

# Review of NASA's Planetary Science Division's Restructured Research and Analysis Programs

Steve Mackwell

*Academies SSB*

*May 4, 2017*

# Charge to the Committee

*The Space Studies Board will convene an ad hoc committee to examine the program elements of NASA's Planetary Science Division (PSD) Research and Analysis (R&A) programs, as they currently exist following restructuring, for their consistency with past advice from the Academies. In conducting its review, the committee will address the following questions:*

- 1. Are the **PSD R&A program elements** appropriately linked to, and do they encompass the range and scope of **activities** needed to support the **NASA Strategic Objectives for Planetary Science** and the **Planetary Science Division Science Goals**, as articulated in the 2014 NASA Science Plan?*
- 2. Are the **PSD R&A program elements** appropriately structured to develop the broad base of knowledge and broad range of **activities** needed both to enable new **spaceflight missions** and to interpret and maximize the scientific return from existing missions?*

*In conducting its task, the committee will:*

- Not examine the PSD R&A programs as they were prior to the restructuring;*
- Conduct its review in the context of current budgetary realities that have differed from projections assumed prior to the release of the most recent planetary science decadal survey; and*
- Not comment on the strategic science goals and objectives of PSD, SMD, or NASA.*

# Committee Membership\*

|                           |                    |
|---------------------------|--------------------|
| Joe Alexander             | NASA (ret.)/NRC    |
| Mike A'Hearn              | U. Maryland        |
| Joe Burns                 | Cornell            |
| Nobu Shimizu (consultant) | WHOI               |
| Larry Esposito            | U. Colorado / LASP |
| Scott Hubbard             | Stanford           |
| Torrence Johnson          | JPL                |
| Peter Kelemen             | Columbia U.        |
| Makenzie Lystrup          | Ball Aerospace     |
| Steve Mackwell (Chair)    | USRA               |
| Juan Perez-Mercader       | Harvard            |
| John Rummel               | McGill U.          |
|                           |                    |
| David Smith               | NRC                |
| Charlie Harris            | NRC                |
| Dionna Williams           | NRC                |

*\* Committee members could not be current recipients of NASA PSD R&A funding*

# PSD R&A Program Elements\*

## 2014 Reorganization of Planetary R&A

- Predominantly to Core Research; Core Technology had been previously reorganized; data analysis programs change as needed
- First announced in ROSES 2014
- First funded award used FY15 funds (around 30% of \$FY15 funded under new program; 66% of \$FY16)

| Core Research             | Strategic                     | Focused                      |
|---------------------------|-------------------------------|------------------------------|
| Emerging Worlds           | PDART (data archiving, tools) | LDAP (lunar data analysis)   |
| Solar System Workings     | PSTAR (analogues)             | CDAP (Cassini data analysis) |
| Habitable Worlds          | Exoplanets (joint with Astro) |                              |
| Exobiology                | DDAP                          |                              |
| Solar System Observations | NFDAP                         |                              |
| Core Technology           | LARS                          |                              |
| MatISSE                   | MDAP                          |                              |
| PICASSO                   | Planetary Protection          |                              |
| Planetary Major Equipment |                               |                              |

