



WFO Tucson Forecast Operations

Using Dual-Pol to Enhance Forecaster
Decision Making

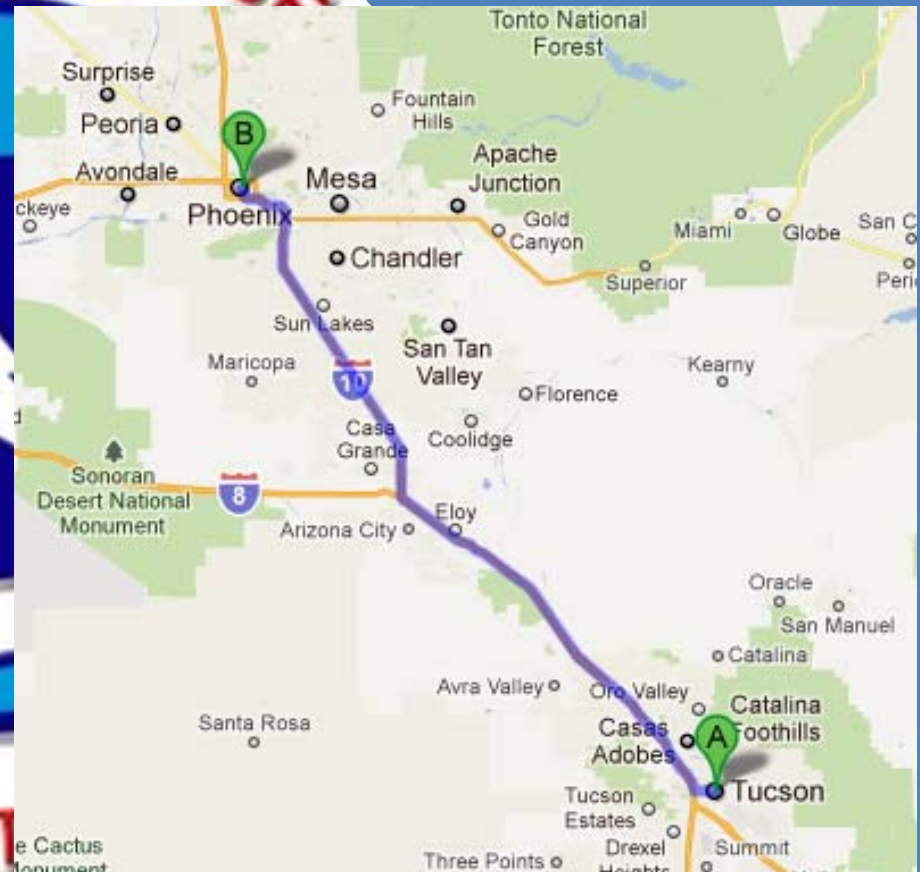
John J. Brost.

Science and Operations Officer
National Weather Service
Tucson, Arizona

Tucson Downpour Sept. 15th, 2011

Overview

- Phoenix (KIWA) dual-pol
 - ~ 80 Miles from Tucson Airport
 - ~ 1,380 feet elevation
- Tucson (KEMX) single-pol
 - ~ 24 Miles from Tucson Airport
 - ~ 2,600 feet elevation

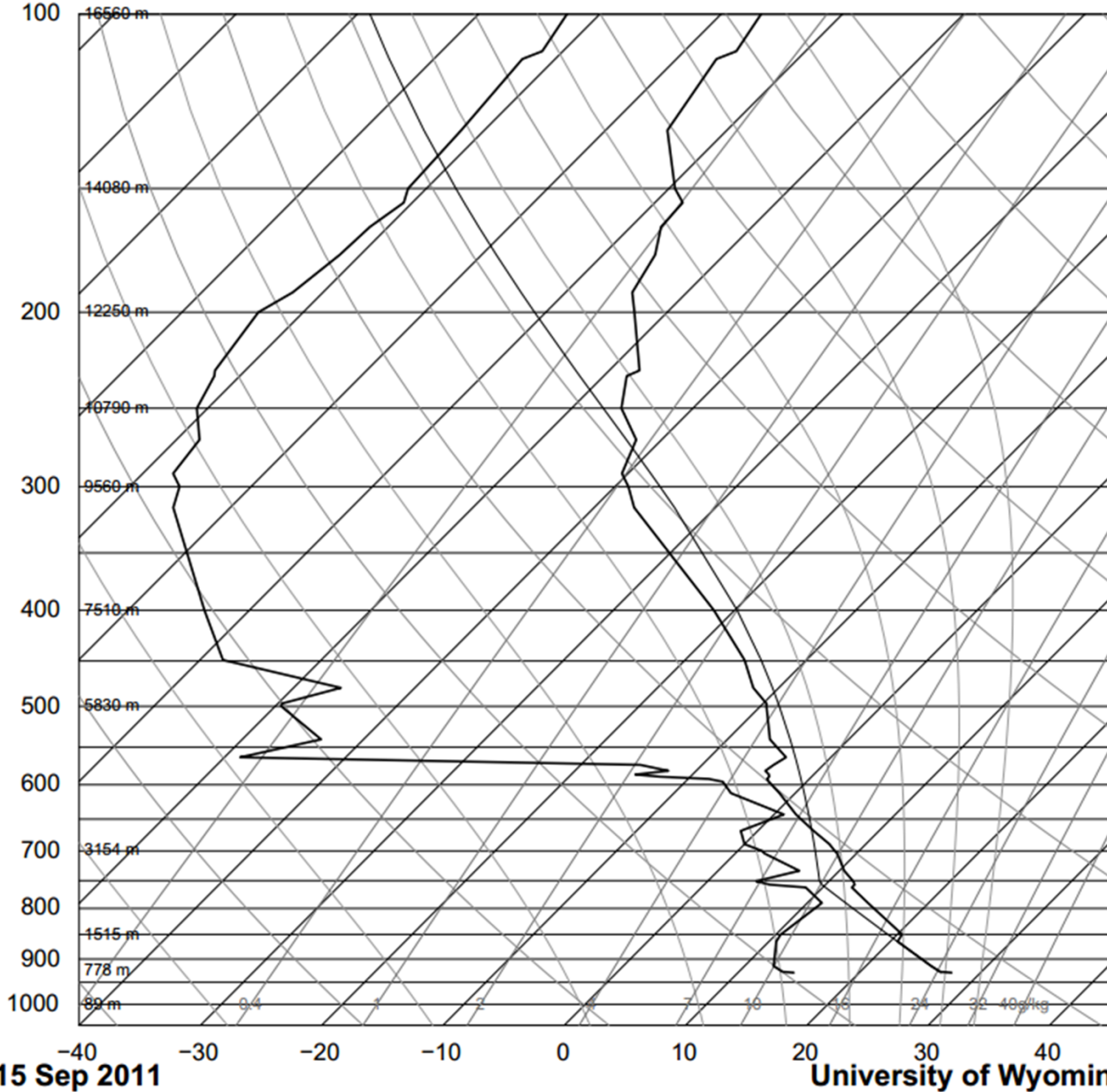


Heavy Rain Application

- September 15th, 2012
- Forecasters identified a heavy rain threat based on the atmospheric conditions
 - Moist unstable air
 - Approaching short wave low pressure system
 - Weakly sheared environment



72274 TUS Tucson



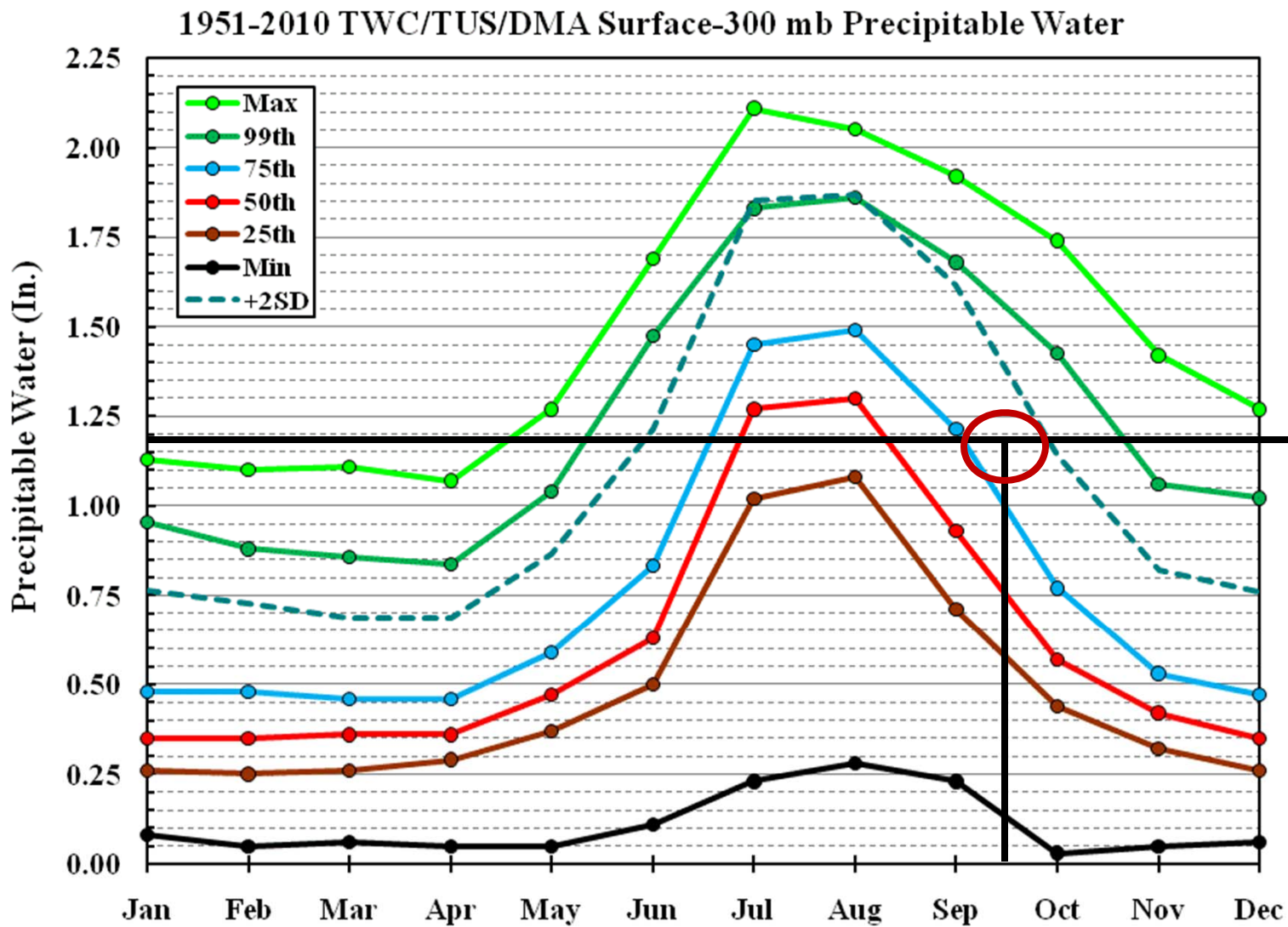
- SLAT 32.23
- SLON
- SELV 751.0
- SHOW -1.03
- LIFT -1.10
- LFTV -1.74
- SWET 177.7
- KINX 34.30
- CTOT 19.90
- VTOT 29.90
- TOTL 49.80
- CAPE 496.7
- CAPV 589.3
- CINS -122.
- CINV -108.
- EQLV 274.4
- EQTV 274.1
- LFCT 665.0
- LFCV 674.0
- BRCH 19.82
- BRCV 23.51
- LCLT 282.5
- LCLP 754.1
- MLTH 306.2
- MLMR 9.93
- THCK 5741.
- PWAT 28.07

PWAT = 1.1"

18Z 15 Sep 2011

University of Wyoming

Brief Atmospheric Review for Sept. 15th



12Z Sounding
PWAT ~ 1.2"

18Z Sounding
PWAT ~ 1.1"

