NATIONAL WEATHER SERVICE

The Development of Thresholding and Artificial Intelligence Techniques to Improve LAMP Visibility Guidance

JANUARY 26, 2022

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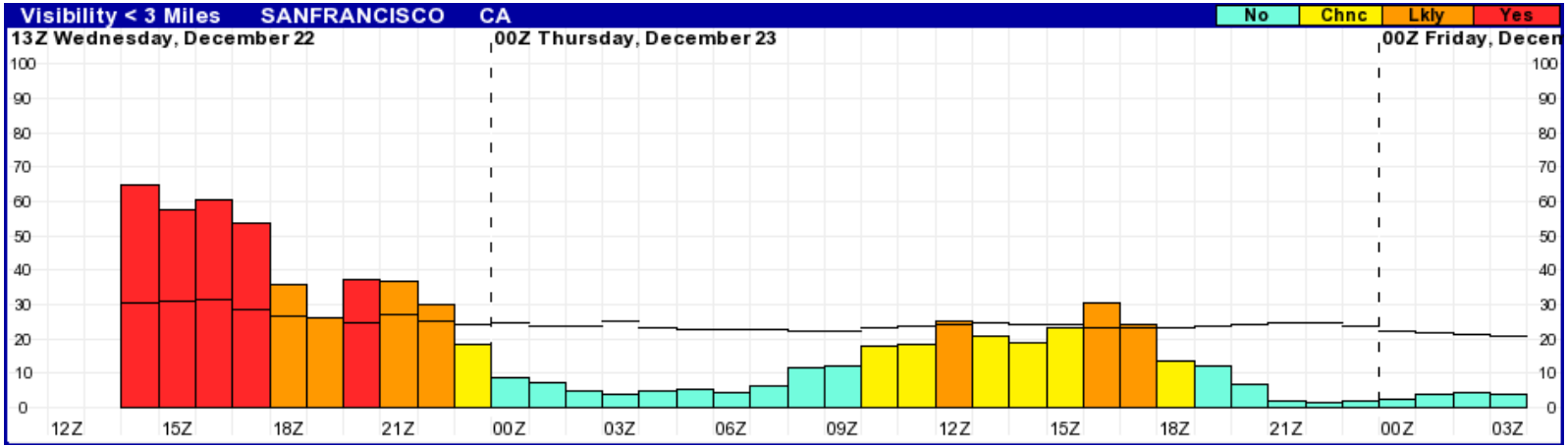
What is LAMP?

- LAMP = Localized Aviation MOS (Model Output Statistics) Program
- Provides guidance for aviation forecasting using observations, MOS output, and model output through multiple linear regression techniques
  - Base LAMP and Meld LAMP
- Produced for individual stations and on a grid
- Hourly guidance for 25 hours
  - Extended guidance to 38 hours for some elements including ceiling height and visibility

BASE LAMP =	Observations + Simple locally-run models + GFS MOS
MELD LAMP =	BASE LAMP + HRRR MOS

Thresholding Methods

- Meld LAMP thresholds are calculated such that using them maximizes the threat score of the forecast within a defined bias range
  - Same thresholds are used for all stations in the CONUS
- Probabilities are created for each forecast and category
- Event is forecast for the rarest category that the threshold is met



