NASA SBIR 2019 Phase I Solicitation

S5.06 Space Weather R2O/O2R Technology Development

Lead Center: GSFC

Participating Center(s): GSFC, MSFC

Technology Area: TA11 Modeling, Simulation, Information Technology and Processing

Space weather has the potential to disrupt telecommunications, aircraft and satellite systems, electric power subsystems, and position, navigation, and timing services. Given the importance of these systems to our national well-being, NASA’s Heliophysics Division invests in activities to improve the understanding of these phenomena and to enable new monitoring, prediction, and mitigation strategies.

The national direction for this work has been codified by the presidential executive order of October 13, 2016 that coordinates agency efforts to prepare the nation for space weather events. Each agency under this order has specific responsibilities to the Space Weather Operations, Research and Mitigation (SWORM) activity as outlined in the National Space Weather Action Plan (NSWAP). NASA’s role under NSWAP is to provide increased understanding of the fundamental physics of the Sun-Earth system through space-based observations and modeling, the development of new space-based space weather technologies and missions and monitoring of space weather for NASA's space missions. This includes research that advances operational space weather needs.

This SBIR subtopic enables NASA to demonstrate progress against NASA Goal 1.4: Understand the Sun and its interactions with Earth and the solar system, including space weather. Specifically, this subtopic provides a means for NASA's Science Mission Directorate (SMD) to meet its obligations under the presidential executive order of October 13, 2016 that coordinates agency efforts to prepare the nation for space weather events. The Heliophysics Living with a Star Program has established a path forward to meet the NASA's obligations to the research portion of these mandates. Further involvement by the emerging Heliophysics space weather commercial community has the potential to significantly advance the space weather applications portion of the mandate. Additionally, space explorers are not protected by the Earth's atmosphere and are exposed to space radiation such as galactic cosmic rays and solar energetic particles. A robust space weather program and the associated forecasting capabilities are essential for NASA's future exploration success.

This SBIR subtopic solicits new, enabling space weather technologies as part of NASA’s response to these national objectives. While this subtopic will consider all concepts demonstrably related to NASA’s Research-to-Operations/Operations-to-Research (R2O/O2R) responsibilities outlined in the NSWAP, four areas have been identified for priority development:

- NASA supports the Community Coordinated Modeling Center (CCMC), located at Goddard Space Flight Center (GSFC), as a centralized government-run facility that hosts, maintains, and validates heliophysics models, some of which will become suitable for use by the space weather operations and forecasting community. Innovations solicited include the preparation and validation of existing science models that may be suitable for transition to operational use. Areas of special interest include, but are not limited to:

- Specifications and/or forecasts of the energetic particle and plasma conditions encountered by spacecraft within Earth's magnetosphere, as well as products that directly benefit end-users such as spacecraft operators;
- Approaches that potentially lead to a 2-3 day forecasting of atmospheric drag effects on satellites and improvement in the quantification of orbital uncertainties in LEO altitude ranges (up to ~2000 km)
- Longer-range (2-3 days) forecasting of SPEs (Solar Particle Events) and an improved all-clear SPE forecasting capability.
- The Heliophysics System Observatory (HSO) data archives include a vast array of spacecraft observations suitable for the development of space weather benchmarks, which are the set of characteristics against which space weather events are measured. Baseline benchmarks have been established (https://www.whitehouse.gov/wp-content/uploads/2018/06/Space-Weather-Phase-1-Benchmarks-Report.pdf). Innovations to produce and/or further refine these benchmarks are solicited, as are concepts for future creative approaches utilizing new data types or models that could become available.
- A particular challenge is to combine the sparse, vastly distributed data sources available with realistic models of the near-Earth space environment. Data assimilation innovations are solicited that enable tools and protocols for the operational space weather community. Priority will be given to proposals that:
    - Develop data assimilation space weather applications or technologies desired by established operational organizations;
    - Integrate data from assets that typically do not share similar time series, utilize different measurement techniques (e.g., imaging vs in-situ particles and fields), or are distributed throughout the heliosphere;
    - Provide new data-assimilation operational forecasting tools that can be straightforwardly validated by the CCMC or another equally robust validation methodology; and/or,
    - Integrate underutilized resources (e.g., space-based radio occultation for ionospheric specification or USGS ground conductivity measurements related to geomagnetically induced currents).
    - Heliophysics science relies on a wide variety of instrumentation for its research and often makes its data available in near-real-time for space weather forecasting purposes. Concepts are solicited for instrumentation concepts, flight architectures, and reporting systems suitable for data assimilation into space weather monitoring and forecasting systems. This includes the miniaturization of existing systems and/or technologies deployable as an array of CubeSats. In order to be considered for investment, SBIR technologies should demonstrate comparable, or better, precision and accuracy when compared to the current state-of-the art. Further, SBIR instrument designs should avoid duplicating current NASA research spacecraft arrays or detector systems including those currently in formulation (e.g., SDO, Van Allen Probes, MMS, IMAP, GDC, Medici, Explorer concepts, etc.).

Proposals must demonstrate an understanding of the current state-of-the-art, describe how the proposed innovation is superior, and provide a feasible plan to develop the technology and infuse into a specific NSWAP activity.

Space weather is a broad umbrella encompassing science, engineering, applications and operations. The ultimate goal of this SBIR is to generate products or services ("deliverables") that enable end-user action. The deliverables can be applied, for example, to provide space weather hazard assessments, real-time situational awareness, or to plan protective mitigation actions. Deliverables can be in the form of new data, new techniques, new instrumentation, or predictive models that are prepared/validated for transition into operations.

Expected TRL for this project is 3 to 8.

References:

- Pursuant to Executive Order 13744, the Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee was chartered to coordinate Federal Government departments and agencies to meet the activities defined in the National Space Weather Action Plan (NSWAP). See https://www.sworm.gov/.

- Executive Order 13744 -- Coordinating Efforts to Prepare the Nation for Space Weather Events: https://www.federalregister.gov/documents/2016/10/18/2016-25290/coordinating-efforts-to-prepare-the-nation-for-space-weather-events
- National Space Weather Action Plan (NSWAP): https://www.sworm.gov/publications/2015/SWAP%20final__20151028.pdf
- Space Weather Phase I Benchmarks: https://www.sworm.gov/publications/2018/Space-Weather-Phase-1-Benchmarks-Report.pdf