NASA’s Planetary Science Program Overview

James L. Green, Director Planetary Science
Presentation to the Planetary Science Subcommittee
November 5, 2013
Outline

• Planetary Budget
• Upcoming Planetary Events
• FY14 EPO Status and Activities
• Selected Planetary Missions Status
• Upcoming Senior Review
• Suborbital Flights
• Research & Analysis Status and Plans
President’s FY14 Planetary Science Budget
Plus an Approved FY13 Budget

* Notional

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<td>Outer Planets</td>
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<td>$147,836</td>
<td>$79,000</td>
<td>$45,600</td>
<td>$24,400</td>
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$1,501,439 $1,271,500 $1,217,600 $1,214,800 $1,225,400 $1,254,400 $1,252,600

• President’s FY14 budget contains:
  – NEO observations enhancement of $20M/yr ($40M/yr total)
  – $50M/yr support of DoE PU-238 infrastructure support
Planetary Science Missions and Outreach Events

2013
May – November – Mars As Art Exhibit at Dulles Airport Gallery
July 19 – Wave at Saturn and MESSENGER’s Earth image from Mercury
August 6 – One Year Anniversary of Curiosity Landing on Mars
September 6 – LADEE launch from Wallops Flight Facility, VA
September 28 – BRRISON launch – Payload Anomaly
October 1 – Close approach of Comet ISON to Mars – Campaign Science
October 9 – Juno flyby of Earth
November 18 - Launch of MAVEN from Cape Canaveral, FL
November 19 – FORTIS rocket launch observing Comet ISON
November 25 – VESPER rocket launch observing Venus
November 28 – Comet ISON Perihelion. Brightest view from Earth of Comet ISON

2014
January – EXCEED-HST observations of Io – Campaign Science
August – Rosetta arrive at Comet Churyumov–Gerasimenko
October 19 – Comet Siding Spring encounters Mars
FY14 EPO Status and Activities
Current SMD EPO Policy

- Under a CR, SMD projects are to continue planned EPO activities at the same level of effort and budget as during FY13
  - Except where decreases were already planned or where directed otherwise by their sponsoring HQ division
- NASA will not implement the proposed consolidation at this time but will continue to make changes during a CR in alignment with the COSTEM strategic plan
- Office of Education and Communications will still oversee a waiver process to approve all education and public outreach activities
Mars as Art at
Dulles Gateway Gallery
Until November 2013
Webbys
Planetary Science Won Four!

Planetary Science’s website
http://solarsystem.nasa.gov
won two Webbys

Curiosity’s social media site also
Won two awards
Cassini site on the NASA portal had 236,000 unique page views; Cassini's Saturn page (sатурn.jpl.nasa.gov) had 265,000 unique visitors. Over 20 countries participated in the Campaign.
Wave at Saturn Media Response

- Coverage before, during and after the event
- International, national and local coverage because outlets could find local groups holding Wave at Saturn events
Selected Mission Status
Objective:
• Measure the lofted Lunar dust
• Composition of the thin Lunar atmosphere

Instruments:
• Science: NMS, UVS, and LDEX
• Technology: Laser Communications

Status:
• Several LLCD “block” tests complete
• Instrument covers off - Commissioning phase has begun
Lunar Laser Communication Demonstration

- **Lunar Lasercom Ground Terminal**
  - White Sands, NM

- **Lunar Lasercom Space Terminal**
  - LADEE Mission Ops Center

- **Lunar Lasercom OCTL Terminal (JPL)**
  - Table Mtn, CA

- **Lunar Lasercom Optical Ground System (ESA)**
  - Tenerife

- **Lunar Lasercom Ops Center**
  - MIT LL

- **Deep Space NW**
  - LADEE Science Ops Center

- **Payload**: 15

- **Bandwidths**:
  - DL 622 Mbps, UL 20 Mbps
  - DL > 38 Mbps, UL > 10 Mbps
  - DL > 38 Mbps, UL > 10 Mbps
Over 30 sites registered on [http://moon.nasa.gov/ladee](http://moon.nasa.gov/ladee)

20 locations in the DelMarVa region were coordinated by the WFF/GSFC team since January 2013. Docents and mobile launch countdown devices deployed.

