# Ensemble Use at WPC

8th NCEP Ensemble User Workshop
Bruce Veenhuis - WPC

WPC QPF Production

- Transitioned from NAWIPS to AWIPS2/GFE - March 2019

- Days 1 to 7: ScaVec blender GUI replaces forecaster-drawn QPF contours

- Greater emphasis on blending high-resolution guidance such as HREF and the National Blend of Models (NBM)

- Effective resolution increase from 20-km to 2.5-km

- Less reliance on post-processed downscaling

- Enhanced collaboration with NWS WFOs
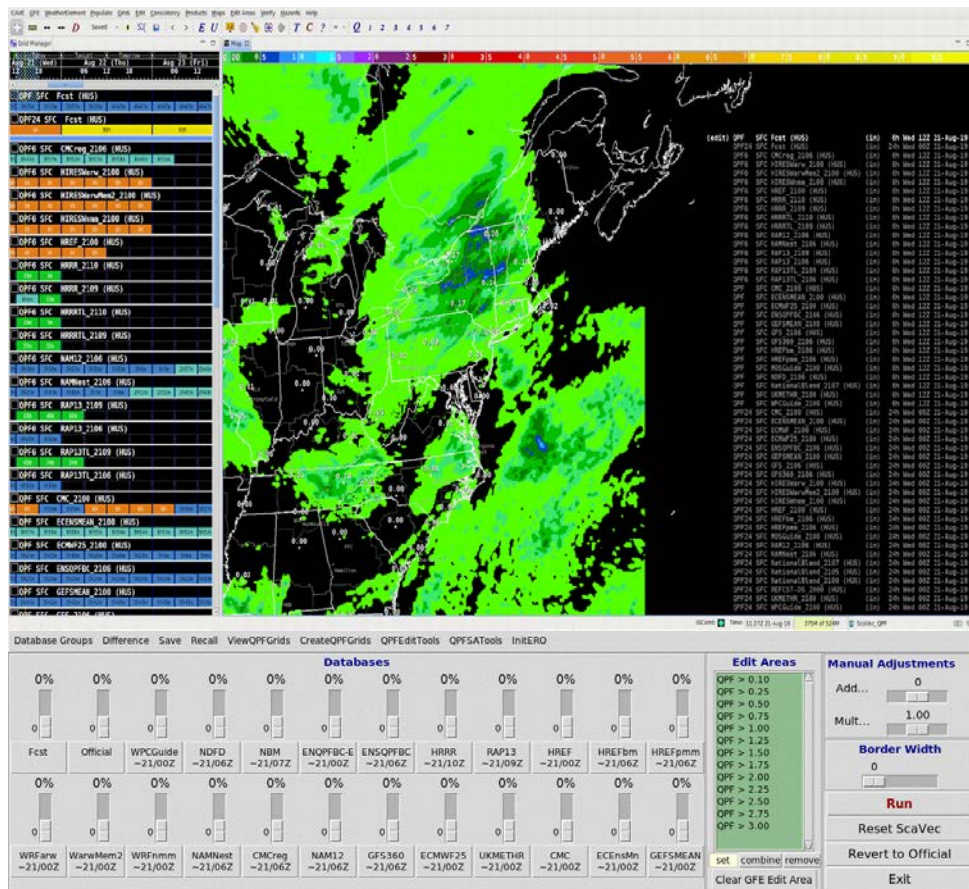
WPC International Desks

- Mean of the global ensembles, compared to the deterministic model, is used at the South American Desk to establish confidence in the medium range forecast pattern.

