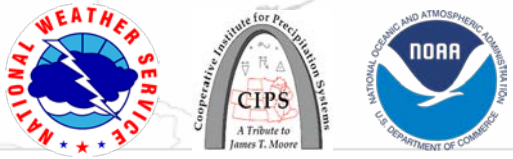
CIPS
Analog-Based Severe Probability Guidance

Alex Elmore
Dr. Charles Graves

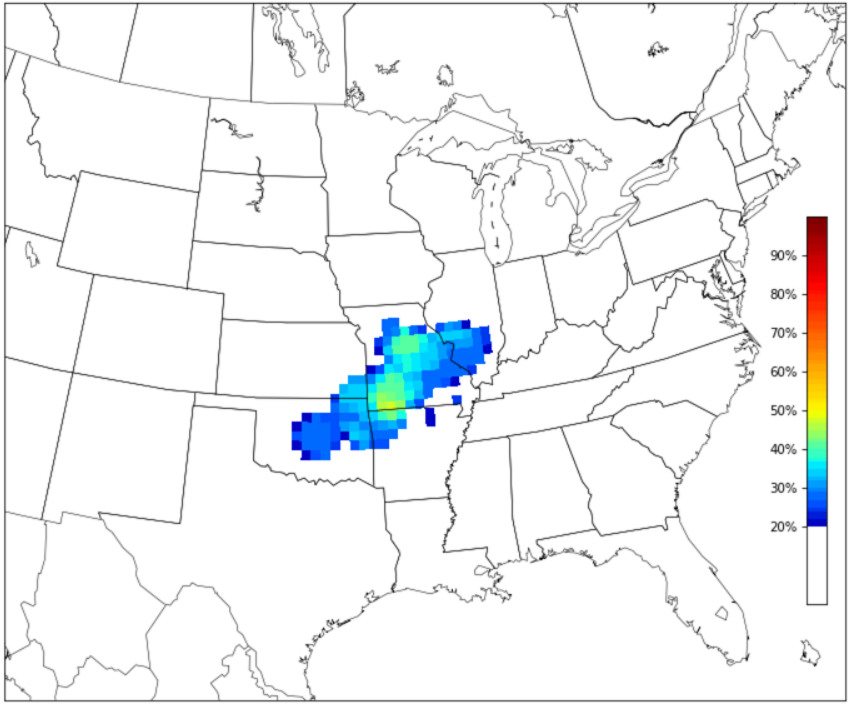


How We Use Analogs

Old CIPS Analog System

- Analogs: Past weather patterns
- **STEP 1:** Find analogs that match the forecast
- **STEP 2:** Frequency of hazard or threshold showing up at a grid point in analogs

Severe Report Frequency



Percentage [%] of Top 15 Analogs Exceeding 1 Severe Weather Report Within 110 km of Grid Point
Using GFS215 20190321/0000F096 and Valid at 20190325/0000 on the SP Domain

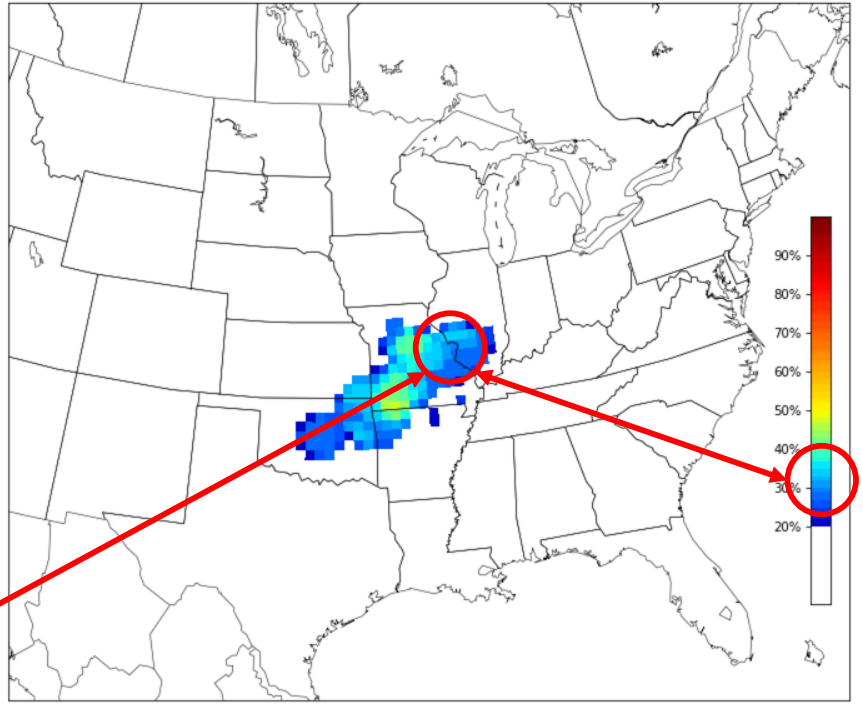
How We Use Analogs

Old CIPS Analog System

- Analogs: Historical Weather Patterns
- STEP 1: Find analogs that match the forecast
- STEP 2: Frequency of hazard or threshold showing up at a grid point in analogs

Approximate frequency around St. Louis=~30%. This translates to ~5 out of 15 analogs having severe here.

Severe Report Frequency



Percentage [%] of Top 15 Analogs Exceeding 1 Severe Weather Report Within 110 km of Grid Point
Using GFS215 20190321/0000F096 and Valid at 20190325/0000 on the SP Domain

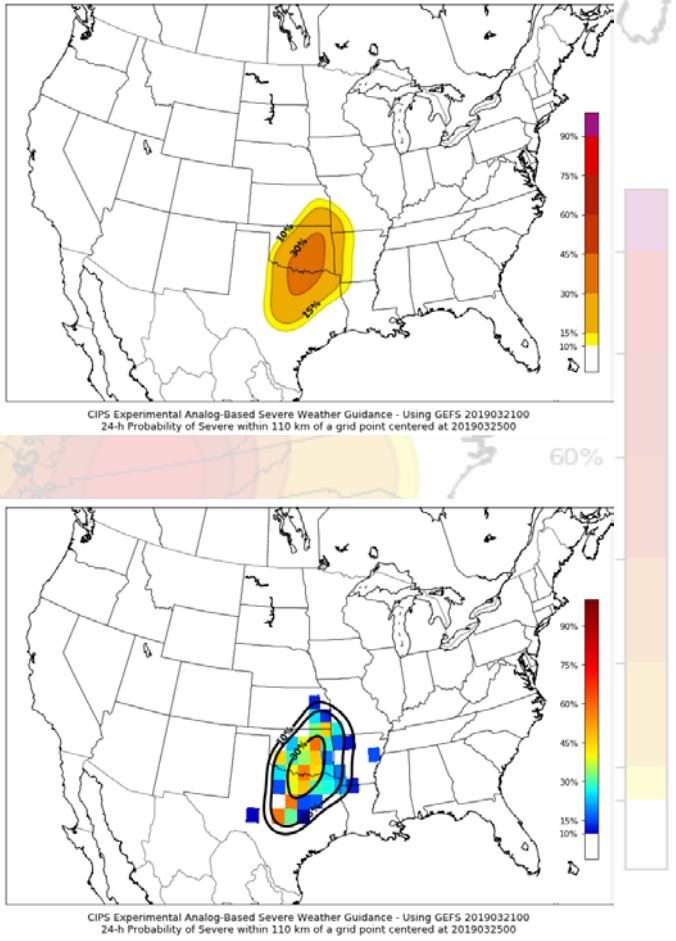
Not Your Father's CIPS

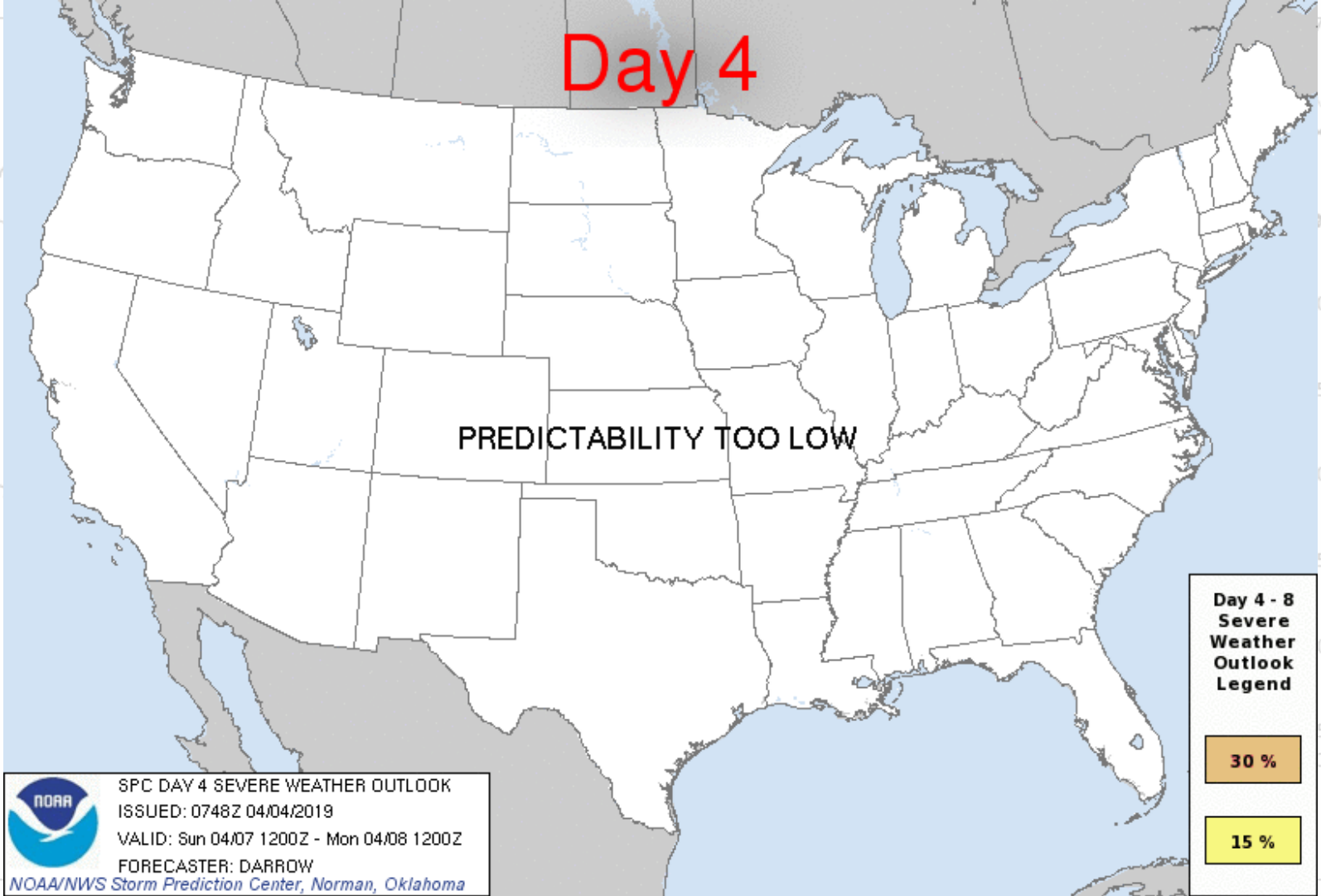
New CIPS Analog System

- Still uses top matching analogs
- Still uses severe reports
- Machine Learning-based probabilities

...Why are we doing this?

Probability of All Severe Hazards



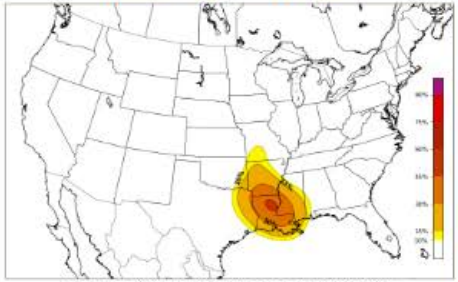

Day 4
PREDICTABILITY TOO LOW
Day 4 - 8 Severe Weather Outlook Legend
30 %
15 %
SPC DAY 4 SEVERE WEATHER OUTLOOK
ISSUED: 0748Z 04/04/2019
VALID: Sun 04/07 1200Z - Mon 04/08 1200Z
FORECASTER: DARROW
NOAA/NWS Storm Prediction Center, Norman, Oklahoma

CIPS Experimental Analog-Based Severe Probability Guidance
Threat Guidance for 20190404/0000 Run

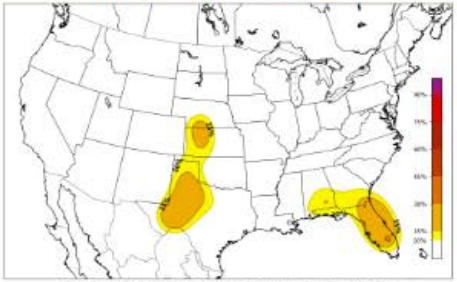
20190404/0000 · 20190403/0000 · 20190402/0000 · 20190401/0000 · 20190331/0000 · 20190330/0000 · 20190329/0000 · 20190328/0000 · 20190327/0000

