CONSShort: An Hourly Short Term "Ensemble" Blend

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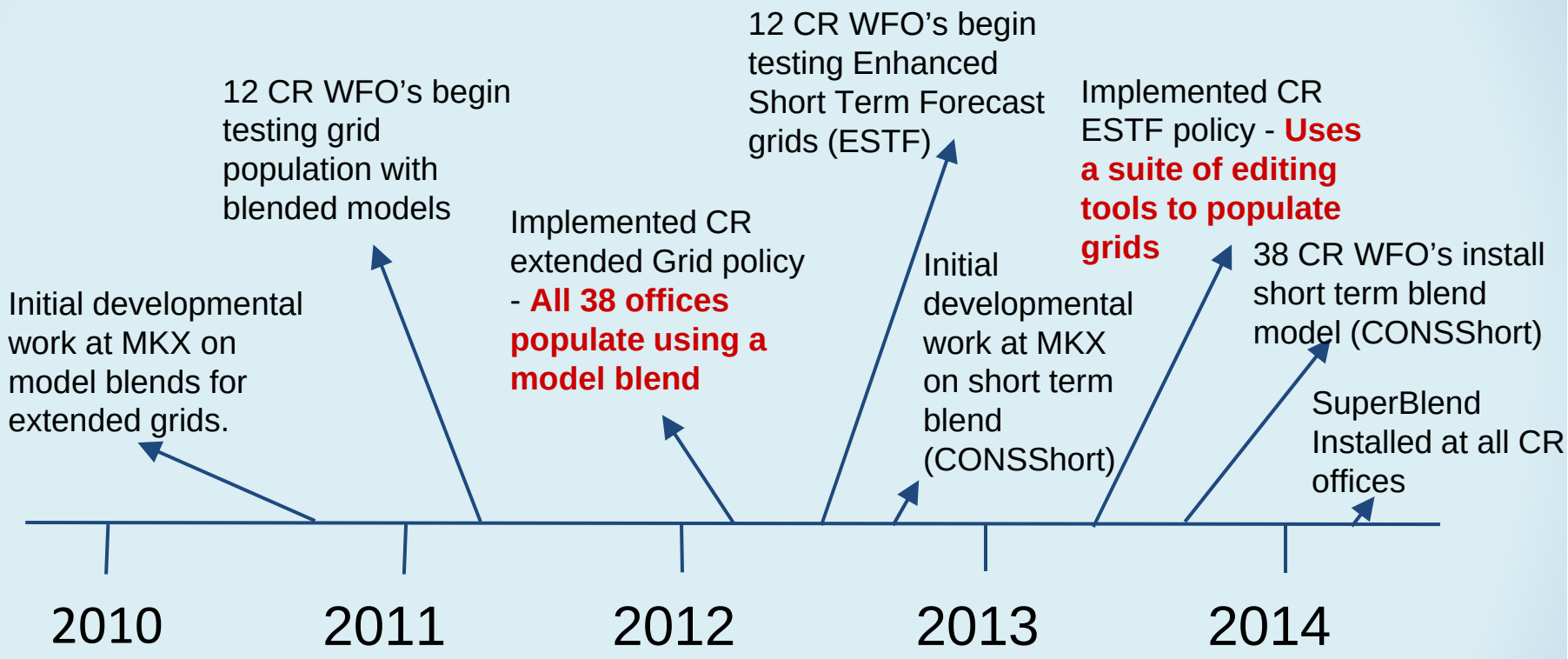
Ensemble Work Shop
3/25/14 – 3/27/14

History of Model Blends in CR



What is CONSShort?

- Blends observations with a short term model blend
- Runs hourly (~50 after the hour)
- Produces hourly guidance to 24 hours
  - T, Td, Wind, WindGust, PoP, QPF, SnowAmt, Sky, Weather, IceAccum
- 3, 6, and 12 hourly elements are computed for
  - PoP, QPF, and SnowAmt

Composition of CONSShort

- Official WFO Grids
- **Obs** (advected by RAP 850-700-500 mb mean wind: PoP, Sky, QPF, Snow)

  -Observations dominate weightings in first 6 hours
- Persistence/obs (all others) adjusted by 7 day mean diurnal hourly variation
- **HRRR** (3km - weighted four times)
- **RAP** (13km – weighted twice)
- **GLAMP** (2.5 km – weighted twice)
- *Local **wsWRF** (4km – weighted twice) -this will vary if office does not have wsWRF*
- WRF ARW (4km)
- WRF NMM (4km)
- NAM12
- NamDNG5 (5km) AWIPS1 NamDNG25(2.5KM) AWIPS2
- **ADJLAV** (RAP adjusted by LAMP stations) (weighted four times)
- ADJMET (NAM12 adjusted by MET stations)
- ADJMAV (GFS40 adjusted by MAV stations)

**Locally created using Tim Barker Serp tool and Station based MOS Guidance*

Composition of Observations

- Five background fields, with observations matched via Tim Barker GFE “serp” analysis
- 20% LAPS (4 km)
- 20% RAP (13 km)
- 20% HRRR (3 km)
- 20% RTMA   (5 km) (2.5km in AWIPS2)
- 20% NAM12 (12km)
- A different analysis is created using each background. That analysis is then blended to form one analysis

Observational Blending

- T,Td,WindSpeed, WindGust
  - Simply taking the current observation does not work due to diurnal changes. I.E 16-17Z warm up.
  - A 7 day running average of diurnal change is computed.
  - The diurnal change grid is the blended based on a weighting with the overall blend of models. (0-3 hr 100% 50%, 25%, 10%, 0)

Observational Blending

- PoP, QPF, SnowAmt, Sky
  - Observational grid is advected using a blend of the RUC13 850, 700, and 500 MB Winds (optionally different in mountains)
  - The advected observation is blended with the model blend using a predefined weight of (0hr - 6hr) 100%, 90%, 75%, 60%, 40%, 20%, 10%
  - This technique does create problems during summertime convection as well as lake effect and terrain induced precipitation

Composition of CONSShort (T, Td, wind, wind gust, RH)

Model Weight Fhr	1	2	3	4	5	6
Official	2%	4%	4%	5%	5%	5%
Obs/persistence	50%	25%	10%	0	0	0
HRRR	10%	14%	17%	20%	20%	20%
RAP	5%	7%	9%	10%	10%	10%
GLAMP	5%	7%	9%	10%	10%	10%
Local wsWRF	*5%*	*7%*	*9%*	*10%*	*10%*	*10%*
WRF ARW	2%	4%	4%	5%	5%	5%
WRF NMM	2%	4%	4%	5%	5%	5%
NAM12	2%	4%	4%	5%	5%	5%
NAMDNG5(2.5km)	2%	4%	4%	5%	5%	5%
ADJLAV*	10%	14%	17%	20%	20%	20%
ADJMET*	2%	4%	4%	5%	5%	5%
ADJMAV*	2%	4%	4%	5%	5%	5%

**Locally created using Tim Barker Serp tool and Station based MOS Guidance*

Composition of CONSShort (PoP, QPF, Sky, Snow)

Model Weight Fhr	**1**	**2**	**3**	**4**	**5**	**6**
Official	0.5%	1%	2%	3%	4%	4%
Obs/persistence	90%	75%	60%	40%	20%	10%
HRRR	2%	5%	8%	12%	16%	17%
RAP	1%	2%	4%	6%	8%	9%
GLAMP (No precip)	1%	2%	4%	6%	8%	9%
Local wsWRF	*1%*	*2%*	*4%*	*6%*	*8%*	*9%*
WRF ARW	0.5%	1%	2%	3%	4%	4%
WRF NMM	0.5%	1%	2%	3%	4%	4%
NAM12	0.5%	1%	2%	3%	4%	4%
NAMDNG5 (2.5km)	0.5%	1%	2%	3%	4%	4%
ADJLAV* (No QPF/SA)	2%	5%	8%	12%	16%	17%
ADJMET*(No QPF/SA)	0.5%	1%	2%	3%	4%	4%
ADJMAV* (No QPF/SA)	0.5%	1%	2%	3%	4%	4%

