**Component:** ARMY  
**Topic #:** A20-009  
**Title:** Transient Combustion Effects on Observable Signatures of Maneuvering Hypersonic Configurations  
**Technology Areas:** Battlespace  

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**OBJECTIVE:** Development of modeling tools that properly account for transient combustion effects on the observable signatures of maneuvering hypersonic configurations during extreme maneuvers.

**DESCRIPTION:** The Army has a strong interest in the observable signatures of hypersonic configurations during extreme maneuvers. Such configurations may employ liquid or solid propellant devices to provide thrust during said maneuvers. However, the associated accelerations are severe and can alter thruster chamber pressure and thrust level significantly. Such variations also occur near the end of liquid or solid propellant burns. As a result, the thrust characteristics, aerodynamic maneuverability, and observable signatures vary significantly from expected steady state conditions. Such changes in behavior must be taken into account when designing survival tactics for offensive assets or when designing and testing detection, track, and guidance algorithms for defending assets. Consequently, the Army seeks modeling tools that can predict the transient combustion effects on the observable signatures of liquid and solid rocket motor thrusters employed by hypersonic configurations during extreme maneuvers.

**PHASE I:** Develop a physics-based modeling technique that fully accounts for the three-dimensional flowfield and chemical kinetics combustion processes that occur within liquid and solid propellant motors during extreme maneuvers and produce observable effects, to include soot and smoke trails, on the resulting exhaust plume signatures. It is expected that the technique will also incorporate the ability to address in-flight ignition transients and thrust tail-off.

**PHASE II:** Integrate the model from the Phase I effort into the current DoD plume flowfield modeling tools. Demonstrate the capability for several transient configurations of interest to the Army. Assess the integrated modeling suite against available plume signature data (visible/IR). Deliver the modeling software in source code and executable format along with all files needed to compile and successfully execute to serve as a prototype for evaluation and cybersecurity assessment by the Government. Deliver technical and software user documentation, model demonstrations and assessment cases with results for Army use. Maximum practical use of existing plume flowfield modeling software is desired to reduce development and validation costs.

**PHASE III DUAL-USE APPLICATIONS:** Demonstrate applicability of the newly developed capability for multiple configurations of interest to the Army. Commercialization: The capability to accurately account for transient combustion effects on the observable signatures of maneuvering hypersonic configurations will enable the DoD, including MDA, to significantly improve their respective abilities to predict what US configurations will look like to its adversaries and what threats to US assets will look like to sensors on-board defending assets.

**REFERENCES:**


KEYWORDS: Transient, combustion, liquid rocket engines, solid rockets, observable signatures, hypersonic, maneuver