A NASA Applied Spaceflight Environments Office Concept

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Short Abstract: The growing need for coordination of the many aspects of space environments is directly related to our increasing dependence on space assets. An obvious result is that there is a need for a coordinated effort to organize and make accessible the increasing number of space environment products that include space environment models and observations, material testing, and forecasting tools. This paper outlines a concept to establish a NASA-level Applied Spaceflight Environments (ASE) office that will provide coordination and funding for sustained multi-program support in three technical areas; (1) natural environments characterization and modeling, (2) environmental effects on materials and systems, (3) and operational and forecasting space environments modeling. Additionally the ASE office will serve as an entry point of contact for external users who wish to take advantage of data, tools and assets associated with space environments, including space weather.

Extended Abstract

1. Context.

The Nation's dependence on space assets is increasing in all aspects. Personal lifestyles are driven by connectivity of cell phones and home entertainment is dominated by satellite and cable feeds. Commercial dependence on connectivity in the banking, commerce, and retail business is increasing. As technologies using information from space based assets evolve, industries such as agricultural and energy are exploring new ways of becoming more efficient and precise. The medical applications for specific applications are beginning to rely on space communication. Military usage of the space assets for multiple reasons continues to be explored. Furthermore, as NASA prepares to send humans beyond low Earth orbit, understanding the environment to which they will be exposed is critical.

As a result, understanding the environment in which space assets operate has received considerable attention from federal agencies. The need to provide design, operational and predictive data and the need to develop tools to implement these in spaceflight systems is driving programs and strategies at various levels within federal agencies.

Evidence of the increased awareness of space weather is evidenced by the specific consideration of Congress in its budget deliberations and language. Many conferences, such as the recent SEASONS workshop (November 2010), are dedicated to various applied aspects of space environment and the impacts of space weather variability. During the 2010 Spacecraft Charging Technology Conference recognized, it was recognized that (1) spacecraft charging failures are likely to be

more prevalent in the future due to the new higher voltage solar array systems, (2) spacecraft charging models are very dependent on degraded/exposed material property data, which often is not available, and (3) there is no centralized data collection for materials research and testing results.

2. Need for Coordination

Within the National Aeronautics and Space Administration (NASA), many organizations in many of its field centers have valuable expertise and have established efforts that attend to one aspect or another of designing systems to operate in the variable space environment. These efforts are varied and include (1) generating design data collected from materials and electronic parts space environments testing, (2) developing models that define the natural space environment used for systems design, and (3) providing tools used to improve operations of robotic and human activities.

In 2008-2009 the NASA Office of Chief Engineer sponsored a series of four reports generally titled "Space Weather Support to NASA Operations", that originally focused on the space radiation aspect of space weather, and subsequently broadened to a more robust and inclusive space weather perspective. These reports articulate NASA mission directorate space weather needs, describe the state of the art of space weather architecture, document the current trends and challenges in operational space weather, and portray a future operational space weather architecture for NASA.

Significant to this effort were the general findings, among which are:

- Improve intra- and inter-agency communication and cooperation in space weather activities
- Develop and implement standards and guidelines for space system radiation hardness and space environment risk mitigation
- Provide faster turn-around from research to operation with improved models

It should be noted that this activity has spawned a valuable working group within the agency called Space Weather Working Group (SWxWG), that maintains a consultant role and to help support Agency level decision-making in areas of space weather.

There is a recognized need to provide a method to coordinate the NASA space environment and space weather activities. There is an absence of a program that ensures the transition of space research products to users, and there is no NASA space environment/space weather point of contact for internal organizations or external agencies or customers. The NASA extended pool of expertise, broad range of activities, multiple testing and measurement facilities, diverse relevant engineering, spaceflight, and science data, valuable scientific models, and existing space environmental and effects engineering models should be coordinated in order for the agency to more effectively meet its own goals, and to play its role to support the nation in addressing the need to operate more effectively in the dynamic space environment.

3. Proposed NASA Applied Spaceflight Environments program

The NASA Applied Spaceflight Environment (ASE) office is designed to address the gap that exists between spaceflight environments knowledge and the application of this knowledge for multi-program, cross cutting NASA use and to transition of these products to external users. Presently, each NASA program/project must fund, establish, and develop their individual spaceflight environments products with the potential consequences of duplication of effort, over/under engineering, using inappropriate critical information, and acceptance of additional risk.

