Proposal Requesting to use NSF Facilities for Education

Project: ‘TOM: Teaching flow Over Mountains’

Requestor:
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Requested Facility:  CSWR Rapid Scan Doppler on Wheels, for Boulder, CO area.

Length of the deployment:  1 March – 15 April 2011

Note: Our goal is to obtain data from two snow events. Ideally, the requested time would start in the beginning of March and end after two snow events have been collected or at the latest 15 April 2011.

Dates of the deployment:  2 snow events during the deployment period

Description of education activity

This activity is a collaborative effort between the Dept. of Atmospheric and Oceanic Science (ATOC) at the U. of Colorado (CU) and the Dept. of Marine, Earth, and Atmospheric Sciences (MEAS) at North Carolina State University (NCSU). We request the Rapid Scan DOW to be deployed in the Boulder, CO area to observe snow storms along the foothills during the spring semester 2011. The instrument will be used in the CU undergraduate courses ATOC 1050 (Weather and the Atmosphere) and ATOC 4500 (Weather Analysis and Forecasting). The resulting data will be used in the aforementioned CU courses and the NCSU course MEA511 (Introduction to Meteorological Remote Sensing). The goal of this activity is to enhance undergraduate and graduate student learning in the atmospheric sciences by providing hands-on instrument experience and data analysis for CU students, and a practical application of scan strategy design and data analysis for NCSU students. While teaching the fundamentals of “flow over mountains” at introductory and advanced levels is important, another goal of this activity is to educate students about field measurements, fundamentals of selection and evaluation of data, and assuring data quality and reliability.
The Rapid Scan Doppler on Wheels radar will be used to show distributions of wind and reflectivity at various heights and distances from the Front Range during snow events. The data will also be used to relate reflectivity observations to the snow amounts measured at the surface, as well as detail the interaction between upstream flow and the mountainous terrain.

The CU education activity emphasizes undergraduate classes which have the broadest representation of student background, experience, and major discipline. This is in keeping the goal to improve science accessibility for a large sector of the student population. These students will be entering primarily non-scientific careers in politics, international affairs, communication, education, and business.

The NCSU education activity is focused on senior meteorology majors and first year atmospheric science graduate students. These students are taking remote sensing as an elective and have career goals to work in the National Weather Service, national laboratories and academia. The cornerstone of the course is a group project which involves developing a radar climatology for a particular location and season (based on WSR-88D radar). Groups then design and justify a radar hardware set-up and scan strategy well suited to observing the precipitation phenomena of interest. See http://precip.meas.ncsu.edu/radarpredicts/index.html for poster presentations on the projects from previous years. Using the Rapid Scan DOW for educational purposes will provide NCSU students with experience in the practical outcomes of their scan strategy designs, and also with the utility of a rapid scan radar (which is representative of the future US operational radar network).

Groups of CU students will be responsible for taking measurements with the Rapid Scan DOW. Both CU and NCSU students will have access to ATOC Skywatch Laboratory instruments (http://skywatch.colorado.edu) deployed on the roof of the Duane physics building on University of Colorado campus. Routine measurements conducted by the National Weather Service (NWS), (e.g. measurements from weather radar, soundings, surface station and rain gauges) will also be made available to the students.

A key requirement for NCSU participation is the availability of web-based data perusal images containing individual elevation angle PPIs and individual azimuth angle RHIs within 24 hours after data collection. Ideally, this web interface would facilitate browsing of successive elevation angles for PPI (or azimuths for RHIs sectors) as well as movie loops of the same elevation angle (or RHI azimuth) over time. We would prefer a VCHILL-like interface for the Rapid Scan DOW to allow for remote classroom use of the instrumentation and more detailed data interrogation and analysis. However, our understanding is that the older processor on the Rapid Scan Dow does not currently facilitate real-time data communication. Hence we are requesting imagery within 24 hours of data collection.

