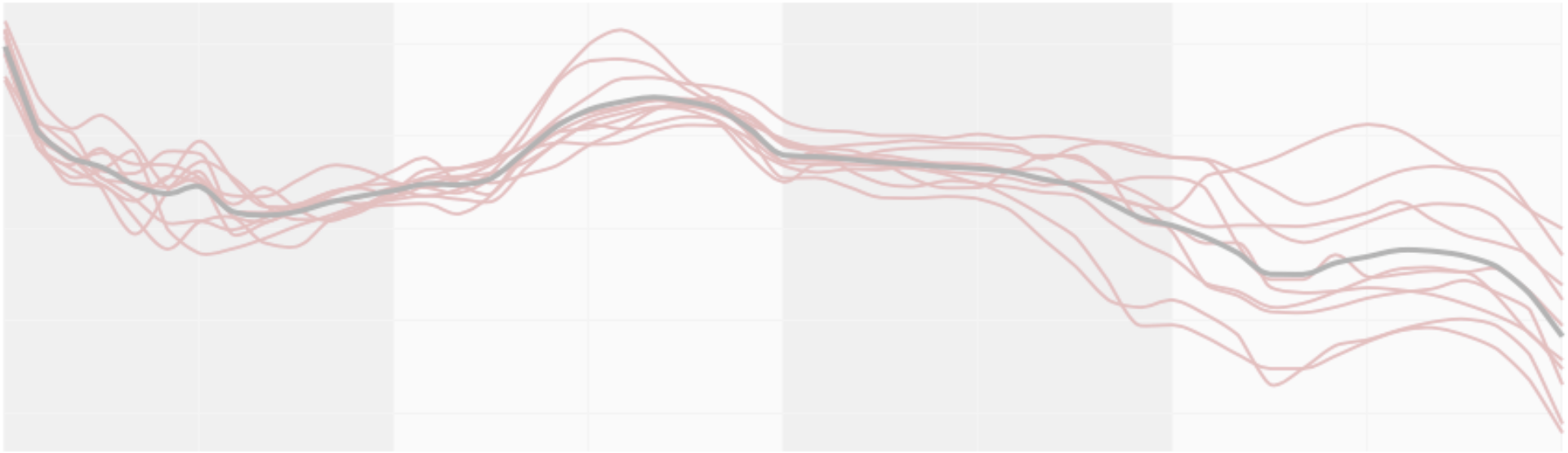
Visualizing ensemble forecast information using a WRF-based ensemble

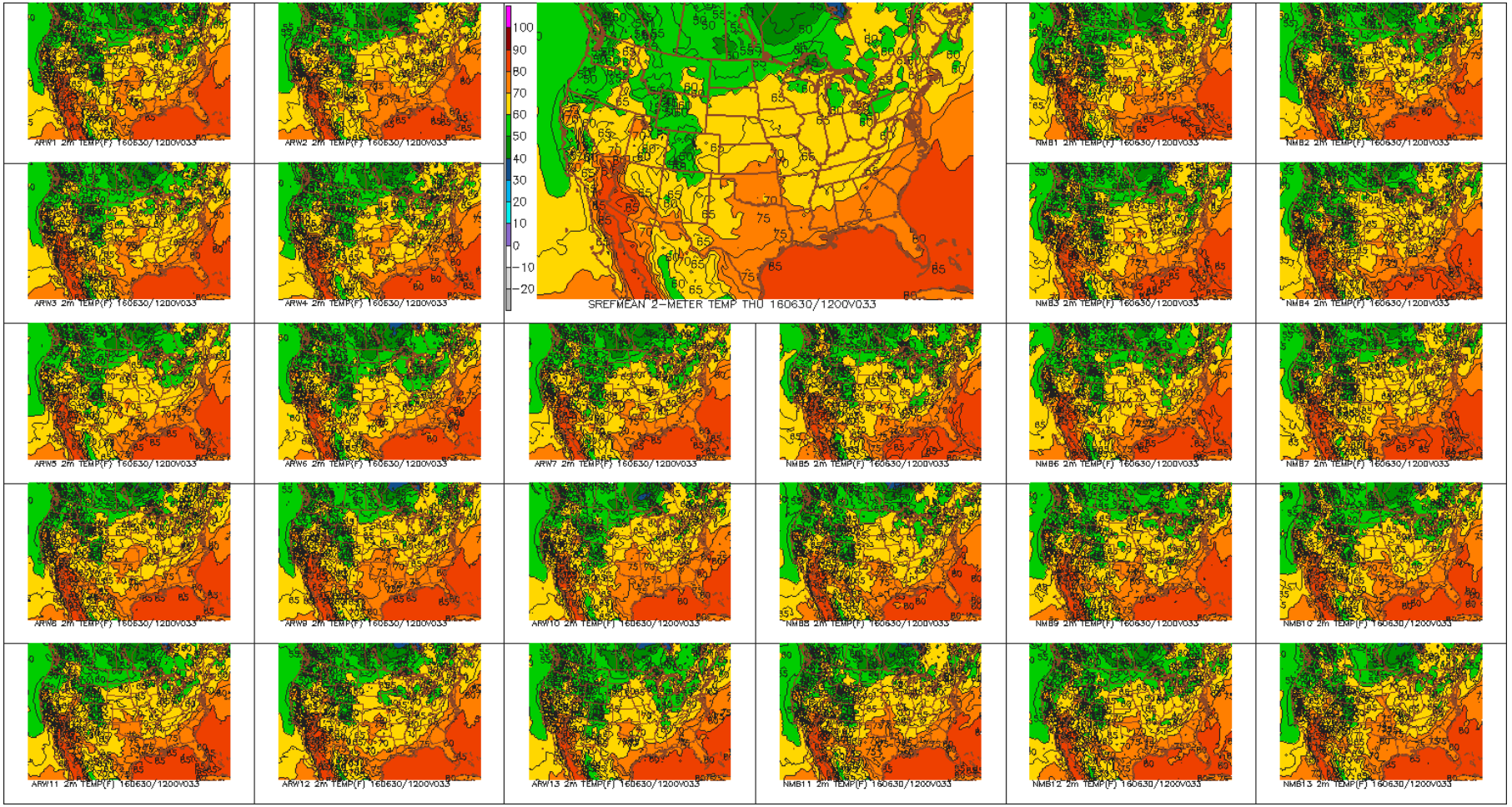
Ryan Sobash



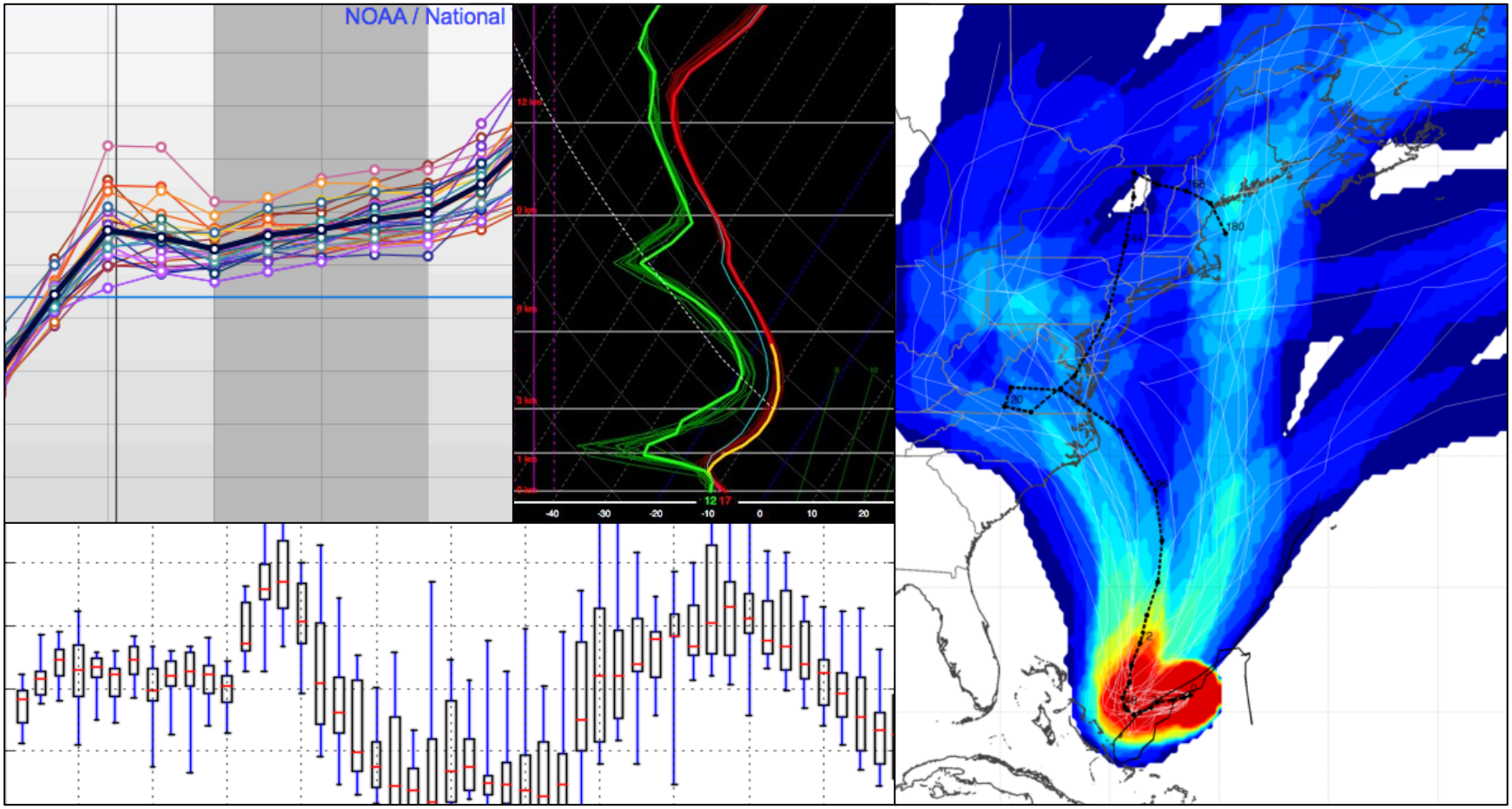
2016 WRF Users' Workshop: WRF-based ensemble tutorial

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Effective visualization of ensemble forecast data is a challenge…