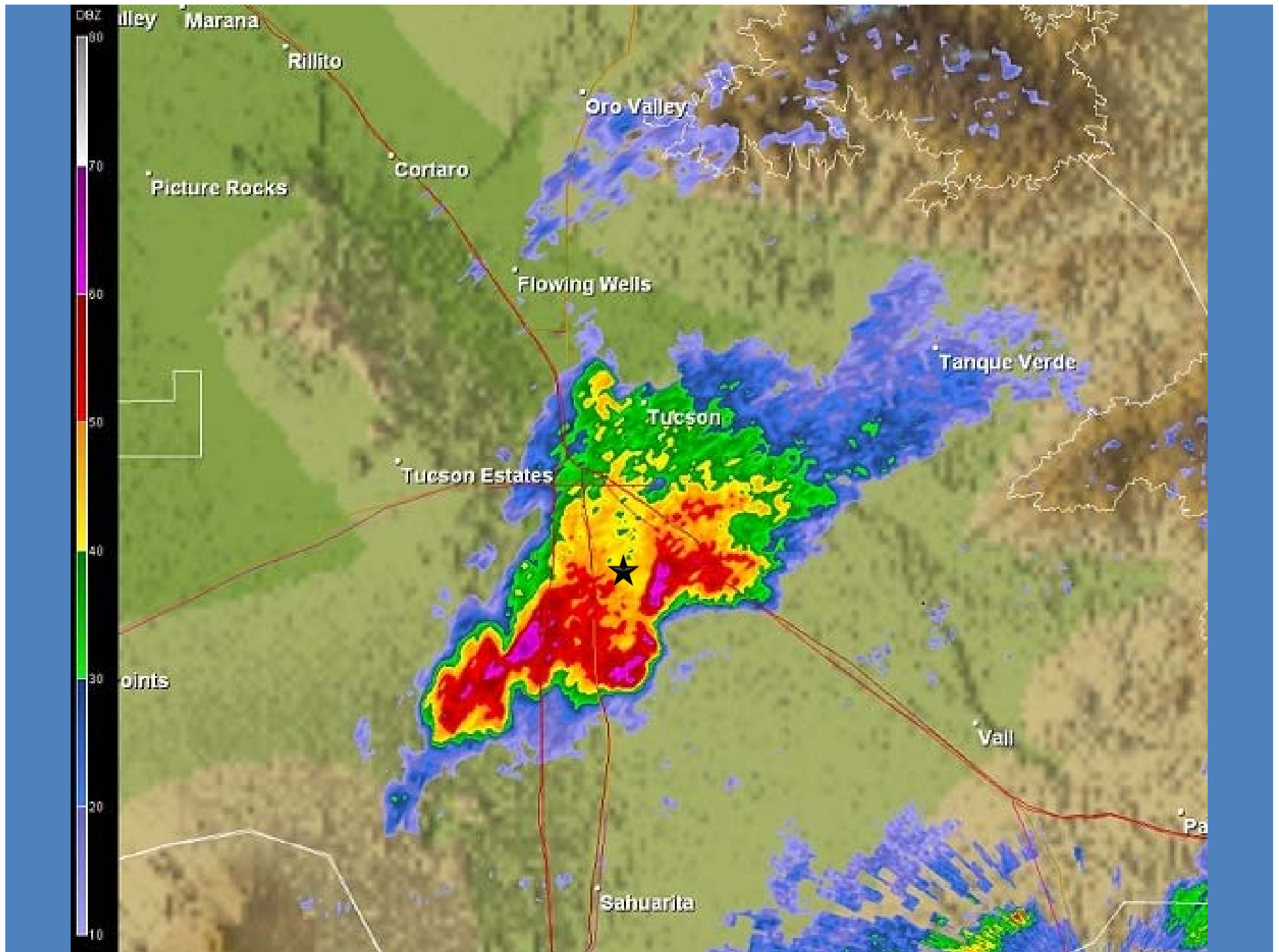
PWAT
Climatology ~
80th Percentile

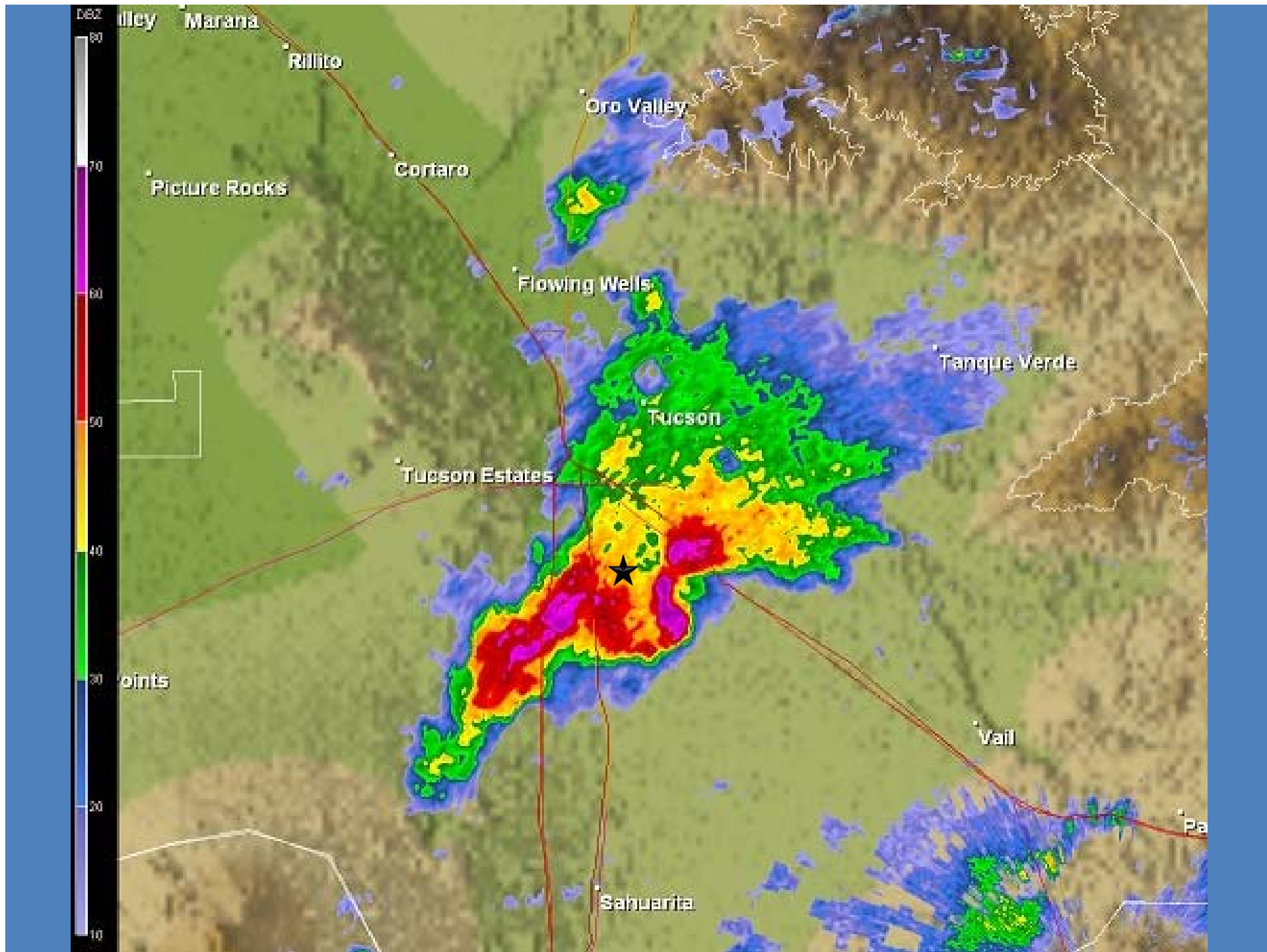


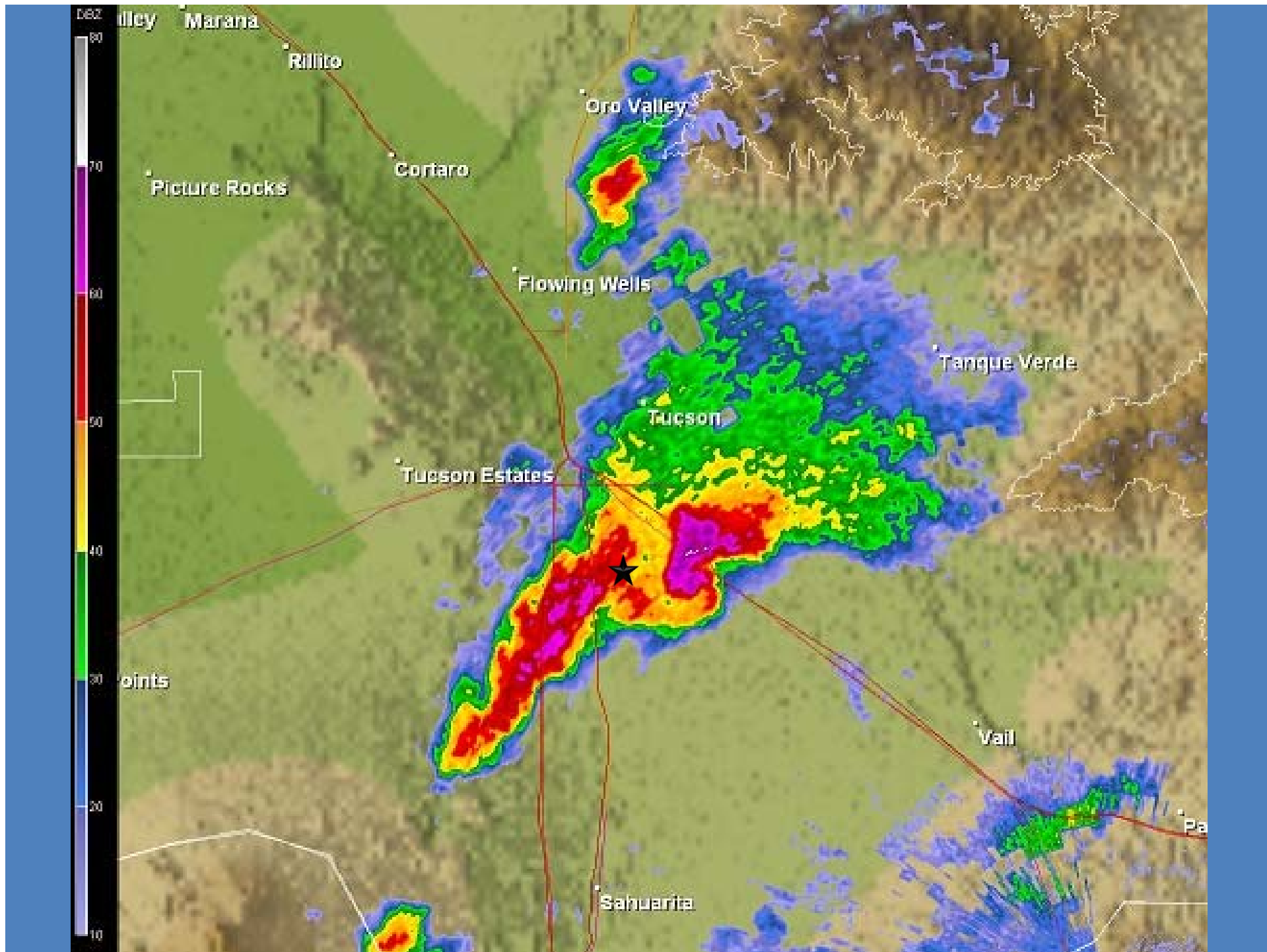
Radar Data from September 15th

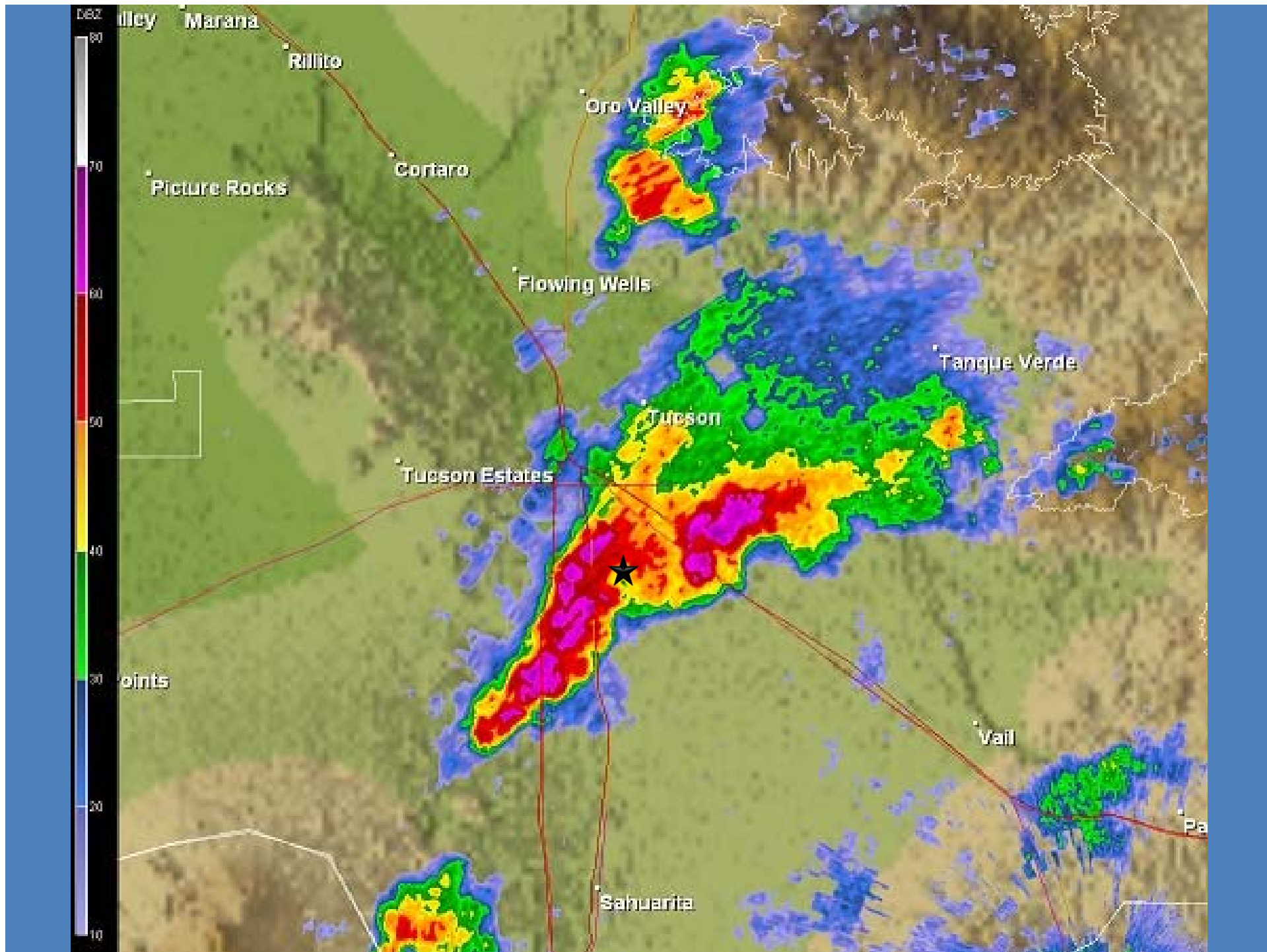
Aprox. 1.5 hours of data from the KEMX
(Tucson) Radar

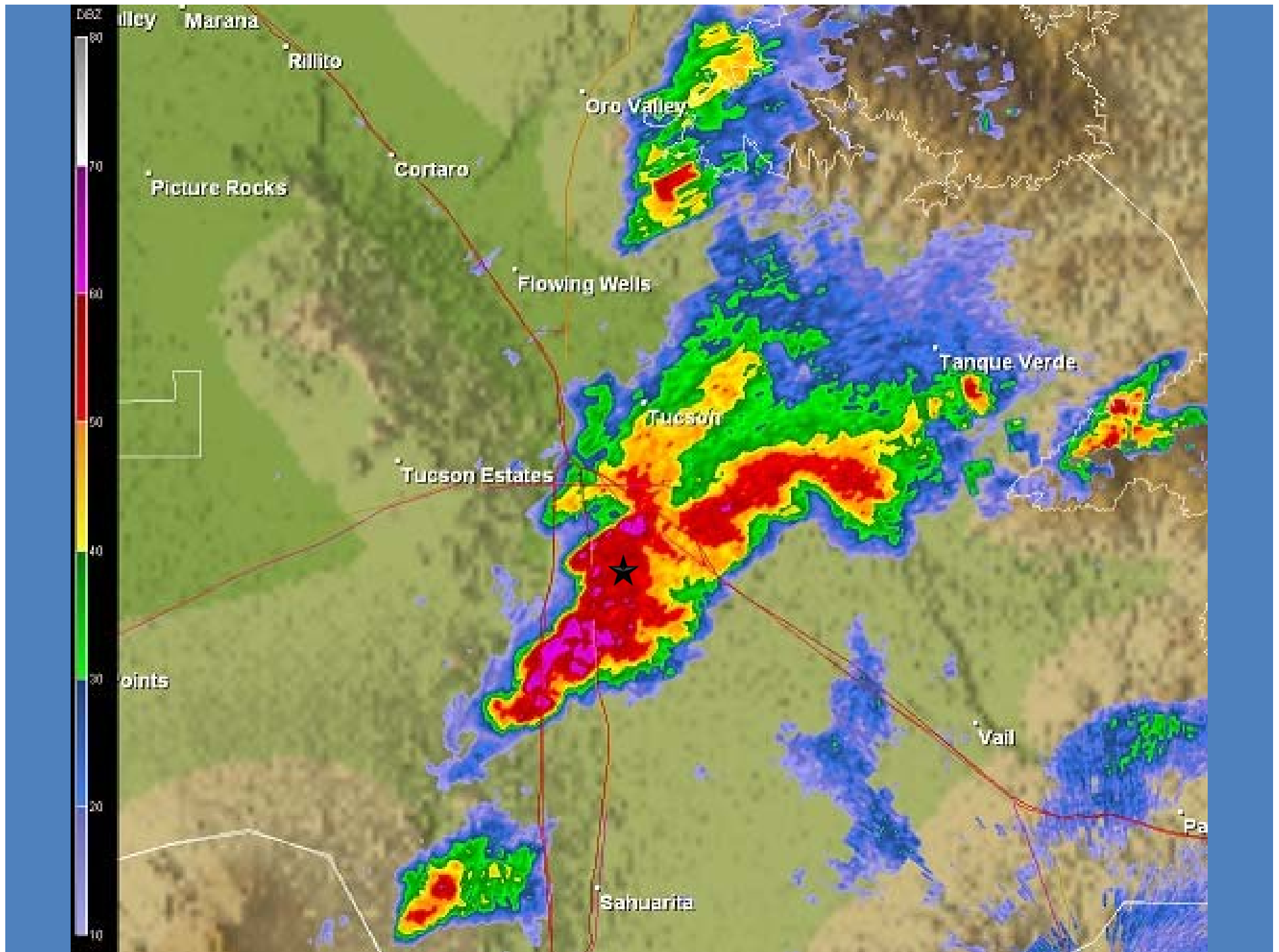
Black Star Represents the Tucson Airport

