BAMS In Box

The Changing Weather Information Landscape: Observations, Conjectures, and Thoughts about the Future

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ABSTRACT: Numerous changes to information technology and media consumption over the last 2 decades have facilitated a fundamental shift in how people receive information, including weather forecasts. Historically, weather information was generally vetted through experts (often broadcast meteorologists) to members of the public in a relatively top-down system. Now, with the availability of internet websites, phone applications, and social media, people have an increasingly diverse set of sources from which to get weather forecasts. In this piece, we present results from CONUS-wide surveys that show this diversification of weather sources for nonroutine weather events. While older respondents still tend to get weather information from television, younger respondents are increasingly reliant on less traditional sources, including phone notifications, internet websites, social media, and family and friends. This shift to nontraditional sources means that a more diverse set of actors will have the opportunity to provide weather information to users, which could impact the quality, reliability, and accessibility of the weather information in the future.

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1. Introduction

Weather influences our daily lives. From minor choices (like deciding to wear a coat) to more significant choices (like cancelling sporting events and concerts), almost everyone relies on some type of weather information to make decisions. This reliance, coupled with changes in information technology and media, have created an increasingly diverse landscape of weather information sources that cater to the varied needs and preferences of individuals. Understanding this landscape is a crucial first step toward understanding the decisions people make when dangerous weather occurs.

Given its importance, the weather information landscape has been a key focus in past research. For example, a 2006 national survey (Lazo et al. 2009) found that local television (33.7 mean times per month) was the primary weather forecast source for U.S. adults, followed by cable TV (18.9), broadcast radio (18.5), non-NWS websites (12.7), newspapers (10.4), NWS web pages (8.3), family/friends (8.1), and weather radio (2.1). Cell phones (1.6) and telephone information (1.2) ranked last, with only 10% using cell phones for weather information.

The landscape evolved significantly over the next decade. For instance, a 2016 survey (Mason et al. 2018) found that television (74.7%) remained the primary source for tornado warnings during the day, but cell phone alerts (66.0%) were close behind. At night, cell phone alerts (61.9%) surpassed television (58.1%). Other studies (Yoder-Bontrager et al. 2017; Miran et al. 2018; Phan et al. 2018; Sherman-Morris et al. 2022) echoed the growing importance of phone notifications.

This trend has continued in recent research. A 2021 survey (Vaughn et al. 2023) found that 74.3% of respondents used a cell phone weather app for routine weather forecasts, while only 6.1% relied on television. For nonroutine weather events, 50.8% relied on cell phone apps after initial alerts, while others turned to internet websites (46.1%), television (22.8%), or social media (18.0%) for more detailed information.

Collectively, these studies underscore the ever-changing nature of the information landscape, influenced by time and the specific hazards in focus. Despite their value, their cross-sectional design limits comparability, making it tough to capture these shifts accurately. Each study employs varying sampling methods, distinct survey questions, and focuses on different hazards, making it difficult to identify consistent trends in the data. We hope to address this difficulty by highlighting recent observations from a longitudinal survey that focuses on the weather information landscape.

Our observations are drawn from the Extreme Weather and Society Survey, a yearly survey of U.S. adults that measures public reception, comprehension, and responses to forecasts and warnings across a variety of hazards. The survey series began in 2017 with a focus on severe weather, so most of our observations come from that domain. We supplement our observations in the severe weather domain with observations from the tropical weather survey (which began in 2020) and the winter weather survey (which began in 2021). These surveys are generally representative of the U.S. population, and the total number of survey responses evaluated in this work is 26 063. The surveys were all fielded online through various survey sampling companies (mainly Qualtrics). These companies use a dynamic

sampling technique with quotas that match the U.S. census. To begin, the company will send invitations to a sample of their panel (who have previously agreed to take surveys) that matches the U.S. census quotas. As surveys are completed, the company will then send more or fewer invitations to certain groups of people based on what quotas still need to be filled. This process results in a survey sample that closely resembles the U.S. population according to the census. For more information about the annual samples and the data collection process, please see the data repository (OU Institute for Public Policy Research and Analysis (IPPRA) 2024). In addition to the observations, we provide some conjectures about the future based on demographic trends. We conclude with some thoughts about the implications of our observations for weather risk communication.

2. Observations

Each wave of the severe weather survey has included the question:

> How much do you, personally, rely on each of the following sources of information about extreme weather?

