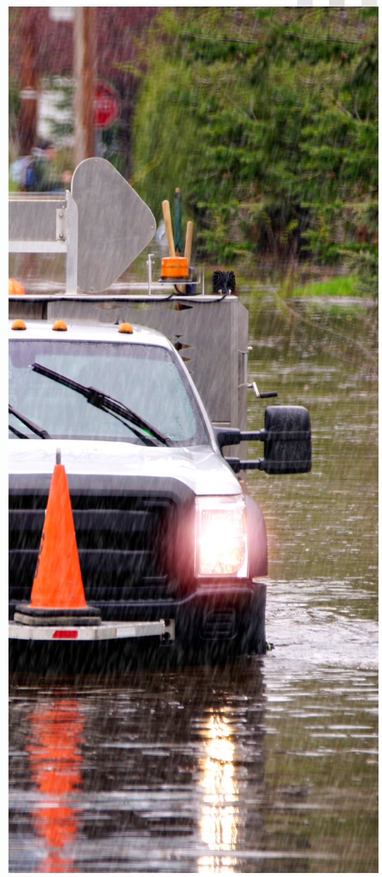
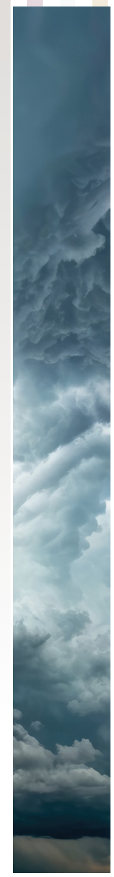
TAILORING PROBABILISTIC INFORMATION TO COMMUNITY NEEDS:

A Rhetorical CRIB Sheet

NOAA Technical Memorandum OAR GSL-72





MEANDER
Meteorology and Environmental Rhetoric

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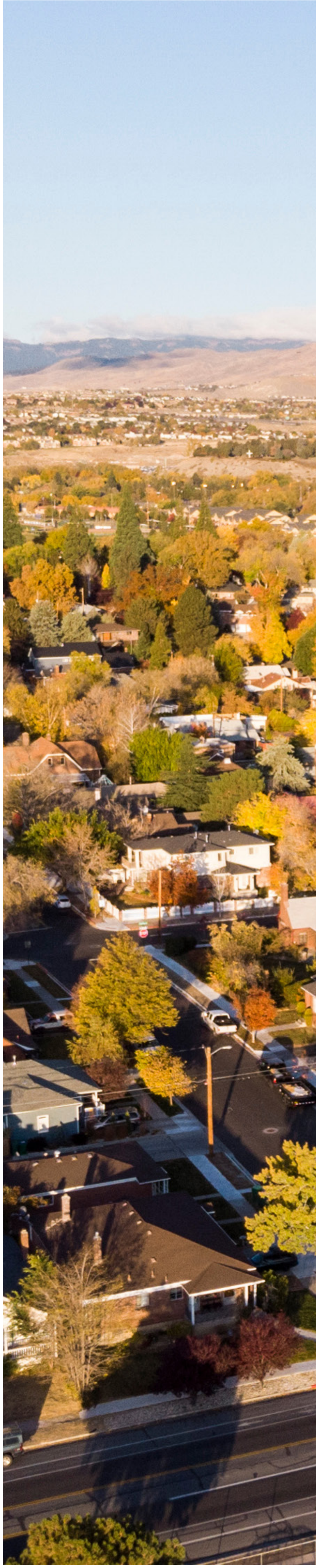
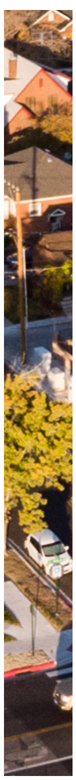
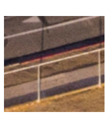






EXECUTIVE **SUMMARY**

Probabilistic information (PI) can assist audiences with weather decision-making while increasing trust in the forecast (Ripberger et al., 2022; Losee & Josyln, 2018; Josyln & Grounds, 2015). However, forecasters need to know how to integrate PI in a way that is effective, meaningful, and aligned with community needs. Specifically, PI can overwhelm forecast users with too much information (Heggli et al., 2023). This technical memorandum provides a rhetorical CRIB (Collect, Review, Identify, Build) sheet, with supporting rationale and resources, to help forecasters tailor PI to community needs via **commonplaces** (shared beliefs, norms, and values).

