Storm Interrogation

AWOC severe track

IC 3-I-C

The nature of the Weak Echo Region

AWOC severe track IC 3-I-C : The nature of the Weak Echo Region (WER)

This lesson is 11 slides long and will take 15 minutes to complete. This is a special session featuring Les Lemon as a guest in conversation with Jim LaDue.

The nature of the WER

- Objective:
  - Understand the characteristics of a WER
    - Specifically, determine the relationship between the WER and the updraft shape and location
- Motivation: The WER is a critical feature for
  - Determining updraft location
  - Estimating updraft severity

The Weak Echo Region is a storm signature commonly used to assess the severity of and to locate a convective updraft. But exploring the nature of the WER is the objective to be satisfied in this lesson. And specifically, what is the updraft shape and location with respect to the WER?

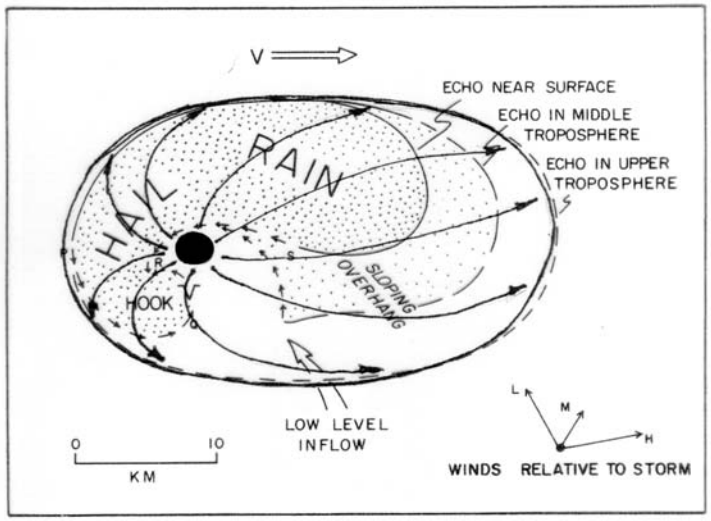


Figure 15.5. Schematic diagram showing horizontal sections at three levels through the radar echo from an SR Storm supercell (equivalent reflectivity factor about 10^3 mm^6 m^{-3}). The heavy black spot marks the position of the highest echo top and also the position of the vault at lower levels. Environmental winds relative to the storm in low, medium, and high levels of the troposphere are represented by the three vectors L, M, and H. When a tornado occurs, it is situated near the leading edge of the hook echo; hail falls from the echo surrounding the vault, and sometimes but not always below the hook itself, and the rain area extends ahead of this region within the storm's left forward quadrant.

This is a paraphrased version of the recordings in this talk and therefore captures the intent but not every word of the conversation.

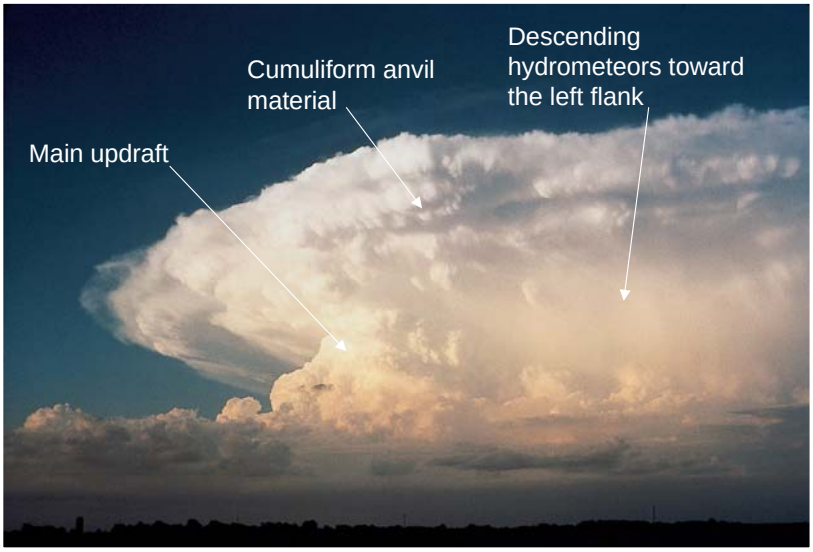
Jim: Les, How does this graphic help explain where the Weak Echo Region (WER) occurs?

