

# A Potentially Valuable WSR-88D Severe Storm Pre-cursor Signature in Highly Dynamic, Low CAPE, High Shear Environments

Lyle Barker  
NOAA/NWS Lincoln Illinois

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# Reflectivity Tag WSR-88D Signature

- Associated with QLCS
- Evolve in a highly sheared, low/moderate CAPE, highly dynamic environment
- For the Midwest, these environments are most likely during the cool and transition seasons
- Best detected through the use of rapid looping

# F3 Tornado – Evansville Indiana Area

0739 – 0822 GMT Nov 6, 2005

- F3 tornado with estimated maximum winds of  $89 \text{ ms}^{-1}$  (200 mph)
- Path length of 66 km (41 miles) with maximum width of 460 m (500 yards)
- Twenty-Five fatalities and 200 injuries

# **F3 Tornado – Evansville Indiana Area**

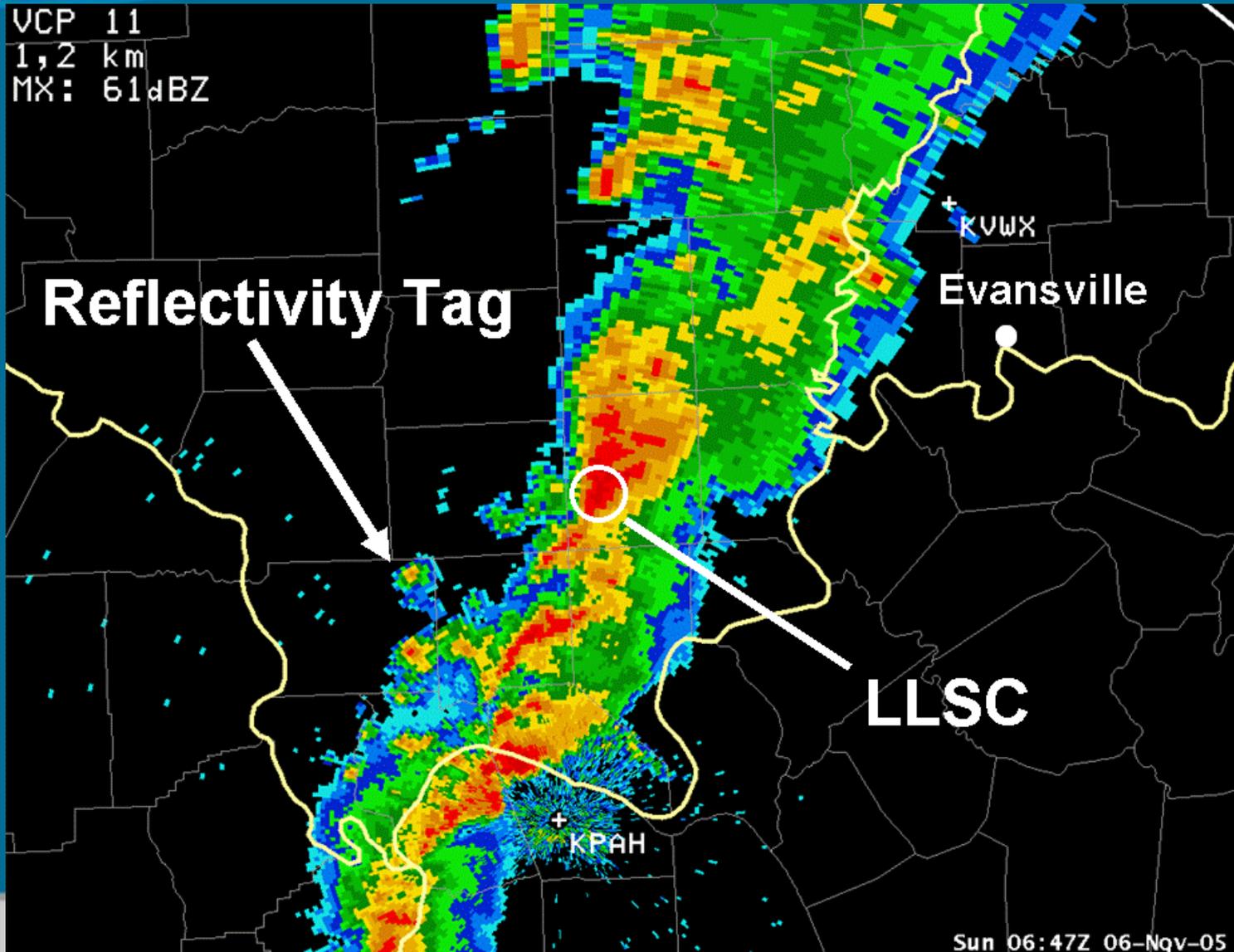
**0739 – 0822 GMT Nov 6, 2005**

- **Six tornadoes reported 0150 and 0500 GMT in southern Missouri and northern Arkansas**
- **Long-lived supercell embedded in QLCS crossed southern Illinois into western Kentucky/extreme southwestern Indiana between 0600 and 0730 GMT**
- **Evolving environment summarized by Wielgos and Spoden (2006), Davies (2006), and Spoden et al. (2006)**
  - **Approaching jet streak**
  - **Weak stable layer decoupling PBL**
  - **Enhanced low-level jet**
  - **Strong moisture advection ahead of QLCS**

Picture of damage in Evansville Indiana (NWS Paducah)

