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Tweeting the Anthropocene: #400ppm as Networked Event

Lauren E. Cagle and Denise Tillery

On Wednesday, May 6, 2015, the National Oceanic and Atmospheric Administration published a press release reporting that, for the first time since atmospheric carbon dioxide has been tracked, “The monthly global average concentration of this greenhouse gas surpassed 400 parts per million in March 2015” (NOAA, 2015). The press release quotes Pieter Tans, lead scientist for NOAA’s Global Greenhouse Gas Reference Network: “We first reported 400 ppm when all of our Arctic sites reached that value in the spring of 2012. In 2013 the record at NOAA’s Mauna Loa Observatory first crossed the 400 ppm threshold. Reaching 400 parts per million as a global average is a significant milestone” (NOAA, 2015). The initial crossing of the threshold of 400 ppm in May 2013 prompted Bruno Latour to argue that the new problem in science studies was “how to understand the active role of human agency not only in the construction of facts, but also in the very existence of the phenomena those facts are trying to document” (2014, p. 2). While the specific measurement of 400 ppm is not new, the monthly global average concentration exceeding that number represents a significant threshold.

Like much contemporary science news, the crossing of the 400 ppm threshold was shared widely across social media platforms, particularly Twitter, where links to the press release were often accompanied by the hashtag #400ppm. To understand how social media's affordances, such as hyperlinks and hashtags, relate to and shape scientific news, we conducted a study of tweets that referred to this news of the carbon dioxide's 400 ppm concentration. After building a dataset of all tweets from May 2015 that used the #400ppm hashtag, we applied Latour’s actor-network theory to understand how hashtags and hyperlinks can function as both text and technology,

thereby accelerating the spread of scientific news. We then analyzed how this scientific news coalesced around common topics and frames apparent in the dataset. Often, those broader ideas draw on elements of the original press release that kickstarted the sharing of this scientific news.

For example, several common frames among the tweets reveal a sense of urgency about climate change that mirrors the urgent, activist tone of the NOAA press release, relayed primarily through quotes attributed to Tans and other experts. Tans refers to “the fact that humans burning fossil fuels have caused global carbon dioxide concentrations to rise more than 120 parts per million since pre-industrial times” (NOAA, 2015). The press release concludes by quoting James Butler, director of NOAA’s Global Monitoring Division, saying, “Elimination of about 80 percent of fossil fuel emissions would essentially stop the rise in carbon dioxide in the atmosphere, but concentrations of carbon dioxide would not start decreasing until even further reductions are made and then it would only do so slowly” (NOAA, 2015). Typical of science reporting, the story frames the human aspect—the interpretation of the measurement and its significance for people—and includes a few details about the methods the scientists used (air samples are collected in 40 remote sites across the globe). The press release also refers to the steady climb in atmospheric CO₂ concentration in recent years and includes a data display as well as photos of the process of sample collection. The urgency of the tone helps to shape the measurement’s significance, and the usual buttons urging users to like, share, and tweet make this web-based article an event that can be shared across social media. Figure 6.1 shows a screenshot of the NOAA website with the sharing buttons prominently displayed between the press release’s headline and body.