The ASE office will provide coordination across NASA, and funding for sustained multi-program support in three technical areas that have a demonstrated customer pull. These technical areas are:

- Natural Environments Characterization and Modeling
- Environmental Effects on Materials and Systems
- Operational Space Environments

In each of these areas, the ASE office would not conduct the efforts, but coordinate across NASA these efforts. It is envisioned as a NASA HQ office.

Note that "spaceflight environments" in this applied context is defined as all natural environments that influence the design, manufacture, development, and operation of spaceflight systems that function on extraterrestrial surfaces and in planetary atmospheres, geospace (including low Earth orbits) and interplanetary space.

The area of natural environments characterization and modeling will be focused on the design phase of programs. It will provide engineering design tools for space systems in the discipline areas of terrestrial and planetary atmospheres, ionizing radiation environments, plasma environments, extraterrestrial surfaces, interplanetary environments, and spacecraft charging. Existing but outdated, engineering design modeling products are available and are used extensively. Customer requests for products range between 200 and 400 per year. As an example, the ASE office would update coordinate the development of additional tools as needed.

Many NASA field centers have materials and parts testing and performance assessment through laboratory facilities and spaceflight experiments. Individual mission programs within NASA or external commercial aerospace and federal agency drive the current assessment efforts. However these activities are not coordinated. ASE would leverage all of these efforts to create one place where public information could be made available, and where those programs that needed this service could be guided to the appropriate facility within the agency.

The research to understand the dynamic nature of the space environment and what drives and modulates it is a vibrant science discipline called heliophysics. It is basically comprised of solar/space/plasma physicists, and aeronomers who study the mass and energy flow from with the Sun to the Earth, and throughout the Solar System. Valuable knowledge in the form of data, models, and theory is generated. However, there is very little effort, or funding incentive to transition this knowledge

to operational and applied tools defined/required by users. ASE would coordinate the transition to operations with the many organizations within the Agency where it has invested in this science research. The ASE office would serve as the organization to fund and ensure this transition. It would be the point of contact within the agency to the other federal agencies, such as NOAA and DoD, and the commercial aerospace industry. ASE would use the valuable experience developed in other successful research-to-application programs, such as the Space Environments Effects project for engineering design tools, the Earth science projects SERVIR for disaster mitigation in developing nations, and SPoRT for mesoscale weather models to the NOAA National Weather Service.

To reemphasize a point made above, the ASE office is NOT proposed to conduct these activities, usurp existing efforts, or replace current collaborations. The ASE office will coordinate these efforts, leverage existing areas expertise and facilities across the field centers and provide resources to the appropriate organizations to develop non-existing design and research-to-application tools, and data products as needed. Responsibilities of the ASE office include:

- Fund the transition from research to application for new and existing models, and data sets
- Respond to internal and external to NASA user needs with product development and technical assistance
- Facilitate flight experiment opportunities
- Coordinate space weather observations for NASA operations
- Provide a coordinated effort to capture, archive, and distribute spaceflight environments and materials data
- Coordinate the development of spaceflight environment guidelines for design, development, manufacture, and operation
- Enable material advancement and space system improvements
- Provide a forum for Subject Matter Expert and user feedback/input
- Serve as the NASA entry/exit point for space environment products, to include
    - Test facilities, capabilities and expertise
    - Space weather products and data
    - Transition of research to applications

An incomplete list of the cooperative interface to the ASE office includes

- NASA Organization
    - Living With a Star (LWS)/SMD
    - Community Coordinated Modeling Center (CCMC)/GSFC
    - NASA EEE Parts and Packaging Program (NEPP)/GSFC
    - Meteoritic Environments Office (MEO)/MSFC
    - Orbital Debris Program Office (ODPO)/JSC
    - Space Radiation Analysis Group (SRAG)/JSC
    - Space Weather Working Group (SWxWG)/OCE
    - . . .
- Non-NASA Organizations

- Space Weather Prediction Center (SWPC)/NOAA
- DoD AFRL/NRL/Army
- National Laboratories
- Private Industry
- International Partners
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