

The Prevalence and Rationale for Presenting an Opposing Viewpoint in Climate Change Reporting: Findings from a U.S. National Survey of TV Weathercasters

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ABSTRACT


The journalistic norm of balance has been described as the practice of giving equal weight to different sides of a story; false balance is balanced reporting when the weight of evidence strongly favors one side over others—for example, the reality of human-caused climate change. False balance is problematic because it skews public perception of expert agreement. Through formative interviews and a survey of American weathercasters about climate change reporting, we found that objectivity and balance—topics that have frequently been studied with environmental journalists—are also relevant to understanding climate change reporting among weathercasters. Questions about the practice of and reasons for presenting an opposing viewpoint when reporting on climate change were included in a 2017 census survey of weathercasters working in the United States ($N = 480$; response rate = 22%). When reporting on climate change, 35% of weathercasters present an opposing viewpoint “always” or “most of the time.” Their rationale for reporting opposing viewpoints included the journalistic norms of objectivity and balanced reporting (53%), their perceived uncertainty of climate science (21%), to acknowledge differences of opinion (17%), to maintain credibility (14%), and to strengthen the story (7%). These findings show that climate change reporting from weathercasters sometimes includes opposing viewpoints, and possibly a false balance, but further research is necessary. Moreover, prior research has shown that the climate reporting practices among weathercasters are evolving rapidly and so the problem of false-balance reporting may already be self-correcting.


1. Introduction

Over the past decade, broadcast weather professionals—including broadcast meteorologists, weather anchors, and others who do broadcast weather work, hereinafter called weathercasters—have become important climate change educators in their local communities (Wilson 2008a;

Maibach et al. 2016). Weathercasters’ views about climate change have rapidly evolved and are now closely aligned with the scientific consensus (Wilson 2002; Maibach et al. 2017b; Perkins et al. 2019, *Broadcast meteorologists’ views on climate change: A state-of-the-community review*, manuscript submitted to *Wea. Climate Soc.*). Climate reporting resource programs that assist weathercasters reporting about the local impacts of climate change have seen considerable growth in participation over the past several years (Wilson 2009; Placky et al. 2016). In 2017, just over one-half (57.9%) of American weathercasters said they informed members of their community about climate change (Timm et al. 2019).

These recent increases in climate change reporting have occurred alongside several important trends that are expanding the duties and roles of weathercasters

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(Henson 2010). In addition to delivering the forecast on air, weathercasters are using a wider variety of communication methods in their work than ever before, including blogs and websites, social media, and community presentations (Henson 2010). Additionally, many broadcast weather professionals—often the only scientist in the newsroom—have embraced the role of *station scientist* and are reporting on a range of science topics beyond the weather (Posegate 2008; Wilson 2008b; Timm et al. 2019). Some weathercasters also have the title of science or environmental reporter and have broader reporting responsibilities in this role (Maibach et al. 2017a, p. 19). Historically, there has been some professional overlap between weathercasters and journalists, but contemporary reporting about climate change has led some weathercasters to adopt a greater journalistic role, increasing this overlap in some news organizations.

Weathercasters have historically held a position that is part scientist and part journalist, with the relative emphasis of each being influenced by professional role, job description, news station, and region of the country (Henson 2010). The expansion of reporting by weathercasters was not completely unexpected; in 1989, John Coleman, founder of The Weather Channel, projected that “a decade from now. . .the weathercast is no longer a part of the newscast. There’ll be weather-news stories, but there won’t be a weathercast” (Henson 2010, p. 202). Wilson (2008a, p. 85) also explained that the days of predicting the weather “may be numbered,” as weathercasters are increasingly expected to report on other science, environment, and health topics. While journalism may be a growing part of the broadcast weather profession, little research to date has investigated how weathercasters think about prominent journalistic norms and routines, such as objectivity and balance.

Objectivity, the ideal and practice of reporting news in an impartial and unbiased way, has been scrutinized in discussions about how climate change is covered by the media (Fahy 2017). Objectivity entails finding and verifying facts, separating facts from values, and giving equal attention to all sides of the issue to produce balance (Schudson 2001; Fahy 2017). While balance can be an effective framing technique in debates of legislation and policy, it can be problematic when it is used to discuss topics where there is widespread agreement among scientists or experts (Fahy 2017). This false balance—balanced reporting about topics where the weight of evidence strongly favors one side over others—has been found in media coverage about the reality of human-caused climate change (Boykoff 2011), and it is then problematic because it creates the perception that there is an ongoing debate among experts, which tends to inhibit further action (Koehler 2016; van der Linden et al. 2015; Dixon and Clarke 2013).

Through formative interviews and a census survey of American weathercasters about climate change reporting, we found that objectivity and balance—topics that have frequently been studied with environmental journalists—are also relevant to understanding climate change reporting among broadcast meteorologists and weathercasters. This study illustrates how weathercasters similarly grapple with practicing objectivity and balance when reporting about climate change. In the name of balance and objectivity, we find that many weathercasters include opposing viewpoints when reporting on climate change, which is possibly resulting in false balance. Last, we find that weathercasters cite a variety of reasons for including opposing viewpoints in their climate change reporting.

2. Literature review

a. *Who is a weathercaster?*

Weathercasters share weather information with audiences through predominantly mass mediated methods (Henson 2010). Their formal job titles vary, but can include weathercaster, broadcast meteorologist, weather reporter or anchor, and others.¹ The profession began in the 1940s when television weather forecasts were first popularized and has grown since then with technological advances in meteorology (Henson 2010). At present, the broadcast weather professional uses a variety of reporting methods. In addition to the TV weathercast, they are expected to communicate in other media, such as blogs, social media, and on the station’s website (Henson 2010, p. 203). As a local public figure, weathercasters often attend local events and present to community and school groups (Wilson 2008a; Henson 2010). In addition to presenting the weather, many weathercasters also contribute to a range of science, environment, and other local news topics (e.g., traffic or recreation). Weathercasters are seen as “affable but authoritative” as they are frequently the only member of the newsroom with any training in science (Henson 2010, p. 19).

“Broadcast meteorology is both a science and an art, and one should receive rigorous training in both the science of meteorology and the art of communication and broadcasting. The ability to connect with individuals in the audience is critical,” explained Doug Gillham, a broadcast weather educator (Henson 2010, p. 35). However, there is no singular model for broadcast weather

¹ We garnered these data from a census of broadcast weather professionals that we have developed, which includes the job title listed on the news organization website.

instruction or license required to communicate weather information on television in the United States (Davie et al. 2006; Green et al. 2019). Weathercasters may have training in meteorology and atmospheric sciences, journalism and mass communication, some combination, or other disciplines (Green et al. 2019). A recent assessment found that between half to two-thirds of weathercasters have a meteorology degree and another one-fifth have a certificate in broadcast and operational meteorology (Green et al. 2019). In an effort to create standardization despite the variety of training pathways, the American Meteorological Society (AMS) and the National Weather Association (NWA) both have certification programs with specific educational requirements (Earl and Pasternack 1991; Hill and Mulvey 2012). However, even with a certification, the weather specialization can be like a journalist's "beat" and the level of expertise can vary greatly.

