GFS-based Localized Aviation MOS Product (LAMP)

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Outline

- Background
  - What is LAMP?
  - How is it developed?
- Thunderstorms
- Verification
- Products
- Current Status
- Future Plans

LAMP Background

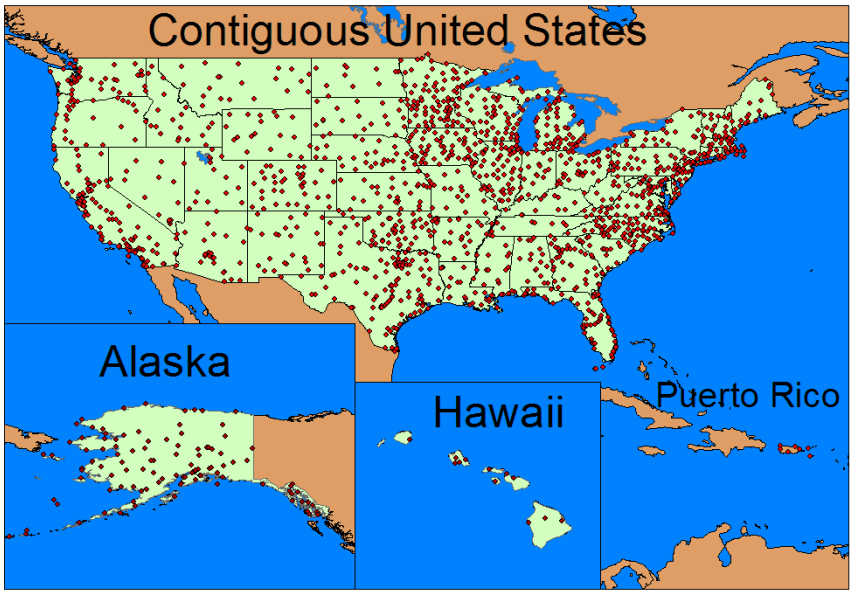
Localized Aviation MOS Program (LAMP) Background

- LAMP is a system of objective analyses, simple models, regression equations, and related thresholds which together provide guidance for sensible weather forecasts
- LAMP acts as an update to MOS guidance
- Guidance is both probabilistic and non-probabilistic
- LAMP provides guidance for aviation elements
- LAMP bridges the gap between the observations and the MOS forecast
    - Good quality recent surface observations help to decrease the uncertainty in the short term. As the observations become less predictive later in the forecast period, the uncertainty increases.
    - Verification shows improvement on MOS in the first hours, then skill comparable to MOS

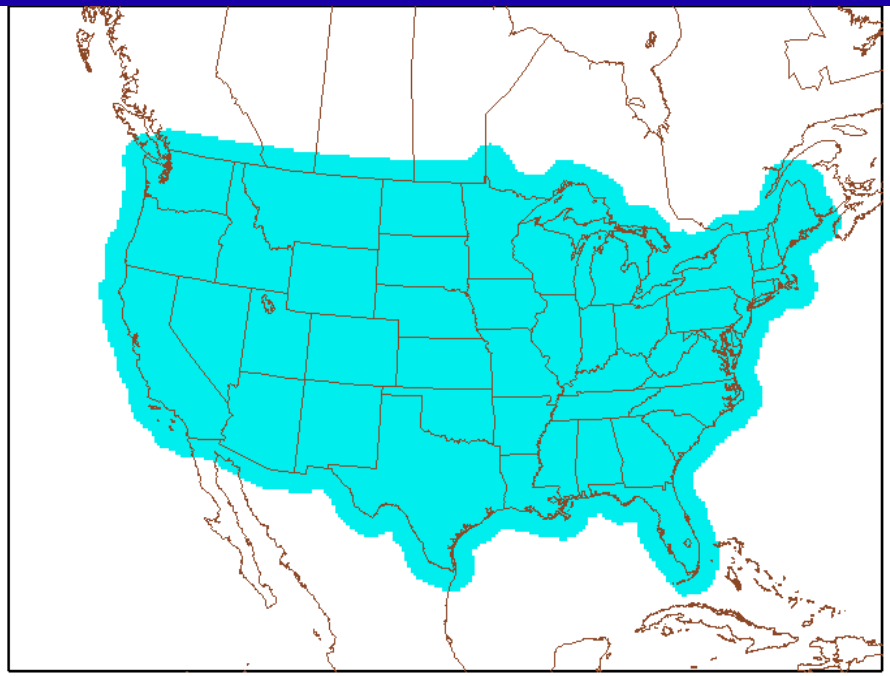
GFS LAMP Guidance Details

- LAMP guidance is in the range of 1- 25 hours in 1 hour projections
- LAMP provides station-oriented guidance for:
  - all LAMP forecast elements
  - ~1600 stations
  - CONUS, Alaska, Hawaii, Puerto Rico
- LAMP provides grid-oriented guidance for:
  - Thunderstorms:
    - Probability of thunderstorm occurrence in a 2 hour period in a 20-km grid box
    - Best Category Yes/No of thunderstorm occurrence in a 2 hour period in a 20-km grid box
  - CONUS only
- Eventually will run 24 times a day (every hour)

Points/Grid for which LAMP generates forecasts

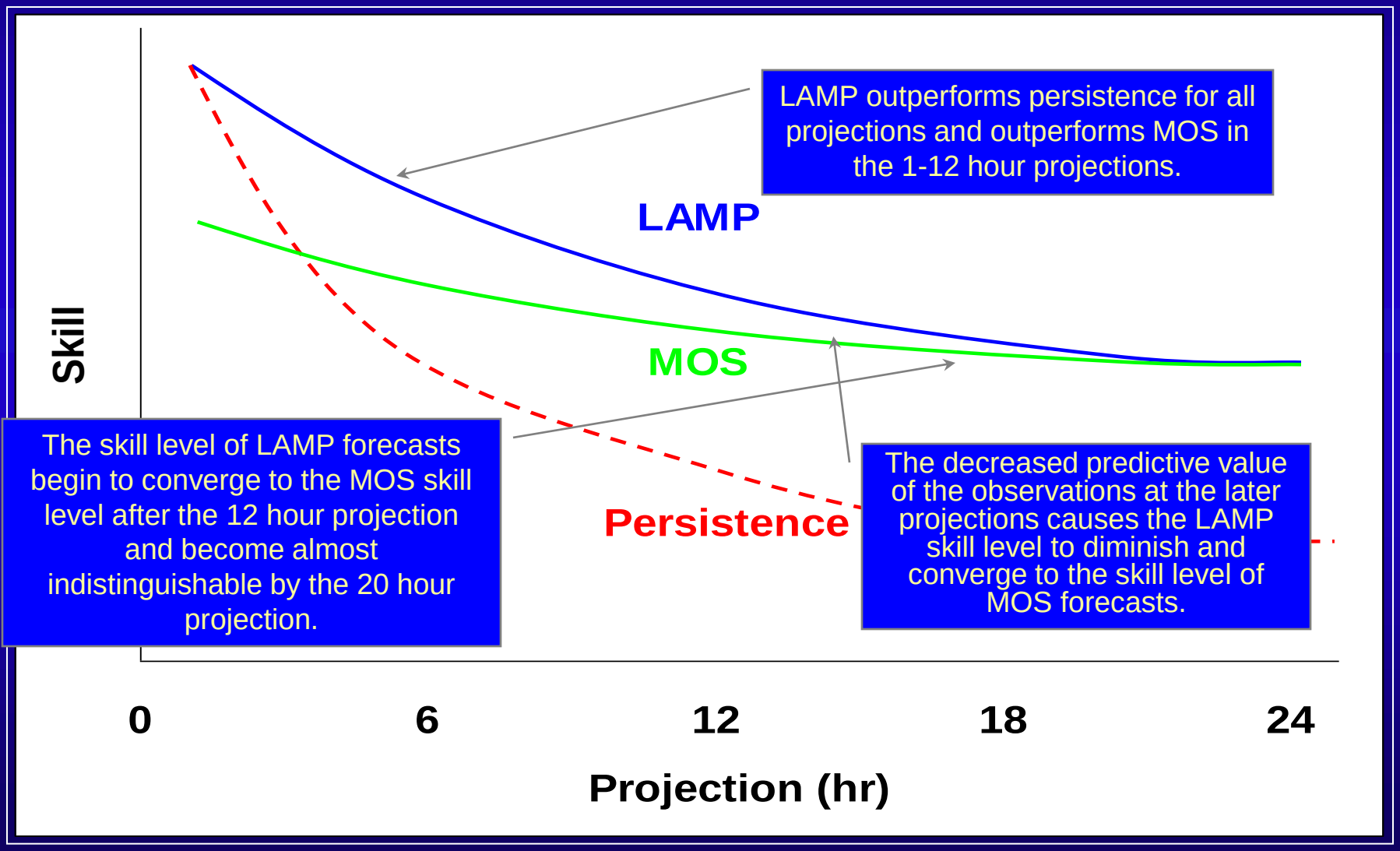


LAMP stations



LAMP thunderstorm grid points

Theoretical Model Forecast Performance of LAMP, MOS, and Persistence



The Development Process of Generating LAMP Forecasts

1) Collate the data from a variety of sources for the regression analysis

2) Generate a regression equation for each element at each projection using a specific training period of data

3) Post-process the forecasts to ensure consistency (e.g., ensure that the temperature is always equal to or greater than the dewpoint) and create thresholds for categorical elements

4) Verify the weather element at each projection hour

LAMP Predictor Data Sources

- Predictors are data (e.g., temperature) that explain a portion of the behavior exhibited by the predictand.

- Possible predictor sources used in LAMP developments include:
  - Hourly METAR Data
  - GFS MOS forecasts
  - Simple models (such as advection of moisture)
  - Radar mosaic data
  - Lightning strike data* from the National Lightning Detection Network
  - GFS model output

- Only those predictors that make physical sense are chosen from these data sources as predictors.

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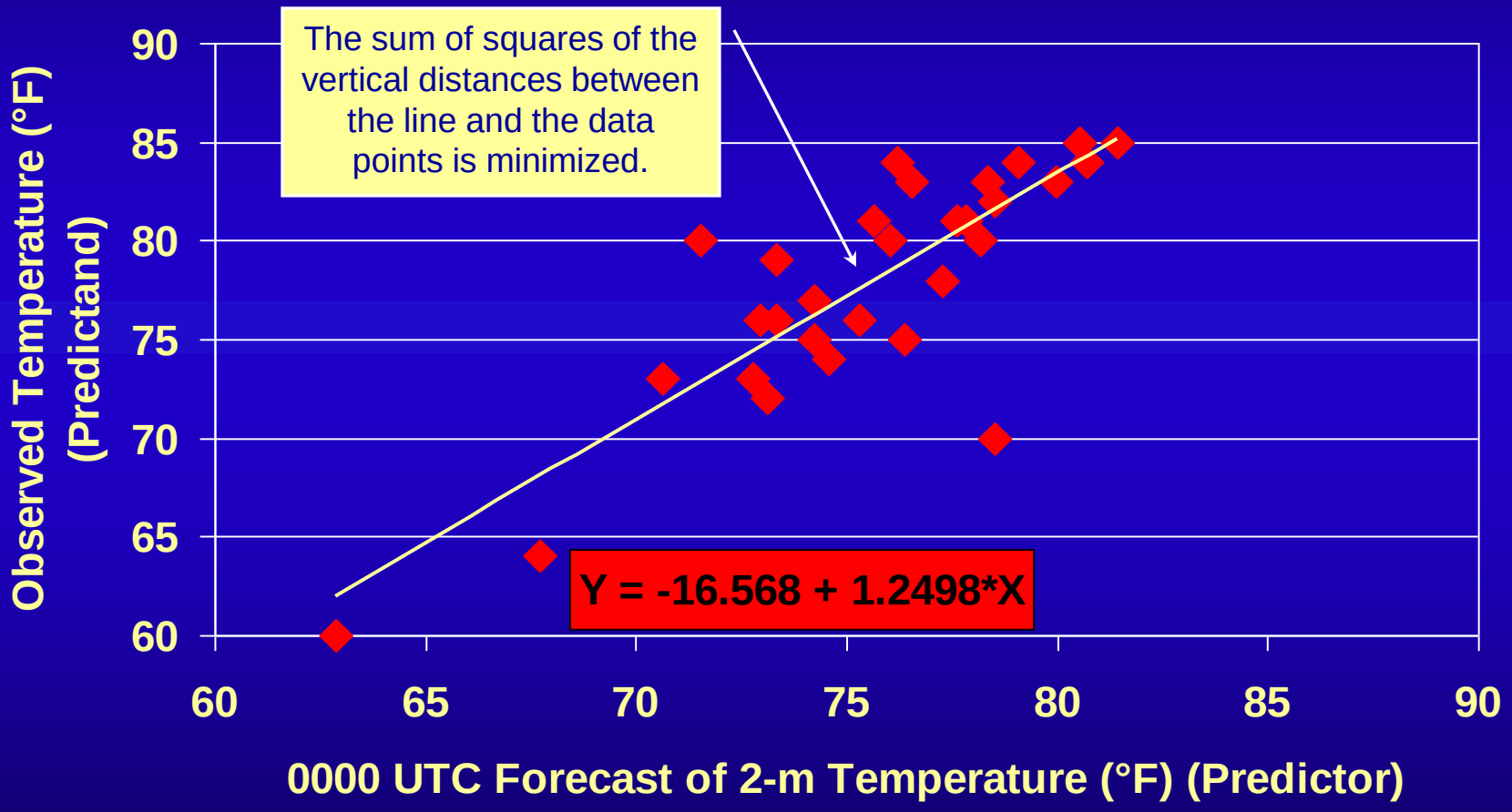
* Archives obtained from Global Hydrology Resource Center (GHRC)

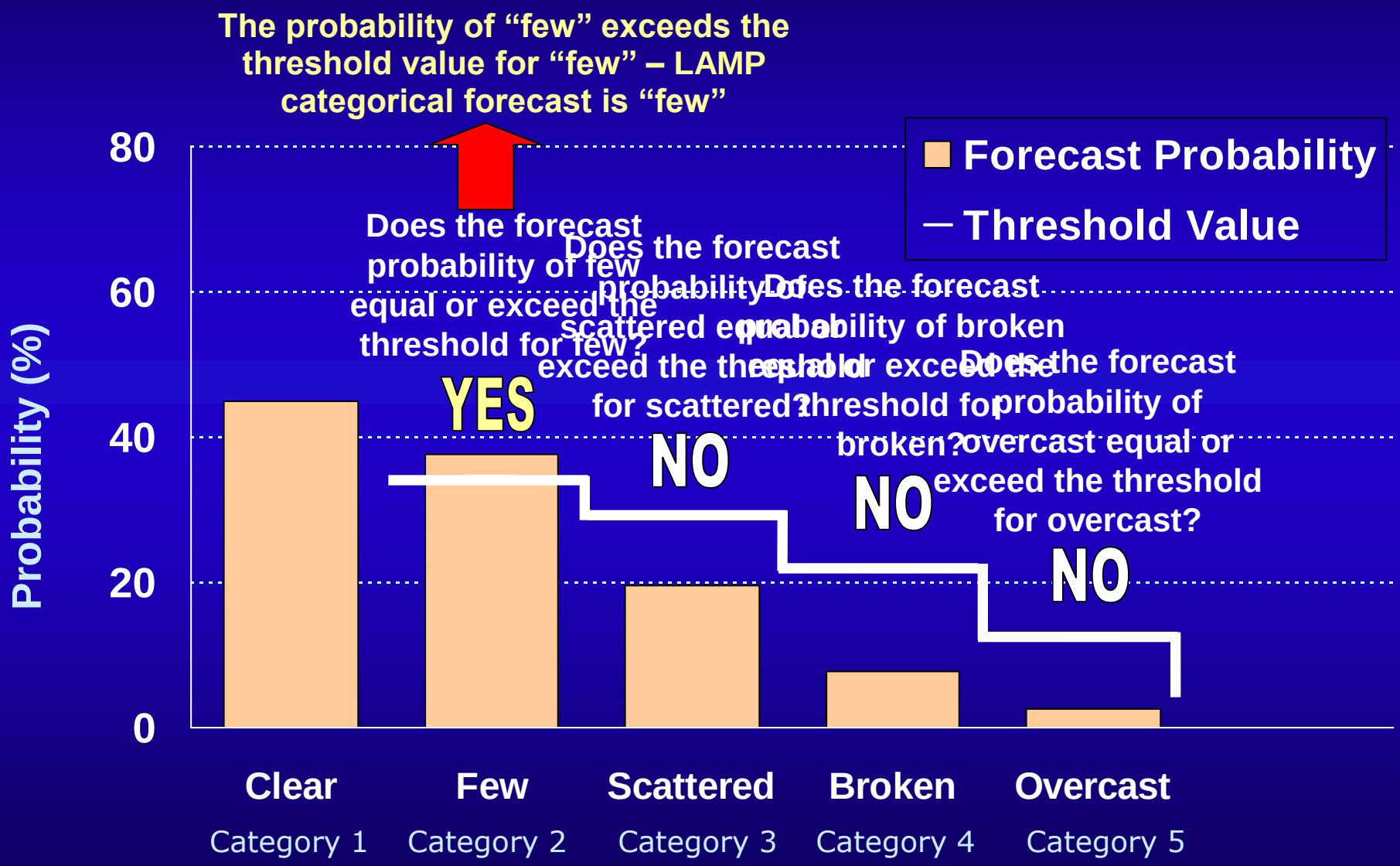
LAMP Equation Development
Sample Linear Regression for KATL, June 2005



LAMP Threshold Development for Categorical Forecasts

- Probabilities can be used to develop “thresholds” for selecting a best category from the probabilistic information
- Thresholds are developed by one of two techniques, either:
  - Targeting unit bias (forecast the event as often as it occurs), or
  - Maximizing the threat score

