The Space Science Decadal Surveys: Lessons Learned and Best Practices

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COMMITTEE ON SURVEY OF SURVEYS: LESSONS LEARNED FROM THE DECADAL SURVEY PROCES

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The Subject of our Report: The Decadal Surveys

The NRC decadal surveys have been a model in the world of science for how community consensus can be achieved—on science goals and on a program of activities to achieve them… –for four disciplines that have much in common, but also many differences in substance, style, and culture.

Our report is 'NASA-centric,' but most of the issues are similar for NSF and the other agencies that use decadal surveys in support of scientific research. We have included text that is relevant to these agencies as appropriate throughout.

Statement of Task (full text in Report Preface)

The NRC will convene an ad-hoc committee to consider lessons learned from the most recent NRC decadal surveys in space science…the study will also review and consider the first round of NRC mid-decade assessment reports…

…consider the organization, process, prioritization, and programmatic aspects of these decadal surveys in terms of lessons learned and to present a set of options—best practices—for possible evolutionary changes and improvements to this process, including the statement of task, advanced preparation, organization, and execution.

Committee's Statement of Task (cont.)

This analysis should recognize the primacy of science goals over implementing missions. …should consider, in particular, …a two-phase decadal survey process that results in a science prioritization report first and then, after a period of community interaction with NASA and mission formulation, a separate implementation prioritization report.

Review problems of recent surveys with respect to fiscal uncertainties and to specifically consider the effect of the "blackout-period" when NASA, NSF, and other federal agencies cannot share the details up the forthcoming federal budget and the NRC cannot share the progress on the decadal-survey's recommendations.

Also, from the Statement of Task:
Consider 'best practices' for prioritizing science, CATE, improving budget guidance, better interagency and international cooperation, use of decision rules after a survey, and review the role of SSB standing committees.

The issues identified during the NRC workshop "Lessons Learned in Decadal Planning in Space Science" held in November 2012 in Irvine will be a major input to the committee's deliberations.

Chapter 1: *Introduction to Decadal Surveys*

A 'Short Course' in Decadal Surveys
Decadal Survey Structure and 'Moving Parts'
The Statement of Task of a Decadal Survey*

Chapter 2: *Decadal Survey Process*

Mission Formulation
Science & Mission Prioritization*
Suggested changes in the Prioritization Process*
The "blackout problem"*
The CATE process*

Chapter 3: *The Decadal Survey Report*

The Existing Program
The Survey's Recommended Program*
- – Advice to Agencies
- – High Profile Missions

Communication of the Decadal Program

Chapter 4: *Implementing the Decadal Survey*

Decision Rules*
Stewardship – SSB & other tactical advice*
International Activities
Interagency Issues

From the Report Summary:

The committee's conclusions are presented in the context of a successful round of recent decadal surveys…In particular, the task of defining the scientific frontier and deciding on a discipline's future direction is complex and difficult, but this has been done smoothly and reliably through the decadal survey process.

The last paragraph:

The committee concludes that the decadal survey process has been very successful. Indeed, decadal surveys set a standard of excellence that encourages the hope that similar processes could be applied more widely across the nation's science programs. While it has no major flaws, the survey process can, and should, improve and evolve. The remarkable record of decadal surveys makes the committee optimistic that useful changes can and will be made.

Goals of the Report

The committee's goal has been twofold: (1) to provide a handbook to guide the organizers of future surveys, with a…discussion of both "tried and true" and novel methods and (2) to identify lessons learned from prior surveys and best practices that have been gleaned from them.

Three examples of guidance to future surveys:

In some communities, implementation is not separable from science goals, while in others the science goal takes precedence and might be implemented in a variety of ways.

***Best Practice**: The practice within decadal surveys of not defining specific NASA mission concepts for lower-cost and competed missions, yet recommending that such missions address priority decadal survey goals and objectives, allows flexibility to leverage innovative implementation approaches.*

The community's perception of a "fair hearing for all comers" is essential: equality of opportunity must be assured where equality of outcome is not. The survey report and, in particular, the panel reports, record the paths taken through the process by the top science priorities and favored implementation strategies...the decadal survey report needs to be seen as a consensus document that is not circumvented by "special interests" pleading their priorities…

Science prioritization – the heart of the decadal survey

Different disciplines prioritize using different approaches and techniques. Common across disciplines is a tendency for survey committees to provide a broad set of prioritization criteria to guide the work of the panels, which individually have a sharper focus.

