Florida DOW Experiment and Weather Study (F-DEWS)

Final Report

October 13, 2015

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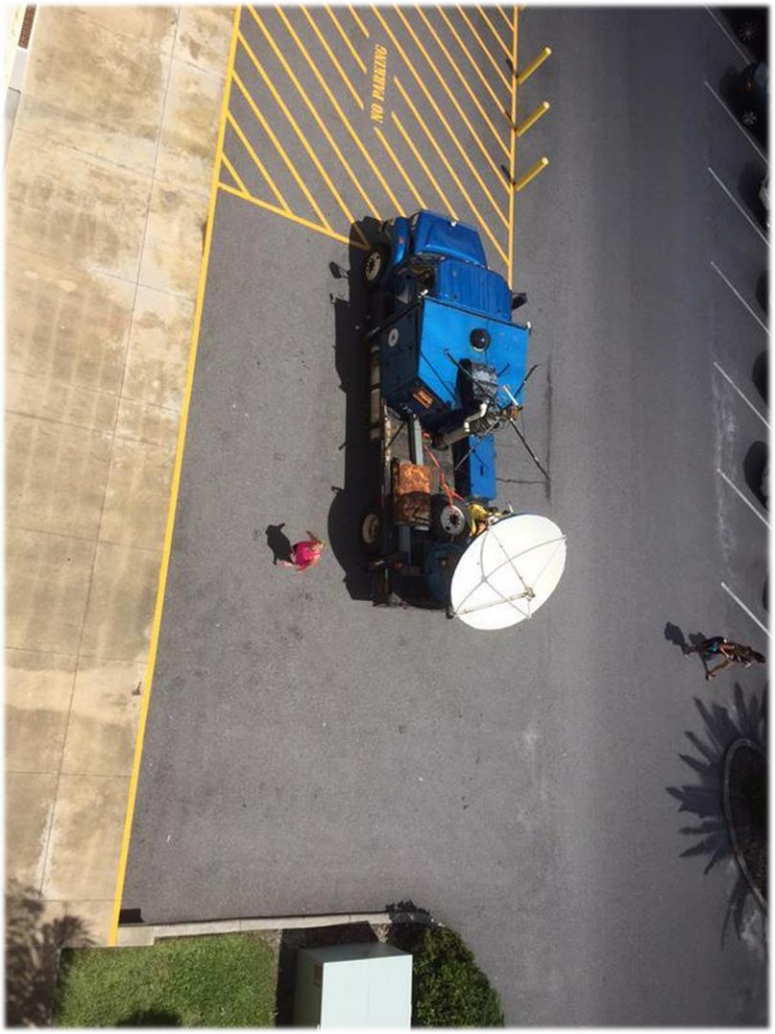

PROJECT TITLE: *Florida DOW Experiment and Weather Study (F-DEWS)*

PI: Dr. Steven M. Lazarus

1. Educational Objectives & Training

F-DEWS coincided with weeks 3 and 4 of our fall semester at Florida Institute of Technology with the main focus on the Atmospheric Remote Sensing course (MET4233/MET5233) with 13 undergraduate and two graduate students. Students from Synoptic Meteorology (MET3401), Weather Briefing (MET1999), Marine and Environmental Systems and Physics/Space Sciences also actively participated. Four graduate students registered for a graduate level special topics course "Doppler-On-Wheels" (ENS5903, see Appendix G) – bringing the total participation to 36 students. The first two weeks of MET4233/5233 were spent covering Doppler basics (Rinehart Chapters 1-5) and included two homework assignments. The course, which normally begins with a dose of radiative transfer, was flipped to introduce radar first. The DOW student training (see Appendix B) began in earnest 31 August 2015 and continued through the following Monday (7 September 2015). The training sessions, conducted by CSWR technician Alycia Gilliland, took place in the DOW-7 with 3-4 students per 1.5 h session. 38 students/faculty were trained during these sessions.

For the duration of the DOW-7 visit (12 days), two students (one graduate and one undergraduate) were scheduled to visit the **Melbourne National Weather Service** for one hour. These slots were limited to the undergraduates enrolled in MET4233/5233. Appendix C details the formal agreement with the NWS, the participating "briefers" (and schedule), a discussion of the elements associated with the weather of interest (as proposed these include: Sea and Lagoon breeze, deep convection/convective initiation, coastal showers/shallow convection, and tropical cyclones), and a "debriefing worksheet". Following the briefing each day, a worksheet was completed by the undergraduate student and a secondary discussion was conducted when the students returned to campus (Fig. 1). The scanned briefing worksheet was then posted to a special DOW-7 list serve (dow@lists.fit.edu) along with a mission status statement (go, no-go). For IOP days, a tentative meeting time was set.

As per the Special Topics course syllabus, team projects were assigned and are due at the end of the fall semester. The four graduate students have each been paired with three undergraduates and have since begun to coordinate research within these subgroups. Topics include:

- Lightning flash density compared to storm structure
- Investigation of the Dual-Pol Differential Phase Products (ΦDP and KDP) and Lightning.
- Initiation and evolution of an Eastern Central Florida gust front
- A comparison of Z-R relationships using the Doppler on Wheels, the WSR 88D, and In-Situ gauge data

30% of the Special Topics grade requires completion of a project poster. Undergraduates on these "poster teams" will be supervised on 'mini-research' topics associated with the graduate projects above. The undergraduate students will submit a short data report (no more than 2 pages) that clearly describes their contribution to the graduate work. The other topic/poster subjects (from the two graduate students enrolled in MET5233) are:

- Examination of the DOW-7 Dual-Pol output to assist with Hydrometeor Classification
- Lightning polarity in relation to thunderstorm evolution


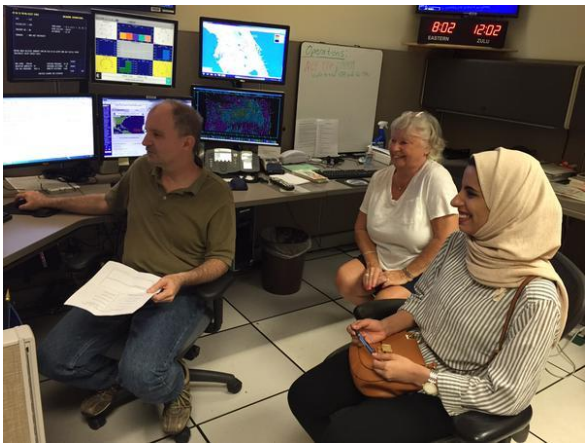

Fig. 1. LEFT: Dr. Josh Wurman (CSWR) with FIT graduate students Bret Dean, Vanessa Haley, and Alex Nickerson and Dr. Lazarus. Right: NWS forecaster Scott Kelly and FIT senior citizen student Karen Kiokemeister with meteorology undergraduate Mahra Al Ruwaishdi.

Students in MET4233/5233 and ENS5903 were required to participate in at least 2 IOPs. However, many students engaged in more than two.

In addition to the training seminars, Josh Wurman and Karen Kosiba travelled to FIT and presented a lecture in a special 'seminar' course to graduating physics seniors (20 students) and then later the same day presented a campus/community seminar in front of an audience of around 100 (see Fig. 2). A flyer advertising the community seminar is provided in Appendix A.

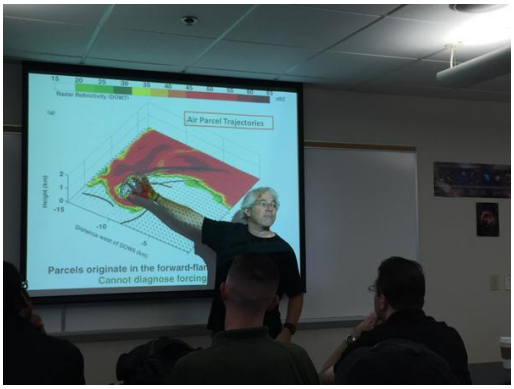

Fig. 2. LEFT: Dr. Wurman presents an early morning lecture to "Senior Seminar" – a special course for graduating physics seniors. RIGHT: Dr. Karen Kosiba talks to FIT Marine and Environmental Systems students (Oceanography, Meteorology, Environmental Science, and Ocean Engineering) along with the greater FIT community.

2. Deployments, Instruments and Data

Students were required to fill-out a 'Mission Summary' form with essential details of the IOP including instruments deployed, locations, etc. (see Appendix F). Given the number of instruments, most of the IOPs involved about a dozen students.

After some coordinated effort, all of the DOW-7 data were 'reprocessed' to an Integrated Data Viewer (IDV) friendly format via the NCAR SOLO software. The process involves rewriting the data as a 'new' DORADE file that is compatible with the latest version of IDV (5.2). As required within the the two courses (MET4233/5233 and ENS5903) *students have begun* to

integrate the aforementioned data sets. In addition to the DOW-7, students in MET4233 were assigned to specific instrument teams that included a research-grade lidar (Zephyr 300), 4 rain gauges (two total/two tipping bucket with Campbell Scientific data loggers), iMet radiosonde, TLE camera, and an electric field mill (Fig. 3). In addition to these data, we have also archived supplementary data sets including the National Lightning Detection Network (NLDN) and the Kennedy Space Center Lightning Detection and Ranging (LDAR) system. The latter also contains data from the KSC CGLSS (Cloud-to-Ground Lightning). During the 12 day visit, there were 6 IOPs as the weather was quite active. Our department (Marine and Environmental Systems) paid for a university van rental ($30/day, Fig. 3) for the duration of the project. The van transported up to 11 students to and from the various IOP data collection locations. Of the 6 deployments, one was 'remote' – on the north shore of Lake Okeechobee (6 September 2015). A summary of each of the IOPs follows.

