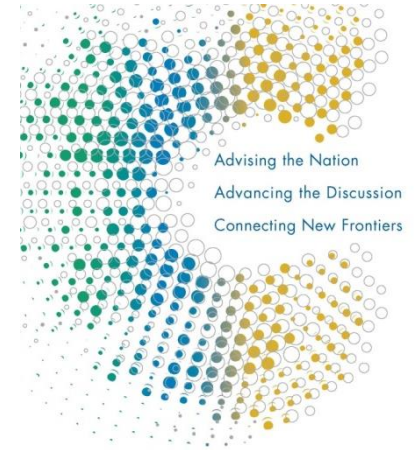


Art Charo
Report to the ESSC
May 23, 2018



- The National Academy of Sciences (NAS) was established on March 3 1863 by Act of Congress, signed into law by President Lincoln in the midst of the Civil War.
- NAS was established to "investigate, examine, experiment, and report upon any subject of science or art" whenever called upon to do so by any department of the government. The National Academy of Engineering (NAE) was established in 1964 and the Institute of Medicine (now the National Academy of Medicine) in 1970. We now call ourselves the **National Academies of Sciences, Engineering, and Medicine**.
- The National Academies provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

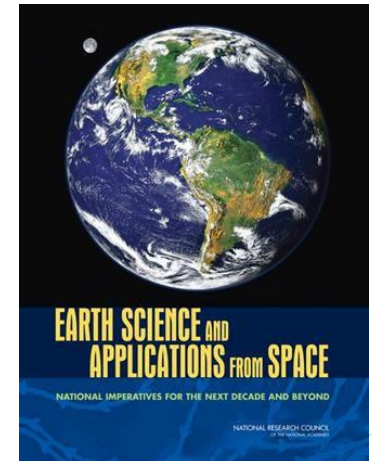
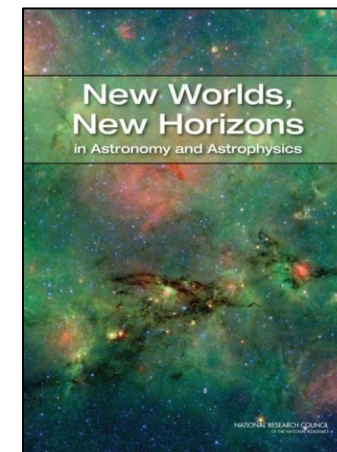
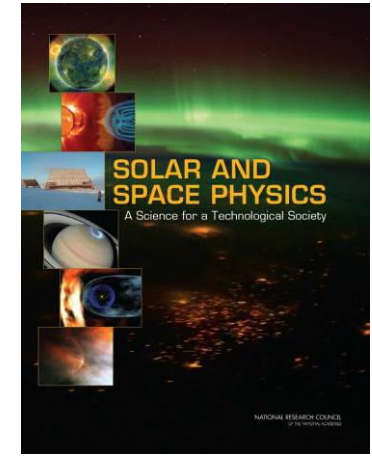
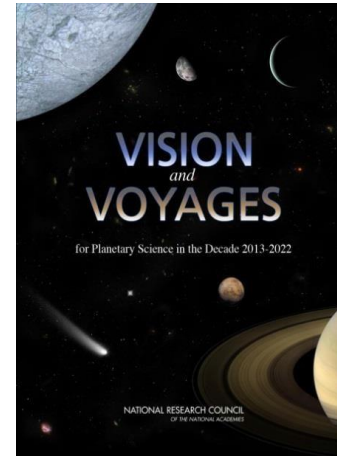
Space at the National Academies

- The **Space Studies Board (SSB)** was established in 1958 to serve as the focus of the interests and responsibilities in space research for the National Academies. The SSB provides an independent, authoritative forum for information and advice on all aspects of space science and applications, and it serves as the focal point within the National Academies for activities on space research. It oversees advisory studies and program assessments, facilitates international research coordination, and promotes communications on space science and science policy between the research community, the federal government, and the interested public. The SSB also serves as the U.S. National Committee for the International Council for Science Committee on Space Research (COSPAR); it exchanges participants with the European Space Sciences Committee; and it is invited to participate as “private partner” in the U.S. delegation to COPUOS. **Its signature product is the decadal survey.**
- The **Aeronautics and Space Engineering Board (ASEB)** was established in 1967 “to focus talents and energies of the engineering community on significant aerospace policies and programs.” In undertaking its responsibility, the ASEB oversees ad hoc committees that recommend priorities and procedures for achieving aerospace engineering objectives, and offers a way to bring engineering and other related expertise to bear on aerospace issues of national importance. Among these issues are: research and development aspects of the Next Generation Air Transportation System (NextGen); NASA’s aeronautics research program; national aeronautics R&D policy and its implementation; space policy and programs, with a focus on human spaceflight and space operations; commercial space activities; and other aerospace engineering topics.



Why Undertake a Decadal Survey?

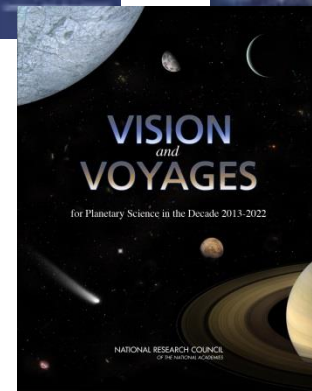
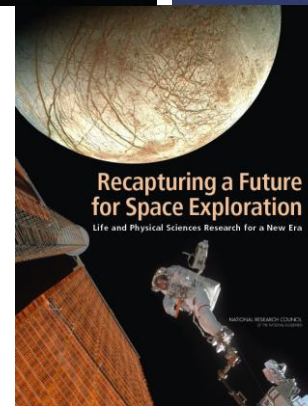
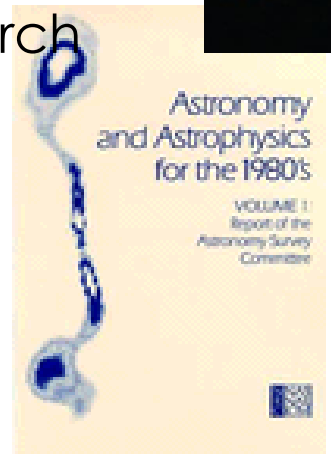
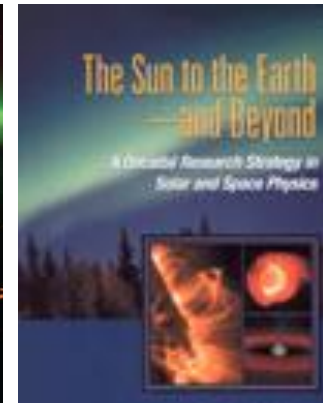
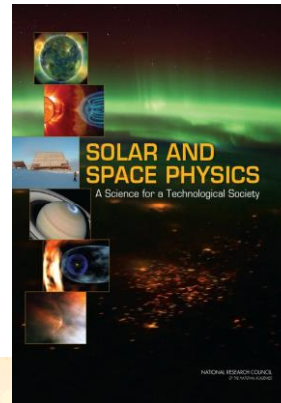
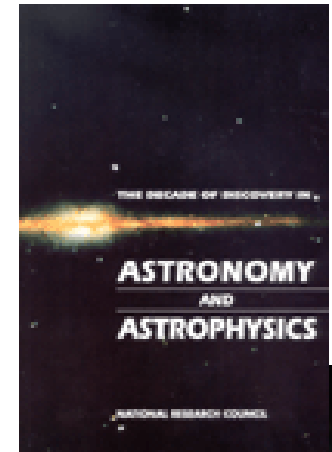
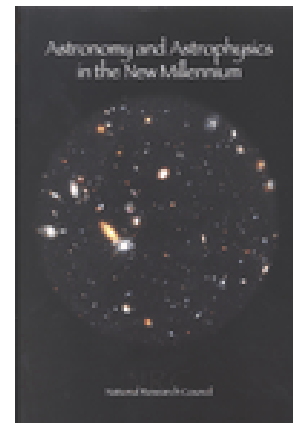
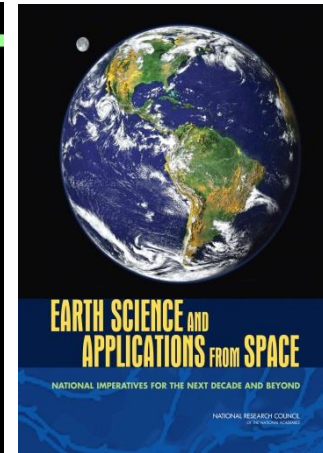
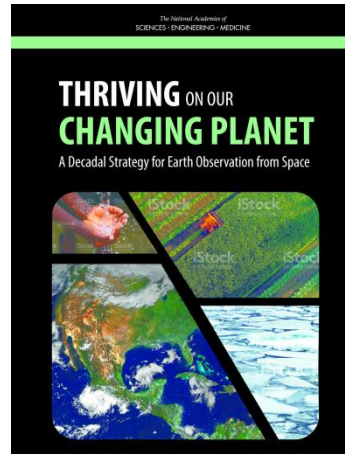
- **Community-led assessment** of the state of knowledge in the field; identify and prioritize questions for the next decade
- Provide **recommendations for programmatic directions** and explicit priorities for government investment in research and facilities, including space flight missions
- **Provide 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

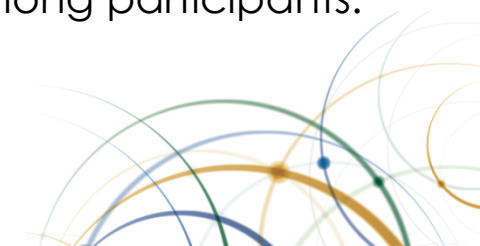
55 Years of NAS Decadal Surveys

- Astronomy and Astrophysics
1963, 1973, 1982, 1991,
2001, 2010, (2020)
- Planetary Science
2003, 2011, (2022)
- Solar and Space Physics
2003, 2012, (2024)
- Earth Science and
Applications from Space
2007, 2017
- Life and Physical Research
in Space
2011