Community **commonplaces** are a key concept from the field of **rhetoric**, which specializes in helping communities resolve uncertainties, like those in weather events, by selecting from available communication strategies. Rhetoric is therefore a strong partner for meteorology, where "just in time" communication of probable weather impacts makes a difference for both responsible decision makers and public audiences.

This memorandum begins with an Introduction that discusses the genesis of the project that led to the rhetorical CRIB sheet, followed by a section dedicated to "Defining a Rhetorical Approach" in relation to probabilistic forecasting. We then share the one-page CRIB sheet for applying rhetorical commonplaces to probabilistic forecast scenarios. We end with supporting resources for enacting the steps outlined in the CRIB sheet. The immediate goal is helping forecasters integrate PI into weather communication in ways that are meaningful to the communities they serve. The ultimate goal is increasing communication and trust between forecasters and their communities, as resilient forecast communities are key to managing the growing risks associated with extreme weather events (Cross & LaDue, 2021).

EXECUTIVE SUMMARY

INTRODUCTION

As part of the initiative to achieve a Weather-Ready Nation, data provided by the National Blend of Models and other forecast ensembles gives forecasters access to a range of post-processed data that can assist audiences with decision-making. The movement towards incorporating probabilistic information (PI) makes use of new data to offer a range of possibilities, moving the National Weather Service beyond deterministic forecast norms (Craven et al., 2019). However, with the development of new tools and a new suite of model output available, forecast offices are faced with a challenge: how can new PI be communicated effectively to target audiences? What amount and type of PI is appropriate and useful for communities making decisions about current and forecast weather, and what kind of visual and textual choices should be used to do so?

In response to growing complexity in forecasting extreme weather impacts at the community-level, the team at the National Weather Service, Reno office began experimenting with different ways to communicate information that could inform decision-making. Specifically, they began embedding what those in rhetoric refer to as commonplaces—recurring beliefs, norms, and values unique to their community—into their forecasts shared on social media (Walsh, 2018). To determine if this strategy worked, they partnered with rhetoricians to conduct research on the topic. The resulting pilot study published in 2019 in the *Bulletin of the American Meteorological Society* found that posts using this technique had stronger interaction with public audiences, helping meteorologists build trust (Lambrecht et al., 2019). Follow-up work on commonplaces in collaboration with the National Weather Service, Phoenix found that extreme heat–a defining characteristic of this region's weather and climate–is a marker of community identity and normalized within the community (Lambrecht et al., 2021).

Building on this initial project, our team of meteorologists, rhetoricians, and science education experts sought to apply these tools to PI integration into forecasts, providing the exigence for the current project. This guideline serves as one of the final deliverables for that project, titled *Employing Rhetoric to Improve Probabilistic Forecast Communication*, funded by a NOAA Weather Program Office grant (NOAA-OAR-WPO-SBES-21). The goal of the project was to survey NWS core partners and public audiences in five forecast communities (Phoenix,

FIGURE 1: NWS Reno forecast examples with (left, i.e.: "I'll believe it when I see it" and top right, i.e.: "Yes, it's going to snow 'down here'") and without commonplaces (bottom right) embedded.

AZ; Reno, NV; San Diego, CA; Pocatello, ID; Portland, OR) about what they found useful and what they would change about existing weather graphics that incorporated PI. Our team then coded responses and identified recurring commonplaces, a sample of which are listed below. Respondents discussed that quantity of weather (how much and what kind of precipitation, for example) guided their decisions. With enough repetition in the dataset, we identified this as a commonplace of Degree. Within these commonplaces, our team also identified a trend of audiences sharing their risk thresholds, specific types of commonplaces that represent go/no-go cutoff points for community members making decisions about the weather (i.e.: "With two inches of snow, I'm staying home"). Examples of the most prevalent commonplaces we found are shown in Table 1 below.

