

**JAXA Symposium for 30th Anniversary of
the 1st Marine Observation Satellite (MOS-1)**

**The 2017-2027 National Academies'
*Decadal Survey for Earth Science and
Applications from Space***

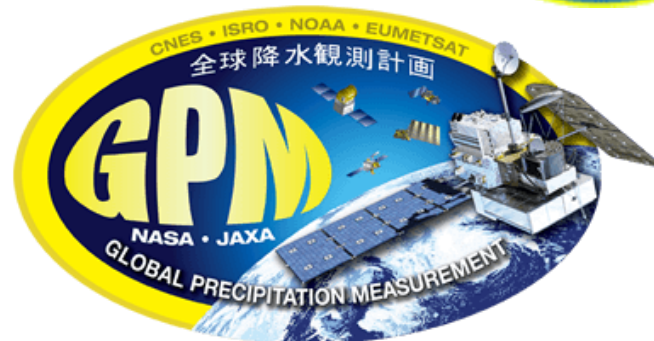
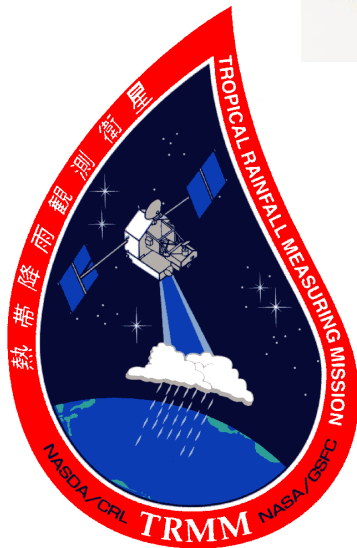
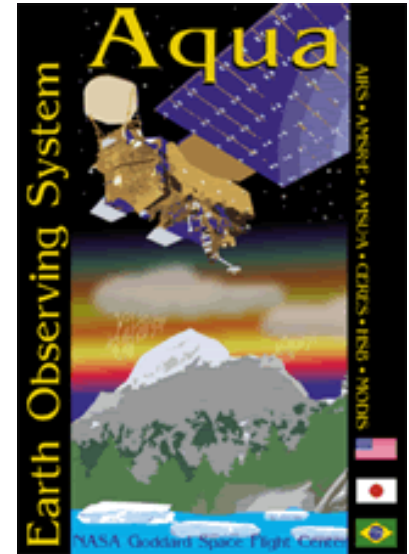
13 February 2017

Co-Chairs:

Waleed Abdalati, University of Colorado

William Gail, Global Weather Corporation

Celebrating 30 Years of Japan-US Collaboration



... And more

US Civil Earth Observation Planning Processes

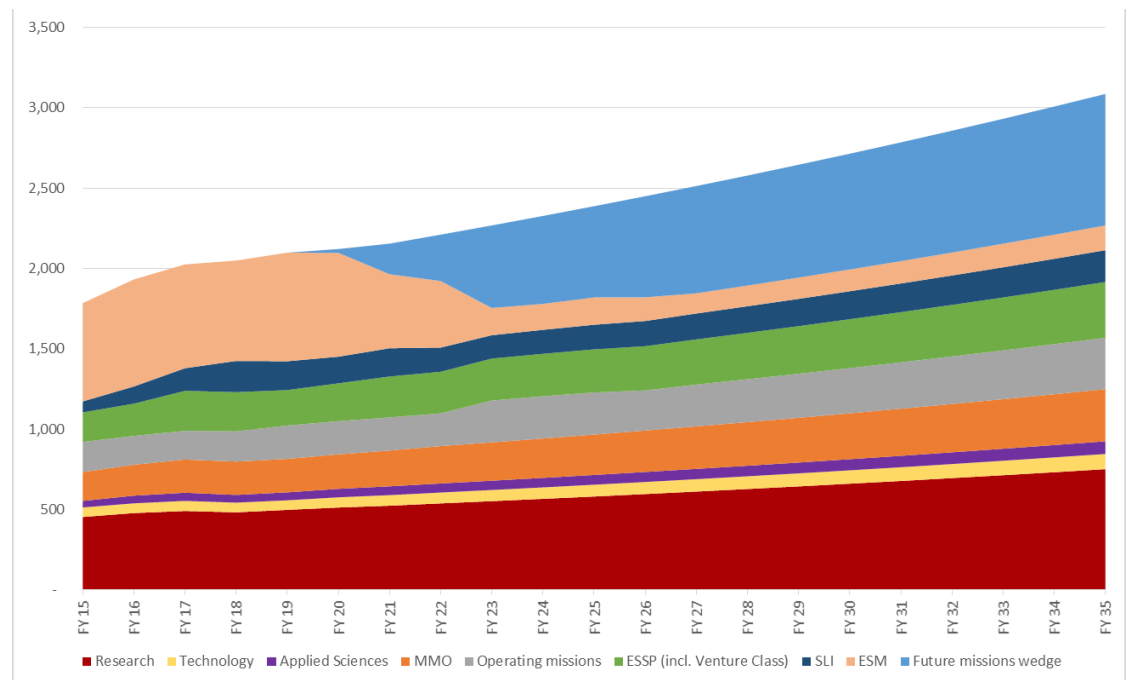
- NASA

- Primary planning through the Decadal Survey
- Must be consistent with expected budget

- NOAA & USGS

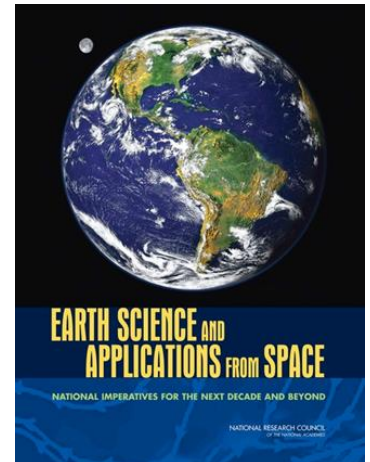
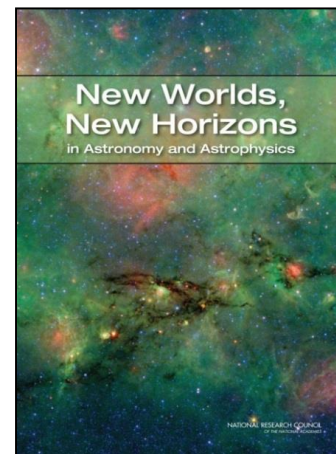
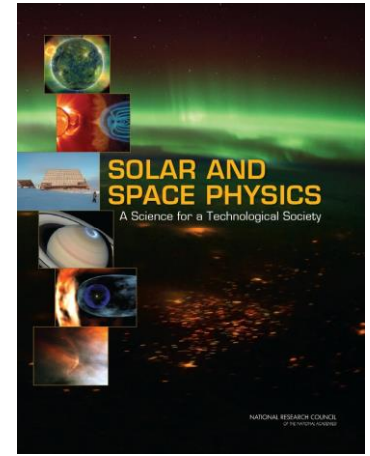
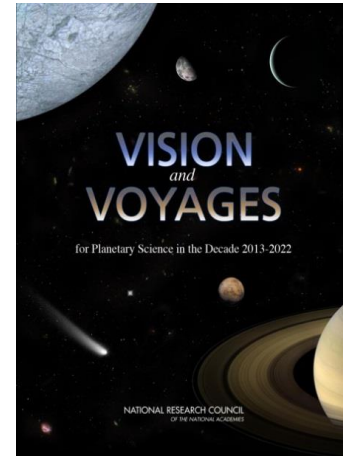
- Primary planning through Agency studies
- Augmented by Decadal Survey science and technology “on ramps”

NASA Earth Science Budget Expectations
2015-2035
(future missions wedge in blue)



Why Undertake a Decadal Survey

- **Community-led** assessment of the state of knowledge in the field; identify and prioritize questions for the next decade
- Provide **recommendations for programmatic directions** and explicit priorities for government investment in research and facilities, including space flight missions
- **Provide a forum** to address issues of advanced technology, infrastructure, interagency coordination, education, and international cooperation
- **Requested by US Congress** under the 2005 & 2008 NASA Authorization Acts

