Final Report

Geoscience Education and Outreach of Weather in New York using the DOW at Hobart & William Smith Colleges II (GEO-WIND-HWS-II) Project

Neil Laird (laird@hws.edu) and Nicholas Metz (nmetz@hws.edu)
Department of Geoscience
Hobart and William Smith Colleges
300 Pulteney Street
Geneva, NY 14456

Summary: The Doppler on Wheels (DOW) deployed to Hobart and William Smith Colleges (HWS) from 20 February to 8 March 2015. The objectives of the visit were to (1) allow students to gain experience in field collection of weather radar data, (2) enhance student knowledge and understanding of conventional and dual-polarization weather radars, (3) introduce real-time forecasting activities as part of determining DOW radar project deployment timing and location, and (4) conduct several outreach events to provide the college community (i.e., students, staff, and faculty) and the general public across New York State opportunities to tour the DOW facility and learn about weather research.

Project: The GEO–WIND–HWS-II project focused on observing high-impact weather systems in the central New York/Finger Lakes region. In particular, the DOW radar collected data during weather events, such as mixed-phase precipitation and warm-frontal snow. Students not only gained valuable experience in the field collection of data, but also honed their real-time forecasting, communication, and presentation skills.

Students in GEO 260 Weather Analysis and GEO 355 Mesoscale and Severe Weather played a significant role in the GEO–WIND–HWS II project. GEO 260 is an intermediate-level course taken by students during a semester following their completion of our introductory meteorology course. GEO 355 is an advanced course taken by students further along in atmospheric science curriculum. Both of these classes contain a component that focuses on forecasting. Thus during the GEO-WIND-HWS II project, students in each of classes took turns in providing daily DOW deployment forecasts for the next day. On each day, the assigned students created a three paragraph forecast. The first paragraph described anything interesting that was forecast to occur over the eastern half of the United States (synoptic forecast). The second paragraph discussed the meteorological impacts and conditions forecast within the DOW deployment area (mesoscale forecast; Fig. 1). Finally, the third paragraph included a deployment recommendation for the DOW that was considered when deciding upon potential operations for the following day. These forecasts were disseminated to all meteorology students at HWS. Thus, students were exposed to the challenges and time constraints of real-time forecasting. This assignment is shown in the appendix of this report.

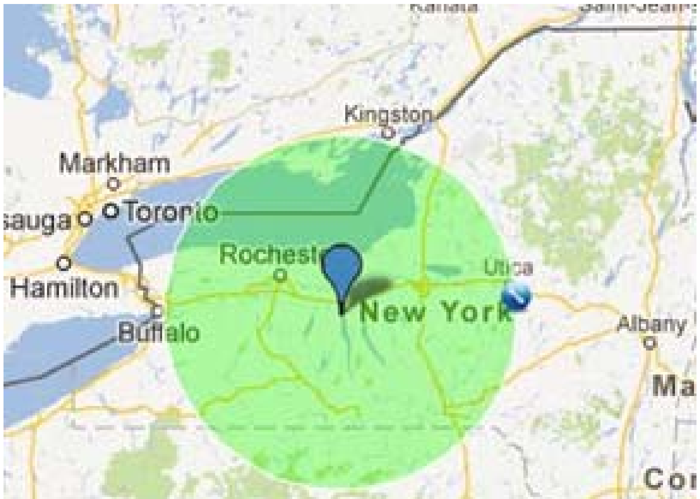


Figure 1: Region for potential DOW deployment during the GEO–WIND– HWS project. The blue marker indicates the location of HWS.

Furthermore, students in GEO 262 *Polar Meteorology* were required to participate in the various outreach activities held during GEO-WIND-HWS-II. As a part of these activities, students utilized large 6' x 3' vinyl posters that were created during GEO-WIND-HWS-I. These thirteen posters described different aspects associated with radar meteorology and severe weather. A sampling of these posters is shown in the appendix of this report. At each outreach event, a number of the posters were set up and in conjunction with the DOW itself and served as a springboard for discussion with visitors to the DOW event. The Office of Communication at HWS also posted an article about the visit of the DOW radar to HWS for the education and outreach project. (http://www.hws.edu/dailyupdate/NewsDetails.aspx?aid=18511).