In response to this question, survey participants are shown eight sources[1] and asked to rate each source on a five-point Likert scale that ranges from "Not much" (1) to "A great deal" (5). Figure 1 plots the mean score on this scale for each source over time, revealing two noteworthy trends. When the survey began in 2017, television was the most relied-upon source, scoring an average of 3.8 out of 5. This level of reliance remained relatively stable into 2018. Since then, reliance on television has noticeably decreased. Conversely, we have seen consistent increases in reliance on nearly all other sources listed in the survey, except for broadcast radio. This trend suggests an increasing diversification in the sources people use to get information about severe weather.

[1] Note that while "Phone notifications" are included as a source, cell phone applications are not specifically asked about in this survey. Future versions should ask specifically about cell phone applications separate from general phone notifications.

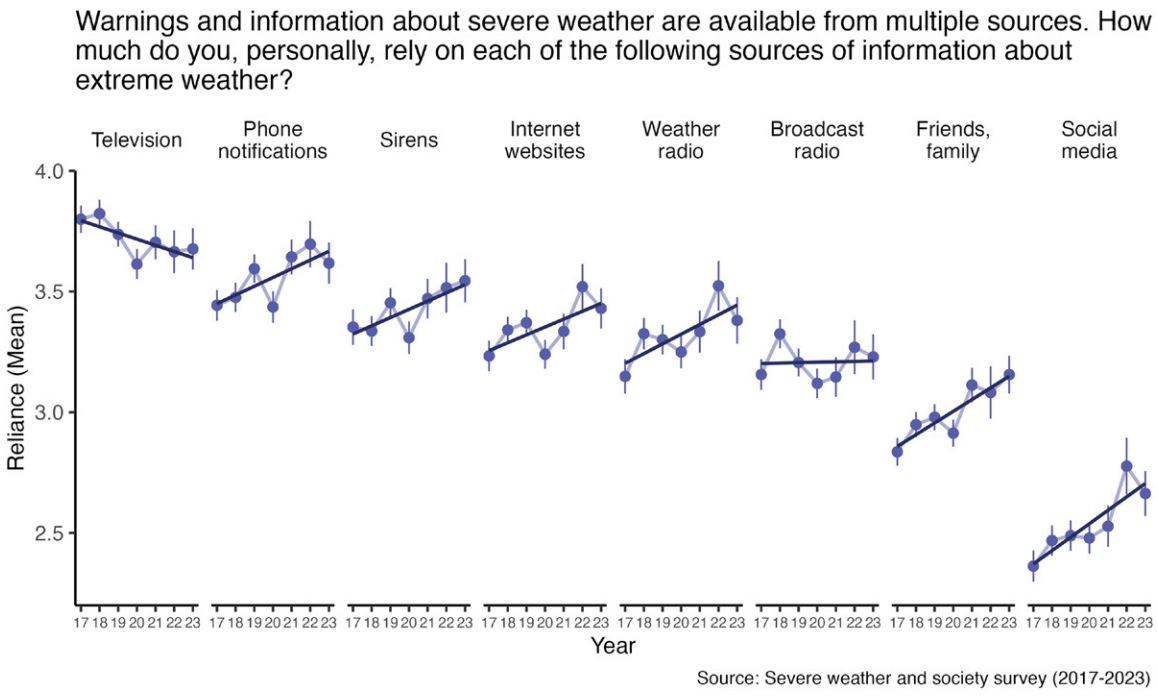

Fig. 1. The mean reliance on different severe weather information sources by year for members of the public between 2017 and 2023. Error bars are the 95% confidence intervals, and dark lines are linear regression estimates.

Within these general trends, a particularly notable development is the growing reliance on automated text or phone notifications, which exceeded television's level in 2022. This shift highlights how deeply technology and mobile devices are woven into our daily lives, emphasizing the ease and promptness with which phone notifications and apps provide weather updates and alerts. Equally interesting is the increase in reliance on personal networks, including friends and family (on the survey: "Word-of-mouth including telephone calls or texts from family, friends, neighbors, employers, co-workers, etc."), as well as social media (on the survey: "such as Twitter or Facebook"). From 2017 to 2023, reported reliance on these sources rose by a mean score of more than 0.3, a larger increase than all other sources studied here. Again, this trend emphasizes the influence of technology and mobile devices on the way that people receive information about the weather. While we are unable to fully explain the increase in reliance on friends and family using these data alone, we surmise that it could be attributed to the ease of sharing and receiving information through modern communication methods like texting. Similarly, it may also indicate a subtle shift toward more individualized and immediate modes of communication, with a rising number of people preferring their social circles over conventional information sources for updates. In the modern information environment, where there are many sources vying for attention, people may also wait to seek out weather information until they are nudged to do so by a personal source, like their friends and family.