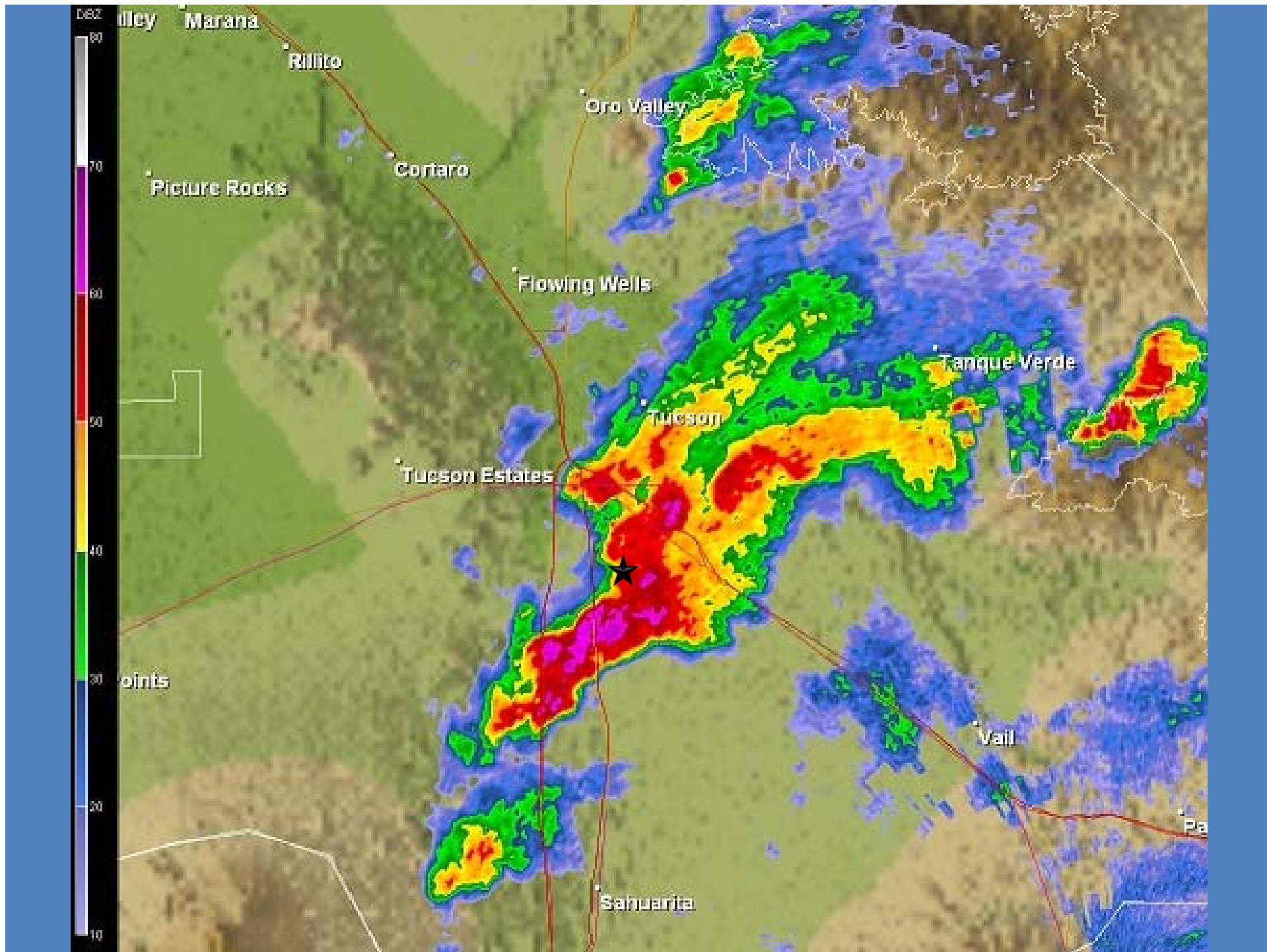


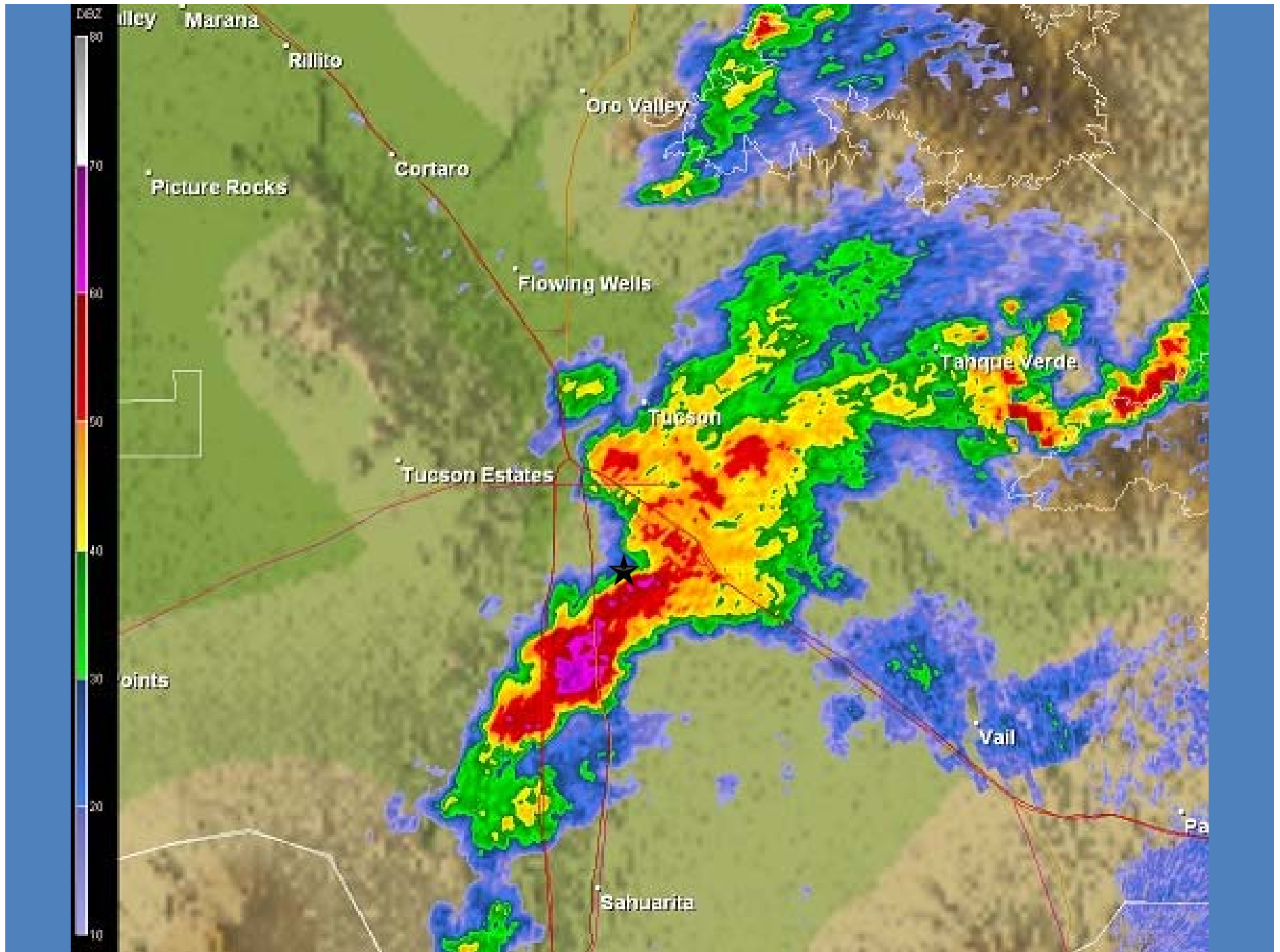


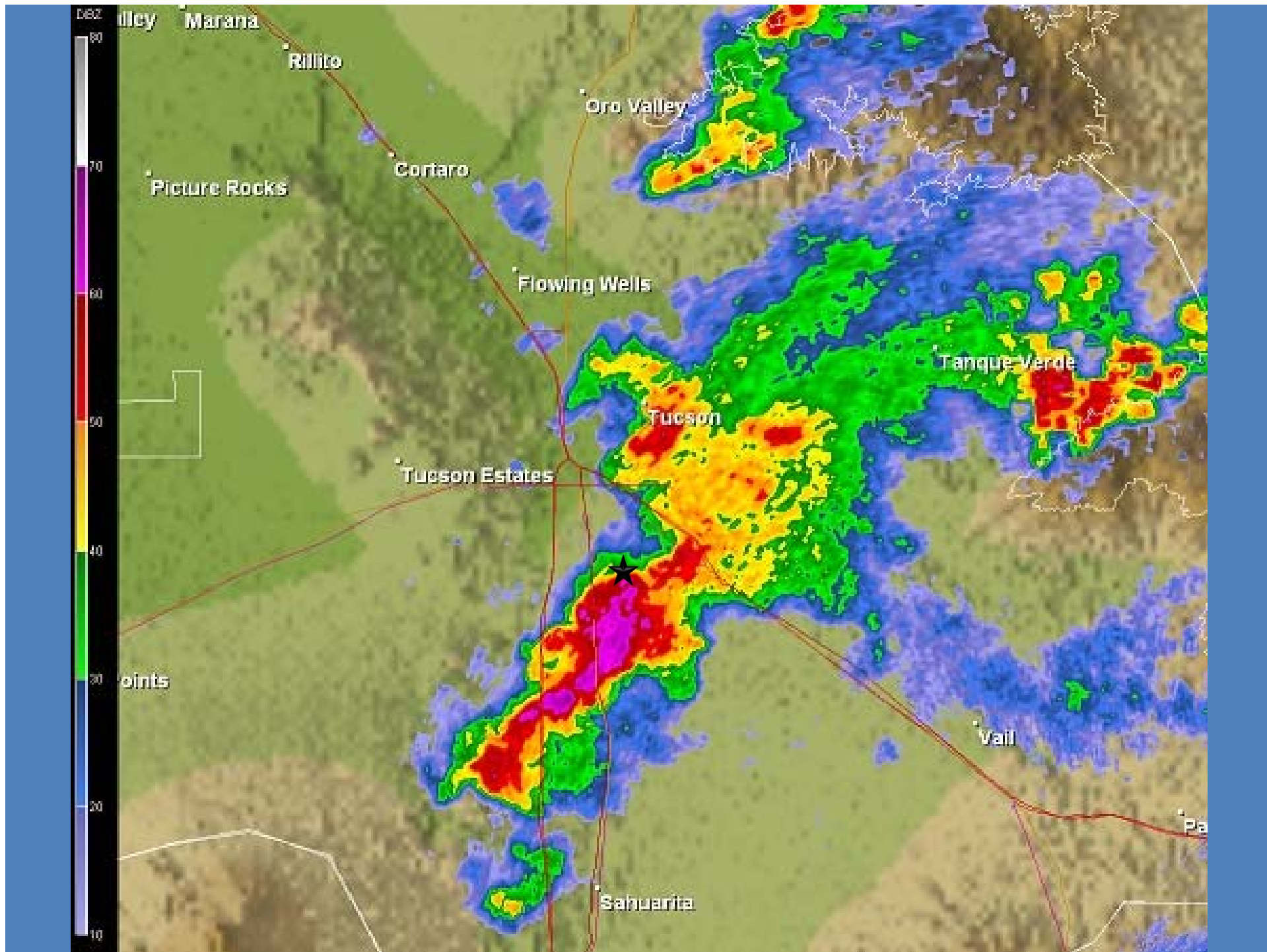


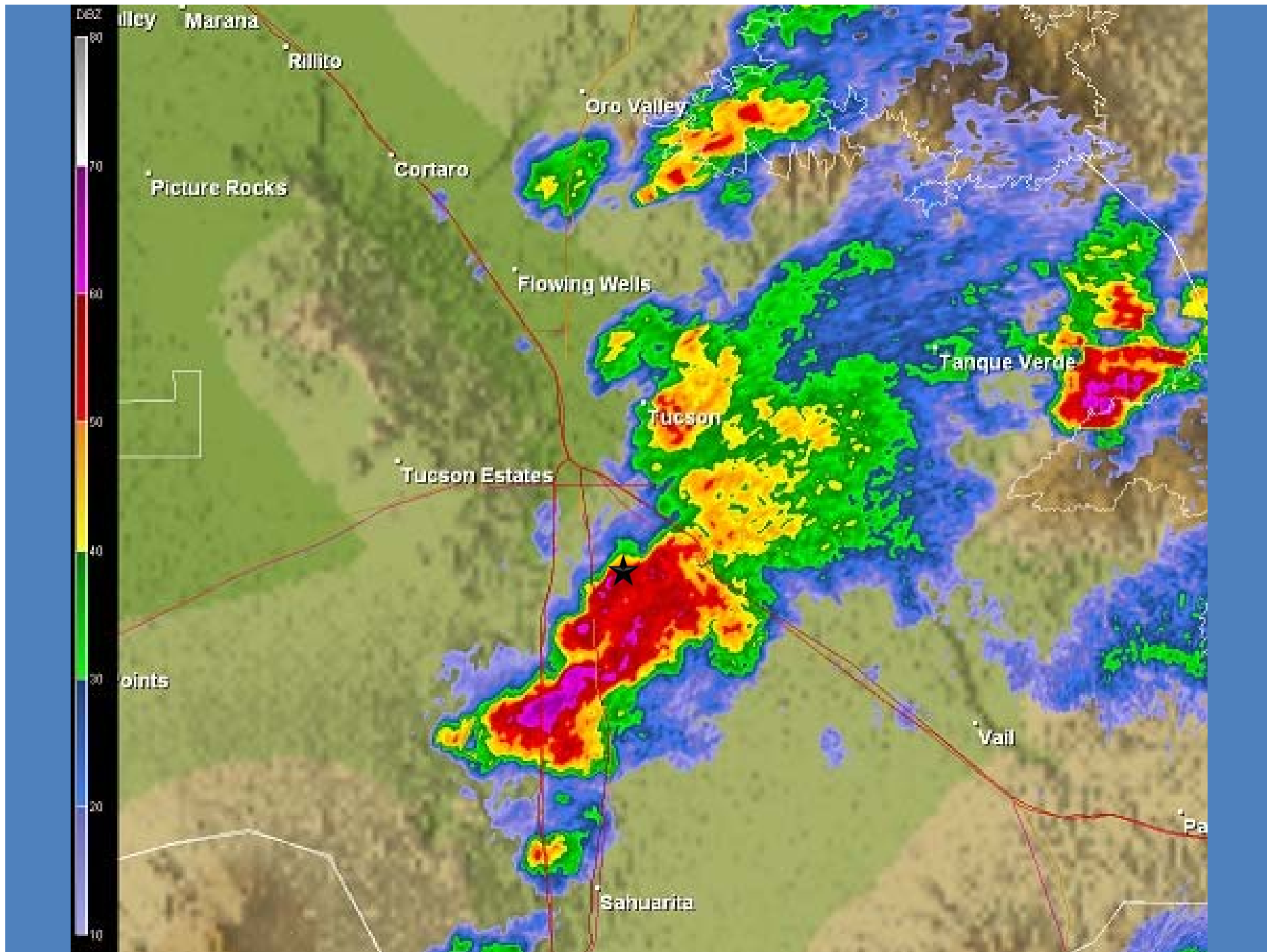


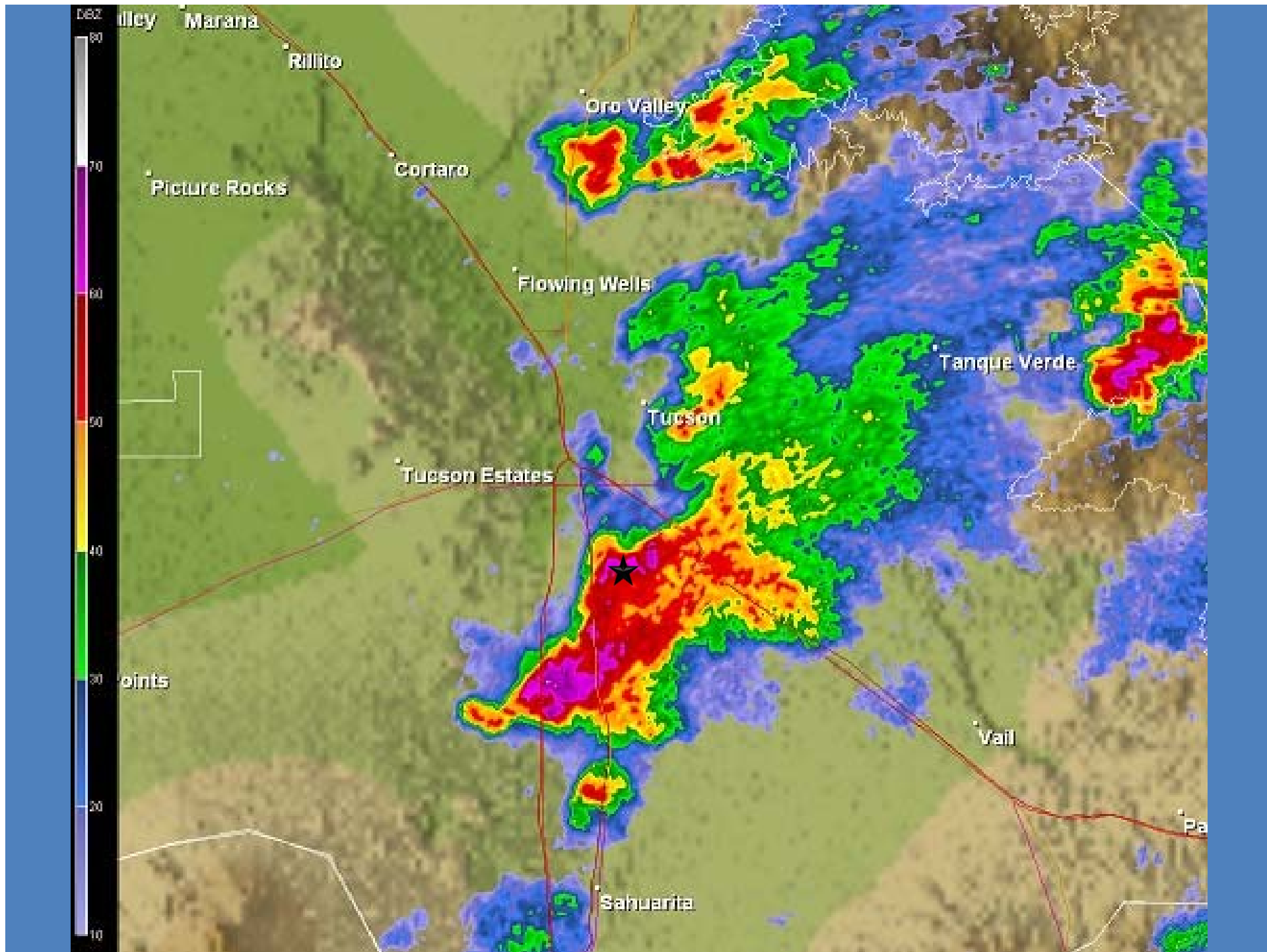


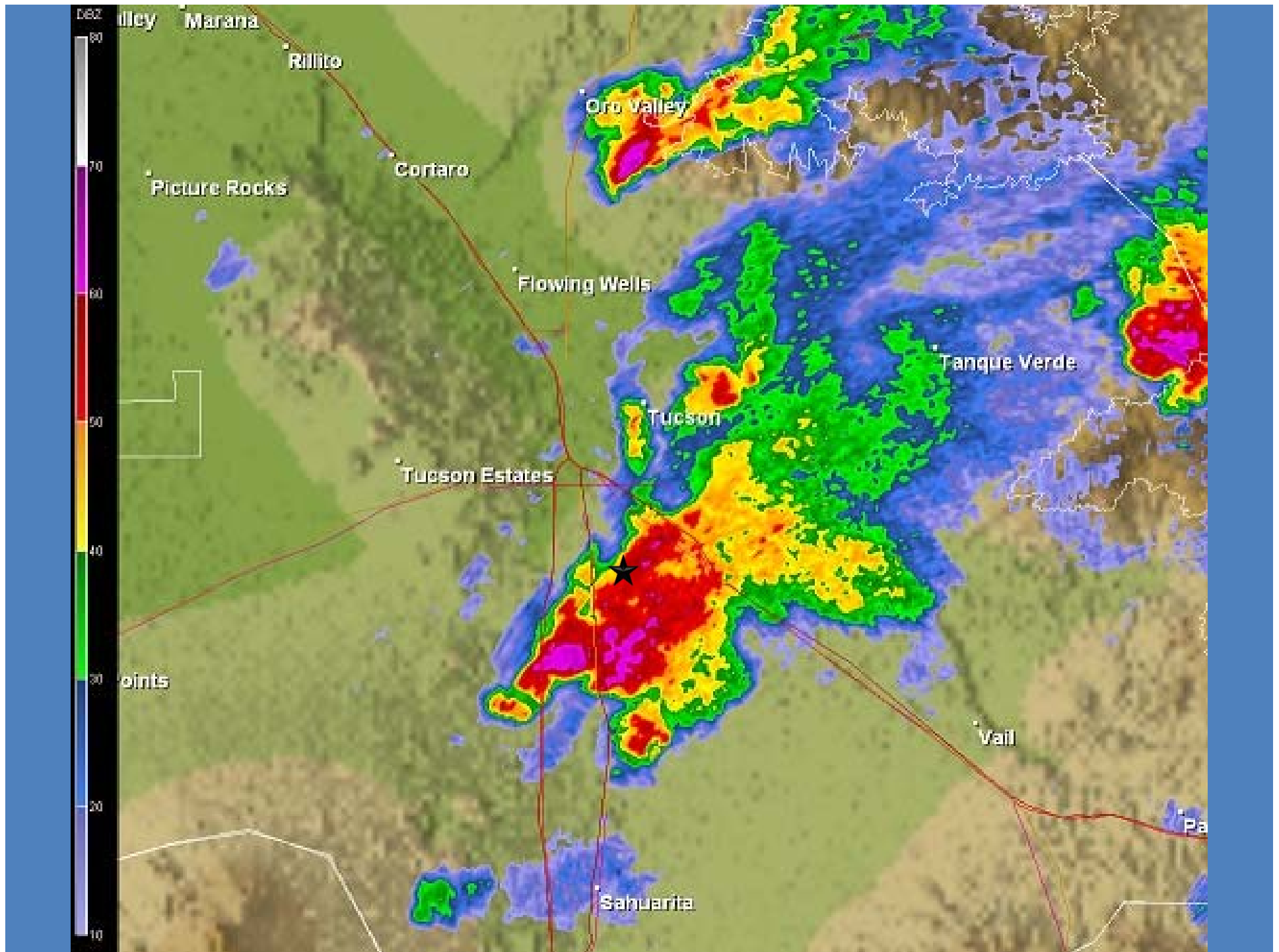


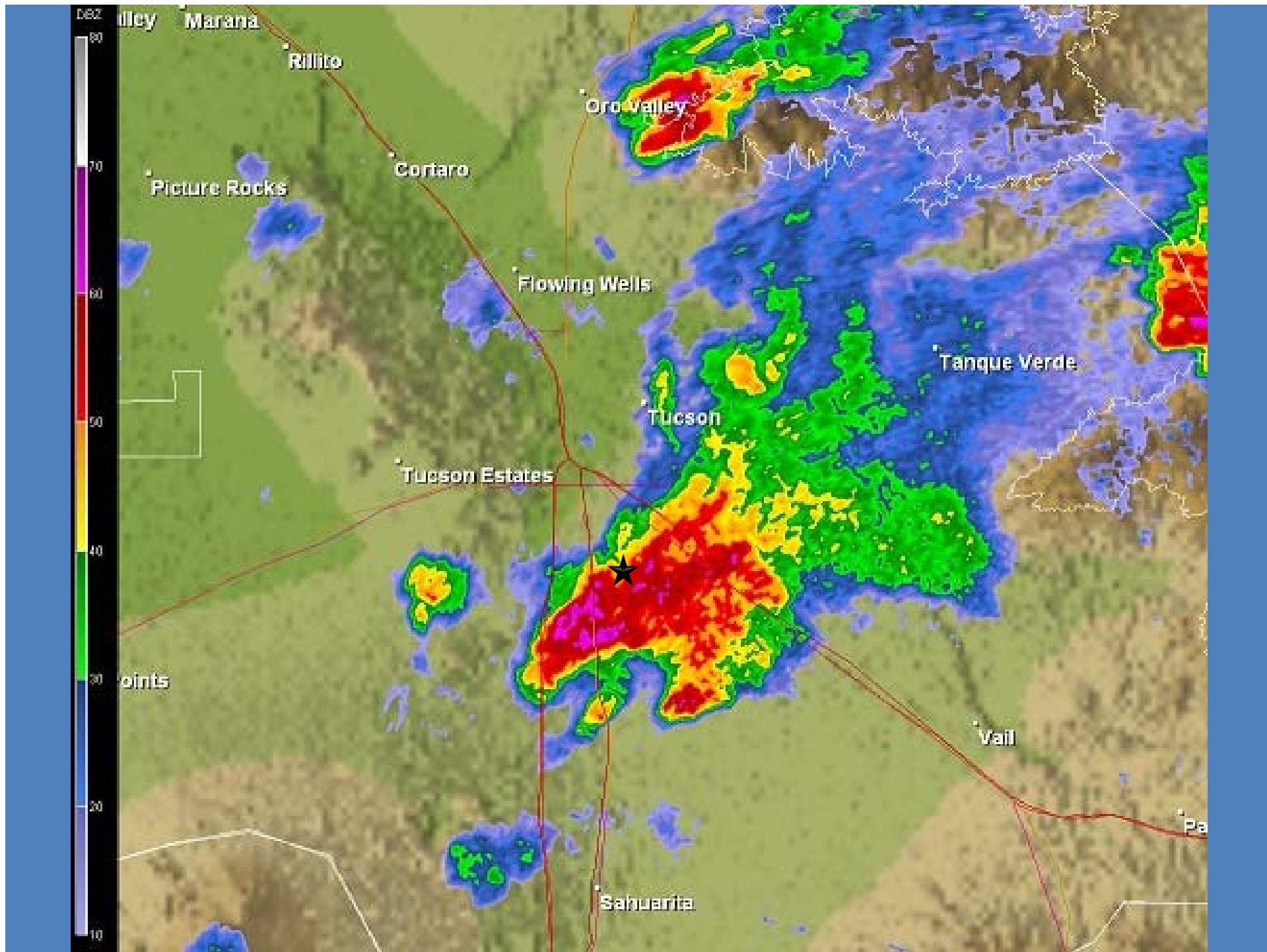


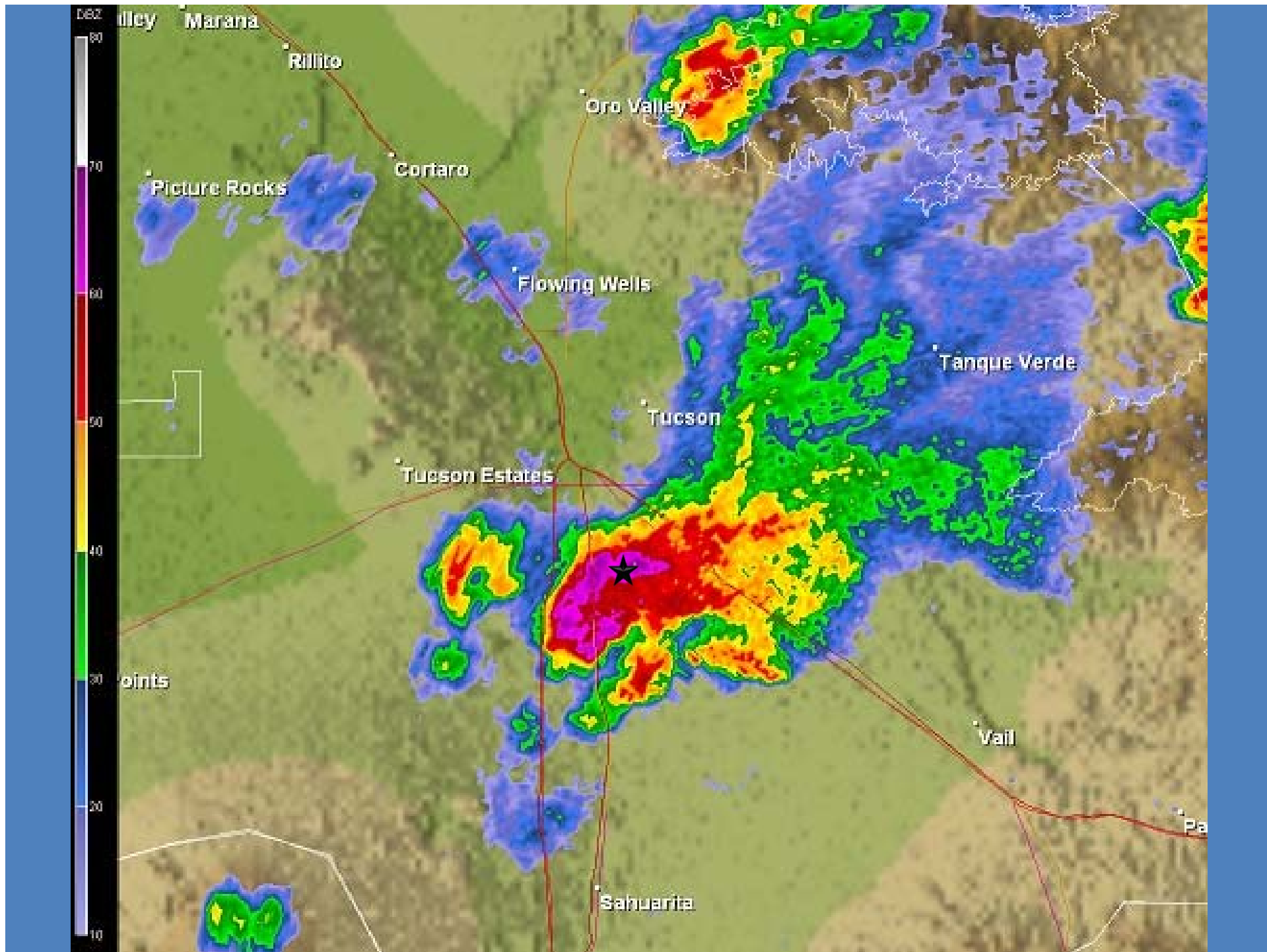


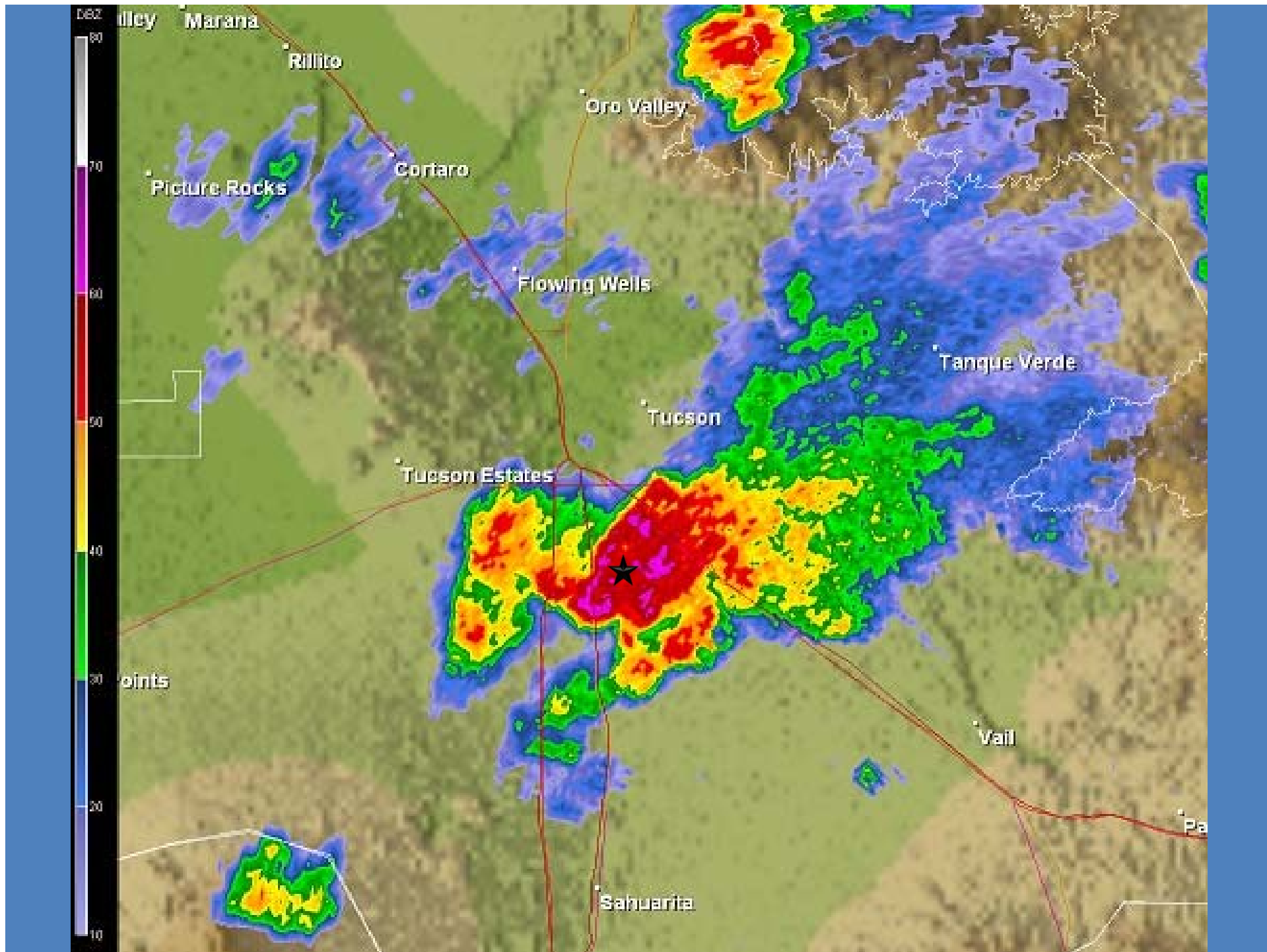


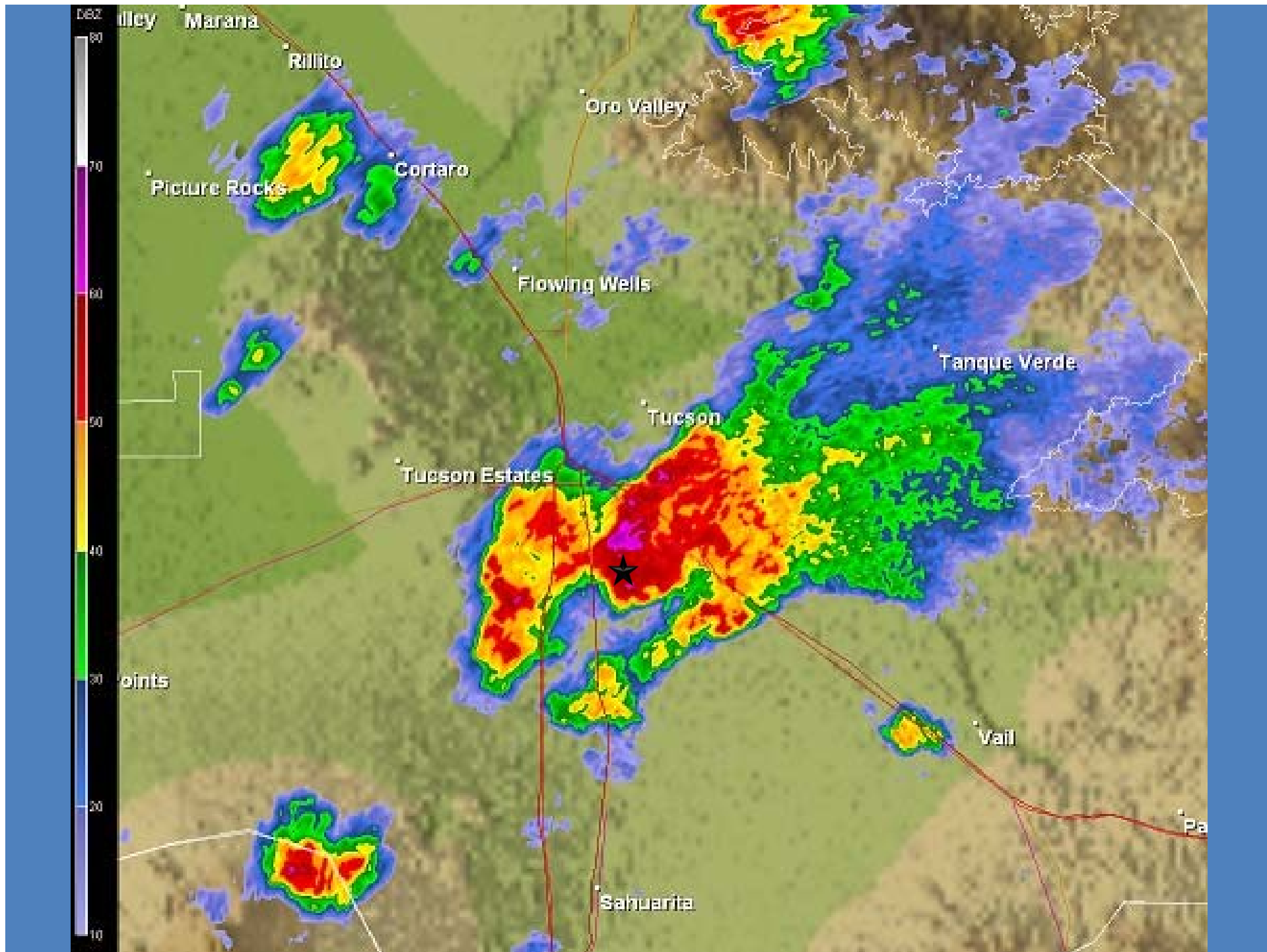


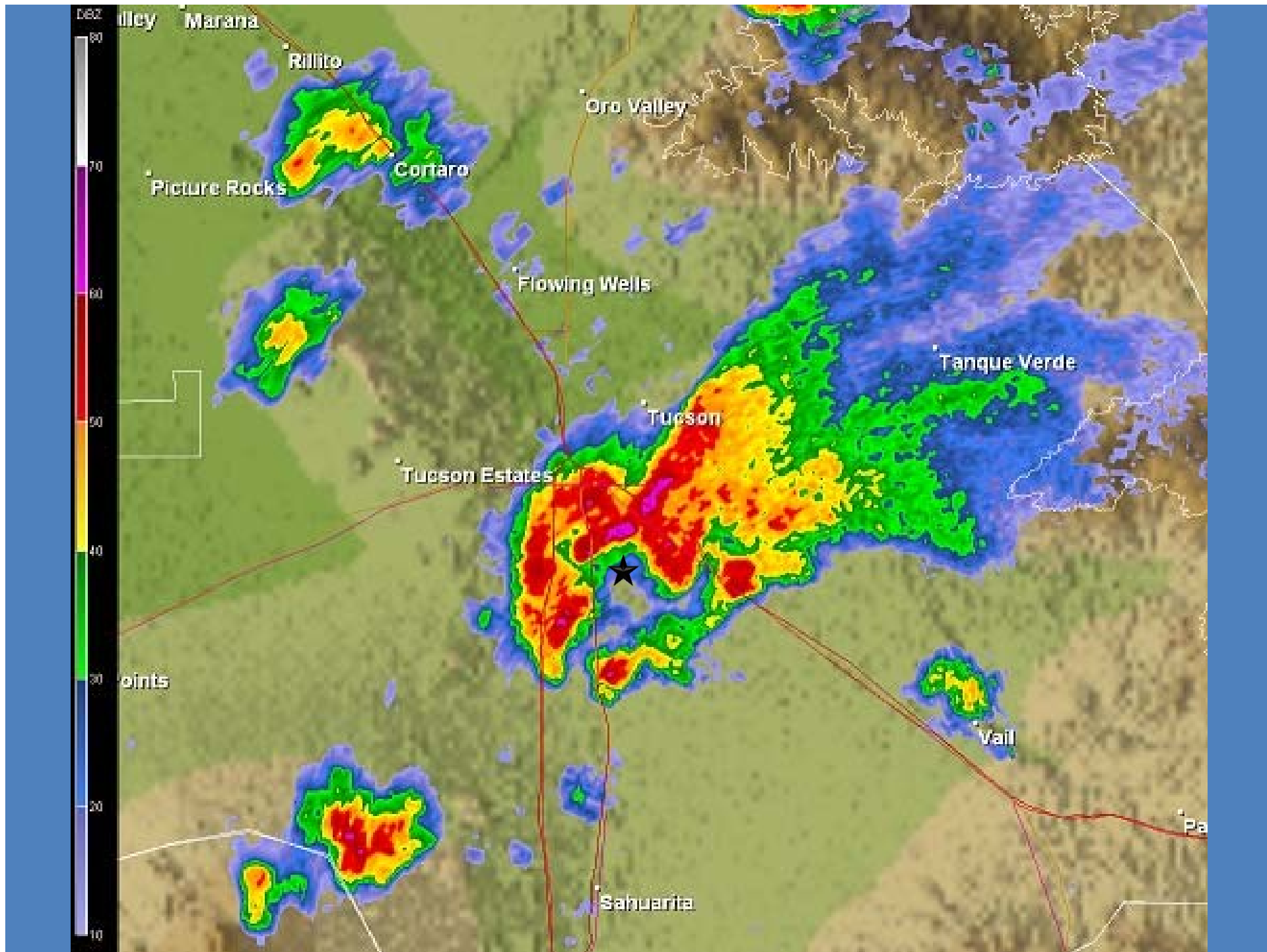


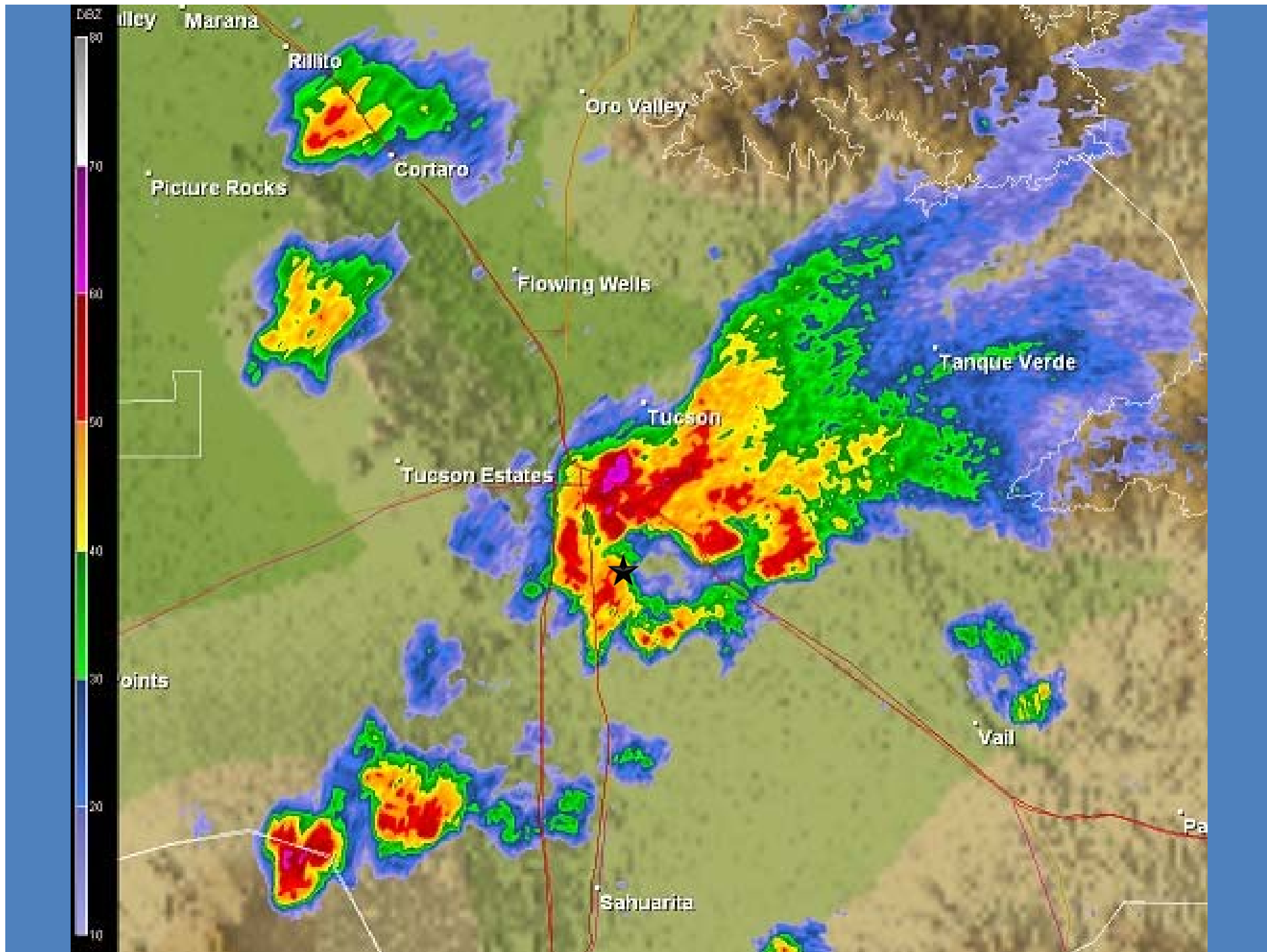






