Student Nowcasting and Observations of Winter Weather with the DOW at University of North Dakota Education in Research (SNOWD-UNDER)

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1. Introduction

The University of North Dakota is requesting a 21-day (November 15 – December 6) on-campus deployment of one of the dual-polarimetric Doppler on Wheels (DOW) radars, managed by the Center for Severe Weather Research (CSWR) for the purposes of

1. Education: providing at least 3 graduate and 20 undergraduate students, in eight Fall 2010 UND Atmospheric Sciences classes, a significant professor-guided hands-on opportunity in planning and conducting components of a field experiment, SNOWD-UNDER;

and

2. Outreach: providing K-12 students in the greater Grand Forks area a tour and overview of the DOW radar by Dr. Wurman, and, pending permission by their parents and teacher, the option of attending and observing data collection. The general public will be informed about the project through UND’s student-produced award-winning Studio One television show and through press releases in the UND Dakota Student and Grand Forks Herald newspapers. In Summer 2011, an overview of the project and its success will be submitted to the Bulletin of the American Meteorological Society.

The facilities are requested for a three-week period at the end of Fall semester to maximize our chances of a winter snow event. (In an average year during that period, there would be four snow events with only one expected to generate a snow depth > 0.1”). UND has a radar technician who can assist with minor unforeseen repair issues related to the DOW so CSWR staff requirements will be minimal.

2. Education Benefits

Students from multiple courses will be responsible for co-writing the operations plan, with guidance from their professors, and learning essential skills during the first part of the semester that will be used during the field experiment. Because the field experiment occurs at the end of a semester, the Fall 2010 semester will focus on planning and data collection while the Spring 2011 semester will focus on analysis. The field experiment will be conducted in conjunction with the following UND courses, many of which will be taken by the same students, and students in these courses will have the following training and responsibilities:
FALL 2010

• Introduction to Radar Meteorology (AtSc-340; Prof. Gilmore): 7-10 undergraduate students taking this course will plan and conduct triple-Doppler scanning with the 10 cm WSR88D at Mayville, ND, polarimetric 3-cm DOW, and UND’s 5-cm radar - NORTHPOL. Earlier in the semester, students will practice and be responsible for designing various scanning strategies and placement of the DOW relative to the other radars and ground-based observing sensors. They will have also learned the basics behind radar operations, radar parameters that need to be considered, and multi-Doppler radar retrievals using Rinehart’s’ text, Radar for Meteorologists. Our UND course has an extensive series of labs in the beginning of the semester involving our NORTHPOL radar, in which students learn basic radar concepts. SNOWD-UNDER will help students practice their skills as well as give them an additional unique experience in planning a triple-Doppler data collection.

• Measurement Systems (AtSc-535; Prof. Delene): 3-5 graduate students will learn earlier in the semester about the HVPS and CPI instruments on UND’s Citation aircraft (used to observe crystal habits and distinguish snow from liquid droplets) and ground-based disdrometers at Road Weather Research Facility locations. (Approximately 1.5 hours of flight time have been donated by UND AtSc for the purposes of the experiment.) Students will then help collect and interpret in situ observations during the field campaign so that this data can be inter-compared with the DOW polarimetric radar data.

• Synoptic Meteorology (AtSc-411; Prof. Osborne): 10-15 undergraduate students taking this mandatory course will study the synoptic environment and associated climatological characteristics of November/December snow events in Eastern North Dakota and snow forecasting techniques earlier in the semester. They will be responsible for providing a winter storm synoptic feature overview to the rest of the student participants, provide regular weather briefings during the experiment (incorporating both larger scale and regional modeling results where necessary), which will help in coordination of the DOW deployment.

• Numerical Methods (AtSc-405; Prof. Mullendore): 10-15 undergraduate students will be responsible for making recommendations for how regional WRF forecasts will be conducted during the experiment. Earlier in the semester, these students will have practiced simulating past snow events to understand model sensitivities to resolution and microphysics, for instance, and will have discussed the plots needed for the student forecasters. These recommendations will guide regional WRF forecasts (led by a graduate student) during SNOWD-UNDER.

• Broadcast Meteorology (AtSc-315; Prof. Remer): 8-10 undergraduate students will be responsible for writing and producing at least one story about the field experiment and participation with the DOW radar which will be presented on

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1 http://radar.atmos.und.edu/
2 http://stwrc.und.edu/fieldsite/live/index.php
UND’s student-run channel, Studio One as outreach to the community. Studio One is an award-winning news and information program produced at the University of North Dakota Television Center. The program airs on UND Channel 3 and Prairie Public Television. The program can also be seen by viewers in Fargo, Bismarck/Mandan and Minot, ND; Minneapolis, MN; Denver, CO; and Winnipeg, MB. Viewers can also watch at [www.studio1.und.edu](http://www.studio1.und.edu).

- **Internship (AtSc-497):** Undergraduate or graduate students who have a strong desire to participate in a leading role in the field experiment may enroll in this course and be supervised by one of the aforementioned professors in tasks related to project planning and operations.