Calculating Biases and Threat Scores

		Events Observed	
		Yes	No
Events Forecast	Yes	a	b
	No	c	d

$$\text{Bias} = \frac{(a+b)}{(a+c)}$$

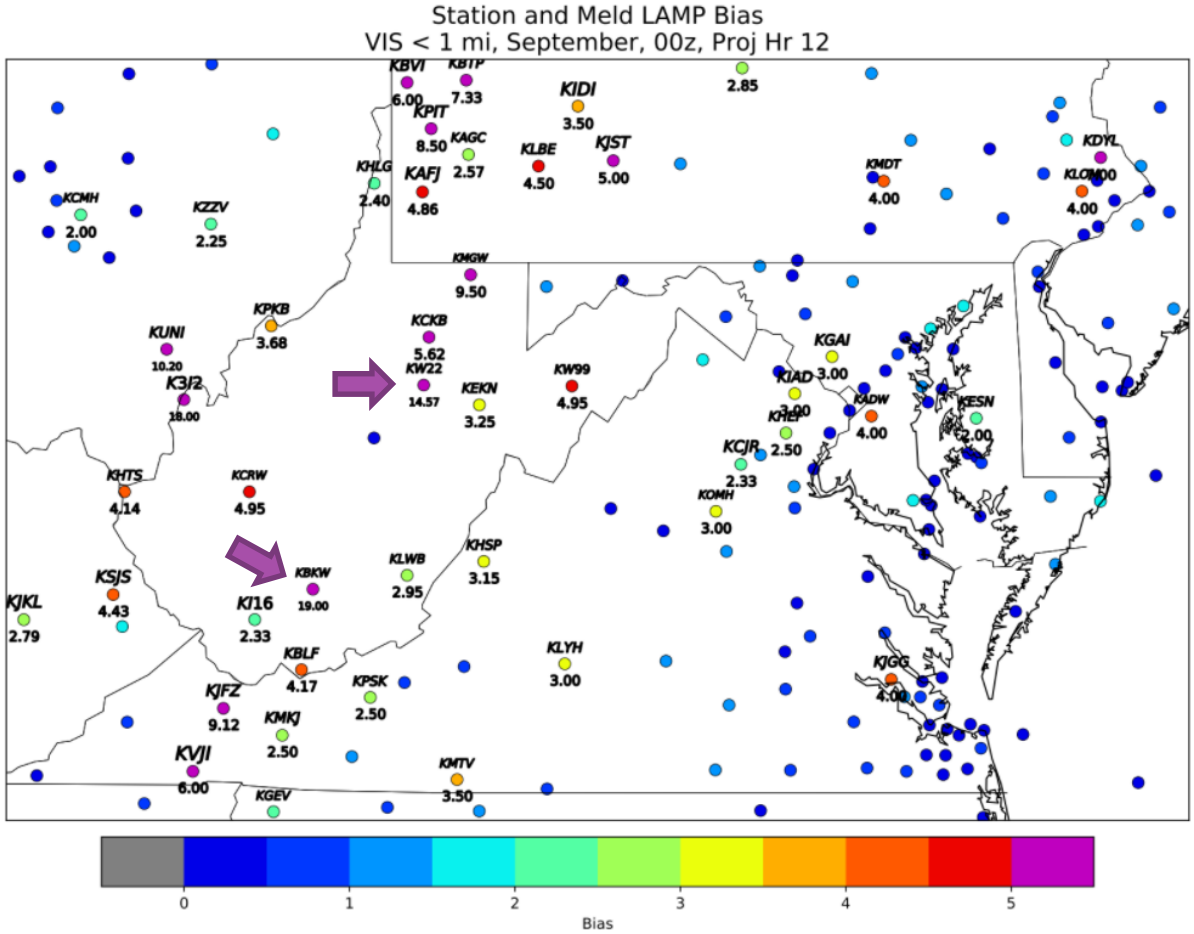
- Ranges 0 to infinity
- Perfect score = 1
- Bias < 1 is under forecasting
- Bias > 1 is over forecasting