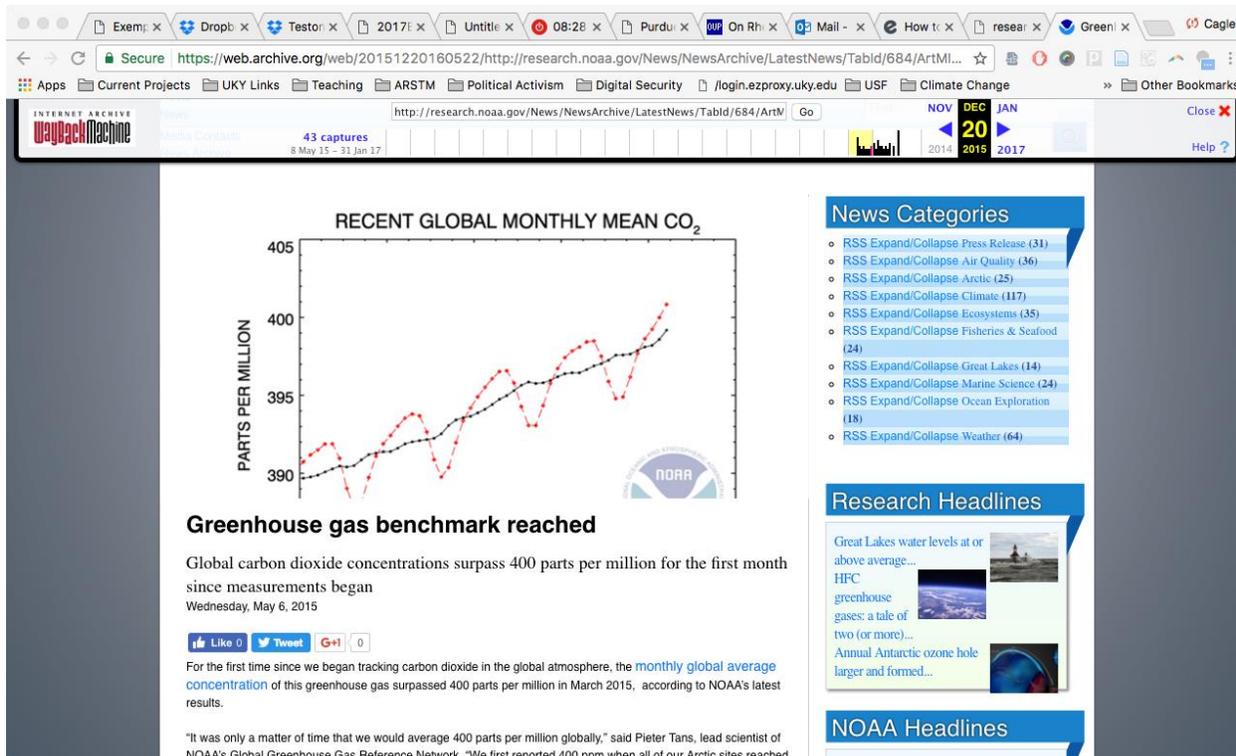


Figure 6.1. Screenshot of May 6, 2015 NOAA press release on official NOAA website. (National Oceanic and Atmospheric Association)

To be clear, of course, the dramatic increase of atmospheric CO₂ is significant whether shared on social media or not. But global warming, as a chronic, slow-moving catastrophe difficult to perceive on an individual scale, requires experts and communicators to find ways to invest particular numbers with news-worthy significance, in order to gain media attention. In essence, they need to create and argue for *kairos*, an appeal to timeliness, which “calls attention to the nature of discourse as event rather than object” (Miller, 1992). And certainly, this event, and NOAA’s press release, did inspire attention, including articles in the *Guardian* and *Mother Jones*, both of which were also published on May 6, 2015. The *Guardian* article connected the CO₂ readings to the Paris climate talks, and also mentions that this 400ppm average “comes nearly three decades after what is considered the ‘safe’ level of 350ppm was passed” (Vaughan, 2015). Similarly, the *Mother Jones* (2015) article also refers to 350 ppm as a goal set by activists

including Bill McKibben, who argued that 350 ppm represented a “tipping point,” after which various risks, including ocean acidification and unreliable monsoons, will increase. That article ends pessimistically with the simple statement “We’re now at 400” (Oh, 2015). These two articles and the press release they are based on, all shared across social media, form part of the network that exemplifies how scientific information is picked up, circulated, disseminated, and discussed in our new media landscape.

In this study, we consider the circulation of the hashtag “#400ppm” on Twitter, which was used to mark the initial eventful moment in May 2015, when NOAA’s press release kicked off a swell of discussion across social media amongst both scientists and non-scientists. Across Twitter in particular, climate scientists, science communicators, and members of the lay public discussed the news. Often, their tweeted reactions included hyperlinks, whether to the original press release, mainstream news stories about it, or other online media they deemed relevant (for example, some users shared links to a music video about climate change). Our interest was sparked by the various ways that scientific information is accommodated, distributed, and changed as specific users hyperlinked to it and, along with a link, shared their responses.

