The University of Illinois DOW Education, Research and Outreach (UIDOW) Project-Final Report

The University of Illinois at Urbana-Champaign was awarded a 19-day campus deployment of a Doppler on Wheels (DOW) for classroom-instruction (in ATMS 410, Radar Meteorology), outreach (tours of the facility to undergraduates in ATMS 100, General Meteorology and ATMS 120, Severe and Hazardous Weather), and research (the plan was for 4-6 undergraduates will use the data for ATMS 492, Capstone Undergraduate Research Experience, in Spring 2011). This report summarizes the activities and outcomes of the deployment and serves as the final report for the project.

1. Objectives

The University of Illinois DOW Education, Research and Outreach (UIDOW) Project had three principal objectives:

1. *Enhance instruction in ATMS 410, Radar Meteorology.*

ATMS 410 is a comprehensive radar meteorology course that covers principles of radar, including conventional, Doppler, and polarization radar, precipitation measurement and microphysical interpretation of radar data, Doppler processing including VAD analysis, dual Doppler radar analysis, radar profiling, airborne meteorological radars and spaceborne meteorological radars. A fundamental deficiency of this course in the past has been lack of access to a radar facility where students could actually see the components of a radar and operate and collect radar data. The University of Illinois recently completed a comprehensive field campaign studying winter storms, but even here we could only expose a few undergraduates to field operations with the ground based radars because of safety limitations in harsh winter conditions, remote distant deployments, and requirements to have trained operators on site (limiting available seats in the facilities). Placing a DOW on campus allowed us to introduce an entire class of 45 students to radar operations. These data also allowed the students to exercise software such as SOLO to experience the basics of radar processing. The radar was used to illustrate concepts taught in class such as, for example, the relationship between maximum unambiguous range, the Nyquist velocity and the PRF, velocity folding, antenna size and its impact on beam width, bright band identification, ground clutter, anomalous propagation, reflectivity in snow vs. rain, the relationship of reflectivity to precipitation rate etc. Data from the radar was also used in class projects. The nature of these depended on the weather and clear air conditions encountered during the deployment.

2. *Introduce a broad spectrum of students to state of the art meteorological radar technology*

We placed the DOW on the University of Illinois campus near the Department of Atmospheric Sciences and gave tours of the facility to our survey classes, ATMS 100 and ATMS 120. These courses are taught by Dr. Jeffery Frame (who rode with the DOWs in VORTEX II for two years) and Mr. Eric Snodgrass (who operated and analyzed data from NCAR's SPOL radar as part of the UI led Rain in Cumulus over the Ocean (RICO) experiment).

3. Provide data for research analysis in ATMS 492 Capstone Experience for Seniors

Every graduate in Atmospheric Sciences at the University of Illinois is required to have a senior capstone research or professional experience. Formally, students register for ATMS 492 and receive 4 credit hours for this experience. We planned to use the DOW as a potential vehicle to conduct research experiences for some undergraduates.

2. Deployments and Class Procedures

The DOW was based on a farm northeast of Gibson City, IL during UIDOW. The PI, Bob Rauber, and his teaching assistant, Jason Keeler, transported students to the site and back with rental vehicles, and out on deployments from the site. During the period, 25 deployments were carried out at 13 different sites, ranging from northern Indiana to central Illinois. Figure 1 shows the site locations:

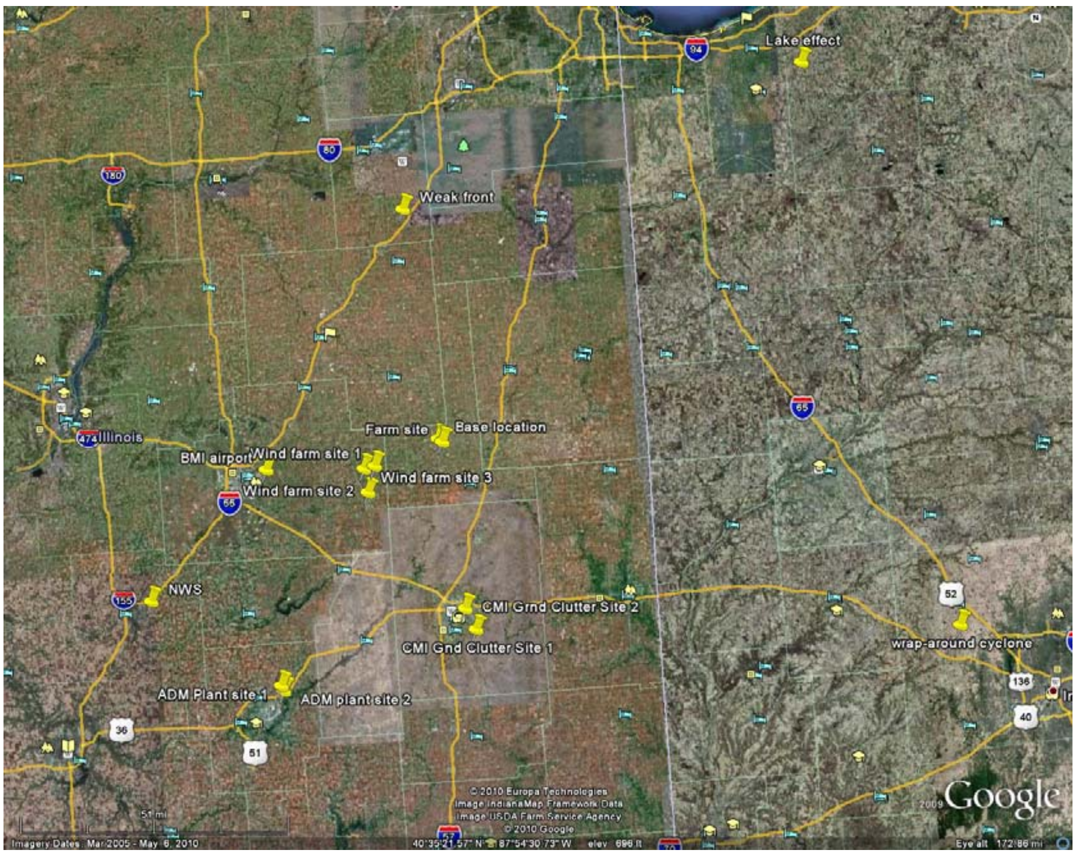


Fig. 1: Deployments of the DOW during the UIDOW project.

Before the deployment, students were divided into groups of 3-4 and were given the following assignment:

Homework 6 ATMS 410
Assigned Oct. 15, 2010 Due Oct 20, 2010

Beginning Nov. 3, 2010, we will be carrying out a field campaign deploying the Doppler on Wheels radar. The Doppler on Wheels is owned by The Center for Severe Weather Research (CSWR), a non-profit research organization located in Boulder, Colorado, funded primarily by the National Science Foundation, with close collaborations with the National Center for Atmospheric Research (NCAR) and the Pennsylvania State University. Their radars include The Doppler On Wheels (DOW) and a Bistatic Network. They also do research on phased array Rapid-Scan radars. CSWR is led by Dr. Joshua Wurman. The DOWS have participated in many projects, and are known for their deployments in tornadic storms.

We will have control of the DOW radar from Nov. 3-21, 2010. You have been assigned to a group of 3 or 4 students, and your group has been give two six hour windows in which you will deploy the radar to carry out experiments. Your open window times are based on the schedules each of you provided. The 6 hour windows run from 6 a.m. to noon, noon to 6 p.m., and 6 p.m. to midnight.

I have chosen a number of possible deployment sites. We are not limited to these, but I would prefer to use them if at all possible since I know there will be parking and we can get into the area easily. The DOW we have will be a dual-polarization, Doppler radar with full scanning capability.

Your assignment:

Get together with your group. As a group, you are to design two experiments using the radar, one for clear air scanning and one for cloud/precipitation situations. The experiments need not be complicated. They should consider a phenomena you want to study, the best location to go, (near Champaign – we have to be out and back in 6 hours), the best time to do the observations, the scan strategy (azimuth range, elevations etc., PPIs, RHIs, time-height scans, scan rates, sensitivity etc) to best observe the phenomena, the PRF (consider range folding and Nyquist velocity), and any other factor you consider important.

We can give your groups some ideas, but I am more interested in what YOU come up with. THINK! There are many phenomena right outside the door.

You are to provide two design documents, one each that describes the phenomenon you hope to investigate and your strategy for sampling its structure. They should be no longer than 2-3 pages each, single spaced, with diagrams if needed.

If, when your window arrives, the phenomena are not around, we will go for what is there, but we will go. On the following page, you will find your group assignments and your two windows. You must be available during these windows, or you will lose credit for the assignment. If you want to change windows as a group, you must take one of the unassigned windows.

Students were assigned to 12 groups. Two deployments per group were scheduled. All deployments were within 6 hour windows (6 a.m. to 12 noon, 12 noon to 6 p.m., 6 p.m. to midnight) over the deployment period. The schedule had to take into account student and instructor availability, which was a difficult task with 45 students with different class and event schedules, as well as an overcommitted professor and graduate student. Nevertheless, we worked out the schedule shown below. The schedule worked with no problem. One group requested and received a third opportunity to take the radar out. We had very few additional requests because almost no significant weather occurred during the project.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
			3-Nov	4-Nov	5-Nov	6-Nov	
				6		2	
					10	5	
			4	11	12		
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
7-Nov	8-Nov	9-Nov	10-Nov	11-Nov	12-Nov	13-Nov	
1		4		6			
11					10	12	
8	9	5	9		7	3	
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
14-Nov	15-Nov	16-Nov	17-Nov	18-Nov	19-Nov	20-Nov	21-Nov
8					1	3	
7	2						
		NO BOB	NO BOB	NO BOB			

Blue: Scheduled deployment,
Gray: Radar not available due to class conflicts
Green: Radar available for extra deployment if requested
Tan: Radar available with Teaching Assistant: Rauber on travel.

During these deployments, the following weather conditions were encountered:

Deployments with precipitation

1. Lake effect snowband	Mission 5	Excellent dataset
2. Frontal passage	Mission 17, 18, 19	Excellent datasets
3. Cyclone wrap around	Mission 23	Excellent dataset
4. Weak warm frontal band	Mission 21	Excellent dataset
5. Convective showers	Mission 3	Excellent dataset

Missions with non-precipitating clouds

1. Boundary layer rolls	Mission 2, 4	Rolls visible
2. Contrail cirrus	Mission 15	Clouds too thin to see
3. Distant frontal clouds	Mission 16	Clouds too distant
4. Cirrus and small cumulus	Mission 20	Clouds visible
5. Stratiform clouds	Mission 24	Clouds visible
6. Cirrus	Mission 25	Clouds visible

Missions without weather

1. Wind farm turbulence	Missions 8, 9, 12, 14, 22	Plume visible on 8, less on others
2. Ground clutter mapping	Missions 1, 7, 10, 11, 13	Data OK
3. ADM plant plume	Missions 4, 6	Plume visible 4, not 6

Details of each of these deployments appears in tables in Appendix B

Before the deployments, one member of each group was trained in radar operations. On the first deployment for a group, that group member, with guidance from the instructor and the DOW operator, trained the other members of the group. During each deployment, the students set up, ran, and shut down the radar, and chose all the scanning and viewing parameters.

The deployments ended just before the Thanksgiving break. Following the break, the students were given their final project assignment. They had less than two weeks to complete it since the end of the semester was fast approaching.

The final project assignment appears on next five pages. An example of a final project appear in Appendix A.

Final DOW project assignment

DOW projects are due by 5 pm at the end of reading day, December 9, 2010 in Bob Rauber's mailbox in the DAS building. The projects are a group project. At the beginning of the project report, a paragraph should be provided that spells out the contribution made by each group member to the analysis and write up.

Groups 1-12 conducted 25 DOW deployments during the period November 3-19, 2010. An excel file listing each deployment, the time period (Morning (M), Afternoon (A), Evening (E), the participants, who (Bob Rauber or Jason Keeler) accompanied the group, the physical location, truck orientation, the latitude(s) and longitude(s) of the DOW, topic studied, surface wind speed, and nearest WSR-88D location, nearest sounding in location and time, and weather conditions is located on the Compass website under the folder DOW VISIT. The missions on the Excel spreadsheet are numbered 1-25. The file is called Dow Missions.

The deployments can be divided into the following topics based on the missions.

Missions with precipitation

1. Lake effect snowband	Mission 5	Excellent dataset
2. Frontal passage	Mission 17, 18, 19	Excellent datasets
3. Cyclone wrap around	Mission 23	Excellent dataset
4. Weak warm frontal band	Mission 21	Excellent dataset
5. Convective showers	Mission 3	Excellent dataset

Missions with non-precipitating clouds

1. Boundary layer rolls	Mission 2, 4	Rolls visible
2. Contrail cirrus	Mission 15	Clouds too thin to see
3. Distant frontal clouds	Mission 16	Clouds too distant
4. Cirrus and small cumulus	Mission 20	Clouds visible
5. Stratiform clouds	Mission 24	Clouds visible
6. Cirrus	Mission 25	Clouds visible

Missions without weather

1. Wind farm turbulence	Missions 8, 9, 12, 14, 22	Plume visible on 8, less on others
2. Ground clutter mapping	Missions 1, 7, 10, 11, 13	Data OK
3. ADM plant plume	Missions 4, 6	Plume visible 4, not 6

Your group will examine the DOW data with Soloii as in Homework 7. You will also analyze WSR-88D data with GRAnalyst as in Homework 2. Your DOW final project will be done with your group. Each group must analyze one case in each of the three categories above (three cases total). The specifics are given on the following pages. I suggest you divide the workload by having two group members lead the development of the precipitation study (which involves DOW and 88D data) and one each on the other two studies, and then have all the group work together to assemble the final products.

I will have members of groups download all of the Level 2 WSR-88D data that we will need. Instructions for where these files are and how to access Soloii and GRAnalyst are in the DOW VISIT folder on Compass in the file Instructions.pdf.

1. Missions with precipitation

Lake effect snowband	Mission 5	Excellent dataset
Frontal passage	Mission 17, 18, 19	Excellent
datasets		
Cyclone wrap around	Mission 23	Excellent dataset
Weak warm frontal band	Mission 21	Excellent dataset
Convective showers	Mission 3	Excellent dataset

Take each of the steps listed below and answer the following questions. Turn in your plots and analyses as part of the project.

1. Plot a 0.5 degree scan of radar reflectivity from the WSR88D data using GR analyst for a time period where echoes exist and a corresponding Surveillance scan from the DOW is available.
2. Plot a corresponding low level scan (1.5 degrees if possible, the nearest one in elevation if not) for the DOW using Soloii. Magnify the plot so that the plot can be compared with the WSR-88D.
3. On the WSR-88D image, plot the location of the DOW. You can figure this out using the latitude and longitude.
4. Compare these images qualitatively and quantitatively. Specifically:
    a. How do the shape and orientations of the echo compare?
    b. How do the location of maxima in reflectivity compare?
    c. Using the standard Z-R relationship used by the 88D, what is the maximum rainfall rate for the 88D vs the DOW?
    d. Is there evidence of bright banding on the reflectivity?
5. Plot an RHI of radar reflectivity from the DOW.
6. Plot a vertical cross section of the reflectivity from the WSR-88D *in the exact same location* as the RHI from the DOW. Again, magnify the DOW plot so that the height of the cloud can be easily determined
7. Using the RHI/88D cross sections data, estimate the height of the top of the echoes made by each radar
8. Compare the DOW RHI with the reconstructed cross section from the WSR-88D. What differences in the radar reflectivity field are evident?

9. Plot a low level PPI scan of radial velocity from the DOW radar and from the WSR-88D. On the DOW, adjust the color scale so that it corresponds approximately to the Nyquist limits (use -10 to 10 m/s).
10. Compare the two radial velocity scans.
11. Based on the surface winds and the nearest sounding, how many times is the DOW data folded?

2. Missions with non-precipitating clouds (Choose 1 case, instructions are different if you choose boundary layer rolls)

Cirrus and small cumulus	Mission 20	Clouds visible
Stratiform clouds	Mission 24	Clouds visible
Cirrus	Mission 25	Clouds visible

Take each of the steps listed below and answer the following questions. Turn in your plots and analyses as part of the project.

1. Plot a high elevation surveillance scan (the highest available) of radial velocity from the DOW. Magnify the plot so that range rings are clear.
2. Plot an RHI of radial velocity from the DOW around the same time. Again, magnify.
3. Determine the approximate altitude of cloud base for the clouds.
4. Determine the approximate altitude of cloud top for the clouds.
5. Obtain the nearest sounding in time and space to the DOW measurements. Plot the sounding. Also get the text values (use the Wyoming site) http://weather.uwyo.edu/upperair/sounding.html
6. Determine the approximate wind speed at the top and bottom of the cloud layer observed with the DOW from the sounding.
7. Now examine the surveillance scan of the radial velocity field, and the RHI of the velocity field closely. The data is very likely to be folded. Keep in mind that it is radial velocity, and so the component of the wind along the direction of the beam is all you can see. Determine how many folds are likely to exist and label on the PPI and RHI in 4 locations of your choice, the true unfolded radial velocity values. (I suggest you start at the point where the radar is looking directly into or along the wind, since you can determine the exact radial velocity at the point from your sounding estimate.