Fig. 3. TOP LEFT: FIT "chase van" with students at the north shore of Lake Okeechobee. TOP RIGHT: Graduate students Gabrielle Ivan and Bret Dean along with Post-Doc Shahab Arabshahi setting up the electric field sensor. BOTTOM LEFT: Foreground – Zephyr 300 lidar. BOTTOM RIGHT: Graduate student Camilla Ramos and undergraduate Nick Lenssen measure the rainfall collected during the 31 August 2015 IOP.

Monday August 31

The DOW-7 (with four MET4233 students) was parked at Eastern Florida State College (EFSC) at the Palm Bay Florida campus (Fig. 4). The van chase team (8 students), with precipitation gauges, travelled south (about 30 miles) to Vero Beach and headed west on route 60 – west of I-95. There was heavy rain (~1.5" in the gauges, Fig. 4) and frequent lightning as well. This event was very "tropical" with high precipitable water values associated with the remnants of tropical storm Erica (an inverted trough). The thunderstorm of interest moved north toward radar but collapsed before arriving there. Given that this was the first IOP, Students were trained

Fig. 4. TOP LEFT: The DOW-7 sitting on the Palm Bay campus of Eastern Florida State College. TOP RIGHT: Freshman Stephen Baron and graduate student Camilla Ramos assist Professor Mike Splitt with the levelling of a rain gauge. BOTTOM The storm approaches rapidly from the south before overtaking the chase van on the evening of 31 August 2015.

in the art of setting up rain gauges and are shown leveling a gauge just prior to the deluge (Fig. 4).

As previously mentioned, the data are now viewable in IDV. This platform is conducive for integrating different data sources, runs in either a Windows or Linux environment, and is being used, by the PI, here at FIT in several courses including MET4233 and MET1999. An example of its capabilities is shown in Fig. 5. Here, we've combined NLDN CG data over a 5 min window that corresponds, in time, to the DOW-7 reflectivity (3 degree tilt) at 2223 UTC 31 August 2015 (IOP 1). The polarity of the strikes are shown as '+' and '-'. The storm to the south of the radar (for which the chase van and precipitation gauge was deployed, see Table 1) is electrically active at this time. Several of the graduate student led research teams are examining the dual—pol products from this storm. In particular, graduate student Jeff Colvin has been looking at "areas" of negative KDP as a proxy for indicating vertically aligned hydrometeors within the electric field. A 5 degree tilt shows areas of negative KDP on

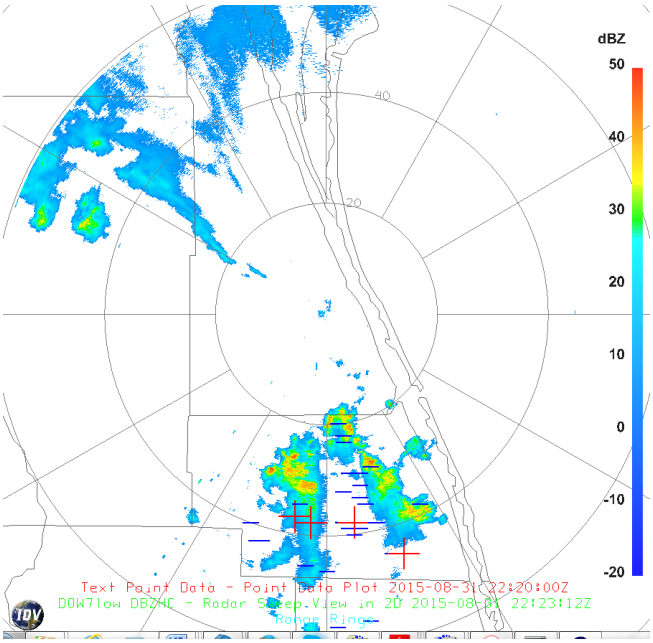

Fig. 5. DOW-7 reflectivity (dBZ, 3 degree tilt) valid 2223 UTC 31 August 2015 (color filled). Also shown are the 5 min window of NLDN cloud-to-ground lightning locations (with polarity).

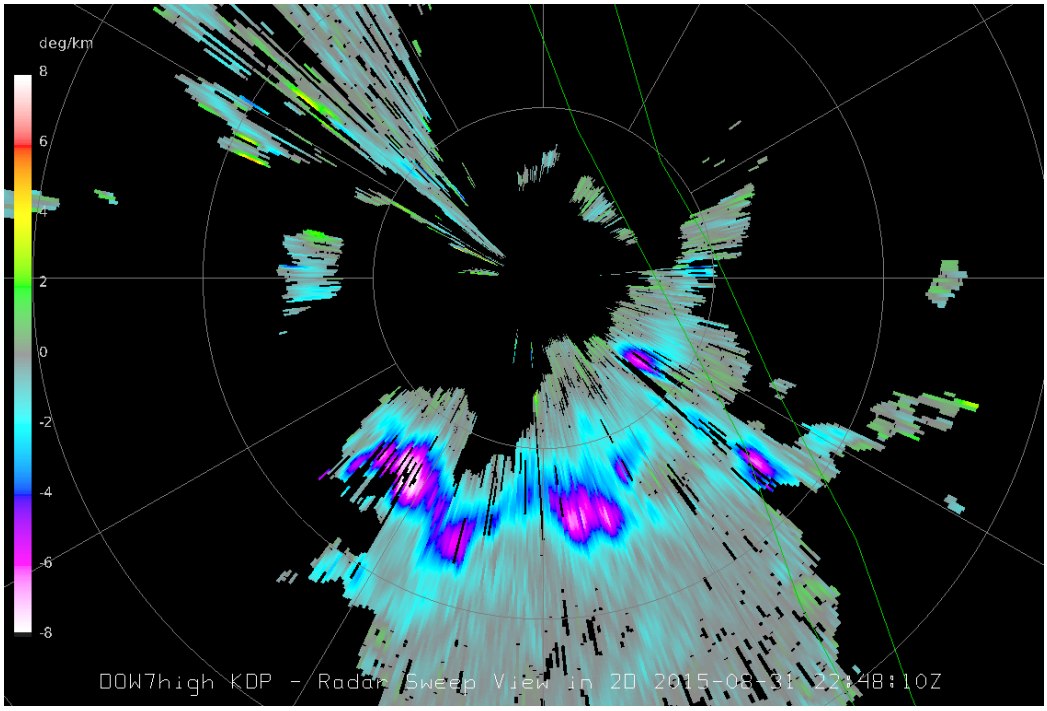

Fig. 6. DOW-7 KDP valid 2248 UTC 31 August 2015. Image provided by meteorology graduate student Jeff Colvin.

the order of –8 to –6 in the core reflectivity south and southwest of the radar (Fig. 6). The DOW-7 polarization data will form the background of several of the student research projects (see Section 1).

Friday September 4

The second IOP caught the end of an active convective event during the early evening hours. A radiosonde was launched on campus at the High Bay area at the Olin Physical Science building. The DOW went west on route 192 between Holopaw and I-95 (Fig. 7). The precipitation (chase) team also went west. We recorded primarily light anvil precipitation with one rain gauge pair (one total/one tipping bucket) placed on campus and one pair near the radar (see Table 1 for gauge locations). 15 students participated in this IOP including those travelling with the DOW, working with the LIDAR, installing precipitation gauges, and the radiosonde launch (Fig. 8).

Fig. 7. FIT undergraduate students Tia Harris and Michael Barnett disembark from the DOW-7 parked off of highway 192 west of Melbourne FL.

Fig. 8. FIT freshmen Stewart Negron and John Panor (left) inflate a weather balloon in the Physics High Bay in support of the 4 September 2015 DOW-7 IOP. Also shown are Nelson Larini and graduate student Vanessa Haley (right).

Sunday September 6

This IOP turned out to be our longest excursion as the van and radar travelled south towards the north shore of Lake Okeechobee. During early September, the sea breeze begins to wane – but the lake generally continues to enhance convection. This outing was in part designed to support the proposed convective initiation work. This was the only day the field mill (Fig. 9) was taken out in the field (note that the field mill was on top of the Physics building on campus for the other IOPs). Eleven students participated and meteorologist Dr. Pallav Ray also went out with chase crew.