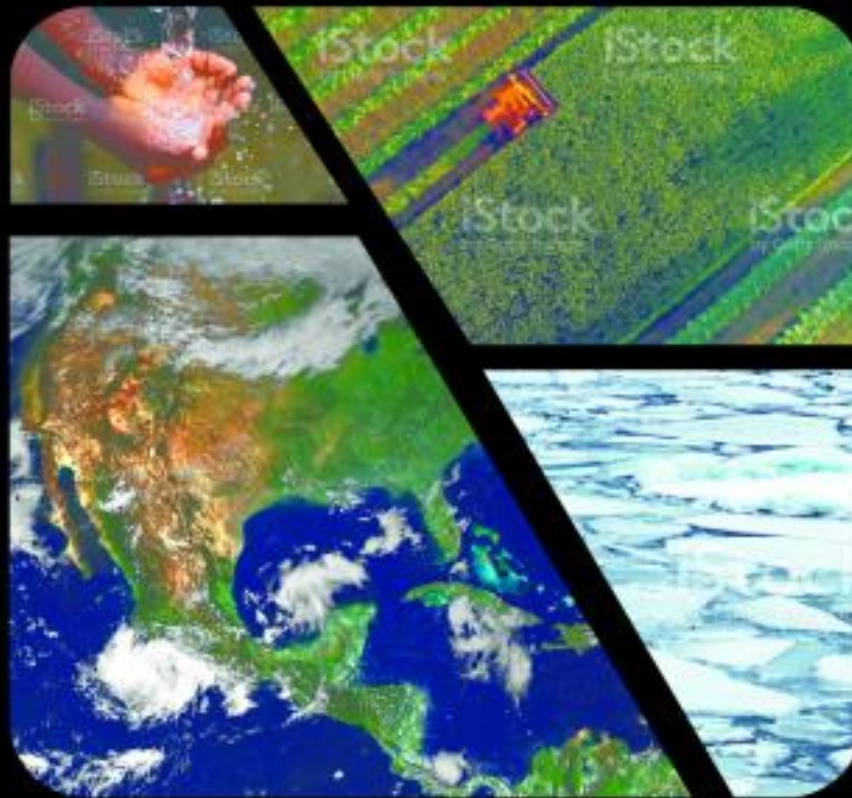
Standing Committees & Roundtables

- The boards devolve detailed oversight responsibilities to its **standing and discipline committees** that provide an **independent, authoritative forum** for identifying and discussing issues in space science between the research community, the federal government, and the interested public. The discipline committees **also monitor the progress in implementation of the recommendations of their respective decadal survey.**
- In fulfilling these responsibilities, the committee may **formulate and oversee ad-hoc studies** related to the implementation of the each survey and on issues in space science more broadly.
- **ASEB Roundtables** convene senior-most representatives from industry, universities, and government agencies to define and explore critical issues related to the space technology and aeronautics research agendas. Roundtables are designed to **facilitate candid dialogue** among participants.



THRIVING ON OUR CHANGING PLANET

A Decadal Strategy for Earth Observation from Space



Report Summary

- Satellite observations of Earth continually transform how we understand our planet, and these measurements are critical for our nation's economy, security, and safety. *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* highlights the ways in which Earth observations are a key part of the nation's information infrastructure and calls for a U.S. program of Earth observations that is robust, resilient, and appropriately balanced.
- Assessing current programs and future needs, the report recommends undertaking a series of measurements to address key aspects of the atmosphere, ocean, land, and ice with the goal of furthering our understanding of climate, weather, sea level rise, ecosystem health, and ocean circulation.
- The report recommends the creation of new program lines within NASA's Earth Science Division and discusses technology on-ramps, the use of commercial data providers, international cooperation, and other ideas to make optimal use of limited resources for the research and operational satellite programs of NASA, NOAA, and the U.S. Geological Survey.



Statement of Task

OVERARCHING TASKS

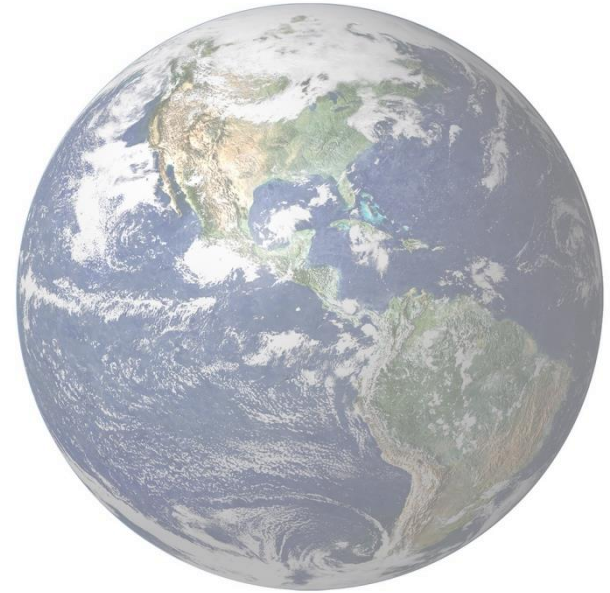
- Assess **progress from 2007**
- Develop a prioritized list of top-level **science and application objectives** for 2017-2027
 - Prioritize objectives, not missions
- Identify gaps and opportunities in the **programs of record** at NASA, NOAA, and USGS
- Recommend approaches to facilitate the development of a robust, resilient, and appropriately balanced U.S. **program of Earth observations from space**

GENERAL & AGENCY-SPECIFIC TASKS

- Cross-Agency
 - Enabling activities
 - Partnerships & synergies
- NASA
 - Program balance and scope
 - Ventures flight element
 - Decision principles and measurement continuity
- NOAA and USGS
 - Non-traditional observation sources
 - On-ramp of scientific advances
 - Research-to-operations
 - Technology replacement/infusion

The Decade Ahead

Thriving on Our Changing Planet



A decade in which we find growing community and public recognition of:

- Society's broad reliance on Earth information to **thrive**
- The growing challenge of understanding and predicting a moving target, as Earth **change** happens around us through natural and human influence



International Opportunities

The Decadal Survey recognized the critical importance of international collaborations within its recommendations. Current and planned European Earth Observation programs (Earth Explorers, Copernicus-Sentinel missions, MetOp) and the Earth Observation programs carried out by JAXA, ISRO and others informed survey recommendations. They are *critical* elements of the baseline Program of Record. The Survey identified general opportunities for additional cooperation, but leaves it to the U.S. agencies to determine which collaborations to pursue.

- **Recommendation 4.5:** Because expanded and extended international partnerships can benefit the nation:
 - NASA should consider enhancing existing partnerships and seeking new partnerships when implementing the observation priorities of this Decadal Survey.
 - NOAA should strengthen and expand its already strong international partnerships, by a) coordinating with partners to further ensure complementary capabilities and operational backup while minimizing unneeded redundancy; and b) extending partnerships to the more complete observing system life-cycle that includes scientific and technological development of future capabilities.
 - USGS should extend the impact of the Sustainable Land Imaging (SLI) program through further partnerships such as that with the European Sentinel program.

Quick Summary of Recommendations

SCIENCE & APPLICATIONS

Address **35 key science/applications questions**, from among hundreds suggested.

Those with objectives prioritized as “most important” fell into **six categories**:

- Coupling of the Water and Energy Cycles
- Ecosystem Change
- Extending & Improving Weather and Air Quality Forecasts
- Sea Level Rise
- Reducing Climate Uncertainty & Informing Societal Response
- Surface Dynamics, Geological Hazards and Disasters

OBSERVATIONS

Augment the **Program of Record** to enable **eight priority observables**:

- **Five** to address observables essential to the overall program; implemented via cost-capped medium- and large-size missions:
 - *Aerosols*
 - *Clouds, Convection, & Precipitation*
 - *Mass Change*
 - *Surface Biology & Geology*
 - *Surface Deformation & Change*
 - **Three** cost-capped medium-size Explorers selected competitively from among six candidates. In addition, add new program elements for:
 - Incubation (technology development)
- A new program element for sustained observations.



Recommended NASA Priorities: Designated

TARGETED OBSERVABLE	SCIENCE/APPLICATIONS SUMMARY	CANDIDATE MEASUREMENT APPROACH	Designated	Explorer	Incubation
Aerosols	Aerosol properties, aerosol vertical profiles, and cloud properties to understand their direct and indirect effects on climate and air quality	Backscatter lidar and multi-channel/multi-angle/polarization imaging radiometer flown together on the same platform	X		
Clouds, Convection, & Precipitation	Coupled cloud-precipitation state and dynamics for monitoring global hydrological cycle and understanding contributing processes	Radar(s), with multi-frequency passive microwave and sub-mm radiometer	X		
Mass Change	Large-scale Earth dynamics measured by the changing mass distribution within and between the Earth's atmosphere, oceans, ground water, and ice sheets	Spacecraft ranging measurement of gravity anomaly	X		
Surface Biology & Geology	Earth surface geology and biology, ground/water temperature, snow reflectivity, active geologic processes, vegetation traits and algal biomass	Hyperspectral imagery in the visible and shortwave infrared, multi- or hyperspectral imagery in the thermal IR	X		
Surface Deformation & Change	Earth surface dynamics from earthquakes and landslides to ice sheets and permafrost	Interferometric Synthetic Aperture Radar (InSAR) with ionospheric correction	X		



Recommended NASA Priorities: Explorer

TARGETED OBSERVABLE	SCIENCE/APPLICATIONS SUMMARY	CANDIDATE MEASUREMENT APPROACH	Designated	Explorer	Incubation
Greenhouse Gases	CO₂ and methane fluxes and trends , global and regional with quantification of point sources and identification of source types	Multispectral short wave IR and thermal IR sounders; or lidar**		X	
Ice Elevation	Global ice characterization including elevation change of land ice to assess sea level contributions and freeboard height of sea ice to assess sea ice/ocean/atmosphere interaction	Lidar**		X	
Ocean Surface Winds & Currents	Coincident high-accuracy currents and vector winds to assess air-sea momentum exchange and to infer upwelling, upper ocean mixing, and sea-ice drift.	Radar scatterometer		X	
Ozone & Trace Gases	Vertical profiles of ozone and trace gases (including water vapor, CO, NO ₂ , methane, and N ₂ O) globally and with high spatial resolution	UV/IR/microwave limb/nadir sounding and UV/IR solar/stellar occultation		X	
Snow Depth & Snow Water Equivalent	Snow depth and snow water equivalent including high spatial resolution in mountain areas	Radar (Ka/Ku band) altimeter; or lidar**		X	
Terrestrial Ecosystem Structure	3D structure of terrestrial ecosystem including forest canopy and above ground biomass and changes in above ground carbon stock from processes such as deforestation & forest degradation	Lidar**		X	
Atmospheric Winds	3D winds in troposphere/PBL for transport of pollutants/carbon/aerosol and water vapor, wind energy, cloud dynamics and convection, and large-scale circulation	Active sensing (lidar, radar, scatterometer); passive imagery or radiometry-based atmos. motion vectors (AMVs) tracking; or lidar**		X	X



