Reflections on ‘Vision and Voyages 2013-2022’

Lessons for the Next Planetary Decadal

A Discussion with OPAG
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Some Background

- December 2008: NASA/NSF requested the NRC to conduct a planetary decadal survey to "inform the development of the FY13 budget"
- Chaired by S. Squyres the survey was begun in 2009 and 'V&V' was published in March 2011.
- With the FY17 budget process underway we are midway through the lifetime (2013-2022).
- The focus of today' discussion: What lessons can we take from the 2013-2022 decadal survey in planning and undertaking the next?

V&V Statement of Task

- A decadal survey is congressionally mandated; it is governed by a "Statement of Task" (SOT) provided to the NRC (who conducts the study) and dictated by NASA and the NSF. The SOT…
- …required that all recommendations should be foremost science-driven.
- …emphasized that there be broad community involvement (V&V received ~200 white papers by ~1700 authors).
- …specified that the Recommendations must include Decision Rules to react to unforeseen changes (budgetary, political, technical…)
- …and by adding a new requirement for V&V, mandated that the
  - "…programs recommended in the survey report must be executable within anticipated resources."
  - "…and in designing and pricing the study, the NRC 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."

Guiding Principles

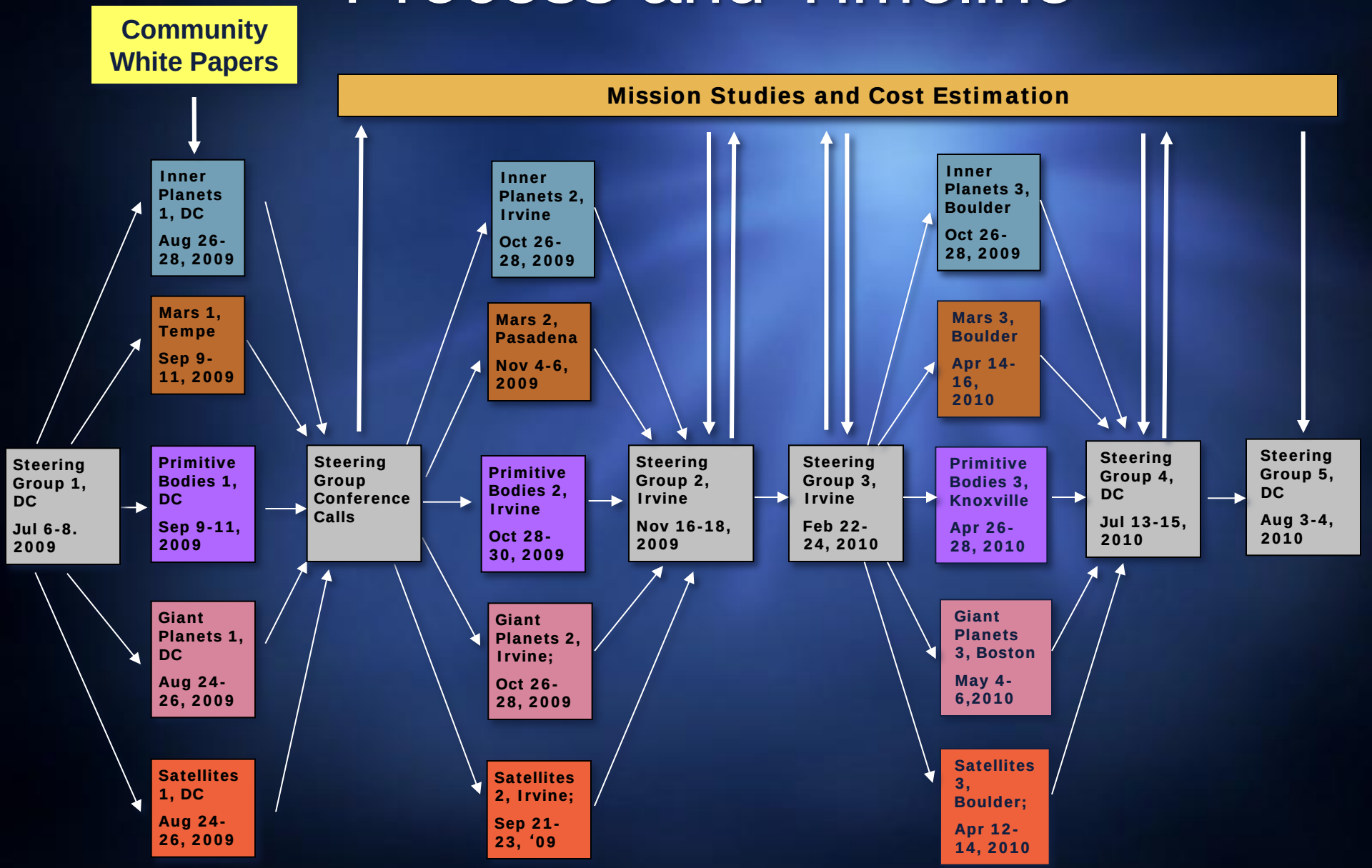
- Science Comes First: All recommendations must be first and foremost science-driven.
- Community Involvement: Solicit community input throughout the process.
- Transparency and Openness: Make the process as open and visible to all interested members of the community as possible.

