

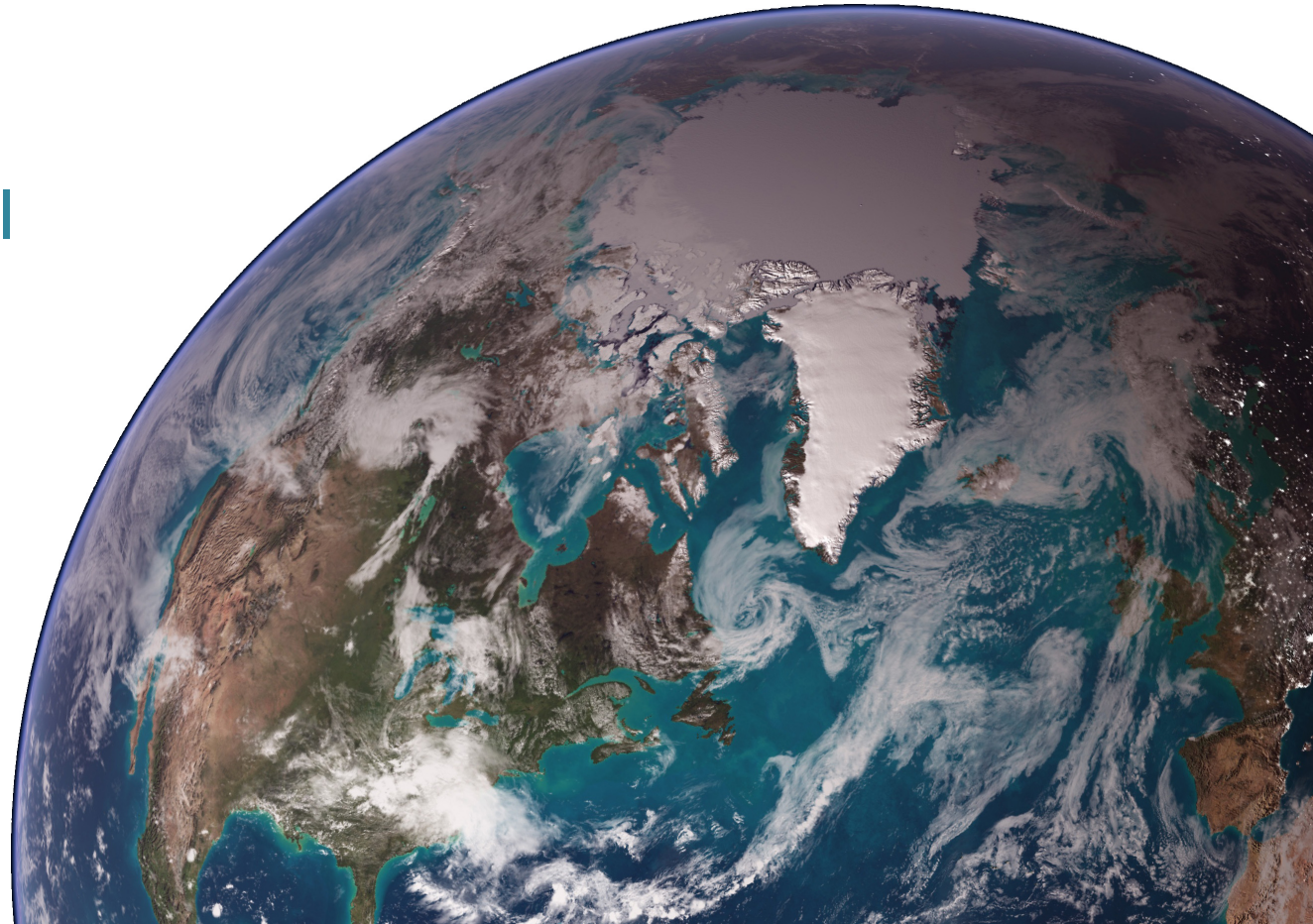


NOAA RESEARCH • ESRL • PHYSICAL SCIENCES DIVISION

Ensemble Reforecasts and Post-Processing