By observing and theorizing the movement and transformation of a single scientific news event through these networks, we hope to suggest some productive ways for scientists and science communicators to use the networks’ affordances. As science communication continues to spread across new media platforms, science communicators can rise to the challenge that Latour identifies of explicating humans’ role in both the construction of phenomena and the construction of facts. In the case of the hashtag #400ppm, people communicating about science, both formally and informally, transformed a scientific measurement into an event. The event is marked by the initial press release, a genre often associated with breaking news, and further

stories based on that press release. On Twitter, the work of these texts is largely represented by and delegated to hyperlinks. We borrow Latour's use of the term "delegate" here, which he defines as the act of shifting work from humans onto non-human technologies and objects, allowing humans to rely on technologies to do work, rather than having to do the work themselves. In the case of hyperlinks, they take on the work of transmitting the content of the texts they link to; the human Twitter user's work is now limited to clicking a share button or copy and pasting, saving them the effort of retyping or paraphrasing the texts their hyperlinks point to. Hyperlinks are thus just one element within a broader network of humans and non-humans, all working together to make this communication of scientific news on Twitter possible. Within Latour's broader Actor-Network Theory (ANT), each human and non-human connected to this network is an actant, a term that refers to both "individual human actors" and "non-human, non individual entities" (Latour, 1996). This approach to hyperlinks as technological delegates suggests that hyperlinks and brief descriptions of them function as pivotal actors propelling the transmission of news about science events. In addition to examining the more traditional modes of the press release and news story, science communication researchers should attend to the technologies that allow their circulation through social media networks and interact with the texts that both comprise and surround them.

Social Media Communication Research on Public Discourse and Environmental Communication

Social media platforms have been widely available for over 10 years, and communication research has responded in part by exploring how Facebook and other social media sites are used for advocacy and public discourse. Two studies (Bortree & Selzer, 2009; Wooley, Limperos, & Oliver, 2010) considered how users and advocacy groups used Facebook in presidential elections

and for environmental advocacy, while more recent work considers how activists use Twitter. Poell traces how social media are “shaped by interacting techno-cultural and political economic relations” (2014, p. 717) through a hyperlink analysis. Potts (2014) and Bowden (2014) focus on Twitter use during emergencies, and Langlois et al. consider how social media platforms, Facebook in particular, “transform public discussion and regulate the coming into being of a public” by imposing specific conditions, possibilities, and limitations of online use (2009, p. 417). Many scholars of social media, including Potts (2014), Poell (2014) and Langlois et al. (2009), approach social media platforms as assemblages, arguing that content cannot be separated from platforms, protocols, and networks.

Environmental issues, including climate change, have also been the focus of much recent work on social media, including *Environmental Communication's* 2015 special issue on Climate Change Communication and the Internet (Koteyko, Nerlich & Hellsten, 2015). Segerberg and Bennett (2011) focused on the use of social media during climate change protests, arguing that social technologies can play a role as organizing mechanisms or agents, and that these technologies may also reflect larger organizational schemes in a protest ecology (p. 212). In later work, Bennet and Segerberg (2012) analyzed digitally networked actions such as the “Putting People First” movement. This movement was coordinated by a number of prominent non-governmental organizations to mobilize the public against the social harms of unrestrained capitalism of the type that led to the 2008 economic meltdown. Bennet and Segerberg found that this movement succeeded in part by using “personal action frames,” such as “we are the 99%,” because such frames “are inclusive of different personal reasons for contesting a situation that needs to be changed” (2012, p. 744). Katz-Kimchi and Manosevitch (2015) described a successful campaign undertaken by Greenpeace to use a Facebook campaign to encourage

Facebook itself to convert to green energy. These studies show how activists and organizers can successfully use the affordances of social media to support their goals.

Although these studies show social media's power to effect positive changes, other researchers note that social media can reveal, or even foster, a sense of passivity or helplessness, or even provide a venue for climate change denialism (Sharman, 2014). Newell and Dale (2015), describing a comprehensive and multi-faceted legislative and policy framework to spur local climate innovation in British Columbia, observed only limited public engagement, suggesting that "the lack of public dialogue and engagement in science and policy has led to a culture that is more inclined to 'learn from the experts' rather than actively engaging in discourse on these topics" (p. 223). The lack of public engagement presents a significant barrier to developing inclusive solutions to the problem of climate change. Sharman's (2015) study of the climate change denial blogosphere concluded that climate skeptic blogs offer an alternative site for audiences to access what they consider expert knowledge on the topic. Matthews (2015), in reviewing skeptical comments on climate change blogs, found that a significant motive for skepticism was the belief that warnings about climate change have been overstated; his findings corroborate other research indicating that dire messaging about climate change may encourage skepticism (Feinberg & Willer, 2011). Thus, social media platforms can work against the goals of climate scientists, activists, and communicators, particularly if they fail to engage publics or are interpreted as being "alarmist."

