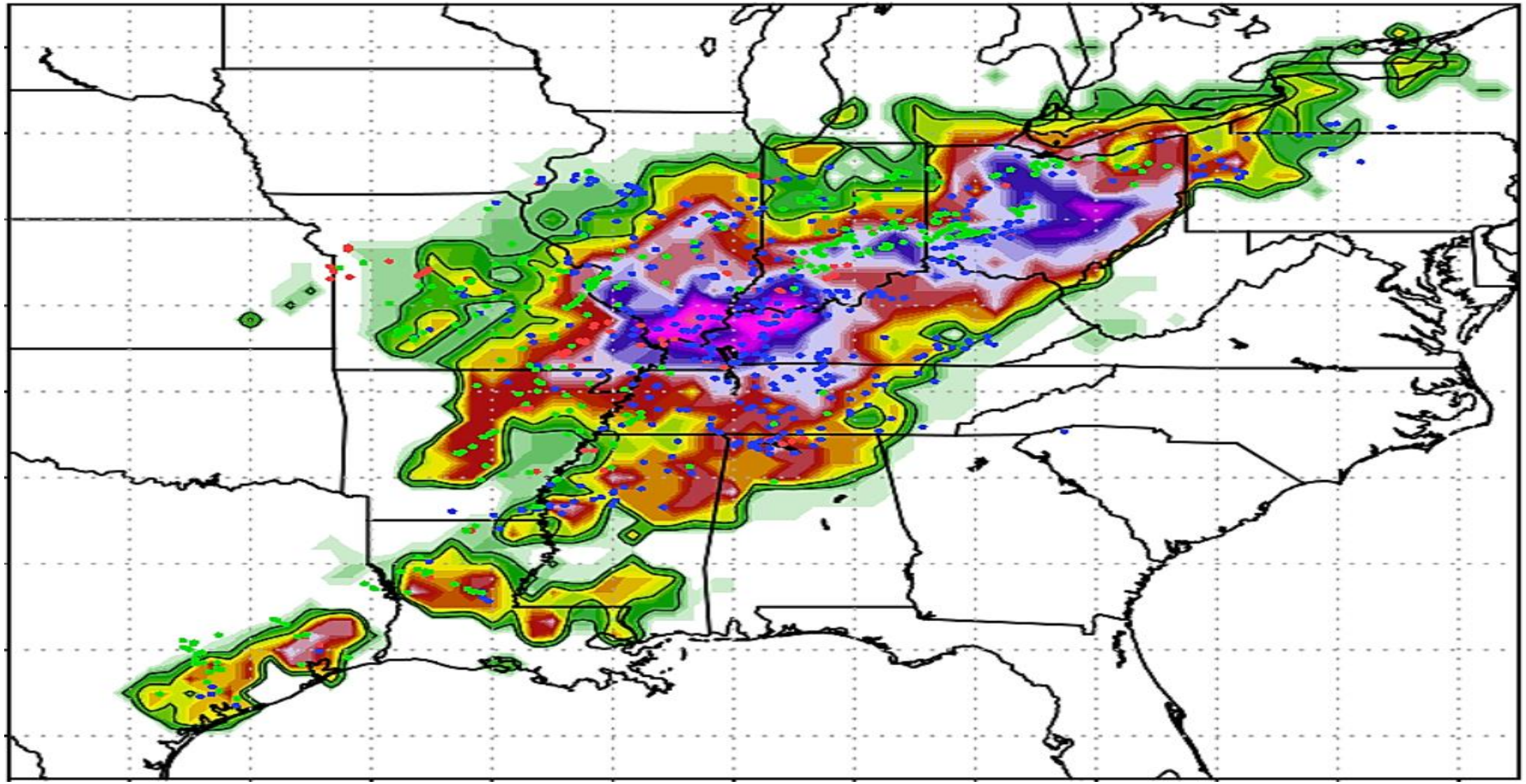
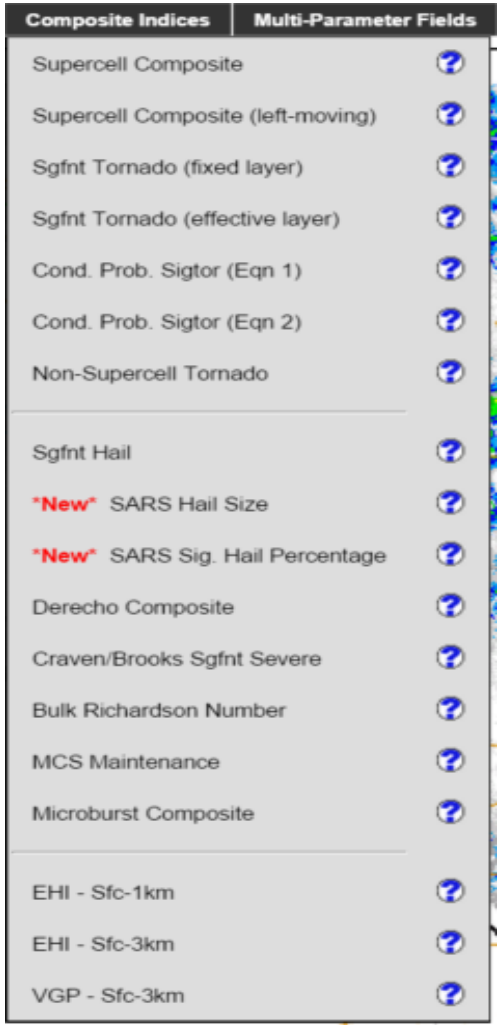
A New Way to Visualize Severe Weather Potential

Don Van Dyke



Motivation

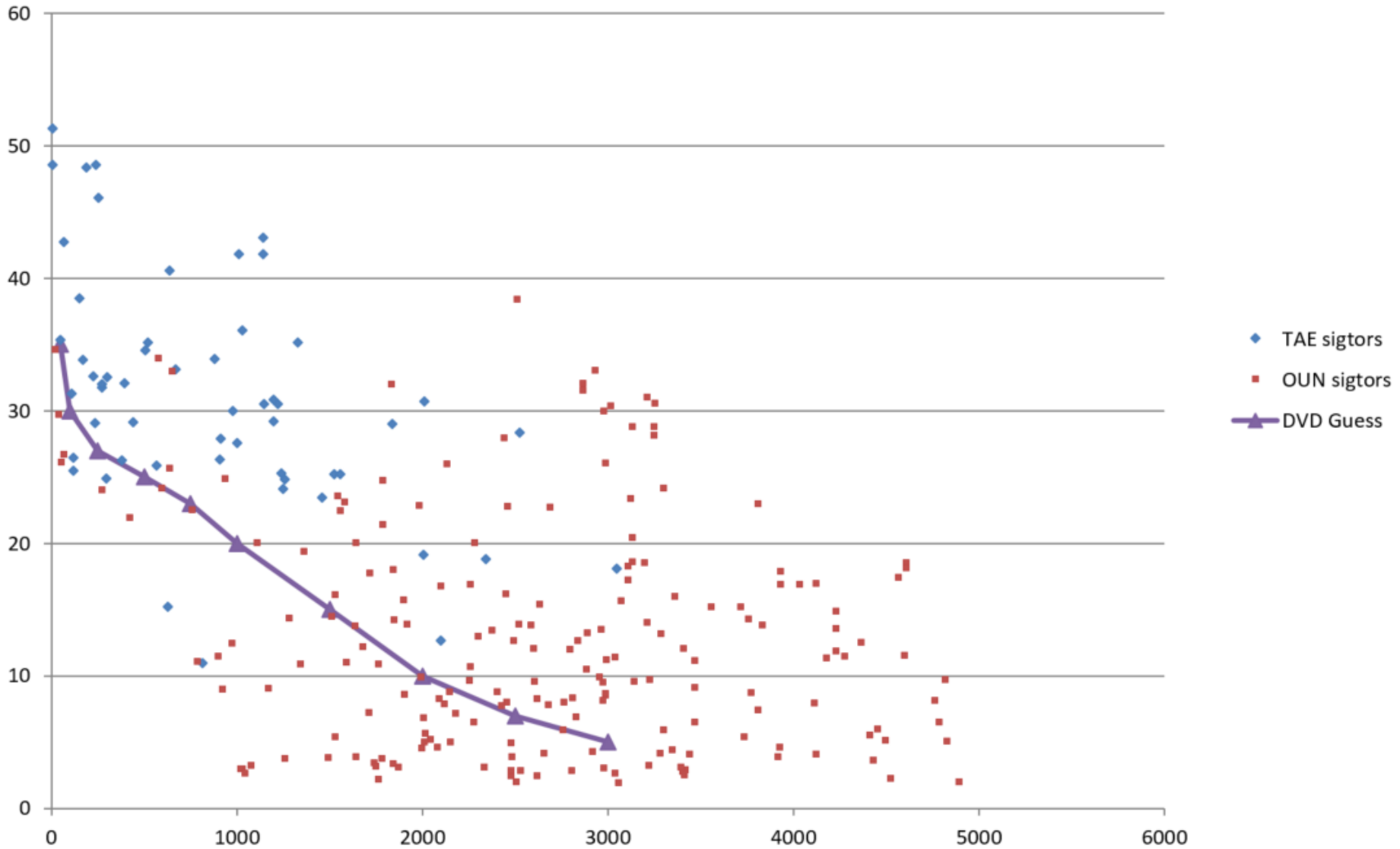
- Create a tool that operational forecasters can use as an initial screen for all types of severe weather to quickly determine which areas may need particular attention.
  - Not meant to be used in a vacuum but rather as a clue to guide forecasters in their analysis.
  - A forecaster's time is limited in an operational setting and this can help highlight more significant areas very quickly by looking at one map.
- There are many different indices for many different things available on the SPC mesoanalysis page, but very few of them attempt to capture the tornado, hail, and wind threat simultaneously on a single map.



