

Large Eddy Simulations of Turbulent Combustion Systems

1. **Research Title:** Large Eddy Simulations of Turbulent Combustion Systems
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Aerospace Engineering / Mechanical Engineering (MS or PhD level)
4. **Objectives:** Develop and apply new turbulent combustion models for predicting ignition, lean blowout, and thermo-acoustic instabilities in propulsion systems operating at Air Force relevant conditions including high pressures, high speed compressible flows, and high turbulence intensities.
5. **Description:** Many existing turbulent combustion modeling and simulation approaches have been developed for and applied to steady-state reacting flows under ideal laboratory conditions. The laboratory conditions typically include low pressures, low speed incompressible flows (i.e. low Mach numbers), low turbulence intensities (i.e. low Reynolds numbers), and gaseous fuels. Current and next-generation Air Force combustion systems operate with high pressures, high speed compressible flows (i.e. high Mach numbers), high turbulence intensities (i.e. high Reynolds numbers), and multi-component liquid fuels. Large eddy simulations (LES) and turbulent combustion models for these more relevant operating conditions require the development of new models or significant improvements to existing models such as the flamelet progress variable (FPV), linear eddy model (LEM), or transported probability density function (PDF) approaches. The primary purposes of this work include the following:
 - (a) Evaluate and quantify the effects of model assumptions at both the resolved scales and unresolved sub-grid scales (SGS) in a systematic manner.
 - (b) Develop models for capturing intermittent transient phenomena (e.g. ignition, extinction, and instability) associated with off-design combustor operation. The models should be capable of predicting the onset of lean blowout and thermo-acoustic combustion instabilities at operating conditions relevant to Air Force propulsion systems.
 - (c) Evaluate the LES results using relevant experimental data such as those being acquired at the Air Force Research Laboratory Aerospace Systems Directorate Turbine Engine Division. Specific turbulent reacting flows of interest include bluff body stabilized premixed flames, confined swirl-stabilized flames, and cavity stabilized flames.
6. **Research Classification/Restrictions:** This research is unclassified. U.S. citizenship is required for this position.
7. **Eligible Research Institutions:**



DAGSI (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati)