

Reporting on Climate Change by Broadcast Meteorologists

A National Assessment

Kristin M. F. Timm, David Perkins, Teresa Myers, Bernadette Woods Placky, and Edward W. Maibach

ABSTRACT: Television weathercasters are uniquely situated to inform their audiences about the local impacts of global climate change and a growing number of them are adopting the role of climate change educator. We surveyed all American broadcast meteorology professionals in 2015 ($N = 2,059$; response rate = 22.6%), 2016 ($N = 2017$; response rate = 31.2%), and 2017 ($N = 2,177$; response rate = 22.1%) to assess weathercasters' interest in reporting about climate change; if, where, and how they report about climate change; and the reactions they get from their audiences when they do. Many participating weathercasters indicated that they were moderately or very interested in reporting about climate change, especially using local historical climate information (56%). Just over half of the weathercasters (57.9%) had used one or more communication mode to inform their viewers, or other people in their community, about the local impacts of climate change in the prior year. The most commonly used modes were social media (42.7%), school visits (36.3%), community events (33.1%), and on-air broadcasts (31.3%). Most weathercasters who had reported about climate change on air indicated they received either positive viewer feedback or little feedback (61.9%); conversely, weathercasters who had not reported about climate change expected to receive mostly negative feedback (44.2%). In sum, this analysis suggests that large numbers of weathercasters have adopted the role of climate change educator in their communities; they use a range of communication modes to share climate change information with their audiences and receive mostly positive feedback from their audiences when they do.

Downloaded from <http://journals.ametsoc.org/bams/article-pdf/101/12/E1294/947204/bamsd180225.pdf> by guest on 22 July 2020

AFFILIATIONS: Timm, Myers, Maibach—Center for Climate Change Communication, George Mason University, Fairfax, Virginia; Perkins—Missouri State University, Springfield, Missouri; Woods Placky—Climate Central, Princeton, New Jersey

<https://doi.org/10.1175/BAMS-D-18-0225.1>

Corresponding author: Edward W. Maibach, emaibach@gmu.edu

Supplemental material: <https://doi.org/10.1175/BAMS-D-18-0225.2>

In final form 16 October 2019

©2020 American Meteorological Society

For information regarding reuse of this content and general copyright information, consult the [AMS Copyright Policy](#).

Through increases in the frequency and intensity of extremely warm temperatures, less frequent instances of cold weather, and changing precipitation patterns, climate change has touched the lives of millions of Americans over the past several years (National Academies of Sciences, Engineering, and Medicine 2016, 85–125). Television meteorologists and weathercasters (hereafter called weathercasters) have long played a critical role in society by interpreting and explaining weather events, preparing audiences for weather-related hazards, and helping their audiences better understand the local environment (Wilson 2008a; Henson 2010). Weathercasters can now play another important role in society by helping viewers understand how climate change influences their weather, both day to day and during extreme events (Wilson 2008a; Maibach et al. 2016). In this manner, weathercasters can effectively link viewers' experiences with their local weather to information about broader, long-term climate trends—making the global local (Zhao et al. 2014; Bloodhart et al. 2015).

Until recently, few weathercasters reported about climate change on air and barriers to such reporting have been documented at multiple levels (Wilson 2009; Shoemaker and Reese 2014). At the individual level, many weathercasters were once skeptical of human-caused climate change (Wilson 2009), perceived low levels of agreement among the climate science community (Wilson 2002, 2009), mistrusted climate models (Wilson 2009), or did not see climate change reporting as part of their professional role (Meldrum et al. 2017). In their news routines, weathercasters felt they did not have time to prepare climate change stories (Wilson 2009), lacked access to climate scientists and easy to use content (Maibach et al. 2011), and felt constrained by the 2–3-min broadcast weather segment (Wilson 2008b, 2009; Meldrum et al. 2017). At the organizational level, barriers included actual or anticipated lack of support from station management (Wilson 2009; Henson 2010; Maibach et al. 2011, 2015; Meldrum et al. 2017). Weathercasters also feared negative feedback from viewers (Henson 2010; Maibach et al. 2011; Meldrum et al. 2017). Some weathercasters avoided climate change reporting to stay out of the broader conflict that had emerged within their professional community on the topic (Wilson 2012; Stenhouse et al. 2017).

Over the past decade, however, many of these barriers have been reduced or alleviated (Maibach et al. 2016). Weathercasters' understanding of climate change has evolved rapidly (Maibach et al. 2017): they are now more aware of the scientific consensus (Perkins et al. 2020) and their views are now more closely aligned with those of climate scientists (Maibach et al. 2017). Climate change reporting resources that simplify the preparation of climate change stories are now freely available (Woods Placky et al. 2016; Perkins et al. 2018) and sustained efforts have been made to use training and peer modeling to show how climate change information can be presented within the weather segment (Maibach et al. 2016). Indeed, Perkins et al. (2018) found that the strongest predictors of climate change reporting were receiving *Climate Matters* reporting resources, personal interest in reporting on climate change, and age. In turn, interest in reporting about climate change was most strongly predicted by certainty that climate change is happening and is human caused (Perkins et al. 2018). As individual weathercasters and their management learn about the benefits of climate change reporting, such as awards and gaining competitive advantages, there are some indications that the organizational barriers to climate change reporting are also being reduced (Maibach et al. 2016).

Climate change reporting embodies a wide variety of activities and behaviors, because the modern weathercaster uses a wide variety of communication methods (Henson 2010). Early studies described how weathercasters used the 15–20-s transitions between the news and weather to discuss climate change, as well as community and school outreach presentations (Wilson 2008a). In the 2000s, with the rise of websites and blogs, news stations' websites and weathercaster blogs became another modality for climate change reporting (Wilson 2009). Weathercasters now also include climate change information in their on-air forecast, longer news stories, and posts on social media (Maibach et al. 2017). Climate change reporting by weathercasters often, but not always, includes explicit references to climate change; some weathercasters prefer to present historical trend data (e.g., temperature trends), but omit the phrase "climate change" or "global warming" (Bloomberg News 2017).

With support from the National Science Foundation, between 2015 and 2017, we conducted the most comprehensive surveys to date of broadcast meteorology professionals—annual census surveys to assess weathercasters' views about climate change, climate change reporting behaviors, and the barriers they face when reporting about climate change. In this article, we describe the present state of climate change reporting among U.S. weathercasters.