For many of these studies, researchers developed methods that incorporated content analysis and quantitative approaches. Veltri and Atanasova (2015) analyzed a data set of 60,000 tweets relating to climate change and identified four common themes: (1) calls for action and increasing awareness of climate change, (2) discussions about the consequences of climate

change such as extreme weather and representations of a risk discourse, (3) policy debate about climate change and energy and (4) local events associated with climate change (Veltri & Atanasova, 2015). While our study is not near the scale of Veltri and Atanasova's, we used a type of content-based thematic analysis to sort the tweets into thematic categories, finding some overlap between our categories and those of Veltri and Atanasova (2015). These tweets, whatever their category, are often legitimized by their inclusion of hyperlinks, which we describe as key technologies to which some of the tasks of science communication have been delegated.

Methodology

We explored a dataset of all the tweets published in May 2015 that used the hashtag “#400ppm,” in hopes that our general conclusions about ways in which users engage with eventful science news can help science communicators approach Twitter more knowledgeably as an open network of users, tweets, hashtags, and hyperlinks to outside actors in other web spaces. We begin by theorizing the work done by hyperlinks that draws on Latour's (1992) conceptualization of nonhuman technology as “delegates” taking on the work of human and other nonhuman actors. This analysis allows us to approach hyperlinks as both discourse and technology, making meaning through the text and images they place in tweets but also enabling users to do connective work more easily through their affordances as technology. Other social media researchers have drawn on Latour's extensive sociological theories to better understand the workings of social media and to make recommendations for technological development. Liza Potts (2009), for example, uses Latour's articulation of Actor Network Theory (ANT) as an approach to studying dynamic online communicative systems. ANT is an ontological approach to studying social and material relations that treats both humans and non-humans as agents

within networks of people and things, all helping to collaboratively build reality and create opportunities for action. Latour's insistence on viewing non-human technologies as making vital contributions to communication networks of humans and texts provides a more inclusive view of how communication works in the deeply technological spaces of social media. For traditional rhetorical analysts, the temptation when combing through discursive data is to stop and sit with a text, focus on the details, analyze each rhetorical move and decision. But ANT reminds us to consider discursive *movement*—what happens as texts connect to each other and discourse is shared by and between actants, assembled ultimately into a network (Latour, 2005).

Latour's actor-network theory allows us to account for the roles played by users, links, hashtags, and other actants in the effort to move this information through a larger network. However, we also want to account for the content of the language itself, to see how the various rhetorical strategies played a role in shaping and moving this message. In other words, we want to account for hashtags, tweets, and links as pieces of discourse as well as actants. For this purpose, we turned to a concept from classical rhetorical theory: *topoi*, often translated as "commonplace," defined as recurring lines of argument that circulate within particular exigencies (Ross, 2013). Rhetorical scholars such as Leff (1996) and Dyck (2002) show the role that *topoi* play in invention. Walsh argues that *topoi* are not static and context-free, instead asserting that "topoi are pervasive and dynamic cognitive strategies—linking people, texts, and experiences—that engage particular rhetorical situations" (2010, p. 122). We've adapted the strategy from Walsh (2013) to identify recurrent *topoi* in 122 tweets.

Denise and another coder unfamiliar with our theoretical approach reviewed the full dataset of tweets, and based on those initial impressions, individually identified prominent themes in the data (including the text of the tweets, the links, and the hashtags). Following

comparison of their identified themes, the two coders agreed to categorize the tweets according to four topoi: “just the facts,” alarmism, “we must act now,” and human impacts. The coders performed separate content analysis to verify the identified topoi, categorizing each tweet into one or two topoi. (For one tweet, our second coder applied a third topos.) The first coding pass yielded interrater agreement of 74% for at least one of the topoi applied by each coder, with 90 of 122 tweets receiving at least one shared code. The most consistent agreement occurred on applying the topos of “just the facts,” while “human impacts” yielded the least agreement. Following this, we discussed the remaining 32 tweets with our independent coder to arrive at consensus for these tweets; this resulted in interrater agreement of 85%, with 18 tweets still coded into different categories. In the results section below, we describe some of the differing interpretations of topoi that led to these remaining differences. We hope that transparency about these differences will offer deeper insight into the topoi under discussion, as well as highlight some of the specific challenges of coding tweets, whose brevity and often referential nature can yield multiple interpretations. By layering this topical analysis on the Latourian analysis of the work done by the hyperlinks, we show how various recurring lines of argument circulate within the more complex assemblage comprised of tweeters, news stories, hashtags, hyperlinks, and facts about climate change.

