Final Report

Doppler Radar for Education And Mesoscale Studies (DREAMS)

at Stony Brook University - SUNY

Dr. Brian A. Colle (brian.colle@stonybrook.edu) and Dr. Kelly Lombardo (kellyann.lombardo@gmail.com)
School of Marine and Atmospheric Sciences (SoMAS)
135 Endeavour Hall
Stony Brook University
Stony Brook, NY 11794-5000

Summary The School of Marine and Atmospheric Sciences (SoMAS) at Stony Brook University, located on Long Island, New York, completed a 3-week Doppler on Wheels (DOW) deployment from 17 June – 8 July 2013 for the **D**oppler **R**adar for **E**ducation **A**nd **M**esoscale **S**tudies (DREAMS) project. This experiment allowed students ranging from high school to graduate school to (1) gain experience operating a weather radar, (2) interpret Doppler radar data for various convective storm and sea breeze situations, (3) synthesize various datasets to make daily forecasts and nowcasts, (4) launch weather balloons in support of DREAMS, as well as (5) expose K-12 students and the general public to the latest atmospheric research, potentially inspiring future scientists.

DREAMS Project

There are a wide variety of mesoscale weather phenomena over Long Island, NY, including sea breezes, the New York Bight jet, and regional convective storms that evolve quickly near the coast. The diversity of weather phenomena provided an opportunity to teach students how to obtain and utilize field measurements, which are vital tools for future employment opportunities and graduate school. There were three phases to the DREAMS experiment, (1) class preparation on radar training and mesoscale weather, (2) field operations and outreach, and (3) post-project research and classroom studies using the DREAMS datasets.

a. Preparation and Training

Stony Brook undergraduate students could either volunteer to participate in DREAMS or take a research class (ATM 487) for 1-3 credits. There were 15 volunteers and 10 students who signed up for ATM487 for at least one credit. Five graduate students also participated through their summer research credit (MAR 650 and 800). There were also three students and a faculty member involved from Nassau Community College. All students were required to participate in two orientation classes ~1-2 weeks before the arrival of the DOW. During these two three-hour sessions, the PI reviewed radar basics/interpretation, local mesoscale phenomena, while students helped to complete the DREAMS experimental design and protocol. These two classes were also co-taught by Mr. Jeffrey Tongue from the New York City (NYC) National Weather Service (NWS) Forecast Office.

On 18 June 2013, there was a general orientation for 20-25 students on the basics of the DOW radar at Stony Brook University (Fig. 1). After this introduction to the radar, 6 students were trained in detail to operate the radar on this day (Fig. 2). Additional training days were scattered throughout the experiment, such that by the end nearly 20 students were trained to operate the DOW.

Figure 1. Students participating in the DOW orientation during the second day of the experiment (18 June 2013).

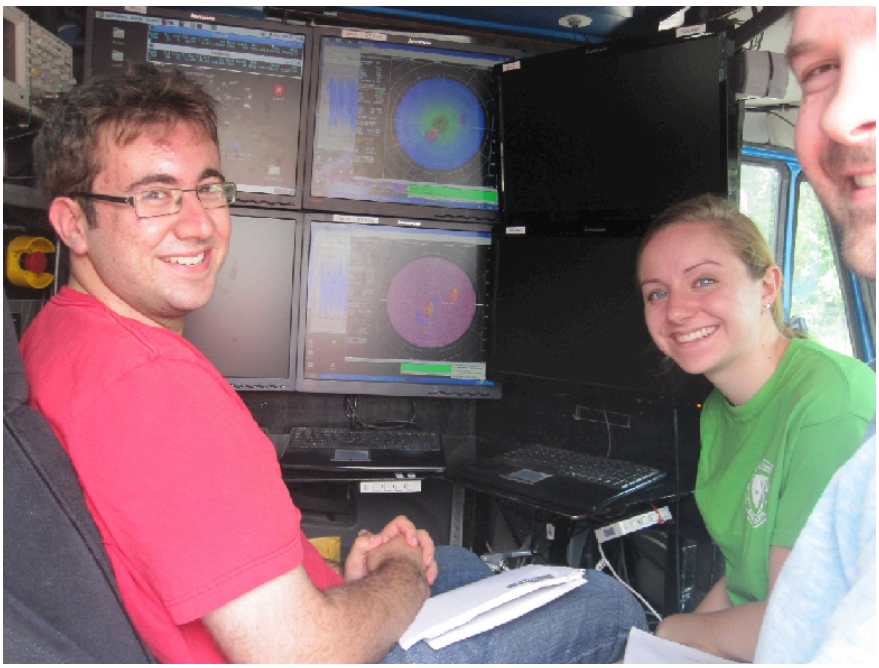

Figure. 2. Stony Brook undergraduates training within the DOW.