Methods

Starting in 2015, we used Cision, a commercial database of news professionals to obtain an initial list of people currently working in broadcast meteorology, and we verified and updated the list manually each year by looking at the websites for each broadcast affiliate. Using the same general protocol each year, we conducted online surveys with every person currently working in weathercasting and broadcast meteorology in the United States. Our first survey was conducted from 20 January through 23 February 2015 and was emailed to 2,059 people, with a response rate of 22.6% ($N = 466$). Our second survey, conducted from 6 to 31 January, 2016, was e-mailed to 2,017 people and had a response rate of 31.2% ($N = 629$). Our final survey was conducted from 9 to 27 January, 2017 and was emailed to 2,177 people with a response rate of 22.0% ($N = 480$). Participation rates were respectable considering the challenges of surveying news professionals (e.g., Brüggemann and Engesser 2014) and that many studies of news professionals rely on a small number of in-depth interviews.

To assess nonresponse error—the most serious form of error in surveys seeking to represent population parameters (Dillman et al. 2014, p. 5)—we compared participants and nonparticipants using publicly available data on each person's gender, region, market characteristics, and occupational position at their station (information we had recorded when developing the census frame). Using chi-square goodness-of-fit tests and t tests (that are fully reported in the supplemental materials; <https://doi.org/10.1175/BAMS-D-18-0225.2>), we found a statistically significant difference in gender [$\chi^2(2) = 7.703, p < 0.01$], such that females were underrepresented in the survey as compared to their proportion in the population. We also found statistically significant differences by occupational positions such that chief meteorologists were overrepresented in the survey [$\chi^2(1) = 25.235, p < 0.001$], and weather anchors [$\chi^2(1) = 4.135, p < 0.05$] and people in the "other" category [$\chi^2(1) = 6.025, p < 0.05$], were underrepresented in the survey. There was no difference in survey participation between people in other occupational positions (meteorologists, weather producers, reporters, and temporary/fill-in meteorologists and weathercasters). Participants and nonparticipants also did not differ on geographic region [$\chi^2(9) = 10.738, p = 0.294$], or on market-level characteristics including population size [$t(2,200) = 1.03, p = 0.305$], economic situation [$t(2,200) = 0.69, p = 0.490$], average temperature [$t(2,200) = 1.55, p = 0.120$], or political ideology of the media market [$t(2,200) = 0.18, p = 0.855$].

The survey instrument consisted of a range of questions including a review of professional practices and pressures in the broadcast meteorology community, views of climate change, climate change reporting interests and practices, and professional development needs. Certain

questions were included in every survey, while others varied year to year based on the project needs and evolving research interests. Each survey was fielded for approximately three weeks, and participants were sent up to five or six e-mail reminders to participate. The median survey completion times were 13.49, 15.13, and 19.63 min, in 2015, 2016, and 2017, respectively.

Participant demographics. A diverse group of weathercasters completed the survey each year. Across all three years, the largest segments of survey participants identified as chief meteorologists (31.3% in 2015; 29.1% in 2016; 29.4% in 2017), weekend meteorologists (14.2% in 2015; 22.4% in 2016; 19.4% in 2017), or morning/noon/midday meteorologists (12.7% in 2015; 19.1% in 2016; 20.6% in 2017).

The majority of survey participants possessed a bachelor's degree in meteorology or atmospheric science (49.1% in 2015; 52.6% in 2016; 54.2% in 2017), and many participants held a master's degree in meteorology or atmospheric science (9% in 2015; 7.3% in 2016; 7.1% in 2017). Additionally, many survey participants had a certificate in meteorology or broadcast meteorology (16.5% in 2016; 15.4% in 2017)¹ or a bachelor's degree in journalism or mass communication (11.8% in 2015; 14.5% in 2016; 14.4% in 2017). Other educational degrees appeared less frequently. Each year, about one-quarter of the weathercasters surveyed had the American Meteorological Society (AMS) Certified Broadcast Meteorologist (CBM) Seal, another quarter had the AMS Seal of Approval, another quarter had no seal of approval, and just less than a quarter had the National Weather Association (NWA) Seal of Approval.

The age of weathercasters surveyed did not vary much from year to year. About a quarter represented the 18–29 age group, another quarter represented the 30–39 age group, about 20% represented the 40–49 age group, about 20% represented the 50–59 age group, and the remaining approximately 9% of survey participants were age 60 or older. Across each year of the survey, about a quarter of the survey participants identified as female and three-quarters identified as male.

More detailed sampling information, methodological information, and participant demographics are provided in the supplemental materials.