Hyperlinks as Technological Delegates

One of the most striking features of the communication circulating within the May 2015 “#400ppm” dataset was the frequency with which Tweets included links to news stories, many of which cited the NOAA press release. Table 6.1 shows the raw number and a percentage breakdown for total tweets in the dataset, the tweets that included hyperlinks, and the tweets with

hyperlinks that originated from .gov URLs (including NOAA’s initial May 6, 2015 press release), suggesting they linked to official reports about the atmospheric CO2 concentration findings. The non-governmental hyperlinks included 32 other news sources, from traditional news outlets such as the *Guardian* (Vaughan, 2015), *National Geographic* (Howard, 2014), and the *New York Post* (Associated Press, 2015) to newer online only news publishers, including *Mother Jones* (Oh, 2015), *Politico* (Restuccia, 2015), and *Democracy Now* (Democracy Now, 2015). Yet others link to sites with a focus on environmental, and often specifically climate-related, news and science, such as *Carbon Brief* (Pidcock, 2015) and *Climate Central* (Kahn, 2015).

	May 2015	
	Raw Count	% of Total Dataset
Total Tweets	122	100.0%
Tweets w/ Hyperlinks	94	77.0%
Tweets w/ non-.gov Hyperlinks	78	63.9%
Tweets w/ .gov Hyperlinks	16	13.1%

Table 6.1. Total count of tweets and tweets with hyperlinks in the May 2015 “#400ppm” dataset.

The high percentage of tweets in the dataset that included hyperlinks shows that these links clearly functioned as key elements for consumers and sharers of the news event in question. The relatively low percentage of tweets with .gov hyperlinks compared to the total hyperlinks count shows the important role played by other outlets picking up the news first released by a government agency. It is perhaps unsurprising that Twitter users would choose to share hyperlinks, as these sources at these links may have been where they first encountered the news

themselves, prompting them to propagate it. Additionally, we suggest that, in cases where users are sharing what they perceive as fact to be learned or acted on, the hyperlinks serve to validate users' promotion of the #400ppm hashtag by lending it credibility as a reference to fact and, moreover, doing so by acting as a delegate for the work of science communication. In other words, the hyperlinks take on the work of providing access to scientific facts and producing news events, replacing the need for a science communicator, whether lay or professional, to do this work in the tweets themselves.

To explain this delegation function played by hyperlinks within the network, we propose that they be understood as examples of Latour's (1992) theorization in "Where are the Missing Masses?" of technology's imbrication in "programs of action, sections of which are endowed to *parts* of humans, while other sections are entrusted to parts of nonhumans" (1992, p. 254).

Latour uses the example of a doorhinge taking on the work of enabling people to pass through walls while maintaining the wall's ability to continue differentiating inside from outside. He observes that without a door, passage through walls would require first breaking a hole in a wall and then rebuilding it in order to maintain its integrity as a wall. By contrast, the technology of the doorhinge creates the possibility of a passageway through the wall that can repeatedly be opened or closed as necessary. Thus, the work done by the doorhinge replaces the work that would be required to break through and rebuild walls whenever we move through them. Latour describes this shift of work as "delegation" or "translation," which names the process by which "we have delegated (or translated or displaced or shifted down) to the hinge the work of reversibly solving the wall-hole dilemma" (1992, p. 229). In this way, we make nonhumans responsible for handling work for us, often in ways that allow us to no longer even think about that work.

For Twitter users sharing the news about #400ppm, hyperlinks to NOAA's press release and news stories about it function as a technology to which users delegate the work of explaining the scientific fact and its eventfulness. To understand the work of delegation, Latour enjoins us to "simply imagine what other humans or other nonhumans would have to do were this character not present" (1992, p. 229). Were the hyperlink not present, the Twitter user would have to laboriously copy out (or, perhaps less physically laboriously, paraphrase) the text of the press release or news story to share its content. In other words, the technology of the hyperlink allows communicators to delegate the work of repeating individual texts ad nauseam. Instead, these texts can circulate, not through actual physical motion—the 1's and 0's encoding them never have to leave their original servers—but rather as a metaphorical circulation that is more accurately described as a process of growing their connections to an expanding network of tweets, users, other texts, and so on.

