



The Decadal Survey on Planetary Science and Astrobiology 2023-2032

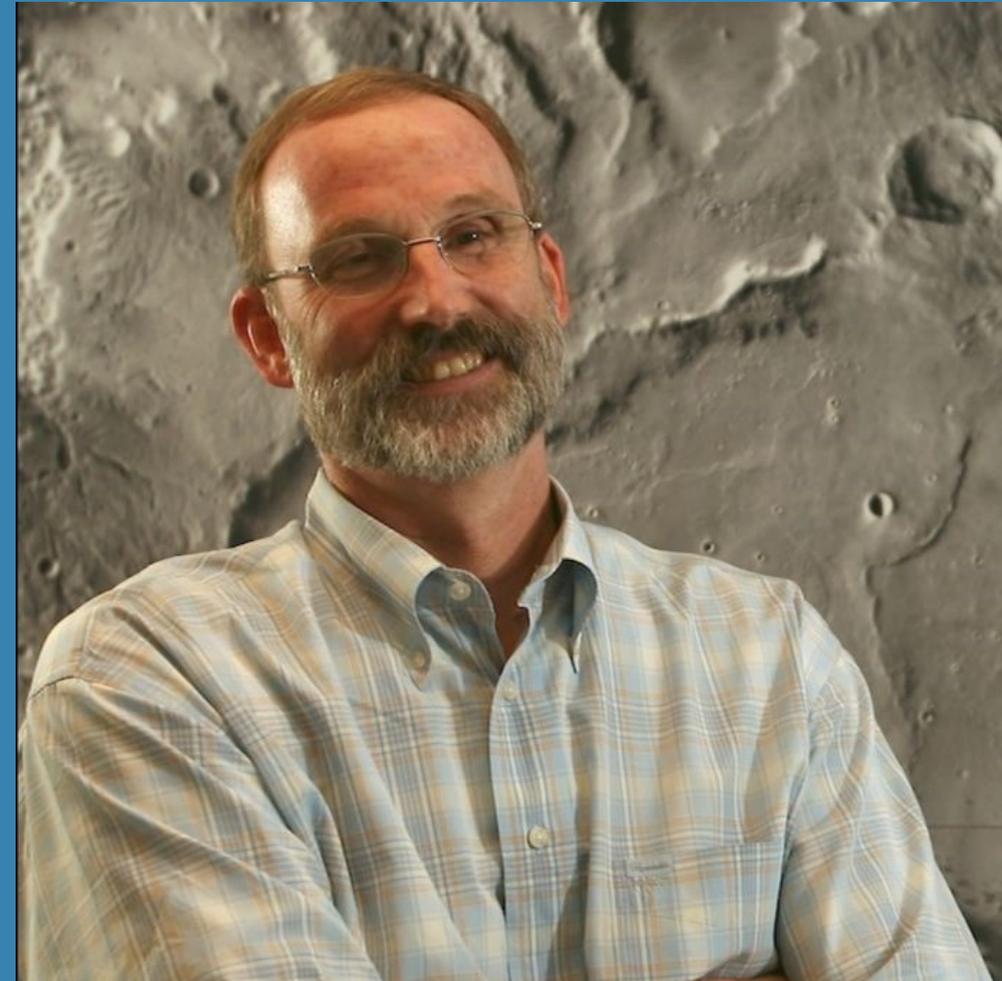
**Robin M. Canup, Philip R. Christensen
and David H. Smith**

**Outer Planets Assessment Group
1 September 2020**

Co-Chairs Appointed



Robin M. Canup: Assistant vice president of the Planetary Sciences Directorate at Southwest Research Institute



Philip R. Christensen: Regents Professor and the Ed and Helen Korrick Professor in the School of Earth and Space Exploration at Arizona State University



What is the Statement of Task?

- The statement of task is posted on the survey's website: <https://www.nas.edu/planetarydecadal>
- It 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, and approach) in the form of suggestions to make the survey most useful to NASA and NSF, but these items are not binding on the survey committee



What is the Same?

