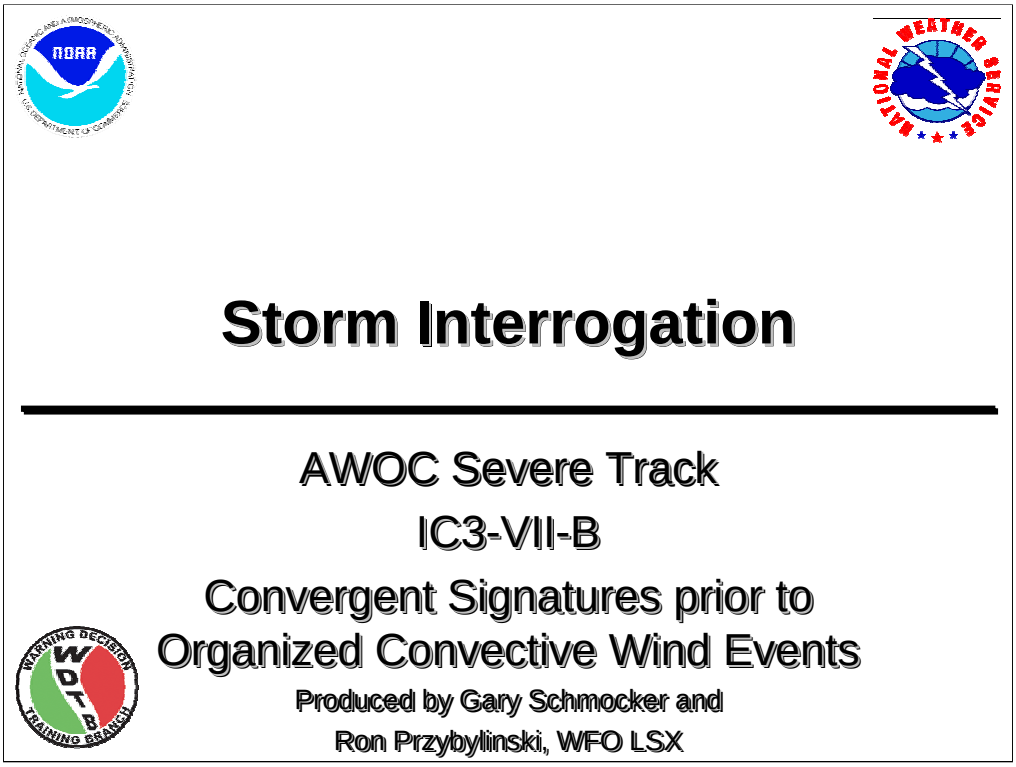

Welcome to the AWOC Severe Track

IC3-VII-B

Convergent Signatures prior to Organized Convective Wind Events

The content of this lesson has been produced by Gary Schmocker of NWS WFO St. Louis, MO

The lesson is about 8 slides long and should take 10 minutes to complete.

Convergent Signatures in Multicell Convective Lines

- Objectives
  - Identify velocity precursors which will lead to improved warning lead time for damaging wind events in multicell convective lines
  - Show the limitations of the precursor velocity signatures

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Identify velocity precursors which will lead to improved warning lead time to damaging wind events in multicell convective lines

Show the limitations of the precursor velocity signatures

Convergent Signatures in Multicell Convective Wind Events

- Przybylinski et al. 1995 noted strong Mid-Altitude Radial Convergence (MARC) along the forward flank of convective lines before they began to “bow out”

- When the intensifying MCS is upstream
  - strong outbounds indicate updraft
  - strong inbound velocities indicate downdrafts & origins of the mesoscale RIJ

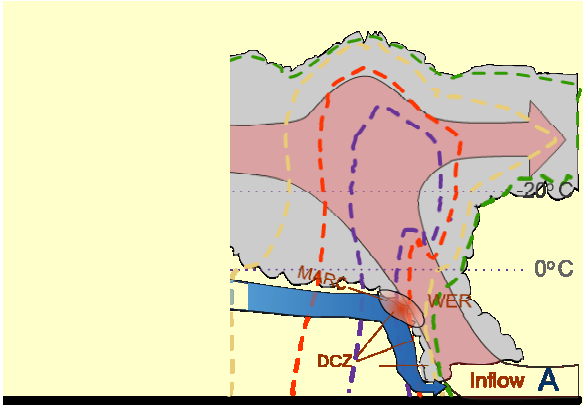
Przybylinski et al. 1995 noted strong Mid-Altitude Radial Convergence (MARC) along the forward flank of convective lines before they began to “bow out”.

