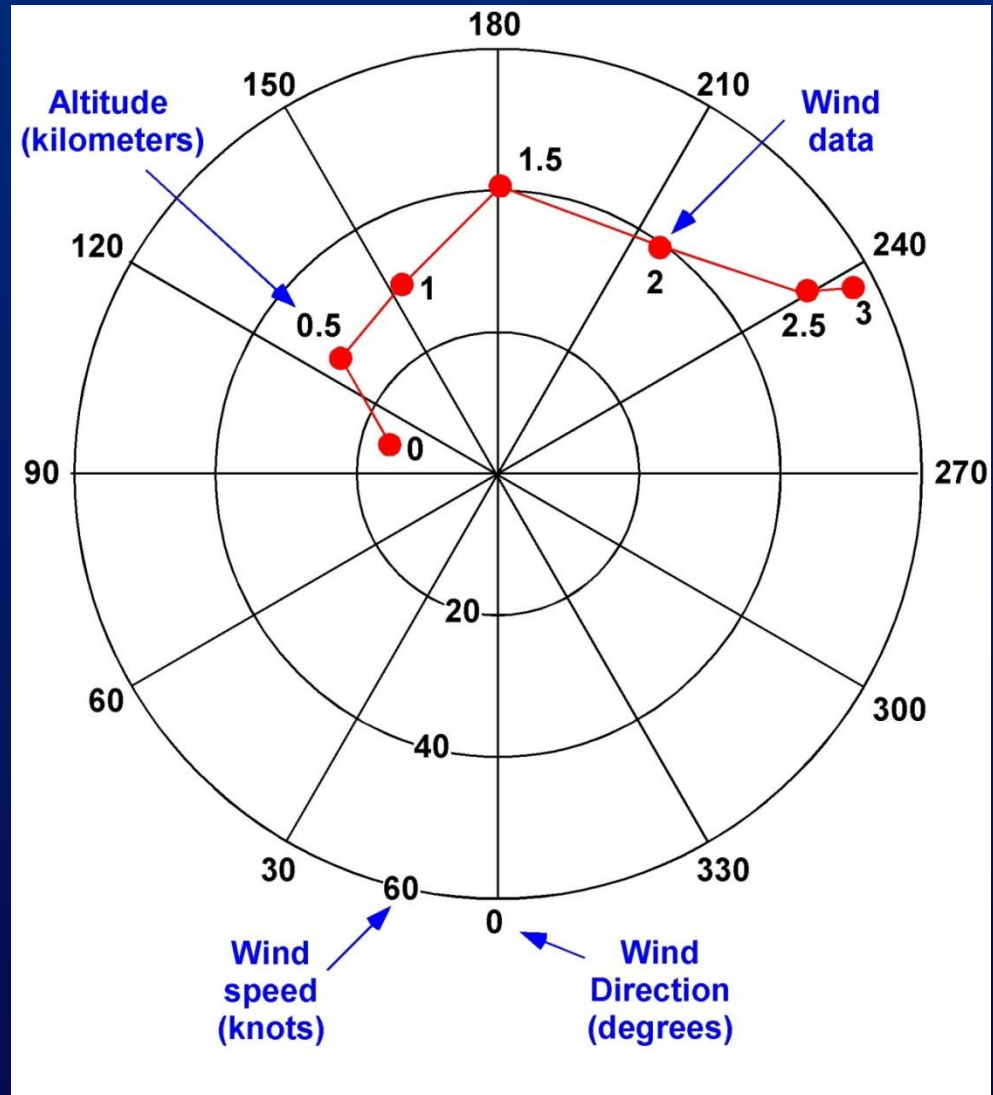


Hodographs and Vertical Wind Shear Considerations

NWS Louisville, KY

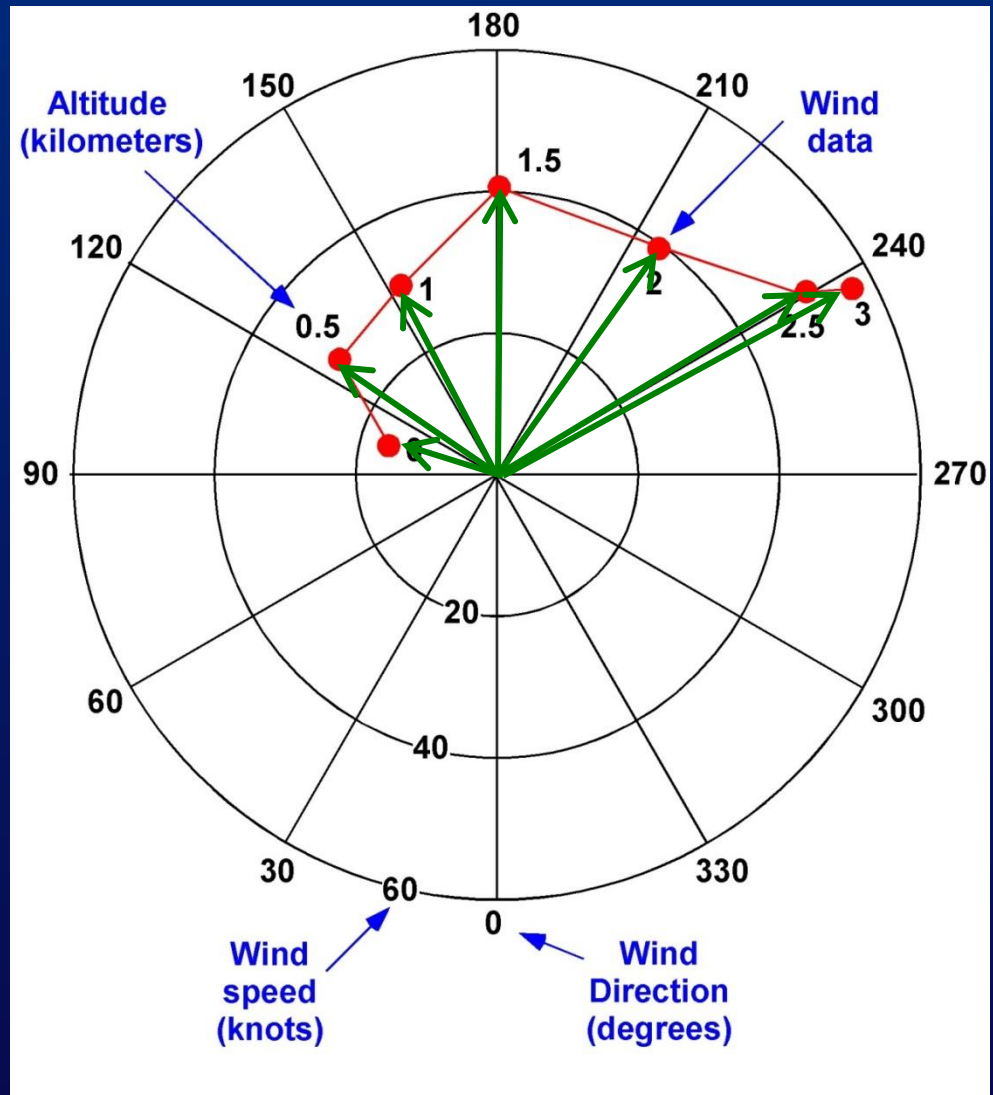
Hodograph

- A hodograph is a line connecting the tips of wind vectors between two arbitrary heights in the atmosphere
- Each point on a hodograph represents a measured wind direction and speed at a certain level from RAOB data (or forecast data from a model)
- A hodograph is a plot of vertical wind shear from one level to another
- The points are then connected to form the hodograph line (red)