Methodology and Climatology

- Downloaded all EF2+ tornadoes from the WFO Tallahassee and Norman forecast areas from 1979-2011.
  - These WFOs were chosen to best capture the spectrum of low CAPE/high shear events (Tallahassee) and high CAPE/low shear events (Norman).
  - Used the North American Regional Reanalysis (NARR) 32 km, 3 hourly dataset to analyze several atmospheric parameters associated with these tornadoes.
  - Created scatter plots to visualize the results and used this information as the initial basis for creating some of the thresholds used in the index.

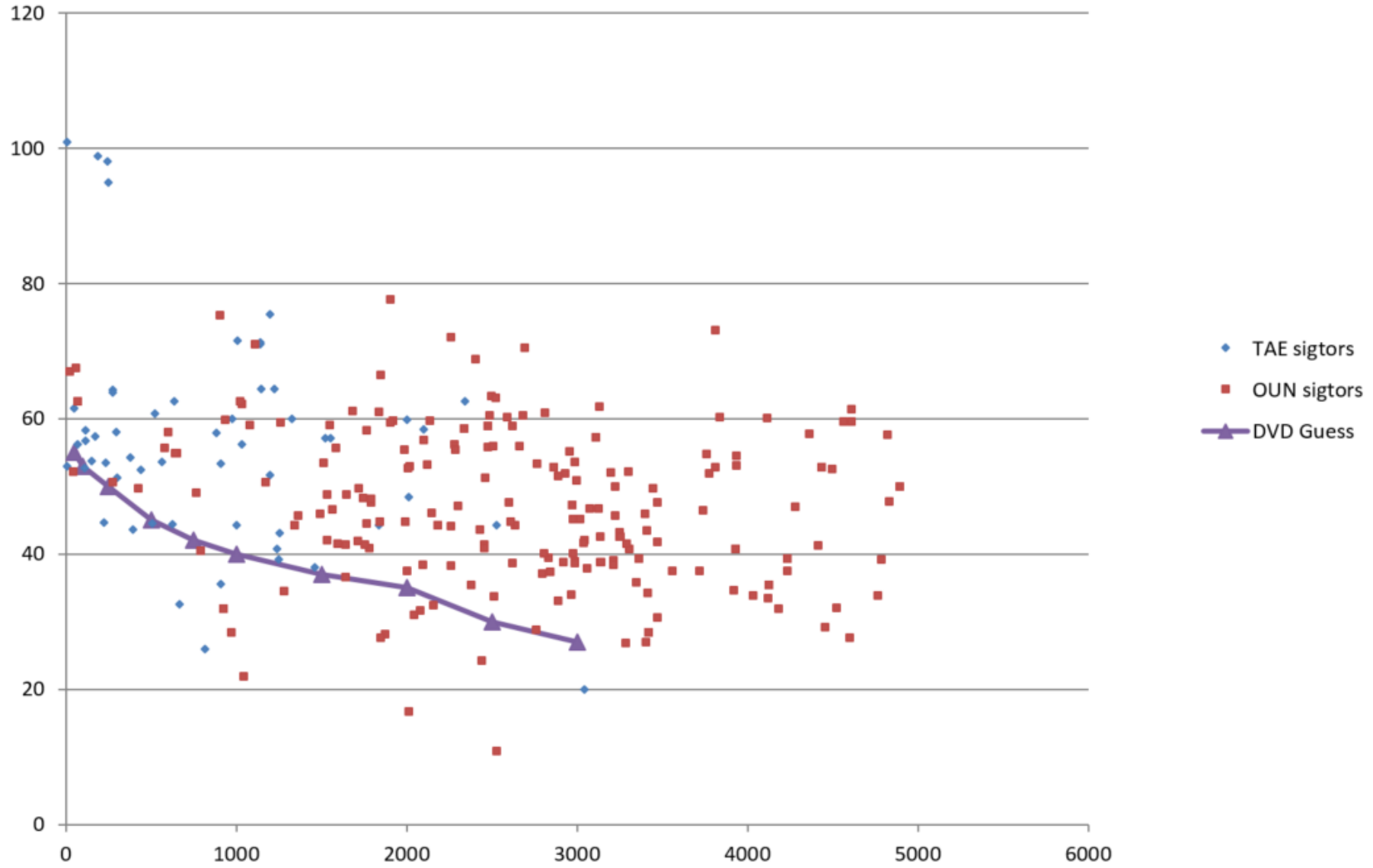
TAE and OUN 0-1 km Shear vs SBCAPE for EF2+ Tornadoes (1979-2011)



Chosen Thresholds Based on Scatter Plots and Testing

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots
2. SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots
3. SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots
4. SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots
5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots
6. SBCAPE >= 1000 j/kg, 0-1 km shear >= 20 knots
7. SBCAPE >= 1500 j/kg, 0-1 km shear >= 15 knots
8. SBCAPE >= 2000 j/kg, 0-1 km shear >= 10 knots
9. SBCAPE >= 2500 j/kg, 0-1 km shear >= 7 knots
10. SBCAPE >= 3000 j/kg, 0-1 km shear >= 5 knots

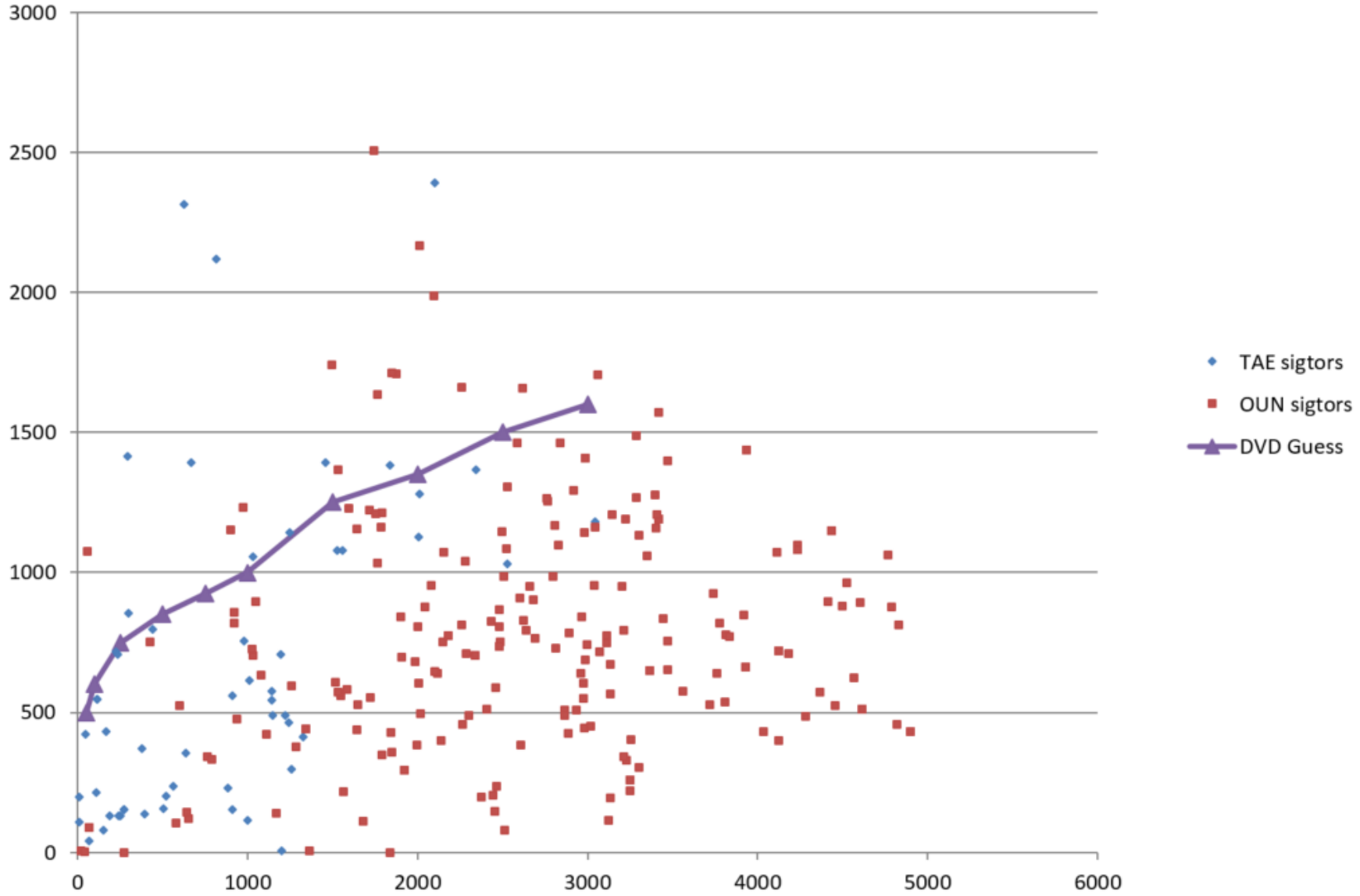
TAE and OUN 0-6 km Shear vs SBCAPE for EF2+ Tornadoes (1979-2011)



Chosen Thresholds Based on Scatter Plots and Testing

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots
2. SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots, 0-6 km shear >= 55 knots
3. SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots, 0-6 km shear >= 50 knots
4. SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots, 0-6 km shear >= 45 knots
5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots
6. SBCAPE >= 1000 j/kg, 0-1 km shear >= 20 knots, 0-6 km shear >= 40 knots
7. SBCAPE >= 1500 j/kg, 0-1 km shear >= 15 knots, 0-6 km shear >= 37 knots
8. SBCAPE >= 2000 j/kg, 0-1 km shear >= 10 knots, 0-6 km shear >= 35 knots
9. SBCAPE >= 2500 j/kg, 0-1 km shear >= 7 knots, 0-6 km shear >= 30 knots
10. SBCAPE >= 3000 j/kg, 0-1 km shear >= 5 knots, 0-6 km shear >= 27 knots

TAE and OUN MLLCL (m) vs SBCAPE for EF2+ Tornadoes (1979-2011)



