The National Academies of SCIENCES ENGINEERING MEDICINE

Status Report on the National Academies' Decadal Survey on Planetary Science and Astrobiology

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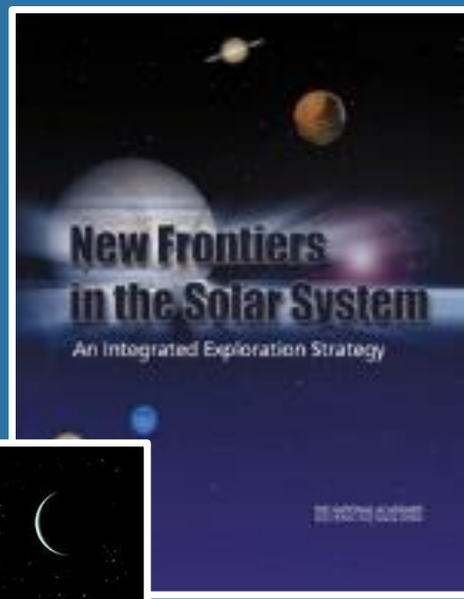
Planetary Advisory Committee

1 March, 2021

What is a Decadal Survey?

1. Assesses the current status of an entire scientific discipline
2. Defines and prioritizes key scientific questions to be addressed in the next decade
3. Prioritizes the most important initiatives to address these questions
4. Conducted by the National Academies, independently of sponsoring agencies
5. NASA Authorization Acts of 2005 and 2008 require decadal surveys in each NASA science area
6. Surveys are required to provide independent cost and technical evaluations of recommended projects/missions

Sponsoring agencies and Congress view surveys as the formal statement of priority by the US space science community, and have repeatedly stated their intent to give highest priority to the missions identified in the survey



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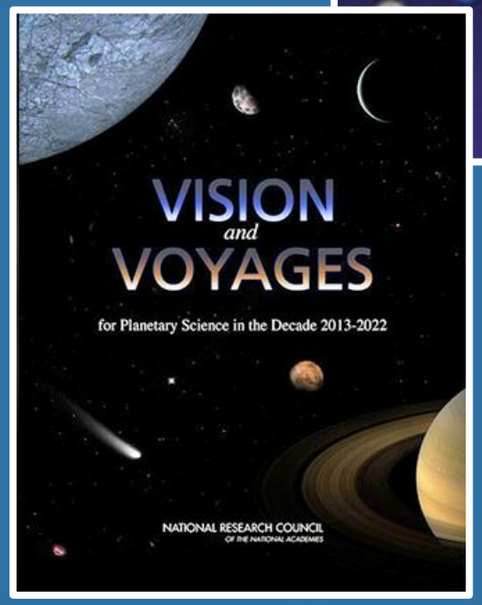

2013-2022

Process is Driven by the Statement of Task

- Posted on the survey's website: https://www.nas.edu/planetarydecadal
- Outlines exactly what the sponsors—NASA and NSF—and the National Academies want the survey committee to do
- The National Academies commits to do no more and no less than that specified in the statement of task
- The website contains additional information (e.g., scope, considerations, planetary defense considerations and approach) and suggestions to make the survey most useful to NASA and NSF, but these items are not binding on the survey committee

What is New this Time?

- A higher profile for astrobiology and planetary defense
- More prominence given to decision rules to accommodate significant deviations in budget, new discoveries, and/or technological development
- Connection to human exploration activities undertaken by NASA and international partners
- Identification of opportunities for multidisciplinary collaboration with other SMD divisions, NASA directorates, federal agencies, international partners and the private sector
- Consideration of issues related to the state of the profession