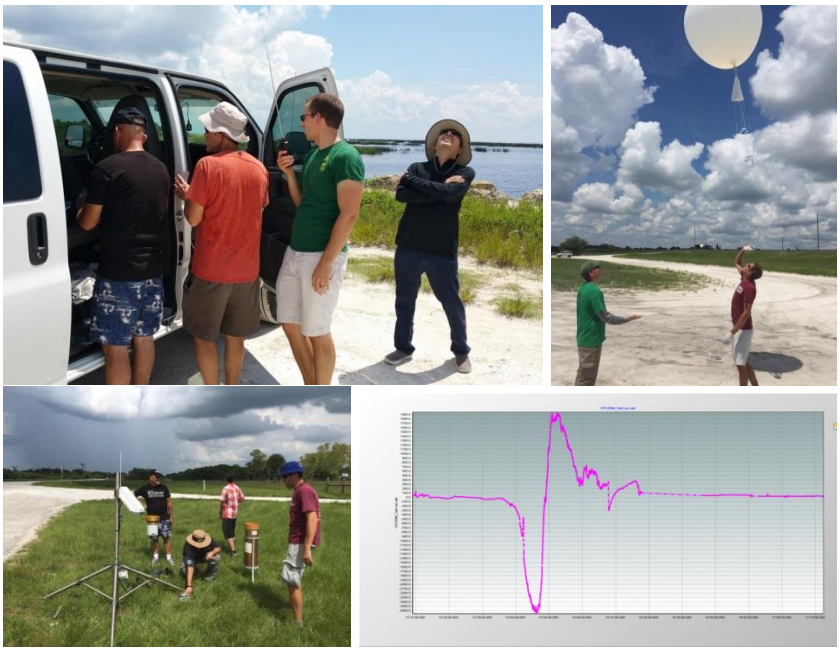

Fig. 9. TOP Left: Graduate student Brett Dean, Dr. Lazarus, graduate student Bryan Holman (holding the iMet radiosonde receiver) and Dr. Ray gazing upwards at the ascending balloon. TOP RIGHT: Sophomore Alex Robertson and graduate student Jeff Colvin watch as the balloon is released. BOTTOM: Setting up the field meter as the storm approaches (left) and field meter data as storm passed overhead (right).

Fig. 10. Panorama looking east-to-west along the north shore of Lake Okeechobee on 6 September 2015. The sky over the lake is clear with cumulus (congestus) along the shoreline.

There was a well-defined lake breeze (Fig. 10) around the entire lake. Although the convection was somewhat anemic – with no reports of lightning there were several well-observed gust fronts. The data from this day will form part of the project work proposed by Graduate student Bryan Holman. As an example, an IDV-generated image at one degree tilt from the DOW-7 is shown in Fig. 11 (provided by graduate student Bryan Holman). A couple of fairly prominent outflow boundaries are present both south and east of the radar during this IOP. Bryan is examining the structure of gust fronts that occurred during the course of the IOPs.

Precipitation data (~0.5") were collected about 15 miles NW of radar (see Fig. 9). The DOW, which was parked on the levy on the north side of the lake, had a great view of the lake generated breeze. A successful radiosonde launch (from the north shore of the lake) recorded data up to around 11.0 km (Fig. 9).

Tuesday September 8

This was an intense convective event (a severe thunderstorm warning was issued for Melbourne) unfortunately the DOW-7 (parked at Eastern Florida State College in Palm Bay) was having technical problems during the storm peak. This was an electrically active storm that had a well-defined gust front which passed directly over the FIT campus during the late afternoon.

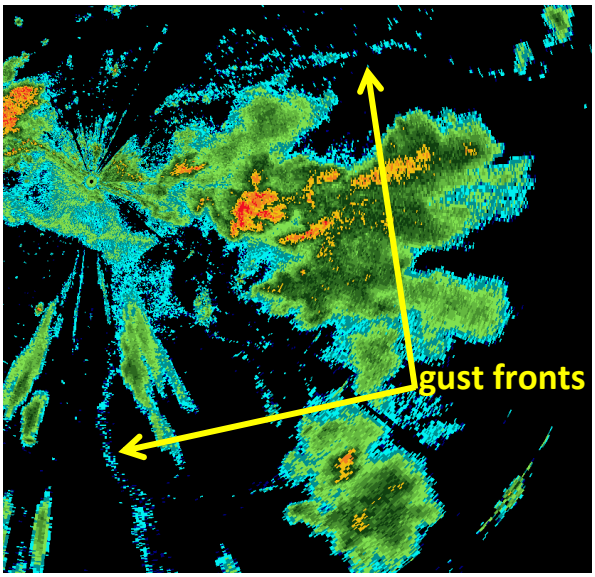

Fig. 11. DOW-7 reflectivity (1 degree tilt) valid 1840 UTC 6 September 2015. The radar was parked on a levy along the north shore of Lake Okeechobee. Several gust front boundaries are visible in this image (courtesy of graduate student Bryan Holman).

The lidar data for the gust front passage indicates peak wind speeds between 50 and 80 m above the surface sustained near 13 m s^{-1} (Fig. 12) as precipitation measurements with two of the gauges deployed in SE Palm Bay and two gauges on campus. A balloon was launched from campus out ahead of the storm – with the storm overrunning the sonde as the balloon reached an

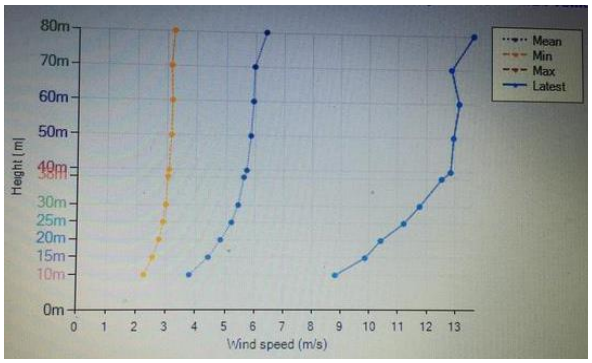

Fig. 12. Lidar wind profiles (min, max, and mean in m/s) from 8 September 2015 gust front passage in Melbourne.

Fig. 13. TOP: Students inflate balloon in preparation for a radiosonde launch on 8 September 2015 (left) and FIT undergraduate students Amanda Sava and Mohamed Al-Sabri on board the DOW-7 with technician Alycia Gilliland. BOTTOM: The severe storm approaches.

altitude of 10.5 km. The Melbourne WSR88D will serve as a DOW proxy for this day. About a dozen students participated during this IOP including 4 with the radar (Fig 13).

Wednesday September 9

This was a relatively short IOP (~ 2 h) with the DOW-7 parked over at Eastern Florida State College. Mid-to-late afternoon weak short-lived convection formed in NW Melbourne. The chase van pursued the storms off of I-95 and Eau Gallie Boulevard in Melbourne. This storm had some lightning with it and did have some back building/pulse convection for about an hour period (Fig. 14).

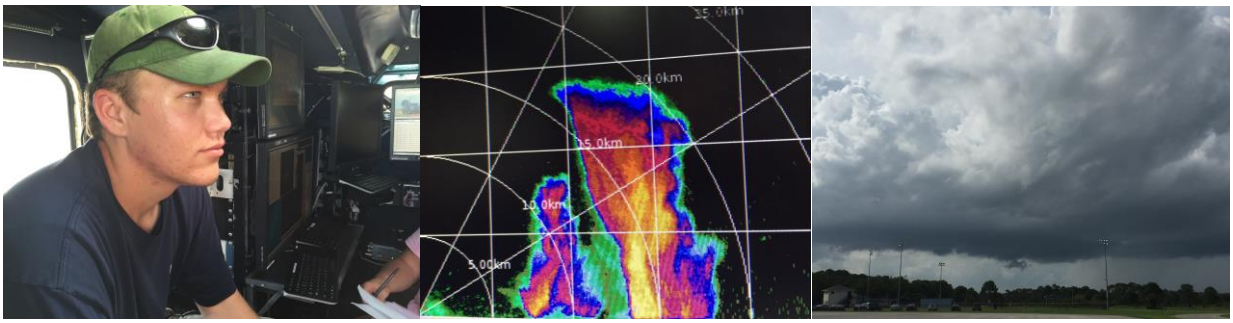

Fig. 14. Left to right: Sophomore meteorology student Alex Robertson on the DOW-7 9 September 2015. RHI scan of the convection and a photo taken near the time of the image.

Thursday September 10 – A small cell developed directly over campus, with nearby lightning strikes. We attempted to launch a field mill however there was only a small window of opportunity where there was an enhanced electric field (~5-10 min) and thus we did not get the mill launched. The radiosonde, which was to be piggy-backed with the mill, will also not launched. There were precipitation gauges deployed on campus only. Both reflectivity and differential reflectivity are shown below in Figure 15. The elevated ZDR is likely associated with large rain drops.

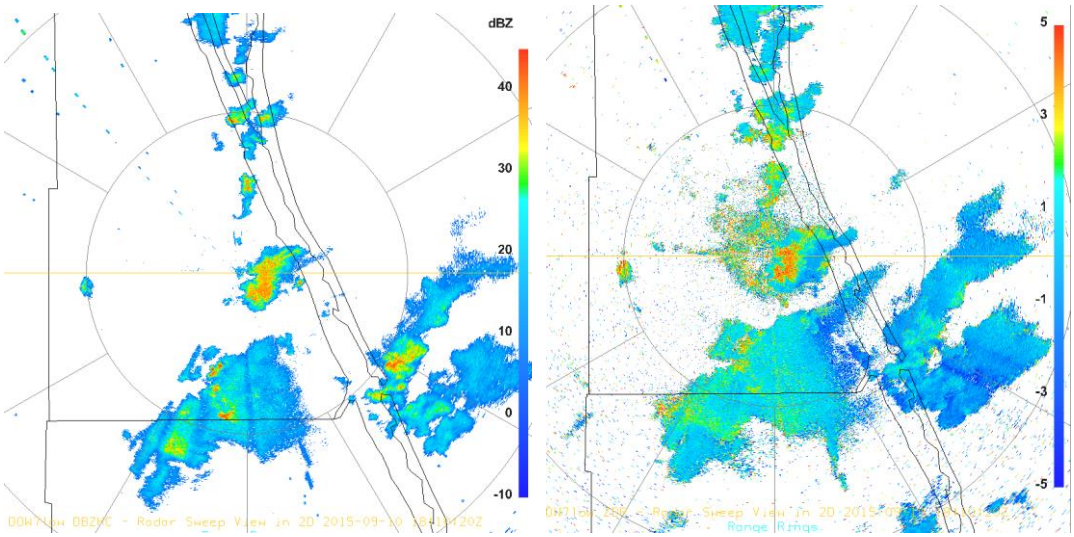

Fig. 15. 3 degree tilt valid 1810 UTC 10 September 2015. LEFT: Reflectivity (dBZ); RIGHT: Differential reflectivity (dB).

