Overview of Downward Convective Available Potential Energy (DCAPE)

NWS Louisville, KY

Overview of Downward CAPE (DCAPE)

- DACAPE is the maximum energy available to a descending parcel of air
- Used to estimate the potential strength of rain-cooled downdrafts within thunderstorms
- The higher the value of DCAPE, the stronger the downdraft potential
- DCAPE values over 1000 J/kg are often significant and imply steep low-level lapse rates which are conducive to downward transport of higher momentum air to the surface resulting in gusty winds and possibly wind damage

Overview of Downward CAPE (DCAPE)

$$\mathrm{DCAPE} = -\int_{P_f}^{P_s} (\alpha_p - \alpha_e)\, dp$$

where α_p and α_e are the specific volumes of the parcel and its environment, respectively, and P_s and P_f are the surface pressure and the pressure of the level aloft of free sink, respectively

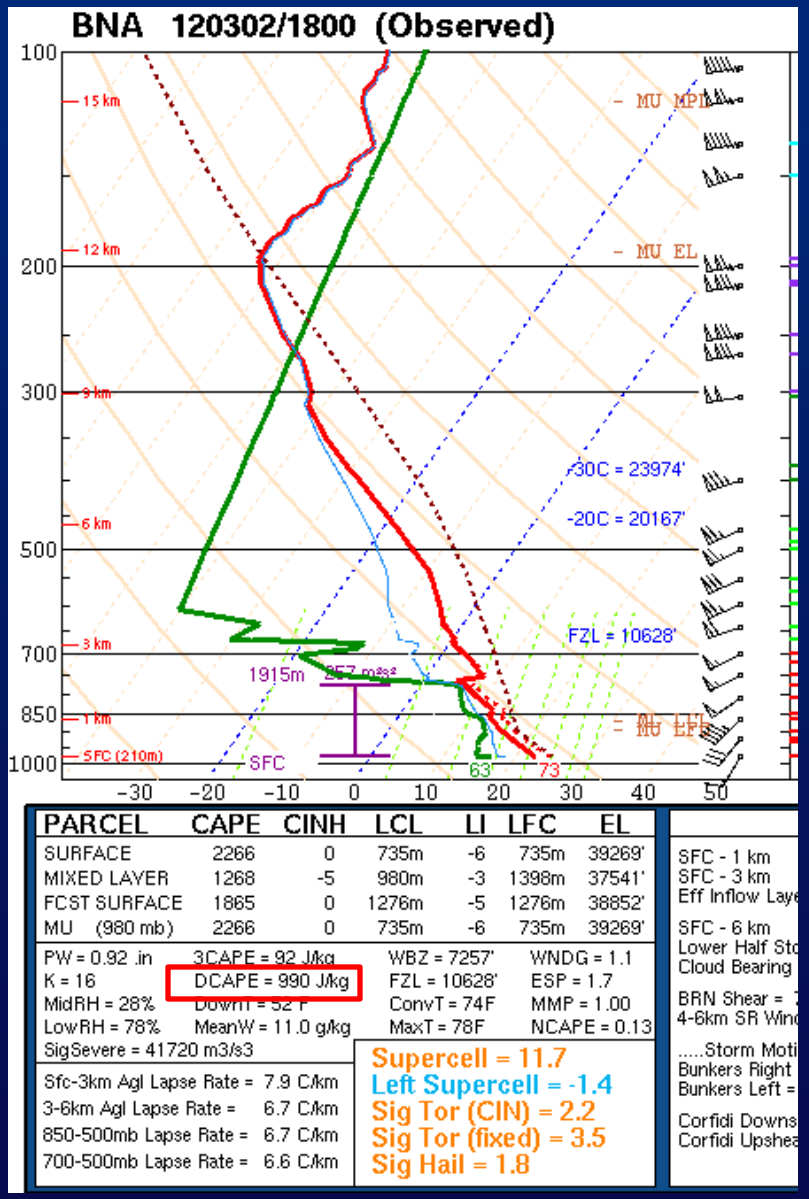
Overview of Downward CAPE (DCAPE)

- The drier the air aloft and the steeper the low-level lapse rates, generally the higher the DCAPE and potential for wind damage along and behind the leading edge gust front

