

# THE ROLE OF STORM PREDICTION CENTER PRODUCTS IN DECISION MAKING LEADING UP TO SEVERE WEATHER EVENTS

Sarah Stough

*NOAA/University of Oklahoma, Norman, Oklahoma*

Elizabeth Leitman and Jeffrey Peters

*NOAA/Storm Prediction Center, Norman, Oklahoma*

James Correia Jr.

*CIMMS/Storm Prediction Center, Norman, Oklahoma*

## ABSTRACT

The Storm Prediction Center (SPC) in Norman, Oklahoma issues tornado and severe thunderstorm watches and other forecast products for organized severe weather over the contiguous United States to ultimately protect the lives and property of the American people. First-order users of SPC services, which are primarily available on the World Wide Web, include Emergency managers, National Weather Service Forecast Office and television meteorologists. These first order users then utilize SPC information in conjunction with their own operations to increase public awareness of hazardous weather events. Because these largely different groups communicate directly with the public, it is important that SPC forecasters can provide the most effective products possible. In order to accomplish this, several representatives from the three aforementioned groups in the central Oklahoma region were surveyed to learn about their reception, interpretation, usage, and thoughts on Convective Outlooks, Mesoscale Convective Discussions (MCD), Watches and Watch Status Messages, Public Weather Outlooks, and experimental enhanced thunder forecasts; and the impact these products have on their respective operations. Preliminary findings suggest that each group generally uses the same products, but the specific information that each uses and disseminates varies widely. For instance, National Weather Service forecasters refer to the discussion element of convective products most frequently, while emergency managers and TV meteorologists tend to favor graphical aspects in comparison. This is also demonstrated by emergency managers' use of the watch graphic for situational comprehension, while TV meteorologists employ it for broadcasting purposes even though, the watch product, commonly thought of as one of the SPC's most important services, was the third most-used product, ranking far behind the Convective Outlooks and MCD products. The users showed that they used probability and timing information from the products and stated that more uncertainty information would be helpful. These findings beg further study of a larger, more geographically diverse set of survey participants to determine how to better meet the array of needs from a variety of primary users. These results will serve as a guide for a national survey that will be conducted in 2012.

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## 1. INTRODUCTION

Operating out of Norman, Oklahoma as part of the National Weather Service (NWS) and the

National Centers for Environmental Prediction (NCEP), the Storm Prediction Center's (SPC) primary responsibility is to release a suite of severe weather forecast and watch products for the

protection of life and property (NOAA/NWS/NCEP/SPC). Published on the World Wide Web, these forecasts are issued and available for as far as eight days in advance. However, the forecast products are tiered such that as a weather event draws closer, forecast precision increases while the size of the area of consideration decreases. Though the forecasts may be accessed by anyone via the SPC webpage, most products were designed to provide technical decision support to specific user groups. Primary users of Storm Prediction Center information include emergency managers, television forecasters, as well as NWS forecasters. These individuals play key societal roles of efficiently relaying hazardous weather information to the public through a broad variety of outlets. As such, it is important that they understand the products available to them, and that they can efficiently utilize those products. The purpose of this study is to gain an idea of how these groups receive, interpret, and employ each form of weather information they receive from the SPC. In the study of the communication and interpretation of warnings, Shumacker *et al.* asserted that “Understanding the flow of warning information among decision makers and the public, and how warnings are interpreted, are key first steps toward maximizing the effectiveness of these warnings” (SCHUMACHER *et al.* 2010). The parallel may be made that understanding how decision makers and first-order users interpret hazardous weather information from the SPC is vital to maximizing its usefulness, an important goal for ultimately achieving better public awareness.

## 2. BACKGROUND

SPC generated forecasts can be categorized by temporal as well as areal characteristics. Those products issued furthest in advance are referred to as Convective Outlooks, and are released multiple times per day as a scheduled product on a nationwide scale. There is a separate forecast for each of Day 1, Day 2, and Day 3, which includes a graphical interpretation as well as a text discussion. While the discussion provides a technical explanation of the forces driving a potential severe weather event, the graphics include a categorical outline of risk expected for an area for the day, which is designated either slight, moderate, and high; the probability of severe weather occurring within the risk for Day 1, 2, and 3 (Figure 1a-d). The Day 1 (Figure 1b)

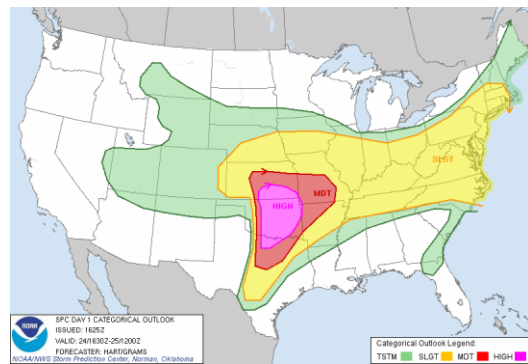


Fig. 1a: Day 1 Convective Outlook with categorical outlines (NOAA/NWS/NCEP/SPC).

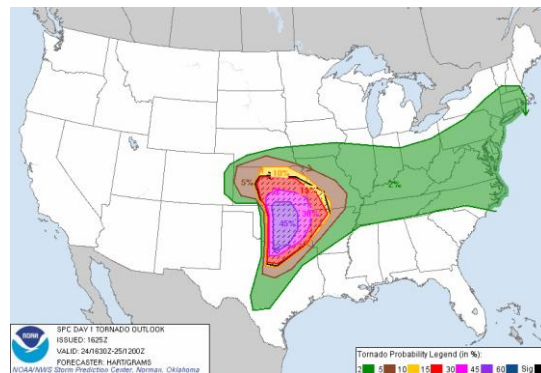


Fig. 1b: Day 1 Convective Outlook with example of probabilistic outlines for tornado threat (NOAA/NWS/NCEP/SPC).