\*Program elements per 2016 ROSES

Calls from previous ROSES Years

New Core Research element in  
ROSES 2014

Origins of Solar Systems

Cosmochemistry

Planetary Geology & Geophysics

Planetary Atmospheres

Lunar Adv. Sci & Exp Research

Outer Planets Research

Mars Fundamental Research

Exobiology & Evolutionary Biology

Planetary Observations

Near-Earth Object Observations

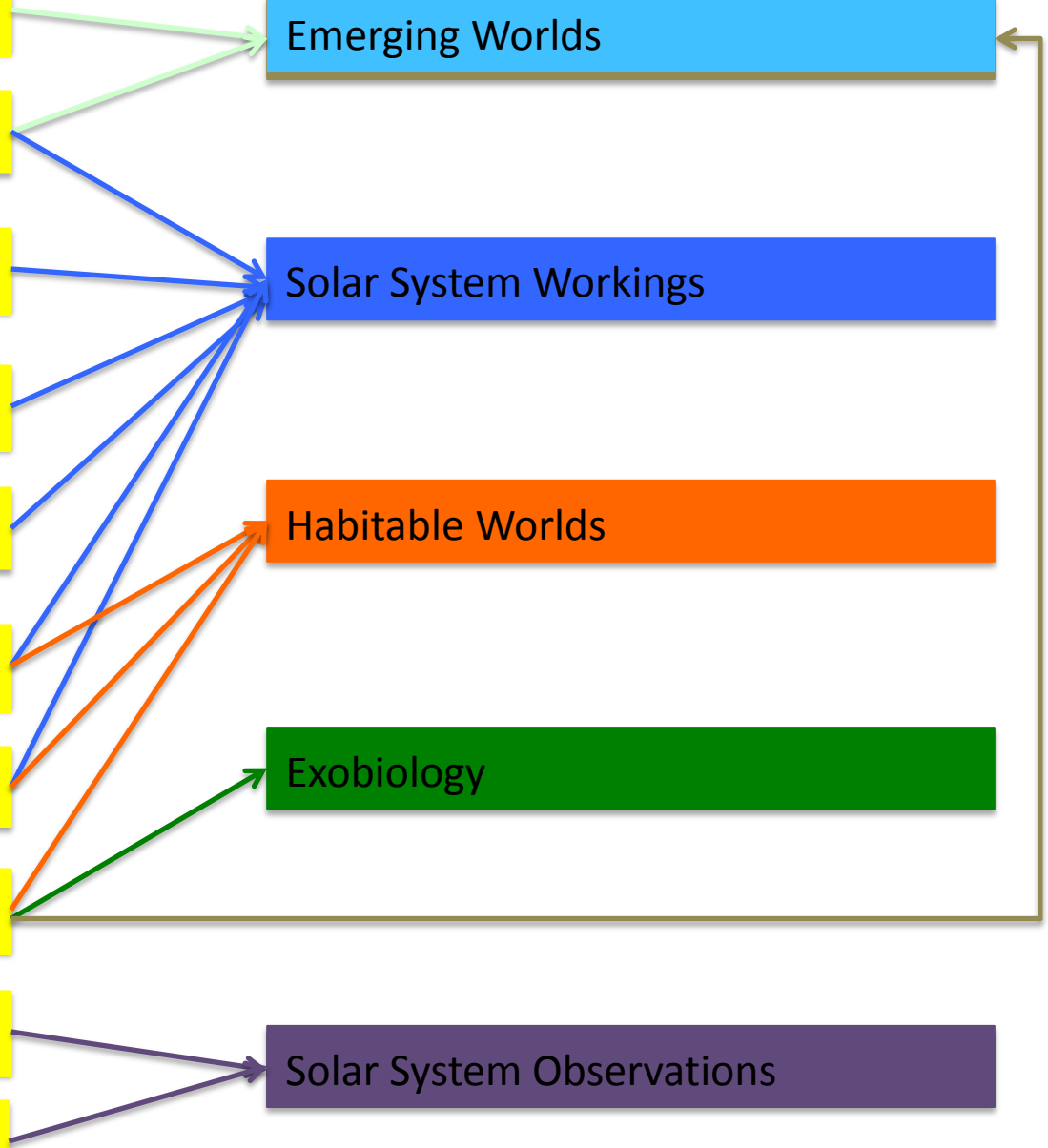
Emerging Worlds

Solar System Workings

Habitable Worlds

Exobiology

Solar System Observations



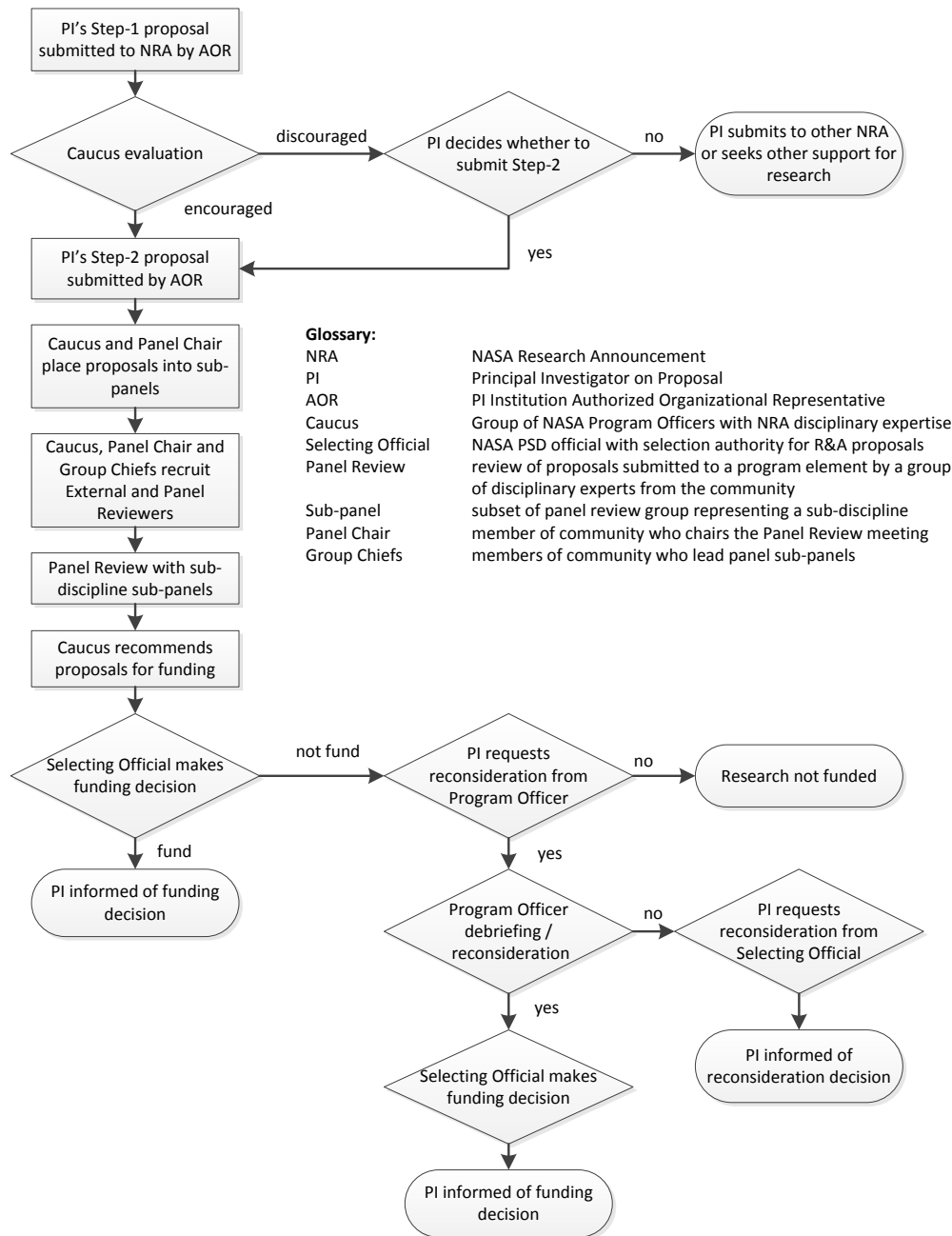
# Answering the questions

In order to answer the 2 questions we needed to understand how PSD has implemented the new program in order to address:

- Whether the implementation strategy has been optimized under the new program structure to support linkage of R&A supported activities to NASA Strategic Objectives for Planetary Science and the PSD Science Goals;
- How strategic funding decisions are made both within and between R&A program elements; and
- How issues of balance are dealt with under the more encompassing program elements - the challenges have changed
  - Balance includes: target bodies, sub-disciplines, interdisciplinary versus disciplinary research, risk/payoff level, innovative versus routine activities, PI career level, diversity, etc.
  - Balance is needed both within R&A program elements and between program elements

# Flow chart for NASA PSD processing of proposals submitted to R&A program elements

- a good process if it is followed



# Process Recommendations

With respect to the procedures followed by PSD in the implementation of the current program, the committee recommends the following:

***Recommendation 2-1:*** In conducting scientific peer reviews of research proposals, NASA PSD should recruit several (at least two or three) external (mail) reviewers well in advance of panel reviews. These reviews are critical to a fair and effective proposal evaluation process, particularly when the review panels have a more interdisciplinary character. The panel chair and group chiefs, if recruited early, can take the lead in identification of appropriate external reviewers.

***Recommendation 2-2:*** NASA PSD should expeditiously complete establishment of the process for reconsideration of proposal selection decisions, develop and implement a formal mechanism to track debriefing and reconsideration requests across program elements, and inform the community about the process. The statistics collected in this way can provide the planetary science community with greater confidence that NASA has appropriate checks and balances in the selection process.

# Question 1:

*Are the **PSD R&A program elements** appropriately linked to, and do they encompass the range and scope of **activities** needed to support the **NASA Strategic Objectives for Planetary Science** and the **Planetary Science Division Science Goals**, as articulated in the 2014 NASA Science Plan?*

Planetary Science Decadal Survey:  
Cross-Cutting Themes

2014 NASA Science Plan:  
NASA's Planetary Science Goals

Building new worlds –  
understanding solar system  
beginnings

Explore and observe the objects in the  
solar system to understand how they  
formed and evolve

Planetary habitats – searching for  
the requirements for life

Advance the understanding of how the  
chemical and physical processes in our  
solar system operate, interact and evolve