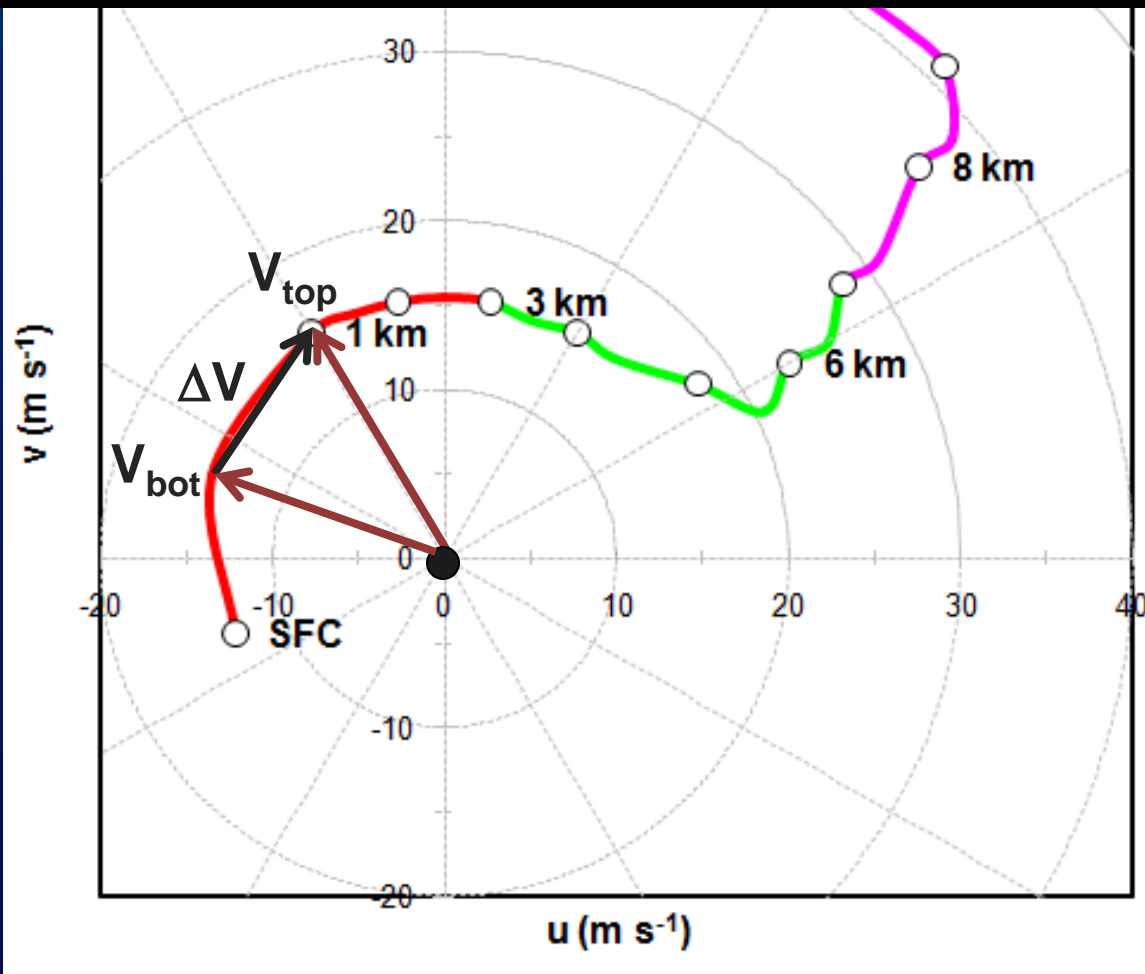
Hodograph

- Green arrows drawn from the origin allows one to better assess (visualize) wind field and wind shear
- Length of red line between 2 points shows amount of *speed* shear if line is *parallel* to radial, amount of *directional* shear if line is *normal* to radial, and amount of *speed and directional* shear if line is at *angle* to radial
- Total vertical shear = speed and directional
- Green lines represent “ground-relative” winds, i.e., the actual wind at various levels
- To determine total shear (in kts), lay out length of line along a radial
- Common layers assessed for severe weather – 0-1 km, 0-3 km, 0-6 km



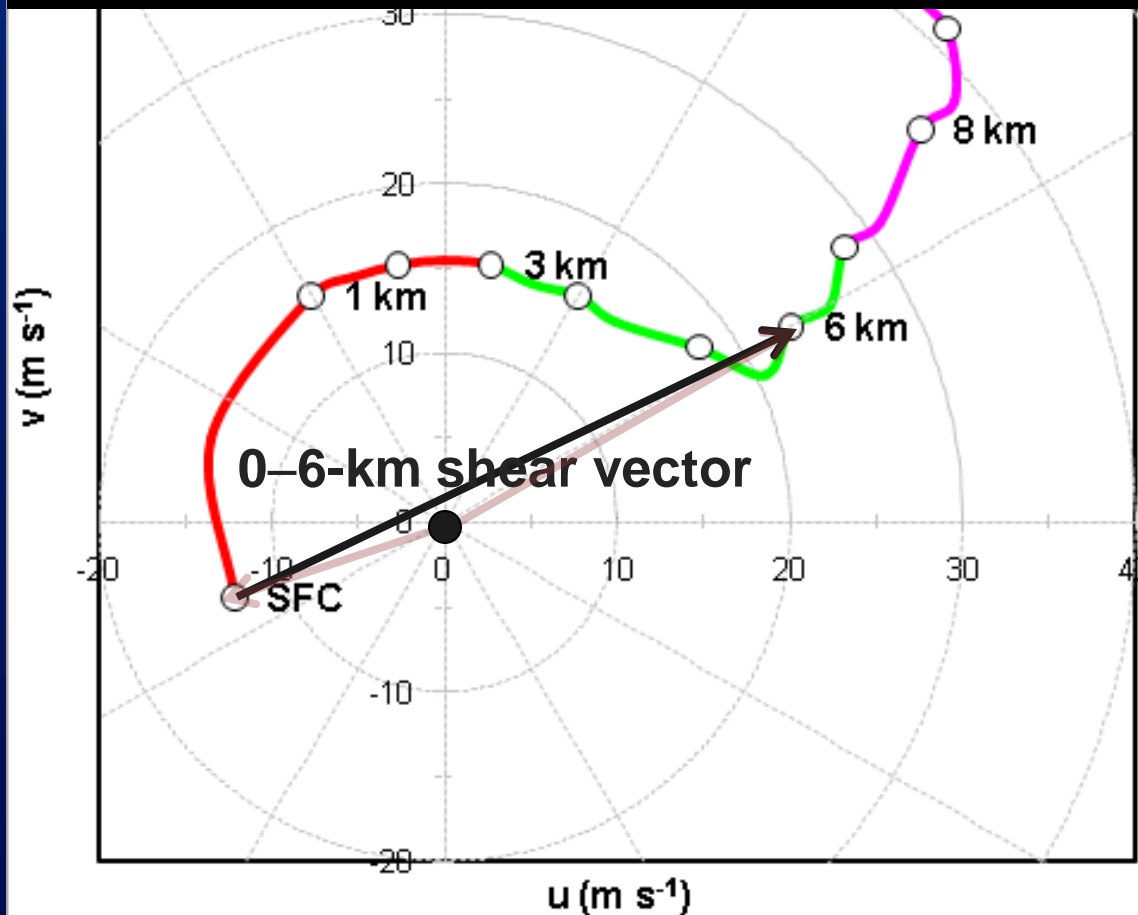
Shear Vectors

Shear vector: $\Delta V = V_{\text{top}} - V_{\text{bottom}}$, i.e., change in wind (speed and direction) between 2 levels