Current SSB Membership

Fiona Harrison, Chair, California Institute of Technology	XCOM
Robert D. Braun, Vice Chair, University of Colorado Boulder (LEAVING BOARD JUNE 2018)	XCOM
James G. Anderson, Harvard University (FINAL TERM ENDS JUNE 2018)	
Jeff M. Bingham, Consultant	XCOM
Jay C. Buckey, Geisel School of Medicine, Dartmouth University	
Adam Burrows, Princeton University	
Mary Lynne Dittmar, Coalition for Deep Space Exploration	
XCOM	
Joseph Fuller Jr., Futron Corporation	
Thomas R. Gavin, California Institute of Technology (FINAL TERM ENDS JUNE 2018)	
Sarah Gibson, National Center for Atmospheric Research	XCOM
Victoria Hamilton, Southwest Research Institute	
Anthony C. Janetos, Boston University (FINAL TERM ENDS JUNE 2018)	XCOM
Chryssa Kouveliotou, The George Washington University	XCOM
Dennis P. Lettenmaier, University of California, Los Angeles	
Rosaly M. Lopes, Jet Propulsion Laboratory	XCOM
David J. McComas, Princeton University	
Larry Paxton, Johns Hopkins University, Applied Physics Laboratory	
Eliot Quataert, University of California, Berkeley	
Barbara Sherwood Lollar, University of Toronto	
Harlan E. Spence, University of New Hampshire	
Mark H. Thiemens, University of California, San Diego	



Triennial Review of the Space Studies Board

- Review Committee: Claude R. Canizares (NAS), MIT, chair; Mark R. Abbott, Woods Hole Oceanographic Institution; Marc S. Allen, NASA (ret.); Laurie A. Leshin, Worcester Polytechnic Institute
- The review committee solicited reviews from 27 individuals; input received from 14. Reviews represented perspectives of former board members, former chairs or co-chairs of SSB committees, current and former sponsors, and leaders from the domestic and international space community.
- The reviews were very complimentary. Multiple reviewers praised the quality, impact, and professionalism of the SSB. Decadal studies received special praise.
- Only a few identified issues of possible concern.



Recommendations

- Study Process: The SSB should continue to explore ways to reduce/shorten the timeline of its studies to the extent possible without compromising the integrity of the process.
 - An issue across the Academy.
- Cost Estimating: There may be value in continuing to strengthen the cost estimating process prior to and during decadal studies.
 - A one-day NASA-sponsored “meeting of experts” to review the CATE process was earlier this month.
- Diversity: SSB should consider including even more diversity among its membership and the membership of its committees. In particular, there may be value in engaging more people from new commercial space entities and younger, respected members of the community.



A Report by a Panel of the
NATIONAL ACADEMY OF PUBLIC ADMINISTRATION
for the National Academies of Sciences, Engineering, and Medicine

**Improving the National Research Council's Study
and Administrative Processes:
An Independent Review**



The National
Academies of

SCIENCES
ENGINEERING
MEDICINE

The National
Academies of

SCIENCES
ENGINEERING
MEDICINE



NATIONAL ACADEMY OF
PUBLIC ADMINISTRATION®

December 2017



Selected Projects and Other Activities of the Space Studies Board

SSB website has full listing and details:
<http://sites.nationalacademies.org/SSB>



Completed SSB Projects

Consensus Studies

- A Midterm Assessment of Implementation of the Decadal Survey on Life and Physical Sciences Research at NASA
- Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space (“ESAS 2017”)

Workshop Proceedings

- America's Future in Civil Space: Proceedings of a Workshop in Brief

All SSB/ASEB publications are available for free download at:

The National Academies of SCIENCES ENGINEERING MEDICINE
www.nationalacademies.org/spaceandaeronautics



Selected SSB Projects Underway

- Astrobiology Science Strategy for the Search for Life in the Universe
 - A study of the state of the science of astrobiology as it relates to the search for life in the solar system and extrasolar planetary systems
- Best Practices for a Future Open Code Policy for NASA Space Science
 - Investigate and recommend best practices for NASA as it considers whether to establish an open code and open models policy, complementary to its current open data policy.
- Exoplanet Science Strategy
 - Input to the upcoming decadal surveys in astronomy and astrophysics and planetary science
- Extraterrestrial Sample Analysis Facilities
 - To prepare for the analysis of diverse extraterrestrial samples in the coming decade
- Planetary Protection Requirements for Sample-Return Missions from Martian Moons
 - Review and assess recent research sponsored by NASA and ESA
- Review of Planetary Protection Policy Development Processes
 - How to assure the planetary protection policy process is supportive of future scientific and societal interests, as well as spaceflight missions.
- Review of Progress Toward Implementing the Decadal Survey Vision and Voyages for Planetary Sciences



Projects in Prep (various stages)

- Review of Progress Toward Implementing the Decadal Survey Vision in Solar and Space Physics: A Science for a Technological Society
 - Midterm assessment of the 2012 decadal survey in heliophysics
- ASTRO 2020
 - The next decadal survey in Astronomy and Astrophysics
- Study on Future of NOAA Satellite Systems and Data and National Weather Survey “Decadal Study”
- Study on international cooperation
- Data Analytics on earth observational data
- Near-Earth Objects; Survey and Mitigation
- Space Traffic Management



Space Science Week 2018

March 27-29, 2018

- Five Discipline Committees met in plenary and parallel sessions.
- Plenary session focus on international collaboration
- Fifth Annual Space Science Week Public Lecture--The Gravitational Wave Astronomical Revolution
 - Dr. David Reitze, Executive Director of the LIGO Project, CalTech
- ESSC liaison have members attended since 2015. We hope we can continue having a liaison to each of the standing committees attend future SSW's
- More Information at www.nas.edu/ssw



PLENARY SESSION – Kavli Auditorium

Opening Session

1:00 PM	Welcome	Fiona Harrison, SSB Chair
1:05 PM	Quick Update on Current SSB Activities	Dick Rowberg, Interim SSB Director

Focus Session on NASA Science Program

1:15 PM	NASA-SMD Budget, Program, and Priorities <i>Presentation 20 mins / Q&A 25 mins</i>	Thomas Zurbuchen, NASA
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Focus Session on International Collaboration – Program Briefs

2:00 PM	Short 15-minute Talks From Agency Representatives <ul style="list-style-type: none">• ESA Space Science – Fabio Favata, ESA-SCI• ESA Human and Robotic Exploration – David Parker, ESA-HRE• ESA Earth Observation Programs - Status and Future Challenges – Maurice Borgeaud, ESA-EO• Chinese Academy of Sciences: Current and Future Programs – Ji Wu, CAS National Space Science Center• JAXA Institute of Space and Astronautical Science – Hitoshi Kuninaka, JAXA-ISAS Deputy Director General• JAXA ISAS Research – Masaki Fujimoto, JAXA-ISAS Research	
3:30 PM	<i>Break, food available in the Great Hall</i>	

Focus Session on International Programs – Discussion on Collaboration

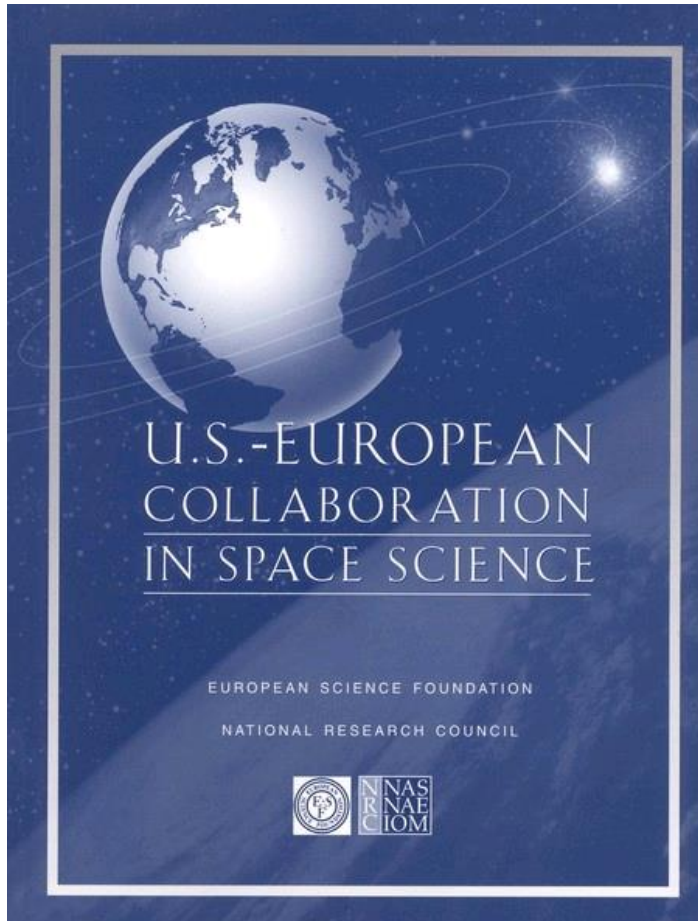
4:00 PM	Personal Perspective on State of International Collaboration: Len Fisk, President of COSPAR	
4:15 PM	Moderated Q&A Sessions with NASA, COSPAR and International Agency Representatives	Moderator: Fiona Harrison, SSB Chair
5:30 PM	Closing Comments <i>Public Meeting Adjourns</i>	Fiona Harrison, SSB Chair

Standing/Disciplinary Committees

- Committee on Astrobiology and Planetary Science (CAPS)
- Committee on Astronomy and Astrophysics (CAA)
- Committee on Biological and Physical Sciences in Space (CBPSS)
- Committee on Earth Science and Applications from Space (CESAS)
- Committee on Solar and Space Physics (CSSP)

Issues before for these committees discussed during May 2018 meeting of the Space Studies Board; slides available at:

Study on Int'l Cooperation?



- The 1998 SSB-ESSC report reviewed 30 years of space-based research and the historical and political context of U.S.-European cooperation and collaboration in space
- The report is often referenced, but is beginning to show its age. There was also a follow-on SSB-ESSC-Japan workshop on space cooperation.
- Is it time for a follow-on study? Three-way cooperation US-Europe-Japan?

A Sampling of NASA Reactions

- Just a survey of international cooperation activities would not be very interesting.
- Currently, the bulk of NASA's astrophysics missions are international in nature, and 100% of the large missions being studied for the future international.
- A good topic is how to start international missions. WFIRST is not international because of the way it was started – by the Decadal Survey.
- Another topic is strategic missions vs PI-led competed missions. What authority should PIs assume when negotiating with international partners?
- There are several positive and negative planetary examples for international coordination. I expect there are some good lessons learned from the recent MOMA-MS and JUICE experiences.



Additional Ideas

- Analysis of previously successful robotic and science cooperation activities, and how lessons learned from them might be applied to future human cooperation.
- Analysis of the difficulties caused by the different funding cycles used by various programs.
 - Interestingly, a similar issue was highlighted in the 2011 SSB study *Assessment of Impediments to Interagency Collaboration on Space and Earth Science Missions*. That study also identified problems in collaboration among agencies that surpassed those between nations!