Explore and find locations where life  
could have existed or could exist today

Workings of solar systems –  
revealing planetary processes  
through time

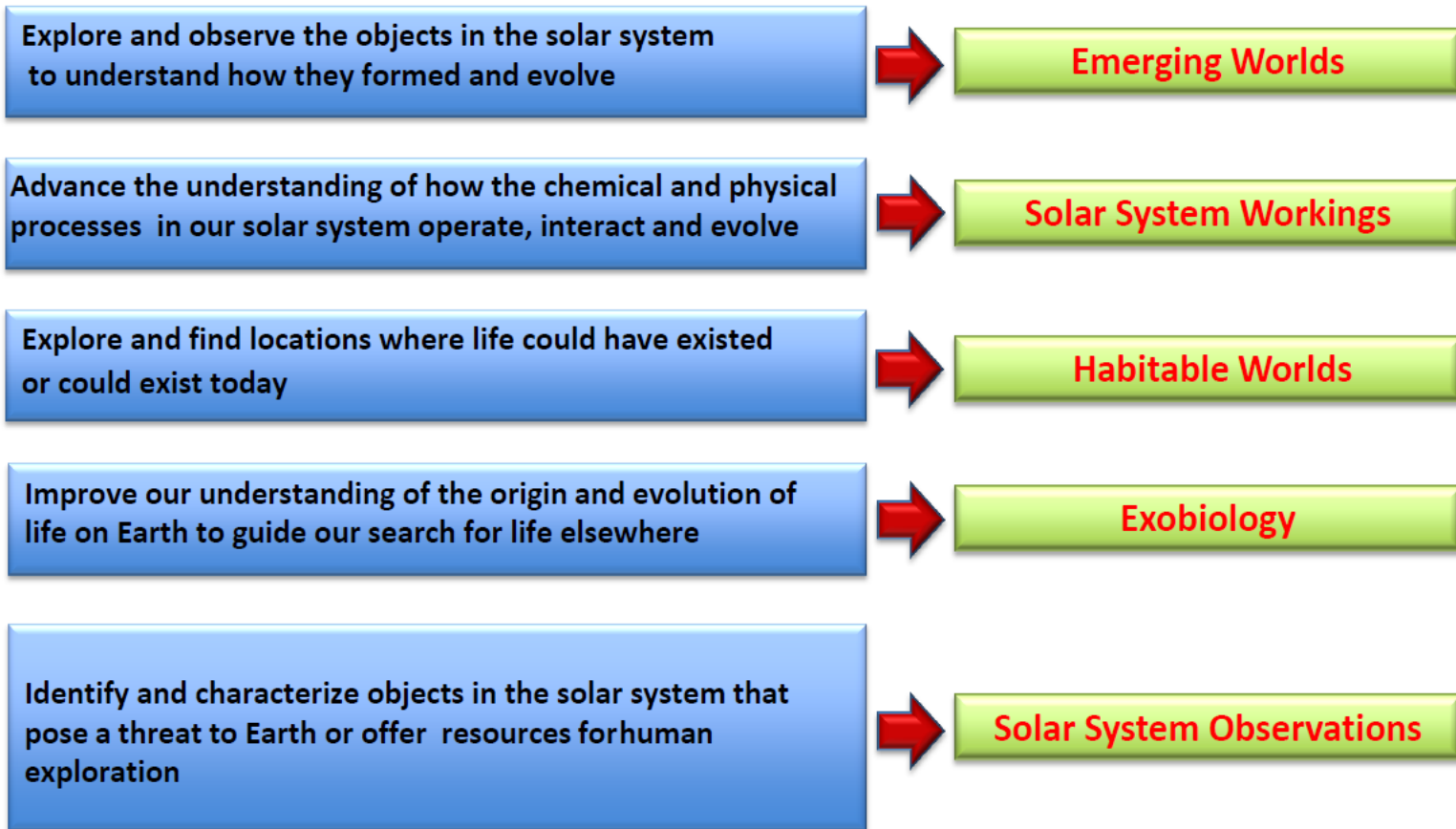
Improve our understanding of the origin  
and evolution of life on Earth to guide  
our search for life elsewhere

Identify and characterize objects in the  
solar system that pose a threat to Earth,  
or offer resources for human exploration



# How the Core Research Programs were designed by PSD

The five new core programs are aligned with PSD's goals/objectives.



