Facility Request Form for Educational Activities

Part I: General Information

Requestor Name	Adam Houston
Institution and Address	University of Nebraska – Lincoln
Phone and Email	(402)472-2416 ahouston2@unl.edu
Faculty Advisor Name (if student requestor)	

Part II: Project Description

Project Title	UNDEO 2015
Project Location	Central Plains
Start and End Dates of Field Deployment	29 March – 12 April 2015
NSF Facilities requested (type and # of systems)	1 DOW
Number of Expendables requested (if applicable)	

Part III: Educational Activities Description

Number of students actively involved	Graduate: 8 Undergraduate: 8
Desired training activities conducted by Facility Staff including time in the field	On-site training of the students is requested
Desired teaching activities conducted by Facility Staff including time in the field	None, outside of outreach events listed below
Additional special requirements that pertain to Facility support	Request includes a 3-4 day off-campus deployment somewhere in the Central Plains.
Ancillary/Opportunistic Outreach Activities	University Students: Seminar by CSWR staff High School Students: Exhibition to several local high schools and the state Future Farmers of America convention Public: Central Plains Severe Weather Symposium

Part IV: Operational Requirements

Please specify data access needs (e.g., real time)	DORADE sweep files
Please specify data analysis needs	None
Please specify communications needs	UHF/VHF radio

The 2015 University of Nebraska DOW Education and Outreach (UNDEO 2015) Project

1. Introduction

The University of Nebraska[1] is requesting a 14-day on-campus deployment of a Doppler on Wheels (DOW) mobile radar for classroom-instruction and hands-on experience with a cutting-edge radar system. The **U**niversity of **N**ebraska **D**OW **E**ducation and **O**utreach (UNDEO 2015) project has two principal objectives:

1. *Education*: To provide undergraduate and graduate students in *Radar Meteorology* an opportunity to use a sophisticated research radar to collect data for student research projects
2. *Outreach*: To exhibit a valuable NSF-supported facility to a broad audience of current and future scientists, members of the general public, and high school students.

Lessons learned during previous UNDEO projects in 2008, 2011, and 2013 have been used to refine the project scope and learning strategies proposed here.

a. Education

The main goal of the education component of this project is to significantly advance student understanding of weather radar theory and application by enabling students to operate a cutting-edge research radar and analyze the data collected. The primary focus of the proposed project will be on the ~16 students enrolled in *Radar Meteorology*, a course for upper-level undergraduate majors and graduate students in the University of Nebraska – Lincoln (UNL) Meteorology-Climatology program of the Department of Earth and Atmospheric Sciences. Students in *Radar Meteorology* will be trained to operate the DOW and will use the DOW during at least one intensive operations period (IOP), executed somewhere in the US Central Plains, to collect data for use in student research projects that culminate in final term papers. Graduate students in the Meteorology-Climatology program who took a radar meteorology course at their undergraduate institution (~3-5 additional students) will also be invited to receive training in DOW operations. Students in *Radar Meteorology* will also attend a Q&A session administered by a Center for Severe Weather Research (CSWR) staff scientist. This Q&A session will be held during the *Radar Meteorology* class time and is designed to allow students to ask specific questions about the fleet of DOWs and DOW deployments.

A second goal for the education component of UNDEO 2015 is to provide non-majors the opportunity to learn how a cutting-edge research instrument is used to conduct atmospheric science. The focus will be on undergraduates enrolled in the William H. Thompson section of *Severe and Unusual Weather*, a general education course in the Meteorology-Climatology program. The William H. Thompson (WHT) section of this course is a restricted enrollment (~30 students) section that is part of the WHT Scholars Learning Community. WHT scholars have been awarded a Susan T. Buffett Foundation scholarship, eligible to low-income students who have graduated from Nebraska high schools and exhibit strong academic potential. A CSWR staff scientist will illustrate examples of science done using the DOW, exhibit the DOW to the students, and administer a Q&A session.

b. Outreach

The outreach component of UNDEO 2015 will involve the exhibition of the DOW at 1) the Central Plains Severe Weather Symposium (CPSWS) 2) the state convention of the Nebraska Future Farmers of America (FFA), and 3) several Lincoln and Omaha high schools. The CPSWS, organized by Dr. Ken Dewey, targets a broad audience including members of the greater-Lincoln community and students and faculty from UNL. The CPSWS also attracts employees of the nearby NWS office in Omaha/Valley and the Air Force Weather Agency at Omaha's Offutt AFB. Nearly 1,000 people attend the CPSWS each year. A DOW mobile radar was exhibited at the CPSWS as part of UNDEO projects in 2011 and 2013. The Nebraska FFA state convention, held annually in Lincoln, regularly hosts more than 3,500 student

[1] The University of Nebraska – Lincoln has been a UCAR member since 1979.

attendees. A DOW mobile radar was exhibited during the 2013 FFA State Convention as part of UNDEO-3. We also propose to exhibit the DOW deployed for UNDEO 2015 to Lincoln and Omaha high school students through assemblies and small group tours. Informal presentations given by the on-site CSWR technician will aim to illustrate how this complex instrument is used along with the scientific method to conduct atmospheric science.

