Localized Aviation MOS Program (LAMP): New Approaches and Techniques for Improved Guidance

Judy E. Ghirardelli presenting

LAMP Team: Jerome Charba, Fred Samplatsky, Andrew Kochenash, Adam Schnapp, Chenjie Huang, Mike Allard, Gordana Sindic-Rancic, and Bob Glahn

National Weather Service
Meteorological Development Laboratory

The Future of Statistical Post-Processing in NOAA and The Weather Enterprise

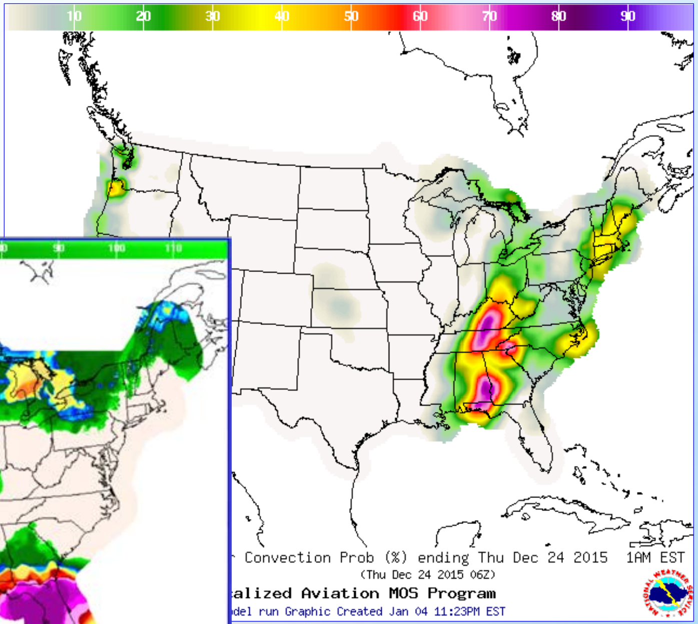
January 20, 2016

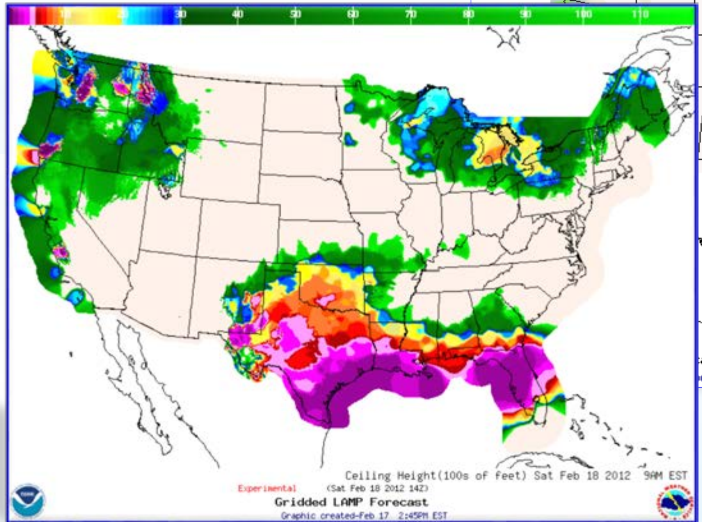
LAMP+HRRR Meld work funded by NOAA's Nextgen Weather Program

The Localized Aviation MOS Program (LAMP)

- Objective -- Improve on MOS forecasts and persistence out to at least 25 hours through rapid infusion of current observational data and the most recent forecast inputs.

- Project Goals:
  - Develop improved LAMP guidance for use in aviation forecasting.
    - Provide station-based LAMP guidance valid at NWS TAF stations.
    - Provide gridded LAMP guidance for inclusion in NWS Enhanced Digital Services.
  - Focus on weather elements that are critical to the aviation community, such as: ceiling height, visibility, convection, and winds.





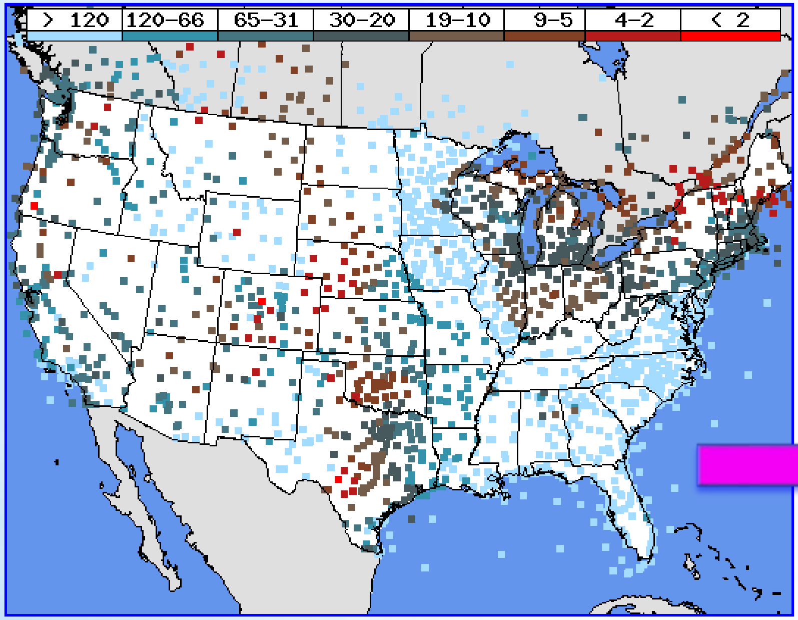
LAMP Statistical Postprocessing

- Background:
  - LAMP combines METAR, radar, satellite cloud product, and lightning observations with forecasts from MOS and direct model output to create station-based and gridded guidance
  - LAMP runs hourly and includes the most recent observations to produce valuable guidance in the short-range period for the aviation community
  - Development is done both at stations and on a grid
  - Technique is multiple linear regression