Examples of prioritization themes and criteria

Earth2007

- *The most important scientific questions facing Earth sciences today (scientific merit, discovery, exploration)*
- *Applications and policy making (societal benefits)*
- *The long-term observational record of Earth*

Planetary2011

'priority themes'

- *Building new worlds—understanding solar system beginnings*
- *Planetary habitats—searching for the requirements of life*
- *Workings of solar systems—revealing planetary processes through time*

'prioritization criteria' (highly interactive committee-panel system!)

- *Science return per dollar*
- *Programmatic balance—striving to achieve an appropriate balance across the solar system and an appropriate mix of small, medium, and large missions*
- *Technological readiness*
- *Availability of trajectory opportunities within the 2013 to 2022 time period*

Science & Mission Prioritization

*The report that emerges from the decadal process translates and transforms the scientific aspirations of the community into a **program**: new facilities—space missions and ground-based observatories/telescopes, technology and infrastructure development, enhanced educational opportunities, and numerous enabling activities… crafted with an awareness of [agency] research and programmatic interests.*

The committee thought long and hard about the question—asked in its SoT—concerning the pros and cons of separating science prioritization from mission prioritization. We agree wholeheartedly regarding the "primacy of science" spoken of in the SoT:

After all, it is first and foremost the science that is being prioritized in a decadal survey, not any particular design for a mission or facility.

However, the committee concluded that prioritization by science alone cannot be taken very far. We point to the 5 Astro2010 Science Frontier Panels. Each composed 4 questions, specific to their subdiscipline but fairly general, to identify 'priority science goals.' However, there was no priority order within each set, nor any prioritization across these subdisciplines.

Nevertheless, these SFP questions were the foundation of the Astro2010's recommended program. By stacking 'what we want to do' against 'what we can do' we add another essential dimension to judging science priority.

The committee was also asked to consider a related proposal matter: a "two-phase" decadal survey process, one where science is prioritized first, as in Astro2010, with a break to communicate the results to the community and the agencies to "tune" the formulation of missions…looking at the Astro2010 example, that a high-priority but unranked list of science goals would not facilitate the mission formulation process…In fact, participants in the 2012 workshop speaking on behalf of planetary science, Earth science, and heliophysics surveys insisted that their highly interactive (and successful) process of science and mission prioritization would be disabled by attempts to divorce the two. The committee concluded that decisions as to how a decadal survey will prioritize science and recommended programs are best left to the survey committee itself.

However, *the committee strongly endorses reviewing the 'state of the science' before a new survey begins, as distinct from creating a new process to do 'science prioritization.' Fortunately, there are ongoing activities to facilitate that activity, including the midterm decadal review, and the Space Studies Board with its discipline-specific standing committees.*

This [science review] *process could include workshops, sessions at meetings of professional societies, white papers, and, perhaps, an NRC-sponsored process under the direction of the Space Studies Board. The goal would be to assess how science has evolved from the last survey and call attention to emerging areas of promise. Community ideas for implementation of these science themes could lead to preparatory studies of missions and facilities.*

– A similar global process for advancing potential international missions is possible.

What motivated "science first" or "science only?"

[In Astro2010] "this 'science first' structure was intended to avoid 'picking specific science goals because they were what a preselected mission was good at doing." The Astro2010 survey's report emphasized that "optimizing [but not choosing] the implementation of their decadal aspirations is the responsibility of agency managers."

From the 2012 Workshop, the committee took NASA's request to consider 'science-only' or 'science-first' prioritization as motivated by a growing trend of surveys 'tying NASA's hands' in implementing the decadal program. **Mitigation**: The committee suggests 'best practices' to give SMD program managers more flexibility to incorporate other agency [NASA] interests, take advantages of new technology, international participation, etc.

***Lesson Learned**: The tendency to over-define mission concepts in pursuit of more accurate cost evaluation can stifle creative approaches to addressing survey goals.*

***Best Practice**: Decadal surveys can present their implementation strategies as reference missions —that is, a credible hardware configuration that can achieve the science goals and is sufficiently defined for robust cost evaluation—instead of blueprints for detailed implementation.*

Boland: The report tries hard to make the point that committees need to be explicit about what they're prioritizing (e.g., a cost-capped mission addressing certain priority objectives or an explicit direction for implementation based on detailed studies and cost evaluations) so the agencies themselves can make the appropriate decisions during implementation.

