SPC Ensemble Review: Use and Applications

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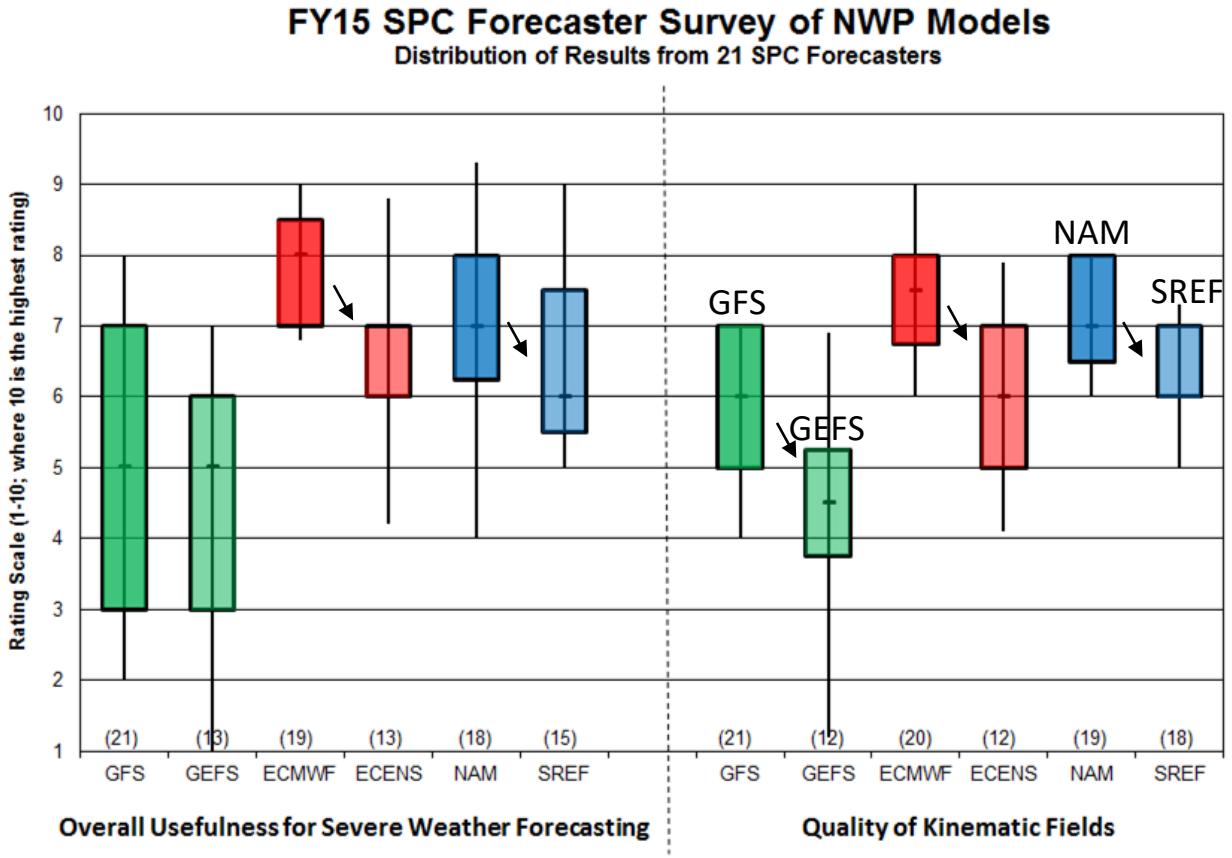
SPC Ensemble Review: Outline

- Forecaster Perspective on Ensemble Usefulness/Quality
- Convection-Allowing Model (CAM) Guidance: HREF
- Mesoscale Guidance: SREF
- Large-Scale, Medium-Range Guidance: GEFS
- Recommendations