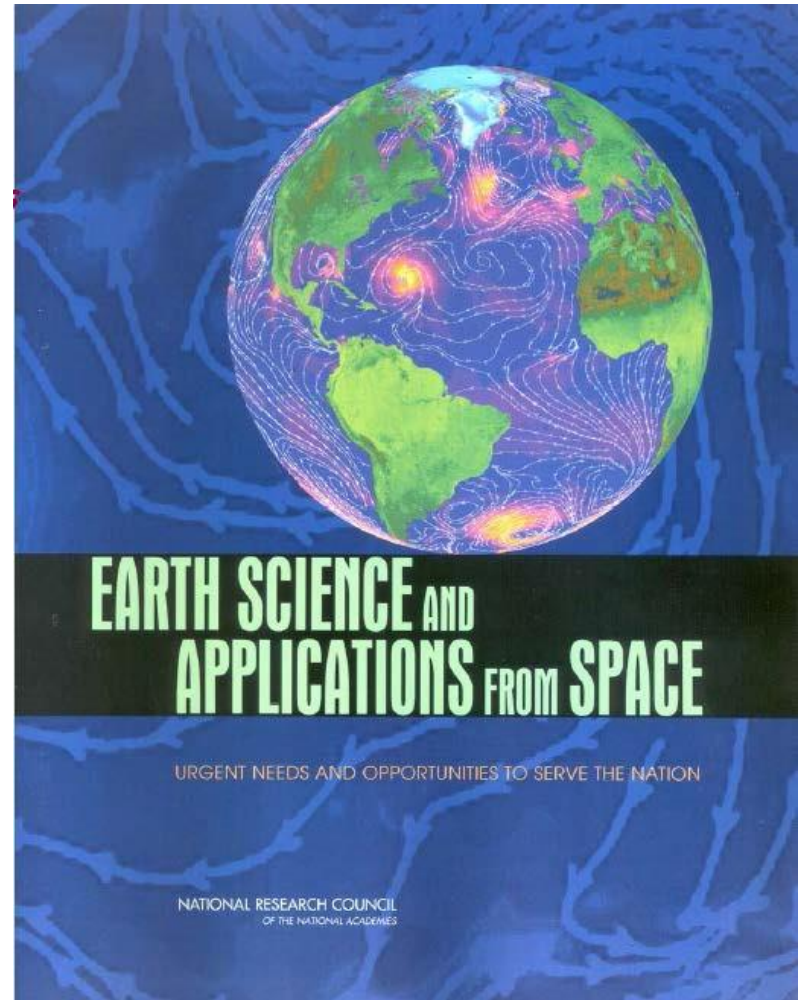


Decadal Surveys Facilitate Planning, Coordination, Advocacy, and Outreach

ESAS 2007: The Inaugural Earth Decadal Survey

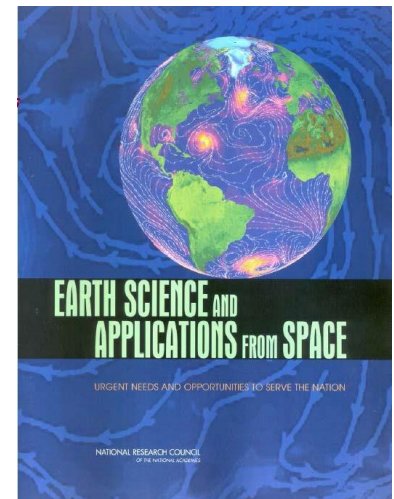
“Understanding the complex, changing planet on which we live, how it supports life, & how human activities affect its ability to do so in the future is one of the greatest intellectual challenges facing humanity. It is also one of the most important for society as it seeks to achieve prosperity & sustainability.”

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



ESAS 2007: Societal Challenges

- **Ice sheets** and **sea level**
- Large-scale and persistent shifts in **precipitation and water** availability
- Transcontinental **air pollution**
- Shifts in **ecosystem** structure and function in response to climate change
- **Human health** and climate change
- **Extreme events**, including severe storms, heat waves, earthquakes and volcanic eruptions



**What has
changed from
2007 to 2017?**

ESAS 2007 Recommendations

TABLE ES.2 Launch, Orbit, and Instrument Specifications for Missions Recommended to NASA