In general, weathercasters with the title of "broadcast meteorologist" tend to have expertise and training in atmospheric science and meteorology. AMS defines a meteorologist as "an individual with specialized education who uses scientific principles to explain, understand, observe or forecast the earth's atmospheric phenomena and/or how the atmosphere affects the earth and life on the planet" (Hill and Mulvey 2012, p. 1080). Specifically, the AMS definition of a meteorologist entails having a degree in meteorology or atmospheric science, years of professional experience in meteorology, and related coursework in mathematics, physics, and computer science (Hill and Mulvey 2012). The chief meteorologist is usually the most experienced meteorologist at the news station, and the other meteorologists are usually newer or less experienced (Henson 2010). Stations in regions of the country with more complex weather phenomena usually hire meteorologists (Henson 2010). Some weathercasters, such as weather anchors or weather reporters, usually have less extensive specialized training in meteorology or atmospheric science than meteorologists (Earl and Pasternack 1991; Hill and Mulvey 2012). Large stations may also hire weather producers, who create graphics and coordinate story development (Henson 2010). Additionally, many meteorologists and weathercasters are also becoming reporters, creating written, online, or broadcast stories focused on science or the "green beat"—stories about energy, technology, recycling, and other environmental issues (Henson 2010; Wilson 2008b, p. 1).

There is some tension and debate about whether weathercasters should be considered journalists, which depends on the context in which journalism is being discussed (Earl and Pasternack 1991; Henson 2010). Journalism can be a profession, a set of practices, an industry or business, or a way of thinking (Deuze 2005).

As a profession, journalists and weathercasters have similar self-definitions of their work. For example, both groups pride themselves in providing information as a public service (Earl and Pasternack 1991; Deuze 2005; Henson 2010). For journalists, their service is as an institutional watchdog and amplifier of the conversations occurring in society (Deuze 2005). For broadcast weather professionals, their service is localized weather information communicated in ways that add value to the more technical National Weather Service reports (Henson 2010, 45–49).

As a set of practices, there are similarities and differences between journalists and broadcast weather professionals. Weathercasters are expected to have specialized skills in meteorology in addition to the skills expected of journalists, which include reporting, researching, interviewing, sourcing, writing, and editing (Joseph 2009). Even weathercasters with no meteorological training are expected to have some specialized knowledge in relation to weather (Green et al. 2019). Both also tend to have a primary medium (e.g., print or broadcast), but are expected to use a range of other media and social media for their reporting (Henson 2010; Gibson 2016).

As employees of a business or industry, journalists and weathercasters both work within the constraints of their news organizations and the commercial forces that put pressure on them (Shoemaker and Reese 2014; Gibson 2016; Meldrum et al. 2017). News organizations have owners, internal structures, cultures, and distinct market forces that influence the development of news products, including the weather broadcast (Henson 2010; Shoemaker and Reese 2014; Meldrum et al. 2017). Both professionals—journalists and broadcast weather professionals—also find themselves adapting their work to respond to the pressures associated with declining revenues, the 24 h per day/7 days per week news cycle, and the increasingly fragmented news environment (Gibson 2016; Meldrum et al. 2017).

Journalists also define their work through a way of thinking or acting, also known as professional norms. Deuze (2005, p. 455) explained how this professional ideology is the social cement that determines who is in and out of the group of professional journalists. Journalists define themselves by their practices of being impartial, neutral, objective, and fair (Shoemaker and Reese 2014; Deuze 2005). However, as a unique kind of journalism, the work of weathercasters has rarely been investigated through the professional values held by journalists. Henson's (2010) book on the history of broadcast meteorology never once mentions "objectivity." While weathercasters and journalists may share some or all of these professional norms due to their joint workplaces

and the close proximity of their professions, it is unclear because the views of weathercasters toward objectivity have not been isolated from the broader professional community.

b. Objectivity and balance

Objectivity is often touted as the cornerstone of American journalism, but the concept can have many different definitions and interpretations (Ward 2009; Fahy 2017). For example, McQuail (2010, p. 200) defines objectivity as reporting news with accuracy, taking a position of neutrality toward the subject of reporting, and avoiding partisanship or bias. Fahy (2017, p. 1) described objectivity as the “reporting of news in an impartial and unbiased way by finding and verifying facts, reporting facts accurately, separating facts from values, and giving two sides of an issue equal attention.” Schudson (2001, p. 150) says that objectivity “guides journalists to separate facts from values and report only the facts.” In general, accuracy and impartiality are the guiding principles of objectivity. However, objectivity is not just an ideal or code of ethics, it is also a “set of reporting and editing practices” that creates observable patterns in news content (Schudson 2001, p. 149). To practice objectivity is to avoid inserting individual opinions, remain unbiased, seek different viewpoints, focus on facts, and include opposing viewpoints in a fair and balanced way (Schudson 2001).

One way that objectivity and neutrality has been achieved is through the practice of balance, which involves giving equal or proportional time, space, or emphasis “between opposing interpretations, points of view, or versions of events” (McQuail 2010, p. 202). Schudson (2001, p. 150) explained that objective reporting aims to “represent fairly each leading side in a political controversy.” Additionally, Fahy (2017) noted how balance involves “citing opposing views in a fair and balanced way.” Entman (1989) said that balance and giving equal attention to both sides is the central feature of objectivity. In the United States, balance often refers to “two sides” or “both sides” corresponding with the two major parties of the political system (Hopmann et al. 2012).

Balance can be defined according to the political system or as a result of journalistic norms and media routines (Hopmann et al. 2012). Media routines can accomplish a variety of goals, but ultimately, they optimize the relationship between an organization and its environment (Shoemaker and Reese 2014, p. 168). Balance has been described as having a defensive purpose; by providing balanced accounts, journalists can avoid offending their sources or audiences (Shoemaker and Reese 2014). However, the practice of balance has been

criticized because it enables journalists and news organizations to avert the consequences of their stories (Tuchman 1972, p. 660). Balance has also been decried for being too passive, privileging elite voices, and limiting the voices of marginalized groups (Fahy 2017). However, balance is also sometimes used to communicate the nature of the political divide and different opinions held by news audiences, even if they are in the minority opinion (Fahy 2017).

