
**Science Committee
Presentation to NAC Plenary
April 16, 2009**

**Jack Burns
Brad Jolliff
Mark Robinson
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SMD Missions Next 12 Months

Astrophysics



Earth Science



Heliophysics



Planetary Science



Apr 2009

May

June

July

Aug

Sept

Oct

Nov

Dec

Jan

Feb

Mar 2010

Topics

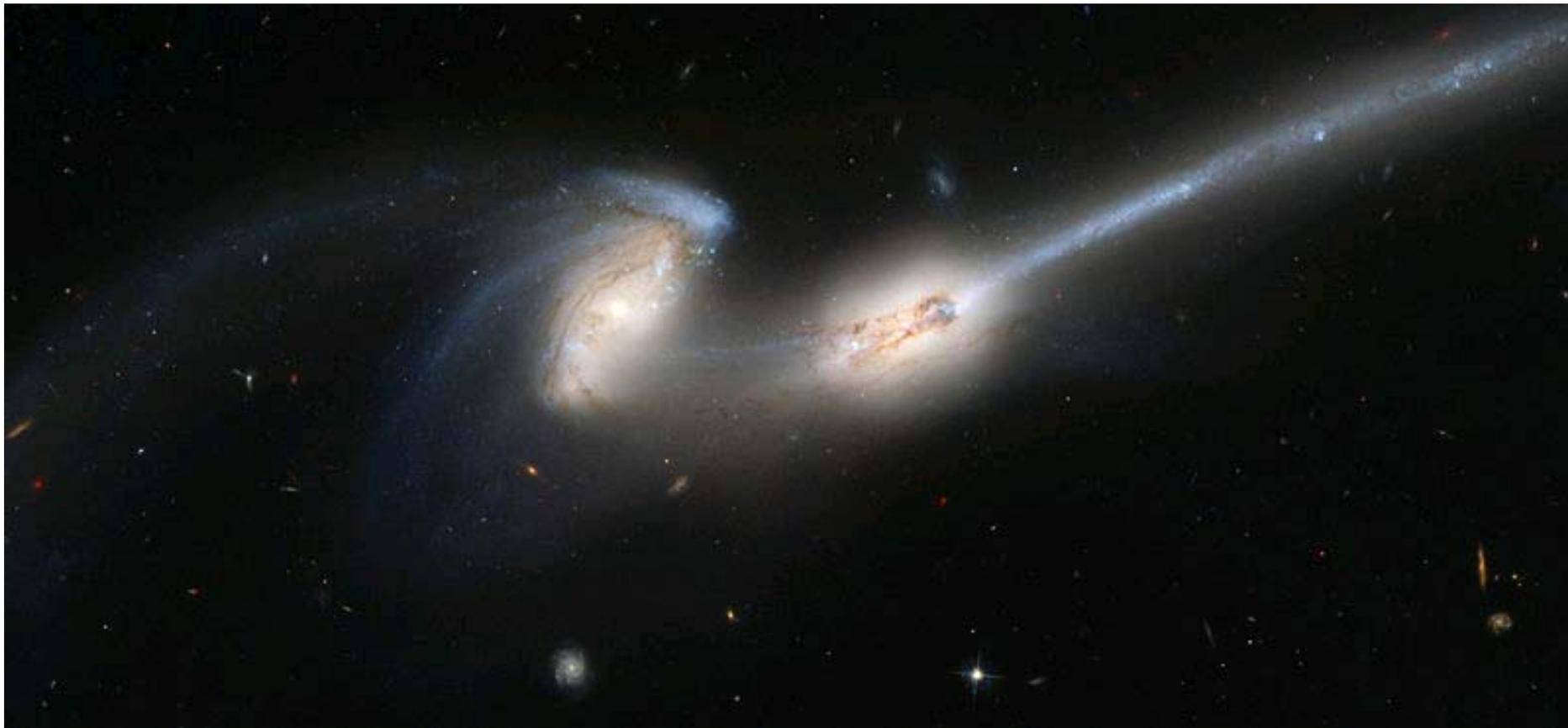
- *Astrophysics: Exoplanet Exploration*
- **Heliophysics: NRC Performance Assessment**
- **Planetary Science: Pu-238 Availability**
- **Earth Science: Requirements for NASA Missions**
- **Space Communications Study**