Boundary layer rolls	Mission 2, 4	Rolls visible

Take each of the steps listed below and answer the following questions. Turn in your plots and analyses as part of the project.

1. Plot a low elevation surveillance scan (1 to 1.5 degrees if possible) of reflectivity and radial velocity from the DOW for mission 2. Magnify the plot so that range rings are clear and any echoes from the rolls are visible.
2. Determine the orientation of the cloud lines along the rolls.

3. Obtain a sounding from Lincoln at the time nearest the deployment and determine the low level wind direction and speed at roll height (~ 0.5 to 1 km).
4. Compare the alignment of the rolls with the wind direction. Quantitatively, by how much does the wind direction and the roll cloud alignment direction differ?
5. What is the horizontal spacing of the rolls
6. Repeat 1-5 with Mission 4.
7. Plot an RHI of radial velocity from the DOW from Mission 2 that is perpendicular to the roll cloud direction. Again, magnify so that the roll circulations appear.
8. Can you see evidence of convergence at the base of the rolls and divergence at the top? If so, indicate on your plot where this might be occurring.
9. Repeat 8 for Mission 4.
10. Was there any change in the character of the rolls between the days (spacing, depth, etc). Was there any corresponding change in the background wind speed?

3. Missions without weather

Wind farm turbulence	Missions 8, 9, 12, 14, 22	Plume visible on 8, less on others
Ground clutter mapping	Missions 1, 7, 10, 11, 13	Data OK
ADM plant plume	Missions 4, 6	Plume visible 4, not 6

These missions were substantially different. Choose one of the three below:

1. Wind farm

The purpose of the wind farm experiment was to determine if the wind farm generated sufficient low level turbulence that its plume could be visible because of Bragg Scattering. We will use the Lincoln sounding at the nearest time to the deployment to determine the low level wind speed and relative humidity. Our hypothesis is that the plume will be most visible downstream on days with high relative humidity and high wind speeds (lots of Bragg scattering due to turbulence) and not visible downstream on low wind speed days and/or days that have very low relative humidity (little Bragg scattering). Our control data is upstream. If a plume is present upstream, then we can not discern the wind farm effects from other effects that may be occurring in the atmosphere (e.g. insect echo). Note that all but the last case were at the same location. The last downstream location was moved because the wind direction changed from the previous cases.

1. Plot a surveillance scan of radial velocity at 1.5 degrees for each of the 10 cases (5 upstream and 5 downstream)
2. Plot an RHI of radial velocity in the upstream and downstream direction in each of the 10 cases.
3. Determine if a plume exists on each case, its depth as determined by the top of the coherent velocities on the RHI, and the distance downwind it extends before it disappears into the noise background.
4. Compare your data to the surface data from the soundings.

5. Is the hypothesis correct based on the data you have collected? Explain.

2. ADM Plume

We examined the ADM plume twice, the first time on a windy day and the second on a relatively calm day. The plume was not visible on the calm day because it rose through the ground clutter echo of the building below. These questions apply to the first day when the plume was visible.

1. Use Google Earth to identify the location of the radar and the location of the effluent stack at the ADM plant.
2. Obtain the nearest sounding in time from Lincoln, determine the wind direction and speed at stack height, and plot on your google earth map the expected direction of the plume.
3. Plot a surveillance scan of radial velocity at 1.0 degrees for a time when the plume was under study
4. Plot an RHI of radial velocity in the expected direction of the plume.
5. Use the coherent radial velocity field to map out the part of the plume visible to the radar. Determine its depth from the RHI.
6. On your google earth map, draw the plume boundaries by estimating them from the radar surveillance scan.

3. Ground clutter

We did ground clutter mapping on several mission with clear skies.

1. Use Google Earth and plot a map centered on the radar location.
2. On this map, draw 5 km range rings out to 25 km(Use a compass, like we did when I was a kid, if you don't know how to use a graphics program).
3. Draw cardinal directions on your map based on the truck orientation (the direction the truck faced is "truck north 0 degrees, the passenger side is truck east 90 degrees etc)
4. Plot the lowest level Surveillance that shows a ground clutter pattern where individual targets such as towers, wind turbines, and individual buildings is reasonably obvious.
5. Match up the radar echoes with the ground targets by labeling them according to what they are likely to be (e.g. wind turbine, assembly hall, line of power poles, Route 150, etc.)

3. Student Outcomes

We were unable to do a survey to determine student outcomes quantitatively. However, students were able to make comments about the course on the student course evaluation forms. Uniformly, the students thought the DOW deployments were the most exciting and positive aspect of the course. They were genuinely delighted with the opportunities, and many of them have used the experience on their resumes when applying for graduate school and jobs.

From an instructor perspective, this was a wonderful opportunity. The DOW made the radar course complete and comprehensive. It gave me the opportunity to show students how a radar really works, to see the components up close, and to analyze data that they themselves collected. They also learned the fun and frustration of field work.

I will definitely propose to bring the DOW to the University again. I hope we have better weather opportunities. We had clear air for most of the deployment, and had to run far and wide to even observe a few showers. Ironically, the week after the DOW left, Illinois experienced an EF4 tornado and a blizzard.

4. Other activities

During the deployment, Dr. Wurman came out to the University of Illinois and gave a lecture to the radar class. Everyone enjoyed the lecture and having the opportunity to meet Dr. Wurman. The lecture was excellent.

On one day when the students were not using the radar, Prof. Rauber took the radar to the High School of St. Thomas More, a local catholic high school. The Science teacher had heard that the radar would be in town and called to ask if the science club could see it. We did more than that. Prof. Rauber had the science club start it up, run it, and shut it down. One of the undergraduate students in the radar class is an alum of the school, and he volunteered to give a lecture to the club (in the school parking lot!) about the radar and the wonderful educational opportunities he had at the University of Illinois.

5. General comments

Justin Walker is a gem. He worked night and day to make sure the DOW operated well, took delight in training the students, and demonstrated better than any words I could use what passion for meteorology and field work is all about. **Give that guy a raise!!**!

The DOW, for all its glories, is hardly a plug and play device. One false keystroke can stop the system cold. When Justin was there, he could always recover from a problem that would stop operations, and problems frequently arose. When he wasn't there, we were often stopped cold on the first glitch. Fortunately, Justin was a cell phone call away. Without him or another DOW operator being available 24/7, we would have packed up on several deployments and drove home. It would be best for an experienced CSWR employee to be with the radar for the full time during deployments.

The DOW needs a set of clear written instructions, possibly with pictures (e.g. push this button) if you are going to deploy regularly to universities, particularly if you are going to let the radar in the hands of inexperienced crews.

Some states require Class C licenses to drive the DOW trucks. Illinois does, and I had to take a driving test in the vehicle before I could legally drive it. This should be checked when deploying somewhere where the PI is expected to drive the vehicle. Along these same lines, insurance documents should be in place with the university before the deployment if university staff are expected to drive the vehicle. This all takes time.

Overall: A wonderful opportunity. Thank you to all the CSWR staff for their hard work to make this deployment a great success.

Appendix A: Example of a student group project

Kim Chamales, Kevin Craine, Tina Hahn, Jeff Pahlke
ATMS 410 DOW Final Project
December 9, 2010

1.1 & 1.3

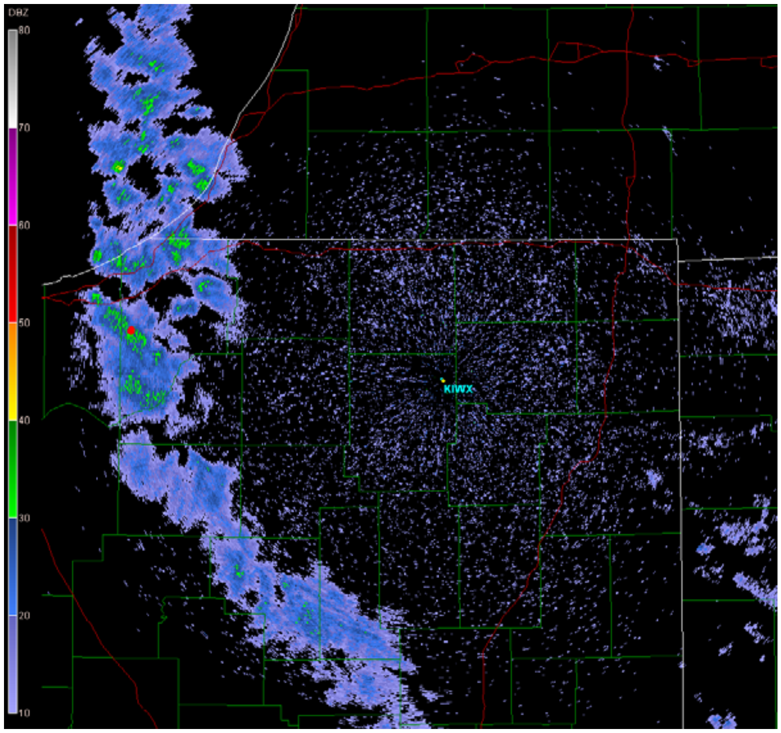


Figure 1 Lake effect snow reflectivity scan at .5° elevation. Red dot is the DOW location

1.2

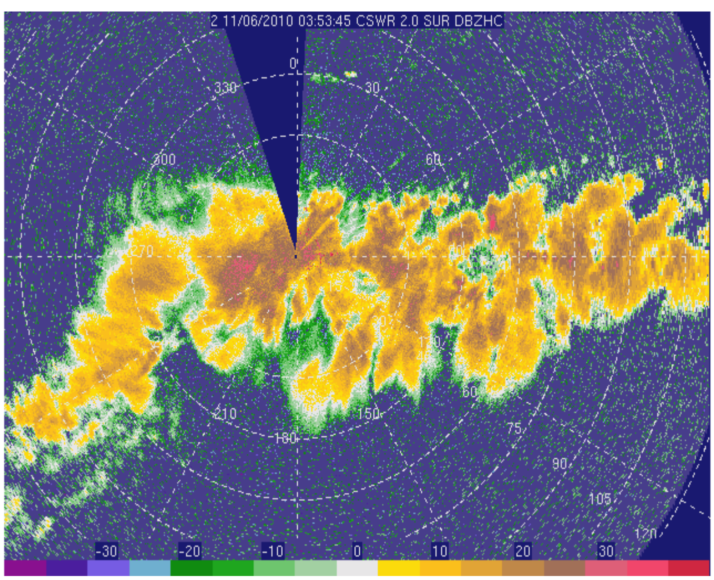


Figure 2 DOW 2.0° elevation surveillance scan. DOW faces west

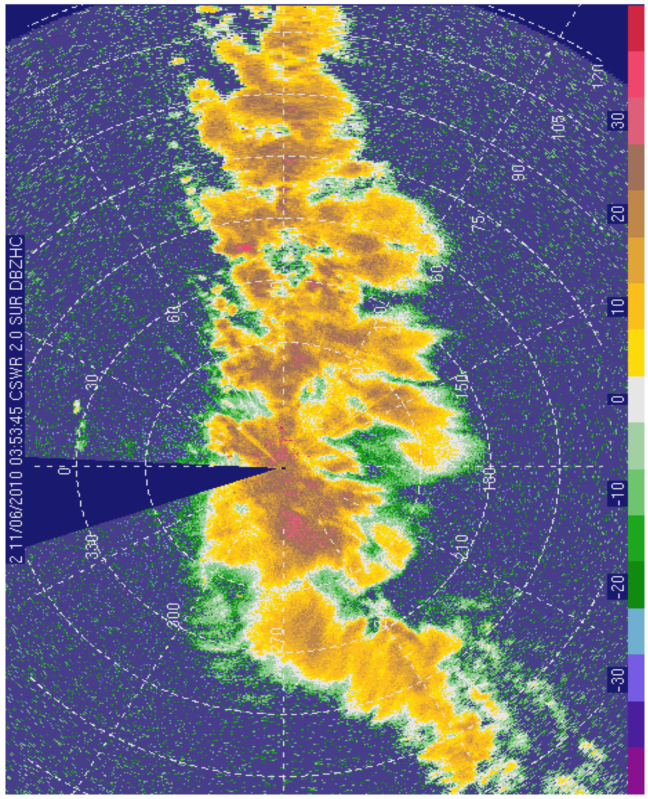


Figure 3 90° counterclockwise rotation of Soloii image

1.4
A: The DOW is facing west in the Soloii image. Upon rotating the image 90 degrees counterclockwise, the similarities become more evident. The shape seen above resembles the 88D data taking a "backwards L" shape. Another distinguishing feature can be seen in the curl to the immediate east of the DOW.

B: The maximum reflectivity value can be seen to the south of the DOW in the red color which corresponds to the 88D data which is in green (30-40 DBZ).

C: The default 88D ZR relationship is $Z = 300R^{1.4}$. Plugging in 30 dBZ for Z with the 10log conversion gave us a result of 2.363 mm/hr for the 88D.
For the DOW, using the same formula with a maximum observed value of 31 dBZ, 2.7856 mm/hour was the precipitation rate.

D: No, there is no evidence of bright banding in the image.

1.5

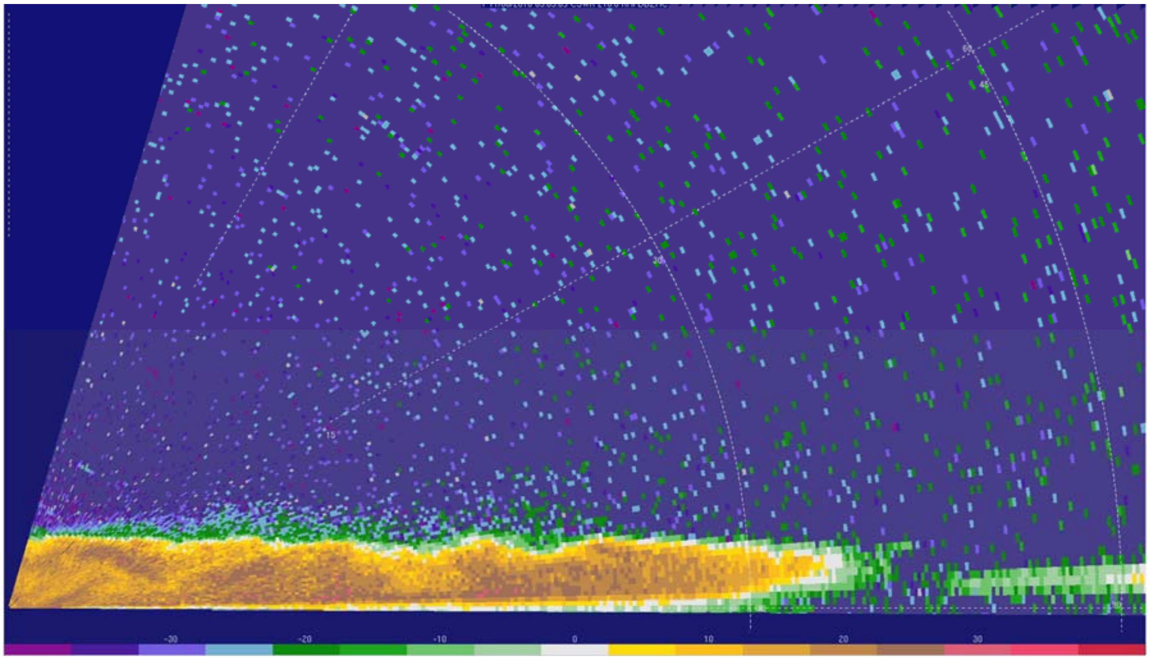


Figure 4 – RHI of DOW data at 210 azimuth with DOW still facing west, range rings are in 15 km increments

1.6

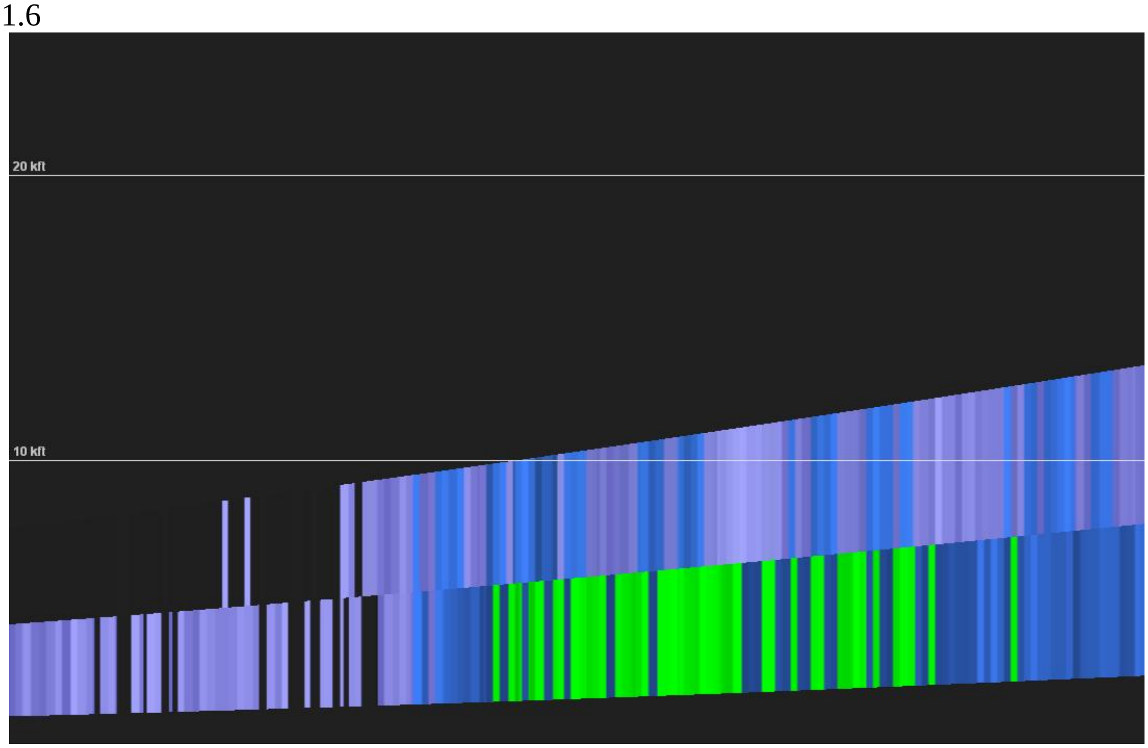


Figure 5 – 88D vertical cross-section showing cloud height. DOW is on right side of image.