Results

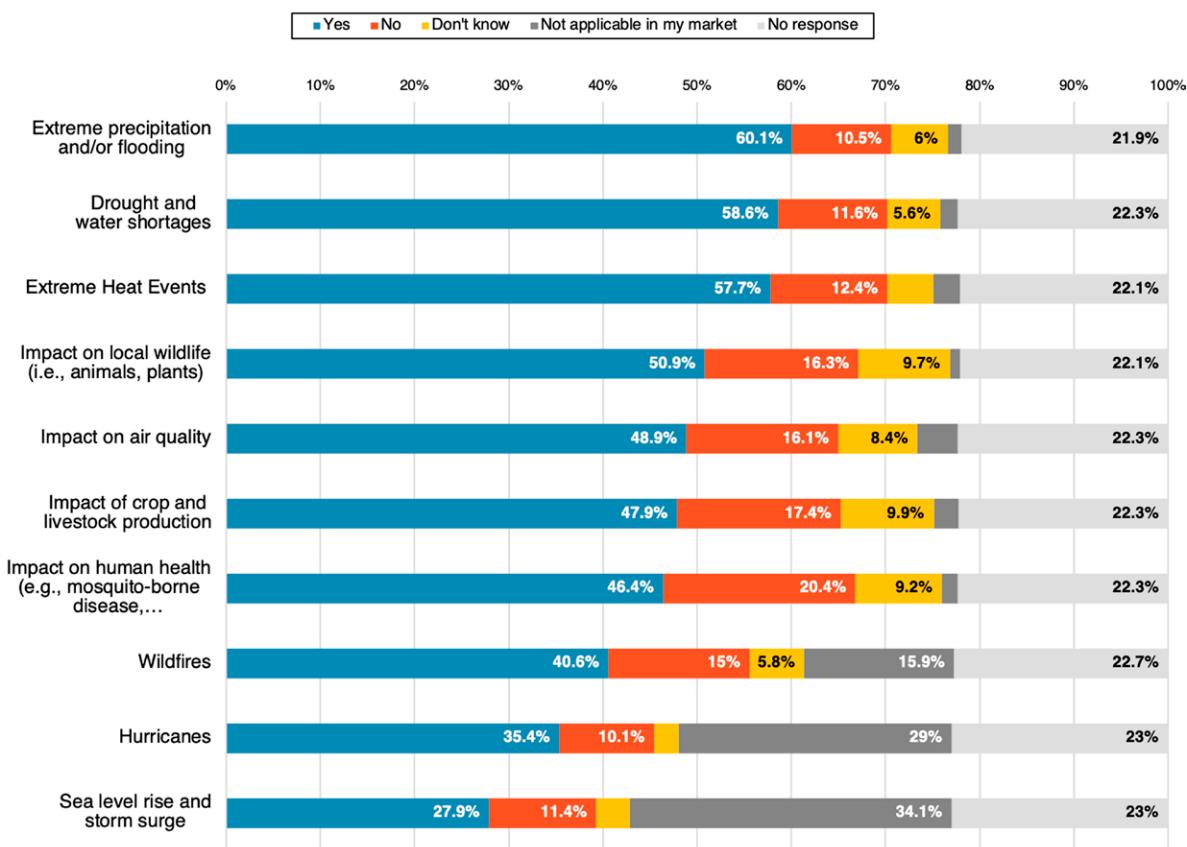
Interest in being the station scientist. The American Meteorological Society's "station scientist" initiative encourages broadcast meteorologists to cover a range of science topics beyond the weather, such as space and astronomy, climate, health, or energy, for their station (Posegate 2008; Wilson 2008b). In 2017, a majority of weathercasters surveyed (67.9%) said they were familiar with the station scientist initiative; of those, many indicated that they were filling this role at their station to some extent (yes: 38.9%; somewhat: 48.9%; no: 10.6%, other 1.5%; $N = 470$). For those unfamiliar with the initiative, a brief description was provided, and about one-third (33.3%; $N = 57$) of these survey participants indicated that they would be interested in filling this role at their station.

Interest in reporting about climate change. In each survey we asked participants questions about their climate change reporting interests, including what kind of local climate change impact stories they would be interested in reporting on (2015), what kind of climate change material they are most confident presenting on air (2016), and what kind of climate change topics they are most interested in presenting on air (2017).

Over half of weathercasters who participated in the 2015 survey said they were interested in presenting climate change topics that have broad, regional relevance, including extreme precipitation and/or flooding, drought and water shortages, extreme heat events, and impacts

¹ The 2015 survey did not include the "certificate in meteorology or broadcast meteorology" response option.

Interest in Reporting Local Climate Change Impact Stories



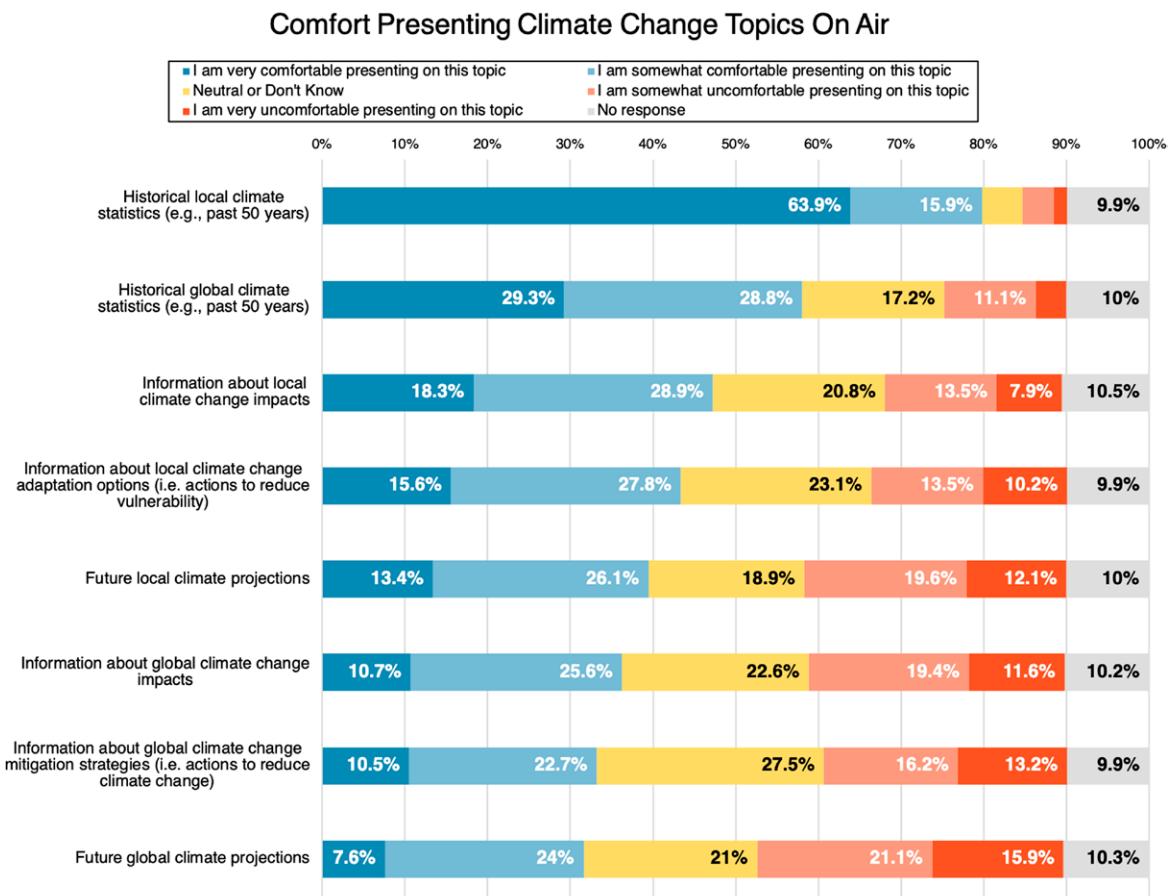
"Which, if any, of the following local climate change stories would you be interested in reporting on?

2015 National Survey of Broadcast Meteorologists ($N = 466$)

Data labels are not pictured for amounts less than 5%.

Fig. 1. Weathercaster interest in reporting on various local climate change impacts.

Fig. 2. Weathercasters feel most comfortable presenting historical local and global climate change statistics on air, as compared to future climate change projections.



