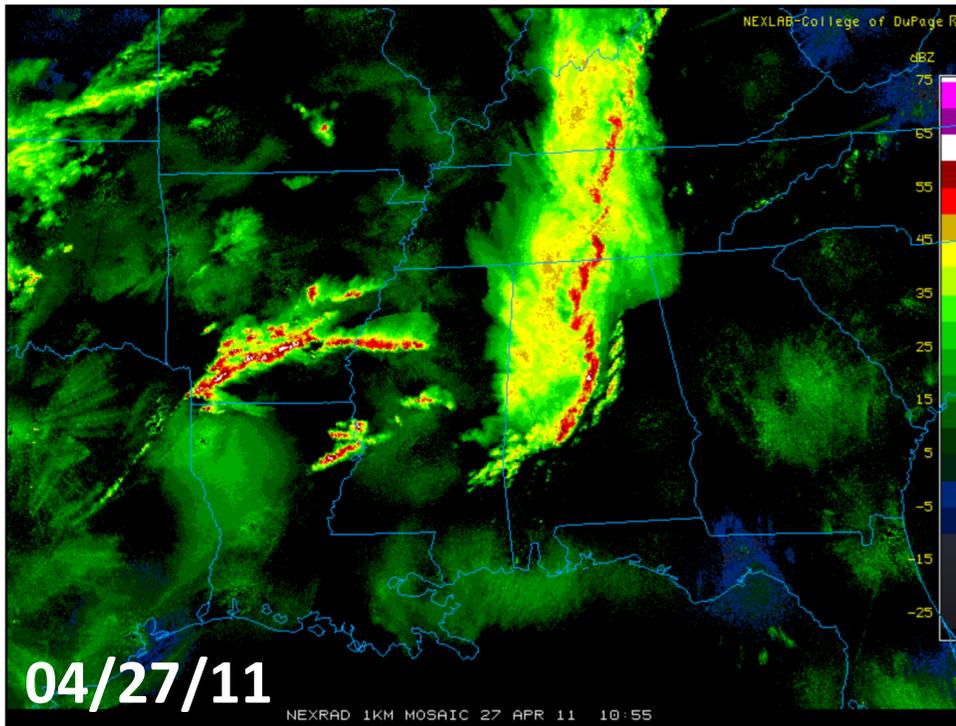


“Convective system structure, evolution and severe weather potential in 1 versus 3 km WRF forecasts”

Morris Weisman, Ryan Sobash, Kevin Manning, Craig Schwartz

2019 Joint WRF/MPAS User’s Workshop

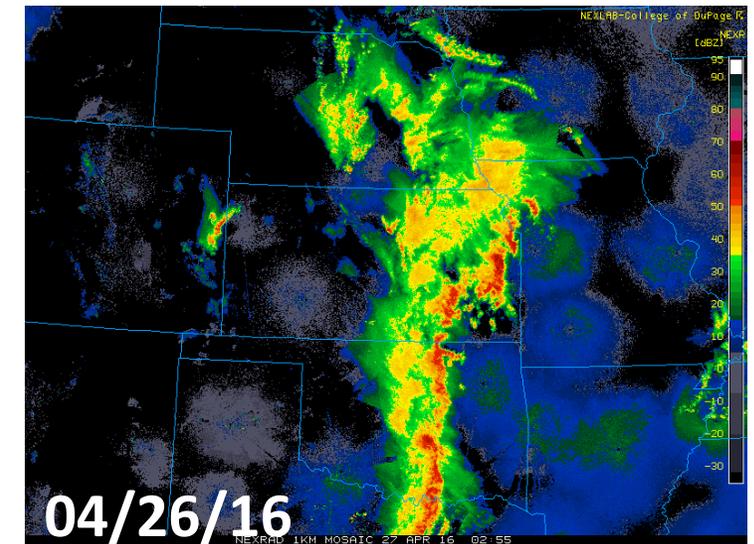
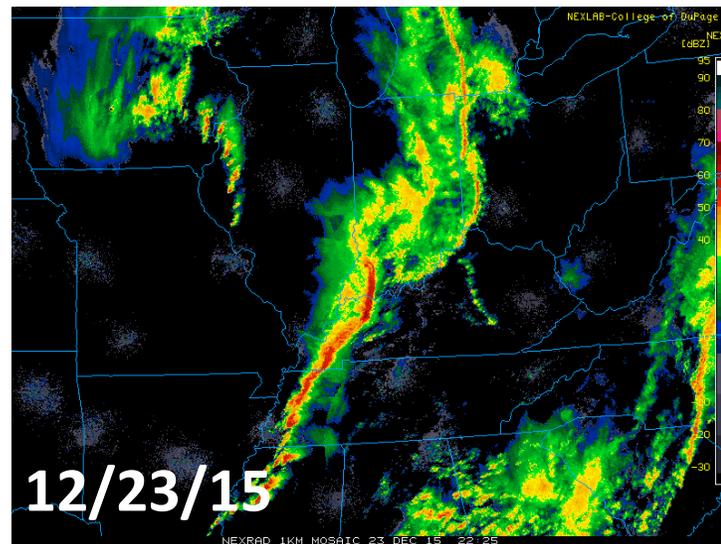
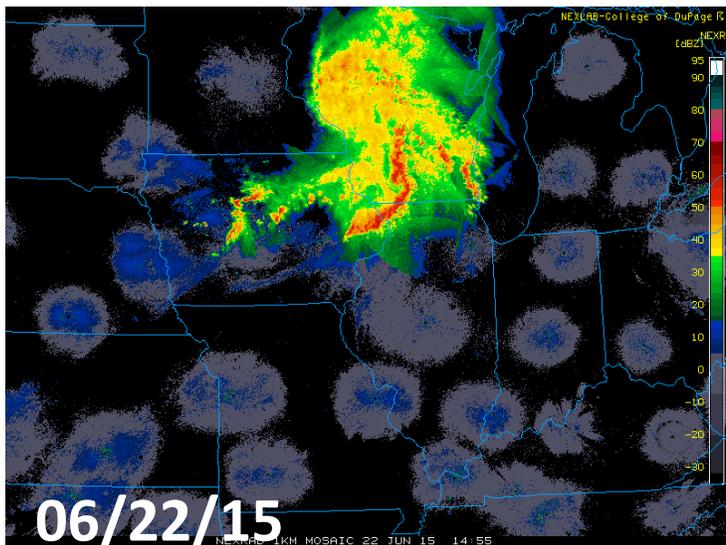
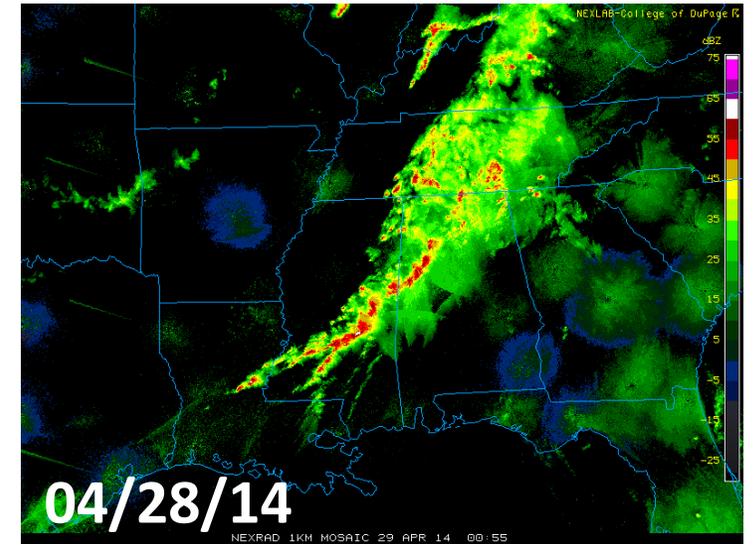
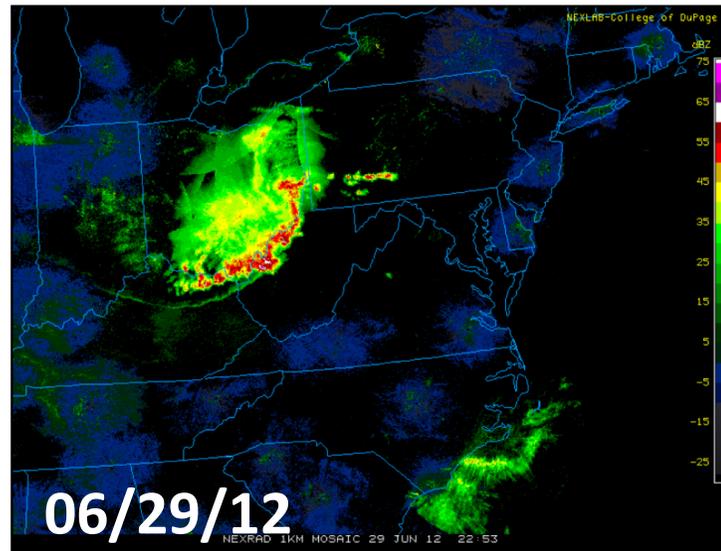
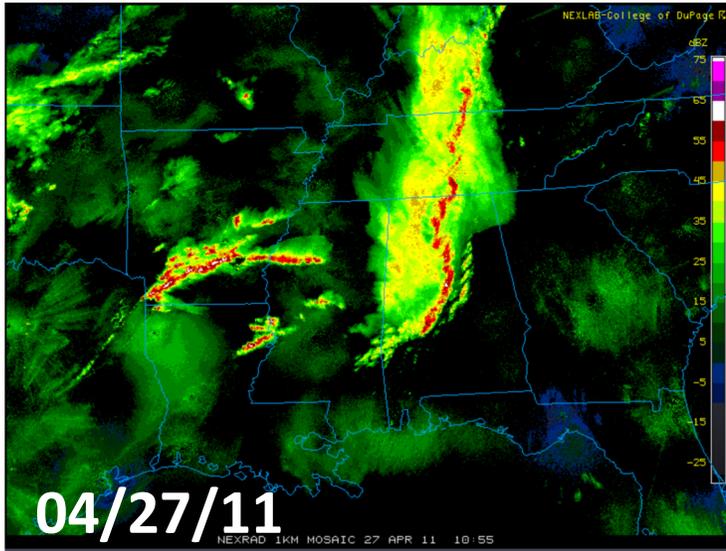


Radar

QLCS characteristics:

- ...convective initiation
- ...cold pool strength/propagation
- ...surface winds
- ...mesovortices
- ...rear-inflow jet
- ...updraft helicity

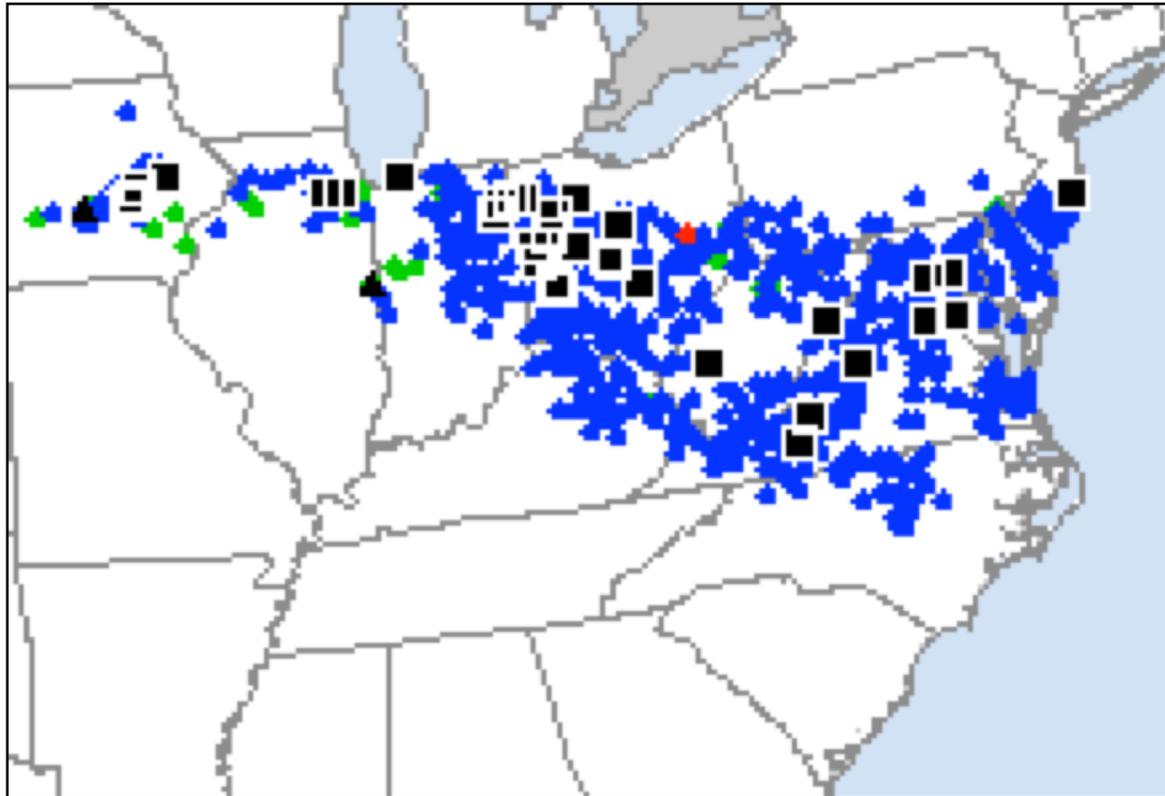
12 Severe Squall Line Cases:



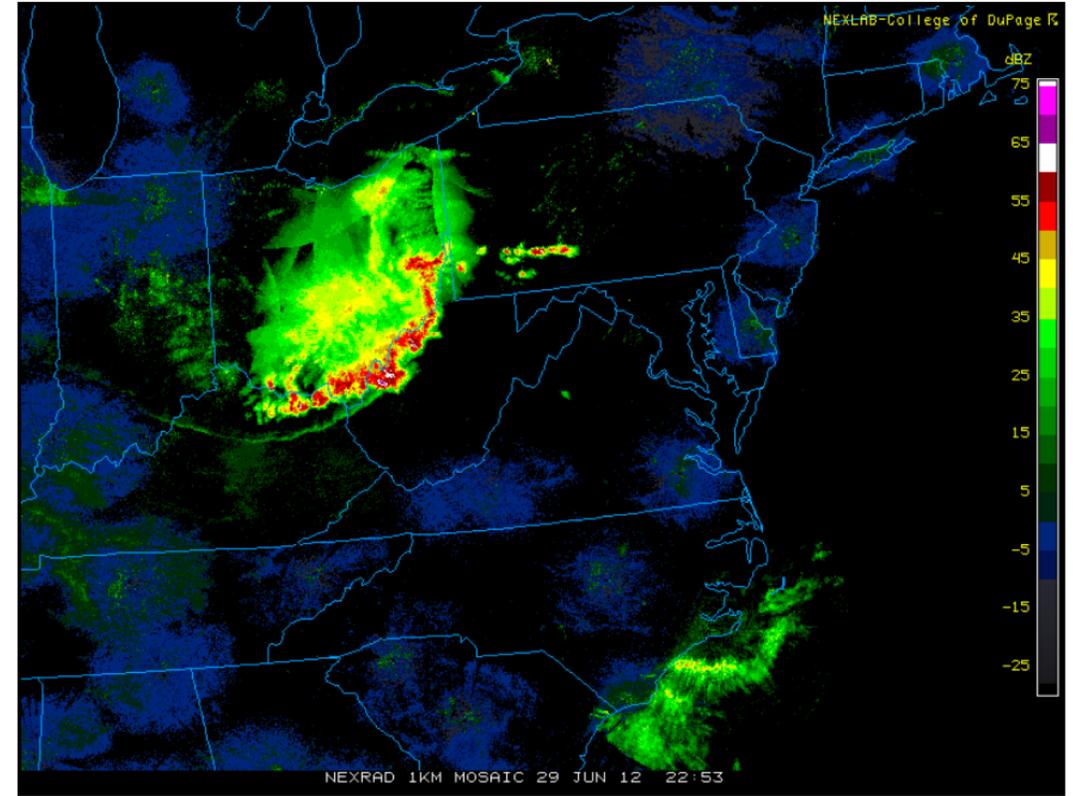
Radar

29 June 2012

SPC Storm Reports



- High Wind Report (65KT +)
- ▲ Large Hail Report (2" dia. +)

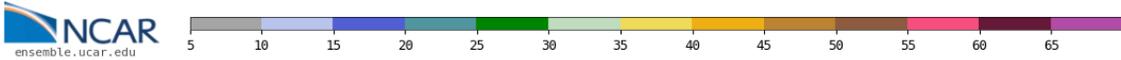
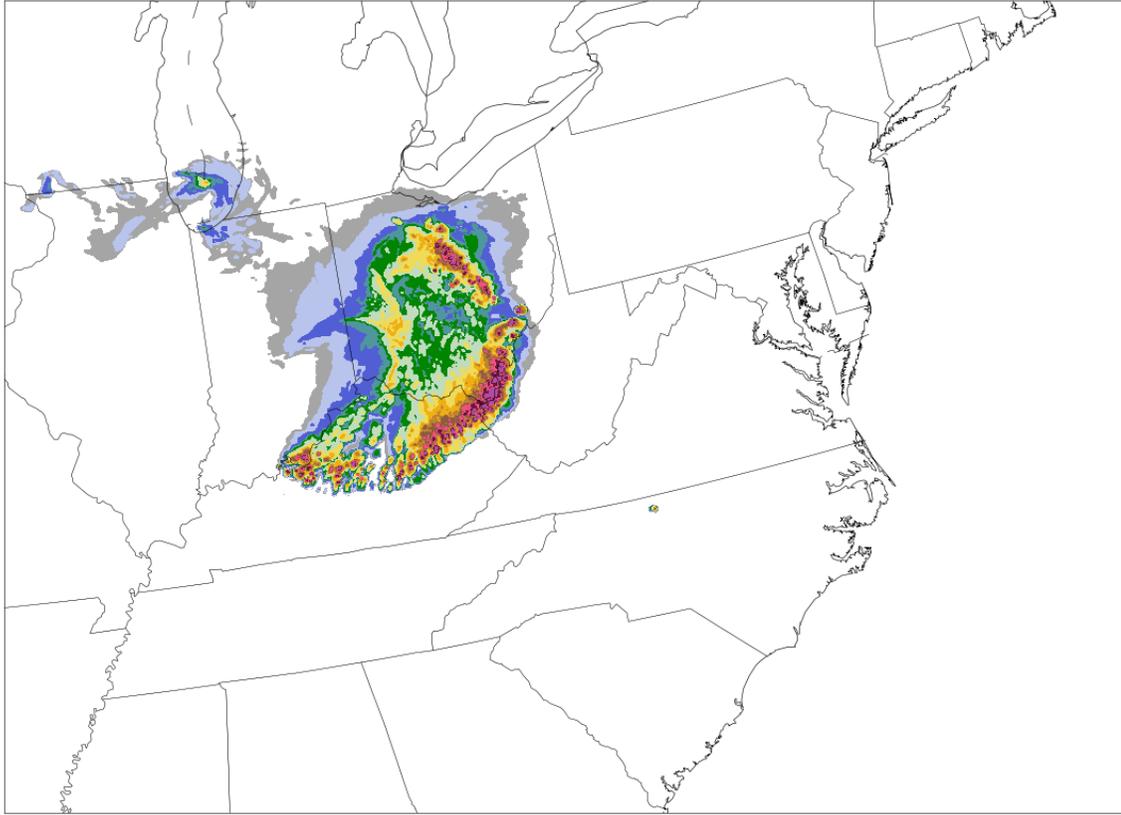


Radar 23:00 UTC

29 June 2012

Composite Reflectivity

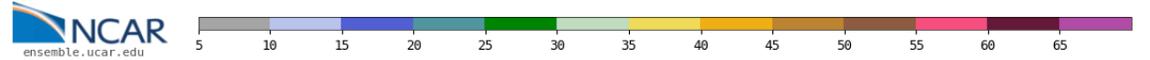
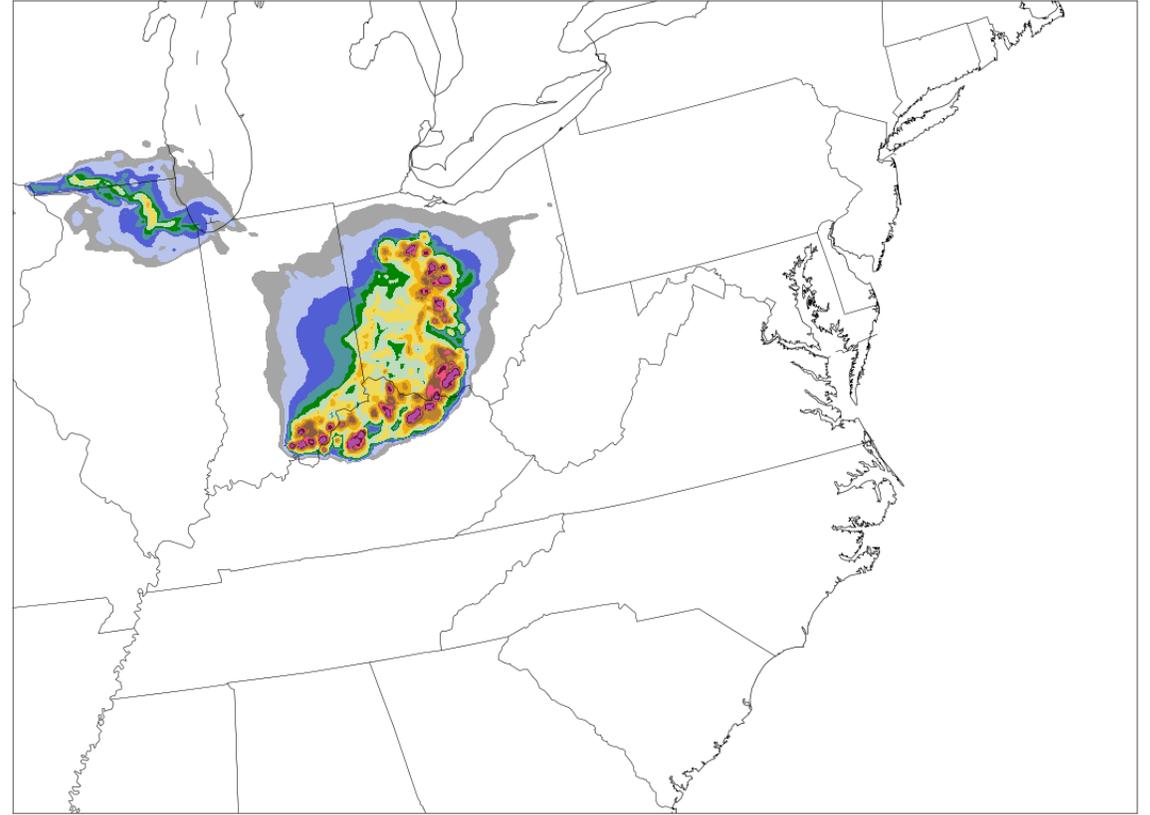
Init: Fri 2012-06-29 00 UTC
Valid: Fri 2012-06-29 21 UTC