Chosen Thresholds Based on Scatter Plots and Testing

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots, LCL <= 500 meters
2. SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots, 0-6 km shear >= 55 knots, LCL <= 600 meters
3. SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots, 0-6 km shear >= 50 knots, LCL <= 750 meters
4. SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots, 0-6 km shear >= 45 knots, LCL <= 850 meters
5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots, LCL <= 925 meters
6. SBCAPE >= 1000 j/kg, 0-1 km shear >= 20 knots, 0-6 km shear >= 40 knots, LCL <= 1000 meters
7. SBCAPE >= 1500 j/kg, 0-1 km shear >= 15 knots, 0-6 km shear >= 37 knots, LCL <= 1250 meters
8. SBCAPE >= 2000 j/kg, 0-1 km shear >= 10 knots, 0-6 km shear >= 35 knots, LCL <= 1350 meters
9. SBCAPE >= 2500 j/kg, 0-1 km shear >= 7 knots, 0-6 km shear >= 30 knots, LCL <= 1500 meters
10. SBCAPE >= 3000 j/kg, 0-1 km shear >= 5 knots, 0-6 km shear >= 27 knots, LCL <= 1600 meters

Chosen Thresholds Based on Scatter Plots and Testing

Red: Tornadoes, wind (and large hail if CAPE is high enough)
Green: Large hail
Blue: Pulse severe microbursts

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots, LCL <= 500 meters, QPF >= 0.01”
2. SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots, 0-6 km shear >= 55 knots, LCL <= 600 meters, QPF >= 0.01”
3. SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots, 0-6 km shear >= 50 knots, LCL <= 750 meters, QPF >= 0.01”
4. SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots, 0-6 km shear >= 45 knots, LCL <= 850 meters, QPF >= 0.01”
5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots, LCL <= 925 meters, QPF >= 0.01”
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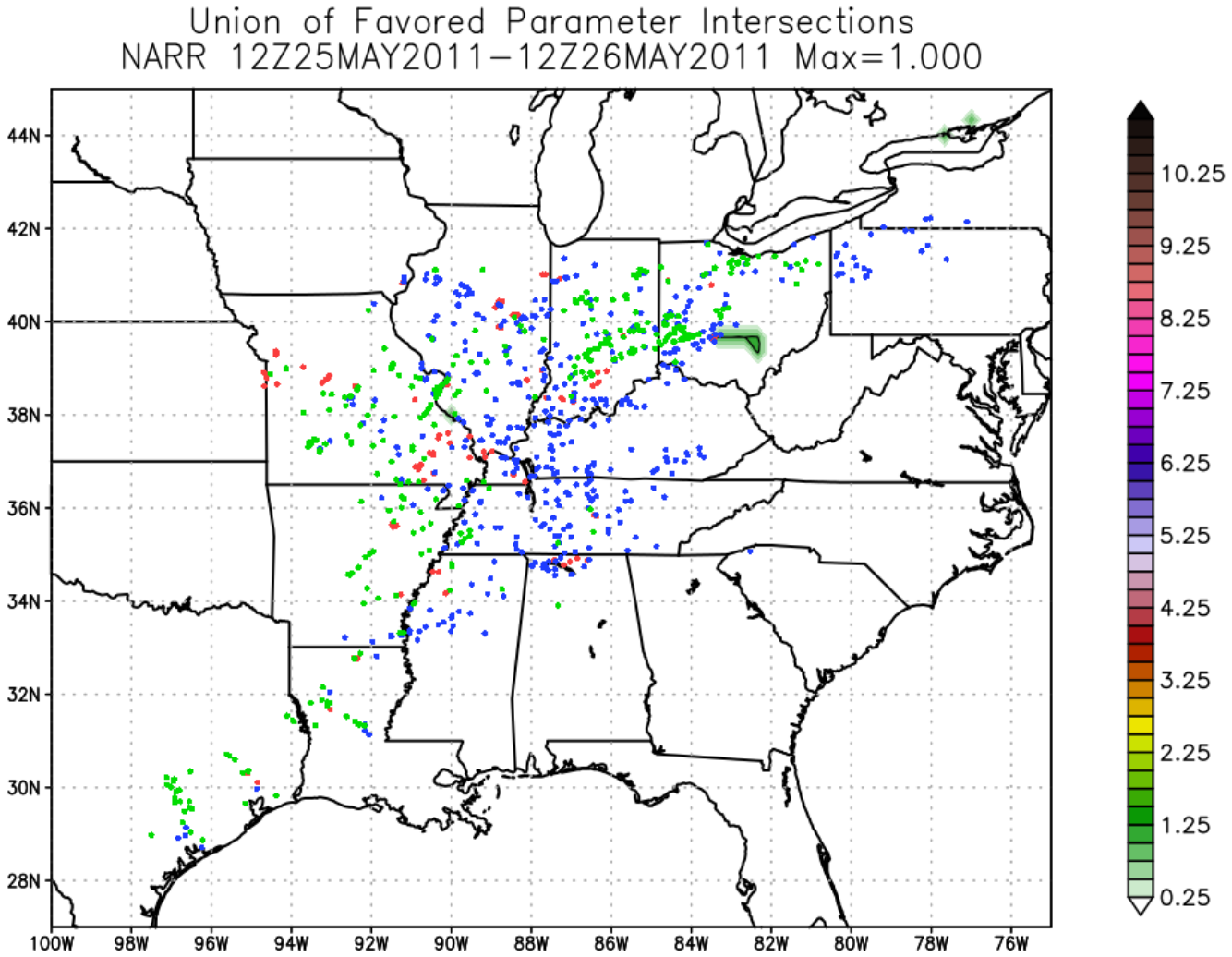
10. SBCAPE >= 3000 j/kg, 0-1 km shear >= 5 knots, 0-6 km shear >= 27 knots, LCL <= 1600 meters, QPF >= 0.01”
11. SBCAPE >= 1 j/kg, MLCAPE >= 600 j/kg, 700-500 mb LR >= 6.8 C/km, 0-6 km shear >= 35 knots, QPF >= 0.01”
12. Wet Microburst Severity Index >= 50, QPF >= 0.01”

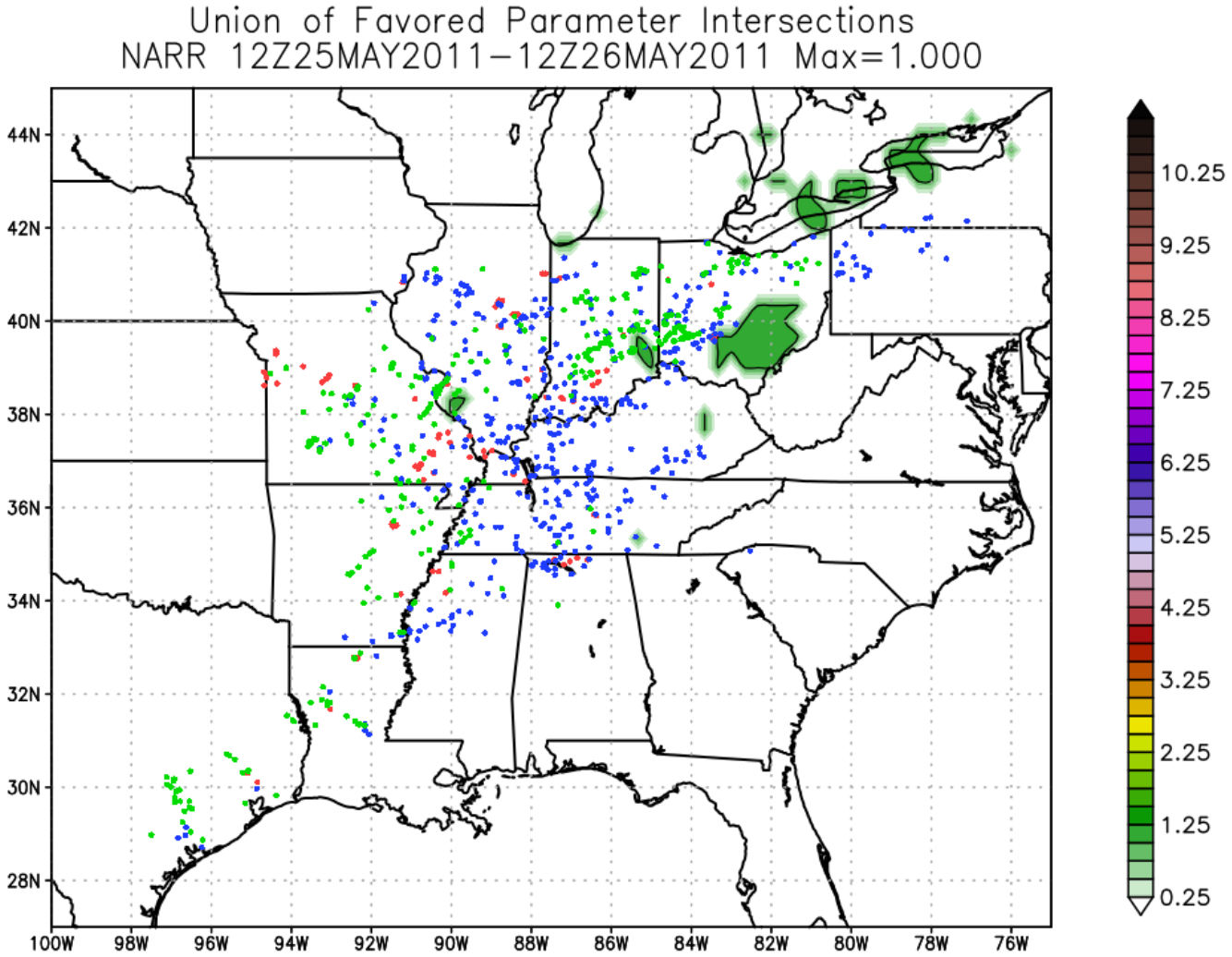
Index Formulation

- Check how many of the 12 possible thresholds are met.
  - For thresholds 1-10, assign a value of 1 for each threshold met.
  - For threshold 11, assign a value of 0.25 if met.
  - For threshold 12, assign a value of 0.50 if met.
- Add up all of the values at each grid point. A maximum index value of 10.75 is possible.

