**ATMO 352**
**Severe Weather and Mesoscale Forecasting**
**Spring 2007**

**Laboratory #5: Meteorological Radar - Doppler Velocity, mesocyclone, and TVS**

Section 501, Thursday
2-15-07

*Due: By beginning of next lab session (2-22-07)*

*Introduction:* The purpose of this laboratory assignment is to introduce you to Doppler radar velocity measurements and interpretation, focusing on convective storm applications including simulated and real data from tornadic supercells.

*Background:*

NOAA NWS operates a network of operational Weather Surveillance Radar – 1988 Doppler (WSR-88D) radars across the United States (Figure 1). These radars provide timely (4-10 minute) reflectivity (Z) and Doppler Velocity ($V_r$) information within precipitation systems and the precipitation free air or the so-called "clear air." WSR-88D imagery plays an important role in severe weather and mesoscale forecasting, including the identification and tracking of severe storms and in the forecasting of storm initiation.

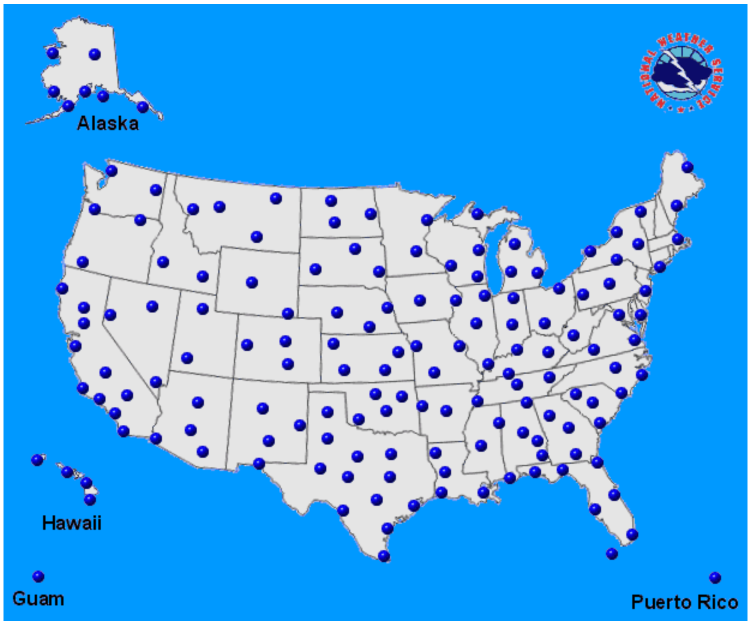



**Figure 1.** Locations of NOAA NWS operational WSR-88D (Weather Surveillance Radar – 1988 Doppler). Real time WSR-88D reflectivity and Doppler velocity data is available at many Internet sites, including http://www.rap.ucar.edu/weather/radar/ and http://weather.noaa.gov/radar/.

*Reading:* To complete this lab, you should first carefully read "Radar Meteorology: Online Remote Sensing Guide by the University of Illinois WW2010 Project" at the following internet web site: http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/rad/home.rxml. See also the supplementary lab 5 material on the class web page.

*Data:* For Part II, you will use composite radar reflectivity images (*LEVEL III*) and radar reflectivity and Doppler velocity from the Sioux Falls, SD (KFSD) WSR-88D (*NIDS*) on 30 May 1998 during the Spencer, SD F4 (on the Fujita scale) tornado. To load the archived case, type and enter "Spencer" in an open terminal window and then type and enter "garp" as usual. Within, NIDS "N0R" refers to radar reflectivity and "N0V" refers to Doppler velocity from the lowest elevation angle PPI (Plan Position Indicator) scan available. "N0RL2" and "N0VL2" refer to the 2nd level (i.e., next available elevation angle) reflectivity and Doppler velocity, respectively (etc).

*Exercises (60 points):*

*Part I (20 points):*

1. (20 points) In order to gain practice in interpreting complex three dimensional flow patterns in and around precipitation from single Doppler radar data, Doppler radial velocity patterns along a plan position indicator (PPI) scan (i.e., fixed elevation angle and varying azimuth angle) have been simulated from simplified horizontal and vertical wind field patterns (Brown and Wood 1987)[1].

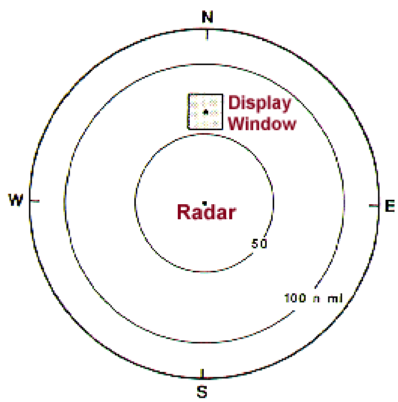



**Figure 2.** The radar domain used for simulations and display of idealized Doppler velocity flow patterns in and around convective storm (Brown and Wood 1987).