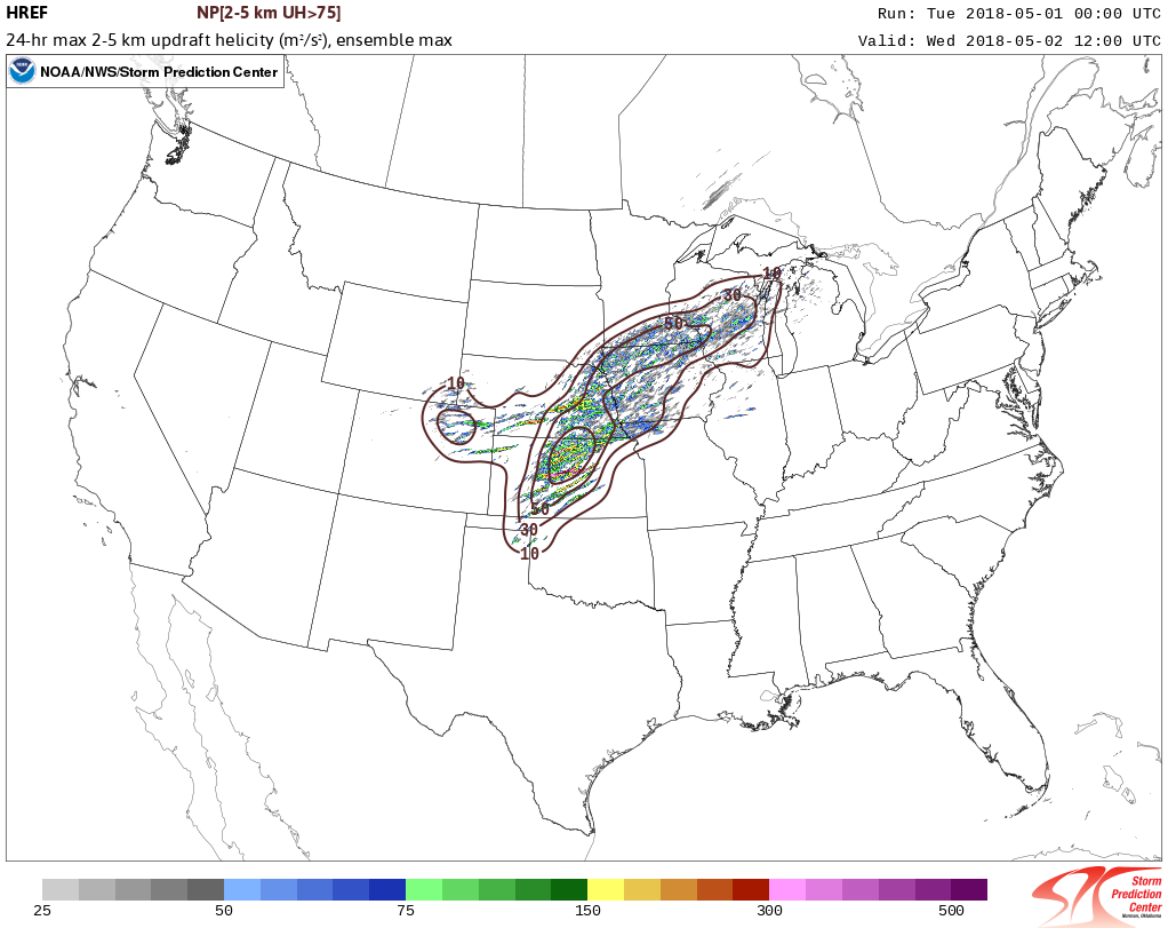
SPC Ensemble Review: Forecaster Perception

- *Challenge:* While acknowledging the benefits of an ensemble approach to forecasting, SPC forecasters perceive the usefulness and quality of current ensembles to be less than that of their deterministic counterparts.
- Can speculate on reasons (resolution, visualization, etc.), but perhaps primary function of ensembles should be for creating derived/calibrated products.