– Conservative Estimate: 13,808

**Chincoteague locations:**

– Beach Road
  • 1500 at Beach Road
  • 1100 Assateague Channel Bridge

– Robert Reed Park:
  • 700-800 people

– Main Street-hotels- (3)
  • 520. All Island hotels reported no-vacancies for evening of launch

– Campgrounds
  • Estimated 1000 across four campgrounds
Over 50 Official Launch Viewing Events Held

- WFF Visitor Center – 1088
- WFF UB-40 - 350
- Captain’s Cove – Estimated 550
- Assateague- State Park-MD
  - Assateague Welcome Center-50
  - Assateague Campgrounds-600
  - Assateague Youth area-150
  - Assateague Bridge-600-700
- Ocean City-Estimated 3500
- Ocean Pines-Estimated 2000
- Crisfield/Tangiers Island – ~200
- NASA EDGE- Ustream.tv/nasaedge: 20,203 views
  - Facebook: 116,000 views
• Over 7000 guests attended Ames Science Night, featuring the LADEE mission. LADEE was the first mission that Ames has designed, developed, and built.
Times Square NYC – September 6

- Mason Peck/SME
- Estimated 2000 in Times Square
- Not as focused as MSL, but Toshiba (LADDEE partner) was pleased with event
Social Media

REACH:
- 7,093,511 total # of people directly following the official launch accounts

TWITTER:
- 231,730,609 potential impressions of @NASA, @NASALADEE & @NASA_Wallops on launch day, Sept. 6. (@NASALADEE alone was 2.4 million of these -- the vast majority were for @NASA).
- 6,319 retweets of official launch accounts on launch day, Sept. 6.
- Gained 11,300 new followers over normal baseline of ~8,000 new followers on @NASA.
- #1 Trending Topic in the United States at the time of launch on Twitter

INSTAGRAM:
- 7 images posted about LADEE & the Moon on NASA's New Instagram, with 53,480 likes across the images.
- 70,000 new followers in 24 hours on the new NASA Instagram account.

FLICKR:
- 270 photos posted on the Flickr Group for LADEE images from 197 members

FACEBOOK:
- 1,201,549 potential impressions of NASA's Facebook posts on launch day, Sept. 6.
- Gained 4,419 new likes on NASA's Facebook page over normal rate (~1,700/day)
- Timeline deliveries was 87% of traffic, visits to the NASA page was 8% of traffic, visits to individual photos posted was 4% of traffic, and visits to the UStream player on Facebook was 1% of traffic.
- On photos, interestingly, uploaded image from LADEE launch was seen by 8,800 people with 319 likes; meanwhile, Instagram uploaded photo reshared onto Facebook has 179,100 people with 8,300 likes.

GOOGLE+:
- 1,349,297 people +1 our NASA page on Google+ as of launch day.
- 3,731 total +1's on LADEE related posts on Google+.

NASA SOCIAL:
- 3,531 tweets containing the #NASASocial hashtag during the two day event.
- 42 NASA Social participants showed out of 50 invited.
- 62,784 Twitter followers combined across the 50 individuals invited to take part in the NASA Social.
Juno Earth Flyby

Sun terminator at C/A

Madrid AOS (10° elevation) 20:38 UTC

Perth AOS (10° elevation) C/A+21:37

Eclipse end C/A+17:36

Spin plane contacts Earth C/A+13:53

Spin plane leaves Earth C/A+3:27

Malargue LOS (10° elevation) C/A−7:22

Eclipse start C/A−1:48

700 km altitude, 1100 km from Cape Town

EFB closest approach (C/A) 19:21:25 UTC
34°S, 34°E, 559 km altitude

Launch 8/5/2011

Juno Earth Flyby

DSPMs 8/30 & 9/14/2012

JoI 7/5/2016

Tilted Ecliptic Pole View, Vernal Equinox Up, 30-day Tick Marks
Juno, launched on August 5, 2011, passed by Earth on its way to Jupiter in a gravity-assist maneuver on October 9, 2013. Images taken by JunoCam instrument.