- Rainfall forecasts from the GEFS ensemble members used to identify consensus for potential heavy rainfall amounts.
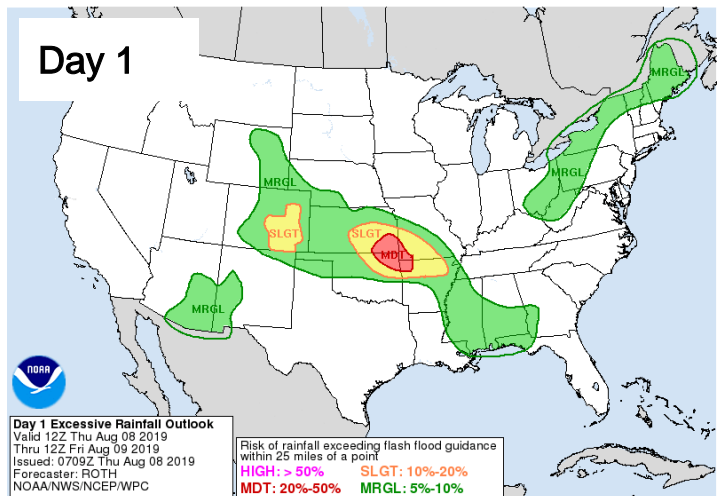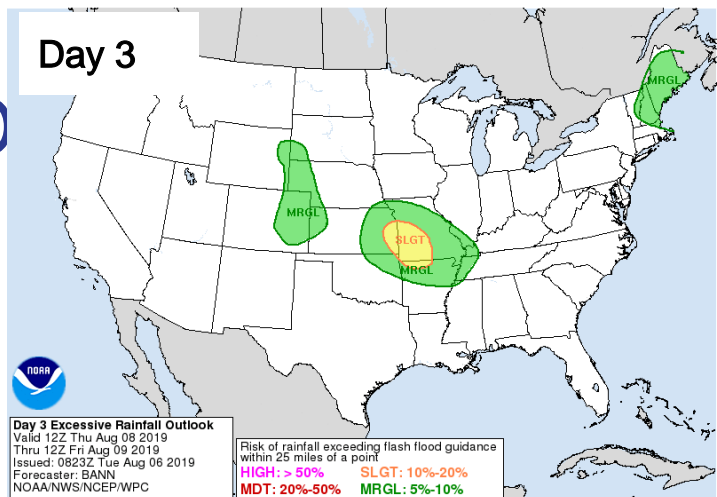

PQPF ≥ 12mm
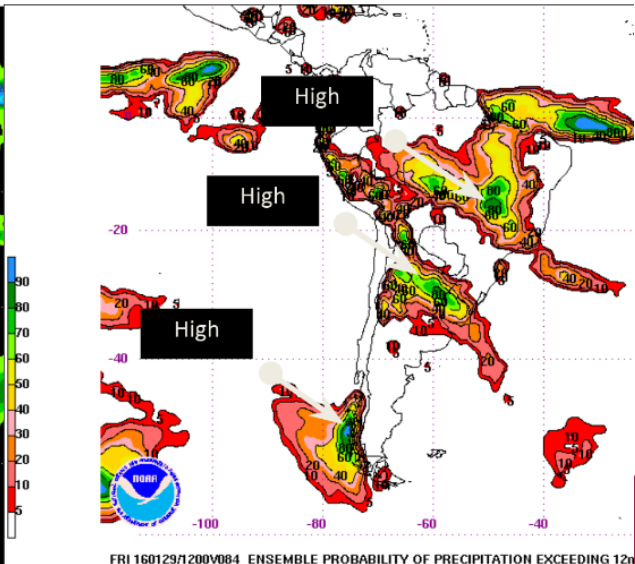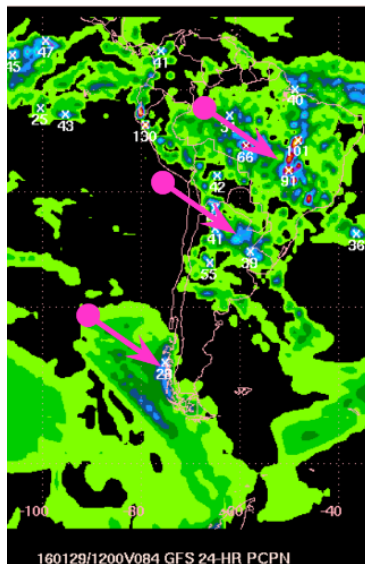
What's the confidence the rainfall amounts are going to exceed 12mm?

