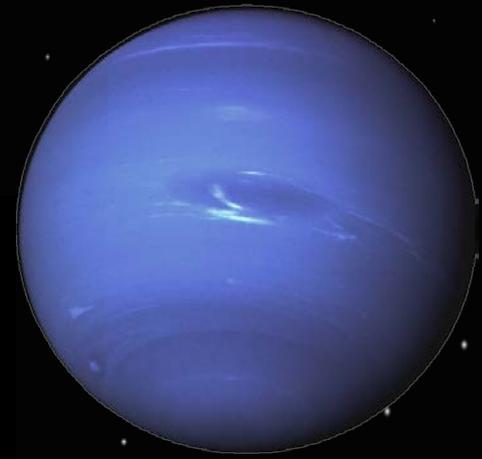
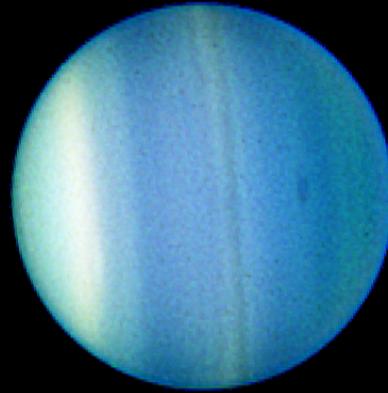
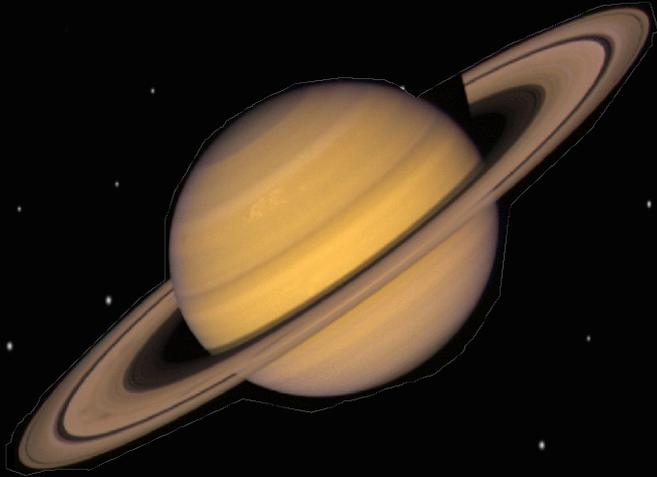


OPAG



13-14 January 2014



Outer Planets Assessment Group Charter

- OPAG is NASA's community-based forum designed to provide science input for *planning and prioritizing outer planet exploration activities for the next several decades.*
- Open to all interested scientists, OPAG regularly evaluates outer solar system exploration goals, objectives, investigations and required measurements on the basis of the widest possible community outreach.

OPAG activities since last meeting

- Two new committee members:
 - Julie Rathbun replaced David Williams
 - Zibi Turtle replaced Ralph Lorenz
- 13 OPAG responses were written and submitted to NASA's RFI for feedback on the Discovery and New Frontiers AO
- Comments on the proposed R&A structure were compiled and passed on to HQ
- Go to the OPAG website, update tab, to see the material for both of these items:

<http://www.lpi.usra.edu/opag/updates.shtml>

OPAG Concerns

New

- Cancellation of ASRG development
- Proposed restructure of the R&A program
- Persistent rumours that the Cassini mission will be terminated in 2015 rather than flying the complete Solstice Mission to September 2017

Ongoing

- Complete lack of new US-led missions to the outer solar system resulting in > decade gap in exploration of the outer solar system

Agenda

Monday, Jan. 13 (times are MST)

8:00 Welcome, meeting objectives, logistics – Candy Hansen (+LaTessa +Linda)

8:15 Remarks from NASA Chief Scientist – Ellen Stofan

8:30 Status of PSD, budget, R&A restructuring – Jim Green

9:45 Outer planet updates, incl. ICEE – Curt Niebur

10:15 Break

Power to the outer solar system

10:30 OPAG responses to AO RFI RPS related – Kevin Baines

10:40 RPS/ASRG review report – Ralph McNutt

11:00 Zero Baseline Review, ASRG termination, power to the outer planets trades – Jim Green

