

Report on Engagement with Weather Prediction Service Forecasters Meeting date: May 30, 2017

Introduction

In response to increased user demand for probabilistic forecasts, National Weather Service's Weather Prediction Center has developed a series of prototype products that provide probabilistic guidance for precipitation and temperature in the 8-10 day time frame. Because user needs for this information vary and because there is a range of possible presentation formats for this information, NWS has engaged with ECS, Inc. to develop user-tested and informed guidance for how to present 8 to 10-day probabilistic forecast guidance. This process will include iterative field-testing of core users and will result in recommendations for preferred delivery methods and the optimal mix of design and delivery considerations.

To initiate this process with the Weather Prediction Center (Project Title: Identify Partners/Users of WPC Products and Mapping Related User Decision-Making for the Day 8-to-10 Time Frame), ECS Inc.'s research team engaged with WPC forecasters and personnel at its headquarters in College Park, MD on May 30, 2017 for a daylong kick-off.

The identified goals for the day for the research team were to:

- Learn about the EMC and MDL systems, and to understand the roles and purposes of models and departments/staff
- Receive some basic training and introduction into the products and processes of the WPC for its 8-10 probabilistic products
- Identify WPC's perspective on the needs of various users
- Identify any technical, temporal or spatial gaps in capacity
- Identify any additional guidance needed in the 8-10 day time frame
- Develop list of priority products for study during the project

In attendance were: Dr. Burrell Montz, East Carolina University; Rachel Hogan Carr, Nurture Nature Center; Dr. Kathryn Semmens, Nurture Nature Center; and from WPC: Michael Bodner, Daniel Halperin, Joshua Kastman and James Nelson (project team members) and forecasters Anthony Fracasso, Michael Schictel and Marty Rausch.

I. Current Systems: Analysis + working list of priority products for study

The research team and WPC personnel discussed the various model and data sources being used by the Weather Prediction Center for the creation of its 8-10 probabilistic products. WPC relies on information from the Meteorological Development Laboratory (MDL) and the Environmental Modeling Center (EMC).

MDL provides statistical data post-processing. As part of its work relevant to the WPC 8-10 probabilistic products, MDL issues Model Output Statistics (MOS) and issues the new National Blend of Models with a global 8-10 day timeframe.

Environmental Modeling Center (EMC) does its own post-processing for different parameters. EMC models precipitation rates and types, and has teams focused on specific areas such as cloud physics and land surface. EMC has an evaluation group that verifies model performance through case studies and object-oriented verification. WPC forecasters reported during the meeting that verification is improving by "leaps and bounds." EMC is the primary model developer for global and regional modeling.

In addition, WPC also applies its own post-processing to EMC data and shares that data. As part of the process of developing probabilistic forecasts, WPC is creating its own model blend, while simultaneously running the national blend. Key questions identified for consideration include: how much of this processing can be automated, and

where is value added from human input? WPC's sample of human-generated forecasts was small at the time of the meeting in May, having begun in January 2017, and the staff anticipated that they would have a better analysis of how the human vs. automated (both WPC's automated blend and the national blend) compared in a few more months. As of the meeting, the human blend was generally performing similarly to the auto-blend in terms of accuracy, but with more months of data the team will refine its understanding of the relative performance of the national blend, the auto-blend and the human blend.

In addition to using EMC and MDL, WPC forecasters reported also using tools from the Climate Prediction Center (CPC). For instance, CPC is developing a new "drop-out" tool that will show where models contain errors; if a model with errors is then embedded within a blend, that error-laden model can have its weight reduced in the blend to de-amplify the impact of the error on the outputs. This function – identifying and reducing the weight of models with errors – is where human input becomes essential.

II. Technical/Temporal/Spatial Gaps

When discussing gaps in the technical, temporal and spatial ability to forecast 8-10 probabilistic hazards, the team identified that the EMC needs better precipitation output and improvements in precipitation post-processing. The team acknowledged that increased skill is needed also in the medium range (days 3-7) and that skill drops after day 4 when looking at joint probabilities which measure two parameters at one time (e.g., heat index, wind chill).

The team noted that work done out of SUNY Stony Brook was allowing for more ensemble sensitivity to account for differences in predictability in flows from the North and South, and encouraged more of this sort of grant-funded research work to continually refine capabilities. Generally, the WPC team did not report any significant challenges related to the performance of the MDL or EMC. The team did note recent improvements, such as progress in verification and the creation of the new national blend of models.

III. Key products

Emerging from the conversation was an acknowledgement that beyond the data, the core challenge the WPC team faces with the development of these products is communicating uncertainty in predictions to the public. The WPC team identified a core set of 8 to 10-day prototype products they want to test and analyze prior to distribution to the public. These include:

- 10% probability of 24-hr maximum temperature not exceeding set values
- Percent Chance of Maximum Temperature > 90 degree F
- Day Eight Probability of Exceeding 0.25 Inch Liquid Equivalent of Snow/Sleet
- Percent Chance of 24 hour precipitation > 0.25"
- 10% probability of 24 hour precipitation exceeding set amounts
- Day 8-10 U.S. Hazards Outlook (being taken from the CPC)

WPC also wanted to acquire feedback on heat index and wind chill, and the need for and usefulness of this information in the 8-10 day timeframe.

IV. User Needs

Generally, forecasters are the most important users of WPC products and are the primary customer. Specifically, WPC identified Weather Forecast Offices as their priority customer. Some core users, such as First Energy, use specific products (for instance, snow or sleet over 0.25 in). The WPC has access to data and tools that are not accessible to WFOs (including the entirety of the European model output) and therefore provides critical information to the WFOs.

When looking at 8-10 probabilistic products, considerations of external users are much larger than usual. End users are likely audiences for these new 8-10 day probabilistic products, and as such, there is a heightened need to ensure information is presented clearly. These products need to clearly convey uncertainty to an audience accustomed to thinking in a deterministic fashion.

V. Research questions:

The team reviewed the function of each of the products and focused conversation on the inherent communication challenges. A guiding, key research question emerged:

- Exceedance probability vs. percentile products: Which are more helpful? To whom? At what preset levels (i.e., what thresholds for precipitation, temperature?)

Additional research areas of interest also emerged:

- The team raised questions about how to identify the timing of hazards within the 8-10 day period. For instance, when issuing the probability of exceedance of 1" of precipitation in a 24-hour period, is it necessary that those 24-hour periods correspond to Days 8/9/10 or should instead the 24-hour periods be defined within increments that correspond to the weather patterns? In short, the team recognizes that weather events do not follow calendar days, and that patterns of intense precipitation in short periods of time may cross day-long borders.
- The WPC is also working on in-house post-mortem forecast verification presentations and asked if these would be helpful for any audiences.
- Would a mean temperature be helpful to specific audiences – perhaps energy or agriculture? Would a range of high temperatures be easier to understand than probabilities?
- How to present departures from normal was also a question: in warm temperatures, currently WPC is using +/- 10 degrees but should standard deviations or other representations be used? What do users need to understand the forecasts most easily and accurately?
- How valuable are joint probabilities – heat index, wind chills?
- For the hazards outlook: at this time frame, are audiences looking for probabilities, or simply outlines of general hazards?

Other questions about communication arose that could be considered during focus group conversation, such as how well people receive and translate terms including "Slight/high/marginal" when applied to risks.

The meeting provided critical context for survey and focus group protocol development and allowed the WPC team to effectively communicate their information questions and needs. A significant challenge is communicating uncertainty in methods that are understandable to priority and end users. The project will seek to assess the need for information at the 8-10 day timeframe, and what types and in what formats the data is most effective in meeting those needs.