Upcoming Meetings

SSB Meetings

~~May 1-3, 2018, Washington DC~~

~~November 7-9, 2018, Irvine, CA~~

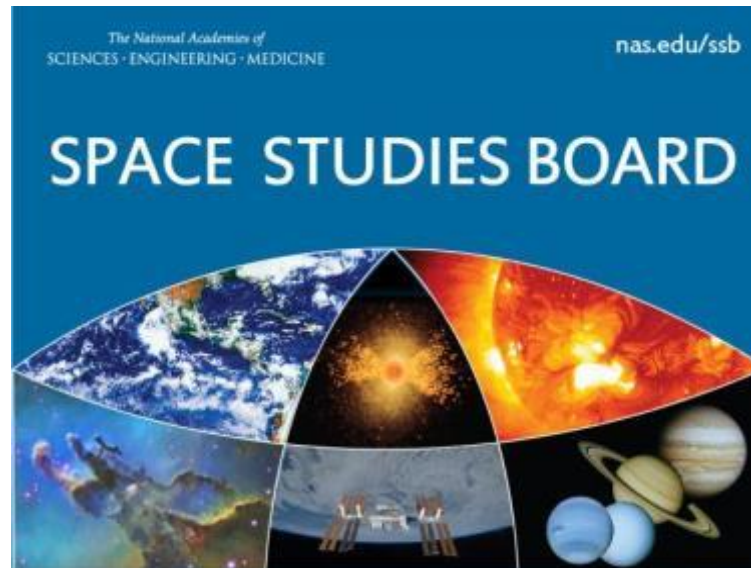
~~April 30 - May 2, 2019, Washington DC~~

~~November 6-8, 2019, Irvine, CA~~

Space Science Week

~~March 27-29, 2018, NAS Building Wash DC~~

~~March 26-28, 2019, NAS Building Wash DC~~



BACKUP SLIDES

Earth Science Decadal



- **BACKUP SLIDES**

- Earth Science Decadal
- Reports from SSB Standing Committees
- Additional Information on the SSB and Academy organization

Earth Information is Increasingly Critical to Thriving on our Planet

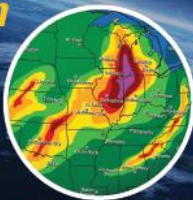
THE IMPORTANCE OF EARTH INFORMATION

Earth-observing satellites provide critical information about our planet. This information supports a broad range of societal needs and enables the scientific discovery required to meet those needs, making us all healthier, safer, and more efficient.

HELPING PLAN OUR DAY

300 billion

weather forecasts used by Americans every year



100+ million

American adults use internet-based mapping services



Americans rely on sophisticated Earth information throughout their everyday lives, from weather forecasts to navigation applications in their cars. Satellites are the original sources of much of the data.

PROTECTING OUR HEALTH

6.5 million

premature deaths from air pollution around the world every year



Earth-observing satellites track the concentration of harmful pollutants across the country, providing air quality data for rural areas without ground-based monitoring systems and measuring the effects of air quality regulations.

50% of the world's population is at risk from malaria.

Satellite observations of temperature, vegetation, and rainfall help predict the spread of mosquito-borne illnesses like malaria, Zika, and West Nile Virus.



KEEPING US SECURE

The estimated value of NASA and NOAA information services to the U.S.

Navy's operational effectiveness is

\$2 billion per year.

The U.S. Navy and other U.S. defense agencies partner with NASA and NOAA to use satellite data, to access operational services, and to leverage their scientific progress.

MITIGATING NATURAL DISASTERS

Extreme weather and fires have cost the federal government

more than \$350 billion over the past decade.

Satellite measurements play a critical role in tracking the paths of hurricanes and wildfires so that we can warn populations at risk, assess the damages, and avoid future costs.



ENSURING RESOURCE AVAILABILITY

Advanced technology, including many types of Earth information,

will unlock up to \$1.6 trillion in economic savings for energy generation and use by 2035.

Satellite observations can also help ensure water availability, which is particularly important to the 20% of the world now living in areas of water scarcity.

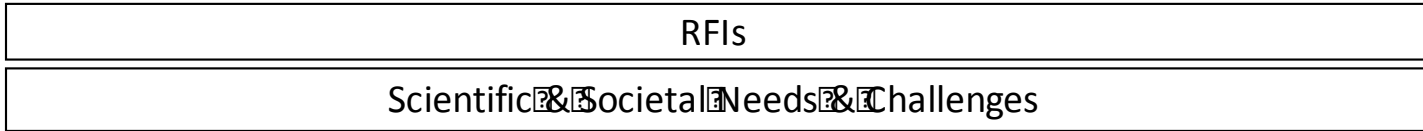


Approach

- **PURPOSE** Respond to Statement of Task
- **ORGANIZATION** Steering Committee and five panels (100 members total)
- **SCHEDULE** *Start:* January 2016
Finish: December 2017
- **COMMUNITY INPUT** Website
Open sessions at committee meetings
White papers: 290 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

Detailed Report Roadmap

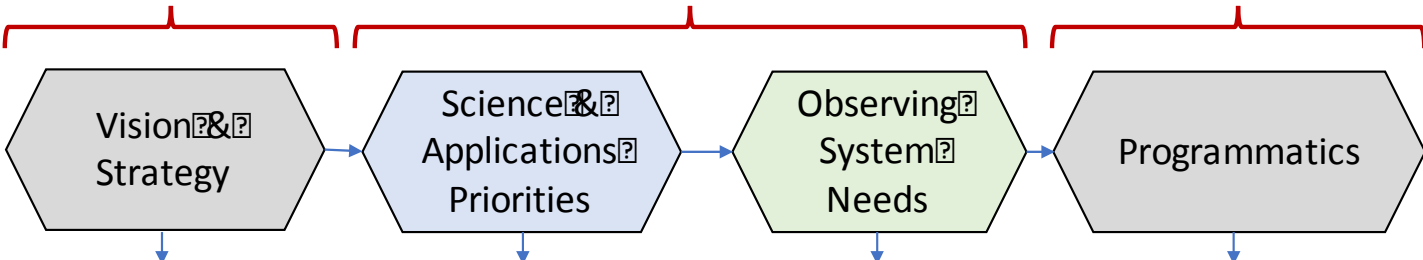
Input



Chapters 1 & 2

Chapter 3

Chapter 4



- Vision Statements
- Strategy Elements

- “Blue Table”: Prioritized Questions & Objectives

- “Green Table”: prioritized Observables (aka “Science Targets”)

- Miscellaneous Findings & Recommendations

Earth Science and Applications Paradigm for the Coming Decade

Earth science and derived Earth information have become an integral component of our daily lives, our business successes, and society's capacity to thrive. Extending this societal progress requires that we focus on understanding and reliably predicting the many ways our planet is changing.

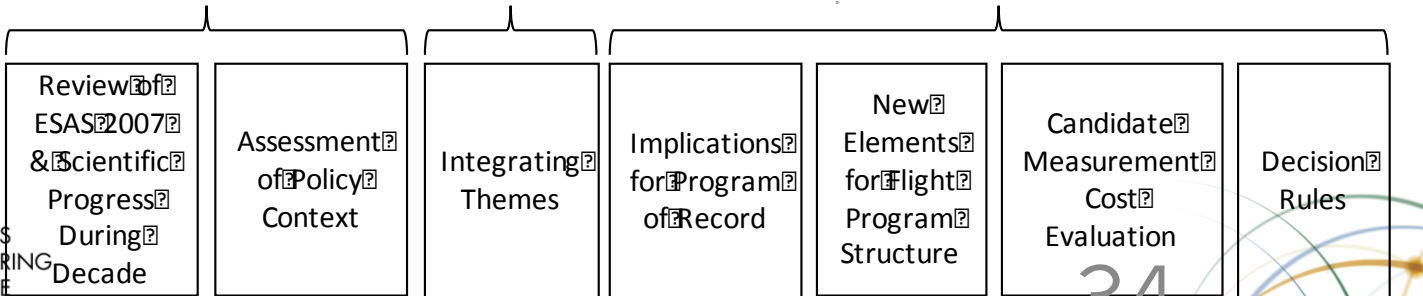
ELEMENTS OF ECADAL STRATEGY
I. Embrace Innovative Multi-Options for Integrated Science Applications
II. Commit to Sustained Science and Applications
III. Amplify the Cross-Benefit of Science and Applications
IV. Leverage External Resources and Partnerships
V. Institutionalize Programmatic Agility and Balance
VI. Exploit External Trends in Technology and User Needs
VII. Expand Use of Competition
VIII. Pursue Ambitious Science, Despite Constraints

Current Science Objectives	Earth Science Applications Objectives	Key Gap Objectives
1. Develop a robust evidence base for the 21st century.	1. Develop a robust evidence base for the 21st century.	1. Develop a robust evidence base for the 21st century.
2. Develop a robust evidence base for the 21st century.	2. Develop a robust evidence base for the 21st century.	2. Develop a robust evidence base for the 21st century.
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9. Develop a robust evidence base for the 21st century.	9. Develop a robust evidence base for the 21st century.	9. Develop a robust evidence base for the 21st century.
10. Develop a robust evidence base for the 21st century.	10. Develop a robust evidence base for the 21st century.	10. Develop a robust evidence base for the 21st century.

Observables	Priority	Measurement	Reporting
1. Global Temperature	High	Global	Annual
2. Sea Level Rise	High	Global	Annual
3. Ocean Acidification	High	Global	Annual
4. Ice Sheet Mass Balance	High	Global	Annual
5. Permafrost Degradation	High	Global	Annual
6. Arctic Sea Ice Extent	High	Global	Annual
7. Antarctic Sea Ice Extent	High	Global	Annual
8. Greenland Ice Sheet Mass Balance	High	Global	Annual
9. Global Precipitation	High	Global	Annual
10. Global Snow Cover	High	Global	Annual

- Finding 4D:** A robust and resilient ESD program has the following attributes:
- A healthy evidence of small/medium missions to provide the community with regular flight opportunities, to leverage advances in technologies and capabilities, and to rapidly respond to emerging science needs.
 - A small number of large cost-constrained missions, whose implementation does not draw excessive resources from smaller and more frequent opportunities.
 - Strong partnerships with U.S. government and non-U.S. space agencies.
 - Complementary programs for airborne, in-situ, and other supporting observations.
 - Periodic assessment of the return on investment provided by each program element.
 - A robust mechanism for trading the need for continuity of existing measurement against new measurements.

Primary Output



Steering Committee*

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

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

Mr. Steven J. Battel
Battel Engineering

Dr. Stacey W. Boland
Jet Propulsion Laboratory

Dr. Robert D. Braun
University of Colorado

Dr. Shuyi S. Chen
University of Miami

Dr. William E. Dietrich
University of California, Berkeley

Dr. Scott C. Doney
Woods Hole Oceanographic Inst.

