National Aeronautics and Space Administration

Science Committee Report

Dr. Wes Huntress, Chair

Science Committee Members

Wes Huntress, Chair

Byron Tapley, (Vice Chair) University of Texas-Austin, Chair of Earth Science
Alan Boss, Carnegie Institution, Chair of Astrophysics
Ron Greeley, Arizona State University, Chair of Planetary Science
Roy Torbert, University of New Hampshire, Chair of Heliophysics
Gene Levy, Rice University, Chair of Planetary Protection

Eugenia Kalnay, University of Maryland, Earth Science Member
Michael Turner, University of Chicago, Astrophysics member
• Scott Hubbard, Stanford University, Planetary Science member
Dave McComas, Southwest Research Institute, Heliophysics member
Noel Hinners, Independent Consultant

Charlie Kennel, Chair of Space Studies Board (*ex officio* member)

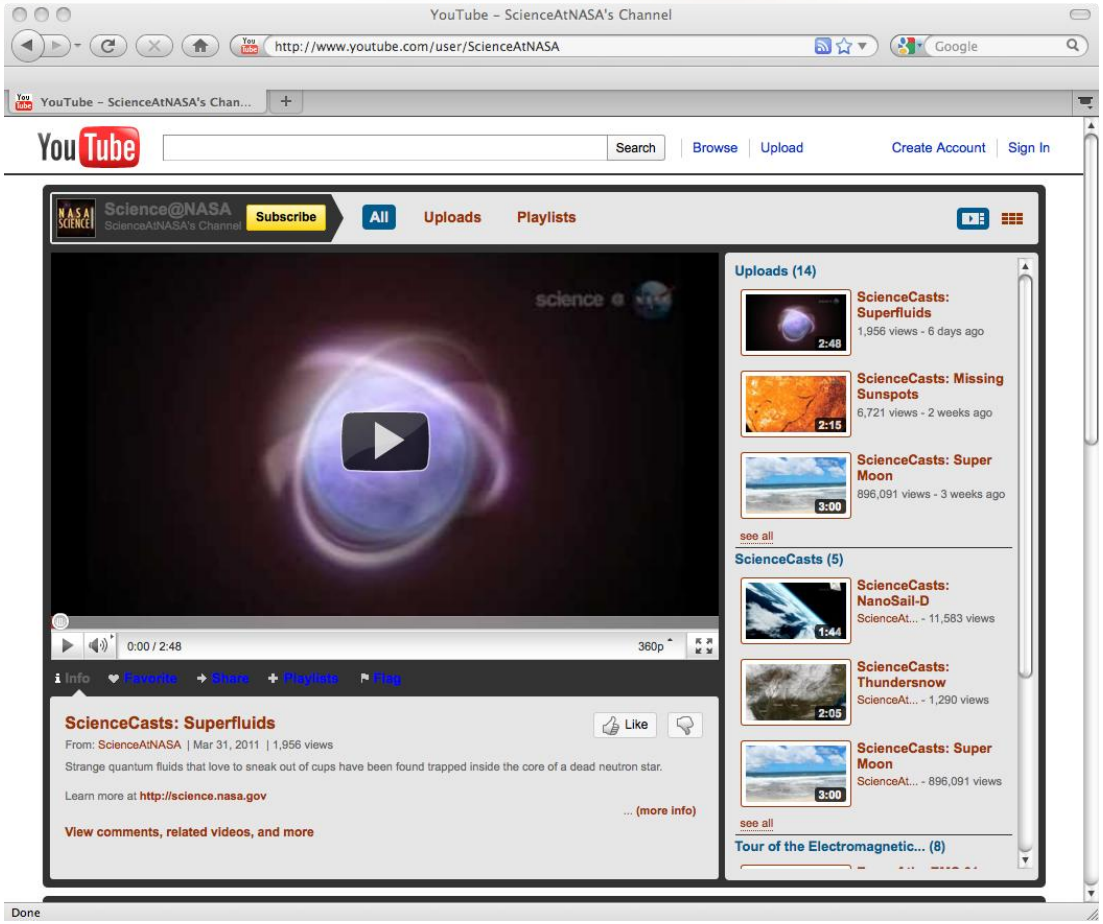
Agenda

- **Science Results**
- Programmatic Status
- Findings & Recommendations

NASA Science YouTube Channel

SMD has a new YouTube channel hosting short science videos.

The first Astrophysics ScienceCast, on the recent Chandra Superfluid core result, was released March 31



