to find additional participants often results in greater trust with new participants when they are referred. Second, snowball sampling allows for the simultaneous gathering of data about both individuals and groups. On the other hand, they note that one clear limitation to snowball sampling is the lack of randomization. Participants are identifying other participants rather than using clear models to randomize recruitment, and thus data gathered can't usually be generalized to describe the group as a whole. Finally, there is the potential for a lack of confidentiality across participants. If Carlos connects a researcher to Marie, then both Carlos and Marie know that the other is participating in the study, which can be especially tricky in research on sensitive topics (like the HIV studies mentioned above, for one).

For my own purposes, I have chosen to adapt snowball sampling into an online space. Because my research questions focus my study on online spaces, I felt that Twitter would be an ideal place to examine. Twitter interactions are mostly public (excepting direct messages and some users who limit the visibility of their posts to followers), and as such, it is easy to track connections between Twitter users. Individuals use tags, hashtags, followers, and other links to connect with each other with institutions, and with events, and as such, those connections can be traced and a sense of the network can be gleaned. Snowball sampling is also a useful tool for participant recruitment in network studies: I start with one or two individuals and see who they interact with online, who follows them, and who they follow. From there, I find another set of participants and do the same. Because I am also focused on seeing how individuals operate within their given contexts, the size of the account is less important than the work the account is doing. I reached out to Twitter users with hundreds of thousands of followers as well as users whose followers numbered in the dozens—they are all part of the same networks, and as such even individuals with fewer followers have the potential to impact those networks. Indeed, my guess is that most of the people who read this (whether it's in its dissertation format or adapted for a future publication) have a smaller circle of online followers themselves and may (hopefully) find the data from users like them to be useful.

### ***3.2.2 Discourse-based Interviews (DBIs)***

To discuss discourse-based interviews (DBIs), we need to start by discussing tacit knowledge. Generally attributed to Polanyi (1966), tacit knowledge consists of those things that we know that have been so internalized that we do them almost without thinking. Polanyi's go-to example is how humans just naturally know what a face is, but tacit knowledge applies to how we walk, how we see, and how we write. Everyone has different kinds of tacit knowledges that they bring to bear on their tasks and activities. The trick is identifying them because tacit knowledge is generally not easily articulated, at least not at first.

When it comes to discovering the tacit knowledge that is used to create written artifacts, Odell, Goswami, and Herrington (1983) developed a method of interviewing that focuses on already-written documents. Posing questions about those documents, they invite the writer to reflect on how and why they wrote in specific ways: why choose one word over another, why go with specific idioms or figurative language, what constraints or contexts influenced those choices. The way that participants answer the questions in these discourse-based interviews reveals the “kinds of world knowledge and expectations that informants bring to writing tasks and to discover the perceptions informants have about the conceptual demands that functional, interactive writing tasks make on them” (p. 228). In other words, discourse-based interviews can help participants articulate the unarticulated knowledges that they have and provide insight that can be adapted for other writers and instructors of writing. Importantly, the DBI operates under the assumption that the choices these writers are making are valid ones. In an interview with Lee Odell reflecting on DBI methods years later, Baird and Dilger (2022) noted that

Odell was enthusiastic about evolutions of the DBI we described to him, especially those that enabled researchers to more accurately identify and present choices that came from those writers. “Always come from the writers,” he explained. “You have to work very hard to not appear to be the English teacher... to acknowledge that people outside of our profession have powerful insights into ways of doing things.” For Odell, building that trust was the key to encouraging participants to speak at length about their writing choices and thus their tacit writing knowledge.

The evolutions described here include the fact that discourse-based interviews have the potential to invite reflection on more than one mode or genre. Baird and Dilger (2022) note that DBI research has been adapted to contemporary, digital, and multimedia writing technologies and texts. In writing studies, this includes use of the DBI in examining digital texts (Gallagher, 2018; Reid, 2019), multimedia (Swarts, 2010; Vincent, 2022), writing processes (Crozier & Workman, 2022),

tool usage (Reid et al., 2022), and even in reviewing the tacit knowledge at work in collegiate program and curriculum design (Bhushan et al., 2022).

The DBI is not without its drawbacks. Odell, Goswami, and Herrington (1983) note that interviewers might bias a writer's responses by asking certain types of questions or focusing on specific parts of a specific document. These questions can make the resulting data weigh more heavily than it probably should, considering the data around it. They also note that interviewers in these contexts are predisposed to trust their participant, and indeed *should* trust their participant. But memories aren't perfect, and participants may fill in blanks in ways that do not accurately represent their thought process at the time of the original writing. To counteract this, they suggest triangulating research by combining DBI with other methodologies (for example, an analysis of the writing itself).

Because of its potential for articulating the tacit knowledge at work, I chose the discourse-based interview for my second method. I designed the study to pair these methods as follows:

1. Use snowball sampling to identify participants connected to each other.
2. Generate questions for a discourse-based interview based on the content of participant tweets.
3. Interview participants.
4. Analyze both original tweets and interview transcripts and triangulate the data.

In the next section, I will provide a step-by-step walkthrough of the research as it progressed, including recruitment procedures, IRB approval, my pilot study and the revised recruitment procedures it inspired, Twitter analysis protocols (how I selected tweets and what I searched for), DBI preparation and execution, participant protections, and data processing and analysis.

### **3.3 Methods, Step-by-Step**

#### **3.3.1 Recruitment Process**

In my original recruitment plan, I intended to search through Twitter to find communicators who met the following criteria:

1. Research and/or communicating science related to climate change was part of their profession (e.g., Professors of Hydrology, meteorology PhD students, NASA writers, etc.).

2. They regularly posted on Twitter about either their research or other research related to climate change, and there were at least 20 such posts from which I could build a discourse-based interview.
3. The communicators were connected to each other in some way. This usually meant that either the communicators followed each other on Twitter, but it also could mean that they tagged each other, shared work by the other, or even collaborated on research. As long as they could justifiably be connected in the network, they qualified.

My goal was to gather between 15 and 20 participants who consented to an interview. I would not include Twitter data from anyone who did not consent, even though the tweets I found were public.

My intent was to begin with a small pilot study of participants (see section 3.3.3 of this chapter and Chapter 4 for more on the pilot study), and then to expand from there. Usually, snowball sampling asks participants to recruit other participants, and to some degree I intended to do (and did do) this, though I would also follow the connections mentioned in criterium 3 above to identify other participants and reach out to them. My goal was—in ANT fashion—to let the structure of the network itself guide the directions my study went rather than presupposing a structure.

### ***3.3.2 IRB Approval***

I originally submitted this project for approval by Purdue's Institutional Review Board in October 2019. The approval process required some amendments of the original research design, primarily in recruitment. Originally, if individuals were mentioned in interviews that seemed ideal for recruitment, I had planned on reaching out myself; however, the IRB pointed out that such a process might infringe on the privacy of these individuals. I amended the process so that following network connections in this way would happen by asking participants to pass along a one-pager describing the study (included in Appendix A) to other potential participants, who would then reach out to me if they were interested in participating.

After revisions, IRB approval (IRB-2019-158) was granted in January 2020.

### ***3.3.3 Pilot Study and Revised Recruitment Procedures***

In 2021, I ran a small pilot study to test the feasibility of the methods. For this study, I collected tweets from three climate science communicators:

1. Jeffrey Dukes, then-director of Purdue University's Climate Change Research Center (PCCRC)
2. Marissa Tremblay, Assistant Professor in the Department of Earth, Atmospheric, and Planetary Sciences at Purdue University
3. Jessica Evans, science writer for NASA (and Purdue alumnus)

Dukes was a professor at Purdue and acquaintance of my dissertation advisor, so when I first reached out, he was more inclined to accept the invitation because of the connection<sup>6</sup>. I found Tremblay through the Purdue Climate Change Research Center, which Dukes was then director of: the PCCRC tweeted about an honor Tremblay was receiving, drawing my attention. When I saw that Tremblay was a frequent Twitter user, I reached out to her and invited her to participate. Jessica Evans was connected to me through a mutual graduate student acquaintance.

I have included the details of the pilot study and its findings in Chapter 4 of this dissertation, but it is worth mentioning that there were two things specifically that I learned from my pilot study. First, the methods as a whole were feasible. Finding and recruiting participants based on the networks they had on Twitter was doable (Tremblay's participation was evidence of that), and both the tweets and the conversations we had revealed interesting—and even surprising—elements about their writing and their knowledge. Expanding the study would likely uncover additional insights into the tacit knowledge of climate science communicators.

The second lesson I learned from my pilot study is that we must make conscious choices toward diversity. The three participants of my pilot study were something of a convenience sample (especially Dukes and Evans, who were connected to me through my own immediate network as a graduate student at Purdue). Because all of these participants were relatively local, my results may not have been as expansive as I had hoped they would be. I knew that I needed to get further

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<sup>6</sup> Dukes's quick willingness to speak with me is in itself a testament to the power of networking. He didn't know me, but because he knew my advisor, and because my advisor was copied on the email and accompanied me to our first in-person meeting, he was likely much more open to sharing some of his time with me.

away from Purdue if I could. When it comes to climate change, different geographical locations are affected differently, and those differing contexts may bring different tacit knowledges to the forefront. In addition to geographical diversity, my pilot study saw a lack of racial diversity. Because I started my study at Purdue, a Midwestern university situated in a largely (but not entirely) white community, my initial participants were white. Going forward with the study, I needed to find ways to incorporate voices from backgrounds that weren't just white Midwesterners.

To recruit a more diverse set of participants going forward, Jennifer Bay (a member of my dissertation committee) suggested adopting what could be called a “cluster” method. Instead of tracing connections from one climate change communicator to another, I would instead find and analyze three smaller networks of 3 to 5 participants. With my pilot study, I already had one cluster: Purdue professors and alumni. I thought to expand my study out to science communicators in the Southwest and in the Caribbean. In this way, I could not only talk to individuals who faced different geographical challenges—weather concerns for Midwestern crops, severe heat and drought in the Southwest, and extreme weather events like hurricanes in the Caribbean, for example—but I would also actively search for participants who came from underrepresented backgrounds: Native Americans concerned with water rights and Spanish-speaking scientists at Caribbean-based universities. I went so far as to translate all of my recruitment materials into Spanish and began searching Twitter for Spanish-speaking scientists who might be willing to participate.

My plan did not pan out entirely. Throughout 2021 and early 2022, the world was still in the depths of a global pandemic, and making unsolicited contact with individuals was largely unsuccessful. When participants are not self-selecting into data collection (for example, as people do when a large group of people are sent an email asking for participation), then many people will decline; and when the biggest criteria for recruitment is “science communicator who has posted at least 20 times on Twitter related to climate change,” that already limits the number of potential participants. Of the dozen I reached out to at Arizona and New Mexico universities, not a single one accepted my invitations. With the Caribbean, it was more difficult, not only because I could find very few science communicators who used Twitter to share research in Spanish, but also because reaching across borders would turn into exacting IRB requirements each time my research took me to a new country, even virtually.

This story does have a happy ending. I went back to my original plan of tracing networks out from Purdue climate science communicators. My initial participant at NASA, Jessica Evans, forwarded the one-pager about my research to several of her coworkers and colleagues, which led me to further contacts within the NASA social media team. In the end, I was able to interview a total of four science communicators who ran three different NASA Twitter accounts. Going back and tracing connections from my participants, I reached out to Laura Bowling, Professor of Agronomy at Purdue. In our conversation, she identified a former student of hers who was active on Twitter. When I looked into this student, I saw that her account was followed by the Twitter account of Black in Environment (@BlackinEnviron), an organization dedicated to highlighting the work of Black scholars doing work in environmental sciences. While I did not secure an interview with Bowling's former student, I did secure interviews with three other scientists whose work was highlighted by @BlackinEnviron, giving me a cluster of three Black communicators.

The recruiting process began in one of two ways:

1. For participants who I found through Twitter, I would either find their public emails or reach out to them through their personal websites and send them a message that explained how I found them (via Twitter) and what my study was about, and I invited them to have a meeting to discuss the project as a whole without any commitment to participate. Appendix A includes a sample email.
2. For participants recruited by other participants, (such as those I interviewed at NASA), the recruiting participants would pass on a one-pager of my project to potential participants and invite them to reach out to me if they were interested in participating. When these individuals reached out, I would arrange a similar meeting with them to discuss the project and gauge their interest in participating.

If participants agreed to this first initial meeting, we met on Zoom for 15 to 20 minutes to allow for introductions and a brief review of the project before inviting them to participate. If they agreed, we would schedule the discourse-based interview and I would begin a more detailed examination of the participant's Twitter feed in preparation for the interview.

In the end, my variation on snowball sampling (visualized in Figure 4) led to three clusters, for a total of 12 participants (listed in Table 2). The first two clusters are separate geographic areas: One cluster of five Purdue professors hail from the Midwestern origin of my study. A second cluster of four NASA scientists (Jessica Evans, Sofie Bates, Jaime Mendoza, and Katy Mersmann)

are all located in Maryland; however, because they write for NASA, their writing must take national and global contexts into greater account. And a third cluster of three Black in Environment scientists represented a wide geographical area: David Burns, a scientist and recent doctoral graduate from California; Rachel Scarlett, a scientist at Chicago's Field Museum; and Nkosi Muse, a scientist and PhD student in Florida. While these clusters were not necessarily the grouping I had originally planned on, the results here show that even tracing from an initial (mostly white) smaller cluster, we *can* find diversity in our networks if we make that diversity one of our aims. It is cliché to say that we are all connected, but at the same time, recognizing that connection can help us as we research these networks and recognize that our connections to underrepresented populations and other parts of the world means that our decisions impact each other. Conscious effort must be made to ensure that our decisions benefit as many people as possible.

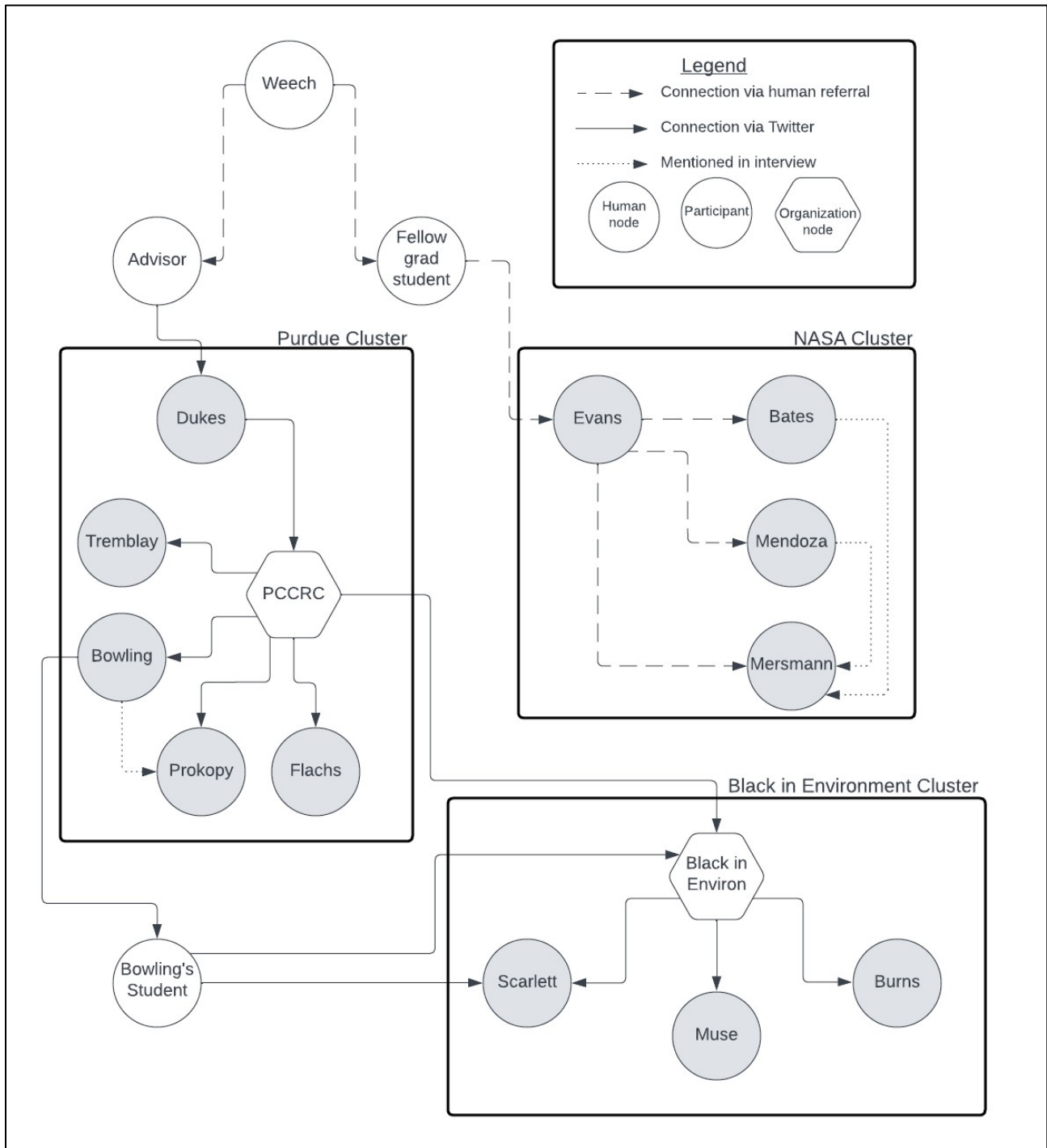


Figure 4: Map of recruitment process using modified snowball sampling. The different types of arrows show different types of connections, including direct references, connections through Twitter, or mentions in an interview.

Table 2: List of Clusters and Participants. Italicized participant names indicate participation in pilot study.

| Cluster:          | Purdue Scientists                                                                                  | NASA Writers                                                          | Black in Environment                         |
|-------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------|
| Name <sup>1</sup> | <i>Jeffrey Dukes</i><br><i>Marissa Tremblay</i><br>Laura Bowling<br>Linda Prokopy<br>Andrew Flachs | <i>Jessica Evans</i><br>Sofie Bates<br>Jaime Mendoza<br>Katy Mersmann | Rachel Scarlett<br>Nkosi Muse<br>David Burns |

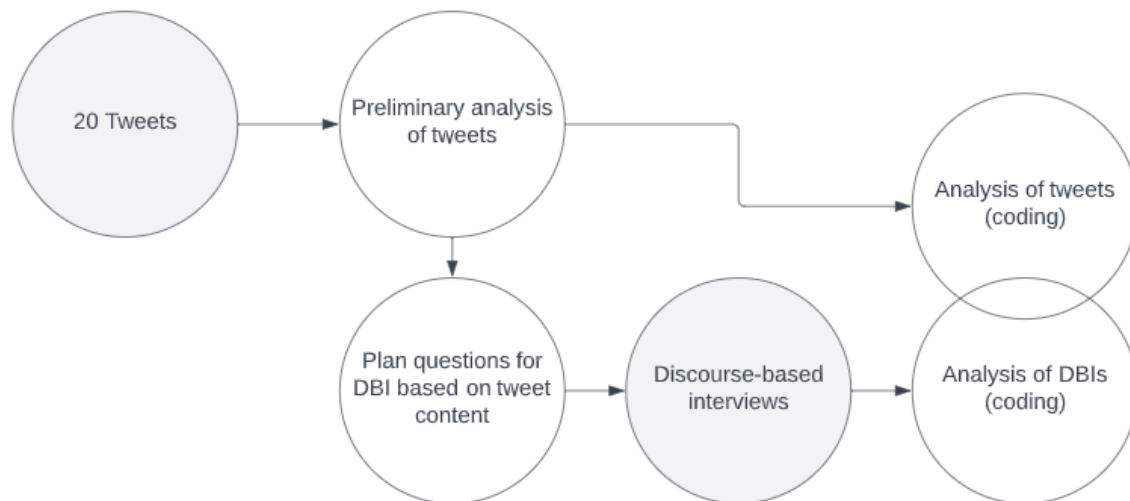


Figure 5: Map of data collection and analysis. Shaded circles show data sources.

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<sup>1</sup> Two participants requested anonymity for this study. To give them that anonymity, I have chosen pseudonyms and have refrained from quoting their tweets directly throughout this dissertation.

### **3.3.4 Twitter Analysis Protocols**

In the sections that follow, I outline the protocols I used for data collection and analysis. Figure 5 maps this process.

With each participant, I collected approximately 20 tweets. This number was sometimes higher if tweets were part of a thread that would drive the total above 20. In addition, with participants who worked for NASA, if they had a personal Twitter account in addition to the NASA account they wrote for, I collected 10 additional tweets to drive conversation about how they wrote for their personal account versus how they wrote as a NASA employee. Starting at the present date, I worked backwards until I had a collection of 20 tweets that met the following criteria:

1. Tweet content was related to climate change
2. Tweet content was related to participant's work or research

I automatically excluded any tweet content that was explicitly personal in nature except where it was related to thoughts about climate change. Exclusions included conversations about films, restaurants, unrelated jokes, and anything else that did not meet the criteria above. To collect a tweet, I created a Word document for each participant with a list of the tweets. On the list, I included a link to the original tweet, the copied text of the tweet (for easier analysis in NVivo, to be discussed below), and a screenshot of the tweet (to see any images that may be present in the tweet; see Figure 6 for a screenshot of one of these documents).

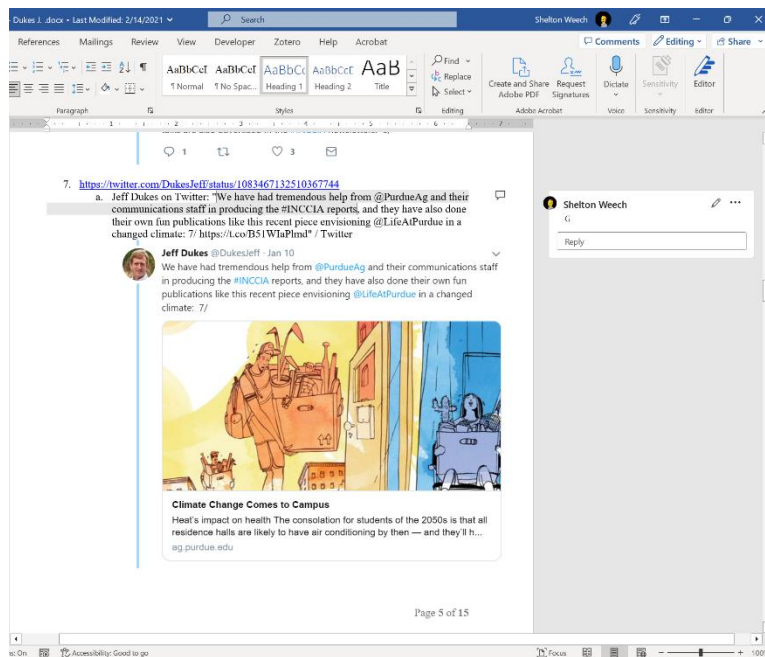


Figure 6: Screenshot of a collected tweet. Note the link to the tweet, the copied text, and the image of the tweet itself. Comments to the side were created to guide discourse-based interview conversation.

At this point, I did an analysis of tweets. First, I did a preliminary analysis in which I identified places where I recognized rhetorical choices being made. Using this preliminary analysis, I began to plan my discourse-based interviews based on those choices. Each choice that related to a question was marked with a comment on the Word document (see Figure 6). This analysis did not involve any serious coding, but instead was a loose analysis that allowed for flexibility in the later conversation. A more detailed analysis followed the interviews. Where I saw definitive rhetorical choices being made, I coded those choices with the rhetorical strategy that I saw being employed. For example, in one tweet, the @NASA\_Ice team described the effect of ice flowing “like syrup on pancakes” (NASA Ice, 2021b, Figure 7). In my first round of coding, I labeled this as “simile.” Other rhetorical strategies were similarly labeled. This coding scheme and its results will be discussed in more detail in Chapter 5.



Figure 7: Screenshot of a tweet from @NASA\_Ice in which ice flow movement is compared to "syrup on pancakes" (NASA Ice, 2021b).

### 3.3.5 Interview Protocols

I designed my discourse-based interviews to be semi-structured because semi-structured interviews are flexible and versatile while still allowing for rigorous research (Kallio et al., 2016). I prepared an interview with a list of questions that was built from the preliminary analysis discussed above (see Appendix B for a Sample Interview Guide). I also sent participants the Word document with the tweets on it so they could know what we would be talking about, and so they could let me know if there were any tweets that they didn't want to discuss. Each interview took place on Zoom, where I could record and export audio for transcription purposes. The interviews lasted about an hour.

Interviews generally ranged between 20 and 30 questions, depending on the participant. I opened each interview by reviewing the study, reminding participants of their protections

(described in the next section), and then asking a series of general questions that I asked every participant. These introductory questions included the following:

- What value do you see, if any, in sharing climate research with a large, public audience?
- Tell me about the planning you do before you write a tweet.
- Who would you say your audience is for your tweets?
- Are there any tweets that you would like to pay particular attention to or discuss?

The goal with these introductory questions was to have participants talk about their broader thoughts about tweeting, identify their audiences, and begin thinking about how they went about writing for Twitter.

At this point, each interview differed, based on the content of the tweets under discussion. The discussion of these tweets was broken into three sections. (1) Audience Questions invited participants to reflect on who their specific audiences were for the tweets in question and how they wrote for those specific audiences. (2) Network Questions invited participants to talk about who they networked with via Twitter and how, as well as what other influences may have impacted the way they wrote on Twitter. (3) Science Communication Questions invited participants to discuss the ways they communicated complex information in a space like Twitter. All three of these categories were, of course, interrelated—an audience is part of a network, and the message in that network was (in the case of these tweets) often scientific. Because each interview lasted about an hour, I followed strict time limits for each section so that I would have time to discuss all three areas with participants. Because I kept the interviews to an hour, I rarely had time to ask all the prepared questions. I asked follow-up questions throughout the interview.

These questions were directly tied to the places in participant tweets where I saw rhetorical and networking moves being made. In the traditional DBI, interview questions about rhetorical choices are often presented in a way that offers participants alternative rhetorical choices and asks them why they went with the choice they did. Odell, Goswami, and Herrington (1983) note that asking writers to consider these alternative choices can “create a cognitive dissonance that would enable a writer to become conscious of the tacit knowledge that justified” their original choice (p. 229). Where possible, I followed this strategy. I found this to be especially possible when discussing rhetorical alternatives—why a participant chose one emoji over another, for example, or why they chose to define a specific scientific term in one instance and not in another. Often

when discussing networking choices, however, alternatives were more difficult to generate. In discussing tagging, for example, participants are connected to many, many more people than I am aware of, and I do not have enough visibility into their various networks to know viable alternative individuals or organizations they might have tagged. In these cases, my questions were more open-ended.

Interviews concluded with another set of broader questions that was (more or less) the same for all participants. These questions invited participants to reflect on the following:

- Other individuals or groups that they turned to for advice when writing for the public
- Limiting factors (including technology, cultural, departmental guidelines, etc.)
- Their “best practices” for sharing information on Twitter

At this point, participants had been reflecting throughout the interview, so my hope was that by concluding with these questions they would be able to draw on specific examples and instances they had been thinking about as we talked.

### ***3.3.6 Participant Protections: Participatory Ethics***

I should pause here to note that throughout the process of recruitment, data collection, data analysis, and general writing of this project, I have taken a strong participatory focus. Powell and Takayoshi (2012) emphasize the importance of *self-reflexivity* in research planning and execution as a way for researchers to recognize their own contexts and positionality as they do research. One way by which Powell and Takayoshi encourage researchers to engage in that kind of flexibility is through collaboration, working more closely with participants, so they are not simply observed, but rather active co-creators of knowledge with researchers.

Throughout this project, I have engaged in a series of member checks. These are moments where I pause to allow participants to offer feedback on the project in multiple stages. When carried out thoughtfully, member checks help minimize miscommunication between participants and researchers (Carlson, 2010) and offer participants space for reflection (Candela, 2019). I worked opportunities for participant collaboration into various points of this project. Before each interview, I sent participants the list of tweets I was planning on discussing with them. Participants were invited to highlight tweets that they wanted to focus on and exclude tweets that they did not want to talk about. During each interview, I began discussing tweets by again asking participants

if they wanted to focus on any tweets beforehand. Participants were under no obligation to share anything they felt was uncomfortable to them. After data collection, I also conducted a series of member checks. I shared interview transcripts with participants so that they could clarify their points or correct anything that either I or the transcription software misheard. I also shared drafts of chapters of the dissertation, including a final draft following my defense.

Participants were also given additional protections upon request. Two participants requested anonymity, and so I have throughout this dissertation used pseudonyms for them while also keeping direct quotes from their public communication to a minimum so reidentification would be more difficult.

By including these member checks and making sure that their personal information was safe, I could ensure that participants felt like they were being represented fairly and that they had a say in feedback about how the project was progressing. This project would not exist without them; the least I could do was make sure that they had a say in how it progressed.<sup>1</sup>

### ***3.3.7 Data Processing and Analysis***

The data in this study came from two sources: tweets and interview transcripts. Tweets—as mentioned above—were transferred to a Word document that could be easily annotated during analysis. Interview audio files were uploaded to Otter.ai, an AI-assisted transcription tool that generates transcripts from audio and video files. I reviewed the transcriptions and corrected errors as well as removing speech artifacts, then exported the file to a Word document. All data was stored on Purdue servers accessible via Box.com.

I should include a brief note about data from my pilot study: because I found the study to be successful, I kept the first-round coding from that study and included it in my first-round coding for the broader project. When I moved on to second round coding for the broader project, I did re-code the pilot study data so the analysis would be more in sync with the rest of the data.

For analysis, I began with NVivo, a software designed to help qualitative researchers code their data. Nvivo allows for various coding styles, including axial, en vivo, and other types of

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<sup>1</sup> An example member check email is included in Appendix C.

coding. What I found particularly helpful about Nvivo was that I was able to create a single “Project” file and upload all my data to it as I analyzed it. Nvivo let me tag each file type (I marked them as “Twitter” and “Interview,” respectively), as well as include information about the participant each file was linked to. I annotated my codes directly onto the documents themselves, and then exported them from NVivo to an Excel spreadsheet for a second coding round and analysis.

I discuss the coding process and its results in more detail in Chapter 5.

### **3.4 Limitations of the Study**

To conclude this chapter, I would like to discuss a few of the study’s limitations. First, the number of participants is limited. Twelve participants may make up a small network, but at the same time, there is much more science communication happening on Twitter than my analysis covers. This is a challenge with focused, qualitative studies like these. One limitation to my methods here requires me to pre-identify potential participants before recruiting, rather than sending out a larger survey and allowing participants to opt into the study. I chose my methods because they more closely follow the structure of the networks I wanted to analyze. I do recognize, however, that there are voices that I might have captured had I chosen other recruitment methods.

In addition, the number of tweets that I gathered from each participant was also limited. I chose to start at the date of access and move backwards until I had collected 20 tweets. This method of data collection always excluded some tweets. In my conversation with Linda Prokopy, this actually came up during our conversation of hashtags, which she said she rarely used except during conferences. I hadn’t collected any tweets from her time at conferences in my data, and so the data made it look like she rarely used hashtags, when in fact she did use them for a very specific purpose that the scope of my data collection simply missed. Likewise, discourse-based interviews—as I discussed above—focus almost exclusively on the discourse at hand. There may be rich examples of other kinds of discourse, other rhetorical techniques, other types of networking that participants are doing online, but by choosing 20 specific tweets, I automatically exclude these other artifacts and the insights they might generate. I attempted to compensate for this to some degree by adding some broader questions at the start and conclusion of each interview that did not focus on the text itself, but the tacit knowledge behind these unseen texts does remain tacit.

Another limitation of the study is time itself—there comes a point when data collection has to stop. My original goal of finding 15 to 20 participants was revised as I began to realize that participants were opting in at a slower rate than I had hoped, and that if I was to proceed with the project, knowing the deadlines ahead, that I would need to move on to data collection and analysis.

This is not to say that the data was less rich. Indeed, the 12 participants I interviewed provided extensive insight into their writing practices and knowledges, so much so that I had to revise another aspect of my original plan. I had originally wanted to map the networks as I found them. These ANT-inspired maps would show human and nonhuman nodes as identified either by participants themselves in interviews or as I saw connections between people on Twitter. I did a smaller-scale version of this in my pilot study (Chapter 4), but the amount of data that I found myself analyzing meant that I needed to revise my research questions and save mapping for a future project (which I discuss more in Chapter 6).