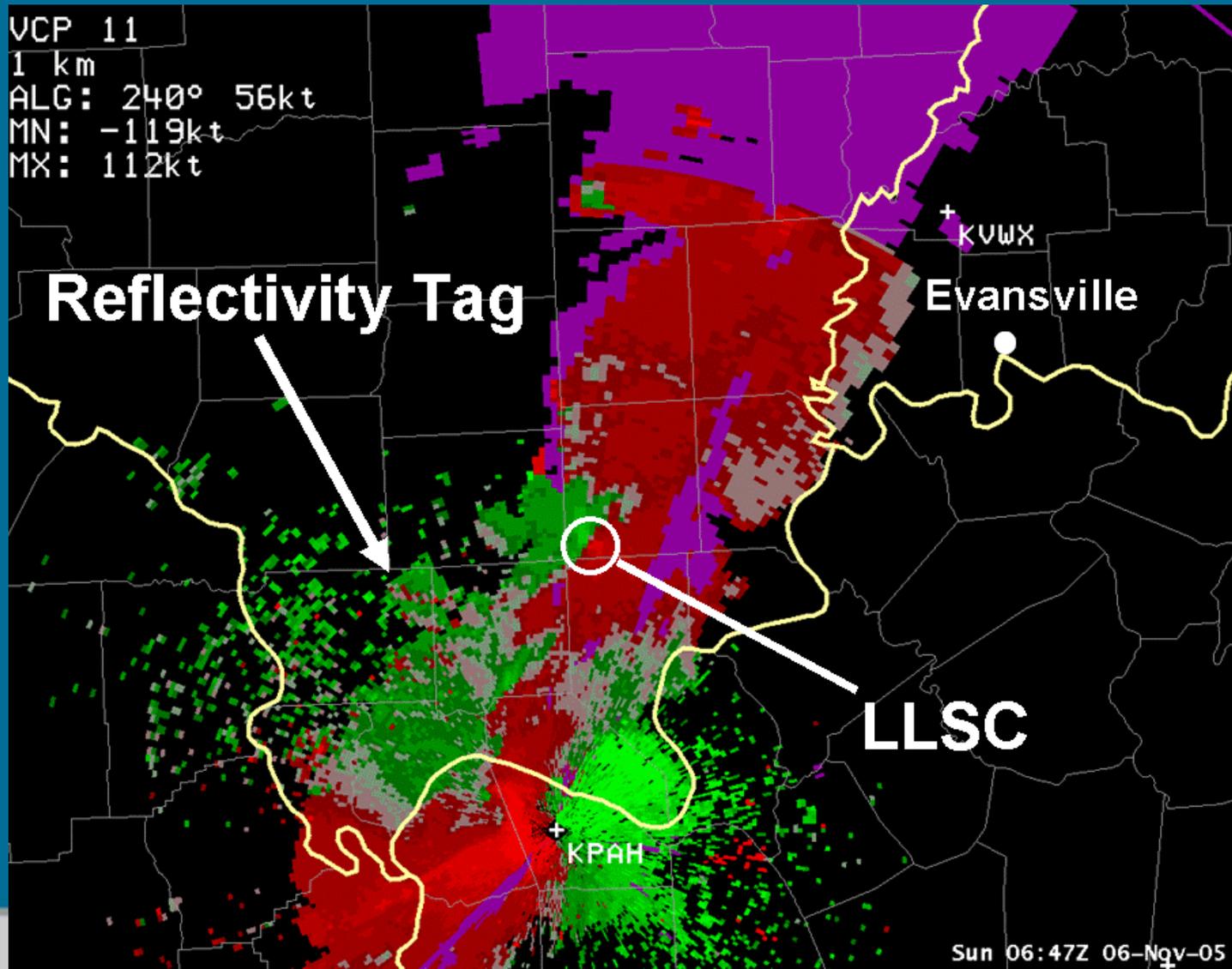
# KPAH 0.5 Degree Reflectivity Image

0647 GMT Nov 6, 2005



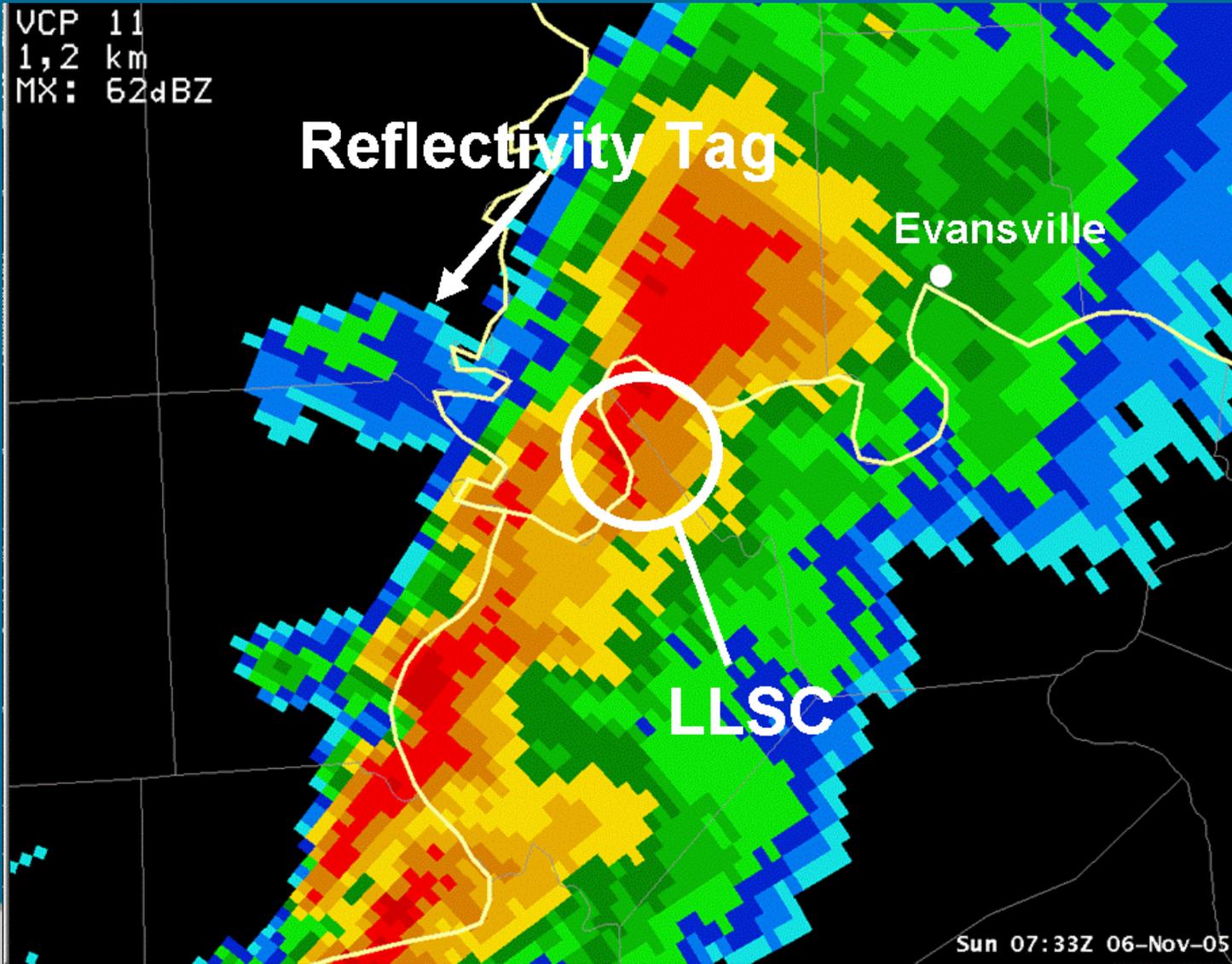
# KPAH 0.5 Degree SRM Image

0647 GMT Nov 6, 2005



# KPAH 0.5 Degree Reflectivity Image

0733 GMT Nov 6, 2005



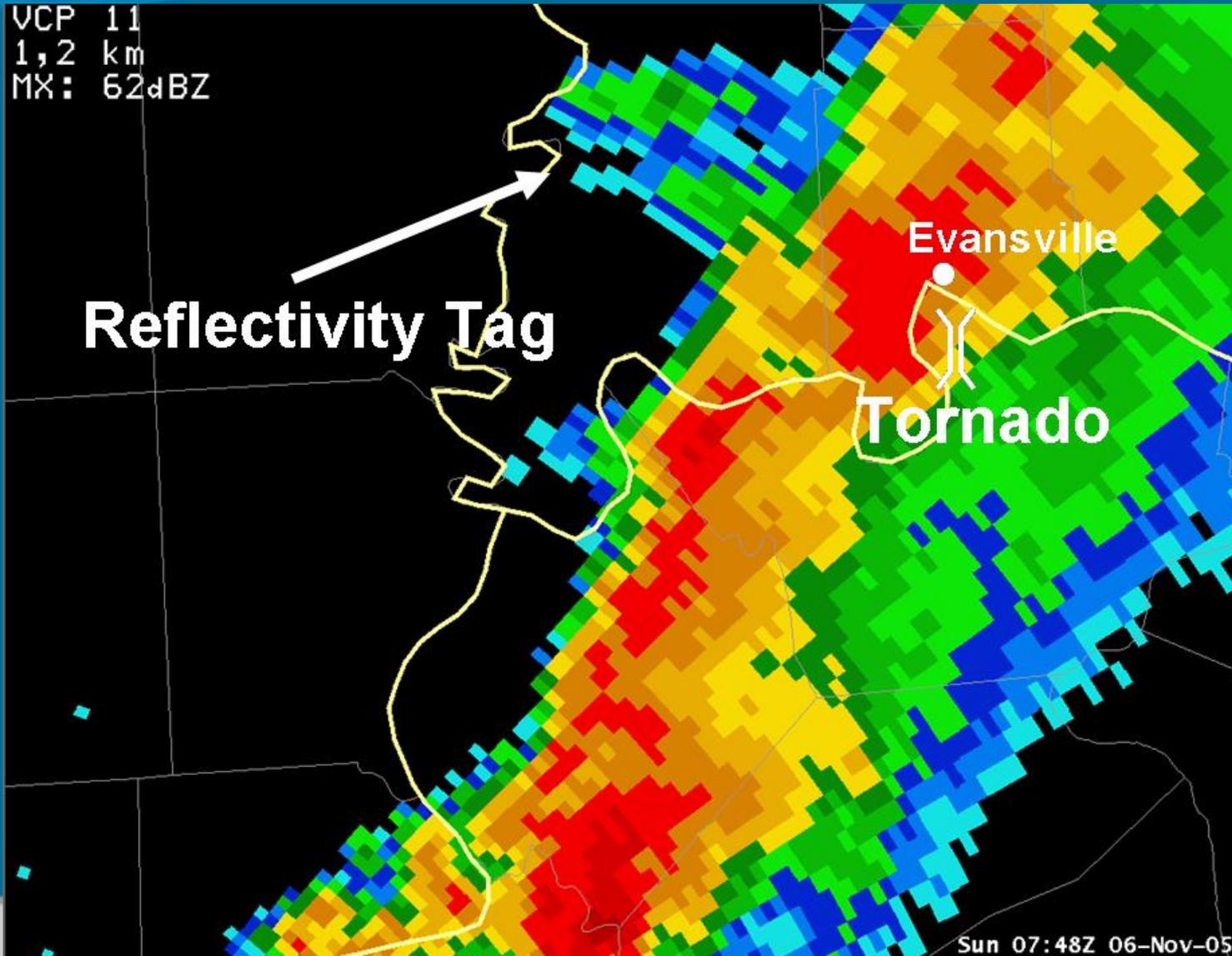
# KPAH 0.5 Degree SRM Image

0733 GMT Nov 6, 2005



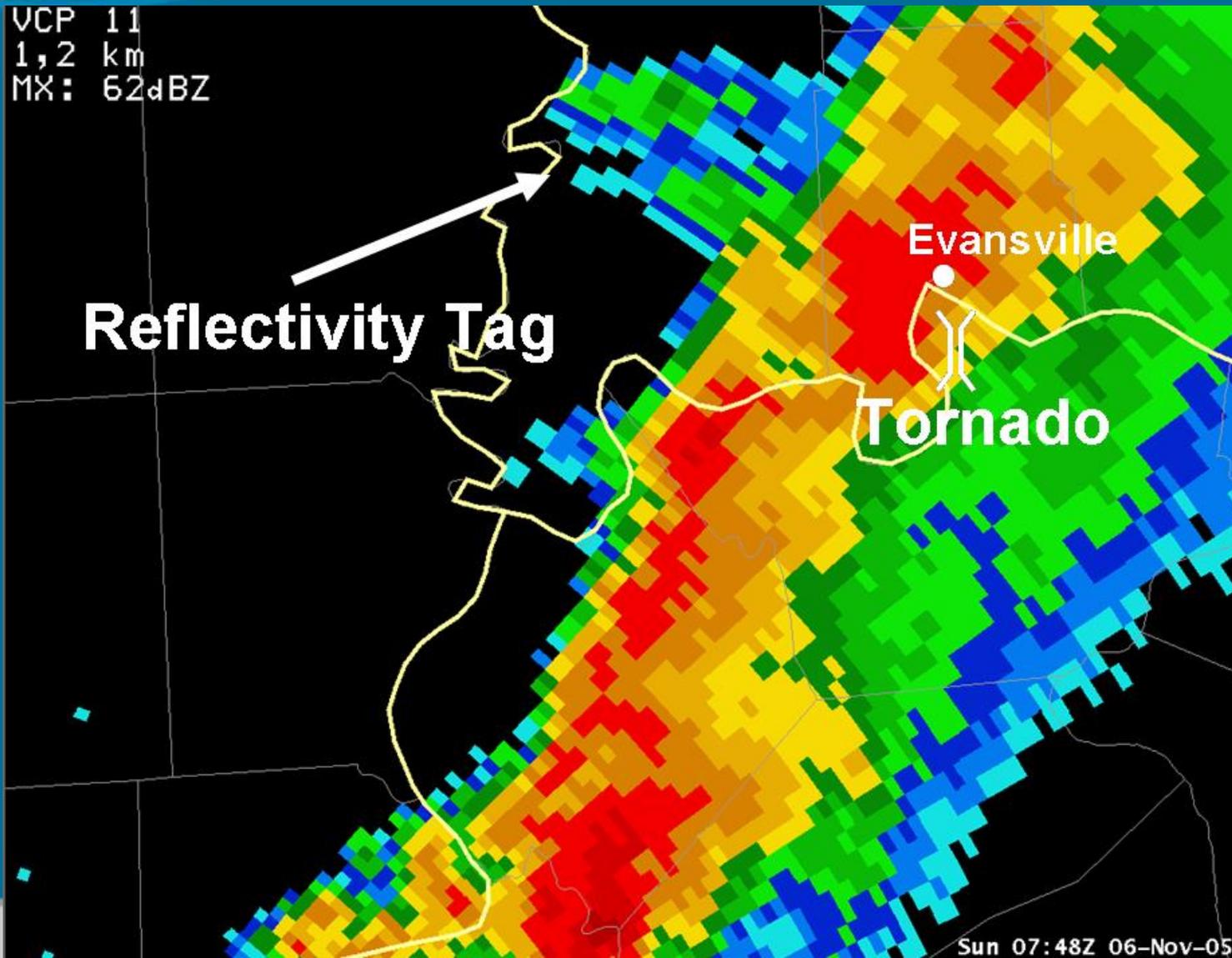
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0748 GMT Nov 6, 2005