http://www.youtube.com/user/ScienceAtNASA

SOFIA

Completed Short Science #2 Flight Series

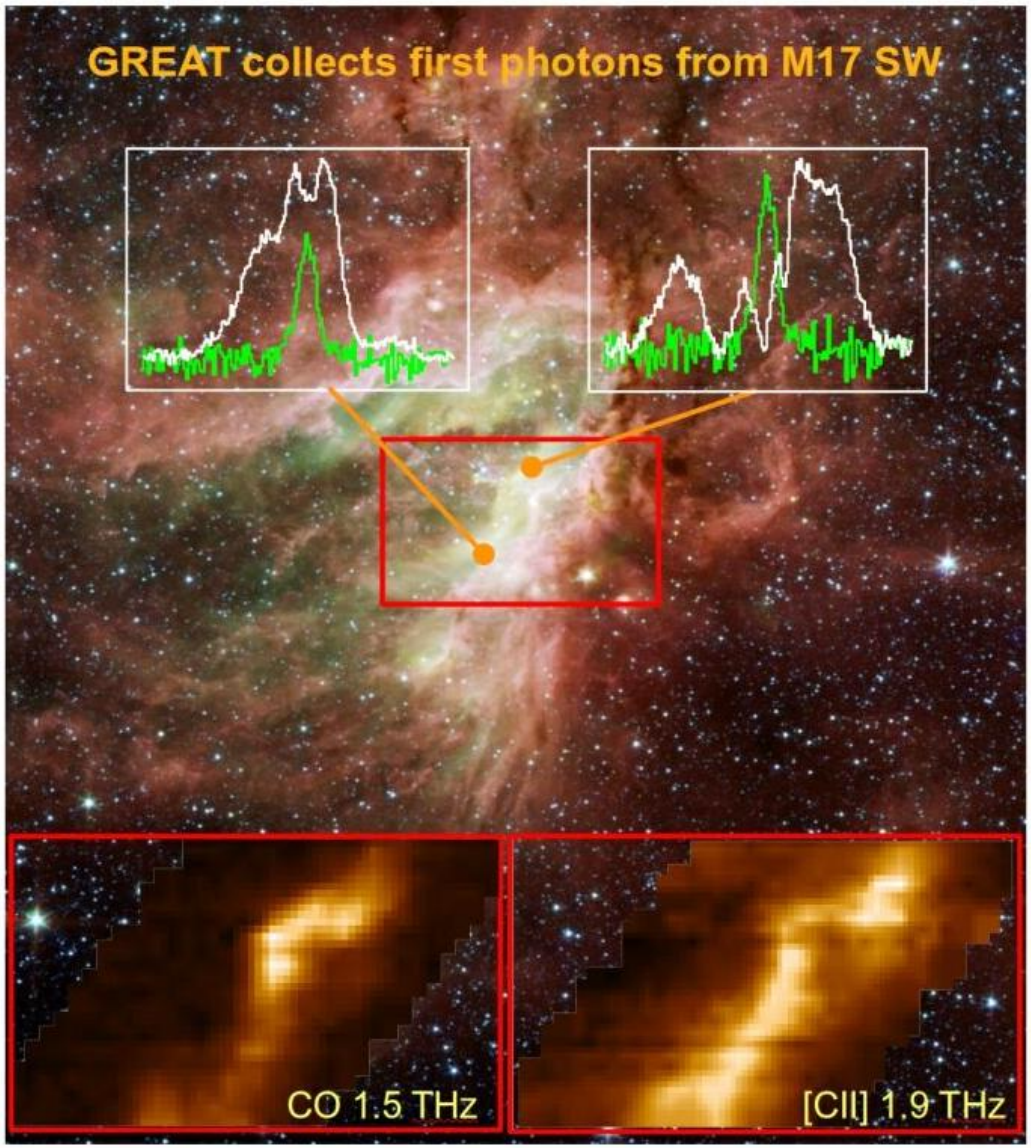
(3 flights)

- German Receiver for Astronomy at Terahertz Frequencies (GREAT) Instrument and Observatory performed well
- Image (at right) released after first flight

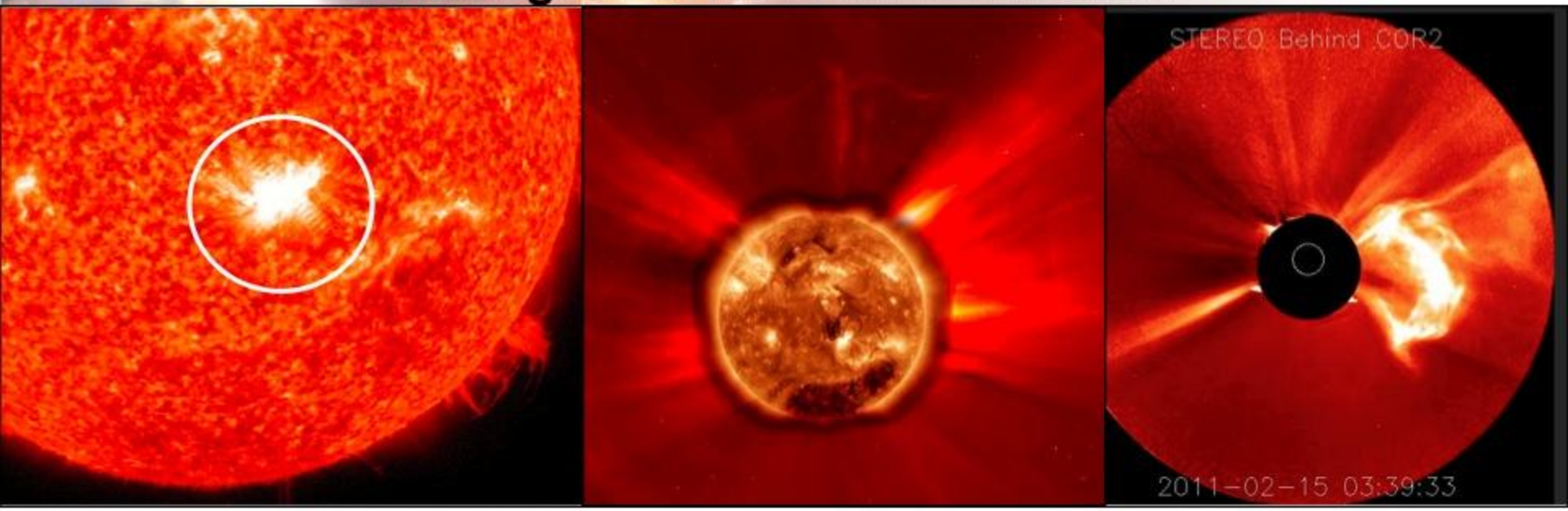
Aircraft received approval for Reduced Vertical Separation Minima (RVSM) which greatly increases Observatory flexibility/capability

- Can fly anywhere in continental US airspace between 29,000 and 41,000 feet
- International certification will come after avionics upgrades are complete

Basic Science campaign (shared risk guest observations) will begin in early May 2011



