The DOW Radar Observations at Purdue Study 2 (DROPS2)

Final Report to the Earth Observing Laboratory
National Center for Atmospheric Research

submitted by

Jeff Trapp
Department of Earth and Atmospheric Sciences
Purdue University
West Lafayette, Indiana

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1. Introduction

Purdue University was granted the use of a Doppler on Wheels radar (DOW), an NSF Facility managed by the Center for Severe Weather Research (CSWR). The usage period, 5-17 March 2012, ran concurrently with the offerings of EAS 523 *Radar Meteorology*, and EAS 391 *Atmospheric Field Projects*, which had respective enrollments of 9 graduate and senior undergraduate students, and 12 undergraduate students (Fig. 1). PI Jeff Trapp was the instructor of EAS 523, and co-instructor of EAS 391.

Figure 1. DROPS2 participants in Florida.

Following the highly successful model employed in 2009 during DROPS (e.g., Toth et al. 2011), the DOW Radar Observations at Purdue Study-2 (DROPS2) had similar objectives: (1) introduce undergraduate and graduate students to the components and operation of a research radar; (2) allow the students the opportunity to plan and lead multiple data-collection missions; and (3) enable the analysis of radar case studies as part of small group projects. Additionally, the DOW was used as a focal point for K-12 outreach activities with area schools (see Section 3).

A unique addition to DROPS2 was a relocation of our base of operations to Venice, Florida, for a focused, student-led study of the sea breeze and associated phenomena. This occurred over the period 10-17 March. The DOW data of the sea breeze were supplemented with surface meteorological observations from 6 Purdue portable stations, and wind data collected using pibals.

2. DROPS2

2.1 DROPS2 Overview

In preparation for DROPS2, lectures and accompanying laboratory exercises were devoted to devising radar deployment and sampling strategies. Laboratory time was also spent on learning the analysis software, using sample data.

DROPS2 consisted of a Purdue-area component (EAS 523 focus) and a Florida sea-breeze component (EAS 391 focus). These two classes were divided into teams of 3-4 students each, and were responsible for the planning and execution of DROPS2 missions, and for the subsequent data analysis. For the sea-breeze component, each team devised a hypothesis to be tested using the DOW and supplementary data. This required the teams to determine instrument placement (and secure permissions, as necessary) as well as design collection strategies prior to the Florida relocation; identification of potential deployment sites was particularly important (see Figs. 2-3). Hence, the students prepared for DROPS2 in much the same way as degreed scientists propose and plan for large-scale field programs.

During the project, weather briefings and proposed Day 1- Day 2 plans were given each day by the mission scientists (these duties were rotated through all students). Deployment sites and travel logistics, as well as radar parameters [pulse repetition frequency (PRF), antenna rotation, sampling rate, etc.] and scanning strategies were included in the mission plans.

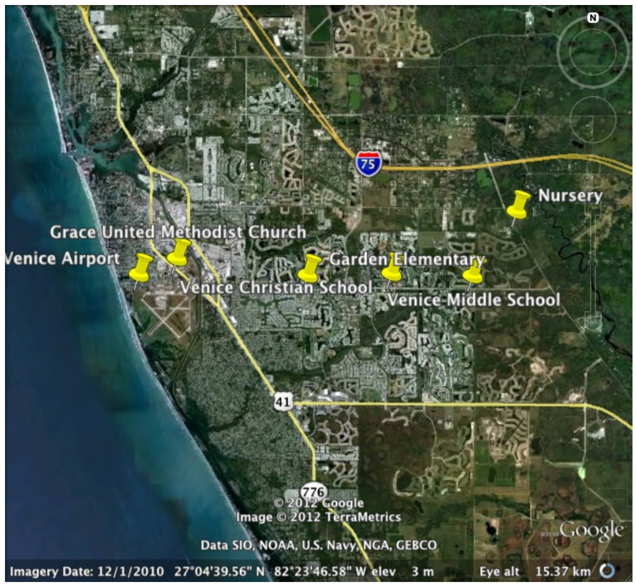

Figure 2. Locations of surface observing systems in Florida, during DROPS2

Figure 3. Two of the DOW deployment sites used to examine the relationship between sea-breeze front structure and shape of the coastline.

Following a day of training (administered by Andrew Arnold of CSWR), a total of 2 missions were executed in the Purdue area, and then 5 missions were executed near Venice, FL (Table 1). Mission summaries and deployment logs were submitted at the end of each mission.

Table 1. Summary of DROPS2 missions.

