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Ultra-high resolution simulations of the atmospheric boundary layer across the shores of Lake Erie

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Abstract

An accurate assessment of wind speeds at various heights and locations is important in the deployment of wind turbines. This study focuses on assessing wind speeds and their trends across the shores of the Lake Erie by unsteady, three dimensional, Large Eddy Simulations (LES) with a horizontal resolution of 50m. In a previous study the Weather Research and Forecasting (WRF) was used for the same region with a coarser resolution of 3km. It did not consistently predict the wind speeds, especially for a well-known nocturnal phenomenon—the Low Level Jet.

Our LES code, DALES (Dutch Atmospheric Large Eddy Simulation), seems to show better performance in this scenario by correctly predicting the Low Level Jet. We also performed sensitivity tests in terms of grid resolution, exact location with respect to the shore, and large-scale advection.

Using a Fourier analysis we estimate the amount of energy at scales that were unresolved by WRF, were wind turbines would not be able to convert to electricity, but would potentially be damaged by the fluctuations instead.