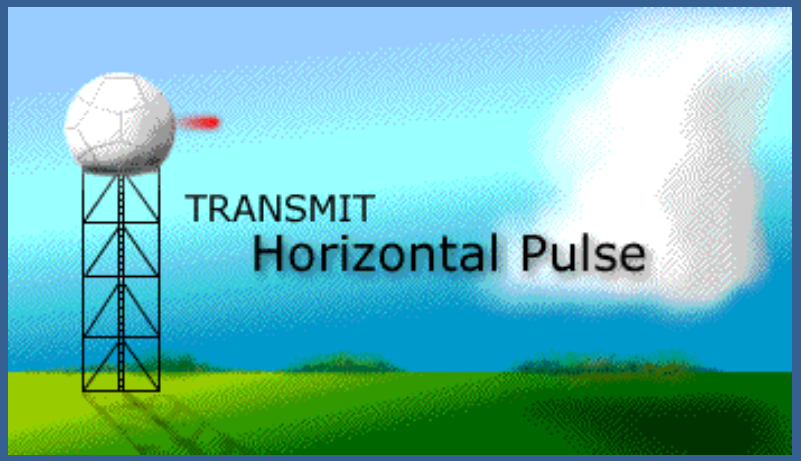
Radar Section

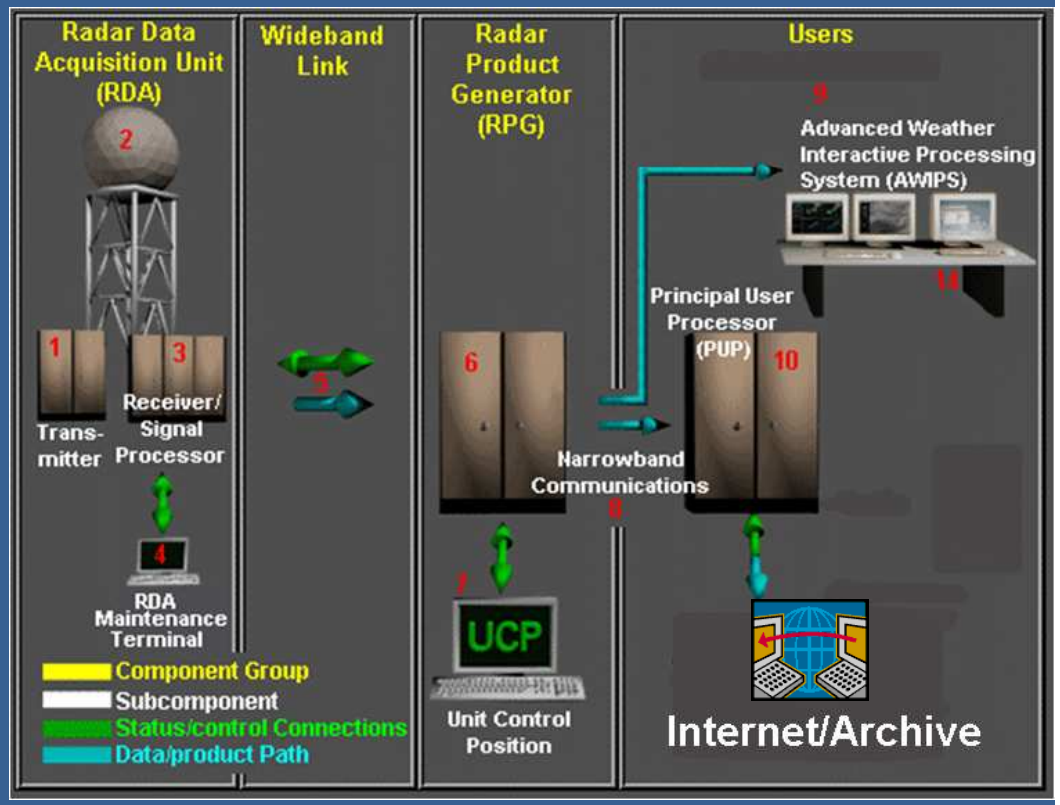
Radar Concepts

- **Remember that this course is not intended to make you an expert, but a more informed spotter.**
- **We will work to try to help you connect what you might see in the field to what we might see on the radar.**

Radar Concepts

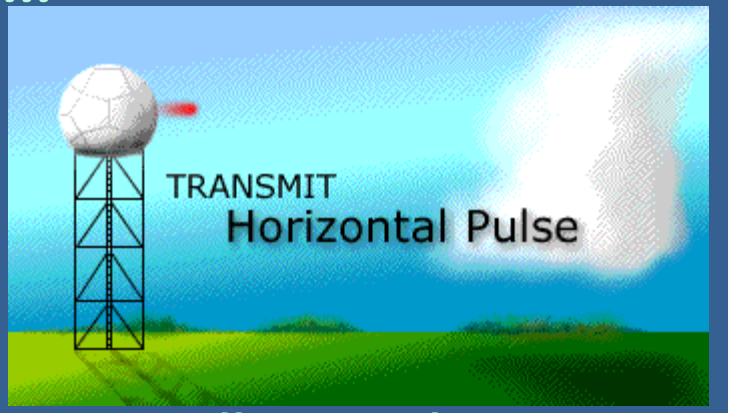
- The WSR-88D (Doppler) is a series of computers connected to a radar





Basic WSR-88D Information

How do we determine...



- The radar sends out numerous pulses of energy. When this energy hits a target, some of the energy returns to the radar. We time the difference between sending and return times, then determine the distance the target is from the radar.

- The intensity is determined by comparing the amount of energy that was sent out from the radar to that which returns to the radar.

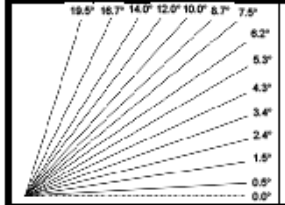
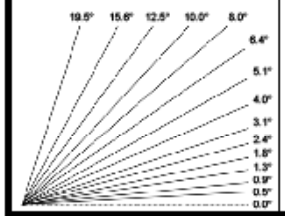
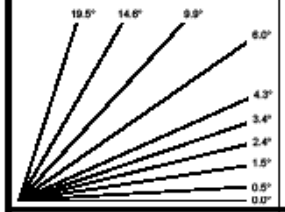
- Motion is determined by measuring the phase shift between pulses.

Scanning

The computers tell the radar how to scan the atmosphere.

There are 9 patterns or VCPs

Quick Reference VCP Comparison Table for RPG Operators — February 2008

Slices	Tilts	VCP	Time*	Usage	Limitations
	14	11	5 mins	Severe and non-severe convective events. Local 11 has Rmax=80nm. Remote 11 has Rmax=94nm.	Fewer low elevation angles make this VCP less effective for long-range detection of storm features when compared to VCPs 12 and 212.
		211	5 mins	Widespread precipitation events with embedded, severe convective activity (e.g. MCS, hurricane). Significantly reduces range-obscured V/SW data when compared to VCP 11.	All Bins clutter suppression is NOT recommended. PRFs are not editable for SZ-2 (Split Cut) tilts.
	14	12	4 ½ mins	Rapidly evolving, severe convective events. Extra low elevation angles increase low-level vertical resolution when compared to VCP 11.	High antenna rotation rates decrease the effectiveness of clutter filtering, increase the likelihood of bias, and slightly decrease accuracy of the base data estimates.
		212	4½ mins	Rapidly evolving, widespread severe convective events (e.g. squall line, MCS). Increased low-level vertical resolution compared to VCP 11. Significantly reduces range-obscured V/SW data when compared to VCP 12.	All Bins clutter suppression is NOT recommended. PRFs are not editable for SZ-2 (Split Cut) tilts. High antenna rotation rates decrease the effectiveness of clutter filtering, increase the likelihood of bias, and slightly decrease accuracy of the base data estimates.
	9	21	6 mins	Non-severe convective precipitation events. Local 21 has Rmax=80nm. Remote 21 has Rmax=94nm.	Gaps in coverage above 5°.
		121	6 mins	VCP of choice for hurricanes. Widespread stratiform precipitation events. Significantly reduces range-obscured V/SW data within 230 km when compared to other VCPs.	PRFs are not editable for any tilt. Gaps in coverage above 5°.
		221	6 mins	Widespread precipitation events with embedded, possibly severe convective activity (e.g. MCS, hurricane). Reduces range-obscured V/SW data beyond 230 km when compared to other VCPs.	All Bins clutter suppression is NOT recommended. PRFs are not editable for SZ-2 (Split Cut) tilts. Gaps in coverage above 5°.
	5	31	10 mins	Clear-air, snow, and light stratiform precipitation. Best sensitivity. Detailed boundary layer structure often evident.	Susceptible to velocity dealiasing failures. No coverage above 5°. Rapidly developing convective echoes aloft might be missed.
		32	10 mins	Clear-air, snow, and light stratiform precipitation.	No coverage above 5°. Rapidly developing convective echoes aloft might be missed.