1 km

Composite Reflectivity

Init: Fri 2012-06-29 00 UTC
Valid: Fri 2012-06-29 21 UTC

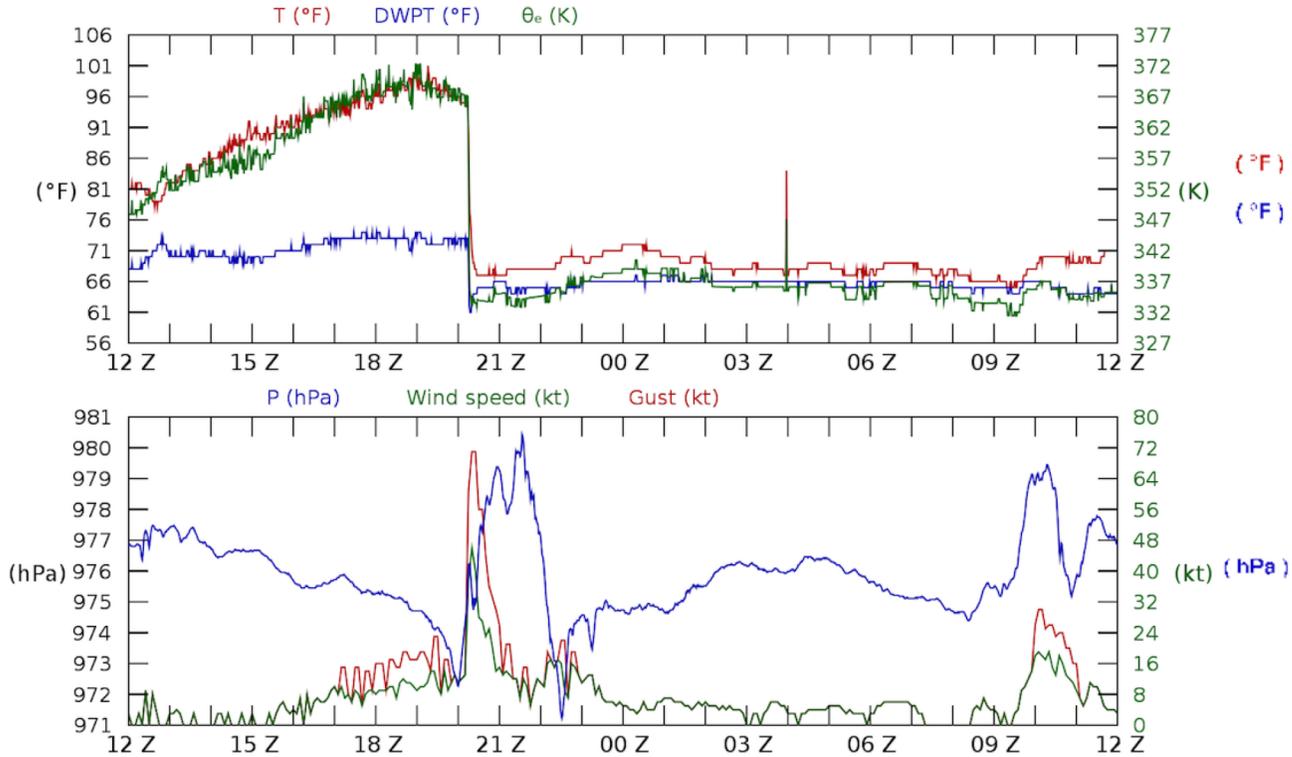


3 km

21:00 UTC

29 June 2012

KDAY : 2012-06-29/12 UTC through 2012-06-30/12 UTC

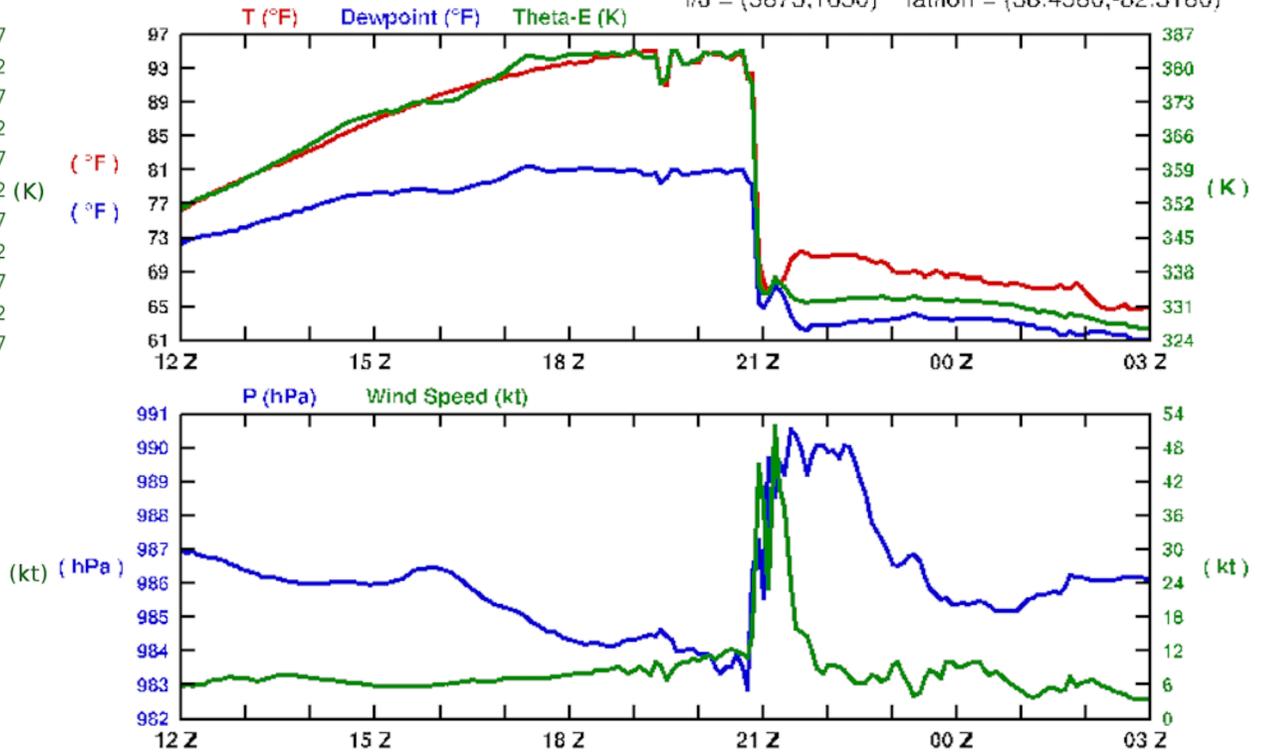


Dayton, OH

DTheta ~17 k 72 kts

2012-06-29/12 UTC through 2012-06-30/03 UTC

I/J = (3675,1650) lat/lon = (38.4380,-82.3180)



1 km model

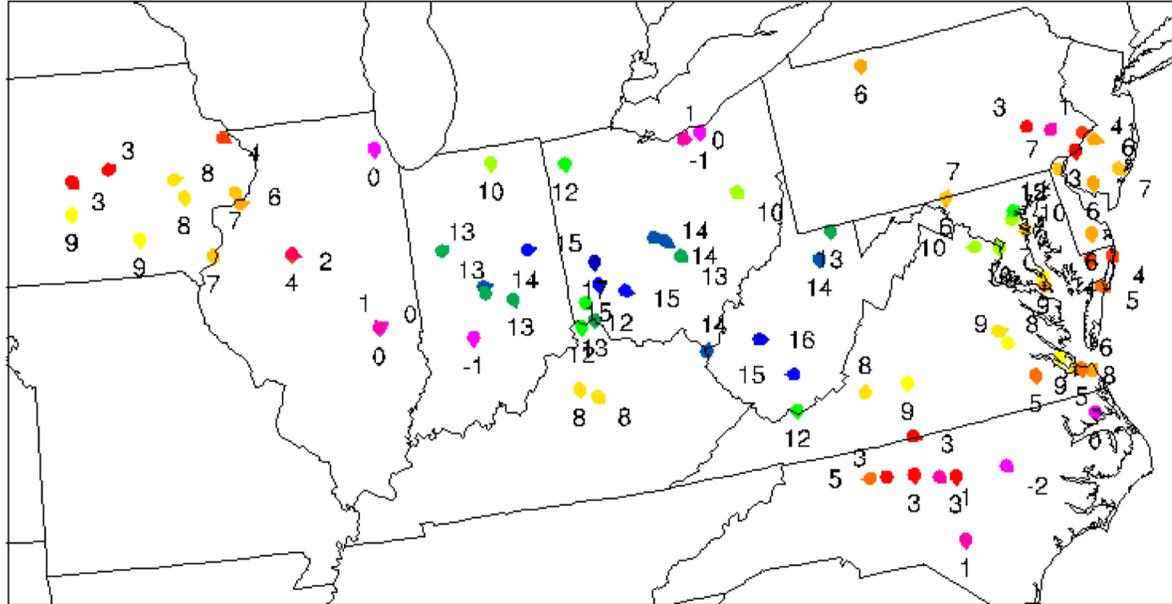
DTheta ~16 k 54 kts

29 June 2012

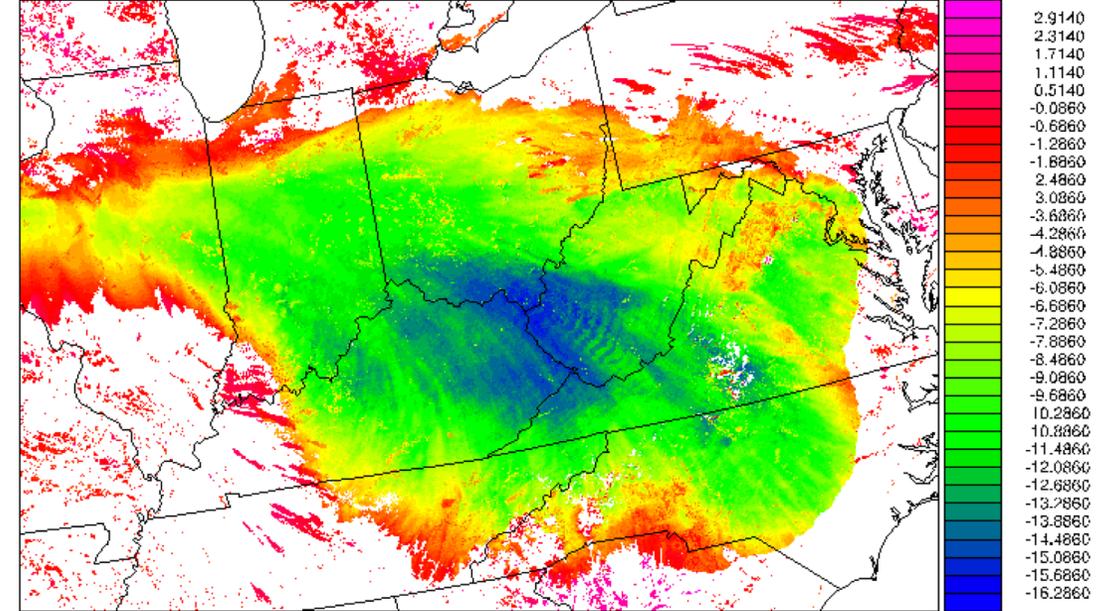
delta-Theta swath

Delta-Theta (K)

2012-06-29/12 through 2012-06-30/12 UTC



Delta-Theta Obs



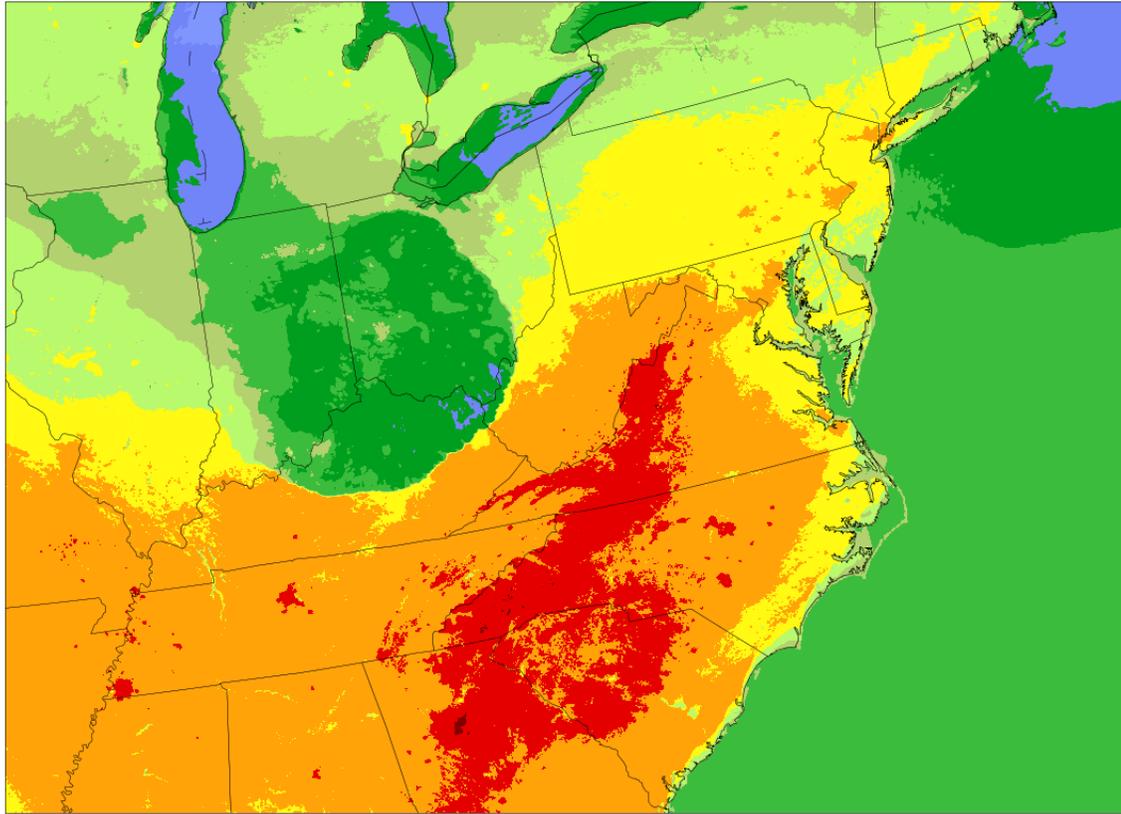
1 km

29 June 2012

Surface Theta (2m)