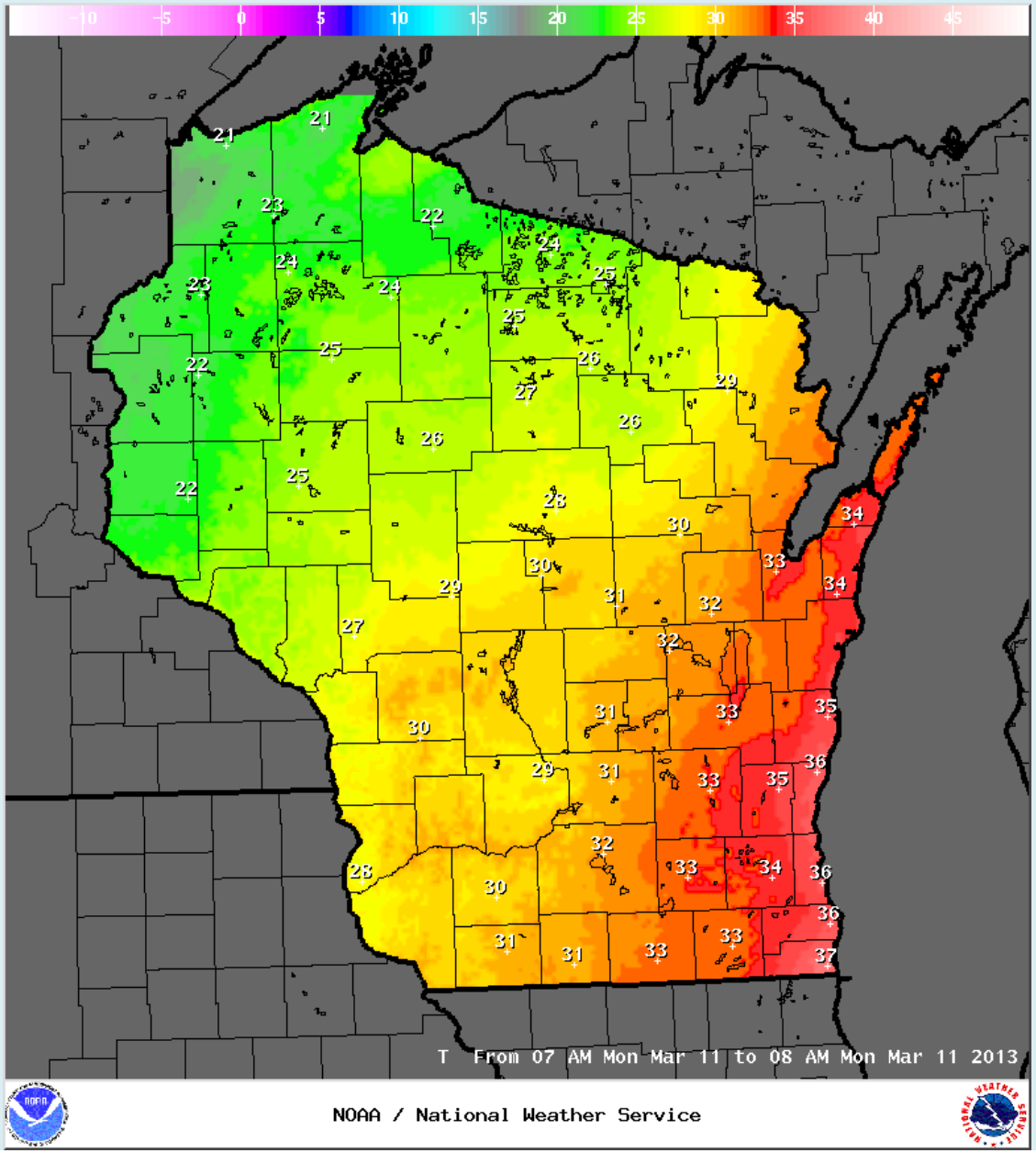
**Locally created using Tim Barker Serp tool and Station based MOS Guidance*

Composition of CONSShort

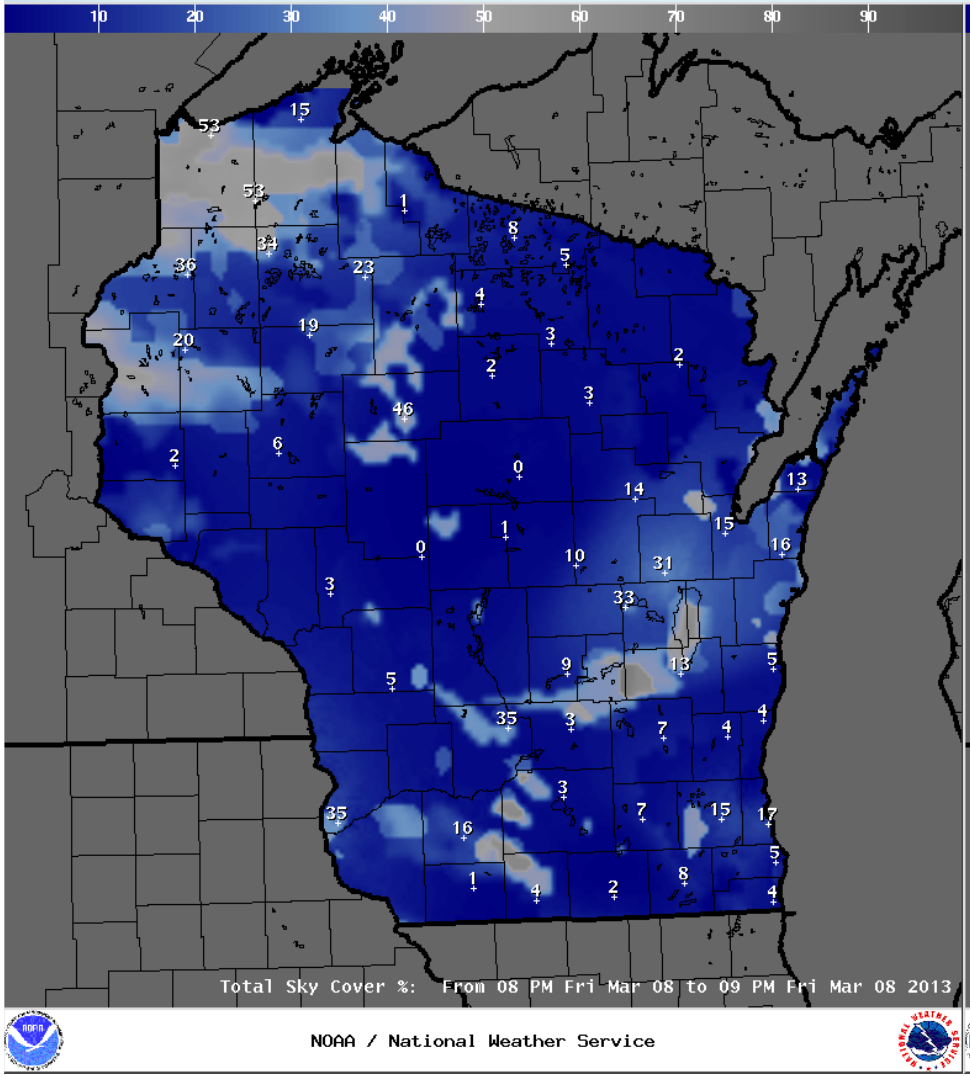
Model	Approximate Weight in 7-24 hour period		
	7-15	16-18	19-24
Official	5%	7%	8%
Obs/Persistence	*0%*	*0%*	*0%*
HRRR	19%	NA	NA
RAP	10%	13%	NA
GLAMP	10%	3%	15%
Local wsWRF	*10%*	*NA*	*NA*
WRF ARW	5%	7%	8%
WRF NMM	5%	7%	8%
NAM12	5%	7%	8%
NAMDNG5 (2.5km)	5%	7%	8%
ADJLAV*	19%	27%	31%
ADJMET*	5%	7%	8%
ADJMAV*	5%	7%	8%