Courtesy of Mike Davison: Chief WPC International Desks

Excessive Rainfall Outlook (ERO

- Probability of exceeding flash flood guidance within 25 miles (40 km) of a point for Days 1-3

- High-resolution CAM ensemble guidance critical for Day 1

- Challenge is lack of high-resolution guidance fully covering Days 2 and 3

Day 3 Excessive Rainfall Outlook
Valid 12Z Thu Aug 08 2019
Thru 12Z Fri Aug 09 2019
Issued: 0823Z Tue Aug 06 2019
Forecaster: BANN
NOAA/NWS/NCEP/WPC

Risk of rainfall exceeding flash flood guidance within 25 miles of a point
HIGH: > 50%   SLGT: 10%-20%
MDT: 20%-50%   MRGL: 5%-10%

Day 1 Excessive Rainfall Outlook
Valid 12Z Thu Aug 08 2019
Thru 12Z Fri Aug 09 2019
Issued: 0709Z Thu Aug 08 2019
Forecaster: ROTH
NOAA/NWS/NCEP/WPC

Risk of rainfall exceeding flash flood guidance within 25 miles of a point
HIGH: > 50%   SLGT: 10%-20%
MDT: 20%-50%   MRGL: 5%-10%

ERO- Day 2/3 First Guess

- Random Forest Algorithm trained using GEFS forecast data, LSR, and ARI exceedances.

- Greg Herman and Russ Schumacher - Colorado State University

- Evaluated in WPC's Flash Flood and Intense Rainfall (FFAIR) experiments

- Available to WPC forecasters

F072 Forecast Issued 6 Aug. 2019 at 1200 UTC
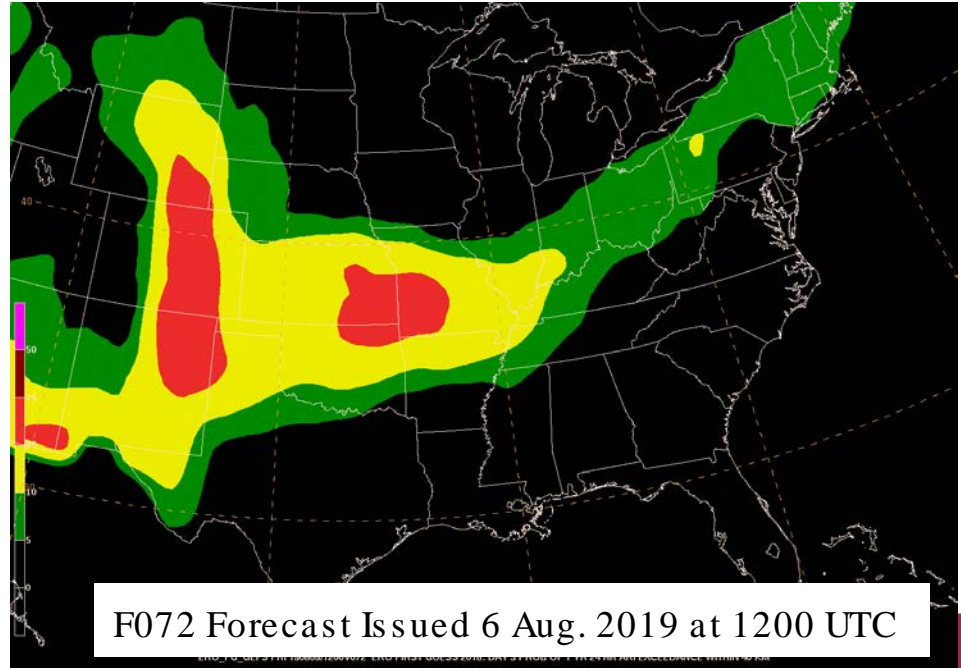
Herman, G.R. and R.S. Schumacher (2018a): Money Doesn't Grow on Trees, but Forecasts Do: Forecasting Extreme Precipitation with Random Forests. Monthly Weather Review, 146, 1571-1600.
https://journals.ametsoc.org/doi/abs/10.1175/MWR-D-17-0250.1

Mesoscale Precipitation Discussions (MPD)