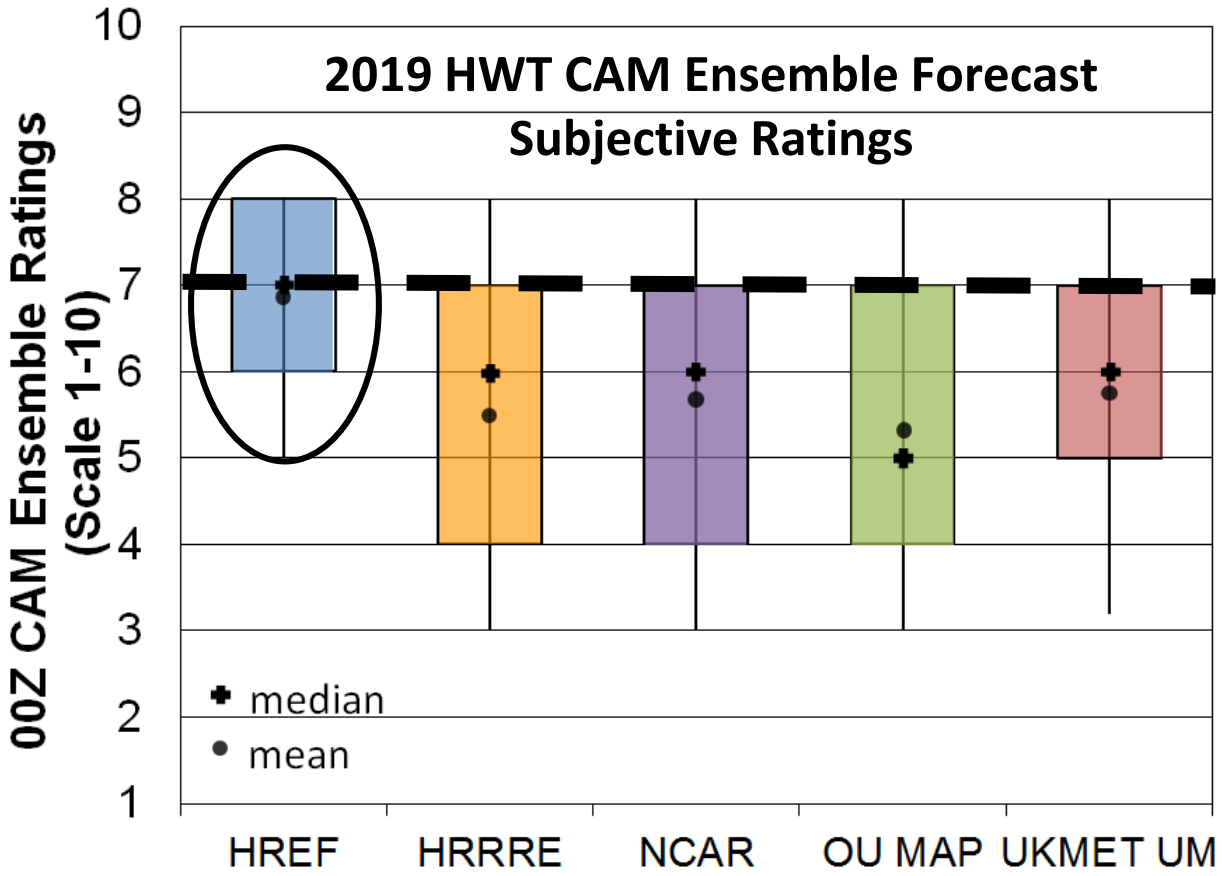
SPC Ensemble Review: HREF

- The HREFv2 was implemented on **1 November 2017**; an operational instantiation of the SSEO (a recommendation from the last Ensemble Workshop!)
- Monumental implementation; convection-allowing aspect provides probabilistic information on thunderstorm timing, mode, and intensity
- Heavily used in NWS operations