In addition, students in Introduction to Meteorology (GEO 182) utilized DOW radar data in classroom exercises. This class of 42 students completed a lab exercise that focused on the DOW and weather radar data after taking a complete tour of the mobile weather radar. Several students in GEO 182 also were individually trained in the operational procedures of the DOW radar.

Students who participated in both meteorological and outreach deployments predominately came from the three upper level classes (GEO 260, GEO 262, and GEO 355). Additionally, students from GEO 182 who completed the in-class lab and were interested in participating in the deployments also completed the DOW training.

In total, the pool of participating students in the deployments numbered around 40. Each of these students signed up to participate in multiple periods during the GEO–WIND–HWS-II project should a deployment occur. An additional 40–45 students gained experience with the DOW radar through the introductory classroom lab activities. In order to add to the data collecting experience, rawinsondes were launched during many of the deployments and were subsequently analyzed by students.

Deployments: All students from the upper-level classes and those who were interested in deploying with the DOW from the introductory classes participated in a one-hour training session between 20 February and 22 February. These students met with DOW technicians, Traeger Meyer and Alicia Gilliland, in small groups of 1–3 students. These training sessions introduced students to the basic procedure to operate the DOW radar and prepared each student for participation in DOW deployments.

Table 1: DOW deployment dates.

Date	Deployment Type	# of HWS Student Participants	# of Attendees for Outreach Event
20 February	Outreach	4	80
22 February	Outreach	5	75
25 February	Outreach	4	50
27 February	Outreach	3	120
28 February	Outreach	6	150
1 March	Operations	10	n/a
2 March	Outreach	9	70
3 March	Operations	7	n/a
6 March	Outreach	3	300
7 March	Outreach	0	150
	Totals	**51**	**995**

1. 20 February 2015: This day featured the first DOW outreach activity. Professor Laird gave a "Friday Faculty Lunch" talk about weather radars, the DOW radar, and the OWLeS field project. Approximately 75 faculty colleagues and administrative staff at HWS attended. Afterwards, faculty and students were invited out to the DOW. Approximately 80 people visited the DOW. A photo from this outreach event is shown below[1].

2. 22 February 2015: For this outreach activity, the DOW traveled to the Ithaca Sciencenter. Approximately 75 people toured the DOW during the three hours it was stationed outside of the museum. HWS students also launched a weather balloon during the deployment to show visitors another way in which meteorologists collect atmospheric data.

[1] All photos are courtesy of Hobart and William Smith Colleges.

3.   25 February 2015: The DOW was parked near the center quad of the HWS campus on this day as students from Professor Metz's Introduction to Meteorology class completed radar-related lab activities and toured the radar. In addition, a number of HWS students and staff stopped by the DOW and were given impromptu tours by the DOW radar technicians and upper-level GEO students. Photos from this event are shown below.

4.   27 February 2015: During this outreach event, the DOW visited Midlakes (Phelps–Clifton Springs) High School. Five separate science classes (~120 students) toured the DOW radar and had opportunity to view the outreach posters to discuss severe weather and weather radars. In addition, HWS faculty and student participants provided a brief question and answer session with the Midlakes students lasting about 15–20 minutes per class.

5. 28 February 2015: The next outreach event featured a visit to the Rochester Museum and Science Center from 10AM – 4PM. Approximately 150 people visited the DOW radar and viewed the outreach banners.

6. 1 March 2015: The first operations period came eight days after the beginning of GEO-WIND-HWS-II. The first week of the project featured extremely quiescent weather conditions. On this day, a surface low-pressure system passed to the south of Geneva and the radar was able to sample warm-advection snow at a deployment location just south of Geneva. Students were deployed in the field for over 10 hours collecting data with various scanning strategies.

