

Rethinking Warning Compliance and Complacency by Examining How People Manage Risk and Vulnerability during Real-World Tornado Threats

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ABSTRACT: The weather community has a keen interest in whether or not people comply with tornado warnings by taking shelter when a tornado threatens. When people do not seek shelter, a commonly attributed reason is that they are complacent due to overwarning, false alarms, routine exposure and experience with tornadoes and warnings, or time between damaging events. Yet, there is a lack of research that focuses on whether people are actually complacent, i.e., whether they ignore or are unwilling to prepare for the threat. We explore whether people exhibit these indicators of complacency by examining how people assessed their risk and responded during real-world tornado threats and how vulnerability influenced these processes. Our analysis is based on in-person interviews with 23 survivors of two deadly EF3 tornadoes that occurred approximately 50 miles apart and within 12 h of each other. Contrary to a threat-disbelieving, threat-ignoring, nonpreparing, and thus complacent public, we instead found that people actively managed their risk from the tornadoes, meaning they actively attended to, evaluated, and responded to the tornado risk as it evolved in space and time. We further found, however, that many people felt limited or lack of efficacy to respond due to static and situational factors that resulted in them having no safe place to seek protection from the threat. Based on this rich, nuanced analysis, we provide recommendations about important ways that the weather community and its partners can mitigate the risks people face from tornadoes, now and in the long term.

KEYWORDS: Tornadoes; Communications/decision making; Risk assessment; Social science; Vulnerability

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Weather forecasters, broadcast meteorologists, emergency managers, and other groups in the forecast and warning system assess and communicate their knowledge of tornado risks with the ultimate goal of protecting people from harm. The weather community therefore has a keen interest in the decisions that people make when facing a tornado threat. Much research has been conducted that examines people's protective behaviors, particularly whether or not they comply with warnings by taking shelter during actual tornado events (e.g., Hammer and Schmidlin 2002; Comstock and Mallonee 2005; Nagele and Trainor 2012; Paul et al. 2015) or their intention to do so given a tornado threat (e.g., Weinstein et al. 2000; Senkbeil et al. 2012; Chaney et al. 2013). In studies of public response to tornadoes, warning compliance (or lack thereof) is often assessed through the lens of the forecast and warning information that people receive, such as whether they received a warning, warning lead time, and warning accuracy (e.g., Schmidlin and King 1995; Balluz et al. 2000; Hammer and Schmidlin 2002; Comstock and Mallonee 2005; Simmons and Sutter 2009; Chaney and Weaver 2010; Sherman-Morris 2010; Nagele and Trainor 2012; Chaney et al. 2013; Silver and Andrey 2014; Ripberger et al. 2015; Stokes and Senkbeil 2017; Mason et al. 2018).

When people do not shelter from tornadoes, causes that are commonly hypothesized or attributed include people's lack of general knowledge about tornado risks and various forecast message-related factors. For instance, there are concerns that people are unable to differentiate between tornado watches and warnings or among different degrees of tornado risks (e.g., Sherman-Morris 2010; NOAA 2011; Donner et al. 2012; Ripberger et al. 2019), and that people may have limited numeracy or map comprehension abilities (Ernst et al. 2021). Also, in the southeastern United States, the lack of a single, traditional tornado season and consequent lack of messaging about the year-round threat is believed to influence people's sheltering behaviors or lack thereof (Doswell 2003; Ashley 2007; Simmons and Sutter 2008).

Another cause that is frequently inferred as to why people do not seek shelter is that they are complacent. In discussions about complacency in the literature, suggested causes include, for example, overwarning, routine exposure and experience with tornadoes and warnings, experiencing false alarms, or extended time periods between damaging events (Chaney and Weaver 2008; NOAA 2011; Sherman-Morris and Brown 2012; Doswell 2015; NOAA 2015; Jauernic and Van Den Broeke 2017; Schumann et al. 2018; Ripberger et al. 2019). Moreover, concerns held by forecasters and broadcast meteorologists about people not sheltering due to public complacency have been documented by Childs and Schumacher (2018) and Walters et al. (2020). Beyond the research sphere, the notion of a complacent public is regularly mentioned in the public sphere in media articles (Table 1).

In the last several years, some scholars have focused on investigating false alarms as a theorized cause of complacency. The research about the effect of false alarms on protective behaviors, which primarily has been based on cross-sectional surveys and experiments, has shown mixed results in the tornado context. Lindell et al. (2016) found no effect of false alarms on sheltering intentions. Trainor et al. (2015) found that higher false alarm ratios where study

Table 1. Examples of public media articles that mention public complacency to tornado warnings. Mentions of complacency are emphasized in bolded, italicized text.

Article source	Article date: Title	Article content
CNN	3 Apr 2012: Weather Service tests graphic tornado warnings	“Complete destruction of entire neighborhoods likely.” Those terms, designed to be used when “catastrophic” tornado damage is imminent, are now at the disposal of five Midwest National Weather Service offices conducting an experiment on how to better convey risks from tornadoes and severe storms. The “impact based” warning test, which began Monday, comes on the heels of the May 22–27 Midwest/Southeast tornado outbreak, including a tornado that killed 158 people in Joplin, Missouri. <i>The National Weather Service is ratcheting up its efforts to combat complacency, with the help of the scary phrases.</i> A tornado is confirmed, on average, only once for every four formal warnings.
Huffington Post	17 Apr 2012: Midwest tornado warnings debated: Could they cause complacency?	Forecasters who issued dire warnings ahead of last weekend’s tornado outbreak in the Midwest deemed the effort a success Monday, largely because dozens of tornadoes hit yet caused only a handful of deaths. <i>But they expressed concern about future public complacency.</i>
Capital Weather Gang	6 Jun 2012: Is a high false alarm rate for tornadoes cause for alarm?	During Friday’s severe weather outbreak in the Washington/Baltimore region, there were more than a few false alarms, prompting questions about whether the barrage of storms was overwarned and overhyped and, if so, what to do about it. [...] <i>The concern about false alarms is that they will lead to public complacency.</i>
Climate Central	23 May 2013: Oklahoma tornado shows progress in weather warnings	The NWS is also working to lower the false alarm rate for tornado warnings, with the dual-pol radars expected to help to some extent. Research shows that for every four warnings issued in the U.S., roughly only one tornado actually touches down. <i>The false alarms can lead to a sense of complacency, reducing the likelihood that people will seek shelter when warnings are issued.</i>
USAToday	30 May 2019: Tornado warnings are meant to save lives. Why do some people roll their eyes?	As forecasters across the country try to warn the public about perilous weather events, their message sometimes gets blown away by another powerful force: human nature. <i>Complaints and complacency have been the reactions engendered at times by a mounting number of tornado warnings as a large part of the USA is battered by one twister after another.</i>
WHAS11 Storm Team Blog	3 Mar 2020: StormTeam Blog T.G. Shuck gives breakdown of Nashville tornado, importance of severe weather alerts at night	And sadly there are many lives lost each year because in today’s society we are all so busy with day to day life, plus <i>the number of Tornado Warnings issued has created a sense of complacency and some folks have become “tone deaf” to the all the warnings.</i> The human factor sadly plays into things and can create a domino effect in situations like Nashville.
NBC4i.com	24 Mar 2021: County tornado sirens tested statewide during Ohio Severe Weather Awareness Week	In 2007, the National Weather Service (NWS) adopted Storm Based Warnings for tornadoes and other severe weather hazards that specify portions within a county that will be directly affected by as severe storm. <i>The goal is to improve quality and accuracy and to avoid over-warning, which could result in complacency in an event.</i>
WTOK-TV	17 Feb 2022: MEMA, MDOT share preparedness tips for spring severe weather season	The Mississippi Emergency Management Agency’s number one piece of advice ahead of spring severe weather is to refresh your disaster preparedness kit. That should have a weather radio or your fully charged phone so you can pay attention to the alerts in your area. <i>“We do not want people to get complacent and turn a blind eye ‘oh, it cannot happen to me. It will not happen to me,”</i> says Malary White, Director of External Affairs at MEMA.

