

Analysis of WRF Model Wind Estimate Sensitivity to Physics Parameterization Choice and Terrain Representation in Andalusia (Southern Spain)

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ABSTRACT

This paper reports on an evaluation of the relative roles of choice of parameterization scheme and terrain representation in the Weather Research and Forecasting (WRF) mesoscale model, in the context of a regional wind resource assessment. As a first step, 32 configurations using two different schemes for microphysics, cumulus, planetary boundary layer (PBL), or shortwave and longwave radiation were evaluated. In a second step, wind estimates that were obtained from various experiments with different spatial resolution (1, 3, and 9 km) were assessed. Estimates were tested against data from four stations, located in southern Spain, that provided hourly wind speed and direction data at 40 m above ground level. Results from the first analysis showed that wind speed standard deviation (STD) and bias values were mainly sensitive to the PBL parameterization selection, with STD differences up to 10% and bias differences between -15% and 10% . The second analysis showed a weak influence of spatial resolution on the STD values. On the other hand, the bias was found to be highly sensitive to model spatial resolution. The sign of the bias depended on terrain morphology and the spatial resolution, but absolute values tended to be much higher with coarser spatial resolution. Physical configuration was found to have little impact on wind direction distribution estimates. In addition, these estimates proved to be more sensitive to the ability of WRF to represent the terrain morphology around the station than to the model spatial resolution itself.

1. Introduction

Reliable wind resource assessment is a key issue in the evaluation of wind energy potential and in studies related to integration of wind energy electricity production (GE Energy 2010). Such wind resource assessment can be divided into two steps (Sempreviva et al. 2008)—a regional wind assessment, which evaluates resources of a region as a first approach, and a site-specific assessment, which is a detailed evaluation of specific areas that exhibit high potential in the regional assessment. At this time, regional wind assessment is mostly based on numerical weather prediction (NWP) models (Frank et al. 2001; Landberg et al. 2003; Lavagnini et al. 2006; Zagar et al. 2006; Kanamitsu and Kanamaru 2007; Byrkjedal and Berge 2008; Jiménez et al. 2007; Hahmann et al. 2010; Shimada and Ohsawa 2011). NWP models facilitate

a comprehensive description of the atmospheric system, using initial and boundary conditions from atmospheric reanalysis. On the basis of dynamical downscaling techniques, current NWP models resolve local and regional circulation patterns, taking into account local topographic surface features to a certain extent. Thus, these models can provide accurate meteorological information, such as wind speed and direction, over large regions at high temporal (a few minutes) and spatial (a few kilometers) resolution.

Despite the high resolution of current NWP models (~ 1 km), there are still two main problems in the estimation of surface meteorological variables, especially near-surface wind speed. These problems are 1) representation of topography and terrain morphology in the modeled domains and 2) representation of the numerous physical processes at subgrid scale.

Topography and terrain morphology have a marked influence on surface meteorological variables, especially on surface wind speed and direction. Surface winds result from interaction between mesoscale circulation and other more local factors, many of which are related to

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