All Severe · Wind · Hail · Tornado

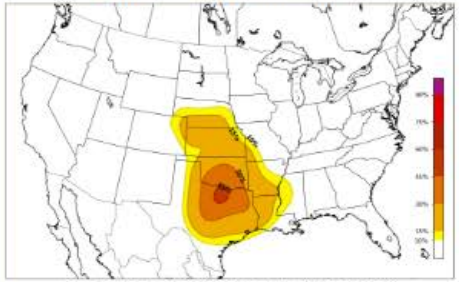
Day 1 - 20190405/0000



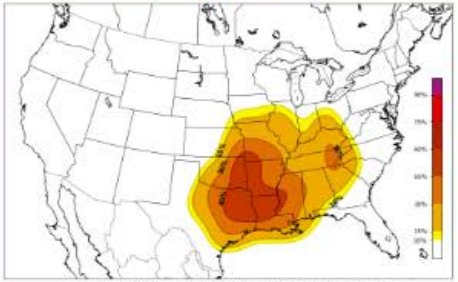
Day 2 - 20190406/0000



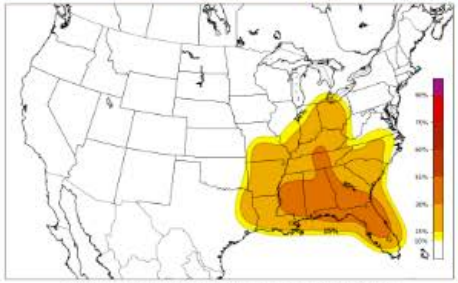
Day 3 - 20190407/0000



Day 4 - 20190408/0000

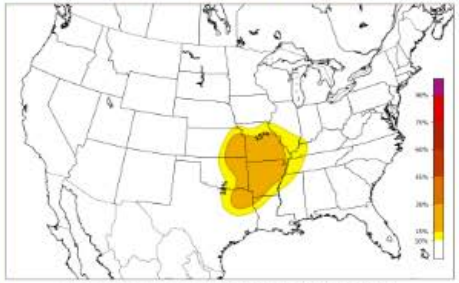


Day 5 - 20190409/0000

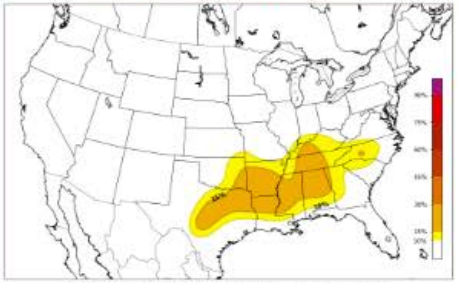


Day 6 - 20190410/0000

Day 7 - 20190411/0000



Day 8 - 20190412/0000



NOAA's National Weather Service

2019-2022 STRATEGIC PLAN in brief

VISION

A Weather-Ready Nation: Society is prepared for and responds to weather, water, and climate-dependent events.

MISSION

Provide weather, water, and climate data, forecasts, and warnings for the protection of life and property and the enhancement of the national economy.

NOAA's National Weather Service

2019-2022 STRATEGIC PLAN in brief

"Integrating the power of human skill with the efficiency of new computing technology will revolutionize *hazard forecasting, enabled by machine learning and advanced probabilistic tools*."

VISION

A Weather-Ready Nation: Society is prepared for and responds to weather, water, and climate-dependent events.

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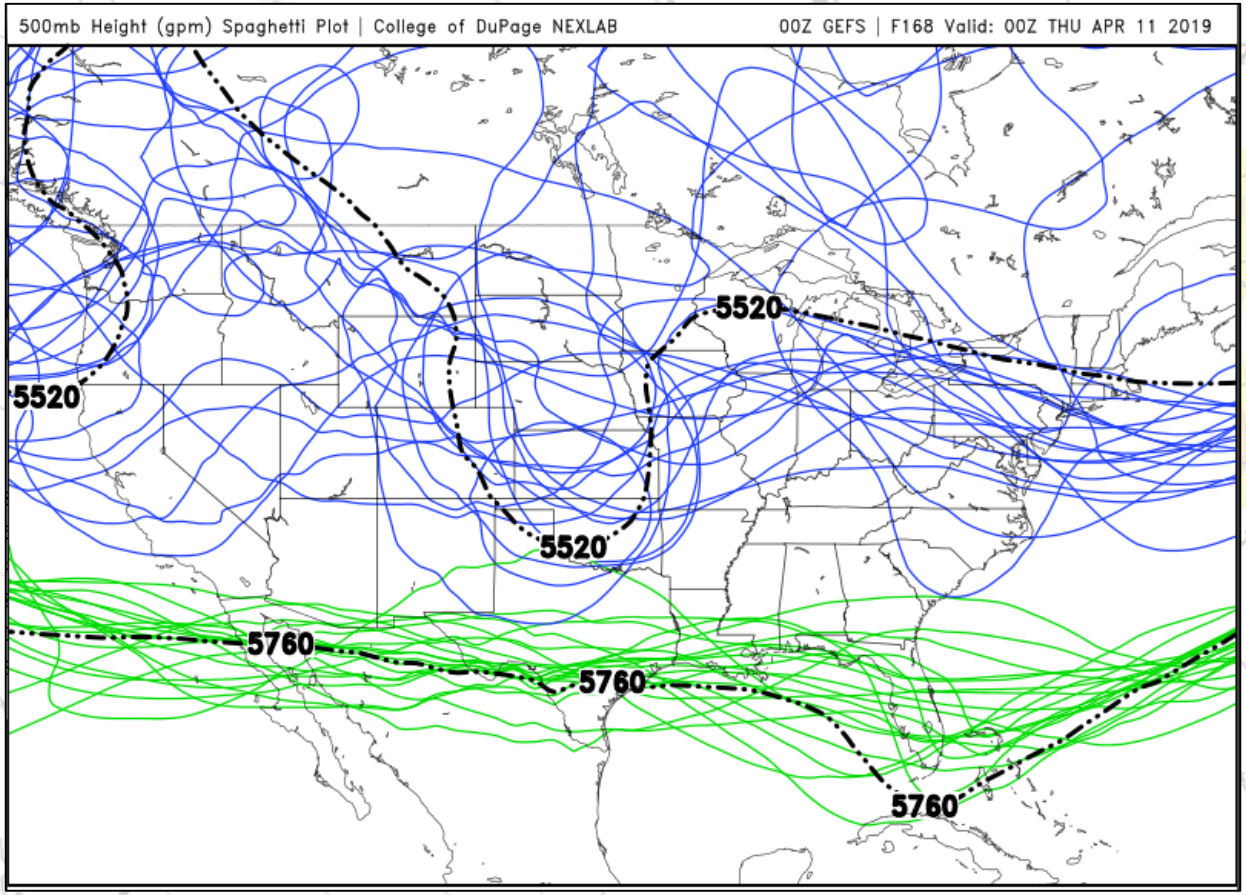
Provide weather, water, and climate data, forecasts, and warnings for the protection of life and property and the enhancement of the national economy.

GEFS 500mb Heights Valid 168 Hours Out (Day 7)

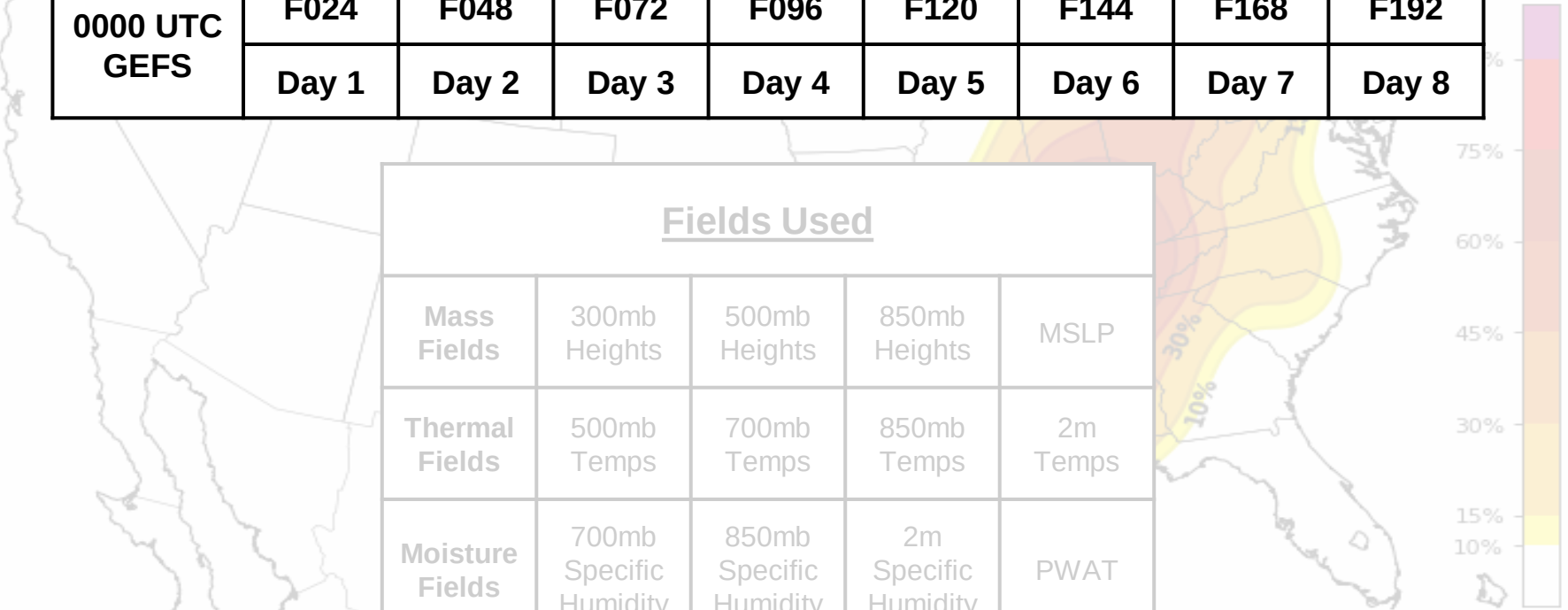


How Does It Work?

STEP 1: Analogs are found based on the 24-192 hour forecasts of 0000 UTC GEFS Mean

0000 UTC GEFS	F024	F048	F072	F096	F120	F144	F168	F192
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8

Fields Used				
Mass Fields	300mb Heights	500mb Heights	850mb Heights	MSLP
Thermal Fields	500mb Temps	700mb Temps	850mb Temps	2m Temps
Moisture Fields	700mb Specific Humidity	850mb Specific Humidity	2m Specific Humidity	PWAT



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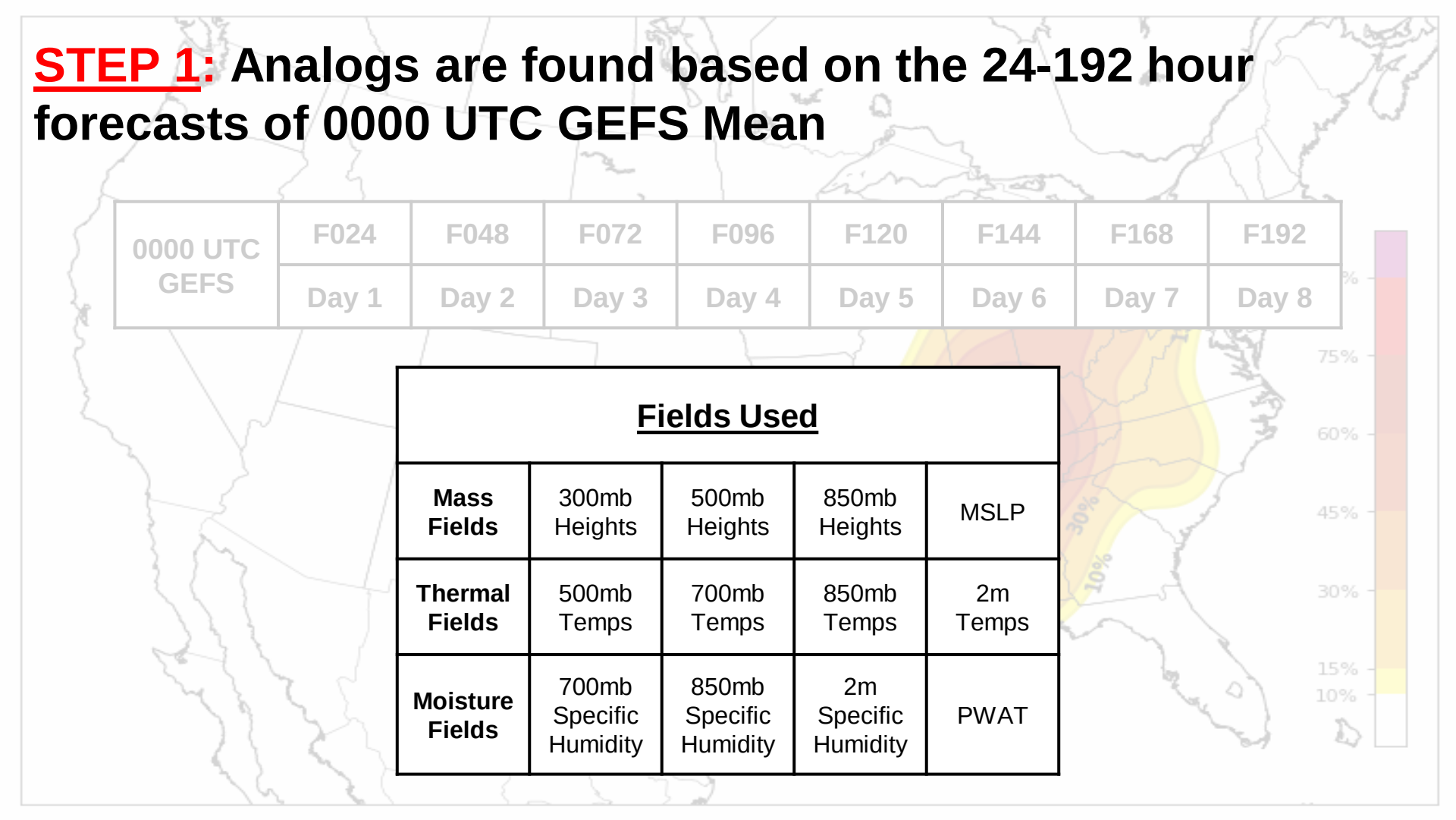
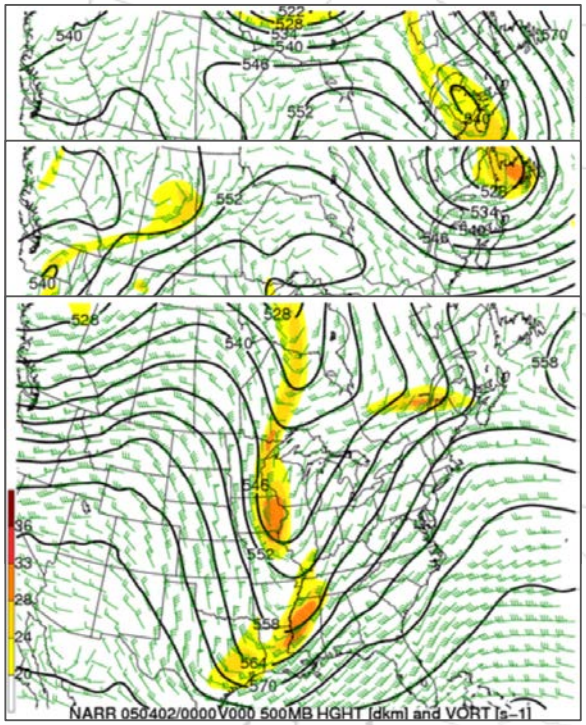
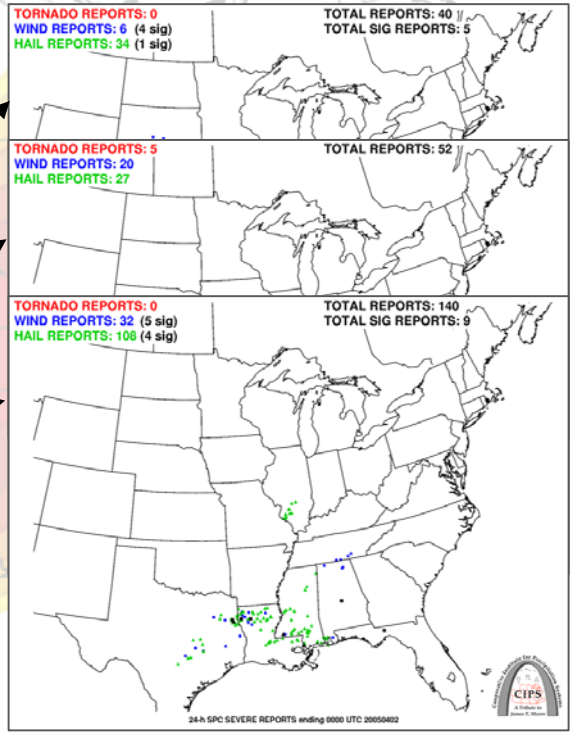


