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Acronyms and Abbreviations

AMF	ARM Mobile Facility
ARM	Atmospheric Radiation Measurement Climate Research Facility
BB	bright band
BNL	Brookhaven National Laboratory
CONUS	Continental United States
DOE	U.S. Department of Energy
GoAmazon 2014/15	Green Ocean Amazon 2014/15
IR	infrared
km	kilometer
LI	lifted index
MHz	megahertz
NEXRAD	next-generation radar
NWS	National Weather Service
PI	principal investigator
RWP	Radar Wind Profiler
TCAP	Two-Column Aerosol Project
UTC	Coordinated Universal Time

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1.0 Summary

The Radar Wind Profiler for Cloud Forecasting at Brookhaven National Laboratory (BNL) [http://www.arm.gov/campaigns/osc2013rwpcf] campaign was scheduled to take place from 15 July 2013 through 15 July 2015 (or until shipped for the next U.S. Department of Energy Atmospheric Radiation Measurement [ARM] Climate Research Facility first Mobile Facility [AMF1] deployment). The campaign involved the deployment of the AMF1 Scintec 915 MHz Radar Wind Profiler (RWP) at BNL, in conjunction with several other ARM, BNL and National Weather Service (NWS) instruments.

The two main scientific foci of the campaign were: 1) To provide profiles of the horizontal wind to be used to test and validate short-term cloud advection forecasts for solar-energy applications and 2) to provide vertical profiling capabilities for the study of dynamics (i.e., vertical velocity) and hydrometeors in winter storms. This campaign was a serendipitous opportunity that arose following the deployment of the RWP at the Two-Column Aerosol Project (TCAP) campaign in Cape Cod, Massachusetts and restriction from participation in the Green Ocean Amazon 2014/15 (GoAmazon 2014/15) campaign due to radio-frequency allocation restriction for international deployments. The RWP arrived at BNL in the fall of 2013, but deployment was delayed until fall of 2014 as work/safety planning and site preparation were completed. The RWP further encountered multiple electrical failures, which eventually required several shipments of instrument power supplies and the final amplifier to the vendor to complete repairs. Data collection began in late January 2015. The operational modes of the RWP were changed such that in addition to collecting traditional profiles of the horizontal wind, a vertically pointing mode was also included for the purpose of precipitation sensing and estimation of vertical velocities. The RWP operated well until the end of the campaign in July 2015 and collected observations for more than 20 precipitation events.

2.0 Campaign Highlights

The RWP operated well for the six-month period from January 2015 through July 2015 and the collected data set will be useful toward the primary goals for the campaign. In particular, a number of interesting winter-storm precipitation events were collected and are currently the focus of further analysis. In particular, some of the interesting events include:

24 January 24 2015: Multi-hour snow-to-rain (and back to snow) transitional event.

26-27 January 2015: Blizzard event, snowfall with strong embedded bands (horizontal, across Long Island, later more vertically oriented) of heavier snow.

30 January 2015: Light snowfall, modest bands throughout the afternoon.

2 February 2015: Snow, transitioning to rain (and back again), having solid convective snow bands and melting layer features throughout.

5 February 2015: Light bands of snow, passing east to west over the profiler.

6 February 6 2015: Lighter bands of snow, possibly lake-effect remnants, evaporating before reaching surface.

7 February 2015: light, possibly lake-effect snow, intensifying a bit before heading over profiler, eventually some reaching the surface.

8 February 2015: weak, evaporating snow early, then remnants of cells that perhaps intensified locally over the Poconos/Eastern Pennsylvania, then reaching lifted index (LI).

9 February 2015: weak, convective rain cells that mostly break up before hitting profiler site.

12 February 2015: light snow bands slowly migrating over the site.

14-15 February 2015: forecasted moderate snow event that mostly hit Central Island, but not profiler site; most snowfall toward end of 14 February through middle of 15 February.

17 February 2015: solid moderate snow event. Some periods of more dense/wet snow (faster falling).

19 February 2015: interesting wave patterns on the continental United States (CONUS) northeast next-generation radar (NEXRAD), looking at this case and previous as sensitive to these waves.

21-22 February 2015: larger-scale snow-to-rain event. 21 February is all snow for the later few hours, then transition is on 22 February, with really clean bright band/rain followed by final transition to snow.

26 February 2015: light snow bands from system that passed further south of Long Island region.

1-2 March 2015: solid, widespread snowfall event. Standard ‘transition’ to rain on 2 March.