TABLE 1: Example commonplaces and risk thresholds identified through survey data.

COMMONPLACE	DEFINITION	EXAMPLE
Degree (i.e., magnitude)	Event quantity and magnitude	"The amount, level, or extent of a weather outcome being described in this graphic are below normal threshold values for our operation. Even if the storm exceeded the 4″+ (14%) probability, the amount of new snow would likely only create a slight rise in avalanche risk."
Location	The proximity of an asset to a weather-related hazard	"This illustration shows the different impacts in various locations within our service territory. I can easily see what areas are going to be impacted the hardest."
Probability	A measure from 0 to 1 (or 0% to 100%) of the likelihood (or chance) of an event occurring	"A less than 5% and a 75% chance of less than an inch gives me hope that minimal disruptions could occur if properly equipped and prepared."
Data Fit	Visuals used to communicate the forecast	"The graphic itself is problematic. We are used to thinking in terms of temperature not likelihood of going over a certain temperature."
Color scale	Colors used in the forecast visuals, can be colors themselves and/or how they are ordered or scaled	"Probability of Temperature above 90% is a bit confusing when combined with the color scheme."

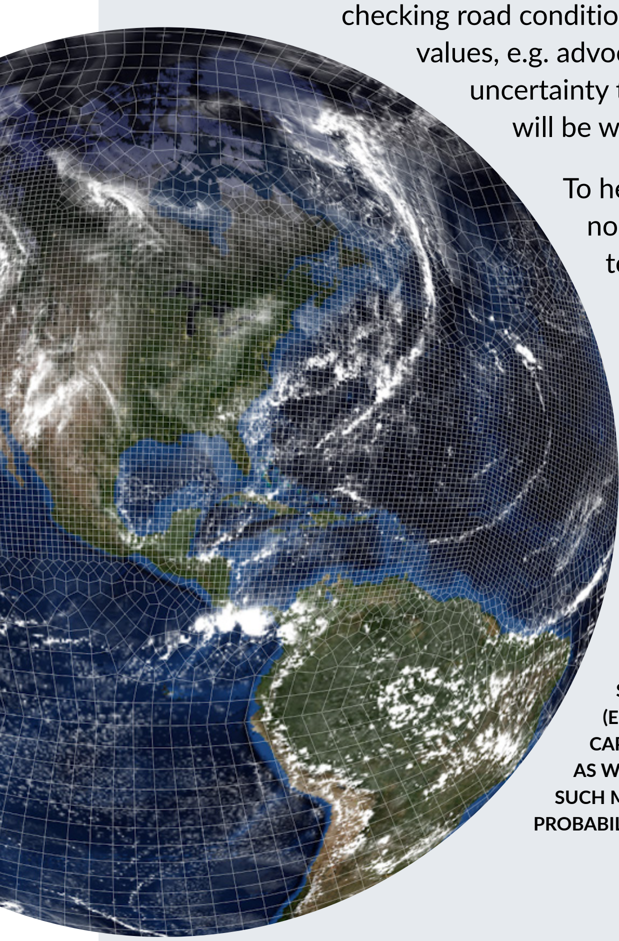
While our coding process followed a step-by-step methodology to identify percent agreement and offer a comparative analysis across forecast offices and visualization types, the goal of this technical memorandum is to offer an adaptable, easy-to-follow reference guide for identifying commonplaces in forecast communities. We discuss the rhetorical approach that grounds this strategy, offer a one-page quick reference guide (CRIB sheet) to share the method, and include resources and tips for implementing a version of this process in any forecast office. Because the goal is to learn about commonplaces in the community and then apply those commonplaces, we discuss examples of what this looks like in practice, including guidance for visualizing PI in forecast scenarios.

