Science Committee Report

Dave McComas
Chair - NAC Science Committee

Science Committee Members

Dave McComas, Southwest Research Institute, Chair

Carle Pieters, (Vice Chair), Brown University
Maura Hagan, NCAR, Chair of Heliophysics
Eugene Levy, Rice University, Chair of Planetary Protection
Janet Luhmann, UC Berkeley, Chair of Planetary Science
Brad Peterson, Ohio State, Chair of Astrophysics
Steve Running, University of Montana, Chair of Earth Science

Doug Duncan, University of Colorado
Noel Hinners, Independent Consultant
Mark Robinson, Arizona State University
Harlan Spence, University of New Hampshire (new member)
Meg Urry, Yale University (resigned, effective 4/10/14)

Charlie Kennel, Chair of Space Studies Board (*ex officio* member; term ends 7/1/14)

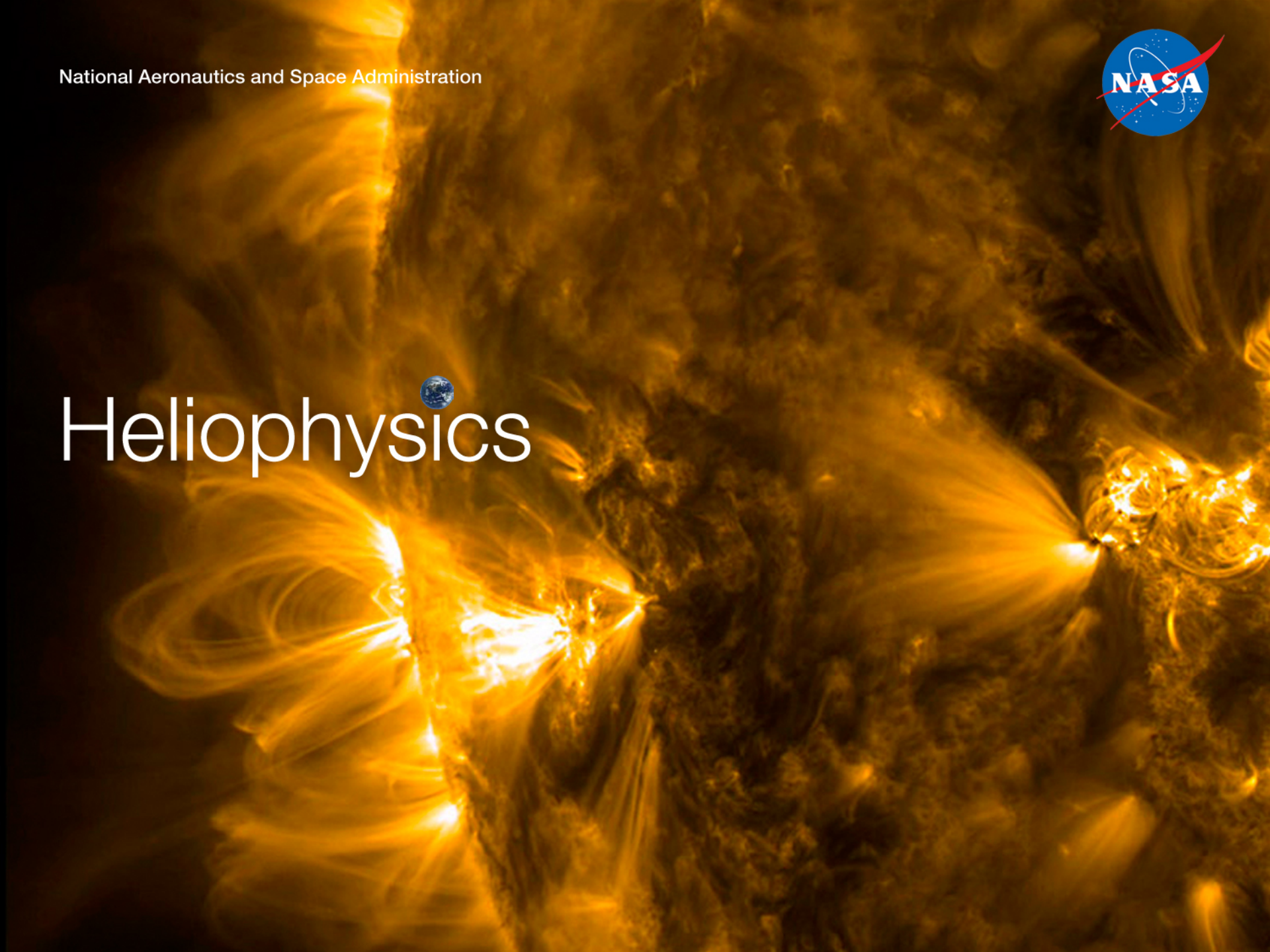
Limited Recent Activity

- Limited number of findings and recommendations flowing upward from Subcommittees
  - Only 2 of 5 Science Subcommittees have met since last NAC Meeting
- Held 4.5-hour telecon last week focused on President's FY15 budget request for SMD
  - Informative discussion, but substantive interaction limited by telecon structure
  - Decided to defer some findings/recommendations to next face-to-face meeting

Outline

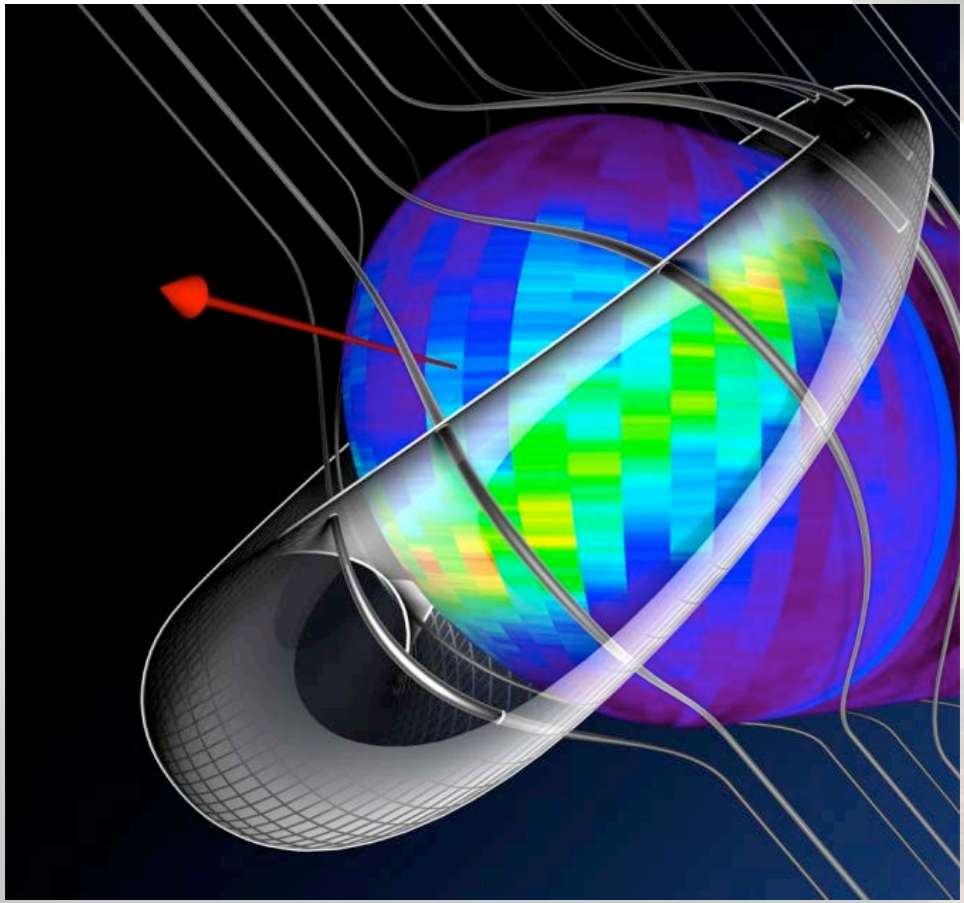
- **Science Results**
- Programmatic Status
- Findings

National Aeronautics and Space Administration



Heliophysics

NASA's IBEX Provides New Insight on the Magnetic System Beyond the Solar Wind



A model of the interstellar magnetic fields – which would otherwise be straight -- warping around the outside of our heliosphere, based on data from NASA's IBEX spacecraft. The red arrow shows the direction in which the solar system moves through the galaxy. Credit: NASA/IBEX/UNH

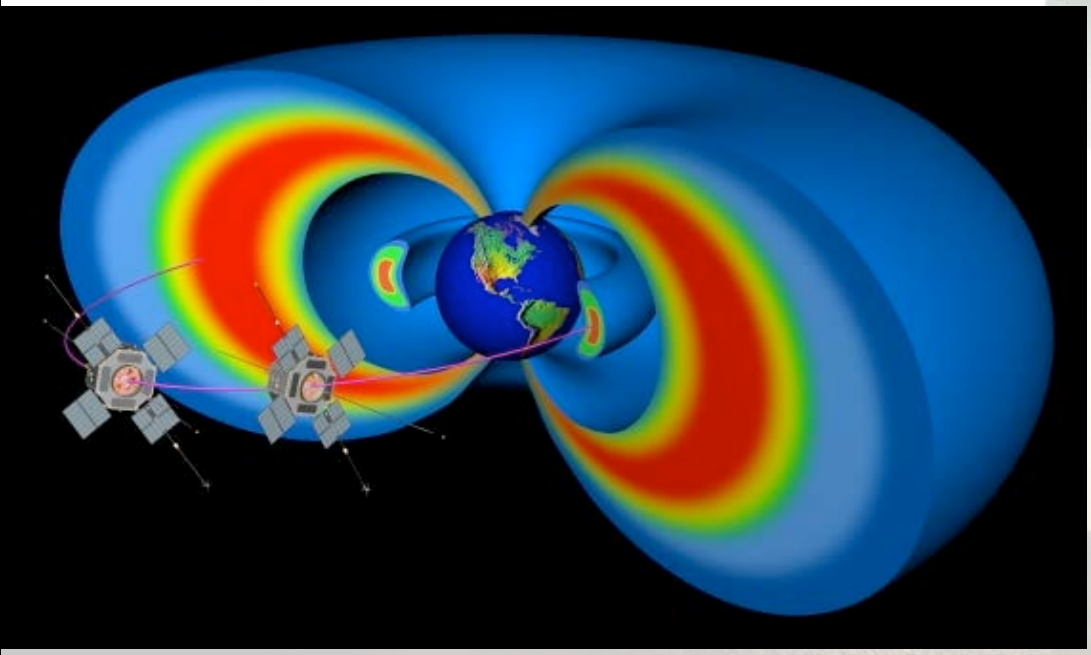
- *Science* paper connecting very local interstellar field from IBEX to 10 TeV CRs

-The heliosphere formed from expanding solar wind inflated "bubble" in interstellar medium

-puzzling feature seen in super high energy cosmic rays on Earth - more cosmic rays coming in from one side of space didn't seem to relate to any special direction in the rest of the galaxy.

-Shown to be consistent with magnetic files ordering around heliosphere from IBEX

New NASA Van Allen Probes Observations Help To Improve Space Weather Models



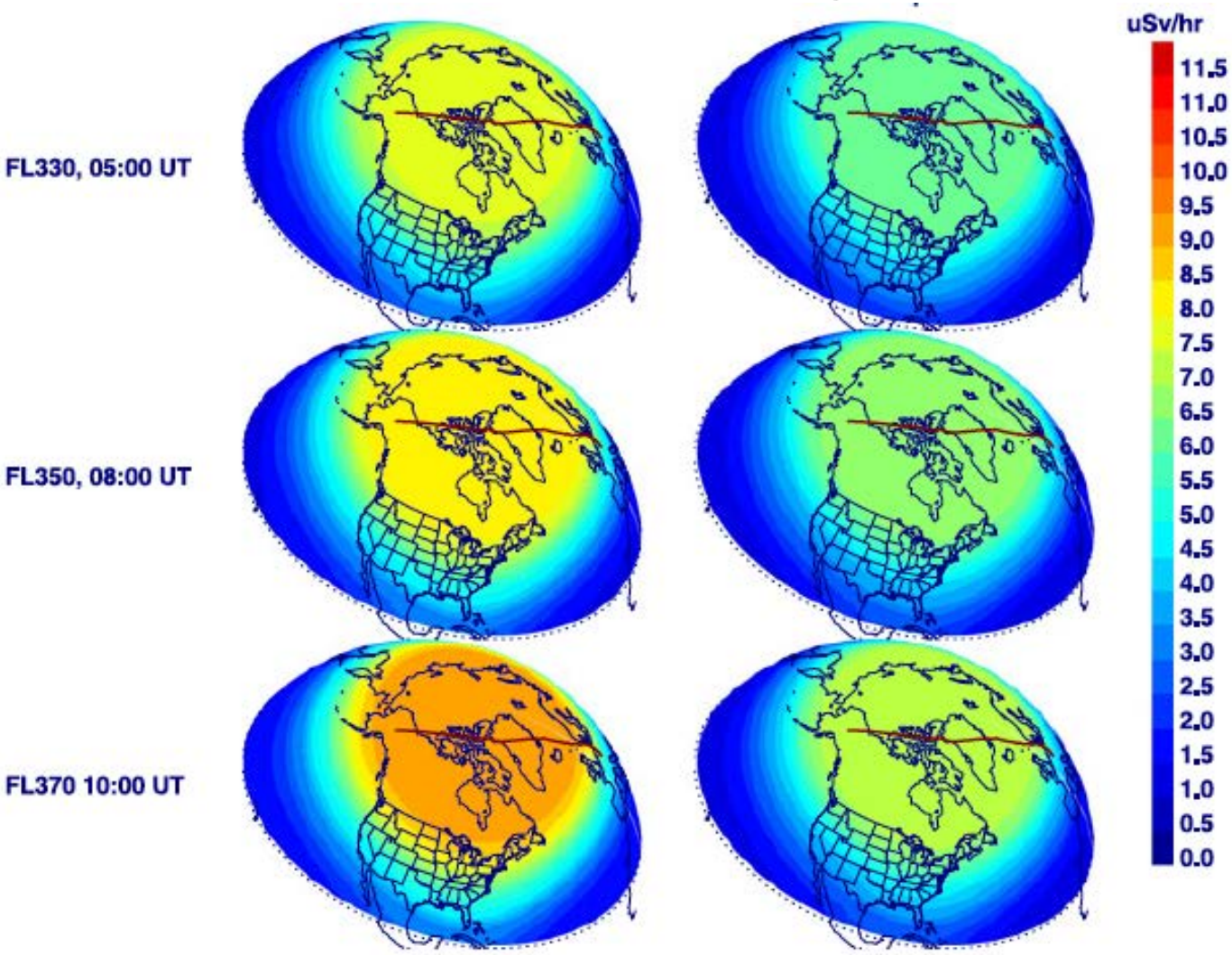
NASA's twin Van Allen Probes orbit through Earth's radiation belts. Their observations help improve computer simulations of events in the belts that can affect technology in space. Credit: NASA

- NASA's twin Van Allen Probes tested and improved a Los Alamos National Laboratory Dynamic Radiation Environment Assimilation Model in 3 Dimensions) model to help forecast near-Earth radiation environment

-Van Allen radiation belts swell and electrons accelerate to .99 c effecting nearby satellites

- Models link Van Allen Probes' local data to global configuration providing info about space weather in the radiation belts

