BROAD AGENCY ANNOUNCEMENT
USAFA-BAA-2015
Research Interests of the United States Air Force Academy

TWO-STEP CALL ANNOUNCEMENT- CALL 0009

FEDERAL AGENCY NAME: United States Air Force Academy (USAFA), Department of Aeronautics

BROAD AGENCY ANNOUNCEMENT TITLE: Research Interests of the United States Air Force Academy

BROAD AGENCY ANNOUNCEMENT NUMBER: USAFA-BAA-2015

BROAD AGENCY ANNOUNCEMENT TYPE: Amendment 0004 to Initial Announcement

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER: 12.800

CALL ANNOUCEMENT TITLE: Hypersonic Turbulence Models Research

CALL ANNOUNCEMENT (CALL) NUMBER: 0009

TECHNICAL POINT OF CONTACT: The technical point of contact for this CALL as outlined in the baseline BAA, Section l - Funding Opportunity Description (a)(3), Aeronautics (Hypersonic Vehicle Simulation Institute) is:

Dr. Russell M. Cummings, Director
Hypersonic Vehicle Simulation Institute (HVSI)
Department of Aeronautics
United States Air Force Academy, CO
Phone: (719) 333-9223
Email: Russ.Cummings@usafa.edu

CONTRACTING POINTS OF CONTACT: The contracting points of contact for this CALL are:

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Christian Cornell
10th Contracting Squadron (10 CONS/PKC)
United States Air Force Academy, CO
Phone: 719-333-8269
Email: Christian.Cornell@us.af.mil

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BACKGROUND: USAFA is seeking unclassified research white papers and proposals that do not contain proprietary information. If proprietary information is submitted, it is the offerors' responsibility to mark the relevant portions of their proposal as specified in USAFA-BAA-2015 Amendment 0004. The HVSI invites white papers and proposals (if requested) for studies in many areas described further below.

The HVSI funds and performs a range of hypersonic research tasks in support of the Department of Defense (DoD) High Performance Computing Modernization Program (HPCMP). HPCMP desires to improve computational simulations of hypersonic vehicles in support of DoD goals by accelerating the successful development of HPC software and hardware. HVSI has the objectives to: facilitate the development and documentation of a national vision for hypersonic vehicle simulation; co-fund projects in the gaps of current DoD, Department of Energy (DOE), National Aeronautics and Space Administration (NASA) and industry research efforts critical to achieving DoD hypersonic vehicle simulation; facilitate transition of hypersonic research into production quality simulation software available to Government, academic, and industry acquisition partners; create a national repository for hypersonic simulation verification and validation data; provide computational resources to provide a measurable leap forward in hypersonic system simulation capability for DoD hypersonic system acquisition. The HVSI will be looking to improve computational simulation approaches including numerical methods, modeling approaches, and simulation of a variety of aerothermodynamics and propulsion aspects of hypersonic flight. Specific science and technology areas include turbulence, boundary layer transition, fluid-structure-thermal interactions, non-equilibrium chemistry, ablation, and combustion.

REQUIREMENT DESCRIPTION: The United States Air Force Academy is soliciting white papers/proposals (if requested) for basic and applied, fundamental research under **Section l - Funding Opportunity Description (a)(3), Aeronautics (Hypersonic Vehicle Simulation Institute) of the Broad Agency Announcement USAFA-BAA-2015 Amendment 004 posted on 2 July 2018** specifically for hypersonic research in accordance with technical requirements detailed below.

White papers are solicited for projects in the general topic area of hypersonic boundary layer transition modeling. Prospective offerors should keep in mind that performing transition analysis in an engineering environment presents different challenges than in a fundamental research environment (such as the straightforward use of transition prediction tools, including stability analysis; the relationship between, and importance of, accuracy vs. prediction speed; and the need for models to be robust); the white paper should demonstrate how those challenges might be overcome by the proposed approach. Ideally, proposed models will include multiple modes of transition. Any proposed transition model should be Galilean invariant so that the transition models can be used in maneuvering vehicle simulations. Also, each approach/model should include an explanation of the limits of applicability, the error of the prediction, and what data sets (experimental or numerical) were used to create the model.