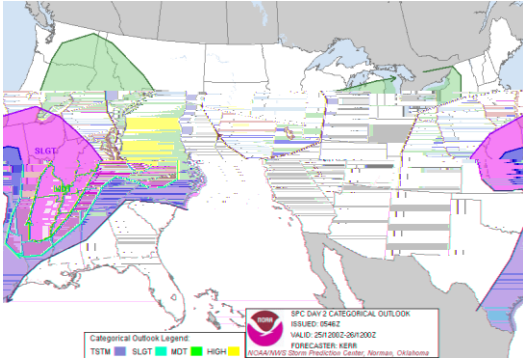


Fig. 1c: Day 2 Convective Outlook with example of categorical outline (NOAA/NWS/NCEP/SPC).



Fig. 1d: Day 2 Convective Outlook with example of complete probabilistic outline for total severe weather threat (NOAA/NWS/NCEP/SPC).

outlook breaks down the area severe weather threat (i.e. tornado, wind, or hail). In addition, the SPC also issues a single Outlook for Days 4 through 8, which includes a graphical probability line for each day on one map as well as a combined discussion.

Another Outlook product is the Experimental Enhanced Thunder Outlook, which is issued in time blocks of four and eight hours. It is a nationwide product that indicates the probability of thunder to occur in an area, outlined by 10 percent, 40 percent, or 70 percent contours. Unlike the Convective Outlook, however, there is no text discussion provided.

Designed to be a non-technical supplement to the Day 1 Outlook, the Public Weather Outlook serves to alert the public to greater probabilities of

tornadoes or high wind associated with a particular severe weather event. However, unlike the Outlook product, it is not meant to serve the entire country, but only the area covered by the aforementioned moderate or high risk outline.

In addition to releasing forecasts for up to days ahead of time, the SPC also issues products meant to provide information concerning the severe weather potential in the near future for a particular area. Mesoscale Convective Discussions (MCD), named for their smaller regional extent as well as the technical nature of communication surrounding it, are released to provide information about whether conditions are favorable for potential severe weather, and are often the precursors to the issuance of a watch. The text discussions are accompanied by a graphic that regularly depicts the potential threat area, interacting environmental forcing mechanisms, instability measures, as well as surface conditions. While MCDs typically signal the issuance of a watch within the next one to three hours, they are also released to give a brief summary of the convective nature of the environment along with an explanation as to why conditions may not necessitate a watch. An example of an MCD graphic may be seen in Figure 2.

Mentioned briefly above in relation to MCDs, many consider the watch to be the SPC's premier product. Another short-term forecast tool issued at least one hour before an event, it may be classified as either a severe thunderstorm watch or as a tornado watch, depending upon the environmental conditions. An example of a tornado watch is captured in Figure 3. Narrower than any of the outlook areas in scope, watches typically

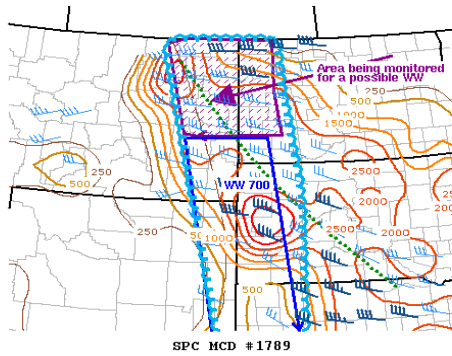


Fig. 2: Mesoscale Convective Discussion graphic detailing meteorological storm environment (NOAA/NWS/NCEP/SPC).

cover from 20,000 to 40,000 square miles and cover a window of six to seven hours. As it is issued for a variety of severe situations, the watch product also contains a probability chart showing the potential for specific hazards expected within the graphic areal outline. Largely acting as an alert to the public to pay attention to evolving weather conditions, and written in plainer text as a result, it is also meant to provide emergency managers and forecasters with lead time to prepare for operations and the arrival of severe weather. While MCDs provide an update to the environment, the watch is the final public product that the SPC issues to signal confidence that conditions will be favorable for organized severe weather for a particular region. It is updated periodically by Status Message to redesignate the severe weather threat area contained within a Watch (Novy *et al.*).

SPC forecasters have constructed these products over time for the consumption of the aforementioned primary user group of emergency managers, television forecasters, and NWS forecasters. Though lumped together into this overall assemblage, each faction represents an extremely different type of profession, as well as a

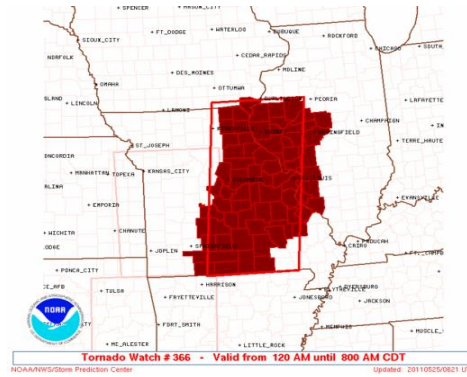


Fig. 3: Tornado watch delineated by polygon as well as county fill-in (NOAA/NWS/NCEP/SPC).

different role in communicating with the public. These considerations must be taken with respect to forecast product design.