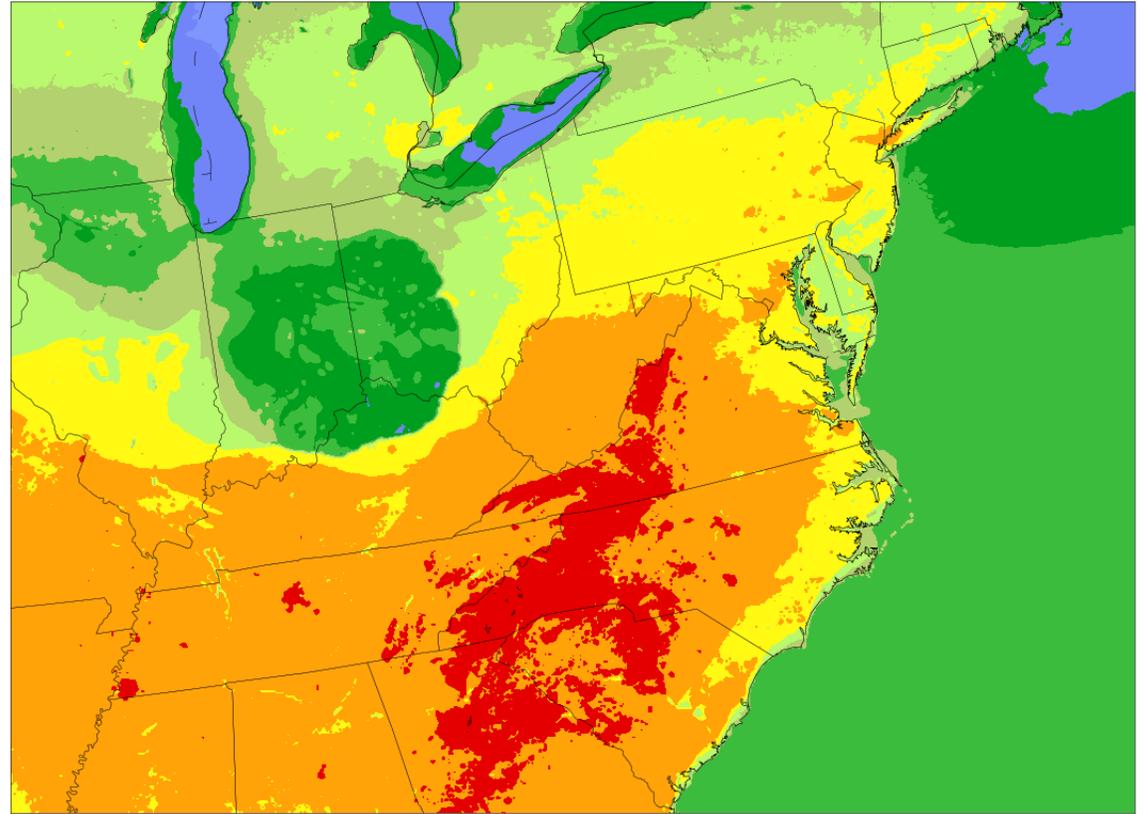
2-m Potential Temperature

Init: Fri 2012-06-29 00 UTC
Valid: Fri 2012-06-29 21 UTC



2-m Potential Temperature

Init: Fri 2012-06-29 00 UTC
Valid: Fri 2012-06-29 21 UTC



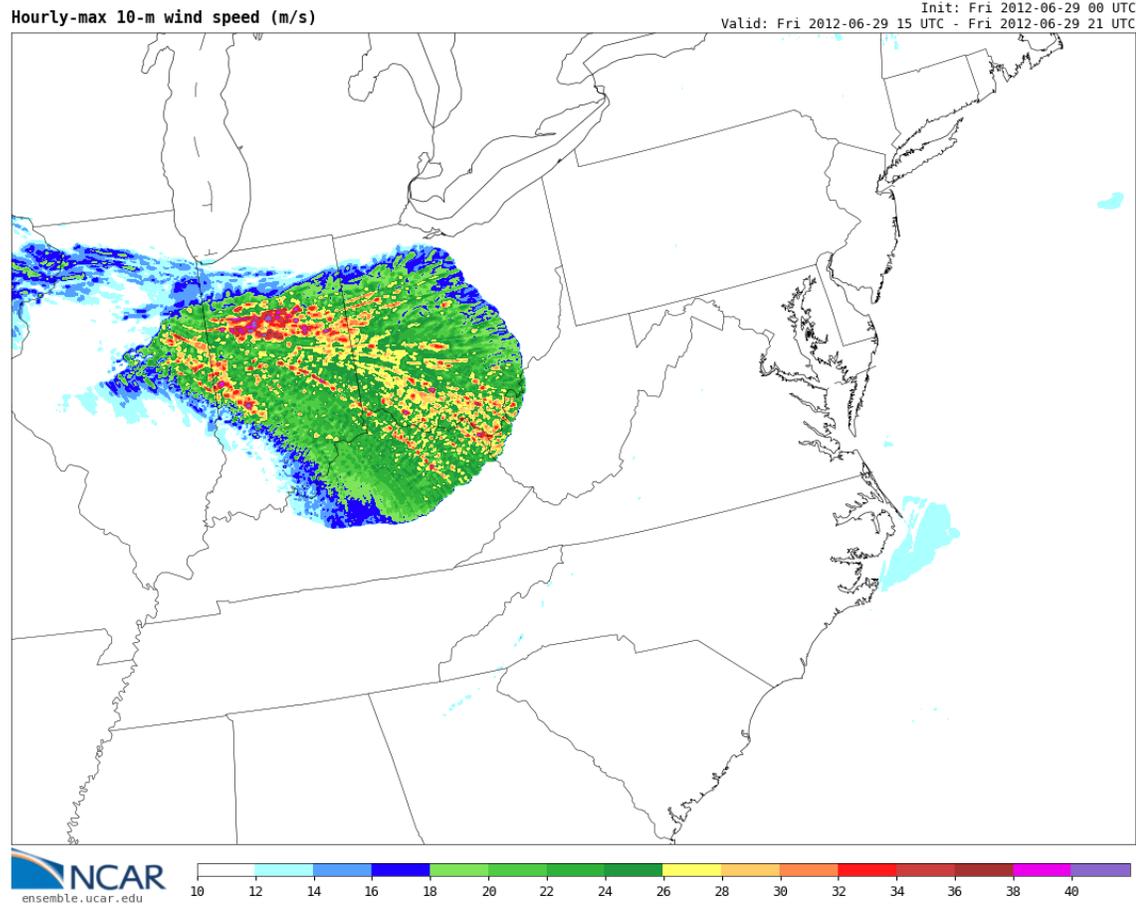
1 km

3 km

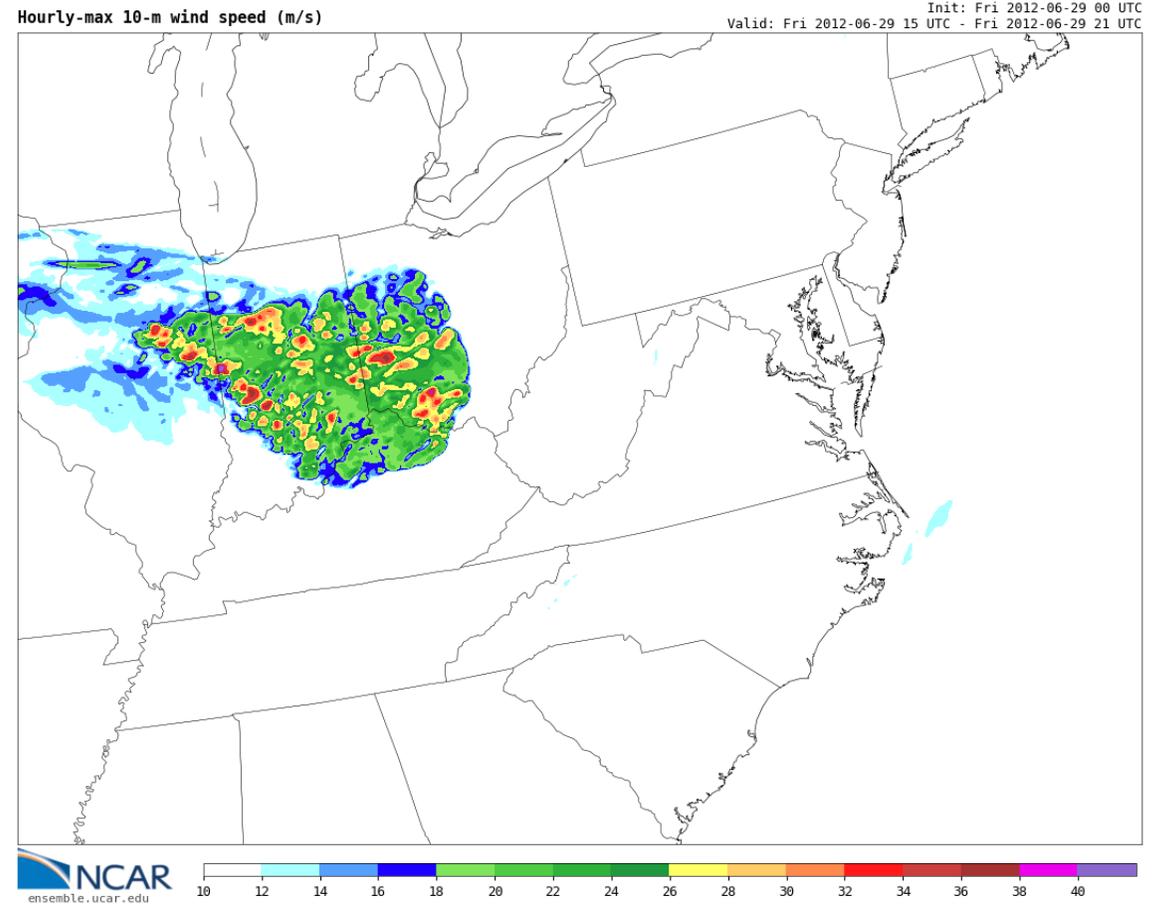
21:00 UTC

29 June 2012

Max Surface Wind (10m)



1 km

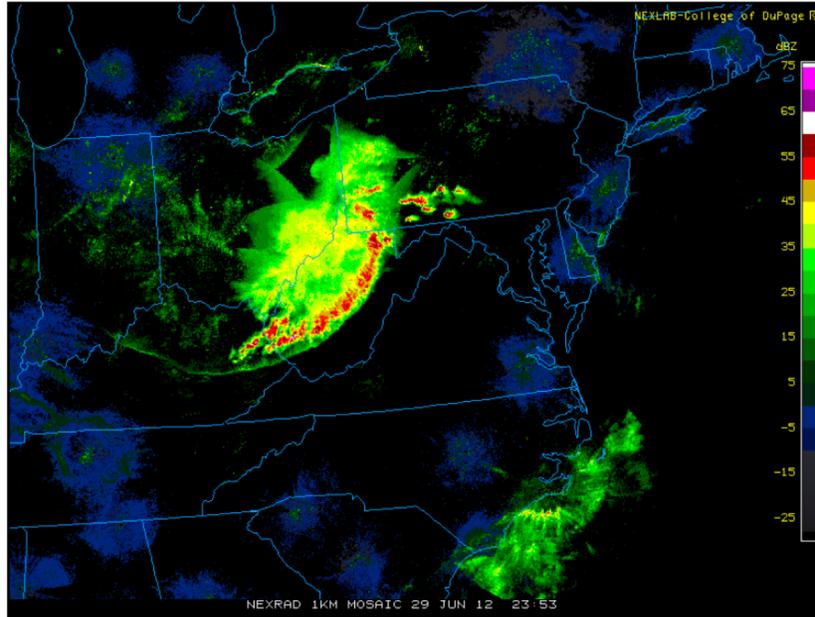


3 km

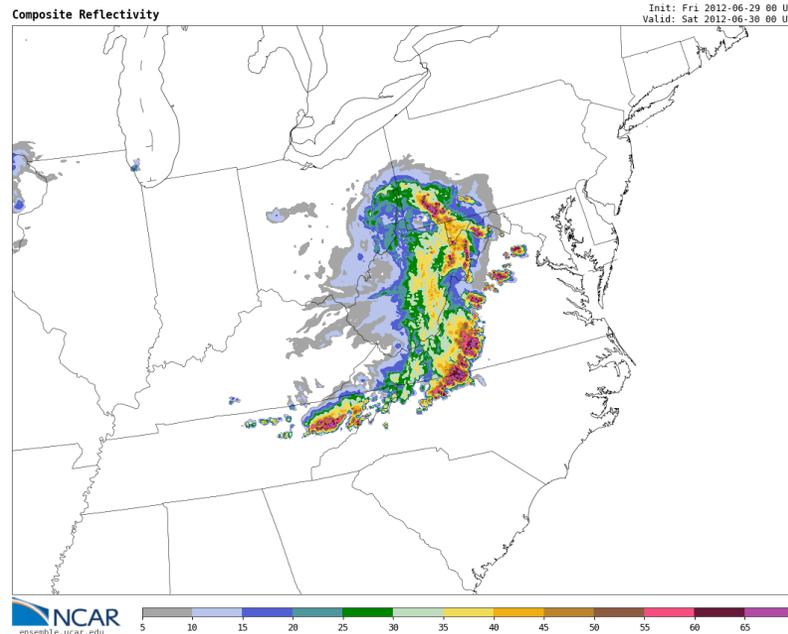
21:00 UTC

30 June 2012

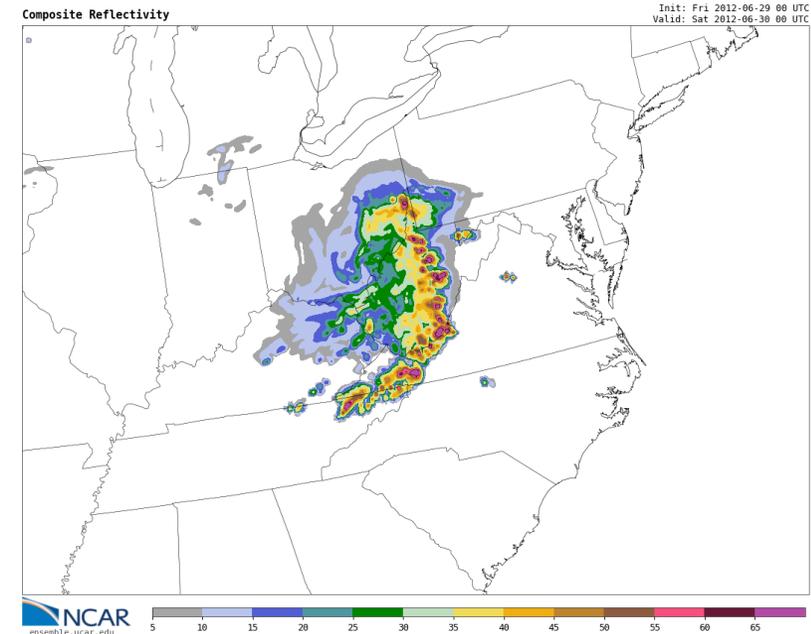
00:00 UTC



Radar



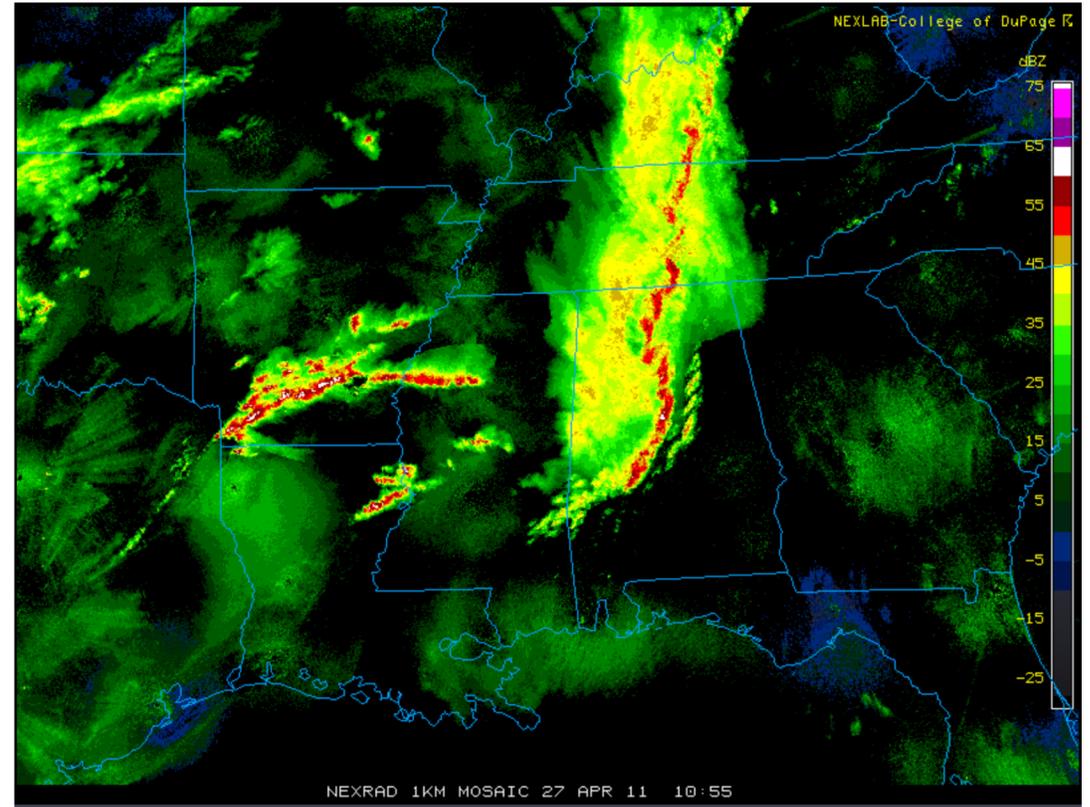
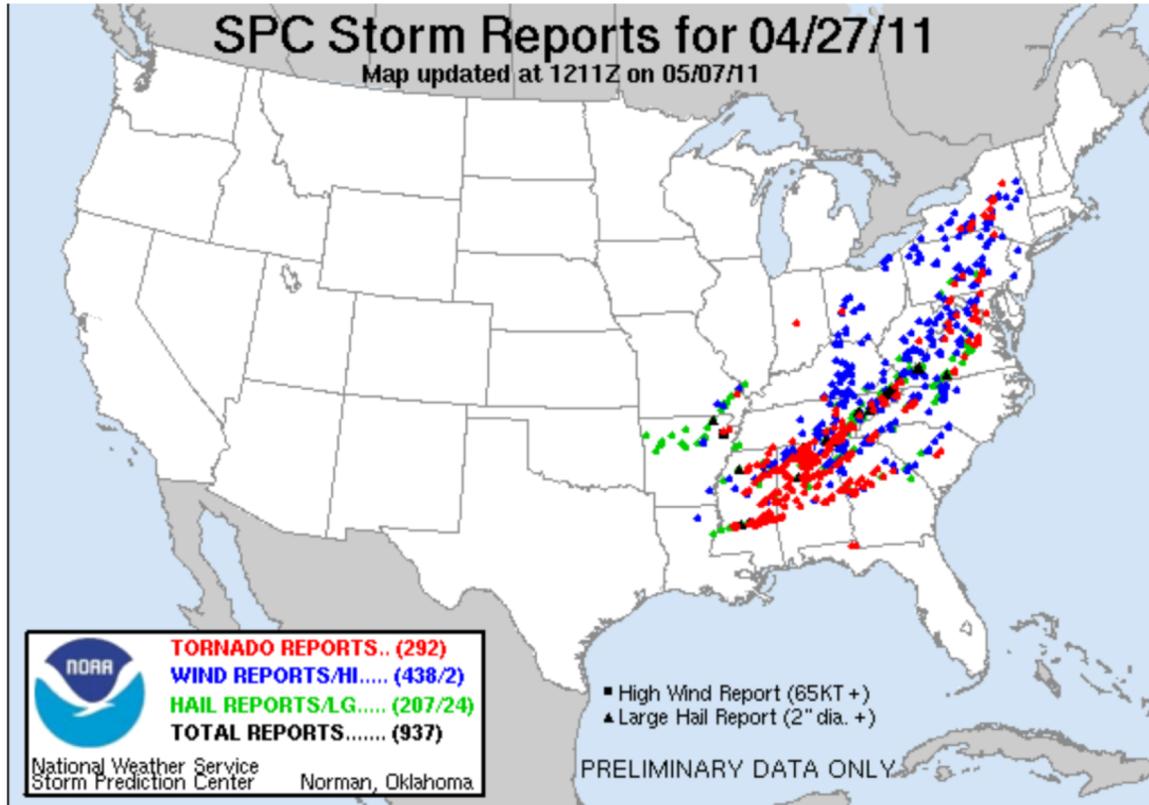
1 km



3 km

3 km system propagation more accurate for this case

27 April 2011

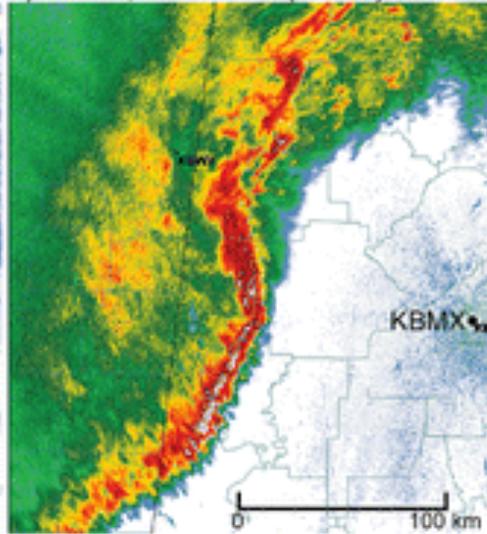


Radar 11:00 UTC

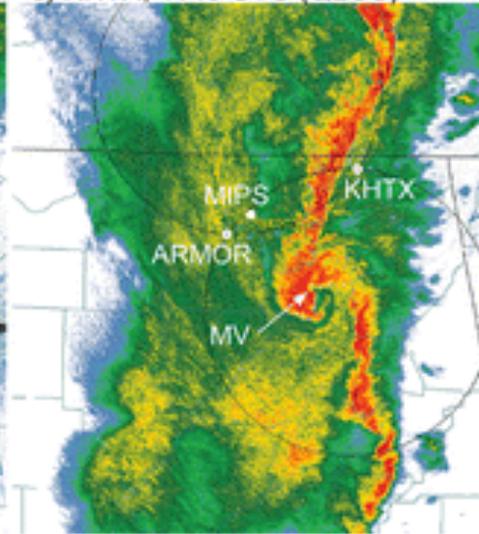
a) KGWX, 0735 UTC (MCS)



b) KBMX, 0940 UTC (QLCS)



c) KHTX, 1140 UTC (QLCS)



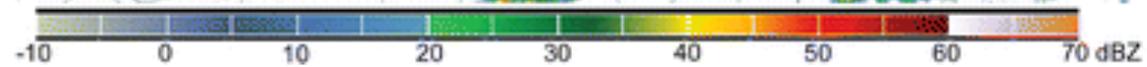
d) KHTX, 1648 UTC (QLCS)



e) KGWX, 2038 UTC (supercells)



f) KBMX, 2219 UTC (supercells)

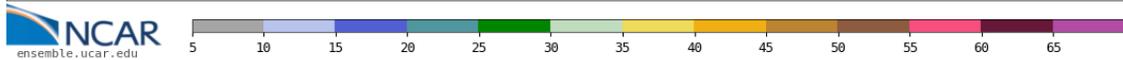
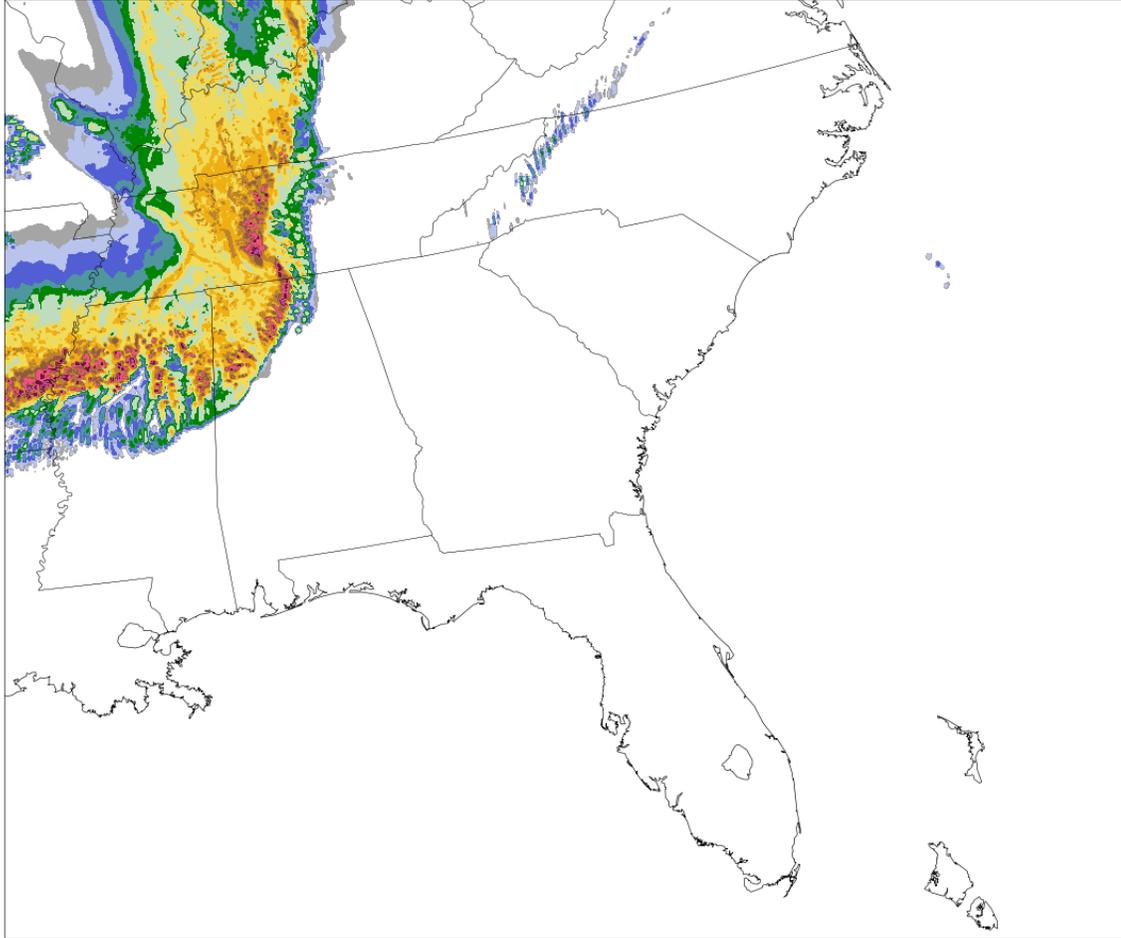


