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915-MHz Wind Profiler for Cloud Forecasting at Brookhaven National Laboratory

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Acronyms and Abbreviations

ARM	Atmospheric Radiation Measurement
BNL	Brookhaven National Laboratory
IOP	intensive operational period
RWP	radar wind profiler
UTC	Coordinated Universal Time

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1.0 Summary

When considering the amount of shortwave radiation incident on a photovoltaic solar array and, therefore, the amount and stability of the energy output from the system, clouds represent the greatest source of short-term (i.e., scale of minutes to hours) variability through scattering and reflection of incoming solar radiation. Providing estimates of this short-term variability is important for determining and regulating the output from large solar arrays as they connect with the larger power infrastructure. In support of the installation of a 37-MW solar array on the grounds of Brookhaven National Laboratory (BNL), a study of the impacts of clouds on the output of the solar array has been undertaken. The study emphasis is on predicting the change in surface solar radiation resulting from the observed/forecast cloud field on a 5-minute time scale. At these time scales, advection of cloud elements over the solar array is of particular importance. As part of the BNL Aerosol Life Cycle Intensive Operational Period (IOP), a 915-MHz Radar Wind Profiler (RWP) was deployed to determine the profile of low-level horizontal winds and the depth of the planetary boundary layer. The initial deployment mission of the 915-MHz RWP for cloud forecasting has been expanded the deployment to provide horizontal wind measurements for estimating and constraining cloud advection speeds. A secondary focus is on the observation of dynamics and microphysics of precipitation during cold season/winter storms on Long Island. In total, the profiler was deployed at BNL for 1 year from May 2011 through May 2012.

2.0 Campaign Highlights

The cloud-forecasting IOP involved the expanded deployment of the 915-MHz RWP at the campus of BNL. The profiler system that was used is part of the Mobile Aerosol Observing System and was originally deployed as part of the BNL Aerosol Life Cycle IOP,¹ which began in May 2011. Following the BNL Aerosol Life Cycle IOP, the Mobile Aerosol Observing System prepared for an international deployment in India; however, the 915-MHz RWP was not included in this deployment because of an issue regarding international frequency allocations. Rather than store the RWP, an extended IOP was proposed and approved for continued deployment of the system for short-term cloud tracking for use in cloud forecasting exercises in support of the 37-MW solar array that had been installed on the BNL campus. The RWP was deployed in the meteorology field on the BNL campus (see Figure 1).

Files containing the consensus wind profiles every 30 minutes are stored in the BNL Aerosol Life Cycle IOP portion of the Atmospheric Radiation Measurement (ARM) Climate Research Facility archive. Comparisons of these wind profiles with sounding observations from the National Weather Service office located on the BNL campus showed reasonable agreement. Higher resolution spectral data have not been stored because unknown interference was observed in the recorded spectra. Attempts to identify the source of the interference were unsuccessful; however, wind sensors on the two meteorological towers could be the source. These possible sources should be considered for any future deployments (e.g., a new site was chosen for the current deployment of this system at BNL). Some data were lost at the end of the campaign when the capacity of local disk was used up, and old files were overwritten. A total of 132 days of consensus wind profiles are available in the ARM archive.

¹ <http://www.arm.gov/campaigns/osc2011aerosolife>



Figure 1. 915-MHz RWP deployed in the BNL aerosol life cycle IOP.

3.0 Interesting Meteorological Episode – Hurricane Irene

On August 28, 2011, the RWP collected data continuously as Hurricane Irene passed over Long Island. Maximum wind speeds of greater than 40 m/s were observed just below 1.5 km at 08:30 Coordinated Universal Time(UTC). Figure 2 shows several wind profiles between 03:30 UTC and 08:30 UTC.

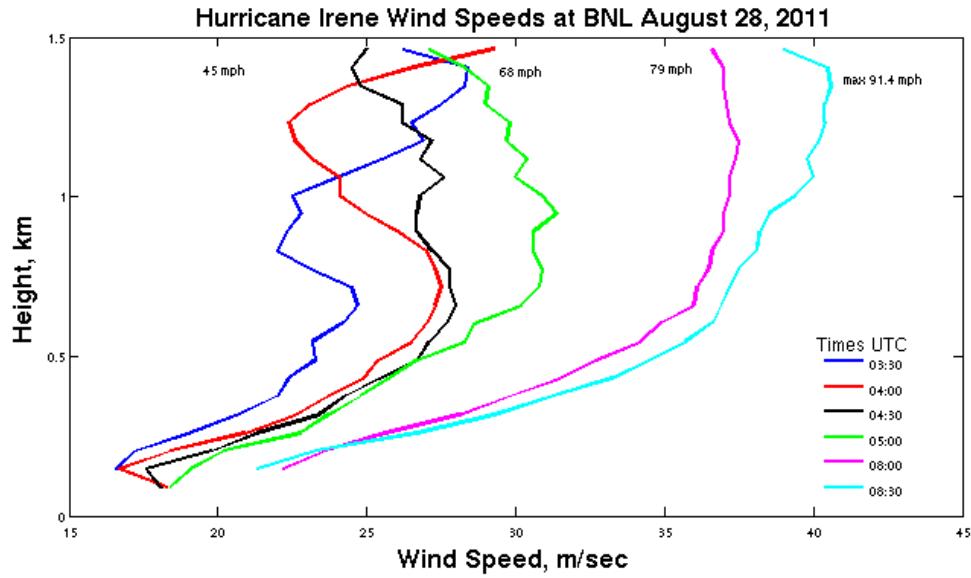


Figure 2. Wind profiles observed at BNL during the passage of Hurricane Irene on August 28, 2011.

4.0 Research Opportunities

Observations from this campaign and follow-on deployments are being used as in testing and verification of short-term cloud forecasting efforts at BNL, including work funded by the U.S. Department of Energy to use small arrays of Total Sky Imager observations for determining cloud advection and cloud base height in the vicinity of the solar array installed on the BNL campus.



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