COMMUNICATION COMPLEXITIES: INSIGHT INTO NATIONAL WEATHER SERVICE METEOROLOGIST COMMUNICATION PERSPECTIVES

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ABSTRACT

The job of an NWS meteorologist is not just to create a forecast but also to communicate it to partners and the general public. While forecasting tools and technology have undergone improvements, refining forecast accuracy, problems arise if that forecast is not effectively communicated. The goal of this study is to examine what shapes NWS meteorologists' communication with partners and the public to better understand opportunities and challenges in implementing the Brief Vulnerability Overview Tool (BVOT). We conducted a thematic analysis on eight interviews from National Weather Service weather forecast offices across the country. Our analysis resulted in four themes: 1. Trust is everything, and is the defining factor for success in forecaster communication. 2. Direct and perceived partner preferences shape the way forecasters tailor their messages. 3. A connecting relationship exists between forecaster experience, confidence, and expertise. 4. Perceived communication obstacles like cultural differences, reaching more vulnerable populations, and the failure of communication to reach all who need it were prevalent. These themes address key elements that shape the communication process of forecasts and directly influence how forecasters communicate with partners and the public.

1. INTRODUCTION

On June 5, 2025, I (the lead author) witnessed an EF-2 wedge tornado near Morton, Texas, on a storm chase. Unfortunately, our vehicle broke down, forcing us to take shelter at a local high school. By this point, the tornado threat had passed, and we were out of imminent danger. Even so, residents stayed sheltered and, after learning our group had been storm chasing, began asking us questions: “Did it ever touch down?” “Where is it?” And sharing their concerns: “I think the storms are going to merge and then come straight for us!”

The confusion in the room from those taking shelter was evident. From this perspective, it was unclear where communication breakdowns were occurring. However, the fact remained that people in our shelter were unsure about their situation. After talking to several more people, we learned that a year prior, a tornado had impacted the community without warning, which was a likely factor in the behavior displayed that day. We also learned that day from a National Severe Storms Laboratory (NSSL) member that that damage had been caused by straight-line winds, not a tornado, and the storm had been properly warned. Despite this, it did not change the fact that the community *believed* they were struck by an unwarned tornado.

What we witnessed on this chase highlights key elements of the IWS (Integrated Warning System) and how people interpreted the messages they were receiving differently. The IWS includes all aspects of the warning communication process, from the National Weather Service (NWS) meteorologist, the tools they use for forecasting, the products that are issued, the warning communication technology, media messaging of the warning message, and aspects of the public and the public's ability to understand and act on the warning message (Doswell et al., 1999).

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The NWS's Impact-based Decision Support Services (IDSS) directive acts as a guideline for communication but focuses on partners as opposed to the general public. The NWS offers these guidelines for communication through its directives under operations and services (National Weather Service, 2024a–d). A thorough guide describing procedures for best practices in providing support to partners can be found in NDS 10-24 Impact-based Decision Support Services (IDSS; National Weather Service, 2024c). The IDSS directive includes a range of information from defining core partners, providing information on conducting video briefings, how to build flourishing relationships with partners, and how to provide aid in severe weather events (National Weather Service, 2024a–d).

IDSS and the IWS provide the foundation NWS meteorologists currently use for communication with partners and the public. While these frameworks are well established, new technologies and tools are showing signs of improving communication as well. Phased Array Radar (PAR) is type of radar recently being applied to weather. It scans the atmosphere significantly faster than spinning dish technology. Meteorologists have reported that PAR has given them greater confidence and allowed for faster decision-making (Garcia, 2025). The Brief Vulnerability Overview Tool (BVOT) is a new tool to support communication, capturing the most acute concerns of NWS partners into a map that enables all meteorologists to provide the same level of decisions support (Friedman et al., 2024). These have the potential to improve communication because forecasters will have access to new cutting-edge technology. Our research focuses on further building on the foundation that IDSS and IWS have provided to analyze NWS meteorologist's perceptions of their communication with the public and partners.

2. LITERATURE REVIEW

NWS meteorologists are tasked with creating forecasts, issuing warnings, and keeping the public safe from weather-related hazards (National Weather Service, n.d.). Improvements in modeling and technology have also greatly improved forecasting accuracy over the years aiding meteorologists in this process (Visual Crossing, 2024). These aspects discussed in the NWS mission statement are elements that shape communication due to the nature of information exchange involved in these facets, and are aimed at decreasing loss of life and loss of property during severe and hazardous weather events. Furthermore, these communicative actions, central to the NWS mission statement, also play a key role in the Nation's economy and are necessary for transportation and trade (National Weather Service, n.d.). Meteorologists are not only tasked with the creation of forecasts; they are also tasked with maintaining communication with partners and providing reliable information for the public and partners alike. The role of providing accurate and timely information is critical to the NWS mission. If information is misconstrued or misunderstood anywhere in the IWS, the results could be tragic.