Steering Group

Robin Canup, NAS, co-chair	Southwest Research Institute
Philip Christensen, co-chair	Arizona State University
Mahzarin Banaji, NAS	Harvard University
Steven Battel, NAE	Battel Engineering
Lars Borg	Lawrence Livermore National Laboratory
Athena Coustenis	Paris Observatory
James Crocker, NAE	Lockheed Martin Space Systems, Retired
Brett Denevi	Applied Physics Laboratory
Bethany Ehlmann	California Institute of Technology
Larry Esposito	University of Colorado
Orlando Figueroa	Orlando Leadership Enterprise LLC
John Grunsfeld	Endless Frontiers Associates LLC
Julie Huber	Woods Hole Oceanographic Institution
Krishan Khurana	University of California, Los Angeles
Barbara Sherwood Lollar	University of Toronto
William McKinnon	Washington University
Francis Nimmo, NAS	University of California, Santa Cruz
Carol Raymond	Jet Propulsion Laboratory
Amy Simon	NASA, Goddard Space Flight Center

- Survey leadership group
- Expertise spans scientific, technical, policy and programmatic scope of the task
- Responsible for overall conduct of survey
- Formulate top-level conclusions and recommendations

Panels Organized by Destination

Moon and Mercury
chair: Timothy Grove, vice chair: Brett Denevi

Venus
chair: Paul Byrne, vice chair: Larry Esposito

Mars
chair: Victoria Hamilton, vice chair: Bethany Ehlmann

Small Bodies
chair: Nancy Chabot, vice chair: Carol Raymond

Giant Planet Systems
chair: Jonathan Lunine, vice chair: Amy Simon

Ocean Worlds and Dwarf Planets
chair: Alex Hayes, vice chair: Francis Nimmo

- Provide targeted scientific and engineering expertise
- Each vice chair is also a member of the steering group
- Panel boundaries are permeable to encourage cross-panel discussions.

What will be Different?

- Survey report will be organized thematically, rather than by destinations
- Survey report will not have individual chapters devoted to particular planetary bodies
- Instead, the report chapters will be organized around cross-cutting science questions and other topics as needed to address the statement of task.
- Each chapter will have an associated working group, with members drawn from across the panels and steering group

Report Organized by Science Questions and Key Topics

- Steering Group
- Moon & Mercury
- Venus
- Mars
- Small bodies
- Ocean Worlds & Dwarf Planets
- Giant Planet Systems

~ 95 members total

Science question

Science question

Science question

Science question

Science question

State of profession

Current state of knowledge

Relation of science to human exploration

Technology

Large mission prioritizations

Infrastructure

Planetary Defense

Collaborative opportunities

Decision rules

- Cross-cutting science questions and recommended research activities
- Additional topics needed to address statement of task
- Each question/topic to be addressed by panel and SG members with related expertise

Lots of Meetings so Far and More to Come

- Steering Group
- Mercury Moon
- Venus
- Mars
- Ocean Worlds
- Giant Planets
- Small Bodies
- State of Profession

September	28	29	30						
October	1	2	5	6	7	8	9	12	13
	14	15	16	19	20	21	22	23	26
	27	28	29	30					
November	2	3	4	5	6	9	10	11	12
	13	16	17	18	19	20	23	24	25
	26	27	30						
December	1	2	3	4	7	8	9	10	11
	14	15	16	17	18	21	22	23	24
	25	28	29	30	31				
January	1	4	5	6	7	8	11	12	13
	14	15	18	19	20	21	22	25	26
	27	28	29						
February	1	2	3	4	5	8	9	10	11
	12	15	16	17	18	19	22	23	24
	25	26							
March	1	2	3	4	5	8	9	10	11
	12	15	16	17	18	19	22	23	24
	25	26	29	30	31				
April	1	2	5	6	7	7	9	12	13
	14	15	16	19	20	21	22	23	26
	27	28	29	30					