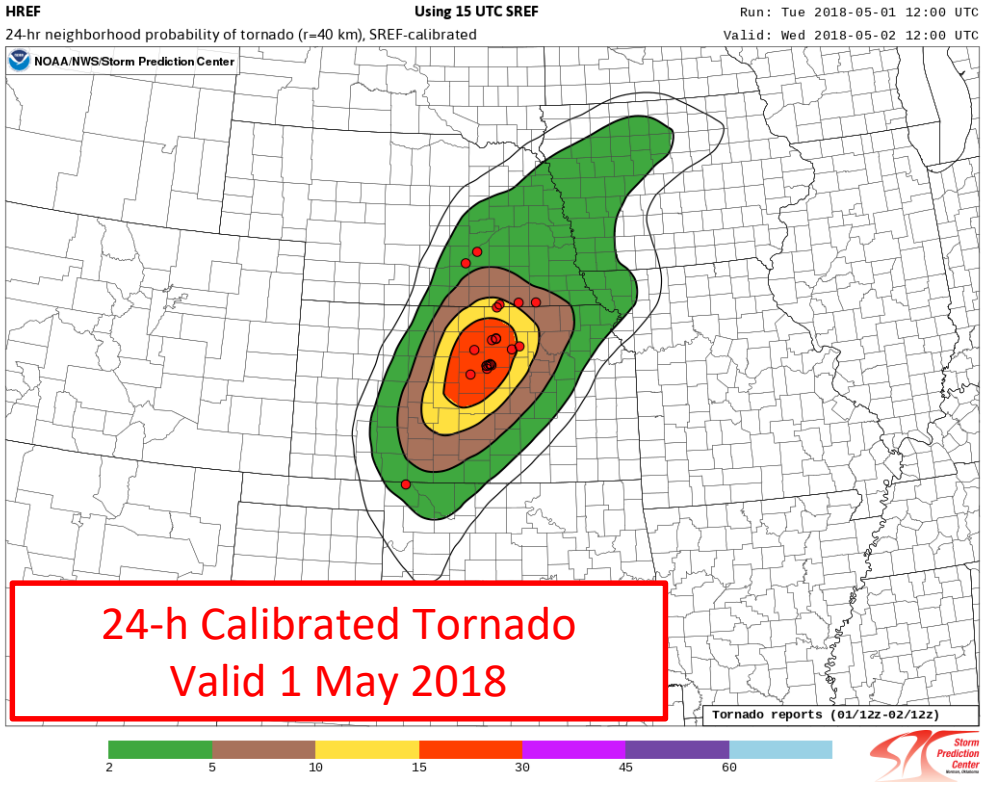
SPC Ensemble Review: HREF

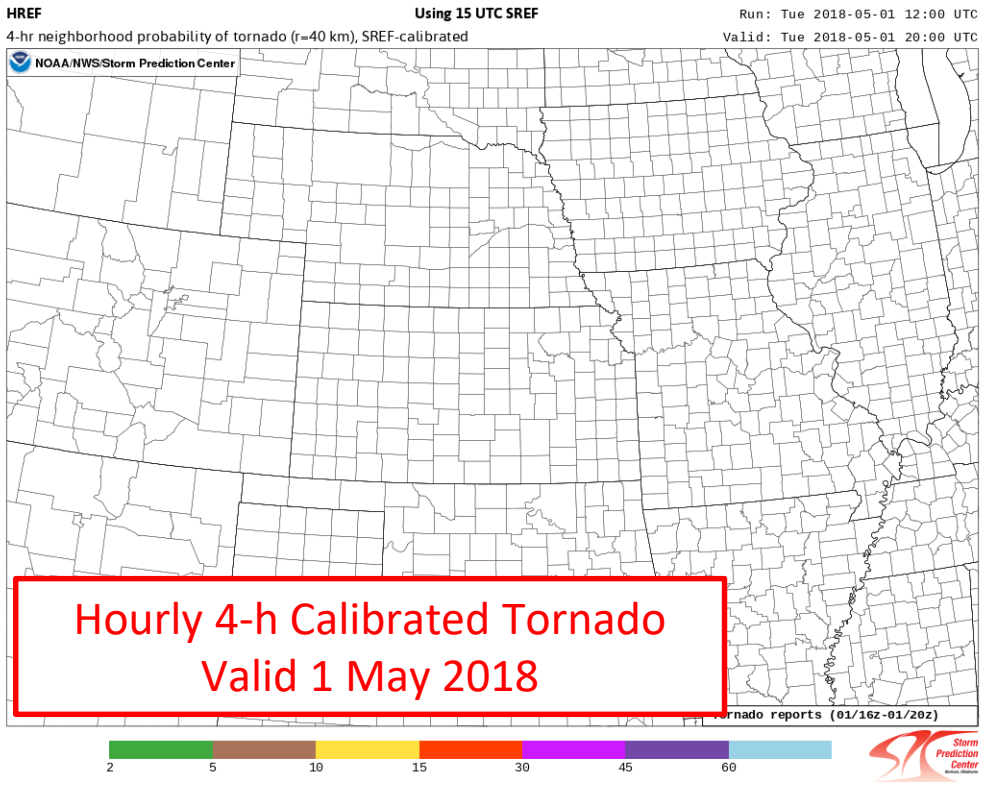
- The HREF is a very useful and skillful CAM ensemble that sets a high operational NWS standard for next-generation CAM ensembles
- The US is the world leader in NWP at the CAM scale, so we should acknowledge that achievement, learn from/leverage those successes, and build on our strengths