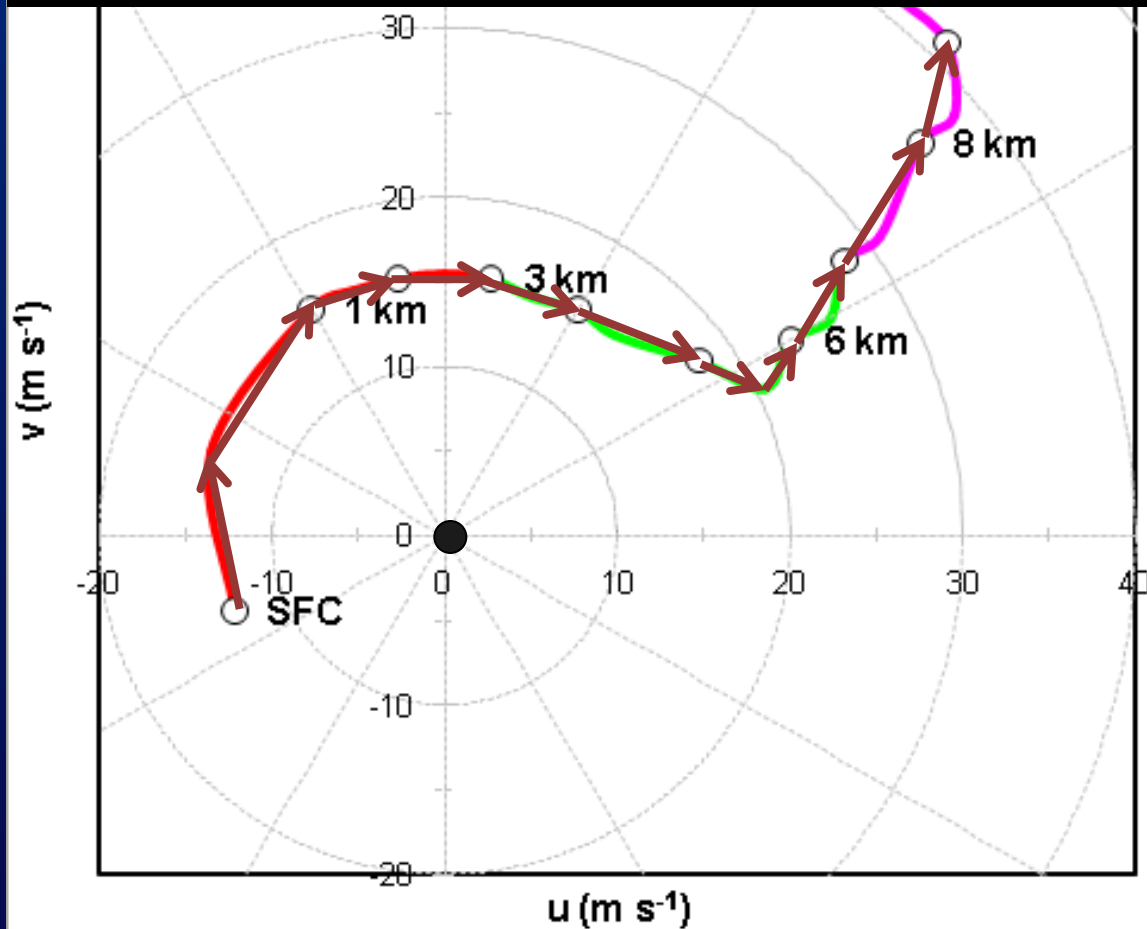
Bulk Shear Vectors

Bulk shear = ΔV (change in wind) between two levels. Ignores shape of hodograph which is important. Shown below is the bulk shear vector between 0 and 6 km.



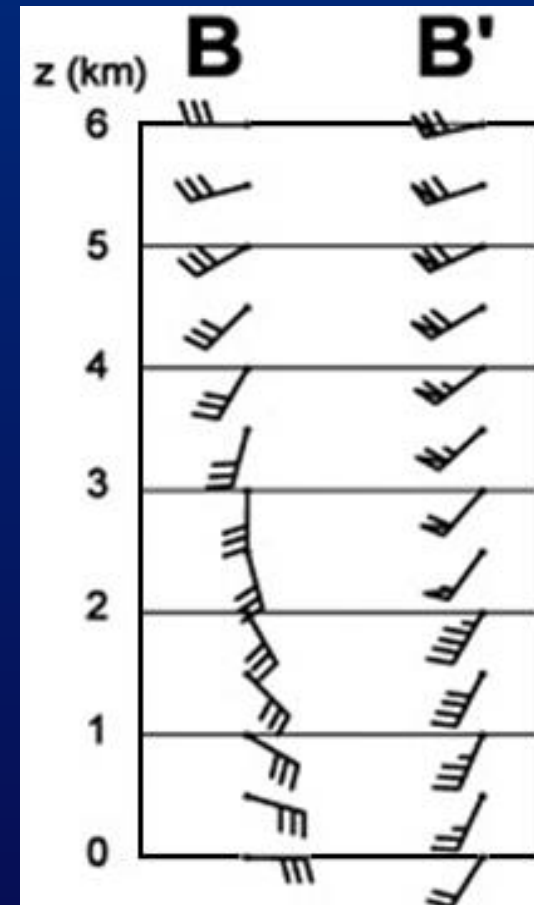
Total Shear

Total shear = sum of all changes in wind (ΔV) over all layers.
Values of total shear are sensitive to the depth of shear layers, curvature, loops, and wiggles in the hodograph



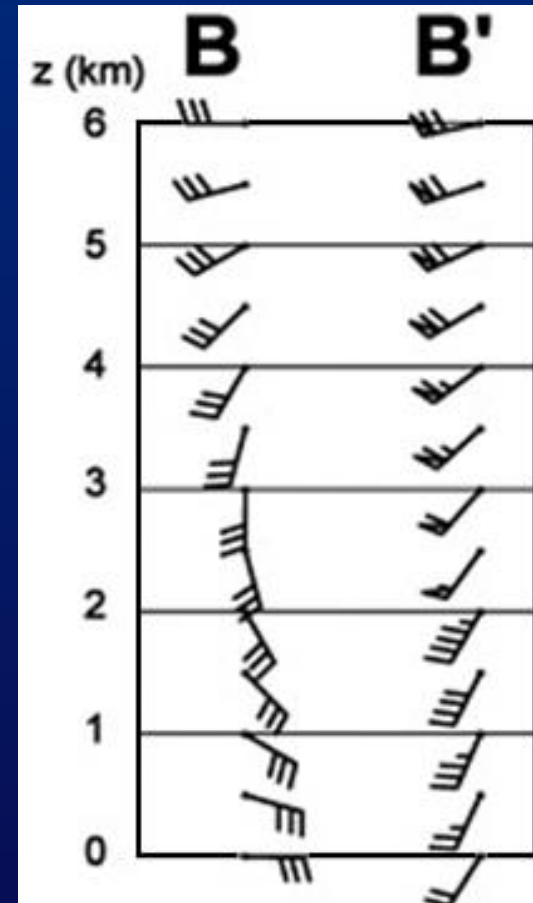
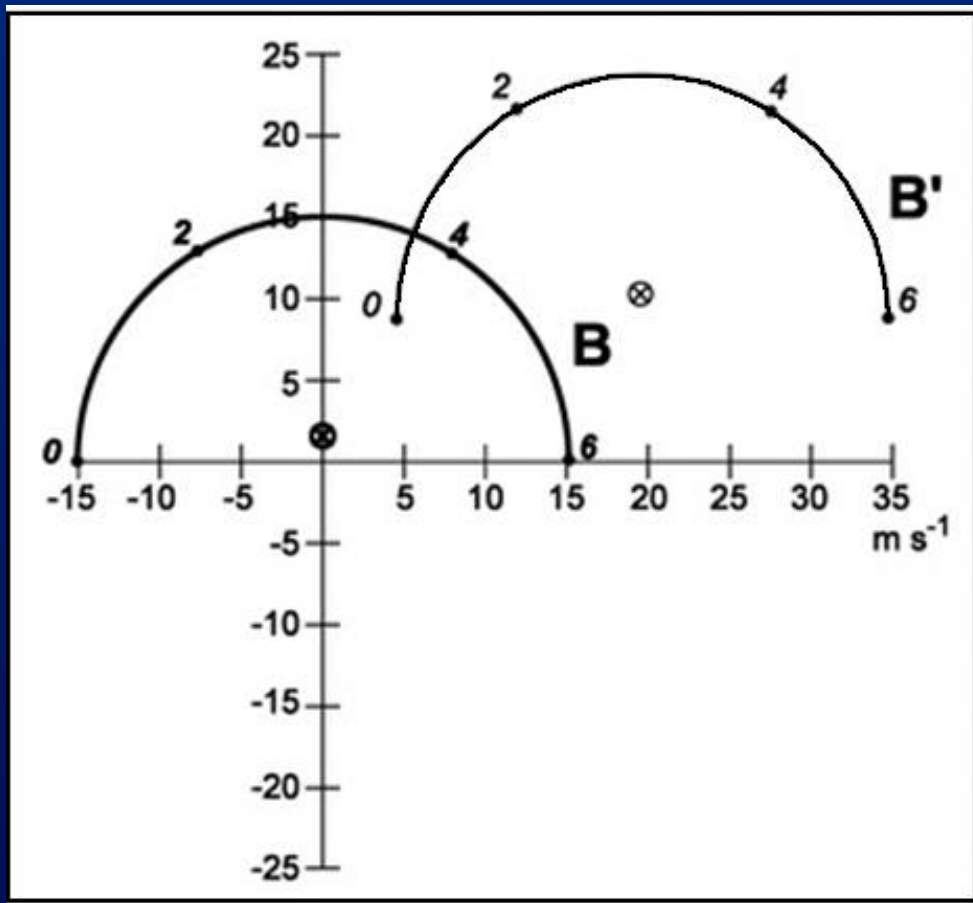
Hodograph Versus Sounding

