

Final Report

Outreach and Radar Education in Orography (OREO)

W. James Steenburgh
Department of Atmospheric Sciences
University of Utah
Salt Lake City, Utah
January 2, 2018

The University of Utah Department of Atmospheric Sciences was awarded a 1-month (1 Nov – 1 Dec 2017) deployment of the Doppler on Wheels (DOW7) for:

1. Undergraduate and graduate instruction in polarimetric radar and its use in complex terrain.
2. Student-directed field research.
3. Outreach

This report summarizes the activities and immediate outcomes in each of these areas and serves as the final report for the project. Note that due to extreme drought during November, DOW7 remained at the University of Utah through December 6.

1. Activities and outcomes

a. Instruction in polarimetric radar

Students in several classes gained hands-on instruction in polarimetric radar operations including Atmos 5200: Cloud Physics (9 students), Atmos 6250: Mountain Meteorology (9 students), Atmos 5110: Synoptic Meteorology I (13 students), and Atmos 3910: Special Topics (2 students). For these students, the DOW was operated on the University of Utah campus, although several also elected to join the DOW for some time during field operations.

Six graduate students, referred to hereafter as “OREO PIs” received end-to-end training in all aspects of DOW operations including leveling, scanning strategies, and data management. These six students led DOW operations during all IOPs.

b. Student-directed field research

Prior to the arrival of DOW7, a team of approximately 15 University of Utah students, including the OREO PIs, students enrolled in Atmos 6250: Mountain Meteorology, and students enrolled in Atmos 3910: Special Topics attended a series of lectures on precipitation processes and polarimetric radar operations in complex terrain and prepared proposals for field deployments in the areas of (1) leeward spillover, (2) multiridge effects, (3) lake-effect precipitation, (4) front-mountain interactions, (5) polarimetric issues in complex terrain, and (6) radar investigation of bird migrations. These proposals provided a foundation for DOW deployments during OREO.

DOW deployments were classified as either Educational Observing Periods (EOPs) or Intensive Observing Periods (IOPs). EOPs were training focused and designed primarily for students to learn how to deploy and operate the radar. IOPs involved deployments to examine specific weather phenomenon and were more strongly concentrated on education in radar interpretation and mountain meteorology, with an additional goal of obtaining high-quality datasets for future student research projects. A total of 6 EODs and 7 IOPs were executed (Table 1).

A few highlights from the IOPs are worth noting. During IOP1, the students deployed the DOW in a deep valley to the east (lee) of the northern Wasatch to examine leeside spillover. The event produced a period in which the leeside precipitation downstream of the Wasatch was heavier than upstream. One RHI during the period, shown below, shows the apparent growth, transport, and downstream fallout of hydrometeors crossing the Wasatch Range near Snowbasin (SB).