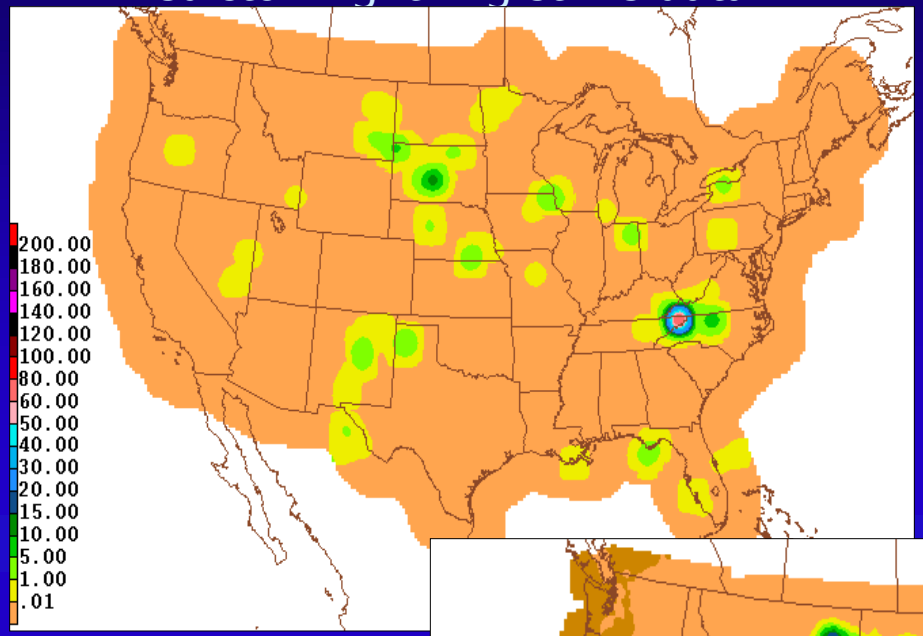
LAMP Categorical Forecast Selection Process



