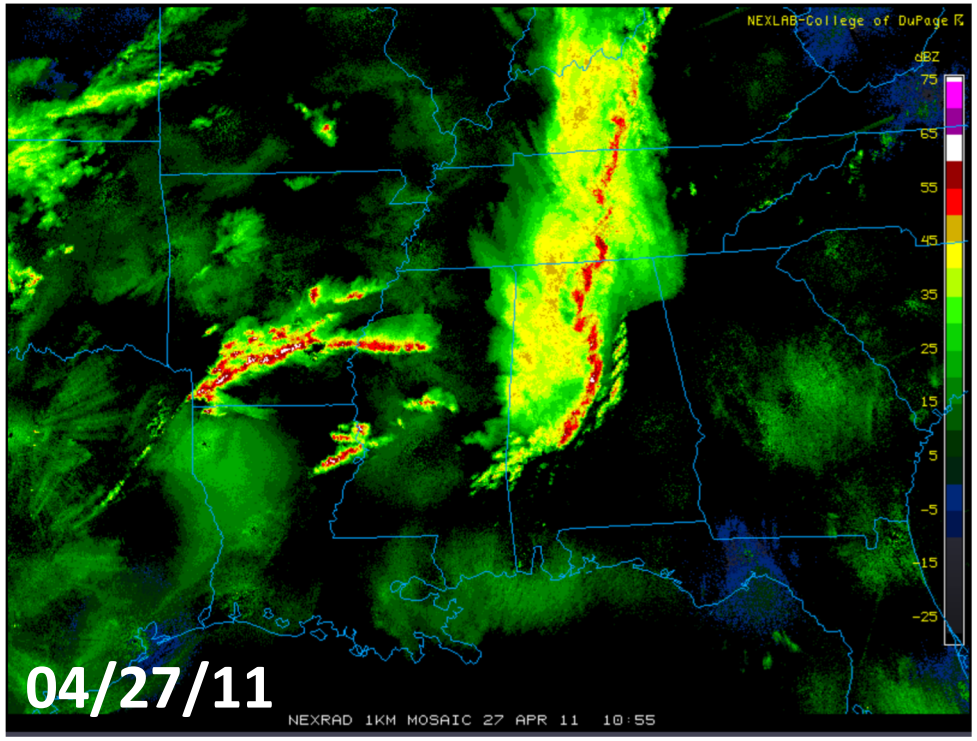
“Convective system structure, evolution and severe weather potential in 1 versus 3 km WRF forecasts”

Morris Weisman, Ryan Sobash, Kevin Manning, Craig Schwartz

2019 Joint WRF/MPAS User’s Workshop

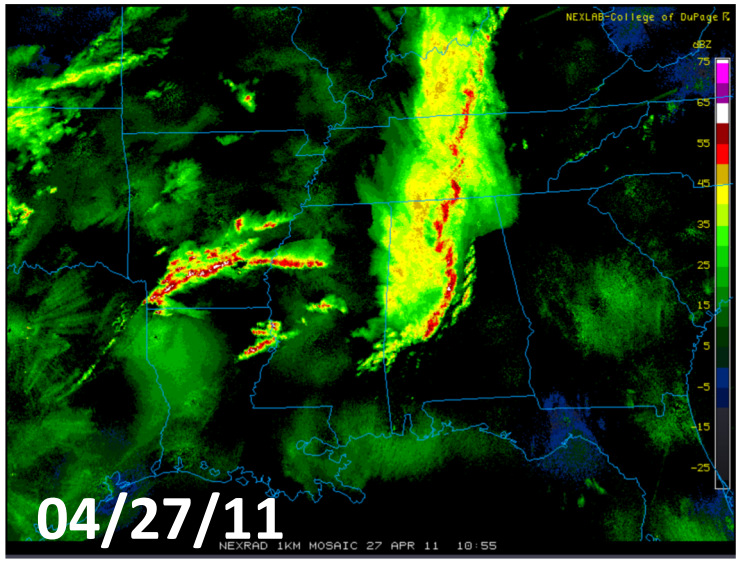


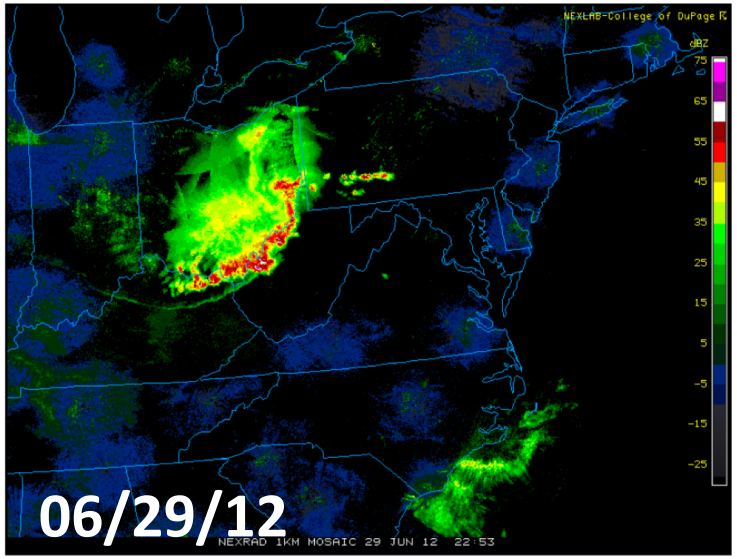
Radar

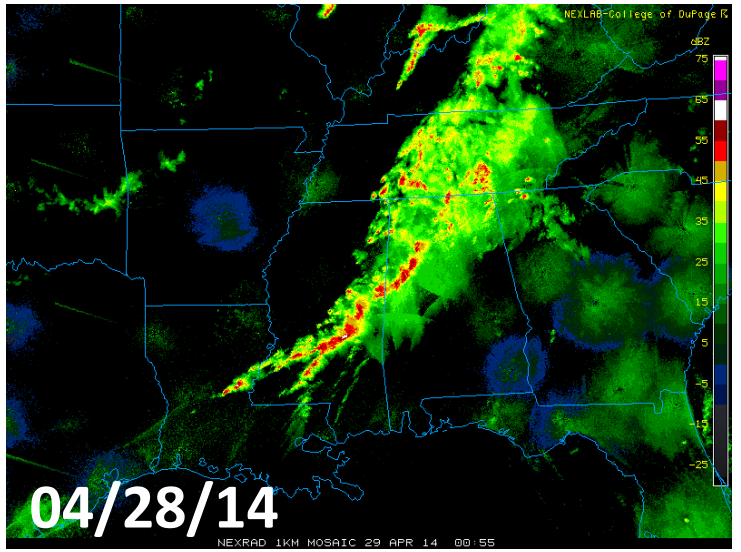
QLCS characteristics:

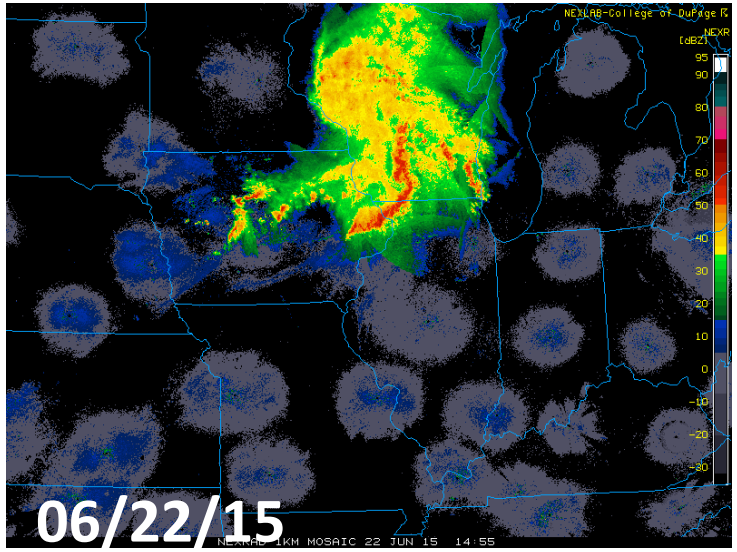
…convective initiation
…cold pool strength/propagation
…surface winds
…mesovortices
…rear-inflow jet
…updraft helicity

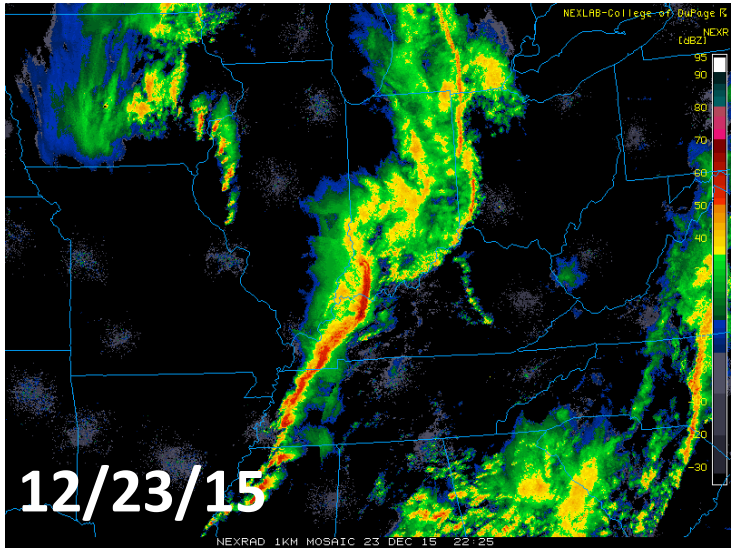
12 Severe Squall Line Cases:

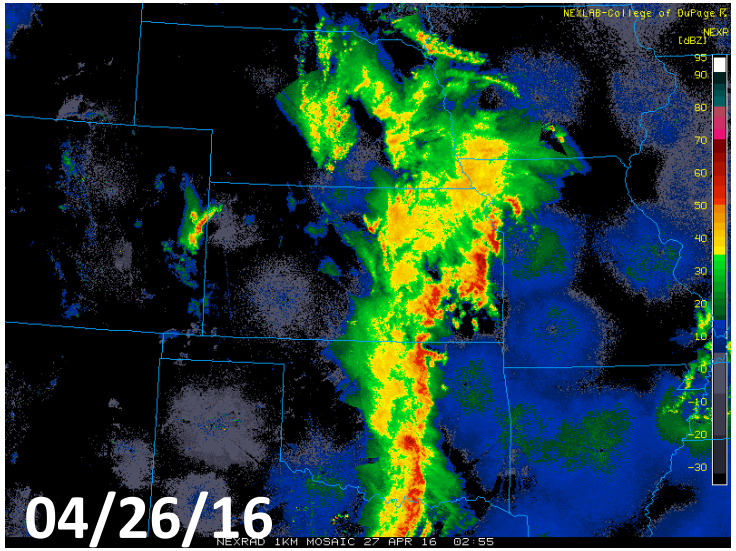








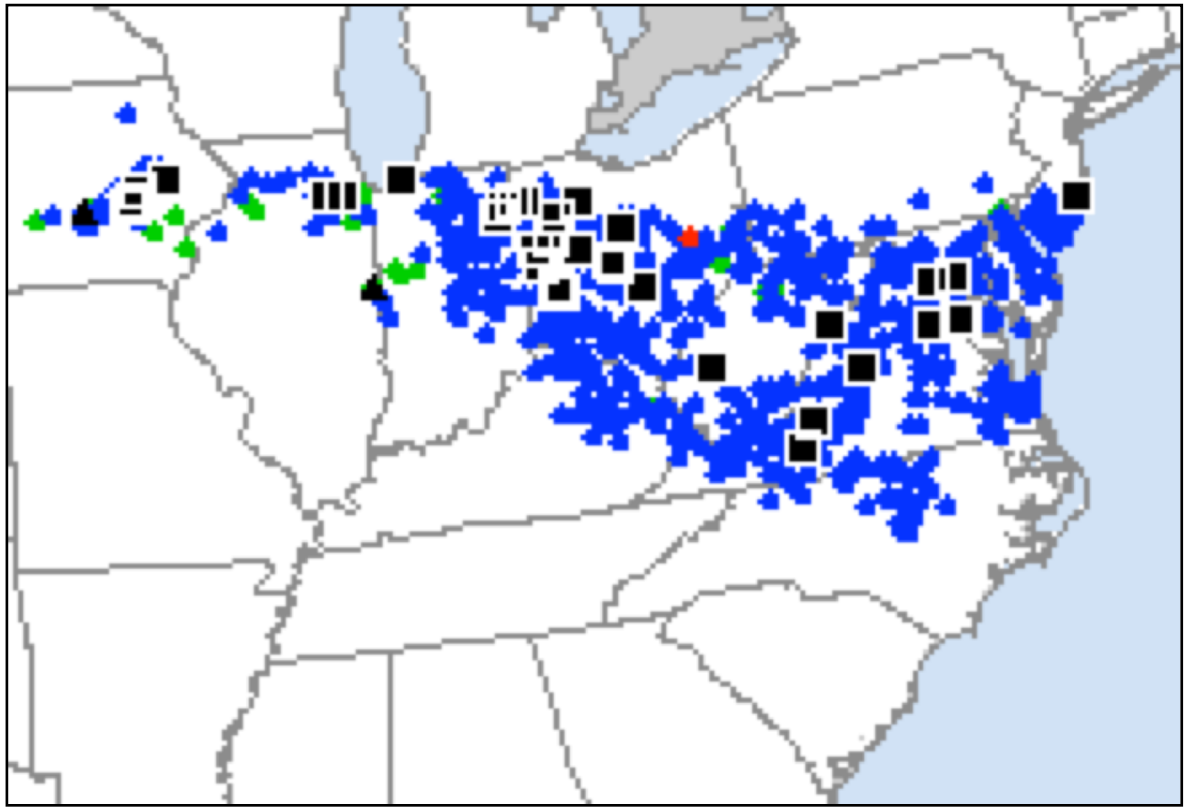




Radar

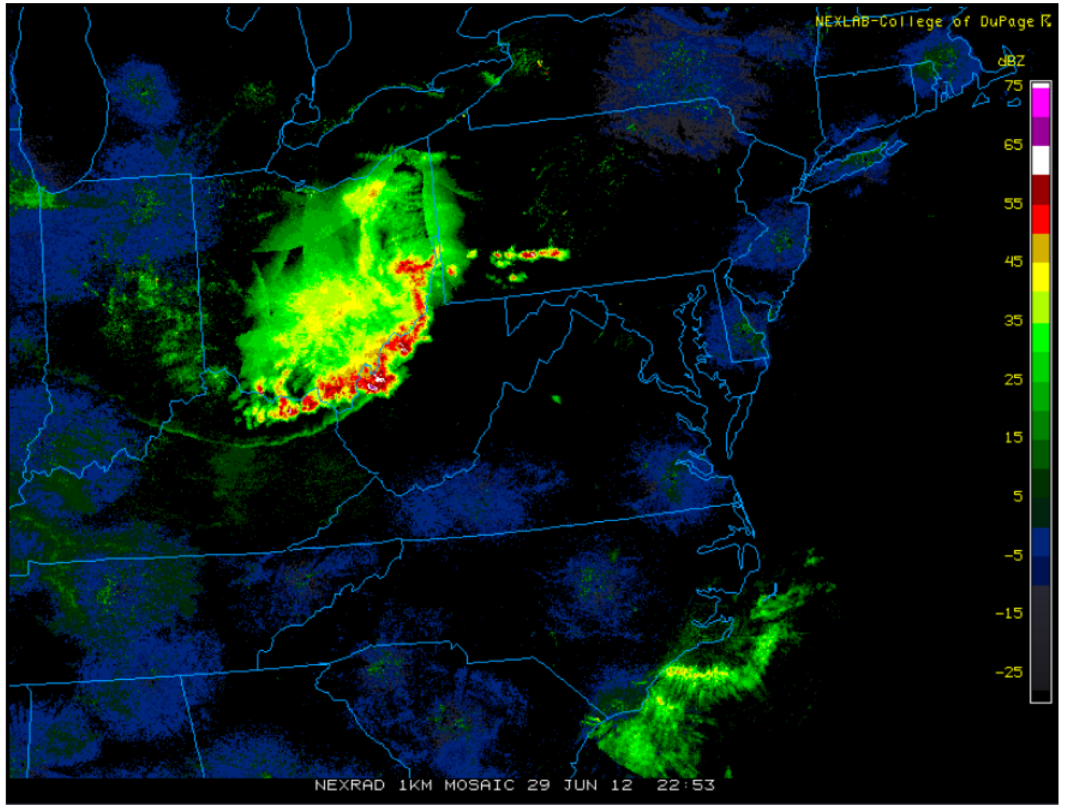
29 June 2012

SPC Storm Reports



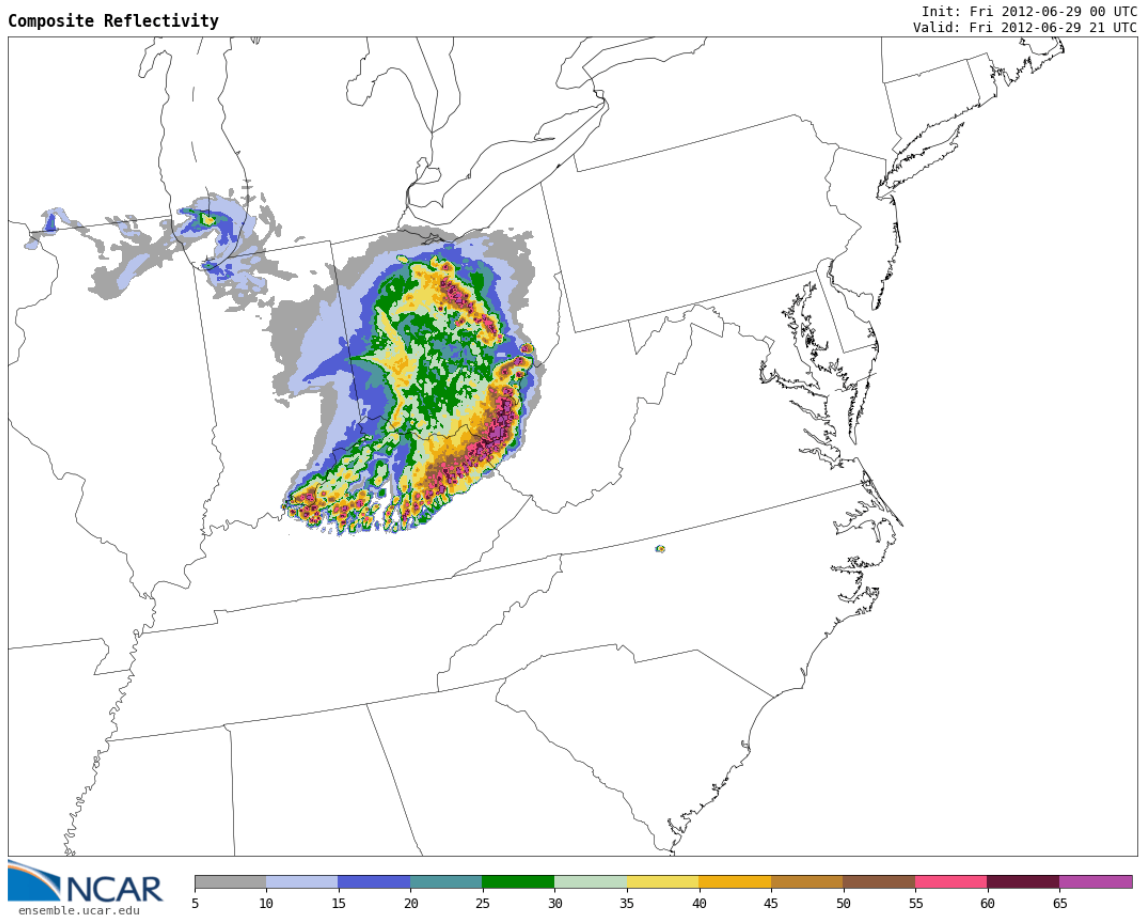
TORNADO REPORTS.. (2)
WIND REPORTS/HI..... (984/36)
HAIL REPORTS/LG..... (57/5)
TOTAL REPORTS..... (1043)
National Weather Service
Storm Prediction Center Norman, Oklahoma

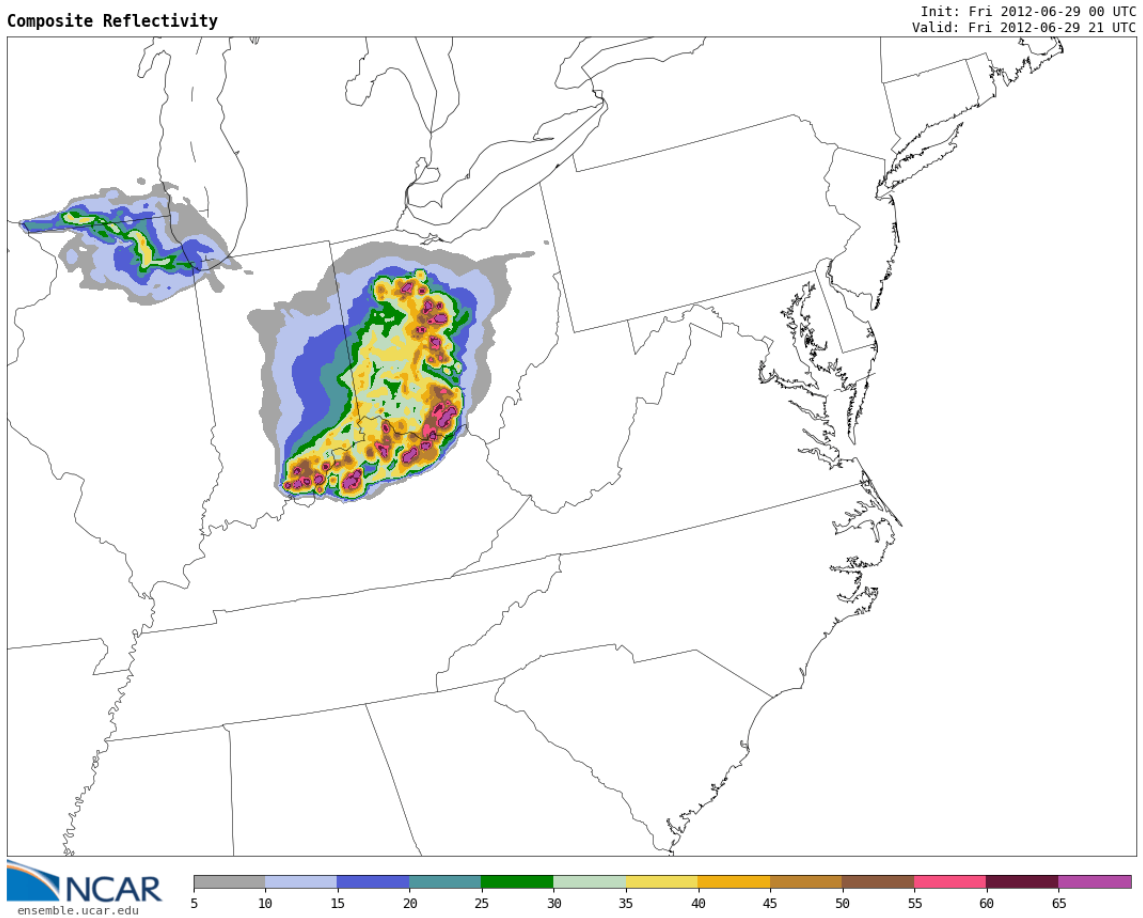
■ High Wind Report (65KT+)
▲ Large Hail Report (2" dia.+)