"How comfortable or uncomfortable are you (or would you be) in presenting the following kinds of materials to your viewers on air?

2016 National Survey of Broadcast Meteorologists ($N = 629$)

Data labels are not pictured for amounts less than 5%.

on plants and animals (see Fig. 1). Weathercasters expressed less interest in reporting on more regionally specific topics such as hurricanes, sea level rise, and wildfires, which may be a function of the weather in the preceding year, the regions of the country survey participants came from, or the number of people impacted for a particular place and time.

Climate change information comes in a variety of formats, such as historical statistics and trends, model projections for the future, and impact, adaptation, and mitigation information. In 2016 we asked weathercasters how comfortable they felt presenting these different types of information to their on-air viewers. A majority of survey participants indicated they were very comfortable presenting historical local climate statistics (63.9%; see Fig. 2). Weathercasters, however, were least comfortable presenting information about global climate change mitigation strategies (13.2% indicated very uncomfortable) and future global climate change projections (15.9%) on air.

Similarly, in 2017, over half (56%) of the weathercasters surveyed were moderately or very interested in presenting local historical climate information from recent decades on air, while approximately one-third were interested in reporting about climate change impacts, adaptation efforts, protective behaviors, mitigation efforts, and future projections; see Fig. 3.

Many weathercasters surveyed voiced an interest in reporting longer-format climate change stories outside of the traditional weather segment. In 2017, nearly half of weathercasters (44.3%) were somewhat, moderately, or very interested in reporting longer-format climate change stories on air outside of the weather segment. However, only about a quarter (27.6%) said they had reported a longer-format climate change story on air outside the weather segment in the past year.

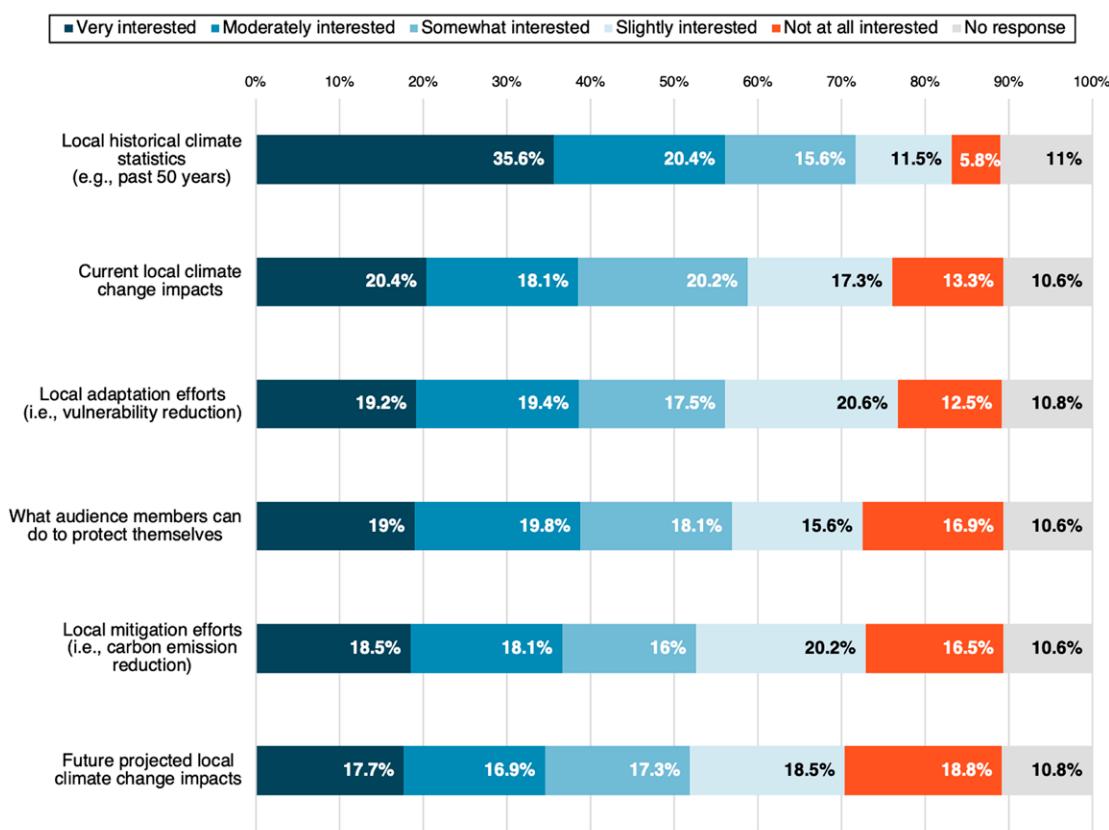
State of climate change reporting. Many weathercasters have informed members of their community about the local impacts of climate change in the past several years. In 2017, just over half (57.9%) of the weathercasters surveyed had used one or more modes of communication to inform their viewers or other people in their communities about the local impacts of climate change, at least one time, in the prior year. Climate change information was most likely to be shared on social media (42.7%), during in-person school (36.3%) and community events (33.1%), and during on-air broadcasts (31.3%); see Fig. 4.

Participants who provided climate change information online ($N = 150$) and on social media ($N = 225$) were asked how often they did so. Over half (58.6%) of the weathercasters who reported about the local impacts of climate change on air, did so one to four times in the past year. Approximately one-quarter (28.7%) presented climate change information on air between 5 and 20 times in the past year. A minority, just 4.6%, presented climate change information on air two or three times a month or more frequently in the prior year. Another 8% said they did not report about climate change on air in the past year.

Communicating with audiences online and on social media is becoming an increasingly common practice for weathercasters, and this is a popular mode for sharing climate change information. In 2017, approximately half (51.3%) of the weathercasters who utilized social media to report about the local impacts of climate change did so one to four times during the past year. An additional 28.2% shared climate change information on social media five to twenty times in the past year, and one-tenth (10.2%) did so several times a month or more frequently. Another 10.3% said they did not communicate about climate change on social media during the past year.

Feedback from viewers. In 2017 we asked weathercasters what kind of feedback they had received when they reported on local climate change topics. More than a quarter (28.6%) of weathercasters who had presented about climate change on air in the past year ($N = 150$) received “very few reactions either way” from their audiences (see Fig. 5). However, of those

Interest in Presenting Climate Topics On Air



"How interested are you in presenting on air about the following climate topics?"
2017 National Survey of Broadcast Meteorologists (N = 480)

Fig. 3. Weathercaster interest in presenting various types of climate change information.