Prior to the start of the DREAMS experiment, a web page was constructed in order to motivate the project, point the public and press towards our goals, promote outreach activities and seminars, and organize the daily planning. The web page is http://dreamsproject.weebly.com/, which is shown in Fig. 3.

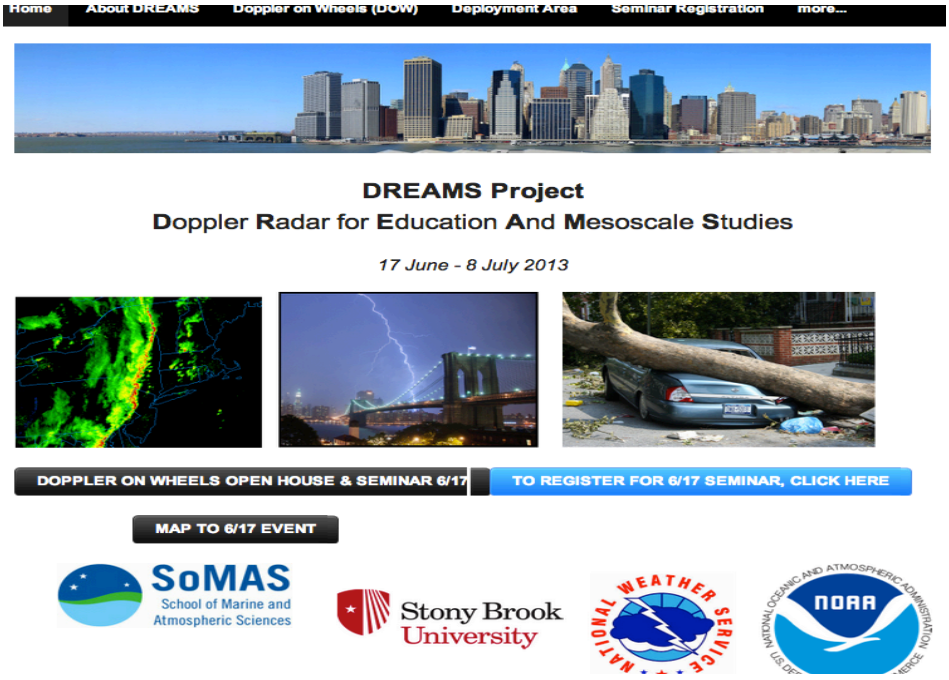

Figure 3. The DREAMS webpage.

b. Project Operations

The daily operations were organized using an online Google calendar as shown in Fig. 4. Each day on this calendar provided information on the following day's activities, including the deployment time and location, as well as the assigned daily roles for the participants. A weather briefing was typically held in the weather lab (Endeavour 139) at 4:30 pm, unless there were operations on that day. For the weather briefings, undergraduate students paired up with a faculty member or graduate student to learn how to compose and present a weather briefing. The weather briefings were broadcast online using Adobe Connect software and camera in the room, which allowed those in the field and at the National Weather Service to participate in the discussions.