Committee Organization

Inputs From The Community

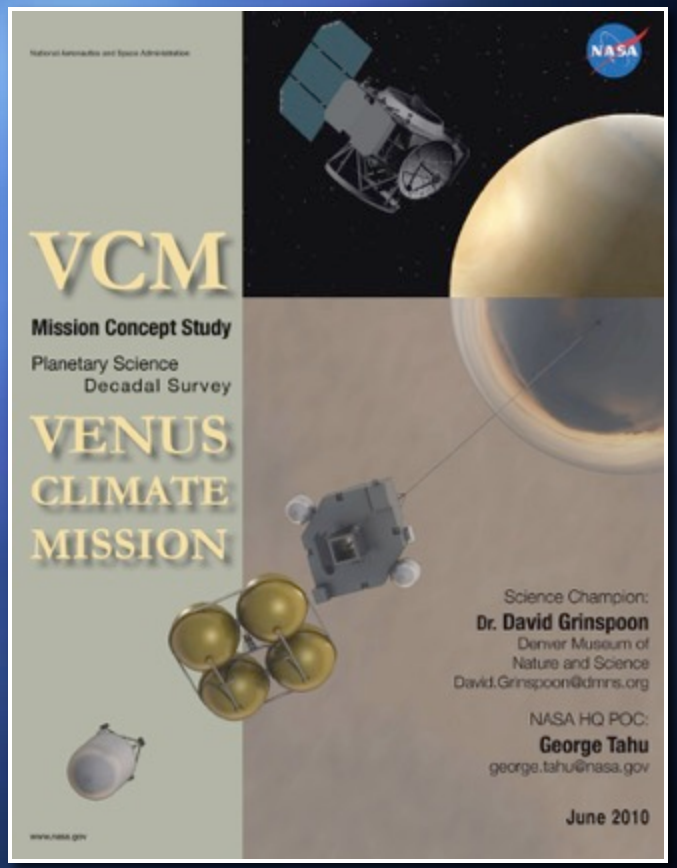
- The goal of the decadal survey is to seek out the community's views, and build a consensus around those views.
- More than a dozen town hall meetings were held: AGU (twice), LPSC (twice), DPS (twice), EPSC, RAS, AbSciCon, NLSI, LEAG, VEXAG, OPAG, MEPAG, CAPTEM, etc.
- The community submitted 199 white papers with 1669 individual authors and endorsers.
- The white papers were the main input to the decadal process, and many white paper authors were invited to present at panel meetings.
- Open sessions of meetings were webcast and put online.
- Draft report was reviewed by 18 peer reviewers.

