Understanding airflow at transonic speeds

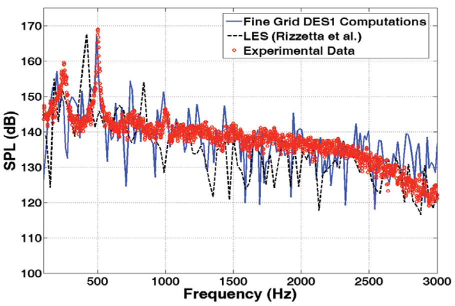
The complex unsteady airflow characteristics of certain aircraft features, such as landing gears and weapon bays, produce pressure fluctuations that reach unacceptable levels for operation and safety at transonic speeds.

To better understand how to control the airflow for pressure fluctuations and noise reduction, Awatef Hamed, Ph.D., Bradley Jones Professor and department head of Aerospace Engineering and Engineering Mechanics at the University of Cincinnati, leveraged the computational resources of the Ohio Supercomputer Center to develop and validate a hybrid unified turbulence model for the Detached Eddy numerical simulations of the unsteady Navier-Stokes equations.

"We worked to simulate and access active flow control using steady and pulsed fluidic actuation for acoustic suppression in transonic flow over an open cavity," Hamed said. "We developed and implemented a new unified methodology to resolve both aerodynamic and aero-acoustic fields to study acoustic control."

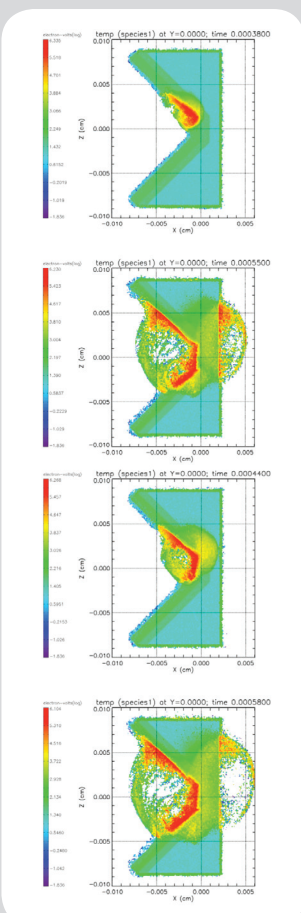
Hamed's research team conducted high-fidelity simulations of supersonic cavity flow with active flow control and compared the results to experimental data and to LES results to assess the fidelity of the hybrid model. They also analyzed the influence of Reynolds number (the ratio of inertial forces to viscous forces) on the unsteady cavity flow and acoustic fields with and without control.

The resulting simulations illustrated that her methodology provides a useful tool for predicting complex 3-D separated unsteady flows over an expansive dynamic range at high Reynolds number and are comparable to LES predictions at one-sixth to one-tenth the CPU resources. ■



Project lead: Awatef Hamed, University of Cincinnati
Research title: Hybrid RANS/LES simuations of transonic cavity flow with control
Funding source: Ohio Space Grant Consortium

Examining laser-plasma keys to fusion energy



Nuclear fusion holds the promise of sustainable, abundant clean energy. Scientists have successfully demonstrated controlled fusion in the laboratory, but have not yet been able to demonstrate useful energy production.

Nuclear fusion must take place in plasma, an ionized medium, and generally requires a combination of density and temperature that is difficult to achieve. As part of a worldwide effort to demonstrate the fast ignition inertial confinement approach to fusion, researchers at The Ohio State University and the Department of Energy's Jupiter Laser Facility have been examining intense laser-plasma interactions.

"We've created numerical models of an intense laser with parameters relevant for fast ignition fusion in a plasma and to determine the resulting distribution of energetic electrons excited and their subsequent propagation," said Douglass Schumacher, Ph.D., an associate professor of Physics at OSU. "Modeling also has been used to help design some aspects of the experimental program."

Schumacher's team has leveraged the computational muscle of the Ohio Supercomputer Center's Glenn Cluster to model specular reflection of an intense laser from a metallic surface, the divergence angle of a laser-generated hot electron beam, the use of K_α radiation as a diagnostic tool, red-shifting of reflected light due to ponderomotive compression of the plasma density profile and the spectra of escaping electrons when ultrashort laser pulses are employed. The research is helping to determine the conditions where fast ignition might work and to develop better diagnostics for fast ignition studies. ■

Project lead: Douglass W. Schumacher, The Ohio State University
Research title: Modeling intense laser plasma interactions in conjunction with an experimental program for 2010
Funding source: Department of Energy, The Ohio State University