NASA Heliophysics Spacecraft Observe Strongest Solar Flare Since 2006



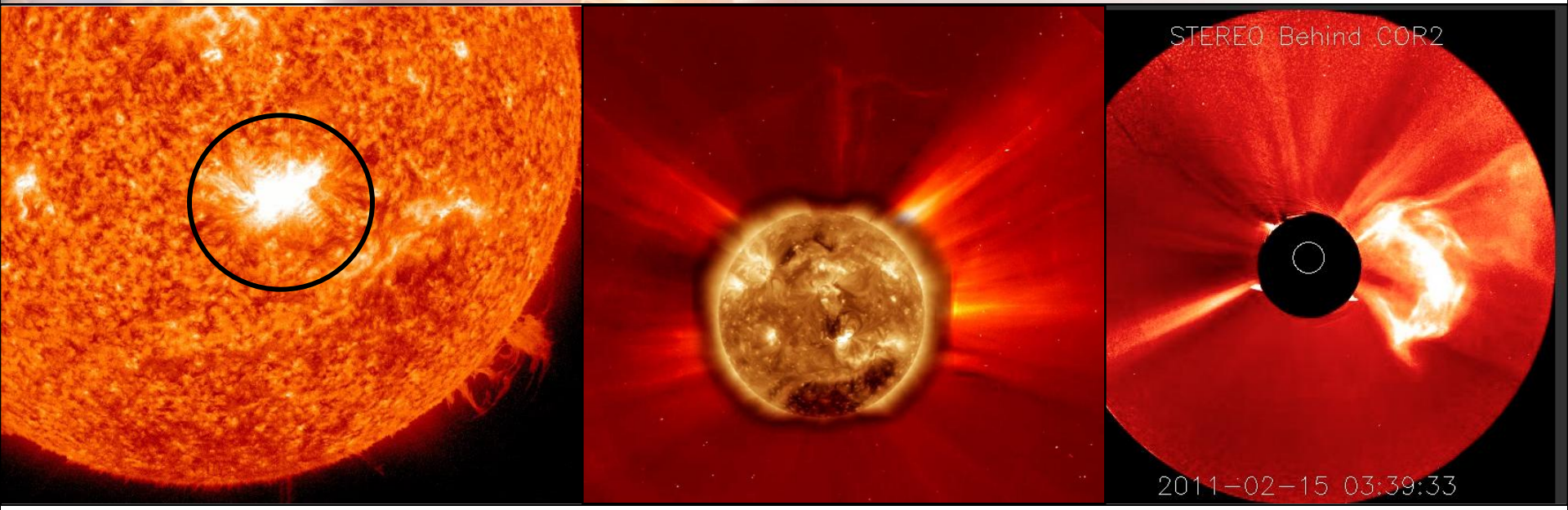
Left: NASA's Solar Dynamics Observatory (SDO) recorded an X-class flare on February 14, 2010. This intense flash of extreme ultraviolet radiation is circled on the image. Credit: NASA SDO. Center: A composite of data from two spacecraft: SOHO and SDO. The SDO golden disk image is an extreme ultraviolet image of the sun. SOHO's C2 coronagraph shows the faint edge of a "halo" coronal mass ejection (CME) as it races away from the Sun and heads towards Earth. Credit: NASA. Right: The expanding CME cloud as it heads out into space observed by the STEREO-B spacecraft. Credit NASA

• **On February 14 at 8:56 p.m. EST, Sunspot 1158 unleashed the strongest solar flare since December 5, 2006.** The eruption, registered X2 on the Richter scale of solar flares which are caused by the sudden release of magnetic energy stored in the Sun's atmosphere. Several Heliophysics spacecraft recorded the event as it evolved.

• **X-flares are the strongest type of solar flare, and this is the first such eruption of new Solar Cycle 24**. They can trigger radio blackouts and long-lasting geomagnetic storms. In addition to flashing Earth with ultraviolet (UV) radiation, the explosion also hurled a coronal mass ejection (CME) toward Earth. The charged particles associated with this CME traveled about 900 Km/second and reached Earth's orbit on 17 February 2011. The impact was not as strong as expected considering the cloud's X-class origin, but aurora have been observed farther south than usual.

• This first X-flare of the new solar cycle occurred after a few M-class and several C-class flares over the previous few days. The next solar maximum is expected in the 2013 timeframe. The X-class flare imaged by SDO's Atmospheric Imaging Assembly was featured as the Astronomy Picture of the Day on 17 February, see: http://apod.nasa.gov/apod/ap110217.html

NASA Heliophysics Spacecraft Observe Strongest Solar Flare Since 2006



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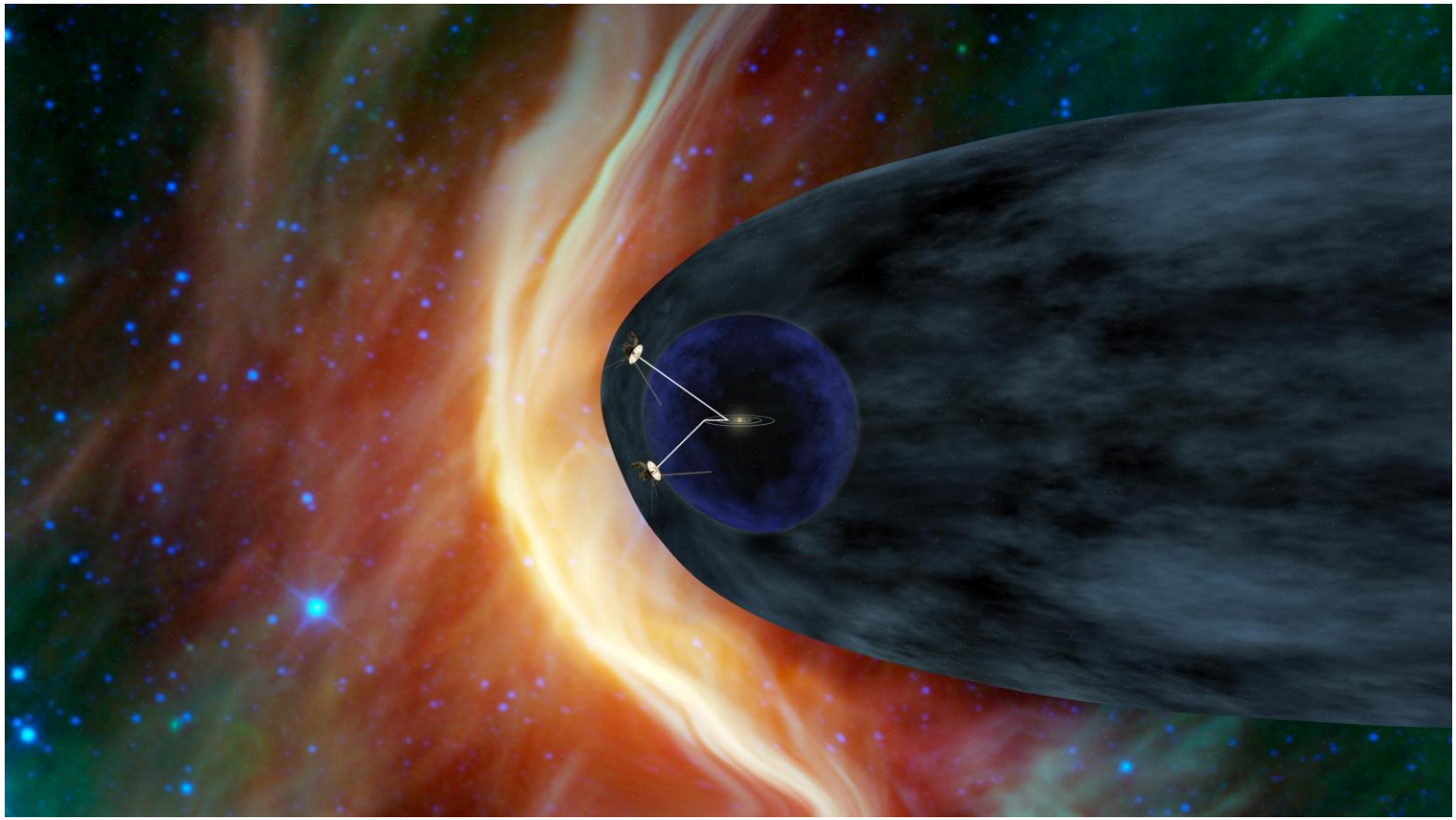
Voyager 1 can still dance