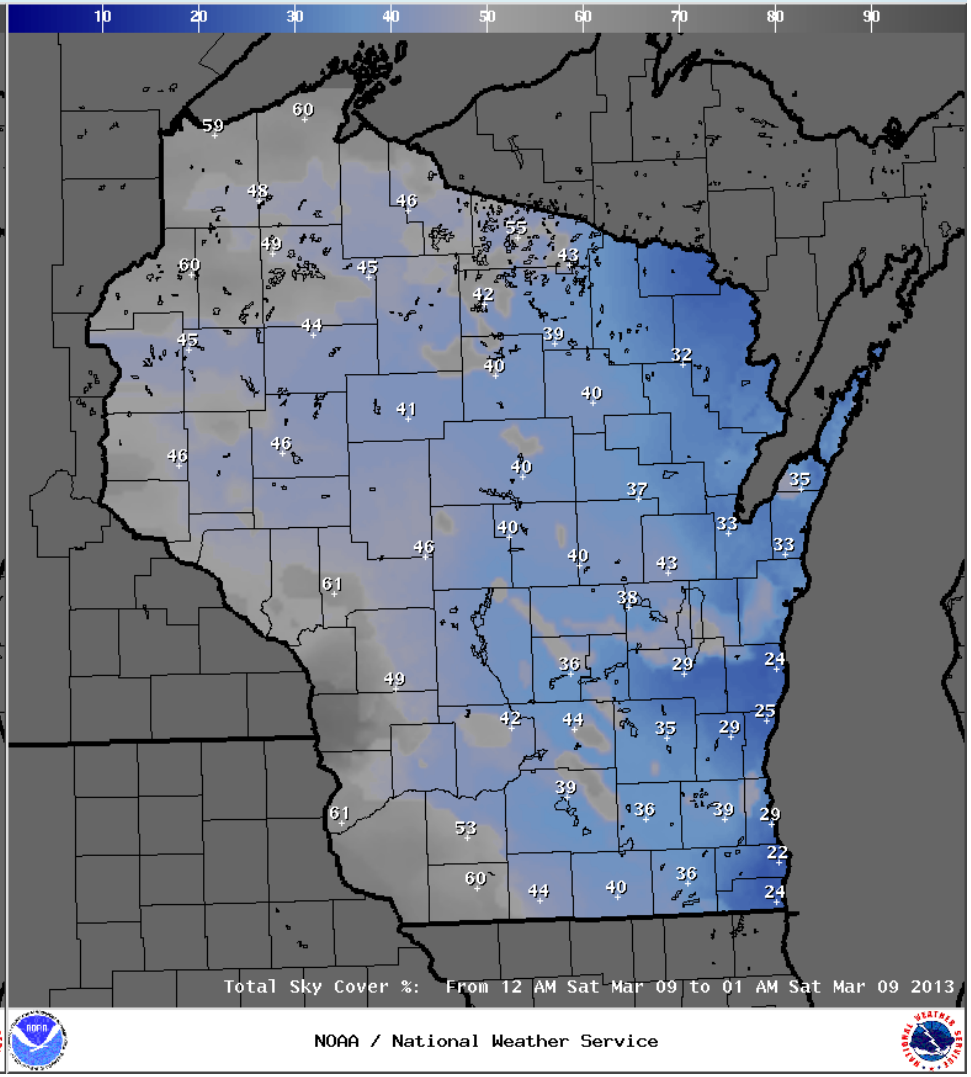
**Locally created using Tim Barker Serp tool and Station based MOS Guidance*

