The Development and Testing of a Day 4-7 Probabilistic Winter Weather Forecast at the Weather Prediction Center

Michael J. Bodner[1], Thomas E. Workoff[1,2], Faye E. Barthold[1,3], Keith F. Brill[1], Wallace A. Hogsett[1], David R. Novak[1]

[1] NOAA/NWS/Weather Prediction Center, College Park, MD
[2] Systems Group, Inc., Rockville, MD
[3] I.M. Systems Group, Inc., Rockville, MD

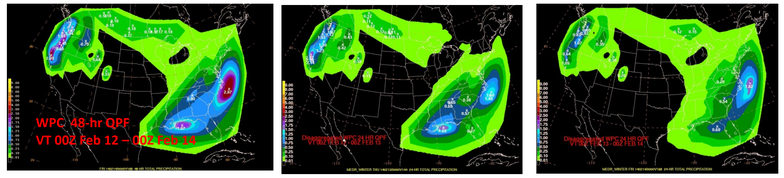
Overview

● Given the increased societal and economic demand to know the potential for winter precipitation as far in advance as possible, a Day 4-7 probabilistic winter weather forecast was developed and tested internally at WPC during the 2013-14 cold season
●Product was generated twice daily by the WPC Winter Weather Desk forecasters
●QPF and identification of frozen precipitation are the two components that are combined to make the guidance forecasts twice daily which were used by WPC forecasters
● The WPC guidance used by forecasters was examined along with alternative data sets during the 2014 WPC/HMT Winter Weather Experiment

Forecast Components

QPF

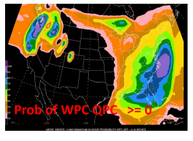
● WPC's 48-hour QPF for Day 4-5, and Days 6-7 are disaggregated into 6-hour amounts using the Global Ensemble Forecast System (GEFS) mean
● 24-hr WPC QPF is then generated from these 6-hr amounts



WPC Day 6-7 48-hr QPF *Day 6 24-hr WPC QPF* *Day 7 24-hr WPC QPF*

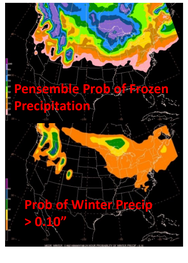
Probability of WPC QPF >= 0.10"

●WPC 24-hr QPF is used as a mean, and the 24-hr QPF from each of the 20 GEFS members, and 50 ECENS members are used as a variance to compute a cumulative distribution function (CDF) of the WPC QPF reaching or exceeding 0.10" *(right image)*



Frozen Precipitation Component

●An ensemble probability of frozen precipitation is generated using the dominant precipitation type fields for snow, sleet and freezing rain in each of the GEFS members (*Top right image*)
●This ensemble probability of frozen precipitation is then multiplied by the probability of the WPC QPF >= 0.10" to arrive at a probability of winter precipitation >= 0.10" (*Bottom right image*)

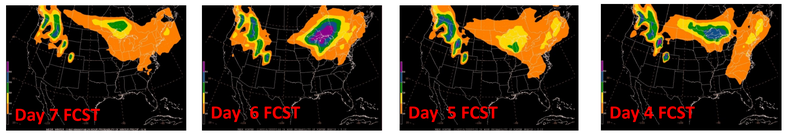


Additional Guidance Developed

● An ensemble probability of frozen precipitation using WPC developed precipitation type for each ECENS member using forecast temperatures at 2-meters and several mandatory levels.
● A combined GEFS and ECENS ensemble probability of frozen precipitation featuring 70 members was also generated
● A probability of frozen precipitation > 0.10" was generated from both additional data sets ' ensemble probability of frozen precipitation and the CDF derived from WPC's QPF.

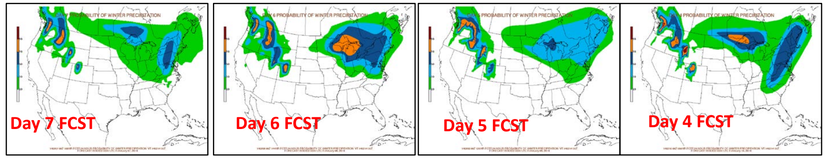
Sample Case – Feb 13-14, Mid-Atlantic and Northeast