Communication is defined as a process that includes the sending and receiving of both verbal and nonverbal messages and is influenced by broader relational and situational contexts (Hawes, 1973). However, communication is not always as simple as two parties interacting with each other. Communication can be influenced by a multitude of outside factors and is a continuous, ever-changing multifaceted process (Van Ruler, 2018). In the following sections, we explore this concept of communication and the role it plays in shaping how meteorologists convey their forecasts. The sub-concepts we identified act as the basis for the remainder of this literature review and were derived from topics that were most prevalently discussed in the data.

Recent social science research has highlighted the benefits of clearly communicating a forecaster's perception of uncertainty in their forecast (e.g., Colle et al., 2021). For example, research suggests that the public seeks additional information on forecast uncertainty (Colle et al., 2021; Morss et al., 2008). Incorporating uncertainty in weather forecasts has been ongoing for decades (Morss et al., 2008), dating back to at least 1909 (Murphy & Winkler, 1984). We cannot perfectly capture the current state of the weather, which means forecasts are based on imperfect data that can be highly sensitive to small changes in that data. (Murphy & Winkler, 1984; Morss et al., 2008). However, despite the known limitations of forecasting, how to best communicate these uncertainties is in development. Probability-based forecasting to convey uncertainty (Murphy & Winkler, 1984) has seen more usage as forecasters gained a better understanding of the link between uncertainty and probability. Following Lorenz's work on chaos theory in the 1960s, which highlights the unpredictability of atmospheric

conditions in the world of meteorology, more probabilistic forecasting began to emerge (Slingo & Palmer, 2011). With uncertainty shaping how forecasts are communicated, there is evidence now that providing this information improves the public's decision-making and encourages taking precautionary measures based on uncertainty forecasts (Joslyn & LeClerc, 2011).

Much of the value in a probabilistic approach to forecasting is the experts' communication of confidence (Henderson et al., 2023). In an experiment conducted in 1951, forecasters were required to assign probabilities to a precipitation forecast to determine their confidence levels (Williams, 1951). With a rise in probabilistic forecasts stemming from this study and Lorenz's chaos theory, communication of confidence saw increased usage due to its intertwinement with uncertainty. Forecaster conviction is an element of the communication of the forecast (Scher Messori, 2018; Henderson et al., 2023). Forecasters have communicated forecast confidence in different ways in the past, with some opting for qualitative language and some utilizing more quantitative methods (Henderson et al., 2023). In addition, displaying confidence levels in forecasts can help guide people's decisions (Padilla et al., 2021; NWS Strategic Plan, 2019–2022). Along with the need for greater use of forecasts that include confidence levels (Padilla et al., 2021; NWS Strategic Plan, 2019–2022), this illustrates a necessity for more attention to communicating forecast confidence in general.

Trust is another important element in communication, with higher levels of trust resulting in more receptiveness to forecasters (Jood et al., 2021). In general, people tend to view low confidence forecasts as the least trustworthy and high confidence forecasts as the most trustworthy (Padilla et al., 2021). Trust is a complex and multifaceted concept (Jood et al., 2021). However, some research suggests that the general public's trust in a forecaster's communication comes down to forecast accuracy (Burgeno & Joslyn, 2023).

Examining communication with partners, especially with emergency managers (EMs), consistent interactions between the two parties improved trust over time (Cross & LaDue, 2021). The IDSS directive highlights the importance of effective IDSS and how this can build strong relationships among those partners (Liu & Seate, 2021). For EMs specifically, there is generally a strong level of trust surrounding forecaster's intent (Cross & LaDue, 2021). While this trust can be responsible for shaping emergency managers' behaviors (Cross & LaDue, 2021), some research suggests that meteorologists are reluctant to provide updated information if it breaks consistency (Burgeno & Joslyn, 2023) or struggle to gain the certitude of the general public if a baseline threshold of trust has not been reached (Jood et al., 2021). Research has been conducted describing the role of trust, but few have investigated the communicative nature that trust represents and how forecasters view it. Also unknown is the extent to which trust from the recipient of a forecast shapes forecaster communication.