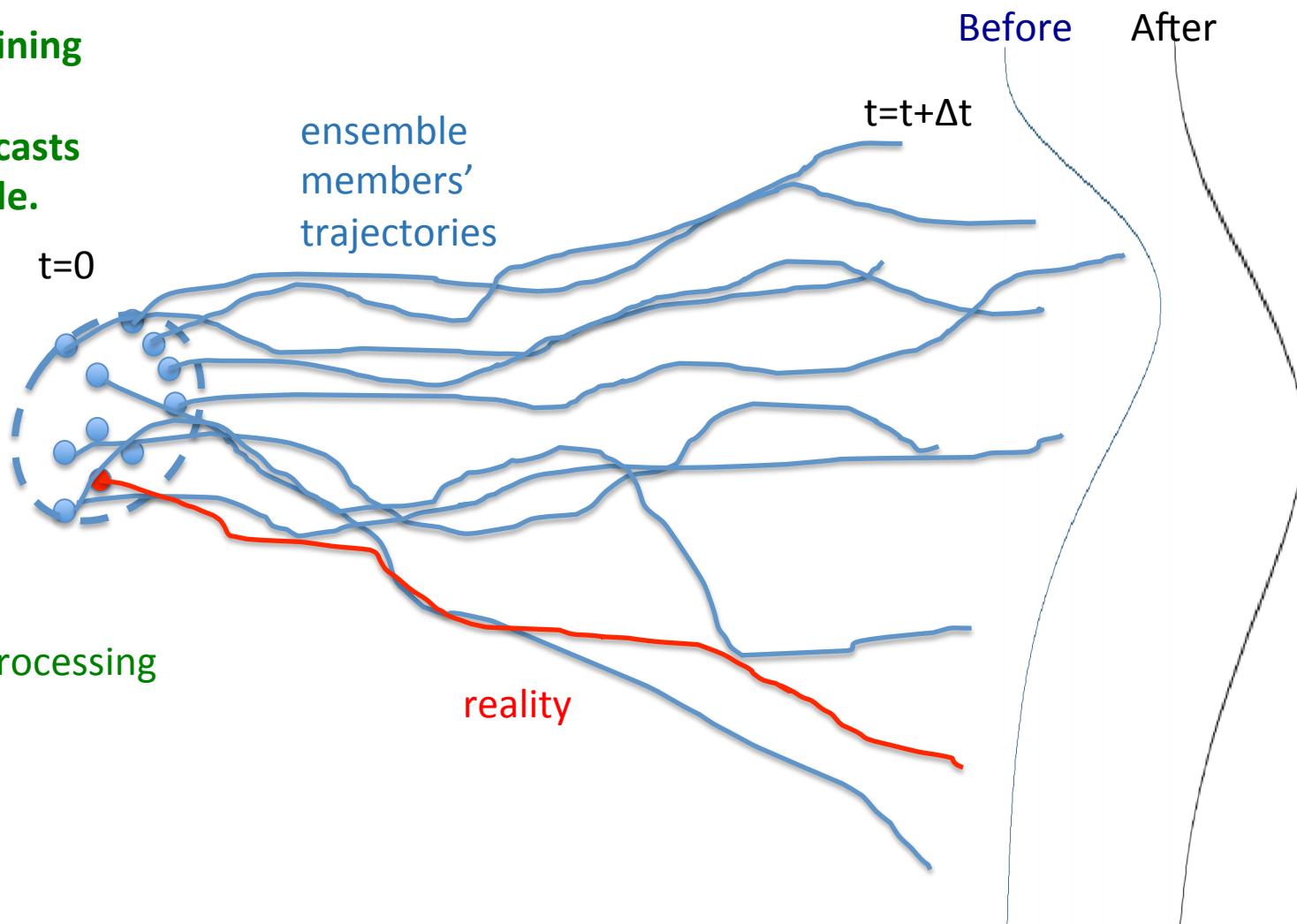
Thomas M. Hamill

Science Review
12-14 May 2015
Boulder, Colorado

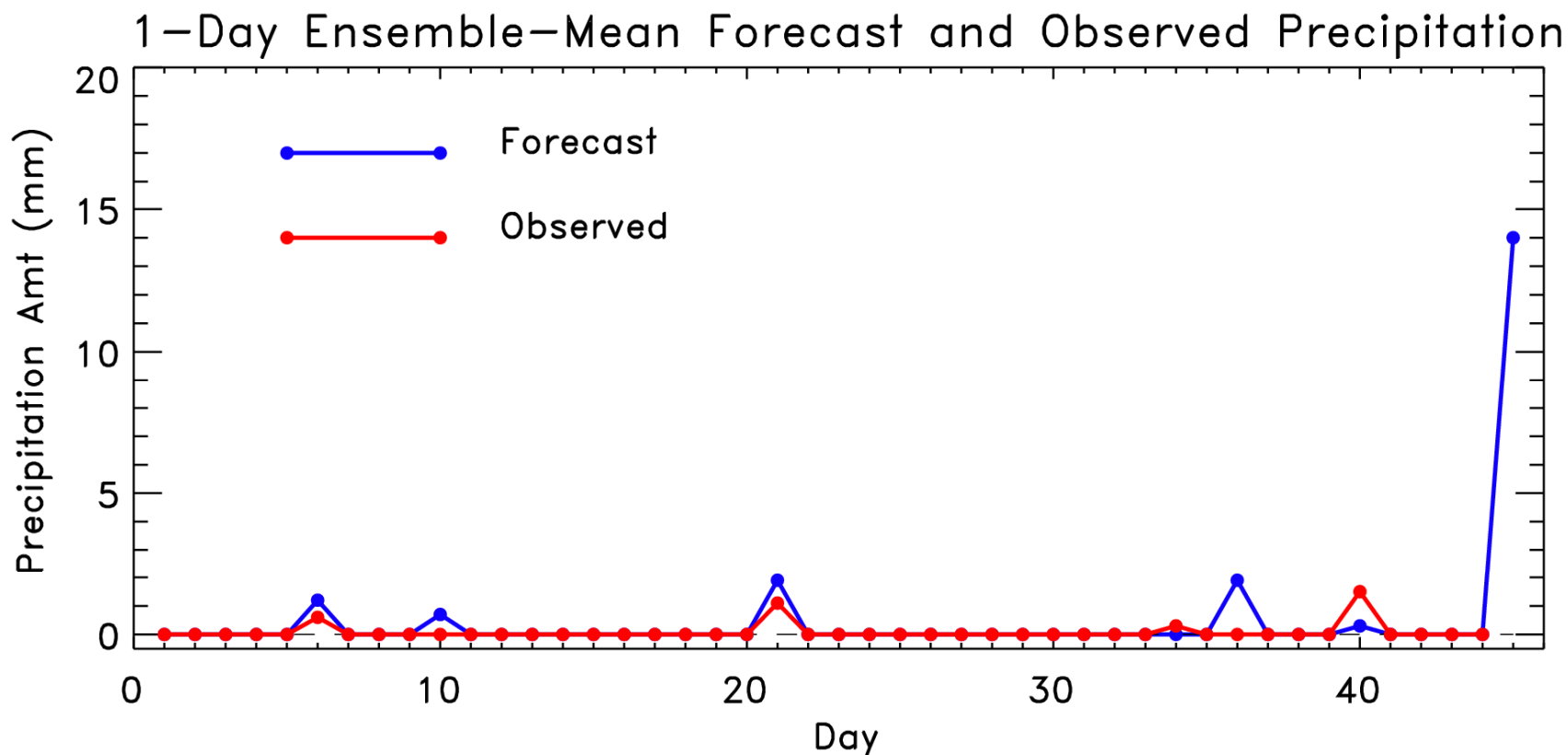


PSD's R2X support for the quantification of uncertainty

Problem 4: Remaining unreliability of probabilistic forecasts from the ensemble.