Dr. Christopher B. Field
Carnegie Institution for Science

Dr. Helen A. Fricker
Scripps Inst. of Oceanography

Dr. Sarah T. Gille
Scripps Inst. of Oceanography

Dr. Dennis L. Hartmann
University of Washington

Dr. Daniel J. Jacob
Harvard University

Dr. Anthony C. Janetos
Boston University

Dr. Everette Joseph
University at Albany, SUNY

Dr. Joyce E. Penner
University of Michigan

Dr. Soroosh Sorooshian
University of California, Irvine

Dr. Graeme L. Stephens
Jet Propulsion Laboratory

Dr. Byron D. Tapley
The University of Texas at Austin

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

Steering Committee Staff

Dr. Arthur Charo, Study Director

Ms. Lauren Everett, Program Officer

Dr. Michael Maloney, Director, Space Studies Board

*Antonio Busalacchi, Jr., co-chair, resigned May 5, 2016; Molly Macauley, passed away 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

ADDITIONAL BACKUP SLIDES



CAA Report

2 May 2018

Marcia Rieke & Steve Ritz CAA Co-Chairs

CAA reports to the BPA and the SSB

Disclaimer: These slides represent a personal assessment of the issues discussed by the CAA. This document should not be cited or quoted because the views expressed do not necessarily reflect those of CAA, SSB, BPA, or the NRC.

CAA Membership

Marcia J. Rieke (NAS), Co-Chair, University of Arizona

Steven M. Ritz, Co-Chair, University of California, Santa Cruz

Jeremiah K. Darling, University of Colorado, Boulder

Megan Donahue, Michigan State University

Thomas Greene, NASA Ames Research Center

Lee W. Hartmann, University of Michigan

Vassiliki Kalogera, Northwestern University

Bruce Macintosh, Stanford University

Christopher F. McKee (NAS), University of California, Berkeley

Angela V. Olinto, University of Chicago

Mark M. Phillips, Carnegie Institution for Science

James M. Stone, Princeton University

Alexey Vikhlinin, Harvard-Smithsonian Center for Astrophysics

Eric M. Wilcots, University of Wisconsin, Madison

A. Thomas Young (NAE), Lockheed Martin (Ret.)

Most recent meeting:
27-29 March, 2018

http://sites.nationalacademies.org/BPA/BPA_048755

CAA Meeting Topics

- A jam-packed agenda!
- Meeting was held during a time of much uncertainty
 - Fluctuating budgets for agencies, outcomes mostly very good
 - Another launch delay for JWST was announced during the meeting, with the launch readiness date being confirmed by a special committee (T. Young)
- Anne Kinney, new head of the NSF Math and Physical Sciences Directorate, met with the Committee. Discussed Mid-decadal recommendation 3-2 on operations funding
- Continued Astro2020 preparations, many discussions, including about timing (again).
- WFIRST responses to WIETR, and next steps.
 - KDP-B was scheduled for April 11, 2018, but will now be May 22, 2018.
- An additional focus of the meeting was another Short Report, this time on the NASA Mission Concept Studies in preparation for the next Astronomy & Astrophysics Decadal.

Astro2020 Preparations

- The latest delay in the JWST launch coupled with the WFIRST issues has re-opened the question of when to start the survey
 - Question posed by T. Zurbuchen: move the Astro Decadal after the Planetary Decadal?
 - Further, timely discussions among the three funding agencies, the NAS, and the astronomical community needed
 - CAA is ready to issue a call for Science White Papers and nearly ready for call on Policy, Infrastructure and “State of the Profession”
- Committee discussed the role of State of the Profession in a decadal survey
 - Excellent feedback from the AAS Town Hall.
 - Very helpful discussions with Dara Norman (NOAO) and Alex Rudolph, Chair of the AAS Diversity and Inclusion Task Force. Discussed types of inputs that can be provided and aspects of the call for white papers.
 - Heard about an NAS event, funded by the Heising-Simons Foundation, to occur in October for early career astronomers to learn about the decadal process. Details at http://sites.nationalacademies.org/SSB/SSB_185166

Mission Concept Studies Report

- NASA tasked the CAA to review its planned mission concept studies (large missions and probe-class missions) activities in preparation for the Decadal Survey and to write a short report.
 - Assess the appropriateness of NASA's plans and, if needed, provide findings toward improving the value to the Decadal Survey Committee.
- Four large mission concept studies are underway with final reports due to NASA HQ in June, 2019
 - NASA will conduct Independent Cost Assessments (but not CATEs)
 - Final reports and ICAs will be submitted to Astro2020
- Ten probe-class concept studies are in progress
 - Studies were selected through a peer-review process
 - Final study reports and ICAs will be produced and can serve as input to Astro2020

See <http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/>

Committee on Earth Science and Applications from Space

Update to the Space Studies Board

Michael King, CESAS Co-Chair

May 2, 2018

Committee Roster

CO-CHAIRS

Michael D. King*
University of Colorado

Joyce E. Penner*
University of Michigan

MEMBERS

Steven A. Ackerman*
University of Wisconsin

Otis Brown
NC State University

Molly E. Brown
University of Maryland

Stacey W. Boland*
Jet Propulsion Laboratory

Efi Foufoula-Georgiou*
UC Irvine

Chelle L. Gentemann*
Earth and Space Research

Everette Joseph
SUNY Albany

R. Steven Nerem
University of Colorado

Eric Rignot
UC Irvine

Christopher S. Ruf
University of Michigan

David L. Skole*
Michigan State University

Steven C. Wofsy*
Harvard University

*Rotating off on June 30; nominees for co-chairs identified and are available to serve, if approved

Meeting during Space Science Week

March 27-29, 2018

- Presentations and updates from
 - NASA (Mike Freilich, Director, Earth Science Division)
 - NOAA (Karen St. Germain, Director, Office of Systems Architecture and Advanced Planning)
 - USGS National Land Imaging Program (Tim Newman and Pete Doucette)
- Briefings on
 - NASA's PACE mission
 - President Trump had proposed cancelation, but Congress continues to support and fund
 - Opportunities for balloons, airships, and UAVs in Earth science research
 - ESAs Earth Science and Copernicus programs
 - NASA's Earth Science Technology Office (ESTO) program
- Briefing by the decadal survey co-chairs on the recently released report, "Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space"
- In closed session
 - Review of a draft of the popularization of the decadal survey (many criticisms)
 - Briefing from "Open Code" study co-chair and CESAS member Chelle Gentemann
 - We also discussed potential candidates to replace departing members
 - Discussion of NASA ESD plans for the Earth System Explorer selections
 - Consensus that HQ should maintain the recommended 3 opportunities (from the 7 overlapping science targets) in coming decade
 - The ESE solicitation should encourage the community to propose innovative solutions that optimize the science and applications return for the investment

Ad-Hoc Studies Under Discussion

- Novel Techniques and Applications for Data Analytics on Earth Observation Data: A Proposed Workshop (joint with NRC Board on Mathematical Sciences and Analytics)
 - Strawman SOT circulated to potential sponsors; to date, most interest at USGS
 - Draws on briefings to CESAS at previous meeting
 - Workshop could help define more focused follow-on consensus study that would make recommendations

Weather Research and Forecasting Innovation Act of 2017

Independent Study On Future Of NOAA Satellite Systems And Data

[NOAA] shall seek to enter into the agreement [by September 30, 2018] with the NAS [for a study on matters concerning future satellite data needs. Study shall:

- (i) develop recommendations on how to make the data portfolio of the Administration more robust and cost-effective;
- (ii) assess the costs and benefits of moving toward a constellation of many small satellites, standardizing satellite bus design, relying more on the purchasing of data, or acquiring data from other sources or methods;
- (iii) identify the environmental observations that are essential to the performance of weather models, based on an assessment of Federal, academic, and private sector weather research, and the cost of obtaining the environmental data;
- (iv) identify environmental observations that improve the quality of operational and research weather models in effect on the day before the date of enactment of this Act;
- (v) identify and prioritize new environmental observations that could contribute to existing and future weather models; and
- (vi) develop recommendations on a portfolio of environmental observations that balances essential, quality-improving, and new data, private and nonprivate sources, and space-based and Earth-based sources

Weather Research and Forecasting Innovation Act of 2017 (continued)

- Likely to be folded into a “weather decadal” that is being requested of BASC by NOAA National Weather Service
- Timeline: Act calls for study request by September 30, 2018 and Academy report within following 2 years

Preliminary Thinking for Fall Meeting

- NASA's response to NAS committee on open code report, which should be out this Summer
 - With report just out, useful to hear from everyone on the committee and NASA about how to best move forward based on any recommendations the report makes
- NASA cloud computing progress (progress on moving data to cloud, initial reactions and lessons learned)
 - Useful to hear from NOAA on same topic
- Discussion of how DAACs are going to evolve as data moves onto cloud, how will their roles change?
- Another discussion on Decadal Survey, now with more time for NASA to digest its recommendations

Committee on Solar and Space Physics Update

Co-Chairs: Sarah Gibson and Maura Hagan*

Members: Brian Anderson, Steve Battel, Yue Deng, Stephen Fuselier, Todd Hoeksema, Mary Hudson, Robyn Millan, Tai Phan, Jiong Qiu, Josh Semeter, Howard Singer, Leonard Strachan, Barbara Thompson, Gary Zank

Staff: Abigail Sheffer, Sarah Brothers, and Anesia Wilks

*These slides are Hagan's personal assessment of issues discussed during recent CSSP meetings; should not be cited or quoted; these views do not reflect those of the CSSP, SSB, or NRC.