Emergency managers are responsible for mitigating the tolls of disaster on society from a variety of fronts, including societal, technological, and environmental (Lindell *et al.*). With the environment being one of the most natural, unavoidable causes of loss of life and property, weather plays a large factor in the concerns of emergency managers on a nearly daily basis. Though not often responsible for directly communicating with the public, these individuals do pass information to potentially hazardous weather to first responders such as fire fighters and police to promote readiness immediately following a severe event.

Television forecasters relay information over one of the largest communication channels, both audibly and visually. In a survey to determine forecast sources and use by the public, Lazo *et al.* found that over 70% of respondents received a forecast from local TV at least once a day (Lazo *et al.*, 2009). In addition to generating their own weather information for broadcast, the nature of their profession requires TV forecasters to condense large

amounts of detailed technical information into clear, concise, digestible statements. Failure to do so may hinder their ability to reach the largest possible audience.

NWS forecasters operate in a significantly different manner than TV forecasters. The weather information they create and the weather warnings for severe weather events that they issue are released directly via the internet and web, but usually matriculates to the public through a variety of partners. In this way, NWS forecaster operations run the most parallel to SPC operations of the three groups.

As shown above, each forecast in the collection of products available from the SPC serves a different purpose and is constructed with a variety of knowledge communication objectives in mind. Additionally, the SPC possesses a diverse consumer group in terms of professional goals and associated information requirements. As such, it is important for SPC forecasters to recognize how their products are actually used once released along with how their forecast applications vary by consumer group. To accomplish this, a selection of members from each of the groups was interviewed on a set of pre-selected products. This was done to determine, in part, which products they are familiar with, how they employ several pre-selected products, how these products can affect their operations, as well as what outlets they depend on most for the communication of weather information. The responses given were then analyzed for trends and discrepancies associated with forecast product use.

### **3. DATA AND METHODS**

#### *3.1 Data Collection Instrument*

To gain information on how the respondents employ the products, an interview format was chosen as opposed to a paper survey in order to heighten the response rate. A predesigned interview form was employed covering a selection of topics in 20 questions. The interviews were conducted in a closed conference room with the interviewer, respondent, and one to two secondary interviewer/transcribers. During the interviews, a digital voice recorder was employed for the purpose of additional complete data collection for later reference.

The survey form itself was created using mostly open-ended questions, which may be viewed in Appendix A. The motivation for this design came as a result of the fact that responses to open-ended questions can offer increased insight otherwise unavailable with a closed-question construction. The difficulty that comes with this enhanced information set is that responses are frequently varied and non-standard, the repair to which will be discussed later (Fink, 2009). Because the survey required respondents to recall specific detail about their usage of several products, the form was sent to them via email in advance to grant time for private recollection and preparation. Additionally, printed examples of all forecast products were provided for reference at the time of the interview.

#### *3.2 Survey Sample*

This study analyzes the responses of a target group of SPC users comprised of emergency managers, TV forecasters, and NWS forecasters. The sample size for this study was small, set three

individuals from each group for a total of nine interviewees. Also, each of the respondents represented the central Oklahoma region, largely narrowing the diversity of the study participants and potential range of insight and opinion. This study is purposefully small to allow for in-depth examination of a number of first-order users and how they utilize SPC products. These results will help shape a future nationwide survey of first-order users and the general public.

### *3.3 Analysis Methods*

The survey itself was meant to extensively cover respondent use and impressions of a particular set of products, including the MCD, Watch, Convective Outlook, Status Message, Public Weather Outlook, and Enhanced Thunder Outlook, all of which are previously defined. Desired information included perception of usefulness of the products and their features, information avenues, as well as general opinions on aspects of SPC forecasts. Questions covering these topics were broken into sections of “Storm Prediction Center Convective Weather Products,” “Storm Prediction Center Convective Weather Products and Your Operations,” “Social Media,” “Public Weather Outlook,” and “Suggestions.” For most cases, analysis by topic, such as operational information, was assisted by the survey section divisions. When analyzing individual products, which often appeared as a part of multiple sections, it was simple to then organize product analysis by survey section. Lastly, for analyzing data by profession, the data needed only to be divided by complete surveys. Where sensible, data was viewed both by blind to as well as relative to the type of respondent.

Analysis of the collected data began with brief notes taken during the interview process. The next step included making transcriptions of the audio recordings of the interviews. Not only did this process provide a more detailed concrete data pool, but it also significantly increased data familiarity by immersion. Despite the length of these interviews, which spanned from 30 minutes to an hour and a half, general trend indications and points of interest could already be detected at this stage.

Because of the extreme qualitative nature of this data, standard scientific analysis methods did not typically apply. Instead, conclusions were formed using comparisons, relationships, and direct common statements, with only a few scoring mechanisms and ranking techniques (Fink, 2009). Also, open-ended questions created a large variety of different responses in several cases. In these qualitative situations, credence was given to the fact that such large discrepancies existed among only small response overlap.

Some open-ended questions with a multitude of different responses involved some aspect of quantitative data. For questions such as this involving some ranking aspect, a scaling method was applied. Since not everyone ranked the same items or ranked items by the same scale, as a closed set of items was not provided, all ranks given had to be scaled over the entire set of listed items from all nine interviews. The items that any individual did not list received a rank of zero, while the highest listed item received the top rank, or rank representing the total number of items. Then, the lowest ranked item received a score of one, while all ranked items in between were scaled between one and

the highest number accordingly. In this way, all items could be ranked relative to each other, and their rankings could be averaged over the entire set to get an overall rank.