An expert forecaster can affect communication due to their "superior practical creative ability to produce a meaningful forecast gestalt out of available information pieces" (LaDue et al., 2019, p. 10). Expertise in forecasting enables effective communication because expert forecasters are able to add value to forecasts by interpreting complex data and analyzing observations, improving forecast accuracy (American Meteorological Society, 2021). One of the biggest differences between expert and novice forecasters is that expert forecasters can apply creativity and factor in nuance when creating a forecast (LaDue & Cohen, 2018). This suggests that due to the communication process in forecasts, expertise affects this communication in the form of more experienced meteorologists creating superior forecasts. With the rapidly changing environments forecasters find themselves in, a constant evaluation of learning needs is necessary in continuing to refine expertise (LaDue & Cohen, 2018).

Finally, vulnerability is extremely important when looking at assessing impacts and crucial for NWS meteorologists to understand (Strader et al., 2021). There are many kinds of vulnerability like geographic, demographic, and cultural vulnerability. Some Weather Forecast Offices (WFOs) have incorporated risk measurements into forecasts, but few have implemented vulnerability (Strader et al., 2021). However, communication about vulnerability has increased recently, partly through the implementation of the Brief Vulnerability Overview Tool (BVOT) (Friedman et al., 2024). The communication of forecasts and impacts is prevalent in IDSS, as IDSS centers itself on impact-based messaging, which can involve places that are particularly vulnerable to weather impacts. (National Weather Service

2024a–d). Overall, a greater understanding of what creates vulnerability to weather hazards to help improve forecasts is recommended (Singhal et al., 2025, Strader et al., 2021).

Literature on these six concepts is plentiful; however, the majority of studies conducted around these concepts focus on the perspective of the general public and NWS partners. Other papers argue for a better understanding or implementation of these concepts into forecasts. While this is important, information focusing on the perspective of NWS meteorologists and how they view these concepts has not been studied. This is important to help fill the gap in literature regarding communication from a forecasters perspective to give more insight into the intricacies of communication. Based on the above literature, a guiding research question was posed: What shapes NWS Meteorologists' communication to the public and partners?

3. DATA & METHODS

This study was part of a larger, applied study on the Brief Vulnerability Tool (BVOT). The BVOT tool is being tested in various WFO's across the country, and provides NWS meteorologists with mapped data of vulnerabilities for specific geographic locations and aims to map the people, places, and things of most concern for potential impacts (Friedman et al., 2024).This mapping process may also help to build and maintain relationships between the NWS and its partners (Hurst et al., 2023). The BVOT team used multiple methods for collecting data with participating forecast offices, including in-person fieldwork and online interviews, focus groups, and surveys (Hurst, 2025). This study analyses a subset of interviews from the BVOT research. The goal of this paper is to examine how communication is approached from the perspective of forecasters and to identify areas where communication could be improved to help further understand how BVOT can fit into NWS operations and enhance communication between NWS forecasters, partners, and the general public.

During applied research on the Brief Vulnerability Overview Tool (BVOT), 70 semi-structured interviews were conducted by members of the BVOT research team. After excluding interviews with the WFO management team, such as Meteorologists in Charge (MIC), Science Operations Officers (SOO), Warning Coordination Meteorologists (WCMs), and other special positions, such as hydrologists. Transcript and audio quality were also checked for the interviews to include in the sample. A total of 40 interviews remained. Of the 40 interviews, each interview was assigned a number. A random number generator was then used to select eight final interviews for analysis. In addition, we ensured that an interview from each WFO was used. Participants came from seven WFOs involved in the study, including: El Paso, Des Moines, Gray, Mobile, Medford, Las Vegas, and Norman. Interviews ranged from roughly 40 minutes to an hour and a half, with an average length of 57.62 minutes. Combined, the eight interviews spanned 405 pages of double spaced 12-pt Arial font. Audio and transcripts were imported into MAXQDA, a qualitative data analysis software for thematic analysis to be conducted.

We chose thematic analysis, a method for constructing themes and identifying patterns in qualitative data, because it allows for a fair amount of flexibility (Braun & Clarke, 2006). Table 1 shows how we implemented Braun and Clarke's (2006) six-phase process for conducting thematic analysis. The first step is familiarizing oneself with the data. The second step is a phase of open coding, while the third and fourth steps focus on searching, constructing, and reviewing themes. The last two steps are defining those themes before finally producing the report (Braun & Clarke, 2006). We also decided on utilizing a Big Q framework, which focuses research within the qualitative paradigm and results in a more organic process of theme construction compared to small q framework (Terry et al., 2017; Braun & Clarke, 2006).