Topics

- NASA Heliophysics Division Leadership Changes
- Other Issues that Bear Watching
- Recent Space Weather Advances

Recent NASA Heliophysics Division Personnel Changes

Division Leadership:

- Heliophysics Division Director – Nicky Fox to start August 2018
- Acting Chief Scientist – Jim Spann* (on detail from MSFC)

Assignments:

- Mona Kessel – on detail to GSFC since Jan 2018

New Faces:

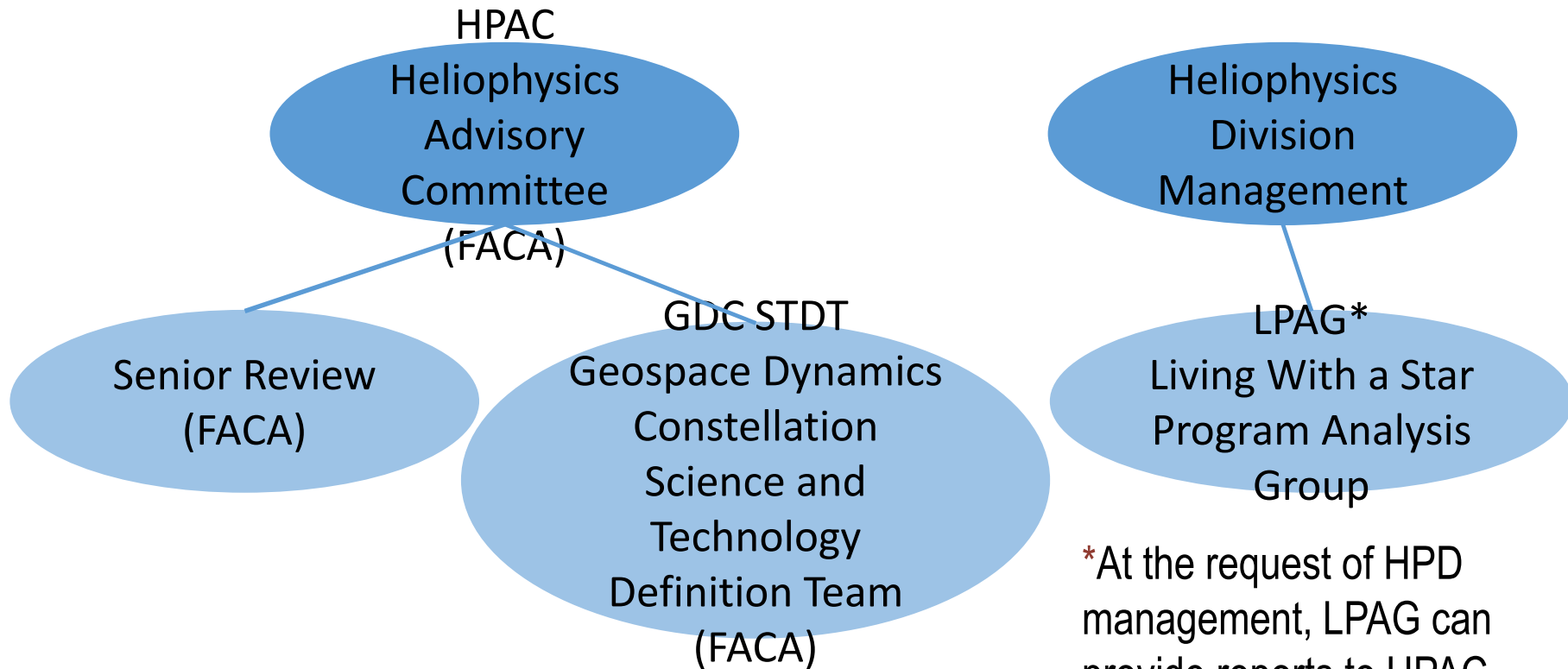
- Terry Onsager – on detail from NOAA/SWPC
- Roshanak Hakimzadeh – on detail from GRC
- Bill Atkinson – on detail from KSC

*Replaces Dr. Elsayed R. Talaat who is now the Director of the Office of Projects, Planning, and Analysis (OPPA) for NOAA's Satellite and Information Service.

Other Issues that Bear Watching

- Upcoming launches
 - Parker Solar Probe - July 2018
 - Ionospheric Connection Explorer - June 2018
 - Space Environment Testbed – June 2018
- Flagship mission delay
 - Geospace Dynamics Coupling constellation (LWS-7) mission formulation shifted from FY 2018 to FY 2019-20
- Daniel K. Inouye Solar Telescope
 - Construction 83% complete as of 31 January 2018
 - Readiness of first-light instruments in 2020
 - Optics, Instrument Integration and Commissioning through 2019
- New Heliophysics Division Advisory Structure

New NASA Heliophysics Division Advisory Structure



FACA meeting requirements:


- Public meeting announcements 30 days in advance
- Requires members become Special Government Employees
 - Ethics training and financial disclosure forms
 - US Citizenship

*At the request of HPD management, LPAG can provide reports to HPAC

New & Noteworthy Interagency Space Weather Collaborations

- NASA and NSF
 - Some DRIVE* Science Centers may implement Space Weather relevant efforts
 - Statement of work to support a benchmarking workshop & community report
- NASA-NSF-NOAA – New pilot O2R research activity
 - \$1.5M with equal contributions from each organization
 - Research focus - improve forecasts of solar wind and coronal mass ejections
 - Proposals were due March 30

26 April 2018 Hearing before the U.S. House of Representatives Joint Subcommittees on Space and Environment of the Committee on Science, Space, and Technology: *Surveying the Space Weather Landscape*

- <https://docs.house.gov/Committee/Calendar/ByEvent.aspx?EventID=108217>
- Witnesses
 - Neil Jacobs (Assistant Secretary of Commerce for Environmental Observation and Prediction, NOAA)
 - Jim Spann (Acting Chief Scientist, Heliophysics Division, NASA)
 -  Sarah Gibson (Sr. Scientist, National Center for Atmospheric Research; CSSP Co-Chair)
 - W. Kent Tobiska (President and Chief Scientist, Space Environment Technologies)
- House space weather bill (H.R.3086) introduced in June 2017 by Mr. Perlmutter (CO), Ms. Johnson (TX), and Mr. Bridenstine (OK)
- Sarah testified, “Legislation is needed now.”

Backup Slides

March 2018 CSSP Meeting Summary

CSSP March 2018 Space Science Week Meeting Highlights

- Agency Briefings
 - NASA Heliophysics Division – Peg Luce
 - NSF Geospace Section – Mike Wiltberger
 - NSF Astronomy Division – Dave Boboltz
 - NOAA Space Weather Prediction Center – Bill Lapenta
- Report from NASA Heliophysics Advisory Committee – Jill Dahlburg
 - Inaugural Meeting 29 November – 01 December 2017
- Mid-Term Review of Decadal Survey
 - Statement of Task Revision
 - Expect June 2018 start
- Virtual Tour of Parker Solar Probe Satellite – Nicky Fox

Highlights - NASA Heliophysics Division - FY19 Budget Request

- Future Mission Funding
 - Up to two SMEX missions and up to two MoOs from SMEX 16 AO
 - Addition of a Tech Demo MoO (2nd MoO), and an Evolved Expendable Launch Vehicles (EELV) Secondary Payload Adapter (ESPA) ring to IMAP (STP-5) mission
 - GDC (LWS-7) mission formulation shifted from FY 2018 to FY 2019-20
- R&A Augmentation:
 - Space Weather, CubeSats/SmallSats, Technology Investment, Early Career Investigator Program
 - Wallops Research Range for facility upgrades and maintenance
- Launch Readiness Date Changes for Missions in development
 - ICON was: October 2017 is: no earlier than June 14, 2018
 - SET was: January 2018 is: no earlier than June 2018
 - Solar Orbiter was: October 2018 is: February 2020

Highlights - NASA Heliophysics Division - Space Weather Augmentation

- Working with NSF
 - Co-funding Community Coordinated Modeling Center (CCMC) facility
 - Co-funding Living With a Star Strategic Capabilities
 - NASA-NSF opportunity with multiple NSF Divisions focused on Computational Aspects of Space Weather
- NASA-NOAA MOU - Collaboration between CCMC and NOAA/SWPC on space weather modeling capability
- NASA-NSF-NOAA - Pilot O2R research activity
 - \$1.5M with equal contributions from each organization
 - NASA-NOAA funding available through ROSES 17
- Some DRIVE Science Centers may implement Space Weather relevant efforts

Highlights - NASA Heliophysics Division – ROSES 18

- ROSES18 HTIDeS restructured
 - Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP) and Instrument and Technology Development (ITD) elements expanded selections via the Diversify, Realize, Integrate, Venture, Educate (DRIVE) initiative
 - Research and Technology (R&T) Flight Program; in-line with NPR7120.8
 - Split LCAS → CubeSats and all sub-orbitals
 - R&T Prime (> \$3.5M total cost) → Mandatory formulation study with down-select
- New Elements included in ROSES18 release:
 - B.8 GOLD and ICON Guest Investigator (TBA)
 - B.9 H Grand Challenges Research - Science Centers (TBA)
 - B.10 H Early Career Investigator Program
 - B.12 H Space Weather Operations to Research

Highlights - NASA Heliophysics Division – Technology Development

- Created a dedicated SmallSat activity within H-TIDeS (Heliophysics Technology and Instrument Development for Science) for SmallSat investigations; separated from LCAS with approximately double the cost cap
- 18 Total HPD CubeSat investigations have been selected to date
 - One HPD CubeSat mission complete – MinXSS
 - Five HPD CubeSats scheduled for launch in 2018
- 2018 Sounding Rocket Launch Manifest
 - 22 NASA missions + four reimbursable missions
- Selections of new missions to begin in 2018
 - Five HPD CubeSat
 - 15 HPD Suborbital; (13 Sounding Rockets, 2 Balloons)

Highlights - NSF Geospace Section Update

- FY2019 President's Budget Request
 - NSF overall -0.4% (with respect to FY2017 enacted)
 - Atmospheric and Geospace Science Division → -5.6%
 - "10 Big Ideas" \$282M → 5% research & related activity reductions across Directorates
- Facilities Update
 - 5-year award for operations of Arecibo Observatory to consortium led by University of Central Florida with Universidad Metropolitana and Yang Enterprises, Inc.
 - \$14.3M in disaster relief funding for Arecibo Observatory repairs
 - Support for Sondrestrom Incoherent Scatter Radar Operations ended on March 31
- Support for SWORM (Space Weather Operations, Research, & Mitigation)
 - Statement of work to support a Benchmarking workshop & community report (w/ NASA)
 - RFI to gather community input on research priorities for space weather closed on April 6
 - Tri-agency O2R pilot program (with NASA & NOAA)

Highlights - NSF Astronomy Division Update

- FY2018 NSF Appropriations
 - NSF overall up 4%; MREFC fully funded, including construction of the Daniel K. Inouye Solar Telescope (DKIST) and Large Synoptic Survey Telescope (LSST)
- DKIST
 - Construction 83% complete; \$324.5M NSF funding to date
 - Remote Office Building in Pukalani scheduled for completion in April 2018
 - National Solar Observatory sponsored 6 Critical Science Plan Workshops (11/17-5/18)
- NSO Divestitures – 2012 Portfolio Review Recommendations
 - Sacramento Peak: New Mexico State University to lead consortium and operate the Dunn Solar Telescope and Visitor Center (NSF bridge and State of New Mexico funding)
 - Kitt Peak: McMath-Pierce in flux – no viable proposals; back-up plan may involve NOAO Visitor Center; vacuum tower deconstruction under investigation
- GONG upgrade ongoing; engineering site relocated to Boulder, CO

