

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

The University of Illinois at Urbana-Champaign was awarded a 17-day campus deployment of a Doppler on Wheels (DOW) for classroom-instruction (in ATMS 410, Radar Meteorology, ATMS 313 Mesoscale Meteorology, and ATMS 505 Weather Analysis and Forecasting), outreach (tours of the facility to undergraduates in ATMS 100, General Meteorology and ATMS 120, Severe and Hazardous Weather, and to the public, as well as visits to a middle school), and research (the plan was for undergraduates will use the data for ATMS 492, Capstone Undergraduate Research Experience, in Fall 2012). 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 2012 (UIDOW12) Project had three principal objectives:

- 1. Enhance instruction in three courses ATMS 410, Radar Meteorology, ATMS 313 Mesoscale Meteorology, and ATMS 505 Weather Analysis and Forecasting.*

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 23 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 a final class assignment. ATMS 313, Mesoscale Meteorology, covers many aspects of mesoscale meteorology. Fundamental to mesoscale meteorology are radar observations. The DOW visit allowed 14 undergraduates in this course to understand basics of radar operation and see phenomena, such as boundary layer rolls and gravity waves, as they are depicted on a radar display. The course ATMS 507, Weather Analysis and Forecasting, introduced 6 graduate students to the basics of

weather and forecasting. The students use WSR88D radar throughout the course, and the DOW permitted them to understand better the nature of radar measurements.

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*

Undergraduates in Atmospheric Sciences at the University of Illinois can elect to take a senior capstone research or professional experience. Formally, students register for ATMS 492 and receive 4 credit hours for this experience. We plan to use the DOW data as a potential vehicle to conduct research experiences for some undergraduates.

4. *Use the DOW for outreach at a nearby Middle School*

The DOW was taken to a local middle school and students in several classes were given tours of the facility and learned how it is used to study severe weather.

5. *Public tours of the DOW were offered. The DOW was featured on the front page of the News Gazette, in an article in the same papers "Environmental Almanac" and on a local TV station on the morning show and evening news.*

2. Deployments and Class Procedures

The DOW was deployed from Champaign, IL to numerous sites within a 1 hour radius of the University. The sites, weather, and primary faculty at the deployment are listed in Table 1. The complete schedule for the deployments are listed in Table 2.

Table 1: Missions during UIDOW 2012

DAY	DATE	TIME	Latitude	Longitude	Orientation	Mission weather	Scientist	
Saturday	April 14, 2012	6:00 am to Noon	39.32277	88.39699	South	Multicellular convection	Frame	
Saturday	April 14, 2012	Noon to 6:00 pm	39.9492213	88.986142	Unknown	Stratiform rain	Nesbitt	
Saturday	April 14, 2012	6:00 pm to midnight	39.68839	88.26514	North	Towering Cu, LLJ, Insect bloom	Frame	
Sunday	April 15, 2012	6:00 am to Noon	No mission					
Sunday	April 15, 2012	Noon to 6:00 pm	39.72008	89.79958	East	Brief showers, light rain	Frame	
Sunday	April 15, 2012	6:00 pm to midnight	39.83012	89.28913	East	Light rain, LG to S, Mod rain, Frequent LG	Frame	
Monday	April 16, 2012	6:00 am to Noon	No mission					
Monday	April 16, 2012	Noon to 6:00 pm	40.02487	88.25702	344 deg	BL rolls, stratiform clouds, shear layer	Rauber	
Monday	April 16, 2012	6:00 pm to midnight	40.04343	88.23426	East	Dissipating fair wx cu, clear air	Frame	
Tuesday	April 17, 2012	6:00 am to Noon	40.094618	88.022867	East	clear-train passed on tracks, gnd clutter	Rauber	
Tuesday	April 17, 2012	Noon to 6:00 pm	No mission					
Tuesday	April 17, 2012	6:00 pm to midnight	40.163507	87.531216	South	Clear air-Bug bloom after sunset	Rauber	
Wednesday	April 18, 2012	6:00 am to Noon	No mission					
Wednesday	April 18, 2012	Noon to 6:00 pm	General Education Class tours					
Wednesday	April 18, 2012	6:00 pm to midnight	40.189534	88.170503	North	Ground clutter, sun spike, insect bloom	Rauber	
Thursday	April 19, 2012	6:00 am to Noon	40.189534	88.170503	North	Stratocumulus cloud layer	Rauber	
Thursday	April 19, 2012	Noon to 6:00 pm	General Public tours					
Thursday	April 19, 2012	6:00 pm to midnight	40.05868	88.44492	North	Virga from AS, few cu below AS, sunspike	Frame	
Friday	April 20, 2012	6:00 am to Noon	No mission					
Friday	April 20, 2012	Noon to 6:00 pm	40.16176	87.531204	North	Cold frontal passage with precipitation	Rauber	
Friday	April 20, 2012	6:00 pm to midnight	40.171015	87.219318	South	Departing cold frontal band to east	Rauber	
Saturday	April 21, 2012	6:00 am to Noon	40.04343	88.23389	West	Dissipating stratus-fair wx cu	Frame	
Saturday	April 21, 2012	Noon to 6:00 pm	No mission					
Saturday	April 21, 2012	6:00 pm to midnight	40.469152	88.763192	West	Wind farm plumes-clouds-ice cloud with sundg	Rauber	

Sunday	April 22, 2012	6:00 am to Noon	No mission				
Sunday	April 22, 2012	Noon to 6:00 pm	40.46916	88.76321	West	Wind farm plume	Frame
Sunday	April 22, 2012	6:00 pm to midnight	39.88227	88.86038	70-80 deg	ADM plant plume	Frame
Monday	April 23, 2012	6:00 am to Noon	No mission				
Monday	April 23, 2012	Noon to 6:00 pm	40.469197	88.763409	West	Wind farm, BL rolls, Ground clutter	Rauber
Monday	April 23, 2012	6:00 pm to midnight	40.02487	88.25702	344 deg	Dissipating BL rolls, cirrus	Rauber
Tuesday	April 24, 2012	6:00 am to Noon	Visit-Mahomet Junior High School				
Tuesday	April 24, 2012	Noon to 6:00 pm	No mission				
Tuesday	April 24, 2012	6:00 pm to midnight	DOW generator failed				
Wednesday	April 25, 2012	6:00 am to Noon	No mission				
Wednesday	April 25, 2012	Noon to 6:00 pm	No mission				
Wednesday	April 25, 2012	6:00 pm to midnight	No mission				
Thursday	April 26, 2012	6:00 am to Noon	40.46916	88.76321	West	Wind farm plume	Nesbitt
Thursday	April 26, 2012	Noon to 6:00 pm	Visit-Mahomet Junior High School				
Thursday	April 26, 2012	6:00 pm to midnight	No mission				
Friday	April 27, 2012	6:00 am to Noon	No mission				
Friday	April 27, 2012	Noon to 6:00 pm	39.88227	88.86038	70-80 deg	ADM plant plume	Nesbitt
Friday	April 27, 2012	6:00 pm to midnight	40.04343	88.23426	East	low stratus, showers to west move over	Rauber
Saturday	April 28, 2012	6:00 am to Noon	40.04343	88.23426	West	altostratus with waves on inversion, sunspike	Rauber
Saturday	April 28, 2012	Noon to 6:00 pm	40.04343	88.23426	West	shallow as, with deeper stratiform to west	Rauber
Saturday	April 28, 2012	6:00 pm to midnight	39.771577	88.220536	West	Tstorms and anvils	Rauber

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The DOW deployment was right up to the end of the Spring Semester, so a complicated project was not possible to give to the students for this deployment. Instead, we developed homework problems using the data. Below is the assignment from ATMS 410, Radar Meteorology:

Viewing DOW Radar Data for frontal passage

ATMS 410 HW 8

Due 5/2/12

For this assignment you will work with your same DOW project group to examine DOW radar data using Solo. The data was collected during the one frontal passage over the time period the DOW was in town. Hand in one homework per group.

There are 3 main steps you will need to follow:

- 1. Log in to Monsoon.**
- 2. Navigate to the directory with the radar data you wish to view and open Solo.**
- 3. Generate plots and answer questions.**

More specifically:

1. Open the start menu on a computer in the Synoptic Lab. Click on “Run...”.

A window with the title “Run” will open up. There will be an area where you can type in the middle of that window. Type and enter:

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“\\atmos-breeze\export\solo.bat”
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You may be asked if you want to trust the server. Say yes.

A new window will pop up prompting you to enter your password for monsoon. Enter the password you use for Compass and hit enter.

You should now be logged into monsoon.

2. Type in “cd /home/monsoon/a/class/atms410/2012/D*/20120420” – note the space after “cd”. This will take you to the directory where the data for this

assignment are stored. If you type in “ls”, a list of all the files in that directory will show up on the screen.

Not surprisingly, the file with SUR towards the end contains data from a surveillance scan and the file with RHI towards the end contains data from a RHI scan.

While in that directory, type “soloii”. A new window will open up – You have now opened Solo and can view the radar data.

3. Viewing data:

It is important that you DO NOT click “x” to close out of any windows in Solo. This can make the program unstable and cause it to close suddenly. Always click on “cancel” to close out any tabs.

Select a particular file - right click on the soloii window and left click on “Sweepfiles” and left click on “Sweeps”. Select the file with the time 19:46:01.000 by left clicking on it. This is a 5.1 degree surveillance scan across the frontal clouds. After selecting the file, click “OK” on the “Sweepfiles” window.

Change the number of products you are viewing - right click on the soloii window click on the “Config” tab at the top of the soloii window. You can now select the dimension of the plot you are looking at (e.g., 2x2).

Change the type of product displayed in each panel of the plot - right click on the panel of soloii you want that product displayed in. Left click on “Parameters + Colors”, then select the product you wish to display. Click “OK”. Specifically select examples DBZHC: reflectivity, ZDR: differential reflectivity, VEL: radial velocity, and RHOHV: correlation coefficient.

If the images are not centered, re-center image Left click on the image where you want the image to be centered, left click on the “Center” tab and select “Last click”.

Zoom if you want to - Left click on the “zoom” tab at the top of the window and select how much you want to zoom in on the image.

Saving an image – Go to the File menu on Solo then pick “Set Image directory”, and you’ll get a dialog box. You’ll need to position the windows such that this dialog box does not cover the radar image.

Don't change the directory, just click "Make PNG Image" and the image file will appear in the solo-images directory window that automatically opens when you run solo.bat

No image cropping is necessary.

Your Assignment

1. Save, and print the image and hand in with your assignment
2. Examine the image and answer the following questions:

There is a cold frontal boundary over the radar and a melting layer.
Calculate the altitude of

- 1) The Cold frontal surface
- 2) The base of the melting layer
- 3) The top of the melting layer

You may use simple trigonometry (ignoring earth curvature) to do these calculations (so you only need distance from the radar and elevation angle).

- 4) State which variable(s) you used to identify the frontal surface and the melting layer, and what you looked for in those variables.

Part II: In this part of the assignment, you will examine a surveillance scan at 0.5 degrees from the DOW which shows the frontal band, and a WSR-88D level 2 scan of the same band at near the same time. The WSR-88D file is on COMPASS in the Homework 8 directory. It is a compressed (zip) file. Download the file and unzip it. Then use GRAnalyst to open the file. While you have this file open in GRAnalyst, open the corresponding file from the DOW in SOLO. To do this:

- 1) Left click "Config" and select 1×1
- 2) Right click on panel and left click on sweepfiles
- 3) Left click on sweeps
- 4) Find the file 19:46:26.000
- 5) Click OK

1. Save and print each image and hand in with the assignment.
2. Compare and contrast the two images, specifically, the width of the band, the typical and maximum reflectivity observed in the band, and any differences in

the band structure you might note. Write a short summary of reasons why these differences exist.

Part III: View an RHI scan through the front from the DOW and reconstructed from the 88D

- 6) Left click “Config” and select 1×1
- 7) Right click on panel and left click on sweepfiles
- 8) Left click on sweeps
- 9) Find the file 19:40:23 (an RHI)
- 10) Click OK
- 11) Recenter and zoom until you can see the cloud clearly
- 12) Do reflectivity. Save the image and turn in with homework.
- 13) Do radial velocity. Save the image and turn in with homework

On GRAnalyst do an east-west vertical cross section across the band.

- 1) Display reflectivity and save the image
- 2) Display radial velocity and save the image.

- 3) Compare the features you can see on this cross section in both reflectivity and velocity with the features that appear on the RHI from the DOW in the same fields. Save the 0.5 degree scan. Create a vertical cross section across the storm in GRAnalyst. Save the cross section.

Groups on first deployments:

- 1) Emily Hogan, Ana Ortiz, Thomas Ventimiglia (April 16, noon-6pm)
- 2) Mark Savin, Amanda Schulz, Zach Weinhoff (April 17 6 am to noon)
- 3) Sean Brokaw, Jacqueline Costello, Alex Goodman (April 17, 6 pm to midnight)
- 4) Kelsey Lyons, Andy Manaster, Clay Matheny (April 18, 6 pm to midnight)
- 5) Gabe Donndelinger, Patrick Edwards, Kyle Yaffe (April 19, 6 am to noon)
- 6) Vince Carretti, Rebecca LaPorta, Brandon O’Berry (April 19, 6 pm to midnight)
- 7) Eric Frederico, Robert Fritzen, Ben Wallace (April 20, Noon to 6 pm)
- 8) Andrew Kumler, Matt Zweibruck (April 24, 6 pm to midnight)

Below is the assignment from ATMS 313, Mesoscale Meteorology:

Viewing DOW Radar Data of Mesoscale Processes

ATMS-314 HW #10 Due Thursday, May 3, 2012

For this assignment, you will examine DOW radar data using Solo. The data was collected over the time period the DOW was in town.

