

# **ESAS 2017**

## **The 2017-2027 NRC Decadal Survey for Earth Science and Applications from Space**

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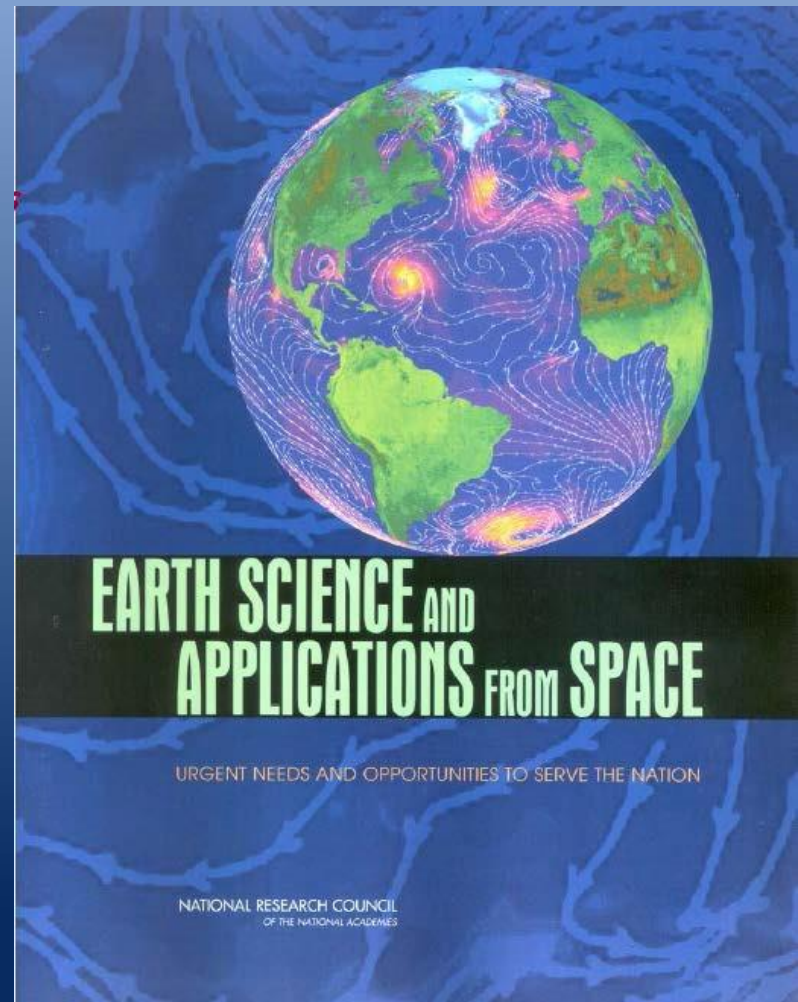
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# Vision of the Inaugural Decadal Survey

## *Advancing Earth System Science to Benefit Society*

“Understanding the complex, changing planet on which we live, how it supports life, & 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 & sustainability.”

-- *Interim Report of the Decadal Survey,*  
*April 2005*



# ESAS 2017

- Sponsors:
  - NASA-Earth Science Division;
  - NOAA-NESDIS; and
  - USGS, Climate & Land Use Change

# Backdrop: In Addition to Tight Budgets...

- **NASA:** Has a backlog of missions recommended in the inaugural survey and increased responsibility—without commensurate budget increases— starting after the JPSS-1 era for vertical profiles of stratospheric and upper tropospheric ozone, solar irradiance, Earth radiation budget measurements, and altimetry (beyond Jason-3).
- **NOAA:** Stabilizing the weather satellite portfolio and avoiding a potential gap between the NPP spacecraft and the first of the next-generation POES systems, JPSS-1, is a top priority. “Climate”-related instruments moving to NASA.
- **USGS:** Interest in survey focuses on future capabilities, including hyperspectral, for a sustained land-imaging program and options for Landsat follow-ons. However, L-9 is projected to be a near-rebuild of L-8 for launch in in 2023. (TIRS on L-8 only has 3-year design life; NASA looking at Class-D TIR free-flyer for 2019 launch. )

# Primary Elements of the SOT

- **Assess progress** in addressing the major scientific and application challenges outlined in the 2007 Earth Science Decadal Survey.
- **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).
- **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.
- **Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. program of Earth observations from space.** Consider: Science priorities, implementation costs, new technologies and platforms, interagency partnerships, international partners, and the *in situ* and other complementary programs carried out at NSF, DoE, DoA, DoD.

