Dual-Pol WES Exercises Overview

This document contains 4 jobsheets that step you through a dual-pol radar analysis in case review mode on the WES. All events are from central Oklahoma from the WSR-88D Dual-Pol KOUN. Each jobsheet in this document is specific to a particular high impact event and you don't have to work through them in any particular order. While completion times will vary from person to person, expect these exercises to take roughly 7 hours to work (including the self-contained answer keys). The jobsheets are:

1. **Winter Weather: ~90 min analysis time + 26 min answer keys**
2. **Heavy Rain: ~60 min analysis time + 22 min answer keys**
3. **Tornadoes and Hail: ~100 min analysis time + 60 min answer keys**
4. **Bow Echo: ~40 min analysis time + 20 min answer keys**

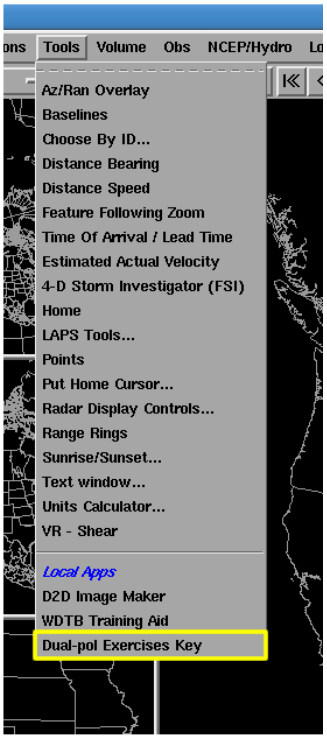
Answer Keys

Answer keys are provided on a question by question basis, and are loaded directly off the WES! They each consist of a narrated video screen capture, demonstrating how Paul Schlatter from WDTB would have answered each question on his WES. It's up to you *when* you want to view the answer key for each question, either immediately after you fill out the answer or at the end of the jobsheet. In any case, please load the answer key launch page right off the tools menu (right graphic below). A firefox window will open containing links to each of the jobsheet answer keys (left graphic below). These videos contain narration, so make sure your WES machine has a working sound card to hear the audio from each video screen capture answer key.

Dual-Pol WES Exercises Answer Key

This page has the links to view camtasia presentations of the answers to each of the questions that make up the dual-pol operations coures WES exercises. Each link below will launch an external window containing the answer(s) to the jobsheet and questions listed.

Winter Weather Jobsheet (12/24/09, 2/26/10, 3/20/10)	Heavy Rain Jobsheet (June 14, 2010)	Tornado/Hail Jobsheet (May 10, 2010)	Bow Echo Jobsheet (May 19, 2010)
Question 1 Key	Question 1 Key	Question 1 Key	Question 1 Key
Question 2 Key	Question 2 Key	Question 2 Key	Question 2 Key
Question 3 Key	Question 3 Key	Question 3 Key	Questions 3-4 Key
Question 4 Key	Question 4 Key	Question 4 Key	Question 5 Key
Questions 5-6 Key	Question 5 Key	Question 5 Key	Question 6 Key
Question 7 Key	Questions 6-7 Key	Question 6 Key	Question 7 Key
Question 8 Key	Question 8 Key	Question 7 Key	Question 8 Key
Question 9 Key	Question 9 Key	Questions 8-9 Key	Question 9 Key
Question 10 Key	Question 10 Key	Question 10 Key	
Questions 11-13 Key	Question 11 Key	Question 11 Key	
Question 14 Key	Question 12 Key	Question 12 Key	
Question 15 Key		Question 13 Key	
Question 16 Key		Question 14 Key	
Questions 17-18 Key		Question 15 Key	
		Question 16 Key	
		Question 17 Key	
		Question 18 Key	
		Question 19 Key	
		Question 20 Key	
		Question 21 Key	
		Question 22 Key	
		Question 23 Key	
		Question 24 Key	



Dual-Polarization Radar Operations Course
WES Exercises

Jobsheet #1: Winter Precipitation

Objective:

- Using the knowledge gained from training modules and with the aid of all training aids, integrate an analysis of dual-pol radar products into two case studies of winter precipitation in central Oklahoma

Case Data: 24 December 2009, 26 February 2010, and 20 March 2010 in central Oklahoma.

Available Data: KOUN radar, and LAPS data for the 24 December event.

Analysis Duration: 90 min
Answer Keys Duration: 26 min

Instructions:

1. Using the WES workstation, left click on the D2D clock in the lower right part of D2D
2. Using the "Set Time" window, set the D2D clock to **2010 March 20 13:45 UTC** (don't bother changing the seconds) and check the "Freeze Time at This Position" box.
3. Set Map Scale to "WFO"
4. Click on the koun menu and load "All Tilts Base Data"
5. Set frames to 64
6. Swap panes to an empty pane
7. Set Map Scale to "WFO"
8. Click on the koun menu and load "0.5 Base Data"
9. Set frames to 30
10. Modify map backgrounds and data magnification as you see fit in both panes

11. In the 0.5 deg base data pane, loop through the 30 frames at 4 panels and/or Panel Combo/Rotate, getting a broad scale view of the base products Z, ZDR, CC, and KDP, the character and movement of the precipitation echoes, and to become familiar with controls if you are not already.

*****During this event the contractor was testing CC noise correction. As a result, there was no noise correction applied at this time. You'll see the result of this in low Signal to noise ratio (SNR), CC drops off quickly. Ignore CC in these areas, restrict your focus on CC to areas of stronger reflectivity, roughly greater than 20 dBZ.*****

12. When ready, go the 0.5 deg 4 panel layout of base data at **13:44 UTC**, and examine ZDR. You can use the 4-panel display or hit the #2 key to enter Panel Combo/Rotate (PCR) mode.

For reference, on the next page you'll find a 12 UTC sounding from near the radar, as well as a graphic with surface observations. The questions follow the graphics.