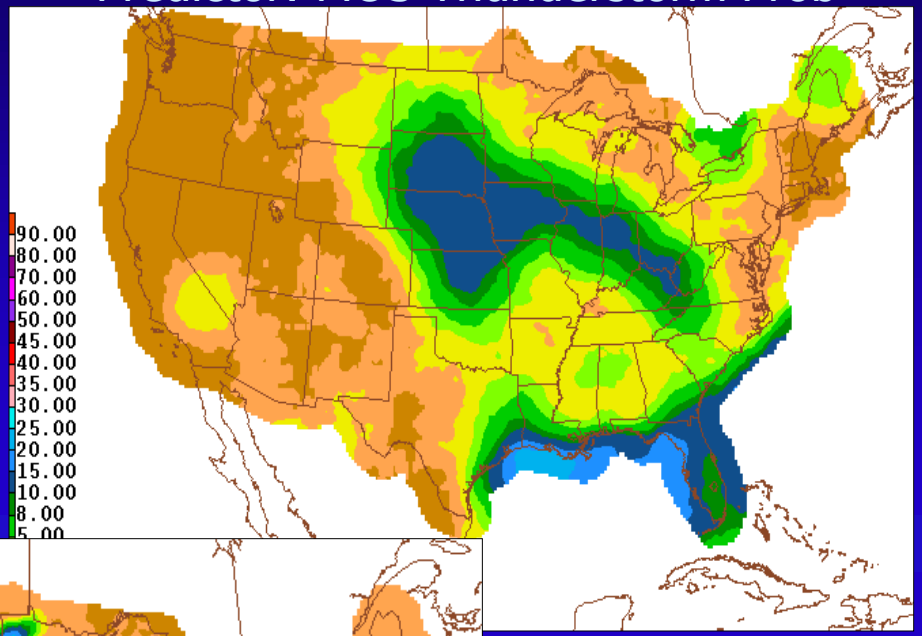
LAMP Thunderstorms

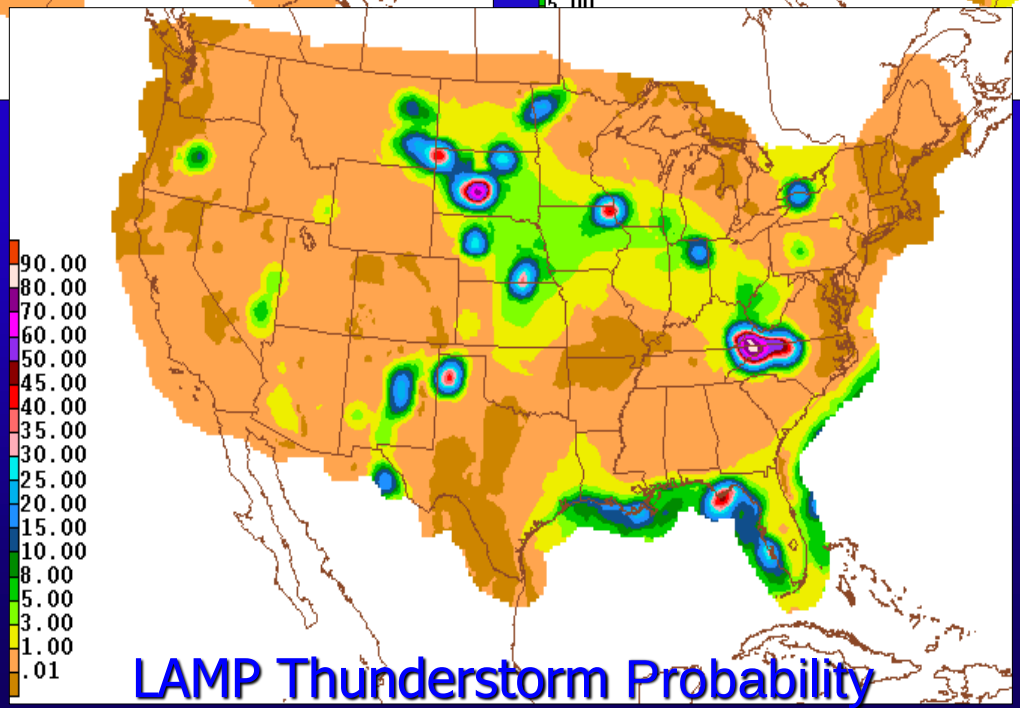
1-3 hr LAMP Thunderstorm forecast

Predictor: lightning strike data



Predictor: MOS Thunderstorm Prob

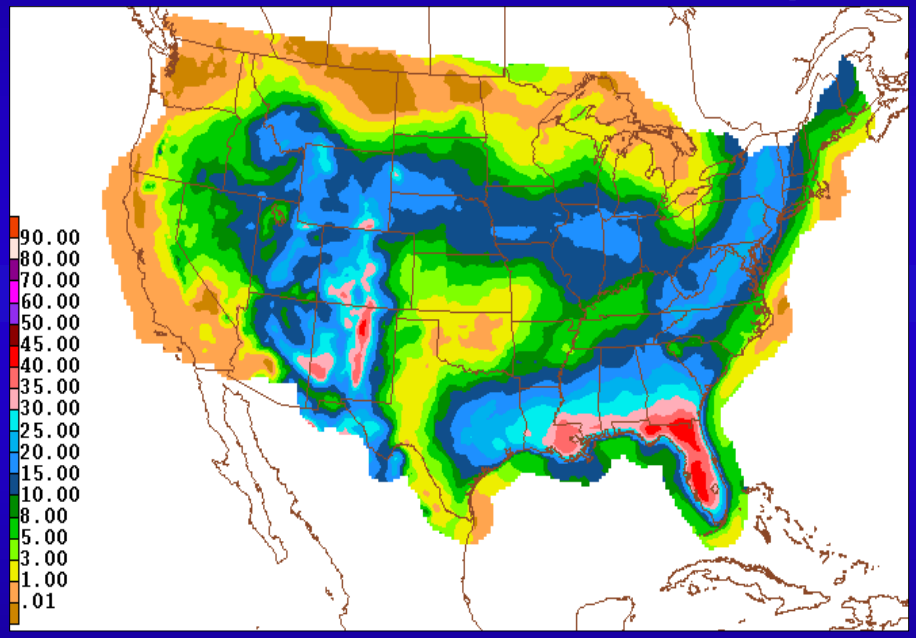




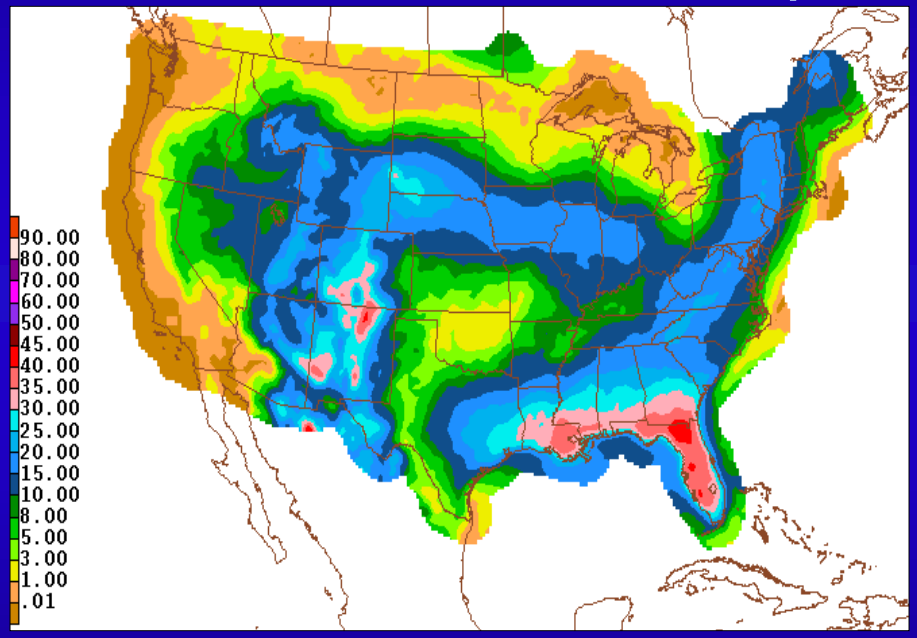
LAMP Thunderstorm Probability

11-13 hr LAMP Thunderstorm forecast

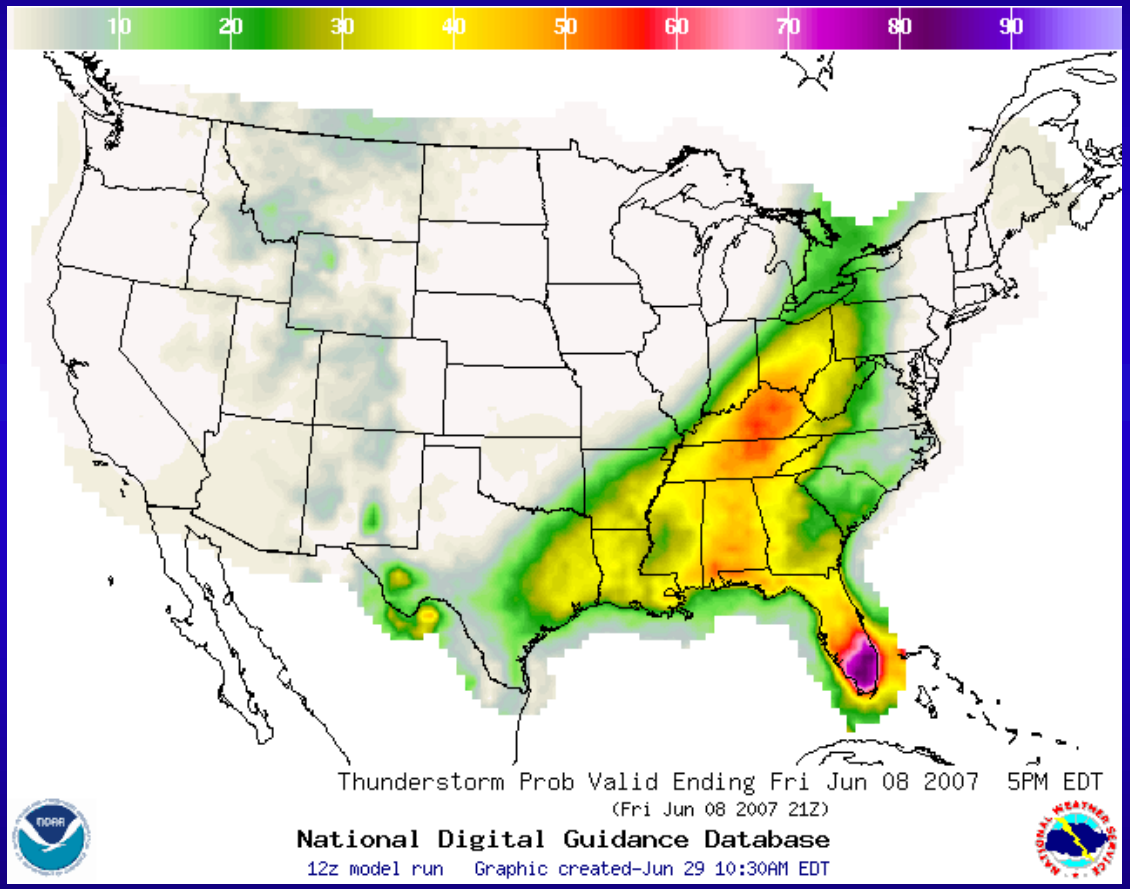
LAMP
Thunderstorm Probability



Predictor: MOS
Thunderstorm Probability

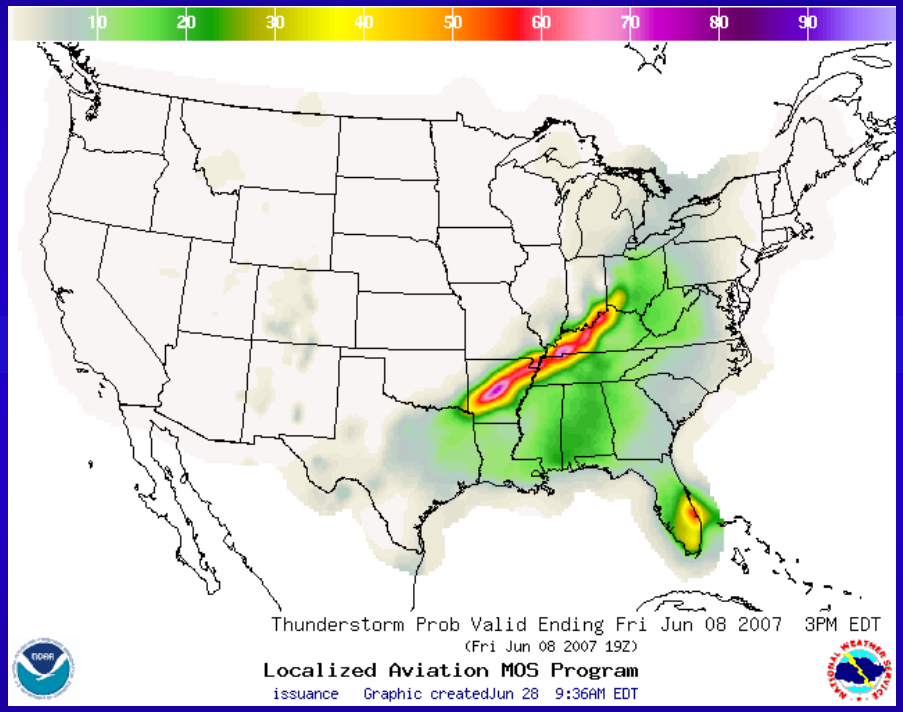


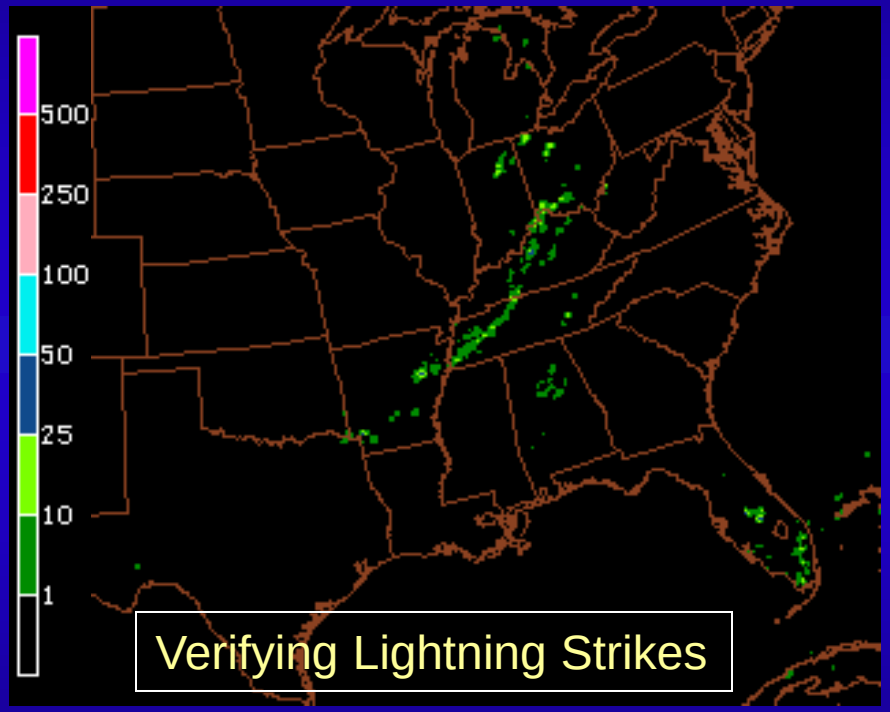
June 8, 2007



GMOS 03h forecast
Available ~16:45 UTC
Valid 18-21 UTC

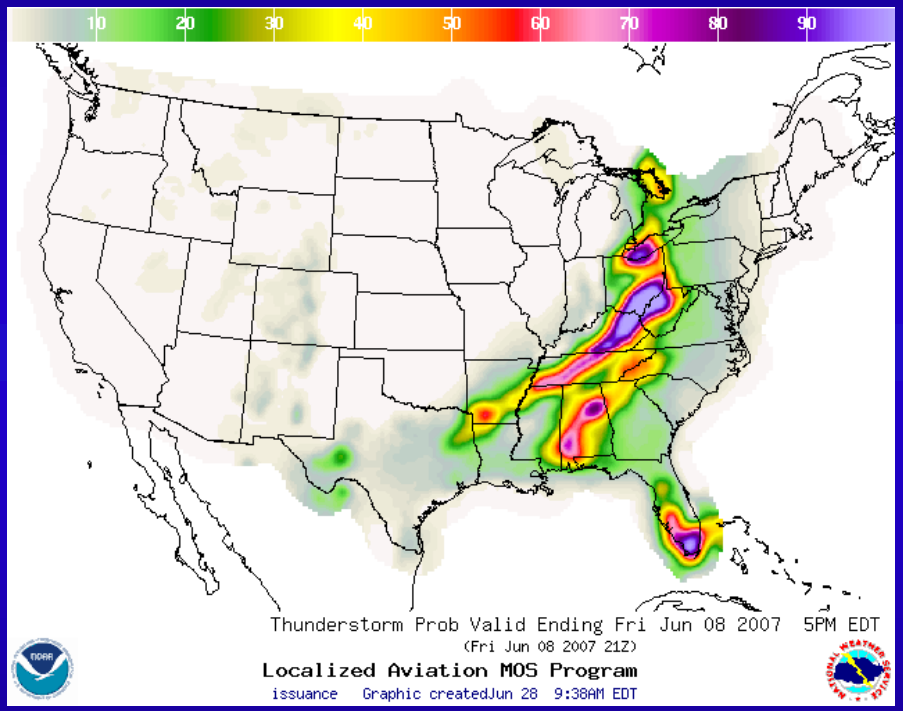
June 8, 2007 1500 UTC LAMP forecast

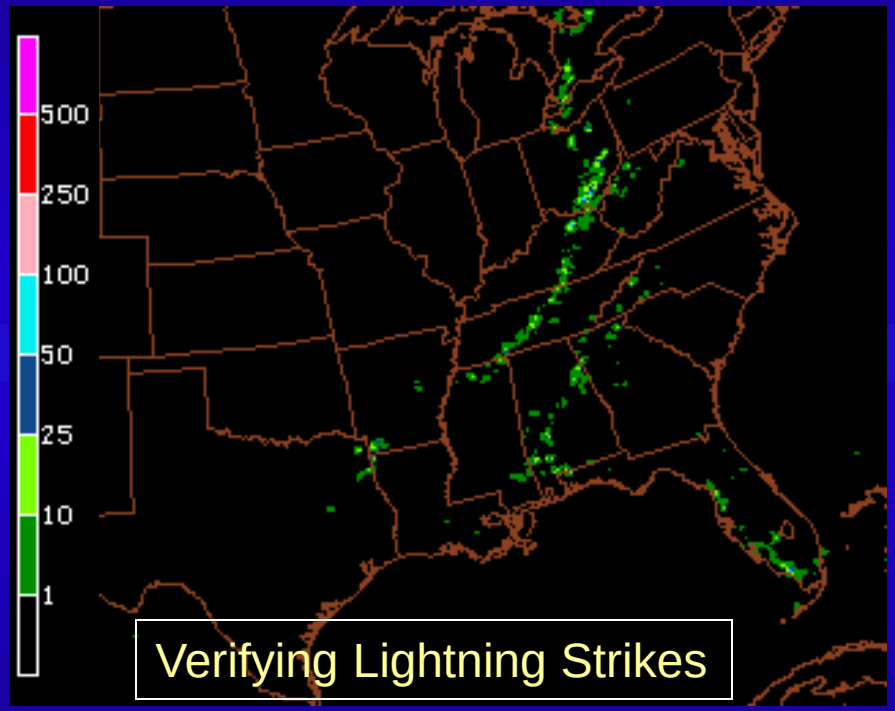




LAMP 02h forecast
Available ~15:45 UTC
Valid 17-19 UTC

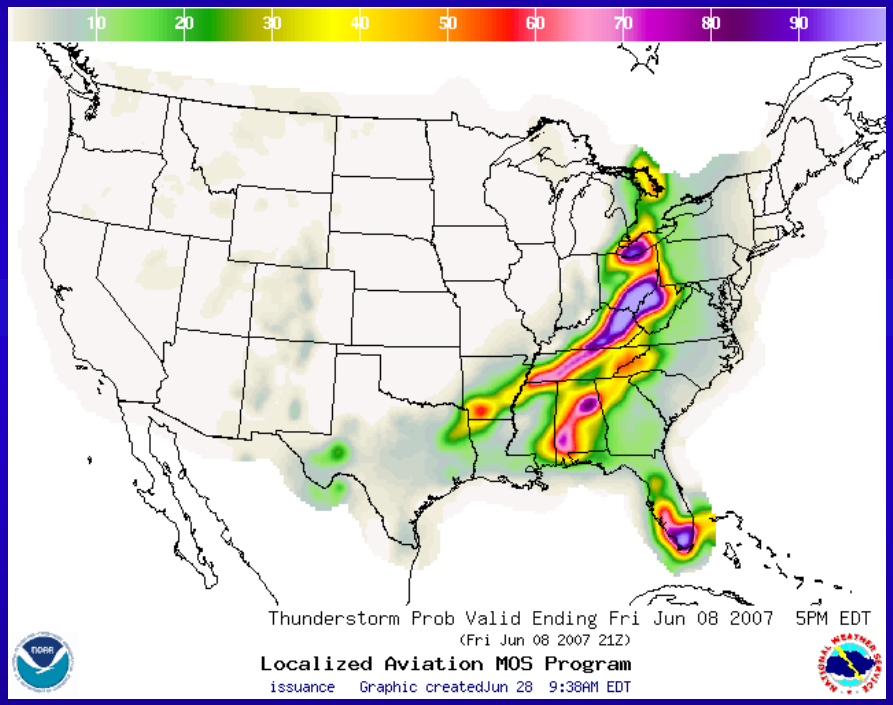
June 8, 2007 1800 UTC LAMP forecast

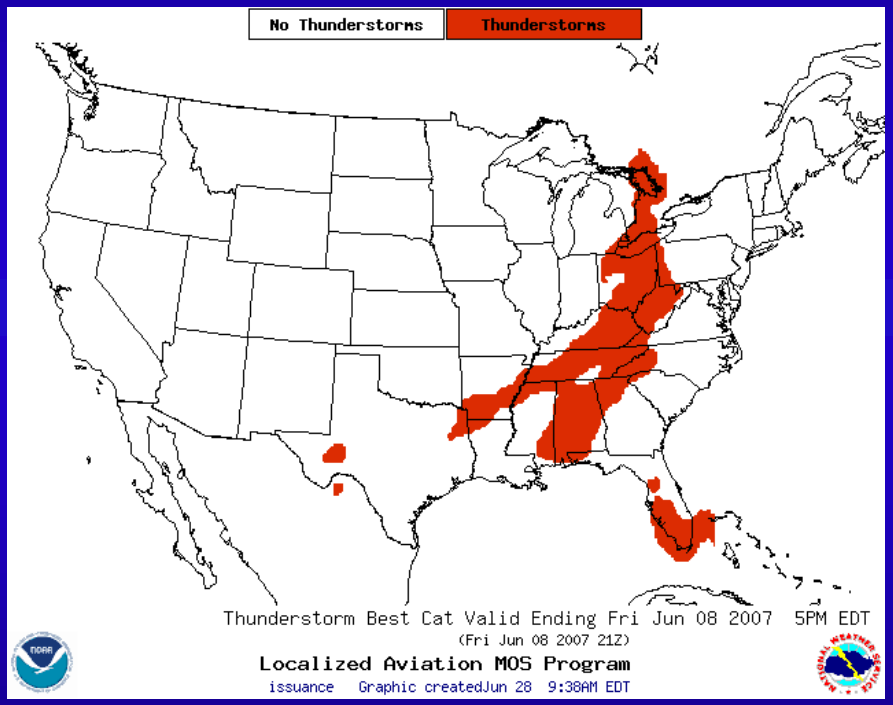




LAMP 02h forecast
Available ~18:45 UTC
Valid 19-21 UTC

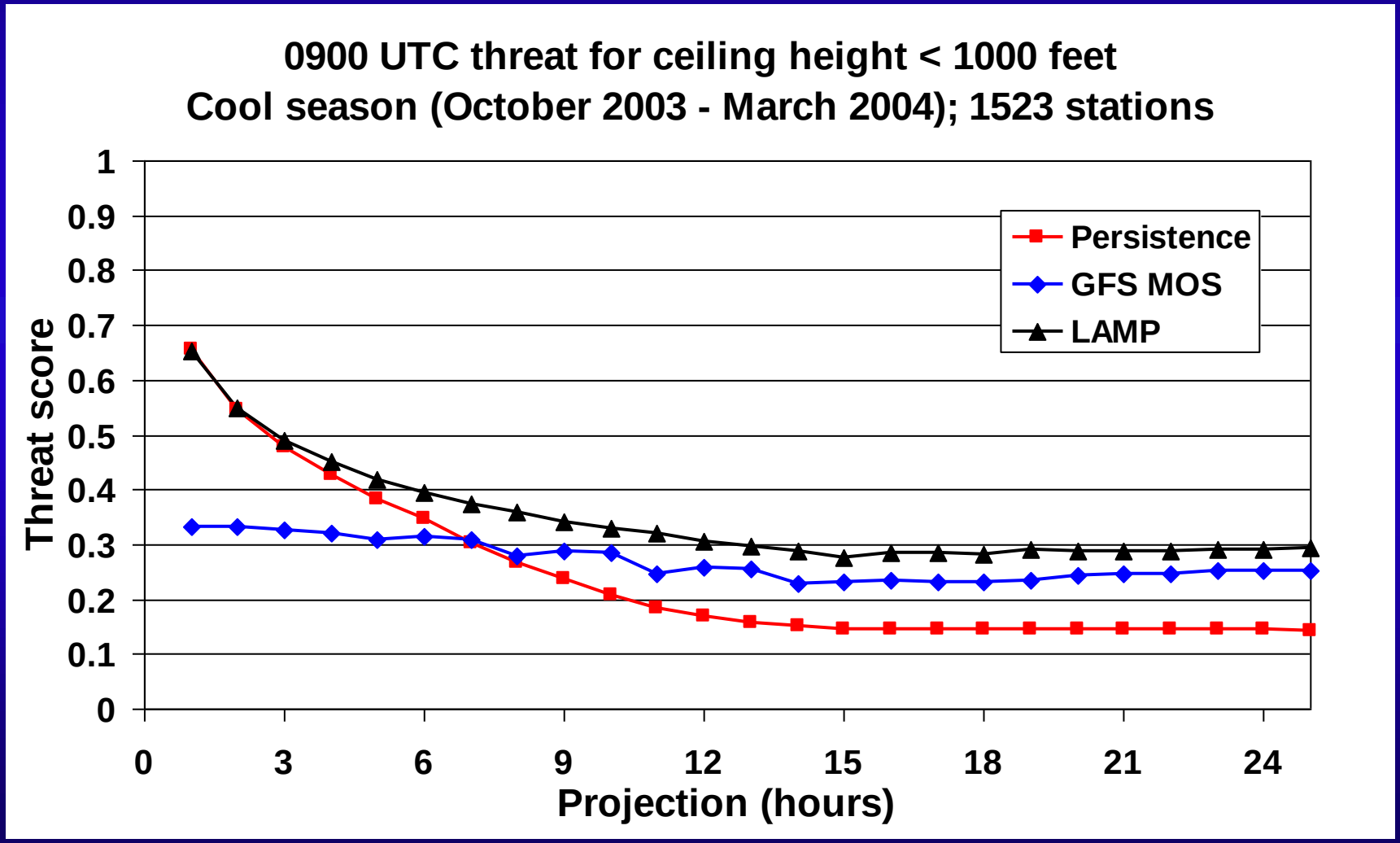
LAMP Thunderstorm: Probabilities and Best Category (Y/N) All Projections





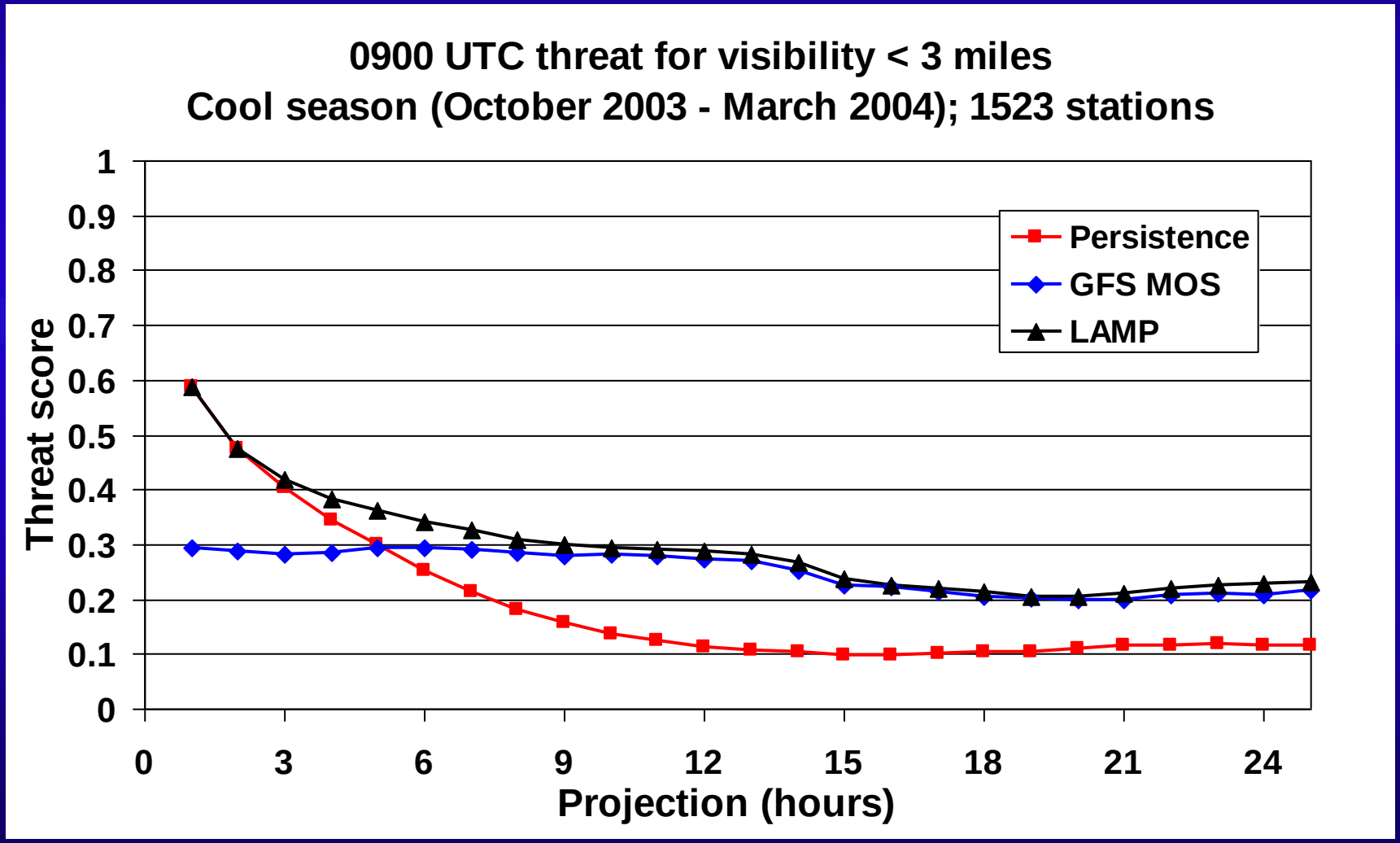
LAMP Verification

0900 UTC LAMP compared to MOS
Categorical Ceiling Height < 1000 feet



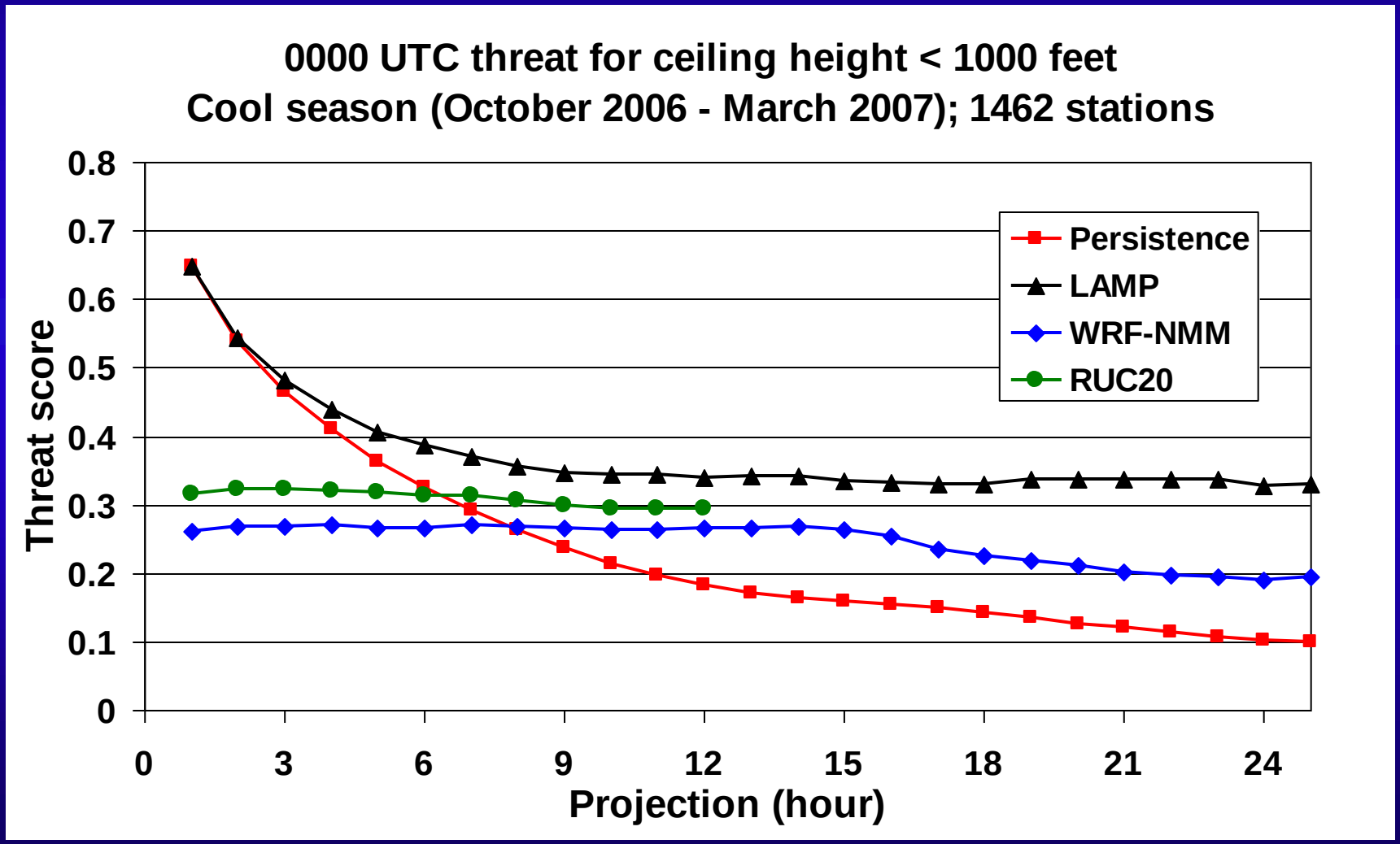
0900 UTC LAMP verified against 0000 UTC GFS MOS