# Agency-Specific Tasks

## NASA

- 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.) ..... For each science target, the committee will 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.

- Other NASA tasks include: 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.

# Agency-Specific Tasks of the Draft SOT

## NOAA & USGS

- The decadal survey committee's recommendations will be framed around **national needs**, including, but not limited to research priorities. .... 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.
- Other tasks include: suggest approaches for evaluating and integrating new capabilities from **non traditional suppliers** of Earth observations; may offer recommendations concerning "**research to operations**" (or "innovation for continuity and service improvements across agencies"); and consider the agencies' ability to replicate existing technologies to improve and sustain operational delivery of public services.

# What Happens to Missions Recommended in the Previous Survey?

TBD, but:

- In developing its recommendations, survey to “include reconsideration of the scientific priorities associated with the named missions from the 2007 decadal survey.”
  - The 2007 survey did not prioritize among the 15 missions for NASA; placement in 1 of 3 time periods (Tiers I, II, III: 2010-13, 2013-2016, 2016-2020) was based on factors including technical readiness; cost; synergy with existing, planned, or recommended missions; and consideration of int’l activities.
- ESD has expressed an interest in having the survey provide guidance on technology investments that will be needed to address recommended science targets.
- Previous surveys have assumed missions in formulation to be considered part of the baseline program of record.



# Other Questions

- Why is this survey different from all other NRC surveys?
  - Systems Approach—Advances require study of the Earth as an integrated system
  - Research driven by user needs
  - Science informs policy
  - Inherently multiagency; R2O and continuity are perennial issues
- How will this survey differ from the inaugural survey?
  - No longer appropriate to recommend based on an aspirational budget
  - Congressionally-mandated independent cost appraisal and technical evaluation (CATE) for big ticket items
  - Likely that the science will be “valued” to avoid having one recommended activity grow at expense of all others
  - Increased opportunities to consider “new space” ideas—new players, smaller and less costly platforms, constellations, hosted payloads etc.
  - Improved consideration of international partners

# STATUS

- NRC Approval, May 6, 2015
- Executed contracts from sponsors: hoping for mid-June.
  - First task: appointment of survey leadership, to be followed by rest of steering committee. Panel appointments once survey organization finalized.
  - CESAS working on white paper requests to front-end survey
- NRC Boards covering atmospheric sciences, polar research, ocean science, hydrology, and the solid Earth will be collaborating partners with the Space Studies Board
  - Includes membership, execution, staffing, etc.
- One-day mini-workshop to discuss survey organization and other top-level issues with survey leads, community representatives, NRC staff and board representatives: late July?
- Final report due ~ 2 years from survey start (backup slide has details).

# Serving on the Survey

- A website has been created that will let you nominate yourself or someone else for service on one of the survey committees. We expect ~ 100 members will serve on an approx. 18-member steering committee or one its approx. 12-member study panels or working groups.
- NASA, NOAA, and USGS employees may serve if they are not in senior management and/or have control over budgets that could be affected by the survey's recommendations. Committee members are also vetted for potential sources of bias and conflicts of interest.

[bit.ly/ESASsignup](http://bit.ly/ESASsignup)

# Backup Slides

# Ideas for Today's Conversation

- Lessons learned from the inaugural survey
- Organization of the Survey
  - Thematic, discipline, matrix with cross-cutting working groups, other??
- How might ESAS 2017 address challenges such as:
  - Developing *credible* evaluations of the potential for smaller satellites and constellations
  - Entraining users of RS data in the survey
  - Ensuring the survey's recommendations are robust against changes in budgets or other disruptions
  - Developing actionable recommendations for mission agencies with operational responsibilities
  - Capturing potential international contributions

# Timeline

- Provision of funds to the NRC     Start of decadal survey
- Survey chair(s) appointed     ~ 1 month after contract approval
- Steering committee appointed     ~ 2-3 months after contract approval
- Panels appointed     ~ 4 months after contract approval
- Town Halls, RFIs     ~ 2-6 months after contract approval
- Steering Committee Meetings     6 meetings over 18-20 months following appointment
- Panel Meetings     3 meetings over 12 months following appointment
- Panel Final Outputs to Cmte     12 months after panel appointment
- Draft Report for Review     NLT 21 months following contract approval
- Report approval     NLT 24 months following contract approval