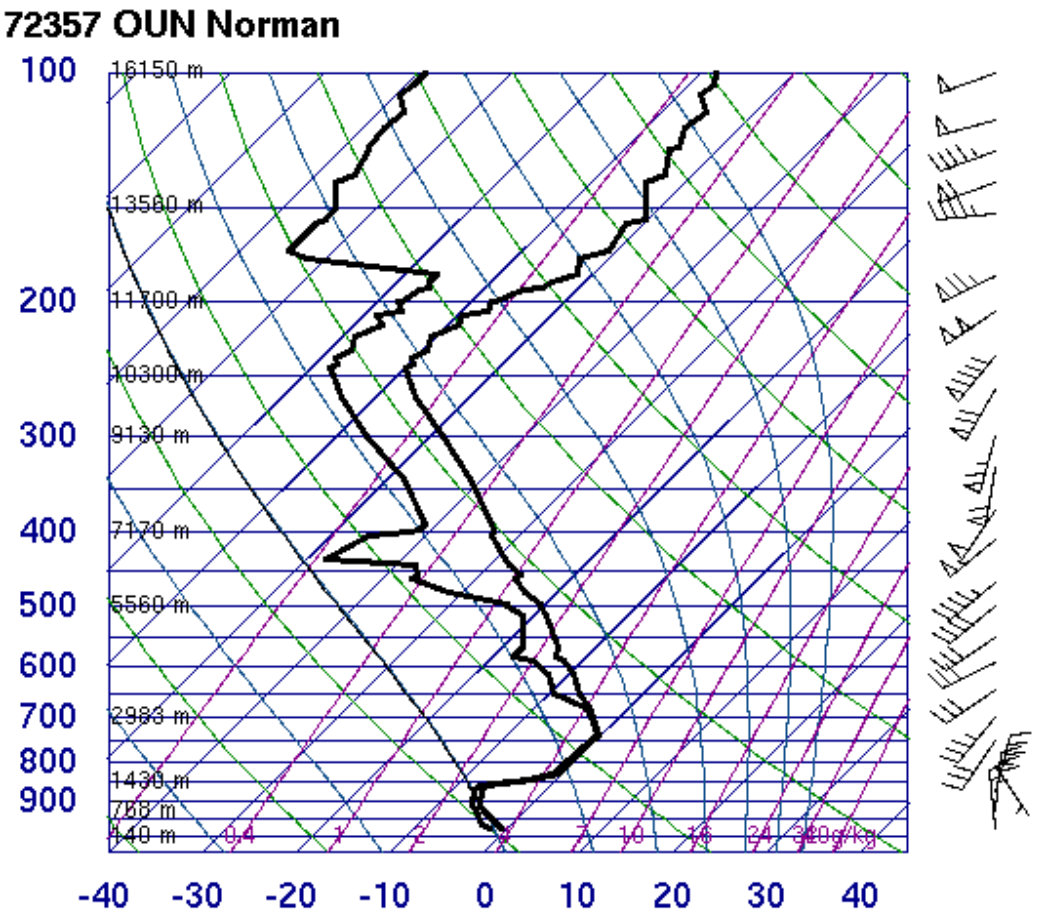


Figure 1: OUN skew-T from 20 March 2010 at 12 UTC.