- Short-fused product to highlight areas of concern for flash flooding and atmospheric rivers prior to WFO issuance of flash flood warnings
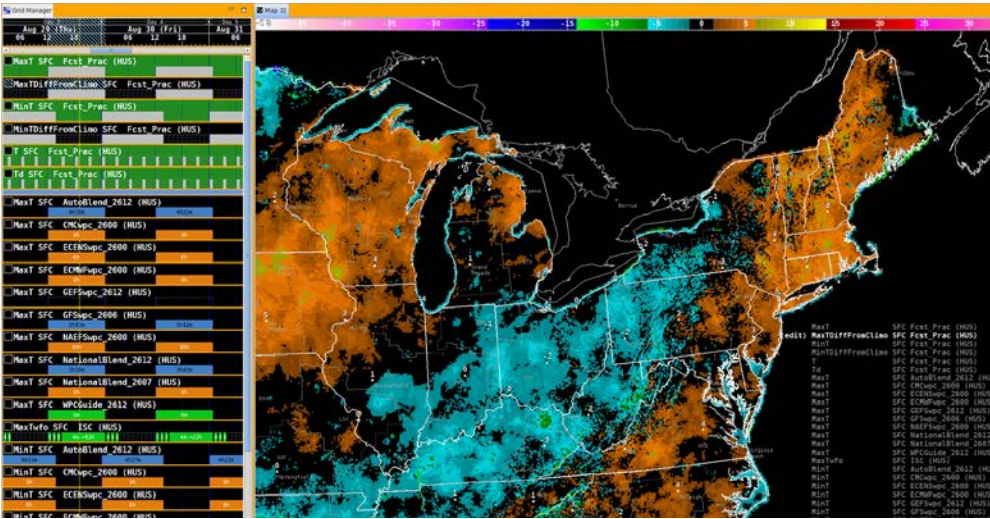

Increasing threat for training convection heavy rainfall amounts this afternoon
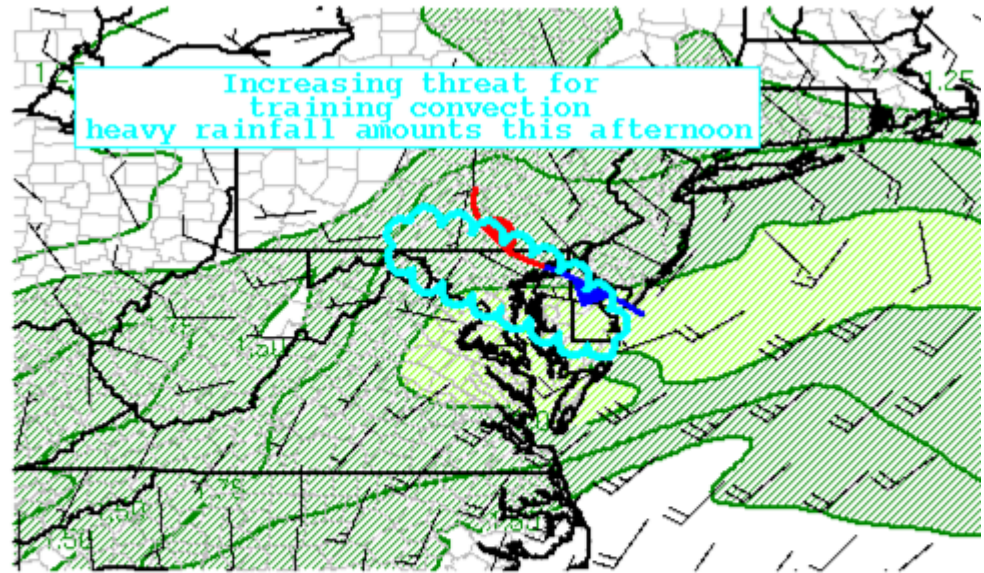
RAP32 PRECIP WATER 180527/1600f002
RAP32 850 MB WINDS 180527/1600f002
WPC MPD #0206

"...HREF NEIGHBORHOOD PROBABILITIES FOR AMOUNTS OF 2 INCHES OR GREATER ARE WELL ABOVE 50 PERCENT ACROSS NORTHEASTERN MD DURING THIS PERIOD..."
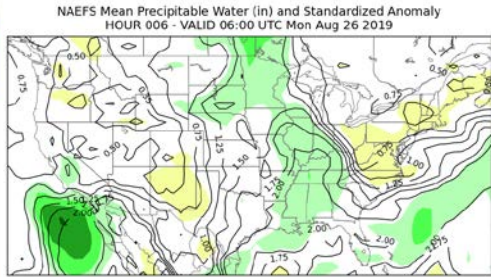
Medium Range Days 4 to 7