Effective visualization of ensemble forecast data is a challenge…



http://**ensemble.ucar.edu**

NCAR Ensemble Forecasts
Initialized: **00 UTC Wed 29 Jun 2016**

Surface / Precip | Upper-Air | Severe | Winter | Hourly-Max | Domains

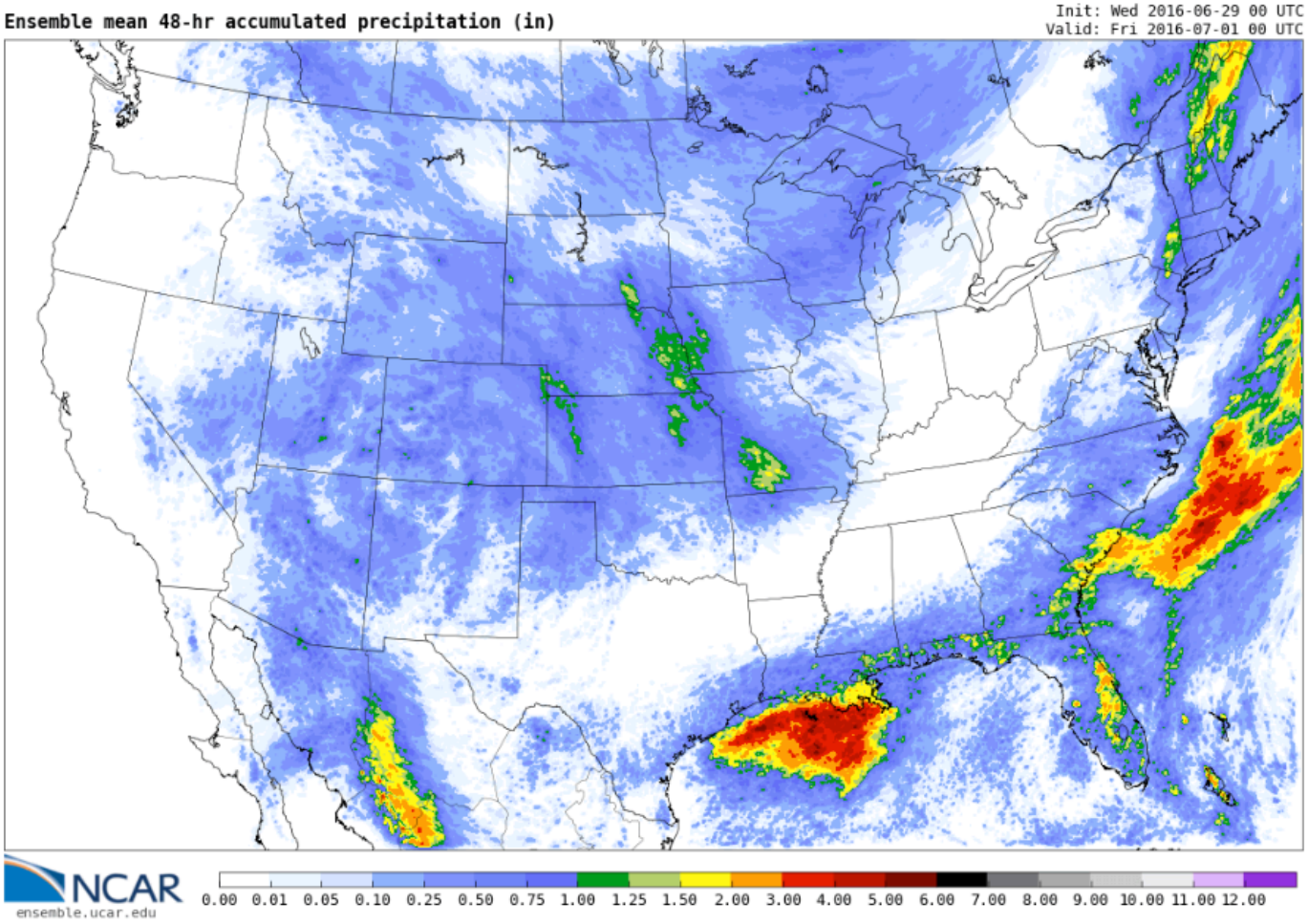
Ensemble Summary

- **Ens Mean 48-hr Precip**
- Ens Mean 48-hr Snowfall
- Ens Mean 48-hr Freezing Rain
- Ens Mean 48-hr Sleet
- Ens Max 48-hr Updraft Helicity
- Ens Max 48-hr Updraft Speed
- Ens Max 48-hr Surface Wind

What's New

- **NEW**: Member Viewer for CREF/UH
- **NEW**: Ensemble Plumes Page

- WAF Article Describing Ensemble System
- Ensemble soundings now available at every 30th grid point
- Addition of Frequently Asked Questions webpage

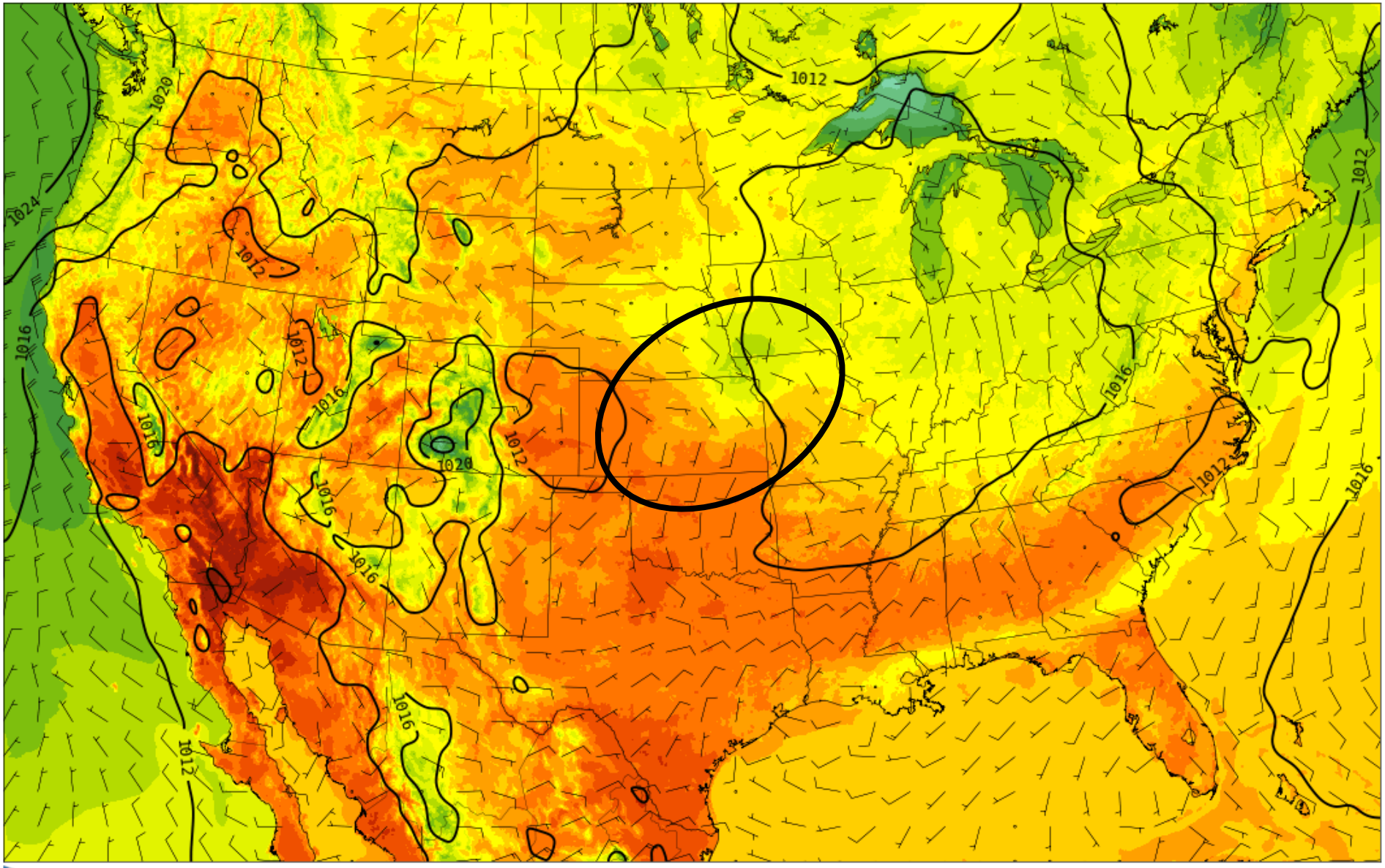


Forecasts sponsored by the National Science Foundation, National Center for Atmospheric Research/Mesoscale and Microscale Meteorology Laboratory, and Computational Information Systems Laboratory
About these Forecasts || Analysis System Statistics || Verification || System Status || FAQ || Contact us: ensemble (at) ucar (dot) edu

Lots of data! (NCAR 10-member 3-km WRF ensemble produces ~4 TB of data/day).

