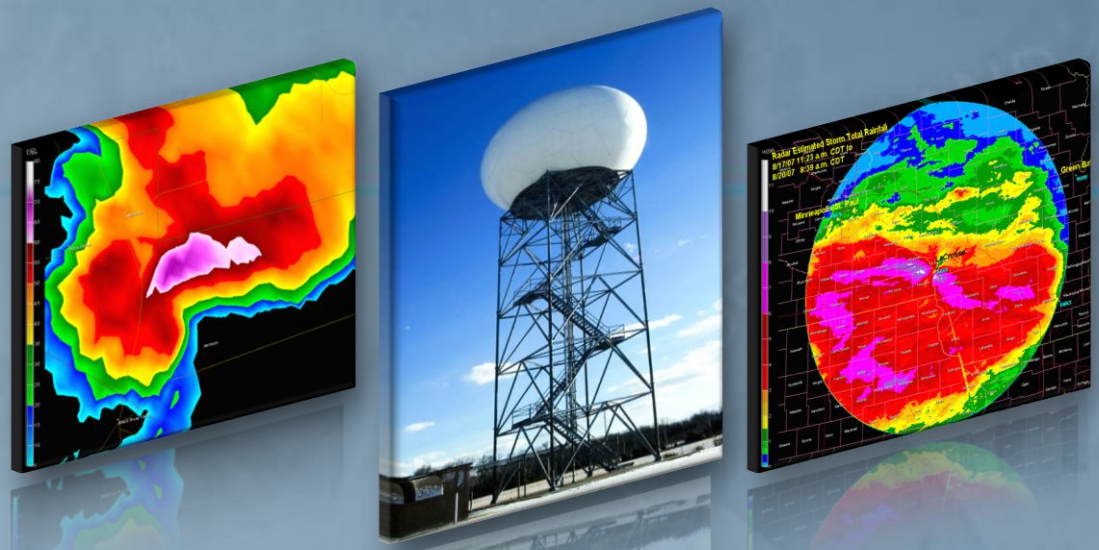


Doppler Radar Basics

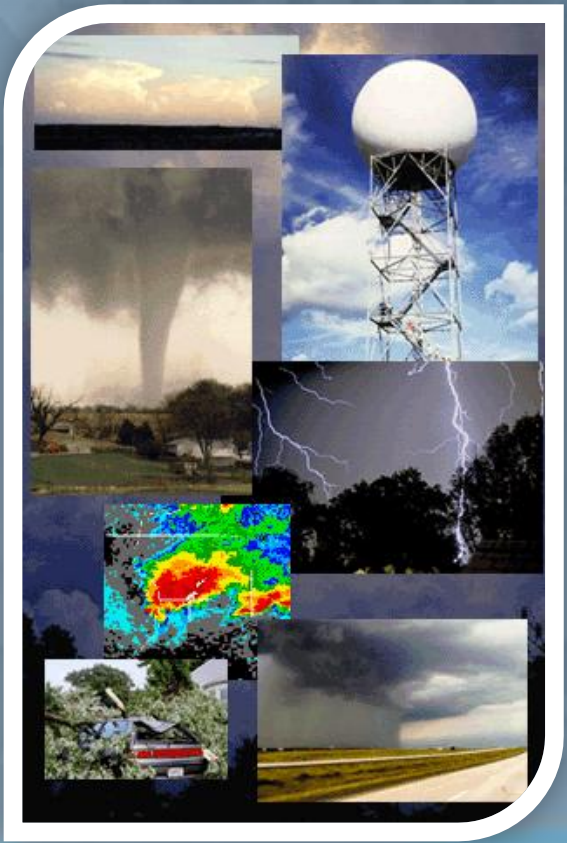
Todd J. Shea

NOAA/NWS La Crosse

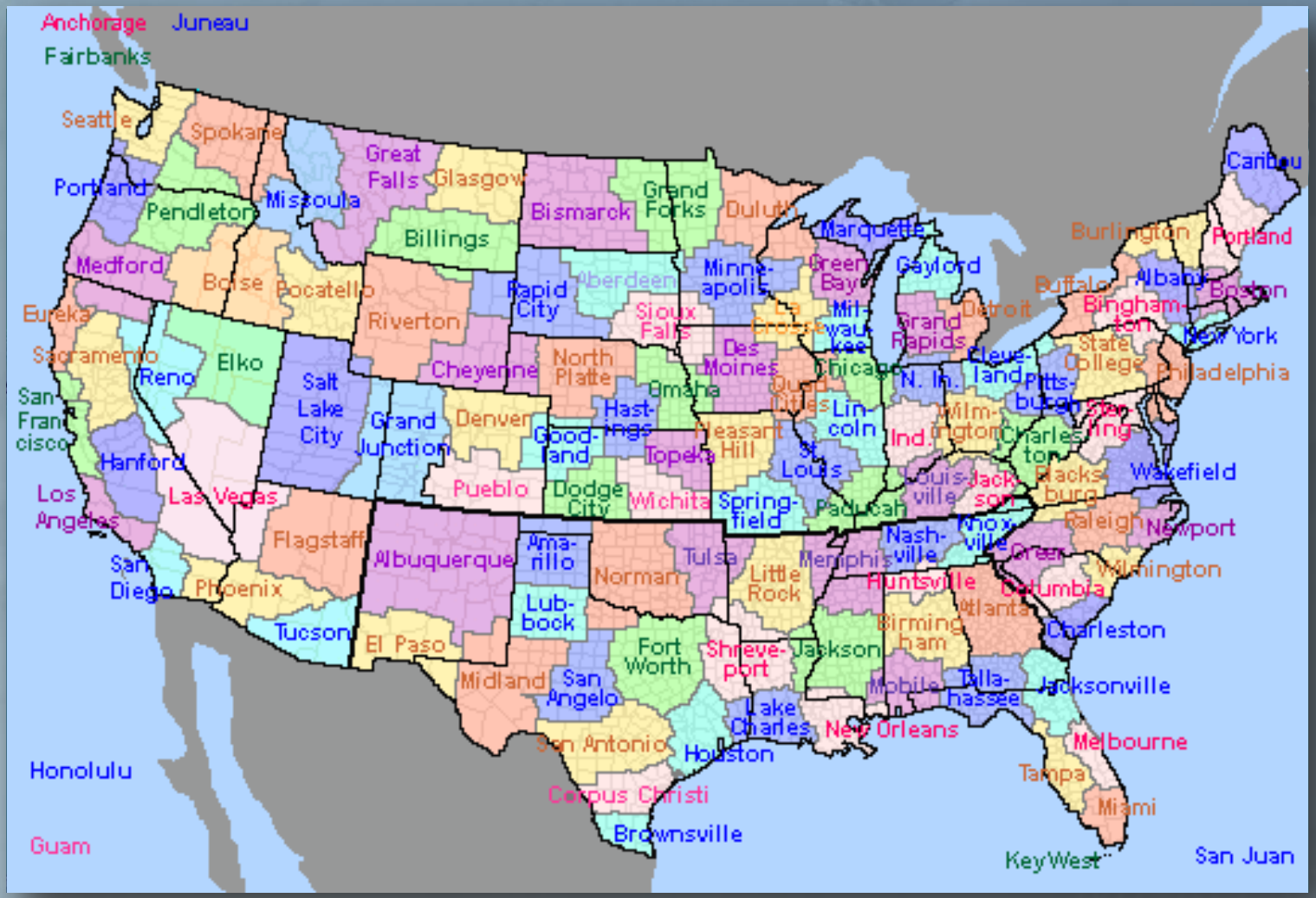
April 17, 2008

National Weather Service

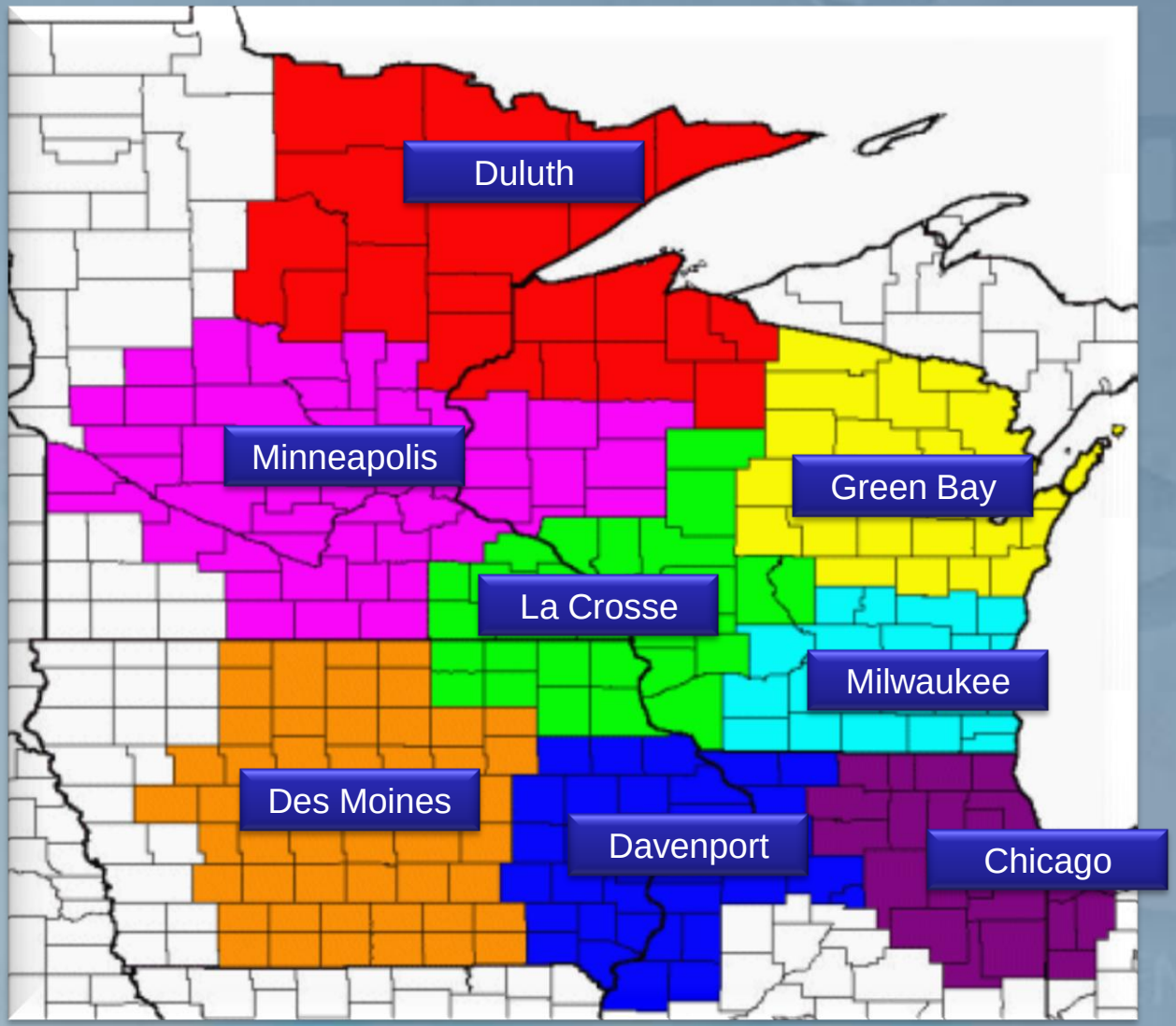
- Mission:
  - Provide warnings and forecasts to…
    - Protect life and property
    - Enhance national economy
- Typical year brings:
  - 7 hurricanes
  - 1000 tornadoes
  - 5000 floods
  - 10,000 violent thunderstorms
  - Etc…



National Weather Service



County Warning / Service Areas



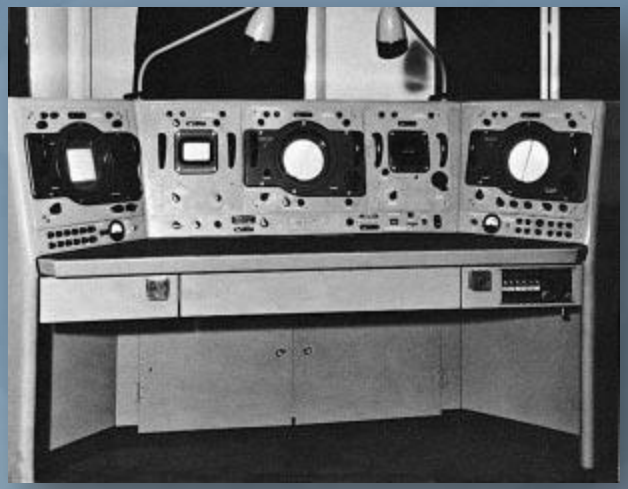
NWS La Crosse

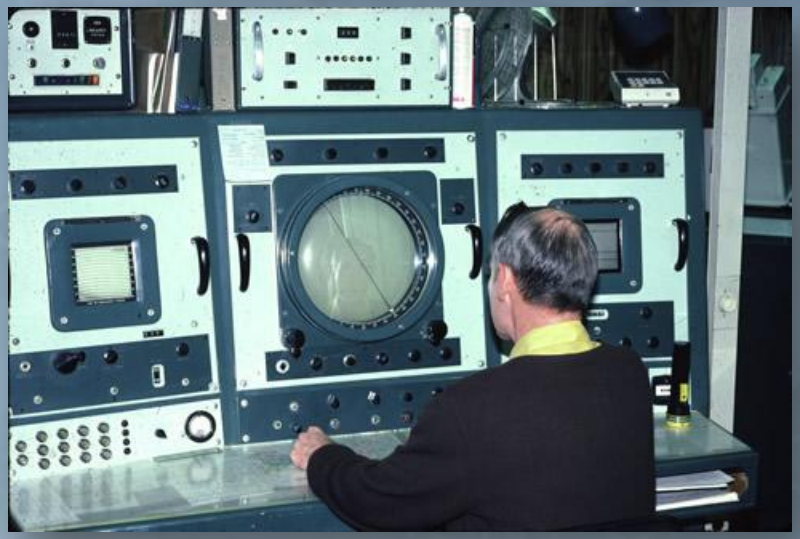
- 24 hour operations
- 22 staff members
- 2-3 per shift
  - *More coverage during active weather*

Continuous Weather Watch !!

Weather Radar History

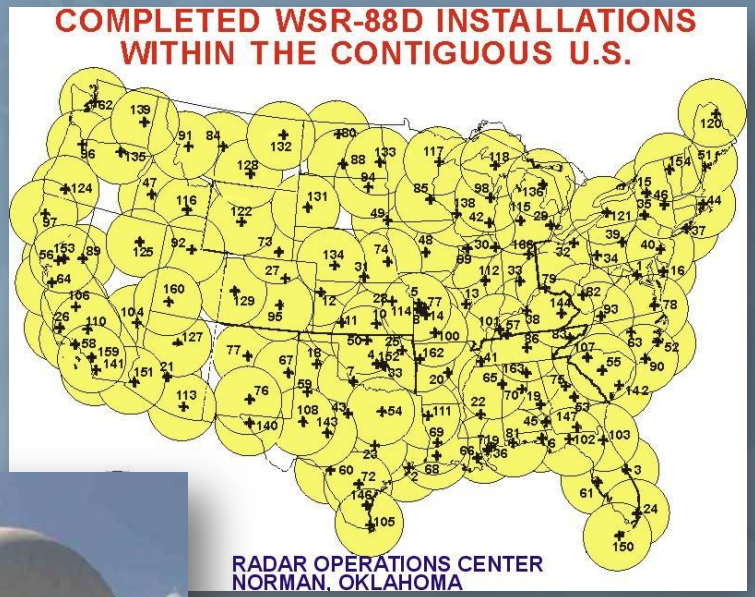
- World War II radar technology
- 1946 – APQ-13s / CPS-9s
- 1959 – WSR-57s
  - Network/53
  - Hurricane / Tornado emphasis
  - Camera added
- 1976 – WSR-74s
  - Local Warning

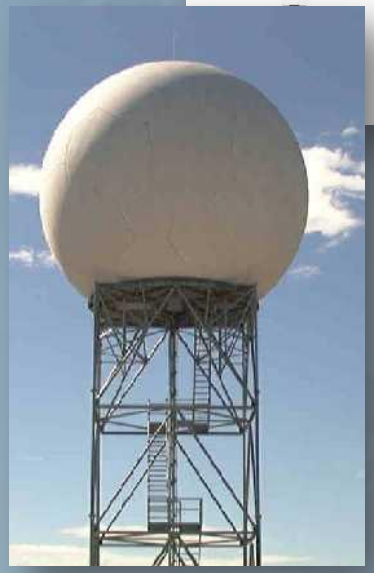




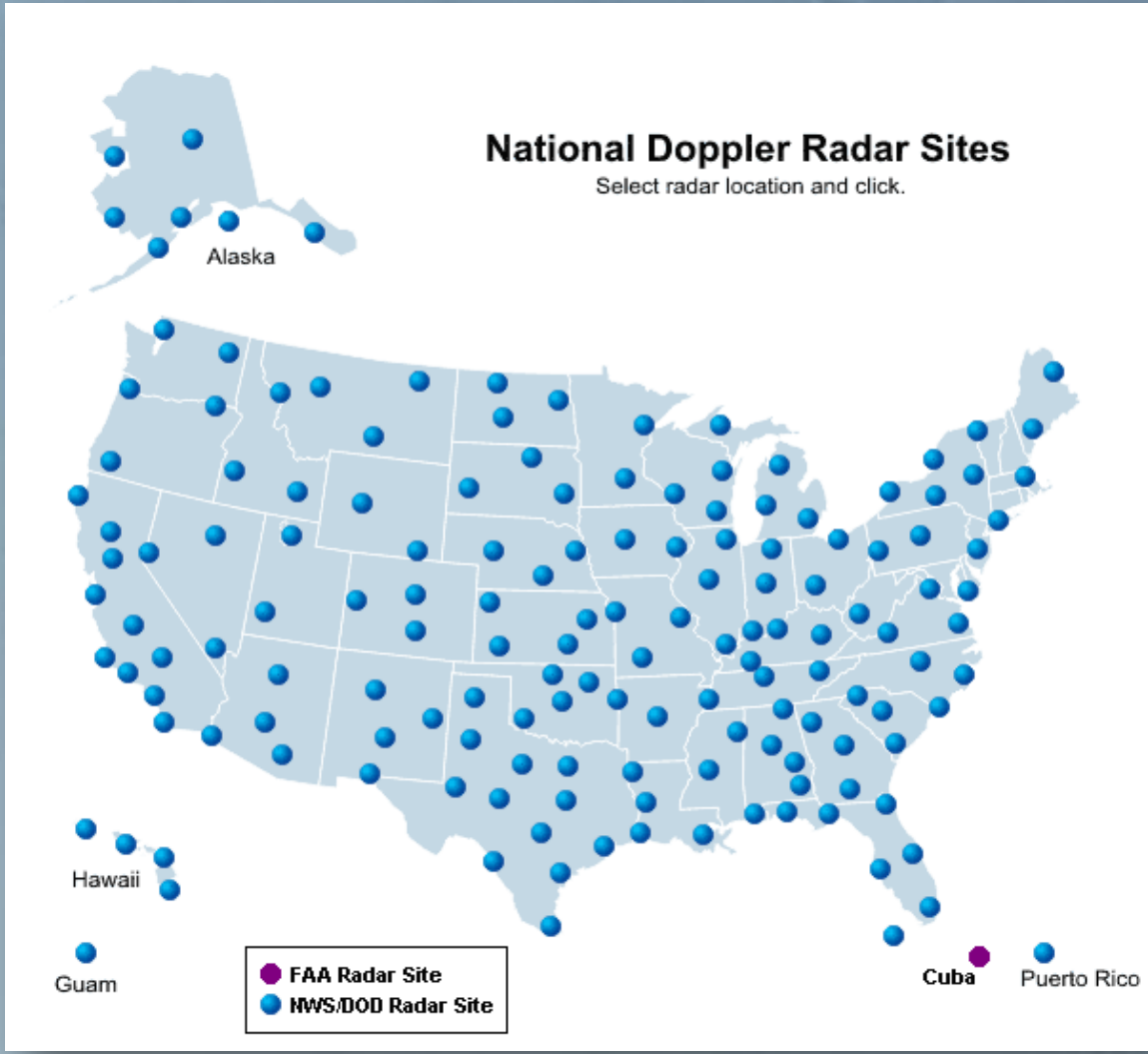
WSR-88D (Doppler)

- Development 1960-1980
- First – Twin Lakes, OK
  - Fall 1990
  - KARX – Feb.1996
- Color imagery
- Doppler data
- Higher resolution
- Scanning strategies

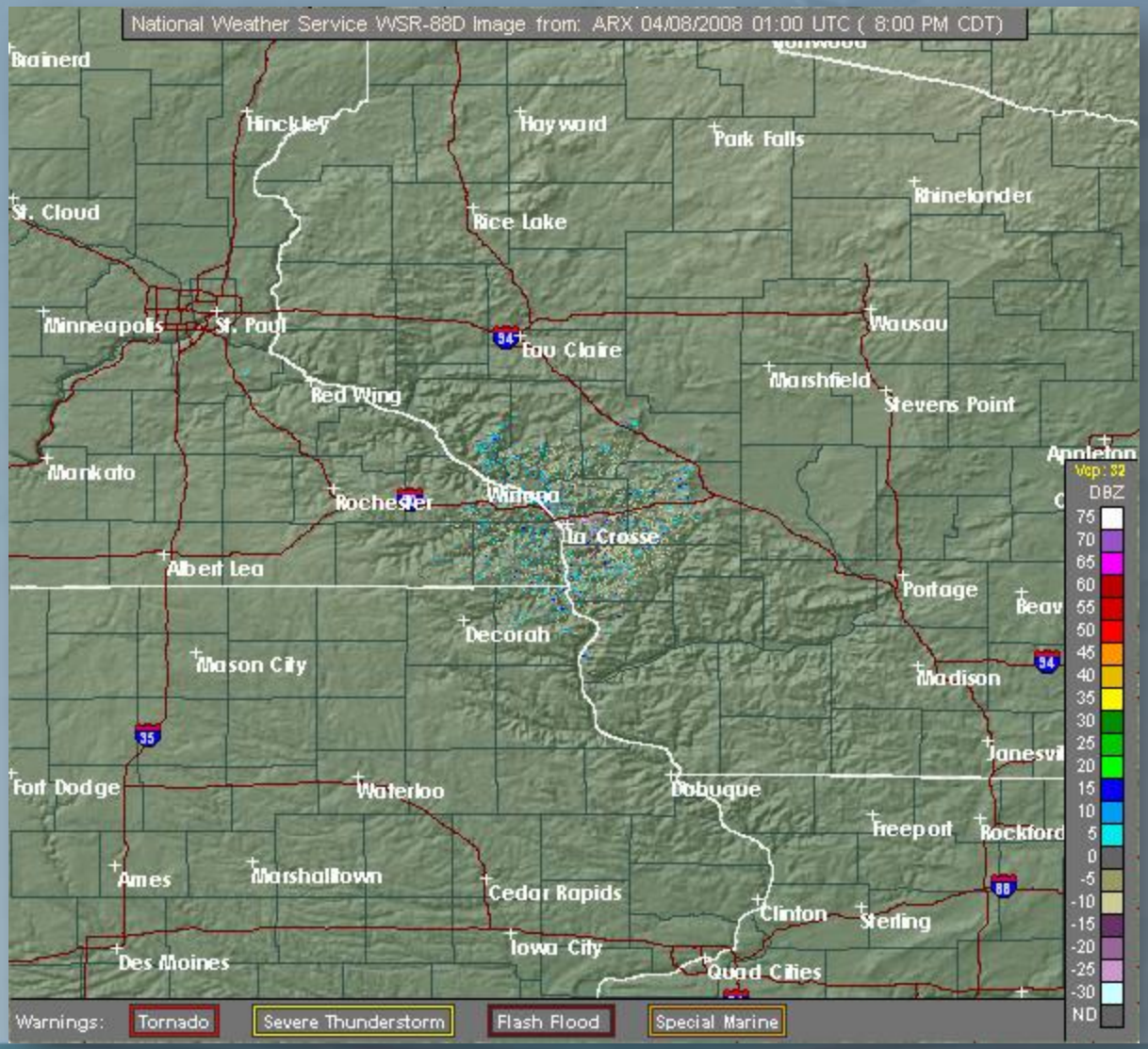




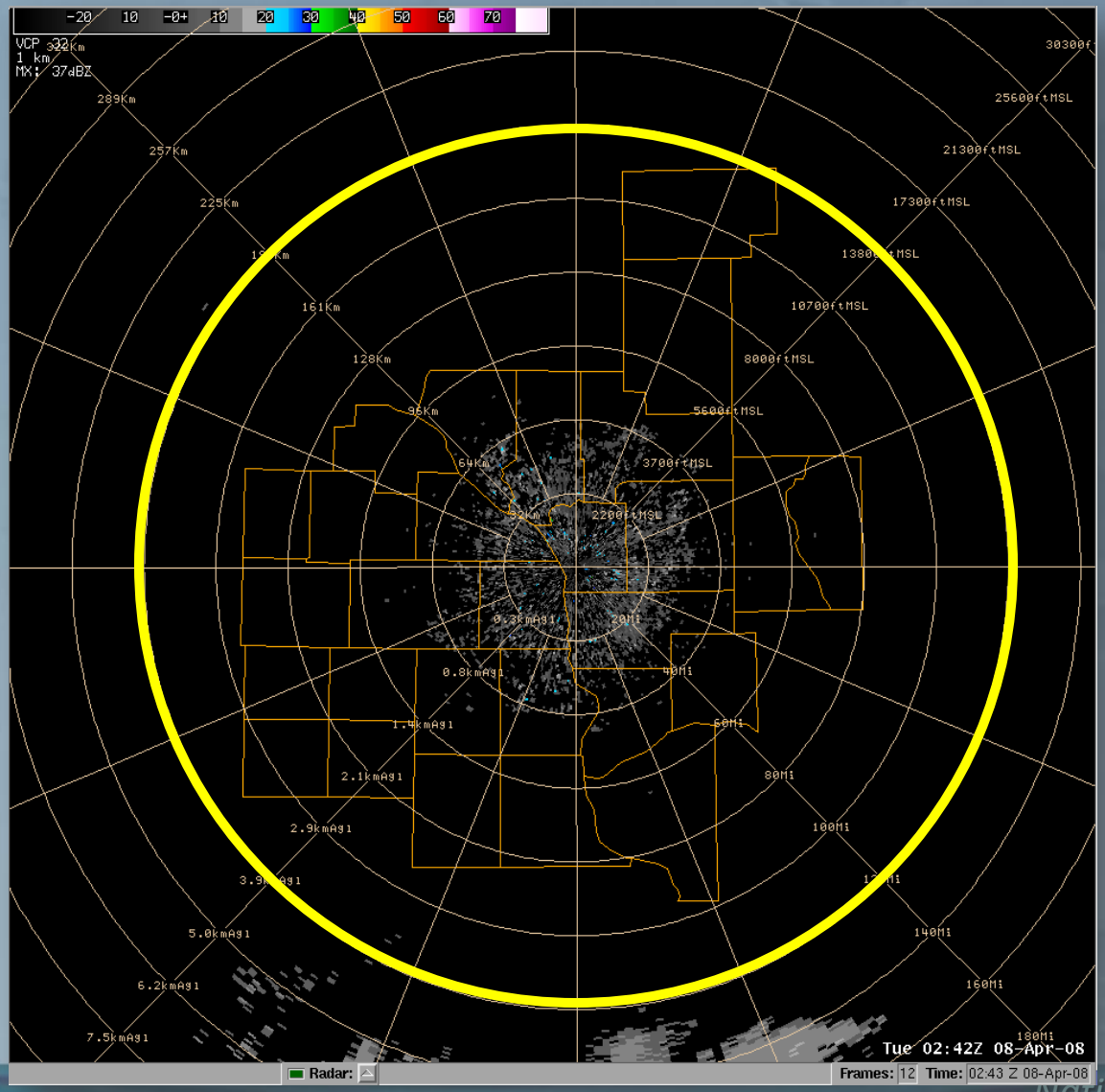
WSR-88D Network



KARX (La Crosse)