participants lived were associated with decreased sheltering intentions. Ripberger et al. (2015) found that higher false alarm ratios led to greater perceptions of false alarms, which reduced trust in the National Weather Service, which reduced intentions to respond to hypothetical warnings. And, Lim et al. (2019, p. 560) found that higher perceptions of false alarm ratios by study participants counterintuitively were associated with greater reported likelihood of taking protective action, leading them to conclude that “concerns about false alarms generating a complacent public may be overblown.” These mixed results suggest that the notion of complacency may be oversimplified or unfounded. Indeed, despite named concerns about complacency and research to explore its causes, noticeably absent from the research is a focus on the phenomenon itself—that is, whether people are *actually* complacent when faced with a tornado risk rather than making inferences that they are.

A definition of public complacency to repeated emergency threats was developed by Wang and Kapucu (2007), who noted the lack of scholarship to describe it. They defined it as the “public’s propensity to believe a threat would not happen and therefore the public ignores the

threat and is unwilling to prepare for the threat. Public complacency reflects the development of a threat-ignoring/unwilling-to-prepare intention even if such a threat appears imminent” (Wang and Kapucu 2007, p. 58). Important to this definition is people’s *intentionality*, that is, their willful ignorance or adversarial behavior. Complacency defines people not as simply unprepared or caught off guard but as deliberately refusing to act.

Here, we explore whether people exhibited evidence of complacency, including whether people ignore a threat and are unwilling to prepare, per Wang and Kapucu’s definitional elements. We approached our analysis by examining the complex, multifaceted risk analysis process that people engaged in during a real-world tornado threat. In other words, we investigated the presence of ways that people managed tornado risks and vulnerability in order to determine if there was an intentional absence of threat attention and preparation.

We conducted an in-depth analysis through in-person interviews of survivors of two deadly EF3 tornadoes that occurred approximately 50 mi apart and within 12 h of each other; the first was a nocturnal tornado and the other occurred midafternoon. Because weather hazards, including tornadoes, are able to be predicted in advance with some skill, albeit also with uncertainty (Morss et al. 2017), we consider the evolution of the tornado threats in the days, hours, and minutes leading up to the events. We conducted this research in the southeastern United States as part of the VORTEX-SE research program, which aims to reduce harm from tornadoes in the Southeast through physical and social science research (NOAA 2020). Research has shown that tornadoes in the Southeast often occur at night and “off season” in fall and winter, which are factors that can exacerbate the risks faced by populations in the region, especially those who are particularly vulnerable to tornado threats (Brooks et al. 2003; Ashley 2007; Ashley et al. 2008; Coleman and Dixon 2014; Childs and Schumacher 2018). Our guiding research questions were 1) how do people get information, assess their risk, and respond dynamically to an evolving tornado threat, and 2) how does vulnerability interact in this process?

Based on this analysis, we provide a rich, nuanced view of how people assess the tornado risks they face and of their decision-making contexts and processes. In doing so, we examine the validity of the notion of complacency, and we identify key factors that influence people’s ability to respond to and comply with warnings. We then provide recommendations to the weather community about important ways that it can work to mitigate the risks people face from tornadoes, now and in the long term.

Methods

Summary of tornado events. Two deadly EF3 tornadoes occurred on Sunday, 22 January 2017, in southern Georgia (GA) (Fig. 1). The first, a nocturnal tornado, hit the small town of Adel, GA. The tornado was on the ground from 0329 to 0358 local time (LT), and it traveled 25 mi at a speed of approximately 60 mph. A tornado warning was issued at 0310 LT, providing an official lead time of 19 min. The Adel tornado killed 11 people, including 7 people in a manufactured-home park. Approximately 12 h after the Adel tornado, a second EF3 tornado hit the city of Albany, GA, which is approximately 60 mi northwest of Adel. The tornado was on the ground from 1515 to 1627 LT, and it traveled 70 mi at a speed of approximately 60 mph. A tornado warning was issued for Albany at 1515 LT, providing zero official lead time; however, multiple other tornado warnings were issued for the counties immediately upstream within the 30 min prior. The Albany tornado killed 5 people, including 4 people in a manufactured-home park. Neither of the manufactured-home parks where the fatalities occurred had storm shelters.

The threats were well forecast in the days and hours leading up to when the tornadoes occurred. The National Weather Service (NWS) Storm Prediction Center (SPC) began highlighting the threat of severe weather in their convective outlooks three days in advance,