Another limitation that needs mentioning regards my position as a white scholar at a Midwestern university. While Purdue is not without its diversity, and while a number of individuals from more diverse backgrounds did volunteer to participate in this study, my identity itself creates some barriers that limit the study to some degree. Klassen and Fiesler (2022) have noted that Black Twitter users often feel differently about their content contributing to research studies by individuals who aren't members of their community, and while the authors encourage researchers of other races to “cultivate cultural competency” and to “get to know the community before researching it” (p. 1), my own positionality remains: I am an outsider to the community who lacks knowledge of “cultural contexts and references” and linguistic biases that I may have (Lockett, 2021, p. 167). While I have taken care to account for some of these challenges by including several layers of member checks to ensure that participants—especially participants who are Black or are members of other racial communities—have a say in how their information and data are being represented, the possibility, of course, remains that my position as a white academic in Indiana may limit not only how I interpret data, but what kinds of data I have access to. While there are certainly climate scientists from other regions that face vast inequities that need to be confronted (like in the Caribbean), my access to those communities was so limited as to make research into those scientists' communications a nonstarter.

Finally, I want to revisit Odell's caution to “not appear to be the English teacher” (in Baird & Dilger, 2022). We teachers of English are often seen as arbiters of language. One potential

weakness in a study that asks people to reflect on their writing involves how they might feel discussing that writing with an English teacher. This may be a drawback of research of this type. But it also presents us with an opportunity. In several of my preliminary conversations with participants, when scheduling interviews, participants expressed some concern about stylistic elements like grammar and mechanics and whether or not they were “doing them right.” Instead, I have tried to work from a perspective of gathering data as a way by which participants and I were “sharing knowledge” (Selfe & Hawisher, 2012, p. 36). Throughout interviews, I sought to reassure participants that their choices were valid and useful, and that in talking about those choices, they were contributing to ways by which others might adopt similar strategies to strengthen their own networks.

## **CHAPTER 4. ASSEMBLING NETWORKS OF CLIMATE SCIENCE: A PILOT STUDY**

To test the feasibility of this dissertation, I ran a pilot study with a small group of three participants in 2021. My goal at the time was to test if my methodologies and methods would lead to useful data that could be repurposed by other communicators. In this chapter, I include an article I wrote describing this study. The study was designed independently with the purpose of creating this article to submit to technical communication journals. As such, it includes its own introduction, literature review, methods, results, and discussion sections. Because I wrote it intending it to stand on its own, much of the material from the literature review and methods sections are shortened versions of what appear in Chapters 2 and 3 of this dissertation. It is also worth noting that this chapter was written when I was also planning on mapping the networks as I found them, which has now turned into a future project.

The pilot study was useful to me as I moved on to the larger study in four primary ways. First, the study helped give me perspective into participant recruiting, especially in the need to recruit diverse participants. The pilot study resulted in three participants who were all white and of Midwestern origin, which indicated to me that if I was going to include more diverse perspectives, I would need to be more deliberate about it and design the study to incorporate those perspectives. Second, the study gave me an initial coding framework. My coding—especially my first-round coding—in the pilot study emerged more directly from the language of participants themselves and gave me an idea of the kinds of themes, topics, and strategies that might emerge as I looked at data from more participants. I was able to build off of these initial codes—with some minor revision—and work from there. Third, the study gave me a sense of the feasibility of the larger study. The data collected from just three participants resulted in an Excel sheet full of codes that was intimidating to a novice researcher, which helped me adjust my larger aims. Instead of recruiting between 20 and 30 participants, knowing the amount of data that would be involved helped me plan to scale back just a little and aim for between 12 and 15 participants instead. Finally, and perhaps most importantly, the results of the pilot study were interesting and surprising to me, which indicated that as I moved to a larger study, I could expect to find more interesting and surprising insights through a larger participant pool.

I have included the study here as it was written for submission, with only minimal edits.

## 4.1 Introduction

In February 2021, the Heartland Institute published an article touting the vast amounts of money that Indiana residents have saved over the past ten years due to fracking (Benson, 2021). The following day, Jeff Dukes, director of Purdue University's Climate Change Research Center (PCCRC) tweeted a screenshot of the article paired with another screenshot showing how renewable energy costs are, in the long run, lower than gas (Dukes, 2021, Figure 8). In an interview I had with Dukes, he shared some of his reasoning for tweeting so quickly after the original article from the Heartland Institute. He noted that it was "worth pointing out" the ways in which the Heartland Institute deliberately misrepresented scientific facts:

They have shown in the past that they are not a fact-based institution, that they're not, in my view, ethically or morally, a justifiable organization to interact with or to depend on...I think that there are also a lot of benefits to pointing out regularly that renewable energy is cheaper than fossil fuels for electricity generation, because that's something that more and more people know (J. Dukes, personal communication, February 16, 2021).

Dukes's comments are a succinct summary of the need for scientists and other communicators to share factual data surrounding climate change. Earth's climate *is* changing, and there are ways to mitigate that, but there are also forces that are resistant to those messages. Finding more effective ways to effectively share research and data publicly becomes increasingly important, as is reaching a broader audience. Dukes went to Twitter to share his message, for example, a platform that is increasingly common for scientists and other science communicators to share research.

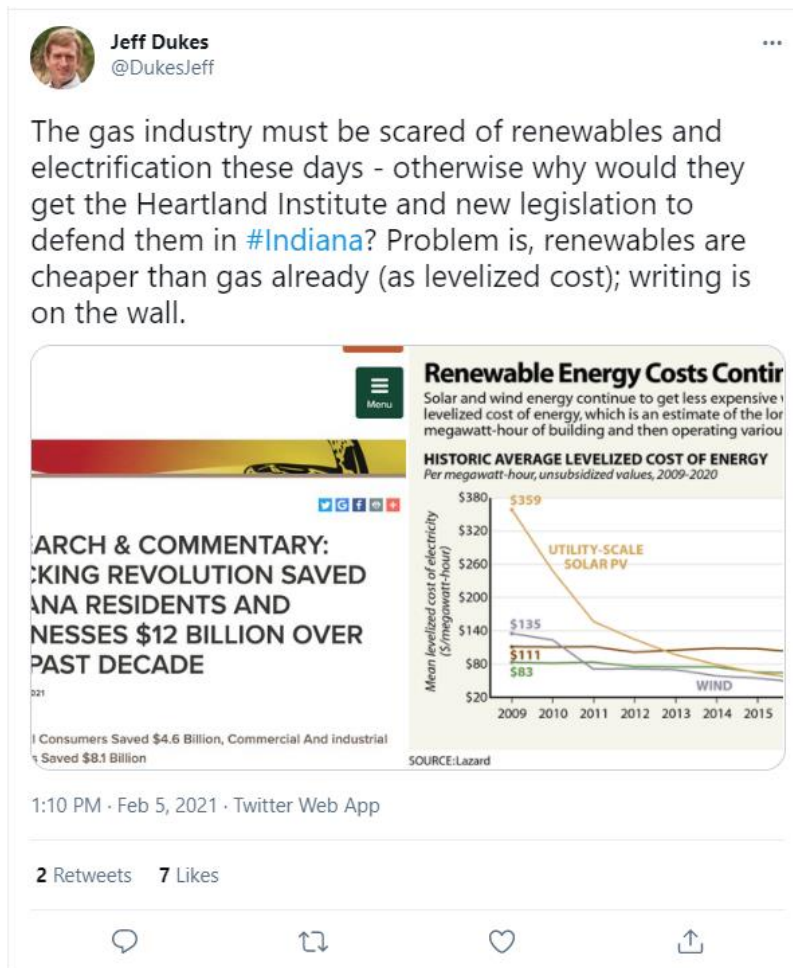


Figure 8: Tweet by Jeff Dukes (2021) using data to address legislation encouraged by the gas industry.

It's interesting to note that in his tweet, the graph that Dukes includes originates from InsideClimateNews ("Chart," 2020). He is not relying on his own research here, but instead appeals to data from the broader body of scientific knowledge surrounding climate change. With one image, he builds another link in a network of climate science that continues to grow daily. This echoes a similar move made by a climatologist as described by Bruno Latour (2013). In Latour's anecdote, a professor of climatology responds to an audience of industrialists when they ask him about whether or not climate change results from human activity, and they pointedly ask him why they should believe him over the many other conflicting voices surrounding the issue. Rather than pointing to his research or to data, the professor instead describes at length the institution of science—the number of researchers, the systems in place for gathering and verifying data, the libraries of articles and reports, the importance of peer review, the infrastructural and

technological web of observation tools and computer systems. In other words, the professor's answer indicates that the most powerful tool communicators have when trying to communicate the strength of their position is the existence of the institution, the network itself. Granted, in a tweet, we are limited to 280 characters, which means we can't lay out this network to quite the same degree, but network-building moves like the ones Dukes makes are crucial, and social media is a prime place to create and share those networks with public audiences. And it is a place where scientists and science communicators are *already engaging in this work*.

But what kind of networking is being done among climate science communicators? In this chapter, I describe the results of a pilot study of the networks surrounding climate science built by scientists and other science communicators. My goal here is to investigate possible answers to four research questions:

1. What rhetorical choices do scientists and professionals (specifically, climatologists) make when they communicate their research and work to a broader, more public audience via social media and other online platforms?
2. How do social media, networking, and other technologies influence those choices?
3. What kinds of networks (with other scientists, professionals, public institutions, corporations, and other entities) do these scientists and professionals create in these online, public discussions?
4. What can be learned by mapping the nodes of the network that I trace?

Through these questions, I hope to not only identify the actors within these networks, but also to speak with individuals whose work expands these networks to get a greater understanding of the choices they make within these networks. The networks of science communication are already expansive—you can use Google Scholar to follow citation trails in endless directions and combinations. With the proliferation of social media, we now have a public view into how such networks operate.

In this study, I used Actor-network theory and assemblage theory as a methodological standpoint and analyzed a selection of posts on Twitter from three science communicators. I then followed up that analysis with discourse-based interviews with these three individuals in which they discussed the choices that they made in these posts. As a result of the analysis and these interviews, I found that participants were not only aware of the power of networking when writing on social media, but that it was one of their principal reasons for writing there in the first place.

Additionally, I found that the building of networks was done for multiple reasons, that participants were aware of context and audience as they wrote, and that when we map these networks, we find interesting, unpredictable connections that are enhanced as we have detailed conversations with people about their networks.

## 4.2 Literature Review and Methodology

### 4.2.1 Networks

In *An Inquiry into Modes of Existence*, Bruno Latour (2013) describes an incident that he witnessed in which a climatologist was faced by a group of industrialists who asked him why they should believe his claims about climate change. We might expect that the climatologist would reply with details from climate science itself: changing temperatures, severe weather events, melting ice caps, mass extinctions, and so forth. Instead, the climatologist described the extensive network of climate science research: the vast number of researchers, technologies, systems, studies, principles of peer review, and data models. Latour's surprise is telling: "It is a little as though, responding to a catechumen who doubts the existence of God, a priest were to sketch out the organizational chart of the Vatican, the bureaucratic history of the Councils, and the countless glosses on treatises of canon law" (p. 4). But—and Latour italicized this for emphasis—the climatologist "*was right*" (p. 4). Relying on the institution of science, the immense network of human and nonhuman agents arrayed to carry out scientific research, rather than the specific results that come out of the research, is what was more likely to sway these doubters. It is the *network* that has the power to convince.

By *network*, I am specifically referring to any immaterial set of links between things—living and unliving. While we may often think of networks in terms of technology, this is not necessarily the way I conceptualize networks here. I see technology as an extension of those networks—actors connect to other actors via the internet, but they also connect in a myriad of diverse methods. For example, De Certeau (1984) wrote about the "networks" of "moving, intersecting writings" that create a "manifold story" of lived experience (p. 93). In another example, Donna Haraway (1988) described an "earthwide network of connections" that enables individuals to "translate knowledges among very different—and power-differentiated—communities" (p. 580). Such networked knowledge does not require technological connection, but it can be

enhanced by it. Elsewhere, Haraway (1998) theorized the connections between the biological and the technological, describing a world that can be “dispersed and interfaced in nearly infinite, polymorphous ways” (p. 163). Technology is an important part of the networks in which we find ourselves, and indeed, we might even utilize technology to study how those networks operate.

In order to study the networks of science communication more closely, I take my methodological positioning from two theories that lend themselves to network studies: Actor-network theory (ANT) and assemblage theory. While similar in some ways, the two theories are different enough in a few key areas that enable a more comprehensive study of networks and the agents that operate within them. In the sections that follow, I will briefly outline the key features of ANT and assemblage theory. I will follow this description with a discussion of how both theories may be useful in my own investigations, and I will conclude with an overview of current scholarship on climate change communication.

#### ***4.2.2 Actor-Network Theory***

Actor-network theory (ANT) is a “family of conceptual and methodological sensibilities” that emerged from science and technology studies in France during the late-20<sup>th</sup> century (Farias et al., 2019, p. xx). ANT is generally associated with the work of Bruno Latour, Michel Callon, John Law, and Annemarie Mol, though it has been picked up by scholars of many other disciplines. In ANT, each node in a network is an individual actor that exercises influence on the nodes to which it connects. These nodes are not necessarily human: ANT does look at human-human connections, but it places equal importance on the influence of nonhuman actors within the network (Callon, 1986; Farias et al., 2019; Law & Mol, 1995; Law & Singleton, 2005).

ANT methodology operates on two main assumptions: first, that a sense of a network can be gleaned by studying the interactions between actors (Latour, 1999, 2002, 2005a); and second, that these interactions can be studied through “traceable associations” that their interactions leave behind (Latour, 2005b). Latour noted that these associations are “unpredictable and heterogenous” (1987, p. 202); in other words, the associations echo the networks themselves—they form around imminent exigencies based on available infrastructures and power structures. Each association has its own context that is worth being analyzed. Analysis of these actors and traces, how and why they associate, and how they affect other actors and associations is the key aim of ANT studies.

How, then, might researchers carry out a study using Actor-Network Theory methodology? Callon (1999) suggested that when investigating complex networks, one task ANT researchers should undertake is to disentangle the actors from each other. In this way, the researcher can better illuminate their actions and connections in the immediate context. Additionally, Latour (1987) offered five potential pathways by which researchers might undertake to utilize ANT methodologies:

- (a) how causes and effects are attributed
- (b) what points are linked to which other
- (c) what size and strength these links have
- (d) who the most legitimate spokespersons are
- (e) and how all these elements are modified (1987, p. 202)

Each of these potential areas of focus could be seen as emphasizing the rhetorical nature of networks and the interaction of the actors that form them. Associations evolve based on situational context: places, power structures, backgrounds of individuals, technologies in use, and so forth. Thus, ANT as a methodology can be utilized within a multiplicity of settings. Within the field of technical and professional communication (TPC), ANT has been used to study workplaces and professional organizations (Pang et al., 2018; Shin et al., 2015; Spinuzzi, 2008b), veterinary practices (Swarts, 2008), disaster response (Potts, 2009), research laboratories (Read & Swarts, 2015), citizen scientist interactions (Walker, 2016), and social media (Cagle & Tillery, 2018).

Despite its usefulness in examining networks, ANT is not without its shortcomings. Latour (2005b) himself acknowledged that “being connected is not enough,” that more important than the connections are “the work, and the movement, and the flow, and the changes,” and he noted that while ANT can be useful in discovering and describing these changes, it often also has difficulty in precisely and accurately figuring out “what the link is” (pp. 141–143). Connections between nodes in a network are often difficult to pin down. Another common criticism of ANT methodology arises from the size and complexity of networks themselves. If everything is connected to everything else, then ANT studies could theoretically be as expansive as all of human experience. The need to parse down ANT studies into workable reports can result in descriptions that are often homogenized and simplified rather than heterogenous and complex (Law, 1999). Knights and Murray (Knights & Murray, 1994; Vidgen & McMaster, 1996) argue that these simplified descriptions of networks can fail to adequately acknowledge or examine the workings

of power, how it exercises influence and control across such networks. If a network is too large, more time is spent in description than in analysis, and true knowledge that might be gleaned from the network may be lost.

Finally, and perhaps most importantly, Kaptelinin and Nardi (2006) have noted that ANT tends to overemphasize the nonhuman at the cost of the human. As an example, they describe a cell phone, which alerts its user when it is low on batteries, perhaps through a sound or an icon, or simply by turning itself off when the battery level is too low. In ANT methodology, the cell phone is an actor in the network at the same level as its human users. Kaptelinin and Nardi suggest, however, that this does not take into account the fact that the cell phone is a technology with a user interface designed by humans for human usage. They also argue that ANT methodology would pay less attention to the fact that, ultimately, regardless of the cell phone's action, the human is the one who decides to charge the cell phone. The phone itself does not have agency to do so (p. 249). In order to better understand the functioning of sociological networks, they argue that researchers should focus on human decisions.

While ANT methodology may have some drawbacks, it is useful to restate the benefit of its adaptability (Mol, 2010). Indeed, ANT as a methodology might especially benefit from being paired with other theories and methodologies. In the case of my research here, I have chosen to pair ANT with assemblage theory.

#### **4.2.3 Assemblage Theory**

The connection between Actor-network theory and assemblage theory is a natural one: In a discussion of ANT, Bruun Jensen (2019) directly connected the networks in ANT studies with *rhizomes*, the interconnecting system of roots that serves as one of the central metaphors of Deleuze and Guattari's *A Thousand Plateaus* (1987). If the networks described in ANT are essentially rhizomatic assemblages of actors, then they could theoretically connect to other facets of assemblages as they are described by Deleuze, Guattari, and other theorists. Deleuze has described assemblages as "alliances" and "alloys" brought together into a "multiplicity" whose "only unity is that of co-functioning" (Deleuze & Parnet, 1987, p. 69). Assemblages are groupings of individuals and things, "living" and "throbbing" and constantly changing, "a web with an uneven topography" (Bennett, 2005, p. 445). Bennett's choice of the term *web* draws a clear line between assemblages and networks. But assemblage theory treats assemblages as more than just

an object. The French word in Deleuze and Guattari from which “assemblage” is translated is *agencement*, which, DeLanda (2016) noted, has two connotations: first, the idea of the *action* of fitting disparate parts together, as well as the *result* of that action. In other words, assemblages are both verb and noun, the act of assembling and the resulting assemblage itself. The parts that are brought together do not need to be uniform in any way, and in fact, they rarely are. The different parts come together and create something entirely new out of their union. From that union also emerges new, collective ways of expression, a “collective assemblage of enunciation, of acts and statements, of incorporeal transformations attributed to bodies” (Deleuze & Guattari, 1987, p. 88). The resulting “collective enunciation” that emerges from assemblages make them ripe for study in the context of TPC (Moore & Richards, 2018), whether that be in medical contexts (Angeli, 2018), business and entrepreneurship (Hoffman & Novak, 2018; Pellegrini & Johnson-Sheehan, 2021), digital scholarship (A. Reid, 2010), or social media studies (Hondros, 2016). Interestingly, assemblage theory has yet to be paired with studies on climate change communication.

It is useful to note two important features of assemblages that make them useful for my own study. First, assemblages are ever growing and evolving. When we look at any assemblage, “we cannot presume that what we see is the final product” (Nail, 2017, p. 24). Assemblages continually evolve and grow, and all elements within the assemblage work to transform all other elements to which they are connected. Thus, like the networks in ANT, assemblages are imminently rhetorical, but assemblage studies are much more focused on the living, evolving movement that results from the contexts and connections of assemblages. Assemblages are always emerging, evolving, changing, or even dying (DeLanda, 2016). Second, assemblages imply agency, but an agency that always emerges from the influences and connections within that assemblage. There are actions being taken, choices being made within an assemblage, but because the parts of the assemblage are so interconnected, individuals are “simply incapable of bearing *full* responsibility for their effects” (Bennett, 2005, p. 457).

Thus, both ANT and assemblage theory can be useful in the study of networks, and they might be used to complement each other. More, they can be useful in studying networks as they are constructed in online contexts. Given that ANT follows the traces that remain from connections between nodes, we might surmise that such traces may be discursive by nature-- whether that is a piece of writing or some other multimodal element, and analyzing these pieces of discourse created by actors within a network can give valuable insight into the network itself. Indeed, if we allow at

even some level that discourse, once uttered or written, is separated from the person who uttered it (Barthes, 1967), we could even consider these discursive traces to be actors themselves, especially in a context such as social media, where posts may take on a life of their own, independent from the original authors. As Cagle and Tillery (2018) have demonstrated, textual artifacts such as hashtags and hyperlinks are crucial actors when it comes to the dissemination of information during scientific events. Indeed, the interactions and the technology that make up social media make possible substantial reconfigurations about what we think of as an actor, and such reconfigurations invite new, adaptive ANT methodologies (Gerlitz & Weltevrede, 2019). Given that ANT places more focus on networks as they stand and less on the constantly evolving, even living nature of such networks, assemblage theory, assemblage theory can serve to complement ANT studies in its acknowledgment of the ways that such networks are constantly evolving. In my own study, this is why I sought to interview participants rather than simply analyze the connections as I saw them. These interviews can provide insight into the ways that the networks are evolving—influences, choices, connections both new and old, forming and reforming. Where ANT finds and examines the connections themselves, assemblage theory can delve further into the *why* of these connections.

#### **4.2.4 Climate Change and TPC**

The literature in technical and professional communication surrounding climate change rhetoric is extensive. Over a decade ago, Johnson-Sheehan and Morgan (2008) identified conservation writing as a growing area within TPC, and in the years since, such research has only expanded. By far, the most frequent approach to climate change rhetoric in TPC is through discussions of *framing*—the ways by which communicators might “package” information to be more palatable or convincing to their audiences (Howell et al., 2016; Rademaekers & Johnson-Sheehan, 2014; Stephens & Richards, 2020; Weathers & Kendall, 2016; Weech, 2022; Weems & Subramaniam, 2017). Another common approach is an interdisciplinary one, pairing rhetorical studies with approaches from other disciplines, and sometimes even co-authoring papers with individuals from other departments (Cagle & Tillery, 2015; Nicotra & Parrish, 2010; Walker, 2016).

One other area that I should address here is how researchers in TPC have researched social media and the climate crisis. There are three studies I want to examine in particular. First, Ashley

Rose Mehlenbacher (2019) has written about the ways in which social media genres have raised questions about expertise and how science, including climate science, is communicated online by scientists and nonscientists alike. More recently, Mehlenbacher and Mehlenbacher (2021) published a case study of scientists who created “rogue” Twitter accounts in order to sidestep a government gag order and publish research on climate change. Both of these studies are genre-focused: through the lens of genre theory, they look at the ways in which the chosen genre both sustains and undercuts their messages. More pertinent to my own work is a study by Cagle and Tillery (2018) which utilized ANT methodology to follow a single hashtag as it was tweeted, retweeted, and shared across various Twitter accounts. They concluded that such sharing of hashtags across networks has potential to inspire activism and change. True to ANT methodology, they view the hyperlinks and hashtags being shared as full actors within the network, and as such, having power and influence of their own on the rest of the network itself.

Cagle and Tillery’s study was a starting point for my own. Similar to them, I will use ANT methodology to follow the traces of networks surrounding climate change communication. I complemented this study by drawing from assemblage theory’s view of living, evolving assemblages that have agency. I chose to study social media as a microcosm of the larger networks that emerge within science communication. Social media is public (or rather, constituted of multiple publics), easily studied, and in many ways creates very visible ways by which network associations can be traced. In the case of Twitter, communicators use a variety of methods to connect to other actors, including (but not limited to) tagging (using the direct Twitter handle, denoted by the “@,” of another person or organization), hashtagging (using a term prefaced by a “#” to link a tweet to other tweets that use that same term), and hyperlinking (directly linking to other webpages). In the section that follows, I outline the methods through which I carried out this study by pairing Twitter analysis with discourse-based interviews.

## **4.3 Methods**

### ***4.3.1 Recruitment and Data Collection***

This study is meant to serve as a pilot for a larger study that will use a mixed methods approach. First, building from an ANT methodological standpoint, I will utilize a variation on snowball sampling (Coleman, 1958) for recruitment. Snowball sampling uses participants to find

other participants and is often used in medical studies to track the path of a virus—notably the HIV virus—through a community. Recently, however, von der Fehr, Sølberg, and Bruun (2018) have discussed how snowball sampling can be used in other arenas, such as mapping the networks of educational actors. Actor-network Theory assumes that traces between such actors can be found, tracked, and mapped, and snowball sampling can give researchers a pathway by which to follow the connections between the actors in a network. As I examine the Twitter activity and speak with these communicators, I look for connections to other communicators that I can follow in order to track the network.

This being a pilot study with only three participants, the snowballing that occurred was minor. Because snowballing has to start somewhere, my first and third participants were connections within my own network. In both cases, they were acquaintances of fellow scholars at my institution who were able to put me in touch with them. If anything, I see this as a validation of the importance of networked connections and my own place within them. At this point, I am an actor in this network of science communication, not only because I had only two degrees of separation from these communicators, but also because I now also follow them on Twitter myself. I might even go as far as suggestion that with any kind of snowball sampling, the snowball starts with the researchers themselves. My second participant was found through snowball sampling as I looked through the Twitter feed of the Purdue Climate Change Research Center (@PCCRC), where she was tagged in a tweet congratulating her on an award for her work.

After recruitment was complete, I collected two types of data from participants: tweets and interview data, from which I developed a coding scheme.

## **Tweets**

I collected a sampling of 20 tweets from each communicator. Usually these tweets were recent; however in the case of Jeff Dukes, I did utilize his featured (or “pinned”) tweets, as well as his newer ones. I only selected tweets that shared information on climate research or made connections to other researchers. No personal tweets were collected. My goal with these tweets was twofold: first, to examine them to get a sense of how these communicators were making connections with other communicators and research using the tweets; and second, to do a rhetorical analysis of the tweets in general to see what other rhetorical choices were being made within them.

## **Discourse-Based Interviews (DBIs)**

The DBI is a method in which participants answer questions regarding previously-created writing in order to help understand the tacit knowledge that was utilized in that writing (Odell et al., 1983). Often, when asking someone about the choices they made when writing, many of those choices have happened without reflection. By giving a participant access to that writing, highlighting certain places where choices are being made, and asking the participant why they made a certain choice over other possible choices, participants put themselves back into a place where they mentally rethink their strategies and are able to articulate them more clearly. Based on an examination of the 20 tweets, I created a series of questions where I saw the participants building networks and making rhetorical choices and conducted a one-hour interview with each participant over Zoom. I then recorded and transcribed the interviews, sharing the transcriptions with participants to make sure they felt that they had a say in how they were being represented, as well as having a stake in the research being done.

## **Coding**

Using grounded theory, I coded the chosen tweets and interview transcripts separately. I first examined the tweets in order to (1) build questions for the DBI, and (2) to get a sense of the networking and other rhetorical strategies at work within the tweets. By coding the interview transcripts afterwards, I could compare the two separate findings to see what additional insight the interviews might add to the data from the tweets.

### ***4.3.2 Data Analysis***

In analyzing the codes as they emerged, I focused on two questions in particular: first, what kinds of networking did I see within the tweets, and how did other rhetorical strategies emerge? Second, how does the data from the DBI validate or complicate these findings, and are there new findings that emerge from the DBI that shed additional light on the tweets? In this way, I hoped to gain insight into the ways that these assemblages were operating—what influences were impacting the ways in which the communicators were writing and how their choices manifested themselves within the writing.

In the spirit of previous ANT studies, I also found it useful to examine the networks that I was tracing. To do so, I also mapped the networks. In the case of this small study, the maps that I created focused on the actors—human and nonhuman—within the network, looking for unexpected connections between them, as well as the influences that affected the writing of the tweets.

### 4.3.3 Participatory Research

Throughout the process of data gathering and analysis, the participants have been included. I have conducted member checks (Koelsch, 2013) in order to make sure that participants not only have a say in how they are represented, but also that they are included as the research progressed. I shared the interview transcript and ongoing findings with them.

Table 3: Pilot study Twitter data results.

| Code                              | Frequency  | Example                                            |
|-----------------------------------|------------|----------------------------------------------------|
| <b>Networking</b>                 | Total: 186 |                                                    |
| tagging                           | 66         | “@PurdueCCRC”                                      |
| hashtagging                       | 43         | #climatechange; #Indiana; #WomeninSTEM             |
| connections without tagging       | 14         | “scientific journal <i>Climatic Change</i> ”       |
| links to publications or websites | 37         |                                                    |
| other                             | 26         |                                                    |
| <b>Audience focus</b>             | Total: 86  |                                                    |
| emphasis on local                 | 18         | “Hoosiers' agriculture, health, forests, tourism”  |
| use of emoji                      | 33         | “🌱🔧🚗”                                              |
| use of emotional language         | 2          | “terrifying number”                                |
| figurative language for shorthand | 12         | “...how the thermochronology sausage is made”      |
| other                             | 21         |                                                    |
| <b>Climate change opposition</b>  | 4          | “The gas industry must be scared of renewables...” |
| <b>Positivity</b>                 | 26         | “May the forest be with you!”                      |

## 4.4 Results

The coding that emerged from both Twitter analysis and the interviews highlighted several trends that are worth examining. I will examine the Twitter results first, and then I will discuss what I found in the interviews. I conclude this section by sharing two maps of the networks involved here.

### 4.4.1 *Twitter*

In analyzing the Twitter data, I coded data related to networking, audience focus, attention to climate change opposition, and positivity. There was, of course, other data, but I focus on these categories because they either directly address my research questions or the code occurred with enough frequency that it was worth drawing out.

The first category of codes was related to networking. In the 60 tweets examined, there were 186 examples of networking. The majority of these were tagging (66) and hashtagging (43). That said, there were still 14 cases of participants connecting with other individuals or institutions by naming them by name, without using tags or hashtags. There were also 37 links to publications or websites; these could be the participant's own publication or the publication of others. Through these instances, I found three cases where the tweet was congratulating someone, eight cases where the tweet was thanking someone for an opportunity, and one request for audience feedback on a scientific paper. Finally, there were two cases where the tweet highlighted the network itself: for example, one used an external application to create an image of the participant's "Twitter Fam," highlighting the connections that participant had made via Twitter.

From the second category of codes, we can see that these tweets clearly work from a perspective of audience consideration. While many of the things that are discussed here are clearly rhetorical strategies, the ways in which participants make rhetorical moves with their audience in mind also makes these rhetorical moves an important part of the networking that they are doing. I pause here to note that a rhetorical move is a "stretch of text with a definable rhetorical function" (Tankó, 2017, p. 43). One common, audience-focused move was an emphasis on the local, something that occurred in 26 tweets. This was more pronounced in tweets by Dukes, whose research and Twitter are aimed at Indiana audiences. All three tweeters used a variety of rhetorical methods to elicit emotion. Among the tweets, emojis were used 31 times to either specifically

represent an emotion (such as laughter) or to represent text in an interesting, engaging way. On 3 other occasions, participants used direct, emotional language. Finally, figurative language was used 12 times for shorthand, conveying more complicated ideas or emotions in a compact way. These techniques all serve to appeal to specific audiences in specific contexts.

The third and fourth categories of codes are, as I see it, interrelated. First, there is surprisingly little attention paid to opponents of climate change. Whether we want to or not, within the context of the networks of climate change discourse, we are connected to those who do not believe in it, or do not believe humans can make a difference to slow or stop it. Since these individuals and organizations are actors within these networks, and they create conditions, policies, technologies, and other elements that are also actors, scientists must continually navigate these various connections as they seek to share their own research. Interestingly, in these case of these tweets, opposition to climate change was often elided completely, allowing the research and messages of the communicators to emerge on its own. In total, opposition to climate change was only mentioned a total of 10 times over 60 tweets. Conversely, there were 26 instances where the participants were explicitly positive in their messaging. Rather than engage with a doom-and-gloom scenario, participants instead used more positive, hopeful language, contradicting the negative view of climate change communicators that deniers often paint.

#### ***4.4.2 Interviews***

From the interview transcripts, a number of different but related codes emerged. First, the purposes for tweeting in general, the reasons for tagging, hashtagging, and the situations under which a researcher will quote tweet (retweet something but add content of their own) rather than retweeting (sharing another tweet without adding any additional context). In this section, I also examine the influences and limitations on tweeting as these participants view them.