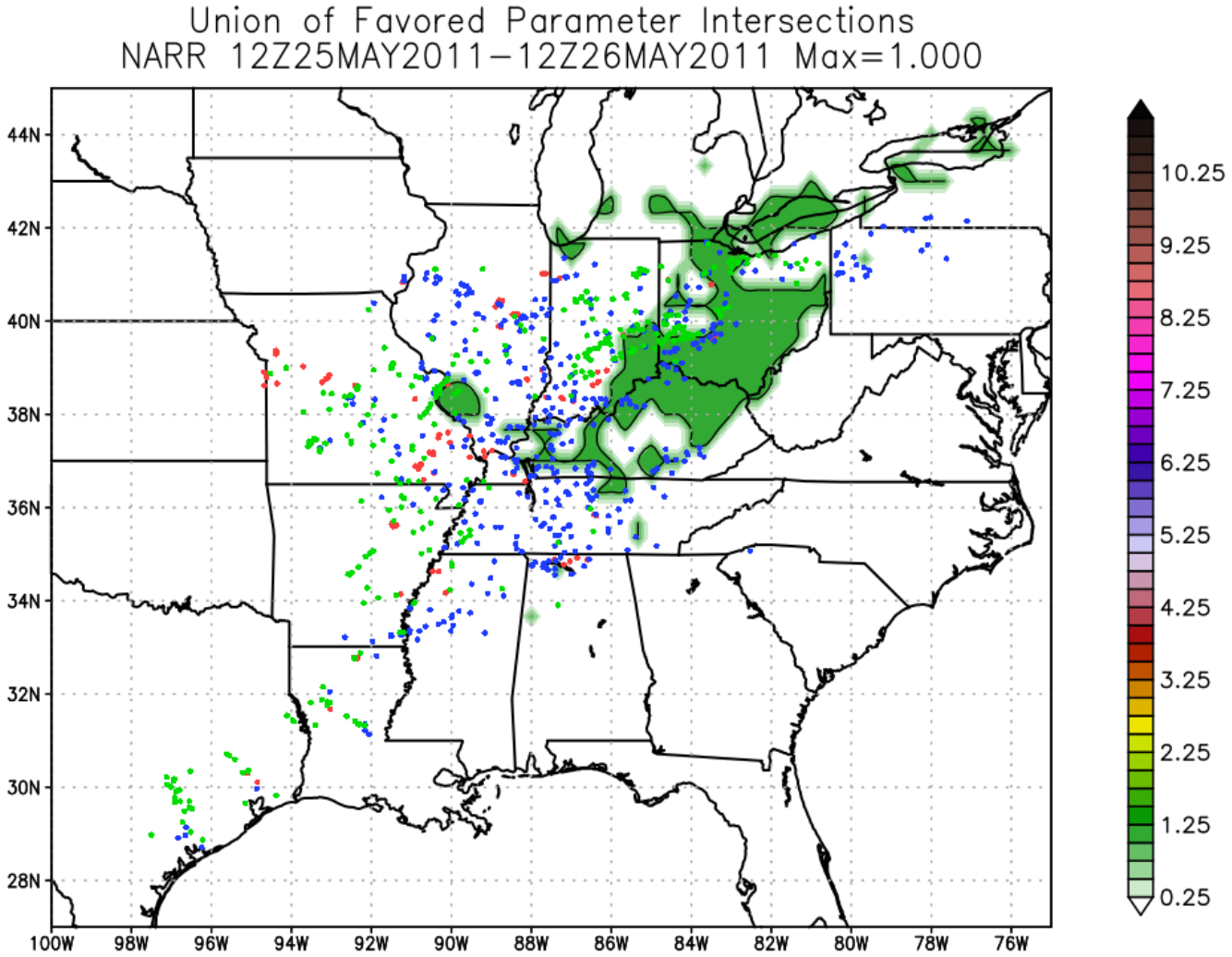
SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots, LCL <= 500 meters, QPF >= 0.01”



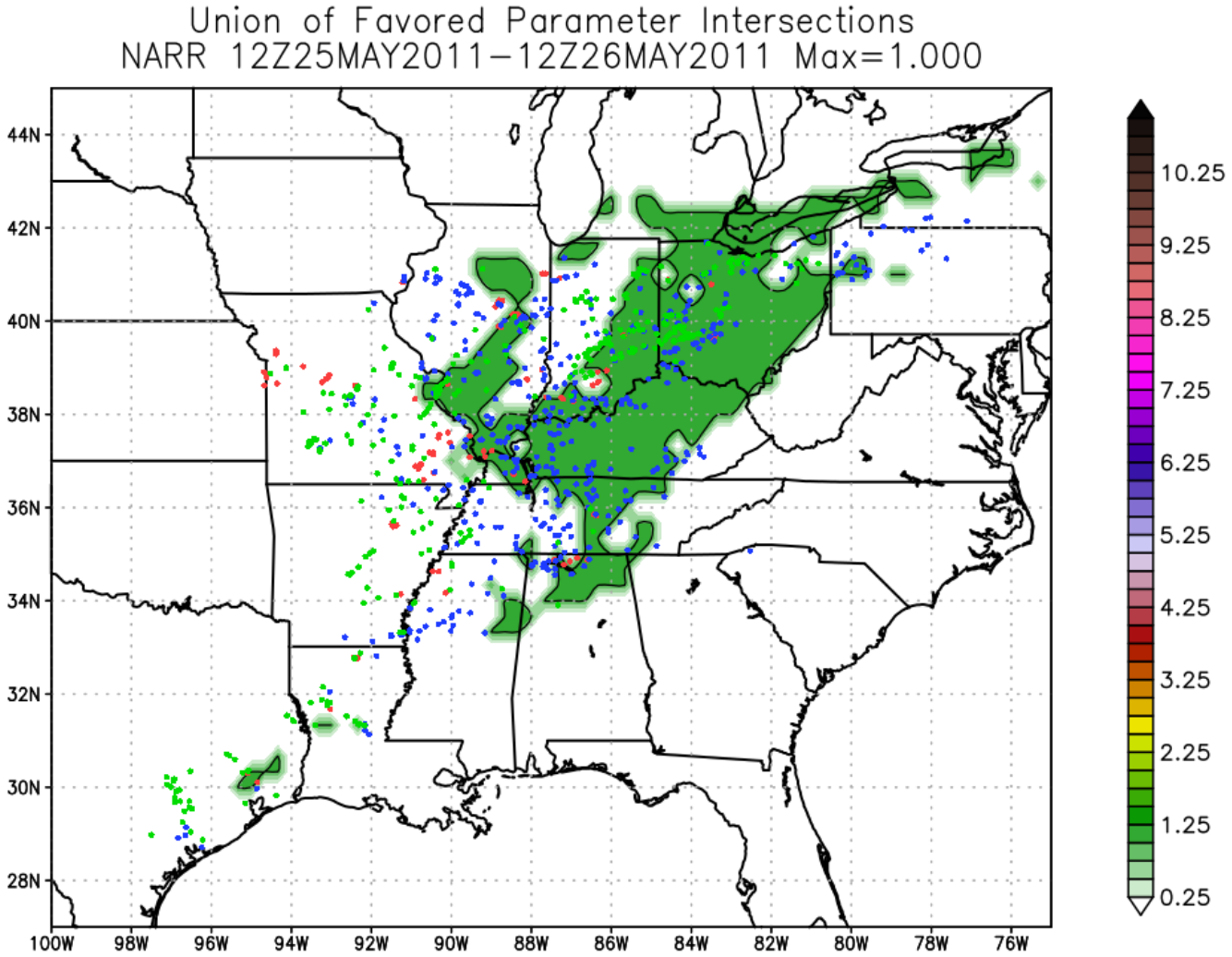
SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots, 0-6 km shear >= 55 knots, LCL <= 600 meters, QPF >= 0.01”



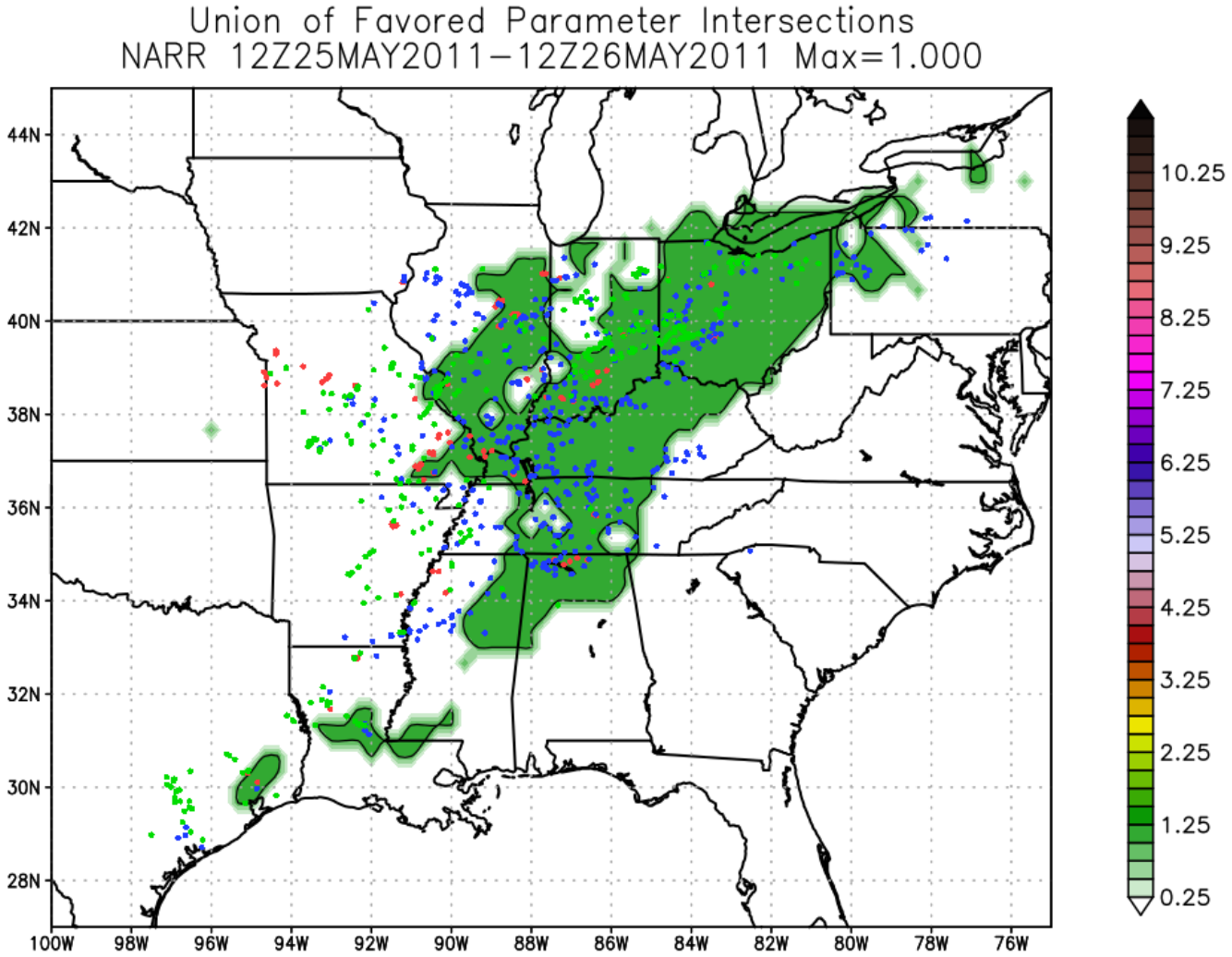
SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots, 0-6 km shear >= 50 knots, LCL <= 750 meters, QPF >= 0.01”



