

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

TWO-STEP CALL ANNOUNCEMENT- CALL 0005

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 0003 to Initial Announcement

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER: 12.800

CALL ANNOUNCEMENT TITLE: Hypersonic Turbulence Models Research

CALL ANNOUNCEMENT (CALL) NUMBER: 0005

TECHNICAL POINT OF CONTACT: The technical point of contact for this CALL as outlined in the baseline BAA, Section I - 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:

Grants/Agreements Specialist:

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

Grants/Agreements Officer:

Chelsea A. Huff
10th Contracting Squadron (10 CONS/PKC)
United States Air Force Academy, CO
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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 0003. 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 aerothermodynamic 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 I - Funding Opportunity Description (a)(3), Aeronautics (Hypersonic Vehicle Simulation Institute) of the Broad Agency Announcement USAFA-BAA-2015 Amendment 003 posted on 2 July 2018** specifically for hypersonic research in accordance with technical requirements detailed below.

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. Reynolds-Averaged Navier-Stokes (RANS) studies with currently available turbulence models to assess how accurate they are for flows over basic geometries (including with adverse or favorable pressure gradients) without significant shock interactions at hypersonic speeds (flat plates, simple cones, hemisphere cones, elliptic cones, BOLT, etc.). Include, where available, comparisons with off-surface experimental data. A number of previous validation experiments have been conducted, including with comparisons to various RANS predictions, and these should be evaluated to fully understand current limitations and challenges. The studies should include comparisons with Turbulent Kinetic Energy (TKE) or other turbulence measures (Reynolds stresses) as well as surface measurements (like high frequency pressure and/or heat transfer rate data). Performing adequately-resolved Large-Eddy Simulation (LES) or Direct Numerical Simulation (DNS) predictions to allow term-by-term comparison with the RANS model. (i.e. creating a detailed TKE budget) would be useful to establish a standard for RANS predictions.
2. RANS and LES studies with currently available turbulence models for more complicated geometries with shock interactions at hypersonic speeds (such as double cone, hollow cylinder/flare, 3D flows, flows with pressure gradients, separation bubbles, etc.). These studies should compare available surface data (pressures and heat transfer rates) with turbulent predictions, and also provide comparisons with off surface data or flow visualizations where available.

3. Any study of hypersonic turbulence (RANS vs LES/DNS and/or experiment) that can identify short-comings in RANS turbulence models (identify what specific characteristics of the model are not working using term-by-term TKE budgets).
4. Develop scaling of turbulence characteristics at hypersonic speeds (most dominant length scales, frequencies, etc.) for different Mach numbers, Reynolds numbers, T_e/T_w , etc. for simple canonical configurations (such as those mentioned in Item 1 above).
5. Compile experimental data for the same configuration tested at different tunnels with similar conditions and study what differences there are in the fully developed turbulent boundary layers—if such comparison cannot be done because the data is not available, then propose what data is needed to verify how much tunnel “noise” affects turbulent boundary layer characteristics. Perform LES or DNS simulations for these experiments to determine the impact of tunnel “noise” where possible.
6. Proposals for new experiments that could provide the validation data (especially off surface data) for shapes that could be predicted using RANS at hypersonic speeds. For any experiments proposed, assess what are the most critical variables a model needs to be verified. Include a description of what data is needed to verify that tunnel “noise” does not affect turbulent boundary layer characteristics. Fully characterize the freestream turbulence for the proposed experiments so the results can be used for code validation.
7. Develop new turbulence models (or improve modeling capabilities of existing models) for RANS and LES for fully-developed turbulent boundary layers for Mach 6 and above. The models should be conducive to application within typical RANS/LES solution algorithms. These improvements should be applied to geometries such as circular cones, elliptical cones, BOLT, double wedges, or double cones. One possibility would be to use machine learning (or other similar approaches) to train hypersonic turbulence models using DNS (or perhaps using experimental data).

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, 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 0005”
- 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 15 October 2018. *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 0003. 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 0003 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 \$2,400,000.00. 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 December 2018

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 apply unless specifically amended and addressed in this CALL. For complete information regarding USAFA-BAA-2015, 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.