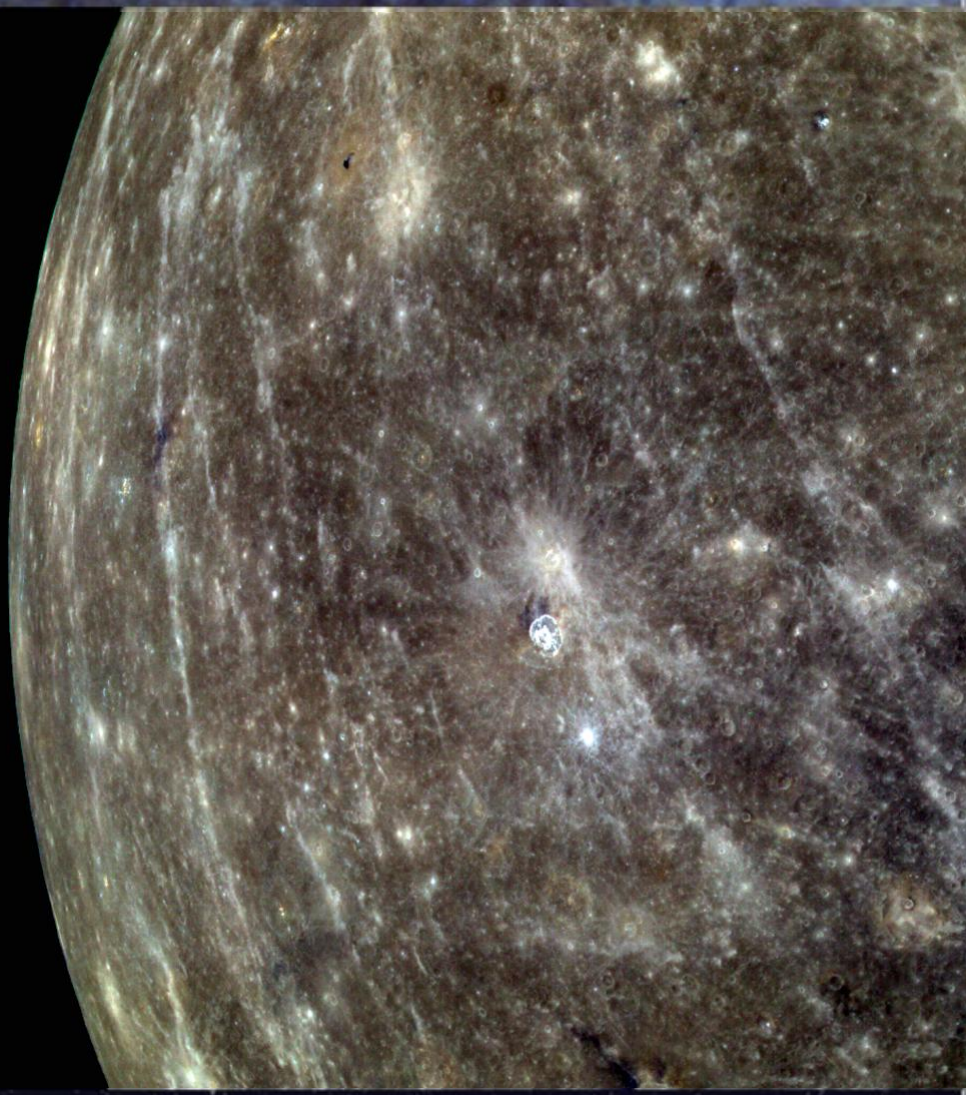
Voyager 1 conducts a maneuver after 21 years!
New aim point for heliospheric plasma measurements