Table 4: Pilot study interview results.

| Code                                                     | Frequency | Verbatim from interview                                                                                          |
|----------------------------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------|
| <b>Purposes for tweeting</b>                             |           |                                                                                                                  |
| raising awareness                                        | 15        | "I try to tweet about things that people aren't going to see from 40 people in their feed"                       |
| promote publications                                     | 12        | "I get to share what I'm doing too."                                                                             |
| educate decision makers                                  | 7         | "We can get that into the hands of local decision makers around the world"                                       |
| educate public about action                              | 6         | "...understand the actions that we need to take to slow the rate of climate change"                              |
| connect with fellow researchers                          | 3         | "...the more time I spend here, I draw lines between other people's names and mine..."                           |
| other                                                    | 16        |                                                                                                                  |
| <b>Reasons for tagging</b>                               |           |                                                                                                                  |
| raise awareness of org or individual                     | 7         | "I think about if it's relevant to tag somebody and usually like give them a boost"                              |
| call attention of tagged person                          | 4         | "I typically tag people for the purpose of letting them know that I am mentioning them in a tweet"               |
| link to orgs and people                                  | 4         | "...if people do see it and want to go to their accounts, then again, it is linked right there within the tweet" |
| give credit                                              | 3         | "...if they've contributed to it in some way..."                                                                 |
| possible retweets                                        | 3         | "...if I tag that account that she checks, she will then retweet it"                                             |
| broaden audience                                         | 2         | "...that gets it out to a somewhat larger ag audience"                                                           |
| connect tagged people with other tagged people           | 2         | "I was trying to, very awkwardly through Twitter, make new friends at Purdue by tagging"                         |
| tagged person or org is related to rest of tweet content | 2         | "...if they're somehow related to what you've done..."                                                           |
| <b>Reasons for hashtagging</b>                           |           |                                                                                                                  |
| broaden audience                                         | 4         | "I was hoping to snag some traffic"                                                                              |
| other                                                    | 6         |                                                                                                                  |
| <b>Influences and limitations</b>                        |           |                                                                                                                  |
| tweet length                                             | 3         | "Not that you can bury things too much in 240 characters"                                                        |
| news embargos                                            | 2         | "In that case, there was an embargo on making it public"                                                         |
| social pressure from workplace                           | 2         | "if your boss were to see it..."                                                                                 |

I begin with the reasons that these participants identified for tweeting because the purposes that they have for tweeting also connected to the reasons that they use social media to network. The most common purpose for tweeting identified in the interviews is to raise awareness, mentioned 15 times over the course of the interviews. Other common reasons to tweet are to promote publications (either their own or others', mentioned 12 times), to educate policy makers in order to help them make decisions (7 times), to educate the public on action that they can take to slow or mitigate the effects of climate change (6 times), and to connect with fellow researchers (3 times). Other reasons that participants discussed were to empower the readers and fellow researchers, to promote organizations, to increase the number of their followers, to start a conversation, and to highlight the work of others.

When it comes to networking (specifically tagging, hashtagging, and quote tweeting versus retweeting), participants identified a number of reasons for doing these individual things. In the case of tagging, the most common reasons were to raise awareness of an organization or individual (7 times), to call the attention of the tagged person and make that person part of the tweet's audience (4 times), to create links with organizations and people (4 times), to give credit (3), to increase the possibility of being retweeted (3), to broaden the participant's audience (2), to connect tagged people with other tagged people in the same tweet (2), and otherwise because the tagged person or organization is somehow related to the rest of the content of the tweet (2). In the case of hashtags, the most common reason was to broaden an audience (mentioned 4 times). The act of hashtagging links a tweet to other tweets that use the same hashtag. By using the hashtag, the participants hoped that people who were interested in tweets surrounding that hashtag might end up seeing their tweet as well. Other reasons mentioned for hashtagging were to call the attention of professionals, to catalog tweets, to use the hashtags descriptively, to connect an audience to others who were using the same hashtags, to engage bots for the possibility of being retweeted, and using a hashtag as a substitute for a Twitter handle (each of these last few were only mentioned once apiece).

In the instance of quote tweeting versus retweeting, the participants discussed a few reasons for doing one over the other. Generally, they turned to quote tweeting when they wanted to provide more context for the message being shared. They also felt that quote tweeting created a stronger, more personal connection with what was being shared. Quote tweeting allows for more detail and information to be given about the link. Retweeting, on the other hand, was used to simply and

quickly amplify voices. Retweeting is easier than finding, copying, and sharing a separate link. One participant also noted that she used retweets as a virtual bookmark of sorts, to mark tweets with content that she wanted to come back to later.

Participants identified a number of influences and limitations on their tweeting. Some of these limitations were identified explicitly, and others were mentioned in other contexts. All three, for example, mentioned tweet length over the course of our conversation; that said, it was not mentioned when I specifically asked about limitations on their writing. Other limitations and influences included embargos on when research or news could be released (2 times), social pressure from the workplace (specifically, consideration of what would happen if a supervisor or department head saw their tweets; this was mentioned 2 times). Influences and limitations mentioned only once were copyright law, codes of conduct, and the importance of sticking to factual information.

#### **4.4.3 Maps**

As I mention above, ANT studies can be expansive, and maps of networks must be limited in scope in some way. That said, I have created two maps here, each of which details this study in different ways.

The first map (Figure 9) details the snowball sampling—how I found participants through other individuals or technologies, and how the participants connect to each other. One-sided arrows trace the snowballing effect from me to the participants. Two-sided arrows show how participants connect to each other. So for example, I found Participant 3 (Jessica Evans) through a graduate student peer of mine who had taken a class with Evans while they were both still attending Purdue University. That said, in her interview, Evans mentioned that she had worked as a communicator for Purdue Agriculture, thus connecting her with Participant One (Jeff Dukes), who is situated within the College of Agriculture. I made contact with Participant Two (Marissa Tremblay) because she was retweeted by the Purdue Climate Change Research Center, a research organization of which Dukes is director.

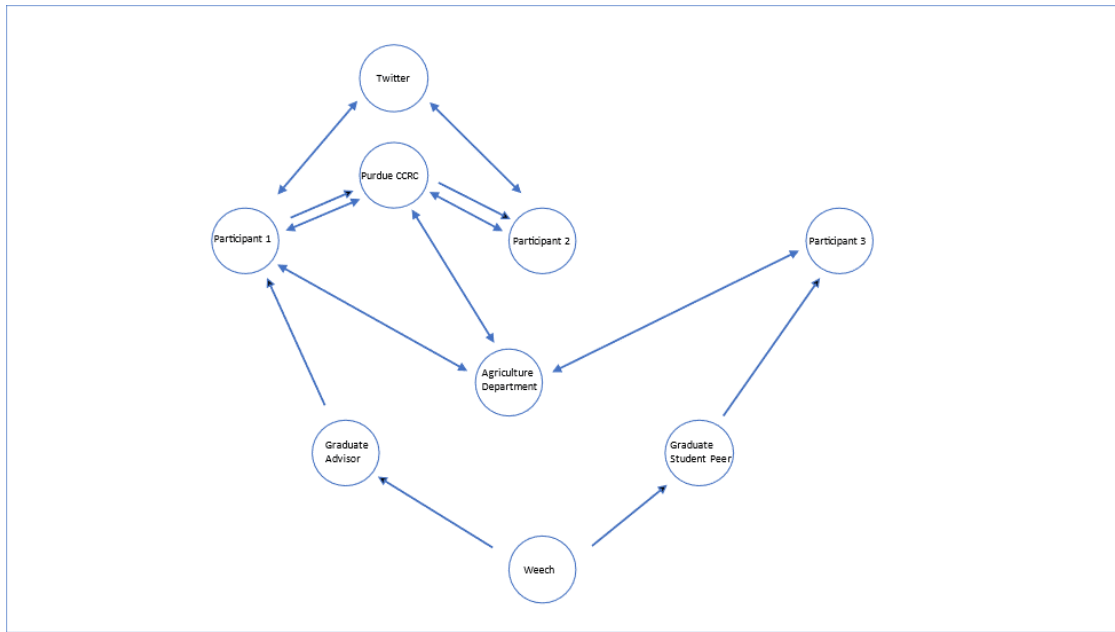


Figure 9: Map of snowball sampling in pilot study

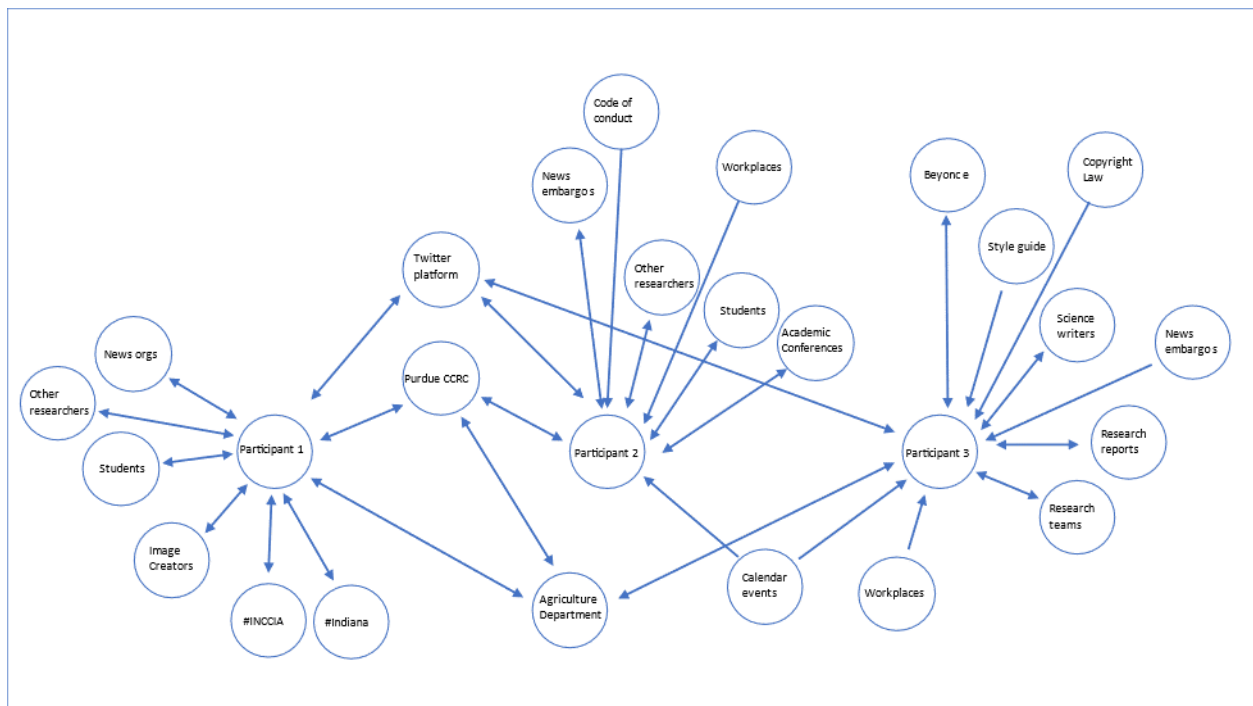


Figure 10: Pilot study participant network map

In the second map (Figure 10), I have created a simplified map of the networks as identified through Twitter and the interviews. This includes a selection of nodes that these participants connected to using tags and hashtags as well as limitations and influences that they identified in their interviews. Due to space constraints here, I did not include every tag or hashtag, but instead categorized them or used examples. This (admittedly incomplete) map illustrates the many connections and actors in this network. Two-sided arrows indicate connections that go both ways; one-sided arrows indicate influences and limitations as identified in interviews.

## **4.5 Discussion**

There are four main takeaways that I would like to offer from the results above: first, when writing on social media, networking is not only a result—it is a purpose. Second, the building of networks happens for a variety of reasons determined by context. Third, science writers are aware of context and audience when they build these networks, and they account for those contexts and audiences as they do so. Fourth, the maps of these networks show connections that aren't otherwise evident, and conversations with individuals in these networks can help us build better maps of the networks.

### ***4.5.1 Networking Is Both a Result and a Purpose***

In her interview, Marissa Tremblay noted that “the more time I spend [on Twitter], I draw lines between other people’s names and mine, because I think it’s really useful to show people how we’re connected and how I’m engaging with them” (M. Tremblay, personal communication, March 29, 2021). Her comment is one of several in which participants acknowledged that one primary reason for interacting on social media was network building. Even the act of sharing research, signal boosting, raising awareness is networking at some level. When engaging in social media to share research, writers are connecting that research with others who may be interested in it. Much like the French word *agencement*, “network” has multiple meanings. It is the thing, the web of connections, but it is also the action of creating that web. And when one engages in the web to help it continue to evolve and grow, the purpose and the result are directly related.

#### ***4.5.2 Networks Are Heterogenous, and the Building of Networks Is As Well***

Latour (1987) has written about the heterogeneity of networks. They are made up of disparate, differing parts. The data examined here suggests that not only are networks heterogenous, but the building of them is as well. On Twitter, for example, participants have identified a large number of potential reasons for tagging. Whether it is to give someone credit for work they've contributed, to give someone a heads-up that you're mentioning them, or even just to "very awkwardly through Twitter, make new friends at Purdue" (M. Tremblay, personal communication, March 29, 2021), the diverse reasons for tagging suggest that networking in general also has more diversity to it, and that recognizing and welcoming that diversity can help us fine-tune strategies that apply in different network contexts.

#### ***4.5.3 Science Writers Are Aware of Context and Audience when They Network***

All three participants noted in their interview that they usually did not put much planning into their tweets, but the discussions we had seemed to indicate otherwise—they are very aware of the people who are reading or may be reading their tweets, and they craft the messages accordingly. For example, there were seven occasions in the interview with Jeff Dukes in which he mentioned local, Indiana audiences for his messages. Jessica Evans discussed the importance of getting accurate information into "the hands of local decision makers" (J. Evans, personal communication, April 1, 2021). With this consideration of audience in mind, these writers craft tweets that are engaging. They include interesting metaphors such as describing "how the thermochronology sausage is made" (Tremblay, 2021a) or allusions to popular culture like Evans (2020b) uses when she asks in one tweet "Why are there so many songs about rainbows?" These techniques show a concern for an audience that these writers are trying to reach, to continue to evolve the network.

Connected to this is the interesting fact that all three participants showed much more interest in being positive in their tweeting than in engaging with climate change opposition. In an earlier discussion, Dukes identified positivity as valuable and important to convince people that there is hope in the face of climate change. Tremblay echoed this sentiment, noting that "I tend to like my feed to be really positive and fun, and that's the type of content that I try to put out too" (M. Tremblay, personal communication, March 29, 2021). This is not to say that there isn't need to occasionally address the negative side of climate change. Evans discussed the importance of

addressing the misinformation that “most nonscientific are going to be interacting with” in newspapers and social media (J. Evans, personal communication, April 1, 2021), and Dukes—as we saw at the beginning of this chapter—spent considerable time in our interview discussing his tweet addressing the actions of the Heartland Institute. But, cliché as it is, there is power in positivity, particularly when positivity can help build stronger networks.

#### ***4.5.4 Maps Show Connections that Aren’t Otherwise Evident, and Conversations with Individuals in the Networks Can Help Build More Detailed Maps***

Finally, I want to say a brief word about mapping the networks. Before my interview with Evans, the only thing I knew about her was that she had attended a class with a former fellow graduate student that I knew, that she worked as a science writer for NASA, and that she frequently tweeted about climate change. I did not know until we had our conversation that she was, in fact, connected to my other participants through her previous employment while attending Purdue. Before our conversation, a map of this network would have been incomplete, and I would not have even known it.

The conversations with participants have enabled more detailed maps of the networks and the actors within them. Participants identified such actors as news embargoes, work environments, and even the limitations of Twitter itself as influences and limitations on their writing. We often don’t think about these limitations until we can articulate them when discussing them with others. As Star and Ruhleder (1996) have pointed out, infrastructure is often not detectable until it’s broken. Sometimes, however, having conversations about that infrastructure can help us see where it stands and how it influences us.

## **4.6 Conclusion**

There are limitations to this study, of course. First, I only surveyed the work of three science communicators, all within a fairly close orbit to me. My first and third participants were only one degree of separation away from myself, and the second participant was only a little further. There are a vast number of other potential participants further removed from me whose work I did not examine, and their work might offer vastly different conclusions. This recruitment system also limits diversity in my participants. Additionally, I only sampled twenty tweets from each participant, going backwards from the present. Depending on how often someone tweets, these

samples might range in date from a few days to over a year, and much can change in the way a person behaves online as time passes.

Further research (which is already underway) may seek to widen the range of diversity of participants both geographically, racially, and culturally. Greater diversity can shed light on more diverse networking strategies, as well as offer opportunities to compare and contrast strategies among those different groups. Commonalities and differences between these groups might offer valuable insight into networked communication in general.

Moving forward from here, however, I suspect that other science writers will be similarly aware of context and audience as they build their networks. These networks, these assemblages are ever growing and shifting, both actions in and of themselves as well as results of those actions. They are diverse, with multiple aims and strategies used to achieve those aims. We as scholars of technical and professional communication can learn much from these communicators who are daily creating stronger alliances, emerging assemblages that are stronger than the sum of their parts, strength to convince others to ally themselves and further the race to save our planet.

## CHAPTER 5. TRIANGULATING TWEETS AND INTERVIEWS: RESULTS FROM TWELVE PARTICIPANTS

### 5.1 Going Beyond the Pilot

My pilot study, shared in its entirety in the previous chapter, gave me three takeaways that I could apply as I expanded my study. First, networking is both a result and a purpose. Calling back to Delanda's (2016) discussion of the French term for assemblages (*agencement*), the action of building networks cannot be divorced from the networks themselves. People network to build networks. Second, even among three participants, I uncovered a wide variety of features within their networks. The large number of codes that emerged from my pilot study indicated that more participants would uncover even more facets of their rhetoric and their network building. Third, science communicators are aware of their audiences and think about them as they write online and in other contexts. These three findings indicated to me that as I expanded the study, I would continue to see broad networks and the use of equally diverse and unique techniques to build them, techniques that might change depending on immediate audiences, contexts, or interlocutors.

My pilot study also gave me a framework for a coding process that I used as I expanded my study. This initial examination gave me literally hundreds of codes that covered networking strategies and rhetorical moves, as well as participants' reasons for making the decisions that they did. I continued to use the first-round coding from the pilot study as a baseline for additional coding, though in expanding the study, I saw an opportunity to reexamine the data and find potential new connections through second round coding and analysis.

In the sections that follow, I will review my coding process and summarize the results that emerged from that coding. As discussed in Chapter 3, here I am examining two datasets: tweets and interview transcripts. I will review each dataset separately as a whole, and then I will also review the data by participant cluster, looking at how participants from each cluster wrote differently. I will discuss these results in more detail in Chapter 6.

### 5.2 Coding Overview

As I have discussed in previous chapters, data from each participant could be divided into two sets: first, the collection of their tweets, around twenty from each participant; and second, the

interview transcript generated from the discourse-based interview in which participants discussed their tweets. I coded each dataset over the course of two rounds of coding. As I coded these documents, I was looking for different things from each dataset. For tweets, I was looking for the rhetorical moves that I saw participants making as they networked. For interview transcripts, I was more interested in participants' discussion of *why* they made the choices I observed in their Twitter data. First-round codes were generated by labelling certain networking techniques, cataloguing rhetorical techniques, and through en vivo coding (drawing directly from participants own words). Codes were then collated and re-coded for analysis.

### ***5.2.1 First Coding Round: Using NVivo to Code Directly on Documents***

The software program NVivo lets users highlight and code words and images directly onto documents and then turn those codes into a spreadsheet. Because of this feature, it was ideal for first-round coding. I used NVivo to code each dataset separately, uploading two documents per participant: one containing their tweets and one containing the interview transcript.

I used first-round coding to generate as thorough a list as possible of language related to my research questions. With tweets, I generated first-round codes in three ways: first, some codes were just to label things I wanted to track, especially in tweets, with little additional wording from me. These included tags, hashtags, and links (for example, the code when I saw a hashtag being used was simply “hashtagging”). Second, I used codes to identify rhetorical techniques participants used in tweets, including codes for similes, metaphors, and (as we will see below with some prominence) hooks. Additional codes were generated more directly from the text of the tweet or transcript itself, what Saldaña (2016) describes as “en vivo” coding (not to be confused with the software tool NVivo). En vivo coding is useful for first-round coding because it draws directly from the words of participants themselves before a researcher begins to narrow categories down.

For interviews, I generated codes in two ways. First, some were tied directly to answers to common questions. For example, when I asked participants about audiences, I wanted to make sure these codes were easily identified in the data, and so each audience identified was labeled “audience – academics” (or “audience – students,” “audience – nonexperts,” etc.). I used a similar first-round coding strategy when participants identified reasons for tagging, hashtagging, identifying best practices, and other such common themes that emerged in interviews that I

believed deserved more attention. Second, as with tweets above, I also coded interview transcripts using en vivo coding.

Figure 11 offers an example of how this worked in NVivo. In this tweet, I coded common networking features of Twitter. Here, the code “Link to livestream” was a way for me to track the use of the link shared in this tweet. Other codes showed purpose (“Event promotion”), rhetorical techniques, (“Conversational Question Hook”), and other communicative moves (“Invitation,” “Science communication – what we can expect”). NVivo uses stripes alongside the codes to see where each code takes place in the tweet, making it simple to find the original text when analyzing the code.

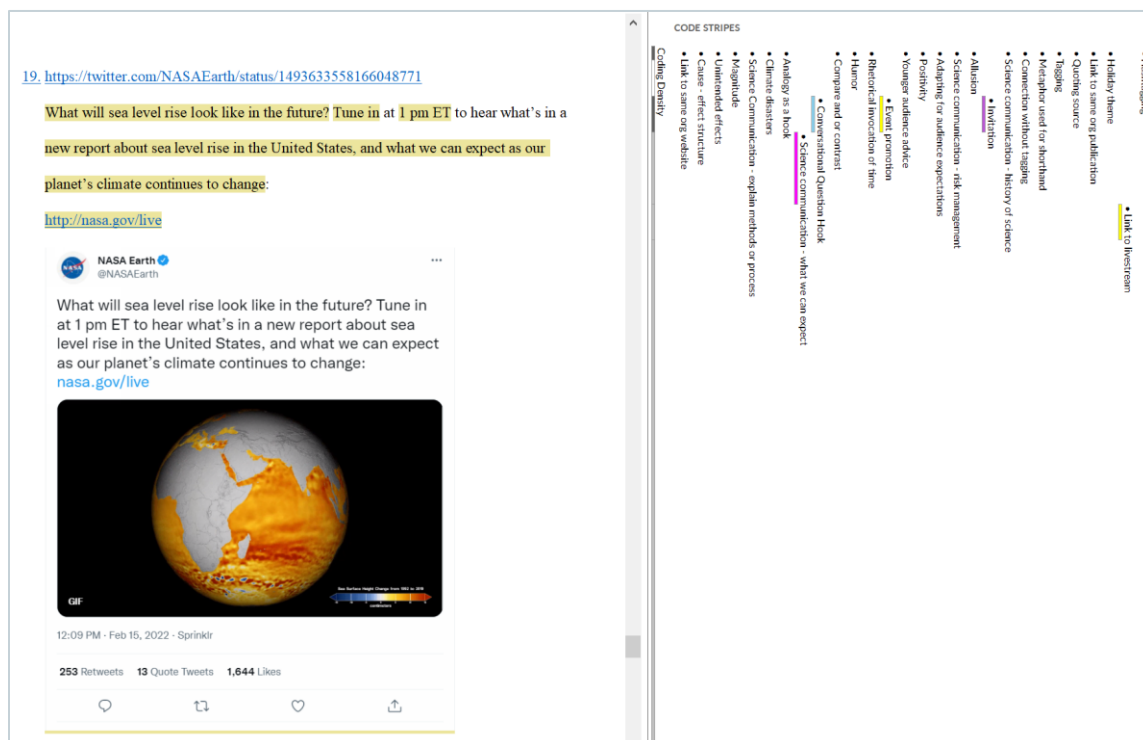


Figure 11: Screenshot of NVivo coding in process. Note the document on the left with coded text highlighted, while stripes on the right indicate specific codes.

## 5.2.2 Second Coding Round: Using Pivot Tables in Excel for Analysis

Once I finished work in NVivo, I exported the codes to Excel for second-round coding. Each code was given its own line, with columns identifying the document it came from (which

participant), what classification of document it was (tweets or interview), and which cluster the code belonged to. One column included the text that I had highlighted in NVivo (see Figure 12). From this point, I added a new column (“Code 2”) for second round coding. For this round of coding, I gathered codes together by themes: for example, simplifying the different rhetorical moves into one code called “Rhetorical techniques.” Excel allowed me to manipulate views of the data for easier analysis. I used pivot tables to quantify the different codes, and through the use of different filters within the pivot tables, I was able to get a sense of which codes emerged most prominently in both the tweets and in the interviews.

| Code Name                                                                 | Code 2                    | Hierarchical Name         | Cluster        | Classification | Coded Text                                                              | J | K | L |
|---------------------------------------------------------------------------|---------------------------|---------------------------|----------------|----------------|-------------------------------------------------------------------------|---|---|---|
| 2023 Codes\\Science communication - climate change #Science Communication | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | Imagine walking on ground that's 140 degrees. You can heat your left    |   |   |   |
| 2024 Codes\\Science communication - climate change #Science Communication | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | preventing the destruction of Atlanta's massive urban forest            |   |   |   |
| 2025 Codes\\Science communication - climate change #Science Communication | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | extreme heat exposure in Atlanta & what's been done to address it.      |   |   |   |
| 2026 Codes\\Science communication - climate change #Science Communication | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | Net zero emissions sound nice & all, but they are not going to get us w |   |   |   |
| 2027 Codes\\Science communication - climate change #Science Communication | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | Natural gas & oil companies can do all they want to offset their emissi |   |   |   |
| 2028 Codes\\Self-promotion                                                | Self-promotion            | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | my master's thesis was cited in a Vice article                          |   |   |   |
| 2029 Codes\\Summarize own research                                        | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | Atlanta has the highest percentage of tree canopy of any urban or me    |   |   |   |
| 2030 Codes\\Summarize own research                                        | Science Communication     | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | Destroying this tree canopy, to increase urban sprawl (& police force c |   |   |   |
| 2031 Codes\\Tagging                                                       | Tagging                   | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | @SustFutures @wyc21& @katharine_mach                                    |   |   |   |
| 2032 Codes\\Tagging                                                       | Tagging                   | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | @smiletrustinc                                                          |   |   |   |
| 2033 Codes\\Tagging                                                       | Tagging                   | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | @aspensideas                                                            |   |   |   |
| 2034 Codes\\Tagging                                                       | Tagging                   | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | @aienvironment @AspenInstitute @MiamiBeachNews                          |   |   |   |
| 2035 Codes\\Urgency                                                       | Urgency                   | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | No time to waste                                                        |   |   |   |
| 2036 Codes\\Younger audience advice                                       | Advice                    | Files\\Tweets - Muse N    | BlackinEnviron | Tweets         | inspire the next generation of leaders, thinkers, entrepreneurs & artis |   |   |   |
| 2037 Codes\\Adapting for audience expectations                            | Rhetoric - audience aware | Files\\Tweets - Prokopy L | Purdue         | Tweets         |                                                                         |   |   |   |
| 2038 Codes\\Adapting for audience expectations                            | Rhetoric - audience aware | Files\\Tweets - Prokopy L | Purdue         | Tweets         | Proliferation of Regenerative Ag certifications                         |   |   |   |
| 2039 Codes\\Allusion                                                      | Rhetorical techniques     | Files\\Tweets - Prokopy L | Purdue         | Tweets         | Kim Stanley Robinson's Ministry for the Future provides a fictional vie |   |   |   |
| 2040 Codes\\Calling attention                                             | Hook - Conversational cal | Files\\Tweets - Prokopy L | Purdue         | Tweets         | Great news!!                                                            |   |   |   |
| 2041 Codes\\Camaraderie                                                   | Identification            | Files\\Tweets - Prokopy L | Purdue         | Tweets         | Great company!!!!                                                       |   |   |   |
| 2042 Codes\\Camaraderie                                                   | Identification            | Files\\Tweets - Prokopy L | Purdue         | Tweets         | What a great meeting and team!!                                         |   |   |   |

Figure 12: Screenshot of Excel file showing second-round coding in process. All columns except “Code 2” were exported directly from NVivo. “Code 2” column was created to facilitate second-round coding based on initial codes in “Code Name” column.

### 5.2.3 Overview of Results

The initial coding pass gave me 2,398 coded data points, with 582 distinct codes across both tweets and interview transcripts. Categorizing and combining codes in the second pass reduced the number of distinct codes to 109. Table 5 lists the 10 codes that emerged most often. Of these codes, three of the top ones were, predictably, the ones I used to catalog things like tags, hashtags, and links. That said, even among these top codes, without delving into the types of documents or clusters, it’s worth noting the extensive amount of networking (233 instances), deliberate thought about science communication (155 instances), awareness and writing for purpose (119 instances), and deliberate appeals to affect or emotion (106 instances). I included examples of each type of code in the table to illustrate.

Looking at the discourse—from either tweets or from interviews—that generated these codes, we can see even more detail. For example, breaking down the 233 instances of Networks shows that communicators networked in a variety of ways, including connecting with others on Twitter without using tags or hashtags, reaching out to coworkers or colleagues, synchronizing different social media platforms like Facebook and Instagram (and even multiple Twitter accounts) with their tweets, navigating news and politics, interacting with different tools and technologies, interacting with online communications campaigns, and even directly soliciting feedback from others as they draft their tweets. And these are just the top ten out of the 233 instances—each of these examples of networking in science communicators’ tweeting suggests different strategies by which they network or different nodes that they connect to as they write online.

Table 5: List of top 10 codes emerging from all data sources.

| Code                  | Count of Code | Example                                                                                                                 |
|-----------------------|---------------|-------------------------------------------------------------------------------------------------------------------------|
| Networks              | 233           | “There were four or five of us who spearheaded that years ago”                                                          |
| Tagging               | 161           | @Beyonce                                                                                                                |
| Science communication | 155           | “obviously, we have to make a nachos joke, but also, I need to explain what this thing does”                            |
| Purpose               | 119           | “my Twitter brand is mostly shameless self promotion”                                                                   |
| Hashtagging           | 109           | #BlackHistoryMonth                                                                                                      |
| Affect and emotion    | 106           | “I like to have that tiny bit of playfulness”                                                                           |
| Link - research       | 96            | "Climate Disruption: Causes and Solutions." It's now available online, here: [LINK]"                                    |
| Reason for tagging    | 92            | “I considered tagging some of the Purdue agriculture accounts specifically because sometimes they will retweet my work” |
| Quote tweet           | 86            | Marked whenever a tweet is quote tweeting another tweet.                                                                |
| Limitations           | 83            | “I was over the word limit.”                                                                                            |

In the sections that follow, I will break down the results further, looking separately at tweets and interview transcripts. I will start with tweets and the emerging patterns there. I will then describe the patterns that emerged from interviews. In each section, I will break down the most common patterns and examine how these patterns played out across the three participant clusters.

## 5.3 Tweets

### 5.3.1 Overview of Tweet Results

Overall, a number of patterns emerged as I examined participants' tweets (Table 6). A tally of the different kinds of networking showed that tagging (using the @ symbol in a tweet to link to another Twitter account) and hashtagging (using the # symbol to turn a word or phrase into a link that Twitter users can follow to other uses of that same word or phrase across the platform) were most common among participants. Counting each tag and hashtag as a separate instance, participants used tags 161 times and hashtags 109 times. I also noted that participants linked to research articles (either theirs or others) 96 times and to other websites 13 times. They also extensively engaged in quote tweeting—sharing another account's tweet while adding one's own commentary or spin—such as in the tweet shown in Figure 13 (Bowling, 2021a). I also noted a number of other methods by which participants networked. Most of these cases consisted of participants making some mention of another individual without tagging them, though in a few cases, participants discussed their networks at large, the interconnectedness of people and planet, and the work of undergraduate collaborators.

Table 6: List of top themes that emerged from participant tweets.

| Second-round code     | Count | Example                                                                                                     |
|-----------------------|-------|-------------------------------------------------------------------------------------------------------------|
| Rhetorical techniques | 163   | "an appetizer for further atmospheric study"                                                                |
| Tagging               | 161   | @insideclimate                                                                                              |
| Hashtagging           | 109   | #climategentrification                                                                                      |
| Science communication | 99    | "the hardest part of my research is actually the matrix manipulation, digestion, and extraction procedures" |
| Link - research       | 96    | "This looks like an AWESOME paper [LINK]"                                                                   |
| Quote tweet           | 86    | [This code is used to tally the number of quote tweets]                                                     |
| Affect and emotion    | 72    | "Just had a VERY deep sigh about climate crisis."                                                           |
| Positivity            | 41    | "Had an amazing and uplifting focus group with farmers..."                                                  |
| Invitation            | 39    | "feel free to join this candid, important conversation"                                                     |
| Conversation          | 38    | "toxins bioaccumulate and harm other life because they are...poisons"                                       |
| Networks              | 29    | "we're all connected by our beautiful home planet"                                                          |



Figure 13: Example of quote tweet by Bowling (2021a), in which she shares a tweet from another participant while adding her own comments and thoughts.