NAIRAS: Nowcast of Atmospheric Ionizing Radiation for Aviation Safety



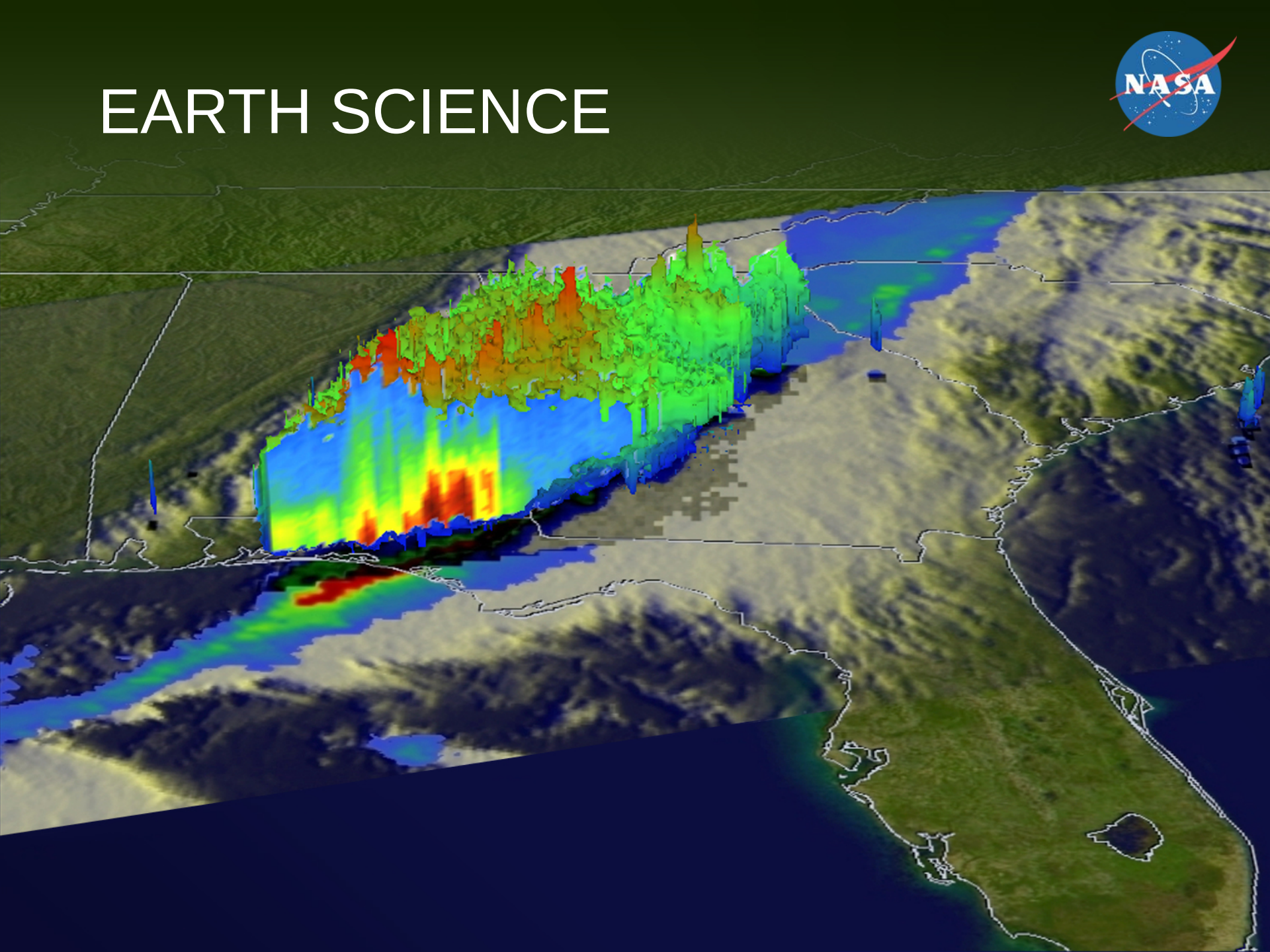
Contours of effective (left) and ambient (right) dose equivalent rates on 23 May 2008 at different flight levels and times during the DLR flight from Fairbanks, AK to Frankfurt (solid red line) after *Mertens et al.* (2013) *SpaceWeather*, doi:10.1002/swe.20100

- new Space Weather tool
- real-time, global, physics-based model
- assesses radiation exposure to commercial aircrews and passengers
- predicts dosimetric quantities from both galactic cosmic rays and solar energetic particles

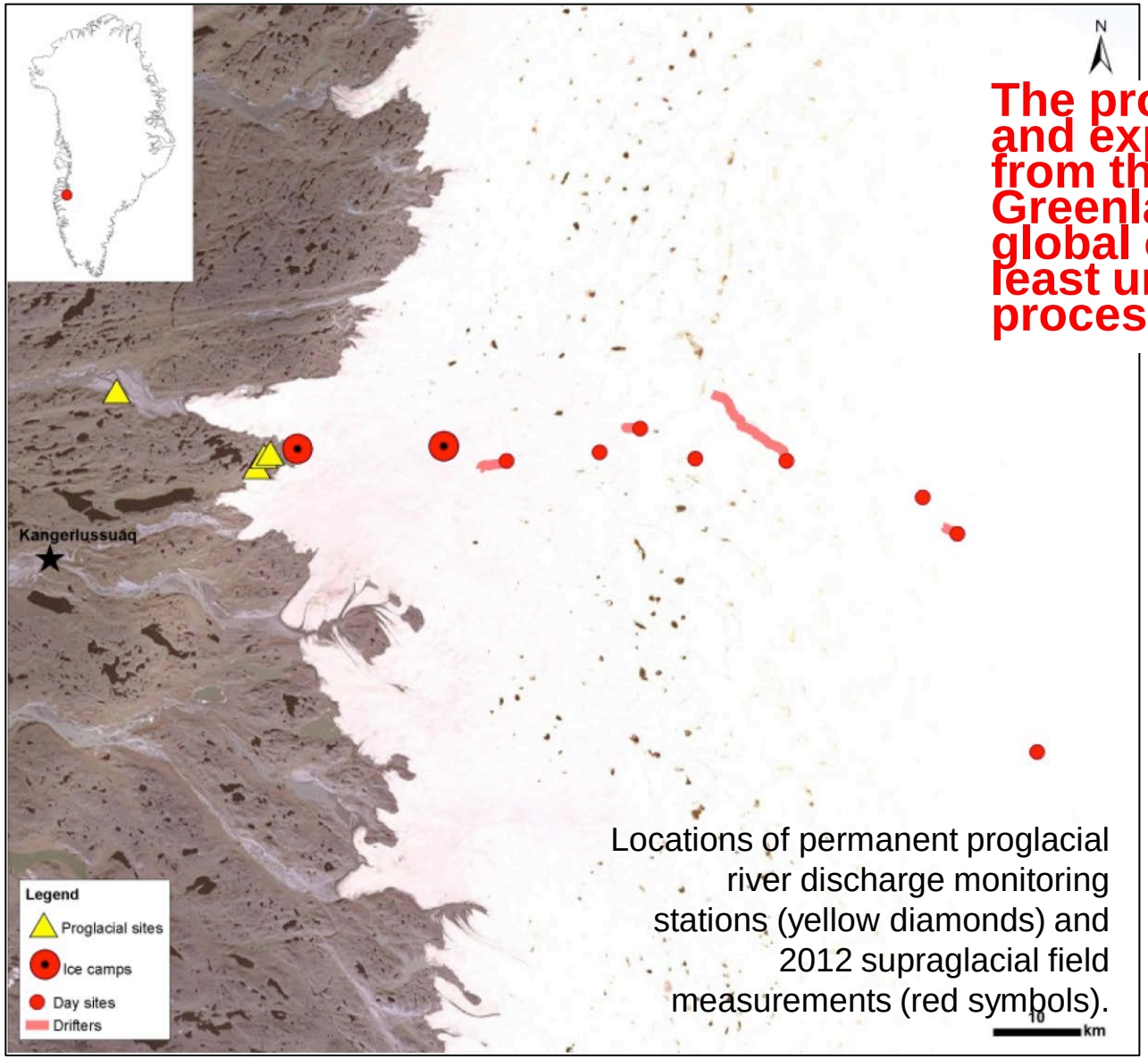
GREECE
Sounding Rocket Launch

On March 3, 2014, at 6:09 a.m. EST, a NASA-funded sounding rocket launched straight into an aurora over Venetie, Alaska. The Ground-to-Rocket Electrodynamics – Electron Correlative Experiment, or GREECE, sounding rocket mission, launched from Poker Flat Research Range in Poker Flat, Alaska, to study classic curls - like swirls of cream in coffee – that form in the aurora in the night sky.

EARTH SCIENCE



Toward Hydrologic Understanding of the Greenland Ice Sheet

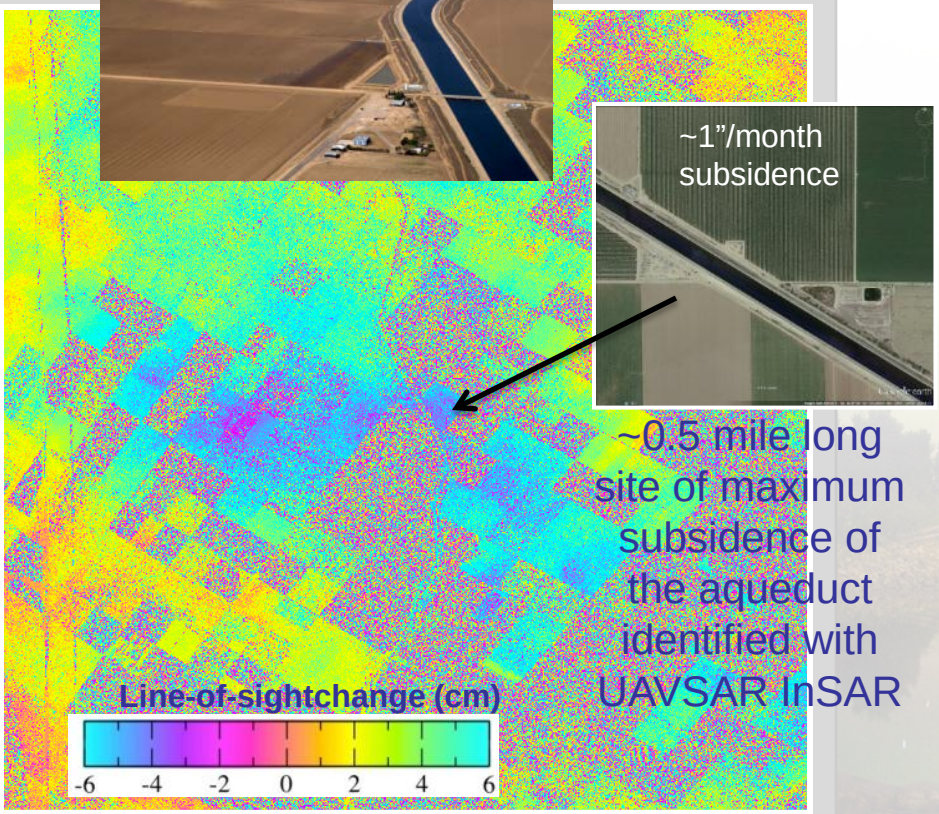


Locations of permanent proglacial river discharge monitoring stations (yellow diamonds) and 2012 supraglacial field measurements (red symbols).

The production, transport, and export of meltwater from the surface of the Greenland ice sheet to the global ocean is one of the least understood hydrologic processes on Earth.

Combines rare in situ hydrologic measurements with high-resolution satellite imagery to show that well-organized supraglacial river networks are the dominant mechanism for removing meltwater from the ice sheet.

California Drought Emergency UAVSAR Remote Sensing of California Aqueduct



UAVSAR InSAR change / 7 m resolution. May 30, 2013 to July 19, 2013,

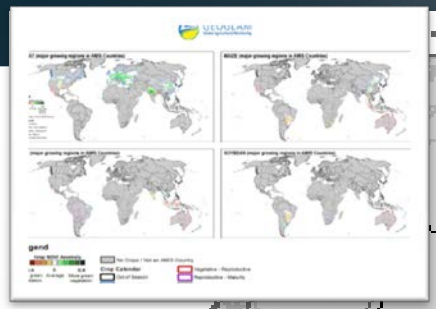
[Analysis by Cathleen E.Jones (JPL)]

Remote Sensing Applied to California's Water Conveyance Infrastructure:

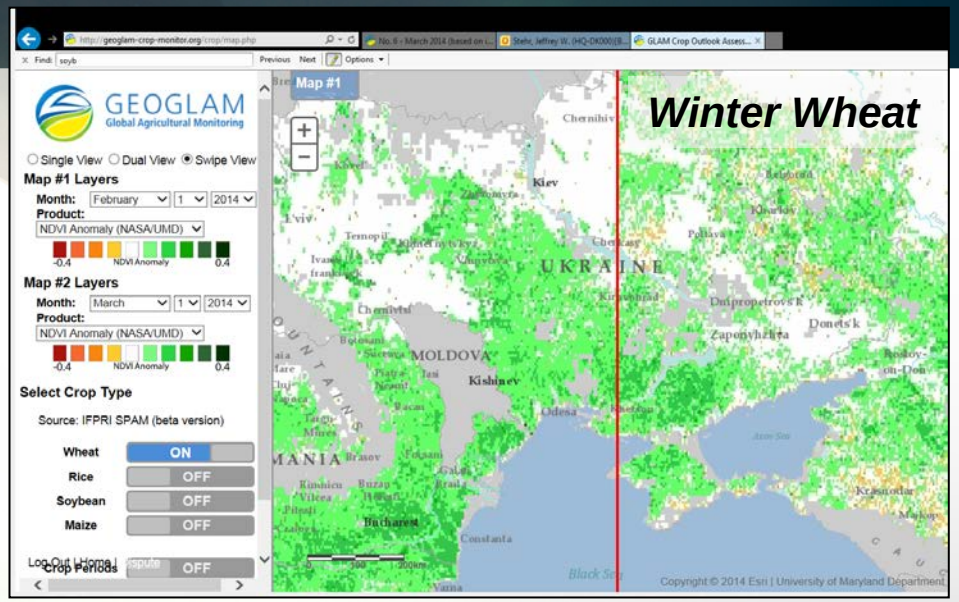
- L-band UAVSAR identified 0.5 mile area where aqueduct subsiding most
- Outcome: CDWR Div. of Engineering - JPL collaboration for UAVSAR monitoring of the California Aqueduct during the drought this year.
- State currently uses ground surveys with a repeat interval of ~5 years.
- Remote sensing will enable rapid IDof subsidence hot spots for inspection, saving time, money, and WATER!

[UAVSAR data are courtesy of NASA/JPL-Caltech.)

MODIS Feeds Monthly Global Crop Report
Market Monitor Covers First Southern Hemisphere Harvest



January 31 Soybeans



MODIS NDVI in standardized crop health assessments

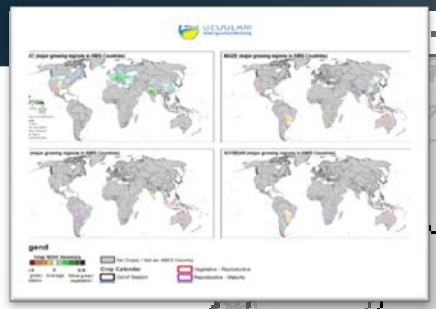
- NASA-developed benchmark
- Reported monthly by AMIS in the *Market Monitor*

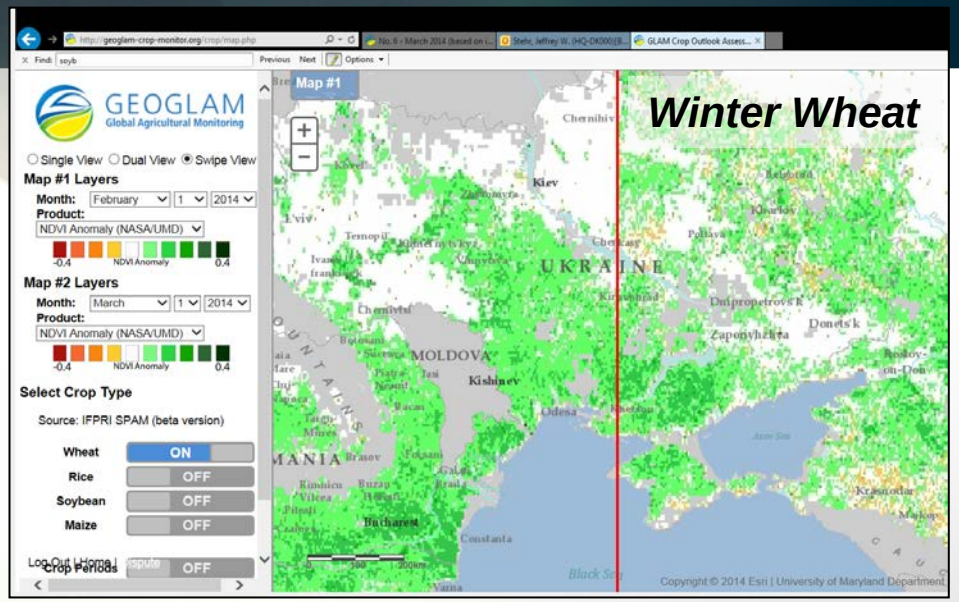
Contributes to more timely, routine assessments

Transparency and fewer price spikes stabilize markets

Lower food prices

MODIS Feeds Monthly Global Crop Report
Market Monitor Covers First Southern Hemisphere Harvest





February 28
Soybeans

2014 S. Hemis. Soybean Harvest:

Argentina: Soybeans rebounded.

