Space Travel

Aerothermal Databases to Support the Orion Crew Exploration Vehicle

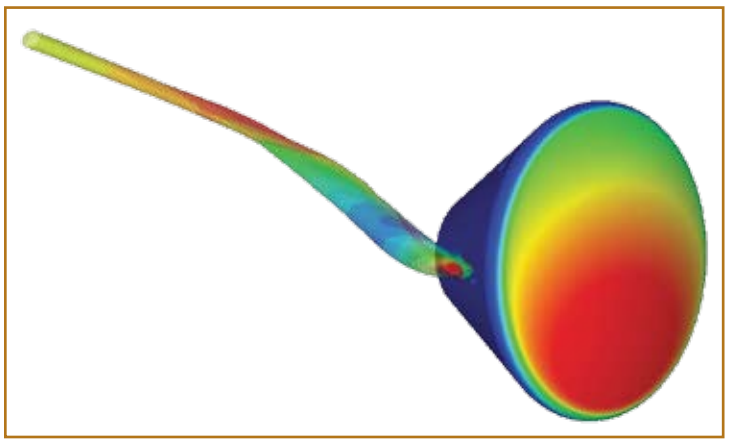
The CEV Aerosciences Project (CAP) at NASA Ames Research Center is tasked with providing the aerodynamic and aerothermal databases for the Constellation Program's Orion Crew Exploration Vehicle (CEV) and Launch Abort Vehicle (LAV). These simulation-based databases are used to design the flight dynamics models and thermal protection systems of the vehicles.

The CAP team is composed of members at multiple NASA centers, Lockheed Martin Corporation, and numerous testing facilities. The team employs multiple high-fidelity analysis codes that model as much of the relevant physics as possible in order to simulate the reentry flight environment. Since it is not possible to perfectly simulate the flight environment in ground test facilities, and flight tests are prohibitively expensive, computationally derived data are necessary to supplement these sources of empirical data.

Team members also use the high-fidelity aerothermal computational fluid dynamics code DPLR to generate a three-dimensional computational mesh of the flight vehicle or test model from a CAD-defined geometry. Then, given the freestream conditions, the systems of equations that govern fluid and gas flows are numerically solved on the computational mesh using DPLR. The solutions can be post-processed to extract useful data, such as surface temperatures and aerodynamic forces. The team's analysis codes are also used to support ground tests of the vehicles, performed at facilities around the country.

The modeling and testing development required to support the Constellation Program will also benefit future NASA exploration missions. In turn, planetary missions designed using these types of analyses return images and data that inspire a generation of future scientists and engineers.

OVERFLOW computational fluid dynamics simulation used to compute 300-plus flow simulations of the Orion Launch Abort Vehicle. Image shows surface pressure contours and plume shape with Goertler vortices (striations on plumes) at supersonic speeds and maximum abort motor thrust.



Simulation of Orion Reaction Control System (RCS) jet firing. The RCS provides attitude control for the capsule during reentry. Notice the large plume generated from the RCS nozzle of the firing yaw jet. These simulations predict both the aerodynamic forces and surface heating augmentation due to the RCS firings.

Ryan Mcdaniel, Kerry Trumble, NASA Ames Research Center
Ryan.D.Mcdaniel@nasa.gov, Kerry.A.Trumble@nasa.gov