I also noted that participants used a number of different rhetorical techniques (in 163 instances), strategies for scientific communication (in 99 instances), and specific appeals to affect or emotion (72 instances). Each of these areas is worth looking at in more detail.

Throughout their tweets, I saw communicators making a number of identifiable rhetorical moves. This is, understandably, a very broad category, and arguments could be made that some of the other coding I did that wasn't labeled as rhetorical could, in fact, be included here as well. That said, based on what I saw, participants used hooks (specific tricks to draw attention of Twitter users and get them to pause their scrolling for enough time to read the participant's tweet) 63 times. Such hooks could be discursive, such as when NASA Atmosphere opens a tweet with the question "Got your head in the clouds?" (NASA Atmosphere, 2022b). The hooks could also be visual, such as in a NASA Earth tweet that autoplays a video showing the spreading of a volcanic plume (NASA Earth, 2022b). With a video like this, both the image and the movement of it could feasibly convince someone to pause their scrolling. Among other rhetorical techniques I noted, participants

emphasized large numbers 27 times, using the magnitude of these numbers to make an impression. They also used metaphor (18 times), classical Aristotelean topoi (cause/effect, compare/contrast, etc., 14 times). Communicators also used several definitive examples (9) and stories (8) in their tweets, and a number of other rhetorical moves, including appeals to nostalgia, allusions, personification, similes, syllogisms, and analogies.

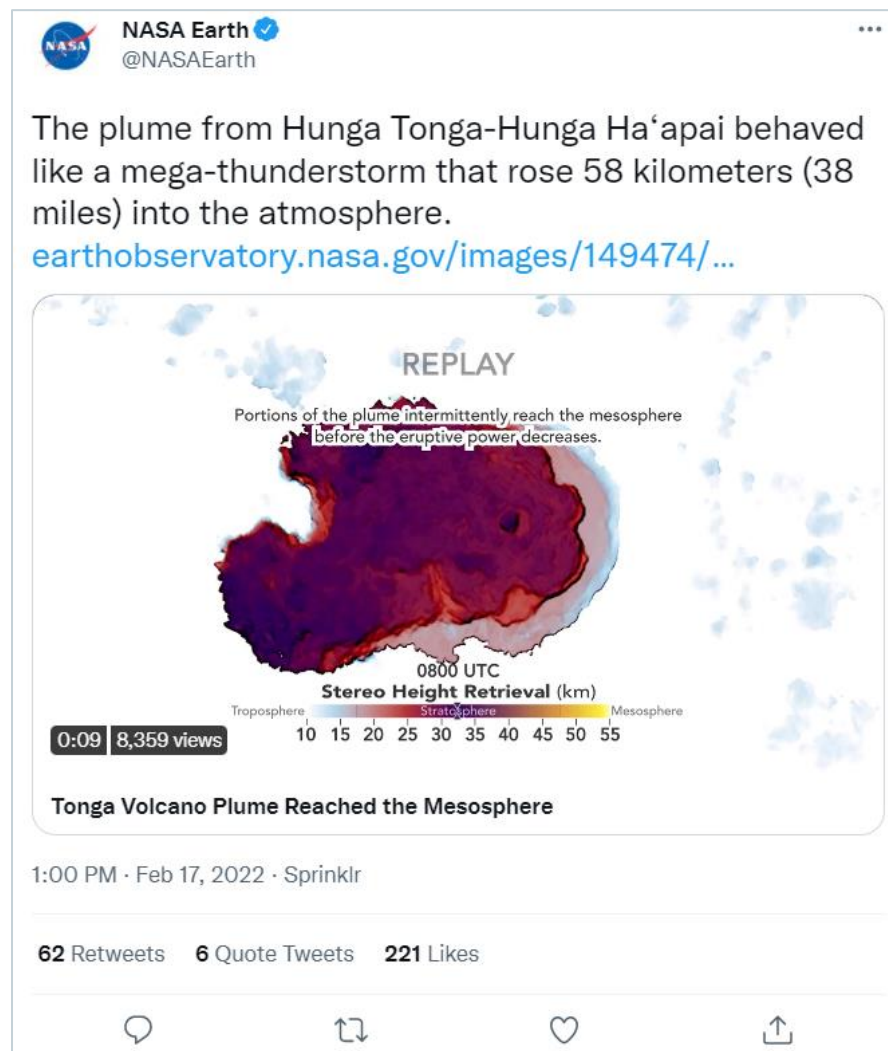


Figure 14: Example of a tweet from NASA Earth (2022b) that uses a visual hook. The video in the image autoplays as Twitter users scroll through their feed, theoretically causing them to stop their scroll.

In the examples above, we can see that these rhetorical tools were used in the service of science communication, but I also saw specific instances where participants were making choices about how to communicate science or research, either their own research or the research of others. Sometimes, participants simply described the science itself (I counted 11 instances of this) or discussed the impacts of climate change (also 11 instances). Interestingly, participants also spent time outlining the methods or procedures of their research (10 instances). This was especially common in NASA tweets, such as when NASA Ice described the ways that two separate satellites “synced their orbits” to gather data together in a way that could not be done on their own (NASA Ice, 2021e). Participants also used Twitter to discuss mitigation of climate change effects (10 instances) and to explain causes of climate change (9 instances).

One interesting point of note: scientific communication often includes language that hedges—that makes certain statements less absolute (Hyland, 1996). At least 8 times over the course of these tweets, I saw participants use language that could have been hedged, but instead of doing so, they used more concrete language. And so we see Dukes, for example, writing about how Indiana’s climate “will change” rather than how it “might” change (Dukes, 2019c), or NASA Atmosphere tweeting about how “climate change has a direct impact on our planet’s atmosphere and weather” rather than “climate change contributes to impacts” or “may have impacts” (NASA Atmosphere, 2022a).

Instances where I saw participants appealing to affect or emotion are, again, heavily related to the above rhetorical techniques and could very easily fall under the blanket rhetorical term *pathos*; however, they occurred enough to deserve special attention. Most of the instances here consisted of participants using emotional language, either positive or negative, to create some kind of emotional reaction in the communicators’ audience. Communicators also used emojis, videos, and humor to elicit an emotional response, for example, Figure 15 shows a tweet from Muse in which he quote tweets a local news station’s video of fish swimming in a flooded parking garage (Muse, 2022d). Muse’s tweet consists of one crying emoji, “😭,” which, paired with the impressive video, indicates Muse’s feelings about the tweet while also inviting readers to feel similarly. In addition, I found at least two cases of communicators engaging with affect, a near-impulsive, embodied response often related to emotion (which I will discuss more in Chapter 6).

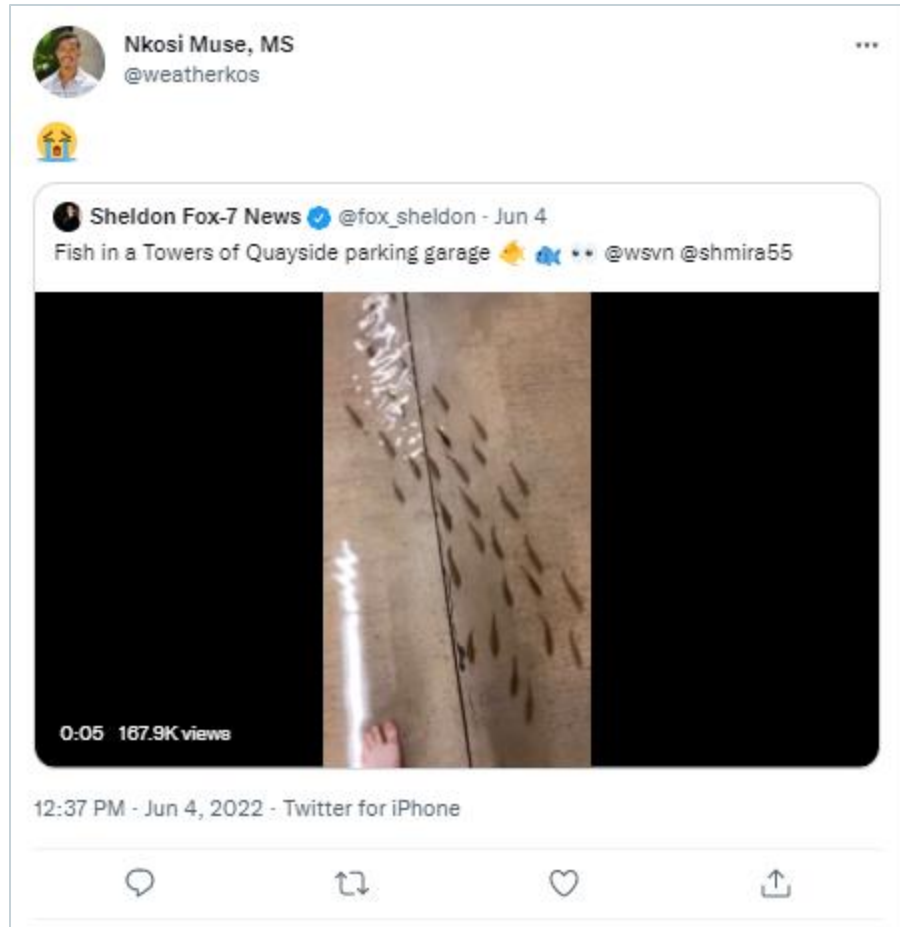


Figure 15: Example of Muse (2022d) tweeting a single emoji, pairing his reaction with the video showing fish swimming in a flooded parking garage.

Related to affect and emotion, I noticed that participants often engaged with emotions that could be considered positive. This happened 41 times, enough that I felt it deserved its own code. These are instances of communicators being explicitly positive about progress made in relation to climate change, whether they are talking about progress in education, progress in mitigation, progress in research, progress in their own work, or just general hopefulness. Such positivity is sometimes expressed in terms of excitement for the work of others, such as Evans’s sharing of a video produced by another NASA team (Evans, 2020d); and at other times expresses general hope about conversations happening with various stakeholders, such as Prokopy’s “uplifting” discussion with farmers about the effects of climate change on their industry (Prokopy, 2022a). Interestingly, there were far more explicitly positive tweets than what I considered “negative” ones:

I only coded three instances of “Negativity,” and in my list of codes, “Negativity” did not even crack the top 30 codes overall.

While it is illuminating to look at the tweets holistically, it is especially interesting to see some of the key differences that play out across the three clusters: Purdue, Black in Environment, and NASA.

### *5.3.2 Comparing Tweets across Clusters*

Before I begin this comparison, I should note that by necessity I will be highlighting only the most common themes that emerged across the different clusters. For a more comprehensive look at the way the data was distributed across the different clusters, see Appendix D, where I include a number of tables summarizing this data. To briefly review, I had three clusters, with a total of 12 participants in total. The Purdue cluster consisted of 5 scientists at Purdue. The Black in Environment cluster consisted of 3 Black scientists. And the NASA cluster included 4 NASA science writers. In this section, I will be looking specifically at how these clusters **(1) addressed questions of diversity and inclusion, (2) networked, (3) shared scientific communication, (4) used specific rhetorical techniques, and (5) appealed to affect and emotion**. I will conclude this section with a brief discussion of **(6) two other notable, cluster-specific themes that emerged from the Twitter data** that I feel are also worth discussing.

#### **1. Questions of Diversity and Inclusion in Tweets**

First, I begin by discussing how the clusters addressed questions of **diversity and inclusion**. While discussions of diversity and inclusion did not emerge as frequently from the data as did some of the other themes I look at below, I do not want to add it to the end of the discussion as if it were an afterthought. I believe the question of diversity deserves a prominent place in these discussions, and I believe my participants would agree with me. To that purpose, I noticed that one of these clusters tweeted specifically about diversity more regularly. In the tweets I examined, participants from the Black in Environment cluster addressed diversity at least six times, specifically noting the need to protect “vulnerable communities” (Muse, 2022g), calling out #climategentrification (Muse, 2022b), or mentioning the difficulties that Black scholars face in

scientific fields (Scarlett, 2021a). Throughout their tweets, they address questions of climate justice and highlight the work of other Black scholars in science.

As individuals from marginalized communities, it makes sense that Black participants would want to call attention to the needs and challenges those communities are facing. In this way, their online writing is in tune with that of “Black Twitter.” According to Brock, Jr. (2020), Black Twitter is an “online gathering (not quite a community) of Twitter users who identify as Black *and* employ Twitter features to perform Black discourses, share Black cultural commonplaces, and build social affinities” (p. 81). Lockett (2021) argues that Black Twitter

Serves as a living archive of collective memories of Blackness. It enacts and represents experiences of misidentification, disinformation, alienation, belonging, forgetting, and remembering. These stories represent various forms of testimony that articulate different accounts of how one experiences being Black (pp. 165–66).

I don’t want to run the risk of making it appear that all Black users of Twitter are part of this group—scholars make it abundantly clear that Black Twitter is by its very nature “amorphous” and “constantly shifting” (Gilyard & Banks, 2018, p. 87)—but it is worth noting that at least in the aspect of wanting to highlight the experiences, needs, and challenges of their community, participants from the Black in Environment cluster are to some degree engaging in similar work as other Black Twitter users, sharing their specific experiences and perspectives with their followers.

This is not to say that the other clusters ignored questions of diversity. Far from it. Among tweets from the NASA cluster, questions of diversity emerged eight times. As with the tweets from the Black in Environment cluster, some of these posts highlight the work of scientists or science communicators that come from marginalized backgrounds (Evans, 2020c; NASA Earth, 2022a), while others discuss issues of climate justice (Bates, 2021b). Among participants from the Purdue cluster, discussion of diversity, equity, and inclusion can be seen in calls for academia to improve (Prokopy, 2022b), in announcements of awards for women scientists (Tremblay, 2021b), and in similar moves across a total of four instances throughout Purdue scientist tweets. I should also note that were my dataset in these two clusters expanded to more tweets, it is very likely that I would find more of these types of tweets—participants from every cluster discussed the importance of diversity, equity, and inclusion to them, as we will see below when we talk about the results of the interviews.

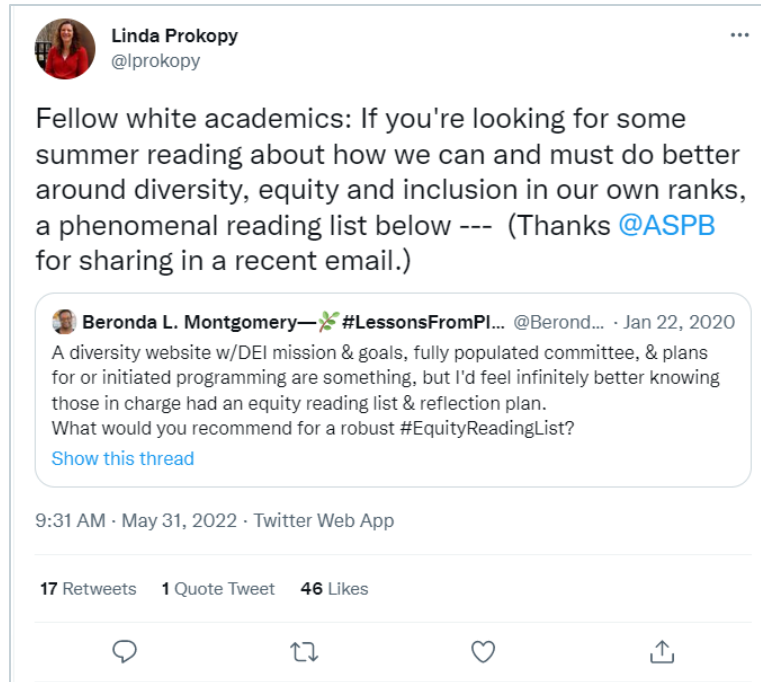


Figure 16: Tweet by Prokopy (2022b) sharing a reading list about how academics can improve diversity, equity, and inclusion.

## 2. Networking across Clusters

Second, participants from different clusters **networked** in different ways. While all participants engaged in significant amounts of tagging, hashtagging, quote tweeting, and linking to research and other websites, participants from the Purdue and NASA clusters more often mentioned the work of individuals who might not be connected to Twitter, such as when Prokopy (2022d) acknowledges the work of an undergraduate in her lab. For Purdue participants, this kind of networking happened 18 times across their 100 (or so) tweets, and for NASA participants, it happened 9 times. While this happened less with the Black in Environment cluster, it did still happen, though the selection of tweets I looked at from them generally connected to specific accounts and links more often than they did not.

## 3. Features of Science Communication

Third, participants from the different clusters **communicated science** in a few notably different ways. Scientists from the Purdue cluster often used Twitter to share details about

scientific processes (6 instances) and summarize the highlights and takeaways of research (5 instances). The scientists who made up the @BlackinEnviron cluster had similar results, especially in terms of discussing the methods and processes behind their science, such as the way Scarlett discusses her “notebook full of untapped ideas” (2021c) or shares a tweet from another scholar discussing the difficulty of writing a dissertation (2021e). Tweets from the NASA cluster saw similar moves in sharing the processes by which NASA labs collected and analyzed data: descriptions of science and its processes appeared a total of 9 times across the NASA tweets). But NASA accounts exist to share scientific information with NASA’s followers, and so it makes sense to see a greater variety of science-related communications being shared by NASA on Twitter, including explanations about the impacts and causes of climate change (appearing in 16 total tweets), the history behind climate science (which 3 tweets were dedicated to), and even time spent defining technical terms (3 tweets).

#### **4. Rhetorical Techniques to Engage with Followers**

Fourth, the different **rhetorical techniques** employed by each cluster speak to how the clusters engage differently with their readers. As discussed above, the most common rhetorical technique that emerged across all tweets was that of the hook, using some kind of language or image to cause a Twitter user to stop scrolling through their feed and pay attention to a specific tweet. Most of the hooks that I noticed came from the Black in Environment and NASA clusters. With the Black in Environment participants, the hooks ranged from the simple emoji discussed above (Muse, 2022d) to commentary on current events to standard question hooks often seen in articles and online posts. Participants from NASA cluster also made significant use of hooks throughout their tweets, whether through a question such as the previously discussed “Got your head in the clouds?” (NASA Atmosphere, 2022b) or through an interesting analogy such as the one used by NASA Earth when comparing the plume of the Hung Tonga-Hunga Ha’apai volcano to a mega thunderstorm (NASA Earth, 2022b).

Another technique that frequently emerged in these tweets was that of magnitude. Rhetorical magnitude is the use of large numbers to create a sense of emphasis or weight (Rice, 2017). Participants from Purdue and NASA clusters tended to use magnitude more. Purdue participants used magnitude in their tweets 11 times, including the use of large numbers like “QUADRILLION” (Prokopy, 2022e), as well as other invocations of something large, such as

links to archives of hundreds of news stories describing the research and work of the Purdue Climate Change Research Center (Dukes, 2019a), among other instances. NASA participants used magnitude 16 times over the course of these tweets, giving a sense of largeness such as in NASA Ice’s description of the 300 trillion photons fired with each laser pulse of a satellite (NASA Ice, 2021d).

I identified a greater range of rhetorical techniques from NASA tweets than from the other clusters, including tweets structured around simplified versions of Aristotelean topoi such as cause/effect (“some clouds look ‘hole punched’ because...”, Bates, 2021a), the use of metaphor, awareness of how time works in a rhetorical sense (which, I would argue, is similar to the classical sense of *kairos*, though this term is perhaps narrower than the 4 instances of “rhetorical time” that I identified), and the use of stories, concrete examples, allusion, sound, personification, capitalization for emphasis, similes, allusions, rhetorical questions, and sports analogies. The variety here speaks to the NASA writers needing to engage with a much wider audience than participants from other clusters, whose focus is often limited to hundreds or (for a few) thousands of followers. NASA Earth, on the other hand, has 3.6 million followers as of April 2023. To engage with such a vast variety of readers, it would be essential to use a similar variety of rhetorical techniques.

## 5. Appeals to Affect and Emotion

Fifth, all three clusters made use of appeals to **affect and emotion**. Participants from Purdue and the Black in Environment clusters in particular made extensive use of emotional language across their tweets (17 instances for Purdue, 14 for Black in Environment). It’s interesting to note that both of these clusters also wrote to represent bodily actions, such as a “sigh” (Prokopy, 2022a; Scarlett, 2021b) or the seeming emotional weight of the events of a “heavy day” on a body (Muse, 2022e). This affective move is more than just emotion—it connects their writing to their bodies’ actions and reactions. This speaks to the more personal nature of the tweeting that participants in these two clusters did: writers for NASA wrote for larger audiences, with more limitations on how they wrote because they were representing a government agency (which we will see discussed in more detail when we discuss Interviews, below). While these writers still used emotional language, they were—by their very position—constrained from doing so to the same extent that other participants did. All that said, I should note that NASA writers *did* engage

with emotion, often in the form of humor. Examples include Jessica Evans's (2020a) play on a Star Wars reference ("May the forest be with you") or NASA Earth's (2022c) play on the shared name ("NACHOS") between a satellite and the Super Bowl Party delicacy.

Another notable difference between clusters in terms of how they engaged with emotional writing was in their use of emojis. While participants from the Black in Environment and NASA clusters frequently used emojis in a variety of ways to represent and engage with emotion (11 times for the Black in Environment cluster, and 8 times for NASA), such emoji use was much less with Purdue participants (only 5 tweets that used emojis). This may have had to do with the nature of tweets examined: I was looking specifically at climate-related tweets, and that often precluded some more personal messages that might have been more likely to call for a user to include an emoji in the message—but it also may have to do with the specific participants. Participants from the Black in Environment cluster were, overall, more familiar with social media and its conventions, and therefore more likely to use those conventions (like emojis). Similarly, NASA writers were—as part of their job—familiar with those same conventions.

One last difference of note is that of how the different clusters used positivity in their tweets. Both Purdue and NASA used positivity extensively (18 and 14 instances of positivity throughout their tweets, respectively), expressing hope and sharing beautiful ideas and images, as we see in NASA Ice's (2021a) discussion of "how beautiful polar ice can be." While these tweets often include news that could come across as doom-and-gloom (several tweets from multiple NASA accounts are dedicated to sharing how 2021 was the hottest year on record), they rarely go in that direction, even when sharing potentially dire news.

On the other hand, participants from Black in Environment used positivity only 9 times. While this may have been a result of there being fewer participants in this specific cluster, it is important to note that from the Black in Environment cluster I noted more instances overall of appeals to affect and emotion. While positivity was not lacking in these tweets, its lesser presence here may connect to our earlier discussion of diversity and the ways in which participants from this cluster highlighted the challenges and needs that marginalized communities were facing because of climate change—positivity is important, but situations often demand honest look at the harsh realities under which people live. Again, similar to what we saw with NASA above, this does not mean these tweets were devoid of positivity. Participants expressed hope to "create a

brighter future” (Muse, 2022a) or shared positive outlooks on mentoring within scientific scholarship (Scarlett, 2021a).



Figure 17: Tweet from NASA Ice (2021a) sharing a photograph and noting how “beautiful polar ice can be.”

## 6. Cluster-Specific Themes

Finally, I want to address two **notable, cluster-specific themes** that emerged as I analyzed this data. The first of these is the presence of a conversational tone. Related to both rhetorical technique and emotional appeals, discussed above, participants from all three clusters used language that simulated spoken, conversational dialogue with their readers. This was most prominent among participants from the Black in Environment and NASA clusters. For participants from the Black in Environment cluster, such conversation emerged in such situations as Muse's (2022f) discussion of the difference between net zero and negative emissions, or in the way that Scarlett (2021a) addresses her audience after a #BlackinAg Week presentation: "Some of yal saw her droppin' wisdom on our panel." This conversational tone runs throughout these tweets, indicating an attempt to reach a more local audience. While NASA may not have the same local focus, they similarly employ conversational language (11 instances, by my count). One tweet by NASA Ice invites scientists to apply to work at NASA, and the way it is written is a direct address to readers, advising them to "start gathering your materials" (2021c).

This conversational tone in NASA tweets often appears as they invite their followers in specific ways. I counted 21 specific invitations across all NASA tweets—far more than any of the other clusters. Examples include all types of invitations, from an invitation for followers to share their photos to help NASA scientists (NASA Atmosphere, 2022b), to the invitation mentioned above to apply for a science job at NASA (NASA Ice, 2021c), to simple invitations to click on links and read more details (for example, NASA Earth, 2022a). These frequent invitations by NASA to its followers again speak to their need to continue finding new and varied ways of interacting with those millions of readers.

It should again be noted (and will be stated again below) that these tweets are not all-encompassing. Just because a networking strategy, rhetorical technique, or other feature does not appear in the tweets I chose does not mean that the writers never engage with that strategy or technique or feature. That said, the data from these tweets serves as a useful base by which I can triangulate the data gathered from interviews. In the next section, I will summarize the coding for interviews, starting with an overview of the data, and then comparing it across the three clusters.

## 5.4 Interviews

### 5.4.1 Overview of Interview Results

As described in Chapter 3, after examining the 20 tweets from each of the 12 participants, I prepared a discourse-based interview with participants to talk with them about the choices they made in writing those tweets. During these interviews, my questions focused on networking and rhetorical strategies, so it would make sense that the patterns that emerged in the data would relate to these strategies.

In reviewing the interview transcripts, when I coded something as “Networks” (212 instances), those codes came from discussions of influences and connections that participants had, whether those were human or nonhuman. Participants discussed reasons that they had for tagging (92 instances), hashtagging (59 instances), quote tweeting (38 instances), and retweeting (21 instances). Also related to networking were our discussions of the limitations participants encountered as they wrote their tweets (83 instances). Throughout our interviews, I also noted multiple instances where participants simulated some kind of internal dialogue, either with imagined readers of their tweets (52 instances) or with colleagues (13 instances).

These internal dialogues often emerged as participants reflected on the rhetorical techniques and contexts that we discussed in these interviews. We discussed participants’ overall purposes behind the tweets (119 instances), their different audiences (72), strategies for science communication (56 instances), the use of specific rhetorical techniques (45), their use of affect, emotion, and positivity (a total of 63 instances), images (29), and methods participants used to adapt to different audiences (23, plus another 14 instances focusing on local audiences and 11 instances of discussion about “opponents” who may be unreceptive to discussions of climate change).

In addition to the themes that emerged above, participants also discussed with me how much (12 instances) or how little (23 instances) preparation went into writing tweets. This last point is particularly interesting when thinking about tacit knowledge. One of the first questions I would ask participants was “Tell me about the planning you do before you write a tweet,” and invariably participants answered with some variation of “I don’t do much preparation.” To offer a pair of examples, Rachel Scarlett noted that “sometimes I just tweet, just off the top of my head” (R. Scarlett, personal communication, July 26, 2022), and Jeff Dukes describes his planning

process as “not perfectly thought out” (J. Dukes, personal communication, February 16, 2021). Interestingly, after telling me that there was little planning, every participant also spent the entire interview answering questions about their writing or networking decisions, and sometimes even explicitly noted that they do, in fact, plan tweets. Sometimes this was only about 10 minutes’ worth of planning, as was the case for David Burns (D. Burns, personal communication, August 24, 2022), and sometimes it was an involved process that required meetings and feedback, as was the case for tweets that emerged from some NASA communications campaigns (K. Mersmann, personal communication, March 8, 2022).

As we did above with the examination of data from tweets, it is worth drilling down further into several of these themes. Table 7 below outlines the major codes across interviews. For the breakdown, please see additional tables in Appendix D.

Anytime participants identified connections or influences that could potentially be used to create a map of their networks, I coded that theme as “networking.” Most of the network connections that participants discussed in these cases were coworkers or colleagues (12 instances), though a number of them also included the different platforms (Instagram, Facebook, etc.) that participants would synchronize their tweeting with (10 instances). Other connections or influences of were news stories or politics (8 instances), the use of multiple Twitter accounts (7 instances), technologies (7 instances), communications campaigns (6 instances), feedback from others (5 instances), style guides (4 instances), pop culture (4 instances), or the COVID-19 pandemic (4 instances).

Table 7: List of themes that emerged from interviews with 12 participants.

| Second Round Codes             | Count | Example                                                                                                                                                                                                                                                                           |
|--------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Networks                       | 212   | "I'm influenced by a lot of general media news that I read. Science, science related news pieces."                                                                                                                                                                                |
| Purpose                        | 119   | "I see my job as empowering people who maybe don't have a science background"                                                                                                                                                                                                     |
| Reason for tagging             | 92    | "It's important for black scholars specifically to connect with other black scholars who are doing similar work. And to cite them."                                                                                                                                               |
| Limitations                    | 83    | "there are rules at NASA about who we can tag"                                                                                                                                                                                                                                    |
| Audience                       | 72    | "the target audience was undergrads"                                                                                                                                                                                                                                              |
| Best practices                 | 64    | "I personally prefer a conversational tone"                                                                                                                                                                                                                                       |
| Reason for hashtagging         | 59    | "I'm trying to draw attention to a tweet"                                                                                                                                                                                                                                         |
| Science communication          | 56    | "A lot of people think that the lab is clean, and you wear this white coat, when it's actually not."                                                                                                                                                                              |
| Internal dialogue              | 52    | "they're like, 'Oh, God, it's gonna be more facts. And I don't have the brain space for facts.' But if they see from a NASA account, 'Do launches make anyone hungry,' 'Okay, now I'm sort of curious. Is there is there a meal contest that's going on? What's happening here?'" |
| Rhetorical techniques          | 45    | "all of these different types of activists use repetitive structures to drill down on their point."                                                                                                                                                                               |
| Reason for quote tweeting      | 38    | "I felt like I had something to add. Maybe a very stupid thing to add, but it was something that I could add."                                                                                                                                                                    |
| Affect and emotion             | 38    | "It's a serious issue, climate gentrification, and it actually does get me hot sometimes. So I think it was kind of like a play/pun on that, showing the seriousness of it, but also poking fun at it in a way"                                                                   |
| Images                         | 29    | "I think there's something in Twitter's algorithms where images get more engagement."                                                                                                                                                                                             |
| Positivity                     | 25    | "I tend to like my feed to be really positive and fun, and that's the type of content that I try to put out too."                                                                                                                                                                 |
| Adapting for audience          | 23    | "I'll try to word it in a way that actually will capture the things that people want"                                                                                                                                                                                             |
| Little preparation or planning | 23    | "I don't, before I compose a tweet, carefully go over to the thesaurus and check my phrasing too much."                                                                                                                                                                           |
| Reason for retweeting          | 21    | "I don't want to step on the toes of someone who's doing something good"                                                                                                                                                                                                          |
| Local focus                    | 14    | "It makes it more local. And I think it's respectful of the people in those cultures that live in these places."                                                                                                                                                                  |
| Team dialogue                  | 13    | "'Hey, I'm going to tag you,' or even maybe 'You should tweet this and @NASA_Ice reshares.'"                                                                                                                                                                                      |
| Diversity equity inclusion     | 12    | "when I see things about climate injustice, environmental inequities, environmental racism, I'll often retweet some of those things."                                                                                                                                             |
| Preparation or planning        | 12    | "how do I get this topic that is very important into like, two sentences"                                                                                                                                                                                                         |

I also delved deeper with participants into their reasons for doing different types of networking on Twitter. To keep my scope narrow, I'm going to focus here on participants' reasons for tagging and hashtagging, which will serve as examples of the mechanisms by which participants built their networks online. Again, tagging is the use of the "at" symbol (@) to "tag" or "mention" an individual or institution who has a Twitter account in your own tweet. These tags turn into links to that individual's account, and they also notify that individual that they were tagged. The most common reason that participants gave for tagging was to broaden their audiences (11 instances)—sometimes this meant simply including the tagged person in the audience, but more often it meant expanding their tweet to the followers of the person who was tagged; related to the idea of broadening their audience, in 8 cases, they also used tags hoping that the tagged person would retweet them, thus broadening their reach even further. Participants also used tags as a method of citation, crediting ideas and work to others (9), to call the attention of the person they tagged (8), to raise awareness about a specific organization or individual (7), to acknowledge collaborators (5), to give their followers links to the tagged organizations or people (5), or simply because they saw some kind of relationship between their work and that of the tagged organization or individual.