$$\text{TS} = \text{CSI} = \frac{a}{(a+b+c)}$$

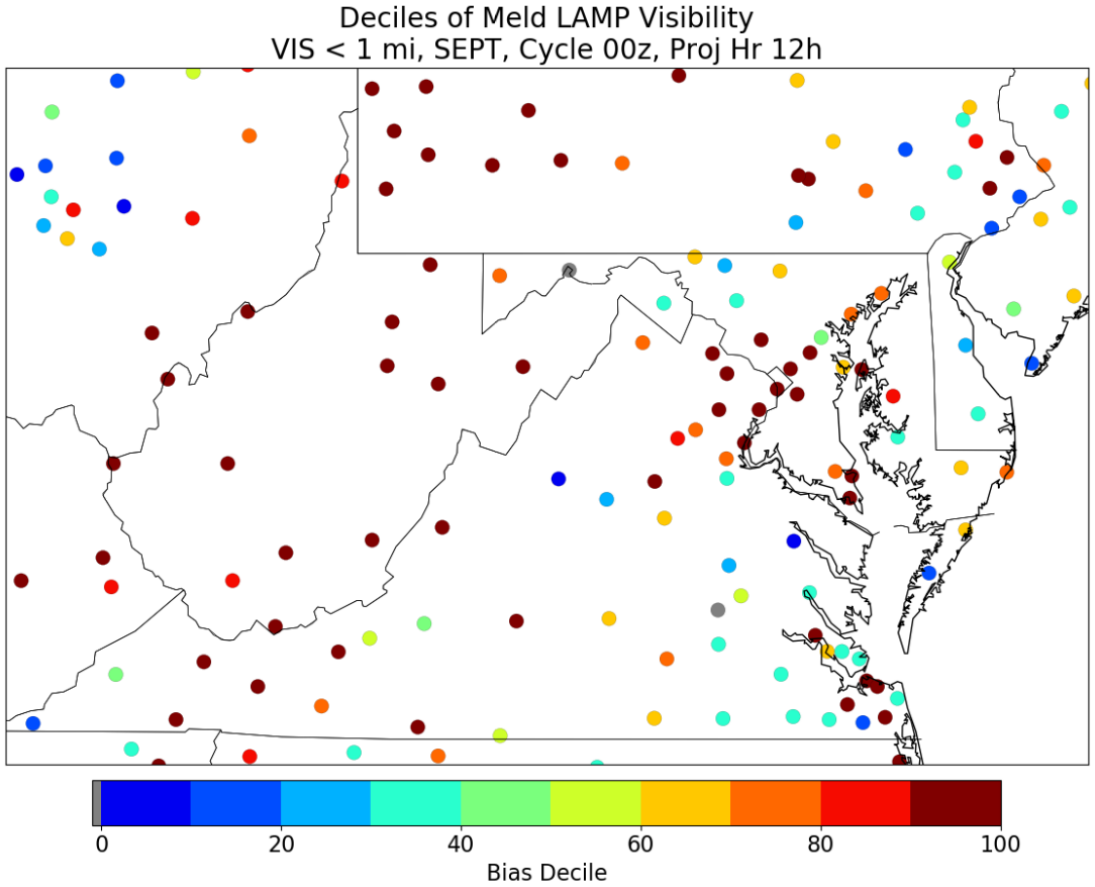
- Ranges 0 to 1
- Perfect score = 1

High LAMP Visibility Biases in West Virginia

- Charleston, WV WFO noticed LAMP forecasts in fall kept fog in too long
- High LAMP visibility biases in morning around 0900 and 1200 UTC in September



- **New Method 1:** Create thresholds in groups based on deciles of Meld LAMP biases
  - No spatial restrictions
- **New Method 2:** Create thresholds for individual stations
  - Must define the number of events required to make a threshold
- Completed for 0000z cycle in September, Fall (SON), and extended cool season (Sept 16 – Apr 15) from Jan 2017 to Dec 2020