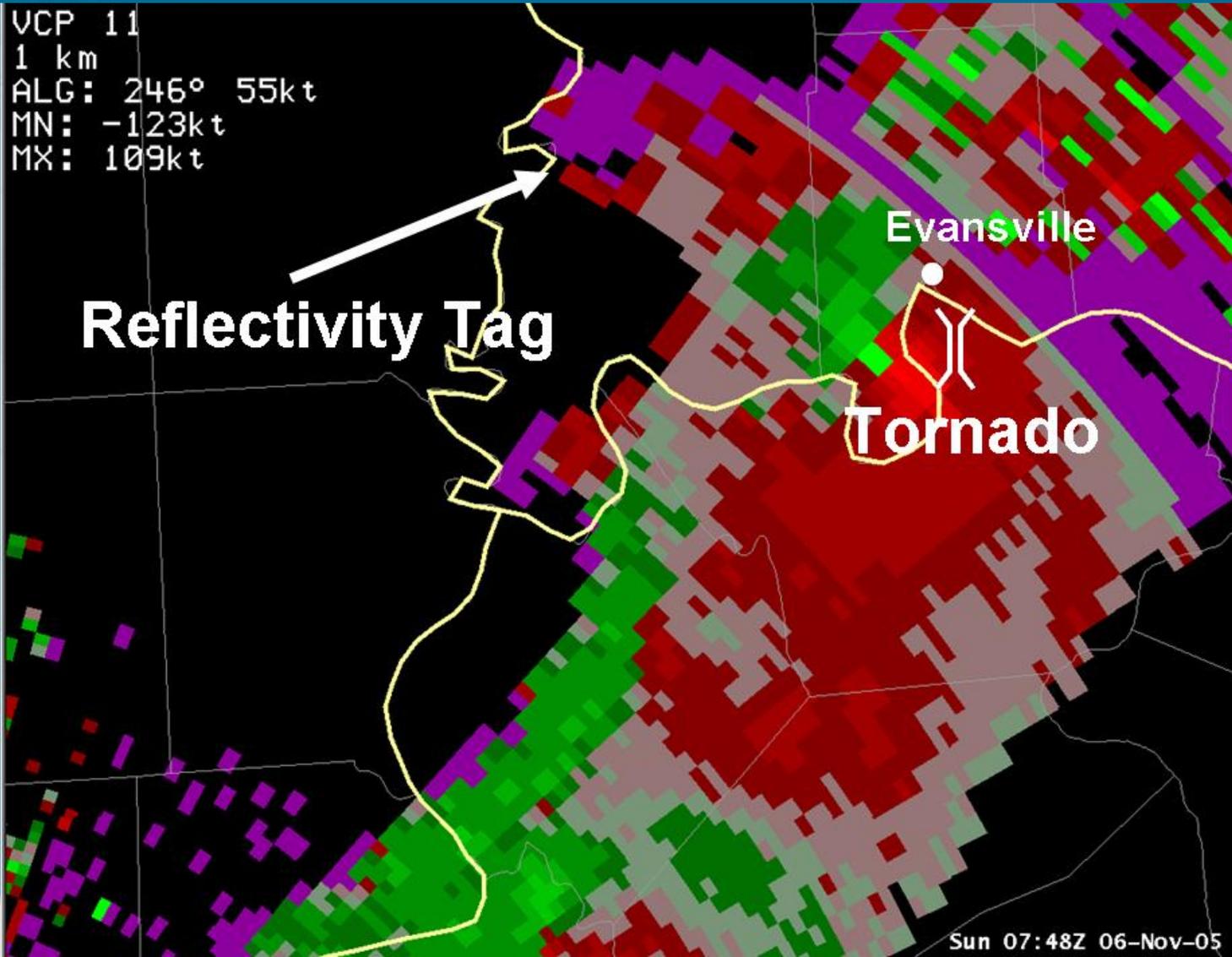
# KPAH 0.5 Degree Reflectivity Image

0748 GMT Nov 6, 2005



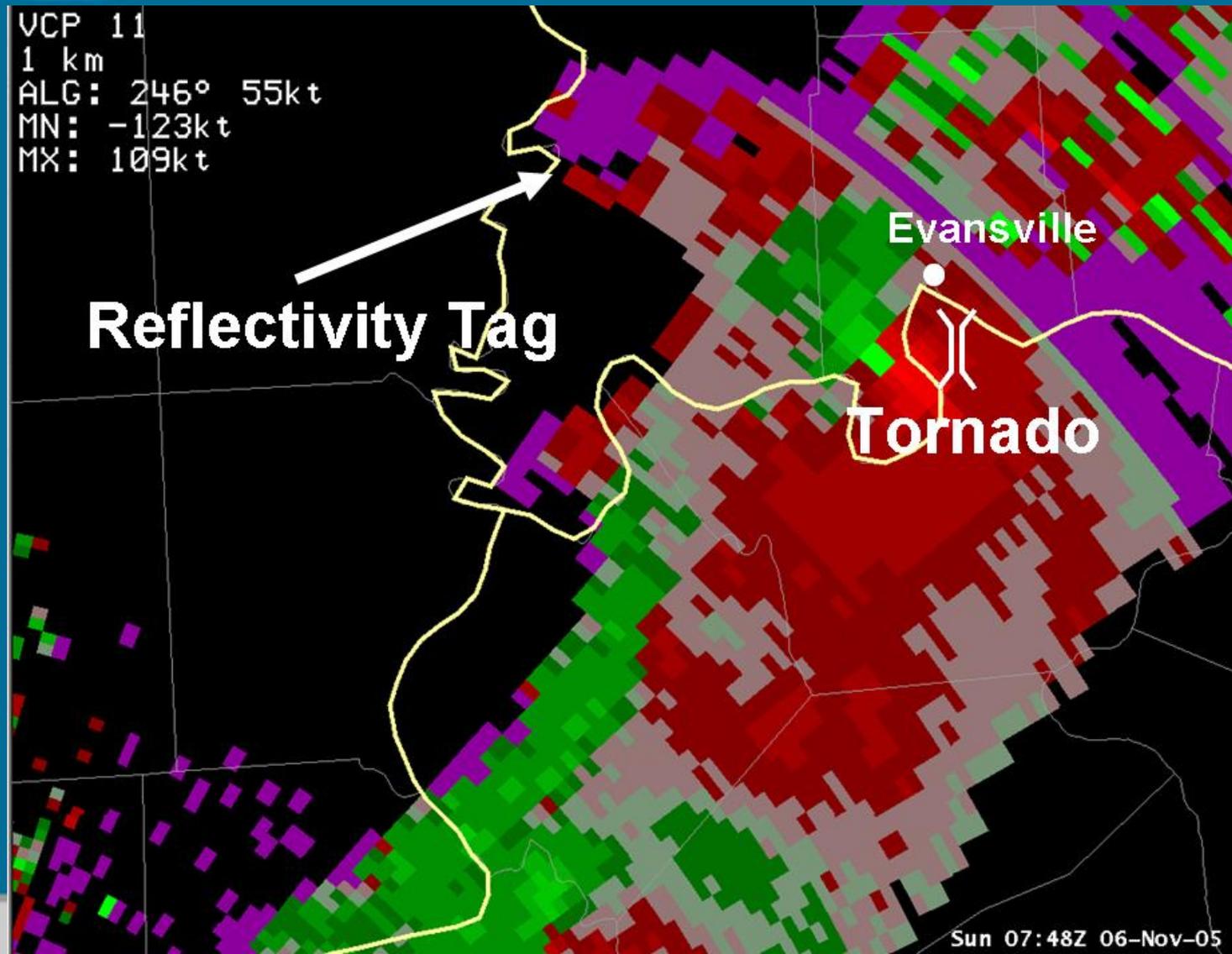
# KPAH 0.5 Degree SRM Image

0748 GMT Nov 6, 2005



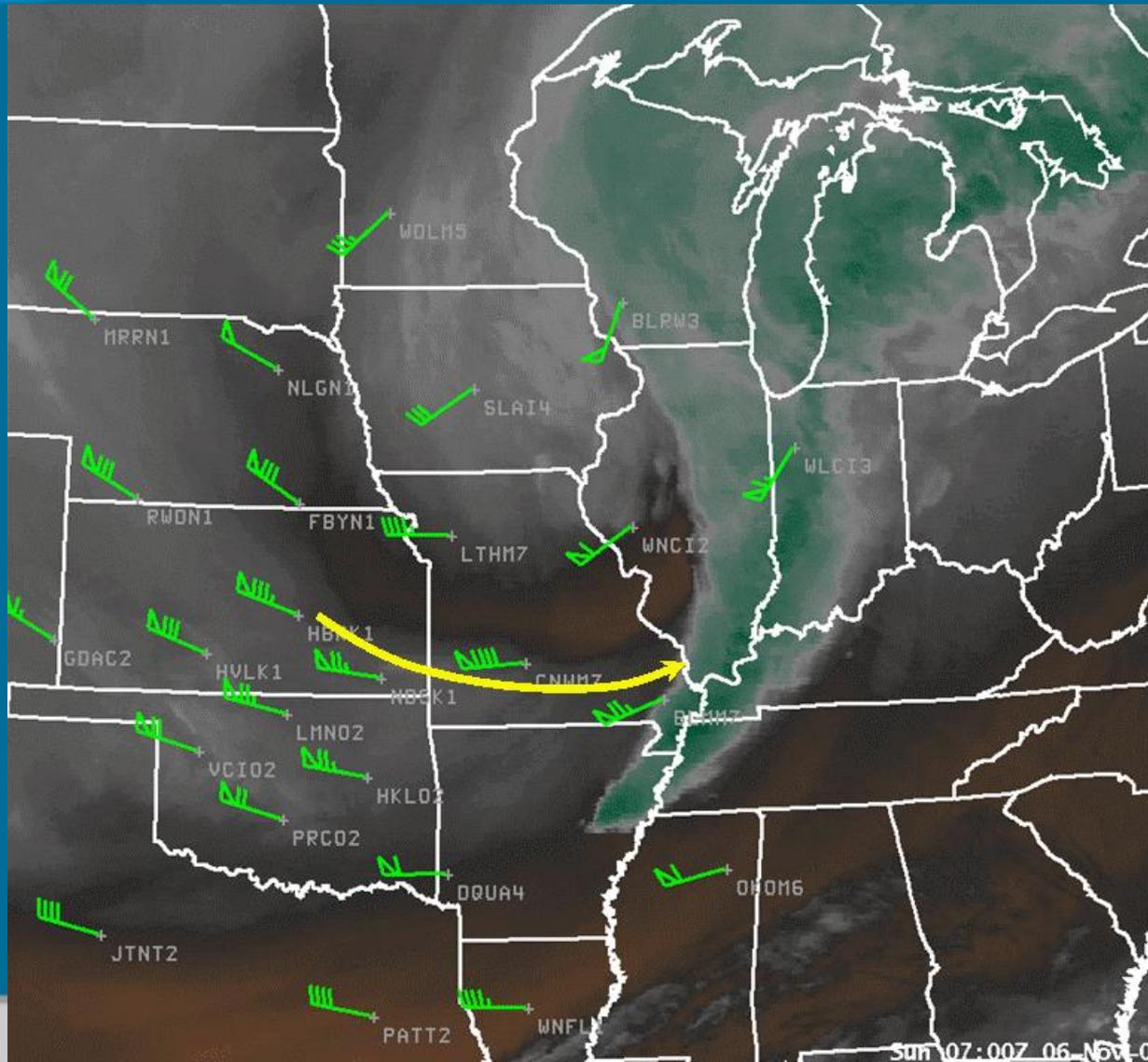
# KPAH 0.5 Degree SRM Image

0748 GMT Nov 6, 2005



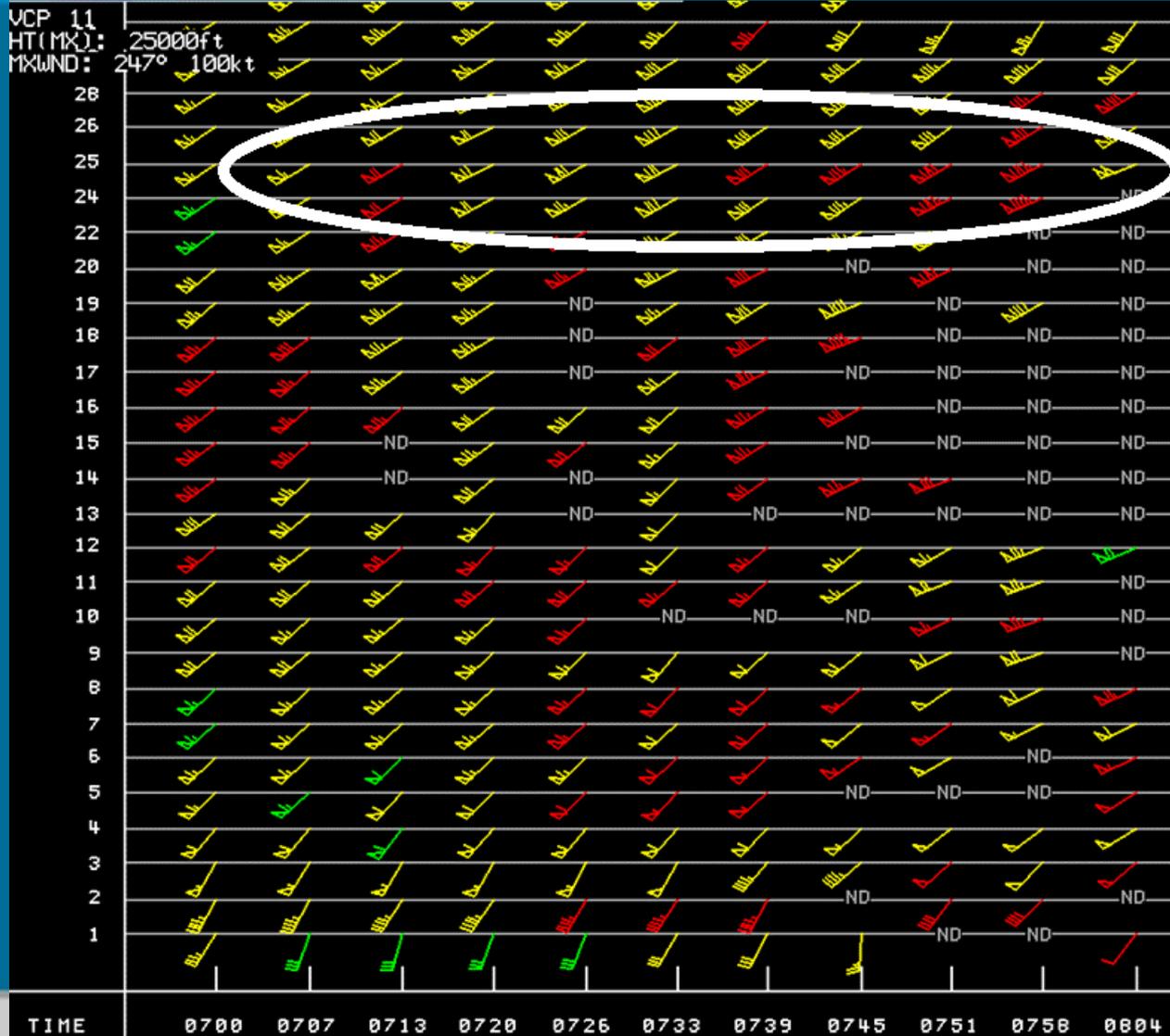
# GOES 6.7 um Image and 400 hPa Profilers

0700 GMT Nov 6, 2005



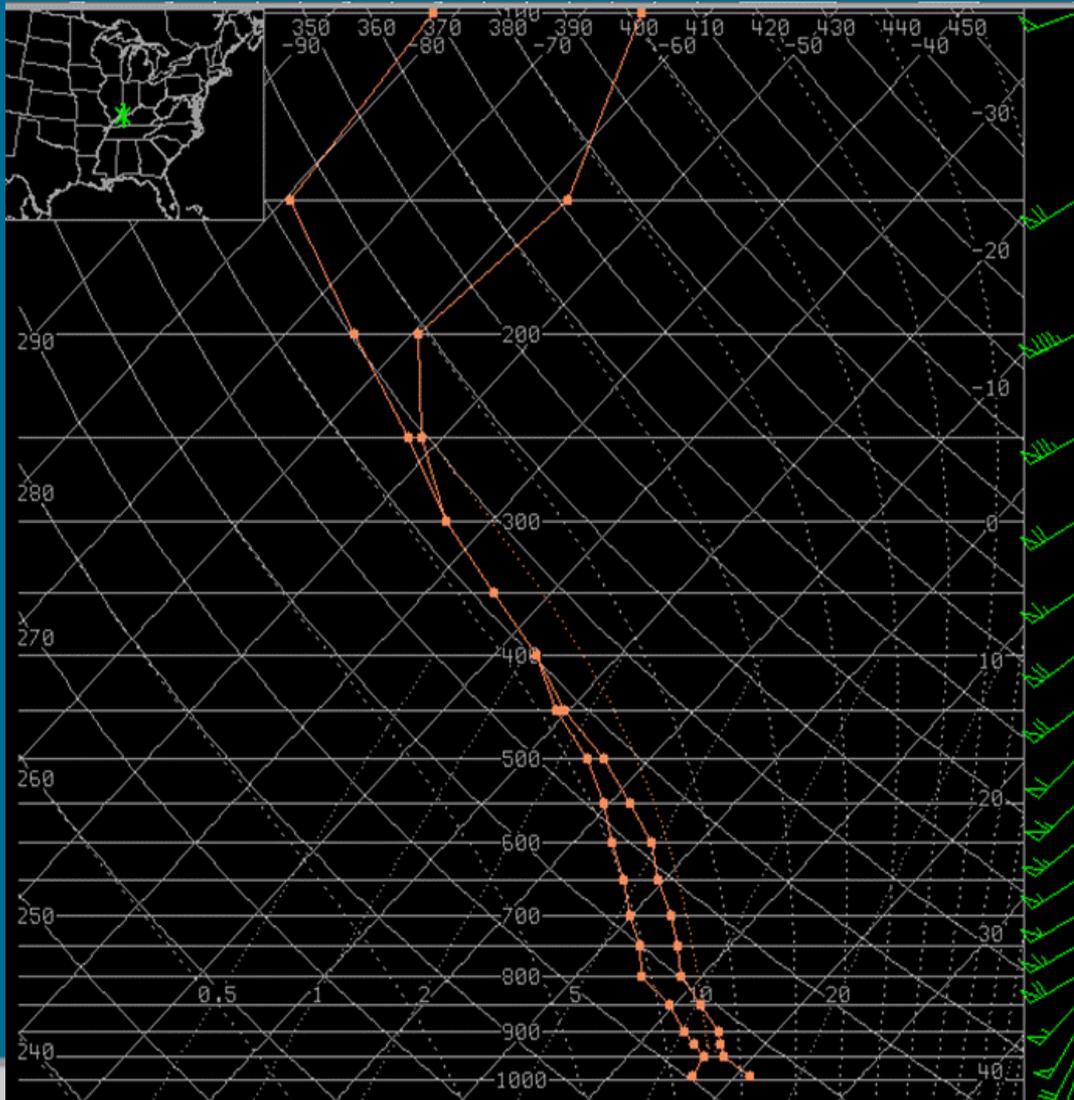
# KVWX WSR-88D VAD Wind Profile

0700-0804 GMT Nov 6, 2005



# LAPS Evansville Vicinity Sounding

0700 GMT Nov 6, 2005



Skew-T Parameters

LAPS ptD 38.0N 87.5W 11/06/05 0700Z

based on a PMAX Lift

Precipitable Water= 1.43 in  
K-Index= 32  
Totals Index= 49  
Sweat Index= 313  
Dry Microburst Pot= 2: Gusts < 30 kts  
Freezing Level= 11705 ft ASL  
Wet-bulb Zero Hgt= 10914 ft ASL  
0-6 km Avg Wind dir/spd= 230/54 kts  
0-6 km Stm Motion (30R75)= 260/40 kts  
0-3 km Stm Rel Helicity= 579 m<sup>2</sup>/s<sup>2</sup>  
Forecast Max Temp= 78 F  
Trigger Temp= 24 C/75 F  
Soaring Index= NA  
MDPI/WINDEX= 0.21 /16 kts

