

An Enabling Foundation for NASA's Earth and Space Science Missions

SPACE STUDIES BOARD



During the 50-year history of the space age, the National Aeronautics and Space Administration (NASA)'s space and Earth science missions have achieved an extraordinary record of accomplishments. Much of the success of these missions has been due to a solid foundation of enabling research and analysis. Mission-enabling activities frame the scientific questions on which plans for flight missions are based; develop advanced technologies that make new, complex missions feasible; and translate the data from spaceflight missions into new scientific understanding. While it has long been recognized that these activities are essential to the achievement of NASA's goals, defining and articulating their appropriate scale have posed a challenge. In 2007, Congress called for the National Research Council (NRC) to examine the balance between spaceflight missions and their supporting activities at NASA, with the goal of assessing whether levels of support for mission-enabling activities were appropriate. This report defines and compares current research and technology development across multiple disciplines within NASA's Science Mission Directorate (SMD), identifies opportunities for improvement, identifies principles and metrics for the effective management of mission-enabling portfolios, and recommends ways to strategically manage programs to maximize their effectiveness.

NASA's space and Earth science program comprises two principal components: spaceflight projects (including the design, development and launch of Earth orbiting and deep-space missions), and activities that are not dedicated to a single spaceflight mission but provide a broad enabling foundation for NASA's spaceflight projects. The latter mission-enabling activities are fundamentally important to both NASA and to the nation, ensuring the preparedness of technology and personnel and optimizing the value of data collected on spaceflight missions.

Maximizing the Effectiveness of Mission-Enabling Activities

To increase the effectiveness of mission-enabling activities, an NRC committee determined that NASA should ensure that these activities are linked to the strategic goals of the agency and of the SMD and that they are structured to:

- Encompass the range and scope of activities needed to support strategic goals
- Provide a broad knowledge base that provides context necessary to interpret data from existing missions and define new missions
- Maximize the scientific return from all spaceflight missions
- Supply a continuous flow of new technical capabilities and scientific understanding into new spaceflight missions
- Enable the healthy scientific and technical workforce needed to conduct NASA's space and Earth science program

Improving Management of Research Portfolios

In addition, the committee identified areas in which current approaches to managing research and technology portfolios could be improved. To most effectively fulfill their purpose, programs should have the following attributes:

- Activities clearly traceable to mission statements and goals
- Portfolio allocations based on systematic criteria and metrics of effectiveness
- Continual interaction with and assessment by the science community via a well-structured advisory apparatus
- Transparent budget structure
- Explicit statement of the role of mission-enabling activities
- Adequate staff for proper management

NASA needs to establish portfolio allocation criteria and metrics of program effectiveness, taking into consideration principles of implementation including the need for different levels of investment across SMD divisions with differing goals, flexibility in the balance of mission-enabling and spaceflight missions, and the continual assessment of portfolios to ensure appropriate allocation of investments. Also required is the clear communication of divisions' strategic priorities and of the programmatic relationships of mission-enabling activities to spaceflight programs.

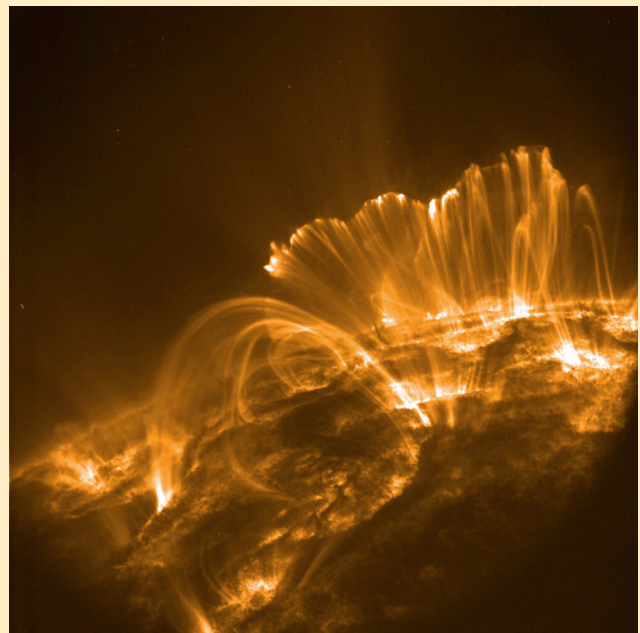
Performance metrics are an essential tool for making effective portfolio management decisions. A metric for each of an SMD division's mission-enabling activities should include the following:

- A simple statement of what the component of the mission-enabling activity is intended to accomplish and how it supports the strategic or tactical plans of the division
- A statement as to how the component is to accomplish the task
- An evaluation of the success of the activity relative to the stated mission, unexpected benefits, and lessons learned
- A justification for the resource allocation that is being applied to the component relative to other mission-enabling activities within the division

Case Study: Mission-Enabling Activities Advance Study of the Solar Corona

In the 1980s, NASA-funded theoretical research led astrophysicist Eugene Parker to observe magnetic field lines on the sun's corona that had been misaligned by convective motions on the solar surface. He suspected that magnetic energy would be explosively released at the interfaces between the field lines, referring to the phenomenon as "nanoflare." To test this theory, NASA developed new optic technology, which has since revolutionized our understanding of coronal structure and dynamics, and is now in standard use on solar missions.

This X-ray image (right) shows loops of magnetic fields extending high above the solar limb into the corona. SOURCE: Courtesy of NASA Transition Region and Coronal Explorer (TRACE) team.



Adoption of an active portfolio management approach is the key to providing an effective program of mission-enabling activities. The SMD should develop and implement a system for continual assessment and management of its program portfolio, including the elements for improvement outlined in this report.

At present, however, the SMD headquarters' scientific and technical staff is not adequately sized to manage mission-enabling activities effectively. Therefore, NASA should increase the number of scientifically and technically capable program officers so that they can devote an appropriate level of attention to actively managing the portfolio of research and technology development that enables a world-class space and Earth science program. It is recommended that program managers be stationed at NASA headquarters where they can divide their time between mission-enabling activities and duties related to spaceflight programs.

Committee on the Role and Scope of Mission-Enabling Activities in NASA's Space and Earth Science

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The National Academies appointed the above committee of experts to address the specific task requested by NASA. The committee members volunteered their time for this activity; their report is peer-reviewed and approved by both the committee members and the National Academies. This report brief was prepared by the National Research Council based on the committee's report. More information can be obtained by contacting the [Space Studies Board](#).

Copies of the full report can be purchased from the National Academies Press, 500 5th Street NW, Washington DC, 20001; (800) 624-6242; www.nap.edu

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