Process and Timeline



Mission Studies

- Based on the science identified via white papers and other community inputs, 25 mission candidates were chosen for detailed study.
- Studies were performed by APL, GSFC, JPL, and MSFC. Each study team included at least one science representative from the appropriate panel.
- The studies involved considerable time and effort. All study reports have been posted on the Web and are included in the decadal survey report.
  - These studies were carefully archived so as to be available as a starting point for the next decadal survey.



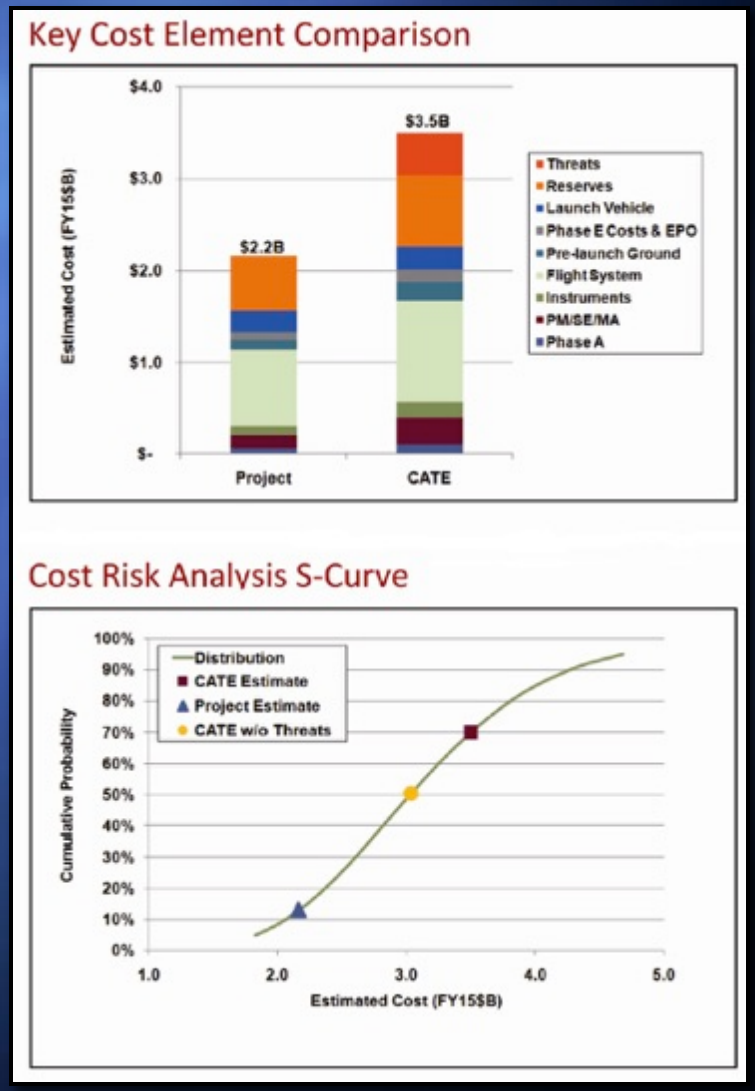
Mission Prioritization

- Criteria
  - Science return per dollar
  - Programmatic balance
  - Technological readiness
  - Availability of appropriate trajectories

- Process
  - All priorities and recommendations were guided strongly by community inputs.
  - Prioritization within the subject area of each panel was done by the panel.
  - Cross-panel prioritization was done by the steering group.
  - All priorities and recommendations were arrived at by achieving strong consensus.

Cost and Technical Evaluations

- After studies were completed, 15 high-priority mission candidates were subjected to a detailed Cost and Technical Evaluation (CATE) by Aerospace Corporation.
- CATE estimates are based on multiple methodologies, including actual costs of analogous past missions, to avoid the optimism inherent in other cost estimation processes.
- The CATE process was probably the most critical new component of the V&V Decadal Survey, insuring the costs and risks of the recommended programs could be as thoroughly understood as possible.



