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EXAMINING PUBLIC RESPONSE TO IMPACT-BASED ICE STORM FORECASTS

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EXAMINING PUBLIC RESPONSE TO IMPACT-BASED ICE STORM FORECASTS

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Dedication

To

The girl from Owasso

who never thought she could make it this far

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Acknowledgements

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Abstract

Ice storms are potentially devastating weather events in which at least ¼ of an inch of ice accumulates on surfaces due to freezing rain. The impacts of these storms include power outages, travel issues, road shutdowns, personal injury, and cold exposure. A growing body of literature in the risk communication space has focused on the use of impact-based warnings and forecast products in which the forecast includes a description of what impacts are possible. Across many types of disasters and weather events, such as hurricanes, tornadoes, earthquakes, and nuclear plant emergencies, impact-based warnings have been proven to be effective at increasing threat perceptions and encouraging recipients to take protective action. However, significantly less research on impact-based alerts has focused on winter weather, particularly ice storms. In this study, I use content analysis of NWS Facebook posts to determine that current forecast practices for ice storms are inconsistent across offices regarding what impact information is included. Additionally, I develop the Impacts of Ice Storms Survey to measure risk perception about ice storms and likelihood of taking protective action. This includes an experimental component in which I directly test different types of forecast products to determine whether impact-based messaging leads to changes in behavior or perception of the severity of ice storms. Through this study, I do not find sufficient evidence that a causal relationship between forecast format and protective action or perceived severity exists.

Introduction

Ice storms are a type of winter storm in which freezing rain causes ¼ inch or more of ice to accumulate on surfaces, and devastating ice storms can cause damage worth hundreds of millions of dollars, major infrastructure failure, and death due to hazards like traffic accidents or cold exposure (Grout et al., 2012; NOAA US Department of Commerce, n.d.). Ice accumulation has a unique set of impacts compared to other types of winter precipitation since ice forming on power lines and trees can weigh them down, causing them to break, and ice is harder to clear from roads since plow blades are designed for snow, not breaking ice from surfaces. These hazards are compounded when long-lasting extreme cold and high winds occur at the same time as the ice storm.

Though ice storms carry very distinct hazards, little work has been done to identify the best communication strategies and tools for ice storms specifically; instead, much of the focus is on winter weather as a whole. Based on this lack of distinction in the communication literature and the growing evidence to support impact-based warnings and forecast products across multiple weather hazards, I seek to determine whether impact-based alerts for ice storms affect the likelihood that people take protective action and their perception of the severity of the storm.

The theoretical basis for this study is the Protective Action Decision Model (PADM) which describes the processes that people go through when deciding whether to take action to protect themselves during dangerous situations. A core aspect of the PADM is that threat perceptions—the perceived severity of a situation and expectations about what will occur—play a significant role in altering decisions to act (Lindell & Perry, 2012). In cases where the threat perception is high, the decision to take protective action is more likely. Across multiple types of hazards, both natural and human-driven, clear communication regarding the impacts brings individuals' threat perception closer to the reality of the situation. Beyond the effect on threat perceptions, impact-based alerts can also change protective action perceptions since knowledge of impacts provides a clear explanation for why certain protective actions should be taken. For example, recommendations to shelter under sturdy objects during earthquakes will seem more reasonable when a person knows that falling objects are a major impact of earthquakes. In line with the theoretical expectations based on the PADM, impact-based warnings have been tested for a variety of weather hazards, including hurricanes and tornadoes, and they have proven to be effective at increasing the likelihood of taking protective action and altering perceived risk.

In this study, I perform a content analysis of Facebook posts that NWS offices made leading up to and during ice storms. I find that, while many forecast offices include impacts in at least some of their posts, there is significant inconsistency across offices. Additionally, most offices only include impacts in a portion of their posts, meaning that the information could easily be missed if they make multiple posts in a short time span. This inconsistency highlights an opportunity for improvement and standardization.

I developed the Impact of Ice Storms Survey to measure risk perceptions and likelihood of taking protective action. This survey also included an experimental component that presents respondents with one of four forecast products, two of which are impact-based and two of which are not. Based on this survey, I analyzed the differences in likelihood of taking protective action and perception of the severity of a hypothetical ice storm between the experimental groups to determine if there is an effect.

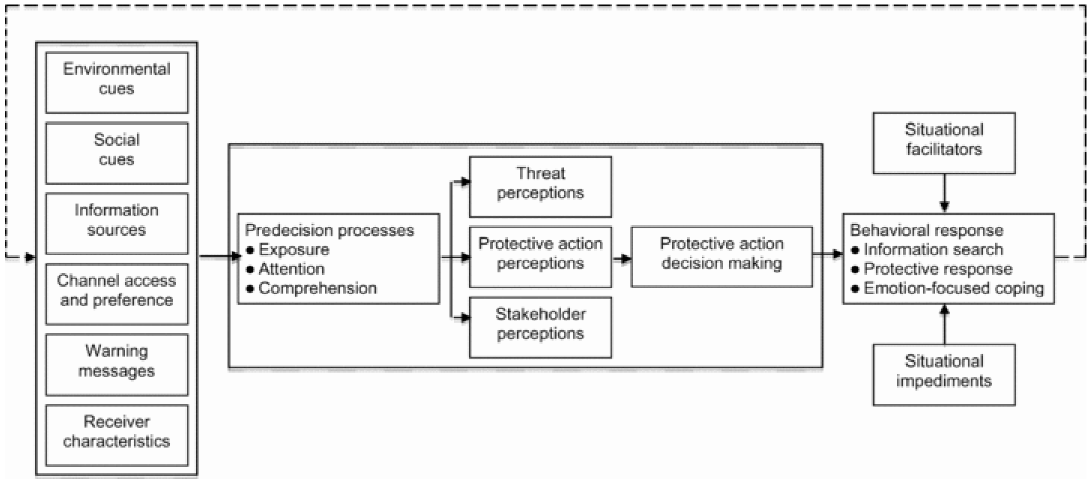
This study reveals that many forecast users already perceive the risk and severity of ice storms to be high even without seeing the experimental products. Additionally, the experimental component of the study failed to identify any specific effect of forecast product format on the outcomes of interest, so the findings cannot effectively be used to identify potential areas of improvement and guidance for current practices.

Chapter 1: Literature Review

Protective Action Decision Model

The Protective Action Decision Model (PADM) describes the process by which people choose whether to take protective action during dangerous situations. The stages of the model include the environmental and social context, psychological processes, perceptions of the situation, and the decision to act (Lindell & Perry, 2012). A diagram of the PADM is shown in Figure 1. Describing impacts in forecasts is most closely related to the psychological processes stage, specifically the threat perception component. Describing why a hazard is dangerous rather than just stating what the hazard is also allows individuals to better understand the justification for taking the action (Mileti & Peek, 2000), and this relates to the protective action perceptions aspect of the PADM. In the days leading up to Hurricane Katrina, officials failed to convey the true magnitude of the storm and its consequences, causing people to not personalize the threat and assume that protective action was not necessary. Prior studies have associated perception of impacts and severity with protective actions for nuclear disasters (Mileti & Peek, 2000), wildfires (Martin et al., 2007), and earthquakes (Lindell & Prater, 2000). Impact-based forecasts can help define the level of threat by specifically drawing attention to important aspects of the hazard. As a result, it is likely that including impacts will create a more realistic perception of the overall threat from a hazard since forecast recipients do not need to independently determine what the impacts are.

Figure 1: Protective Action Decision Model



Impact-based Alerts for Non-Winter Weather

Prior literature has demonstrated that impact-based warnings are effective for a variety of weather events with long or short lead times. For hurricanes, which have a lead time of multiple days, presenting information about the storms to the public without explaining how the information should be used or how it relates to individuals leads to less success in altering forecast recipients' actions (Demuth et al., 2012). In experimental studies, forecasts about hurricanes that included high-impact messaging or fear-based messaging resulted in more intention to evacuate and perception of threat, though fear-based messages specifically led some to believe that the forecast was overdramatic (Morss et al., 2018). Additionally, if the description of impacts seems too extreme to recipients, there is a loss of trust and perception that the impacts are unrealistic (Morss et al., 2016). This indicates that, for hurricanes, there is a level of discussion of impacts that is beneficial but that forecasters should be mindful to avoid overly dramatic messages. Among emergency managers surveyed, some express that they prefer storm surge forecasts that explain the practical impact and that it is important to relay this information to the public (Morrow et al., 2015).