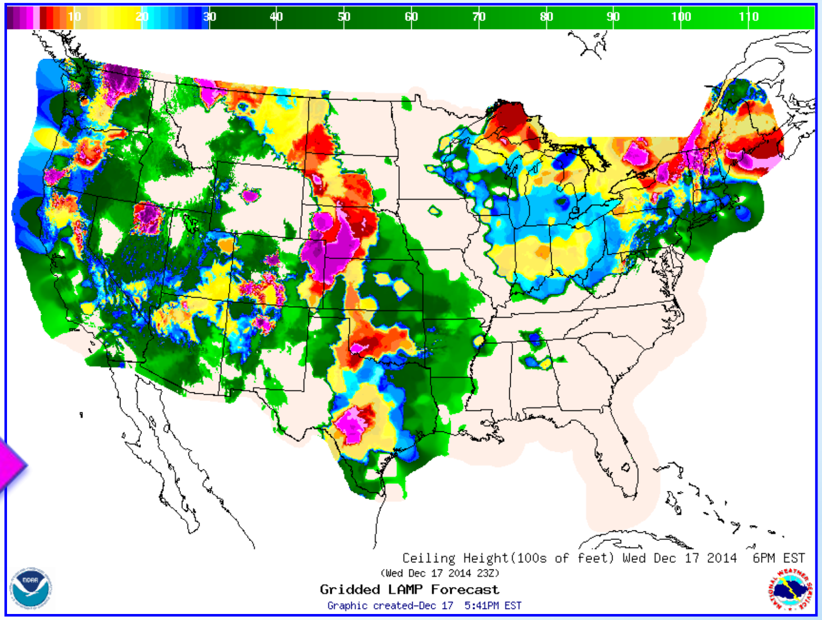
- Challenges:
  - Gridding of discontinuous fields
  - Quality of observational data
  - Rapidly-changing models problematic for LAMP since hourly cycles very time-intensive to re-develop (24 cycles, 2 seasons, backup & primary eqns)
  - Short-range rapidly-updating guidance requires a different approach than long-range guidance requires

LAMP Statistical Postprocessing

- Methodology – traditional MOS technique:
  1. Station-based development and application:
     - Suitable when predictand & predictors are at stations
     - The multiple linear regression equations are developed at stations
     - The guidance is produced at stations and analyzed to a grid



Developed and produced at stations



Analyzed to a 2.5km grid

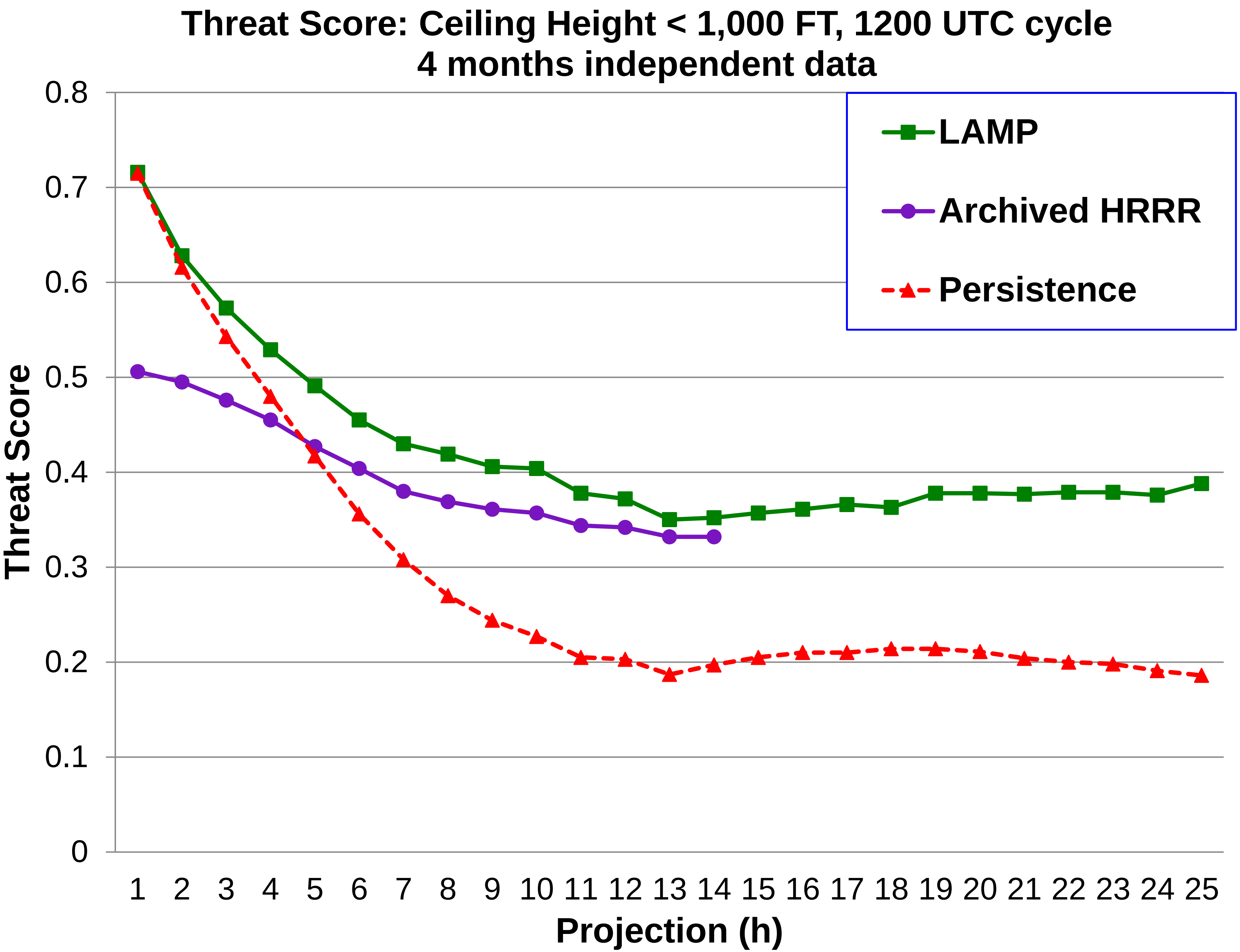
     - Applies to most elements, including ceiling height and visibility

