Launch Environment Simulations

Exploration Systems Mission Directorate

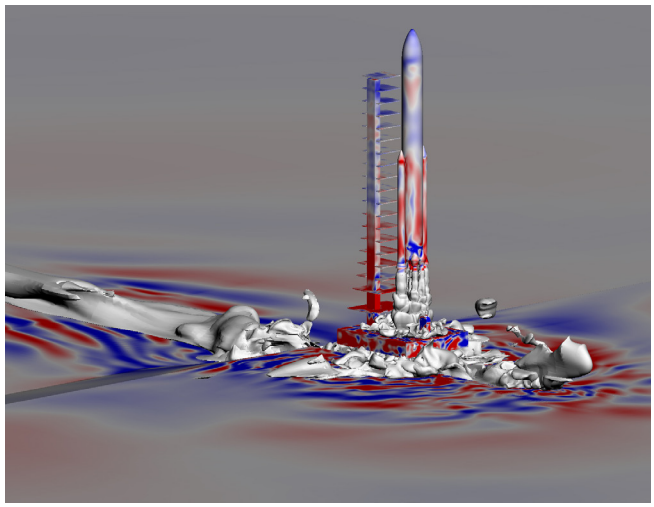
Computational tools and techniques have been developed to simulate the launch environment for NASA's future heavy lift launch vehicles (HLLVs). This work includes simulation of the ignition overpressure (IOP) phenomenon, in order to predict pressure loads on the vehicle and launch pad trench walls.

In addition, computational methodologies have been established to predict acoustic noise sources and sound propagation during liftoff. Acoustic noise is generated by exhaust jets and their interactions with the launch tower, platform, and trench. The acoustic waves then propagate in all directions and interact with the launch vehicle and tower, potentially causing oscillations that could damage the payload. Computational fluid dynamics (CFD) simulations of HLLV launch environments have yielded IOP and acoustic level results in agreement with flight data and empirical prediction methods, validating the approach's accuracy for future vehicles.

Accurate characterization of acoustic environments and sound pressure levels during liftoff is an important step toward the development of new HLLVs. This work helps assess the suitability of existing launch facilities for larger vehicles, and will help ensure successful HLLV launches. Advancing technology to predict acoustic noise could also benefit noise reduction efforts for everyday vehicles, such as cars, trains, and airplanes.

NASA supercomputing resources enable both the large-scale simulations required to resolve the complex physics involved, and the large parameter studies needed to develop sound computational methodologies.

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Gauge pressure contours are shown on the Ares V vehicle and surrounding structures, and exhaust gases are depicted by an isocontour at 5% concentration. Note that acoustic pressure waves radiate predominantly in the direction of the flame trench. *Jeffrey Housman, NASA/Ames*