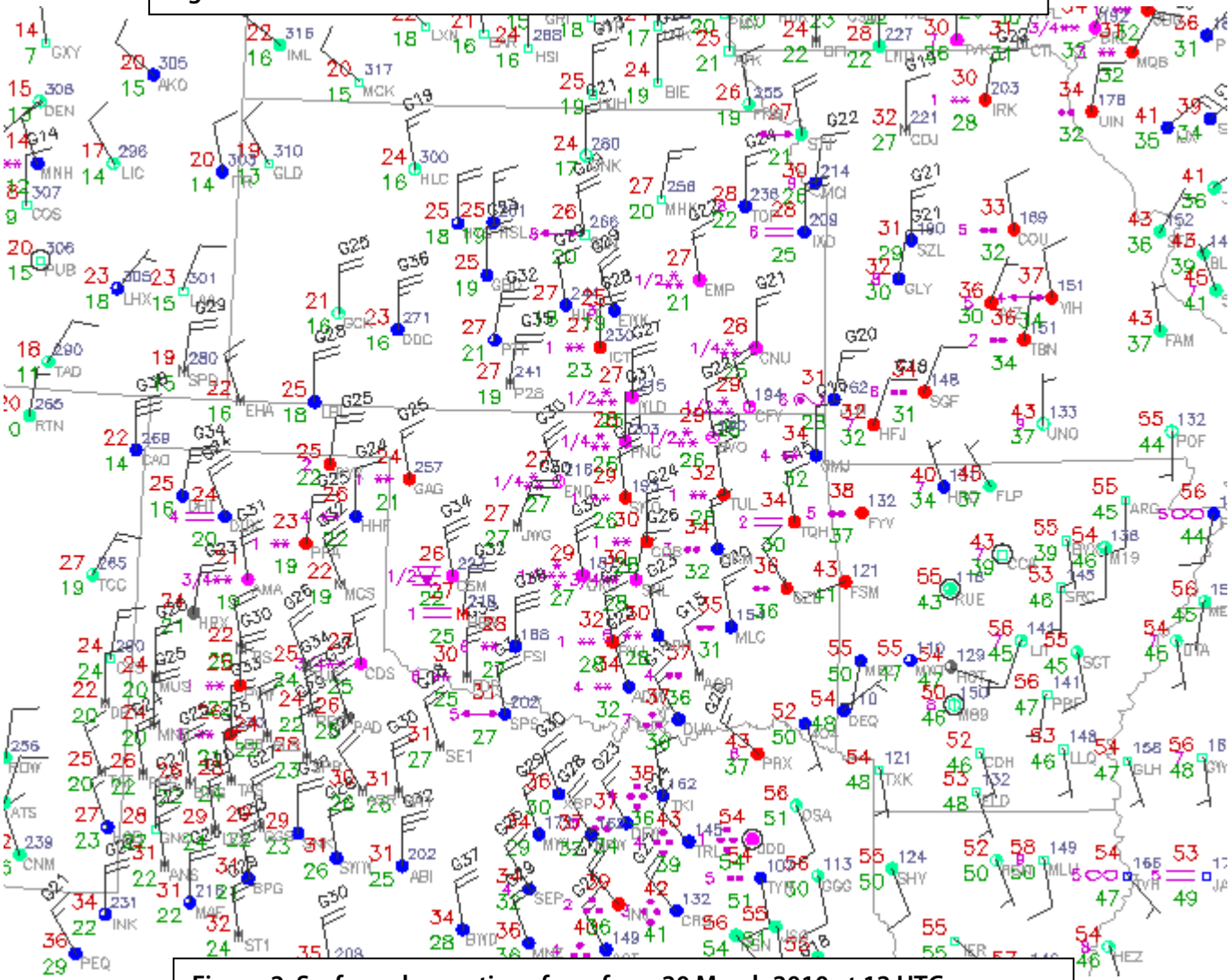


Figure 2: Surface observations from from 20 March 2010 at 12 UTC.

Question 1: Using the cursor readout sampling, what are the average ZDR values (using your eyes to average) north and east of the radar roughly between 15 and 40 nm in reflectivity greater than 20 dBZ (toggle between Z and ZDR using 1 and 2 keys)? Refer to Figure 3 below.

ZDR ~ _____ dB

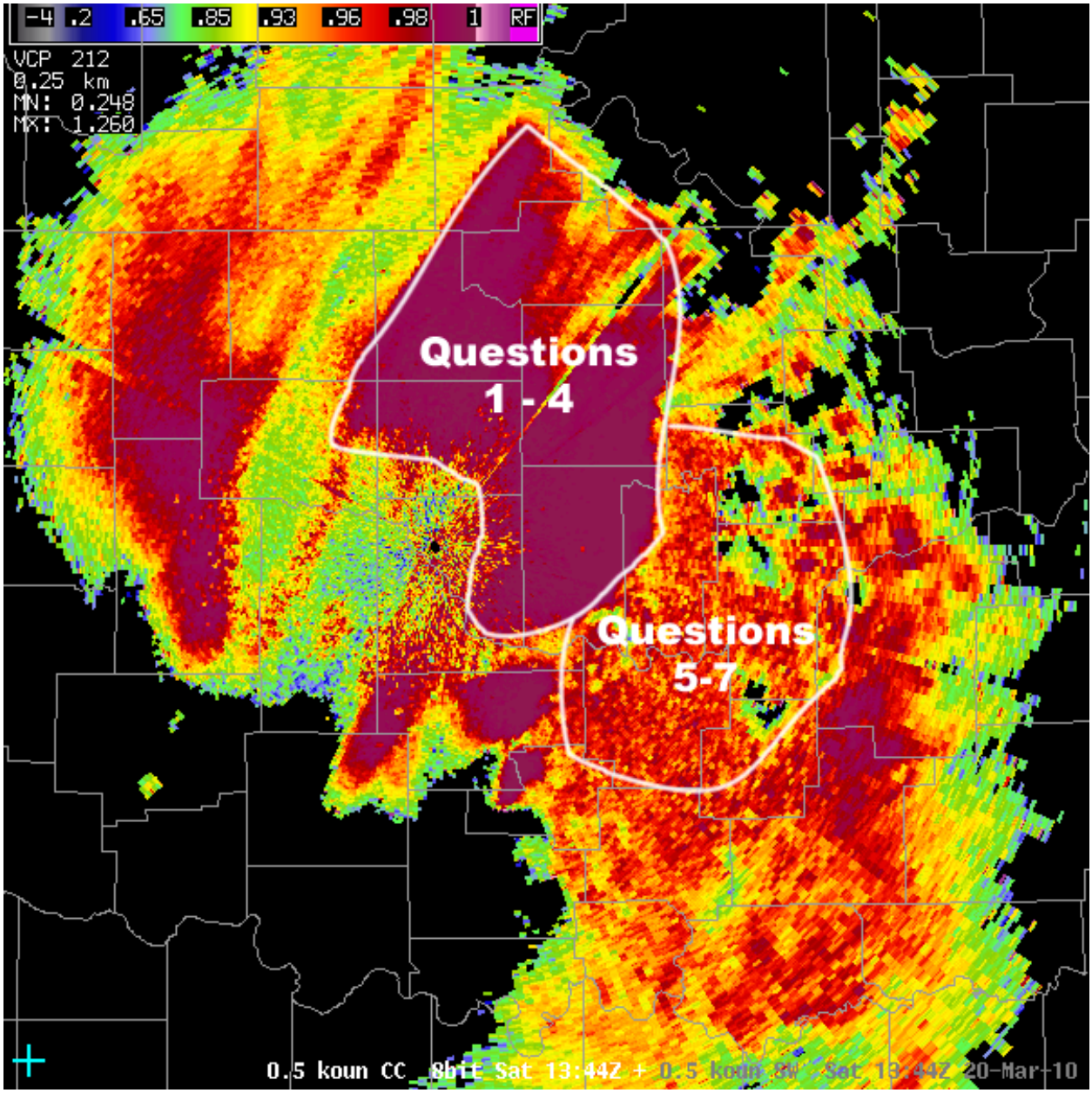


Figure 3: 0.5 deg Correlation Coefficient product from 20 March 2010 at 13:44 UTC. The region on your own workstation to analyze Z, CC, and ZDR for each set of questions is as indicated in the graphic.

Question 2: What is an "eyeball" averaged correlation coefficient (CC) values to the nearest hundredth within this same region (Use the #3 key to toggle to CC)?

CC ~ _____

Question 3: Switch to your All-Tilts Base Data display, ensuring you are looking at the 1344 UTC volume scan. Zoom into CC (using #3 key) and examine all elevation angles of CC (inside of 40 nm). Is there evidence of a clear cut melting layer ring? (see next page) (Circle One Below) Stick to stronger reflectivity regions in your search (i.e. > 15 dBZ), keeping in mind that along edges of the echo CC is far too low (see Fig. 1).