Example hourly temperature

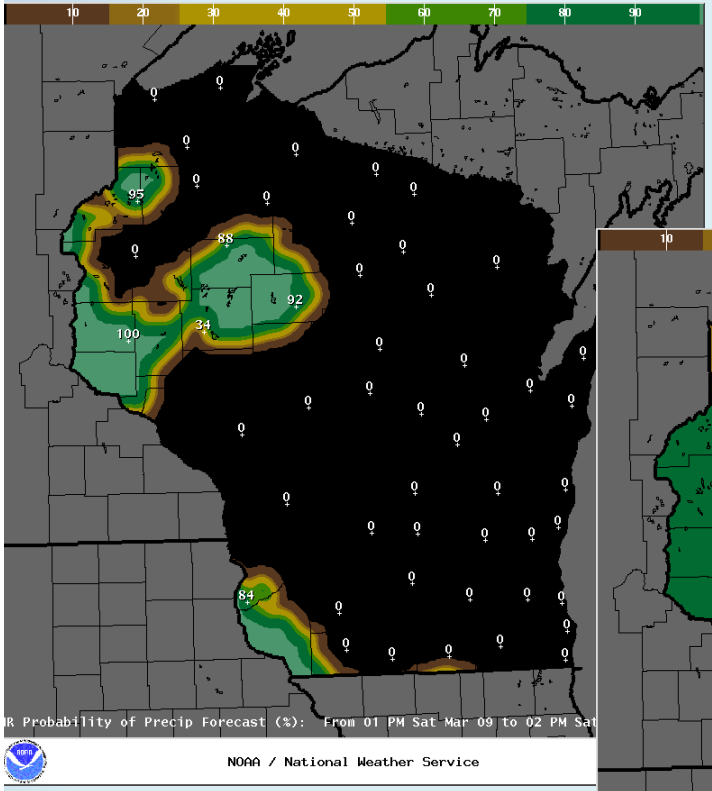


Examples hourly Sky

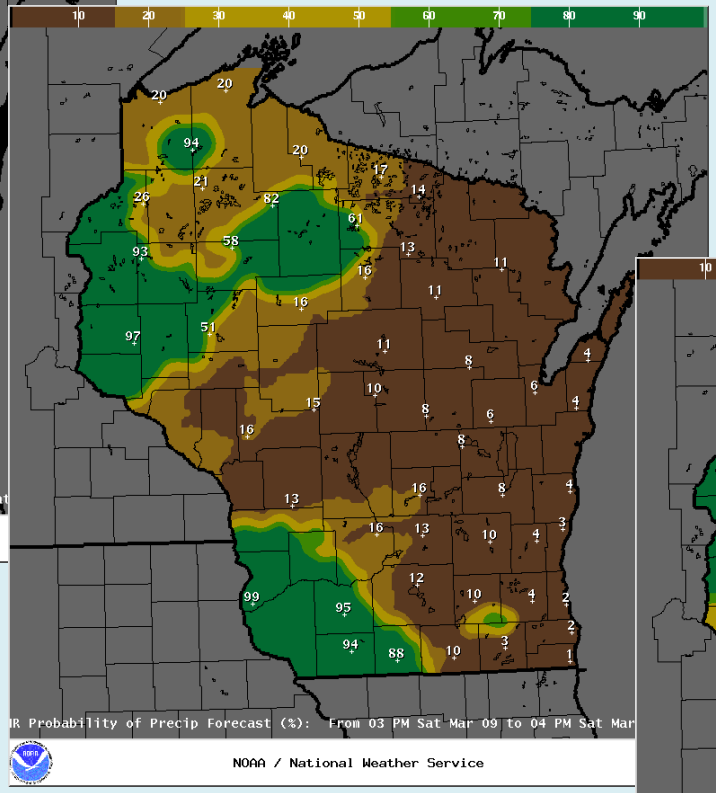




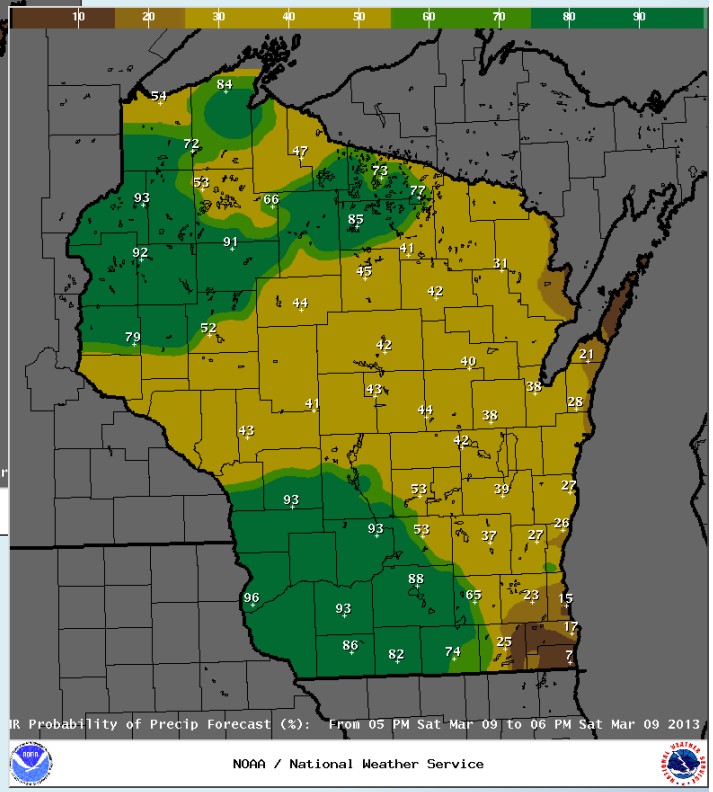
Examples hourly PoP



0 hour

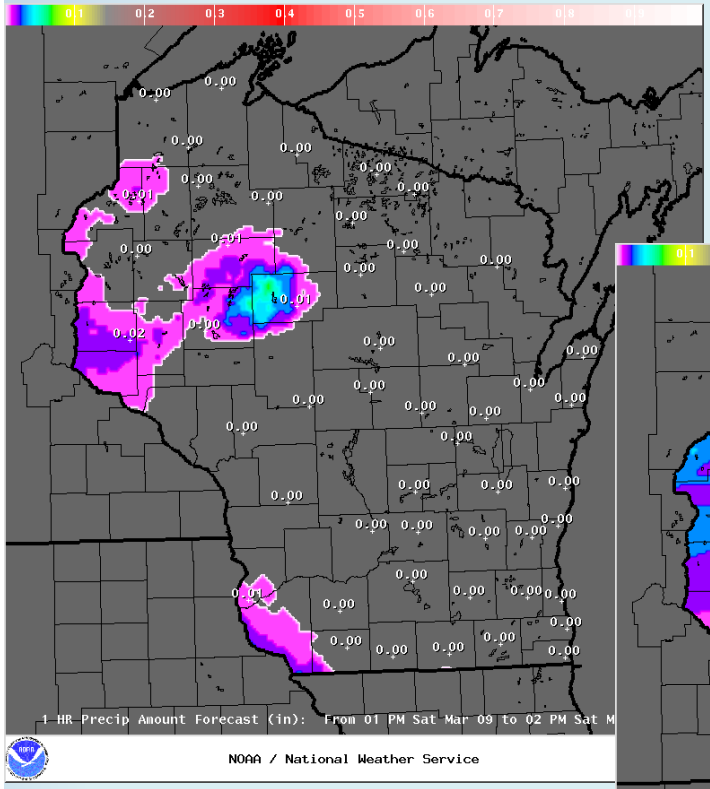


2 hour

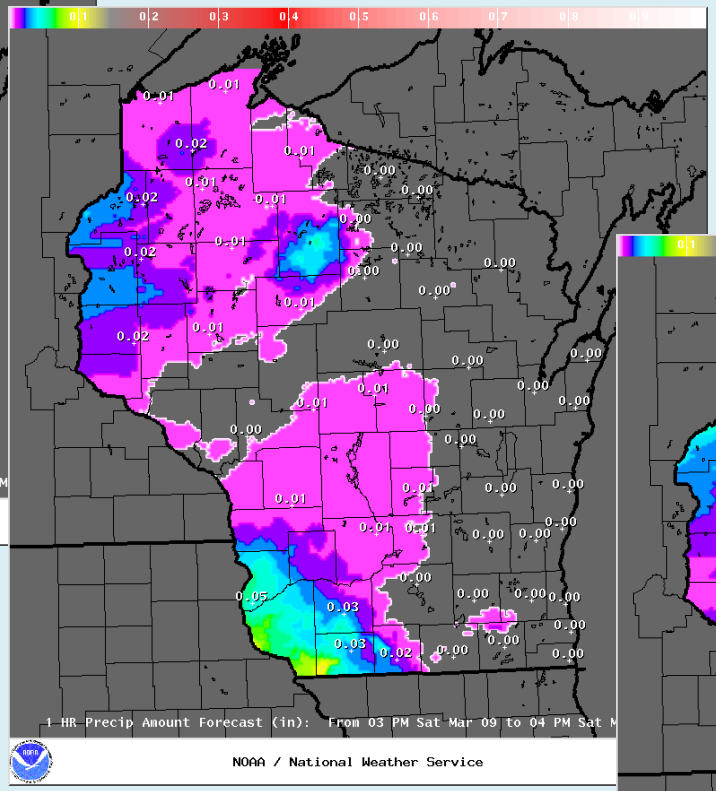


4 hour

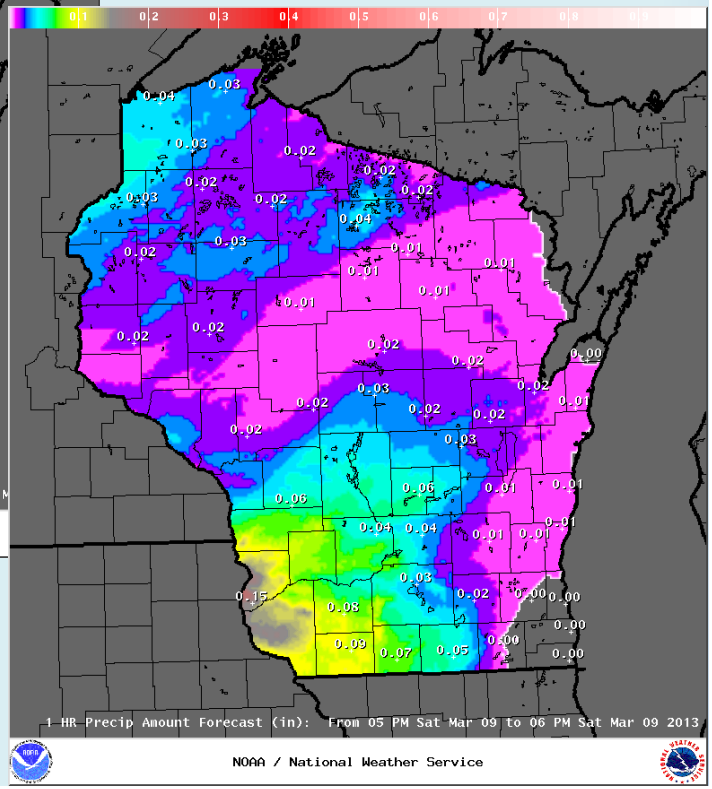
Examples hourly QPF



0 hour



2 hour



4 hour

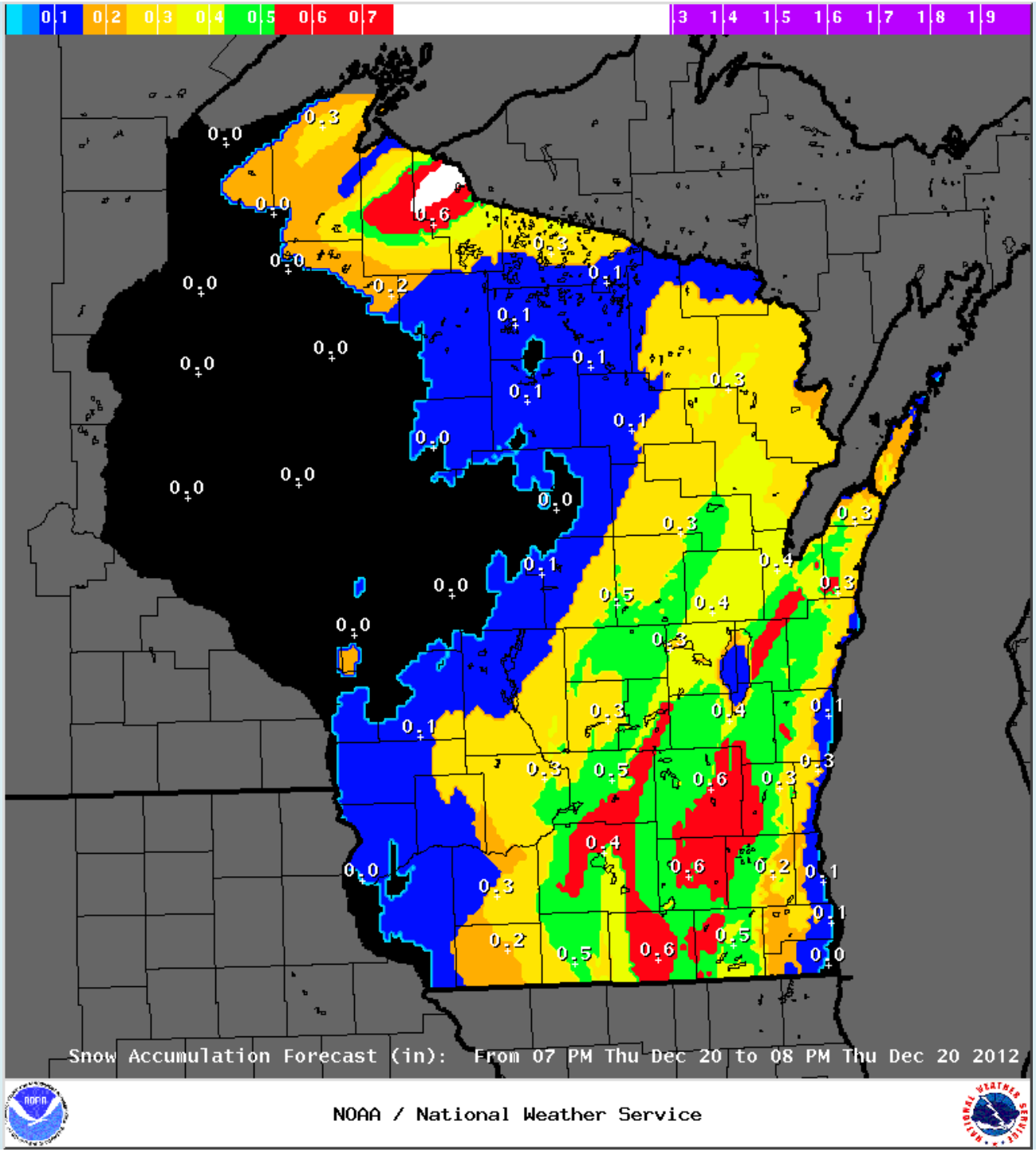
02z

Obs

Fcst

KMSN
0.01”