A Decadal Survey's 'Statement of Task (SoT)'

From our SoT: "Identify best practices for the statement of task that will result in a [survey] report that reflects the consensus of the authoring community, is attentive to the needs of sponsoring agencies, and remains "relevant in the face of technology and science advancements, budget evolution, and international cooperation opportunities…"

The committee believes that, in fact, the items in its SoT have become synonymous with what decadal surveys do and are. This means that the instructions given to surveys via their statements of task have consistently led to surveys that succeed in achieving these primary goals.

In other words, we're doing the right things, although perhaps we can do them better.
We give some examples:

SoTs can, for example, be made more explicit with respect to consideration of multiple budgetary scenarios (Chapter 2) and the extent to which existing programs, projects, or prior surveys' recommendations are reviewed. Agencies can also use the statement of task to identify any strong agency preferences with respect to how high-profile missions and interagency and/or international participation are considered (Chapter 3).

BOX 1.8
Specificity of Statements of Task

In order to appreciate the increase in scope and specificity of the statements of task that launched the most recent decadal surveys, it is necessary to study and compare them. The following eight quotes give a flavor of what is now expected:

> Take into account the principal federal- and state-level users of these observations and identify opportunities and challenges to the exploitation of the data generated by Earth observations from space (Earth2007, p. 383).
>
> [T]he committee will consider what ground-based and in-situ capabilities are anticipated over the next 10-20 years and how future space-based observing systems might leverage these capabilities (Earth2007, p. 383).
>
> In contrast to previous surveys of the field, in view of the number of previously recommended but unrealized projects, the prioritization process will include those unrealized projects, and it will not be assumed that they will go forward (Astro2010, p. 266-267).
>
> [I]t will develop its own estimate of the costs of the activity with help from an independent contractor with expertise in this area. It will not uncritically accept estimates provided by activity proponents or the agencies (Astro2010, p. 267).
>
> The Committee shall review relevant programs of other nations and will comment on NSF opportunities for joint ventures and other forms of international cooperation (Planetary2011, p. 320).
>
> This summary should, to the extent possible, be accompanied by decision rules that could guide NASA in adjusting the queue in the event of major unanticipated technical, cost, or other programmatic changes (Planetary2011, p. 320).
>
> [T]he findings and recommendations in the present survey should be harmonized with those developed and reported by the ongoing astronomy and astrophysics decadal survey (Helio2013, p. 328).
>
> In proposing a decadal research strategy, the Committee will make recommendations within the boundaries of expected future budgets and address choices which may be faced, given a range of budget scenarios. To that end, it is anticipated that NASA and NSF will provide an up-to-date understanding of these limitations during the course of the survey (Helio2013, p. 328-329).

NOTE: The Academies decadal surveys, Astro2010 (*New Worlds, New Horizons in Astronomy and Astrophysics*, 2010), Earth2007 (*Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, 2007), Helio2013 (*Solar and Space Physics: A Science for a Technological Society*, 2013), and Planetary2011 (*Vision and Voyages for Planetary Science in the Decade* 2013-2022, 2011), were published by the National Academies Press, Washington, D.C.

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The 'Blackout Problem'

During the formulation of the decadal survey, changes from previous notional "out-year" budgets for NASA may occur in OMB's formulation of the president's budget request for the coming year and notional budgets for the following 4 years. The net effect can be that a survey's recommendations may be inconsistent with the budget available when the decadal report becomes available. In addition, because the Academies cannot share the status of the survey's recommendations while committee deliberations are ongoing, the recommendations cannot be used to communicate science community planning to NASA or other agencies for use in formulating arguments to OMB for future funding.

(Agencies can continue to engage the Academies' standing committees while the decadal survey is in process…there are many other science-related issues that can and should be productively discussed during the approximately 2-year period…so that both the agencies and communities remain situationally aware. This also enables the agencies to request and receive advice in the interim, should it be needed to respond to emergent and/or time-sensitive opportunities.)

A different approach to setting anticipated funding levels, one separated from year-to-year expectations and fulfillment, would be to use the previous budgets of the particular NASA or NSF division, averaged over some number of years preceding the survey, as a "baseline" budget for the survey program. A flat budget, perhaps with a yearly adjustment for inflation, could be the starting point for planning a program, with a possible "up" and "down" adjustment assumed to provide a budget that would envelope future fluctuations in the division budgets.

How now, fare CATE?