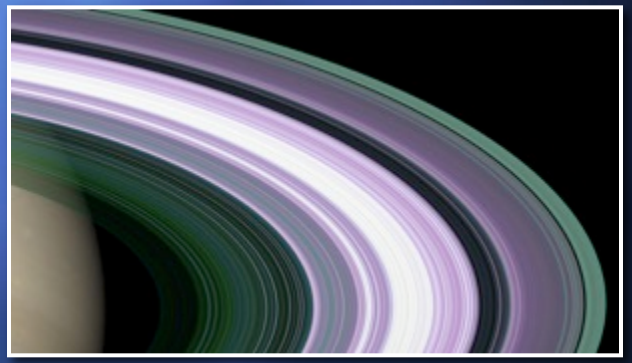
Science in the Decadal

Crosscutting Themes

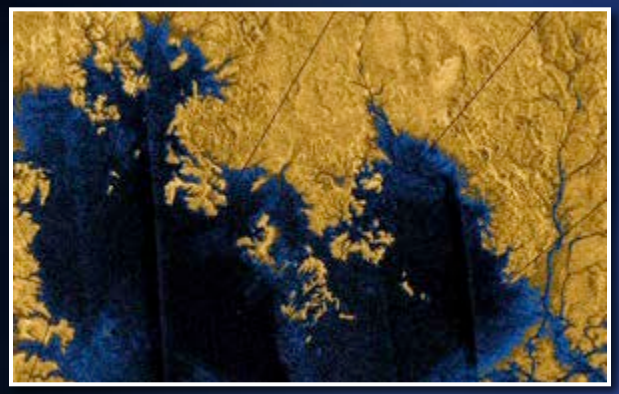
- The community inputs led to identification of three Crosscutting Themes for planetary science:
  - Building New Worlds: Understanding solar system beginnings
  - Planetary Habitats: Searching for the requirements for life
  - Workings of Solar Systems: Revealing planetary processes through time
- The report expands on these themes, identifying key scientific questions for each.

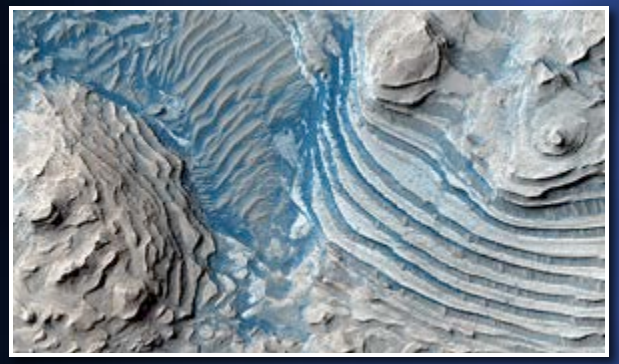
Building New Worlds

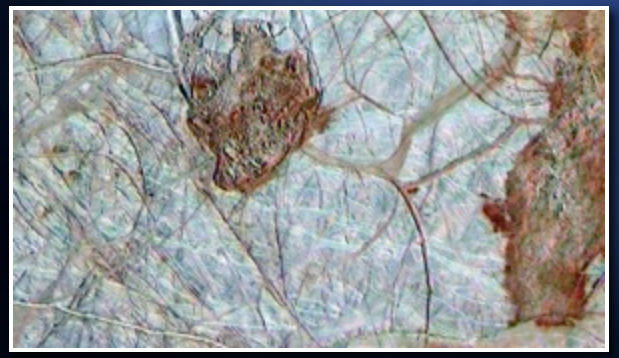
- What were the initial stages, conditions and processes of solar system formation and the nature of the interstellar matter that was incorporated?
- How did the giant planets and their satellite systems accrete, and is there evidence that they migrated to new orbital positions?
- What governed the accretion, 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