0900 UTC LAMP compared to MOS
Categorical Visibility < 3 miles

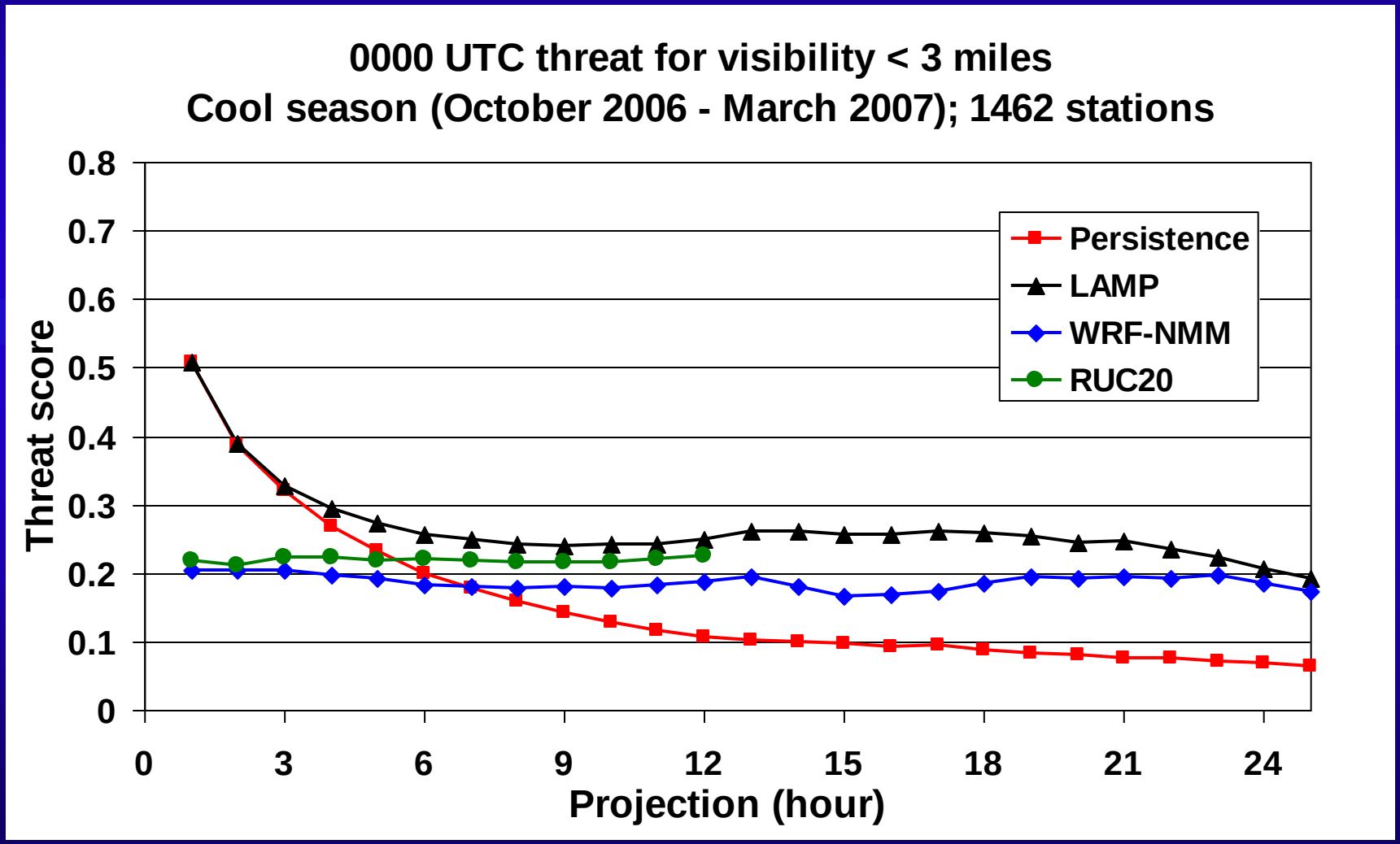


0900 UTC LAMP verified against 0000 UTC GFS MOS

LAMP compared to WRF-NMM and RUC20
Categorical Ceiling Height < 1000 feet



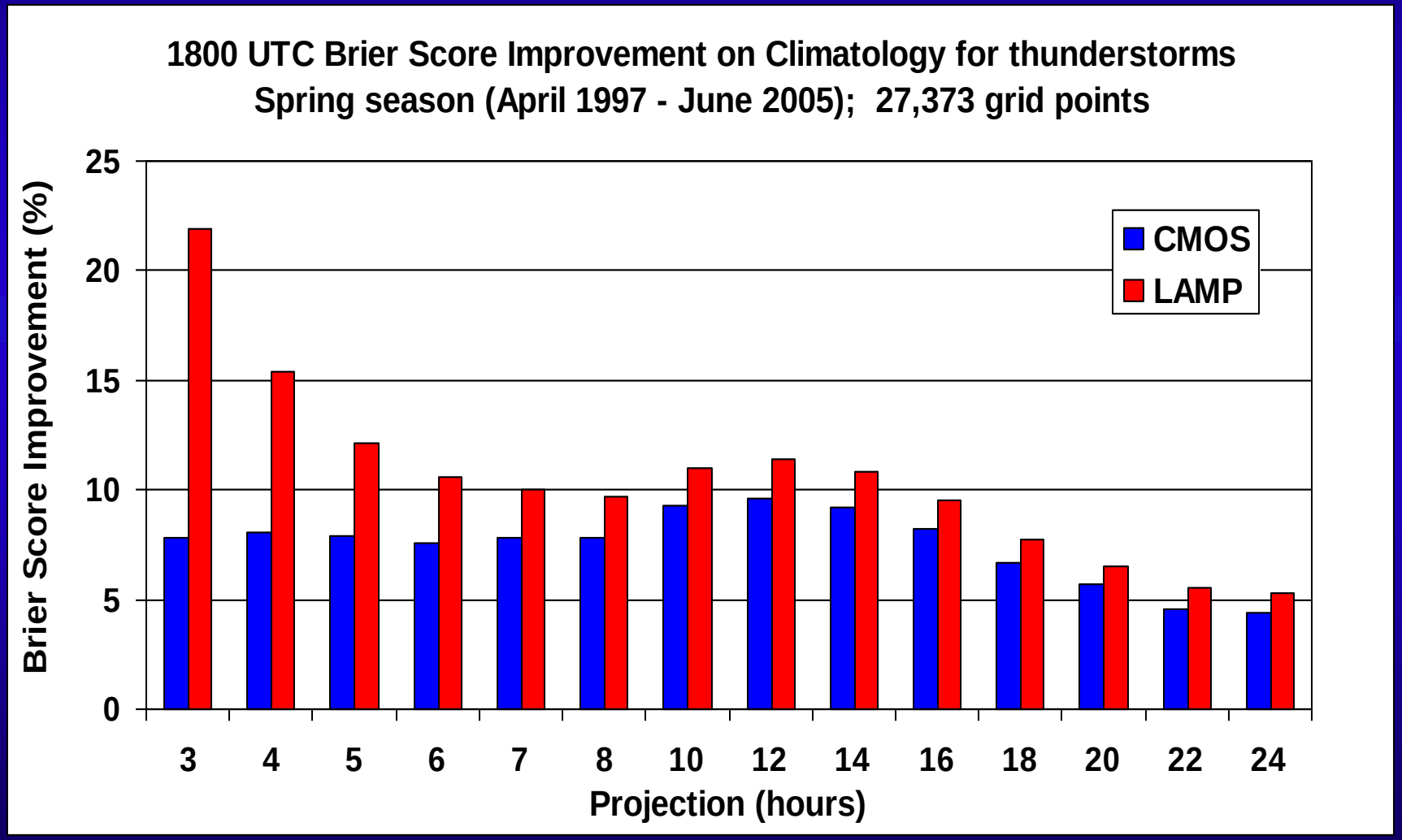
LAMP compared to WRF-NMM and RUC20
Categorical Visibility < 3 miles



Probabilistic Verification

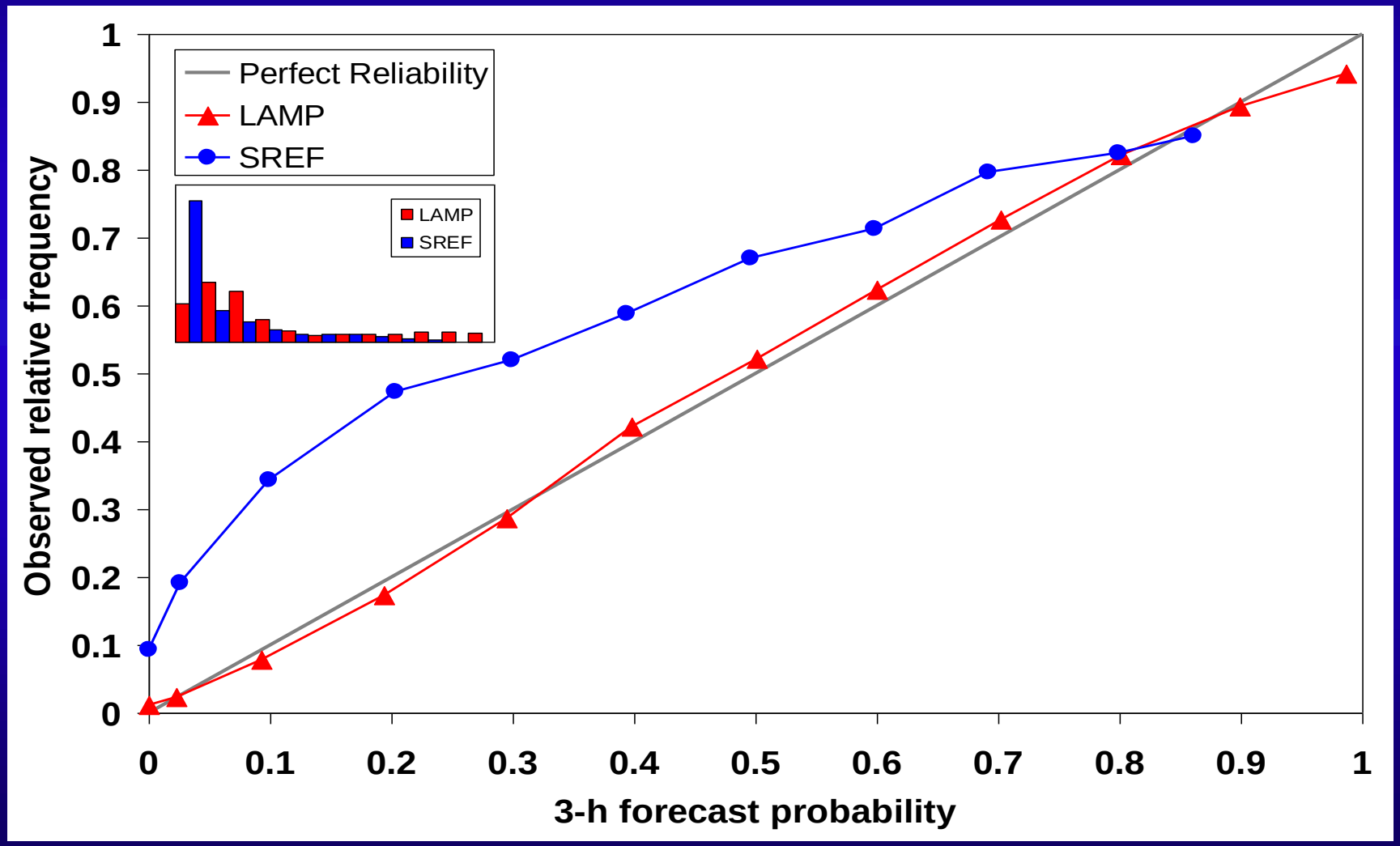
- Basic measure of accuracy is Brier score (lower is better).
- Measure of skill is the improvement in Brier score over a benchmark standard, such as climatology.
- The reliability of probability forecasts describes the degree to which the observed relative frequency of the weather event has an overforecasting or underforecasting bias.

LAMP vs. CMOS* Thunderstorm Brier Score Improvement on Climatology

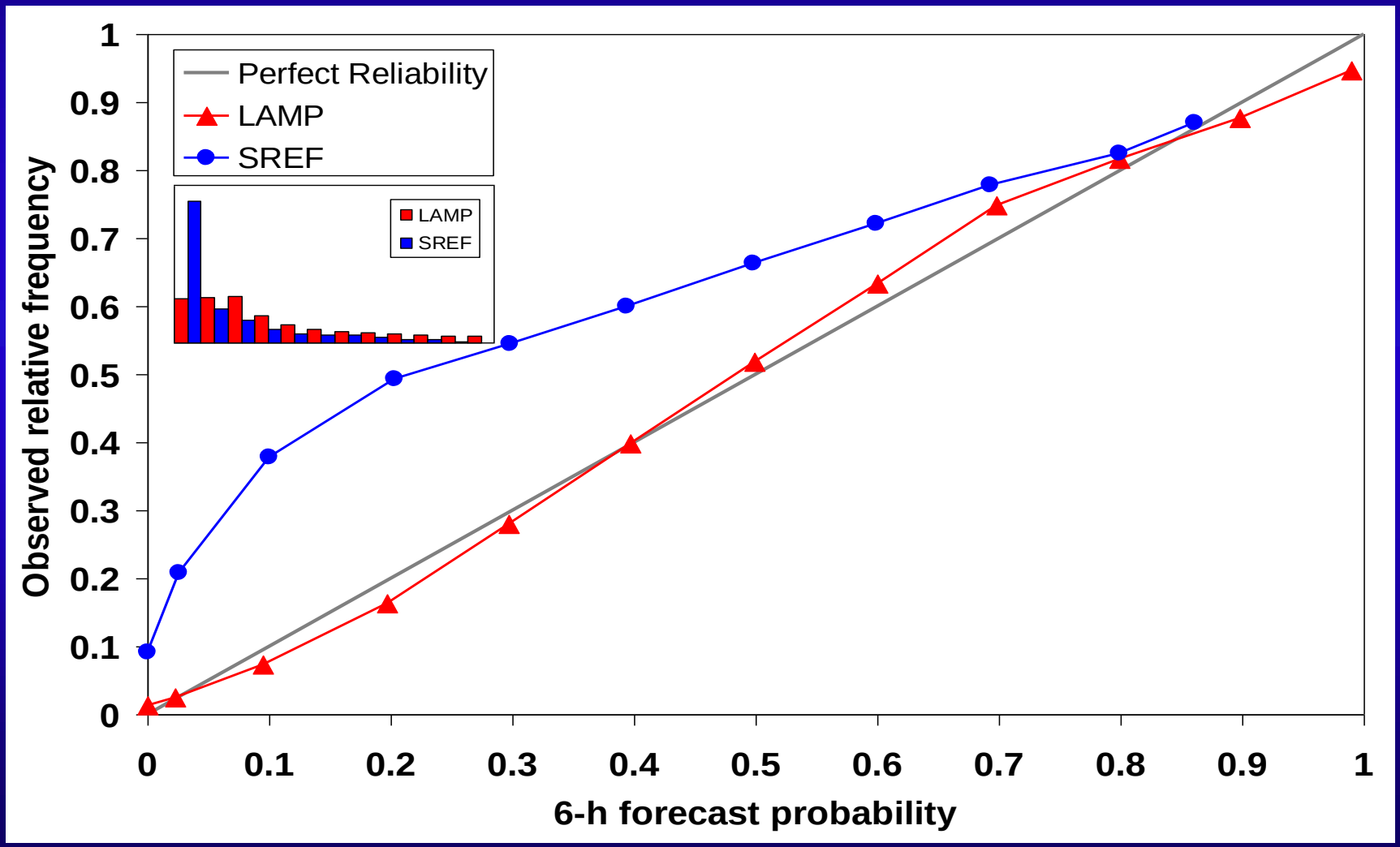


* CMOS stands for calibrated MOS, wherein the 1200 UTC GFS MOS is calibrated from a 3 h valid period to a 2 h valid period.