11:30 Open Mic

11:50 OPAG responses to AO RFI (non-RPS) – Kevin Baines

12:10 NASA responses to AO RFI submissions - Michael New and Curt Niebur

12:30 pm LUNCH 1.5 hr

Agenda

- 2:00 Europa plume discovery – Lorenz Roth
- 2:20 Europa study report update - Barry Goldstein, Bob Pappalardo, Brian Cooke
- 3:20 Cassini Report, EOM and plans for Senior Review – Linda Spilker
- 3:45 Plans for Senior Review – Bill Knopf
- 4:00 *Break*
- 4:15 Outer planet science possibilities with BRISSON – Karl Hibbits
- 4:45 JWST Status Update, and 'Beyond JWST' Study Announcement – Heidi Hammel
- 4:55 HST planetary science – Glenn Orton
- 5:00 *Open Mic; possible findings*
- 5:30 Adjourn

Agenda

Tuesday, Jan. 14

- 8:00 Reconvene, OPAG items – Candy Hansen
- 8:10 Planetary Science Summer School: Neptune mission study - Kyle Uckert

- 8:30 JUICE report – Dmitri Titov
JUICE Pis' reports
- 9:00 UVS – Randy Gladstone
- 9:20 RIME – Jeff Plaut
- 9:40 PEP – Pontus Brandt

- 10:00 break*

- 10:20 Juno – Scott Bolton
- 10:50 Io Workshop / EXCEED – Julie Rathbun
- 11:00 Technology updates
Propulsion systems for the outer solar system – Len Dudzinski
STMD updates – Pat Beauchamp
- 11:45 Overview and Status of the SLS – Steve Creech

- 12:15 pm Lunch*

Agenda

Uranus

- 1:30 Planetary Science Summer School: Uranus mission study - Ingrid Daubar
- 1:50 Update on the Uranus Entry Study - Parul Agrawal, ARC
- 2:10 Ground Test Facility Capabilities for Outer Planet Entry Missions - Helen Hwang, ARC
- 2:20 TPS for Saturn and Uranus – Ethiraj Venkatapathy

- 2:45 Formation of OPAG subcommittee to brainstorm ground-based data and modeling possibilities - Mark Hofstadter

- 3:00 Future Uranus workshop – Amy Simon

- 3:15 *Open Mic; Findings discussion; adjourn*

Buses to LPL Colloquium

January 14, 2014 – 3:45 p.m.
Kuiper Space Sciences Building Room 308

LPL Colloquium

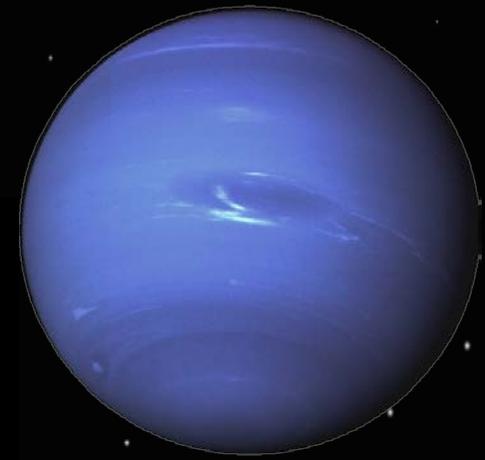
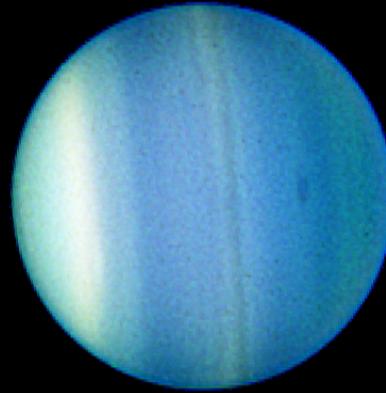
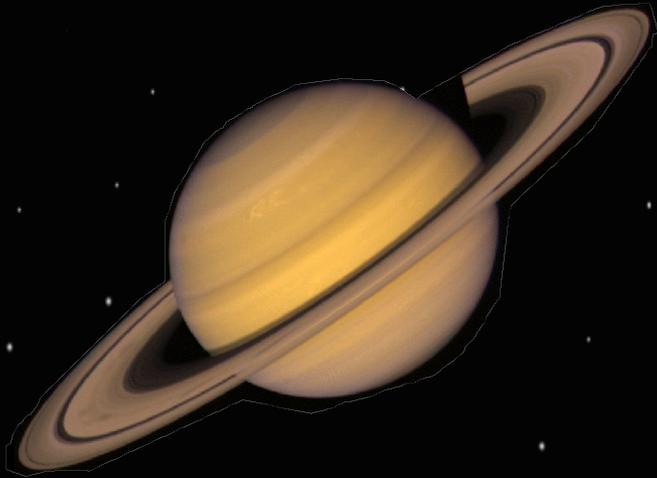
Dr. Jim Green
Planetary Science Division Director
NASA Headquarters