Further, some open questions concerning greatest use of an item required scoring mechanisms to get a true sense of the overall answer to the question. In this case, any items directly mentioned were given two points, while items recalled following prompts or from other questions were awarded one point. Items not mentioned or not used received zero points. In this way, points could be tallied over nine users and totals could be ordered to get a better idea of most use overall. In addition, when this method was applied, products were also considered without any type of scoring.

#### 4. DATA ANALYSIS AND DISCUSSION OF RESULTS

##### 4.1 Data Analysis

One of the first topics discussed during the interviews was general product use. When asked which products were employed, respondents listed any that came to mind, sometimes with the use of the printed examples or from notes they had taken prior to the meeting. All products (Figure 4a), and observed after the scoring method discussed in Section 3.3 was applied in Figure 4b.

From the first figure, it appears that many products are tied in terms of amount of use between individual products, with the Convective Outlook, MCD, and Watch close together at the top of the list. Upon inspection following scoring, it may be seen instead that the Convective Outlook and MCD are tied for primary use while the Watch comes in third place with a significant separation in score. Meanwhile, Watches were listed in third and Status Messages, an associated product feature, are shown to be fifth most-used. When observing

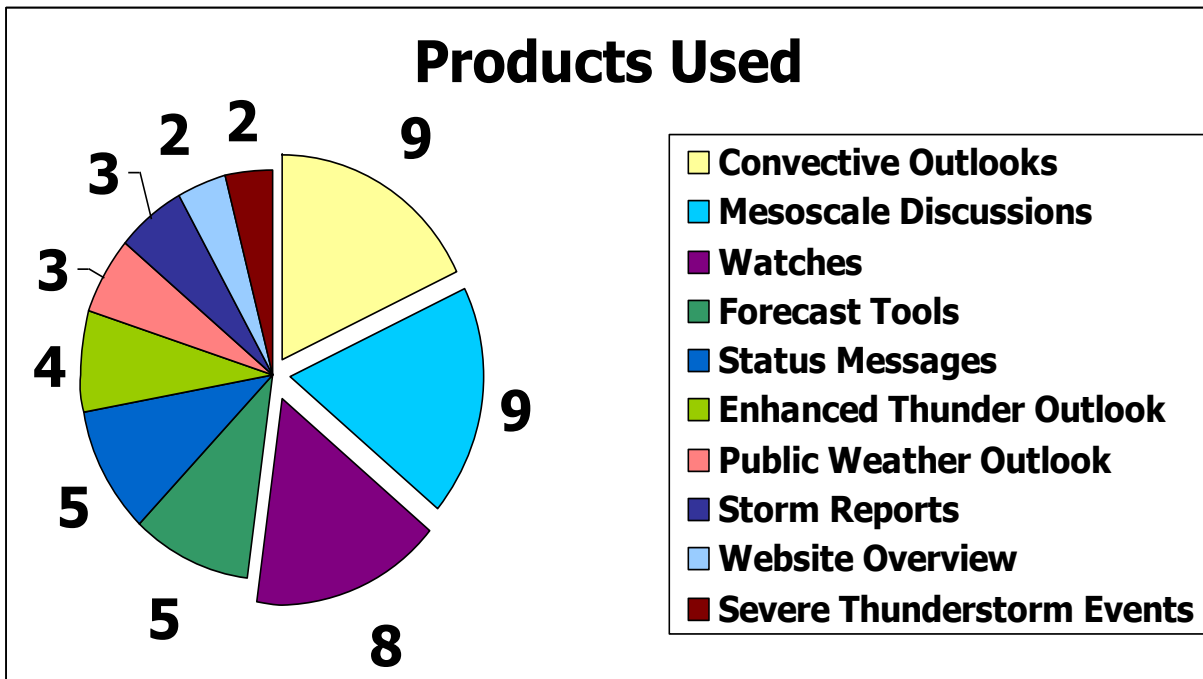


Fig. 4a: Products used as listed by the respondents.