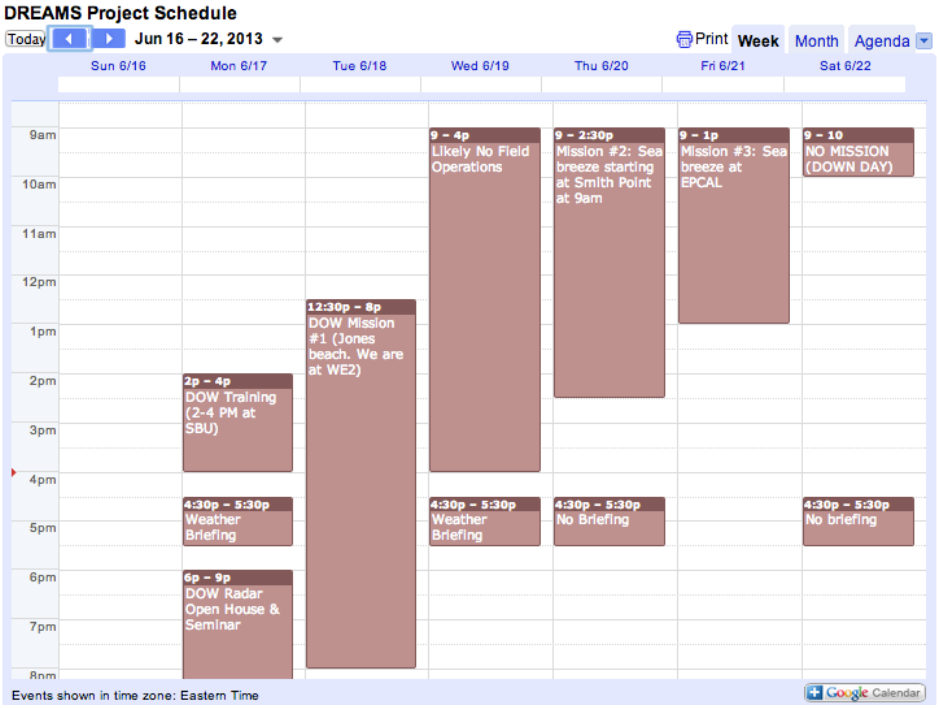

Figure 4. DREAMS Google calendar example for the first week of the experiment.

Figure 5 shows a Google map of the field locations available for the DREAMS experiment, which can be accessed at: http://goo.gl/maps/9vmsk
These locations were chosen given their accessibility for the DOW, exposure for the radar (limited obstructions from buildings and trees), and the mesoscale weather expected. Not all of these sites were used during the field study, especially those on the north fork (NE part) of Long Island. Many of these sites were state and county park locations, which required us to get a special parking access and parking permits before the start of DREAMS. The DOW and a group of students typically met at Stony Brook in the morning before heading to one of these locations.

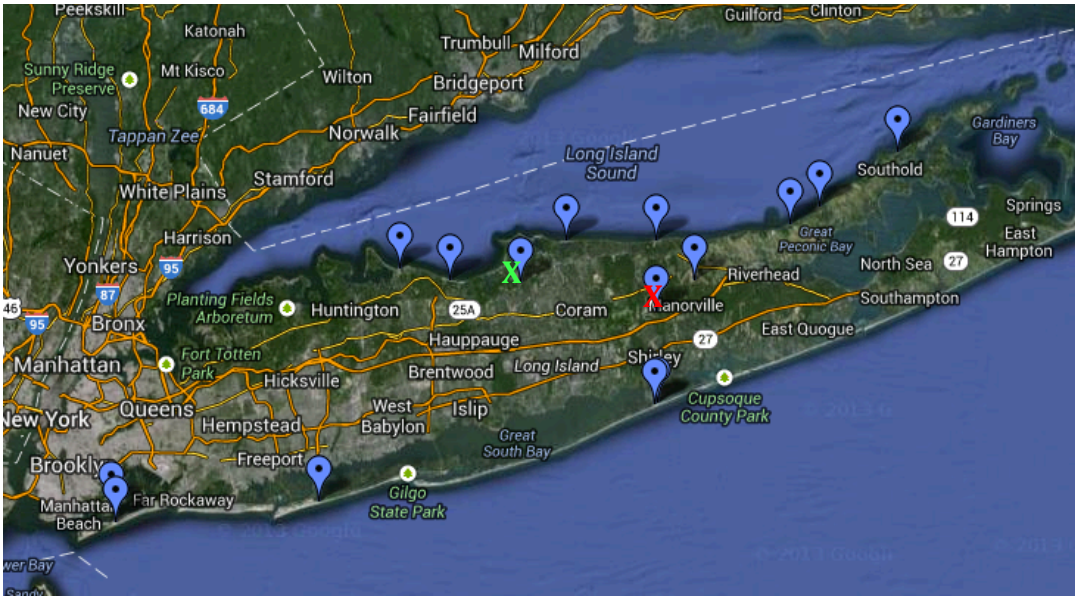

Figure 5. DOW sampling locations in Google Earth for the DREAMS experiment. The green X is Stony Brook, and the red X is the NWS office for NYC-Long Island.

c. Project Missions

A wide variety of mesoscale weather was sampled during the experiment. The various missions are described below. Also, several students helped launch weather balloons at the local NWS office at Brookhaven National Laboratory (red X location in Fig. 5), as shown in Fig. 6. The SoMAS department purchased the helium for the balloons, while ~10 balloons and instruments were kindly donated by the NWS.

Figure 6. Stony Brook undergraduate students completing a balloon launch at the NWS office (red X in Fig. 5).