Knupp et al. BAMS 2014

27 April 2011

Composite Reflectivity

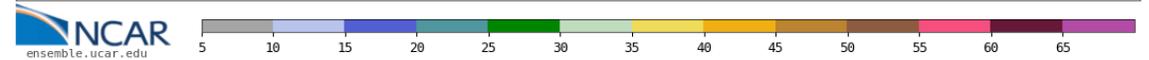
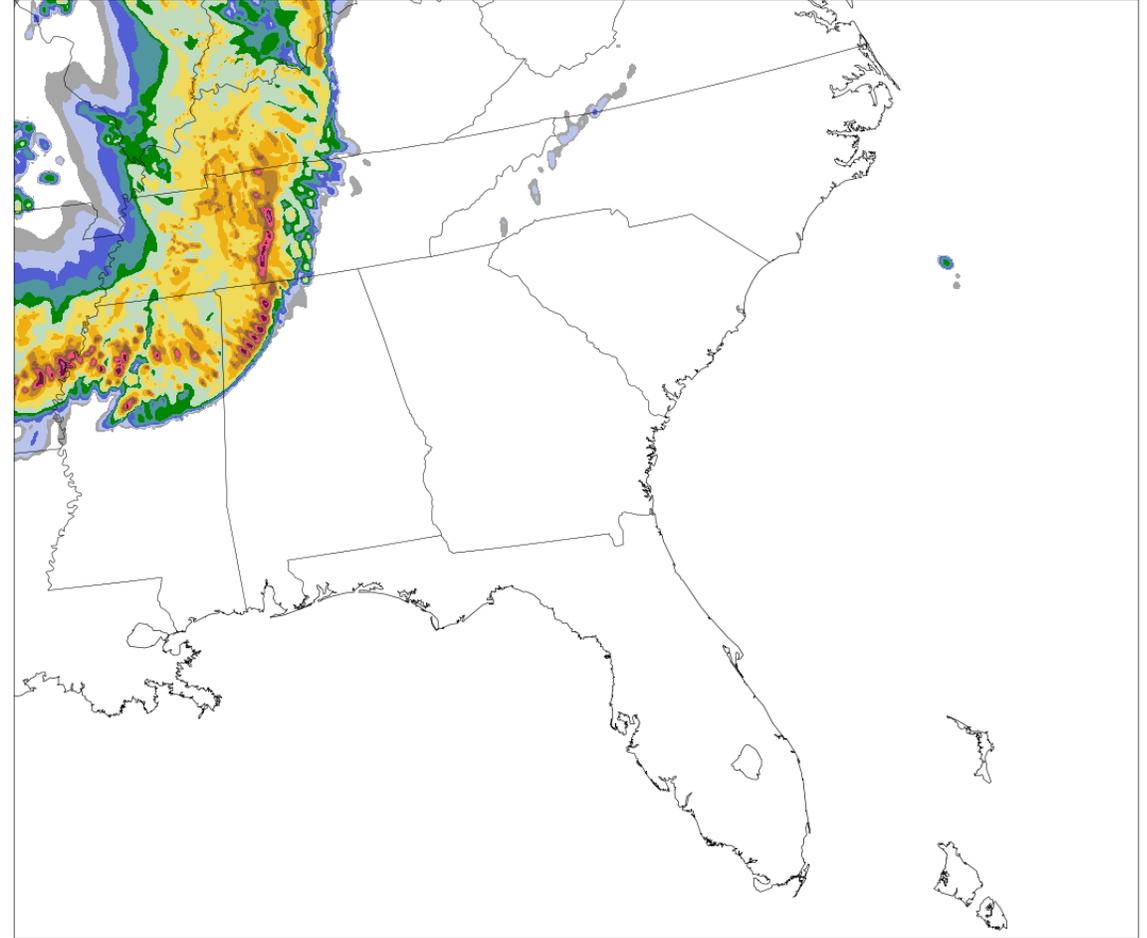
Init: Wed 2011-04-27 00 UTC
Valid: Wed 2011-04-27 10 UTC



1 km

Composite Reflectivity

Init: Wed 2011-04-27 00 UTC
Valid: Wed 2011-04-27 10 UTC



3 km

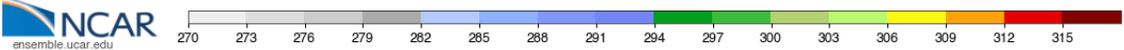
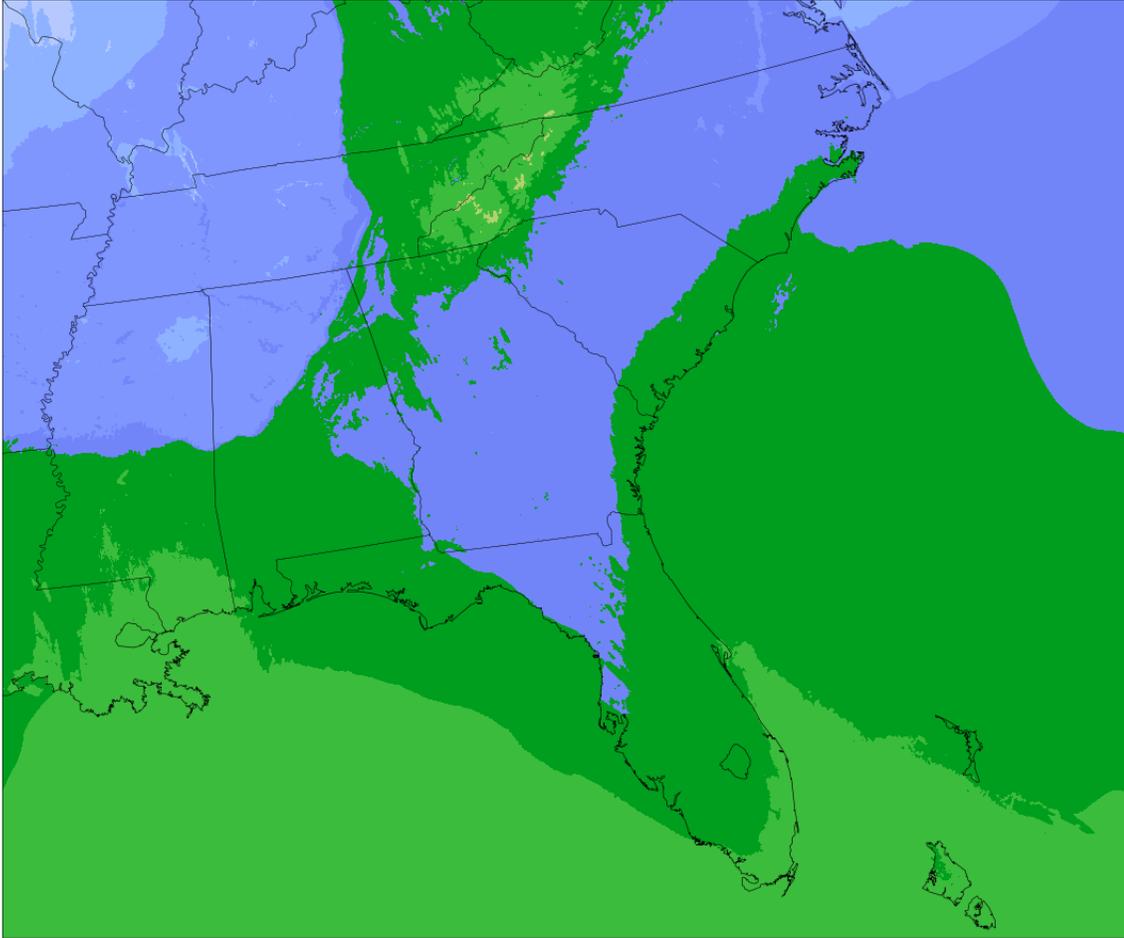
10:00 UTC

27 April 2011

Surface Theta (2m)

2-m Potential Temperature

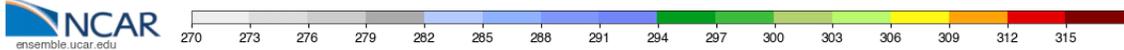
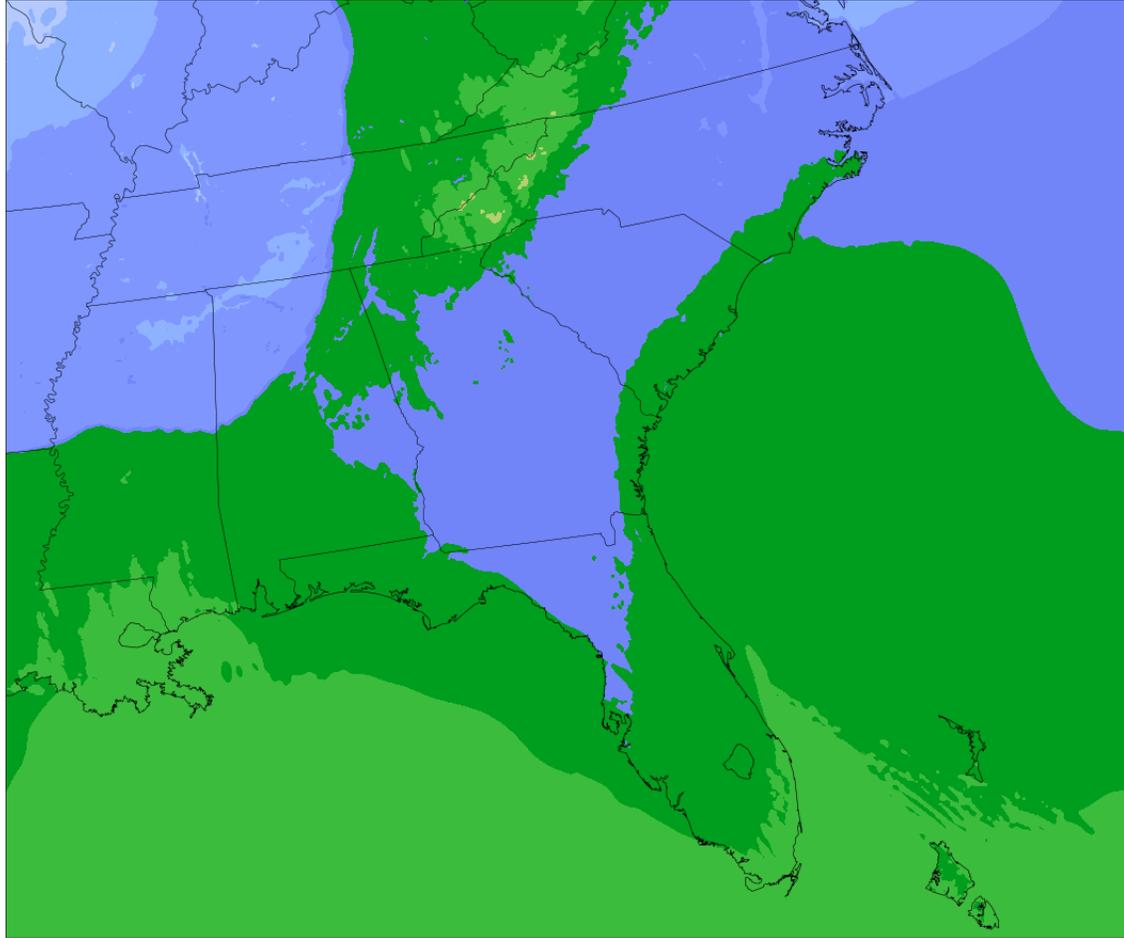
Init: Wed 2011-04-27 00 UTC
Valid: Wed 2011-04-27 12 UTC



1 km

2-m Potential Temperature

Init: Wed 2011-04-27 00 UTC
Valid: Wed 2011-04-27 12 UTC

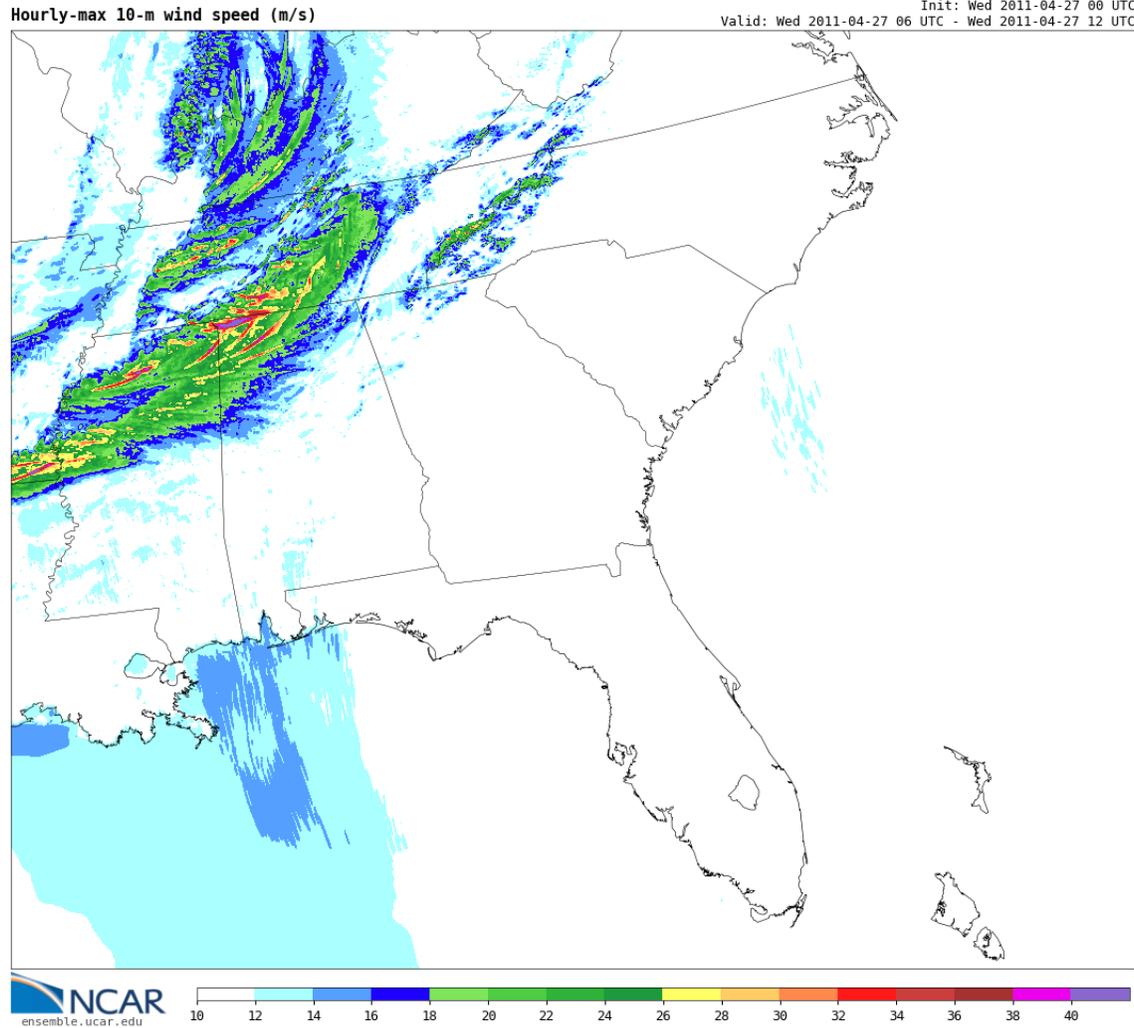


3 km

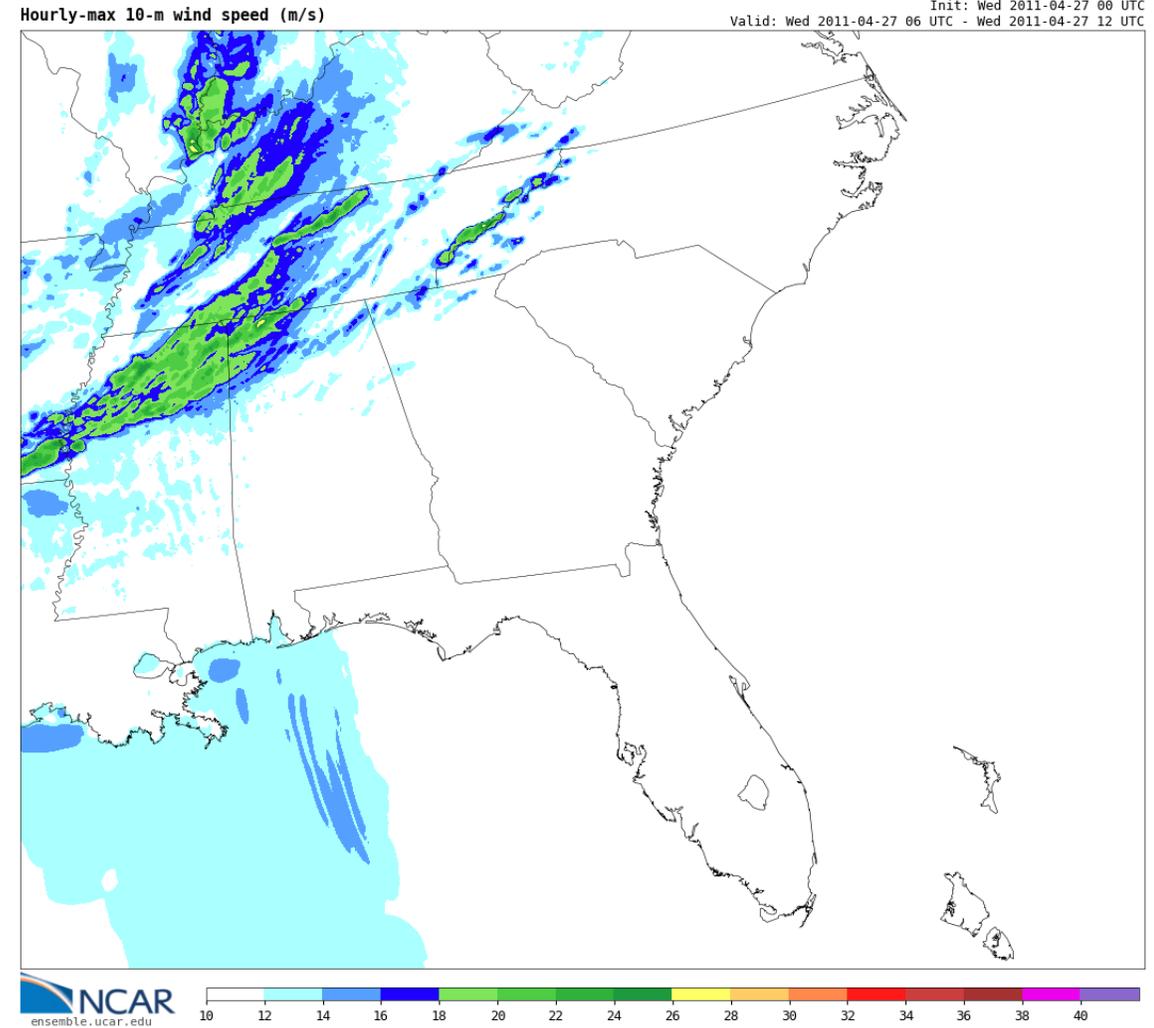
12:00 UTC

27 April 2011

Max Surface Wind (10m)