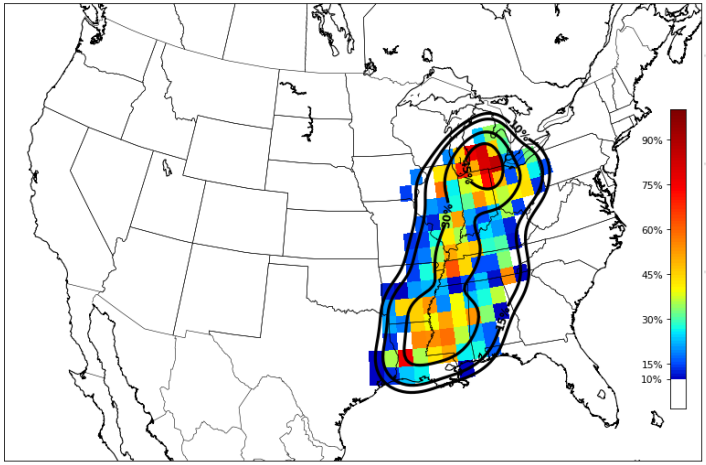
STEP 2: Machine Learning algorithm examines the relationship between analogs and severe reports





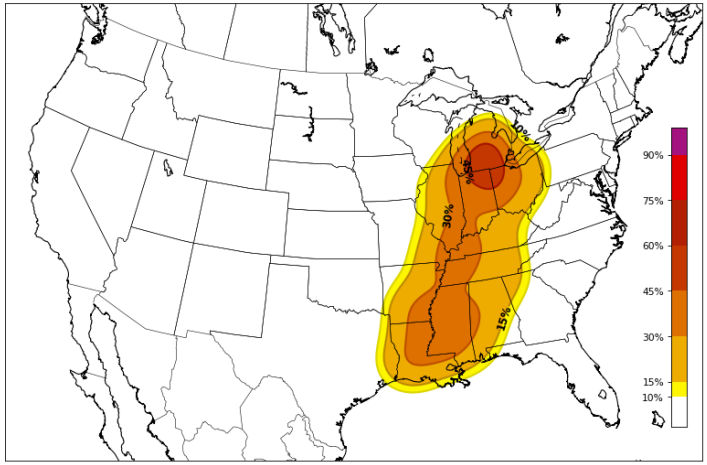
STEP 3: Machine Learning algorithm applies historical relationship to forecast. Output is probability of severe within 110km of a grid point.

Pixel Map



CIPS Experimental Analog-Based Severe Weather Guidance - Using GEFS 2019031400
24-h Probability of Severe within 110 km of a grid point centered at 2019031500

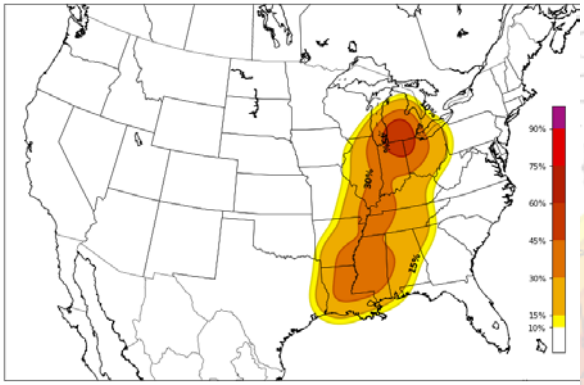
Smoothed Map



CIPS Experimental Analog-Based Severe Weather Guidance - Using GEFS 2019031400
24-h Probability of Severe within 110 km of a grid point centered at 2019031500

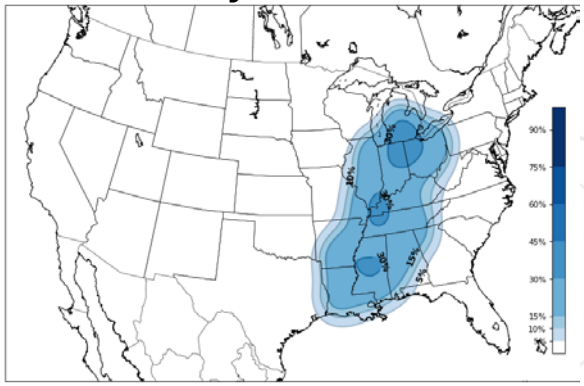
Hazards

Probability of All Severe Hazards



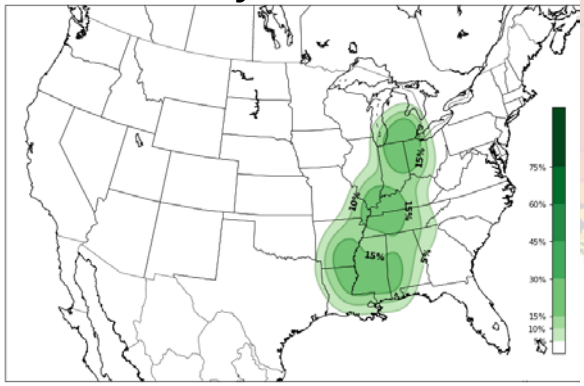
CIPS Experimental Analog-Based Severe Weather Guidance - Using GEFS 2019031400
24-h Probability of Severe within 110 km of a grid point centered at 2019031500

Probability of Severe Wind



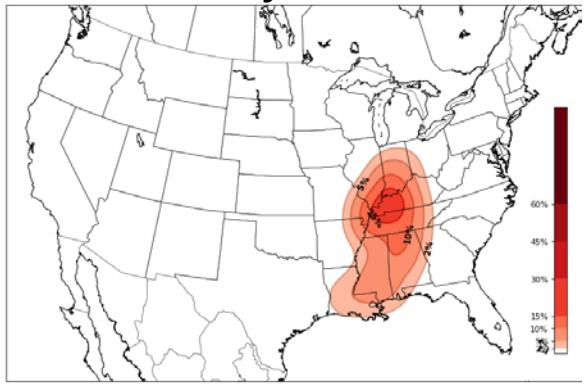
CIPS Experimental Analog-Based Severe Weather Guidance - Using GEFS 2019031400
24-h Probability of Wind within 110 km of a grid point centered at 2019031500

Probability of Severe Hail



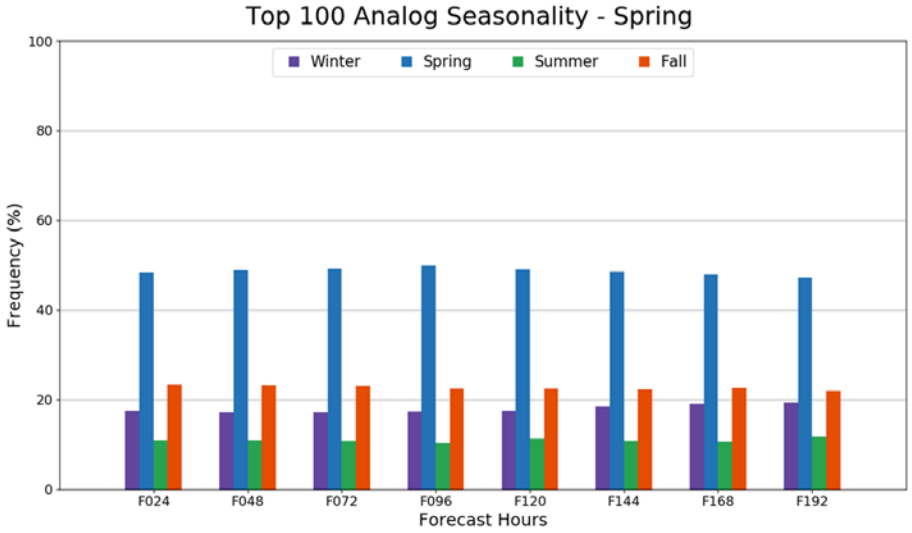
CIPS Experimental Analog-Based Severe Weather Guidance - Using GEFS 2019031400
24-h Probability of Hail within 110 km of a grid point centered at 2019031500

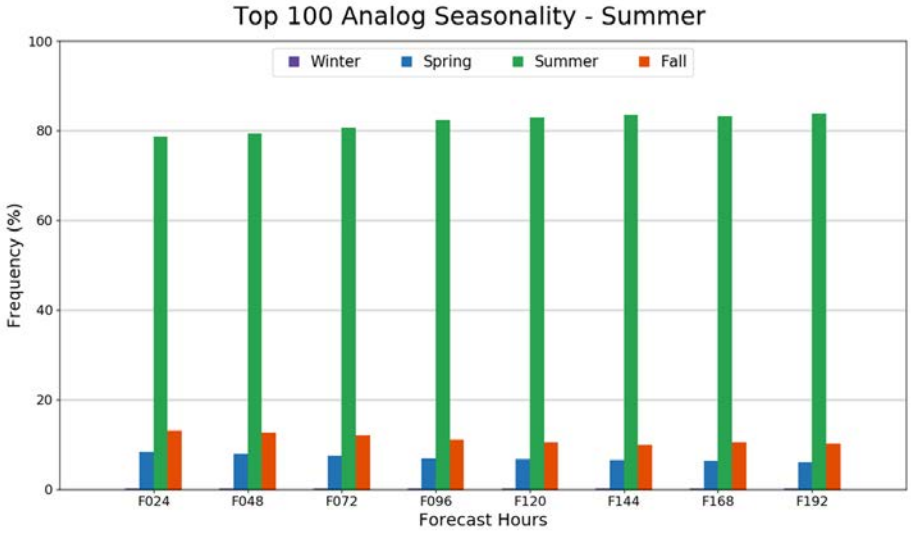
Probability of Tornado



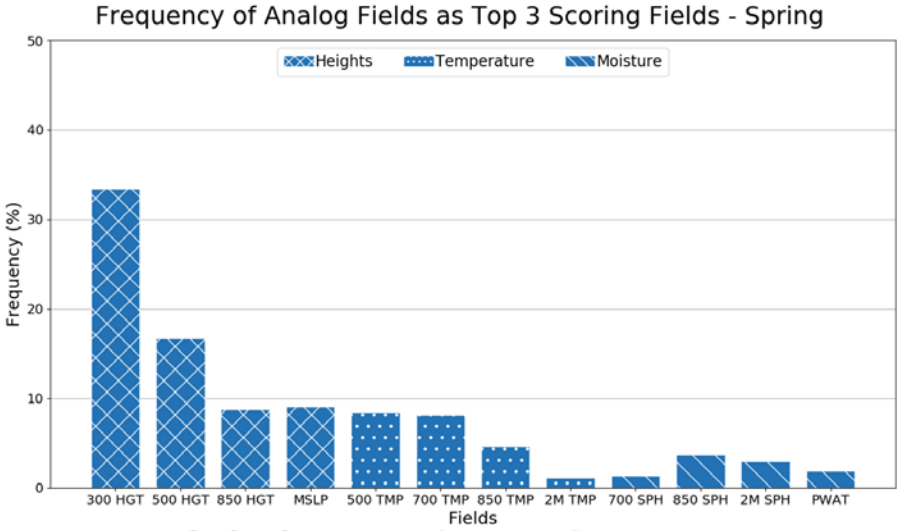
CIPS Experimental Analog-Based Severe Weather Guidance - Using GEFS 2019031400
24-h Probability of Tornado within 110 km of a grid point centered at 2019031500