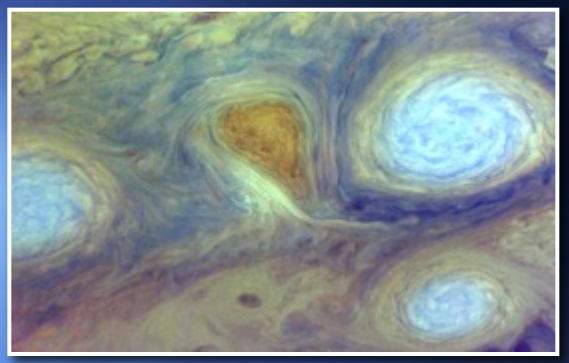




- What were the primordial sources of organic matter, and where does organic synthesis continue today?
- Did Mars or Venus host ancient aqueous environments conducive to early life, and is there evidence that life emerged?
- Beyond Earth, are there modern habitats elsewhere in the solar system with necessary conditions, organic matter, water, energy, and nutrients to sustain life, and do organisms live there now?

Workings of Solar Systems

- How do the giant planets serve as laboratories to understand the Earth, the solar system and extrasolar planetary systems?
- What solar system bodies endanger and what mechanisms shield the Earth's biosphere?
- Can understanding the roles of physics, chemistry, geology, and dynamics in driving planetary atmospheres and climates lead to a better understanding of climate change on Earth?
- How have the myriad chemical and physical processes that shaped the solar system operated, interacted, and evolved over time?



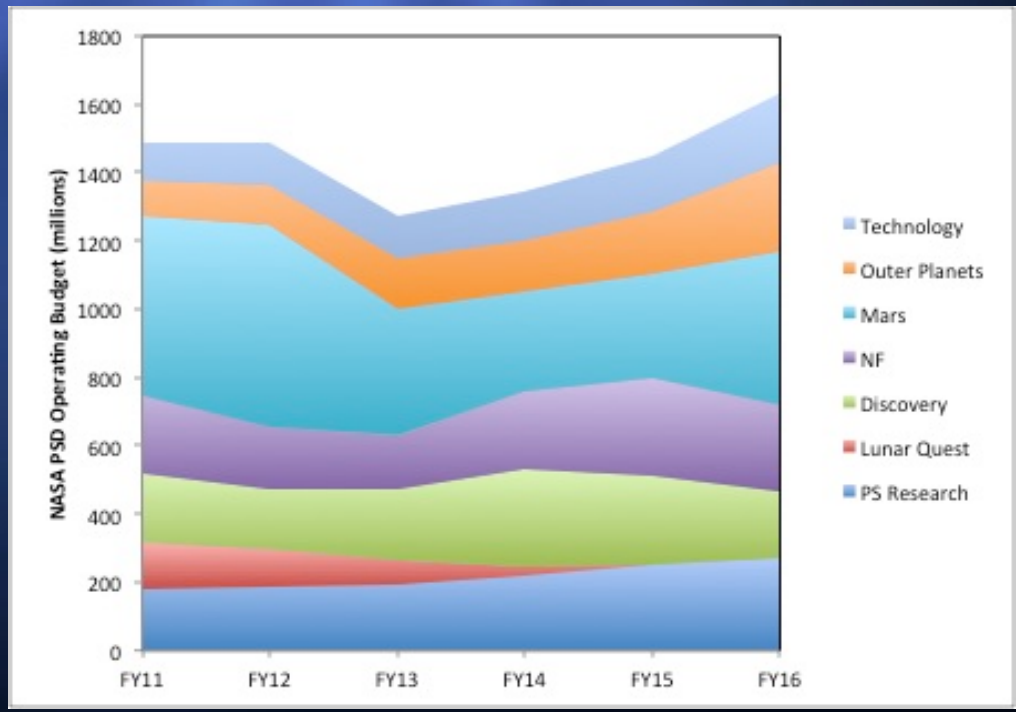
Recommendations of the Decadal Survey

V&V on Discovery Program, R&A, and Technology

- *Fund the Discovery Program at its current level, adjusted for inflation, to a cost cap per mission of $500 million FY15$*
- *Increase R&A budget by 5% in FY'11 and by 1.5% above inflation thereon.*
- *Technology programs should be funded at 6-8% of the total Planetary Science Division budget.*

Outcome:

In general the Discovery, Research and Analysis, and Technology Programs have all remained roughly flat but have kept up with inflation: a remarkable NASA PSD accomplishment in the face of the severe budgetary decline in FY13-14.