- Overview of relevant disciplines
- Broad survey of the current state of knowledge
- Inventory of top-level science questions and research activities
- Recommendations on optimum balance between target bodies, large/medium/small missions, ground versus space, etc.
- Assessment of infrastructure
- Discussion of strategic technology development needs
- Identification and ranking of large/medium space missions (with cost and technical evaluation), plus recommendations on other initiatives



What is New?

- A higher profile for astrobiology and planetary defense
- Recommended activities clearly traceable to goals/objectives
- More prominence given to decision rules to accommodate significant deviations in budget, new discoveries, or technological development
- Awareness of human exploration activities undertaken by NASA and international partners
- Discussion 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



What will be Different?

- The co-chairs decided very early in their discussions that the survey report will be organized around cross-cutting science themes and priority questions
- The survey report will not have individual chapters devoted to particular planetary bodies
- Rather, the survey report will contain chapters organized around priority science questions
- The model for the cross-cutting science themes will be Table 3.1 in *Vision and Voyages*
- The survey will draft its own version of Table 3.1 very early in its deliberations



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?



Early-Career Events

- **Event 1:** 27 March—Kickoff Webinar for Early Career Professionals
~340 participants
https://youtu.be/j1j_tbj9WI4
- **Event 2:** 7 May—Writing White Papers for the Planetary Science and Astrobiology Decadal Survey: Overview and Perspectives from the Experts
>350 participants
<https://vimeo.com/418576172>
- **Event 3:** 2 July—Perspectives and Lessons Learned: Decadal Surveys in Space Science
~350 participants
<https://vimeo.com/436536613>



Key Dates for Decadal Survey

1. Statement of Task finalized—January, 2020
2. Survey officially began—20 March, 2020
3. Deadline for public nominations—1 May—347 nominations (~300 unique)
4. Co-Chairs announced—18 May, 2020
5. Deadline for science whitepapers—15 July, 2020—333 submitted
6. Deadline for mission whitepapers—15 August, 2020—96 additional submissions
7. Deadline for all other whitepapers—15 September, 2020

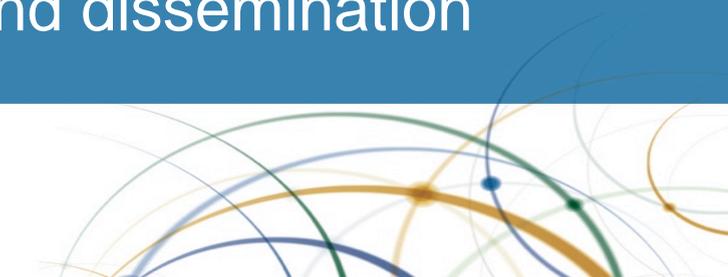
8. Steering Group members appointed—August-September, 2020
9. Panel members appointed—September, 2020
10. Survey report released—late 1st quarter, 2022
11. End of dissemination/NASA contract—late 1st quarter, 2023



Decadal Survey Process as Currently Envisaged

The survey can be broken down into eight steps, of which **three are rate determining**:

1. Determining cross-cutting themes/priority questions. Assess what additional mission studies are needed beyond PMCS etc.; e.g., promising concepts from whitepapers
2. **Promising additional concepts being studied by design centers at committee's request**
3. Assessing how progress might be made in next decade to address relevant priority questions in each panel's areas of responsibility. Initial parts of survey report drafted
4. Assess all mission studies (PMCS etc. plus any new ones) to determine those best able to address cross-cutting themes/priority questions. Most promising concepts sent to a contractor for independent cost/technical evaluation. More parts of report drafted
5. **Most promising concepts being assessed for cost and technical realism by contractor**
6. Assess results from contractor studies and determine priority missions. Draft remaining text and assemble all of the components of the survey report
7. **Report review, response to reviewer comments, final adjudication and report approval**
8. Release report to sponsors and public, publish survey report and dissemination