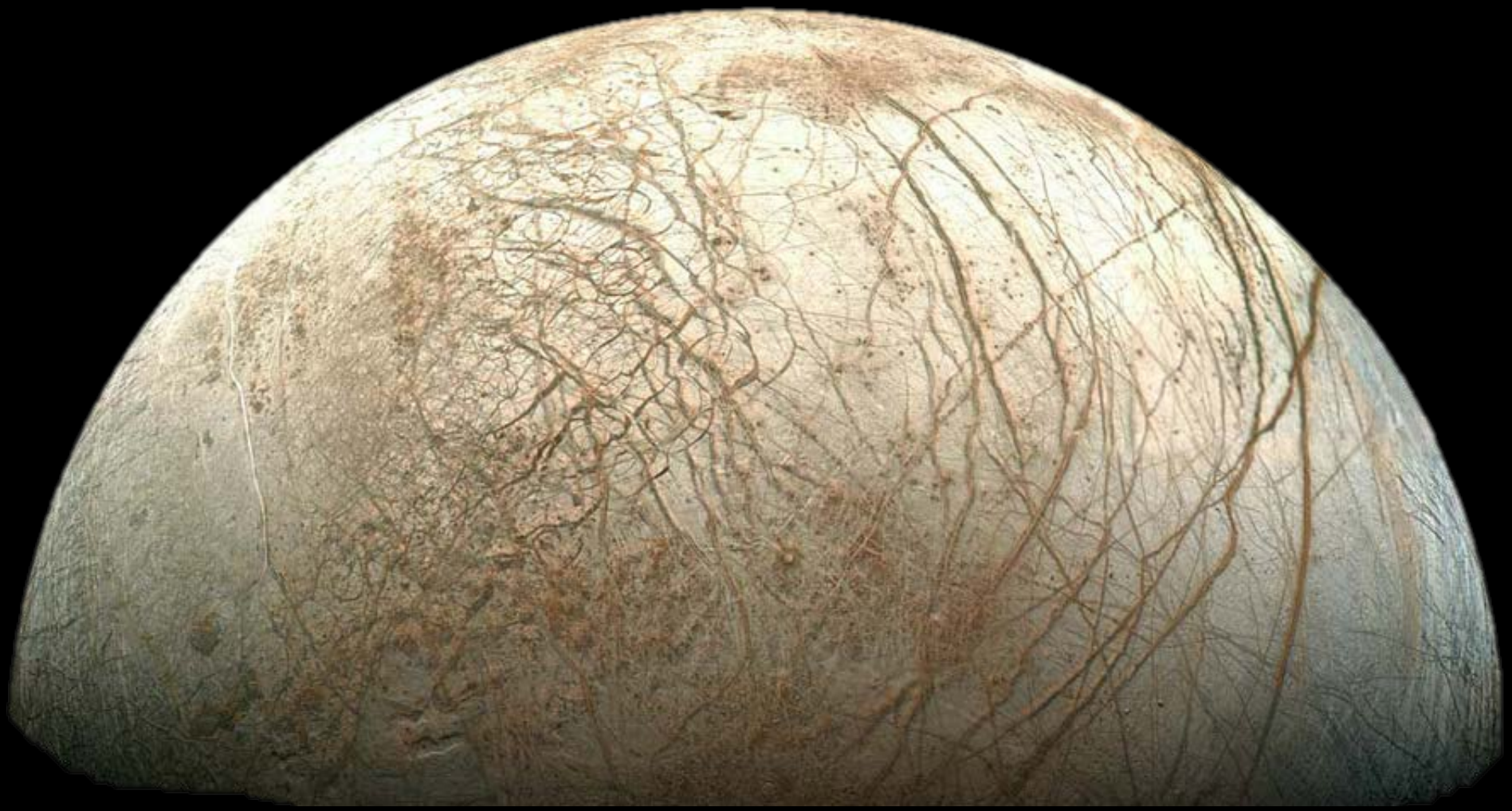
Brazil: Soybeans declined due to excessive rains in last month and drought in the south.

Harvest underway but delayed due to wetness.

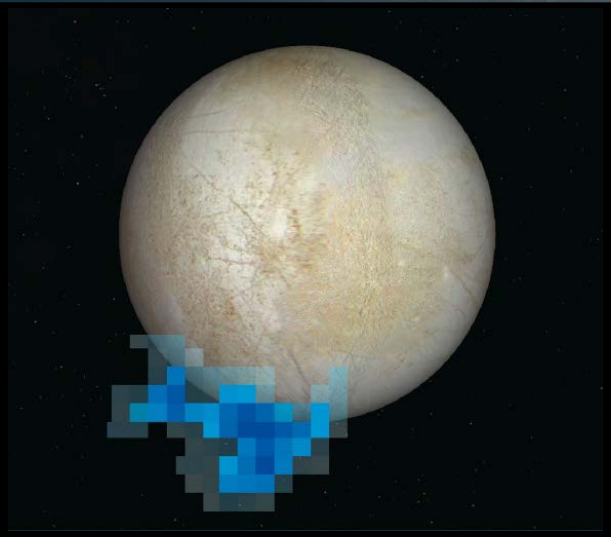
Bumper crop still expected; estimate down from Jan. but above last year.

Next planting (maize) is delayed.

Planetary Science

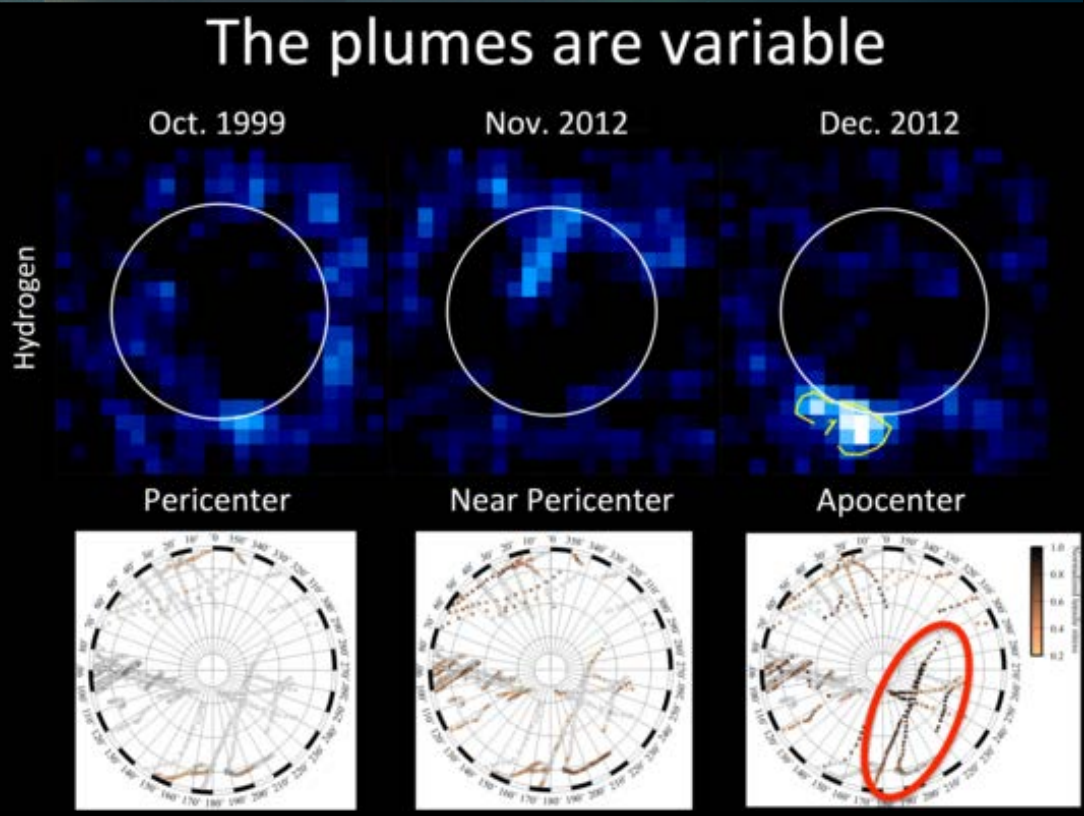


Hubble Discovers Water Plumes at Europa!



The 125-mile-high plumes were discovered in observations from the *Hubble Space Telescope* obtained in December 2012.

HST's Imaging Spectrograph detected faint ultraviolet light from an aurora at the Europa's south pole. This aurora is the signature of collisions of the plume water molecules with particles in Jupiter's magnetosphere. The resulting oxygen and hydrogen ions revealed themselves to *HST* with their specific colors.



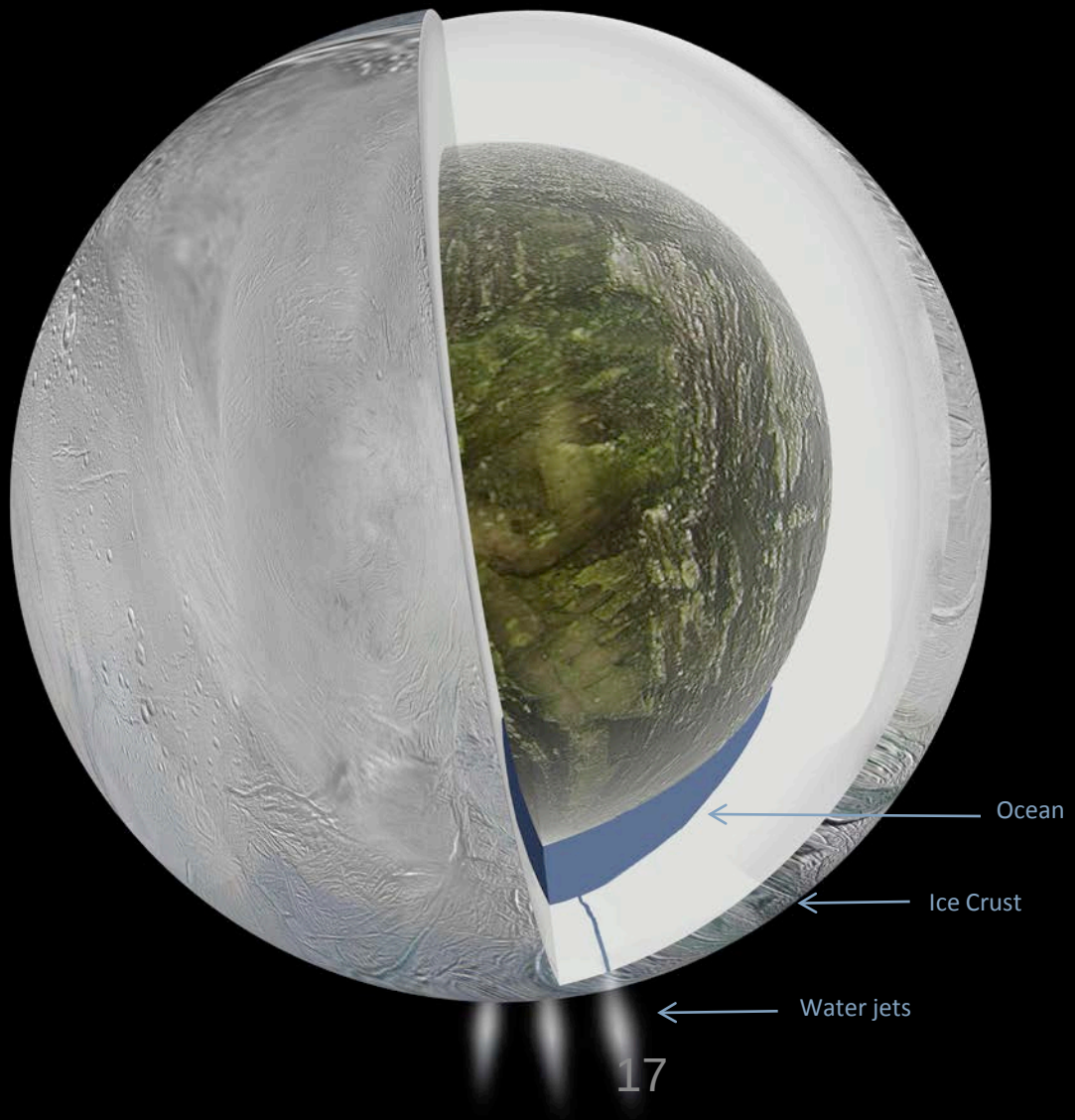
Europa's plume activity was observed when Europa were at its apocenter and cracks in the polar regions were pulled open, consistently with theoretical modeling of Europa's response to the tides exerted by Jupiter.

Roth et al. (2013) Transient water vapor at Europa's South pole, Science 343, 171-174.

Cassini Detects Enceladus Ocean: A Habitable World?

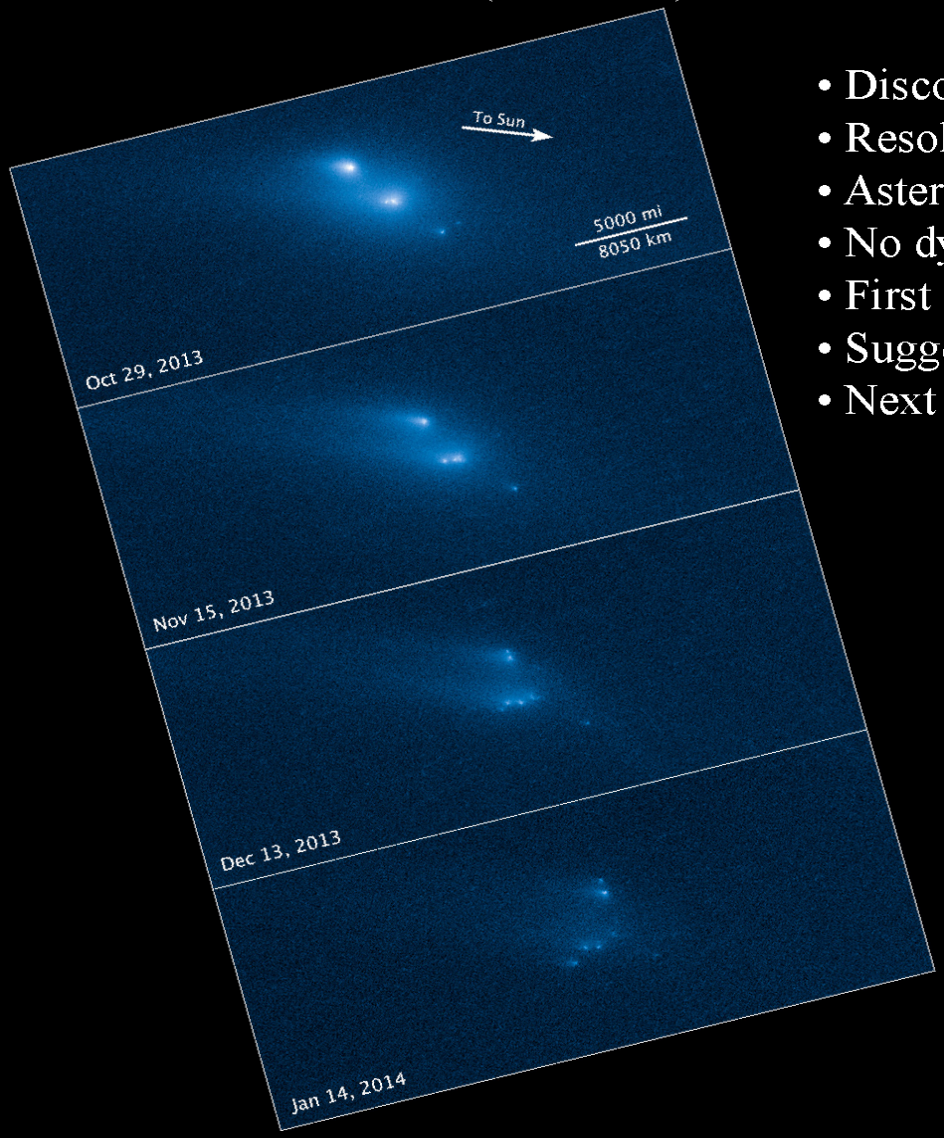
Saturn's moon Enceladus harbors a large, 6-mile deep underground ocean of liquid water, indicated by gravity measurements by the Cassini spacecraft and Deep Space Communications network.

- Radio measurements of Enceladus' gravity indicate an interior reservoir of liquid water, which may be connected to water jets gushing from fractures near the small moon's south pole.
- The newly reported finding validates the inclusion of Enceladus among the most likely places in our solar system to potentially host life.