1.7) According to the 88D, the cloud height is approximately 12,000 feet or 3.66km above the surface.
The DOW agrees with the 88D and shows a cloud height at approximately 3.5km.

1.8) The 88D data showed an average reflectivity value of 25 dBZ through the storm. There were some observed green colors (30-35 dBZ) as the storm passed. Using the 88D and looking around 25nm away from the DOW to the SE (like the cross section above), the observed values were 10-20 dBZ.

The highest observed value from the DOW RHI scan was around 30 dBZ, but the average reflectivity from the DOW through the clouds was approximately 25 dBZ. Farther away from the DOW the values decreased to around 0 to -10 dBZ.

1.9)

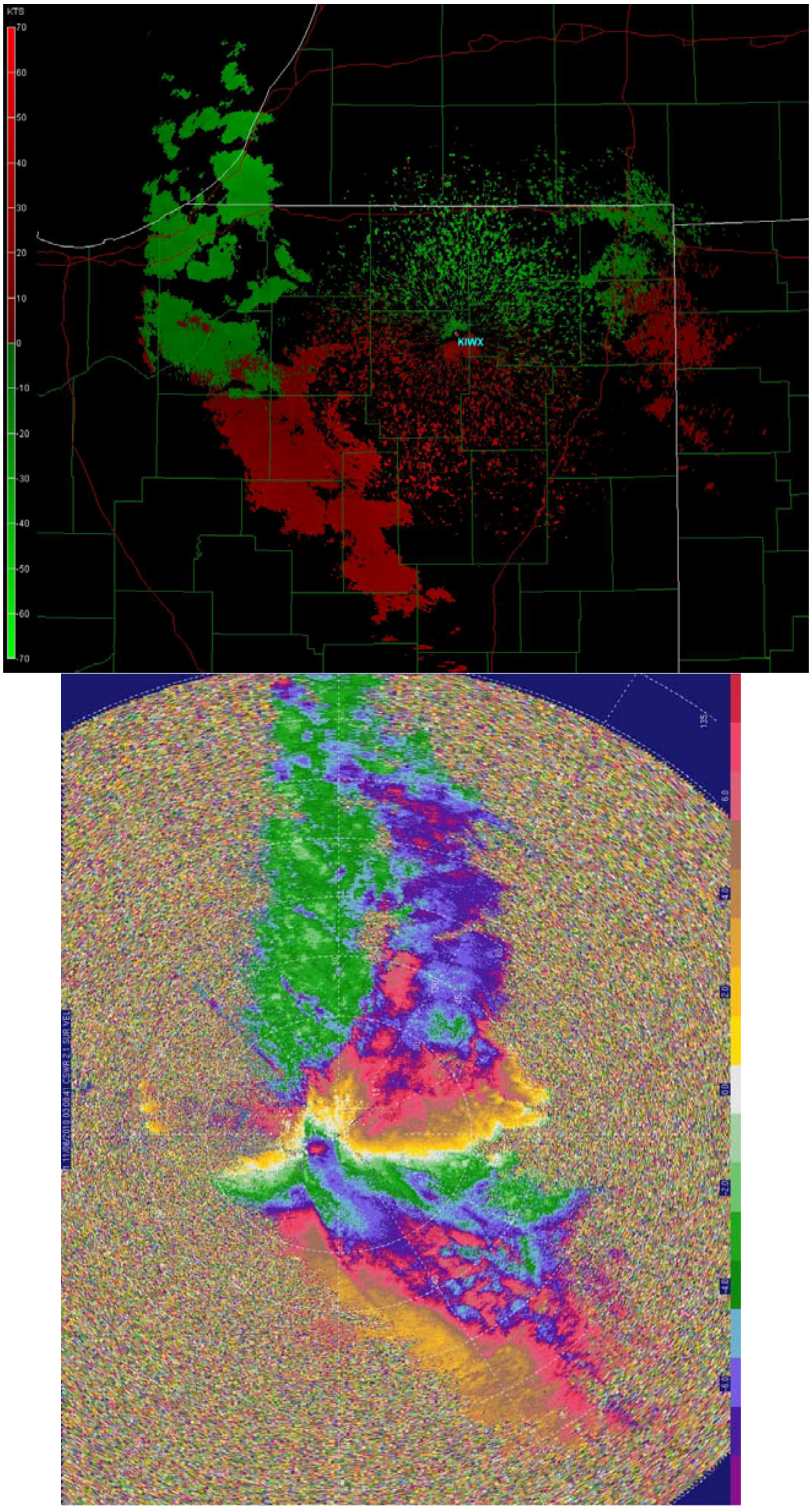


Figure 6 – TOP: 88D 1.5 degree elevation radial velocity scan. BOTTOM: DOW 2.1 degree radial velocity scan

1.10) Looking at the 88D radial velocity scan slightly to the north of the DOW the data showed a value of -23 knots which means that it was moving southward towards the radar. Taking DOW data from a location close to that of the 88D data and after unfolding it, we observed a value of -13 m/s which is approximately 25.26 knots. Also, between the two scans the pattern of a southward moving storm was apparent. The 88D and the DOW both showed a very clear zero line. Speed comparisons between the two were relatively close.

1.11)

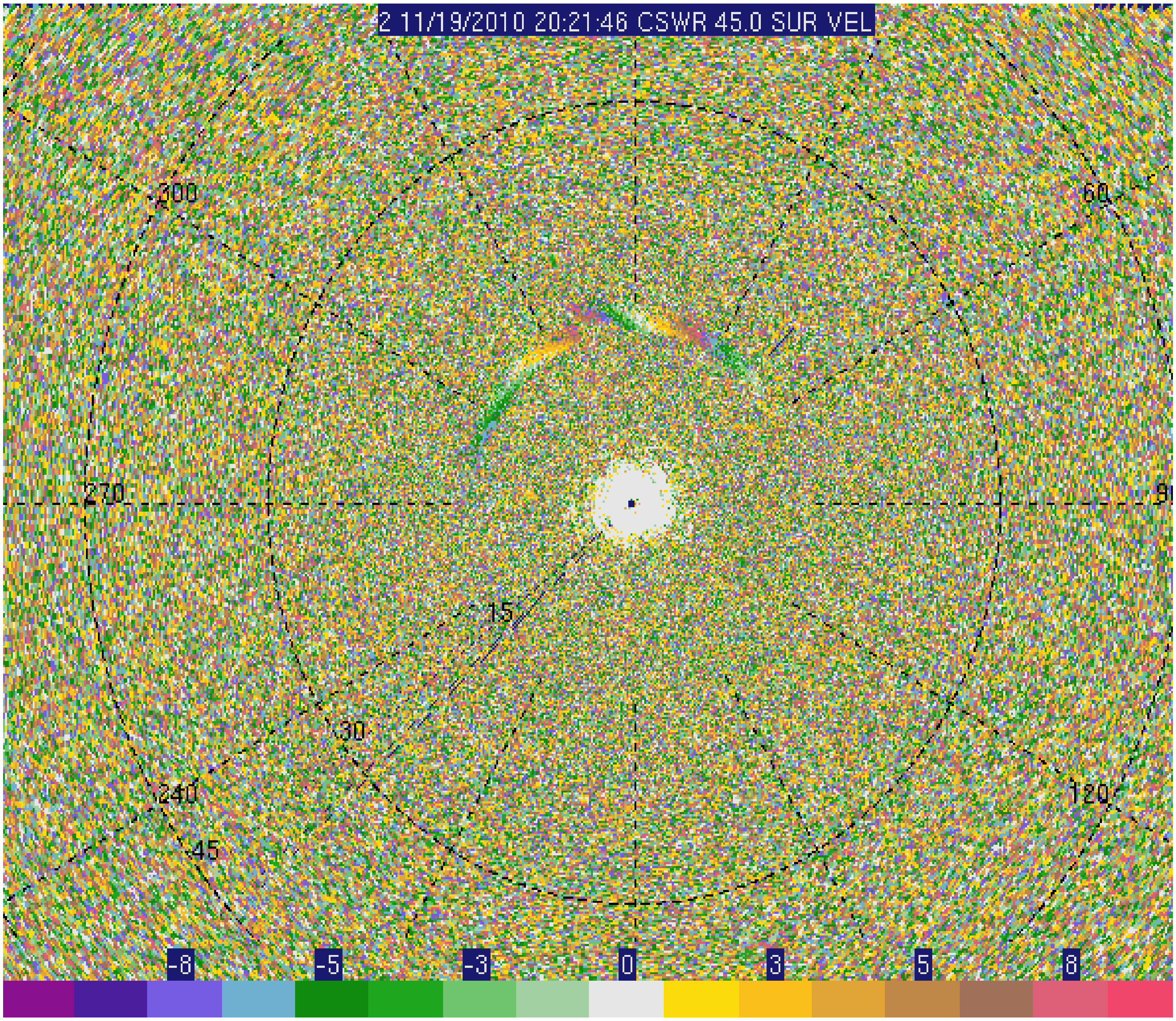
72632 DTX White Lake Observations at 00Z 06 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	121									
974.0	329	0.2	-6.8	59	2.37	330	7	275.4	282.2	275.8
950.0	530	-1.9	-8.9	59	2.06	341	11	275.2	281.2	275.6
940.6	610	-2.6	-8.8	63	2.10	345	13	275.3	281.3	275.6
925.0	744	-3.9	-8.6	70	2.17	340	14	275.3	281.5	275.7
905.1	914	-5.4	-9.2	75	2.11	335	16	275.5	281.5	275.8
870.4	1219	-8.2	-10.3	84	2.01	315	22	275.7	281.5	276.0
859.0	1322	-9.1	-10.7	88	1.98	307	20	275.8	281.5	276.1
850.0	1403	-9.5	-10.8	90	1.98	300	19	276.2	281.9	276.5
804.4	1829	-10.4	-11.1	94	2.04	215	5	279.7	285.6	280.0
797.0	1900	-10.5	-11.2	95	2.05	199	6	280.2	286.2	280.6
772.9	2134	-12.3	-13.1	94	1.81	145	9	280.8	286.1	281.1
742.7	2438	-14.6	-15.6	92	1.54	140	8	281.5	286.1	281.7
734.0	2528	-15.3	-16.3	92	1.47	97	9	281.7	286.1	281.9
725.0	2622	-14.9	-16.1	91	1.51	53	9	283.1	287.7	283.4
721.0	2663	-14.7	-17.2	81	1.38	33	9	283.8	288.0	284.0
713.5	2743	-15.0	-21.0	60	1.01	355	10	284.3	287.4	284.4
707.0	2812	-15.3	-24.3	46	0.76	7	8	284.7	287.1	284.8
700.0	2887	-15.5	-24.5	46	0.76	20	5	285.3	287.7	285.4

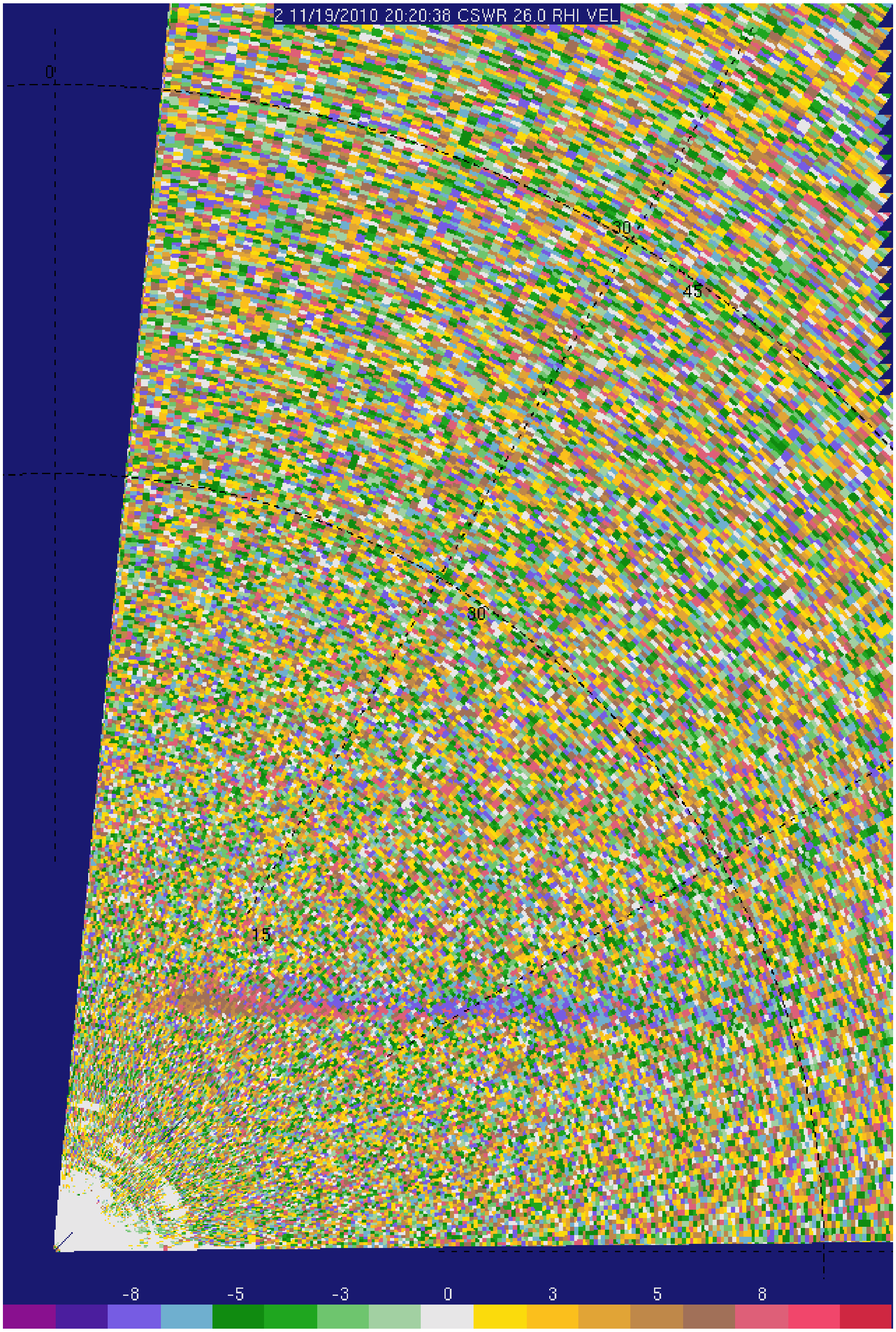
As can be seen from the DTX sounding data (eastern Michigan was the nearest site we determined), the winds near the surface ranged from 7-22 knots out of the north. With the Nyquist limits being -8.5 to 8.5, this would allow for one fold to be seen on the DOW. This is seen on Figure 6 BOTTOM when observing the shifts from red to blue to the north and south of the DOW.