Ensemble mean 2-m temperature (fill; F), MSLP (contour; hPa), and 10-m wind (kts)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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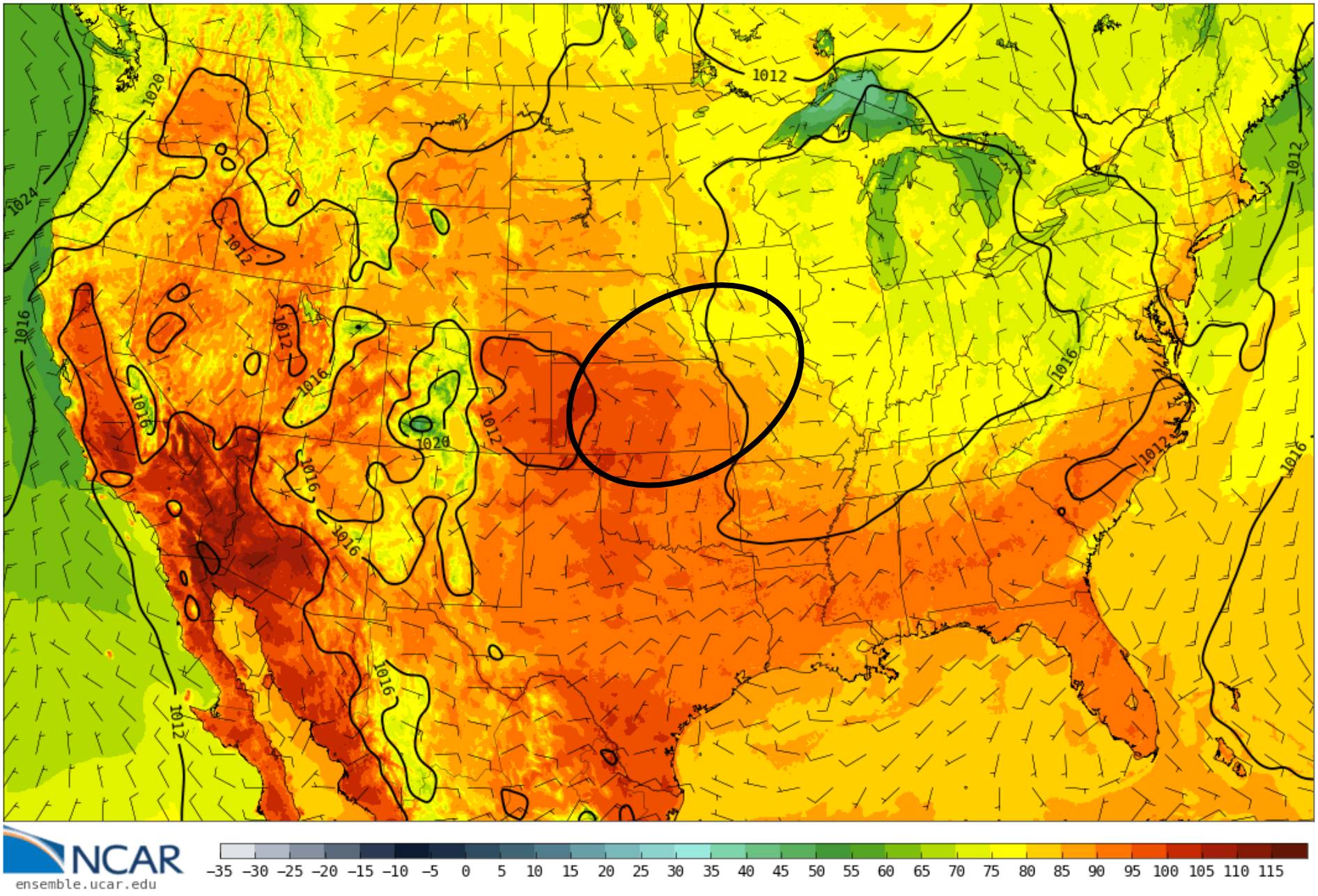
−35 −30 −25 −20 −15 −10 −5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115


Ensemble max. 2-m temperature (fill; F), mean MSLP (contour; hPa), and mean 10-m wind (kts)
Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC
1012
1020
1024
1016
1012
1016
1012
1016
1020
1012
1016
1016
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1012
1016
−35 −30 −25 −20 −15 −10 −5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115
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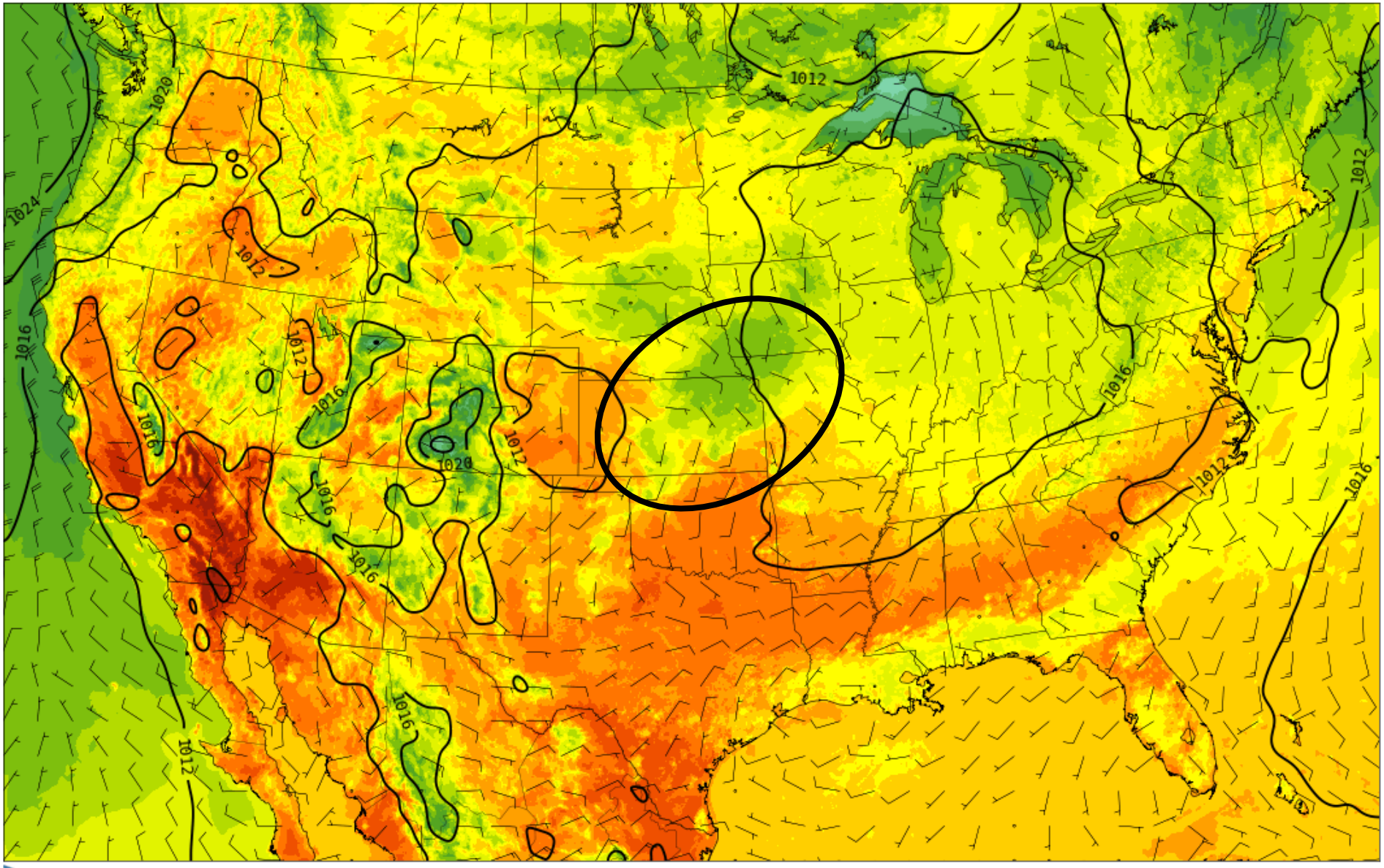
Ensemble min. 2-m temperature (fill; F), mean MSLP (contour; hPa), and mean 10-m wind (kts)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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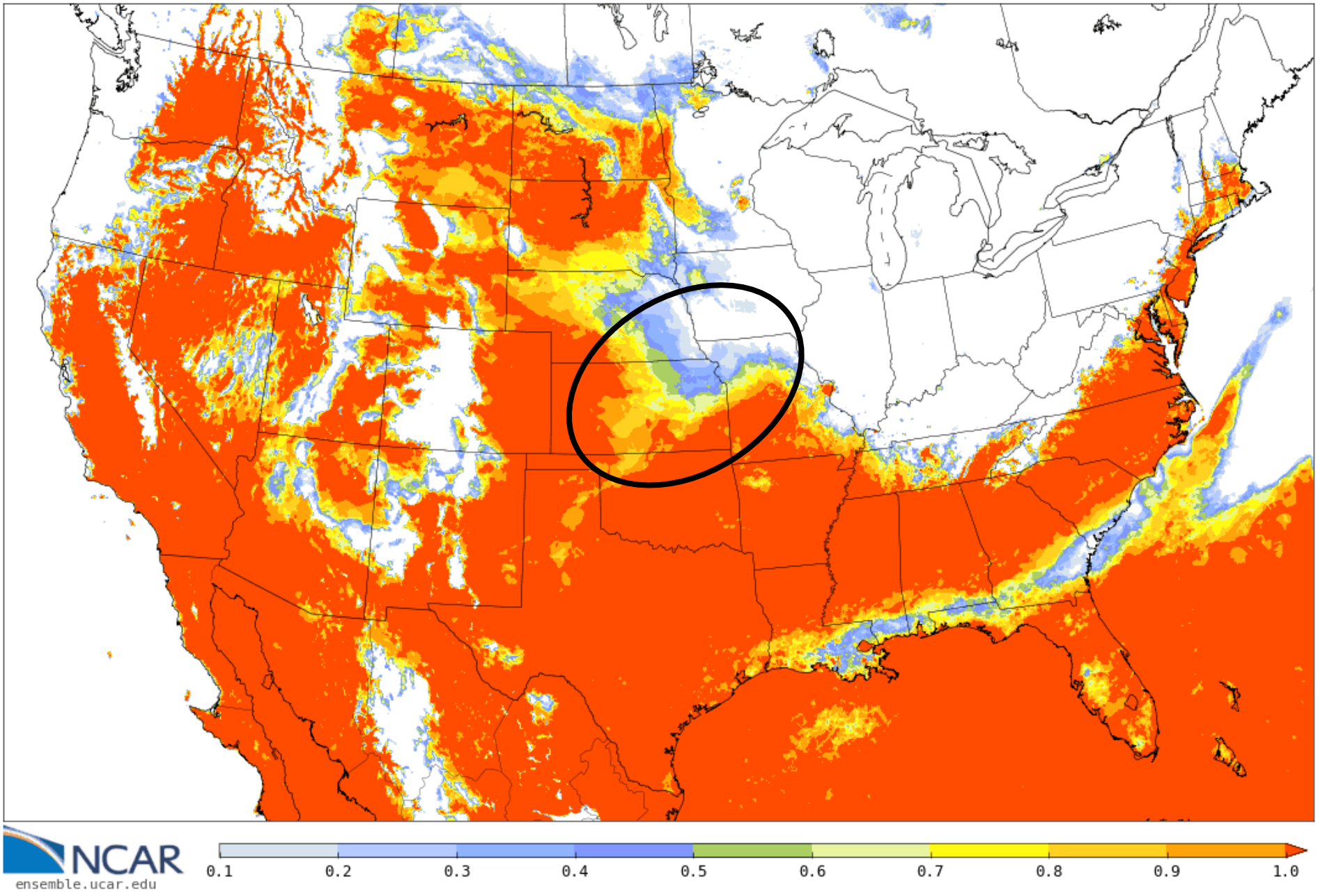
−35 −30 −25 −20 −15 −10 −5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115