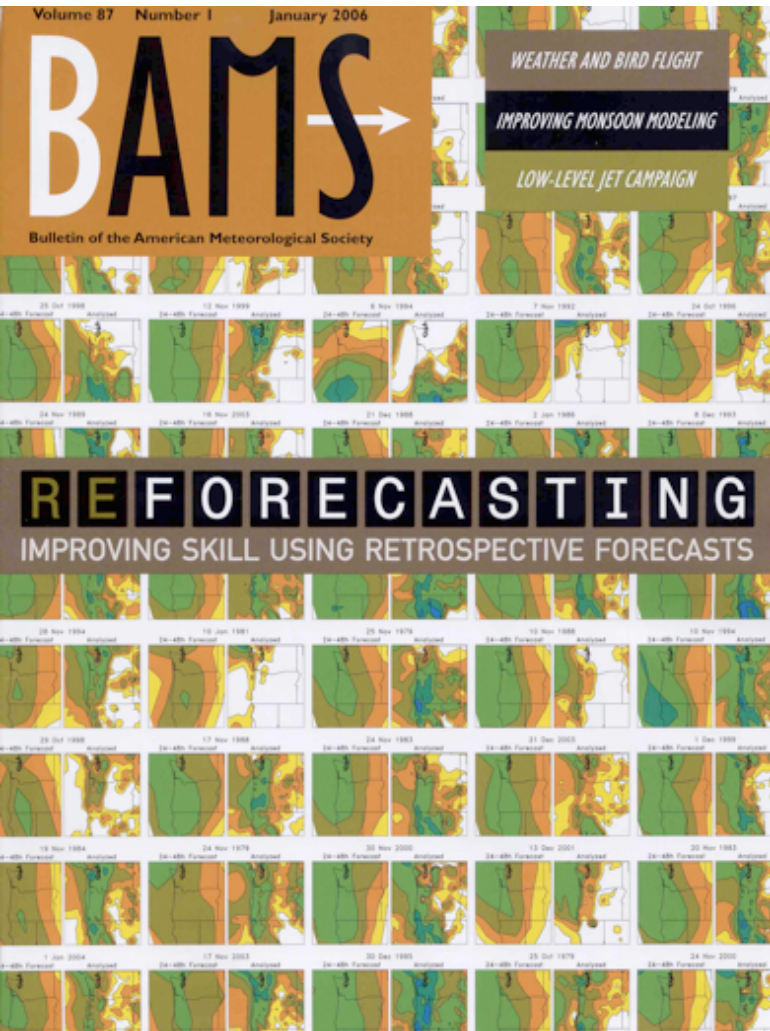


Some challenges in the post-processing of precipitation



The heavy precipitation events that users care the most about can be uncommon, and a short time series of past forecasts may not provide useful training data.

Reforecasts



- In our experience, **sample size** matters as much or more than the post-processing method.
- Reforecasts: numerical simulations of the past weather (or climate) using the same forecast model and assimilation system that (ideally) is used operationally.
 - Common with climate, uncommon with weather models.
- We've now generated two reforecasts for the NCEP GEFS system, including with the currently operational model version. Working with NWS on a third, including a new reanalysis.

Select Desired Variables and Associated Levels:

Single Level (1°x1°) Pressure Levels (1°x1°) Hybrid Levels (1°x1°) Single Level (Gaussian ~.5°)

- | | |
|--|--|
| <input type="radio"/> Total Accumulated Precipitation | <input type="radio"/> Temperature at 2 meters |
| <input type="radio"/> U-Component of Wind at 10 meters | <input type="radio"/> V-Component of Wind at 10 meters |
| <input type="radio"/> U-Component of Wind at 80 meters | <input type="radio"/> V-Component of Wind at 80 meters |
| <input type="radio"/> Convective Available Potential Energy | <input type="radio"/> Convective Inhibition |
| <input type="radio"/> Surface Downward Long-Wave Radiation Flux | <input type="radio"/> Surface Downward Short-Wave Radiation Flux |
| <input type="radio"/> Surface Upward Long-Wave Radiation Flux | <input type="radio"/> Surface Upward Short-Wave Radiation Flux |
| <input type="radio"/> Ground Heat Flux | <input type="radio"/> Surface Latent Heat Net Flux |
| <input type="radio"/> Surface Sensible Heat Net Flux | <input type="radio"/> Mean Sea Level Pressure |
| <input type="radio"/> Surface Pressure | <input type="radio"/> Precipitable Water |
| <input type="radio"/> Volumetric Soil Moisture Content | <input type="radio"/> Specific Humidity at 2 meters |
| <input type="radio"/> Total Cloud Cover | <input type="radio"/> Total Column-Integrated Condensate |
| <input type="radio"/> Skin Temperature | <input type="radio"/> Maximum Temperature |
| <input type="radio"/> Minimum Temperature | <input type="radio"/> Soil Temperature (0-10 cm below surface) |
| <input type="radio"/> Upward Long-Wave Radiation Flux | <input type="radio"/> Water Runoff |
| <input type="radio"/> Water Equivalent of Accumulated Snow Depth | <input type="radio"/> Wind Mixing Energy |
| <input type="radio"/> Vertical Velocity at 850 hPa Surface | <input type="radio"/> Temperature on 2 PVU Surface |
| <input type="radio"/> Pressure on 2 PVU Surface | <input type="radio"/> U-Component of Wind on 2 PVU Surface |
| <input type="radio"/> V-Component of Wind on 2 PVU Surface | <input type="radio"/> Potential Vorticity on 320 K Isentrope |