*VCP update times are approximate.

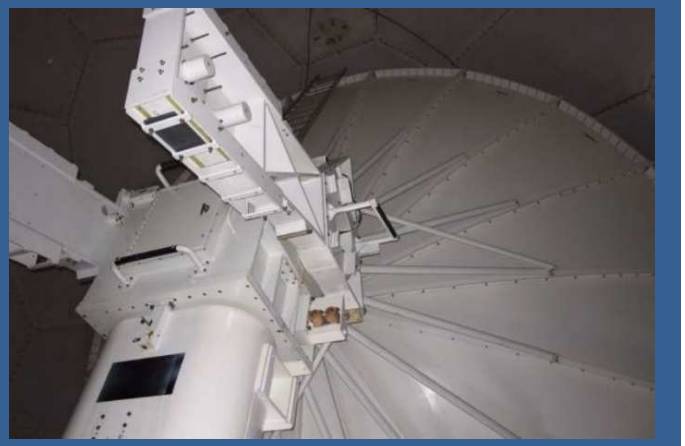
VCP = Volume Coverage Pattern

VCPs

Volume Coverage Patterns

VCP 31, 32 - 5 angles / 10 minutes

Clear air mode



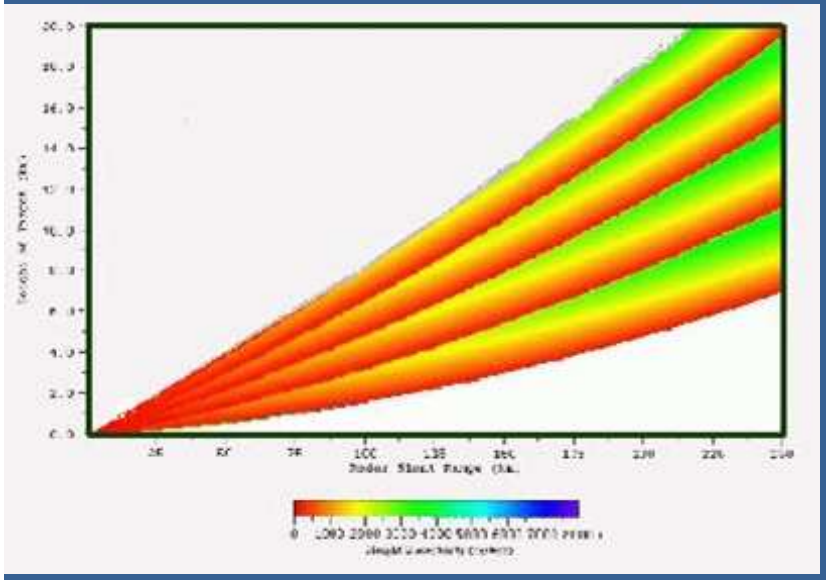
VCP 21 9 angles / 6 minutes
VCP 121 9 angles / 5 minutes
VCP 221 9 angles / 6 minutes*

Non-severe or isolated severe convection

VCP 11 14 angles / 5 minutes
VCP 211 14 angles / 5 minutes*
VCP 12 14 angles / 4.1 minutes
VCP 212 14 angels / 4.1 minutes*

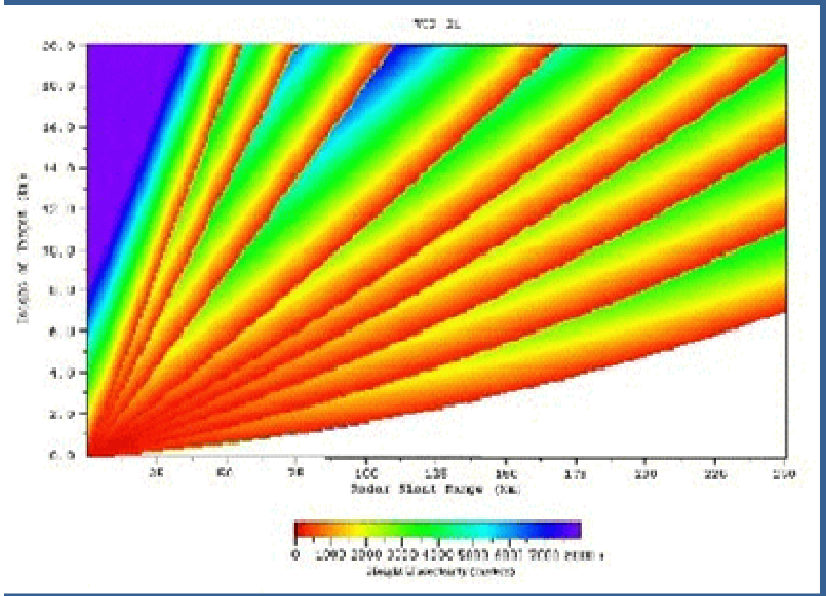
* Better clutter suppression

VCPs



VCPs 31 & 32

5 elevation angles in 10 min.



VCP 21 & 221

9 elevation angles in 6 minutes

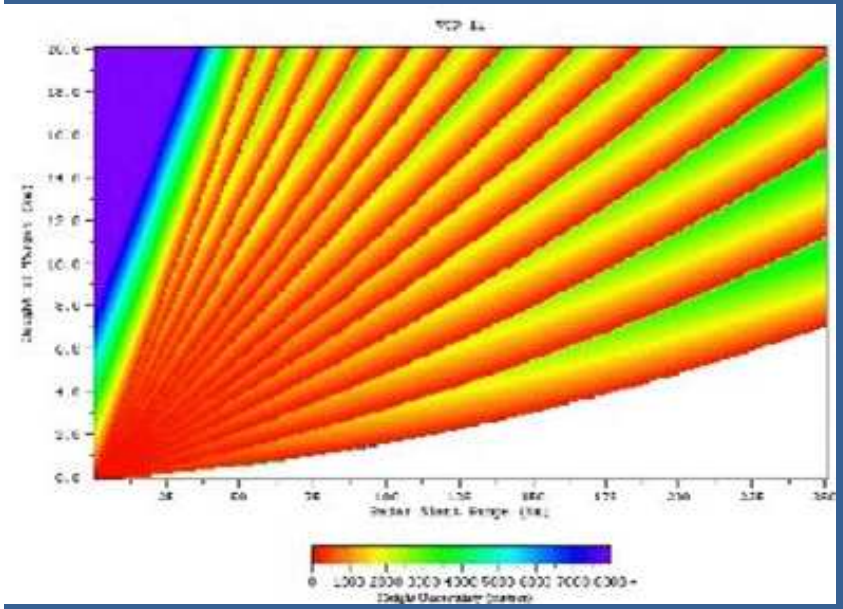
VCP 121

9 elevation angles in 5 minutes

The radar goes around at least 1 complete revolution at each angle, then moves up to the next angle and does the same thing.

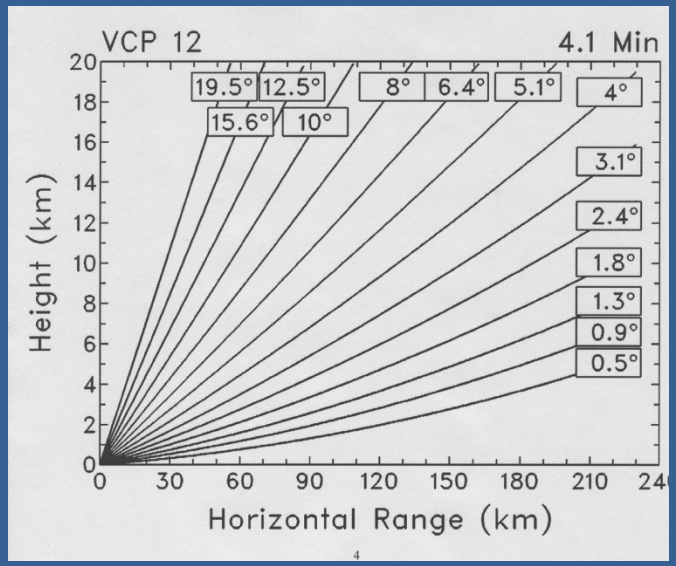
Once it scans the top elevation angle, the radar goes to the bottom does the whole scan again. The time when the new scan starts is the time given to all products created during that scan, no matter when it was scanned or created.