Table 1: Precipitation gauge locations for the 6 IOPs. Also shown are the start/stop time for the data collection and the DOW-7 location.

DATE	IOP #	Gauge	Location	Start	Stop	TOTAL		DOW-7	Location
		LAT	LON	LOCAL TIME (p.m.)	LOCAL TIME (p.m.)	(inches)			
AUG 31	1	27.641389	80.533056	5:42	6:52	1.34		27.988148	80.630267
		27.641389	80.533056			1.30			
SEP 04	2	28.062720	80.624607	4:01	7:11	0.01969		28.135215	80.8965000
		28.173525	81.2999709	5:35	5:58	0			
SEP 06	3	27.239722	80.977778	3:42	4:17	0.5		27.193103	80.763905
		27.193103	80.763905	1:13	4:49	0.2875			
SEP 08	4	28.06272	80.624607	2:55	5:01	0.19685		27.987588	80.629705
		27.98252	80.556533	4:00	4:29	0.92913			
SEP 09	5	NO GUAGE DEPLOYMENT						27.987992	80.629592
SEP 10	6	28.06206	80.624676	2:13	3:24	0.11417		27.988663	80.630307

3. Outreach

F-DEWS had a fairly significant outreach effort that included visits to three area schools, an "Open House" on campus, an on-air interview on the local public radio station (WFIT), a television interview (Orlando Channel 13), and an article in the Florida Today newspaper (Space Coast). These are detailed below.

FIT Open House

The first event was a community wide 'Open House' on the FIT campus (on Wednesday September 9). The event was widely broadcast via university multimedia and through the public radio station WFIT. The event attracted students from across the campus as well as engineering faculty, NWS personnel, and even some local families! We had a steady stream of visitor over a 4 h period from 8:00 a.m. to noon (Fig. 16).

Fig. 16. Campus open house on the 9th of September 2015. TOP: FIT engineering faculty Mani Subramanian and Paul Cosentino (left); Melbourne NWS SOO David Sharp and home-school visitors from the local community. BOTTOM: Biology students (left), FIT student senior citizen Karen Kiokemeister and friend (center). A mix of local and FIT (right).

Area Schools

At each of the three schools, there were two of us working in tandem – one inside the vehicle and one outside. While outside the DOW, I engaged the students with a series of questions such as "*Why put a radar on a truck*"? This was a natural lead-in to radar beam width, range folding, resolution and accessibility issues. We also talked briefly about electromagnetic radiation, pulses, and the speed of light. On board the radar, Ph. D student Jeff Colvin walked the students through a discussion involving the radar operation and the different demo imagery being shown (from past DOW tornado and hurricane deployments).

PALM BAY HIGH

The first of our three area visits was to Palm Bay High on Tuesday morning 8 September (8:30 through 11:30 a.m.) The school has a large minority student population running at about 50%. Students from both their marine sciences and physics classes visited with the DOW. We interacted with two sections each totaling approximately 75 students. The PI talked to students outside of the truck while 4 students at time boarded the vehicle (Fig. 17).

STONE MAGNET MIDDLE

On Thursday 9 September we visited Stone Magnet Middle School for a 4 hour period. Approximately 120 students boarded the DOW-7 during our visit from 8:00 a.m. to noon that day. The students were 7th grade general sciences with an upcoming unit on hurricanes in their November curriculum. Below I have included some follow-up email from teacher Jeffrey Kelly. This was clearly the best of the three visits to area schools – with a phenomenal level of enthusiasm and effort put forth by their science program teachers. Stone Middle has a high minority enrollment (see comments below by teacher Jeff Kelly).

Fig. 17. TOP: Palm Bay High (left and center), Stone Magnet Middle (right). MIDDLE: Stone Magnet Middle (left three) and Melbourne Central Catholic High (right). BOTTOM: Group photo at Stone Magnet Middle.

"This has been an amazing day for me, my students, and a number of teachers here who just can't stop talking about it. Thank you so much for choosing us to come out to. We've definitely inspired some kids today."

Jeffrey Kelly
7th Grade Science - Eagles Team
Advisor Stone TSA
Stone Magnet Middle School
For Release Pending Review

"With the coming afternoon storms and the last chance for them to be storm chasing, it is a shame that Dr. Steven Lazarus and Jeffrey Colvin had to leave with the Doppler on Wheels. That being said the pair of scientists from Florida Tech had a major impact on our students today. Many people may be familiar with the DOW from the Verification of the Origins of Rotation in Tornadoes (VORTEX and VORTEX 2) projects that were videotaped with the Storm Chasers show on Discovery Networks, the DOW has also proven successful in researching snow storms and even been on scene for a number of hurricanes making landfall including Hurricane Frances in Fort Pierce back in 2004. Dr. Lazarus drummed up enthusiasm for the basics of how the truck mounted radar station worked, emphasizing the fact that it allowed for a portable, fast, close range radar picture enabling scientists and researchers to see inside storms while lamenting the fact that in Florida the amount of trees and other ground clutter made it difficult to see a lot of what was happening at low levels. Fortunately for our students and future scientists and engineers, the talk didn't end standing outside of the truck. Jeff Colvin a PhD candidate at Florida Tech was running the show from the inside. Students were brought into the truck in small groups to get an idea of the interior workings of the radar. Inside was a complex array of computers and equipment showing stored radar feeds from a tornado that the DOW project recorded in Wyoming in 2009 as well as video that was taken from their weather pods that are dropped in the paths of oncoming storms in the hopes of collecting data from inside the storms. Additionally were some radar feeds from Hurricane Gustav as it made landfall with highlight high velocity winds that were normally not scene with traditional long range doppler radars. Video from near where the DOW was located tracked these wind bursts and obtained footage of them tearing apart a metal overhang. As students jumped out they were excited and were sharing the pictures that they took of the DOW with their classmates. Some indicated this was the coolest thing they had ever seen and were super excited for the once in a lifetime chance to get inside of the vehicle.

The Doppler on Wheels is wrapping up its to week stay at Florida Institute of Technology tomorrow, a result of a grant from the National Science Foundation to Dr. Lazarus, a professor at Florida Tech. Dr. Lazarus and his assistant Jeffrey Colvin trained 30 students as radar technicians on the DOW and took them out storm chasing across Central Florida as part of his classwork. The pair both recognize the high importance of having a population that is technologically savvy coupled with having a good background in STEM (science, technology, engineering and math). In an effort to reach out and connect with the local community Dr. Lazarus came in as a late entrant to talk to a group of teachers at the Florida Tech hosted Indian

River Lagoon Teacher Training summer workshop, where he coordinated with teachers there selecting three schools to visit: Palm Bay Magnet High School, Melbourne Central Catholic High School, and Stone Magnet Middle School through the invitation of Jeffrey Kelly. Dr. Lazarus mentioned, "When looking at schools to come to there was a lot that wanted us, but we chose to come to the schools where we'd have the opportunity to make the biggest impact, and develop the interest needed for our future scientists. Stone was that school, and Mr. Kelly was a big part of making that happen, because [he] wanted us here." Approximately 125 students and teachers were impacted directly from the visit, getting to hear the presentation and climb inside the DOW to get a better look. However, due to our upcoming hurricane unit, and this opportunity with the DOW, students will be creating multimedia presentations to share with their fellow students to ensure that every single seventh grade student as Stone Magnet Middle School will be able to have the same access to the information as they did.

While the DOW will be leaving the state Friday, to head up to Illinois, you can check out some of the twitter posts at #DOWFIT as well as their own blog post here http://ecurrent.fit.edu/blog/campus/research-academics/doppler-on-wheels-florida-tech/".

MELBOURNE CENTRAL CATHOLIC HIGH

This was the last day for the radar here at FIT. We spent the morning visiting with environmental science students and a meteorology class. Approximately 100 students climbed into the DOW during the show and tell.

Media (and Social) Coverage

There was excellent media coverage that included the Orlando television market (Channel 13), WFIT radio, and the Space Coast newspaper Florida Today. The National Weather Service put together a promotional ad (see item C below). In particular

A. The PI did an on-site story with the Florida Today newspaper. The reporter was a former FIT meteorology student, for more on this see:

http://www.floridatoday.com/videos/news/local/2015/09/09/71979414/?from=global&sessionKey=&autologin=

B. The PI did an on-air promotion called "Inside Florida Tech". The broadcast ran 4 minutes, and was aired on the public/campus radio station WFIT during week the radar arrived.

