1. Storm Interrogation

Instructor Notes:

Student Notes:

Storm Interrogation

AWOC Severe Track
ICSvr 3-V-D
Hailstorm Characteristics

2. Hailstorm Characteristics

Instructor Notes:

Student Notes:

Objective

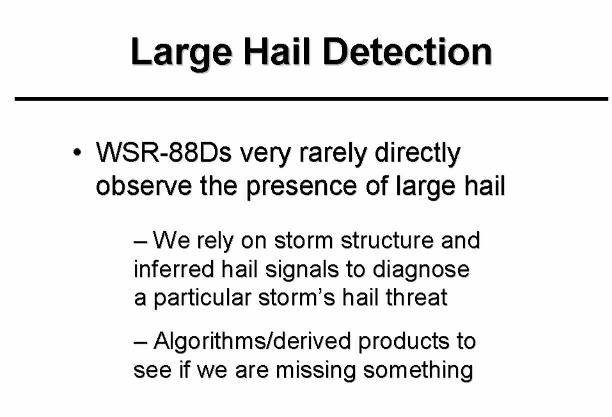
Objective:

- Recognize the following radar signatures of severe hailstorms and understand the limitations of the data.
  - Reflectivity height
  - Convergence/Divergence
  - Storm structure

3. Large Hail

Instructor Notes:

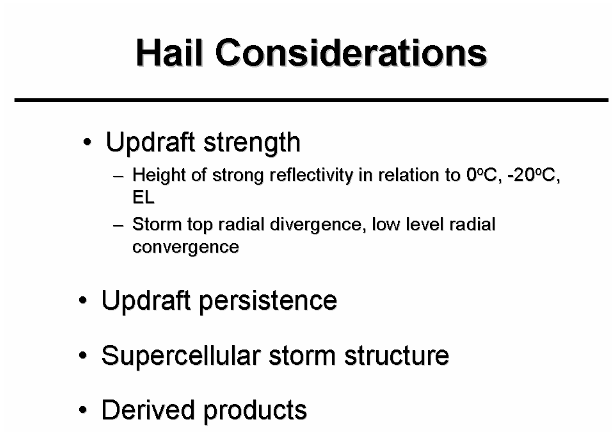
Student Notes:



4. Hail Considerations

Instructor Notes: These are the 4 areas to examine for the severe hail threat. Updraft strength was covered in an earlier lesson, but with regards to hail, it is important how high above the freezing level, -20, and EL strong reflectivities extend. Velocity signatures for updraft strength with regards to hail include radial divergence in the upper levels and convergence in the lower levels.

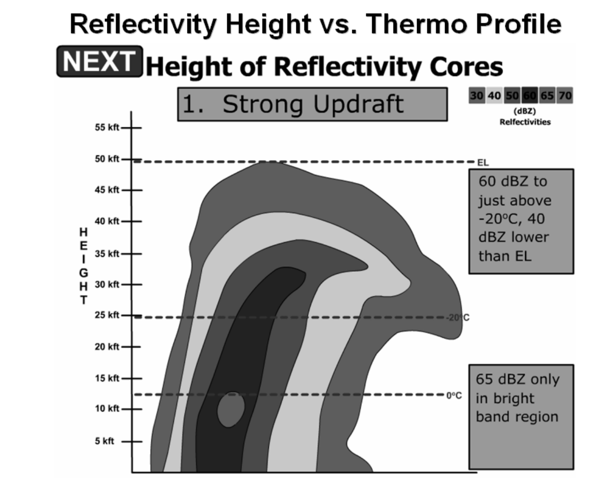
Student Notes:



5. Reflectivity Height vs. Thermo Profile

Instructor Notes: Show the graphic: If used properly, can be the most reliable since it depends only on base data. Higher Z aloft had to be transported by some mechanism: That mechanism is a stronger updraft. The greater the Z aloft above the –20°C, the greater the hail threat. This assumes accurate knowledge and representation of the NSE thermodynamic profiles. 65 dBZ is particularly important in that studies have shown that nearly all storms that have > 65 dBZ above the 0°C go on or are in the process of producing severe hail OR winds. One of the problems with this technique, and as it turns out, with any hail forecasting technique, is that the lead times widely vary. Sometimes the strong cores develop aloft simultaneously with severe hail at the ground, sometimes there can be as much as 30 minutes lead time from strong core development aloft and severe hail at the ground. Dual-pol radar should help out here.