VCPs



VCP 11 & 211

14 elevation angles in 5 minutes



VCP 12 & 212

14 elevation angles in 4.1 minutes

This VCP uses different lower elevation angles!

Radar Concepts

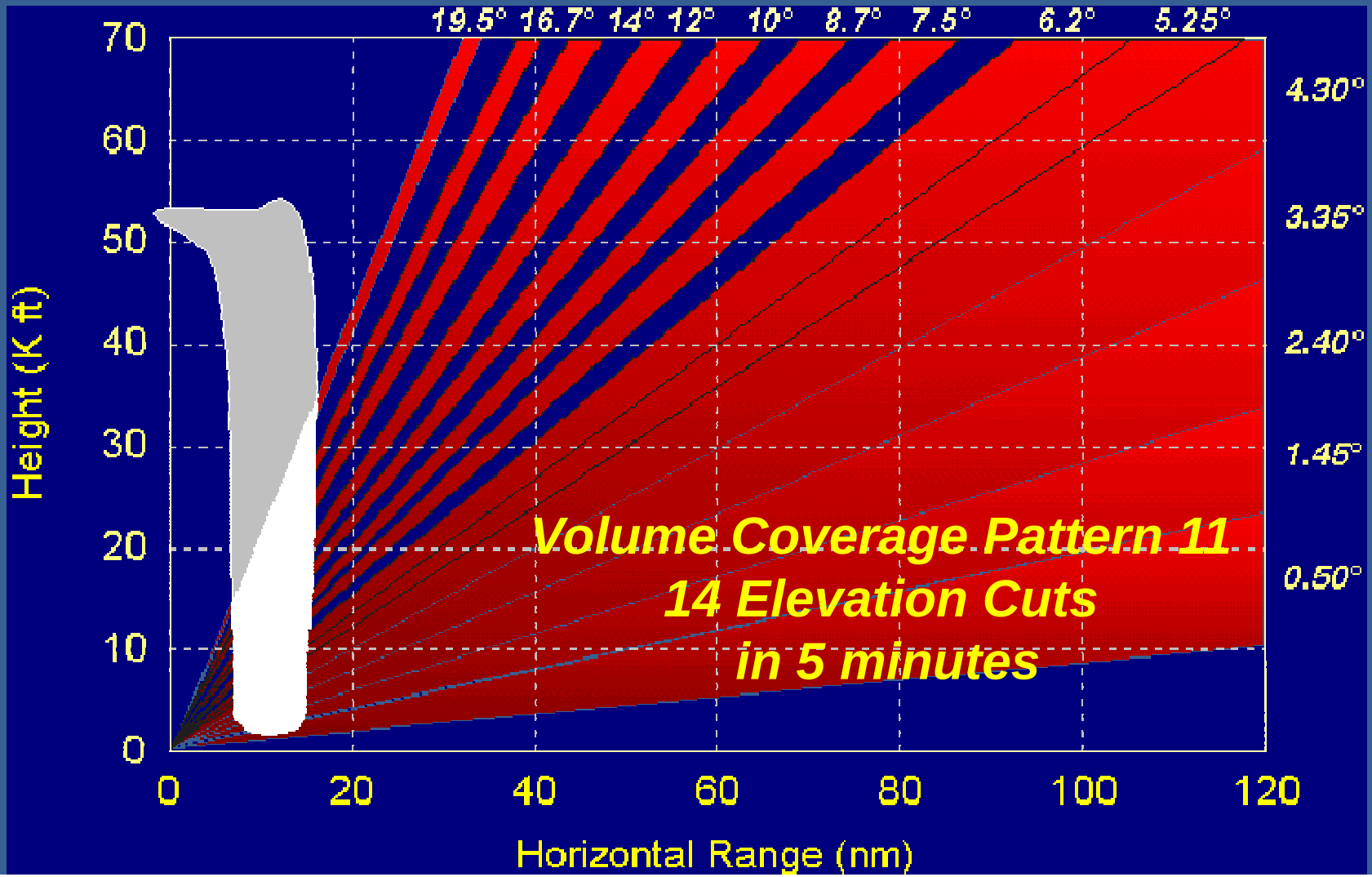
- You probably notice in the previous images that there are blank areas directly above the radar.
- The data is partially “cleaned-up” by computer programs
- Some data, however, is suspect and you need to know about these issues

Cone of Silence

- **Limitation of the radar due to the VCPs used.**
- **The tops of strong convective storms can not be viewed within 20 miles from the radar antenna.**
- **This limitation becomes increasingly significant, the closer to the radar the storm moves.**
- **Forecasters are trained to look at data from other nearby radars anytime storms move into the “Cone of Silence”.**

Effect of Cone of Silence

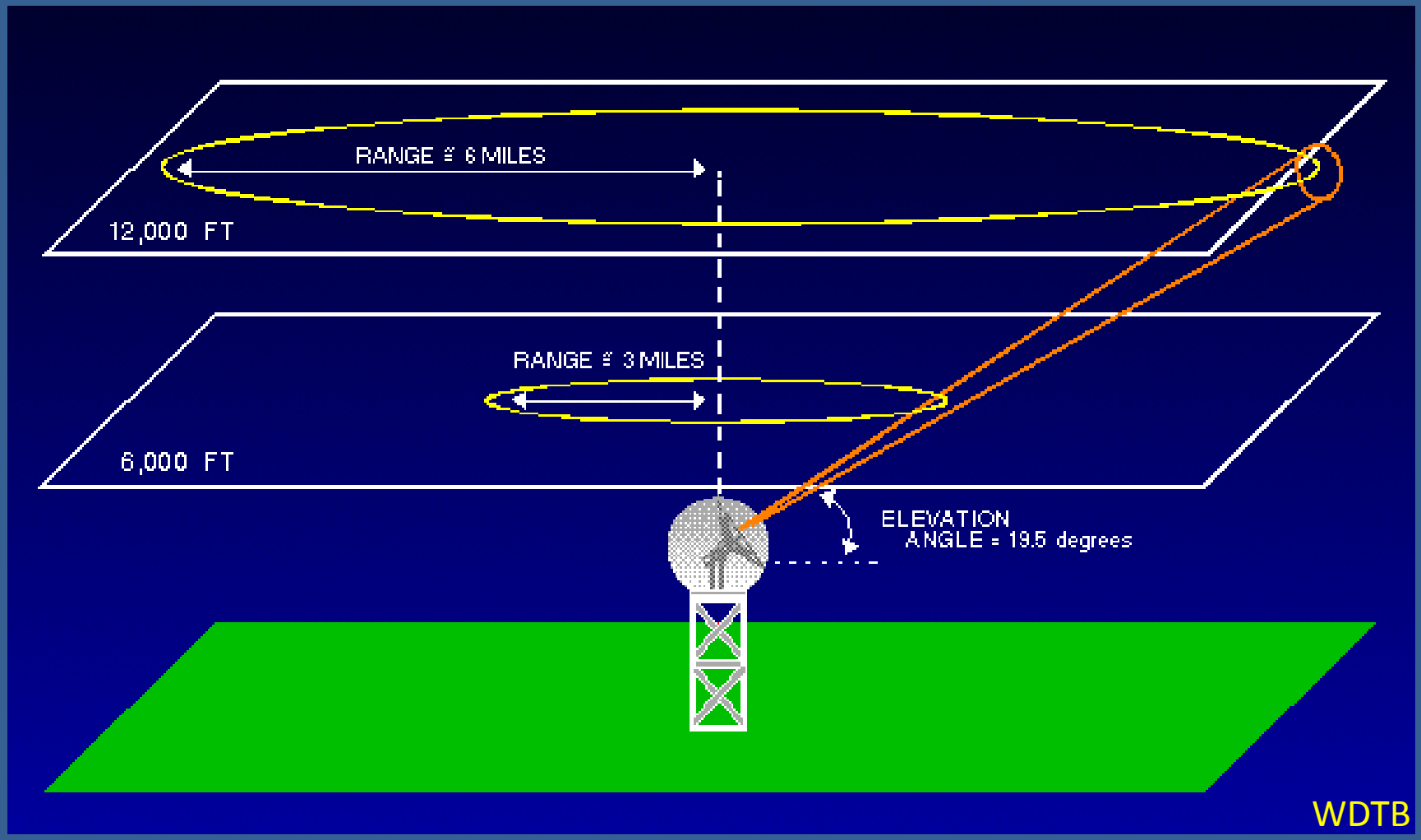
Storms close to antenna not sampled well