Highlights – NOAA Space Weather Prediction Center Update - 1

First Operational Coronagraph

- FY17&18 funds towards NRL Compact CORonagraph (CCOR) development
- CCOR In Phase B
- NRL Preliminary Design Review 9/28/18
- Possible deployment on GOES U 2024

Space Weather Forward Observatory (SWFO)

- Partnership under consideration with NASA to fly separate solar wind monitor with IMAP launch 2024
- NESDIS Office of Planning, Projects and Analysis (OPPA, led by Elsayed Talaat) developing path forward

Highlights – NOAA Space Weather Prediction Center Update - 2

Space Weather Models

- Major upgrades to WSA-Enlil Heliospheric Model in 2018 (USAF partnership)
- Current Geospace Model focus on regional validation of storm predictions
- Validating total electron content coupled whole atmosphere model and ionospheric plasma electrodynamics (WAM-IPE) model predictions with GloTEC data driven assimilative model
- Experimental Geoelectric Field Model computed from ground-based magnetometer data and ground-conductivity maps

Coordinated Interagency Space Weather Research Funding

- Joint NASA/NOAA pilot funding opportunity (National Space Weather Action Plan)
- Research focus - improve forecasts of solar wind and coronal mass ejections
- Proposals were due March 30

Potential Topics for Next CSSP Short Report

- Missions studies in advance of the next Decadal Survey
 - Actions taken since previous DS → What has been done? What can be done?
 - Candidate areas for future studies
 - Constellation missions → cost of scale-up
 - Smaller class mission accomplishments
- Space Weather, including O2R
 - Pressing need
 - O2R metrics
 - Draw from expertise in other disciplines
 - Validation
 - Benchmark - what is accomplished → next steps

Overview of Recent CAPS Meeting

Christopher House
and Bill McKinnon

CAPS Co-chairs

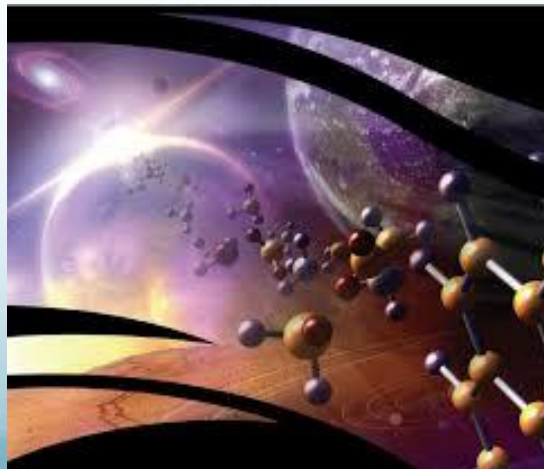
SSB Meeting May. 2, 2018

Committee on Astrobiology and Planetary Science

- Bill McKinnon, Wash. U.,
Planetary Science, Co-Chair
- Christopher House, Penn
State, Astrobiology, Co-Chair
- Erik Asphaug, ASU
- Sushil Atreya, U. Michigan
- Ronald Breaker, Yale
- John Clarke, Boston
University
- Bethany Ehlmann, Cal Tech
- Alexander Hayes, Cornell
- Sarah Horst, Johns Hopkins
- James Kasting, Penn State
- Edwin Kite, U. of Chicago
- Alyssa Rhoden, ASU
- Nita Sahai, U. of Akron
- Mark Saunders
- David Stevenson, Cal Tech

Astrobiology & Planetary Science Status Presentations

- Planetary Science Division James Green
- Astrobiology Program Mary Voytek
- NSF Planetary Astronomy Faith Vilas
- Large Synoptic Survey Telescope Nigel Sharp
- VEXAG Status Update Martha Gilmore
- Planetary Protection (x3) Pratt, Coustenis, Neal
- Europa Clipper & Europa Lander Pappalardo, Hand



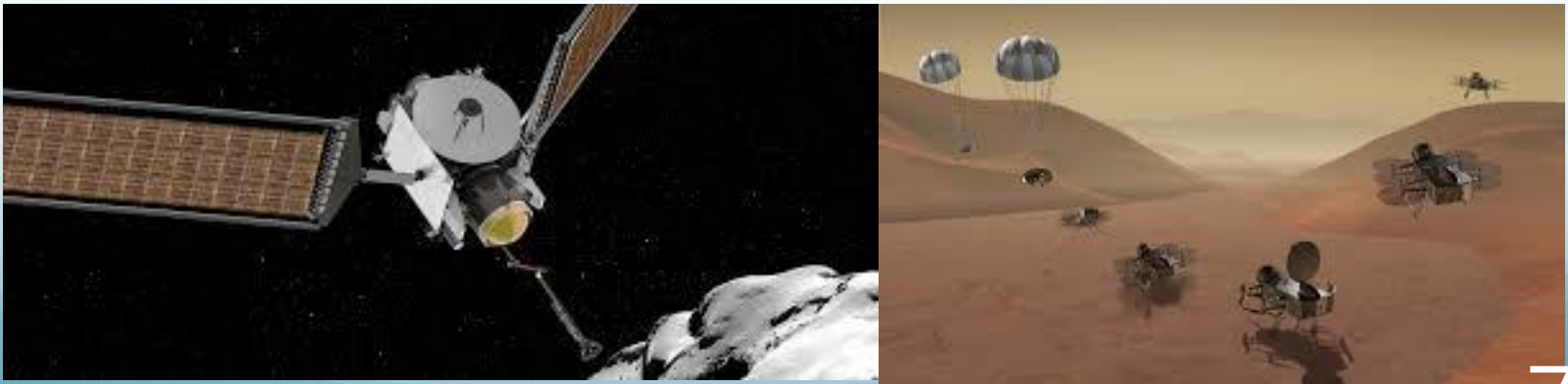
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Status of Astrobiology and Planetary Science

- Healthy budget for Astrobiology and Planetary (NASA)
- Planetary Decadal Survey to start (on time) in 2020
- Proposed growth for Planetary Defense
 - Welcomed by community as there is good support for asteroid detection & characterization
- Europa Clipper and Mars 2020 are on-track
 - Clipper Launch vehicle is nominally SLS, but its first flight is still a ways off
- Europa Lander is in Congressional budget, but not President's budget

Status of Astrobiology and Planetary Science

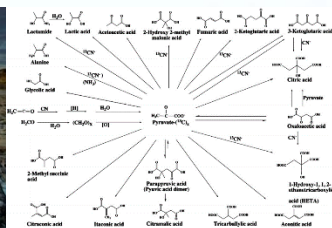
- New Frontiers in phase A (CAESAR and Dragonfly)
 - Healthy integration of Astrobiology in missions (again)
- Next Discovery opportunity soon
- New NAI proposals selected, but few details at this point
- Encouraged to see growing NSF interest in the Origin of Life research (in addition to NASA Astrobiology)



Origin of Life Perspectives Talks

- Origin of Life field is rather polarized right now
 - RNA World and its associated work
 - Hydrothermal metabolisms-first models

- Three talks:



- Prebiotic Chemistry and Life's Emergence:
Where have we been? Where are we going?
Where are we going? - Karyn Rodgers
- Dynamic Organic Reaction Networks And
Where to find them – George Cody
- Origin of Life Perspectives – Nita Sahai

Lunar Science and Exploration Initiative

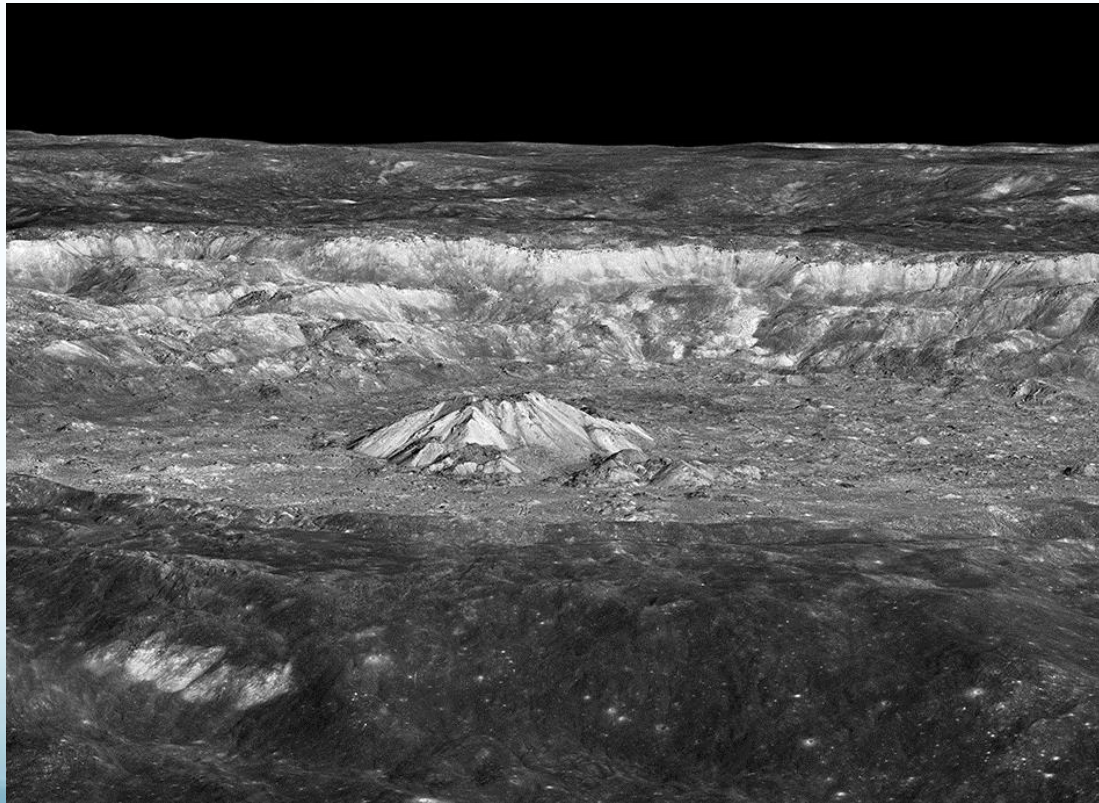
- NASA “Forward to the Moon” – New Funding to support a variety of lunar science and exploration initiatives:
 - ROSES 2018 enhancement
(new sample analyses, Korean lunar mission PS, DALI)
 - DALI: lunar instrument maturation program
 - Lunar cubesats (part of SIMPLEx)
 - Interest in establishing commercial transportation service to lunar surface: RFIs on small (science) & medium (science & exploration) landers; draft request for proposals to CLPS: Commercial Lunar Payload Services)
 - ^{238}Pu held in reserve to support instrumentation, increase lifetimes
 - SSERVI CAN 3 in works (lunar emphasis)

Lunar Science and Exploration Initiative

- CAPS tasks from Jim Green for the April meeting (report to NASA in summer):
 1. Review PSD's portion of NASA's plans for the lunar science and exploration initiative
 2. Determine if NASA's plans are consistent with V&V and other National Academies' reports
- CAPS task from Jim Green for the September meeting
 1. What might be realistically done with small commercial lunar landers?