Methods Used to Share Local Climate Change Information

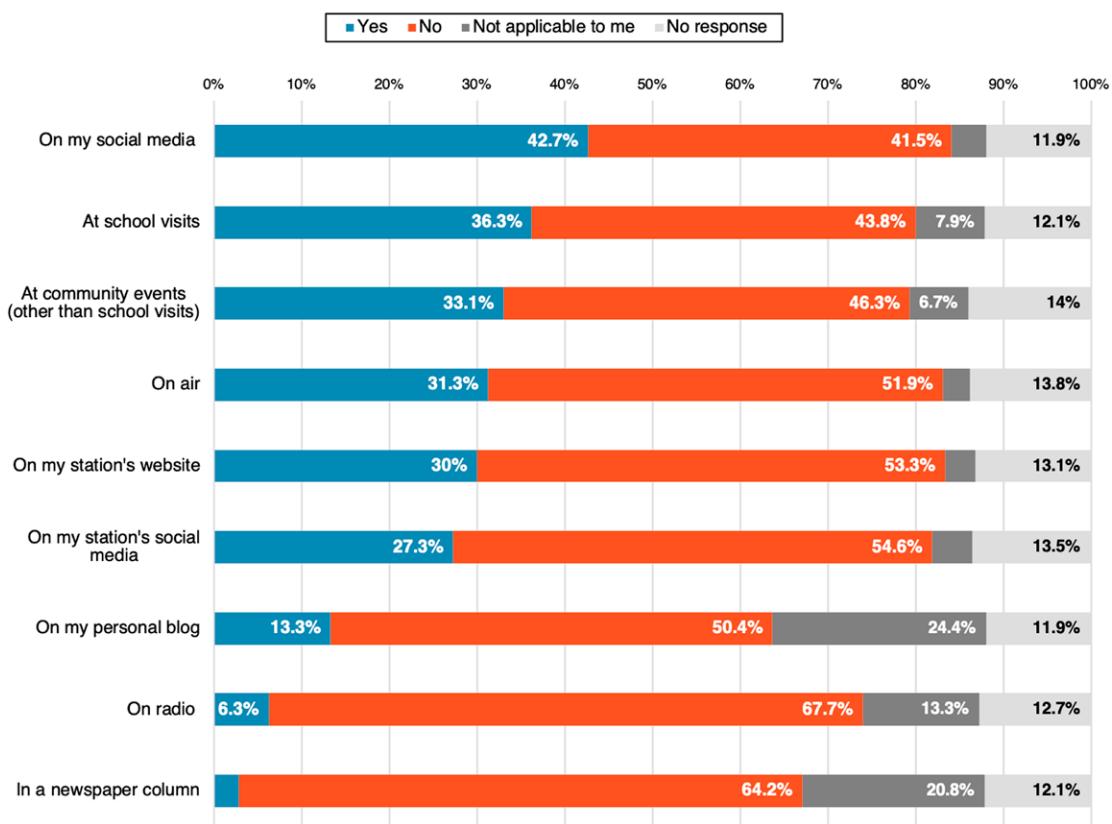
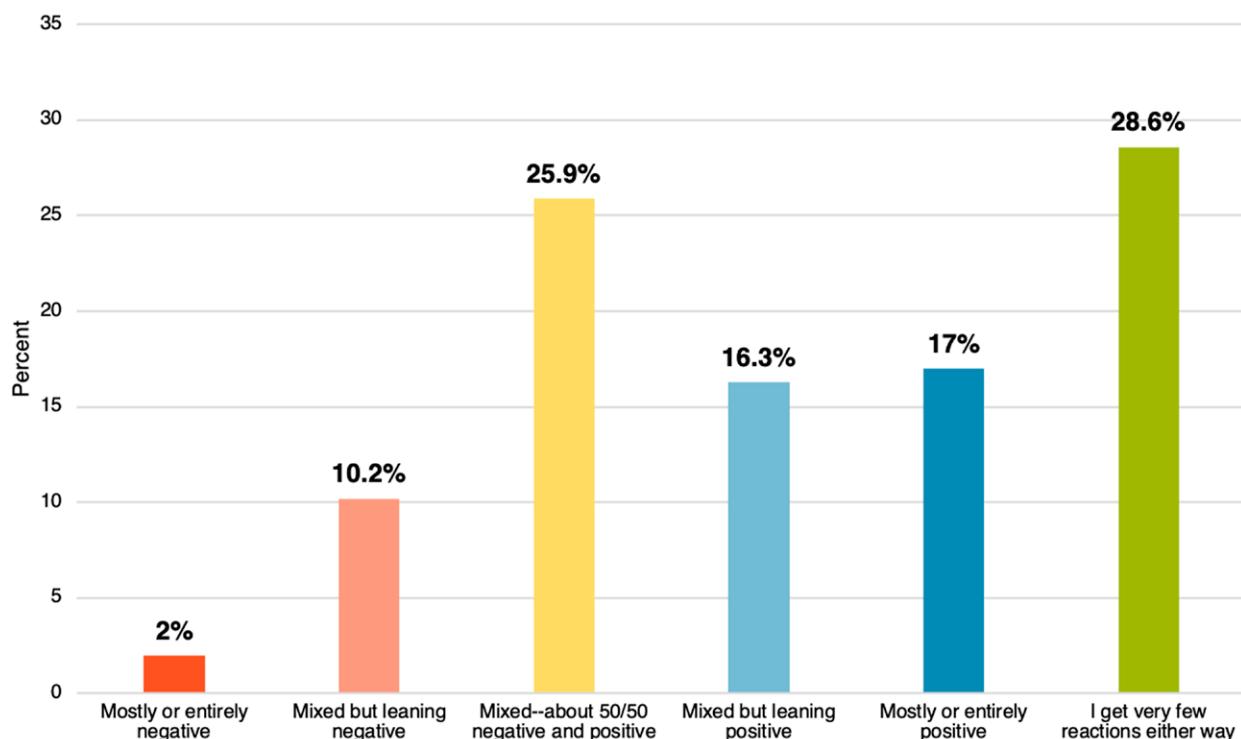


Fig. 4. Weathercasters use a variety of methods to share local climate change information with their audiences and members of their community.

"Over the past 12 months, did you use the following channels to inform your viewers, or other people in your community, about the local impacts of climate change?"
2017 National Survey of Broadcast Meteorologists (N = 480)
Data labels are not pictured for amounts less than 5%.