Probability of 2-m temperature > 80F (fill)
Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC
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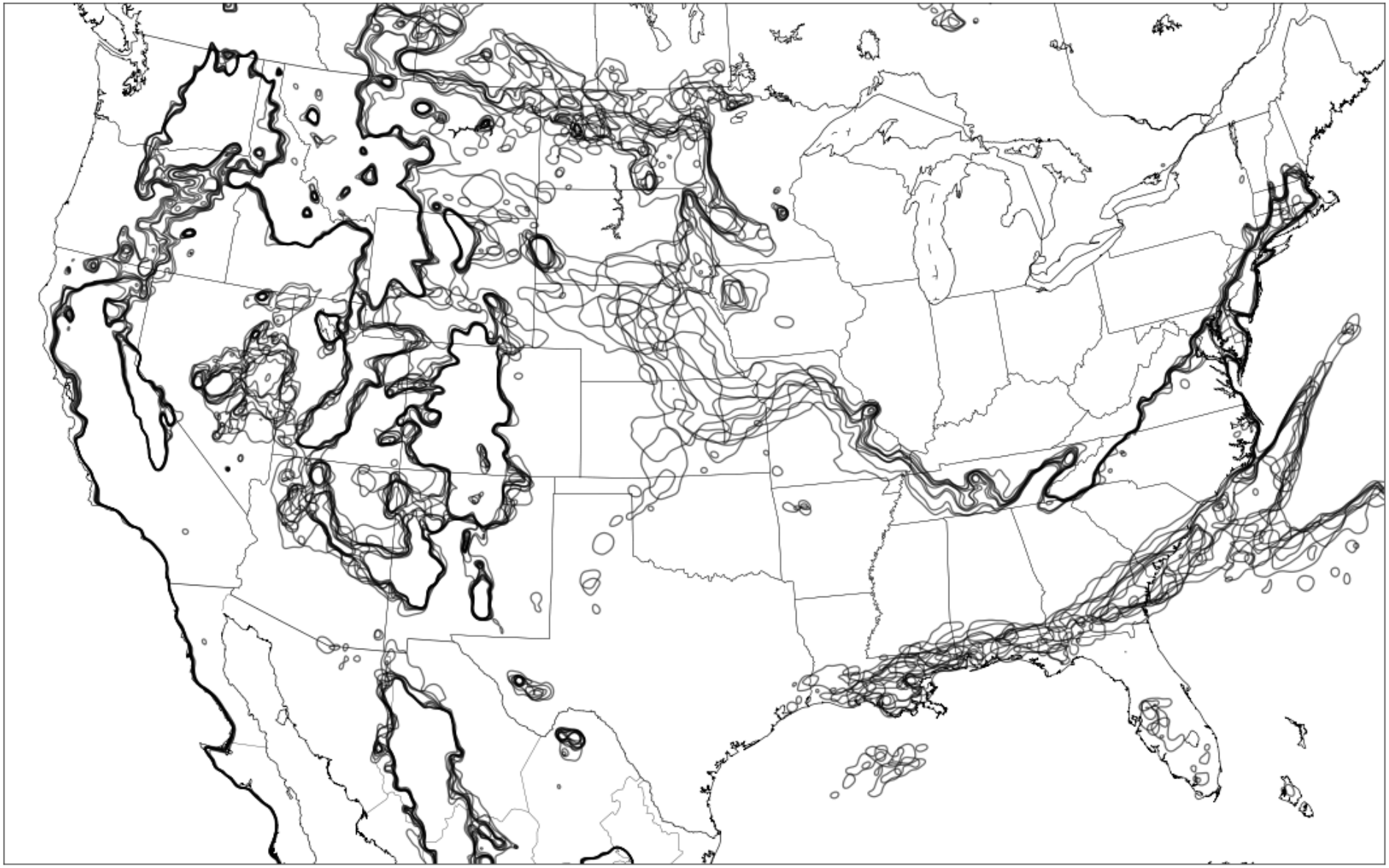
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

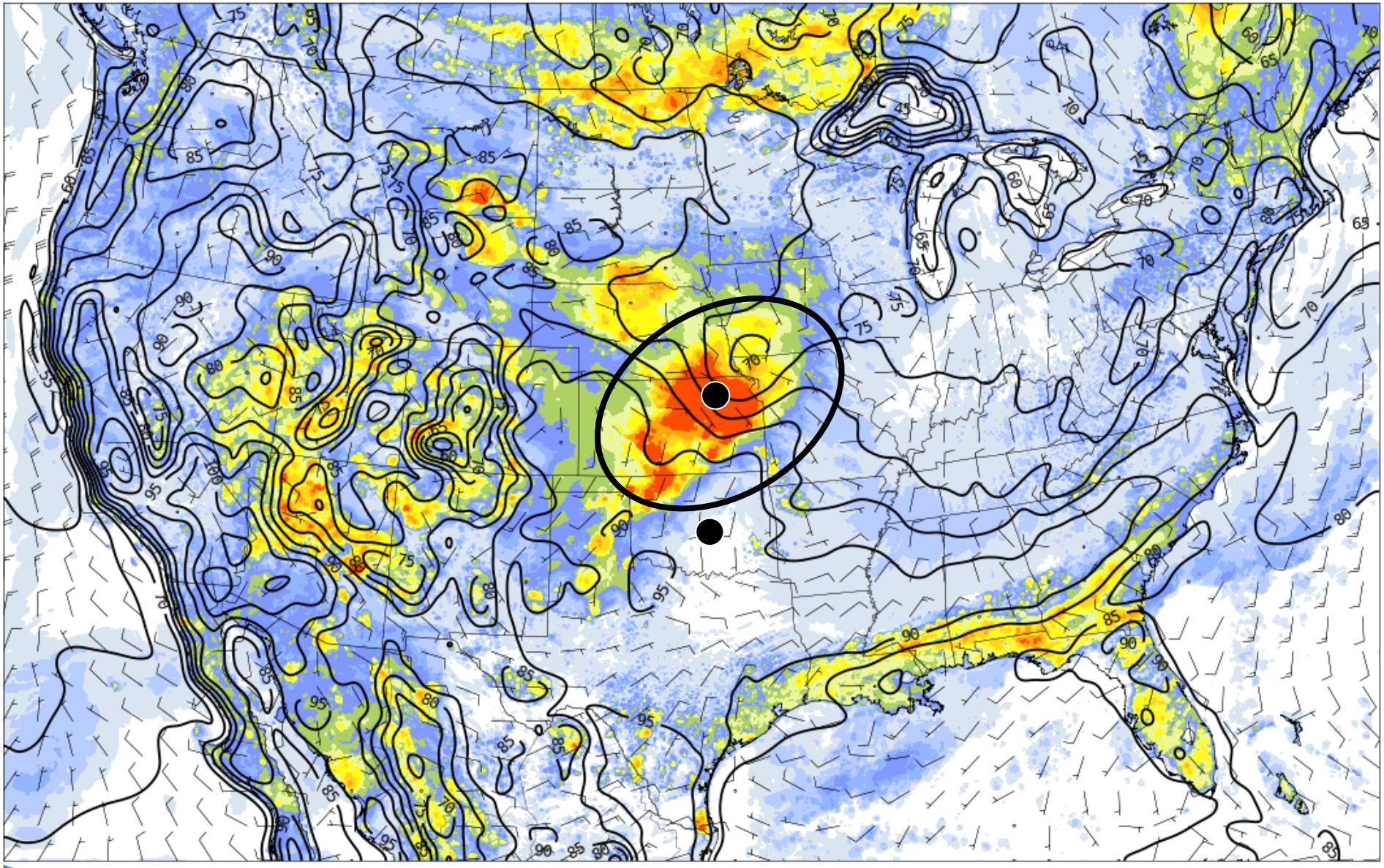
Ensemble 2-m temperature (80F contours)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