- Parcel Data -

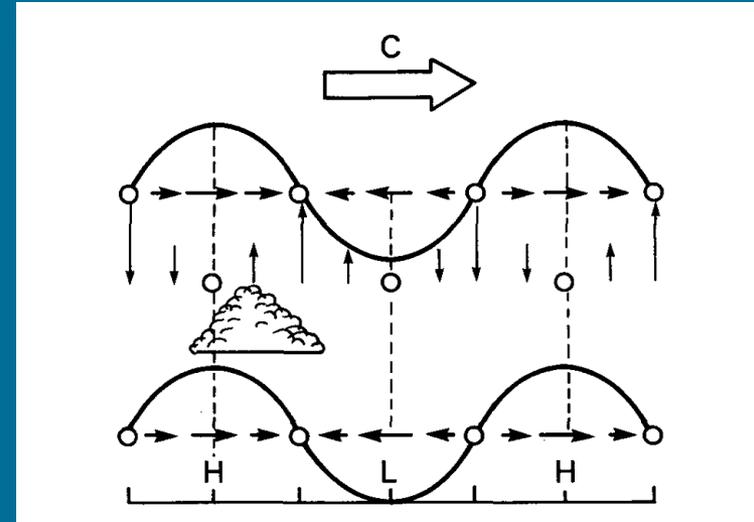
Initial Parcel Pressure= 989 mb  
Initial Parcel T/Td= 70/62 F  
Initial Parcel T/Td= 21/17 C  
Convective Temp= 75 F  
Lifted Index= -2.62  
CCL= 3322 ft ASL/894 mb  
LCL= 2311 ft ASL/928 mb  
LFC= 4511 ft ASL/857 mb  
LFC2= NA  
Max Hailsize= 5.92 cm/2.33 in  
Max Vertical Velocity= 36 m/s  
Equilibrium Level= 35023 ft ASL/245 mb  
Approximate Cloud Top= 43963 ft ASL  
Positive Energy Above LFC= 886 J/kg  
Negative Energy Below LFC= -19 J/kg

# Contributing Physical Processes

- The Reflectivity Tag signature at the very least represents an area of enhanced lift moving along the QLCS
- One possible process contributing to the change in storm character is the rapidly increasing jet-level winds
  - Provides enhanced outflow in the upper portions of the storm
  - Resultant increase in updraft vertical velocity
    - Leads to storm intensification and a contracting circulation
    - May lift and diminish the impact of the weak low-level stable layer enabling the PBL to interact with the free atmosphere
    - The breakdown in the stable layer enables the change in storm mode from elevated to surface-based.

# Contributing Physical Processes

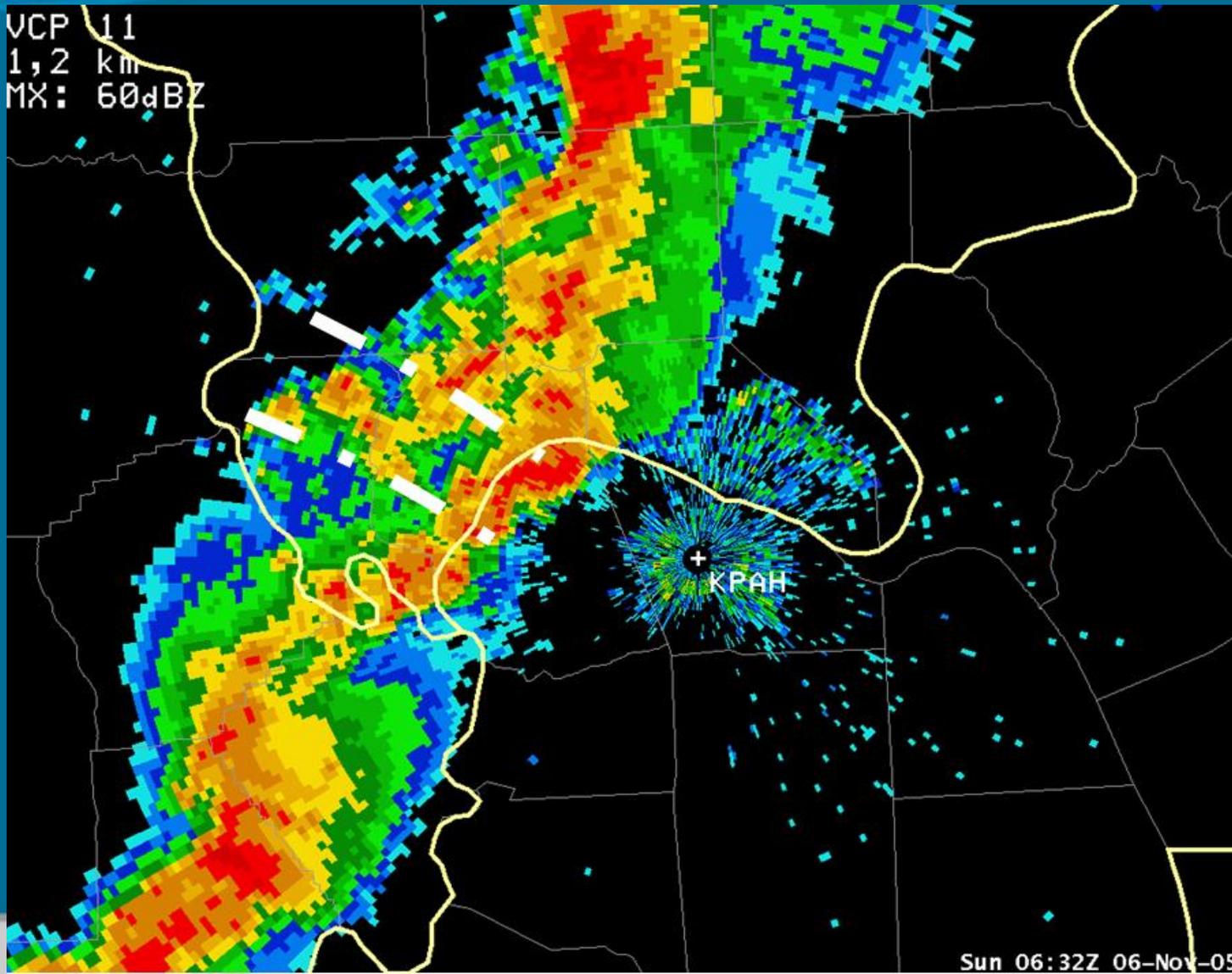
- Wave-like structure of signatures possibly due to meso-scale gravity waves
  - Although, Jewett et al. (2003), Koch and Saleeby (2001), Stobie et al. (1983) and others have highlighted meso-scale gravity wave-convective storm interaction, the process has not been emphasized within the operational convective warning community
  - Coleman and Knupp (2006) provide a discussion of current theories with regard to this interaction
  - If this is the case, evidence of convergence/divergence or wind shift couplets in WSR-88D data may be evident



Schematic illustration of the height variation in the phase relations between the horizontal wind component and wave-induced vertical motions (From Koch et al., 1993)

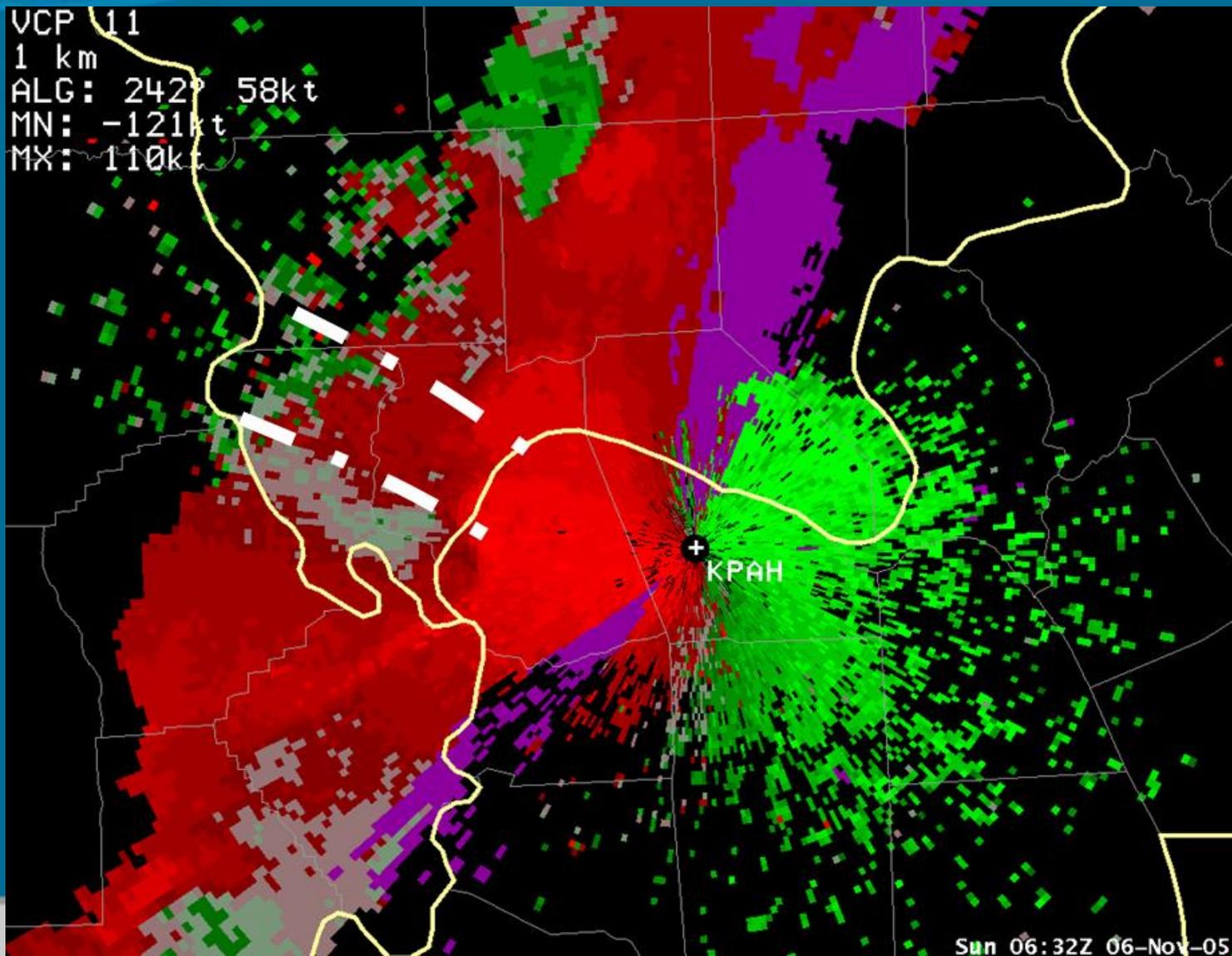
# KPAH 0.5 Degree Reflectivity Image

0632 GMT Nov 6, 2005



# KPAH 0.5 Degree SRM Image

0632 GMT Nov 6, 2005



# F1 Tornado – Jasper County Illinois

2115-2123 GMT Nov 15, 2005

- F1 Tornado with estimated maximum winds of 40 to 44.5  $\text{ms}^{-1}$  (90 to 100 mph)
- Path length of 16 km (10 miles) and width of 27 to 46 m (30 to 50 yards)
- Three homes and eleven outbuildings damaged