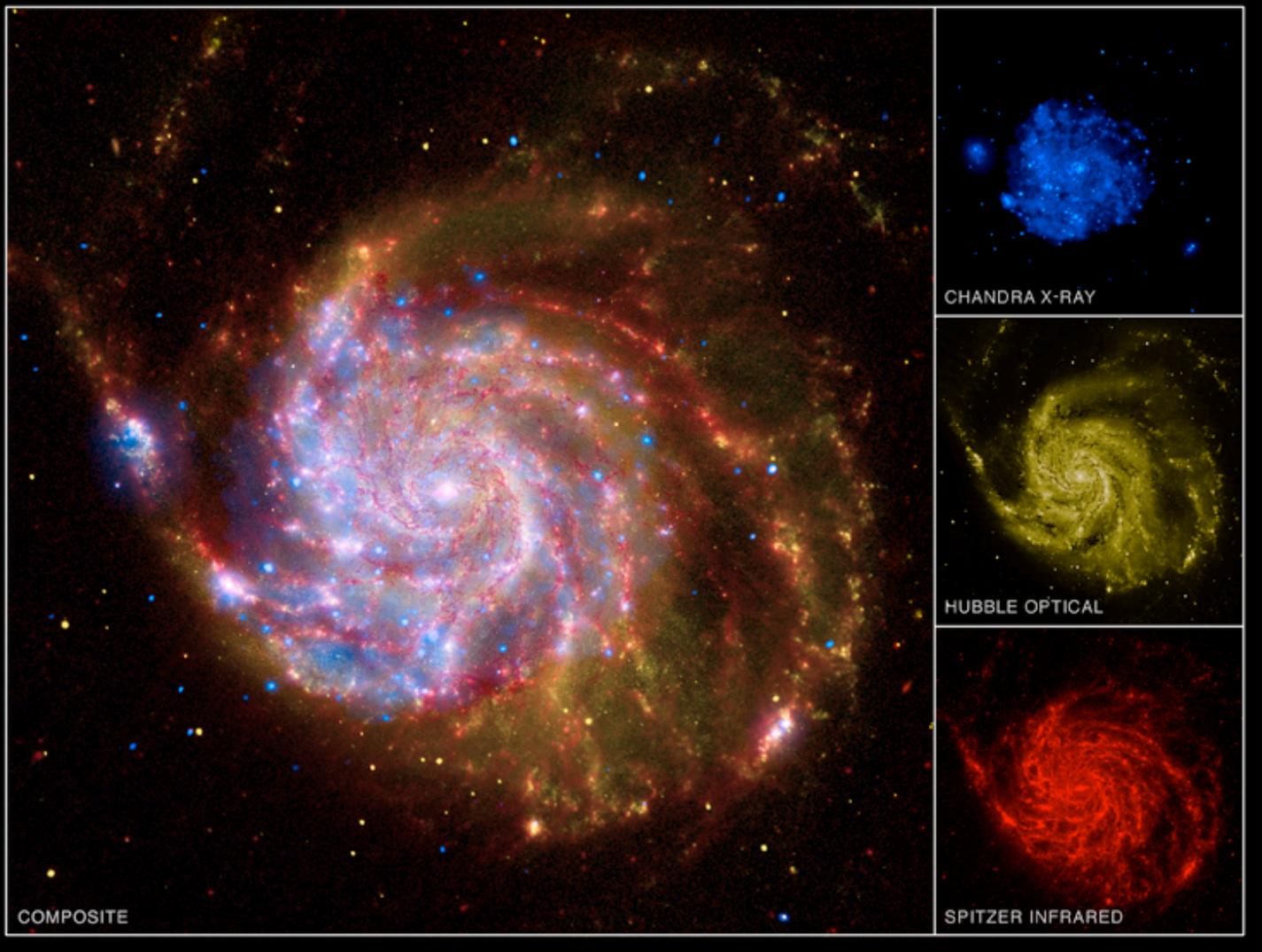


NASA, ESA, and M. Livio and the Hubble Heritage Team (STScI/AURA)

STScI-PRC09-14

Galaxy Triplet ARP 274 On April 1-2, the Hubble Space Telescope photographed the winning target in the Space Telescope Science Institute's 'You Decide' competition in celebration of the International Year of Astronomy (IYA).





THE UNIVERSE
YOURS TO DISCOVER



INTERNATIONAL YEAR OF
ASTRONOMY
2009

This new "Great Observatories" composite image of M101 combines data from NASA's Chandra X-ray Observatory, the Hubble Space Telescope, and the Spitzer Space Telescope. M101 is a face-on spiral galaxy about 22 million light years away in the constellation Ursa Major, similar to the Milky Way in many ways, but larger. This image was distributed to over 100 planetariums, museums, nature centers, and schools across the country in conjunction with Galileo's birthday on February 15.

HST-SM4 on Track for May

The New York Times

Scientist at Work: John Grunsfeld

Tuesday April 14, 2009
Cover of Science Times

Last Voyage for the Keeper of the Hubble



Both Shuttles Being Readied for HST-SM4

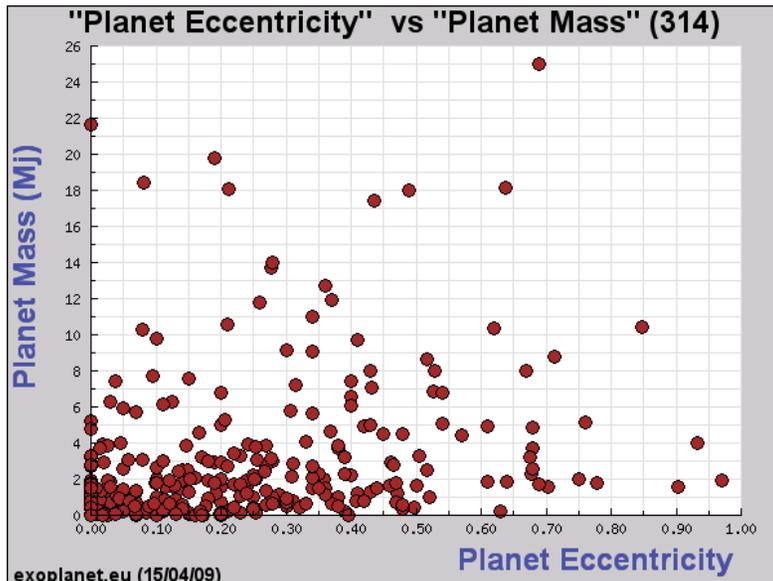
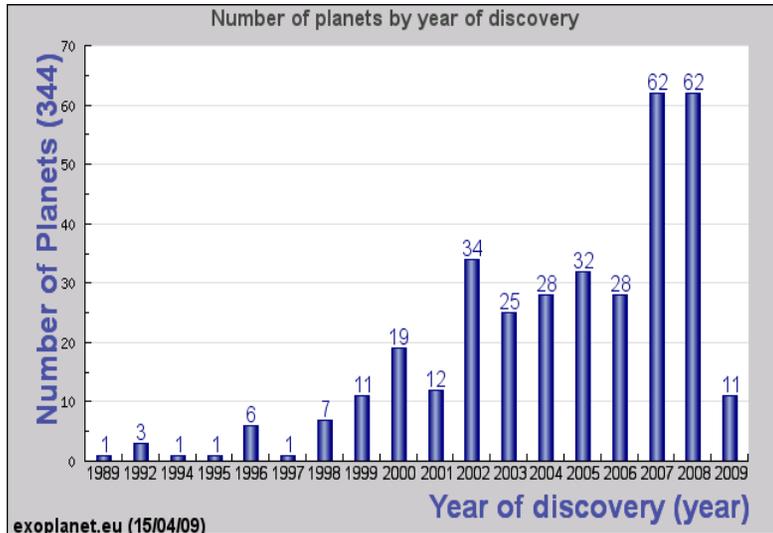


Space Shuttle Endeavor roles to the VAB. Endeavor was attached to the external tank and solid rocket boosters over the weekend.