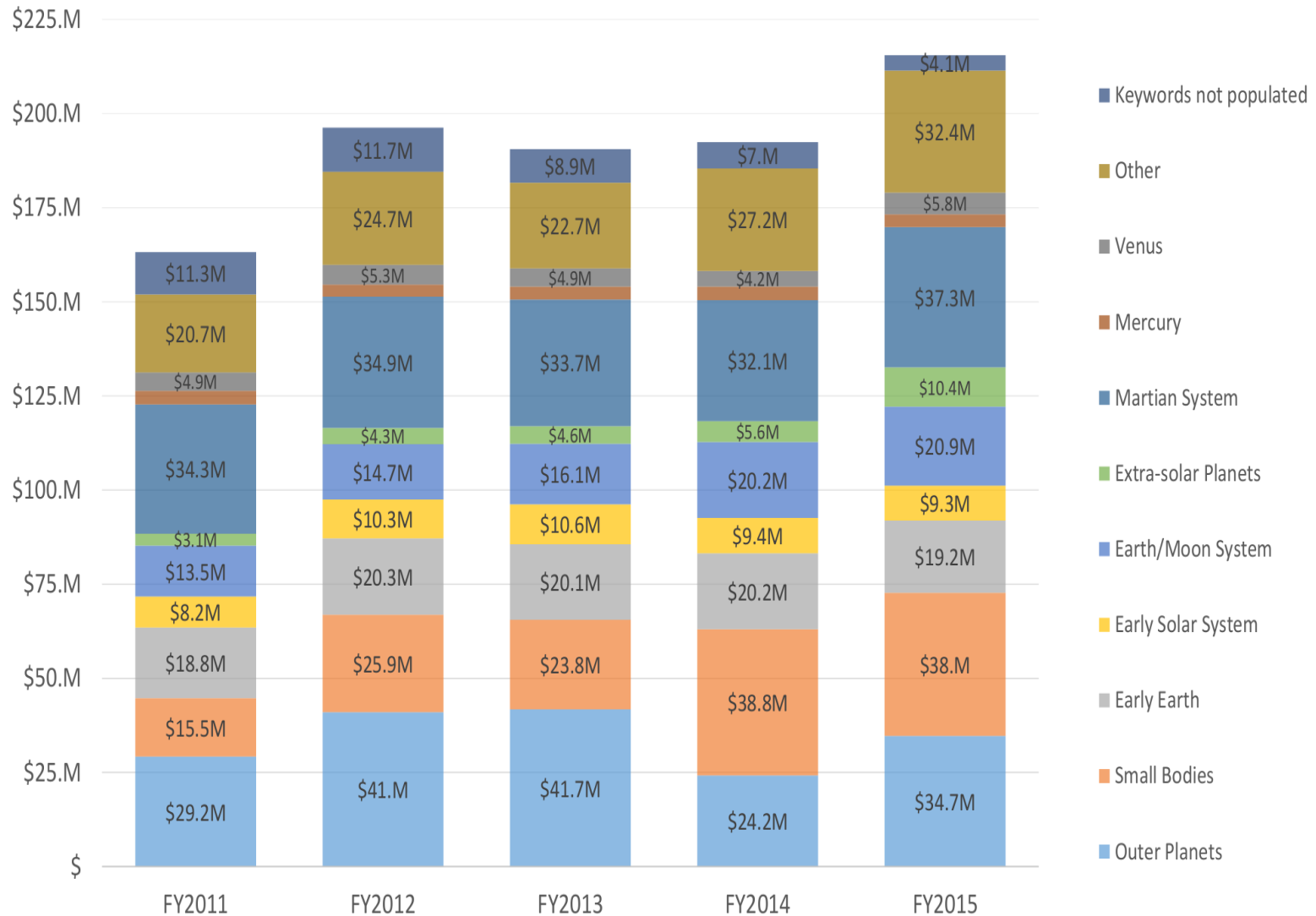
# How can we tell if the new program elements fully encompass the needs in NASA's strategic planning documents?

*Were any planetary science community groups disenfranchised by reorganization?*

PSD program officers assign keywords to each proposal to identify:

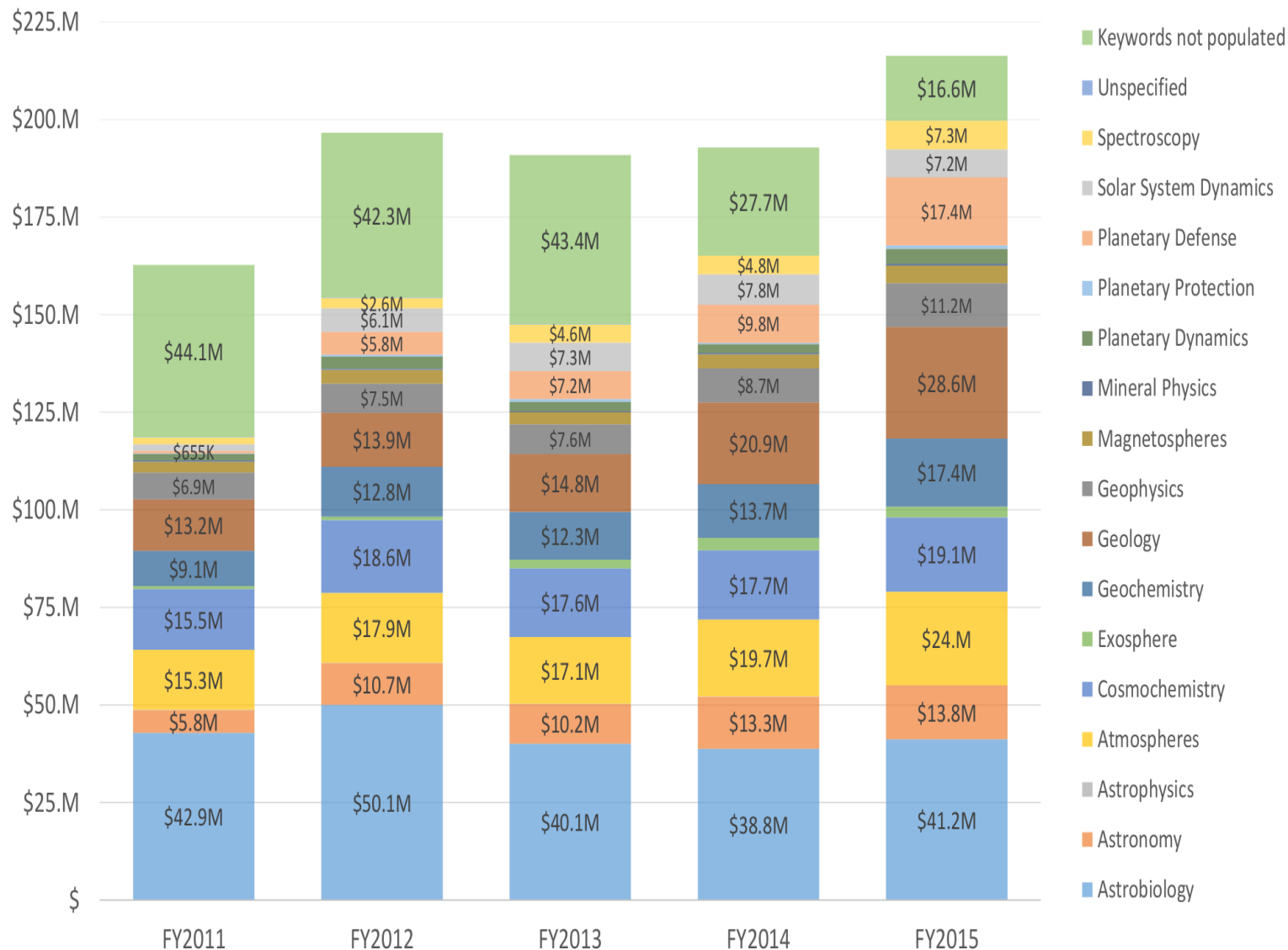
1. *Type of task (e.g., sample analysis, theory, experimental, field-based, mission data analysis)*
2. *Target body (e.g., Venus, Jupiter, extra-solar planets, outer planets, and subsets thereof)*
3. *Science discipline (e.g., cosmochemistry, spectroscopy, astrobiology, geophysics)*
4. *Data/sample source (mission or facility) (e.g., Ames vertical gun range, Pioneer Venus, Juno, Mars Odyssey, Curiosity, New Horizons)*

## KEYWORD 2 - TARGET BODY OVERVIEW



Note that FY2014 was fully in the previous program structure, while only about 30% of funding for FY2015 was under the new program element structure

### KEYWORD 3 - SCIENCE DISCIPLINE



Note that FY2014 was fully in the previous program structure, while only about 30% of funding for FY2015 was under the new program element structure

# Question 1: General Conclusions

Question 1: Are the *PSD R&A program elements* appropriately linked to, and do they encompass the range and scope of *activities* needed to support the *NASA Strategic Objectives for Planetary Science* and the *Planetary Science Division Science Goals*, as articulated in the 2014 NASA Science Plan?

*Do they align well?*

YES

*Did any subdiscipline or target body/group get lost in the reorganization?*

NOT THAT WE CAN SEE; there is no clear evidence of any substantial change in distribution of funds by discipline or target body

*Do the new program elements and associated processes encompass the range and scope of activities needed...?*

Interdisciplinary science, and high-risk/high-payoff research do not necessarily review well. There are some advantages to the new program, but there is still work to do.