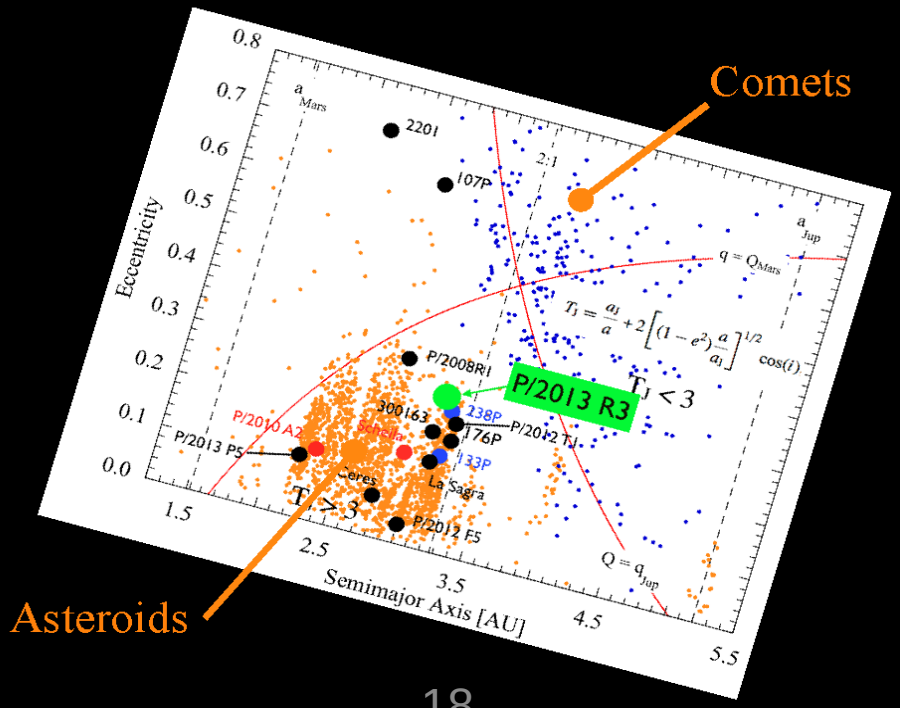


"The Gravity Field and Interior Structure of Enceladus," Luciano Iess, et al., Science, April 4, 2014

Asteroid P/2013 R3 is Disintegrating!



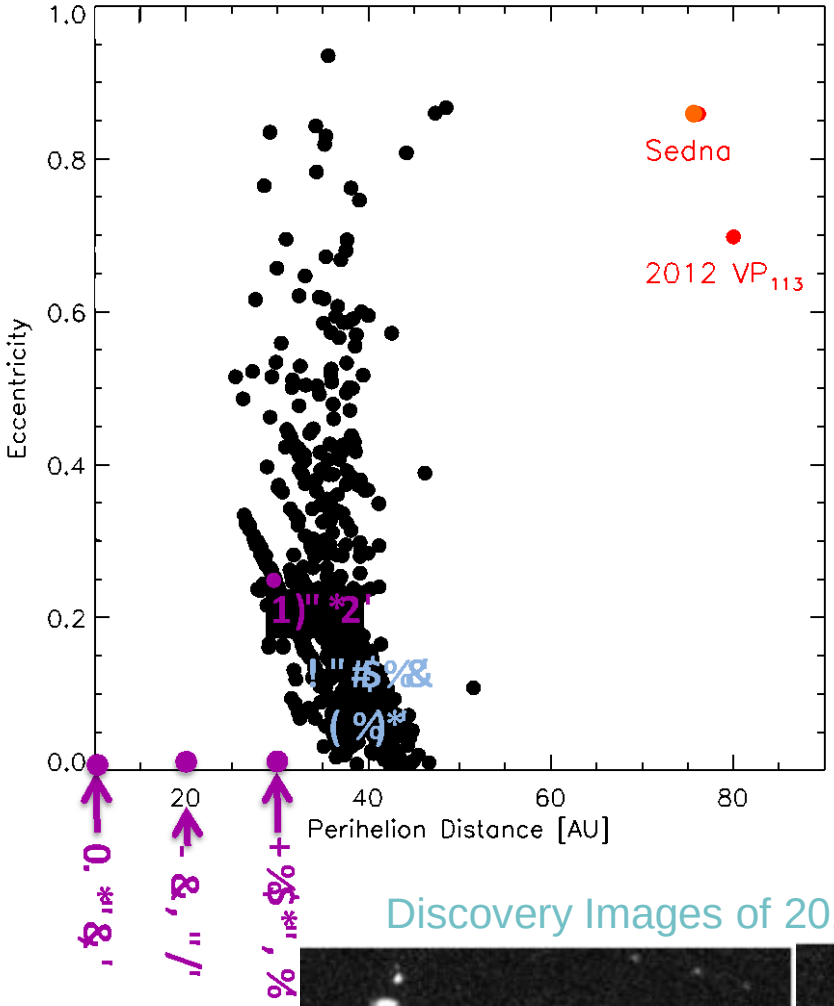
- Discovered by ground-based telescopes
- Resolved by HST as multiple, evolving body
- Asteroidal orbit @3AU
- No dynamical path to the Kuiper belt
- First ever observed disintegrating asteroid
- Suggested cause - rotational breakup by YORP
- Next step - get more data to determine dynamics



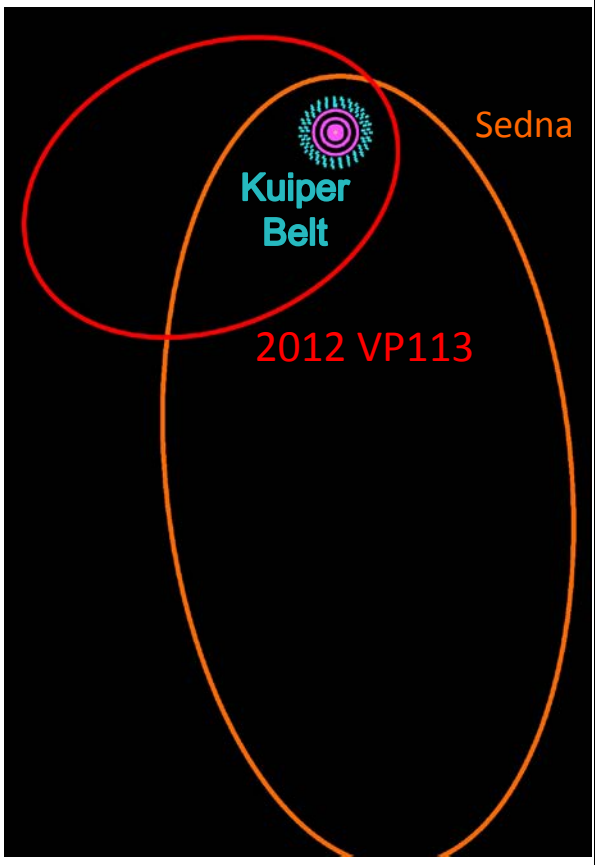
D Jewitt, J Agarwal, J Li, H Weaver, M Mutchler and S Larson. Disintegrating Asteroid P/2013 R3. Astrophysical Journal, 784:L8 (2014)

2nd Inner Oort Cloud Object Found!

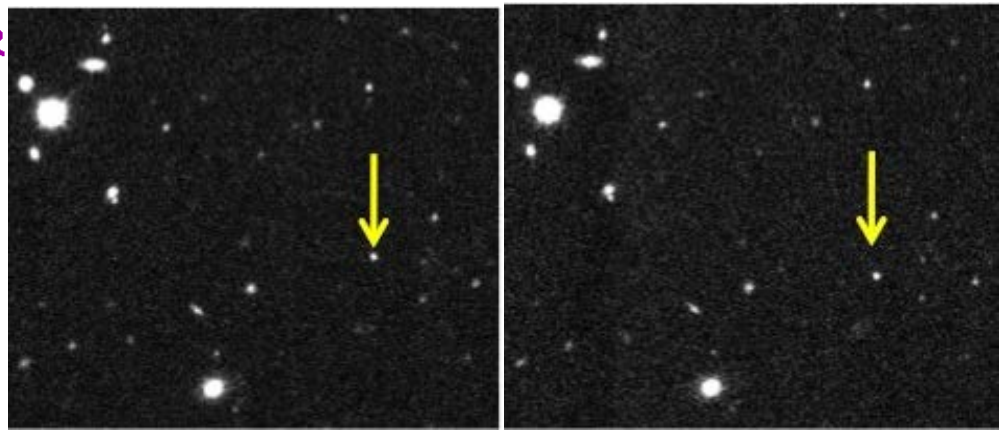
2012 VP113 and Sedna have distant, eccentric orbits that are decoupled from the known planets.



-We expect 1000 bigger than 1000 km in size.
-Cannot create their orbits in current Solar System.
-Their orbits are primordial and tell us about the Solar System's formation environment and evolution.



Discovery Images of 2012 VP113 from CTIO 4m

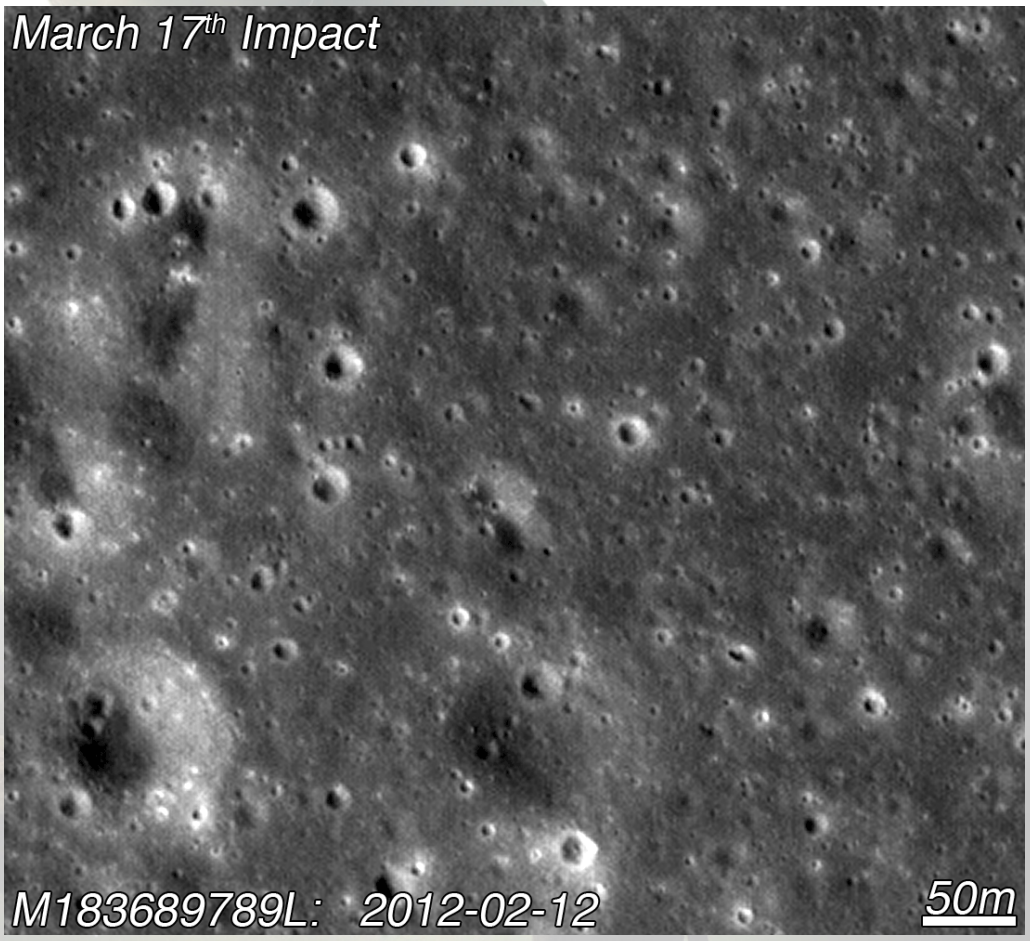


By Scott Sheppard/Carnegie Institution for Science (ssheppard@carnegiescience.edu)

Trujillo and Sheppard, 2014, Nature, 507, 471

LROC NAC Temporal Imaging

- Discovered hundreds of impact related changes since start of mission (NAC Before/After pairs)
- Twenty resolved craters!
- Value:
  - Refine flux of >0.5 bolides inner Solar System
  - Seeing new complex ejecta patterns
  - Secondaries from small craters are extensive



17 March 2013 impact, 18 m crater, secondaries found >30 km distant

Lunar Pits

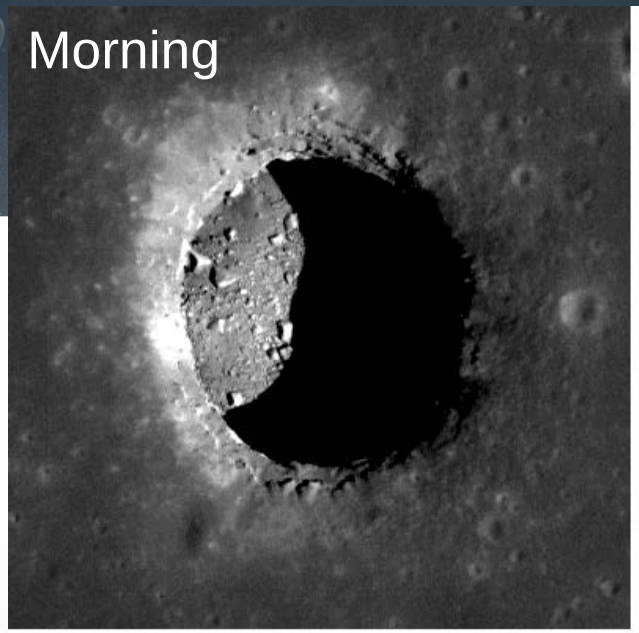
- Mare Tranquillitatis pit →
- Pit diameter 100 m
- Pit depth 107 m

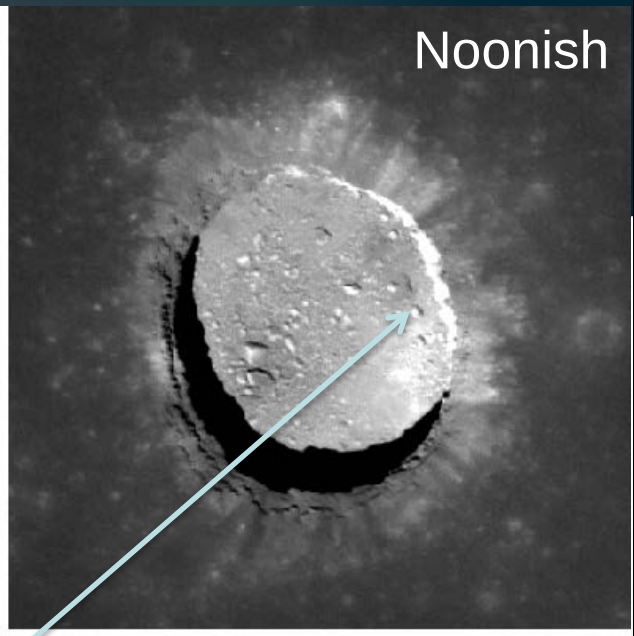
- Are there extant sublunarean tubes?

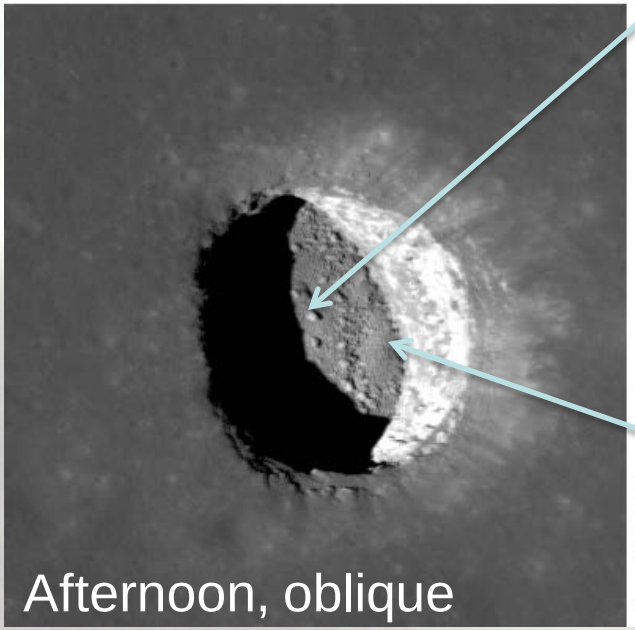
- Oblique imaging! See under the overhang 20 meters!