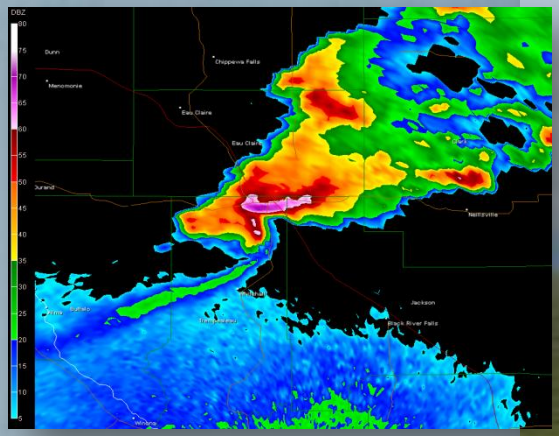


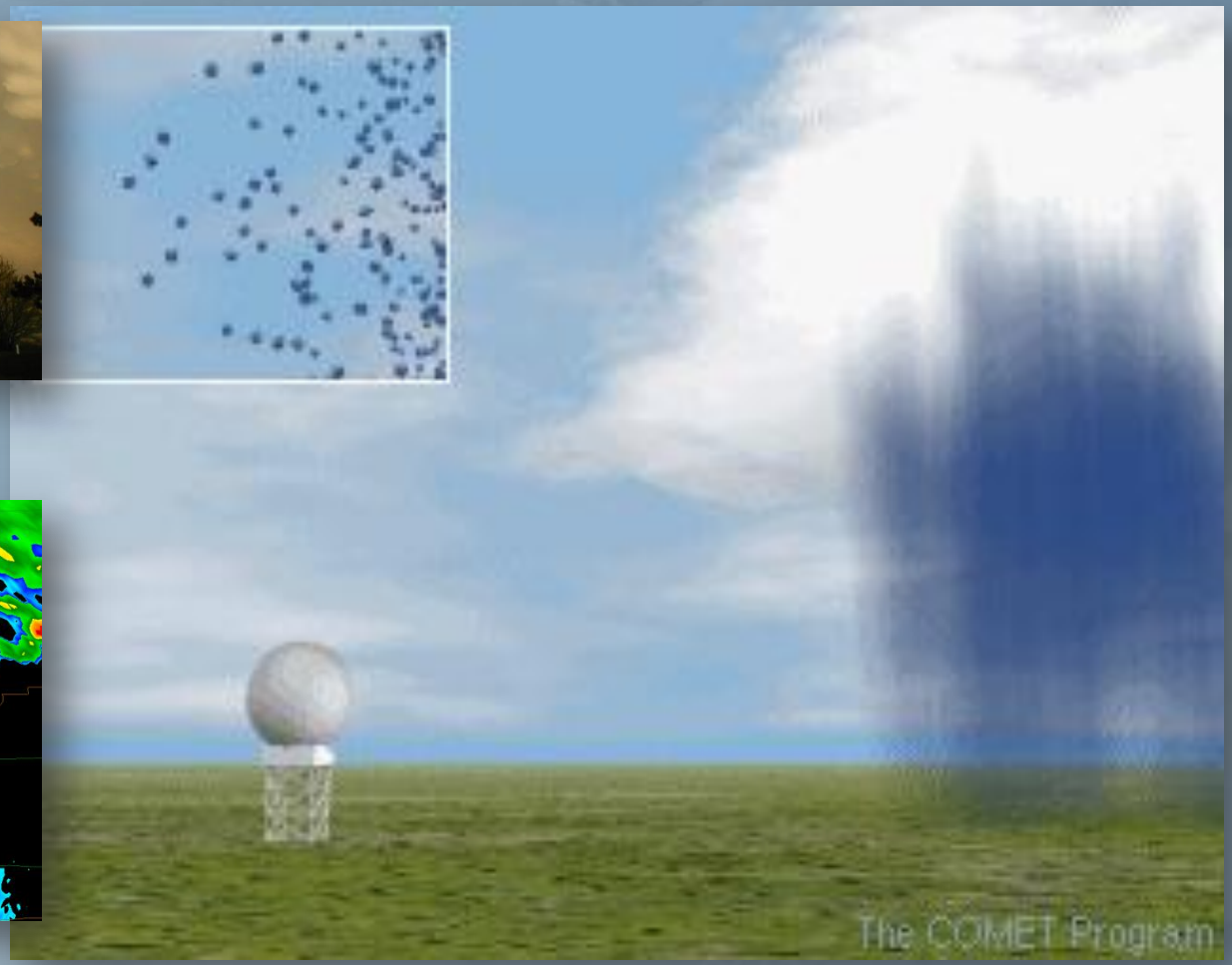
KARX (La Crosse)



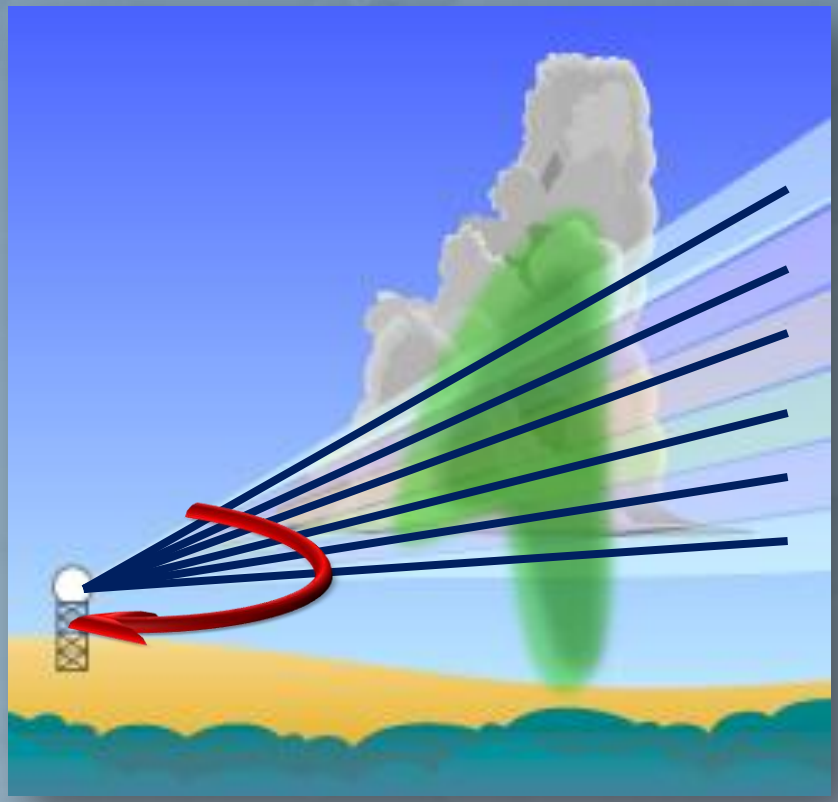
National Weather Service
La Crosse, WI

Radar Basics



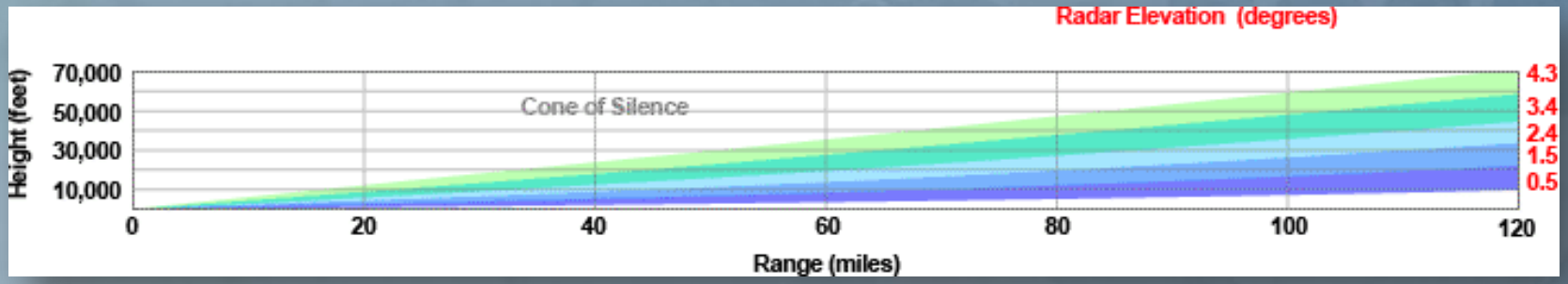


Radar Scanning

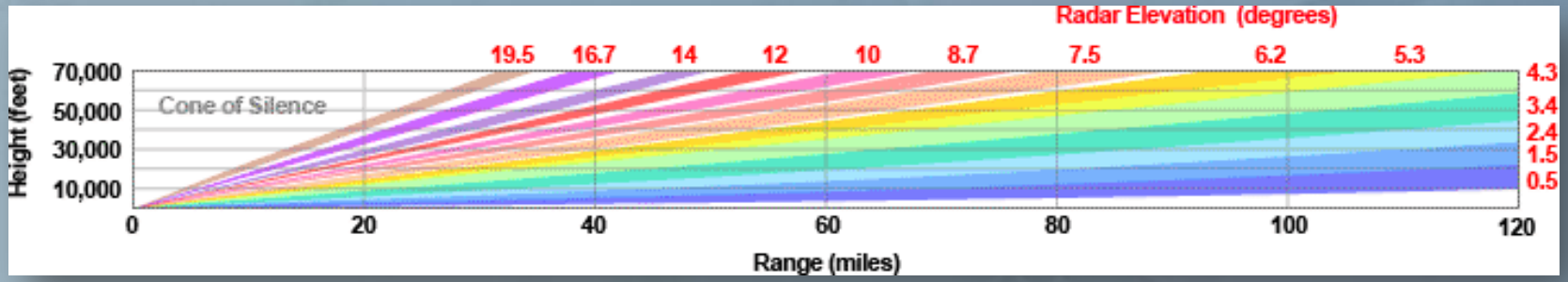


Volume Coverage Patterns

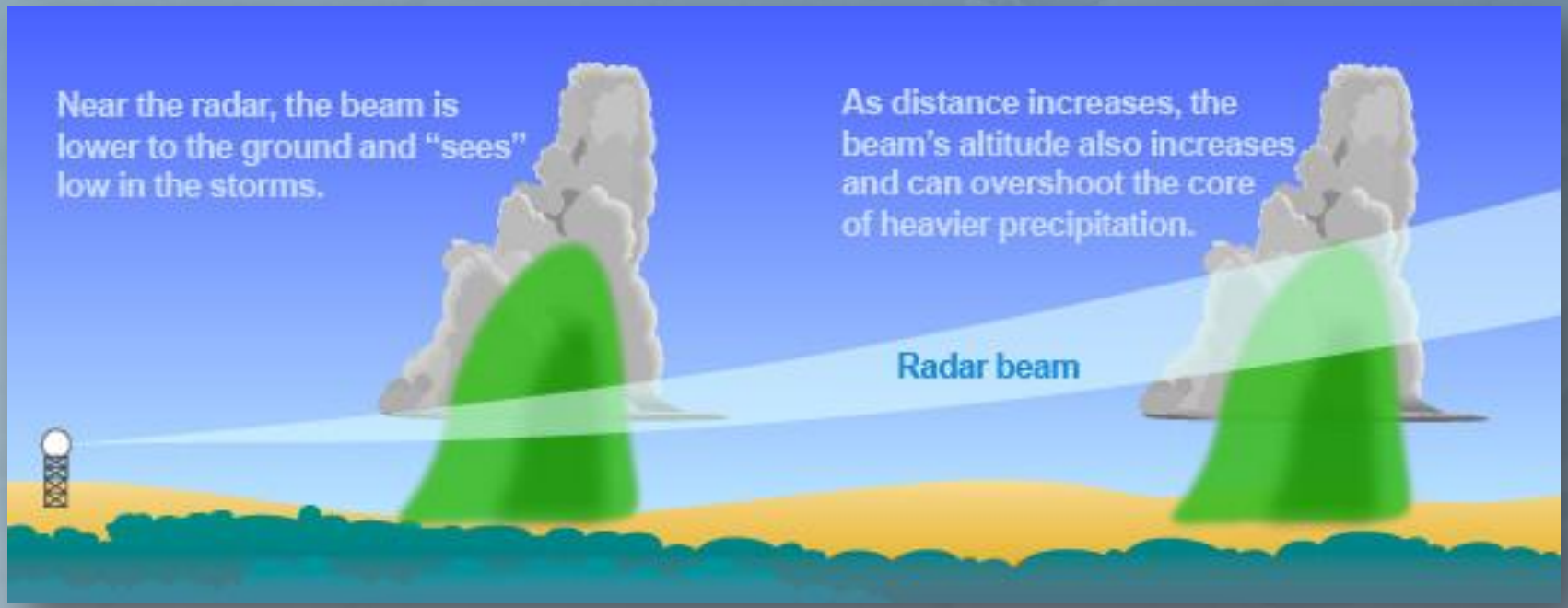
Clear Air Mode (10 min)



Precipitation Mode (4 min)

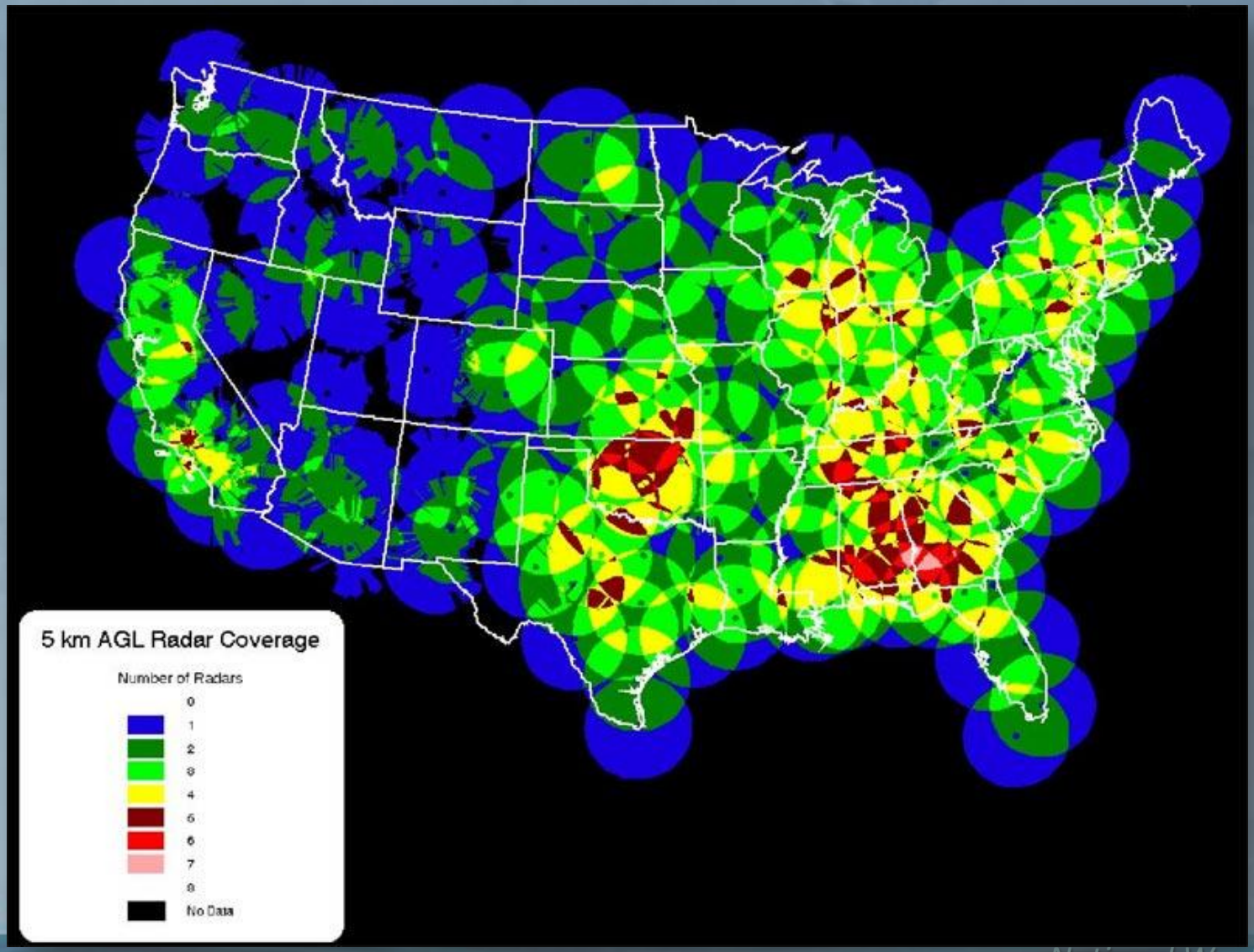


Distance


Near the radar, the beam is lower to the ground and "sees" low in the storms.
As distance increases, the beam's altitude also increases and can overshoot the core of heavier precipitation.
Radar beam

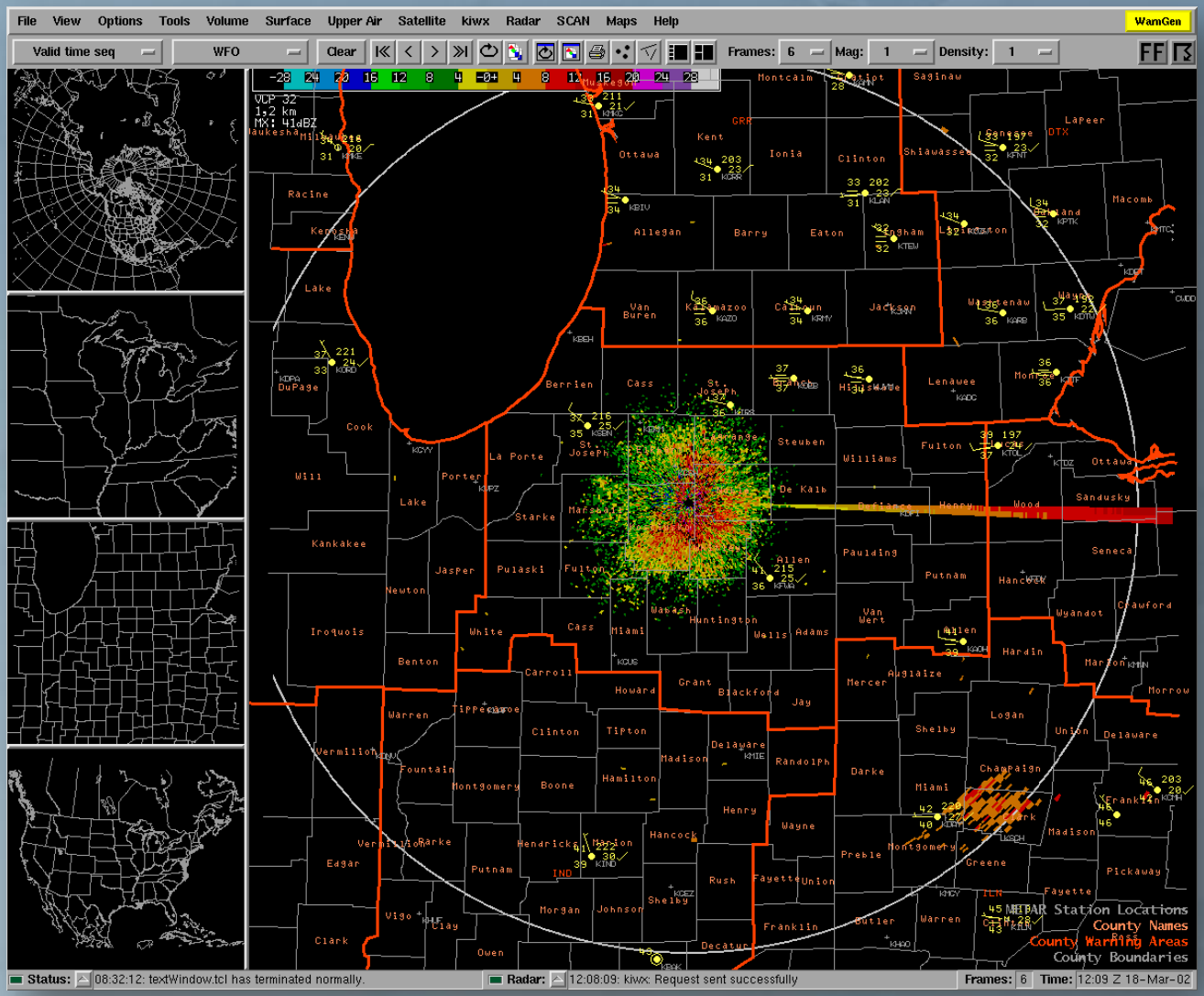
Cone of Silence
19.5°

Distance

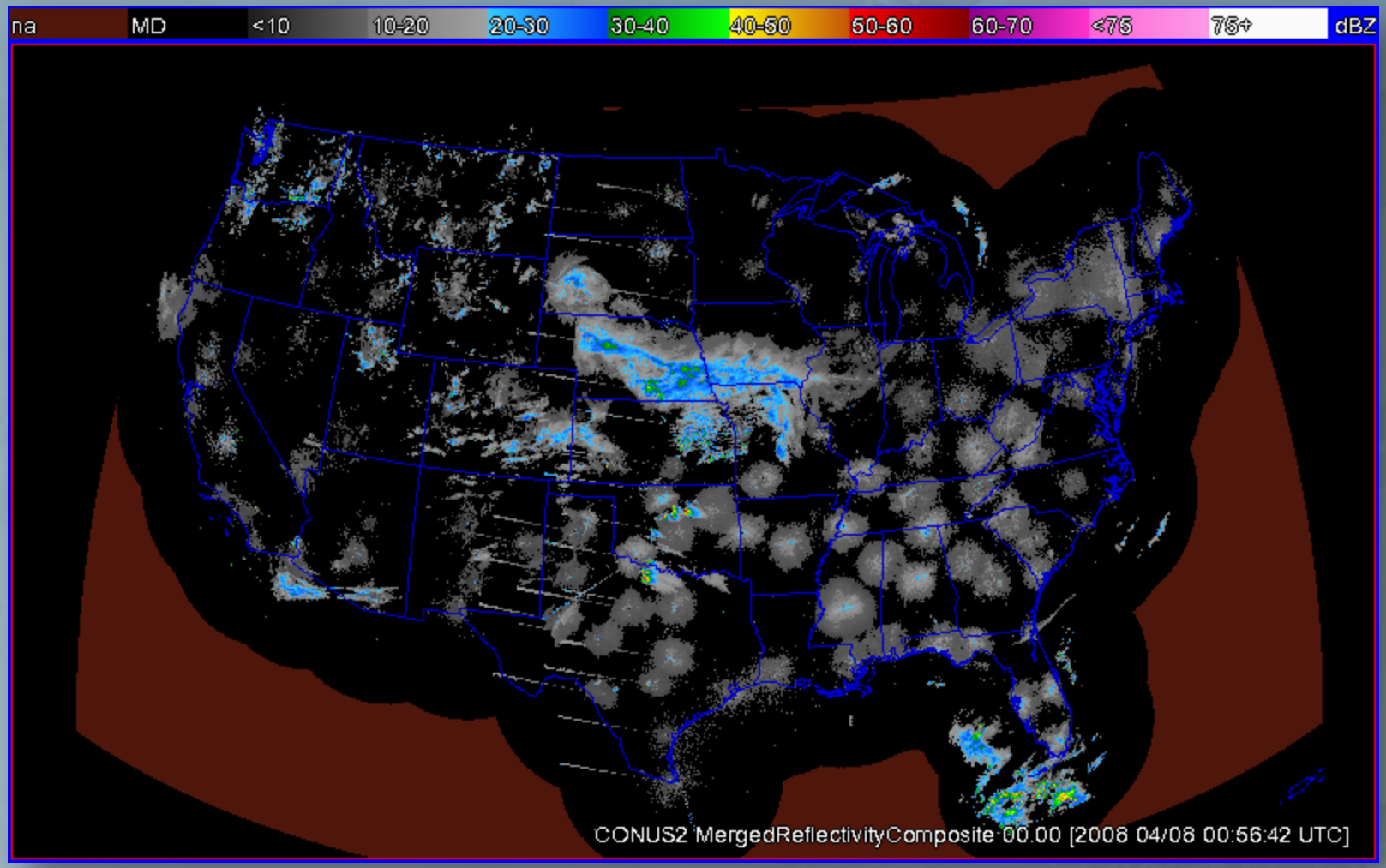


Atmospheric Effects

Ground Clutter

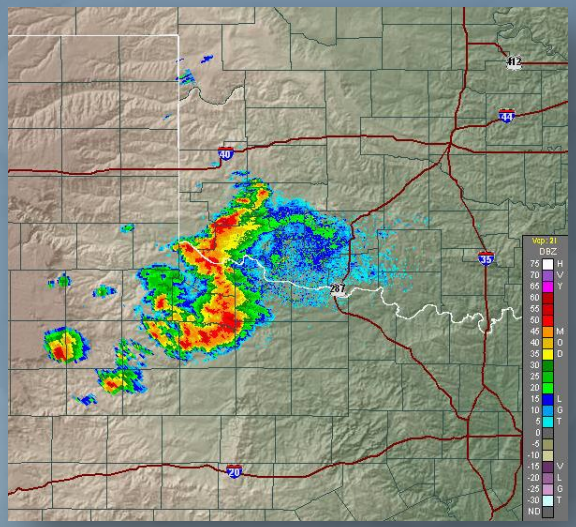


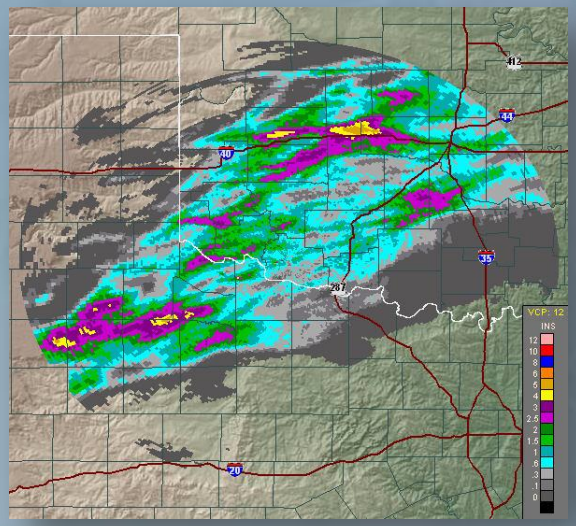
Radar Mosaic

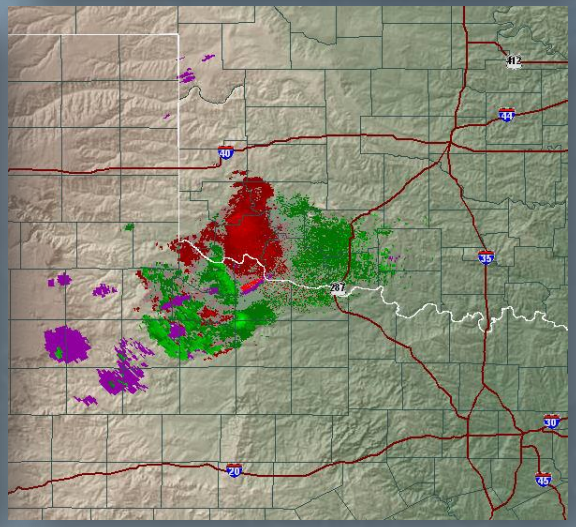


Basic Imagery

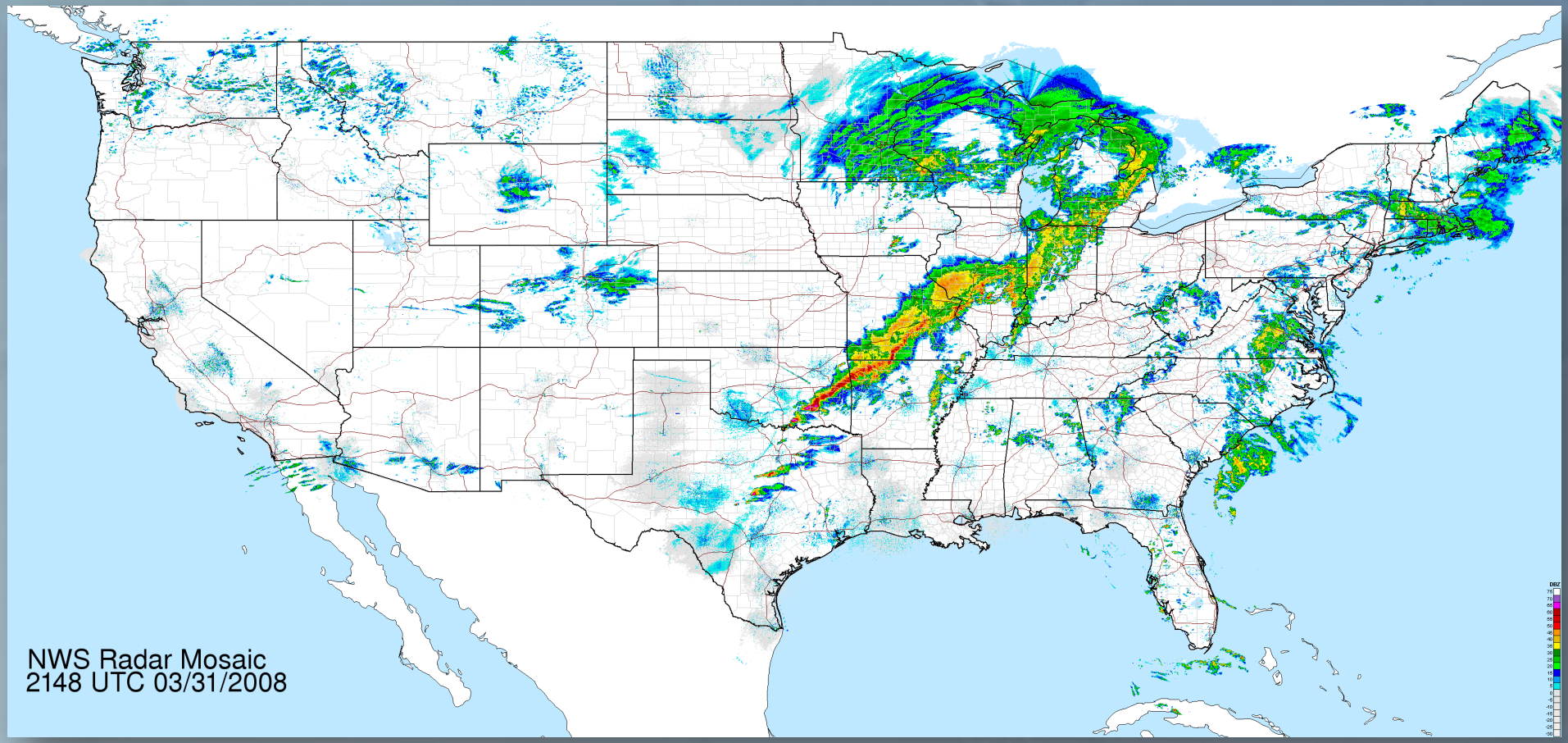
- Base Reflectivity
- Composite Reflectivity
- Base Velocity
- Storm-Relative Motion
- Precipitation Estimates
- Others