11 16 2005

# F1 Tornado – Jasper County Illinois

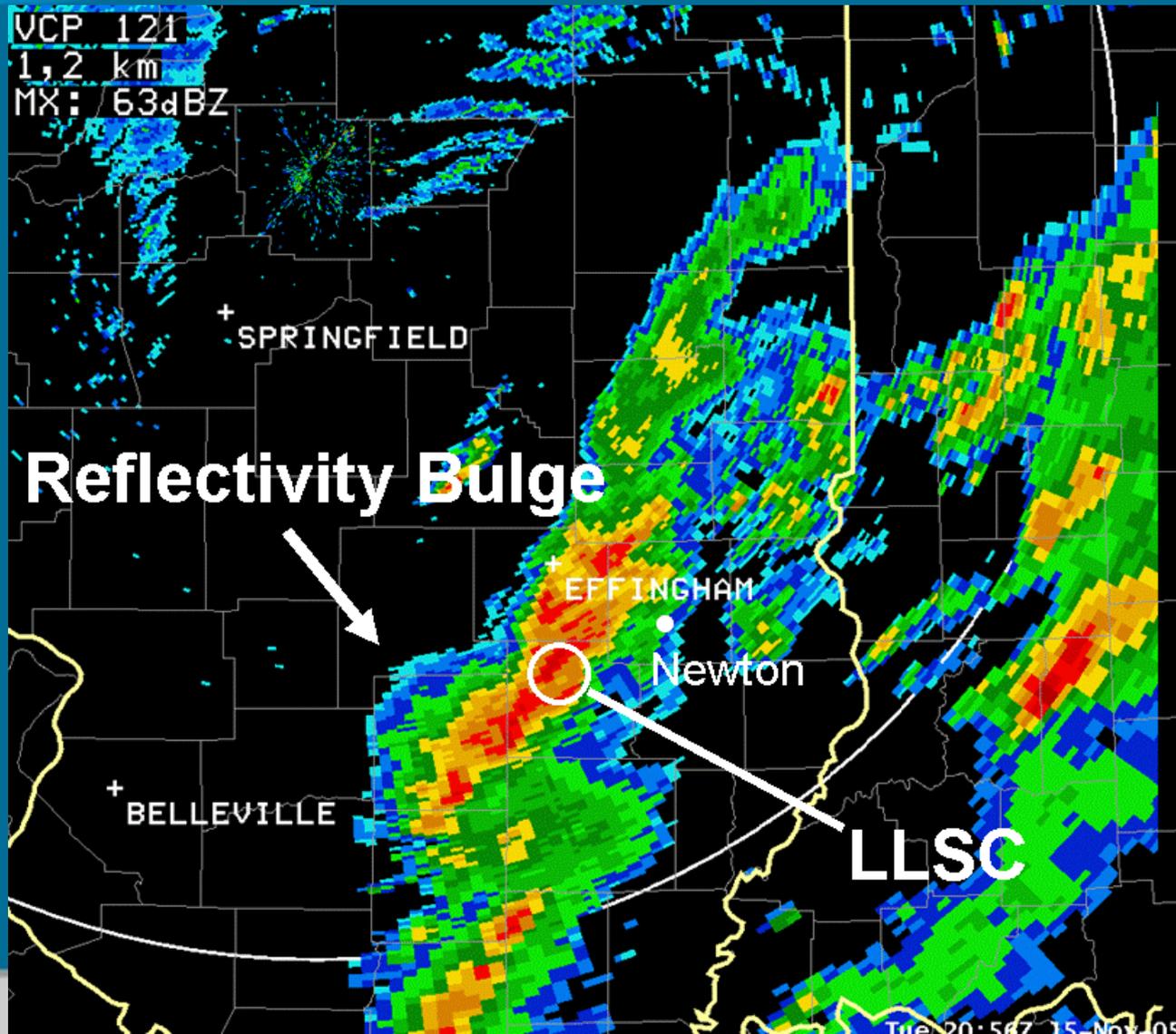
2115-2123 GMT Nov 15, 2005

- Although 50+ tornadoes occurred across Arkansas into the Ohio and Tennessee Valleys on November 15<sup>th</sup> 2005, the Newton Illinois tornado was the only tornado confirmed in the far northern segment of the QLCS
- A Reflectivity Bulge appeared over south central Illinois and moved northeast along the QLCS eventually interacting with a previously rotating storm