WDTB

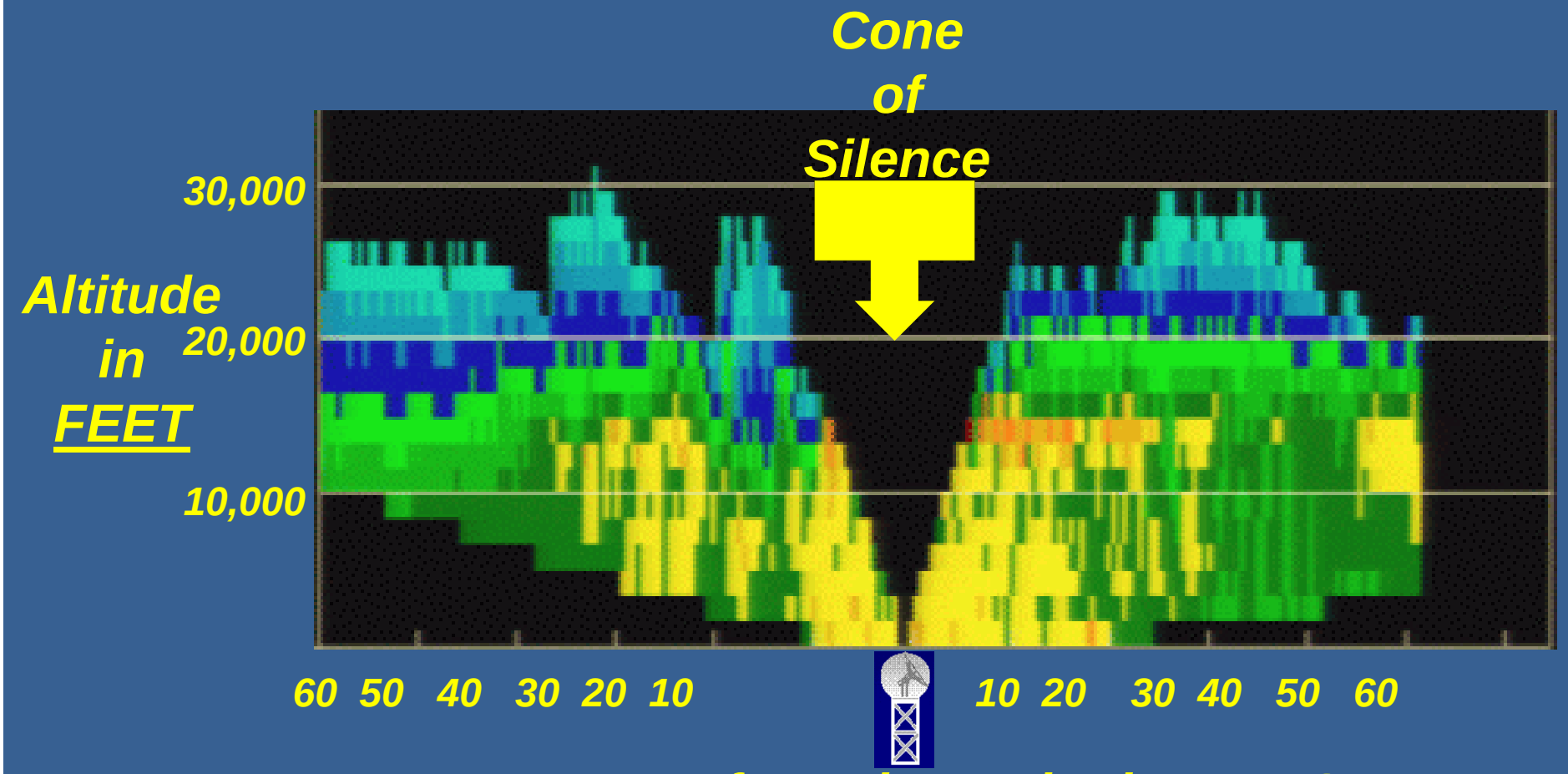
Cone of Silence

An area above the antenna not sampled by radar



Cone of Silence Effects

Cross Section of Reflectivity Data across the RDA

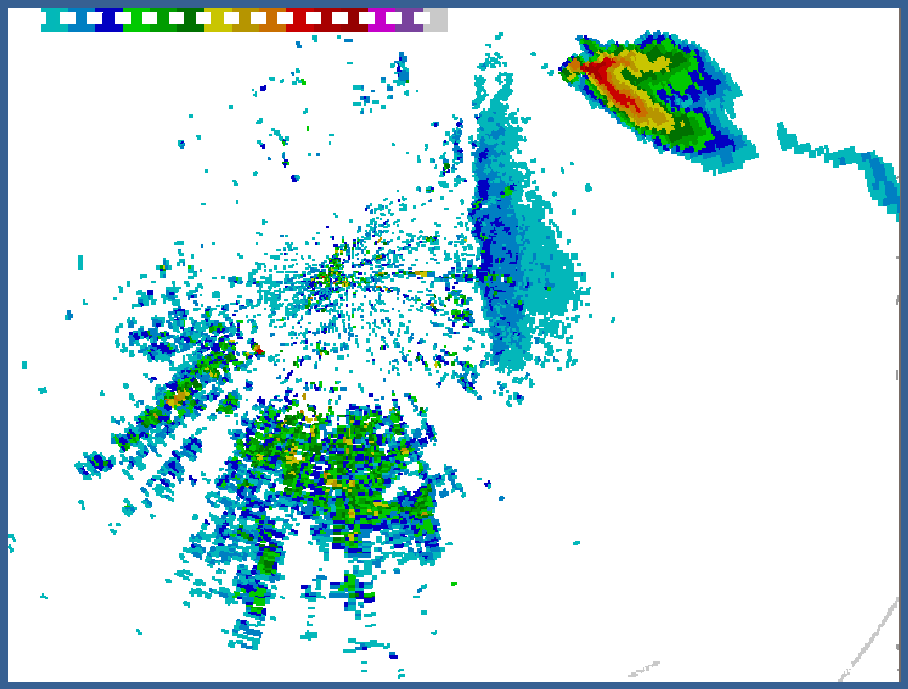


WDTB

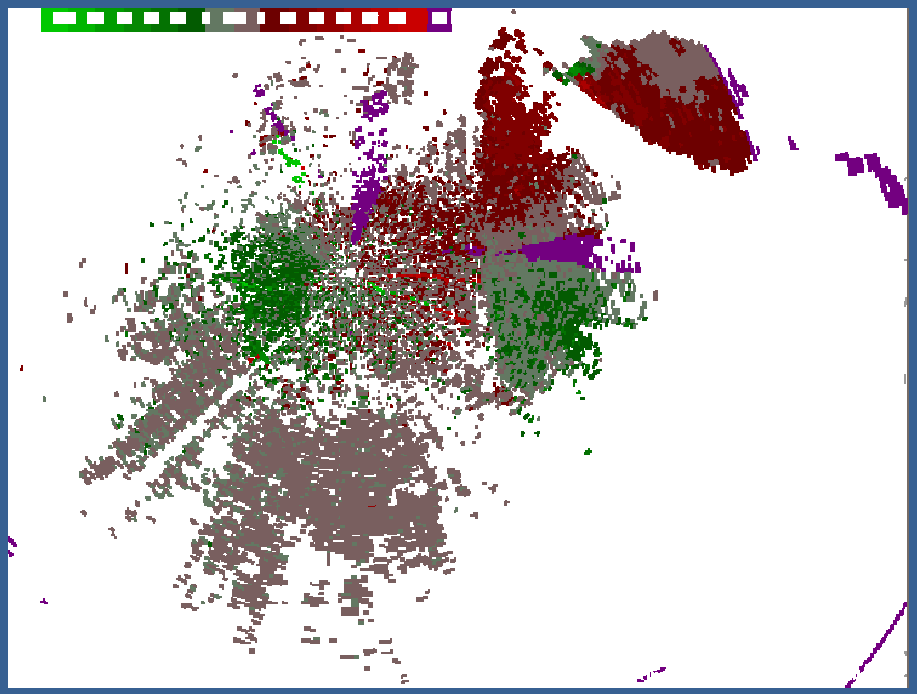
Anomalous Propagation

How to spot it…

WDTB



Reflectivity



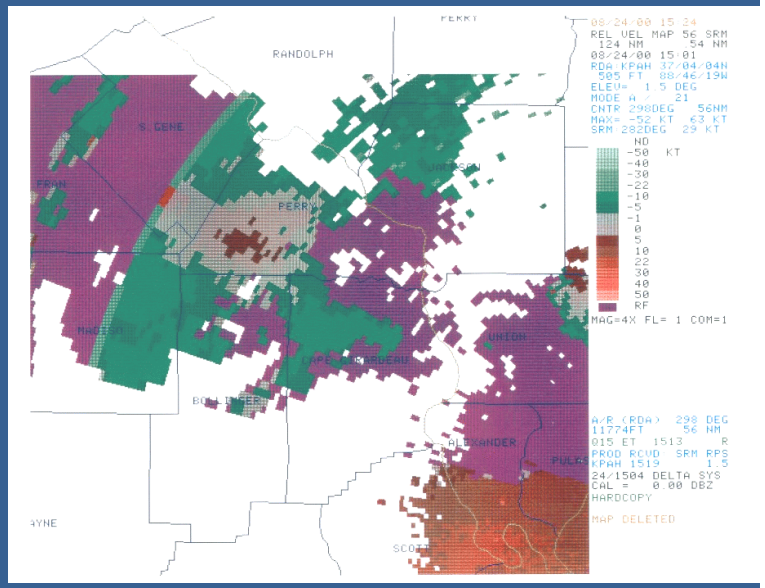
Base Velocity

In these pictures you can see that the storm in the upper right hand corner is real, along with the large area of blue near the center of the picture. Notice the smooth appearance in reflectivity and the velocity values are high. The blocky pattern over the left half of the picture is AP. Note that the velocity values are near zero.

Basic WSR-88D Information