How will the shape of the hodograph differ based on these two vertical wind profiles (VWP)?



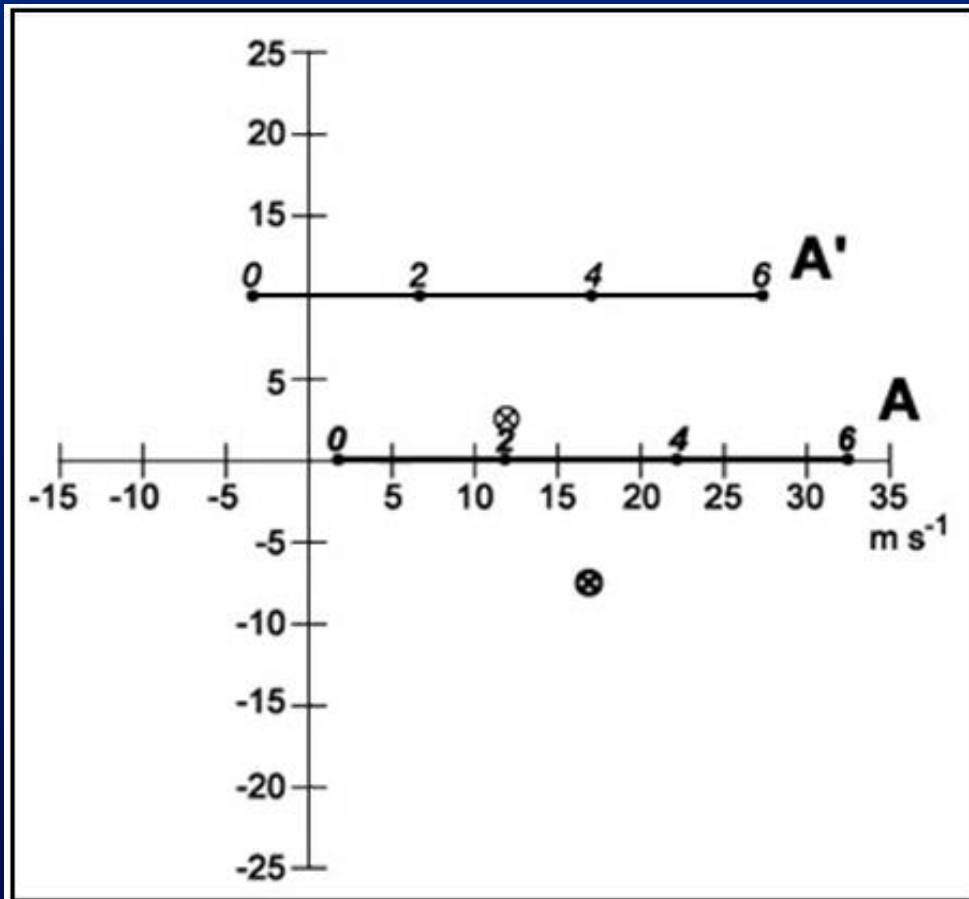
Hodograph Versus Sounding

Completely different VVPs create the same shape hodograph despite different ground-relative winds.



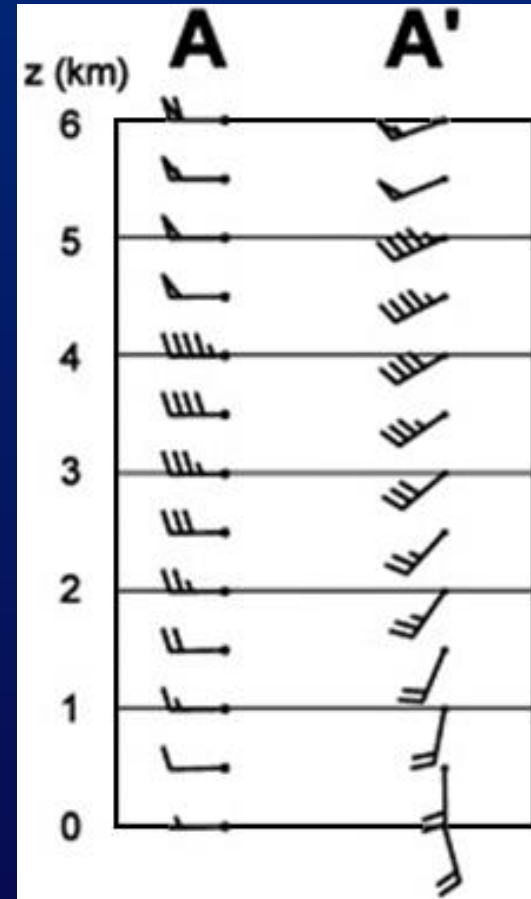
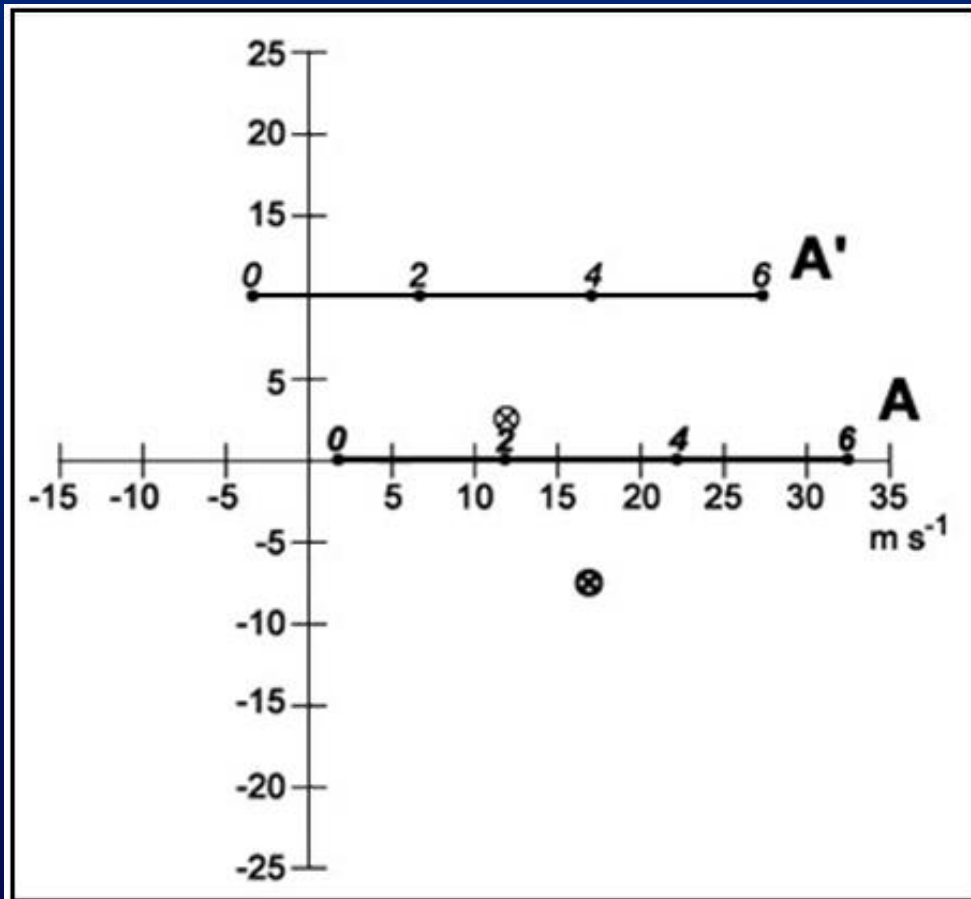
Hodograph Versus Sounding