Les: This is an old graphic from Browning (1964) but it illustrates the structure of the WER in showing the echo in the Upper, mid and lower troposphere and he called the echo overhang the sloping echo overhang because all winds are approaching the right flank of the storm thus the echo overhang cannot be explained by the ambient wind field. The precipitation in the echo overhang has to arrive in that position by vertical shear.

Jim: When I overlay the streamlines onto Browning's model, I see an awful lot of divergence. How strong is that divergence?

Les: It is not often appreciated how much mass is being transported upward in an updraft. The velocity difference across an updraft summit of roughly 20 km can be as high as 150 m/s (300kts). That large amount of divergence brings with it a high density of precipitation that goes on to form an echo overhang. The precipitation as it descends in the echo overhang is swept along by the storm-relative flow as it falls eventually forming a sloping echo overhang. The precipitation finally descends to the surface to form the edge of the low level echo.

The physical appearance of the WER

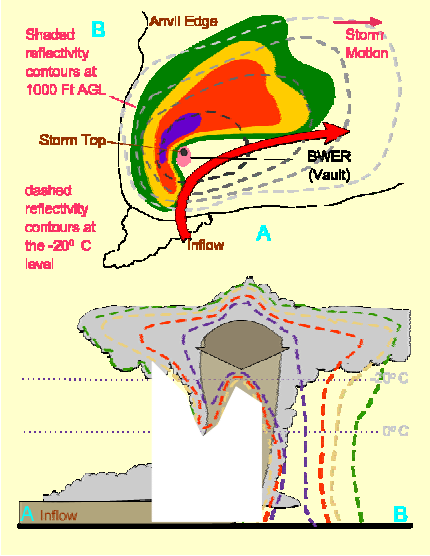


Jim: Here is a classic picture of a supercell from the distant southeast. Strong anvil-layer flow is coming in from the left and still the supercell is able to push a lot of anvil material upwind of its updraft. From this picture, Les, where would the WER be?

Les: You can actually see the WER in that you can see the cumuliform anvil (upside down convective bulges). The main updraft is located under the anvil and the foggy area right of the updraft tower is the descending precipitation that marks the sloping echo overhang. The highest reflectivities in the echo overhang are in the cumuliform anvil and then they slowly decrease as the hydrometeors descend and move toward the left flank of the storm.

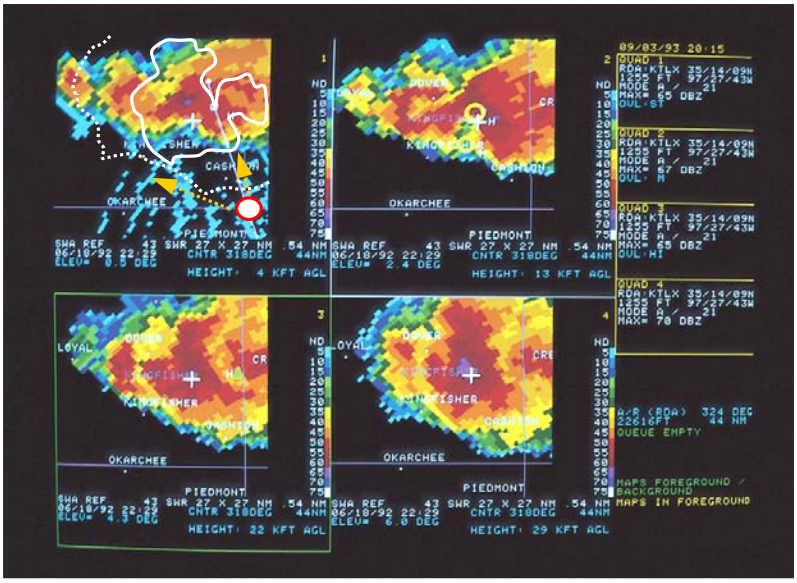
Background

- The WER
  - Is the region of weak echoes underneath the sloping echo overhang (> 45 dBZ)
  - Persists longer than it would take for hydrometeors above the WER to fall to ground