Date	**Location**	**Description**
3/7/2012	40.49 N, 82.12 W (Otterbein, IN)	altocumulus clouds
3/8/2012	40.21 N, 86.92 W (Romney, IN)	stratiform precipitation
3/11/2012	27.05 N, 81.97 W (Venice, FL)	sea breeze, convective initiation
3/12/2012	27.02 N, 82.28 W (Venice, FL)	sea breeze
3/13/2012	27.39 N, 82.35 W (Venice, FL)	strong sea breeze with highly curved front
3/14/2012	27.19 N, 82.16 W (Venice, FL)	sea breeze, convective storms
3/15/2012	27.39 N, 82.35 W (Venice, FL)	weak sea breeze

Post-event data analysis was accomplished using software such as SOLOii and IDV. The analysis proceeded without incident, owing especially to PI Trapp's experience in DOW-data analysis. All necessary software was available on Purdue computers.

2.2 DROPS2 highlights

The teams prepared written reports and then oral presentations on these events listed in Table 1. The analyses are being compiled into a poster that will be presented during the Student Conference of the American Meteorological Society's Annual Meeting in 2013.

11 March 2012

On 11 March, the very first day of our Florida operations, a significant sea breeze occurred in tandem with the initiation of convective cells (Fig. 4). A subsequent analysis made use of the polarimetric variables. This was a particularly long deployment in the DOW, in a remote setting; this experience helped the students adjust their daily scheduling, and prioritize data collection.

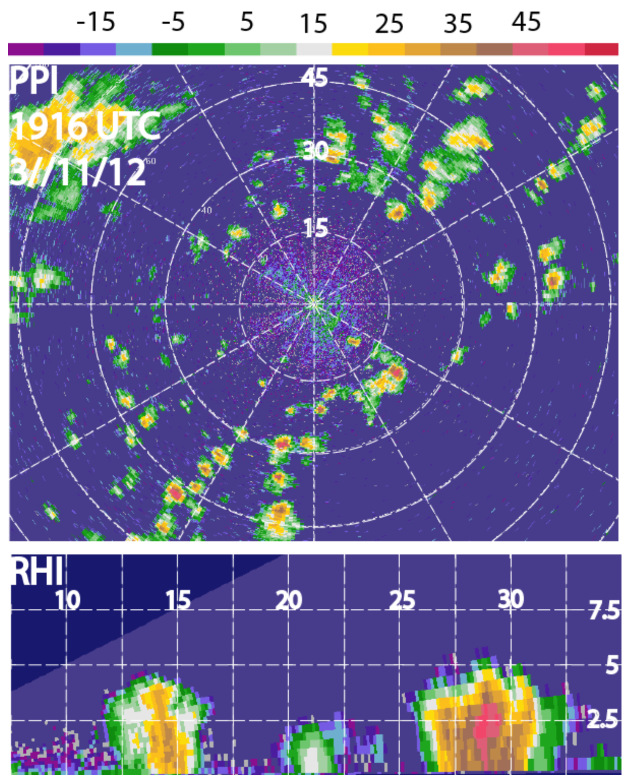

Figure 4. DOW PPI and RHI collected on 11 March, showing structure of convective cells.

13 March 2012

On 13 March, the sea breeze was detected at the MAWS1 site (closest to the coast) at 1815 UTC (Fig. 5). It progressed inland from the southwest at an average speed of 3.65 mph until reaching MAWS2 (farthest inland) at 2010 UTC. Pibal observations at the coast indicated a maximum sea breeze circulation height of 425 m. This corresponded well to the sea-breeze depth as determined in RHIs well inland (Fig. 6). The sea-breeze depth measurements, along with the tracked frontal motion, were used to support one of the hypotheses that a ‘deeper sea breeze will penetrate farther inland’. The front was highly curved on this day, and was used to address a hypothesis that ‘the effect of the coastline curvature on sea-breeze front curvature will diminish with inland penetration’.

