Overview of WFIP 2 Observations: Concept, Execution, and Results

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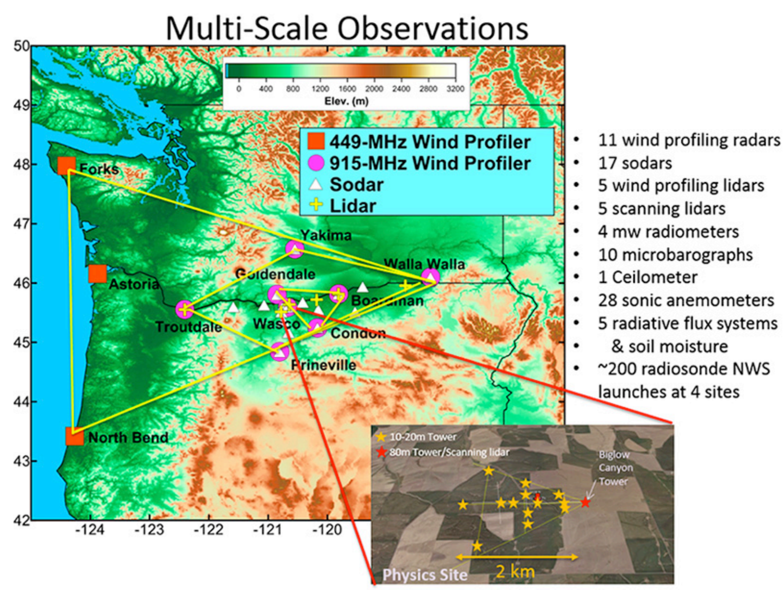
Abstract

The year-long observational phase of the second Wind Forecast Improvement Project (WFIP 2) concluded on 31 March 2017. The overall scientific goals of the project are to improve understanding of the physical processes that affect wind power forecasting in complex terrain and to incorporate this improved understanding into operational weather forecast models, which provide the foundation for wind energy forecasts. The intent of the field measurements was to record atmospheric processes over a broad range of scales that ultimately affect wind power forecasting in order have the necessary information to develop and evaluate improved parameterizations of those processes.

Keywords: Forecasting, field measurements, WFIP 2

Introduction

Short-term (0–45 hr) forecasting of wind energy is important both for efficiently balancing power production with loads on the electrical grid and for the effective operation of electricity markets. Accurately forecasting the wind across the rotor diameter for wind turbines remains a challenge, and particularly so in complex terrain. The first Wind Forecast Improvement Project (WFIP 1) in 2011-12 examined the value of enhanced observations to improving wind power forecasts through better model initialization. WFIP 2 is tackling the more challenging task of improving the ability of forecast models to accurately represent unresolved physical processes in complex terrain where normally disregarded horizontal gradients become important.



Field Measurement Configuration

Figure 1 shows the study area in the Columbia Basin of eastern Oregon and Washington. This area encompasses multiple large wind plants sited in terrain of moderate complexity. Atmospheric flows in the area are further complicated by gravity waves and wakes generated by the Cascade Mountains just to the west, by gap winds through the Columbia Gorge, and by strong shear at top of cold pools that form within the basin, particularly in winter.

Observations in WFIP 2 were designed to capture both broad structure as well as details of the flow using a combination of in situ and remote sensing instrumentation. This was accomplished by arranging instruments within nests of increasing sampling density. The largest scale, defined by the coastal profilers (red squares in the figure above) and the profiling radar at Walla Walla, captured general mesoscale circulation in the area. The next scale, marked by the 915 MHz profilers at Troutdale, Prineville, Yakima, and Walla Walla (pink circles in the figure above) served to define the along- and cross-river circulations and encompassed most of the wind plants in the area. The third nest contained a greater density of systems to provide data to evaluate processes resolved by several 750-m grid cells of NOAA's High Resolution Rapid Refresh (HRRR) model. Finally, the "physics site" was configured with dense vertical and horizontal observations of in situ turbulence sensors to investigate the impact of local variability on conventional surface layer parameterizations.

The field data collection began on 1 October 2015, and the 18-month field duration was intended to maximize the opportunity for collecting as complete a set of observations as possible over a full annual cycle.

Planned Analyses

The data collected will serve multiple purposes:

- *Initialization of forecast models*. Some of the data will be used to enhance model initialization so that differences between control (unmodified) and improved NWP modules will be most directly attributable to physics.
- *Validation of model improvements*. Data not used in initializations will be used for formal validation of NWP model improvements, including assessment of uncertainties in modules and overall model forecasts.
- *Investigation of subgrid-scale processes*. Data from remote sensing systems and arrays of instruments will be used to examine the fine structure and variability of atmospheric flows to provide additional insight into processes that parameterizations must capture in complex terrain.
- *Development of techniques to extract increased information from remote sensing systems.* Efforts are underway to extract profiles of turbulence kinetic energy dissipation rate from the radar wind profilers and to provide improved automation of the detections of atmospheric boundary layer depth. An early result comparing sodars to radars showed that less expensive (and more numerous) sodars are as effective as radars at defining the timing and intensity of wind ramps.

Both raw and processed data from WFIP 2 will be archived and ultimately freely available to the public at the DOE Wind Energy Technologies Office's (WETO's) Data Archive and Portal (https://a2e.energy.gov/projects/wfip2)

Summary

The field phase of the second Wind Forecast Improvement Project has concluded successfully and has provided a wealth of data that is now being analyzed to improve the ability of NWP models to support wind energy forecasting in complex terrain.

Acknowledgment

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