Impact-based forecast products are also useful for events with a short lead time, such as tornadoes. Tornado warnings that include information about the extent and magnitude of the damage, debris, and risk of injury or death result in increased likelihood of taking action compared to those that exclude the information (Ripberger et al., 2015). Although longer alerts require more time or attention to process the message during fast-progressing events, impact descriptions offer a clear benefit regarding protective action. Much like hurricanes, though, tornado warnings with particularly strong descriptions of impacts may be counterproductive. In the case of tornadoes, warnings with extreme impacts can increase the likelihood that an individual tries to flee the area (Ripberger et al., 2015), which is a more dangerous situation than sheltering. Additionally, impact-based tornado warnings decrease the delay between individuals receiving alerts and acting based on the alert (Gelino & Reed, 2020). These findings show clear evidence that impact-based tornado warnings are beneficial. Impact-based warnings also provide a benefit for other fast-developing weather hazards. Weyrich et al. (2018) conducted a survey experiment where respondents were asked whether they would interrupt a hike because they received alerts about a thunderstorm. Those who received an impact-based warning were more likely to take protective action than those who received standard alerts. Potter et al. (2018) find that impact-based warnings for a wind event increased recipients perception of the threat, but they did not lead to a significant increase in likelihood of taking protective action. They were also more likely to seek out additional information, understand the warning, and express concern about the event than those who received standard warnings.

Impact-based alerts for Winter Weather

Following a major winter storm in February of 2021, residents in Texas stated that they did not understand the impending severity of the storm based on the forecasts that they received. The location and duration of power outages during the storm were a key concern. Prior to the storm, residents did not have an accurate perception of the threat that the storm posed, so they were not able to prepare for major power outages and other impacts (Li et al., 2023). Inadequate preparation due to a lack of crucial information points to a need for more detailed communication, especially for those who are already at a heightened level of vulnerability. Despite the expressed need for impact information ahead of winter storms, only a small amount of literature addresses the use of impact-based alerts for public communication about winter storms.

The Winter Storm Severity Index is the primary operational impact rating system that the NWS uses. Despite its widespread use, the WSSI can be ineffective or confusing for members of the public based on its format and the conditions that are used to predict the impact level. During focus group testing, some users indicated that they would like to see the accumulation amounts and other factors that the individual impact ratings were based on (Semmens et al., 2023). Participants' desire to see the factors that contribute to the WSSI rating reveals that impact-based alerts must include general storm information as well. Communicating general storm information—accumulation, timing, etc.—allows forecast users to personalize risk based on their experiences alongside the overall impact rating. Additionally, the WSSI can lack specificity about what impacts could occur since the system is simply an overall impact score. During the focus groups, participants specifically requested information about travel and power outages as part of the forecasts (Semmens et al., 2023).

For ice storms, limited examples of impact-based communication have revealed positive effects and higher likelihood of taking action. Ahead of and during the February 2021 winter storm, utility providers in Norman, OK, provided information to customers stating that they expected power outages due to the storm, and they encouraged customers to limit their electricity usage during the storm to minimize strain on the power grid. A large majority of customers voluntarily complied with different recommended actions, such as avoiding the use of major appliances and keeping their home heat set to 68 degrees or less (Goodin et al., 2023). A major difference between this example and other impact-based alerts is that in this case, customers are told that an impact is possible unless the community takes a specific set of actions. Most impact-based forecast products instead focus on the impacts that are expected to occur rather than impacts that could be prevented. Despite the difference, this example still demonstrates the theoretical benefit of using impact-based alerts for ice storms specifically.

Chapter 2: Current Practices in National Weather Service Offices

Introduction

The National Weather Service and its partners currently maintain systems that allow them to predict which impacts will occur and how severe they will be during the ice storm. These include the Sperry-Piltz Ice Accumulation Index which is designed for estimating impacts to utilities and the Winter Storm Severity Index which combines meteorological and non-meteorological factors to forecast the overall severity and coverage of impacts. Between these systems and their own judgment, forecasters have the option to inform the public of these impacts ahead of ice storms.

For this study, I perform a content analysis of Facebook posts from different NWS WFOs that were made ahead of and during ice storm events. The main goal of this analysis is to determine whether offices are issuing products that are similar to those issued by other offices. The second goal is to determine what information is generally included in these messages.

I find that there is significant variation across offices based on whether they include information about accumulation amounts, what impacts are mentioned, and the extent to which they qualify the impacts that they mention. This lack of consistency is problematic and may represent a need for standardized guidelines for WFOs to ensure that people receive similar information regardless of which WFO covers their area. Any standardization efforts would require minimal resources since the NWS already operates systems that allow them to forecast impacts. This means that any change would be related to policy and agency practices rather than technology.

Operational Products for Describing Impacts

Sperry-Piltz Ice Accumulation Index

The Sperry-Piltz Ice Accumulation Index (SPIA) is a tool that describes the impacts of different amounts of freezing rain on infrastructure. The index is based both on the amount of ice accumulation and wind speed during the storm. The Oklahoma Association of Electric Cooperatives and NWS Tulsa collaborated to develop the SPIA so that they could predict damage to utilities ahead of ice storms, so the index primarily focuses on impacts to the power grid (McManus et al., 2008). However, the SPIA has been updated to include a description of potential travel impacts as well (*SPIA Index*, n.d.), and this increases its effectiveness as a product for broader audiences.

Winter Storm Severity Index

The Winter Storm Severity Index (WSSI) is an operational tool that NOAA and NWS offices use when forecasting and communicating about winter storms. The WSSI is a general-purpose tool that is useful for all types of winter weather—not just ice storms—since it incorporates snow accumulation, quantitative precipitation, ice accumulation, wind speeds and temperature. It also includes factors such as population, land use, and land cover since experienced impacts will be greater in more populated areas or areas where infrastructure is especially susceptible to damage (Kastman et al., 2025). While the WSSI mentions infrastructure damage, the descriptions of each impact level focus primarily on travel rather than power outages or other specific types of impacts (National Weather Service, n.d.).

Content Analysis: National Weather Service Facebook Posts

I chose to analyze Facebook posts since the public is the focus of this study. While text-based products, such as ice storm warnings, may include information about specific impacts differently, they are less public facing than other methods except for people who use weather radios as their primary source of weather information. Instead, they are well suited for emergency managers, news media, and policymakers due to their format. Social media allows meteorologists to communicate directly to members of the public through easily accessible platforms. Since social media platforms provide tailored content to users based on their interests and pages that they follow, NWS offices can passively reach audiences even if they are not seeking out information through websites or other means. Additionally, members of the public have the ability to engage with posts, provide reports, or ask questions, so the platforms act as public forums with direct and reciprocal communication.

Events Included in Analysis

For this analysis, I selected 6 ice storm events from a list of ice storms that occurred between January 1, 2022, and February 1, 2026. After selecting the events, I then selected County Warning Areas, each of which has a dedicated Weather Forecast Office (WFO), that saw significant ice accumulation during the storm. This resulted in the inclusion of 11 County Warning Areas in the analysis. A list of events and WFOs is available in Table 1. For each office, I selected posts in a range from 2 days before the precipitation began to 1 day after the precipitation ended. This leads to a total of 286 posts, 157 of which mention ice as a hazard.

I chose this range of years to ensure that the analysis reflects the current practices at NWS WFOs while also providing many possible events to analyze. A wider temporal range would the chances that WFOs significantly changed their practices at some point during the time period, and former practices that have since been abandoned are not relevant to this study.