Radar 23:00 UTC

29 June 2012



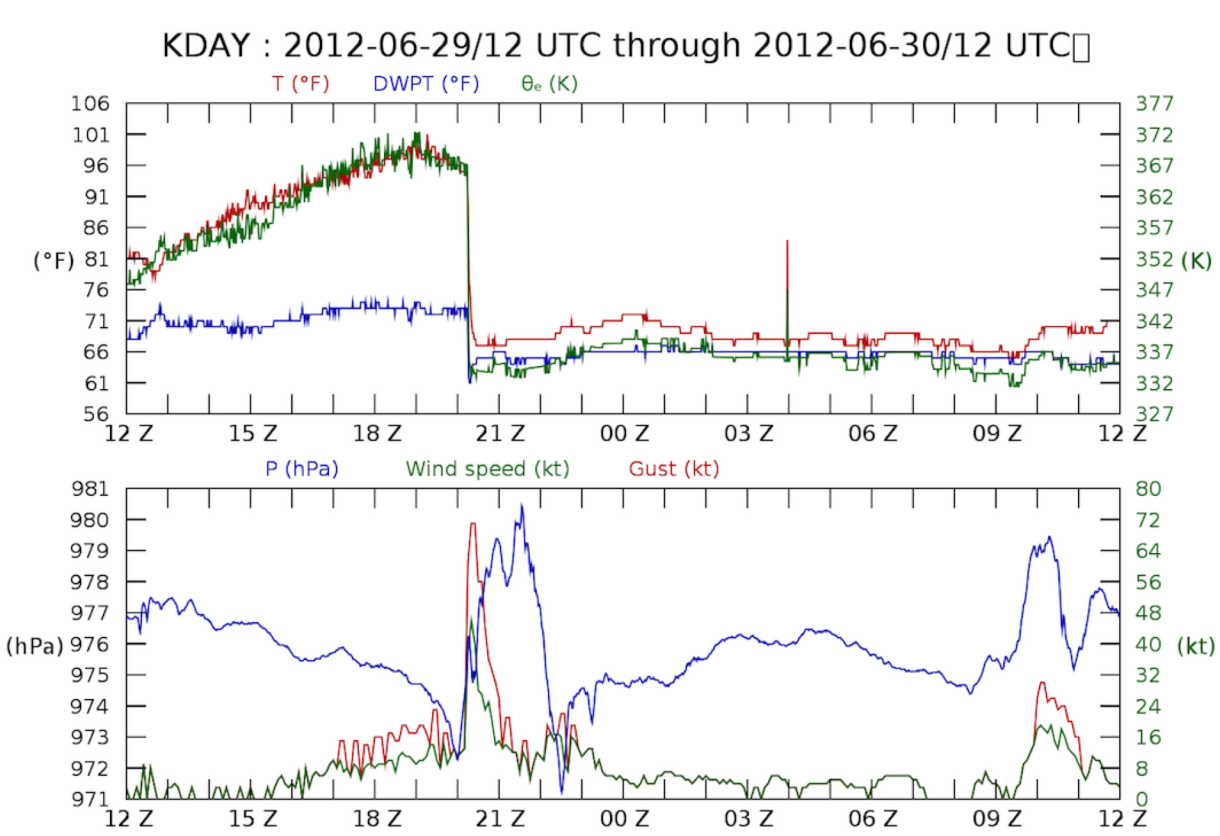


1 km

3 km

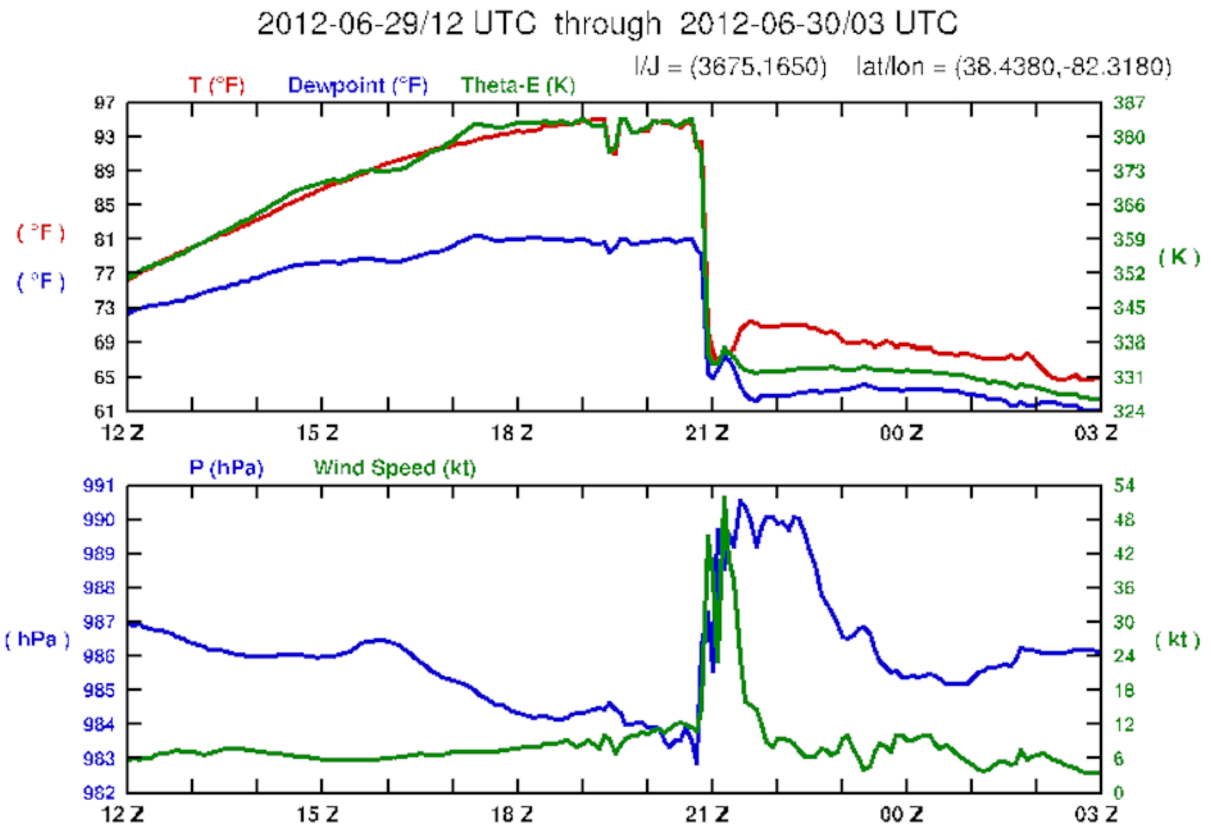
21:00 UTC

29 June 2012



Dayton, OH

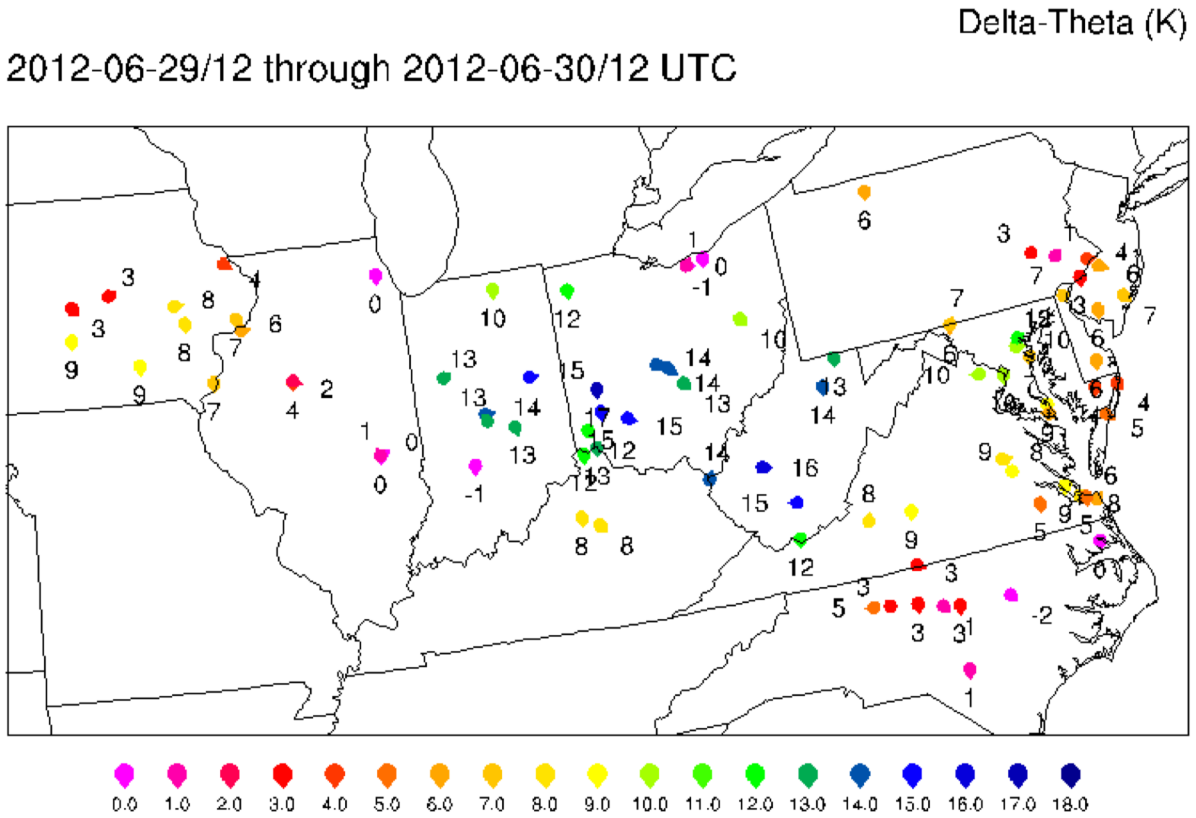
DTheta ~17 k 72 kts



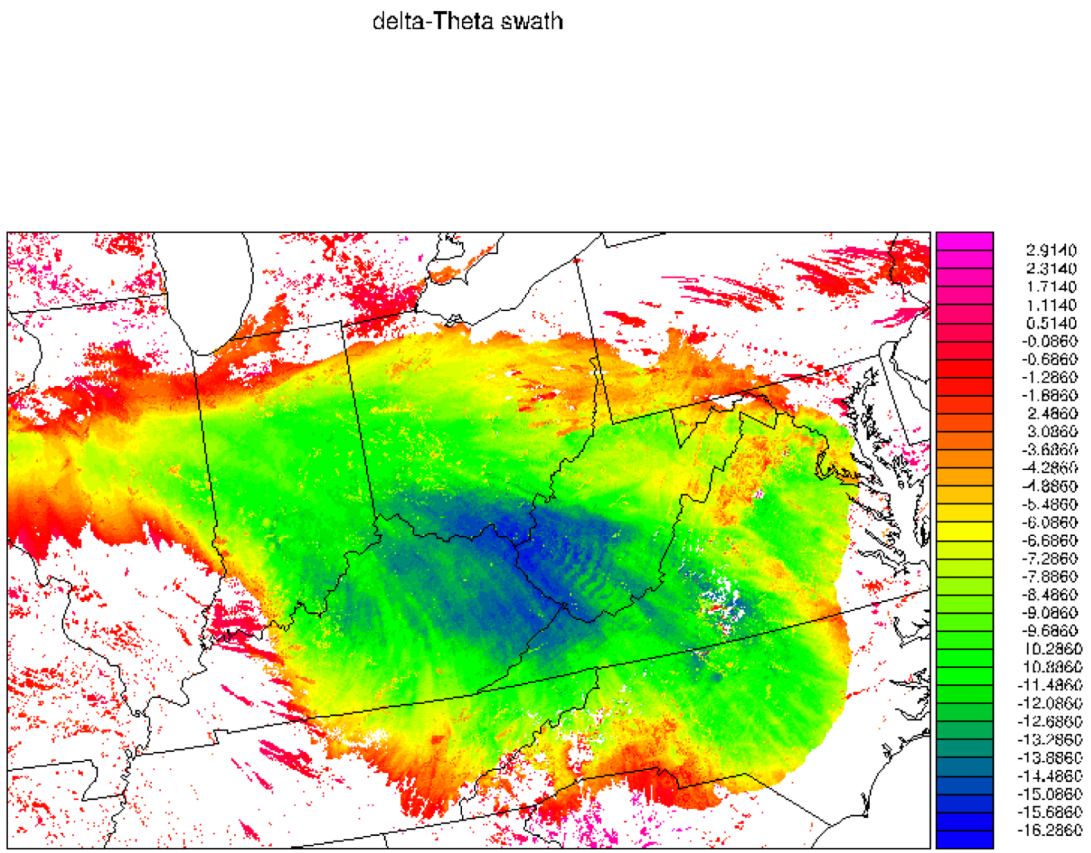
1 km model

DTheta ~16 k 54 kts

29 June 2012

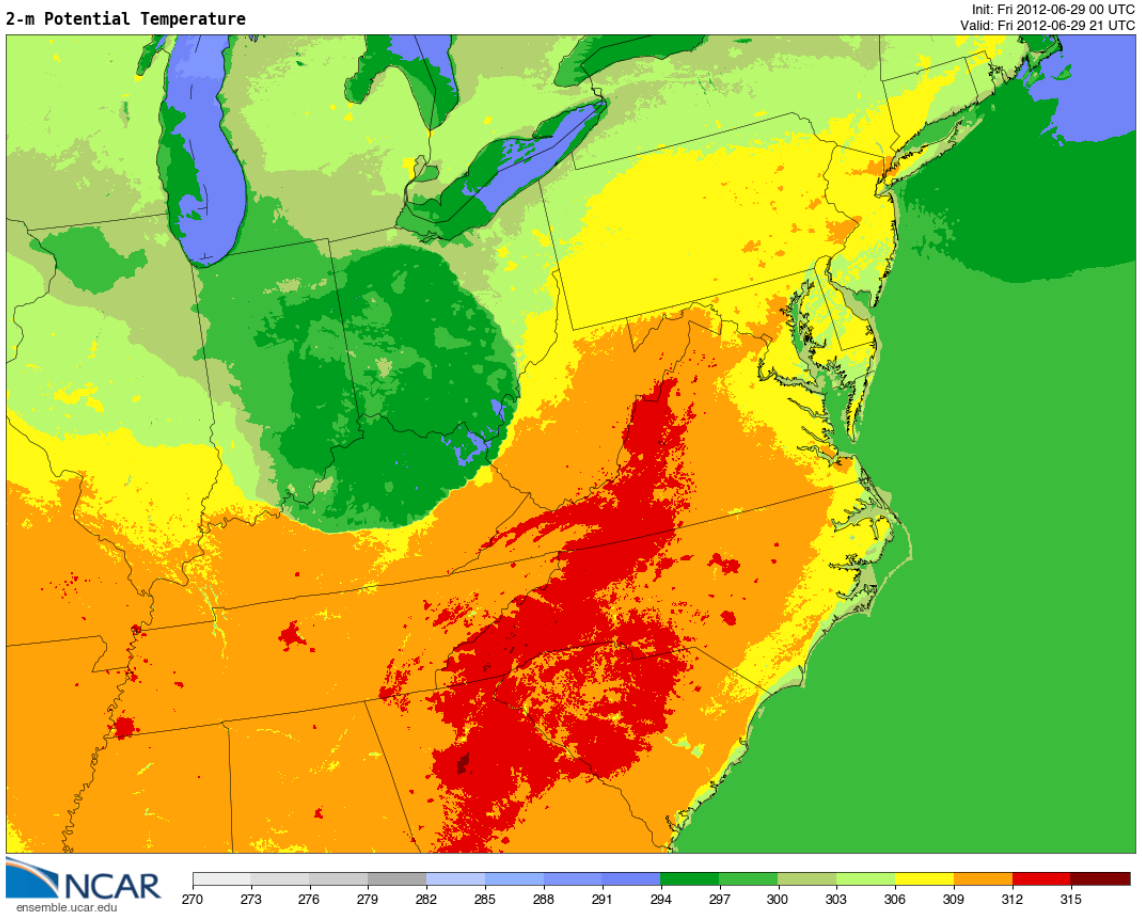


Delta-Theta Obs

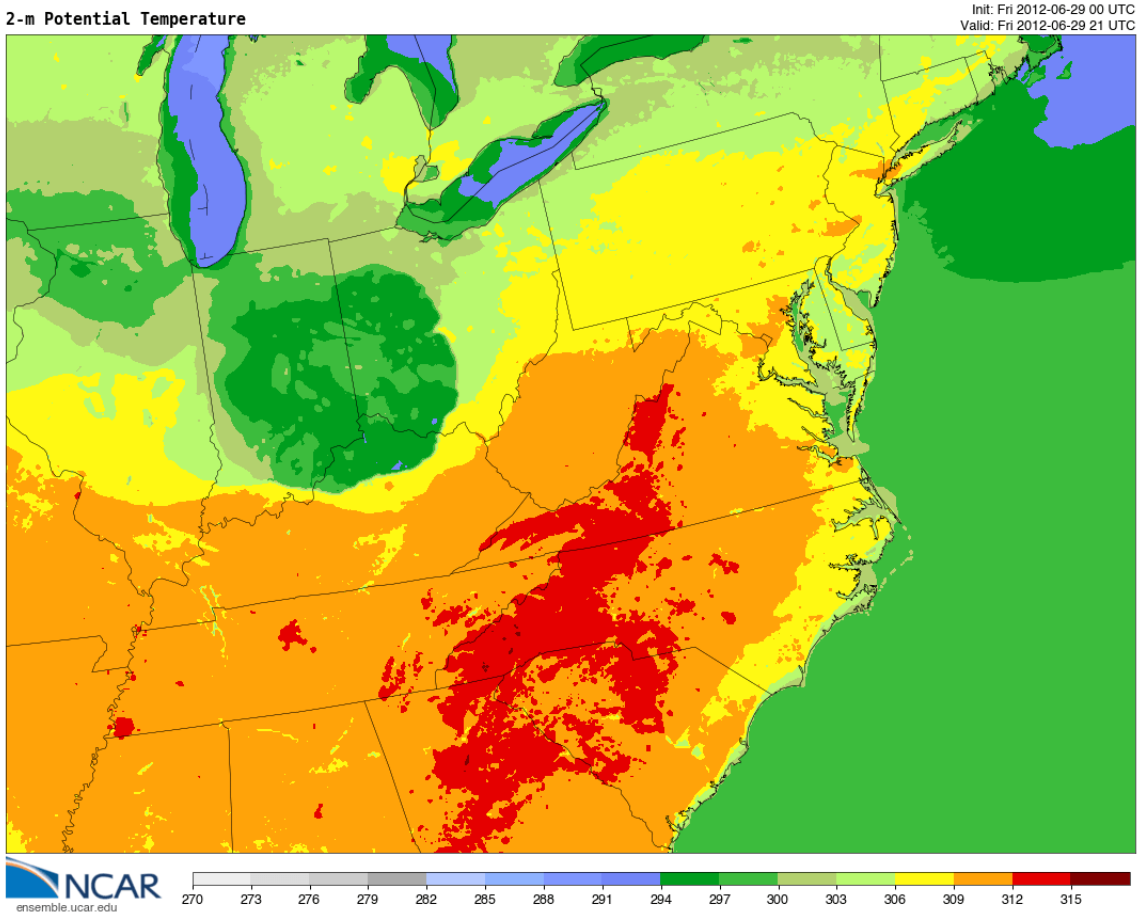


1 km

29 June 2012 Surface Theta (2m)



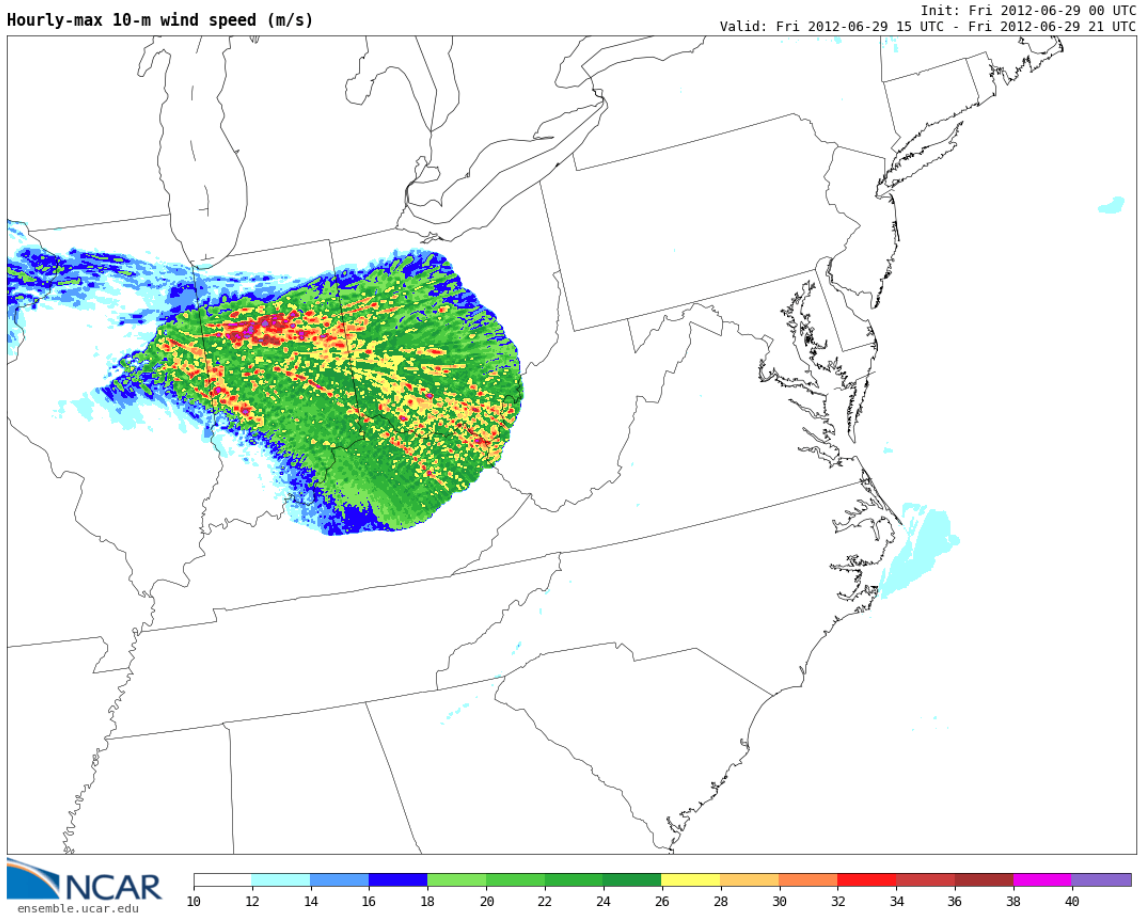