MESSENGER
MErcury Surface, Space ENvironment, GEochemistry, and Ranging

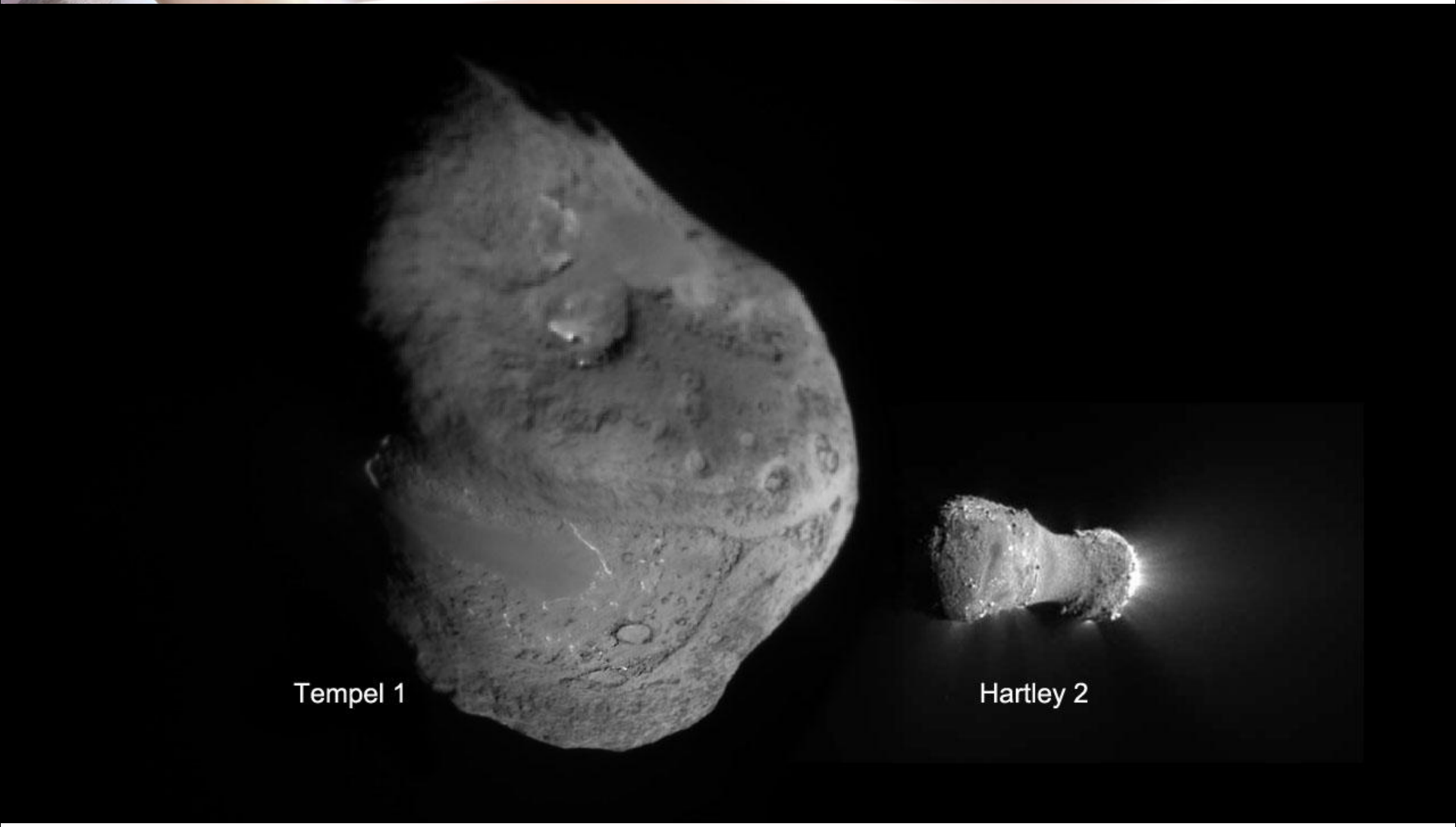
Global Imaging Campaign of Mercury Has Begun

- As the first spacecraft to orbit Mercury, MESSENGER will map Mercury's surface globally with a broad imaging campaign.
- Global images will be obtained for morphology and stereo at 250 m/pixel and in 8 colors at 1 km/pixel.
- In the 1-year mission, MESSENGER will acquire >75,000 images.
- As of 20 April, >11,000 images have already been sent back to Earth.



MESSENGER color image, with the central wavelengths of 1000 nm, 750 nm, and 430 nm displayed in red, green, and blue, respectively, highlights compositional and optical maturity variations.

Stardust NExT encountered Tempel 1 on Feb 14th



This composite image shows the approximate length of Comet Tempel 1 (7.6 km) in relation to Comet Hartley 2 (2.0 km). Stardust-NExT will encounter Tempel 1 on February 14, about 5 years after the Deep Impact encounter. Tempel 1 will be the first comet ever visited twice and will provide important data on how comets change over time

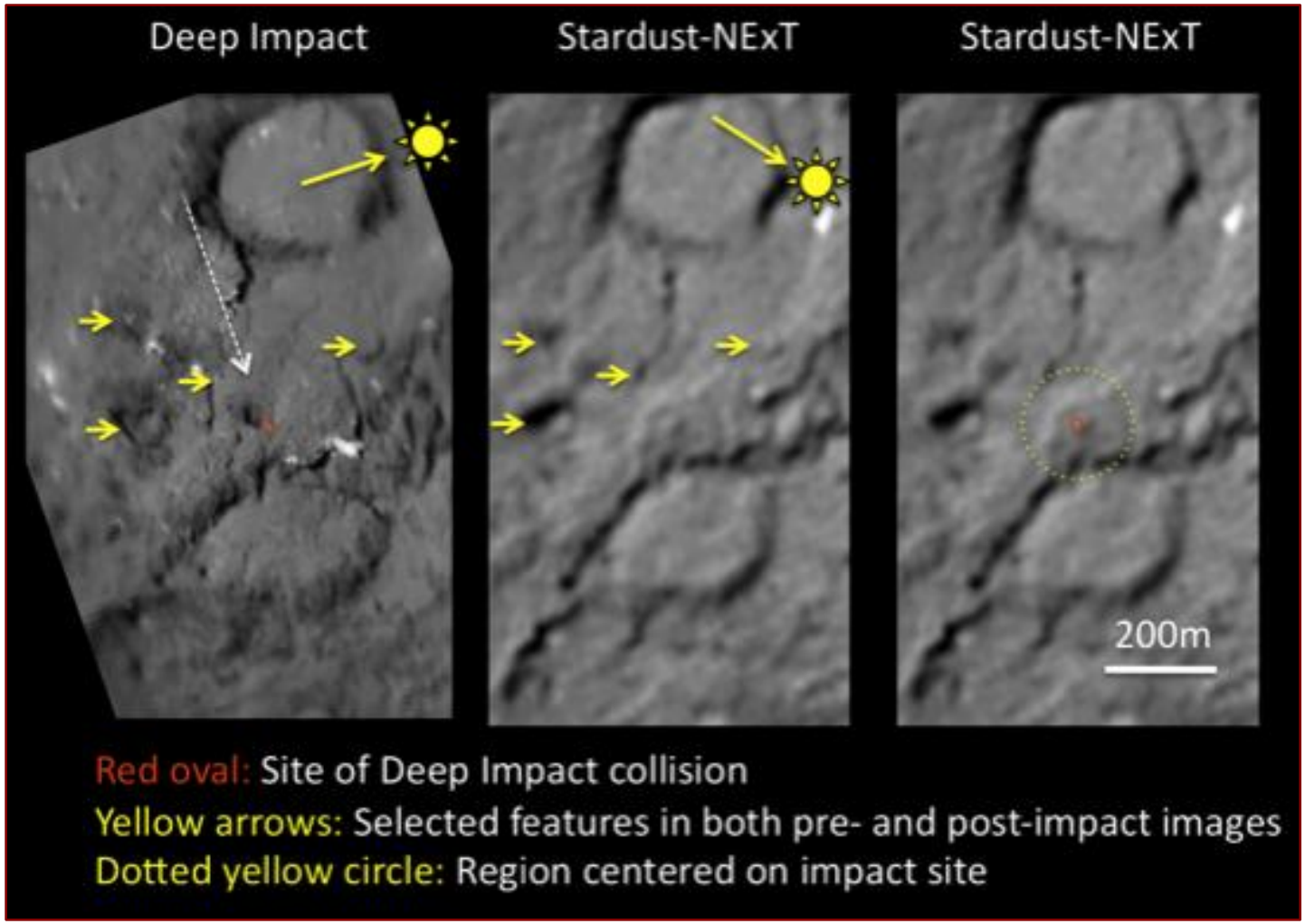
Comet Tempel 1 Deep Impact Crater Revealed

The February 14, 2011 Stardust-NExT encounter with comet Tempel 1 has revealed features of the impact crater created by the Deep Impact (DI) mission in 2005.

