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## Earth Science and Applications from Space: A Community Assessment and Strategy for the Future—*Report Brief*

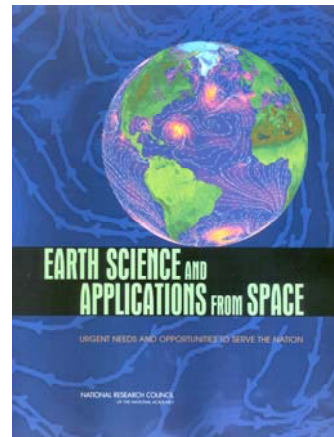
SPACE STUDIES BOARD

### Background

Natural and human-induced changes in Earth's land surface, water, and atmosphere, and interior affect all aspects of life. Understanding these changes requires a range of observations acquired from land-, sea-, air-, and space-based platforms. To assist NASA, NOAA, and USGS in their planning, the NRC was asked to carry out a “decadal strategy” survey of Earth science and applications from space that would:

- Develop the key scientific questions on which to focus Earth and environmental observations in the period 2005-2015 and beyond, and
- Present a prioritized list of space programs, missions, and supporting activities to address these questions.

This report presents a vision for the Earth science program; an analysis of the existing Earth observing system and recommendations to help restore its capabilities; an assessment of and recommendations for new observations and missions needed for the next decade; an examination of and recommendations concerning effective application of those observations; and an analysis of how best to sustain that observation and applications system.



### Findings and Recommendations

**A Vision for the Future** A critical element of the study's vision is its emphasis on the need to place the benefits to society that can be provided by an effective Earth observation system on a par with scientific benefits. This will require a renewed investment in Earth observing capabilities both to answer important scientific questions and apply new knowledge for the benefit of society.

*“The U.S. government, working in concert with the private sector, academe, the public, and its international partners, should renew its investment in Earth observing systems and restore its leadership in Earth science and applications ” (Chapter 1)*

*“Between 2006 and the end of the decade, the number of operating sensors and instruments will likely decrease by around 40% given that most satellites in NASA’s current fleet are well past their nominal lifetimes.” (Chapter 2)*

Many significant environmental and health challenges are identified in Chapter 1 which can benefit significantly from space-based observation, including the behavior of the ice sheets; the spread of diseases such as mosquito-borne viruses; the frequency of tropical cyclones; drought patterns; and the effect of human activity on coastal and ocean ecosystems, to name only a few.

**Setting the Foundation** The existing NASA Earth Observing System and related NASA, NOAA, and USGS space-based systems have made substantial scientific and

societal contributions. The foundation of this system is at risk, however, and substantial capability loss is likely over the next several years due to a combination of decreased budgets and aging satellites already well past their design lifetimes. Missions that provide critical climate, weather, water, and ecosystem data are identified which will continue the needed sustained measurements into the next decade.

### Earth Observing Instruments (2000-2020)

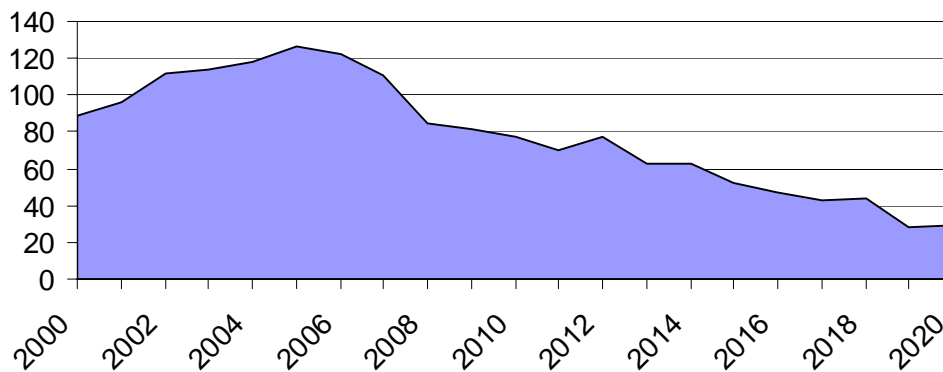


Figure 1 Existing and Currently Planned

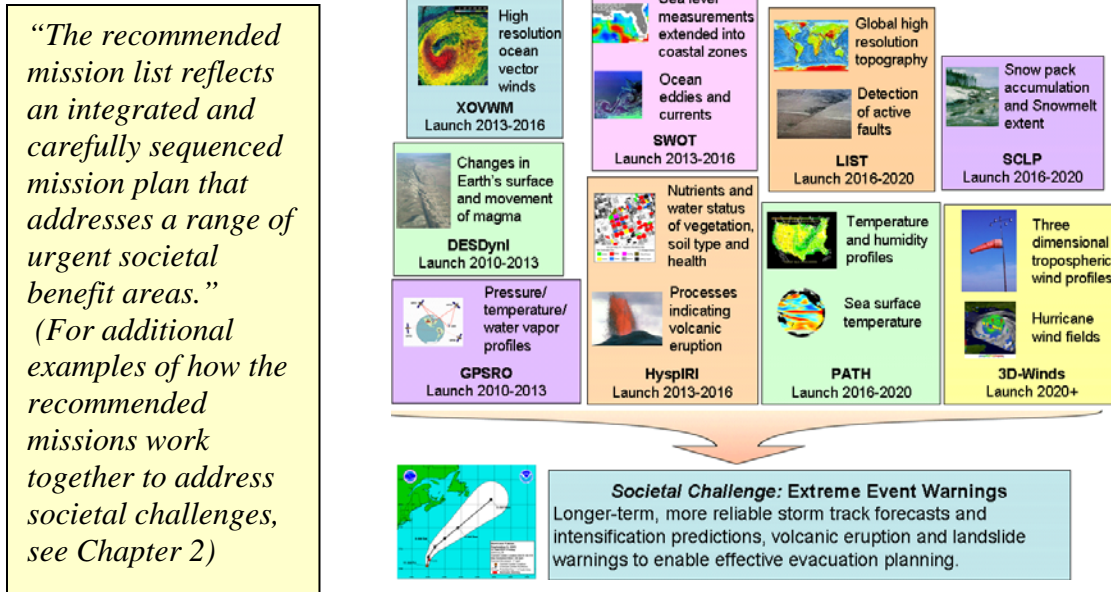
To sustain critical measurements, both NASA and NOAA need to take several actions. NOAA needs to restore key climate, environmental, and weather observation capabilities to its planned NPOESS and GOES-R missions. NASA should continue sustained precipitation and land cover measurements in order to provide understanding of the effect of climate change on global precipitation patterns and how land use patterns change due to population and economic forces.

