ATMO 352
Severe Weather and Mesoscale Forecasting
Spring 2007

Laboratory #4: The Hodograph, Wind, and Wind Shear

Section 501, Thursday
2-08-07

Due: By beginning of next lab session (2-15-07)

Introduction: The purpose of this laboratory assignment is to 1) introduce you to the Hodograph as a technique for visualizing and calculating various sounding parameters related to wind (e.g., wind shear in a layer, mean wind in a layer), 2) learn how to manually plot, interpret, and analyze a Hodograph using idealized wind data, 3) introduce you to NSHARP as a Hodograph plotting and wind/wind shear analysis tool, and to 4) explore the complexities of real Hodographs using NSHARP.

Reading: If you have not already done so, complete the laboratory reading assignment at http://meted.ucar.edu/mesoprim/hodograf/ (UCAR COMET - Principles of Convection II: Using Hodographs). This reading is best done on a computer with audio. In addition, a simple "print version" html page can be accessed for quick viewing. Finally, you may find the following NSHARP overview useful for interpreting various aspects of the display and output - http://www.unidata.ucar.edu/software/gempak/tutorial/nsharp.html

Data: For exercise #2 below, you will need the upper-air sounding data from Norman, OK (OUN) at 0000 UTC (or 1900 CDT, CDT = UTC – 5 hours) on 4 May 1999 (or 3 May 1999 CDT).

Loading Case Study Data into NSHARP: To load archived case study data for lab exercise #2,

1. select load
2. select observed soundings
3. select file
4. select uair
5. place your cursor in the "filter" box and delete the directory path
6. replace the above path with "/h/metr352/cases/Oklahoma_May3/" and enter
7. select (double-click) on the "/h/metr352/cases/Oklahoma_May3//upperair" directory from the list
8. select (highlight) the file "smot1589990504_upa.gem" for data from 5/3/1999 event.
9. select OK
10. select the appropriate date/time, "990504/0000"
11. select the appropriate "red diamond" for the upper air sounding site you require (e.g., OUN) in the CONUS map to the right

Exercises: (70 points)

1. (*50 points*) Using the idealized wind data in the table below,

Height Level (km)	Wind Direction (°)	Wind Speed (kts)
0.0 (surface)	140	15
1.0	170	30
2.0	210	40
3.0	235	45
4.0	250	50
5.0	260	55
6.0	270	60

a) (4 points) Plot the associated hodograph on the chart provided (i.e., plot the points and then connect the points using a smooth curve/line). Use 5 kts as a radial increment. Label each point with its respective height.

b) (4 points) In what 1-km layer is the shear the strongest? How can you determine this directly from the plotted hodograph?

c) (6 points) Determine the SFC – 6 km vertical wind shear magnitude using the hodograph. In meteorology, the strength of the vertical wind shear is sometimes represented by the magnitude of the velocity vector difference $|\Delta\vec{v}|$ over a specified vertical depth (e.g., 6 km) and is reported in units of velocity (e.g., kts or m s^{-1}). Strictly speaking vertical wind shear is defined as $\partial\vec{v}/\partial z = |\Delta\vec{v}|/\Delta z$, and is reported in units of (s^{-1}). For this question, provide an answer using both conventions (i.e., m s^{-1} and s^{-1}). (NOTE: 1 kt ≈ 0.514 m s^{-1})

d) (6 points) Determine the SFC – 2 km vertical wind shear magnitude from the hodograph. Provide your answer in both units as above in c).

e) (10 points) Using the hodograph, determine the *total* vertical wind shear magnitude (kts) from SFC – 2 km *and* SFC – 6 km, $|\Delta\vec{v}|_{total}$.

f) (6 points) Using the hodograph, estimate the *direction* of the *mean wind shear* vector in the 0-6 km layer. Show the direction of the mean wind shear vector on your hodograph and also describe in words.

g) (4 points) Describe the shape (straight vs. curved) of the hodograph. If the hodograph curves, determine the height level through which it curves and the sense or direction of the curvature.

h) (7 points) Using the technique described in the UCAR COMET module, estimate the direction (°) and speed (kts) of the mean wind in the 0-6 km layer. Mark the location on your hodograph with an “X”.

i) (3 points) Assuming that storm motion can be approximated by the mean wind in the 0-6 km layer, estimate the direction (°) and speed (kts) of the *storm relative* surface (0 km) wind.

2. (*20 points total*) Load sounding data from OUN on 04 May 1999 from 0000 UTC into NSHARP using the directions provided above. Using NSHARP, select the Hodograph option (i.e., instead of Skew-T). Use the calculated parameters on page two of the numeric output, which should pop up automatically when you select the hodograph option. Note that the sounding terminated early at about 10 km and is therefore incomplete. However, we will focus on the lowest 6 km of the troposphere.

a) (6 points) Describe qualitatively what you see in the OUN hodograph. Be sure to discuss curvature in your answer.

b) (2 points) Using NSHARP, determine the SFC – 2 km and SFC – 6 km wind shear, $|\Delta\vec{v}|$. Use kts and m s^{-1}.

c) (2 points) Using NSHARP, determine the shear in the SFC – 2 km and SFC – 6 km layers using the "true definition of shear" or dv/dz (i.e., using units of s^{-1}). (Note: NSHARP provides these quantities in the column called "TOT SHR." The provided numbers (usually in the tens to hundreds) have units of 10^{-4} s^{-1}.)

d) (3 points) Using NSHARP, determine the storm motion vector (direction and magnitude) for the early stages of convective cells forming in the environment represented by the OUN sounding, assuming that this motion is approximately equal to the SFC – 6 km mean wind. Report the wind magnitude in units of kts and m s^{-1}.

e) (7 points) By slightly modifying the directions given above, load the sounding data from OUN on 3 May 1999 at 1800 UTC. How did the mean wind and wind shear in the SFC-6 km layer and wind shear in the SFC – 2 km layer change from 3/1800 UTC to 4/0000 UTC? Describe the changes both qualitatively and quantitatively.