DEFINING A **RHETORICAL APPROACH** TO WEATHER FORECASTING

Rhetoric is a field that emerged from ancient Greek attempts to found a stable democracy. It is both an analytical discipline and a productive art focused on the role that communication plays in community-building. Because communities face uncertain circumstances that they must handle as a group, rhetoric identifies which communication strategies best prepare communities to address uncertainty by building trust and resilience. Thomas Goodnight (1982) therefore defines rhetoric as the “creative resolution and resolute creation of uncertainty” (p. 215). Since PI deals with uncertainty at its core, meteorologists and rhetoricians largely strive for the same goal: to build weather-ready communities. A rhetorical approach to forecasting argues that the most important factor in preparing communities for the impacts of extreme weather is to build stronger ties and trust between forecasters and their communities so that together they can manage the risks associated with weather events.

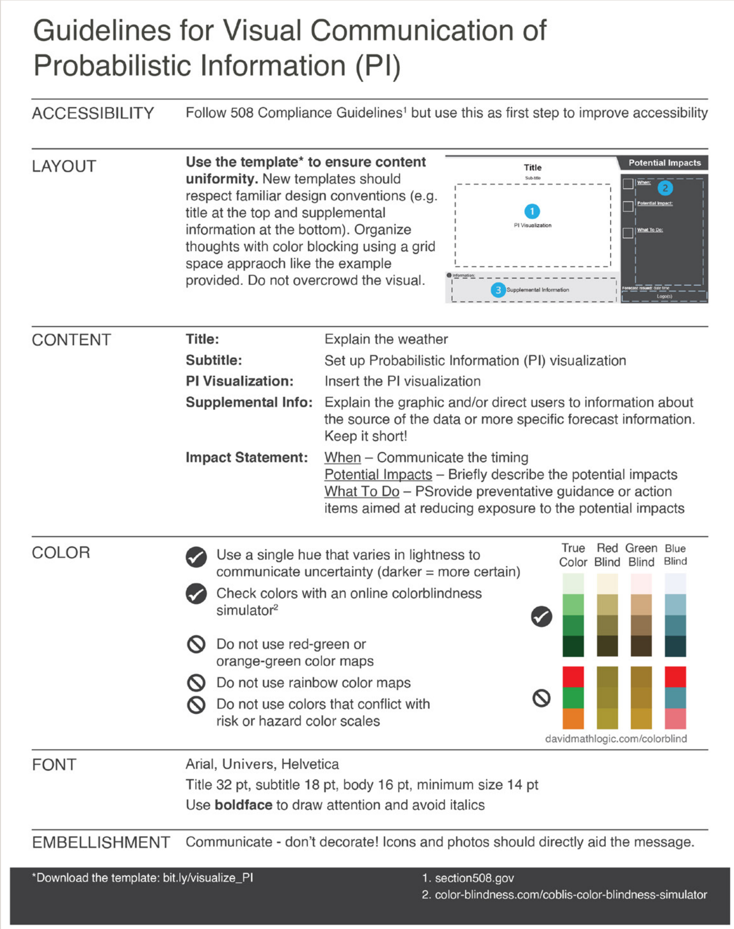
Rhetoric and meteorology make great operational partners because they are both interested in helping communities make decisions about risk and uncertainty quickly and effectively. Because weather hazards and the resultant risks can shift quickly, communication regarding the weather needs to be nimble, responsive, and iterative. Accordingly, rhetoric relies on modifying communication quickly to adapt to changing conditions; it is the engineering counterpart of social science. At the center of this practice is an awareness that community decision-making requires an expanded definition of uncertainty. While meteorologists tend to focus on technical uncertainty (uncertainty linked to technical processes like probability, e.g., models simulating a range of different outcomes), Goodnight (1982) offers that there are at least two other types of uncertainty that arise when making decisions: personal (linked to individual or community norms, e.g., checking road conditions ahead of a work commute) and public (linked to political stances or values, e.g. advocating for weather policy changes). Accounting for all three of these uncertainty types helps communicators determine what the most effective tools will be when communicating weather risks to public and partner audiences.