The hyperlink's centrality to the internet's ability to function as a network, rather than a series of siloed texts, is, of course, well-documented. Often, this networking is conceived of as a way to connect related texts, as in internet pioneer Doug Engelbart's 1962 theorization of "associative linking" possibilities, a notion that was to serve as the forerunner of hypertext and led three decades later to the World Wide Web" (Markoff, 2005, p. 48). Demonstrating a similar concern for hyperlinks as discursive demonstrations of relationships among texts, media scholars Schneider and Foot conceive of the internet as made up of web spheres, which they describe "as not simply a collection of Web sites, but as a hyperlinked set of dynamically defined digital resources spanning multiple Web sites deemed relevant or related to a central theme or "object" (2004, p. 118). The hyperlink brings together otherwise scattered parts of the web. While this use as a textual marker of digital texts' relevance to each other is certainly a key function of the

hyperlink, the hyperlink also functions as a critical technological delegate, allowing web users to do much more work with ease than they would without it. Thus, while Latour (1992) carefully distinguishes between text and technology, then, the hyperlink troubles this distinction by being both discourse and technology. This insight recalls theorizations of computer code that complicate treatments of it as mere text, despite being made up of orthographic marks; these include Mackenzie's (2003) and Berry's (2016) careful distinction between code as text and code as process. Twitter further muddies this distinction between text and hyperlink by affording users the ability to share story headlines and visuals within the tweet when they tweet out a hyperlink; many of the users in our dataset did precisely this.

In a previous ANT study of social media, Potts highlights hyperlinks as just such key actants in the sharing and validation of information: "The use of hyperlinks (i.e., links) was an effective means of guiding people to information. Links allowed information to travel throughout these networks, thus providing a sense of consistency when more than one actor would refer to these links in communicating information to each other" (2009, p. 294). Potts also notes that this centrality of hyperlinks illustrates participant behavior that escapes specific social media networks to draw connections beyond it: "Rarely sticking to one Web site, participants are actively moving among sites, gathering information and turning that information into knowledge as they share it with others. Presenting this kind of literate activity is something new, requiring a different lens through which to study these experiences" (2009, p. 284). The technology of the hyperlink replaces human labor, but also makes methodological demands on us to take their work seriously.

We turned next to the specific topoi that users relied on when sharing hyperlinks and how these topoi relate to the texts that the hyperlinks, as delegated science communicators, work to relay. We identified four major topoi in our dataset. These four topoi can largely be classified according to Aristotle's three types of discourse: political (or deliberative), which focuses on questions of policy and proposed future actions; legal (or forensic), which focuses on questions of guilt and innocence; and ceremonial (epideictic), which focuses on questions of praise and blame (Aristotle, 2006). Gross (1994) suggests that traditional one-way science communication is epideictic in nature, in that it is designed to increase the audience's appreciation for science. Gross also argues for the connection between ethical and political considerations: "As Aristotle saw, rhetorical activity is also ethical and political activity: nothing significant can be advocated in the public forum that does not entail judgments of right and wrong." (1994, p. 5). In particular, epideictic rhetoric, with its focus on ethics and shared values (Golden, et al, 1992), and deliberative rhetoric, with its focus on public action, at times overlap (Tillery, 2003). In relation to the four topoi we describe below, the alarmist topos seems most often to be epideictic, characterized by self-blame, and the "we must act now" topos is most often deliberative, characterized by calls to action. But even in the coding, we found that these two topoi and functions often overlap. The following section is a description of the topoi, with connections to some of the texts the hyperlinks functioned as summaries of and connections to.

Topos #1: "Just the Facts"

The first major topos is a claim of factual reporting, summed up in a "just the facts" attitude and exemplified by a neutral statement that global monthly averages of CO₂ have surpassed 400 ppm. Typically, these tweets use the hashtag #400ppm and rely on the linked

stories to relate alarm or connect to other topoi. This category of neutrally sharing a fact was the largest (with both coders applying the topos to 63 out of 122 tweets), although many of those were categorized as using more than one topos. Several users presented a neutral fact in the tweet but embedded a more alarmist or activist claim within a hashtag, such as #oceanacidification, or more commonly (3 occurrences) #keepitintheground. For example, “Global #CO2 concentrations surpass #400 ppm for first time #oceanacidification” (Morgan, 2015) offers a neutral statement (a “fact” in Latour’s sense) in the text of the tweet, but the hashtag #oceanacidification implies a causal link to concrete and serious environmental impacts. The tweets using the hashtag #keepitintheground allow that hashtag to work as an enthymeme, leaving readers to work out the implications regarding the harmful impacts of fossil fuels.