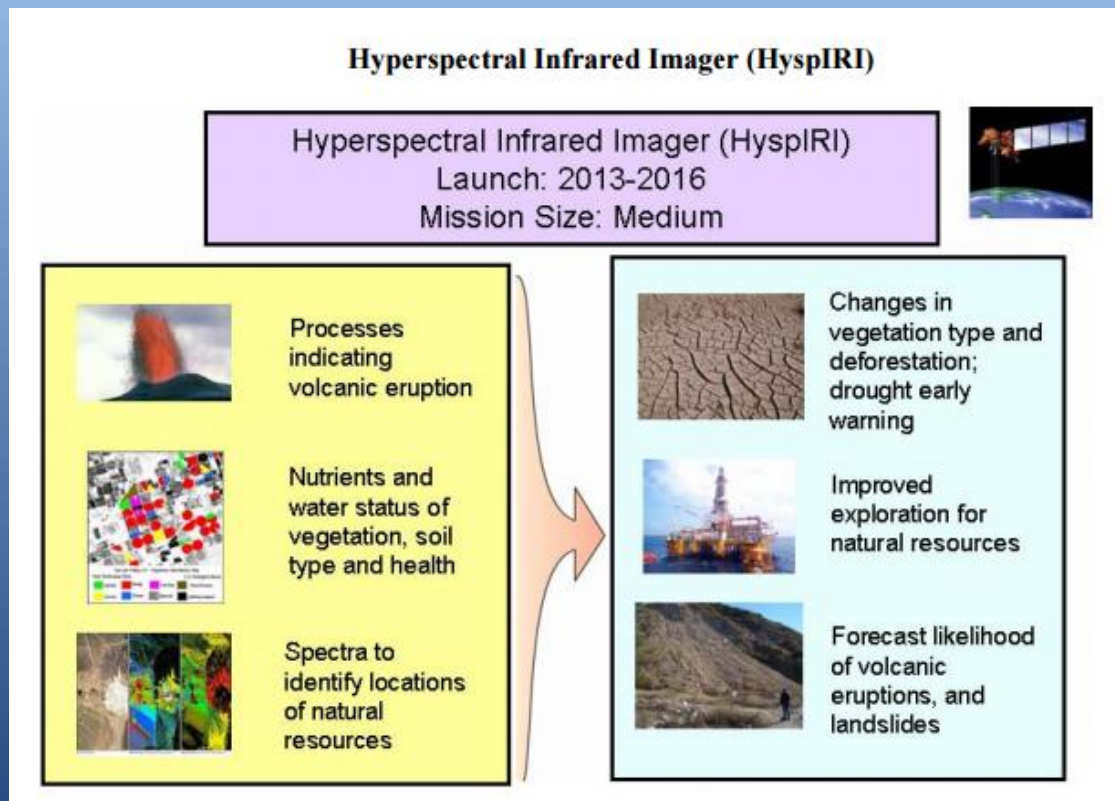
# Organization of the Inaugural Survey

The inaugural decadal survey was led by an Survey Steering Committee that drew on the work of seven thematically-organized study panels:

1. Earth science applications and societal needs.
2. Land-use change, ecosystem dynamics, and biodiversity.
3. Weather (including space weather<sup>5</sup> and chemical weather<sup>6</sup> ).
4. Climate variability and change.
5. Water resources and the global hydrologic cycle.
6. Human health and security.
7. Solid-Earth hazards, resources, and dynamics.

The organization of the panels for ESAS2017 will be a decision for the survey steering committee; we have budgeted for 6-7 panels and several cross-disciplinary working groups.

# HyspIRI in the 2007 Decadal Survey



HyspIRI uses imaging spectroscopy (optical hyperspectral imaging, 400-2500 nm and multispectral infrared, 8-12  $\mu\text{m}$ ) of the global land and coastal surface. The mission will obtain global coverage from LEO with repeat frequency of 30 days at 45 m spatial resolution. A pointing capability is required for frequent and high resolution imaging of critical events such as volcanoes, wildfires, or droughts. The payload consists of a hyperspectral imager together with a thermal multispectral scanner, both on the same platform, and both pointable. Cost: ~\$300M



# 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. 17

# Primary Tasks

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.

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.

1. 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.

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:

- 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.
- 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.
- 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.
- 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.