Recommendations for New Frontiers 4

- *Change the New Frontiers cost cap to 1B in FY15$, excluding launch vehicle costs*
- Close to being realized: The NF4 Draft AO cost cap is 850M+LV in FY15$ compared to NF3 of 650M+LV in FY09$ (=> actual cost-cap increase in FY15$~120M) ***and*** Phase E and F costs are no longer under the AO Cost Cap
- *Select New Frontiers missions NF-4 from*
  - *Comet Surface Sample Return* ✓
  - *Lunar South Pole-Aitken Basin Sample Return* ✓
  - *Saturn Probe* ✓
  - *Trojan Tour and Rendezvous* ✓
  - *Venus In Situ Explorer* ✓
  - *Titan and/or Enceladus**

*Added in response to the Ocean Worlds initiative

Flagship Recommendations and Decision Rules

TABLE ES.3 Large-Class Missions (in priority order)

Recommendation	Science Objectives	Key Challenges	Decision Rules
1. Mars Astrobiology Explorer-Cacher Requires Descope	1. Perform in situ science on Mars samples to look for evidence of ancient life or prebiotic chemistry 2. Collect, document, and package samples for future collection and return to Earth	1. Keeping within Mars Science Laboratory design constraints 2. 2. Sample handling, encapsulation, and containerization 3. Increased rover traverse speedover Mars Science Laboratoryand Mars Exploration Rover	Should be flown only if it can be conducted for a cost to NASA of no more than ~$2.5B (FY2015$)
2. Jupiter Europa Orbiter Requires Descope	Explore Europa to investigate its habitability	1. Radiation 2. Mass 3.Power 4. Instruments	Should be flown only if changes to both the mission design and the NASA planetary budget make it affordable without eliminating any other recommended missions
3. Uranus Orbiter and Probe (no solar-electric propulsion stage)	1. Investigate the interior structure, atmosphere, and composition of Uranus. 2. Observe the Uranus satellite and ring systems	1. Demanding entry probe mission 2.Long life (15.4 years for orbiter) 3. High magnetic cleanliness for orbiter 4. System mass and power	Should be initiated even if both MAX-C and JEO take place

Outcome of Recommended Flagships

- Descoping the two highest priority Flagship missions and retaining much of the science has been realized, each at a cost of <$2.5B.
  - The CATEs provided essential leverage for driving down the costs of those missions to realizable levels.
  - Mars 2020 will utilize much of the MSL technology and engineering and will cache samples at the Martian surface for future mission retrieval
  - Europa Clipper will explore Europa's internal ocean and surface at less that half the cost of JEO while achieving >90% of the key scientific goals.

Decision Rules: If Less Funding Is Available

- Descope or delay Flagship missions.
- Slip New Frontiers and/or Discovery missions only if adjustments to Flagship missions cannot solve the problem.
- Place high priority on preserving R&A and technology development funding.

…onto the next

Summary: Lessons for the next Planetary Decadal

- A Carefully Crafted Statement of Task
  - Explicitly laying out the requirements and constraints.
- Broad and Open Community Involvement
  - A community that owns and embraces the plan is critical.
- Comprehensive Mission Studies by the Centers
  - That certify mission concepts are believable and achievable.
- Independent Cost and Technical Evaluation (CATE)
  - Independently vetted mission costs and risks are mandatory.
- Decision Rules imbedded within Recommendations
  - As nothing ever stays the same, a good set of decision rules can give a Survey longer life against obsolescence.
- The Planetary Science Division must be dedicated in underwriting the Survey with the necessary support!

Q & A