Fiscal Year:	FY 2017	**Task Last Updated:**	FY 03/24/2017
PI Name:	Farouk, Tanvir Ph.D.		
Project Title:	Effect of External Thermo-Convective Perturbation on Cool Flame Dynamics: A Multidimensional Multi-Physics CFD Analysis		
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:	29208-4104	**Congressional District:**	6
Comments:			
Project Type:	Flight,Ground,Physical Sciences Informatics (PSI)	**Solicitation / Funding Source:**	2015 Physical Sciences NNH15ZTT001N-15PSI-B: Use of the NASA Physical Sciences Informatics System – Appendix B
Start Date:	02/15/2017	**End Date:**	02/14/2019
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No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
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Flight Program:			
Flight Assignment:			
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COI Name (Institution):	Alam, Fahd Ph.D. (University of South Carolina) Charchi, Ali M.S. (University of South Carolina)		
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Task Description:	The current proposal will explore the aspects of flame dynamics and ultimate fate of an already 'established droplet cool flame' under external thermal and convective perturbation through multi-physics based multi-dimensional computational fluid dynamics (CFD) analysis addressing the variability observed in the ISS experiments. Here, we will investigate the two extremities of n-heptane droplet sizes pertaining to droplet combustion- (a) large diameter (typical to that of NASA FLame Extinguishment Experiment (FLEX) experiments, 1-4 mm) and (b) small diameter (submillimeter dimension, ~0.5 mm). The discovery of n-heptane droplet 'cool flame' on board the International Space Station (ISS) has introduced new research thrust in understanding the intricate behavior of 'cool flame' for diffusion control environment. Even though these studies were targeted to be performed in near- absence external convection influence, perturbations in the experiments resulted in slow drift of the droplet thereby generating an unintentional convective field. The role of this convective field on the observed "cool flame" dynamics is not quantified and determined. Additionally, to address the design of next generation combustor deploying cool flame and/or low temperature (LT) kinetics, a better understanding about how quasi-steady 'self-sustained' cool flame behave in response to induced convective perturbation is important and critical. The objective of the proposed research is to determine the role of thermal and convection influence on the cool flame dynamics – analyzing and interpreting the ISS data and hence extend the interpretation to submillimeter sized droplets. In order to achieve the proposed objectives, multi-dimensional multi-physics OpenFOAM (Foam Optics And Mechanics) based CFD platform will be utilized incorporating detailed combustion chemistry and associated fluid physics under the influence of convection and thermal field. ISS FLEX cases performed under microgravity will serve as base comparison case. Subsequently, three possible fluid fields (with convection influence, with heat flux influence and combination thereof) for single droplet will be considered. For initial model development in OpenFOAM, simplified reaction kinetics will be deployed and subsequently the computation effort will be casted towards the incorporation of reduced kinetics. The proposed hybrid multi- physics model will be developed to get deeper insight into the FLEX cool flame experimental observation exploring the influence of external perturbation to cool flame itself. Therefore, any constitutive analysis, conclusion and/or hypothesis drawn from such numerical works will directly and coherently support the title objective of the NRA Appendix B solicitation, i.e., 'reusability' of the available database. Furthermore, these detailed analyses will help NASA in developing test matrix for large diameter cool flame experiments under external perturbation. Lastly, ozone assisted small diameter investigations using the proposed computational strategies can assist NASA in designing experimental test matrix for observing first ever submillimeter sized droplet cool flame and its interaction with external perturbation.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2017.
Bibliography Type:	Description: (Last Updated: 06/13/2025)