- Hot and sub-saturated boundary layer air (large temp-dewpoint spread) will also contribute to effective downward momentum transfer and strong surface winds

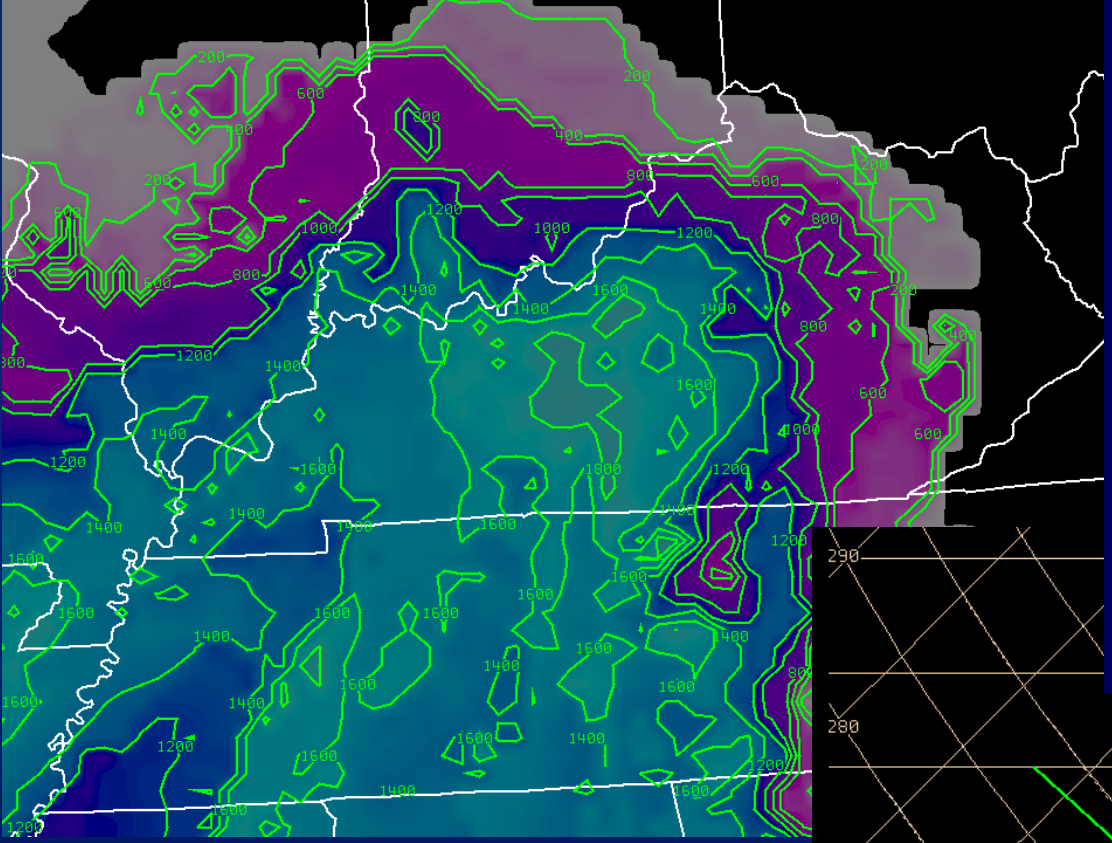
Overview of Downward CAPE (DCAPE)

- DCAPE = the negative area (region between the descending parcel curve and the environmental sounding, from the parcel's level of free sink [parcel cooler than environment] to the surface)
- Values > 800 J/kg are decent
- Values > 1200 J/kg are very high