Listen to the interview at:
http://wfit.org/post/doppler-wheels-open-house-september-9th#stream/0

C. The NWS Melbourne WFO posted (Facebook and Twitter) a promotional advertisement on 3 September 2015.

D. On 3 September 2015, the student paper "The Crimson" ran an article titled "Storm Chasing at Florida Tech".

E. Florida Tech multimedia ran several different threads of DOW announcements including the campus front page web site, alumni page, campus newsroom, etc.

http://ecurrent.fit.edu/blog/campus/research-academics/doppler-on-wheels-florida-tech/

F. A 'live' Twitter feed ran throughout the IOPs – search for #DOWFIT to see the entire collection of tweets.

https://twitter.com/search?q=%23dowfit

G. FIT meteorology graduate student Bryan Holman posted to the FIT Instagram site for the two week duration. Links to a few of the posts are provided below.

https://instagram.com/p/7aPLePJgFN/?taken-by=myfloridatech
https://instagram.com/p/7dhO6XpgE-/?taken-by=myfloridatech
https://instagram.com/p/7aa31RpgHs/?taken-by=myfloridatech
https://instagram.com/p/7YMchMpgMi/?taken-by=myfloridatech

A. FLORIDA TODAY

B. WFIT RADIO “Inside Florida Tech” interview

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Doppler on Wheels Open House September 9th

By TERRI WRIGHT • SEP 2, 2015

SHARE
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Doppler on Wheels Open House

When: Wed Sept 9

Time: 8-12 noon

Where: Olin Physical Science High Bay (across from FIT Panther Dining in the Olin Engineering parking lot).

The DOW radar will be open to the campus and general community. An onsite technician will be there to answer your questions. More info

Listen
3:52

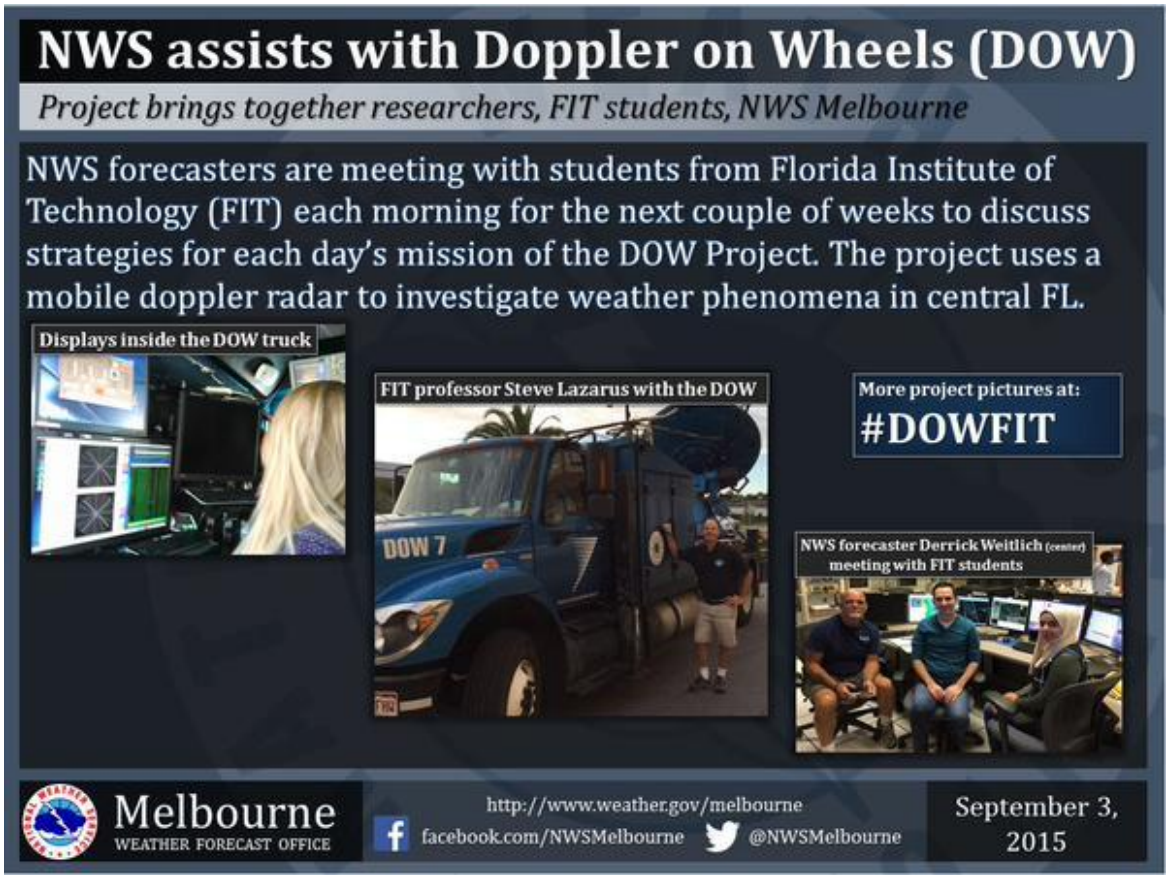
Wes Sumner talks with Dr. Steven Lazarus about the Doppler on Wheels coming to campus.

The development of mobile radar: Doppler on Wheels

The DOW radar facility has served the NSF community as part of the LAOF program since 2008. Prior to then, the DOWs operated as a de facto NSF-community resource, participating in many scientific and educational field programs not led by the DOW PI. The DOWs have been among the most widely used facilities, participating in over 30 field campaigns since VORTEX1. DOWs have been requested for several planned future field programs [e.g., PECAN (2015), SNOWIE (2015/2016), Victoria (2016), RELAMPAGO (2016) and OLYMPEX-NSF (2015)]. DOWs have been the most frequently requested and allocated LAOF facility for education and outreach, have deployed at 18 universities, and participated in extensive nationwide outreach tours impacting over 100,000 students.

RELATED PROGRAM: INSIDE FLORIDA TECH

C. NATIONAL WEATHER SERVICE PROMOTIONAL ADVERTISEMENT



D. FLORIDA TECH STUDENT NEWSPAPER (THE CRIMSON)

STORM CHASING AT FLORIDA TECH

PHOTO BY ANDREW SHIPOTOFSKY

Doppler-on-Wheels provides hands-on learning for Meteorology Dept.

Andrew Shipotofsky
Sports Editor

Imagine racing down the road in a truck with an 8-foot radar dish in tow, intent on catching the next storm system.

That's what students in the Department of Marine and Environmental systems have been doing for the last week in the Doppler on Wheels 7.

"In July, I got an email from Josh Wurman and his crew from the Center for Severe Weather Research," said Steven Lazarus, lead professor of meteorology on the DOW project.

He brought in the DOW on a education grant for his Remote Sensing class after several proposals while on sabbatical in Colorado.

"We were approved ... by the National Science Foundation and they were going to make that 2,000-mile ride to Melbourne," Lazarus said.

DOW7, one of three fully-outfitted storm-chasing trucks in the Center for Severe Weather Research's fleet, has been parked next to the Olin Physical Science Building since Aug. 31.

A Doppler radar determines the location and velocity of storms, clouds and precipitation. The DOW setup allows scientists and meteorologists to bring this radar system along with them into storms.

This technology allows for a high definition view of the system compared to a more pixelated view on transitional radars, like the WSR-88D at the National Weather Service in Melbourne.

"The radar has dual polarization, which means it sends out pulses of electromagnetic radiation that both horizontal and vertical oriented," Lazarus said.

Lazarus said this tells you a lot about the micro-physics of a cloud, showing the difference which between water droplets and ice, which are essential to lightning.

During this project, students from Lazarus' class go to the weather service in the morning and work with professional meteorologists to where the best place is for potential storms to occur later that day. That information is then relayed to the class.

"We sit down with a forecaster from the National Weather Service for about an hour and get a briefing on that day's storms," Nick Lensson, President of the Florida Tech student chapter of the American Meteorological Society and a member of the class.

Students later in the day will then go out in the field and take their own measurements of the storm systems they chase.

"Students are actually in the radar at ground zero working through all the scan strategies," Lazarus said.

Students were able to intercept a storm and gather precipitation data on a chase experience when the DOW was set up at the Eastern Florida State College Palm Bay campus. "It was an awesome experience being out there on the first day," Lensson said.

About 30 students will go through a 90-minute class inside the DOW to learn how it works and understand how to take data from it.

Lazarus said students are learning how to operate the dish, radar, set up scan strategies, as well as learning about plane position indicators and range height indicators — which are electromagnetic radar sensing systems that produce map-like images.

"We got to sit in and see where all the magic happens," Lensson said. "It looks complicated at first, but when it was broken down, it was really simple and accessible to take measurements quickly when there is a storm."

"The most exciting part about the DOW was how fast it scans. I did see some of the pictures; and the dual pole the images are just phenomenal," Lensson said.

The ultimate goal of the research that is going on this side of the education is to look at the convection initiation, deep convection (thunderstorms), lightning, coastal showers, and coastal conversance.

Many students were also pleased to have inventor of the original DOW, Josh Wurman, on campus. Wurman is atmospheric scientist noted for his research on tornadoes, tropical cyclones and weather radar. He is also very well-known for the television show, Stormchasers, on the Discovery Channel.

Wurman and his colleague spoke to students for about 75 minutes on Sep. 3 about their research and to get them excited about their futures in the field.

"I thought it was amazing," Lensson said. "The video he has of an intercept and the pictures he had from supercells were just phenomenal, and work they do all year long and how they are able go all around the country and overseas was very impressive." ❖

E. FLORIDA TECH MULTI-MEDIA

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Doppler on Wheels Brings Weather Technology to Campus

September 2, 2015

782 SHARES SHARE TWEET SHARE SHARE

THE DOPPLER ON WHEELS WILL BE AT FLORIDA TECH THROUGH SEPT. 11. PHOTO BY JEFF COLVIN/FLORIDA INSTITUTE OF TECHNOLOGY.