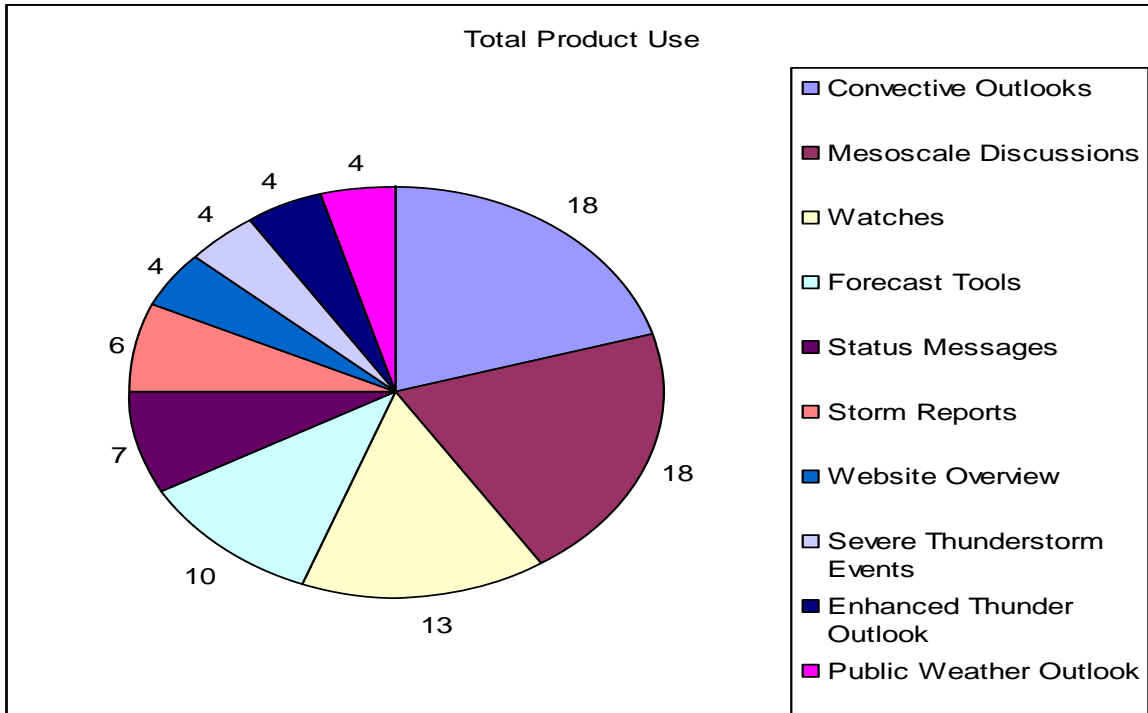


Fig. 4b Chart denoting total scored product use. Numbers represent the total score applied to the product.

user trends from response to this question, it is most notable that emergency managers use the least amount of products of the three professions (Table 1).

Next, individuals were requested to rank the products in terms of most use. This was asked in the form of an open-ended question, the ramifications of which were that many products were listed, not everyone gave the same products, and because not all ranked lists were the same size, the rankings themselves were given on different scales. The procedure given in Section 3.3 for this situation was applied to this data set, the results of which may be seen in Table 1. Once again, the Convective Outlooks ranked highest, with MCDs in second and the Watches in third. Status Messages, which are associated with watches, were farther down the list. Also, though the Enhanced Thunder Outlook was listed by four

individuals and the Public Weather Outlook by three, the Enhanced Thunder Outlook was not ranked by any individual, and the Public Weather Outlook was the lowest ranked product. This signifies that in some cases, though products were cited as being used, not all were then considered to be useful.

Many of the next questions of the survey dealt specifically with the usage of the Convective Outlook, MCD, and Watch products, which are considered to be the main convective forecast products. First, respondents were asked what information in each product they found to be most useful. While as many as six to eight different aspects arose for each product, four common themes threaded through each: textual discussion, graphical elements, probability information, as well as some form of timing information. In the Convective Outlook and Watch, these four aspects are readily apparent, with



timing information being integrated into the text discussion. In the Mesoscale Convective Discussion, timing and probability information are slightly less evident, but both are included in the wording in terms of whether a Watch issuance is likely or unlikely, and typically include a timeline both for severe weather initiation and Watch issuance. Out of the four elements, the discussion proved to be the most popular, with NWS forecasters taking the lead in use out of the three groups

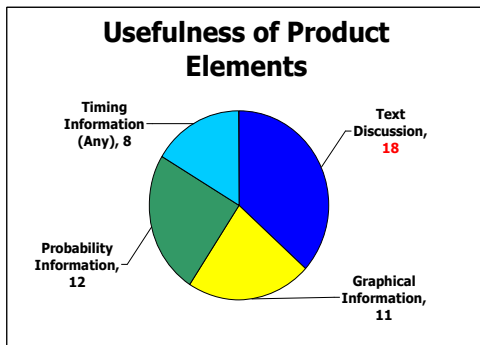


Fig. 5: Numbers represent the sum of each individual's use of three products; Outlooks, MCDs, Watches. The total number would therefore be out of 27.

(Figure 5). The next most popular elements were those of graphics and probabilities. Graphics were chosen by emergency managers and TV meteorologists equally, while TV forecasters were shown to be the heaviest users of probability information. Timing information was the least used in general, but the most evenly distributed between groups (Figure 6). Though neither the timing nor probability element was at the top of the list of helpful features, the fact that they were listed as helpful signifies that individuals are using this information to become more aware and prepared, advancing a more weather-ready society. As part of the analysis, specific attention was given to the preferences of each

professional group as well. The group that tended to be the most rounded in terms of product element use was that of the emergency management sector. TV forecasters also possessed roughly equally distributed preferences, except for timing element use in the clear minority. The group with the strongest tendencies was that of the NWS forecasters, who preferred text