LAMP Statistical Postprocessing: Ceiling and Visibility

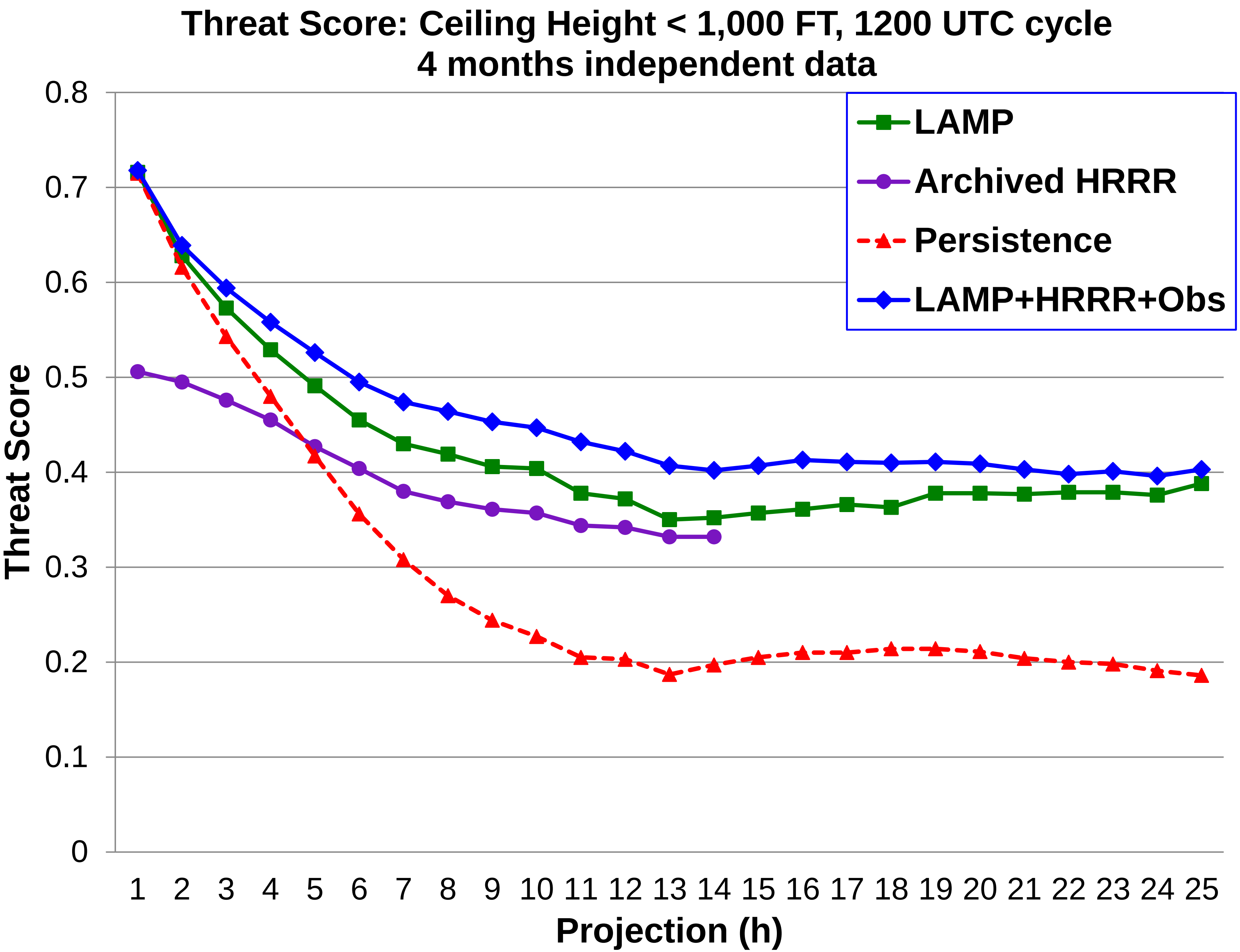
- Challenge: It is challenging to post-process model output for non-normally distributed elements like ceiling and visibility because:
  - typical bias-correction techniques assume quasi-normally distributed data.
  - until recently, model forecasts did not exist for these fields. Even now, the model algorithms to forecast these elements are still evolving and improving.
  - need for good-quality gridded "truth."