An instrumented Long-EZ aircraft (Fig. 7) was available for a couple of the sea breeze missions, since the PI (Colle) and the pilot from Ultra-Pure Inc. were involved in another field experiment using that aircraft along the coast. The plane took off from eastern Long Island and sampled the temperature, winds, and humidity from 30 m to 1500 m above the ocean surface for three DREAMS missions (June 19, 21, and 24).

Figure 7. The Long-EZ aircraft used for two missions in DREAMS.

Table 1 highlights the 12 missions during DREAMS, which are described in more detail below.

Table 1. DREAMS missions

Date	**Start Time (UTC)**	**End Time (UTC)**	**Type of Event**	**Number of students participating**
18 June	1400	2300	Convective Storms off NJ coast	15
19 June	1330	2000	Sea breeze front	10
21 June	1315	1830	Sea breeze front	8
24 June	1415	2330	Convective storms along sea breeze front and NY Bight jet	12
26 June	2000	2300	Possible storms over Long Island Sound	10
27 June	1530	2230	Long Island convective storms	8
28-29 June	1615	0300	Scattered convection over Connecticut	10
30 June	1800	2330	Long Island convective storms	6
1 July	1500	1900	Long Island convective storms	10
2 July	1500	1700	DOW Mechanical Issues	--
6-7 July	2300	0300	Fireworks display	5
8 July	1400	1900	Sea breeze front	8

1. **Convective Storms off NJ coast (18 June 2013)**
DOW Location: Jones WE2; POD deployment – right next to truck)
Number of Students Participating: 15

Figure 8. DOW deployment at Jones Beach on the Long Island south shore sampling convective storms over the Atlantic Ocean.

The DOW departed SBU at 1400 UTC for Jones Beach (Fig. 8). The target was the convective storms that developed over NJ and moved over the coastal ocean. The storms were mainly embedded in an expanding stratiform region (well defined bright band in DOW RHI). The storms seemed to maintain themselves and there were some interesting velocity gradients offshore. By ~2100-2200 UTC, precipitation was mainly stratiform and moved over Jones Beach. The winds were mainly out of the north, suggesting the precipitation was forming along a boundary to the south.

2. **Developing Sea breeze and associated Cu (19 June 2013)**
DOW Location: Smith Point Park (N side of lot) from 1400 UTC to 1630 UTC. EPCAL (Latitude 40.922745; Longitude -72.79737; Heading 90^{o} East) POD deployment by concession stand at Smith Point and by DOW truck at EPCAL.
Number of Students Participating: 10

The DOW departed SBU at 1330 UTC. The initial position was at the north side of Smith Point. The WSW flow transitioned to SW around 10-11 am, and by 11 am some cumulus began to develop to the north along a W-E sea breeze boundary along central Long Island (Fig. 9). This boundary seemed to separate the developing Sound Breeze from the SWerlies to the south. It is unclear how much the ocean enhanced these SWerlies just inland of the coast, since the mean flow was weak SW above the surface. Students took measurements up the William Floyd to near this boundary. Since Smith Point was relatively far away from this boundary we moved to EPCAL around 1630 UTC and got an hour or so of nice RHI and PPI scans of the W-E cumulus and wind shift. This boundary pushed to the north shore and weakened by around 2000 UTC.

Figure 9. The DOW and students measuring the sea breeze front. The line of cumulus was situated along the sea breeze boundary.

3. **Sea breeze convergence boundary (21 June 2013)**
DOW Location: EPCAL (Latitude 40.922745; Longitude -72.79737; Heading 90^{o} East; No POD deployment)
Number of Students Participating: 8
Initially, no sea breeze boundary was detected. At ~1437 UTC, mobile student observers were instructed to collect observations every 10-15 minutes beginning at the DOW location following a southward transect along the William Floyd Parkway to Smith Point Park to locate the position of the boundary. An E-W oriented boundary developed in situ parallel and along the north shore of Long Island, ~3-6 km north of the deployment site, as detected by the DOW at ~1540 UTC. Shallow cumulus clouds were observed along the radar-detected boundary providing visual evidence of the boundary. The cumulus did not develop in height due to the dry atmosphere, and evaporated quickly. The mission concluded by ~1822 UTC when the convergence boundary was no longer detected by the DOW, with no visual evidence (shallow cumulus) as well. The Long-EZ collected observations from the sea breeze to an offshore spiral location to the south of Long Island (Fig. 10).

