Fiscal Year:	FY 2022	**Task Last Updated:**	FY 01/27/2022
PI Name:	Chien, Yu-Chien Ph.D.		
Project Title:	PeleLM CFD of Ion Driven Winds from Diffusion Flames		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	COMBUSTION SCIENCE--Combustion science		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	92697	**Congressional District:**	45
Comments:			
Project Type:		**Solicitation / Funding Source:**	
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No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA GRC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Dunn-Rankin, Derek Ph.D. (University of California, Irvine)		
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Performance Goal No.:			
Performance Goal Text:			

The focus of this project is to comprehensively simulate the behavior of a small diffusion flame under the influence of an externally applied electric field in zero-gravity. A detailed model will be used that includes the chemistry of charged ions and chemiluminescent flame intermediates to capture any feedback between ion-driven convection and combustion behavior, and to allow quantitative comparisons with experimental measurements. To date, the capability of accurately simulating electric field flames has eluded researchers because the system exhibits dramatic ranges of coupled temporal and spatial scales. Moreover, in Earth gravity the hot combustion products are subject to buoyancy effects that are difficult to isolate from those generated by the electric field. We propose implementations to an existing powerful simulation framework (PeleLM) for this problem, and to use the Physical Sciences Informatics (PSI) data set from Electric-Field Effects on Laminar Diffusion (E-FIELD) Flames for validation of the model and investigation of the complex coupled system.
PeleLM is a state-of-the-art reacting flow code tailored with a unique integration scheme that efficiently couples

Task Description:	high-speed processes with the slower evolution of the flow structures using the adaptive mesh refinement (AMR) strategy. We have already completed simulations with PeleLM of a coflow burner, without an electric field, in Earth gravity, in comparison to experiments of OH fluorescence (Vicariotto, University of California Irvine dissertation, 2019). This proposal is to improve the ion chemistry and generalize the electric field configurations in PeleLM (with PeleLM's primary developer, Dr. Day), and to then simulate zero-g coflow flames in the E-FIELD Flames dataset. Comparisons include V-I (voltage-ion current) curves and flame shapes (deduced from CH* images), varying with fuel types, compositions, and flow rates. The data includes step function changes in voltage that can be used to evaluate the time response of the flame. The Principal Investigator, Dr. Chien, was responsible for acquiring the data, and is an expert in the impact of image and ion current collection timescales, which will be critical for model validation. The proposed work will take advantage of the unique E-FIELD Flames data, measured in microgravity, to validate the proposed PeleLM model augmentations, to permit a detailed investigation of the ion dynamics under the influence of electric fields, and to evaluate the subsequent interactions with non-charged species, as well as to assess the potential of electric field forcing to affect thermal transport and sooting in diffusion flames. Once the simulation is validated against the zero-g data, it will be possible to further extend the simulations to flames in Earth gravity, where potential applications for improved heat release and emission reduction can be explored. This utilization of zero gravity data from the E-FIELD Flames experiment for beneficial purposes on Earth and for a better understanding combustion control is compatible with the NASA objectives. Reference: M. Vicariotto, Water vapor addition in high concentrations to the fuel side of a two-dimensional methane/air diffusion flame, Ph.D. Dissertation, UC Irvine, 2019.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Once the simulation is validated against the zero-g data, it will be possible to further extend the simulations to flames in Earth gravity, where potential applications for improved heat release and emission reduction can be explored. This utilization of zero gravity data from the E-FIELD Flames experiment for beneficial purposes on Earth and for a better understanding combustion control is compatible with the NASA objectives.
Task Progress:	New project for FY2022.
Bibliography Type:	Description: (Last Updated:)