0900 UTC LAMP and SREF Reliability
October 2006 – March 2007
Probabilistic Ceiling Height ≤ 3000 Ft



0900 UTC LAMP and SREF Reliability
October 2006 – March 2007
Probabilistic Ceiling Height ≤ 3000 Ft



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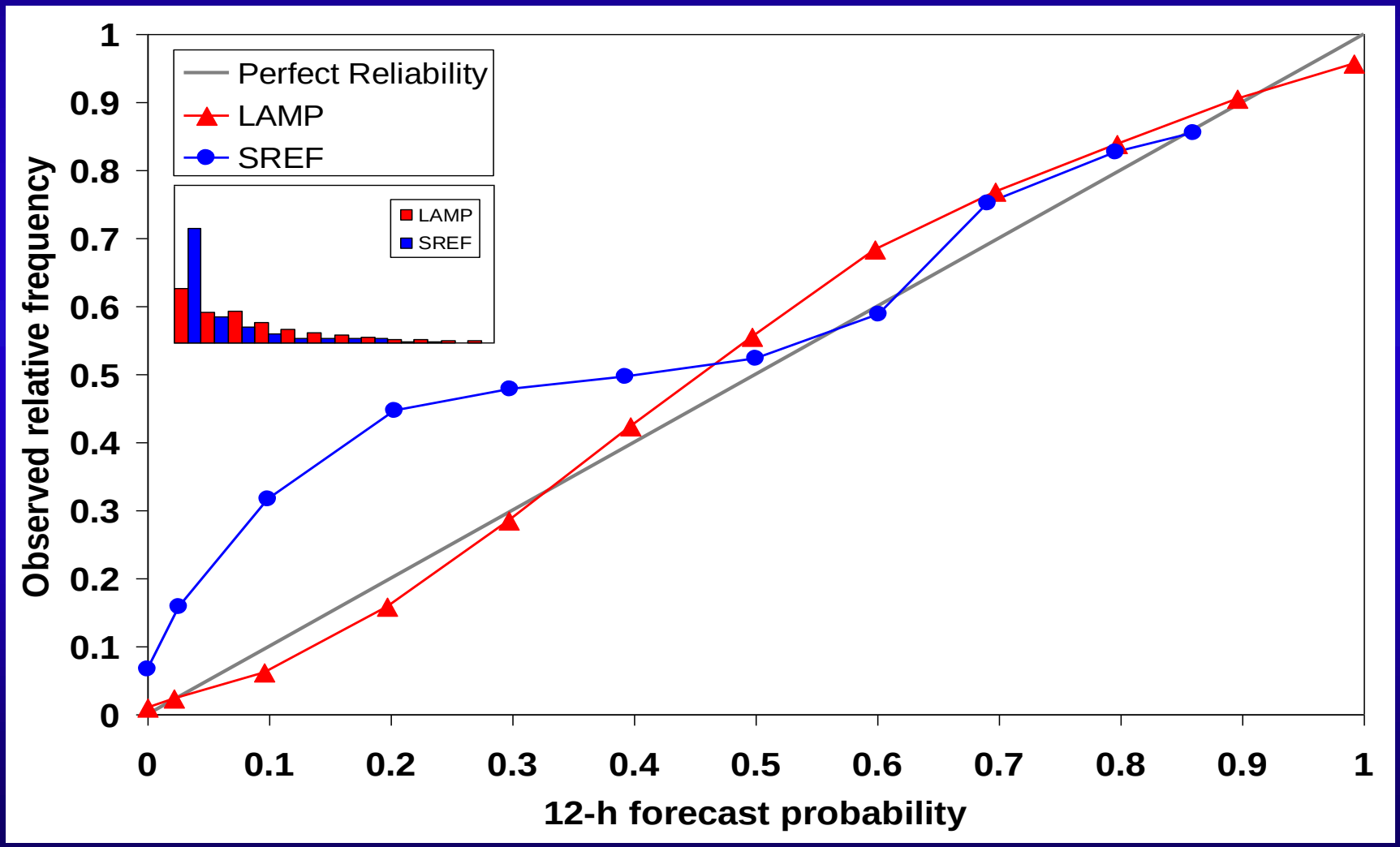
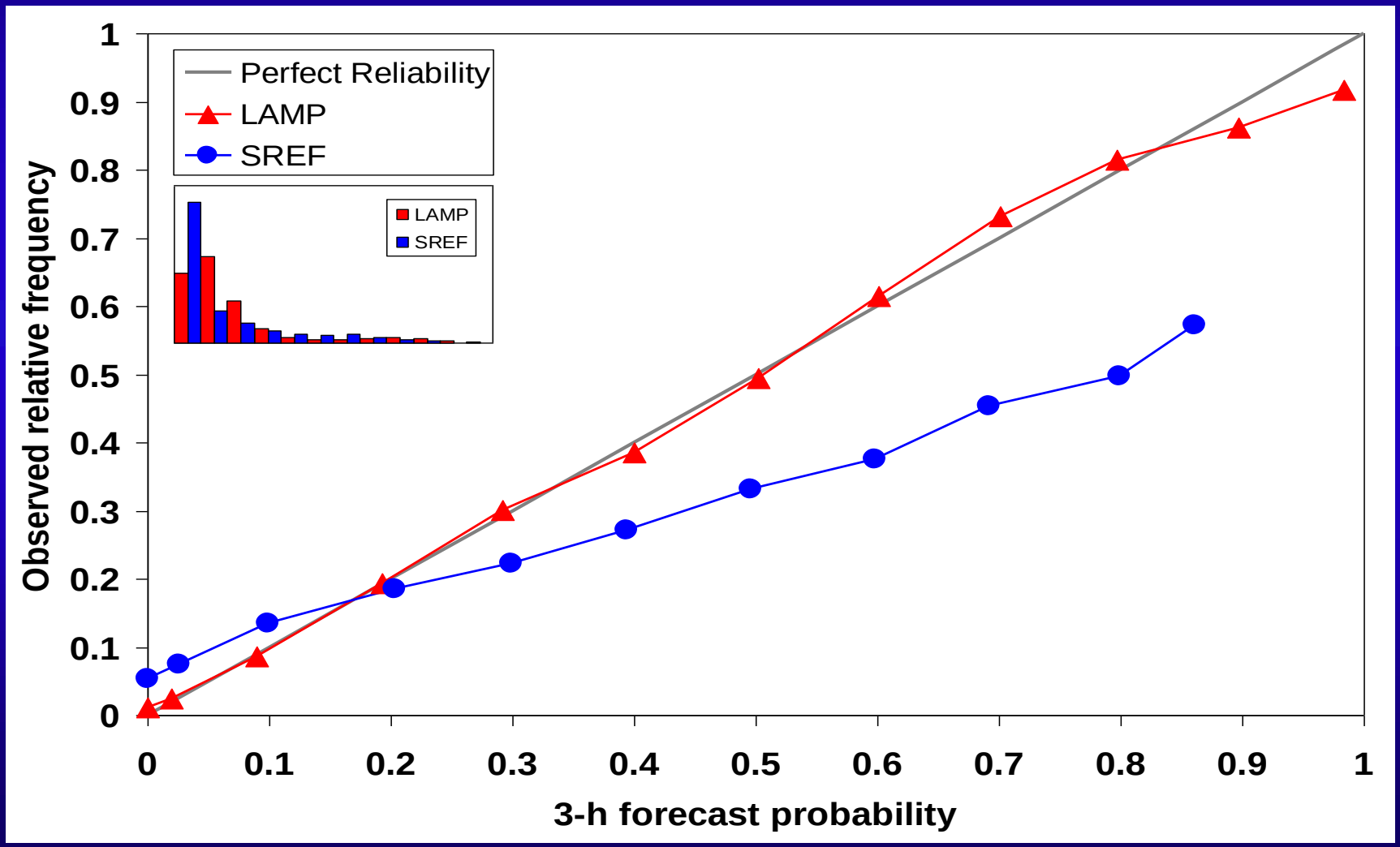


0900 UTC LAMP and SREF Reliability
October 2006 – March 2007
Probabilistic Ceiling Height < 1000 Ft



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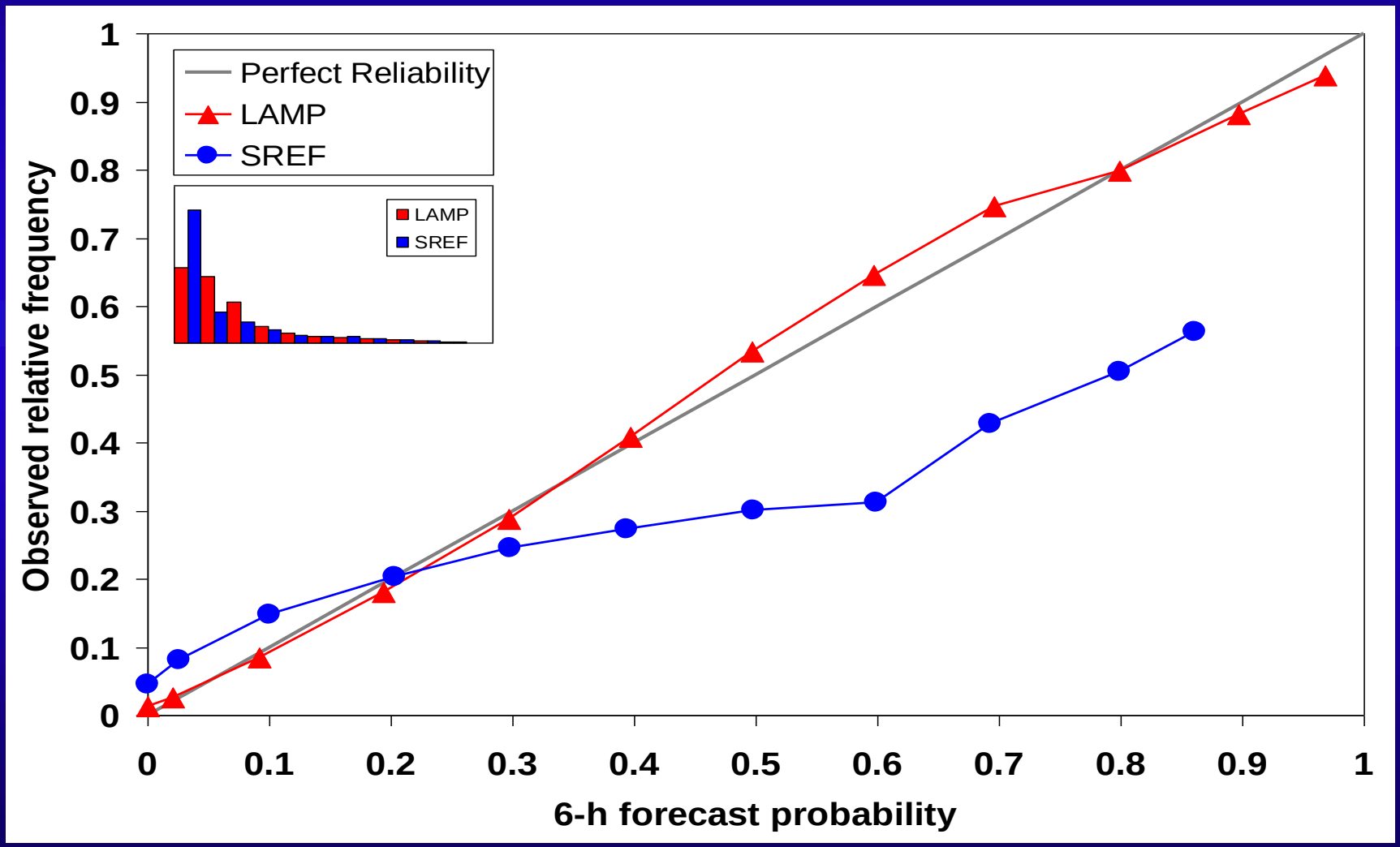

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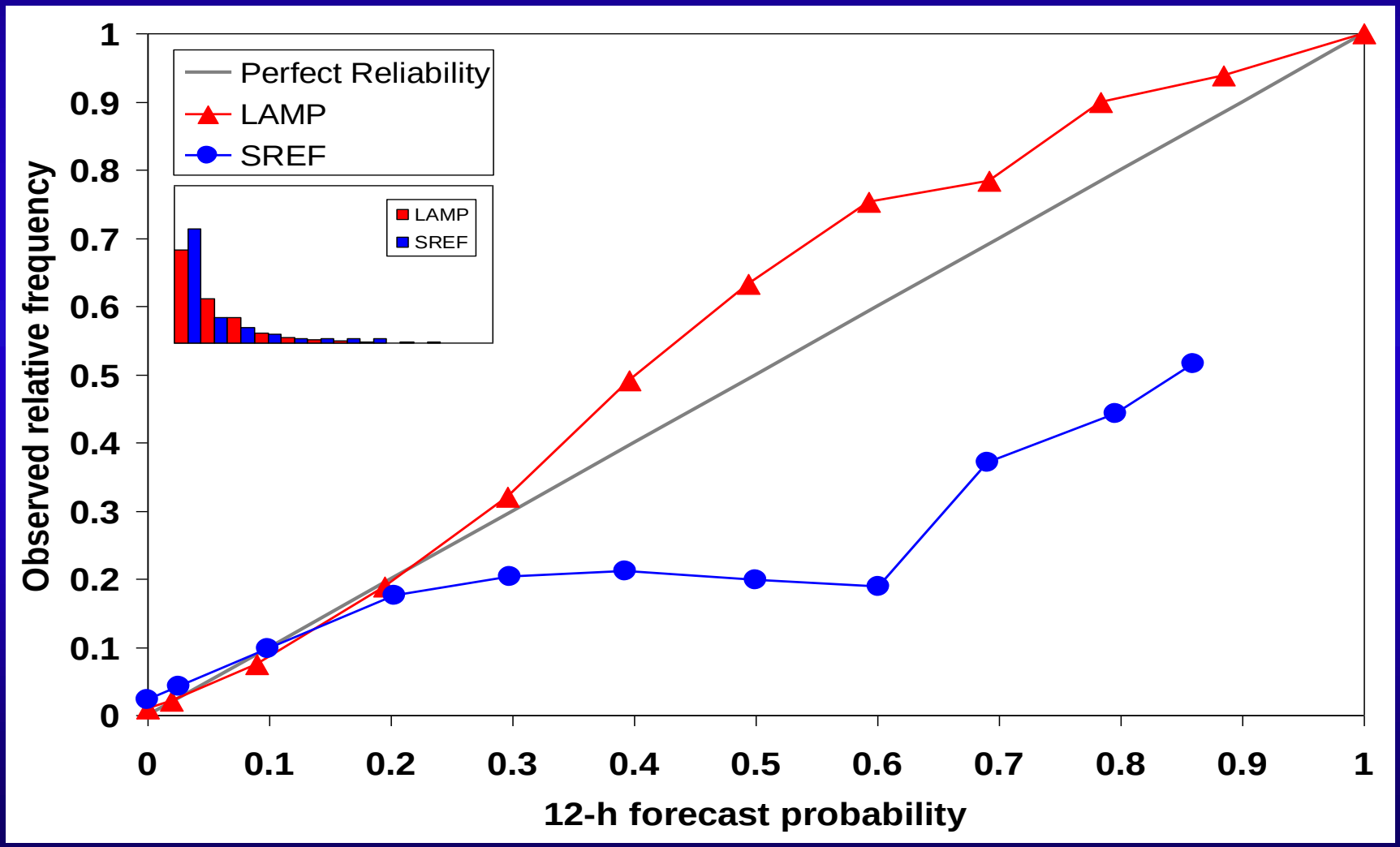
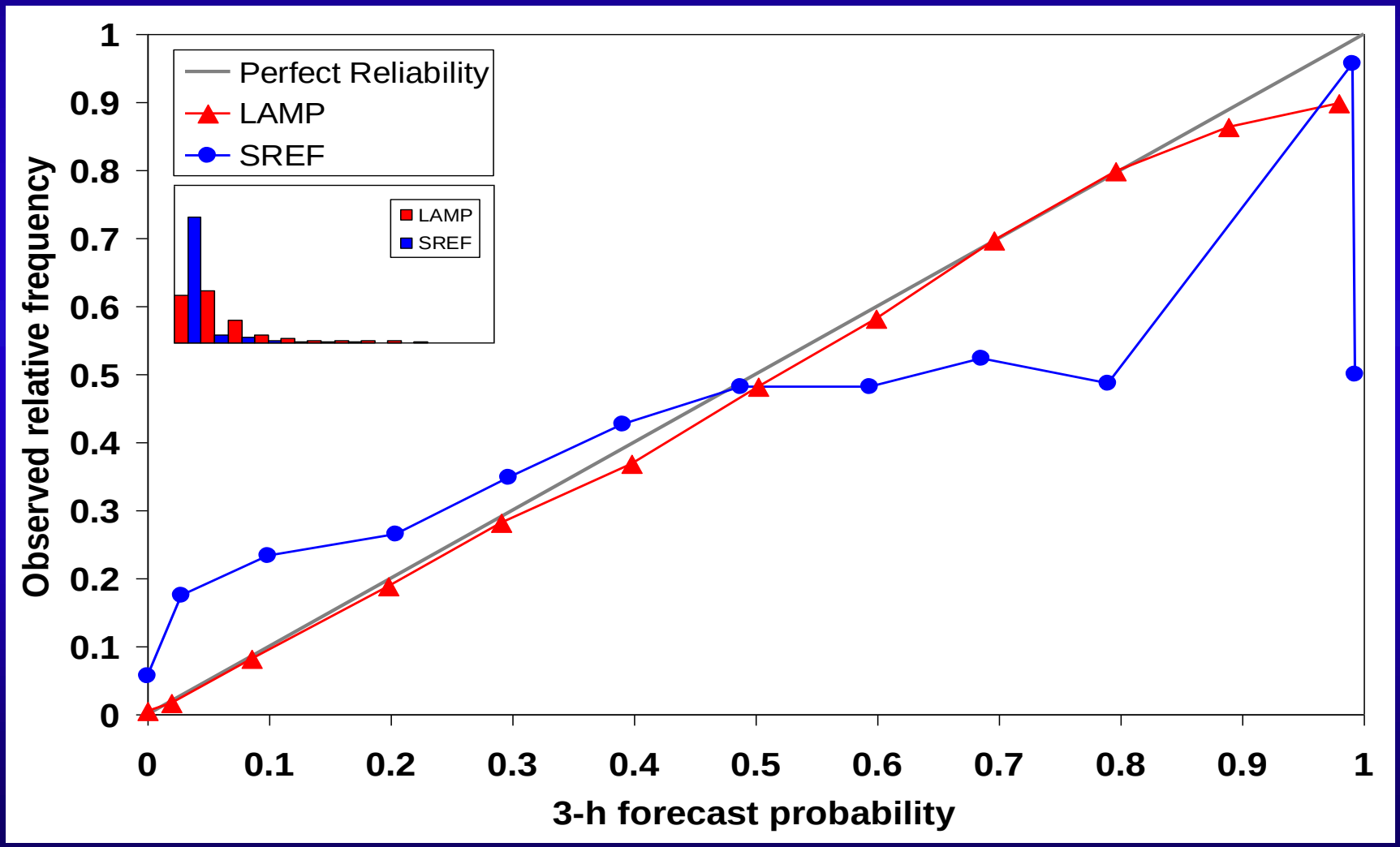