After listening to each recording and checking transcript accuracy, we began an initial phase of memo writing. This consisted of writing down interesting points or quoting excerpts that could be used later. We then created a Google document of bullet points for each interview before creating code memos in MAXQDA. Code is an integral part of data analysis for qualitative work and helps structure observations. We decided, however, to scrap most of these initial codes in favor of a more open coding approach, which we felt would lead to a more organic and immersive experience with the data. Open coding, as the name suggests, advises the researcher to remain open to various possibilities and interpretations, limiting preconceived notions (Sybing, n.d.). This second phase of open coding began by categorizing our notes in MAXQDA and attaching

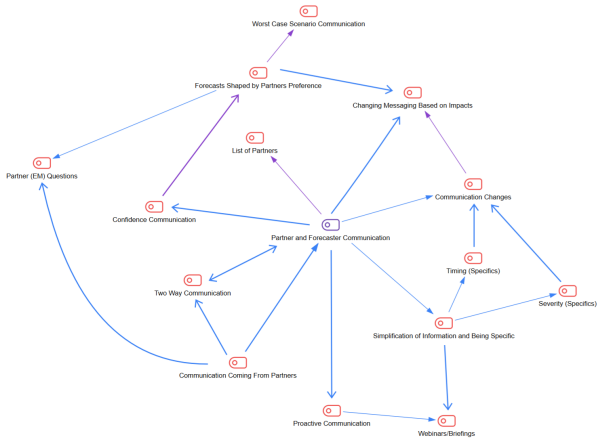
labels to them. Throughout this process, we familiarized ourselves with literature like Vaismoradi et al. (2016) which helped in the learning process of good theme and category construction, and Braun & Clarke (2023) which gave insight on how to avoid thematic analysis pitfalls.

Table 1
How Braun & Clarke's six-step process was used in this study

Step	Description
Familiarization	Reading and listening to transcripts
Open Coding	Coding all interview segments in qualitative software MAXQDA
Searching For Themes	Using MAXMaps to organize codes and start finding connecting patterns
Reviewing Themes	Analyzing MaxMaps to focus on specific connections to construct themes
Defining & Naming Themes	Decide on theme names and write definitions for each theme
Producing Report	Incorporate themes into the paper and write the report

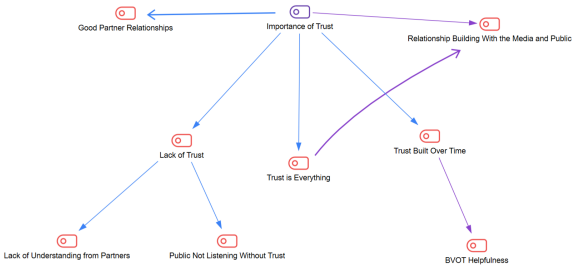
A rigorous open coding phase resulted in approximately 200 open code labels and 1800 individual coded segments. As we searched for themes, in the next step, codes were organized and condensed to find broader patterns. These were labeled through a feature in MAXQDA called MAXMaps as seen in the examples in figures 1 and 2. We created 14 figures connecting existing codes. The next step, reviewing themes, involved narrowing down these codes using our figures as a roadmap. After this phase of theme construction, a thorough review of themes was conducted to ensure that all codes were accurately represented. We ensured that there was reasoning behind every constructed theme and verified its importance before proceeding to the last two steps. The next step consisted of defining and naming themes. These themes were named through the combination of several segments within MAXMaps. After adjusting several theme names, we incorporated them into the paper. The goal was to aim for a style of writing that used a storytelling-like methodology to craft something that was interesting yet informative. After this was completed, I reviewed each step to ensure that proper thematic analysis was conducted.

Figure 1
MAXMap on Partner and Forecaster Communication



Note. Partner and Forecaster Communication was not a central theme, but the connecting segments aided in the construction of other themes

Figure 2: MAXMap on the Importance of Trust



Note. The Importance of Trust was adjacent to one of our key themes

3.1 Limitations

Because this study analyzed eight interviews, it may not generalize to all forecasters. Other forecasters may have different perspectives on key matters, and different themes could emerge. Interviews were collected by three

different interviewers with slightly different interview guides across two studies. However, because this analysis was led by someone separated from the data collection, there was opportunity for a unique perspective into the interpretation of data. Finally, initial data collected through these interviews were not collected by meteorologists; they were collected by an anthropologist, communication scholar, and a geographer. The interviewers were “outsiders” and thus took an outsider perspective. As such, meteorological and NWS jargon were used sparingly. This did not present itself as a barrier but does shape the nature of questions and responses seen in the interview transcripts.