**Right:** Earth as seen by JunoCam during Juno’s Earth flyby. This monochrome view shows exquisite detail in the clouds and coastlines of South America.

**Inset, top left:** The west coast of South America is visible in this image, taken when the Juno spacecraft was 15,091 km from the Earth. Processed by “Gerald” at unmannedspaceflight.com

**Top:** Methane band image of the terminator region taken at 12:15:30 PDT on Oct. 9.
Launch November 18, 2013, from Cape Canaveral on an Atlas V – on schedule
Mars orbit insertion in Sept. 2014

Science:
• Determine the structure and composition of the Martian upper atmosphere today
• Determine rates of loss of gas to space today
• Measure properties and processes that will allow us to determine the integrated loss to space through time
Atlas V Payload Fairing for MAVEN
New Horizons
Pluto Fly-by Flight Rehearsal (July 5-14, 2013)

• The flight rehearsal was successful, thoroughly testing the command sequence, exercising the team, and practicing the procedures that will be used in 2015

• The command sequence executed from start to finish without a glitch
  – All subsystems and instruments performed nominally
  – All instruments collected the correct type and amount of data
  – Inserting a time shift had no adverse effects on the system, although one measurement might not have been downlinked as a result of the shift. (This is under investigation...)

• The extensive DSN support was very good and ground systems were nominal
  – All three DSN complexes were used repeatedly throughout the rehearsal
  – Aside from occasional drop-outs and one contact that began with a misconfiguration (which was quickly remedied), the support was very good
  – The MOC and SOC both processed all data without delay or data corruption

• Lessons learned are being collected and will be compiled
  – Data will be downlinked for another few weeks, and will be examined as it becomes available to confirm detailed pointing, etc.
  – A Flight Rehearsal Lessons Learned Review is scheduled for September 3 at APL
NEO-WISE Reactivation

• Reactivated the WISE spacecraft on 19 August to continue the detection and characterization of NEOs for the time that the WISE spacecraft can remain in effective operations (estimated to be 3 yrs)

• Cool-down will take up to ~ 3 mos before effective operations can begin
CONDUCT RIGOROUS IN-SITU SCIENCE

GEOLOGICALLY DIVERSE SITE

COORDINATED, NESTED CONTEXT AND FINE-SCALE MEASUREMENTS

ASTROBIOLOGY

ENABLE THE FUTURE

RETURNABLE CACHE OF SAMPLES

CRITICAL IN-SITU RESOURCE UTILIZATION AND TECHNOLOGY DEMONSTRATIONS REQUIRED FOR FUTURE MARS EXPLORATION

- FBO released August 12, 2013
- AO released September 24, 2013
- NOIs due November 4, 2013
- Proposals due January 15, 2014
Next Discovery AO
Process for Next Discovery AO

Receive RFI Responses → Analyse Responses → (Virtual?) Town Hall → Strategic Decisions

57 responses received. RFI closed on 1 Nov 2013.

1. Cost cap
2. LV pricing
3. Target list
4. LRD etc.

Release Draft → Write Draft AO → SMD SMaC → Budget Analysis

Michael H. New, Lead Discovery Program Scientist
Upcoming Senior Review
Senior Reviews

• Last Senior Review was completed in July 2012 for fiscal years FY13 and FY14
• Guidelines for the next senior review to be issued early 2014
  – Total funding available for extended missions is approximately constant at FY14 levels
  – Missions in the review: Cassini, LRO, Mars Express, MRO, Opportunity, Mars Odyssey, and Curiosity
• Due to a constrained budgets what should be critical features/discriminators of the next call for proposals?
Suborbital Flights
BRRISON Anomaly Summary