Space Shuttle Atlantis sits on Launch Pad 39A after rollout from the Vehicle Assembly Building.



The Revolution in Extra-solar Planets



- **344 extra-solar planets identified as of April 10, 2009**
 - 318 by radial velocity
 - 58 transits
 - 8 microlensing
 - 11 direct imaging
 - 7 “pulsar planets”
 - ~300 planetary systems
 - 291 stars have planets, only 53 searched with negative results
 - Smallest mass: few Earths
- **Surprises: Hot Jupiters, large eccentricities, migration**
- **No evidence for habitable planets yet**

<http://exoplanets.org/massradiiframe.html>

Kepler

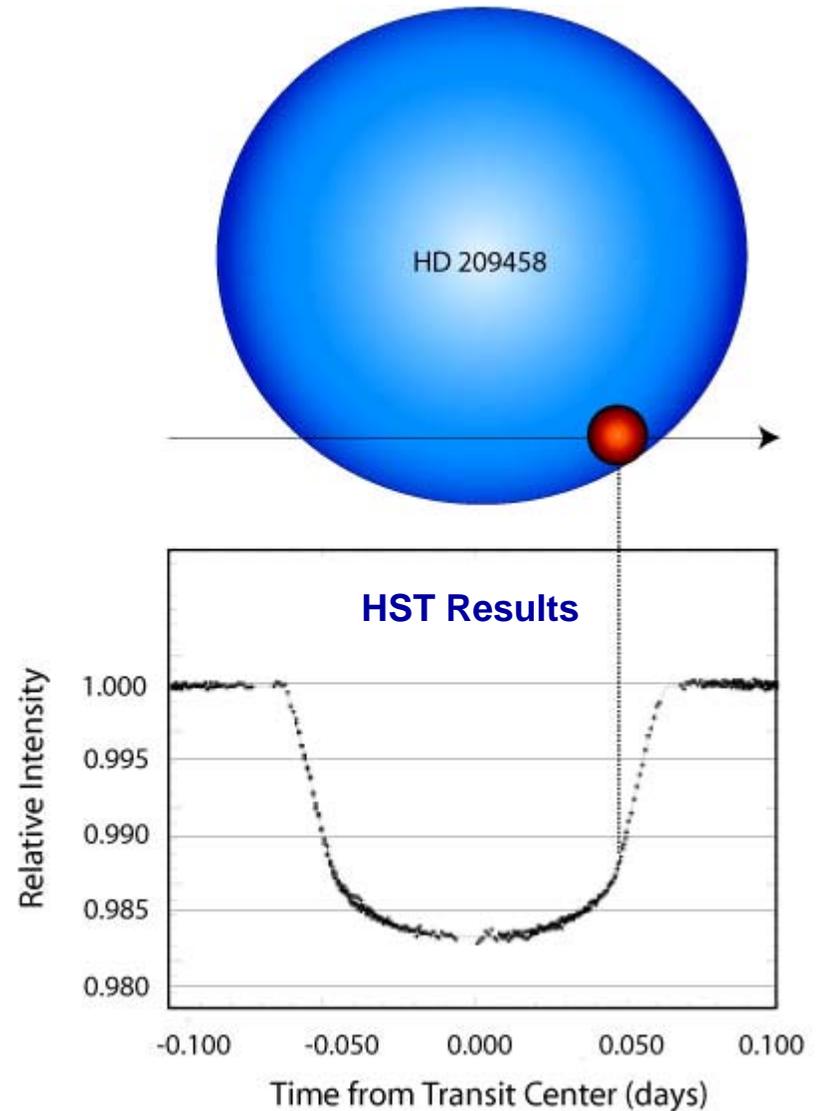
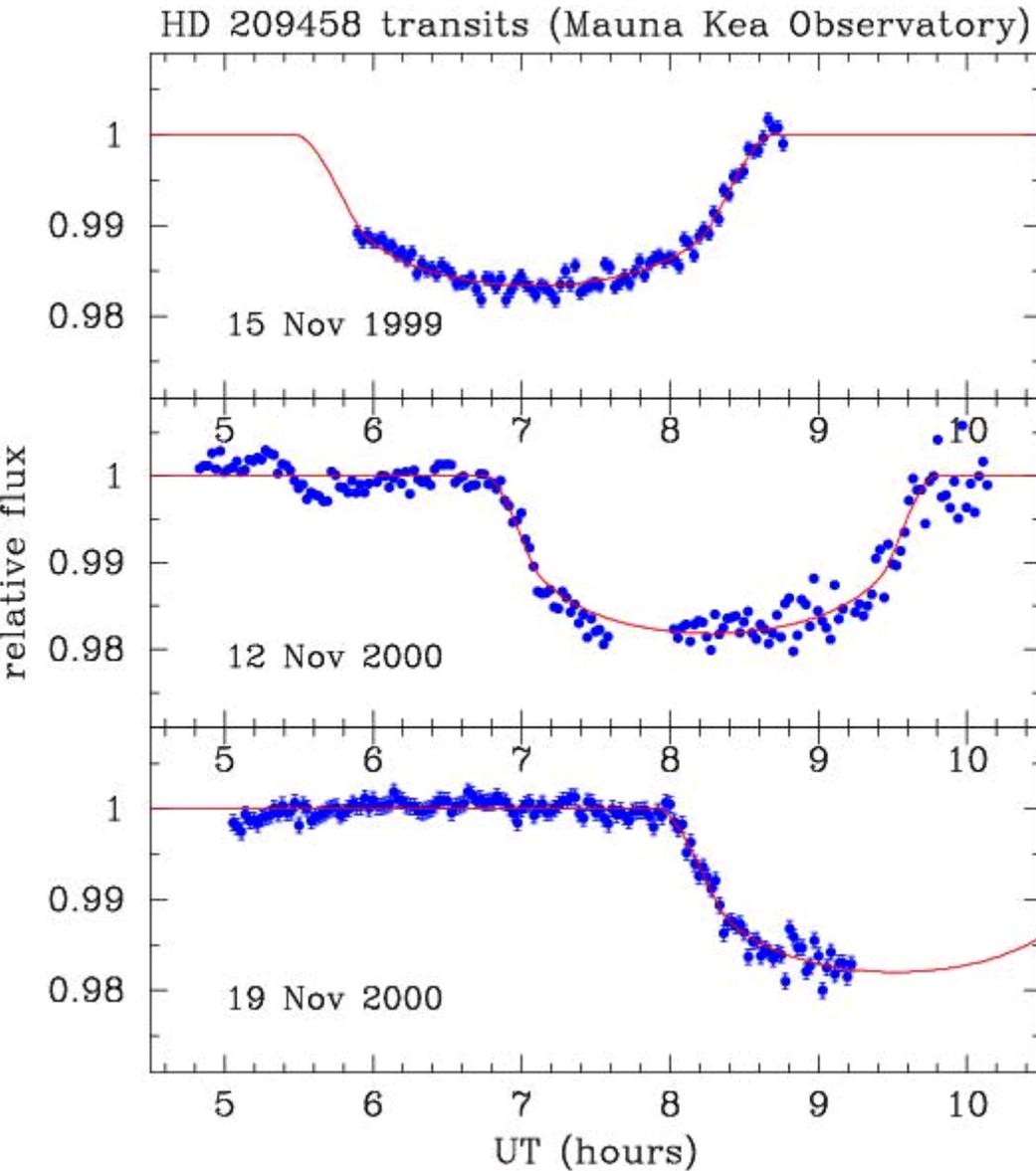
1st Mission to detect Earth-like planets