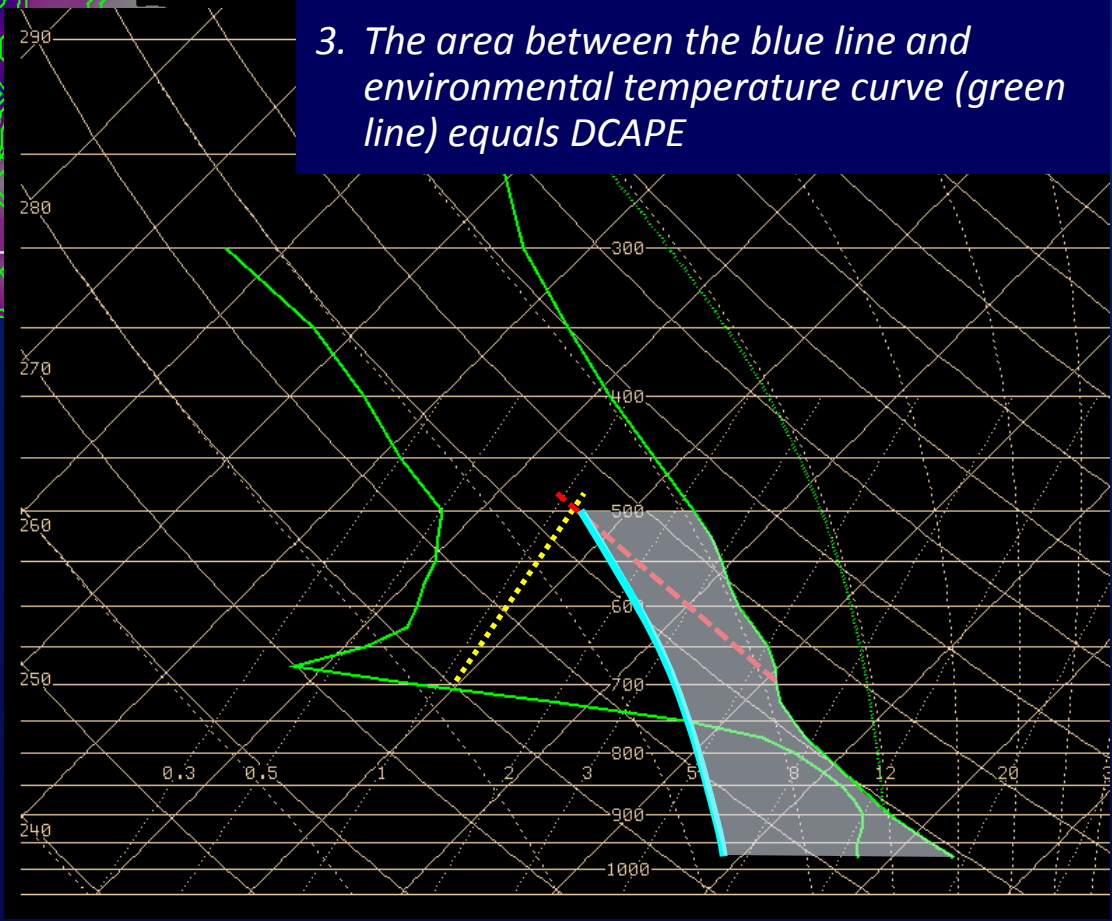
Finding DCAPE on a Sounding:

1. *From 700 mb, find the Lifting Condensation Level (LCL) (600 mb or average wet bult temp from 500-700 mb are used at times). LCL = level where dotted yellow and dashed red lines meet (where saturation occurs)*
2. *Follow moist adiabat on sounding down to surface (solid blue line)*
3. *The area between the blue line and environmental temperature curve (green line) equals DCAPE*