- New technique: MDL is testing a "second-order regression development"
  - Development:
    - Statistically post-processed current LAMP with HRRR ceiling & visibility direct model output at stations → new LAMP+HRRR Meld equations
    - Generalized Operator Approach → many cases
    - Persisted the longest HRRR projection to provide continuity in forecasts beyond HRRR period
    - Thresholds developed to convert from probabilities → single value forecast
  - Implementation:
    - Evaluate Meld equations and thresholds at stations → updated LAMP guidance at stations
    - Evaluate Meld equations at gridpoints → gridded LAMP probability guidance
    - Apply thresholds to gridded probabilities at gridpoints → updated LAMP gridded deterministic guidance

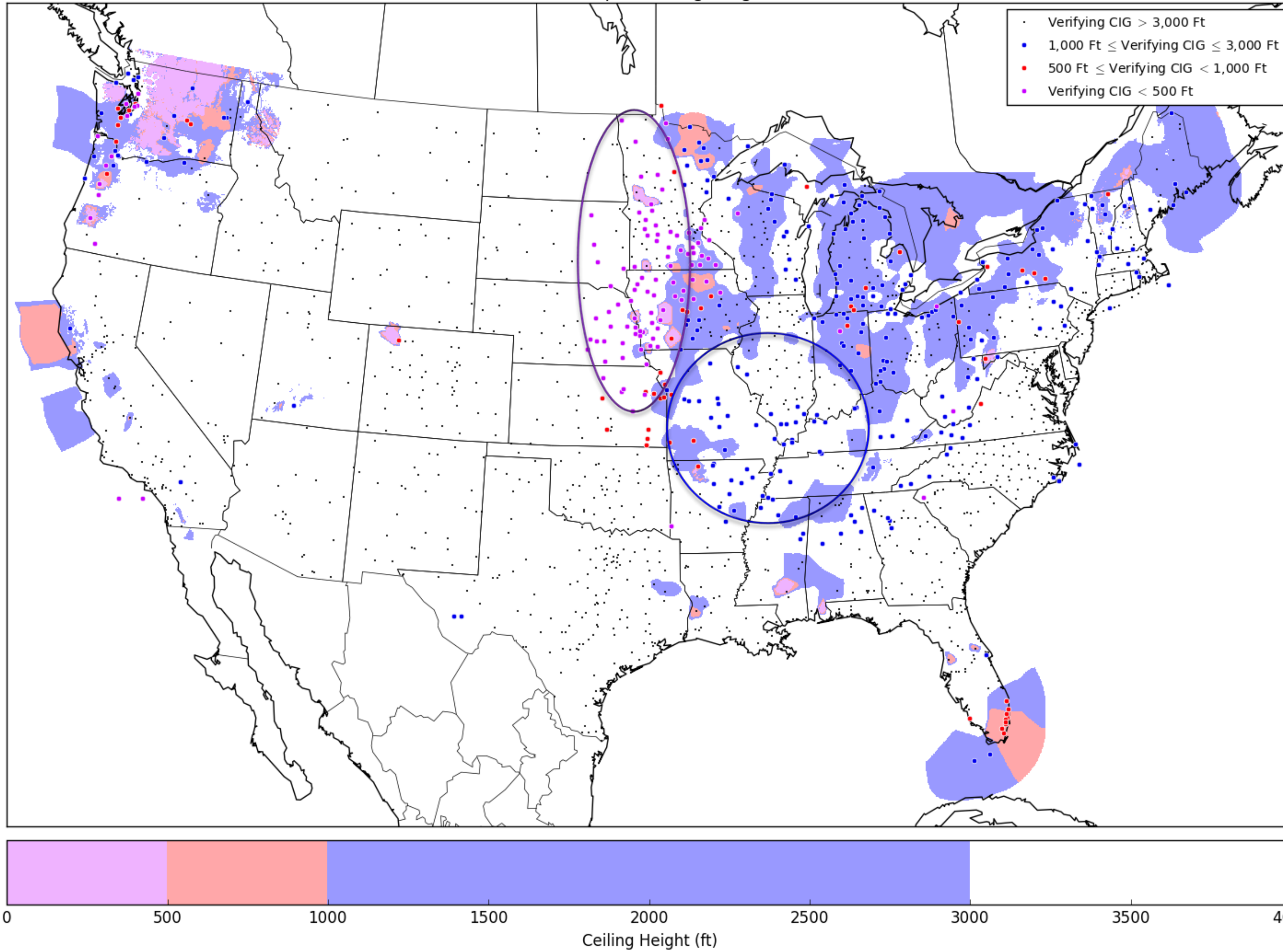
LAMP + HRRR Cool Season CIG

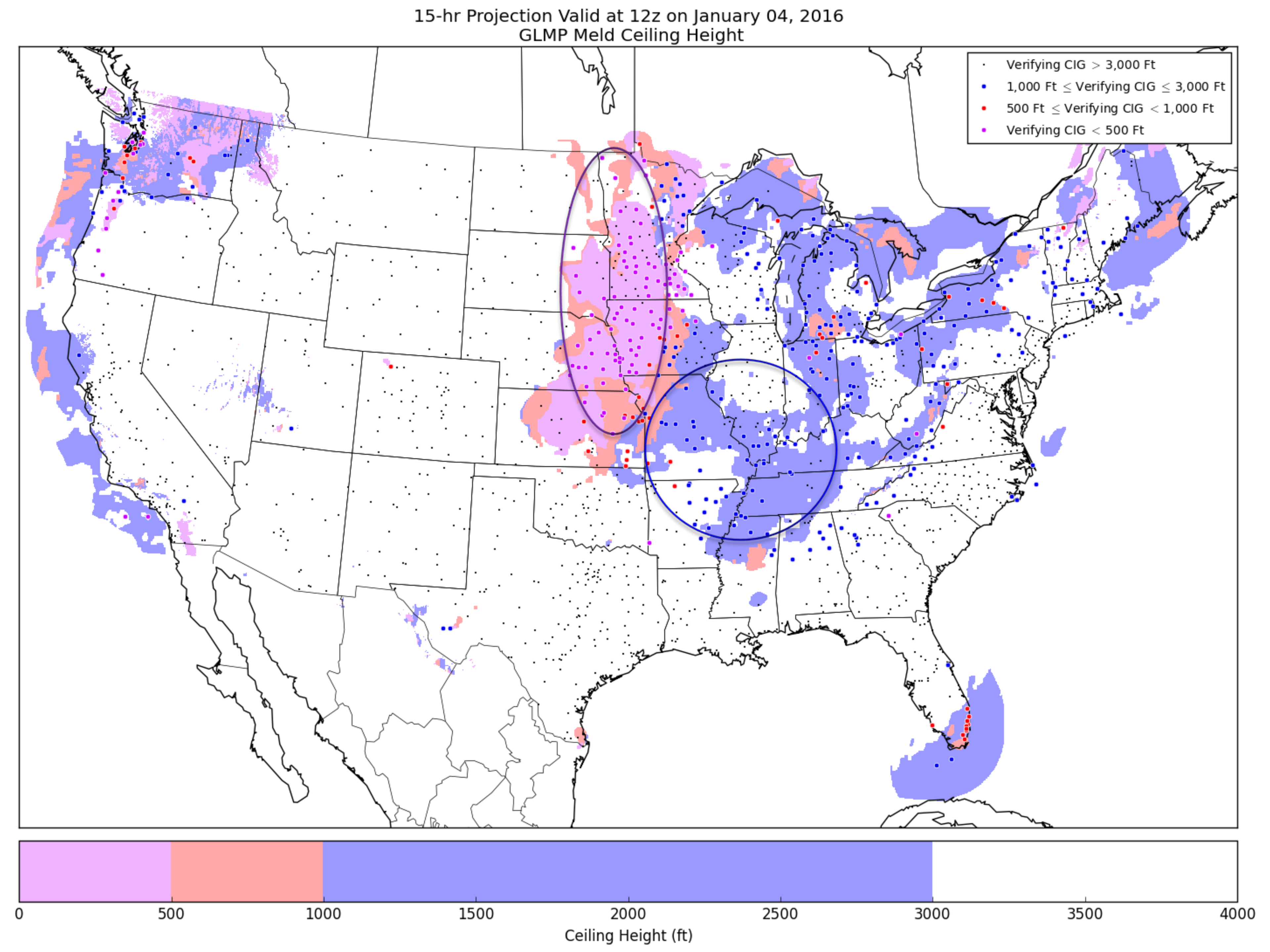


LAMP + HRRR Cool Season CIG



15-hr Projection Valid at 12z on January 04, 2016
GLMP Oper Ceiling Height

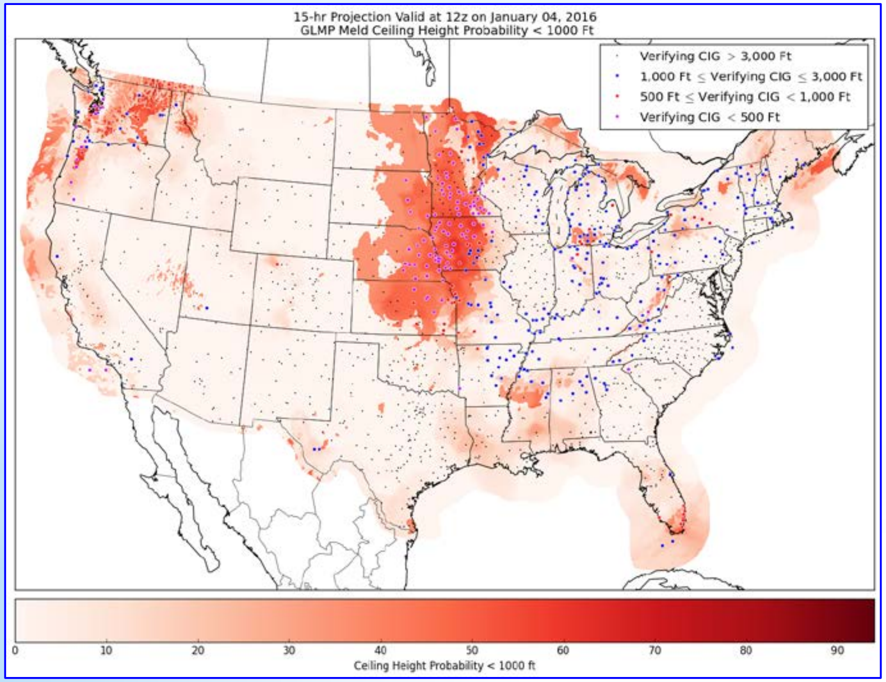




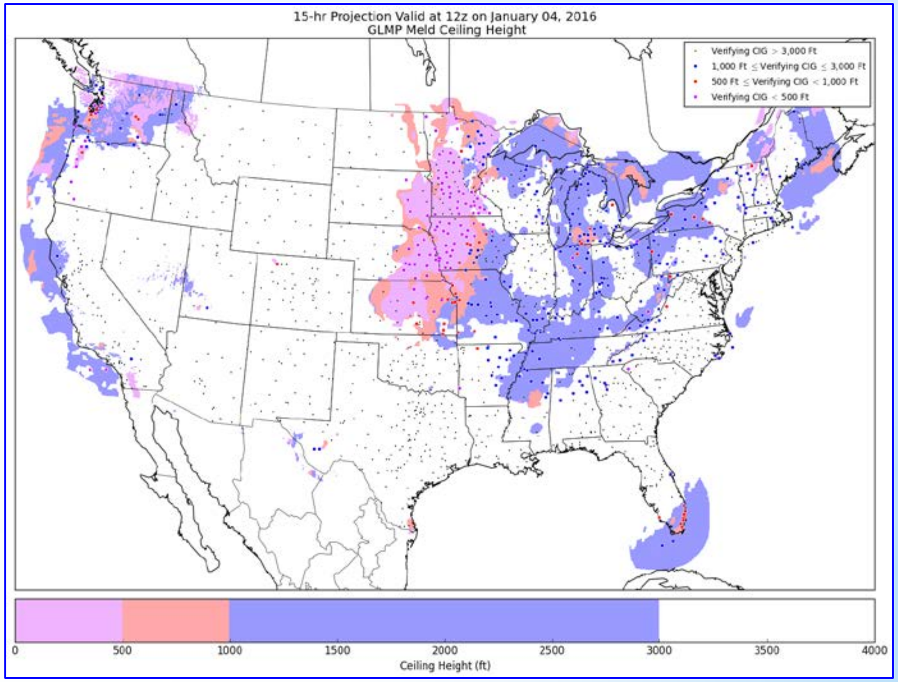
15-hr Projection Valid at 12z on January 04, 2016
GLMP Meld Ceiling Height
Verifying CIG > 3,000 Ft
1,000 Ft ≤ Verifying CIG ≤ 3,000 Ft
500 Ft ≤ Verifying CIG < 1,000 Ft
Verifying CIG < 500 Ft
0
500
1000
1500
2000
2500
3000
3500
4000
Ceiling Height (ft)