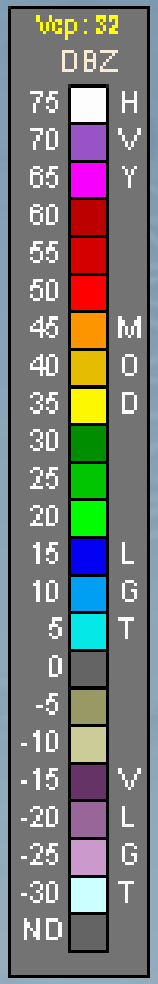


Base Reflectivity



- Key base radar data
- Usually displayed from 0.5 degree slice

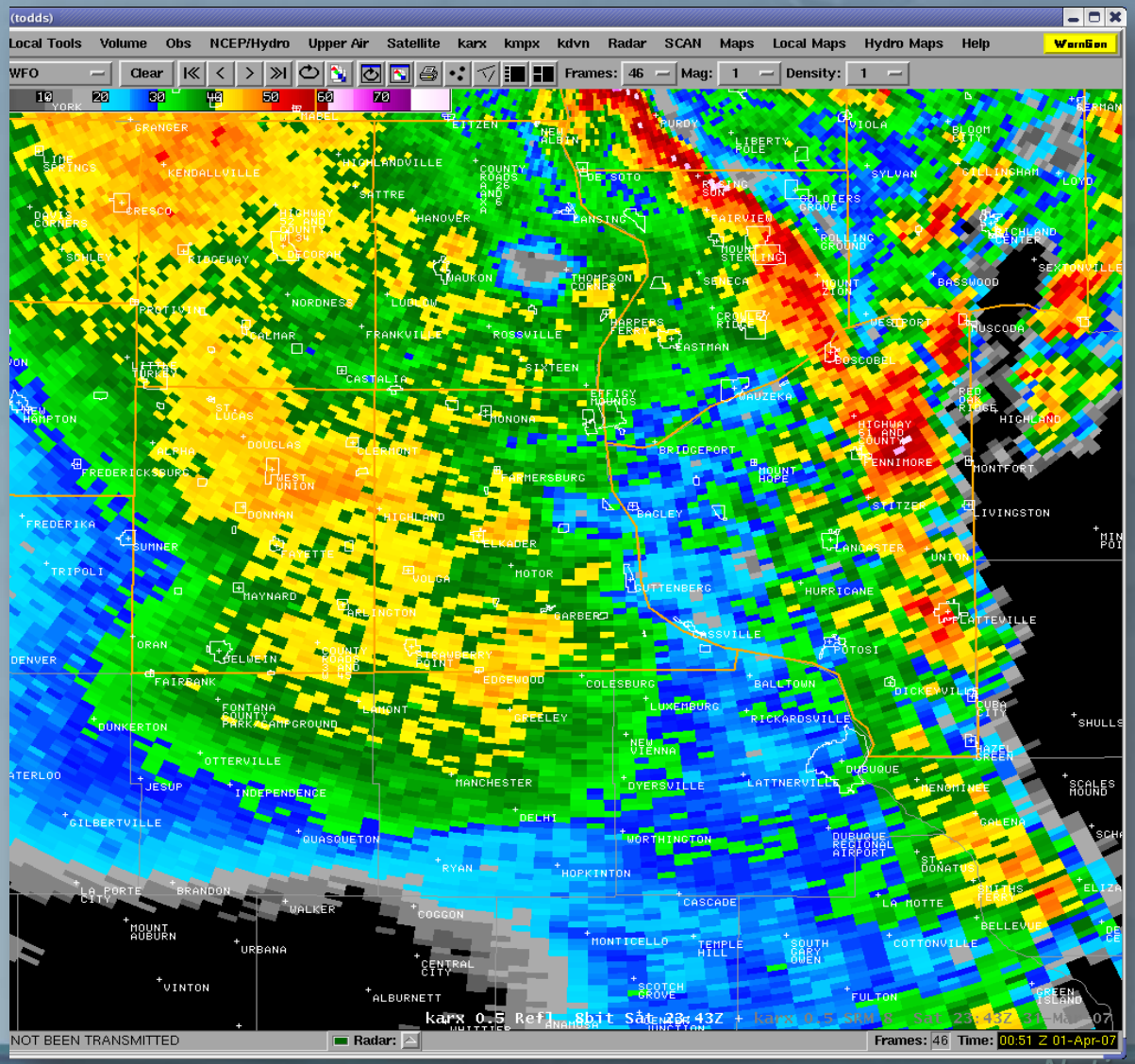
Reflectivity (dBz)



Precipitation Mode

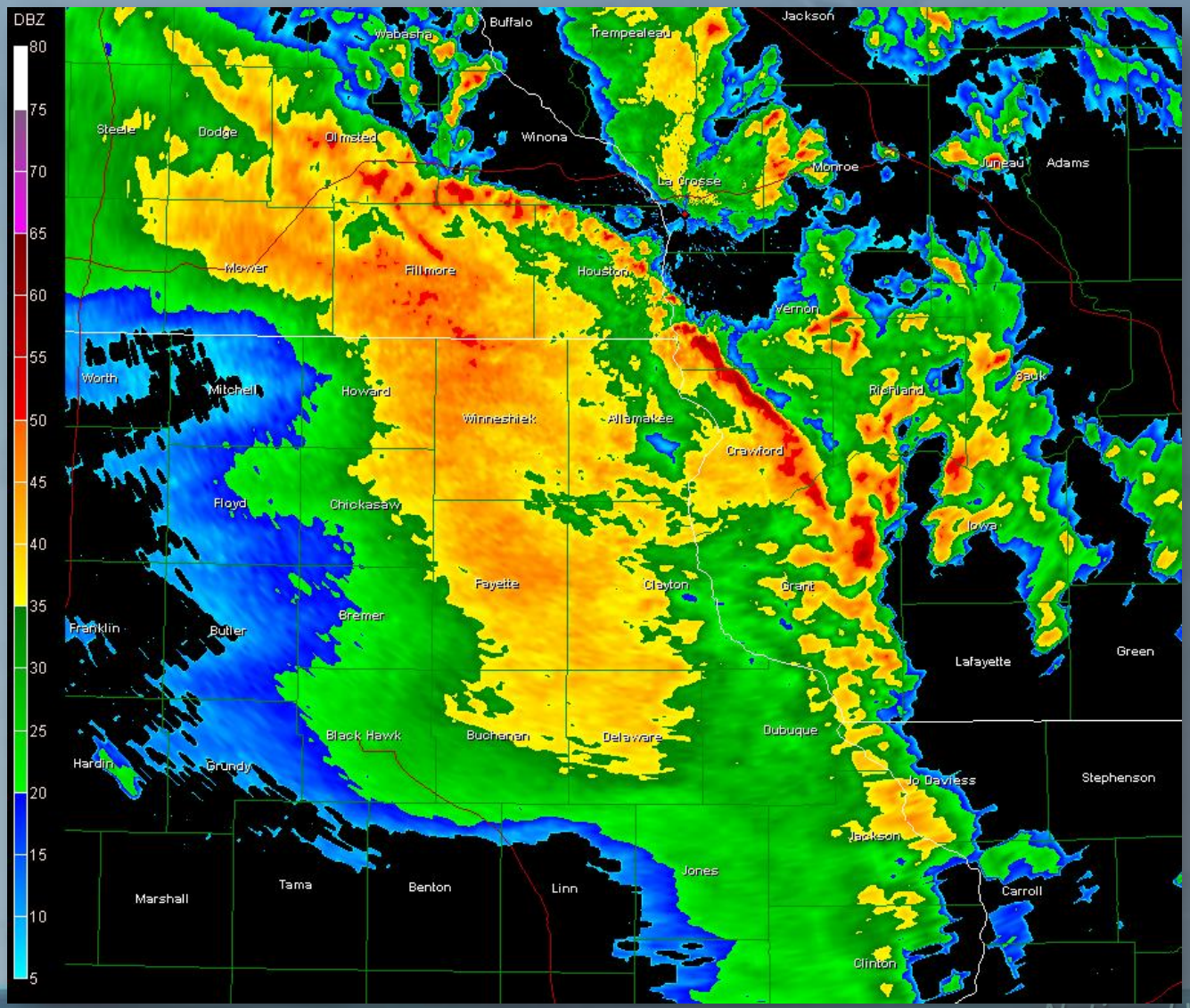
Clear Air Mode

March 31, 2007



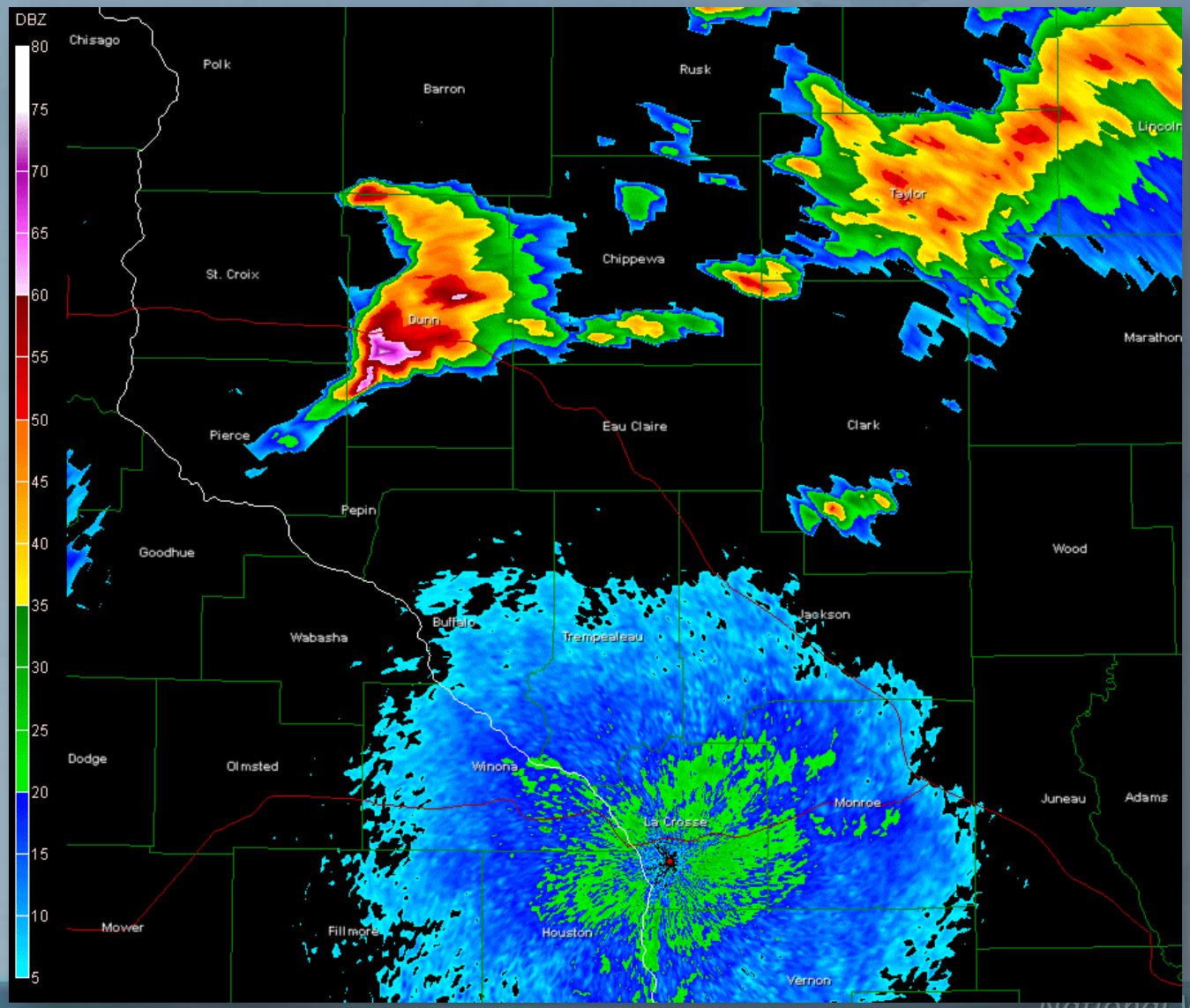
National Weather Service
La Crosse, WI

March 31, 2007



National Weather Service
La Crosse, WI

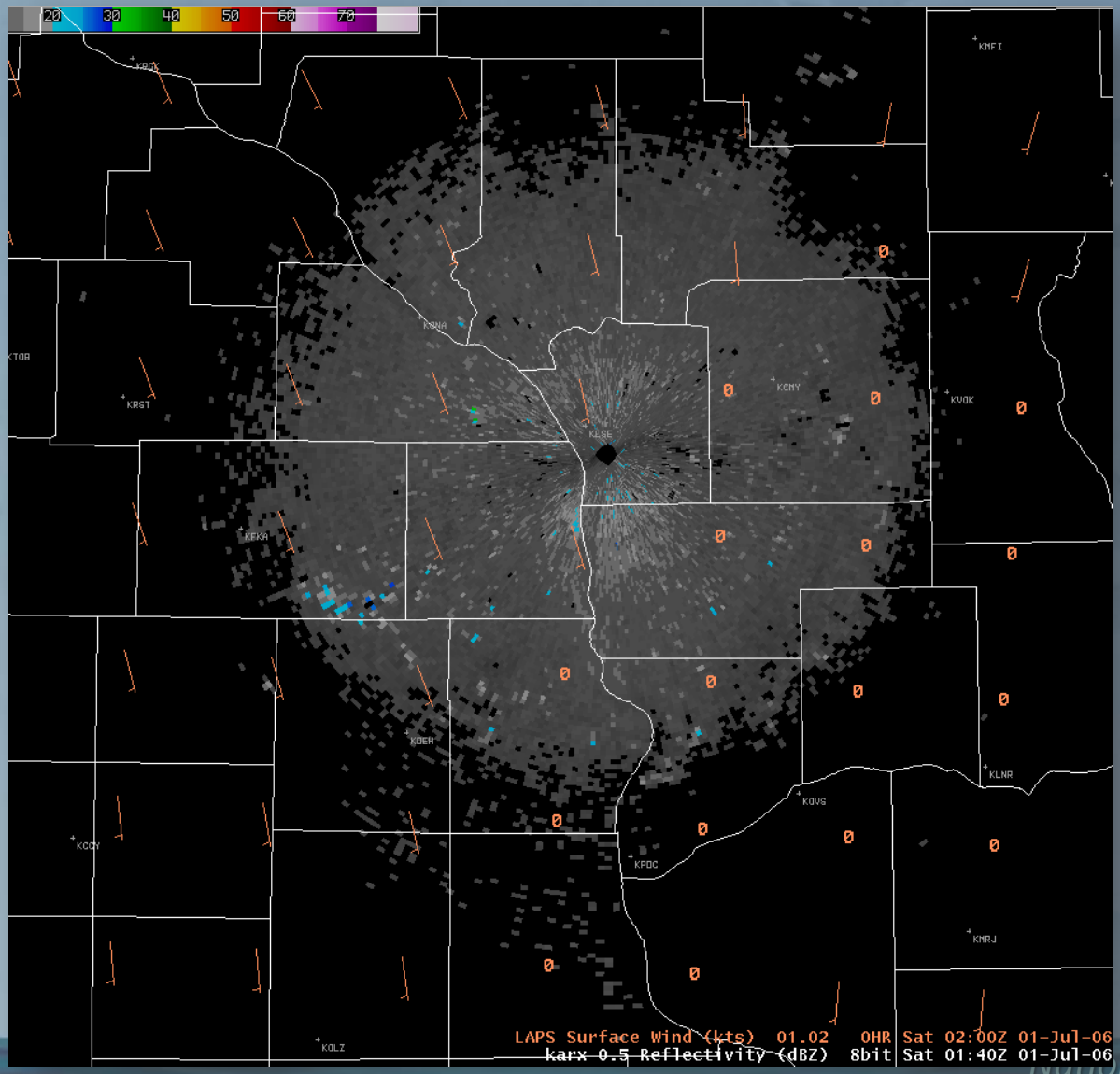
October 3, 2006



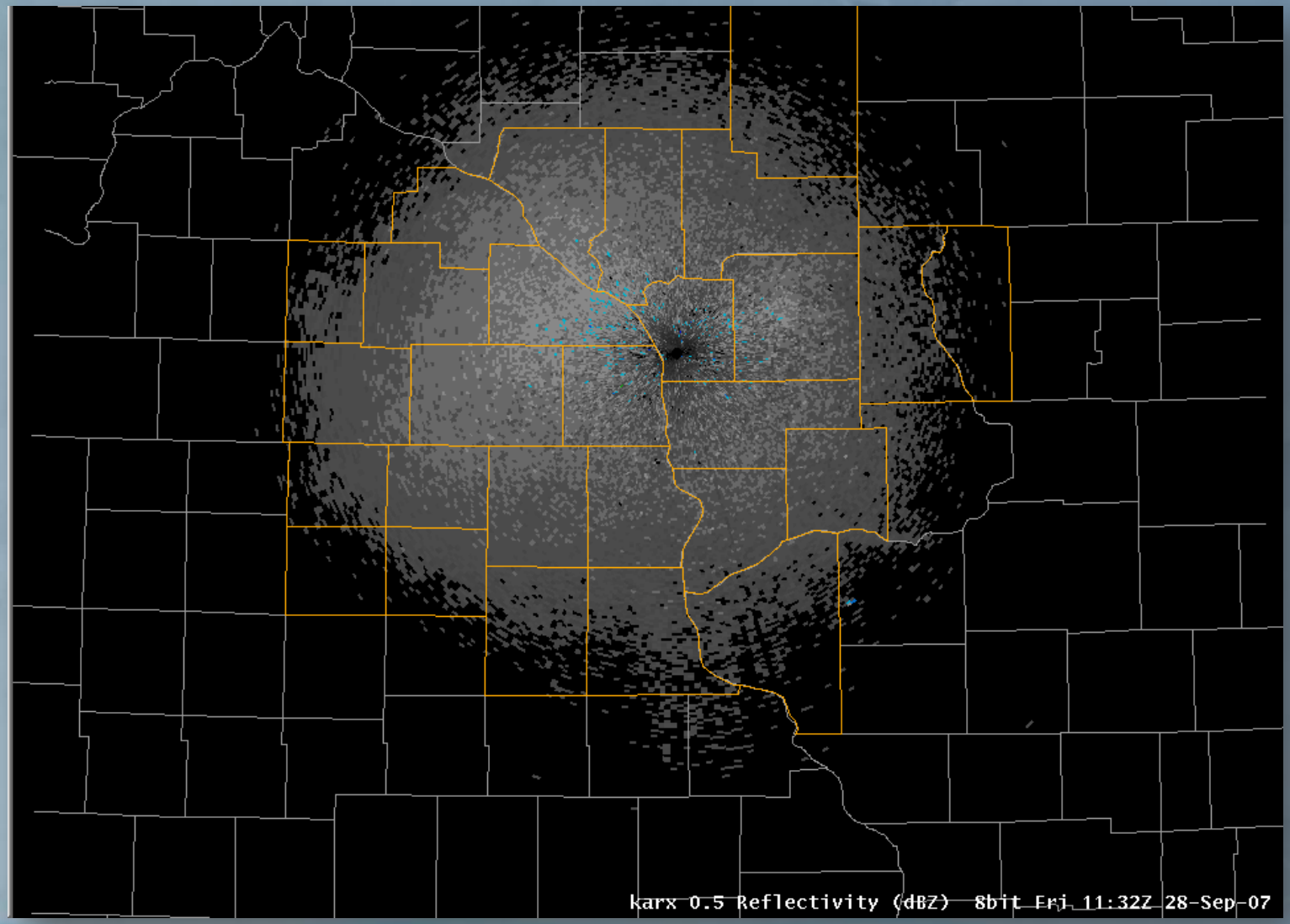
National Weather Service
La Crosse, WI

June 6, 2006

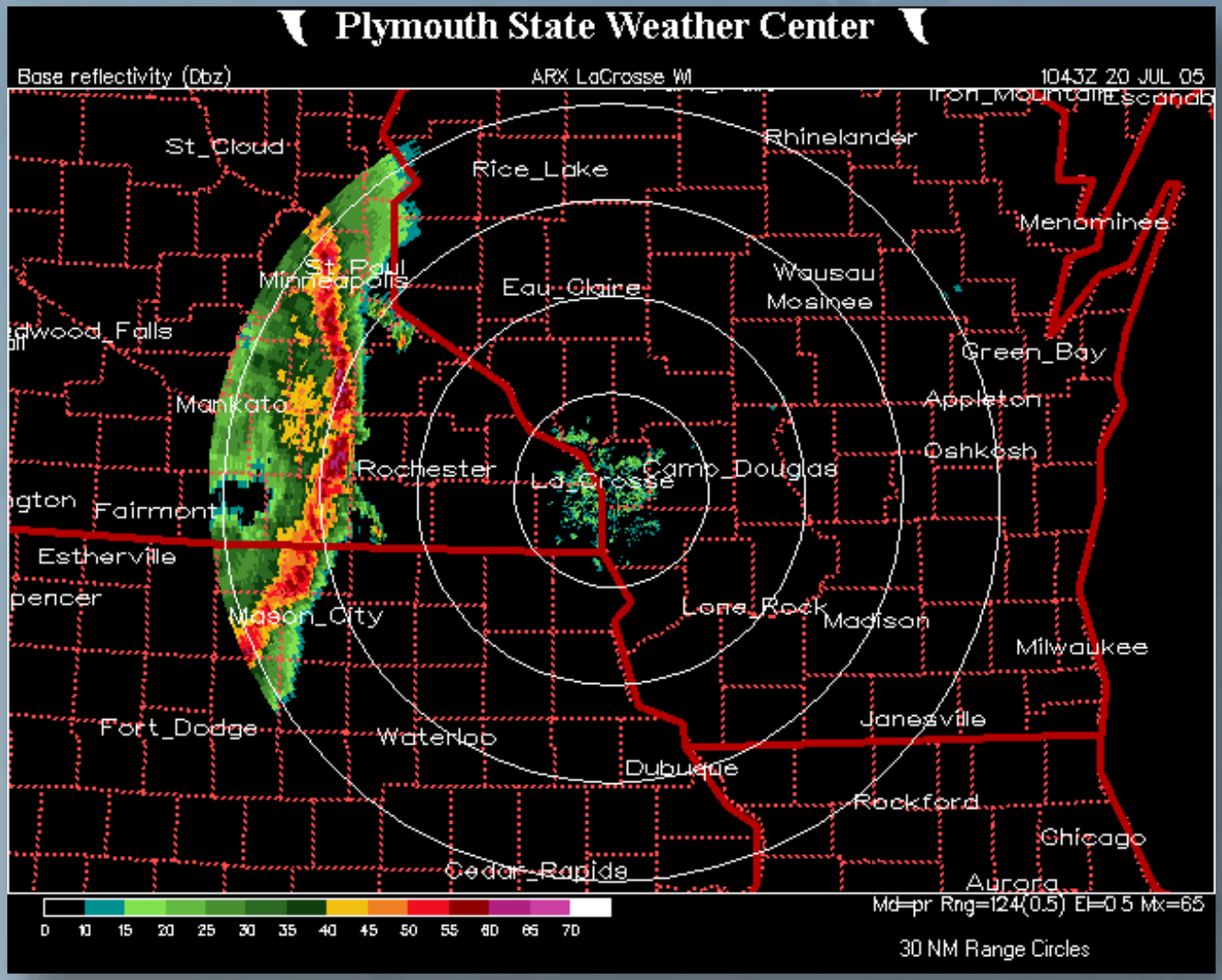
Insects


20
30
40
50
60
70
KMFI
KRGT
KCMY
KVOK
KLSE
KEKA
KDEH
KLNR
KAVS
KCCY
KPDC
KMRJ
KALZ
LAPS Surface Wind (kts) 01.02 0HR Sat 02:00Z 01-Jul-06
karx 0.5 Reflectivity (dBZ) 8bit Sat 01:40Z 01-Jul-06