The committee concluded that the process has become a ***best practice*** *by adding credibility to implementation plans. Furthermore, the CATE process will likely evolve to become more efficient and more easily adaptable to any particular decadal survey. The committee found little interest in returning to 'decadal surveys without CATE,' but instead widespread support of CATE and support for improving the CATE process.*

A best practice *for future CATEs could be to initially run a much larger number of candidate missions through a faster but coarser "cost-box" analysis, to provide a sense of scale for initial consideration. This extra step would reserve the full CATE for missions that are likely to become part of the recommended program—that is, those that require more detailed estimates. This 'two-step' approach would also help prevent CATE from pacing the survey process.*

Boland: Directly related to our suggested "reference-mission" concept: CATE can be used as an existence proof (cost box) or a detailed [CATE] estimate for a specific implementation.

A best practice *for future surveys is will be to give greater attention and added care in assessing and recommending potentially "discipline-disrupting" programs. A thorough and rigorous CATE process can help, but too often the true cost of such a mission cannot be well established until the program is well underway. Surveys can provide clear decision rules and decision points that will effectively establish cost caps, with the intent of triggering reconsideration of the mission and the possibility, or necessity, of rescoping its science capability.*

Challenges for Future Surveys (from the Report Summary)

***The biggest missions and facilities**. The difficulty, complexity, and cost of "flagship" (or "strategic," or "high-profile") missions and facilities have grown, creating substantial challenges for decadal surveys…How can robust evaluations of the costs of such missions be made, and cost growth be contained, to protect other missions and activities?...How can multi-decade programs be managed successfully? How might we protect important human resources, for example, the education and research support of the next generation of scientists, especially those with skills in technology development?*

Better understanding of cost, technical difficulty, and risk.

Better definition of the budget available to a decadal survey

Interactions with, and between, Federal Agencies.

International cooperation

High-Profile[1] (Flagship) Missions

Within each division of NASA SMD, there are facilities and missions with the potential to have large-scale impacts on the program due to their strategic importance, scope, and/or size. These so-called high-profile missions address critical science goals or questions for the decade. They are uniquely characterized by an implementation strategy that is performance-driven rather than cost-constrained.

Performance-driven missions are driven by specific measurement or other requirements rather than cost constraints. This is contrasted with (typically) PI-led cost-capped missions where de-scopes are required if a performance requirement cannot be met within pre-established cost constraints.

Because a substantial part of the science accomplished in a decade comes from smaller missions, it is important for surveys to strike a balance between larger, non-competed, high-profile missions and the competed line of smaller missions. Yet, high-profile missions continue to be critical parts of the program because certain missions cannot simply be broken down in an efficient or effective manner into smaller components and still accomplish the science goal.

[1]High-profile missions, as the term is used here, refer to missions of significant importance to a program that are able to have substantial negative impact on program health if not implemented successfully or within fiscal constraints.

High-Profile Missions (cont.)

Lesson Learned: *High-profile missions are special cases within each of the disciplinary areas, presenting great opportunities for major advances in understanding, but also carrying significant risk for maintaining a balanced portfolio of activities—should unanticipated cost growth occur.*

Lesson Learned: *Mission creep within high-profile missions and large facilities and a general unwillingness to de-scope or cancel large missions or facilities during development can result in large, negative impacts on other programs at the division and directorate level.*

Best Practice: *When recommending high-profile missions, survey committees are advised to explicitly state which aspects of the project are essential to retaining the mission's consensus priority and which can be further considered during design development to enable cost control.*

Best Practice: *Clear decision rules for high-profile missions and large facilities that include both de-scope and cancellation options can provide some level of protection against unconstrained cost growth and possible collateral damage to other programs.*

Best Practice: *Strong preferences by the agencies on how to deal with high-profile missions and interagency and/or international participation in missions and facilities need to be spelled out in the statement of task.*

Other important topics in the Report

Evaluating the Existing Program

Balance in the Program

Decision Rules

Stewardship

International Activities

Interagency Issues

Evaluating the 'Existing' Program

An issue brought up by NSF Directors in testimony to the committee:
In addition to reprioritizing "non-started" programs from the past survey should decadal surveys *"examine the existing program facilities and missions and make recommendations on their continued operation*," to free up resources for the new program?

A survey committee is constituted with an eye to broad across-the-discipline balance: it is unlikely to contain either the scientific or technical expertise to compare the merits of continuing or terminating a small group of extant missions or facilities.

Best Practice: *Decadal surveys may review the recommended program from previous surveys and choose to endorse certain activities in their own recommendations. Such reviews are best if they focus on those missions and facilities that play a critical role in the proposed science of the survey report.*

The freedom to review and endorse (or not) previously recommended program elements only applies to activities, such as missions, facilities, and observing systems, for which implementation has not yet begun. Decadal survey committees may choose to look at the cost-effective science return of existing missions and facilities and make evaluations based on their relevance and importance to the new proposed program, with the aim of increasing available resources for the next decade.

Balance in the Recommended Program

Balance must be considered between small, medium, and large missions; between competed and non-competed missions; between long time-continuity and science-focused missions (e.g., Earth sciences and heliophysics); between PI-led and (NASA) center-led missions; between missions and programs for research and those for technology, education, and workforce development; and between sub-disciplines within each division (e.g., destination classes within the solar system for PSD).

Lack of balance has negative consequences. For example, programs that strongly emphasize high-profile mission opportunities can make significant progress on one or two important topics, but may lack the agility to respond to scientific developments…

Reducing support for theory, modeling, and data analysis may advance the start of the next project…but…lead to inadequate exploitation of investments made in collecting observations and ultimately break the cycle that creates the scientific and technical innovations for the future.

***Best Practice:** In developing the recommended decadal program, survey committees and panels are advised to include explicit consideration of various forms of programmatic balance…for example, the balance across the subdisciplines, between mission and non-mission activities, between novel and continued observations, across mission and facility cost, and between program elements (e.g., R&A, technology, infra- structure, missions) and activities (e.g., education, engagement, and workforce development).*

Decision Rules

Decision rules serve several purposes. First, simply by considering alternative scenarios, the survey committee can clarify its process for setting priorities.

Second…when external priorities shift, swings in the national economic situation take place, scientific or technical advances…a plan developed with quite reasonable initial assumptions can become suboptimal, if not obsolete…decision rules anticipate such changes, they can help preserve the relevance of the strategic goals, even if the original implementation can no longer be realized.

***Best Practice:** Decision rules ordinarily are best when strategic in nature rather than tactical. The objective is to provide insight into how science priorities evolve or change under specific circumstances without over-constraining implementation. Long-term advice that advances the scientific goals of the community is useful, whereas short-term rules quickly become obsolete or are better determined by administrators, policy makers, and community members familiar with the immediate situation.*

Decision Rule 1. Missions in the STP and LWS lines should be reduced in scope or delayed to accomplish higher priorities. Chapter 6 gives explicit triggers for review of Solar Probe Plus.
Decision Rule 2. If further reductions are needed, the recommended increase in the cadence of Explorer missions should be scaled back, with the current cadence maintained as the minimum.
Decision Rule 3. If still further reductions are needed, the DRIVE [Diversify, Realize, Integrate, Venture, Educate initiative] augmentation profile should be delayed, with the current level of support for elements in the NASA research line maintained as the minimum.

Stewardship – Standing Up the Standing Committees

It has been traditional for the SSB standing committees of a particular discipline to "stand down" during the 2 years or more that its new decadal survey is in progress …is thought to have resulted from a concern that federal agencies might receive contradictory input…The actual benefits of this practice are uncertain, but the disadvantage is clear: a hiatus of 2 years or more during which NASA and other agencies are unable to engage with a standing committee on implementation of the previous decadal survey or any other time-sensitive issues that may arise.

***Lessons Learned**: As long as the standing committee restricts its work to the current program, there is no meaningful conflict that would preclude continuation of the SSB standing committees during the execution of a decadal survey.*

***Best practice**: SSB standing committees can continue their work throughout the period when a new decadal survey is in process in order to provide an uninterrupted channel of communication between the SSB standing committees and NASA and other agencies, with respect to the strategic issues that concern the current program.*

Stewardship – Short-term Tactical Advice on Strategic Visions

The NAC , a [FACA] committee reporting to the NASA Administrator...provides rapid tactical advice…[on] performance of individual programs and projects…In the case of SMD, the appropriate advisory group is the NAC Science Committee. While the activities of the NAC Science Committee follow FACA guidelines, they are not officially a FACA committee and cannot provide official advice to NASA…the Science Committee does not officially advise the associate administrator (AA) for SMD except by providing input to the NAC that is then passed either through the NASA Administrator and back down to the AA.