Question #2

Part 1:



Part 2:



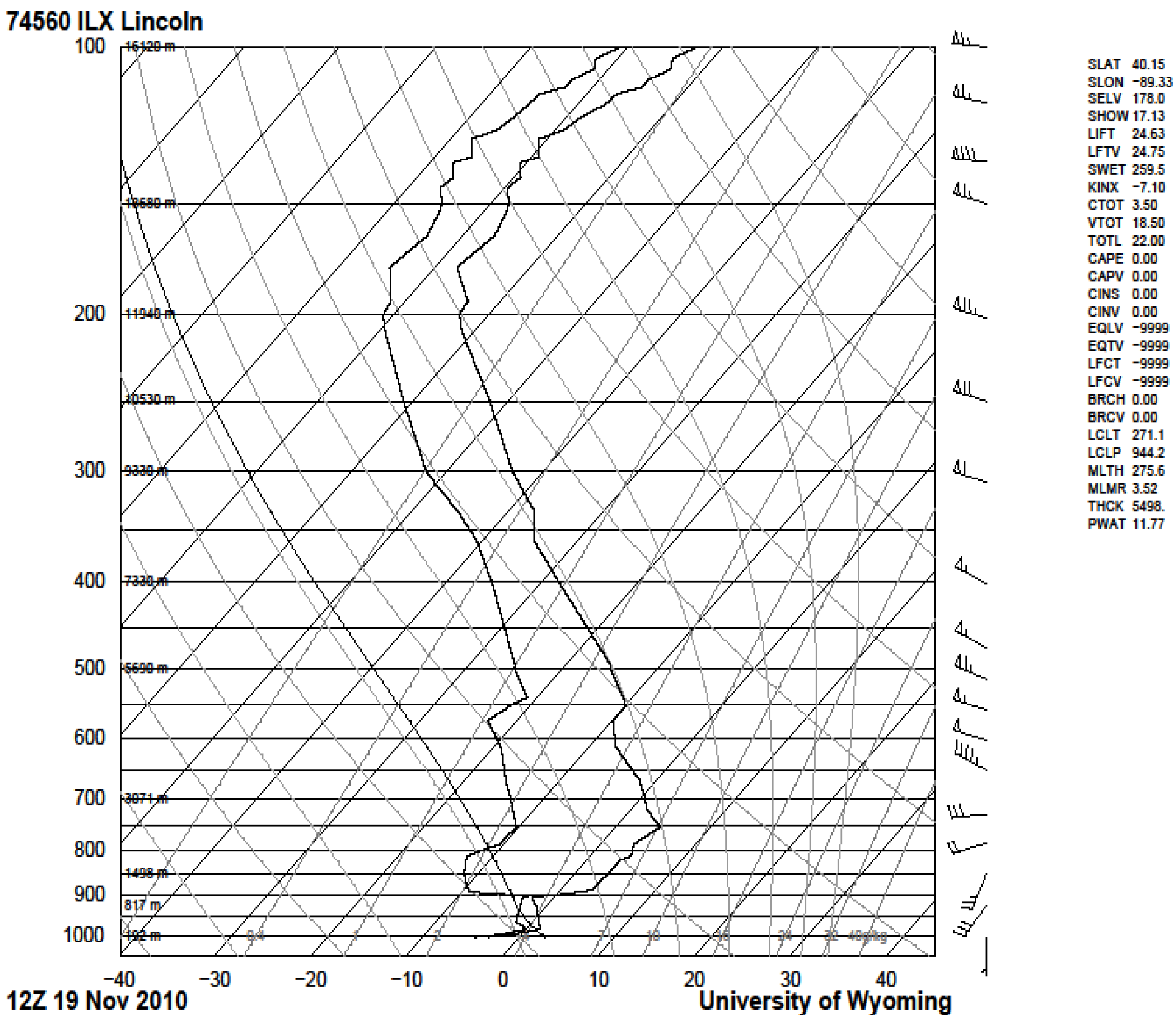
Part 3:

The approximate altitude of the cloud base for the clouds is 9.3487 km.

Part 4:

The approximate altitude of the cloud top for the clouds is 11.3182 km.

Part 5:



74560 ILX Lincoln Observations at 12Z 19 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1002.0	178	-3.3	-4.7	90	2.70	180	3	269.7	277.1	270.1
1000.0	192	-2.3	-3.7	90	2.92	185	6	270.9	278.9	271.3
997.0	216	-1.3	-2.6	91	3.18	186	7	272.1	280.9	272.6
982.0	337	1.4	0.0	90	3.91	192	14	276.0	286.8	276.6
963.0	495	0.6	-1.8	84	3.50	199	23	276.7	286.5	277.3
949.2	610	-0.0	-2.2	85	3.45	205	29	277.2	286.9	277.8
925.0	817	-1.1	-2.8	88	3.38	220	32	278.2	287.7	278.8
913.8	914	-1.8	-3.1	91	3.35	220	31	278.4	287.9	279.0
906.0	982	-2.3	-3.3	93	3.32	214	30	278.6	288.0	279.2
902.0	1018	-1.7	-2.9	92	3.44	211	30	279.6	289.3	280.1
900.0	1035	-0.7	-3.0	84	3.42	210	29	280.8	290.6	281.4
894.0	1089	1.2	-7.8	51	2.39	206	29	283.3	290.3	283.7
890.0	1125	2.6	-9.4	41	2.12	203	28	285.1	291.4	285.4
885.0	1171	3.2	-9.8	38	2.06	199	28	286.2	292.4	286.5
879.8	1219	3.2	-10.1	37	2.03	195	27	286.7	292.8	287.0
850.0	1498	3.4	-11.6	32	1.86	205	26	289.7	295.4	290.0
823.0	1760	3.4	-12.6	30	1.77	229	23	292.4	297.9	292.7
816.0	1829	3.9	-12.7	29	1.77	235	22	293.6	299.2	293.9
812.0	1869	4.2	-12.8	28	1.77	238	22	294.4	299.9	294.7
788.0	2112	3.4	-10.6	35	2.17	254	21	296.0	302.8	296.4
785.9	2134	3.5	-10.6	35	2.18	255	21	296.3	303.2	296.7
757.1	2438	4.5	-10.4	33	2.30	270	27	300.6	307.9	301.0
754.0	2471	4.6	-10.4	33	2.31	269	28	301.1	308.4	301.5
729.1	2743	2.4	-11.9	34	2.12	265	32	301.6	308.4	302.0
720.0	2845	1.6	-12.4	35	2.06	268	30	301.8	308.4	302.2
700.0	3071	0.4	-13.6	34	1.92	275	27	302.9	309.1	303.2
669.0	3433	-1.7	-15.7	34	1.69	287	38	304.5	310.0	304.8
650.2	3658	-3.5	-16.9	35	1.58	295	45	304.9	310.1	305.2
613.0	4122	-7.3	-19.3	38	1.36	287	48	305.8	310.3	306.0
601.6	4267	-8.1	-20.3	37	1.27	285	49	306.5	310.8	306.8
578.5	4572	-9.7	-22.5	34	1.09	280	52	308.1	311.9	308.3
572.0	4659	-10.1	-23.1	34	1.05	281	53	308.6	312.2	308.8
556.1	4877	-10.1	-22.4	36	1.15	285	55	311.1	315.0	311.3
550.0	4962	-10.1	-22.1	37	1.19	286	56	312.1	316.1	312.3
539.0	5117	-11.1	-21.1	44	1.33	287	58	312.7	317.2	312.9
513.5	5486	-13.7	-23.7	43	1.11	290	63	313.9	317.8	314.1
500.0	5690	-15.1	-25.1	42	1.00	290	58	314.6	318.1	314.8
496.0	5751	-15.3	-25.3	42	0.99	291	58	315.0	318.5	315.2
473.2	6096	-18.1	-27.5	44	0.85	295	55	315.8	318.8	315.9
400.8	7315	-28.2	-35.2	51	0.48	295	55	318.1	319.9	318.2
400.0	7330	-28.3	-35.3	51	0.48	295	55	318.1	319.9	318.2
383.9	7620	-30.7	-37.4	52	0.40	295	58	318.7	320.2	318.8
359.0	8096	-34.7	-40.7	54	0.31	292	58	319.5	320.7	319.6
333.0	8618	-37.3	-45.3	43	0.20	289	59	322.9	323.7	322.9
308.3	9144	-41.7	-50.5	38	0.12	285	59	323.9	324.4	323.9
301.0	9308	-43.1	-52.1	36	0.10	285	62	324.2	324.6	324.2
300.0	9330	-43.3	-52.3	36	0.10	285	62	324.2	324.6	324.2
250.0	10530	-52.1	-61.1	33	0.04	285	70	328.5	328.7	328.5
209.0	11668	-61.3	-69.3	34	0.02	285	74	331.3	331.4	331.3
201.7	11887	-62.8	-70.8	33	0.01	285	75	332.4	332.5	332.4
201.0	11909	-62.9	-70.9	33	0.01	287	74	332.5	332.6	332.5
200.0	11940	-63.1	-71.1	33	0.01	290	73	332.7	332.7	332.7
193.0	12159	-63.5	-71.5	33	0.01	286	73	335.4	335.5	335.4
177.0	12684	-67.7	-74.7	36	0.01	275	73	336.9	337.0	337.0
163.0	13180	-66.7	-73.7	37	0.01	280	69	346.7	346.7	346.7
154.0	13522	-67.5	-74.5	36	0.01	283	66	351.0	351.0	351.0

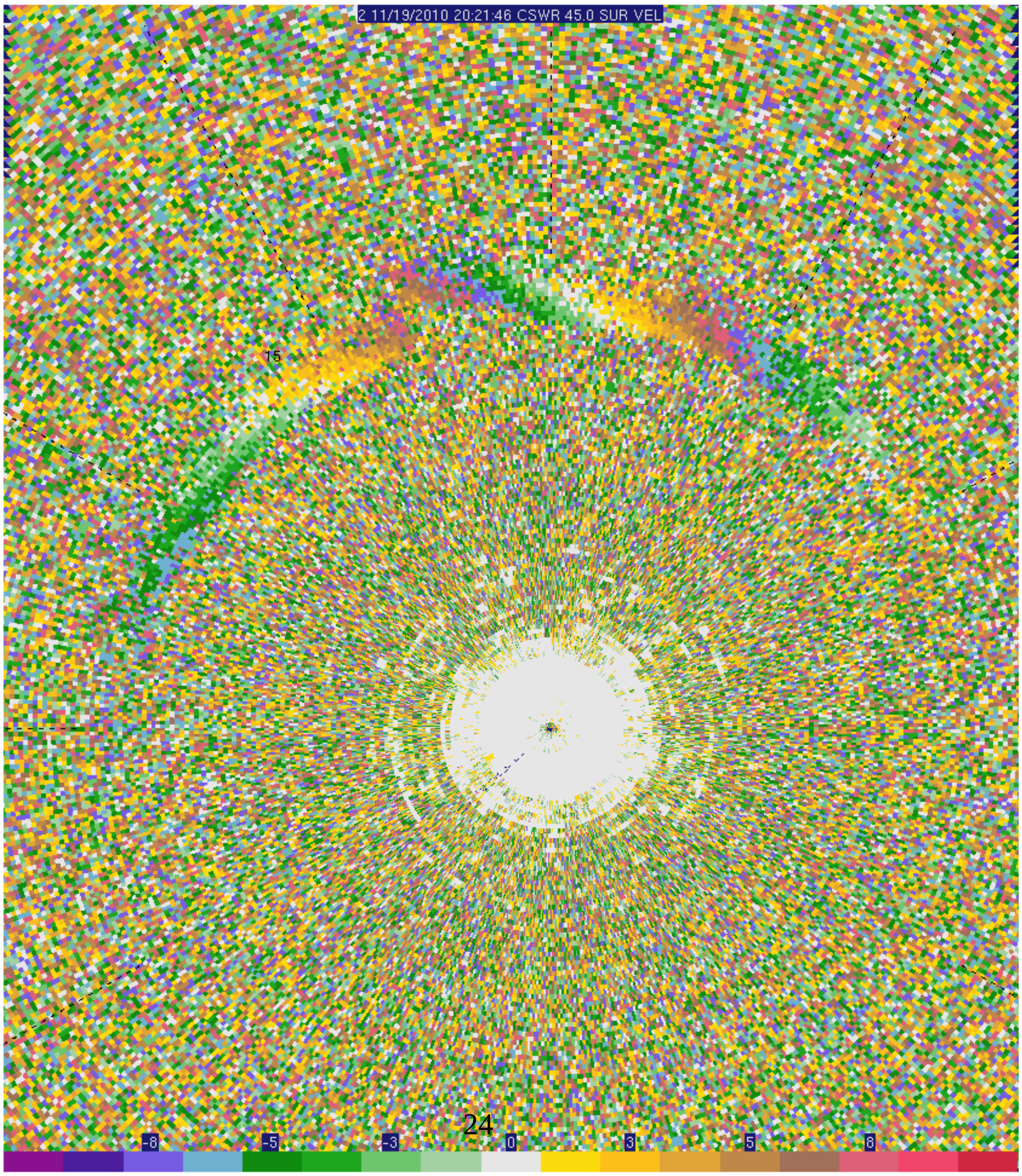
150.0	13680	-68.1	-75.1	36	0.01	285	65	352.6	352.6	352.6
149.1	13716	-68.3	-75.3	36	0.01	280	65	352.8	352.8	352.8
144.0	13924	-69.7	-76.7	35	0.01	278	70	353.9	354.0	353.9
140.0	14092	-69.3	-76.3	36	0.01	277	74	357.5	357.5	357.5
135.0	14309	-70.7	-77.7	35	0.01	275	79	358.8	358.8	358.8
134.6	14326	-70.4	-77.4	35	0.01	275	79	359.5	359.6	359.5
133.0	14397	-69.3	-76.3	36	0.01	275	79	362.8	362.8	362.8
127.0	14672	-70.9	-77.9	35	0.01	277	74	364.7	364.8	364.7
124.0	14814	-69.1	-76.1	36	0.01	277	71	370.5	370.5	370.5
120.0	15010	-68.5	-75.5	36	0.01	279	67	375.1	375.1	375.1
116.0	15214	-67.1	-75.1	31	0.01	280	63	381.3	381.4	381.3
115.5	15240	-67.1	-75.1	31	0.01	280	63	381.8	381.9	381.8
113.0	15372	-66.9	-74.9	31	0.01	282	61	384.5	384.6	384.5
111.0	15481	-64.9	-72.9	32	0.02	284	59	390.3	390.4	390.3
109.8	15545	-64.9	-72.9	32	0.02	285	58	391.4	391.5	391.4
109.0	15592	-64.9	-72.9	32	0.02	284	58	392.3	392.4	392.3
106.0	15763	-63.5	-71.5	33	0.02	281	60	398.1	398.2	398.1
103.0	15939	-64.3	-72.3	33	0.02	278	61	399.8	400.0	399.8
100.0	16120	-62.7	-70.7	33	0.03	275	63	406.3	406.5	406.3
91.1	16691	-64.9	-72.9	32	0.02	272	57	412.9	413.1	412.9
83.1	17254	-62.9	-70.9	33	0.03	270	50	428.0	428.2	428.0
78.6	17596	-63.9	-71.9	33	0.03	268	47	432.8	432.9	432.8
75.1	17876	-62.1	-70.1	33	0.04	267	44	442.2	442.5	442.2
70.2	18288	-62.9	-70.9	33	0.04	265	39	449.1	449.4	449.1
70.0	18310	-62.9	-70.9	33	0.04	265	39	449.5	449.7	449.5
69.8	18328	-62.9	-70.9	33	0.04	265	39	449.9	450.1	449.9
67.4	18545	-60.7	-68.7	34	0.05	263	36	459.1	459.5	459.1
65.1	18760	-61.9	-69.9	34	0.05	262	33	461.1	461.4	461.1
63.7	18896	-59.9	-67.9	34	0.06	261	32	468.3	468.8	468.4
62.0	19065	-60.9	-68.9	34	0.06	260	29	469.8	470.1	469.8
60.3	19239	-58.9	-67.9	30	0.07	259	27	478.0	478.4	478.0
56.6	19636	-59.5	-68.5	30	0.07	256	22	485.3	485.8	485.4
55.0	19812	-58.6	-67.7	30	0.08	255	20	491.2	491.7	491.2
52.5	20117	-57.2	-66.2	31	0.10	240	33	501.4	502.1	501.4
50.0	20422	-55.7	-64.7	31	0.13	250	30	511.9	512.8	511.9
50.0	20420	-55.7	-64.7	32	0.13	250	31	511.8	512.7	511.8
49.3	20510	-54.7	-64.7	28	0.13	244	28	516.2	517.1	516.2
47.6	20726	-55.5	-65.5	28	0.12	230	24	519.2	520.1	519.3
44.4	21175	-57.3	-67.3	27	0.10	256	27	525.5	526.3	525.6
43.3	21336	-57.2	-67.2	27	0.10	265	28	529.7	530.5	529.8
41.2	21641	-56.9	-66.9	27	0.11	265	30	537.7	538.6	537.8
39.7	21883	-56.7	-66.7	27	0.12	253	26	544.1	545.0	544.2
37.8	22192	-58.7	-68.7	26	0.10	238	20	546.7	547.4	546.7
37.5	22250	-58.5	-68.5	26	0.10	235	19	548.6	549.4	548.6
35.7	22555	-57.6	-67.6	27	0.12	265	28	558.6	559.5	558.6
34.0	22860	-56.7	-66.7	27	0.14	255	20	568.8	569.9	568.8
33.3	22991	-56.3	-66.3	27	0.15	249	22	573.2	574.4	573.3
32.4	23165	-57.0	-67.0	27	0.14	240	24	576.0	577.1	576.0
30.9	23470	-58.1	-68.1	27	0.13	260	29	580.9	582.0	581.0
30.6	23525	-58.3	-68.3	27	0.13	258	28	581.8	582.8	581.9
30.0	23650	-57.7	-67.7	27	0.14	255	27	586.8	587.9	586.8
29.4	23774	-57.5	-67.8	26	0.14	255	27	590.5	591.6	590.5
27.9	24108	-57.1	-68.1	24	0.14	263	27	600.7	601.9	600.8
26.7	24384	-57.5	-68.5	23	0.14	270	27	607.2	608.4	607.2
24.9	24825	-58.1	-69.1	23	0.14	256	28	617.7	618.9	617.7
23.1	25298	-57.3	-68.3	23	0.17	240	29	633.4	634.8	633.4
22.6	25436	-57.1	-68.1	24	0.18	243	32	638.0	639.5	638.0
21.9	25635	-55.1	-67.1	21	0.21	248	35	649.7	651.6	649.8
21.0	25908	-56.9	-68.9	20	0.17	255	40	652.2	653.7	652.2
20.9	25932	-57.1	-69.1	20	0.17	255	39	652.4	653.9	652.5
20.0	26210	-57.3	-69.3	20	0.17	260	33	660.0	661.6	660.1
19.2	26469	-56.3	-68.3	21	0.20	266	33	670.9	672.8	671.0
18.2	26822	-57.4	-69.4	20	0.18	275	32	678.3	680.0	678.4