0.2”
0.4”



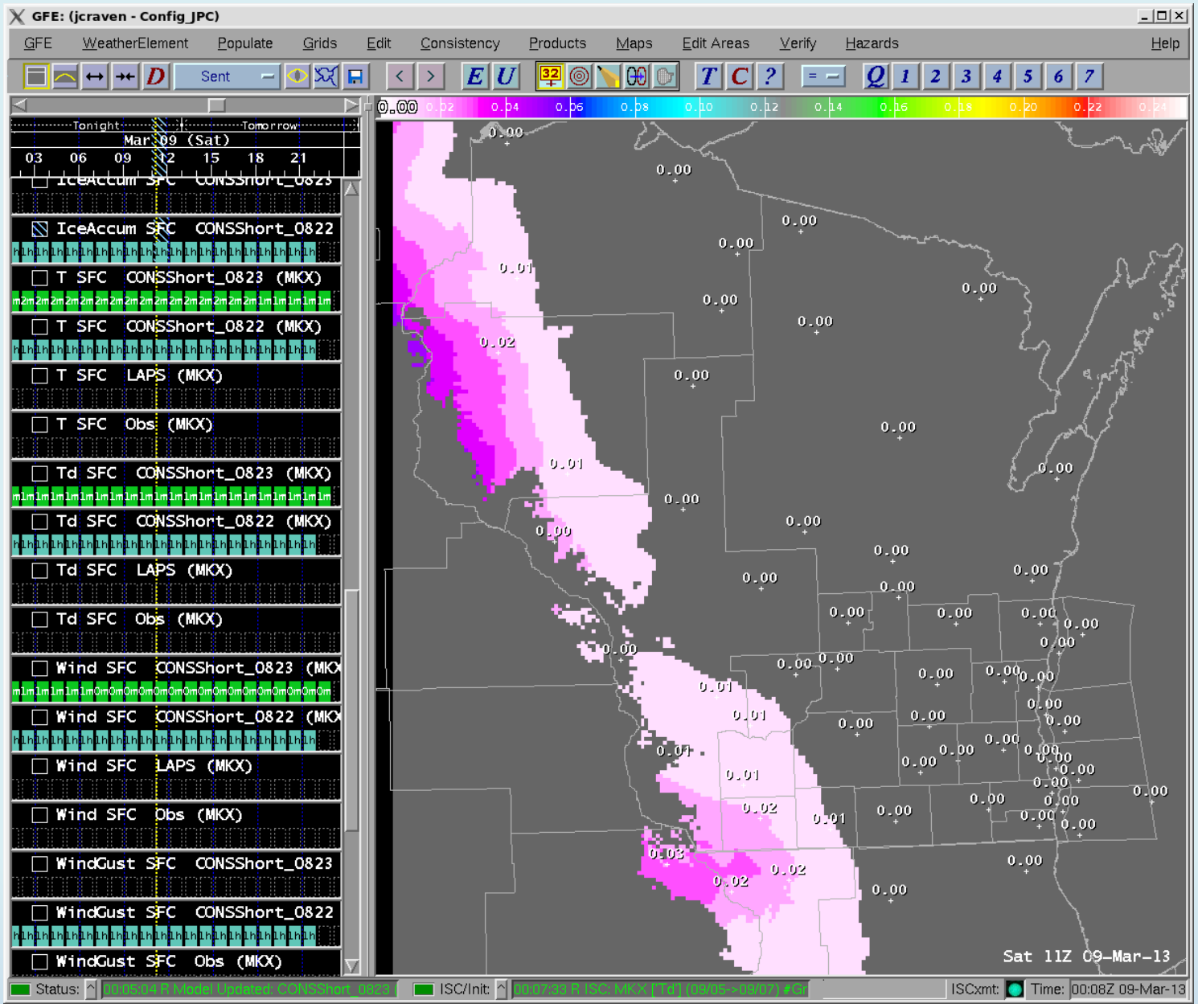
18z run

KMSN
30F
1 -SN

KMKE
33F
2 ½ -SN

0.02”
0.2” 0.1”