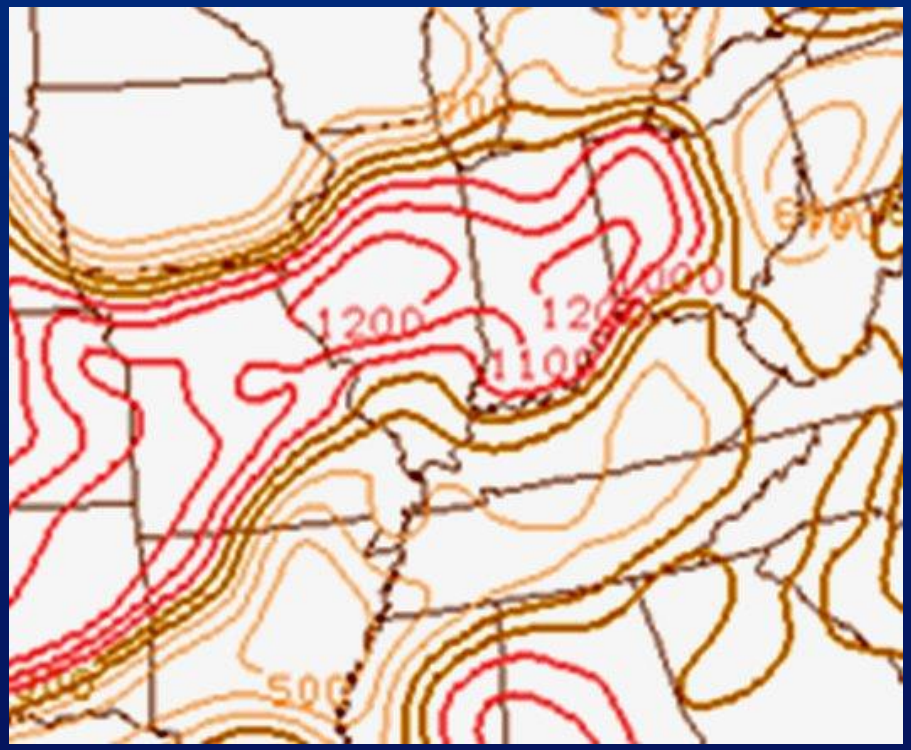
DCAPE – 18Z Mar 2, 2012

High DCAPE (above) resulted in outflow-dominated and wind-producing storms in central Kentucky. Tornadic supercells occurred in parts of southern Indiana.



NAM Sounding – Bowling Green, KY at 21Z Mar 2, 2012

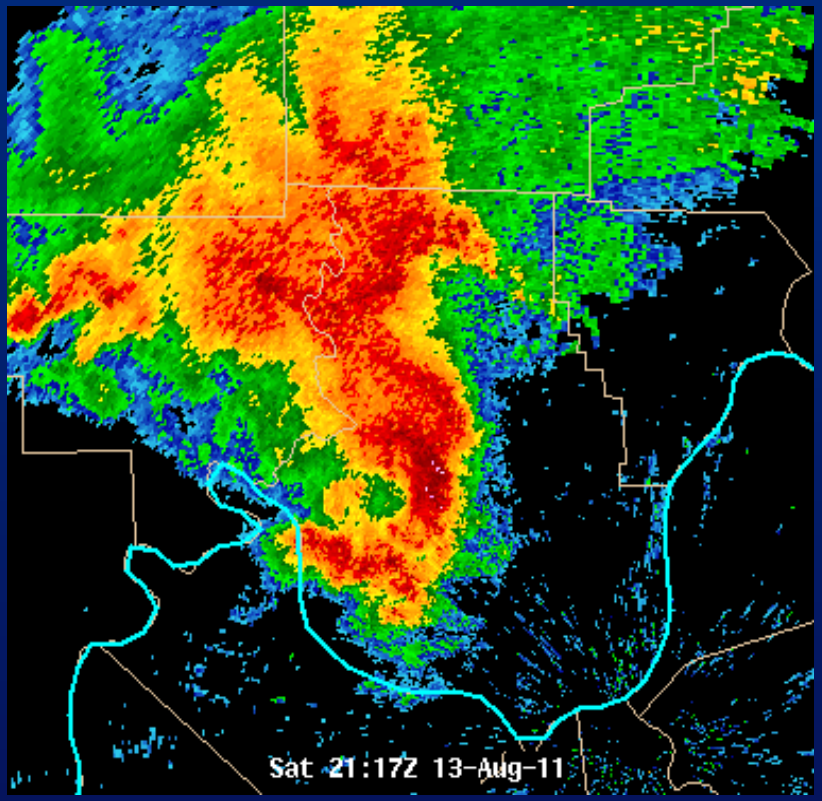
SPC Downward CAPE – Aug 13, 2011 at 1900 UTC