- Kepler will point at a patch of the Milky Way and monitor the brightness of ~100,000 stars, looking for *transits* of Earth-sized (and other) planets
- 10^{-5} precision *photometry*
- 0.95-m aperture \Rightarrow capable of detecting 100s of Earths
- Launched: March 7, 2009
- Dust cover jettisoned: April 7



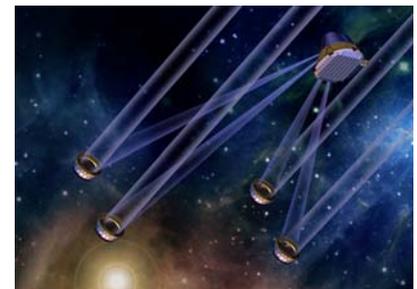
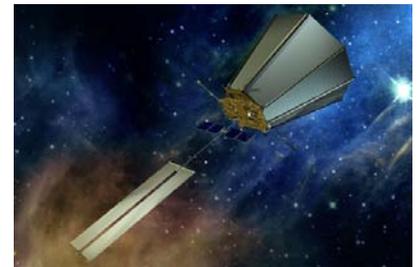
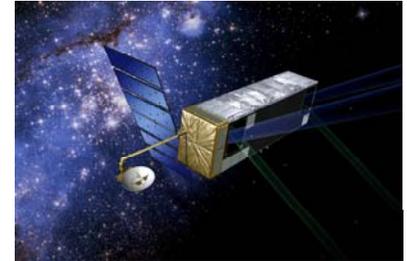
<http://www.nmm.ac.uk/uploads/jpg/kepler.jpg>

The Space Advantage: Accuracy, Coverage, ...



Planning The Future of Exoplanet Exploration

- **Exoplanets will be a major topic for the Astronomy & Astrophysics Decadal Survey**
- **The Astrophysics Subcommittee (APS) and SMD need tactical input from the community**
- **The APS and Science Committee recommend formation of an Exoplanet Exploration Program Analysis Group (ExoPAG), analogous to the existing Analysis Groups under the Planetary Science Subcommittee**



Recommendation

- **Short title of proposed recommendation:**
Form an Exoplanet Exploration Program Analysis Group under the Astrophysics Subcommittee.
- **Short Description of Proposed Recommendation:**
 - **Recommend NASA form an Exoplanet Exploration Program Analysis Group (ExoPAG) to conduct analyses at the request of the NAC Science Committee, the Astrophysics Subcommittee, and SMD. The ExoPAG will take direction from APS, and report to APS.**

Topics

- **Astrophysics: Exoplanet Exploration**
- ***Heliophysics: NRC Performance Assessment***
- **Planetary Science: Pu-238 Availability**
- **Earth Science: External Needs for NASA Missions**
- **Space Communications Study**