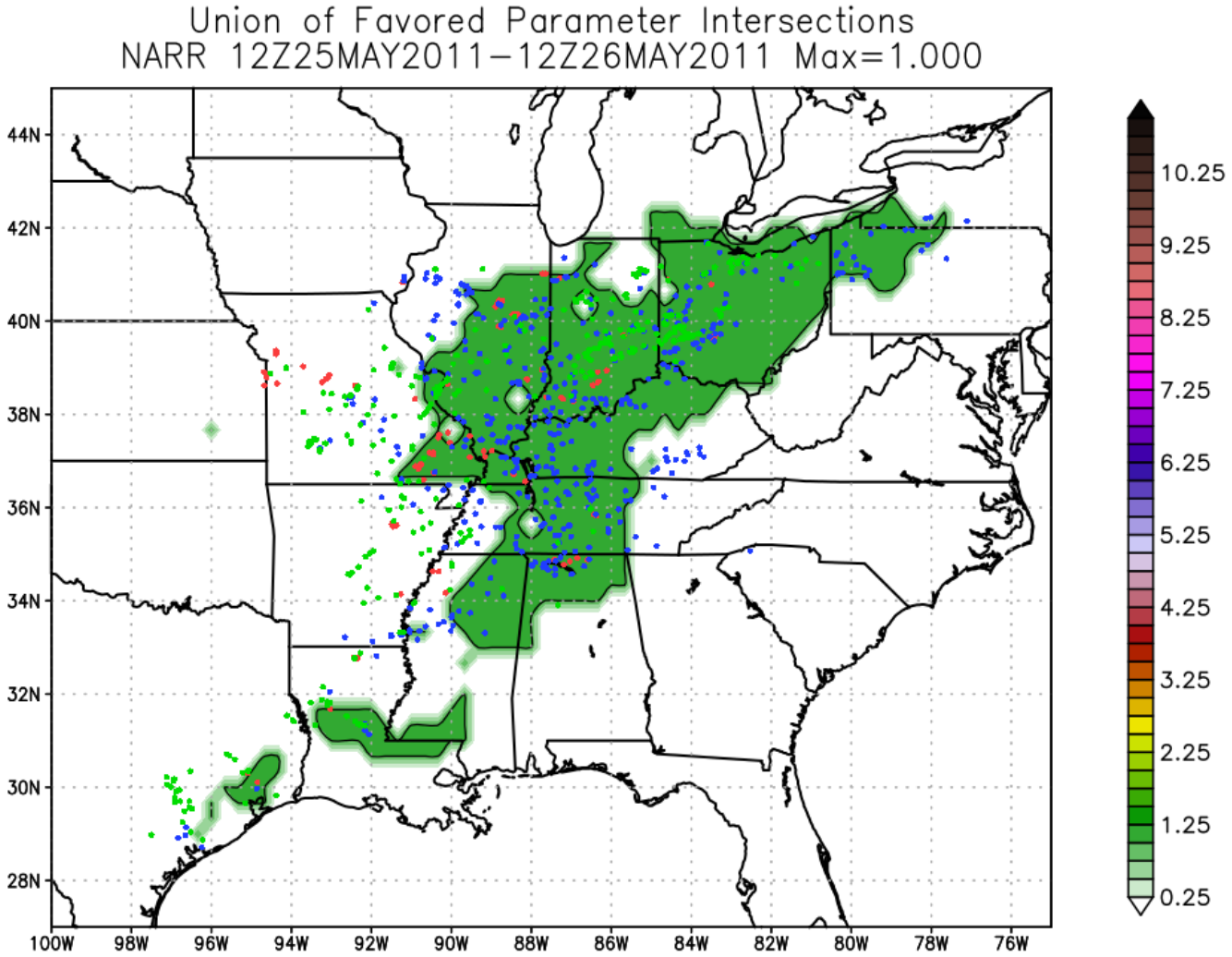
SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots, 0-6 km shear >= 45 knots, LCL <= 850 meters, QPF >= 0.01”



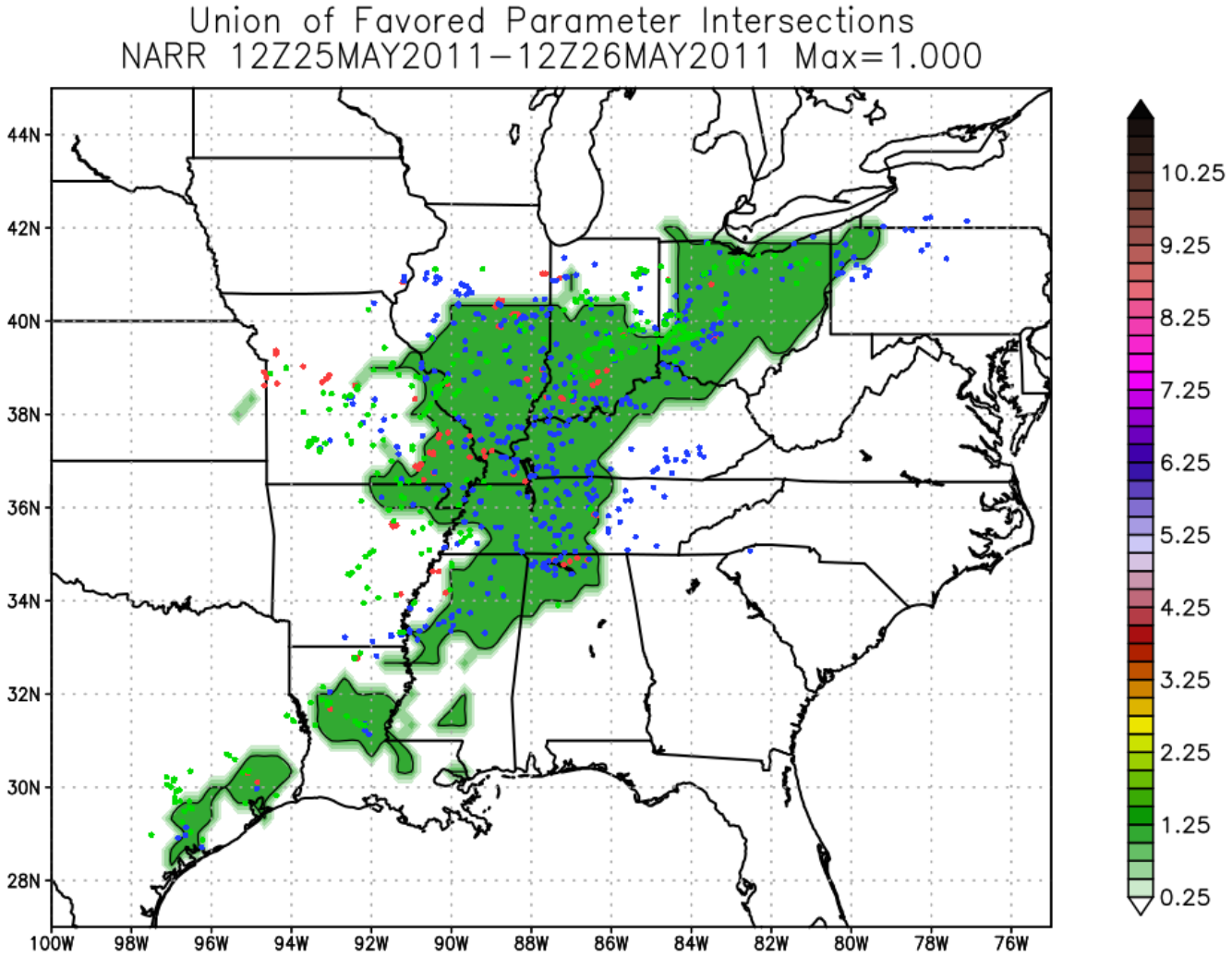
SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots, LCL <= 925 meters, QPF >= 0.01”