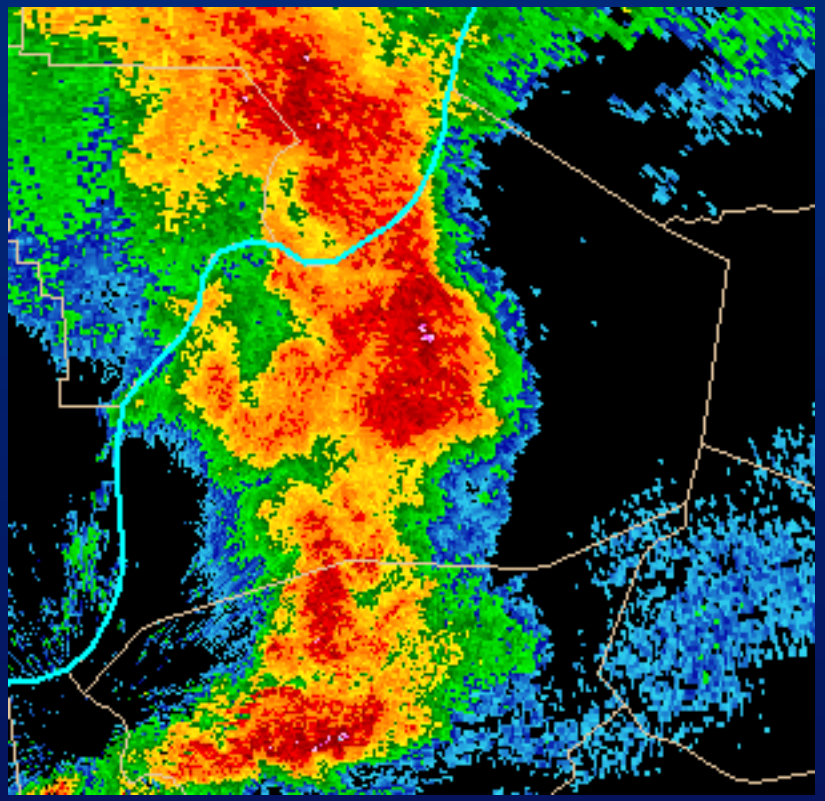


Storm Prediction Center (SPC) mesoanalysis of Downward CAPE (DCAPE) showed 1000-1300 J/kg from central Missouri to western Ohio, extending south to Louisville. This axis shifted east/southeast with time and was in place along and ahead of a damaging line of storms (next slides).

DCAPE greater than 1000 J/kg are *high* and indicate potential for downward momentum transfer and significant surface wind damage. Even higher values could be associated with long-lived derechos.