STEREO Views Earth-impacting Coronal Mass Ejections

NRC Heliophysics Performance Assessment

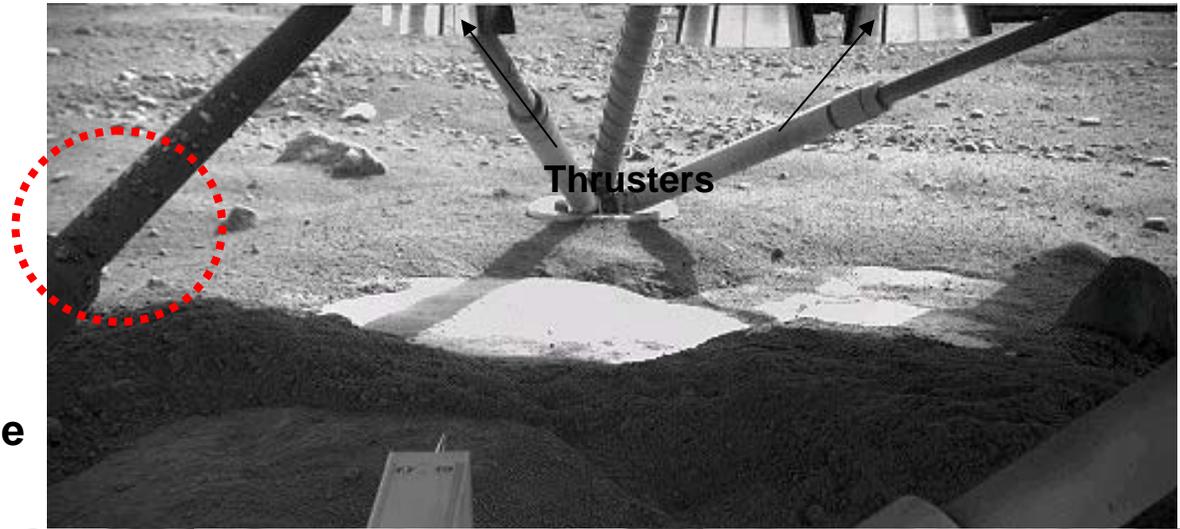
- **The 2005 NASA Authorization Act requires that “the performance of each division in the Science directorate of NASA shall be reviewed and assessed by the National Academy of Sciences at 5-year intervals.”**
 - NASA is required to submit a report to Congress on actions taken in response
 - Astrophysics was reviewed in 2006-7 and Planetary Science in 2007-8
 - The Heliophysics assessment report was released last month
- **Progress on the decadal survey in each area was the basis for the NRC’s assessment**
- **SMD’s Heliophysics Division is preparing a response to the NRC’s recommendations. Will be discussed by the HPS in May.**

Topics

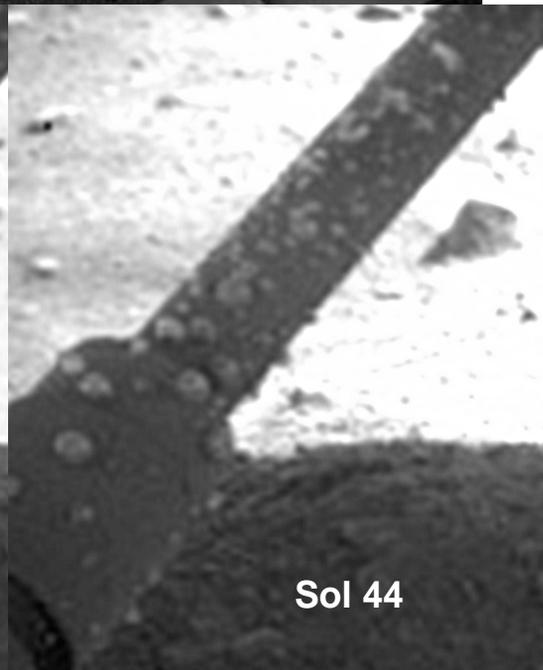
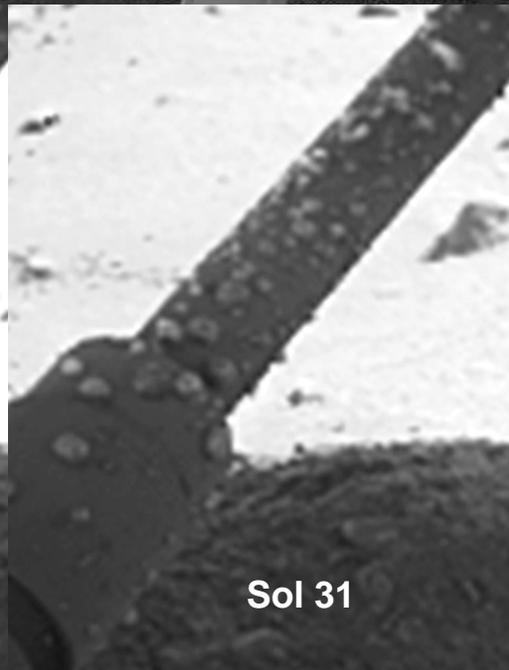
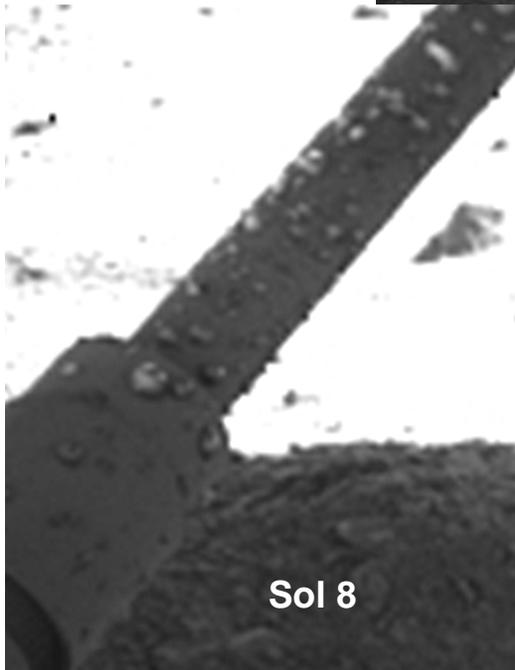
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Phoenix: Physical Evidence for Brines on Mars?

Theory: Phoenix's thrusters splashed materials on landing struts. These strut deposits appear hemispheric and could be brines! Brines absorbed water vapor from the air explaining the growth in size during the first 44 Martian days before slowly evaporating as the temperatures dropped.