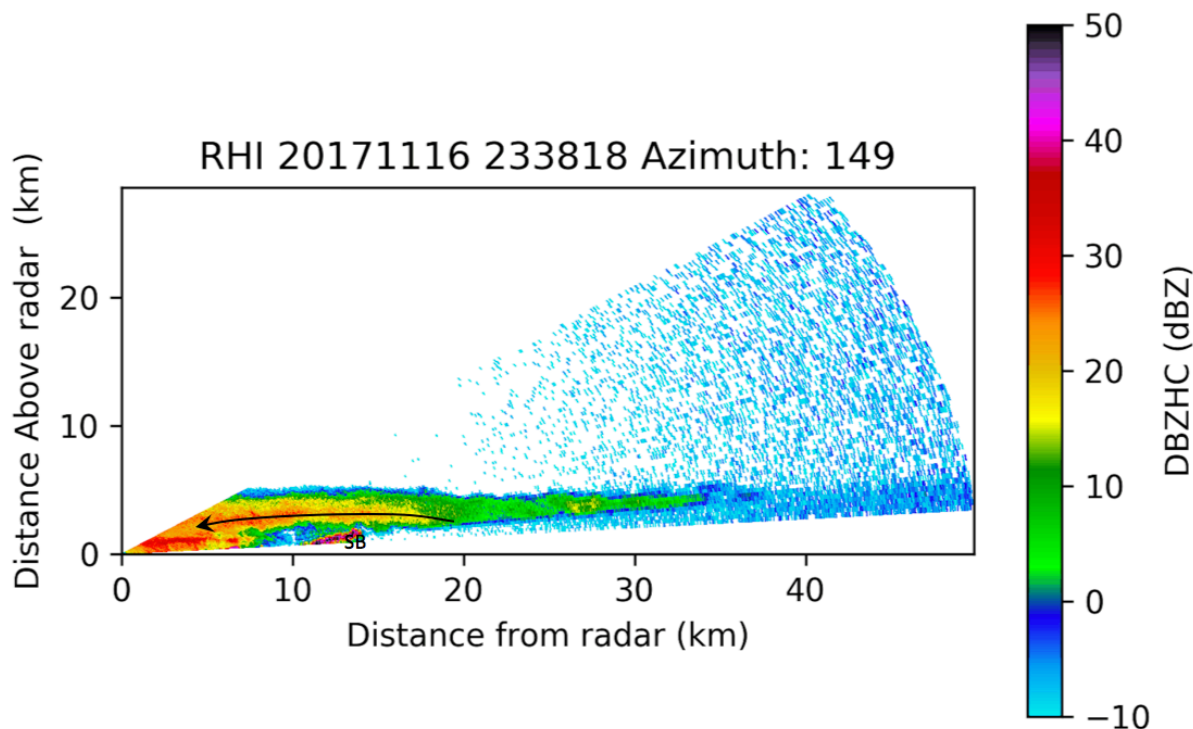


Figure 1. DOW RHI toward the WSW showing precipitation spillover and fallout across the Wasatch Range.

During IOP5 students were able to examine an intense, but shallow cold front as it entered the Tooele Valley. Doppler velocity PPIs of the event illustrated nicely the shallow nature of the post-frontal northwesterly flow (Fig. 2). Analysis of this event will be a centerpiece of the Atmos 5120: Synoptic-Dynamic Meteorology class this spring semester.

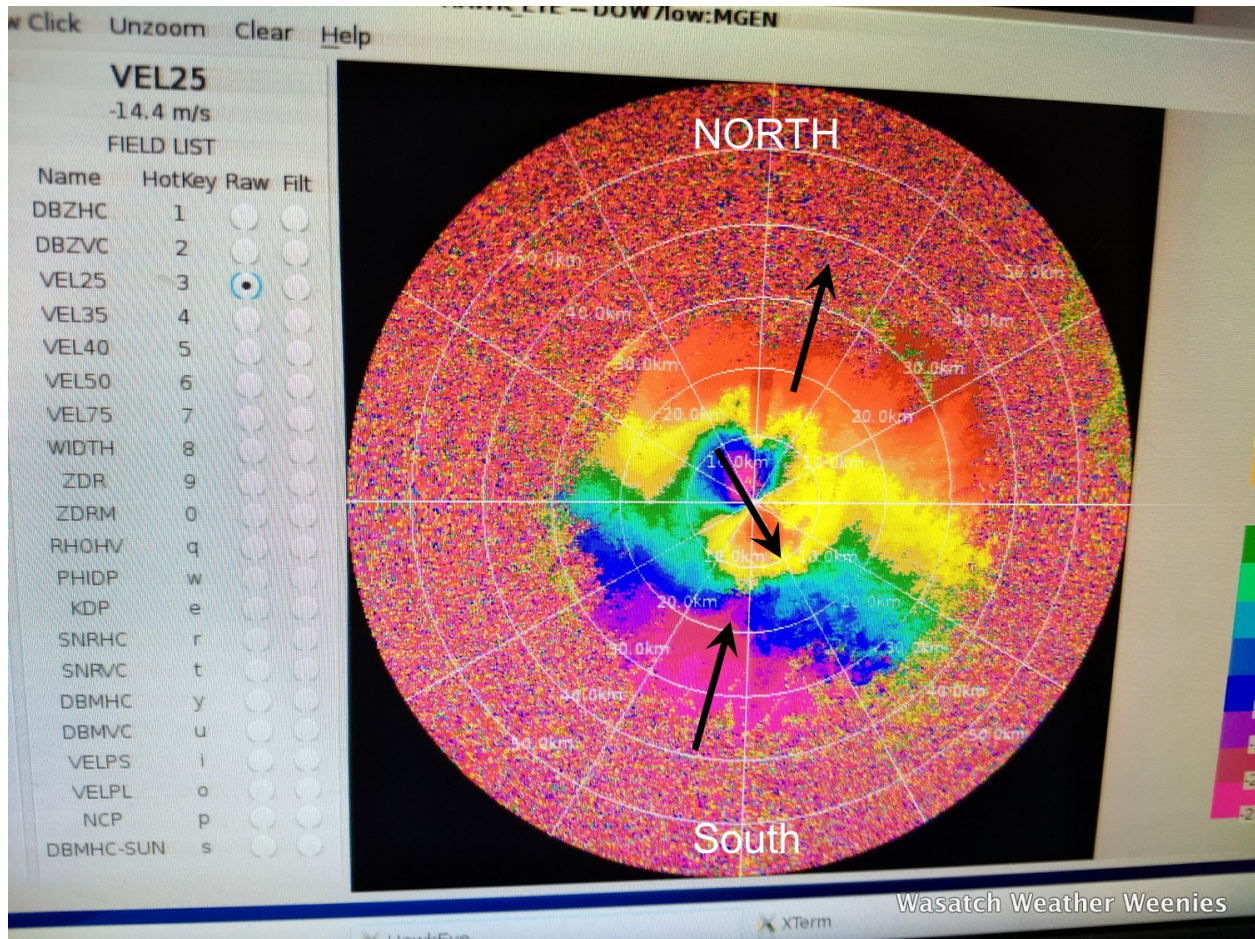


Figure 2. Doppler velocity PPI illustrating strong post-frontal wind shear during IOP5.