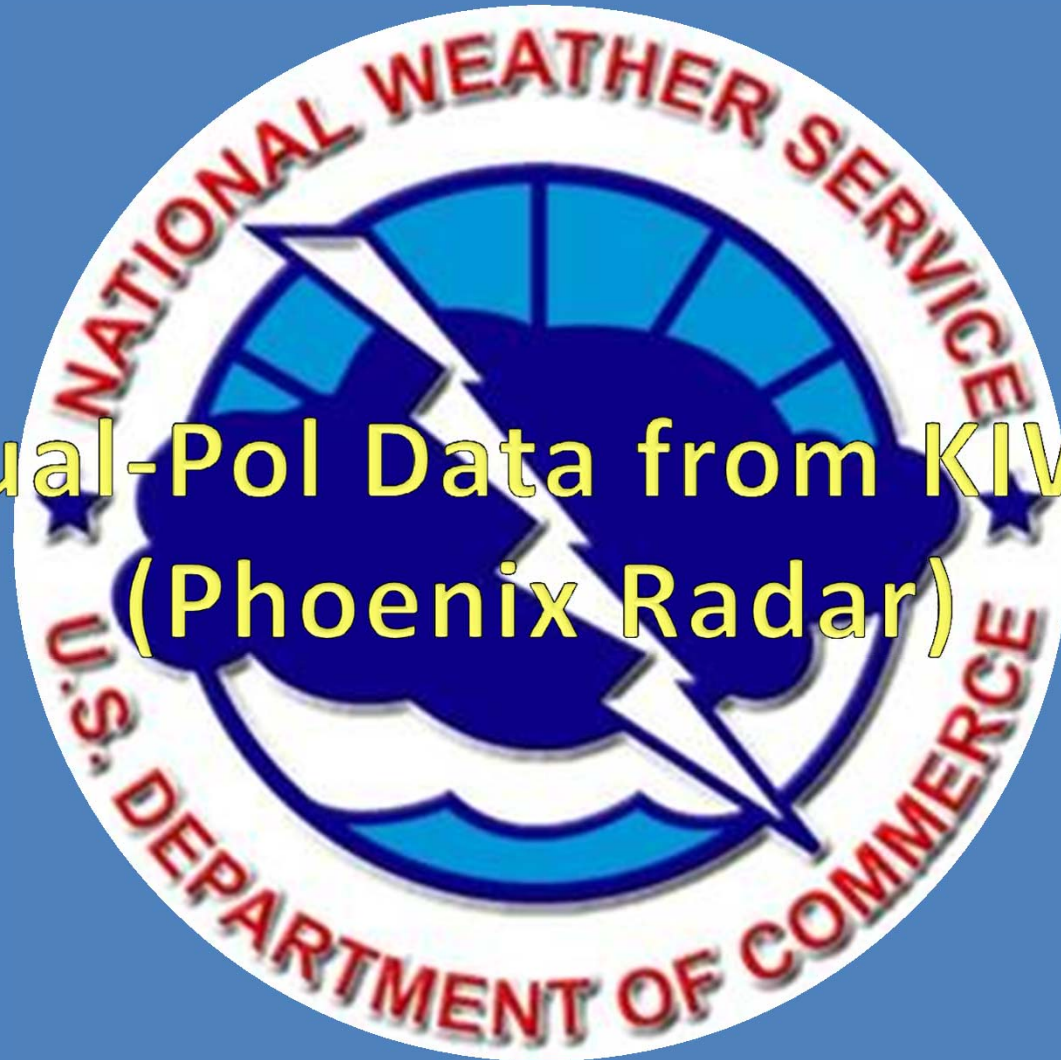






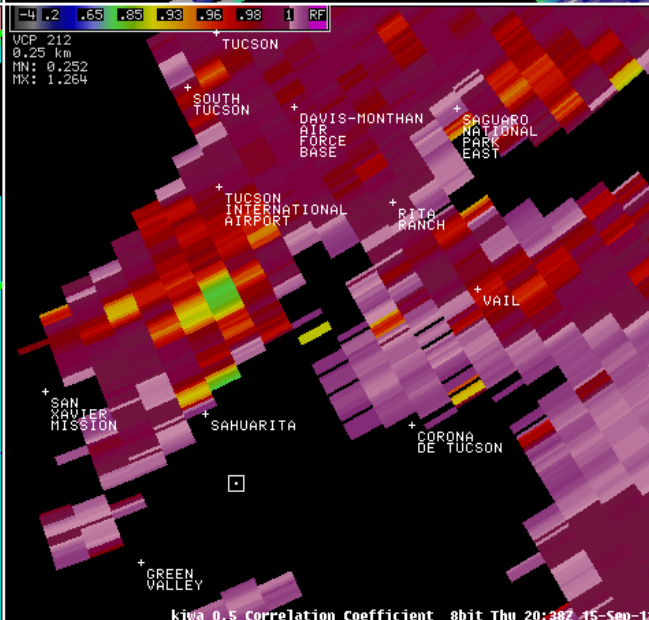
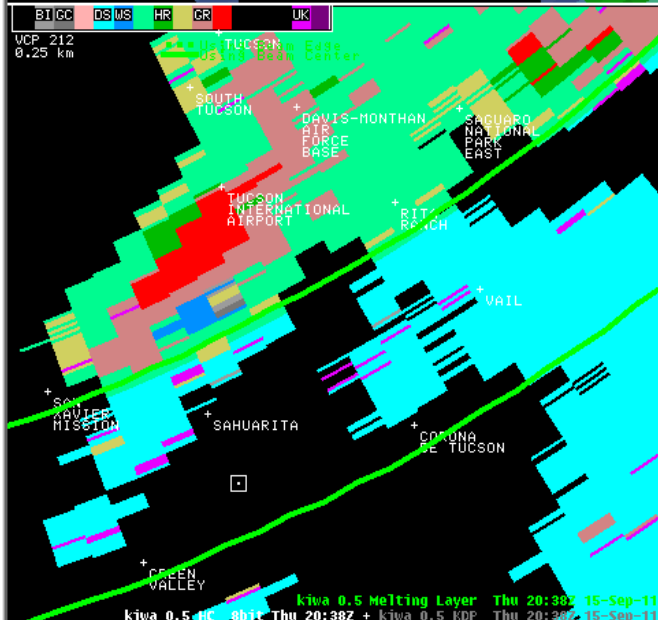
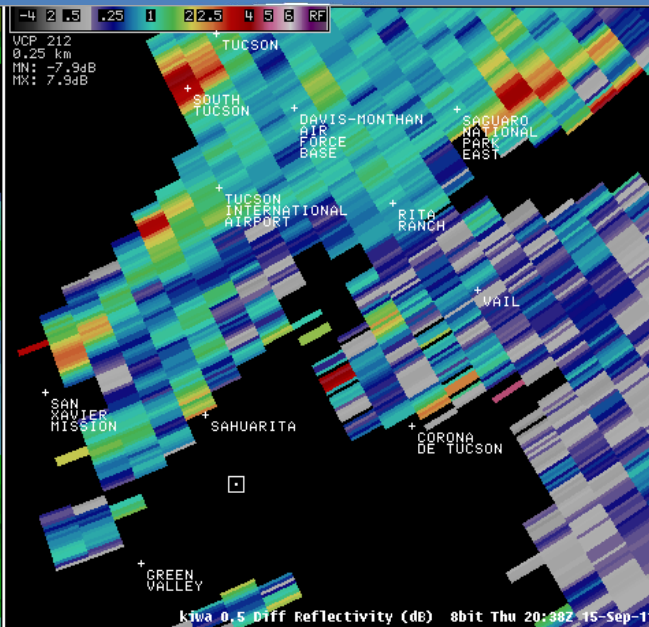
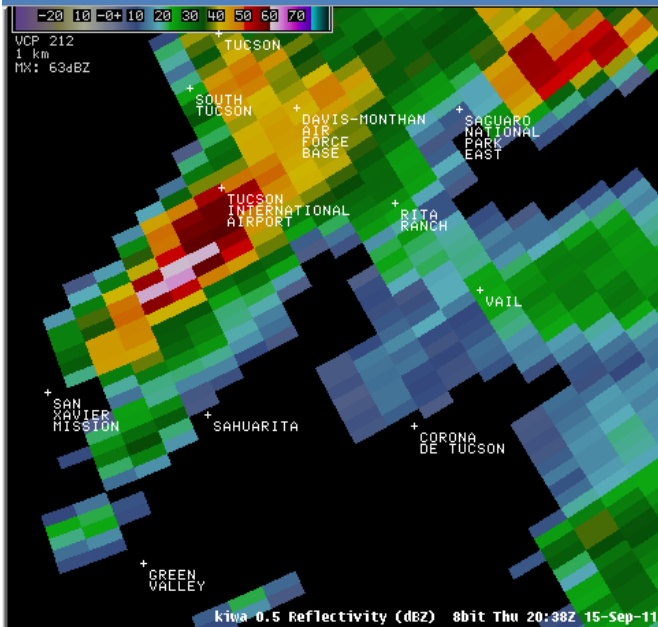


Dual-Pol Data from KIWA (Phoenix Radar)



Radar Products from Sept. 15th

Images are near the 20:38 Z time frame



Top Left = KIWA 0.5 Reflectivity
Top Right = KIWA 0.5 Diff Reflectivity

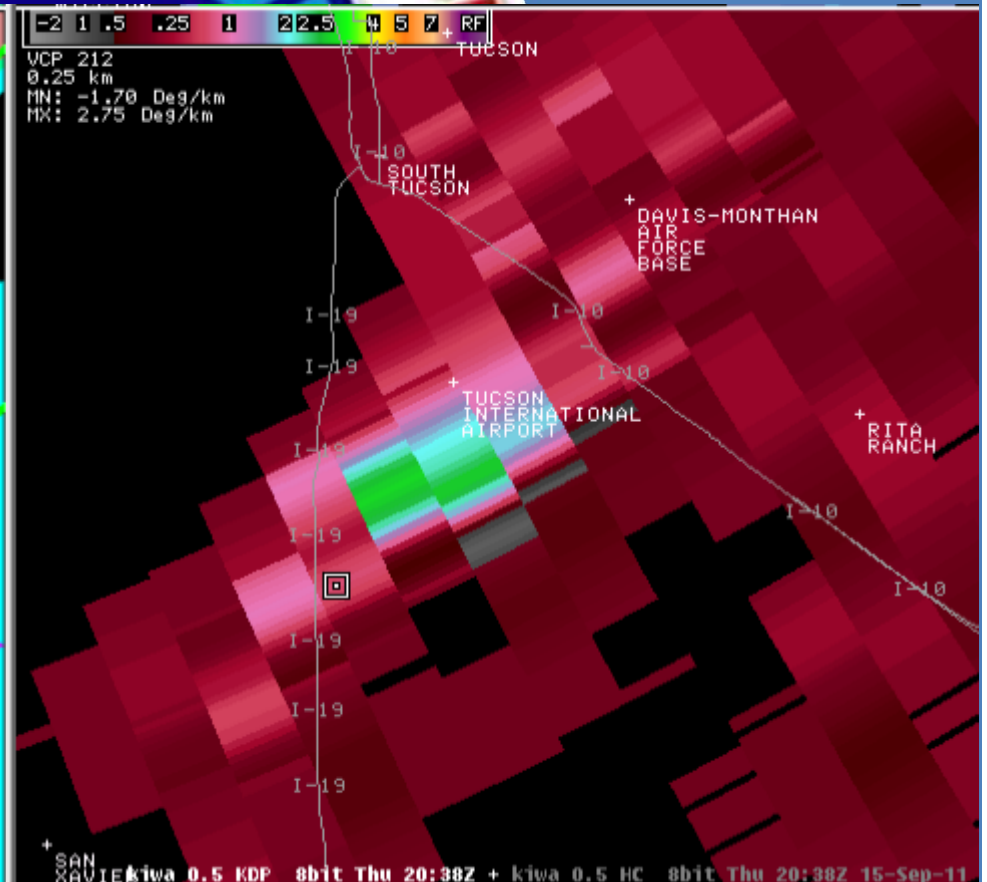
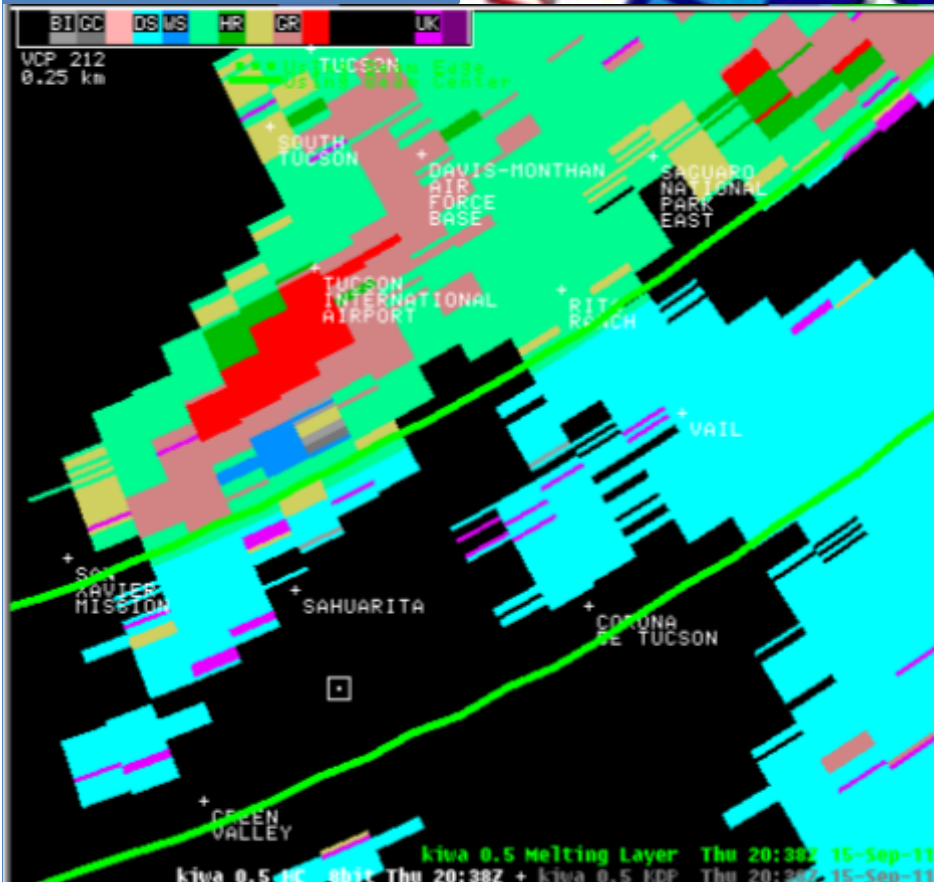
Bottom Left = KIWA MHC with ML
Bottom Right = KIWA CC