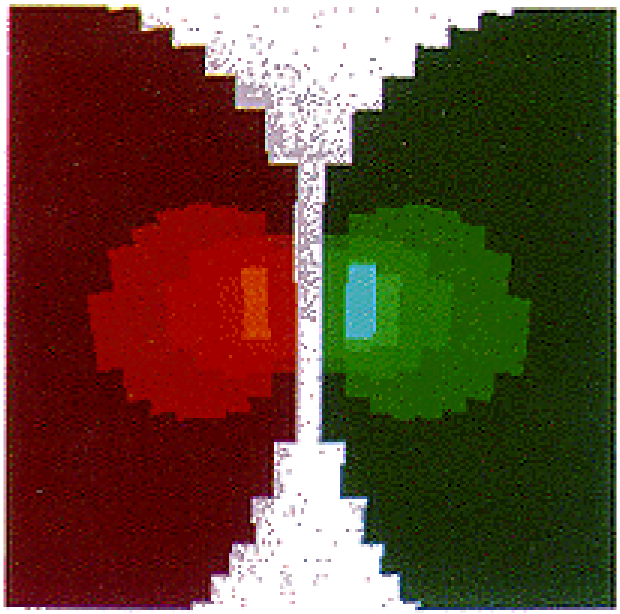
Figure 2 above shows the location and size of the 27 nmi x 27 nmi display window used for simulated Doppler velocity patterns of convective storm features. The window is 65 nmi due north of the radar located at the center of the overall display region.

Negative Doppler velocities (blue-green color) in knots (kts) are toward the radar and positive (yellow-red) are away from the radar. For your reference, the radial velocity color bar for each PPI scan below is.

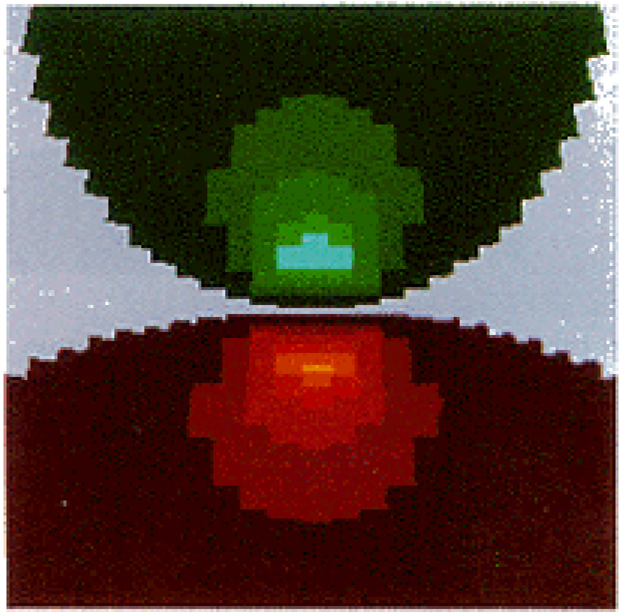

[1] Brown, Rodger & Vincent Wood, 1987: A Guide to Interpreting Doppler Velocity Patterns, NSSL, Norman OK.

***Using both textual and graphical means, qualitatively describe* (in your own words) the approximate near storm wind field inferred from each PPI scan of radial velocity data below.**

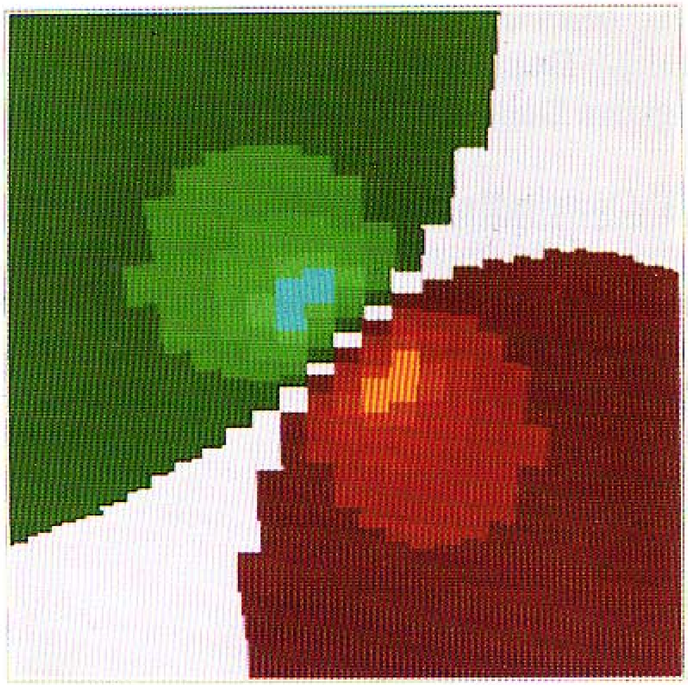
A. (5 points) The following image is a small portion (27 nm x 27 nm) of a low level PPI scan that is zoomed in on a particular Doppler velocity feature of a severe convective storm that is to the north of the radar (see radar domain figure above).