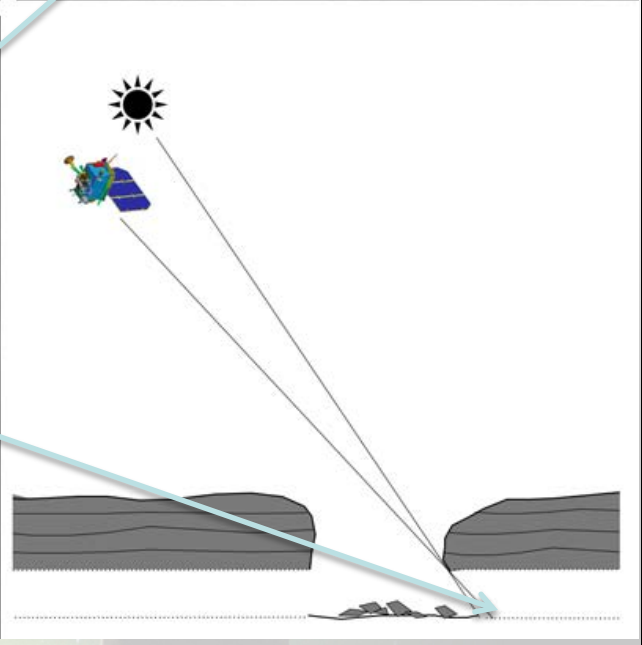
- How far does the void extend?

- Subsurface voids (caves) provide shelter from radiation, micro-meteorites and provide constant T (-20° C)







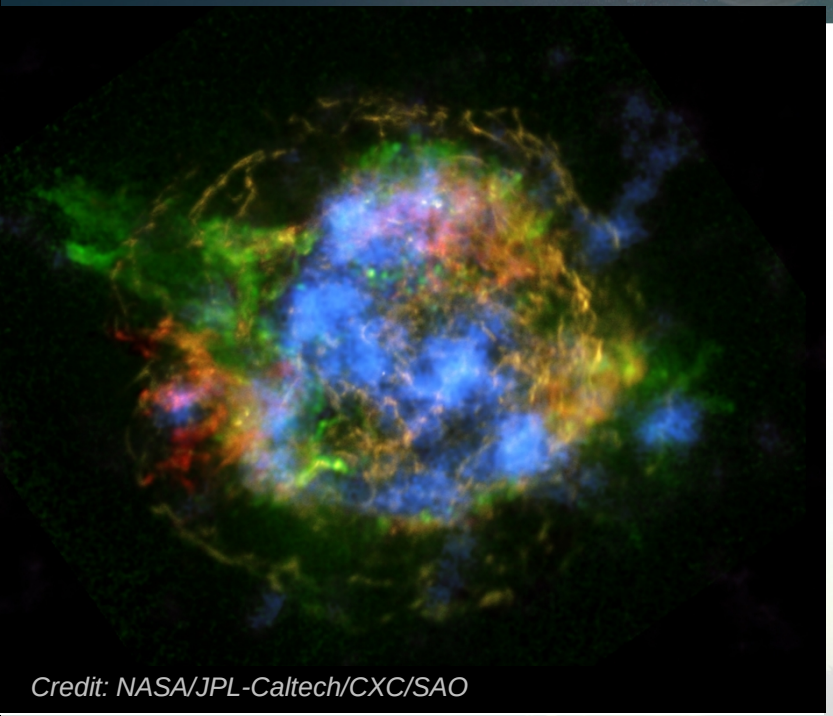


Over 200 pits discovered in impact melt deposits!


National Aeronautics and Space Administration
NASA
Astrophysics

NuSTAR Untangles Mystery of How Stars Explode

This result appeared in the Feb. 20 issue of Nature.



Credit: NASA/JPL-Caltech/CXC/SAO

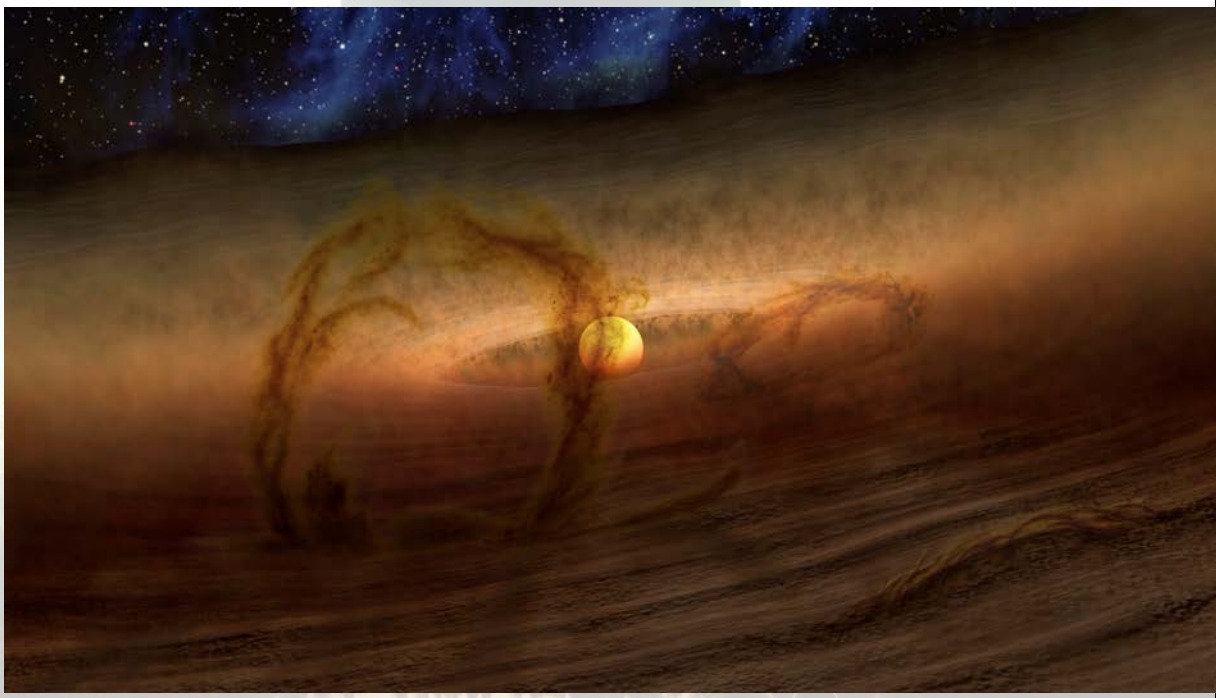
- Cassiopeia A, from supernova event whose light reached Earth about 350 years ago, located 11,000 light-years away from Earth.
- NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) is the first telescope capable of taking detailed pictures of the radioactive material
- Supernova create elements, including radioactive elements like titanium-44, the decay of which sends out high-energy X-ray light that NuSTAR can see.
- By mapping titanium-44 in Cassiopeia A, astronomers get a direct look at what happened in the core of the star when it was blasted to smithereens.

NuSTAR data complement previous observations made by the Chandra X-ray Observatory, which show elements (e.g. iron) that were heated by shocks farther from the remnant's center.

- Red, yellow and green data collected by Chandra from 1-7 keV. The red shows iron, and green silicon and magnesium. The yellow is continuum emissions. The titanium-44, shown in blue, was detected by NuSTAR at energies ranging between 68 and 78 keV.
- The NuSTAR observations point to how stars detonate. Titanium -- a direct tracer of the supernova blast -- is concentrated in clumps at the core supports theory referred to as "mild asymmetries." where material sloshes about at the heart of the supernova, reinvigorating a shock wave and allowing it to blow out the star's outer layers.

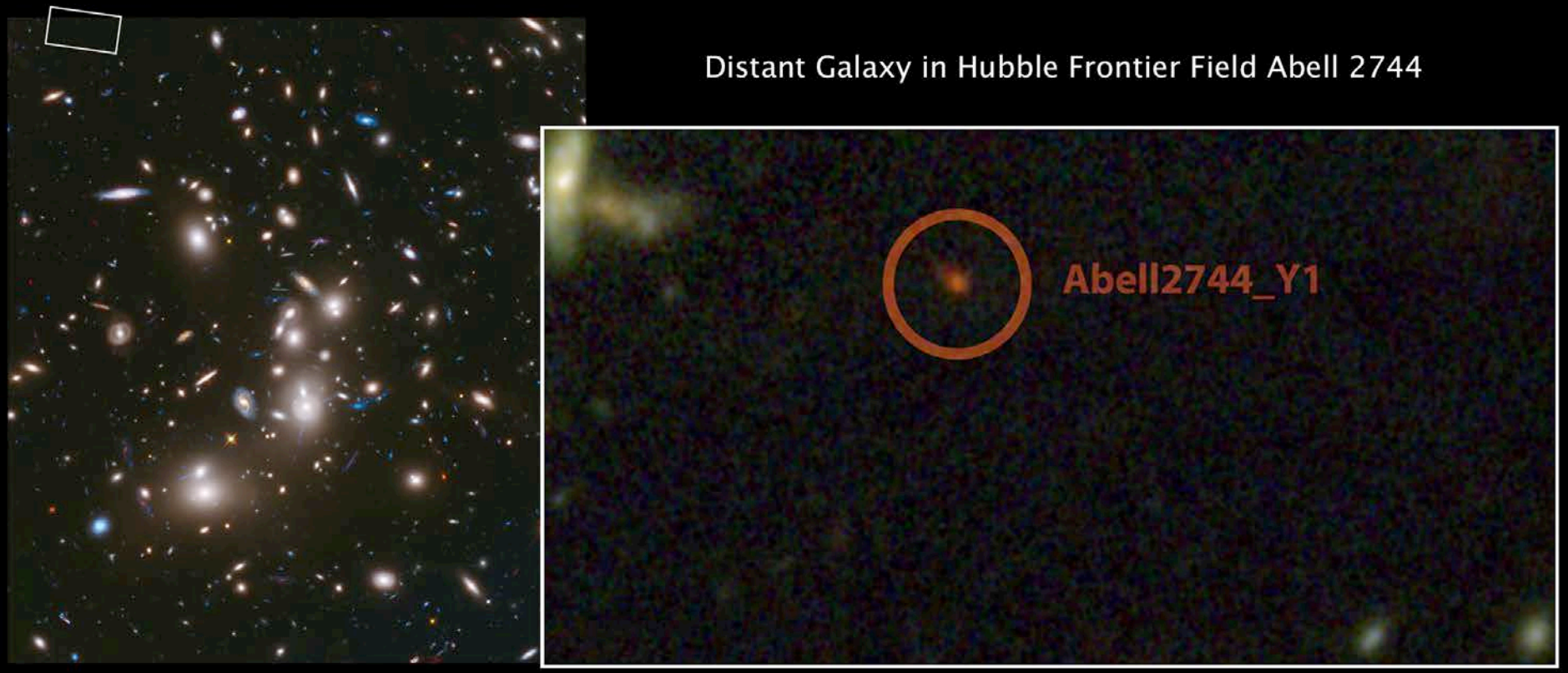
Mystery of Planet-forming Disks Explained by Magnetism

- Magnetic storms in the gas orbiting young stars may explain 10 year mystery
- NASA's Spitzer Space Telescope show stars give off more IR than expected for planet-forming disks that circle young stars heated by starlight
- A new theory, based on 3-D models of planet-forming disks, suggests answer: Gas and dust suspended above the disks on gigantic magnetic loops, like those seen on the sun, absorb the starlight and glow with infrared light.



Artist Concept: NASA/JPL-Caltech

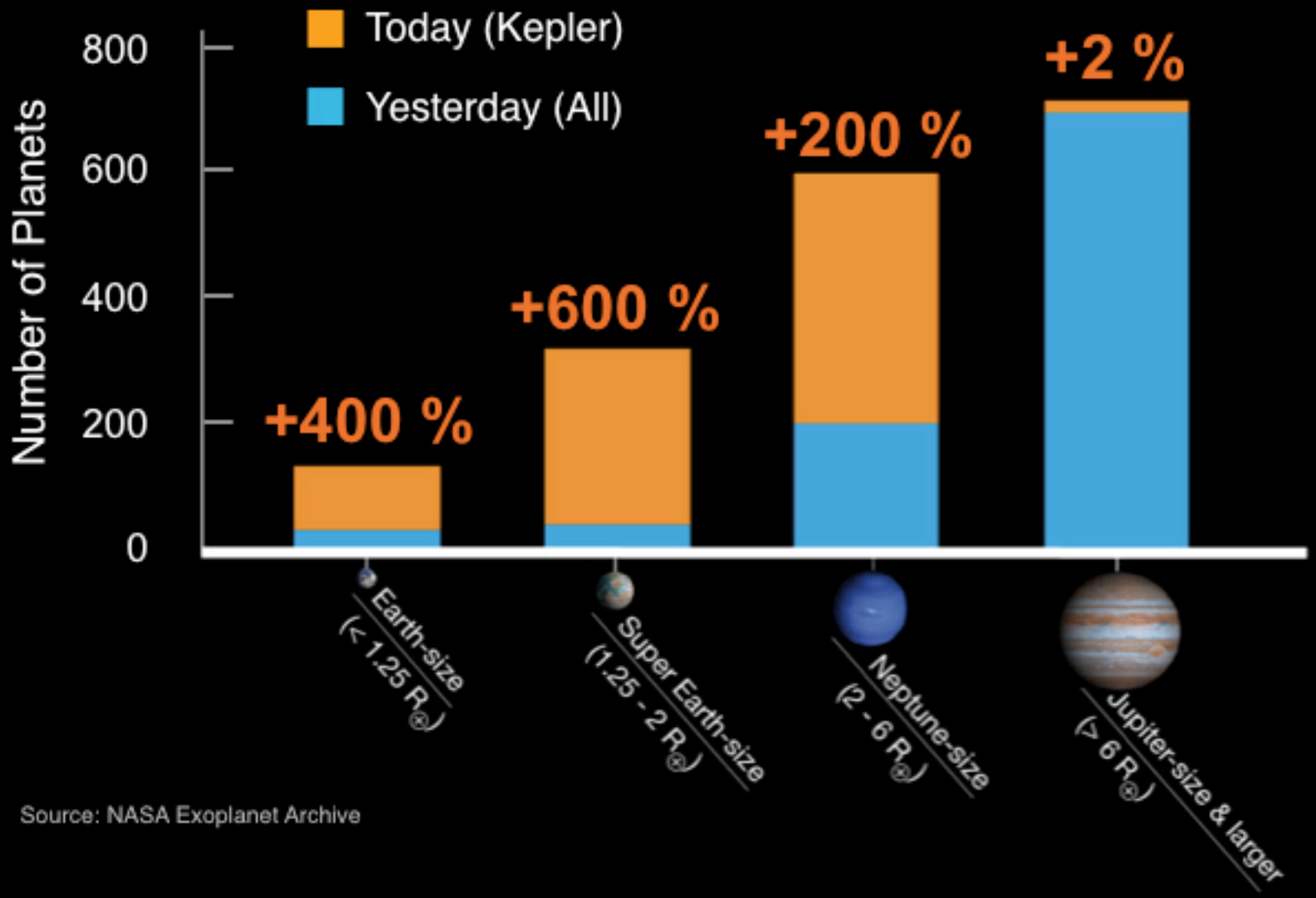
Hubble and Spitzer Space Telescopes Find One of the Youngest Galaxies in the Universe



Light emitted 650 million years after the big bang
Brightened by gravitational lensing in the cluster

