P1.6 **Utilizing Experimental Graphical Severe Weather Warning Probabilities to Supplement the Hazardous Weather Outlook**

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1. INTRODUCTION

The National Weather Service Forecast Office (WFO) in Tulsa, Oklahoma has developed and produced severe weather warning probabilities as a supplement to the routine Hazardous Weather Outlook, which is issued by all National Weather Service Forecast Offices. The probabilities and associated graphics are produced at a 2.5 km grid spacing for the WFO Tulsa County Warning Forecast Area (CWFA) and represent the probability that any given location, or grid point, will be within a severe weather warning (i.e. Severe Thunderstorm Warning or Tornado Warning) within the Day 1 period (current day and night).

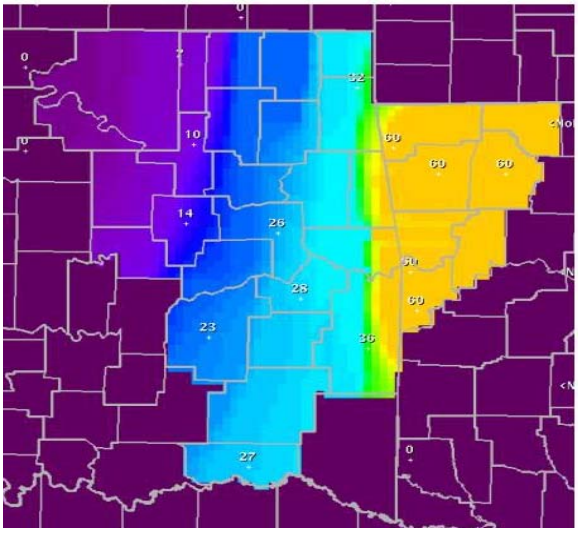

Figure 1: Combined outlook for 28 September 2005

The idea of forecasting severe weather warning probabilities was chosen for the experiment, since the actual probability of severe weather at any one location is statistically small and may not be overly compelling to inspire preparation for a severe weather threat. Additionally, severe weather reports are collected sporadically providing a limited measure of the overall severe weather coverage. Severe weather warnings, however, contain exact points and times providing more complete data of potential severe weather impacts. The resultant forecast of severe weather warning coverage attempts to more effectively communicate the likelihood of severe weather by forecasting the probability of a response, which is understandable to local decision makers. The concept for this argument is in planning for the response, one is prepared for the event.

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2. DEFINITIONS

The basis of forecasting severe weather warnings was divided into elements to best utilize the forecaster's expertise, while keeping any additional workload minimal. These elements required definitions for consistent application, and were developed with a storm-scale mindset as opposed to the more limited scale of observed severe weather.

The initial element, "Chance of Thunder", is a by-product of the required weather element in the National Digital Forecast Database. This provides an integral link of consistency between the warning probabilities and the dynamic nature of the forecast database.

The next input, "Conditional Probability of Severe", means: if a thunderstorm occurs at this point, the chance that it will be severe (i.e. require either a Severe Thunderstorm or Tornado Warning). The "Chance of Thunder" multiplied by the "Conditional Probability of Severe" yields the probability of a severe thunderstorm at a point, or "Probability of Severe". For example, if the "Chance of Thunder" equals 50% and the "Conditional Probability of Severe" equals 50%, the resulting "Probability of Severe" is equal to 25%. Each severe thunderstorm should, in theory, be included in a severe weather warning and assuming the warning polygon encompasses the entire storm, makes the "Probability of a Warning" equal to 25%. Maintaining a storm-scale mindset, a thunderstorm is defined as severe if any portion of the thunderstorm is severe; therefore, in the example, the 25% chance represents the chance of being affected by some portion of the severe thunderstorm, and not the chance of experiencing severe criteria conditions. Figure 1 is an example of the "Probability of Severe" graphic, and is also referred to as a "Combined Outlook" since the probabilities express the potential of experiencing either a Severe Thunderstorm or Tornado Warning.

The "Probability of a Tornado Warning" is the product of the "Probability of Severe" multiplied by the conditional probability of a tornado warning ("Conditional Probability of Tornado"). This second conditional probability means: if a severe weather warning is issued at this point, what is the chance the warning will be a Tornado Warning. A schematic of the probabilities is shown in Figure 2.

