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Task Description:	Cool flames are important in knock formation in internal combustion engines and in modern engine concepts operating at low temperature to achieve high efficiency and low pollution. Cool flames have been observed on the International Space Station in droplet combustion in a quiescent chamber where cool flames appeared after the hot droplet flame extinguished due to radiation. Cool flames in practical devices are subject to flow unsteadiness that stretches and curves the flames. Under NASA Physical Sciences Informatics (PSI) Research Announcemuscience, flat cool premixed and diffusion flames in the presence of fluid stretch have been studied in opposed-jet flames that feature the interplay of finite-rate chemistry, molecular transport, and heat transfer, including radiative extinction. In opposed-jet burners, flat cool flames tare transition to warm flames and hot flames with each transition driven by different chemical reactions. Flame regimes have been determined in flat cool premixed and diffusion flames, including transitions between cool, warn, and hot flames, formation of multi-stage flames, and flame extinction.	
Rationale for HRP Directed Research:		
Research Impact/Earth Benefits:	Cool premixed and diffusion flames are found in diesel engines and other modern internal combustion engine concepts such as HCCI, RCCI and PPCI. Understanding the effects of curvature and stretch rate on cool flame transitions and structure will lead to better insight into cool flame propagation in practical internal combustion engines.	
Task Progress:	The primary task of the first year of this project was to investigate the effect of curvature on cool diffusion flames at high pressure and compare to previous Physical Sciences Informatics (PSI) NASA Research Announcement (NRA) Science data involving the numerical study of opposed-jet cool diffusion flames. This investigation involves comparing both temperatures and specific species concentrations that play important roles in cool flames. The in-house tubular flame code was modified to accept the larger chemical kinetic mechanisms associated with more complex fuels such as dimethyl ether (DME) and dibutyl ether (DBE). This code can simulate both negative curvature (concave to the fuel) and positive curvature (convex to the fuel) effects to further determine the important role curvature may play in non-unity Lewis number fuels. These simulations are underway for N2-DME vs. N2-O2 diffusion flames with multiple chemical kinetic mechanisms, and show promising results for cool, warm, and hot flame structure when compared to previous opposed-jet results from other research groups under similar conditions. The simulations cover a range of curvature values and pressures up to eight atmospheres. Continued computational work involves building a more complete dataset for cool flame regimes and transitions into warm or hot flames along with temperature and species profiles at the various cool flame conditions.	
Bibliography Type:	Description: (Last Updated: 02/18/2011)	