7. 2 March 2015: This outreach event was held at the studios of WROC-TV (CBS-8) in Rochester, NY. The DOW, HWS faculty, and students were featured repeatedly in live segments on the 5, 530, and 6 PM newscasts. Broadcast meteorologists Scott Hetsko and Matt Jones interviewed Professor Metz and student Macy Howarth live on the air. In addition, approximately 70 community members toured the DOW truck in between live shots. Photos from this event are shown below.

A portion of the footage from the WROC-TV visit can be found at the following link:
http://www.rochesterhomepage.net/story/d/story/new-mobile-doppler-technology-helping-meteorologis/41904/etGWIVJ9ZkCwTqWdT2c4MQ

8. 3 March 2015: The final data collection deployment of the GEO-WIND–HWS-II project occurred to the south of Geneva as the dual-polarization radar sampled an area of mixed-phase precipitation associated with a slow-moving extratropical cyclone. Data was collected during intermittent periods of snow, sleet, and rain with pronounced mesoscale bands in the precipitation with observation of low-level convergence.

9. 6 March 2015: The DOW, along with Professor Laird and three students traveled to Burnt

Hills–Ballston Lake High School in eastern New York. This outreach activity featured discussions with almost 300 students for three hours during the morning along with a discussion that centered on many of the outreach posters and additional meteorological instrumentation, such as tornado pods and mobile rawinsonde systems.

10. 7 March 2015: the final outreach activity took place at the 40th Northeastern Storm Conference in Saratoga Springs, NY. During breaks in the conference, participants were invited to tour the DOW. The conference has around 400 participants, of which, about 150 toured the DOW facilities.

Student Research: HWS places significant focus on undergraduate research by developing opportunities in class during the academic year, as well as offering student opportunities to conduct more comprehensive research projects during the long-running Summer Research Program on the HWS campus. The real-time collection of data and the dissemination of information during outreach events about weather research and the opportunities to study atmospheric science as part of the Geoscience curriculum at HWS were of benefit to the students. These opportunities piqued many students interest and two of the HWS students who participated in GEO-WIND-HWS-II applied and were accepted to work with Professors Laird and Metz during the 2015 HWS Summer Research Program.

Instructor Perspectives: The GEO-WIND-HWS-II project was very successful in introducing students at HWS to the field collection of weather radar data. While a number of students who participated in the project were already majoring in Geoscience with a concentration in atmospheric science, a number were still undeclared first-year/sophomore students. Out of this undeclared pool of students, a number subsequently declared a major, with some expressing interest in conducting field research. Professor Metz had 12 students from his Introduction to Meteorology class train on the DOW and many participated in operations and outreach events.

The outreach events and tours of the DOW radar were very successful in large part from the participation of HWS students. They played a large role in interacting with the people of all ages visiting the DOW radar. The student discussed a variety of weather-related topics with visitors, as well as discussing the workings of the DOW radar when visitors had a chance to climb inside the DOW radar. Not only did our students gain hands-on experience with a weather radar and enhance their understanding of radar operations and data, they also gained experience in discussing and presenting scientific information with the general public. The informational posters were a successful resource for providing information to DOW radar visitors on several aspects of weather radars and weather systems.

Finally, from a forecasting perspective, students learned a tremendous amount from their daily DOW deployment forecasts. While learning how to forecast through artificial in-class activities is a vital part of a meteorological education, students seemed much more invested in their forecasts when they knew that they would play a role in whether or not the DOW radar would be deployed. Each student had the opportunity to create two forecasts across the timeframe of the GEO–WIND–HWS-II project and they almost universally improved as they gained forecasting experience and had the opportunity to read other student forecasts. Professor Metz notes that these forecasting experiences carried over into other parts of student's classroom experience and helped them to achieve at a high level.