Complex multiscale precipitation processes associated with a cold front and flow interactions with the Oquirrh and Wasatch Ranges were examined during IOP6. For some time, the event featured clear rain shadowing east of the Oquirrh Range, but frontal precipitation with fallout over the Wasatch Range.

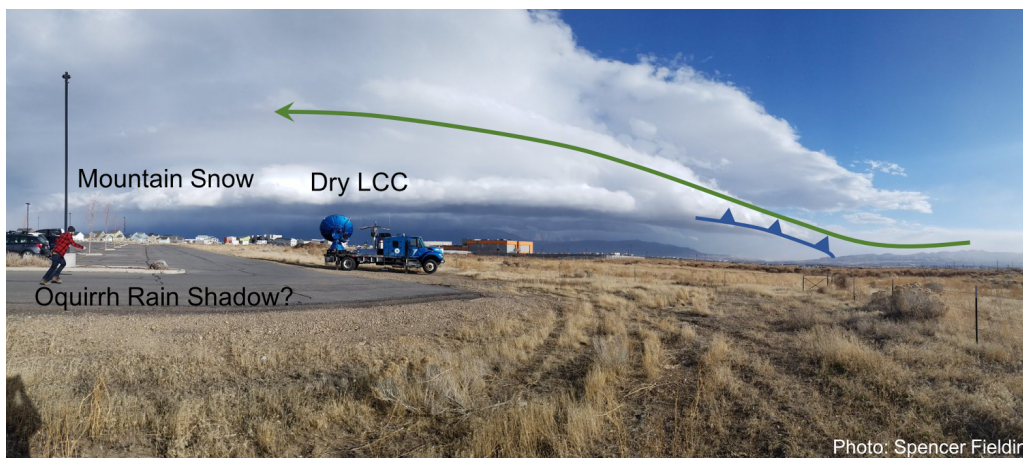


Figure 3. DOW operations during IOP6.

A pronounced shallowing of precipitation was evident in RHIs directed to the west toward the Oquirrh Mountains (OM, Fig. 4), with a pronounced “snow foot” evident at the observing site (not shown).

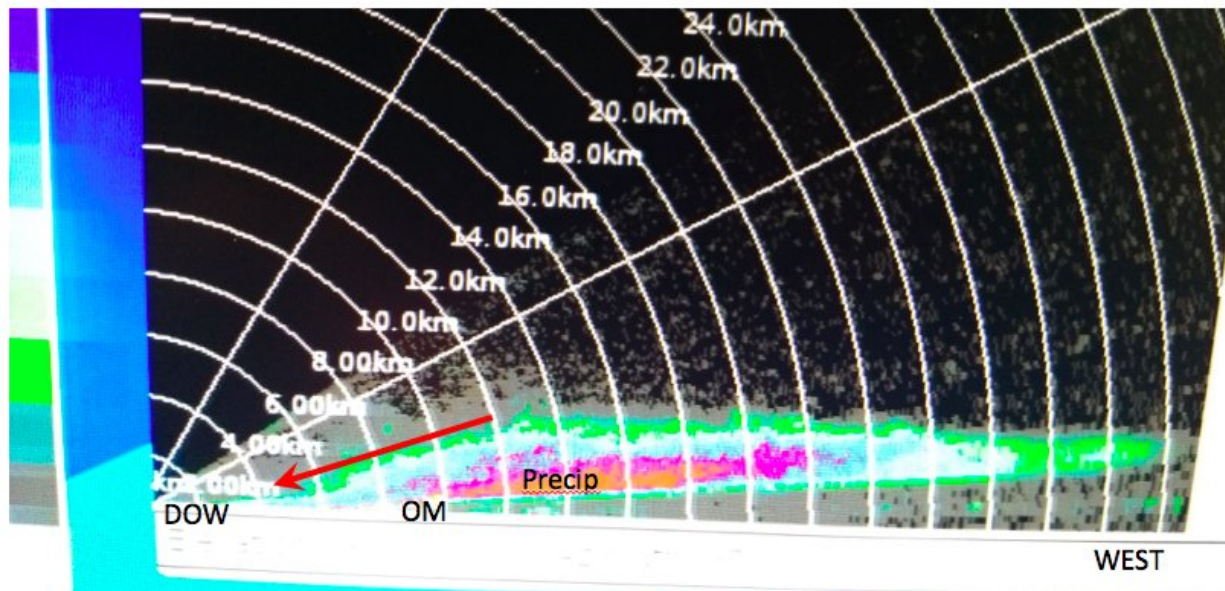


Figure 4. Reflectivity RHI showing impact of downslope flow in lee of Oquirrh Mountains (OM).