0900 UTC LAMP and SREF Reliability
October 2006 – March 2007
Probabilistic Visibility < 3 Miles



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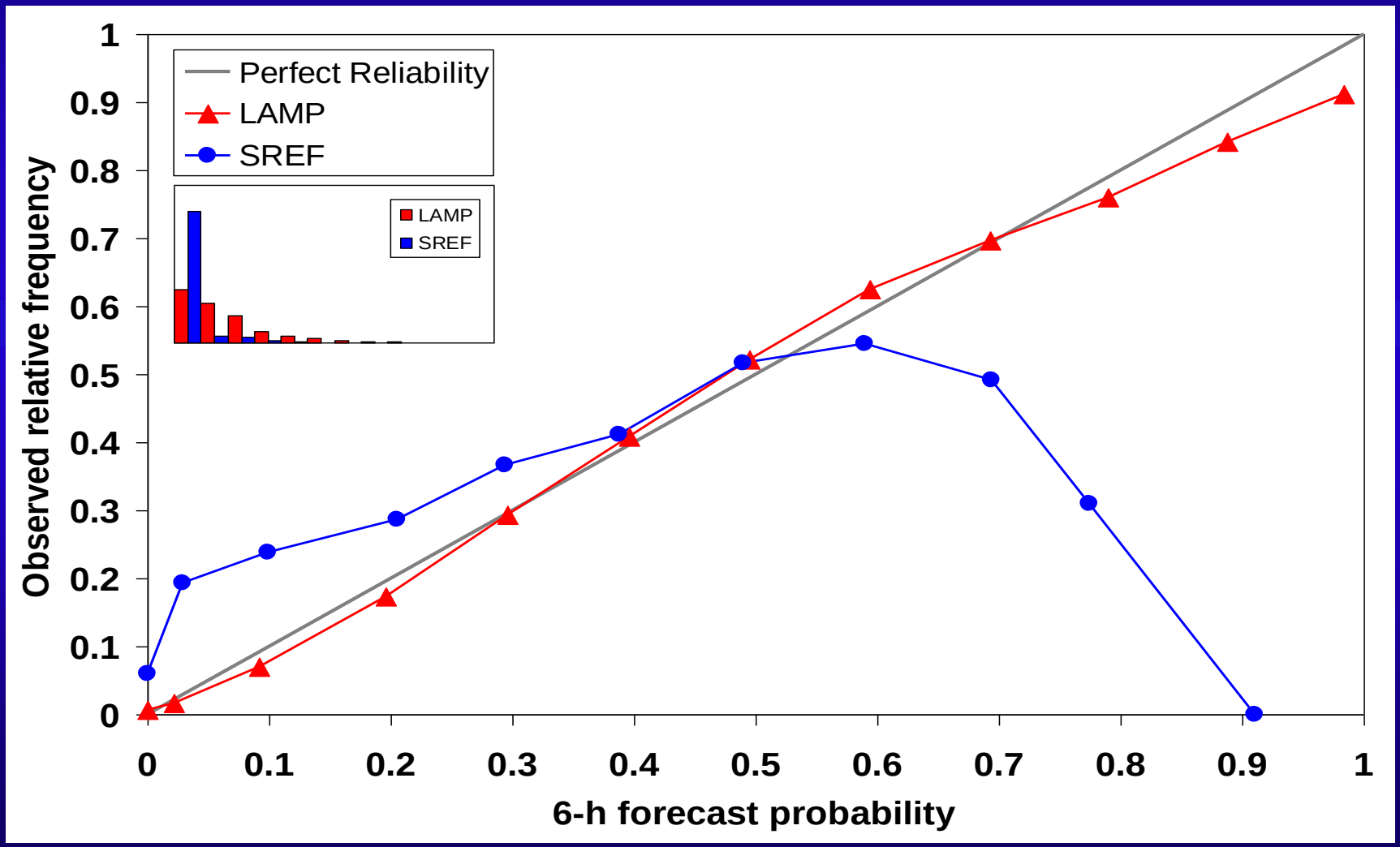

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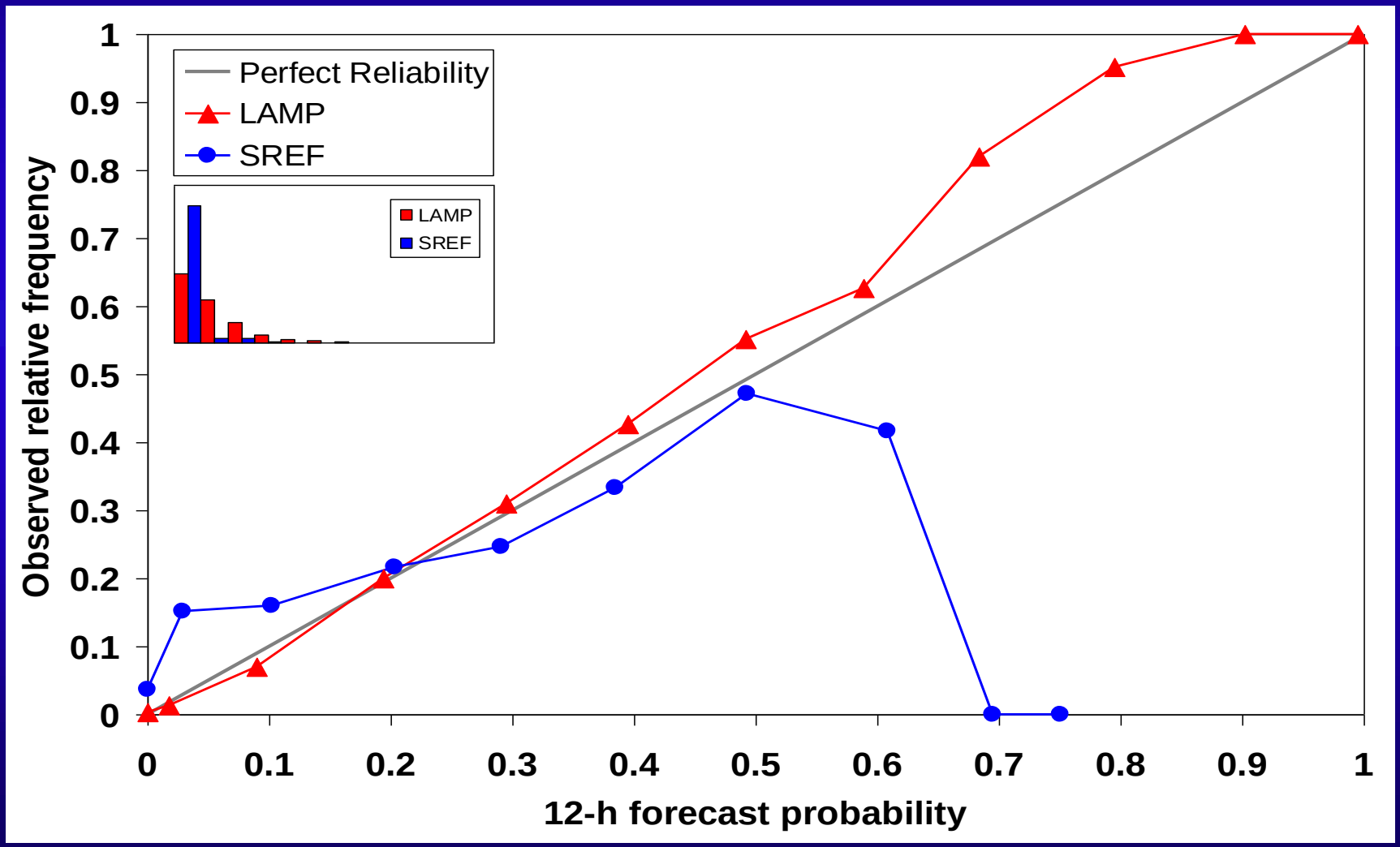


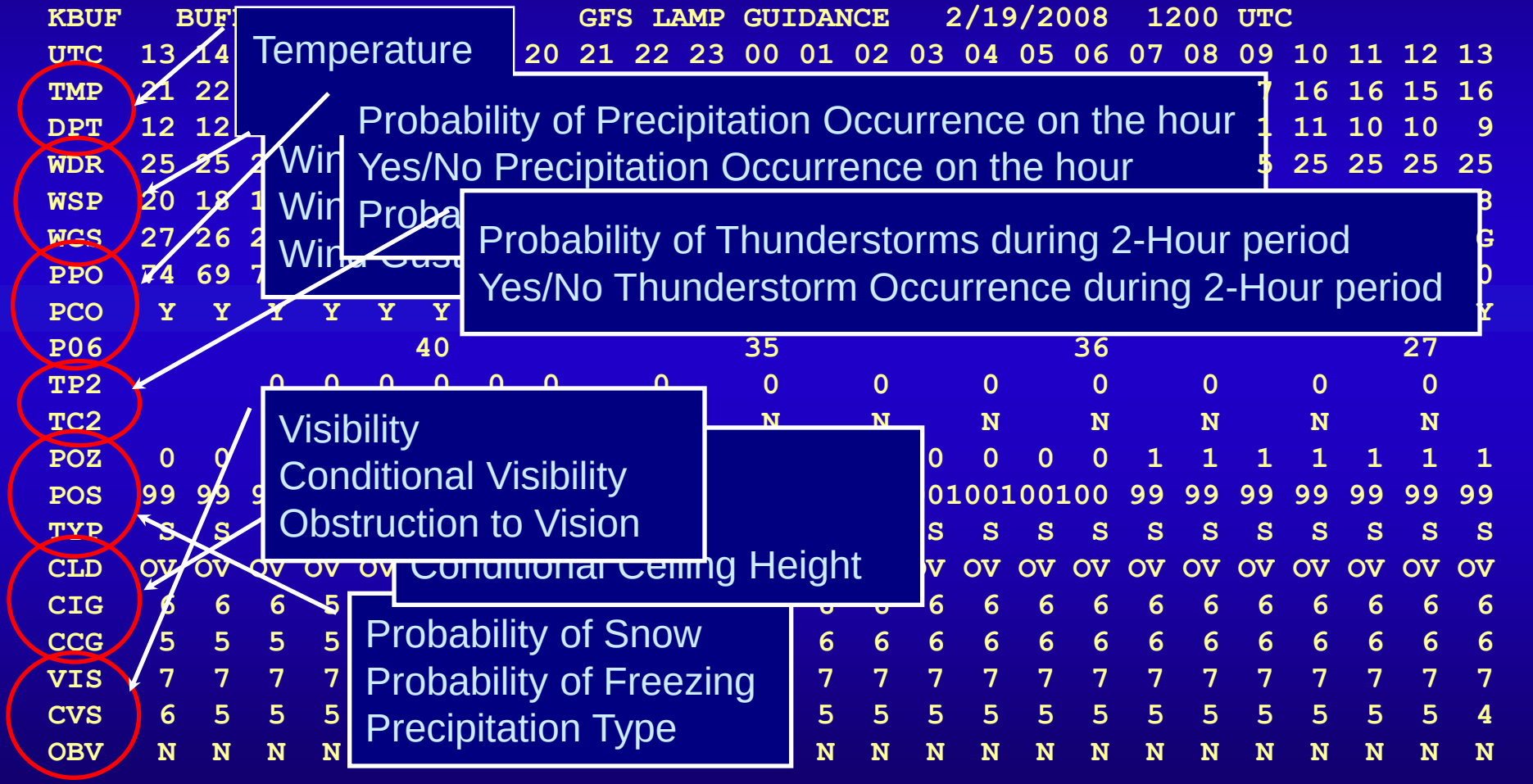
LAMP Products

Overview of Available Products

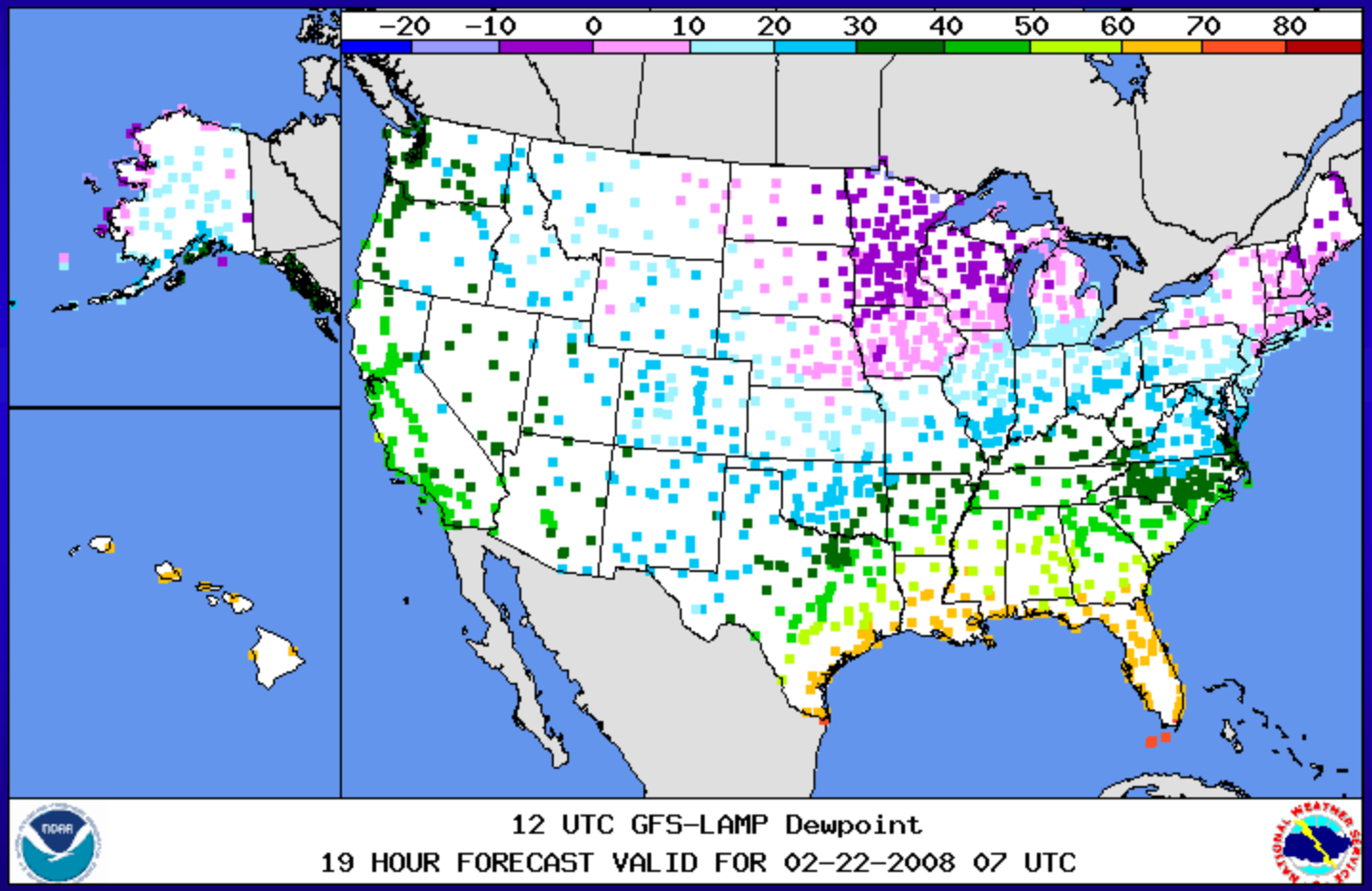
- Sent out on SBN/NOAAPort and NWS FTP Server
  - ASCII text bulletin
  - BUFR data
  - GRIB2 thunderstorm data
- AWIPS
  - Displayable in D2D
    - Local menu
    - Volume Browser
  - Guidance available for display and Terminal Aerodrome Forecast (TAF) preparation via the Aviation Forecast Preparation System (AvnFPS)
- GFS LAMP Website

  http://www.nws.noaa.gov/mdl/gfslamp/gfslamp.shtml

Example of a GFS LAMP Text Bulletin



GFS LAMP Station Plots



Elements

- Flight Category
- Ceiling Height
- Visibility
- Obstruction to Vision
- Total Sky Cover
- Precipitation Type
- Probability of Precipitation
- Wind Speed
- Wind Gust
- Wind Direction
- Temperature
- Dewpoint

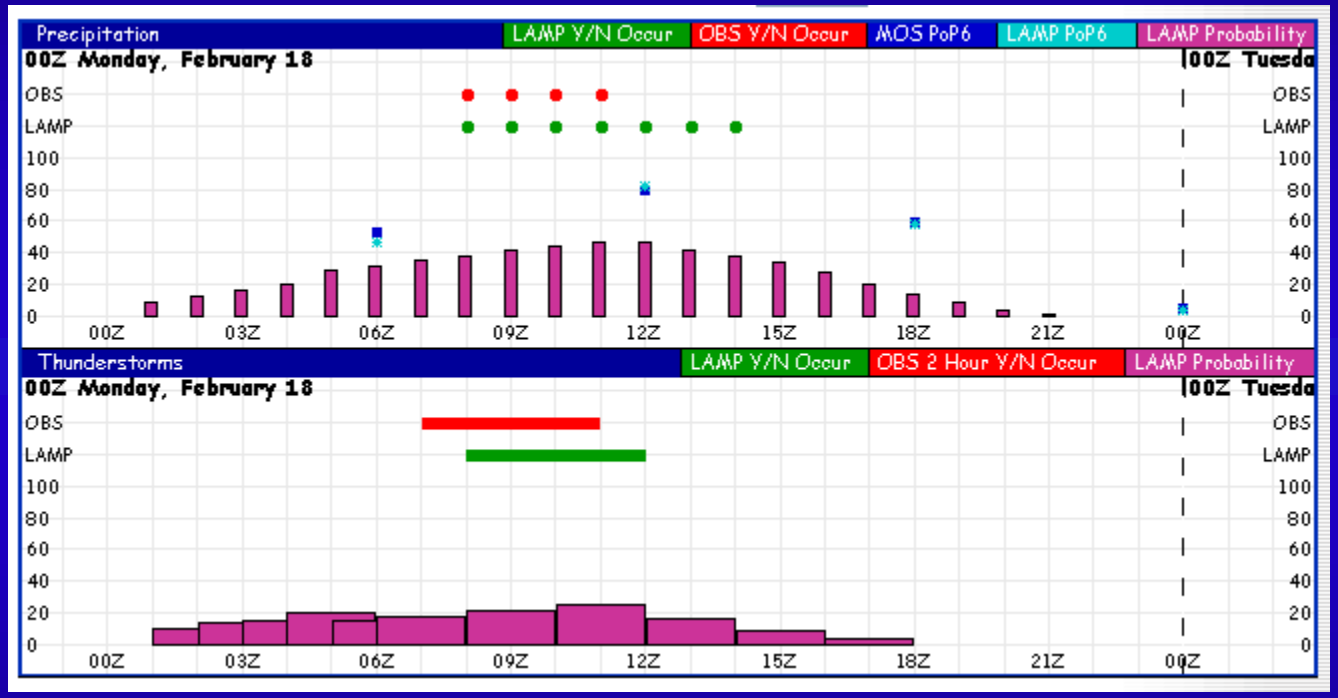
Click an element name on this slide to see its plot