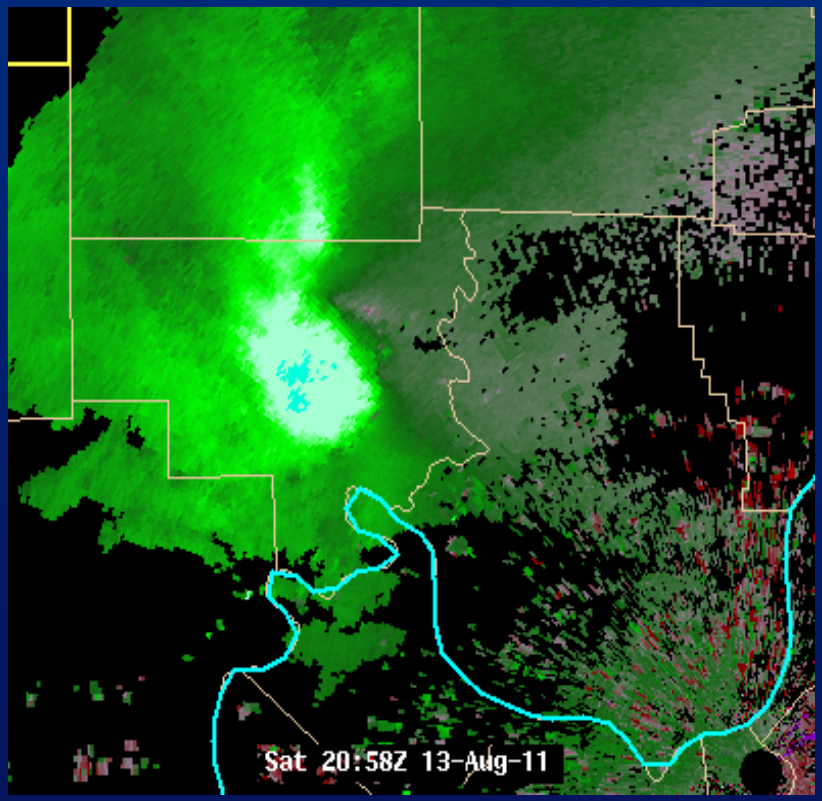
Aug 13, 2011 – KLVX 0.5° Reflectivity

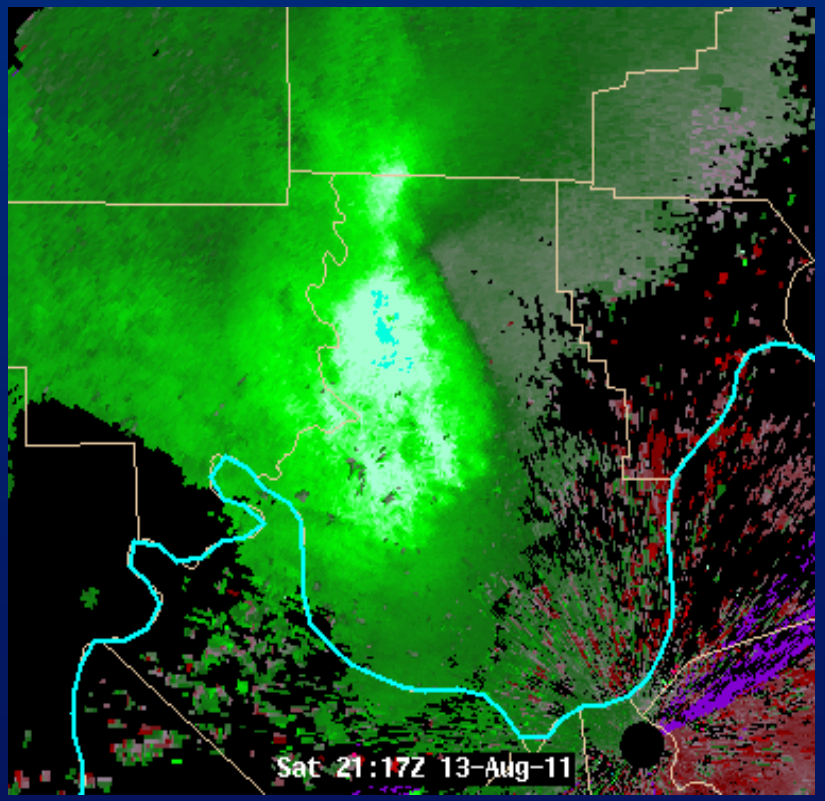




A bowing line of thunderstorms moved from south-central Indiana to east-central Kentucky during the afternoon and evening of 13 August 2011, passing through the Louisville metro area. Given high DCAPE values in place, damaging winds easily transported downward in many locations. For example, Bowman Field airport in Louisville reported 69 mph wind gusts. Environmental conditions must be considered to determine if bowing convection will result in damaging surface winds. Evaluation of DCAPE is an important way to do so.