Comparing HCA and KDP

HCA from 20:38 Z

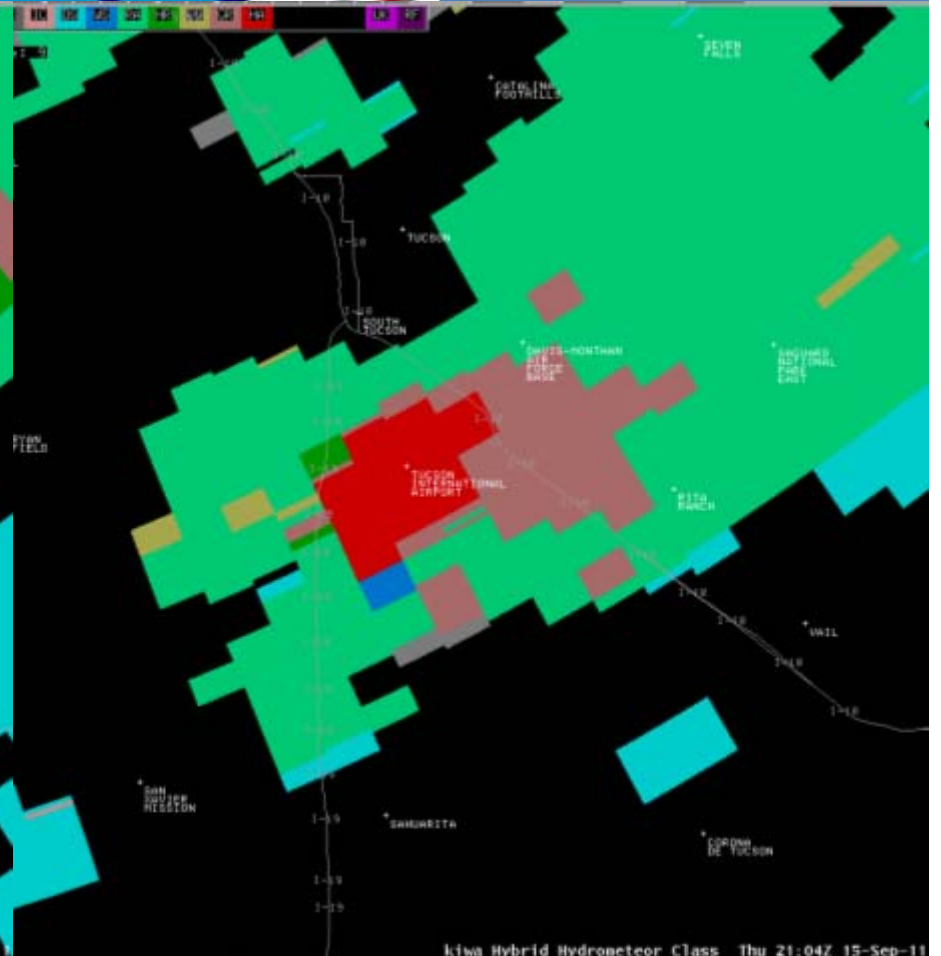
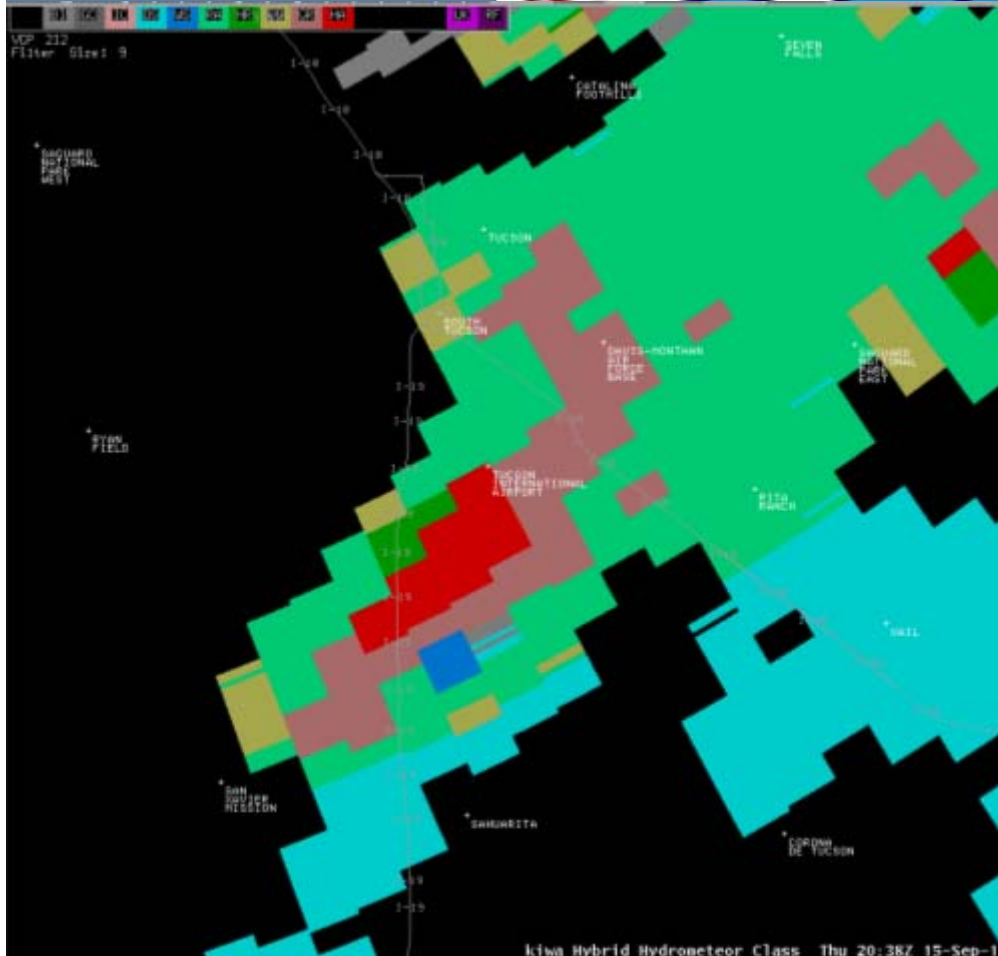
KDP from 20:38 Z



Storms trained over same area for +1 Hour. The Hybrid Hydrometeor Classification algorithm (HHC) exhibited a similar look and feel as the images below during that 1 hour period

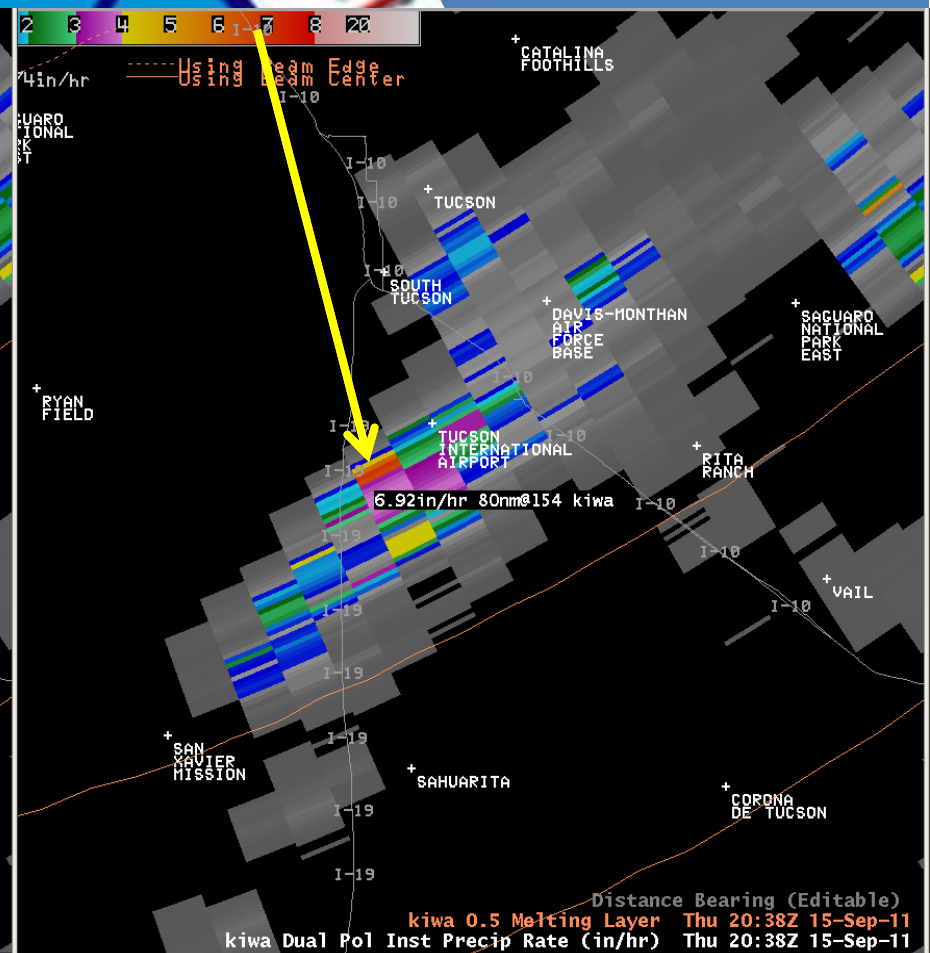
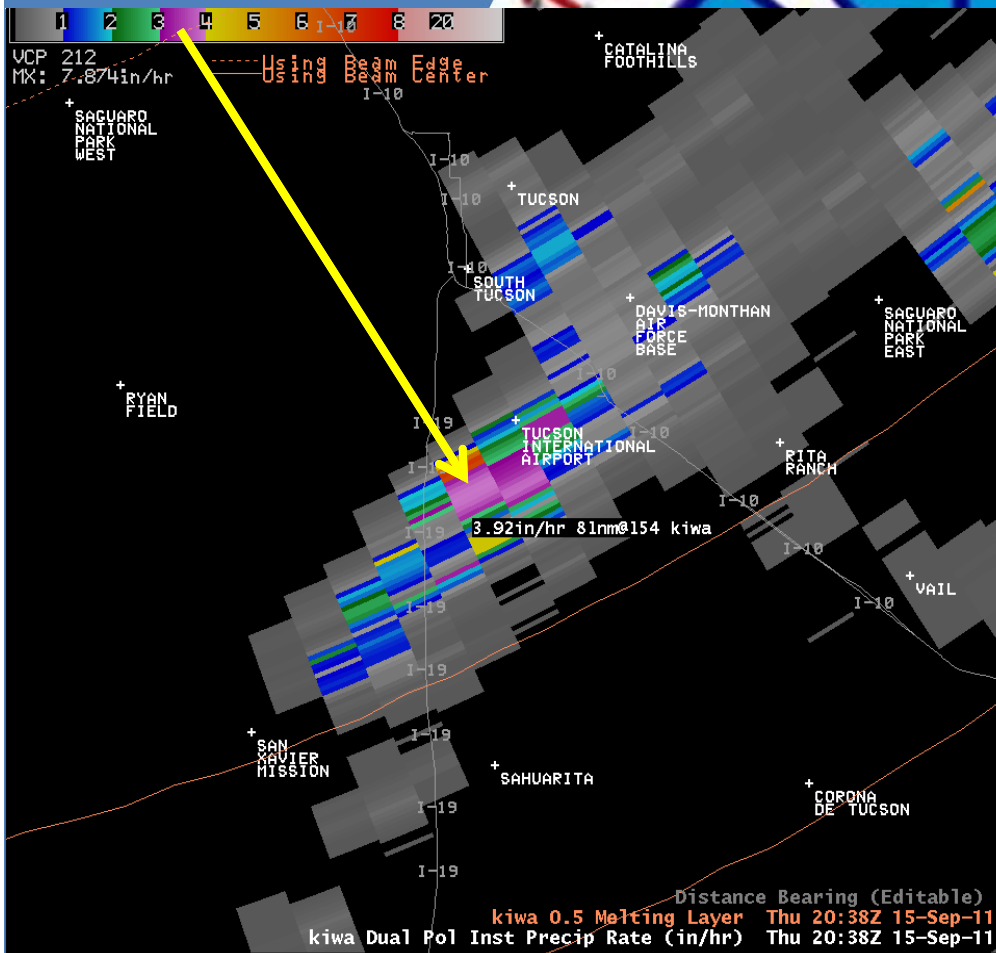
KIWA HHC at 20:38 Z

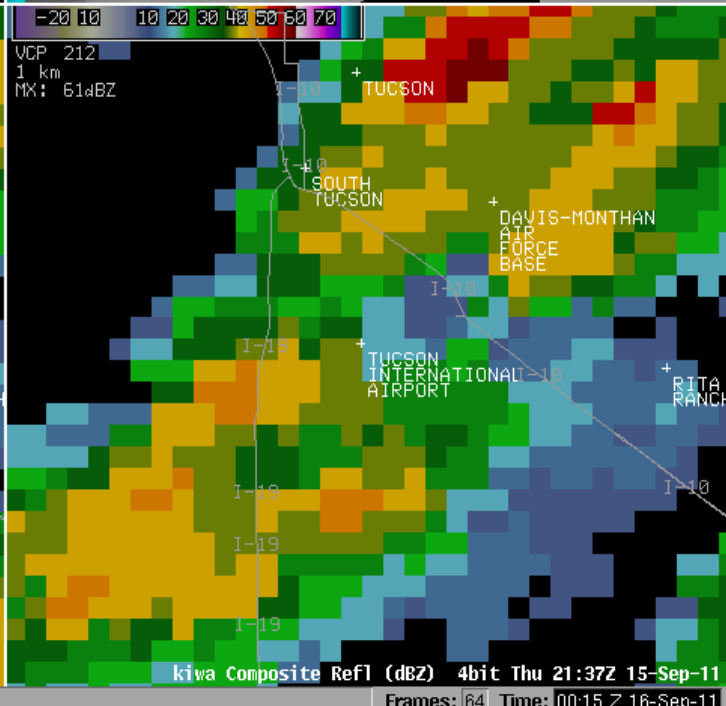
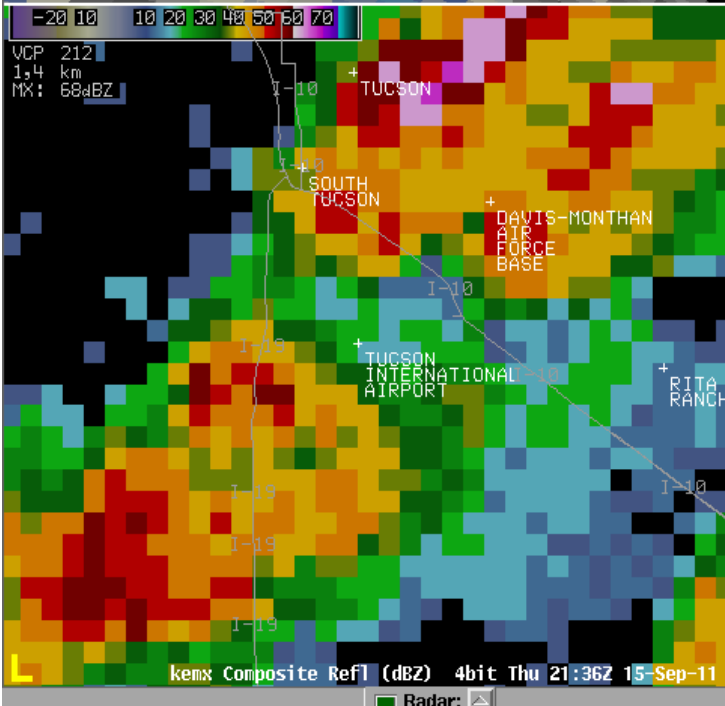
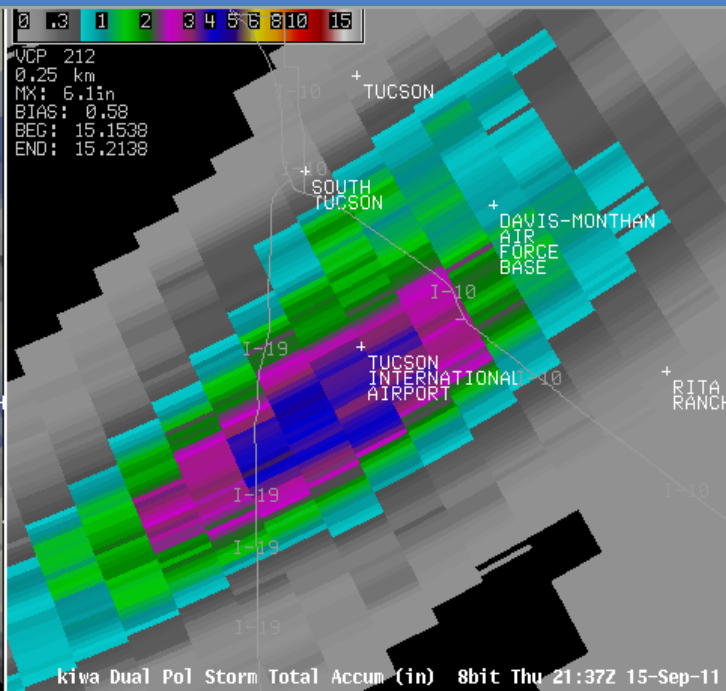
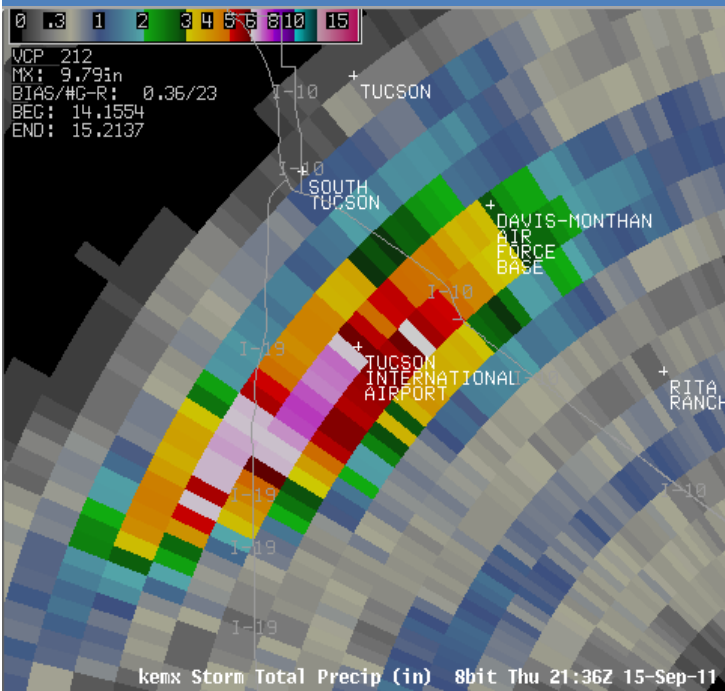
KIWA HHC at 21:04 Z



KIWA Instant Precip at 20:38 Z
Highlighting the Purple areas ~
4 inches per hour

KIWA Instant Precip at 20:38 Z
Highlighting the Orange areas ~
7 inches per hour

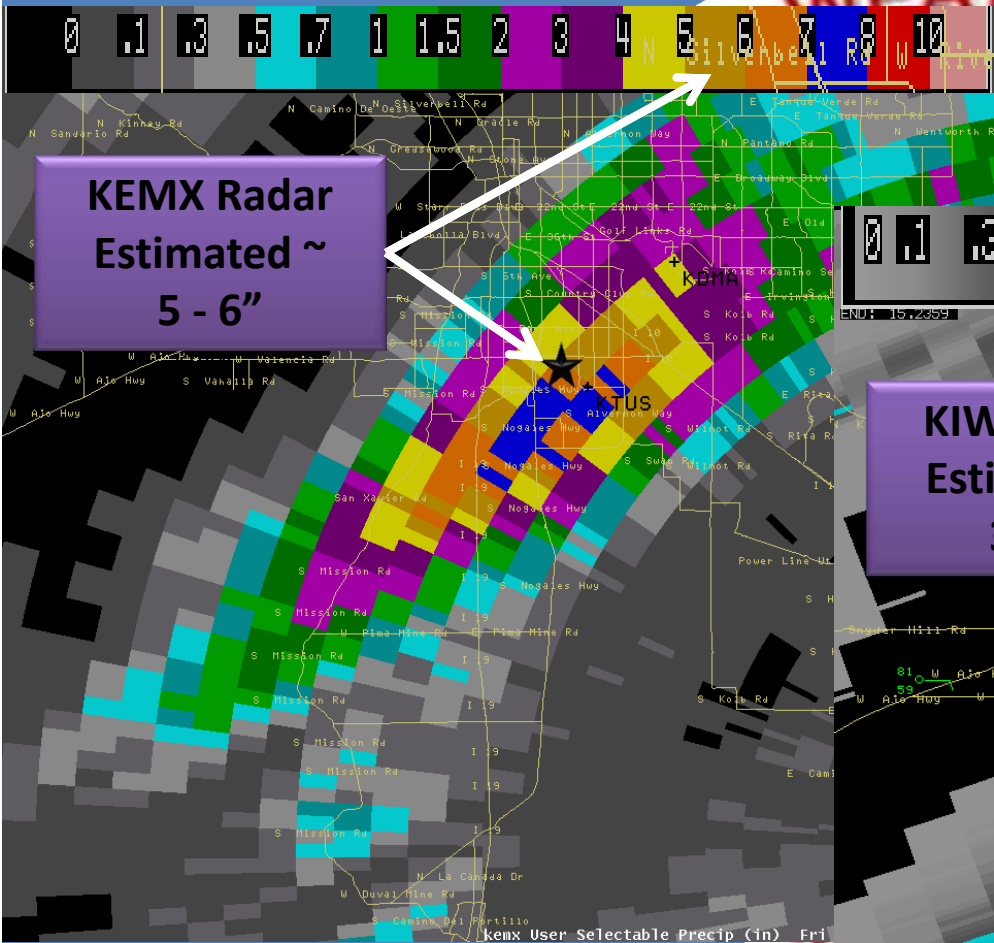




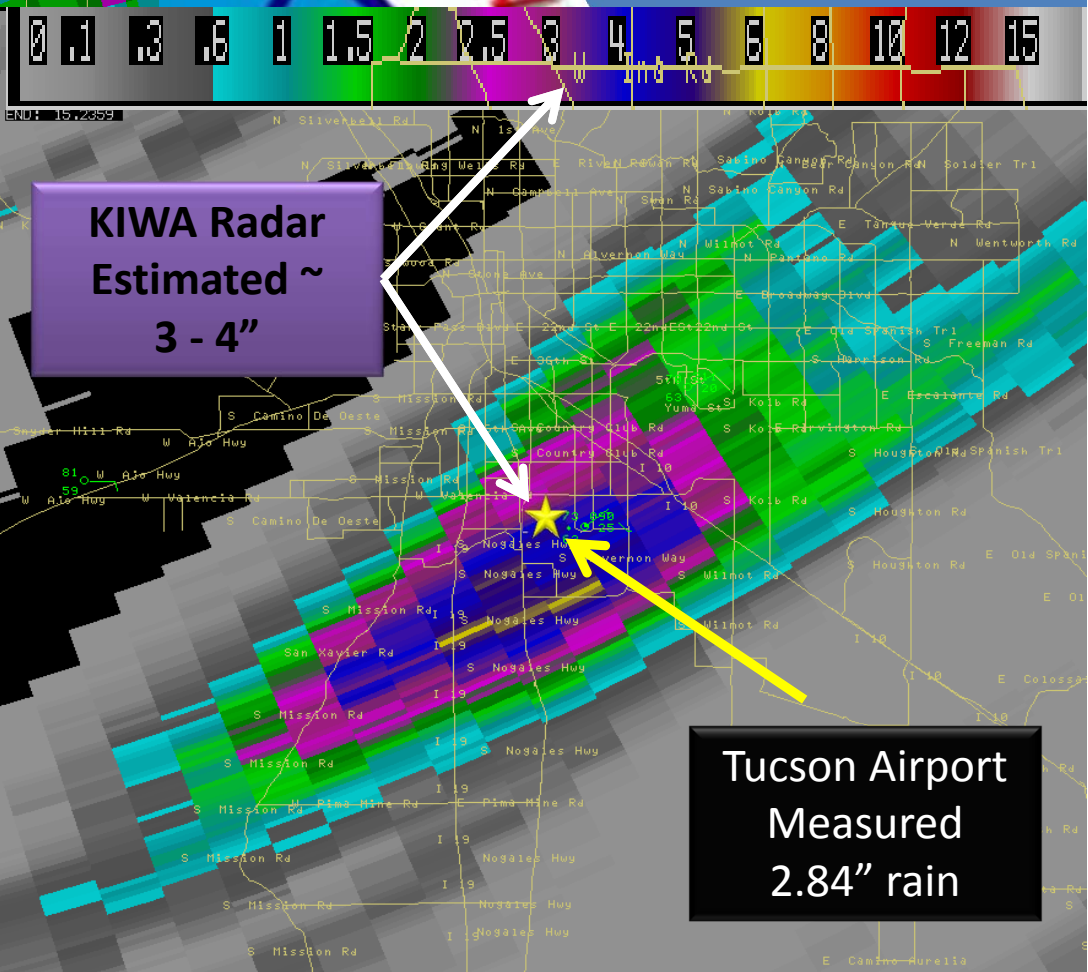
Top Left = KEMX
Storm Total Precip at
21:36 UTC
Top Right = KIWA
Storm Total Precip at
21:37 UTC