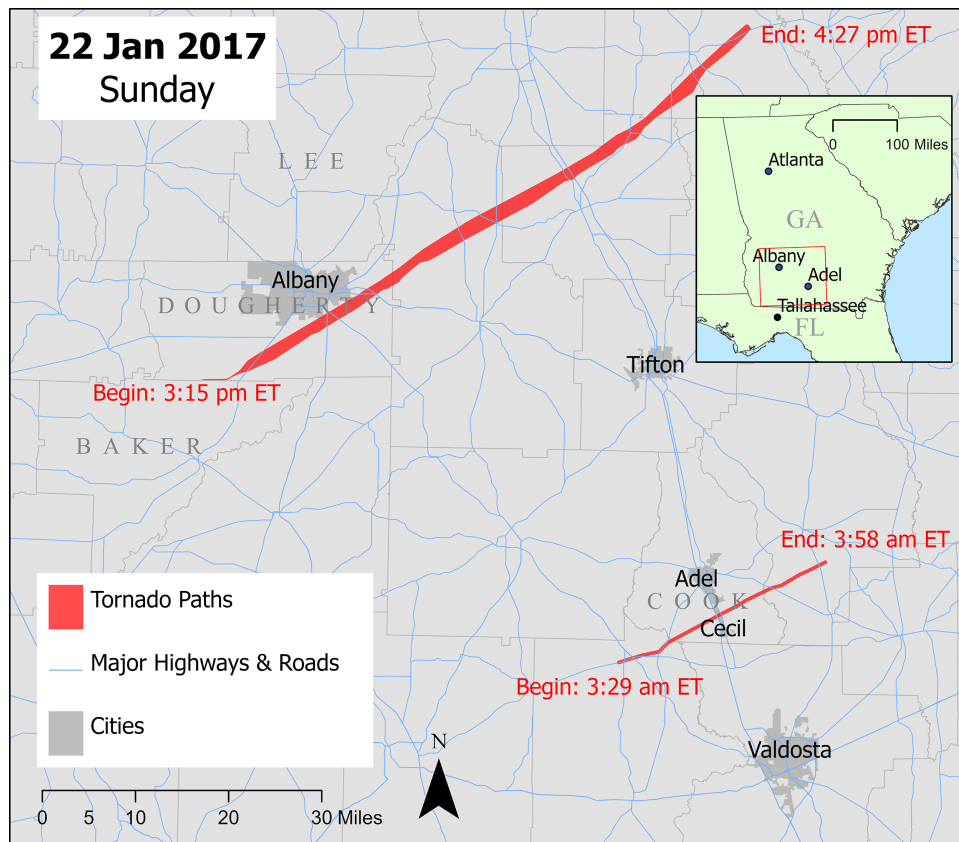


Fig. 1. Paths and times of day for the two EF3 tornadoes that occurred on 22 Jan 2017, with the local cities and counties that are discussed in the manuscript shown for context. The Albany tornado path is plotted as a polygon based on detailed data from the NWS Damage Assessment Toolkit (NWS 2021). No such detailed path polygon is available for the Adel tornado, so it is drawn to represent the approximated path width of 700 yards as reported in the official NWS SPC database (SPC 2021). County names are denoted using small caps text case.

and they progressively elevated the categorical risk levels, culminating in a moderate risk during the Day 1 period when the Adel tornado occurred and in a high risk during the Day 1 period when the Albany tornado occurred.¹ Moreover, SPC issued a particularly dangerous situation tornado watch, specifying the threat of long-track, significant tornadoes for the afternoon tornado threat, including for Albany.

Multiple rounds of storms occurred on 22 January, including other severe- and tornado-warned storms for both Adel and Albany. Indeed, the NWS Weather Forecast Office in Tallahassee issued over 25 tornado warnings for southern Georgia on 22 January. Additional details about the Adel and Albany tornadoes are available from the National Weather Service (NWS 2017).

As noted above, this research was funded by the VORTEX-SE program, which aims to reduce harm from tornadoes in the southeastern United States through physical and social science research. The Adel and Albany tornadoes were cool-season tornadoes in the Southeast, one of which was nocturnal, that directly affected both manufactured and site-built home residents, resulting in a number of fatalities. We chose to study these two tornadoes due to these intersecting geographical, meteorological, and societal factors.

¹ Although the Adel and Albany tornadoes occurred on the same calendar day, SPC outlooks are valid for a 24-h period from 1200 to 1200 UTC, which is from 0700 to 0700 local time (LT) in Georgia in January. Accordingly, the Day 1 outlook for the Adel tornado ended at 0700 LT 22 January and therefore is different from the Day 1 outlook for the Albany tornado, which began at 0700 LT 22 January.

Interview data collection and analysis. Two of the study authors (Demuth and Lazrus), who are trained field researchers with experience conducting interviews following

disasters, deployed to Georgia to jointly conduct in-person interviews with the survivors of the Adel and Albany tornadoes. We waited until 3 weeks after the tornadoes to deploy to the field out of respect for the people and communities affected, in order to allow them time to manage immediate response and recovery efforts. Due to length constraints, we summarize key aspects of our methods below. More in-depth guidance is widely available about how to conduct this type of research and about associated issues of ethics and mental health (e.g., Bertrand 2005; Phillips 2014; Merriam and Tisdell 2016; Natural Hazards Center 2022).

Our intention was to understand the risk assessment and response processes and the vulnerability of people who were at the highest risk of being directly affected by the tornado and thus for whom sheltering was especially relevant. We therefore employed a purposive sampling strategy with a focus on the areas where the tornado damage and fatalities occurred. The two manufactured home parks in Adel and Albany had the majority of the fatalities, and thus they were our starting point for interviews. We fanned out from there to site-built homes in adjacent neighborhoods.

We knocked on residents' doors, introduced ourselves and the purpose of our visit, and invited them to talk with us about their tornado experience, explaining that doing so was completely voluntary and that they would be anonymous. Our invitation included screening questions so that we only spoke with adults who were 18 years or older and, in light of our research questions, with people who were in the area when the tornadoes occurred. All participants provided oral informed consent to be interviewed. All but two people agreed to be audio recorded, and thus we relied on handwritten notes for those interviews. We conducted 19 semistructured interviews. Three interviews were with husband-and-wife couples, and one interview was with two men who are neighbors, yielding a total of 23 participants. Interviews with more than one person are reported together but with the two interviewees separately identified. Of the 23 total participants, 10 were residents of site-built homes and 13 were residents of manufactured homes, 9 were in Adel and 14 were in Albany, and 10 were women and 13 were men. Six people declined to be interviewed; although not everyone gave a reason for declining, two people conveyed the emotional toll the tornadoes had taken on them.

During the interviews, we asked about what information people received about the tornado threat as it evolved from the time when they first learned about the threat to when the storm hit, what they thought about the information in general and as it pertained specifically to them, and if any information was especially helpful or confusing. We also asked what they did in response to the information and, when discussing when the tornado hit, what prompted them to shelter if they did or why they did not shelter. Throughout, we asked what, if anything, made these aspects easier or harder for them. We also asked about interviewees' past tornado experiences, if any. At the end of the interview, we provided each person with a handout we developed that included a brief summary of our study, our contact information, and the contact information for local resources (i.e., local Red Cross, emergency management, a tornado survivor support group) if they needed assistance. The interviews lasted an average of 22 min but ranged in length from 8 to 42 min.

The recorded interviews were professionally transcribed, and the data were analyzed using NVivo qualitative software. To analyze our data, we drew on literature pertaining to behavioral responses to risk [e.g., Griffin et al.'s (1999) Risk Information Seeking and Processing model, Lindell and Perry's (2012) Protective Action Decision Model], risk perception, and social vulnerability. Risk perception can be thought of as judgments people make about events, situations, or activities that could lead to negative consequences; people make such judgments by collecting and interpreting signals about uncertain impacts (Slovic et al. 2004; Renn 2008; Wachinger et al. 2013). We consider vulnerability as the condition that arises from multiple intersecting systemic and situational factors that leads to some people

being more susceptible to harm than others (Turner et al. 2003; Adger 2006; Lazrus et al. 2012; Vickery 2018; Lazrus et al. 2020).

Based on this literature, we developed a coding scheme and qualitatively coded all interviews for mentions of (i) tornado threat information, including forecast information, recommended preparedness and protective actions, environmental cues, social cues, and message perceptions and interpretations; (ii) risk perception, including perceived likelihood of the tornado, perceived effects from it, and negative affective feelings; (iii) responses, including preparatory actions, protective responses, and information seeking or sharing; (iv) vulnerability, including contributing factors, alleviating factors, and adaptive capacities; (v) past tornado experience; and (vi) emergent factors, such as the translational speed of the storm.