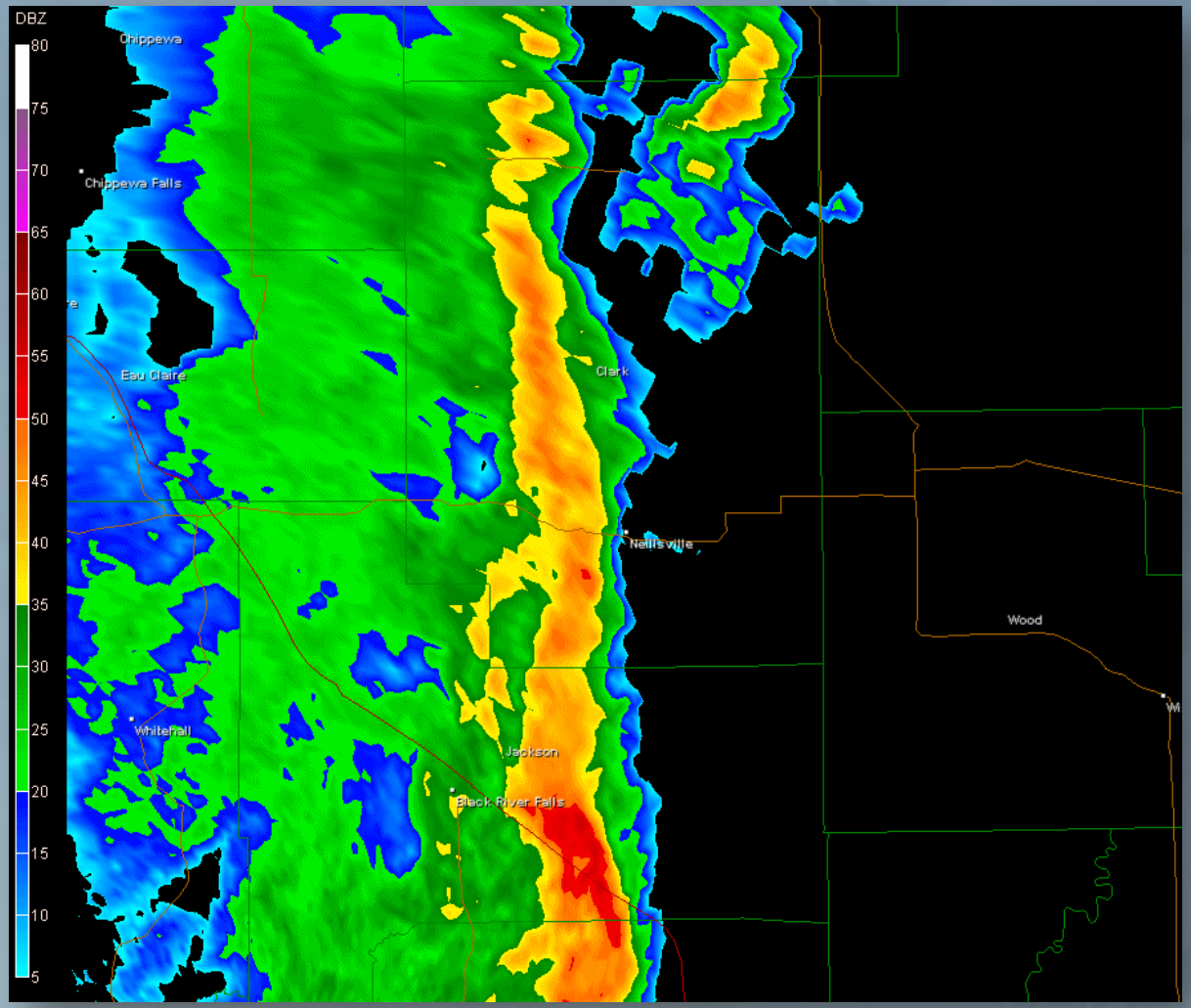
Birds



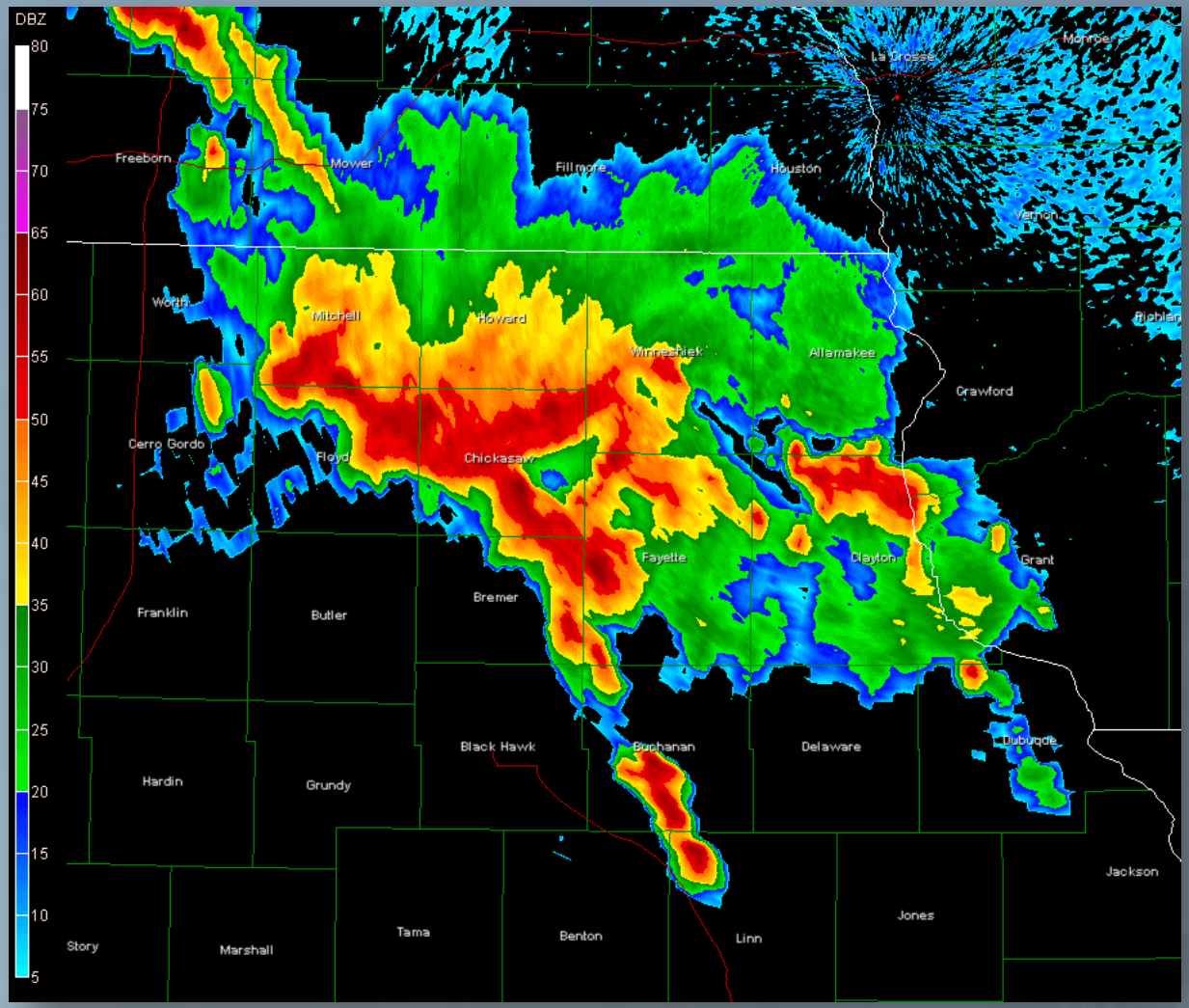
Squall Line


Plymouth State Weather Center
Base reflectivity (Dbz)
ARX LaCrosse WI
1043Z 20 JUL 05
St_Cloud
Rice_Lake
Rhinelander
Menominee
St_Paul
Minneapolis
Eau_Claire
Wausau
Mosinee
Green_Bay
Mankato
Appleton
Oshkosh
Rochester
La_Crosse
Camp_Douglas
Fairmont
Estherville
Mason_City
Lone_Rock
Madison
Milwaukee
Fort_Dodge
Waterloo
Janesville
Dubuque
Rockford
Chicago
Cedar_Rapids
Aurora
0 10 15 20 25 30 35 40 45 50 55 60 65 70
Md=pr Rng=124(0.5) El=0.5 Mx=65
30 NM Range Circles

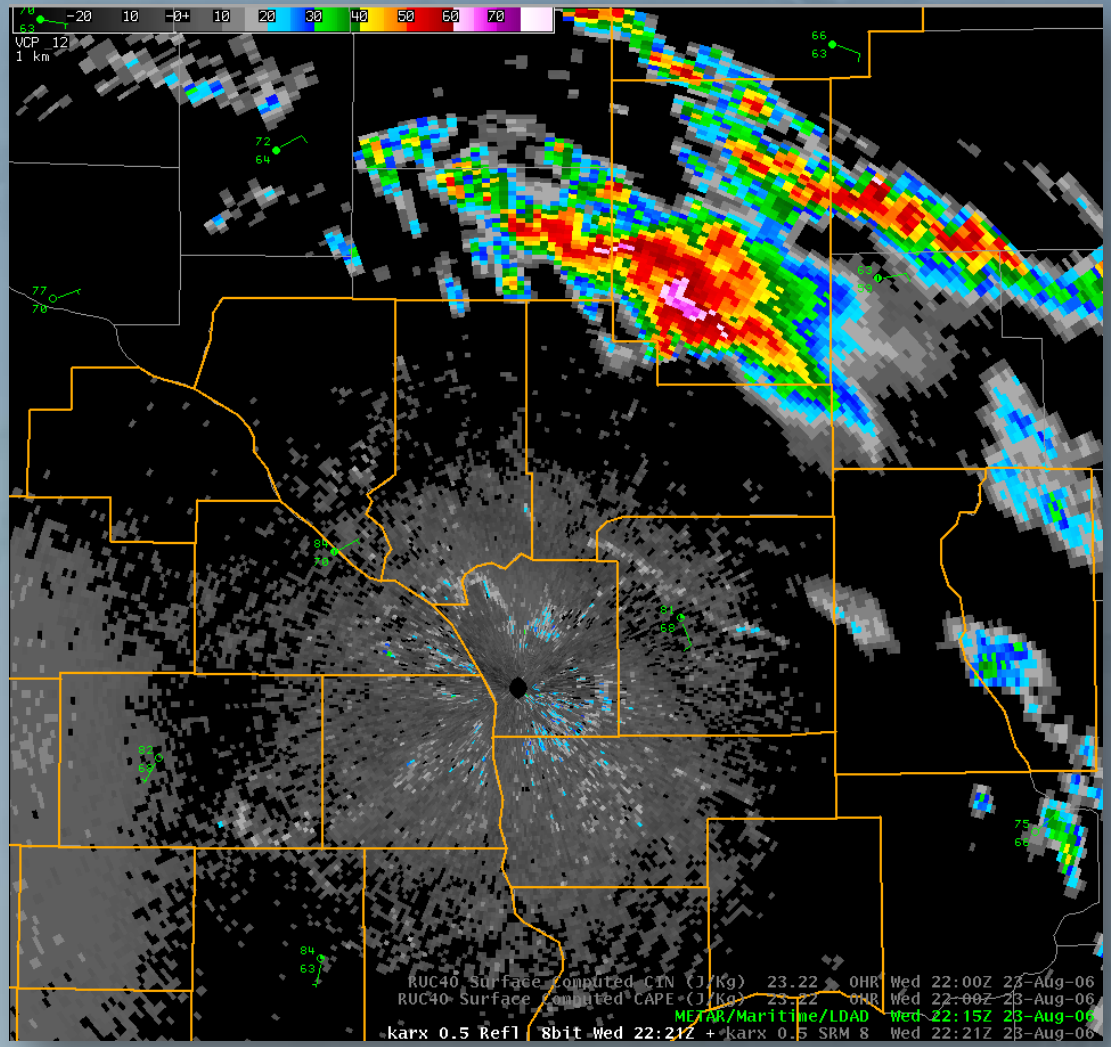
Squall Line


DBZ
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Chippewa
Chippewa Falls
Eau Claire
Clark
Neillsville
Wood
Whitehall
Jackson
Black River Falls

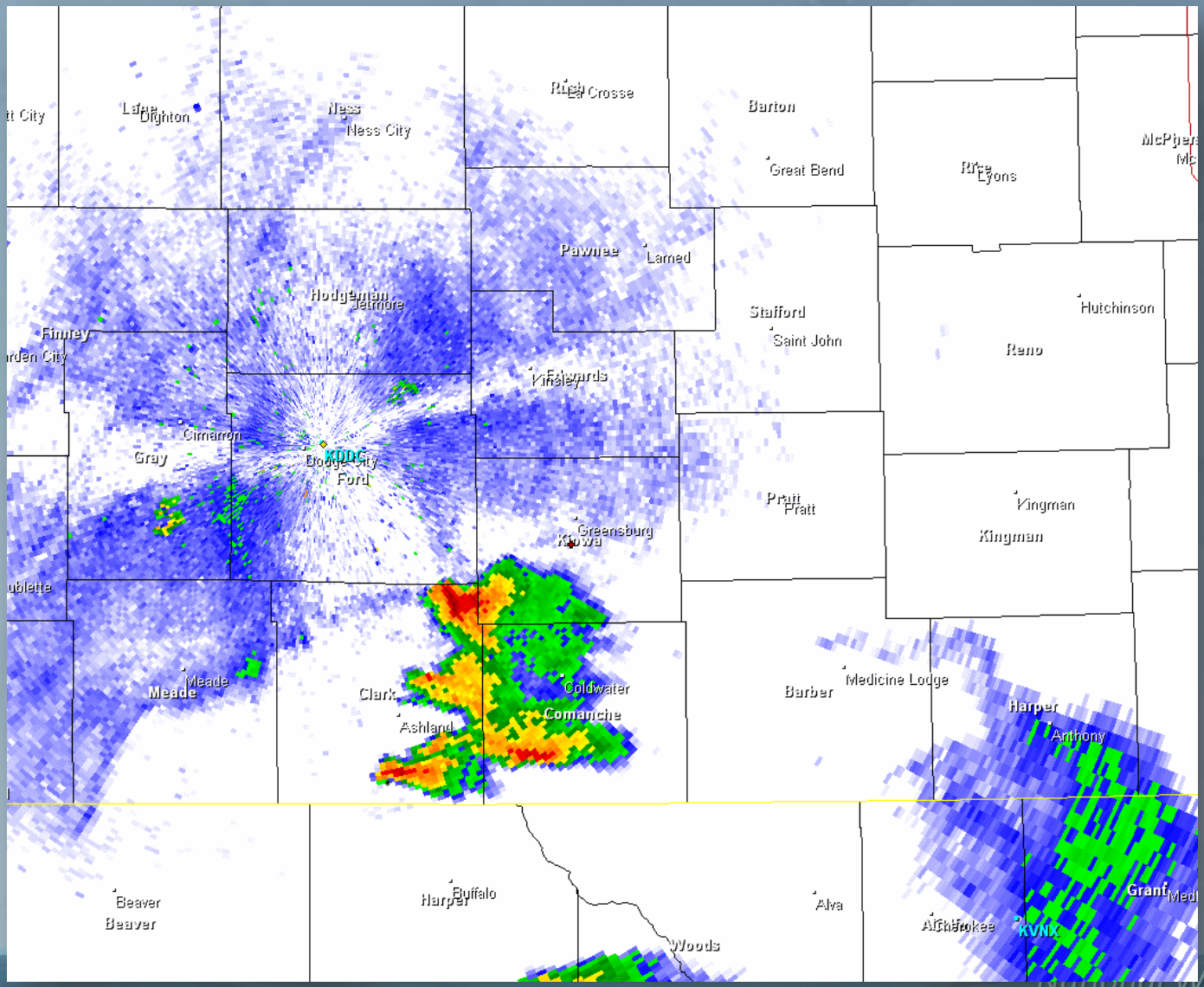
Squall Line


DBZ
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
La Crosse
Monroe
Freeborn
Mower
Fillmore
Houston
Vernon
Worth
Mitchell
Howard
Winneshiek
Allamakee
Richland
Crawford
Cerro Gordo
Floyd
Chickasaw
Fayette
Clayton
Grant
Franklin
Butler
Bremer
Black Hawk
Buchanan
Delaware
Dubuque
Hardin
Grundy
Jackson
Jones
Story
Marshall
Tama
Benton
Linn

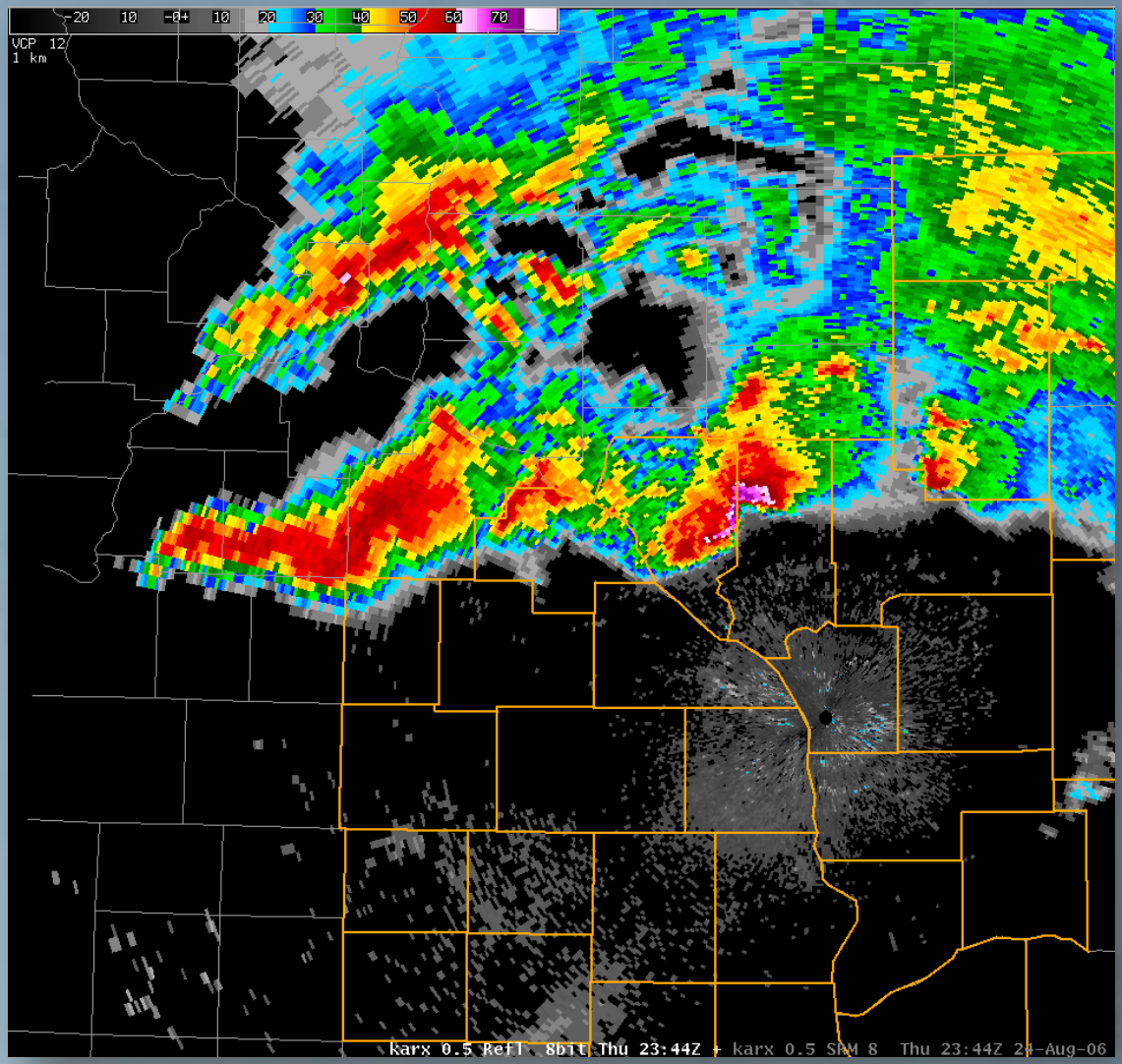
Supercell


VCP 12
1 km
RUC40 Surface Computed CIN (J/Kg) 23.22 0HR Wed 22:00Z 23-Aug-06
RUC40 Surface Computed CAPE (J/Kg) 23.22 0HR Wed 22:00Z 23-Aug-06
METAR/Maritime/LDAD Wed 22:15Z 23-Aug-06
karx 0.5 Refl 8bit Wed 22:21Z + karx 0.5 SRM 8 Wed 22:21Z 23-Aug-06

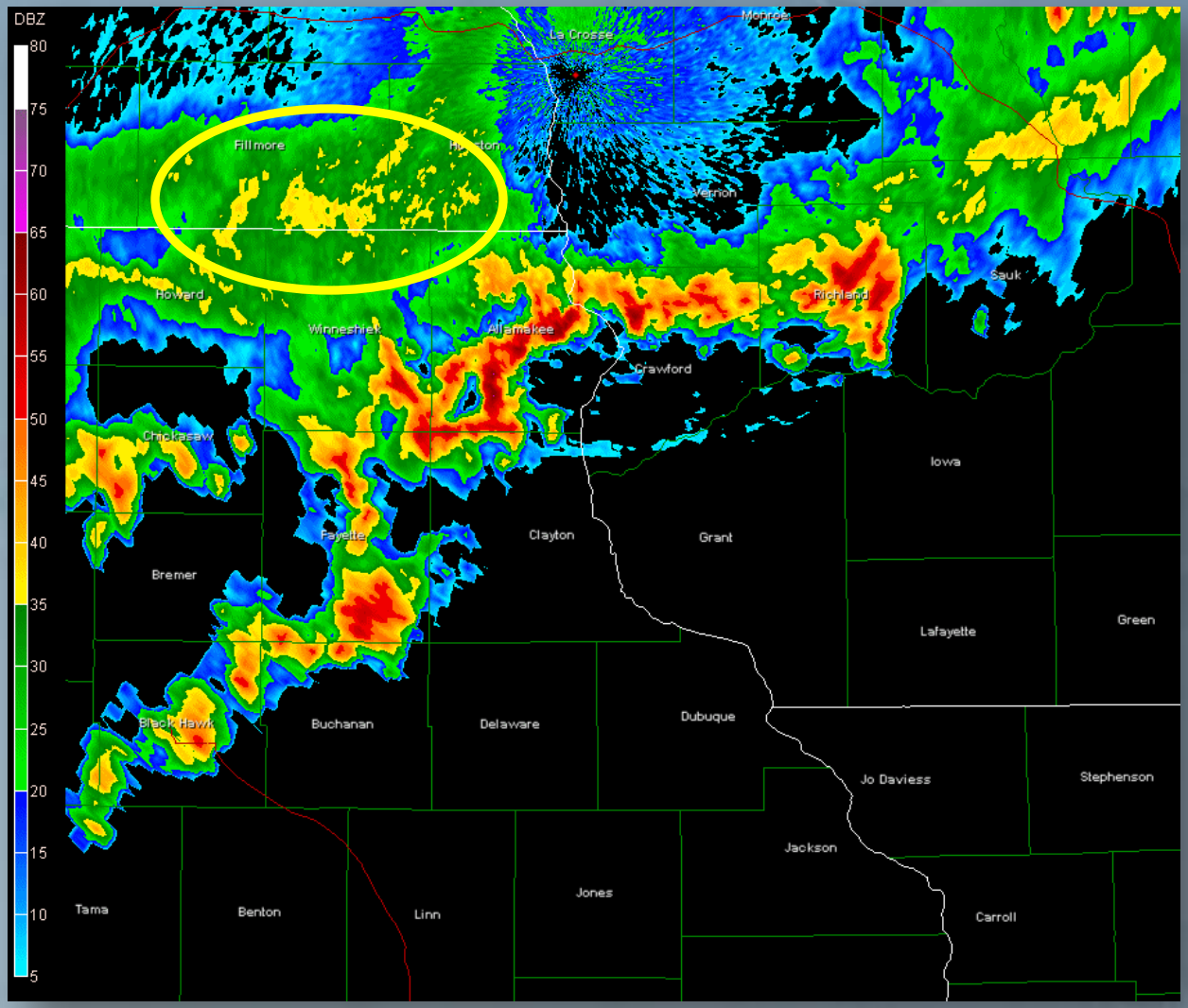
Supercells


Ness
Ness City
Barton
Great Bend
Lyons
Pawnee
Larned
Hodgeman
Jetmore
Finney
Stafford
Saint John
Hutchinson
Reno
Edwards
Kinsley
Cimarron
Gray
KDDC
Dodge City
Ford
Pratt
Kingman
Greensburg
Kiowa
Meade
Clark
Coldwater
Comanche
Ashland
Barber
Medicine Lodge
Harper
Anthony
Beaver
Buffalo
Alva
Woods
Grant
KVNX

Multicell

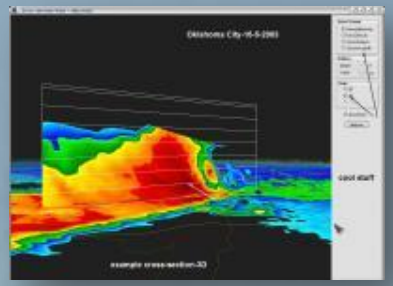

-20 10 -0+ 10 20 30 40 50 60 70
VCP 12
1 km
karx 0.5 Refl 8bit Thu 23:44Z + karx 0.5 SRM 8 Thu 23:44Z 24-Aug-06

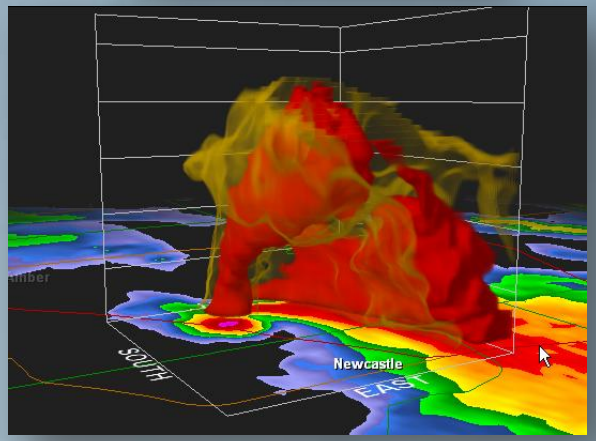
Multicell

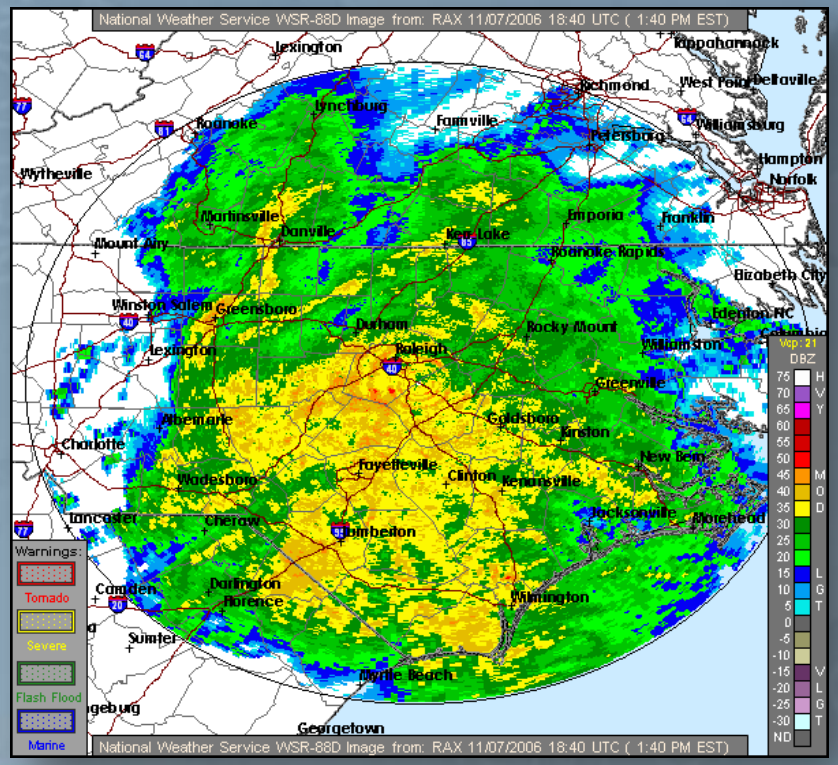

DBZ
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
La Crosse
Monroe
Fillmore
Houston
Vernon
Howard
Winneshiek
Allamakee
Richland
Sauk
Crawford
Chickasaw
Iowa
Fayette
Clayton
Grant
Bremer
Lafayette
Green
Black Hawk
Buchanan
Delaware
Dubuque
Jo Daviess
Stephenson
Jackson
Jones
Tama
Benton
Linn
Carroll