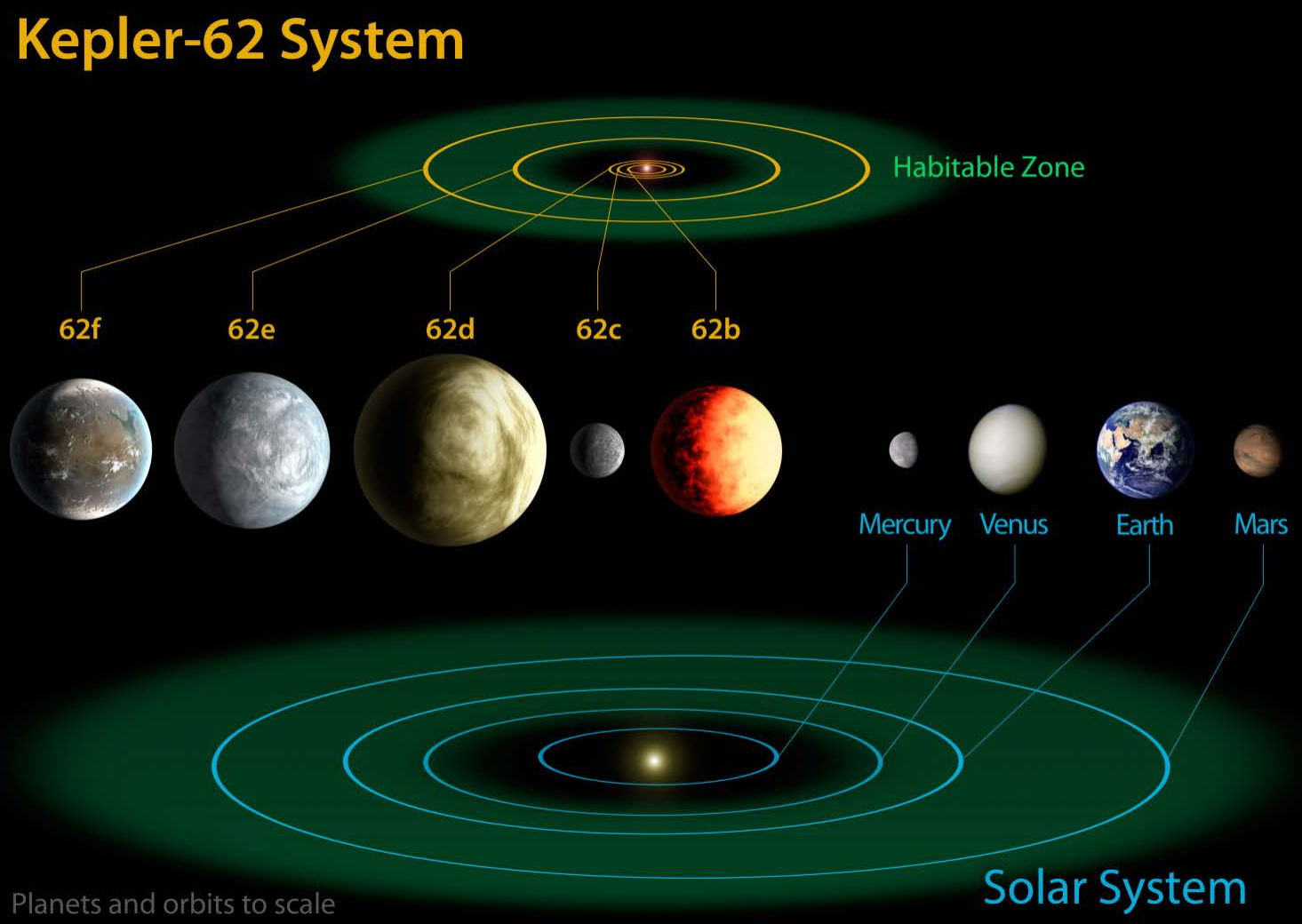
Sizes of Known Exoplanets

As of February 26, 2014



Source: NASA Exoplanet Archive

Solar Systems–A Comparison



Outline

- Science Results
- **Programmatic Status**
  - Heliospheric Physics
  - Earth Science
  - Planetary Science
  - Astrophysics/JWST
- Findings & Recommendations

Astrophysics Earth Science
Heliophysics Planetary Science
Joint Agency Satellite Division (JASD)

Total Missions / Spacecraft
96 / 122

2014-Mar-18

Formulation 12 / 12

JPL 4
OCO-3 7/2016
SWOT 10/2020
Mars 2020 2020
NI-SAR Late 2020/2021

GSFC 6
Polar Free Flyer NET 1/2017
ICON 2/2017
TESS 8/2017
GOLD 9/2017
MOMA 2018
JPSS-2 2022

LaRC 1
TEMPO 11/2018

MSFC 1
JUICE 2022

Implementation 25 / 38

JPL 7/8
OCO-2 7/1/2014
SMAP 11/5/2014
ST-7 NET CY2015
Jason-3 3/31/2015
Euclid 3/2020
InSight 3/2016
GRACE FO (1/2) 8/5/2017

GSFC 14/20
GPM 2/27/2014 UTC
MMS (1/4): NET 11/26/2014
DSCOVR: 1/13/2015
Astro-H: 11/2015
SET-1: 9/2015
GOES-R (1/4): 10/2015
ICESat-2: 3/2017
OSIRIS-REx: 9/3/2016
JPSS-1: 11/15/2016
Solar Orbiter Collaboration: 7/2017
MetOp-C: 10/2/2017
JWST: 10/31/2018
NICER: 8/2016
Solar Probe Plus 7/31/2018

DFRC 1 / 0
SOFIA (1/0) 2/2014 FOC

LaRC 2/9
SAGE III-ISS 3/2015
CYGNSS (1/8) 10/2016

MSFC 1
Strofio 8/16/2015

Primary Ops 14 / 15

ARC 1
LADEE

MSFC 1
New Horizons

JPL 5
NuSTAR
Rosetta
Dawn
Juno
MSL Curiosity

GSFC 7 / 8
SDO
Suomi NPP~
Van Allen Probes (1/2)
Aquarius
Landsat 8~
IRIS
MAVEN

ARC 1
Kepler

Extended Ops 45 / 57

JPL 13/15
Spitzer
ACRIMSAT
CloudSat
GRACE (1/2)
OSTM/Jason-2~
QuikSCAT
Voyager (1/2)
Mars Express
Mars Odyssey
MER Opportunity
Cassini
MRO
NEOWISE

MSFC 3
Chandra
Hinode
MESSE-NGER

GSFC 27/37
HST
Suzaku
EO-1
XMM-Newton
Swift
Aqua
SORCE
IBEX
Terra
TRMM
Landsat 7~
THEMIS (1/5)
STEREO (1/2)
Geotail
Cluster II (1/4)

LaRC 1
CALIPSO
Fermi
CINDI
ACE
AIM
Aura
RHESSI
SOHO
TIMED
Wind
LRO
LAGEOS (1/2)
TWINS-A & B (1/2)

Div	Form	Imp	Pri Ops	Ext Ops	Total
Astro	1	6	1	8	**16**
Earth	4	7	3	14	**28**
Planet	3	3	7	8	**21**
Helio	2	4	3	15	**24**
JASD	2	5	0	NA	**7**
Total	**12**	**25**	**14**	**45**	**96**

Italics = NASA instruments on commercial, DOD, or international spacecraft X / Y = # of missions / # of spacecraft
~ Operated by another agency

Updates:
(1) GRACE-FO moved to Implementation following successful KDP-C on 2/21/14
(2) NICER moved to Implementation following successful KDP-C on 2/24/14
(3) CYGNSS moved to Implementation following successful KDP-C on 2/26/14
(4) Solar Probe Plus moved to Implementation following successful KDP-C APMC on 3/12/14
(5) Added NI-SAR to Formulation following successful KDP-A on 3/19/14
(6) Updated Jason-3 LRD from 3/1/15 to 3/31/15 to reflect latest FPB manifest
(7) Updated Solar Orbiter Collaboration LDR from 1/2017 to 7/2017 to reflect latest FPB manifest

12 font: LCC > $1B
10 font: $250M < LCC < $1B
8 font: LCC < $250M
} for projects in formulation & implementation

Recent Cost and Schedule Performance

Since August 2011, NASA Science has launched 11 missions for which we had made Development cost commitments.

Six were completed under their original cost commitment.

MSL/Curiosity and Suomi NPP were originally baselined in 2006, prior to NASA implementing its “70% confidence” management reforms. Those two missions overran significantly.

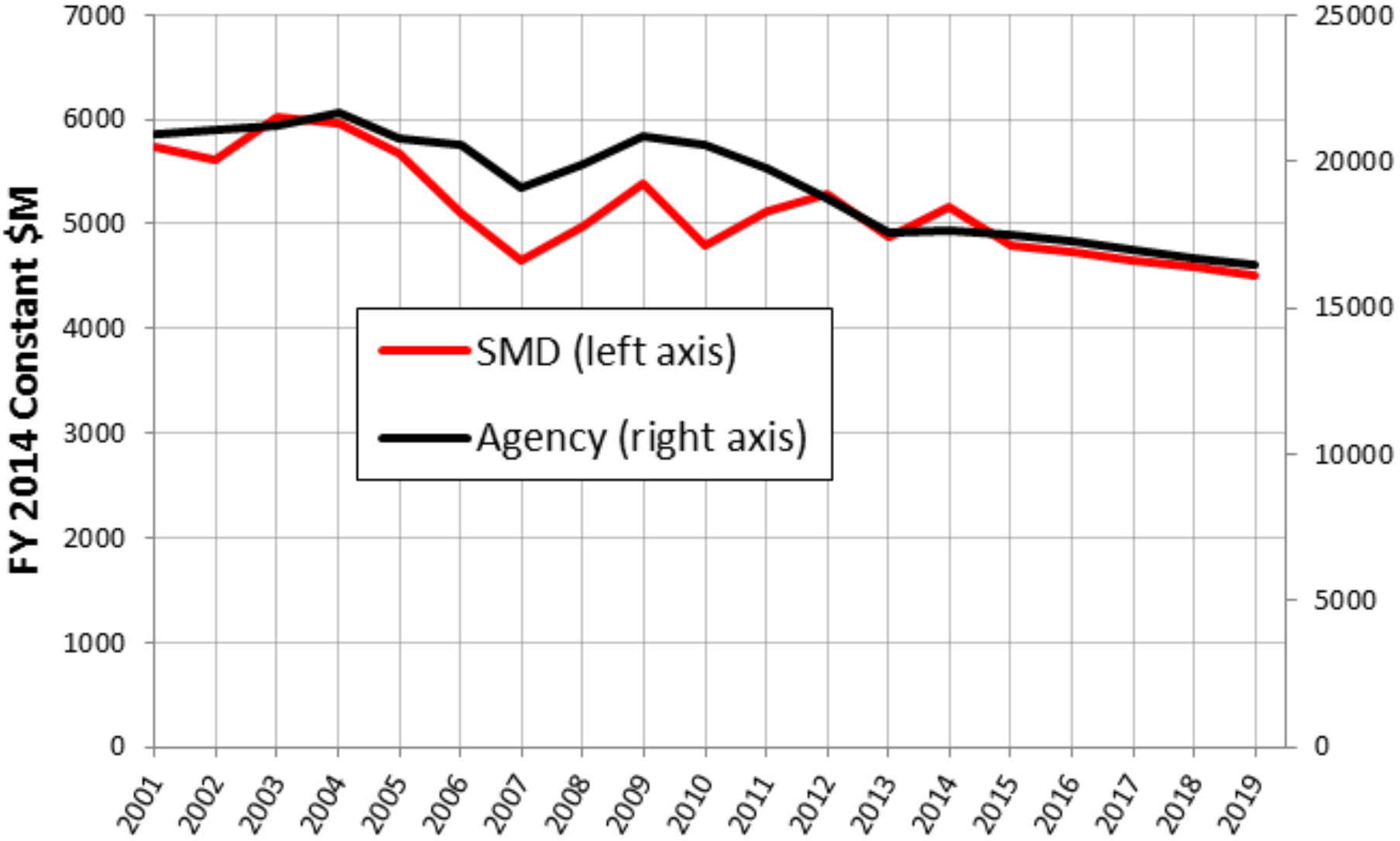
Excluding Curiosity and Suomi NPP, ***the other nine missions underran their original cost estimates, in the aggregate, by about six percent – and the outlook for the future reflects similar outstanding performance.***

Good cost and schedule performance contributes to stability in SMD’s programs.

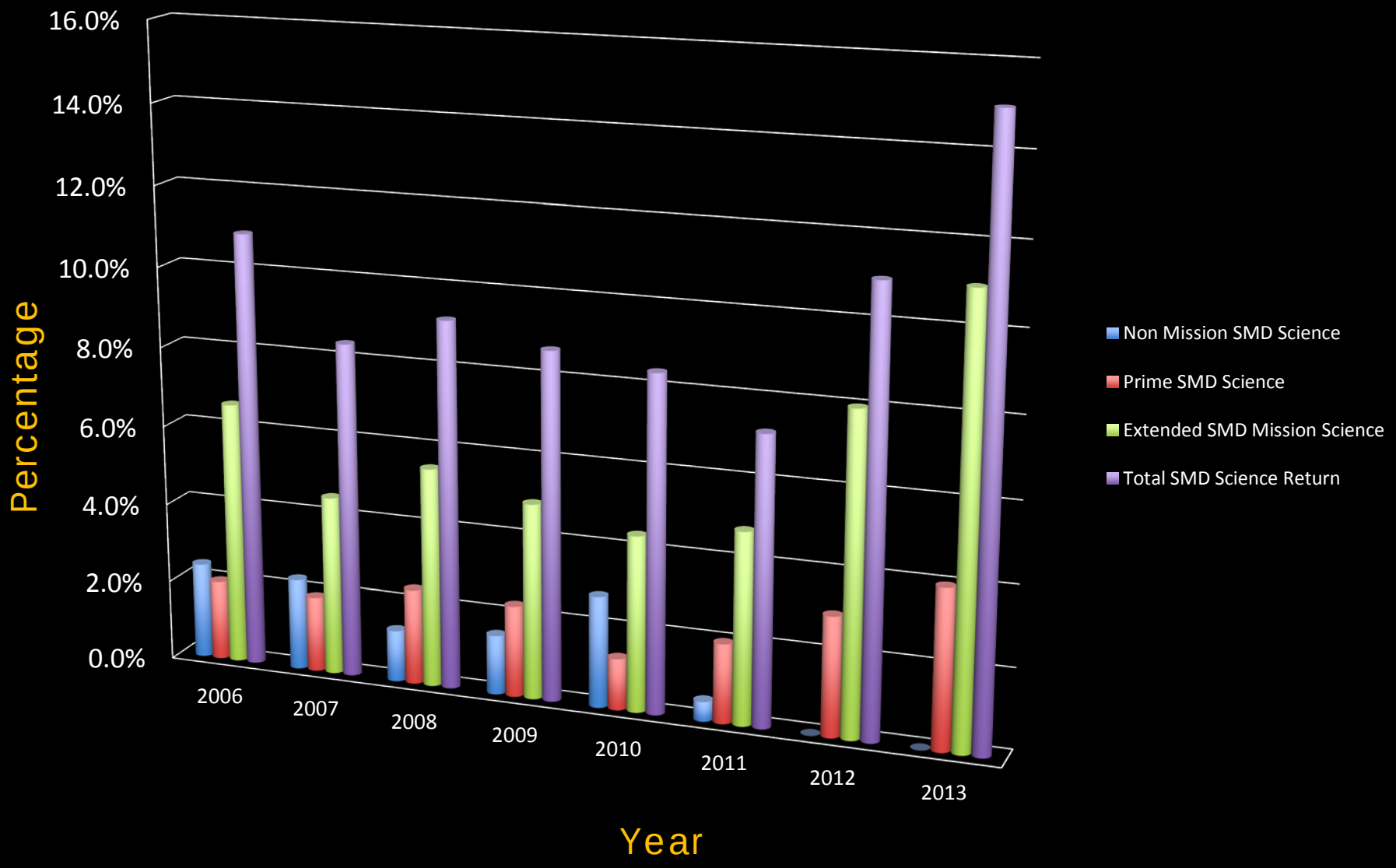
FY 2015 SMD Budget Request ($M)

					Notional			
	FY12	FY13 Op Plan	FY14 Enacted	FY15 Request	FY16	FY17	FY18	FY19
NASA FY 2014	17,770.0	17,893.4	17,646.5	17,460.6	17,635.3	17,811.5	17,989.7	18,169.7
Science	5,073.7	4781.6	5,151.2	4972.0	5021.7	5071.9	5122.6	5173.9
Earth Science	1,760.5	1659.2	1,826.0	1770.3	1815.5	1837.6	1861.9	1886.3
Planetary Science	1,501.4	1274.6	1,345.0	1280.3	1304.9	1337.1	1355.7	1374.1
Astrophysics	648.4	617.0	668.0	607.3	633.7	651.2	696.8	933.0
JWST	518.6	627.6	658.2	645.4	620.0	569.4	534.9	305.0
Heliophysics	644.8	603.2	654.0	668.9	647.6	676.6	673.3	675.5

Agency and SMD Budget Trends
(FY16-19 estimates are notional)