One of the most significant concerns about the practice of balance has been the misrepresentation of factual information. Balance relies on sources to provide factual information, but when these sources are inaccurate or incorrect, the reporting exhibits a false balance (Fahy 2017). False balance is created when both sides of a story are presented, regardless of significant weight of evidence on one side (Entman 1989; Illman 2015). Balance can be a useful tool for telling simple stories or explaining policy debates, but Illman (2015) described that when balance is introduced to more complex stories ethical questions about objectivity emerge. For example, is it the role of the media to share accurate information or is it to present the different views of the issue that exist and let the audience decide?

A story that presents a false balance has several impacts on audience members perceptions of a given issue. Research conducted in a variety of contexts has found that false balance distorts the perception of expert opinion (Koehler 2016; Dixon and Clarke 2013). In addition, false balance suggests that experts are still debating the issue, and therefore there may be too much uncertainty to warrant changes in behavior or policy (Koehler 2016; Corbett and Durfee 2004; Dixon and Clarke 2013). In the context of media ethics, false balance could also affect individual perceptions of risk, which could lead to death or serious injury (Ward 2009; Illman 2015).

c. False balance in climate change reporting

Fahy (2017, p. 3) described how the interpretation of objectivity has “profound implications for climate change.” Although an overwhelming majority (97%) of climate scientists assert that human-caused climate change is happening (Cook et al. 2016), climate change journalism has been particularly vulnerable to false-balance media coverage, but the prevalence has varied over time (Boykoff 2011; Fahy 2017). In the late 1980s, news stories about climate change were predominantly framed as science stories, coverage was limited, and the presentation of opposing viewpoints was practically nonexistent (Boykoff 2011; Fahy 2017). However, as climate change became a political topic, the inclusion of an opposing viewpoint—a common practice in political

news framing—became more common (Fahy 2017). Between the mid-1990s and early 2000s, 70% of television outlets covered climate change as a balance of natural and human causes. In the mid-2000s the scientific evidence for anthropogenic climate change increased and false balance in climate change reporting began to decline (Boykoff 2011). Fahy (2017) explained that by 2010–11, incidents of false balance had practically disappeared from prestige press newspapers. Gibson and colleagues (2016) recently found that environmental journalists think the profession has moved beyond false-balance coverage of climate change.

However, it is premature to declare that false balance in climate change reporting on television is dead. Many conservative news sources continue to report about climate change as if there is still a debate about whether human-caused climate change is occurring (Feldman 2016). In addition, several mainstream TV networks continue to air segments containing outlier perspectives on climate change by people who deny the existence of climate change and its human causes (MacDonald and Hymas 2019; Kalhoefer 2018). Broader trends in the news industry have also led climate change to be covered with a false balance (Ward 2009; Fahy 2017; Gibson 2016). As news budgets have declined, environmental and science reporters have been eliminated from the newsroom, and general assignment reporters—who are less likely to have specialized knowledge about climate change—are often left to cover climate change stories (Gibson 2016; Boykoff and Yulsman 2013). Climate change does not fit neatly into the established categories of news reporting; it can be a political, environmental, or economic story, and so selecting the right frame can be a challenge (Fahy 2017). Furthermore, there have been strategic efforts to undermine and influence news coverage about climate change; conservative think tanks and special interest groups have leveraged the journalistic tendency to provide an opposing viewpoint to propagate messages of scientific uncertainty (Fahy 2017; Jacques et al. 2008). Finally, public opinion about climate change is polarized (Funk and Kennedy 2016). Because of its defensive quality, false balance may be presented to protect journalists or news organizations from negative audience feedback and retain audiences in the competitive media environment (Shoemaker and Reese 2014; Meldrum et al. 2017).

d. *Converging trends*

In the history of the broadcast weather profession, the notions of objectivity and balance may have never been as salient as they are now. Given the converging trends of increased climate change reporting by those in the weather profession, longer format reporting by

weathercasters, and the political polarization of the climate change issue, objectivity and balance may be increasingly relevant for understanding the work of weathercasters. The journalistic practice of balance in climate change reporting has rarely been discussed with respect to weathercasters, with the exception of one survey of 121 AMS members where several respondents alluded to the practice of balance (Wilson 2009). One survey respondent specifically noted how “it’s best not to use one source” (Wilson 2009, p. 1461). The purpose of this study is to build on this prior research and develop a better understanding of whether and how often weathercasters present an opposing viewpoint when they present about climate change, and if so, why. Understanding the extent to which weathercasters are incorporating opposing viewpoints when they present about climate change is important because a resulting false balance could undermine recent improvements in local climate journalism and ultimately audiences understanding of the scientific agreement with respect to climate change.

3. Study 1

a. *Study 1 methods and materials*

From September to October 2016, formative interviews were conducted with 31 weathercasters located throughout the United States to better understand the practice of climate change reporting. Weathercasters were purposefully selected to capture a variety of climate change reporting experience, representing one of three categories: frequent climate change reporting on air and online, frequent climate change reporting online, and little or no climate change reporting in either media. Approximately half of the interviewees were their station’s chief meteorologist and the other half had other broadcast weather positions. The interviews included questions about their job and professional experience, barriers and opportunities related to climate change reporting, and attitudes toward *Climate Matters* reporting resources (Placky et al. 2016).

b. *Study 1 results*

When asked about the barriers they face when it comes to reporting about climate change, 6 of the 31 weathercasters interviewed brought up issues related to objectivity, balance, and opposing viewpoints.

Most frequently, the issue of balance was related to station management. A weekend meteorologist and reporter who occasionally reports about climate change described how they tend to avoid climate change because they know they will be required to include voices

from the other side and that those voices will go against the consensus of climate change science. A chief meteorologist who infrequently reports about climate change described how “consultants are telling us that people really like balance. They want balance in their newscast, they want balance . . . If I do an update, say this is the wettest October on record. This could be due to slowing down of jet stream and blah, blah, blah. Whatever I do, they want the opposite side.” The same interviewee added that their management is supportive of climate change reporting but explained how “the only caveat that we operate under is that we need to get an opposing view.” Another broadcast weather professional described how their producer assigned them to conduct a live interview about climate change that turned out to be a spokesperson for an organization that doubts the existence of human-caused climate change.