We look forward to the possibility of requesting the DOW radar for a future education and outreach project.

Appendix A: GEO 260/GEO 355 DOW Forecasting Assignment. All students in these two classes issued two separate DOW forecasts that were disseminated to all participants in the GEO-WIND-HWS-II Project. The assignment has been reproduced below.

Task:

For the next couple of weeks, the Doppler on Wheels (DOW) will be stationed on campus. We will be going on deployments based upon the local weather conditions in the region. We plan to deploy within a one-hour radius of Geneva.

You will create a three-paragraph forecast (~2–2.5 pages single spaced) on the day you are scheduled. The forecast will be for the next day and will take the following format. The first paragraph will describe anything interesting that is going to occur in the eastern half of the United States (focus both on synoptic and mesoscale weather). The second paragraph will discuss the meteorological impacts and conditions forecast near Geneva, NY (distinctly mesoscale). The final paragraph will include a deployment recommendation for the DOW. Do you recommend that we deploy the next day? If so, what type of weather will we be sampling? Is there a particular location near Geneva that we should consider?

For example, if a strong low-pressure system and cold front are situated in the eastern United States, this should be discussed in the first paragraph. Perhaps this cold front will leave the Geneva region with strong winds and three hours of snow between 3 PM and 6 PM. Following the frontal passage, lake effect snow may set up under WNW winds over Syracuse from 6 PM until Midnight. This information should appear in the second paragraph. Finally given this information, your recommendation might be that we set-up shop with the DOW just north of Geneva beginning around 4 PM. This would let us sample the cold frontal passage and then “see” lake-effect snow.

Your forecast for the following day **is due to me by 9 PM the day prior and should cover the 6 AM to Midnight period the following day!** For example if you are due to forecast for Friday, your forecast should include 6 AM until midnight on Friday, and is due to me by 9 PM on Thursday. You may use any source you wish to create your forecast and should include 7–10 images embedded in your forecast. Be sure to reference each figure you include. The more specific you can be in your forecast the better. Once you send me the forecast, I will disseminate it via email to the students in GEO 355, GEO 182, GEO 260, and GEO 262 (those that may take part in a deployment). My GEO 260 class will also be creating similar forecasts. I will provide the first forecast as a guide (see schedule below).

Grade:

Your forecast will be graded in the following method.

1. 20 points: Scientific Reasoning

   Your grade will not be based on the accuracy of your forecast, but rather the scientific reasoning you use. For example, if you discuss a cold front, describe a bit about the conditions it will bring. How fast will it move through our region? What will the weather be like behind it? If there is lake-effect snow, where will the major accumulations set up? Why? You are free to ask me questions in the days leading up to your forecast.

2. 5 points: Scientific Writing

   Your forecast should be carefully written and edited. Remember that I will be sending your forecast out to many other people and we will be using it in order to make a decision if we should deploy the DOW. Thus, it is important that you write clearly and concisely. The conclusions you reach in the third paragraph of your forecast should reflect the weather you discuss in the first two paragraphs. The local impacts you discuss in paragraph two should relate to the large-scale weather that is ongoing in the eastern portion of the United States that you describe in paragraph one.

Appendix B: A sampling of outreach posters used during GEO-WIND-HWS-II outreach events are included below. Posters were displayed at locations surrounding the DOW radar during outreach events to promote discussion with visitors while waiting to tour the inside of the DOW radar.