Ensemble mean (contour; F) and spread (fill; F) of 2-m temperature, and mean 10-m wind (kts)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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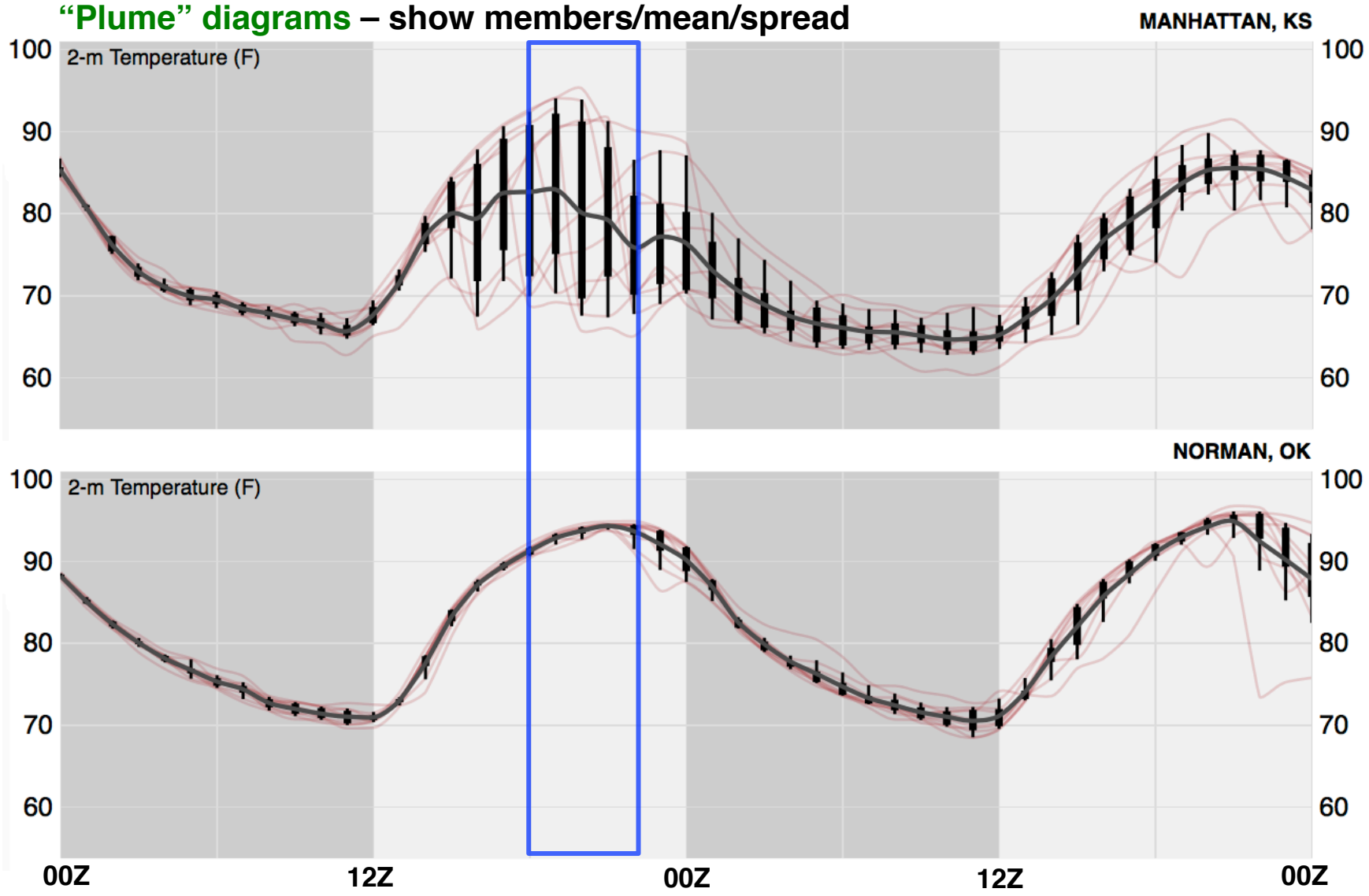
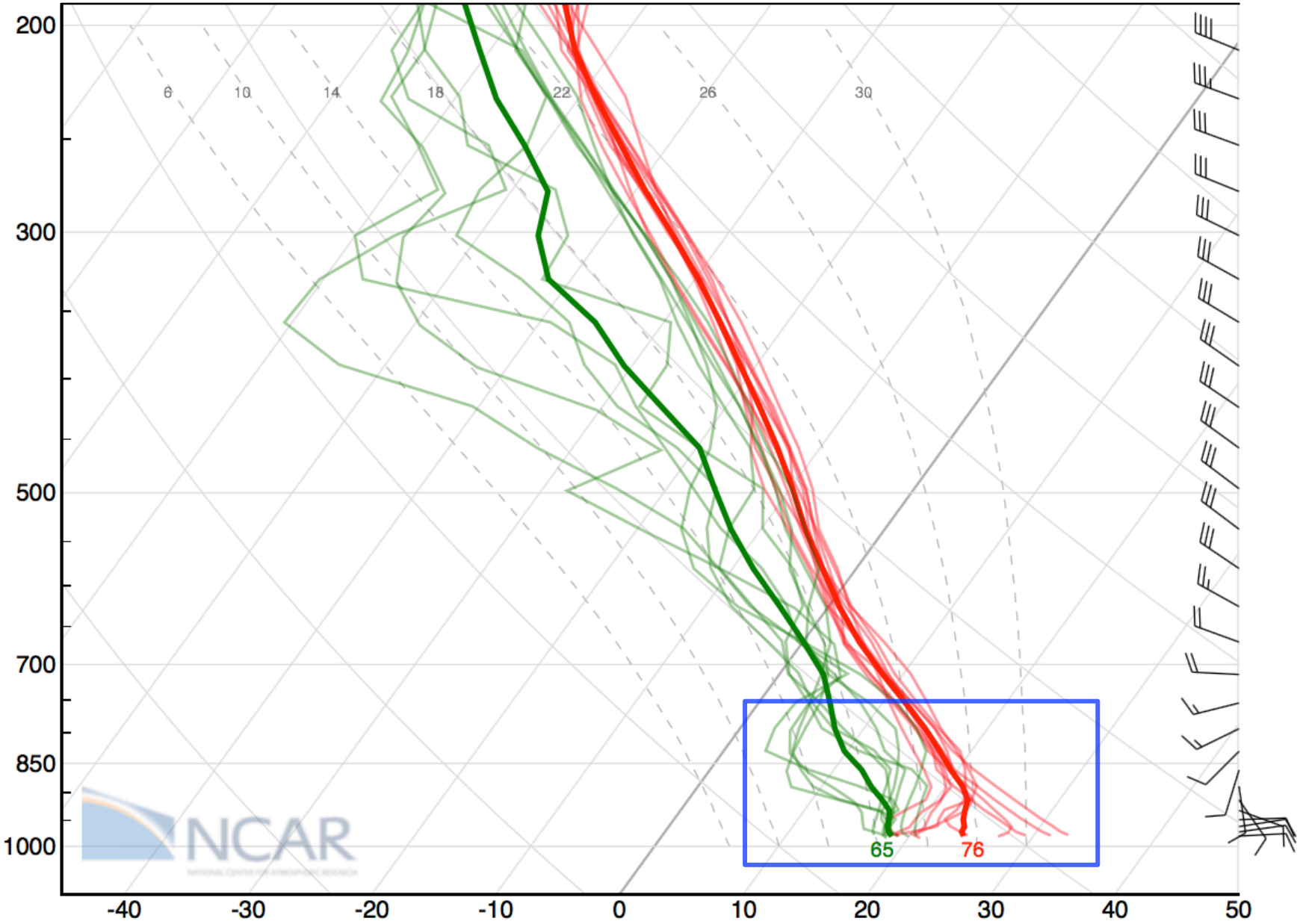
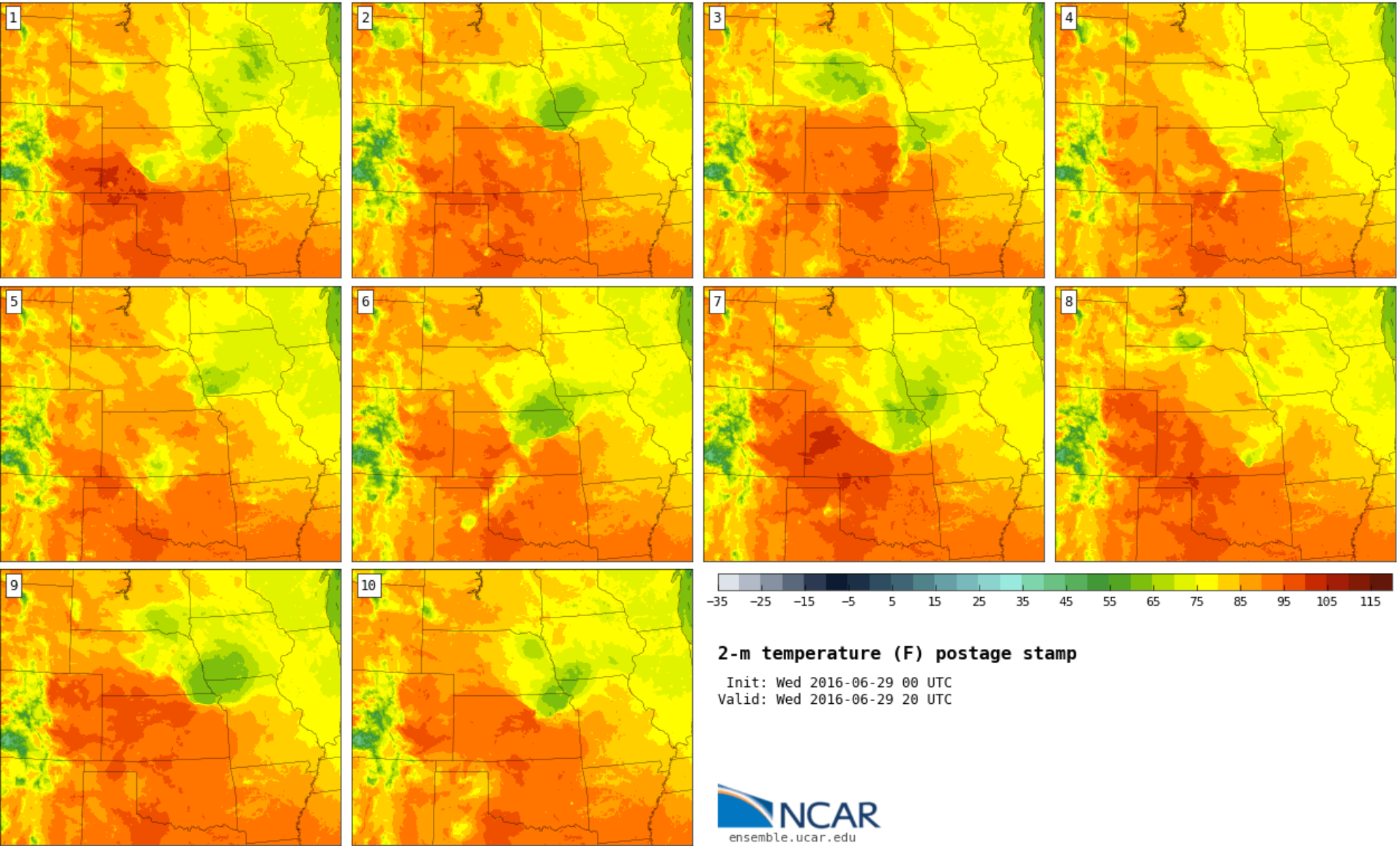
0.5 1.0 1.5 2.0 3.0 4.0 5.0 6.0 7.0 8.0


"Plume" diagrams – show members/mean/spread
MANHATTAN, KS
2-m Temperature (F)
100
90
80
70
60
NORMAN, OK
2-m Temperature (F)
00Z
12Z
00Z
12Z
00Z