What will the vertical wind profile (VWP) look like based on these two straight hodographs?



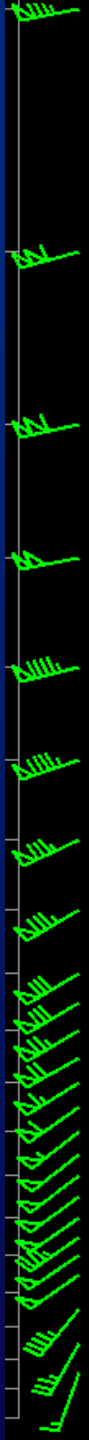
Hodograph Versus Sounding

Despite the same shape hodographs (straight line), the VWP are completely different. One VWP shows uniform westerly flow with height, while the other shows veering winds with height implying warm advection and is more conducive to thunderstorm activity.

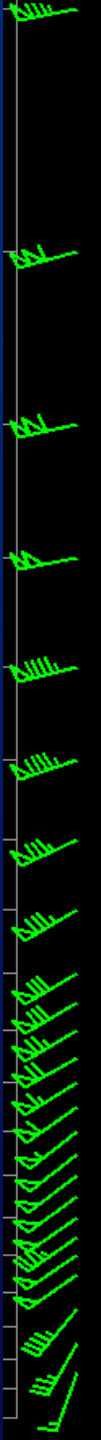


1

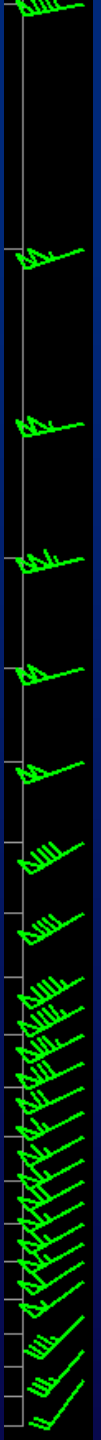
Comments on VWP shear?
How will hodograph look?



1



2



Comments on VWP shear?
How will hodograph look?

Changes in shear?
Any different from 1st VWP?
What will hodographs look like?

1

2

Comments on VWP shear?
How will hodograph look?

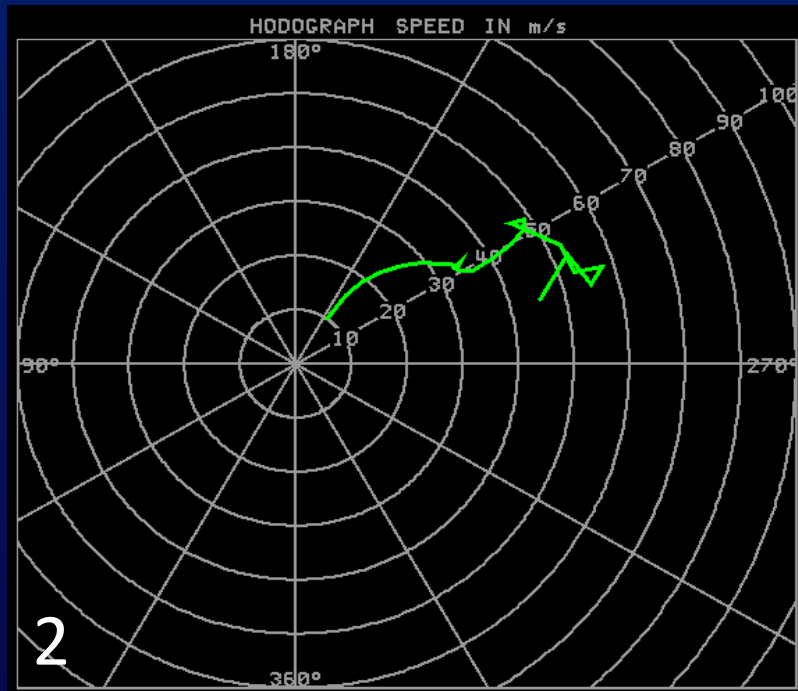
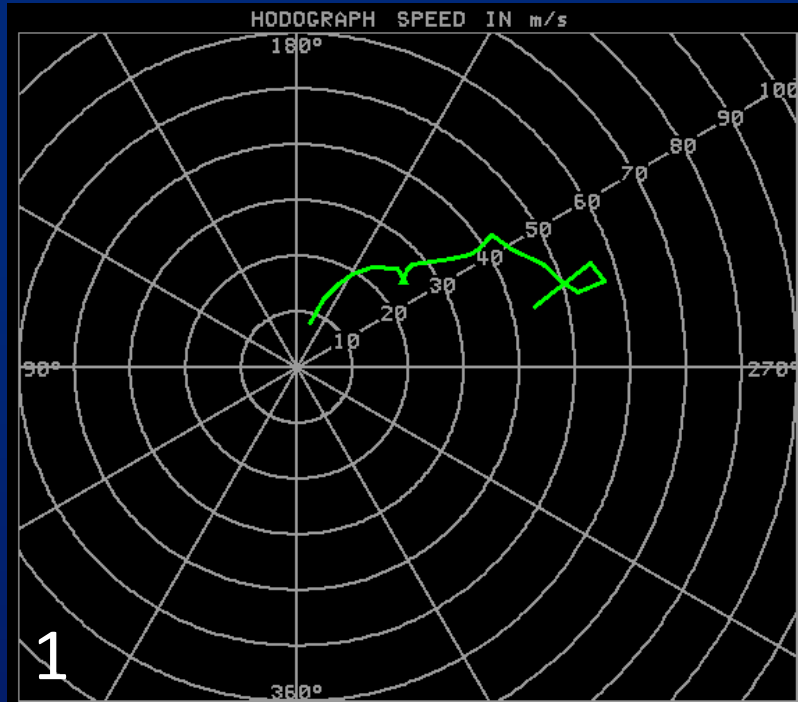
Changes in shear?
Any different from 1st VWP?
What will hodographs look like?