- During ascent the telescope deployed and commissioning began; included capture of star image shown
- At ~90,000 feet the telescope unexpectedly returned to the stowed upright position with high torque
- The telescope’s angular rate was too fast and its stow bar became trapped behind the stow latch
- Numerous commands were issued to release the telescope during the overnight flight but were all unsuccessful
- Payload recovered in excellent shape
- Probable cause under investigation
- Telescope will be repaired and available for future flights (for example: Comet Siding Spring)
Comet ISON observations with FORTIS
(Far-uv Off Rowland-circle Telescope for Imaging and Spectroscopy)

Launch: November 19, 2013
White Sands Missile Range

• Far-UV (800-1950 Å) spectra and imagery of comet ISON.
• Measure volatile production rates of CO, H, C, C+, O and S
• Search for previously undetected atomic and molecular species (e.g., Ar, N, N+, N2, O+ and O5+)

Stephan McCandliss, PI, JHU
Paul Feldman, Co-I/Science PI, JHU

Jointly funded by Planetary and Astrophysics Divisions
The Venus Spectral Rocket Experiment (VeSpR)

NASA’s next Venus flight mission

<table>
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<th>Scheduled Launch:</th>
<th>November 25, 2013</th>
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<tr>
<td>Launch Site:</td>
<td>White Sands Missile Range, New Mexico</td>
</tr>
<tr>
<td>Mission Number:</td>
<td>36.261</td>
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<tr>
<td>Principle Investigator:</td>
<td>John Clarke (Boston University)</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:jclarke@bu.edu">jclarke@bu.edu</a></td>
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<td></td>
<td>617-353-0247</td>
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Purpose: To study the present day escape of water from the atmosphere of Venus and relate it to the past abundance of water on Venus.
Research & Analysis Status & Plans

Jim Green – SSERVI
Jon Rall – ROSES
SSERVI was created to further the goals of science and exploration by addressing fundamental and applied science questions and human spaceflight concerns, i.e., to bring science to bear on issues related to potential targets for human exploration.

- Science which enables human exploration
- Science enabled by human exploration

SSERVI is funded jointly by SMD/PSD and HEOMD/AES through the Joint Robotic Precursor Activity (JRPA)

- Important opportunity to advance joint goals

The NASA virtual institute structure is uniquely suited to create and foster inter-team, as well as interdisciplinary, collaborations (e.g. heliophysics and geology) that previously would not have existed. Therefore, expansion of the NASA Lunar Science Institute’s scope to include all potential near-term human destinations (Moon, NEAs, Phobos/Deimos) is the most effective method of integrating science (SMD) and exploration (HEOMD) research goals.
SSERVI Selected Teams


• **Dan Britt**, University of Central Florida. “Center for Lunar and Asteroid Surface Science”


• **Bill Farrell**, Goddard Space Flight Center. “Dynamic Response of Environments at Asteroids, the Moon, and moons of Mars (DREAM2)”

• **Tim Glotch**, Stony Brook University. “Remote, In Situ and Synchrotron Studies for Science and Exploration”


• **Mihaly Horanyi**, University of Colorado. “Institute for Modeling Plasma, Atmospheres and Cosmic Dust (IMPACT)”


• **Carle Pieters**, Brown University. “Evolution and Environment of Exploration Destinations: Science and Engineering Synergism (SEEED)”
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<th>Science emphasis</th>
<th>Exploration emphasis (SKGs)</th>
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<td>Role of Target Body(s) in revealing the origin and evolution of the inner Solar System</td>
<td>Innovate observations that will advance our understanding of the fundamental physical laws, composition, and origins of the Universe, NEA, and Martian moon investigations as windows into planetary differentiation processes</td>
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<tr>
<td>Target Body structure and composition</td>
<td>Dust and plasma interactions on Target Body(s)</td>
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<tr>
<td>Near-Earth asteroid characterization (including NEAs that are potential human destinations)</td>
<td>Geotechnical properties (Moon, NEAs, Mars)</td>
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<tr>
<td>Regolith of Target Bodies</td>
<td>Volatiles (in its broad sense) and other potential resources on Target Body(s)</td>
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<tr>
<td>In-Situ Resource Utilization (ISRU)/Prospecting (Moon, NEAs, Mars)</td>
<td>Propulsion-induced ejecta (Moon, NEAs, Mars)</td>
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<tr>
<td>Operations/Operability (all destinations, including transit)</td>
<td>Human health and performance (all destinations, including transit)</td>
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Planetary Research & Analysis
Program Consolidation & Restructuring