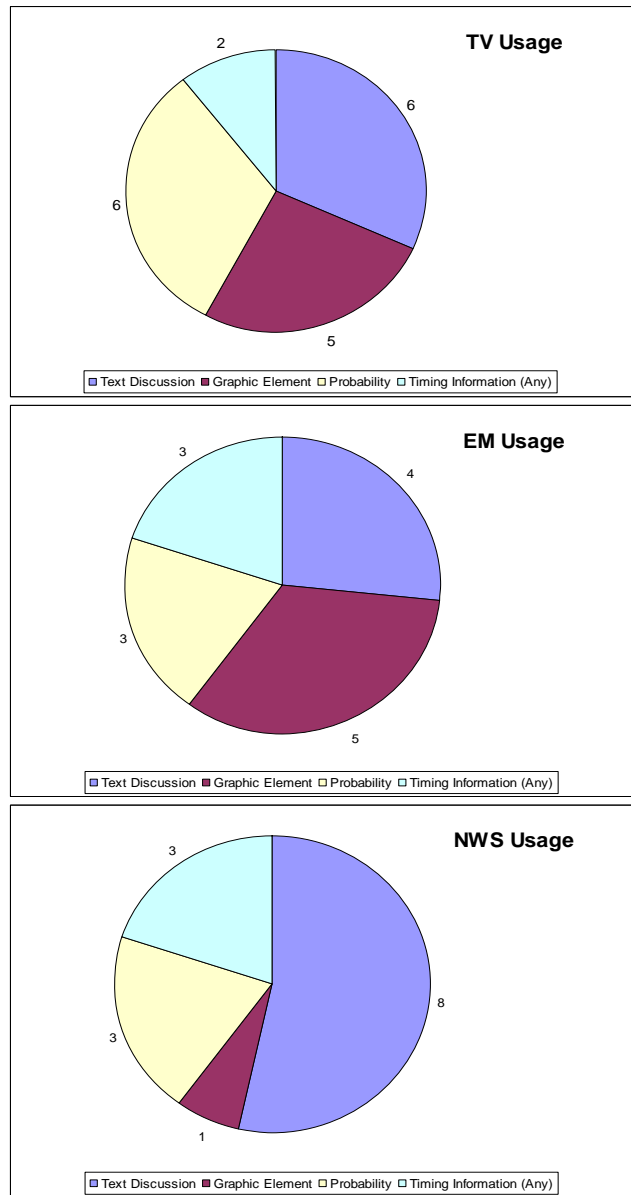


Fig. 6: All three groups' usages of products are given here. Purple denotes the text discussion, red denotes the graphical information, yellow denotes probability information, and green denotes timing information.

discussions by and large over all other elements found in the three products. Meanwhile, for this group, timing and probability information ranked second most desired, while only one forecaster uses the graphical information from one product. Breakdown of all of the above information may be found in Figure 6. The second set of questions covering individual products was about how the products affect operations, or specifically how the groups use them. As could be expected, there was a wide variety of uses for each. Of the three products, MCDs had the narrowest range of utilizations, with nine functions. Between how it is used as a product and how its size plays a role in operations, the Watch had the most different uses at a total of 14. However, there was some use overlap between products. As seen in Table 2, all three products were used to signal alerts to partners. Five more uses were common to a combination of two products. On an individual level, most use the Convective Outlook, MCD, and Watch products for staffing, alerts to partners, and for the purpose of thought confirmation. When viewed with respect to profession, it became evident that all groups had a fair variety of uses across all products. However, emergency managers have the fewest number of utilizations, with at least two individuals using products the same way. TV meteorologists had the most uses between products, followed by NWS forecasters in close second. However, NWS forecasters had the most consistency in usage, with all three individuals from the group finding commonality across four different employments of the products. All in all, there was no strong differentiation in type of use, or effect on operations, between groups for the three products.

In addition to learning how products affect operations, it was also asked how long it takes to generally act in a hazardous weather emergency. While the definition of “hazardous weather emergency” generally varied between groups, response times were not as diverse. To the TV forecasters, an emergency action means going into live, interruptive broadcast mode, while the NWS forecaster will go into warning mode, or a state of operations where the suite of hazardous weather warnings may be issued. The emergency manager, however, typically does not act until after a disaster, but readies for such an event far in advance. Despite the variety of explanations for the meaning of emergency operations, all but one respondent said that it would be possible to commence such actions within minutes. Four respondents, including all three emergency managers, said it would take only a day to prepare their agency and partners. In total, the responses ranged in scale from instant action to a day’s worth of preparation.

The step of learning about speed of readiness for severe weather is associated closely with the topic of issuance time preference. Not surprisingly, though many were pleased with the current times, six of the nine stated simply that the latest information, even with unscheduled release, would always be appreciated or preferable. Meanwhile, others suggested having more MCDs for more frequent updates.

Another aspect of the survey included questions concerning channels of information. For methods of receiving SPC information, the website was cited by everyone, with AWIPS, NWS Chat, and iPhone applications being the next most-uses. Nine sources in all were given, shown in Table 3. When asked

how any weather information, SPC related or otherwise, was received or disseminated, a total of 19 sources or outlets were given. Twitter and Facebook were tied at the top of the list with eight individual responses, each. NWS Chat, phone alerts, and email came in second or third with four or three individual users, respectively. Out of the three groups, the NWS forecasters used the largest variety of tools for communication and information collection, but the least amount of sources for SPC information at two. On the other hand, emergency managers used six different methods for getting SPC outputs, representing the group who used the most sources.

When asked what kinds of information was generally dispersed or sought, 20 different items were mentioned in total. Of these, Watches came in first with six individual responses, while spotter reports and warnings came in second place at four. As many as 16 different kinds of information resulted from only a single respondent's answer.

At the end of the survey were two questions concerning website and product suggestions. For the website, only one item occurred twice, appearing as a request for an area to show only the latest released products or most relevant information at any given time. Other suggestions included having the option for having a white background for graphical products, having a filter for Local Storm Reports, and displaying text discussions in lower case lettering. For the general product suggestions, three individuals requested a simpler vocabulary with fewer acronyms and less use of jargon, while appeals for more graphics and unscheduled outlooks were each made by two individuals.

Requests for forecaster hand analysis maps, less uncertainty information, less model comparison, more experimental products, separate outlooks for instances when two waves of events are forecasted to occur within the Day 1 time frame, and quality control for the Local Storm Reports page were among other suggestions.

#### 4.2 *Discussion of results*

After viewing a range of aspects from the collected data set, assorted trends and interesting features came to light, both for the entire sample of participants as well as for each individual group.