When you report about local climate change topics on air, is the feedback you receive from viewers...



2017 National Survey of Broadcast Meteorologists ($N = 150$)

Note: This question was administered to only people who said "Yes" they had presented "On air" in the question, "Over the past 12 months, did you use the following channels to inform your viewers, or other people in your community, about the local impacts of climate change?"

Fig. 5. Weathercasters already reporting about climate change on air find that they get few reactions from viewers, but when they do the viewer response is mostly mixed or positive.

receiving feedback, about a third (33.3%) indicated that they received mixed but leaning positive or mostly positive feedback from their audiences. About a quarter (25.9%) said the feedback was equally mixed between negative and positive; while only 12.2% said feedback was leaning or mostly negative.

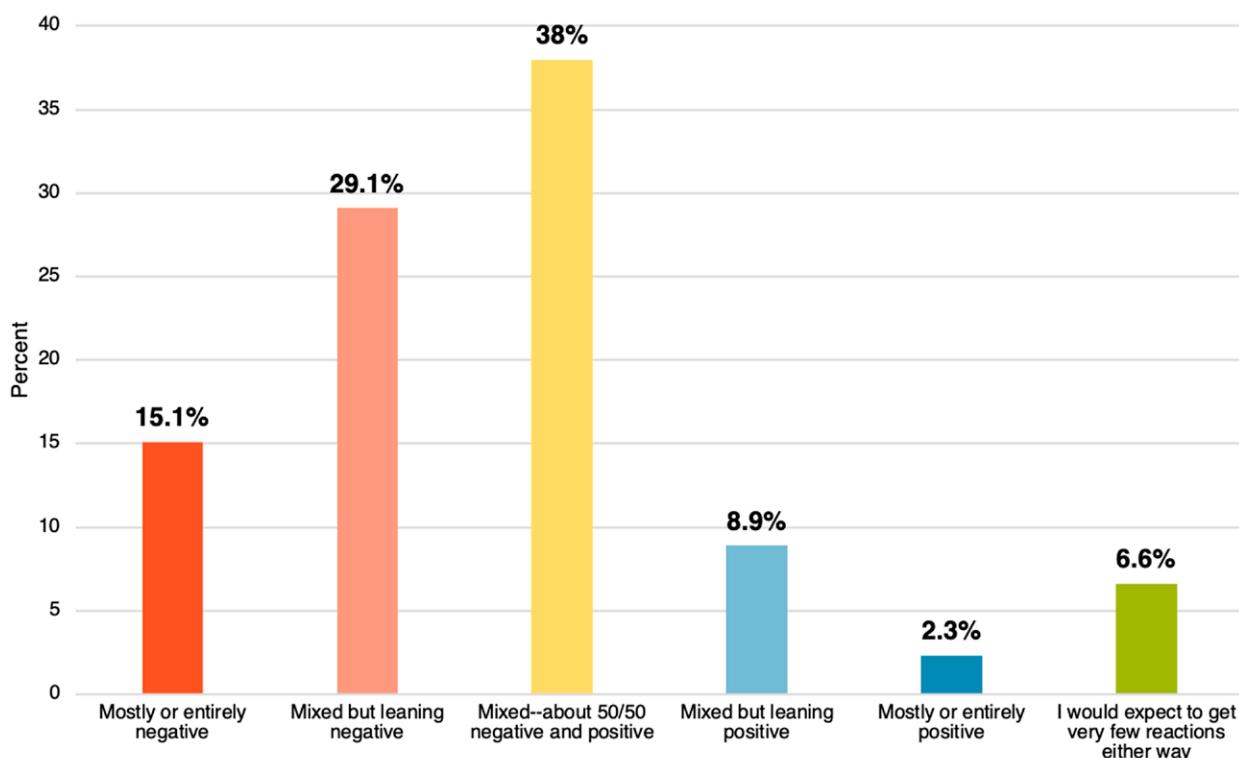
For those who had not previously reported on local climate change topics, we asked them what kind of feedback they expected to receive. In contrast to the mostly positive experiences of weathercasters who had reported on air about climate change, most weathercasters who had not reported local climate change topics on air ($N = 264$) believed that viewer feedback would be mostly negative. Almost half (44.2%) expected negative feedback and relatively few (11.2%) believed they would get positive feedback from viewers (see Fig. 6).

Conclusions

Our surveys suggest that large numbers of weathercasters are interested in reporting about climate change; however, weathercasters are most confident and interested in presenting local, historical climate change information as compared to projections of future climate. Future climate projections include several sources of uncertainty that may be difficult to explain during the short weather segment (Henson 2010). Considering weathercasters' attention to accuracy and sensitivity to viewer's accusations of producing inaccurate forecasts, their reluctance to discuss future climate projections is not surprising (Wilson 2009; Schweizer et al. 2014).

However, many survey participants expressed an interest in producing longer-format climate change stories outside of the weather broadcast. Reporting longer-format science stories

If you were to report about local climate change topics on air,
what kind of feedback would you expect from viewers...



2017 National Survey of Broadcast Meteorologists ($N = 264$)

Note: This question was administered to only people who said "No", "Don't Know", or "Not applicable to me" when asked if they had presented "On air" in the question, "Over the past 12 months, did you use the following channels to inform your viewers, or other people in your community, about the local impacts of climate change?"

Fig. 6. Weathercasters not already reporting about climate change on air perceive that the viewer response will be mostly mixed or negative.

is a new role for many broadcast meteorologists, one that is closely related to the American Meteorological Society's station scientist initiative (Posgate 2008; Wilson 2008b). The station scientist initiative encourages broadcast meteorologists—often the only scientist in the newsroom—to cover a range of science topics beyond the weather. In addition to the station scientist initiative, there are a variety of personal, organizational, and cultural factors that influence whether and how often weathercasters report about climate change, but being personally interested in climate change and actively engaging with scientific and climate information are some of the greatest predictors of climate change reporting (Perkins et al. 2018).

The self-described reporting behaviors indicated by our survey participants closely mirrored their high levels of interest in climate change reporting. About a third of the survey participants reported on climate change in social media, school presentations, community events, on air, or on the station's website at least one time in the prior year. Many weathercasters reported about climate change infrequently, but a small number of weathercasters reported about climate change regularly, conveying information multiple times a month on air and/or on social media. These results are supported by the growth of programs like *Climate Matters*, which e-mail regular updates on localized climate change information to its subscribers (Woods Placky et al. 2016). *Climate Matters* has experienced incredible growth in the past eight years, going from a pilot project with one weathercaster in 2010 to 668 weathercasters as of February 2019.