This project will integrate radar meteorology into the ATOC graduate and undergraduate student curriculum, focusing on research and classroom use of Doppler radar data sets. The collected data will also be used in other graduate and undergraduate
courses in fall 2011:

- At CU-- ATOC 3300 (*Analysis of Climate and Weather Observations*), ATOC 4720 (*Introduction to Atmospheric Physics and Dynamics*), ATOC 5235 (*Introduction to Atmospheric Radiative Transfer and Remote Sensing*), ATOC 5600 (*Physics and Chemistry of Clouds and Aerosols*),
- At NCSU--MEA213 (*Fundamentals of Meteorology I*, first semester freshman meteorology majors), and MEA715 (*Dynamics of Mesoscale Precipitation Systems*, advanced graduate class).

**Usage of instruments**
Radar measurements will be obtained with the help of CU students during university hours (Monday-Friday; 8am – 6pm). During the intensive observation periods (IOPs), 2 CU students at a time will actively be involved in the real-time data collection. Depending on the duration of the event and the availability of students, each group should spend ~1.5 hours at the radar site. For a 12-hr event, 8 students will have the opportunity to operate the Rapid Scan DOW radars. The radars will run in predefined plan-position indicator (PPI) and range-height indicator (RHI) scan strategies that will be designed by the NCSU students.

**Usage of data**
Concepts of upslope winter storms, flow over mountains, and radar principles will be introduced to each class prior to the experiment. Students will be encouraged to actively observe the weather for the relevant period of the learning activity, especially as part of CU’s ATOC 4500. During the observation period, important details such as the synoptic set-up, unique characteristics of upslope precipitation events, and the interaction between flows and terrain will be discussed at the appropriate level of detail during class.

**Number of students:**

University of Colorado: A maximum of 2 students at a time will assist in operating the Rapid Scan DOW. Depending on the event and student availability, students will operate the radar for 1.5-hour shifts (i.e. during a 12-hr event a total of 8 students will be able to accomplish measurements). Radar observations will be used for ATOC 1050 (~300 undergraduate students) and ATOC 4500 (~20 undergraduate students).

North Carolina State University: Enrollment in MEA 511 typically consists of 12 seniors and 8 graduate students though exact numbers vary year to year.
Appendix I – Facility Request Form for Educational Activities

Part I: General Information

| Requestor Name | +Dr. Katja Friedrich & Dr. Julie Lundquist  
*Dr. Sandra Yuter |
|----------------|--------------------------------------------------------------------------|
| Institution and Address | +Department of Atmospheric and Ocean Sciences  
University of Colorado  
UCB 311  
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*Dept. of Marine, Earth and Atmospheric Sciences  
North Carolina State University  
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1125 Jordan Hall  
Raleigh, NC 27695 |
| Phone and Email | Katja.Friedrich@colorado.edu; 303-492-2041  
Julie.Lundquist@colorado.edu; 303-492-5724  
seyuter@ncsu.edu; 919-513-7963 |

Part II: Project Description

<table>
<thead>
<tr>
<th>Project Title</th>
<th>‘TOM: Teaching flow Over Mountains’</th>
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<tbody>
<tr>
<td>Project Location</td>
<td>Vicinity of Boulder, Colorado</td>
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</table>
| Start and End Dates of Field Deployment | 1 March – 30 March 2011  
(operation during 1-2 events) |
| NSF Facilities requested (type and # of systems) | - One rapid scan DOW |

Part III: Educational Activities Description

| Number of students involved Graduate: | Graduate: ~8 (MEA 511)  
Undergraduate:  
~300 (ATOC 1050)  
~20 (ATOC 4500)  
~12 (MEA 511) |
<p>| Desired training activities conducted by Facility | Short training sessions at the |</p>
<table>
<thead>
<tr>
<th>Staff incl. time in the field</th>
<th>facility</th>
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<tbody>
<tr>
<td>Desired teaching activities conducted by Facility Staff incl. time in the field</td>
<td>None</td>
</tr>
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<td>Additional special requirements that pertain to Facility support</td>
<td>None</td>
</tr>
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Part IV: Operational Requirements

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<tr>
<th>Please specify data access needs (e.g., real time)</th>
<th>Access within 24 hrs</th>
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<tr>
<td>Please specify data analysis needs</td>
<td>Web-based perusal of radar scans (PPIs and RHIS) within 24 hours.</td>
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<tr>
<td>Please specify communications needs</td>
<td>Maybe: High-speed internet for live video streaming inside the radar cabin and transferring images in real-time to a web server at CU.</td>
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