1 km

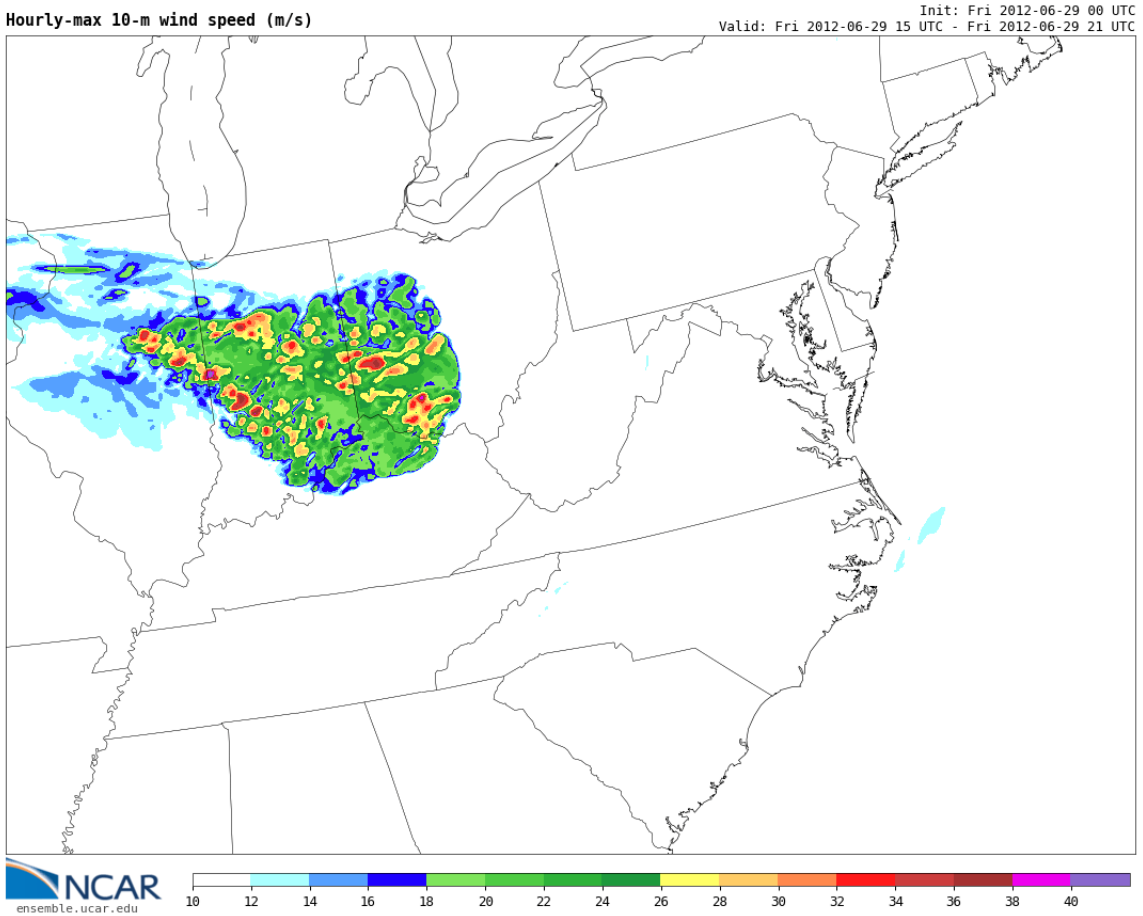


3 km

21:00 UTC

29 June 2012 Max Surface Wind (10m)





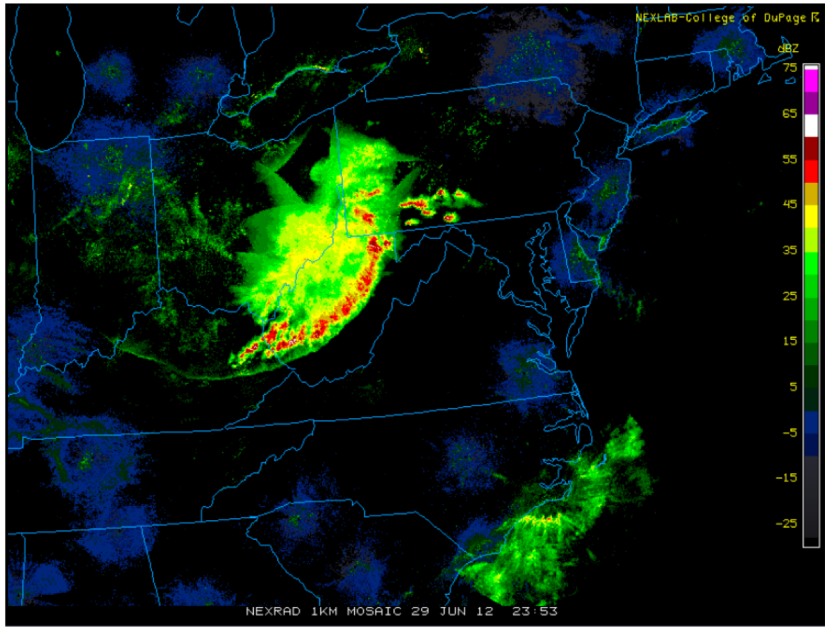
1 km

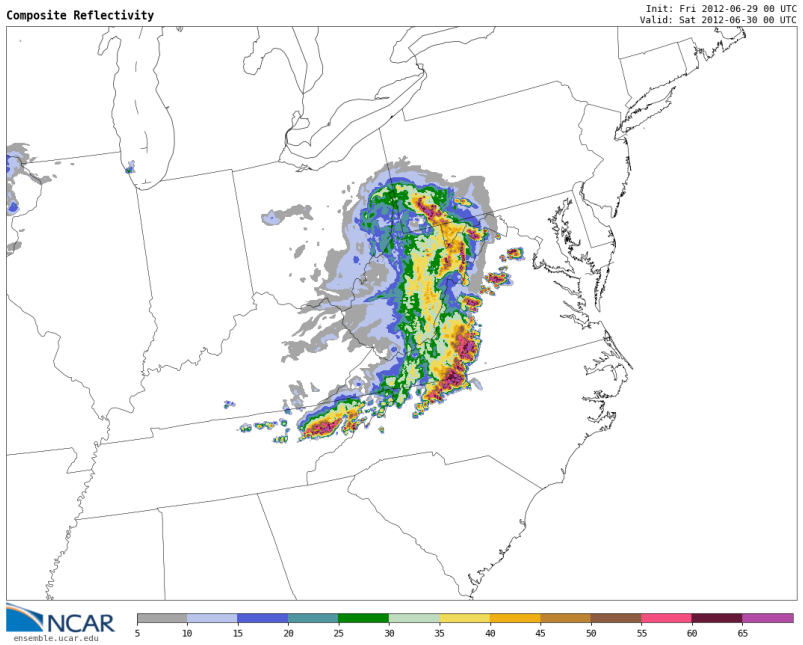
3 km

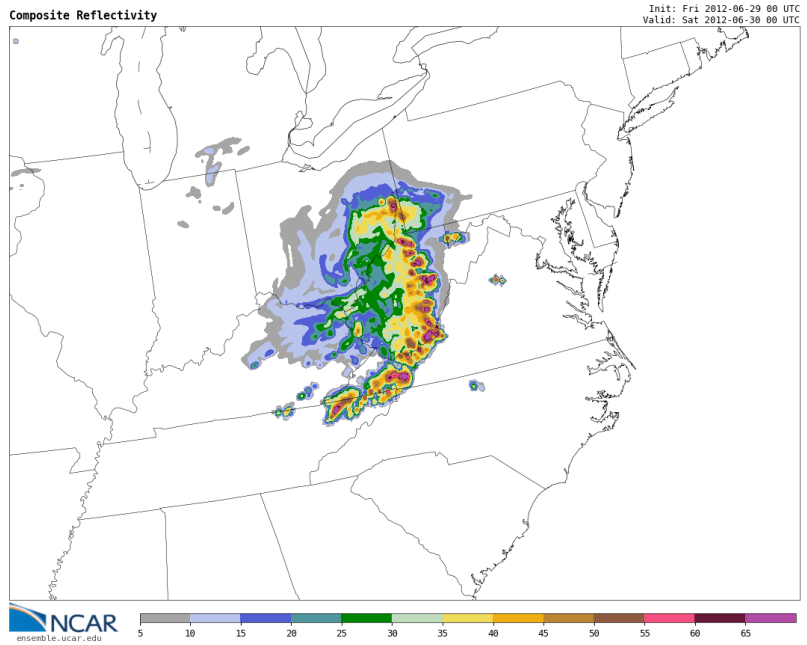
21:00 UTC

30 June 2012

00:00 UTC



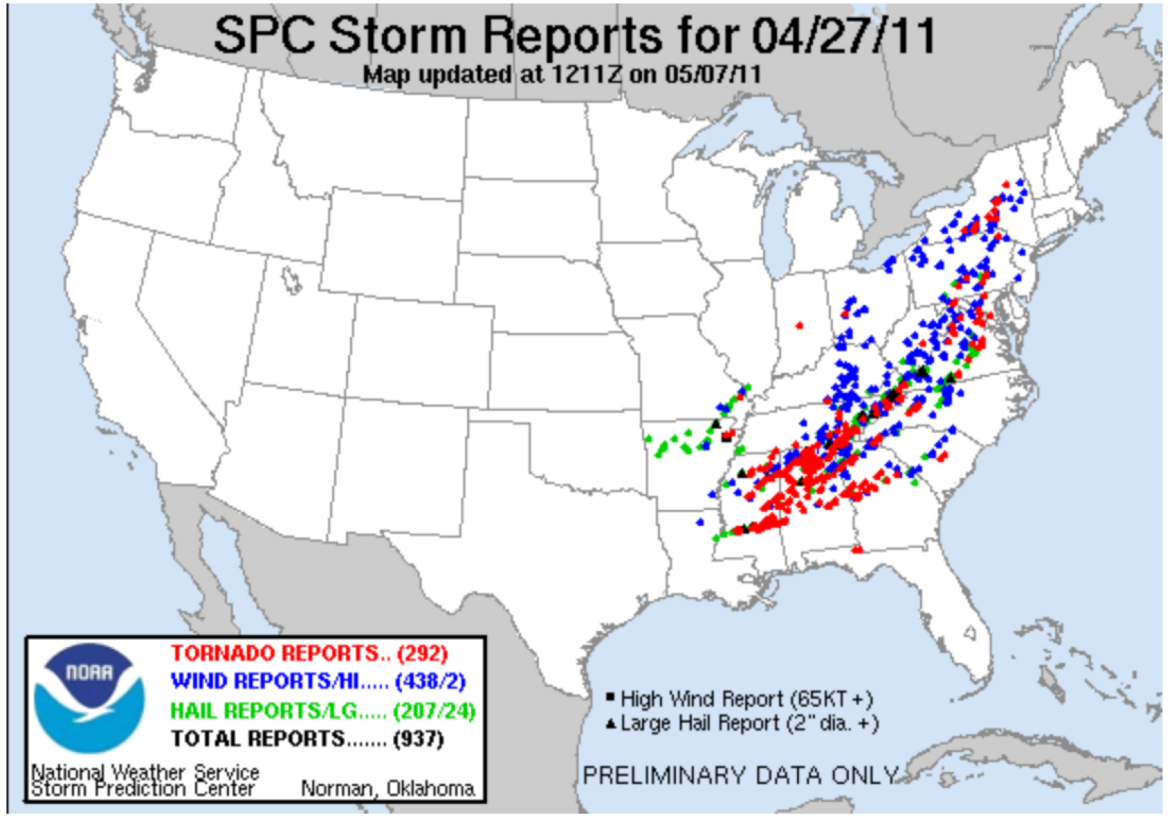


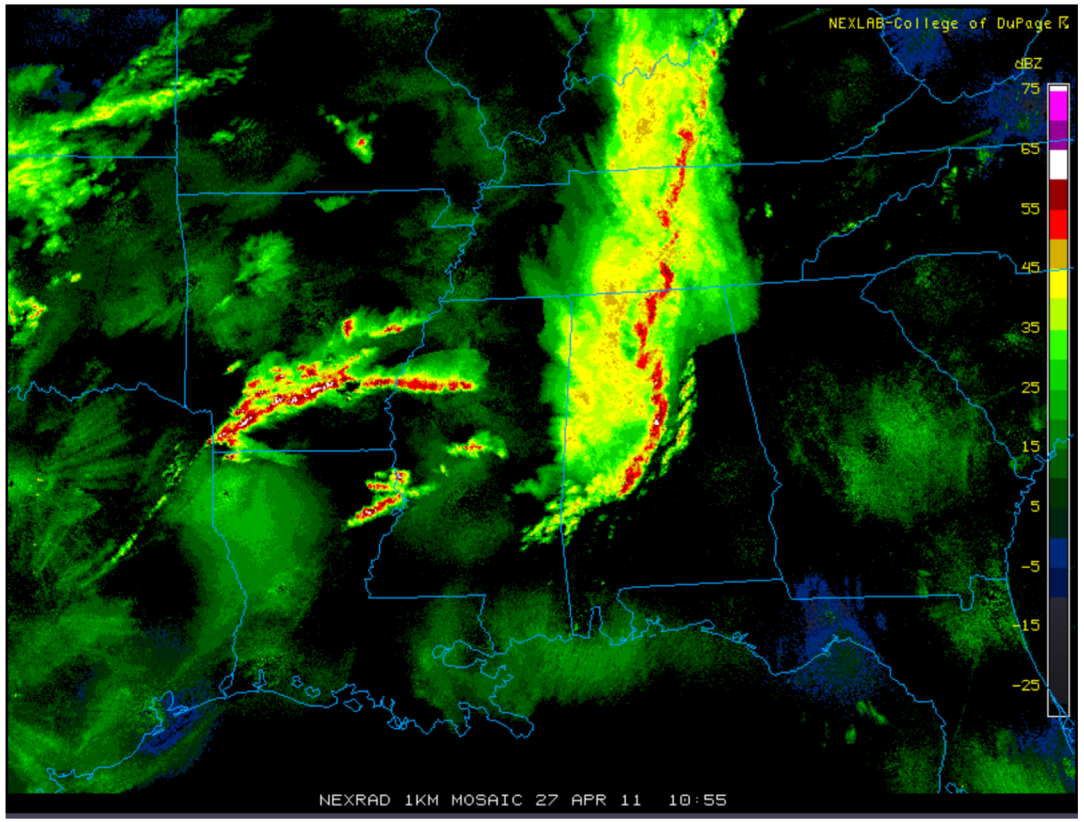


Radar **1 km** **3 km**

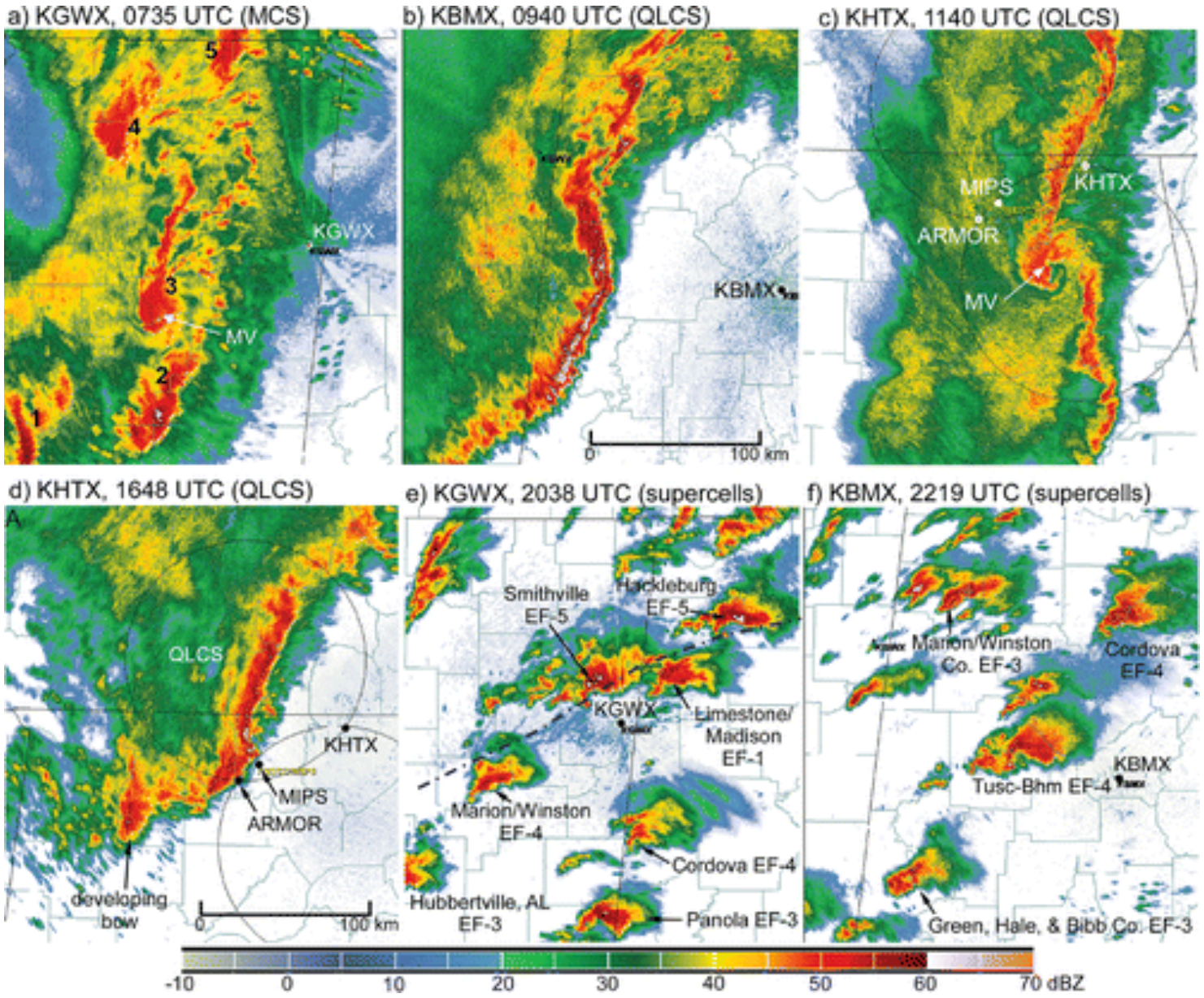
3 km system propagation more accurate for this case