Range Folding (Range Obscured Data)

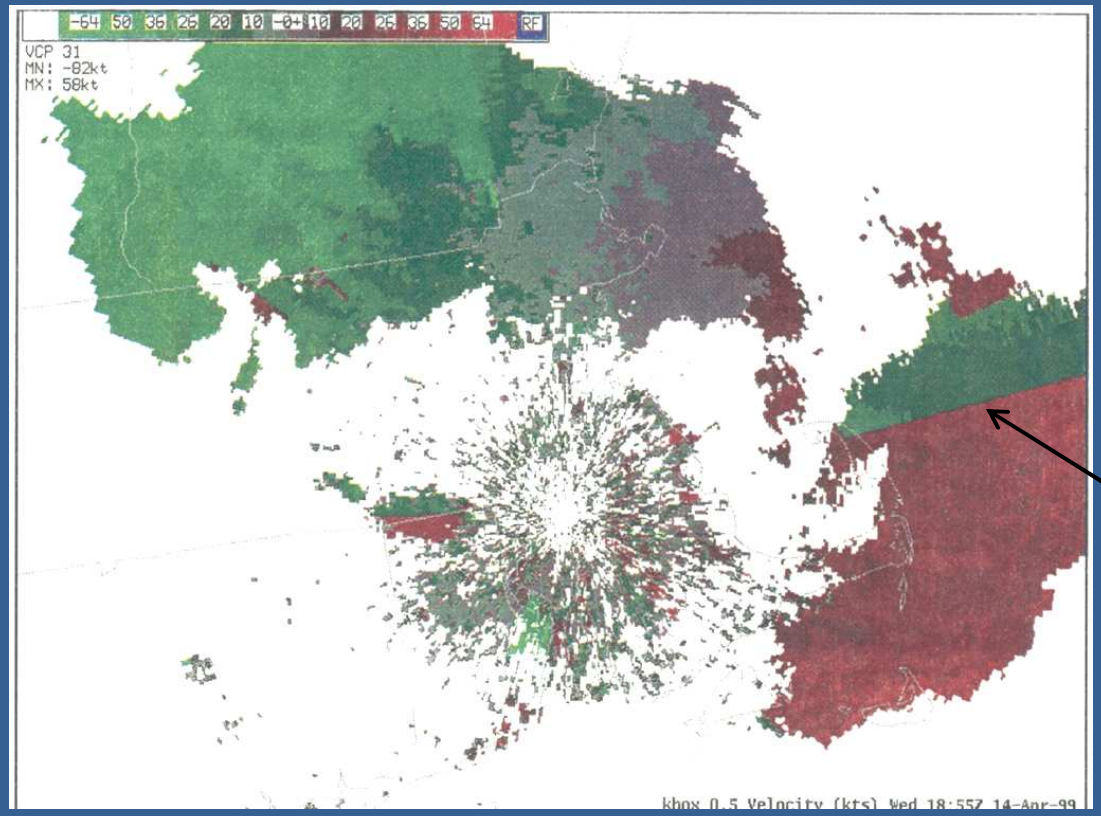
- Known as *"Purple Haze"*
- Essentially multiple trip echoes
- Most of the time, the WSR-88D can unfold these multiple trip echoes and assign accurate velocities
- If the velocity algorithm cannot accurately assign a velocity estimate for that range (location), the purple color is assigned



Basic WSR-88D Information

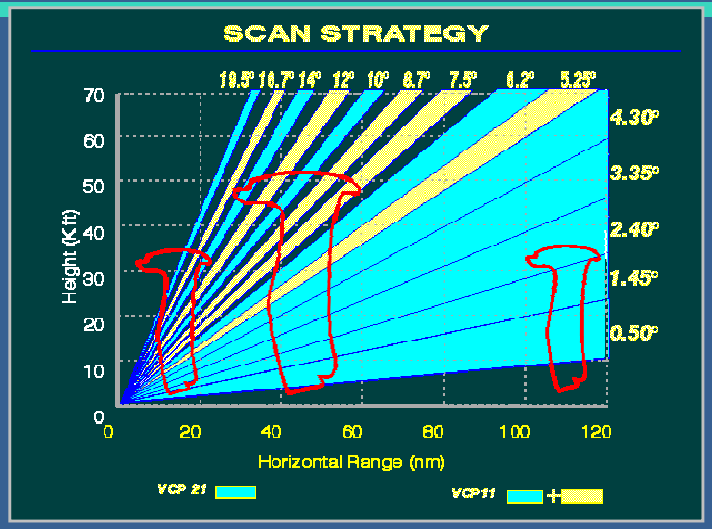
Improper Dealiasing

Actually a rare event to see this

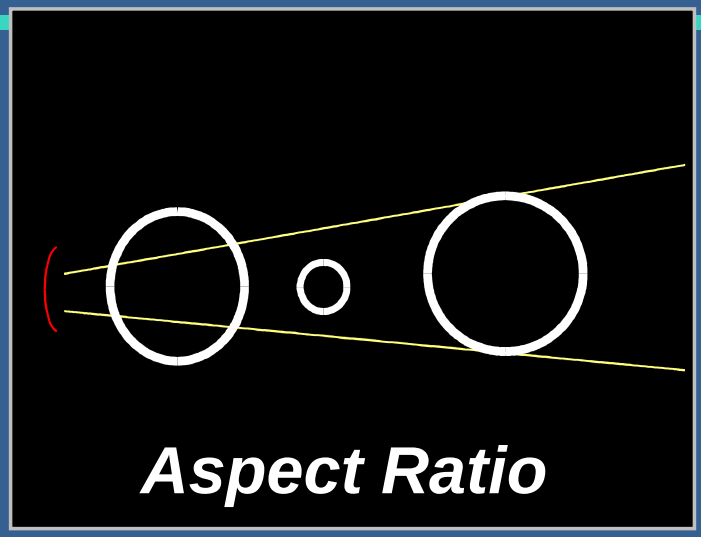


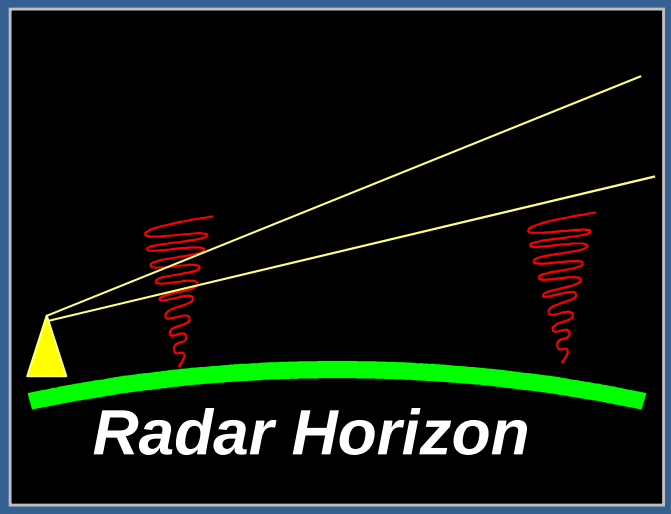
Note the straight line along this echo. The dramatic shift from outbound velocities (red) to inbound velocities is not realistic. There is no zero isodop between the changes in direction.