- National Blend of Models (NBM) provides initialization

- Forecasters examine model and ensemble mean differences

- ScaVec Blender

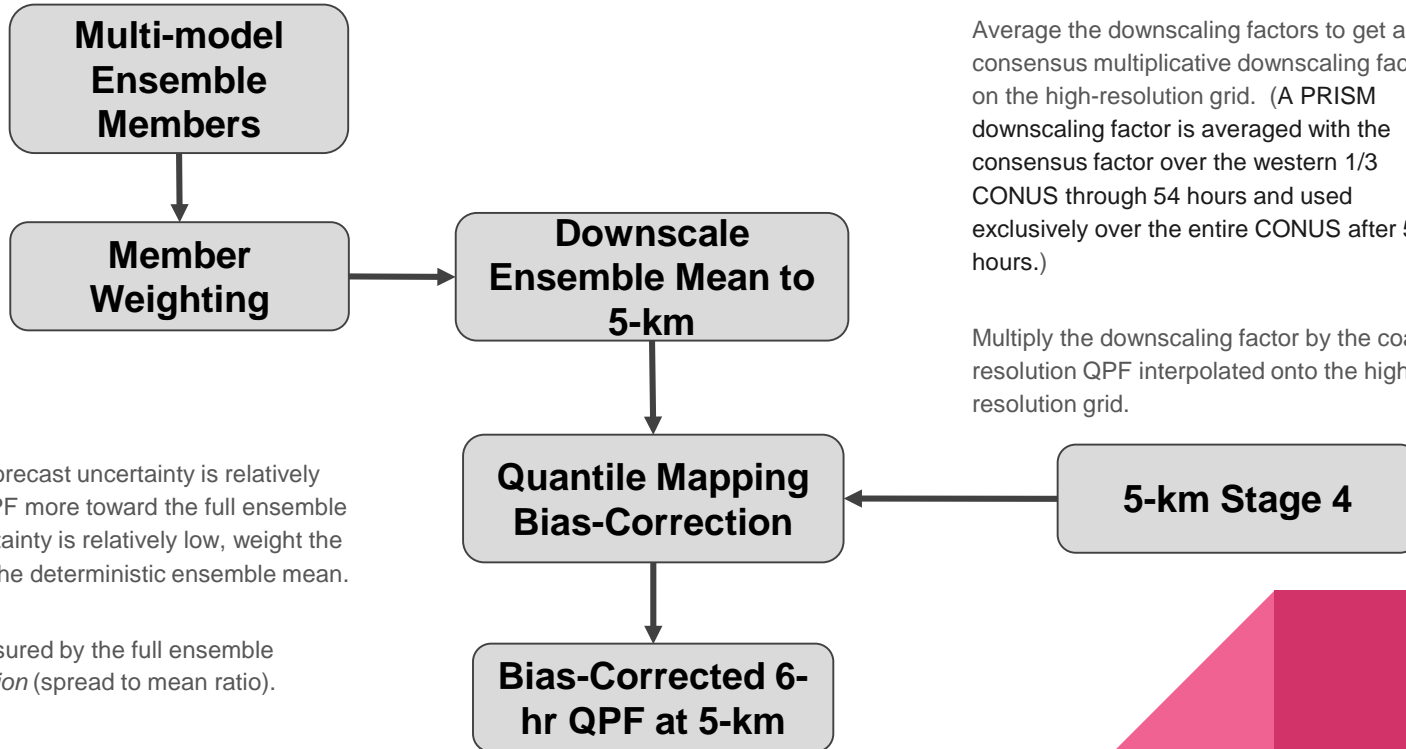- WPC's Multi-Model Ensemble Bias-Corrected (MMEBC) QPF

Difference Grids

Ensemble Situational Awareness Table

WPC's Multi-Model Bias-Corrected (MMEBC) QPF

Downscaling: Create downscaling factors by dividing high-resolution QPFs by coarse versions of themselves or by the coarse QPF being downscaled. (This is done on the high-resolution grid.)

Average the downscaling factors to get a consensus multiplicative downscaling factor on the high-resolution grid. (A PRISM downscaling factor is averaged with the consensus factor over the western 1/3 CONUS through 54 hours and used exclusively over the entire CONUS after 54 hours.)

Multiply the downscaling factor by the coarse resolution QPF interpolated onto the high-resolution grid.