Yes Clear ML / No Clear ML

Question 4: Given the ZDR and CC values from Questions 1 and 2, added with your melting layer analysis in Question 3, do you think rain, snow, or a mixture of rain and snow is the dominant precipitation type north and east of the radar from 15-40 nm? (Circle One)

Rain / Snow / Rain + Snow Mix

Question 5: Return to your 0.5 deg base data pane at 1344 UTC. Examine ZDR and CC east of the radar at ranges <u>further than ~40 nm east</u> of the radar in reflectivity greater than 20 dBZ (See Fig. 3). Use your eyes to find the average ZDR and CC values out there.

ZDR ~ _____ dB

CC ~ _____

Question 6: Are ZDR and CC values smooth or noisy in the area east of the radar at ranges beyond ~40 nm in reflectivity greater than 20 dBZ? (Circle one)

SMOOTH / NOISY

Question 7: Given the ranges of values for CC and ZDR in the previous 2 questions, and recalling the melting layer information found in Question 3, do you think rain, snow, or a mixture of rain and snow is the dominant precipitation type east of the radar roughly outside of 40 nm?

Rain / Snow / Rain + Snow Mix

Moving onto the Next Winter Event

1. Swap panes to a blank pane, you will now move onto the 2nd winter weather event.
2. Left click on the D2D clock in the lower right of D2D
3. Set the D2D clock to **2010 February 26 7:20 UTC** (don't bother changing the seconds) and check the "Freeze Time at This Position" box.
4. Set Map Scale to "WFO"
5. Click on the koun menu and load "All Tilts Base Data". NOTE: There is no KDP with this event.
6. Set frames to 64
7. Modify map backgrounds and data magnification as you see fit in both panes
8. Using All Tilts get to 0.5 deg, and loop through the 0.5 deg fames at 4 panels and/or using Panel Combo/Rotate, getting a broad scale view of the base products Z, ZDR, and CC.
9. Navigate to the **0.5 deg 0717 UTC** volume scan, and answer the following questions.

For reference, below you'll find a 12 UTC sounding from near the radar (00 UTC sounding does nothing for this event), as well as a graphic with surface observations on the next page. The questions follow the graphics.

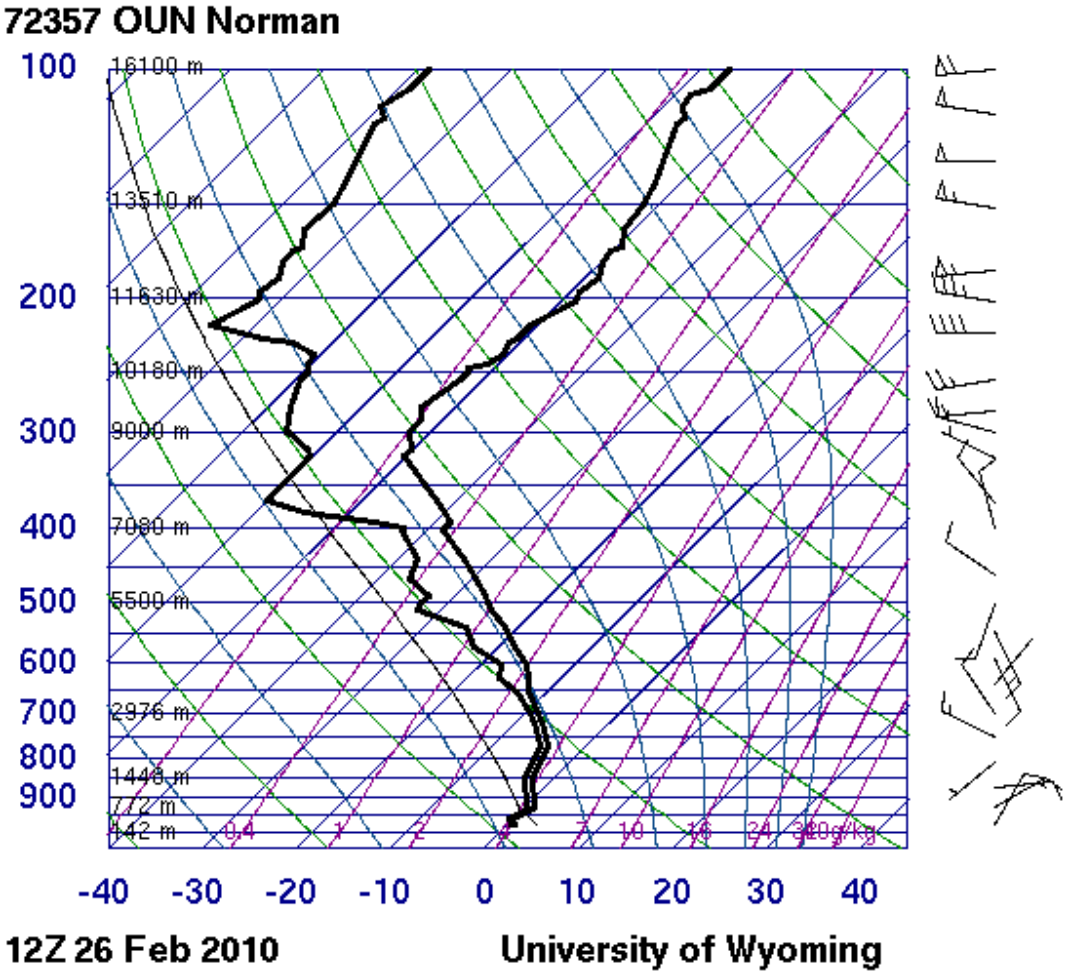


Figure 4: OUN skew-T from 26 February 2010 at 12 UTC.