Coding for these concepts was driven by our aforementioned guiding research questions to examine how people got information, assessed their risk, and responded dynamically to the evolving tornado and how vulnerability interacted in these processes. Rather than solely interpreting each of these codes on their own, however, we were interested in inductively identifying the key latent themes that cut across these concepts, “reflecting a *pattern* of shared meaning” (Braun et al. 2019, p. 3, emphasis in original). Per Braun et al., themes “unite data that might otherwise appear disparate, [...] (often) explain large portions of a dataset; [...] captur[e] implicit ideas “beneath the surface” of the data, but can also capture more explicit and concrete meaning; and they are built from smaller meaning units (codes).” Thus, themes are the analytic output, representing an outcome of coding. We identified and refined the resultant key themes, reported in the results, reflexively and recursively through comparison of and discussion about the interview data excerpts presented below and the themes they reflect. Additional details about such coding and analysis methods can be found in Merriam and Tisdell (2016) and Braun et al. (2019).

Results

Two principal findings emerged from our analysis. The first finding is that everyone interviewed—with a sole exception—was an active manager of their risk, meaning they actively attended to, evaluated, and responded to the tornado risk as it evolved in space and time. All of these behaviors challenge the ideas of a threat-disbelieving, threat-ignoring, nonpreparing and thus complacent public. Juxtaposed with this finding, however, is the second finding that many people felt limited or lack of efficacy to respond due to static and situational factors that resulted in there being no safe place for them to seek protection from the threat.

We present these findings and components of them in two ways: 1) with quotes from the interview data to demonstrate different themes, which we parse for exposition purposes and 2) with complementary, short narratives from two interviews to illustrate the complexity and interconnectedness of the themes. Furthermore, the findings emerged across both the Adel and Albany interviews, and thus we include data from both locations in reporting of the results and specifically reference one or the other tornado event only when necessary. To protect the anonymity of the interviewees, we use pseudonyms and reference the interview number. We also denote whether the interviewee resides in a manufactured home (MH) or site-built home (SBH).

People are active risk managers. The interviewees discussed multiple ways of being aware of and informed about the tornado threat, ranging from the days to minutes leading up to when the tornado hit. They described ways they ensured they had access to forecast and warning information, attended to it when received, and actively sought and interpreted it.

For example, Rachel and Jack (Adel, MH, interview 17) described primarily using their cell phones with multiple weather apps for information. Rachel showed screen shots of

a radar reflectivity image from her Weather Channel app that she captured on Saturday, the afternoon before the nocturnal Adel tornado. She also explained ways that she seeks forecast and warning information and that she purposely sets the app options to push information to her phone.

Rachel: This was some screen shots [of radar image] I took on Saturday of the weather from the Weather Channel. This was on Saturday at 2:30 PM. I mean, we knew some rough stuff was coming in. [...]

Interviewer: So do you guys primarily get your information from that Weather Channel app?

Jack: Yes.

Interviewer: Or do you also watch local news?

Rachel: We don't have a TV. We don't watch TV. [On our phones] we have the actual Weather Channel [app], and I also have Channel 10 News [app], the local news around here.

Interviewer: Do you look at both of those when there's something unusual in the weather?

Rachel: I just look at it sometimes anyway. And, if anything comes up, the Weather Channel notifies us. I have my alerts turned on.

Another person, Jessica (Adel, MH, interview 11), similarly described that her husband has the “WeatherBug app on his phone, and it sends alerts to him to let him know” and that they were awakened by the app “weather alarm.” Many other interviewees in both MH and SBH mentioned getting weather alerts on their cell phones, including from local television station apps. Moreover, some discussed watching local broadcast meteorologist on television and on Facebook Live. Devon (Albany, MH, interview 3) described getting information in all of these ways. He further indicated that the fact that the forecast and warning information was coming from all of these channels was a cue to him about the seriousness of the threat.

Interviewer: You said you were watching the television. What were they saying?

Devon: That there was going to be a severe storm, possible tornado. And there was also live coverage on Facebook too. I got the phone out and it let me know that a storm was coming, so I was pretty aware.

Interviewer: Who was posting that on Facebook? Was it the local station?

Devon: Local WALB. On TV and on Facebook [...] live streaming.

Interviewer: Interesting. And you said you got an alert on your phone?

Devon: Uh-huh. WALB.

Interviewer: Did you sign up for that or did you just get it?

Devon: I signed up for it in the app store. [...] As much as there was on Internet and the broadcast and live streaming on Facebook, I knew it was probably pretty bad. [...] They don't usually do that.

Two men, Miles and Ben (Albany, SBH, interview 19), who are neighbors who live on the same street, described getting forecast information via weather apps on their iPhones about the tornado threat the day before and morning of the Albany tornado. Both described, with different examples, how the forecast information influenced them to intentionally decide *not* to go somewhere and instead stay in a place they thought would be safer. Ben explained that he was with his wife in Atlanta, which is about a 3-h drive north of Albany and that, “normally we’ll come back on a Sunday to [Albany], but when we heard about the predictions regarding

the severe weather, we decided not to.” He elaborated by saying that it was the information about “how severe the weather was going to be” that made them stay and that “it was my better half who decided” that they were “not going to go on the road.” Based on Ben’s story, Miles then shared that “I didn’t go to church that Sunday” because of the tornado threat. When relaying these stories, both men expressed their appreciation for the accuracy of the forecasts and warnings from meteorologists, sentiments that Ben synthesized by saying, “my hat’s off to the [National] Weather Service.”

As the above quotes already reveal, people engaged in a range of behavioral responses that illustrate they attended to and gave credence to the threat. People also discussed taking action in the best ways that they could, given the circumstances. These responses included multiple types of actions, such as getting out of bed, getting dressed or putting shoes on, turning to their local television meteorologist to get additional information, and looking outside to directly assess the weather. Such behaviors are antecedent to taking protective action and therefore constitute valid ways that people assess the tornado risk to themselves.

People described multiple factors that spurred these behaviors, namely, forecast information, different environmental cues, social cues from others, and negative affective feelings. In most cases, people mentioned more than one of these factors, suggesting that the compilation—and even co-occurrence—of them is important for shaping how they assess and respond to the rapid-onset, spatially localized risk that tornadoes pose.

Alex (Adel, SBH, interview 18) exemplified many of these factors and response actions. In particular, he described a “bad feeling,” feeling “weird,” and that he could “sense” something different from usual, which motivated him to take the tornado threat seriously and respond in multiple ways.

Alex: At right around 3 o’clock [a.m.], maybe a little after that, I got the alert on my phone that a tornado warning had been issued for my area. [...] That night I just kind of went, okay, I probably need to make sure I’ve got some shoes on because something is up. So something got me out of bed. I came in here, sat down, turned on my television. I still had power at the time, and was watching WALB out of Albany. [...]

Interviewer: You said that something got you out of bed. Do you have a sense of what that something was? How would you describe it?