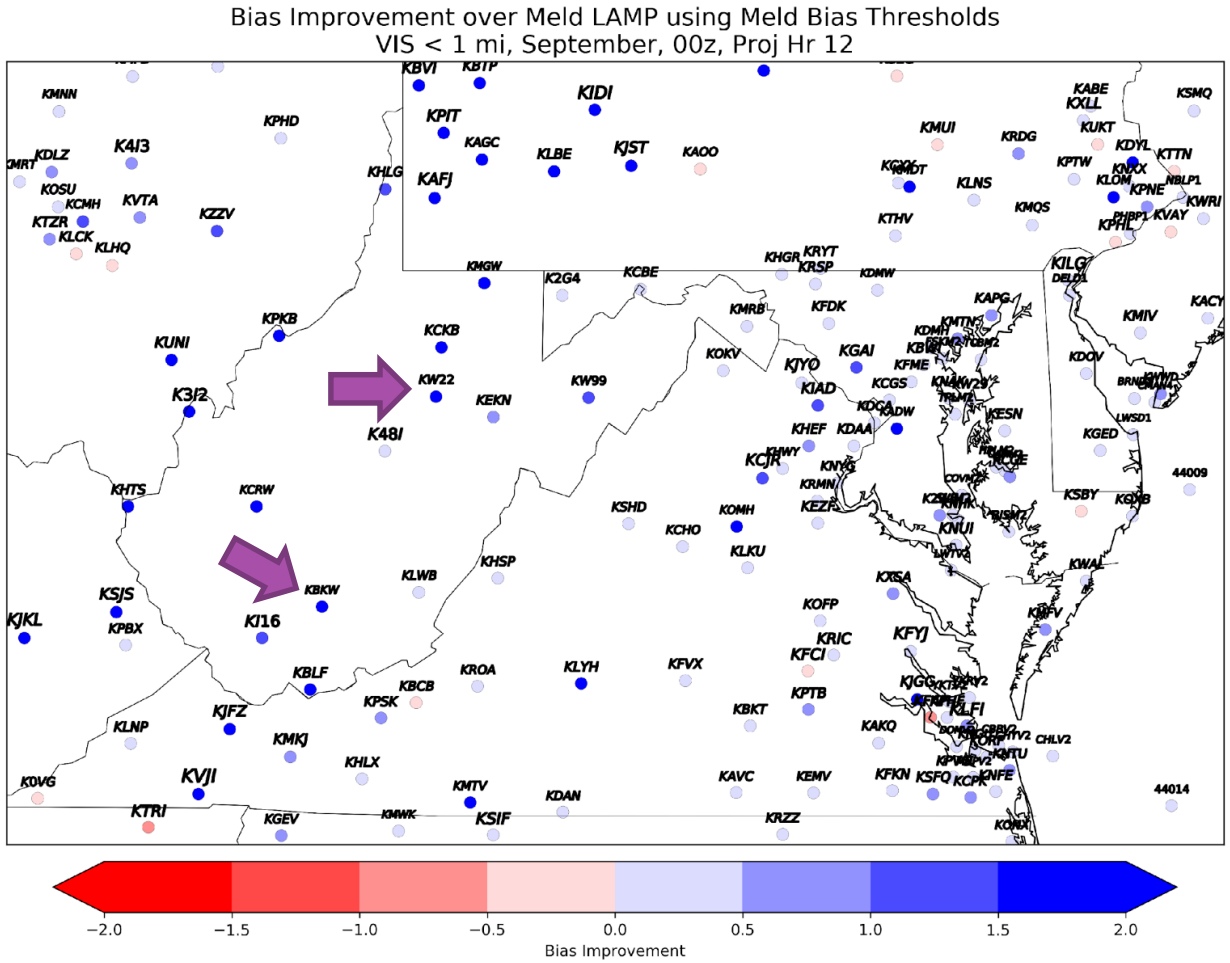


New Method 1: Thresholds based on Meld LAMP Biases

Vis < 1 mi

September

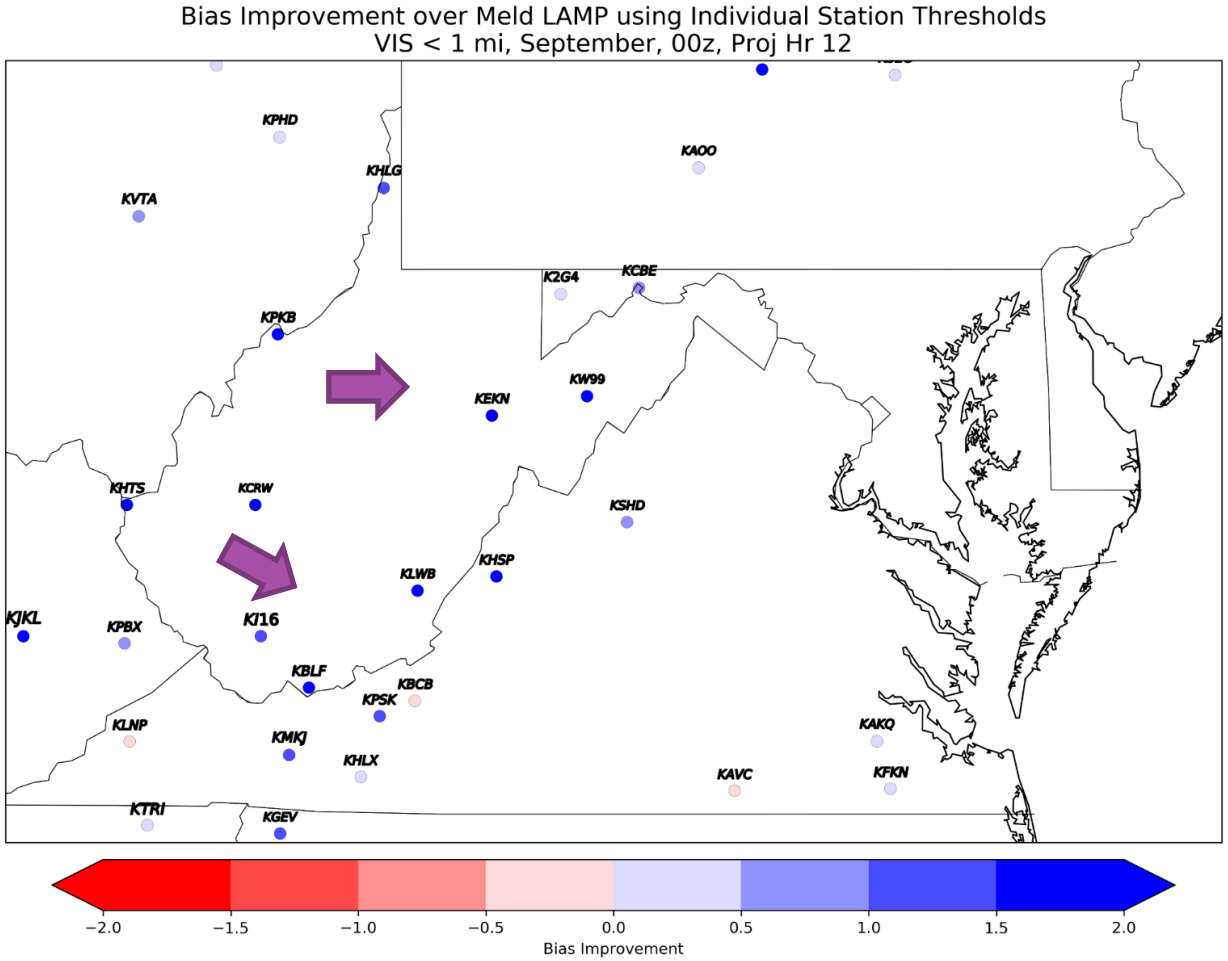
KW22: 14.57 → 10.43
KBKW: 19 → 6