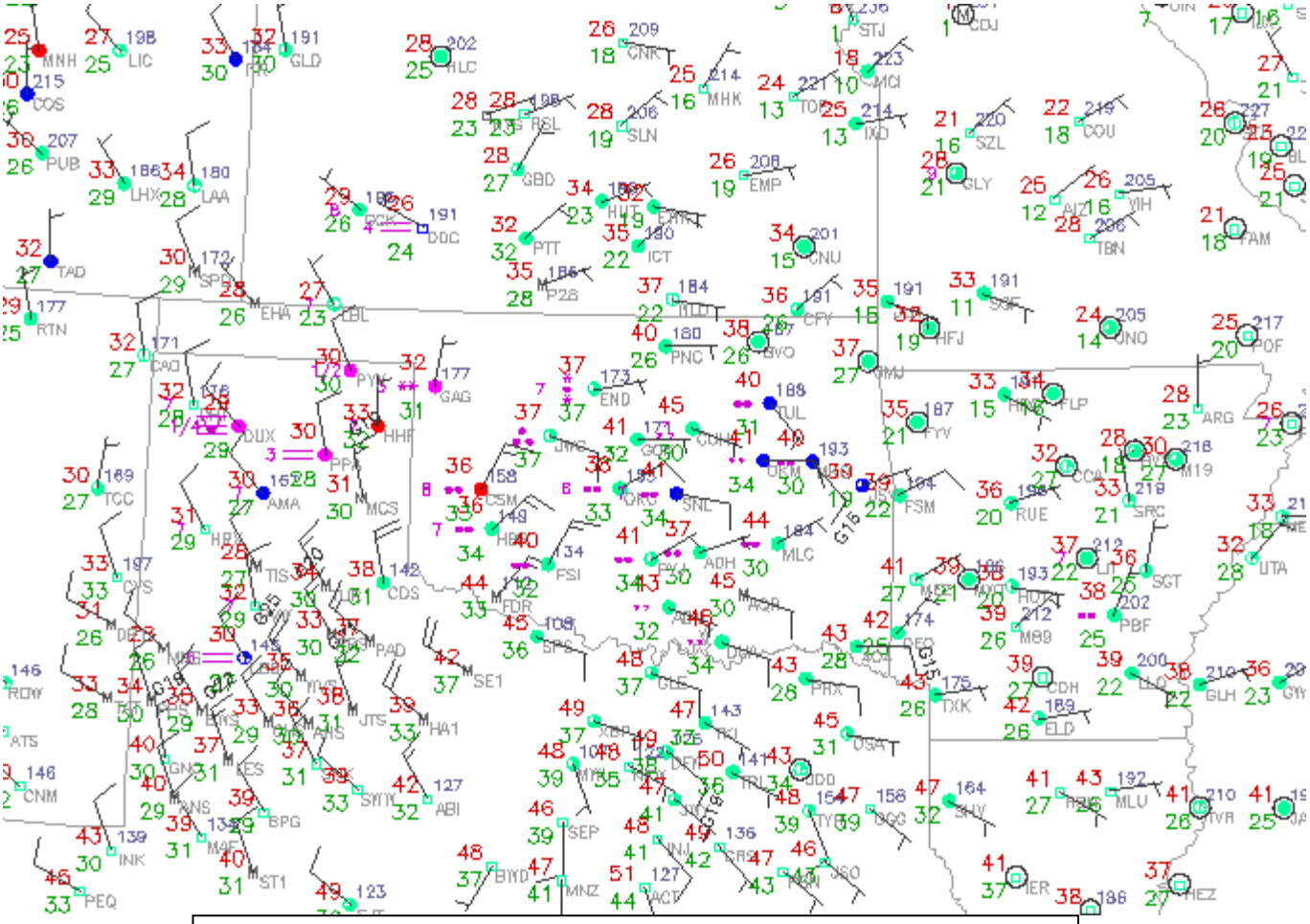


Figure 5: Surface observations from 26 February 2010 at 12 UTC.

Question 8: Toggle between Z and ZDR (buttons 1 and 2), and then add CC (button 3) to the toggle. Fill out the table below with the mean values for Z, ZDR, and CC. Scan several bins around each range and azimuth to determine the general value from each radar product listed in the table. You will use this table to answer Question 10.

	Z	ZDR	CC
20 nm @ 308°	dBZ	dB	
6 nm @ 32°	dBZ	dB	
7 nm @ 130°	dBZ	dB	
13 nm @ 281°	dBZ	dB	

Question 9: Now step up in elevation angle to 1.3 deg. Using Z, CC, and ZDR, identify areas around the radar that appear to have a melting layer signature at 1.3 deg. Only use CC and ZDR in reflectivity greater than 10 dBZ in your search. As an example, your answers only needs to be of the form: "Northwest of the radar from 10-20 nm"

Question 10: Using your melting layer information from Question 9 and your Z/ZDR/CC values from Question 8, what is your best guess at dominant precipitation type at the 0.5 deg tilt that correspond to the same points from Question 8: Choose from rain, snow, or rain/snow mix and fill out the table below?

	Pure Rain, Pure Snow, or Rain and Snow Mix?
20 nm @ 308°	
6 nm @ 32°	
7 nm @ 130°	
13 nm @ 281°	

Moving onto the Final Winter Event

1. Swap panes to a blank pane, you will now move onto the 3rd and final winter weather event.
2. Left click on the D2D clock in the lower right of D2D
3. Set the D2D clock to **2009 December 24 1907 UTC** (don't bother changing the seconds) and check the "Freeze Time at This Position" box.
4. Set Map Scale to "WFO"
5. Click on the koun menu and load "All Tilts Base Data".
6. While in the same pane as the All Tilts products, click on the Volume menu, then "Std Env Data Package", then "LAPS"
7. Set frames to 64
8. Modify map backgrounds and data magnification as you see fit in both panes
9. Using All Tilts get to 0.5 deg, and loop through the 0.5 deg fames at 4 panels and/or using Panel Combo/Rotate, getting a broad scale view of the base products Z, ZDR, and CC.

*****This event was very early in the development and testing process. As a result CC will look poor in weak reflectivity, so stick to stronger signal, roughly in regions with greater than 20 dBZ. KDP was not calibrated for this event, so it's probably best if you ignore it during your analysis.*****

For reference, below you'll find surface observations from 19 UTC. On the next page you'll find 12 UTC and 18 UTC soundings from near the radar. The questions follow the graphics.