LAMP Statistical Postprocessing: Ceiling and Visibility

- Benefits of new ceiling and visibility development approach:
  - Incorporation of high-resolution detail into the grids.
  - Simpler development → quicker redevelopment in response to changing models.
  - Probabilities created via the Meld are consistent with the deterministic guidance grids.
  - Inclusion of HRRR model output provides a mesoscale forecast component currently lacking in LAMP.



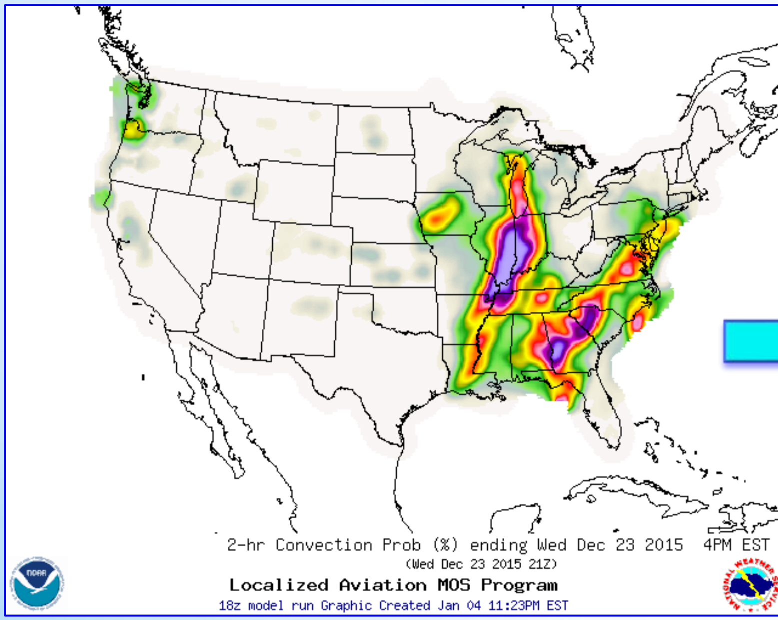
Probabilistic Guidance



Deterministic Guidance

LAMP Statistical Postprocessing

- Methodology – traditional MOS technique:
  2. Gridded development and application:
     - o Suitable when predictand & predictors are gridded
     - o The multiple linear regression equations are developed at grid points via a multi-scale blend of observation and model predictors
     - o The guidance is produced at gridpoints and also interpolated to stations



KSMF SACRAMENTO MET AP GFS LAMP GUIDANCE 1/19/2016 0100 UTC

UTC	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02
TMP	57	57	56	56	55	55	55	55	55	54	55	55	56	56	55	54	55	56	56	57	58	57	57	57	56
DPT	51	52	52	52	52	52	51	52	52	51	51	52	52	52	51	52	52	53	54	54	54	54	53	53	53
WDR	18	17	17	16	16	16	16	15	15	15	15	15	15	15	15	16	16	16	16	16	17	17	17	17	17
WSP	06	06	06	06	07	07	07	06	07	09	12	13	15	18	20	22	22	23	24	24	24	21	20	17	19
WGS	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	24	27	30	29	30	31	31	30	28	25	24	25
PPO	22	3	4	6	8	10	12	15	28	41	55	63	67	71	74	81	83	71	59	48	43	37	27	23	19
PCO	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
P06											81						98						91		
LP2			0	0	0	0	0		0		0		1		2		1		3		4		0		0
LC2			N	N	N	N	N		N		N		N		N		N		N		N		N		N
CP2			10	6	7	7	5		8		16		24		56		69		63		29		6		3
CC2			N	N	N	N	N		N		L		M		H		H		H		H		N		N
POZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POS	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TYP	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
CLD	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV
CIG	7	6	6	6	6	6	5	4	5	5	5	5	5	5	5	5	5	4	4	3	4	4	4	4	4
CCG	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	4	4	4	4	4	4	4
VIS	7	7	7	7	7	7	7	6	6	6	6	7	7	7	5	5	5	5	5	5	5	5	7	7	7
CVS	7	7	6	6	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	6	7
OBV	N	N	N	N	N	N	N	BR	BR	BR	BR	N	N	N	BR	BR	BR	BR	BR	BR	BR	BR	N	N	N