Table 1: List of events, WFOs, and number of posts from each WFO

Event Date	WFO	Number of Posts
December 12, 2022	St. Louis, MO (LSX)	29
January 12, 2024	Portland, OR (PMK)	17
December 12, 2024	Quad Cities IA/IL (DVN)	32
January 5, 2025	Louisville, KY (LMK)	19
	St. Louis, MO (LSX)	19
	Paducah, KY (PAH)	23
March 30, 2025	Gaylord, MI (APX)	19
	Marquette, MI (MQT)	19
January 24, 2026	Jackson, MS (JAN)	27
	Memphis, TN (MEG)	39
	Shreveport, LA (SHV)	43

Coding

I coded each post made by a WFO during the selected time period based on whether they make a reference to ice as a hazard, accumulation amounts, power outages, the severity of power outages, the duration of power outages, travel impacts, the severity of travel impacts, and protective actions. These references could either be in graphics attached to the post or the text of the post itself. Posts that mention a “light glaze” as an accumulation measurement are not coded as including accumulation amounts due to the lack of clear definition or reference point for the amount. For posts that I code as including the severity of power outages, the most common phrasing is “widespread power outages.” Similarly, if a post describes potential outages as “long-lasting,” they are coded as including the duration of outages. Any post that includes clear modifiers such as “extremely dangerous” or “impossible” is coded as including the severity of travel impacts. If any mention of ice, power outages, or travel impacts are mentioned, the post is coded as having the respective aspect.

Figure 2 shows a graphic which includes references to power outages; the graphic specifically mentions duration of outages when stating that they may last multiple days, and the inclusion of the term “numerous” indicates that the extent and coverage of power outages across the region is likely to be severe. Additionally, the graphic mentions impacts to travel and describes the expected level of impact with some areas having “hazardous travel conditions” and others having roads that are “impassable.” The graphic does not include information about expected accumulation amounts (National Weather Service Jackson Mississippi, 2026). The graphic shown in Figure 3 as only referencing accumulation amounts and no impacts (National Weather Service Louisville Kentucky, 2025). The graphic shown in Figure 4 describes “prolonged power outages” as a possible impact, though there are no qualifiers indicating potential severity of the outages. The graphic mentions that travel may be impossible in some areas, and this demonstrates that the severity of impacts to travel is expected to be high. Forecast ice accumulation amounts are present as well (National Weather Service Shreveport Louisiana, 2026).

Figure 2: Graphic with mention of impacts but not accumulation

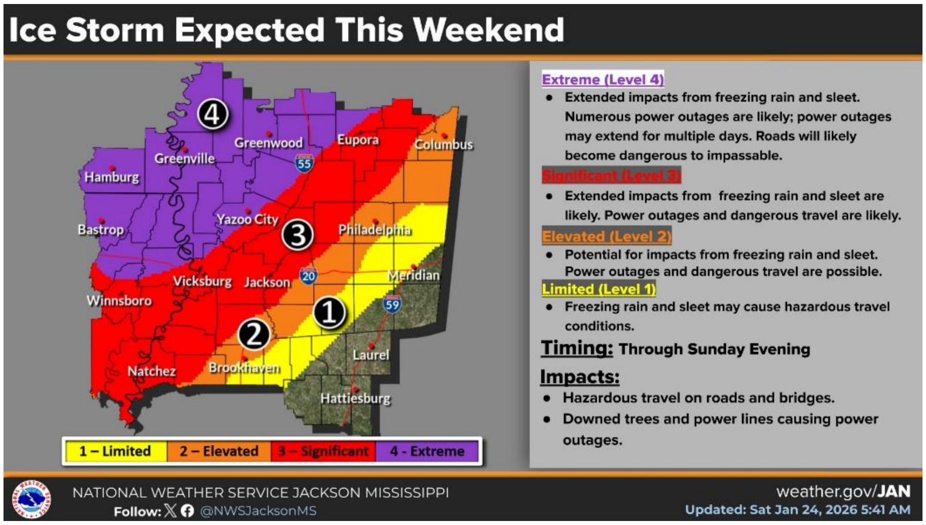


Figure 3: Graphic with mention of accumulation but not impacts

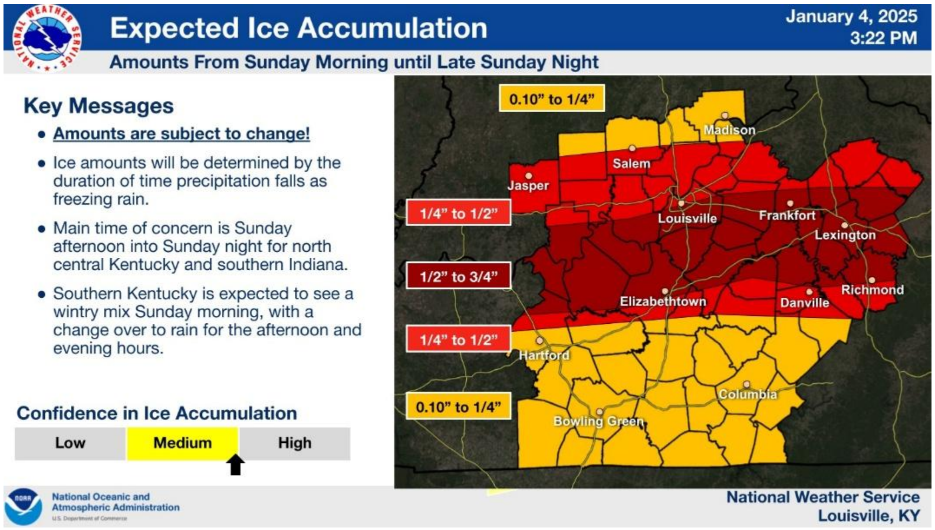
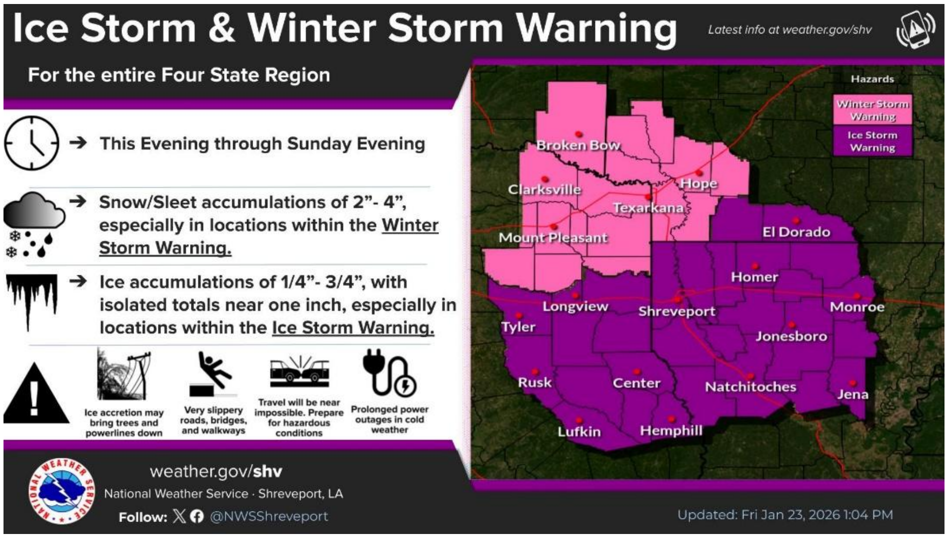