“NASA’S Solar System Exploration Paradigm: The First 50 Years and a look at the Next 50”

Abstract:

In exploring any particular solar system object over the past fifty years, NASA has followed a general paradigm of “flyby, orbit, land, rove, and sample return.” A complete campaign may not be performed for each object in the solar system, since not all our scientific questions can be studied at all objects, and there are high technological and financial hurdles to overcome for some missions and certain destinations. Moreover, a healthy program of solar system exploration requires a balance between detailed investigations of a particular target and broader reconnaissance of a variety of similar targets. In following this paradigm, a descriptive review of the past exploration of solar system bodies will be discussed, the significant progress on a number of solar system bodies currently underway, and the recipe for exploration as applied to the recent Planetary Science Decadal Survey. Finally, a thoughtful reflection will be made of NASA’s creation of the discipline of planetary science, predictions for the future, and the potential for the discovery of life beyond Earth.

Outer Solar System Exploration



Outer Planets
Assessment Group
(OPAG) Findings
July 2013

OPAG Assessment: Mind the Gap

- OPAG regularly evaluates outer solar system exploration goals, objectives, investigations and required measurements on the basis of the widest possible community outreach. The group assembles twice per year to assess the current state of outer solar system exploration, goals for future exploration, and technology development needed to achieve those goals.
 - >500 people have signed up on OPAG website with indication of interest
 - Most recent OPAG meeting was 15-16 July 2013
- ***Our biggest concern remains the looming gap in missions to the outer solar system***
- The near-term future is bright
 - Juno at Jupiter
 - Cassini at Saturn
 - New Horizons flyby of Pluto
- After that we have only
 - Limited participation in JUICE
 - Possible New Horizons flyby of a KBO

Threat to Cassini's final years?

- NASA's notional budget for the outyears no longer includes funding for Cassini in the outer planets line
- The final three years of the Cassini mission promise entirely new discoveries as the orbit of the spacecraft is cranked to high inclination and periapse is brought inside the rings. *This geometry enables acquisition of new data on Saturn's interior and magnetosphere, as well as a new perspective for viewing its rings, that continue the Cassini legacy of ground-breaking new scientific discoveries in the Saturnian system*
- **OPAG finding:** *NASA should explicitly show a notional budget for the Cassini Solstice Mission in 2015, 2016, and 2017. OPAG asserts that the unique science return from the Cassini end-of-mission observations strongly warrants full funding of the final three years of the mission.*
- **OPAG finding:** *OPAG seeks clarification from NASA PSD on the details of the senior review process as well as a better understanding of the ground rules for these reviews. In addition OPAG suggests NASA PSD should consider returning to senior reviews focused solely on the merit of individual extended missions.*

Europa Clipper

- We are pleased that the US Congress has partially restored funding for NASA's planetary science division in its FY14 request, including specific funding for the Europa Clipper Study.
- We continue to support the Europa Clipper as a scientifically compelling, technologically feasible and fiscally responsible approach to exploration of Europa. The Clipper will accomplish flagship-worthy science by investigating access to Europa's subsurface ocean, a potential habitable zone.
- **OPAG finding:** *We are enthusiastic that NASA is funding studies of a potential Europa mission and that NASA has allocated a significant fraction of the funds to instrument maturation. It is important that the outer planets community be kept up-to-date on the goals, balance, and progress of these studies, such as via frequent regular reports to the Europa Science Advisory Group and OPAG. We request that the next such report to OPAG include a notional schedule (perhaps expressed in relative time) for moving the Clipper from a study to the launchpad.*