The trends in the severe weather domain alone are worthy of attention, yet it is crucial to acknowledge the distinct nature of various weather phenomena. For instance, significant risks from severe thunderstorms and tornadoes are generally brief and impact relatively small areas. In contrast, tropical and winter weather events usually come with longer forecast and warning periods and affect broader regions. These distinctions may influence the information sources people depend on.

To investigate this possibility, Fig. 2 presents a comparison of public reliance on the same set of information sources (excluding sirens) for both tropical and winter weather threats. The survey questions are slightly different to reflect the different hazard spaces (see the figure titles for the exact question wording), and the time series is not as long, but we see a few similar trends. Most prominently, the data show a noticeable decrease in the use of television as an information source in the tropical weather context and an even more marked decline in its use for information about winter weather. Conversely, reliance on phone notifications has significantly increased in the tropical weather domain, and there is a steady, albeit less dramatic, increase in its use for winter weather. Social media usage is also on an upward trend in both contexts, with a somewhat sharper increase observed in the winter weather domain. As in the severe weather context, these trends reinforce the effect of technology and mobile devices on the way that people receive information about the weather.

3. Conjectures

The weather information landscape is evolving, so predicting what it will look like in the next 5–10 years requires speculation. One approach to speculation involves extrapolation from the overall trends shown here. If the trends continue, the future is likely to be characterized by more diverse and individualized modes of communication that are driven by advances in mobile technology. Another approach to predicting the future involves analyzing generational preferences, with the premise that the preferences and behaviors of younger generations offer insights into what the future may hold. Figure 3 presents one take on this analysis, aggregating data across all three hazards from 2021 to 2023. It illustrates mean reliance on each source, by generation, which is defined as Silent Generation (1928–45), Baby Boomers (1946–64), Generation X (1965–80), Millennials (1981–96), and Generation Z (1997–2012).