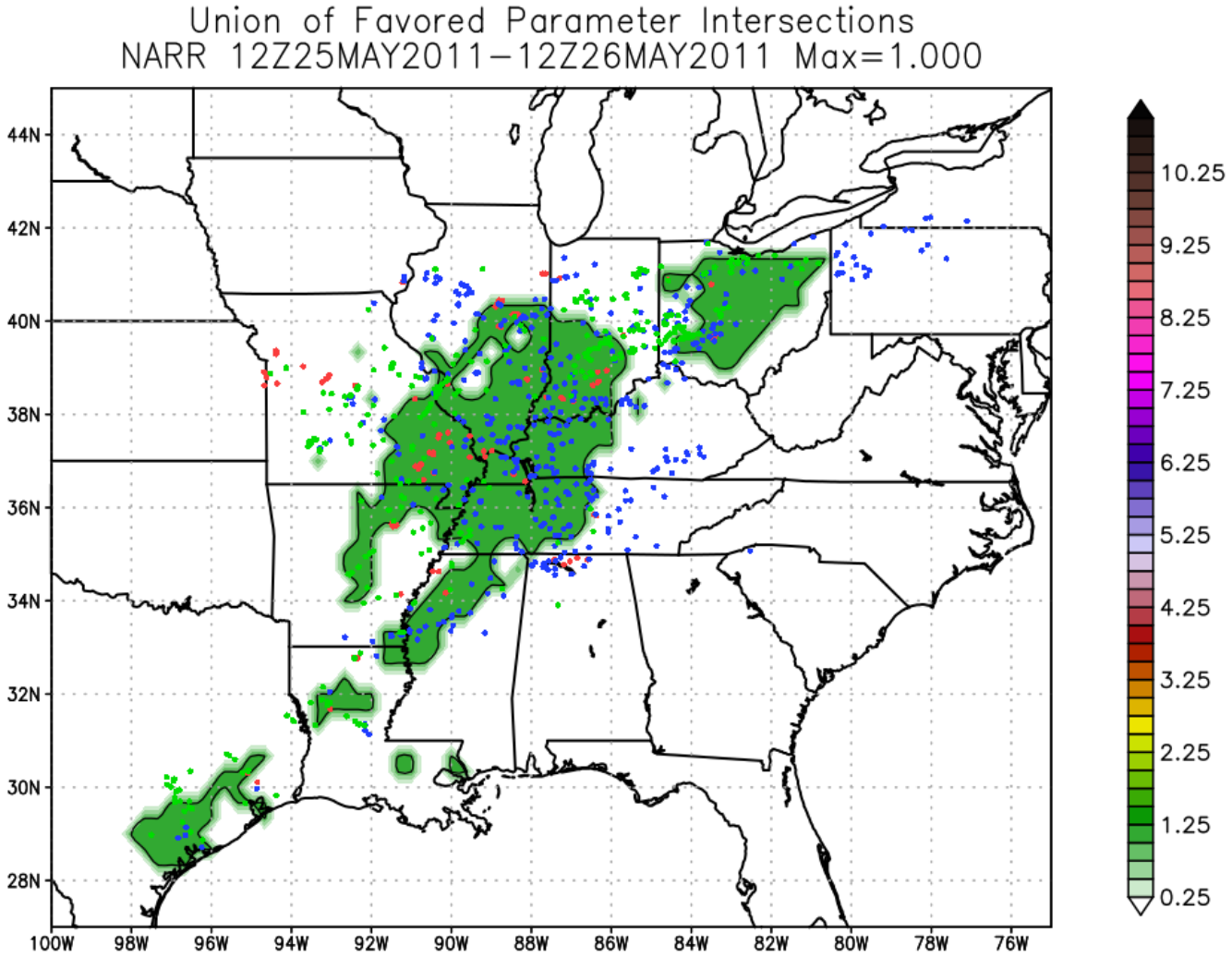
SBCAPE >= 1000 j/kg, 0-1 km shear >= 20 knots, 0-6 km shear >= 40 knots, LCL <= 1000 meters, QPF >= 0.01”



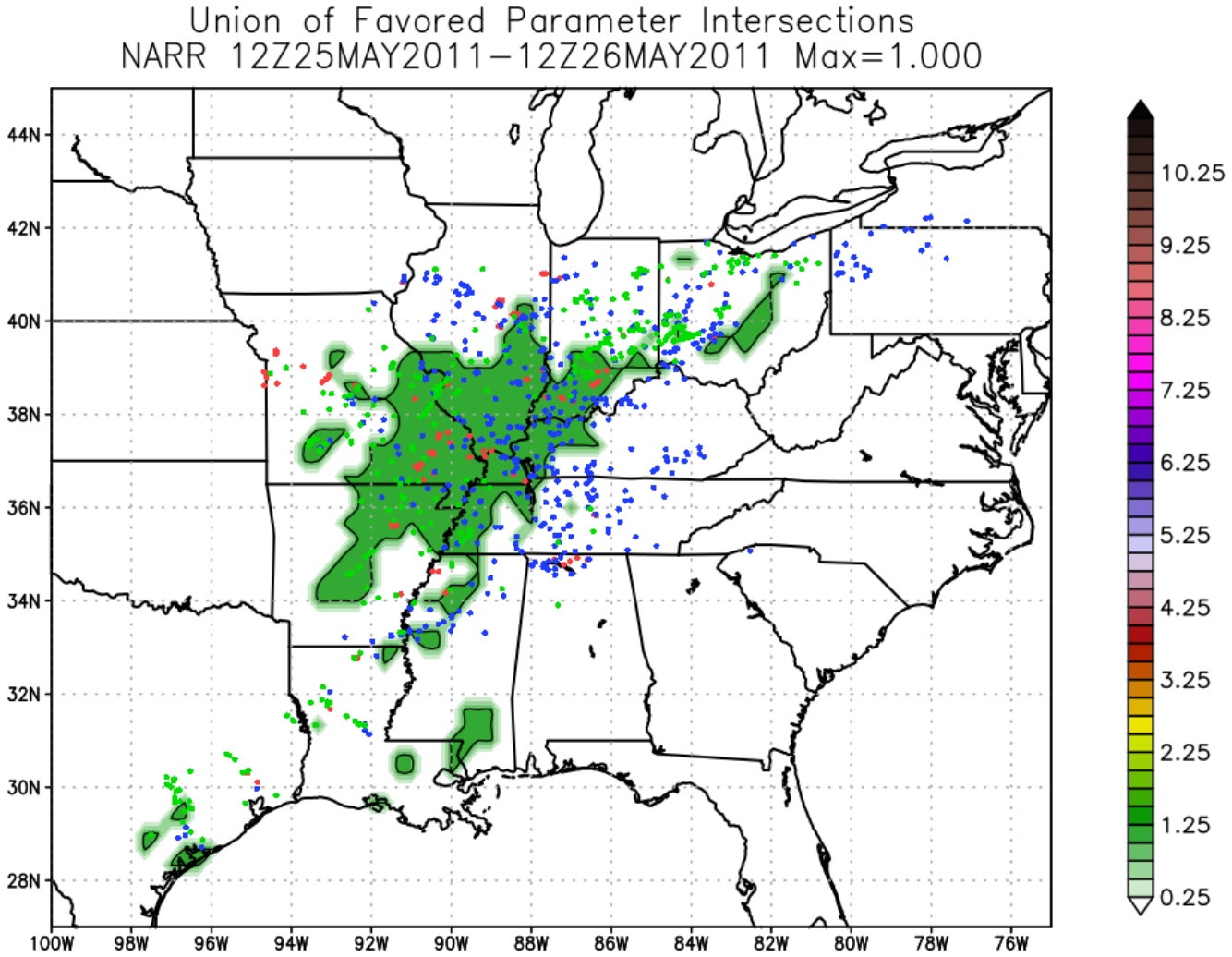
SBCAPE >= 1500 j/kg, 0-1 km shear >= 15 knots, 0-6 km shear >= 37 knots, LCL <= 1250 meters, QPF >= 0.01”



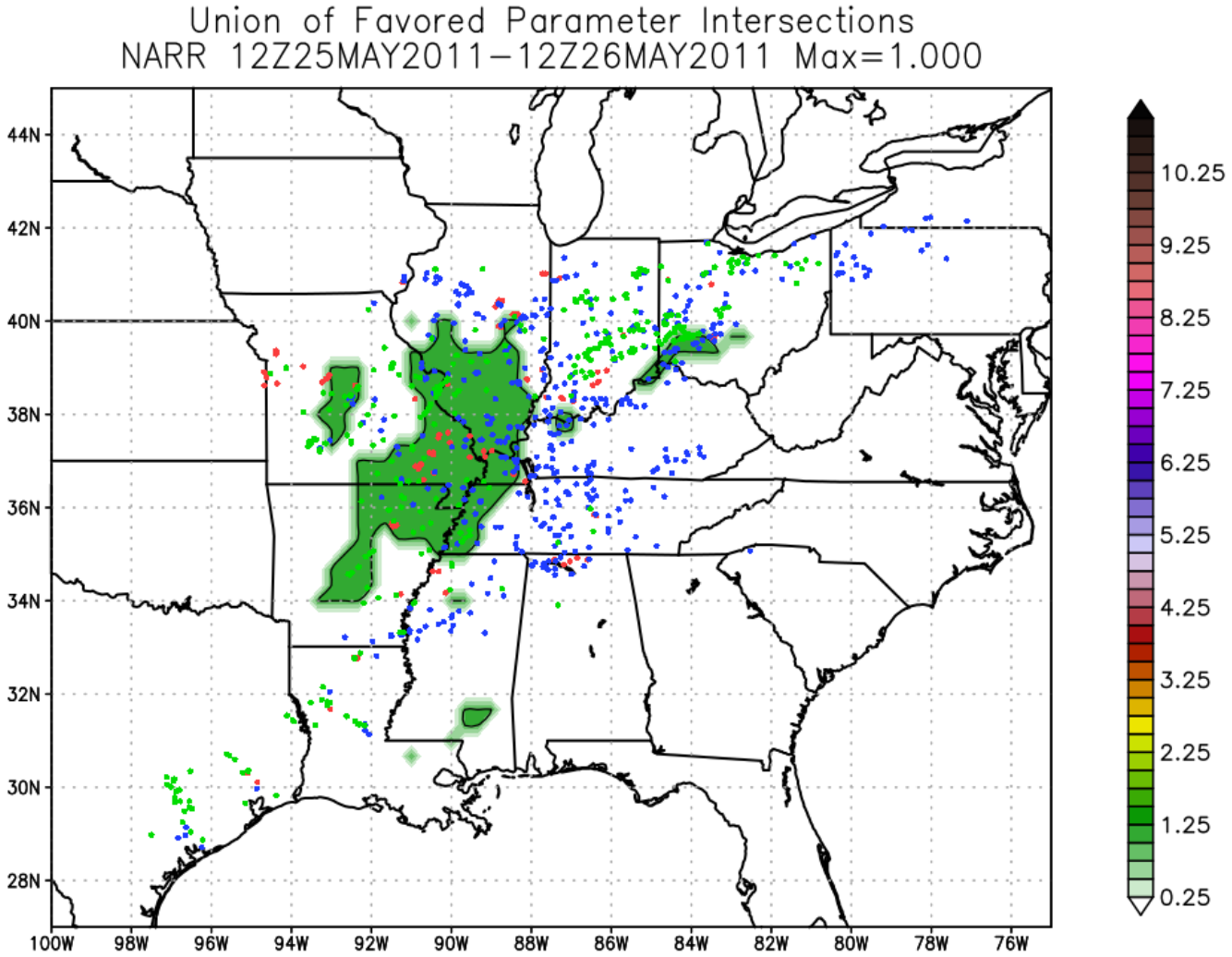
SBCAPE >= 2000 j/kg, 0-1 km shear >= 10 knots, 0-6 km shear >= 35 knots, LCL <= 1350 meters, QPF >= 0.01”