As defined earlier, hashtagging is the use of the pound symbol (#). Hashtags do not connect to specific individuals or accounts, but they are often used with keywords or terms so that individuals interested in those keywords can follow them across multiple accounts, even from individuals they aren't yet connected to on Twitter. As with tagging, the most common reason participants used hashtags was to broaden their audiences (11 instances). They also used hashtags to connect with other individuals who either use the hashtags or follow them (4), to call the attention of other professionals interested in those hashtags (3), to catalogue their own tweets (3), to join a conversation (2), or to show visible connections (2). In two instances, participants noted that hashtags could be used to rhetorical effect, adding emphasis to a tweet. Hashtags were also used as shorthand for longer methods or processes and to connect at conferences.

It is worth noting that on a few occasions, participants gave reasons against using hashtags. The two reasons given were related to questions of accessibility—several participants noted that some screen readers have difficulty reading hashtags, and they were concerned that if they chose to use hashtags, these limitations might make it difficult for differently abled readers to receive

their messages. The other reason—mentioned twice—was that more and more, hashtags are outdated and don't actually generate the interest or audience that they used to.

In terms of rhetorical situations, participants and I discussed the various purposes they had behind their tweets. The most common purpose they cited was “raising awareness” in audiences (21 instances), usually to raise awareness of the work they or others in their network were doing, but also sometimes to raise awareness about conditions and updates in their scientific areas of expertise. They frequently used Twitter to promote publications by other scholars (12 instances), to promote their own publications (11 instances), to educate their audiences about different actions that could be taken to reverse or mitigate the effects of climate change (9 instances), to try to influence decision makers (7 instances), or to broaden their audiences (5 instances). Other reasons for tweeting included educating audiences about science, connecting with fellow researchers, boosting the voices of younger scholars, engaging in conversation, generally linking audiences to research, promoting various organizations, empowering other individuals, telling stories, describing projects, promoting themselves, and discussing the value of mentorship in academia.

I also asked participants about the audiences for their tweets. All participants identified more than one audience for their tweets, and different tweets had different audiences and audience combinations. The most common audience participants discussed was an academic one made up of fellow scientists and scholars (14 instances), followed by an audience made up of the general public (8 instances). In 7 cases, participants didn't identify a specific audience, instead mentioning the multiplicity of their readership. Other audiences mentioned—to a lesser degree—included activists, professionals, students, public officials, climate change doubters, and nonexperts. Participants also listed agricultural professionals and farmers, individuals across international boundaries, people who believe in climate change, journalists, and nonprofit organizations.

Participant awareness of audience, and of the different individuals and groups that make up their audiences, was emphasized by the fact that during the interviews, almost every participant engaged in a vocalization of a kind of internal dialogue showing how they engaged with their audiences. For example, in discussing opening a NASA Earth tweet by using a question hook like “Did you know,” Katy Mersmann discussed the thoughts that went back and forth in her head:

...as much as I was taught that [using a question as a hook is] sort of a hacky way to open, it does get people's attention. And so again, do I think, “Did you know,” when people see that from a NASA account, they're like, “Oh, God, it's gonna be more facts. And I don't have the brain space for facts.” But if they see from a NASA

account, “Do launches make anyone hungry,” [they then think,] “Okay, now I’m sort of curious. Is there is there a meal contest that’s going on? What’s happening here?” (K. Mersmann, personal communication, March 8, 2022)

Imagined dialogue with audiences and within participants themselves occurred 52 times across twelve interviews.

In discussing science communication, there weren’t any overwhelming topics that came up more than others. Common discussions that came up more than once included discussions of how to make science communication accessible to more audiences (7 instances), the use of accurate language (5 instances), when it’s not useful to define technical terms in tweets (5 instances), and when it is useful to do so (4 instances), the importance of clearing up misconceptions (4), and sharing experiences (4). Participants also discussed presenting evidence using twitter threads rather than single posts, explanations of methods or processes, the importance of summarizing or explaining linked content, when it is appropriate to hedge, the importance of celebrating the work of collaborators, discussions of what “science” is, and avoiding “buzzwords.” By “avoiding buzzwords,” I refer to a conversation I had with Jaime Mendoza, who mentioned that terms like “climate change” and “global warming” were overused to the point that they “don’t mean anything anymore,” and that science writers should carefully and purposefully use terms like these (J. Mendoza, personal communication, March 4, 2022).

I also discussed participants’ thoughts about the use of emotion in their tweeting. On 14 occasions, they discussed the importance of using humor in their tweets. Another 7 occasions saw them discussing emotional language. They also discussed using a playful tone (3), using emojis for emotional effect (5), being unfiltered in the expression of their emotions (2), described embodied reactions in ways that I classified as “affect” (2), and once tied the use of allusions to emotion. They all uniformly expressed the importance of a positive tone throughout their tweeting (25 instances).

Participants also shared insights into their use of a variety of rhetorical techniques. The most common technique discussed was the hook, that thing—whether it be an image, a question, or careful word choice—that catches the eye of someone scrolling through their Twitter feed and causes them to stop and read. Participants discussed hooks 17 times. Other rhetorical techniques that we discussed included the use of stories, the use of careful word choice, identification, the value of repetition and repeating a message, metaphor, allusions, and even the importance of a simulated, written silence using ellipses. Less frequent, but also mentioned were the use of obscure

references that only very specific audiences would know, when to quote versus summarize linked material, the use of visible changes to text (like capitalization) for emphasis, personification, the use of economics in arguments, and a recognition of the impact of time on a rhetorical situation.

Finally, I asked participants two concluding questions related to their tweets. For the first question, I asked participants to identify any limitations (human or nonhuman) on their tweeting, and I also coded other instances throughout the interview where these kinds of limitations appeared. By far, the most common limitation participants mentioned was a nonhuman one: the limited character count imposed by Twitter (14 instances). Other nonhuman limitations included style guides that were set in place by their organization (this came up 5 times specifically in discussions with participants from the NASA cluster) and technological limitations such as phone batteries and internet connections (3 instances). The most common human-caused limitations included thoughts about whether or not an audience would understand a reference (5 instances), the limitations of co-managing an account with others (again, this was a limitation exclusively mentioned by NASA participants, mentioned 5 times), awareness of how a tweet might be received and whether or not that might result in “cancellation” (4 instances) or how supervisors or bosses might read a tweet (4 instances), the way that certain emojis have been associated with bawdy humor and can no longer be used in other ways (3 instances), and the challenges of being a contractor rather than a direct employee (another unique NASA discussion, mentioned 3 times).

Table 8: List of limitations to communicating on Twitter, as identified in participant interviews.

| Code                                    | Count |
|-----------------------------------------|-------|
| Tweet length                            | 14    |
| Obscure References                      | 5     |
| Style guides                            | 5     |
| Co-managing Twitter account             | 5     |
| Awareness of how tweet will be received | 4     |
| Social pressure - boss can see tweets   | 4     |
| Emojis and dirty jokes                  | 3     |
| Technology                              | 3     |
| Contractor vs direct employee           | 3     |

The second concluding question I asked participants invited them to list two or three of what they considered “best practices” for tweeting. Most answers focused on stylistic concerns like ordering words and ideas within a tweet (16 instances). Participants also discussed the

importance of thinking about one’s audience (13 instances). Other best practices listed included the importance of attaching some kind of media to a tweet (6 instances), the thoughtful use of tags and hashtags (6 instances), staying positive (5 instances), considering context when writing (4 instances), making sure that tweets are accessible (here, participants did not just mean reaching a broader audience—they are specifically referring to elements such as how text readers will approach a tweet or the importance of using alt text with images; this was mentioned 4 times). Finally, participants stressed the importance of the use of evidence when writing about science (3 instances). Mentioned less often, but still worth noting were mentions of staying humble, using emotion, trusting one’s gut when writing, getting feedback from others, staying open to people from diverse backgrounds, and using tweets to engage with other people on Twitter.

Table 9: List of participant “best practices” for communicating on Twitter, discussed during interviews.

| Code                  | Count | Example                                                                                                     |
|-----------------------|-------|-------------------------------------------------------------------------------------------------------------|
| Stylistic concerns    | 16    | “put the most interesting content right up front”                                                           |
| Consider audience     | 13    | “use everyday language that people can connect with”                                                        |
| Include media         | 6     | “including a picture or an image or an illustration”                                                        |
| Use tags thoughtfully | 6     | “tagging other accounts, and using hashtags”                                                                |
| Positivity            | 5     | “not using it as a vehicle for airing dirty laundry.”                                                       |
| Consider context      | 4     | “comprehensive understanding of institutional knowledge”                                                    |
| Accessibility         | 4     | “alt text”                                                                                                  |
| Evidence-based        | 3     | “Correct misinformation on the internet.”                                                                   |
| Be humble             | 2     | “sharing credit and acknowledging their contribution”                                                       |
| Emotion               | 1     | “be unfiltered with my emotions, so let my emotions show”                                                   |
| Trust yourself        | 1     | “trust my gut”                                                                                              |
| Get feedback          | 1     | “have someone who you trust [...] but who has no grounding in the science who is able to read over things.” |
| Consider diversity    | 1     | “Try to be open to people from any background.”                                                             |
| Engage with others    | 1     | “quote tweets that challenge the original tweet”                                                            |

In the next section, I will compare and contrast the ways the themes emerged differently among the clusters of participants.

#### **5.4.2 Comparing Interviews across Clusters**

As I did above when comparing and contrasting Twitter results across participant clusters, and as I compare interview results across clusters, I will be looking specifically at the most

common themes that emerged. I have included a series of Tables in Appendix D that contain a more comprehensive view of the data. In this section, I will look at participants' discussions of (1) the importance of **diversity and inclusion**, (2) their **networking influences and connections**, (3) their **purposes** for tweeting, (4) who they consider to be their **audiences**, (5) their strategies for **communicating science**, (6) how they use **emotion** in tweets, (7) the **rhetorical techniques** they use, (8) the **limitations** on their communication via Twitter, and (9) what they consider to be their **best practices**.

## 1. Discussions of Diversity and Inclusion

As above, while our discussion of diversity and inclusion may not have been extensive (I specifically coded it only 8 times across 12 interviews), that does not mean that questions about diversity were not important to participants, and I want to foreground that discussion so as not to make it into a footnote of this overall dissertation. Indeed, questions of diversity and inclusion particularly stood out throughout much of my conversations with participants from the Black in Environment cluster. For example, when participants in this cluster spoke about their purposes in tweeting, of specific individuals whose voices they wanted to promote or audiences they wanted to reach, they often (but not always) meant individuals and activists in the Black community, as we will see in our later discussion of audience. For example, in discussing her reasons for quote tweeting a message by a Black herpetologist, Rachel Scarlett noted that “you usually don’t see Black herpetologists and you usually don’t see them with this large platform, so I like my followers to see the work that she’s doing” (R. Scarlett personal communication, July 26, 2022).

As I discussed above, this is another indication that, even if the term “Black Twitter” did not come up in our interviews, Black writers were aware of the style and purposes of other Black Twitter users and worked toward similar purposes. Brock, Jr. (2020) notes that among the most common practices that Black Twitter users engage in are the use of relevant hashtags, “network participation,” and the use of “propagation” to help messages spread virally for greater visibility on Twitter (p. 90). Scarlett’s discussion above especially emphasizes networking (highlighting the work of Black scientists and connecting that work to her other followers) and propagation (helping spread that work so it becomes more visible overall). Again, as I discussed above, my participants and I did not discuss Black Twitter in specific, but those trends do emerge to a degree here and are worth mentioning.

Discussions around diversity may have emerged less with other participant clusters, but that does not mean that they didn't happen at all. As I mentioned in Chapter 3, one limitation of the discourse-based interview is that it focuses specifically on the writing at hand and not on additional writings. And while tweets from Purdue and NASA participants may not have touched on questions of diversity as much as tweets from the Black in Environment cluster, when I did see tweets about those issues, I made sure to ask about them. Prokopy noted, for example, that she would often retweet or quote tweet when she saw messages about “climate injustice, environmental inequities, [or] environmental racism” (personal communication, July 27, 2022). And Bates discussed that, when writing for NASA, it was important to think about and be “respectful of the people” who live in the various places around the world that NASA posts highlight (S. Bates, personal communication, February 11, 2022).

## **2. Networking Influences and Connections**

Participants across all clusters spoke openly about their reasons for networking and the individuals, groups, and things that made up those networks. I discussed above the reasons that participants had for networking (specifically in tagging and hashtagging). These reasons remained fairly consistent across all participant clusters, and so it is less useful to reiterate them here. I do think it will be useful to discuss some of the different connections and influences that participants identify in their networks. With participants from the Purdue and NASA clusters, the most common connection and influence was that of fellow colleagues or peers both inside and outside of participants' institutions and organizations (8 instances at Purdue, 9 instances at NASA). For these participants, the strong influence of coworkers, colleagues, and peers makes sense, considering participants contexts. Purdue participants work in departments in close proximity and often collaborate. Purdue participant Laura Bowling specifically named another Purdue participant as the person who gave her “initial advice” when she started tweeting (L. Bowling, personal communication, May 24, 2022). NASA participants similarly come from a context in which they were hired to create the articles and posts they are writing. Participants from the Black in Environment cluster also mentioned the influence of coworkers and colleagues on their writing, but they did so to a lesser extent than the other clusters, only mentioning it three times in their interviews.

Participants from the Black in Environment cluster differed from the other clusters in that they discussed much more often the need to synchronize their tweeting with the use of other tools and how that influenced them. All three participants from this cluster discussed their use of platforms like Facebook, Instagram, or Zoom to complement the messaging they were putting out on Twitter, usually in the context of making sure that their messages were being shared effectively with local communities or specific audiences.

### **3. Purposes for Tweeting**

In our discussions of their reasons for tweeting, participants across all clusters offered a variety of reasons. The most common reason that participants gave was “raising awareness” (15 instances at Purdue, 1 instance at Black in Environment, and 5 instances at NASA). By this, they generally meant that they might raise awareness in their followers about the “nuances that go into [...] doing research in climate science” (J. Mendoza, personal communication, March 4, 2022) or awareness among people “who maybe don't have access to science journals” (J. Evans, personal communication, April 1, 2021). Participants from the Purdue and the Black in Environment clusters also emphasized their desire to share research, either that of others (10 instances with Purdue participants, 2 instances with Black in Environment participants) or their own (10 instances with Purdue, 1 instance with Black in Environment). Again, this makes sense, considering their contexts—these participants are all in scientific fields where doing and sharing research is seen as part of their personal ethos.

One other note of interest regarding purpose is the range of purposes that the different clusters had. Participants from NASA listed, overall, a smaller range of purposes than other participants (6 distinct purposes from NASA versus 11 from Purdue and 17 from Black in Environment, to be specific). Again, this speaks to the very specific goals of messaging from official NASA accounts, whereas other participants were tweeting from their own personal accounts and could as a result have more reasons for wanting to tweet.

### **4. Audiences, Identified**

All three clusters of participants acknowledged the multiplicity of audiences for their online writing (2 instances for Purdue, 3 instances for Black in Environment, 4 instances for

NASA). One NASA participant even noted that “I think there's many publics and many sub-publics, right? [...] The @NASA\_Ice account serves many different audiences” (J. Mendoza, personal communication, March 4, 2022). When asked to drill down and identify more specifically who these publics were, the most common audience identified was academics (5 instances for Purdue, 4 for Black in Environment). Again, this makes sense, especially for the scientists that made up the Purdue and Black in Environment clusters. Their online circles included many in their same field, and so their audience would often be academics like themselves.

A few notable differences in audience did emerge. Purdue participants came largely from fields that dealt with agricultural science, and—unsurprisingly—they listed agricultural professionals and farmers among their audiences. Participants from the Black in Environment cluster, writing for the specific communities they are working with, mentioned on three occasions that some of their audience was made up of “the activist community folks that are involved in wanting to have some type of climate advocacy with their work” (N. Muse, personal communication, August 5, 2022).

## 5. Discussion of Science Communication

In our discussions of science communication, conversation often centered on questions about how much detail to include. In three instances, Purdue participants discussed the use of Twitter threads—as opposed to single tweets—to present more evidence for scientific claims. They also discussed on three occasions situations under which they might not choose to define technical terms; for example, Andrew Flachs noted that he assumed that most of his readers “would have a vague idea of what those [technical] terms mean,” and thus the terms would not require additional elaboration or explanation (A. Flachs, personal communication, August 16, 2022). NASA participants also expressed opinions about when it was appropriate to define a technical term (4 instances) as opposed to when they would choose not to define the term (1 instance). Writing for a broader swath of audiences, NASA communicators needed to make affordances for readers who may or may not be familiar with those terms. For example, in discussing the use of the term *aerosols* in a NASA Earth tweet, Katy Mersmann told me,

We talk about aerosols all the time. For earth scientists, aerosols are a specific thing. To the general public, aerosols mean the hairspray that they think still depletes the ozone layer, despite that not being true for about 30 years now. So, I have preset definitions of aerosols. When I need to put out a tweet about a research paper

involving aerosols, I will say, “tiny particles in the atmosphere like sea salt, dust, and smoke,” because that’s what an aerosol is. That’s how we describe an aerosol to the public. (K. Mersmann, personal communication, March 8, 2022)

Unlike Purdue scientist participants, whose primarily academic audience led them to spend less time defining terms their readers likely already knew, NASA participants were focused on making their work accessible to more readers.

Similarly, participants from the Black in Environment cluster also discussed the need to make science communication accessible to more people (4 instances), and in particular the importance of explaining technical concepts in ways that more people would understand and that would reach broader audiences. In discussing this, David Burns noted,

I think one of the biggest pieces of advice I got was from a professor [...] who said that, when you share your science, you’re supposed to try and make other people feel smart. Meaning you’re supposed to get them to understand your science and be able to speak about it at certain level, which makes them feel smart and that they understand what you’re talking about, while also not being reductive. (David Burns, personal communication, August 24, 2022)

Again, remembering that participants from this cluster sought to include local, activist audiences, it makes sense that they would want to think of ways to make that science more accessible and available for communities to use to improve the lives of their residents. Participants from this cluster also discussed the importance of sharing experiences (4 instances) as a way to make their work more personal and accessible to others. The experiences that participants discussed here were particularly oriented towards young scholars and graduate students just getting started in academia. Rachel Scarlett, for example, talked about “how difficult the PhD journey is” and the struggle to “build a mentor network,” hoping that her experience would uplift other students “who may be in a similar place, may be feeling like they’re not reaching their potential” (R. Scarlett, personal communication, July 26, 2022).

## **6. Discussion of Emotion and Positivity**

While emotional language was used by all participants in their tweets, in our interviews, such emotion was discussed most often by participants from the Black in Environment cluster, such as when Rachel Scarlett talked about using “unfiltered,” emotional language, as well as the use of emojis as ways to represent emotion and bodily action such as sighing (R. Scarlett, personal communication, July 26, 2022). But overall, participants did discuss the importance of humor: 2

instances with Purdue, 3 instances with Black in Environment, and 7 instances with NASA, who also discussed in 3 instances the importance of understanding when *not* to use humor. One NASA participant noted that when it comes to climate change, specifically, “we do not joke about it, because we want to be clear that we're being very serious about that” (K. Mersmann, personal communication, March 8, 2022).

Having noticed the overall positive tone of their tweets, I also asked participants about that positivity. All five Purdue participants stressed the importance of being positive, and it was mentioned 15 times over the course of the five interviews. In the pilot study, both Jeff Dukes and Marissa Tremblay discussed the importance of positivity. Tremblay noted, “I tend to like my feed to be really positive and fun, and that’s the type of content that I try to put out too” (M. Tremblay, personal communication, March 29, 2021). This sentiment was echoed by later participants: Laura Bowling discussed that “a more positive message, emphasizing solutions, can get us further than browbeating” (L. Bowling, personal communication, May 24, 2022), and Linda Prokopy said that she tries to “be positive and optimistic. Sometimes the world weighs me down. But yes, in general, I try to be” (L. Prokopy, personal communication, July 27, 2022). Participants from the Black in Environment cluster did not discuss positivity as much as those from Purdue, though they did still talk about it 6 times. In the face of the many challenges and climate injustices Black communities face, these participants also reinforce the importance of making sure that their Twitter feeds weren’t exclusively “serious, serious, serious” (N. Muse, personal communication, August 5, 2022). Similarly, NASA participants also discussed positivity, though not as much as participants from other clusters (only 4 instances). That said, NASA participants discussed how emojis could be used to help someone’s experience on Twitter be more positive.

## **7. Discussion of Rhetorical Techniques**

By far, the most common rhetorical technique that participants discussed was that of the hook, using some kind of device, whether it be through language or through “‘grab you’ words” (J. Evans, personal communication, April 1, 2021), to make Twitter users stop scrolling through their feeds and read a specific tweet. Discussion of hooks occurred 10 times with NASA participants, 5 times with Purdue participants, and 2 times with Black in Environment participants. Among the specific hooks identified were the use of some kind of interesting image to stop readers from scrolling “past your tweet” (L. Prokopy, personal communication, July 27, 2022), or opening

tweets with a question to draw in readers. Andrew Flachs noted that if readers wanted to know the answer to the question asked, they would be more “likely to click” (A. Flachs, personal communication, August 16, 2022).

Two other unique techniques are worth examining here. The first is one I have labelled “identification.” By this, I am specifically talking about situations where the participant uses language to try to identify with their audience. This was especially prominent in 3 instances during my conversations with participants from the Black in Environment cluster. For example, when asked about why she shared specific details about her scholarly journey, Scarlett noted that “a lot of people forget about the value of your peers going through this with you” (R. Scarlett, personal communication, July 26, 2022). By sharing details of her own journey, she hopes to uplift younger scholars following a similar path. The second technique worth discussing is that of storytelling or narrative. This was especially common with NASA participants, whose tweeting was often discussed in narrative terms. Katy Mersmann saw tweets as being made up of “puzzle pieces” that would be fit together to tell some kind of narrative or story (K. Mersmann, personal communication, March 9, 2022).

## **8. Limitations on Tweeting**

I concluded my interviews with all participants by asking them about any limitations they perceived on their tweeting and about what they consider to be some best practices worth sharing. We will focus first on limitations.

The most commonly discussed limitation across all participants was technological in nature. Most prominently, almost every participant mentioned the 280-character limit that Twitter places on tweets (5 instances from Purdue, 2 instances from Black in Environment, and 7 instances from NASA, respectively). Flachs described this limitation as a feature rather than a bug, “the economy of Twitter,” as he put it (A. Flachs, personal communication, August 16, 2022). Bates also noted that this economy of Twitter led to her thinking very carefully about what she would write and how she would write it: “Twitter is so small, right? It’s one tweet. You’ve got such a limited amount of space” (S. Bates, personal communication, February 11, 2022). That said, Twitter’s character count was not the only technological limitation that participants faced. Prokopy discussed the fact that sometimes she would tweet if she was in a place where accessing the photos on her phone was convenient (L. Prokopy, personal communication, July 27, 2022), and Bowling mentioned that

sometimes her tweets were limited by whether or not her devices were even charged (L. Bowling, personal communication, May 24, 2022).

One limitation that emerged in conversations with participants from the Purdue and Black in Environment clusters was that of an awareness of how their tweets would be received (5 instances in total for Purdue participants and 3 instances for Black in Environment). Prokopy and Flachs both noted in 2 instances that this awareness included political considerations, with Prokopy noting that she thinks about political tweets a lot but needs to think twice about what to retweet and to say about political topics, knowing who follows her on Twitter. Two participants from the Black in Environment cluster mentioned a concern about “cancel culture,” with one adding that “you don’t want to tweet something that may offend your organization or offend anybody that’s affiliated with you” (N. Muse, personal communication, August 5, 2022).

Participants’ concern for how a tweet may be received was heightened by other limitations related to a participant’s occupation. In discussing the limits on her political tweeting, mentioned above, Prokopy added that there were certain expectations about how she would represent herself online in her position as Department Head (L. Prokopy, personal communication, July 27, 2022). Other Purdue participants expressed concern about supervisors or deans reading their tweets and wanting to write tweets that reflected well on them and on their institution (3 instances). Occupational concerns were particularly ubiquitous among NASA participants. Again, these participants were paid by a government agency to do the tweeting under discussion, and so they were hyperaware of institutional policies and cultures as they wrote. NASA participants discussed, for example, the challenge of co-managing Twitter accounts (5 instances): most of the NASA accounts are run by multiple NASA employees, and so those employees coordinate their time and writing to make sure that as they post they are not stepping on each other’s toes. All participants also mentioned that NASA has a style guide with policies in place for how to write for the organization online (5 instances), and two of the four participants mentioned (for a total of 3 instances) the challenges inherent in being contracted to write for NASA rather than being a full employee of the government.

## 9. Best Practices for Online Communication and Networking

Three categories emerged when participants were asked to share their best practices: strategies for better considering audiences, ways to engage Twitter's algorithm, and stylistic concerns.

All three participant clusters stressed best practices that might help writers consider their audiences (3 instances for Purdue participants, 7 instances for Black in Environment participants, and 6 instances for NASA participants). For Black in Environment participants, audience consideration was a key strategy to reach specific, local communities: Burns noted the importance of writing in a way that was open to people from all backgrounds (D. Burns, personal communication, August 24, 2022). Scarlett discussed the importance for Black scholars to use casual language so that they could reach "wider audiences" beyond other scientists (R. Scarlett, personal communication, July 26, 2022). When thinking about his audience and his message, Muse noted "if I tweet something, it's because I'm open to conversation about it, or open to having a dialogue about it" (N. Muse, personal communication, August 5, 2022). Thinking about those dialogues with his audience helped Muse determine what he was going to tweet in the first place. When considering audience, NASA participants emphasized "being aware of how people think about climate change and what some of their concerns about it are" (J. Evans, personal communication, April 1, 2021), engaging in conversation with the audience (J. Mendoza, personal communication, March 4, 2022), and not taking too seriously the criticisms that might come from internet trolls (K. Mersmann, March 9, 2022).

Both Purdue and NASA participants discussed ways to properly engage Twitter's algorithms to increase the readership of tweets. For Purdue participants, these ranged from a thoughtful use of tags and hashtags (5 instances) and the use of media like videos or pictures (4 instances). One best practice of note mentioned by both Linda Prokopy and Laura Bowling is that of using tags on photos uploaded to Twitter as a way to get around Twitter's character count limit, since Twitter does not count tags on images toward the character count (*Photos Just Got More Social*, 2014).

Finally, all participants addressed to some degree the need to pay attention to stylistic concerns (4 instances from Purdue, 3 instances from Black in Environment, and 9 instances from NASA). At Purdue, stylistic concerns included front-loading tweets with the most important content and using accessible language. With participants from Black in Environment, this included

keeping tweets brief and to the point and using hooks to draw readers in. And with NASA participants, stylistic concerns ranged from maintaining good grammar and mechanics to making sure to use engaging language.

In the following chapter, I will delve deeper into what these findings mean. I will talk about how the different clusters address questions of networked audiences and networked rhetorical strategies. In particular, I will focus on questions of multiple audiences, discuss more the internal dialogue that I saw participants engage in, discuss the different ways that the networks affected the writing of scientific tweets, and spend time discussing how participants used rhetorical strategies of identification and appeals to pathos to reach their readers. I'll also offer an examination of what can be gleaned from participants' discussions of limitations and best practices, and I'll suggest several takeaways from the data.

## **CHAPTER 6. DISCUSSION AND CONCLUSION: USING IDENTIFICATION, AFFECT, AND EMOTION FOR MORE EFFECTIVE NETWORKED COMMUNICATION**

### **6.1 Planning Tweets: A Review of Tacit Knowledge**

As mentioned in the previous chapter, when asked to tell me about the planning they did for their tweeting, every participant (without exception) told me “I don’t” in one variation or another:

- “There’s no planning” (D. Burns, personal communication, August 24, 2022).
- “There’s a lot less strategy in my tweeting than I realized there was” (J. Evans, personal communication, April 1, 2021).
- “I don’t, before I compose a tweet, carefully go over to the thesaurus and check my phrasing” (J. Dukes, personal communication, February 16, 2021).

Interestingly, the remainder of our conversations uncovered that these communicators did in fact put thought into their writing, even into their shorter tweets. Purdue participant Andrew Flachs told me he thought about how he might use hashtags or tags to engage Twitter’s algorithms (personal communication, August 16, 2022). Another Purdue participant, Marissa Tremblay, noted that sometimes her preparation for tweeting began even earlier, noting that she would sometimes take photographs of her work knowing that she might later share them on Twitter (personal communication, March 29, 2021). Writers said they didn’t plan. But they also acknowledged that they did. How can both be true?

To answer this question, let’s return to the concept of tacit knowledge, discussed in Chapter 3. To review, tacit knowledge includes those things that we know but cannot easily articulate (Polanyi, 1966): how we know when we’re seeing a sibling’s face, how we know when we’re hearing a friend’s voice. Incorporating ideas from tacit knowledge into her concept of “para expertise,” Rice (2015) emphasizes that tacit knowledge is related to our bodily experience, the way we live in things: “In the act of deploying tacit knowledge, we bring that proximal term ‘inside,’ so to speak, by dwelling within it. [...] The particulars are ‘interiorized’ and ‘dwelled within,’ rather than explicitly stated” (p. 126). Tacit knowledge is tied to experience, emerging from activities and sensations that we engage in often enough that we don’t think about them. Consider how we internalize writing knowledge—simple or complex—as we learn it: even with

something as simple as capitalizing the letter *I* when writing in the first person. When I first started writing, I would have needed to think about that rule of capitalization every time I wrote. But now, decades later, I do it without even thinking about it. The knowledge has become tacit.

Odell, Goswami, and Herrington (1983) suggested that the tacit knowledge employed in writing could be articulated, and indeed, the seemingly contradictory statements by the participants in this study confirm this fact. On first reflection, participants may not think that they do much planning when they write a tweet, just as I don't think much about capitalizing the word *I*. Because these are communicators that regularly use Twitter, their experience in the medium is such that they have internalized much of the planning they might do. On reflection, they are still able to describe the strategies they used, even if such strategies occurred over a period of seconds. The choices in their networking and rhetoric were conscious ones, and as we saw in Chapter 5, there were definitive patterns that emerged through an examination of their tweets and in discussions with them.

In this chapter, I delve deeper into how participants engaged in network building and rhetoric as they wrote on Twitter. More specifically, I discuss the implications of the data I shared in Chapter 5. I talk about the different influences and connections that these writers identified, and the many audiences that they write for. I then transition into a discussion of the rhetorical situations that participants wrote for, how participants used the rhetorical technique of identification to reach their readers, and how they engaged with affect and emotion. I summarize some implications of the limitations and best practices that participants identified. I conclude this chapter (and this dissertation) by offering four takeaways from the data: first, we science communicators should engage in a greater effort to take control of our networks; second, when communicating science, even public writing that can be seen by anyone should be directed at specific audiences; third, even in scientific contexts, we should think of ways to engage reader emotion; and fourth, we can teach writing as a networked process.

## 6.2 Networked Publics

As we discuss the ways in which participants networked, it will be useful to review the six features of networks that I introduced in Chapter 2:

1. Networks are collections of nodes or actors that link to each other in some way.
2. **Nodes can be human or nonhuman.**

3. Connections can be tangible or ephemeral.
4. Nodes with more connections often have more influence.
5. That said, weak ties can also be influential, especially when communicating simple information and behaviors.
6. **Networks are rhetorical: we make choices and use language to connect with other people and things.**

Of these six features, in the context of the results shared in the previous chapter, it is especially worth thinking about features 2 and 6.

First, the shapes of networks and the actions of individuals within them are influenced by both nonhuman and human nodes. To start, overwhelmingly, participants identified technology in some form or another as the most common nonhuman element in their networks. These nodes included other social media platforms and how participants considered changing their message on Twitter when compared with how they might write on other platforms or other accounts. For example, I spoke with some participants from the NASA cluster about the way they ran their personal Twitter accounts differently from the NASA accounts they managed. Because NASA accounts have a set of NASA guidelines codified in a style guide, there are things that these writers might want to write about or ways they want to write but cannot. And so, when they approach their personal accounts, they can

put a lot of what my coworkers and I call our “cursed” Twitter thoughts: the tweets that we think of that we want to put on the [NASA] account, but for whatever reason we don’t: maybe they’re too silly, too raunchy, they’re a meme that nobody would get but we know that our following of other social media nerds and journalists will think it’s funny. I’ll put that kind of stuff on my personal [Twitter account]. (S. Bates, personal communication, February 11, 2022)

The nonhuman influence of other accounts (paired with the nonhuman influence of the style guide) impacts these writers not only in what they can write for the official NASA accounts, but it also influences their choices in what they want to write in their personal accounts. In a way, the personal accounts become a method by which they sidestep the limitations put upon them.