Similarly, the subcommittees of the NAC Science Committee that represent the four SMD disciplines cannot provide official advice to the appropriate division directors…Because the various committees and subcommittees of the NAC meet only every few months, official tactical advice at the divisional level is rarely rapid, and discipline-level issues do not often qualify as sufficiently important to justify attention from the NAC during its meetings.
(difficulties also with tactical advice through SSB standing committees and NASA AGs)

Lesson Learned: *The current advisory structure does not provide an effective mechanism for short-term tactical guidance [on strategic visions] from the scientific community.*

Best Practice: *NASA [SMD] division directors and program offices for other interested agencies…can work with the SSB's standing committees to commission letter reports, meetings of experts, or workshops when specific advice is needed on a more rapid turnaround basis.*

International Activities – pros and cons

- *Optimizing the mission definition*
- *Enabling missions that could not be afforded by individual agencies*
- *Enhancing mission capabilities*
- *Accelerating mission implementation*
- *Reducing mission cost in some tangible way to one or more partners*
- *Strengthening the national commitment to the mission*

- *Mission selection processes that may be asynchronous and have substantial differences.*
- *Difficulty in securing commitment to a joint project—Who will commit first to a program that one nation cannot accomplish on its own?*
- *Technologies are often proprietary and not easily shared (e.g., issues associated with ITAR*
- *Differences in data policy.*
- *Community building and mission-concept development processes that may vary greatly over the world's space agencies.*
- *Varying planning processes.*
- *Different relationships between agencies and their governments, in particular in terms of commitments to funding or the cancellation of existing commitments.*
- *Concerns about security and sharing of resources—for instance, the security requirements for launching missions using nuclear power sources from Europe on a European launcher, and vice-versa*
- *Organizational communication and managerial issues.*
- *International politics.*
- *Cost evaluation of foreign contribution.*
- *Impediments to U.S. participation in foreign meetings, given current federal restrictions on travel and conference attendance.*

International Activities – Best Practices

Best Practice: *Decadal studies can use a combination of existing scientific conferences, meetings, and symposia, as well as more targeted dialogues between survey committees and their closest analogs in the scientific advisory apparatus of other countries, to ensure that lines of communication are open.*

Best Practice: *Individual, non-U.S. scientists can be invited to participate in a decadal survey. Participants need to be selected for their scientific backgrounds and expertise, not as institutional representatives, and be cognizant of a broad range of international activities. International representatives that are experienced and senior enough can provide information that will open avenues for collaboration and strengthen channels of communication back to their home space agencies and national space societies and organizations.*

Best Practice: *Decadal reports can include specific descriptions of the types of international collaboration that the decadal survey committee finds desirable (e.g., cost-sharing, development of instrumentation, coordination of individual missions, or mission architecture).*

Best Practice: *Decadal reports can explicitly identify any significant programmatic uncertainties and/or craft decision rules that might be required when considering international collaborations. This may be particularly important when international collaborations are a significant component of the survey's recommended program—in terms of budget or scientific strategy.*

Interagency Issues

In its 2011 report about interagency cooperation, the Academies made the strong recommendation that any given space program of the U.S. government be carried out—if at all possible—by a single responsible agency. However, it was recognized that, in some instances, a particular agency might not have the mix of experience and technical capability to carry out the requisite programmatic functions to assure space mission success. In these cases, interagency cooperation would be deemed essential. Examples included certain kinds of instrument designs unique to DOE laboratories for NASA Astrophysics missions…Another example is the extensive use of NASA's capabilities in support of NOAA's weather mission.

Best Practice: *Achieving the science goals of a decadal survey and successfully implementing survey recommendations requires that the science program be acknowledged as an interagency, multi-agency activity, one that typically extends beyond the purview of a NASA SMD division.*

Best Practice: *Participation by all relevant agencies is optimized when decadal reports include specific descriptions of the types of interagency collaboration that the decadal survey committee finds desirable.*

In conclusion…

Steve Mackwell says: “I also think that it should be on the last slide in your set, following the presentation mantra - tell them first what you are going to tell them, and then tell them at the end what you have just told them. The key issue in many respects is that the Decadals work and work exceptionally well, and this statement says that loud and clear. Our major statement is, in many ways, don't screw them up.’’

The committee concludes that the decadal survey process has been very successful. Indeed, decadal surveys set a standard of excellence that encourages the hope that similar processes could be applied more widely across the nation’s science programs. While it has no major flaws, the survey process can, and should, improve and evolve. The remarkable record of decadal surveys makes the committee optimistic that useful changes can and will be made.