How Nominees are Identified **and Appointed**

A multi-step process is used to identify potential candidates and select nominees:

1. Solicitations to academy section liaisons, and the members of the Space Studies Board and the Aeronautics and Space Engineering Board
2. Suggestions made during the survey's 11-13 September organizing meeting
3. Nominations and self-nominations via the public website (almost 300 received)
4. Committee staff identified additional candidates to fill areas not otherwise represented
5. Co-chairs and committee staff held an extensive series of conference calls during the second half of May and in June to sort through the various nominees and finalize the list of nominees
6. **The Academies reviews all nominees and then they require the approval of NAS President Marcia McNutt. The Academies looks for:**
 - a. an appropriate range of expertise for the task;
 - b. balance of perspectives and close look at diversity;
 - c. a careful screening for conflicts of interest.



Thank You

<https://www.nas.edu/planetarydecadal>



What is a Decadal Survey?

1. Assesses the current status of an entire scientific discipline
2. Defines and prioritizes the key scientific questions that could potentially be addressed in the next decade
3. Prioritizes the most important initiatives that might be undertaken to address the most important questions
4. Conducted by the National Academies, independently of sponsoring agencies and organizations
5. Required by language in the NASA Authorization Acts of 2005 and 2008 to engage with the National Academies and conduct decadal surveys in all major space science disciplines
6. Post-2005 surveys have required independent cost and technical evaluations of recommended projects

Sponsoring agencies and Congress views 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



The Statement of Task I

1. An overview of planetary science, astrobiology, and planetary defense—what they are, why they are compelling undertakings, and the relationship between space- and ground- based research;
2. A broad survey of the current state of knowledge of the solar system;
3. The most compelling science questions, goals and challenges which should motivate future strategy in planetary science, astrobiology, and planetary defense;
4. A coherent and consistent traceability of recommended research and missions to objectives and goals;
5. A comprehensive research strategy to advance the frontiers of planetary science, astrobiology and planetary defense during the period 2023-2032 that will include identifying, recommending, and ranking the highest priority research activities (research activities include any project, facility, experiment, mission, or research program of sufficient scope to be identified separately in the final report). For each activity, consideration should be given to the scientific case, international and private landscape, timing, cost category and cost risk, as well as technical readiness, technical risk, lifetime, and opportunities for partnerships. The strategy should be balanced, by considering large, medium, and small research activities for both ground and space;



The Statement of Task II

6. Recommendations for decision rules, where appropriate, for the comprehensive research strategy that can accommodate significant but reasonable deviations in the projected budget or changes in urgency precipitated by new discoveries or unanticipated competitive activities;
7. An awareness of the science and space mission plans and priorities of potential foreign and U.S. agency partners reflected in the comprehensive research strategy and identification of opportunities for cooperation, as appropriate;
8. The opportunities for collaborative research between SMD's four science divisions (for example, comparative planetology approaches to exoplanet or astrobiology research); between NASA SMD and the other NASA mission directorates; between NASA and the NSF; between NASA and other US government entities; between NASA and private sector organizations; between NASA and its international partners; and
9. The state of the profession including issues of diversity, inclusion, equity, and accessibility, the creation of safe workspaces, and recommended policies and practices to improve the state of the profession.