Student Notes:



6. Reflectivity Height

Instructor Notes:

Student Notes:

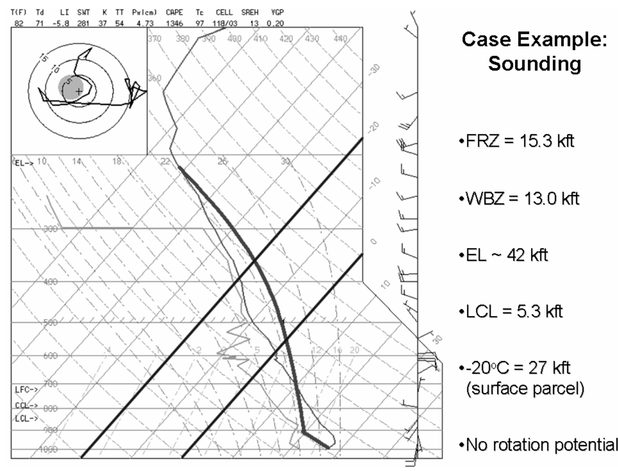
Reflectivity Height

- A recent study (Gerard 1998) of 39 convective events (64 storms total) in CLE and JAN: 96% of storms with 65 dBZ height above FRZ were severe (wind or hail or both)
  - 30% of the storms with 65 dBZ max heights below FRZ were severe
- Waiting for 65 dBZ also a bad idea since storm could already be severe before 65 dBZ core develops

7. Example

Instructor Notes: This is an example of hail production potential good for single cell with a pulse mode of convection. Looking at this sounding, several things stand out concerning the hail threat: Decent CAPE profile, plenty of low level moisture, cloud bases well below freezing for liquid drop production for embryos, lots of CIN, very little wind shear through any layer Melting potential in this sounding appears very high: very high WBZ, FRZ, VERY moist in the low levels, fairly warm in the low levels. But remember what you learned in IC severe 1 Lesson 5 Hail, if you have large hail aloft, the large hail will still make it to the surface fairly large. The next slides are radar images from this day.

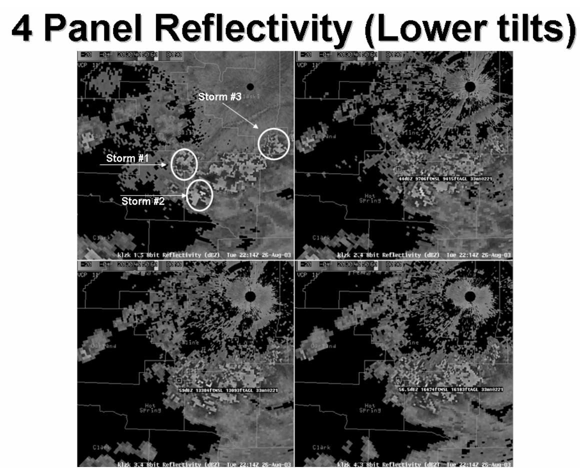
Student Notes:



8. Example (Lower tilts)

Instructor Notes: Focus on the three storms circled in the upper left panel. Storm 3 is very close to the radar.

Student Notes:

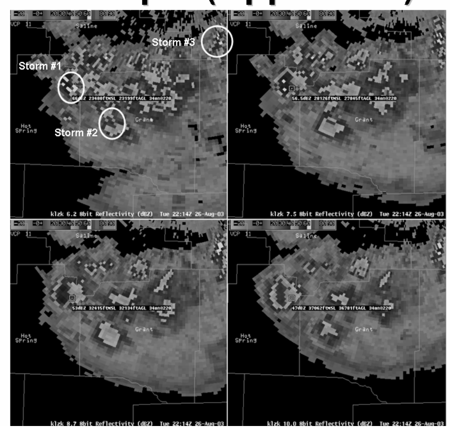


9. Example (Upper tilts)

Instructor Notes: Storm one has a strong core aloft, with well over 50 dBZ to 37 kft (lower right), 43 dBZ at 50 kft (not shown), and 65 dBZ near the –20C level, and is in the mature phase. Golfball hail was indeed reported with storm #1 15 minutes from this image and the HDA had a good handle on it with a max size of 2.00 inch hail, POSH 70%. Storm 2 is just as deep at storm #1, but the core right around the –20C level is weaker as it had descended during the previous scans, as this storm is in the decaying stage. Just one volume scan ago this storm looked just like storm 1 looks now, with 67 dBZ at –20C. Golfball hail is falling right now out of this storm, and the HDA has 1.5 inch hail max with 60% POSH. Storm 3 has 40 dBZ to 40 kft (not shown) at the highest available tilt. This storm is not as deep out there although the max reflectivities (60-65 dBZ) are below the 0C level. Like storm 2, this is in the decaying stage. HDA has 1.00 inches right now, with a POSH of 40%. No hail was reported with this storm, although that could be due to the core being over rural Pulaski County. Moral of this example?: shows that even in a warm, moist, summertime environment large hail is still possible if the large hail signature is there (deep cores, high Z around –20C). Severe hail can and will reach the surface.

Student Notes:

Example (Upper tilts)



10. Updraft Signatures: Velocity

Instructor Notes:

Student Notes:

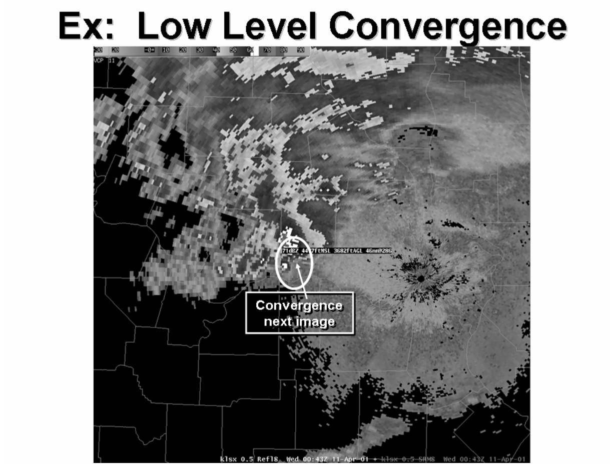
Updraft Signatures: Velocity

- Refer to updraft strength section in IC Severe 3-II (lessons 5-9)
- Problematic: due to viewing angle, dealiasing, range folding, range from radar, etc.
- Seeing div./con. should only validate what you may already know: the updraft is very strong and the hail threat is enhanced

11. Ex: Low Level Convergence

Instructor Notes: This is the hybrid multi-supercell hailstorm monster that hit KC to Columbia to St. Louis, all within a 5-6 hour period. This first image is of 0.5 degree reflectivity that should be used to compare to the next image, SRM to see placement of low level convergence.

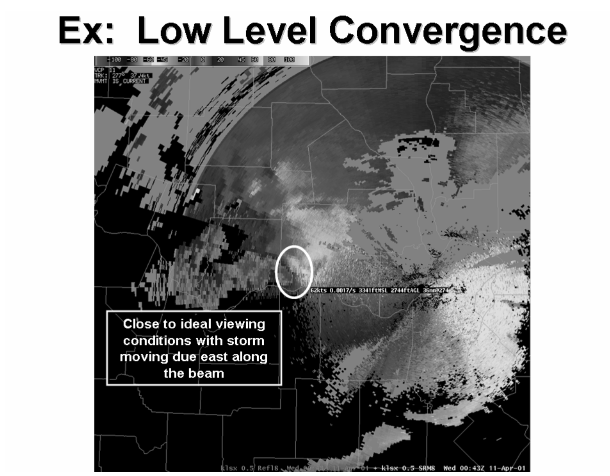
Student Notes:



12. Ex: Low Level Convergence

Instructor Notes: The circle is in the identical position from the previous image. It had a DCZ.

