Modeling method refines accuracy of wind resource maps.

A novel wind atlas modeling method

Almost every country has created wind resource maps to find potential windy places suitable for building new wind plants. Modelers use a wide range of methods to create these wind resource maps. Yet new methods are needed to capture the detail required to enable dynamic line rating, which could boost transmission and distribution line capacity by 10 to 40 percent.

Idaho National Laboratory researchers are working with the simulation company WindSim to develop a new wind atlas method using specialized software. The new approach enables dynamic line rating modeling and simulation that can expand over hundreds of miles. To be as accurate as possible, the method combines wind speed and wind direction data from smaller simulation areas, and is based on scaling against measurements where available.

Many modeling methods

To create these wind resource maps, scientists have many modeling options to choose from, including mesoscale modelling, linear methods and computational fluid dynamics (CFD).

Using mesoscale models has the advantage that the entire area of interest can be fully covered by one model, while using other approaches requires that several simulation areas be combined afterwards. However, mesoscale modeling does not reach the horizontal resolution necessary for a reliable wind resource map.

For example, mesoscale models reach their limits in rough terrain because the roughly 1-km resolution is too coarse and forces over-simplified orography. By comparison, CFD can simulate the wind flow with a horizontal resolution of 10 m, or even 1 m with specialized data collection. As a result, the CFD approach can better predict the flow pattern within smaller valleys and in very difficult terrain.

For that reason, it has become common to use CFD to generate wind resource maps of smaller areas, and then combine the different simulation areas in the end to see the big picture.

A new modelling approach

INL researchers are working with software developers at WindSim to evaluate different approaches for combining the CFD results obtained for every simulated area:

- Combining the already weighted wind resource maps. This approach has the advantage that those maps can be created for every project individually.

Continued next page

The Energy of Innovation

Idaho National Laboratory

For more information

Jake P. Gentle
Project Manager
(208) 526-1753
jake.gentle@inl.gov

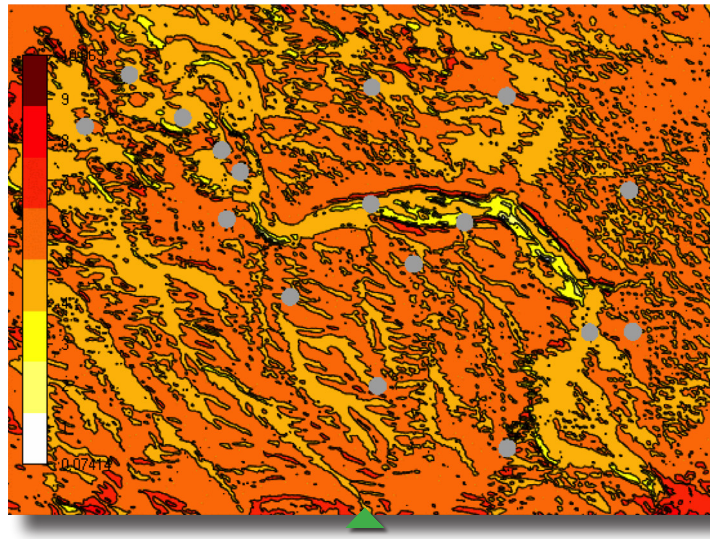
Nicole Stricker
Research Communications
(208) 526-5955
nicole.stricker@inl.gov

A U.S. Department of Energy National Laboratory

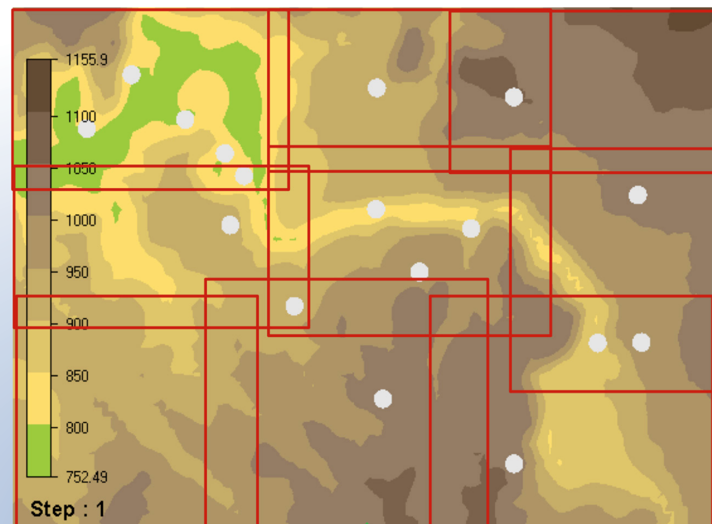
Continued from previous page

As a result, the processing is simplified, as weighting against the measurements is done before combining the maps. One drawback is that differences between maps covering the same area can be large because each map is weighted against different measurements.

- Combining the wind fields of the individual areas. This approach is physically more precise because the simulated wind fields are combined before they are weighted by any measurements. The approach compiles several WindSim CFD models, then combines up to 36 sectors with differing atmospheric stability using a 3-D CFD wind flow model. Direction-dependent interpolation combines all results into a single map, then results are scaled with measurements that are weighted according to distance and representativeness.



Wind speed for entire domain, including the weather stations that are used to weight the results.



Example of a WindSim CFD model — each red section is one simulation area.

INL researchers validated the more precise method by applying it to a real project. The process revealed the need to have sufficient quality measurements throughout the area. Without them, mesoscale model results must be incorporated as virtual climatologies. Also, the boundary area of each domain must be large enough to allow boundary effects to be discarded.

Researchers also discovered that the roughness and terrain data for all areas should be provided from the same data source and should be checked for consistency against the entire area of interest. INL scientists note that it is important that CFD boundary conditions describing behavior on the top of the domain guarantee that the wind flow is maintained throughout the area, since this function is usually completed by the geostrophic wind for large areas. Finally, a clever interpolation and decision technique must be used to ensure smooth transitions at the borders between one area and the next.