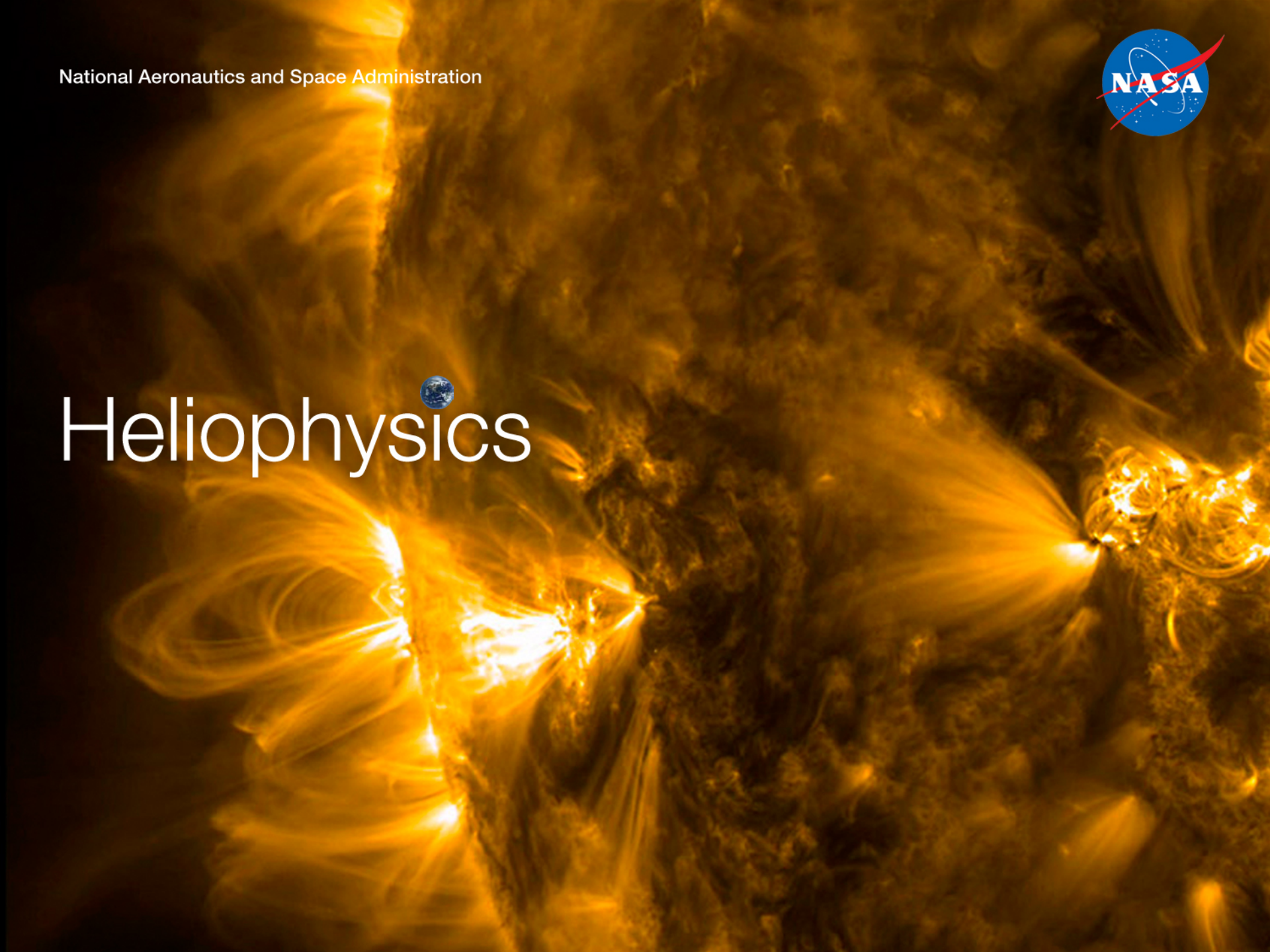


SMD Science as a Percentage of Worldwide Science



Source: Greg Davidson's *Science News* Metric (2014)

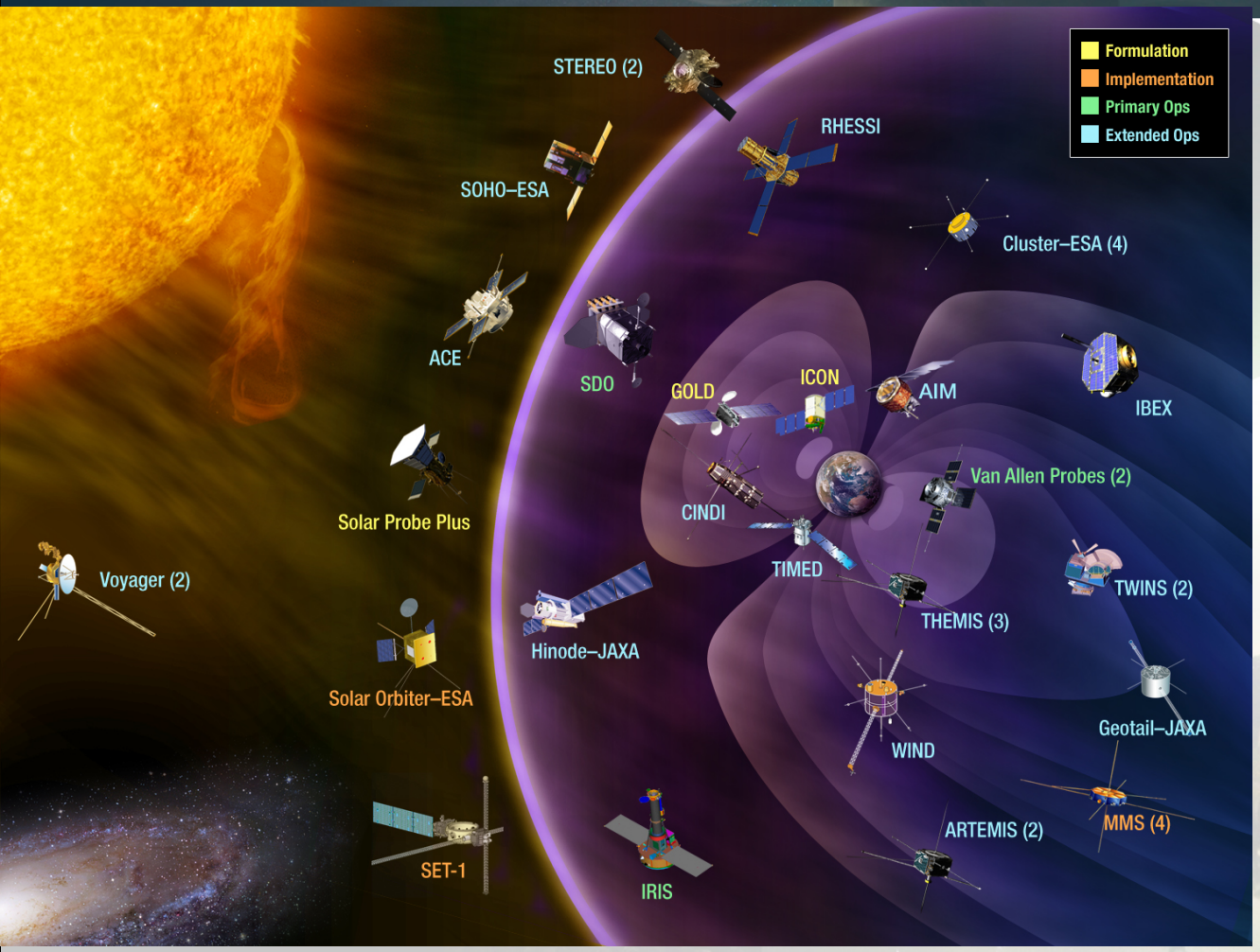
National Aeronautics and Space Administration



Heliophysics

Heliophysics System Observatory

A coordinated and complementary fleet of spacecraft to understand the Sun and its interactions with Earth and the solar system



- **Heliophysics has 18 operating missions (on 29 spacecraft): Voyager, Geotail, Wind, SOHO, ACE, Cluster, TIMED, RHESSI, TWINS, Hinode, STEREO, THEMIS/ARTEMIS, AIM, CINDI, IBEX, SDO, Van Allen Probes, IRIS**

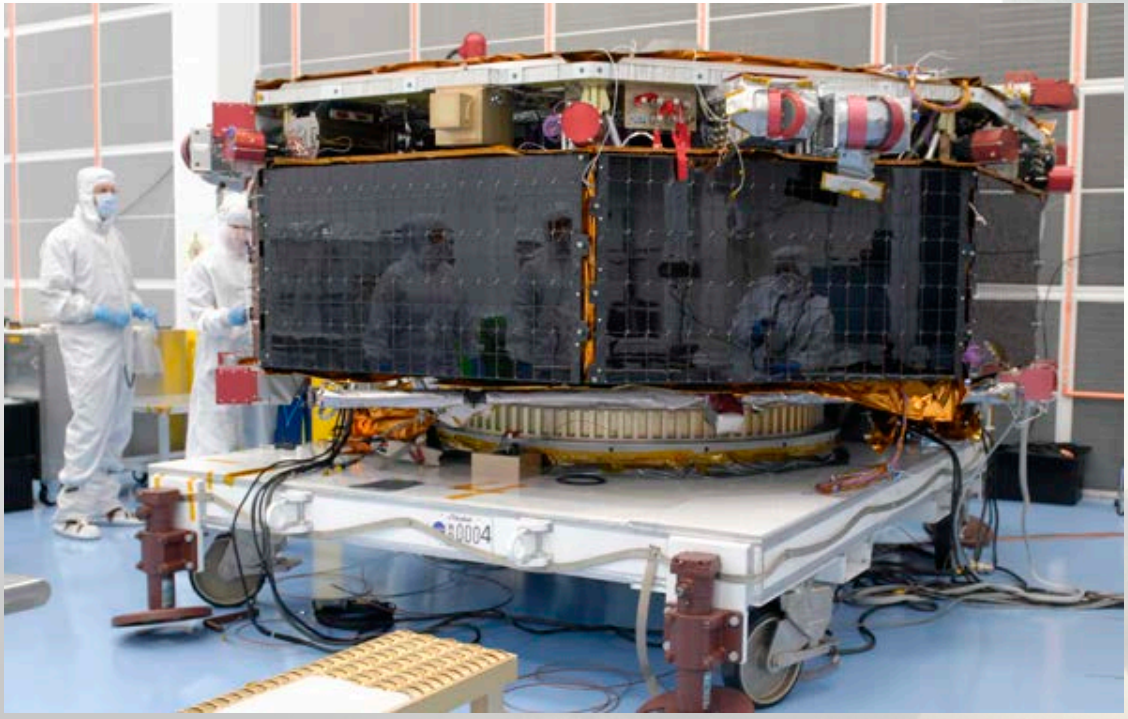
  (Missions in red contribute to operational Space Weather.)

- **6 missions are in development: SET, MMS, SOC, SPP, ICON, and GOLD**

$5.5B total investment in Heliophysics space assets (excluding launch costs)
$68M annual operating budget (1.2% per year)

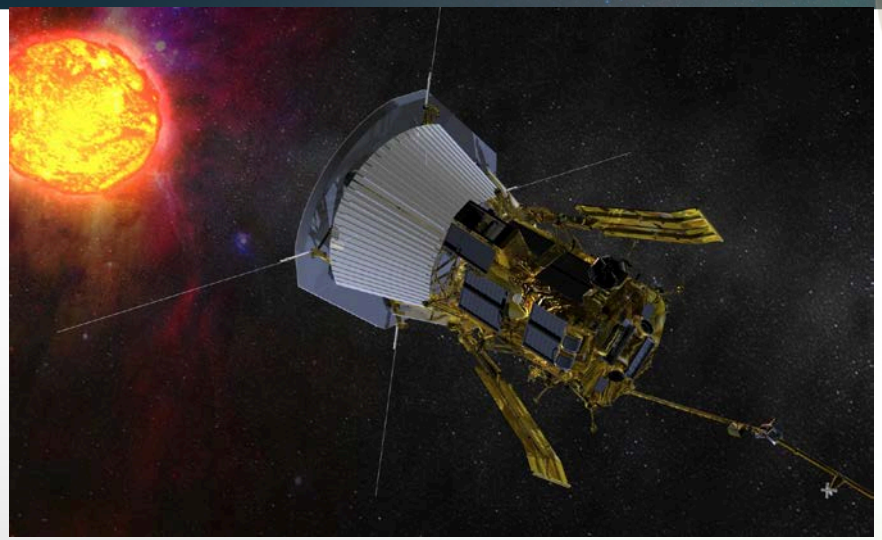
Magnetospheric Multi-scale (MMS)Status

Observatory #4 in final assembly



2 of 4 as stacked for launch

Solar Probe Plus (SPP) Confirmed!



- Sponsor: NASA/GSFC Living With a Star (LWS)
- LWS Program Manager – GSFC
- Project Manager – APL
- Project Scientist – APL
- Spacecraft Development & Operations – APL
- Investigations selected by AO:
  - FIELDS – University of California
  - ISIS – Southwest Research Institute
  - SWEAP – Smithsonian Astrophysical Obs
  - WISPR – Naval Research Laboratory
  - HelioOrigins – Jet Propulsion Laboratory

Overview

Using in-situ measurements made closer to the Sun than by any previous spacecraft, SPP will determine the mechanisms that produce the fast and slow solar winds, coronal heating, and the transport of energetic particles.

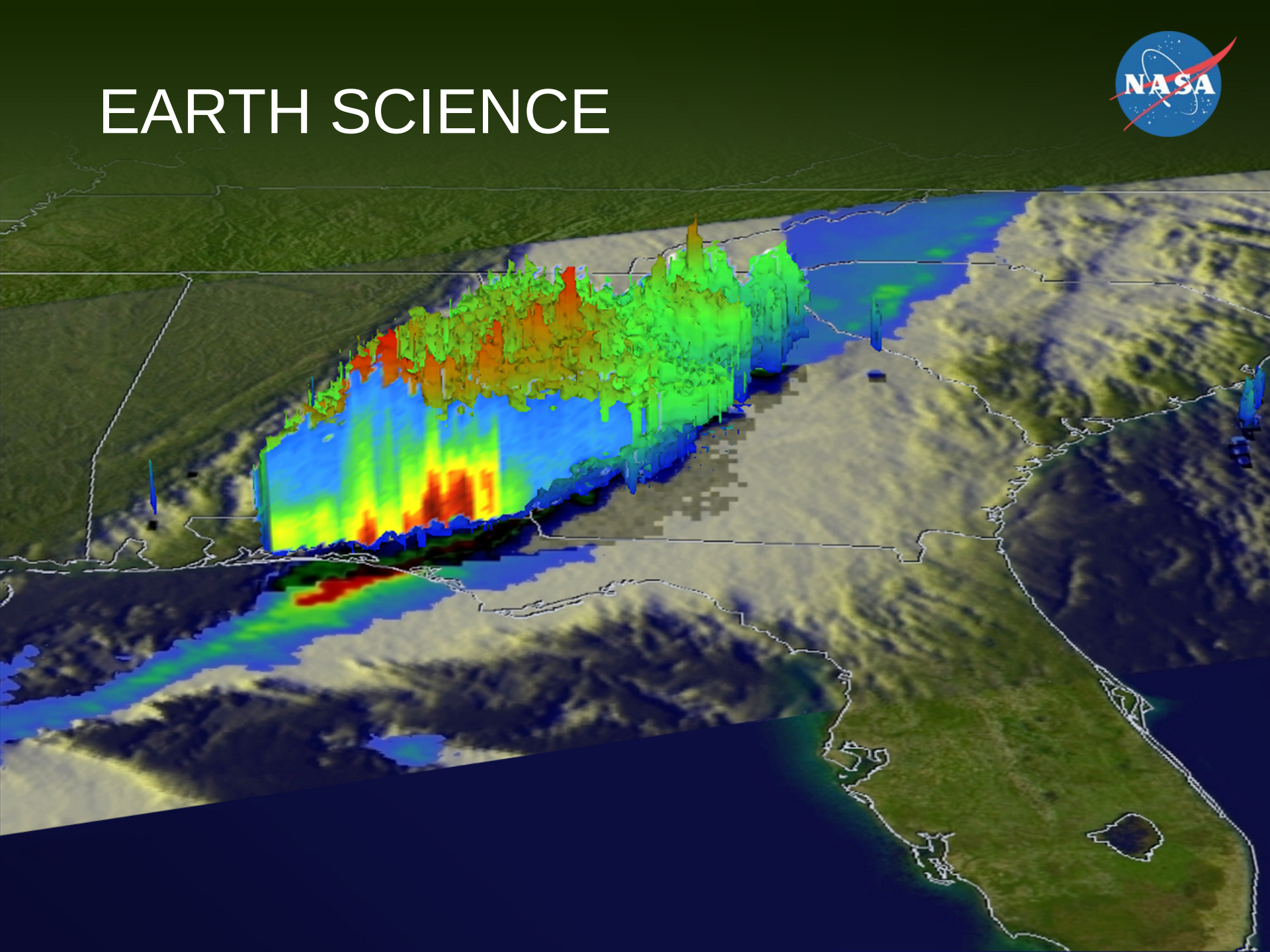
Solar Probe Plus will fly to less than 10 solar radii (R_s) of the Sun, walking-in from 35 R_s over 24 orbits.