We are using the WSR-88D to survey a component of the squall line’s sloping updraft/downdraft currents along the forward flank of the MCS during the intensifying stage.
The region of strong outbound velocities signifies a component of the storm’s updraft current and FTR flow (with respect to approaching storm west or upstream of radar)

The region of strong inbound velocities represent the component of the storm’s downdraft current or early stages of the mesoscale Rear Inflow Jet (RIJ).

MARC signature in a mature MCS

- Persistent localized strong radial convergence
- In larger background of convergence
- In forward flank of intense convective line echoes



The MARC signature represents the convergence of two air streams, the developing Rear Inflow Jet (RIJ) and the leading convective updraft.

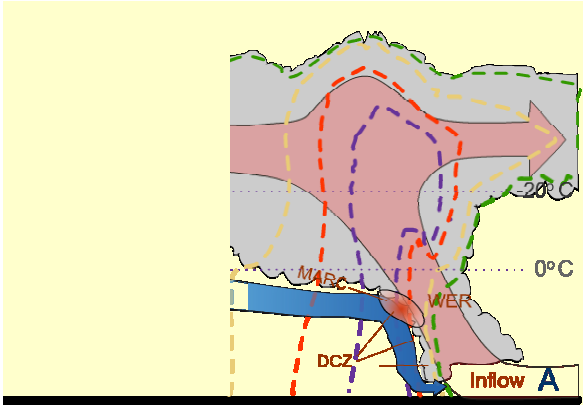
The RIJ in a severe Mesoscale Convective System (MCS) forms on the upshear side immediately behind the tall convective towers and develops rearward with time.

The MARC manifests itself as a persistent localized zone of radial convergence as viewed by radar. It is typically embedded in a longer region of background convergence and resides in the forward flank of the intense convective line echoes.

MARC signature in a mature MCS (contd)

- Length < 15 km
- Width < 7 km
- Nearly gate to gate strong velocity gradient

  $\Delta V \geq 25$ m/s increases potential for severe surface wind



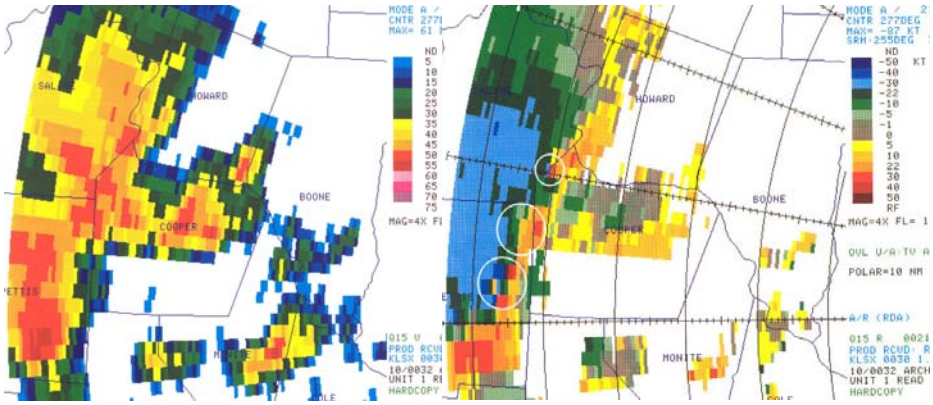
Actual convergence ranges from .0056 to .025 s^{-1} within a 7 km baseline

The length of a typical MARC signature is approximately less than 15 km long by 7 km or less wide. There can be nearly gate to gate radial velocity differences that can exceed 25 m/s (50 kt). If you detect 25 m/s or more of velocity difference, expect an increased threat of severe surface winds.

You can calculate actual convergence, either by using the Vr shear tool, or by visual inspection by taking the near gate to gate radial velocity difference and dividing by the distance of the baseline. You should see values ranging up to .025 s^{-1} or more for severe MARC signatures. These convergence values were taken within a 7 km baseline. Remember that you want to pick a consistent baseline if you use the Vr shear tool.