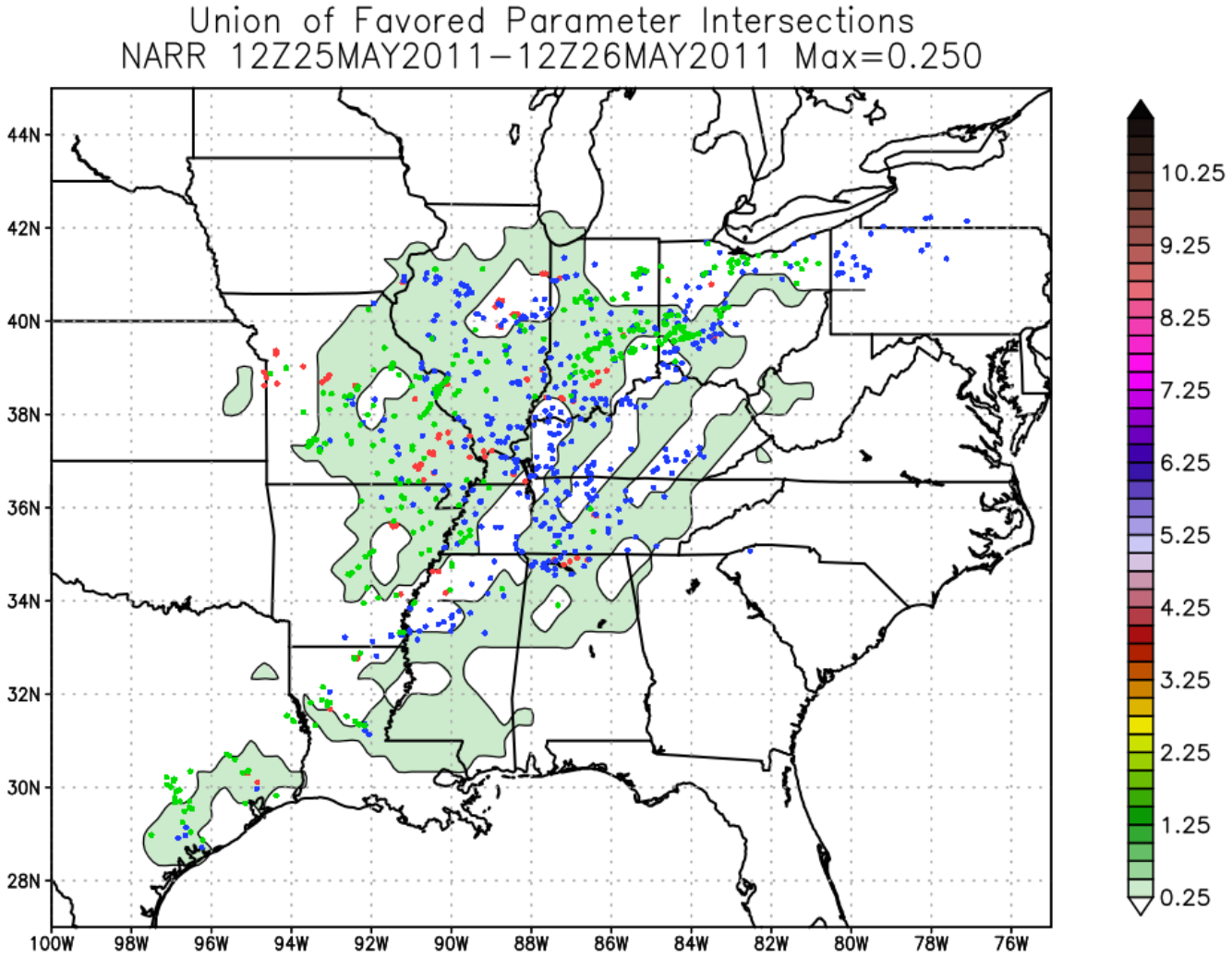
SBCAPE >= 2500 j/kg, 0-1 km shear >= 7 knots, 0-6 km shear >= 30 knots, LCL <= 1500 meters, QPF >= 0.01”



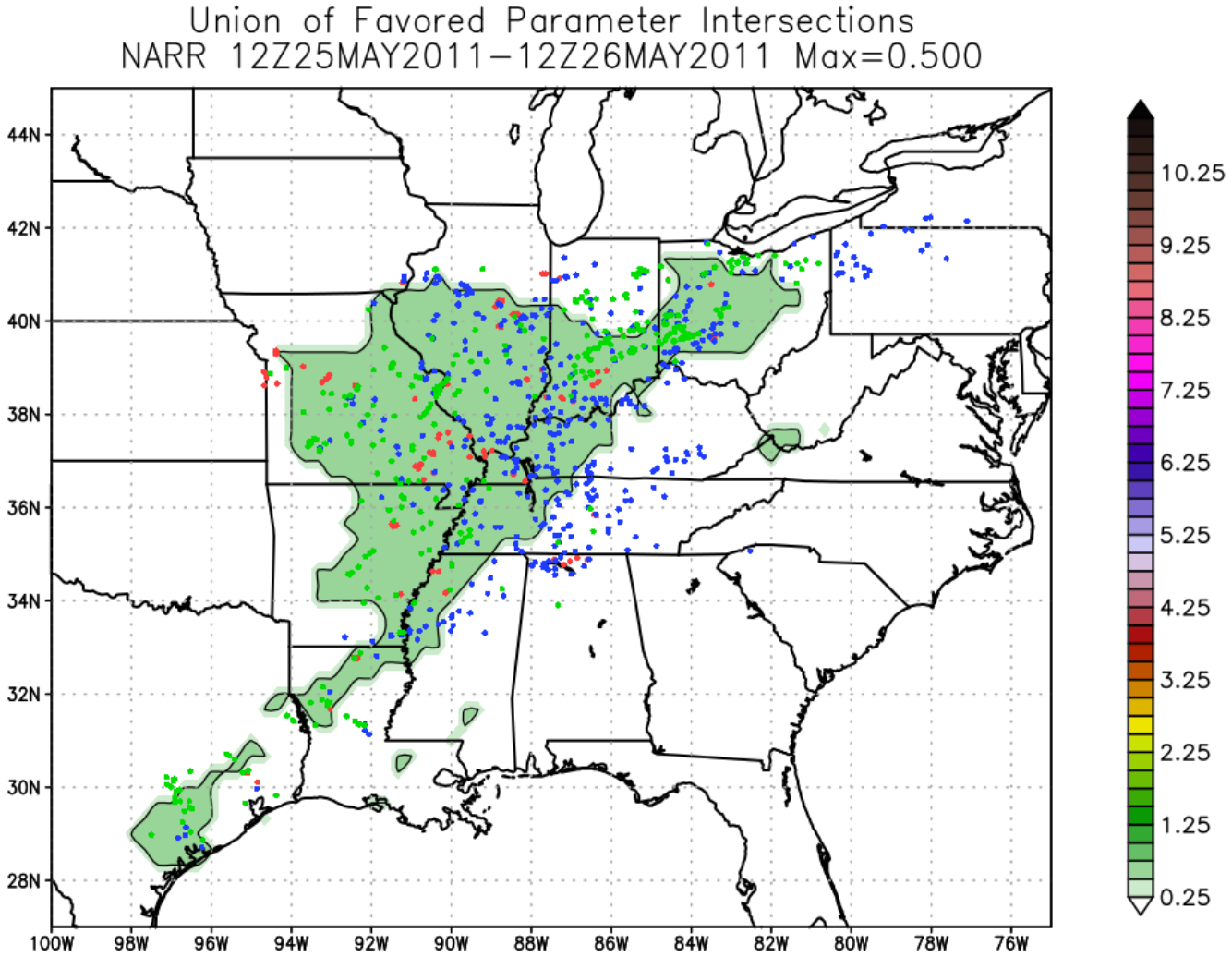
SBCAPE >= 3000 j/kg, 0-1 km shear >= 5 knots, 0-6 km shear >= 27 knots, LCL <= 1600 meters, QPF >= 0.01”