27 April 2011



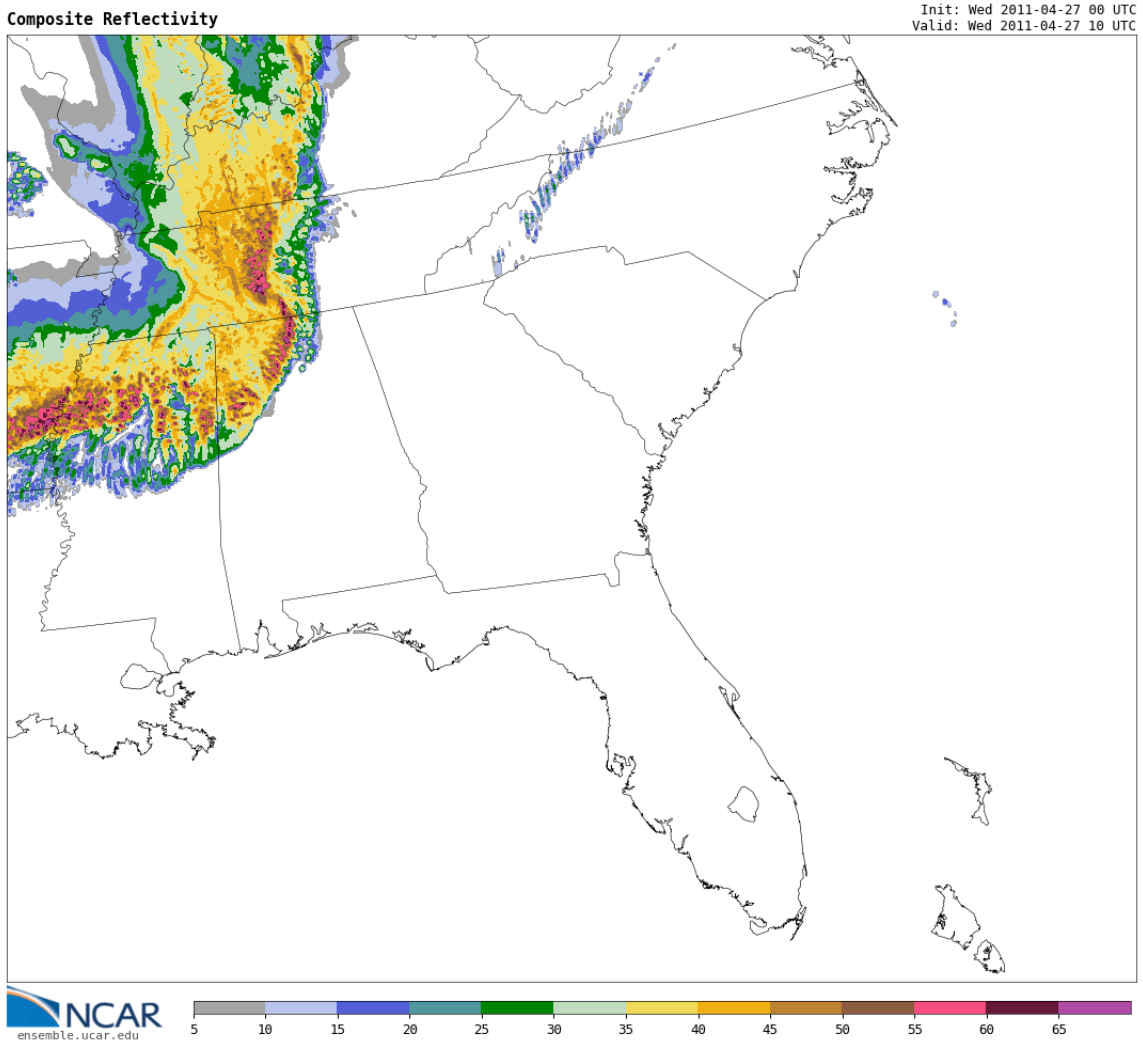


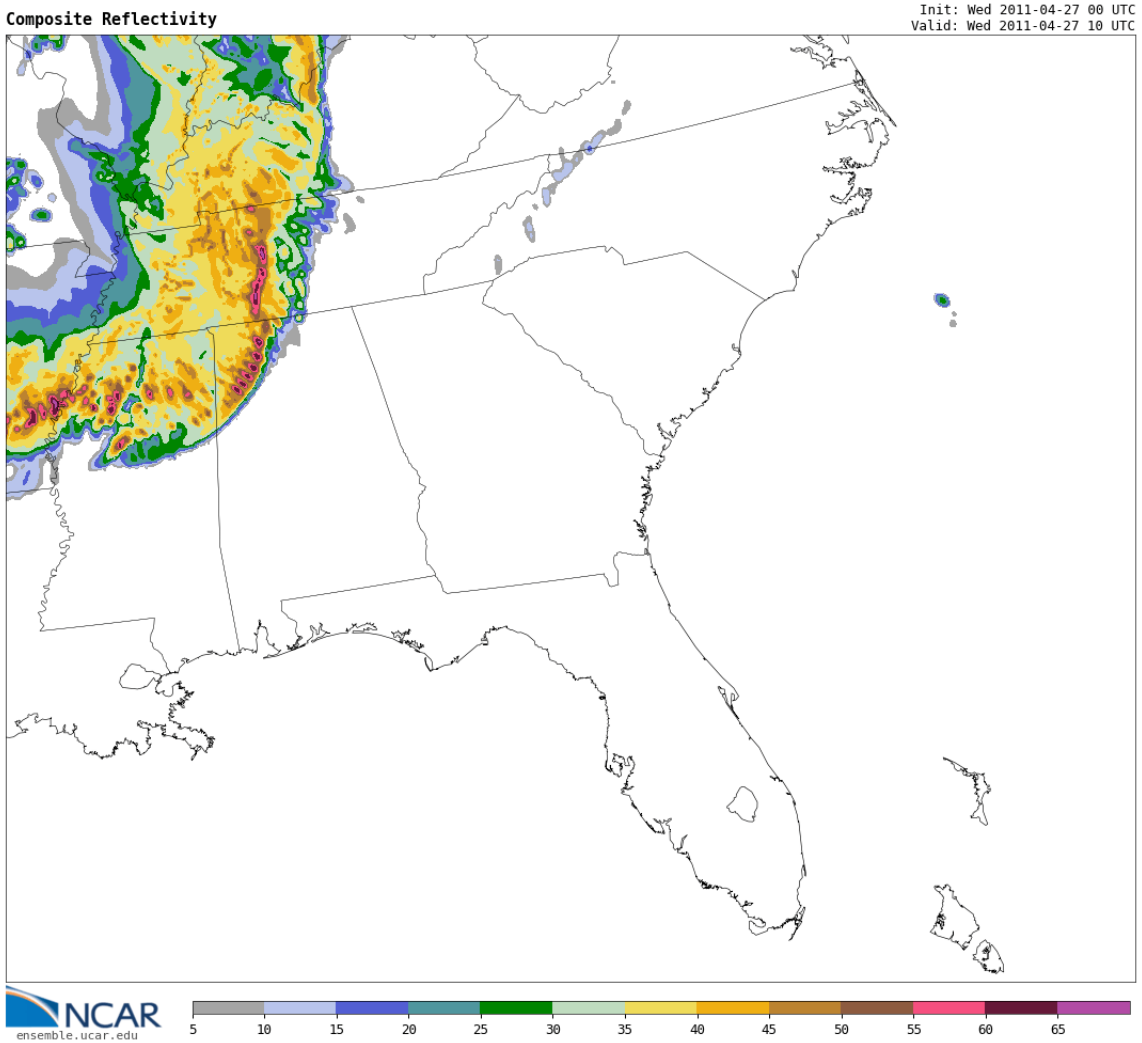
Radar 11:00 UTC



Knupp et al. BAMS 2014

27 April 2011



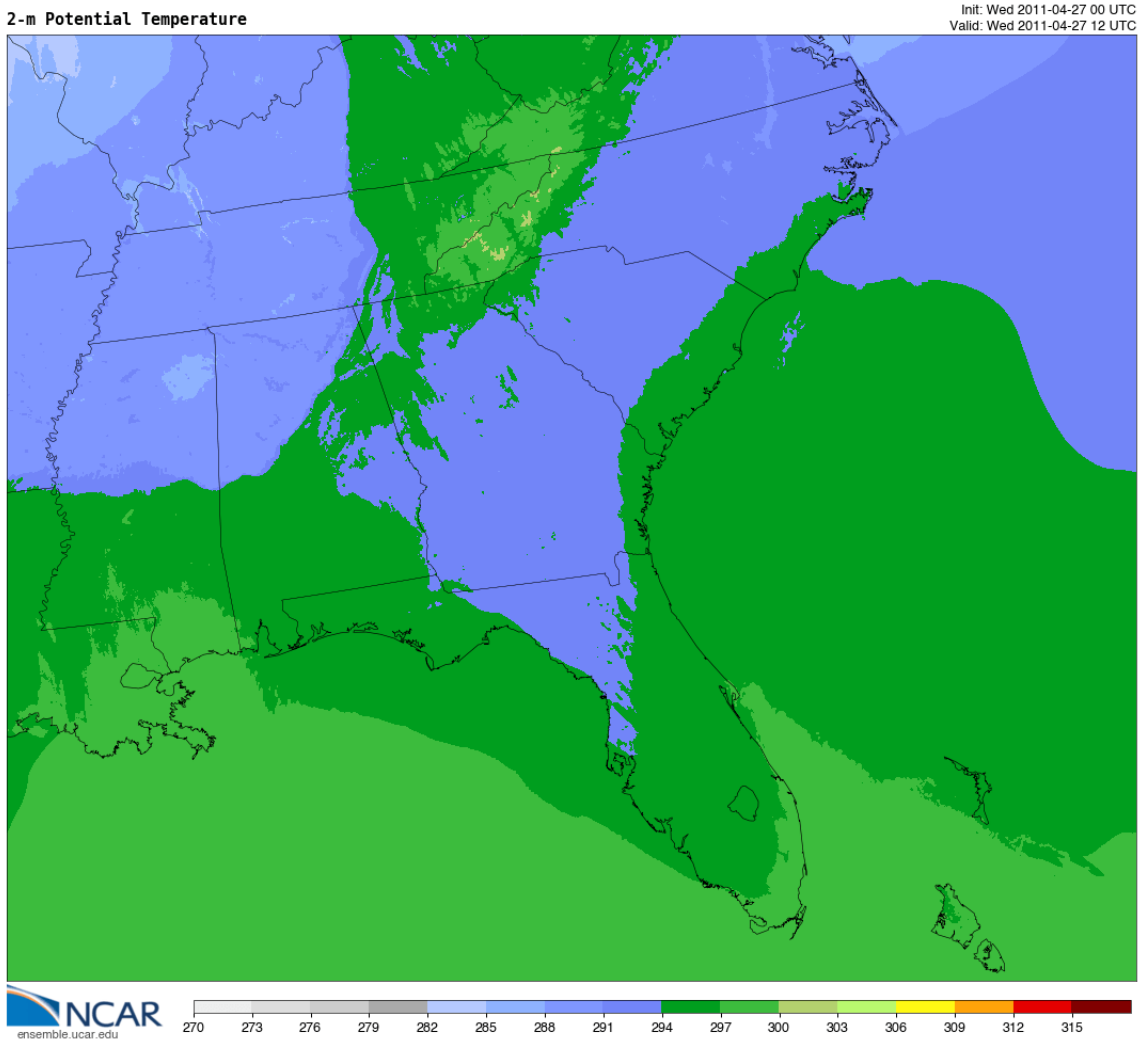


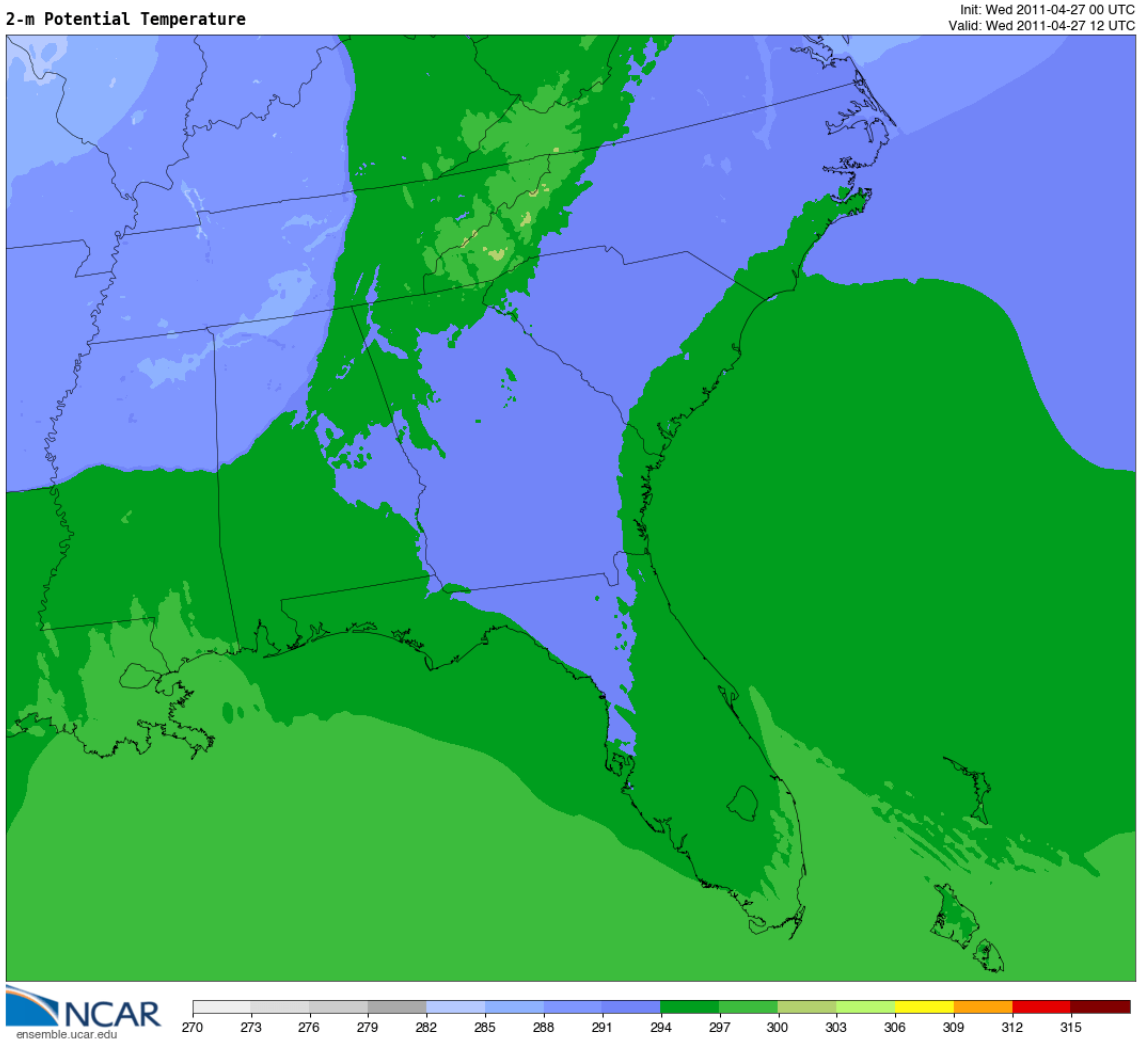
1 km

3 km

10:00 UTC

27 April 2011 Surface Theta (2m)



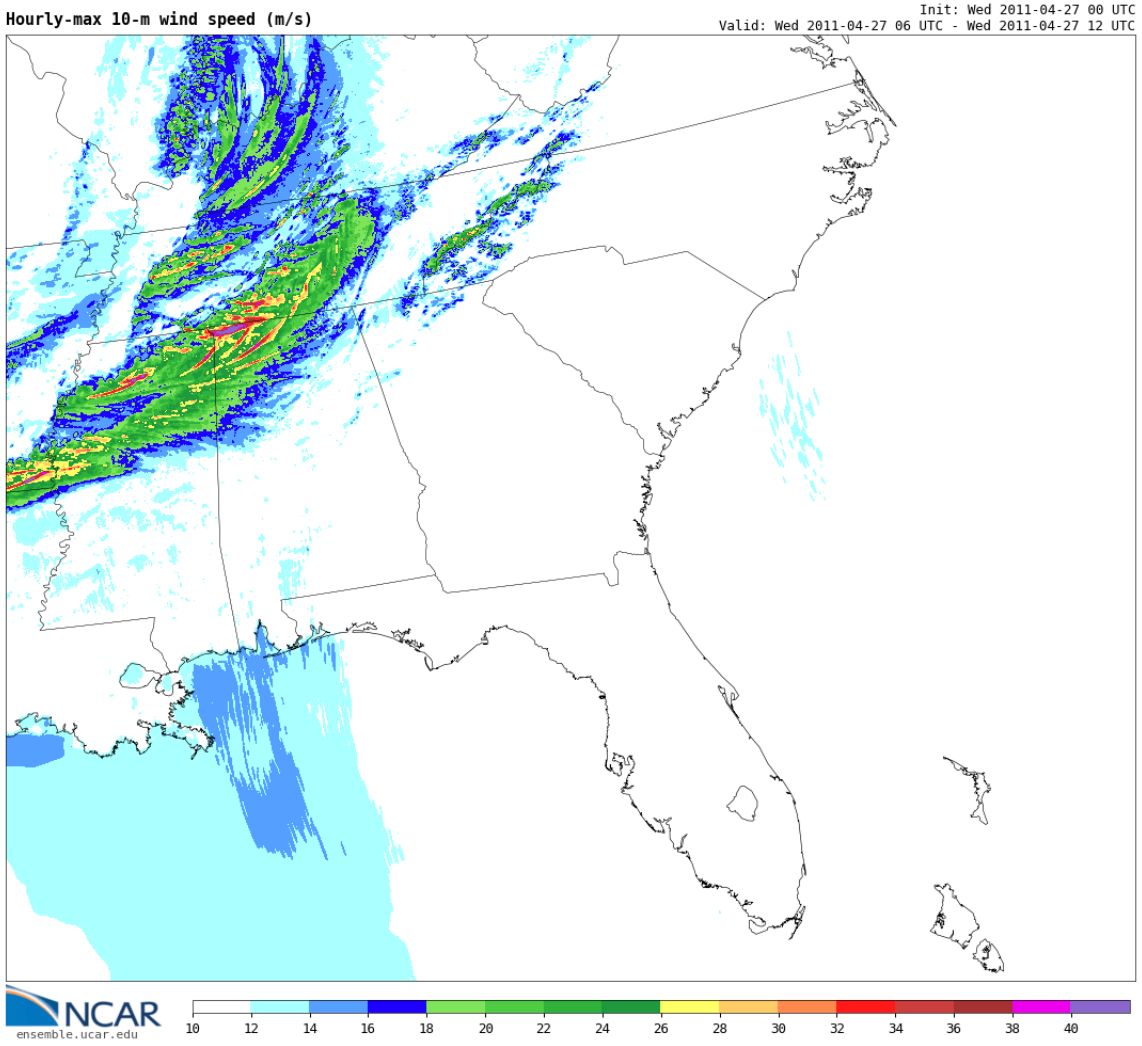


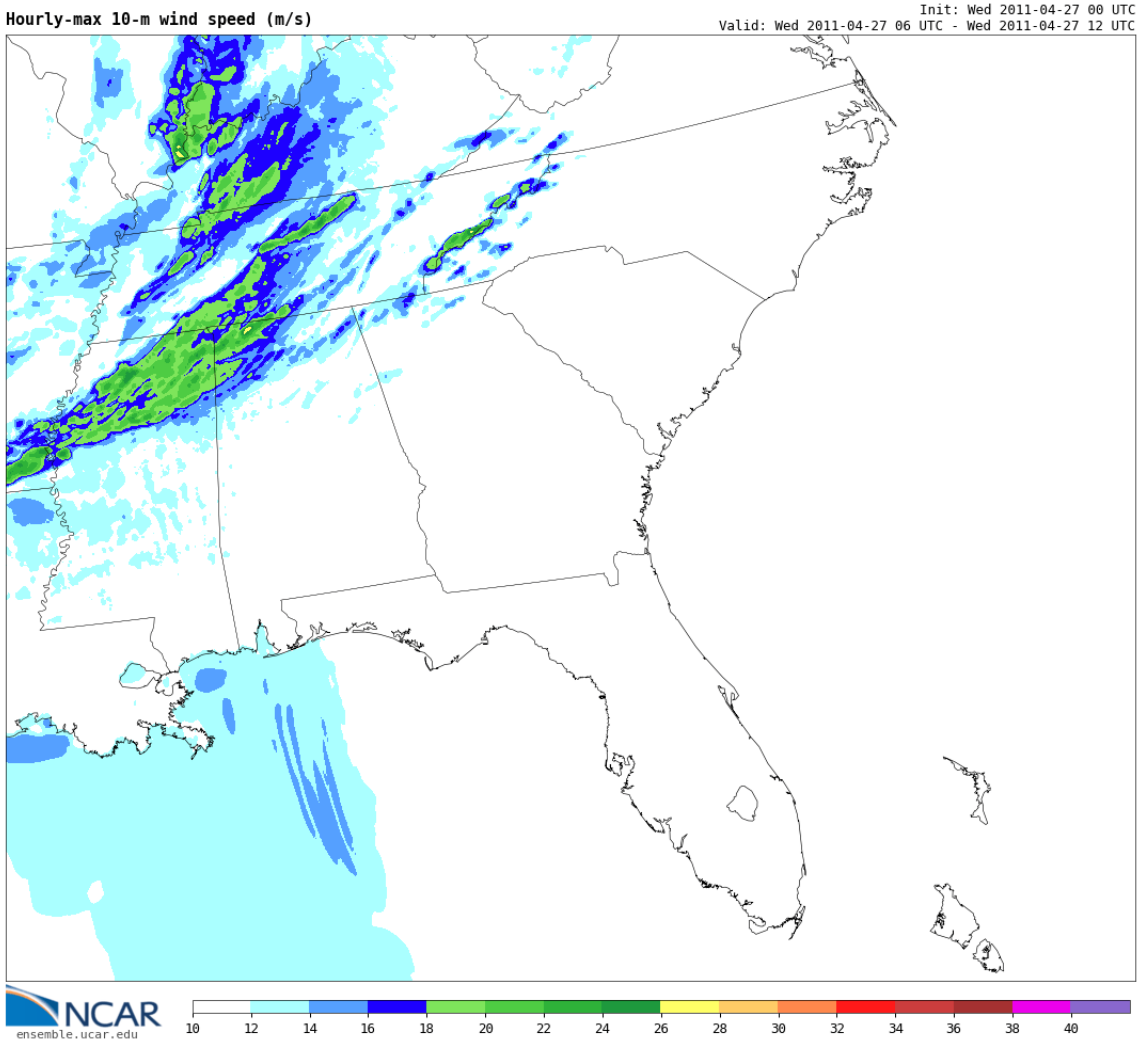
1 km

3 km

12:00 UTC

27 April 2011 Max Surface Wind (10m)