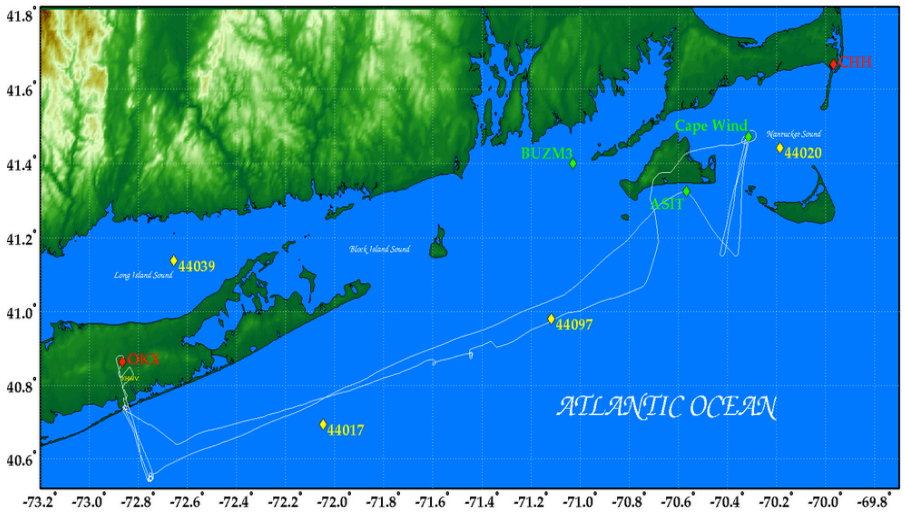

Figure 10. The Long-EZ flight track, which included north-south flight legs from the sea breeze front to an offshore location.

4. **New York Bight jet and scattered convection (24 June 2013)**
DOW Location: Jacob Riis (Latitude 40.567474; Longitude -73.867940; Heading 70 º East Northeast; POD deployment ~ Latitude 40.566835; ~ Longitude -73.867669)
Number of Students Participating: 12

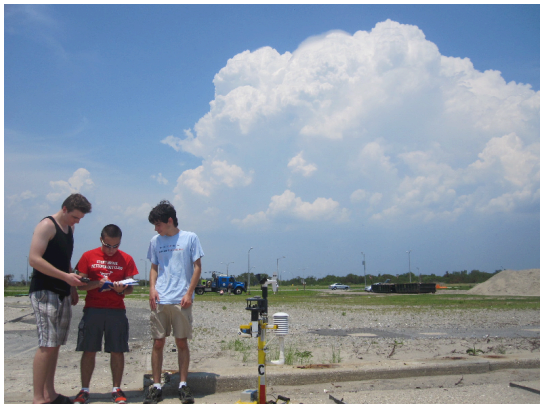

Figure 11. The DOW and students with the POD sampling a developing severe storm to the northeast over Nassau County.

The DOW documented the development and evolution of the convection as it moved eastward along a sea breeze convergence boundary (Fig. 11). The NWS issued a severe thunderstorm warning for this convection for Nassau and western Suffolk counties.

Between 1800 UTC and 2030 UTC the Long-EZ flew from Brookhaven airport to sample the New York Bight jet and marine layer from 100 km east of northern New Jersey to a series of north-south legs ~10 km east of the NJ coast. RHI scans of mammatus clouds were made at 1953 UTC (Fig. 12), associated with the anvil from a storm located in eastern New Jersey. Between 2012 UTC and ~2100 UTC, lightning was observed from this cell, and light rain began falling over our location at 2046 UTC.

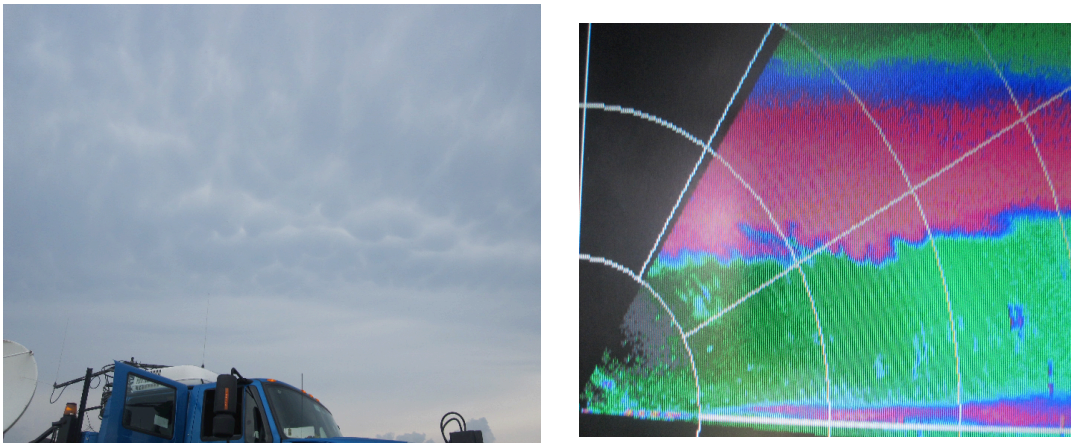

Figure 12. Mammatus clouds observed under the anvil by camera and the DOW RHI scans.