To help communities make decisions, rhetoricians identify community norms that sustain decision-making and then apply them in relation to uncertain conditions. A rhetorical approach analyzes language to identify commonplaces and incorporates those commonplaces into the forecast long before extreme weather happens. Shared language and values delivered in the forecast via commonplaces helps strengthens community ties so that when uncertain or dangerous conditions arise, trust in the community is already strong. In combining methods from rhetoric and meteorology, we can select the most appropriate communication tool for the forecast situation. In terms of PI, this means identifying which data and information is going to be most useful for communities making decisions about the weather and framing that information in alignment with commonplaces.



STATE-OF-THE-ART GLOBAL MODELS, SUCH AS THE ENERGY EXASCALE EARTH SYSTEM MODEL (E3SM) CONFIGURATION OF THE SIMPLE CLOUD RESOLVING E3SM ATMOSPHERE MODEL (SCREAM) CAPTURE MULTISCALAR PROCESSES THAT IMPROVE FORECAST SKILL, ACCURACY, AND LEAD TIME AS WELL AS HINDCAST ASSESSMENTS OF PAST EXTREME EVENTS. ADVANCES IN COMPUTING MEAN SUCH MODELS CAN BE IMPLEMENTED AS INCREASINGLY LARGE ENSEMBLES, OPENING A NEW ERA OF PROBABILISTIC INFORMATION PRODUCTION CAPABILITIES. IMAGE CREDIT: PAUL ULLRICH/UC DAVIS

RHETORIC



Guidelines for Visual Communication of Probabilistic Information (PI)

ACCESSIBILITY — Follow 508 Compliance Guidelines[1] but use this as first step to improve accessibility

LAYOUT — **Use the template* to ensure content uniformity.** New templates should respect familiar design conventions (e.g. title at the top and supplemental information at the bottom). Organize thoughts with color blocking using a grid space appraoch like the example provided. Do not overcrowd the visual.

CONTENT		
	Title:	Explain the weather
	Subtitle:	Set up Probabilistic Information (PI) visualization
	PI Visualization:	Insert the PI visualization
	Supplemental Info:	Explain the graphic and/or direct users to information about the source of the data or more specific forecast information. Keep it short!
	Impact Statement:	When – Communicate the timing Potential Impacts – Briefly describe the potential impacts What To Do – PSrovide preventative guidance or action items aimed at reducing exposure to the potential impacts

COLOR
- Use a single hue that varies in lightness to communicate uncertainty (darker = more certain)
- Check colors with an online colorblindness simulator[2]
- Do not use red-green or orange-green color maps
- Do not use rainbow color maps
- Do not use colors that conflict with risk or hazard color scales

FONT — Arial, Univers, Helvetica
Title 32 pt, subtitle 18 pt, body 16 pt, minimum size 14 pt
Use **boldface** to draw attention and avoid italics

EMBELLISHMENT — Communicate - don't decorate! Icons and photos should directly aid the message.

*Download the template: bit.ly/visualize_PI

1. section508.gov
2. color-blindness.com/coblis-color-blindness-simulator

OVERVIEW OF **BEST PRACTICE** RESOURCES

This memorandum focuses on how and why identifying commonplaces is an important method for integrating PI into the forecast. However, because forecasts rely on a combination of language and visuals, this overview shares additional resources about effective PI communication developed for this project that complement the rhetorical guidelines provided.

1. **BEST PRACTICE GUIDELINES FOR VISUALIZING PROBABILISTIC INFORMATION:** Our 2023 *Bulletin of the American Meteorological Society* publication "Visual Communication of Probabilistic Information to Enhance Decision Support" (Heggli et al., 2023) reviews best practices in PI visualization and consolidates them into a set of specific guidelines, including information about accessibility, layout, content, color, font, and embellishments. The publication features a quick reference one-page guide available here that summarizes best practices in visual communication of PI. Combining this rhetorical guide with the visual guidelines ensures proper integration of PI to meet audience needs.