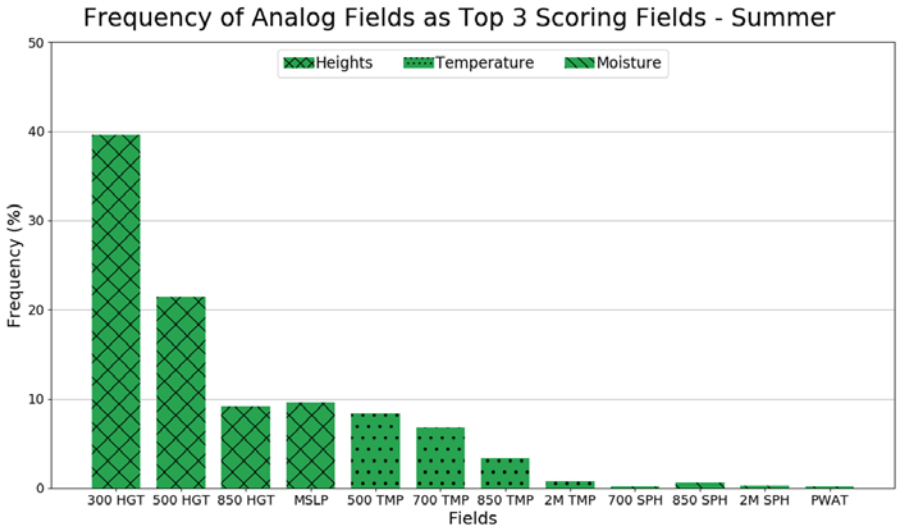
Analog Seasonal Source



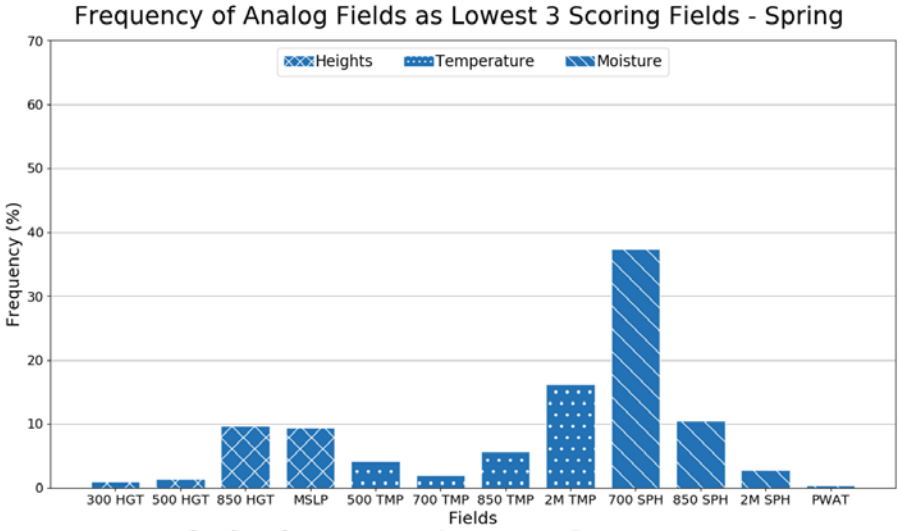


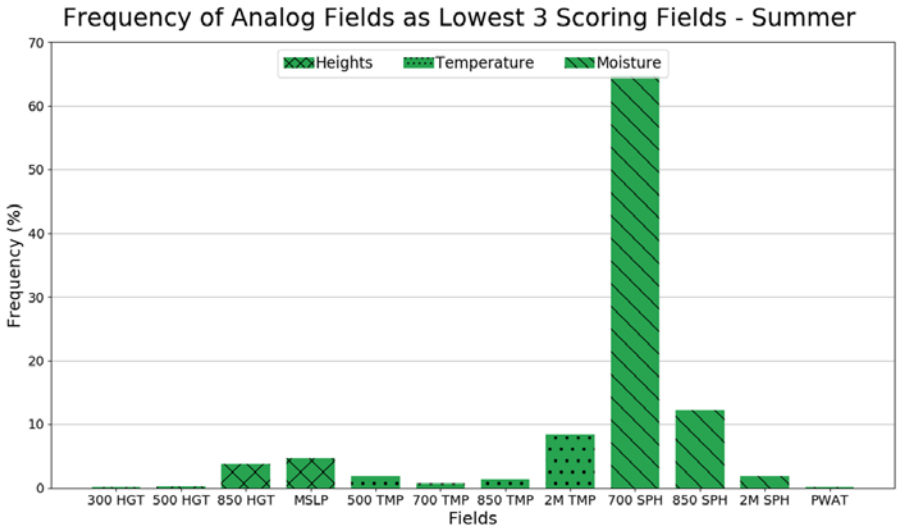
Best Matching Analog Fields



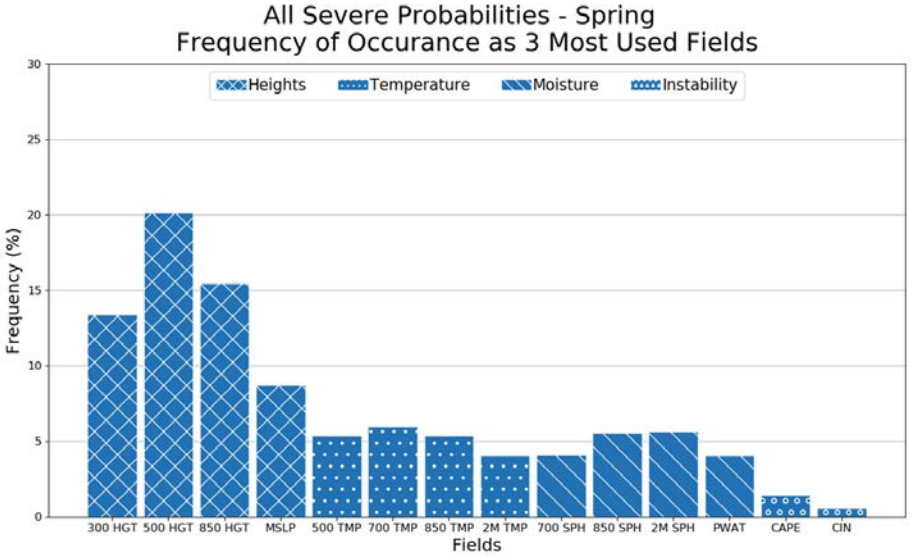


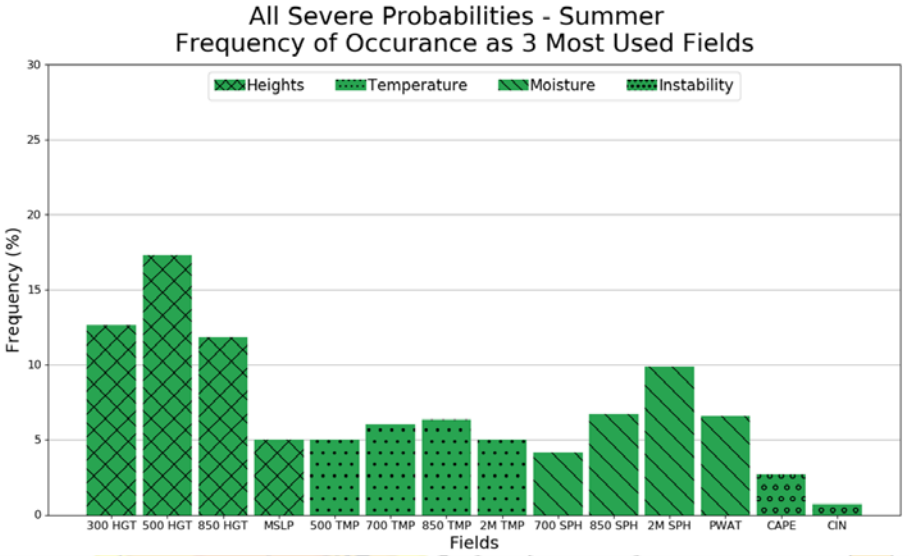
Worst Matching Analog Fields