A more complete summary of many IOPs and EODs is available at <http://wasatchweatherweenies.blogspot.com/search/label/OREO>.

c. Outreach

Our major outreach endeavor involved exhibiting DOW7 at the Natural History Museum of Utah for their “Behind the Scenes” Day, with 1500 visitors total. As part of these activities, DOW7 was positioned on the walkway to the museum, where we provided introductory tours both inside and outside the cab (Fig. 5). University of Utah professors and graduate students performed a variety of demonstrations at the museum entrance.



Figure 5. Outreach at the Natural History Museum of Utah.

We also conducted a sidewalk exhibit of DOW7 next to the primary buildings housing the Department of Atmospheric Sciences, with roughly 300 students and walk-up visitors given tours (Fig. 6).



Figure 6. Walk-up tours on the University of Utah campus.

Finally, we provided a special exhibition of the DOW for secondary students enrolled in the University of Utah REFUGEES program, an afterschool program designed to address the under-representation of women, minorities, refugees, non-native English speakers, and economically disadvantaged students in STEM disciplines.



Figure 7. The University of Utah REFUGEES program with DOW7.

2. Student and instructor outcomes

Student outcomes were not quantified. However, the level of participation and engagement amongst the OREO PIs was very high and at least two IOPS (IOP1 and IOP6) had more than 10 student visitors despite long drives from campus. It is the view of the PI that this was the most engaging student activity in which he has participated. There is no way to replicate such an experience solely in the classroom. The ability for students to plan field activities and then execute them, including configuring and adjusting scanning strategies on-the-fly in response to evolving weather is a very powerful learning experience.

3. Final thoughts

We thank everyone at CSWR, especially Alycia, for a great experience. We hope to do it again.

Table 1. DOW activities including Educational Observing Periods (EOPs), Education and Outreach Deployments (EODs), and Intensive Observing Periods (IOPs).

Date (UTC)	Name	Summary
2 Nov	EOP1	Initial DOW training for OREO PIs.
3 Nov	EOP2	Continued DOW training for OREO PIs.
4 Nov	EOD1	All day deployment to the Natural History Museum of Utah (NHMU) for outreach during their “Behind the Scenes Weekend” (1500 people in attendance).
5 Nov	IOP0	Deployment to Antelope Island Marina for a practice IOP examining a weak orographic precipitation event.
6 Nov	EOP3	Radar educational activities including the use of PPIs, RHI, and polarimetric capabilities for Atmos 5200: Cloud Physics and Atmos 6250: Mountain Meteorology.
8 Nov	EOP4	Data management training for OREO PIs.
9 Nov	EOD2	All day sidewalk exhibit at the University of Utah, including educational activities for the Atmos 5110: Synoptic Meteorology program and the University of Utah REFUGEES after-school program (300 visitors, plus 10 REFUGEES students, the latter all from underrepresented groups)
12 Nov	EOP5	Clutter mapping and DOW training for OREO PIs at Daybreak site.
16-17 Nov	IOP1	Leeside spillover IOP to Huntsville, plus windward balloon launch for ancillary data with very nice data obtained. News coverage at http://kutv.com/news/local/doppler-on-wheels-helps-u-of-u-scientists-improve-weather-forecasting .
17 Nov	IOP2	Frontal and post-frontal orographic precipitation deployment to Fielding-Garr Ranch on Antelope Island.
21 Nov	IOP3	Brief IOP to near Willard Bay to examine orographic precipitation enhancement (that never materialized) on Ben Lomond/Willard Peaks.
25 Nov	IOP4	IOP to the northern Tooele Valley to examine eared grebe migration that never materialized.
27 Nov	IOP5	Frontal IOP deployment to Antelope Island Causeway with very nice dataset obtained.
3 Dec	IOP6	Frontal and post-frontal precipitation IOP deployment to Daybreak with very nice dataset obtained.
4 Dec	IOP7	Post-frontal and lake-effect IOP deployment to site along Baccus Highway near 7000 South with very nice dataset obtained including high-frequency RHIs of lake-effect convection.