Scope I

To ensure the committee provides actionable advice and is consistent with other advice from the National Academies, guidelines for the scientific scope of the survey are as follows:

1. The report should address and be organized according to the significant, overarching questions in planetary science, astrobiology, and planetary defense.
2. Basic or supporting ground- and space-based, laboratory, field, and theoretical research in astrobiology is within scope. Any findings and recommendations in the area of astrobiology should take into consideration the National Academies' report *An Astrobiology Strategy for the Search for Life in the Universe* (2018);
3. Interactions between solar and heliospheric phenomena and the atmospheres, magnetospheres, and surfaces of solar system bodies are within scope. Reassessment of recommendations treated in the National Academies' *Solar and Space Physics: A Science for a Technological Society* (2012) is out of scope;
4. Excluding analog studies, focused study of the Earth system, including its atmosphere, magnetosphere, surface, and interior, is out of scope (these topics are treated in the National Academies' *Thriving on our Changing Planet: A Decadal Strategy for Earth Observation from Space* (2017);
5. Studies of meteorites and other extraterrestrial materials in terrestrial laboratories that further planetary science goals are in scope but findings and recommendations in this area should take into consideration the National Academies' report *Strategic Investments in Instruments and Facilities for Extraterrestrial Sample Curation and Analysis* (2018);
6. Recommendations for ground- and space-based investigations to detect exoplanets are out of scope (these topics are being addressed by "ASTRO2020: Decadal Survey on Astronomy and Astrophysics" currently in progress). However, the identification of scientific issues and questions related to the study of exoplanets, including the comparative planetology and potential habitability of solar and extrasolar planets, is in scope;



Scope II

7. Scientific investigations of near-Earth objects, both for the impact hazard presented to Earth and the future exploration and resource opportunities, are within scope. Findings and recommendations in this area should take into consideration the National Academies' report *Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies* (2010) as well as more recent National Academies' and community studies related to this area such as the *Near-Earth Object Observations in the Infrared and Visible Wavelengths* (2018)

8. Findings and recommendations concerning planetary protection policies are out of scope. But, the identification of planetary protection considerations for recommended missions— as recommended in the National Academies' *Review and Assessment of the Planetary Protection Policy Development Processes* (2018)—and research or technology development to mitigate concerns about biological contamination are in scope.

9. Recommendations regarding new construction of major new ground-based observatories are out of scope (these are addressed within the scope of the ASTRO2020 decadal survey currently in progress). The role that current and contemplated new ground-based facilities can play in advancing planetary science is in scope. How the facilities under consideration in the ASTRO2020 survey (when available) could benefit planetary science is within scope.

10. The scientific identification and initial validation of technosignatures is in scope but the application of such signatures in survey studies is out of scope. Recommendations in this area should take into account the summary of the Technosignatures Workshop found in the meeting report *NASA and the Search for Technosignatures* (2018) as well as the National Academies' reports *An Astrobiology Strategy for the Search for Life in the Universe* (2018) and *Exoplanet Science Strategy* (2018).



Considerations I

The report should reflect NASA's statutory responsibility for flight mission investigations. The committee is strongly encouraged to adhere to the following guidelines as they draft the principal components of the NASA implementation portion of the report:

1. Recommendations for individual flight investigations for initiation between 2023 and 2032 as follows (note that dollar values do not include launch vehicle or Phase E costs):
 - a. Flight investigations believed executable for less than approximately \$500 million (candidates for the Discovery or SIMPLEx programs) should not be identified or prioritized. They will be proposed by community investigators to address the science goals and challenges called for in the statement of task;
 - b. The report should consider whether specific flight investigations with costs in the approximate range \$500-900 million (New Frontiers class) should continue to be specified or whether this mission class should be open in a manner similar to the Discovery program; If specific flight investigations are recommended, the report should provide a candidate list of objectives for each mission;
 - c. The report should identify specific destinations and science goals for "large strategic missions" with costs projected to exceed \$900 million;
 - d. The prioritization of flight investigations for Mars and the Moon should be integrated with flight investigation priorities for other solar system objects into a single prioritized list of all recommended missions;



Considerations II

- e. The findings and recommendations contained in Visions into Voyages for Planetary Science in the Decade 2013-2022, together with other recent National Academies' reports on topics relevant to planetary science, astrobiology and planetary defense should be used as input to the decadal efforts. . Missions identified in these reports that have not yet been confirmed for implementation must be reprioritized; and
 - f. It is understood that initiation of missions on these lists will depend on actual resource availability.
2. Recommendations for NASA-funded supporting research required to maximize the science return from the flight mission investigations and to provide the context and impetus for future flight mission investigations;
 3. A discussion of strategic technology development needs and opportunities relevant to NASA planetary science programs; and,
 4. A discussion of:
 - a. Potential opportunities for conducting planetary science investigations involving humans in situ; and
 - b. The relative value of human-tended investigations to those performed solely robotically.