Left: DI shows a dark mound about 50 meters (~160 feet) in size. The red oval shows the area hit by the impactor released by Deep Impact.

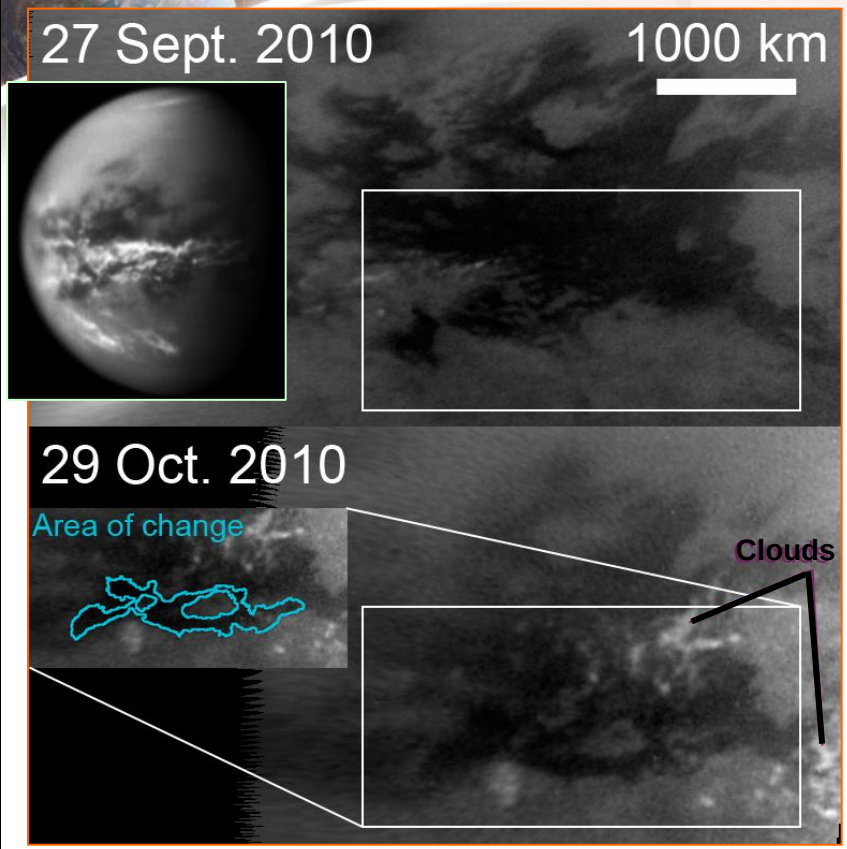
Middle: Stardust-NExT shows that the impactor erased the dark mound and flattened the area.

Right: The yellow circle shows the outer rim of the crater. The crater is estimated to be 150 meters (~500 feet) in diameter.



Seasonal Methane Rains Transform Titan's Surface

First observational evidence of substantial rainfall in the equatorial region of Saturn's moon Titan



Methane clouds in the troposphere, the lowest part of the atmosphere, appear white and are mostly near Titan's equator. The darkest areas are surface features; the inset boxes indicate the area of change. Cassini observations of clouds like these provide evidence of a seasonal shift of Titan's weather systems to low latitudes following the August 2009 equinox in the Saturnian system.

- Dramatic new findings reported in *Science*[1] suggest that Titan's weather is changing with the seasons, now early northern spring (~April on Earth), and storms have become more common at low latitudes.
- A huge cloud observed on Titan in Sept. 2010 was quickly followed by extensive changes on the surface:

  ~500,000 km^2, roughly the combined area of Arizona and Utah.
- The best explanation for the changes is widespread methane rainfall from the storm making the surface wet, perhaps even flooding it in some places.
- The observation of recent rain suggests that the climate is similar to the southwestern U.S., where infrequent rain carves washes and riverbeds.
- The new data also provides good reason to believe that the river channels carved in Titan's arid desert regions, such as those sighted in the images returned by the Huygens probe during its descent near the equator in January 2005, are in fact carved by seasonal rains.

[1] Rapid and Extensive Surface Changes Near Titan's Equator: Evidence of April Showers, E. P. Turtle, et al, *Science* 18 March 2011: 1414-1417.

03/25/11

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- Science Results
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JWST Summary

- Despite budget issues and re-plan activities, JWST continues to make progress
  - 74% of flight hardware is past CDR (either ready for fab, in fab, test or delivered)
- Re-plan is on track for late June/early July
- Budget flat-lined at $375M in FY12 and beyond (“notional”)
  - Not consistent with flight project development requirements
  - Real budget requirements will be determined by the re-plan

SMD Missions launching in Calendar 2011

- Glory – Launched attempted on a Taurus-XL March 4
  - Failure, similar to OCO last year
- Aquarius – Launch on a Delta II June 9
  - Argentina spacecraft, US science instruments and launch service
- Juno – Launch on an Atlas V August 11
  - Shipped to KSC this week
- GRAIL – Launch on a Delta II September 8
  - Ships to KSC later in May
- NPP – Launch on a Delta II October 25
  - Launch for NOAA
- Mars Science Laboratory – Launch on an Atlas V November 25
  - Ships to KSC in June