Decadal Survey Mission	Mission Description	Orbit ^a	Instruments	Rough Cost Estimate (FY 06 \$million)
2010-2013				
CLARREO (NASA portion)	Solar and Earth radiation; spectrally resolved forcing and response of the climate system	LEO, Precessing	Absolute, spectrally resolved interferometer	200
SMAP	Soil moisture and freeze-thaw for weather and water cycle processes	LEO, SSO	L-band radar L-band radiometer	300
ICESat-II	Ice sheet height changes for climate change diagnosis	LEO, Non-SSO	Laser altimeter	300
DESDynI	Surface and ice sheet deformation for understanding natural hazards and climate; vegetation structure for ecosystem health	LEO, SSO	L-band InSAR Laser altimeter	700
2013-2016				
HypSIrI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Hyperspectral spectrometer	300
ASCENDS	Day/night, all-latitude, all-season CO ₂ column integrals for climate emissions	LEO, SSO	Multifrequency laser	400
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO, SSO	Ka- or Ku-band radar Ku-band altimeter Microwave radiometer	450
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High-spatial-resolution hyperspectral spectrometer Low-spatial-resolution imaging spectrometer IR correlation radiometer	550
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar	800
2016-2020				
LIST	Land surface topography for landslide hazards and water runoff	LEO, SSO	Laser altimeter	300
PATH	High-frequency, all-weather temperature and humidity soundings for weather forecasting and sea-surface temperature ^b	GEO	Microwave array spectrometer	450
GRACE-II	High-temporal-resolution gravity fields for tracking large-scale water movement	LEO, SSO	Microwave or laser ranging system	450
SCLP	Snow accumulation for freshwater availability	LEO, SSO	Ku- and X-band radars K- and Ka-band radiometers	500
GACM	Ozone and related gases for intercontinental air quality and stratospheric ozone layer prediction	LEO, SSO	UV spectrometer IR spectrometer Microwave limb sounder	600
3D-Winds (Demo)	Tropospheric winds for weather forecasting and pollution transport	LEO, SSO	Doppler lidar	650

TABLE ES.1 Launch, Orbit, and Instrument Specifications for Missions Recommended to NOAA

Decadal Survey Mission	Mission Description	Orbit ^a	Instruments	Rough Cost Estimate (FY 06 \$million)
2010-2013				
CLARREO (instrument reflight components)	Solar and Earth radiation characteristics for understanding climate forcing	LEO, SSO	Broadband radiometer	65
GPSRO	High-accuracy, all-weather temperature, water vapor, and electron density profiles for weather, climate, and space weather	LEO	GPS receiver	150
2013-2016				
XOVWM	Sea-surface wind vectors for weather and ocean ecosystems	LEO, SSO	Backscatter radar	350

- NASA: 14 missions, in three timed phases
- NOAA: 3 missions, in two timed phases

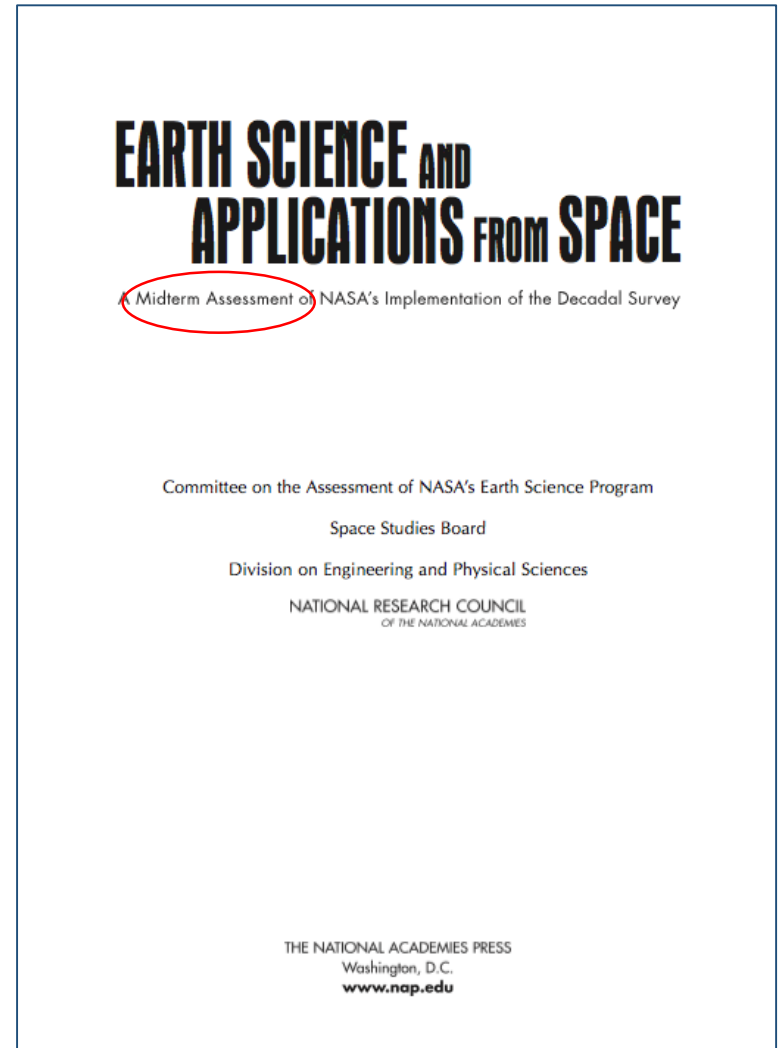
ESAS 2007 Mid-Term Guidance

FINDING

NASA responded favorably and aggressively to the 2007 decadal survey, embracing its overall recommendations for Earth observations, missions, technology investments, and priorities for the underlying science.