Profile 1: More LL direc shear

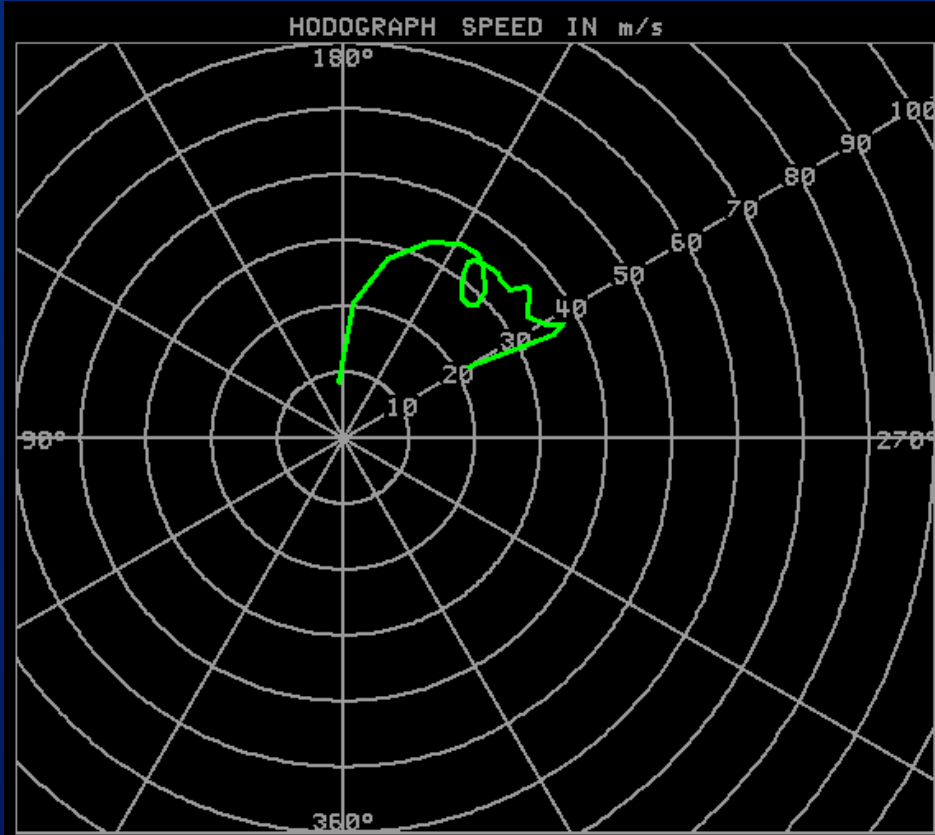
Profile 2: Stronger winds aloft
but less direc shear

Result: Similar hodographs and
total shear

NAM12 VWP/Hodograph:
18z March 2, 2012
Clark County, IN



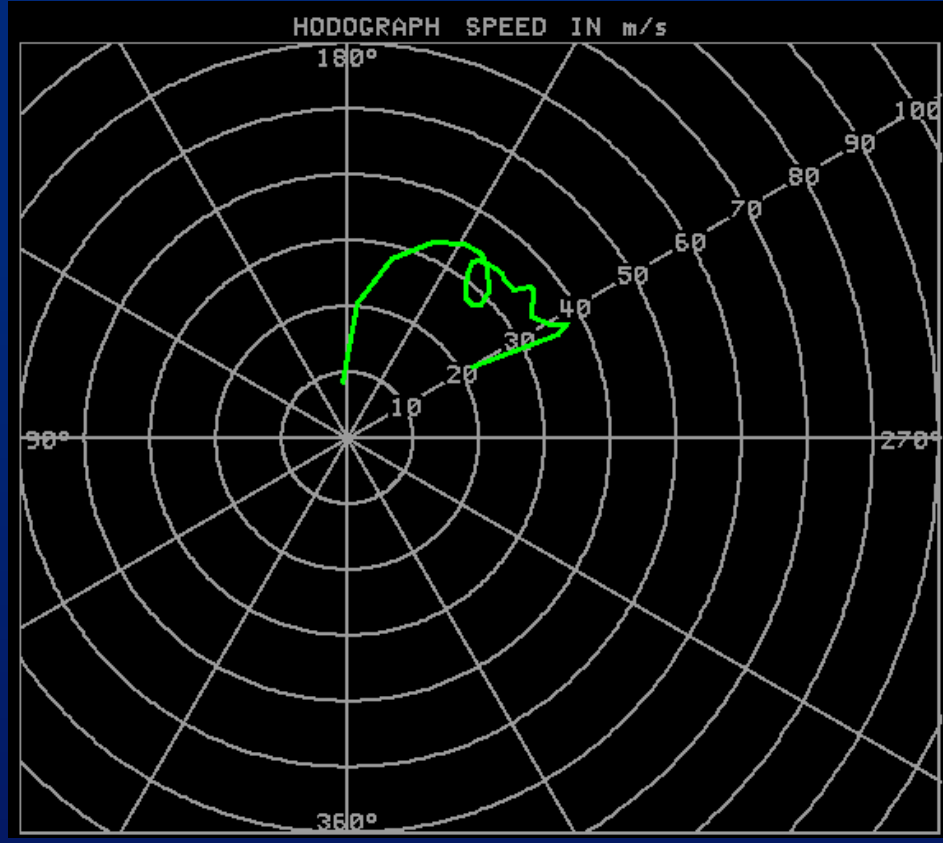
Thoughts on hodograph?
Storm type? Tornadoes?
What will VWP look like?





Thoughts on hodograph?
Storm type? Tornadoes?
What will VWP look like?

Is VWP what you expected?
What storm type?



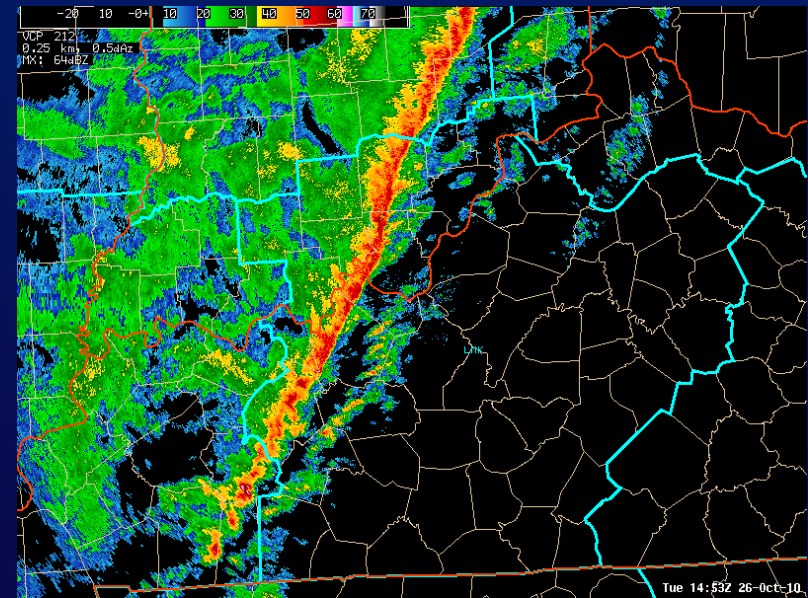
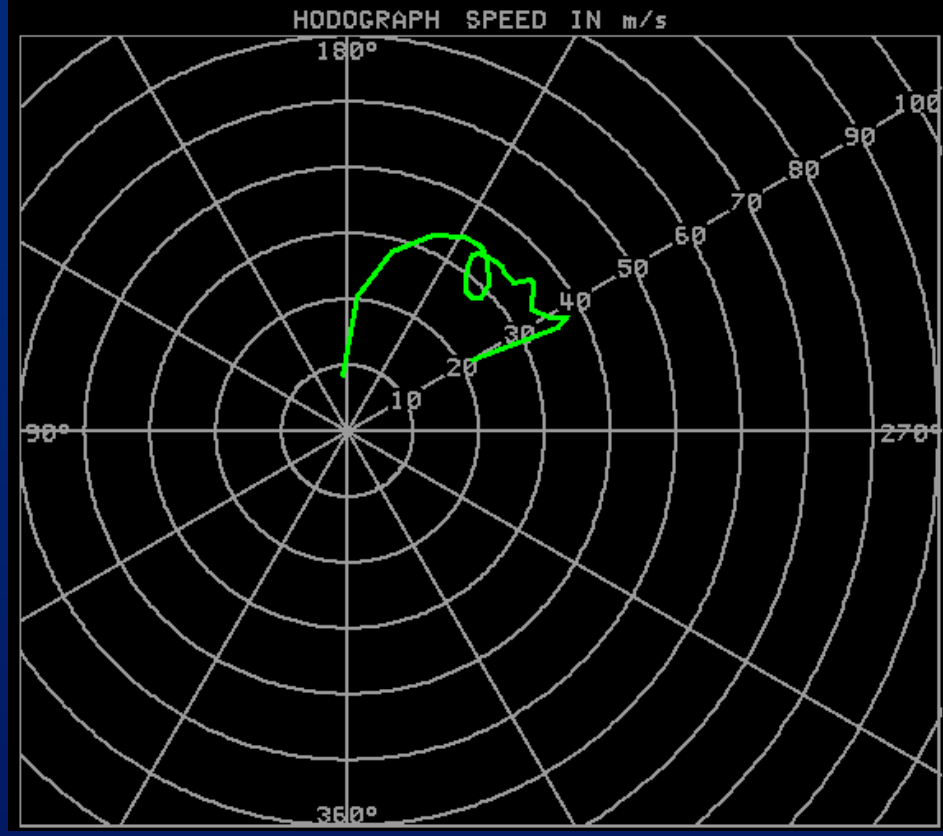


Thoughts on hodograph?
Storm type? Tornadoes?
What will VWP look like?