A significant focus is placed upon those products that rank in the top few spots of frequency of use, which prompted the question as to what individuals generally seek in a product as they are considering it for use. When analyzing the responses to the question of what each individual deemed useful in the Convective Outlook, Mesoscale Discussion, and Watch, four distinct elements emerged, the text discussion was found to be most important, as previously discussed. This is not, however, to say that the discussion should be most focused on in future issuances of any of these products at the expense of other aspects. With reference to the text discussion, one individual stated, "We don't have a lot of time to read that sort of level of detail...that's why we kind of rely on pictures," indicating that despite what the statistics show, all elements of the products are important.

Determining which product aspects these consumers deemed useful was helpful in understanding the roles they play within operations for each

group. On the whole, the three main convective products were used to alert partners and/or first responders, plan staffing, and to confirm forecast thoughts. When analyzed by product, however, more idiosyncrasies are visible in terms of the Watch, aside from simply a lower ranking of usefulness. While the Convective Outlook and Mesoscale Convective Discussion most affect how staffing is planned, the contacting of outside individuals, and forecast confirmation, the Watch did not have any major outstanding impacts on operations, prompting the question of whether it may be outdated. In total, there were 14 different ways that the Watch is used, and the largest number of individuals supporting any single usage was three.

When the usages were analyzed by profession, several other noticeable factors appeared, beginning with TV meteorologists. The most useful element was reported to be the text discussion, followed by the probability information and graphics. Though they consider the largest effects of SPC products to be on broadcasting, which includes “when watches get issued...showing (them) on the air,” or specifically relaying graphics to the public, TV meteorologists do not consider graphical information to be among the most effective elements. Rather, graphics fall in third place after the text discussion and probability information. Then, planning of staffing and forecast confirmation, associated with textual and probabilistic information, came in second and third place after broadcasting objectives, but corresponds with the first and second most helpful elements of text discussion and probability information. This is perhaps because of the fact that once severe weather begins to affect an area,

it becomes more difficult to create and update forecasts while broadcasting, making outside technical text assistance more valuable, yet actual broadcast is the main objective of a TV meteorologist. A similar trend was also noted with emergency managers. The group cited notification to make alerts to outside partners as the largest way in which products could affect operations, yet the timing and probabilistic information they use to do this fell at a tie to the third place in the list of helpful elements. Meanwhile, the graphical product elements were most helpful, yet corresponded to the third largest usage for operational readiness. Again, this may be because emergency managers gain the most for their understanding from graphical means of communication, yet their most important function is to alert others of impending events. NWS forecasters did not display similar behavior, but their relative product ranking shows in a more distinct sense the nonlinearity of the relationship of product ranking between groups. These results show both that not all consumers utilized all products, nor in the same way. Also, even when a group found a particular product aspect to be more useful than another, it did not necessarily mean that that aspect would have the largest impact on operations.

In addition to analysis of the most-mentioned products, it was also important to question which major convective products were not cited as being heavily used or very helpful. Among these products was the Public Weather Outlook. The PWO, as a non-technical product, is geared specifically for public dissemination and comprehension. Of the three groups, TV meteorologists and emergency managers might be the only people to distribute

that information. All individuals had heard of it, but most use it only secondarily, as half stated that they have other sources for the same information. The collective feedback for this product is shown in Table 4. Out of all three professional groups, TV meteorologists were the only ones to not list the Public Weather Outlook. Additionally, neither the TV meteorologists nor the NWS forecasters ranked it in terms of frequency of use. However, the emergency management group, though they only ranked 6 of the total 10 forecast services, listed the Public Weather Outlook, though as the sixth most-used product. This prompts the question of who the product is really geared for, and whether it requires people to actively seek it out. When asked whether the protocol for PWO issuance should be altered to include slight risk days, the split was half and half with one undecided response. Of those who said “yes,” most gave the response that more information is better and that the product could be used to generally communicate with the public. Of all who said “no,” the reason was that the product would lose its effectiveness.

A second product not heavily mentioned is the Enhanced Thunder Outlook. From the smattering of comments relating to use of this product, it appears many are still unfamiliar. Seven of the nine respondents stated that they use it only slightly, if at all, while those who do use it say that it is a recent addition to the tools that they use or that they read it only for confirmation of their own forecast. Others who are unfamiliar or do not use it often state that they do not require the level of detail offered, that it is too complicated, or that it is too general.

## 5. CONCLUSION

One of the most notable realizations from the study is that not everyone uses the same products, nor are they used in the same way. However, the Convective Outlook and Mesoscale Convective Discussion consistently stand out, while the Watch somewhat surprisingly falls to the third tier in terms of use. This could possibly indicate that first-order consumers are adapting to SPC products, particularly in terms of interpreting the forecast timeline.

Also noted was that while all three user groups are clumped together under the characterization of “first-order consumers,” they, by no means, can be grouped this way in terms of information communication desires. While the text discussion certainly was a prominently used element, it was also noted that other individuals rely heavily on the other elements for understanding and disseminating weather information, stressing the importance of varied communication styles within each product. Further, though probability and timing information were not considered to be the most useful elements, several individuals alluded to their importance in interpreting a forecast, indicating that those elements are being used as desired to promote understanding and readiness.

Generally, though results may not have been what was expected in all cases, most users are quite satisfied with SPC products and distribution methods. Should considerations be made to alter forecast products in the near future to better meet user needs, it will be important to note the features and aspects of products and dissemination methods that individuals already consider to be beneficial as well as successful.

## 6. FUTURE WORK

Though a fair set of results and conclusions could be obtained and drawn from this study, it will be important in the future to utilize a larger, more diverse data set. From these results, it appears that the three users groups are all relatively well-versed in SPC products, which may not necessarily be the case in a region where convective, severe weather is not as frequent or ordinary and these forecast products are not called upon for assistance in operations as often.