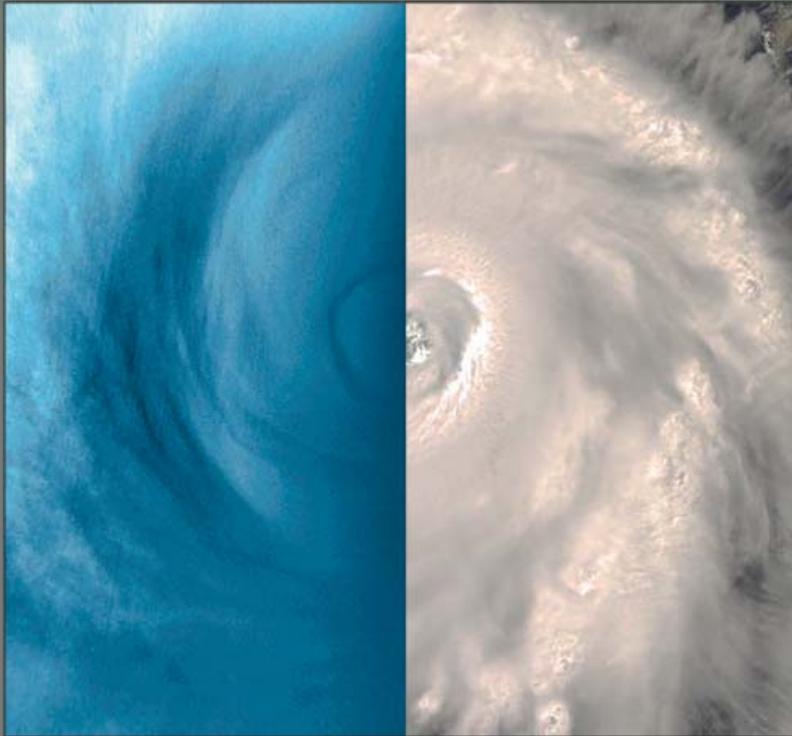
Status: The possibility of liquid salty water or brines on Mars is under review by the scientific community. Presented at LPSC on March 24, 2009



Vortices on Venus Have Similarities to Cyclones / Hurricanes on Earth

Geophysical Research Letters

28 FEBRUARY 2009
Volume 36 Number 4
American Geophysical Union



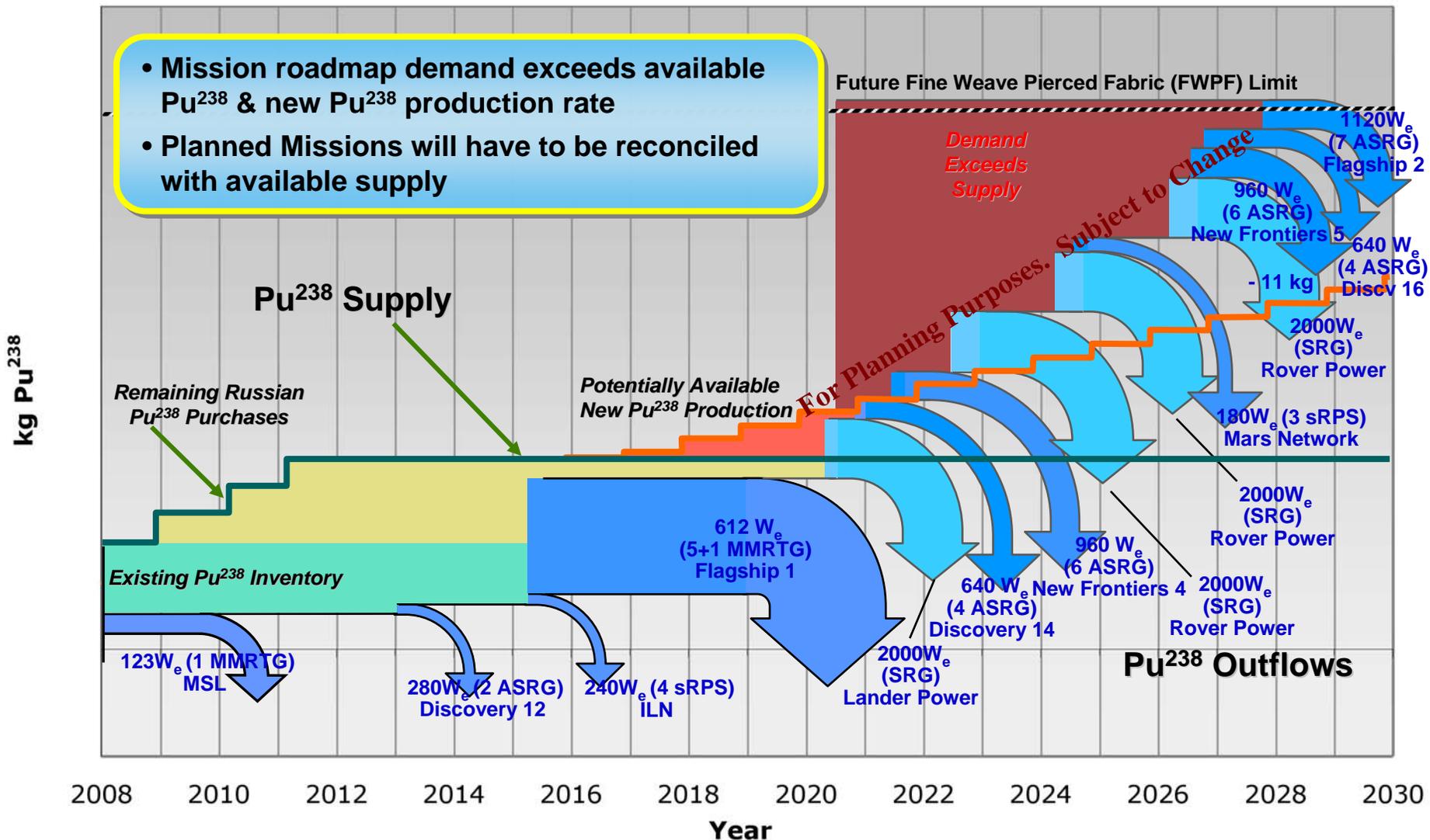
- Vortex circulation on Venus: Dynamical similarities with terrestrial hurricanes
- Understanding mantle flow near the core-mantle boundary
- New tool in the study of marine carbonate biomineralization
- Relationship between south polar ozone concentrations and large-scale atmospheric variability

A comparison of vortex storms on Venus shows remarkable similarity to cyclones on Earth. Planetary Science's participating scientist program with ESA's Venus Express mission funded fundamental research into how hurricanes form that may help us understand these storms on Earth. This is a very good example of how "Comparative Planetology" can impact the understanding of our own environment. The JGR cover image is half Venus Express and half Hurricane Frances from NASA's MODIS instruments on Aqua and Terra. The original Venus vortex was discovered from Mariner 10, observed again by Pioneer Venus and later by Galileo Orbiter in 1974, 1979-1982 and 1990.