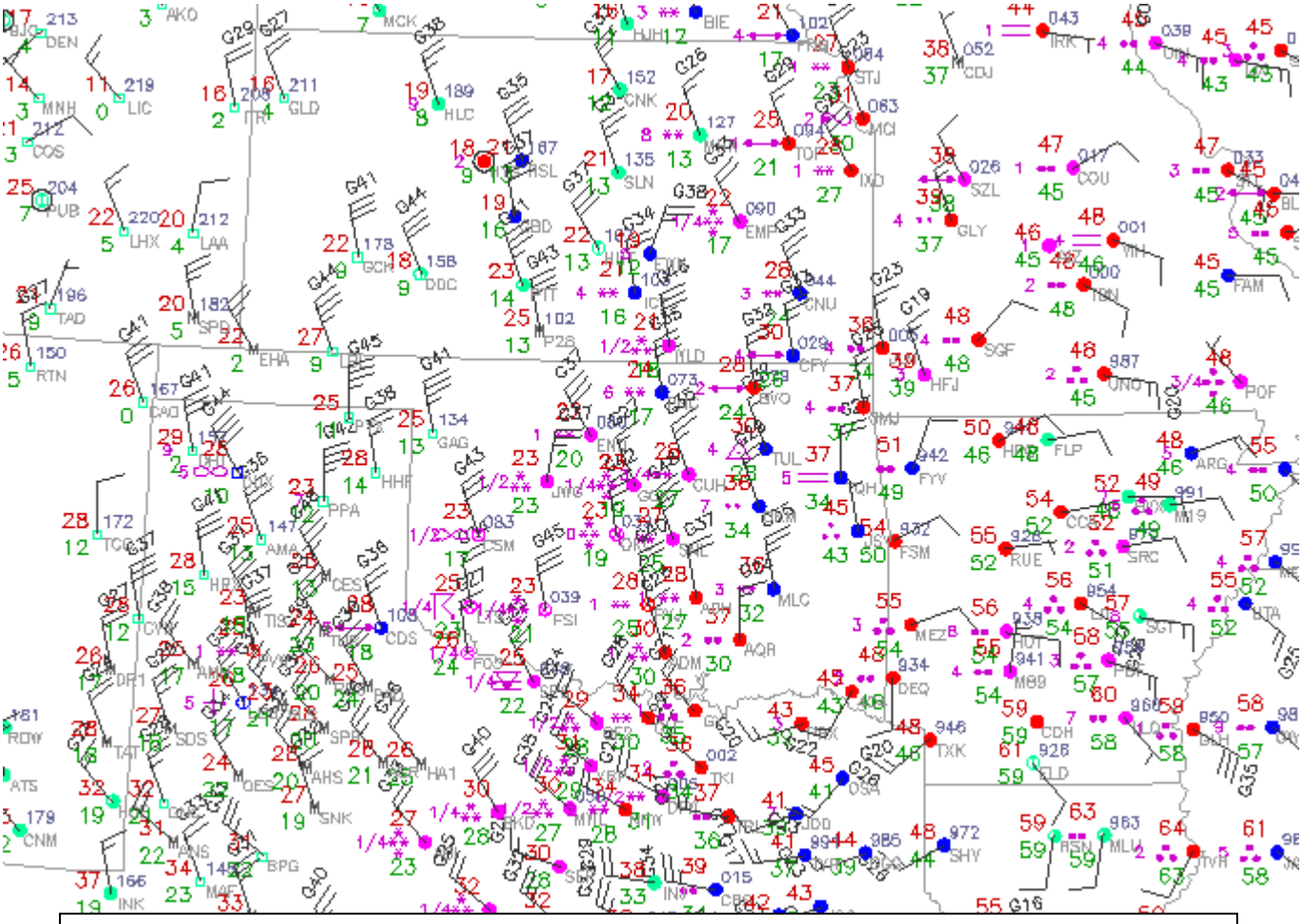


Figure 6: Surface observations 24 December 2010 at 19 UTC.