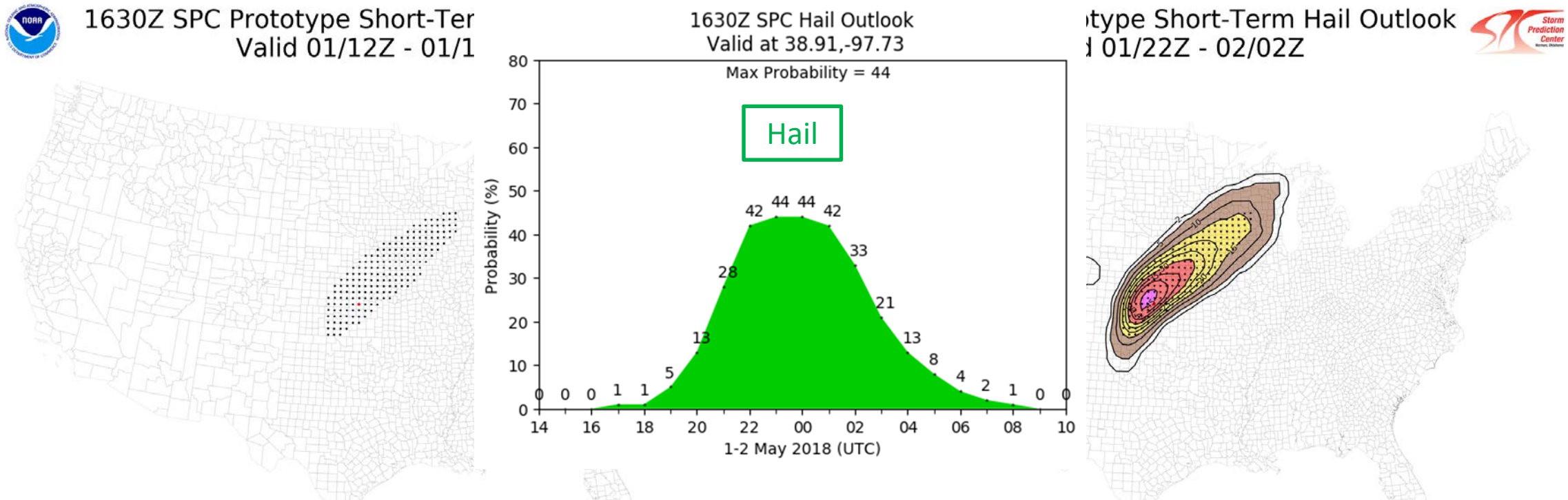
SPC Ensemble Review: HREF

- HREF enables generation of calibrated probabilistic hazard information

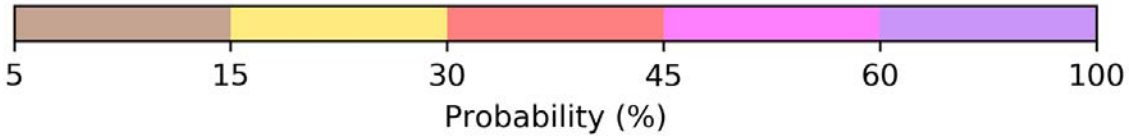




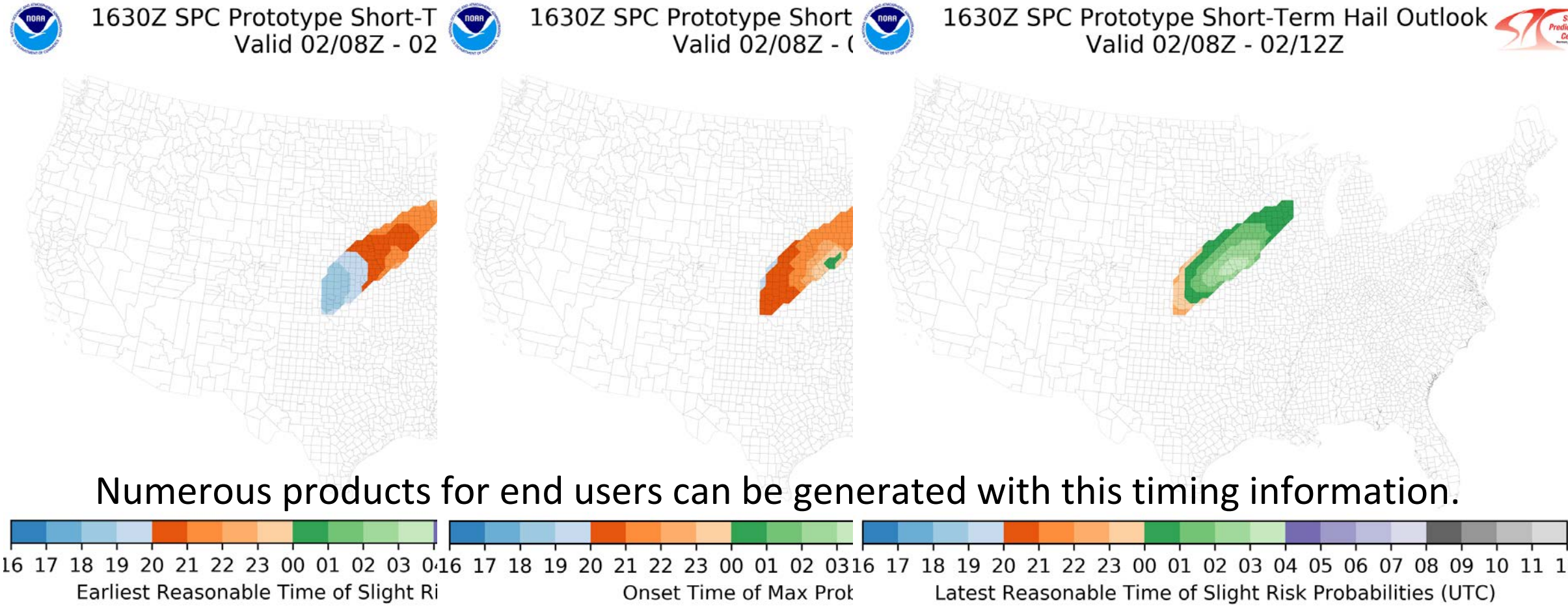
SPC Ensemble Review: HREF



Explicit convection in HREF allows for improved convective timing and evolution.