• Why are we consolidating & restructuring R&A?
• What are the goals of consolidation?
• What are the pros and cons of consolidation?
• What are modestly healthy and sustainable funding levels for a restructured R&A program?
Why are we consolidating & restructuring R&A?

• Planetary R&A originally started with a few “Core” programs decades ago based on disciplines (Planetary Atmospheres, Planetary Astronomy, Cosmochemistry, Exobiology (think planetesimals))
• To grow the R&A budget, new program elements were created and added on (planetary accretion)
• Special targeted and focused program elements that should have retired have stayed in the portfolio so that we have a mix of program elements
  – Some covering science disciplines and some covering single planetary targets. (differentiation and crust forming)
• With limited budgets and growing numbers of planetary scientists, proposal pressure is increasing and selection rates plummeting
Two sets of goals

**PSD Director’s Goals**

- To make the structure of the R&A program explainable to those outside of NASA.
- To make it easy for those outside of NASA to compute the amount of money spent on grants.
- To reduce the time between proposal submission and award announcement.

**Program Officers’ Goals**

- To encourage interdisciplinary research.
- To enable PSD strategic decision making.
- To be more flexible in responding to changing research priorities.
- To reduce overlaps between program elements.
Planetary Science Objective:
Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.

Establish 5 new core programs aligned with the five basic science themes (which are also our annual performance goals).

• How did the Sun’s family of planets, satellites, and minor bodies form and evolve? (Building New Worlds)
• How do the chemical and physical processes active in our solar system operate, interact and evolve? (How Planetary Systems Work)
• What are the characteristics of the solar system that lead to habitable environments? (Habitable Worlds)
• How did life originate and evolve here on Earth and can that guide our search for life elsewhere? (Exobiology & Evolutionary Biology)
• What are characteristics of planetary objects and environments that pose threats to, or offer potential resources for, humans as we expand our presence into the solar system? (NEOO & PAST)
Building New Worlds
Solar systems origins and evolution

– Protoplanetary Disks
– Early Solar Systems
– Planetary systems
– Primitive bodies
– Life (Studies of characteristics of the solar system that led to the origin of life? e.g. organics, water)
How Planetary systems work
Physical and chemical processes and the major characteristics of the planetary bodies

– Surfaces
– Interiors
– Atmospheres
– Rings
– Magnetospheres and exospheres
Habitable Worlds

Characteristics and distribution of habitable environments

- Early Earth
- Mars
- Icy Worlds
- Exoplanets
Exobiology and Evolutionary Biology:
How did life originate and evolve on Earth?

- Prebiotic evolution
- Early evolution of life in the Biosphere
- Evolution of Advanced Life
- Causes of and biological responses to Mass Extinctions
NEOO & Planetary Astronomy

Planetary Observations

- NEO observations
- Payload development for Suborbital
- Ground-based observations
- Suborbital observations
Planetary Science R&A – path forward

• All ROSES 2013 calls are closed with some reviews are yet to be completed – paid with FY14 funding

• Implement some or all of restructuring in ROSES 2014 solicitation – budget dependent
  – ROSES 2014 is paid out of FY15 dollars

• Planning a virtual “town hall” for first week of December (week before AGU Fall meeting)
  – WebEx, Adobe Connect, Google Hangout etc. but widely advertised and open to everyone
  – Will accept comments and recommendations
“Flyby, Orbit, Land, Rove, and Return Samples”

NASA’s

Planetary Science

Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.