Technological influences come in a variety of forms, and sometimes the way that writers talk about these influences can be surprising. In the previous chapter, I described talking with Tremblay about her use of three heart-eyed emojis, “  ,” in the tweet shown in Figure 18 (Tremblay, 2020). Tremblay’s response indicated that she was thinking about how emojis autoformat in text messages on cell phones: “Because in texts it stays bigger, right? So once you

go to more than three, they get small. I like having them big. On Twitter, it doesn't matter. It's the same size" (M. Tremblay, personal communication, March 29, 2021). In her response, we see how even indirectly technology can influence the ways we write—she herself acknowledges that Twitter wouldn't change the size of her emojis in the message, but because it happens in text messages, she chose to limit the number to three here.



Figure 18: Tweet by Tremblay (2020) in which she uses three smiley emojis in succession when expression congratulations to a colleague.

Human influences also play a heavy role in participants' networks. Some influences are more direct. Prokopy told me that when she was promoted, a supervisor told her to avoid tweeting in some of the more controversial ways she'd tweeted previously (L. Prokopy, personal communication, July 27, 2022). Other participants named specific individuals whose tweets they purposefully modeled their own tweets after. In discussing the use of repetition in her tweets, Rachel Scarlett acknowledged that her writing there was influenced by Black Civil Rights activists, "Dr. King's speeches and how he had a repetitive structure. I've read a lot of Dr. King and I've read a lot of Malcolm X" (R. Scarlett, personal communication, July 26, 2022). Unlike with technologies, participants did not indicate many indirect connections (such as we saw with

Tremblay, above). Instead, they were up front about the people and organizations who either gave them direction, feedback, or inspiration as they tweeted.

The limitations that participants identified in their interviews are also important elements of these networks. As above, these limitations can be nonhuman (Twitter limitations on character count was the most commonly mentioned limitation) or human (thoughts about how a tweet might be received, for example, could make participants consider wording—or whether to tweet at all). Such limitations can breed creativity, of course. We have already seen above how NASA participants used personal Twitter accounts to share information in ways that they weren't allowed to do over the official NASA accounts. And while some limitations could not be circumvented (edicts from supervisors to “be careful about what you tweet,” for example, are difficult to justify ignoring without consequence), other limitations were embraced by participants. Some participants, for example, embraced Twitter's character count as a feature and not a bug, stressing the importance of keeping messaging brief, what Flachs called “the economy of Twitter” (A. Flachs, personal communication, August 16, 2022), a site where brevity and concision were the norm, as opposed to other mediums used to communicate complicated scientific ideas.

Participants were also aware of the individuals and groups for whom they were writing. Remembering that the sixth feature of networks that I outlined above is that networks themselves are rhetorical, and that the formation of them results from choices made because of context and language, we can see the matter of audience as one that is directly related to the networks that participants are forming online and the rhetorical situations they face as they share their messages and form those networks. Every participant identified specific multiple audiences when asked about who their tweets were directed at, and several even acknowledged directly their awareness that they were writing for multiple audiences. Mendoza noted that in writing for NASA, he was writing for “many publics, and many sub-publics” (J. Mendoza, personal communication, March 4, 2022).

In this, Mendoza's words echo thoughts by theorists who have noted that throughout human history, there was not one, but rather multiple public spheres in competition for influence. Habermas (1962) presented a blueprint of the bourgeois public sphere, which included multiple smaller spheres, including economic groups, families, political groups, groups organized around writing, cultural groups, and the State itself. In discussing Habermas's theories of the public sphere, Fraser (1990) pointed out that

virtually contemporaneous with the bourgeois public there arose a host of competing counterpublics, including nationalist publics, popular peasant publics, elite women's publics, and working class publics. Thus, there were competing publics from the start. [...] Moreover, not only were there always a plurality of competing publics, but the relations between bourgeois publics and other publics were always conflictual. Virtually from the beginning, counterpublics contested the exclusionary norms of the bourgeois public, elaborating alternative styles of political behavior and alternative norms of public speech. (p. 61)

Thus, the various publics and counterpublics—and the individuals within them—communicate within and across each other (through what I would suggest is a networked societal structure) to influence decisions and behaviors.

The existence of competing publics and the struggles between them informs communication in a public, online forum. While Twitter began as a simple place for someone to keep friends, family, and coworkers updated with the answer to the question “What are you doing?” (Twitter, 2007), by 2007, this “new thing that was sort of instant messaging and sort of blogging and maybe even a bit of sending a stream of telegrams” was being used by attendees at Austin's South by Southwest conference, by the John Edwards political campaign, and by many others (Levy, 2007). With some limitations, Twitter is a place where it is possible for anyone to read anyone else's tweets<sup>2</sup>, regardless of whom the tweet is actually written for. It is a forum where countless publics coexist and communicate with and across each other.

And Twitter users know this. As discussed above, participants in this study identified many different audiences as they wrote, but they always had specific, primary audiences in mind. And while most of the participants in this study identified “academic audiences” as being one of their primary audiences, different audiences were mentioned more often by participants from different clusters. Aside from academic audiences, Purdue participants largely identified professional audiences—usually meaning agricultural professionals or farmers. Participants from the Black in Environment cluster identified activists and the general public. These two focuses make sense, knowing the context and the content these participants were writing. Several of the Purdue scientists I interviewed work closely with agricultural interests, and so they use Twitter as a way

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<sup>2</sup> I acknowledge here that there is a level of customization available to Twitter users who are able to limit their tweets to their followers or can block specific individuals from interacting with them. But in general, Twitter is designed to be a place where public discussion occurs.

to keep those interests updated on their work. Participants that I connected with from the @BlackinEnviron Twitter account maintained a socially conscious perspective as they wrote—they were working to keep people updated about their work, and their work also addressed issues of social justice. They used Twitter to give the activists they work with the information those individuals needed to take action and advocate for affected communities. With the NASA cluster, the audiences identified were not as cut-and-dry. More often than mentioning a specific audience, NASA participants acknowledged the multiplicity of their audiences before describing some. Academic audiences were the most often named, but mentioned almost as often were nonexperts, climate change doubters, people who do believe climate change is real, and the peers of the writers themselves.

Writing for different audiences—different publics—led these communicators to adopt different priorities and rhetorical strategies, depending on the writing situation. In the following section, we will look more closely at those strategies and their implications.

### **6.3 Networked Rhetorics**

To discuss the rhetorical strategies that participants used as they tweeted, it is worth discussing in greater detail the different purposes participants identified for the selection of tweets that we discussed. In my interviews with them, Purdue participants most often identified their reason for tweeting was to promote publications by other scholars and by themselves, to educate audiences, and to connect with other researchers. Participants from the Black in Environment cluster described a greater number of purposes than Purdue participants did, but the purposes listed were also mentioned fewer times. These purposes included the promotion of publications by other scholars, educating audiences, saving lives, and a general desire to raise awareness. NASA writers stated that they wanted to raise awareness as well, and that they also wrote to inform decision makers and educate audiences. As with the different audiences listed above, the different purposes for writing are tied to these participants and the rhetorical situations they found themselves in as they wrote. Purdue professors, embedded in universities as they are, find importance in the research and publications they and others in their field do. The Black scientists I interviewed similarly saw importance in these publications, but the three participants came from different contexts: one is a researcher at a museum in Chicago, and the other two are currently finishing up their PhDs and doing research work and forming public partnerships with local associations.

NASA writers come to Twitter with the knowledge that they have a larger number of Twitter followers who may read their tweets—as of this writing, @NASAEarth alone has 3.6 million followers. With an audience that broad, “raising awareness” of science and scientific processes would naturally be a high priority; these writers cannot assume that their audience is aware of what they’re writing about, unlike—for example—Purdue scientists, who can assume that their largely academic followers already have some familiarity with the work they are doing.

Participants identified a number of rhetorical strategies as we spoke, detailed in Chapter 5. Because so many strategies were discussed, I’m going to home in on two that seemed particularly relevant in our conversations and discuss those in more detail. First, I’m going to discuss how participants engaged in a process of identification with their readers, and I will then talk about how they focused on emotion as they wrote.

### **6.3.1 Identification**

As I mentioned in the previous chapter, when participants talked with me about the ways they wrote to these specific audiences and for these specific purposes, they recreated a kind of internal dialogue to show their thought processes. Mersmann imagined how an audience might react to a question at the beginning of her tweet: “Oh, God, it’s gonna be more facts. And I don’t have the brain space for facts” (K. Mersmann, personal communication, March 8, 2022). Mendoza did something similar:

A lot of people will say, “Eh, I don’t really care about Greenland or Antarctica.” So I think about those people specifically. And then I think about those people, when I say to them, “Okay, well, these Antarctic ice shelves went through these extreme conditions,” and they’re going to say, “You know, what, I still don’t care. So I’m just gonna keep scrolling.” (J. Mendoza, personal communication, March 4, 2022)

In reenacting this dialogue, participants show that they are thinking about how their audiences may react, but more interestingly, they are taking on internal personas that represent the audiences they are writing to. In these two cases, both Mersmann and Mendoza anticipate objections or disinterest in what they’re saying and think about ways to address those concerns.

I see this internal dialogue as a form of Burkean identification. Burke (1969) writes that to be persuasive, a speaker is only successful “insofar as he yields to that audience’s opinion in other respects. Some of their opinions are needed to support the fulcrum by which he would move other opinions” (p. 56). Successful speakers, then, use language to bridge the gap between themselves

and their audiences, using a variety of stylistic and other rhetorical techniques to build a sense of commonality with those audiences. It could be argued that identification is simply a new perspective on using classical rhetorical strategies (Day, 1960)—it is, in a sense, a form of ethos-building in which speakers present themselves in a manner such that audiences can see themselves there. But I hold that Burkean identification is more than just modifying a message. Instead, communicators should be looking to adopt some of the viewpoints of that audience, to see themselves in a way as *part of that audience*: to genuinely *identify* with them. This identification should be sincere, unfeigned.

It is important to acknowledge that to some degree, the readers that participants imagine are fictionalized. I would also reiterate Ong's (1975) assertion that all audiences are fictional to some degree, but that does not diminish the utility of this strategy. In creating an imaginary approximation of the audience, in taking on the persona of the reader, participants in a way *become* that reader. These writers imagine specific, local audiences in the same way that writers—according to Perelman and Olbrechts-Tyteca—approach universal audiences: the writer appeals to “the image he himself holds of the universal audience that he is trying to win over to his view” (Perelman & Olbrechts-Tyteca, 1969, p. 33).

Indeed, such an approach allows writers to develop other strategies that might effectively work with these audiences. For example, looking at rhetorical techniques that participants used from this lens, it makes sense why so many participants were concerned with hooks. Even when a reader follows someone on Twitter, their Twitter feed is so full of content that there is no guarantee that they will stop scrolling through that feed to read any one particular tweet. In imagining dialogue between themselves and their readers, they imagined what readers may or may not say when seeing specific tweets, and they employed a hook that they felt would encourage those readers to pause their scrolling for long enough to engage with the writing at hand. For example, in discussing a tweet in which he shared a *Vice* article that cited his master's thesis, Muse noted that he wanted the language he used to “prompt” his readers to stop and “look into” the issue further (N. Muse, personal communication, August 5, 2022).

Participants also engaged in a form of identification as they repeatedly reached out to their readers with invitations. Some of these invited readers to specific events; for example, in the tweet shown in Figure 19, Muse (2022c) invites local followers to listen in to a conversation about hurricane preparedness in the Miami area. Other invitations gave audiences the chance to become

part of the research in one way or another: Prokopy invited local agricultural professionals to subscribe to her research team’s newsletter and to join her research through “focus groups, field trials, visioning sessions” (Prokopy, 2022c). Sophie Bates, writing for NASA Atmosphere, invited readers to submit pictures of cloud formations to help with NASA research (NASA Atmosphere, 2022b).



Figure 19: Muse (2022c) shares an invitation for an online community discussion about hurricane preparedness in the Miami area.

In these tweets, we see invitational rhetoric at work. Attributed to Foss and Griffin (1995), invitational rhetoric suggests an alternative to traditional, persuasive rhetoric. This kind of rhetoric invites audiences

to enter the rhetor’s world and to see it as the rhetor does. In presenting a particular perspective, the invitational rhetor does not judge or denigrate others’ perspectives but is open to and tries to appreciate and validate those perspectives, even if they differ dramatically from the rhetor’s own. Ideally, audience members accept the

invitation offered by the rhetor by listening to and trying to understand the rhetor's perspective and then presenting their own. (Foss & Griffin, 1995, p. 5)

Emerging from a feminist standpoint, invitational rhetoric engenders a greater sense of appreciation and value for different perspectives on the parts of both the speaker and the audience. By inviting their audience to join them in some way, participants are both identifying with their audience and asking that audience to—in some way—identify with them. In this way, they reach a sense of mutual understanding. For polemical topics like climate change, this can be extremely beneficial to encourage dialogue and understanding, as well as for discussing strategies on climate change mitigation or reversal.

We also see participants engage in identification with their audience through the use of conversational language. In one tweet, Andrew Flachs writes that “toxins bioaccumulate and harm other life because they are...poisons” (Flachs, 2022). In my interview with him, we discuss his use of the ellipses, and he noted that he saw it as a way “to have somebody read something in the way that you [...] were speaking it” (A. Flachs, personal communication, August 16, 2022). Here, Flachs consciously works to create a conversational tone, writing in a way that he imagines his audience reading, and thus identifying with them.

For participants in the Black in Environment cluster, participants' conversational language was often employed to appeal to individuals in Black communities that are particularly affected by issues related to climate change or have experienced similar challenges in academia:

I do try to be my full self and speak to my followers in the same manner that I speak to my friends and family. There is this idea that Black professionals need to “code switch” in professional atmospheres. I consciously do not code switch on twitter in an effort to defy that pressure and show early career or aspiring scientists that they can bring their full personality and identity to science and it only helps them to do this because we can connect with broader audiences. (R. Scarlett, personal communication, July 26, 2022)

Scarlett thus engages in rhetorical identification using this conversational language, refraining from code switching into a more “academic” tone in order to draw closer to that audience and improve the effectiveness of her messaging. In this way, Scarlett's writing helps identify her with other Black Twitter users, whose “refusal to code switch” marks a similar “refusal to perform for a White gaze, whether a White media gaze or the gaze of White and other non-Black Twitter users” (Gilyard & Banks, 2018, p. 84). It is through this conversational language that Scarlett achieves this kind of identification.

In both cases above, the conversational language used is adopted specifically with audiences in mind. And indeed, remembering *who* these audiences are can remind us that, through identification, rhetors earnestly adopt features of their audiences. Flachs comes from the Purdue cluster, and he (and the rest of the cluster) identified his audience as being fellow scholars and academics. In creating a conversational dialogue (and noting that in this same tweet, he discusses a technical process: the accumulation of biotoxins), it is clear that he envisions himself as “speaking” to peers, and he uses language to simulate that speech. Similarly, Scarlett mentioned in her interview that it was important to her to reach aspiring scientists and early-career scholars from Black communities. Using this conversational tone, she is reaching out specifically to individuals from these communities.

When I asked participants about their best practices, several of the ones they listed are related to this strategy of identification. Stylistic concerns such as “put the most interesting content right up front” (J. Dukes, personal communication, February 16, 2021) or “have something that’s engaging” (S. Bates, personal communication, February 11, 2022) correlate with participants’ thoughts about how they might best reach audiences. Mendoza mentions as a best practice gaining and maintaining a “comprehensive understanding of institutional knowledge” about the institutions in which writers are both embedded, write about, and write for (J. Mendoza, personal communication, March 4, 2022). In these situations and others, participants acknowledge the need for writers to think about and identify with audience concerns, and—in a way—adopting those same concerns as they write.

### **6.3.2 *Affect, Emotion, and Persuasion***

The second rhetorical strategy that participants used in their online writing that I want to spend time discussing is the appeal to emotion. It’s important to note that participants did stress the importance of sharing facts and correcting misinformation in their tweets, but more often than that was the use of humor, emotional language, amusing images and emojis to appeal to their readers’ emotions. The power of using emotion in science writing has been discussed frequently in recent years (Davies et al., 2019; Joubert et al., 2019; Nabi et al., 2018; Yeo & McKasy, 2021). The consensus among these studies is that adding a measure of emotion to factual discussions of science will be more effective than writing without that emotion. This is by no means a new

argument, of course. Aristotle (2007) connected emotion to the ways people “come to differ in their judgments” (p. 113). But what is it about using emotion in our discourse that is so effective?

To understand this better, I turn to affect theory. According to Seigworth and Gregg, affect is what we call those “visceral forces beneath, alongside, or generally *other than* conscious knowing (2010, pp. 1–2). Writers who discuss affect often use the term “visceral” (Anderson, 2014; Schaefer, 2015; Seigworth & Gregg, 2010; Stark, 2018): it is an embodied sense connected to those organs that feel impelled in highly charged moments, like the sight of a wasp or the first glimpse of the Grand Canyon. Affect and emotion are connected and often conflated—and theorists have discussed the difficulty in distinguishing the two, to the point that Nelson (2016) suggests that it would be better for scholars to analyze and theorize affect and emotion together rather than separately.

I see affect and emotion as critically connected and essential in understanding human decision making. We may think we make decisions based on facts; however, research suggests otherwise. In a study still cited today, psychologist Robert Zajonc (1980) revealed that our decisions are motivated by emotion more than they are by rational thought. We may consider our options, weigh the pros and the cons, but in the end we will go with what “feels” right and then after the fact use our rational analysis to justify our decision. Zajonc writes that

complete and thorough computation is not performed before the decision. We buy the cars we “like,” choose the jobs and houses that we find “attractive,” and then justify those choices by various reasons that might appear convincing to others who never fail to ask us, “Why this car?” or “Why this house?” We need not convince ourselves. We know what we like. (p. 155)

Tapping into someone’s emotions, then, can change their decision-making, and in turn can change their behavior.

Technology can serve as a powerful medium for affect and emotion. Zizi Papacharissi’s (2015) book *Affective Publics* examines the ways that social media can act as a conduit for affect in cases of social unrest such as the Arab Spring or the Occupy Wall Street movement. Much in the way that I trace human and nonhuman connections across climate science communication on Twitter, Papacharissi analyzes the use of specific hashtags during the span of these social movements. Papacharissi concludes that social media does not *generate* the affect in these situations, but rather that it *enables the transmission* of the affect. She goes further than just these movements as well, analyzing the ways in which personal expressions in a digital public forum such as Twitter “bears the potential of a political act” (p. 111). Social media networks connect

individuals, communities, even countries, and those networks facilitate the transmission of affect across and through those networks. Social media gives virtual space for affective events such as community formation and expressions of dissent or solidarity. And the value of such emotion being transmitted online is understood by people in those online communities.

I see my own study as an extension of Papacharissi's work. Participants freely admitted that they saw social media as a place where users were meant to share their emotions: "To me, that's what you're supposed to do on Twitter. That's how I've known Twitter" (R. Scarlett, personal communication, July 26, 2022). And they consciously used a variety of techniques to appeal to the emotions of their readers, including emotional language, playfulness, and fun emojis. They also included their fair share of jokes. Katy Mersmann, writing for NASA Earth, described the work of a new satellite by starting her tweet with a pun: "Do launches make anyone hungry? This one is carrying nachos! Er...NACHOS-1, a small satellite to find sources of trace gases [...] an appetizer for further atmospheric study from space" (NASA Earth, 2022c). In her discussion with me, Mersmann described a meeting she was in where the name of the NACHOS-1 satellite caused the room to erupt in a series of jokes about nachos: "It had to be some kind of a joke, because the meeting erupted when this came up. We couldn't just let it go. So then it was a matter of how do I fit in a joke and also what the satellite does" (K. Mersmann, personal communication, March 8, 2022). Even writing from a professional account (NASA Earth), Mersmann knew the power that the humor would have in this tweet in drawing in the attention of her audience.

As I analyzed participants' tweets, I noticed that they used positive emotions more often than negative ones. The negative ones did appear, of course: climate change is a serious subject, and sometimes the weight of it deserves gravity, whether it is a discussion "poisoning" the environment (Scarlett, 2021d) or current events that seem to put roadblocks in mitigation or reversal effects (Prokopy, 2022a). Both of these tweets are notable because, in spite of the negative emotion expressed, there are also seeds of hope. Scarlett thanks the activists fighting to improve conditions, and Prokopy's frustration is expressed only after she describes being "hopeful for the future" after "an amazing and uplifting focus session with farmers."



Figure 20: NASA Earth (2022c) tweet using humor while discussing the work of a satellite.



Figure 21: Tweet by Scarlett (2021d) thanking activists for their work in Los Angeles County.

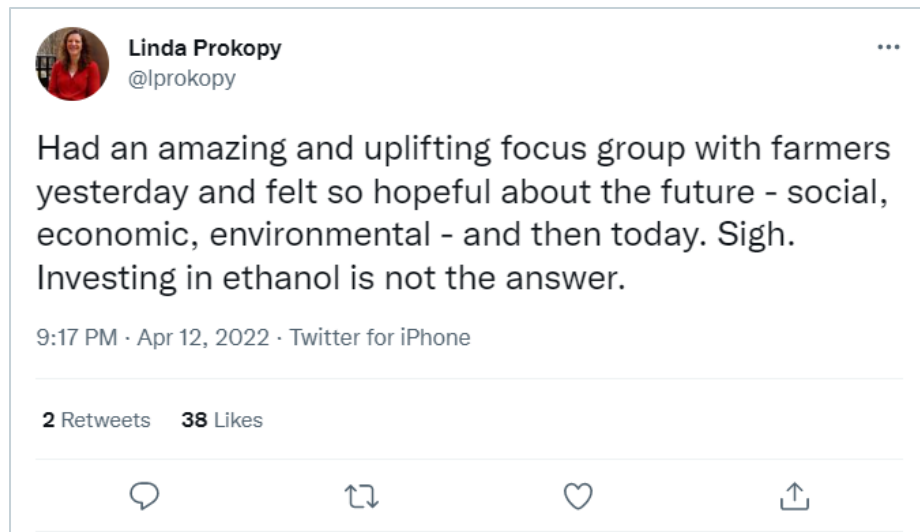


Figure 22: Tweet by Prokopy (2022a) describing the hopeful emotions after a positive focus group experience, paired with discouragement from current events.

The positivity expressed in these tweets is not accidental. Every participant addressed the value they saw in being positive. As mentioned in the previous chapter, Laura Bowling told me that “a more positive message, emphasizing solutions, can get us further than browbeating” (L. Bowling, personal communication, May 24, 2022). Tremblay said that she liked her “feed to be really positive and fun, and that’s the type of content that I try to put out, too” (M. Tremblay, personal communication, March 29, 2021). Prokopy echoed these sentiments: “people like positive people,” and that she aspired on Twitter to “be somebody people want to follow, want to connect to” (L. Prokopy, personal communication, July 27, 2022). Muse talked about the balancing act of treating climate change and climate justice as the serious issues they are while also using humor and playfulness, “showing the seriousness of it, but also poking fun at it in a way” (N. Muse, personal communication, August 5, 2022). All of these participants seem to be reinforcing ideas discussed by Nabi and others (2018), whose study emphasized hope as one of the most powerful emotions that communicators could leverage in climate change communication.

I should note that negative emotions do have their power. Chu and Yang (2019) argue that negative emotions have more of an impact than positive ones. And, as discussed in Chapter 2, digital spaces are often sites where bad actors can coopt tools and conversations in negative ways that may gain traction in ways that gains more followers (Potts et al., 2019; Trice & Potts, 2018). And participants in my study noted this as well: as Burns noted, “you might actually get more

engagement when you focus on the negative sometimes” (personal communication, August 24, 2022). Online marketing, clickbait, and other factors have made an industry out of generating clicks from negative emotion. That said, Burns added that with such a negative focus, “I sometimes feel like it cheapens the tweet.” Remembering that these participants are writing for specific audiences that they identify with, they tweet messages they would want to read, which in their case means that they are keeping their tweets positive for others, even knowing that using negativity might increase reader engagement and even gain them more followers.

Several participants saw using emotion as an essential feature of their writing, so much so that they listed it in their best practices. Scarlett spoke about the importance of being “unfiltered” on Twitter (R. Scarlett, personal communication, July 26, 2022). Tremblay emphasized the benefits of using humor, while Bowling discussed the importance of keeping Twitter “positive and not using it as a vehicle for airing dirty laundry” (L. Bowling, personal communication, May 24, 2022). To participants, Twitter is by nature a place where people share emotion. Staying true to that can not only help get their messages out, but also make those messages more effective.

## **6.4 Questions of Diversity**

It is also worth discussing the ways that participants address questions of diversity as they write online. As I mentioned in Chapter 5, my conversations with participants did not often turn towards the topic of diversity and inclusion, but the topic *did* come up in ways that showed how important it was for audiences. As might be expected, participants from the Black in Environment cluster, whose audiences included other Black scientists and activists, spoke about diversity more frequently than other participants. All three participants quote tweeted messages from other Black scientists, highlighted the work of Black scholars, and thanked activists in Black communities. Again, remembering questions of identification and how we can connect with our readers, this makes sense.

I have discussed Black Twitter to a small degree in Chapter 5, but it is worth spending some more time here. As I defined earlier, Black Twitter is that collection of Black individuals who use Twitter for purposes specifically for the Black community. Black Twitter serves as both “public, counterpublic, and underground” and serves broad public needs as well as narrower, more everyday ones (Gilyard & Banks, 2018, pp. 85–86). While the broadness of its purposes and the constantly amorphous and transnational nature of the coalitions within it (which, I acknowledge,

sound very assemblage-like), Black Twitter can be difficult to study (Lockett, 2021). But in many ways, it is that amorphous nature that gives it power to create “critical posthuman coalitions and affirmative bonds” (Prasad, 2016).

By its very nature, Black Twitter serves as a striking illustration of the power of networks. Scholars have noted how many features of Black Twitter find themselves making their way into other conversations by non-Black individuals. Gilyard and Banks (2018), for example, discuss “the THIS!!!,” which is a technique originating in Black Twitter now used by individuals across the platform (p. 91). This technique consists of quote tweeting a tweet with a simple affirmation of agreement, often the word “This!” with occasional brief commentary. The quote tweets that I discussed with participants from the Black in Environment cluster almost all followed this pattern, and in this way, that stylistic flourish emphasized the interconnectedness of individuals throughout the Black scientific community. Here, we see networks being built and strengthened.

Participants from other clusters also found ways to tweet or talk about diversity. As shared in Chapter 5, Prokopy tweeted a link to a list of readings about how white academics “can and must do better around diversity, equity, and inclusion in our own ranks” (Prokopy, 2022b). NASA writer Sophie Bates shared a link to an interview she gave that discussed how “O<sub>2</sub> levels for communities of color were still higher than the pre-pandemic NO<sub>2</sub> levels for the whitest communities” (Bates, 2021b). In an interview, Bates discussed the importance of highlighting the struggles of these different communities: “It makes it more local. And I think it’s respectful of the people in those cultures that live in these places” (S. Bates, personal communication, February 11, 2022). In just these two examples, we see calls to action (read to make oneself better) and a local focus on communities as ways to emphasize the importance of keeping diverse perspectives in mind as science is communicated. And diversity and inclusion were seen as so important that several participants listed it when describing their best practices. Bates and Prokopy both mentioned the importance of using alt text with images, for example, to make those images more accessible to visually impaired readers. Burns stresses the importance of writing in a way that keeps the writer open to individuals from different backgrounds.

## **6.5 Takeaways**

Over the course of this dissertation, I have discussed strategies of networking and rhetoric that participants used. But what can we take away from all of this?

In the pilot study that I shared in Chapter 4, I offered three takeaways<sup>3</sup> that are worth revisiting. First, my pilot study found that *networking is both a result and a purpose*; that is, much like Deleuze and Guattari’s assemblages, participants saw networking as both an action and the thing that results from that action. Second, *networks are heterogenous, and the building of networks is as well*: with just three participants in the pilot study, I saw a very large number of reasons for networking being expressed. I saw this as a feature of networking rather than a bug—the diversity of individuals who network results in a myriad of reasons for networking, and diverse, exciting networks result as these individuals interact with each other. Third, *science writers are aware of context and audience when they network*. This takeaway is a result of the tacit knowledge I saw being used across participants: they wrote for specific groups and used specific strategies for those groups. Feedback from readers suggested that these takeaways, while valuable, were of stronger value in showing me that my study was a viable one, but that in wider applicability they may be on the obvious side. After expanding the study to an additional nine participants, I find that these original takeaways hold true. But I would like to add four more takeaways that scholars of rhetoric, writing, and communication can use as they both write online and teach others to communicate online.

### **6.5.1 Takeaway 1: Take Control of Our Networks**

Related to the first two takeaways from my pilot study, I encourage writers to take control of their networks. In this, I connect my research here to research I have participated elsewhere about the importance of creating a visible infrastructure within collaborative settings (McMullin et al., 2022). In this research, we discuss that to make effective teamwork happen, attention needs to be paid to make visible the often-unseen infrastructural elements—both technological and human—that make up a project. Making these infrastructural elements visible can help team members create an environment where they can work together more equitably.

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<sup>3</sup> I also offered a fourth takeaway about mapping networks (which can be read in Chapter 4). Because this project ballooned in size and mapping seemed out of reach, I won’t revisit that takeaway here. See the “Future Research” section later in this chapter for more on mapping.

I would argue that such attention to infrastructure is also important for writers writing alone. As seen above, when tweeting, participants were influenced by a variety of human and technological factors. Being aware of those factors can not only help us write more effectively in our specific situations. Careful networking can also help us broaden (or narrow, depending on the situation) our audiences, and it can also be used to create a sense of ethos. For example, taking time to use specific tags or hashtags is one effective way that participants thought about getting their messages out. In one tweet, Jessica Evans pointed out that a recent music video from Beyonce used a NASA visualization, and in her tweet, she tagged Beyonce (Evans, 2021). In her interview, she explained that she didn't tag Beyonce thinking to get any actual engagement from the artist or her publicists. Instead, she did so "to let anyone know who did come across my tweet [...] that it was not a knockoff. The actual, legit Beyonce used our video. [...] That was just an authenticity marker" (J. Evans, personal communication, April 1, 2021). Careful consideration of who we network with, or of the technologies we surround ourselves with, can facilitate effective communication.

### ***6.5.2 Takeaway 2: Even Public Writing Should Be Directed***

Repeatedly, participants pointed out that they were writing for specific audiences, but they also knew that Twitter was a place where anyone might see what they are writing. I would argue that what we learn here is that even public writing should be directed at specific individuals or groups. Prokopy mentioned that, while she knew that she wanted to share messages about climate change, she had to do so in a way that would not turn away the large contingent of Midwestern farmers that she frequently partnered with (L. Prokopy, personal communication, July 27, 2022). This meant that Prokopy had to navigate writing in a public space, knowing that even writing for one audience, another may read what she writes.



Figure 23: Tweet by Evans (2021) in which she shares a NASA video that was used in a recent Beyonce video. In writing this tweet, she decided to tag Beyonce.

All participants navigated their various audiences by engaging in different kinds of identification, whether that be through the use of internal dialogue, conversational language, or other strategies. The key, though, is that they were thinking about those audiences—those other parts of the network—along the way, asking themselves how their writing might be received. And yet, they still stayed focused. Scarlett, Muse, and Burns all reached out to various individuals and groups connected to @BlackinEnviron, @BlackinChem, and other associations of Black scientists. Even NASA accounts, with their large number of followers, frequently reached out to specific ones, asking for assistance from “citizen scientists” (S. Bates, personal communication, February 11, 2022) to contribute photographs to help with research, or publishing calls for scientists to apply for a job at NASA (NASA Ice, 2021c). These specific messages, meant for specific audiences, strengthen the ties between those nodes of the network and make it more possible to effect change among those audiences.

### **6.5.3 Takeaway 3: *Engage with Emotion***

Overwhelmingly, participants not only often wrote in ways that seemed to appeal to audience emotions, but they also stressed in their interviews that they did so purposefully in their scientific tweets. While it is important to not further spread misinformation in our online communications, it is important to note that emotional writing can be more persuasive than facts. As discussed above, we make decisions based on emotion. Repeated decisions become habits, and repeated habits become behavior. If we want to change behavior, we may benefit from sharing emotion through our networks, whether that be through humor, emotional language, or simply being “unfiltered” (R. Scarlett, personal communication, July 26, 2022).