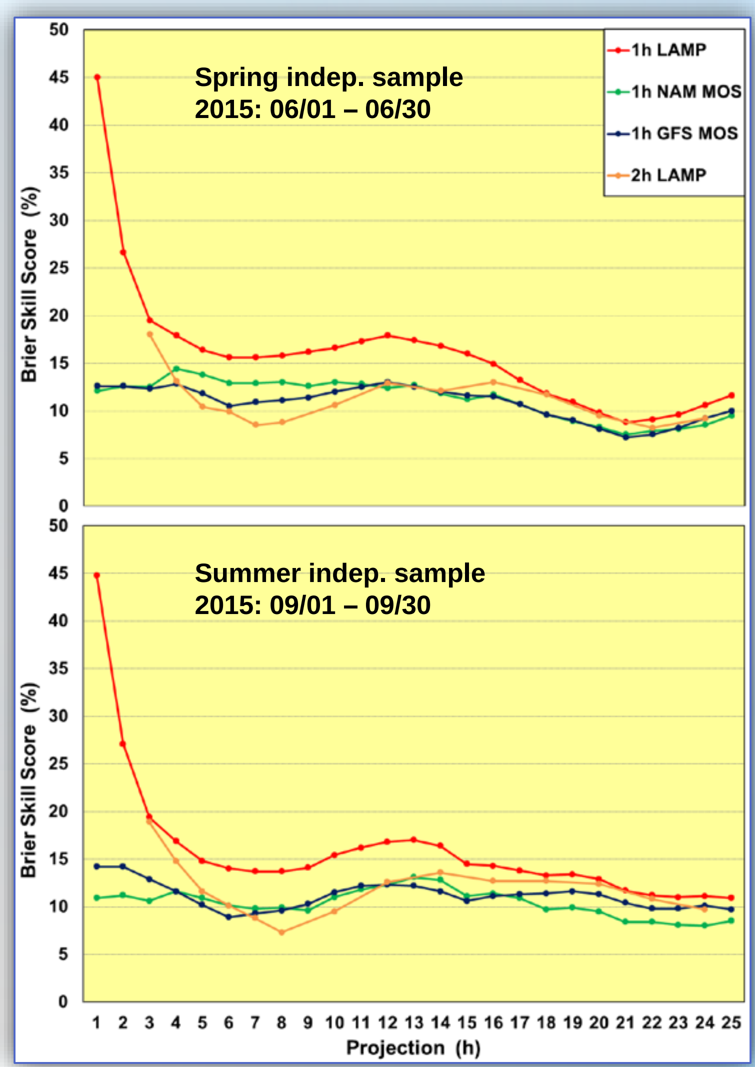
Developed and produced on a grid

Interpolated to stations

- o Applies to Convection and Lightning

LAMP Statistical Postprocessing: Upgraded Convection

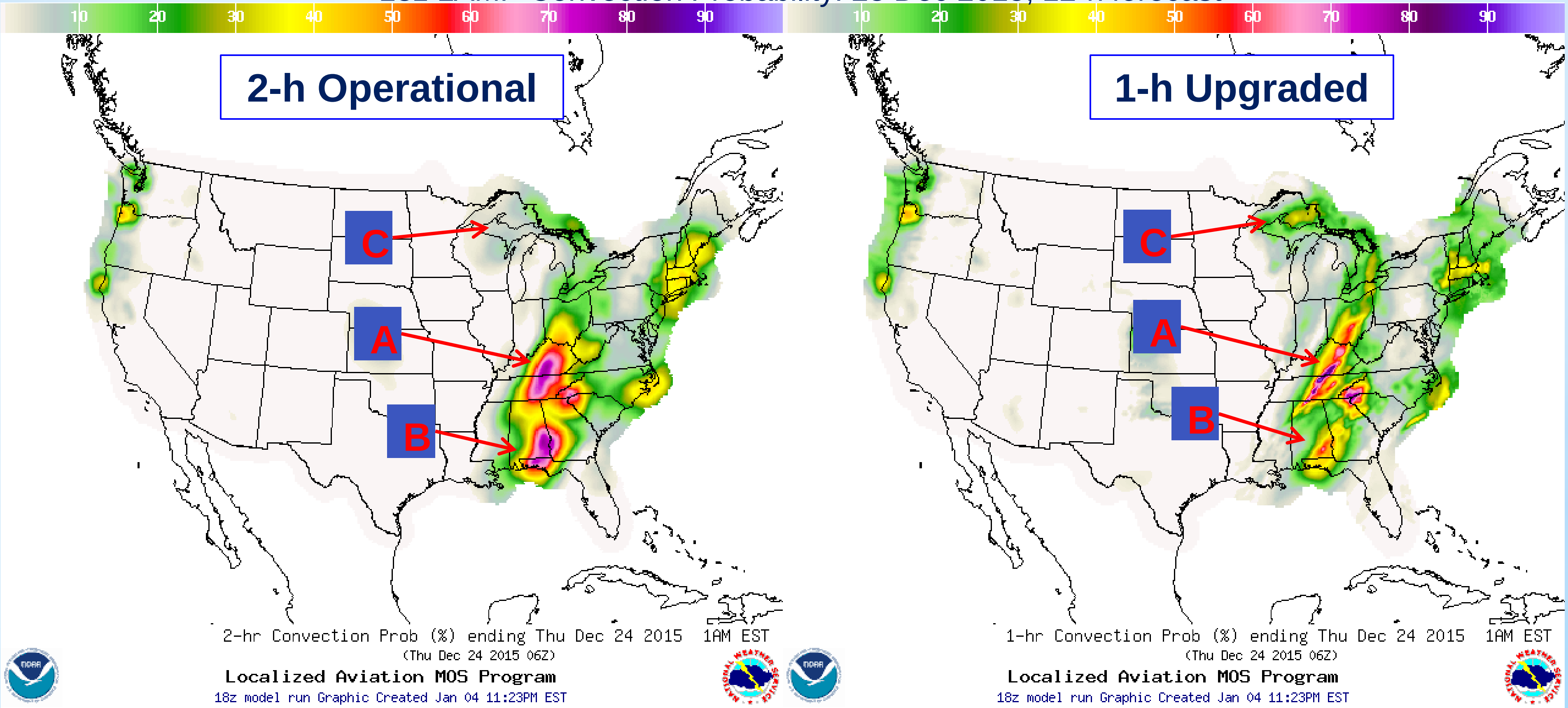
- Challenge:
  - Users need higher temporal and spatial resolution of convection products while at least maintaining current skill level.
- New technique:
  - 1-h valid periods instead of 2-h periods
  - Probabilities produced on 10-km grid instead of 20-km grid
- Predicted convection event is probability of occurrence of:
  - MRMS reflectivity 40 dBZ or higher and/or
  - One or more ENI total lighting (TL) flashes
- Predictors derived from:
  - Observed and advected QC'd MRMS grids
  - Observed and advected TL grids
  - HRRR model forecasts
  - GFS-based MOS convection probabilities
  - NAM-based MOS convection probabilities