2. **PI VISUALIZATION TEMPLATE:** In addition to the visual guidelines established through our publication and one-page guide, a customizable template designed for use by forecasters that incorporates best practices is also available for download and customization here. The template offers slides and spreadsheets for both Google and Microsoft Products and includes instructions for how to customize based on the needs of your forecast office. The rhetorical guide offers a method for determining *what* to build into your PI-based forecast, this template offers the *how*.

3. **PI EDUCATIONAL VIDEO SERIES:** While putting together forecasts that include PI should follow best practices from both visual and rhetorical methods, this information can be new for some public audiences. To prepare communities for forecasts that use this new information to communicate probabilistic information, our team has created a series of public-facing videos that discuss why PI is important and how to use PI information, available here. These videos are designed to supplement forecasts, and guidance is provided for when and how these materials can be used to interface with public audiences.

BEST PRACTICES

RHETORICAL METHOD FOR INTEGRATING PI IN THE FORECAST: **CRIB**

CRIB

CRIB SHEET

Use the method from this CRIB sheet (Collect, Review, Identify, Build) to integrate PI into the forecast in ways that are meaningful to the community.

1. **COLLECT:** Collect comments from your forecast community. Start with 50–100 comments from the constituency you're interested in. Collect responses from a particularly robust conversation on an NWS post or core partner email thread; or, collect comments from multiple posts over a period of time.

FIGURE 2: Public commentary on snow fall

2. **REVIEW:** Review comments and note any theme or phrase that's repeated at least three times; that's a **commonplace**. Commonplaces are the shorthand that your community uses to discuss and manage risks associated with weather events. They reflect shared norms, values, and beliefs relevant to weather risks.

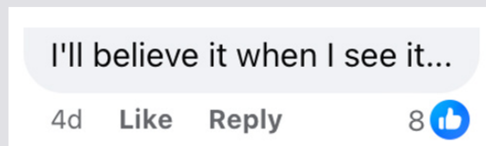


FIGURE 3: Use of a weather commonplace

3. **IDENTIFY:** Identify risk thresholds expressed in the commonplaces; these will typically express tipping points (e.g., 2″ of snow) or visual norms (e.g., legends being too small to read on cellphones). Any repeated comment about how weather-risk decisions are made counts as a risk threshold.

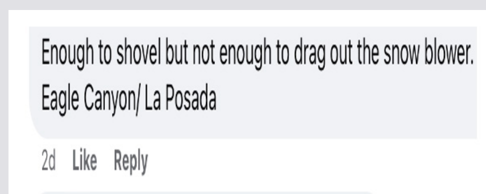


FIGURE 4: Use of a community risk threshold

4. **BUILD:** Build one or more of the risk thresholds that you identified into your next forecast graphic for that constituency, visually, verbally, or both. Using risk thresholds communicates that you know what's important to your forecast community and therefore that you are part of that community.

FIGURE 5: Use of a snow commonplace in a winter season NWS Reno post

CRIB

RESOURCES AND TIPS
TO SUPPORT CRIB SHEET

The tips below apply the CRIB sheet method to a sample of comments from an NWS Phoenix post about record-setting heat. The bracketed information at the end of each step outlines how the process looks in the context of the public commentary shown on the right.

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1. **COLLECT**

a. It may help to set a specific goal for improving PI communication with your forecast community (or sub-group within that community): maybe that's more shares and likes of forecasts on Facebook; more diversity in your Facebook users; or less confusion around particular impacts or technical concepts. [Example goal: Start conversations in the Facebook comments about heat safety in addition to reactions to the forecast]

b. Even if you just sit down with your colleagues in the conference room and scroll through as many comments as you have time for in 20 minutes, you'll still have a valuable discussion about how better to tailor PI to your community. [n=126 comments]