New Method 2: Thresholds based on Individual Stations

Vis < 1 mi

September

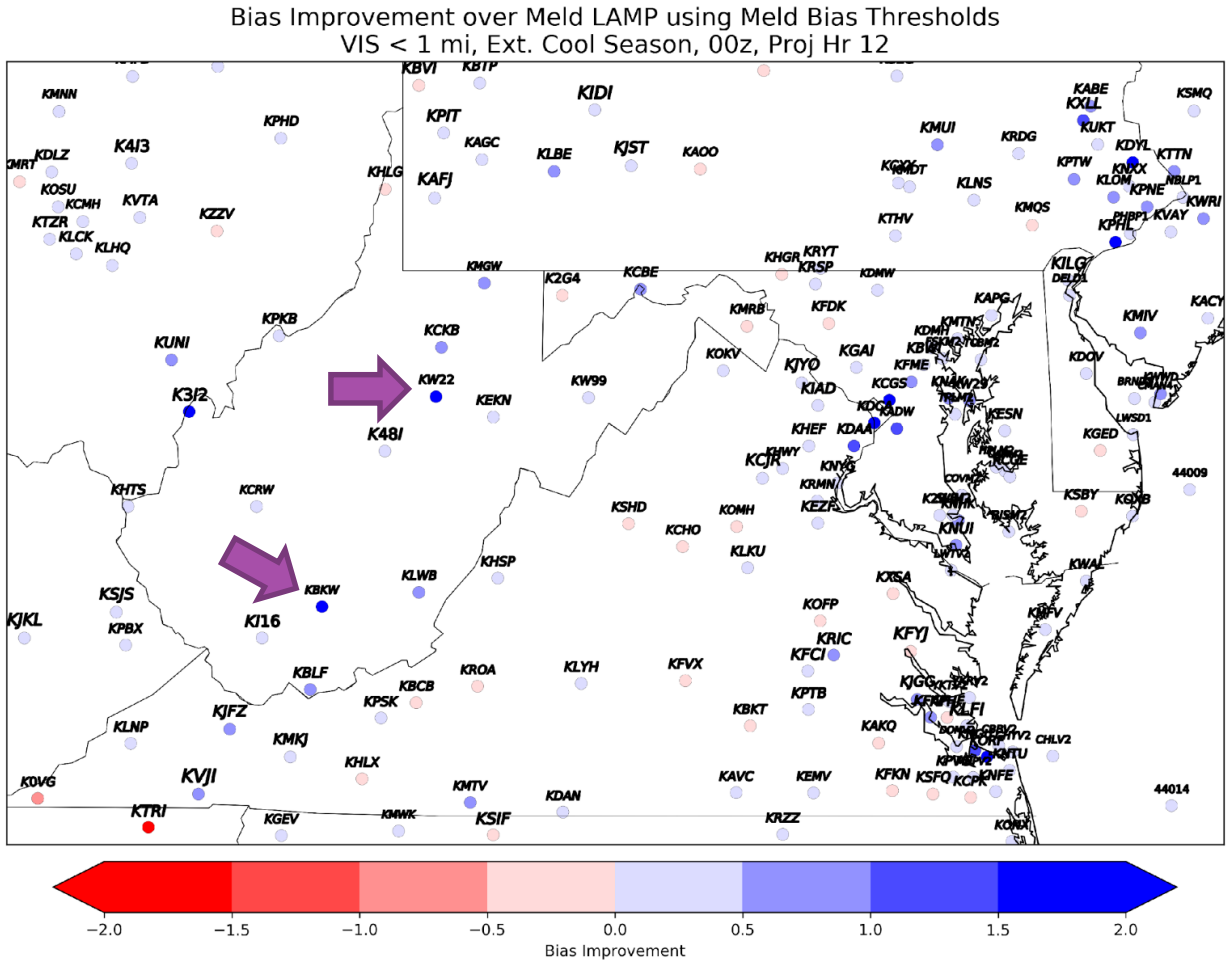


New Method 1: Thresholds based on Meld LAMP Biases

Vis < 1 mi