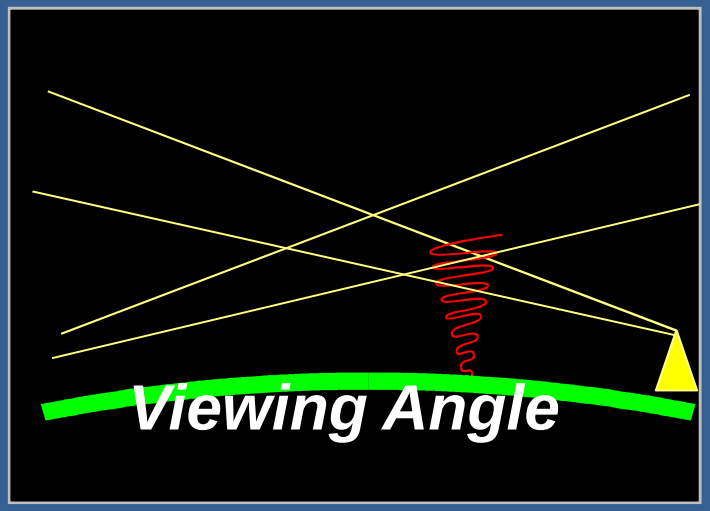
The Impacts of Radar Sampling



VCP/ Cone of Silence







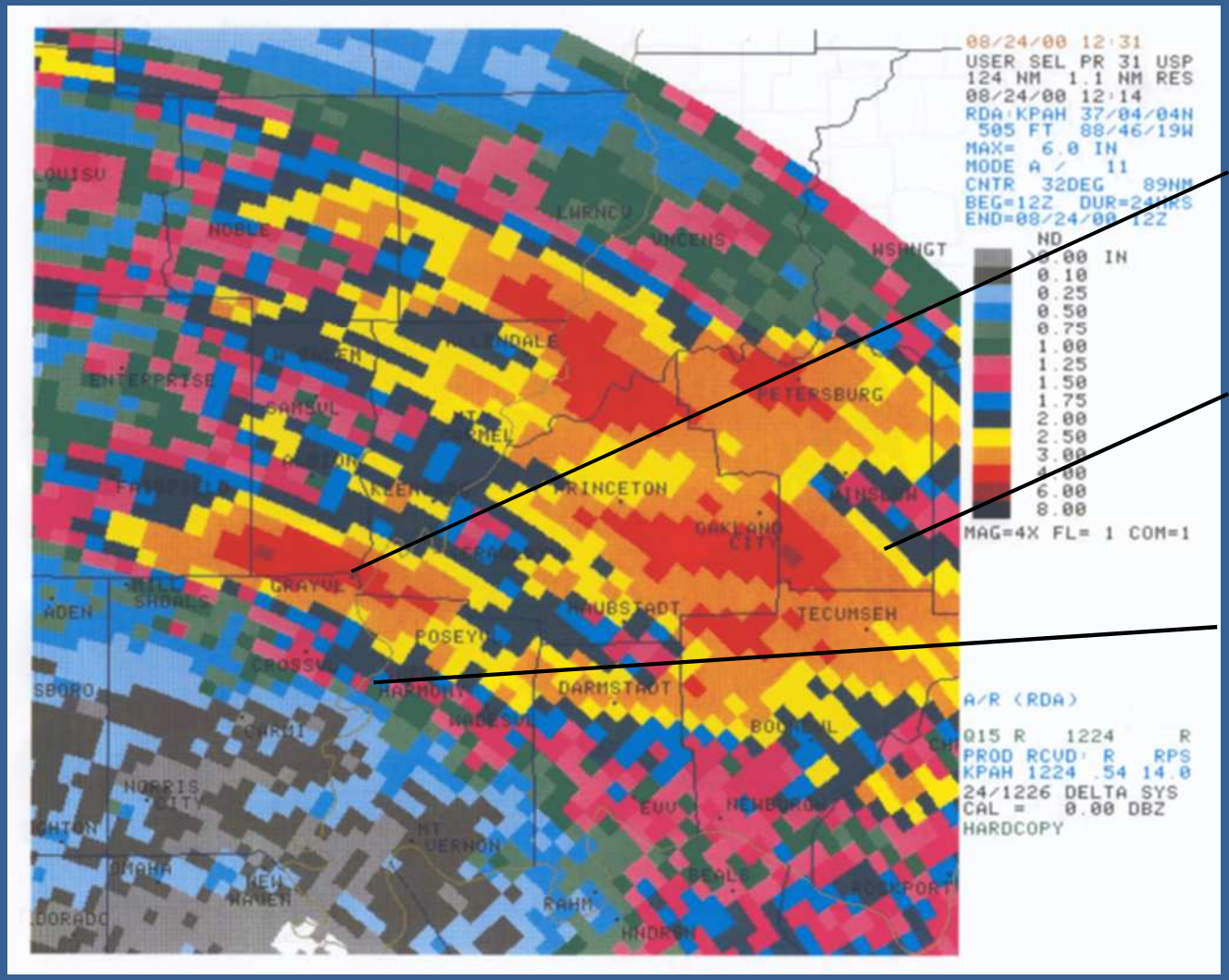
Precipitation Estimates

WSR-88D has extensive algorithms to estimate precipitation

1. **Radar cannot measure rainfall, but can measure returned power**
2. **This information is then fed through a series of equations (algorithms)**
3. **Precipitation estimation is highly dependent upon 2 variables - rainfall rate and drop size**

Precipitation Estimates

Even with all of these possible errors it works pretty well



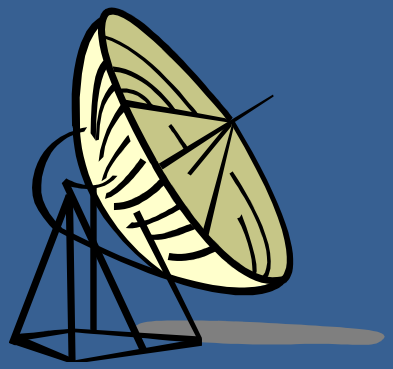
Grayville, IL 5.48"

Stendal, IN 2.68"