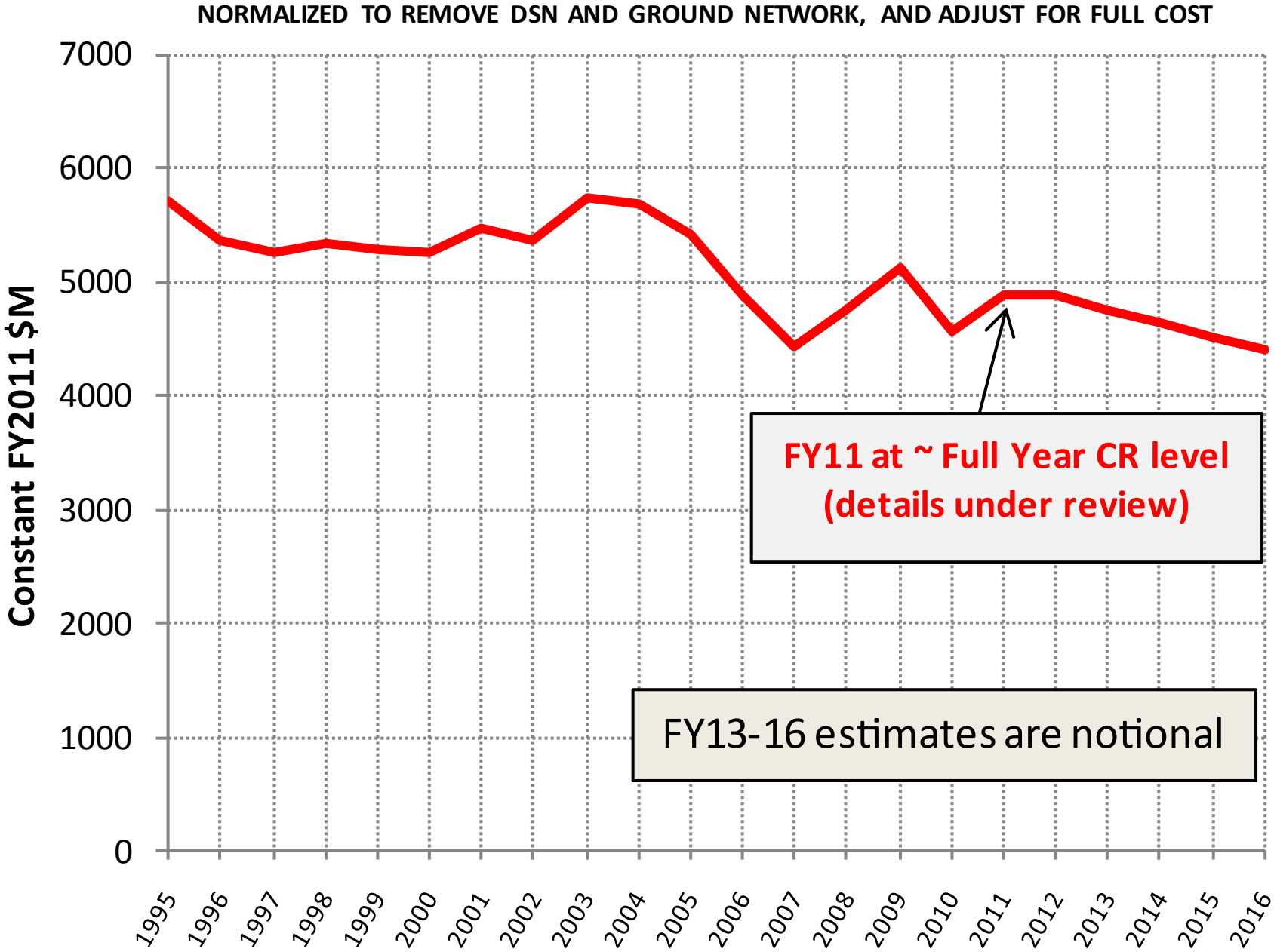
Launch Vehicle Crisis

- NASA is losing reliable, predictable, access to space via affordable, proven launch vehicles
- After 2 consecutive failures of the Taurus-XL, there is no certified U.S. launch vehicle with capacity between the Pegasus (440kg to LEO) and the Atlas-V (9750-29240 kg to LEO)
- Costs of the Atlas-V has escalated to the point where flight missions are being descoped (e.g., Solar Orbiter) and future flight rates diminished
- Launch vehicle availability and reliability problems are causing launch delays and cost increases now, and will have greater impacts on the Earth and space science programs in the coming decade

US Launch Vehicles

- **Pegasus (440 kg)** **Cat 2**
- **Taurus-XL (1350 kg)** **Cat 2 (3 of last 4 failed)**
  - Several Earth Science payloads manifested
- **Minotaur-IV (up to 1735 kg)** **Unrated**
  - Non-commercial
- **Taurus-II (up to 7000 kg)** **Unrated**
- **Falcon-9 (up to 10450 kg)** **Unrated**
- **Delta-II (2700-6100 kg)** **Cat 3**
  - Production discontinued
  - ~5 more may be available, but not on NLS-2 list
- **Atlas-V (9750-29240 kg)** **Cat 3**
  - Exceptionally costly ($250M-500M)
  - Crowded manifest and SMD has low priority

