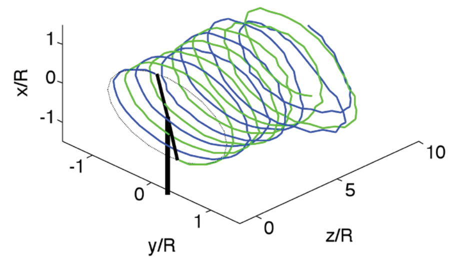
Improving wind turbine computer models

Renewable energy is increasingly important with rising energy demands, finite fossil fuel supplies and growing environmental concerns. Over the last 25 years, wind turbine technology has increased in power output, but to meet a federal goal of generating 20 percent of the nation's energy from wind by 2030, production must increase dramatically and several significant technological advancements are needed, including improved structural and aerodynamic modeling tools.

"The inability of current state-of-the-art wind turbine design codes to accurately and reliably predict performance and loads demonstrates the need for enhanced models," said Jack McNamara, Ph.D., assistant professor of mechanical and aerospace engineering at The Ohio State University. "One issue noted in previous work is inadequate modeling of the rotor wake. For more accurate modeling of the problem, a wake model is required, where the vortex trailing the blades is tracked and its effects are included in the aerodynamic calculations."

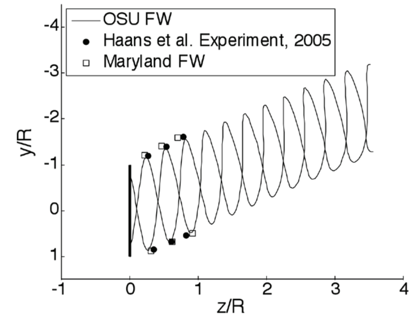
McNamara's Computational AeroElasticity Laboratory is accessing Ohio Supercomputer Center resources to study the effect of the wake on the aeroelastic response and performance of a representative wind turbine. Krista Kecskemety, a graduate student in McNamara's lab, is currently incorporating the OSU Free Wake model into the open-source NREL wind turbine aerodynamics code, AeroDyn. This will then be used in conjunction with the NREL FAST and MSC ADAMs comprehensive wind turbine codes to study of the interaction of the wake with the turbine and its impact on predicted power performance and aeroelastic blade loads. ■

Project lead: Jack J. McNamara, The Ohio State University
Research title: Impact of wake effects on the performance and aeroelastic behavior of wind turbines
Funding sources: Ohio Space Grant Consortium



above: Wake Geometry in a Turbulent Flow

below: Wake Verification and Validation (top view)



Enhancing ocean surface height calculation

With more than 70 percent of the Earth's surface covered in water, studying ocean topography is vital to researchers who produce atmospheric models for forecasting hurricanes, optimizing commercial shipping routes, tracking floating debris and helping manage marine animal populations.

To measure the surface height of oceans, scientists at The Ohio State University ElectroScience Laboratory (ESL) analyze satellite altimeter data. While these instruments produce highly accurate measurements, small but important errors occur because waves are not symmetrical: wide, shallow wave troughs reflect electromagnetic energy more strongly than the narrow, sharp wave crests.

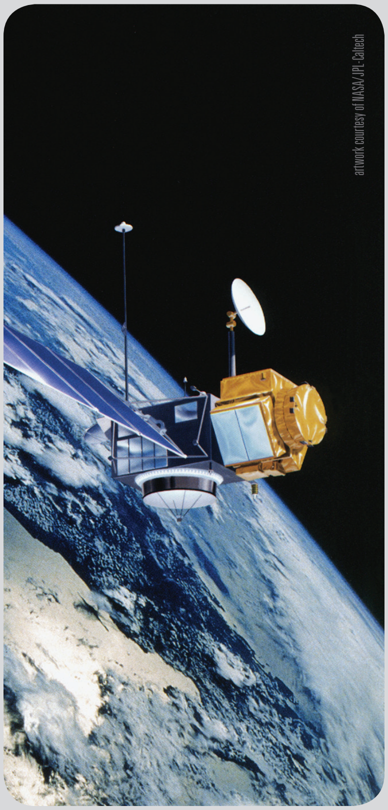
Joel Johnson, Ph.D., a professor of electrical and computer engineering, and Praphun Naenna, a graduate research assistant, have leveraged Ohio Supercomputer Center (OSC) resources to correct an "electromagnetic bias" that reports surface levels that are too low.

"Our study uses a method for hydrodynamic simulations that can better capture these effects than models previous studies employed," said Johnson. "This method, however, comes with far more computational burden, so we use supercomputing resources at OSC to produce a deterministic set of sea surface profiles and the corresponding altimeter pulse returns."

To this point, the development of EM bias simulation tools has been completed, and the numerical results have been verified.

"The focus is now on using these tools to investigate the impact of various physical effects on the EM bias, including variations with the wind speed and the radar frequency, and also the influence of short scale roughness," said Naenna. ■

Project lead: Joel Johnson, The Ohio State University
Research title: Monte Carlo simulations of altimeter pulse returns and the electromagnetic bias
Funding source: The Ohio State University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