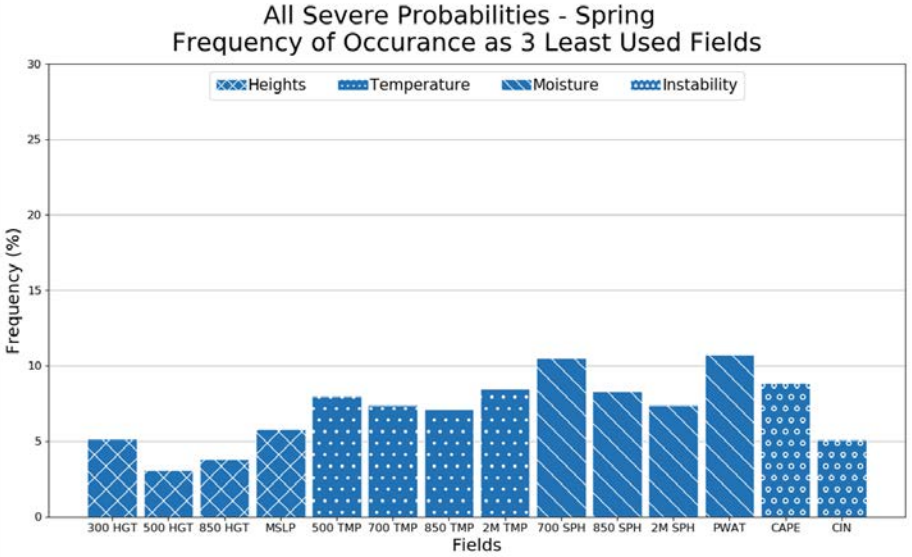


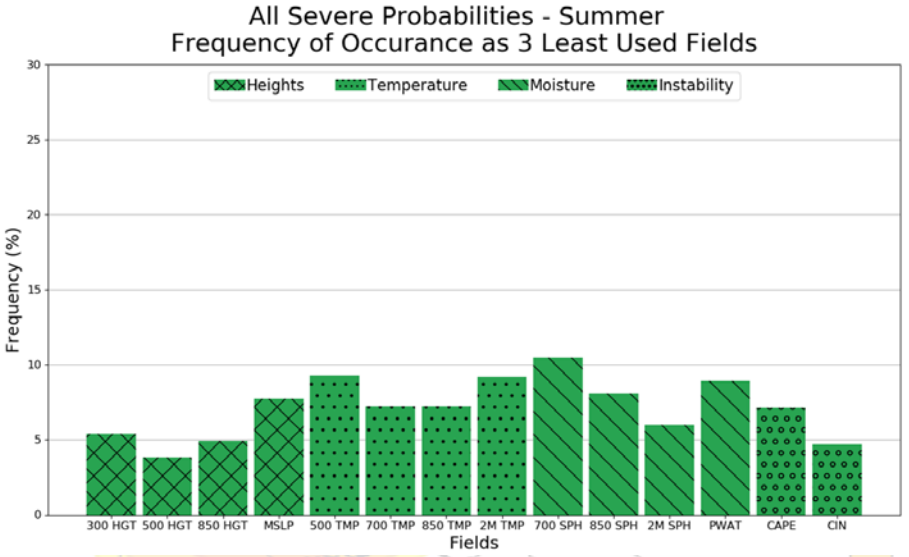
Most Used Fields

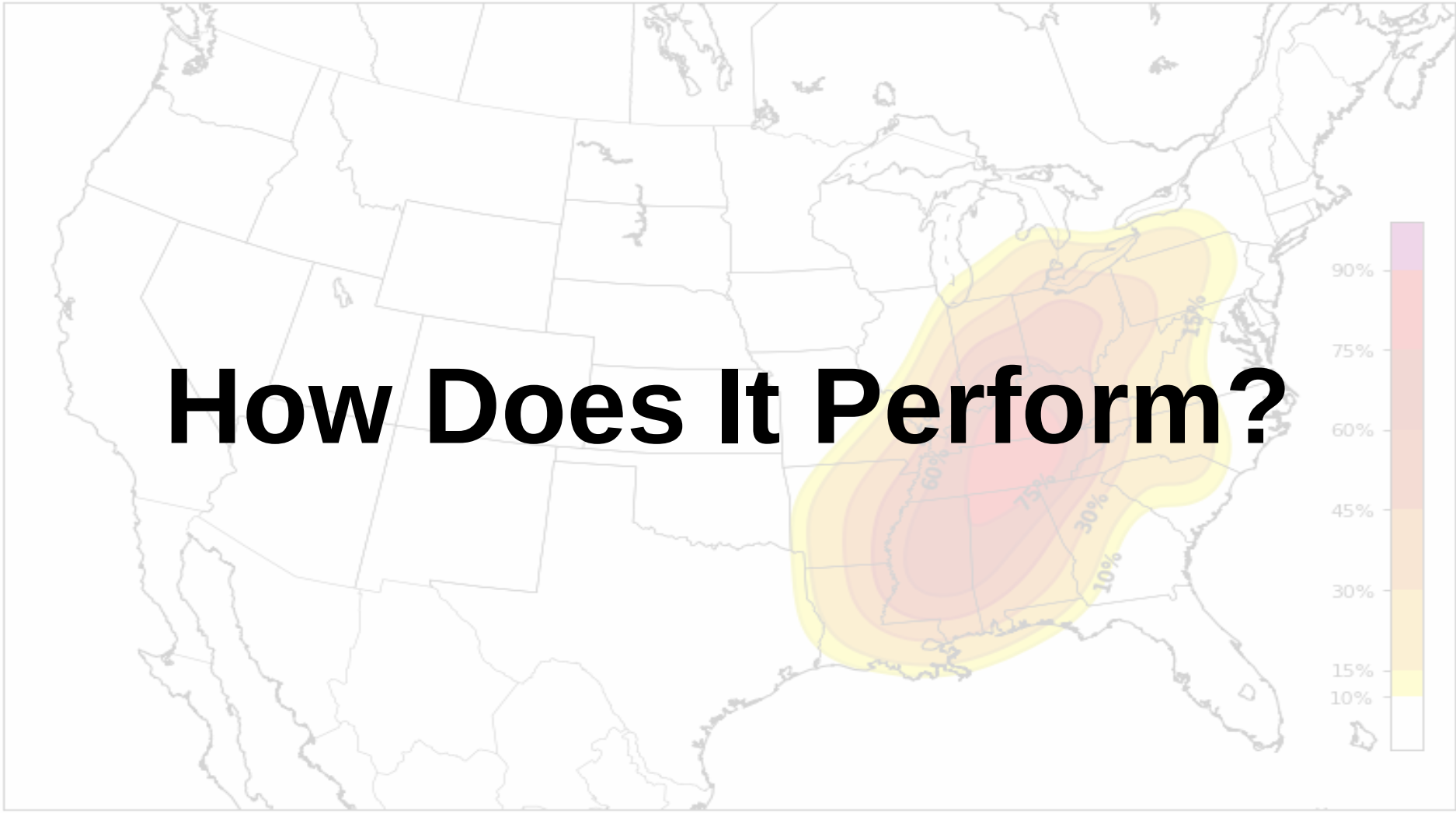




Least Used Fields

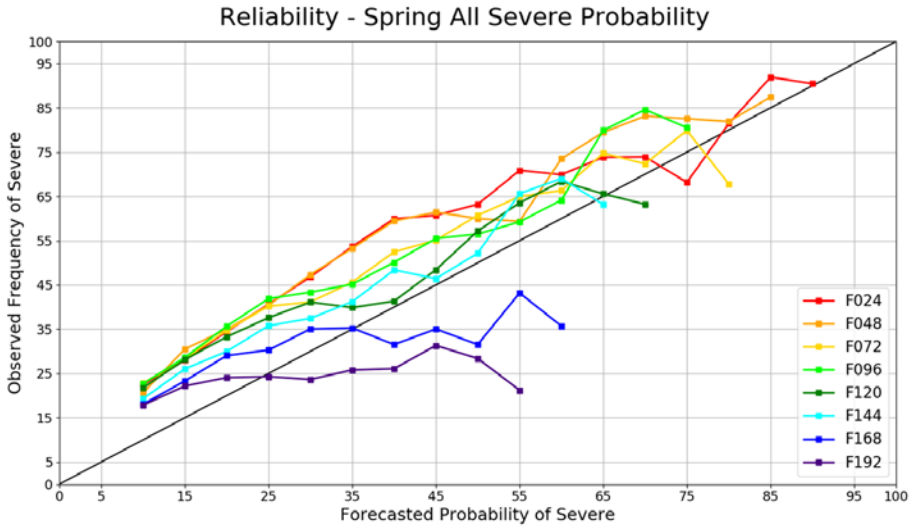


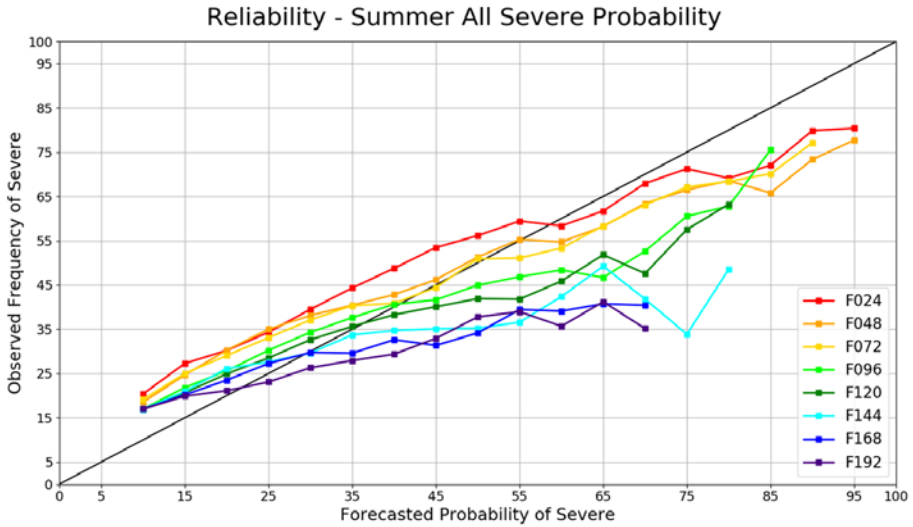




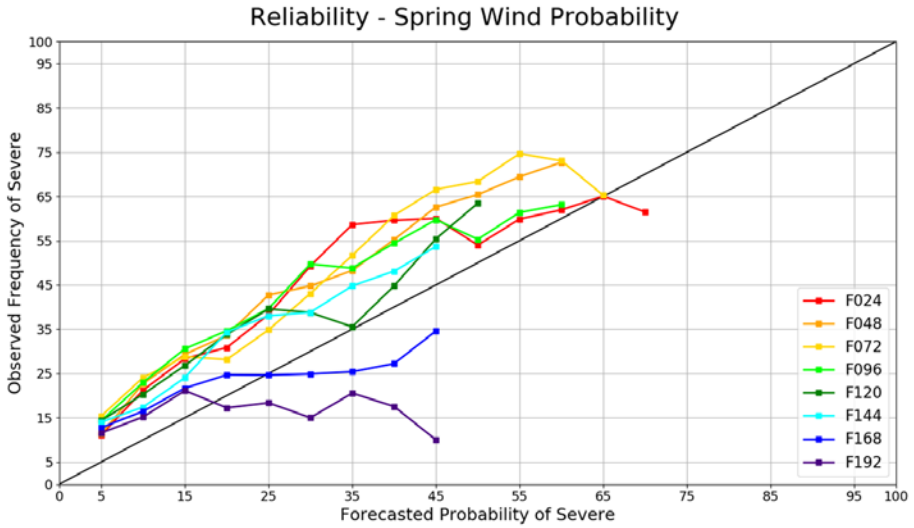
How Does It Perform?