Other issues with objectivity and balance were also described during the interviews. One meteorologist and environmental reporter who frequently reports about climate change, pointed out how their limited time on air exacerbates the issue: “Because on air time is so limited, it is easy to look biased, because there is no time to present the ‘other side’ . . . I didn’t have time to do it, if I go into one side, I feel like I should go into the other side of it.” Another evening meteorologist who infrequently reports about climate change realized that other members of the weather team “do not believe in climate change, and will voice that opinion as freely as I voice my opinion about climate change.” One chief meteorologist who rarely reported on climate change spoke broadly about false balance, noting how “people don’t understand the issue fully and they revert to their journalism background of there have to be two sides to each story. That false balance issue is a problem.”

c. Rationale for additional study

In summary, the formative interviews produced unexpected findings about weathercasters’ concerns about objectivity, balance, and the inclusion of opposing viewpoints with respect to local climate change reporting. There were an insufficient number of interviewees to produce generalizable findings about the reasons for presenting opposing viewpoints in climate change reporting. To follow up on these findings and investigate them in the broadcast weather community at large, we posed two research questions (RQ):

RQ1: Do weathercasters present an opposing viewpoint when they report on climate change, and if so, how often?

RQ2: When weathercasters present an opposing viewpoint on climate change, what are their reasons for doing so?

4. Study 2

a. Study 2 methods and materials

In 2015, a list of all people working in the broadcast weather profession was obtained from Cision (<http://www.cision.com/us/pr-software/media-database>), a commercial database of news professionals. The list was manually verified and updated (in 2015, and again in 2016 and 2017) by checking both the websites of all individuals on the list and of each local, regional, and national broadcast television station. On 9 January 2017, using the most current census list, an invitation to participate in the online survey was sent via e-mail using Qualtrics (<https://www.qualtrics.com/>) to all 2177 weathercasters currently working in the United States. After making an initial request to participate, up to five additional reminder emails were sent to people who had not yet responded; the survey participation period closed on 27 January 2017. A total of 480 individuals consented to participate and completed at least one question in the survey, yielding a response rate of 22% and completion rate of 18% [American Association for Public Opinion Research (AAPOR) 2016].

To assess nonresponse error, survey participants were compared with nonrespondents on several publicly available variables, including gender, job title, and regional geographic location (Dillman et al. 2014, p. 5; see the online supplemental material). Using chi-square goodness-of-fit tests, 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 in occupation, 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” job category [$\chi^2(1) = 6.025, p < 0.05$] were underrepresented in the survey. Survey participation did not differ for individuals in other job roles (meteorologists, weather producers, reporters, and temporary/fill in meteorologists and weathercasters), nor were there differences by geographic region [$\chi^2(9) = 10.738, p = 0.294$].

The survey included measures for professional practices, reporting activities and frequency of climate change reporting, climate change beliefs and self-reported subject matter knowledge, interest in educational opportunities, and demographic measures (see the online supplemental material). It took participants an average of about 15 min

TABLE 1. Reasons for including an opposing viewpoint. A variety of themes emerged to classify the reasons for providing an opposing viewpoint in climate change reporting, and the most prevalent theme in the open-ended responses was that providing an opposing viewpoint is “essential to balanced journalism.” Note that the percentages do not total 100% because responses could be assigned more than one code. The base is $N = 124$: weathercasters who report about climate change in one or more medium and responded to the question, “Why do you present an opposing viewpoint?”

Theme	Description	Percentage of total themes
Essential to balanced journalism	Balance, fairness, integrity, etc., are a responsibility or characteristic of ethical journalism	53.2%
Represents scientific uncertainty	The science is still uncertain or not settled; explains how climate change is just natural or not happening	21.0%
Acknowledge different views	Realize that not everyone agrees, so may have to present or interview people with other views	16.9%
Maintain reliability and credibility	Showing one side will make viewers dismiss or be skeptical of the information; prevent negative viewer feedback or other negative outcomes	14.5%
Strengthen story	Present an opposing viewpoint to strengthen their argument or point out the flaws in the counter argument	7.3%
Other	Avoids stories with two sides, sticks to forecast, or other reasons	11.3%

to complete the survey. The survey and research protocol were approved by the George Mason University Institutional Review Board (no. 625417).

We used two items from the survey in the current analysis: frequency of presenting an opposing viewpoint and reasons for presenting an opposing viewpoint. All survey participants were asked, “When you present climate change information, how often do you present an ‘opposing viewpoint’ to your main story?” The response options were on a six-point scale (1 = *Never or rarely*, 2 = *Less than half the time*, 3 = *About half of the time*, 4 = *Most of the time*, and 5 = *Always or almost always*, 6 = *I have not presented climate change information*). Of the 480 survey participants who completed at least one question, 63 skipped this question and 149 said they had not presented climate change information; those 212 participants were excluded from further analysis. The analysis in this paper includes 268 weathercasters who reported about climate change in one or more media, one or more times during 2016.

Anyone who said they had presented an opposing viewpoint more frequently than never or rarely ($N = 170$), were asked the open-ended question: “Why do you present an opposing viewpoint?” There were 124 open-ended responses that varied in length from 1 to 89 words ($M = 18.1$ words). The open-ended responses were content analyzed using thematic analysis. The entire response was the unit of analysis. A codebook (see the online supplemental material) was developed based on emergent themes and the literature about objectivity and balance, and the responses were assigned between one and three codes from six possible codes. Two people independently coded all 124 open-ended responses. The intercoder reliability was calculated using ReCal (Freelon 2010). Using Krippendorff’s alpha, the average

intercoder reliability of for each thematic code was 0.789, with individual codes ranging from 0.7 to 0.8 (see the online supplemental material; Krippendorff 2004). After reaching sufficient intercoder reliability (>0.7), the discrepancies were discussed and agreed upon among the two coders to produce the final percentages for each thematic code described in Table 1.

b. Study 2 results

1) FREQUENCY OF PRESENTING AN OPPOSING VIEWPOINT

To answer RQ1, we calculated the frequency with which survey participants said they present an opposing viewpoint when they present climate change information. As seen in Fig. 1, among those participants who had reported about climate change in the prior 12 months ($N = 268$), 36.6% never or rarely present an opposing viewpoint, while 17.5% did so less than half the time, 10.8% about half the time, 19.4% most of the time, and 15.7% present an opposing viewpoint always or almost always. Thus, 46.9% percent of weathercasters who presented about climate change in one or more media during 2016 included an opposing viewpoint half of the time when they reported about climate change, or more frequently.