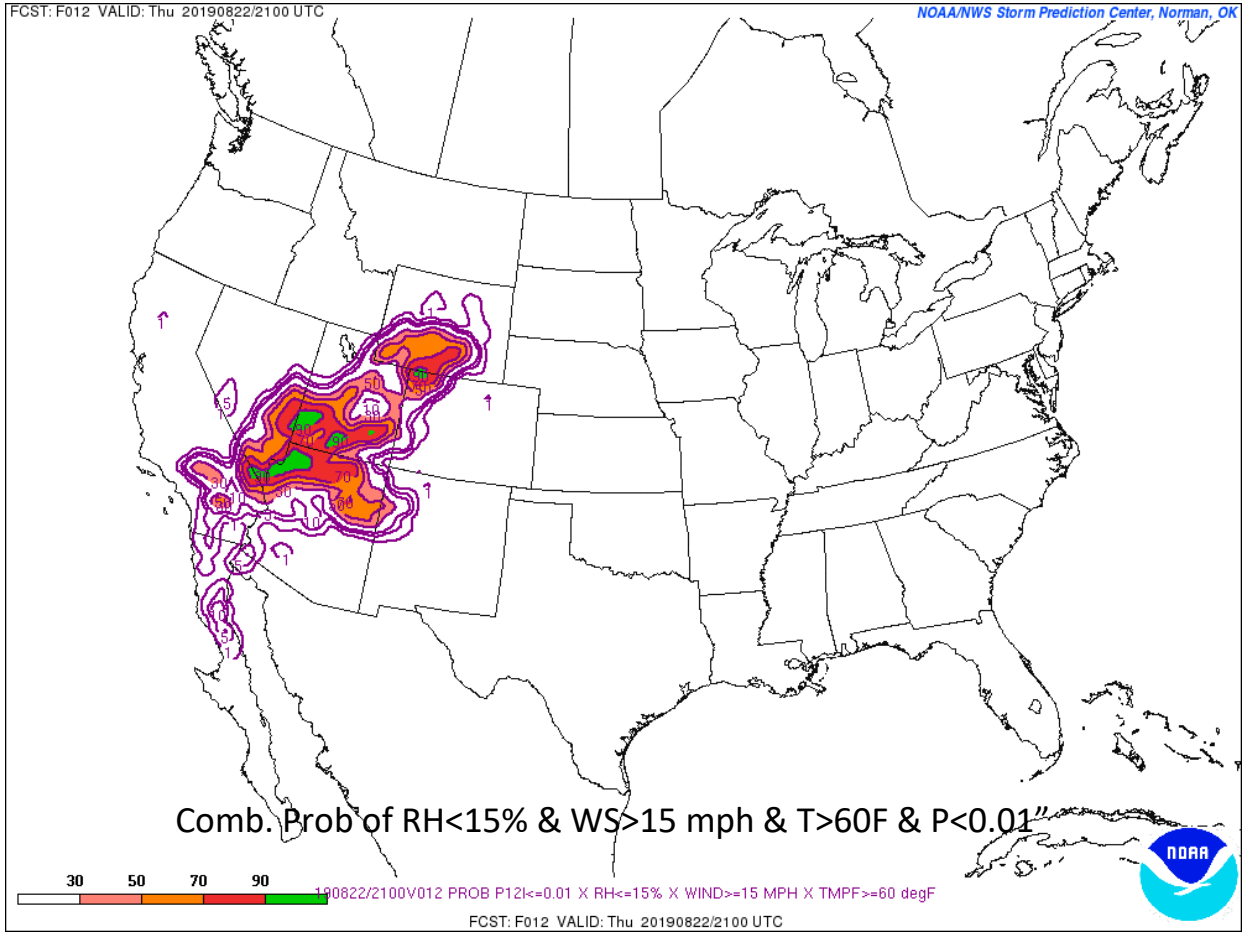
SPC Ensemble Review: HREF



Numerous products for end users can be generated with this timing information.

SPC Ensemble Review: SREF

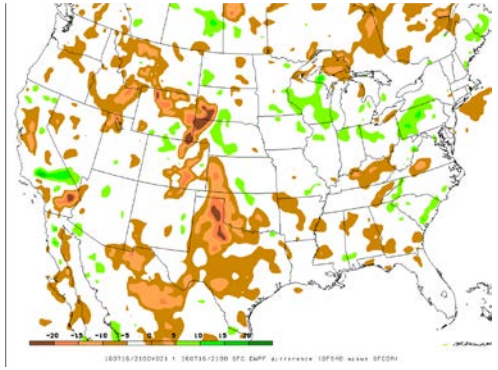
- The SREF continues to serve as an important modeling system for operational SPC products:
  - Days 1-3 Convective Outlooks
  - Days 1-3 Fire Wx Outlooks
  - Day 1 Thunderstorm Outlook
  - Day 1 Winter Wx Meso. Disc.
- The specialized derived and calibrated probabilistic output is especially useful as summary, confidence tools for forecasters

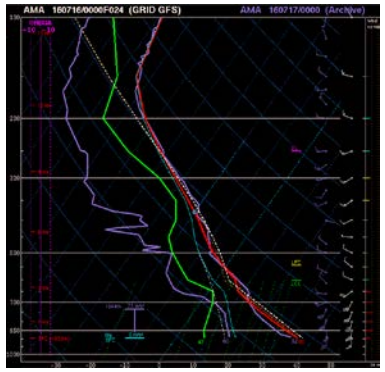


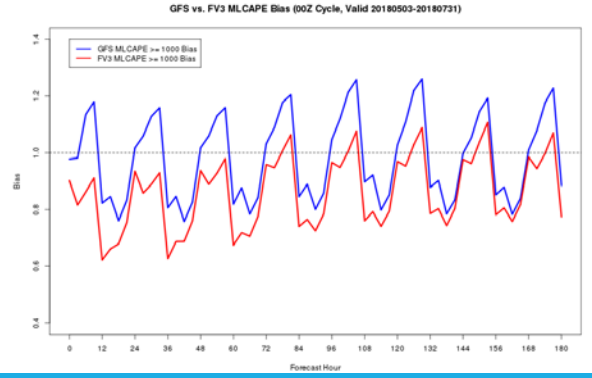
Comb. Prob of RH<15% & WS>15 mph & T>60F & P<0.01"

SPC Ensemble Review: GEFS

- With the GEFS at nearly the same horizontal resolution as the SREF, why not just use the GEFS and turn off the SREF?
- Mesoscale details of near-surface features play an increasing role as the forecast lead time decreases, whereas a large-scale pattern recognition approach (e.g., 500 mb height AC) is relied on more at longer lead times
- Issues with boundary-layer thermodynamics in the GFS/GEFS have limited their usefulness to SPC/NWS forecasters, especially in the short range (i.e., Days 1-3)