If I were the photographer who took the picture in the previous page, I would be standing at point A depicted in light blue in the horizontal cross-section of this supercell schematic. The WER is a region of weak echoes underneath the sloping echo overhang whose reflectivities are generally above 45 dBZ. The WER should persist longer than the transit time for hydrometeors to reach the ground. This second requirement eliminates the temporary WERs associated with the updraft phases of low shear pulse convective cells.

Note that only part of the WER(in white) is occupied by updraft in the vertical cross-section.



Jim: Here's a classic 4 panel image of the Cashion supercell from back in June 18, 1992 where the upper-left panel is at 4 kft, upper right is at 13 kft, lower left is at 22 kft and the lower right is at 29 kft MSL. Les, this storm does not have a clearly defined hook echo but it still has all the features associated with a severe storm such as a WER. What do you see?

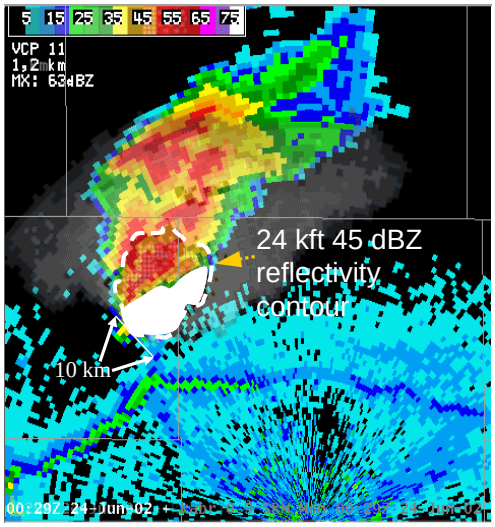
Les:The storm is moving to the SSE and we can see along the leading edge of the storm a high reflectivity gradient and an echo notch. That's outlining the region where the inflow is feeding into the base of the updraft. In the upper right, we can see the BWER and in the lower right, you can see the echo core aloft. Those features where the cursor is located outlines the three-dimensionality of the updraft.

Now we can see the echo overhang of 45 dBZ or greater within the solid white contour. That again is the precipitation out over the front flank of the storm forming the top of the WER. Note the location of the photographer as the white, red bordered circle in the upper left panel. The photographer turned his camera almost straight up to image the outer edge of the anvil. That edge essentially marks the outer edge of the reflectivity echo marked by the dashed white contour.

Jim: Spotters in the field often note how sharp the anvil edges are with severe storms. We've seen such an example with the previous 4 panel by noting how close the 45 dBZ and 0 dBZ echoes are located to each other in the anvil. This picture is from the photographer's site highlighted in the previous 4 panel .

The Weak Echo Region

- WERs are elliptical in shape
- Is that the shape of the updraft?



Here is a more recent example of a WER in a supercell from 24 June 2002 in South Dakota. The lowest slice is depicted by the bright reflectivities near the ground. Overlaid on top of that is a region of greater than 45 dBZ echo at about 24 kft above ground within the dashed white contour. The dull grey reflectivities outside the low-level echo represent weaker reflectivities at 24 kft. Where the strong reflectivities overlay the weak echoes below carve out an elliptical WER.

WER Summary

- In moderate to strong shear, the WER is partly due to
  - intense storm summit divergence
  - And the updraft itself
- More is needed to locate the updraft in sheared convection

Jim: In moderate to strong shear, the WER is partly due to strong storm summit divergence advecting hydrometeors horizontally into the anvil canopy, and it is partly due to the updraft suspending hydrometeors above the ground. However, in order to locate the updraft itself, we have to do more than solely identifying the WER location. Other sessions in storm interrogation focus more detail on updraft location.