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┌──────────────────┐
│  Multi-model     │
│  Ensemble        │
│  Members         │
└──────────────────┘
        │
        ▼
┌──────────────────┐      ┌──────────────────┐
│  Member          │─────▶│  Downscale       │
│  Weighting       │      │  Ensemble Mean to│
│                  │      │  5-km            │
└──────────────────┘      └──────────────────┘
                                   │
                                   ▼
┌──────────────────┐      ┌──────────────────┐
│  Quantile Mapping│◀─────│  5-km Stage 4    │
│  Bias-Correction │      │                  │
└──────────────────┘      └──────────────────┘
        │
        ▼
┌──────────────────┐
│  Bias-Corrected 6-│
│  hr QPF at 5-km  │
└──────────────────┘
```

Weighting: If the forecast uncertainty is relatively high, weight the QPF more toward the full ensemble mean. If the uncertainty is relatively low, weight the QPF more toward the deterministic ensemble mean.

Uncertainty is measured by the full ensemble *coefficient of variation* (spread to mean ratio).
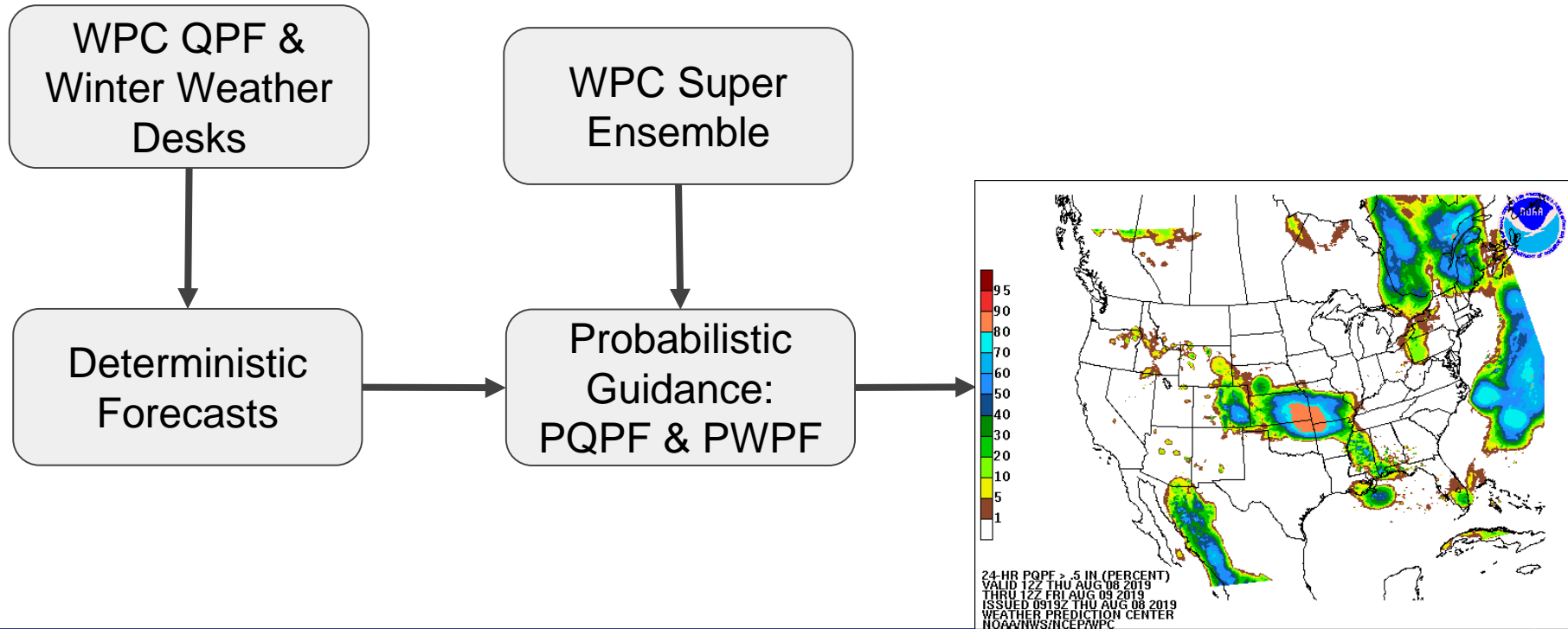
Courtesy of Keith Brill - WPC/IMSG

Winter Weather Outlook (WWO)

- Produced by Medium Range forecasters for Days 4 to 7