Bottom Left = KEMX
Composite Z at 21:36
UTC
Bottom Right = KIWA
Composite Z at 21:37
UTC

Tucson Downpour & QPE Performance



**KEMX Radar
Estimated ~
5 - 6"**



KIWA Dual-Pol Rainfall Estimates

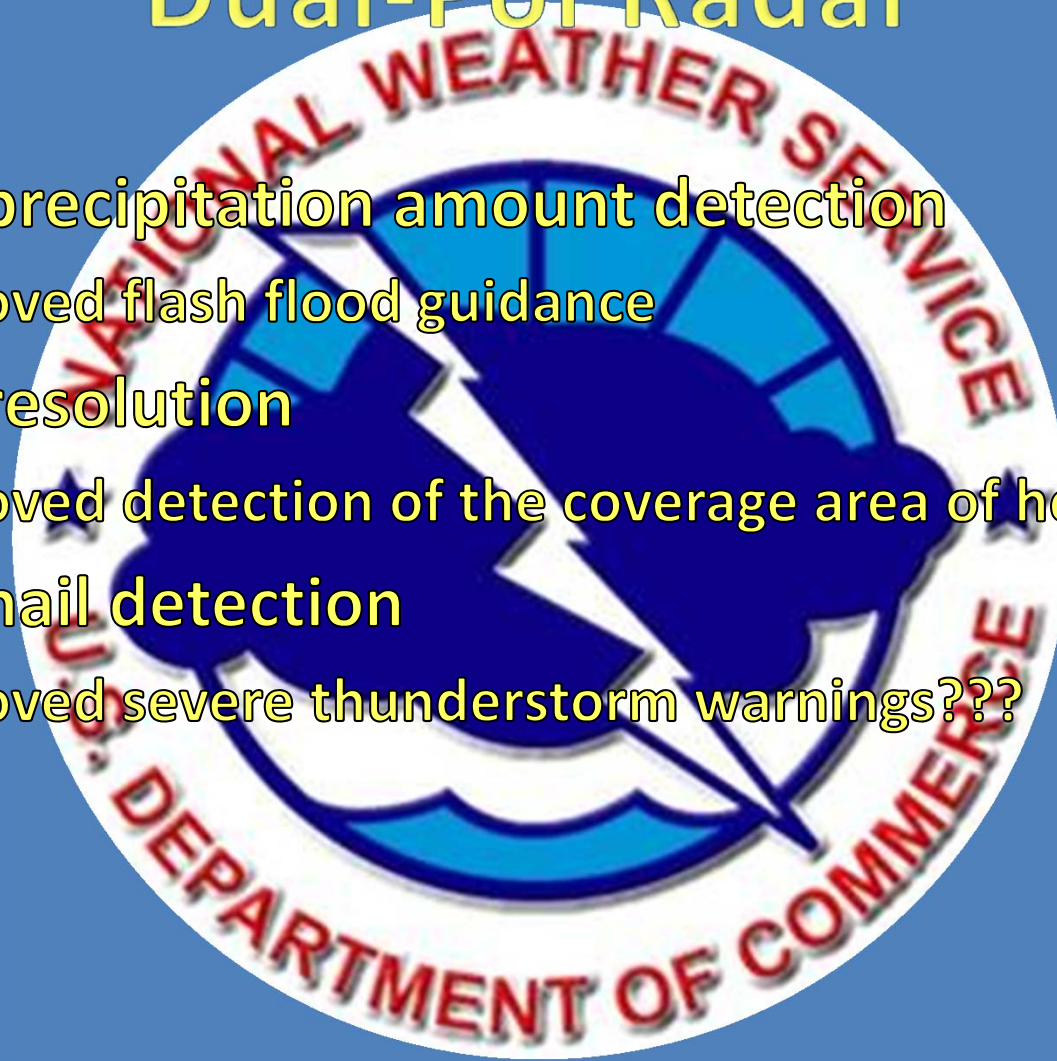
**KIWA Radar
Estimated ~
3 - 4"**

**Tucson Airport
Measured
2.84" rain**

**KEMX Legacy Rainfall Estimates
2+ inches too high
1.5" Hail Report near Airport**

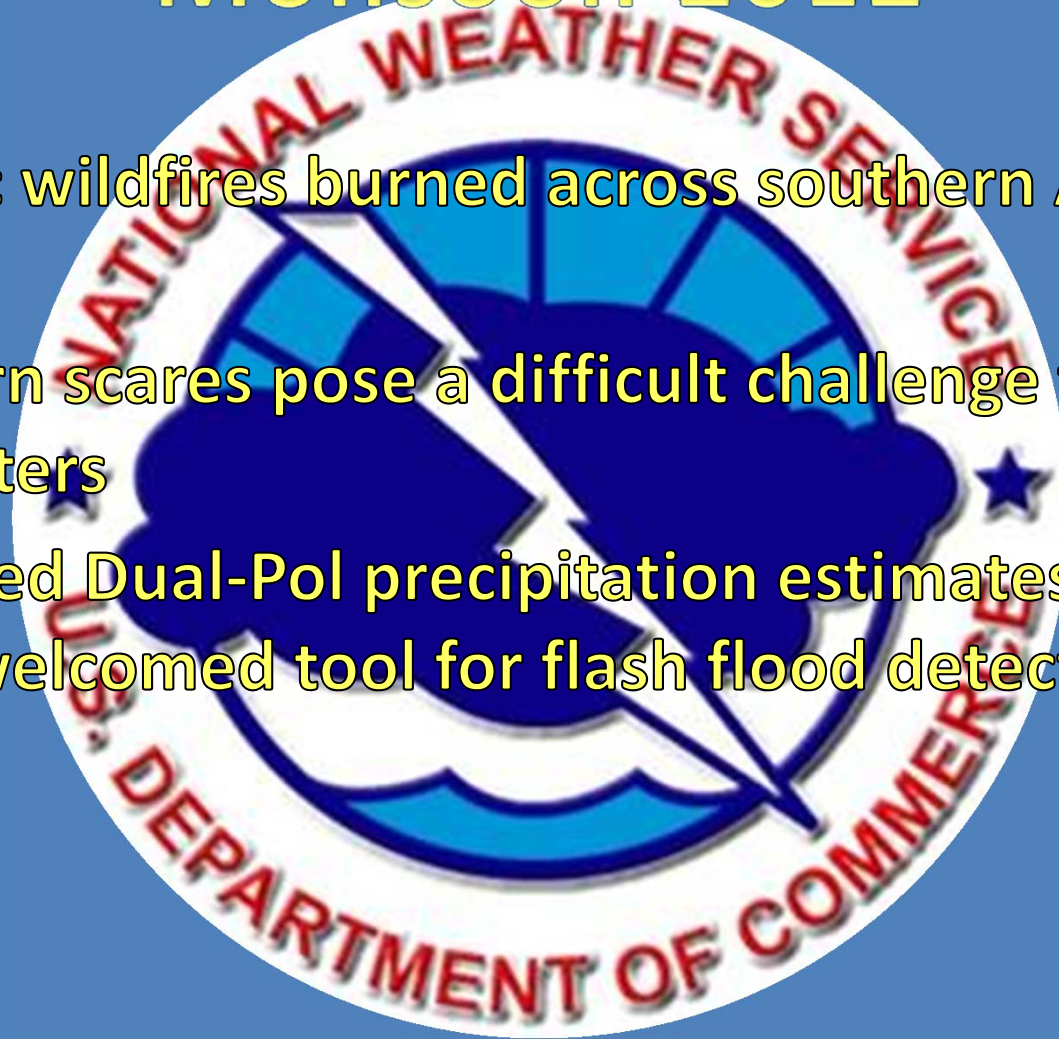
Dual-Pol Radar

- Better precipitation amount detection
 - Improved flash flood guidance
- Better resolution
 - Improved detection of the coverage area of heavy rain
- Better hail detection
 - Improved severe thunderstorm warnings???



Monsoon 2012

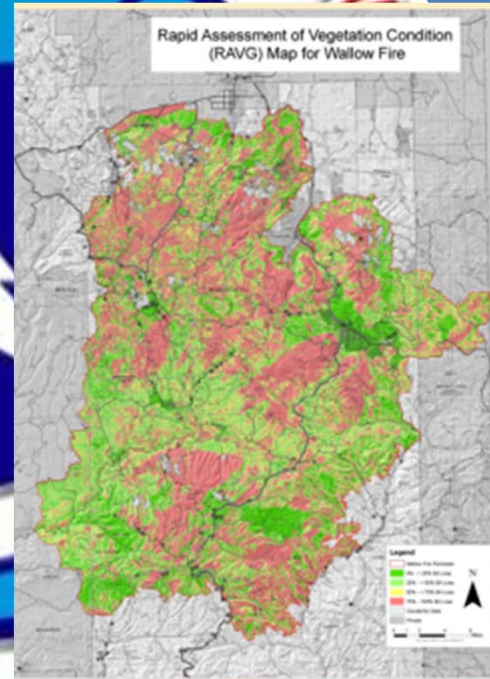
- Historic wildfires burned across southern Arizona in 2011
- The burn scars pose a difficult challenge to forecasters
- Improved Dual-Pol precipitation estimates will be a much welcomed tool for flash flood detection



The Fires

Wallow

- Wallow Fire
- Largest Wildfire in Arizona State History
- Smoke Plume extended into Canada
- 32 Homes Destroyed, 5 Damaged
 - 62 Total structures lost
- Burned from May 29th through July 8th



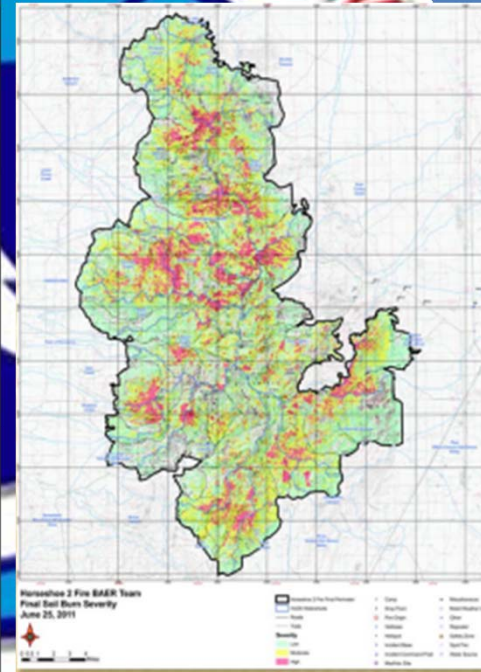
WALLOW FIRE

Soil Burn Severity	Acres	Percent
High	86,115	16%
Moderate	73,634	14%
Low	257,349	48%
Unburned	120,951	22%

Total Acres = 538,049

Horseshoe 2

- Horseshoe 2 Fire
- Destroyed 9 Homes
- Burned from May 8th through June 25th



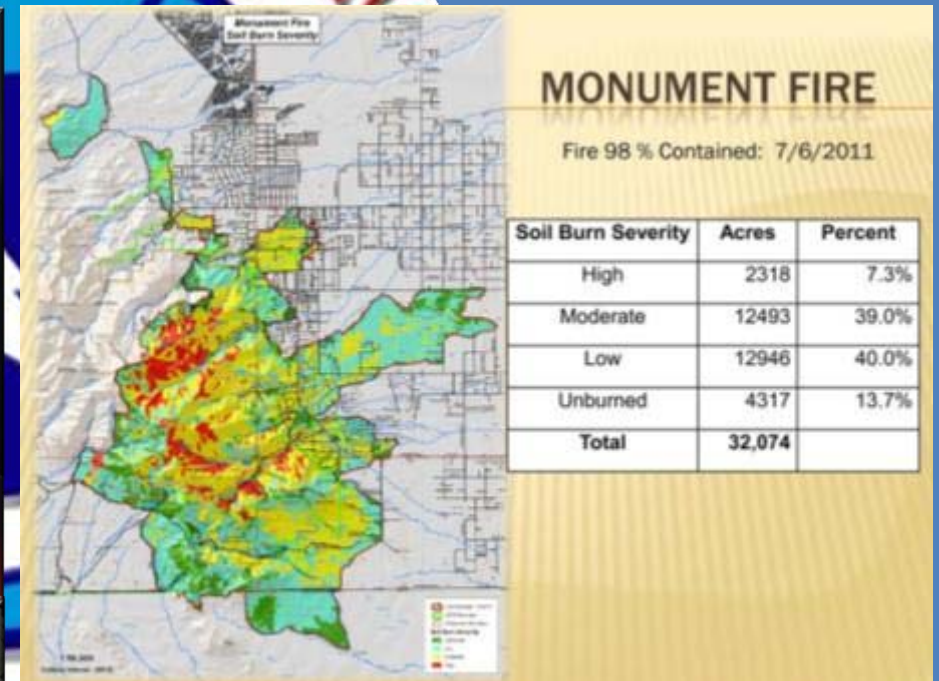
HORSESHOE 2 FIRE

Soil Burn Severity	Acres	Percent
High	27,730	12%
Moderate	66,226	30%
Low	84,852	38%
Unburned	44,093	20%

Total Acres = 222,954

Monument

- Monument Fire
- Threatened a major population center – Sierra Vista
- Burned from June 12th through July 6th
- Damaged or destroyed 57 homes
- Over 100 structures impacted



Images Courtesy of US Forest Service

Soil Modification

Severe Burn Areas



Created

Hydrophobic Soil Conditions



Promoting

Increased Flash Flood/Debris Flow Threat



- Dramatically altered soil conditions and intense rainfall rates greatly increased flash flood threat. Post-burn 5-year peak flows were estimated to be 3 to 45 times greater than pre-burn peak flows.

- (Based on July 15, 2011 NOAA/NWS report by Reed, Schaffner and Kahler).

Raising Awareness



NWS Tucson staff participated in numerous community meetings in communities near the burn areas.

Fliers



Image Courtesy of Jay Breidenbach - NWS Boise, Idaho

Know The Signs

Get Ready—Thunderstorm clouds build over the mountains (typically early in the day)

- ◆ Dark areas under the thunderstorm clouds imply heavy rainfall
- ◆ The rain may not fall on you—remember, flooding occurs downstream of the heavy rain.

Get Set—Monitor the News and weather observations for your area

Go—Flash Flood Warning issued for your area

- ◆ The News or weather observations may also indicate flooding is imminent for your area

Prepare Now—The 5 P's of Immediate Evacuation (Ready.Gov)

Have these items ready to go before the flooding arrives:

- ◆ People/Pets
- ◆ Papers—Important Documents
- ◆ Pictures—Irreplaceable Memories
- ◆ Prescriptions—Medications, Eyeglasses, Hearing Aids
- ◆ Personal Computer—Information on Hard Drives, Disks, or Back-Up Drives

Do not wait for the flood waters to become prepared



Image Courtesy of Apache County Emergency Management

Take Action

When the flood waters arrive be ready to take action.

DO:

- ◆ Be ready to leave on a moments notice
- ◆ Stay aware of weather conditions (monitor NOAA Weather Radio, rainfall observations, www.weather.gov/tucs)



- ◆ Have multiple evacuation plans and routes
- ◆ Be sure your roof is fitted with proper gutters and downspouts

- Two types of fliers were developed to highlight the flash flooding risk and suggested actions.
- The fliers were a huge success and appeared on various government agency web pages in digital form.

Observe the Rain



Two weather stations were installed in the Horseshoe 2 fire burn area on the Chiricahua Mountains. Service Hydrologist, Erin Boyle, produced burn area background maps and amended the Flash Flood Guidance to increase situational awareness within WFO Tucson.

Observing stations will help verify rain amounts from the Dual-Pol data

Snow Level Application

- Dual-Pol improves winter weather forecasting and analysis

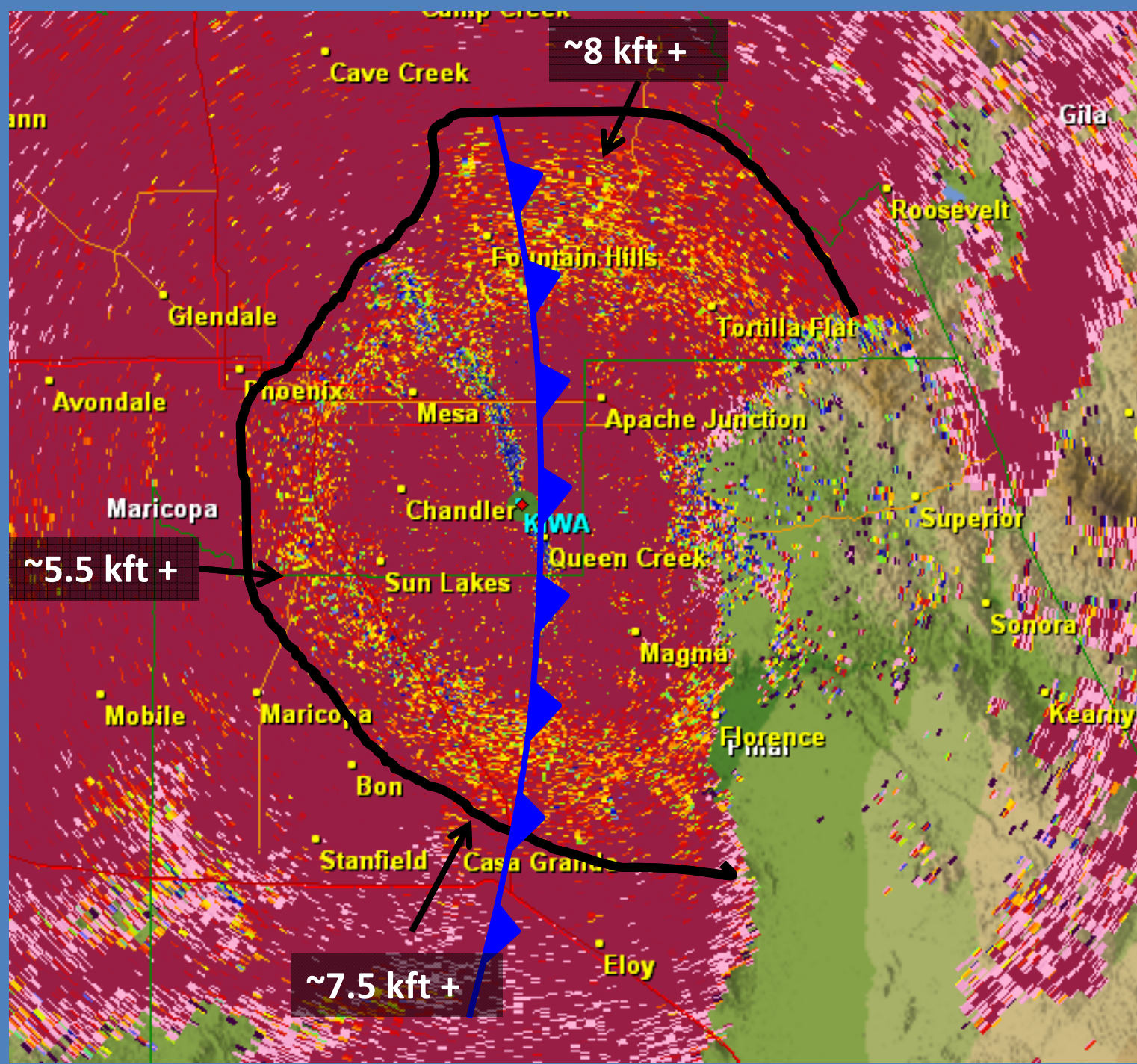


Snow Level Drop with Approaching Cold Front

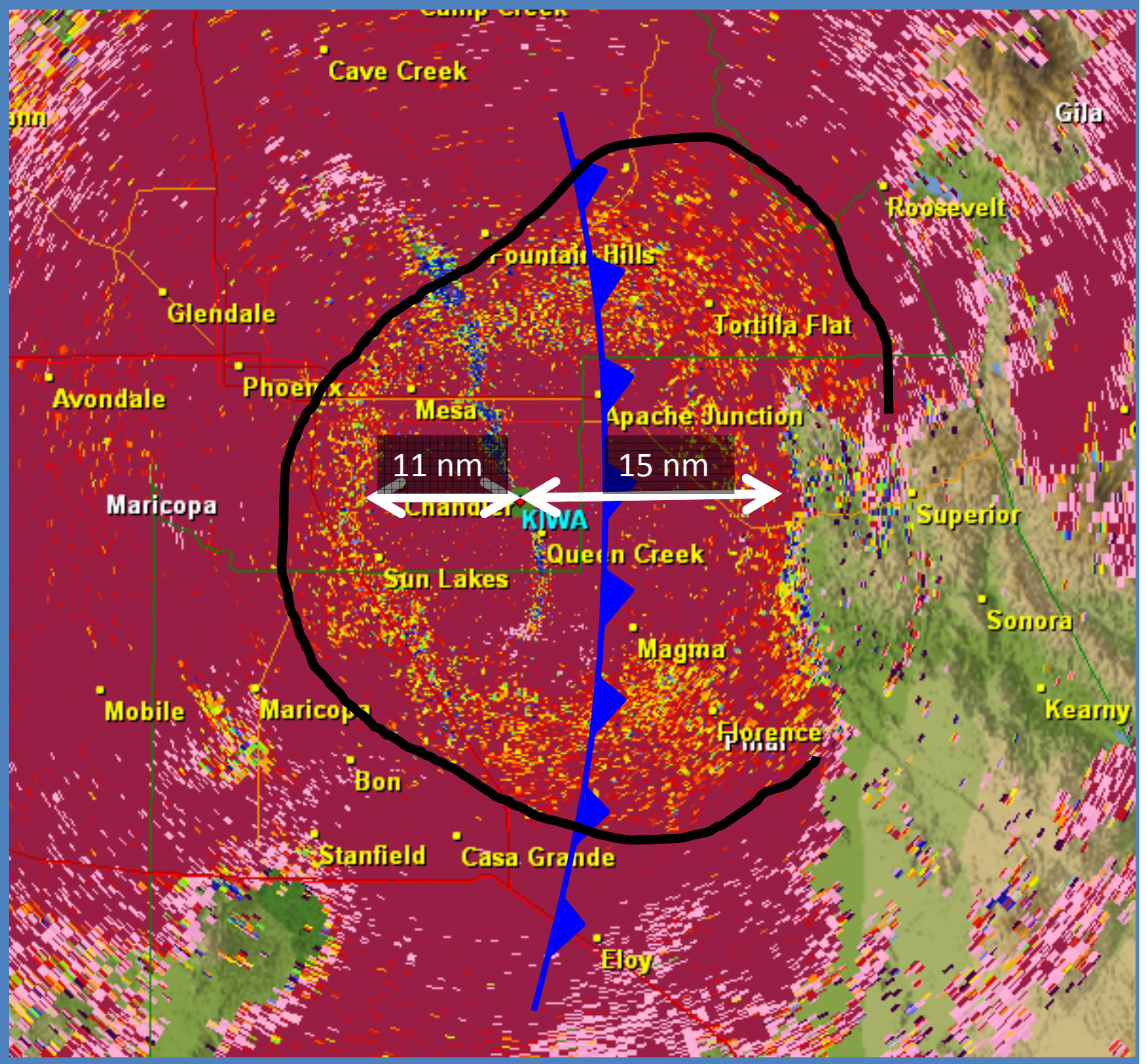
- November 5th
- Cold frontal passage across Arizona
 - WFO Tucson/Phoenix
- CC shows snow level drop
 - Using KIWA (WFO Phoenix Radar)
- Tucson forecasters amended package based on Dual-Pol Data



