

Initiation of the 2017-2027 Decadal Survey for Earth Science and Applications from Space

<http://sites.nationalacademies.org/ESAS2017>

Initial Request for Information (RFI)

“Understanding the complex, changing planet on which we live, how it supports life, and how human activities affect its ability to do so in the future is one of the greatest intellectual challenges facing humanity. It is also one of the most important for society as it seeks to achieve prosperity and sustainability.”

-- From the interim report of the inaugural National Research Council (NRC) Decadal Survey, *Earth Science and Applications from Space*. April 2005¹

The first National Research Council (NRC) decadal survey in Earth science and applications from space, completed in 2006 and published in January 2007,² recommended a balanced interdisciplinary program that would observe the atmosphere, oceans, terrestrial biosphere, and solid Earth, and the interactions between these Earth system components, to advance understanding of how the system functions for the benefit of both science and society. In presenting its recommended program, the survey’s authors, representing the consensus views of hundreds of participants working across the Earth sciences, noted that:

¹ *Earth Science and Applications from Space: Urgent Needs and Opportunities to Serve the Nation* (2005). Available at: http://www.nap.edu/openbook.php?record_id=11281.

² *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (2007). Available at: http://www.nap.edu/openbook.php?record_id=11820.

“The world faces significant environmental challenges: shortages of clean and accessible freshwater, degradation of terrestrial and aquatic ecosystems, increases in soil erosion, changes in the chemistry of the atmosphere, declines in fisheries, and the likelihood of substantial changes in climate. These changes are not isolated; they interact with each other and with natural variability in complex ways that cascade through the environment across local, regional, and global scales. Addressing these societal challenges requires that we confront key scientific questions related to ice sheets and sea-level change, large-scale and persistent shifts in precipitation and water availability, transcontinental air pollution, shifts in ecosystem structure and function in response to climate change, impacts of climate change on human health, and the occurrence of extreme events, such as severe storms, heat waves, earthquakes, and volcanic eruptions.”

The next decadal survey in Earth science and applications from space, covering the approximate period of 2017-2027, will commence in earnest in the fall of 2015.³ Appended to this document is the task statement for this activity, which was developed in consultation with the study sponsors, NASA (Earth Science Division), NOAA (NESDIS), and the USGS (Climate and Land Use Change). The initial steps in the organization of the survey are being managed by the Space Studies Board’s Committee on Earth Science and Applications from Space (CESAS: http://sites.nationalacademies.org/SSB/SSB_066587), which is working in collaboration with units of the Academy that also have substantial interests in the decadal survey.⁴

³ A Congressionally-mandated review of progress in implementing the 2007 decadal survey can be found in *Earth Science and Applications from Space: A Midterm Assessment of NASA’s Implementation of the Decadal Survey* (2012). Available at: http://www.nap.edu/openbook.php?record_id=13405.

⁴ In particular, the Division of Earth and Life Studies (DELS, <http://dels.nas.edu>) Boards on Atmospheric Sciences and Climate, Polar Research, Ocean Sciences, Water Science and Technology, and Earth Sciences and Resources. The organizers are also consulting with the Board on Environmental Change and Society.

The present RFI is being issued to inform the initial organization and structure of the committee and panels that will conduct the survey, as well as to provide direct input to the work of those groups. **Toward that end, we are requesting input from the broad community on the following questions:**

1. *What are the key challenges or questions for Earth System Science across the spectrum of basic research, applied research, applications, and/or operations in the coming decade?*⁵
2. *Why are these challenge/questions timely to address now especially with respect to readiness?*
3. *Why are space-based observations fundamental to addressing these challenges/questions?*

In your responses to these questions, please focus on the role of space-based observations and comment on:

- a. Whether existing and planned U.S. and international programs will provide the capabilities necessary to make substantial progress on the identified challenge and associated questions. If not, what additional investments are needed?
- b. How to link space-based observations with other observations to increase the value of data for addressing key scientific questions and societal needs;
- c. The anticipated scientific and societal benefits; and
- d. The science communities that would be involved.

(Please limit your response to approximately 1500 words or less)

All submissions will be posted online; as part of the submission process, participants will be asked to agree for such public posting. We ask that responses be organized as answers to the questions shown above. **Responses are requested by November 02, 2015** to ensure appropriate consideration as the survey is organized, but submissions will be accepted through the end of the calendar year and made available to the survey steering committee. **To submit your response, please visit: <http://www.surveygizmo.com/s3/2289356/ESAS-2017-Call-For-Papers>**

⁵ An Addendum to this RFI lists reference documents that may be of interest.

2017 Decadal Survey for Earth Science and Applications from Space

“ESAS 2017”

SUMMARY

The National Research Council (NRC), led by the Space Studies Board in collaboration with other Earth Science related boards across the NRC, will organize a “decadal survey” that will generate consensus recommendations from the environmental monitoring and Earth science and applications community on an integrated and sustainable approach to the conduct of the U.S. government’s civilian space-based Earth-system science programs. These programs are carried out predominantly by the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the United State Geological Survey (USGS), with supporting and complementary contributions from agencies including the National Science Foundation (NSF), Department of Agriculture (USDA), Department of Energy (DoE), and Department of Defense (DoD).