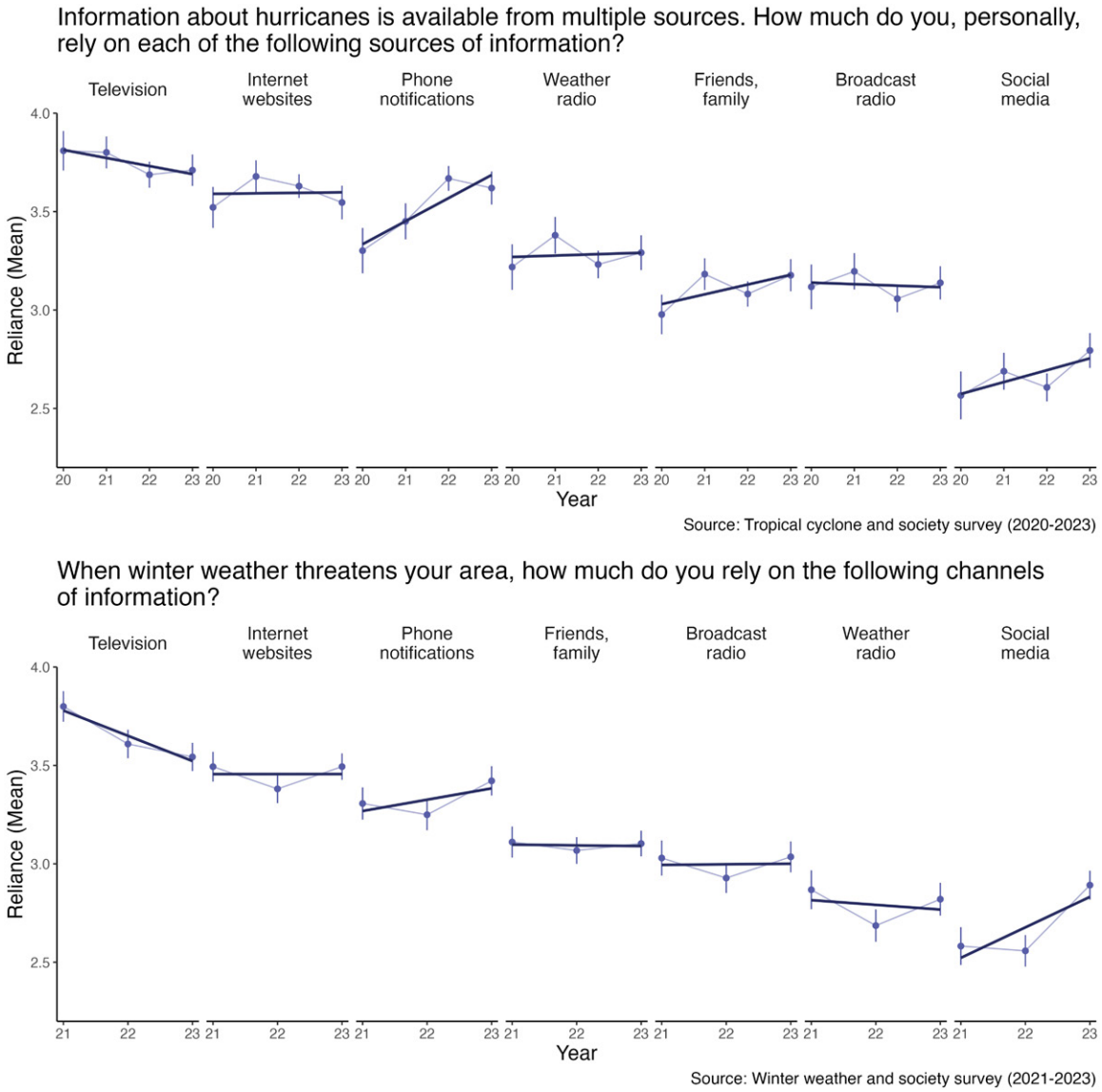

Fig. 2. The mean reliance on different tropical and winter weather information sources by year for members of the public between 2020/21 and 2023. Error bars are the 95% confidence intervals, and dark lines are linear regression estimates.

The surveys only targeted U.S. adults aged 18 and over, so there are no participants from Generation Alpha (born 2013 onward) included in the data.

Television and social media reveal the most striking trends in this analysis. Younger generations are much less likely to obtain weather information from television than older generations. By contrast, younger generations demonstrate a significantly higher tendency to rely on social media compared to older generations. Though a bit less striking, the same is true of internet websites, phone notifications, and friends and family. This is somewhat unsurprising given that younger generations have been more heavily influenced by and are therefore more comfortable with digital technology, the internet, and social media.

An alternative perspective on these findings can be gained by examining the primary source of information across the generations (i.e., the source with the highest mean reliance for each generation). Television is the predominant source of information for both the Silent Generation and the Baby Boomers. This aligns with previous observations regarding the weather information landscape, where although information is accessed from a variety of sources, television remains the preeminent medium. While this is true for the Silent Generation, Baby Boomers, and (mostly) Generation X, our observations differ for Millennials and Generation Z, as