Select Desired Dates (Available from Dec 1 1984 to Apr 24 2015):

From: To:

- Download all the forecasts within the chosen time period. [Help](#)
- Download forecasts within the month-days range for the chosen years. [Help](#)

Select Desired Forecast Hour(s):

High Resolution: (Select All or Clear)

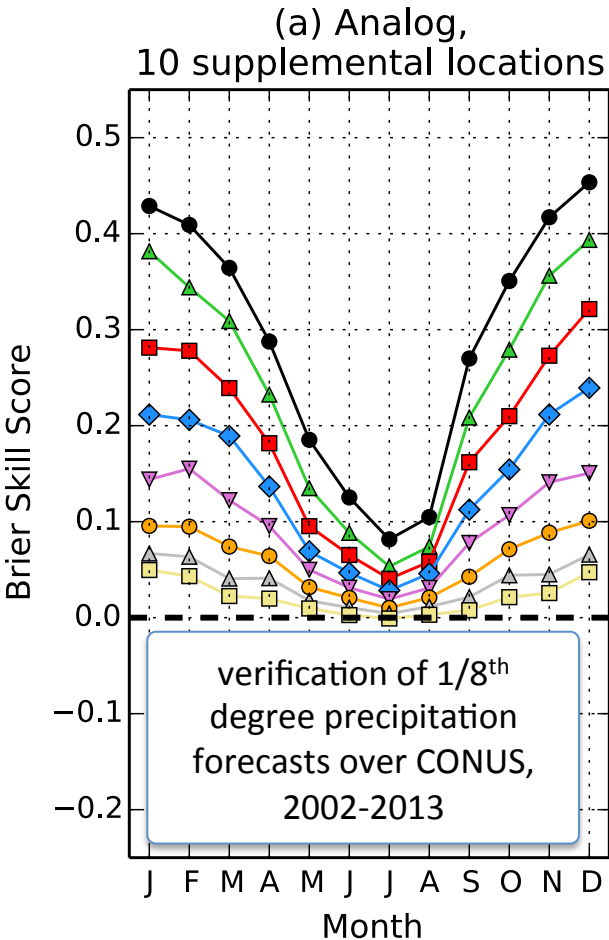
- | | | | | | | | | | |
|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| <input type="checkbox"/> 0 | <input type="checkbox"/> 3 | <input type="checkbox"/> 6 | <input type="checkbox"/> 9 | <input type="checkbox"/> 12 | <input type="checkbox"/> 15 | <input type="checkbox"/> 18 | <input type="checkbox"/> 21 | <input type="checkbox"/> 24 | <input type="checkbox"/> 27 |
| <input type="checkbox"/> 30 | <input type="checkbox"/> 33 | <input type="checkbox"/> 36 | <input type="checkbox"/> 39 | <input type="checkbox"/> 42 | <input type="checkbox"/> 45 | <input type="checkbox"/> 48 | <input type="checkbox"/> 51 | <input type="checkbox"/> 54 | <input type="checkbox"/> 57 |
| <input type="checkbox"/> 60 | <input type="checkbox"/> 63 | <input type="checkbox"/> 66 | <input type="checkbox"/> 69 | <input type="checkbox"/> 72 | <input type="checkbox"/> 78 | <input type="checkbox"/> 84 | <input type="checkbox"/> 90 | <input type="checkbox"/> 96 | <input type="checkbox"/> 102 |
| <input type="checkbox"/> 108 | <input type="checkbox"/> 114 | <input type="checkbox"/> 120 | <input type="checkbox"/> 126 | <input type="checkbox"/> 132 | <input type="checkbox"/> 138 | <input type="checkbox"/> 144 | <input type="checkbox"/> 150 | <input type="checkbox"/> 156 | <input type="checkbox"/> 162 |
| <input type="checkbox"/> 168 | <input type="checkbox"/> 174 | <input type="checkbox"/> 180 | <input type="checkbox"/> 186 | <input type="checkbox"/> 192 | | | | | |

Accessing reforecast data

- We've made it easy for users to access the 200 TB of data on disk and ~ 1 PB on tape.
- 99 variables available from disk, including mandatory level data and many surface fields, as shown.
- Produces netCDF files.
- Also: direct ftp access to allow users to download the raw grib files.