STATEMENT OF TASK

The National Research Council will appoint a steering committee and supporting study panels to carry out a decadal survey in Earth Science and Applications from Space. The study will generate consensus recommendations from the environmental monitoring and Earth science and applications communities for an integrated and sustainable approach to the conduct of the U.S. government’s civilian space-based Earth-system science programs.

The survey’s prioritization of research activities will be based on the committee’s consideration of identified science priorities; broad national operational observation priorities as identified in U.S. government policy, law, and international agreements (for example, the 2014 National Plan for Civil Earth Observation) and the relevant appropriation and authorization acts governing NASA, NOAA, and USGS; cost and technical readiness; the likely emergence of new technologies; the role of supporting activities such as in situ measurements; computational infrastructure for modeling, data assimilation, and data management; and opportunities to leverage related activities including consideration of interagency cooperation and international collaboration. As the committee starts its work it will be provided the guidance contained in Appendix A. The survey committee will work with NASA, NOAA, and USGS to understand agency expectations of future budget allocations and design its recommendations based on budget scenarios relative to those expectations. The committee may also consider scenarios that account for higher or lower than anticipated allocations.

During this study, the committee’s primary tasks will be:

1. Assess progress in addressing the major scientific and application challenges outlined in the 2007 Earth Science Decadal Survey.

2. Develop a prioritized list of top-level science and application objectives to guide space-based Earth observations over a 10-year period commencing approximately at the start of fiscal year 2018 (October 1, 2017).
3. Identify gaps and opportunities in the programs of record at NASA, NOAA, and USGS in pursuit of the top-level science and application challenges—including space-based opportunities that provide both sustained and experimental observations.
4. Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. program of Earth observations from space.

In addition the committee will conduct the following agency-specific tasks:

5. Recommend NASA research activities to advance Earth system science and applications by means of a set of prioritized strategic “science targets” for the space-based observation opportunities in the decade 2018-2027. (A science target in this instance comprises a set of science objectives that could be pursued and significantly advanced by means of a space-based observation.) The prioritization process will begin with the committee identifying the critical measurement capabilities associated with the science target. For each science target, the committee will then identify a set of objectives and measurement requirements/capabilities for space-based data acquisitions. If appropriate and usually only for recommendations associated with major investments, the committee will (via a “CATE” process) assemble notional proof-of-concept missions with the recommended capabilities in order to better understand the top-level scientific performance and technical risk options associated with mission development and execution. In addition:
 - a. The committee will carry out its prioritization with a view towards minimizing mission development and acquisition costs and maximizing the role of competition in implementing flight recommendations.
 - b. For each science target, the committee will establish the context, criteria, and justifications for its recommended prioritization, and identify scientific and/or programmatic developments of sufficient significance that they would warrant reexamination of the committee’s recommendation.
 - c. The prioritization process will include reconsideration of the scientific priorities associated with the named missions from 2007 Earth Science and Applications from Space Decadal Survey.
 - d. In considering budget scenarios for NASA, the committee may consider scenarios that account for higher or lower than anticipated allocations. For NASA, the committee’s recommendations will also include guidance on how to rebalance programs upon failure of one or more of the criteria/assumptions underpinning a mission recommendation.
 - e. The committee may also identify potential interagency and international synergies; proposed augmentations to planned international missions; and adjustments to U.S. missions planned, but not yet implemented.
 - f. The committee may comment on technology investments; new areas of research emphasis; or suborbital, ground, or in situ activities.
6. For NASA, the committee will pay particular attention to prioritizing and recommending balances among the full suite of Earth system science research, technology development, flight mission development and operation, and applications/capacity building

development conducted in the Earth Science Division (ESD) of the Science Mission Directorate. In particular, while making clear its assumptions regarding the overall scope of the NASA ESD program relative to the contributions of the mission agencies NOAA and USGS, the committee will make recommendations on:

- a. The target budgetary balance between Flight and Non-Flight aspects of the ESD portfolio;
- b. In the Non-Flight portion of the program, the target balance between R&A, Applied Science, and Technology elements;
- c. In the Flight element, the target budgetary balance between systematic/directed, and competed/cost/schedule-constrained mission programs;
- d. In the Flight element and considering overall resource constraints, the target budgetary balance between general mission-enabling investments (such as common spacecraft development, highly disaggregated constellations, etc.) and traditional focused single-mission developments;
- e. In the Flight and Technology elements, the degree that NASA investment decisions could be informed by NOAA and USGS operational satellite measurement objectives,;
- f. Expanding or modifying the present 3-strand Venture-Class competed program, including examining whether ESD should initiate additional or different Venture Class strands, possibly with different cost caps;
- g. Decision principles for balancing new measurements against time series extensions of existing data sets; and
- h. Any changes in scope(s) of the non-flight R&A, Applied Sciences, and Technology Development elements.