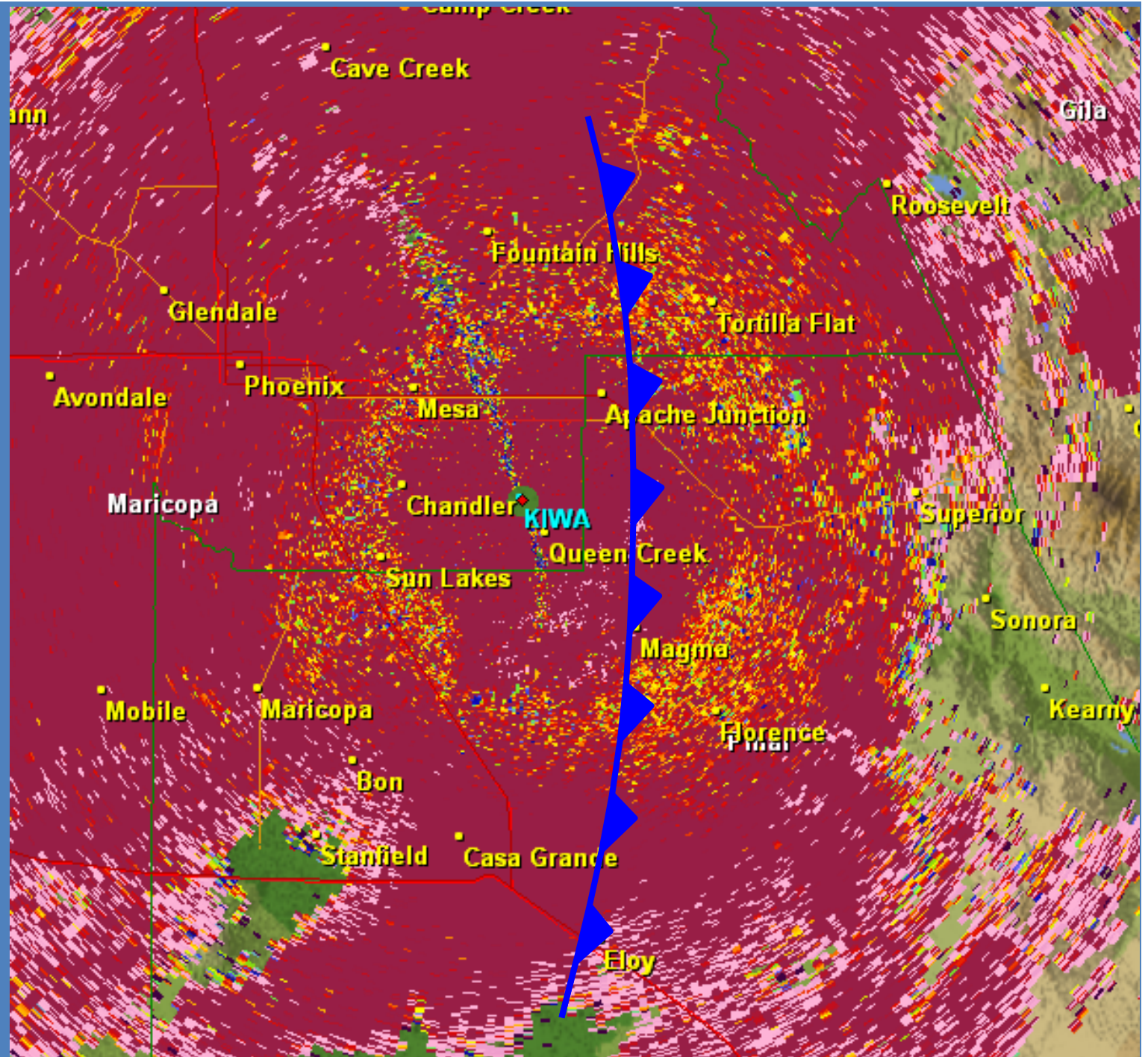
- 7:34z – Front just east of Radar
- Melting level drops behind front by 2 to 3 kft



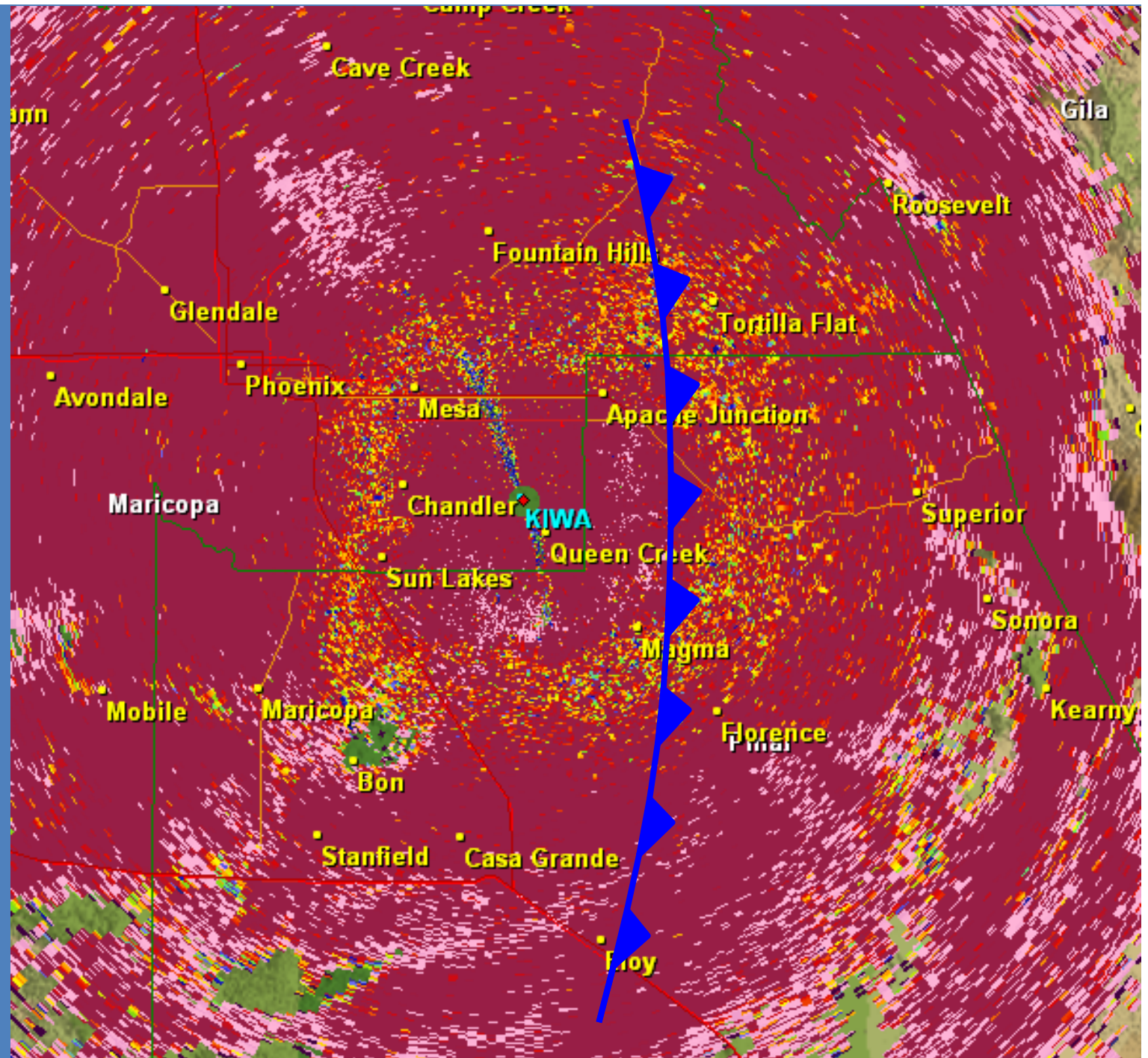
- 7:48z - Inner edge of melting layer is oblong shaped
- Front continues pushing east



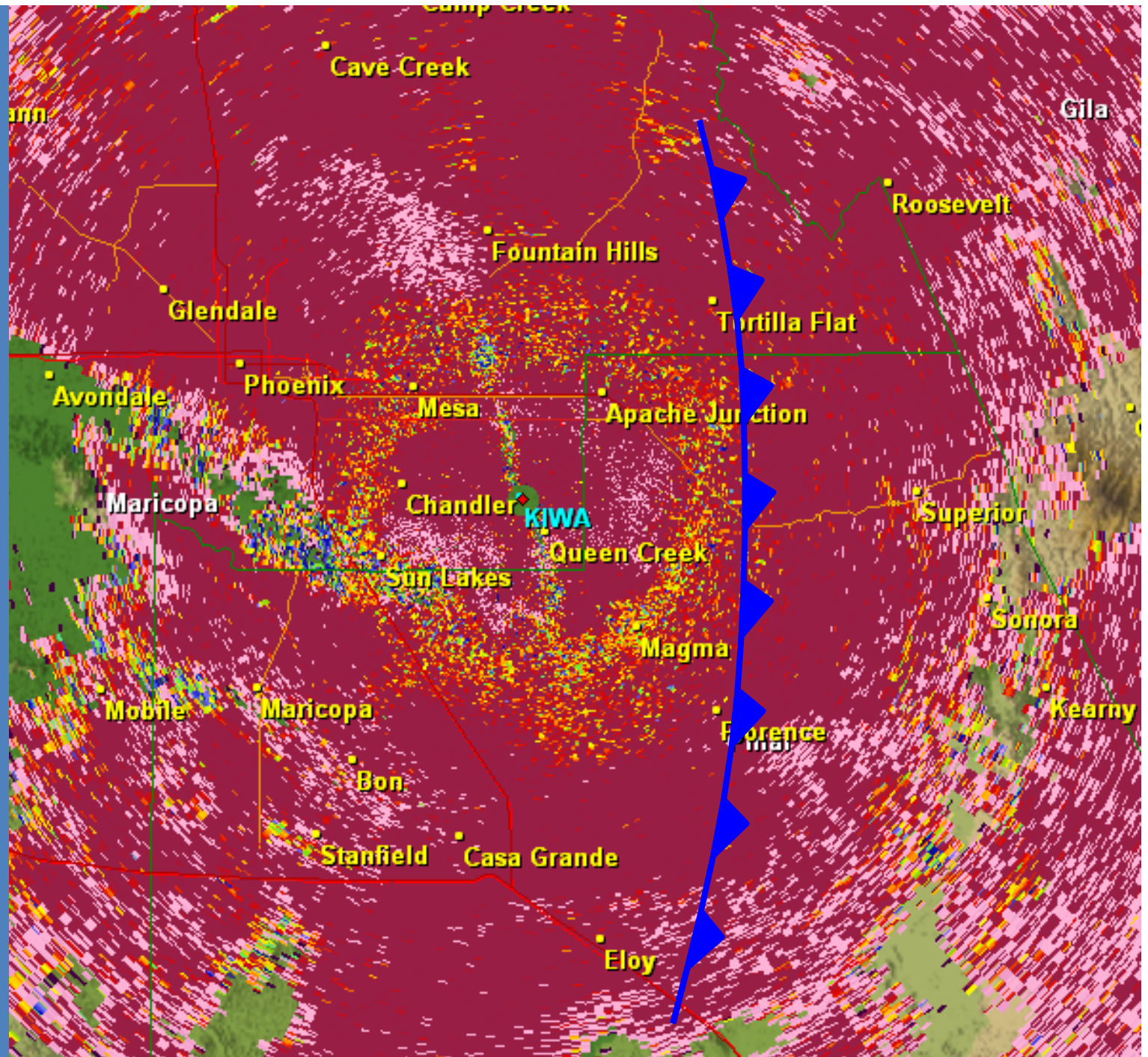
- 8:00z – Entire melting layer becomes visible



- 8:18z –
Melting layer
shape
“tightens up”



- 8:38z – Melting layer become a fairly well defined circle
- Melting level now sitting at about 5,500 to 6,000 feet
- Forecasters amend AFD and grids



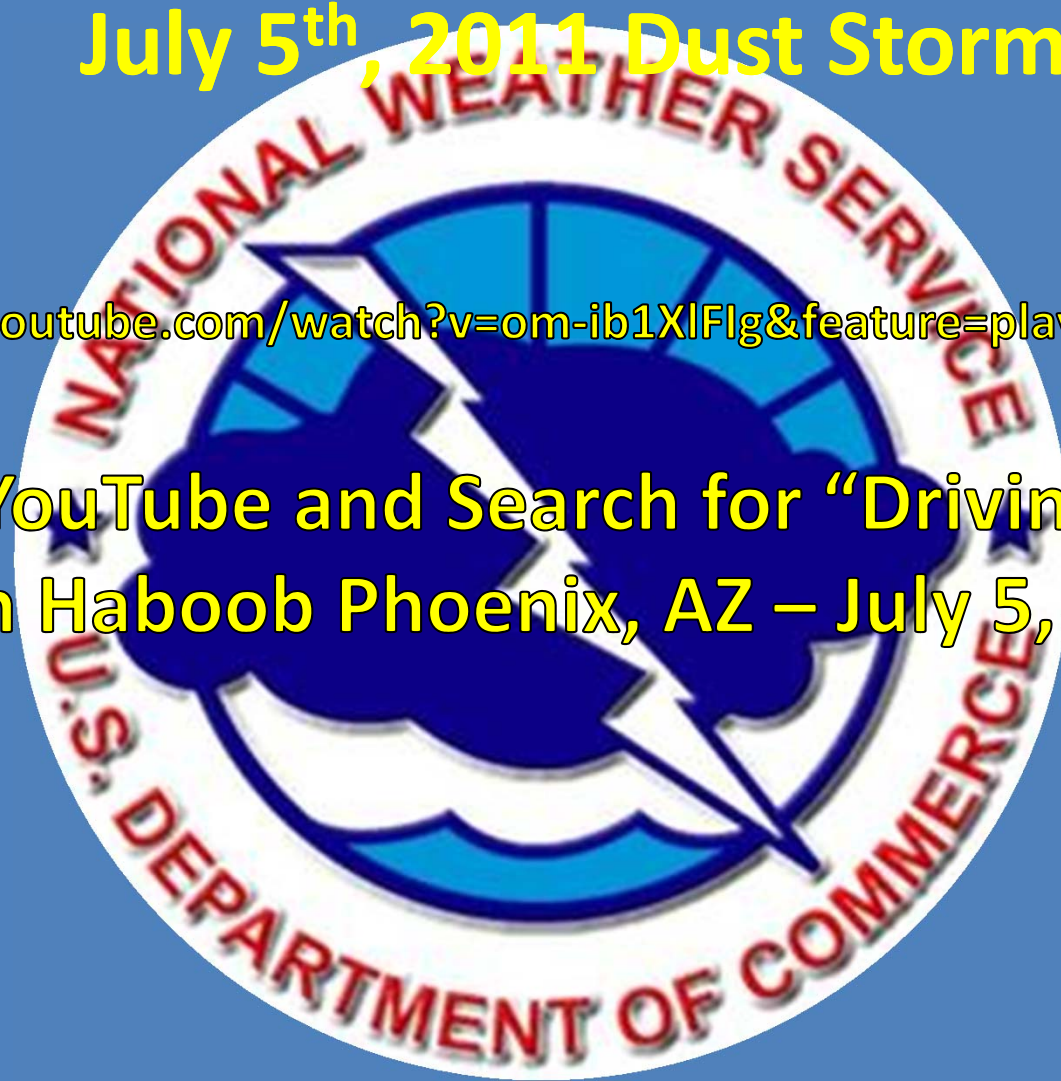
AFD and Forecast Package Amended

- “SNOW LEVELS HAVE DROPPED DRAMATICALLY BEHIND THE FRONT...DOWN TO AROUND 5000 FEET PER PHOENIX DUAL POL RADAR. SNOW AMOUNTS ABOVE 6000 FEET WILL BE IN THE 2 TO 6 INCH RANGE...WITH HIGHEST AMOUNTS UP IN THE WHITES.”

July 5th, 2011 Dust Storm

http://www.youtube.com/watch?v=om-ib1XIFlg&feature=player_embedded

(Or go to YouTube and Search for “Driving into dust storm Haboob Phoenix, AZ – July 5, 2011)



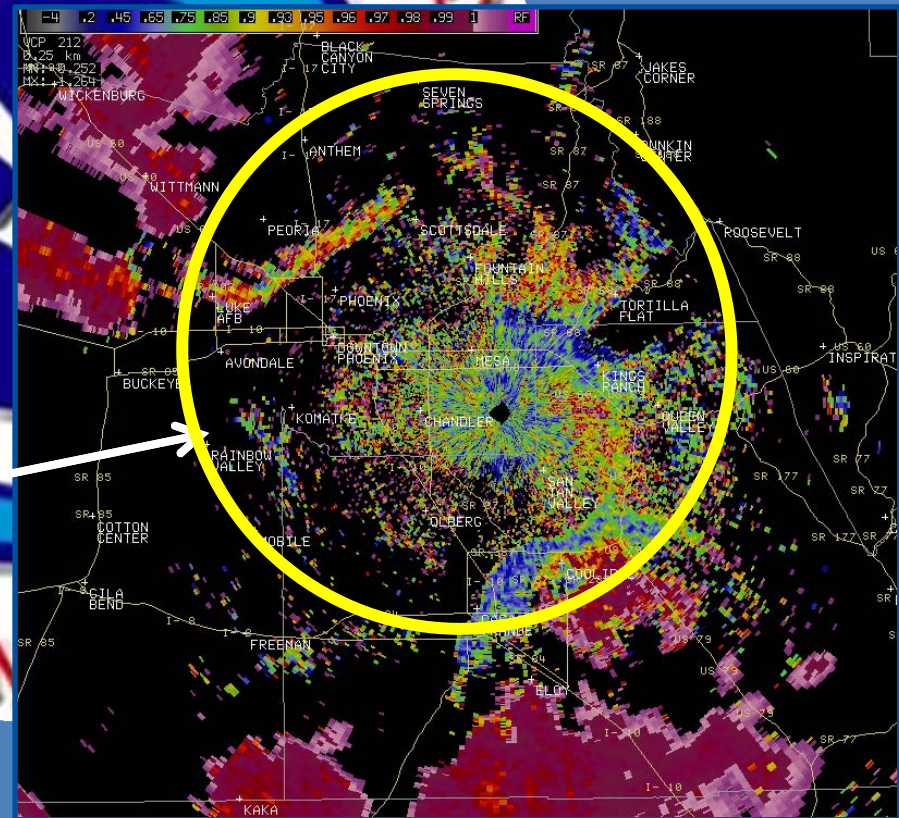
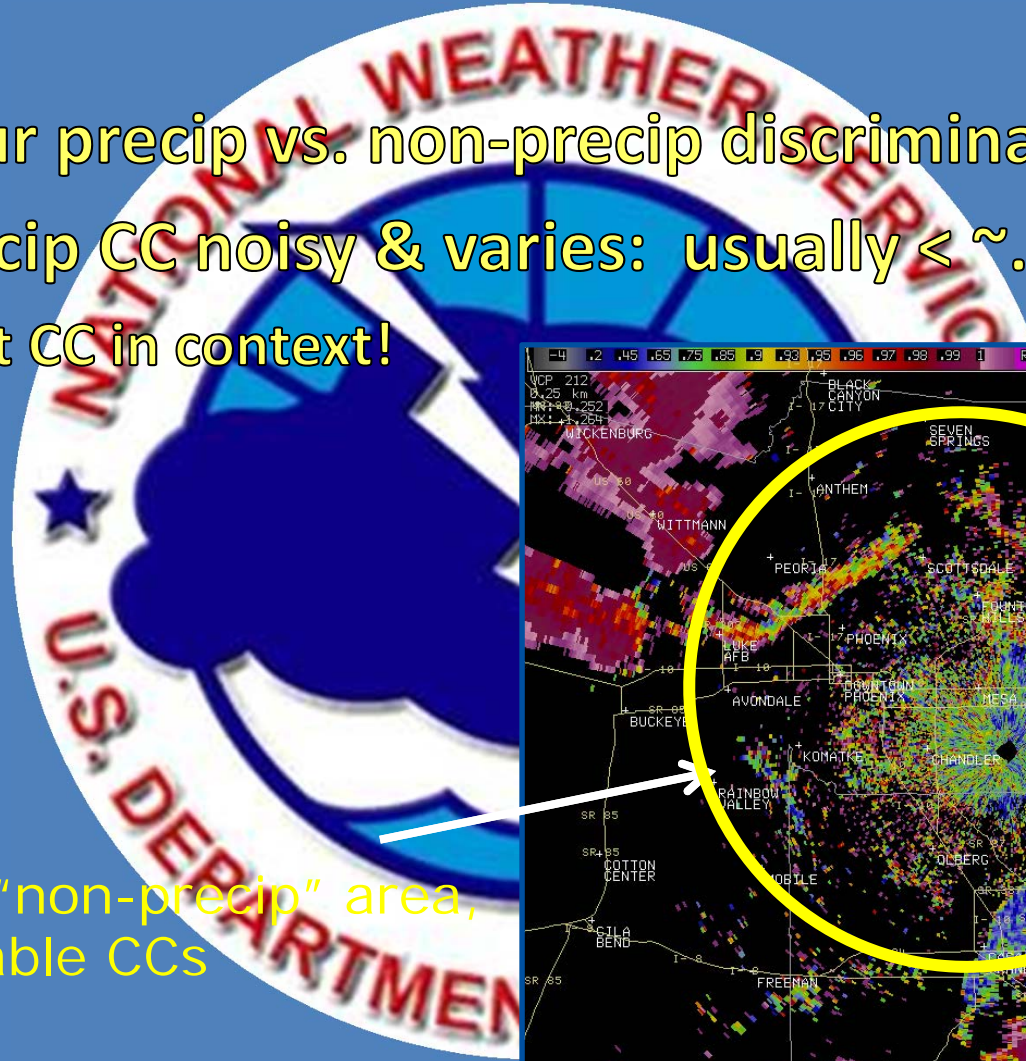
**Pictures Taken from Motorist Driving from Phoenix to Tucson
on July 5th, 2011**