There is considerable variability in the frequency with which weathercasters report about climate change, ranging from about 58% reporting about climate change on air one to four times in the past year to 34% reporting 5–20 times in the past year ($N = 150$; Timm et al. 2019). We conducted a post hoc examination, using a Mantel-Haenzel test, to determine if weathercasters who rarely report about climate change on air are more likely to include an opposing viewpoint than those who frequently

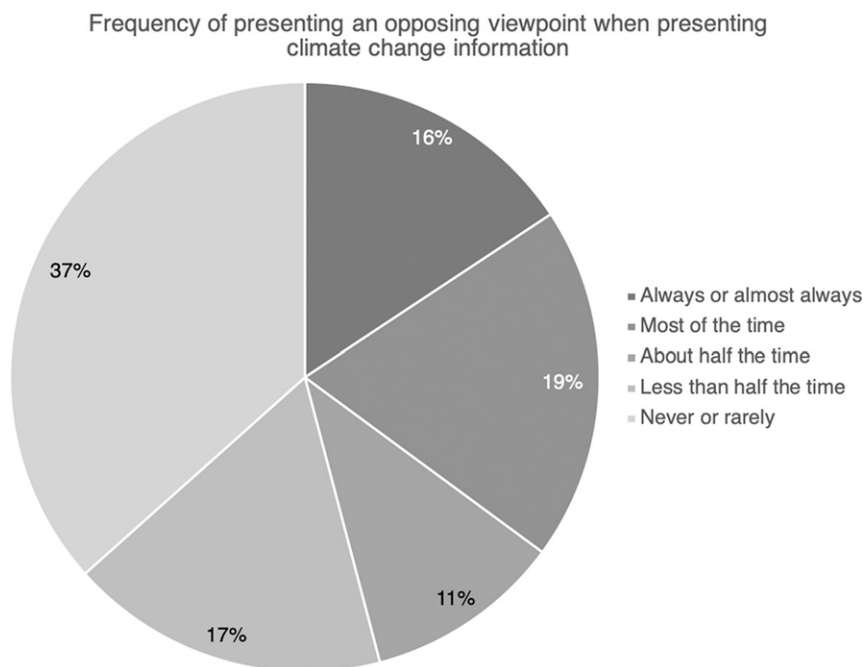


FIG. 1. Weathercasters' frequency of presenting an opposing viewpoint when they present climate change information.

report about climate change on air. That proved not to be the case; the trend test did not indicate a statistically significant linear association [$\chi^2(1) = 0.184, p > 0.05; r = 0.037$].

Balance is a journalistic practice that has been discussed most often in the context of television and newspaper. However, many weathercasters are also using social media to report about climate change. Therefore, we also conducted a trend test to determine whether a linear association existed between the frequency of including an opposing viewpoint and the frequency of reporting about climate change in social media. Again, this proved not to be the case; the Mantel-Haenszel test of trend did not indicate a statistically significant linear association [$\chi^2(1) = 0.560, p > 0.05; r = -0.054$]. In summary, we found no association between frequency of presenting climate change information on air or in social media and the frequency of including an opposing viewpoint when doing so.

2) REASONS FOR PRESENTING AN OPPOSING VIEWPOINT

To answer RQ2, the open-ended survey responses ($N = 124$) were analyzed using thematic analysis. As shown in Table 1, the most prevalent reason for presenting an opposing viewpoint, identified in 53.2% of responses, is that an opposing viewpoint is *essential to balanced journalism*. These responses mentioned the

need for remaining unbiased, objective, or fair. These statements often expressed the belief that showing both sides of a story are essential for good journalism. For example, one participant described how “both sides of any issue are critical for the media to convey. The info needs to be presented to viewers. News of any sort should never be one sided.” Another noted that “it is our job as broadcasters to be unbiased and present both sides of every story. As with any news story, if you get a rise out of both sides of the argument, you’ve done your job. If only one side gets angry, you probably presented a bias.”

Comments about how an opposing viewpoint *represents the scientific uncertainty* were found in 21% of responses. These responses described how the available information should be shared when the science is uncertain or that climate science is not yet settled. For example, one participant described how they are “still learning and don’t have a one-sided view on climate change. . . many factors need to be considered and proven before I can take a stand totally on one side.” Another noted that they present an opposing viewpoint because “the cause of the change is still up for debate within the scientific community. While those who back the human induced side have been extremely vocal in the past to a point of bullying the natural cause believers, my job as a reporter is to present both sides of the debate and allow the viewer to judge.”

The third most prevalent theme, found in 16.9% of responses, was that an opposing viewpoint is used to *acknowledge different views*. These responses described how sometimes the people they interview have different views or they know different views exist, and so they want to ensure those perspectives are represented in the report. For example, one respondent said, “I believe that it is fair and objective to give viewers/readers the information but present that not everyone is in lock step with that viewpoint and they can read both sides and make an informed decision on where they stand.” Another noted how they present an opposing viewpoint “only if the person I’m interviewing has an opposing viewpoint. If there isn’t one there, I don’t push for it, I simply present the story.”

Closely related to the *essential to balanced journalism* theme, 14.5% of the responses were comments about how including an opposing viewpoint enables the them to *maintain reliability and credibility*. These responses described how showing one side will cause viewers to lose trust, become skeptical of the information presented, accuse the station of being biased, or lead to other negative audience reactions (i.e., being sued). For example, one survey participant described that “if you bring up opposing viewpoints it makes you a more reliable source.” Another survey participant said, “showing only one side a) immediately makes viewers skeptical and b) makes it seem as if I have an agenda.”

The final theme, identified in 7.3% of the comments, talked about how an opposing viewpoint can be used to *strengthen a story* or a persuasive argument. These responses described how an opposing viewpoint is needed to show how the argument that climate change is not happening is flawed or misguided. For example, one participant noted how “it is important to use the oppositions [sic] viewpoints to further your own point. It is also important to viewers to see where people could have another viewpoint and how they possibly got it.” Another participant described how they present an opposing viewpoint “to convey a complete picture or idea of why we believe climate change is happening.” They added how “if you lay out the opposing view, it’s much easier to understand the flaws in that viewpoint and arrive at a more complete understanding of the facts and science. You have to separate science from junk science.”

The *other* category (11.3%) included comments that were unclear, did not fall into an existing category, or were not prevalent enough to form a new thematic category.

5. General discussion

Many broadcast weather professionals are adopting the role of *station scientist* and reporting beyond the

weather forecast, including stories about climate change. How climate change is reported—specifically the sources featured in the news story—affects how audiences perceive scientific agreement, and so it is valuable to understand how weathercasters interpret and practice objectivity and balance in their work. We found that among weathercasters who told us they reported on climate change in 2016, 35.1% present an opposing viewpoint most of the time when they present about climate change.

