# P8.123 Usefulness of Storm-Scale Model Guidance for Forecasting Dry Thunderstorms at SPC

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## What?

- Dry thunderstorms are defined as a storm with one or more cloud-to-ground (CG) lightning flashes with minimal precipitation (usually less than or equal to 0.1 inches)

## Goal:

- Examine the value of using storm-scale model guidance from the NSSL version of the WRF-ARW (Kain et al. 2010) to accurately identify dry thunderstorms from 06-2011 – 08-2011. Given favorable results, a calibrated, first-guess forecast could then be formulated that would ultimately improve Storm Prediction Center (SPC) products on the fire weather desk

## Why?

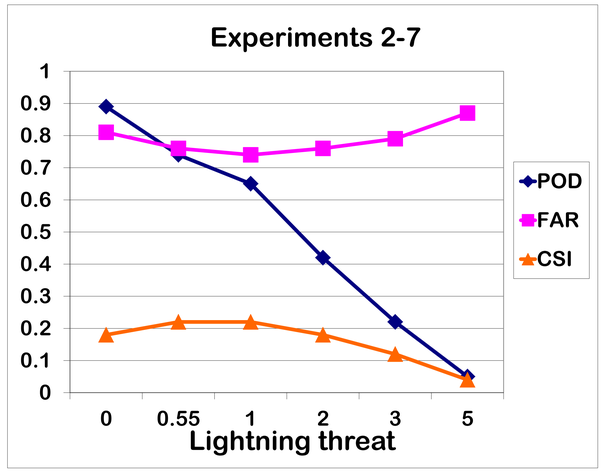
- In 2011, over 10,000 wildfires were started by lightning [source: National Interagency Fire Center]
- The SPC creates daily dry thunderstorm outlooks out to three days highlighting critical areas at risk for fire weather
- Dry thunderstorms remain a difficult phenomena to forecast

## How?

- Create daily (12Z-12Z) binary forecast grids based off of thresholds of 24-hr PF, 24-hr average PWAT, and 24-hr maximum Lightning Threat (McCaul et al. 2009, predicts flash rate density (FRD) in flashes (5 min)$^{-1}$ km$^{-2}$)
- Compare forecast grids to corresponding verification grids created from the SPC Mesoscale Analysis (PWAT), the NMQ (Zhang et al. 2011; QPF) , and the NLDN (lightning)
- Determine the skill of the forecast through traditional verification statistics (see contingency table)
- Vary the thresholds to see what creates the best statistical forecast
- Also, utilize a neighborhood approach with a varying radius of influence (ROI) to create grids
- This neighborhood approach identifies the maximum value of a grid within a given ROI, and then assigns that value to each grid point in the ROI (Harless 2010)

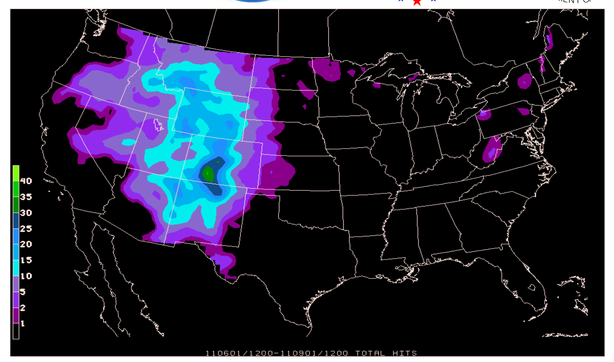
| Experiment Number | Creation Approach | Lightning Threat ≥ | QPF ≤ | Average PWAT ≤ | Hits | False Alarms | Misses | POD | FAR | CSI | BIAS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | grid point | 0.55 | 0.1" | 1.0" | 5755 | 11744 | 15155 | 0.28 | 0.67 | 0.18 | 0.84 |
| 2 | neighborhood on LTG, ROI = 40 | 0 | 0.1" | 1.0" | 18657 | 81389 | 2253 | 0.89 | 0.81 | 0.18 | 4.78 |
| 3 | neighborhood on LTG, ROI = 40 | 0.55 | 0.1" | 1.0" | 15406 | 47629 | 5504 | 0.74 | 0.76 | 0.22 | 3.01 |
| 4 | neighborhood on LTG, ROI = 40 | 1 | 0.1" | 1.0" | 13581 | 39878 | 7329 | 0.65 | 0.74 | 0.22 | 2.56 |
| 5 | neighborhood on LTG, ROI = 40 | 2 | 0.1" | 1.0" | 8694 | 27396 | 12216 | 0.42 | 0.76 | 0.18 | 1.73 |
| 6 | neighborhood on LTG, ROI = 40 | 3 | 0.1" | 1.0" | 4677 | 17883 | 16233 | 0.22 | 0.79 | 0.12 | 1.07 |
| 7 | neighborhood on LTG, ROI = 40 | 5 | 0.1" | 1.0" | 992 | 6542 | 19918 | 0.05 | 0.87 | 0.04 | 0.36 |
| 8 | neighborhood on WRF event | 0.55 | 0.1" | 1.0" | 522 | 7694 | 654 | 0.44 | 0.93 | 0.06 | 6.99 |
| 9 | neighborhood on LTG, ROI = 20 | 0.55 | 0.1" | 1.0" | 12958 | 34927 | 7952 | 0.62 | 0.73 | 0.23 | 2.29 |
| 10 | neighborhood on LTG, ROI = 10 | 0.55 | 0.1" | 1.0" | 10807 | 26520 | 10103 | 0.52 | 0.71 | 0.23 | 1.79 |