Pu238

- OPAG wishes to express its deep gratitude to NASA for persisting and now succeeding in the quest to **re-start domestic production of Pu238**. Without the availability of this fuel, access to the outer solar system would be severely curtailed if not terminated, as exemplified by the exclusion of missions requiring a nuclear power system in the New Frontiers 3 Announcement of Opportunity. In addition to its importance to exploration of the outer solar system OPAG notes that Pu238 also enables some missions in the inner solar system.
- ***OPAG finding:*** *The re-start of domestic production of Pu238 is a **huge achievement** and enables our continued exploration of the outer solar system.*

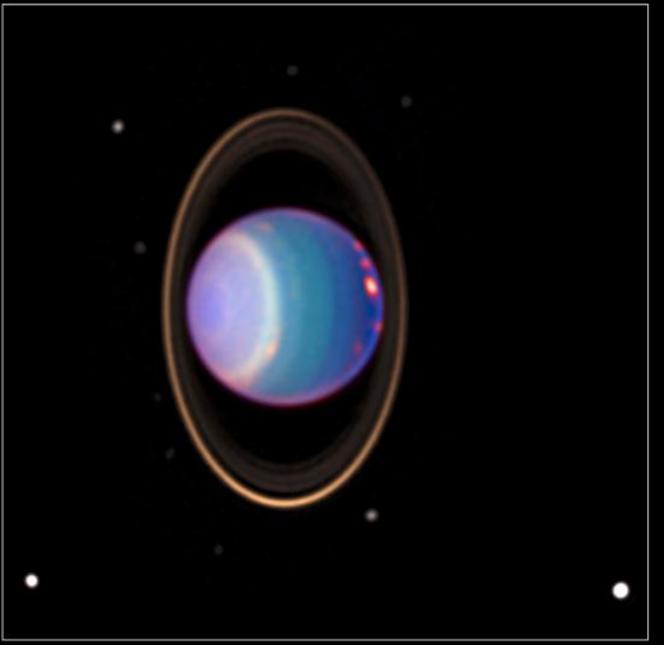
JUICE Co-I Funding



- Strong international collaborations extend the capabilities and reach of any individual space-faring institution
- The ESA JUper ICy moons Explorer (JUICE) flagship-class mission is a logical successor to the fruitful Cassini- Huygens partnership. As in previous assessments, OPAG lauds NASA's commitment of \$100M (total lifecycle) to enable U.S. participation.
- OPAG is, however, concerned about the NASA announcement that it will not be able to fund US Co-Is on selected European instruments if they were not directly associated with selected hardware, because of the excess costs above the \$100M allocation that this would require.
- We recognize that in times of tight budgets every investment must be carefully considered. OPAG therefore requests that NASA continue the dialogue with ESA to better understand critical scientific needs.
- ***OPAG finding:*** *OPAG is concerned that not funding US JUICE Co-I's damages JUICE science as well as international relations, and reduces the yield from NASA's JUICE investment. A lack of international scientific cross-fertilization risks the isolation of outer solar system scientific communities in Europe and the US. The collaborative international framework built by Cassini-Huygens represents years of effort and investment, and is a benefit to science that should be nurtured.*

Thermal Protection Systems

- OPAG heard reports on a variety of technological developments - OPAG is pleased that a study of probe entry technologies applicable to Uranus is being undertaken as part of the program at Ames Research Center, because it provides an actual point design.
- Thermal protection systems (TPS) are key to probe missions and aerocapture missions – it is essential to make timely progress on bringing the technology to the level of technical readiness required
- ***OPAG finding:*** *OPAG is concerned about the consistency of the thermal protection system (TPS) development with the likely schedule for NF- 4. It is not clear that TPS required for a Decadal-Survey-recommended Saturn Probe mission will be at an appropriate TRL level by the time the NF-4 AO comes out. OPAG would also like to receive, as part of the current Uranus probe study, a report on missions possible with current technology and what would be enabled by new technology.*