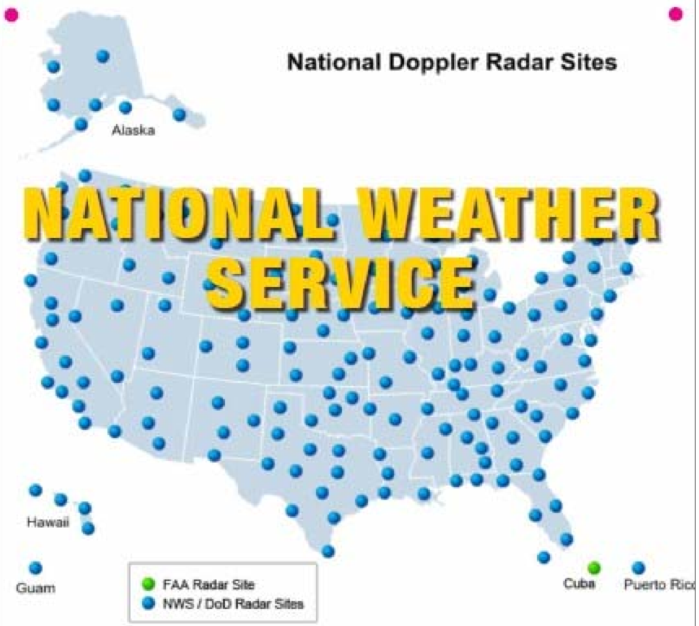
DOPPLER-ON-WHEELS (DOW)

Mobile Weather Radar

- The Center for Severe Weather Research (CSWR) owns and maintains a fleet of three DOW mobile radars. CSWR is led by atmospheric scientist Dr. Joshua Wurman and is funded primarily by the National Science Foundation since its creation in 1995.
- The mobility of the DOW radar allows for monitoring and collecting data of tornadoes, hurricanes, lake-effect snow squalls, mountain snow storms, supercell thunderstorms, thunderstorm microbursts, and dust devils.
- DOW radar has observed nearly 150 tornadoes at close range and intercepted the eye of 11 land-falling hurricanes
- DOW measured the most intense winds ever recorded (Bridge Creek, 3 May 1999) – a wind gust of 318 mph within an EF-5 tornado.
- DOW weighs 26,000 pounds and measures 8 ft. wide x 27 ft. long x 14 ft. tall
- DOW has never seen flying cows in tornadoes, but has observed flying snakes in hurricanes

Department of Geoscience

HOBART AND WILLIAM SMITH COLLEGES



NATIONAL WEATHER SERVICE

WSR-88D RADARS

- The National Weather Service (NWS) operates a network of about 160 Doppler radars in the U.S. to monitor storm systems in real-time.
- The name WSR-88D is short for Weather Surveillance Radar – 1988 Doppler, but is more commonly known as the NEXRAD radar. It is a S-Band radar with a 10-cm wavelength.
- Most WSR-88D radars are located at airports in order to gauge the weather of the immediate surroundings for smooth take-offs and landings. These radars help to monitor severe conditions such as icing, severe fog, high winds, and thunderstorms that cause dangerous flying conditions.
- The NWS network of WSR-88D radars provides unparalleled information when monitoring the current weather. However, these radars cannot help with weather forecasts – that is the job of weather forecast computer models.
- The National Weather Service radar network is currently being upgraded with DUAL-POL to allow them to better estimate of the size, shape and variety of hydrometers. This will lead to better flash flood detection, easier differentiation between heavy rain, hail, snow and sleet, improved detection of non-meteorological targets (such as birds), identification of the melting layer, and detection of aircraft icing conditions.

Department of Geoscience

HOBART AND WILLIAM SMITH COLLEGES

Basics – PART 1

- Radars were first used to monitor weather systems shortly after World War II. Before then, radars were primarily used to identify the location of airplanes by the Army, Navy, Air Force, and civilian air traffic controllers.
- Radars emit pulses of energy as radio waves into the atmosphere. Once these pulses hit a target, some of the energy then returns to the radar and provide information about precipitation type, size, and concentration (number in a volume of air), as well as location.
- Radars emit radio waves in a conical beam. The "radar beam" often rotates 360 horizontally around the radars position to survey the atmosphere. With each rotation, the radar increases its elevation angle to look higher in the atmosphere.
- As the pulse of energy moves outward along the radar beam axis, it is spread over a larger volume of the atmosphere. Think of a cone – with the point being the radar location.
- Most weather radars can "see" storms out to about 100 – 250 miles from their location.
- Although radars do emit directed radiation to observe storms, the average power from radars is 100 times less than the limit for maximum permissible exposure for human beings.