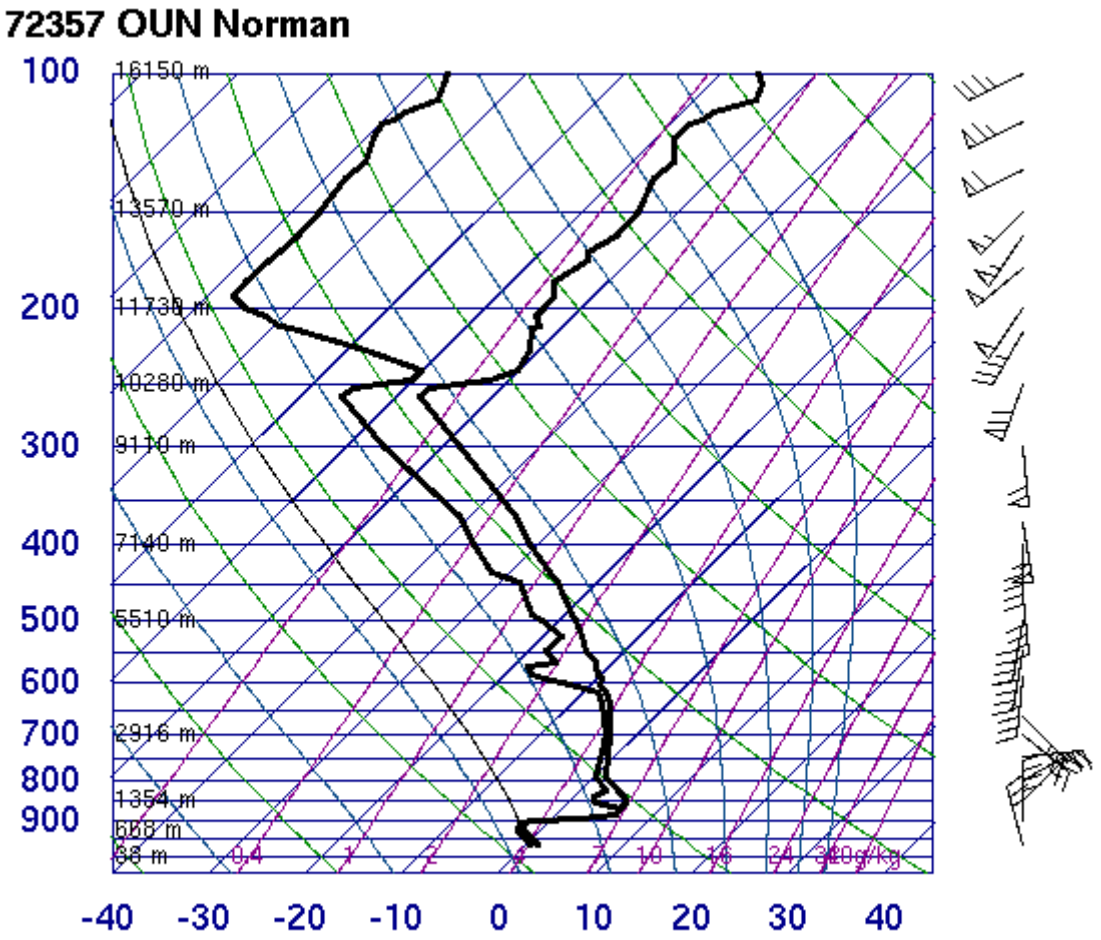


Figure 7: OUN Skew-T from 24 December 2010 at 12 UTC.

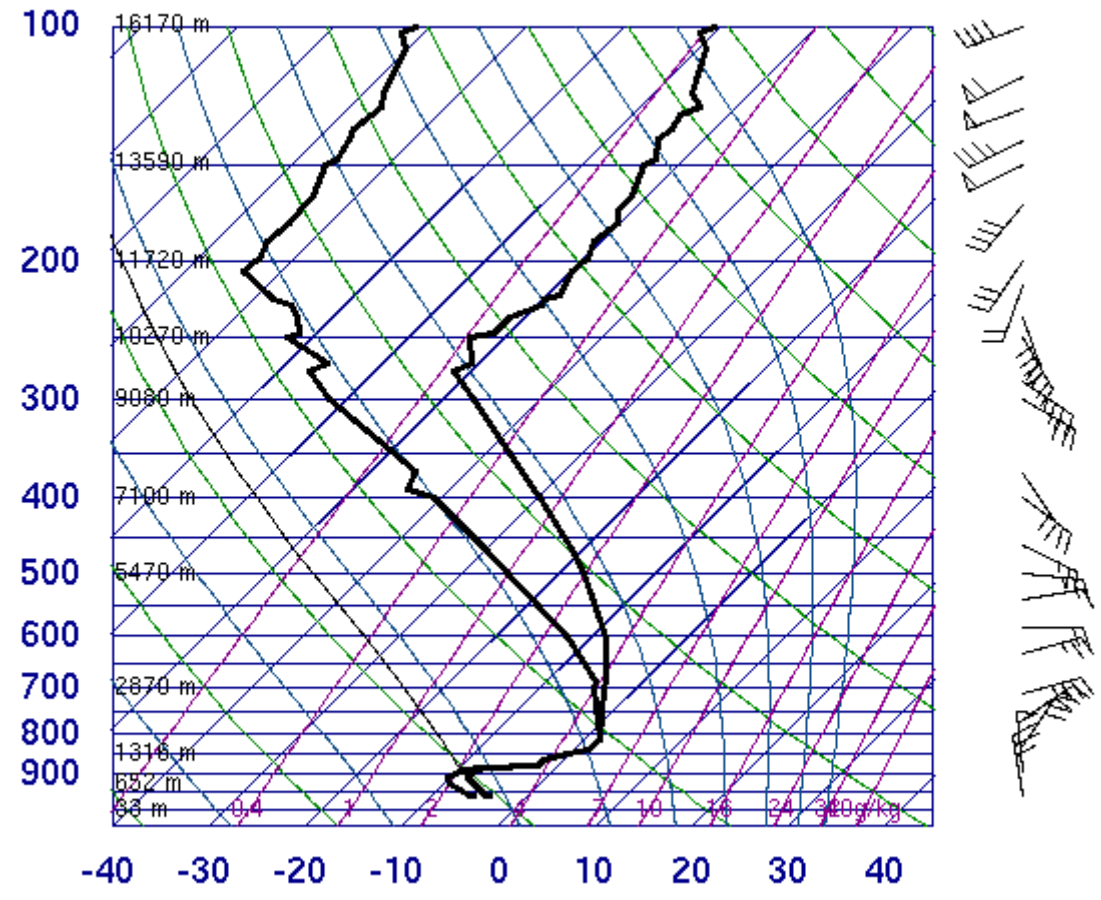


Figure 8: OUN Skew-T from 24 December 2010 at 18 UTC.

Question 11: We will apply the decision tree help determine precipitation type at the surface using the radar data that spans 1824 UTC through 1907 UTC. The first step is trying to find a melting layer. Using CC all-tilts and using trends in CC over time, are you able to identify a melting layer? (Circle one)

Yes Melting Layer / No Melting Layer

Question 12: Now look for a melting layer using LAPS temperature readout. Do the LAPS temperatures suggest any melting? (Circle one)

NO Melting / YES Melting

Question 13: Given your answers to 13 and 14, which data source do you trust in this event for the potential of a melting layer?

LAPS / Radar

Question 14: Given your answer to Question 13, where relative to the radar do you expect to find sleet or freezing rain at the surface at 1907 UTC? Where relative to the radar to you expect to see pure snow at the surface? Give your answer in a range of azimuths for each in the clockwise direction. For example, 0 deg to 90 deg means a certain type is located from north to the east of the radar. If none, enter none.