The number of weathercasters including an opposing viewpoint when they report about climate change is interesting in light of recent research with environmental journalists, who are similarly assigned to write stories about climate change, but who appear to be shifting away from the practice of balance when reporting on climate change (Gibson et al. 2016; Brüggemann and Engesser 2017; Hiles and Hinnant 2014). Brüggemann and Engesser (2017) described how “balanced coverage of a ‘he said/she said’ style has been replaced by an active contextualization and evaluation of contrarian voices.” Similarly, Gibson et al. (2016, p. 424) found that “most environmental journalists had moved beyond ‘balance as bias’ coverage.” However, television and local-scale journalists are underrepresented in these prior studies, and weathercasters are rarely included in studies of science or environmental journalists.

The pressure to adhere to the journalistic norms of objectivity and balance were prevalent in weathercasters’ reasons for presenting an opposing viewpoint when they report about climate change. This is noteworthy, because weathercasters enter the journalism profession with a range of educational backgrounds, and as such, they probably have differing amounts of exposure to journalistic norms through their formal education (Green et al. 2019). Among the survey participants analyzed in this study, only 15.7% had bachelor’s degrees in journalism or mass communication, and 63.1%—the majority—had bachelor’s degrees in meteorology or atmospheric science. Wilson (2012) noted how weathercasters may actually have limited exposure to journalistic practices like objectivity during their education, because it may not be emphasized in meteorology degree programs. Given their unique training as compared to other journalists, understanding how weathercasters develop and interpret journalistic norms and practices is an opportunity for future research.

As we found in analyzing the open-ended survey responses, especially the codes for *strengthening argument*, it is important to point out that the inclusion of an opposing viewpoint is not always synonymous with false balance. Some weathercasters described using an opposing viewpoint to strengthen their argument about

why climate change is happening, to reflect the different views of people they interview, or amplify the conversation they already perceive in their community. The inclusion of an opposing viewpoint is just one technique for creating a balanced story, but this technique could be executed in more nuanced ways. For example, Brüggenmann and Engesser (2017) found that journalists often quoted climate contrarians, but three-fourths of those articles included a negative evaluation of the contrarians who were quoted—essentially debunking what the contrarians said. However, Brüggenmann and Engesser's study focused on international and national media sources, and so more research is needed to determine what balance looks like in the context of the local news, if it presents a false balance, or whether similar contextualization of sources occurs at this level.

Understanding how weathercasters interpret and practice objectivity is important because a growing number of weathercasters are adopting the role of *station scientist*, reporting more long format science stories, and becoming the local news expert for science and climate (Timm et al. 2019). The job titles appear to be changing accordingly; we found that 11% of survey participants had a weather-related job title (i.e., meteorologist) and also had the title of reporter. As more weathercasters take on reporting duties it will be important for them to have education and access to training to help them avoid the pitfalls of balance and accurately report scientific concepts.

Several techniques for accurate and balanced science reporting have been proposed, practiced, and studied. For example, many environmental journalists are shifting to weight-of-evidence approaches, where two sides of an issue are reported but the volume of evidence and expert opinion for those different sides are quantified and described (Dunwoody 2005; Hiles and Hinnant 2014). This has been cited as a more ethical approach to reporting issues with expert agreement on one side, and it could reduce uncertainty and help citizens make more informed decisions about the information that is presented (Kohl et al. 2016). However, studies of the weight-of-evidence approach have had mixed results. In some cases, it has enhanced audience understanding of expert consensus (Corbett and Durfee 2004; Kohl et al. 2016; Kortenkamp and Basten 2015), but in other cases the results were found to be no different from just presenting two sides (Koehler 2016). In fact, Koehler (2016) found that when experiment participants were exposed to a table numerically describing the share of experts on either side of a debate, including a quote from each side in the adjacent article distorted the audience's perceptions of expert opinion presented in the table.

Other models of objectivity for science journalists have also been suggested, such as journalists as knowledge

brokers (Nisbet and Fahy 2017; van Witsen and Takahashi 2018). In this role, Nisbet and Fahy (2017) suggest that journalists should be informed critics of the science, explaining and making the processes of knowledge production more transparent to their audiences. However, shifting toward the professional norms and practices suggested of knowledge-based journalism has significant implications for education and training, practice, and news organization function (van Witsen and Takahashi 2018). Yet, as experts in both science and journalism, weathercasters have the potential to be knowledge brokers and could help evaluate the merits or obstacles to knowledge-based journalism. Discussion within the broadcast weather and journalism professions about these different approaches to objectivity along with further research will be important for determining which approaches to objectivity weathercasters should adopt in the future.

a. Limitations and recommendations for future research

There are several study limitations that must be explained. First, the survey only included one measure of frequency of using an opposing viewpoint and no definition of opposing viewpoint was provided. In our survey question we used the phrase “opposing viewpoint” because many weathercasters who participated in the formative interviews used that phrase. We interpreted their use of this phrase to mean contrarians who do not believe that human-caused climate change is happening. The findings from our survey would have been clearer if we had explicitly defined the meaning of “opposing viewpoint” in the survey question. Because we were not explicit, this question could have been interpreted differently among the respondents, which would affect the overall results. Nonetheless, the consistent themes identified in the open-ended responses suggest that most survey participants understood what was being asked. Future research on this practice should use more precise questions and rely on a larger set of measures.

In addition, our study does not shed light on the possibility that weathercasters present opposing viewpoints when reporting climate stories in some channels and not others. Most weathercasters report through a range of channels including television, newspaper, radio, social media, and community presentations. The practice of including an opposing viewpoint may be more or less common or relevant in some of these channels than others. Previous research has shown some differences in objectivity between television and YouTube videos, with a “relaxing of traditional objective standards” in online news (Shoemaker and

Reese 2014, p. 101). This possibility should be examined in future research.

Future studies of objectivity and balance, and the issues related to them, should also take into consideration a larger number of influencing factors than what we considered in this study. A review by Engesser (2017) suggests that there are several individual, organizational, and societal factors that may lead a journalist to present a false balance when they present about climate change, including journalistic training, pressure from management, and personal political beliefs. While the survey included measures of some of these variables, the data were not collected in ways that enabled us to look at how all of these factors impact the practice of including an opposing viewpoint or which of these underlying factors are most influential on reporting practices. For example, personal political beliefs or ideology may be important (Wilson 2012), but this was not included on the survey.

In addition, educational background may be influential, but this was measured by degree name (e.g., atmospheric science, journalism), which does not provide enough information to draw conclusions about exposure to the journalistic norms of objectivity or experience with climate science. Guenther and Ruhrmann (2016) conducted a study of the factors underlying the presentation of scientific uncertainty and had similar limitations. Shoemaker and Reese's (2014) theory of media content presents a hierarchy of influences on journalistic decisions that might provide a useful framework to guide future research in this area. Their model suggests that social systems, social institutions, media organizations, routine practices, and individual factors all influence news decisions (Shoemaker and Reese 2014). Measuring variables associated with each of these factors—and trying to understand which are most influential—would be valuable future research.

