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Development and evaluation of high-resolution wind simulation tools to improve fire weather forecasts

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Current fire weather forecasts depend on numerical weather simulations where the grid resolution is 4 km x 4 km or larger. These weather models are not capable of handling the effects of sub-grid complex terrain, such as wind speed-up over ridges, flow channeling in valleys, flow separation around terrain obstacles, and enhanced surface roughness due to forest canopies; however, the effects of complicated terrain are important for predicting fire behavior. This paper presents an overview of a new research effort aimed to evaluate several different high-resolution wind modeling tools which could be adapted to improve fire weather forecasts. Wind models chosen for evaluation include: WindNinja, a mass consistent interpolation scheme; WindNinja, enhanced to use a computational fluid dynamics solver; WindWizard, a computational fluid dynamics solver; CALMET as employed in ClearSky, a smoke dispersion forecast system; and WRF-Fire, a fire physics scheme for WRF, developed at the National Center for Atmospheric Research, which includes a fire behavior model with fire/atmosphere dynamic feedback. In order to evaluate these wind models for a wide variety of terrain features and land cover types, we have instrumented the first of three research sites. The three research sites include a large isolated butte; a low-vegetation, steep river canyon; and a dissected montane environment with a mature forest stand. The first of these sites was instrumented in southern Idaho, USA between June–October 2010, during which time we collected surface wind speed and direction data at over 50 locations within and around an isolated butte. We employed SODAR units, sonic anemometers, and radionsondes to characterize approach flow and upper air wind profiles during the study period. Data collected at the butte site will be presented along with a preliminary evaluation of wind model performances for application at this research site.