2. Lessons learned from previous UNDEO Projects

The first, second, and third UNDEO projects took place in November 2008 and March-April 2011, and March-April 2013[2]. While the principal objectives of UNDEO 2015 are largely unchanged, lessons learned from the previous projects have allowed us to refine the scope and strategies of UNDEO 2015:

- As in second and third UNDEO projects, field deployments of the DOW mobile radar to collect data for student projects will not be restricted to the Lincoln area. This flexibility enabled successful data collection in the previous projects.
- The DOW was exhibited in three outreach events at Omaha high schools during UNDEO-3. Our aim is to focus more on Lincoln high schools this year, although 1-2 events at Omaha area high schools are still anticipated.
- As noted in the final report for UNDEO-3, while the students generally found the DOW training to be effective, it appears that there is room for improvement. Predicated on the assumption that the perceived value of the training would improve if students had more opportunities to assess their understanding, in UNDEO 2015, a second "DOW Exercise" will be administered. This second assignment will be completed the second week of the educational deployment.

3. Educational Activities

As stated in Section 1, the main educational goal of UNDEO 2015 is to significantly advance student understanding of weather radar theory and application by enabling students to operate a cutting-edge research radar and analyze the data collected. In order to achieve this goal, students in *Radar Meteorology* will participate in the following activities:

1. Students will identify a scientific question that can be answered with data collected by the DOW during the project.
2. Students will be trained by a staff member of CSWR to operate the DOW.
3. Students will complete 2 "lab" exercises that use the DOW to explore fundamental concepts in radar theory.
4. Students will develop an experiment design to use the DOW to collect data necessary for their proposed research projects.
5. Students will operate the DOW during the primary IOP anywhere within ~800 km of Lincoln that targetable meteorological phenomena are predicted for the predetermined date. Students may also use the DOW for supplementary IOPs near Lincoln.
6. Students will process and analyze the data collected and synthesize their results into final term papers.

Individual graduate students and undergraduates in small groups will be asked to choose a research project focused on phenomena associated with deep convection and/or an airmass boundary. Airmass boundaries were successfully targeted in all three previous UNDEO projects and deep convection was successfully targeted in both of the warm-season UNDEOs. Students will be given the freedom to determine the specific focus of their projects, but each project will be vetted by the PI in his review of project abstracts, submitted 2 weeks prior to the DOW's arrival on campus. Example topics from previous UNDEOs include,

[2] More information on UNDEO-3, including the final report, can be found at https://www.eol.ucar.edu/field_projects/undeo-3

- Comparison of Deep Convection on GOES East Imagery to High Resolution Radar Data
- Cold Pool Depth Detection Using Radar Analysis with the aid of the Propagation Speed Equation
- Structure of Outflow Surges
- The Impact of Spatial Resolution on the Velocity Field: A Comparison between DOW and WSR-88D Data
- Comparison of a Thunderstorm Gust Front Observed by the DOW to Density Current Theory
- Modification of a Gust Front by an Urban Area

Approximately 2 days of training are scheduled for the ~16 students in *Radar Meteorology* and 3-5 additional students in the Meteorology-Climatology program. Immediately following the training, 2 days will be reserved for the students in *Radar Meteorology* to complete the first exercise which has been developed to further acquaint them with the operation of the DOW and to enable exploration of fundamental concepts in radar theory. A second exercise will be assigned the second week of the on-campus deployment. An example exercise is included as a supplement below.

Prior to the planned IOP, students in *Radar Meteorology*, along with the instructor/PI, will develop a general experiment design. In this planning meeting the students will collectively determine the scanning strategies necessary to collect the data required for their projects.

The date for the IOP will be set ahead of time to ensure that all students can participate. "Laboratory Fees" are collected from all students enrolled in *Radar Meteorology* as part of their tuition/fees. These funds will be used to cover student travel and lodging.

Radar operations during the deployment will be performed by the students working in shifts. The cooperative nature of such an activity has the ancillary benefit of fostering teamwork amongst the students. The IOP will also engender a sense of ownership of the data; a perception that will invariably add value to both the data sets and the projects that are crafted from them.