| Contingency Table | | |
|---|---|---|
| | *Observed* Yes | *Observed* No |
| *Forecasted* Yes | Hit (a) | False Alarm (b) |
| *Forecasted* No | Miss (c) | Correct Negative (d) |
| POD = a / (a + c), FAR = b / (a + b) | | |
| CSI = a / (a + b + c), BIAS = (a + b) / (a + c) | | |

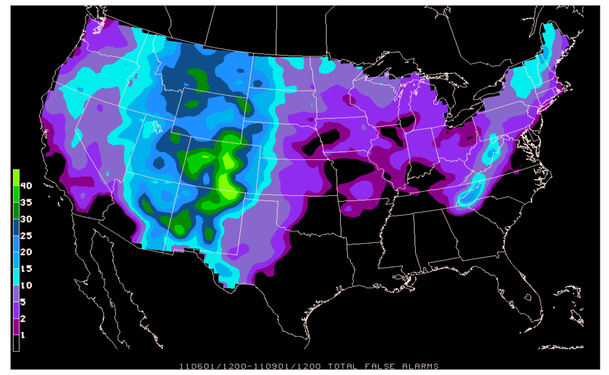



## Results

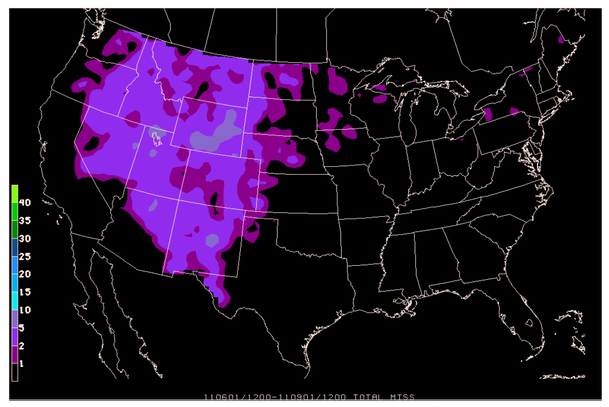
- All experiments show an unfavorably high FAR and low CSI
- The neighborhood approach captures far more events than the grid point approach
- Unrestrictive thresholds are required to capture a majority of the dry thunderstorm events
- Experiment 3 (lightning threat ≥ 0.55 FRD, PWAT ≤ 1.0" and QPF ≤ 0.1") produced the best guidance for the time period
- The most favorable statistical outcome is to attempt to have a high POD, and live with the high FAR




Total hits at each grid point from exp. 3




Total false alarms at each grid point from exp. 3




Total misses at each grid point from exp. 3

## Summary & Conclusions

- The NSSL version of the WRF-ARW was used to create gridded, deterministic forecasts of dry thunderstorms
- Using various thresholds of PWAT, QPF, and lightning threat, we determined that grid points with lightning threat ≥ 0.55 FRD, PWAT ≤ 1.0" and QPF ≤ 0.1" produced a forecast capable of capturing most of the dry thunderstorm events during our period of study
- With these encouraging results, we feel further research is warranted
- Given the small sample size of this study, additional study is needed to fully understand the capabilities of this forecasting technique
- We believe that this technique will provide a valuable first-guess forecast and will ultimately improve SPC products on the fire weather desk

**References:** Harless, A.R., 2010: A report-based verification study of the CAPS 2008 storm-scale ensemble forecasts for severe convective weather. M.S. Thesis, School of Meteorology, University of Oklahoma, 143 pp.
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