Plutonium Supply vs Potential NASA Demand

Magnitude of the Potential Shortage

- Mission roadmap demand exceeds available Pu^{238} & new Pu^{238} production rate
- Planned Missions will have to be reconciled with available supply



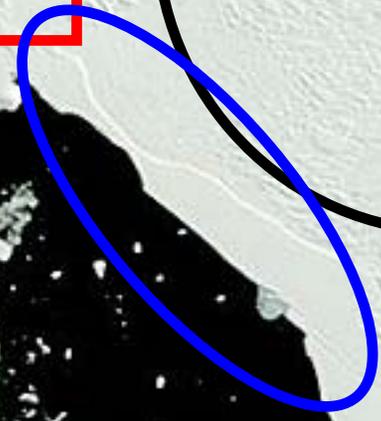
- NRC study "Radioisotope Power Systems: A Day of Reckoning for U.S. Leadership in Space Exploration" expected in late June.

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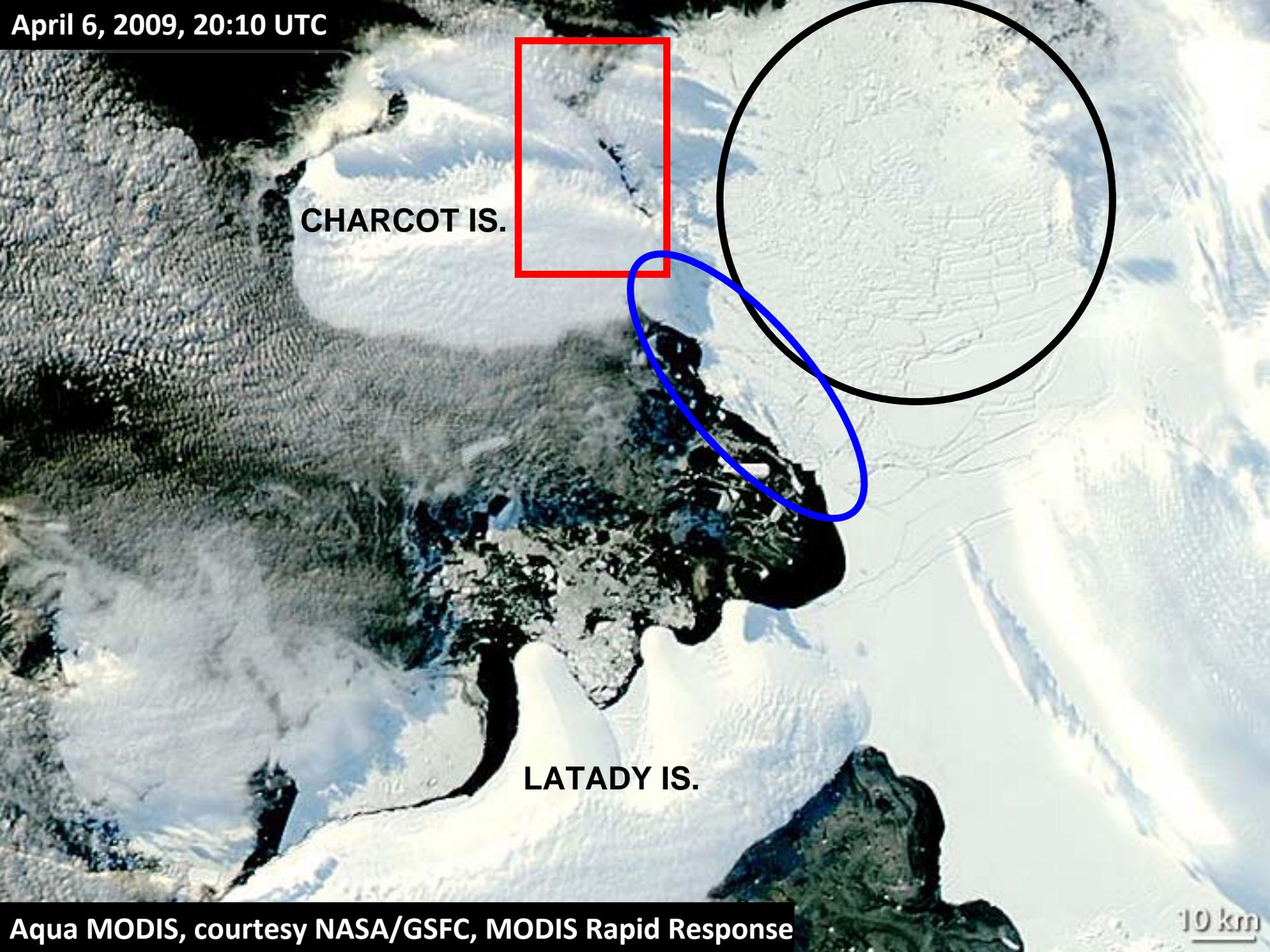
March 31, 2009, 13:30 UTC

CHARCOT IS.



LATADY IS.

April 6, 2009, 20:10 UTC



CHARCOT IS.

LATADY IS.