Ensemble Skew-T plots





2-m temperature (F) postage stamp

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC

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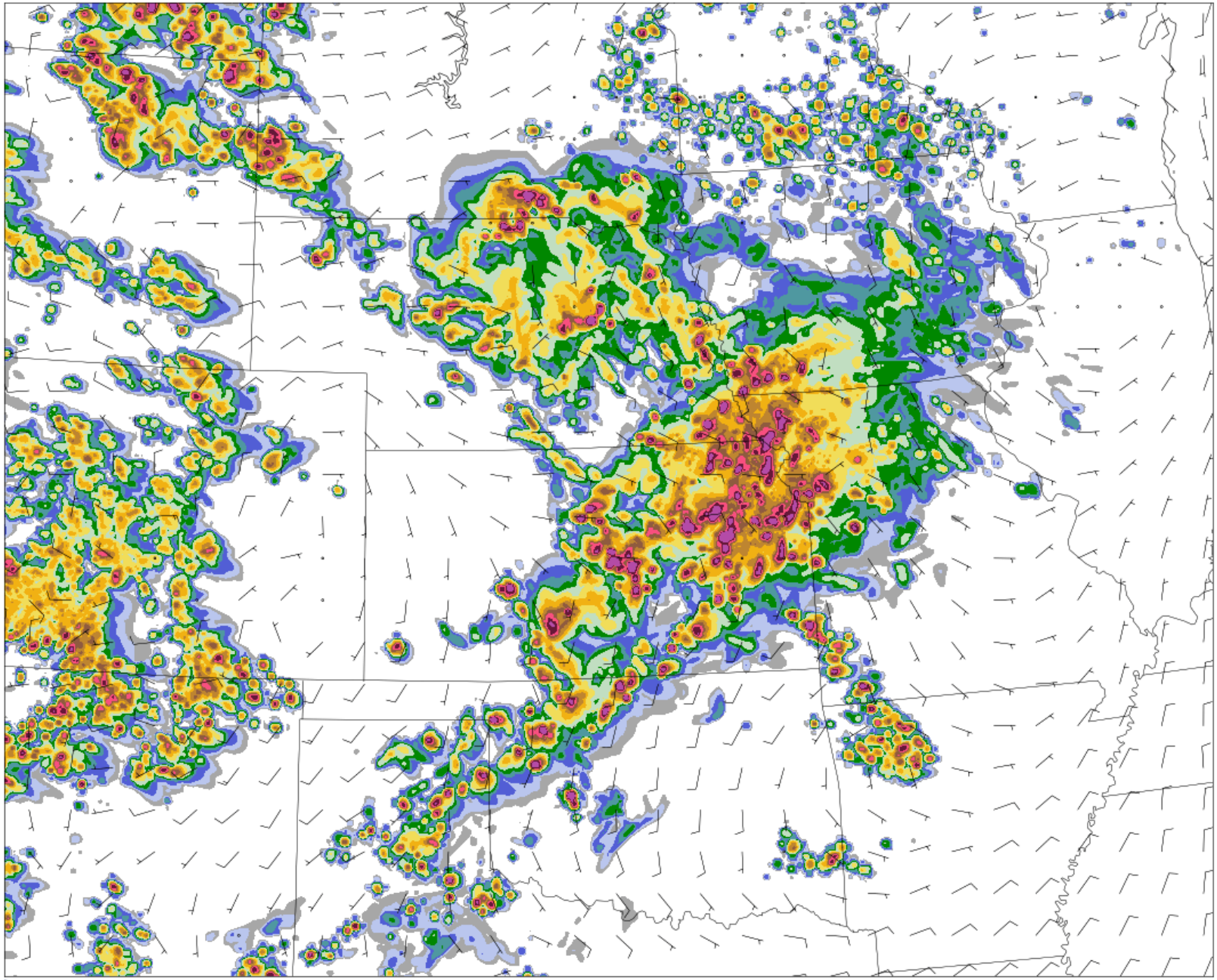
Unique ensemble fields for small-scale phenomena

Thunderstorms, heavy rain

Ensemble mean not useful for discrete fields containing spatial displacements

Ensemble max. column reflectivity and ensemble mean 10-m wind (kts)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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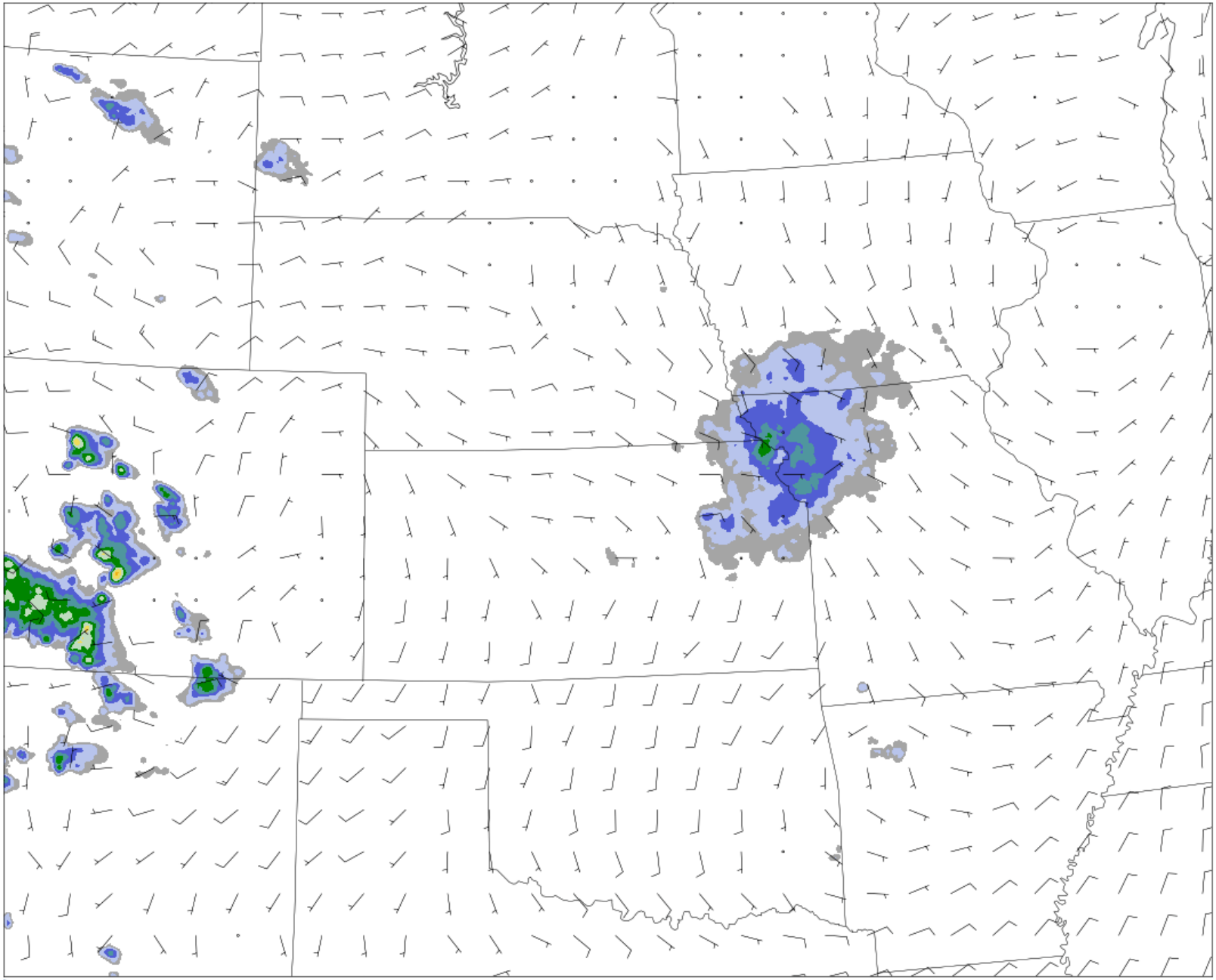
5 10 15 20 25 30 35 40 45 50 55 60 65

Ensemble mean max. column reflectivity and ensemble mean 10-m wind (kts)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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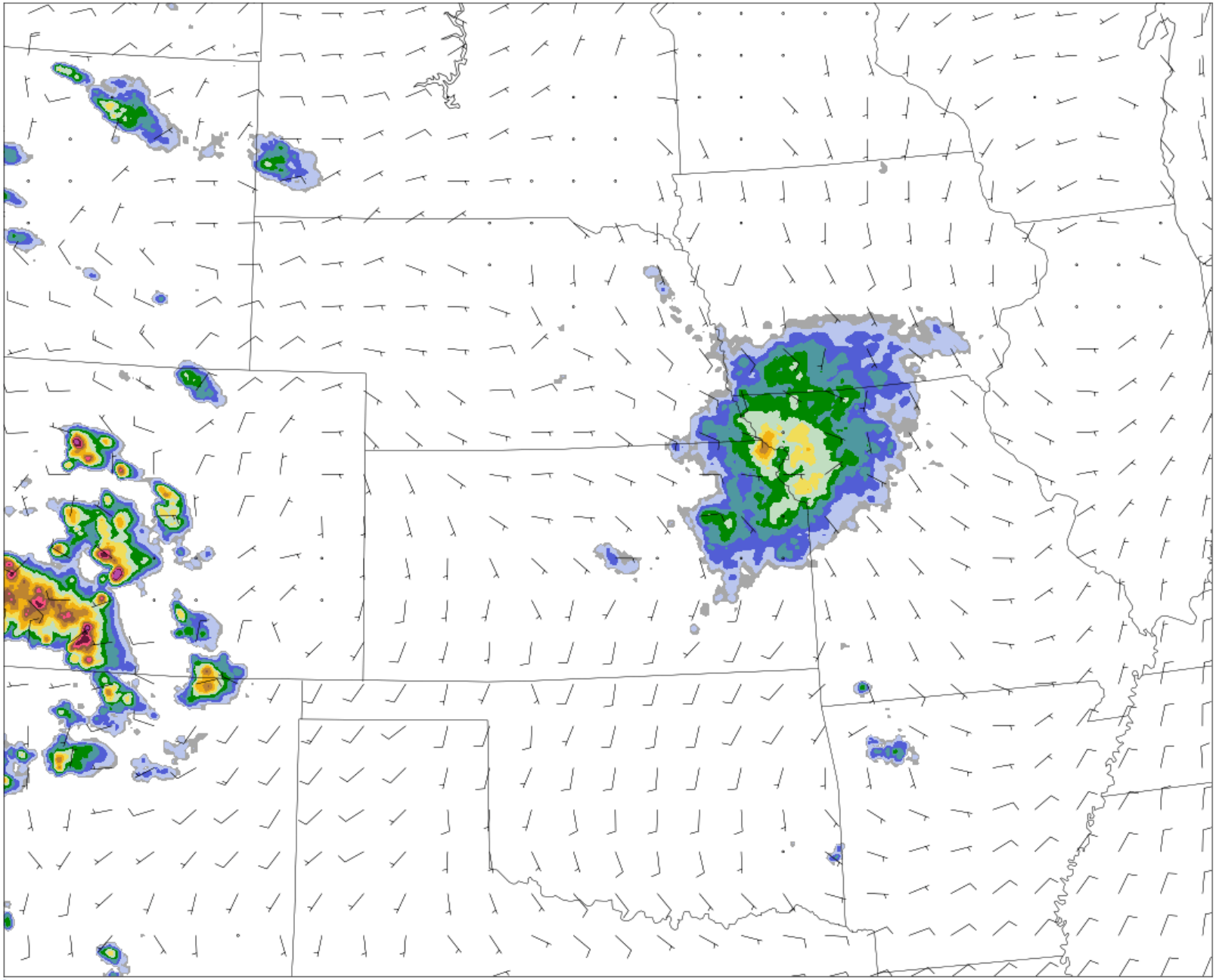
5 10 15 20 25 30 35 40 45 50 55 60 65