There are 3 main steps you will need to follow:

- 4. Log in to Monsoon.**
- 5. Navigate to the directory with the radar data you wish to view and open Solo.**
- 6. Answer questions.**

More specifically:

1. Open the start menu on a computer in the [Synoptic Lab](#). Click on “Run”.

A window with the title “Run” will open up. There will be an area where you can type in the middle of that window. Enter: [\\atmos-breeze\export\solo.bat](#) (without quotes). You may be asked if you want to trust the server. Say yes.

A new window will pop up prompting you to enter your password for monsoon. Enter the password you use to log in to the machines and hit enter. You should now be logged into monsoon.

2. Type “cd /home/monsoon/a/class/atms410/2012/D*/” – note the space after “cd”. This will take you to the directory where the data from the DOW are stored. If you type in “ls”, a list of all the files (or subdirectories) in that directory will show up on the screen. For example, data collected on April 14 will be in the directory 20120414. Dates are determined by UTC time. To change into any of these subdirectories, you may type “cd directory_name.” Typing “ls” will then list the contents of this directory. If you wish to return to the parent directory, type “cd ..” (i.e., cd space dot dot).

Not surprisingly, the files with SUR toward the end contain data from a surveillance scan, the files with PPI contain data from a sector scan, and the files with RHI toward the end contain data from an RHI scan.

While in a directory with sweep (radar data) files, type “soloii”. A new window will open up – You have now opened Solo and can view the radar data.

3. Viewing data:

It is important that you DO NOT click “x” to close out of any windows in Solo. This can make the program unstable and cause it to close suddenly. Always click on “cancel” to close out any tabs.

Select a particular file - Right click on the soloii window and left click on “Sweepfiles” and left click on “Sweeps”. For example, you can select a file from the time 19:46:01.000 by left clicking on it. After selecting the file, click “OK” on the “Sweepfiles” window.

Change the number of products you are viewing - Select on the “Config” menu at the top of the soloii window. You can now select how many windows you are viewing at once (e.g., 2x2 or 2x1). I recommend at least two – one for reflectivity and one for velocity.

Change the type of product displayed in each panel of the plot - Right click on the panel of soloii in which you want that product displayed. Left click on “Parameters + Colors”, then select the product you wish to display. Click “OK”. Specific examples are DBZHC = reflectivity, ZDR = differential reflectivity, VEL = radial velocity, and RHOHV = correlation coefficient.

If the images are not centered, re-center image - Left click on the image where you want the image to be centered, left click on the “Center” menu at the top of the window and select “Last click”.

Zoom if you want to - Left click on the “zoom” tab at the top of the window and select how much you want to zoom in or out on the image.

Saving an image – Go to the File menu on Solo then pick “Set Image directory”, and you’ll get a dialog box. You’ll need to position the windows such that this dialog box does not cover the radar image.

Don't change the directory, just click "Make PNG Image" and the image file will appear in the solo-images directory window that automatically opens when you run solo.bat. No image cropping is necessary.

Changing range rings - Right click on the soloi window and left click on "View." In the left column, you can select a different value for the range rings (rings plotted at a constant distance, regardless of PPI or RHI, from the radar). Changing this can be useful for viewing zoomed in data. The value is the first number listed after "Rings (km) & Spokes (deg)."

1. Examine the RHI image collected at 14:14:09 UTC 14 April. Is this a single-cell, multi-cell, or supercell thunderstorm? Explain.

2. On the RHI collected at 14:25:59 UTC 14 April, can you identify the rear-inflow jet into this system (remember that the velocities are multiplied by a factor of negative one and may be folded in certain instances)? What is its approximate altitude?

3. Compare the 2.6° PPI scans taken at 00:39:10 UTC and 02:00:15 UTC 15 April. Why are the reflectivities greater on the scan taken later that evening (it was not precipitating)?

4. Compare the 5.6° PPI scans taken at 00:40:08 UTC and 02:01:13 UTC 15 April. What mesoscale process is causing the velocities to be stronger on the second image? Note that the front of the truck was pointing north, so down on the image is south in truck-relative coordinates. An archived synoptic map is available here:
http://www.hpc.ncep.noaa.gov/html/sfc_archive.shtml

5. Examine the volume scan (series of surveillance scans) that was collected beginning at 02:01:43 UTC 16 April. Why does the area of higher reflectivity appear to shrink with increasing elevation angles (it was precipitating)?

6. Examine the series of RHIs taken immediately after this volume scan. At what approximate height is the melting level? How were you able to tell?

7. Is this melting level roughly consistent with the 00Z 16 April KILX sounding? (Data available here: <http://weather.uwyo.edu/upperair/sounding.html>) Explain.

8. Examine the volume scan taken beginning at 00:24:35 20 April. Why does the region above the DOW appear to be free of echo, especially on the higher elevation scans? (You may wish to look at an RHI scan or the 00Z KILX sounding to help you.) What does this suggest is causing the radar echo?