5. **Convection over southern Connecticut (26 June 2013)**
DOW Location: Cedar Beach Park on north shore
Number of Students Participating: 10
The Dow was deployed to view convection over southern Connecticut, but the storms weakened.

6. **Scattered Convection from Jones Beach (27 June 2013)**
DOW Location: Jones Beach West End 2 Lot (Latitude 40.583478N; Longitude -73.561714W; Heading 90^{o} East; No Pod Deployment)
Number of Students Participating: 8
At 1718 UTC, there was observational evidence of a cluster of cumuli developing to our north. Within an hour of the DOW deployment, precipitation along the Queens/Nassau border was captured by the OKX radar and was sampled by the DOW with PPI and RHI scans (see notes for details). A tornado watch was issued by SPC at 1800 UTC, valid until 0300 UTC, which convinced us to wait at Jones Beach for any scattered convection that may develop. Any convection that developed in NJ was steered by the southerly flow and moved north-northeast. We waited to leave until ~2200 UTC, after evening rush hour, which provided plenty of time for a Fox 5 news representative to come and take photos of the operation and interview Kelly, Rachel, Jessica, and Michael. The DOW shutdown was initiated at 2203 UTC.

7. **Scattered Convection over Connecticut (28 June 2013)**
Location: Cedar Beach in Mt Sinai (Latitude 40.964657; Longitude -73.030760; Heading

South 180^{o}; POD deployment)
Number of Students Participating: 7
Scattered storms around the area were expected given the marginal vertical wind shear, decent CAPE, and ample low-level moisture. Only a mechanism for lift was absent. At 1700 UTC, convection was ongoing in Connecticut, moving northward. There was a steady development of cumulus to the NE/E of the DOW. Visually, small, shallow cumuli were visible in every sector over LI, showing the vertical extension of the marine boundary layer. At 2120 UTC, a pileus cloud formed over a vigorous updraft within a developing cumulus to our north over CT. Subsequently, storms were firing up over NJ and moving N-NE. By ~2200 UTC, an anvil from the storms to the southwest was overhead and the DOW was scanning the associated stratiform precipitation. Throughout the day, especially after 2100 UTC, there was public large interest in the DOW (> 40 different groups). Lisa and Sara tag-teamed as PR reps for the project.

8. **Scattered Convection Around Long island** (June 30, 2013)
Location: Smith Point Beach
Number of Students Participating: 6
At startup, ~1900 UTC, the DOW was able to pick up storms to the south and east over the Atlantic at a distance of ~80 km, as well as some weak echoes to the NW of the DOW. There was fog and low cloud present until ~2200 UTC, which was replaced by a moderate mist. RHI scans were performed on the area of enhanced reflectivity to the northwest of the DOW between 2000 - 2130 UTC. A discrete cell became visible to our south so at 2130 UTC the RHI specified azimuth angles were changed to target that cell. At 2208 UTC the RHI azimuth angles were adjusted to keep pace with the cell. Small-scale cells were developing behind the larger cell to the south that we had been tracking, so at 2247 UTC, we adjusted the RHI scans to include them in the scans.

9. **Line of Storms Measured from Cedar Beach** (1 July 2013)
Location: Cedar Beach in Mount Sinai (Latitude 40.964696N; Longitude -73.030910W; Heading South 180^{o}); Pod Deployment (Latitude 40.96511N; Longitude -73.03120W; Heading North)
Number of Students Participating: 10
Initially, a robust line of storms was observed by the DOW, located ~40 km to the southwest, moving northeast towards the DOW. RHI scans were performed on the area of enhanced reflectivity (primary convective core) to the southwest of the DOW beginning at 1616 UTC (until ~1700 UTC). A shelf cloud was observed to the northwest of the DOW as the primary convective cell moved to the immediate north of Cedar Beach (Fig. 13). A second round of convection developed and moved northeast toward the DOW, with the primary convective cell observed to our south. At 1718 UTC, the RHI specified azimuth angles were changed to scan the second primary convective core as it moved toward the DOW. The convective core passed over the DOW. Light rain was observed at Cedar Beach at 1727 UTC, with heavy rain at 1745 UTC.