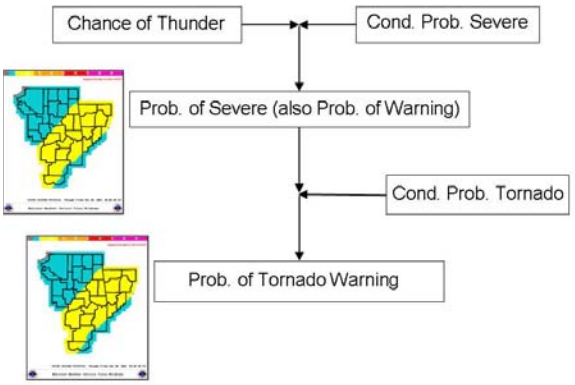

Figure 2: Severe Weather Warning Probability Schematic

3. FORECAST PREPARATION

The WFO Tulsa forecast staff utilize the Graphical Forecast Editor (GFE; Forecast Systems Laboratory 2001) to calculate and produce the severe weather warning probabilities and corresponding graphics. GFE is the software WFO's use to edit the National Digital Forecast Database. This allows the required inputs into the severe weather probabilities to be produced on the same 2.5 km grid as that used for all other forecast elements. The forecaster is responsible for the "Chance of Thunder" probability and the two severe weather conditional probabilities across the CWFA. Tools within GFE are available to assist the forecaster with generating the conditional probabilities (McGavock, et. al., 2004). Additionally, forecasters may chose to edit the final severe weather probabilities first, with tools available to calculate the required conditional probabilities. The functionality of GFE is further utilized by incorporating the probabilities into a dynamic Hazardous Weather Outlook text formatter and by exporting the probabilities as graphics available on the WFO Tulsa website.

4. VERIFICATION

The "Probability of Severe" (or Combined Outlook) and the "Probability of a Tornado Warning" values are verified with warning polygons, with the former verified by both Severe Thunderstorm and Tornado warning polygons and the latter by only Tornado warning polygons. Though the probabilities can be updated at any time, the routine issuance times of 5 a.m. and 1 p.m. local time are used for verification statistics. GFE is again utilized with its framework for grid manipulation and calculation serving as the foundation for the verification efforts. The warning polygons are ingested into GFE and mapped at the same resolution as the probability grids, with resultant probabilistic verification statistics computed at each grid point. The current verification period is 17 March 2005 to 30 September 2005, with 41 days within that period having at least one warning issued within the WFO Tulsa CWFA. Figures 3 and 4 illustrate output from the verification procedures, and correspond with the outlook shown in Figure 1.

Initial feedback from the verification shows an overall reluctance to forecast the higher probabilities as shown in the reliability diagram (Wilks, 1995) for the 5 a.m. combined outlook (Figure 5). This diagram incorporates all grid points across the CWFA yielding a large number of point forecasts, and is dominated by low probability/no warning forecasts so care should be taken when viewing the results. Warning polygon coverage is most often underestimated during the more widespread events, and forecaster feedback suggests this is often a result of underestimating the conditional probabilities in an environment of high thunderstorm coverage.

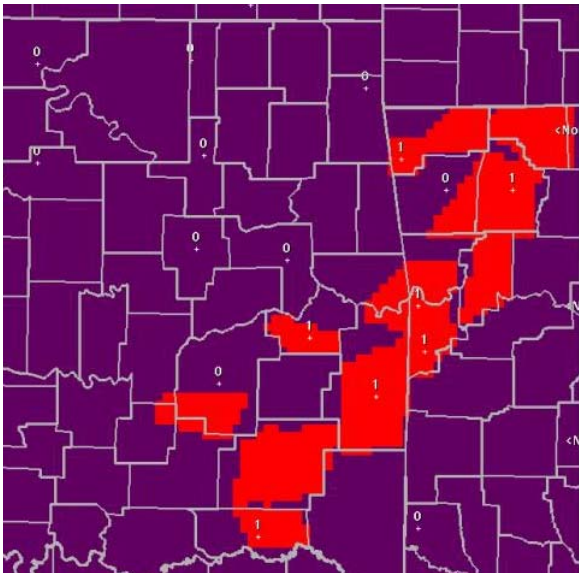

Figure 3: Warning polygons observed on 28 September 2005

Brier scores (Brier, 1950) were computed for each point across the outlooks, similar to Figure 4, with all outlooks averaged giving a display of any spatial biases across the CWFA. These brier scores were then averaged for the entire CWFA yielding the results shown in Table 1. Again, these results include all outlooks and are dominated by low probability/no warning forecasts.

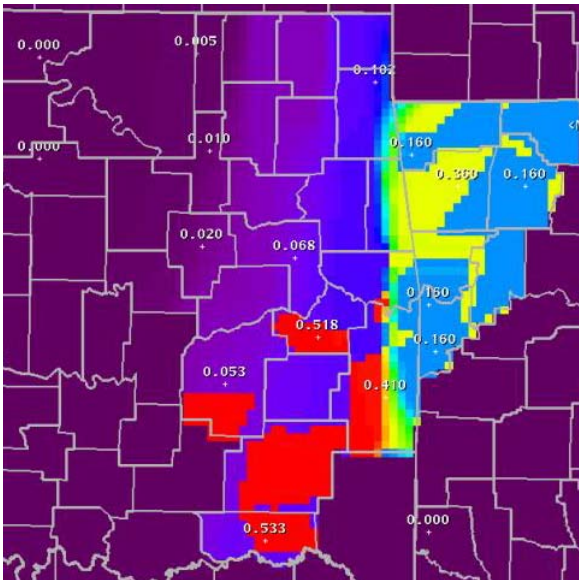

Figure 4: Brier scores for 28 September 2005 Combined Outlook

Avg. Brier Scores	Combined Outlook	TOR Warning Outlook
5 a.m. Issuance	0.026	0.001
1 p.m. Issuance	0.024	0.001