4. RESULTS

With our research question in mind: “What Shapes NWS Meteorologists' Communication with Partners and Public,” several prominent themes emerged in the data. The four that best addressed the ways forecaster communication is shaped were *Trust is Everything, Perceived Partner Preferences, The Experience Connection, and The Struggle is Real* (see table 2).

Table 2
Themes and Definitions

Theme Name	Definition
Trust Is Everything	Trust makes or breaks communication and is vital for effective messaging
Direct & Perceived Partner Preferences	Information that partners want dictates forecasters' communication
The Experience, Expertise, and Confidence Connection	Experience, expertise, and confidence all share a direct relationship with each other
The Struggle Is Real	Communication barriers can make effective messaging difficult

4.1 Trust is Everything

Throughout the interviews, trust appeared to be the most important aspect of communication identified by forecasters. The importance of trust came in two distinct categories. First was the general sentiment that trust is the defining factor in effective communication. This was shared by several quotes that stressed this, one of them being, “I think trust is really kind of everything. I think if, obviously, if you don't have that trust built, I don't think people will be as receptive to your message” (Interview 11).

When asked about trust, forecasters had concrete and concise answers like this quote, where a forecaster said, “Oh, trust. I think, well, they have to trust us. I think that's the most important thing.” (Interview 18). The first category had a multitude of these concrete and assertive responses, devoid of any uncertainty or doubt. In addition to stressing how trust is everything, some forecasters also added how trust shapes people’s actions: “Yeah. I think that's everything. It comes right back to what I said before about taking action based on what we tell them the weather is going to be” (Interview 16).

This sentiment about trust informing people’s actions was also prevalent in the second part of this theme. This second category came from interviews where the forecaster was not directly asked about trust. In these instances, trust still emerged as a central talking point, with this quote highlighting that fact: “Well, the role that it plays is kind of the difference between acting on our information and relying on it versus dismissing it. And so, you know, you got to have that trust if you want the information to be acted on and relevant” (Interview 3). An explanation of how trust affects the perception of information in this way was mostly found in interviews where a question about trust was not explicitly asked. This still stresses the importance of trust but adds another layer discussing its effect on people’s interpretations.

Another example of trust affecting the interpretation of information was when a forecaster said: “Well, then if they don't trust you, then they won't -- they of course won't believe what you're saying is credible. And if you don't have any credibility, then they won't act on your statements, or they'll go elsewhere for the information” (Interview 16). In this case as well, we find trust to still be prominent even if not directly asked about in an interview. Even this quote which says: “We have a pretty good relationship with them. For the most part, I think we understand each other fairly well. Usually, if our media partners, they have that background in meteorology” (Interview 10), still reflects aspects of trust. This particular case was

in reference to partners, and we interpret the good relationship as a product of trust, showing its importance in other areas apart from the public's interpretation of messaging.

Forecasters who were directly asked about trust generally answered with stronger, more concrete wording on the importance of trust in communication. While this is not enough to conclude that trust directly shapes how forecasters communicate, trust in itself is an element that shapes the communication process of forecasts. The forecast communication process involves relaying information to the public, and with strong wording from forecasters on trust's role in this, we believe that our theme *Trust is Everything* plays a large part in shaping this process. In addition, from the data, we believe that trust is a necessary condition for communication to be effective. While other concepts like vulnerability and uncertainty, which were highlighted in the literature review, saw discussion throughout the interviews, no concept was spoken about with as much passion and emphasis as the significance of trust.

4.2 Direct & Perceived Partner Preferences

The second theme was how partners' direct and perceived preferences shape forecaster communication. This theme, similar to our first theme on the importance of trust, can be split into two subcategories. The first was when forecasters would listen to feedback that partners provided and use that information to update their messaging while the second involved forecasters tailoring their messages based on perceived preferences. While there were varying levels of comprehension between forecasters and partners on how well each party understood the role of the other, there was consistency among forecasters that the information partners wanted was the information they tried to provide. For example, a forecaster was describing how an EM requested more specific timing information: "So say like 10:00 a.m. to 06:00 p.m, or west of I-65, 06:00 p.m. to midnight east of I-65. We'll include that visually on a graphic. The emergency managers have really liked that kind of graphic. That's the feedback" (Interview 7). This feedback was noted in several interviews, and in each case, there were several examples of information being updated upon these requests.