*What about program balance (distribution of funding across sub-disciplines within a program element, and across program elements)?*

Seems to be working, but needs to be watched and evaluated periodically

*Transparency between NASA and the science community?*

Clearly needs work, despite PSD efforts

# Mapping to Goals Recommendations

With respect to how effectively the current R&A program elements align with PSD science goals, and whether specific research areas or sub-disciplinary groups that are critical to NASA's mission are not supported appropriately in the current program, the committee made the following recommendations:

***Recommendation 3-1:*** An appropriate mechanism is needed to ensure that high risk/high-payoff technology and research activities can receive appropriate consideration during the review process.

***Recommendation 3-2:*** A formal assessment by NASA of how well the program structure and funding are aligned with Planetary Science Division's Science Goals should be conducted at least every 5 years.

## Question 2:

*Are the **PSD R&A program elements** appropriately structured to develop the broad base of knowledge and broad range of **activities** needed both to enable new **spaceflight missions** and to interpret and maximize the scientific return from existing missions?*

# Question 2: General Conclusions

Question 2: Are the *PSD R&A program elements* appropriately structured to develop the broad base of knowledge and broad range of *activities* needed both to enable new *spaceflight missions* and to interpret and maximize the scientific return from existing missions?

*Is the current program structured to prepare for future missions?*

*In general yes, though science involving surveys of planetary objects in preparation for future missions does not usually fare well in review.*

*Is the current program optimal for scientific return from past and current missions?*

*In general, yes.*

*Are the current technology programs sufficient to prepare for future missions?*

*Likely greater priority is needed to these programs.*

*Is there a timeline problem? (R&A – 3 years, missions – 6+ years, sample return – 10+ years)*

*There is a concern about maintenance of facilities and expertise from R&A funding on mission timelines. Long lead times are needed for receiving and curation of returned samples (cryogenic / astrobiological samples)*

# Mapping to Missions Recommendations

With respect to whether the current R&A program adequately supports existing missions and prepares the way for future missions, the committee recommended the following:

***Recommendation 4-1:*** NASA should support the development of the capability to return astrobiological and cryogenic samples to Earth and the appropriate containment, curation and characterization facilities consistent with Planetary Science Division Science Goals and planetary protection requirements.

***Recommendation 4-2:*** In making funding decisions for the various R&A program elements, NASA should consider the need to sustain critical scientific/technical expertise and instrumental/facilities capabilities required for scientific return on future missions, as defined in the planetary science decadal survey.

## *Overarching Comments*

The reorganization has largely achieved the intended plan to improve linkage of PSD's R&A program to NASA's strategic objectives for planetary science and PSD goals, as well as to current and future missions.

Nonetheless, diligence is needed to ensure maintenance of programmatic balance and optimal distribution of scarce resources.

# Meeting 1:

*National Academies, Washington, DC*

*May 12-13, 2016*

## **Presentations**

### *Setting the stage:*

|               |             |                                                                                                 |
|---------------|-------------|-------------------------------------------------------------------------------------------------|
| James Green   | NASA HQ     | background to charge to the committee                                                           |
| Jonathan Rall | NASA HQ     | status of PSD R&A program                                                                       |
| Max Bernstein | NASA HQ     | status of other SMD R&A programs                                                                |
| Len Fisk      | U. Michigan | report on Academies <i>“An Enabling Foundation for NASA’s Earth and Space Science Missions”</i> |
| Mark Sykes    | PSI         | report on Planetary Science Subcommittee’s Greeley-Sykes Report                                 |

### *Community perceptions:*

|                |               |        |
|----------------|---------------|--------|
| Clive Neal     | Notre Dame    | LEAG   |
| Nancy Chabot   | JHU-APL       | SBAG   |
| Alfred McEwen  | U. Arizona    | OPAG   |
| Andy Westphal  | UC Berkeley   | CAPTEM |
| Jeff Johnson   | JHU-APL       | MEPAG  |
| Jani Radebaugh | Brigham Young | MAPSIT |
| Bob Grimm      | SWRI          | VEXAG  |

# Meeting 2:

## *Keck Center, Washington, DC*

### *August 16-18, 2016*

#### **Presentations**

|              |         |                                          |
|--------------|---------|------------------------------------------|
| Ellen Stofan | NASA HQ | Planetary Science Community Demographics |
|--------------|---------|------------------------------------------|