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Doppler on Wheels Arrives on Florida Tech Campus

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BY SPRESTON ON SEPTEMBER 2, 2015 RESEARCH

Students Chase Severe Weather with the 'Biggest Dish on the Road'

The Doppler on Wheels at Florida Tech, ready for action. Photo: Jeff Colvin

STUDENTS, PUBLIC TO LEARN ABOUT STORM CHASING, WEATHER FORECASTING

MELBOURNE, FLA. — A National Science Foundation grant awarded to Florida Institute of Technology meteorology professor Steven Lazarus has won the university two weeks with a unique teaching aid: a Doppler on Wheels.

Through Sept. 11, Florida Tech students have the opportunity to chase lightning storms and fronts using the powerful mobile weather tool. Each day, students will develop a Doppler on Wheels, or DOW, deployment strategy based on the weather of the day. They will get weather information in part from daily meetings with National Weather Service forecasters in Melbourne. Students will then plan, design and implement radar scan strategies for various phenomena such as the sea/lake/lagoon breezes, thunderstorms and coastal showers.

"This is a once-in-a-lifetime opportunity for the students," Lazarus said.

The truck and its technician arrived Monday after a 2,000-mile trek from Boulder, Colorado, where they are based at the Center for Severe Weather Research.

The public is invited to get in on the excitement of having DOW on campus with two exciting events:

- **Doppler on Wheels – The Biggest Dish on the Road**: 3:30-4:45 p.m. Thursday, Sept. 3, Evans Library Pavilion, Auditorium Room P133. This free lecture in the Weekly Seminar Series of the Department of Marine & Environmental Systems presents Joshua Wurman and Karen Kosiba from the Center of Severe Weather Research. (Discovery Channel fans may recognize Wurman from his recurring role on the reality series *Storm Chasers*.) The atmospheric scientists will talk about their adrenalin-charged experiences chasing super cells, tornadoes and other intense weather with a Doppler on Wheels.

- **Doppler on Wheels Open House:** 8 a.m. to noon Wednesday, Sept. 9, Olin Physical Sciences parking lot, across from Panther Dining Hall. The DOW radar will be open to the campus and general community during this free event. A technician will be there to answer questions about the vehicle, its equipment and weather data gathered during a storm chase.

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Here comes the rain...the DOW is on it. Photo: Jeff Colvin

Thanks to meteorology professor Steven Lazarus, Florida Institute of Technology students have a rare opportunity to chase lightning storms and fronts with the Doppler on Wheels (DOW) through Sept. 11. Lazarus was awarded a National Science Foundation grant to bring the mobile radar, often referred to by weather geeks as "the biggest dish on the road," from the Center for Severe Weather Research in Boulder, Colorado, to campus. The Doppler on Wheels also comes with a technician, Alycia Gilliland (who made the 2,000-mile trek with the vehicle to Florida) to operate the DOW's powerful equipment during chases.

"This is a once-in-a-lifetime opportunity for the students," says Lazarus. "Only a handful of schools in the country get access to these vehicles."

Every morning, around 8 a.m., students meet with National Weather Service forecasters in Melbourne to develop a Doppler on Wheels deployment strategy based on what's brewing in the atmosphere.

"For meteorologists, good weather is bad weather," says Bryan Holman, a graduate student pursuing his Ph.D. in meteorology at Florida Tech. Some days are "better" than others for chasing down a storm and a decision is made if the mobile radar will be deployed that day. Students then plan, design and implement radar scan strategies for various phenomena such as the sea/lake/lagoon breezes, thunderstorms and coastal showers. When the optimal time and location are chosen, the chasing begins. Four students travel in the DOW to the heart of a front with more students following behind in a van filled with other weather equipment to complement the DOW's radar data such as weather balloons and rain gauges.

Florida Institute of Technology Alumni Association
shared a link.
September 9 ·

Doppler on Wheels Arrives at Florida Tech Campus

A National Science Foundation grant awarded to Florida Tech won the university two weeks with a unique teaching aid: a Doppler radar on wheels.

NEWSROOM.FIT.EDU

F. TWITTER (#DOWFIT)

#dowfit

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Steven Lazarus @slazmo · Sep 11
#**DOWFIT** DOW tailgating! Great idea.

> **Paul Boone** @paulboone
> @slazmo I've been following! It looked like so much fun! If I were closer, would've come tailgated w/you (or whatever you do on a DOW truck)

Steven Lazarus @slazmo · Sep 11
#**DOWFIT** Stellar students at Melbourne Central Catholic High! Great place to wrap up the 2 week DOW visit.

1

Steven Lazarus @slazmo · Sep 11
#**DOWFIT** Melbourne Central Catholic High school students experience the DOW at today's outreach!

4. PROJECT SUCCESS

Instructor's Perspective

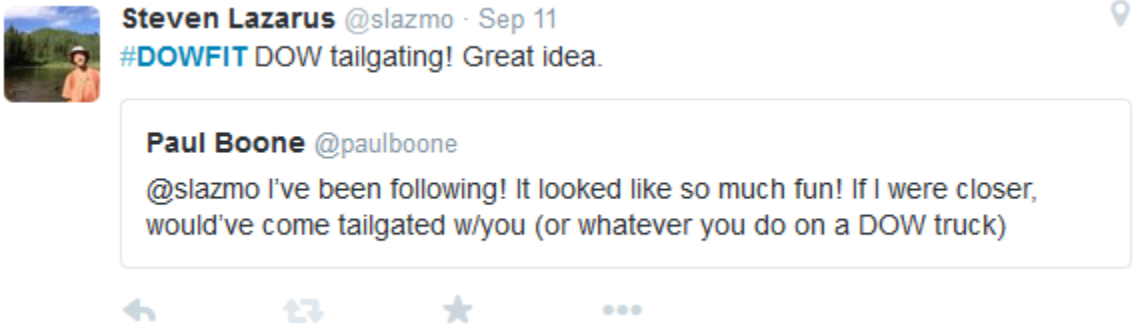
The inclusion of students from 5 courses provided many students with access to the DOW-7. We trained 38 people – primarily meteorologists, but also physics post-docs, ocean engineers, and environmental science students. Given the wide-spread interest, we added an additional school visit (beyond what we promised in the original proposal). The campus open house was also a success as it brought folks from the greater community (off-campus). In addition to the DOW-7, we offered a suite of hands-on experience for our students including weather balloons, field mill, rain gauges (with Campbell Scientific data loggers), and a research-grade lidar. The PI never had any of this kind of field work as an undergraduate! There's no substitute for working with data that students collected themselves as it inspires a sense of ownership in their work.

Fig. 18. Authentic DOW print signed by the students.

Despite his Oklahoma roots, the PI has never had direct experience with a radar. The students seemed surprised about this and enjoyed the co-experience.

Student's Perspective

The participation levels were great despite the fact that most of the IOPs occurred during class time. The students wrote a thank you note to the NWS in Melbourne in appreciation for opening their doors to them during the 2-week period. The briefings proved to be quite illuminating and beneficial for most of the students – and many of them remarked that they have not interacted with forecasters before the radar visit. At the end of the project, the students presented the PI with a signed framed picture of the DOW-7 . I believe that the TWITTER feed (see previous section) is the best way to get a flavor of the students' (as well as those watching from the sidelines) experience. Here are a few sample of these tweets.



Michael Splitt favorited

Da'Vel Johnson @u2race · Sep 1

Just had the #**DOWFIT** Crew come into the office this morning. Hope you guys get some great late evening storms today! #flwx

1 2

Mohammed ALMashaykhi @M7MDALmashaykhi · Aug 31

#**DOWFIT** selfie with one of the VIPs

1

Nick Lenssen @NLenssen · Sep 4

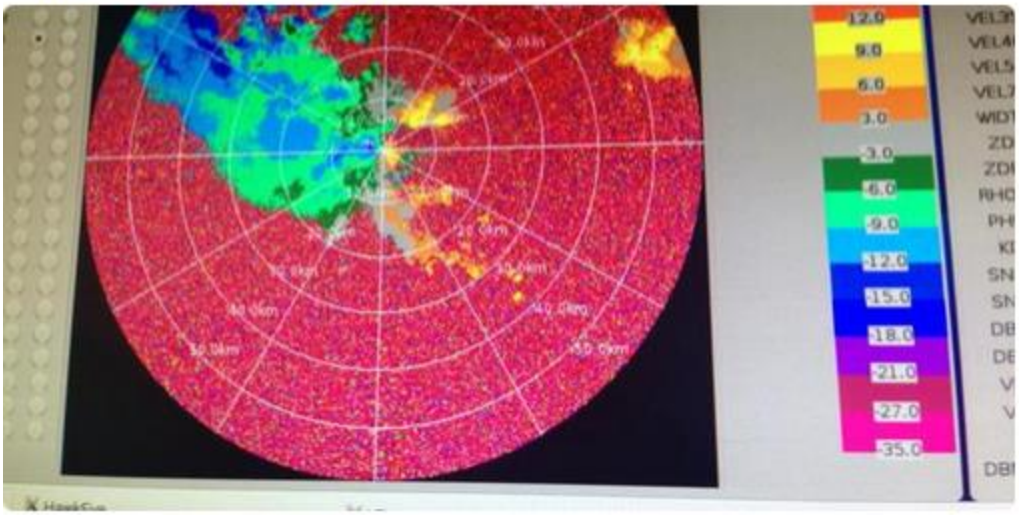
NWS morning briefing to forecast for the DOW. Today and the weekend look promising! #**DOWFIT** @NWSMelbourne

4 6

Camila Gomes Ramos and 1 other Retweeted

Bryan Holman @bryanpholman · Aug 31

Rain is upon us! Allows us to easily see the wind direction out of the SSE (the DOW is facing WSW) #**DOWFIT**



3 5

Camila Gomes Ramos favorited

Jeff Colvin @meteoJeff · Sep 10

Dr. Weaver (Florida Tech Ocean Engineering) brings out the drone to check out DOW 7 #**DOWFIT**

2

Camila Gomes Ramos and 1 other favorited

Brett Dean @deanb1_brett · Sep 6

#**dowfit** # mainolfi Awww. The rain Guage is getting all wet.