Figure 13. The DOW and POD deployed at Cedar Beach on the north shore of Long Island.

10. **Convection and Bird Samples (**2-3 July 2013)
Location: The DOW was headed for Jones Beach WE2 on 3 July, yet did not reach the deployment site because of mechanical issues. The mission was called off and the DOW was unavailable until 6 July.

11. **Fireworks at Calverton Airport (**6 July 2013)
Location: Calverton Airport (EPCAL), along northwest taxiway (Latitude 40.922155; Longitude -72.800151; Heading South-Southeast); No POD Deployment
Number of Students Participating: 5
The targeted fireworks display was of the Peconic Bay Medical Center Family Festival located at 6164 New York 25A, Wading River, NY 11792. The publicly listed time of the display was 0130 UTC, though the actual display did not occur at this time. The DOW sampled the ongoing scattered fireworks from further displays, which were within range of the PPI scans, using a faster azimuthal rate (40 rather than 30). The smoke from the display was potentially visible with the range of 120-180 degrees on the truck relative screen.

12. **Sea Breeze at Calverton (**8 July 2013)
Location: Calverton Airport (EPCAL), along northwest taxiway (Latitude 40.9222227; Longitude -72.79979; Heading East-Northeast); POD Deployment (Latitude 40.92217; Longitude -72.80016; Heading North)
Number of Students Participating: 8
Our target was the sea-breeze convergence boundary as well as any convection developing along the boundary or moving into the area (Fig. 14). At ~1700 UTC, a balloon was launched from the Upton NWS. The boundary moved approximately northward over the DOW during the deployment period. No precipitation fell from the clouds that developed along the boundary, which eventually dissipated.

Figure 14. The DOW sampling the sea breeze front as identified by a row of Cumulus over the site.

DREAMS Outreach

a. Open House and Seminar

This project provided a unique educational opportunity for those within the community as well. SoMAS and the NYC-Long Island Chapter of the American Meteorological Society hosted a DOW open house and seminar on 17 June 2013 for the general public to tour and learn about the DOW. Drs. Josh Wurman and Karen Kosiba gave a seminar about the DOW and their various scientific projects, followed by a 30-minute question and answer period. Figure 15 shows the flier for the event and the open house, while Fig. 16 highlights some seminar photos. There were approximately 150 registered participants for the open house and seminar.

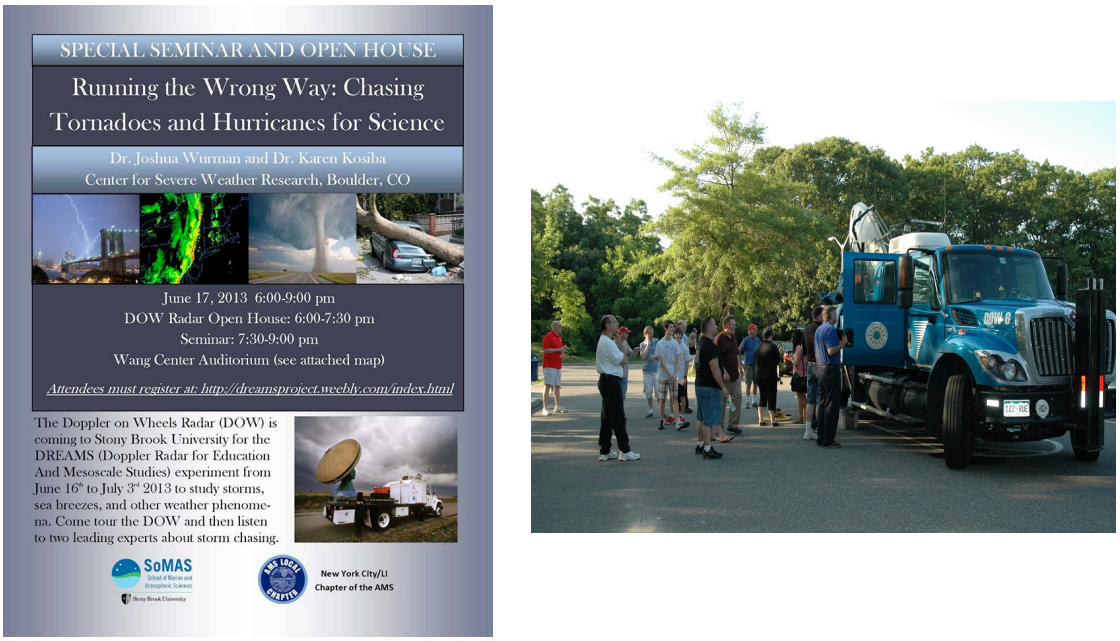

Figure 15. Open house announcement and gathering of the public with the DOW on 17 June 2013.