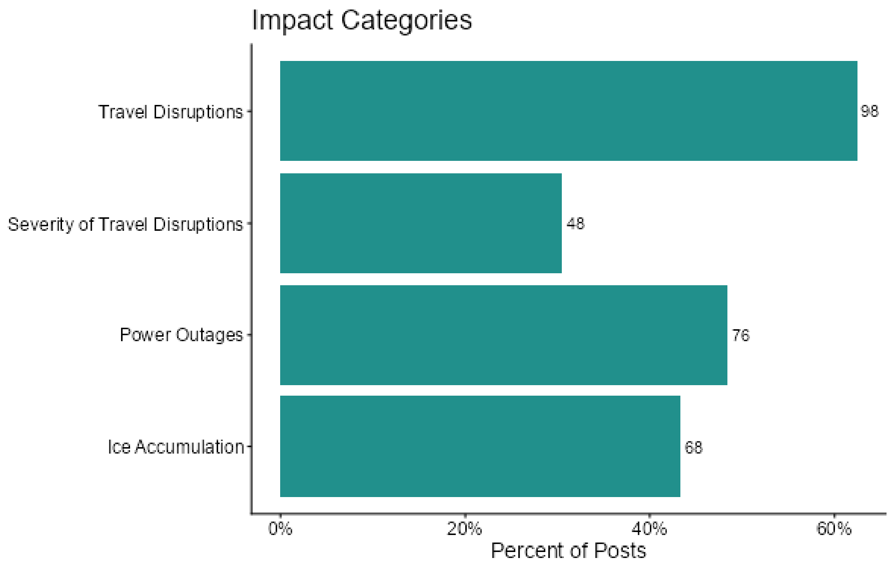
Figure 4: Graphic with mention of both accumulation and impacts



Results

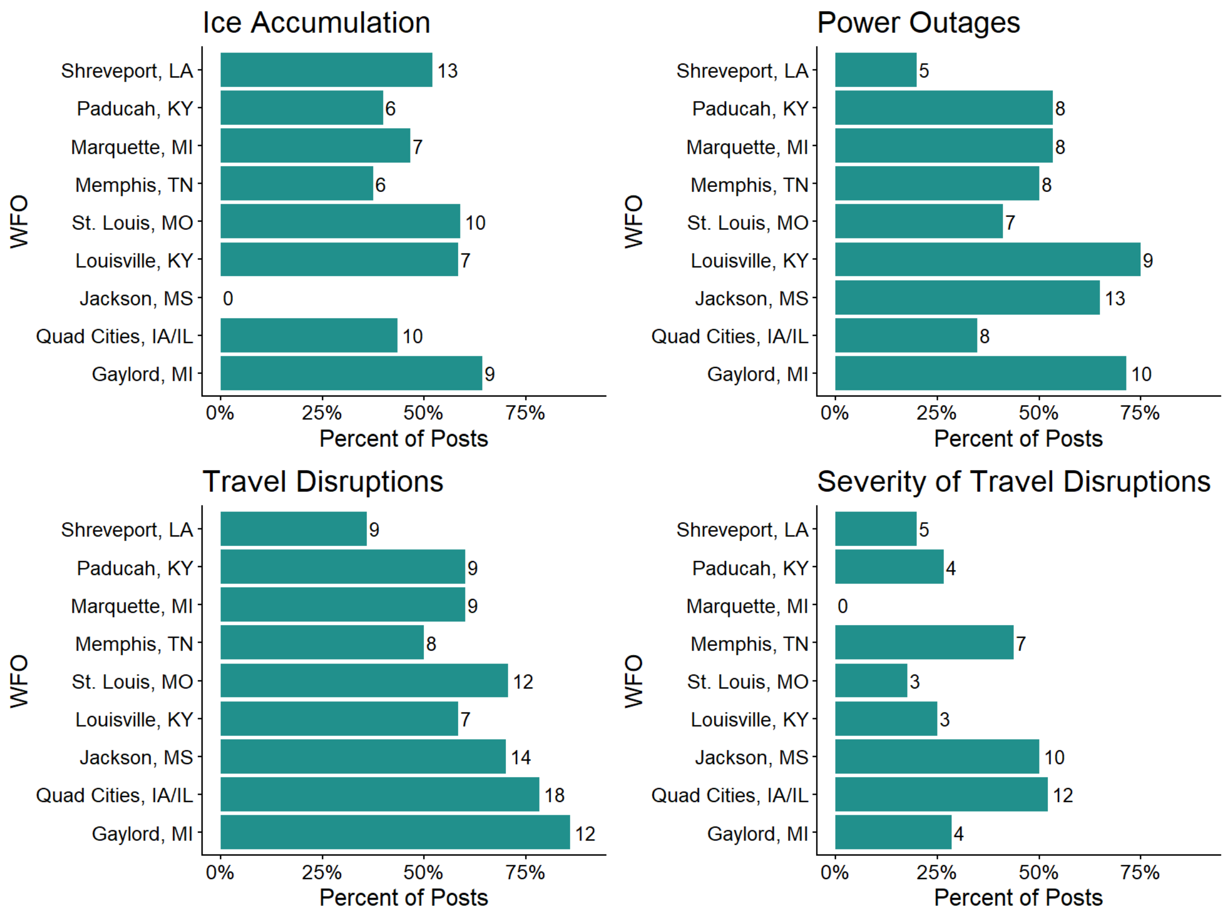
For posts that include references to ice as a hazard, only 43.3 percent of posts specifically mention the forecast ice accumulation. This percentage is lower than expected partially because the Jackson, MS, WFO did not reference accumulation amounts in any of their posts leading up to the event. 62.4 percent of posts however, mention travel disruptions of some form, making it the most referenced impact. 49 percent of posts that mention travel disruptions also mention the severity of the disruptions. Less than half—45.2 percent—of all posts mention power outages.

Figure 5: Percent of posts that include mentions of ice or specific impacts



When excluding the Jackson, MS, the references to ice accumulation amounts are most uniform across offices with Memphis, TN, having the lowest at 37.5 percent of posts mentioning the hazard and Gaylord, MI, having the highest at 64.3 percent. The least uniform of the impacts is power outages with Shreveport mentioning the impact in only 20 percent of posts versus 75 percent for Louisville, KY.

Figure 6: Percent of posts from each office that include mentions of accumulation or specific impacts



Discussion

This analysis reveals that there is a distinct lack of consistency across offices regarding the information that they include in public facing forecasts about ice storms. This inconsistency is present for multiple types of information that could be useful to members of the public, such as accumulation and specific impacts. The differences in information provided across offices reflect a potential area for improvement and standardization for NWS practices. If the content of the messages does affect public perception and understanding, the lack of standardization reveals that people in some regions are receiving insufficient information that could aid or alter their decisions.

Because of this possibility, determining how the messaging in these forecasts leads to different outcomes is critical to ensure that members of the public are receiving the best and most useful information possible. Even if the messaging does not significantly change peoples' understanding and response, establishing standard practices means that forecasts for neighboring offices will convey similar information which also benefits stakeholders. Those who are near the boundaries of the CWAs may rely on information from multiple offices, so including similar information means that they can easily compare the forecasts from each WFO. This standardization would also provide better opportunities for meteorologists to collaborate with other offices both in the region and nationwide.

Other than Jackson, MS, WFOs generally strike some balance between inclusion of basic storm information—such as ice accumulation—and descriptions of impacts. The key variation between offices is not whether they include the information but rather how often they include the information. Ultimately, this means that members of the public in most WFOs that were analyzed have access to each type of information. However, when the information is separated into multiple posts, members of the public may not receive or view each of the posts, meaning that they could miss the information even if it is provided. If the inclusion of impacts does noticeably affect response and understanding, forecasters should, within reason, ensure that the information is available across most of their posts and public facing products rather than continue using the scattered and disorganized approach that is currently common.

Since the National Weather Service currently has operational systems that are designed to estimate and forecast impacts from ice storms, standardizing the communication of impacts would not require significant changes in effort or resources needed to generate forecast products. The lack of inclusion of certain information in public facing products is primarily an issue with agency policy and guidelines, and the low amount of resources needed to change these guidelines means that the work surrounding the changes only needs to focus on whether they should occur, not how they should occur.

Chapter 3: Developing the Impacts of Ice Storms Survey

Introduction

The Impacts of Ice Storms Survey is primarily designed to test the role that impact-based forecasts play on individual perception of severity and willingness to take action for ice storms. I also measure respondents' baseline perception of the risk of ice storms in their area, the protective actions that they would be likely to take ahead of and during ice storms, the specific impacts that they are concerned about, and their experience with the storms. The survey includes an experimental section where respondents are randomly assigned to view different forecast products to determine the difference in response to each product.

The intended population is adults in states that are prone to ice storms. The survey was distributed using an online opt-in panel operated by CloudResearch, and the sample size was [].

The survey data is weighted to ensure that the analysis is more reflective of the general population than if no weighting occurred. This allows for a higher level of external validity for the results. Additionally, attention checks are used to identify careless respondents. After identifying careless respondents, I can determine whether their inclusion significantly changes the results of the analysis.

Population and Sampling Method

The target population for this project is all adults in states that are prone to ice storms. States that are prone to ice storms will be defined as states where the value of the FEMA National Risk Index (NRI) ice storm risk score is greater than 50. This will limit the analysis only to the top

25 states for ice storm risk. These states are shown in Table 2. The population is limited to those in ice storm-prone areas since messaging for ice storms is more relevant to this population than for the full US adult population. The NRI is a tool used to estimate the risk and potential impact of various hazards across the United States. The index is based on exposure and historic losses from specific hazards. the resiliency of communities, and social vulnerability. Social vulnerability and resiliency are measured using a combination of 29 socioeconomic factors. The scale for risk scores is 0-100, and the score represents the risk relative to other areas. (Zuzak et al., 2022).

The survey was distributed using the CloudResearch online opt-in panel. The sample size for the survey was 582 respondents. The use of online opt-in panels presents some challenges compared to traditional probability sampling survey methods. First, the survey platforms compensate respondents for the surveys that they complete. This can create an incentive for people to respond to questions carelessly so that they can complete more surveys in the same amount of time, leading to lower quality of data. Careless responses result in higher variance in the dataset due to their random nature, but attention checks can help identify these respondents. These checks can include questions where participants are directed to select a specific response. They may also take the form of questions where some options are nonsensical to ensure that respondents are reading the options or questions that are similar to previous items in the survey with reversed scales (Ward & Meade, 2023).

Additionally, online opt-in panels tend to underrepresent certain demographics, including those who have less access to broadband internet or elderly people. As use of internet platforms becomes more widespread, issues of representativeness of elderly populations are beginning to lessen (Kelfve et al., 2020), so the potential for overall underrepresentation is reduced. However, limited access to broadband internet disproportionately affects minority populations, women, low income peoples, and rural populations (Reddick et al., 2020). Issues of representativeness can be mitigated with weighting techniques where researchers assign weights to individual responses based on their demographic characteristics to align the analysis more closely with true population values.

Table 2: States included in sample

Alabama	Massachusetts	Ohio
Arkansas	Michigan	Oklahoma
Connecticut	Mississippi	South Carolina
Georgia	Missouri	Tennessee
Iowa	Nebraska	Texas
Kansas	New Hampshire	Vermont
Kentucky	New Jersey	
Louisiana	North Carolina	
Maine	North Dakota	

Questionnaire Design

Within the questionnaire, respondents self-reported their demographics using questions that mirror the language of the National Public Opinion Reference Survey to ensure that weighting is possible. These questions include the respondents' age, gender, race/ethnicity, state of residence, community type, education, and income.

Respondents then answered questions about their experiences with winter weather and their perceptions of the risk of winter weather in their area. First, they indicated whether their area or areas that they travel to receive winter weather followed by the risk of extreme cold, snow, and ice/freezing rain in their area. They also answered questions about what impacts they have experienced due to winter weather at any point in the past two years.

To understand the respondents' concerns about specific hazards, I provided a question where respondents rank specific impacts by how concerned they would be if an ice storm occurred. Understanding which impacts are most concerning to participants could help forecasters know what information is most relevant to communicate. For example, if a majority of respondents are most concerned about road conditions, forecasters could specifically address this impact.

Following the questions about individual experience and concerns, respondents answered questions about their likelihood of taking specific protective actions for extreme winter weather. These questions include both proactive and reactive measures. The proactive measures—protective actions taken in advance of the winter weather event—that I assess in the survey are purchasing supplies, canceling or rescheduling plans, ensuring that respondents have an emergency kit in their car, and testing smoke/carbon monoxide alarms. The reactive measures—protective actions taken during the winter weather event, are avoiding travel, using generators in case of power outages, and using multiple layers of clothing and blankets to stay warm. If respondents answered that they are "somewhat unlikely" or "very unlikely" to take these protective actions, they received a follow-up question for each action. In the follow-up question, respondents were asked why they are unlikely to take said action. For this question, they chose between the options of "I do not feel the need to take this action" and "I cannot take this action due to resource or financial limitations." Respondents were also provided an option for "other," and if they selected this option they are asked to write out their answer. A third set of protective action questions focuses on methods for heating homes. Some are recommended methods (central heating, fireplaces, and space heaters) while others are dangerous methods (stovetops, ovens, grills, and camp stoves).

Respondents also had the opportunity to provide additional information or feedback using an open-ended question at the end of the survey.

Some questions were sourced from the Winter Weather and Society Survey that the Institute for Public Policy Research and Analysis conducts annually (Bitterman et al., 2025). Multiple rounds of expert reviews of the questionnaire were conducted prior to fielding the survey to ensure that question wording was clear and that the flow of the survey was effective.

Survey Experiment

For this survey, respondents were randomly assigned one of four experimental winter weather forecast products, and they then answered questions about the product to determine whether it affected their perception of severity and the protective action that they would take. Since the sample size for the survey is 582 respondents, each experimental group includes approximately 582 responses.

Two of the products are graphics depicting the forecast information, and the other two are Facebook-style posts about the event. For each product type, there is one version that includes a description of impacts alongside the general forecast information and one that only includes the general forecast information. The experimental products are included in Appendix B.

After viewing the forecasts, respondents answered a series of questions about the forecast to measure the outcome variables. These questions measured how impactful the respondent thinks the storm would be to their daily life, how likely they would be to take protective action, how likely they would be to seek out additional information, and whether the product was easy or difficult to understand.

Weighting and Data Quality

To account for potential issues of representativeness, I use simple raking to assign weights to each respondent based on age, gender, race/ethnicity, state of residence, and level of education. This is important both due to the method of distribution and the low sample size. Since online opt-in panels underrepresent certain populations, weighting can help correct bias that may result. Additionally, smaller samples are less likely to be representative than larger samples since the average of estimates tends to converge on the true value as the sample size increases. I use the National Public Opinion Reference Survey as a benchmark for the weighting.

To account for careless respondents, I include an attention check question in which respondents are asked to indicate which option is not a potential hazard of ice storms. Incorrect responses to this question can signal careless responses. Additionally, responses to open-ended questions can also reveal whether respondents are frustrated or disengaged with the survey. If responses that could be careless make up a substantial portion of the sample, I will perform the analysis with and without the flagged responses included to determine whether there is an effect on the results.

Chapter 4: Survey Data Analysis and Results

Introduction

For this study, I measured respondents' baseline risk perception for ice storms and the protective actions that they would take. One key application of this data is to determine what impacts members of the public are most concerned about. This information can then be used to refine impact-based products so that they focus on the forecast users' needs. For example, if I find that people care most about travel impacts and power outages during ice storms, I can use the data to offer recommendations that reflect that preference. Additionally, if respondents indicate that they would be likely to take protective action during the experimental section, I can reference their responses to questions about protective actions to determine the most likely actions that they would take after seeing the forecast. More broadly, this data can be used to assess whether people's evaluation of the ice storm risk in their area and their own vulnerability is in line with reality.

I also assess whether impact-based forecast products have an effect on protective action and perception of severity for ice storms based on the experimental component of the Impact of Ice Storms Survey. I use OLS models to determine whether there are significant differences between products as well as the magnitude of the differences to determine the effects.