Alex: [...] There was some sort of bad feeling, I got kind of a shiver, you know? And that’s not me, that doesn’t happen to me. [...] Nothing really stuck out that it was going to be any worse than anything else. But my phone went off, and I’m lucky I heard because God knows I’m going deaf. And I just woke up and I looked at it, and I started to go back to bed and then I said, “No, no, no, no, I need to get up, there’s something else going on,” and I just kind of felt—weird. I could sense it, and that’s the only way I know how to explain it. [...] So I was watching ALB and was listening to them talk about “it looks like there’s a tornado in the Cecil area,” which of course is right down the road, and I thought, “wow, that’s really close!” And then all of a sudden [snaps fingers] my power went off. And then I sat here for a couple of minutes completely in the dark, and I thought, “okay, so maybe I should go get in the middle of the house.” I was thinking about that when all of a sudden the house felt weird [...] And it sounded almost like rain on a tin roof on all sides of my house all of a sudden.

Billy (Adel, MH, interview 13) is another example of taking multiple behavioral responses and of visual, tactile, and auditory environmental cues—some of which he indicated were unusual—all signaling the threat to him. Further, as Billy shared, he had only seconds to ascertain what was happening and realize a tornado was approaching his home, and he responded by praying. This type of response is sometimes characterized as fatalism (Sims and Baumann 1972; Senkbeil et al. 2012; Walters et al. 2020). Yet, with the deeper, contextual

understanding from the interview, we see this as a form of taking the threat seriously and exercising agency by drawing on one's religious beliefs in a situation in which there is extremely limited time for additional protective actions.

Billy: I woke up about 3 o'clock in the morning. It was thundering and lightning and raining, okay, and that woke me up. So I jumped up and put on a pair of britches, I didn't have no shirt on. I run right out of that room right there, the door was wide open, and it was raining. That was also when it stopped, and then right after it stopped, probably maybe a second after, here come a hail storm, just like that, and it was over. Then it got calm and it started getting kind of warm and musky like, and I said, "Well, I hear a train coming," and I said, "God," I got down on my knees and I said, "Lord, I tell you what, you know how long my wife's been dead," and I said, "if you want to take me to be with her today, tonight," I said, "I'm willing to go. But if you don't, please," I asked him "just please take care of me and my little dog." So I knew that thing would come right over my trailer here, then I started hearing trees snapping and all that. It probably did not even last 15, 20 seconds and then it was over with.

Interviewer: You said you woke up around 3 a.m. Was it the rain that woke you up or something else?

Billy: Yeah, the lightning and thunder woke me up. I knew it wasn't normal, and I've never seen the lightning and thundering that fast and that hard.

Whereas the environmental cues during the nocturnal Adel tornado signaled the tornado threat for Alex and Billy (and others, discussed below), a few people in Albany shared that the sun was shining when the tornado hit. For instance, James (Albany, MH, interview 5) said, "The funny thing about it, it rained and then it cleared up. The sunshine was beautiful. And when the tornado hit here, the sun was shining." His wife, Sally, followed up by saying that someone else who was in the Albany tornado told her, "they looked at one part of the sky and it was real bright and sunny, and they looked at the other part and it was real dark." Although the sun shining may have been a confusing cue, the quotes nevertheless reveal that people noticed changes, even oddities, in their environment. Paying close attention in these ways and trying to make sense of the risk are additional indicators that people were not complacently ignoring the threat.

In Albany, some interviewees mentioned attending to social cues and how the cues influenced their protective responses. For instance, Devon (Albany, MH, interview 3), who was quoted above as discussing multiple information sources, explained that his neighbor across the street urged them to leave, which she herself was hurrying to do. Devon did end up leaving (with his mom, not discussed here) to seek safer refuge at his grandmother's brick home, which he later described as "project housing."

Devon: I was in the house. We were actually watching the news about the tornado coming. We've been here like 19 years, and every storm we stay in the house. But the people across the street were like, "You all better leave. You all better leave, tornado coming." So I went to my grandma's house, in a brick house. And, like an hour later when I made it to my grandma's house, I was hearing on the news how a tornado was actually coming this way. [...]

Interviewer: How did [the neighbors] let you know? Did they come knock on the door? Did they call you?

Devon: I went to the door. A lady, she was walking—well, she was really running—and she put her stuff in the car and at the same time, "y'all better leave," all at the same time she was running to the car.

Similarly, Veronica (Albany, SBH, interview 8) shared that her sister-in-law, who lives in the county southwest of where Albany is and who knows that Veronica does not attend to

news much, alerted her about the storms that were coming her way. That information coupled with the auditory cues of the tornado spurred her and her family to shelter in the hallway.

Veronica: I have family that lives in Baker County, and they kept me informed of when it came through there, “it’s coming your way,” and then eventually it got here. And my granddaughter and my great grandkids are here with me, and we heard it. Everything got really quiet for a minute and then this roaring sound came around. I wouldn’t say it was a train-like sound. It was more like—let’s see, how do I want to explain it? I do not know. I just cannot explain it. It’s just like you hear cars gearing up to race on the track. Those sort of sounds. [...] But anyway when it started coming in, we closed the hallways off [...] and we huddled in the hallway back there. [...]

Interviewer: I wanted to go back to what you were initially saying about the family members who live in Baker County. They told you first about the tornado coming?

Veronica: Oh yeah. My sister-in-law called me and she said, “It’s headed your way, it’s headed our way.” [...] Because she knows that I do not listen to the news that much.

The data above illustrate the multitude of ways that the survivors from these tornadoes obtained, attended to, and gave credence to the forecast and warning information they received along with the ways that the information, coupled with other cues, prompted them to assess their risk and respond. Some interviewees, when sharing their experiences, made reference to the uncertainty associated with tornado forecasts and their consideration of it when evaluating and responding to the risk. Yet, the uncertainty did not translate to them ignoring the threat or render them unwilling to respond, as the interview with John (Adel, SBH, interview 16) indicated. He discussed knowing about the threat of tornadoes but referred to the uncertainty by explaining, “You know, when they say that there’s a storm evident, it’s not that it’s chiseled in stone.” He elaborated that his wife received the warning on her phone, woke up him, and then “she started trying to call my daughter” who lived next door with her husband and 3-year-old twin girls. He indicated that his wife “hated to call them because she didn’t know” if it was necessary or not, yet she did anyway. She had to call repeatedly to wake them and “finally, on the third try, got them.” Then, he and his wife took shelter in the shower. He described the sound of the tornado as it approached by saying, “it sounded just like a train. Everybody talks about a train, and I heard a train coming but Johnny Cash wasn’t playing.” His home was not directly hit, but his daughter’s was. Fortunately, because his wife had woken her, her family “got in the old part of the house [that was] built before the Civil War,” and the girls “put beanbag chairs over the top of them.” The daughter and her family all were fine because that part of the house was not damaged; the bedrooms they had been sleeping in moments earlier were damaged, however.