Composite Reflectivity

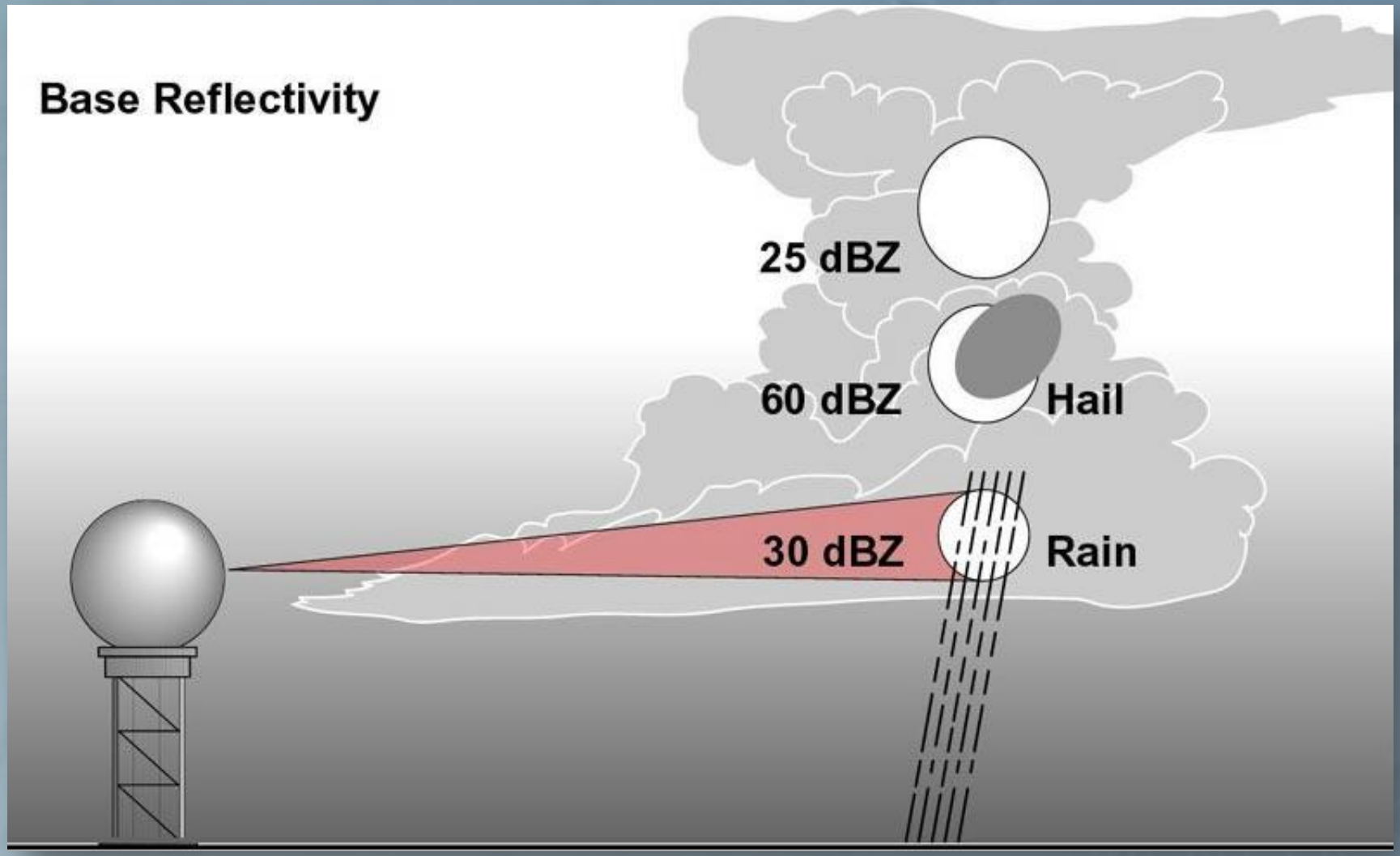
- Highest reflectivity through entire scan
- Composite of all layers



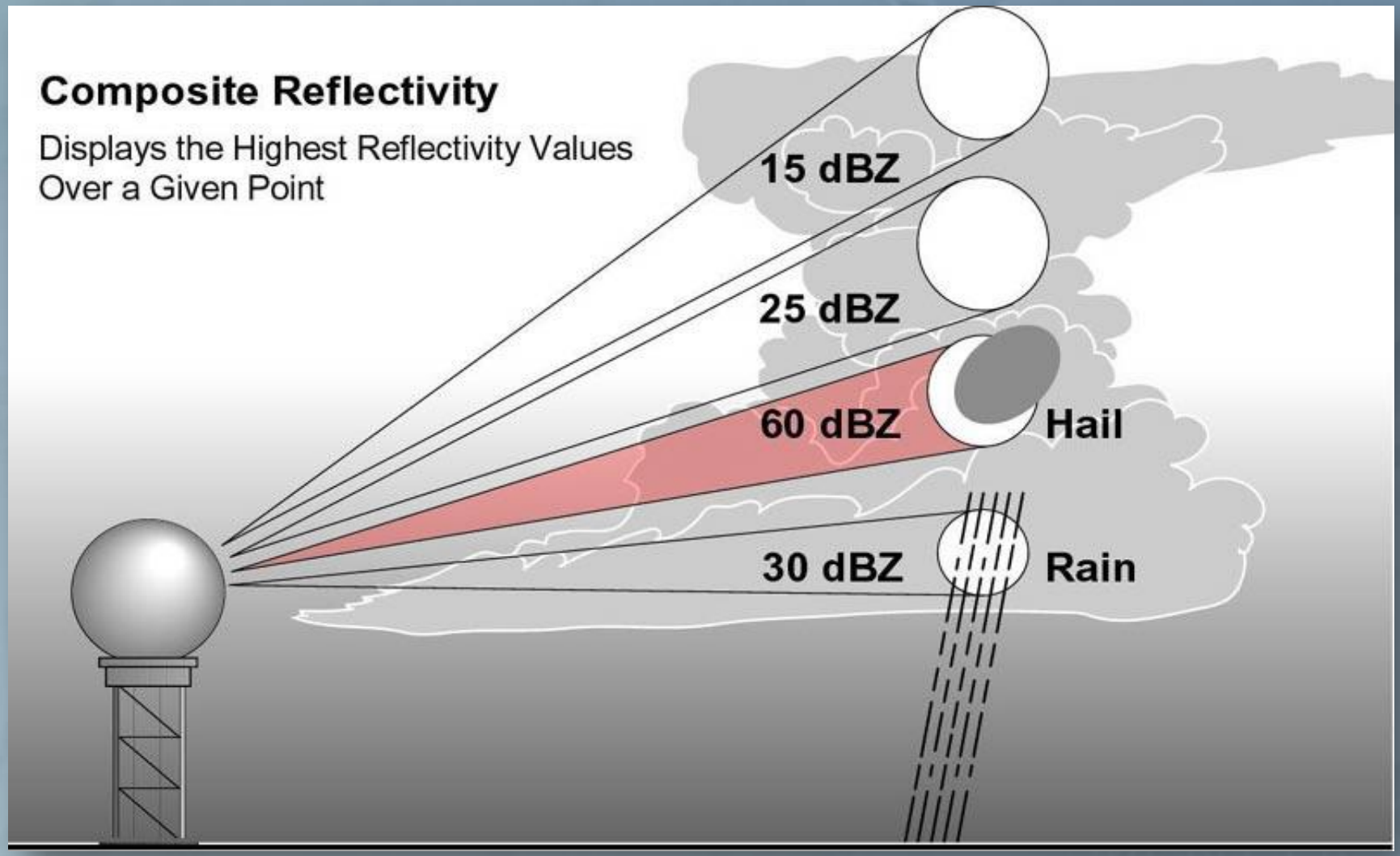




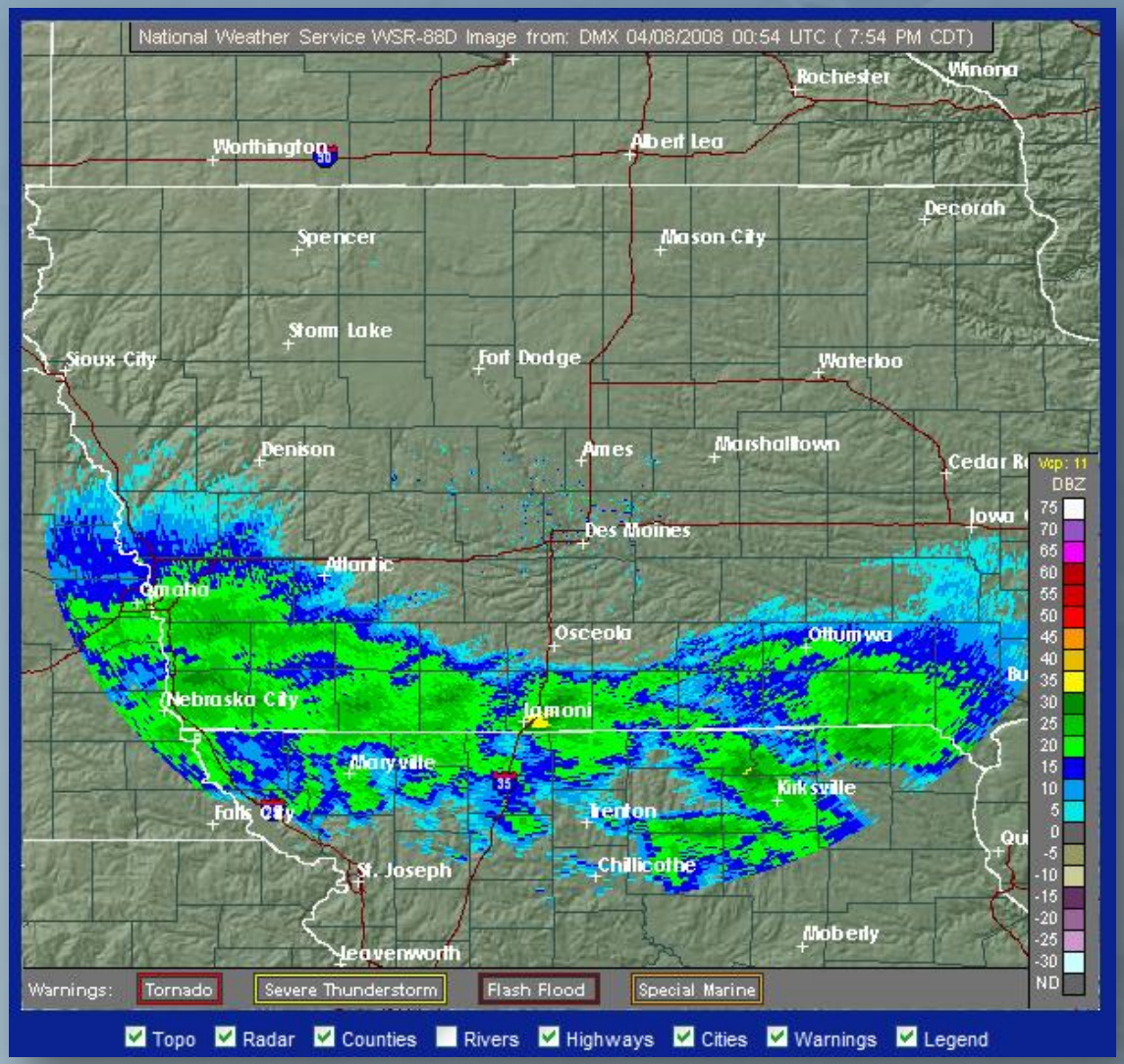
Base Reflectivity



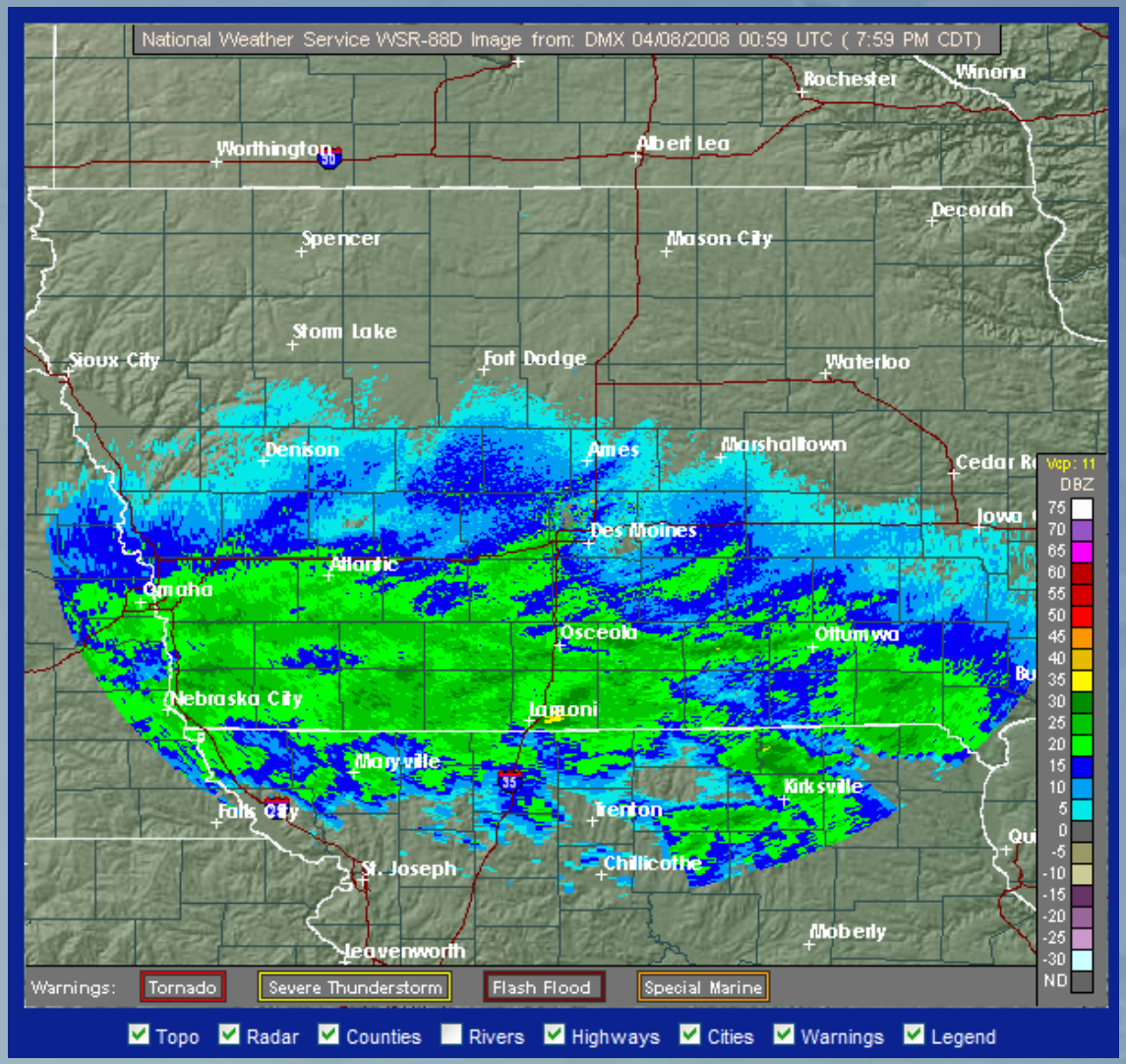
Composite Reflectivity



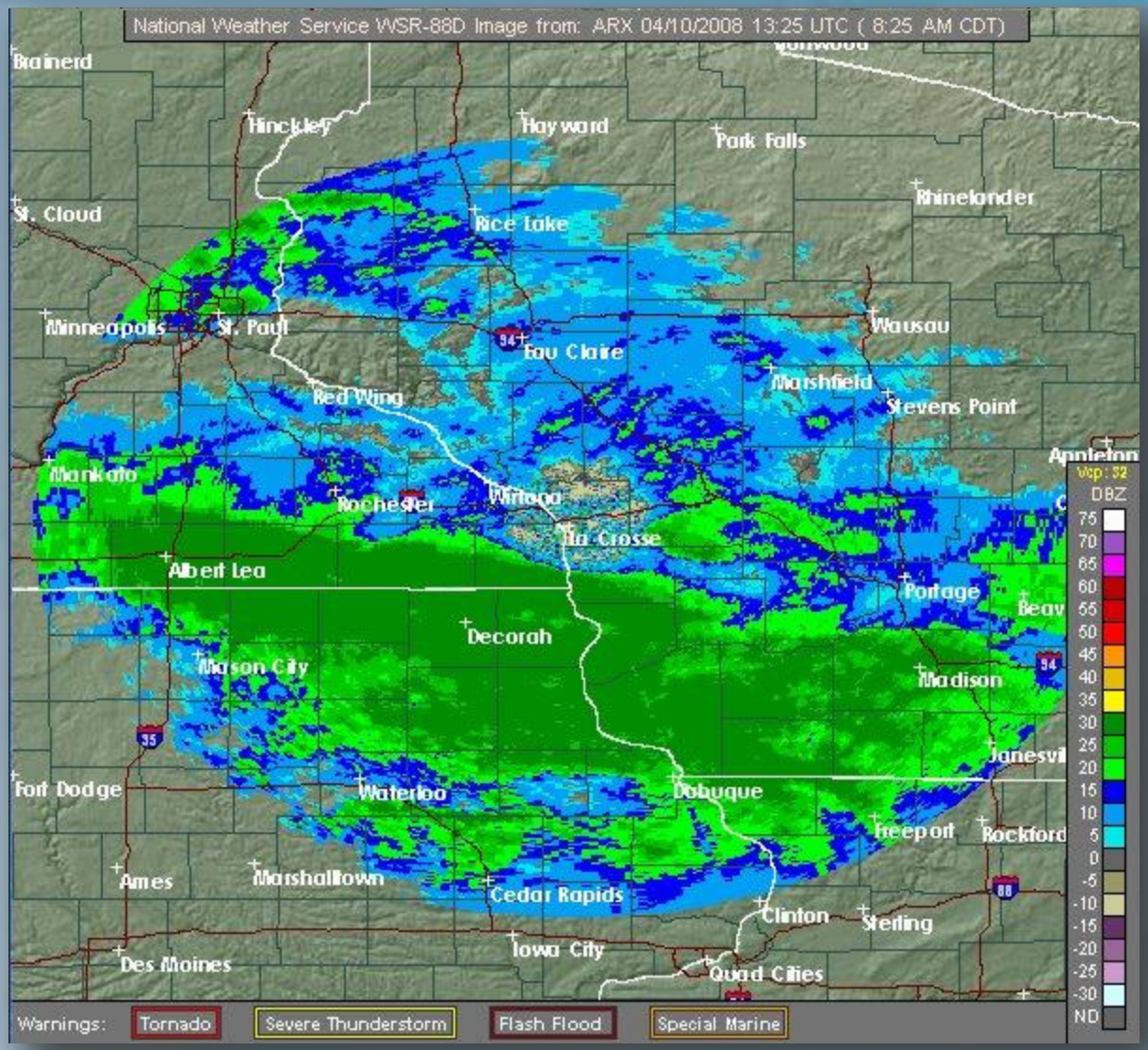
Base Reflectivity



Composite Reflectivity

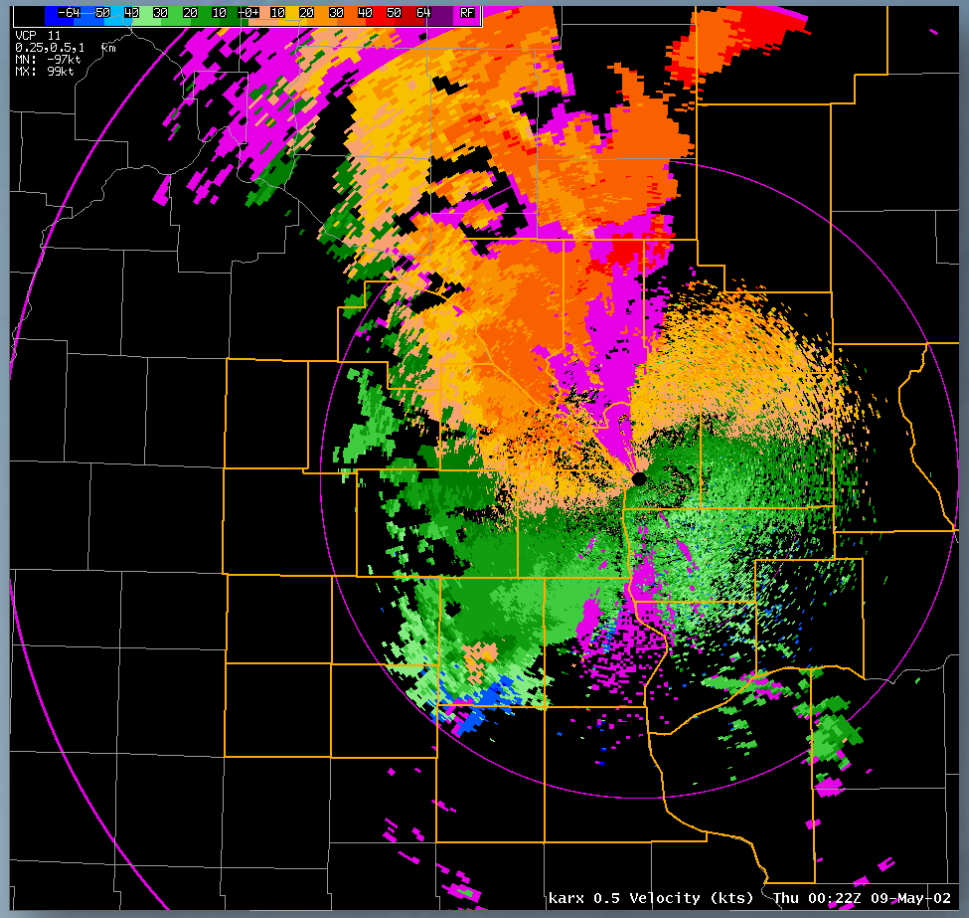


Base vs. Composite

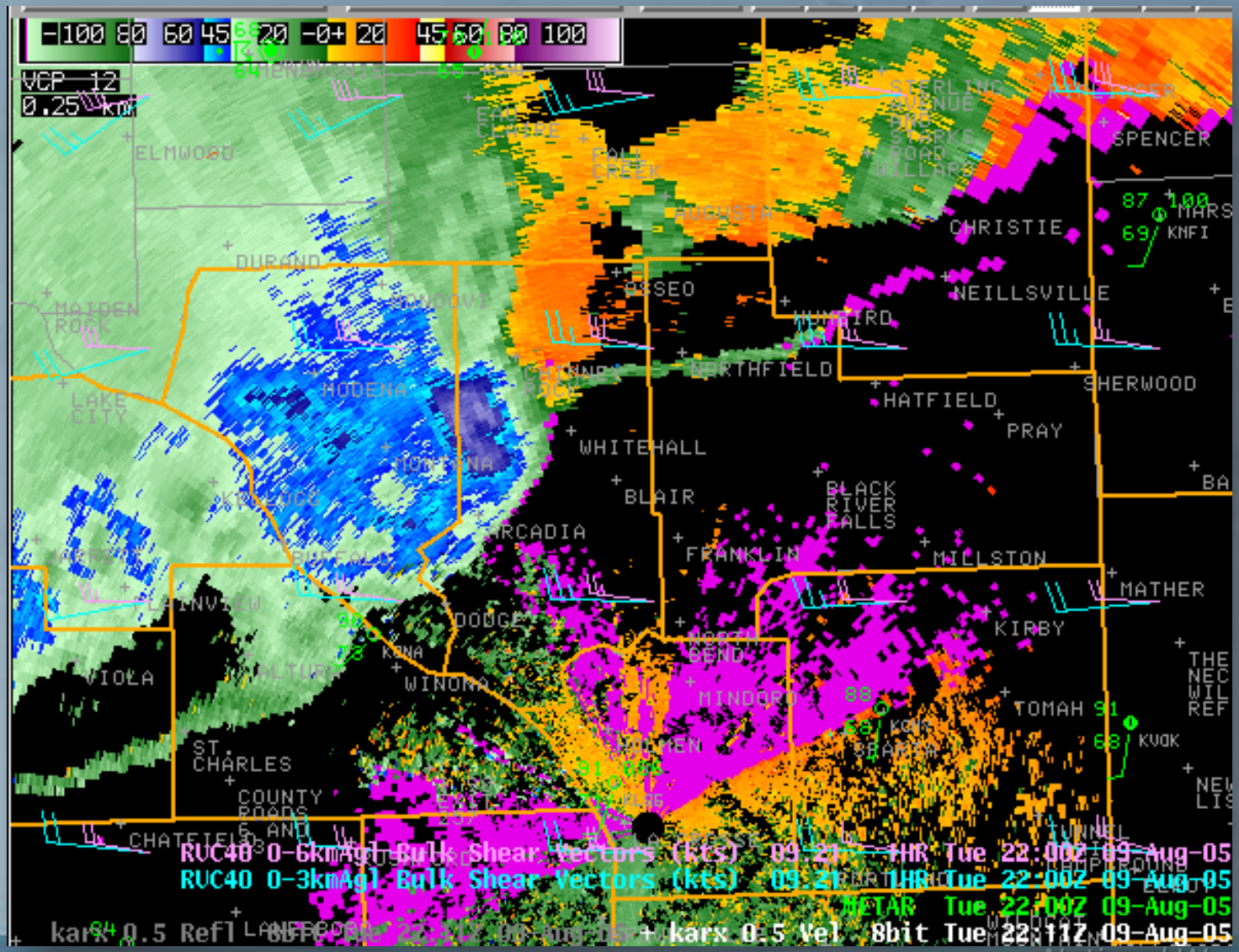


Base Velocity

- Base data
- Scale is knots
- Cool colors = inbound wind (neg)
- Warm colors = outbound wind (pos)
- Used for downburst, straight-line wind detection