Probability matched mean max. column reflectivity and ensemble mean 10-m wind (kts)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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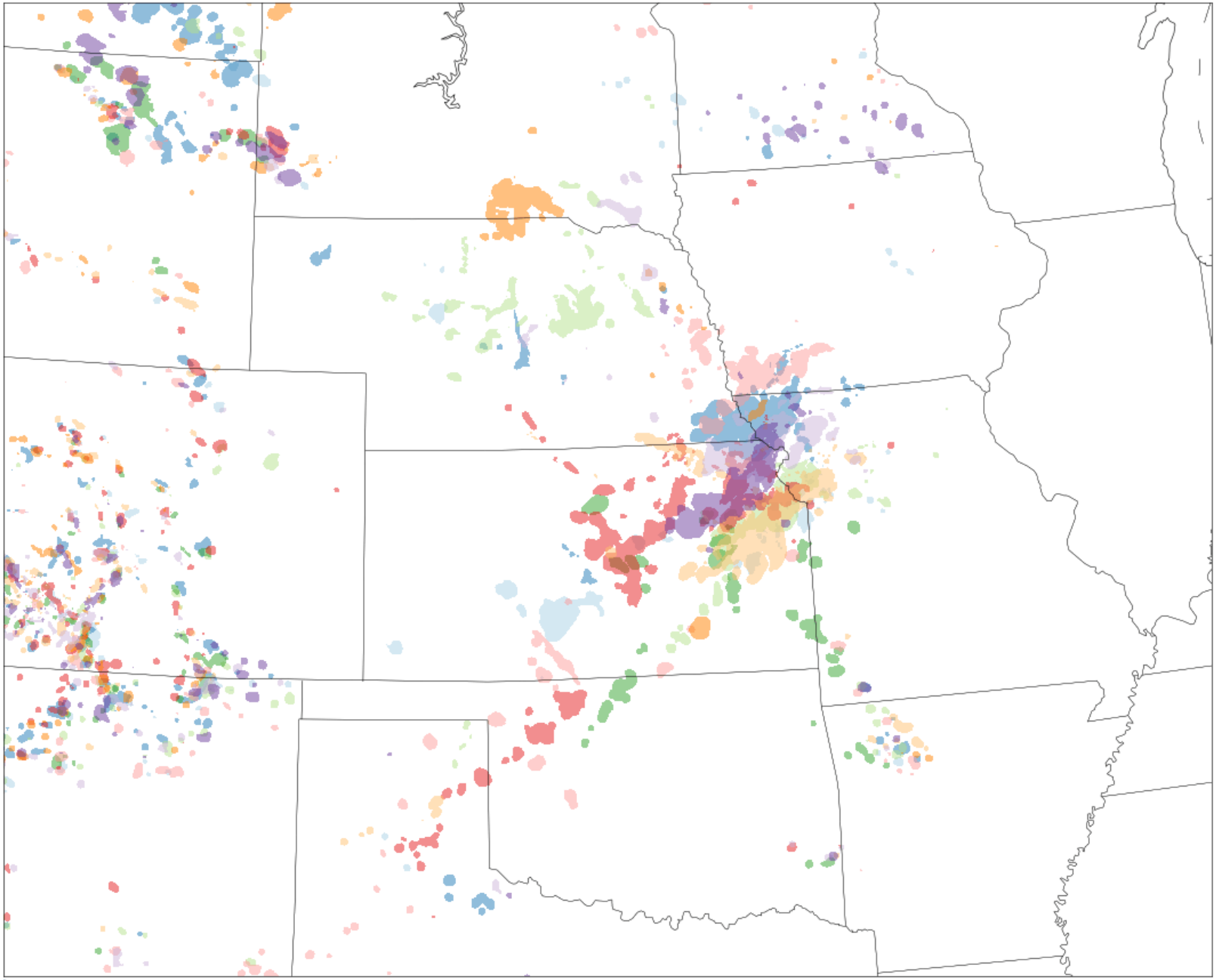
5 10 15 20 25 30 35 40 45 50 55 60 65

Max. column reflectivity > 40 dBZ from each member

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC



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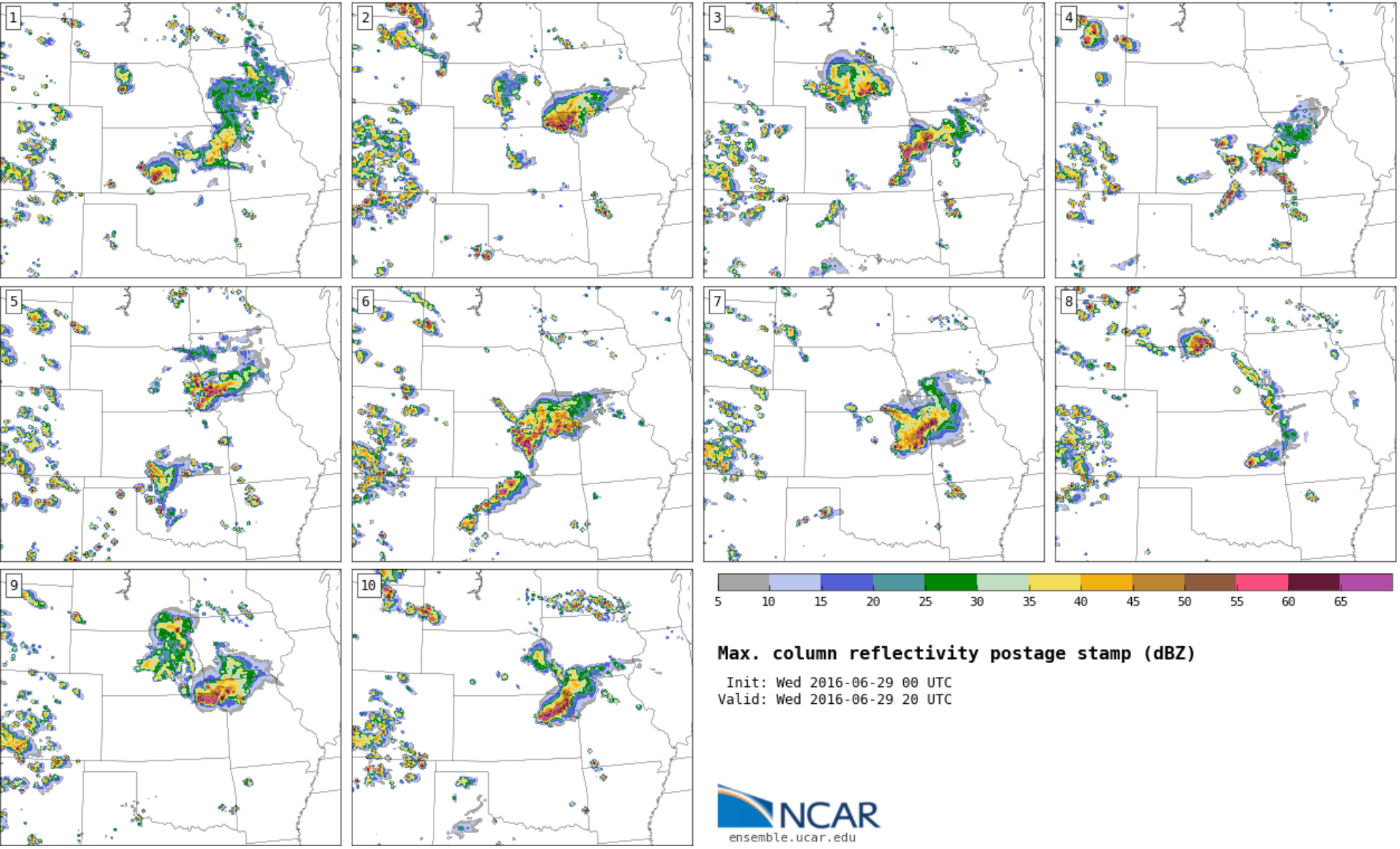
member 1 member 2 member 3 member 4 member 5 member 6 member 7 member 8 member 9 member 10



Max. column reflectivity postage stamp (dBZ)