Progress to Date I

1. Solicit community whitepapers
   → More than 500 received by 15 September

2. Determine cross-cutting themes/priority science questions
   → Twelve key questions identified

3. Identify additional mission studies required
   → Nine studies underway at three design centers

4. Identify a contractor to perform technical/cost evaluations
   → Contractor identified, onboard soon

Progress to Date II

5. Draft an outline for the survey report
   → Done

6. Panels draft their contributions to the “Current State of Knowledge” chapter
   → Done

7. Form cross-panel writing group for “State of the Profession” chapter
   → First meeting 4 February

8. Form cross-panel groups for the 12 key-science question chapters
   → Assembling now

9. Ditto. for programmatic chapters
   → Planetary defense and R&A assembling, others to follow

Mission Study Process and Prioritization I

- The panels consider the pool of publically available mission concept studies (e.g. Ice Giant, Europa Lander, Venera-D…., PMCS, concepts from V&V) and identified what they thought was missing in terms of medium/large-class missions addressing important science goals

- The panels formulated ~15 gap-filling concepts. Some were inspired by white papers, others came from V&V, some were related to PMCS or prior large-class mission studies. Some came from one panel, others were cross-panel collaborations

- A detailed questionnaire (including a STM) was completed for each concept and was forwarded to the steering group in early-December for presentation and prioritization

Mission Study Process and Prioritization II

- The steering group ranked each mission concept via a multi-step process and sent the top nine to NASA just before Christmas
- By mid-January, studies of all nine concepts were underway, three each at APL, GSFC and JPL
- Each study team includes a “science champion” from the originating panel to ensure the concepts remains faithful to the science goals originally proposed
- Preliminary/final study reports are available by late-March/late-April respectively
- But, these nine concepts are NOT the finalists.
  All PMCS and other missions recently studied are still in play

Draft Schedule for Decadal Survey

1. Steering group holds its first meeting—September, 2020
2. All panel meetings begin and steering group begins process of formulating key science questions—October
3. Panels identify and steering group prioritized additional mission study requests to NASA—December
4. Nine mission concept studies under way at three design centers—January 2021
5. RFI issued to identify contractor for independent technical/cost evaluations and contractor selected—February
6. Panels draft current state of knowledge chapter. Writing groups formed to draft other parts of report—February

7. Mission studies at APL, GSFC and JPL completed and final reports delivered—April
8. Initial drafts of chapters from writing groups delivered to the steering group—May
9. Steering group and panels begin final prioritization of a pool of some 25 mission concepts--June
10. Deliver priority missions concepts to external contractor for cost/technical evaluation—Summer
11. Determine final findings and recommendations—September
12. Complete draft of report assembled—early/mid-October
13. Report sent to external reviewers—late-October/early-November
14. Reviewer comments received and revision of report begins—mid/late-November
15. Fully revised report returned to RRC for final adjudication—early/mid-January 2022
16. Report approved for release by RRC—early/mid-February
17. Deliver report (prepublication format) to NASA and NSF—early-March
18. Report released at LPSC—mid/late-March, 2022

Thank You

https://www.nas.edu/planetarydecadal

Initial Task Identify Priority Questions

Examples from *Vision and Voyages* (Table 3.1)

Crosscutting Themes	Priority Questions
Building New Worlds	1. What were the initial stages, conditions and processes of solar system formation and the nature of the interstellar matter that was incorporated?
	2. How did the giant planets and their satellite systems accrete, and is there evidence that they migrated to new orbital positions?
	3. What governed the accretion , supply of water, chemistry, and internal differentiation of the inner planets and the evolution of their atmospheres, and what roles did bombardment by large projectiles play?
Planetary Habitats	4. What were the primordial sources of organic matter, and where does organic synthesis continue today?
	5. Did Mars or Venus host ancient aqueous environments conducive to early life, and is there evidence that life emerged?
	6. Beyond Earth, are there modern habitats elsewhere in the solar system with necessary conditions, organic matter, water, energy, and nutrients to sustain life, and do organisms live there now?
Workings of Solar Systems	7. How do the giant planets serve as laboratories to understand the Earth, the solar system and extrasolar planetary systems?
	8. What solar system bodies endanger and what mechanisms shield the Earth's biosphere?
	9. Can understanding the roles of physics, chemistry, geology, and dynamics in driving planetary atmospheres lead to a better understanding of climate change on Earth?
	10. How have the myriad chemical and physical processes that shaped the solar system operated, interacted, and evolved over time?