Model Development Efforts During the Wind Forecast Improvement Project 2 (WFIP2)

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Abstract

The Wind Forecast Improvement Project 2 (WFIP2) is a public-private partnership effort led by the U.S. Department of Energy (DOE) and National Oceanic and Atmospheric Administration (NOAA). The goals of this project are twofold: first, to increase understanding of atmospheric processes that affect wind and wind power forecasts in regions of complex terrain, and second, to incorporate this increased understanding into foundational weather forecast models to improve wind power forecasts. The project team includes Vaisala, who is developing decision-support tools to provide uncertainty information to industry agents and operators. The model development efforts were shared between all agencies. Most of the improved model physics will be implemented into future versions of the operational models.

Keywords: *WFIP2, Model physics, turbulence, low-level winds*

Presentation Content

This presentation will provide an overview of the project, with focus on the model development efforts. The project includes a field campaign in the Columbia River Gorge, a region of the country affected by the Pacific Ocean, Cascade Mountains, and the Gorge, which was conducted October 2015 through March 2017. Special observations, including many vertical profiles from wind profiling radars, sodars, and lidars were collected. Instruments were deployed in a nested configuration to investigate phenomena across a range of spatial scales. This data set is available for public use, and the project team has used it for model verification and assimilation (of some, not all, observations). The Columbia River Gorge hosts approximately 5 GW of installed wind power capacity, and is subject to many phenomena that complicate forecasting, including mountain wakes, marine pushes, cold pools, and gravity waves.

The NOAA hourly updating, 13-km Rapid Refresh (RAP), 3-km High Resolution Rapid Refresh (HRRR) numerical weather prediction models, and a very high resolution 750-m nest (Fig. 1) have been targeted for improvements. Many aspects of the model physics used in each of these products will be discussed. These areas include the boundary layer scheme's treatment of local and non-local vertical mixing, orographic drag, horizontal diffusion, the representation of clouds, and a wind farm parameterization. Special effort has been made to introduce scale-aware adaptive physics, which can be applied to any model resolution, even sub-km scales. This was the primary reason for choosing to run the nest at 750-m, which is in heart of terra incognita, the spatial scales where important boundary layer physics approximations break down.

During the project, several forecast error modes have been identified; the most systematic are the low-bias in the depth of cold pools during the winter, which result false-alarm forecasts for wind energy, and the low wind speed bias in thermal trough-induced gap flows during the summer (example shown in Fig. 1). This presentation will highlight the testing and development of many model components, showing the improvements over original versions for temperature and wind profiles under specific weather regimes and as a function of diurnal cycle. Examples of case studies and retrospective periods will be presented to illustrate the improvements. Ongoing and future RAP/HRRR physics development will be touched upon.

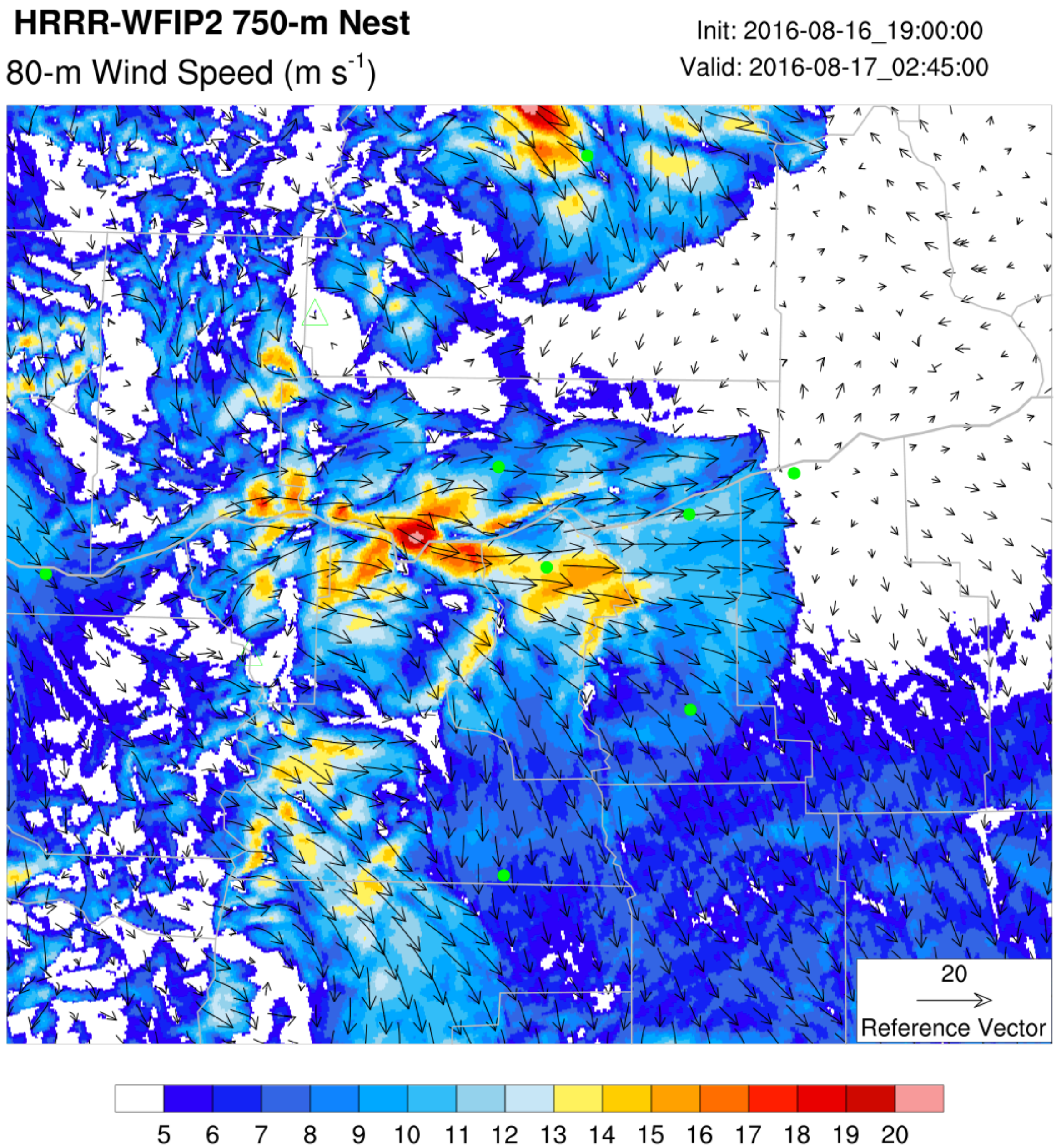

Figure 1. Example of a gap flow (wind speeds in color, m s^{-1}) simulated by the 750-m nest within the HRRR. This gap flow was produced by the development of an inland thermal trough on 16 August 2016. This is an important weather event that drives wind energy in the Columbia River Basin during the summer.