Example hourly Ice Accumulation

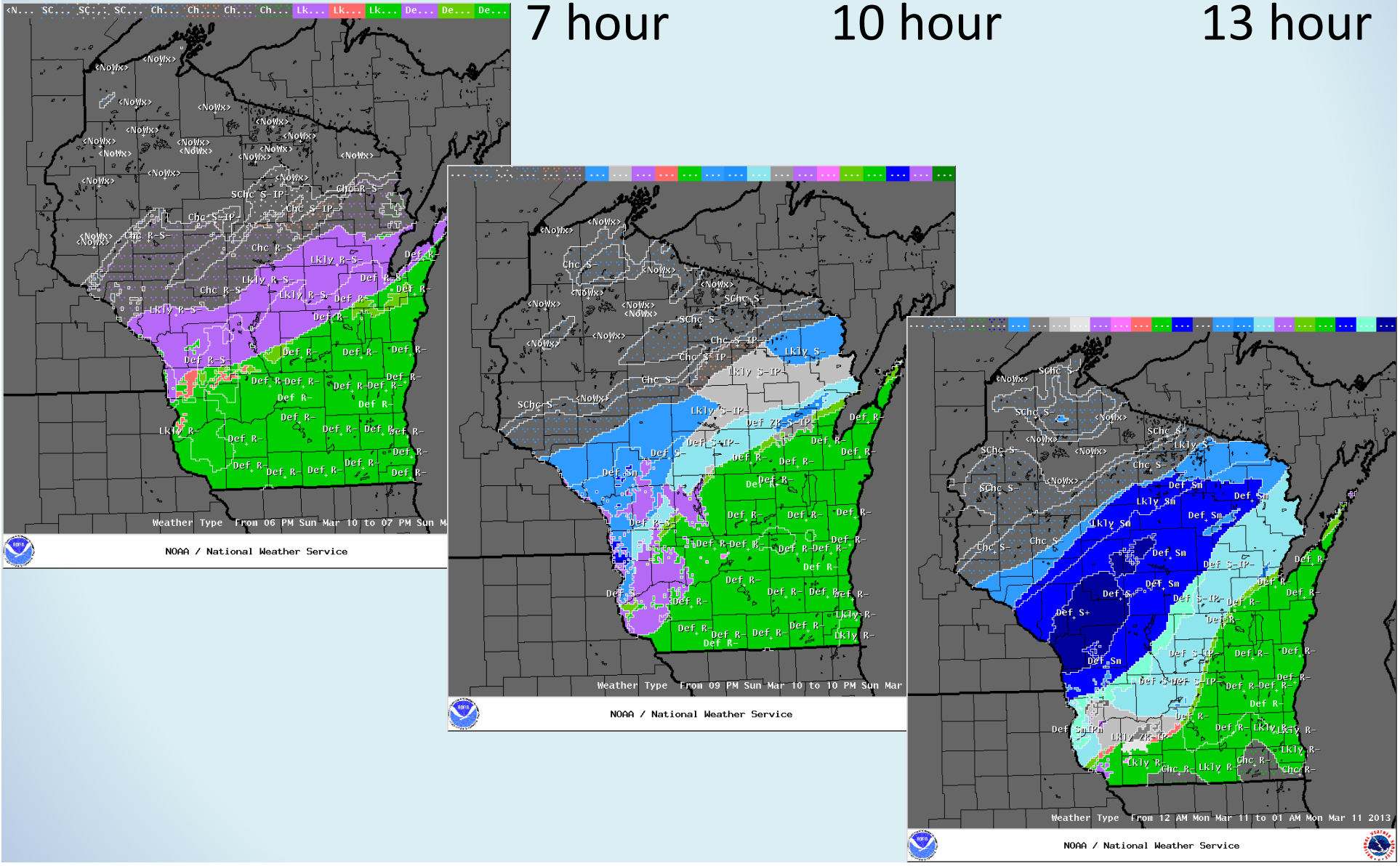


Examples hourly Wx

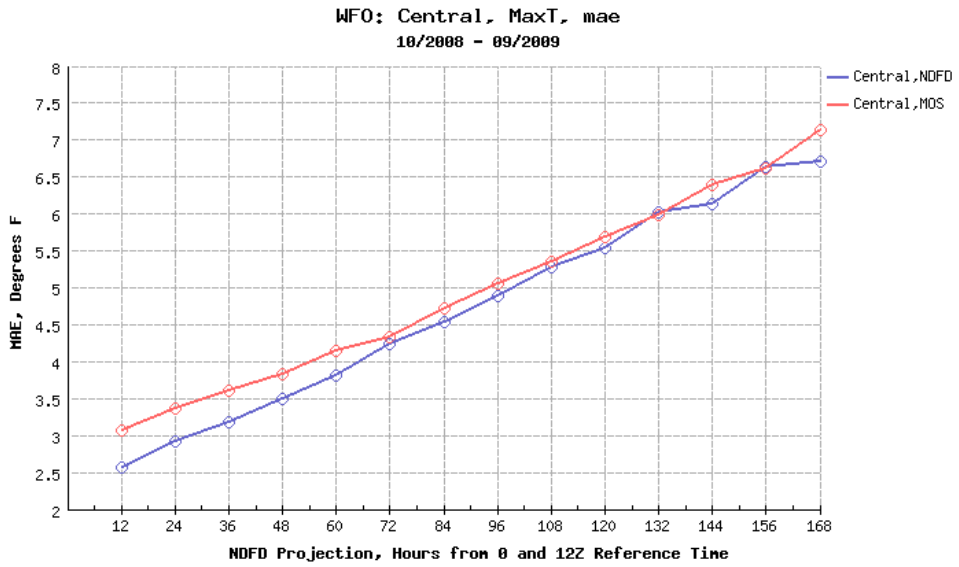
7 hour

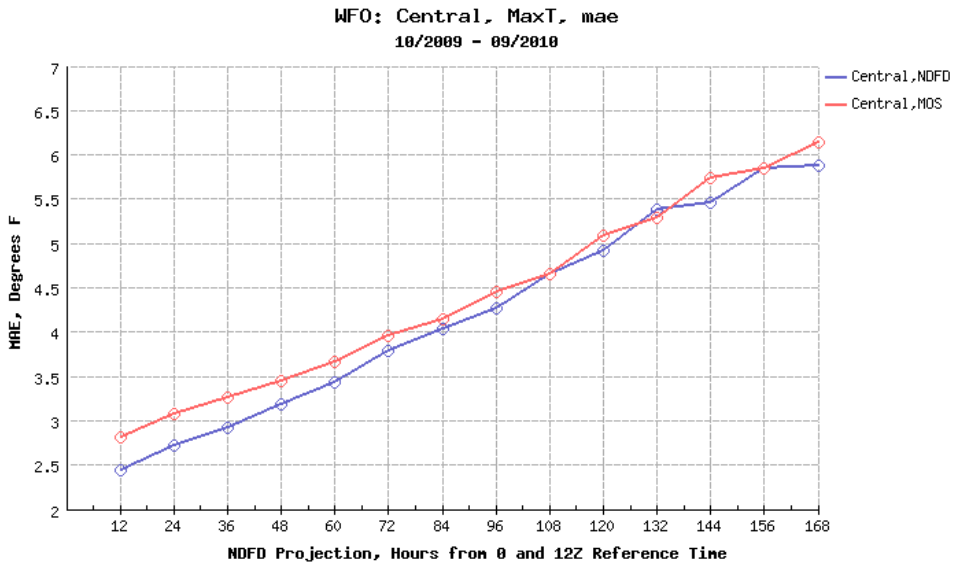
10 hour

13 hour



Verification

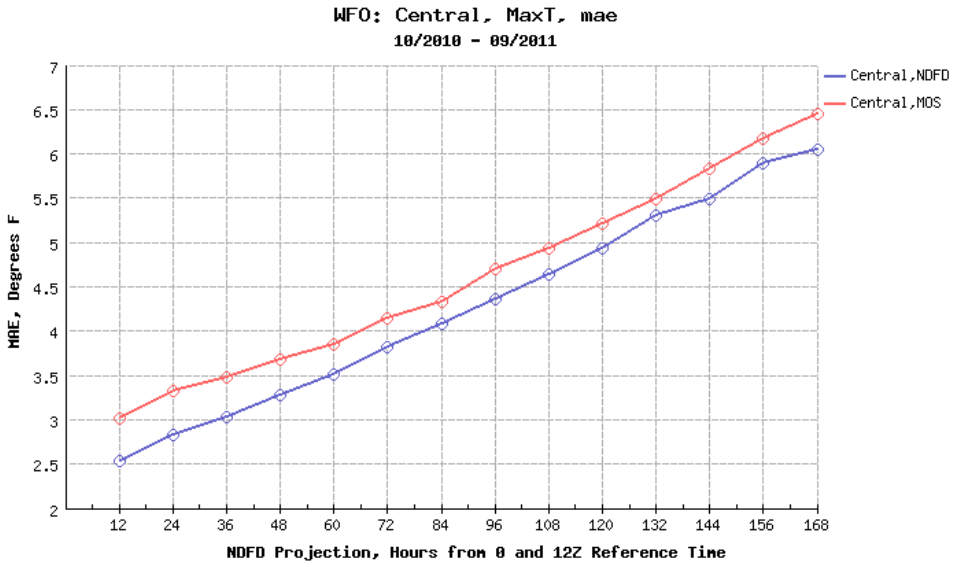


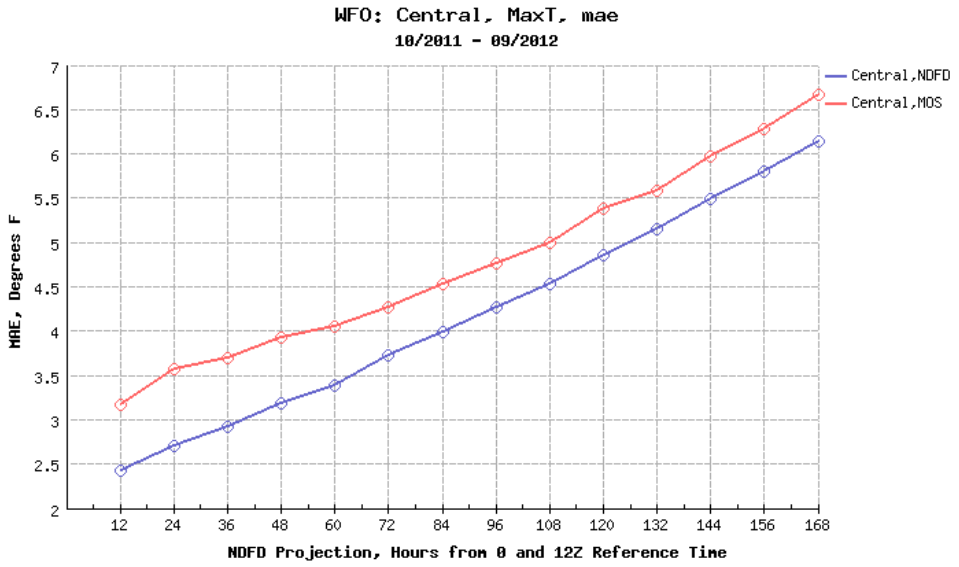


FY09 (No Grid Init Policy) **MaxT** FY10(No Grid Init Policy)

CR Extended Verification using blends

FY11 (12 WFOs Testbeds) FY12 (All CR)