The interview quotes and excerpts presented above, although rich, are brief illustrations of different components of the many ways that people actively managed their risk from the Adel and Albany tornadoes. In Fig. 2, we present a longer narrative from Ken (Adel, SBH, interview 14) that conveys more fully and with added texture how he used different pieces of weather information and environmental cues to assess his risk and make protective decisions, how these components are interconnected, and how he engaged in these processes repeatedly from multiple days to seconds leading up to when the nocturnal Adel tornado hit. Ken does not have an in-ground or reinforced storm shelter, and he did not leave his home to drive somewhere safer. People who lived in the manufactured home park immediately upstream of his home were killed, and people who lived in a newly built brick home immediately downstream of him were seriously injured. Under different circumstances, Ken could have been injured or killed by the tornado. Nevertheless, his story, and the stories of others, reveals that he was anything but complacently ignoring the threat or unwilling to prepare for it.

Ken: It was like five days out, severe thunder storms, everything is perfect for this. And in my mind still I said, "well, we're going to have some rough winds, some straight-line winds, we'll probably have some hail." But the closer we got to that day, like the day before, I started to thinking to myself, "you know what, I never actually researched where I need to be in that house in case something actually happens." So I took a Rangefinder, and I measured the distance to the trees. [...] I did that, and I decided to be right in here because it's just one small window and the laundry room and that's it, and there's two closets in there. So that's where I chose.

[...]

The next morning, inadvertently my phone went off. I didn't mute it that night and it went off at 3 o'clock. [...] But what actually woke me up wasn't [the phone]. It went off during the time that I saw just constant lightning, I mean, unbelievable lightning. I'll be 67 this year. I've never seen it like that, ever. And, I just said, "well, I might as well get up", and I got up and put my jump suit on and put my shoes on. [...] And I stood right there.

Interviewer: On the inside?

Ken: No, I stood right here. [Points to cement landing]

Interviewer: Just outside here, okay.

Ken: Right there, watching the lightning and it was just popping everywhere. I mean, it was just boom-boom-boom. I mean, you could see for miles just like daylight, and no pause in there, no pause whatsoever. And then I kept watching [radar on cell phone]. I kept watching that [storm] cell, and in that cell there was a little purple curlicue in there and I said, "That's not good there." I knew what that was.

Interviewer: So this was radar imagery that you were looking at?

Ken: Yeah.

Interviewer: Do you know what app you were using or what you were looking at?

Ken: The Weather Channel. Anyhow, I kept watching the direction, and I knew where it was prior to, and I knew where it was then, and I knew where it was going, which is to the blue bubble, the blue bubble being right there. [Points to his house].

Interviewer: You.

Ken: Yeah. And so I just kept watching it, and it just kept getting closer and closer. [...] And then all of a sudden it just, boom, everything just stopped. You could have heard a pin drop. And the wind started coming out of here, and I knew that was coming off the rotation. And right straight in there I could hear a faint train sound, just like I always hear when it goes through [the nearby town of] Cecil down there. I said, "That sounds just like the train." But it got closer quicker. [...] They said it was moving like 60 miles an hour. So, anyway I turned and ran in there [to where he had previously decided to shelter]. And by the time I got in there, boom, it hit just that quick. I mean it wasn't 10 seconds and it was unbelievable. I mean the sound was just – it was overwhelming. I mean you couldn't hear anything but just that. It sounded like the demons just were coming up out of the ground. It was just that loud, horrifying roar, and the wind coming in between the back door and the door jamb was just a high-pitched squealing sound. And my ears was popping, and the house just started shaking like that. I said, "Well, I may not be in the right place," and I kind of questioned it. 15 seconds, it was gone.

Fig. 2. Narrative from Ken (Adel, SBH, interview 14) that illustrates the multitude of complex, interwoven ways that he actively managed his risk from the Adel tornado.

FRANK AS THE EXCEPTION. Frank (Albany, SBH, interview 9) is the sole person we interviewed who differed from the others interviewed, all of whom actively managed their risk in multiple ways. Frank explained that he received the tornado warning on his cell phone but that he has gotten “a lot of tornado warnings, and [the tornadoes] have always gone around us” and thus “I just didn’t think it would happen to me.” His wife also got the warning and told him to “get in the hallway” with her, but he declined. He described that “about that time, whoosh, the freight train came over and the air pressure changed, and that’s when I said ‘oh-oh, I have screwed up.’” He said his “ears started popping” and it “almost felt like it lifted me out of my recliner.” The tornado killed his next door neighbor. Upon reflection, Frank acknowledged that “we had sufficient warning” and that “it should have worked,” but “I just didn’t listen.” He credited his wife in contrast, saying, “She uses her brain. She listened.” He then described that, next time, he would take shelter in the half bath in his home that is “very sturdy” with “no windows.” Frank closed by summarizing that his experience with the Albany tornado was “very profound” and saying “I’m going to listen next time.”

Frank’s story illustrates that, even if one exhibits attitudes in a given situation that are associated with complacency, such as disbelieving a threat and not taking protective action, such attitudes are not static. Rather, they are fluid and can evolve based on context and experiences. Furthermore, Frank was not disbelieving about the tornado threat itself, but

rather he did not believe that the tornado would hit *him*. This is an example of optimism bias, which is when people think they are less likely than others to be negatively affected or harmed by an event (Weinstein 1989). Differentiating complacency from other cognitive mechanisms, like optimism bias, is important for understanding why people behave as they do.

“No safe place”: Limited and lack of efficacy to respond. As the results in the previous section reveal, the people represented in this study actively managed their risk from the Adel and Albany tornadoes in many ways. They did not ignore nor dismiss the tornado threats. On the contrary, they engaged in preparedness and protective responses in ways that they could given their circumstances—that is, given the interconnected factors of the time of day, how much lead time they had to respond, and what options they had for seeking safety. But, many of the interviewees revealed that their choices for safe refuge were limited. This critical limitation emerged both directly, by interviewees stating that there are no safe places, and indirectly, by them being unable to think of safer places they could go to in the future. These comments reflect a limited and lack of self-efficacy, which is one’s belief that they can do what is needed to produce an outcome (Bandura 1977), and of response efficacy, which is one’s belief that the recommended actions will reduce harm (Rogers 1983). Both concepts have been applied in the risk context to measure perceptions about performing recommended protective response (e.g., Rogers 1983; Witte and Allen 2000).

For example, when thinking about where they could go in the future if they had had more time to respond, Rachel and Jack (Adel, MH, interview 17) initially indicated they might go “up town somewhere.” However, later in the conversation, Rachel expressed that “there’s nowhere safe” and that it would not have mattered because the tornado “took out big homes and all.” She then reiterated that “There’s nowhere to really go. We would have went to the same spot,” which for them was to the center of their manufactured home. She went on to say that “next time, I’m just going to crawl underneath the bed and hope for the best.”

Also in the Adel MH park, Kimberly (interview 12) shared that, in the future, her husband “would take me to the ditch over there and put us down.” She proceeded to say that they would go there “because I don’t know where any shelter is around here.”

Adel SBH resident, Alex (interview 18), explained that his bathroom is his shelter location because it is “surrounded by walls surrounded by walls.” When asked about whether he would always go there or if he would consider going anywhere else, he noted that his landlord who has “got a brick home” said “If this happens again, if we think it’s in this area, come over here to my house.” However, Alex conceded that “that might be a consideration, but even that means I would have to get outside the house,” which he indicated is not ideal.