Prospective offerors may respond to one of the following HVSI desired research areas or may propose other research studies in these general topic areas:

1. Critical evaluation of historical experimental data (flight test and/or ground test) that can lead to improvements in currently available transition models, or the development of methodologies that can be used to derive new transition models for certain classes of hypersonic vehicles.

2. Design and execution of experiments that include accurate knowledge of the mean flow and detailed measurements that allow for the differentiation of results from multiple modes of transition. These measurements should include accurate measurement of the fluctuating flow field to determine the accuracy of transition codes or models. The freestream disturbance levels and flow properties would need to be measured and simulated (preferably using DNS), and surface

roughness on the models would need to be measured. Experiments in quiet tunnels are encouraged.

3. Development or improvement of transition models consistent with RANS CFD simulations for hypersonic flows with simple to moderate geometric complexity. Examples of simple geometries include sharp cones, blunt cones, and wedges. Examples of moderate complexity geometries include configurations such as HIFiRE-5, BOLT, ogives and scarfed (sliced) cones, and flows with strong surface temperature gradients and/or surface roughness. Studies should compare model performance with respect to transition Reynolds number and surface heating or wall temperature ratio, as compared to experiments. Methods should also consider both transition onset prediction and the length of the transition process. Multiple modes of transition should be included in the creation of the model (example: second and crossflow transition modes). Some possible examples include development of:

    - Boundary layer transition models based on stability analysis predictions using reduced-order modeling or other approaches that do not require running stability codes for each geometry and flight condition; these models could possibly use correlations for receptivity and breakdown derived from experiments or DNS.

    - The necessary high-speed correlations for an existing boundary layer transition model (such as the Menter one equation intermittency model), especially for the second and crossflow transition modes.

    - Data-driven approaches to create transition models that take into account the large amount of experimental data available for the different modes of transition.

4. Development of transition models that also include the impact of other important issues, such as: thermo-chemistry, thermal protection systems (including gas-surface interactions such as oxidation, surface catalysis, decomposing surfaces, and/or ablation), surface roughness or gaps, freestream disturbances (including particulates), or other realistic aspects of transition on flight vehicles.

5. Creation of a taxonomy of when different modes of transition are important based on vehicle geometry, freestream conditions (Mach number, Reynolds number, total enthalpy, wall temperature ratio, etc.), and vehicle attitude (angle of attack and/or sideslip). That is, lay out a design guide that can predict and explain the main issues of each design choice and its impact on hypersonic boundary layer transition so that vehicle designers can understand what to expect in terms of transition behavior and can devise control methods to minimize the impact of their design choices.

6. Creation of a methodology to develop models for hypersonic boundary layer transition, including the modeling or process definition approach that will create the model, how the model would be created following the approach, what steps would be included in that process, how to check such a methodology, and how validation could be made part of the approach. These approaches should be as general as possible so once a new geometry or conditions are given, a design team could use the methodology to come up with a new but trustworthy first set of transition models upon which they can iterate and design from.

7. Development of other transition prediction methodologies not specifically mentioned above that could be used directly in design, test, and evaluation of hypersonic vehicles.

THIS WILL BE A TWO-STEP CALL ANNOUNCEMENT:

FIRST STEP: WHITE PAPERS

WHITE PAPER FORMAT: White papers submitted in response to this call should conform to the requirements found in USAFA-BAA-2015 Amendment 0004, section IV, I(a)(3) Aeronautics (HVSI) and IV(c) Content and Form of White Paper Submission, as well as also include a brief resume of the principle. White papers must include the following areas:

Cover Page: The Cover Page shall be titled "WHITE PAPER" and include the following:

- BAA and CALL number "USAFA-BAA-2015 CALL 0009"
- Title of white paper that is descriptive of the research to be conducted
- Offeror's administrative and technical points of contact, with telephone numbers and email addresses.

Technical Concept: White papers must briefly describe the proposed research:

- Objective
- Length of effort
- General/technical approach
- Rough-order of magnitude cost
- Anticipated outcome
- Impact of specific research
- Government/cadet involvement
- Public purpose.