Department of Geoscience

HOBART AND WILLIAM SMITH COLLEGES

Basics – PART 2

- The strength of the energy that returns to the radar from a distant target is called the REFLECTIVITY. The reflectivity is characterized by different colors that indicate the intensity of rainfall, snowfall, or hail in storms.
- The PPI (Plan Position Indicator) scan used by radars offers a 360 degree survey of the atmosphere surrounding the radar location. Continuous surveillance scanning by weather radars is used to monitor changes in position and strength of storms every few minutes.
- Weather radars are used to monitor changes that storms undergo. Radars do not help predict weather conditions beyond 1-2 hours. This short-term forecast of 1-2 hours is called NOWCASTING.
- Weather radars also can often "see" insects, birds, and bats flying in the atmosphere. Scientists have begun using information from the U.S. weather radar network to watch bird migration patterns.

Department of Geoscience

HOBART AND WILLIAM SMITH COLLEGES

TORNADOES

- A TORNADO WATCH is issued when the atmosphere has conditions favorable for tornadoes to form.
- A TORNADO WARNING is issued when a tornado has been observed by a person or the National Weather Service radars have observed significant rotation within the severe thunderstorm.
- Tornadoes occur most often in TORNADO ALLEY – area spread across the central U.S. including the 10 states of Texas, Kansas, Oklahoma, Florida, Nebraska, Iowa, Illinois, Missouri, Mississippi, and Alabama (presented in order of greatest number of tornadoes).
- The strength of a tornado is determined by the damage it causes not by measuring its wind speeds directly. The amount of damage is related to wind speed by the Enhanced Fujita Scale (EF-Scale). The EF-Scale ranges from EF-0 (weakest) through EF-5 (strongest).
- The DOW mobile radar has measured winds of greater than 300 miles per hour in an EF-5 tornado.
- Ingredients needed for tornadoes to form:
  1. Vertical wind shear; winds change speed and/or direction with increasing height
  2. Warm moist air lifted within severe thunderstorm updraft
  3. Air temperature cooling rapidly with height above ground
  4. Circular rotation within severe thunderstorm updraft

Department of Geoscience

HOBART AND WILLIAM SMITH
COLLEGES

HURRICANES

- The word hurricane comes from the Taino Native American word, hurucane, meaning evil spirit of the wind.
- Hurricanes are one form of TROPICAL CYCLONES. Tropical cyclones are also called TYPHOONS (in western north Pacific Ocean), CYCLONES (in Indian and western south Pacific Oceans), and HURRICANES (in eastern north Pacific and north Atlantic Oceans)
- Before a storm becomes a hurricane, it first starts as a TROPICAL DISTURBANCE, then strengthens to a TROPICAL DEPRESSION, and then can intensify to a TROPICAL STORM. A tropical storm is classified as a hurricane once wind speeds increase to 74 miles per hour or higher.
- The most violent winds and heaviest rains take place in the EYE WALL, the ring of clouds and thunderstorms closely surrounding the eye.
- Every second, a large hurricane releases the energy of 10 atomic bombs as water vapor (gas) is converted to cloud and raindrops (liquid) during condensation. This energy is called LATENT HEAT RELEASE.
- Hurricanes can also produce tornadoes. They are not as strong as regular tornadoes and often last only a few minutes.
- Most people who die in hurricanes are killed by the towering walls of sea water that come inland called STORM SURGE.
- Hurricane season is from June to November when the oceans are at their warmest and the tropical atmosphere is warm and moist.

Department of Geoscience

HOBART AND WILLIAM SMITH
COLLEGES