- Probability of frozen liquid equivalent exceeding 0.25 inches as proxy for winter weather

WPC WWO Reliability
Forecast Valid 1 Oct. 2018 - 31 May 2019
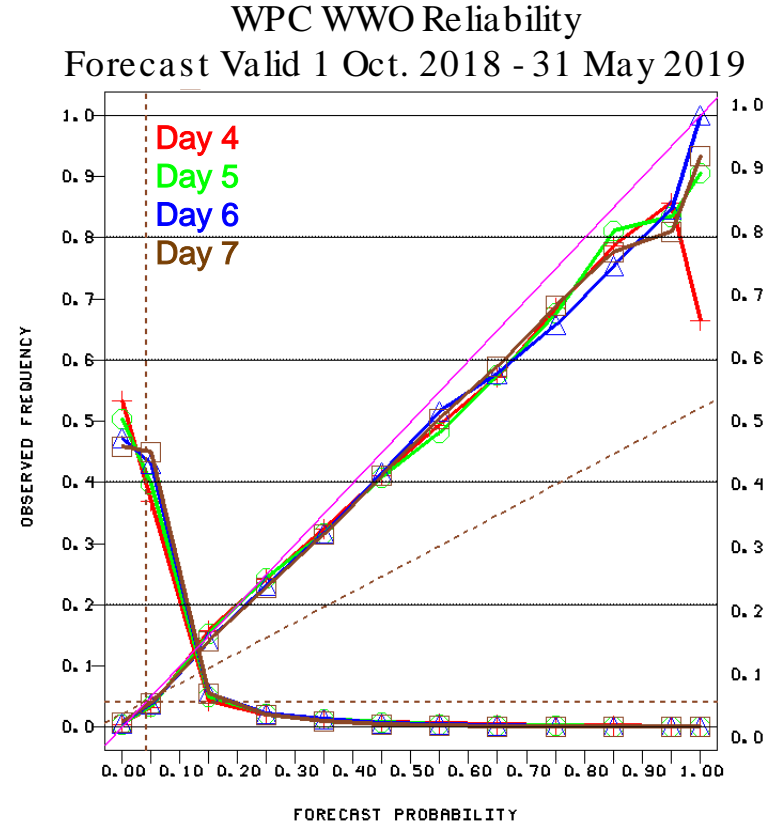
Probabilistic Quantitative Precipitation Forecast (PQPF)
Probabilistic Winter Precipitation Forecast (PWPF)

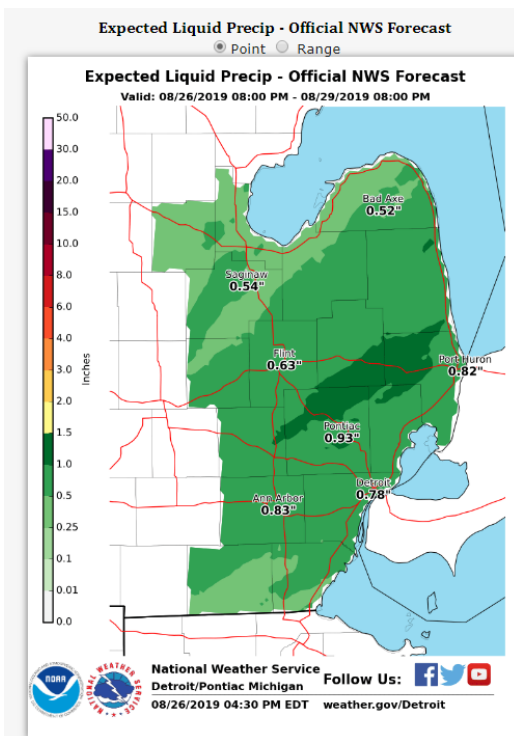Probabilistic guidance for snow, ice and total liquid equivalent amounts

24-HR PQPF > .5 IN (PERCENT)
VALID 12Z THU AUG 08 2019
THRU 12Z FRI AUG 09 2019
ISSUED 0919Z THU AUG 08 2019
WEATHER PREDICTION CENTER
NOAA/NWS/NCEP/WPC

NWS Probabilistic QPF and Snow Experiments

WPC PQPF & PWPF
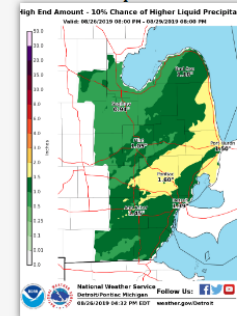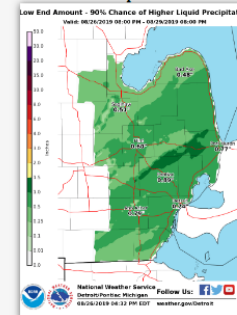
WFO Forecasts

An example of PQPF graphics from NWS WFO Milwaukee, WI

Recent Development Work

- Targeted development effort to correct issues noted by current PQPF and PWPF users

- Improved statistical calibration of PQPF - July 2019
  - PQPF 10th percentiles too low in synoptic precipitation events
  - Improved calibrated POP used in binormal distribution fitting process

- Similar testing performed for PWPF to ensure consistency with PQPF

- WPC maintains a 20-km archive of the multi-model ensemble data used by PQPF/PWPF for retrospective testing

CONUS-wide PWPF Brier Skill Score Forecasts Valid 15 Nov. 2018 - 31 Mar. 2019