As a consequence, the **science and applications communities have made significant progress** over the past 5 years.

Along with more detailed Findings and Recommendations



ESAS 2017 Approach

- **PURPOSE** Respond to Statement of Task
- **ORGANIZATION** Steering Committee and five panels (100 members total)
- **SCHEDULE**
Start: August 2015
Finish: December 2017
- **COMMUNITY INPUT**
Website
Open sessions at committee meetings
White papers: 288 regarding science themes, approaches
- **ACADEMY ROLES**
Space Studies Board (lead)
Board on Atmospheric Sciences and Climate
Board on Earth Sciences and Resource
Ocean Studies Board
Polar Research Board
Water Sciences and Technology Board
- **REPORT THEME** To be decided, building from prior themes (1980's: Earth as a System, 2000's: Societal Benefits)

ESAS 2017 Statement of Task

- A Statement of Task, negotiated by the National Academies with the sponsoring agencies (NASA, NOAA, USGS), defines what will be done in the report. Key elements include:
 - **Progress.** Assess progress from the 2007 Decadal
 - **Priorities.** Develop a prioritized list of top-level science and application objectives, based on gaps and opportunities in the program of record and guided by feasibility of measurement approaches
 - **Programmatics.** Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. program of Earth observations from space

Steering Committee

Dr. Waleed Abdalati, Co-Chair
University of Colorado Boulder

Dr. William B. Gail, Co-Chair
Global Weather Corporation

Mr. Steven Battel
Battel Engineering

Dr. Stacey W. Boland
Jet Propulsion Laboratory

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University of Miami

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Dr. W. Stanley Wilson
NOAA/NESDIS, Ret.

Steering Committee Staff

Dr. Arthur Charo, Study Director

Ms. Lauren Everett, Program Officer

Dr. Michael Moloney, Director, Space Studies Board

* Antonio Busalacchi, Jr., Co-chair,
resigned May 5, 2016

Molly Macauley, RFF,
passed away on July 8, 2016

Panels

I. Global Hydrological Cycles and Water Resources

Co-Chairs: Jeff Dozier, UC Santa Barbara and Ana Barros, Duke University

The movement, distribution, and availability of water and how these are changing over time

II. Weather and Air Quality: Minutes to Subseasonal

Co-Chairs: Steve Ackerman, University of Wisconsin and Nancy Baker, NRL

Atmospheric Dynamics, Thermodynamics, Chemistry, and their interactions at land and ocean interfaces

III. Marine and Terrestrial Ecosystems and Natural Resource Management

Co-Chairs: Compton (Jim) Tucker, NASA GSFC and Jim Yoder, WHOI

Biogeochemical Cycles, Ecosystem Functioning, Biodiversity, and factors that influence health and ecosystem services

IV. Climate Variability and Change: Seasonal to Centennial

Co-Chairs: Carol Anne Clayson, WHOI and Venkatachalam (Ram) Ramaswamy, NOAA GFDL

Forcings and Feedbacks of the Ocean, Atmosphere, Land, and Cryosphere within the Coupled Climate System

V. Earth Surface and Interior: Dynamics and Hazards

Co-Chairs: Dave Sandwell, Scripps and Doug Burbank, UC Santa Barbara

Core, mantle, lithosphere, and surface processes, system interactions, and the hazards they generate

Comparison to ESAS 2007

- **Prioritization Method.** Prioritize science and applications targets instead of missions
- **Budget Resources.** Align with planned budgets instead of aspirational
- **Large Missions.** Avoid having one recommended activity grow at expense of all others
- **Innovation.** Consider “new space” technology and business ideas
- **Policy.** Existence of recent high-level US government policy guidance regarding Earth observations
- **International.** Increased recognition of important role of international partners

International Opportunities

- Decadal Survey will recognize importance of international collaborations within its recommendations, and identify general opportunities, but won't make specific suggestions
- US agencies determine which international collaborations will be pursued related to Decadal Survey recommendations
- 30 years of US-Japan collaborations on oceans, precipitation, clouds and other areas have been successful and motivate further collaboration

Charting the course for the next decade of Earth observations

nas.edu/esas2017



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