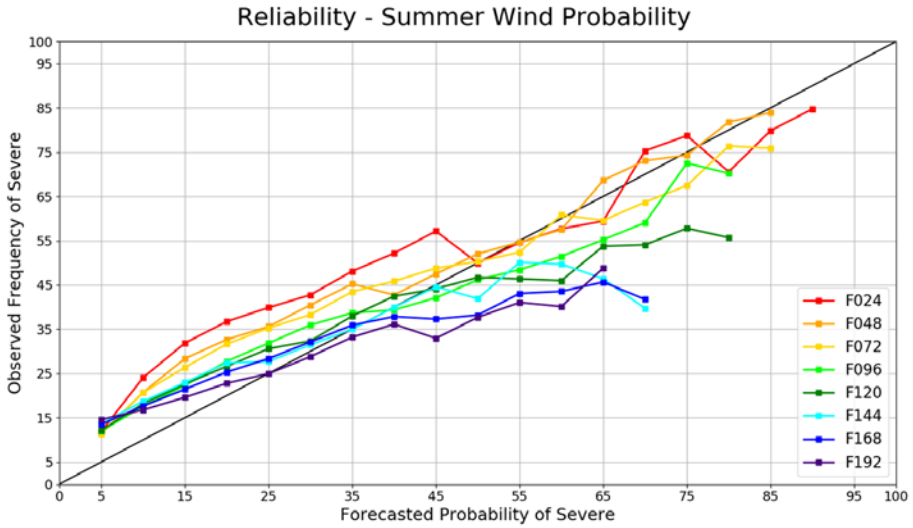
All Severe Reliability



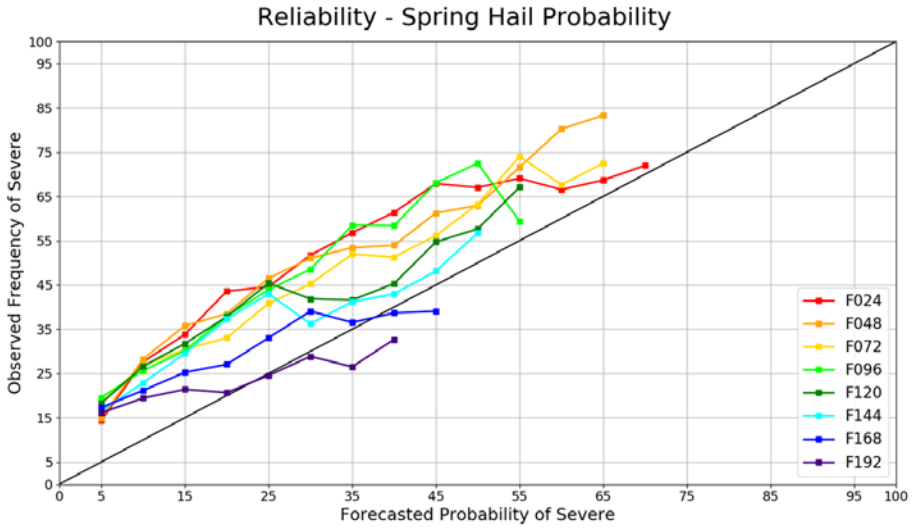


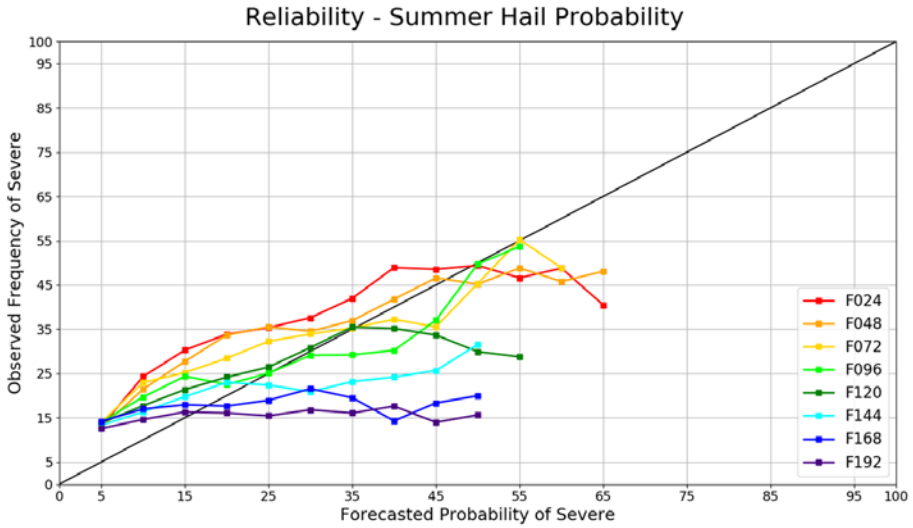
Wind Reliability



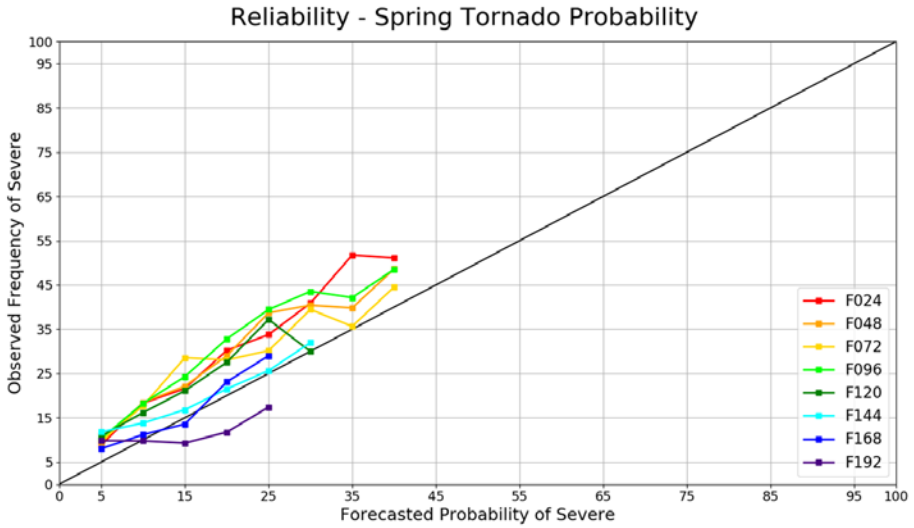


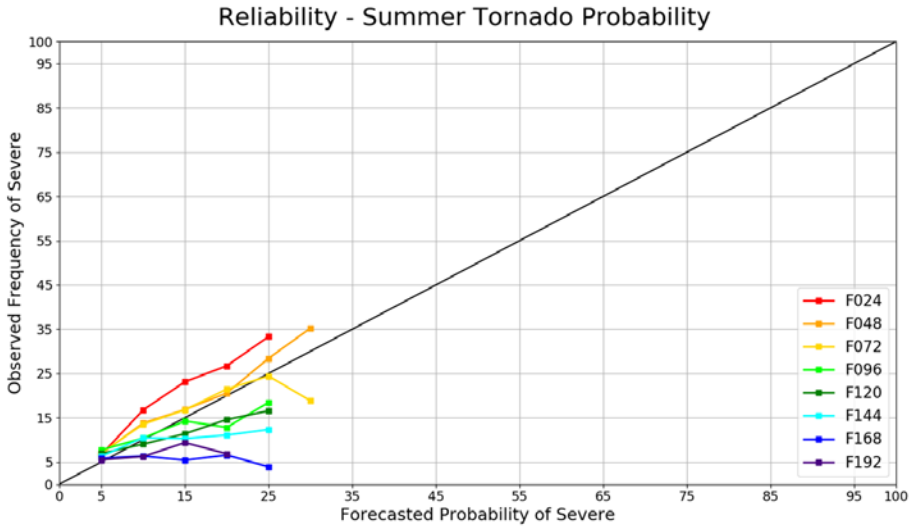
Hail Reliability

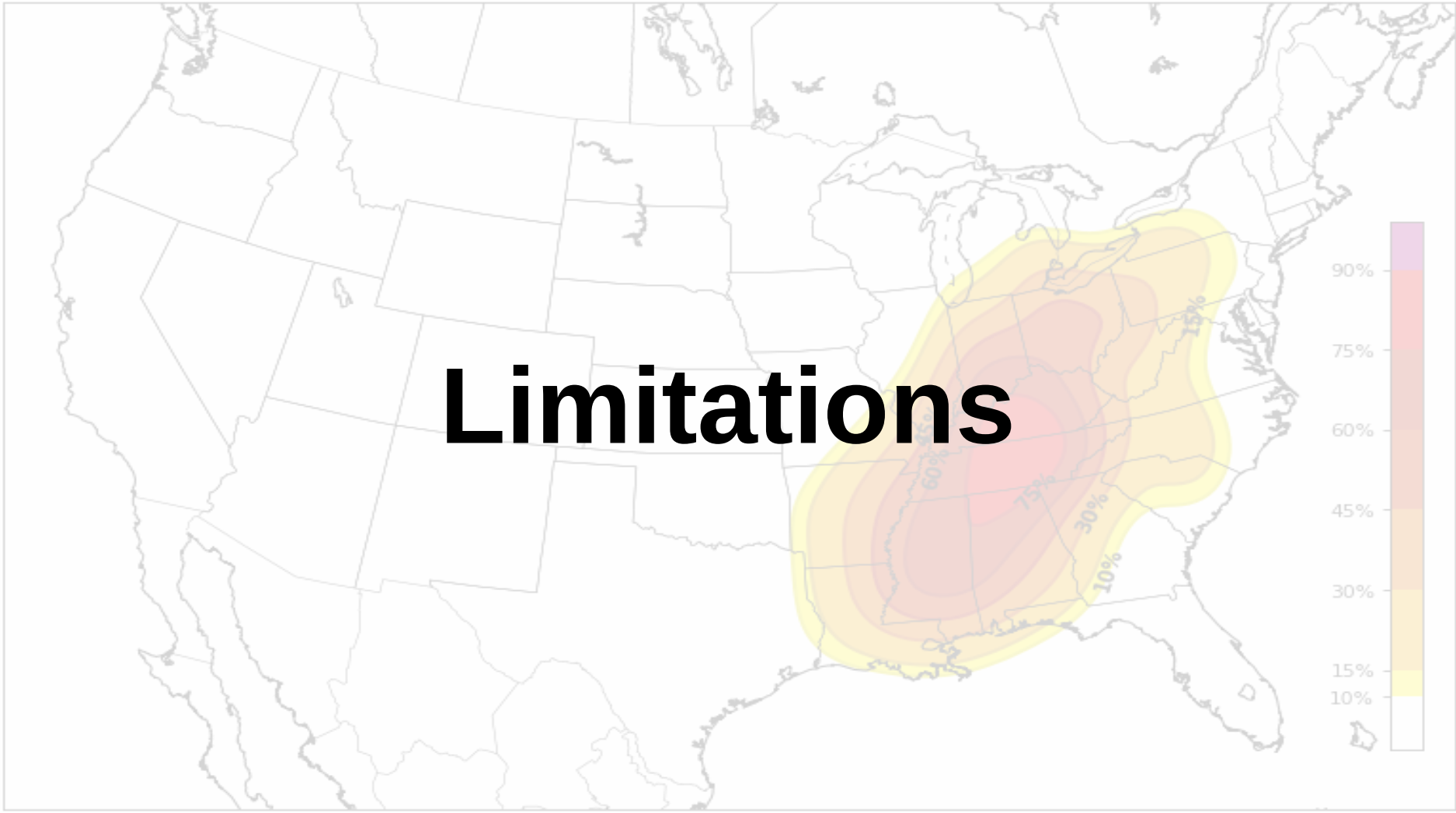




Tornado Reliability

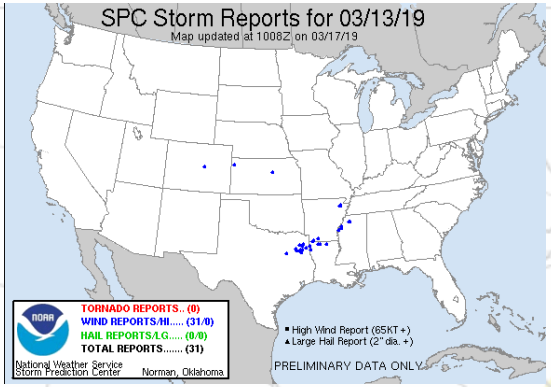




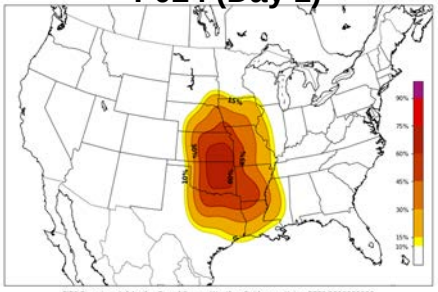


Limitations

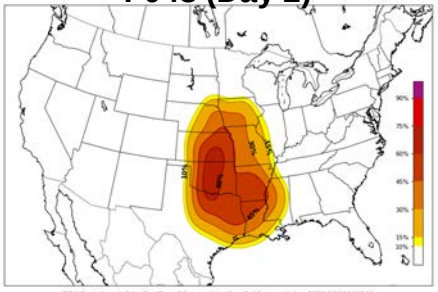
Limitations: Anomalous Events



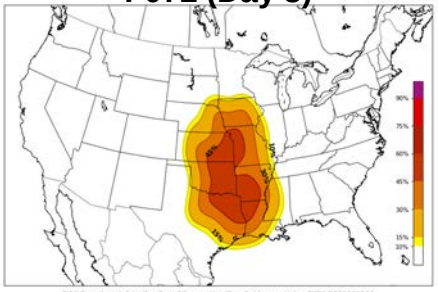
F024 (Day 1)



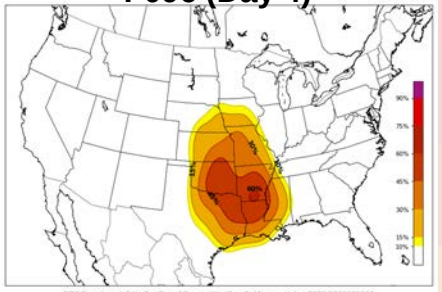
F048 (Day 2)



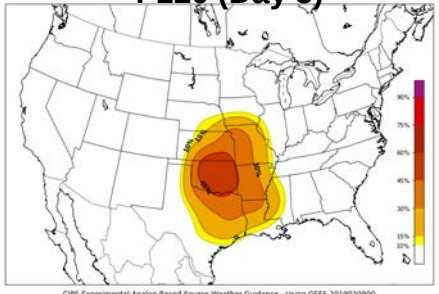
F072 (Day 3)



F096 (Day 4)

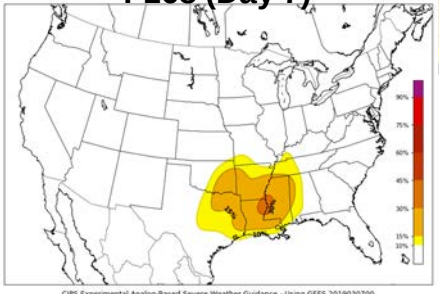


F120 (Day 5)

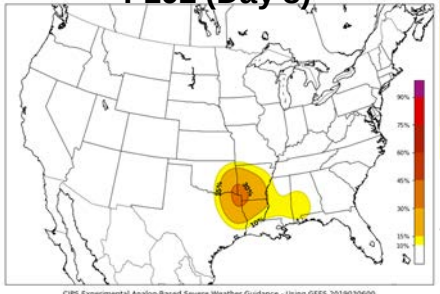


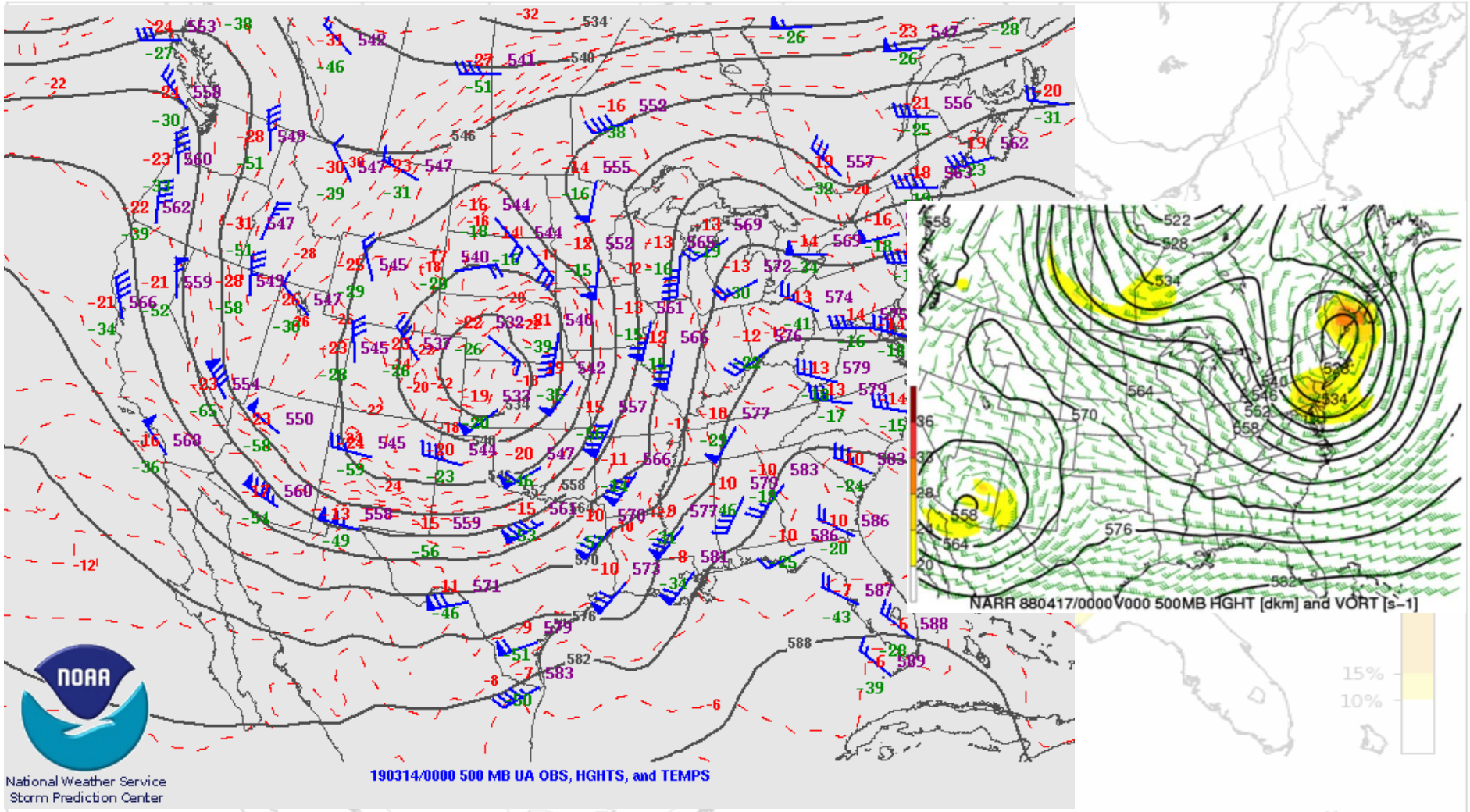
F144 (Day 6)