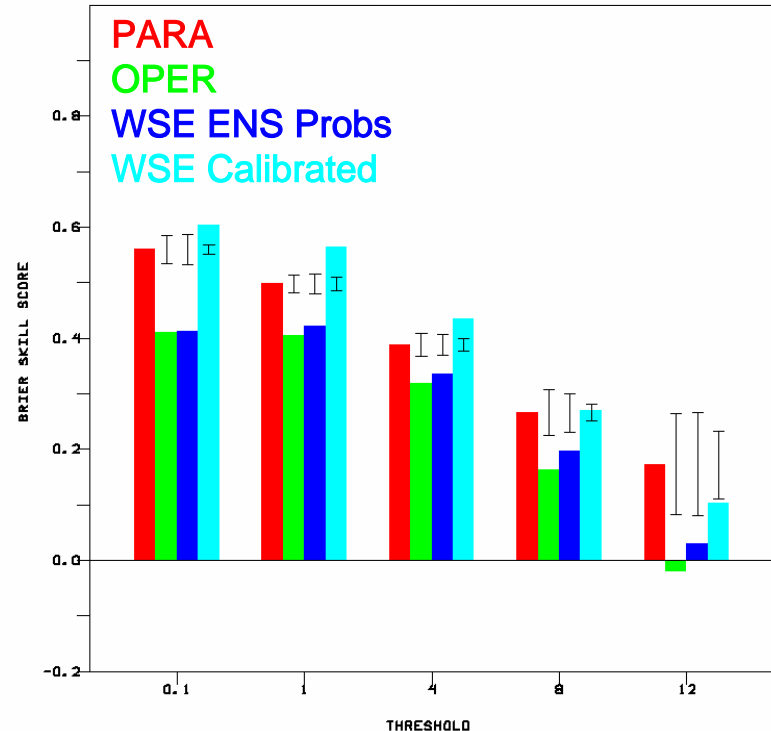
Leveraging the National Blend of Models (NBM) Probabilities

- Plan for winter 2019-2020

- Explore transitioning to NBM's PQPF and PWPF
  - At WFO-level, requires testing and development of new GFE methodology for Prob Snow and QPF
  - Collaborate with Prob Snow and QPF technical teams

- Collaborative verification and development effort with MDL
  - Objectively verify PQPF and PWPF from WPC and NBM

- Goal is to inform NBM development and provide the best possible PQPF and PWPF

WPC's Top Ensemble Requirements

- Need high-resolution guidance fully covering Days 2 and 3
  - Implies model guidance available through 84 hours
  - Supports QPF, ERO, PQPF, and PWPF

- Improve under-dispersion of ensemble systems
  - Currently post-processing is required to correct under-dispersive ensemble spread
  - Supports PQPF and PWPF

- Improve winter precipitation type forecasting
  - Currently model precipitation type information is only available at discrete time intervals (1-hr, 3-hr, or 6-hr)
  - Difficult to accurately derive snow and ice accumulations in transition zones
  - Ideally snowfall and ice accumulations should be derived internally at each model time step using precipitation type algorithms than account for the model microphysics