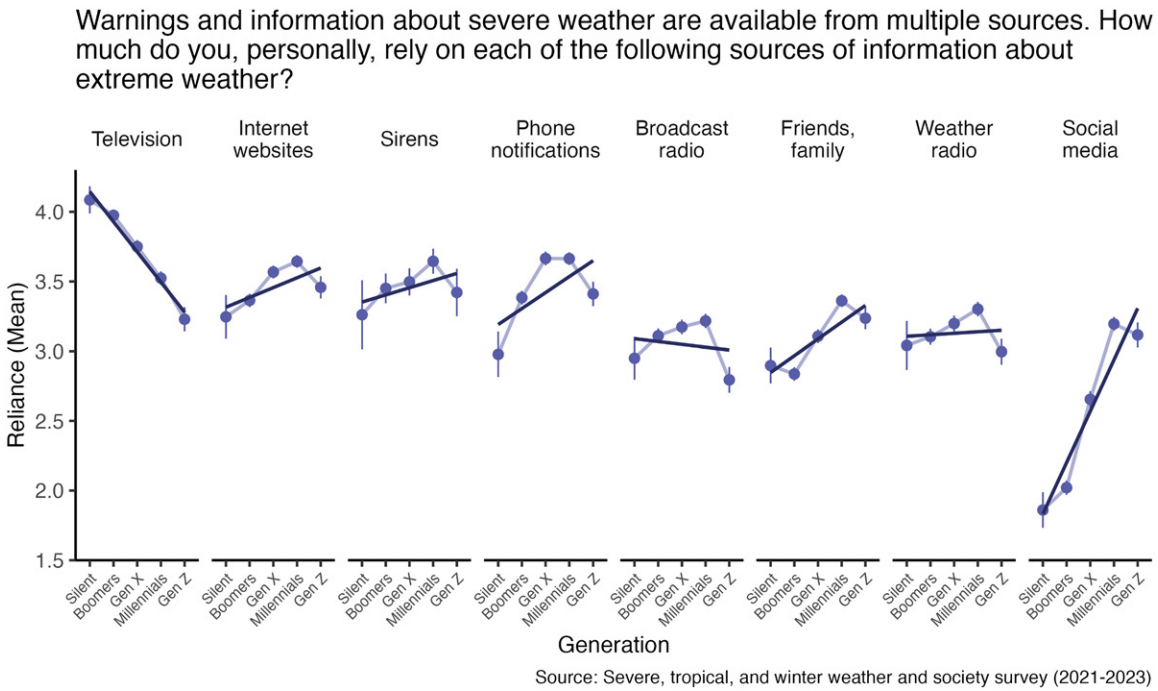

Fig. 3. The mean reliance on different information sources across hazards by generation for members of the public between 2021 and 2023. Error bars are the 95% confidence intervals, and dark lines are linear regression estimates.

there is no single dominant source of information for these groups. Currently, internet websites and phone notifications are in the lead, but other sources like friends and family, along with social media, are not far behind.

If the behaviors of younger generations provide a glimpse into future trends, these patterns may indicate that the weather information landscape is at the onset of a significant transformation. Moving away from a singular, dominant source like television, people are beginning to embrace a wider array of sources for weather information. Assuming individuals maintain their preferences as they age, there will likely be a shift toward mobile technologies and sources that offer more tailored information, including personal networks such as friends and family, as well as social media platforms.

4. Implications

These observations and conjectures have implications for the future of weather risk communication. The move away from traditional sources like television toward more diverse and personal sources, such as social media, internet websites, and mobile notifications, may necessitate a strategic shift in communication approaches. One question that remains is about what kinds of information people are looking for in nontraditional spaces like social media. Are people getting information from their local broadcast meteorologist on a Facebook live stream? Are they seeking out information from a National Weather Service X (formerly known as Twitter) page? These questions will require further detailed investigation to fully understand the shift in the information landscape. In the long term, these changes may improve weather risk communication—more people will have the information they need to make decisions that align with their preferences and goals.

In the short to medium term, the evolving landscape of information dissemination might present new challenges, particularly regarding information quality. Historically, weather risk communication has been top-down. For many years, a small set of experts (primarily television broadcasters) were responsible for assimilating information and delivering it to viewers. This resulted in relatively high-quality information that was vetted by experts before it was

released to the public. A shift toward a more diverse and decentralized information landscape could impact the quality and reliability of the weather information that is communicated. The weather enterprise needs to be prepared to meet this shift in information preferences. In this new environment, individuals who are not formally trained experts, like amateur meteorologists or weather enthusiasts, and even those with malicious intent, are able to produce and share information. This shifts the responsibility of discerning high-quality information from trained experts to members of the public. Reputable, known agencies and forecasters need to be present in the spaces where people are looking for information. If there are no known weather sources present on new technology or on a new social media platform, people may default to those that are present, regardless of reputability. While expert guidance, emerging technologies (like artificial intelligence, for example), and collective wisdom will eventually help in filtering out low-quality information, this development might take time. In the interim, it is crucial to be vigilant and develop strategies to counter the spread of low-quality (or pernicious) weather information.

In addition to information quality, accessibility may prove challenging in the new information ecosystem. Despite the growing prevalence of advanced technology like the internet and mobile devices, notable gaps exist in coverage and affordability. These disparities raise concerns about inequality, as not everyone has equal access to the technology necessary to receive the best available weather information. As the weather enterprise continues to embrace more tailored, individualized mediums for weather forecast information, these accessibility gaps will need to be addressed to ensure equitable access to weather information in the future.

In sum, our observations and conjectures suggest that the weather information environment is changing. Many of these changes are driven by advances in information technology and media, which enable access to more diverse and personalized weather information. We are optimistic about the future, but the next few years will require an adjustment to ensure that everyone has access to individually relevant and high-quality weather information.

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Data availability statement. Data from the Extreme Weather and Society Survey can be found at https://dataverse.harvard.edu/dataverse/wxsurvey. R code to reproduce the results in this manuscript can be found on the OU Institute for Public Policy Research and Analysis GitHub: https://github.com/oucrcm/wxsurvey.

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