SMD FY12 BUDGET

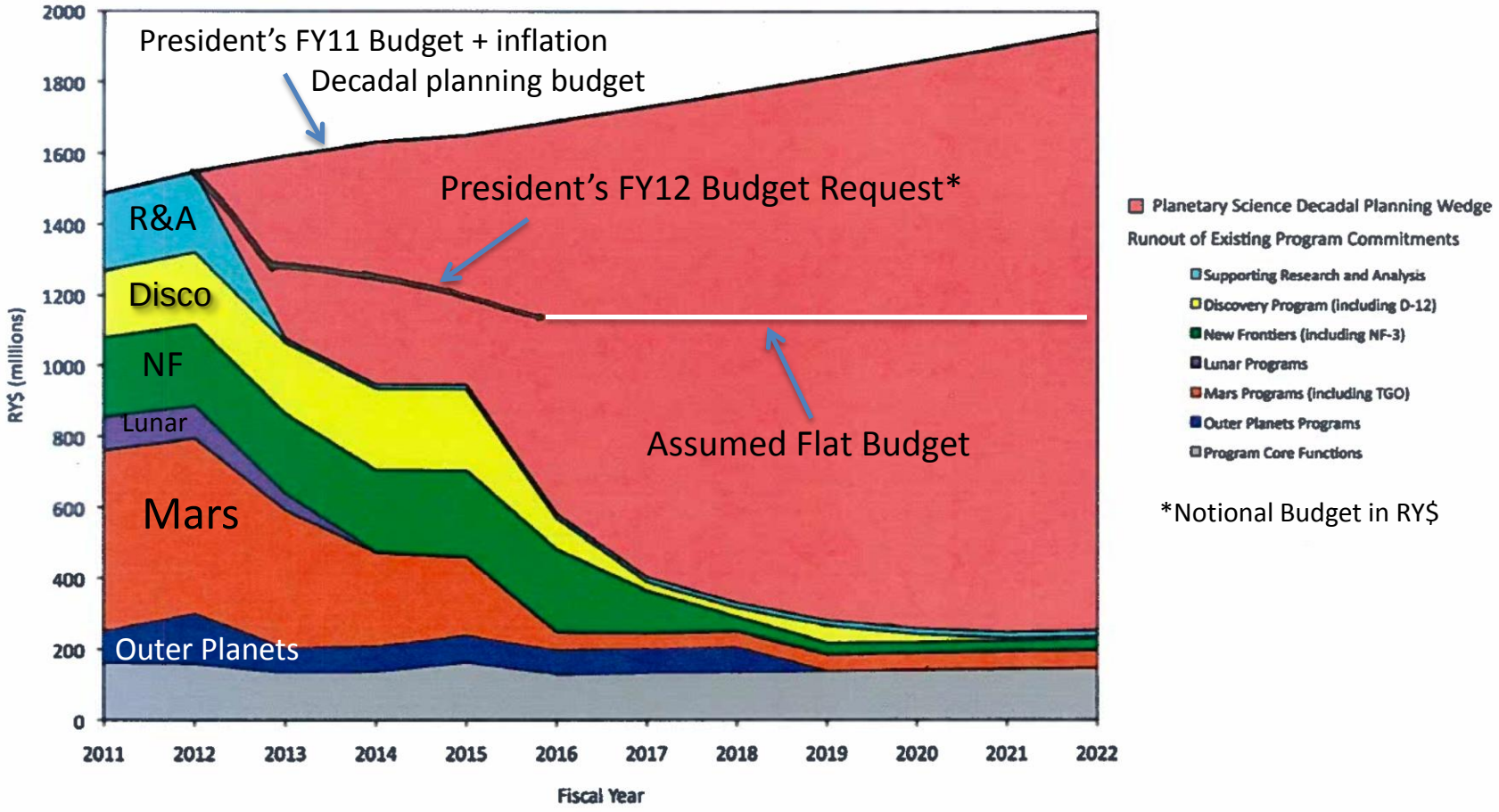


FY12 Science Program Summary

FY 2013-FY 2016 estimates notional

		FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
SCIENCE	FY11	4497.6	5005.6	5248.6	5509.6	5709.8	5814.0	-
	FY12		4750.0	5016.8	5016.8	5016.8	5016.8	5016.8
Earth Science	FY11	1420.7	1801.7	1944.4	2089.4	2216.5	2282.1	
	FY12			1653.0	1679.2	1665.3	1691.4	1727.3
Planetary Science	FY11	1341.3	1485.8	1547.3	1591.3	1630.2	1649.5	
	FY12			1488.9	1365.7	1326.4	1271.0	1188.9
Astrophysics	FY11	1103.9	1076.3	1109.3	1149.1	1158.7	1131.6	
	FY12			992.3	1067.6	1086.3	1085.1	1113.5
Heliophysics	FY11	627.4	641.9	647.6	679.8	704.4	750.8	
	FY12			577.9	591.0	612.4	627.2	628.6

Planetary Funding Profiles



*Notional Budget in RY$

Effects of the FY12 Budget Proposal on SMD

- Planetary Science will not be able to fulfill the recommendations of the newly released NRC Planetary Decadal Report without severely descoping or eliminating its Flagship mission objectives. Two of five flight program lines are eliminated.

- Earth Science has lost half of its Climate Initiative, has reduced planned augmentations to non-flight programs, and deferred two of four Tier 1 flight projects.

- Flat-funding of JWST will result in an additional launch delay and increased total cost. There is no funding for WFIRST, the highest priority Astrophysics flagship, until after the launch of JWST. Several extended missions will be terminated.

- Renegotiations with ESA on joint projects are required; some NASA contributions will be reduced (Mars 2018), others terminated (LISA, IXO, Laplace).

Effects of the FY12 Budget Proposal on SMD (Cont'd)

- The Administration's FY12 budget proposal reducing the five-year run-out relative to the FY11 budget proposal is a serious blow to Earth and space science.

- SMD is restructuring it programs to meet this new budget challenge, but it is clear that a great deal of science will be lost in the coming years.

Agenda

- Science Results
- Programmatic Status
- **Findings & Recommendations**

Losses to Science in the FY12 Budget

Finding

The Administration's FY12 budget proposes a significant reduction in the five-year run-out of the NASA Earth & space science program relative to the FY11 budget. This reduction puts at serious risk NASA's ability to accomplish the goals set out in several recent Decadal Surveys for Earth and space science, undermines SMD's international collaborations, and threatens the health of the Earth and space science enterprise.

Affordability of Small & Medium Missions

Finding

Small and medium missions, which comprise a major element of the SMD portfolio, are increasingly less affordable. Lower cost flight missions require prudent but less conservative mission assurance and review processes than flagship missions. A return to affordable missions requires, in part, that NASA tailor 7120.5 for lower cost SMD mission categories and instill this tailoring into the engineering (TMCO) review process.

Recommendation

Short Title: Lowering the Cost of Expendable Launch Services

Recommendation:
We recommend that NASA work aggressively to lower the cost of expendable launch services through whatever means possible. This may include block buys or other innovative approaches in the NASA Launch Services II (NLS II) contract, and pursuing alternate sources such as new commercial entries and international collaborations.

Major Reasons for the Recommendation:
The new NLS II contract greatly increases the cost of launch services, resulting in loss of the number of flight missions that SMD can afford.

Consequences of No Action on the Recommendation:
The SMD launch rate will be reduced and there will be reductions in the science content of those missions which are launched.

Recommendation

Short Title: Re-acquiring Reliable and Affordable Mid-range Launch Vehicle Services

Recommendation:
We recommend that NASA take urgent action to re-acquire reliable and affordable mid-range launch vehicle services (Taurus-XL to Delta II class) to enable access to space by its Earth and space science flight missions.

Major Reasons for the Recommendation:
There is a crisis in access to space in Earth and space science. The current stable of mid-range launch vehicles are either not reliable (Taurus-XL has failed in 3 of 4 last launches), or uncertified (i.e., Minotaur, Taurus II and Falcon 9) and launch failure does NOT change the certification level!

Consequences of No Action on the Recommendation:
There are SMD flight missions now in development for which there are no reliable launch vehicles available. These will be delayed at significant cost.