LAMP Statistical Postprocessing: Upgraded Convection

- Benefits of new convection approach:
  - Incorporation of high-resolution data provides improved spatial resolution
  - Improved quality of predictors and predictands provides ability to improve temporal resolution
  - Inclusion of HRRR model output provides a mesoscale development and dissipation component currently lacking in LAMP

18z LAMP Convection Probability: 23 Dec 2015, 12-h forecast



1-h: (A) has better spatial focus for convection line from northwest AL to western PA, (B) as for (A) in southeast AL; (C) forecasts convection observed over Lake Superior while 2-h does not show this feature.

LAMP Statistical Postprocessing

- Still needed!!
  - Re-forecasts of model data when models are upgraded.
  - Re-analyses of URMA when URMA is upgraded. We need the “truth!”
- AMS extended manuscripts detailing this work will be updated to the LAMP website shortly

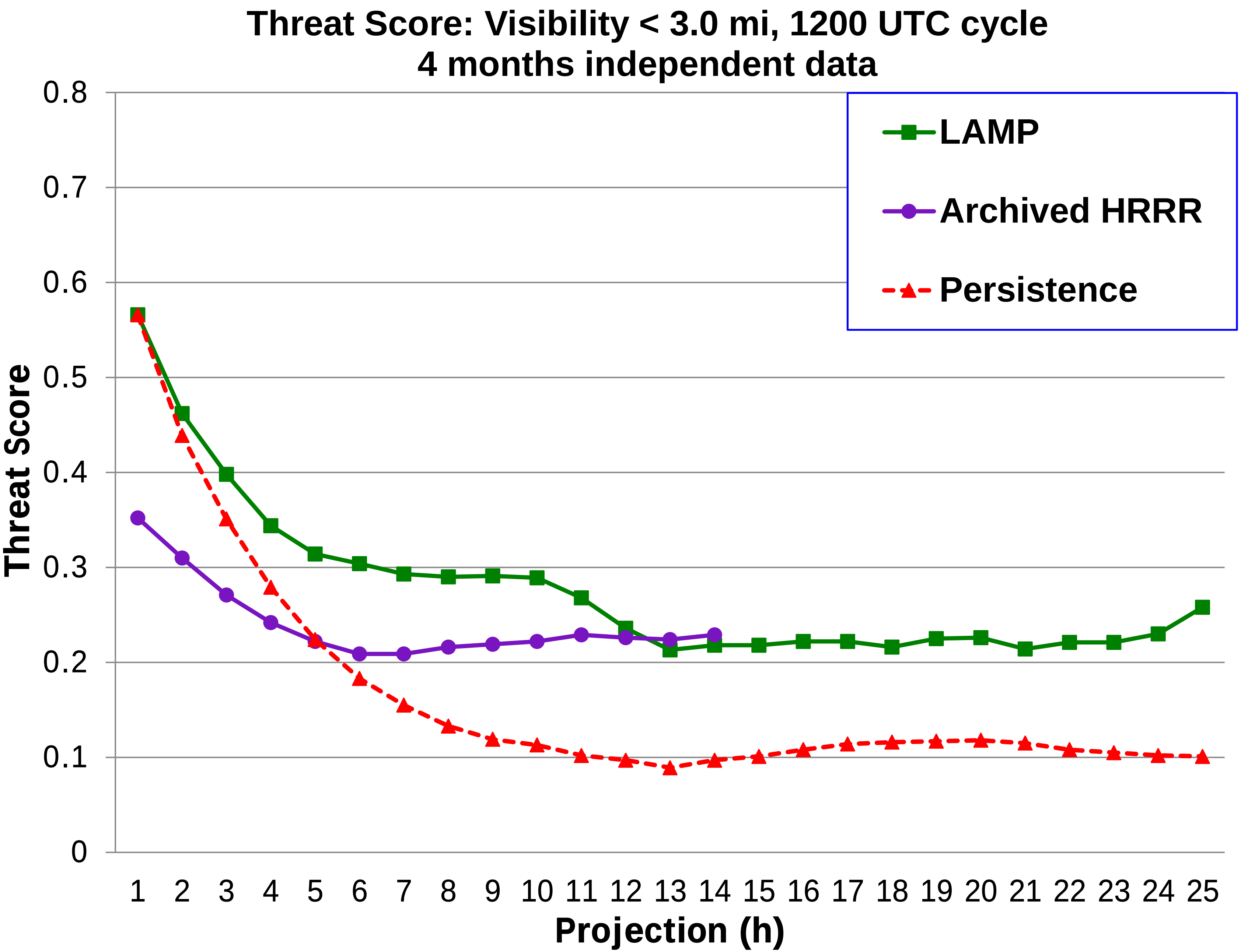
Contact: Judy.Ghirardelli@noaa.gov

Website: http://www.weather.gov/mdl/lamp_home

Thank You!

Backup Slides

LAMP + HRRR Cool Season VIS



LAMP + HRRR Cool Season VIS