One limitation of these results is that our survey did not specify precisely what constitutes a "climate change news story" or "reporting on climate change." In the survey, we asked

weathercasters if they had informed their viewers, or other people in their community, about the local impacts of climate change and if they had reported “on the local impacts of climate change.” Unfortunately, there is no way to know exactly how survey participants interpreted these questions. In future surveys related to this topic, it would be valuable to provide a definition of climate change reporting specific to different communication modalities. For example, climate change reporting on Facebook may be defined as one Facebook post that discusses the local effects of climate change. On air, this could be defined as any discussion about the local effects of climate change anywhere within the broadcast news program. Furthermore, it would be valuable to specify whether climate change reporting must include the words “climate change” or if any discussion about warming trends should also be considered reporting on climate change.

Interestingly, online and social media were the most popular communication methods for weathercasters to share information about climate change. Weathercasters are increasingly expected to use a range of communication methods in their work, including social media (Henson 2010). However, social media can be a source of incivility that can deter participation in online discussion for contested issues, such as climate change (Su et al. 2018; Howarth and Sharman 2017). Still, weather information, as compared to other kinds of news, may be less likely to lead to incivility (Anderson and Huntington 2017). It is also possible that the expectations for negative feedback or consequences of receiving negative feedback are different for online versus other communication modes. Future research could investigate whether and how weathercasters’ audiences and audience feedback differ between broadcast and social media modes, the kind of communication these different methods afford, and any possible difference in effects of local climate change information presented by weathercasters in different media.

In addition to investigating climate change reporting across different communication methods, future research should also investigate the types of information weathercasters are presenting. For example, *Climate Matters* reporting resources often attempt to enhance perceptions of personal relevance of the issue by presenting the local or regional impacts of global climate change on weather, health, agriculture, water resources, and other local interests (Woods Placky et al. 2016). Presenting climate change as a local story should help publics who see climate change as a distant issue (i.e., affecting the polar regions) see how it affects their own communities, is connected to their own experiences, and thus become more personally relevant (Maibach et al. 2016). Several additional models for improving climate change reporting have also emerged. For example, personalizing climate change by sharing stories about how local people are being affected could also decrease distance, increase personal relevance, and model effective behaviors to adapt and respond to climate change impacts (e.g., <https://climateshortiesncc.org> or <https://climatewisconsin.org>).

A range of influences affect news professionals’ reporting choices, and weathercasters are likely affected by a similar variety of influences, including feedback from audiences (Brüggemann 2014; Shoemaker and Reese 2014). The large gap between perceived and actual viewer response among weathercasters who have not and those who have presented local climate change information on air was a notable finding. However, it is apparent why some weathercasters are hesitant to do anything that may erode their relationship with viewers. Weathercasters are one of the most important influences on a viewers’ selection of a news program and are under an exceptional amount of pressure to maintain a positive relationship with their audiences (Meldrum et al. 2017). Schweizer and colleagues (2014, p. 93) noted how weathercasters, “aim to be perceived by viewers as approachable, trustworthy sources of news,” and because they work in competitive markets, they are hesitant to say anything that would alienate viewers.

Audiences may not be as hostile toward climate information as some weathercasters

perceive them to be. Even audience members who may be considered “unconvinced” that climate change is happening may not be opposed to seeing information about it in their local news (Engblom et al. 2019). Nonetheless, weathercaster’s perception of how audiences are expected to respond to climate change information may play an important role in shaping climate change reporting decisions. Future research should investigate these dynamics, and the role that perceived audience response plays in shaping journalistic decisions, which may vary by region of the country, type of climate change information, or even by method of communication.

These results may be limited in that we cannot conclude how many people did not see or receive the survey because of e-mail filters, firewalls, or online security. Despite that, our comparisons show that the survey participants were similar to those who did not participate in the survey across several different dimensions, increasing our confidence in the representativeness of these results. Chief meteorologists were slightly overrepresented and weather anchors were slightly underrepresented, and so these results may be slightly biased toward those weather professionals having more meteorological education and experience.

Furthermore, the timing of the survey may have influenced some of the results. Our survey has always been fielded in January or February, which may have made any recent weather events—and their reporting—more salient. Additionally, we only asked about interest in reporting about climate change impacts in 2015 (i.e., drought, floods, hurricanes), and the responses may have been affected by the weather of that prior year. In fact, in the United States, 2014 was notable for drought and heat, and less so for large hurricanes (Herring et al. 2015).

In conclusion, we find that a growing number of weathercasters are adopting the role of climate change educator. In doing so, they are finding a variety of ways to communicate about the changing weather and climate change in their local communities and regions, and likely helping their audiences understand more about this important issue.

ACKNOWLEDGMENTS. This research was supported by the National Science Foundation (Award DRL-0917566, DUE-1043235, DRL-142243), with additional support provided by NASA (Award NNX11AQ80G).

References

Anderson, A. A., and H. E. Huntington, 2017: Social media, science, and attack discourse: How Twitter discussions of climate change use sarcasm and incivility. *Sci. Commun.*, **39**, 598–620, <https://doi.org/10.1177/1075547017735113>.

Bloodhart, B., E. W. Maibach, T. Myers, and X. Zhao, 2015: Local climate experts: The influence of local TV weather information on climate change perceptions. *PLOS ONE*, **10**, e0141526, <https://doi.org/10.1371/journal.pone.0141526>.

Bloomberg News, 2017: The red-state weatherwoman on a climate change mission. YouTube, www.youtube.com/watch?v=9cOngRAQuxo.

Brüggemann, M., 2014: Between frame setting and frame sending: How journalists contribute to news frames. *Commun. Theory*, **24**, 61–82, <https://doi.org/10.1111/comt.12027>.

—, and S. Engesser, 2014: Between consensus and denial: Climate journalists as interpretive community. *Sci. Commun.*, **36**, 399–427, <https://doi.org/10.1177/1075547014533662>.

Dillman, D. A., J. D. Smyth, and L. M. Christian, 2014: *Internet, Phone, Mail, and Mixed Mode Surveys: The Tailored Design Method*. 4th ed. Wiley, 509 pp.