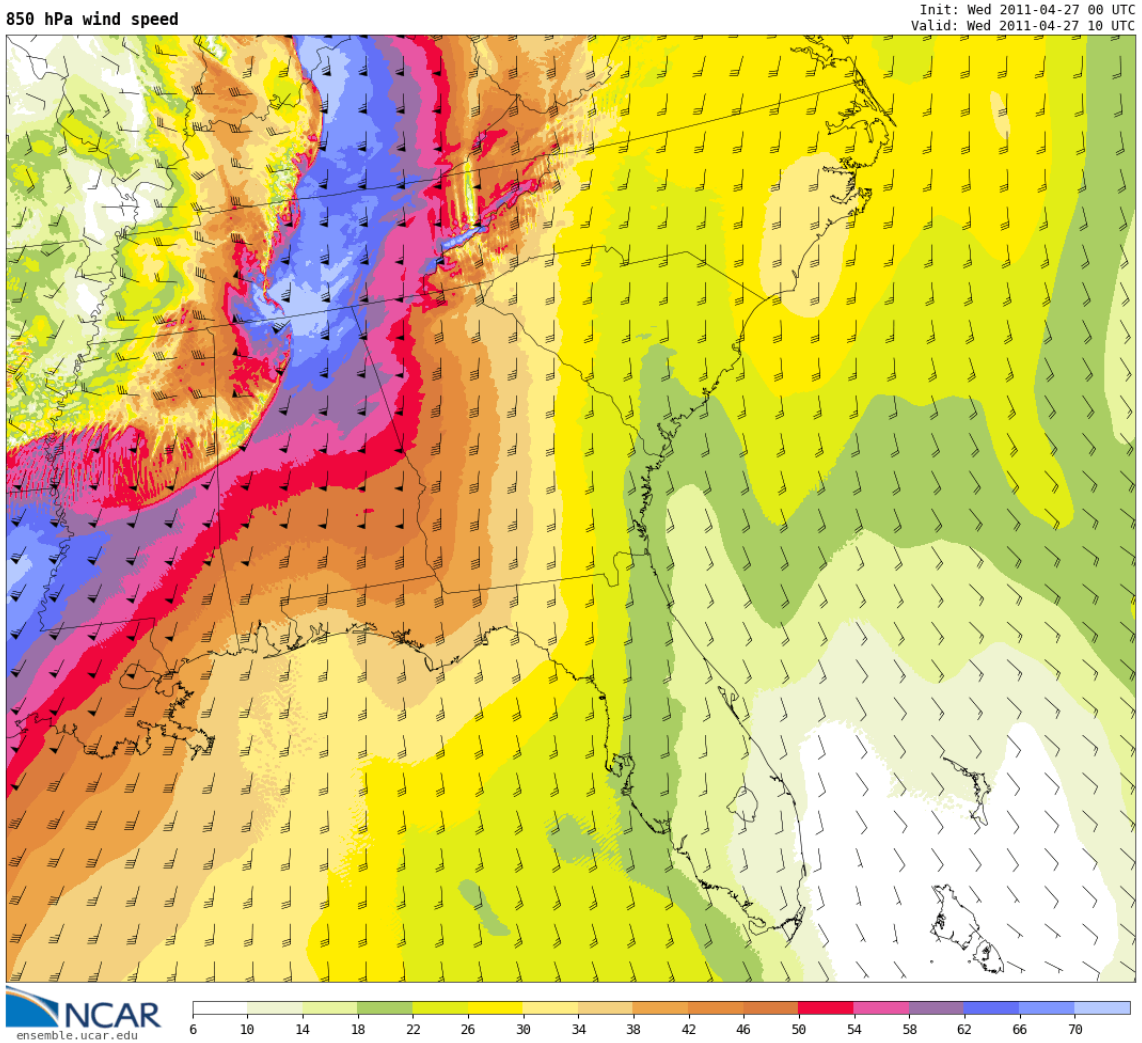


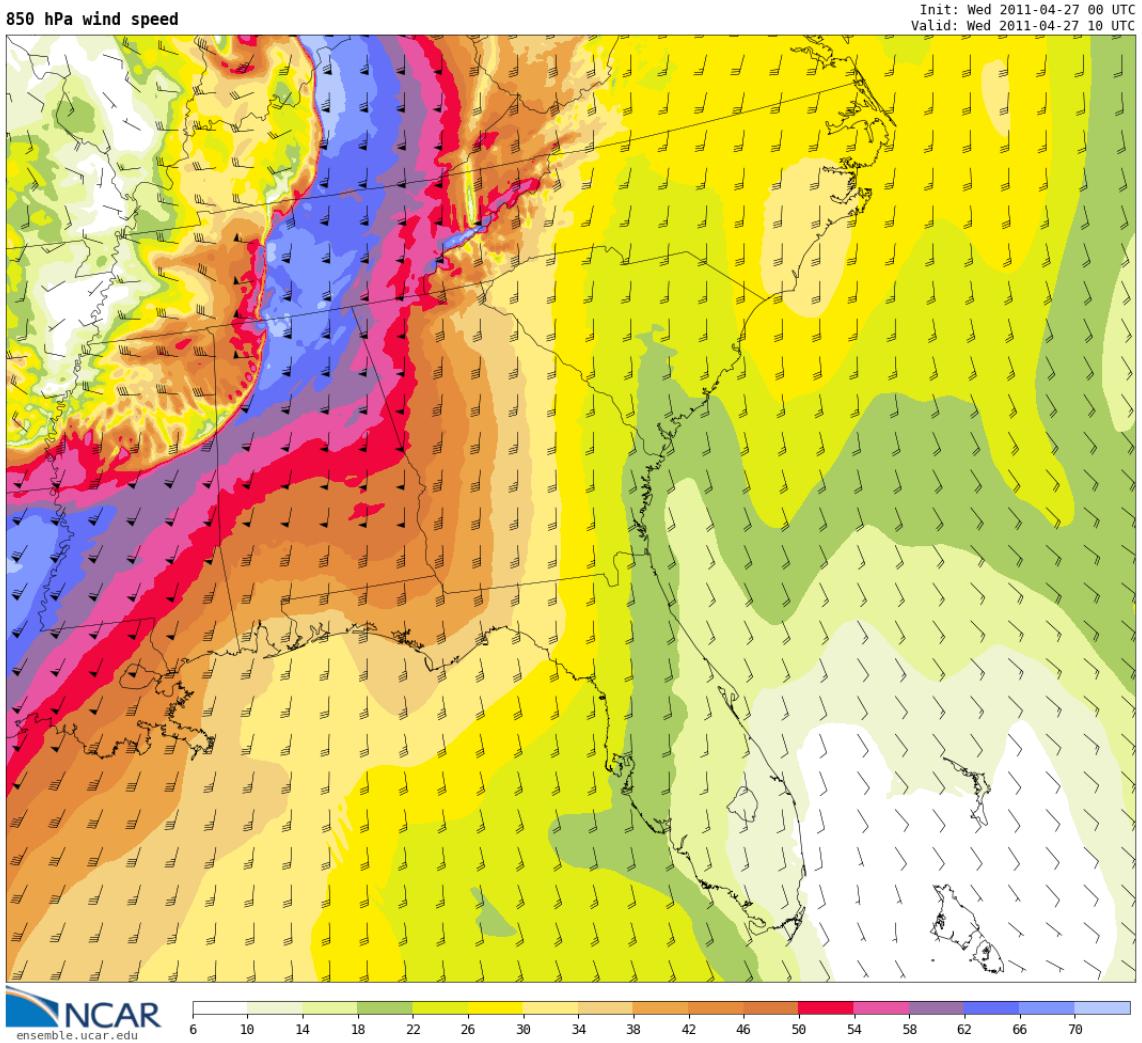
1 km

3 km

12:00 UTC

27 April 2011 850 hPa Winds

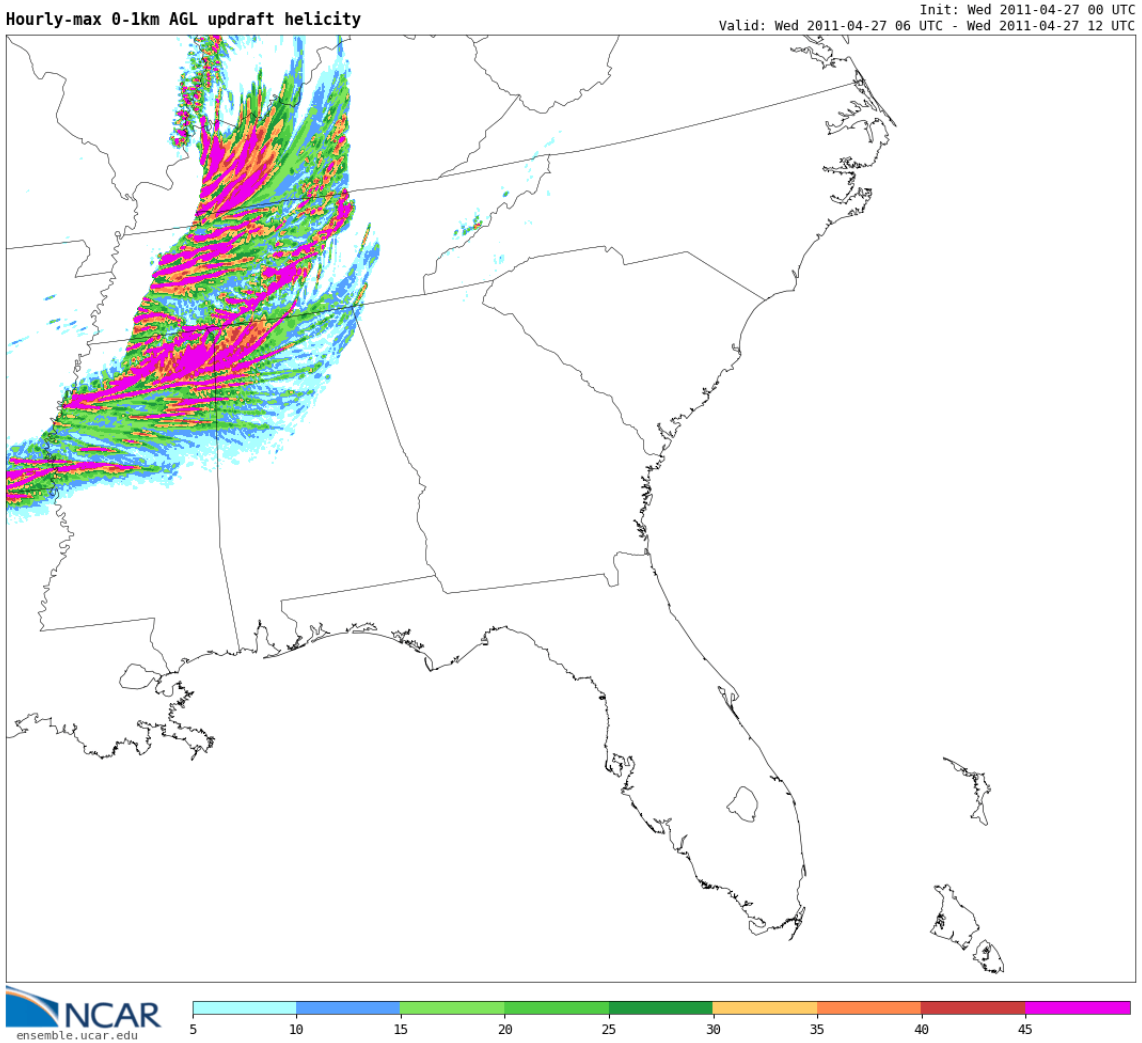


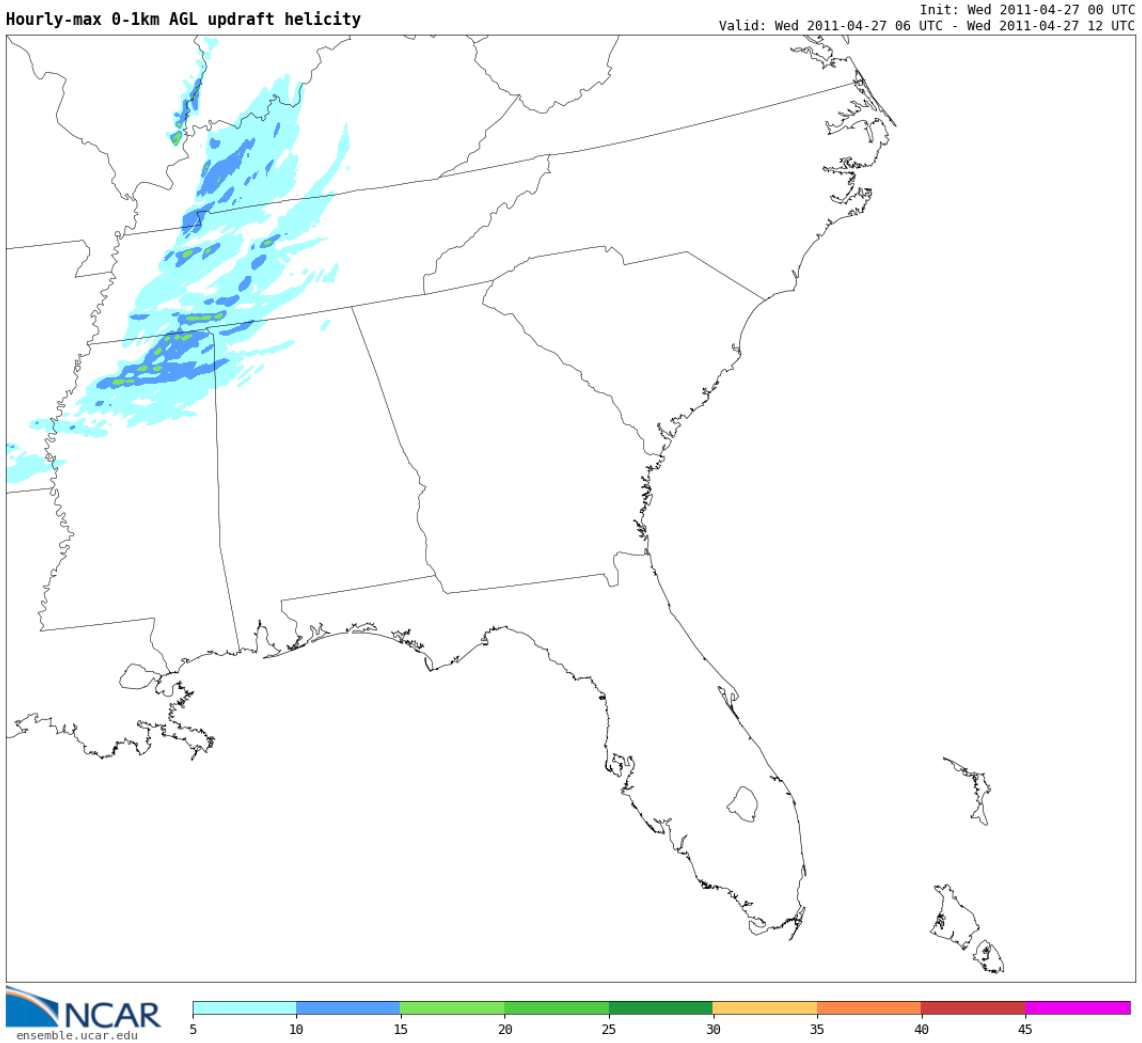


1 km 3 km

10:00 UTC

27 April 2011 Max Updraft Helicity (0-1km)





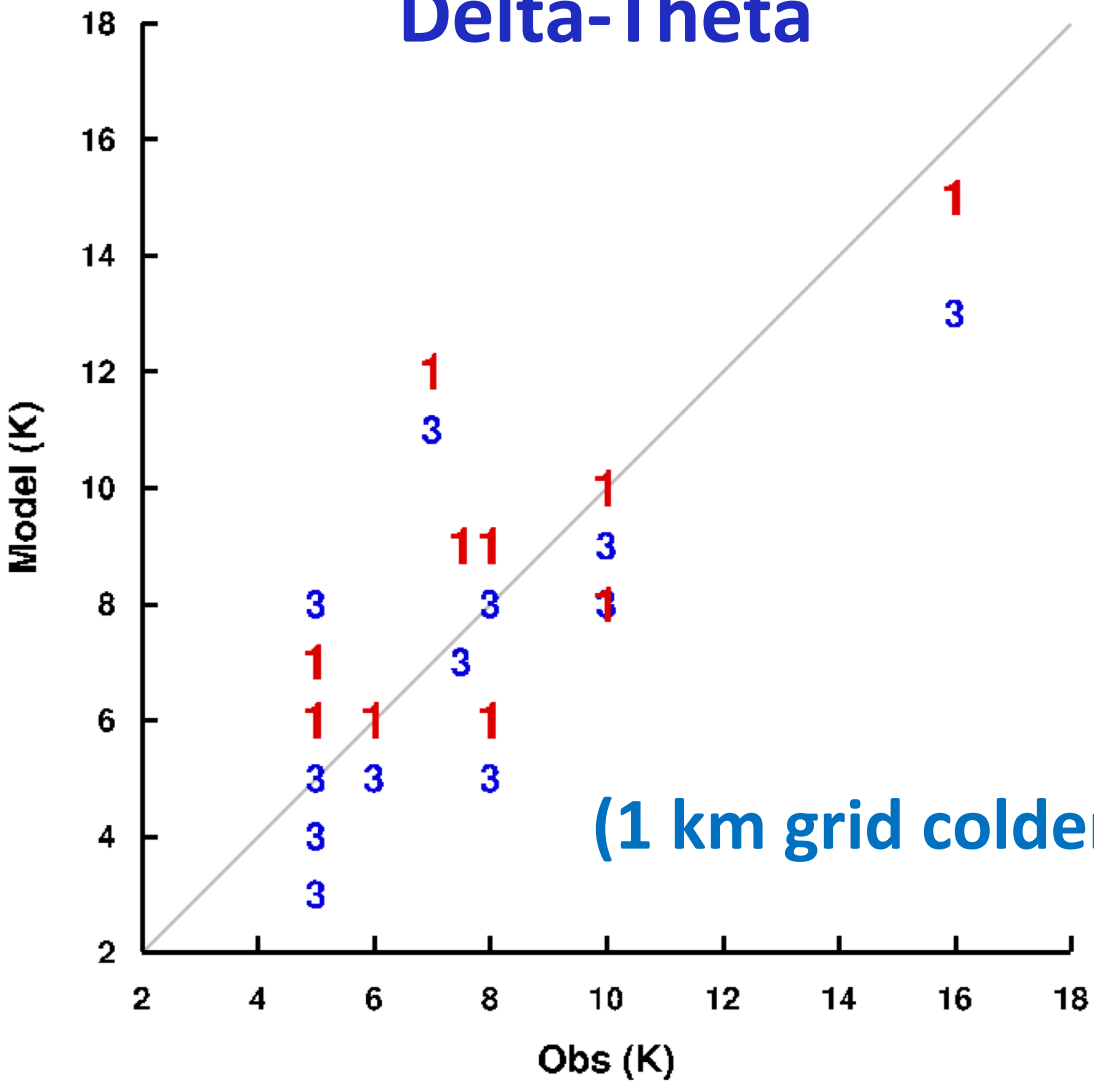
1 km

3 km

12:00 UTC

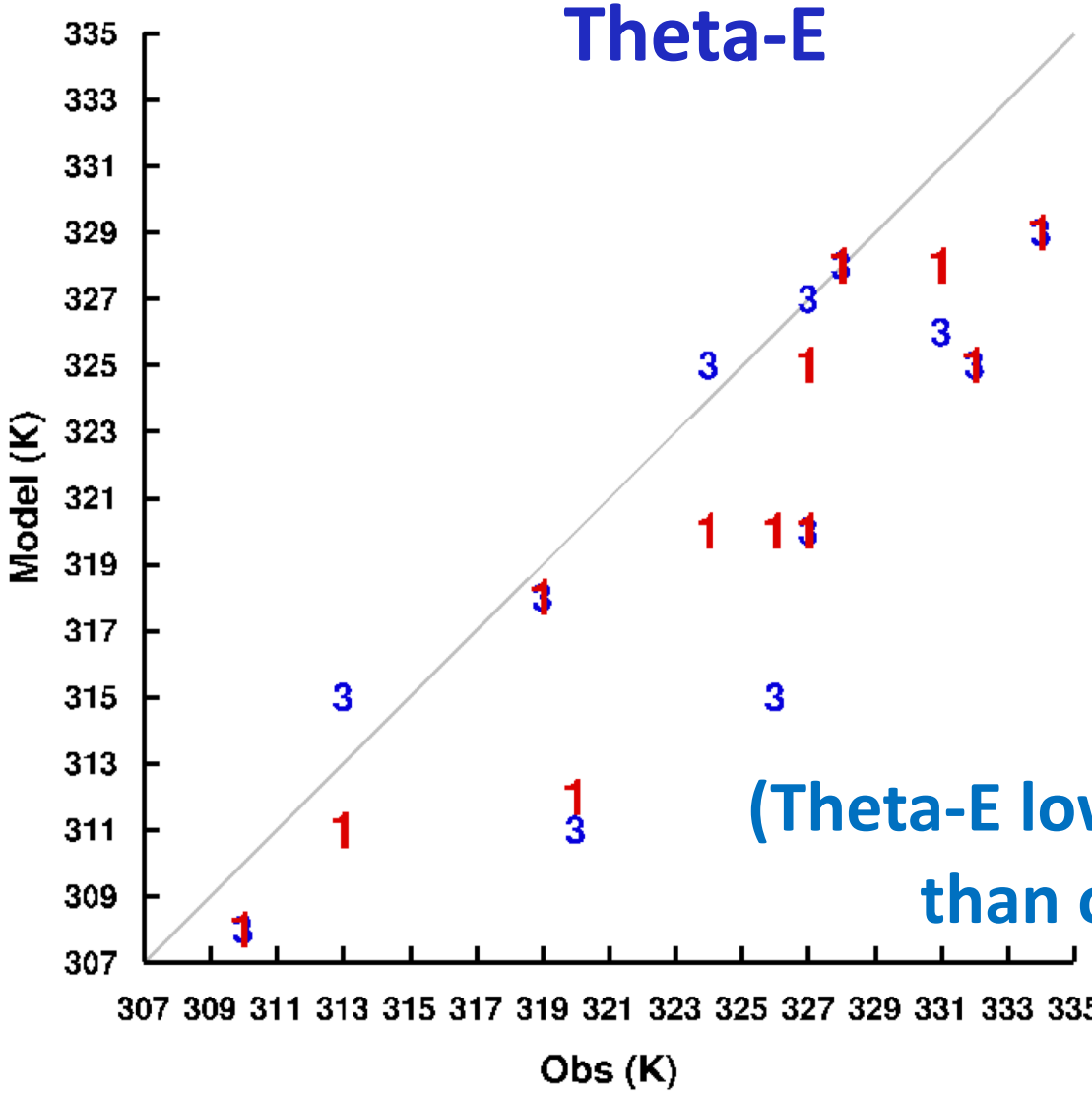
Summary Cold Pool Statistics:

Delta-Theta



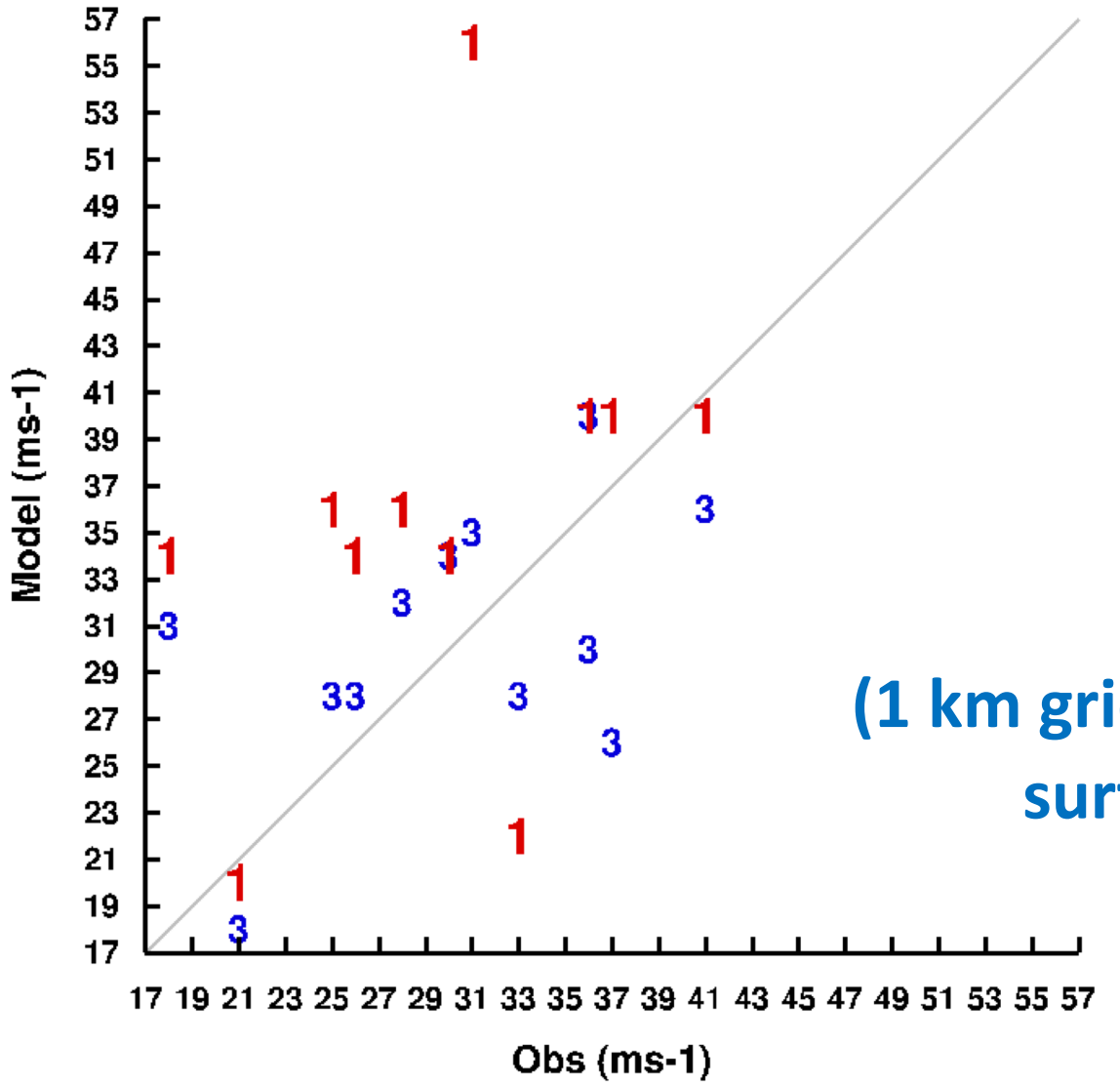
(1 km grid colder)

Theta-E



(Theta-E lower than obs)

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)

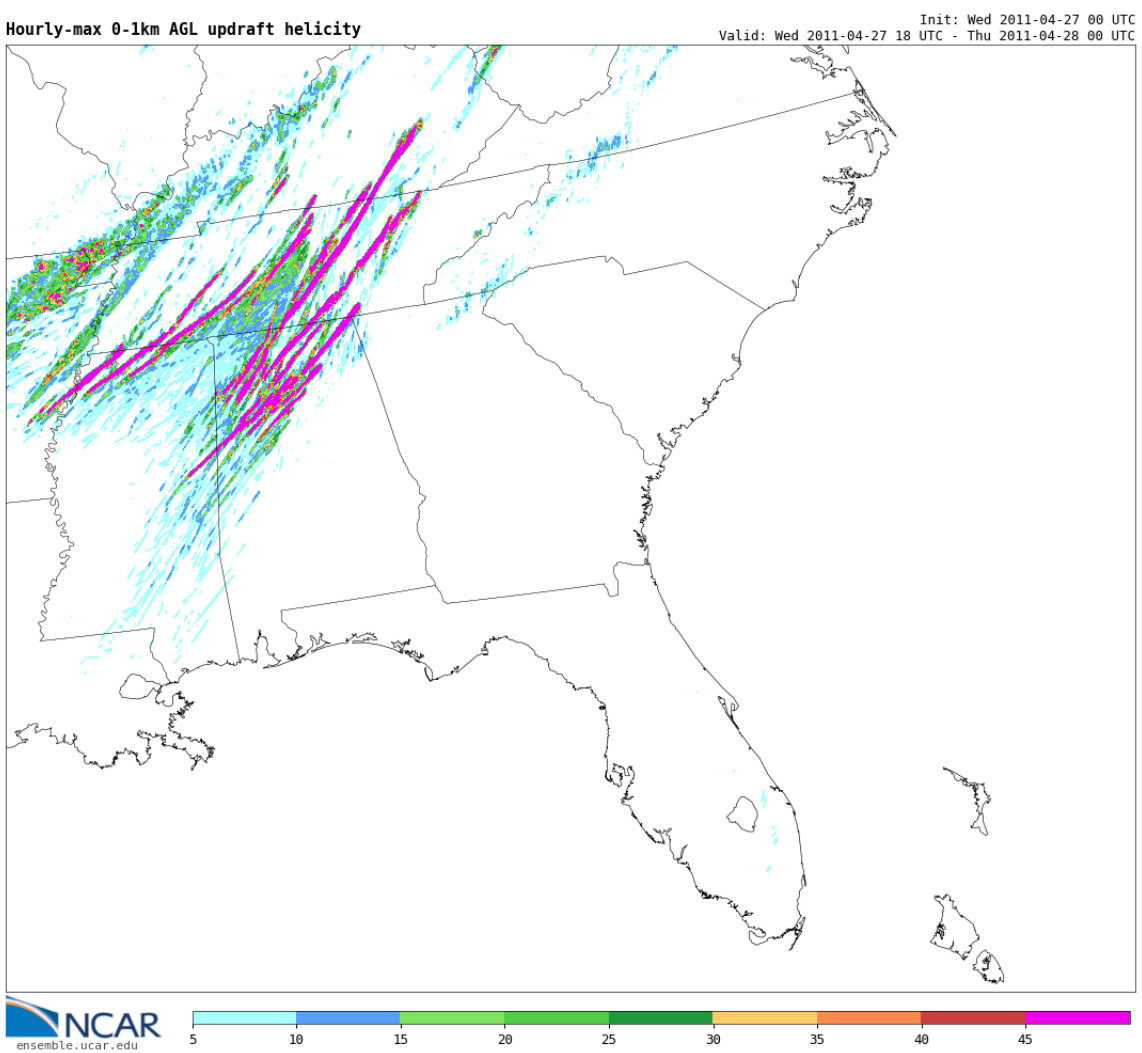
…surface winds (1 km stronger)

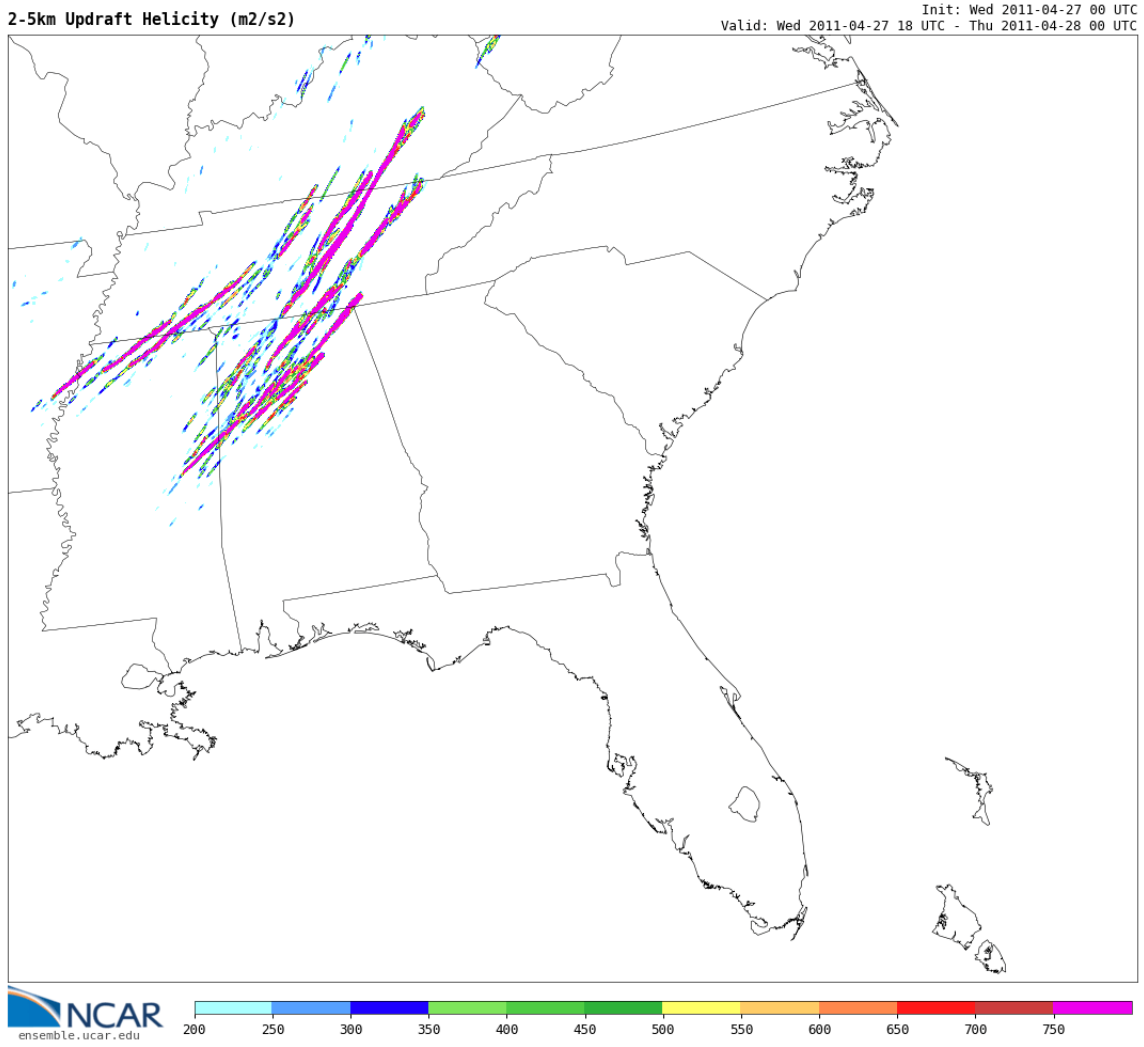
…mesovortices (more leading line vortices at 1 km)

…rear-inflow jet (similar)

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

27 April 2011 Max Updraft Helicity



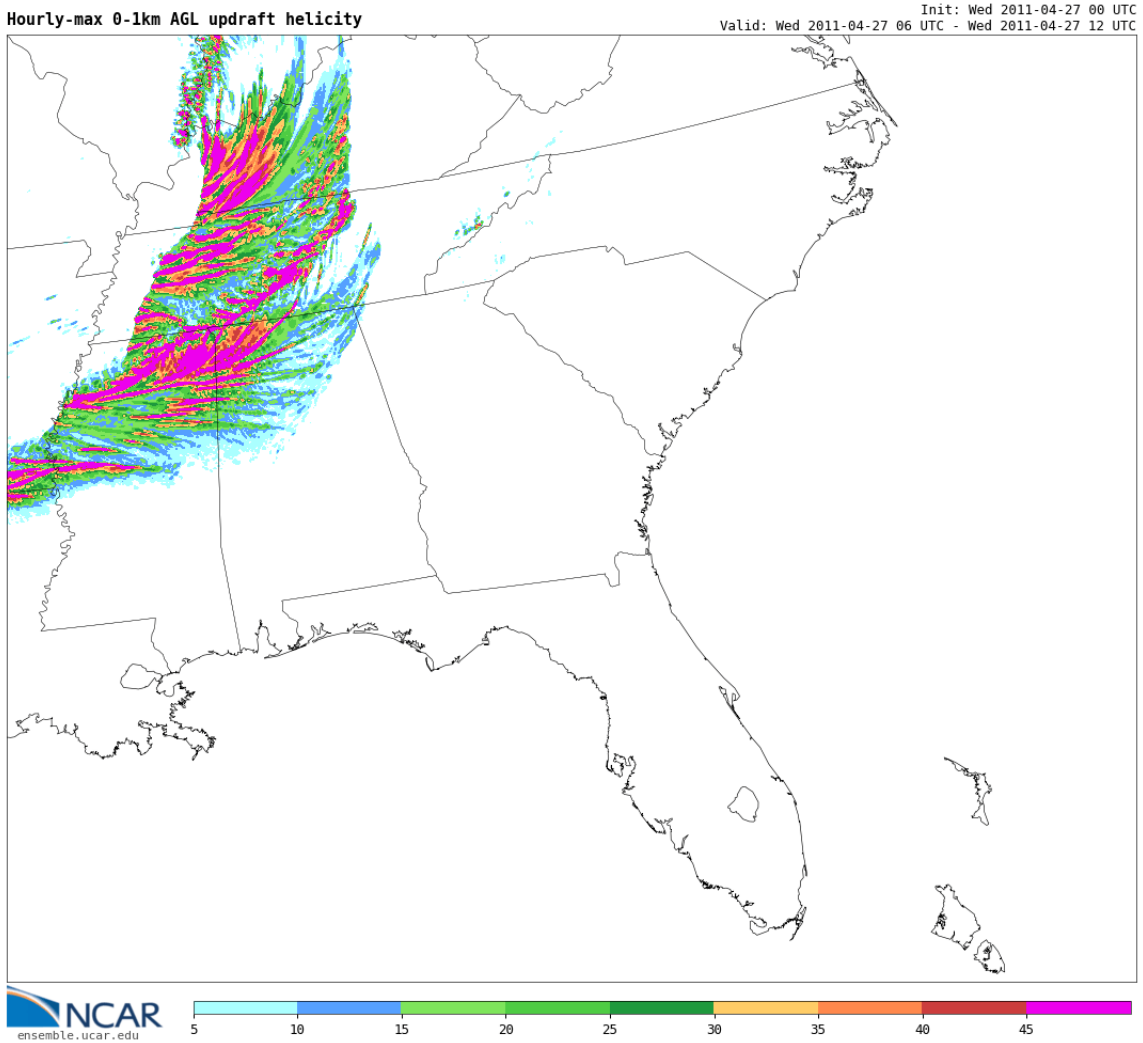


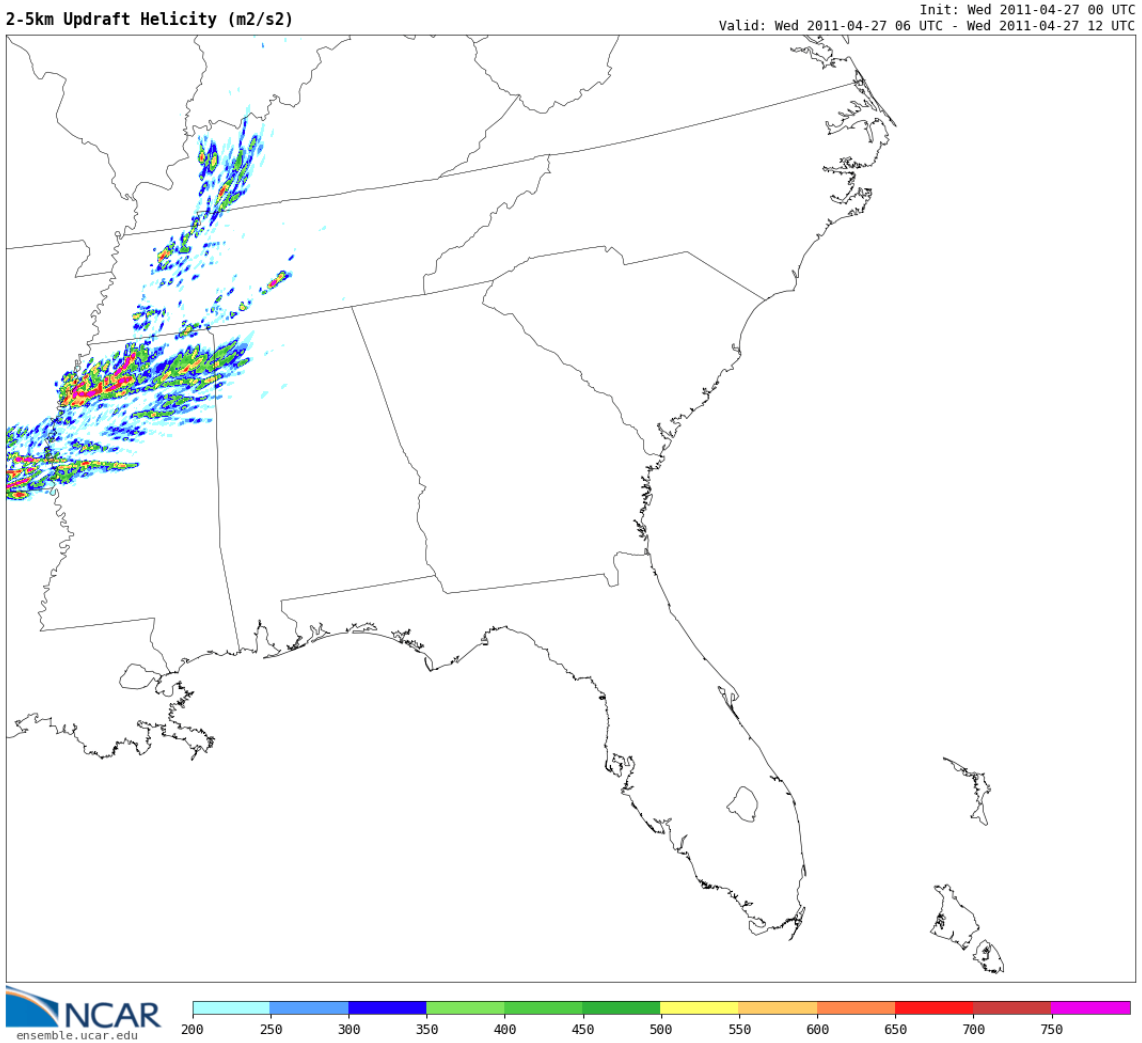
1 km 0-1 UH

00:00 UTC

1 km 2-5 UH

27 April 2011 Max Updraft Helicity



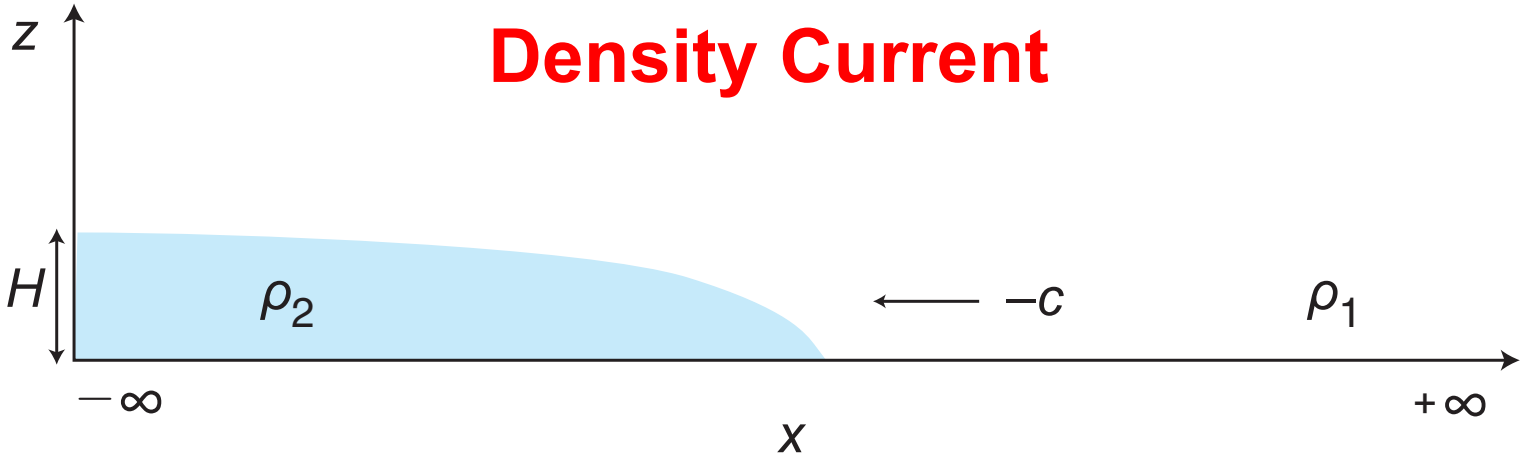


1 km 0-1 UH

12:00 UTC

1 km 2-5 UH

Density Current



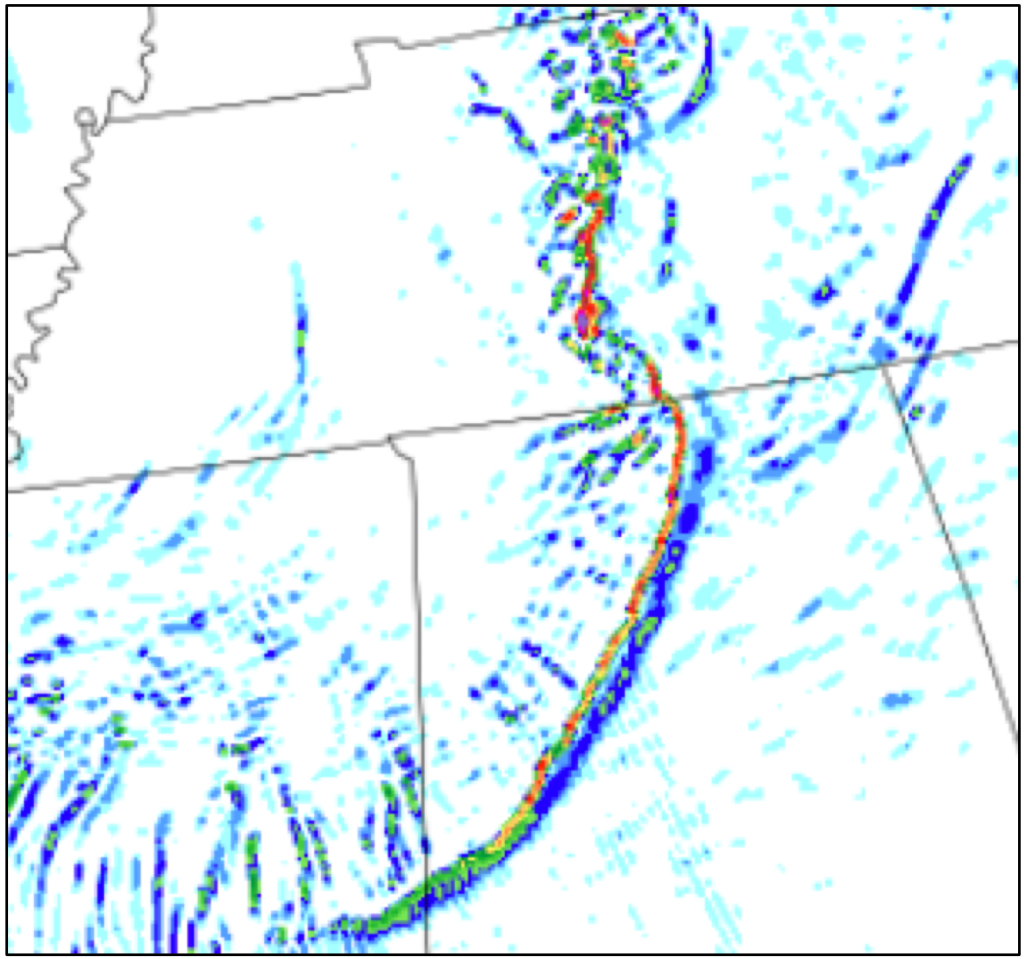
Theoretical speed of propagation:

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

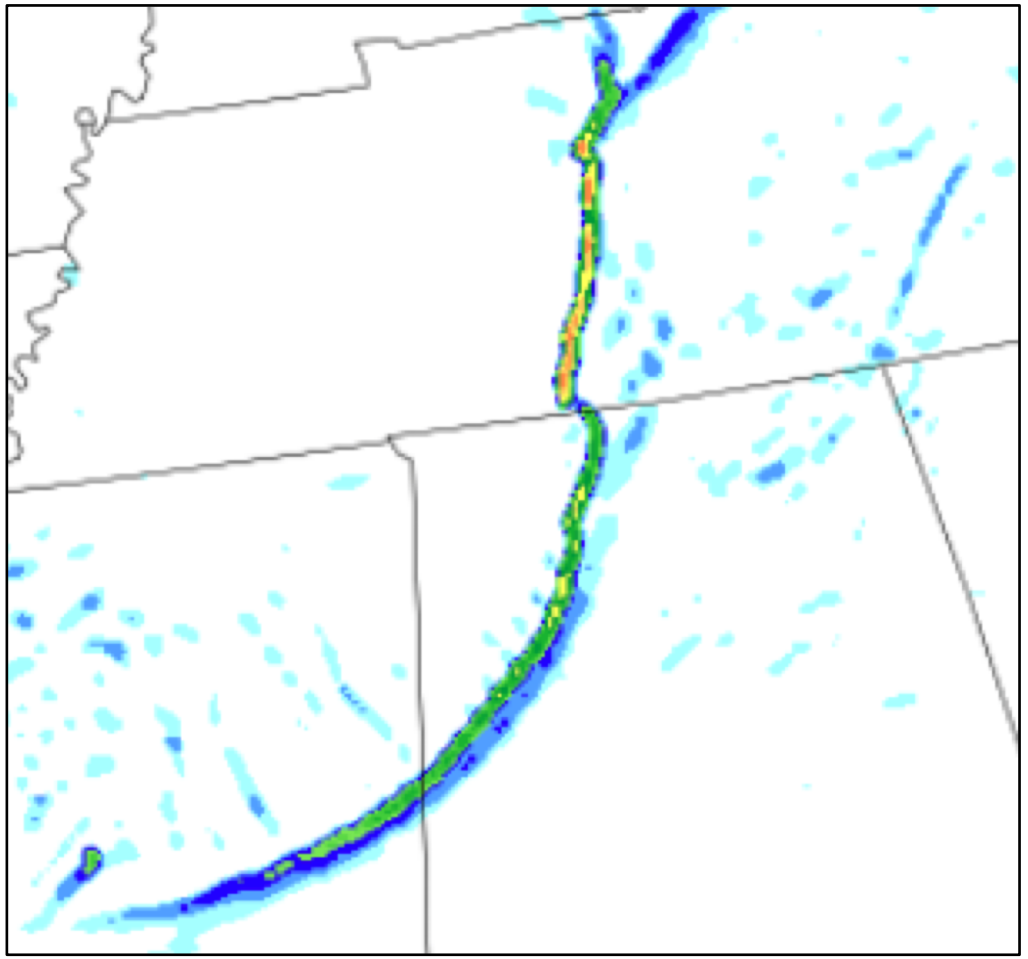
$$c = \sqrt{2g\frac{\bar{\theta}'}{\bar{\theta}}H} = \sqrt{2\frac{\Delta P}{\bar{\rho}}}$$