17.3	27127	-58.3	-70.3	20	0.17	262	34	684.8	686.4	684.9
16.5	27432	-57.5	-69.8	19	0.19	250	36	696.8	698.6	696.9
15.0	28042	-55.9	-69.0	18	0.24	265	39	721.4	723.8	721.5
13.1	28895	-53.7	-67.7	16	0.32	265	48	757.3	760.6	757.4
11.4	29785	-55.1	-70.1	14	0.26	265	57	782.9	785.8	783.1
11.2	29870	-54.9	-70.1	13	0.27	265	58	786.8	789.7	786.9
10.8	30131	-54.1	-70.1	12	0.28	271	54	798.8	801.9	798.9
10.2	30480	-55.7	-71.7	12	0.23	280	49	805.3	807.9	805.4
10.1	30559	-56.1	-72.1	12	0.22			806.8	809.3	806.9

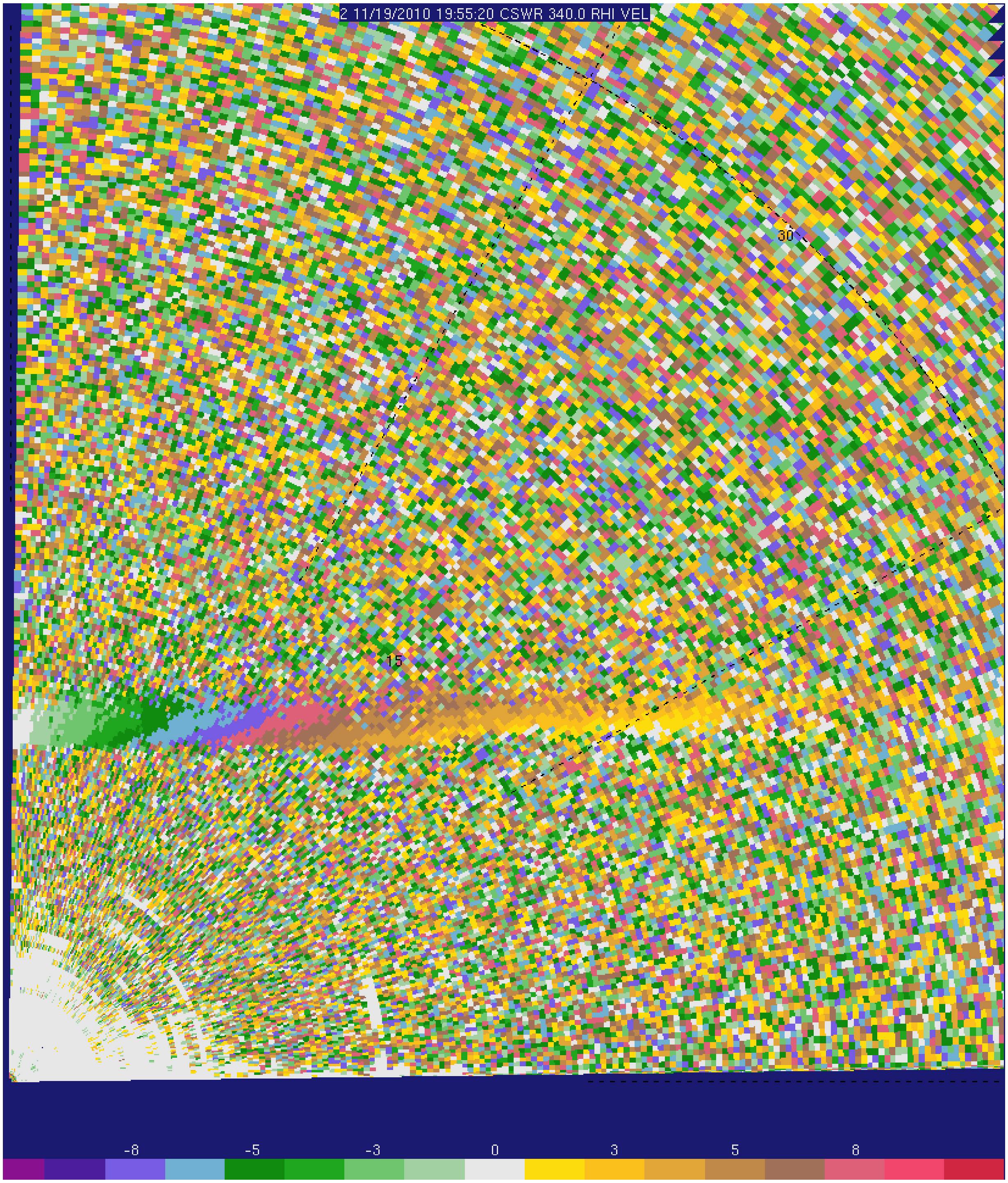
Part 6:

-The approximate wind speed at the top of the cloud layer observed with the DOW from the sounding is 72kts (which is about 37.04 m/s).
-The approximate wind speed at the bottom of the cloud layer observed with the DOW from the sounding is 62 kts (which is about 31.9 m/s).

Part 7:
PPI:



RHI:

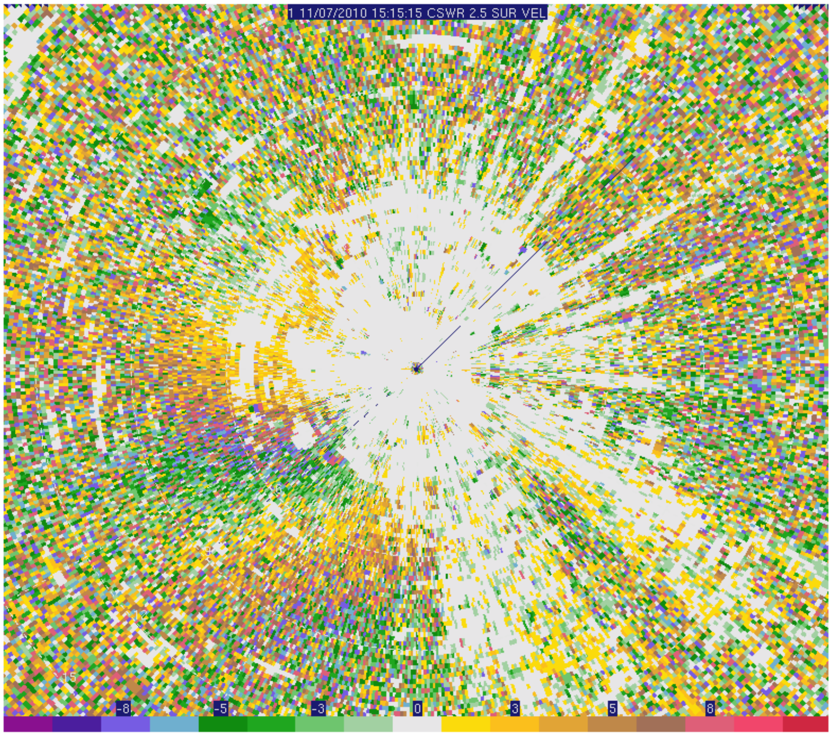


3. Missions without weather – Wind farm turbulence

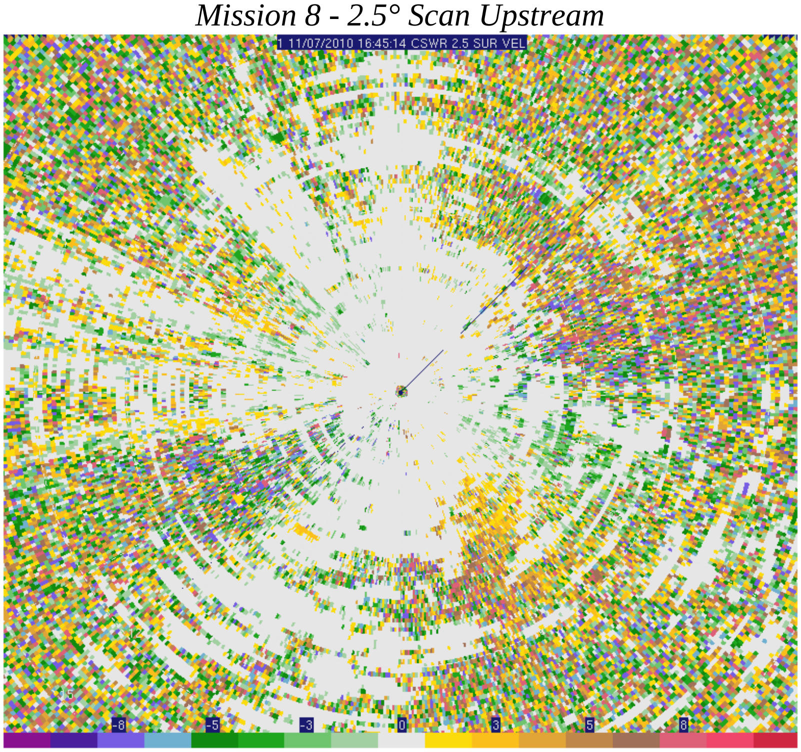
1.) Surveillance scans of radial velocity, ordered by mission

*Each scan image has 3 km range rings, and all images are zoomed in at the same amount, unless otherwise noted