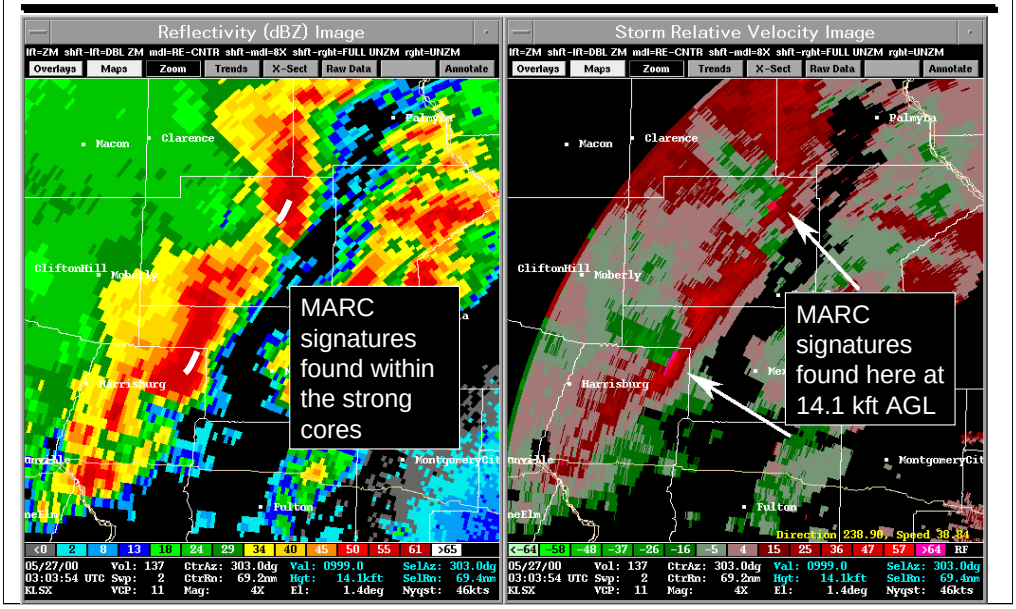
An example MARC

- White circles indicate three enhanced convergent signatures embedded in longer region of convergence



This example shows three MARC signatures, each one roughly in a localized enhanced reflectivity core, and about 15 kft AGL. Note that the velocity difference in these MARCs exceed 50 kts. All three MARCs are embedded in a contiguous convergent zone along the axis of the convective line.

MARC example 27 May 2000



Another example here shows two MARC signatures in eastern Missouri on 27 May 2000. The radar beam is 14 kft AGL and in a good elevation to see this signature. Each MARC shows nearly 50 kts of gate-to-gate velocity differences with increasing range, a sign of intense convergence. Also note that each MARC signature is embedded in the most intense cores in this display.

In some ways, it appears that the MARC signature in an MCS (or a Quasi Linear Convective System, QLCS), is similar in appearance to mid-level convergent signatures found in single cell pulse convection. Both of them occur in intense midlevel cores and are precursor signatures to severe surface winds. The difference lies in the fact that the MARC signatures in an organized event are embedded along a sloping interface between a long-lasting updraft sheet and the rear inflow associated with the RIJ and cold pool. This sloping interface is able to keep its configuration over a long period of time, much longer than the time it takes for individual air parcels to traverse its length, on either side. The pulse storm midlevel convergence and downdraft result in a spreading outflow, quickly resulting in the demise of the original cell.

Here, the MARC signature often marks the genesis of a bow echo, and in fact, the localized downburst activity helps to initiate the bow echo. Many times the worst wind damage may occur before a bow echo has formed.

Summary: MARC signature

1. Look for $\Delta V \geq 25$ m/s in a small region (typically 15 by 7 km) embedded in larger scale convergence
2. Usually prior to formation of bows, line end vortices, low-level vortices within intense, deep reflectivity core
3. Found at midlevels of 4 – 5 km (13-16.5 kft)
4. Difficult to discern when line is parallel to the radials

To summarize, look for velocity differences > 25 m/s in a small region, typically 15 by 7 km and embedded in a larger convergent region at midlevels

The MARC signatures occur prior to the formation of bows, line-end vortices and low-level vortices within the intense deep reflectivity core.

Look to the midlevels, approximately 4 – 5 km AG for the MARC signature.

One final note, if the radials of your radar are roughly parallel to the line axis, you will have a difficult time detecting the MARC signature since most of the air flow is tangential and not radial.

Summary: MARC signature (contd)

5. Environment favors these events in regions where surface-based CIN is not large
   - Downdrafts have increasing difficulty penetrating to the surface if cool, stable layer exceeds 2 km
   - Damaging wind potential thus mitigated in areas deep in the cool side of a polar front or ourflow boundary

Finally, the environment in which a MARC signature leads to severe surface winds, the optimal situation for severe surface winds in the vicinity of a MARC is one in which the pre-storm CIN is low and there is no shallow stable layer. However, there are a minority of events where severe winds have been observed in elevated MCSs where the stable layer can reach 2 km, even a bit more.