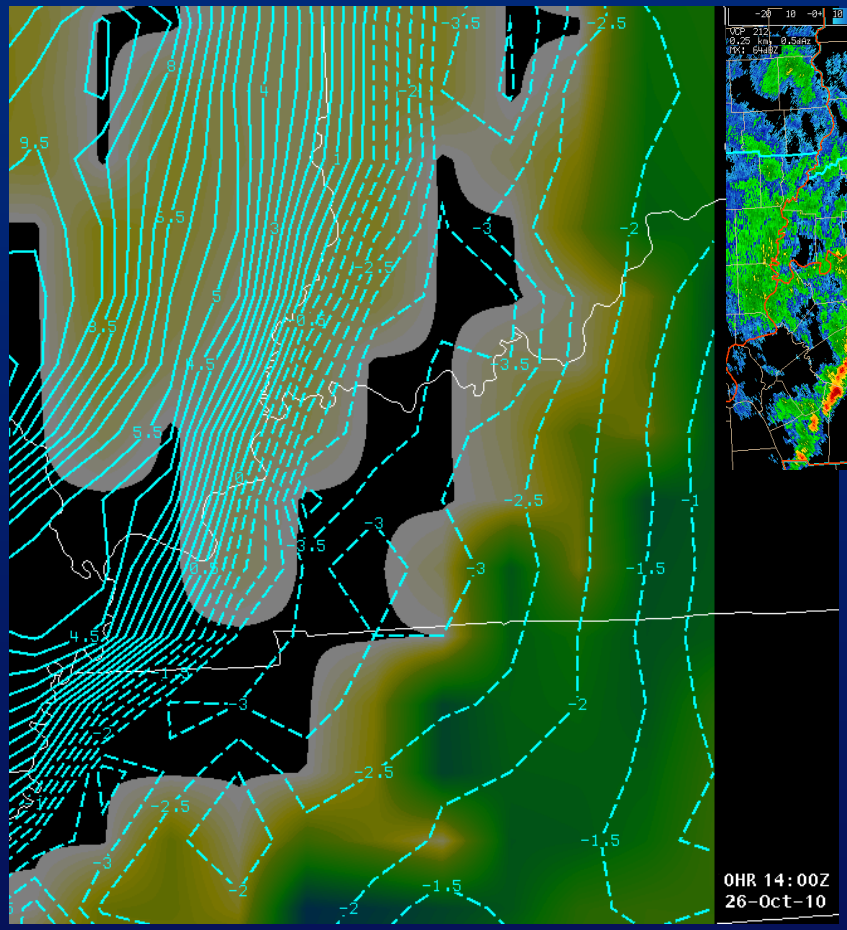
Aug 13, 2011 – KLVX 0.5° Base Velocity

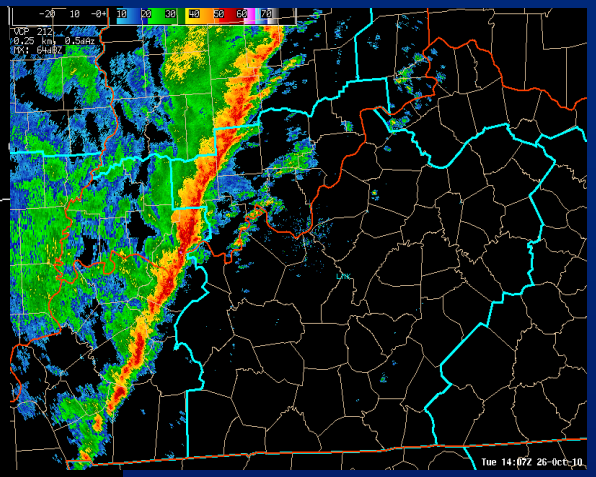


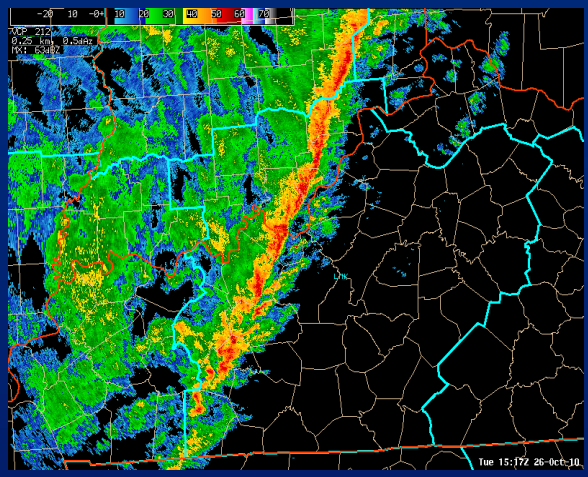


Retrieved base velocity data was over 70 kts just above the ground (small light blue inbound colors within white and bright green area) as a rear inflow jet (low-level wind maximum) associated with the thunderstorms moved from Crawford to Harrison Counties in south-central Indiana. The winds were along and behind the leading edge of the convection. As the storms moved into Louisville, 69 mph wind gusts occurred at Bowman Field. The small black circle in the lower right part of both images above is the NWS Doppler radar location at Ft. Knox (KLVX).

Model Analysis of Lifted Index and DCAPE on 26 Oct 2010







On 26 Oct 2010, a squall line moved across central Kentucky and southern Indiana producing sporadic reports of wind damage, but less so than the line and strong wind fields aloft suggested. However, very gusty gradient surface winds occurred ahead of the line.

- Along line: Modest instability (Lifted Index values -3; dashed blue lines) from southern IN to middle TN with minimal DCAPE values (image) < 10 J/kg (black) and soundings (not shown) nearly saturated
- Ahead of line: DCAPE much greater (yellow/green colors) with drier air aloft and steeper low-level lapse rates conducive to downward momentum transport
- Result: Very gusty gradient winds, even minor wind damage, occurred ahead of line, with lesser wind along the line, except where bowing cells were noted