Engblom, A., K. Timm, R. Mazzone, D. Perkins, T. Myers, and E. Maibach, 2019: Local TV news viewer reactions to weathercasters reporting the local impacts of climate change. *Wea. Climate Soc.*, **11**, 321–335, <https://doi.org/10.1175/WCAS-D-18-0066.1>.

Henson, R., 2010: *Weather on the Air: A History of Broadcast Meteorology*. Amer. Meteor. Soc., 241 pp.

Herring, S. C., M. P. Hoerling, J. P. Kossin, T. C. Peterson, and P. A. Stott, Eds., 2015: Explaining Extreme Events of 2014 from a Climate Perspective. *Bull. Amer. Meteor. Soc.*, **96** (12), S1–S172, <https://doi.org/10.1175/BAMS-ExplainingExtremeEvents2014.1>.

Howarth, C., and A. Sharman, 2017: Influence of labeling and incivility on climate change communication. *Climate Science*, Oxford University Press, <https://doi.org/10.1093/acrefore/9780190228620.013.382>.

Maibach, E. W., and Coauthors, 2011: A national survey of television meteorologists about climate change education. George Mason University Center for Climate Change Communication Rep., 53 pp., www.climatechangecommunication.org/wp-content/uploads/2016/03/June-2011-A-National-Survey-of-Television-Meteorologists-about-Climate-Change-Education.pdf.

—, and Coauthors, 2015: A 2015 national survey of broadcast meteorologists about climate change: Initial findings. George Mason University Center for Climate Change Communication, 71 pp., www.climatechangecommunication.org/wp-content/uploads/2015/04/2015-Broadcast-Met-Final-Survey-Report-rev.compressed.pdf.

—, and Coauthors, 2016: TV meteorologists as local climate change educators. *Climate Science*, Oxford University Press, <http://climatescience.oxfordre.com/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-505>.

—, and Coauthors, 2017: TV weathercasters' views of climate change appear to be rapidly evolving. *Bull. Amer. Meteor. Soc.*, **98**, 2061–2064, <https://doi.org/10.1175/BAMS-D-15-00206.1>.

Meldrum, H. M., D. Szymanski, E. A. Oches, and P. T. Davis, 2017: Speaking out or staying quiet on climate change: Broadcast meteorologists influenced by the need to be pithy, popular and politically cautious. *Climate Change Adaptation in North America*, W. L. Filho and J. Keenan, Eds., Springer, 261–277, https://doi.org/10.1007/978-3-319-53742-9_16.

National Academies of Sciences, Engineering, and Medicine, 2016: *Attribution of Extreme Weather Events in the Context of Climate Change*. National Academies Press, 186 pp., www.nap.edu/catalog/21852/Attribution-of-Extreme-Weather-Events-in-the-Context-of-Climate-Change.

Perkins, D. R., IV, T. Myers, Z. Francis, R. Mazzone, and E. Maibach, 2018: Attributes of weathercasters who engage in climate change education outreach. *Wea. Climate Soc.*, **10**, 487–500, <https://doi.org/10.1175/WCAS-D-17-0025.1>.

—, and Coauthors, 2020: Broadcast meteorologists' views on climate change: A state-of-the-community review. *Wea. Climate Soc.*, <https://doi.org/10.1175/WCAS-D-19-0003.1>, in press.

Posegate, A., 2008: Station scientists: Beyond the daily forecast. *Weatherwise*, **61**, 20–25, <https://doi.org/10.3200/WEWI.61.6.20-25>.

Schweizer, V., S. Cobb, W. Schroder, G. Chau, and E. W. Maibach, 2014: TV weathercasters and climate education in the shadow of climate change conflict. *Climate, Culture and Politics: How Information Shapes Our Common Future*, D. A. Crow and M. T. Boykoff, Eds., Routledge, 83–101.

Shoemaker, P. J., and S. D. Reese, 2014: *Mediating the Message in the 21st Century: A Media Sociology Perspective*. 3rd ed. Routledge, 288 pp.

Stenhouse, N., A. Harper, X. Cai, S. Cobb, A. Nicotera, and E. Maibach, 2017: Conflict about climate change at the American Meteorological Society: Meteorologists' views on a scientific and organizational controversy. *Bull. Amer. Meteor. Soc.*, **98**, 219–223, <https://doi.org/10.1175/BAMS-D-15-00265.1>.

Su, L. Y.-F., M. A. Xenos, K. M. Rose, C. Wirz, D. A. Scheufele, and D. Brossard, 2018: Uncivil and personal? Comparing patterns of incivility in comments on the Facebook pages of news outlets. *New Media Soc.*, **20**, 3678–3699, <https://doi.org/10.1177/1461444818757205>.

Wilson, K. M., 2002: Forecasting the future: How television weathercasters—Attitudes and beliefs about climate change affect their cognitive knowledge on the science. *Sci. Commun.*, **24**, 246–268, <https://doi.org/10.1177/107554702237849>.

—, 2008a: Television weathercasters as potentially prominent science communicators. *Public Understanding Sci.*, **17**, 73–87, <https://doi.org/10.1177/0963662506065557>.

—, 2008b: Television weathercasters as station scientists. *Bull. Amer. Meteor. Soc.*, **89**, 1926–1927, <https://doi.org/10.1175/1520-0477-89.12.1925>.

—, 2009: Opportunities and obstacles for television weathercasters to report on climate change. *Bull. Amer. Meteor. Soc.*, **90**, 1457–1465, <https://doi.org/10.1175/2009BAMS2947.1>.

—, 2012: Ideology trumps meteorology: Why many television weathercasters remain unconvinced of human-caused climate change. *Electron. News*, **6**, 208–228, <https://doi.org/10.1177/1931243112469610>.

Woods Placky, B., E. Maibach, J. Witte, B. Ward, K. Seitter, N. Gardiner, D. Herring, and H. Cullen, 2016: *Climate Matters*: A comprehensive educational resource program for broadcast meteorologists. *Bull. Amer. Meteor. Soc.*, **97**, 709–712, <https://doi.org/10.1175/BAMS-D-14-00235.1>.

Zhao, X., and Coauthors, 2014: Climate change education through TV weathercasts: Results of a field experiment. *Bull. Amer. Meteor. Soc.*, **95**, 117–130, <https://doi.org/10.1175/BAMS-D-12-00144.1>.

Ziegele, M., and P. B. Jost, 2016: Not funny? The effects of factual versus sarcastic journalistic responses to uncivil user comments. *Commun. Res.*, **43**, <https://doi.org/10.1177/0093650216671854>.