Last, while these results are drawn from one of the largest surveys of weathercasters to date, they may be somewhat limited in their representation of the broader community. Our nonresponse bias test suggests that women were underrepresented, and chief meteorologists were overrepresented among the survey participants, but it is uncertain how that would specifically affect these results. Wilson (2012) found that among weathercasters the male gender was a predictor for being unconvinced of human-caused climate change, but it is unclear the extent to which this would also affect climate change reporting. Because climate change has been a contentious issue in the broadcast weather community (Stenhouse et al. 2017; Meldrum et al. 2017), the survey may also over or underrepresent individuals who are most interested in voicing their opinions about climate change,

but we have no way to compare climate change interests or knowledge between the survey participants and the publicly available variables included on the census. In summary, more research is needed to increase the confidence of these results.

b. Conclusions

Public understanding of the scientific agreement about climate change is an important predictor of motivation and issue engagement (van der Linden et al. 2015). The media play an important role in shaping public perceptions of scientific agreement through the means by which sources are quoted and presented, which is a function of the journalistic practice of balance. This research builds on previous indications that the journalistic norms of objectivity and the practice of balance are relevant to many weathercasters, especially when they present information about climate change.

The bottom line in our research is that about half of the weathercasters who participated in our survey include opposing viewpoints in about half or more of their climate change stories. However, more research is needed to understand specifically how objectivity and balance influence weathercasters' reporting about climate change. How scientific agreement is presented depends on the social systems, social institutions, media organizations, routine practices, and individual views of journalists with respect to climate change and norms of objectivity (Boykoff 2011). More research is also needed to see whether weathercasters are including opposing viewpoints in ways that are more nuanced than we were able to measure here or if their reports include a false balance. The results of this study—and future work in this area—will have important implications for journalism and weathercaster education and professional development related to climate change. Ultimately, these journalistic decisions critically affect how members of the public citizenry understand and engage in critical scientific issues, such as climate change.

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REFERENCES

- AAPOR, 2016: Standard definitions: Final dispositions of case codes and outcome rates for surveys. 9th ed. American Association for Public Opinion Research Rep., 81 pp., https://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf.