John Windsor and 2 others favorited

Camila Gomes Ramos @camilagmr · Sep 6

Radar got bugged at lake Okeechobee! #**DOWFIT**

1 4

5. LESSONS LEARNED

One of the biggest take-home lessons for the students was the difficult nature of forecasting deep convection. As they helped plan the IOPs, they developed an appreciation for which they had to commit to a 'chase' early in the day. They also learned that they had to be flexible (and pay attention) while out in the field – calling audibles, changing up scan strategies as well as a last minute cancellation (and subsequent disappointment) were all part of the mix during the DOW visit. The PI greatly appreciates the opportunity that NSF provided with this radar – offering our students a unique opportunity to operate a radar and participate in field work.

APPENDIX A: WURMAN/KOSIBA CAMPUS/COMMUNITY LECTURE

Florida Institute of Technology

College of Engineering

Weekly Seminar Series of the

Department of Marine & Environmental Systems

DOPPLER ON WHEELS – The Biggest Dish on the Road!

Drs. Joshua Wurman and Karen Kosiba
Center for Severe Weather Research

Date: Thursday, September 3, 2015
Time: 3:30 – 4:45 p.m.
Location: FIT Campus, Evans Library Pavilion, Auditorium Room P133.

Everyone is welcome!

APPENDIX B: Radar Training Sign-Up

Monday 8-31-15

8:00-9:30 a.m.	9:45-11:15 a.m.	12:30-2:00 p.m.
Mohamed Al Sabri	Jeff Colvin	Joe Langelier
Amanda Sava	Bryan Holman	Nelson Larini
A. Emerenciana	A. Crowder	Vanessa Haley
Mohamed Al Mashaykhi		

Thursday 9-03-15

8:00-9:30 a.m.	9:45-11:15 a.m.	12:30-2:00 p.m.
Mahra Al Ruwaishdi	Tia Harris	Kaleb Alexander
Gabi Ivan	Kelly Reardon	Alex Nickerson
A. Emerenciana	Lina Al Rashdi	Atoosa Saberi
Nick Lenssen	Lindsey Rodio	

Friday 9-04-15

8:00-9:30 a.m.	9:45-11:15 a.m.	12:30-2:00 p.m.
James Vann	Shahab Arabsha	Sumaiya Al Azri
Alex Robertson	Samenah Sadighi	Anoud Al Hosni
Nick Burton	Peyman Taeb	John Panor
Andrew Shipotofsky		Aysha Al Qasimi

Monday 9-07-15 (Labor Day)

9:00-10:30 a.m.	10:45-12:00 p.m.
Michael Barnett	Bushra Al Saadi
Jacob Lashely	Munira Al Quraini
Mackenzie Kane	Mike Splitt

APPENDIX C: Operation Plan for FIT/NWS Doppler-On-Wheels

1. Period: August 31-Sept 11 2015

- Daily (weekdays and weekends) visits to the Melbourne WFO: Scheduled visit time 8:00-9:00 AM. Visits will be limited to no more than 1 h.

- FIT will put together a specific list of visiting students and share this with the NWS. Project teams will consist of no more than two representatives that will visit the WFO during the hour window.

- Forecasters and students will collaborate (by conferring, in person, at real-time workstations at the Melbourne WFO). The students will work directly with forecasters and share thoughts on analyses, forecasts, and discussions.

- Provide support for short-term (<24 h) weather forecasts as well as a smaller component that extends out 2-3 days.

- Produce forecasts that focus on the meso-to-convective scales (this might include sea and lagoon breezes, convective initiation, deep convection, first-lightning, coastal showers, coastal convergence, easterly moisture surges, deep oceanic convection, tropical waves and TCs).

- Students will then return to FIT to disseminate (brief) for a possible deploy strategy for that day.

- IOPs (Intensive Operation Periods): The NWS will provide a reasonable level (weather-dependent) of interaction with its personnel while the DOW is in the field. This might include limited graphics (accessible via the web) and chat capabilities (via NWSChat or phone).

- FIT will use multi-media (e.g., Twitter) to promote the project – this will include the NWS support.

- FIT recognizes and appreciates the gratis forecast support and will act accordingly and prudently.

2. NWS Briefing Schedule Assignments 8:00-9:00 a.m.

Mon 8-31-15: Kelly Reardon, Jeff Colvin
Tues 9-01-15: Sumaiya Al Azri, Bryan Holman
Wed 9-02-15: Anoud Al Hosni, A. Crowder
Thur 9-03-15: Aysha Al Qasimi, Bret Dean
Fri 9-04-15: Nick Lenssen, Vanessa Haley
Sat 9-05-15: Mahra Al Ruwaishdi, Prof. Splitt
Sun 9-06-15: Mohamed Al Sabri, Gabrielle Ivan
Mon 9-07-15: Kaleb Alexander, Jeff Colvin (Labor Day)
Tues 9-08-15: Michael Barnett, Bryan Holman
Wed 9-09-15: Tia Harris, A. Crowder
Thur 9-10-15: Nelson Larini, Bret Dean
Fri 9-11-15: Joe Langelier, Vanessa Haley
ALTERNATES: Mackenzie Kane, Jacob Lashley

3. DOW/NWS Briefing Tips and Comments

SEA / LAGOON BREEZE:
Both of these, in part, relate to convective initiation. However, we are also interested in the vertical and horizontal structure of these features. The mesoscale and large scale flow are important factors in determining whether or not a sea breeze forms near the coast, inland, or not at all. In terms of the sea breeze – its timing and location are relevant. The NWS runs WRF locally with resolution down to 3 km – which should improve the sea breeze forecast over that of the large scale models. However, at 3 km, it will not resolve the IRL and may not see the barrier island at all in some locations!

CONVECTION INITIATION:
The timing of the storms for day1 (and subsequent days out to day 3) and preferred (favored) locations. This might include lightning information as well (first strike, frequency). Probability of deep convection is important and how this relates to the sounding and meso-to-large scale flow.

DEEP CONVECTION / TLEs:
All thunderstorm activity is of interest. However, lightning frequency is important. First lightning is of interest.
TLE's (Transient Luminous Events – such as sprites, jets, gigantic jets). Sprites tend to occur with MCS (organized thunderstorm clusters) and can occur in conjunction with tropical disturbances (tropical waves, depressions). Jet and Gigantic jets are only visible at nighttime – and thus the probability of nighttime convection is important – especially over the water (e.g.,

deep/intense Gulfstream convection) since jets appear to prefer oceanic convection (and tropical disturbances. Hail potential is relevant.

COASTAL SHOWERS:
These tend to occur in conjunction with deep easterly flow and are limited in depth (relatively shallow) due to stability (the sounding often has a "subtropical inversion" that caps the convection). They can form downwind of the Bahama Islands (island wake convergence with possible thermal forcing during the day) and advect westward or northwestward toward the peninsula in the easterly low level flow. These showers can form independent of the Bahamas as well – i.e., embedded in the easterlies. They are sometimes associated with "easterly surges" – which are areas of 'enhanced' easterly flow (not sure I'd call them jets however). The nose (or head) of the strong easterly flow can be a source of low level convergence – especially as the flow impinges on the Florida coastline. This is related to coastal convergence in general. Sometimes the enhanced flow is associated with inverted trough/easterly wave or post frontal NE flow. Strong easterly winds in general enhance the moisture and heat flux from the warm ocean surface. Often times the coastal showers dissipate as they move inland (especially during the daytime). They tend to make their way on shore late in the day and are frequently nocturnal (dusk or later).

Water spouts. These are generally distinct from the coastal shower phenomenon as they tend to occur in association with weaker surface flow.

TROPICAL SYSTEMS:
This includes waves (inverted troughs), depressions, tropical storms and hurricanes. Note that jets, gigantic jets, and some sprites tend to be associated with tropical disturbances.