Ice Giants Knowledge Gap

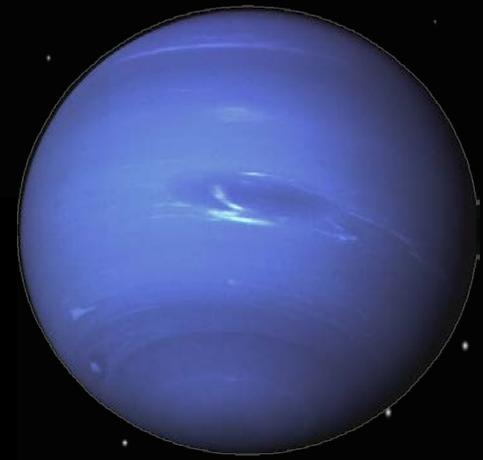
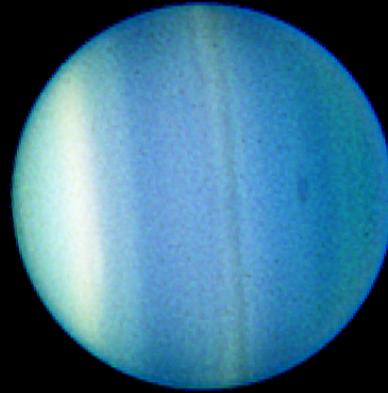
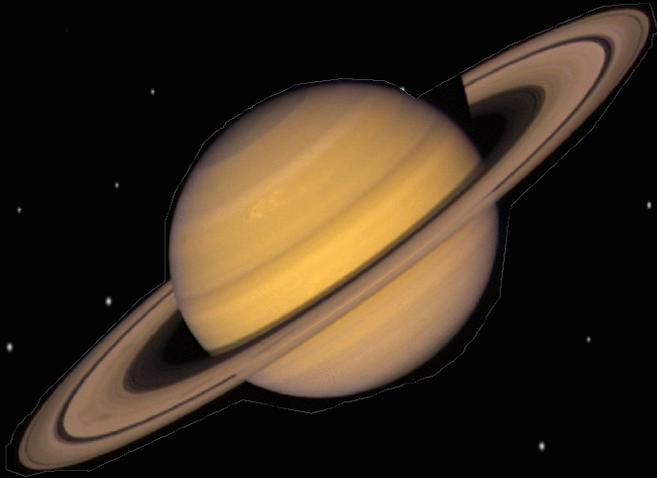


- OPAG also notes that to enable future probe missions, refined knowledge of the upper atmospheres of the Ice giants is needed, as well as an analysis of the spacecraft hazards posed by ring particles on trajectories suitable for probe delivery.
- ***OPAG finding:*** *OPAG highlights the lack of knowledge in the outer solar system that brings risk to future missions to the ice giants. OPAG will establish a subcommittee to assess how some of the knowledge gaps can be filled.*

Concern about proposed changes in Education and Public Outreach at NASA

- In the FY14 budget, the Office of Management and Budget (OMB) proposed to consolidate 90 Science, Technology, Engineering and Math (STEM) programs and to realign ongoing STEM education activities “to improve the delivery, impact, and visibility of these efforts.”
- For NASA, this reorganization affects not only the NASA Office of Education, but more importantly the individual Education and Public Outreach (EPO) programs carried out within the Science Mission Directorate (SMD).
- ***OPAG Finding:*** *OPAG is concerned that the elimination of EPO from NASA science missions such as Cassini, Juno, and New Horizons removes a major opportunity for the science community to maintain their competitiveness and communicate their relevance to broader societal goals. Further, if EPO science mission partnerships with diverse communities can no longer be included in mission proposals, this would disenfranchise constituencies who would contribute to a future, more diverse scientific community.*