11 16 2005

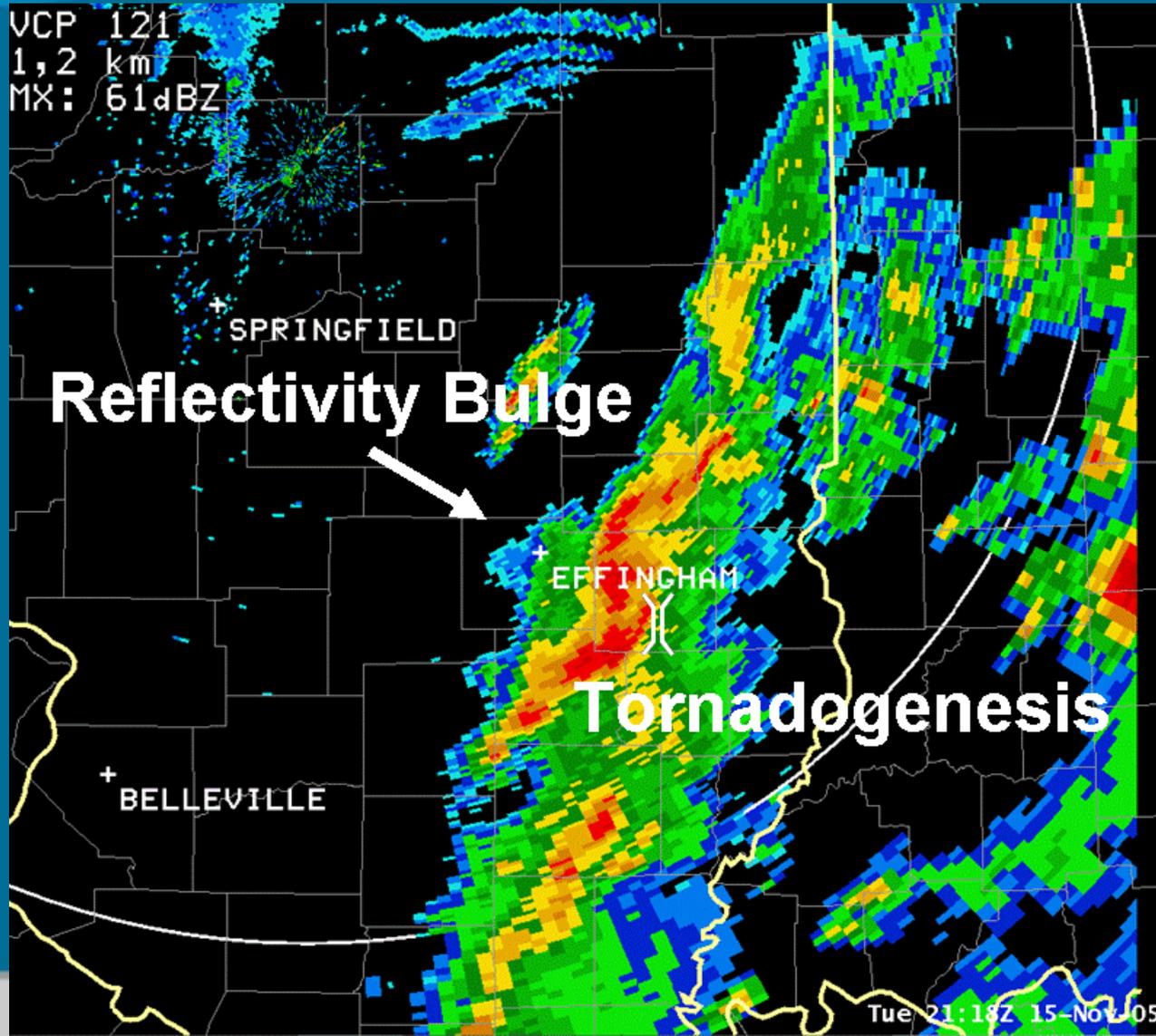
# KILX 0.5 Degree Reflectivity Image

2056 GMT Nov 15, 2005



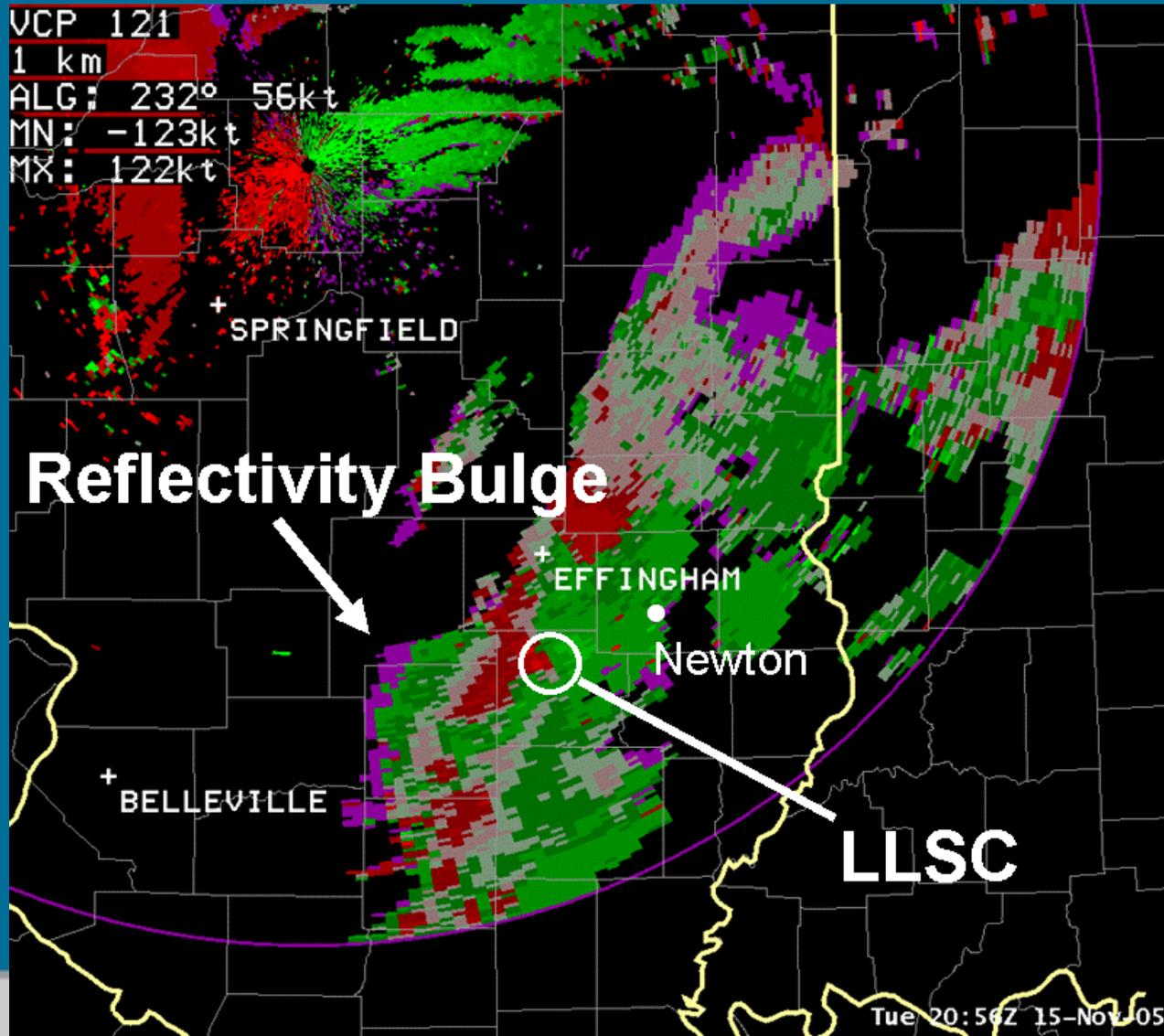
# KILX 0.5 Degree Reflectivity Image

2118 GMT Nov 15, 2005



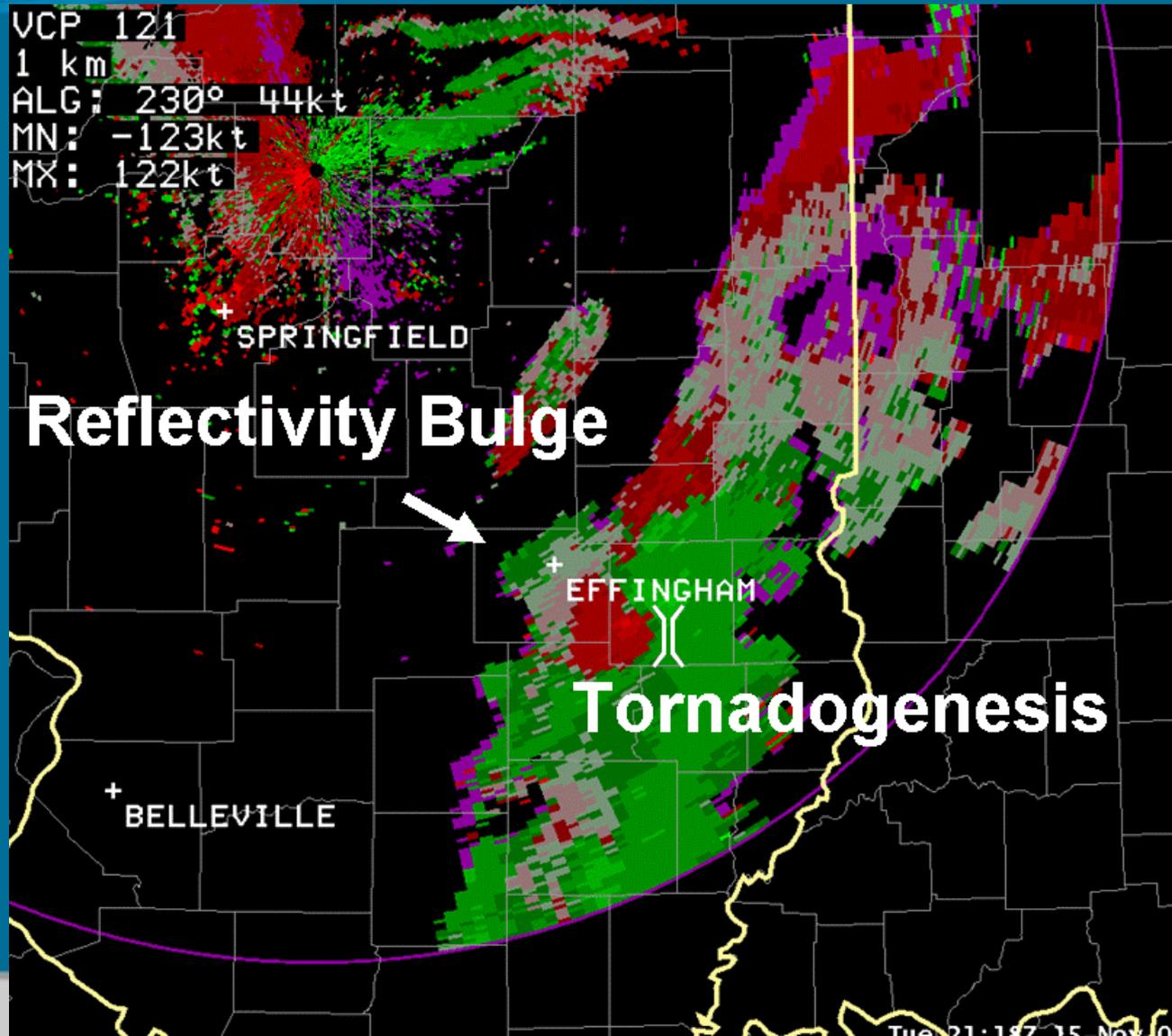
# KILX 0.5 Degree SRM Image

2056 GMT Nov 15, 2005



# KILX 0.5 Degree SRM Image

2118 GMT Nov 15, 2005



# Microburst Wind Damage

## Saybrook Illinois

0940 GMT March 13, 2006

- **Building in downtown Saybrook collapsed**
- **Several other nearby buildings damaged**
- **Debris path was five blocks wide and was comprised mostly of tree damage**
- **Survey estimated wind speeds of 31 ms<sup>-1</sup> (70 mph)**

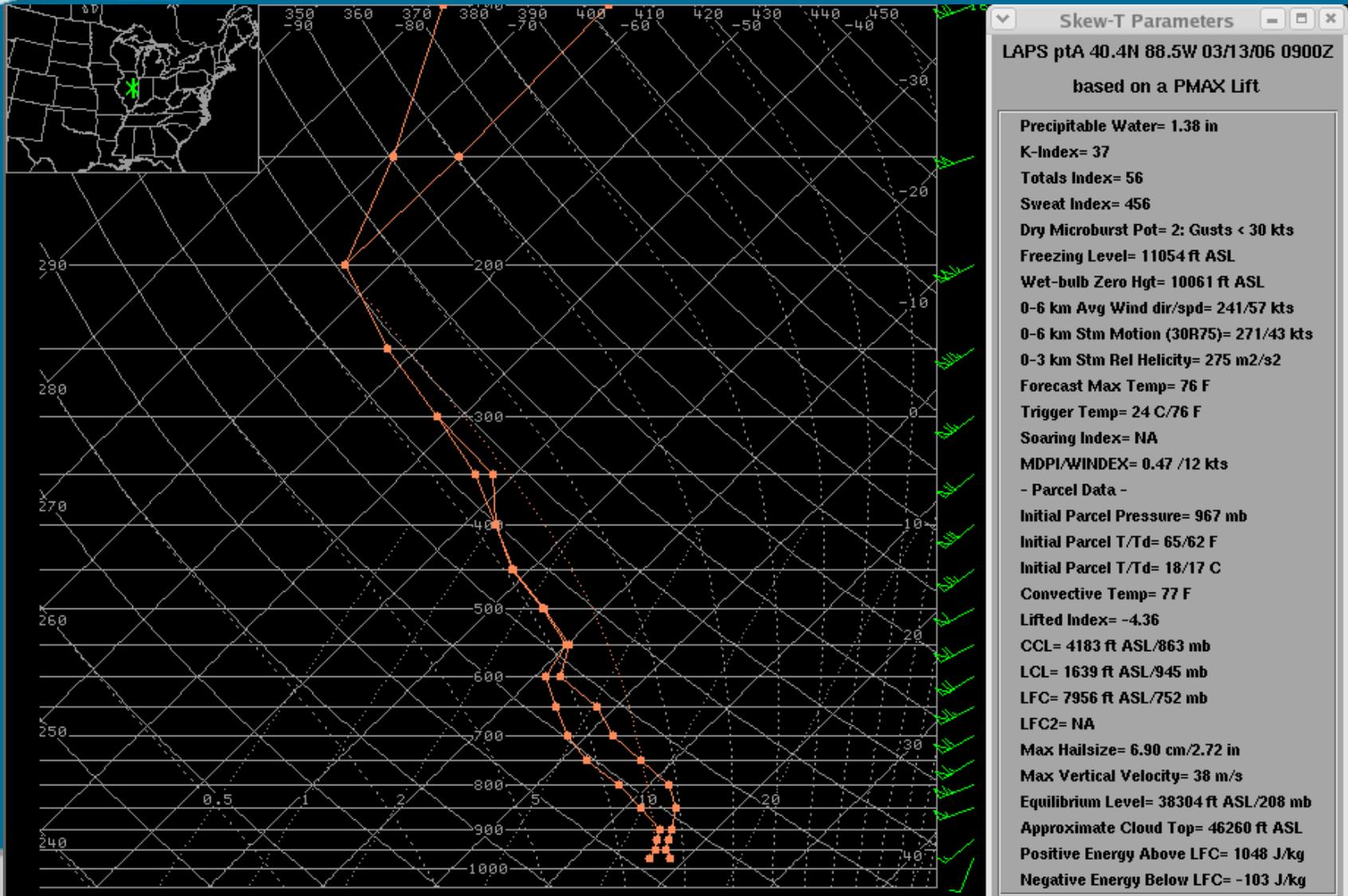
# Microburst Wind Damage Saybrook Illinois