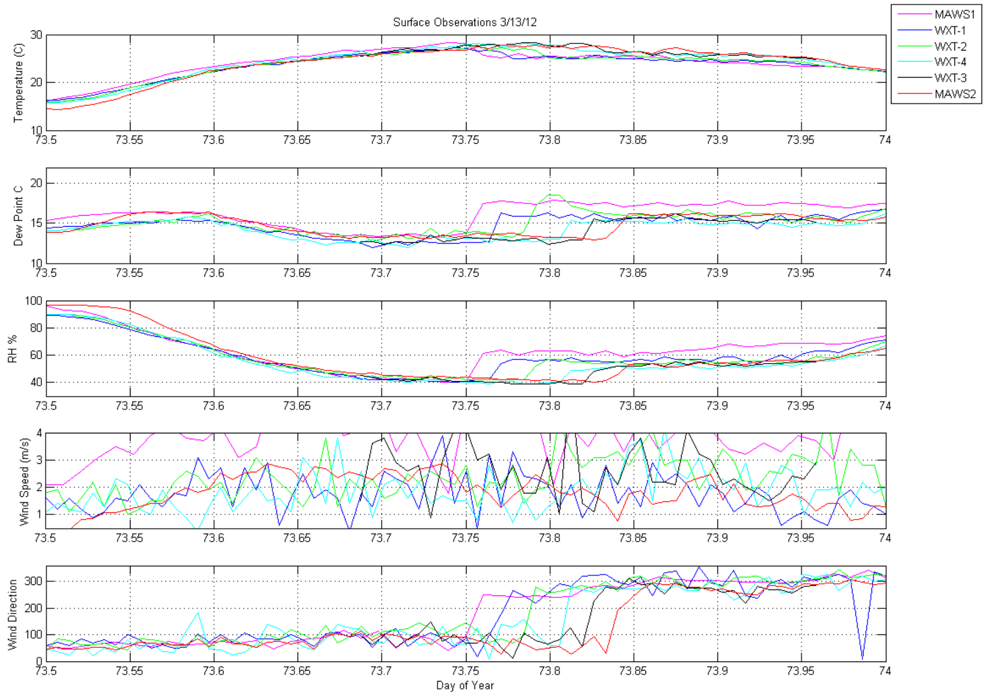

Figure 5. Time series of surface conditions on 13 March 2012, as sampled by Purdue's array of instruments.

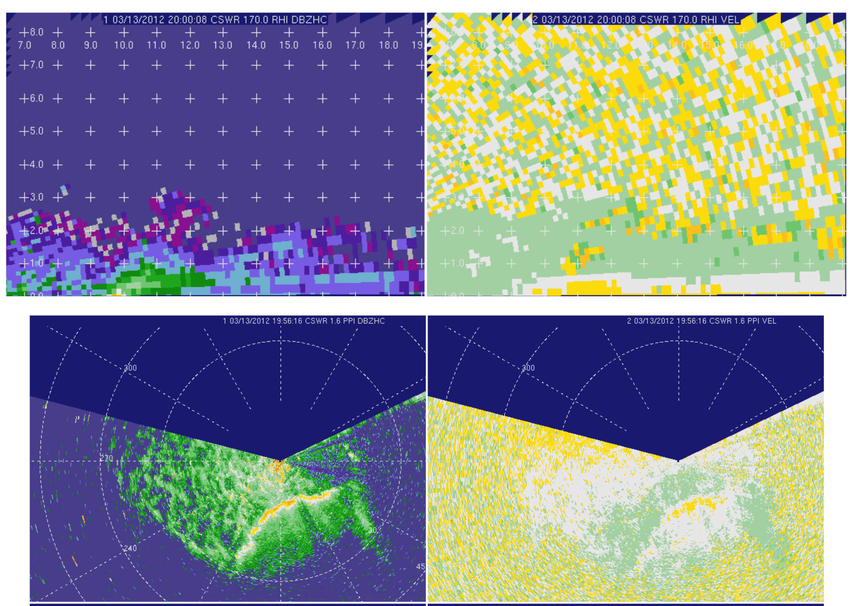

Figure 6. DOW RHI (top) and PPI (bottom) of the sea-breeze front on13 March 2012.

3. Outreach

On two days prior to the relocation to Florida, the DOW was used for community, university, and K-12 outreach activities. The schools were Klondike Elementary, and Klondike Middle (Fig. 7). The total number of K-12 students who viewed the DOW was approximately 200.

Figure 7. DOW prior to the first of several demonstrations to science students at Klondike Middle School in West Lafayette, IN.

Numerous Purdue University students also had the opportunity to see DOW demonstrations and learn more about radar meteorology. These outreach activities were conducted by the PI and various (current and past) students in EAS 523.

We had planned to conduct additional K-12 outreach activities while in Florida, but unfortunately, the schools were on Spring Break during that time. We did, however, give demonstrations to members of the local community.   This turned out to be a valuable learning experience for the undergraduate students, as they attempted to explain both their science objectives and the basics of the instrumentation.

4. Closing comments

One of the challenges university faculty in the atmospheric sciences face is how to develop hands-on learning exercises that engage and interest the students. Part of this challenge is in the identification of atmospheric phenomena that can be consistently observed over limited periods of time. Candidate phenomena are those that are mechanically forced and have scales within the mesoscale range. The sea breeze is one such phenomenon, and for students in the Midwestern U.S., the sea breeze is particularly compelling because it is not something they experience often.

It was extremely beneficial to have the use of a DOW for the sea-breeze focus of DROPS2. When coupled with the surface observations and pibals, it allowed each team a different sub-mission each day, and helped them appreciate the various ways of sampling the atmosphere. It also helped the students better appreciate the (3D) spatial and temporal variations of the atmosphere. Finally, it gave the students a bona fide experience in planning and executing a field program. Indeed, although the PI obviously was involved in every mission, he did very little of the DOW operating. Rather, he or the class assistant (Ph.D. student, and SOARS protégée, Cecille Villanueva-Birriel) mostly nudged the students in one direction or the other, making sure they were collecting data in a safe and sensible (though necessarily his preferred) way.

Toth, M., E. Jones, D. Pittman, and D. Solomon, 2011: DOW radar observations of wind farms. *Bulletin of the American Meteorological Society*, **92**, 987-995.