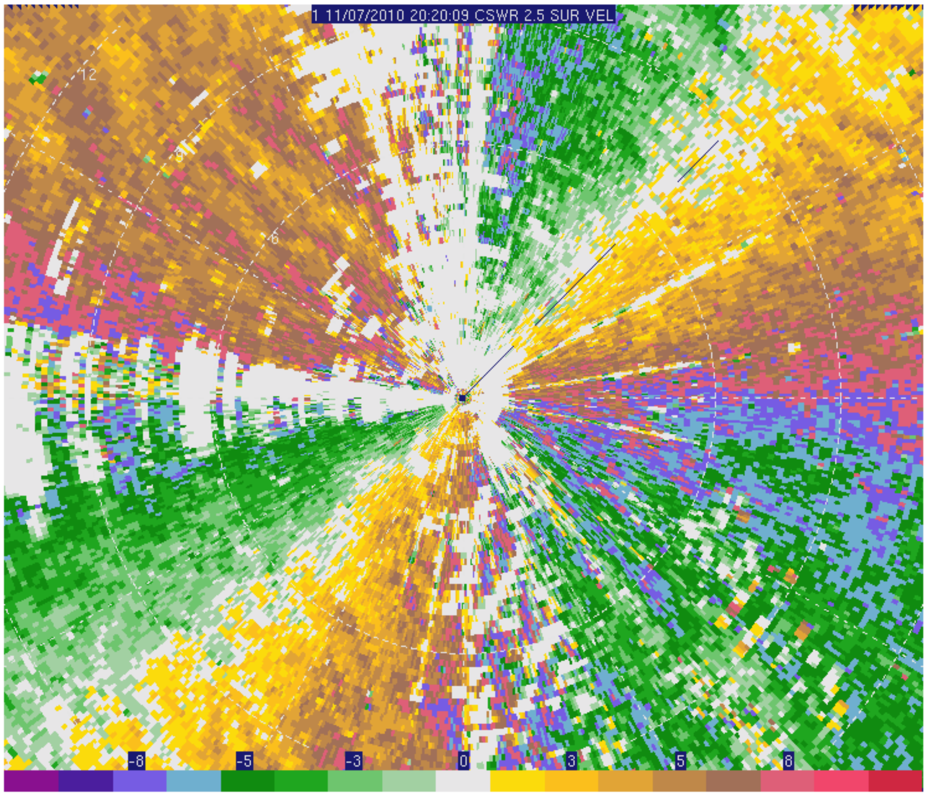
Mission 8 – 2.5° Scan Downstream



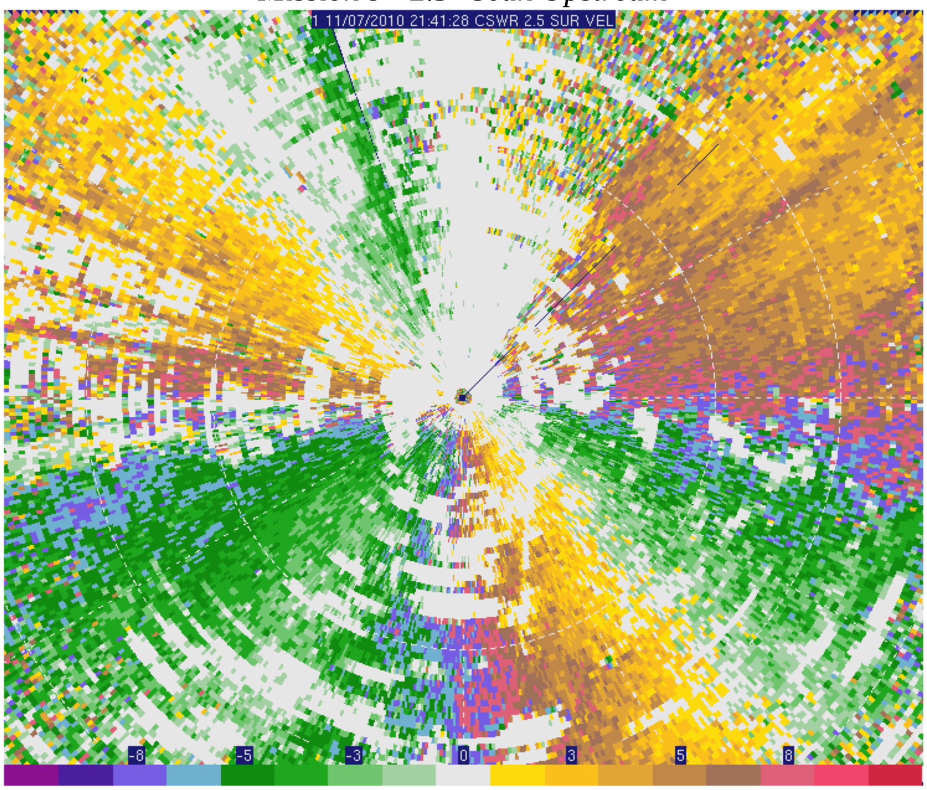
Mission 8 - 2.5° Scan Upstream



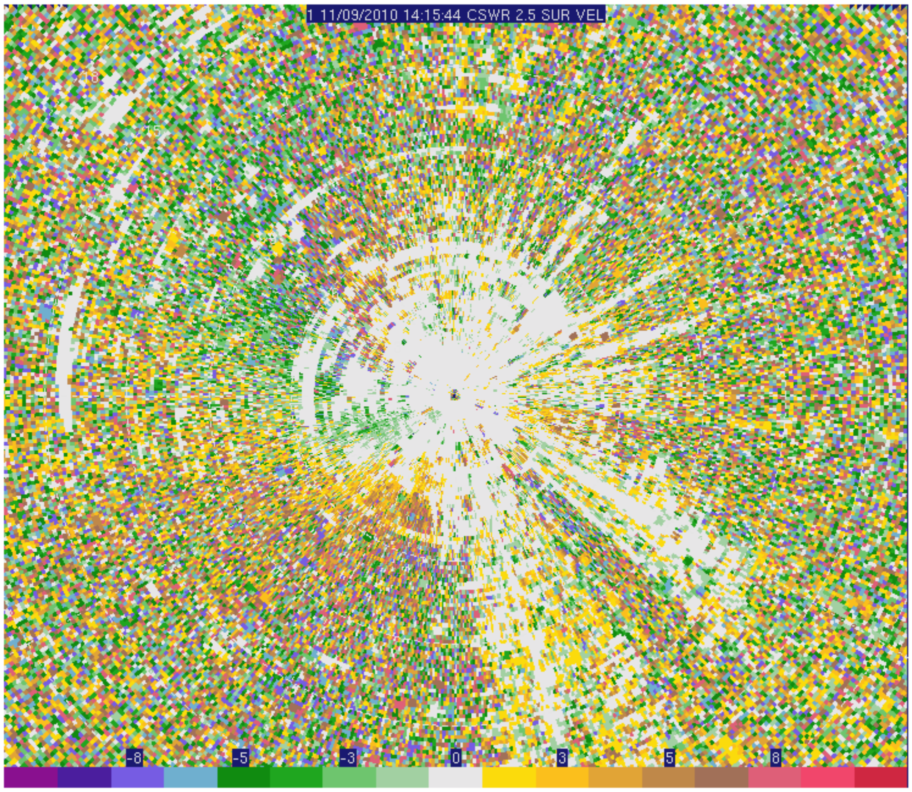
Mission 9 - 2.5° Scan Downstream



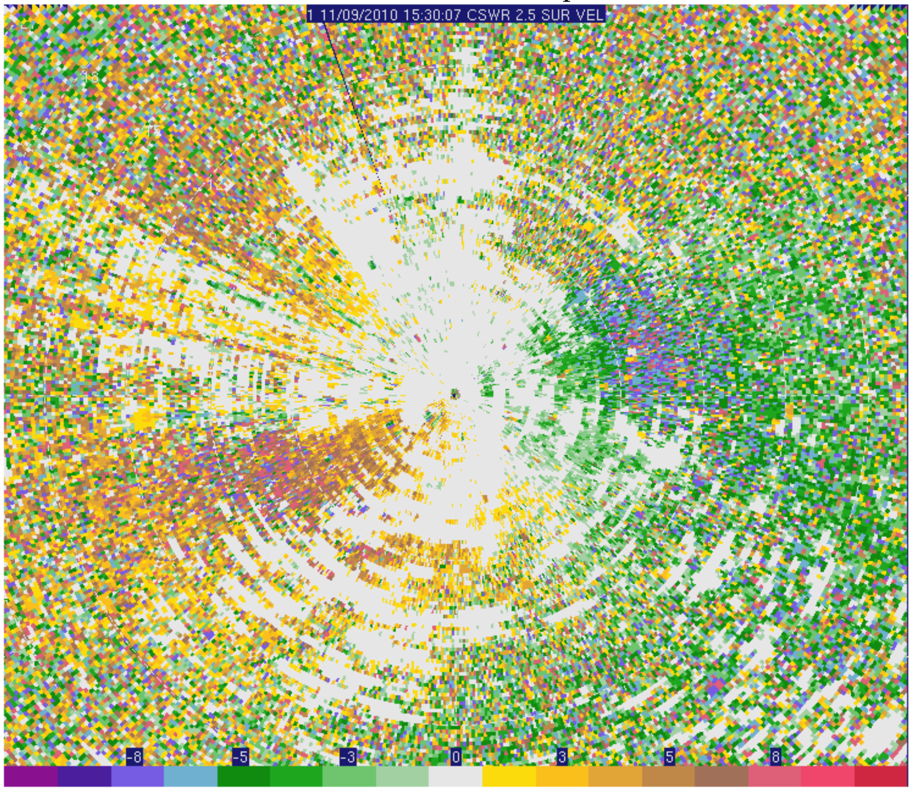
Mission 9 - 2.5° Scan Upstream



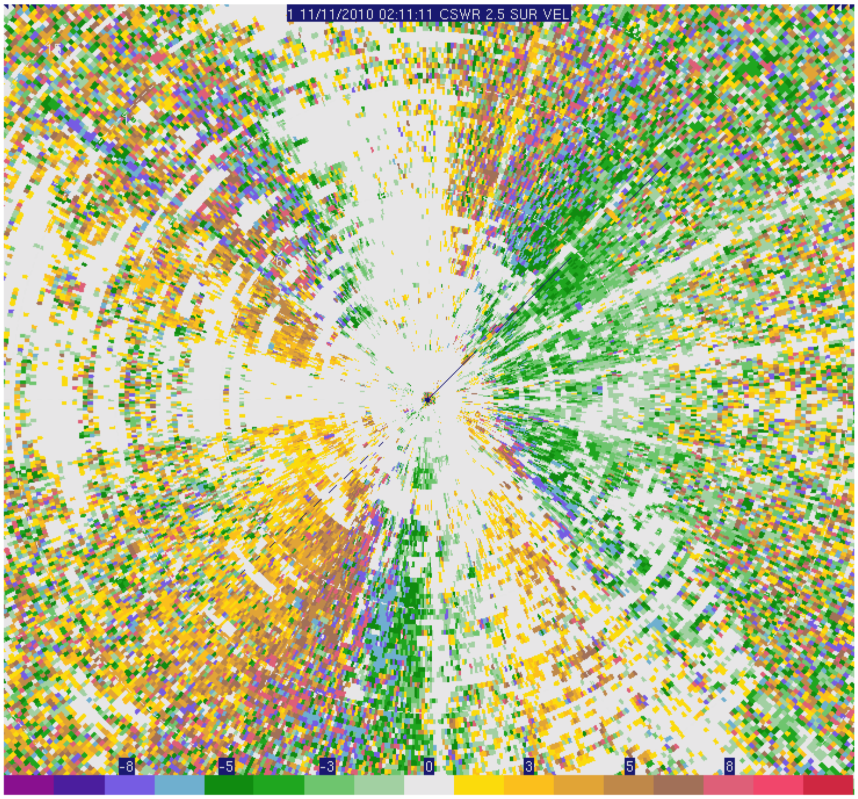
Mission 12 - 2.5° Scan Downstream



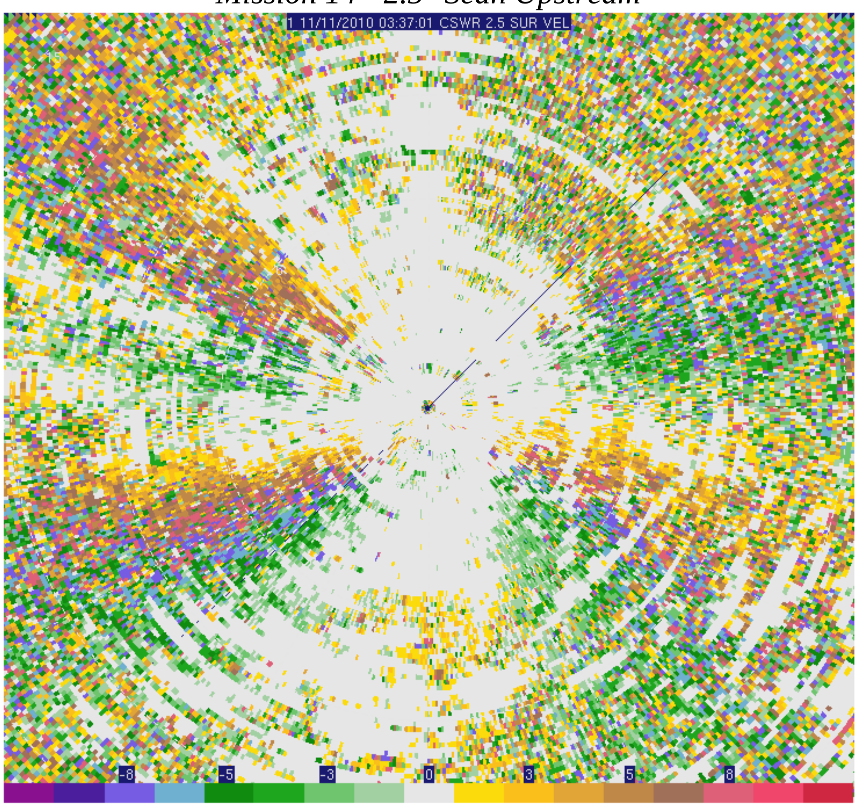
Mission 12 - 2.5° Scan Upstream



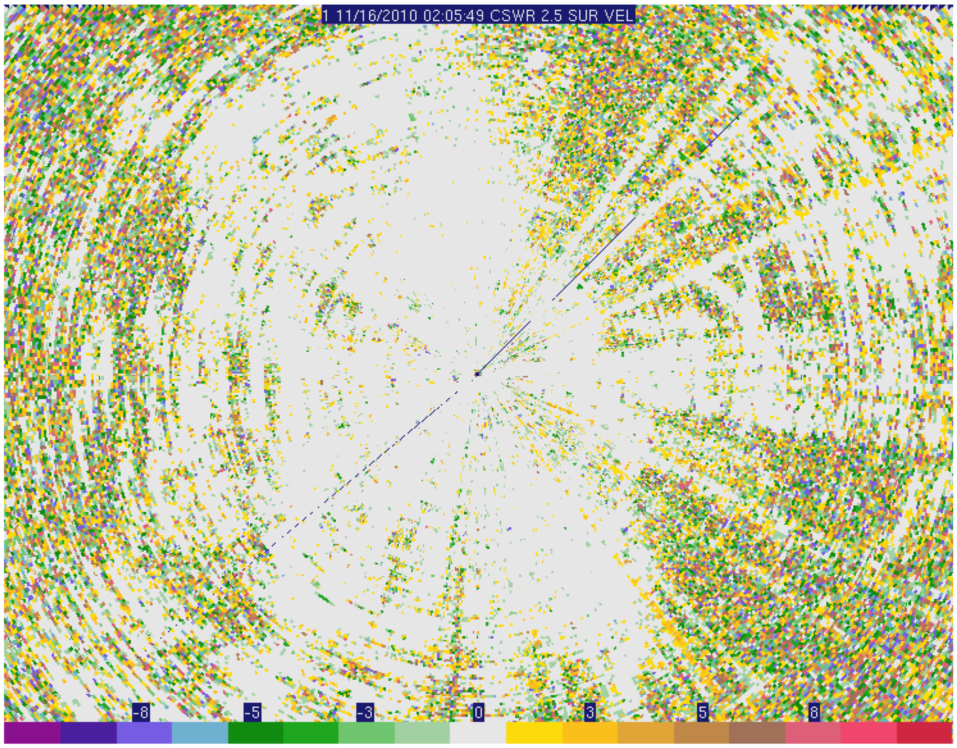
Mission 14 - 2.5° Scan Downstream



Mission 14 - 2.5° Scan Upstream

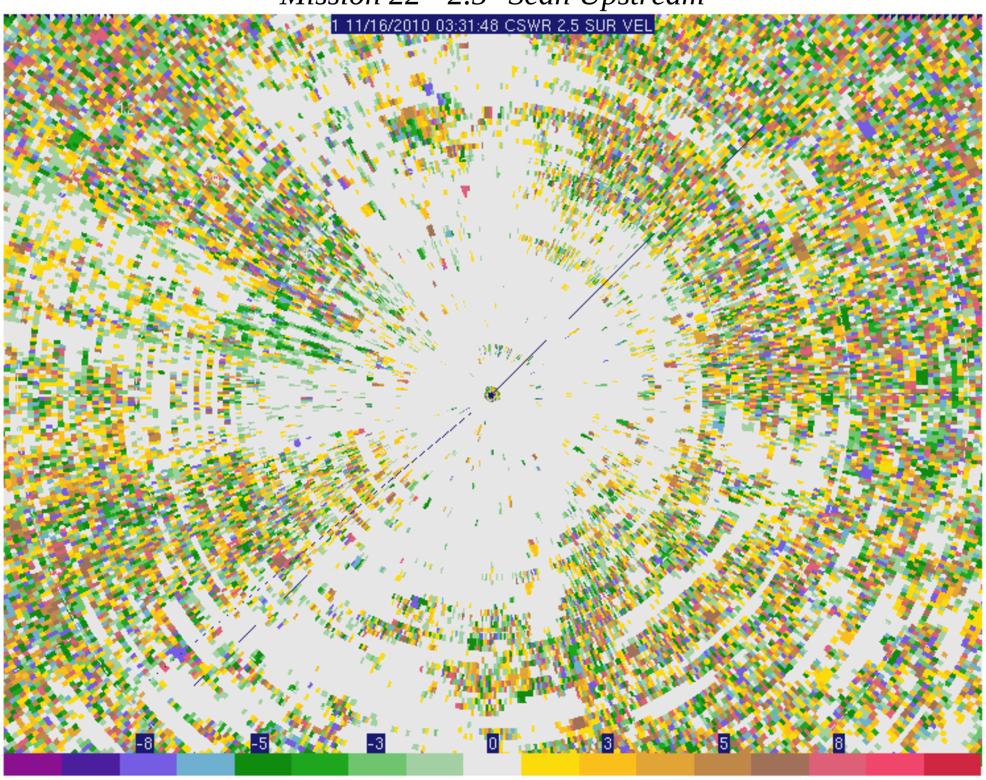


Mission 22 - 2.5° Scan Downstream



*This image is zoomed out farther than all of the other surveillance scans due to an increase in ground clutter, as this mission took place at a different location from the other four. In addition, there is a lower amount of scatterers near the radar in relation to the other four missions.