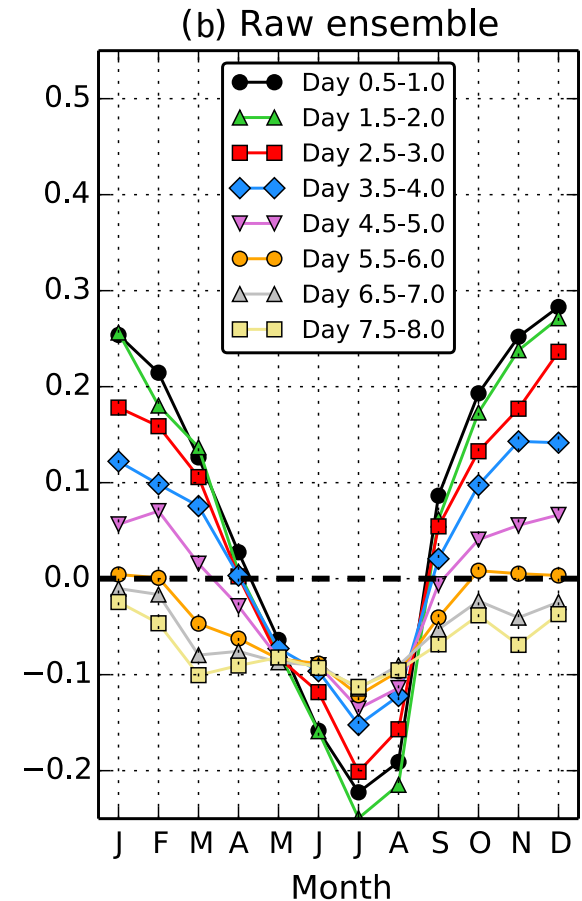
Development of techniques for post-processing

Brier skill scores, > 10mm



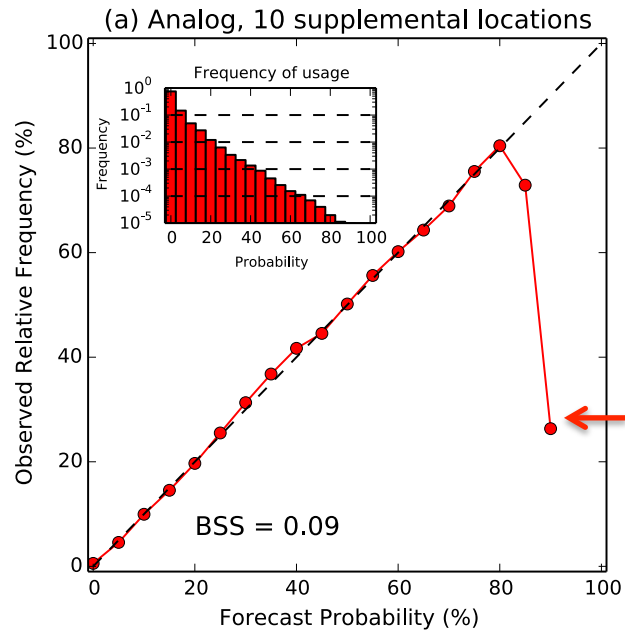
We have developed post-processing techniques that dramatically improve upon the skill of the raw forecast guidance. These techniques include analog and distribution-fitting techniques (see also Michael Scheuerer poster).

We are also working with NWS on multi-model post-processing for the “National Blend of Models” project.



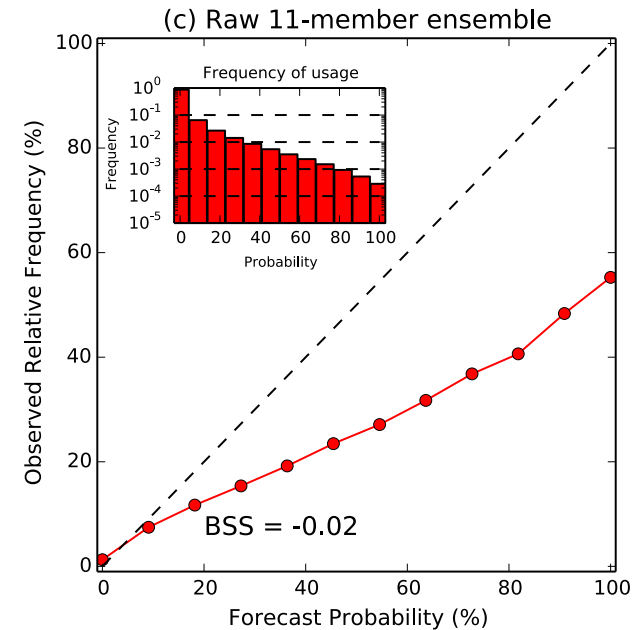
Post-processed guidance is highly reliable