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

27 April 2011



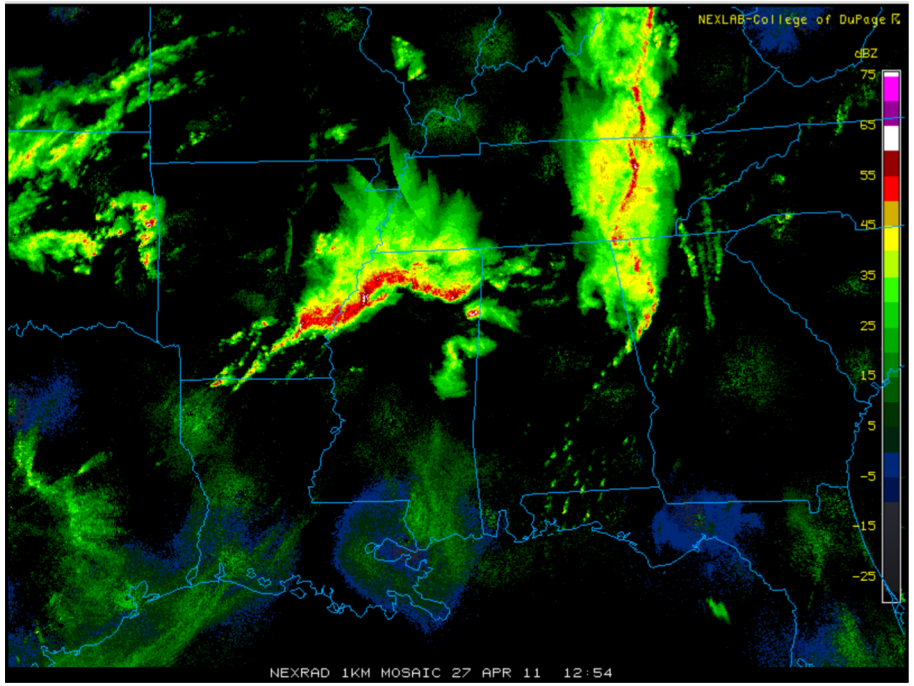
1 km

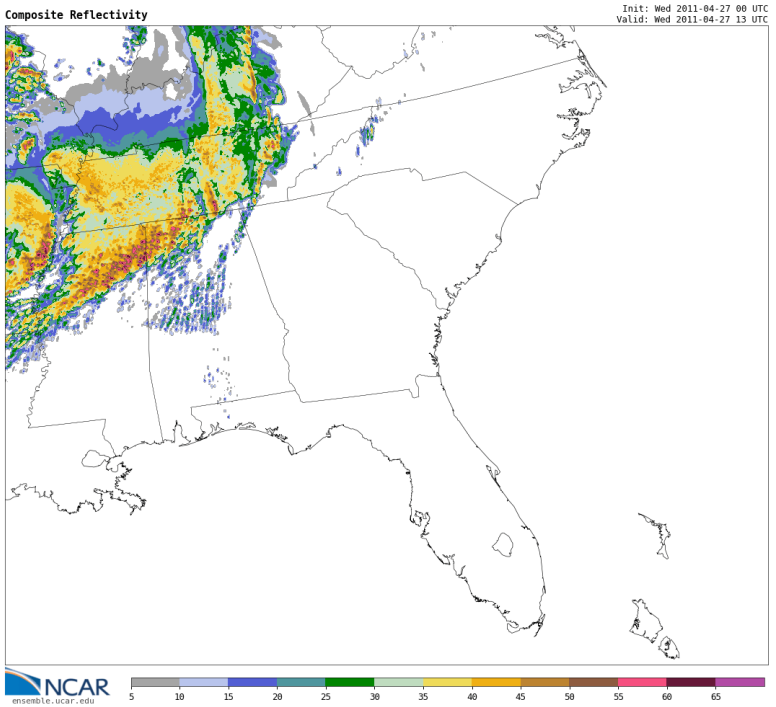


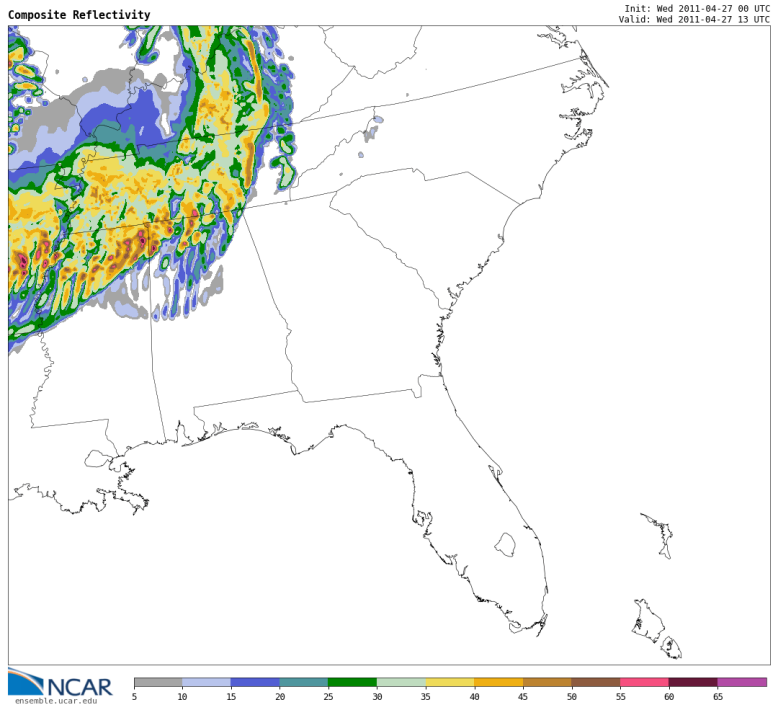
3 km

10:00 UTC

27 April 2011

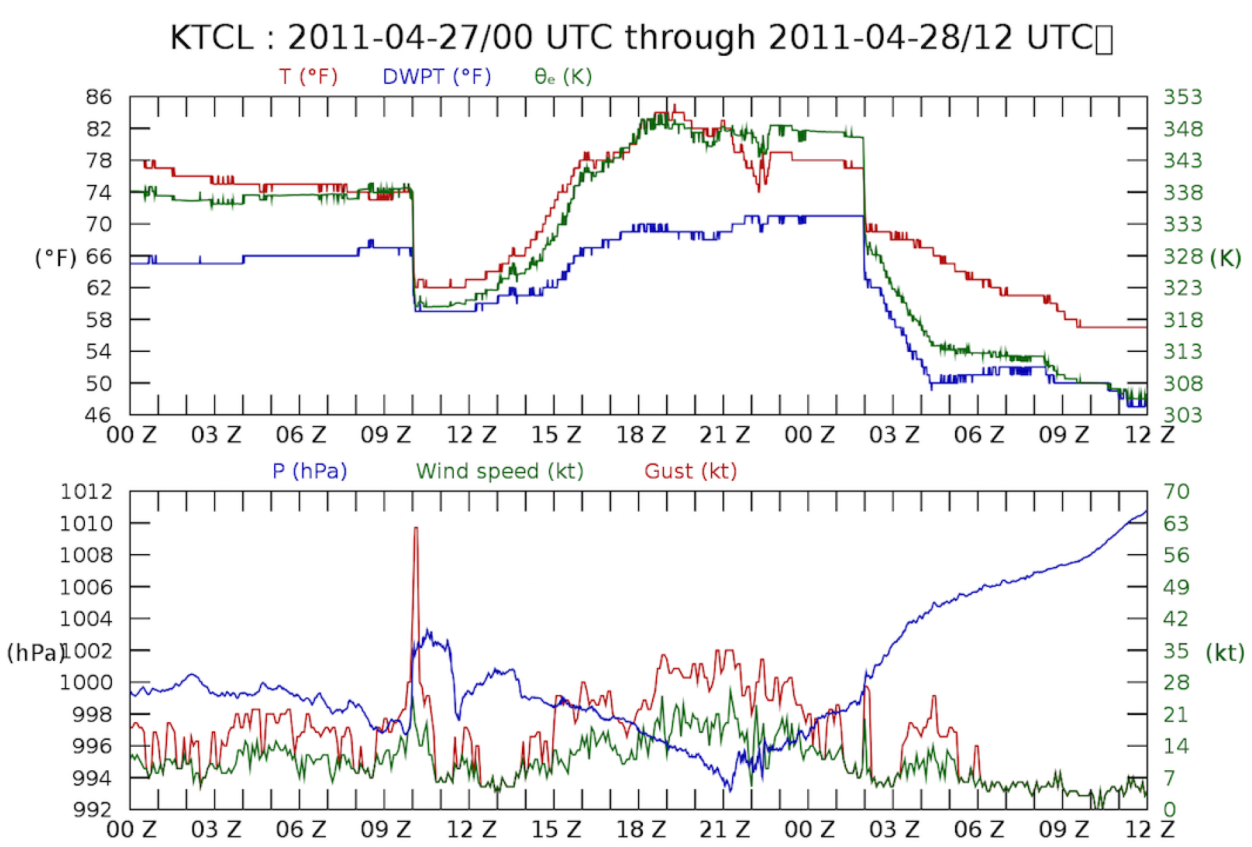






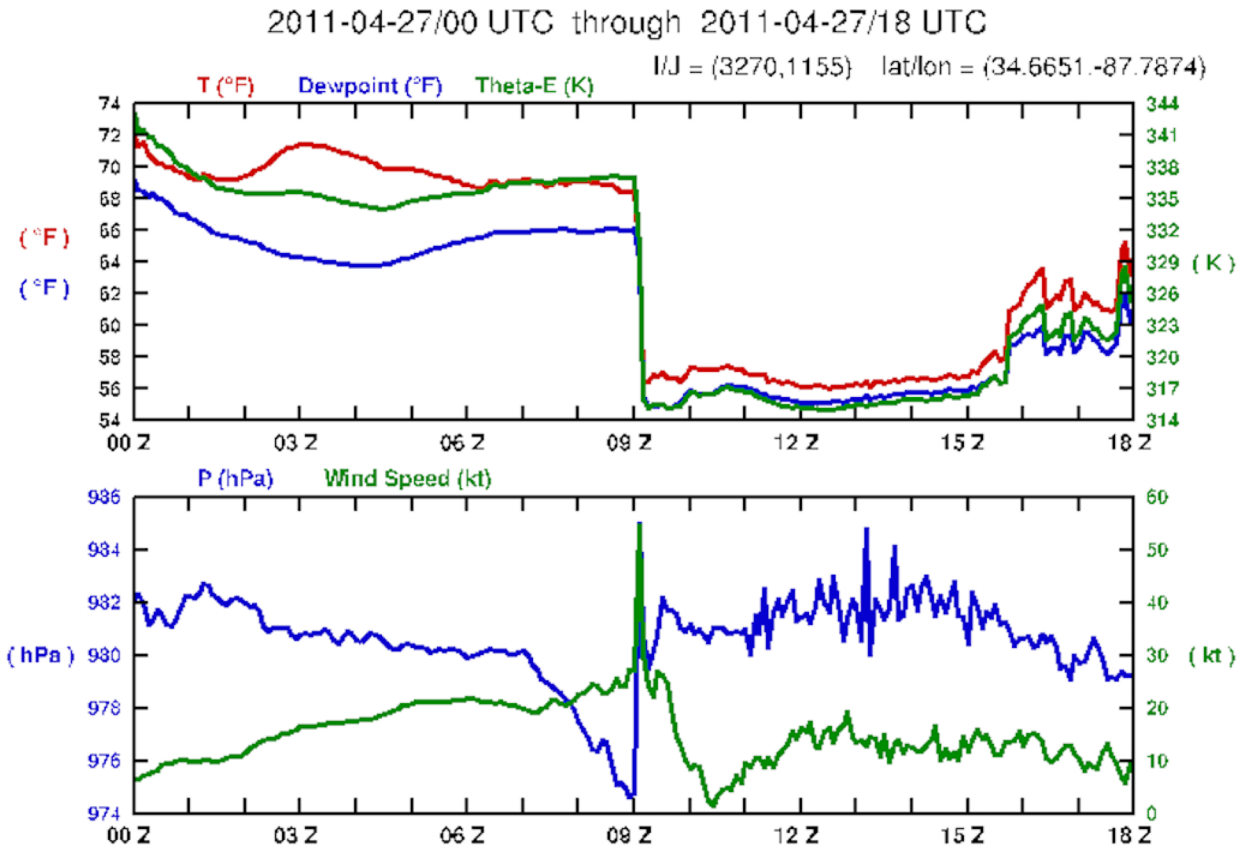
13:00 UTC

27 April 2011



KTCL

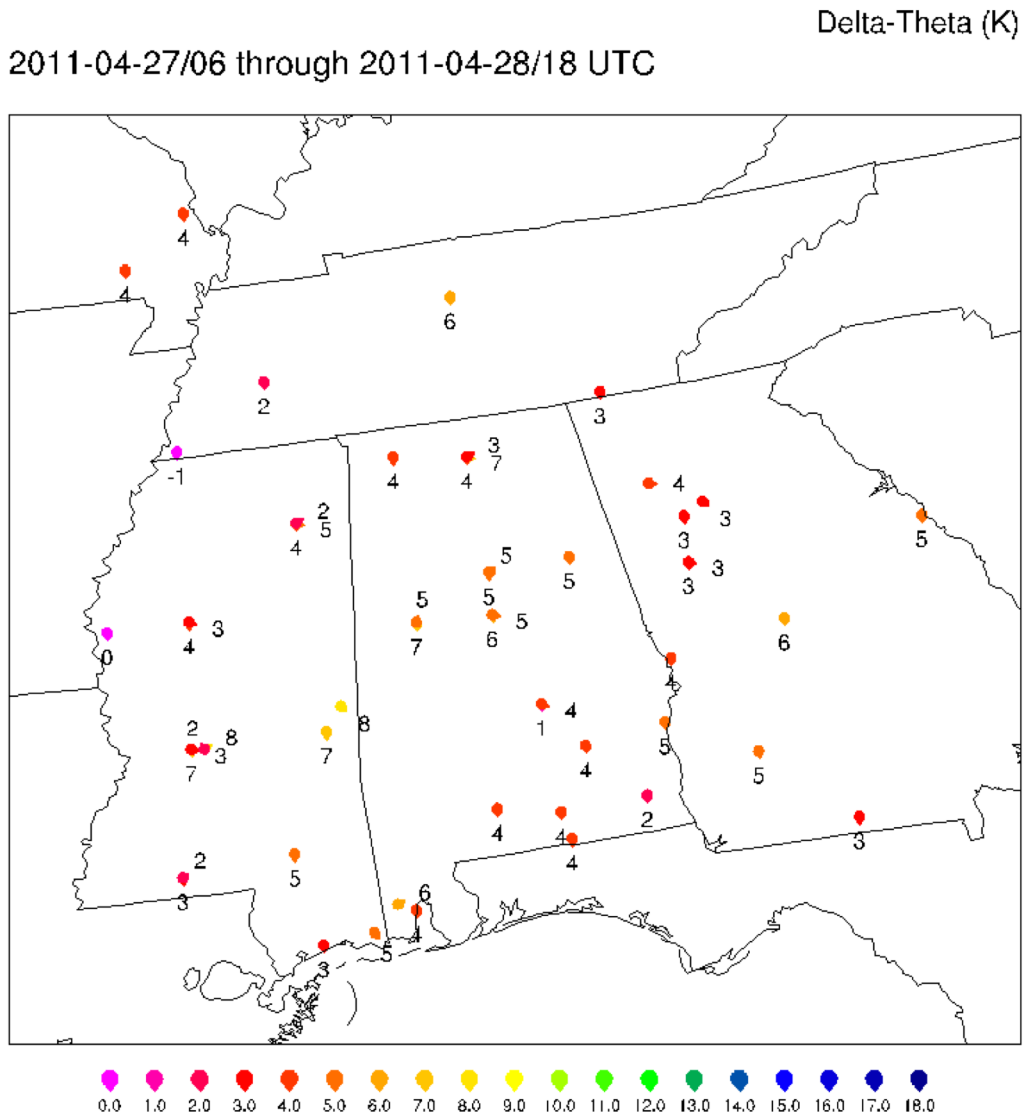
DTheta ~6 k 63 kts

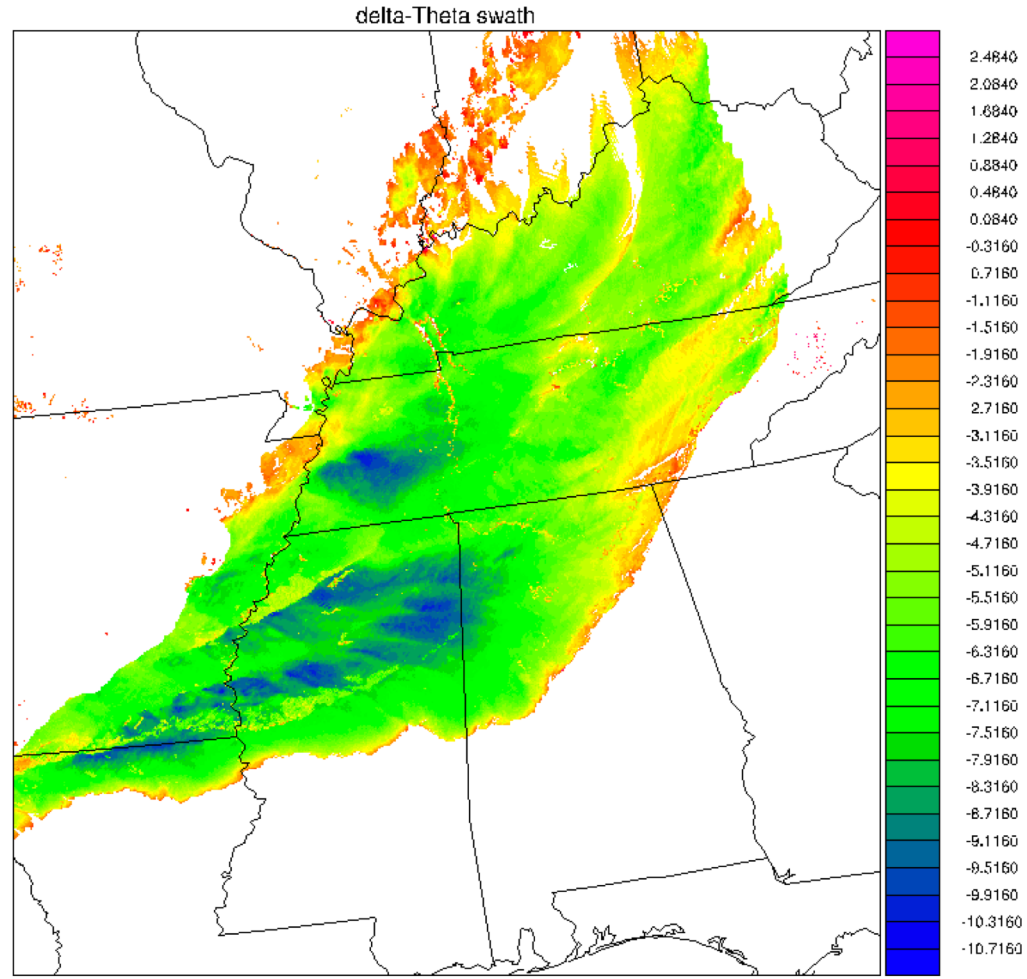


1 km

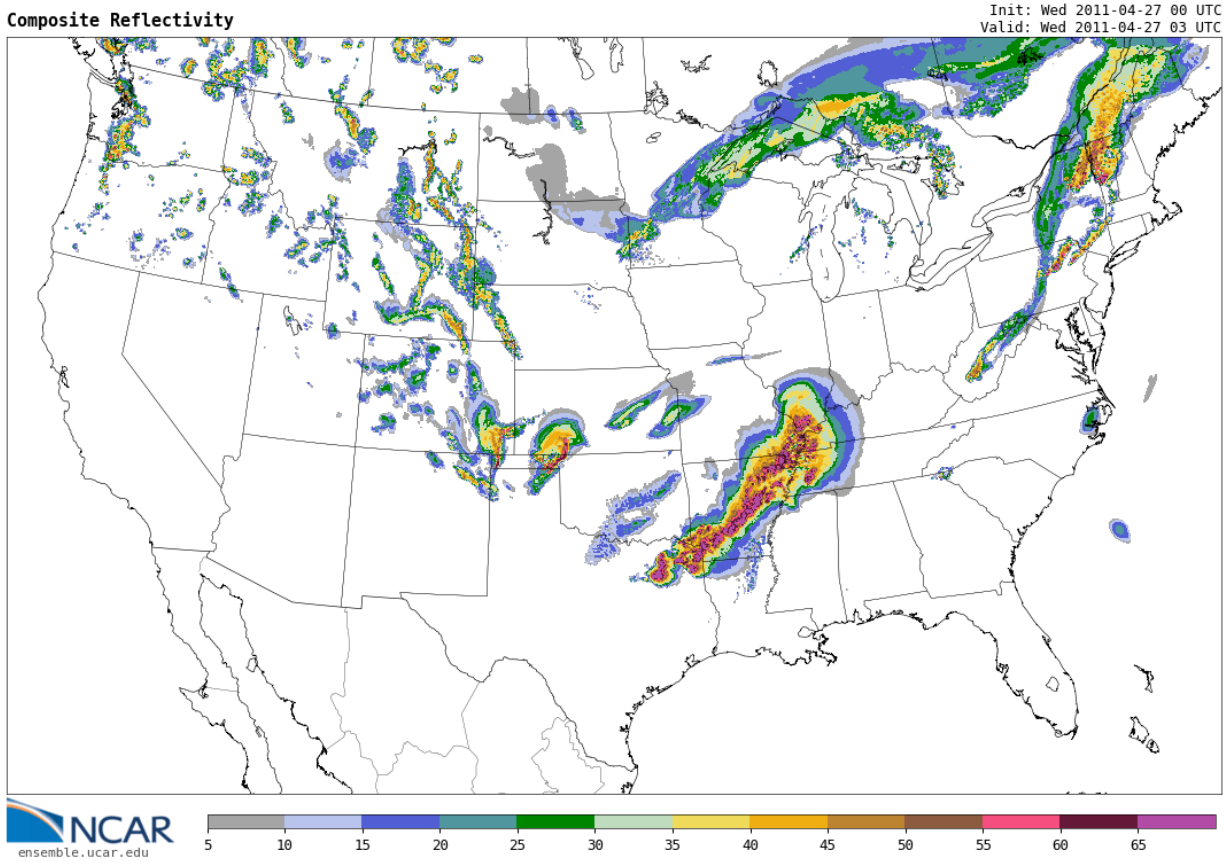
DTheta ~7 k 56 kts

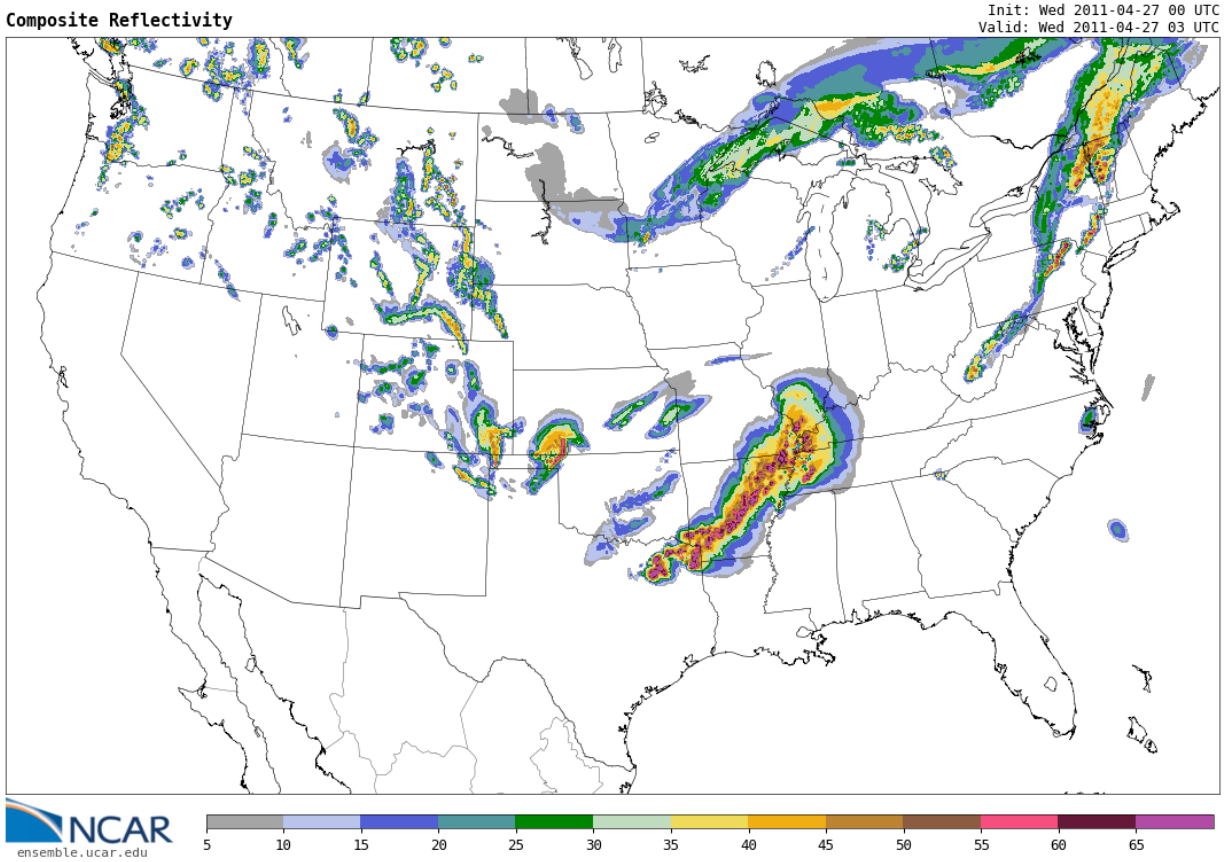
27 April 2011





27 April 2011



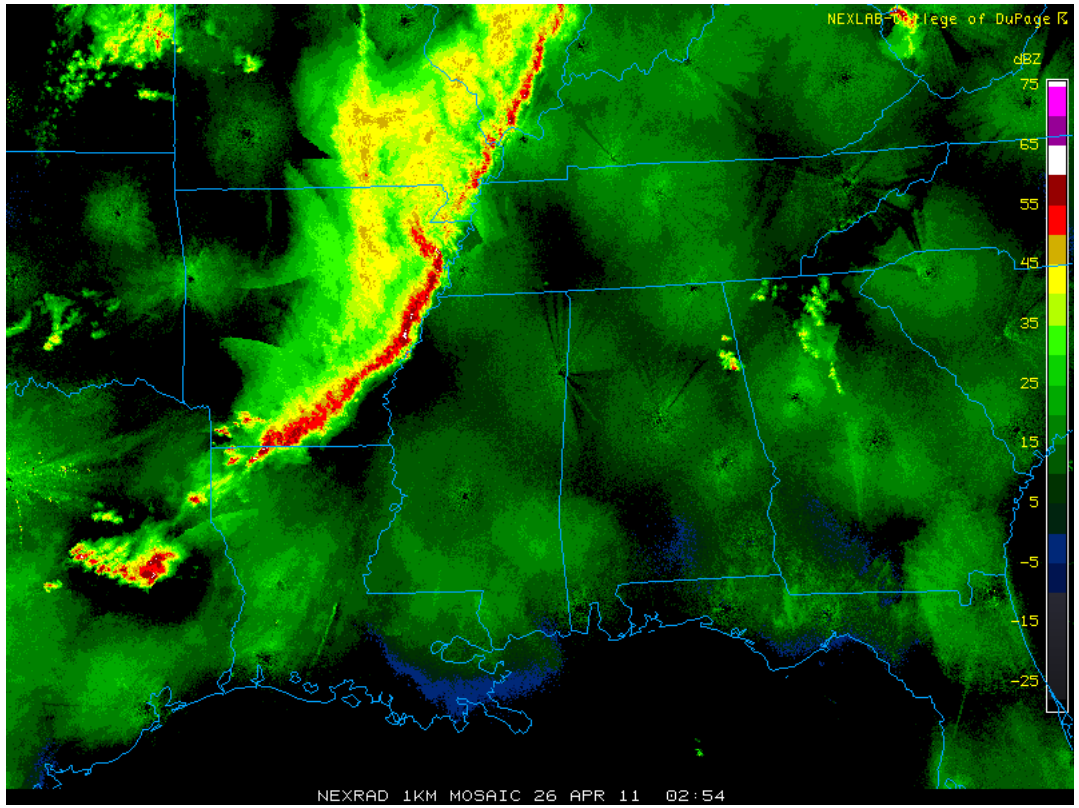


1 km

3 km

03:00 UTC

27 April 2011



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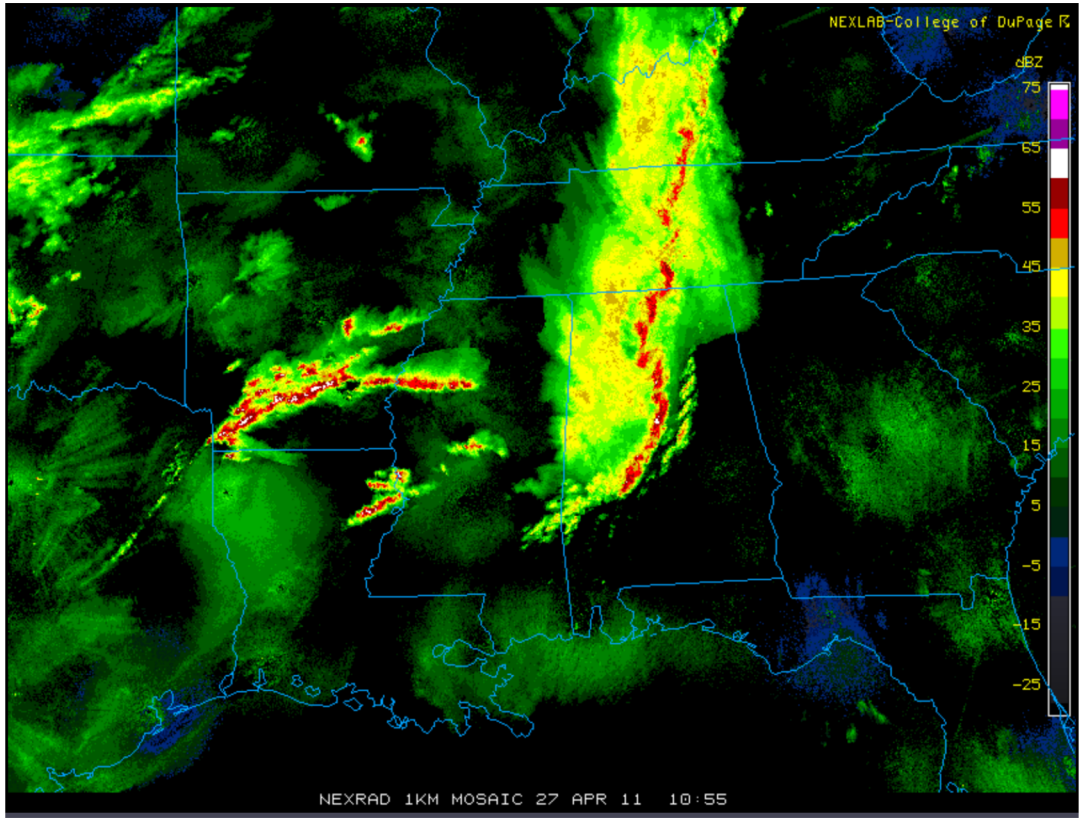
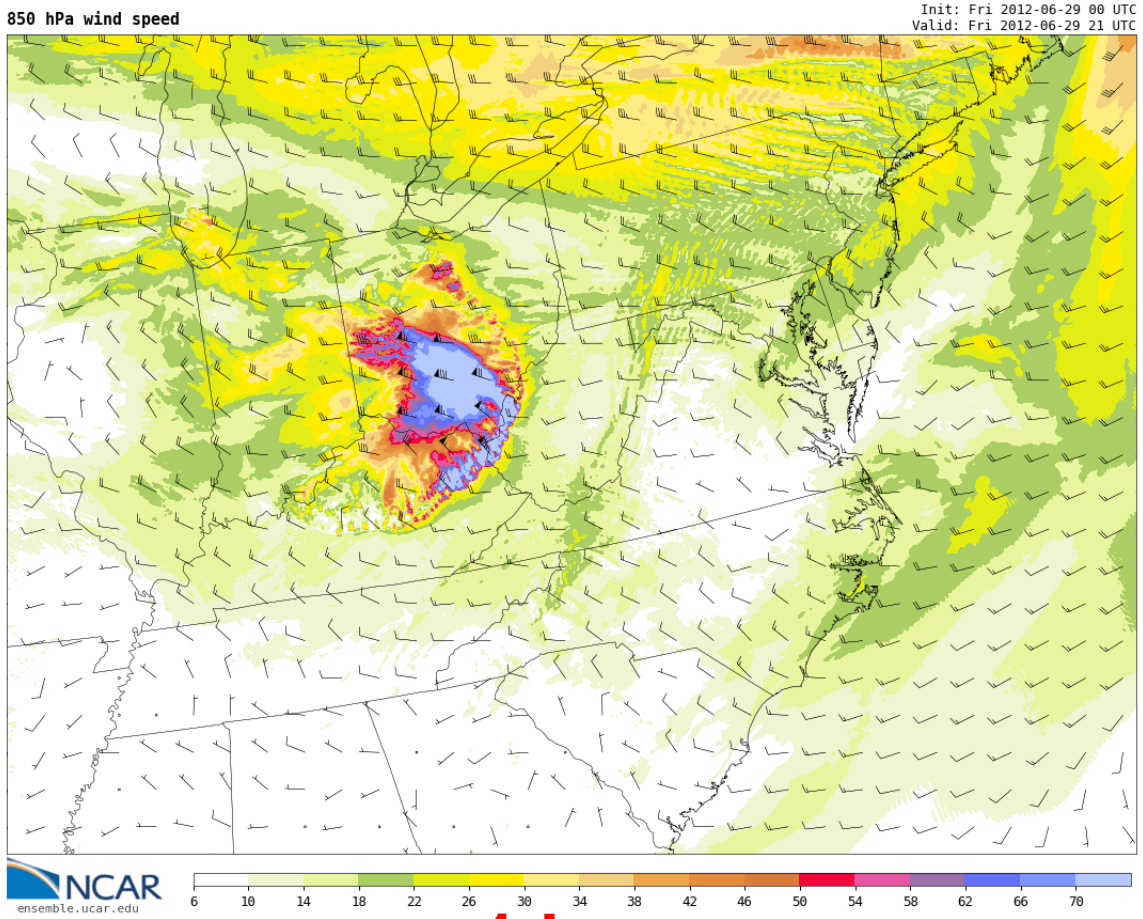
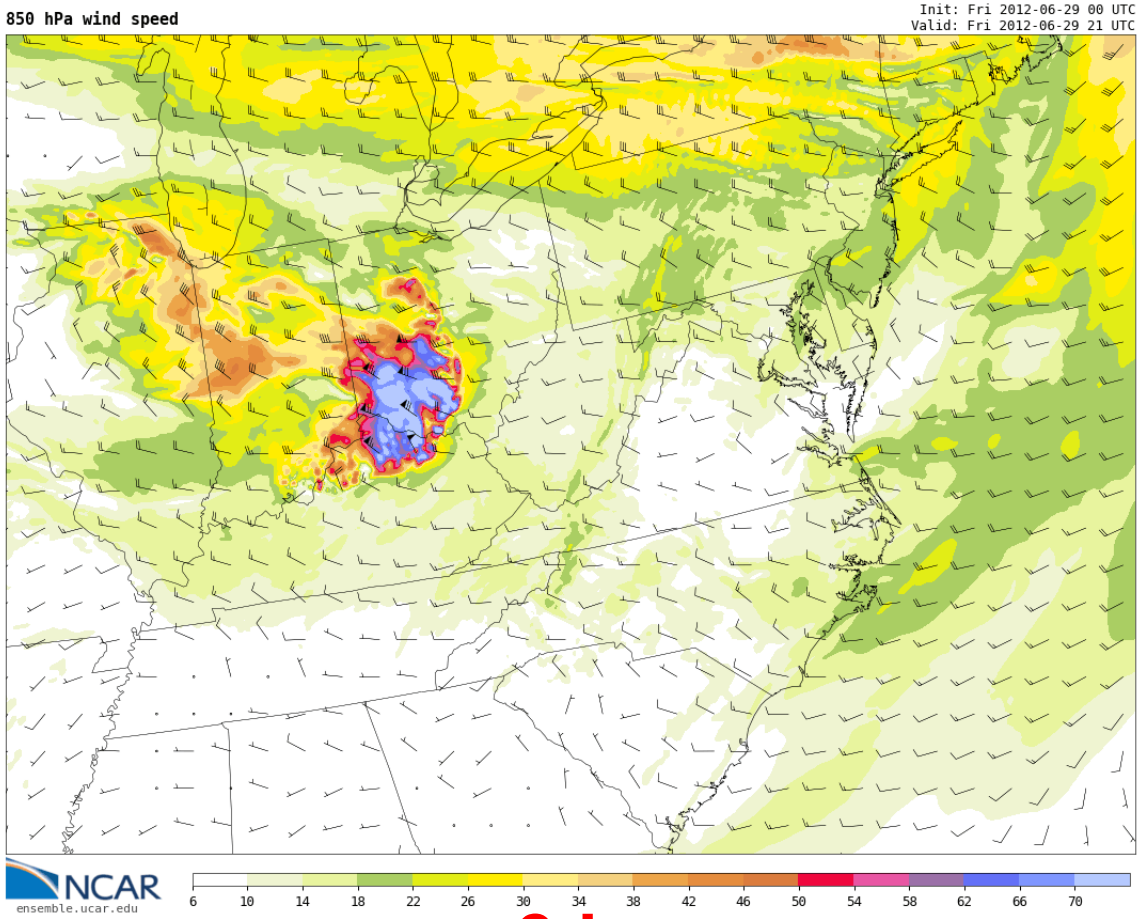


11:00 UTC

29 June 2012 850 hPa Winds



1 km



3 km

21:00 UTC