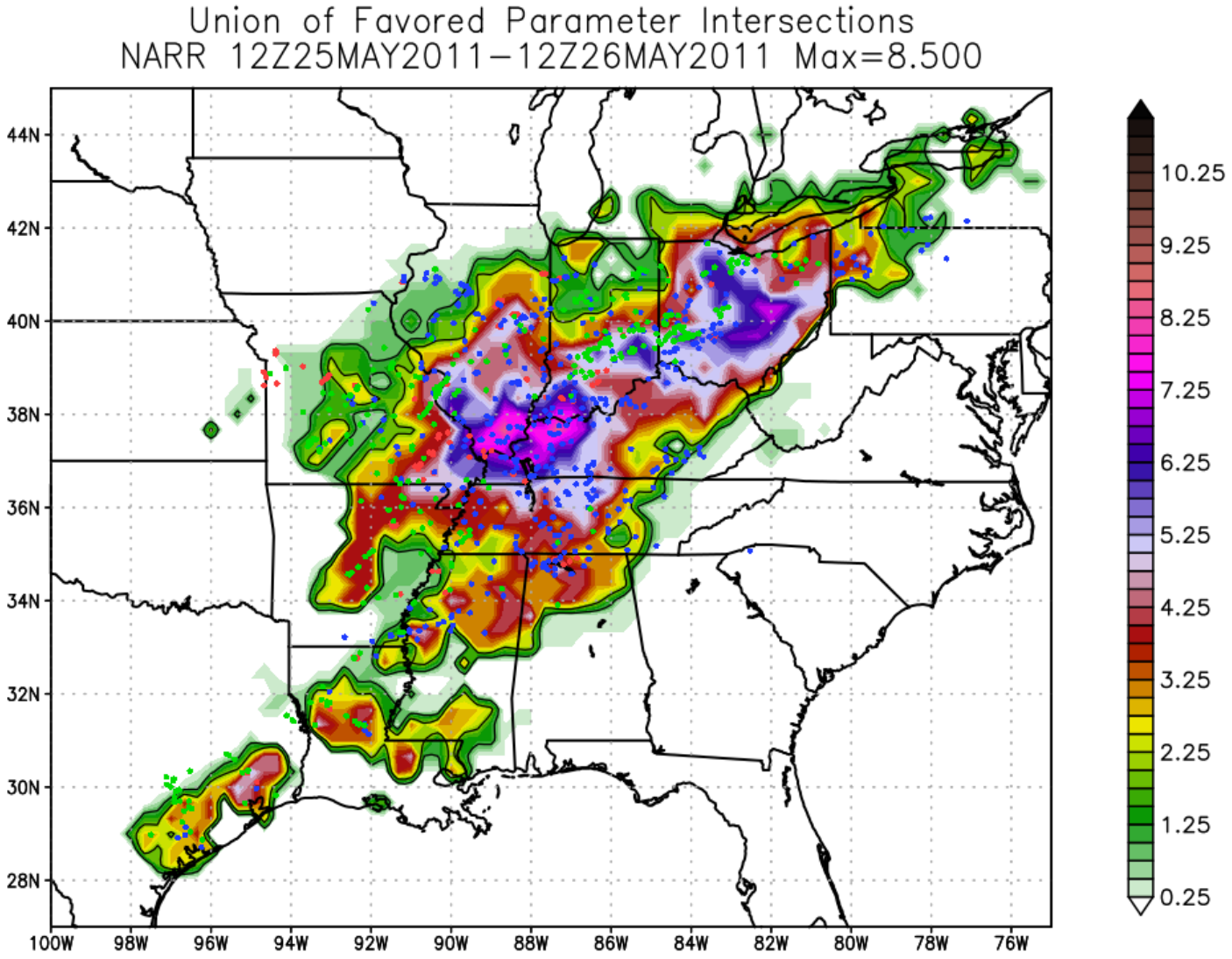
SBCAPE >= 1 j/kg, MLCAPE >= 600 j/kg, 700-500 mb LR >= 6.8 C/km, 0-6 km shear >= 35 knots, QPF >= 0.01”



Wet Microburst Severity Index >= 50, QPF >= 0.01”



The final total is the sum of the previous maps.



The Number's Hidden Meaning

- Whether or not the final value is a whole number or ends in a decimal gives you information
  - Whole number indicates no contribution from wet microburst or large hail check.
  - Ending in .25 tells you an environment favorable for large hail is present
  - Ending in .50 tells you an environment favorable for wet microbursts is present
  - Ending in .75 tells you both wet microbursts and large hail may be possible
- Given only the index number, you can automatically determine the minimum forecast CAPE value with no other information.
- Given the index number and CAPE value, you can determine the minimum amount of shear and maximum LCL height possible with no other information.

Quiz Time!

1. If the CAPE is forecast to be 700 J/kg, then what is the maximum value possible on the index? (Ignore the hail and microburst checks.)

Chosen Thresholds Based on Scatter Plots and Testing

Red: Tornadoes, wind (and large hail if CAPE is high enough)
Green: Large hail
Blue: Pulse severe microbursts

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots, LCL <= 500 meters, QPF >= 0.01”
2. SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots, 0-6 km shear >= 55 knots, LCL <= 600 meters, QPF >= 0.01”
3. SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots, 0-6 km shear >= 50 knots, LCL <= 750 meters, QPF >= 0.01”
4. SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots, 0-6 km shear >= 45 knots, LCL <= 850 meters, QPF >= 0.01”
5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots, LCL <= 925 meters, QPF >= 0.01”
6. SBCAPE >= 1000 j/kg, 0-1 km shear >= 20 knots, 0-6 km shear >= 40 knots, LCL <= 1000 meters, QPF >= 0.01”
7. SBCAPE >= 1500 j/kg, 0-1 km shear >= 15 knots, 0-6 km shear >= 37 knots, LCL <= 1250 meters, QPF >= 0.01”
8. SBCAPE >= 2000 j/kg, 0-1 km shear >= 10 knots, 0-6 km shear >= 35 knots, LCL <= 1350 meters, QPF >= 0.01”
9. SBCAPE >= 2500 j/kg, 0-1 km shear >= 7 knots, 0-6 km shear >= 30 knots, LCL <= 1500 meters, QPF >= 0.01”
10. SBCAPE >= 3000 j/kg, 0-1 km shear >= 5 knots, 0-6 km shear >= 27 knots, LCL <= 1600 meters, QPF >= 0.01”
11. SBCAPE >= 1 j/kg, MLCAPE >= 600 j/kg, 700-500 mb LR >= 6.8 C/km, 0-6 km shear >= 35 knots, QPF >= 0.01”
12. Wet Microburst Severity Index >= 50, QPF >= 0.01”

Quiz Time!

1. If the CAPE is forecast to be 700 J/kg, then what is the maximum whole number value possible on the index? (Ignore the hail and microburst checks.) Answer: 4
2. If the index value is forecast to be 6, then what is the minimum amount of CAPE that must be present?

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Red: Tornadoes, wind (and large hail if CAPE is high enough)
Green: Large hail
Blue: Pulse severe microbursts

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5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots, LCL <= 925 meters, QPF >= 0.01”
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11. SBCAPE >= 1 j/kg, MLCAPE >= 600 j/kg, 700-500 mb LR >= 6.8 C/km, 0-6 km shear >= 35 knots, QPF >= 0.01”
12. Wet Microburst Severity Index >= 50, QPF >= 0.01”

Quiz Time!

1. If the CAPE is forecast to be 700 J/kg, then what is the maximum whole number value possible on the index? (Ignore the hail and microburst checks.) Answer: 4
2. If the index value is forecast to be 6, then what is the minimum amount of CAPE that must be present? Answer: 1000 J/kg
3. If the CAPE is forecast to be 1700 J/kg and the index value is forecast to be 3, then what are the minimum possible shear values and maximum possible LCL height value?

Chosen Thresholds Based on Scatter Plots and Testing

Red: Tornadoes, wind (and large hail if CAPE is high enough)
Green: Large hail
Blue: Pulse severe microbursts

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots, LCL <= 500 meters, QPF >= 0.01”
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3. SBCAPE >= 250 j/kg, 0-1 km shear >= 35 knots, 0-6 km shear >= 50 knots, LCL <= 750 meters, QPF >= 0.01”
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5. SBCAPE >= 750 j/kg, 0-1 km shear >= 25 knots, 0-6 km shear >= 42 knots, LCL <= 925 meters, QPF >= 0.01”
6. SBCAPE >= 1000 j/kg, 0-1 km shear >= 20 knots, 0-6 km shear >= 40 knots, LCL <= 1000 meters, QPF >= 0.01”
7. SBCAPE >= 1500 j/kg, 0-1 km shear >= 15 knots, 0-6 km shear >= 37 knots, LCL <= 1250 meters, QPF >= 0.01”
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12. Wet Microburst Severity Index >= 50, QPF >= 0.01”

Quiz Time!

1. If the CAPE is forecast to be 700 J/kg, then what is the maximum whole number value possible on the index? (Ignore the hail and microburst checks.) Answer: 4
2. If the index value is forecast to be 6, then what is the minimum amount of CAPE that must be present? Answer: 1000 J/kg
3. If the CAPE is forecast to be 1700 J/kg and the index value is forecast to be 3, then what are the minimum possible shear values and maximum possible LCL height value? Answer: 25, 42, 925
4. What is the whole number index value given (2200, 8, 40, 800, 0.30)? Ignore the hail and downburst check.

Chosen Thresholds Based on Scatter Plots and Testing

Red: Tornadoes, wind (and large hail if CAPE is high enough)
Green: Large hail
Blue: Pulse severe microbursts

1. SBCAPE >= 50 j/kg, 0-1 km shear >= 42 knots, 0-6 km shear >= 60 knots, LCL <= 500 meters, QPF >= 0.01”
2. SBCAPE >= 100 j/kg, 0-1 km shear >= 40 knots, 0-6 km shear >= 55 knots, LCL <= 600 meters, QPF >= 0.01”
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4. SBCAPE >= 500 j/kg, 0-1 km shear >= 30 knots, 0-6 km shear >= 45 knots, LCL <= 850 meters, QPF >= 0.01”
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12. Wet Microburst Severity Index >= 50, QPF >= 0.01”

Quiz Time!

1. If the CAPE is forecast to be 700 J/kg, then what is the maximum whole number value possible on the index? (Ignore the hail and microburst checks.) Answer: 4
2. If the index value is forecast to be 6, then what is the minimum amount of CAPE that must be present? Answer: 1000 J/kg
3. If the CAPE is forecast to be 1700 J/kg and the index value is forecast to be 3, then what are the minimum possible shear values and maximum possible LCL height value? Answer: 25, 42, 925
4. What is the whole number index value given (2200, 8, 40, 800, 0.30)? Ignore the hail and downburst check. Answer: 0

Summary

- This index provides a quick way for forecasters to judge the overall risk of general severe weather.
- One can interpret a higher index value as meaning the environment is forecast to be deeper into the favorable parameter space for severe weather. However, it is important to keep in mind that any index value of at least 1 could be significant as some EF2+ tornadoes have occurred in that environment.
- Not meant to be used in a vacuum but rather as a clue to guide forecasters in their analysis.