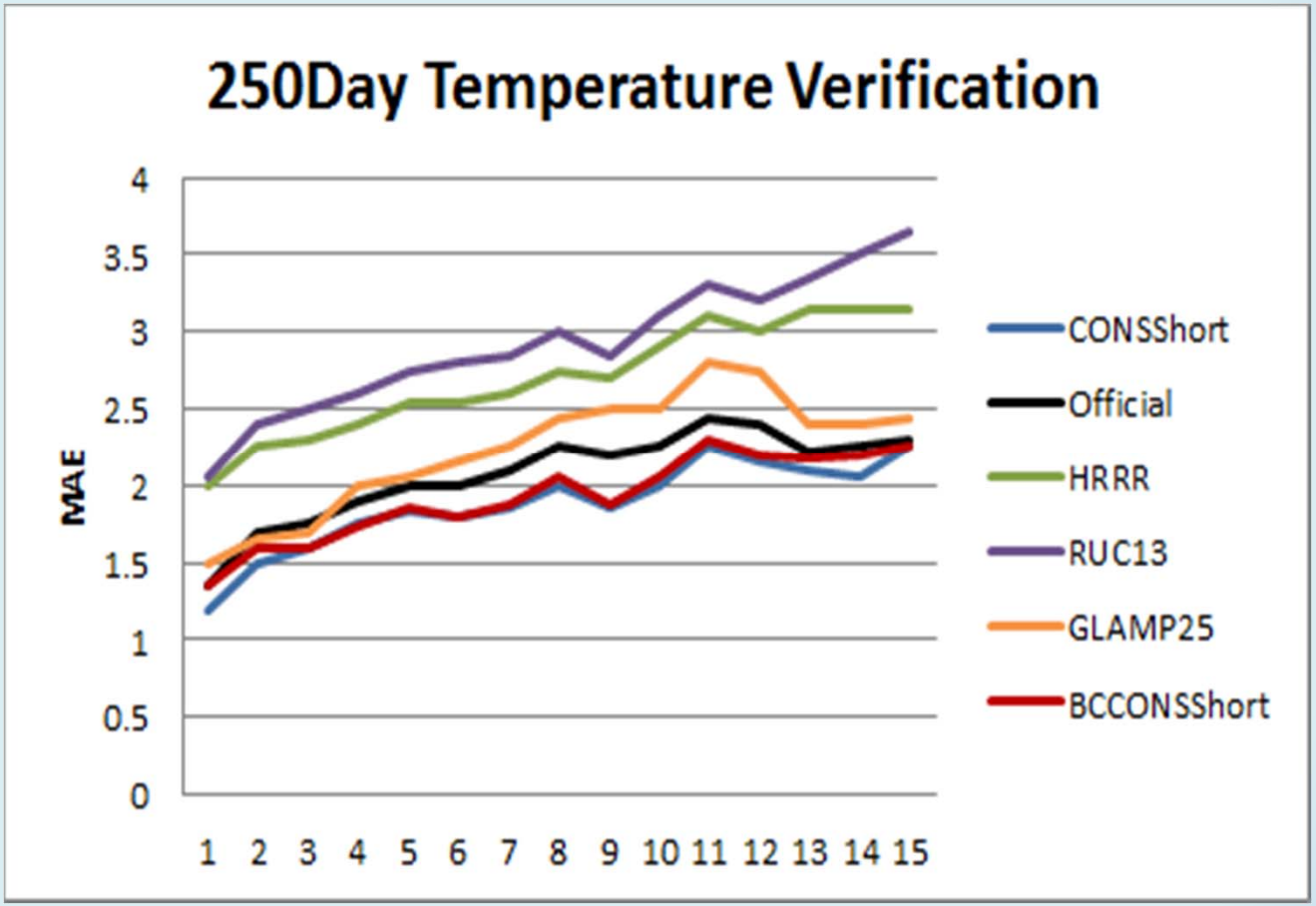




Hourly Temperature Verification

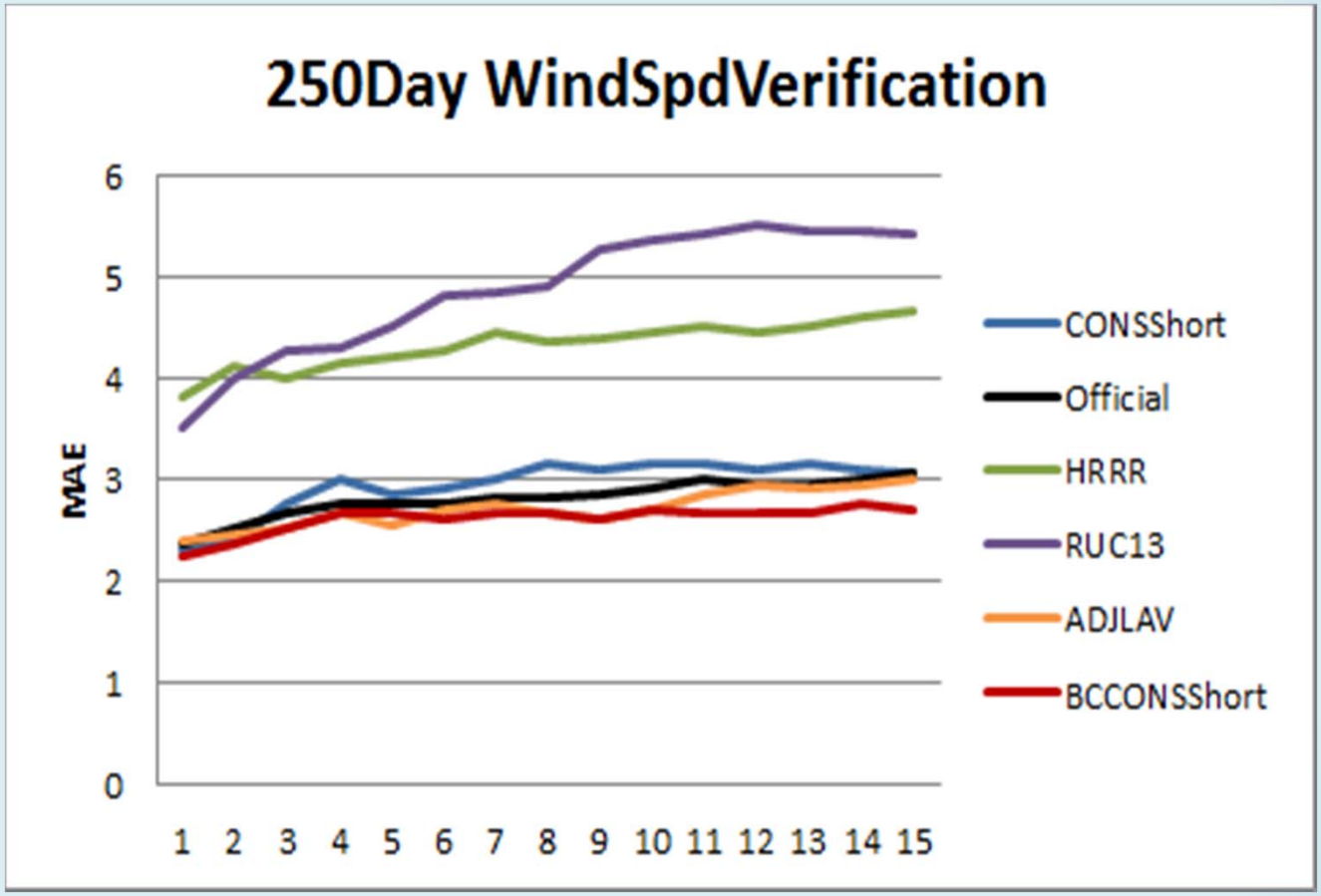
BCCONSShort= Consensus of Bias Corrected models.