- Boykoff, M. T., 2011: *Who Speaks for the Climate? Making Sense of Media Reporting on Climate Change*. Cambridge University Press, 228 pp.
- , and T. Yulsman, 2013: Political economy, media, and climate change: Sinews of modern life. *Wiley Interdiscip. Rev.: Climate Change*, **4**, 359–371, <https://doi.org/10.1002/wcc.233>.
- Brüggemann, M., and S. Engesser, 2017: Beyond false balance: How interpretive journalism shapes media coverage of climate change. *Global Environ. Change*, **42**, 58–67, <https://doi.org/10.1016/j.gloenvcha.2016.11.004>.
- Cook, J., and Coauthors, 2016: Consensus on consensus: A synthesis of consensus estimates on human caused global warming. *Environ. Res. Lett.*, **11**, 048002, <https://doi.org/10.1088/1748-9326/11/4/048002>.
- Corbett, J. B., and J. L. Durfee, 2004: Testing public (un)certainly of science. *Sci. Commun.*, **26**, 129–151, <https://doi.org/10.1177/1075547004270234>.
- Davie, W. R., P. J. Auter, and L. F. Dinu, 2006: Identifying the goals of weather instruction: Toward a model approach for broadcast meteorology. *J. Mass Commun. Educ.*, **61**, 149–164, <https://doi.org/10.1177/107769580606100203>.
- Deuze, M., 2005: What is journalism? Professional identity and ideology of journalists reconsidered. *Journalism*, **6**, 442–464, <https://doi.org/10.1177/1464884905056815>.
- Dillman, D. A., J. D. Smyth, and L. M. Christian, 2014: *Internet, Phone, Mail, and Mixed Mode Surveys: The Tailored Design Method*. 4th ed. John Wiley and Sons, 528 pp.
- Dixon, G. N., and C. E. Clarke, 2013: The effect of falsely balanced reporting of the autism-vaccine controversy on vaccine safety perceptions and behavioral intentions. *Health Educ. Res.*, **28**, 352–359, <https://doi.org/10.1093/her/cys110>.
- Dunwoody, S., 2005: Weight-of-evidence reporting: What is it? Why use it? Nieman Reports, <http://niemanreports.org/articles/weight-of-evidence-reporting-what-is-it-why-use-it/>.
- Earl, R. A., and S. Pasternack, 1991: Television weathercasts and their role in geographic education. *J. Geogr.*, **90**, 113–117, <https://doi.org/10.1080/00221349108979249>.
- Engesser, S., 2017: Impact of journalistic background, professional norms, and culture on climate change coverage. *Oxford Research Encyclopedia of Climate Science*, Oxford University Press, 2424 pp., <https://doi.org/10.1093/acrefore/9780190228620.013.353>.
- Entman, R., 1989: *Democracy without Citizens: Media and the Decay of American Politics*. Oxford University Press, 256 pp.
- Fahy, D., 2017: Defining objectivity, false balance, and advocacy in news coverage of climate change. *Oxford Research Encyclopedia of Climate Science*, Oxford University Press, 2424 pp., <https://doi.org/10.1093/acrefore/9780190228620.013.345>.
- Feldman, L., 2016: The effects of network and cable TV news viewing on climate change opinion, knowledge, and behavior. *Oxford Research Encyclopedia of Climate Science*, Oxford University Press, 2424 pp., <https://doi.org/10.1093/acrefore/9780190228620.013.367>.
- Freelon, D., 2010: ReCal: Inter-coder reliability calculation as a web service. *Int. J. Internet Sci.*, **5**, 20–33, <https://pdfs.semanticscholar.org/c434/2385c5af470a551d11bf53b2de745392ac9c.pdf>.
- Funk, C., and B. Kennedy, 2016: The politics of climate. Pew Research Center Rep., 114 pp., <https://www.pewresearch.org/science/2016/10/04/the-politics-of-climate/>.
- Gibson, T. A., 2016: Economic, technological, and organizational factors influencing news coverage of climate change. *Oxford Research Encyclopedia of Climate Science*, Oxford University Press, 2424 pp., <https://doi.org/10.1093/acrefore/9780190228620.013.355>.
- , R. T. Craig, A. C. Harper, and J. M. Alpert, 2016: Covering global warming in dubious times: Environmental reporters in the new media ecosystem. *Journalism*, **17**, 417–434, <https://doi.org/10.1177/1464884914564845>.
- Green, T. A., C. J. Schreck, N. S. Johnson, and S. S. Heath, 2019: Education backgrounds of TV weathercasters. *Bull. Amer. Meteor. Soc.*, **100**, 581–588, <https://doi.org/10.1175/BAMS-D-17-0047.1>.
- Guenther, L., and G. Ruhrmann, 2016: Scientific evidence and mass media: Investigating the journalistic intention to represent scientific uncertainty. *Public Understanding Sci.*, **25**, 927–943, <https://doi.org/10.1177/0963662515625479>.
- Henson, R., 2010: *Weather on the Air: A History of Broadcast Meteorology*. Amer. Meteor. Soc., 241 pp.
- Hiles, S. S., and A. Hinnant, 2014: Climate change in the newsroom. *Sci. Commun.*, **36**, 428–453, <https://doi.org/10.1177/1075547014534077>.
- Hill, J. D., and G. J. Mulvey, 2012: The ethics of defining a professional: Who is a meteorologist? *Bull. Amer. Meteor. Soc.*, **93**, 1080–1082, <https://doi.org/10.1175/BAMS-D-11-00205.1>.
- Hopmann, D. N., P. Van Aelst, and G. Legnante, 2012: Political balance in the news: A review of concepts, operationalizations and key findings. *Journalism*, **13**, 240–257, <https://doi.org/10.1177/1464884911427804>.
- Illman, J., 2015: The danger in a second opinion. *Br. Journalism Rev.*, **26**, 37–41, <https://doi.org/10.1177/0956474815604295>.
- Jacques, P. J., R. E. Dunlap, and M. Freeman, 2008: The organisation of denial: Conservative think tanks and environmental scepticism. *Env. Polit.*, **17**, 349–385, <https://doi.org/10.1080/09644010802055576>.
- Joseph, B., 2009: *Journalism education. The Handbook of Journalism Studies*, K. Wahl Jorgenson and T. Hanitzsch, Eds., Routledge, 42–56.
- Kalshoefer, K., 2018: How broadcast TV networks covered climate change in 2017. Media Matters for America, <https://www.mediamatters.org/donald-trump/how-broadcast-tv-networks-covered-climate-change-2017/#csandpbsled>.
- Koehler, D. J., 2016: Can journalistic “false balance” distort public perception of consensus in expert opinion? *J. Exp. Psychol. Appl.*, **22**, 24–38, <https://doi.org/10.1037/xap0000073>.
- Kohl, P. A., S. Y. Kim, Y. Peng, H. Akin, E. J. Koh, A. Howell, and S. Dunwoody, 2016: The influence of weight-of-evidence strategies on audience perceptions of (un)certainly when media cover contested science. *Public Understanding Sci.*, **25**, 976–991, <https://doi.org/10.1177/0963662515615087>.
- Kortenkamp, K. V., and B. Basten, 2015: Environmental science in the media: Effects of opposing viewpoints on risk and uncertainty perceptions. *Sci. Commun.*, **37**, 287–313, <https://doi.org/10.1177/1075547015574016>.
- Krippendorff, K., 2004: Reliability in content analysis: Some common misconceptions and recommendations. *Hum. Commun. Res.*, **30**, 411–433, <https://doi.org/10.1111/j.1468-2958.2004.tb00738.x>.
- MacDonald, T., and L. Hymas, 2019: How broadcast TV networks covered climate change in 2018. Media Matters for America, <https://www.mediamatters.org/donald-trump/how-broadcast-tv-networks-covered-climate-change-2018>.
- Maibach, E. W., B. W. Placky, J. Witte, K. Seitter, N. Gardiner, T. Myers, S. Sublette, and H. Cullen, 2016: TV meteorologists as local climate change educators. *Oxford Research Encyclopedia of Climate Science*, Oxford University Press, 2424 pp., <https://doi.org/10.1093/acrefore/9780190228620.013.505>.
- , D. Perkins, K. Timm, T. Myers, B. W. Placky, S. Sublette, A. Enghblom, and K. Seitter, 2017a: A 2017 national survey of broadcast meteorologists: Initial findings. George Mason University Rep., 76 pp., <https://www.climatechangecommunication.org/wp-content/uploads/2017/03/2017WeathercasterSurveyReport.pdf>.

- , and Coauthors, 2017b: 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>.
- McQuail, D., 2010: *Mass Communication Theory*. Sage Publications, 622 pp.
- 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. M. Keenan, Eds. Springer International Publishing, 261–277.
- Nisbet, M. C., and D. Fahy, 2017: New models of knowledge-based journalism. *The Oxford Handbook of the Science of Science Communication*, K. H. Jamieson, D. M. Kahan, and D. A. Scheufele, Eds., Oxford University Press, 273–281.
- Placky, B. W., 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>.
- Posegate, A., 2008: Station scientists: Beyond the daily forecast. *Weatherwise*, **61**, 20–25, <https://doi.org/10.3200/WEWI.61.6.20-25>.
- Schudson, M., 2001: The objectivity norm in American journalism. *Journalism*, **2**, 149–170, <https://doi.org/10.1177/146488490100200201>.
- Shoemaker, P. J., and S. D. Reese, 2014: *Mediating the Message in the 21st century: A Media Sociology Perspective*. 3rd ed. Routledge, 308 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>.
- Timm, K. M. F., D. R. Perkins, T. Myers, and E. W. Maibach, 2019: Reporting on climate change by broadcast meteorologists: A national assessment. *Bull. Amer. Meteor. Soc.*, <https://doi.org/10.1175/BAMS-D-18-0225.1>, in press.
- Tuchman, G., 1972: Objectivity as strategic ritual: An examination of newsmen's notions of objectivity. *Amer. J. Sociol.*, **77**, 660–679, <https://doi.org/10.1086/225193>.
- van der Linden, S. L., A. A. Leiserowitz, G. D. Feinberg, and E. W. Maibach, 2015: The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLOS ONE*, **10**, 2–9, <https://doi.org/10.1371/journal.pone.0118489>.
- van Witsen, A., and B. Takahashi, 2018: Knowledge-based journalism in science and environmental reporting: Opportunities and obstacles. *Environ. Commun.*, **12**, 717–730, <https://doi.org/10.1080/17524032.2018.1455723>.
- Ward, B., 2009: Journalism ethics and climate change reporting in a period of intense media uncertainty. *Ethics Sci. Environ. Polit.*, **9**, 13–15, <https://doi.org/10.3354/esepp00097>.
- 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 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>.