WPC Generated Guidance – 24-hr Forecast Ending at 0000 UTC Feb 14, 2014

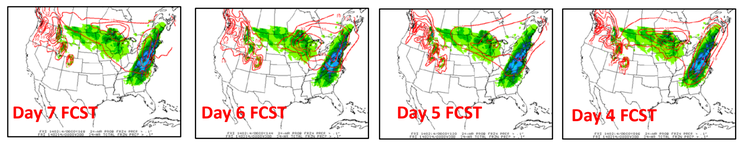


00Z Feb 7 F168 HRS Prob Frozen > 0.10" | *00Z Feb 8 F144 HRS Prob Frozen > 0.10"* | *00Z Feb 9 F120 HRS Prob Frozen > 0.10"* | *00Z Feb 10 F96 HRS Prob Frozen > 0.10"*

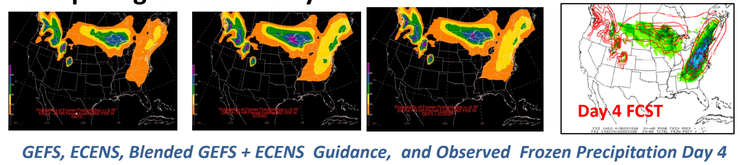
Forecasts - issued by WPC Winter Weather Desk for each of the days corresponding to the guidance



● WPC forecast probabilities (red isopleths) for each of the seven days
● Observed frozen precipitation (shaded) – precipitation estimates from Stage 4 radar where surface temperatures were 32 degrees or colder

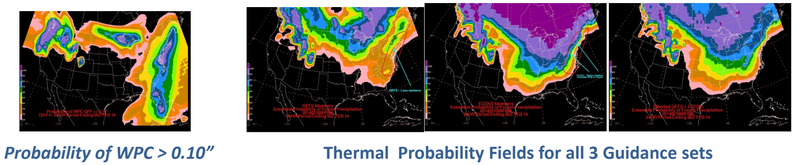


Comparing Guidance Day 4



GEFS, ECENS, Blended GEFS + ECENS Guidance, and Observed Frozen Precipitation Day 4

Evaluating Guidance Forecast Components Day 4

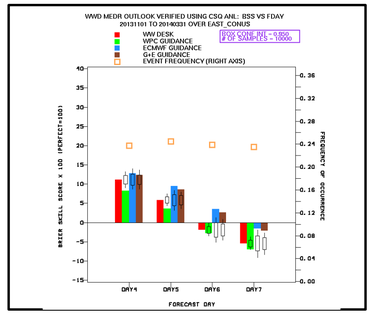


Probability of WPC > 0.10" | Thermal Probability Fields for all 3 Guidance sets

Objective Verification

● Day 4-7 forecasts prepared by WPC winter weather forecasters were objectively verified by computing a Brier skill score for all forecasts issued from November 1, 2013 through March 31, 2014
● The WPC forecasts were contrasted with all 3 guidance data sets listed earlier.
● WPC forecasters improved upon the GEFS precip-tupe guidance, and the results were statistically significant. *Note this guidance was provided as a first guess for forecasters, while ECENS and GEFS+ECENS based forecasts were only available in test capacity only.*
● A take away hypothesis: improving WPC guidance , by combining multi ensemble systems, translates to an improved WPC forecast

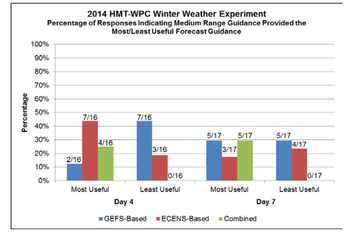
Bar graph to the right illustrates Brier skill scores for WPC manual forecast and 3 model based forecasts. WPC forecast in red, WPC guidance in green, ECENS based guidance in blue, and blended guidance in brown. Black whisker plot boxes show where results were statistically significant, and that WPC manual forecasts improved the primary GEFS based test guidance.



HMT-WPC Winter Weather Experiment

● Guidance and forecast process were examined thoroughly at the 2014 HMT-WPC Winter Weather Experiment
● Experiment participants prepared a Day 4-7 forecast each day using all three aforementioned guidance packages
● Participants also used ESRL GEFS Reforecast data to evaluate the QPF component of the process more thoroughly
● Numerous suggestions to improve the forecast process came from the experiment and several will be implemented by WPC for 2014-15.
● Subjective evaluation of forecasts and the guidance data was conducted each day (some of results available below).

Figure to the right shows the results of the subjective evaluation of forecast guidance utility conducted during the HMT-WPC Winter Weather Experiment. Participants ranked the three data sets from most useful to least useful, . The combined GEFS and ECENS thermal guidance was determined to be most useful.



Future Work

Based on the results from internal testing, objective verification , and the winter weather experiment:

●WPC will expand precipitation type guidance to include all GEFS, ECENS and CMCE members
●WPC will explore adding ensemble QPF mean from other ensemble systems to improve the disaggregation of the QPF component
●WPC medium range forecasters will prepare the product in 2014-15