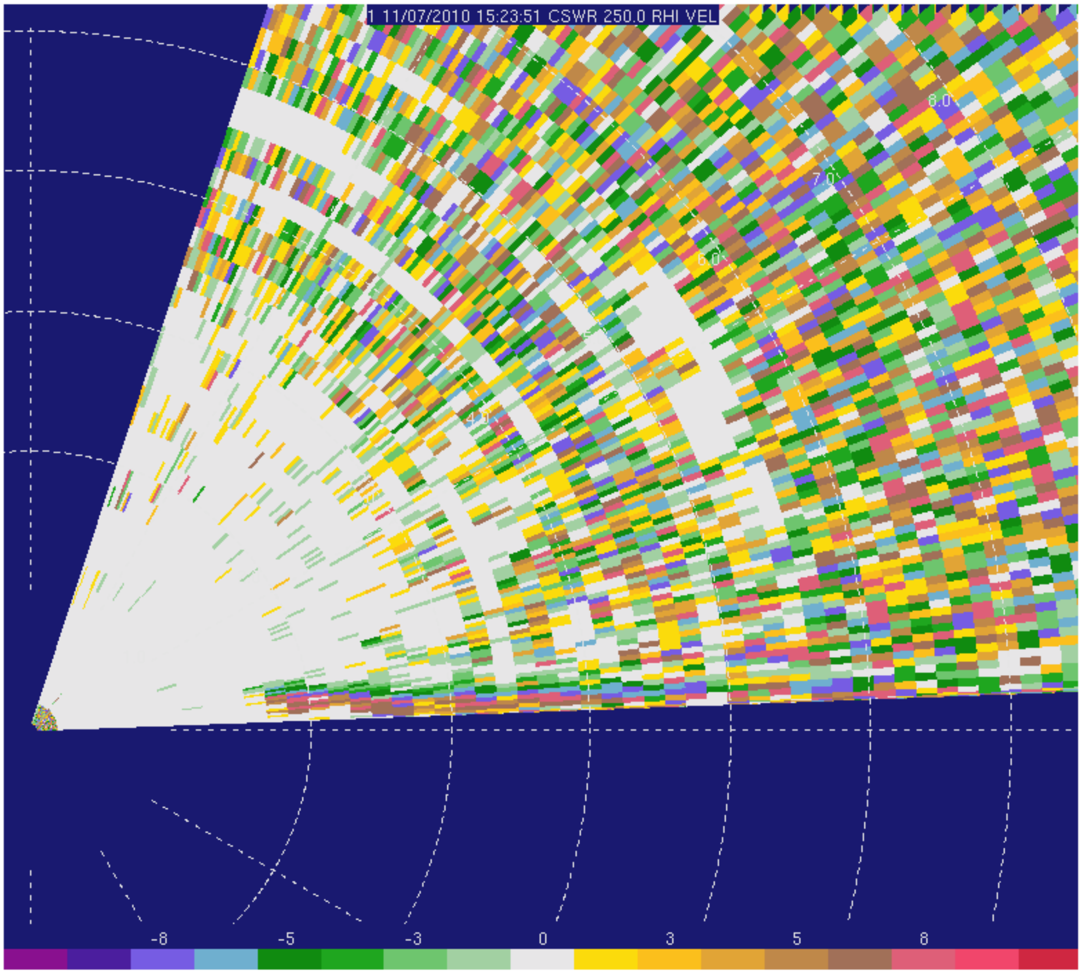
Mission 22 - 2.5° Scan Upstream



2 & 3) RHIs of radial velocity, ordered by mission

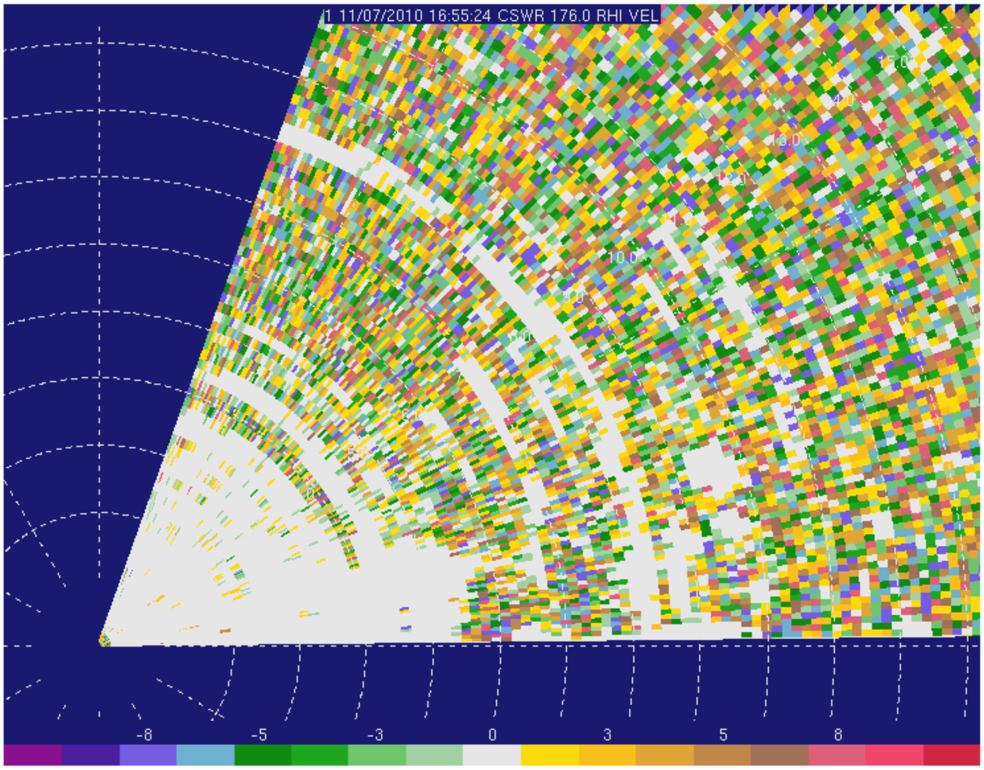
*The range rings are 1 km apart in every RHI image

Mission 8 – RHI Downstream



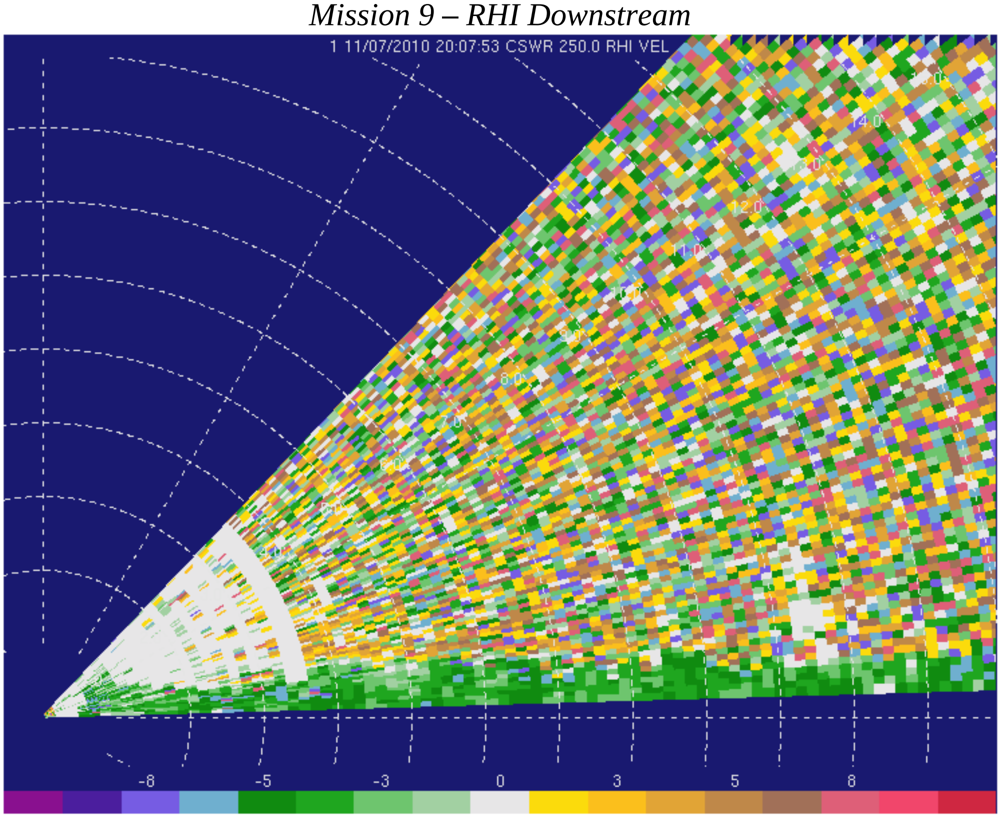
In this case, a low level plume can be observed that is about 300 meters deep, and which extends roughly 4.5 km downstream before disappearing into the noise background.

Mission 8 – RHI Upstream



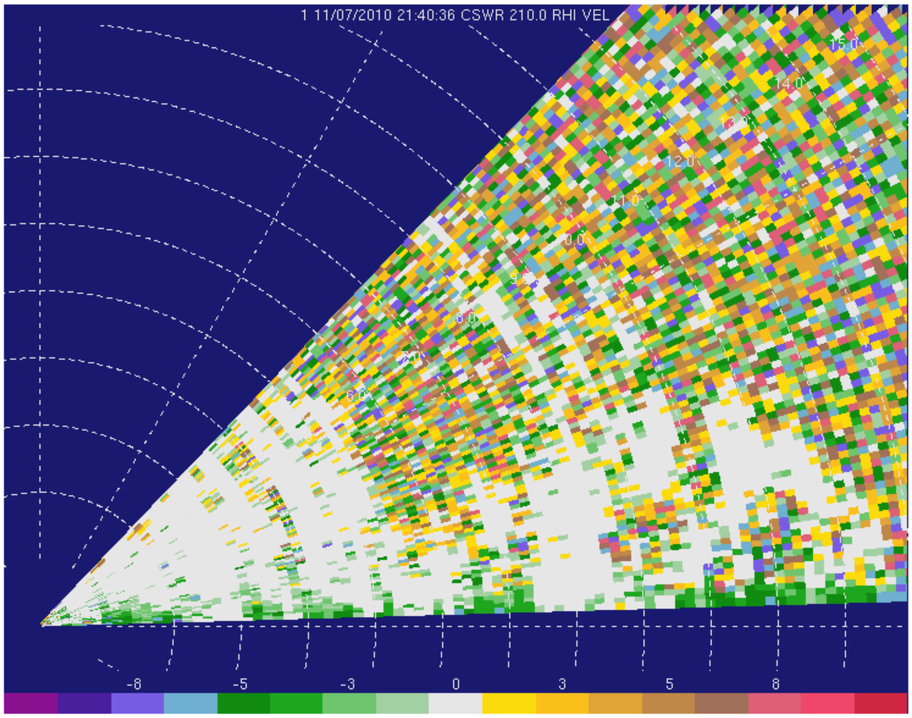
For this mission, there is no observable plume in the upstream direction.

Mission 9 – RHI Downstream



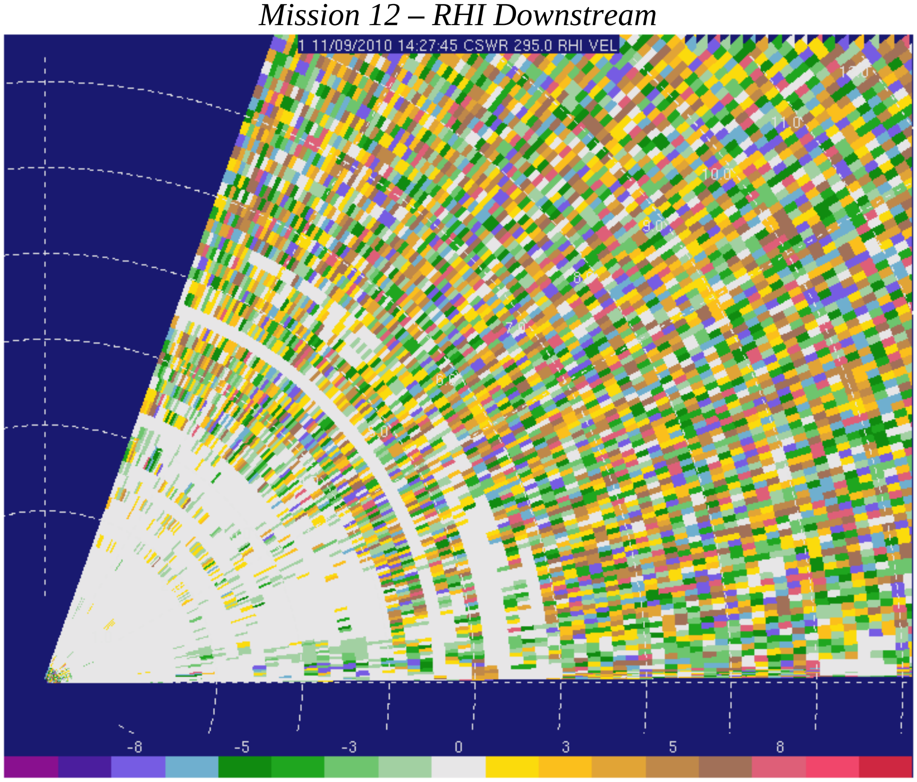
In this image, a plume that is approximately 750 meters thick is seen extending 12.5 km downstream.

Mission 9 – RHI Upstream



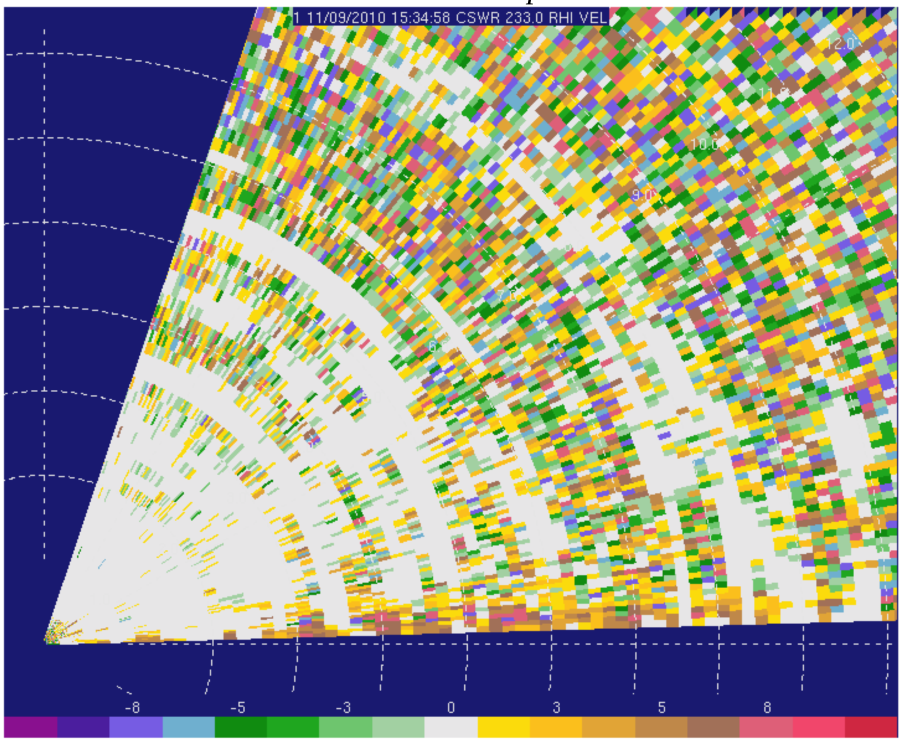
Amongst the clutter, a very shallow plume, which is at most 500 meters deep, is seen extending just over 12 km downstream. It must be noted that the depth, range, and velocities in this plume are nearly identical to the downstream case for the same mission, rendering the downstream case inconclusive in regards to our hypothesis.

Mission 12 – RHI Downstream



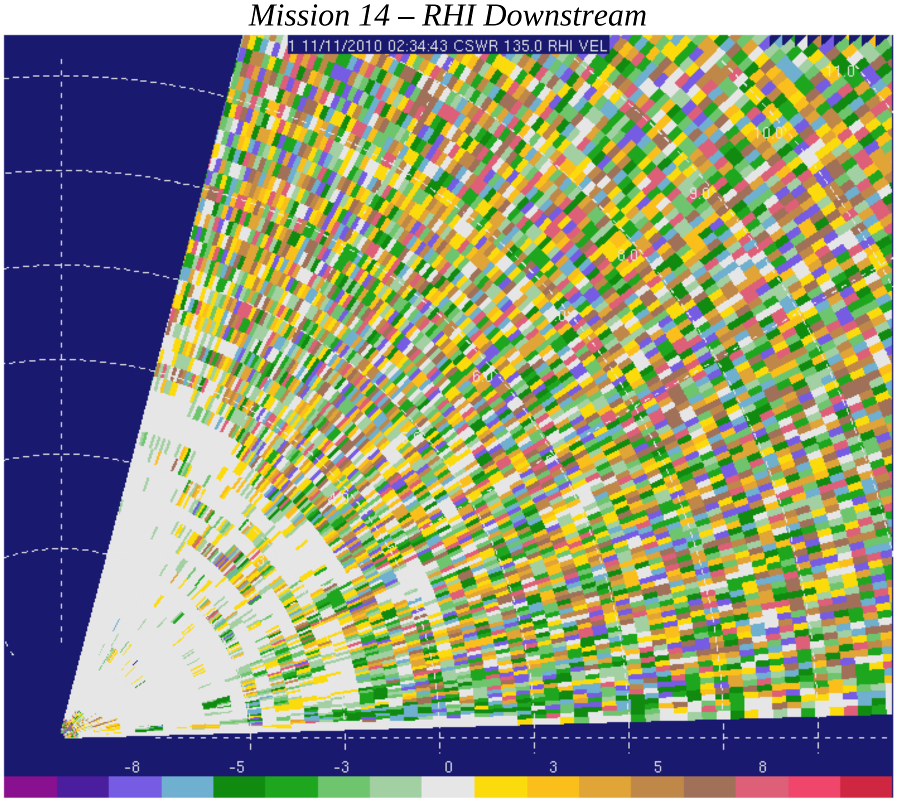
No plum can be distinguished from the noise background in this downwind case.

Mission 12 – RHI Upstream



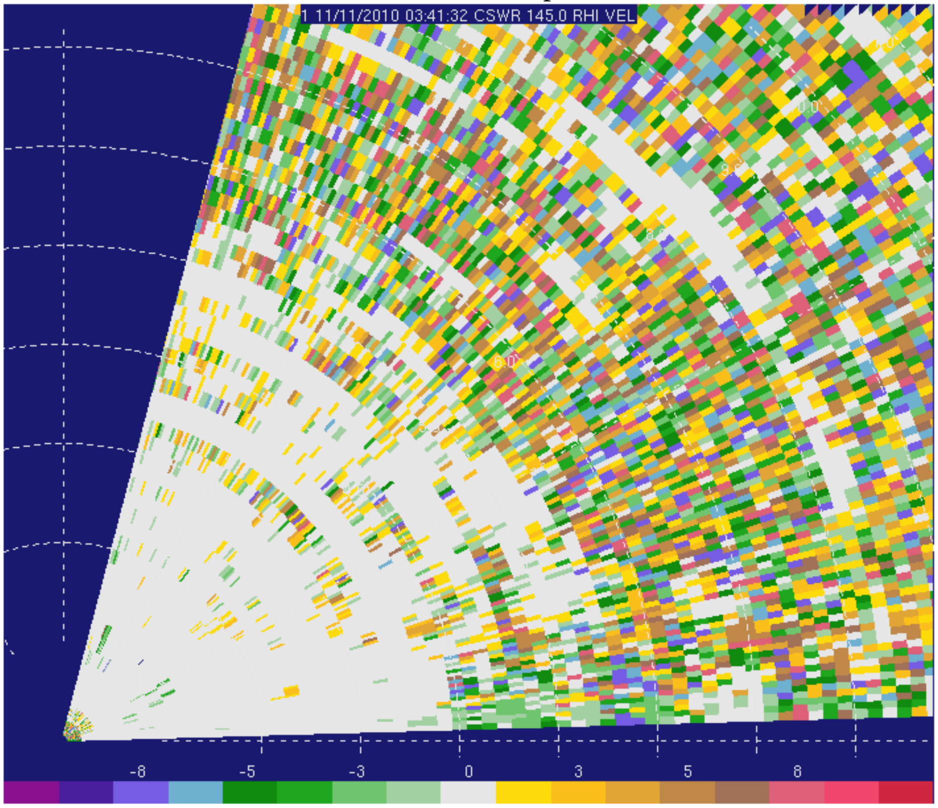
A plume can be observed extending approximately 7 km downrange, and having a depth of 300-500 meters.