Reliability for 108-120-h, > 10mm



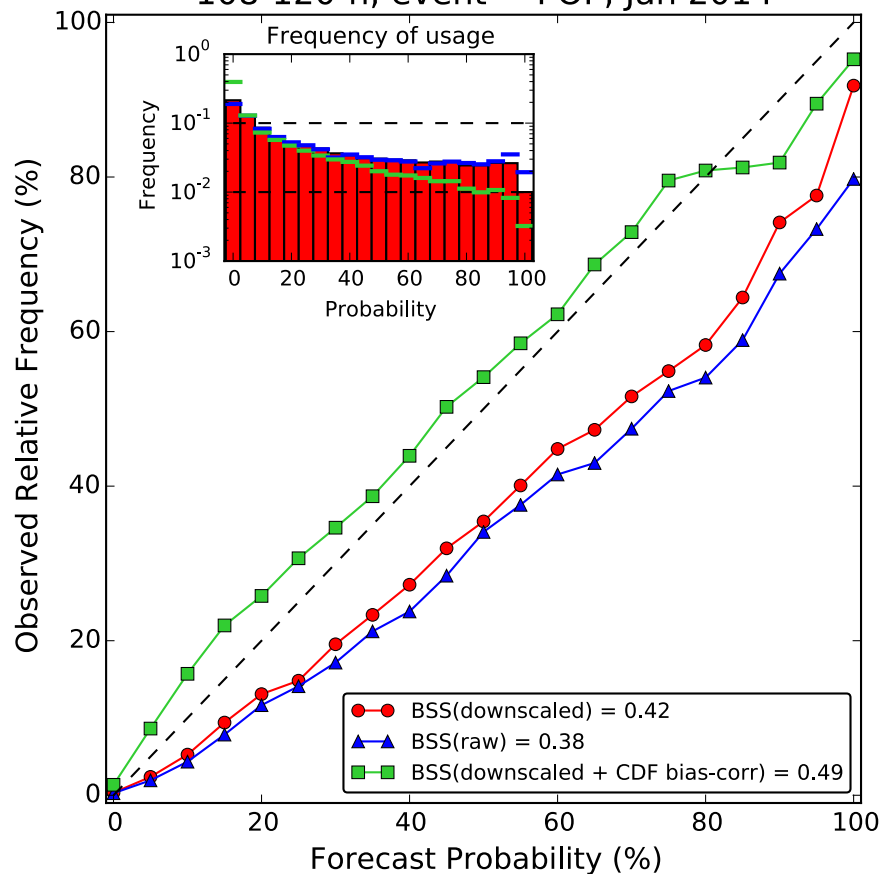
The post-processed guidance that we generate is very highly reliable, making it suitable for use in decision-making.

The high-end unreliability at left is simply due to small sample size; those high probabilities are issued very rarely.



Doing the best possible with short training data sets

Statistically downscaled and raw reliability,
108-120-h, event = POP, Jan 2014



POP = probability of (nonzero) precipitation.

For multi-model ensemble data, we explored whether we could improve on the technique with two simple procedures, a statistical downscaling and a CDF (cumulative distribution function)-based bias correction, also known as “quantile mapping.”

This technique will be used to populate the operational NWS National Digital Forecast Database via the “National Blend of Models” project.

Summary and conclusions

- We have built strong collaborations with NWS partners on the generation of reforecasts for post-processing.
 - CPC, OHD, WPC, MDL are now advocates for operationalizing weather reforecasts.
 - At the 2014 NCEP Production Suite Review, Hendrik Tolman indicated that EMC plans to regularly generate reanalyses/ reforecasts.
- PSD is joined at the hip with NWS on ensemble and post-processing technique development.
 - Example: I am NWS post-processing team lead for National Blend of Models Project and team lead for NWS Next-Generation Global Prediction System ensemble and post-processing teams.