Supercomputing for Aircraft Fuel Injector Swirler Design

Aeronautics Research Mission Directorate

Aircraft gas turbine combustor emissions—comprised of nitrogen oxides, carbon monoxide, sulfur dioxides, and particulates—are harmful to health and the environment. To help design cleaner-burning aircraft engines, the National Combustion Code (NCC) is being used to simulate the swirler mixing process in low-emission gas turbine combustor concepts. In engine combustors, the swirler is a critical component that enhances fuel-air mixing and creates a recirculation zone that stabilizes the combustion process.

In particular, the NCC is being used to model Lean Direct Injection (LDI) concepts designed to reduce nitrogen oxide emissions or smog, and to potentially decrease fuel consumption. To increase the predictive capability of the NCC, computational results are currently being validated against measurements from a research air-blast/air-assist fuel injector combustor at NASA Glenn Research Center.

Realistic modeling of gas turbine combustion requires solving complex, multi-disciplinary equations involving thermochemistry, fluid dynamics, heat transfer, mass transport, material science, and spectroscopy. NASA's highly parallel supercomputing resources enable these intensive computations, some of which require up to 4,000 processors to run. NASA's work with LDI and other lean combustion concepts has contributed to the development of jet engines that produce far less nitrogen oxides, helping to reduce smog, acid rain, asthma, and ozone layer depletion.

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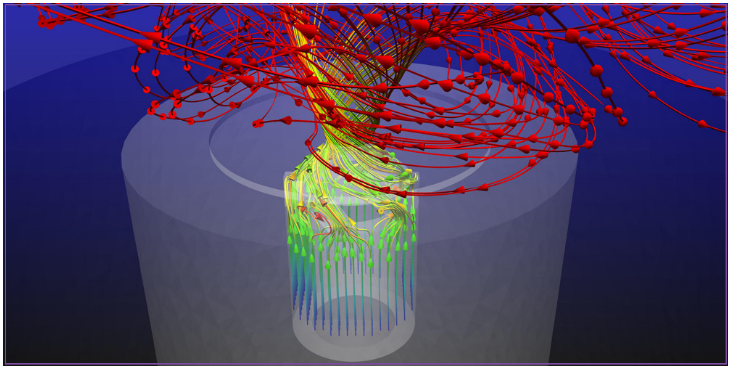

Stream-tubes show the airflow in the air-blast region of a research combustor. Air enters the concentric tube, is spun via a four-slot swirler, and then moves out of the fuel injector region with a tornado-like action. *Anthony Iannetti, NASA/Glenn*