WHITE PAPER DUE DATE AND TIME: The due date for white papers submitted in response to this CALL is no later than 4:30 PM Mountain Standard Time on 29 July 2019. ***White papers received after the due date and time shall be governed by the provisions of FAR 52.215-1(c)(3).***

***Please note: It is the responsibility of the submitting organization to ensure white papers have been received by the USAFA. If you do not receive a confirmation email within 48 hours of submitting your white paper, it is your responsibility to contact the contracting office to ensure receipt. Failure to do so may result in a late white paper. White papers not received on time will NOT be processed.**

WHITE PAPERS ARE TO BE E-MAILED OR MAILED TO:
10 CONS/PKC
Attn: Christian Cornell
8110 Industrial Drive, Ste # 200
United States Air Force Academy, CO 80840
Email: 10MSG.LGCC@us.af.mil

WHITE PAPERS EVALUATED AND SELECTED: White papers will be evaluated and full proposals requested in accordance with USAFA-BAA-2015 Amendment 0004. Offerors whose white papers are determined to be of interest to the Government will be asked to submit full cost and technical proposals in response to this CALL. Offerors whose white papers are not of interest to the Government will be notified via letter that the effort proposed is not of interest to the Government.

SECOND STEP: PROPOSALS

INTENT TO PROPOSE: Potential offerors are requested to advise the Grants/Agreements point of contact (by e-mail) if they intend to submit a proposal after receiving a formal request for proposal. Such notification is merely a courtesy and is not a commitment by the offeror to submit a proposal.

PROPOSAL INSTRUCTIONS: Offerors are requested to follow the instructions within the baseline BAA, USAFA-BAA-2015 Amendment 0004 for instructions on how to submit a proposal. All proposals must be submitted through Grants.Gov, https://www.grants.gov and include all the required forms specified within the baseline BAA.

REGISTRATION REQUIREMENTS: Prospective Awardees shall be registered in the System for Award Management (SAM) database prior to award, during performance, and through final payment of any award resulting from this announcement. Offerors may obtain information on registration and annual confirmation requirements www.sam.gov.

ANTICIPATED FUNDING: Anticipated funding for multi-year awards resulting from this CALL is up to $2,000,000.00. All funding is subject to change due to Government discretion, availability and technical needs; additionally, efforts may be incrementally funded.

ANTICIPATED TYPE OF CONTRACTS/INSTRUMENTS: The Government anticipates awarding the instrument best suited to the nature of research proposed including a grant, cooperative agreement, or procurement contract. Potential offerors are reminded that in accordance with 32 CFR 22.205 and 2 CFR 200.400, a fee or profit may not be paid to the recipient of a cooperative agreement or grant.

PERIOD OF PERFORMANCE: The anticipated period of performance for the award(s) resulting from this CALL is approximately 18-36 months, depending on the proposed effort.

PROPOSAL DUE DATE AND TIME: The due date for proposals will be 30 days after formal request for proposal has been sent to the submitter of the selected white paper(s). Proposals for any other technology area identified in the baseline BAA will not be accepted under this call. **Proposals received after the due date and time shall be governed by the provisions of FAR 52.215-1(c)(3).**

ANTICIPATED NUMBER OF AWARDS: The Government anticipates awarding three to five cooperative agreements as a result of this CALL. However, the Government reserves the right to make multiple awards, single awards, or no awards pursuant to this CALL.

ANTICIPATED AWARD DATE: 30 October 2019

CALL AMENDMENTS: Offerors should monitor **GRANTS.GOV** http://www.grants.gov for any additional notices to this CALL that may permit extensions to the white paper submission date or otherwise modify this announcement.

APPLICABILITY OF BASELINE BAA: All requirements of USAFA-BAA-2015 Amendment 0004 apply unless specifically amended and addressed in this CALL. For complete information regarding USAFA-BAA-2015 Amendment 0004, refer to the initial opened-ended BAA as amended. It contains information applicable to all CALLS issued under the BAA and provides information on the overall program, proposal preparation and submission requirements, proposal review and evaluation criteria, award administration, agency contacts, etc. Direct questions to the contracting points of contact identified above.