The experimental component of this study reveals that the format of the forecast product does not have a significant impact on the likelihood of taking protective action, likelihood of seeking out additional information, or the perceived severity of the storm. This may be due to overall high baseline levels of willingness to take protective action or due to the way that the products are designed.

Preparedness and Risk Perception

Methodology

For preparedness and protective action questions, I created a scale which is the mean of an individual's responses to each question relating to what they would do before and during ice storms. For the battery that assesses how people would heat their homes during an ice storm, each item has a weight of .5 since the items are measuring small components of potential heating practices. Since the questions over heating include some options that are discouraged, the values for those will be negative while the values for all recommended practices will be positive.

Results

As shown in Table 3, baseline likelihood of taking protective action is relatively high with means of 3.76 for action taken ahead of storms and 3.79 for action taken during storms. Since the means include all possible actions, they could be reduced if a respondent indicates that they will take some actions but not others.

Table 3: Baseline levels of perceived risk and protective action

	Mean	SD
Preparation action	3.76	.93
Action during storms	3.79	.57
Probability of impactful ice in area	3.45	1

Table 4 shows the mean rank of concern that respondents indicated for each possible impact of ice storms. Of the 6 options, respondents were most concerned about road conditions in power outages with mean ranks of 2.77 and 2.51 respectively. They were least concerned about damage to property and physical harm with means of 4.16 and 4.20 respectively.

Table 4: Mean rank of concern about impacts

Impact	Mean Rank	SD
School or work closures / delays	3.77	1.90
Poor road conditions or road closures	2.77	1.47
Power outages	2.51	1.43
Water issues / frozen pipes	3.58	1.29
Damage to homes / property	4.16	1.39
Harm to you or a loved one	4.20	1.89

Impact-based Forecast Products

Hypotheses

H1: *Participants who receive impact-based forecast products will perceive the forecast storm as being more impactful than those who receive standard products*

H2: *Participants who receive impact-based forecasts will be more likely to take protective action than those who receive standard products.*

Methodology

Although each of the outcome variables of interest are 5-point Likert scales, I chose to treat the responses as continuous rather than ordinal (Norman, 2010) to allow for the use of OLS regression models for ease of interpretability and clarity. I used OLS regression models with binary variables for whether the forecast product is a text post or graphic and for whether it includes impacts. For the type of product, a value of 0 represents a text post and a value of 1 represents a graphic. Impact-based products were assigned a value of 1 and products with no impacts were assigned a value of 0. The reference group for the analysis is text posts with no impact descriptions included. Since the respondents were randomly assigned products, I do not include control variables under the assumption that demographic characteristics will be similar across experimental groups.

$$Y = \beta_0 + \beta_1 X + \beta_2 Z + \varepsilon$$

I also used a second OLS model with an interaction term to determine whether any effect from product format is dependent on whether impacts are included.

$$Y = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 XZ + \varepsilon$$

Results

Table 5 shows the results from OLS regression models with no interaction terms. Each model fails to achieve statistical significance, so there is not sufficient evidence to establish a causal relationship between the product types and the outcomes of interest. Additionally, the magnitude of the coefficients is negligible, so even if statistical significance was achieved, the effect would not be substantial.

Table 5: Experimental outcomes

	Perceived Severity	Protective Action	Information Seeking
(Intercept)	3.761	4.095	4.095
	(0.079)	(0.077)	(0.077)
Graphical Product	0.055	-0.031	-0.031
	(0.091)	(0.088)	(0.088)
Impact Descriptions	0.070	0.084	0.084
	(0.091)	(0.088)	(0.088)
Num.Obs.	581	582	582
R2	0.002	0.002	0.002
R2 Adj.	-0.002	-0.002	-0.002
RMSE	1.10	1.06	1.06

<.05, ** p < 0.01, *** p < 0.001

Similar to the models with no interaction terms, the models with interactions—shown in Table 6—fail to achieve statistical significance or coefficients with a high enough magnitude to be meaningful.

Table 6: Experimental outcomes with interaction term

	Perceived Severity	Protective Action	Information Seeking
(Intercept)	3.745	4.076	4.076
	(0.092)	(0.089)	(0.089)
Graphical Product	0.089	0.007	0.007
	(0.130)	(0.126)	(0.126)
Impact Descriptions	0.103	0.123	0.123
	(0.129)	(0.125)	(0.125)
Graphical Product * Impact Descriptions	-0.066	-0.077	-0.077
	(0.183)	(0.177)	(0.177)
Num.Obs.	581	582	582
R2	0.002	0.002	0.002
R2 Adj.	-0.003	-0.003	-0.003
RMSE	1.10	1.06	1.06

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Removing respondents who failed the attention check did not meaningful change the results.

Discussion

Respondents indicated high willingness to take protective actions during ice storms even before seeing the forecast products. This reveals that they generally recognize the severity and potential dangers of ice storms. Because of the high baseline levels, formatting inconsistency between different offices does not seem to present an immediate or significant concern, especially when compared to other hazards such as flooding. The values of the means for these questions suggest that many people would take some action to protect themselves even if they do not take every possible action. Additionally, the perceived level of risk in the respondents' area is in line with what can be expected considering the broad range of states included in the sample. Based on the respondents' level of concern about specific impacts, any messaging that discusses impacts should focus on power outages and road conditions. Since impacts like school or work closures, water issues, and damage to property are less relevant to safety and of lower concern to people, discussing them in forecast products is less important. Despite low levels of concern about potential physical harm, communicators could choose to describe the risks so that people understand the safety issues that they face even when not driving.

However, the experimental component failed to demonstrate a difference in outcomes between different forecast products, so there is no evidence that standardizing forecast products around an impact-based model would lead to higher levels of safety. These results are not in line with theoretical assumptions based on risk communication models and literature regarding other forms of hazards. If there is an effect, there are a few reasons that could explain the lack of significant results in this study. The first is that there may be an effect, but the experimental products are not formatted in a way that can take advantage of the effect. The second possible reason is that the overall high baseline levels of protective action and perceived risk among respondents means that the outcomes cannot meaningfully increase even if there would otherwise be an effect.

Chapter 5: Summary and Conclusions

This study includes analysis of 157 social media posts from various National Weather Service offices made in the days leading up to ice storms. These posts were coded based on whether they mentioned ice as a hazard, ice accumulation, and various other impacts. This analysis revealed that, across forecast offices, there is significant variation in the forecast products that are issued leading up to ice storms. Some offices exclusively describe impacts with minimal information about the storms, while others mention impacts in a relatively small portion of their products. For offices that frequently discuss impacts, there is also inconsistency in what specific impacts they discuss. The lack of consistency presents an opportunity for standardization. Standardizing messaging across offices could benefit people who live close to the boundary of their County Warning Areas or people who frequently travel across different areas so that they are receiving consistent messages regardless of where they are. Standardization could also aid forecasters since it would aid communication between different offices and outside partners. For example, a news station that covers two different CWAs could receive entirely different products from each office, leading to potential for misjudgment or confusion.

To determine whether forecasts should be standardized around an impact-based model, I fielded the Impacts of Ice Storms Survey. The goal of this survey was to measure baseline levels of perceived severity of ice storms, willingness to take protective action, and perceived level of risk in the respondents' area. I also included an experimental component in which I randomly presented respondents with one of four forecast products. Two of the products were graphics and two were text based social media posts. For each format, one product included discussion of impacts and the other did not. Respondents then indicated the perceived severity of the event and their willingness to take protective action. The analytic sample included 582 people.

Respondents indicated an overall high baseline level of willingness to take protective action both ahead of and during ice storms. Even if they would not take every possible action to prepare, most respondents would take some forms of action. Additionally, their perceived level of risk in their area appears to be in line with expectations based on the range of states included in the sample. An important finding from the survey is the level of concern that respondents have about different potential impacts. The impacts that people are most concerned about are road conditions and power outages, so any attempts to use impact-based products should highlight these specific impacts. Additionally, offices that currently describe impacts in some or most of their forecast products already include discussion of these impacts, revealing that many existing products reflect the needs of stakeholders.