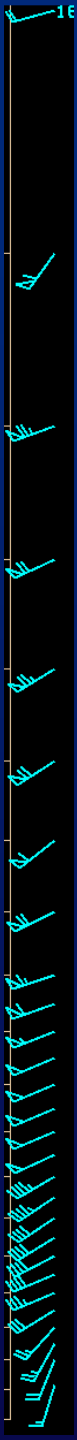
Is VWP what you expected?
What storm type?

GFS Hodograph/VWP:
12z Oct 26, 2010
Jefferson County, KY

(QLCS with few tornadoes
and little supercell structure)

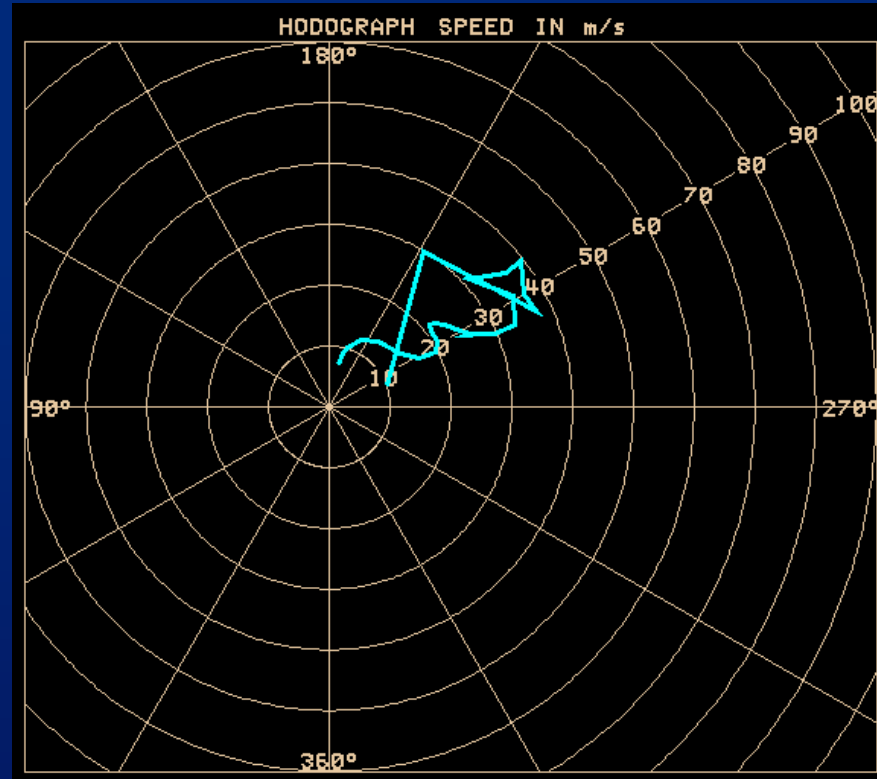


Thoughts on VWP shear?
Storm type? Tornadoes?
How will hodograph look?



Thoughts on VWP shear?
Storm type? Tornadoes?
How will hodograph look?

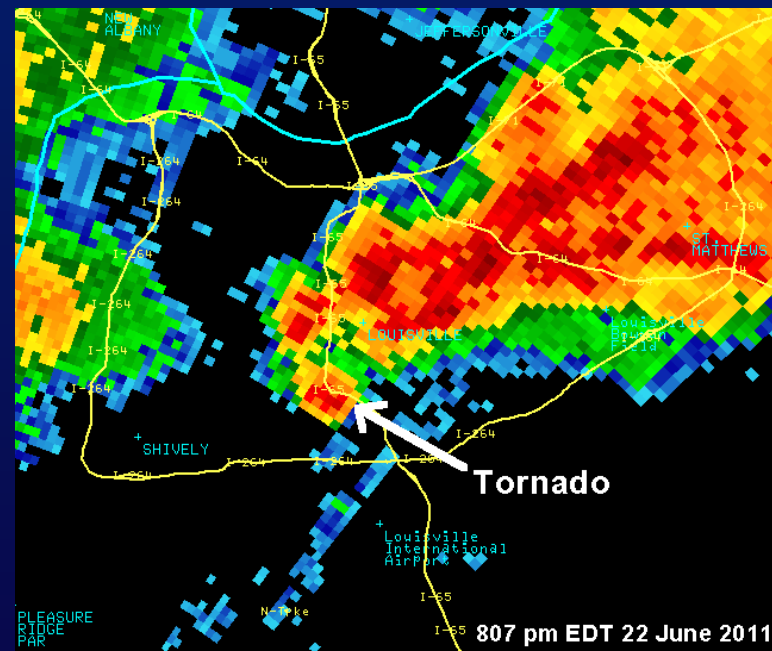
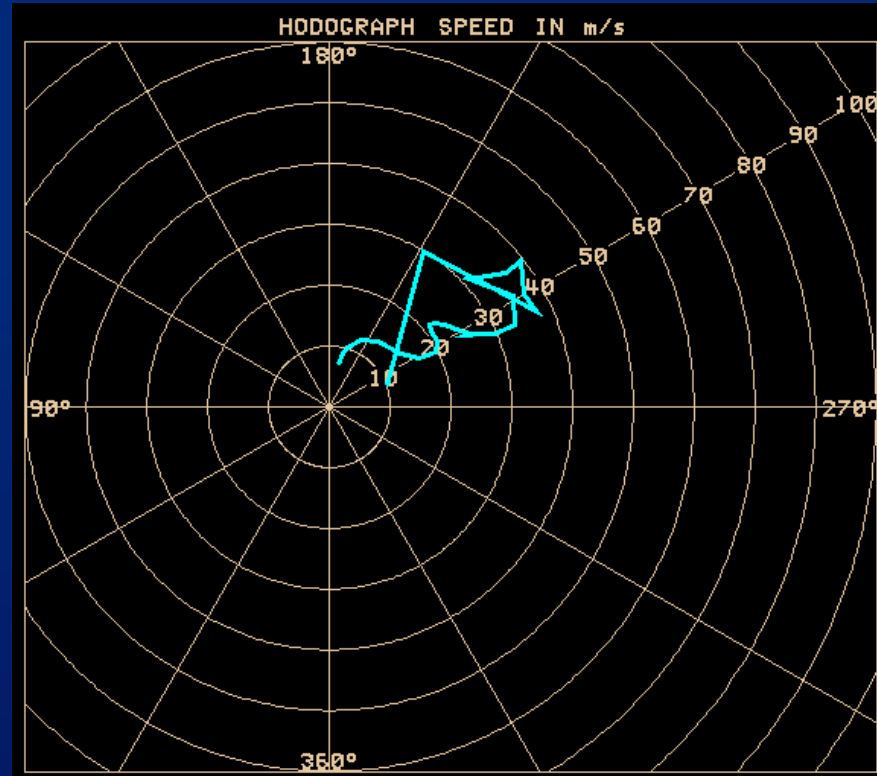
Is hodograph what you expected?
Now what storm type?



