ACTIVITY Detecting Winds with a Doppler Weather Radar

Upon completing this activity, you should be able to:

- describe what aspects of the actual wind a Doppler radar can detect
- determine the location and speed of wind motion towards or away from the radar
- construct air motion patterns as they are detected by Doppler radar and compare them with the actual winds

Introduction

Displays of colourful radar images are often included in television weathercasts. These radar reports can cover the local area or be summaries of radar information from across the country. They indicate precipitation (rain or snow) patterns and intensities. If images are shown in rapid sequence, they reveal storm changes and movements over time. Doppler radar, can also provide information on winds. This is especially useful in tracking strong thunderstorms, locating areas of possible tornadoes, and following hurricanes. Doppler radar is making it more promising than ever to warn the public of threatening weather occurrences in time to take appropriate action. The purpose of this activity is to investigate wind information made available by Doppler radar.

Materials Needed

- red and blue pens or pencils,
- an 8 cm x 13 cm card (or an index card)

Procedure

The accompanying Figure 1 represents the display screen of a Doppler weather radar. The radar is located in the centre. The concentric circles are called range rings and indicate distance from the radar's location at 50 kilometre intervals. The straight radius lines extending from the centre indicate direction from the radar's location and are labeled N for north, NE for northeast, E for east and so on. Direction is also given in degrees, beginning at north and then measured clockwise.

The circled points represent locations where actual wind observations were made. The arrows drawn from them describe the winds. The lengths of the arrows indicate the wind speeds. The arrowheads point towards the direction the winds were blowing. Winds are named using the direction they are blowing from. This is the direction from the start of the arrow to the arrowhead.

The winds reported in Figure 1 were the actual winds observed at a dozen or so locations at the same time within the viewing range of the radar. Note that all arrows point from southwest to northeast, and are of the same length. This means the wind was steady from the southwest over the entire region viewed by the radar.

What Air Motions Can Doppler Weather Radar Detect?

1. Doppler radar detects air motion directly towards or away from the radar. Actual winds are fully sensed by Doppler radar only when the winds are directly towards or away from the radar. Examine the locations with wind reports in Figure 1 that are labelled with letters. Two of them have winds that are blowing directly towards or away from the radar.

   The actual wind is directly away from the radar at location _____.

   Draw a **red** arrow over the top of the existing wind arrow at this location. Red will be used in this activity to describe air moving away from the radar site.

   The actual wind is headed directly towards the radar at location _____.

   Draw a **blue** arrow over the top of the existing wind arrow. Blue will be used to describe air moving towards the radar site.

   Air motion along the radius lines through these two locations is called radial velocity. In this activity, the radial velocities will be called *Doppler Winds*. When the actual wind is blowing along a radius line, the actual wind and the *Doppler Wind* at that location are _____.

2. There are three locations, including one labelled "C", where the Doppler radar would detect no air motion. They are observations where the actual wind direction is at right angles to the radius line at the point of observation. While the air is moving at these points, none of the motion is either towards or away from the radar. Therefore, the Doppler radar senses no Doppler airflow at these locations. Write the word "ZERO" across each of these locations to indicate zero *Doppler Wind*.

3. Winds at all other locations reported in Figure 1 are not directly along or at right angles to, radius lines. Their *Doppler Winds* can be determined with the Doppler Motion Detector. To make this device and to determine the *Doppler Wind*, print "Doppler Motion Detector" on one side of the 8 cm x 13 cm card and follow the steps below,

   Step 1… Locate the wind arrow labelled "D". Lay the Doppler Motion Detector on the radar view so it completely covers the "D" wind arrow and one of its long sides lines up on the radius line running through Point "D".

   Step 2… Slide the card along the radius line until a short edge of either end of the card touches the pointed end of the wind arrowhead.

   Step 3… Follow that short edge to the Detector's corner positioned on the radius line and place a mark on the radius line.

   Step 4… Draw the *Doppler Wind* arrow by marking a **blue** arrow on the radius line starting at the circled data point and ending at the mark you made at the

Detector's corner. Add an arrowhead to show the direction of motion towards the radar. Remember that the arrow is blue when the motion is towards the radar.