Outer Solar System Exploration

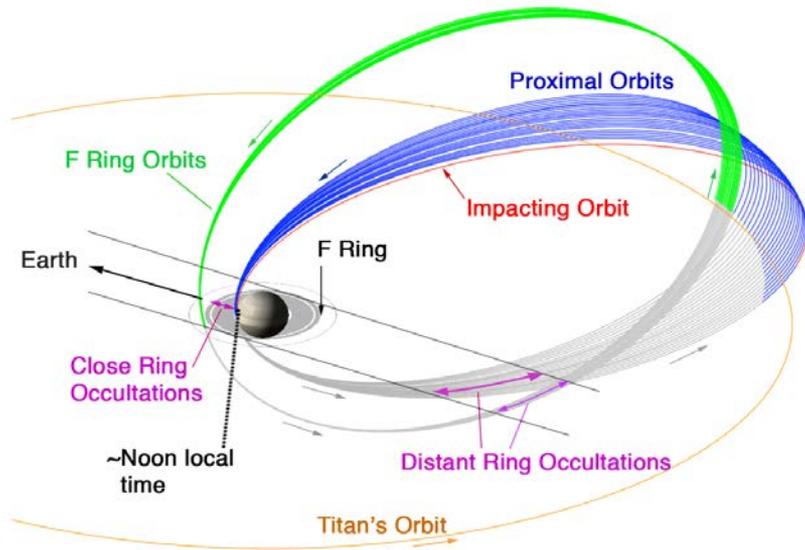


Worth the journey

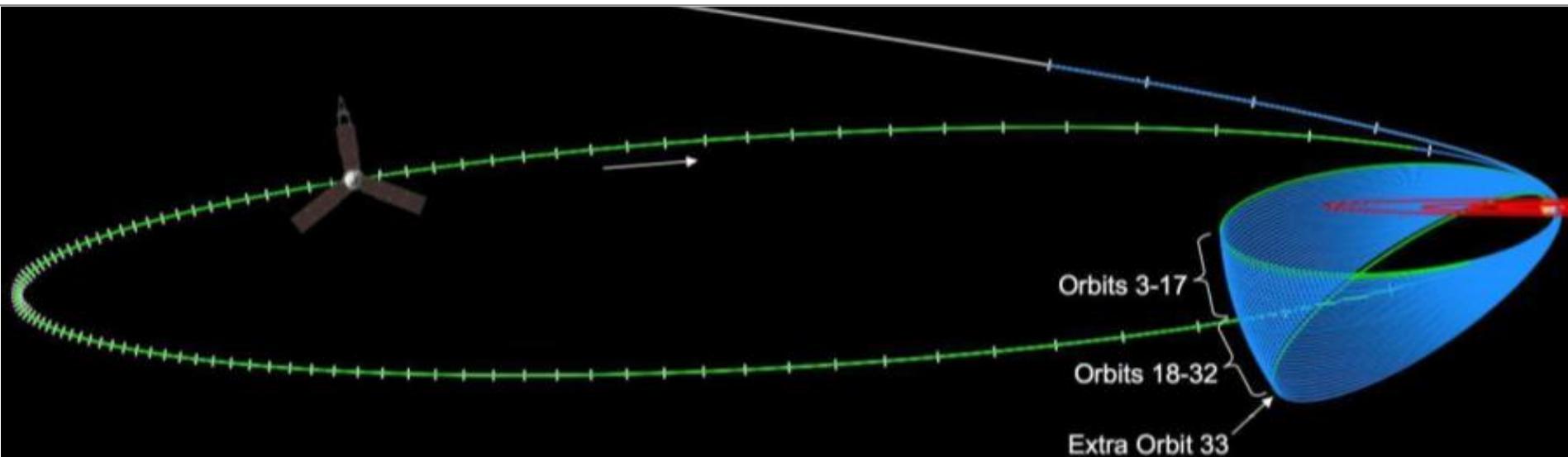
Backup

This is what we're up against...