Figure 16. The public seminar by Drs. Josh Wurman and Karen Kosiba on 17 June 2013.

Since many of our field locations were at populated beaches and parks, the public often approached us to ask questions about the DOW. We estimate that at least 10-20 people visited our group during each of the missions, especially at Cedar Beach, Jones Beach, and Jacob Riis parks.

b. Media Coverage

There was a press release by Stony Brook University about the DREAMS experiment: http://commcgi.cc.stonybrook.edu/am2/publish/General_University_News_2/Stony_Brook_University_Hosts_NSF_Funded_Storm_Chasing_Project.shtml.

At the open house there were reporters from New-12 Long Island, Newsday, and NBC, who did interviews during the event (Fig. 17). Here is the Newsday article: http://long-island.newsday.com/search/stony-brook-storm-chasers-1.5507456

Fox 5 news also came to the field at Jones Beach on June 27 to interview the students about the project (see mission # 6 above).

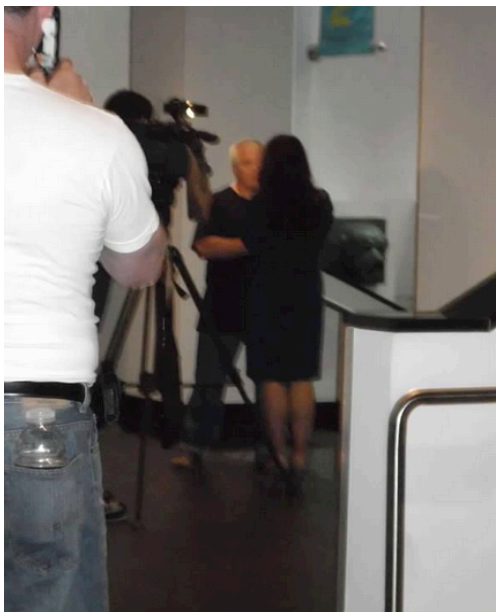

Figure 17. DREAMS open house and media interview of Dr. Josh Wurman during the event.

c. Undergraduate research

Several of the undergraduate students who participated in DREAMS will use the DREAMS dataset for their junior and senior research projects by registering for more credits of ATM 487. The university has an URECA poster presentation every spring in which the students active in research get to present their work to the campus community. The students involved in this project are already gathering other surface, upper air, and radar data to synthesize for their case studies.

d. K-12 Outreach

Unfortunately, DREAMS took place when most of the schools were wrapping up their academic school years, so no formal tours could be organized. However, a few local high school students did participate in DREAMS by joining us in the field and taking measurements.

Final Thoughts (Lessons Learned)

The DREAMS project (17 June to 8 July 2013) was very successfully to get students highly involved in field planning, operations, and forecasting. Most of the undergraduates never had field experience before, so this gave them an opportunity to apply what was learned in the classroom. Students were able to rotate duties between DOW operations, POD deployment, hand-held meteorological data gathering using their cars, forecasting, and weather balloon launches in order to get a broad experience. Many of these students continue to help after the DREAMS field phase by synthesizing various datasets for research case studies.

The DREAMS open house and seminar was a very successful outreach opportunity, illustrating to the broader public how the DOW can be used in scientific investigations of severe weather. This was very important considering the numerous severe storms that have recently impacted the NYC area, such as hurricane Sandy in late 2012. There were many younger students in the audience during this event, so we hope this helped motivate the importance of Geoscience research to the next generation of scientists.

The DREAMS dataset will be very useful for the classroom and research. The case studies will be used to highlight sea breeze development, convective storm development along the sea breeze, and radar operations in various laboratory exercises in synoptic/mesoscale classes (such ATM 247 and 347 at Stony Brook). These same case studies will be used to explore the evolution of these phenomena, utilizing the DOW data in conjunction with the additional weather balloons launched during many of these events as well as some flight-level data from a Long-EZ aircraft offshore over the coastal Atlantic Ocean, providing a set of very unique data sets.

We believe this experience will motivate other future regional field studies to explore convective storms in coastal New England and Long Island. Our long-range goal is to request the DOW again for additional experiments.

From the whole DREAMS team, we thank the staff at the Center for Severe Storms Research and NSF for this great experience (Fig. 18).

Figure 18. A group photo of part of the DREAMS team. Thank you for a great experience!!