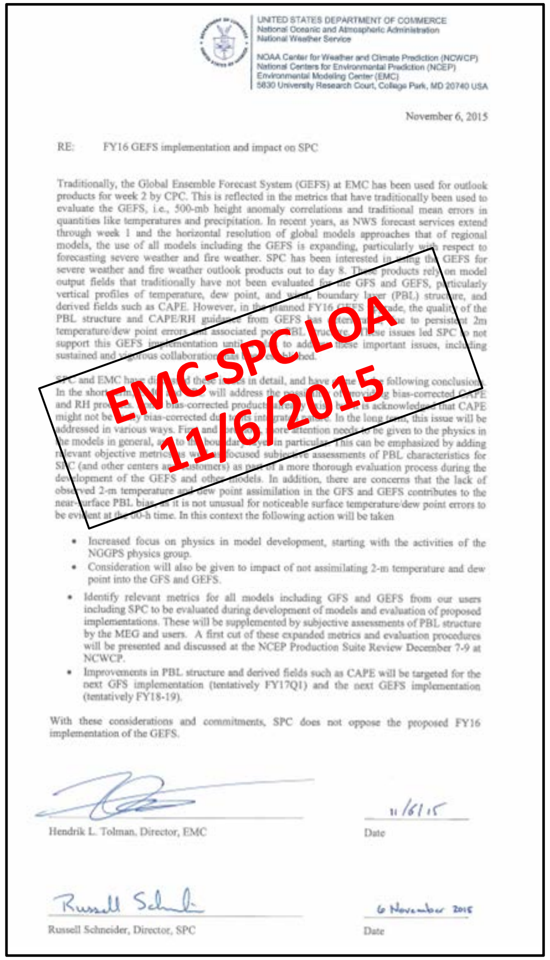






SPC Ensemble Review: GEFS

- A letter of agreement between EMC and SPC was signed almost four (4) years ago to address these issues (PBL scheme, assimilation of 2-m T/Td, etc.), following the GEFS implementation in FY16
- Unfortunately, limited progress has been made during this time on improving PBL thermodynamics in the GFS/GEFS
- Furthermore, there has been little collaboration with SPC on these issues in the GFS/GEFS, which is in contrast to the level of collaboration and engagement by the CAM group at EMC, which led to the successful HREFv2 implementation



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

NOAA Center for Weather and Climate Prediction (NCWCP)
National Centers for Environmental Prediction (NCEP)
Environmental Modeling Center (EMC)
5830 University Research Court, College Park, MD 20740 USA

November 6, 2015

RE: FY16 GEFS implementation and impact on SPC

Traditionally, the Global Ensemble Forecast System (GEFS) at EMC has been used for outlook products for week 2 by CPC. This is reflected in the metrics that have traditionally been used to evaluate the GEFS, i.e., 500-mb height anomaly correlations and traditional mean errors in quantities like temperatures and precipitation. In recent years, as NWS forecast services extend through week 1 and the horizontal resolution of global models approaches that of regional models, the use of all models including the GEFS is expanding, particularly with respect to forecasting severe weather and fire weather. SPC has been interested in using the GEFS for severe weather and fire weather outlook products out to day 8. These products rely on model output fields that traditionally have not been evaluated for the GFS and GEFS, particularly vertical profiles of temperature, dew point, and wind, boundary layer (PBL) structure, and derived fields such as CAPE. However, in the planned FY16 GEFS [illegible]ade, the quality of the PBL structure and CAPE/RH guidance from GEFS has [illegible] to persistent 2m temperature/dew point errors [illegible] associated poor PBL structure. These issues led SPC to not support this GEFS implementation until [illegible] to address these important issues, including sustained and vigorous collaboration [illegible]blished.

SPC and EMC have discussed these issues in detail, and have [illegible] the following conclusion. In the short term, [illegible] will address the possibility of providing bias-corrected CAPE and RH products. [illegible] bias-corrected products already exist, [illegible] is acknowledged that CAPE might not be [illegible] bias-corrected due to its integrated nature. In the long term, this issue will be addressed in various ways. First and foremost, more attention needs to be given to the physics in the models in general, and to the boundary layer in particular. This can be emphasized by adding relevant objective metrics as well as focused subjective assessments of PBL characteristics for SPC (and other centers and customers) as part of a more thorough evaluation process during the development of the GEFS and other models. In addition, there are concerns that the lack of observed 2-m temperature and dew point assimilation in the GFS and GEFS contributes to the near-surface PBL bias, as it is not unusual for noticeable surface temperature/dew point errors to be evident at the 00-h time. In this context the following action will be taken

- Increased focus on physics in model development, starting with the activities of the NGGPS physics group.
- Consideration will also be given to impact of not assimilating 2-m temperature and dew point into the GFS and GEFS.
- Identify relevant metrics for all models including GFS and GEFS from our users including SPC to be evaluated during development of models and evaluation of proposed implementations. These will be supplemented by subjective assessments of PBL structure by the MEG and users. A first cut of these expanded metrics and evaluation procedures will be presented and discussed at the NCEP Production Suite Review December 7-9 at NCWCP.
- Improvements in PBL structure and derived fields such as CAPE will be targeted for the next GFS implementation (tentatively FY17Q1) and the next GEFS implementation (tentatively FY18-19).