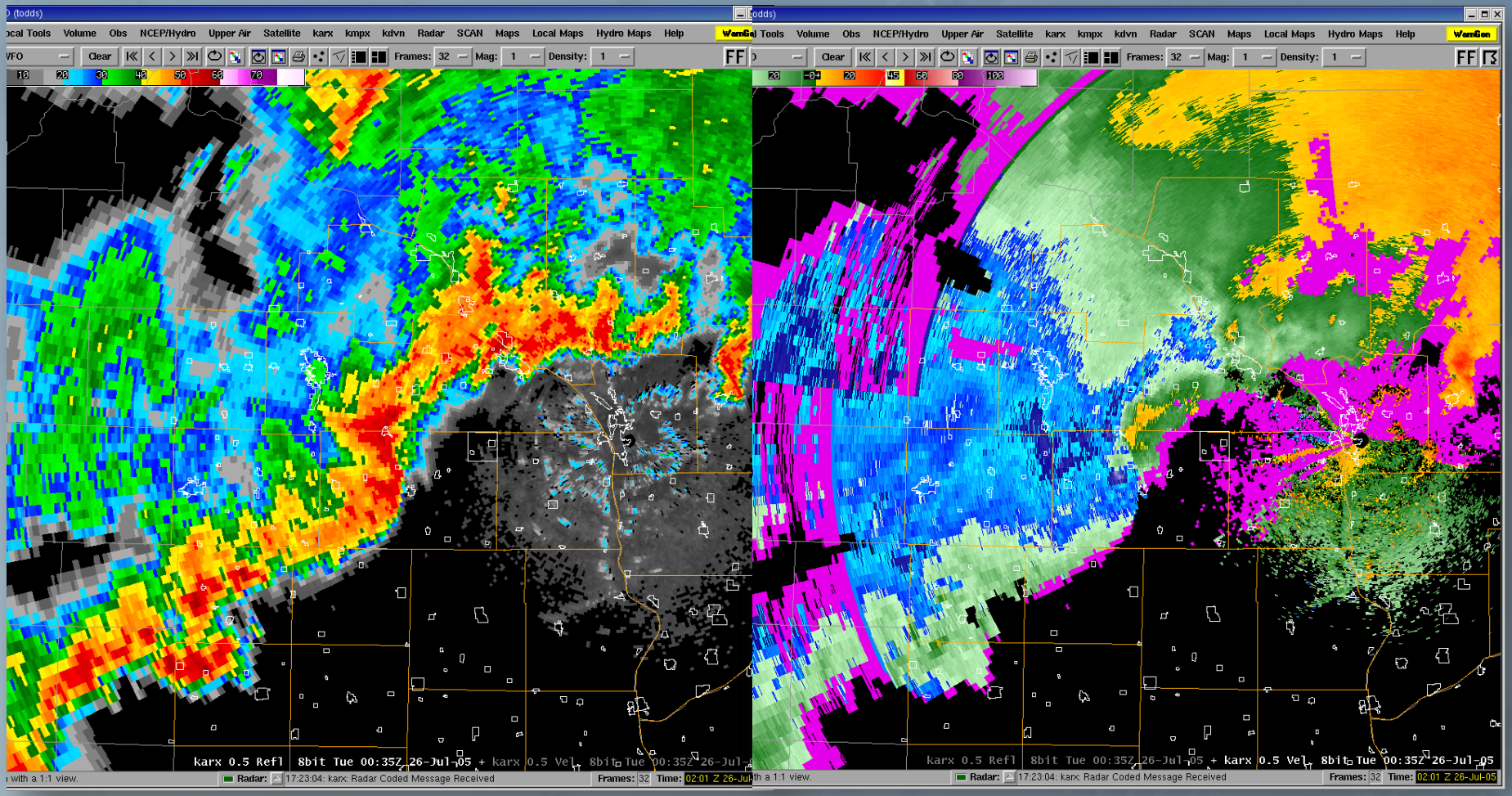


August 9, 2005



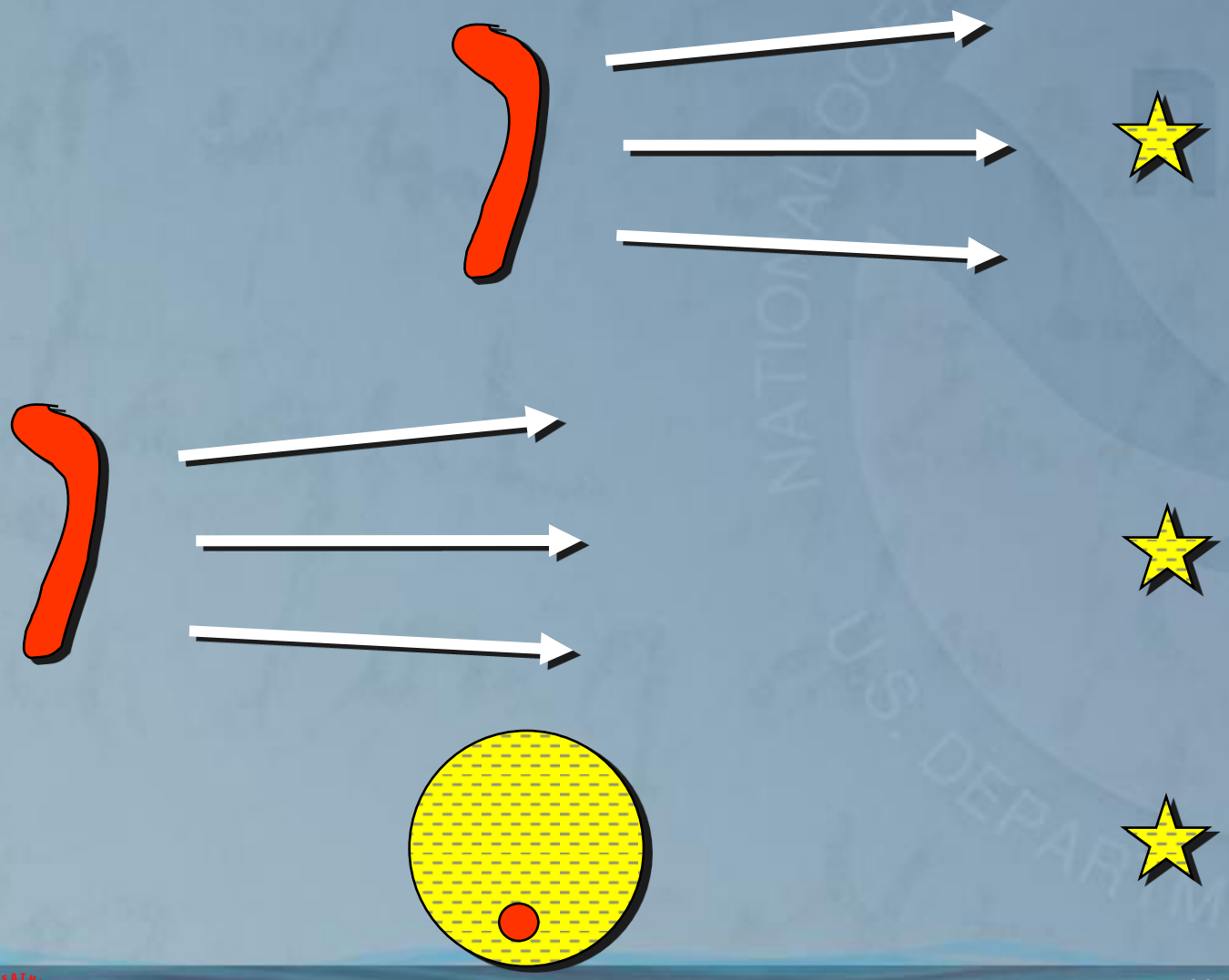
National Weather Service
La Crosse, WI

July 25, 2005



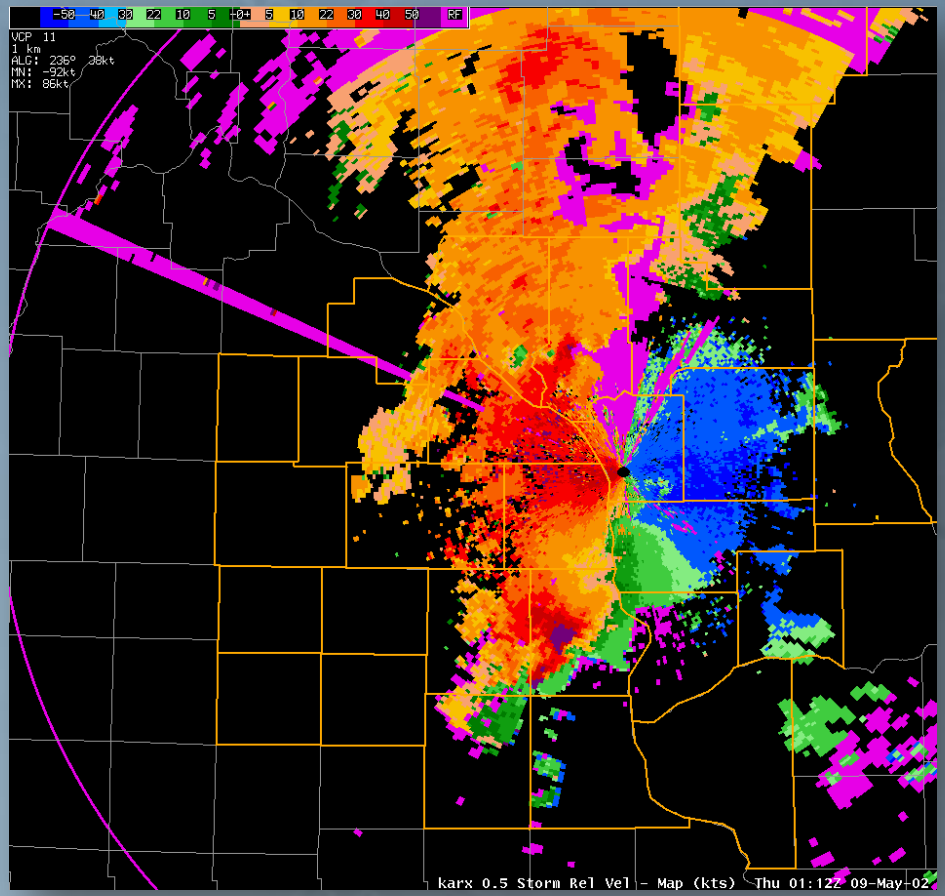
National Weather Service
La Crosse, WI

Ground Relative vs Storm Relative

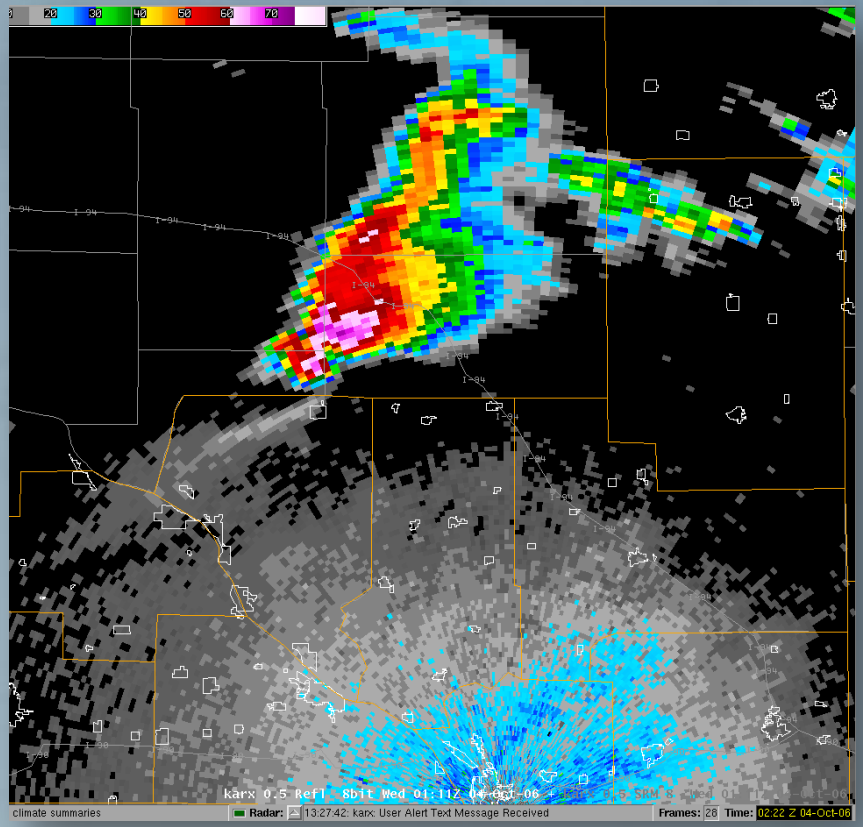


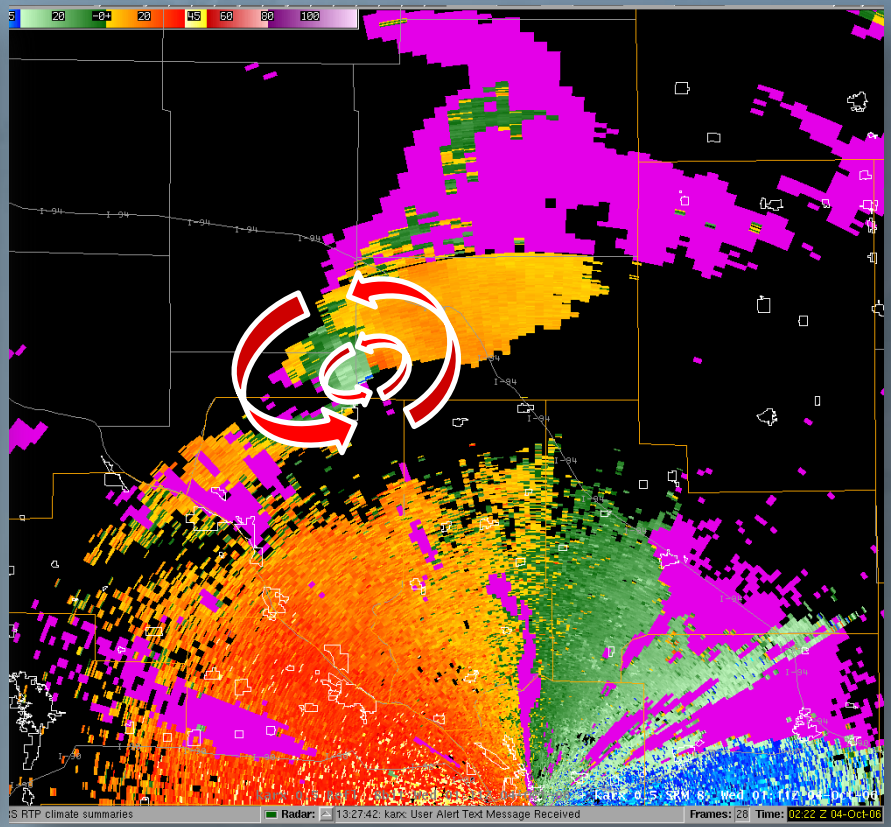
Storm Relative Velocity (SRM)

- Used for rotation detection
- Scale is knots
- Cool colors = inbound wind (neg)
- Warm colors = outbound wind (pos)

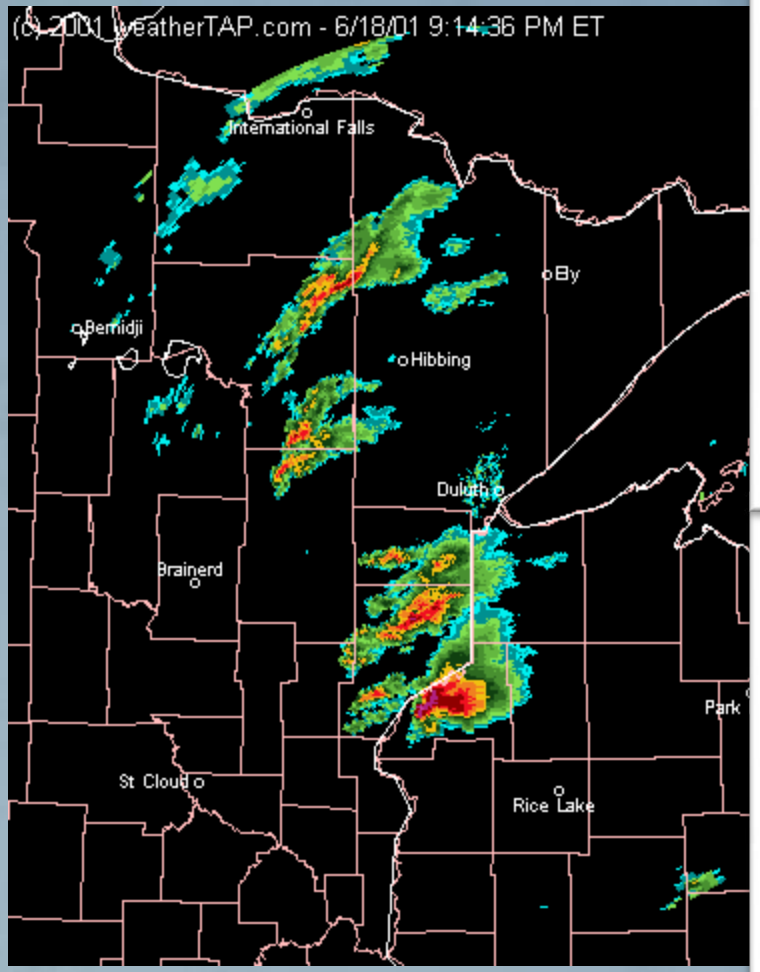


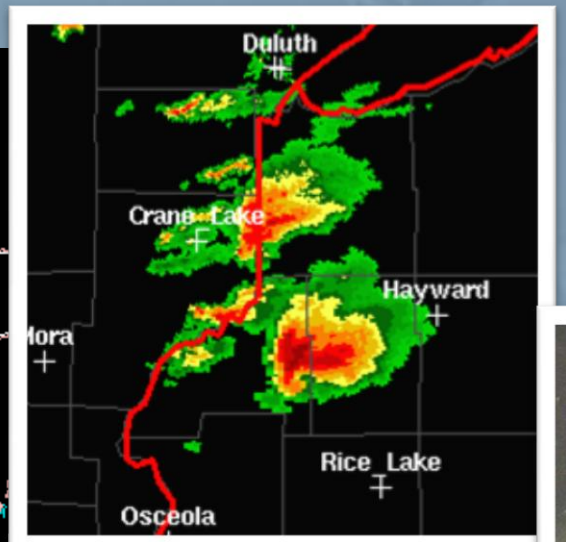
Storm Relative Velocity (SRM)

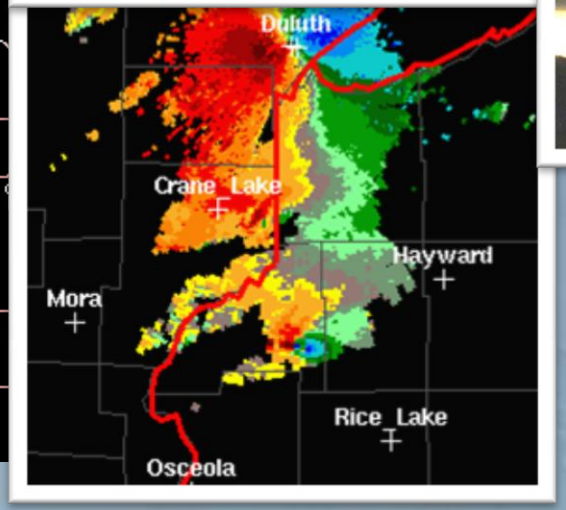




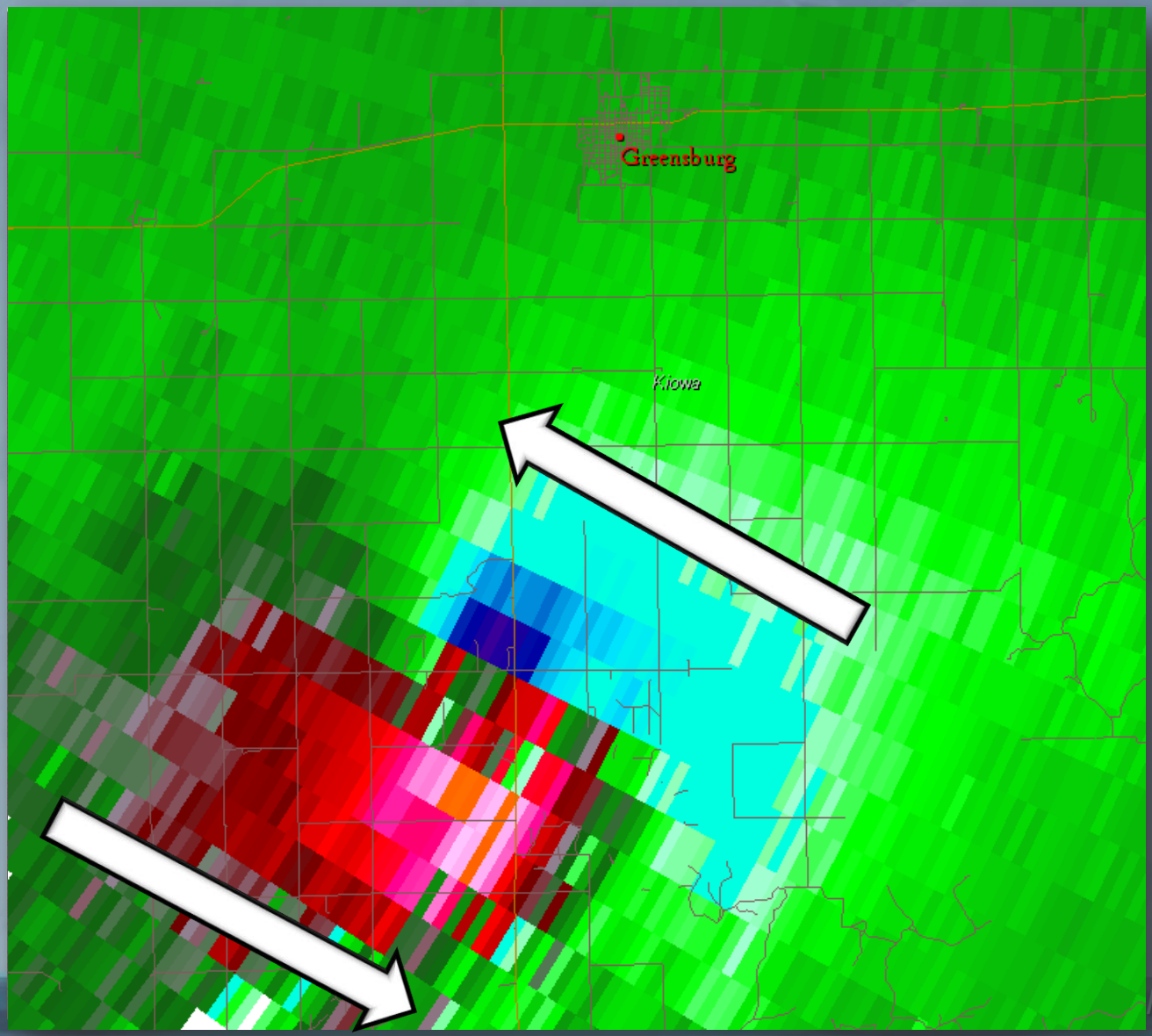
June 18, 2001


(c) 2001 WeatherTAP.com - 6/18/01 9:14:36 PM ET
International Falls
Bemidji
Hibbing
Duluth
Brainerd
St Cloud
Rice Lake

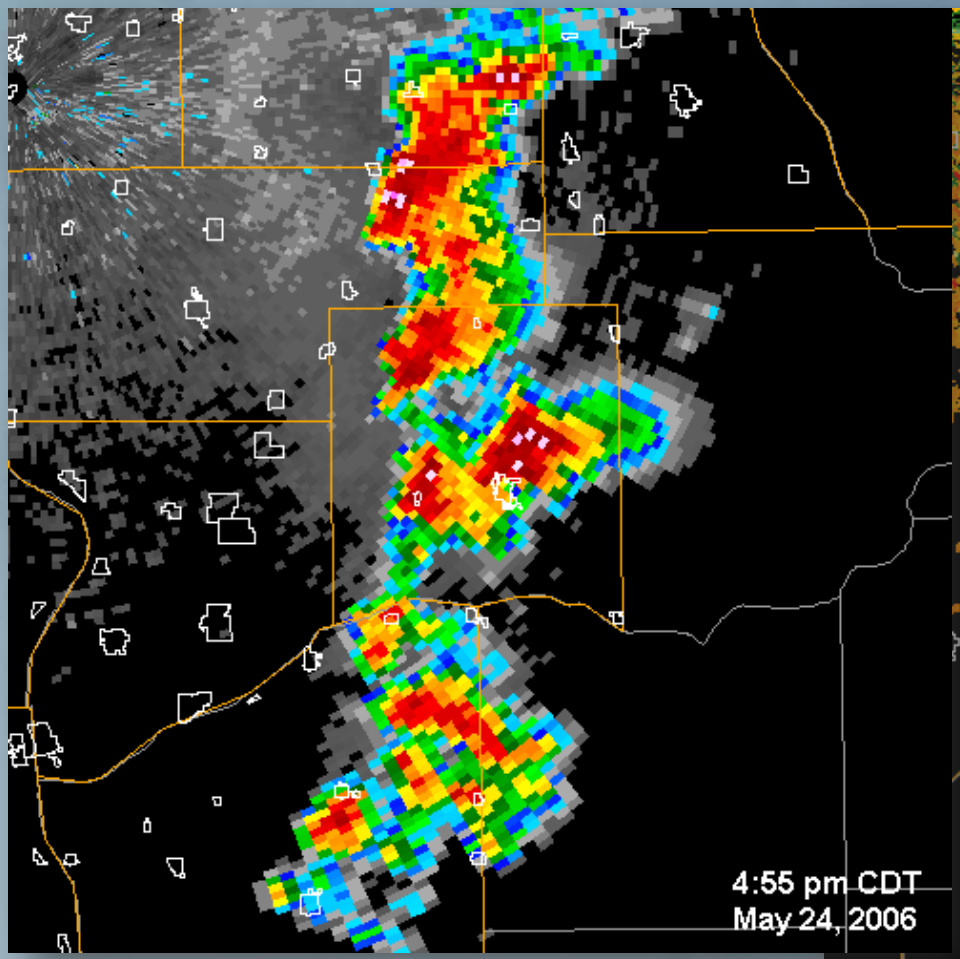

Duluth
Crane Lake
Hayward
Mora
Rice Lake
Osceola

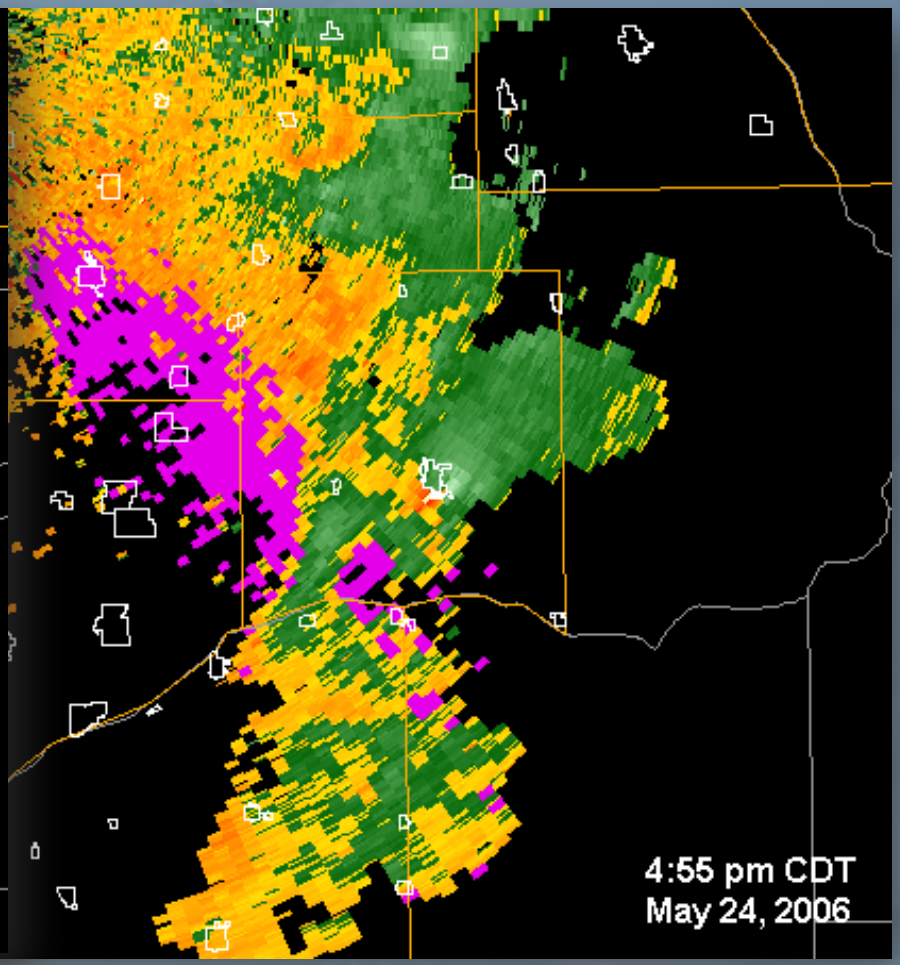

Duluth
Crane Lake
Hayward
Mora
Rice Lake
Osceola

Greensburg, KS (EF5)