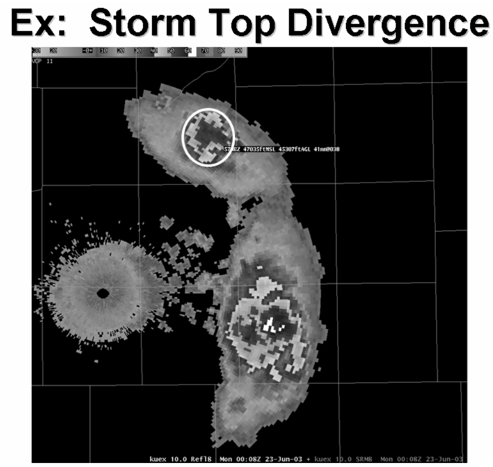
Student Notes:



13. Ex: Storm Top Divergence

Instructor Notes: This reflectivity image is near the top of the BWER and near the storm top as well. Not related to the issue of storm top divergence, but this is just about the highest occurrence of 55-65 dBZ I have seen (45-50 dBZ to 56 kft with these 2 super-cells as well).

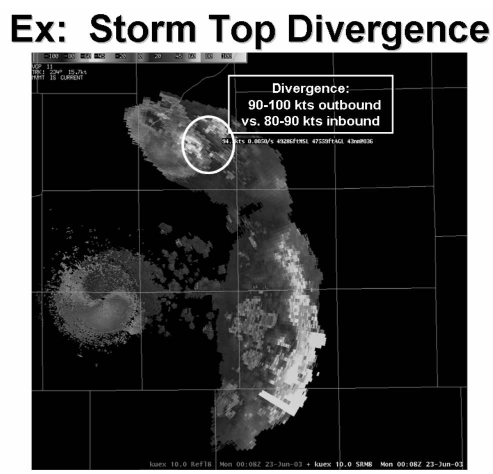
Student Notes:



14. Ex: Storm Top Divergence

Instructor Notes: There are some dealiasing problems with the southern supercell. You aren't likely to see divergence of this magnitude on any storm, this is just about as strong as it gets.

Student Notes:



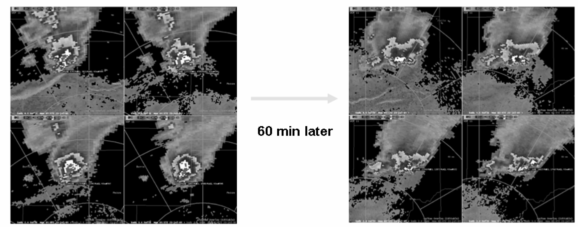
15. Updraft Persistence: Considerations

Instructor Notes: There have been no studies showing the importance of having a persistent updraft. In theory, a persistent updraft could have sufficient time to have multiple recycling trajectories across and through the updraft, leading to a greater chance of severe hail.

Student Notes:

Updraft Persistence: Considerations

- Investigate the longevity of the updraft signatures
- Updraft signatures that last longer than ~20 minutes could allow for longer residence time, more recycling, etc.



16. Storm Structure

Instructor Notes: Most of these signatures indicate supercellular structure, which is responsible for the majority of truly giant hail.

Student Notes:

Storm Structure

- WER, BWER, mid-level mesocyclone, inflow notch, low level strong reflectivity gradients
  - As long as supercells are not low-topped (examine the reflectivity above -20°C level), any storm with supercellular structure has the capability to produce severe hail

17. Storm Structure

Instructor Notes:

Student Notes:

Storm Structure Example

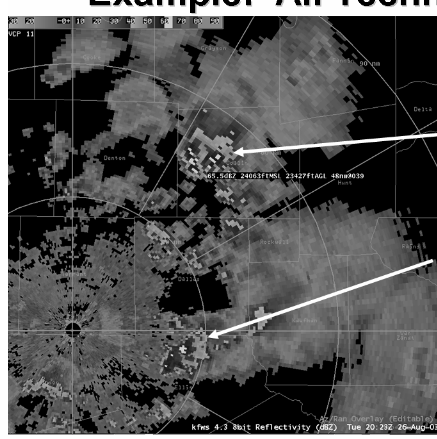
- Even subtle supercell characteristics (i.e. weak rotation in mid-levels) can make a huge difference in hail size
  - See the next example:

18. Example: All Techniques

Instructor Notes: Same day as 1st example in AR, this one near DFW. This area had similar environments with 0°C level at 14.5 kft and –20°C at 26.5 kft, very little vertical wind shear. We are looking at pulse storms in Colllin and Ellis Counties that have fired along a westward moving gust front. This environment should be good for VIL since storm movement is less than 10 knots. The 4.3 degree slice hits the Collin County storm right around the –20°C level, while in Ellis County it is at around +3°C. Heights of the respective reflectivity levels are given above for each storm. The Ellis County storm has a 45 knot shear gate to gate mesocyclone at 15 kft, while the Collin County storm has no rotation at all.