With these considerations and commitments, SPC does not oppose the proposed FY16 implementation of the GEFS.

Hendrik L. Tolman, Director, EMC — Date: 11/6/15

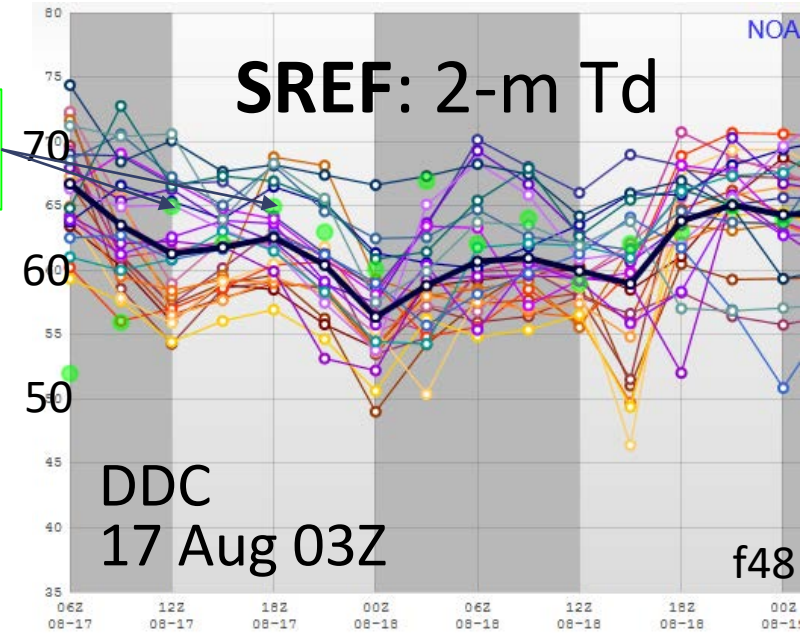
Russell Schneider, Director, SPC — Date: 6 November 2015

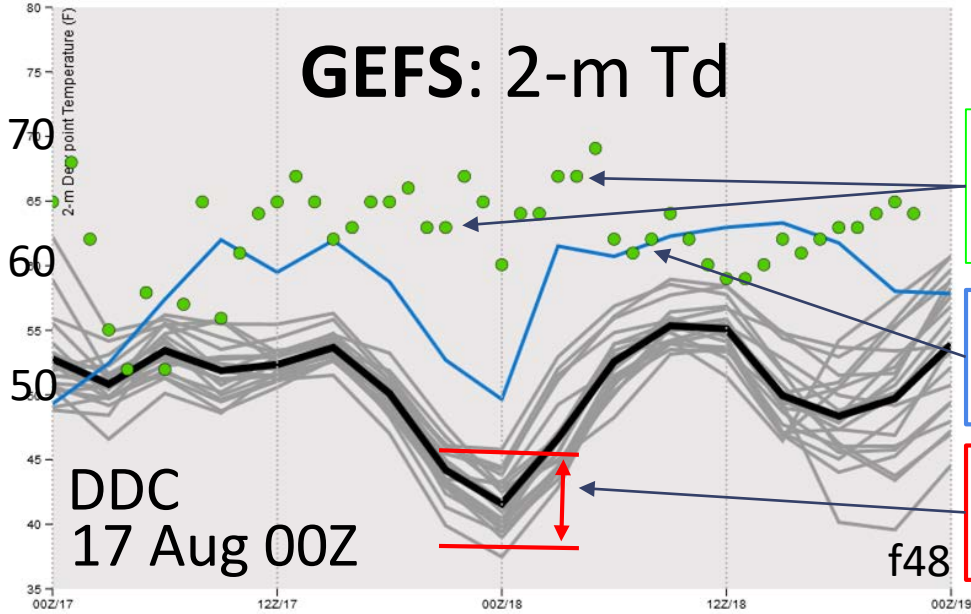
SPC Ensemble Review: GEFS

- Plume diagrams are a quick, easy way to highlight the GEFS issues:
  - **Underdispersiveness**: Little spread in the first few days
  - **Boundary Layer Thermodynamics**: Overmixing of plains PBL in warm season

Obs often fall within ensemble envelope

SREF better captures uncertainty and moisture quality, enabling a better convective forecast





Obs often fall well outside ensemble envelope (too dry)

GFS improvement over GEFS

GEFS spread is too small

SPC Ensemble Review: Recommendations

- **Convection-Allowing Model Guidance: *HREF***
  - Continue effective collaboration within NCEP and with community, using evidence-based decision making, including use of NOAA Testbeds (e.g., CLUE in HWT)
- **Mesoscale Guidance: *SREF***
  - Continue running SREF until the derived/calibrated products (many based on accurate depictions of PBL thermodynamics) from the GEFS are of the same quality (i.e., evidence-based decision making)
- **Large-Scale, Medium-Range Guidance: *GEFS***
  - Collaborate with SPC, MEG, others on improving PBL thermodynamics