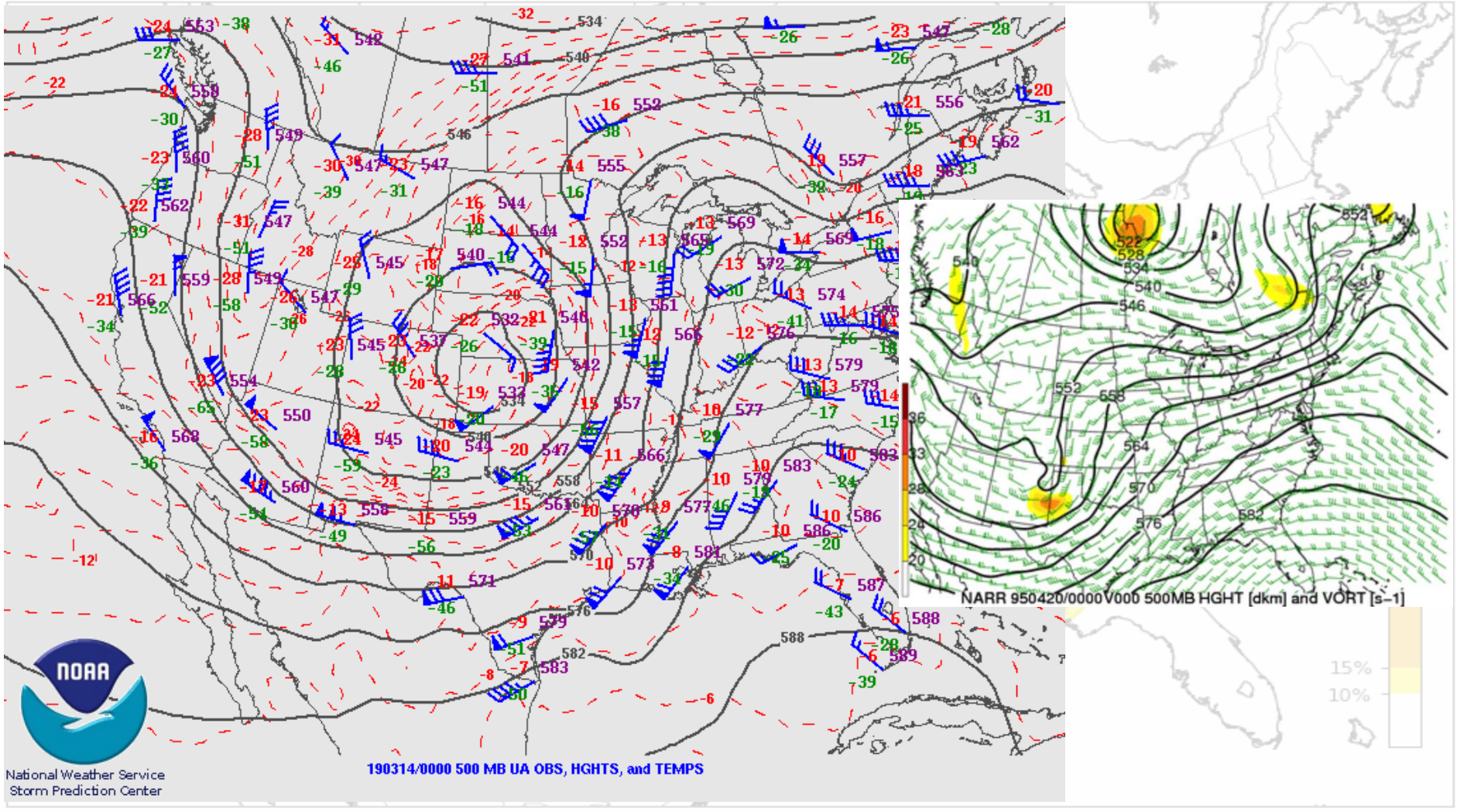
F168 (Day 7)



F192 (Day 8)




National Weather Service
Storm Prediction Center
190314/0000 500 MB UA OBS, HGHTS, and TEMPS
NARR 880417/0000V000 500MB HGHT [dkm] and VORT [s-1]
15%
10%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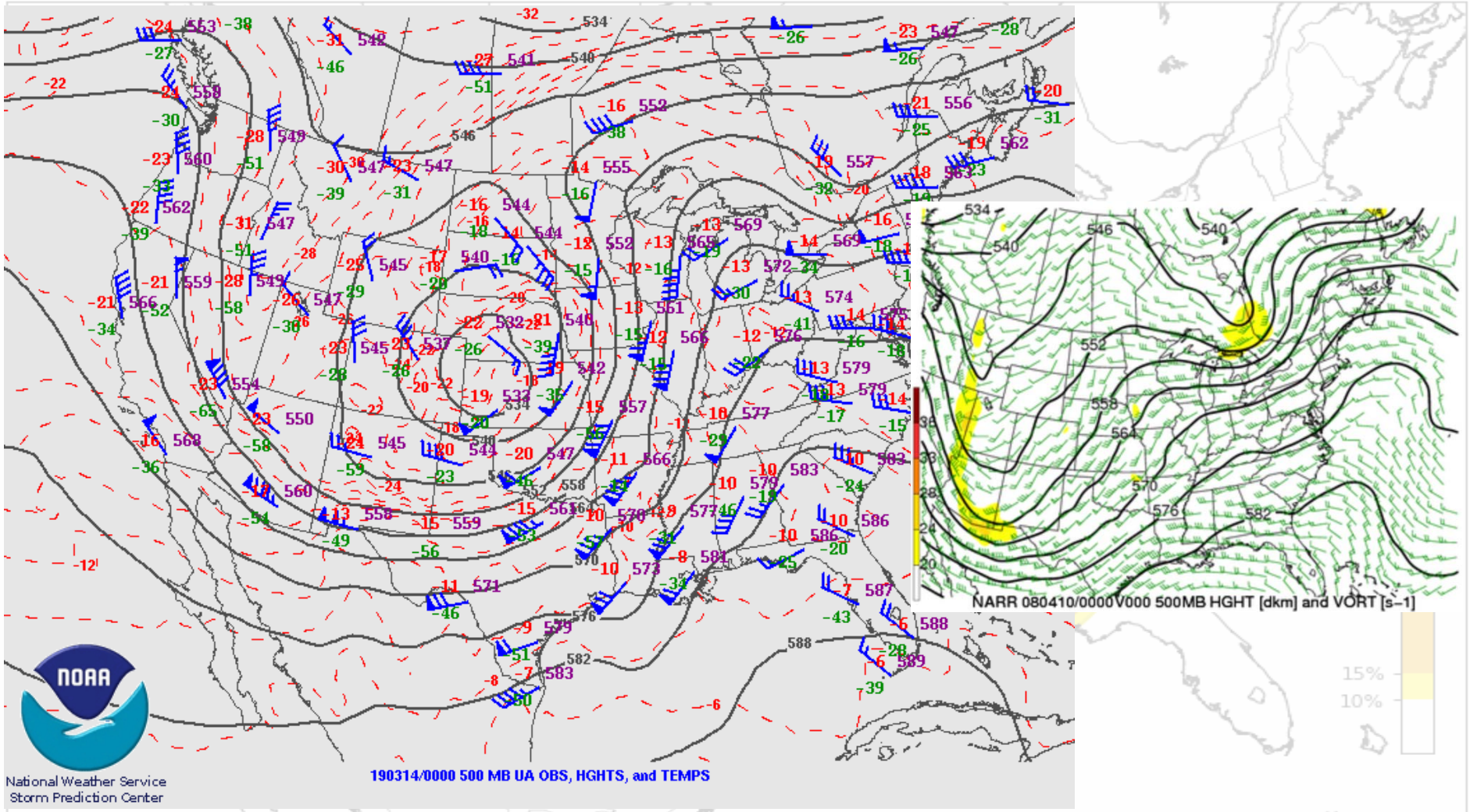
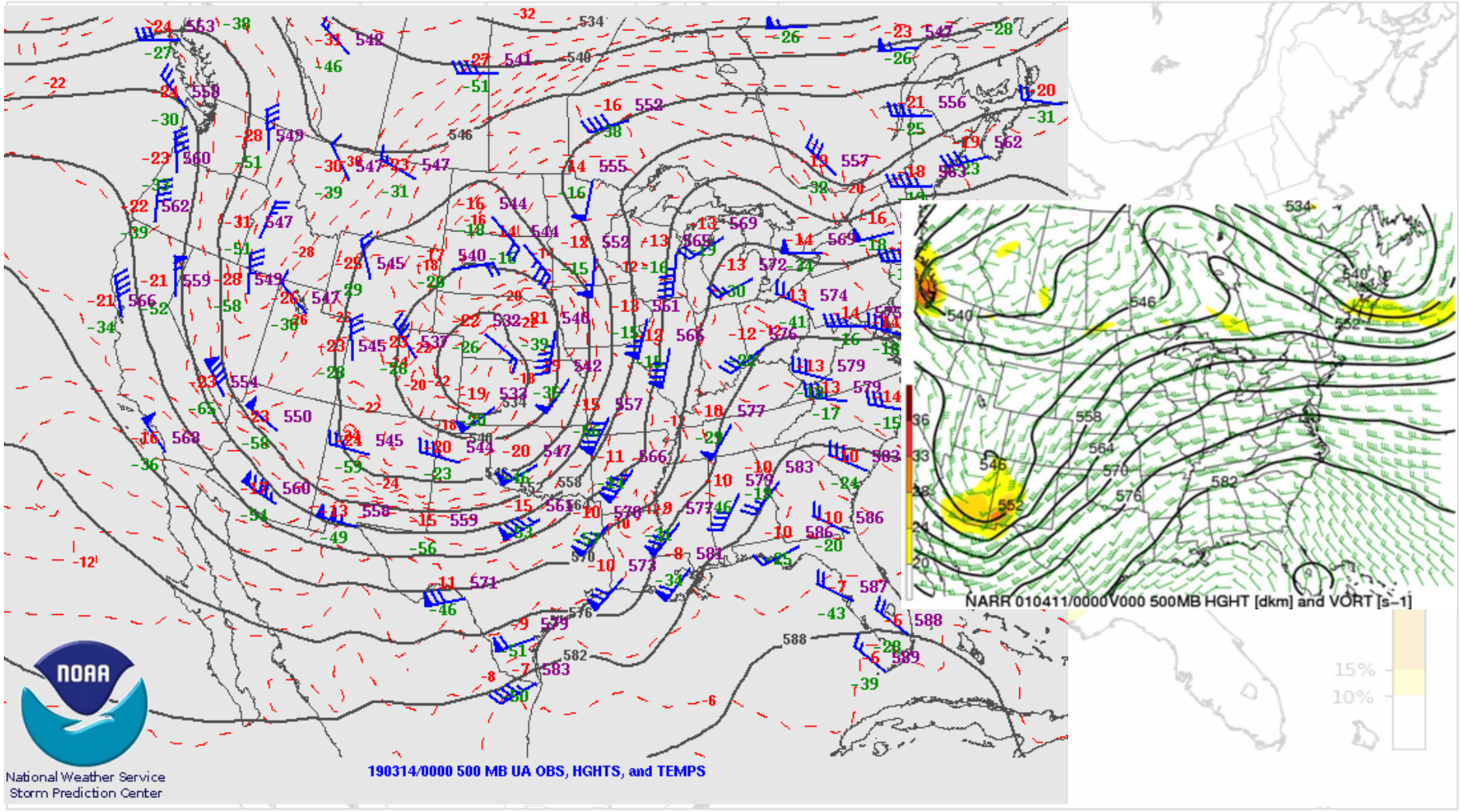
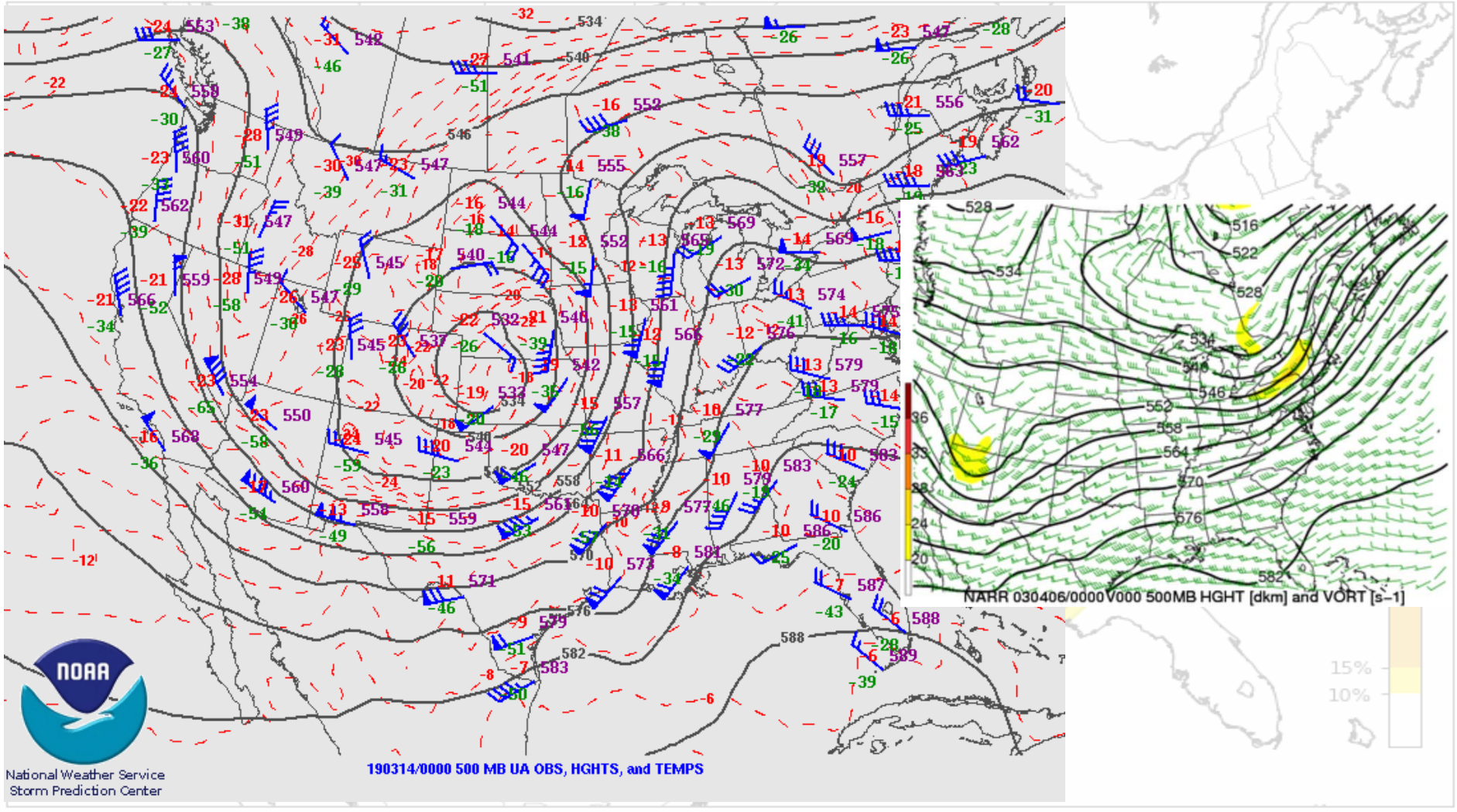
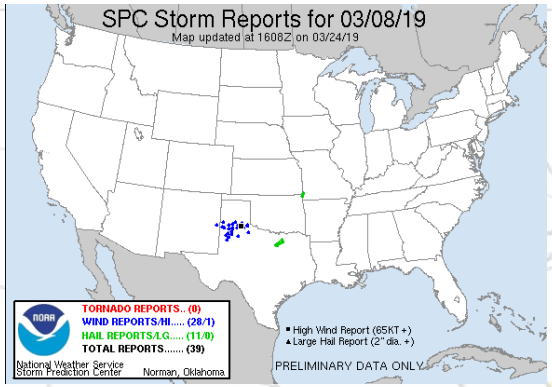
National Weather Service
Storm Prediction Center
NOAA