3-6 March 2015: sustained winter storm. 3 March started as snow followed a rapid transition to rain (around 23 Coordinated Universal Time [UTC] on 3 March), possible “saggy” bright bands on 4 March around 12 UTC. 5 March was mostly rain early, but transitioned back to some really deep snow bands, possible mixtures of wet, convective-type snow early to drier snow late (see Figure 1). Some lingering snow on 6 March, but very fast falling (3 m/s), could be “wet.”

8 March 2015: weaker, lake-effect (i.e., from Eerie) snow bands making it to Long Island.

10-11 March 2015: solid event. Starts as rainfall early with clean bright band (BB) signatures, then BB signatures slowly increase in altitude with time (perhaps by almost 1 kilometer [km]). No evidence of snow.

14-15 March 14 2015: (widespread event)

17 March 2015: (snow)

18 March 2015: (strange snow bands from Great Lakes making it to Long Island)

20-21 March 2015: (snow event)

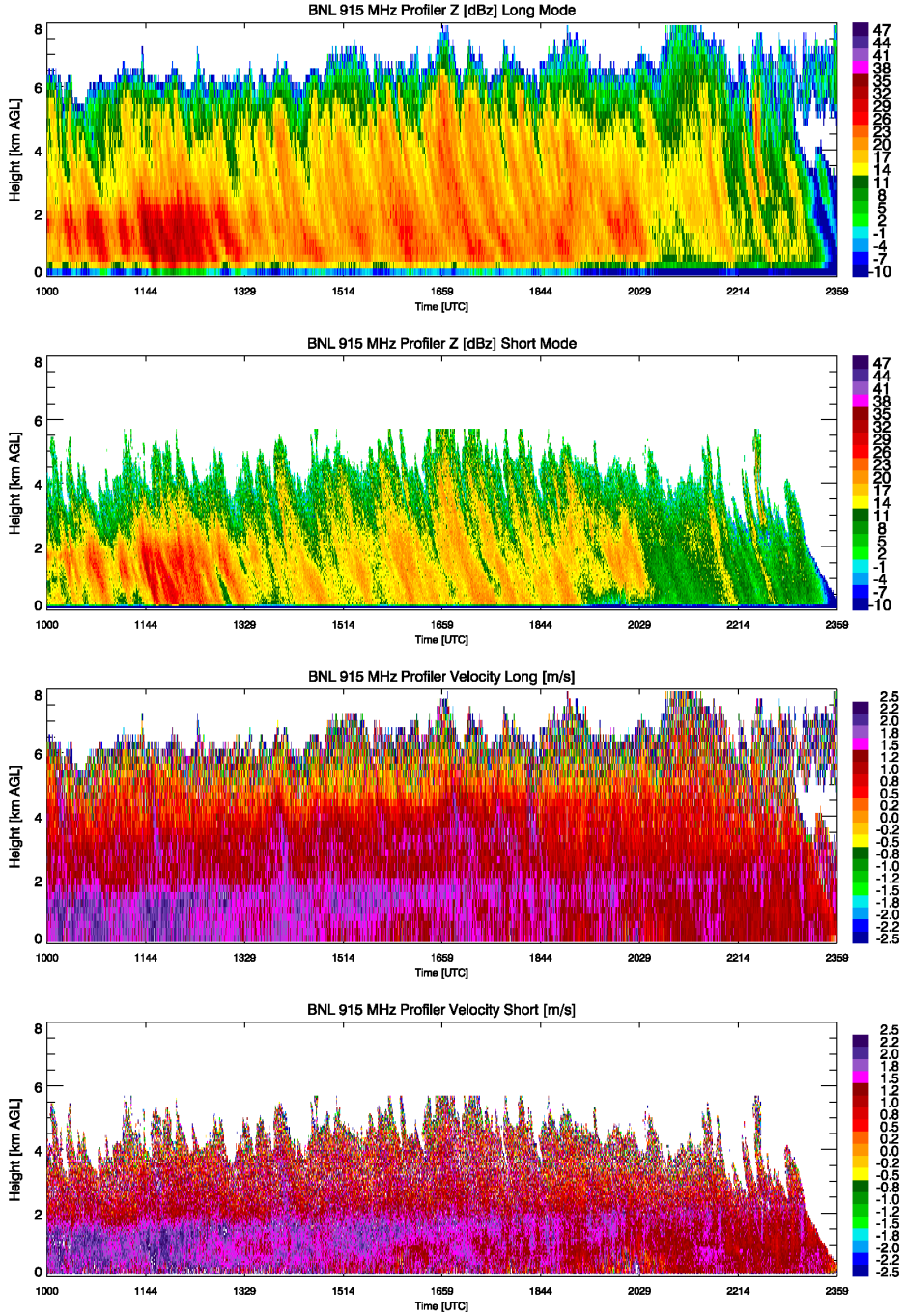

Figure 1. Reflectivity (top two panels) and Doppler velocity (bottom two panels) for the long- and short-pulse modes of the RWP for 5 March 2015 winter storm case. Observations illustrate wet snow transitioning to dry snow near the surface, with sporadic higher-density snow aloft throughout the event.

3.0 Instrument Summaries

3.1 Scintec 915 MHz RWP (AMF1)

The RWP became available for this campaign at BNL following the deployment of the AMF at Cape Cod, Massachusetts as part of the TCAP campaign. It could not accompany the AMF1 to the next deployment in Brazil due to radio-frequency allocation restrictions for international deployments, and so became available for an offsite campaign on short notice. The RWP arrived at BNL in the fall of 2013, but deployment was delayed until fall of 2014 as work/safety planning and site preparation were completed. There was also a part not included in the shipped boxes that needed to be tracked down and sent to BNL. The RWP was deployed in the courtyard of building 490 near the Cloud Processes Group rooftop instrument platform and offices (see Figure 2)

Figure 2. ARM 915MHz RWP deployed at BNL.

The RWP further encountered multiple electrical failures, which eventually required several shipments of instrument power supplies and the final amplifier to the vendor to complete repairs. Data collection began in late January 2015. The RWP operated well through the end of the campaign in July 2015 and collected observations for more than 20 precipitation events.

The operational modes of the RWP were changed so that in addition to collecting traditional profiles of the horizontal wind, a vertically pointing mode was also included for precipitation sensing and estimation of vertical velocities. The data collected from January 2015 through July 2015 were processed using the standard ARM ingest and stored in the ARM Data Archive [available at http://www.arm.gov/campaigns/osc2013rwpcf].

In addition to the ARM 915 MHz wind profiler, complementary observations were collected at the BNL site. Currently, these data are available by request from the principal investigator (PI) (mjensen@bnl.gov), but could be shared through the ARM Data Archive. This instrumentation includes:

- An ARM Parsivel disdrometer
- Two BNL Total Sky Imagers (One coincident with the RWP and another several kilometers away)
- Broadband radiometers (solar/infrared (IR) direct/diffuse radiation)
- NWS NEXRAD WSR-88D precipitation radar
- NWS radiosondes (2/day).

This instrumentation provides the opportunity for calibration checks on the RWP observations, complementary observations of cloud field characteristics, and polarimetric radar and radiosonde observations that can be used toward the scientific objectives.

4.0 Lessons Learned and Anticipated Research Opportunities

4.1 Site Preparation

The site preparation and logistics at BNL took much longer than anticipated. As mentioned in the summary, the RWP became available at the end of the TCAP AMF deployment. As it was being packed up, BNL was contacted to ask if we would be interested in having the RWP shipped to our laboratory for deployment. We took this opportunity, but obviously had done no planning or preparation. The RWP had previously been deployed at BNL as a component of the 2011 Aerosol Lifecycle field campaign at BNL [http://www.arm.gov/campaigns/osc2011aerosolife] and the follow-on 915 MHz wind profiler for cloud forecasting at BNL campaign [http://www.arm.gov/campaigns/osc2011wndproflr]. During that previous deployment we had identified some issues with the deployment site. After some investigation, a new site was chosen (see Figure 1) that required some BNL investments for power access and safety. When these were completed, the RWP was unpacked and installed in April 2014.

4.2 Solving Operational Problems

Following installation, we found a number of operational issues with the RWP—most importantly, it was not transmitting. Working with the ARM instrument mentor and the vendor (Scintec), we were able to identify the issues, send the parts to the vendor for repair, make progress, and finally collect useful data from the RWP. Our lesson here was that a good working relationship with both the mentor and vendor can be critical to instrument performance and thus a successful field campaign.

4.3 Support from ARM Infrastructure

Overall, we enjoyed very strong support from ARM infrastructure. The instrument mentor was helpful in defining and establishing the operating modes of the RWP once it was running. These modes seem to

have worked as expected, allowing us to address the science objectives for the abbreviated time the instrument was operating. The Data Management Facility staff were extremely helpful in working with us to ingest the RWP data, making the archiving of this data simple.

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