Ext. Cool Season

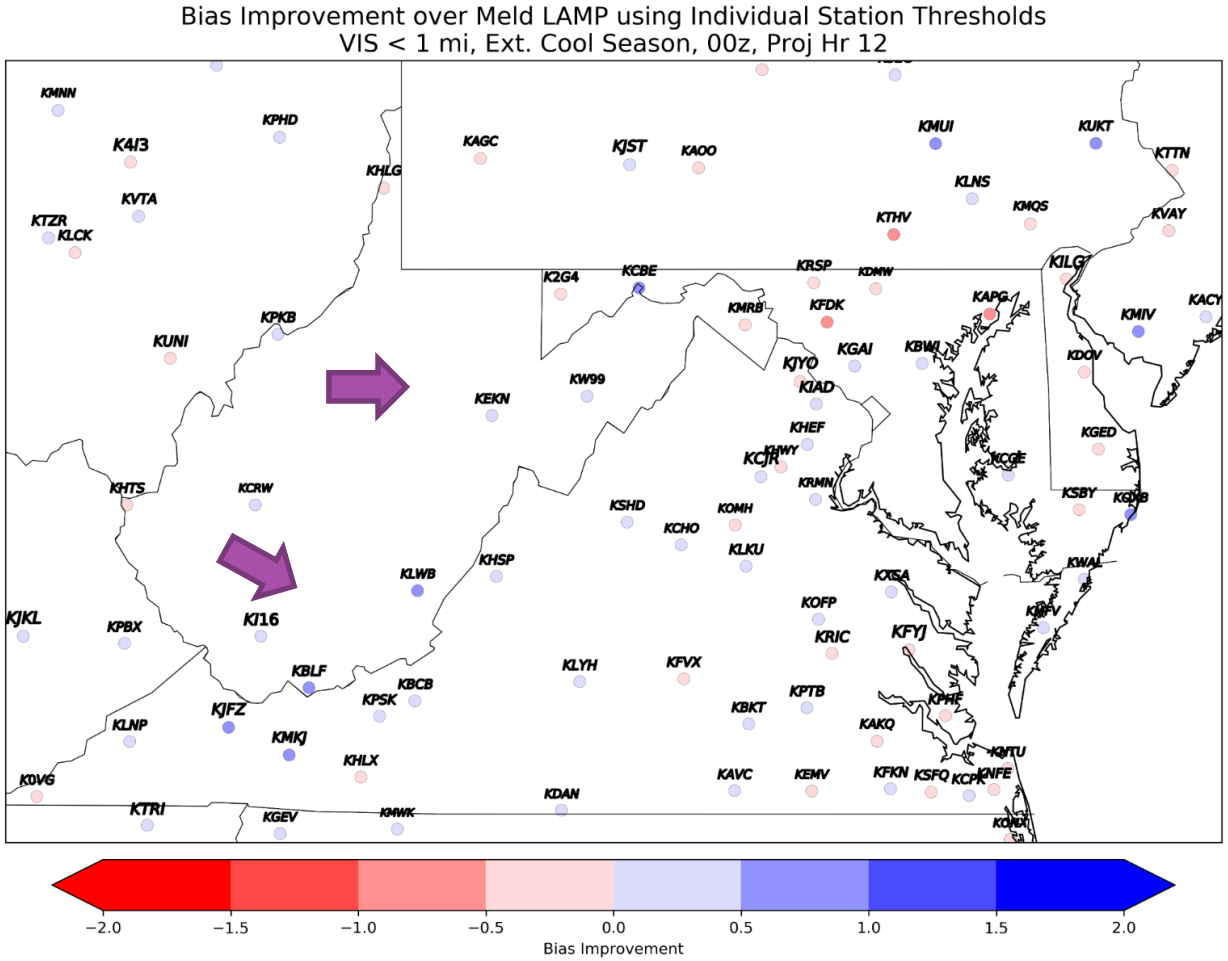
KW22: 4.43 → 2.7
KBKW: 4.47 → 1.68



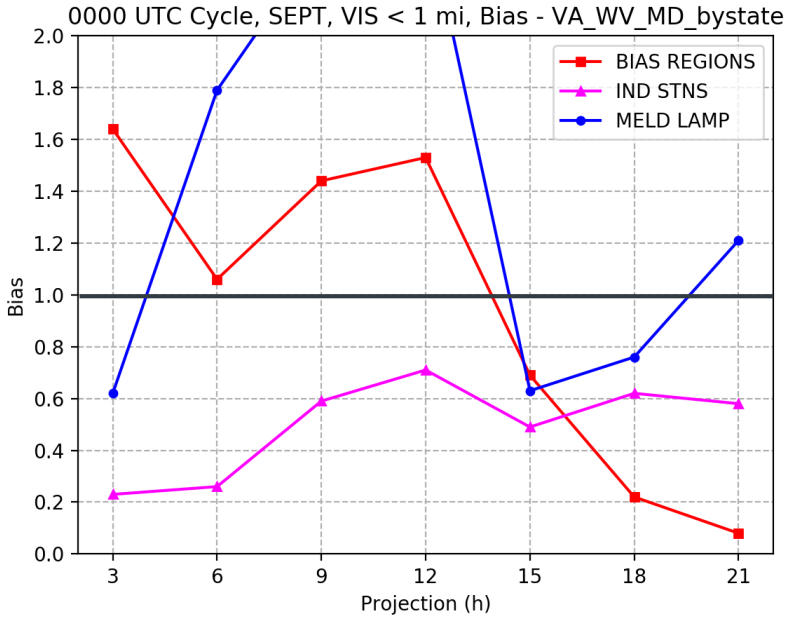
New Method 2: Thresholds based on Individual Stations