New Harmony, IN 1.97

WSR-88D Examples

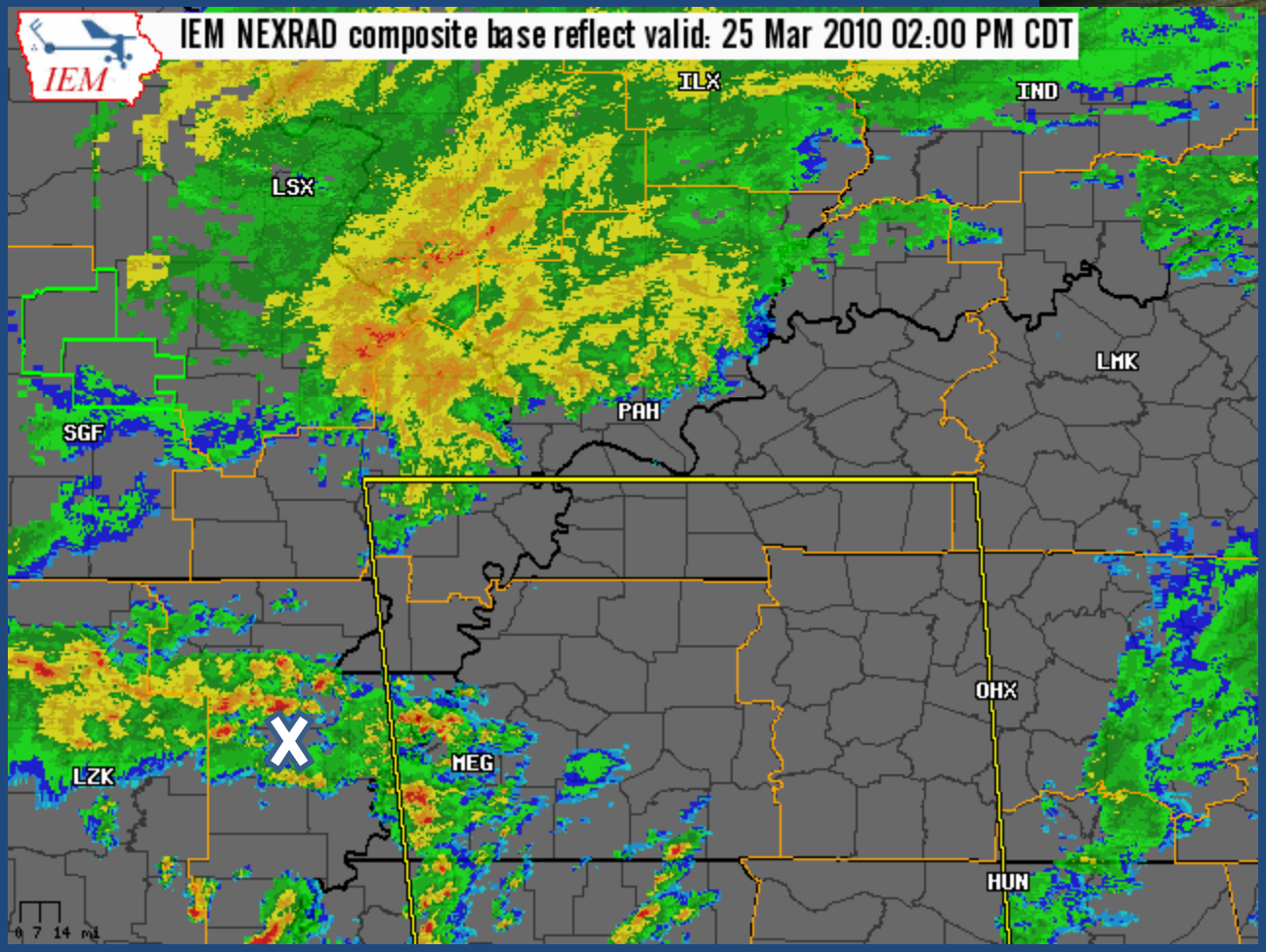
- Updated 3/10
- ***The views expressed are those of the author and do not necessarily represent those of the National Weather Service.***



Severe Weather

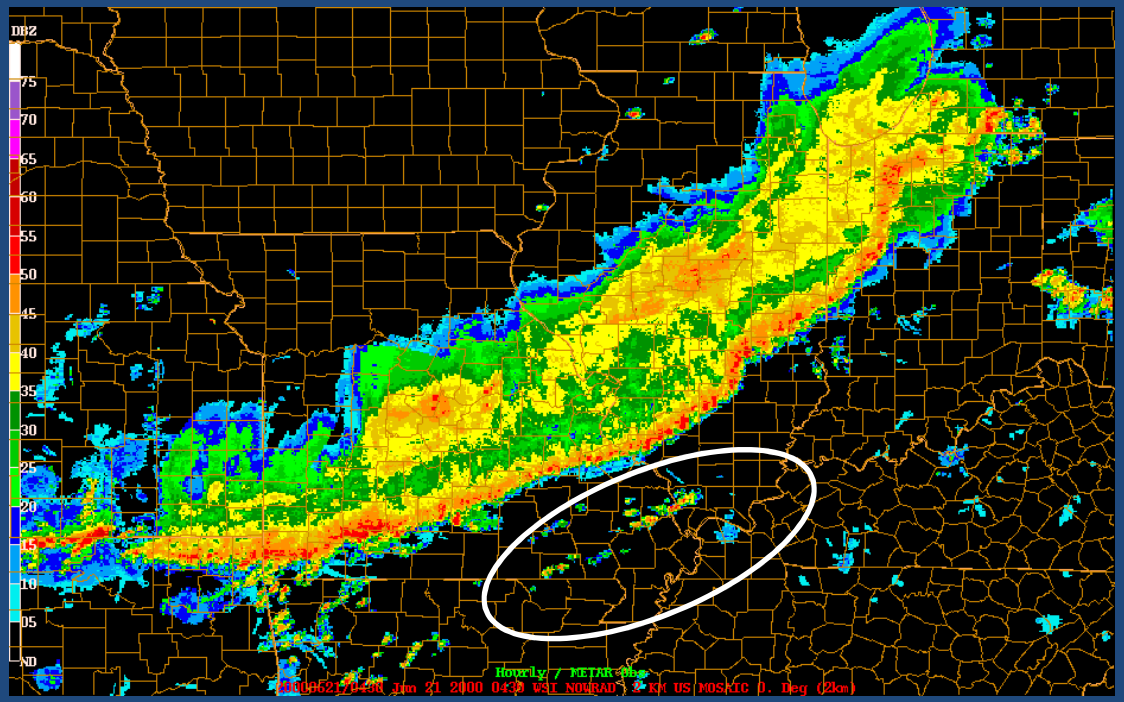
- Severe weather as seen on the radar come in all shapes and sizes which is determined by the environment.
- There are many things that we cannot see, things that are too small, but yet likely hold the key to what happens.

Multi-cell



At “x” looking north

Squall Lines

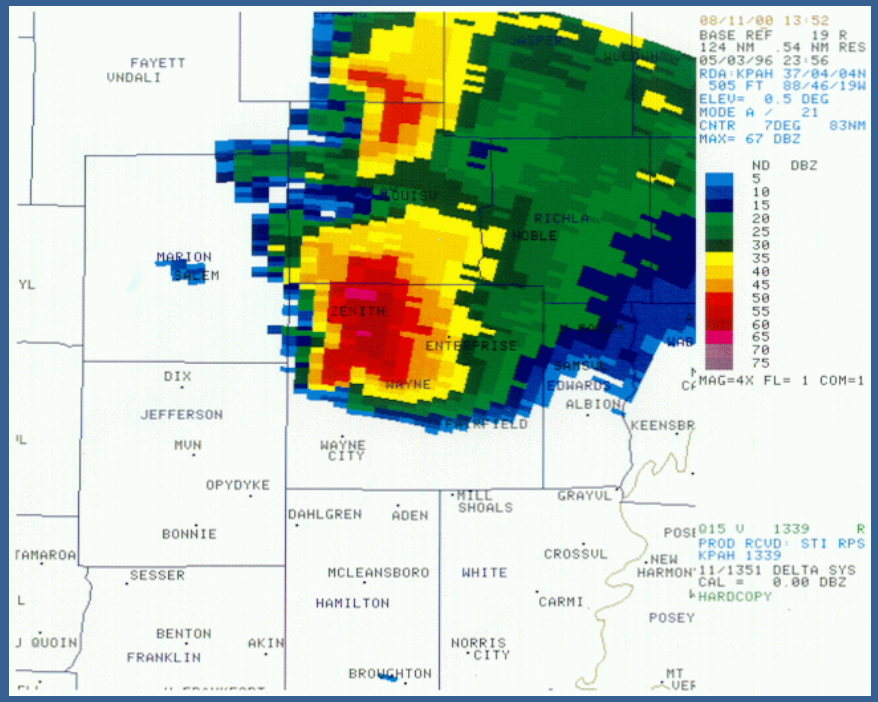


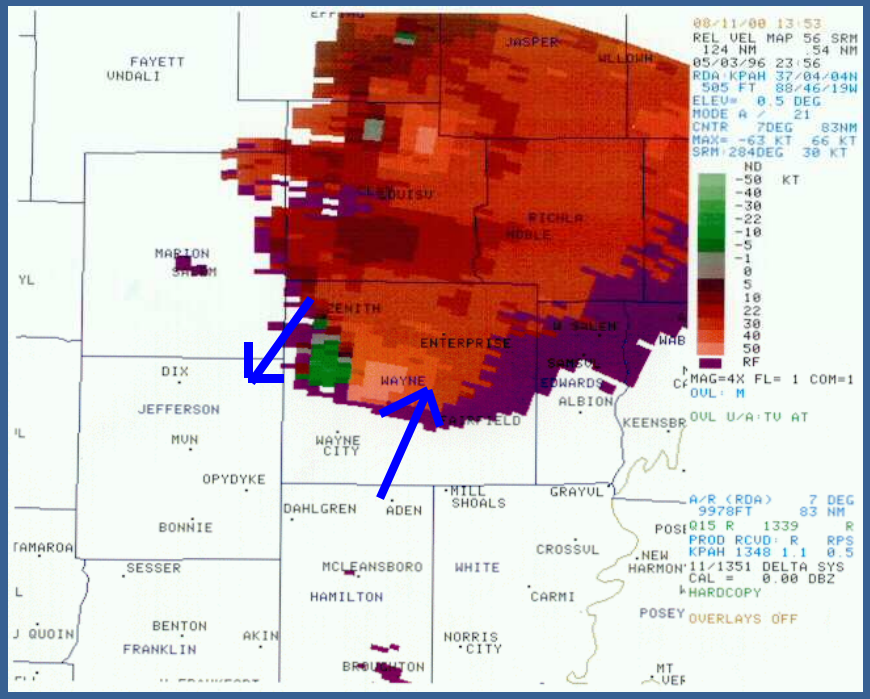
Although the squall line looks to be the most significant, and it can be….