4. Schedule

12 March	Student project abstracts due
19 March	IOP planning meeting
29 March	DOW arrives on campus
30-31 March	DOW operation training
31 March	CSWR staff scientist 1) administers Q&A session for students in *Radar Meteorology* and 2) gives presentation to students in *Severe and Unusual Weather*
1-2 April	DOW lab exercise #1
3-5 April	IOP
6-7 April	DOW lab exercise #2
6-10 April	Outreach activities at Lincoln- and Omaha-area high schools Supplemental DOW data collection in the Lincoln area
10 April	Exhibition of DOW at FFA State Convention
11 April	Exhibition of DOW at Central Plains Severe Weather Symposium
12 April	DOW leaves campus
4 May	Student term papers due

5. Assessment of Student Learning

The success of this project and identification of opportunities for improvement will be assessed using the following vehicles:

- Anonymous survey of the students
  Students will be asked to evaluate how well the learning objectives were met and will also be asked to make recommendations for improvement. The survey used in UNDEO-3 is included as

supplementary material below.

- Two graded assessments in *Radar Meteorology*
  Student learning will also be measured through standard assessment tools (final exam, project report, etc.)

6. Supplementary Material

a. DOW Exercise

METR 463/863 DOW Exercise

Assigned:
Due:

For each question requiring DOW data collection, **capture images** from the Hiq-Hi screen and **include these images in your completed assignment**

Config File	PRF (Hz)	Rmax (km)	Vmax (m/s)	Pulse Length (μs)
educFAR	800/1200	90	19.2	0.8
educCLOSE	2000/3000	30	47.9	0.4

Questions in blue can be answered before/after going to the DOW

1. Beamwidth [this question doesn't require data collected using the DOW]

   A. The beamwidth of the DOW is approximately 1°. Assuming a typical antenna efficiency for a circular, parabolic reflector that is 1.8 m in diameter, calculate the theoretical beamwidth of the DOW antenna system.

   B. How would the theoretical beamwidth change if the wavelength was 10 cm instead?

   C. How much closer to a target would the DOW need to be if sampling required a beam diameter of 10 m?

2. Clear-air sensitivity to pulse duration

   The sensitivity of the radar depends on the amount of power returned to the radar. As you determined in an earlier homework assignment, the returned power is very sensitive to the pulse duration. In this set of questions you will determine the theoretical impact of the pulse duration and also the practical (qualitative) impact.

   A. Assuming an antenna gain of 43.4 dB, a beamwidth of 1°, and a peak power of 45 kW, plot the minimum *theoretical* logarithmic reflectivity factor (defined based on the linear reflectivity factor $z \equiv \sum_{UnitVol} d^6$) as a function of range (consider a maximum range of 100 km) detected at an MDS of -108.4 dBm for the following pulse durations:
      i. 0.4 μs
      ii. 0.8 μs

B. Discuss the implications of the results from part A in terms of radar sensitivity.

C. Using the educFAR configuration, find the elevation angle that yields a PPI of radar reflectivity factor with a nominal amount of ground clutter and a returns above the noise level out to range as close to Rmax as possible. For this same elevation angle, collect a sweep using the educCLOSE configuration. Making sure to zoom in so that individual bins are clearly visible, discuss any differences that you might see in the resolution and noisiness of the 2 reflectivity fields. Provide theoretical justification for any differences that you might see.

b. Student Survey from UNDEO-3

Student Survey of DOW Deployment

1.	How would you rate the value of Dr. Karen Kosiba's presentation?	Very low	1 2 3 4 5	Very high
2.	How would you rate the length of the on-campus deployment of the DOW?	Too short	1 2 3 4 5	Too long
3.	How would you rate the overall effectiveness of the DOW training, including the DOW exercise, in preparing you to operate the DOW with some assistance?	Not effective	1 2 3 4 5	Very effective
4.	How would you rate the overall helpfulness of Ab Pfeifer both prior to and during the field deployments of the DOW?	Not helpful	1 2 3 4 5	Very helpful
5.	How would you rate the level of involvement of students in the strategic planning of the deployments for data collection?	Too little	1 2 3 4 5	Too much
6.	How would you rate the level of involvement of students in the actual data collection during the field deployments?	Too little	1 2 3 4 5	Too much
7.	How would you rate the benefit of the DOW research project to your understanding of radar meteorology?	No benefit	1 2 3 4 5	Very beneficial
8.	How would you rate the overall benefit of the DOW activities to your understanding of radar meteorology?	No benefit	1 2 3 4 5	Very beneficial
9.	How would you rate the overall benefit of the DOW activities to your career goals?	No benefit	1 2 3 4 5	Very beneficial
10.	How would you rate your overall enjoyment of the activities associated with the DOW visit?	No enjoyment	1 2 3 4 5	Very enjoyable