APPENDIX D: NWS WORKSHEET

Kelly Reardon
Jeff Colvin

DOW/NWS MORNING BRIEFING DATE: 08/31/15

00 - 24 HOUR NOTES	24 - 72 HOUR NOTES
SEA / LAGOON BREEZE: East coast - moving inland @ 3PM (southern county warning area) mainly moving S-SE	**SEA / LAGOON BREEZE:** East coast moving inland 3-5 PM
CONVECTION INITIATION: towards the interior @ 3-5 PM scattered lightning (moderate) low probability of deep convection	**CONVECTION INITIATION:** afternoon hours: moving interior
DEEP CONVECTION / TLEs: in morning: east coast (Brevard and south) afternoon: northern county warning area	**DEEP CONVECTION / TLEs:** low hail threat moderate lightning threat
low chance of hail **COASTAL SHOWERS:** afternoon: southern Brevard and north	**COASTAL SHOWERS:** mostly inland
TROPICAL SYSTEMS: remnants of Erika south, open trough along eastern Gulf.	**TROPICAL SYSTEMS:** Erika may push N to west coast (just remnants)

00 - 24 HOUR SYNOPSIS main threat: heavy rainfall and moderate lightning. Along interior: isolated lightning, storm motion S-SE 20 kts. High Precipitable water values, moist through column, cause for flood watch across CWA. Any deep convection will move due North. Scan strategy: 10°-160° for sea breeze, 360° for Atlantic, sector for storm.

24 - 72 HOUR SYNOPSIS Deep moisture over the interior - heavy rain is largest threat. Storm motion will be S-SE.

Scan strategy: precipitation mode - more vertical slices and faster update time. When looking for lightning, focus radar in mixed phase layer.

SIGNATURES: _____ _____

APPENDIX E: Instrument Training/Assignments

Lidar

Mackenzie Kane; Joe Langelier; Jacob Lashley; Kaleb Alexander;

Precip Gauges/Loggers:

Angela Crowder, Bret Dean; Gabby Ivan; Aysha Al Qasimi; Michael Barnett

Soundings

Bryan Holman; Camilla G-M Ramos; Mahra Al Ruwaishdi; Nelson Larini; Nick Lenssen

TLE Camera:

Vanessa Haley; Tia Harris; Mohamed Al-Sabri; Sumaiya Al Azri

Field Mill

Shahab Arabshahi; Samenah Sadighi; Jeff Colvin; Kelly Reardon

APPENDIX F: Mission Summary Form

Mission Summary DATE: 8-31-15

Participant Names:

Mahra	Camile	Split
Sumariya	Dr L.	Joe
Aysha	Thomas	Mohammad
Conor	Kelly	Stephen

Nelson Bryan Jeff Nick

Weather seen (brief description): Cloud to ground lightning. Shelf Cloud. Gust front. Terential rain, 1.30", 1.34 in Total

Radar deployment location (lat/lon):

DOW arrival time (at specified location): 16:40

DOW time of return: 19:40

Radar Operations (scan strategies, PRF, start time/end time, etc.):

Equipment Deployed (see Checklist items) 17:40

1 Precip Gauge INCR
2 Precip Gauge TOT
1 Data Logger

Lat/lon
27° 38.483' N
80° 31.983' W

Route 60 CVS Distribution ~1 mile west of I95/Vero

Rain Start [redacted] 17:52 End 18:52

APPENDIX G: SPECIAL TOPICS COURSE SYLLABUS

Florida Institute of Technology College of Engineering
DEPARTMENT OF MARINE AND ENVIRONMENTAL SYSTEMS

Course: MET 5903 Doppler On Wheels! (Special 3 credits) Fall 2015 Only
Instructor: Dr. Steven Lazarus
Pre-Requisites: Instructor Permission
Location: Link 325 (Synoptic Lab)
Class meets: Tue/Thurs 3:30 - 4:45 p.m. FROM Aug. 17 – Sep 18 (IS thereafter)
Office Hours: T/TH 10:30-11:30 a.m. (or by appointment)
Office phone: 394-2160
email: slazarus@fit.edu

Grading: IOP participation 40%, Undergraduate student supervision 30%, FINAL project 30%[1]

A (90-100%), B (80-89%), C (70-79%), D (60-69%), F (<60%)

Class participation: THE DOW RADAR WILL BE IN TOWN 31 AUG – 11 SEP! **40%** OF YOUR GRADE WILL COME FROM PARTAKING IN IOPs. This includes DOW deployment, LIDAR deployment and soundings as needed. **30%** of the course grade involves interaction/pairing/collaboration/shared responsibilities with undergraduate students. This includes: visits to the National Weather Service; coordinated briefings; mission summary reports; data processing; etc. The remaining 30% requires completion of a project poster on a topic that will depend on the data collected during the IOPs. There will be "poster teams" in which 2-3 undergraduate students will be assigned to a graduate student for intermittent supervision on mini-research topics related to your project. These undergraduate students shall submit a short data report (no more than 2 pages) that clearly describes their contribution to your work.

CRN: 99775; **Textbooks**: NONE

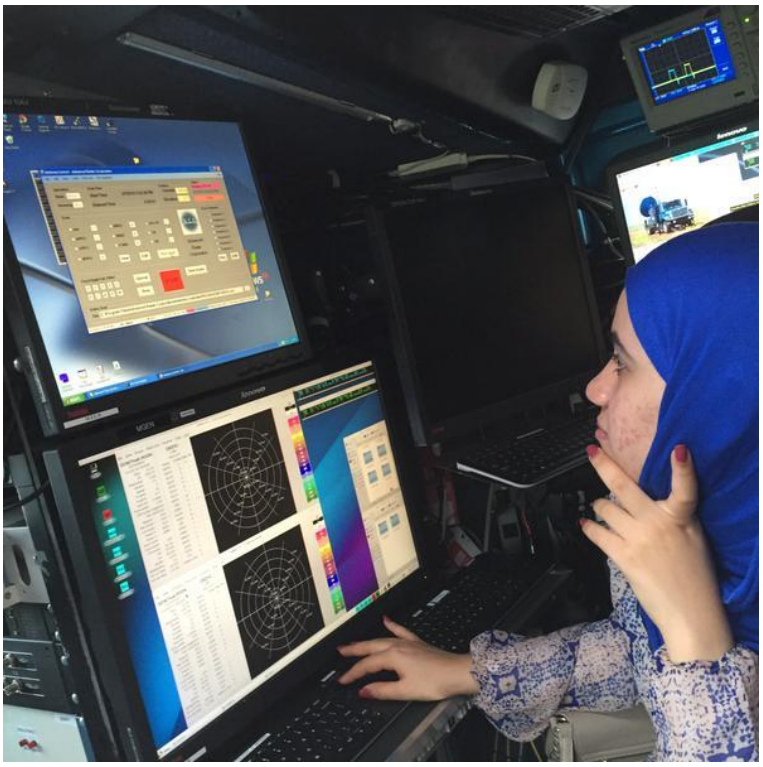
Course Objectives: The course is designed fulfill, in part, the requisites associated with a graduate degree in meteorology –including basic research and pedagogy. At the end of the course, students will have:

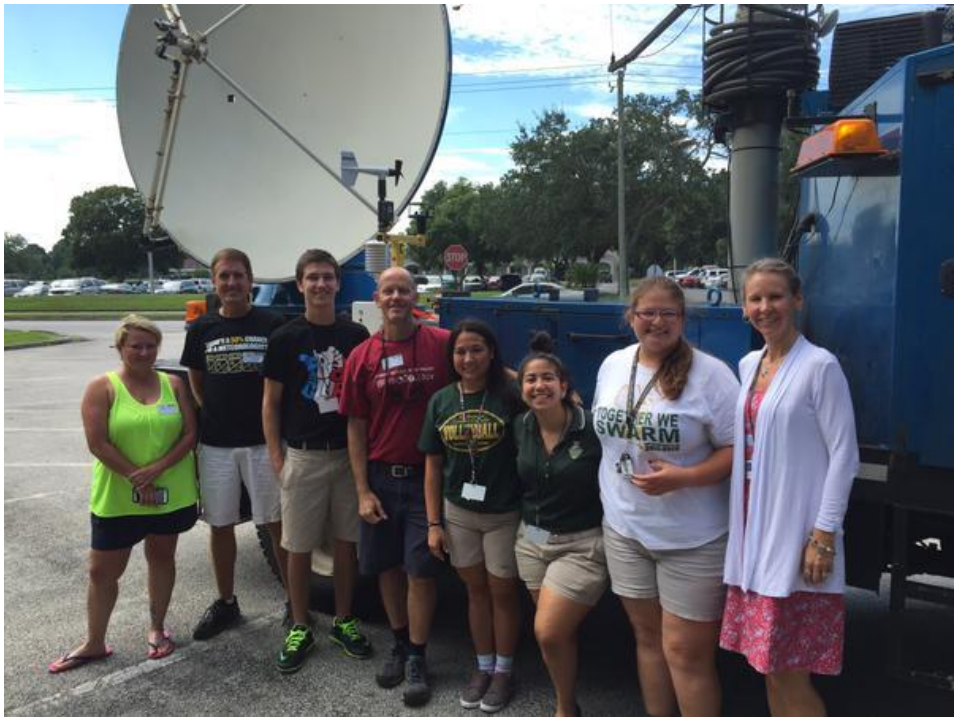
1. honed their data collection (e.g., sampling strategies) and processing skills
2. developed an understanding of the physical principles and limitations associated with Doppler radar
3. an improved understanding of the operational aspects and nuances of Doppler radar deployment
4. better insight on the nature and evolution of small scale atmospheric phenomena

Topics Covered: Physical principles of radar, radar deployment strategies, basic radar applications, radar data processing, viewing, and interpretation.

[1] Graduate students shall schedule a meeting with the instructor soon after (within a week) the close of the data collection period (Sept 11) to discuss a relevant project.

APPENDIX H: ADDITIONAL PICTURES






DOW 7


DOW 7
AERO NY


DMES


DOW 7


FLORIDA TECH