Pure Snow: _____ deg to _____ deg azimuth

IP/FZRA: _____ deg to _____ deg azimuth

Question 15: Go back to 1907 UTC, and the 0.5 deg elevation angle. Toggle between Z and ZDR (buttons 1 and 2), and then add CC (button 3) to the toggle. Fill out the table below with the mean values for Z, ZDR, and CC for the 0.5 deg elevation angle. Scan several bins around each range and azimuth to determine the general value from each radar product listed in the table, using the figure on the next page as a guide. You will use this table to answer Question 16.

Location	Z	ZDR	CC
A: 36 nm @ 205°	**dBZ**	**dB**	
B: 34 nm @ 24°	**dBZ**	**dB**	
C: 25 nm @ 187°	**dBZ**	**dB**	
D: 8 nm @ 115°	**dBZ**	**dB**	

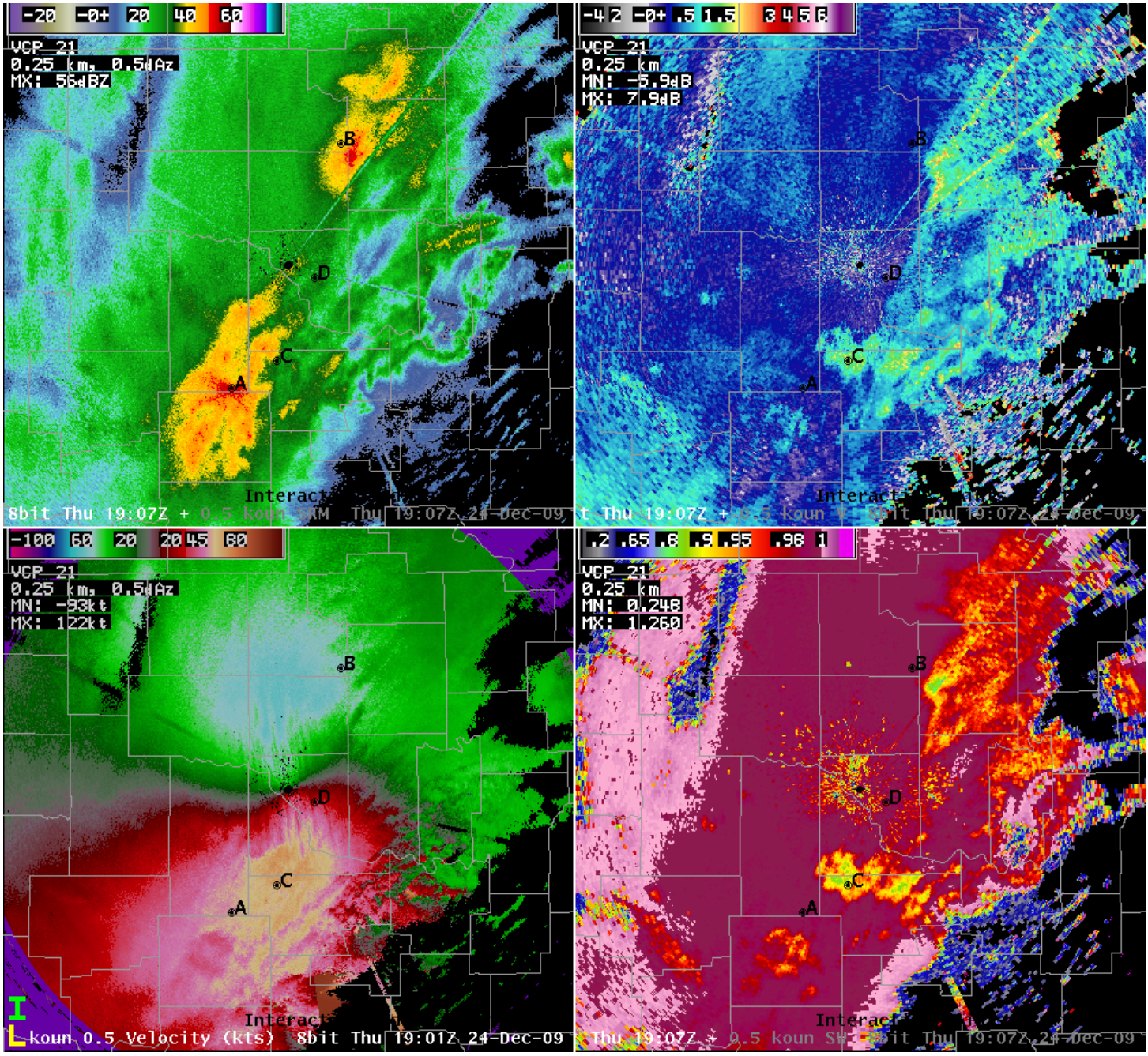


Figure 9: 0.5 deg Reflectivity (top left), Differential Reflectivity (top right), Correlation Coefficient (bottom right), and Velocity (bottom left) products from 24 December 2009 at 1907 UTC. The region on your own workstation to analyze Z, CC, and ZDR for each set of questions is as indicated in the graphic in black letters. Use these to answer questions 15 and 16.

Question 16: Using the table in question 15, the winter weather dual-pol radar decision tree, and the knowledge that any melted hydrometeors will freeze into sleet prior to reaching the surface, provide your best estimate of expected precipitation type at the height of the radar beam and at the surface for each of the 4 points.

Location	Radar Beam P-Type	Expected Surface P-Type
A: 36 nm @ 205°		
B: 34 nm @ 24°		
C: 25 nm @ 187°		
D: 8 nm @ 115°		

Question 17: Swap panes, and then load a 3.4 deg elevation angle 4-panel "base data" off the "KOUN Hi base data tilts" sub-menu option half way down the primary koun radar menu. Load 30 frames in the pane, zoom into the radar and focus on CC (Lower right pane in 4-panel, key #3 for PCR). Fill in the table below for the bottom of the melting layer in feet above ground level (MSL):

Time	Melting Layer Bottom Height (MSL)
1630 UTC	ft
1728 UTC	ft
1832 UTC	ft

Question 18: Loops all frames using the 3.4 deg CC, which should show CC data from 1624-1907 UTC. Explain in words what is physically happening to the melting layer during this time and what this means for precipitation type at the surface.