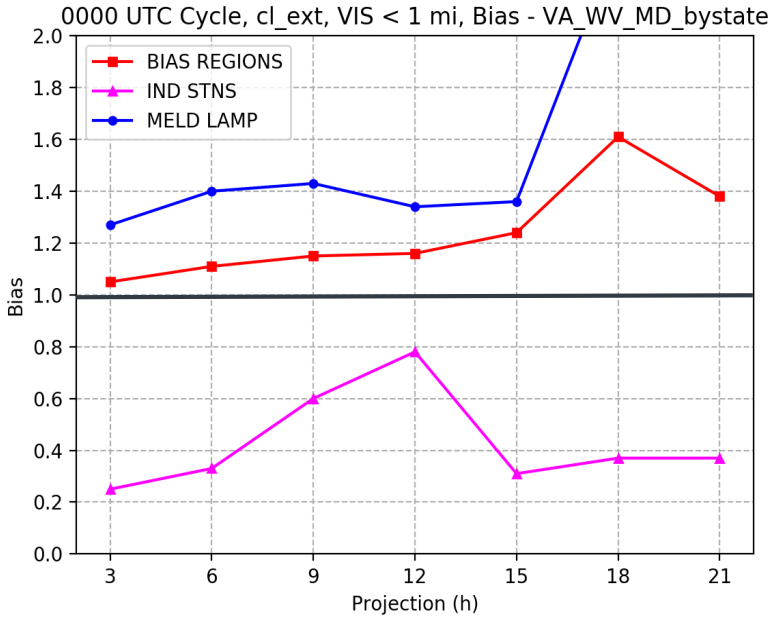
Vis < 1 mi

Ext. Cool Season



Results of New Thresholding Methods – VA, WV, MD





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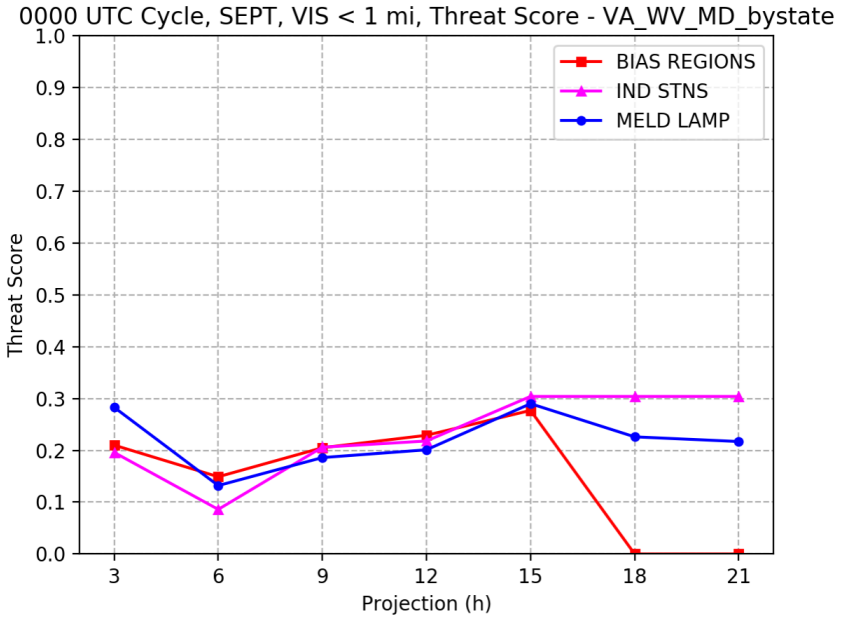

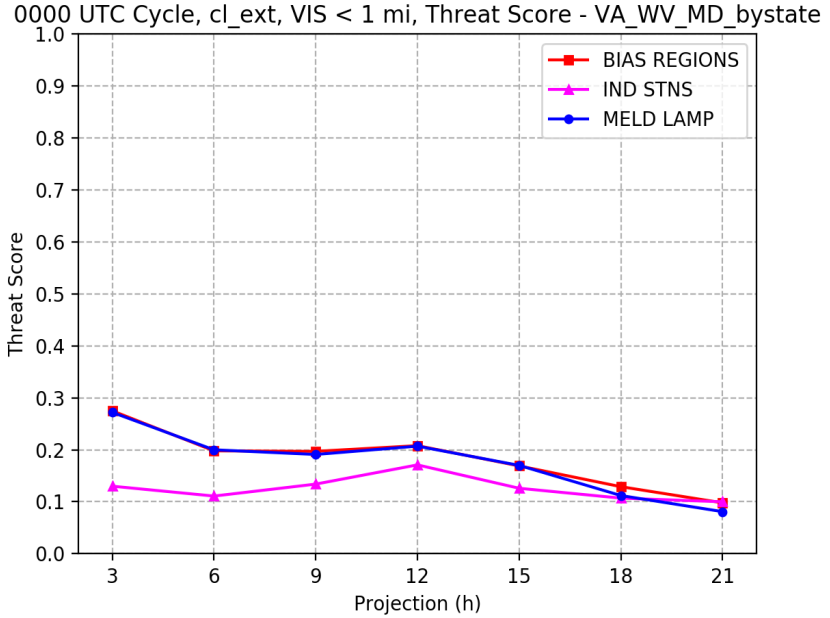

Utilization of AI Methods to Improve VIS Biases

- Compared logistic regression, random forest, and artificial neural network
- Input: the probability of each VIS category, the discrete category at each LAMP station
- Hourly data at 0000z in the extended cool season (Sept 16 – Apr 15) from 2017-2020
  - 2/3 used for training, 1/6 used for validation, 1/6 used for testing
- Tested and compared methods for only 9-h projection in the extended cool season