4. Now determine the *Doppler Wind* at the arrow labeled "E". Since there is no radius line through the point representing this location, draw one using a long side of the Detector as a straight edge from the radar site to the outer circle. Then follow the same general directions already given to draw the *Doppler Wind* arrow. This time, the radial motion is away from the radar, so draw the arrow **red.**

5. Compute the rest of the *Doppler Winds* for each location on Figure 1 using the Doppler Motion Detector. Draw radius lines where needed. When the Doppler Wind arrow you draw point towards the radar site, colour it blue. When it points away form the radar, colour it red.

What Interpretations Can Be Made From the Motions Doppler Radars Detect?

6. The coloured *Doppler Wind* arrows you have drawn represent air motion directly towards or away from the radar. The lengths of the arrows represent the speeds of the wind motion directly towards or away from the radar. The longer the arrows, the greater the speeds. The arrows you have drawn show a Doppler radar interpretation of a wind from the southwest.

   To see this more clearly, colour in the regions with neighbouring red arrows with shades of red. Use the deepest, most intense shade where the *Doppler Winds* are the highest (coloured arrows longest) and gradually grade to lighter shades as winds lower or approach "ZERO". Colour regions of blue arrows, going from the most intense blue where winds are greatest to the lightest shading at the lowest winds.

7. An actual Doppler velocity radar view would show only Doppler Winds. While ignoring the actual wind arrows in Figure 1, list as many clues from the Doppler Wind pattern as you can that would lead to the conclusion that a steady southwest wind existed at viewing time over the entire radar map. The arrows start in the southwest with the arrowhead pointing in the same direction the wind is blowing toward.

Can Weather Features be Detected With Doppler Weather Radar?

8. Now look at Figure 2. To determine the *Doppler Winds*, follow the steps used to analyze Figure 1. Colour code the *Doppler Wind* arrows and use varying shades of blue and red to highlight velocity differences towards and away from the radar.

9. Examine the zero ("ZERO") velocity line(s) in Figure 2. What is the angular relationship that always appears to exist between the actual wind direction and the zero velocity line?

10. For Figure 2, there was actually a cold front existing at viewing time. Draw it in. Its position was a straight line along the radius line extending from the southwest, through the radar's location, and on to the Northeast. The front was moving from the northwest towards the southeast.

    Note that *Doppler Winds* detected by the radar near, but ahead of the front, (to the southwest and Northeast), were high. Behind the front, they were low. Give a reason for the difference.

11. Suppose the cold front continues to march southeastward and eventually leaves the radar's field of view. Describe or sketch the resulting *Doppler Wind* pattern. Compared to the Figure 1 view, how is this pattern similar and different?

