There is significant interest in the meteorological community about the effective provision and use of weather forecast uncertainty information. Recent evidence of this includes the 2006 National Research Council “Completing the Forecast” report, the AMS Ad-Hoc Committee on Uncertainty in Forecasts, and the 2008 updated AMS statement on probability forecasts. However, limited empirical information exists about the provision and use of weather forecast information in general, and even less is known specifically about forecast uncertainty information. Some work has begun to tackle the important knowledge gaps that exist, but much is yet to be learned.

The forecast and communication system is complex, and includes many key “actors”—public- and private-sector operational forecasters; print, radio, and television media; public officials; and members of the public—that have different knowledge, perceptions, and roles. Although all components of this forecast system need to be studied to gain a complete understanding and begin to change what forecast information (including uncertainty) is communicated and how, this project focuses on broadcast meteorologists.

Broadcast meteorologists are an important but rarely researched group from which much can be learned. As intermediaries between forecasters and the public, broadcasters are an essential component of the Weather Enterprise. Research has shown that local and cable television are primary sources of weather information for people for everyday weather and for major weather events. A recent nationwide survey by Lazo et al., published in the June 2009 BAMS, revealed that, on average, respondents get weather forecasts from local television over 33 times per month and from cable television over 18 times per month. These numbers illustrate the large audience that broadcast meteorologists reach. As a regular, tangible face of science, broadcasters have been the staple of providing weather forecast information—including uncertainty information—for decades.

Broadcasters are unique in their role as both interpreters and communicators of forecast uncertainty information. Although their time on air is limited, broadcasters have opportunities for flexibility and creativity in communicating their message. They can utilize numerous communication modes (e.g., verbally, graphically, numerically), have more latitude in the terminology they use than entities like the National Weather Service (NWS), and can more readily draw on new technology and increasingly sophisticated graphics packages for enhanced storytelling. Broadcasters also constantly receive feedback from their viewers, creating an end-to-end-to-end
process. Moreover, broadcasters themselves have to receive, interpret, and utilize forecast uncertainty information.

As both providers and users of uncertainty information, broadcast meteorologists have experientially developed knowledge and perceptions that can inform the broader meteorological community. To begin to tap into the knowledge and perceptions of the broadcast community and to better understand their role in the forecast process, we conducted exploratory research to assess broadcast meteorologists’ (a) use of and preferences for current and future forecast uncertainty information, and (b) perceptions of the public’s understanding of, use of, and preferences for forecast uncertainty information.

This article is meant to accomplish two things. First, we illustrate how social science has a role in the meteorology community by discussing how social science methods—in this case, focus groups—can be used to conduct this type of research. Second, we report the focus group findings that begin to demonstrate the important perspective of broadcast meteorologists. The topics discussed here are sufficiently complex that a single project cannot provide definitive answers. Moreover, this specific research project is based on a small sample size, and the results are not meant to be conclusive or generalizable. Rather, the purpose of this project and the focus group methodology we employed was to begin to identify what issues the broadcasters discussed and how—in other words, what topics they identify as being relevant and important. The findings serve as groundwork to build on, to spur future, more-focused quantitative and qualitative research projects.

FOCUS GROUPS AS QUALITATIVE RESEARCH. Focus groups are a method of qualitative data collection based on discussion among a small group (typically 6–12 people) guided by a moderator. Because focus groups offer an interactive setting where participants are free to talk with and react to each other, they are useful for generating ideas and insights, and for highlighting common and differing viewpoints. These interactive discussions distinguish focus groups from individual interviews.

Focus groups were chosen for this study because they are useful for exploring topics in the early stages of research, improve the efficiency of data-collection efforts, and help keep study costs low. However, focus groups generally do not allow for data collection from large, representative samples. Other potential drawbacks include the potentially strong influence of the focus group moderator, the discussion being directed or dominated by a single individual, and difficulty separating individual viewpoints from the collective group viewpoint. To control for these, it is important to be trained in focus groups before utilizing this research method.

Prior to conducting the focus groups, a set of questions was developed. The questions were broad and open-ended as they were meant to draw out the topics deemed important by the focus group participants. The questions were structured around what forecast uncertainty information broadcasters use and provide; what uncertainty information they think their users understand, like, and use; what feedback they get from their users; and what future needs, possibilities, and challenges they think exist regarding providing uncertainty information. The set of focus group questions was reviewed by meteorology and social science peers to ensure the questions were relevant and that the wording was clear. This protocol served as a guide and was adapted as appropriate based on the group discussion.

We conducted our focus groups at the AMS’s 36th Conference on Broadcast Meteorology, held June 2008 in Denver, Colorado. The conference represented a low-cost opportunity to access broadcast meteorologists from various geographic areas and market sizes. We solicited participation via e-mail before the event, and flyers were distributed during the conference at the registration desk and during a preconference short course. In all, 13 broadcast meteorologists participated in two focus groups. A 14th broadcast meteorologist was the sole attendee of a third scheduled session, and he was interviewed individually.