Another forecaster highlighted how they are trying to serve partners better by giving them customized information (Interview 18). This customized information came in the form of information on the severity of an event, the expected timeframe, and, oftentimes, requests for forecasters to include a confidence section on the likelihood of an upcoming severe weather event. This acts as clear evidence that these direct preferences shaped forecaster communication.

The second part of this theme was when forecasters would not receive direct feedback from partners. In these cases, forecasters would still try to tailor their messaging through the simplification and detailing of information. The process of tailoring messages is illustrated in the following quote: "So, we kind of try to break everything down in terms that they can understand, you know, try to avoid acronyms and so forth, even though there's a ton of them. So, we kind of try to put it in terms of language that they can understand." (Interview 33)

Generally, forecasters believed the simplification and detailing of information would allow for the easiest interpretation of messages from partners for example, one forecaster explained: "We want to simplify it as much as possible and try and avoid complex terms and things that we might communicate with internally, but yeah, for our external partners, we wanted to try and be simple and straightforward" (Interview 3). While ultimately, forecasters were unsure whether partners preferred this information, the preconceived notion was that partners would benefit from this type of messaging. These perceived preferences have clearly altered how forecasters communicate with their partners and combine to shape communication along with direct feedback.

Similar to our first theme, *Trust is Everything,* this theme was largely constructed from the prevalence of these preferences within each interview. Both subcategories clearly illustrate a change in communication because of partners. Direct feedback focused more on the different types of information that partners wanted, whereas the perceived preferences were more based on the language of the message rather than the content. Regardless, a clear indication of partners' influence on communication was present throughout the data.

4.3 The Experience, Confidence, and Expertise Connection

The third theme was crafted through our interpretations to a greater degree than the other themes: experience, confidence, expertise connection. We found reasonable evidence to

suggest a connection between experience, confidence, and expertise, sharing a cyclical relationship.

Confidence was a concept that was discussed in different ways. For example, a quote from a forecaster discussed learning how to be confident: “It was kind of almost a learned experience, a learned confidence” (Interview 11). Another quote that highlights this approach discusses how a lack of experience could lead to limited confidence: “But if I'm just getting probabilistic data and I have no experience of it, even if it says a 100%, I still might not feel confident because I don't have experience” (Interview 18). Another way confidence was discussed was through the inclusion of confidence information in forecasts. “And so, you have to let them know through confidence levels, probabilities of things happening” (Interview 3).

Communicating confidence and including confidence in a forecast based on our interpretations stemmed from forecaster experience. However, expertise also influenced confidence. This quote, which says: “If something is more probable, I’m going to be more confident” (Interview 7), highlights a common sentiment shared by forecasters who displayed expertise. Expertise manifested itself in several ways, including weighing models with personal observations, using past events for guidance on a current situation, being in tune with the geographic area and any microclimates within the weather forecast area, and understanding probabilities' role in confidence. The quote above highlights this last element of expertise forecasters displayed and in turn provides evidence on how confidence connects to expertise as well as experience.

We had no independent measure of forecaster expertise, instead inferring it through what they said. “Because you also look for when you’re dissecting through your conceptual knowledge, looking at the different layers in the atmosphere and trying to come together with your understanding of what’s going on, you look for the ingredients” (Interview 7). Quotes similar to this expressing forecaster methodology showed this expertise.

The link between expertise and experience and confidence can be summed up with this quote: “Of course, there's always an outlier which could bust, I mean, bust a forecast. But if I'm using probabilistic data regularly and I feel like it's a reliable forecast system based on experience, then I'll have high confidence in that” (Interview 18). Experience plays a large role in the intricacies of forecasting, like the usage of probabilistic data resembling a level of expertise built on experience. As for confidence, the forecasters discussed confidence changing based on elements that shape expertise, like the weighing of models, something we mentioned as a trait of expertise displayed by many forecasters.

A quote we feel encompasses this theme well says: “But now that I've, you know, three years under my belt, I feel confident. I've started gaining some of that experience and been burned a couple of times and very humbled” (Interview 20). Overall, the link between confidence and experience was prevalent. We also believe the influence of expertise, while more hidden, is still prevalent as the product of experience and an element that shapes confidence. The inclusion of confidence sections in forecasts, which, like trust, are part of the communication process, shows how the inclusion of confidence has shaped forecast messaging recently. As for confidence levels displayed by forecasters, and its connection to expertise and experience, we believe these three factors can greatly alter the accuracy of a forecast, especially expertise as seen in LaDue et al. (2019). Accuracy is another integral part of the communication process and can affect the interpretation of this information. In this sense, this connection can have large implications for how forecasters are shaping their communication.

4.4 The Struggle is Real

The fourth theme we identified was the struggle is real. This was present in two main ways: cultural differences and communication not reaching those who need it. For cultural differences, it was noted that in more rural areas with older populations, people tended to be less receptive to messaging, essentially wanting to be left alone. “These people, they just want to essentially be left alone. There's nothing you really can do, maybe to get in there with a message. You know, they might hear alert sirens if they're close to them in some of these rural locations. Some of these rural locations, they probably are not” (Interview 11). Other cultural differences, like language barriers with Hispanic populations in the Southeast were mentioned, but the cultural aspect that seemed to have the most negative presence on effective communication was rural living and the general sentiment of wanting to be left alone.

The second aspect of this theme was the perception of communication not reaching those

who need it. This theme had several examples like this quote, which says: “Sometimes you don't know what happens because not that many people look there, and they just don't call us, or our outreach may not be great there” (Interview 18). Another example from the same interview that highlights this is: “There's many times where I feel like we issue things and it's like, I don't even know who's impacted by this” (Interview 18). Both of these quotes discuss outreach difficulties coming from the forecaster due to the isolation of many communities, an issue mentioned in other interviews as well. Another element of this is poor outreach caused by the issue of bad cell service. In these cases, people were unable to receive alerts on their phones, and vital communication could be entirely cut off. We see communication not reaching those who need it as a byproduct of disconnect, either from a lack of forecaster knowledge on the geographic area or a lack of sufficient infrastructure in communities.

Forecasters are aware of these problems. There was a general sentiment that they hoped to increase their outreach and do better to mitigate these communication barriers. For example, a forecaster recalling a surprising experience resulted in understanding a partner better: “And I was, I now know like all of what they're bringing in and out of the port. And that was -- it was really eye-opening” (Interview 20). This quote describes a learning process that helped inform a forecaster who their messages were reaching and how those people were receiving and interpreting them. With forecasters discussing the importance of outreach with partners, this highlights that forecasters do see the benefits this outreach can have and commonly express the desire to learn more. We believe that this outreach can help improve communication in these areas, and in doing so, will alter how that communication is shaped.

5. DISCUSSION

Our findings examine four themes, the first being that *trust is everything*. Trust is a prominent element in the communication process, and the importance of trust for effective messaging in this communication process is imperative. The second theme, *direct and perceived partner preferences*, looks at how forecasters tailor their messages to partners, utilizing their feedback or simply catering information based on perceived preferences. Our third theme discusses the experience, expertise, and confidence connection, identifying the direct relationship these three elements share. Finally, our last theme highlights communication barriers and failures, and how these shape how forecasters are approaching communication.

All eight interviews highlighted the importance of trust, and the implications couldn’t be clearer. Forecasters stated that trust was the single most important factor that determines effective communication. Much of our data leaned heavily towards trust between forecasters and their partners, but with several interviews also discussing how trust results from building relationships with the public, we conclude that trust is important to maintain with both the public and partners. While our data, being from one side of many communication dyads, do not allow us to attribute any of the communication barriers to a lack of trust, it’s clear that its importance calls for a better understanding of how trust can be improved going forward.

This theme connects to literature on trust from the public's perspective as well as trust with partners (Jood et al., 2021; Burgeno & Joslyn 2023; Cross & LaDue, 2020). While a theme like *Trust is Everything* might come with accurate preconceived notions on its importance, we present data that adds basis to this, filling the gap in the literature on this aspect from the viewpoint of the meteorologist. For future research, a further dive into trust that synthesizes perspectives from forecasters, partners, and the general public would be helpful in further understanding both sides of these communication dyads. In addition, analyzing more interview data could help reinforce the evidence further.

Our second theme of partners shaping forecaster communication is tied heavily to the values of meteorologists in the field. Forecasters shape their communication to help those who need it because their job entails protecting the livelihood of the people they serve. These values were mentioned at the start of most interviews and likely explain why partners' preferences have such a large influence on the way that forecasters communicate. Initially, we believed that good partner relationships would be the determining factor in why forecasters listened to partners. However, while good partner relationships exist to an extent among all WFOs, a lack of evidence equating this to our theme makes the jump in interpretation difficult. Because of this, we conclude that forecaster values were the strongest reason information was so readily updated to match partners' preferences.