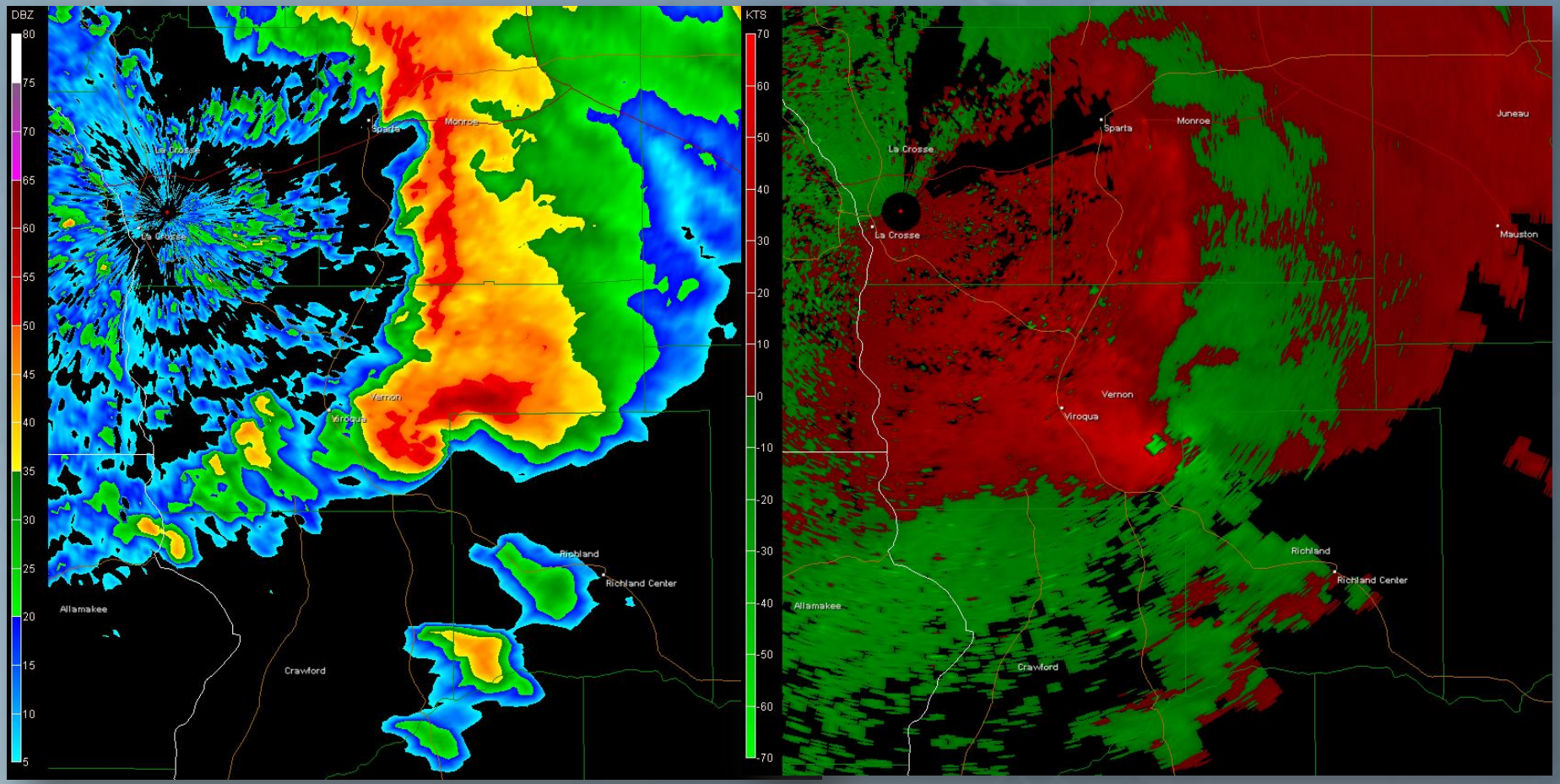


May 24, 2006

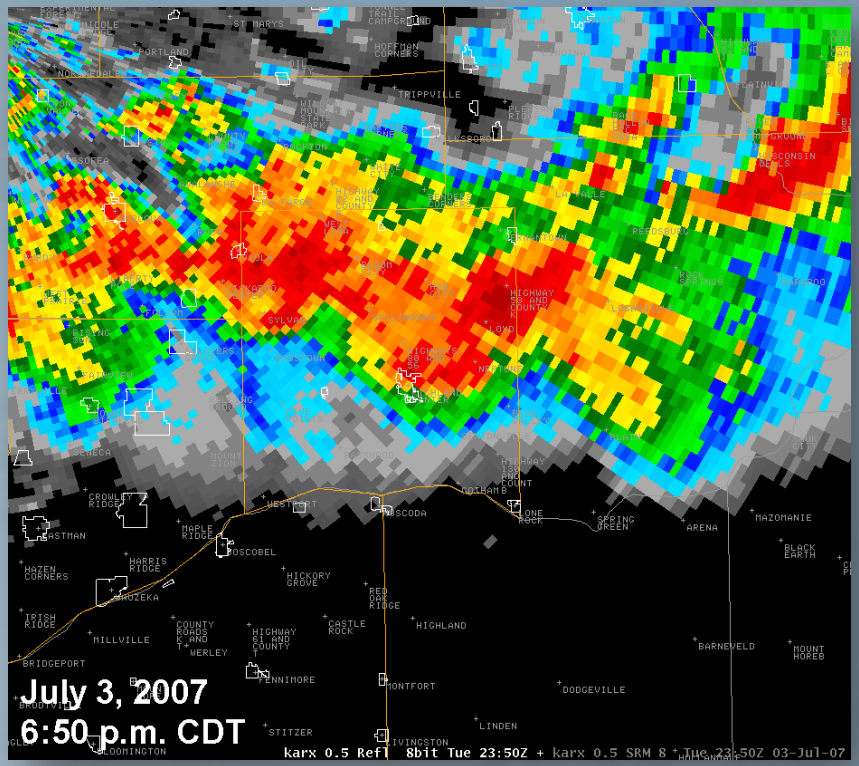


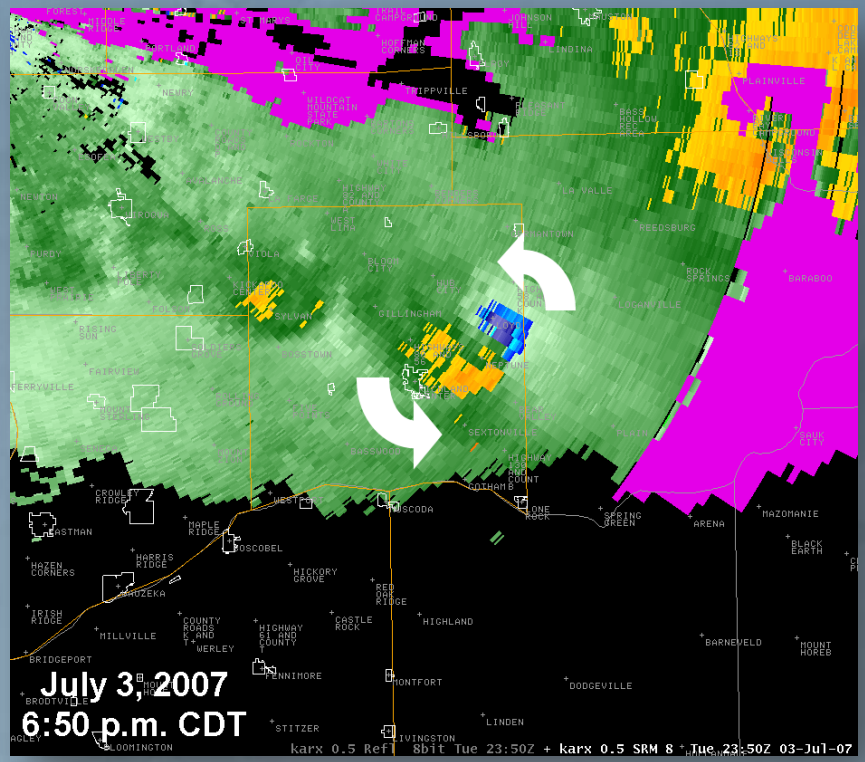


August 18, 2005



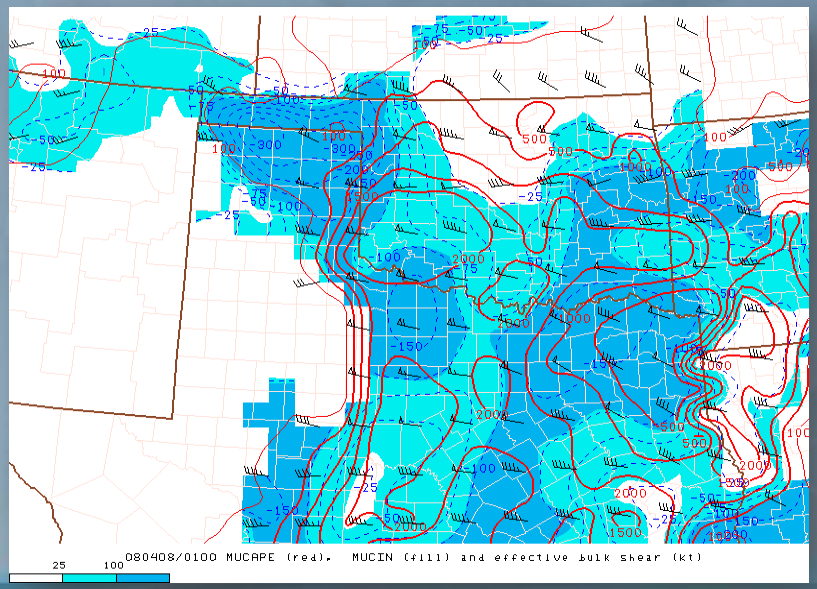
July 3, 2007


July 3, 2007
6:50 p.m. CDT
karx 0.5 Refl 8bit Tue 23:50Z + karx 0.5 SRM 8 + Tue 23:50Z 03-Jul-07

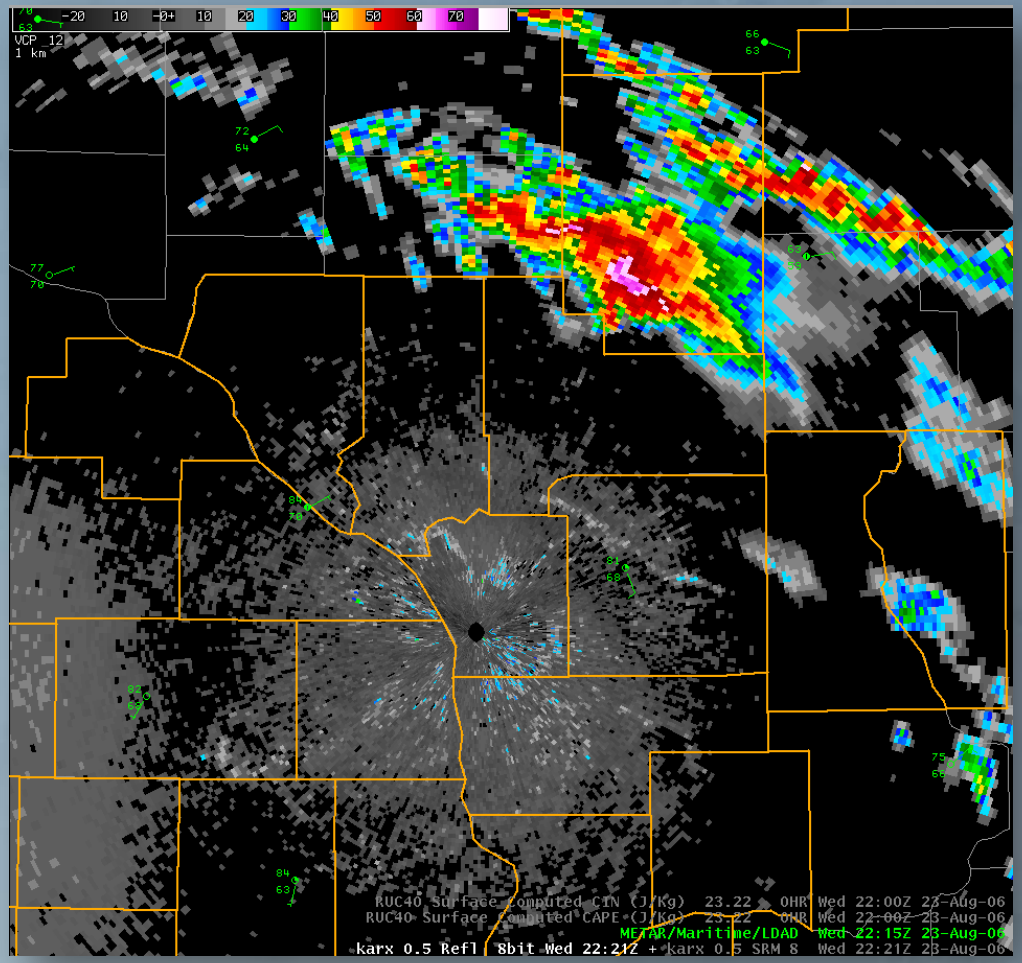

July 3, 2007
6:50 p.m. CDT
karx 0.5 Refl 8bit Tue 23:50Z + karx 0.5 SRM 8 + Tue 23:50Z 03-Jul-07

Be careful…

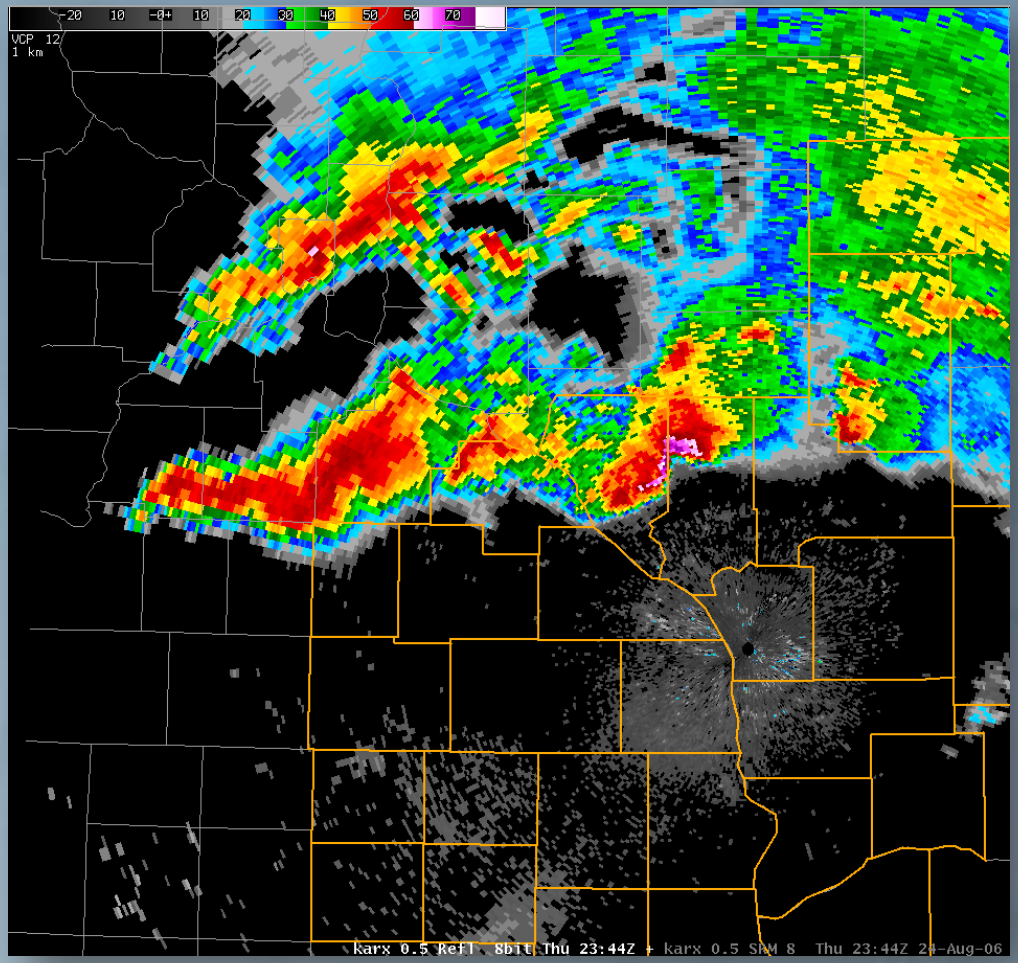
- Meteorologists track environment setup
- Helps determine expected storm character
- Perhaps biggest improvement in warning decisions since Doppler Radars installed



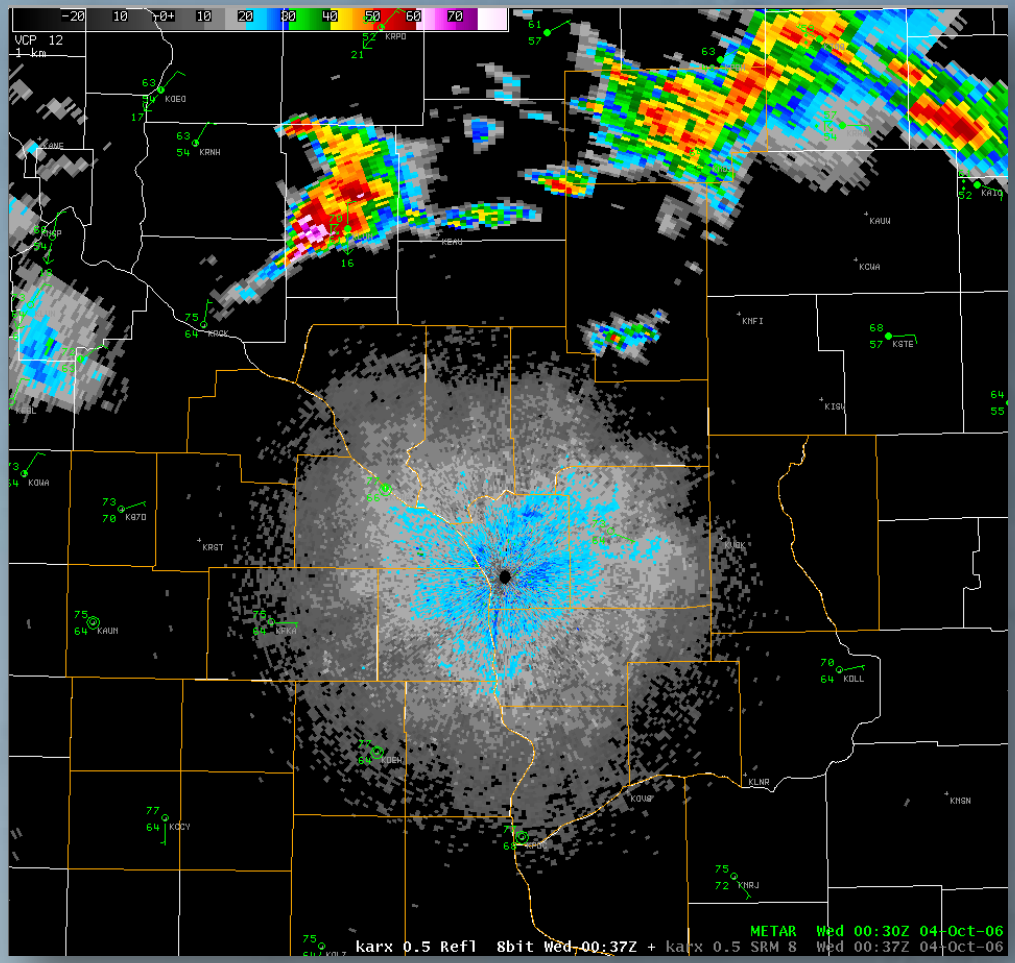
No Tornado


-20 10 -0+ 10 20 30 40 50 60 70
VCP 12
1 km
RUC40 Surface Computed CIN (J/Kg) 23.22 0HR Wed 22:00Z 23-Aug-06
RUC40 Surface Computed CAPE (J/Kg) 23.22 0HR Wed 22:00Z 23-Aug-06
METAR/Maritime/LDAD Wed 22:15Z 23-Aug-06
karx 0.5 Refl 8bit Wed 22:21Z + karx 0.5 SRM 8 Wed 22:21Z 23-Aug-06

No Tornado

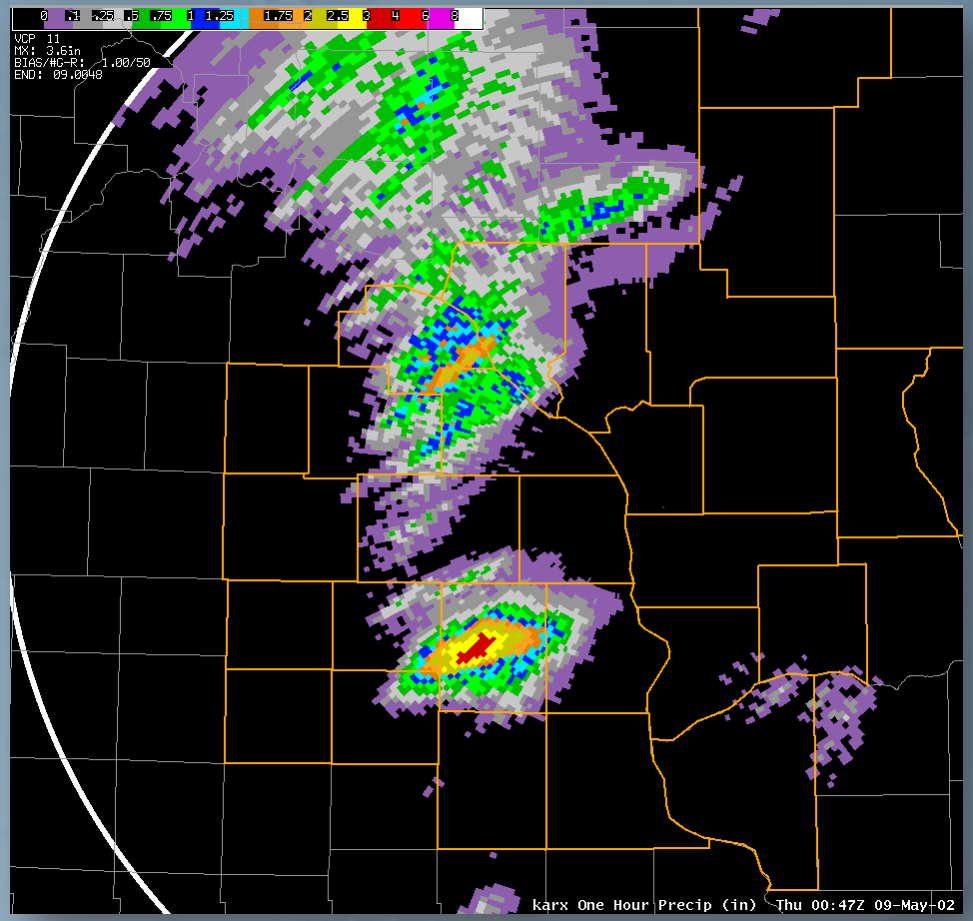

-20 10 -0+ 10 20 30 40 50 60 70
VCP 12
1 km
karx 0.5 Refl 8bit Thu 23:44Z + karx 0.5 SRM 8 Thu 23:44Z 24-Aug-06

No Tornado

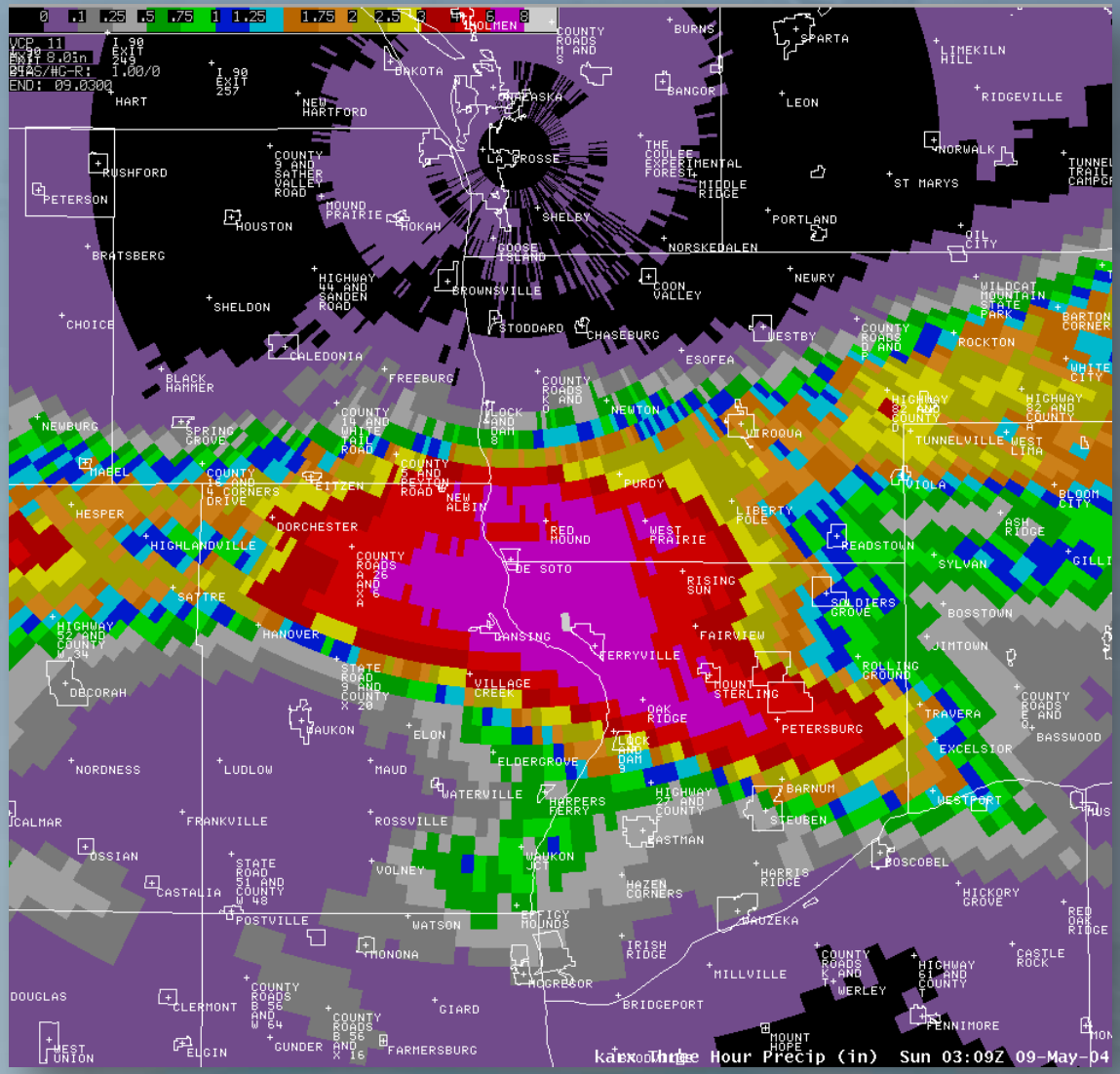

VCP 12
1 km
karx 0.5 Refl 8bit Wed 00:37Z + karx 0.5 SRM 8 Wed 00:37Z 04-Oct-06
METAR Wed 00:30Z 04-Oct-06