Lunar Science Talks

- Three talks:
 - Science Enabled by Lunar Exploration... Carlé Pieters (Brown)
 - Advancing Science of the Moon Brett Denevi (JHU-APL)
 - NASSA-SMD's Lunar Robotic Exploration Program Clive R. Neal



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National Academy of Engineering
C.D. (Dan) Mote, Jr., President

National Academy of Sciences
Marcia McNutt, President

National Academy of Medicine
Victor J. Dzau, President

Executive Office
Bruce B. Darling, Executive Officer
James F. Hinchman, Deputy Executive Officer & Chief Operating Officer

Program Units

Division of Behavioral and Social Sciences and Education

Division on Earth and Life Sciences

Division on Engineering and Physical Sciences

Health and Medicine Division

Policy and Global Affairs Division

Transportation Research Board

Gulf Research Program

Division on Engineering and Physical Sciences

Executive Director: Peter Blair
Deputy Executive Directors: Joan Fuller and Scott Weidman

Aeronautics and Space Engineering Board

Director: Michael Moloney
Chair: Alan Epstein

Board on Mathematical Sciences and their Applications

Director: Michelle Schwalbe
Chair: Stephen Robinson

National Materials and Manufacturing Board

Director: James Lancaster
Chair: Celia Merzbacher

Air Force Studies Board

Director: Joan Fuller
Chair: Douglas Fraser

Board on Physics and Astronomy

Director: James Lancaster
Chair: Barbara Jacak

Naval Studies Board

Director: Charles Draper
Chair: Paul Schneider

Board on Army Science and Technology

Director: Bruce Braun
Chair: David Maddox

Computer Science and Telecommunications Board

Director: Jon Eisenberg
Chair: Farnam Jahanian

Space Studies Board

Director: Michael Moloney
Chair: Fiona Harrison

Board on Energy and Environmental Systems

Director: Jim Zucchetto
Chair: Andrew Brown

Intelligence Community Studies Board

Director: Alan Shaw
Chair: Donald Kerr

Board on Infrastructure and the Constructed Environment

Director: Cameron Oskvig
Chair: James Whittaker

Laboratory Assessments Board

Director: Jim McGee
Chair: John Lyons

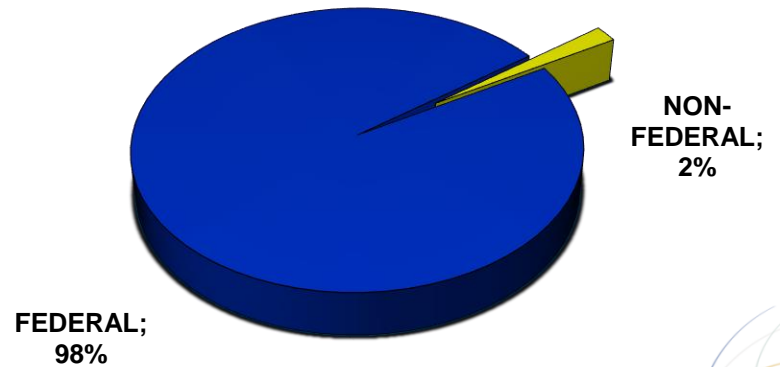
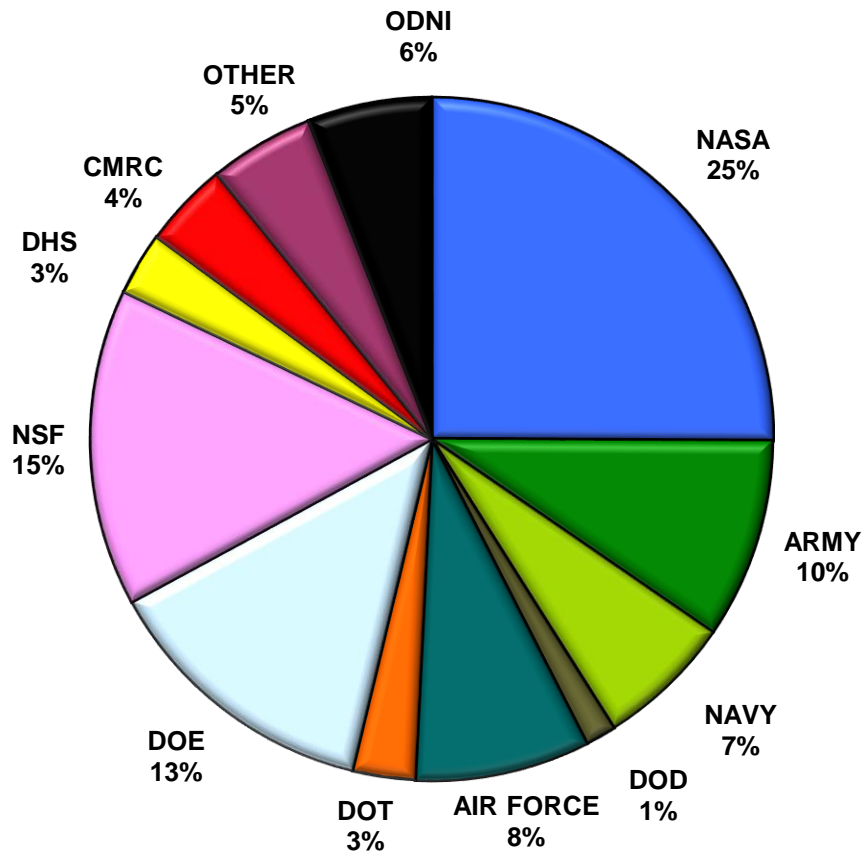
Staffing at the SSB & ASEB

The ASEB/SSB staff currently comprises:

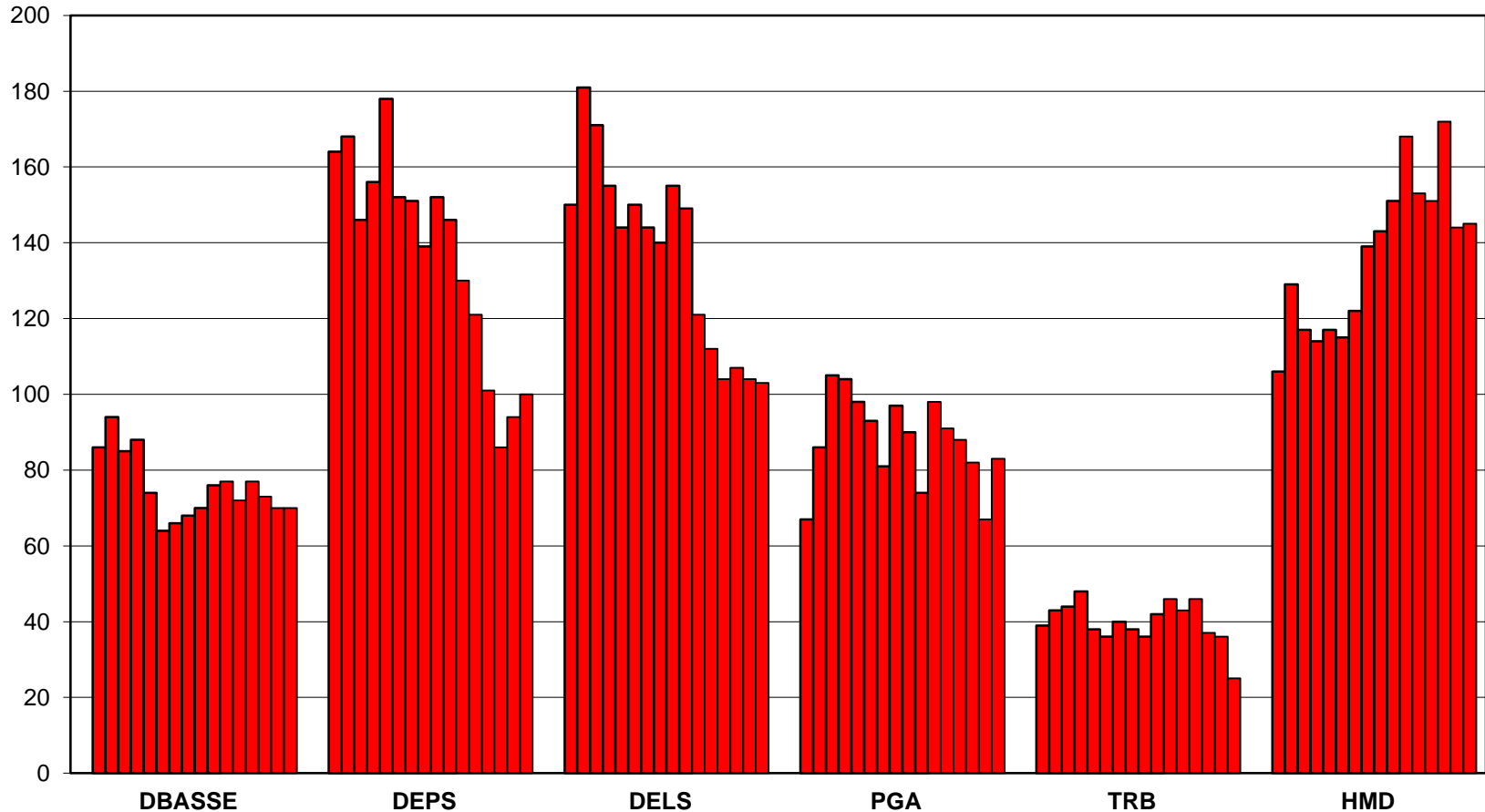
- Board Director,
- 2 ASEB study directors (one part time)
- 4 SSB study directors (all full time — also one additional shared with BPA)
- 2 SSB associate program officers
- 2 Research Associates (shared between SSB & ASEB)
- 3 meeting and travel coordinator staff (shared by both boards)
- 5 administrative staff Program Manager, Administrative Coordinator, Information and Communications Manager, and two financial management officers (shared by both boards).
- Budget of ASEB/SSB was ~30% of DEPS in CY 2016. Staff is ~25% of DEPS. Processed 45% of DEPS travel claims.



DEPS 2016 Total Program Support \$24.958M by Sponsor



Academies Appointed Committees* by Program Division 2001 – 2016



The Academies, in total, had over 500 active committees in 2016.



Number of ASEB & SSB Reports: 1994 - 2017

SSB Report Total = 181
ASEB Report Total = 82