7. For NOAA and the USGS, which have a critical requirement for continuity of observations and delivery of services and information to the public and commercial sectors, the decadal survey committee's recommendations will be framed around national needs, including, but not limited to research priorities. The committee's recommendations for NOAA and the USGS will, as far as practicable, align with anticipated budgets at the relevant portion(s) of the agencies, with any deviations from those budgets clearly presented. Recommendations may be organized around 1) how new technology may enhance current operations, and 2) what new science is needed to expand current operations, either to enable new capabilities or to include new areas of interest. In making these recommendations, the committee will consider the need to bridge current operations and support a viable path forward for the uninterrupted delivery of public services through these generational changes. In particular, the committee:

- a. Will, with the expectation that the capabilities of non-traditional providers of Earth observations continue to increase in scope and quality, suggest approaches for evaluating these new capabilities and integrating them, where appropriate, into NOAA and USGS strategic plans. The committee will also consider how such capabilities might alter NOAA's and USGS's flight mission and sensor priorities in the next decade and beyond.
- b. Will consider which scientific advances are needed to add to NOAA's future predictive capabilities. This includes taking into the account the overlap and interdependencies between water, weather and climate, and encouraging the

development of extended, and diversified forecasts. The committee will similarly consider advances needed to meet the needs of USGS science priorities and data users, for example advising on advances that can support both the natural resource management community and the climate research community.

- c. May offer recommendations concerning “research to operations” (or “innovation for continuity and service improvements across agencies”). For example, the committee may identify areas where NASA technology investments may lead to more efficient or effective NOAA and USGS missions by raising the Technology Readiness Level (TRL) of enabling technologies.
- d. Will consider the agencies’ ability to replicate existing technologies to improve and sustain operational delivery of public services, and also to produce consistent and reliable science and applications data products across different generations of measurement technology, as new measurement innovations are introduced.

Addendum

Selected Sources of Key Questions and Challenges for Earth System Science

Several community-based and interagency efforts have developed lists of key questions similar to that developed by the 2007 decadal survey. They include:

- U.S. Global Change Research Program “Our Changing Planet” (2015): <http://www.globalchange.gov/sites/globalchange/files/Our-Changing-Planet-FY-2015-full-res.pdf>
- USGCRP National Climate Assessment (2014): <http://nca2014.globalchange.gov/>
- OSTP National Plan for Civil Earth Observations (2014): https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/national_plan_for_civil_earth_observations_-_july_2014.pdf

The Earth observation programs of international partners are also organized around key questions and challenges; for example:

- European Space Agency (ESA): http://www.esa.int/About_Us/ESA_Publications/ESA_Publications_Monographs/ESA_S_P-1329_EO_Science_Strategy
- World Climate Research Programme (WCRP): <http://www.wcrp-climate.org/index.php/grand-challenges>
- The intergovernmental Group on Earth Observations (GEO), Global Earth Observation System of Systems (GEOSS): <http://www.earthobservations.org/documents/10-Year%20Plan%20Reference%20Document.pdf>

The NRC has also produced a number of relevant reports; including:

- A Framework for Analyzing the Needs for Continuity of NASA-Sustained Remote Sensing Observations of the Earth from Space (forthcoming):
http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_084713
- Sea Change: 2015-2025 Decadal Survey of Ocean Sciences (2015):
http://www.nap.edu/openbook.php?record_id=21655
- The Arctic in the Anthropocene: Emerging Research Questions (2014):
http://www.nap.edu/openbook.php?record_id=18726
- Opportunities to Use Remote Sensing in Understanding Permafrost and Related Ecological Characteristics: Report of a Workshop (2014)
http://www.nap.edu/openbook.php?record_id=18711
- Landsat and Beyond: Sustaining and Enhancing the Nation's Land Imaging Program (2013):
http://www.nap.edu/openbook.php?record_id=18420
- Abrupt Impacts of Climate Change: Anticipating Surprises (2013):
http://www.nap.edu/openbook.php?record_id=18373
- Review of NOAA Working Group Report on Maintaining the Continuation of Long-Term Satellite Total Irradiance Observations (2013):
http://www.nap.edu/openbook.php?record_id=18371
- Earth Science and Applications from Space: A Midterm Assessment of NASA's Implementation of the Decadal Survey (2012):
http://www.nap.edu/openbook.php?record_id=13405
- America's Climate Choices (2011):
http://www.nap.edu/openbook.php?record_id=12781
- Understanding the Changing Planet: Strategic Directions for the Geographical Sciences (2010):
http://www.nap.edu/openbook.php?record_id=12860
- Ensuring the Climate Record from the NPOESS and GOES-R Spacecraft: Elements of a Strategy to Recover Measurement Capabilities Lost in Program Restructuring (2008):
http://www.nap.edu/openbook.php?record_id=12254