Thoughts on VWP shear?
Storm type? Tornadoes?
How will hodograph look?

Is hodograph what you expected?
Now what storm type?

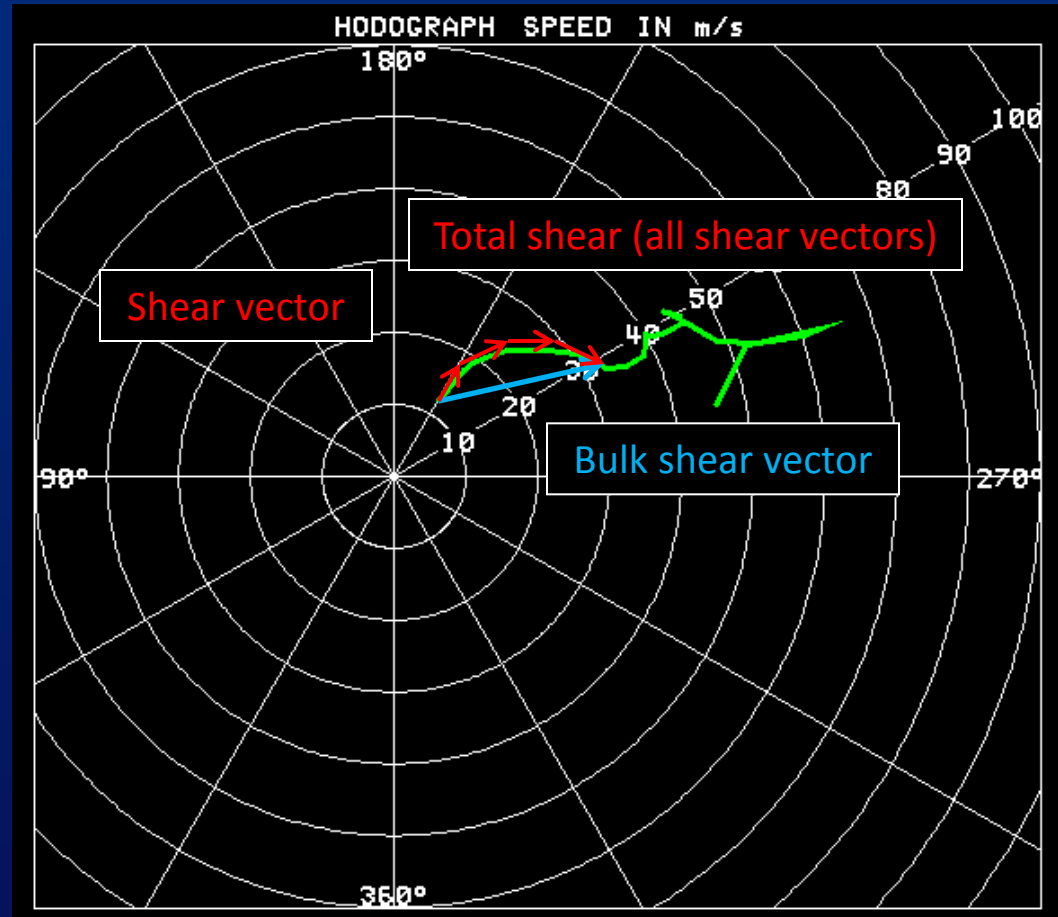
NAM12 VWP/Hodograph:
21z June 22, 2011
Jefferson County, KY
(Several supercells with a
couple tornadoes –
Churchill Downs)



Hodograph Summary

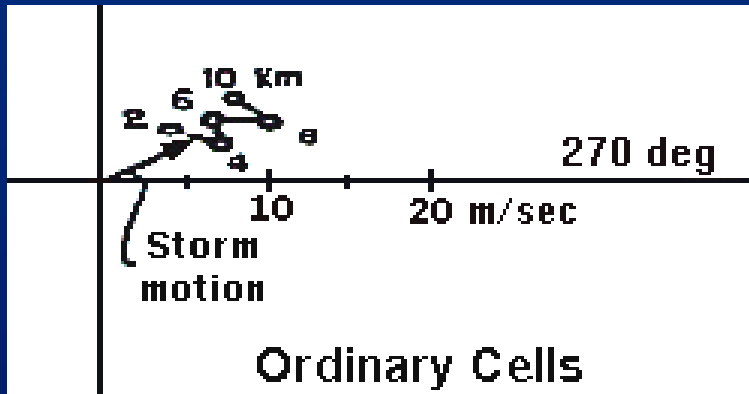
NAM12

VWP/Hodograph:
18z March 2, 2012
Warren County, KY

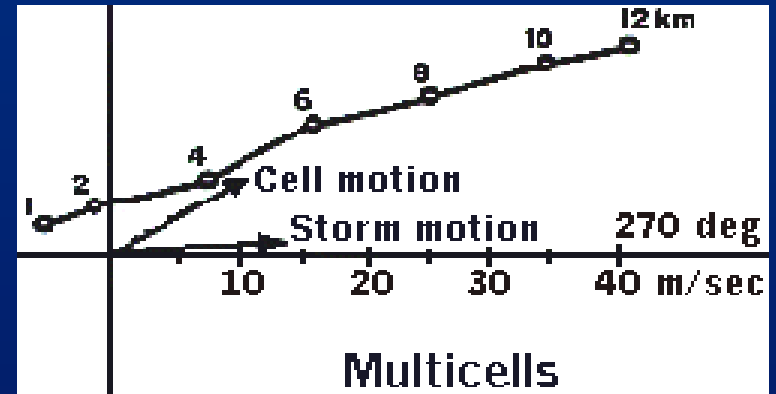


- Hodograph parallel to radial – no directional shear, only speed shear
- Hodograph crosses radial – there is directional shear
- Shear vector – line connecting points on hodograph between 2 levels
- Bulk shear – ΔV (shear vector) between any 2 levels (ignores hodograph shape)
- Total shear – sum of ΔV (shear vectors) over all layers; accounts for all speed/directional shear; sensitive to wiggles/loops; total shear always \geq bulk shear

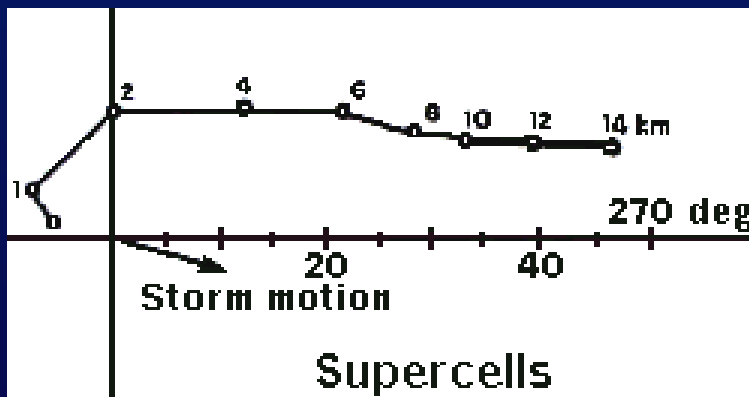
Hodograph Summary



Chaotic VWP; pulse type storms; efficient rainfall producers if high precipitable water/moisture is present in atmosphere



Straight hodograph; low-level directional shear present! No real low-level jet (wind max). Aloft, speed increases but direction is constant with height; multicells/supercells (splitting); tornadic supercells possible (*local augmentation of low-level shear needed through boundary/cell interactions*)



Clockwise low-level curvature due to low-level jet (wind max) present in environment (which enhances storm-relative inflow); curvature is most pronounced if speeds decrease above low-level jet; slowly increasing winds above low-level jet; tornadic supercells more supportive in large-scale environment (*less local augmentation needed through boundary/cell interactions*)