I would also add the importance of being positive in our communication. It may be true that, as Chu and Yang (2019) point out, negative emotions can spur action more easily than positive ones. But in talking with participants, most of them described wanting their online networks to be places of positivity. Tremblay spoke of actively curating her Twitter feed to make it a more positive, uplifting place (M. Tremblay, personal communication, March 29, 2021). A negative message may spur some in one’s network to action, but how many others will tune out entirely? Positive emotions like hope can encourage people in our networks to continue their efforts in sharing messages and in acting to mitigate the effects of climate change while also encouraging them to connect more closely to us, thus making it possible for us to continue sharing our message.

#### **6.5.4 Takeaway 4: Teach Writing as a Networked Process**

Finally, I do want to briefly share one final takeaway: in technical and professional communication, we frequently describe the importance of remembering both primary and secondary audiences as we write. It may be useful to use concepts discussed here with our students. If we help them identify and see the networks they are part of, if they see how others write within and for those networks, they can better conceptualize how their writing may be received across those networks. Even writing not done in a social media space takes its place within a network and has the power to impact any number of stakeholders.

We can emphasize the networked nature of communication through all stages of the writing process. We might encourage students to map out their own networks, including identifying the nonhuman elements that impact how they write (and especially identifying network elements that facilitate and challenge them in their writing). We might encourage students to map out potential audiences in terms of a network map rather than just a list—who are those audiences, and how are they connected to each other? How might audiences pass the messaging on to other potential audiences, and how might students keep that possibility in mind as they write? As we generate classroom assignments and activities that encourage students to visualize and write for those networks, we can incorporate many of the principles that I share here in ways that can improve students' networked communication through technologies both traditional and emerging.

### **6.6 Some Concluding Remarks**

#### **6.6.1 Limitations of Study**

As I come to the end of this dissertation, I find it important to acknowledge some of the limitations of the research. First, I want to restate that the analysis here emerges from a very limited number of participants. The network I followed here consisted of 12 individuals. While these individuals do excellent work as they share research about climate change online, it is not the only work being done. As I mentioned in Chapter 3, at one time I thought that I might engage with the writing of Native American or Caribbean scientists, and I still think the writing those individuals brings to this discussion may both confirm and complicate these findings. I also acknowledge that both myself and my participants all come from a very specific, university-trained background. Every participant was either a scientist or a trained science communicator. It might be interesting

to look at the networked communications of other individuals outside of science or academic circles to see what additional tacit knowledges may emerge.

I should also stress again that my background as a white scholar from Indiana influenced and limited the study. I have mentioned in several places that discussions of diversity and inclusion were limited, that Black Twitter did not come up in my discussions with Black participants. Some of this almost certainly emerged from some of my own blind spots as a white man—perhaps these conversations did not go deeper because I wasn't asking the right questions, questions that did not even occur to me because I am an outsider to these communities. Deeper conversations with Black Twitter users would almost certainly result in data that reflects those topics that, while I did not delve into them to the degree deserved, absolutely merit investigation.

Similarly, the data I gathered originated with a limited number of tweets. From each of my 12 participants, I only examined about 20 tweets, working backwards from the day I identified the participant. This means that if I found a participant in June and they had tweeted 20 times between May and June, I wouldn't have chosen any tweets from earlier than May, even if April tweets may have resulted in a very different dataset (and, by extension, a different set of questions for the discourse-based interview). This is one of the challenges of the discourse-based interview: we only talk with participants about the discourse at hand.

Another limitation to this study is the focus on the more positive, generative side of online discourse. Participants did acknowledge that they on occasion did need to deal with internet trolls and other negative aspects of communication on Twitter. That said, this study ended up focusing more on positivity largely because the tweets that I chose (again, arbitrarily chosen based on the day I started looking at those tweets) had more examples of positivity than negativity. This abundance of positivity was unexpected, and it generated specific questions and discussion in the interview, which resulted in more data that focused on positivity. When talking about network-building, I have found that conversation generally skews positive: we like to focus on the positive aspects of our networks, and often don't consider the trolls or the arguments to be part of that same network (even though they are). Study into this negative online discourse and the dark side of networking would be warranted, because it *does* exist. But the limited sample of participants and tweets led to data that pointed me in different directions here.

At the same time, the goal here was not to create a comprehensive databank of rhetorical and networking techniques, but rather to learn from the tacit knowledge of participants by looking

at a very specific slice. This is a feature of the research, not a bug. And the conclusions I draw here should be taken as conclusions drawn from a very narrow dataset—these are not necessarily takeaways that would (or should) apply in every situation. Instead, I view these as conclusions drawn from online science communication that may be useful for others similarly communicating online. While there is an argument to be made that these results would be applicable in other settings as well, further research *in those settings* would be required to confirm my suspicions.

### **6.6.2 Future Research**

Like networks themselves, this research could branch off in a variety of different directions, but there are three that I see having definite potential: the mapping of the networks, the expansion of the study into other networks, and research about how best to teach the networking principles discussed.

When I began this project, I originally planned to create maps of the networks as I saw them emerging through Twitter data and interviews. Maps can be used to visualize connections between large amounts of distinct and diverse data, and thus can prove insightful in finding otherwise elusive connections (Angeli, 2018; Soja, 2011). As my analysis deepened, I realized that the work of mapping this data was a different project, a next step, rather than the project itself. Going forward, I would like to look at the different connections identified by participants and see where the crossover lies, examining influences both common and unique to each participant and each cluster.

As discussed in the previous section, the limited data here also precludes my ability to apply my conclusions across multiple types of communication. This is a specific type of communication in a specific, online setting. Expanding the study out to other platforms and types of communication (does networking on Reddit function differently? What about intra-organizational communication like emails, proposals, memos?) is a logical step to triangulating the data and results across different networks and would further validate my process of data collection and analysis.

The data I have analyzed and discussed here could also be used to be extended further into classroom contexts. How do we teach students to write in networked situations, using the principles uncovered in my discussions with participants? How might we teach students to replicate similar research and discover their own findings in fields that matter to them? Extending

the research into classroom contexts will provide essential guidance on improving our pedagogy surrounding networking and social media writing, skills that are essential for students in numerous disciplines.

### ***6.6.3 Networks, Rhetoric, and Behavior***

While I have focused on how participants communicate and network on Twitter, this dissertation isn't just about Twitter. It's not even just about social media. It's especially important to discuss how the principles discussed here can transfer to other contexts in the light of recent events at Twitter: in recent months, billionaire Elon Musk purchased Twitter and began rolling out a series of new features and policies while also reconfiguring the company and making many fear for Twitter's future as a platform (Siddiqui & Merrill, 2023). While as of this writing Twitter still exists, there is no guarantee that it will continue to do so. At the very least, it is in the middle of a metamorphosis into something new. This is not unique to Twitter: any social media platform could change form or cease to exist at any time.

But the principles of networking and rhetoric underlying the specific mechanics of Twitter persist. What are tagging and hashtagging but ways to reach out to others, to call attention to details, to broaden a network or categorize a message? The findings of this dissertation reinforce the power of both weak ties (Granovetter, 1973) and strong ones (Centola, 2020). It is through these connections that people come into contact with different ideas, and ultimately, it is through these connections that, one by one, people may change behavior, eventually reaching a critical mass, a point at which the behavioral change is normal and, even, expected (Oliver et al., 1985). In the face of misinformation surrounding climate change, in the face of actions that continue to affect the environment, such networks become ever more essential to change minds and behaviors. Whether science communicators are writing on Twitter, on a blog, in a book, or even communicating in other mediums or modes entirely (news interviews, podcasts, infographics, and so forth), keeping in mind ways to identify with audiences and how to effectively and ethically engage with the emotions of those audiences can help spread messaging about climate change. In this dissertation, I have seen the work of twelve individuals doing this kind of work, and through my conversations with them, I am convinced that the knowledges that they bring to their communication does serve to change minds and behaviors, and—eventually—may lead to changing the world itself.

## APPENDIX A. RECRUITMENT MATERIALS

### A.1 Sample Recruitment Email

Below you will find a sample email sent to Marissa Tremblay on February 23, 2021. In this email, I attached a one-pager that described the study (included here in Section A.2). I have redacted personal contact information from the email. I have retained formatting from the original email export to Word.

From: XXXXX  
Sent: Tuesday, February 23, 2021 12:40 PM  
To: Tremblay, Marissa  
Cc: Dilger, C Bradley  
Subject: Request to Participate in Study on the Rhetorics and Networks of Public Research  
Communication, IRB-2019-158  
Attachments: Recruitment One-Pager-Researcher.pdf

Hello Dr. Tremblay,

I hope the semester is treating you well and that you and yours are staying safe during the pandemic. We are reaching out to you because we are doing a study on the online, public communication of researchers and professionals whose work touches on the effects, impacts, and communication about facts surrounding climate change. You are ideal for this study because of your use of Twitter to share your work and to connect with the work of other researchers and institutions in earth science.

We would like to set up a time to discuss this study further, where we will also discuss the possibility of your participating in one or two interviews for our study. Would you be free to have a conversation via Zoom in the next week? We can go over more details of the study then and (if you are still interested) set up a time for an actual interview.

I have attached a one-pager that describes the study in more detail. If you have questions, comments, or concerns about this research project, you can talk to one of the researchers. Please contact Bradley Dilger, XXXXX, or Shelton Weech, XXXXX.

To report anonymously via Purdue's Hotline, see [www.purdue.edu/hotline](http://www.purdue.edu/hotline). If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at 765-494-5942, email ([irb@purdue.edu](mailto:irb@purdue.edu)), or write to

Human Research Protection Program  
– Purdue University Ernest C. Young  
Hall, Room 1032 155 S. Grant St.  
West Lafayette, IN 47907-2114

Thank you,

Shelton Weech  
PhD Student, Rhetoric and Composition  
Department of English  
Purdue University

## A.2 Recruitment One-Pager

Here I have included the one-pager that I attached to recruitment emails.

### **The Rhetorics and Networks of Public Research Communication** Invitation to Participate in Research

#### The study

This study seeks to investigate the rhetorical choices that researchers make when they speak about their work on social media and on other digital platforms, as well as studying and identifying the networks they make as they do so. In this study, we will be examining the social media and online activity of participants as they discuss their research, as well as conducting interviews with them for the following: to discuss with them the choices that they make as they compose their online discussions and networks, and to execute member checks with them to discuss my findings from their online discourse.

We will also be examining the ways that these participants are influenced in their communications by interviewing individuals who help guide the choices that researchers make when presenting their research to the public. These individuals may include public relations officers, managers, supervisors, department heads, etc.

In pursuing this study, we hope to discover rhetorical strategies that are more effective than others in order to help other scientists and professionals utilize those strategies in their own public communications. We hope to find ways in which researchers and professionals utilize online media to motivate their audience to action (Warnick, 2007; Bazerman, 2004). We also hope to discover the ways in which networks of individuals and technology (Spinuzzi, 2008) play a part in these rhetorical strategies and how professionals can take advantage of the networks they create to make the effectiveness of their communication.

#### How you can contribute

If you are involved in the public communication of research in any of the ways listed below, we would love to interview you for this study.

- You are a researcher who communicates your research publicly via the internet, or
- You are someone who influences the public communication of researchers, either through direct interaction with researchers, or indirectly by authoring protocols or guidelines for researchers to follow when communicating their research.

If you are interested in becoming involved with this study, please reach out to us for more details.

### A.3 Spanish Recruitment Email and One-Pager

At one point, my plan was to expand this research into countries in the Caribbean or elsewhere in Central or South America. While this plan did not pan out (see Chapter 3 for more details), I did translate a number of recruitment documents into Spanish. Here I include Spanish versions of the recruitment email and one-pager.

#### A.3.1 Spanish Recruitment Email

Asunto: Solicitud de participación en el estudio sobre la retórica y las redes de comunicación pública de investigaciones, IRB-2019-158

Estimado \_\_\_\_\_,

Nos ponemos en contacto con usted porque estamos haciendo un estudio sobre la comunicación pública en línea de investigadores y profesionales. Usted sería ideal por este estudio porque **[(1) habla del trabajo del investigador y sus interacciones públicas en línea, O (2) habla de las comunicaciones que influyeron a los participantes]**. Nos gustaría concertar una cita para seguir hablando de este estudio, en la que también hablaremos de la posibilidad de que participe en una o dos entrevistas para nuestro estudio.

¿Estaría usted libre para dialogar en **[insertar hora y lugar]**?

Si usted tiene preguntas, comentarios, o dudas sobre este proyecto de investigación, usted puede hablar con uno de los investigadores. Por favor, póngase en contacto con Shelton Weech en +1-818-967-9387 o [sweech@purdue.edu](mailto:sweech@purdue.edu), o Bradley Dilger en +1-309-259-0328 o [dilger@purdue.edu](mailto:dilger@purdue.edu).

Para informar de forma anónima a través de la línea directa de Purdue, consulte [www.purdue.edu/hotline](http://www.purdue.edu/hotline). Si usted tiene preguntas sobre sus derechos mientras este tomando parte en este estudio, o si tiene dudas sobre el tratamiento de participantes de esta investigación, llame al Programa de Protección de la Investigación Humana al 765-494-5942, mande un correo electrónico a [irb@purdue.edu](mailto:irb@purdue.edu), o escriba una carta a:

Human Research Protection Program – Purdue University  
Ernest C. Young Hall, Room 1032  
155 S. Grant St.  
West Lafayette, IN 47907-2114  
United States

Muchas gracias.

### ***A.3.2 Spanish One-Pager***

## **El retórico y las redes de la comunicación pública de investigaciones**

### **Invitación para participar en la investigación**

Nosotros le invitamos participar en un estudio de investigación. Le hemos identificado como posible participante en una entrevista con NOMBRE, que ha aceptado participar. Este documento describe el motivo y lo que le pedimos que haga si usted acepta la invitación.

#### El estudio

Nuestro estudio busca investigar las elecciones retóricas que hacen los investigadores cuando comparten su trabajo en las redes sociales y en otras plataformas digitales, así como estudiar e identificar las redes que construyen cuando comunican en estas plataformas. En este estudio, examinamos las actividades de los participantes en las redes sociales y en línea cuando comparten sus investigaciones. Conduciremos entrevistas con los participantes para conversar sobre sus elecciones cuando compongan sus comunicaciones en línea y en redes.

También estamos examinando las maneras en que los participantes sean influidos en sus comunicaciones por individuos quienes ayudan a guiar las decisiones que investigadores toman cuando compartan sus investigaciones al público. Entre estos individuos se podría incluir funcionarios de relaciones públicas, gerentes, supervisores, jefes de departamento, etc. Ahí es donde entra usted: nuestra entrevista con NOMBRE describió la forma en que usted influyó sus escritos y comunicaciones, y nos gustaría realizar una breve entrevista con usted para obtener más información.

**¿Interesado?** Háganoslo saber. Compartiremos nuestro formulario de consentimiento y responderemos a cualquier pregunta que tenga. Si usted participa en el estudio, podemos asignarle un seudónimo y ocultar su identidad si lo prefiere.

**¿No le interesa?** Usted se puede escribirnos para declinar – o simplemente puede ignorar este email. Si usted no acepta participar, no lo identificaremos en nuestro estudio cuando informamos sobre nuestra entrevista con NOMBRE>

**¿No está seguro?** Nuestro sitio de web describe nuestro estudio en más detalle (en inglés—si necesita traducción, díganos y podemos proveerla). Si tiene más preguntas, háganoslo saber.

<https://www.sheltonweech.com/dissertation.html>

En este estudio, esperamos descubrir estrategias retóricas que sean efectivas y comprobadas que puedan ayudar a los científicos y a los profesionales a crear comunicaciones públicas más sólidas. Esperamos encontrar formas en que los investigadores y los profesionales utilicen los medios en línea para motivar a su audiencia a la acción (Warnick, 2007; Bazerman, 2004). También esperamos descubrir formas en que las redes profesionales y técnicas (Spinuzzi, 2008) juegan un papel en estas estrategias y cómo los profesionales aprovechan sus redes para fortalecer sus comunicaciones. Si usted participa, su participación ayudaría, y nosotros esperamos saber de usted pronto.

## APPENDIX B. SAMPLE INTERVIEW GUIDE

Here I include a sample Interview Guide for one of my early participants, Marissa Tremblay. The guide opens with some introductory materials, a few broader questions, and then moves into specific questions about Tremblay's tweets. The questions here are copy/pasted directly from my copy, and I have left any errors or typos intact.

### Marissa Tremblay Interview Guide

---

#### Introductions:

- Reintroduce myself, my research.
- Ground rules of interview
  - a. We will be conducting a “discourse-based interview” in which we look at pieces of your writing and talk about that writing, the strategies, thoughts, feelings, and contexts that went into creating it.
  - b. Before this meeting, we sent you a document with the writing we would be discussing as well as a brief outline of some of our preliminary findings as we examined those materials. We will be looking at specific places in that writing where we see significant rhetorical choices being made regarding the crafting of your messages as well as the building of networks.
  - c. As we discuss your writing, we will also be looking at other writing that influences you (departmental guidelines, public relations documentation, etc.). You are under no obligation to share any of this writing with us if you do not choose.
  - d. The recording of this interview and other data we gather will be stored on secure Purdue servers.
- This project:
  - a. We are looking to examine the rhetorical choices and networks that researchers in climatology make and create as they share their research publicly via social media or other public, online forums (such as Twitter).
  - b. As our country (and our world) becomes increasingly divided and divisive, we are hoping to uncover strategies that are useful and unifying that can be shared so that the urgency of climate change can be better communicated to the public.
  - c. Methods:
    - i. Analyze public-facing messaging (starting with Twitter, but potentially looking elsewhere).
    - ii. Reaching out to researchers who share their work (and the work of others) on Twitter to conduct an interview such as this.
    - iii. Finding other influences on the creation of this writing.
    - iv. Tracing connections via Twitter or mentions in interviews to find additional researchers or influential figures who we can interview.

- v. We will then analyze the data from both Twitter and the interviews in greater detail to see what we find.

### **Introductory Questions**

1. Do you have any questions about either of us or the research project and its methods?
2. What value do you see, if any, in sharing your research with a large, public audience?
3. What benefits if any, do you imagine might come from sharing this research?
4. Because we take a participatory view of ethics in our research, we want to make sure that the people who participate in our studies have a say for how they interact with us, as well as give them a chance to offer feedback once we have preliminary findings, in order to make sure that they are represented ethically and equitably. What are your expectations for participation, feedback and involvement in the discussion and conclusions of this study?

### **Broader Questions about Tweets:**

5. Tell us about the planning you do before you write a tweet.
6. Of the tweets we sent you, are there any you would like to pay particular attention to or discuss?

### **Audience Questions**

7. In comments F and L (Tweets # 5 and 12), you respond to requests to describe elements of your research in emoji and gif form. What kind of audiences do you hope are reading these tweets?

### **Network Questions**

8. In comments A, K, and M (Tweet #1, 10, 11, and 14), you tag different people in these tweets. When do you generally choose to tag someone? Would you ever just write their name out instead of tagging them?
9. In comment G (Tweet #6), you ask those reading your tweet to give “feedback” on a “technical note.” Why use Twitter to reach out for feedback in this way?
10. In comment J (Tweet #9), you use Chirpty.com to create a “Twitter interaction circle” (from [www.chirpty.com](http://www.chirpty.com)). What do you see the benefit of this image being?

### **Science Rhetoric Questions (come to these at 20 minutes left, no matter what)**

11. In comment C (Tweet #2), you mention “and beyond”—why do you point to the future in this way?
12. Throughout your tweets, you use emojis to communicate ideas and feelings. For example, in comment D (Tweet #3), you use a smiley face with hands. Would you ever consider using a different emoji, such as a simple smiley face?
13. Similarly, in comment F, you respond to a tweet asking you to explain your doctoral thesis using only emojis. Why did you choose these particular emojis and not others? What audience do you see this tweet being directed at?
14. For the purposes of this interview, I did not choose any tweets where you were simply retweeting others without comment. There are some tweets, however, where you retweet or share articles from others while adding comments of your own. For example, in comment I (Tweet 7), you share a research article with the commentary “I dig it, although

don't ask me to say the word anisovolumetric out loud." Why do you make this comment rather than just share the article without comment? When do you generally add writing of your own versus simply retweeting?

15. In Comment E (Tweet #4), your tweet includes a picture of the "board" of your proposals. Your picture includes proposals that have been accepted (green checks) and others that have not (red X's). Why include the other proposals in the image? Would you ever consider just focusing on the current NSF proposal that your tweet mentions?
16. In Comment H (Tweet #6), you use a really interesting metaphor when you talk about "how the thermochronology sausage is made." Would you be willing to use more direct language, like "what goes on behind the scenes"?
17. Twice last year, you shared a link to your article from *Geochronology* (Comment N, Tweets 16 and 18). Why do you share it more than once? The first time (Tweet 18), you focus more on one of your coauthors than on your own contributions to the article ("Check out Jack Carter's second paper from his PhD!"). When do you choose to focus on specific individuals—for example, why focus on Carter in this specific tweet?

**Concluding Questions (come to these when there are 10 minutes left, no matter what)**

18. Are there other individuals or groups you turn to for advice when writing Tweets or releasing research communication to the public? What kind of advice have you received from them in the past?
19. Are there any limiting factors in how you write Tweets? For example, technology limitations, disciplinary culture or courtesy, departmental guidelines, etc.
20. As a concluding question, if you had to list some of your "best practices" for crafting these types of communications, what would they be?
21. How do you think these practices might be adapted for other disciplines and areas of research?
22. Is there anything else you can think of about your public research communication that you would like to share that we haven't covered?

## APPENDIX C. SAMPLE MEMBER CHECK EMAIL

Below I have pasted the text from a member check email. This particular email was to Laura Bowling, inviting her to review the transcript of the interview and allowing her to clarify anything she said or add anything she wanted to say.

**From:** Weech, Shelton  
**Sent:** Wednesday, June 1, 2022 1:23 PM  
**To:** Bowling, Laura C  
**Cc:** Dilger, C Bradley  
**Subject:** Interview Transcript - Rhetoric and Networks of Climate Change  
**Attachments:** BowlingLaura\_Transcript.docx

Hi Dr. Bowling,

Thank you again for participating in the interview last week. I have attached the transcript of the interview for your review. As you can see, the transcript isn't verbatim; I tried to clean up some of the artifacts of speech.

You're welcome to use Track Changes or Comments to make any edits if that works for you. You're also welcome to clarify anything that you'd like to rethink. My goal is to make sure you're comfortable with what you see.

Let me know if you have any questions or concerns.

Regards,

Shelton Weech  
PhD Candidate, Rhetoric and Composition  
Assistant Director of Professional Writing  
Department of English  
Heavilon 207  
West Lafayette, IN 47906



## APPENDIX D. ADDITIONAL TABLES

In this Appendix, I include multiple tables of my data. I start by showing additional data across all data sources, then break down the data by source (tweets and interview transcripts). The tables also examine data by cluster (Purdue, Black in Environment, and NASA).

**Table A1: A list of top coding across all data sources.**

| Code                       | Count of Code | Example                                                                                                                 |
|----------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------|
| Networks                   | 233           | "There were four or five of us who spearheaded that years ago"                                                          |
| Tagging                    | 161           | @Beyonce                                                                                                                |
| Science communication      | 155           | "obviously, we have to make a nachos joke, but also, I need to explain what this thing does"                            |
| Purpose                    | 119           | "my Twitter brand is mostly shameless self promotion"                                                                   |
| Hashtagging                | 109           | #BlackHistoryMonth                                                                                                      |
| Affect and emotion         | 106           | "I like to have that tiny bit of playfulness"                                                                           |
| Link - research            | 96            | "Climate Disruption: Causes and Solutions." It's now available online, here: [LINK]"                                    |
| Reason for tagging         | 92            | "I considered tagging some of the Purdue agriculture accounts specifically because sometimes they will retweet my work" |
| Quote tweet                | 86            | Marked whenever a tweet is quote tweeting another tweet.                                                                |
| Limitations                | 83            | "I was over the word limit."                                                                                            |
| Rhetorical techniques      | 79            | "daily doses of geo-goodness"                                                                                           |
| Audience                   | 72            | "I started out with an academic audience"                                                                               |
| Positivity                 | 66            | "People like positive people."                                                                                          |
| Best practices             | 64            | "Put the most interesting content right up front in the tweet"                                                          |
| Reason for hashtagging     | 59            | "hashtags are a great way to place emphasis on a tweet"                                                                 |
| Conversation               | 49            | "Some of y'all"                                                                                                         |
| Local focus                | 42            | "The oil field that's been poisoning my neighborhood..."                                                                |
| Internal dialogue          | 41            | I thought to myself, "Oh, great. I wrote a paper on charisma."                                                          |
| Hook - Emoji               | 41            | "terrifying number of ☹️'s."                                                                                            |
| Invitation                 | 39            | "Follow my escapades..."                                                                                                |
| Reason for quote tweeting  | 38            | "I would maybe quote tweet and add more of that atmospheric angle"                                                      |
| Images                     | 29            | "I probably did an image search for gas and that's the one that came up."                                               |
| Diversity equity inclusion | 26            | "we must protect it to protect vulnerable communities"                                                                  |
| Gratitude                  | 25            | "It was such an honor to be featured..."                                                                                |
| Adapting for audience      | 24            | "The farmer community is probably the one I'm most concerned about upsetting with some of my tweets."                   |

**Table A1 continued**

|                                |    |                                                                                                                 |
|--------------------------------|----|-----------------------------------------------------------------------------------------------------------------|
| Little preparation or planning | 23 | "Sometimes I just tweet, just off the top of my head."                                                          |
| Reason for retweeting          | 21 | "I also retweet things because I don't want to lose them..."                                                    |
| Topoi                          | 14 | "causing skies to turn orange, visibility to drop..."                                                           |
| Team dialogue                  | 13 | "then someone told me, 'you really shouldn't use an eggplant emoji'"                                            |
| Stories                        | 13 | "how do I fit these together to tell the story that we're telling"                                              |
| Kairos                         | 13 | "Because we're West Coast, you want to get the largest overlap of people. So tweet at around 8am."              |
| Self-promotion                 | 13 | "this is also self-serving"                                                                                     |
| Link - website                 | 13 | "our website is now live: [LINK]"                                                                               |
| Hook - Question                | 13 | "What will sea level rise look like in the future?"                                                             |
| Hook                           | 12 | "how do I make it stand out..."                                                                                 |
| Audience appeal                | 12 | "All my environmental water chemists and engineers, please check out this awesome conference!"                  |
| Preparation or planning        | 12 | "I took about 10 minutes to think about..."                                                                     |
| News and Politics              | 12 | "I know there's legislation going through the statehouse"                                                       |
| Opposition                     | 11 | "the natural gas industry is freaking out"                                                                      |
| Identification                 | 10 | "it's also my paycheck, my livelihood"                                                                          |
| Ethos                          | 10 | "That would depend on whether I were posting officially on behalf of NASA, or if I were just posting as myself" |

## D.1 Tables from Tweet Data

**Table A2: Results showing participant networking connections and influences across all data**

| Code                              | Count | Example                                                                                   |
|-----------------------------------|-------|-------------------------------------------------------------------------------------------|
| Connection without tagging        | 24    | "researchers around the state"                                                            |
| Coworker or colleague             | 12    | "I had a project manager who went to a Twitter training"                                  |
| Synchronizing different platforms | 10    | "My YouTube channel"                                                                      |
| News and politics                 | 8     | "the Supreme Court rolling back some of the protections of the Clean Air Act"             |
| Dual Twitter accounts             | 7     | "on my personal account, I can totally do that"                                           |
| Technologies                      | 7     | "I'll put a smiley face because it makes it automatically when you do it on the computer" |
| Other digital tools/platforms     | 6     | "I'm sure it originated on Tumblr"                                                        |
| Communications campaign           | 6     | "this was a plan that we had as part of a communications mini-campaign"                   |
| Solicit feedback                  | 5     | "I may run it by somebody, maybe my advisor..."                                           |

**Table A3: Codes emerging from participant tweets**

| Code                          | Count | Example                                                                                                                                     |
|-------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Rhetorical techniques         | 163   | “an appetizer for further atmospheric study”                                                                                                |
| Tagging                       | 161   | @insideclimate                                                                                                                              |
| Hashtagging                   | 109   | #climategentrification                                                                                                                      |
| Science communication         | 99    | “the hardest part of my research is actually the matrix manipulation, digestion, and extraction procedcures”                                |
| Link - research               | 96    | “This looks like an AWESOME paper [LINK]”                                                                                                   |
| Quote tweet                   | 86    | [This code is used to tally the number of quote tweets]                                                                                     |
| Affect and emotion            | 72    | “Just had a VERY deep sigh about climate crisis.”                                                                                           |
| Positivity                    | 41    | “Had an amazing and uplifting focus group with farmers...”                                                                                  |
| Invitation                    | 39    | “feel free to join this candid, important conversation”                                                                                     |
| Conversation                  | 38    | “toxins bioaccumulate and harm other life because they are...poisons”                                                                       |
| Networks                      | 29    | “endless ways we’re all connected by our beautiful home planet”                                                                             |
| Local focus                   | 28    | “local, county-level fact sheets...”                                                                                                        |
| Gratitude                     | 24    | “Thanks...”                                                                                                                                 |
| Diversity equity inclusion    | 18    | “If you’re looking for some summer reading about how we can and must do better around diversity, equity, and inclusion in our own ranks...” |
| Link - website                | 13    | “our website is now live [LINK]”                                                                                                            |
| Purpose - event               | 13    | “a conversation about preparedness tonight at 6”                                                                                            |
| Rhetoric - audience awareness | 12    | “Heads up to my #publichealth peeps”                                                                                                        |
| Self-promotion                | 8     | “my master’s thesis was cited in a Vice article”                                                                                            |
| Direct address                | 7     | “You deserve this”                                                                                                                          |
| Quotation                     | 6     | “groan zone”                                                                                                                                |
| Discuss or address opponents  | 6     | “Heartland Institute”                                                                                                                       |
| Praise                        | 6     | “She’s worth all the Endorsements”                                                                                                          |
| Data                          | 6     | [This code is used when data is shared]                                                                                                     |
| Mentorship                    | 6     | “Peer-to-peer mentoring”                                                                                                                    |
| Promote others                | 5     | “your expertise”                                                                                                                            |
| Kairos                        | 5     | “It’s the end of an era”                                                                                                                    |

**Table A4: Top rhetorical techniques identified in participant tweets.**

| Code                        | Count | Example                                                                                                                        |
|-----------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------|
| Hooks                       | 63    | “Got your head in the clouds?”                                                                                                 |
| Magnitude                   | 27    | “plume from Hunga Tonga-Hunga Ha‘apai behaved like a mega-thunderstorm that rose 58 kilometers (38 miles) into the atmosphere” |
| Metaphor used for shorthand | 18    | “how the thermochronology sausage is made”                                                                                     |
| Topoi                       | 14    | “some clouds look ‘hole-punched’ because part of the cloud basically falls out of the sky!!!”                                  |
| Examples                    | 9     | “Imagine walking on ground that’s 140 degrees”                                                                                 |
| Stories                     | 8     | “got a great tour of a melon farm”                                                                                             |
| Identification              | 7     | “Fan boy moment”                                                                                                               |

**Table A5: Top instances of science communication identified in participant tweets**

| Code                                      | Count | Examples                                                                                                   |
|-------------------------------------------|-------|------------------------------------------------------------------------------------------------------------|
| Description of science                    | 11    | “have a notebook full of untapped ideas”                                                                   |
| Climate change impacts                    | 11    | “extreme heat exposure in Atlanta”                                                                         |
| Explain methods or process                | 10    | “remove the drip irrigation tape that we so carefully installed last May”                                  |
| Climate change mitigation                 | 10    | “helps ranchers make better decisions for their herds and the land”                                        |
| Explain climate change overall            | 9     | “Current climate change on Earth is driven primarily by the greenhouse effect”                             |
| No Hedging                                | 8     | “Higher global temperatures fuel hurricanes”                                                               |
| Share Research - highlights and takeaways | 5     | “Our faculty do critical research and Extension to support this industry”                                  |
| Define technical term                     | 5     | “a large hole in sea ice known as a polynya”                                                               |
| Summarize own research                    | 3     | “Atlanta has the highest percentage of tree canopy of any urban or metropolitan area in the United States” |
| History of climate science                | 3     | “extends back to 1880”                                                                                     |
| Summarize main point of linked research   | 3     | “New paper dipping a toe in #degrowth”                                                                     |
| Hint at research                          | 3     | “they talk about a conclusion my dissertation kinda suggests as well”                                      |
| Hedging                                   | 3     | “I think...”                                                                                               |