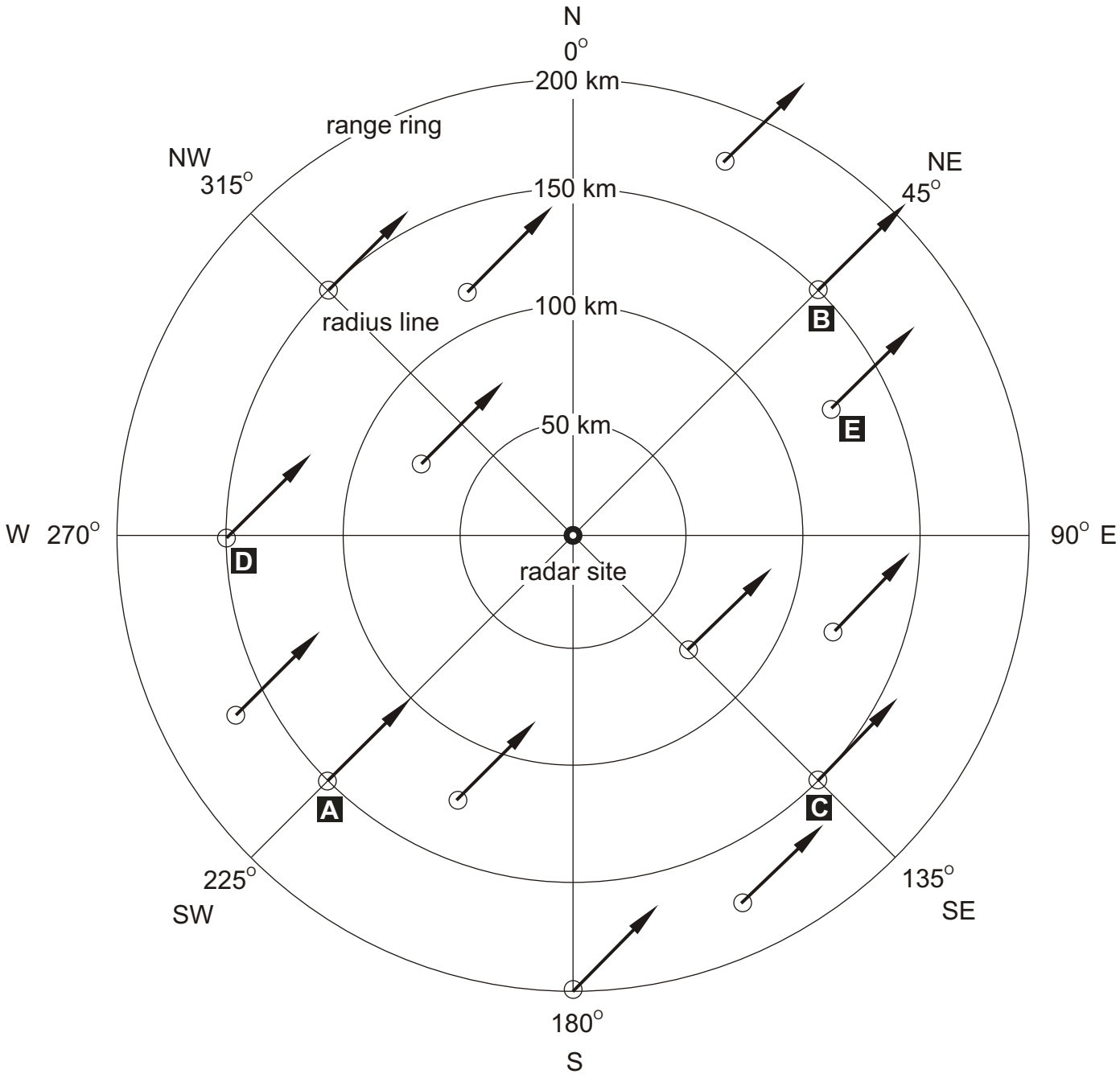


Figure 1: Velocity Radar Screen at 2 p.m.