Several of these more “neutral” tweets also use understatement as a rhetorical device, including references to CO2 reaching “prehistoric” levels, without comment on any implications. The inclusion of such adjectival qualifications led to some disagreement between coders, raising the question of how to distinguish between tweets sharing facts which happen to be alarming to environmentally-concerned readers from tweets sharing facts already framed as alarming and tweets actively engaging the topos of alarmism. For example, one tweet sharing a story from salon.com reads, “For the first time in recorded history, CO2 levels averaged above #400ppm for the entire month of March” (Earth Island Journal, 2015). While this could be read as a simple statement of fact, both coders categorized it as both “just the facts” and “alarmism,” as the phrase “for the first time in recorded history” highlights the unusual and alarming nature of this fact. This example demonstrates the difficulty of determining precisely what can be interpreted as “just the facts,” particularly when our rhetorical training prompts us to read for these kinds of rhetorical moves which frame facts in particular ways for particular purposes. For other tweets,

though, the alarmism was clearly layered onto the facts, as when one tweet editorialized with a one-word interjection: “Yikes! The world’s carbon dioxide levels just hit a new milestone of #400ppm” (Amazon Aid, 2015). The category of alarmism is discussed in greater detail below.

Most of the tweets in the “just the facts” category, even when also fitting rhetorically into other categories, seem to participate in the goal seemingly established by the NOAA’s original press release: to transform this global average measurement from a fact into an event. Movement towards alarmist, activist, or human-centric topoi often happened within the hashtags, suggesting that hashtags can be viewed as affordances, actants, and forms of argument.

Topos #2: Alarmism

The second most prominent category, with 24 out of 122 tweets categorized as such by both coders, consists of expressions of alarm, the apocalyptic, doomsday scenario that has recurred throughout environmental discourses for decades and is often criticized for fostering a defeatist response (Foust and O’Shannon Murphy, 2009). In many cases, that doomsday topos is enabled or invoked by the tweeted link’s headline or pull quote; 5 of the tweets in this category tweeted out a link to the Mother Jones article, with the headline referring to a “staggering new milestone.” That key phrase was repeated in the tweets. Other alarmist tweets included frequent references to the first time in one million years that atmospheric CO₂ averaged 400 ppm, including one tweeted image of a Tyrannosaurus Rex dinosaur (4USolution, 2015). Alarmist hashtags included prompts to be alarmed because there is #notmuchtime and we are #screwed, as well as highly emotionally charged and apocalyptic phrases like #massextinction, #ecocide, and #fuckingsuicide. The level of alarm called for by these hashtags varies, with the extreme end of the spectrum suggesting that we are past the point of irretrievable damage.

Such a suggestion would seem to foreclose the possibilities of deliberative rhetoric. It may be that these tweets are acting as epideictic rhetoric, seeking to form a network of contacts with similar values or assumptions. In this sense, alarmist environmental discourse may serve to establish values and beliefs, rather than to persuade, and such expressions play a role in fostering a community of actors. More pessimistically, we can see these expressions as symptomatic of the problem Latour describes: “I think that it is easy for us to agree that, in modernism, people are not equipped with the mental and emotional repertoire to deal with such a vast scale of events; that they have difficulty submitting to such a rapid acceleration for which, in addition, they are supposed to feel responsible while, in the meantime, this call for action has none of the traits of their older revolutionary dreams” (2014, p. 1).

Topos #3: We Must Act Now”

The topic of activism as a response to the message of 400 ppm was also a common response, with 20 of the 122 tweets placed by both coders in this category (many cross-listed with “just the facts”). Unlike the alarmist or just-the-facts tweets, this topos was more often expressed only within hashtags. Along with #keepitintheground, other activist hashtags include #carbontax, #ParisClimate, #emissions or #ZeroEmissions, #divestment, or the less specific #StopThisRise. Like the activist hashtags described by Bennet and Segerberg (2012) such as “#wearethe99%,” these climate-related hashtags offer broad frames that can encompass a variety of messages and welcome broad perspectives. In conjunction with the #400ppm hashtag that provides the frame of this study, #keepitintheground, #divestment, and #ZeroEmissions offer concrete goals that groups and individuals can both promote through social media and work towards through deliberative, activist efforts.