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC

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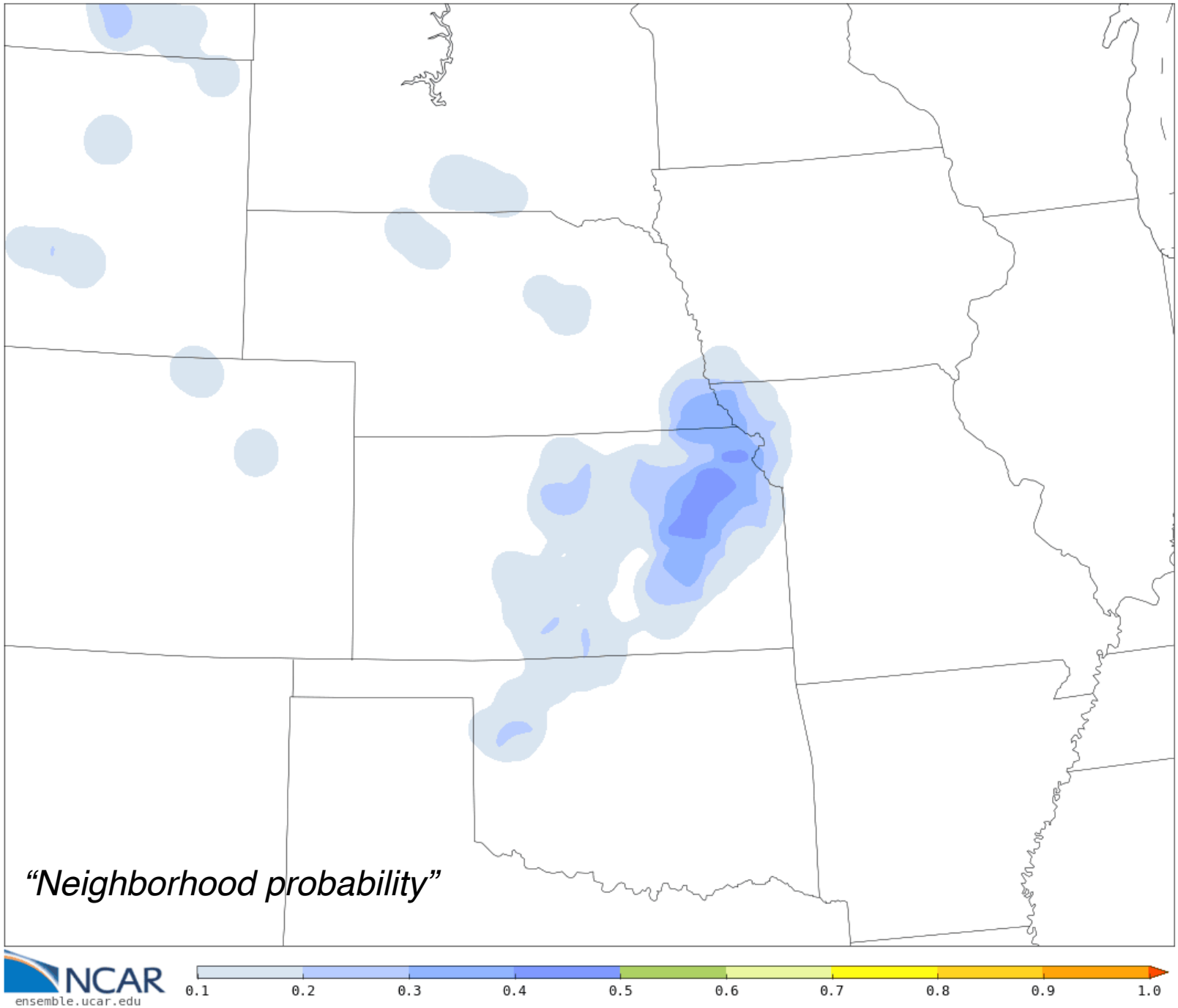
Probability of hourly max. wind speed > 20 m/s within 25-mi
Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 20 UTC
"Neighborhood probability"
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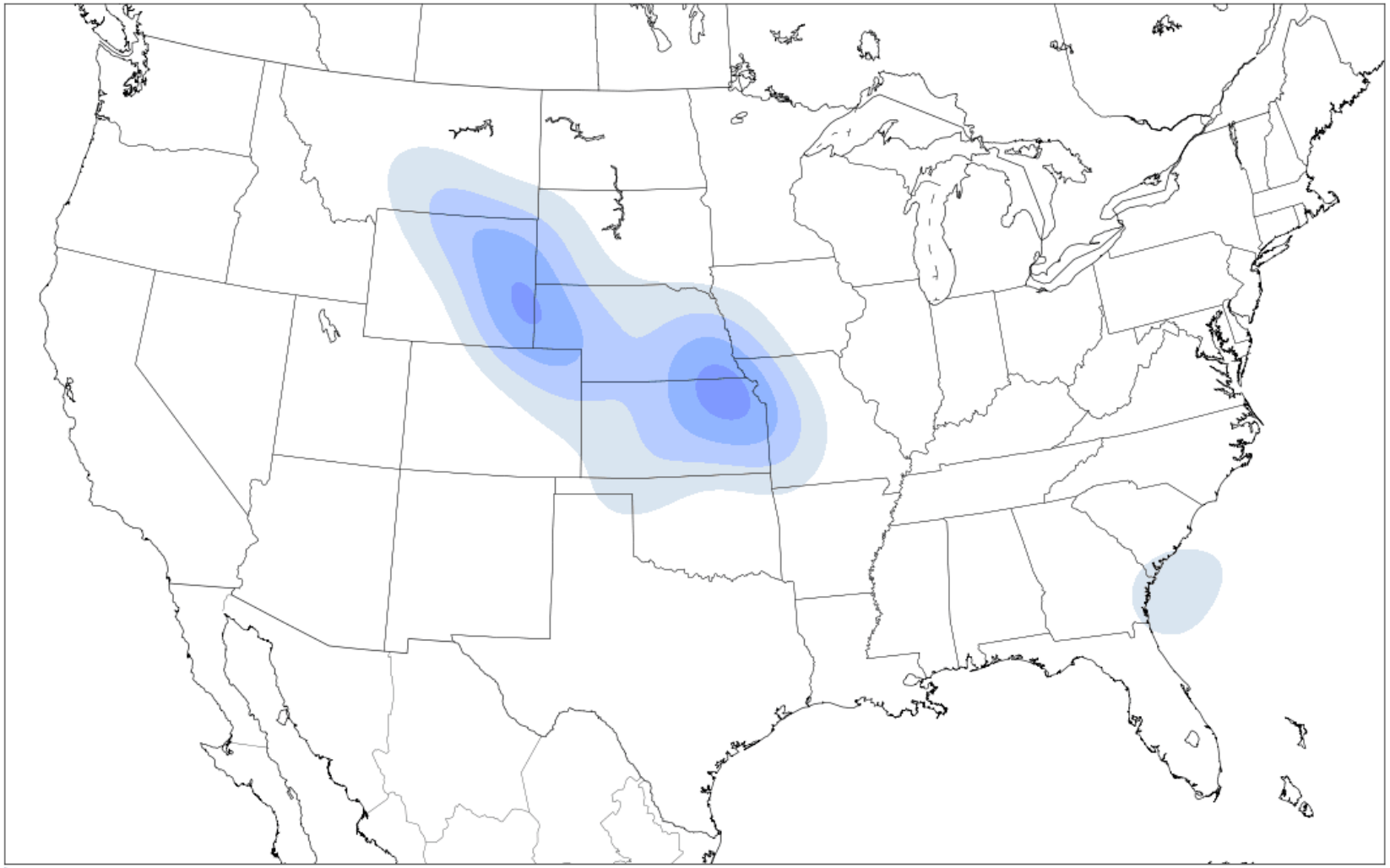
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Day 1 (12Z - 12Z) smoothed prob. of 2-5km UH > 75 m2/s2

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 12 UTC - Thu 2016-06-30 12 UTC



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0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Useful software packages:

e.g., NCL/Python/Grads

Web-based visualization libraries:

e.g., javascript/d3

NCAR Ensemble Forecasts

Initialized: 00 UTC Wed 29 Jun 2016

Surface / Precip | Upper-Air | Severe | Winter | Hourly-Max | Domains

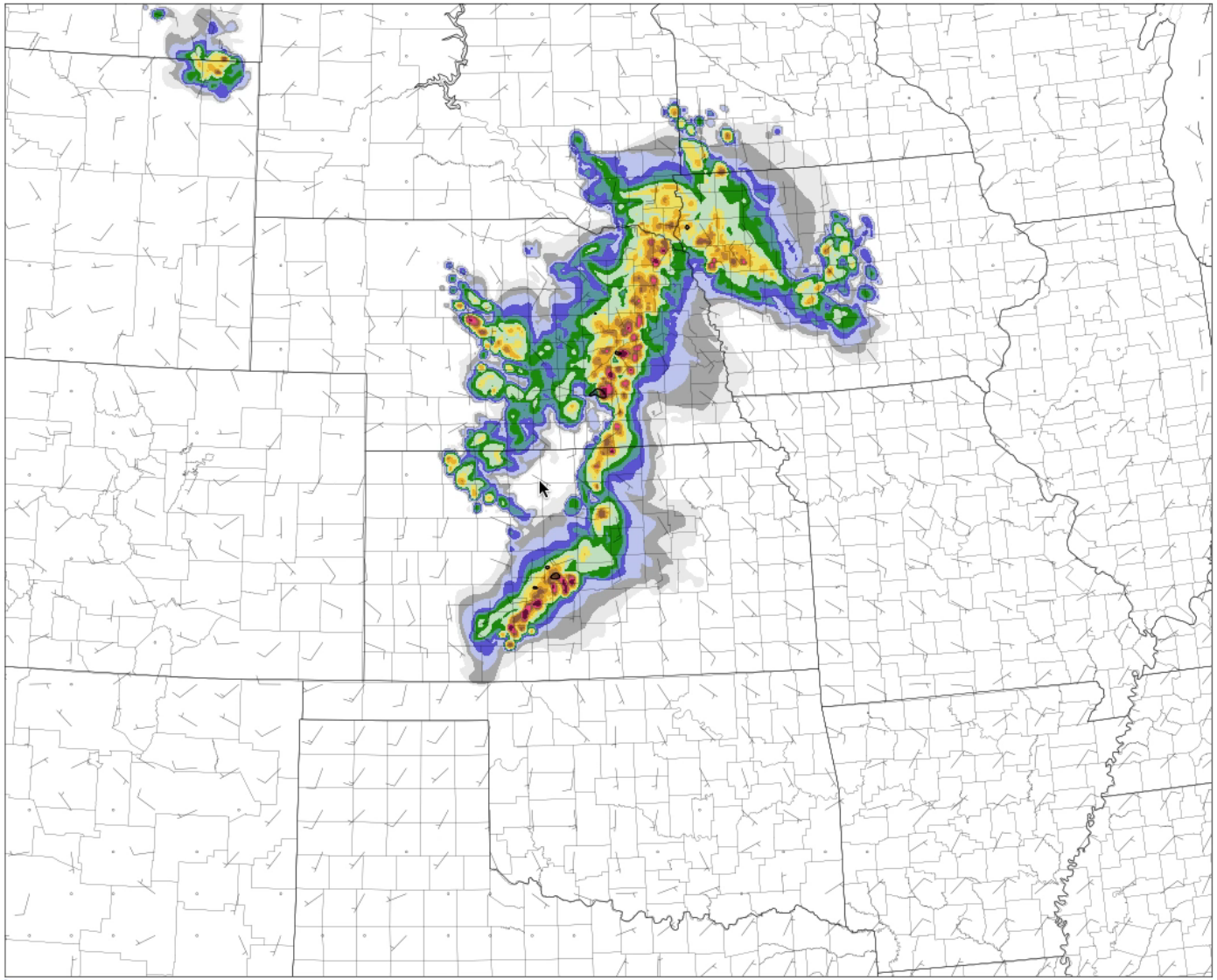
13 14 15 16 17 18 19 20 21 22 23 24

Mem 1
Mem 2
Mem 3
Mem 4
Mem 5
Mem 6
Mem 7
Mem 8
Mem 9
Mem 10

D1: 01 - 12 UTC
D1: 13 - 00 UTC
D2: 01 - 12 UTC
D2: 13 - 00 UTC
Full 48-hour

Member 1 column maximum reflectivity, 10-m wind speed, and hourly-max 2-5 km UH > 50 m2/s2

Init: Wed 2016-06-29 00 UTC
Valid: Wed 2016-06-29 13 UTC



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5 10 15 20 25 30 35 40 45 50 55 60 65

Forecasts sponsored by the National Science Foundation, National Center for Atmospheric Research/Mesoscale and Microscale Meteorology Laboratory, and Computational Information Systems Laboratory

Thanks!

sobash@ucar.edu

Mostly talk about ways to look at output from WRF-based regional ensembles (not covering global models, long time-scales).

Draw on experience with convection-allowing WRF-based ensembles. Interested in high-impact weather (e.g. severe convection, heavy precip, winter weather).

Useful for interacting with real-time ensemble information via internet, but also useful for research (producing good visualizations for interrogating output, publications)

Relevant questions:

What fields to use and why?

Ensemble mean, spread, max, min, probabilities, neighborhood probabilities, probability matched mean, postage stamps, plumes, spaghetti plots, paintball plots

Choices for visualization

Useful color tables/threshold selection, important for interpreting output and decision-making

Choices for software

What tools exist to view/make graphics?

Novel uses for web-based visualizations

Answers to these questions depend on a few factors…