Important future questions to ask include those that further assess the utility of the Watch, as it was shown here to not necessarily be among the most important products that aid in preparing for severe weather as previously thought. Also, future surveys will need to inquire into preferred communication styles and methods. Other individuals who may not be as familiar with the technicality of severe storm environment discussions as those in central Oklahoma also may not necessarily turn to the text discussion of forecast products as often as reported in this survey. In this instance, more importance would be placed on other product aspects.

Lastly, inquiry into public perception of SPC forecast products and their usefulness will be necessary for future studies. Ultimately, decision makers are responsible for dispersing severe weather information, and must communicate it effectively to the general public. In any efforts to increase understanding and effectiveness of forecasts among first-order users, their end goals must also be acknowledged.

## 7. REFERENCES

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## 8. APPENDIX – Tables and Survey

### Tables

Table 1: Rankings of products are provided for each individual. The response provided during the interviews is given under each individual’s identification number, with the adjusted rank in the column immediately to the right. Yellow denotes TV meteorologist response, green marks emergency manager response, and blue signals NWS forecaster response.

Ranked Product Use	1	2	3	4	5	6	7	8	9									
Convective Outlooks	1	9	3	1	1	9	1	9	2	5	1	9	1	9	1	9	1	9
Mesoscale Discussions	2	7.666	2	5	2	5	2	1	1	9	2	6.333	2	7	2	5	2	6.333
Watches	3	6.333	1	9	3	1	0	0	0	0	3	2.666	4	3	0	0	0	0
Forecast Tools	4	5	0	0	3	1	0	0	0	0	0	0	5	1	3	1	3	2.666
Status Messages	0	0	0	0	0	0	0	0	0	0	3	2.666	3	5	0	0	0	0
Website Overview	5	3.666	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1
Storm Reports	6	2.333	0	0	3	1	0	0	3	1	0	0	0	0	0	0	0	0
Severe Thunderstorm Events	7	1	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0
Public Weather Outlook	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0

Table 2: Table shows effects that each product had on operations, according to survey response.

Total Effects	Watch	Outlook	MCD
Prepare for operations	1	1	1
Alert Partners	1	1	1
Staffing	1	1	1
Resource readying		1	1
Alert first responders		1	1
Little to no effect	1	1	
Broadcast effects	1		1
Thought verification		1	1
Crew Placement/Distribution	1		
Situational use	1		
Increased calls in	1		
Alter priority levels of operation	1		
Finances	1		
Size of operations issues	1		
Alert Agency		1	
Alter meeting schedules		1	
Product Production		1	
Forecast resource			1
Generate timeline			1

Table 3: Sources reported for obtaining SPC information. Yellow denotes TV meteorologist answers, green denotes emergency manager answers, and blue denotes NWS forecaster answers.

	1	2	3	4	5	6	7	8	9
Website	1	1	1	1	1	1	1	1	1
AWIPS							1	1	1
NWS Chat		1				1			
iPhone App				1		1			
COD Text Page		1							
NWS Norman Briefing					1				
Twitter						1			
OK First						1			

Table 4: Table gives individual opinions of Public Weather Outlook. Yellow denotes TV meteorologist response, green denotes emergency manager response, and blue denotes NWS response.

<b>PWO Opinions</b>	1	2	3	4	5	6	7	8	9
Heard of them	1	1	1	1	1	1	1	1	1
Has other sources		1			1		1	1	
Posts for others		1			1			1	
Reads sometimes		1	1		1				
Reads for consensus						1		1	1
Too general	1								1
No use				1				1	
More for the public	1						1		
Not high priority	1								
Can't find quickly			1						
Too technical				1					
Reads for detail						1			



## Survey

### Storm Prediction Center Convective Weather Products

1a. Which SPC products do you use?

1b. Of the products listed above, which do you use most often? *Please rank them in order, with the first product on the list being the one used the most and the last product on the list being the one used the least.*

1c. You said you did not use \_\_\_\_\_. Have you heard of this product? If so, why do you not use it?

2. Where do you receive Storm Prediction Center information?

3a. What information do you find most useful in the SPC Outlook products? *Please rank items in order from most important to least important.*

3b. What information do you find most useful in the SPC Mesoscale Convective Discussion product? *Please rank items in order from most important to least important.*

3c. What information do you find most useful in the SPC Watch products? *Please rank items in order from most important to least important.*

3d. How do tornado/severe thunderstorm watch sizes affect your operations?

### Storm Prediction Center Convective Weather Products and Your Operations

4a. How, if at all, do SPC Outlook products affect your operations?

4b. How, if at all, do SPC MCD products affect your operations?

4c. How, if at all, do SPC Watch products affect your operations?

5. When do you think it would be most useful to receive SPC Outlook, MCD or Watch products leading up to a hazardous weather event?

6. How long does it take to enact your emergency operations plan?

### Social Media

7a. Do you or your agency use social media (Facebook, Twitter, etc), text, email or other notification system to receive or disseminate hazardous weather information?

7b. If, yes, which systems do you use?

7c. What information do you receive and/or disseminate?

### **Public Weather Outlook**

8. Do you use the PWO when issued by the SPC and if so, do you find it useful? Why or why not?

9. Should the PWO be issued when any categorical risk area (Slight, Moderate or High) is included in the Day 1 Convective Outlook? Why or why not?

### **Suggestions**

10. Do you have specific suggestions for improvements you would like to see on the SPC website?

11. Do you have any specific suggestions for new products or services or changes to existing products or services that would help you do your job better?