Student Notes:

Example: All Techniques

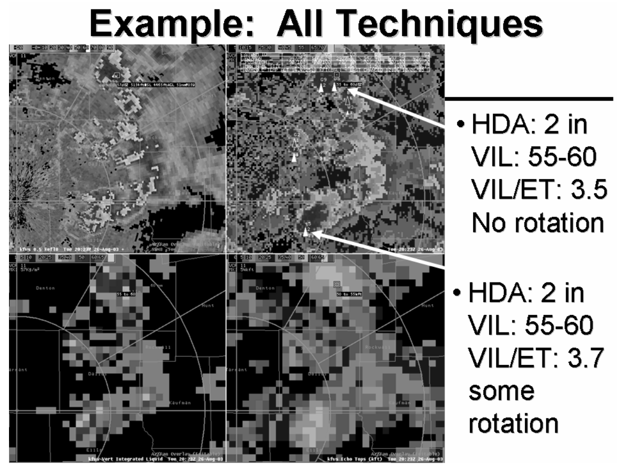


- 65 dBZ @ 24 kft
  60 dBZ @ 27 kft
  55 dBZ @ 30 kft
  50 dBZ @ 34 kft
  45 dBZ @ 41 kft
- 65 dBZ @ 22 kft
  60 dBZ @ 25 kft
  55 dBZ @ 30 kft
  50 dBZ @ 35 kft
  45 dBZ @ 42 kft

19. Example: All Techniques

Instructor Notes: POSH 90% on storm in Collin County (north storm), 80% in southern storm, certainly enough to warn on for hail alone in either storm

Student Notes:



20. Event Summary

Instructor Notes: The Collin County storm “should have” had hail reported but did not. It is possible decent hail fell and went unreported despite the fact that the core fell over a highly populated area.

Student Notes:

Event Summary

- Collin County (north storm) had no hail but damaging winds
- Ellis County (south storm) had 0.88 inch hail reports

→ Subtle differences can make a difference (like the presence of weak rotation), but there are many storm scale aspects concerning hail we cannot measure with our current instrumentation

21. Multicell/MCS Considerations

Instructor Notes: Derechos and bow echoes may be enormous wind producers, but they can still produce very large hail and need to be monitored as such. Once systems become linear updrafts are far more tilted, forward speed increases, and residence time within the updraft is dramatically decreased, all leading to smaller hail sizes. Embedded rotation can mitigate these effects however, by further increasing residence time.

Student Notes:

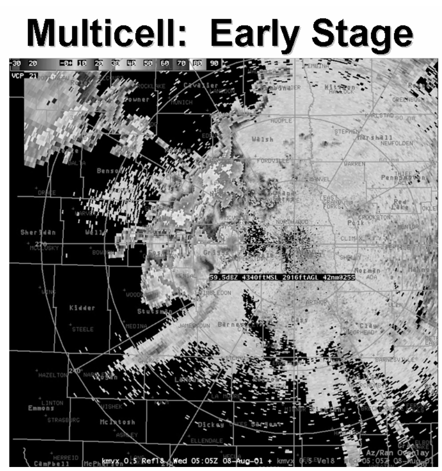
Multicell/MCS Considerations

- Same interrogation strategies apply: height of reflectivity in relation to –20, 0°C heights, erectness of updraft, rotation in mid-levels, then consistency checks with algorithms
- Linear systems tend to have larger hail earlier in their lifecycles, especially before convective line becomes solid

22. Multicell: Early Stage

Instructor Notes: Golfball to baseball hail out of this developing derecho at this time (midnight local). Had very high Z aloft in a very high CAPE environment and some mid-level rotation. Once the storm organized into a linear system with raging surface winds, the hail was never larger than 1.00 inch.

Student Notes:



23. Summary: Large Hail Radar Interpretation

Instructor Notes:

Student Notes:

Summary: Large Hail Radar Interpretation

- At long range from the radar certain updraft characteristics may not be well resolved
- Understand data limitations, especially far from radar and/or with fast moving systems
- Usage of velocity signatures depend on range from radar and on viewing angle