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2. **REVIEW**

a. Make a note of a theme, phrase, or meme that comes up at least three times in the comment set. But use your judgment: if you recognize a phrase you know you've seen often before in other comments, write it down. [Comparing extreme heat to cold]

b. If you like, you can use a text miner like Orange (see this YouTube page for tutorials) to generate word-clouds and trigrams (recurring patterns of three words) that will point you toward recurring themes. ["It's a dry heat"]

c. If you find so many commonplaces that you need to organize them, sort them into categories, i.e., those having to do with visual presentation of the forecast; or those discussing a particular weather hazard or event type. Or, you can categorize according to **uncertainty types**. Whatever grouping makes the most sense to your group is the best one. [Heat reactions vs. safety concerns]

FIGURE 6: Public commentary on extreme heat

3. IDENTIFY

a. In our research we found two kinds of **risk thresholds**: visual norms that gave information about what audiences could and could not process visually (like confusing color scales or labels that were too small); and, tipping points (for example, a certain temperature or number of inches of precipitation that triggered different behavior; or, concerns about levels of something that might put someone at risk). Start looking in these two areas for specific expressions of thresholds that you could focus the presentation of PI around in forecasts. But you may find other kinds of thresholds as well. Trust your judgment.

b. When identifying **risk thresholds**, look for go/no-go cutoffs, or points at which your community says their behavior changes or is affected. These are the discontinuities on continuous PI that you will focus the forecast around. [105° is identified as a tipping point]

4. BUILD

a. Have an open-ended conversation with your peers about the best thresholds to build into the forecasts and the best ways to do so. As forecasters, you have the best intuition about what will produce the biggest impact with your community in terms of uptake and engagement.

b. Here are some ways to build commonplaces into forecasts that we saw in our research:
   i. Repeat a commonplace in the forecast title to grab community attention. [Highs of 105° possible as early as the lunch break today]
   ii. List any impacts you know the community is particularly concerned with. [High temps likely to impact hiking safety after 10 am]
   iii. If you know your community has a particular **risk threshold** for making go/no-go decisions about a weather hazard (such as 1″ of snow, or heat above 100°), visually emphasize it in the forecast graphic with an outline, bold font, contrasting color, etc.

c. After you publish these new forecasts, check the community commentary on them to see what kind of uptake and feedback you're getting. If you set a goal, evaluate any changes in uptake according to that goal. Iterate the CRIB procedure periodically as workload allows in order to keep up with shifting norms in the community.

FIGURE 7: Public commentary on snow posts

GLOSSARY

GLOSSARY

Commonplaces are the expressions of beliefs, values, and norms that fundamentally shape a community's relationship to topics like extreme weather (Locke, 1999). Avoiding driving over the mountain to avoid dangerous weather, for example, is grounded in the commonplace of safety for oneself or loved ones. Because commonplaces are reflected in how we react to the world around us, we can uncover commonplaces and the norms and values they highlight in community discussions.

Rhetoric is an ancient discipline that studies how communication forms communities to make decisions. Because decisions often arise due to conditions of uncertainty, Goodnight (1982, p. 215) defines rhetoric as the "creative resolution and resolute creation of uncertainty." Rhetoric uses communication to help communities cope with uncertainty by developing trust and strengthening community bonds.

Risk thresholds are commonplaces that share specific information about where and how communities make decisions about weather risk. In this case, the crossing of a threshold dictates the weather response (for example, "I will cancel plans outside if it's over 100°"). While in some cases risk thresholds are numerical, in other cases they have to do with actions, resources, or norms (for example, "I won't drive in the snow unless I have an all-wheel drive car"). Risk thresholds can be individual, but when they are repeated across communities, they become commonplaces that can be used to deliver forecast information (for example, 1″ of snow may not be a big deal in Iowa, but might cause huge impacts in south Texas).

Uncertainty types represent different orientations to uncertainty that circulate amongst public and stakeholder audiences. Goodnight (1982) identifies three uncertainty types: personal (individual and community impact), technical (probability, and reliability of methods), and public (political stances and widely shared norms). In meteorology, weather forecasting has been treated as a problem primarily of technical uncertainty, but rhetoric predicts that people generally assess risk from a standpoint of personal uncertainty.

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