The Demise of Juno and Cassini



- Cassini End-of-Mission September 2017
- Juno End-of-Mission October 2017

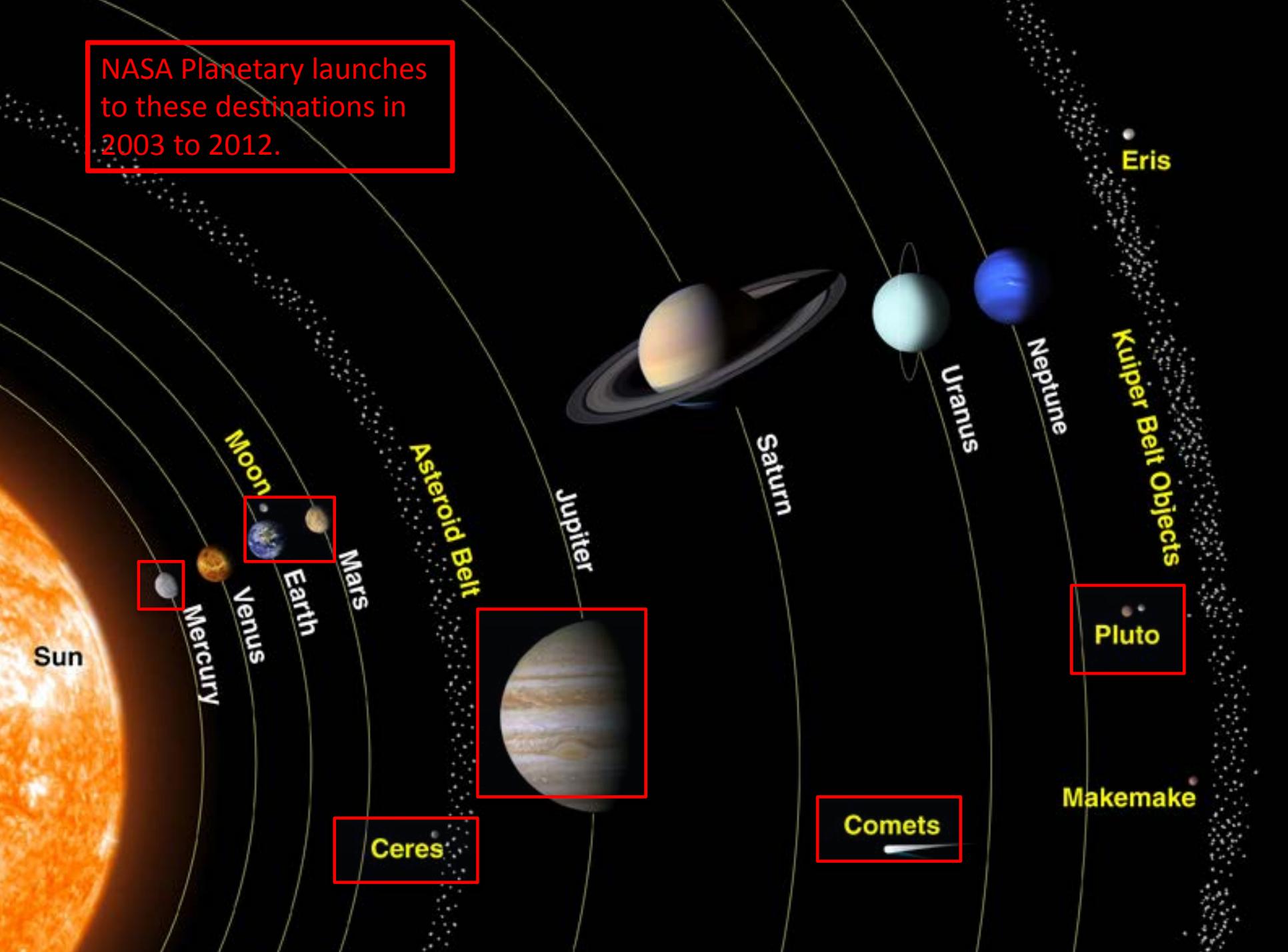


Decline in NASA Planetary Launches

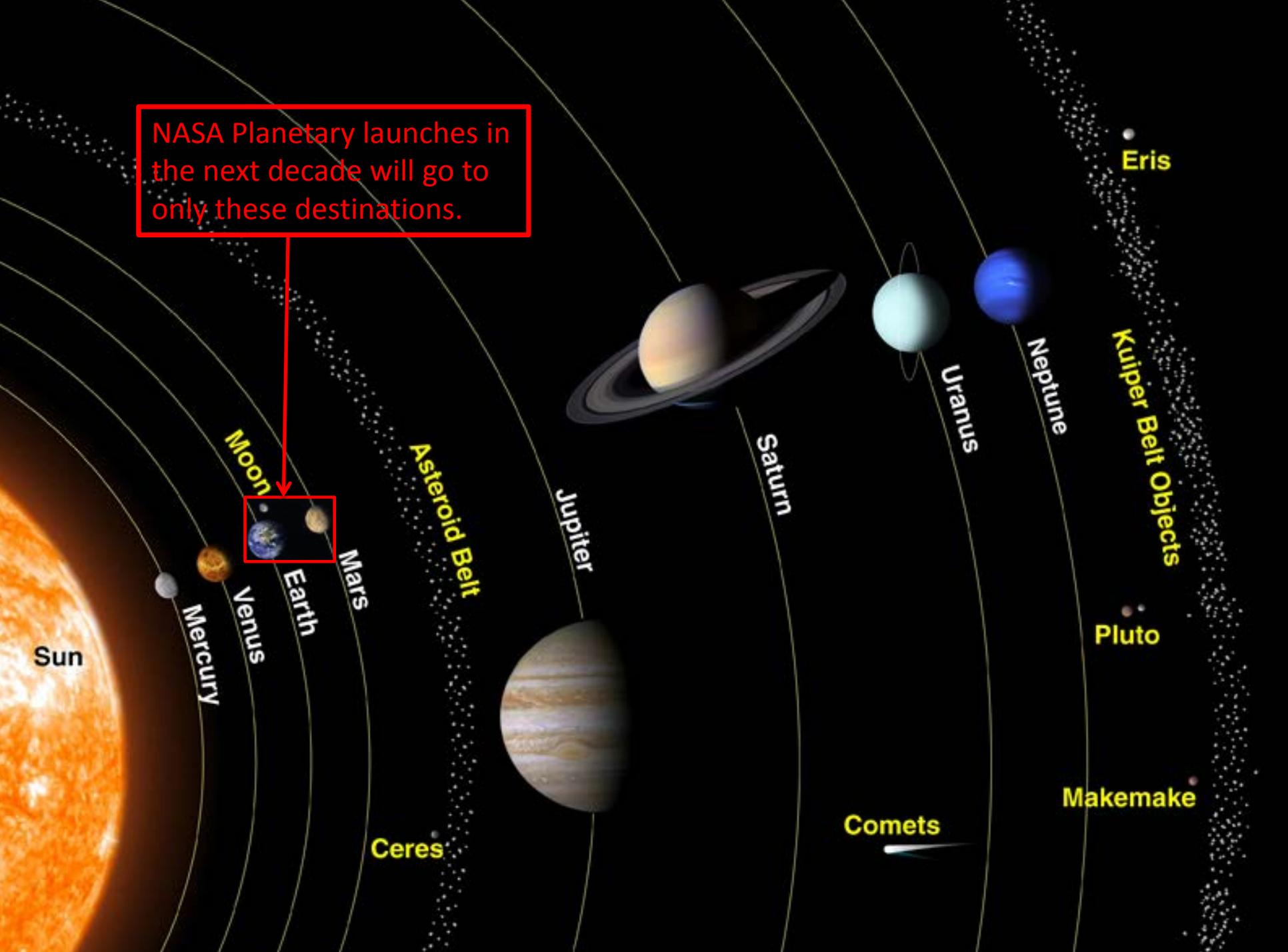
- 2003-2012:
 - MESSENGER – Mercury
 - GRAIL -- Moon
 - Lunar Reconnaissance Orbiter
 - MER-Opportunity
 - MER-Spirit
 - Mars Reconnaissance Orbiter
 - Phoenix – Mars lander
 - Mars Science Laboratory
 - Dawn – Vesta and Ceres
 - Juno – Jupiter
 - Deep Impact – comets
 - New Horizons – Pluto
 - **Total: 12 missions, from Mercury to Pluto, all successful**

- 2013-2022:
 - LADEE – Moon
 - MAVEN – Mars orbiter
 - InSight – Mars Lander
 - OSIRIS-Rex – near-Earth asteroid sample return
 - 2020 Mars rover
 - New Discovery mission?
 - **Total: 5 or 6 missions**
 - **It is already too late to increase the number of launches over the next decade, except for one Discovery mission if the planetary budget is restored soon.**

NASA Planetary launches
to these destinations in
2003 to 2012.



NASA Planetary launches in the next decade will go to only these destinations.



Sun

Mercury

Venus

Earth

Mars

Moon

Asteroid Belt

Ceres

Jupiter

Saturn

Uranus

Neptune

Pluto

Makemake

Eris

Kuiper Belt Objects

Comets