NASA SBIR 2019 Phase I Solicitation

A1.03 Low Emissions/Clean Power - Environmentally Responsible Propulsion

Lead Center: GRC

Participating Center(s): LaRC

Technology Area: TA1 Launch Propulsion Systems

Environmentally responsible propulsion allows high turbine engine performance with lower pollution and engines that are quiet. Achieving low emissions and finding new pathways to cleaner power are critical for the development of future air vehicles. Vehicles for subsonic and supersonic flight regimes will be required to operate on a variety of certified aircraft fuels and emit extremely low amounts of gaseous and particulate emissions to satisfy increasingly stringent emissions regulations. Future vehicles will be more fuel-efficient, which will result in smaller engine cores operating at higher pressures. Future combustors will also likely employ lean burn concepts that are more susceptible to combustion instabilities. Fundamental combustion research coupled with associated physics-based model development of combustion processes will provide the foundation for technology development critical for these vehicles.Â

Combustion involves multi-phase, multi-component fuel, turbulent, unsteady, 3-D, and reacting flows where much of the physics of the processes are not completely understood. Computational Fluid Dynamics (CFD) codes used for combustion do not currently have the predictive capability that is typically found for non-reacting flows. Low emissions combustion concepts require very rapid mixing of the fuel and air with a minimum pressure loss to achieve complete combustion in the smallest volume.Â Â

Specifically, this subtopic is seeking research that includes:Â

- Development of laser-based diagnostics for quantitative spatially and temporally resolved measurements of fuel/air ratio in reacting flows at elevated pressure.
- Development of ultra-sensitive instruments for determining the size-dependent mass of combustion generated particle emissions.Â
- Low emissions combustor concepts for small high-pressure engine cores.
- Development of miniature high-frequency fuel modulation valve for combustion instability control that is able to withstand the surrounding high-temperature air environment.Â
- Infusion/commercial potential.Â These developments will impact future aircraft engine combustor designs (e.g., lower emission, control instabilities). In addition, these developments may have commercial applications in other gas-turbine based industries, such as power generation and industrial burners. The modeling and results can and will be employed in current and future hydrocarbon rocket engine designs (e.g., improving combustion efficiency, ignition, stability, etc.).Â

The expected Technology Readiness Level (TRL) range at completion of the project is between 2-5.Â

The Transformational Tools and Technologies (TTT) Project is developing computer-based tools and models, as well as scientific knowledge that will lead to significant advances in our ability to understand and predict flight performance for a wide variety of air vehicles.Â

Examples of this research include the development of new computational tools that are used to predict the flow around vehicles and inside turbine engines. Another area of research that is of benefit to a number of vehicle types is improving the understanding and development of new types of strong and lightweight materials that are important for aviation.Â

Therefore, several major deliverables will be computer simulation software to predict the best and most effective combustor configuration,Â prototype flow control devices to control combustor efficiency, andÂ sensor development for monitoring engine emissions and sound levels.Â

Environmentally responsible propulsion includes all these potential research areas:Â Â

- Fuels/Propellants; Thermal; Development Environments; Fluids; Metallics; NanomaterialsÂ
- Actuators & Motors; Exciters/Igniters; Isolation/Protection/ShieldingÂ
- Software Tools (Analysis, Design); Operating Systems; Programming Languages; Visible; Infrared; Simulation & Modeling; Active Systems; Heat Exchange; Passive Systems; Diagnostics/Prognostics; Aerodynamics; 3D Imaging; Image Analysis
- Conversion; Generation; Sources (Renewable, Nonrenewable); Characterization; Models & Simulations (see also Testing & Evaluation)
- Detectors (see also Sensors); Lasers (Measuring/Sensing); Analytical Instruments (Solid, Liquid, Gas, Plasma, Energy; see also Sensors)**Â**

References:Â

- https://www.nasa.gov/aeroresearch/programs/tacp/tttÂ
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