In Albany, Sally and James (MH, interview 5) reported that the storm arrived about 45 min earlier than they had anticipated. They explained that there is nowhere safe to go. They decided to shelter in the closet, an experience they vividly describe. When asked about other places they might go in the future, Sally mentioned Walmart as a possibility. Although large stores can be constructed to have safe refuge for customers, fatalities due to tornadoes have occurred in them (NIST 2014).

Sally: We sat in the closet. The tornado was mentioned. You know we ought to do something. Because we really have no place to go you know. No place really for us to go, there’s no shelters or anything like that. [...]

James: I said, “Babe, let’s go ahead and get in the closet here.” And we got into that cubbyhole right there. And that’s where we rode it out. [...]

Sally: While it was going on we were right here in that little dinky hallway holding on to each other real tight. He had his arms around me and I had mine around him real tight, and we were praying.

That was all we could do. And everything was just shaking like that and you know, and we could hear the metal just flying, hitting up against the house and everything. And then it stopped briefly and then it started right back up again. We really felt like this place was just going to come apart. [...]

Interviewer: You were talking about nowhere to go for shelter before, so I wanted to follow up on that. Do you think that if you had known earlier that the tornado was coming right here that you might have been able to leave the house or would you have stayed here?

James: Oh yeah, we would have left.

Interviewer: Where do you think you would have gone?

James: Wherever there was a shelter. There ain't no shelter around here.

Sally: The only thing that I can possibly think of that might withstand something like that would be Walmart and it's a good little ways from here. [...] It's the only place that I can think of. [...] I still feel that shaking. Just like the place was jumping up and down like we were in a bowl of Jell-o or something.

Sally's powerful retelling of her and James riding out the tornado in their hallway closet points to the trauma of her tornado experience. Indeed, Sally expressed that she wants to "get out of here so bad. I still have a phobia. I don't know when I'm going to be past this." Such emotional effects were mentioned by multiple people. For instance, Scott (Albany, MH, interview 2) shared that, "when the wind gets high, it kind of scares me now." From Adel, Ken (SBH, interview 14; see Fig. 2) divulged, "I still cloud up a little bit when I think about it." And, Jessica (Adel, MH, interview 11), shared that her 5-year-old daughter "was terrified" and "didn't want to go outside" immediately after the tornado. Jessica elaborated that, since then whenever the weather is bad, her daughter asks if they can go to her sister-in-law's brick home due to her fear. These quotes illustrate the profound emotional tornado experiences that people can have (Demuth 2018). Minimizing their behavior by inaccurately characterizing them as complacent minimizes these emotional effects as well.

In Fig. 3, we present a longer narrative from Donna (Albany, MH, interview 4), who strikingly articulates details of her experience and, in doing so, illustrates some of the factors that contribute to making her vulnerable as well as her adaptive capacities. She shares how multiple pieces of information shaped her decision to leave her manufactured home to go somewhere safer, but she describes in particular detail the declarative and pointed language used by the local television meteorologist, which spurred her to leave. She further explains her consequent uncertainty about where she and her family could go to be safer than in her manufactured home and the steps she took leading up to the ultimate decision to go to her friend's home in a different county. Donna is the neighbor who encouraged Devon and his mom to go to his grandmother's home, as described above. That Donna left to find somewhere safer and that she urged others to follow suit reflects a sense of self- and response efficacy that something can be done to enhance safety, but it is a matter of determining where and when to go. Indeed, reflecting on her experience, Donna expressed that she was unsure where else she might go if her friend had not been home, which suggests efficacy limitations. Her story is rounded out by her expression of her experiences with the emotional toll of having to always run someplace else, just to be safe.

Summary, discussion, and implications

We conducted in-person interviews to explore how people got information, assessed their risk, and responded to two deadly EF3 tornadoes that hit the southern Georgia towns of Adel and Albany on 22 January 2017, and how factors that contributed to people's vulnerability were relevant in these processes. We conducted our analyses with an eye toward exploring

Donna: Well we knew it was going to be bad because all night we was jumping in and out of the closet. The phones kept going off. Tornado, tornado in your area. But that Sunday morning my sister left about 10, said "I'm getting ready to go, girl."

Interviewer: She was leaving because of the tornado?

Donna: Right, she left about 10 o'clock that morning. I said, "Well I'm going to ride it out." That's what I kept saying in my mind [...] Started cooking Sunday dinner. I tell you, about 1:34, something says, "Watch the news. Watch the weather." And I begin to just sit down and just watch the weather. And it was at 1:34. I'll never forget the time. I was watching the weather. [TV meteorologist] had this pattern about where the storm was going to hit, and I saw I'm in that number. I said, "Uh-oh Lord." [TV meteorologist] began to read out, and when get got to us he said, "Albany, Georgia, mobile homes, trailer park – he even said trailer park – mobile homes, trailer parks, get to your safe zone in one hour." He didn't say "might hit", he said, "it will hit." And I told my husband, I said, "baby, it's time to go." I went and turned off the oven, turned off the stove. I said it was time to go. [...] I said, "Lord, where are we going to go?" I tried to call my sister because she goes to the Kingdom Hall.

Interviewer: Where is that?

[...] Donna: It's where they go. The Jehovah's Witnesses go there. So I tried to call her. I couldn't get her. No service. So I said, "Lord". So I said, "Call your friend Angela. She's in Lee County." I called Angela, I said, "Girl, we got no place to go, can we come out there?" She said, "Yes, come on."

[...]

Interviewer: So your friend Angela who is in Lee County, what kind of place does she live in?

Donna: She lives in a brick home.

[...]

Interviewer: You said you were cooking your Sunday dinner, but you said something told you to watch the news. What was it? Can you explain that?

Donna: It did. It's the spirit. It had to be the Lord, you know what I'm talking about? [...] The spirit is so nice, you know what I'm talking about? But I heard a voice in my mind say, "You had better watch the news." So it had to be God.

[...]

Interviewer: Is that the news channel you always watch or did you just look for anybody who was on?

Donna: I always watch WALB because that's their local channel, and they are good. Yolanda Amadeo and the other guy. I can't remember his name. I can tell you what he said because he was the one on. He said, "I don't like to say this, but these things are spinning everywhere and they are so small. Once you see this kind of weather here, watch out, because they'll come quick and they'll hit, they'll hit." When he said that I said, "Oh my god." So he said because he did call the name of them, but they are spinning everywhere and he said "I don't like this." When he said, "I don't like this kind of weather here because it's unpredictable, I just don't know, y'all keep watching because these things are coming up, and when they come, they come quick and they come one after another. One after another." And that's what happened.

Interviewer: So if your friend Angela hadn't been home, where else would you have gone?

Donna: Sweetheart, I don't even know. I have no idea because I really didn't think of nobody else at the time. [...] I tell my husband we might have to move out of here because it's devastating. I'd rather be in a brick home than every time I turn around I've got to try to run. That's not a good feeling. It's very—it's depressing.