- **Senior Project (AtSc-492).** Additionally, there may be one or more senior students who choose to help in data collection as a part of their capstone research.

In the Spring 2011 and 2012 semesters after the experiment is over, the following courses plan to use the datasets that are collected.

**SPRING 2011**

- **Radar Meteorology (AtSc-441; Prof. Gilmore):** 5-10 upper level undergraduate & graduate students taking this elective course will conduct triple-Doppler wind retrievals from the KMOV WSR88D, DOW, and NORTHPOL and will conduct hydrometeor identification algorithm retrievals using polarimetric fields from the DOW and NORTHPOL radars. The datasets collected in SNOWD-UNDER will then be compared to the in situ datasets (both ground-based and aloft) that were collected. Analysis software is already maintained at UND (SOLOII, CEDRIC, and REORDER) and will be used by students in analyzing events that are collected. Because the NORTHPOL and DOW operate at different wavelengths, there is a unique opportunity to study the dual-wavelength technique for distinguishing graupel and rimed snow from pristine snow crystals and how this technique compares to the fuzzy logic hydrometeor ID retrieval algorithms using polarimetric and in situ data.

- **Senior Project (AtSc-492) or Thesis (AtSc-998):** 1-5 senior undergraduate students or 1-2 graduate students may perform observational or WRF modeling projects related to the snow observations that were collected. Preference will be given to students most actively involved in the planning and field operations.

Also professors may guide individual students who pick thesis topics involving the events where data were collected. It is anticipated that preliminary analysis of results from this study will be used to motivate future NSF-funded snow studies, helping to support both graduate and undergraduate student theses, here at UND.
3. Overview and Summary of Experiment’s Educational Benefits

The timing of the deployment will be ideal as students in the Fall 2010 classes will have had time to learn the essential skills that will be used to plan and conduct the experiment together, with guidance of the professors. Then students in Spring 2011 will focus on analysis. Spanning over two semesters will give more time for a careful and thoughtful data collection and analysis. Students will be asked to think carefully about their measurement objectives and to design experiments that address real research questions. Students in Intro to Radar will know how to plan and set up a dual Doppler scans and coordinate with students in Measurement Systems who are trained on interpretation of in situ measurements with the Citation aircraft and ground-based sensors. Students in Numerical Methods will know how to interpret and guide the forecasts using ensemble of regional scale forecasts while students taking Synoptic Meteorology will know the synoptic/dynamic characteristics of typical Northern Plains snow events and how to forecast them. These essential forecasting activities will provide students an opportunity to experience the realities of operational weather forecasting and the challenges and excitement it affords.

Students will have already developed the operations manual, with professor guidance, prior to the beginning of the event that details all aspects of data collection and cooperation among the various students. Then, the first few days of deployment, a staff person from CSWR will visit to train the students who will be operating the DOW radar. Dr. Josh Wurman will also visit that same week to give an overview of the different types of research that has been done with the DOW.

Having the DOW radar will provide a hands-on and unique learning experience that will be much improved over what is possible with our existing fixed-site radar and which will improve our analysis and interpretation of the events that are studied. The research-quality in situ and remotely sensed data will also benefit senior-level undergraduates and graduate students who are seeking additional experience in radar data editing, analysis, and who are interested in studying snow events in their thesis projects. Students will also benefit in the more advanced Radar Meteorology follow-on course, AtSc-441 in Spring 2011, along with graduate students who will learn how to conduct a triple-Doppler wind retrieval (in conjunction with the UND 5 cm radar and Mayville WSR88D) using the NCAR REORDER and CEDRIC software, which are already being used at UND for other case studies.

4. Outreach

In addition to the above-mentioned courses, Atmospheric Science undergraduates (85 total) and graduate students (26 total) will be invited to attend an overview seminar of the DOW radar by Dr. Josh Wurman and are free to observe and possibly help with operational tasks. Other interested students from other majors and K-12 schools will also be invited to the talk at UND’s Chester Fritz Auditorium (2400 seats) and to tour the facilities. Thus, the potential impact on other students and community is much greater than those who will be directly involved in planning and carrying out operations. The K-12 teachers in UND’s Professional Development for Educators (and their classrooms), and interested educators from around North Dakota and Minnesota who are identified through the Dakota Science Center will be invited to the introductory talk by Dr. Wurman. Once approved by NSF, announcements will be made in UND AtSc courses, the local American Meteorological Society meeting (frequented by AtSc majors), through mail, and in both the Dakota Student and Grand Forks Herald newspapers. Student interns at the NWS who are participating in the project will also coordinate any real time collection with local National Weather Service (NWS) employees.
5. Learning Assessment

Because students will know from the beginning of the semester that the DOW is coming and significant excitement will be generated amongst all of our courses that are participating in the field experiment, students are expected to perform better in all of these courses compared to previous years.

The research experience using the DOW in the field project and student learning will be assessed using proven learning assessment techniques that were developed at the University of Colorado with funding from the National Science Foundation\(^3\).

\(^3\) http://spot.colorado.edu/~laursen/accessURSSA.html