By calling for specific actions, these hashtags also function as deliberative rhetoric, making the political dimensions of the #400ppm event explicit. As such, hashtags invoking the “we must act now” topos connect this single climate change milestone to broader policy discourses that prompt us to treat such scientific events not just as isolated, apolitical facts, but as kairotic opportunities to advocate for individual and structural actions (also see Schneider-Bateman, this volume). In their attention to specific actions, these hashtags distinguish themselves from alarmist ones which either suggest the time for action is past (such as #screwed) or allow that there may still be time for actions, but do not offer suggestions for what those might be (such as #notmuchtime). This distinction may matter especially to scientists and science communicators invested in encouraging support for pro-environmental action, given research showing that directing people’s attention to problem-solving can encourage environmentally beneficial behaviors (Homburg, Stolberg, & Wegner, 2007). Moreover, while social science research has shown mixed results to the fear appeals embedded in the alarmist topos, research suggests they can support critical decision making when used to show causal relationships between actions and environmental outcomes (Meijinders, Midden, & Wilke, 2001). The “we must act now” topos could thus enable hashtags to both open deliberative debates about responding to climate change and to encourage efficacy and thoughtful responses to climate change events.

Topos #4: Human Impacts

This was by far the smallest and most contentious category of topics, with one coder applying the topos to 18 tweets and one coder applying the topos to 9 tweets during the first coding pass. Upon discussion, the reason for the disparity became apparent: while one

interpreted human impacts to mean “human impacts on the climate causing climate change,” the other interpreted human impacts to mean “impacts climate change will have on humans.” These are very different topoi, with the former typically applying to epideictic tweets intending to lay blame on humans for the news of #400ppm, and the latter looking ahead to the future in a variety of ways.

The tweets looking to future impacts on humans usually referred to extreme weather events such as hurricanes and cyclones, rather than to longer-term (and perhaps higher-impact) problems such as ocean level rising (one tweet referred to population displacement) or drought (no references). This lack of emphasis on the human impacts of climate change in relation to the #400ppm hashtag was surprising, as the effects of climate change, particularly now that it has reached this milestone, are likely to be severe on human health and infrastructure. However, this lack of emphasis in tweets and hashtags on human impacts was in keeping with most of the press releases and new stories whose links were tweeted, which generally did not emphasize the possible human impacts. The human impacts that were referred to included human populations (e.g., @NO_ACP’s tweet including the phrase “500,000 population displacement”) or commonly known weather cycles (e.g., @knollster’s tweet pointing out unusual weather: “Massive storm system in the Midwest, tropical cyclone developing in the Atlantic a month before hurricane season... #400ppm”). Certainly, though, human impacts could be inferred from some of the other hashtags coded as alarmist or “we must act now.” While the hashtag #screwed, for example, does not specify *who* is screwed, the suggestion that there will be dire consequences to the #400ppm event raises the possibility that those dire consequences will include dire impacts on humans. Again, the topoi in these tweets are mutable and open to interpretation depending on the views, values, and knowledge readers bring to them. This is not to suggest a porous topos such as

“human impacts” cannot do valuable rhetorical work; rather, as with all communication, even topos-driven ones are deeply contextual.

Conclusion

As we consider what these results might mean for science communicators, it seems clear that typical press releases and news stories can be structured in ways to foster certain patterns of sharing on social media. Invoking certain topoi in their press releases and news stories—even less political topoi such as human impacts—would give scientists and science communicators a grounding from which to develop usefully deliberative and epideictic hashtags with which to publicize and circulate their hyperlinked writing, with the acknowledgement that these hashtags and grounding topoi are highly susceptible to variable interpretation in the compressed space of a tweet. Attention to the text and technology of the hashtag suggests it has the potential to encourage the circulation of information in ways that promote activism rather than despair. This robust circulation depends on hyperlinks, the technology underlying both hashtags’ and news stories’ ability to be shared. Despite being non-human technologies, these hyperlinks are themselves important actors in the network of science communication, in both their guises, of text and technology. Against efforts to cleanly and neatly distinguish among humans and nonhumans, Latour counters, “I see only actors—some human, some nonhuman, some skilled, some unskilled—that exchange their properties” (1992, p. 235). Attending to the human and the nonhuman, the skilled and the unskilled actors in social media networks, can help both scientists and science communicators leverage news stories and social media platforms to spread science facts as they become important events.

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