The key component of this study is the experimental component. Despite theoretical assumptions based on the Protective Action Decision Model and evidence on the benefits of impact-based systems for other hazards, there is no significant evidence that impact-based messaging about ice storms affects perceived severity, willingness to take protective action, or information seeking behaviors.

There is some potential that these findings are type II errors due to a few limitations. These limitations include minimal testing of the products prior to fielding the survey. Future research should include methods such as focus groups to determine whether the products are effective or in line with peoples' desired information. Another potential source of a type II error is the already high baseline level of willingness to take protective action. Since a large portion of respondents indicated that they would take at least some form of protective action for ice storms before seeing the experimental products, it is possible that there is a causal relationship that is obscured by the lack of variation. Additionally, people in different areas may have different needs and desires for forecast products, so future research may benefit from considering variation at regional or sub-regional levels.

Although the results of the content analysis indicate a potential opportunity for standardization, this study fails to determine whether standardization should be based on a specific product format. Since there is not sufficient evidence to determine that impact-based products are more effective than those without impacts, changes in practices should be considered with caution and regard for the needs of local populations and the risks that they face.

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Appendix A: Questionnaire

You are invited to participate in a research study entitled "Impacts of Ice Storms." This study seeks to assess how different forms of forecasts about ice storms affect public response and understanding of risk for the event. You were selected as a possible participant because you volunteered to participate in online surveys through CloudResearch or one of its partners.

If you agree to participate, you will complete this approximately 10-15 minute online survey. There are no risks or benefits.

If you participate, you will be compensated according to your agreement with CloudResearch or one of its partners.

This survey will collect geographic data including your state of residence and current zip code. It will also collect demographic data including age, gender, race/ethnicity, level of education, and household income.

Your participation is voluntary and your responses will be de-identified before they are shared for research purposes or published.

Even if you choose to participate now, you may stop participating at any time and for any reason. Your data may be used in future research studies, unless you contact me to withdraw your data.

Data collected online: The organization hosting the data collection platform has its own privacy and security policies for keeping your information confidential. There is a risk that the external organization, which is not part of the research team, may gain access to or retain your data or your IP address which could be used to re-identify you. No assurance can be made as to their use of the data you provide for purposes other than this research. If you have questions about this research, please contact Riley Worley at riley.s.worley@ou.edu and Joseph Ripberger at jtr@ou.edu.

You can also contact the University of Oklahoma - Norman Campus Institutional Review Board at 405-325-8110 or irb@ou.edu with questions, concerns or complaints about your rights as a research participant, or if you don't want to talk to the researcher.

By answering the survey questions, I agree to participate in this research. Please print this page for your records.

This research has been approved by the University of Oklahoma, Norman Campus IRB.

IRB Number: 19685

Approval date: 04/10/2026

consent Do you agree to participate in this research? [If consent = 1, skip to end]

1 – Disagree

2 - Agree

-----------------------End Web pg 2----------------------

age What is your age?

gender Do you describe yourself as a man, a woman or in some other way?

1 – A man

2 – A woman

3 – In some other way

ethnicity Are you of Hispanic, Latino, or Spanish origin, such as Mexican, Puerto Rican or Cuban?

0 – No

1 - Yes

race What is your race or origin? [Check all that apply]

1 – White

2 - Black or African American

3 – Asian or Asian American

4 – American Indian or Alaska Native

5 - Native Hawaiian or other Pacific Islander

6 - Two or more races

7 – Some other race or origin (please specify):

race_specify [VERBATIM]

state Please select the state or district where your current residence is located.

zip What is the five-digit zip code at your residence?

-----------------------End Web pg 2----------------------

rural How would you describe the community where you currently live?

1 – Urban

2 - Suburban

3 - Rural

home Which of the following categories best describes the nature of your current primary residence?

1 - Stand-alone (detached) permanent structure such as a house

2 - Condominium, townhouse, or duplex that is attached to another structure

3 - Apartment or dormitory room that is part of a larger residential complex

4 - Mobile home (whether placed on a permanent foundation or not)

5 - Boat, boathouse, ship, dock, or other floating structure

6 - Other type (please specify)

home_specify [VERBATIM]

------------------------End Web pg 3-----------------------

ww_live Do you live in an area that experiences winter weather?

1 – No

2 – Yes

ww_travel Do you ever travel to areas that experience winter weather?

1 – No

2 – Yes

ww_fam Do you have family or friends who live in areas that experience winter weather?

1 – No

2 – Yes

------------------------End Web pg 4-----------------------

How do you rate the risk of the following winter weather events to you and the people in the area where you live?

risk_cold Extreme Cold

1 – No risk

2 – Low risk

3 – Moderate risk

4 – High risk

5 – Extreme risk

risk_snow Snow

1 – No risk

2 – Low risk

3 – Moderate risk

4 – High risk

5 – Extreme risk

risk_ice Ice or freezing rain

1 – No risk

2 – Low risk

3 – Moderate risk

4 – High risk

5 – Extreme risk

------------------------End Web pg 5-----------------------

At any point in the last two years, have you experienced the following impacts because of winter weather?

past_school School or work closures/delays

1 – No

2 - Yes

past_road Poor road conditions or road closures

1 – No

2 - Yes

past_power Power outages

1 – No

2 - Yes

past_water Water issues/frozen pipes

1 – No

2 - Yes

past_damage Damage to homes/property

1 – No

2 - Yes

past_harm Harm to you, a friend, family, or other loved one (e.g., injury or other health impacts)

1 – No

2 – Yes

------------------------End Web pg 6-----------------------

ice_vign The focus for the rest of this survey is freezing rain events and ice storms. An ice storm is typically defined as a storm which results in over 1/4 of an inch of ice to accumulate on surfaces.

ice_thrsh If you were to get freezing rain or ice, what is the smallest amount that can disrupt your daily activities?

1 - Any amount

2 - 1/10 of an inch

3 - 1/4 of an inch

4 - 1/2 of an inch

5 - 1 or more inches

ice_prob How likely do you think it is that the area where you live will experience at least one storm that produces [] of freezing rain or ice during an average winter?

1 - Not at all likely

2 - Not very likely

3 - Somewhat likely

4 - Very likely

5 - Extremely likely

------------------------End Web pg 7----------------------

ice_impacts_rank If an ice storm were to occur, which impacts are you the most concerned about? [RANK ORDER]

Drag and drop the following options with the impact of highest concern at the top of the list.

impacts_school School or work closures/delays

impacts_road Poor road conditions or road closures

impacts_power Power outages

impacts_water Water issues/frozen pipes

impacts_damage Damage to homes/property

impacts_harm Harm to you, a friend, family, or other loved one (e.g., injury or other health impacts)

------------------------End Web pg 8----------------------

In the days before ice storms are forecast to occur, how likely are you to take the following actions?

prep_supplies Purchase supplies (such as food, water, blankets, or fuel)

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

prep_reschedule Cancel or reschedule plans

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

prep_kit Ensure that you have an emergency kit for your car that includes items such as jumper cables, a first aid kit, and winter clothing

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

prep_alarms Test carbon monoxide and smoke detectors

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

------------------------End Web pg 9-----------------------

[Show if prep_supplies = 1, 2]

unlikely_supplies It seems that you are unlikely to *purchase supplies* in the days before ice storms are forecast to occur. Can you tell us why? [VERBATIM]

1 – I do not feel the need to take this action

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_supplies_specify [VERBATIM]

[Show if prep_reschedule = 1, 2]

unlikely_reschedule It seems that you are unlikely to *cancel or reschedule plans* in the days before ice storms are forecast to occur. Can you tell us why? [VERBATIM]

1 – I do not feel the need to take this action

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_reschedule_specify [VERBATIM]

[Show if prep_kit = 1, 2]

unlikely_kit It seems that you are unlikely to *create an emergency kit for your car* in the days before ice storms are forecast to occur. Can you tell us why? [VERBATIM]

1 – I do not feel that this action is important

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_kit_specify [VERBATIM]

[Show if prep_alarms = 1, 2]

unlikely_alarms It seems that you are unlikely to test carbon monoxide and smoke detectors

in the days before ice storms are forecast to occur. Can you tell us why? [VERBATIM]

1 – I do not feel that this action is important

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_alarms_specify [VERBATIM]

------------------------End Web pg 10-----------------------

attention Which of the following is *not* a potential impact of ice storms?

