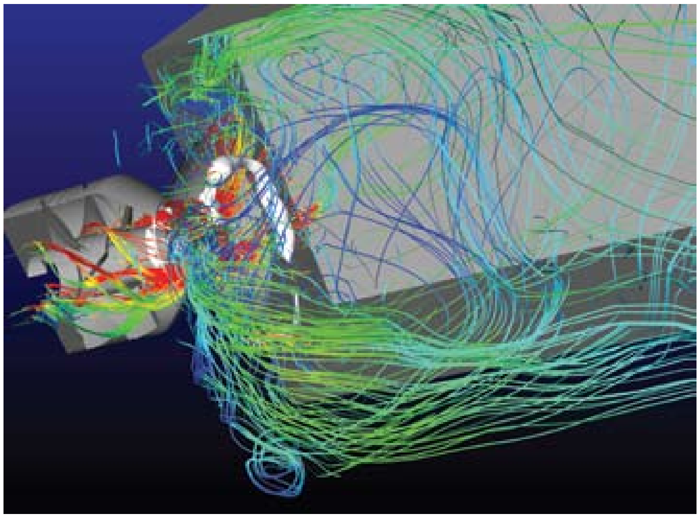
The National Combustion Code: Simulations from Scalability

Aircraft gas turbine combustor emissions—Nitrogen Oxides (NOx), Carbon Monoxide (CO), Sulfur Dioxides (SOx), and particulates—are harmful to one's health and the environment. Reducing these emissions, a major goal of NASA's Fundamental Aeronautics Program, requires both theoretical and experimental approaches.

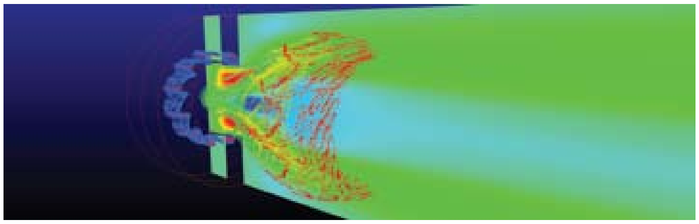
There are no straightforward, direct approaches in combustion modeling. Combustion is described by very complex equations that cannot be directly solved—in other words, use of a supercomputer is required. Full combustion simulations require so much computing power that the world's most powerful systems, such as NASA's Pleiades supercomputer, must be used. We currently use anywhere from 96 to over 4,000 processors on Pleiades for our current low-emissions gas turbine combustion simulations.

Our tool for performing combustion calculations is called the National Combustion Code (NCC). This code was designed via a NASA-industry collaboration in 1992 specifically for use with parallel computers. NCC is currently used to simulate various low-emissions aircraft gas turbine engine combustor concepts, particularly Lean Direct Injection (LDI) concepts. LDI concepts reduce NOx emissions, or smog, and may decrease fuel consumption.

NASA's work with LDI and other lean combustion concepts has been gradually transferred to industrial aircraft gas turbine engines such as the GE-90 and GE-NX. These engines produce far fewer NOx emissions than past jet engines, which reduce smog, acid rain, asthsma, and ozone layer depletion.



A transient flow mixing study of a Lean Direct Injection (LDI) combustor swirler. Pathlines are colored by axial velocity. The white isosurface of pressure elucidates the vortex core resulting from the swirler. (Jay Horowitz, NASA Glenn)



A flow study of a radial swirler Lean Direct Injection (LDI) concept. Air moving through the swirler is colored by residence time. The shape of the recirculation zone (blue contour) is determined by the swirler blade angle. (Anthony Iannetti, NASA Glenn)

http://www.aeronautics.nasa.gov/fap/index.html

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