1 km

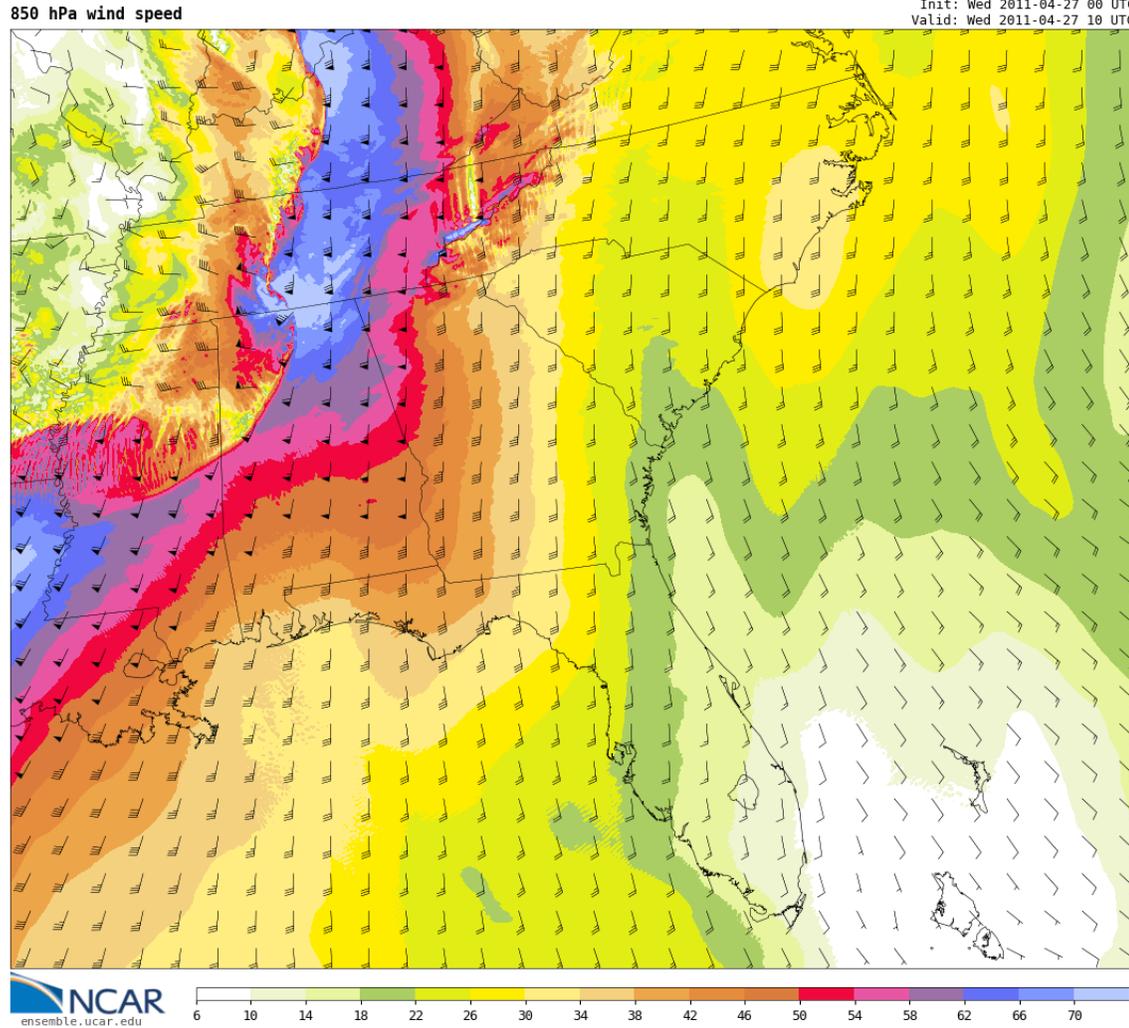


3 km

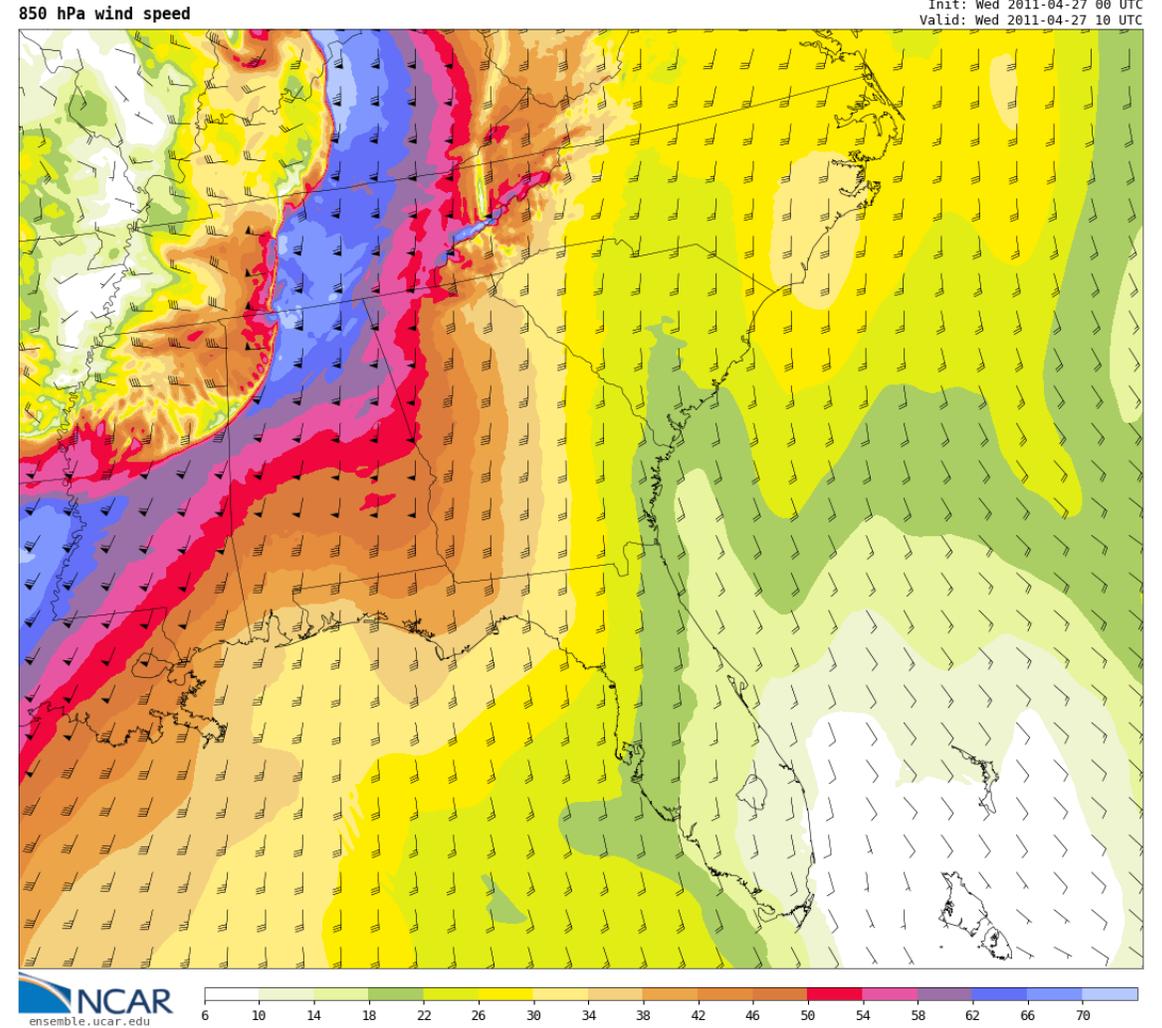
12:00 UTC

27 April 2011

850 hPa Winds



1 km

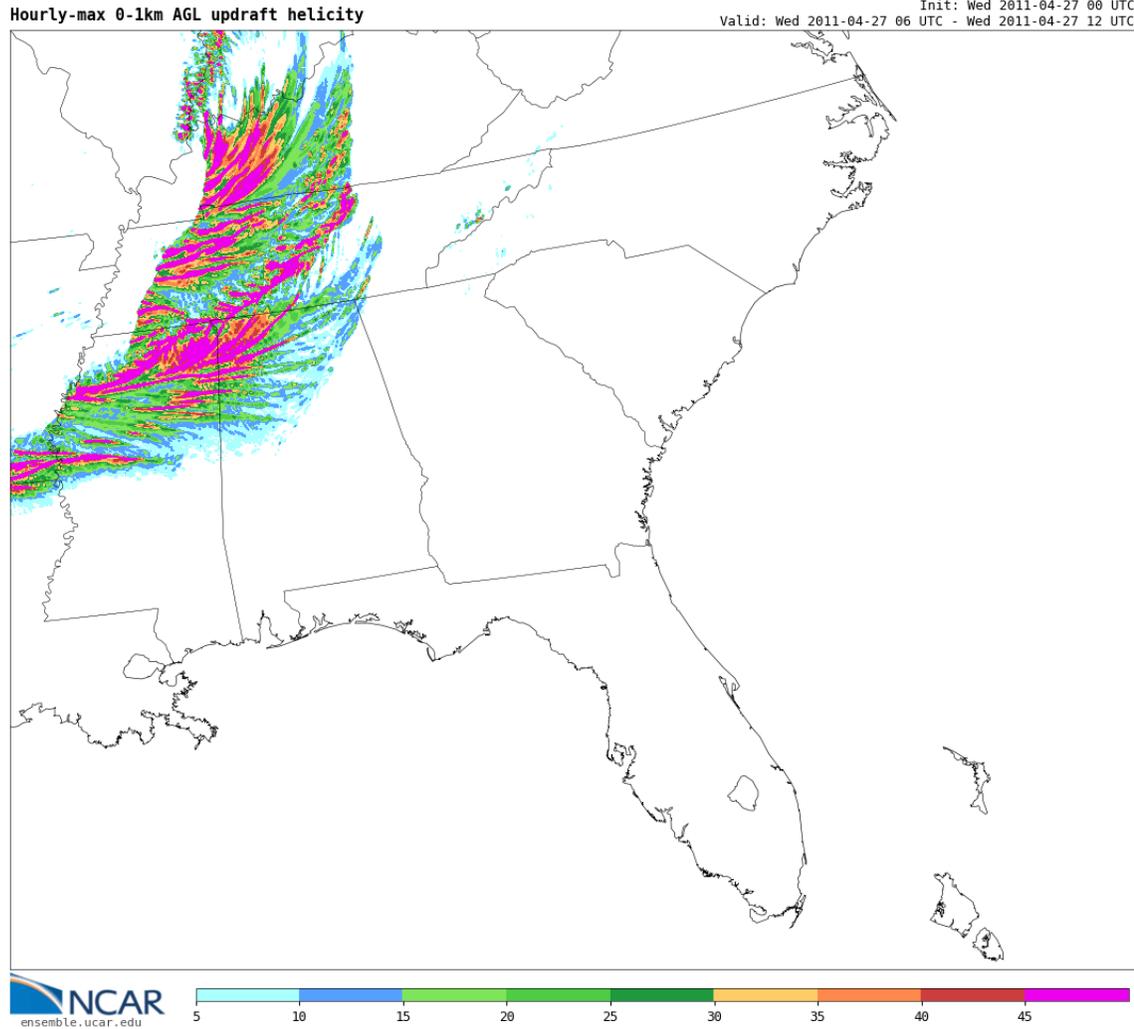


3 km

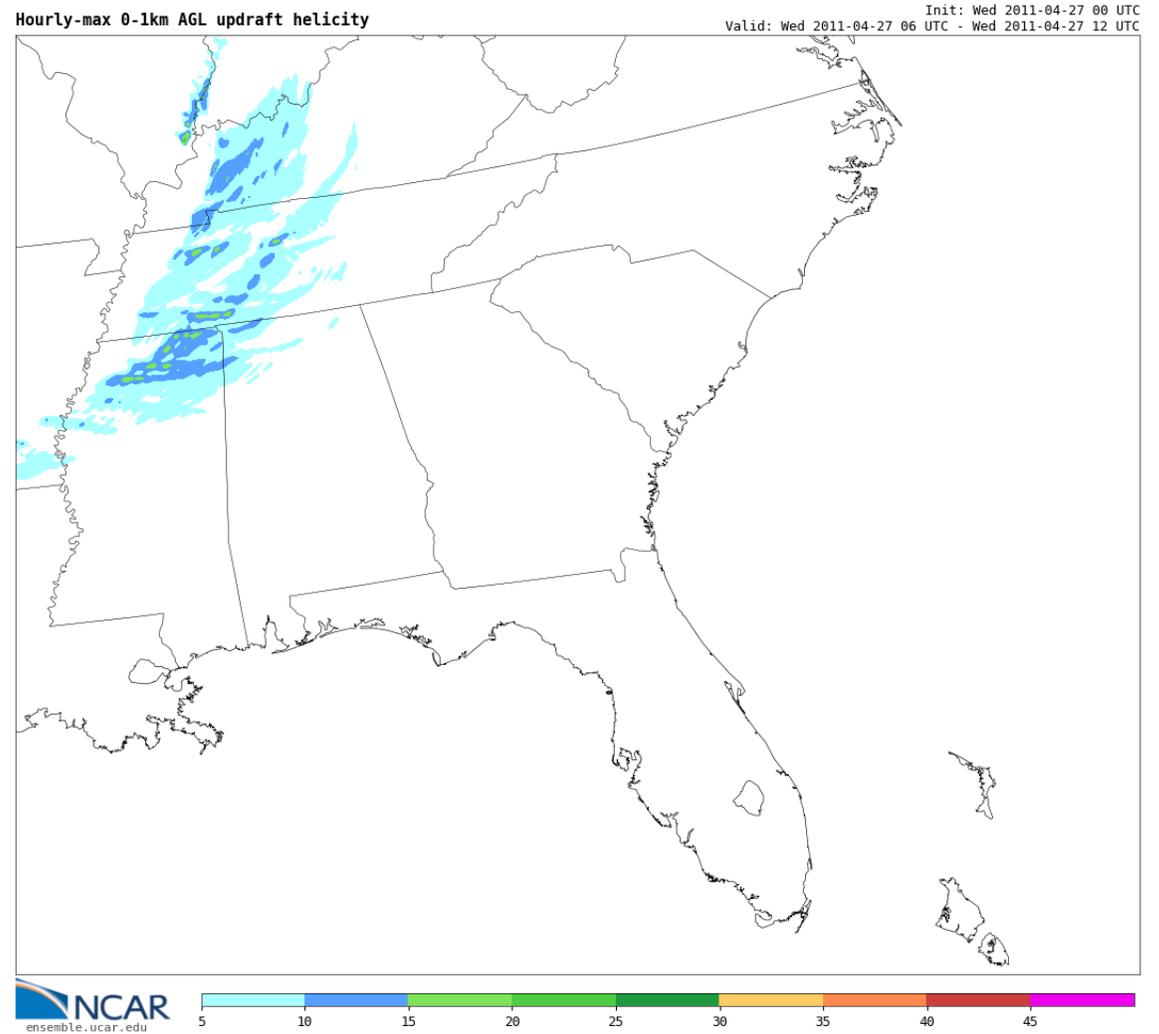
10:00 UTC

27 April 2011

Max Updraft Helicity (0-1km)



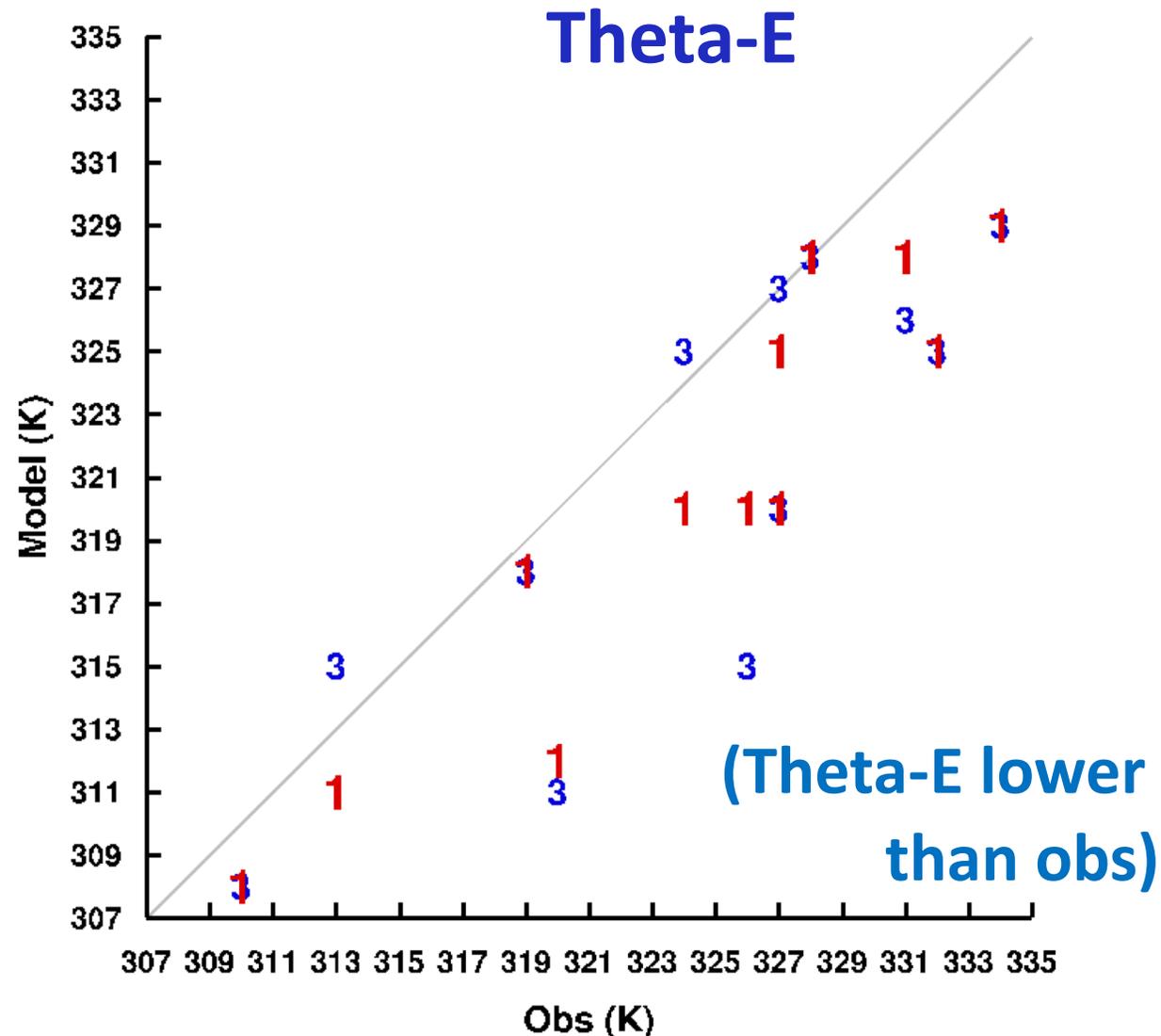
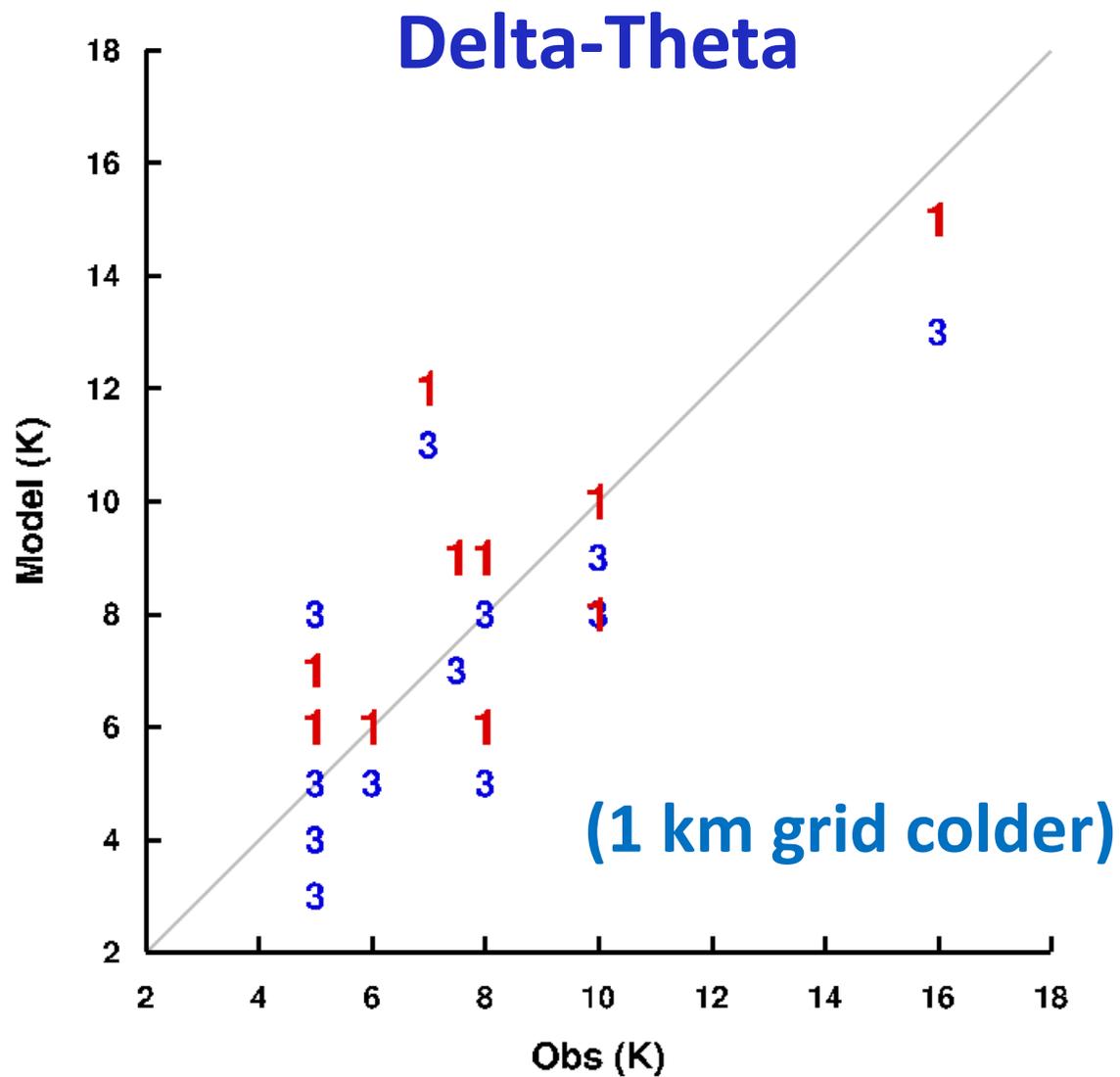
1 km