Aqua MODIS, courtesy NASA/GSFC, MODIS Rapid Response

10 km

NASA Earth Science in the Interagency Context

- **NASA's Earth Science satellites are essential to global climate monitoring**
 - The Earth Observing System is the space-based component of the nation's Climate Change Science Program and provides the only means for obtaining global and near-synoptic observations
- **The national requirements for Earth observations from space exceed the resources available to NASA**
 - The slate of NRC decadal survey recommended missions cannot be implemented in the time frame defined by the survey
 - The NRC Earth Science decadal survey recommended an integrated slate of missions; its scientific strategy requires simultaneous observation of several key parameters
 - NASA has requirements for a number of other missions that are not funded
- **The nation requires an inter-agency collaboration to satisfy the requirements**
 - NASA and NOAA are working well together in several key areas, but
 - NOAA also faces budget shortfalls vis-à-vis requirements
 - The NPOESS partnership may not provide the long-term climate-quality data records needed for climate change research

Mission Classes (ESD and ???)

“Foundational”

- Glory (1/2010)
- Aquarius (5/2010)
- NPP (1-6/2010)
- LDCM (12/2012) (w/o TIRS)
- GPM (7/2013, 11/2015)

Funded

“Decadal Survey” (NRC)

- Venture-Class (2009, 2011, ...)
- SMAP (3/2014)
- ICESAT-II (2015)
- CLARREO
- DESDynI (SAR, LIDAR)
 - Tier-2 (5 missions)
 - Tier-3 (6 missions)

*Totals \$15B
against a \$1.27B
annual mission
budget*

Partially Funded

“National Needs” (Congress)

- Carbon Recovery (vice-OCO)
- TIRS (LDCM or free-flyer)
- DSCOVR
- SAGE-III
- GIFTS

Unfunded*

“Climate / Operational” (Other Agencies)

- *Vector Winds (vice QuikSCAT)*
- *Space Weather (vice ACE)*
- *Ocean color, Aerosols (vice MODIS)*
- *Nadir Altimetry (vice OSTM/Jason-2)*
- *GPSRO*
- *Broad-band Radiation Bud.(CERES)*
- *“R 2 O” infusion ...*

Unfunded

* Some seed funds for TIRS & DSCOVR included in FY09 Appropriation

Carbon Cycle Science and OCO-type Measurements

The Need for Atmospheric Carbon Dioxide Measurements from Space: Contributions from a Rapid Reflight of the Orbiting Carbon Observatory

April 9, 2009

Contributors:

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- **No existing or planned near-term satellite sensor will duplicate OCO's unique contributions to Carbon Cycle and Climate Science**
 - Accuracy/Stability/Precision
 - Coverage
 - Spatial resolution
 - Rapid global repeat
- **Growing interest in the policy community for actionable information on CO₂ sources and sinks**
- ***No near-term carbon recovery mission will be possible without new top-line funds to ESD, or significant delays to ongoing and decadal survey missions***

Recommendation

- **Short title of proposed recommendation:**
Process for identifying non-science requirements and funding for Earth observations.
- **Short Description of Proposed Recommendation:**
 - Recommend NASA work with OSTP and other agencies at the highest levels to define responsibilities and secure funding for Earth observations beyond those recommended by the Decadal Survey to advance Earth System Science.

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Space Communications

- **NASA's infrastructure to enable space communications is aging, while the number of missions and data rates are increasing.**
- **NASA is already constrained by communications capability limits in receiving science data from some missions.**
- **For the future, NASA is embarking on long-term planning for human exploration of the Moon and beyond and continued scientific exploration of the solar system and universe. Both scientific data collection and robust mission operations will be impacted by communications capability.**
- **This planning could be usefully informed by an NRC study of future space communications needs and capabilities, including the future of the Deep Space Network.**

Recommendation

- **Short title of proposed recommendation:**
NRC study of space communications: requirements, capabilities, and architecture.
- **Short Description of Proposed Recommendation:**
Recommend NASA task the NRC to conduct a study of space communications needs for science, exploration, and space operations, including:
 - **Assessment of needs**
 - **Assessment of new and emerging communications technologies**
 - **End-to-end view of the communications system**
 - **Identification of future capabilities that may not be available commercially**
 - **Identification of factors including cost that should define an optimal mix of optical communications, radio arrays, and other techniques**
 - **Consideration of international and interagency plans**

Progress On 2009 Operations Plan

2009 Work Plan Elements	Feb	Apr	Jul	Oct	Comments
Lessons Learned on Large Mission Cost Growth					Recommendation in Feb mtg for NASA compilation of lessons learned – <i>NRC study initiated; due Jan 2010</i>
Review Balance in SMD Portfolio					NRC study on Mission-enabling program elements due in mid-2010. <i>Program balance discussion on 4/15 agenda; background for review of FY10 budget request in July.</i>
Review plans for use of new ELVs for science missions					NAC recommendation in Oct. '08; NASA has requested a Minotaur IV for launch of LADEE
Requirement & Plans for Space Communications					Joint session with SOC in Oct resulted in request for more info; potential April agenda item. <i>Space Comm recommendation in April NAC meeting.</i>
Advise on Portfolio Mgmt for Advanced Technology					<i>SMD technology investment in 4/15 program balance presentation.</i>
Work with EC on science enabled by or enabling human exploration					Joint session in Feb mtg on Planetary Protection. <i>Joint session with EC & AC on EDL on 4/15.</i>
Monitor progress on Earth Science decadal survey implementation					In work by ESS; following NASA's preparation of an implementation plan due in July
Monitor and advise NASA on NPOESS evolution & long-term data records					In work by ESS; requesting that NASA factor this into decadal survey implementation plan
Monitor Lunar Science Plan development and LEAG/OSEWG Workshop planning					First draft of LEAG Lunar Goals Roadmap expected this Summer; LEAG will hold workshop in conjunction with NLSI workshop in July