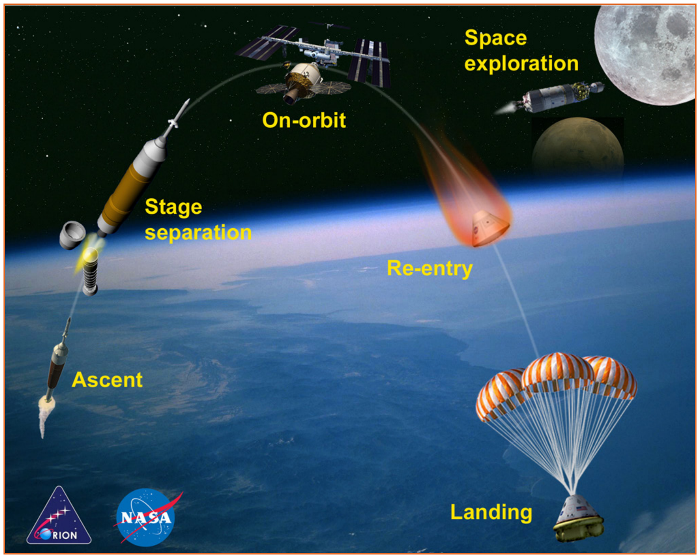
Analysis of Orion Crew Exploration Vehicle Reentry Flow Environments

Exploration Systems Mission Directorate

Advanced simulations of the Orion Crew Exploration Vehicle (CEV) during atmospheric reentry are supporting the design of the vehicle's thermal protection system (TPS) and reentry maneuvering control system. These analyses predict surface heating for TPS design, assess flow interactions and surface heating caused by the descent maneuvering jets, and model unsteady wake flows behind the vehicle to determent their effect on aerothermal heating and aerodynamics. Analyses are also being performed to reduce uncertainties associated with complex, chemically reactive flows, in which chemical properties and reactions play an important role in gas properties and dynamics.

These analyses are performed using a computational fluid dynamics (CFD) flow solver called the Langley Aerothermodynamic Upwind Relaxation Algorithm (LAURA). Using CFD to model complex flow phenomena provides more accurate prediction of quantities needed for TPS assessment, enabling NASA to design the CEV with smaller weight tolerance margins while still ensuring proper protection for the crew.



Mission profile for the Orion Crew Exploration Vehicle (CEV).
NASA/Langley

Extensive supercomputing resources are needed to compute the complex flow structures involved in Orion's wake region, which is highly separated, chemically reacting, and unsteady. Each LAURA calculation solves for over 200 million unknown quantities and requires approximately 31,000 processor-hours on NASA's Pleiades supercomputer for each trajectory point analyzed. This detailed data plays a key role in understanding CEV reentry environments to design a vehicle that will bring astronauts home safely.

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