1 – School or work closures/delays

2 – Water issues/frozen pipes

3 – Poor road conditions or road closures

4 – Poor air quality due to smoke

5 - Damage to homes/property

------------------------End Web pg 11-----------------------

During an extreme winter weather event, how likely are you to take the following actions?

during_travel Avoid unnecessary travel

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

during_gen Use generators to power your home if the power goes out

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

during_blanket Use multiple layers of clothing and blankets to stay warm

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

-----------------------End Web pg 12----------------------

[Show if during_travel = 1, 2]

unlikely_travel It seems that you are unlikely to *avoid unnecessary travel* during extreme winter weather events. Can you tell us why? [VERBATIM]

1 – I do not feel that this action is important

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_travel_specify [VERBATIM]

[Show if during_gen = 1, 2]

unlikely_gen It seems that you are unlikely *to use generators to power your home if the power goes out* during extreme winter weather events. Can you tell us why? [VERBATIM]

1 – I do not feel that this action is important

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_gen_specify [VERBATIM]

[Show if during_blanket = 1, 2]

unlikely_blanket It seems that you are unlikely to *use multiple layers of clothing and blankets to stay warm* during extreme winter weather events. Can you tell us why? [VERBATIM]

1 – I do not feel that this action is important

2 – I cannot take this action due to resource or financial limitations

3 – Other (please specify)

unlikely_blanket_specify [VERBATIM]

-----------------------End Web pg 13----------------------

during_heat During an extreme winter weather event, how likely are you to use the following methods to heat your home?

		Very unlikely	Somewhat unlikely	About as likely as not	Somewhat likely	Very likely
during_heat_cent	Central heating (radiator/furnace)					
during_heat_fire	Fireplace					
during_heat_space	Space heater					
during_heat_stove	Stovetop/range					
during_heat_oven	Oven					
during_heat_grill	Grill					
during_heat_camp	Camp stove					

------------------------End Web pg 14----------------------

For this scenario, imagine that you are in Tulsa, Oklahoma, On a Tuesday morning, and the National Weather Service issues this forecast for a storm that will occur the next morning.

[Experimental Forecast Product]

exp_impact What level of impact would you expect this storm to have on your daily activities?

1 – Very low impact

2 – Low impact

3 – Moderate impact

4 – High impact

5 – Very high impact

exp_type What impacts do you expect this storm to cause? Select all that apply.

1 – School or work closures/delays

2 – Poor road conditions or road closures

3 – Power outages

4 – Water issues/frozen pipes

5 – Damage to homes/property

6 – Harm to you, a friend, family, or other loved one (e.g., injury or other health impacts)

exp_protect If you saw this forecast, how likely would you be to take action to protect yourself (such as purchasing supplies, rescheduling plans, or avoiding travel)?

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

exp_info If you saw this forecast, how likely would you be to seek out other information about this storm?

1 – Very unlikely

2 – Somewhat unlikely

3 – About as likely as not

4 – Somewhat likely

5 – Very likely

exp_understand How easy is it to understand the information presented in the forecast?

1 – Very easy

2 – Somewhat easy

3 – Somewhat difficult

4 – Very difficult

------------------------End Web pg 15-----------------------

[Show if exp_understand = 3, 4]

understand_why It seems that you found the forecast difficult to understand. Can you tell us why? [VERBATIM]

------------------------End Web pg 16-----------------------

edu What is the highest degree or level of school that you have COMPLETED?

1 – No schooling completed

2 – Kindergarten through grade 11

3 – Regular high school diploma or GED

4 – Some college credit but no degree

5 – Associate’s degree (such as AA, AS)

6 – Bachelor’s degree (such as BA, BS)

7 – Master’s degree or higher

income Last year, that is in 2025, what was your total family income from all sources, before taxes?

1 – Less than $30,000

2 – $30,000 to less than $40,000

3 – $40,000 to less than $50,000

4 – $50,000 to less than $60,000

5 – $60,000 to less than $70,000

6 – $70,000 to less than $80,000

7 – $80,000 to less than $90,000

8 – $90,000 to less than $100,000

9 – $100,000 or more

------------------------End Web pg 17-----------------------

comments Is there anything else that you would like us to know about your experience with winter weather and ice storms? [VERBATIM]

Appendix B: Experimental Forecast Products

Figure 7: Facebook-style post containing storm information but no impact descriptions

US National Weather Service Tulsa Oklahoma
Jan 17 at 6:17 AM ·

We have high confidence that freezing rain will occur overnight tonight into early tomorrow morning, and more precipitation will be possible tomorrow afternoon. Temperatures will remain below freezing through Monday.

Significant ice accumulation will occur across the region. Expect up to 3/4 of an inch of ice, particularly along I-44 and the Tulsa metro.

1.7K 162 comments 37 shares

Figure 8: Facebook-style post containing both storm information and impact descriptions

US National Weather Service Tulsa Oklahoma
Jan 17 at 6:17 AM ·

We have high confidence that freezing rain will occur overnight tonight into early tomorrow morning, and more precipitation will be possible tomorrow afternoon. Temperatures will remain below freezing through Monday.

Significant ice accumulation will occur across the region. Expect up to 3/4 of an inch of ice, particularly along I-44 and the Tulsa metro.

Impacts:
- Travel will be extremely dangerous or impossible across much of the region
- Expect widespread power outages which may last multiple days
- Slick sidewalks will increase risk of injury

1.7K 162 comments 37 shares

Figure 9: Graphic containing storm information but no impact descriptions

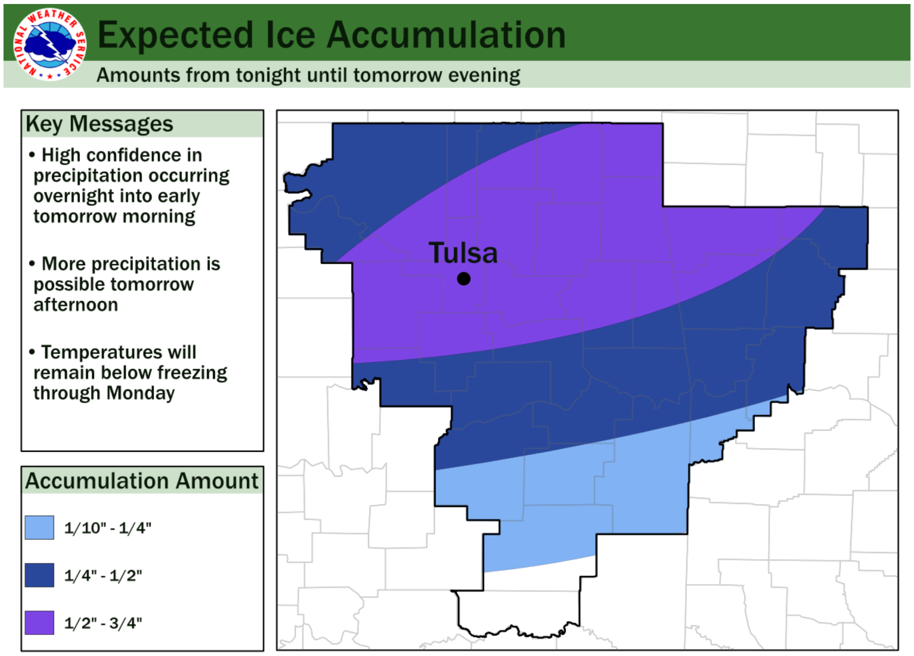

Figure 10: Graphic containing both storm information and impact descriptions