Precipitation Estimates

- Only an estimate
- Usually too high if storm has hail
- Used primarily for flash flood detection
- 1-hour / Storm Total

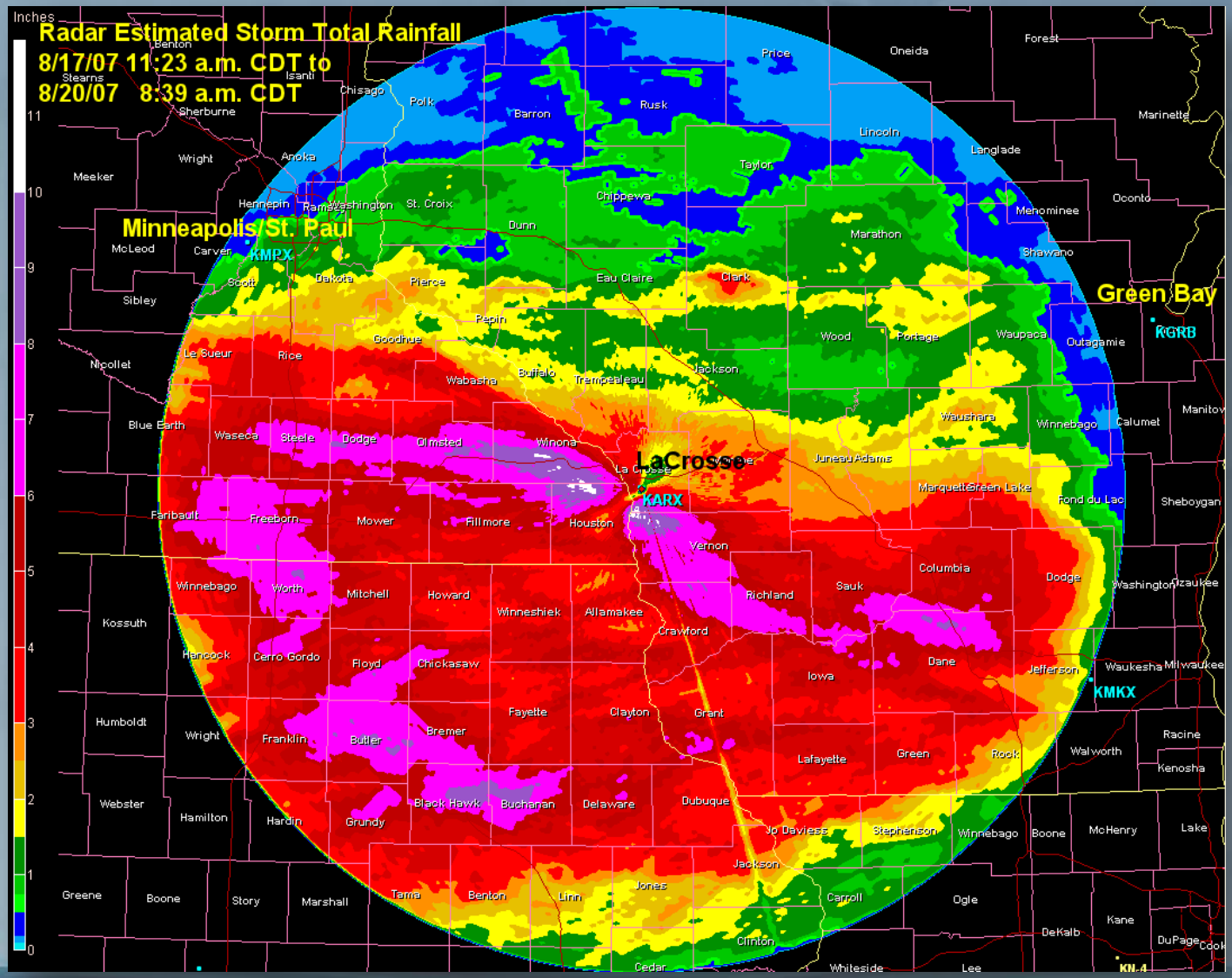


May 8, 2004



National Weather Service
La Crosse, WI

August 2007

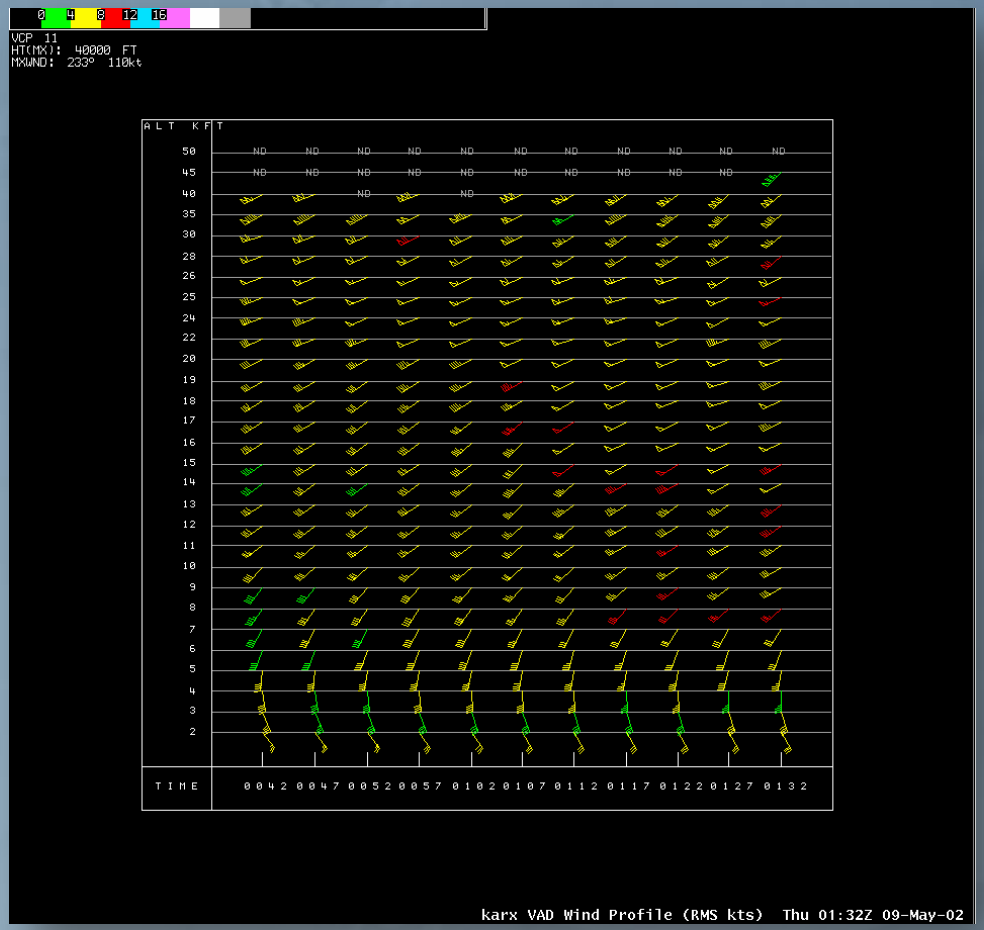


National Weather Service
La Crosse, WI

Other Radar Products

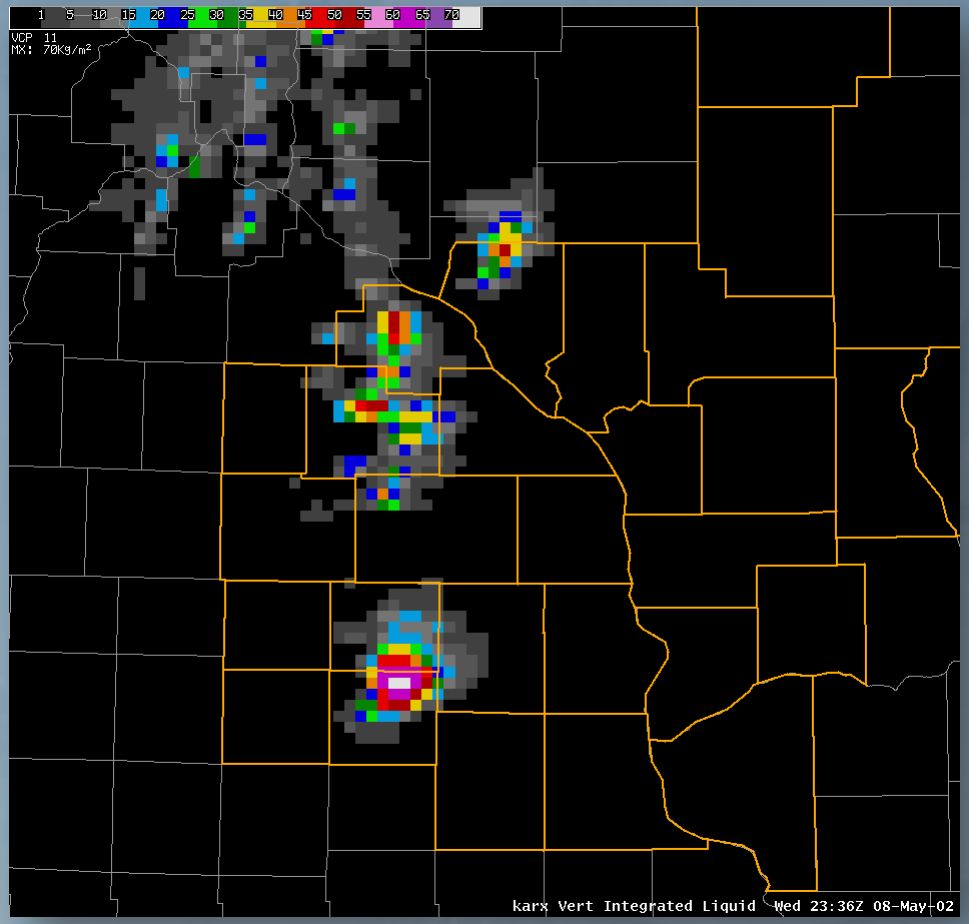
VAD Wind Profile

- Vertical wind profile
- Wind changes over past hour
- Needs clouds or precipitation

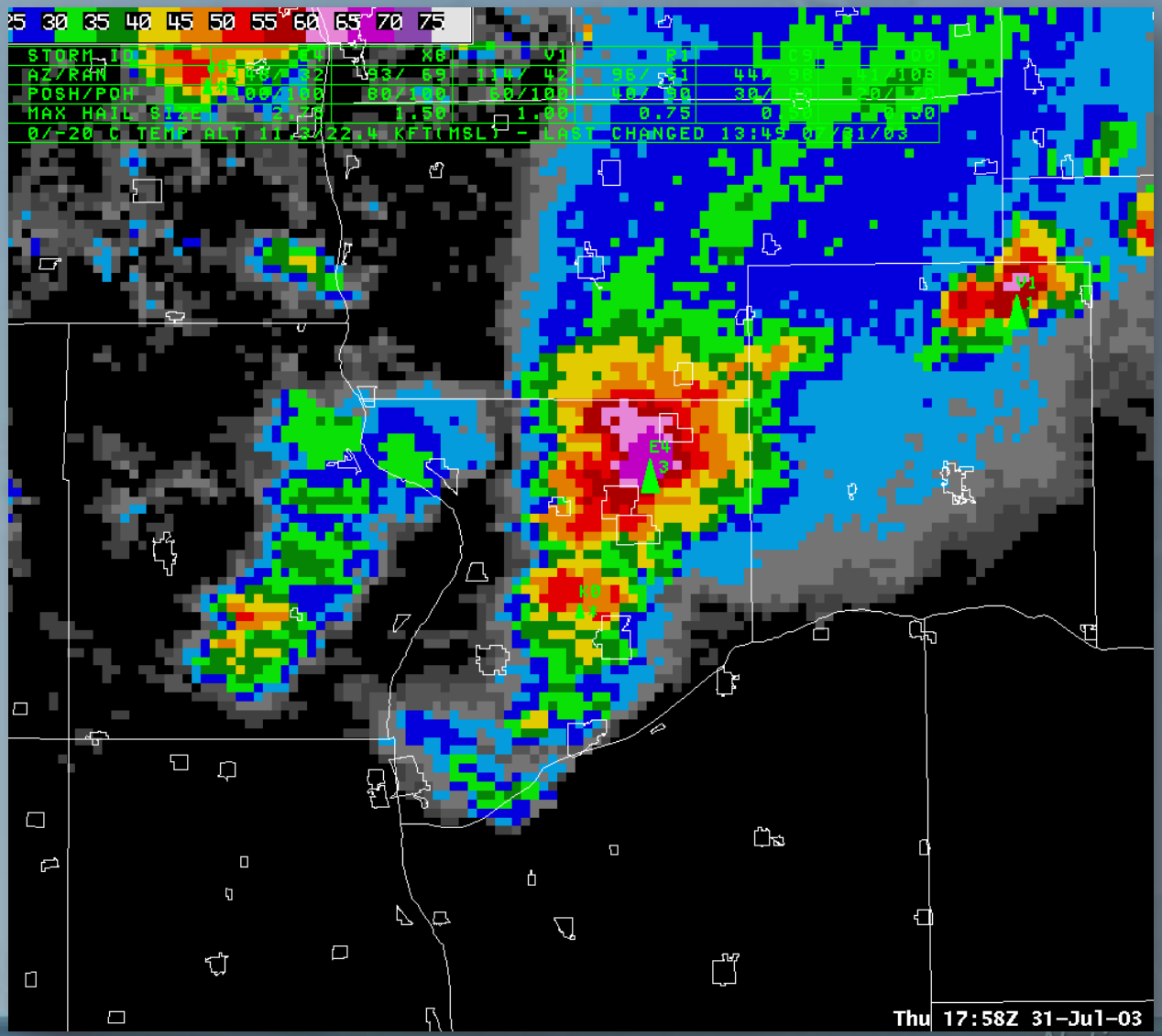


Vertically Integrated Liquid (VIL)

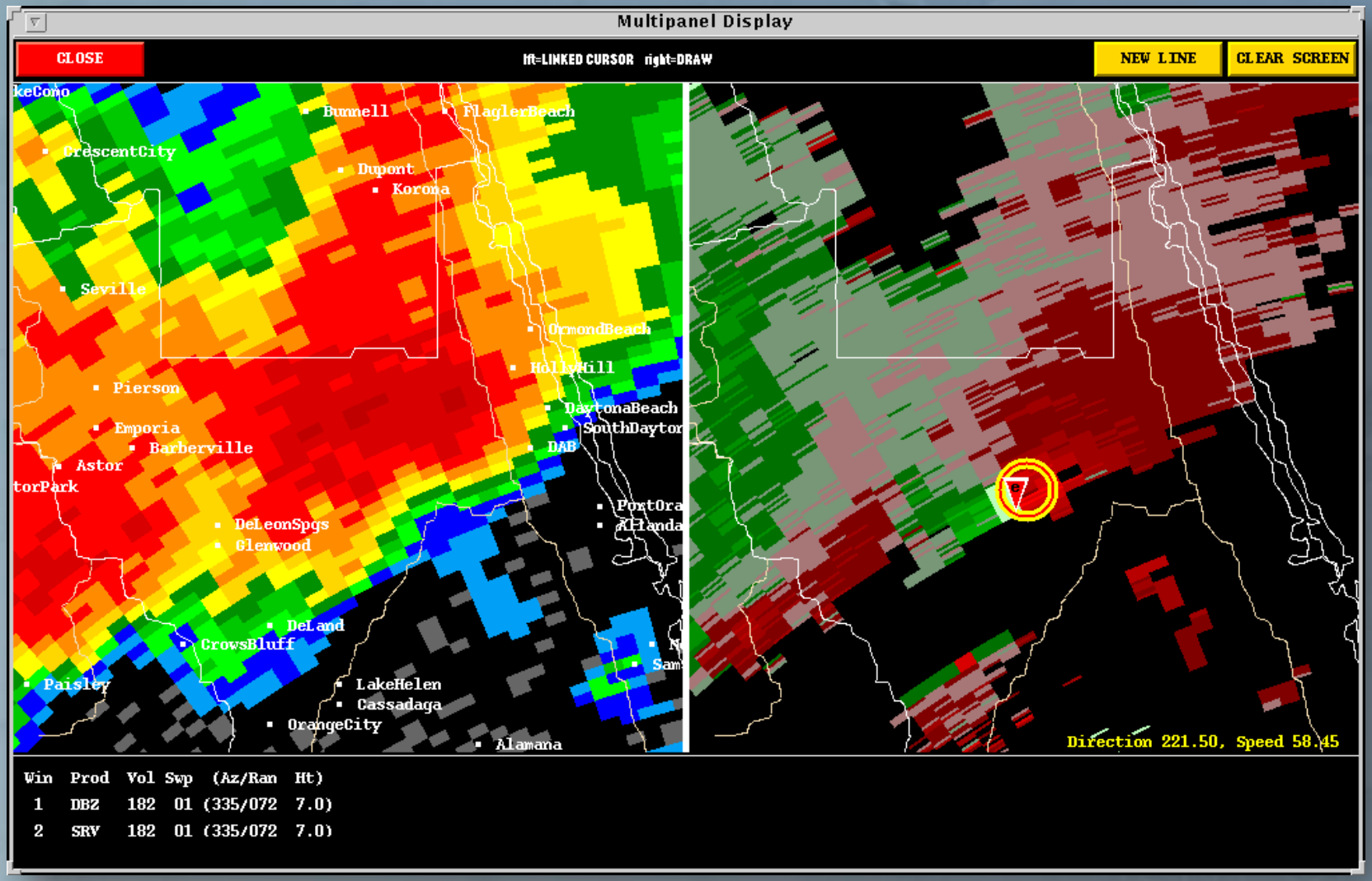
- Reflectivity converted to liquid values
- Pin-points most intense storms
- Hail gives very large values



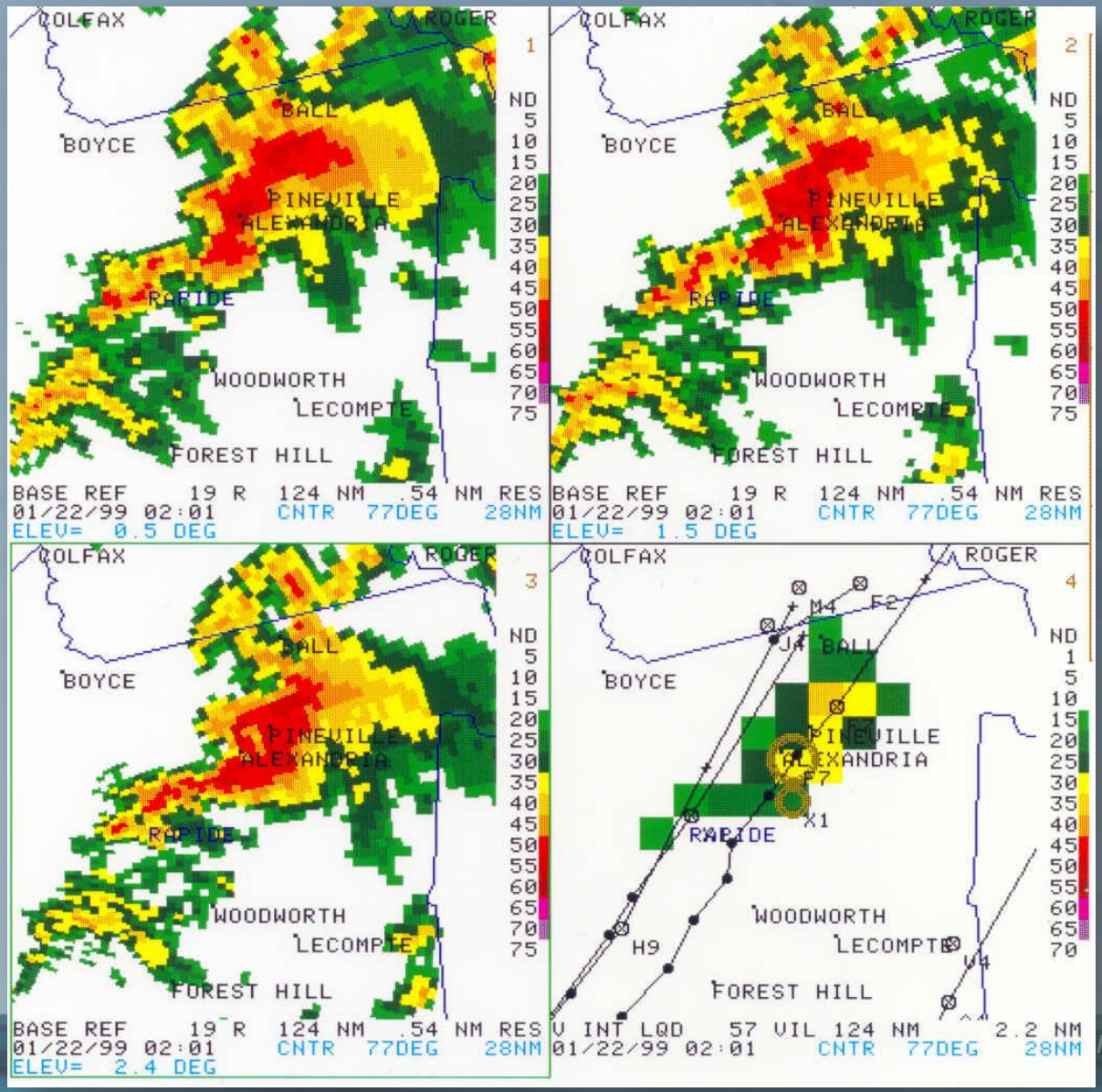
Hail Algorithm



Mesocyclone / Tornado Vortex

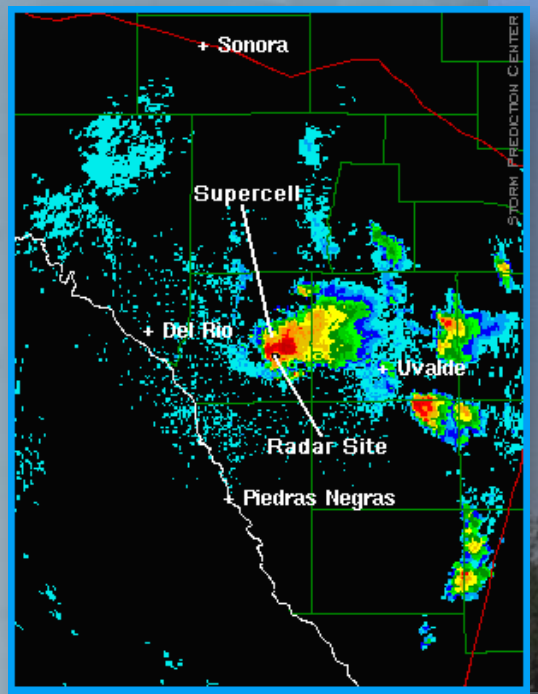


Four Panel View



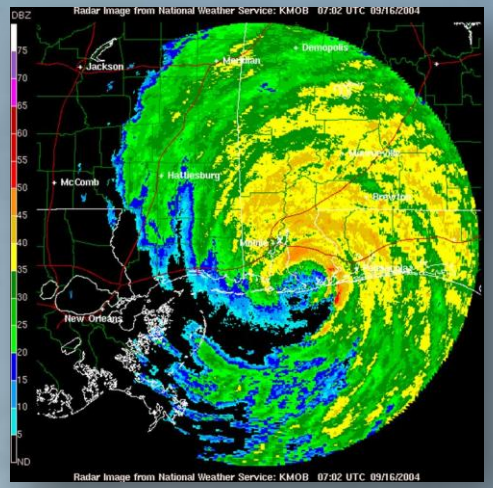
Del Rio, TX – May 26, 2001

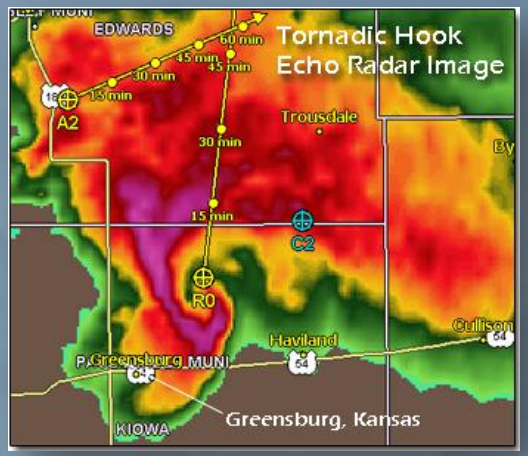
- Radar sampled by thunderstorm!

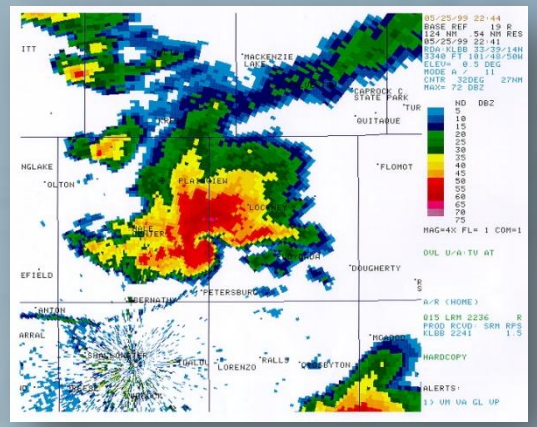
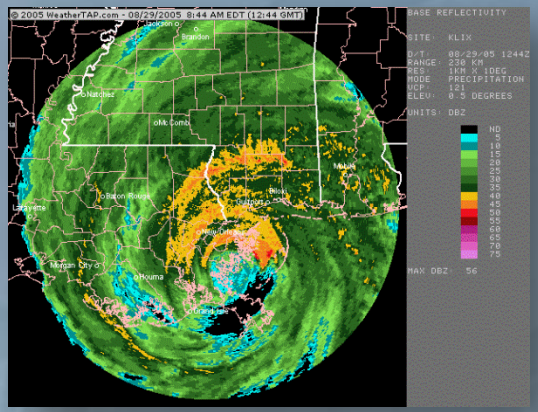


Damaging Supercell over Del Rio WSR-88D
0612 Z (1:12 a.m. CDT), 26 May 2001

Thank you!


Radar Image from National Weather Service: KMOB 07:02 UTC 09/16/2004
Jackson
Demopolis
McComb
Hattiesburg
New Orleans
Radar Image from National Weather Service: KMOB 07:02 UTC 09/16/2004


Tornadic Hook
Echo Radar Image
EDWARDS
60 min
45 min
30 min
15 min
A2
Trousdale
C2
R0
Haviland
Greensburg_MUNI
Greensburg, Kansas
KIOWA
Cullison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