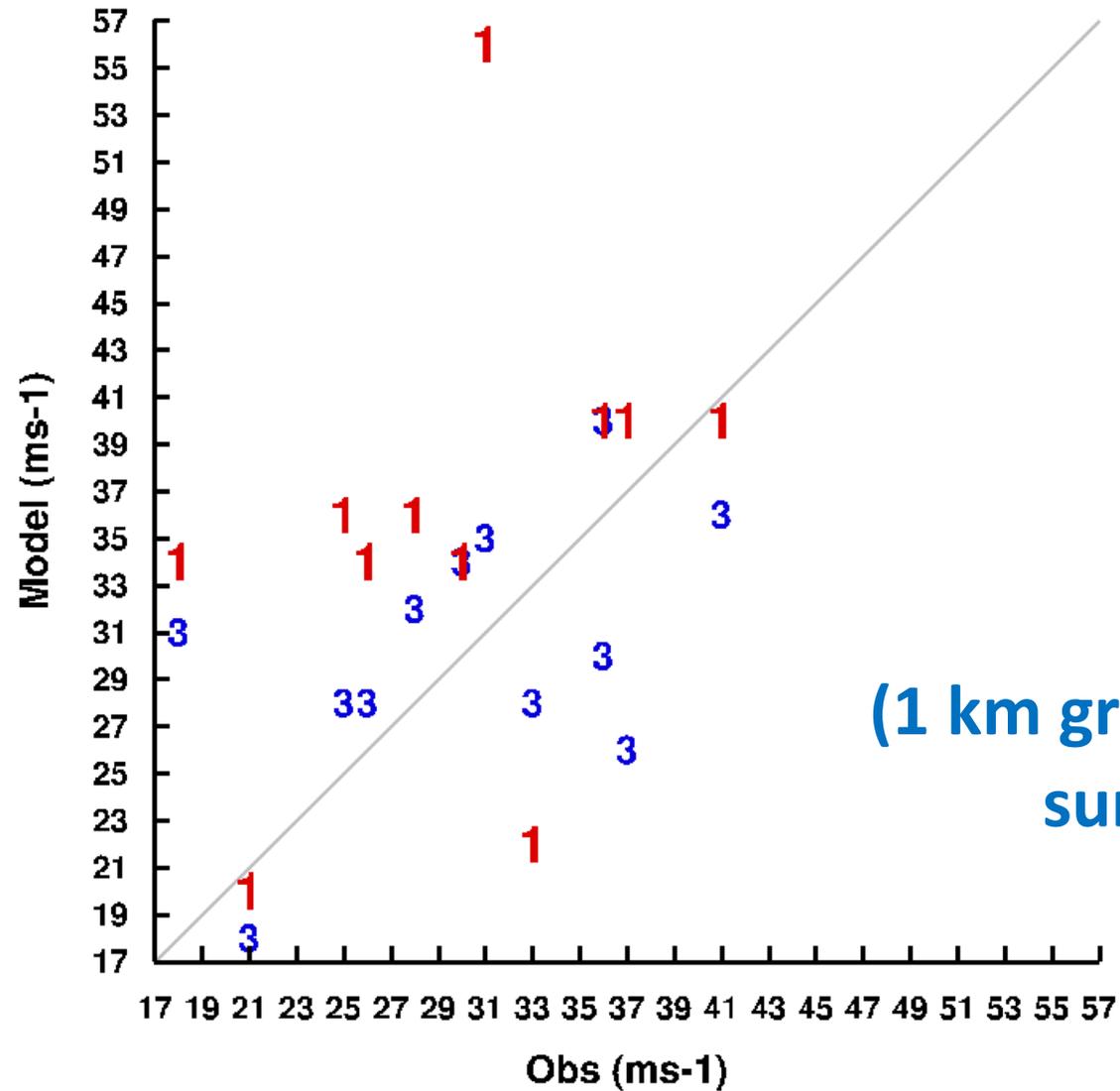
3 km

12:00 UTC

Summary Cold Pool Statistics:



Summary Max Surface Wind Statistics:



(1 km grid stronger surface winds)

QLCS characteristics: 1 vs. 3 km

...convective initiation (similar)

...cold pool strength/propagation (1km cooler, a bit faster)

...surface winds (1 km stronger)

...mesovortices (more leading line vortices at 1 km)

...rear-inflow jet (similar)

Caution: present results could be sensitive to microphysics (Thompson)

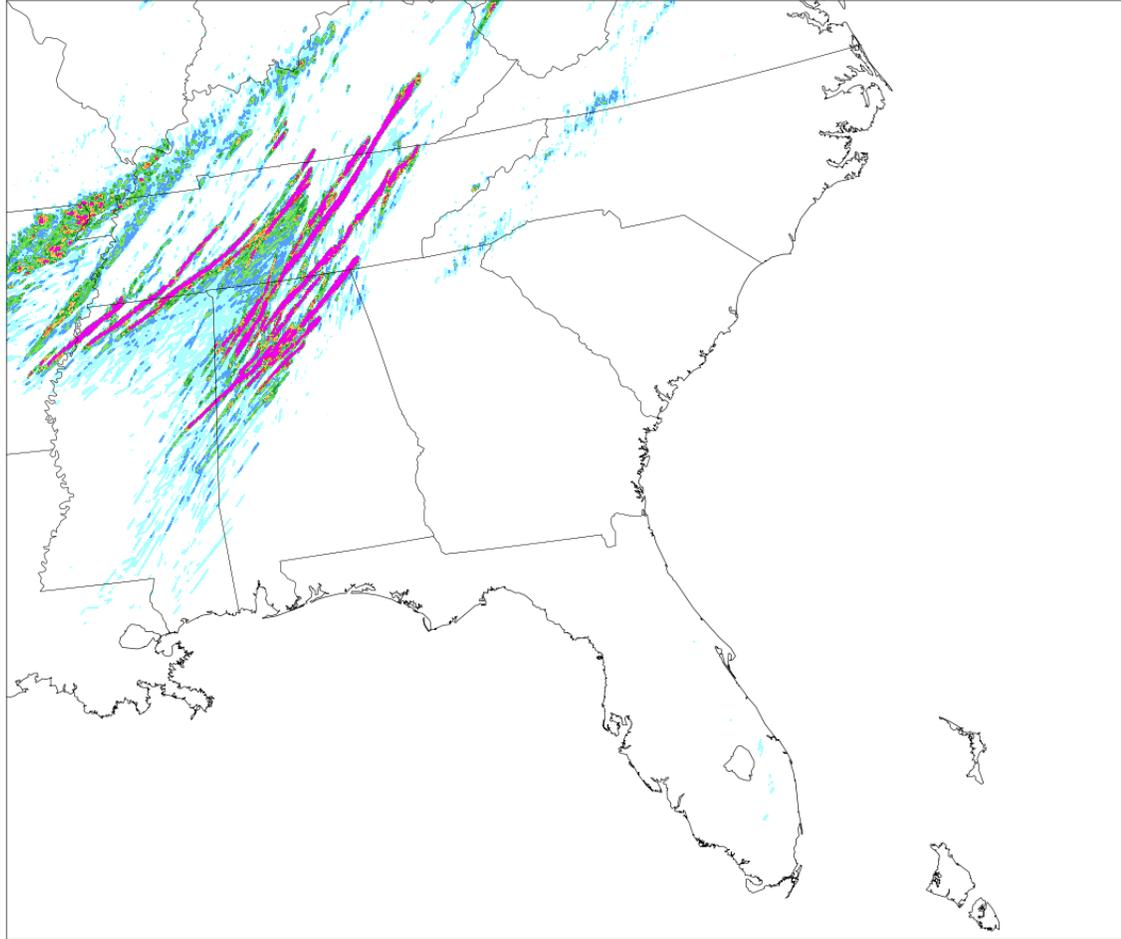
27 April 2011

Max Updraft Helicity

Hourly-max 0-1km AGL updraft helicity

Valid: Wed 2011-04-27 18 UTC - Thu 2011-04-28 00 UTC

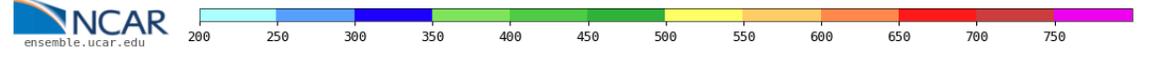
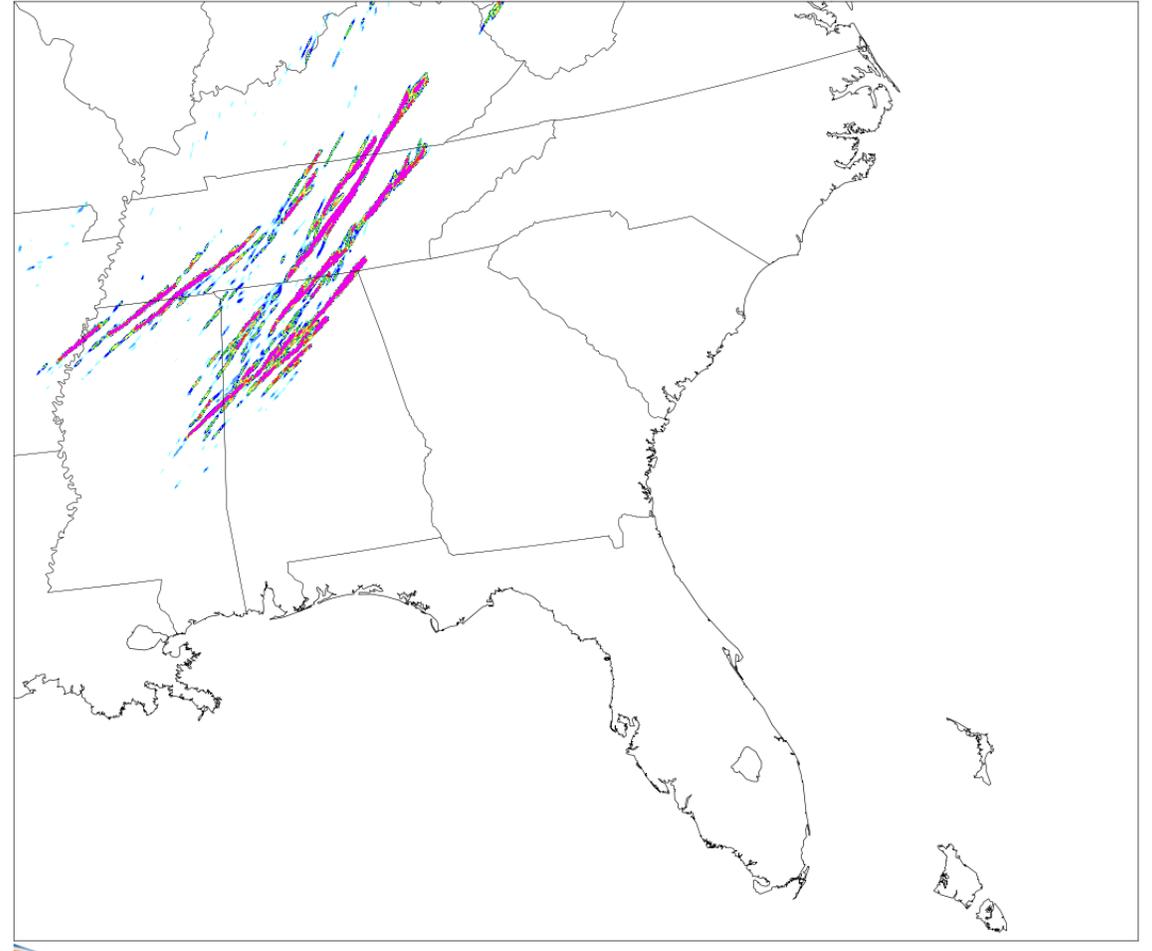
Init: Wed 2011-04-27 00 UTC



2-5km Updraft Helicity (m2/s2)

Valid: Wed 2011-04-27 18 UTC - Thu 2011-04-28 00 UTC

Init: Wed 2011-04-27 00 UTC



1 km 0-1 UH

00:00 UTC

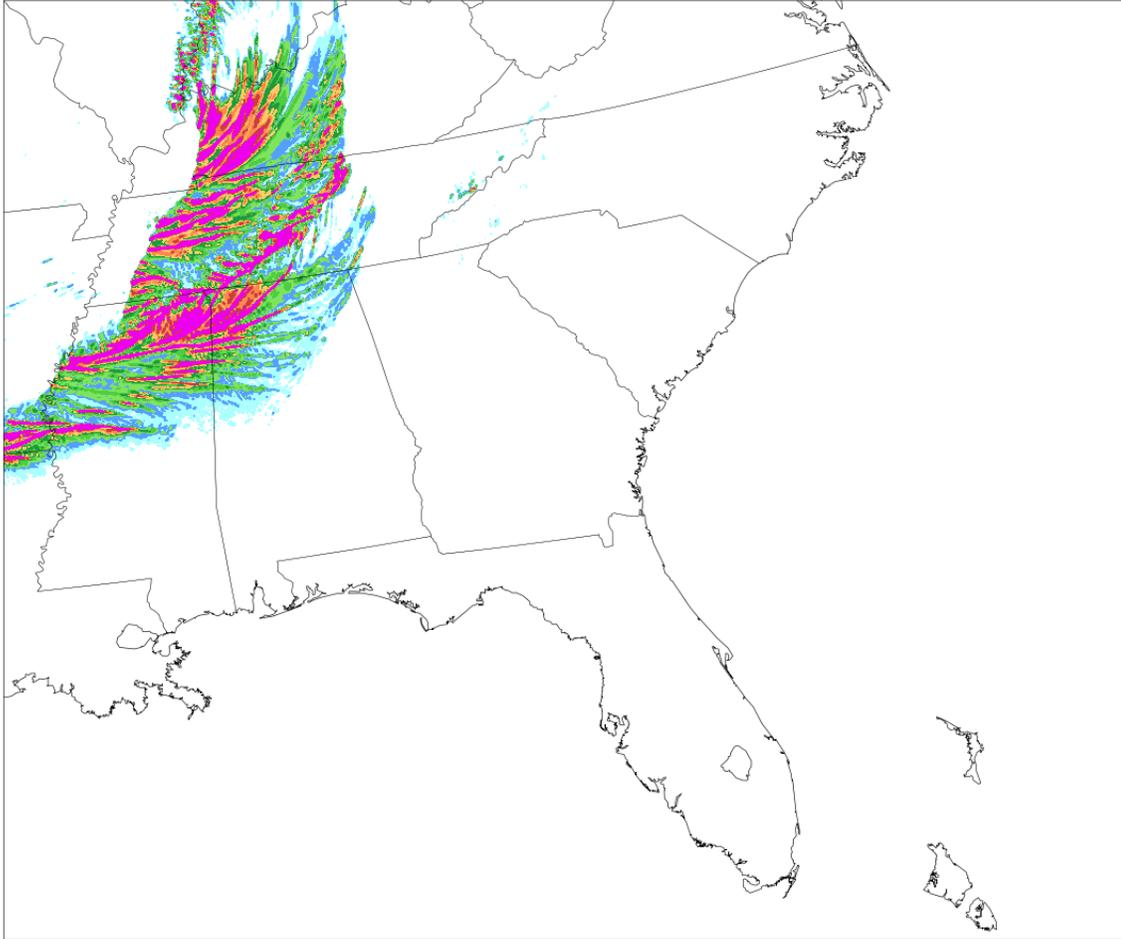
1 km 2-5 UH

27 April 2011

Max Updraft Helicity

Hourly-max 0-1km AGL updraft helicity

Init: Wed 2011-04-27 00 UTC
Valid: Wed 2011-04-27 06 UTC - Wed 2011-04-27 12 UTC

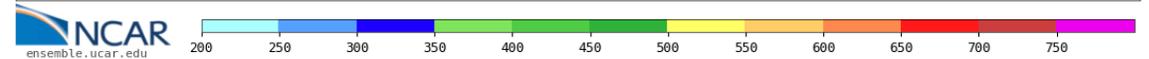
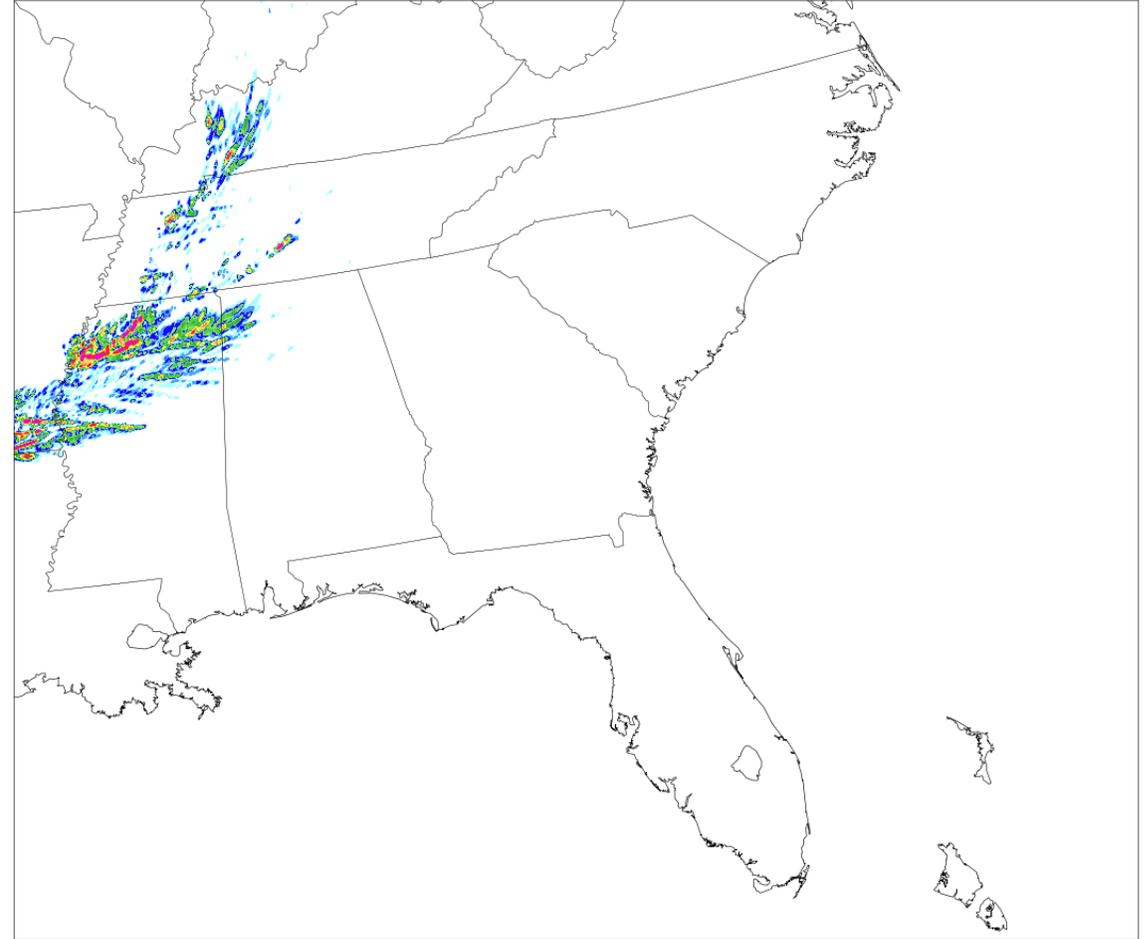


1 km 0-1 UH

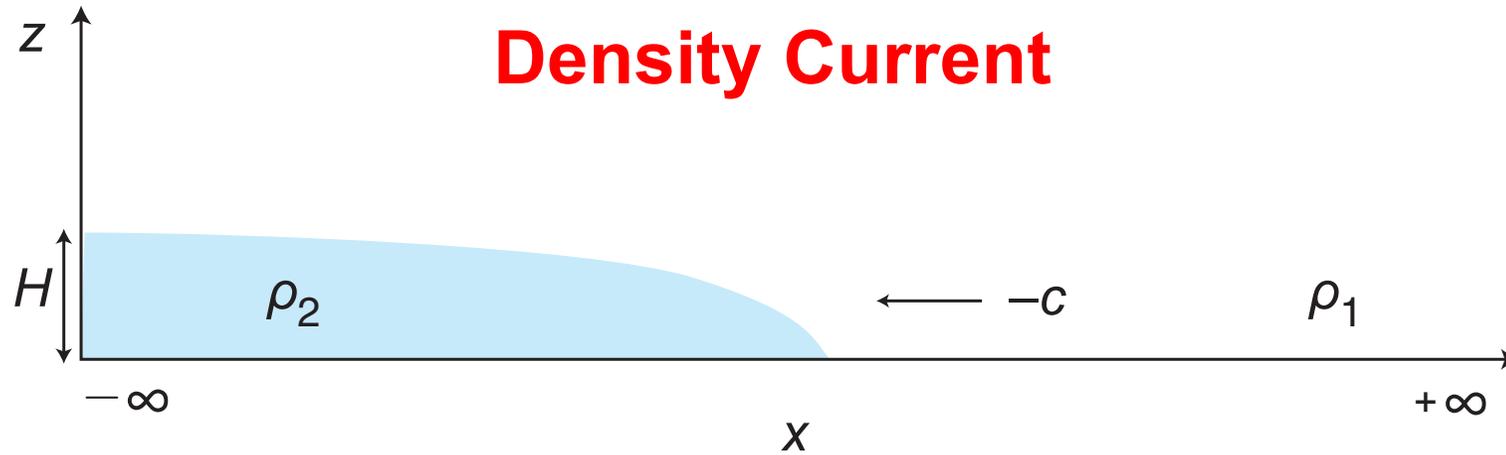
12:00 UTC

2-5km Updraft Helicity (m2/s2)