For NSF, the survey will be most effective if it is aspirational, inspirational, and transformative. The decadal survey should assess how the current NSF portfolio of facilities and individual investigator grants address these priorities, as well as how currently planned and new facilities under consideration in the ASTRO2020 survey could benefit the planetary science priorities. The study may recommend any changes to this infrastructure that it deems necessary to advance the science and to optimize the value of current and future facilities. The decadal survey steering committee is encouraged to comment on NSF opportunities for expanding partnerships, whether private, interagency, or international.



Approach I

The organization of the study is sized based upon prior planetary decadal surveys. The committee will consist of a steering group—approximately 15-20 members, responsible for the overall organization and execution of the study, and the production of a final consensus report that will undergo the usual National Academies review processes—and five or six supporting panels—approximately 10-12 members each—responsible for providing the scientific and technical breadth to span the diverse suite of scientific topics and potential solar system destinations.

The scheme used to allocate the domain of study among the panels should support delivery of a report organized according to the significant, overarching questions in planetary science, astrobiology, and planetary defense. Individual panels may span multiple solar system target bodies, with specific panel structure determined by the National Academies and the committee's chair(s). An important role of the panels will be to evaluate input from the research community about issues of scientific and programmatic priorities in the field. In keeping with prior planetary science decadal surveys, the work of the study panels will be integrated and incorporated as chapters in the final survey report.

One representative from each of the panels shall serve on the steering group. The composition of the steering group and panels will take full advantage of the diversity of the planetary science, astrobiology, and planetary defense communities in factors such as gender, race, ethnicity, career stage, types and sizes of institutions, geographic distribution, etc. It is imperative that some early career researchers be invited to serve on panels.

In assembling the committee and panels, calls for nominations will be sent to the planetary science, astrobiology, and planetary defense communities and sponsors. National Academies' staff will nominate a candidate for chair after consultation with the Space Studies Board, the Committee on Astrobiology and Planetary Science and other relevant stakeholders. The chair will work with committee staff and others to develop the structure for the study and a slate of nominees for the balance of the committee's membership.



Approach II

In assembling the slate of nominees for the steering group and panels, committee staff will follow National Academies' procedures for reducing and balancing biases, and for ensuring that the steering group and panels have the needed expertise across disciplines and diversity among their members, including gender, career stage, underrepresented groups, types and sizes of institutions, and geographic distribution.

In designing and pricing the study, the Academies should include resources for independent and expert cost analysis support to ensure that all flight mission cost estimates can be meaningfully intercompared and are as accurate as possible given the varying maturity of project concepts and other recognized uncertainties. The prioritized list of science missions should be developed with the anticipated resources in mind.

The final report must represent a comprehensive and authoritative analysis of the subject domain and represent the community stakeholders. The study activity will include town hall meetings, sessions at geographically dispersed professional meetings, and aggressive use of electronic communications for soliciting and aggregating inputs from across the community and country. It is anticipated that a call for white papers will be issued prior to the commencement of the study itself. The committee may also convene focused workshops on special topics of interest. Other input-gathering methods will be explored and used, including a pre-study event to inform early-career researchers about the scope of, and their potential role in, the decadal survey.



Products

It is suggested that the committee produce three products: a complete, integrative report of the findings and recommendations of the study, incorporating the reports of the supporting panels; an abbreviated high-level presentation of the main findings and recommendations suitable for distribution to the general public; and a web-based archive of report-relevant documents, including all community white papers and mission studies.