Participants represented a wide range of experiences and markets. Most had 20 or more years of experience, but early-career broadcasters with less than 5 years of experience were also participants. The markets represented were geographically diverse and ranged from cities with less than 200,000 people to large urban areas with over 1 million people. All but two of the focus group participants hold either the AMS Certified Broadcast Meteorologist or AMS Seal of Approval; the two youngest participants do not yet hold these AMS credentials, but they both have degrees in meteorology. Given that the conference attendees likely represented only a subset of the overall population of broadcasters and that those who opted to participate in the focus groups likely are interested...
in the topic of forecast uncertainty, the results of this study cannot be generalized to the general population of broadcast meteorologists. However, they do provide initial insights into the type of knowledge and perceptions found among broadcast meteorologists.

Two researchers moderated each focus group, and a third served as the rapporteur. Each focus group lasted approximately 1.5 hours. The focus groups were video- and audiotaped, and the transcripts were analyzed using NVivo qualitative data analysis software. In qualitative research, participant quotations comprise the data supporting the conclusions, with words taking the place of numbers in the analysis. Following confidentiality requirements for research with human subjects, the identity of the participants is protected in the findings presented.

**A SUBSET OF THE FOCUS GROUP FINDINGS.** Many interesting findings stemmed from the focus groups. In the interest of brevity, we present only a few of them here. The full report can be found online at [www.sip.ucar.edu/publications.jsp](http://www.sip.ucar.edu/publications.jsp).

**Nature of broadcast meteorology.** Better understanding the nature of broadcast meteorology and the general role of the broadcaster provides a valuable foundation for understanding current practices related to the provision of forecast uncertainty information. The broadcasters discussed the context and conditions under which they work, and there was explicit and implicit discussion of the competitive nature of broadcast meteorology. One example is how the industry promotes forecast accuracy that is not commensurate with scientific capabilities, and how such efforts can imply a certainty that does not exist.

"We fought going from 5 days to 7 days for years. Everybody else in the market was doing it, and we finally had to... It has nothing to do with reliability." [Participant #3]

"For years now we've been misleading the public that we are more accurate than we are. By giving these deterministic numbers, the high to 51 as opposed to 49-53. They see these models with the green blobs going across their pixel point where they live, and they think that means it's going to be raining at that point at that time." [Participant #8]

**Viewer expectations.** The broadcasters also discussed viewer expectations for weather forecast information.

There was some difference in opinion about whether people want a deterministic forecast versus one that explicitly conveys uncertainty information, and how these expectations may vary depending on the impact of the weather.

One participant indicated:

"I think that temperature-wise the audience wants that number; they want to see an extended forecast either 5-7 days. If you don't put it on there, they'll go to another station that does." [Participant #10]

But others remarked:

"Well, I don't think they care if you go for a high of 74 and get 79. That's not going to be important to them. It's the weather that's going to interrupt their plans that they want to know about." [Participant #14]

Most acknowledged that, although members of the public might want a deterministic forecast, they are actually more realistic in their expectations.

"What they're after is my best guess. Now, I think most of them realize that there's uncertainty in weather." [Participant #3]

"I think the public understands in an honest moment... that there are always going to be some uncertainties in any forecast." [Participant #1]

**Broadcasters' use of NWS products.** The broadcasters discussed at length the importance of NWS products and communication with NWS forecasters for better characterizing and communicating the uncertainty associated with a forecast.

"Now on the Internet you actually have access to the ensembles. You can get spaghetti graphs and the mean and variations for the short-range forecast. You have many different things to look at. That gives me a degree of how certain I'm going to be about the forecast." [Participant #14]

"I think they [NWS] have a good opportunity in their discussions... at least in my office usually I get a pretty good sense from them how good they feel about their forecast. I think it's really good for them to express their level of comfort with that, especially for 'non-mets' who are ripping and reading the forecasts. That's an avenue for them to say,
"Okay, this is how good we feel about the forecast.””
[Participant #1]

Expressing forecast uncertainty. In discussing communicating forecast uncertainty, it became apparent that most broadcasters do express uncertainty in some manner. These expressions are largely possible because the on-air medium allows broadcasters to explain the forecast situation and to use intonation and nonverbal communication in conveying their message.