LAV Visibility (VIS) and Conditional Visibility (CVIS) Categories	
1	< 1/2 miles
2	1/2 - < 1 miles
3	1 - < 2 miles
4	2 - < 3 miles
5	3 - 5 miles
6	6 miles
7	> 6 miles

Preliminary Results of AI Work

- AI methods may be promising to improve forecasts of very low VIS (< ½ mi) and high VIS (> 6 mi)
- Additional work needed to analyze AI output in the middle VIS categories

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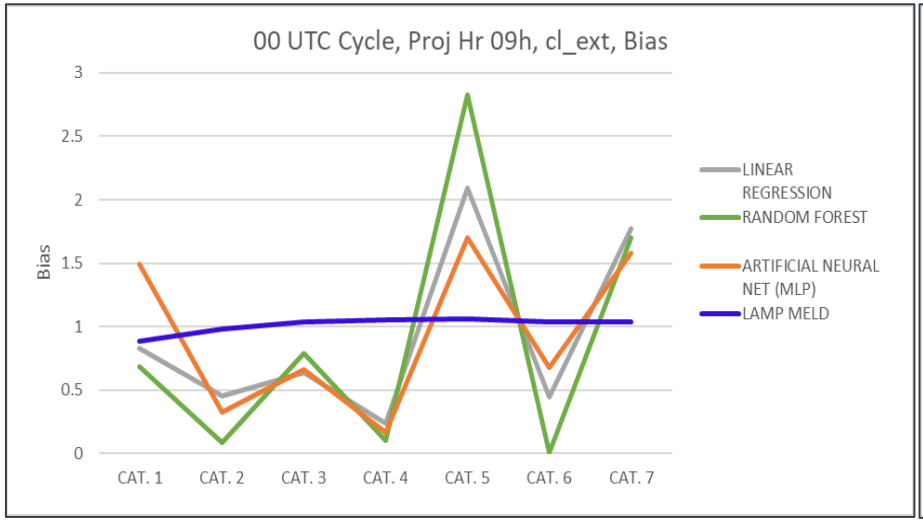

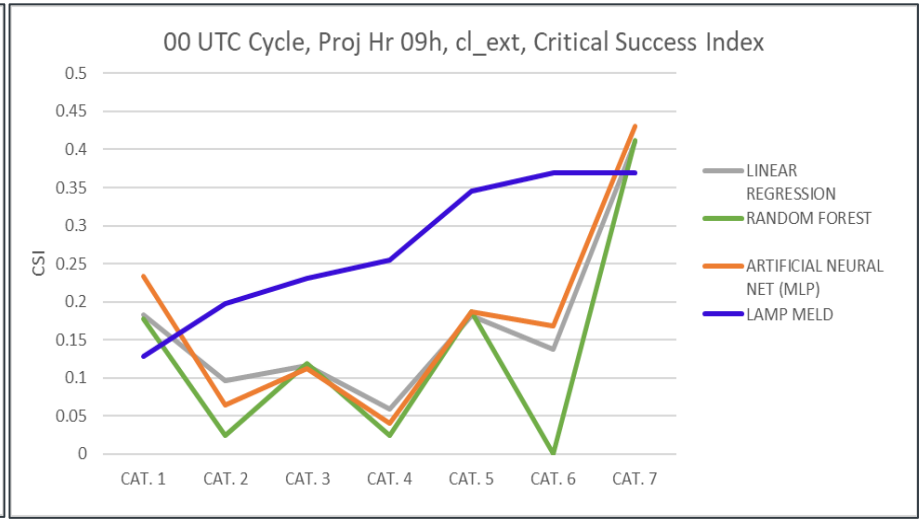

Conclusions & Future Work

Thresholding Method Work

- Creating thresholds using Meld LAMP biases improved biases in the Mid-Atlantic
  - Could be applied to operational forecasts in the future, additional testing needed
- Future work
  - Examine results in other locations
  - Consider spatial bounds for bias regions
  - Multiple iterations

AI Work

- The use of AI techniques is promising to improve visibility biases
- Future work
  - Apply methodology to other cycles and projection hours
  - Incorporate other variables (e.g. Relative frequency of event, Relation to a river or water body)

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Current LAMP Webpage:
https://www.weather.gov/mdl/lamp_home

Transitioning to:
https://vlab.noaa.gov/web/mdl/lamp