GFS LAMP Station Meteograms

Features

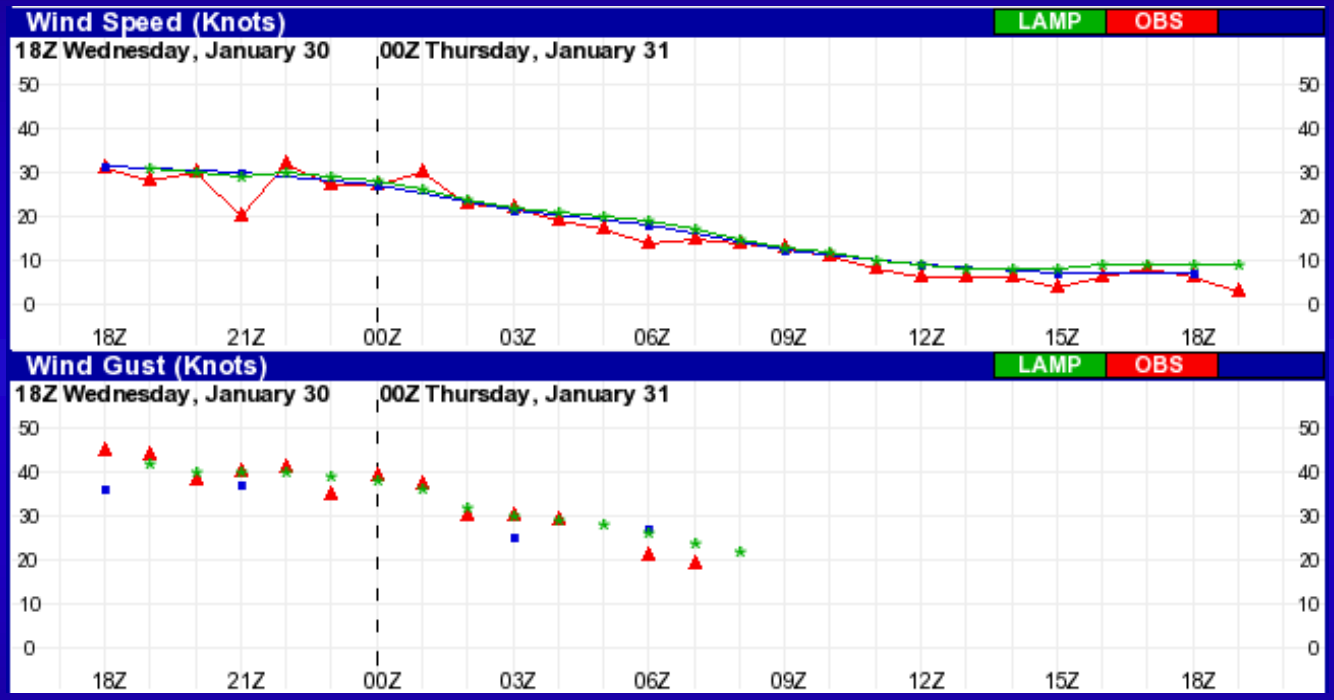
- Up to 12 displayable GFS LAMP forecast elements
- Real-time verification of current and past cycles
- Verification of completed past cycles including the corresponding GFS MOS forecast

Timing of Precipitation start/stop



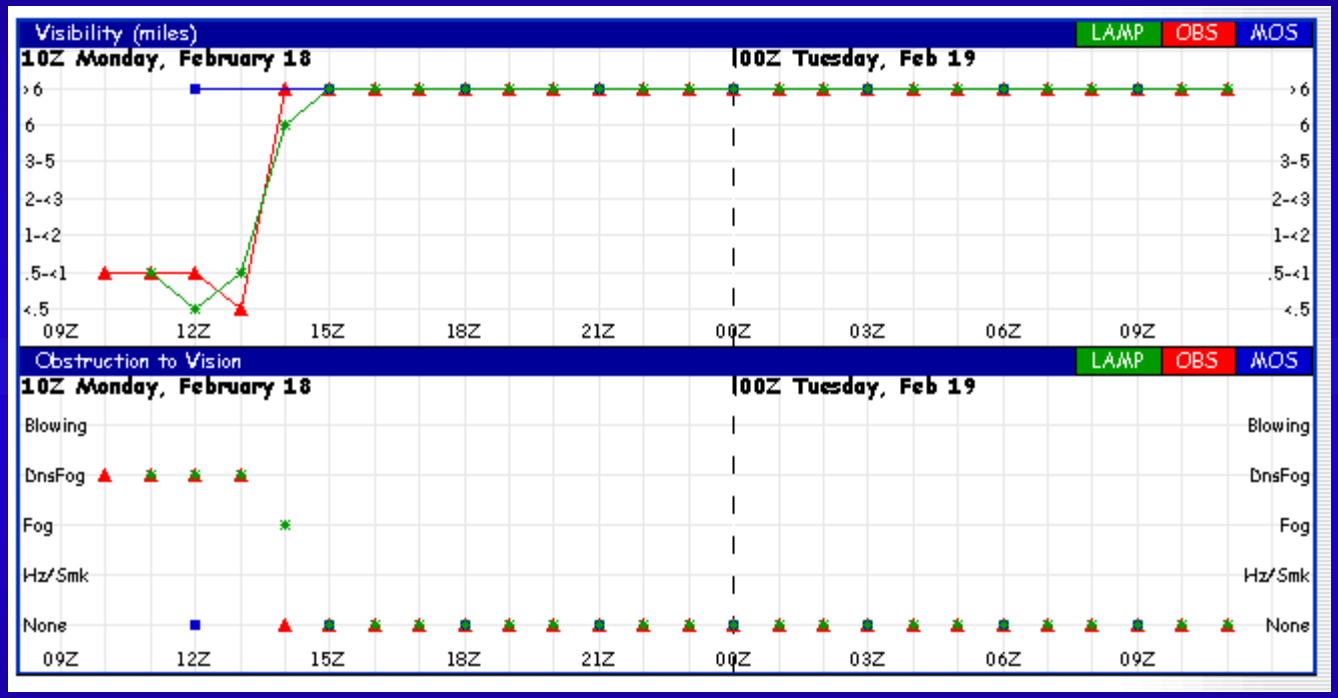
The meteograms can be helpful in determining the timing of a particular weather event. In the example above, LAMP correctly forecasted that precipitation would begin at 08Z Monday, which was eight hours before the event, but missed the onset of the thunderstorms by one hour.

Timing of gusts



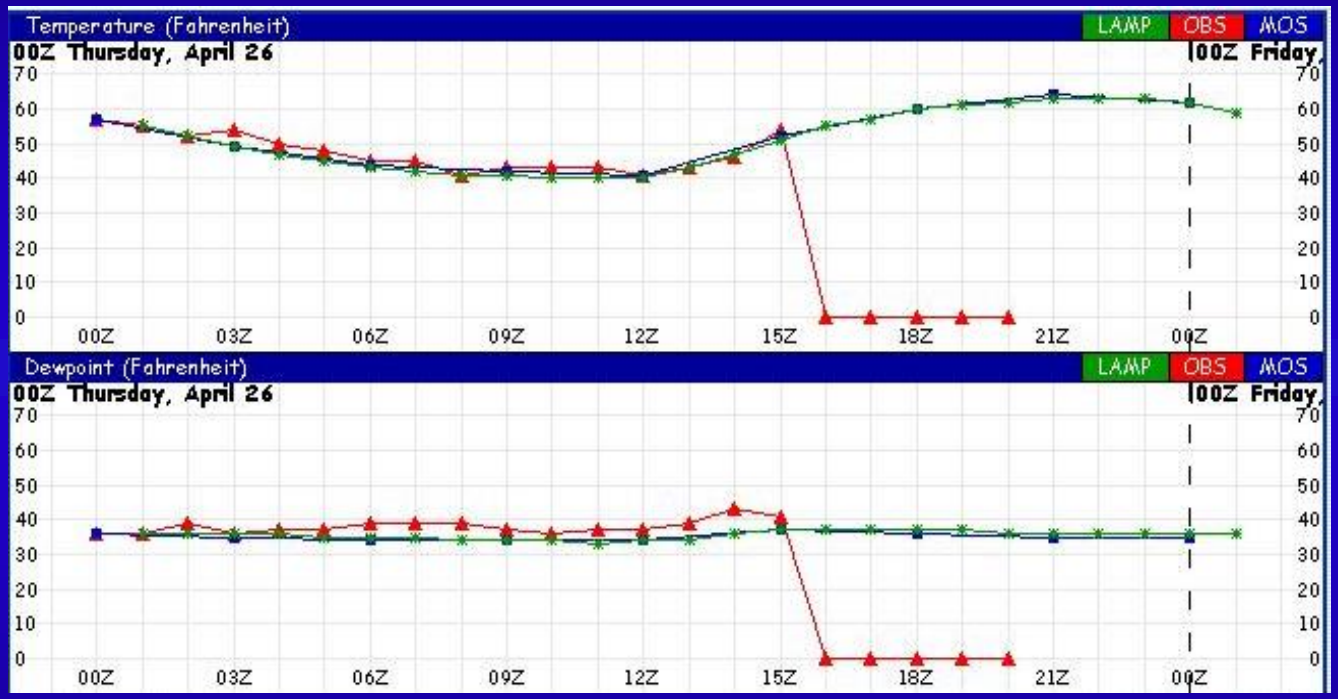
In another example, these meteograms show LAMP handling the timing of a high wind event by correctly forecasting 40 knot gusts and diminishing the high winds in the overnight hours.

The Influence of the Observation (Improvement)



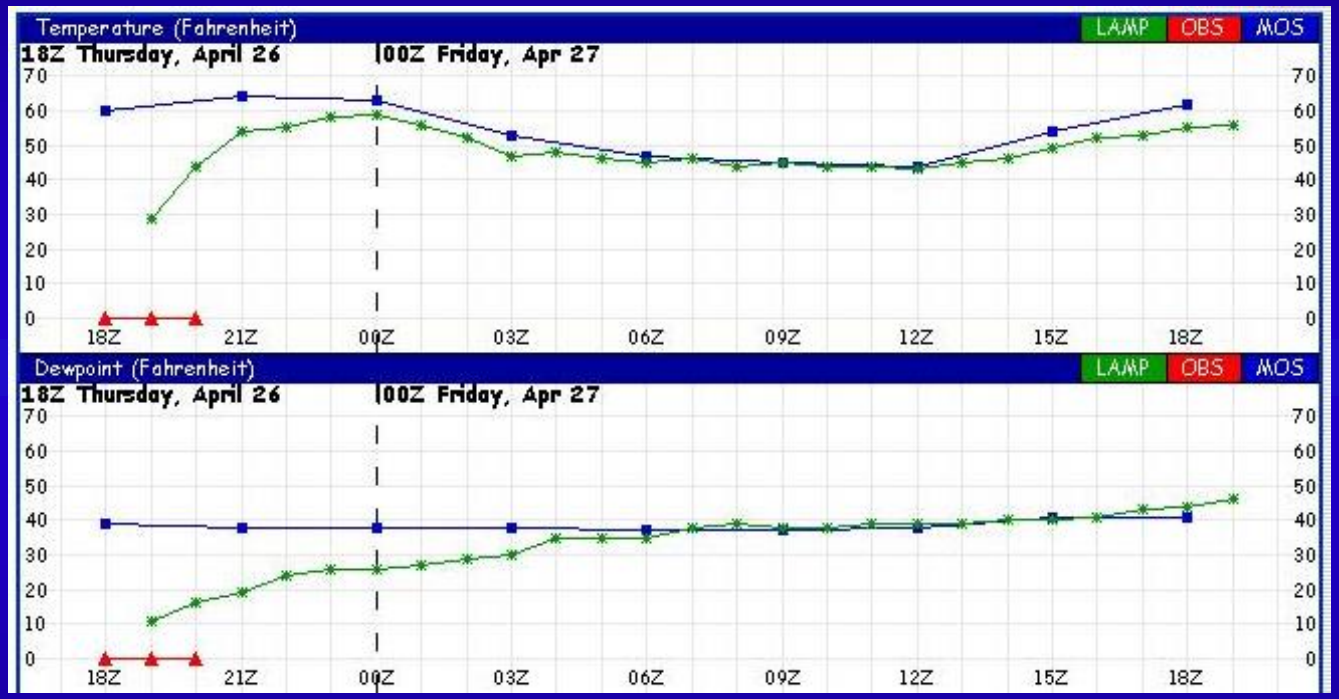
LAMP was able to catch this dense fog event on Monday morning, when the 06Z MOS had no reduced visibilities. The influence of the observed dense fog allowed the LAMP to “update” the MOS forecast and correctly depict this event.

The Influence of the Observation (Degradation)



The above image shows the 00Z LAMP temperature and dewpoint meteograms with the corresponding GFS MOS forecast and the verifying observation. You'll notice that the observation becomes bad after 15Z. On the next slide, we will see how this impacts the temperature and dewpoint forecasts at the 18Z cycle.

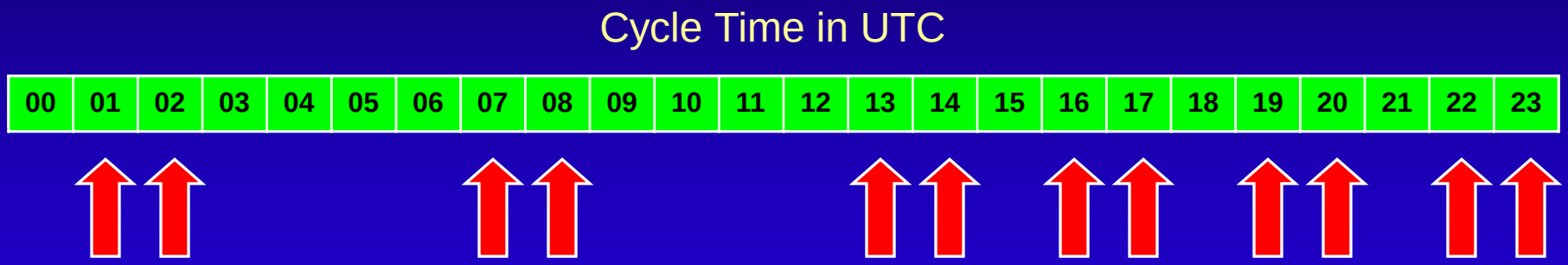
The Influence of the Observation (Degradation) - Continued



With bad observations still being reported at 18Z, we see a negative influence on the temperature and dewpoint forecasts. The influence of this observation causes the LAMP forecasts to be unreasonably lower than MOS at many of the forecast projections.

Current Status and Future Plans

Hourly Implementation

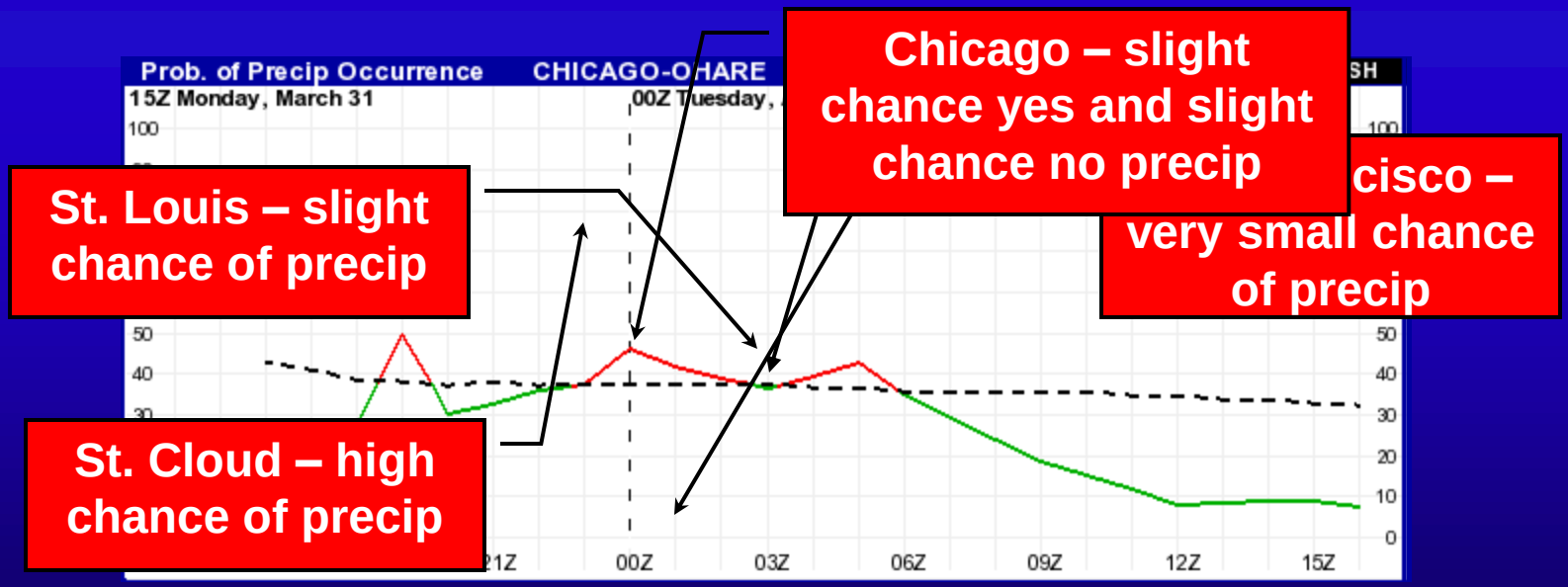


- Operational Implementation:
  - 04/03/2008: 12 cycles running operationally at NCEP
  - 04/08/2008: four additional cycles running
  - 06/24/2008: four additional cycles running
  - Final four cycles running in early 2009
  - LAMP runs every hour!