Init: Wed 2011-04-27 00 UTC
Valid: Wed 2011-04-27 06 UTC - Wed 2011-04-27 12 UTC



1 km 2-5 UH



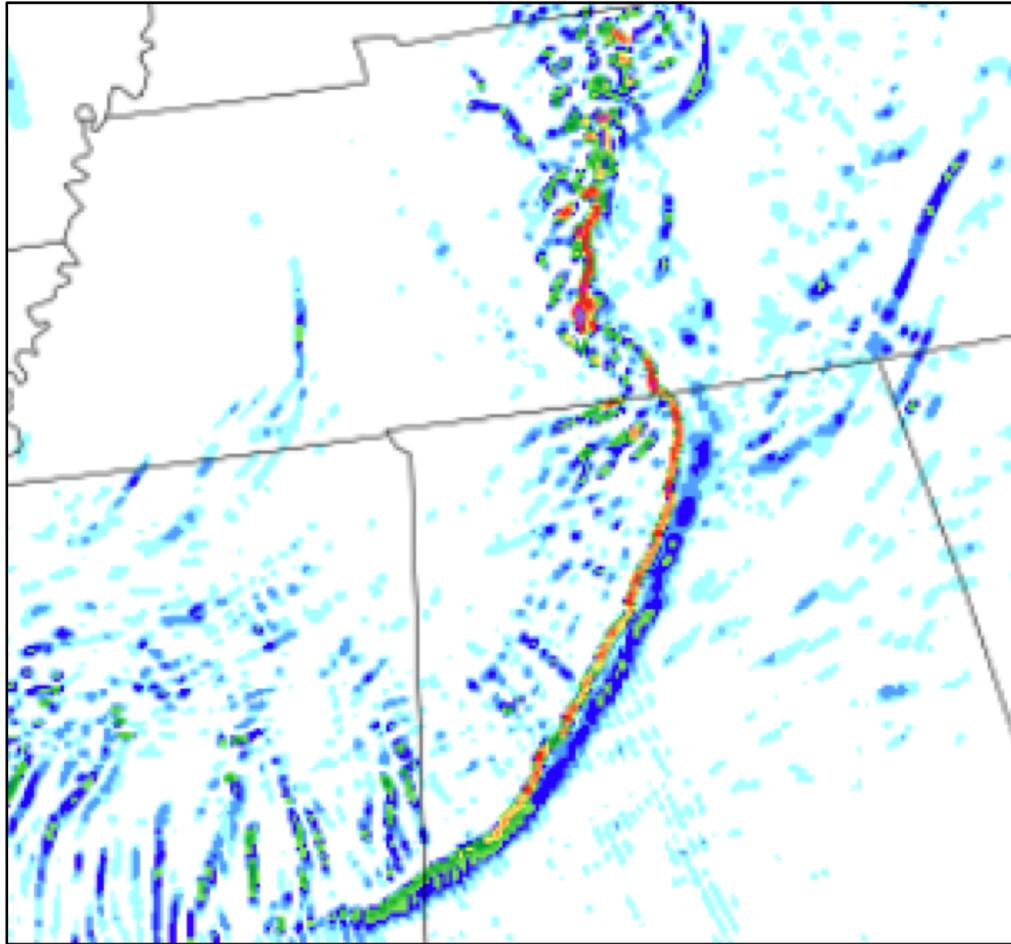
Theoretical speed of propagation:

$$c^2 = 2 \int_0^H (-B) dz \quad B \equiv -g \frac{\rho'}{\bar{\rho}} \equiv g \frac{\theta'}{\bar{\theta}}$$

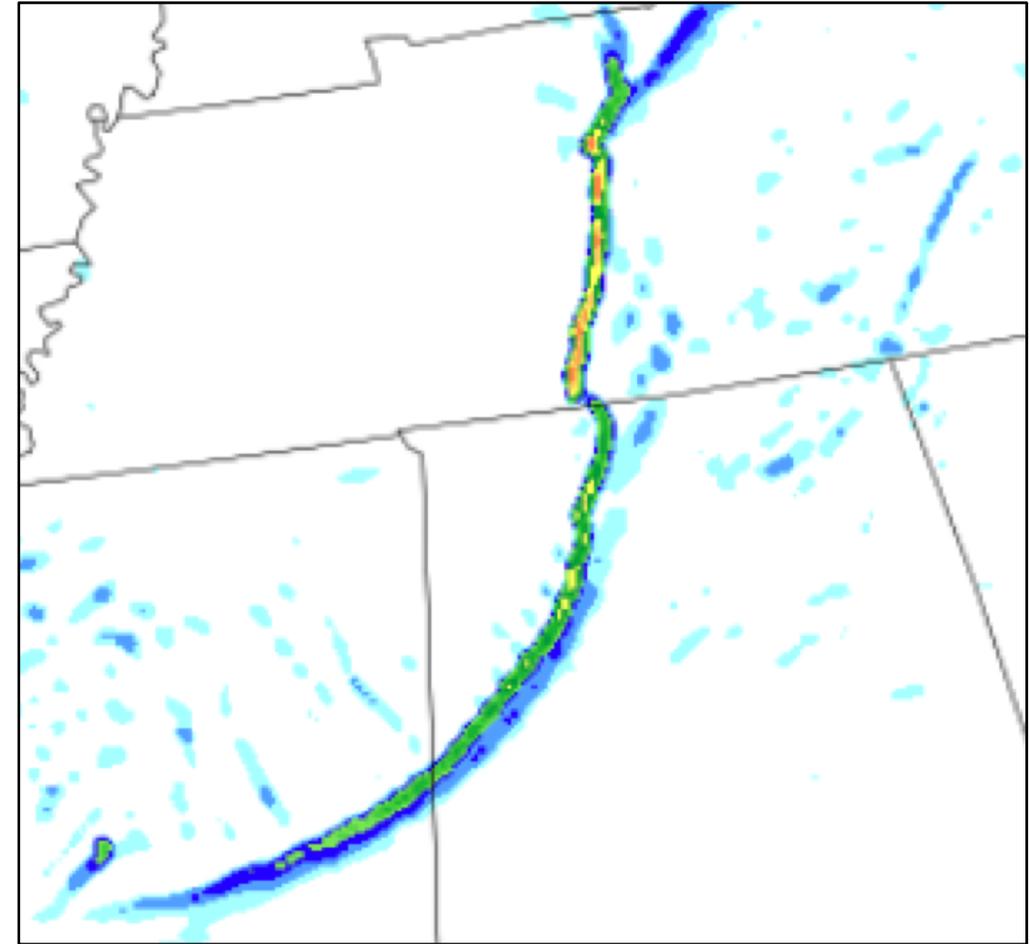
$$c = \sqrt{2g \frac{\bar{\theta}'}{\bar{\theta}} H} = \sqrt{2 \frac{\Delta P}{\bar{\rho}}}$$

Strength of a cold pool can be estimated from change in surface T, Theta, P....

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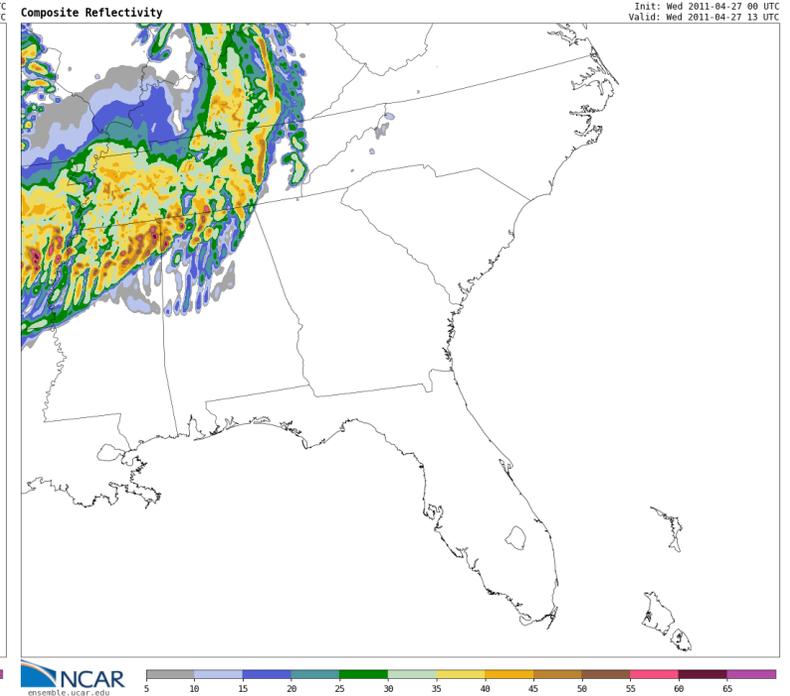
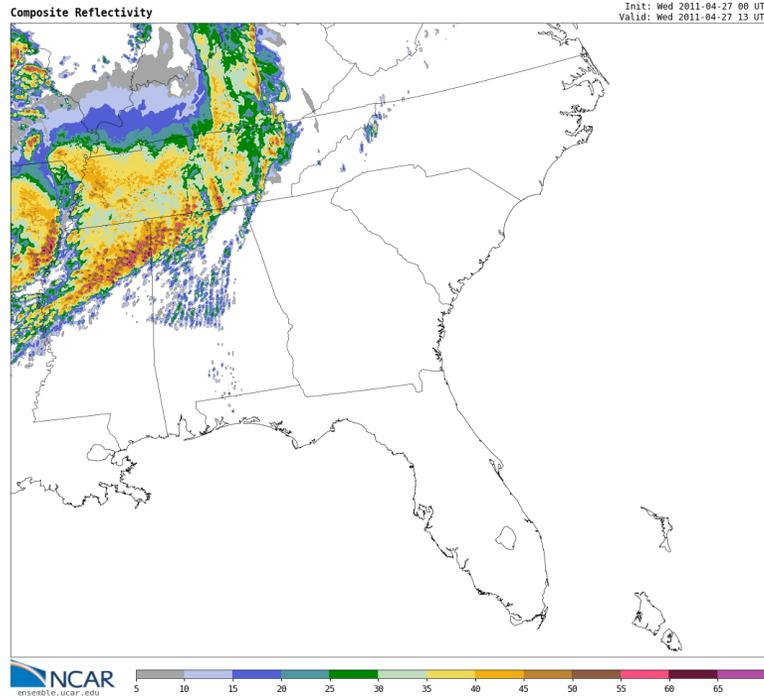
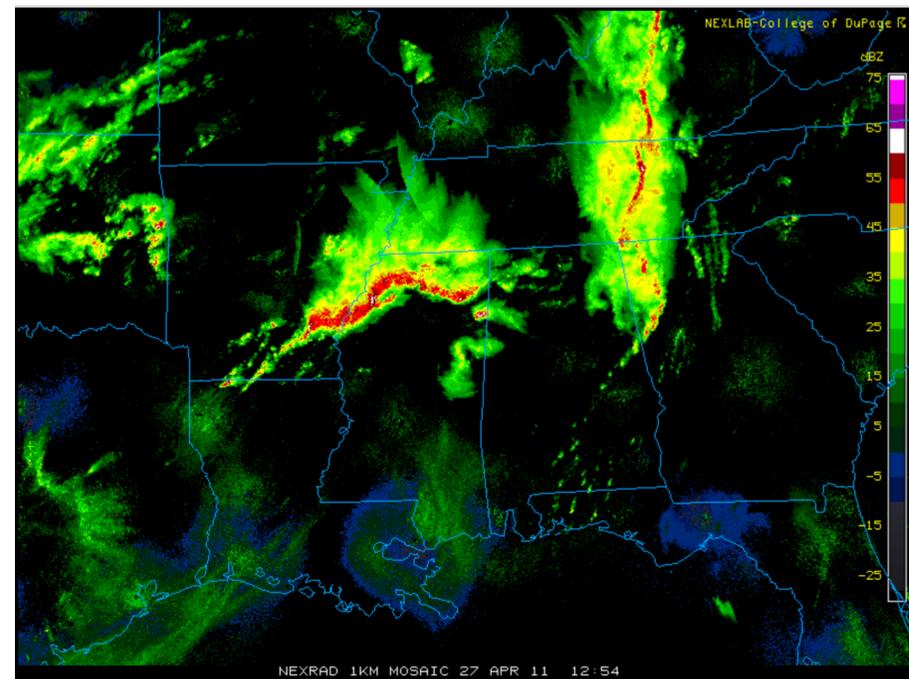
1 km



3 km

10:00 UTC

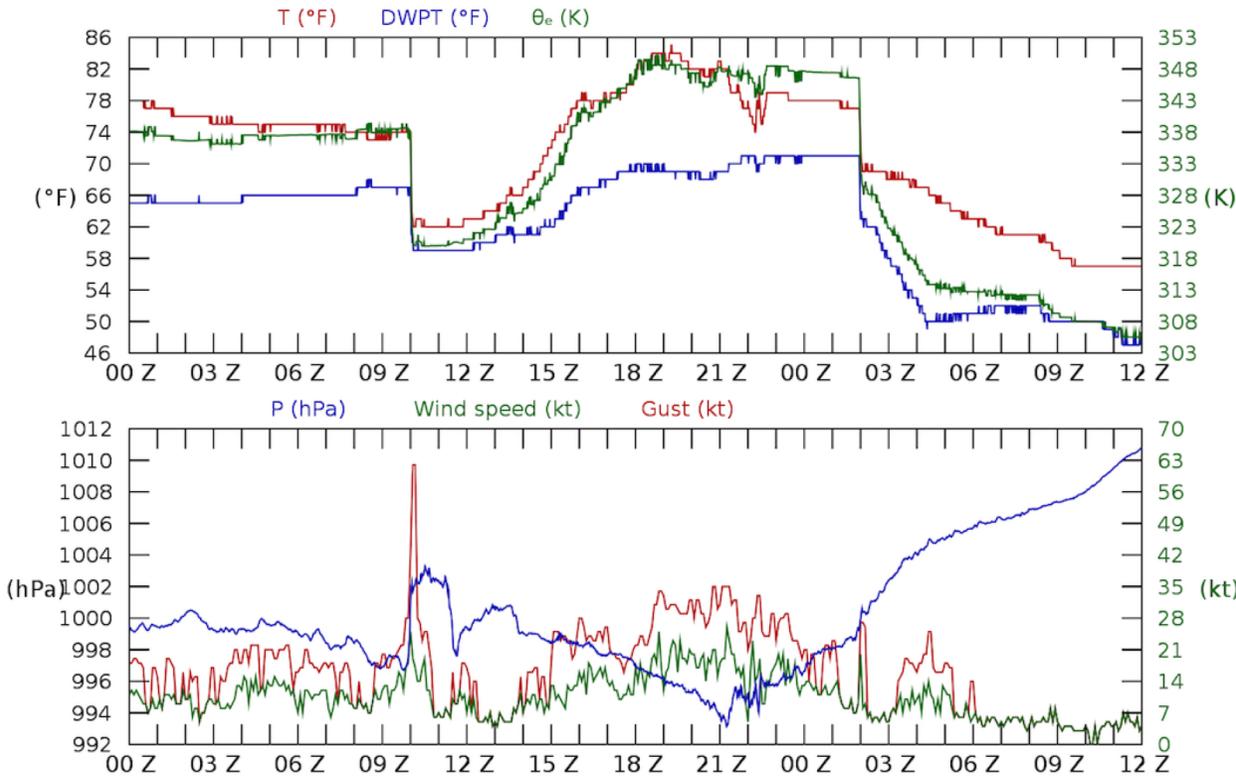
27 April 2011



13:00 UTC

27 April 2011

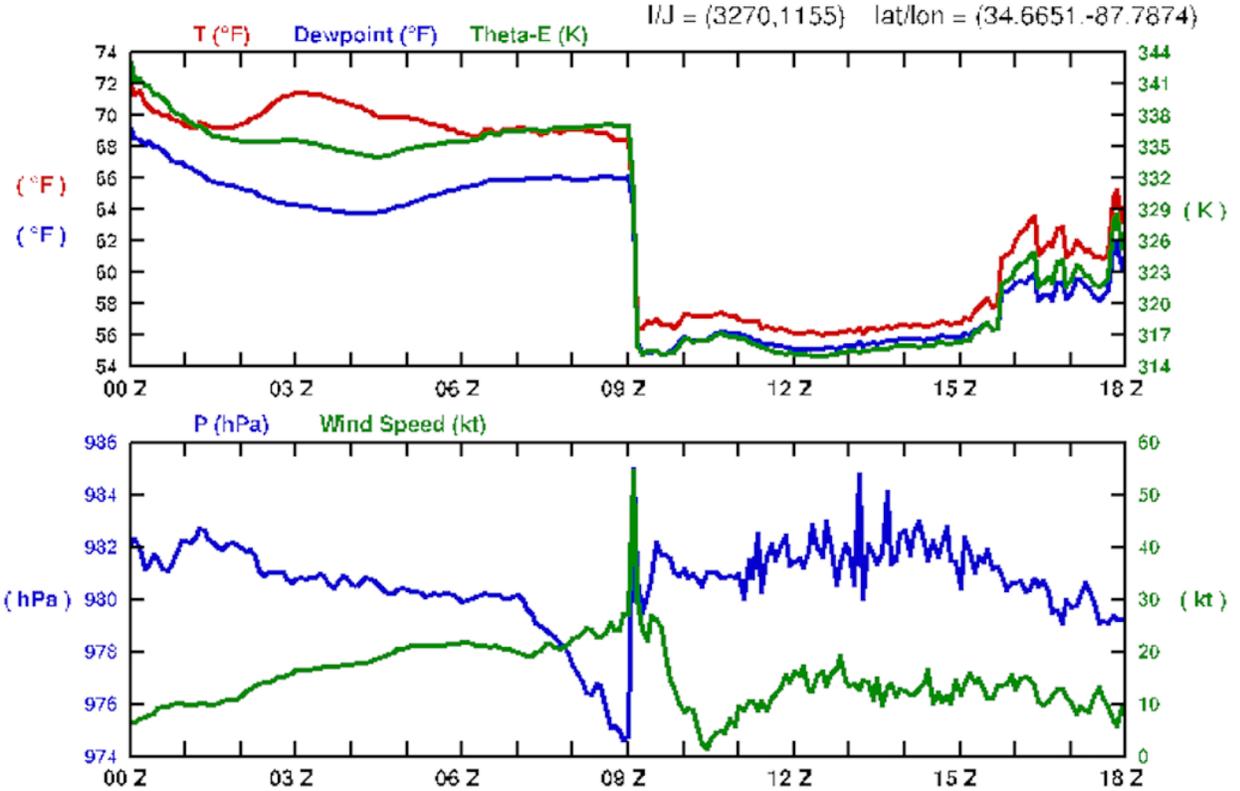
KTCL : 2011-04-27/00 UTC through 2011-04-28/12 UTC



KTCL

DTheta ~6 k 63 kts

2011-04-27/00 UTC through 2011-04-27/18 UTC



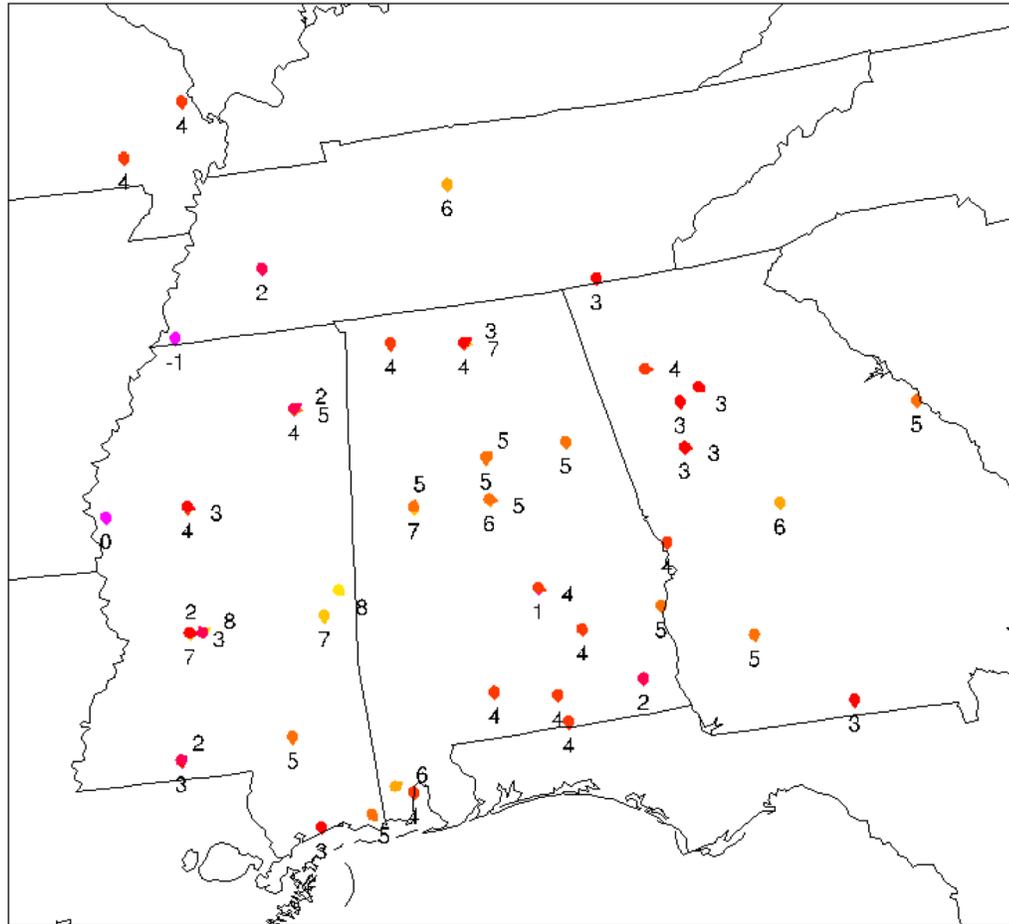
1 km

DTheta ~7 k 56 kts

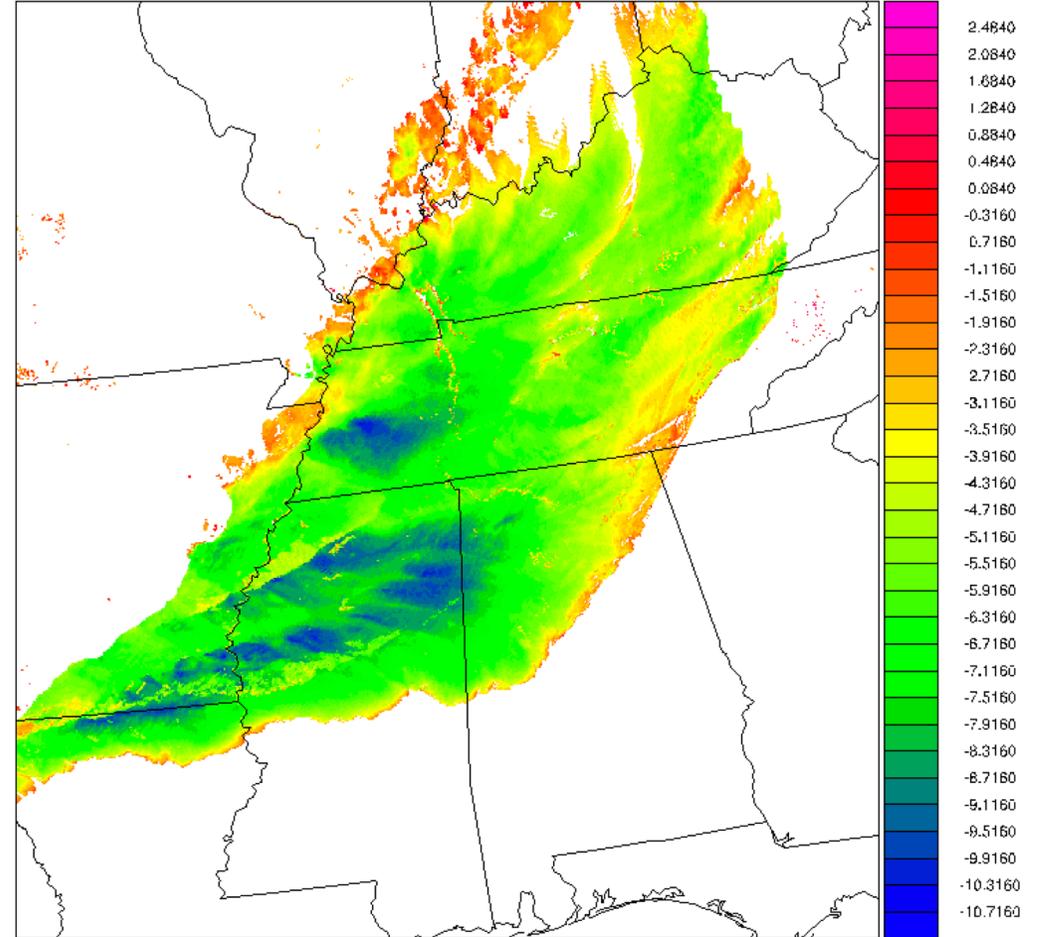
27 April 2011

Delta-Theta (K)