CONSShort and BCCONSShort beat Official throughout



Hourly Wind Speed Verification

BCCONSShort overall winner although ADJLAV is competitive

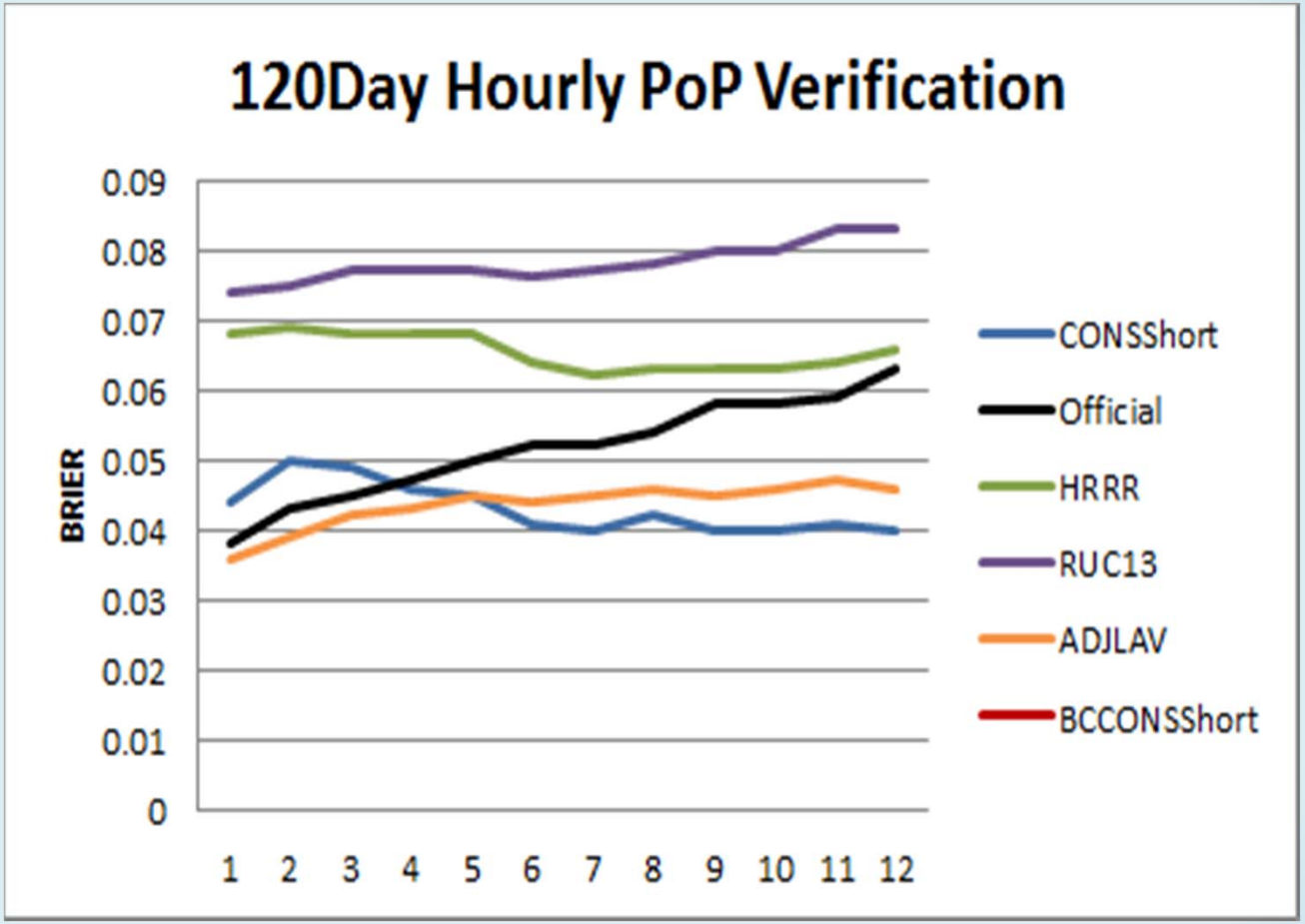


1 hour PoP Verification

Official beats CONSShort in first 4 hours.

Thereafter CONSShort is the best.

This is most likely due to advection during the convective season.



Known Issues

- Lag/delay between observational and hourly model data being available in GFE. This causes spinup issues in precip/QPF
- The advection of features using 850/700/500 mb wind can cause poor results (e.g. Lake effect snow showers and orographic features)
- Non-diurnal events, especially in first 3 hours (e.g. frontal passage)

Future

- Aviation: Ceiling and Visibility Grids
- Improved Sky Cover Analysis from CIMSS
- Add spread information to give the idea of forecast confidence.
- Need for better Precipitation Analysis
- Need for high resolution rapidly updating short term ensemble information
  - SREF only updates 4 times a day and has 3 hourly resolution in AWIPS

Summary

- CONSShort creates realistic hourly grids
- Detailed features are subject to usual model error and can be off a county or so and a few hours
- For most fields CONSShort verifies better than most input models through 12 hours.
- Some work still needed to blend Observation into model data, i.e advection during convective events
- Observed hourly precip fields like LAPS, RTMA, MPE, RFCQPE could use additional work. These are critical for spinning up the PoP/QPF/Snow

Extra Slides

The relationship between 1, 3, 6, and 12 hour grids in CONSShort

-
- The 1, 3, 6, and 12 hour grids are consistent
- Thus, adding up 6 hourly QPF grids will yield the same value as the QPF6 grid
- Adding up the 6 hourly SnowAmt grids will yield the same value as the SnowAmt6 grid

QPF

- Observed grid is created by taking highest value of LAPS, MPE, RTMA. If those are all missing, then the HRRR QPF is used as a starting point. *(Great need for better Hourly Precip Analysis)*
- Weighted Observed grid is used hours 0-6
  - 100%, 90%, 75%, 60%, 40%, 20%, 10%
  - The Ob grid is advected using an average of the forecasted RAP winds at 850, 700, and 500 mb
- Since many models do not have hourly QPF, Took QPF over its period and fragmented the grid to hourly QPF
- Produces 1, 3, and 6 hour QPF, which are consistent

Details of the nowcast feature

- From hours 7-24 of the forecast, the consensus of the available guidance is weighted just about equally with exception of HRRR and ADJLAV
- From hours 1-6, there is a heavy weight toward the current observations, which decreases each hour until it is gone at hour 7
- **For parameters like T, Td, wind, wind gust,** the current observations are tweaked in the next 3 hours based on a 7 day running average of the diurnal hour to hour change (for example, you would not want to use a 15z T for 16z, because it would normally go up about 3 degrees)

Details of the nowcast feature

- **For parameters like Sky, PoP, QPF, and Snow:**
- The observed Sky, QPF, and Snow are “advected” by the mean hourly RAP wind averaged from 850 mb, 700 mb, and 500 mb
- The PoP is derived from the QPF, which is a combination of the advected QPE and the model forecast QPF. This starts heavily weighted towards continuity, but then becomes more model driven as you approach 6 hour mark
- Snow is created from QPF, surface temperature, and the Caribou/Cobb derived Snow Ratio using the latest RAP during hours 1-18 then NAM12/GFS40 there after
- https://ams.confex.com/ams/pdfpapers/94815.pdf

WindGust Computation

- Many models do not produce WindGust guidance
- Used smart inits to generate a wind gust using the transport wind and different threshold constants for windgusts.
  - Typically over land wind gusts are between 1.3 (high friction) and 1.8 (low friction) x wind speed
  - Transport Wind is the horizontal transport of air within the mixing layer. If it is strong the likelihood of strong wind gusts goes up

WindGust Computation

- If Transport < 1.3 X WindSpeed, WindGust=Transport Wind
- If Transport > 1.8 X WindSpeed, WindGust=1.8xWindSpeed
- All other cases WindGust=1.5xWindSpeed
- A final consistency check is done to ensure the WindGust is at least the WindSpeed.

SnowAmt

- Used CONS QPF and Temperature as well as RAP/GFS40/NAM12 consensus SnowRatio (Caribou/Cobb) to compute SnowAmt
  - Weighted time interpolation is used for GFS40/NAM12 snow ratios
  - First compute raw snow amounts by multiplying QPF by SnowRatio
  - Post process based on temperature
  - If T > 32, ((36-T)^2/16) x SnowAmt
  - If T > 36 set to 0
  - Otherwise set to originally computed SnowAmt

PoP

- Weighted Observed grid is used hours 0-6
  - 100%, 90%, 75%, 60%, 40%, 20%, 10%
  - The Obs grid is advected using an average of the forecasted RAP winds at 850, 700, and 500 mb
- Since many models do not have hourly PoP, QPF was used to generate an hourly “PoP”
  - Took QPF over its period and fragmented the grid to hourly QPF
  - If QPF > .01” PoP=100%, otherwise 0% (not same as CONSALL method which is tied more to QPF amount)
- Run a smoother over the final CONSField
- Produces 1, 3, 6, and 12 hour PoP, which are consistent

Ice Accumulation

- If there is hourly QPF but the hourly Snow Amount is zero, then locations with temperatures of 32F or colder will have that QPF assigned as ice accumulation

- This field is later used to determine Wx grids that include Freezing Rain

Weather

- Harnessed a variety of information:

- Snow Ratio (RAP/NAM12/GFS40)
- Snow amounts (CONSShort)
- Ice Accumulation (CONSShort)
- Surface Temperature (CONSShort)
- 850 mb Temperature (RAP/NAM12/GFS40)
- QPF (CONSShort)
- PoP (CONSShort)
- SBCAPE (RAP/NAM12/GFS40)

Weather

- If snow amount calculated, then precip type snow
- If no snow and temp 32F or less, then freezing rain with ice accumulation from QPF
- Several simple mixed algorithms that look at snow ratio, CONSShort surface temperature, and 850 mb temperature from RAP/NAM12/GFS40 to determine snow, sleet, freezing rain, and rain mixes
- If no snow or ice & temp above 33F, then rain when QPF $\geq$.01”
- Looks at consensus model SBCAPE to determine stratiform, showers, and thunder
- No fog or blowing snow (yet)

Weather Matrix

WX	Snow or ice amt?	Snow Ratio	Surface Temp	850 mb Temp
SN	Snow	> 8:1	≤33F	<0C
RN/SN		0	33-36F	<0C
PL/SN		<8:1	≤32F	0-1C
PL		0	≤32F	0-1C
FZRA/PL		0	≤32F	1-2C
FZRA/PL/SN	Ice	0	≤32F	0-0.5C
FZRA/PL	Ice	0	≤32F	0.5-2C
FZRA	Ice	0	≤32F	≥2C
RA/PL		<8:1	32-35F	<1C
FZRA/RA		<8:1	32-33F	1-2C