#### *Center and PSS perceptions:*

|                  |              |                                        |
|------------------|--------------|----------------------------------------|
| Colleen Hartman  | NASA Goddard | Goddard Planetary Science Perceptions  |
| Eileen Stansbery | NASA JSC     | JSC Astromaterials Perceptions         |
| Christophe Sotin | NASA JPL     | JPL Planetary Science Perceptions      |
| Janet Luhmann    | UC Berkeley  | Overarching PSS Perceptions            |
| Jim Spann        | NASA MSFC    | Marshall Planetary Science Perceptions |
| Michael Bicay    | NASA ARC     | Ames Planetary Science Perceptions     |

#### *Brief AG revisits (by phone):*

|               |            |      |
|---------------|------------|------|
| Alfred McEwen | U. Arizona | OPAG |
| Tim Swindle   | U. Arizona | SBAG |

#### *Follow-up questions to NASA:*

|             |         |                                               |
|-------------|---------|-----------------------------------------------|
| Michael New | NASA HQ | Keywords and other issues raised by committee |
|-------------|---------|-----------------------------------------------|

#### **Closed Sessions**

Draft outline of report and preparation of a series of Findings and Recommendations

# Meeting 3:

## *Woods Hole, MA*

## *September 21-23, 2016*

### **Presentations**

Meagan Thompson NASA HQ

Key word analysis

### **Closed Sessions**

Draft text for report:

Chapter 1: Introduction

Chapter 2: PSD R&A Review, Recommendation and Reconsideration Processes

Chapter 3: Question 1: Mapping to Science Goals

Chapter 4: Question 2: Mapping to Missions

Cleaning up Findings and Recommendations in Chapters 2-4

# Vision and Voyages for Planetary Science in the Decade 2013-2022

## Cross –cutting themes:

### ***Building new worlds—understanding solar system beginnings***

- What were the initial stages, conditions, and processes of solar system formation and the nature of the interstellar matter that was incorporated? Important objects for study: comets, asteroids, Trojans, and Kuiper belt objects.
- How did the giant planets and their satellite systems accrete, and is there evidence that they migrated to new orbital positions? Important objects for study: Enceladus, Europa, Io, Ganymede, Jupiter, Saturn, Uranus, Neptune, Kuiper belt objects, Titan, and rings.
- 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? Important objects for study: Mars, the Moon, Trojans, Venus, asteroids, and comets.

### ***Planetary habitats—searching for the requirements for life***

- What were the primordial sources of organic matter, and where does organic synthesis continue today?
- Important objects for study: comets, asteroids, Trojans, Kuiper belt objects, Enceladus, Europa, Mars, Titan, and uranian satellites.
- Did Mars or Venus host ancient aqueous environments conducive to early life, and is there evidence that life emerged? Important objects for study: Mars and Venus.
- Beyond Earth, are there contemporary habitats elsewhere in the solar system with necessary conditions, organic matter, water, energy, and nutrients to sustain life, and do organisms live there now? Important objects for study: Enceladus, Europa, Mars, and Titan.

### ***Workings of solar systems—revealing planetary processes through time***

- How do the giant planets serve as laboratories to understand Earth, the solar system, and extrasolar planetary systems? Important objects for study: Jupiter, Neptune, Saturn, and Uranus.
- What solar system bodies endanger Earth's biosphere, and what mechanisms shield it? Important objects for study: near-Earth objects, the Moon, comets, and Jupiter.
- 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? Important objects for study: Mars, Jupiter, Neptune, Saturn, Titan, Uranus, and Venus.
- How have the myriad chemical and physical processes that shaped the solar system operated, interacted, and evolved over time? Important objects for study: all planetary bodies.

# NASA's 2014 Science Plan

## Planetary Science Questions:

1. How did our solar system form and evolve?
2. Is there life beyond Earth?
3. What are the hazards to life on Earth?

## Planetary Science Goals 2014 (with 2010 Science Plan questions in parentheses)

1. Explore and observe the objects in the solar system to understand how they formed and evolve (*How did the Sun's family of planets, satellites, and minor bodies form and evolve?*)
2. Advance the understanding of how the chemical and physical processes in our solar system operate, interact and evolve (*How do the chemical and physical processes active in our solar system operate, interact and evolve?*)
3. Explore and find locations where life could have existed or could exist today (*What are the characteristics of the solar system that lead to habitable environments?*)
4. Improve our understanding of the origin and evolution of life on Earth to guide our search for life elsewhere (*How did life originate and evolve here on Earth and can that guide our search for life elsewhere?*)
5. Identify and characterize objects in the solar system that pose threats to Earth, or offer resources for human exploration (*What are the characteristics of planetary objects and environments that pose threats to, or offer potential resources for, human as we expand our presence into the solar system?*)