Depicting Probabilistic Information

Purpose: indicate to user the uncertainty associated with the Best Category forecasts given the probabilistic information

Threshold = dashed black line
Probability < thres = green line
Probability ≥ thres = red line

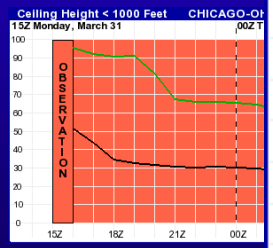


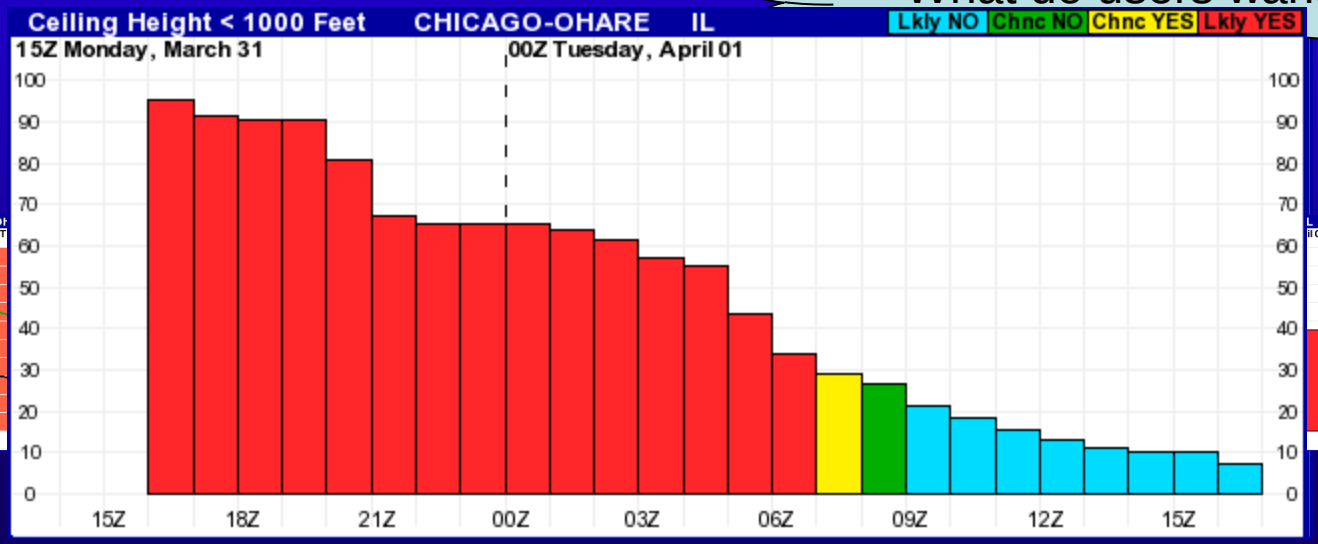
Depicting Probabilistic Information

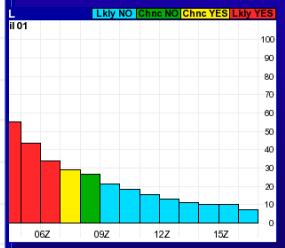
Options:

1) Don't show probabilistic information
2) Show probability and related threshold by element, by category (one category at a time) (similar to WFO RLX)
3) Show probability and related thresholds by element, multiple categories (selected by user) at one time
4) Show probability and likelihood (relationship between probability and threshold, indicating relationship between threshold and probability)

What do users want?

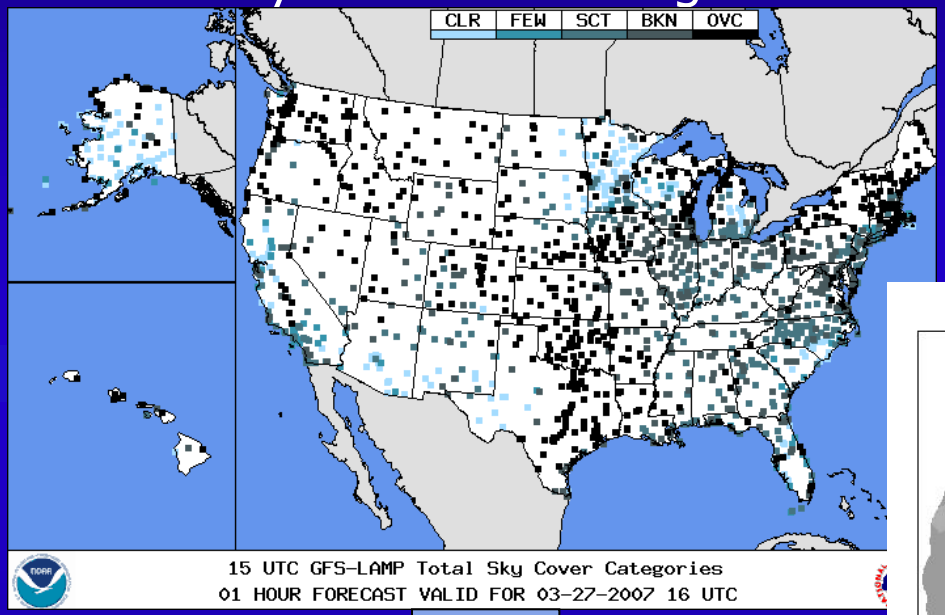




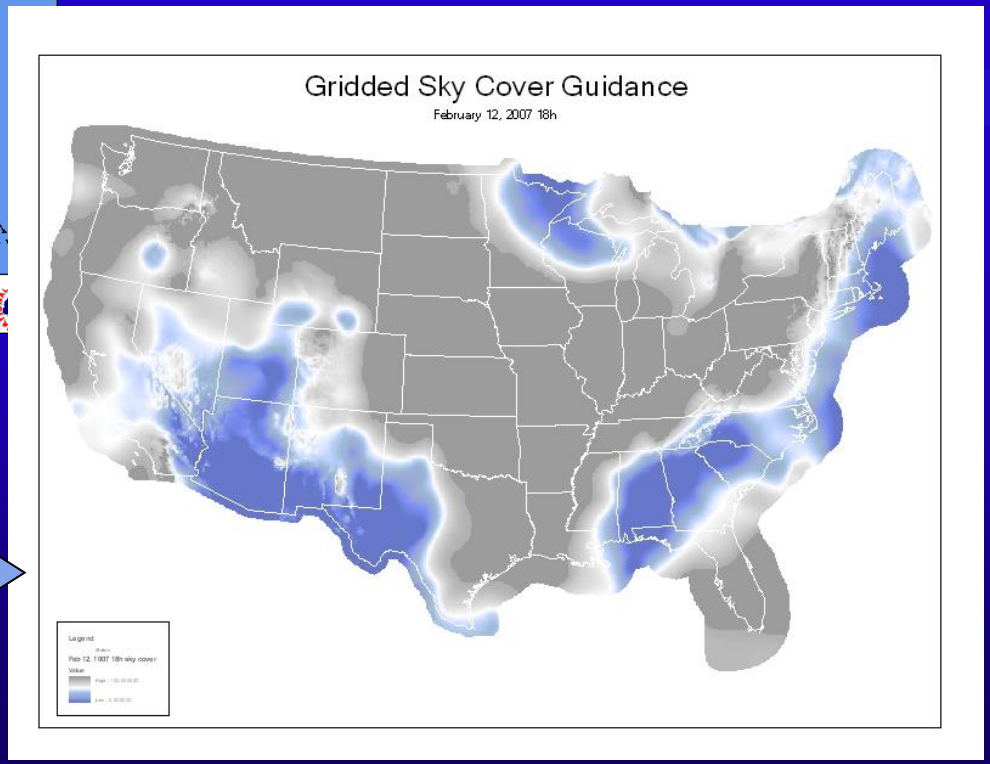


What's next?
Gridded LAMP

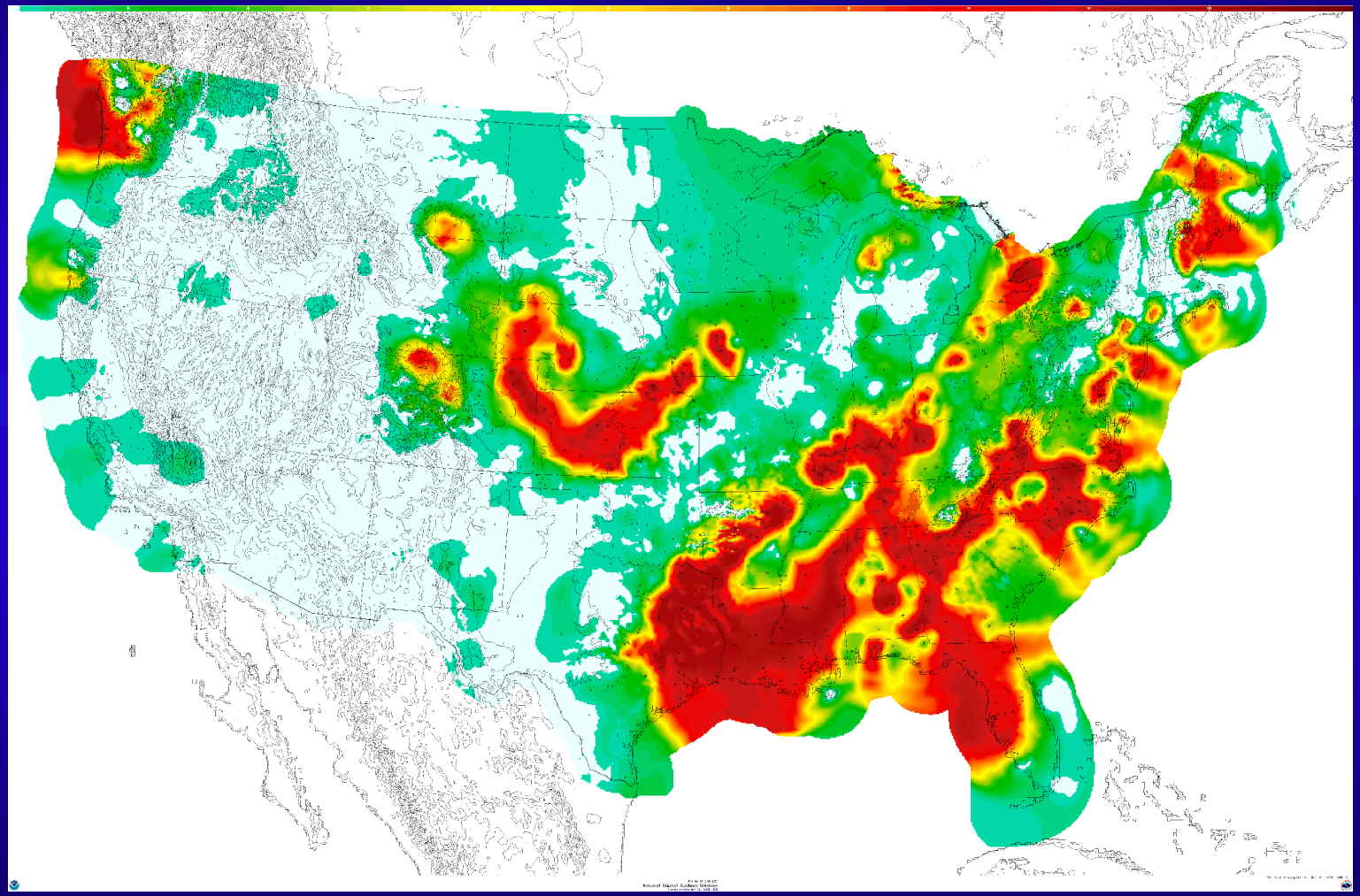
Total sky cover - Station guidance



Total sky cover - Gridded guidance

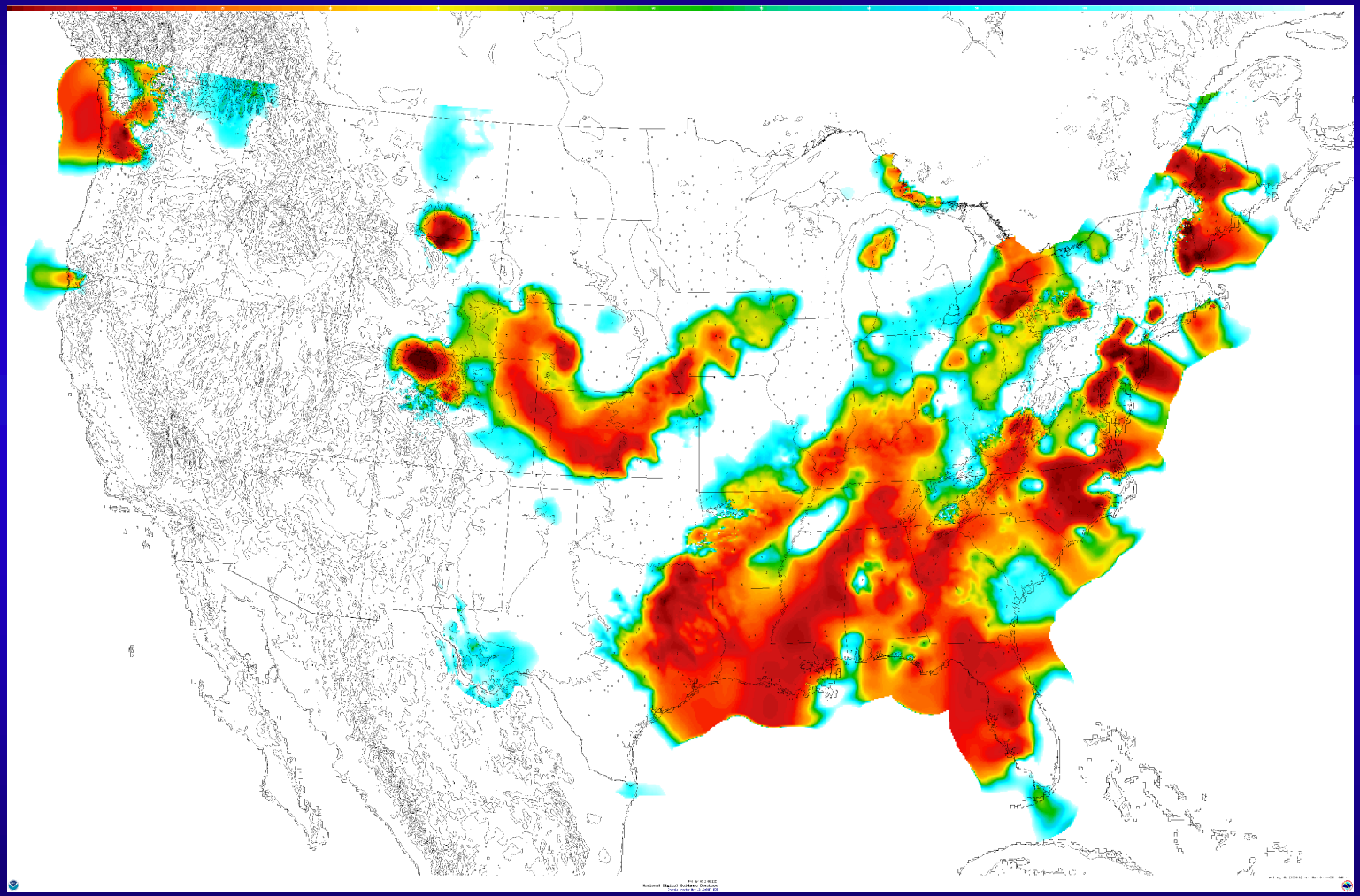


LAMP Aviation Grids



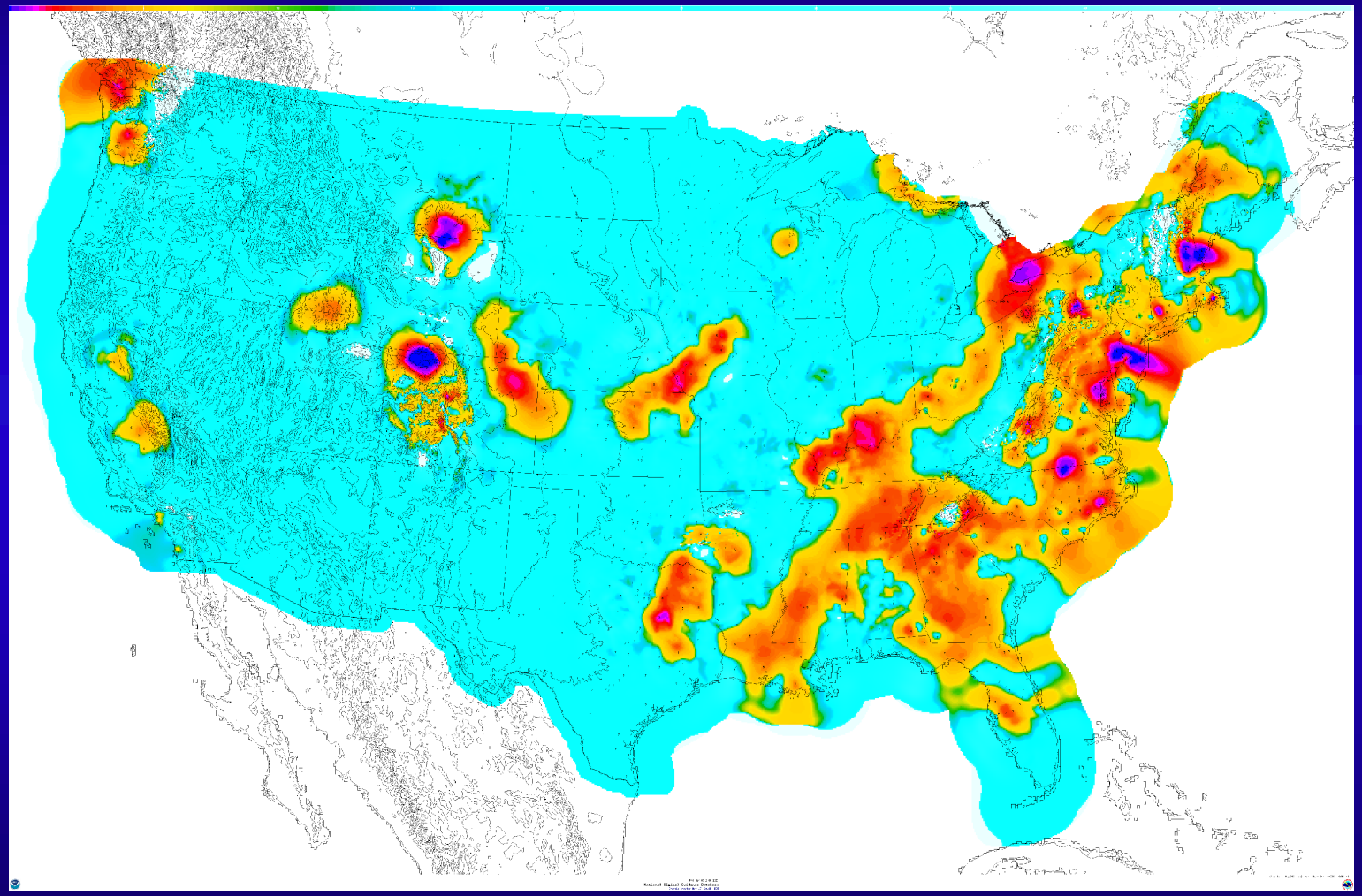
LAMP Probability of ceiling height ≤ 3000 feet

LAMP Aviation Grids



LAMP Best Category of Ceiling Height

LAMP Aviation Grids



LAMP Best Category of Visibility

LAMP Training

- Two LAMP training modules developed by MDL
  - An Introduction to The Localized Aviation MOS Program (LAMP)
  - Accessing and Using GFS LAMP Products
- Delivered to Aviation Services Branch in March 2008

Questions?

- GFS LAMP Website:
  - http://www.nws.noaa.gov/mdl/gfslamp/gfslamp.shtml
- Contact:
  - Judy.Ghirardelli@noaa.gov