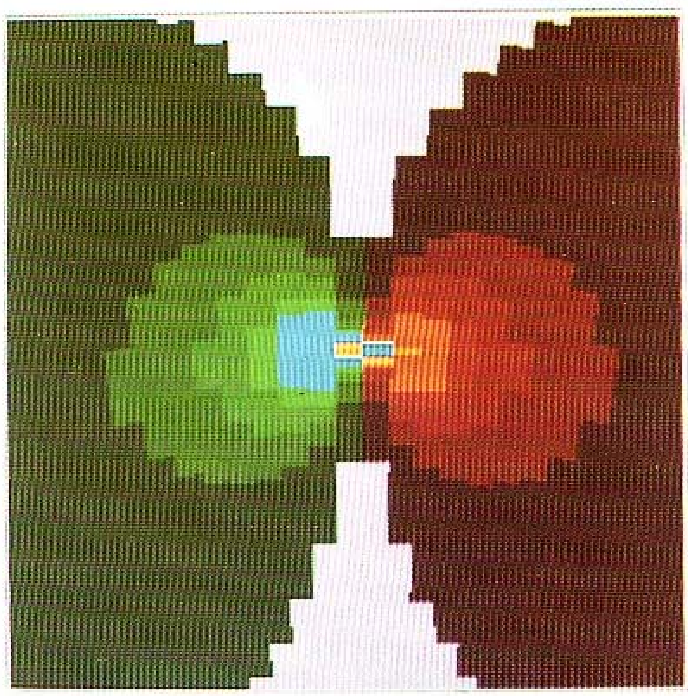
B. (5 points) The following image is a small portion (27 nm x 27 nm) of a low level PPI scan that is zoomed in on a particular Doppler velocity feature of a severe convective storm that is to the north of the radar (see radar domain figure above).



C. (5 points) The following image is a small portion (27 nm x 27 nm) of a low level PPI scan that is zoomed in on a particular Doppler velocity feature of a severe convective storm that is to the north of the radar (see radar domain figure in online reading).



D. (5 points) The following image is a small portion (27 nm x 27 nm) of a low level PPI scan that is zoomed in on a particular Doppler velocity feature of a severe convective storm that is to the north of the radar (see radar domain figure in online reading).



*Part II (40 points):*

1. (8 points) View LEVEL III composite radar reflectivity data animation or loop over western South Dakota and southern Minnesota every 15 minutes from 0000 UTC to 0200 UTC 31 May 1998. Describe what you see, keeping in mind the definition of supercell convection discussed below.

2. (8 points) A supercell is a large, quasi-steady, uni-cellular severe convection cell. The supercell is often characterized by a reflectivity feature called the "hook echo." For tornadic supercells, the tornado is often located within the hook echo. Load radar reflectivity at the first elevation angle (N0R) from the KFSD radar at 0128 and 0133 UTC. Locate the center of the supercell and the hook echo by providing approximate latitudes and longitudes at both times.

3. (12 points) A mesocyclone is a vortex (i.e., rotational feature), usually cyclonic, which is on the order of 10 km wide and is collocated with the supercell updraft. Load Doppler velocity (N0VL2) from the $2^{nd}$ available elevation angle at 0128 and 0133 UTC. Zoom in on the location of the supercell. Locate the mesocyclone by identifying a couplet in the velocity field that indicates strong azimuthal shear. Provide the approximate latitude and longitude of the center of the velocity couplet or mesocyclone at both times. What is the relationship between the hook echo and the mesocyclone?

4. (12 points) A tornado vortex signature (TVS) is the Doppler velocity signature of a tornado. When a tornado is present, it is typically small enough that it fits within one or two radar beam widths. Depending upon the scanning geometry of the beam, the distance of the tornado from the radar, and the location of the beam relative to the tornado, the strong winds of the tornado will typically occupy one or two radar pixels. The TVS is typically characterized by extreme Doppler velocity values of opposite sign separated in azimuth by one beamwidth or, equivalently, one pixel. Often, the velocities are folded. The TVS is often embedded within a parent mesocyclone. Beginning by locating a parent mesocyclone, then identify any potential tornado vortex signatures (TVS's) in the $1^{st}$ elevation angle (N0V) at 0143 and 0148 UTC. Provide the latitude and longitude of any TVS's you identify at each time.