Flow Solver Predicts Condensation During Supersonic Wind Tunnel Tests

Project Purpose: *The goal of this project is to use High Performance Computers (HPCs) and Computational Fluid Dynamics (CFD) to test Scramjet aircraft engines using a Flow solver and supersonic wind simulations.*

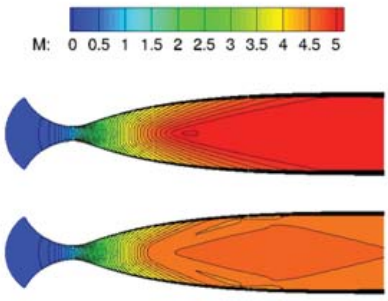
Sweating the Details

Ground test facilities, or wind tunnels have been an important part of aircraft engine development.The simulation of flight during supersonic speeds is a challenge to duplicate. To replicate the high temperatures at this speed, the air is heated.

During this process, oxygen is replenished and the resulting gaseous mixture contains high concentrations of water vapor. As the air velocity increases, it cools and causes condensation. This moisture affects the accuracy of probes and instruments.

A CFD code, REACTMB-MP was developed specifically for the prediction and analysis of this phenomena and helps understand the phase changes during the ground test simulations.

Graphic representation of a possible condesation event during a X51A engine test at a wind tunnel facillity



CFD image of Mach number, the purely gaseous simulation is on top and the two-phase simulation is on the bottom, with lower Mach numbers and greater non-uniformity.

IMPACTS:

- ***Augments accuracy of supersonic ground-tests***
- ***Scramjet engine research, such as the X-51A aircraft***
- ***Reduces contaminates on critical engine parts and instruments thus saving costs***

Working with the lead code developer Dr. Jack Edwards of NCSU, Dr. Susan Cox-Stouffer, a Taitech employee, performed simulations on ten processors on AFRL and ERDC computers (particularly Eagle, Hawk, Sapphire, and Jade) and required approximately two days to reach convergence.