Mission 14 – RHI Downstream



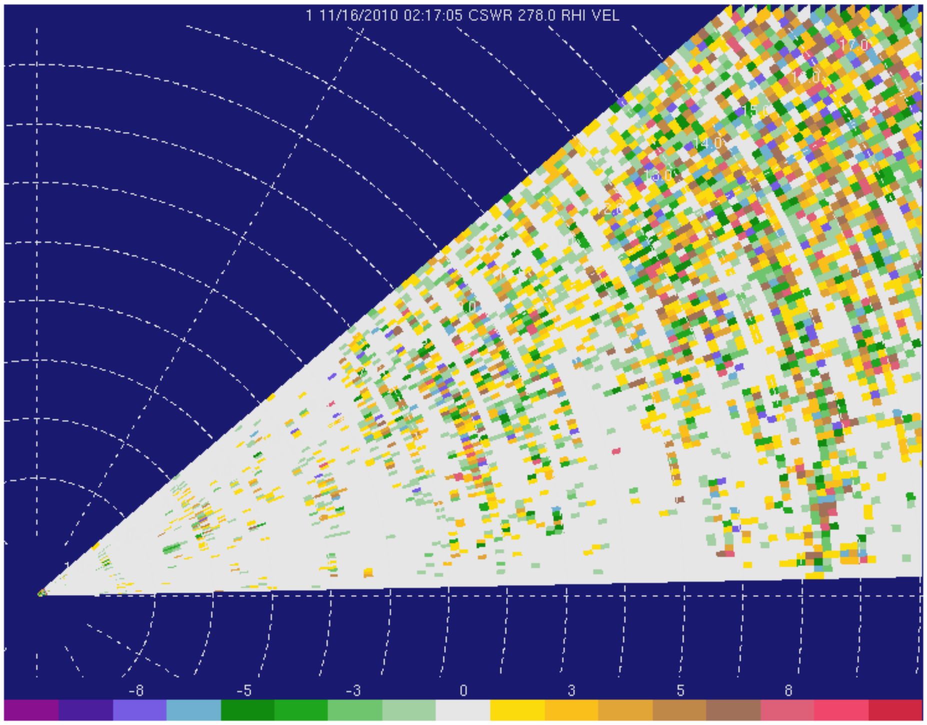
No distinguishable plume can be seen in this downstream image.

Mission 14 – RHI Upstream



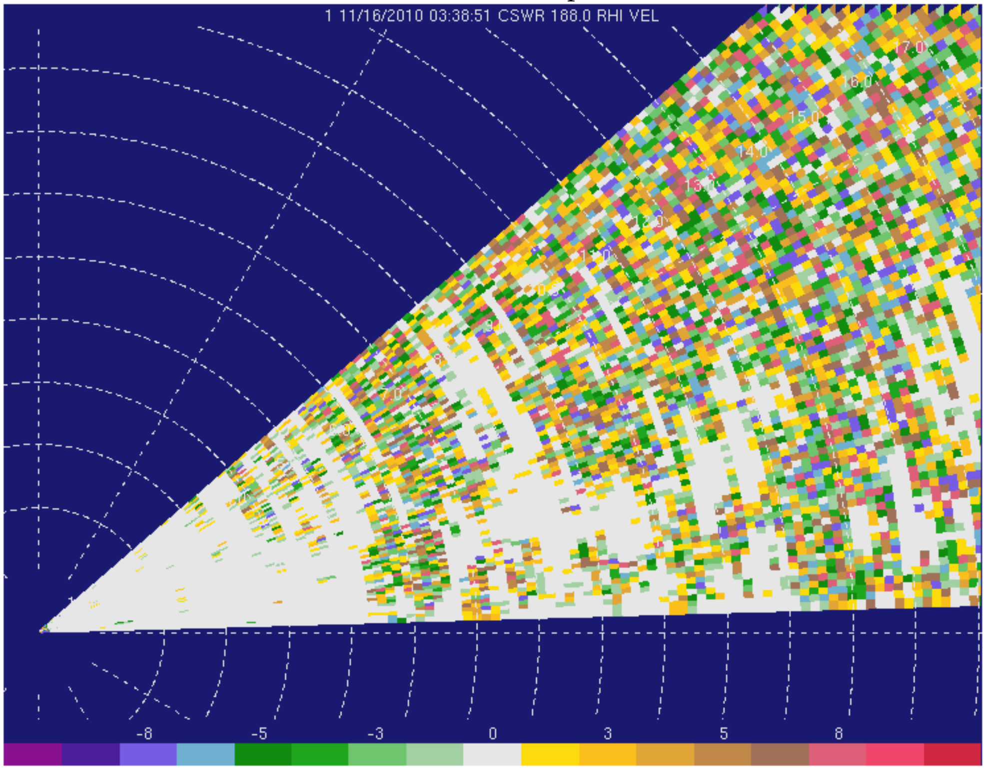
Again, no distinguishable plume can be found in this mission 14 image.

Mission 22 – RHI Downstream



Due to the combination of clutter and a relative lack of scatterers, there was no observable data near the ground from Mission 22.

Mission 22 – RHI Upstream



Although there is are returns near the ground in the upstream direction during mission 22, it is all noise and no plume is able to be distinguished.

4.) Low level sounding data for each mission. Given is the text for the lowest 1000 meters of the sounding which was launched nearest to each mission's time of deployment.

Mission 8 – 6:00 AM Nov. 7, 2010

74560 ILX Lincoln Observations at 12Z 07 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1005.0	178	-0.1	-4.5	72	2.74	175	9	272.7	280.3	273.1
1000.0	221	1.0	-5.0	64	2.65	190	17	274.1	281.6	274.6
983.0	360	4.2	-5.8	48	2.53	208	22	278.7	286.0	279.1
967.0	495	10.4	-7.6	27	2.24	225	28	286.3	293.0	286.7
960.0	555	11.2	-8.8	24	2.06	233	30	287.7	293.9	288.0
953.7	610	11.0	-9.4	23	1.97	240	32	288.0	294.0	288.3
928.0	837	10.0	-12.0	20	1.65	253	28	289.3	294.4	289.6
925.0	864	10.0	-13.0	18	1.53	255	27	289.5	294.3	289.8
919.4	914	10.0	-13.8	17	1.44	260	28	290.0	294.5	290.3

Mission 9 – 12:00 PM Nov. 7, 2010

74560 ILX Lincoln Observations at 00Z 08 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	163									
998.0	178	14.8	-0.2	36	3.79	205	6	288.1	299.3	288.8
994.0	212	16.2	-2.8	27	3.14	207	7	289.9	299.2	290.4
987.0	272	16.8	-4.2	23	2.85	212	10	291.0	299.6	291.5
948.6	610	15.4	-5.6	23	2.67	235	24	292.9	301.1	293.4
927.0	806	14.6	-6.4	23	2.57	244	27	294.1	301.9	294.5
925.0	824	14.8	-6.2	23	2.61	245	27	294.4	302.5	294.9
915.2	914	15.0	-6.9	21	2.50	275	33	295.5	303.3	296.0
914.0	925	15.0	-7.0	21	2.49	275	33	295.6	303.4	296.1

Mission 12 – 6:00 AM Nov. 9, 2010

74560 ILX Lincoln Observations at 12Z 09 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	121									
993.0	178	3.6	0.5	80	4.01	170	4	277.3	288.5	278.0
989.0	211	7.8	3.3	73	4.93	178	6	281.8	295.7	282.7
978.0	305	14.4	6.4	59	6.20	200	11	289.4	307.2	290.5
974.0	339	15.4	6.4	55	6.22	208	13	290.7	308.8	291.8
965.0	418	16.2	6.2	52	6.20	226	17	292.3	310.4	293.4
943.5	610	15.3	6.4	55	6.43	270	28	293.3	312.1	294.5
925.0	778	14.6	6.6	59	6.65	285	20	294.2	313.7	295.4
924.0	787	14.6	6.6	59	6.66	285	20	294.3	313.9	295.5
910.2	914	14.3	5.3	55	6.18	290	14	295.3	313.6	296.4

Mission 14 – 6:00 PM Nov. 10, 2010

74560 ILX Lincoln Observations at 00Z 11 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	145									
996.0	178	18.0	9.0	56	7.28	150	10	291.5	312.5	292.8
989.0	239	19.2	9.2	52	7.43	151	13	293.3	314.9	294.6
972.0	388	18.8	6.8	46	6.41	152	20	294.3	313.2	295.5
947.1	610	16.8	6.2	49	6.29	155	30	294.5	313.1	295.7
934.0	729	15.8	5.8	51	6.23	164	28	294.6	313.0	295.8
925.0	811	15.2	6.2	55	6.47	170	27	294.9	313.9	296.0
913.7	914	14.3	6.4	59	6.63	170	28	295.0	314.5	296.2

74560 ILX Lincoln Observations at 00Z 16 Nov 2010

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1000.0	92									
989.0	178	10.8	2.8	58	4.76	170	3	284.9	298.4	285.7
984.0	221	11.6	2.6	54	4.71	173	4	286.1	299.6	286.9
959.0	437	10.2	-1.8	43	3.51	188	12	286.8	297.1	287.4
939.4	610	8.6	-2.3	46	3.46	200	18	286.8	297.0	287.4
925.0	739	7.4	-2.6	49	3.43	195	16	286.9	296.9	287.5
905.5	914	5.8	-2.2	56	3.61	195	15	287.0	297.5	287.6

5.) Based upon our limited amount of data, our results are inconclusive. To be able to draw more conclusive results, it would be necessary to have far more than 5 data sets. We should also alter our hypothesis to include more quantitative values for relative humidity and wind speed, rather than simply generalizing them as ‘high’ or ‘low’. However, we do have evidence, specifically from Mission 8, which would suggest our hypothesis may be true. Based upon the generalized criteria in our hypothesis, the conditions for Mission 8 produced the best combination of high wind and high relative humidity. The results of this mission showed a clear plume downstream of the wind farm in the lowest 300 meters of the atmosphere, as well as no plume in the upstream direction. On each of the other four missions that we have data for, none had a combination of high wind speeds with high relative humidity, although one of these two criteria was present on two of the missions. Of these four missions, a plume was visible on only one (Mission 9). In this case though, there were nearly identical plumes visible in both the upstream and downstream directions, rendering that mission’s data inconclusive in regards to our hypothesis. Overall, the limited data that we have collected hints at our hypothesis being correct, with the strong data from Mission 8 lending the most credibility to it. However, as previously mentioned, a much larger sample size would be required to obtain more definite results.

4. APPENDIX B: DATA AND WEATHER FOR MISSIONS DURING UIDOW DEPLOYMENT

Mission #	Date	Morning Afternoon or evening	Group	Location	Truck faces	Latitude	Longitude
1	11/3	M	4	Farm site	East	40 32 13.89	88 16 17.03
2	11/4	M	6	Farm base	North	40 32 41.95	88 17 08.28
				Farm site	East	40 32 13.89	88 16 17.03
3	11/4	E	11	Farm site	East	40 32 13.89	88 16 17.03
4	11/5	A	10	ADM plant	North	39 53 26.17	88 53 10.53
5	11/5	E	12	N. Indiana	East	41 29 31.11	86 53 19.92
6	11/6	M	2	ADM plant	North	39 54 16.59	88 53 36.79
7	11/6	A	5	N of farm	North	not	sure
8	11/7	M	1	Wind farm	East	40 28 59.71	88 30 56.17
					North	40 24 46.05	88 32 42.52
9	11/7	A	11	Wind farm	East	40 28 59.71	88 30 56.17
					North	40 24 46.05	88 32 42.52
10	11/7	E	8	Lincoln NWS	East	40 09 02.77	89 20 17.22
11	11/8	E	9	Champaign	South	40 05 01.76	88 13 41.25
					West	40 01 31.43	88 11 41.22
12	11/9	M	4	Wind farm	East	40 28 59.71	88 30 56.17
					North	40 24 46.05	88 32 42.52
13	11/9	E	5	Champaign	South	40 05 01.76	88 13 41.25
					West	40 01 31.43	88 11 41.22
14	11/10	E	9	Wind farm	East	40 28 59.71	88 30 56.17
					North	40 24 46.05	88 32 42.52
15	11/11	M	6	Farm site	East	40 32 13.89	88 16 17.03
16	11/12	E	7	BMI airport	East	40 29 23.16	88 54 07.95
17	11/13	M	3	Farm site	East	40 32 13.89	88 16 17.03
18	11/13	A	2	Farm site	East	40 32 13.89	88 16 17.03
19	11/13	A	12	Farm site	East	40 32 13.89	88 16 17.03
20	11/14	A	8	Farm site	East	40 32 13.89	88 16 17.03
21	11/14	E	7	Dwight, IL	West	41 10 11.58	88 21 32.26
22	11/15	E	2	Wind farm	East	40 38 38.83	88 33 15.68
				Wind farm	North	40 24 46.05	88 32 42.52
23	11/16	E	10	Indiana	North	39 56 15.83	86 29 14.31
24	11/17	E	3	S. Champaign	East	40 01 31.43	88 11 41.22
25	11/19	A	1	S. Champaign	South	40 05 01.76	88 13 41.25

Mission #	Date	Nearest WSR-88D	Nearest Sounding	Surface wind direction	Surface wind speed (kt)	Topic 1	Topic 2	Weather
1	11/3	KILX	KILX	0	0	Ground clutter mapping		Clear, cold, windy
2	11/4	KILX	KILX			Sun angle calibrations		Clear, cold, windy

		KILX	KILX	310	9		Boundary layer rolls	Cloud streets, windy, cold
3	11/4	**KILX**	KILX	355	13	Convective showers		Convective showers with graupel
4	11/5	KILX	KILX	320	7	ADM plant plume	Boundary layer rolls	Cold, strong N wind
5	11/5	**KIWX**	KILX or KDTX	320	7	Lake Effect storms		Strong shore parallel band inch/hr snow
6	11/6	KILX	KILX	0	0	ADM plant plume		Clear, weak winds
7	11/6	KILX	KILX	185	2	Ground clutter mapping	Leaf burning plume	Clear, cool, light breeze
8	11/7	KILX	KILX	175	9	Wind farm generated turb.		Strong southerly winds, cold
		KILX	KILX					
9	11/7	KILX	KILX	205	6	Wind farm generated turb.		moderate southerly winds, cold
		KILX	KILX					
10	11/7	KILX	KILX	205	6	Ground clutter mapping		
11	11/8	KILX	KILX	185	8	Ground clutter mapping		warm, dry
		KILX	KILX					
12	11/9	KILX	KILX	170	4	Wind farm generated turb.		weak southerly winds, warm
		KILX	KILX					
13	11/9	KILX	KILX	185	6	Ground clutter mapping		warm, dry
		KILX	KILX					
14	11/10	KILX	KILX	150	10	Wind farm generated turb.		weak southerly winds, very warm
		KILX	KILX					
15	11/11	KILX	KILX	180	4	Contrail cirrus		warm, dry
16	11/12	KILX	KILX	130	4	distant frontal clouds	TDWR mock scans	warm, dry
17	11/13	**KILX**	KILX	200	9	cold frontal passage		warm, windy, rain when front passed
18	11/13	**KILX**	KILX	200	9	cold frontal passage		warm, windy, rain when front passed
19	11/13	**KILX**	KILX	260	10	cold frontal passage		cold after frontal passage
20	11/14	KILX	KILX	205	6	cirrus and small cumulus		cool, dry

21	11/14	**KLOT**	KILX	205	6	weak frontal rainband		cool, drizzle
22	11/15	KILX	KILX	170	3	Wind farm generated turb.		cool, moderate wind, dry
		KILX	KILX					
23	11/16	**KIND**	KILX	350	5	wrap-around on cyclone	2 soundings- 0 an 2 UTC	raining
24	11/17	KILX	KILX	325	7	stratiform clouds	airplanes	cloudy and cold
25	11/19	KILX	KILX	205	5	cirrus	ground clutter	cool, dry