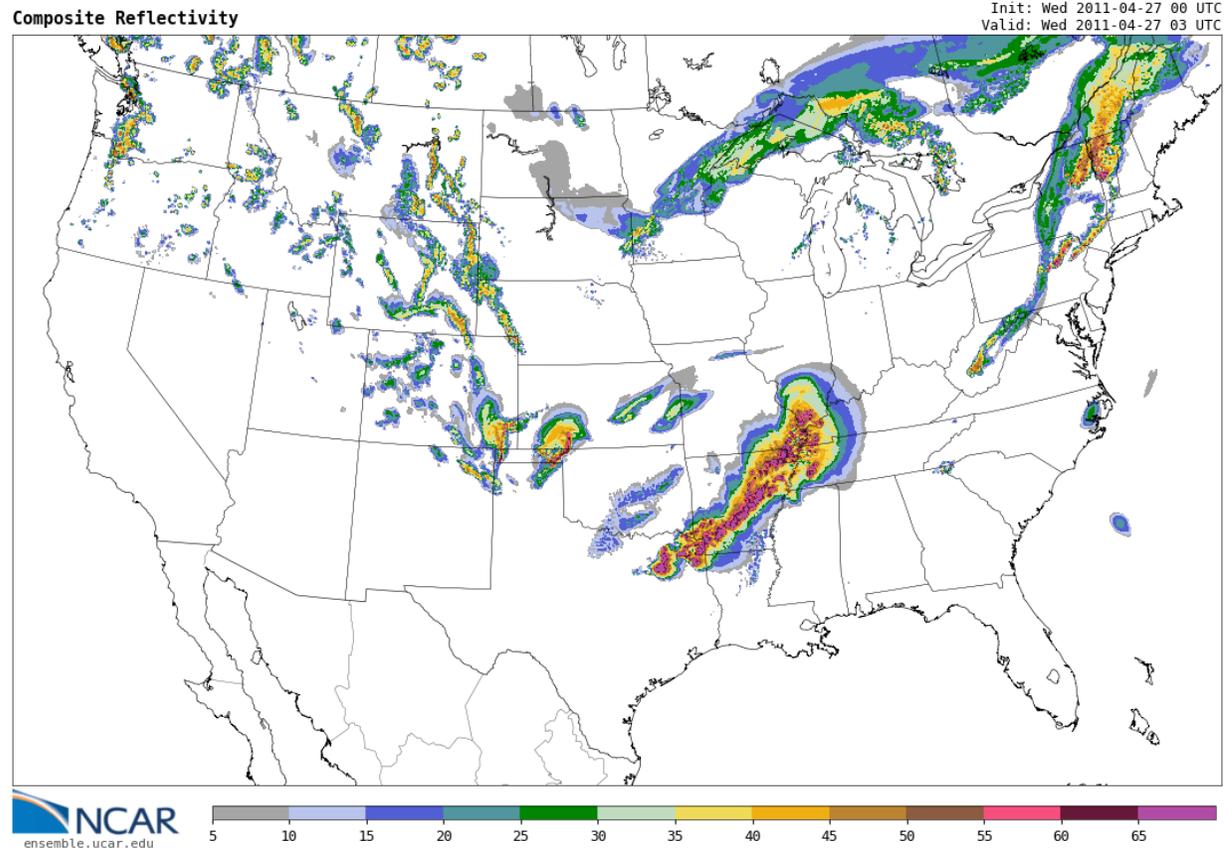
2011-04-27/06 through 2011-04-28/18 UTC



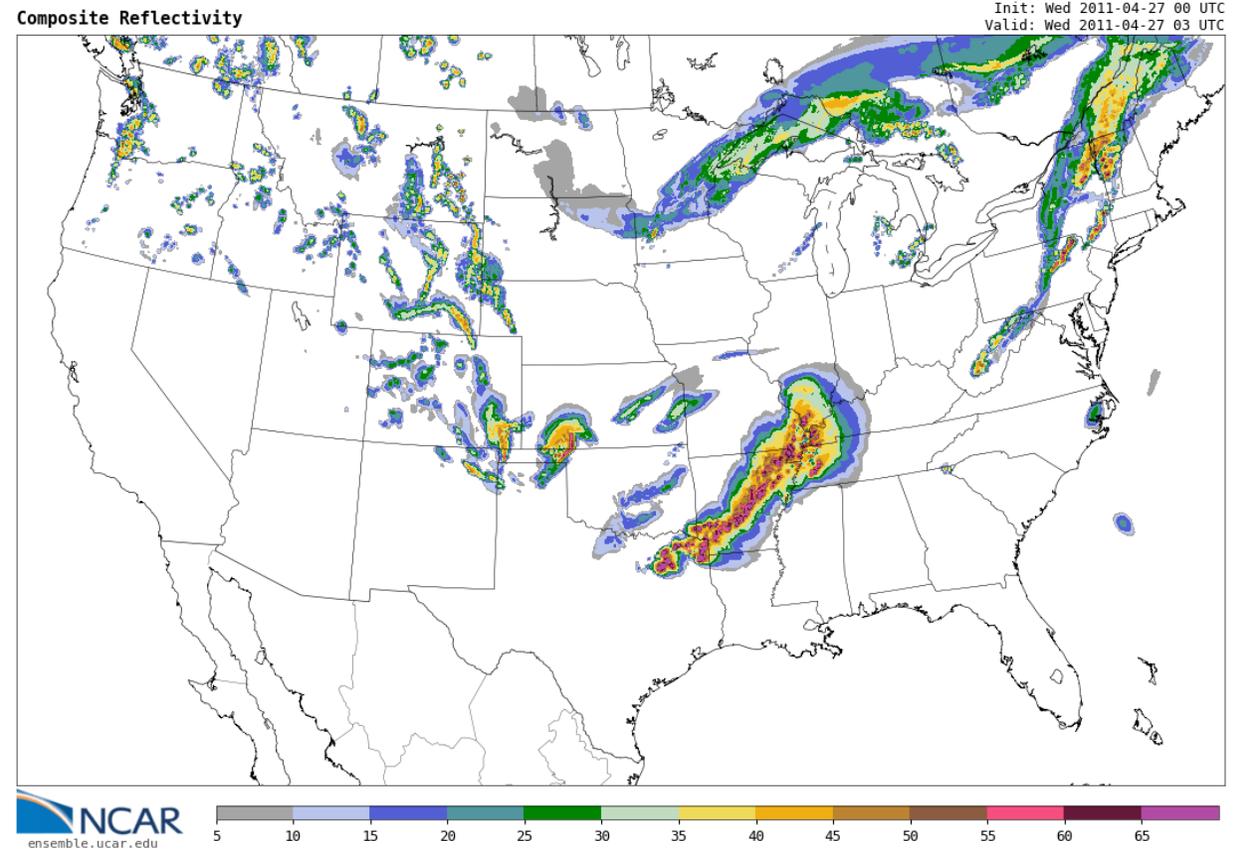
delta-Theta swath



27 April 2011



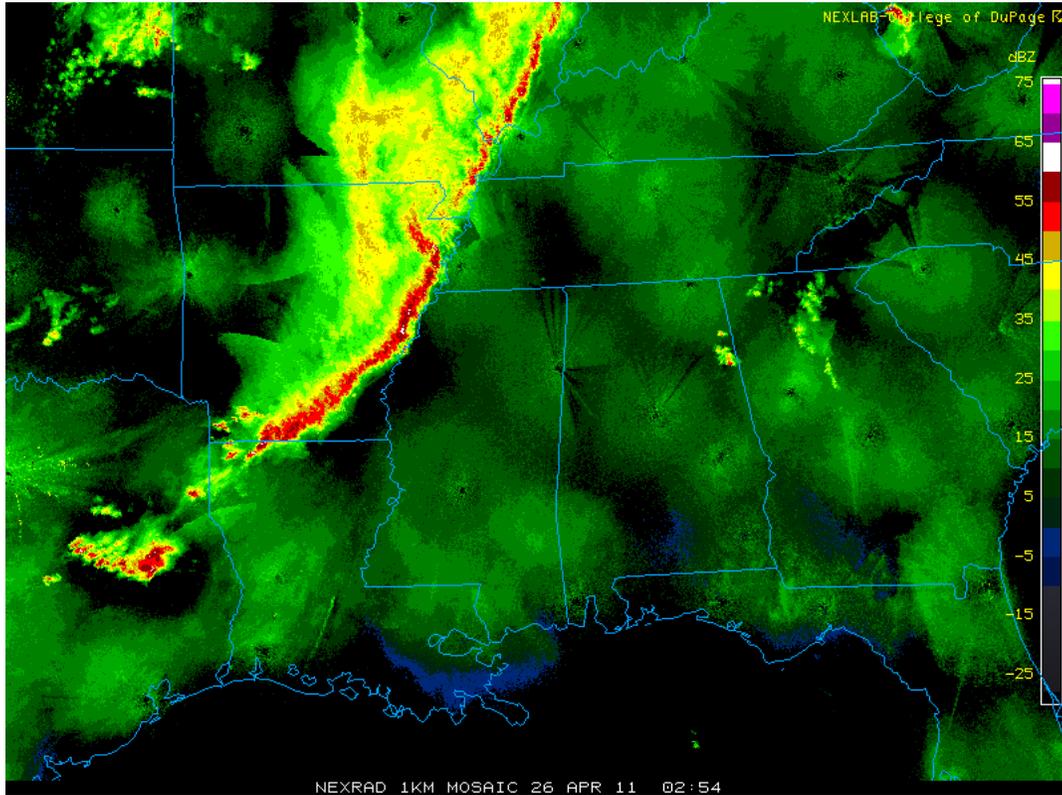
1 km



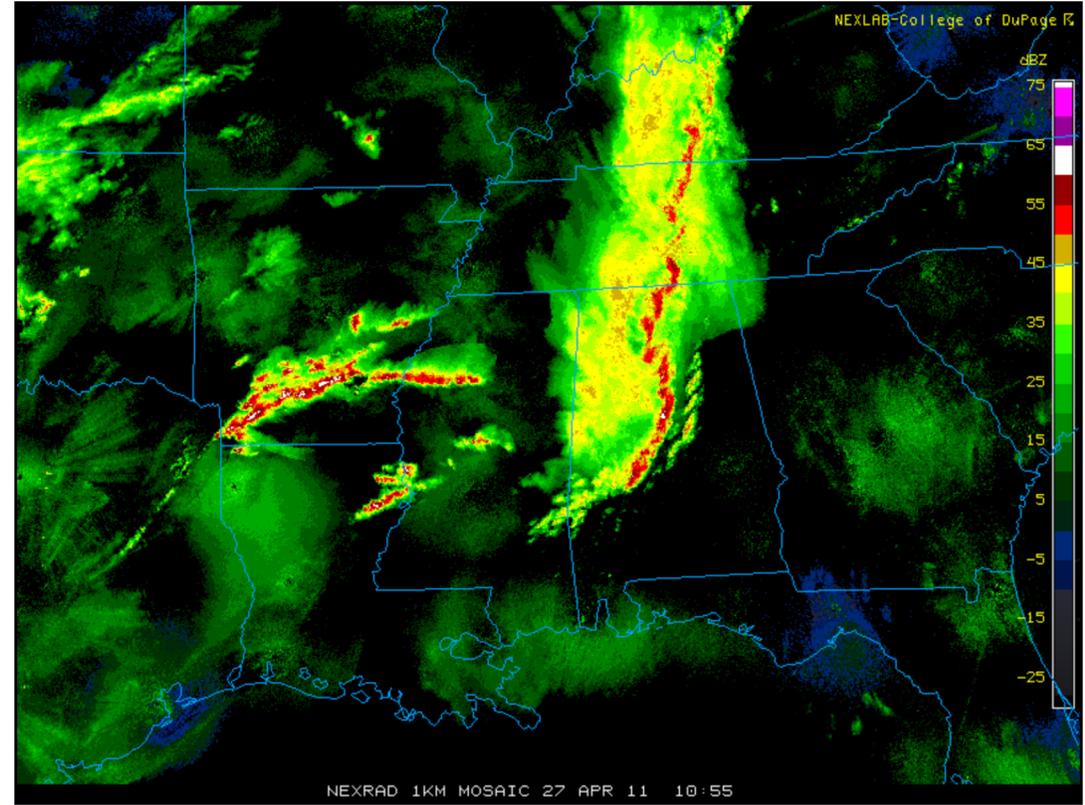
3 km

03:00 UTC

27 April 2011



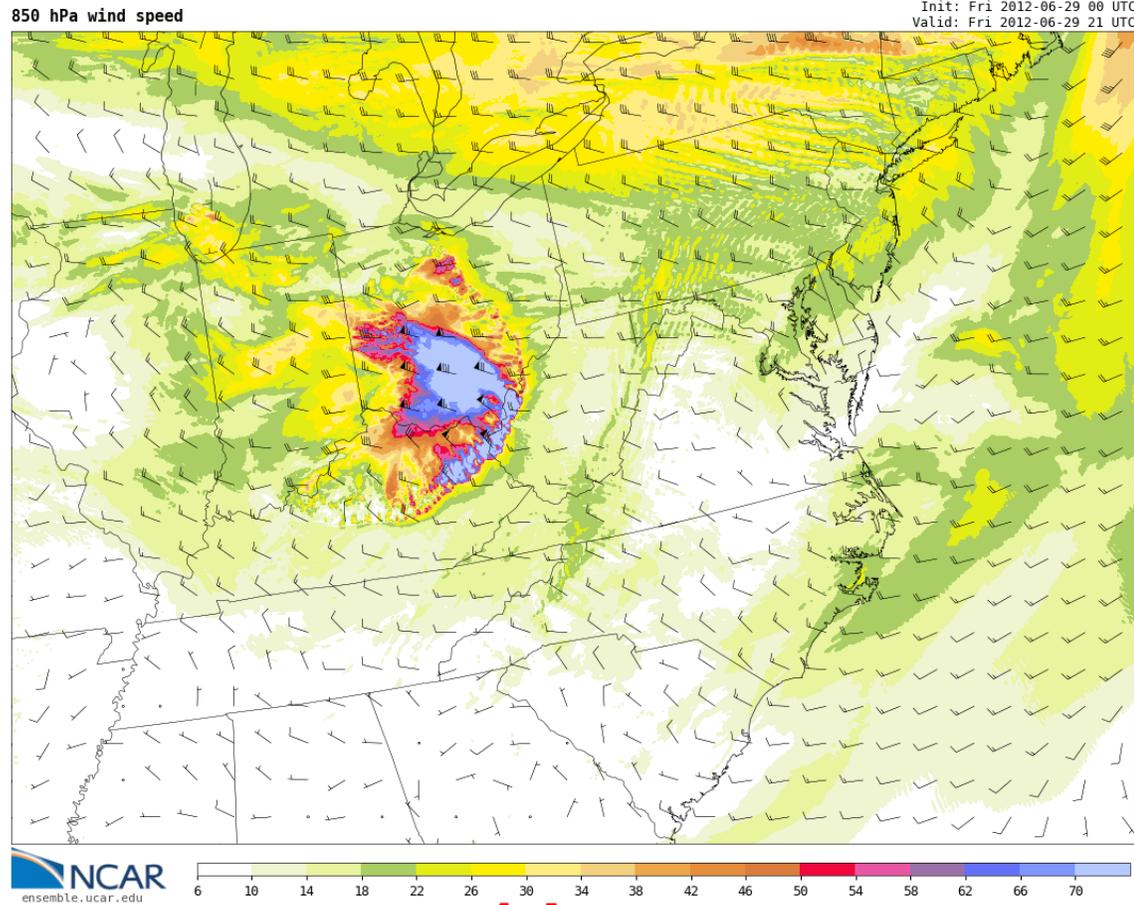
03:00 UTC



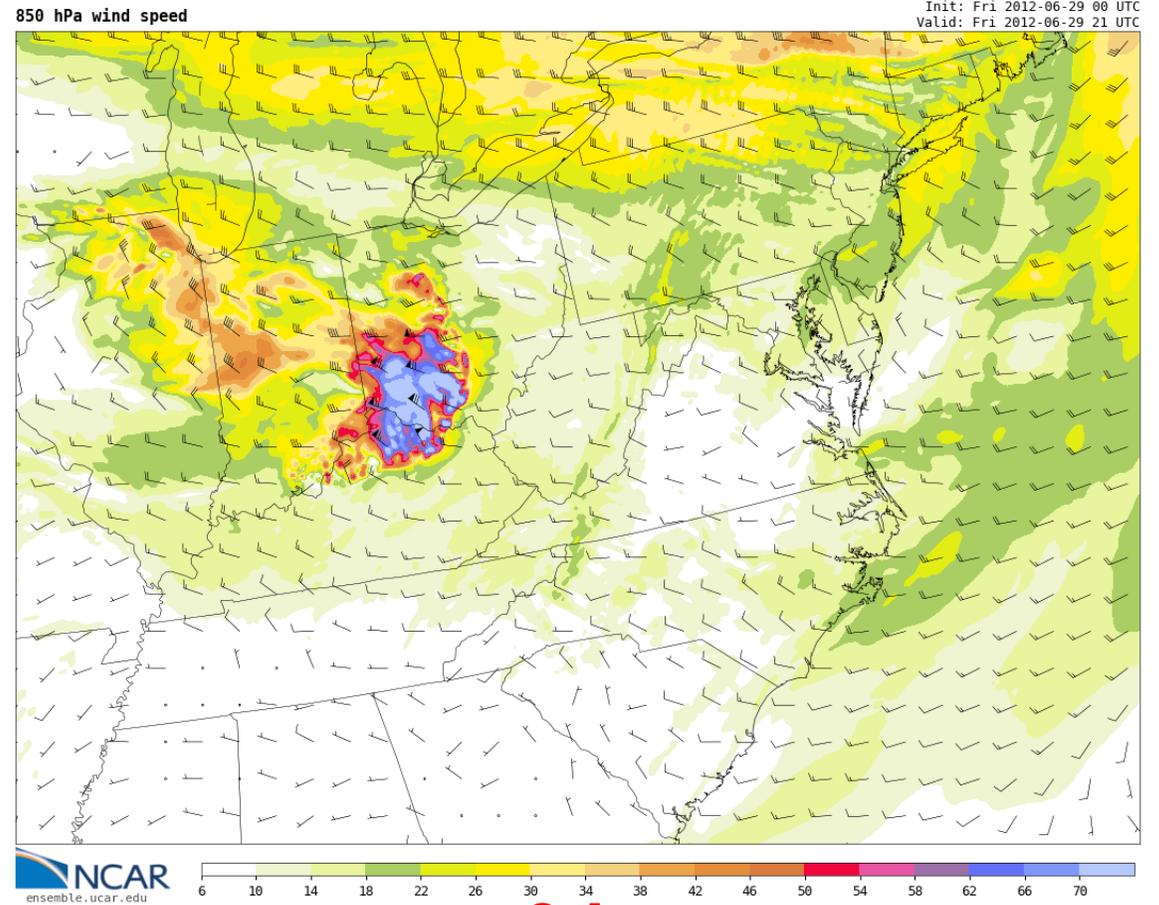
11:00 UTC

29 June 2012

850 hPa Winds



1 km



3 km

21:00 UTC