National Weather Service
Storm Prediction Center
190314/0000 500 MB UA OBS, HGHTS, and TEMPS
NARR 080410/0000V000 500MB HGHT [dkm] and VORT [s−1]
15%
10%


National Weather Service
Storm Prediction Center
190314/0000 500 MB UA OBS, HGHTS, and TEMPS
NARR 010411/0000V000 500MB HGHT [dkm] and VORT [s-1]
15%
10%


National Weather Service
Storm Prediction Center
190314/0000 500 MB UA OBS, HGHTS, and TEMPS
NARR 030406/0000V000 500MB HGHT [dkm] and VORT [s-1]
15%
10%

Limitations: Late Period & Mesoscale Events



F024 (Day 1)

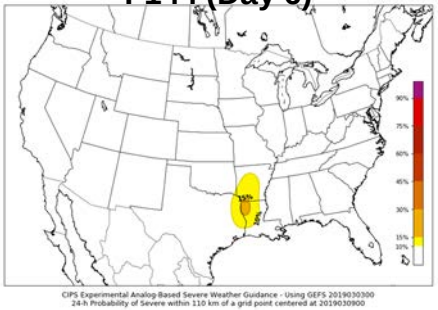
F048 (Day 2)

F072 (Day 3)

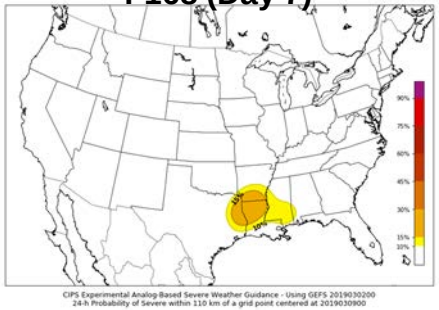
F096 (Day 4)

F120 (Day 5)

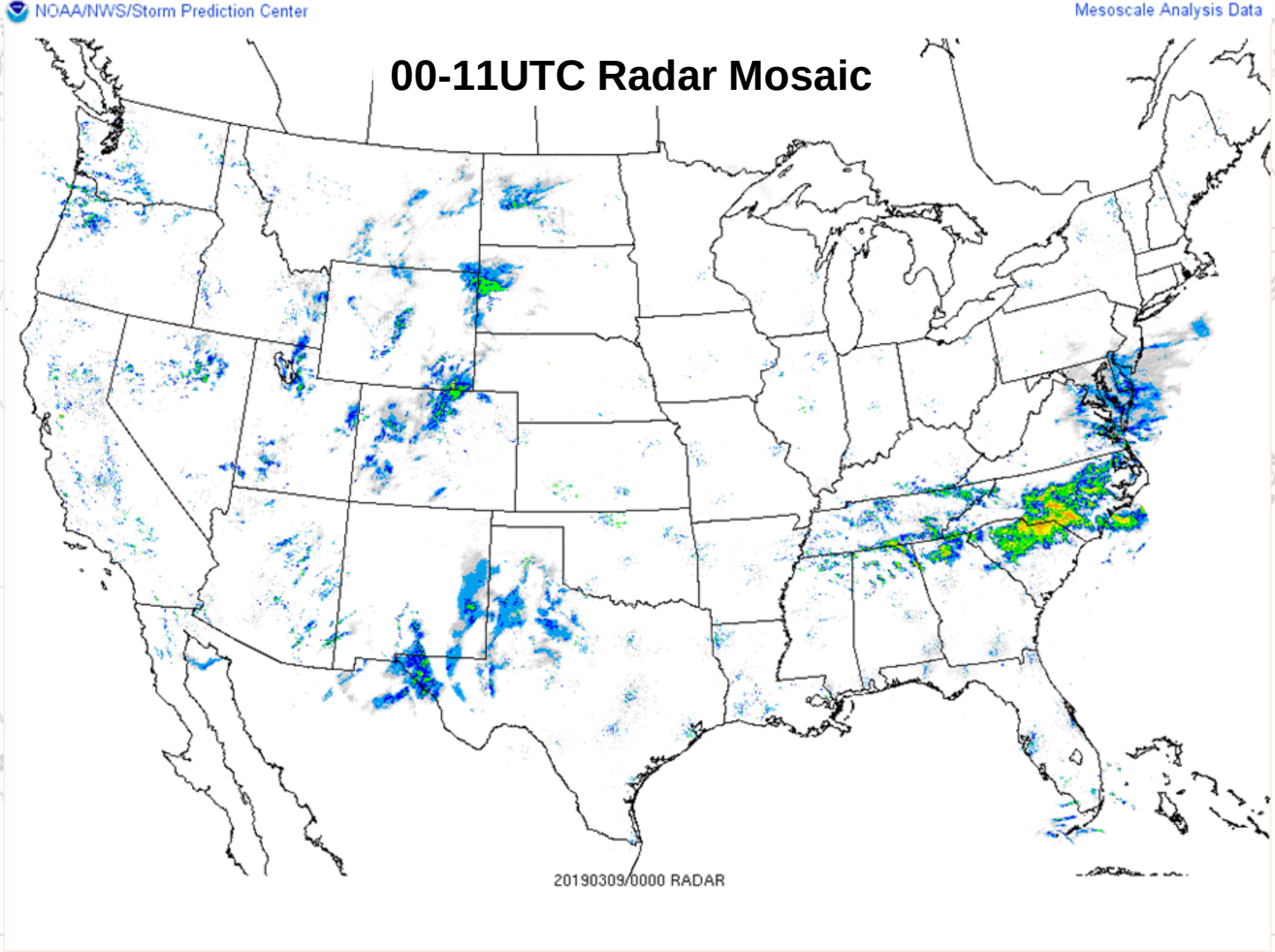
F144 (Day 6)



F168 (Day 7)



F192 (Day 8)


NOAA/NWS/Storm Prediction Center
Mesoscale Analysis Data
00-11UTC Radar Mosaic
90%
75%
60%
45%
30%
15%
10%
20190309/0000 RADAR

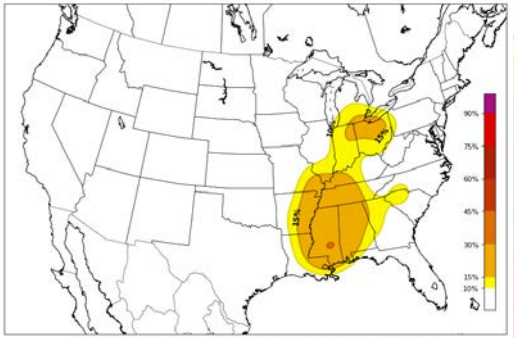
Ongoing Work

New Version:

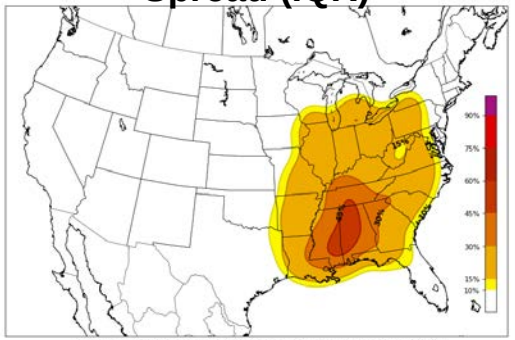
- **Each GEFS member is processed individually**
- **Allows for use of percentile statistics (assess uncertainty)**

F192 (Day 8)
Valid 20110428 at 0000 UTC

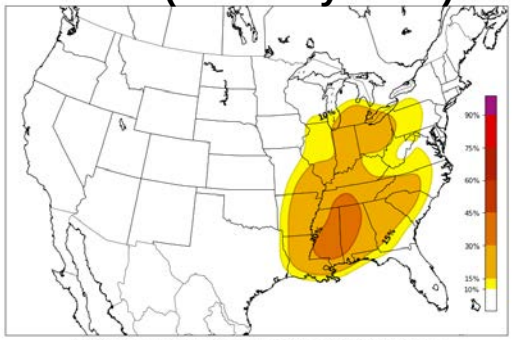
Median



Spread (IQR)

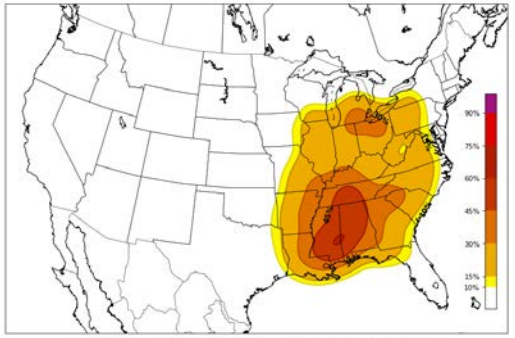


Mean (Currently Used)

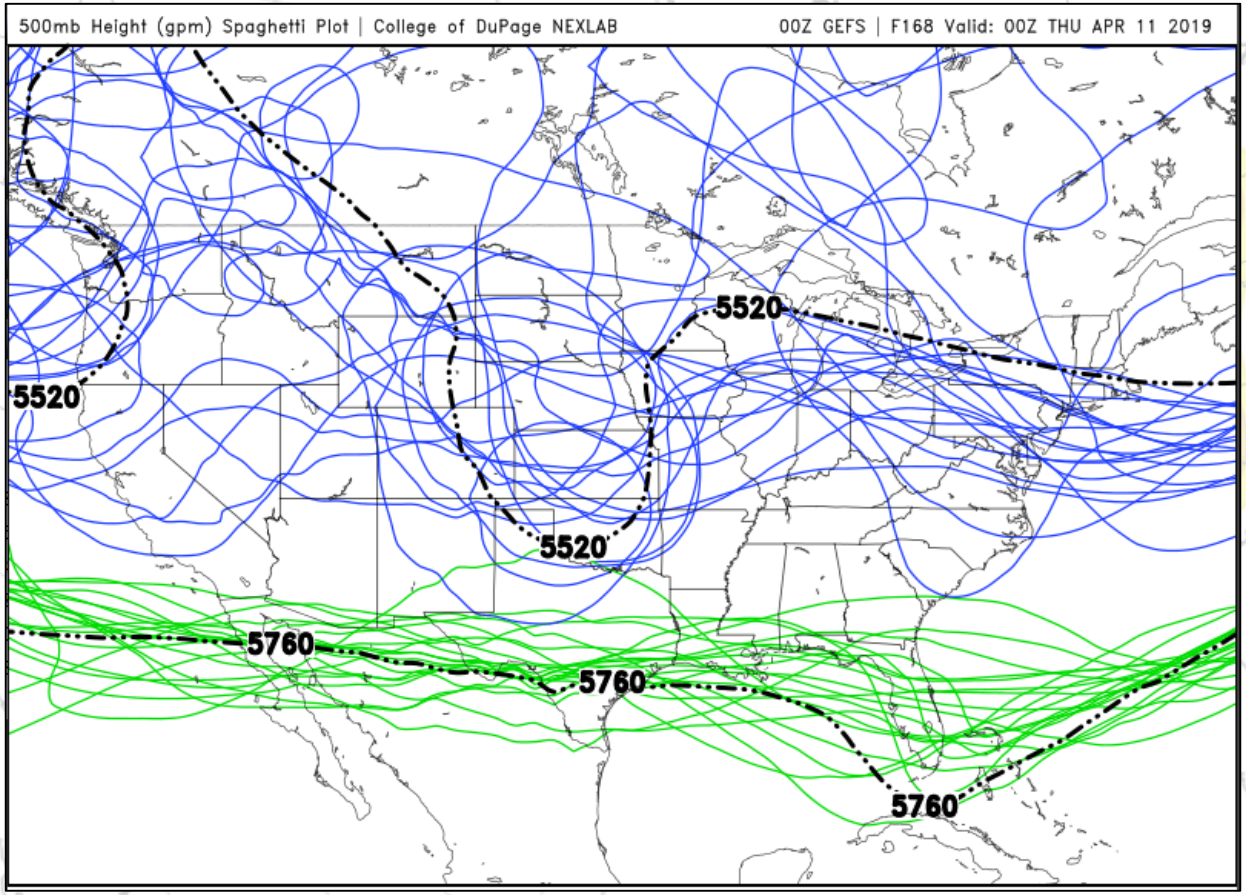


25th Percentile

75th Percentile



GEFS 500mb Heights Valid 168 Hours Out (Day 7)



Summary

Purpose:

- Provide probabilistic guidance for severe weather

Strengths:

- Identifies severe potential of large-scale pattern
- Provides forecast certainty/uncertainty

Limitations:

- Based on single model/ensemble
- Early- or late-period events
- Mesoscale events

Thank You:
NWS and SPC collaborators
Kyle Perez - Springfield, MO WFO
(Former SLU Master's Student)

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@CIPSAnalogs

Link to real-time guidance:
www.eas.slu.edu/CIPS/SVRprob/SVRprob.php