Our literature review did not directly cover the relationship of forecaster values and forecaster communication. However, shared values, such as those values instilled as members of the NWS, should shape how and why NWS forecasters communicate with the public and partners. Even for perceived preferences, wanting to provide simplified and detailed messaging shows how important achieving effective communication with partners is for forecasters. In the future, it will be important to further analyze partner preferences for incorporating BVOT into NWS operations, as well as possible future work analyzing the degree to which tailored forecaster information helps partners.

The theme on experience, confidence and expertise suggests a cyclical relationship between the three. This analysis shines light on the deep interconnection between each of the three constructs. It was also clear that expertise was an expansive concept reached through many different angles and methods, compared to confidence. Despite this, enough evidence was still present for this theme to be conclusive. Experience, confidence and expertise have been examined independently (e.g. LaDue et al., 2019; Henderson et al., 2023; Stuart et al., 2007). However, by examining their relationship from forecasters' perspectives, this allows for a more thorough understanding of how these connections shape forecaster communication. Additional research is needed on the interconnections between the three constructs, especially related to forecaster communication.

Going forward, a deeper analysis on this connection, or searching for other concepts that fit into this cyclical relationship may provide more answers on how deep this connection goes. In addition, conducting additional interviews with more specific questions that further examine this unique relationship could yield promising new results and prove helpful in understanding these complex relationships and how they shape forecaster communication.

In general, this theme seemed to lean more towards forecasters and the public rather than partners. Communication with the general public is more complex as compared to partners, who are trained for specific roles in a community. Forecasters tended to display a much better understanding of partners due to direct and maintained relationships.

Finally, our last theme, captured communication failures and barriers. While disconnect was brought up several times, we conclude that communication barriers were more encompassing of our general forecaster sentiment. Communication barriers presented themselves in many ways; however, one could make the argument that many of these barriers are simply just the way things are. In this case, communication failures may be a more appropriate word to describe these issues. These failures aren't necessarily the fault of any particular party and can result when an attempt to address a barrier is not successful. The reason this is important is that when examining solutions, focusing on the barriers rather than the failures is the most beneficial.

While the overall goal of this research is not to look for solutions to these problems, for the smooth incorporation of BVOT into NWS operations, identifying these barriers can help inform forecasters and EMs alike, how BVOT might address these issues. Based on our interpretations, we conclude that communication not reaching those who need to hear is the barrier that could see the most improvement. With literature on the implementation of BVOT like Friedman et al., 2024, an analysis after BVOT is fully incorporated into the NWS could be conducted to assess the state of many of these issues at a later date.

For future work, a couple of recommendations are suggested with this research's limitations in mind. The first is some form of ethnographic study that looks at specific communities during severe weather events to analyze how the public behaves during these events. Data examining the public's perception of elements that shape communication has been limited to survey data, and an in-depth ethnographic study could offer further insight into how communication is received and interpreted. Restructuring interviews to then conduct with partners could help provide useful data on how partners understand communication. This could also help give insight into any knowledge gaps we still have in examining forecasters' perspectives by seeing these topics through the lens of partners. In general, though, due to the small sample size and multitude of interviews not used for this paper, the best approach to future research would be the analysis of more interviews. This would allow us to build on existing themes or aid the process of constructing all new themes. Forecasters, partners, and the general public represent the big picture, and by pursuing future work, we can

further understand the communication nexus in these three areas.

6. CONCLUSION

We started this research process by constructing a research question through interview data that was conducted for BVOT. From there, we found literature based on preliminary topics mentioned in interviews. We conducted a six-step thematic analysis using Braun and Clarke's method as a guide. Four prominent themes that tie back to our research question were discussed, as well as commentary highlighting their meaning and importance. We conclude by providing areas for future work as well as researcher suggestions to aid this process. The most powerful takeaway in our opinion, was the theme *Trust is Everything* highlighting how important trust is for effective communication. This theme provided the strongest evidence based on the prevalence of its occurrence throughout the data in an area that is extremely important. While this theme may have served more to reinforce preconceived notions, we confirm this through our interpretations.

With our research aiming to provide analysis to help further understand how BVOT can fit into NWS operations, by finding themes on forecaster communication, we can help in achieving this. Through new tools like BVOT and research like ours on communication, we can give insight to forecasters, partners, and the public on how important communication is. We can understand the role communication plays in a shelter in Levelland, Texas. And finally, we can gain insight into the intricacies that shape the process of communication.

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