Fiscal Year:	FY 2019	**Task Last Updated:**	FY 03/09/2020
PI Name:	DesJardin, Paul Ph.D.		
Project Title:	Concurrent Flame Spread Modeling Using Flamelet Generated Manifolds in Micro-Gravity with Comparison to BASS Experiments Using Two-Color Tomography		
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		
PI Email:	ped3@buffalo.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	716-645-1467
Organization Name:	University at Buffalo (State University of New York, Buffalo)		
PI Address 1:	Department of Mechanical and Aerospace Engineering		
PI Address 2:	318 Jarvis Hall		
PI Web Page:			
City:	Buffalo	**State:**	NY
Zip Code:	14260-4400	**Congressional District:**	26
Comments:			
Project Type:	GROUND	**Solicitation:**	2017 Physical Sciences NNH17ZTT001N--17PSI-E: Use of the NASA Physical Sciences Informatics System – Appendix E
Start Date:	05/01/2019	**End Date:**	04/30/2021
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No. of PhD Candidates:		**No. of Master' Degrees:**	
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No. of Bachelor's Candidates:		**Monitoring Center:**	NASA GRC
Contact Monitor:	Urban, David	**Contact Phone:**	216-433-2835
Contact Email:	david.l.urban@nasa.gov		
Flight Program:			
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Task Description:	One of the largest modeling challenges in understanding concurrent flame spread is the coupling between thermal and mass transport processes along with chemical kinetics near the solid-vapor interfaces. Since explicitly resolving all these processes in 3D at engineering scales is impossible even with today's most advanced supercomputers, a modeling or scaling methodology must be introduced to correlate near-surface behavior to far-field flow dynamics. Current modeling approaches for defining this coupling often rely on the superposition of turbulence and chemistry models that are not theoretically or mathematically self-consistent, e.g., use of a near-wall turbulence model for shear-stress, coupled with a Newton's law of cooling for heat transfer, coupled with a simplified ad-hoc Arrhenius expression for the surface burning rate. Predictions are often qualitatively correct at best and do not include the details of important intermediate chemistry steps which define pollutants. A new modeling approach is therefore desirable which, at a minimum, includes the detailed coupling of all relevant processes in the near-wall region. The objective of the proposed research is to explore newly developed flamelet generated manifold (FGM) modeling approaches for use in concurrent flame spread modeling. Central to this approach is a newly developed unsteady FGM (UFGM) modeling approach for reacting interfaces which maps the reacting state space into lower dimensional manifolds. The UFGM allows for affordable calculations of multidimensional simulations of burning phenomena. Fully coupled numerical simulations of a subset of the Burning and Suppression of Solids (BASS) experiments will be conducted using a computational framework developed over the last 15 years by the Principal Investigator. The framework allows for fully coupled simulations of fluid-solid response – specifically designed for charring and ablating materials. In the proposed effort, the use and validation of UFGM will be explored for use in prediction of flame spread from NASA's BASS and BASS-II experiments. The imagery from these experiments will be post-processed using newly developed two-color tomography techniques for digital single lens reflex (DSLR) cameras so 3D soot and temperature fields may be determined and compared to modeling predictions. The appeal of using the BASS series for validation is the absence of buoyancy forces, allowing for unambiguous assessment of the UFGM modeling to predict concurrent flame spread in complex geometries, e.g., sphere and end rod configurations. Simulations of flat, spherical, and rod Polymethyl methacrylate (PMMA) samples will be conducted, along with the cylinder geometry of wax. Specific metrics are identified for the comparisons which include flame temperature, soot volume fraction, flame geometry, flame spread rate, etc. A particularly interesting phenomenon of interest to explore with the model is to see if it can reproduce the `Goldilocks' flammability zone discussed recently by Olson and Ferkul. These comparisons will be conducted in conjunction with an on-going National Science Foundation (NSF) funded project in exploring UFGM for upward flame spread so relative comparisons of model agreement in terrestrial and non-terrestrial settings can be assessed. The long-term impact of developing the UFGM modeling approach is the ability to screen new material flammability limits which may be used in future spacecraft. In addition, the UFGM can be used as a subgrid scale model (SGS) for Large Eddy Simulations (LES) of fire to explore potential hazardous scenarios on spacecraft. S. L. Olson and P. V. Ferkul. Micogravity flammability boundary for PMMA rods inaxial stagnation flow: Experimental results and energy balance analyses. Combust. and Flame, 180:217-229, 2017.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2019.
Bibliography Type:	Description: (Last Updated:)