0940 GMT March 13, 2006

- **Nine tornadoes touched down in central Illinois between 0030 and 0325 GMT**
  - associated with an isolated supercell
  - Longest track was a tornado with F2 damage that hit Springfield Illinois
  - Tornado had continuous 106 km (66 mile) path
- **A QLCS developed overnight associated with a cold front and jet streak**
  - Numerous non-tornadic wind reports of greater than  $25 \text{ ms}^{-1}$  were reported from Springfield Illinois to Decatur Illinois associated with a bow echo in the QLCS between 0835 and 0932 GMT
  - Northern segment of QLCS initially appeared benign
  - Microburst at Saybrook Illinois occurred as Reflectivity Tag interacted with developing bow echo.

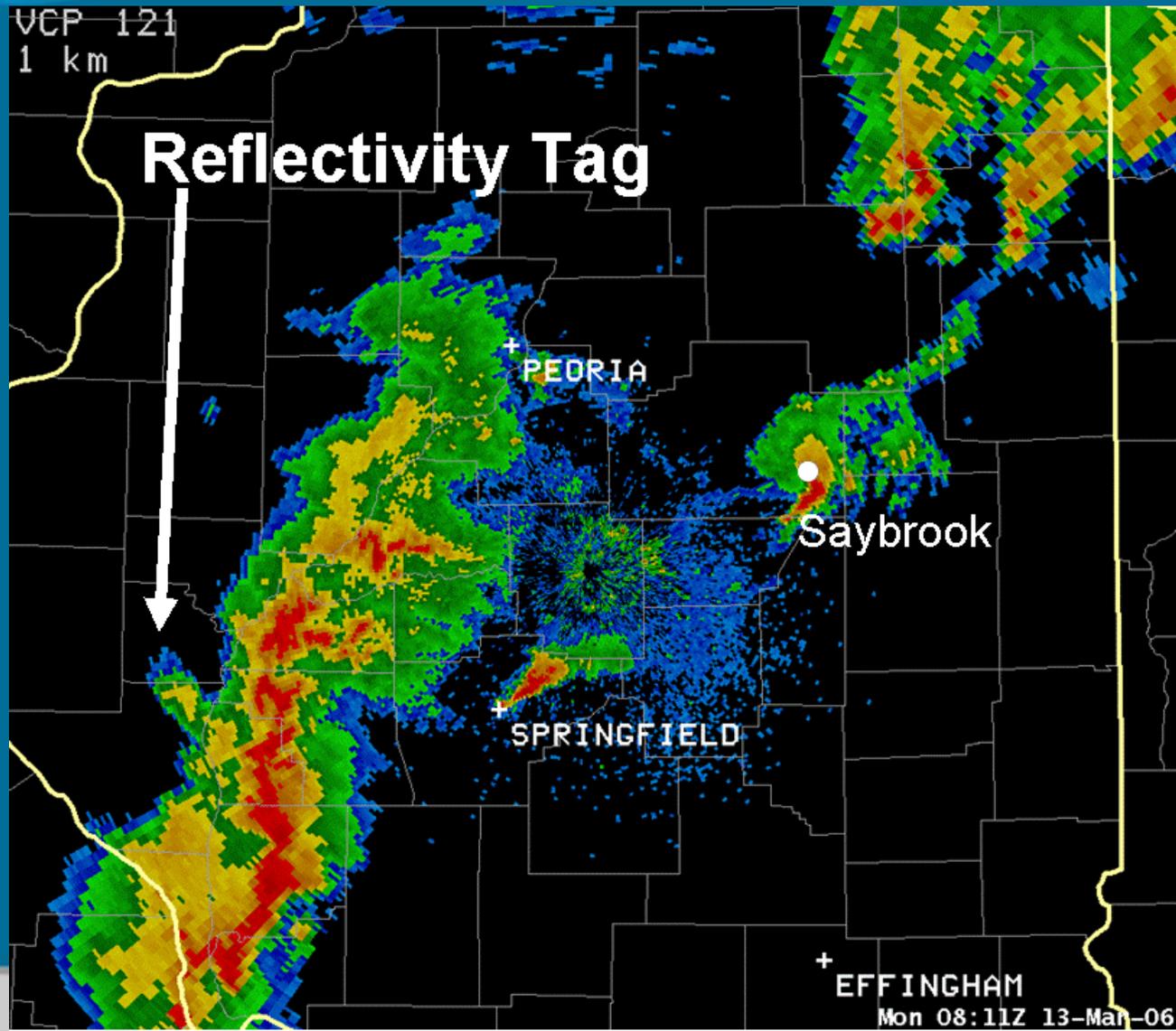
# LAPS Saybrook Vicinity Sounding

0900 GMT March 13, 2006



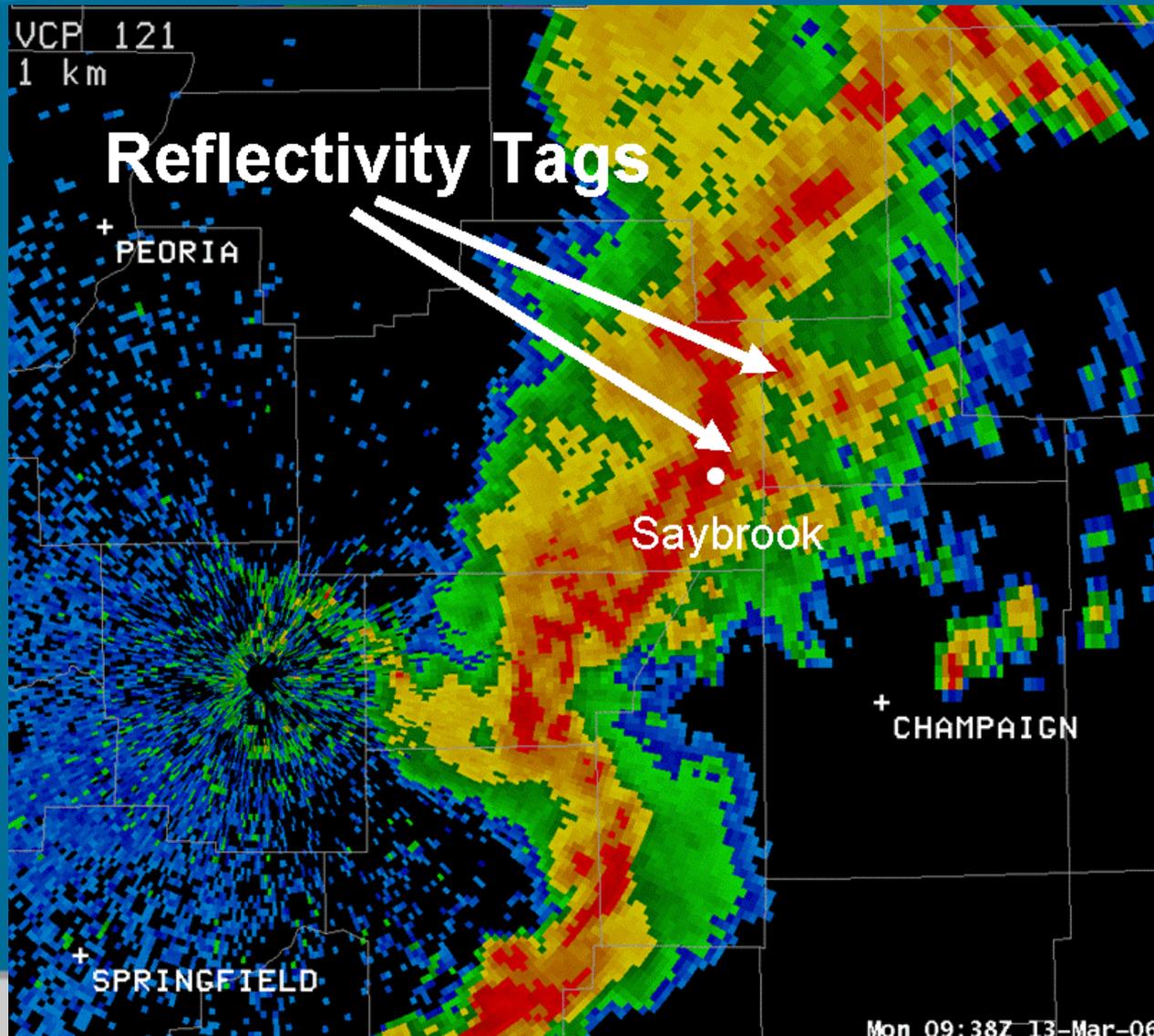
# KILX 0.5 Degree Reflectivity Image

0811 GMT March 13, 2006



# KILX 0.5 Degree Reflectivity Image

0938 GMT March 13, 2006



# Reflectivity Tag WSR-88D Signature

- Since WSR-88D upgrades in 2004, improvements in real-time data and temporal resolution have enabled NWS Central Illinois Warning Meteorologists to increasingly detect a radar signature, the “Reflectivity Tag”, when monitoring QLCS in highly sheared, low/moderate CAPE, highly dynamic environments
- Five of seven cool or transition season severe weather events investigated since 2004 in the central Midwest exhibit this signature concurrent with a subset of severe weather reports
- This is not a “stand-alone” signature due to a significant false alarm rate. It is additional input into the warning decision making process and can be used as a storm triage tool to identify areas in need of further investigation
- The signature is being utilized successfully in real-time operations (September 22, 2006)
- Further research will expand the dataset by looking at additional events beyond the central Midwest and prior to 2004

# Acknowledgements

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