Phoenix Dust Storm & Dual-Pol

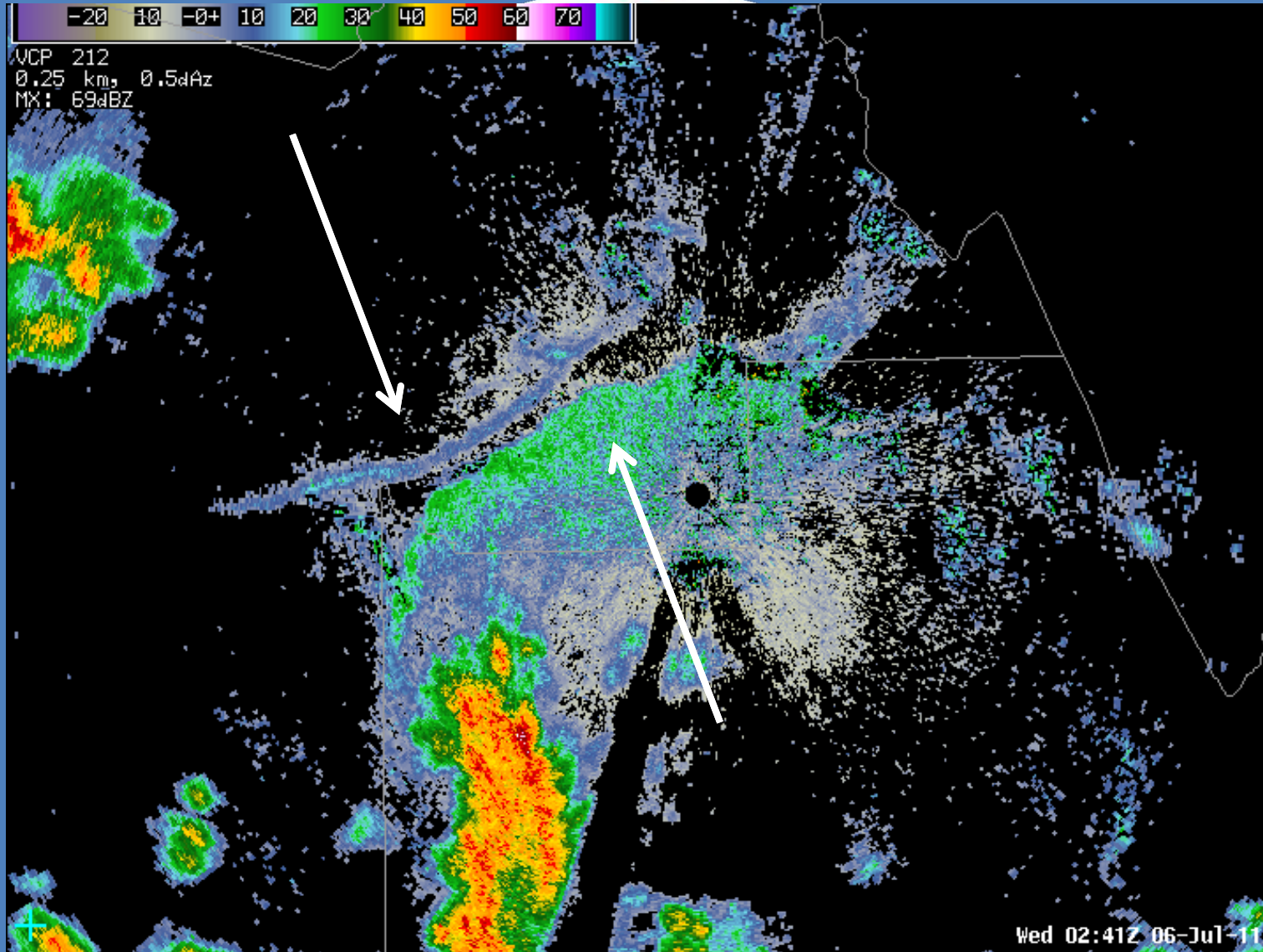


- CC is your precip vs. non-precip discriminator
- Non-precip CC noisy & varies: usually $< \sim .80-.85$
 - Look at CC in context!

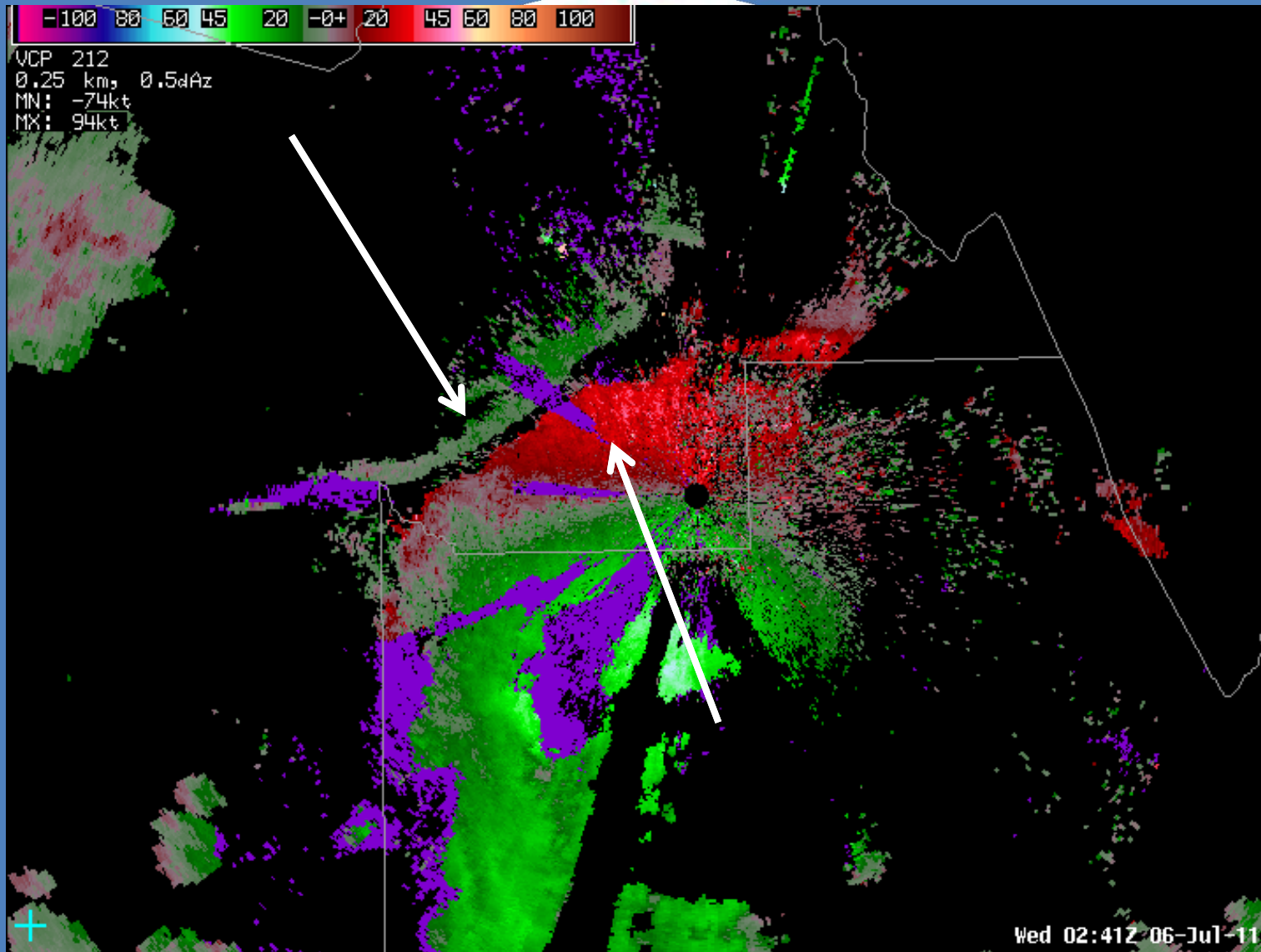


Within the "non-precip" area,
highly variable CCs

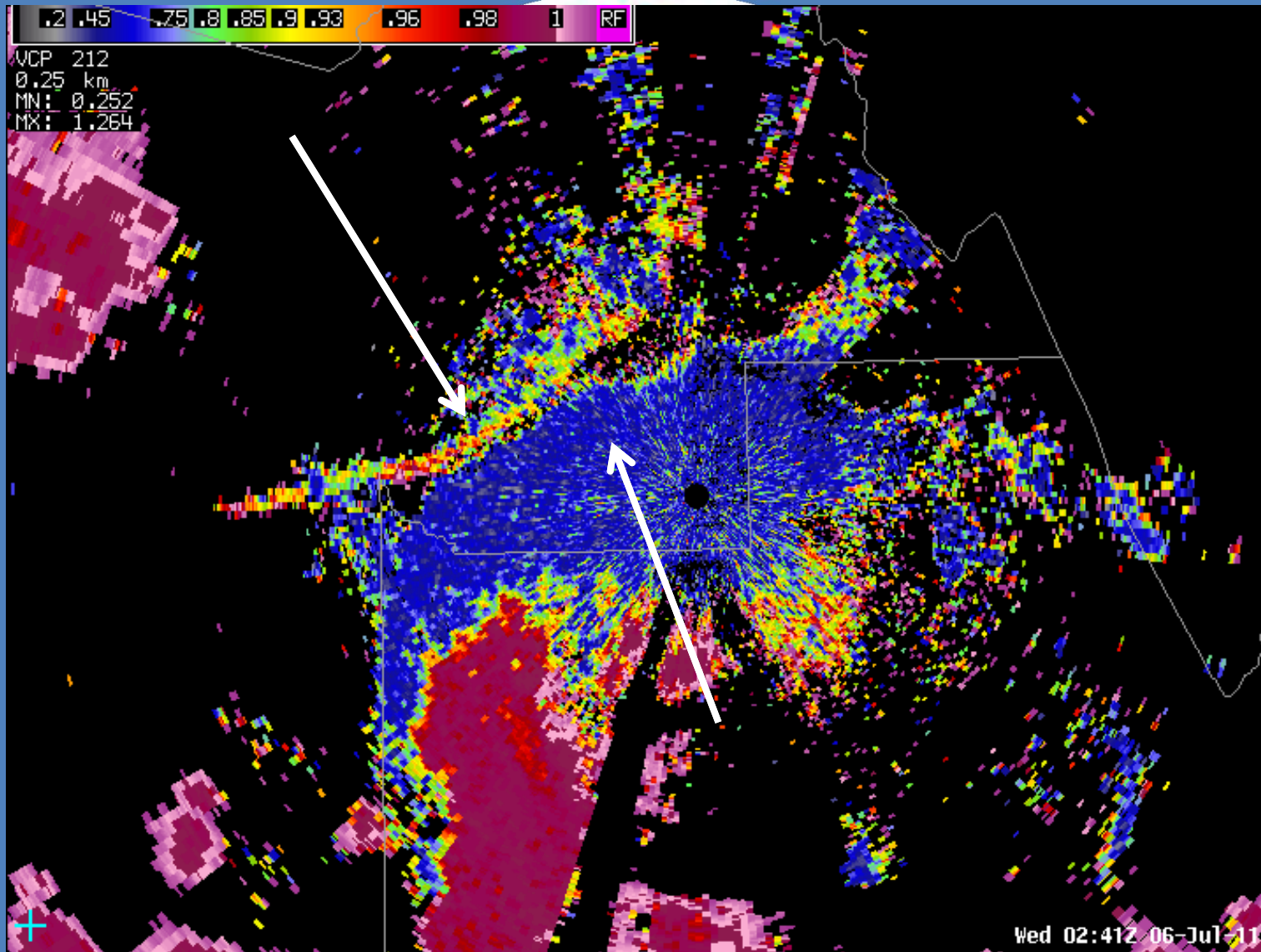
Reflectivity – July 5, 2011



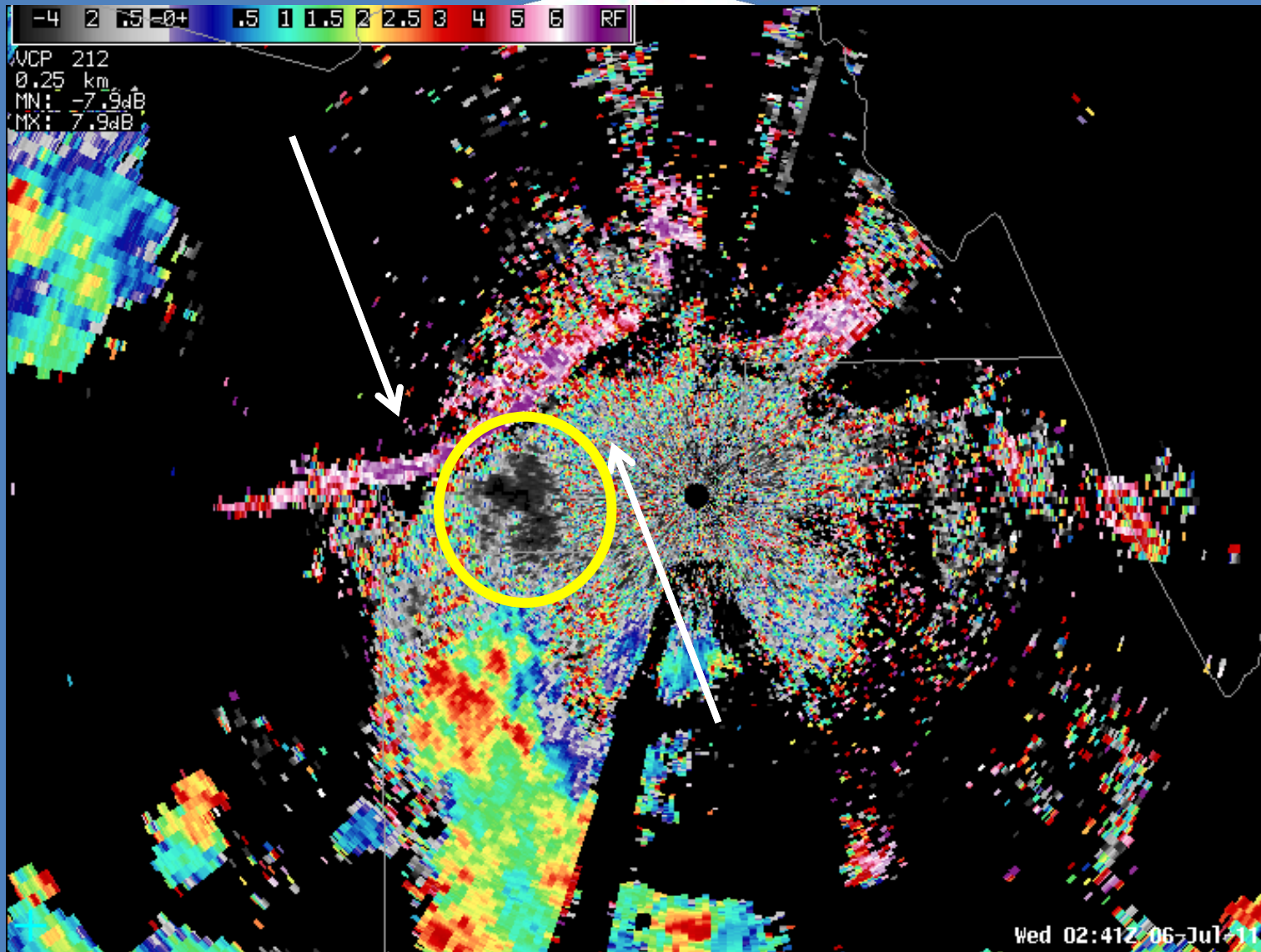
Velocity – July 5, 2011



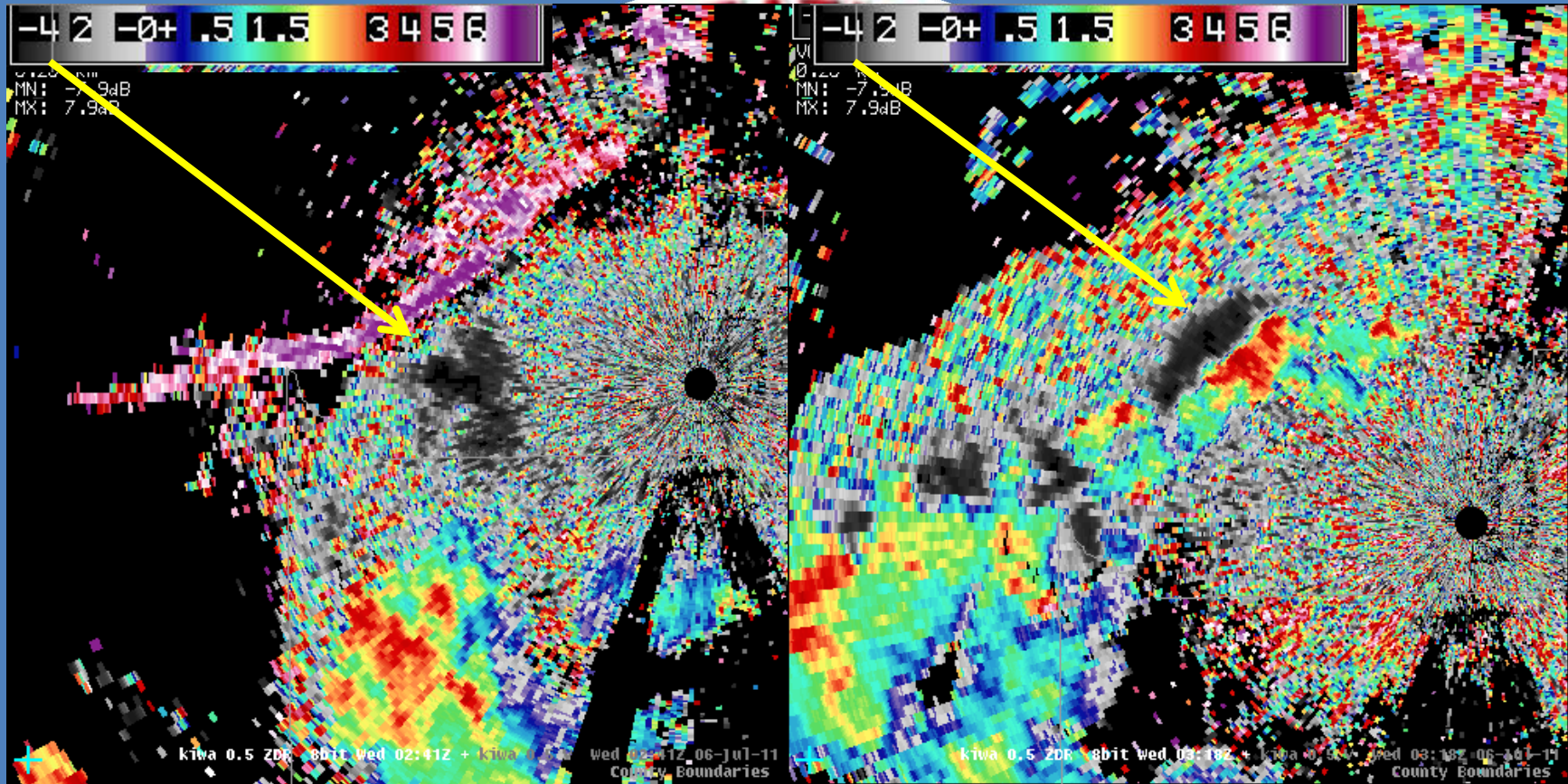
CC – July 5, 2011



ZDR – July 5, 2011



Intrigues of the July 5 Storm



- Negative ZDR (“black hole”)
- Occurred adjacent to & away from areas of precip

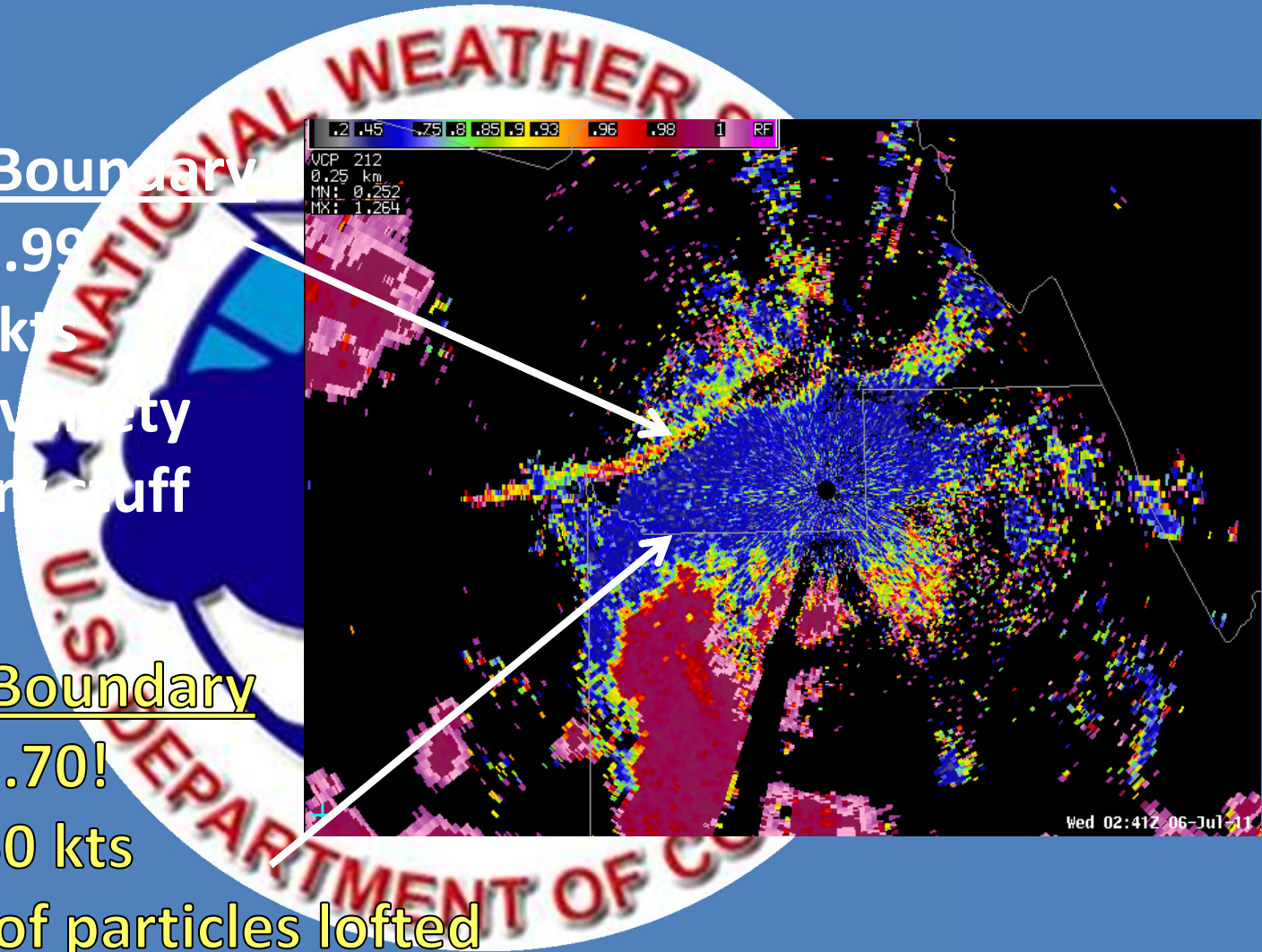
Intrigues of the July 5 Storm

Northern Boundary

- CC .73 - .99
- Vel ~20 kts
- Garden variety boundary stuff lofted

Southern Boundary

- CC .40 - .70!
- Vel 40-50 kts
- Variety of particles lofted



Thank You



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