NASA and NOAA should take steps to ensure efficient transition of critical research observations into operational status. NASA should also develop a science strategy for obtaining long-term, continuous, stable Earth observations for all applications. OSTP should facilitate development of a plan for achieving sustained Earth observations.

**New Observations** Earth knowledge requires understanding of how the Earth’s many, related processes interact with one another. To provide that understanding, a robust program consisting of a prioritized set of 17 missions should be carried out by NOAA and NASA over the next decade. This set of missions provides a sound foundation for Earth science and its associated societal benefits well beyond 2020.

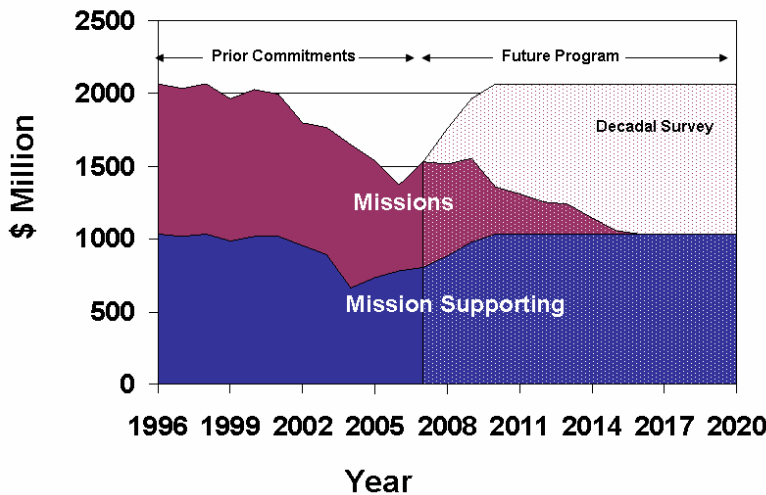
*“These missions form a minimal but robust component of an Earth information system that is capable of addressing a broad range of societal needs.” (Chapter 2)*

The recommended missions were selected to address multi-disciplinary issues in climate change, water resources, ecosystem health, human health, solid-Earth hazards, and weather. Elimination of any of these missions would severely compromise the benefits that accrue to one or more of these important societal areas, and those consequences should be carefully considered if changes are proposed.



**Figure 2 Recommended Missions for Extreme Event Warning**

The suggested mission sequence was determined by evaluating the maturity of key prediction and forecast tools, the need for particular observations to improve those tools, and the potential for complementary international missions. Science and measurement synergies are exploited to establish a more capable and economic system capable of advancing societal needs as well as scientific inquiry within a reasonable budget profile.



**Figure 3 NASA Budget for Earth Sciences**

*“The overall cost to implement the recommended NASA program...is estimated to exceed currently projected program resources, but fits well within funding levels provided to NASA Earth Science as recently as 2000.”*

NASA needs to invest in technology development comparable and in addition to its basic technology program to make sure the necessary technologies are ready when needed. Also, to help with the development of innovative ideas and technologies, NASA should create a new Venture class of low-cost research and application missions that can establish entirely new research avenues or demonstrate key application-oriented measurements.

**Applying Satellite Observations** To ensure these observations will benefit society, the mission plan must be accompanied by efforts to translate raw observational data into useful information. The space agencies should place a high-priority on modeling, data assimilation, data archive and distribution, and research and analysis. Distribution of data should be free or at low cost to users, and provided in an easily-accessible manner.

*“However, the missions are but one part of a larger program that is required to translate raw observations of Earth into useful information.” (Chapter 3)*

Data from suborbital and land-based platforms and socio-demographic studies are needed to complement the space-based data. These and other complementary observations are discussed in more detail in Chapter 3.

**Sustaining the System** A formal planning and review process is needed to sustain a robust Earth observing system beyond the next decade. A set of programmatic decision strategies and rules that leverages international efforts, manages technology risk, and responds to budget pressures should be considered throughout this process.

*The missions recommended in Chapter 2, together with other national and international missions, will provide the necessary space-based observational foundation for the coming decade of Earth information needs. However, these missions were developed against a backdrop of programmatic constraints and available resources that are expected to evolve over time...Therefore, all programs should be reviewed regularly for potential problems as well as new opportunities, by an external, independent, and community-based advisory body.” (Chapter 3)*

## **For Further Information**

Copies of the complete report, *Earth Science and Applications from Space: A Community Assessment and Strategy for the Future*, can be obtained from the Space Studies Board, The National Academies, 500 Fifth St., NW, Washington, DC, 20001, 202-334-3477, < <http://books.nap.edu/catalog/11820.html> >.

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<sup>1</sup>Term ended January 2006.

<sup>2</sup>The committee notes with deep regret Aram Mika's death on May 18, 2005.