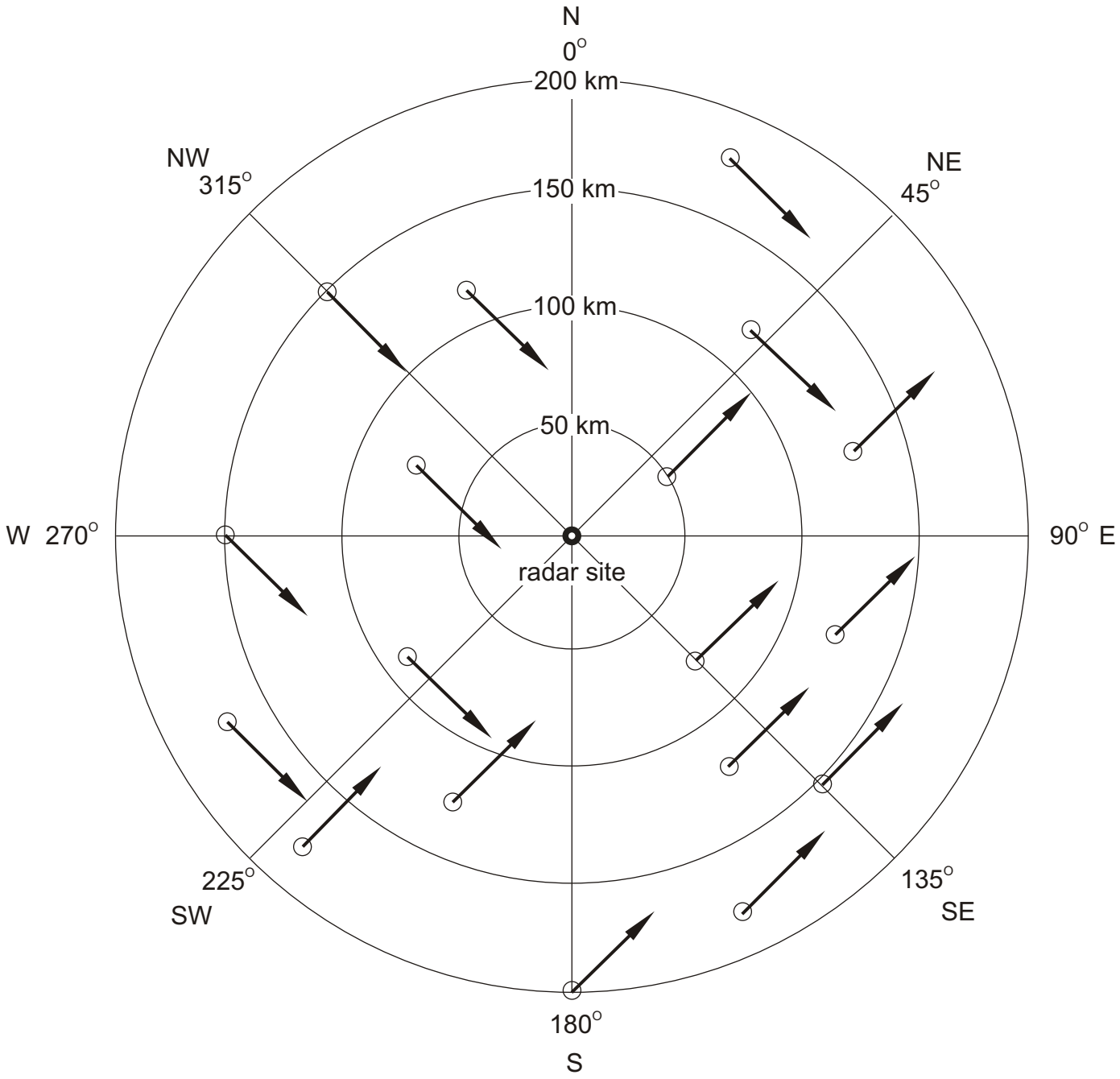
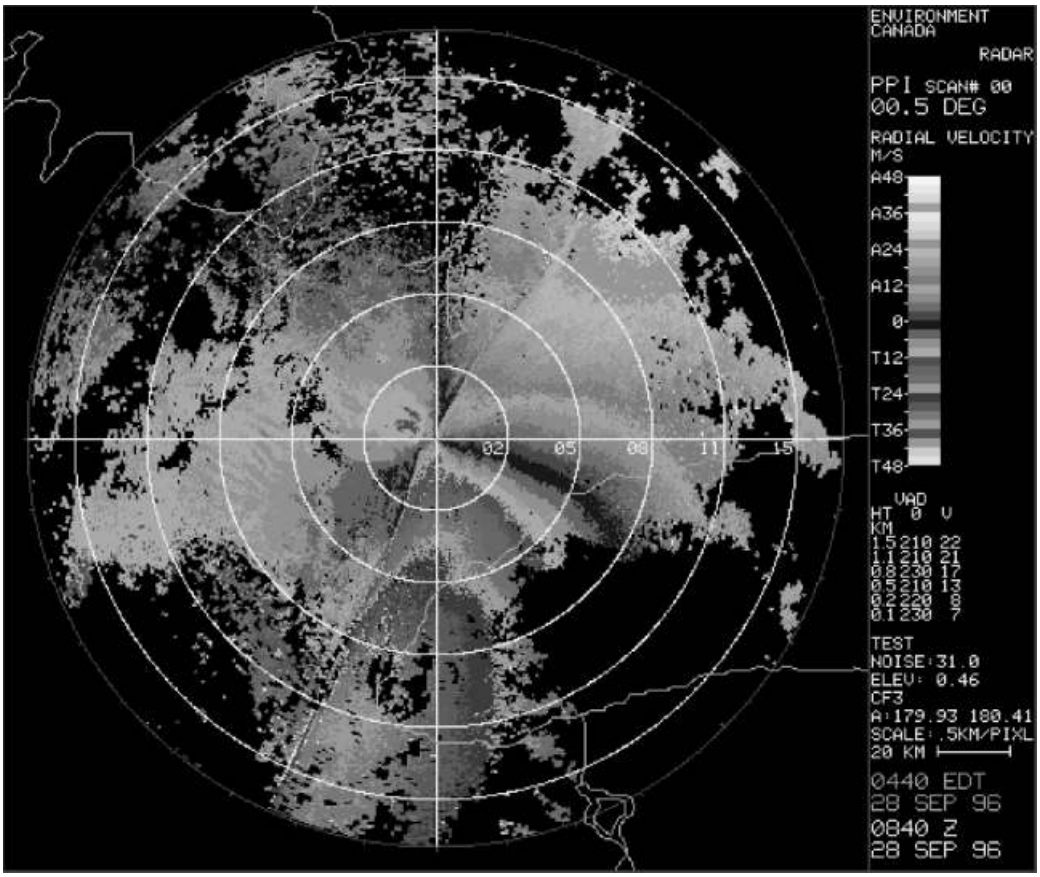
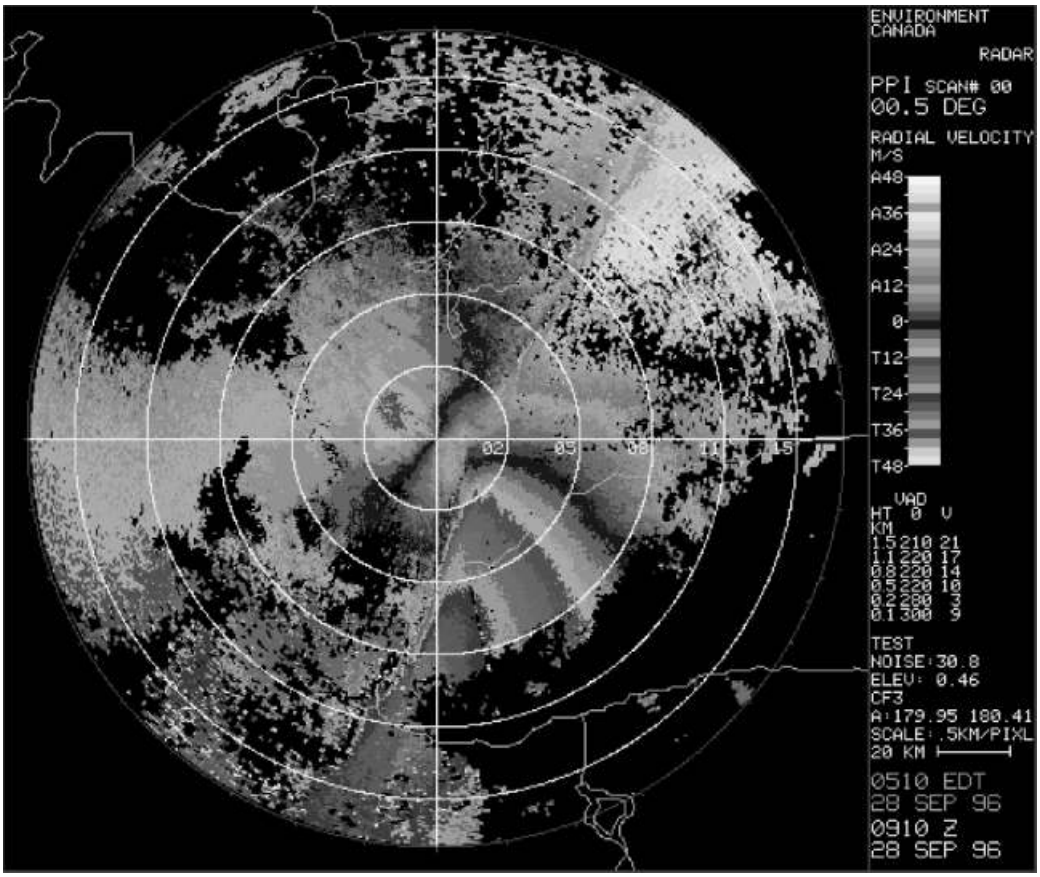


Figure 2: Velocity Radar Screen at 6 p.m.



A Doppler Radial Velocity radar view 28 Sep 96 at 0840Z



A Doppler Radial Velocity radar view 28 Sep 96 at 0910Z