“If it’s a complicated forecast, I’ll say that I’m not too sure what’s going to happen. But not with the numbers. . . . One way, in our 6-day forecast, the way I set it up, we do 3-day and talk those up. We show 3 tombstones. This is what you can expect the next 3 days. And then at the end I show the other 3, but I just kind of brush those off. And here’s what it might look like 6 days out. So there’s a way of expressing uncertainty without having to get into the numbers and PoPs and stuff like that.” [Participant #4]

“I think that it doesn’t necessarily hurt your credibility, especially if you’ve been in the market for a fair amount of time to just say, ‘We don’t really know what’s going to happen with this storm yet.’ I think the audience can accept that and not think you don’t know what you’re doing.” [Participant #10]

“Here’s my take: There’s a risk that we’re going to see some severe weather tomorrow. And if we do see it, it’s most likely going to be during the afternoon and early evening hours. If you’re making plans for [a holiday], you need to be watching the weather closely from noon on. Now, that’s an expression of uncertainty, because I don’t know what time it’s going to occur. In fact, I don’t even know if it is going to occur, but if it is, it’s going to be sometime between these parameters. For a person making plans, that’s probably more useful than slight, moderate, or high. And it’s probably more useful than a probability too, because I’m expressing my confidence level right there.” [Participant #3]

However, when it comes to communicating forecast uncertainty information in a formal, consistent way, several broadcasters wondered how best to convey this information.

“For a while I used [qualifying terms, like slight chance or a chance or isolated or widely scattered], but it almost seemed to me that the public maybe didn’t correctly understand, but at least they had enough to be comfortable with the probabilities without the numbers. I’m using numbers again back in radio, but I’ve always wondered . . . what the perception is in the community about whether they want to see the 20%, or the widely scattered, or the isolated?” [Participant #9]

“We did try over the last couple of winter storms to do a confidence scale, a 1–7 scale. . . . We’re playing with that a little bit. I’d love to get some input. If we had something along the lines of, ‘This one looks like it’s a 5 on a scale of 1 to 5. This storm is going to happen’ . . . it might be some type of system that we could develop on your confidence on an approaching storm.” [Participant #10]

There was discussion that a good place to begin expressing uncertainty in more formal ways may be with major events.

“I think we need to look at what we can do about major seminal weather events of the season. Maybe look at some type of a scale. . . . It would at least give people a chance to know we’re not that sure on this storm so maybe I won’t cancel my flight.” [Participant #10]

SUMMARY AND FUTURE WORK. Providing and using weather forecast uncertainty information are complex challenges involving numerous components of the forecast and communication system. Effectively providing and using forecast uncertainty information is not a simple problem with a single solution. It requires multiple research efforts and methods pertaining to all actors of the forecast system.

The research discussed here has contributed toward this effort by exploring the role and perspective of one key component of the forecast system—broadcast meteorologists. Although this study was an exploratory first step, it elicited several valuable points through empirical research. First, broadcasters have varied perceptions with respect to what their audiences want, need, and can understand. Although they generally feel the public already understands that uncertainty is implicit in forecast information, there are mixed viewpoints on how members of the public can benefit from additional information about forecast uncertainty. Second, broadcasters have posi-
tive feelings about NWS communication, including recent advances, such as chat rooms. Although broadcasters may not explicitly pass on uncertainty information they glean from the NWS to their audience, they use it to develop their own understanding and can communicate their feelings of forecast reliability through nonquantitative means. Finally, like other providers of forecast information (e.g., NWS and private sector forecasters, emergency managers), broadcasters have constraints in their ability to communicate forecast information, including uncertainty. Broadcasters face competing demands for time on air from other aspects of a newscast and advertisers. Moreover, broadcasters are sensitive to competitive forces, such as the actions of other broadcasters in the same market as well as the needs of their audiences and the information available from the NWS or other sources. Thus, broadcasters’ ability and desire to provide forecast uncertainty information may vary regionally.

This exploratory project also raised several questions for follow-on research, such as when and how to communicate forecast uncertainty information depending on the context, the interpretation and effectiveness of the informal ways that broadcasters express uncertainty, and how to effectively communicate forecast uncertainty in formal, consistent ways. Research—especially that which integrates meteorology with social science theories and methods—in these and other related areas is necessary to develop this knowledge. Investing time, resources, and commitment into such efforts is critical to providing more effective and usable weather forecast uncertainty information.

ACKNOWLEDGMENTS. We thank the 14 broadcast meteorologists who participated in the focus groups for their valuable time, energy, and thoughts. We thank NOAA for their support of this research. This work is supported by NCAR’s Collaborative Program on the Societal Impacts and Economic Benefits of Weather Information (SIP), which is funded by the National Science Foundation and NOAA through the U.S. Weather Research Program. NCAR is sponsored by the National Science Foundation. Views and opinions in this report are those of the authors.

This project was recommended by the AMS Ad Hoc Committee on Uncertainty in Forecasts (ACUF). The findings will be included in the report of ACUF Subgroup 1: Needs, Opportunities, and Benefits of Providing Hydro-meteorological Forecast Uncertainty Products and Services to the Nation.

FOR FURTHER READING


AMS Ad Hoc Committee on Uncertainty in Forecasts (ACUF), 2007: AMS Ad Hoc Committee on Uncertainty in Forecasts Charter. [Available online at www.ametsoc.org/boardpages/cwce/docs/BEC/ACUF/Charter.pdf]