Often times, it is the individual cells out ahead of the line can be severe or even tornadic. These cells often have the potential to be supercells

Supercells

5/3/96

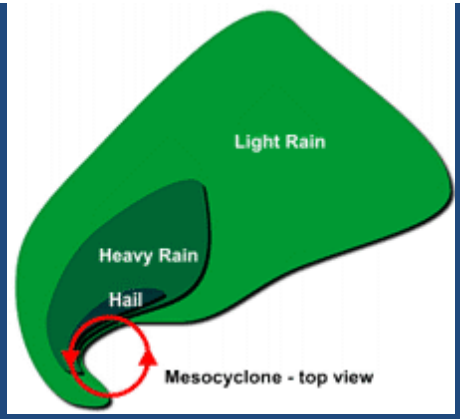


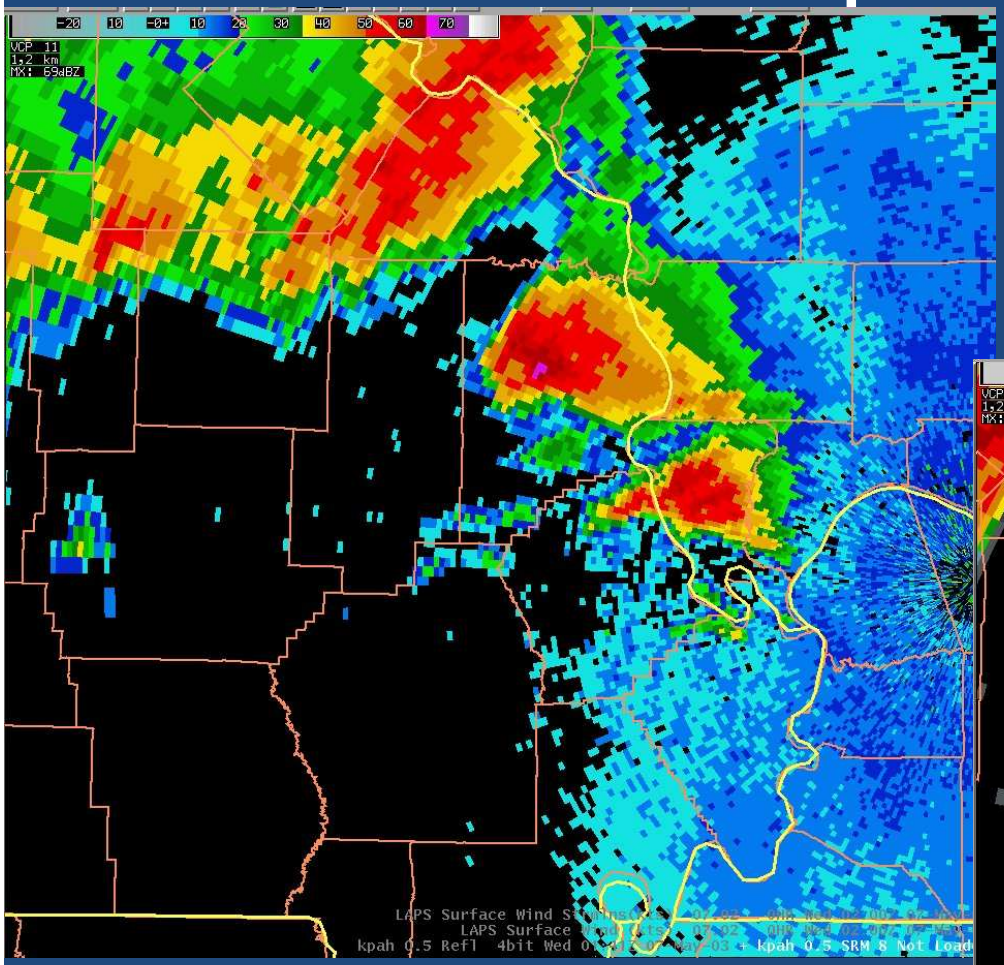


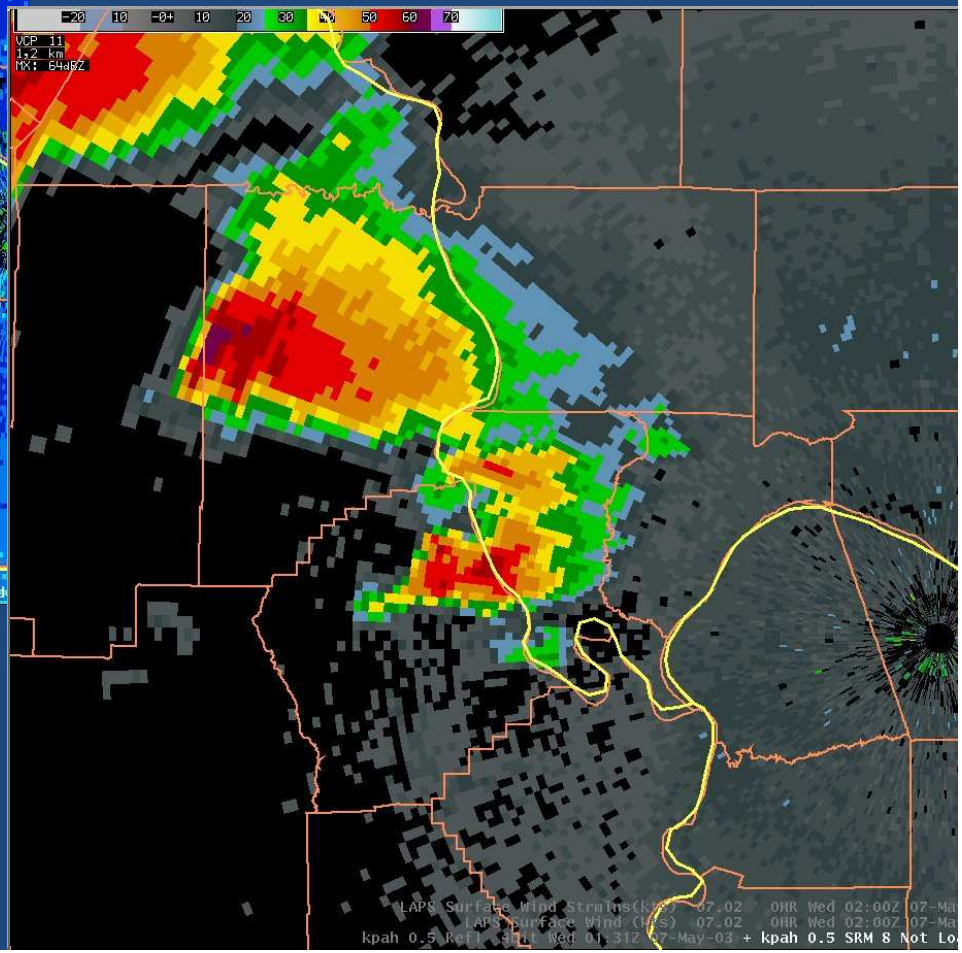
Reflectivity **Storm-Relative Map**

Notice that in the reflectivity data, a hook is not as clear as when the storm is closer to the radar. As the beam travels away from the radar, it gains altitude, and it gets bigger, thus affecting the resolution of the products one sees. However, we can still clearly see the rotation in the southwest portion of the supercell storm. This did produce several tornadoes in Wayne County, and 3 more in southwest Indiana. Where would you place spotters?

Supercells







Not all have classic hooks