Fig. 3. Narrative from Donna (Albany, MH, interview 4) that illustrates the multiple pieces of information that she attended to and her decision to leave to go someplace safer in order to manage her risk from the Albany tornado.

whether the interviewees exhibited indications of complacency, defined by Wang and Kapucu (2007) as believing a threat would not happen and therefore ignoring and being unwilling to prepare for it.

Contrary to these elements of a threat-disbelieving, threat-ignoring, nonpreparing and thus complacent public, we instead found that people actively managed their risk from the tornadoes in multiple ways at multiple times.

To prepare for tornado threats in general, some people described that they had installed one or more weather apps on their smartphones and set up push notifications in order to be sure they would receive weather alerts. Specifically for the 22 January tornado threats that are the focus of the analysis presented here, people shared the multiple ways that they got information, evaluated their risks, and responded in the days leading up to the events. They followed weather forecasts, determined which room in their own home was safest to shelter in, and made decisions not to travel in order to stay in a safer location. The day of the tornadoes, the interviewees continued following weather forecast and

warnings information from multiple sources and channels—including phone apps, television, Facebook Live, and family members. One person described watching the radar on his phone as the storm approached. People also attended to what others were doing and to an array of atmospheric environmental cues, such as the humidity, lightning, and sounds of the wind and rain. They assessed the risks they faced through the information they received as well as the affective ways they felt. They engaged in an array of actions, small and large. They got out of bed in the middle of the night, put on shoes, sought information, and paused cooking dinner. Many took protective action in the best ways that they knew, including by sheltering in the best refuge area in their home and, for some who lived in manufactured homes, by leaving to seek shelter in a safer place. Indeed, the suite of preparatory and response actions that people engaged in reveals that people demonstrate capacity in the ways that they can despite their vulnerability. Simply put, regardless of the specifics, all but one interviewee gave credence to the threat and did something; they were not complacent.

Only one interviewee exhibited indicators associated with complacency by not believing the tornado would hit him and thus doing nothing. Yet, he was reflective, even self-recriminating, and said he would heed the warning next time. This illustrates how complacency, if it is embodied in ways by some people, is dynamic and shaped by experience and the context of the threat and situation.

Even though nearly all people actively managed their risk, however, we also found from multiple interviewees a limited and lack of efficacy about sheltering. Many people explicitly indicated that they do not have a safe place to shelter, do not know where is safe to go, or do not believe that there are places where they can be safe during strong tornadoes. These barriers to sheltering are exacerbated in certain situations, such as that presented by the Adel tornado which was a nocturnal, fast-moving tornado.

This finding that people do not have a safe place is not new. Not having access to safe shelter locations has been noted in the NOAA Service Assessments conducted after the 2008 Super Tuesday tornado outbreak (NOAA 2009) and the historic tornadoes of April 2011 (NOAA 2011), and in research with the public conducted by, for instance, Comstock and Mallonee (2005), Schmidlin et al. (2009), Chaney et al. (2013), Ash (2016), Liu et al. (2019), and Ash et al. (2020). Furthermore, Strader et al. (2019) conducted an analysis of the distance from every mobile and manufactured home in Alabama to the closest community designated storm shelter; they found that it takes mobile and manufactured home residents 5 to 10 min longer than permanent home residents to reach such shelters.

Decades of risk analysis and communication research have shown that self- and response efficacy—one's beliefs that they can perform a recommended response and that it will work to reduce harm, respectively—are essential for helping people manage the risks they face. Simply telling people that they are at risk if they do not have concrete, feasible options for reducing their chance of harm does not work. In other words, there must be viable response options for *all* people to protect themselves from tornadoes.

Our set of findings complicate beliefs held by many in the weather community about people's seeming inaction in the face of tornado threats and the corollary characterizations of them as being complacent. Implicit in these discussions is that people did not comply by taking protective action how, when, and where they were "supposed" to—that is, in the preferred ways or the ideal ways recommended. Yet, our study finds that, for many, the recommended actions during a tornado threat are hypothetical rather than achievable. People not doing what meteorologists think they should do does not mean people are complacent. Indeed, there are a number of flaws with such reasoning. First, it fails to recognize that there are a range of cognitive, perceptual, emotional, coping, and other protective behaviors that

people engage in that in fact constitute *responding*. Second, it does not account for the very real, multiple barriers that people encounter when trying to respond and protect themselves, thereby minimizing their vulnerability.

Third, and arguably most importantly, framing the problem as noncompliance and complacency places the blame on people, e.g., their knowledge, interpretations, and responses. The corollary is that the weather community focuses on solving the “problems” of people by educating them (Blanchard-Boehm and Cook 2004; Donner et al. 2012; Walters et al. 2020) or by using extreme or fear-inducing language in attempt to garner attention (Perreault et al. 2014; Ripberger et al. 2015; Casteel 2016). Although these efforts may address some problems, they fail to address significant systemic and long-term problems that contribute to considerable societal impacts from tornadoes.

If instead we recognize and credit the myriad ways that people try to manage their risks from tornadoes and we identify the barriers they encounter when trying to protect themselves, this shifts the problem frame to the forecast and warning and emergency response systems. This, in turn, shifts—and broadens—out view of the solution space.

We therefore offer a few concrete recommendations. First, there is a need for additional disciplinary and interdisciplinary research in order to answer such questions as (i) what are the safest sheltering options under a variety of circumstances, with different amounts of lead time (e.g., from a couple of minutes to hours), and (ii) how can people more safely shelter-in-place for situations in which that is their best option? Second, there is a need for governments and community organizations to more clearly establish and communicate policies for community safe spaces during tornado threats, including what are the options (e.g., dedicated shelters, churches, schools), where they are, how to access them, and whether and when they are open. Finally, intertwined with the prior recommendations, it is important that trusted sources of tornado forecast and warning information, particularly broadcast meteorologists and NWS forecasters, communicate about both the tornado threat as well as the efficacy—what people can do and where they can go to best protect themselves—as the threat evolves.

In addition to these recommendations, systemic change and innovation are needed pertaining to the provision and maintenance of affordable and safe housing options, especially in tornado-prone regions such as the southeastern United States. Although housing policy is not strictly the purview of meteorologists, sustained engagements with academic, government, and industry partners in fields such as engineering, construction management, urban planning, and public administration could lead to better building, inspection, and maintenance practices and therefore improved housing infrastructure to reduce casualties associated with all wind hazards. It would be much easier for households to respond effectively to tornado forecasts and warnings if people could survive at home and not require, or risk, traveling to other locations.

These are complex problems to solve that necessitate additional research, political will, and community-inspired solutions and that will require long-term commitment and investment from many.

In closing, the in-depth research with members of the public that is presented here was of two tornadoes in southern Georgia that were respectively forecast as moderate and high risks by SPC. Although we cannot say that our findings generalize to other populations or tornado threats, our findings suggest the need for our community to rethink how we judge warning compliance and attribute complacency as an explanation of behavior (or lack thereof). We hope that additional, careful research with the public will be conducted that builds on the work presented here, in order to develop further, valid understanding of how people manage the tornado risks they face.

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