**Table A6: Instances of emotion in participant tweets**

| Code               | Count | Example                                              |
|--------------------|-------|------------------------------------------------------|
| Emotional language | 35    | “It’s already a heavy day”                           |
| Emoji for emotion  | 24    | 😞😞😞                                                  |
| Humor              | 10    | “the soil, not the high proof Schnapps”              |
| Affect             | 2     | “Just had a VERY deep sigh about the climate crisis” |
| Pun                | 1     | “nachos! Er...NACHOS-1”                              |

**Table A7: Overall results from tweet data, Purdue cluster**

| Code                  | Count | Example                                                                                                    |
|-----------------------|-------|------------------------------------------------------------------------------------------------------------|
| Tagging               | 78    | @LifeAtPurdue                                                                                              |
| Link - research       | 51    | “This looks like an AWESOME paper [LINK]”                                                                  |
| Science communication | 37    | “quantifying the positive (and some negative) impacts of temporary water storage in isolated depressions!” |
| Quote tweet           | 34    | [This code is used to tally the number of quote tweets]                                                    |
| Hashtagging           | 30    | #SciComm                                                                                                   |
| Rhetorical techniques | 28    | “writing is on the wall”                                                                                   |
| Affect and emotion    | 25    | “scared”                                                                                                   |
| Local focus           | 24    | “Hoosiers’ agriculture, health, forests, tourism”                                                          |
| Positivity            | 18    | “recent rains are helping...”                                                                              |
| Networks              | 18    | “rigorous new work done by teams of experts”                                                               |
| Gratitude             | 15    | “Thank-you Linda!”                                                                                         |
| Conversation          | 12    | “Yep.”                                                                                                     |
| Invitation            | 10    | “check it out”                                                                                             |

**Table A8: Instances of science communication in tweets, Purdue cluster**

| Code                                      | Count | Example                                                                                                                                                    |
|-------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Explain methods or process                | 6     | “we are finally getting a water control structure installed”                                                                                               |
| Share Research - highlights and takeaways | 5     | “influential and important writing about leadership and plants”                                                                                            |
| No Hedging                                | 5     | “how the climate in Indiana will change”                                                                                                                   |
| Climate change mitigation                 | 5     | “Investing in ethanol is not the answer”                                                                                                                   |
| Hedging                                   | 3     | “can...”                                                                                                                                                   |
| Summarize main point of link              | 2     | “New paper dipping a toe in #degrowth for insights on ethnography and alternative agriculture”                                                             |
| Define technical term                     | 2     | “the ‘groan zone’—suddenly realizing that we don’t all see the problem the same way”                                                                       |
| Don’t define technical term               | 2     | “charisma”                                                                                                                                                 |
| Explain climate change                    | 1     | “toxins bioaccumulate and harm other life”                                                                                                                 |
| Summary of other research                 | 1     | “innovative study of climate change, work, and air pollution in California’s Inland Empire”                                                                |
| Summarize own research                    | 1     | “So much of measuring success in alternative ag (farmers enrolled, markets grown, tons produced) mimics the hunger for growth that drives productivist ag” |
| Research sites                            | 1     | “Indiana’s St. Marys watershed”                                                                                                                            |
| Description of science in general         | 1     | “rigorous”                                                                                                                                                 |
| Climate change impacts                    | 1     | “ended the water year dry”                                                                                                                                 |
| Terminology as hook                       | 1     | “Glyphosate”                                                                                                                                               |

**Table A9: List of top rhetorical techniques in tweets, Purdue cluster**

| Code                             | Count | Example                                                                       |
|----------------------------------|-------|-------------------------------------------------------------------------------|
| Magnitude                        | 11    | “QUADRILLION”                                                                 |
| Metaphor used for shorthand      | 10    | “getting our permitting ducks in a row”                                       |
| Identification                   | 3     | “In spirit, you are always with us”                                           |
| Syllogism                        | 1     | “if farmers can’t imagine making a living doing it, then its not sustainable” |
| Visible text effect for emphasis | 1     | “STUDENTS”                                                                    |
| Allusion                         | 1     | “Kim Stanley Robinson’s <i>Ministry for the Future</i> ...”                   |
| Nostalgia                        | 1     | “It takes me back to my #Arctic hydrology roots”                              |

**Table A10: List of emotional appeals in tweets, Purdue cluster**

| Code               | Count | Example                                             |
|--------------------|-------|-----------------------------------------------------|
| Emotional language | 17    | “Love these future plans! Can’t wait!”              |
| Emoji for emotion  | 5     | 😄                                                   |
| Humor              | 2     | “Pete” [humorous image of a toy at a research site] |
| Embodied action    | 1     | “Sigh”                                              |
| Positivity         | 18    | “Great start...”                                    |

**Table A11: Overall results from tweet data, Black in Environment cluster**

| Code                       | Count | Example                                                                                                                                                   |
|----------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Affect and emotion         | 30    | “Getting pumped for our seminar starting today!!!”                                                                                                        |
| Tagging                    | 28    | @BlackInChem                                                                                                                                              |
| Hashtagging                | 25    | #FoundThatLizard                                                                                                                                          |
| Quote tweet                | 23    | [This code is used to tally the number of quote tweets]                                                                                                   |
| Science communication      | 18    | “Destroying this tree canopy, to increase urban sprawl (& police force development), will have more negative effects on the region than positive effects” |
| Rhetorical techniques      | 17    | “the jacket comes off”                                                                                                                                    |
| Conversation               | 15    | “You got this!!”                                                                                                                                          |
| Purpose - event            | 10    | “the Indiana Water Summit”                                                                                                                                |
| Positivity                 | 9     | “Fear mongering about hurricane season isn’t helping”                                                                                                     |
| Invitation                 | 8     | “help my friend out...”                                                                                                                                   |
| Diversity equity inclusion | 6     | #juneteenth2022                                                                                                                                           |
| Gratitude                  | 6     | “So glad I got to speak...”                                                                                                                               |
| Link - research            | 6     | “Paper of the day! Love it! [LINK]”                                                                                                                       |

**Table A12: List of emotional appeals in tweets, Black in Environment cluster**

| Code               | Count | Example                                          |
|--------------------|-------|--------------------------------------------------|
| Emotional language | 14    | “Lool I love this photo!!!”                      |
| Emoji for emotion  | 11    | 😄😄                                               |
| Humor              | 4     | “the lion is goals!!”                            |
| Affect             | 1     | “Just had a VERY deep sigh about climate crisis” |
| Positivity         | 9     | “Great convos with great folks”                  |

**Table A13: Instances of science communication in tweets, Black in Environment cluster**

| Code                      | Count | Example                                                                                                                                                                                                                                        |
|---------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description of science    | 6     | “The feelings of genius vs complete idiot you get when your experiments work vs when they don’t work.”                                                                                                                                         |
| Climate change mitigation | 4     | “Net zero emissions sound nice & all, but they are not going to get us where we need to be, we need NEGATIVE emissions”                                                                                                                        |
| Hint at research          | 3     | “over 300 peaks I have to integrate manually”                                                                                                                                                                                                  |
| Climate change impacts    | 2     | “extreme heat exposure in Atlanta & what’s been done to address it.”                                                                                                                                                                           |
| Summarize own research    | 2     | “Atlanta has the highest percentage of tree canopy of any urban or metropolitan area in the United States. Tree canopy & green space are extremely important to health of urban populations (e.g., climate change protection, exercise, etc.)” |
| Preparation               | 1     | “2022 Hurricane season is almost officially underway (June 1), and preparedness is more important than ever!”                                                                                                                                  |

**Table A14: List of rhetorical techniques in tweets, Black in Environment cluster**

| Codes                       | Count | Example                                                                                                                                         |
|-----------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Hooks                       | 5     | “Are you an Environmental Water Scientist?”                                                                                                     |
| Metaphor used for shorthand | 3     | “iron the kinks out”                                                                                                                            |
| Identification              | 3     | “up to us”                                                                                                                                      |
| Stories                     | 2     | “this happened!!!!”                                                                                                                             |
| Examples                    | 1     | “Imagine walking on ground that’s 140 degrees.”                                                                                                 |
| Parallel structure          | 1     | “Yes it’s the storms. yes it’s the wind. yes it’s the flooding. yes it’s the infrastructure failure. Yes it’s the inequitable flood insurance.” |
| Metonymy                    | 1     | [Describes condition of work clothes as a way to represent the lab work as a whole]                                                             |
| Analogy                     | 1     | “You can heat your leftovers up on that.”                                                                                                       |

**Table A15: Overall results from tweet data, NASA cluster**

| Code                       | Count | Example                                                                                                                            |
|----------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------|
| Rhetorical techniques      | 112   | “an appetizer for further atmospheric study”                                                                                       |
| Tagging                    | 55    | @NASAGoddard                                                                                                                       |
| Hashtagging                | 54    | #womeninscicomm                                                                                                                    |
| Science communication      | 44    | “critical insights for spotting lakes hidden deep under the Antarctic ice sheet”                                                   |
| Link - research            | 39    | “Check out the series here: [LINK]”                                                                                                |
| Quote tweet                | 29    | [This code is used to tally the number of quote tweets]                                                                            |
| Invitation                 | 21    | “Icy or not, share your own photos”                                                                                                |
| Affect and emotion         | 17    | “my global disaster accent wall”                                                                                                   |
| Positivity                 | 14    | “an ideal place for solar power”                                                                                                   |
| Link - website             | 12    | [This code was used to tally the number of links to external websites, not including those linking to specific research articles.] |
| Conversation               | 11    | “It’s tempting to blame the craziness of 2020 on ... well, 2020”                                                                   |
| Networks                   | 9     | “Dr. -----” [named individual without tagging, anonymized here]                                                                    |
| Diversity equity inclusion | 8     | #HispanicHeritageMonth2020                                                                                                         |

**Table A16: List of rhetorical techniques in tweets, NASA cluster**

| Code                        | Count | Example                                                        |
|-----------------------------|-------|----------------------------------------------------------------|
| Hooks                       | 55    | “The rankings are in and things are heating up”                |
| Magnitude                   | 16    | “300 trillion photons”                                         |
| Topoi                       | 14    | “causing icebergs to break off into the ocean”                 |
| Metaphor used for shorthand | 6     | “deep dive into our rising seas”                               |
| Kairos                      | 4     | “It’s the end of an era”                                       |
| Examples                    | 4     | “heavy rain and destructive wind”                              |
| Stories                     | 3     | “a team of NASA-funded scientists has tracked these emissions” |

**Table A17: Instances of science communication in tweets, NASA cluster**

| Code                              | Count | Example                                                                                                                       |
|-----------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------|
| Climate change impacts            | 8     | “An Antarctic ice shelf sustained extreme surface melting during the 2019-2020 melt season.”                                  |
| Explain climate change in general | 8     | “fueled the formation of more clouds that trap heat in the atmosphere and hinder the refreezing of new sea ice.”              |
| Description of science            | 5     | “NASA’s PACE mission will use all the colors of the rainbow to study ocean ecosystems when it launches in 2023”               |
| Explain methods or process        | 4     | “The missions synced their orbits to conduct new science that would be impossible to explore with each mission independently” |
| History of climate science        | 4     | “NASA’s longest running expeditions, and one of the largest airborne surveys of Earth’s polar ice ever flown”                 |
| Define technical term             | 3     | “a large hole in sea ice known as a polynya fueled”                                                                           |
| No Hedging                        | 3     | “Climate change has a direct impact on our planet’s atmosphere and weather.”                                                  |

**Table A18: List of emotional appeals in tweets, NASA cluster**

| Codes              | Count | Example                                    |
|--------------------|-------|--------------------------------------------|
| Emoji for emotion  | 8     | “🌍❤️”                                      |
| Humor              | 5     | “the soil, not the high proof schnapps...” |
| Emotional language | 4     | “terrifying number of 📦's.”                |
| Positivity         | 14    | “stoked to see this amazing video”         |

## D.2 Tables from Interview Data

Table A19: List of top networking strategies discussed across all participant clusters during interviews

| Code                              | Count |
|-----------------------------------|-------|
| Coworker or colleague             | 19    |
| Synchronizing different platforms | 10    |
| News and politics                 | 8     |
| Dual Twitter accounts             | 7     |
| Technologies                      | 7     |
| Solicit feedback                  | 7     |
| Communications campaign           | 6     |
| Other digital tools and platforms | 6     |
| Writing influences                | 5     |
| Style guides                      | 4     |
| Affiliated orgs                   | 4     |
| Supervisors                       | 4     |
| Image resources                   | 4     |
| Other tweets                      | 4     |
| Pop culture                       | 4     |
| Pandemic                          | 4     |

Table A20: List of top reasons participants gave for tagging or mentioning (@), discussed in interviews

| Code                                 | Count |
|--------------------------------------|-------|
| Broaden audience                     | 11    |
| Giving credit                        | 9     |
| Call attention of person tagged      | 8     |
| Possible retweets                    | 8     |
| Raise awareness of org or individual | 7     |
| Acknowledge collaborators            | 5     |
| Link to orgs or people               | 5     |

**Table A21: List of top reasons participants gave for hashtagging (#), discussed in interviews**

| <b>Code</b>                                                      | <b>Count</b> |
|------------------------------------------------------------------|--------------|
| Broaden audience                                                 | 11           |
| Connect with others                                              | 4            |
| Call attention of professionals                                  | 3            |
| Cataloguing                                                      | 3            |
| Join a conversation                                              | 2            |
| Add emphasis to tweet - affect                                   | 2            |
| Show connections                                                 | 2            |
| Shorthand for science methods and processes                      | 2            |
| Reason for NOT hashtagging - accessibility, screen readers, etc. | 2            |
| Connect at conferences                                           | 2            |
| Reason for NOT hashtagging - hashtagging is outdated             | 2            |

**Table A22: List of top purposes for tweeting identified by participants across all clusters during interviews**

| <b>Code</b>                         | <b>Count</b> |
|-------------------------------------|--------------|
| Raising awareness                   | 21           |
| Promote publication of others       | 12           |
| Promote own publications            | 11           |
| Audience education on action        | 9            |
| Government or decision maker policy | 7            |
| Broaden audience                    | 5            |
| Audience education about science    | 4            |
| Connect with fellow researchers     | 4            |

**Table A23: List of audiences identified by participants across all clusters, discussed during interviews**

| <b>Code</b>             | <b>Count</b> |
|-------------------------|--------------|
| Academic                | 14           |
| Public                  | 8            |
| Multiple                | 7            |
| Activists               | 4            |
| Professional            | 4            |
| Students                | 3            |
| Public officials        | 3            |
| Climate change doubters | 3            |
| Nonexperts              | 3            |

**Table A24: List of top themes about science communication discussed in interviews by participants across all clusters**

| <b>Code</b>                 | <b>Count</b> |
|-----------------------------|--------------|
| Accessibility               | 7            |
| Accuracy of language        | 5            |
| Don't define technical term | 5            |
| Clear up misconceptions     | 4            |
| Share experiences           | 4            |
| Define technical term       | 4            |

**Table A25: List of themes surrounding emotion that emerged in interviews with participants across all clusters**

| Code                              | Count |
|-----------------------------------|-------|
| Positivity                        | 25    |
| Humor                             | 14    |
| Emotional language                | 7     |
| Playfulness                       | 3     |
| Emoji for positivity              | 3     |
| Unfiltered                        | 2     |
| Emoji to represent bodily actions | 2     |
| Affect                            | 2     |

**Table A26: List of rhetorical techniques discussed in interviews with participants across all clusters**

| Code                                      | Count | Example                                                                                                                                                                        |
|-------------------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hooks                                     | 17    | "I think it's almost reflective of the journalistic structure you would see in the first few paragraphs of a news story."                                                      |
| Stories                                   | 5     | "how do I fit these together to tell the story that we're telling today?"                                                                                                      |
| Tweet content - careful word choice       | 4     | "the word 'crisis' starts to sound a little bit like I'm encouraging action"                                                                                                   |
| Identification                            | 3     | "I thought that would be something that a lot of people can relate to. We always have ideas, and we don't always have funding or time or anything, to be able to get it done." |
| Value of repetition and repeating message | 3     | "repetitiveness"                                                                                                                                                               |
| Metaphor used for shorthand               | 2     | "a roller coaster fits"                                                                                                                                                        |
| Silence                                   | 2     | "a long pause is a way to just be like, 'Yeah, it's toxic.'"                                                                                                                   |
| Tweet content - pop culture allusion      | 2     | "references often are a stronger way to make a joke. Again, with a pop culture reference we go back to, 'Do people understand this reference?'"                                |

**Table 27: Results of interviews with Purdue cluster**

| Code                      | Count | Example                                                                                                                                                                                                                   |
|---------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Purpose                   | 73    | "I will share each and every article that one of my former students or postdocs tweets, pretty much without any kind of discernment"                                                                                      |
| Networks                  | 71    | "I think schematics like this, you can also like draw a web are really helpful for seeing, one, who I'm interacting with. So, who's seeing the content that I'm creating, but then who's also interacting with it?"       |
| Reason for tagging        | 43    | "I thought what he was doing was really cool, so I wanted to amplify his voice and let people know that he was there."                                                                                                    |
| Limitations               | 30    | "I try not to tweet too much sarcasm because I know it doesn't translate well."                                                                                                                                           |
| Best practices            | 27    | "you can tag as many people as you want in the photo. So it's a way that you can get more out of each tweet."                                                                                                             |
| Audience                  | 22    | "a professional audience"                                                                                                                                                                                                 |
| Reason for quote tweeting | 16    | "I think it's always good to provide some context."                                                                                                                                                                       |
| Positivity                | 15    | "I was feeling really, really positive."                                                                                                                                                                                  |
| Images                    | 14    | "I did a screen capture here because I wasn't sure if the YouTube link was actually going to pull up the video"                                                                                                           |
| Science communication     | 14    | "I might try to avoid using super specific language. But yeah, in this case, there was definitely an assumption that you would have some idea what that meant."                                                           |
| Reason for retweeting     | 13    | "in my current role, I sometimes retweet things, and I intentionally don't add text, because then I'm just retweeting and I'm not saying what I think."                                                                   |
| Internal dialogue         | 19    | "do I say we were at the biggest melon farm in Indiana and blah, blah, blah, and I'm like, 'No, I probably don't need to do that.'"                                                                                       |
| Reason for hashtagging    | 12    | "try to get some hashtags that somebody might click"                                                                                                                                                                      |
| Rhetorical techniques     | 12    | "I've seen stuff that kind of looked like this that drew me in. And I think I did this for a previous paper as well. I don't know if it started off with a question. But it fits for the format: it's short, it's pithy." |

**Table A28: Network connections and influences, Purdue cluster**

| <b>Code</b>                             | <b>Count</b> |
|-----------------------------------------|--------------|
| Colleagues                              | 8            |
| Technologies                            | 6            |
| News and politics                       | 3            |
| Pandemic                                | 3            |
| Other tweets                            | 3            |
| Visualization tools                     | 2            |
| Twitter links                           | 2            |
| Admired scholars                        | 2            |
| Writing influences                      | 2            |
| People who help build digital materials | 2            |
| Affiliated orgs                         | 2            |

**Table A29: List of purposes for tweeting identified in interviews with Purdue cluster participants**

| <b>Code</b>                         | <b>Count</b> |
|-------------------------------------|--------------|
| Raising awareness                   | 15           |
| Promote publication of others       | 10           |
| Promote own publications            | 10           |
| Audience education on action        | 5            |
| Connect with fellow researchers     | 4            |
| Government or decision maker policy | 3            |
| Boost younger scholars              | 2            |
| Promote organization                | 2            |
| Conversation                        | 2            |
| Broaden audience                    | 2            |
| Self-promotion                      | 2            |

**Table A30: Audiences identified by Purdue participants**

| Code                       | Count |
|----------------------------|-------|
| Academic                   | 5     |
| Multiple                   | 2     |
| Professional               | 2     |
| Agricultural professionals | 2     |
| Farmers                    | 2     |
| Journalists                | 2     |

**Table A31: Elements of science communication discussed in interviews with Purdue participants**

| Code                                   | Count |
|----------------------------------------|-------|
| Threads to present evidence            | 3     |
| Don't define technical term            | 3     |
| Celebrate collaborators                | 2     |
| Explain methods or process             | 2     |
| Accuracy of language                   | 1     |
| Simplification                         | 1     |
| Description of science                 | 1     |
| Make science understandable to publics | 1     |

**Table A32: List of themes surrounding emotion discussed by Purdue participants**

| <b>Code</b>                 | <b>Count</b> |
|-----------------------------|--------------|
| Positivity                  | 15           |
| Emotional language          | 3            |
| Tweet content - playfulness | 2            |
| Tweet content - humor       | 2            |
| Allusion for emotion        | 1            |

**Table A33: List of rhetorical techniques discussed in interviews with Purdue participants**

| <b>Code</b>                               | <b>Count</b> |
|-------------------------------------------|--------------|
| Hooks                                     | 5            |
| Silence                                   | 2            |
| Value of repetition and repeating message | 1            |
| Economic argument                         | 1            |
| Visible text effect for emphasis          | 1            |
| Tweet content - careful word choice       | 1            |
| Tweet content - quotation vs summary      | 1            |

**Table A34: List of limitations identified by Purdue participants**

| <b>Code</b>                             | <b>Count</b> |
|-----------------------------------------|--------------|
| Tweet length                            | 5            |
| Technology                              | 5            |
| Supervisors, deans, bosses              | 3            |
| Political considerations                | 2            |
| Expectations of job                     | 2            |
| Awareness of how tweet will be received | 2            |

**Table A35: List of best practices for sharing science via Twitter, identified by Purdue participants**

| <b>Code</b>           | <b>Count</b> |
|-----------------------|--------------|
| Use tags thoughtfully | 5            |
| Positivity            | 4            |
| Include media         | 4            |
| Stylistic concerns    | 4            |
| Consider audience     | 3            |
| Evidence-based        | 3            |
| Be humble             | 2            |
| Accessibility         | 2            |

**Table A36: Results of interviews with participants from Black in Environment cluster**

| <b>Code</b>               | <b>Count</b> | <b>Example</b>                                                                                                                                                                                            |
|---------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Networks                  | 49           | "I copied the tweet before I posted it and asked a friend group with my sister, her partner and my wife to see if they thought that it was weird to tweet it"                                             |
| Audience                  | 25           | "people who are maybe diverse, or conscious of systems of oppression, whether it be, being a minority in academia in general, or LGBTQ+, or having a disability, someone who is I guess conscious"        |
| Reason for hashtagging    | 20           | "I hashtag #blackinchem, because that's the most popular hashtag for the week, where people introduce themselves, so it would have been more likely for people to see."                                   |
| Science communication     | 20           | "I wanted to jump more into explaining what it was...not necessarily my thesis, but more so explaining why it's so important to protect Atlanta's massive urban forest"                                   |
| Purpose                   | 18           | "highlighting Black people who work in agriculture, from farmers to scientists, engineers to social scientists"                                                                                           |
| Reason for tagging        | 16           | "wanted to uplift her work"                                                                                                                                                                               |
| Best practices            | 14           | "Try to not use too much jargon"                                                                                                                                                                          |
| Internal dialogue         | 14           | "I thought you were in a lab. I thought you work in a lab all the time and run experiments and then write the papers.' And I'm like, that is such a small fraction of what I do."                         |
| Affect and emotion        | 14           | "I think I usually go for drawing on emotions. To me, that's what you're supposed to do on Twitter"                                                                                                       |
| Reason for quote tweeting | 9            | "when I identify directly with the situation, like literally I was writing my dissertation at that time, that's when I choose to quote tweet because I know that I directly identify with that situation" |
| Limitations               | 9            | "I have been scolded for the way that I tweet by...I'll just say in my university"                                                                                                                        |
| Images                    | 7            | "if you're going to be tweeting about kayaking, you should have a picture"                                                                                                                                |
| Positivity                | 6            | "I don't want my Twitter to be all just serious, serious, serious, you know?"                                                                                                                             |

**Table A37: List of networking connections and influences identified by participants from Black in Environment cluster**

| <b>Code</b>                         | <b>Count</b> |
|-------------------------------------|--------------|
| Synchronizing different platforms   | 8            |
| Coworker or colleague               | 3            |
| News and politics                   | 3            |
| Academic advisor                    | 3            |
| Interdisciplinarity                 | 2            |
| Technologies                        | 2            |
| Events                              | 2            |
| Media package for campaign or event | 2            |

**Table A38: List of purposes for tweeting, identified by participants from Black in Environment cluster**

| <b>Code</b>                                 | <b>Count</b> |
|---------------------------------------------|--------------|
| Promote publication of others               | 2            |
| Audience education about science            | 1            |
| Save lives and the world                    | 1            |
| Raising awareness                           | 1            |
| Boost younger scholars                      | 1            |
| Show full self and not just researcher side | 1            |
| Broaden audience                            | 1            |
| Audience education on action                | 1            |
| Promote own publications                    | 1            |
| Conversation                                | 1            |
| Recruit students                            | 1            |
| Empowerment                                 | 1            |
| Share own research projects                 | 1            |
| Link audience to research                   | 1            |
| Tell what happened                          | 1            |
| Mentorship                                  | 1            |
| Promote organization                        | 1            |

**Table A39: List of audiences identified by Black in Environment participants**

| <b>Code</b>      | <b>Count</b> |
|------------------|--------------|
| Academic         | 4            |
| Activists        | 3            |
| Multiple         | 3            |
| Public           | 2            |
| Students         | 2            |
| Public officials | 2            |

**Table A40: List of elements of science communication discussed in interviews with participants from Black in Environment cluster**

| <b>Code</b>                               | <b>Count</b> |
|-------------------------------------------|--------------|
| Share experiences                         | 4            |
| Accessibility                             | 4            |
| Clear up misconceptions                   | 3            |
| Description of science                    | 1            |
| Share Research - highlights and takeaways | 1            |
| Accuracy of language                      | 1            |
| Show creativity in science                | 1            |
| Use rhetoric to indirectly educate        | 1            |
| Climate change impacts                    | 1            |
| Summarize main point of link              | 1            |
| Don't define technical term               | 1            |
| Perceptions vs reality                    | 1            |

**Table A41: List of elements of emotion discussed in interviews with participants from Black in Environment cluster**

| <b>Code</b>                       | <b>Count</b> |
|-----------------------------------|--------------|
| Positivity                        | 6            |
| Emotional language                | 4            |
| Humor                             | 3            |
| Emoji to represent bodily actions | 2            |
| Affect                            | 1            |
| Embodied action                   | 1            |

**Table A42: List of rhetorical techniques discussed in interviews with participants from Black in Environment cluster**

| <b>Code</b>                      | <b>Count</b> |
|----------------------------------|--------------|
| Identification                   | 3            |
| Hook                             | 2            |
| Metaphor                         | 2            |
| Repetition and repeating message | 1            |
| Word choice                      | 1            |

**Table A43: List of limitations in tweeting identified by participants from Black in Environment cluster**

| Code                                                   | Count |
|--------------------------------------------------------|-------|
| Awareness of how tweet will be received                | 3     |
| Tweet length                                           | 2     |
| Obscure References                                     | 1     |
| University pressure                                    | 1     |
| Common courtesy                                        | 1     |
| Institutional preference for traditional communication | 1     |

**Table A44: List of best practices identified by participants from Black in Environment cluster**

| Code               | Count |
|--------------------|-------|
| Consider audience  | 7     |
| Stylistic concerns | 3     |
| Consider context   | 1     |
| Include media      | 1     |
| Positivity         | 1     |
| Emotion            | 1     |

**Table A45: Results of interviews with NASA cluster**

| Code                           | Count | Example                                                                                                                                                 |
|--------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Networks                       | 84    | "There were four or five of us who spearheaded that..."                                                                                                 |
| Limitations                    | 46    | "hard to say with 280 characters..."                                                                                                                    |
| Reason for tagging             | 33    | "I wanted her to see it and retweet it."                                                                                                                |
| Purpose                        | 28    | "decision maker empowerment..."                                                                                                                         |
| Reason for hashtagging         | 27    | "they help, for example, to create a more cohesive message in terms of the people who are producing the tweets, to connect everything with the hashtag" |
| Rhetorical techniques          | 26    | "the word 'crisis' starts to sound..."                                                                                                                  |
| Audience                       | 25    | "I don't think there is one audience"                                                                                                                   |
| Best practices                 | 23    | "definitely keeping good grammar"                                                                                                                       |
| Science communication          | 22    | "people who know NO2 is nitrogen dioxide are probably the same people who would read 'nitrogen dioxide' and know what that means"                       |
| Internal dialogue              | 16    | "somebody who is like, 'oh, that's an ice cube'"                                                                                                        |
| Affect and emotion             | 15    | "I can use a pun or a joke"                                                                                                                             |
| Reason for quote tweeting      | 13    | "adding context"                                                                                                                                        |
| Team dialogue                  | 11    | "I had to tell one of the other account managers..."                                                                                                    |
| Adapting for audience          | 10    | "it makes something that's scientific seem more approachable"                                                                                           |
| Images                         | 8     | "throw an emoji or two in there"                                                                                                                        |
| Little preparation or planning | 8     | "I wish I was more strategic with social media"                                                                                                         |

**Table A46: List of networking connections or influences identified by NASA cluster**

| Code                          | Count |
|-------------------------------|-------|
| Coworker or colleague         | 9     |
| Dual Twitter accounts         | 6     |
| Communications campaign       | 5     |
| Style guides                  | 4     |
| Other digital tools/platforms | 4     |
| Supervisors                   | 4     |
| Solicit feedback              | 3     |
| Pop culture                   | 3     |
| Writing influences            | 3     |

**Table A47: List of purposes for tweeting identified by NASA participants**

| <b>Code</b>                         | <b>Count</b> |
|-------------------------------------|--------------|
| Raising awareness                   | 5            |
| Government or decision maker policy | 4            |
| Audience education on action        | 3            |
| Audience education about science    | 2            |
| Broaden audience                    | 2            |
| Empowerment                         | 2            |

**Table A48: List of audiences identified by NASA participants**

| <b>Code</b>                          | <b>Count</b> |
|--------------------------------------|--------------|
| Multiple                             | 4            |
| Academic                             | 3            |
| People who believe in climate change | 2            |
| Public                               | 2            |
| Nonexperts                           | 2            |
| Climate change doubters              | 2            |
| Peers                                | 2            |

**Table A49: List of elements of science communication discussed with NASA participants**

| <b>Code</b>                            | <b>Count</b> |
|----------------------------------------|--------------|
| Define technical term                  | 4            |
| Accuracy of language                   | 3            |
| No hedging                             | 3            |
| Avoid buzzwords                        | 2            |
| Summarize main point of linked article | 2            |

**Table A50: List of elements of emotional appeals discussed with NASA participants**

| <b>Code</b>                           | <b>Count</b> |
|---------------------------------------|--------------|
| Humor                                 | 7            |
| Positivity                            | 4            |
| When to not use humor                 | 3            |
| Emoji for positivity                  | 3            |
| Emotional language to excite audience | 1            |
| Playfulness                           | 1            |

**Table A51: List of rhetorical techniques discussed with NASA participants**

| Code                                      | Count |
|-------------------------------------------|-------|
| Hook                                      | 10    |
| Stories                                   | 5     |
| Pop culture allusion                      | 3     |
| Word choice                               | 2     |
| Metaphor                                  | 1     |
| Value of repetition and repeating message | 1     |
| Personification                           | 1     |
| Rhetorical invocation of time             | 1     |
| Framing                                   | 1     |
| Magnitude                                 | 1     |

**Table A52: List of limitations identified by NASA participants**

| Code                                    | Count |
|-----------------------------------------|-------|
| Tweet length                            | 7     |
| Co-managing Twitter account             | 5     |
| Style guides                            | 5     |
| Obscure references                      | 4     |
| Contractor vs direct employee           | 3     |
| Emojis and dirty jokes                  | 2     |
| Government rules for its orgs           | 2     |
| Awareness of how tweet will be received | 2     |

**Table A53: List of best practices identified by NASA participants**

| Code                  | Count |
|-----------------------|-------|
| Stylistic concerns    | 9     |
| Consider audience     | 6     |
| Consider context      | 3     |
| Use tags thoughtfully | 1     |
| Trust yourself        | 1     |
| Include media         | 1     |
| Accessibility         | 1     |
| Get feedback          | 1     |

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