Table1: Average Brier Score Comparisons

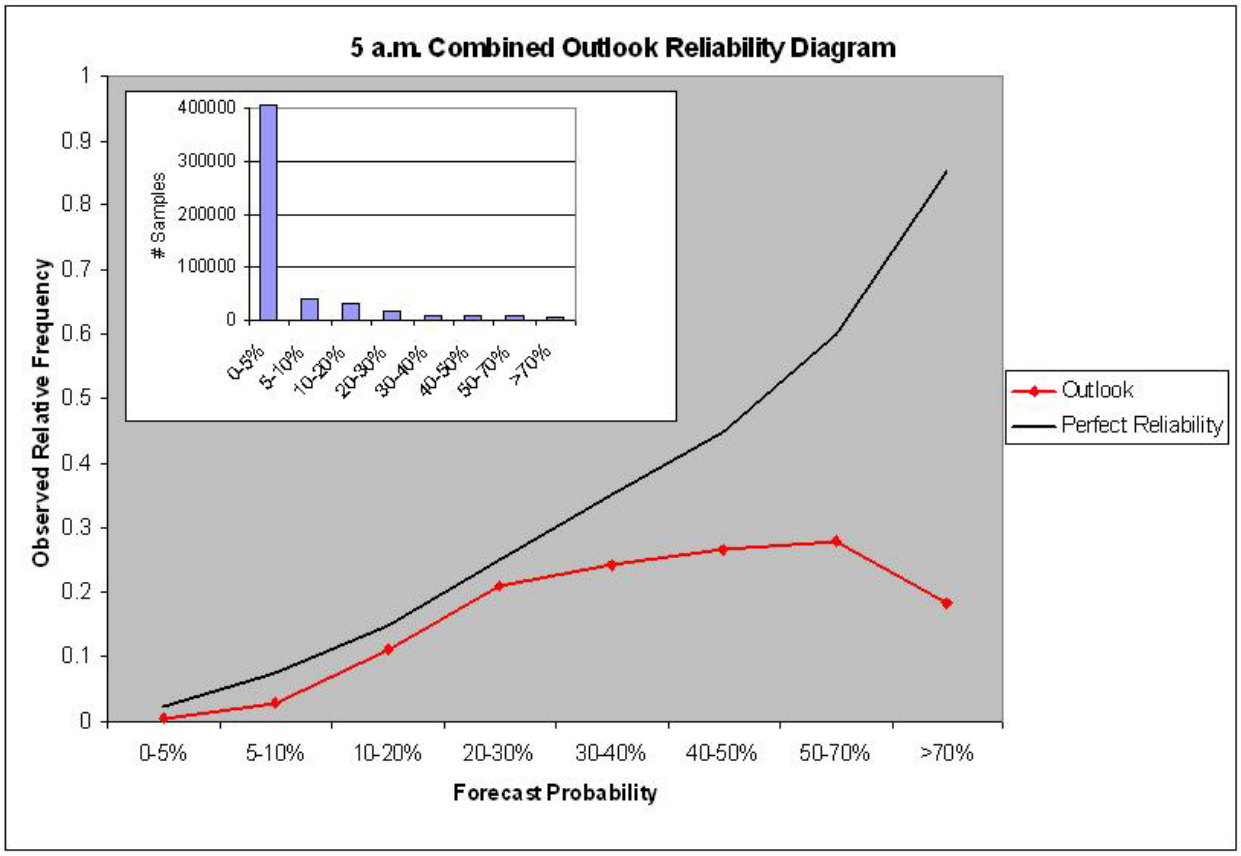

Figure 5: 5 a.m. Combined Outlook reliability diagram with forecast histogram

5. FUTURE WORK

Probabilistic warning forecasts will continue to be issued by WFO Tulsa yielding an increase in the verification database. Efforts are underway to provide near real-time verification to forecasters after each outlook via an internal website, with additional work focused toward identifying any forecaster, seasonal, or event type biases. Reviews of severe weather events will also be aided by the subjective verification of the conditional probabilities thus serving as an additional training source for forecasters.

The conditional probabilities will be explored as input to enhance the severe weather portion of the textual Hazardous Weather Outlook. Customer education and feedback will be required to effectively utilize this additional information; however, it is possible that these conditional probabilities may be more beneficial for local decision makers, especially in efforts to prepare resources needed during severe weather events.

6. REFERENCES

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