Milestones

✓Pre-Phase A:	07/2008 – 11/2009
✓Phase A:	12/2009 – 01/2012
✓Phase B:	02/2012 – 03/2014
Phase C/D:	03/2014 – 08/2018
LRD:	August 2018
Phase E:	09/2018 – 09/2025

PDR and Mission Confirmation (KDP-C) Successfully Completed!

EARTH SCIENCE



A Busy Year for Earth Science

NASA Launches 5 New Missions in 2014

NOVEMBER, 2014

SMAP
Soil Moisture Active Passive
Studying soil moisture

JULY, 2014

OCO-2
Orbiting Carbon Observatory
Measuring atmospheric carbon dioxide

SEPTEMBER, 2014

CATS
Cloud-Aerosol Transport System
Observing pollution, dust & smoke in the atmosphere from ISS

AUGUST, 2014

ISS-Rapidscat
Monitoring ocean winds from ISS

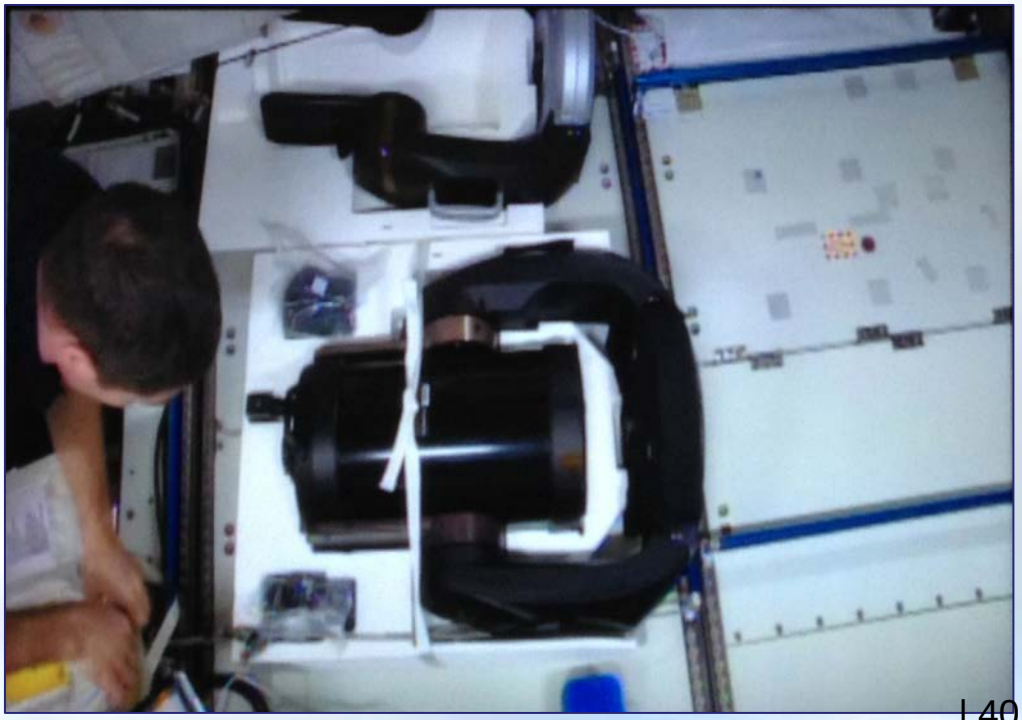
FEBRUARY, 2014

GPM
Global Precipitation Measurement
Next-generation measurements of global snow and rain

Repaired ISERV instrument captures “second first light” image

<<< ISERV acquired the image of Dina Huapi, Rio Negro, Argentina, on 5.Feb.2014.

Part of the first series of images following a successful repair and checkout of ISERV pointing system 29-30.Jan.2014.

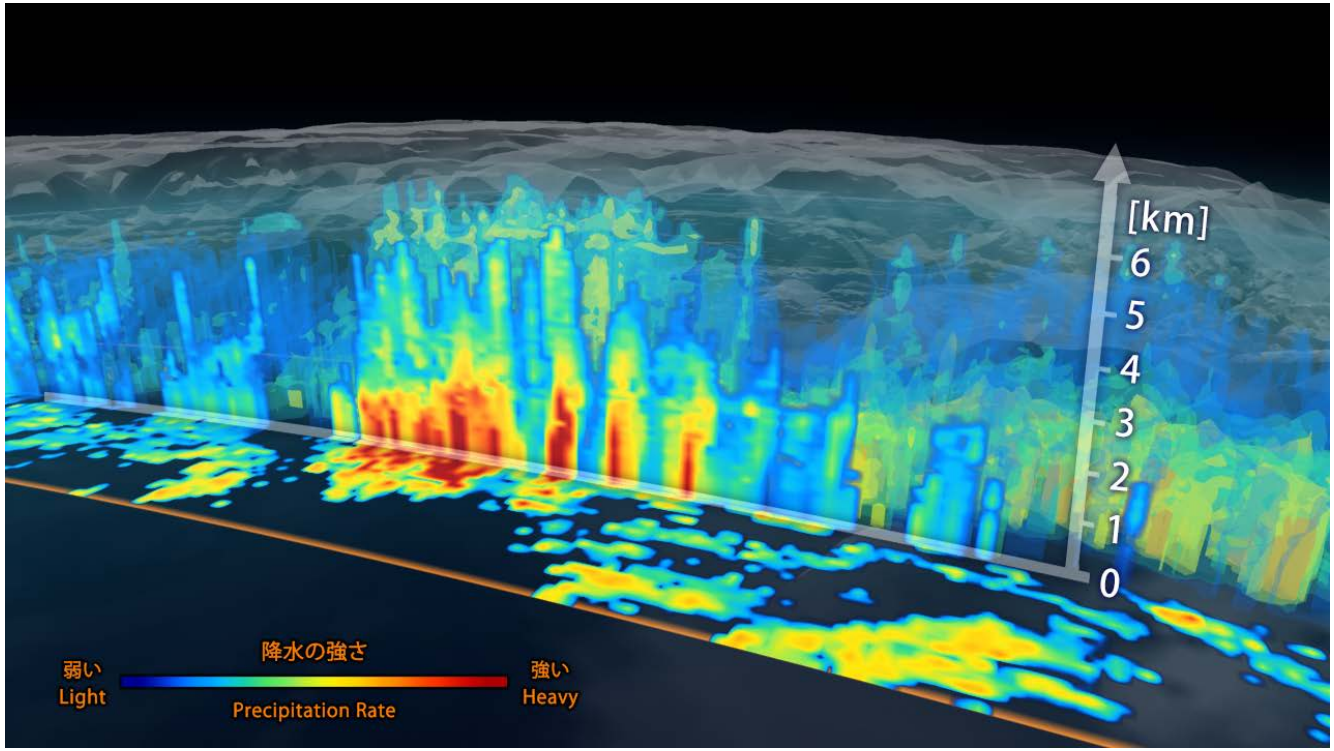


GPM Core Observatory launched at 3:37 A.M. JST on February 28, 2014

The GPM Core Observatory was launched on a JAXA-supplied MHI H-IIA 202 launch vehicle from JAXA's Tanegashima Space Center, on Tanegashima Island, Japan.

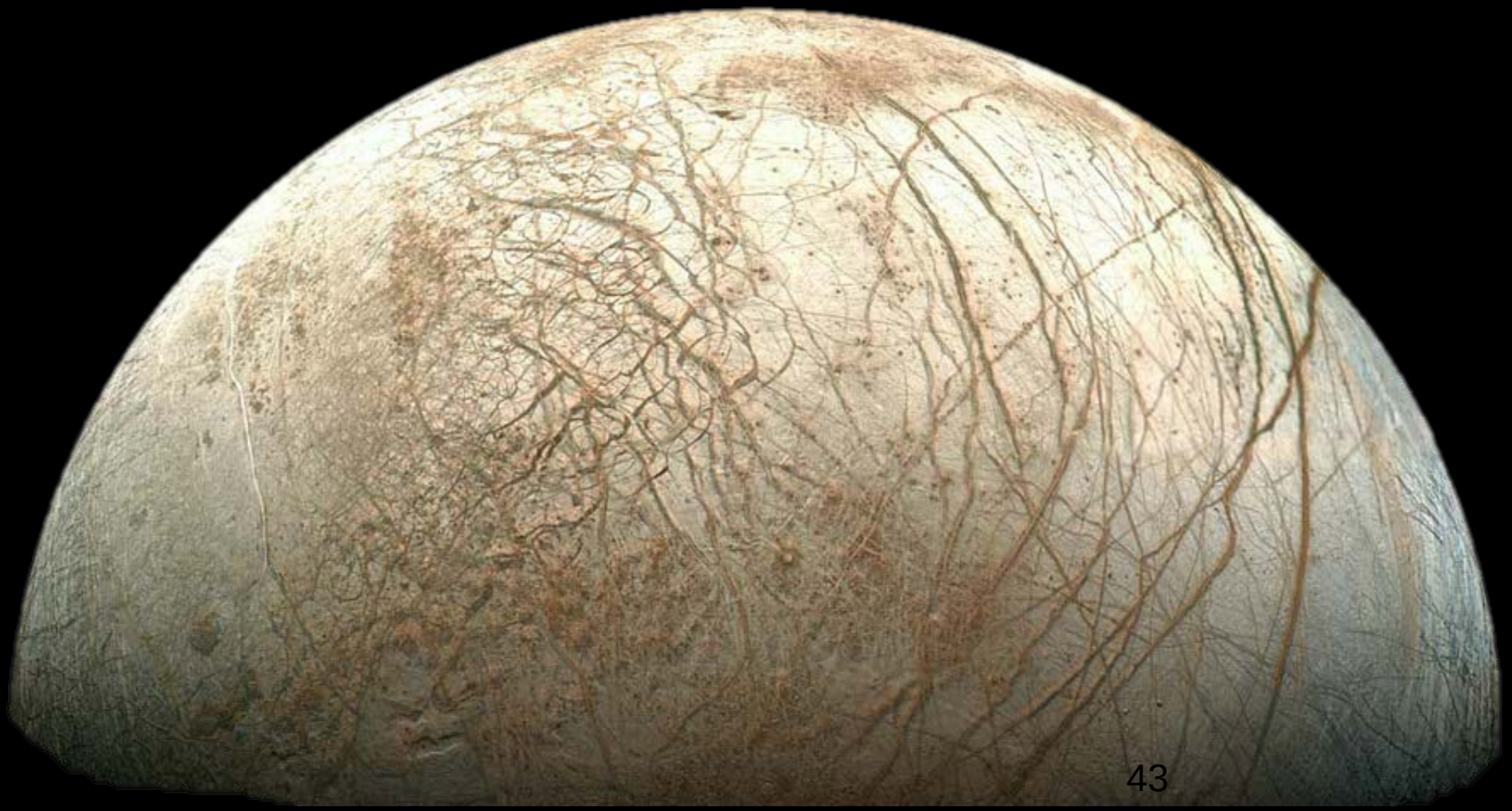
The Core Observatory separation from the H-IIA second stage occurred ~16 minutes after launch.

GPM “First Light” Images - DPR

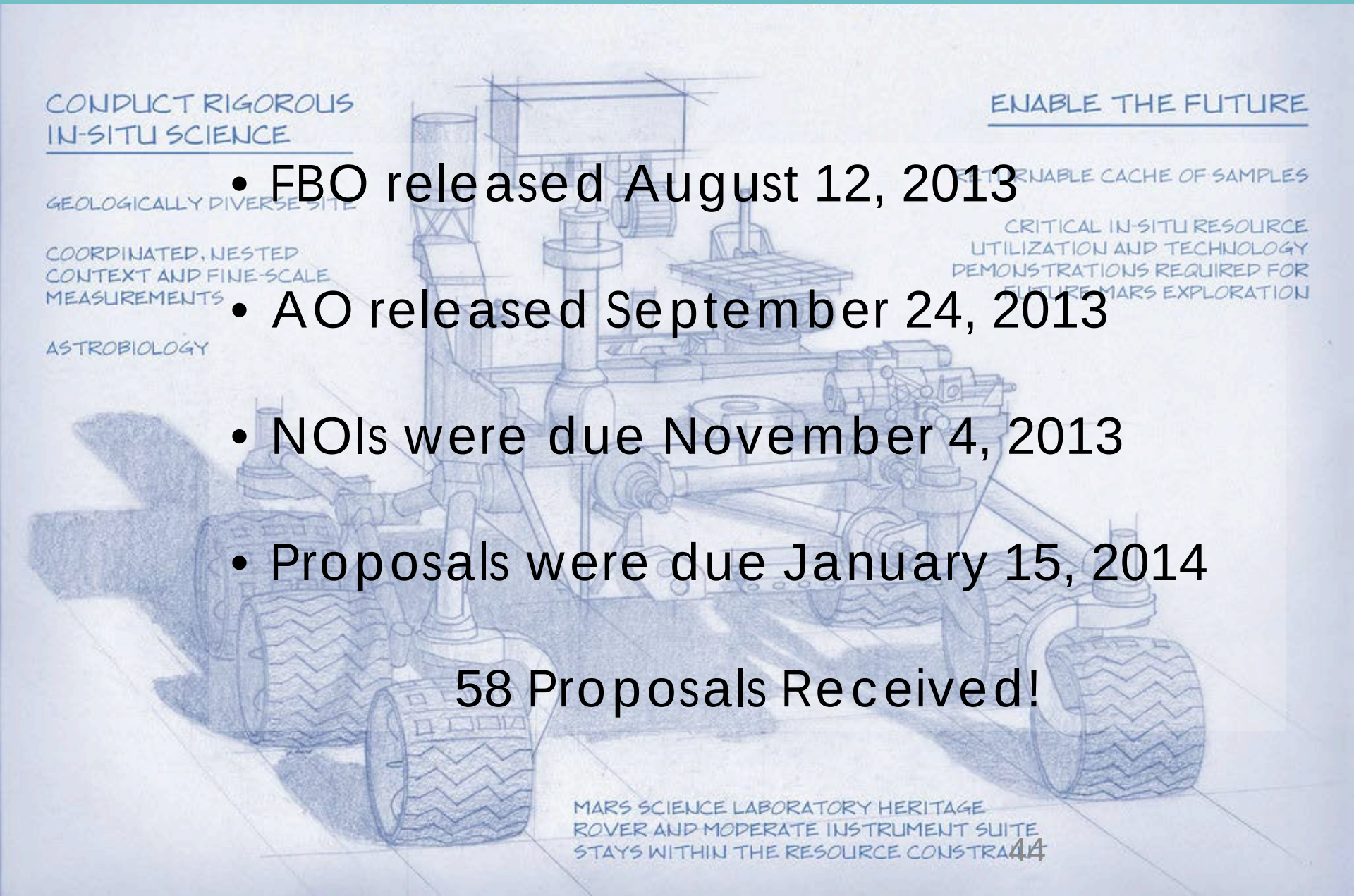


This is the first data visualization of the three-dimensional structure of precipitation collected by GPM’s Dual-frequency Precipitation Radar (DPR). The image shows rain rates of a vertical cross-section approximately 7 kilometers high through the same extra-tropical cyclone observed off the coast of Japan on March 10, 2014. Red areas indicate heavy rainfall while yellow and blue indicate less intense rainfall.

Planetary Science



Mars 2020



- FBO released August 12, 2013
- AO released September 24, 2013
- NOIs were due November 4, 2013
- Proposals were due January 15, 2014

58 Proposals Received!

Mars 2020

The requirements for this investigation payload were documented in the Sept. 24th AO.

SMD, HEOMD, and STMD personnel will participate in the proposal evaluation process

NASA's Space Technology and Human Exploration Operations Mission Directorates (STMD & HEOMD) are sponsoring Mars 2020 investigations to address technology gaps.

ISRU technology demonstration being competitively selected with HEOMD

Mars 2020 MEDLI Project is also jointly managed between STMD and HEOMD.

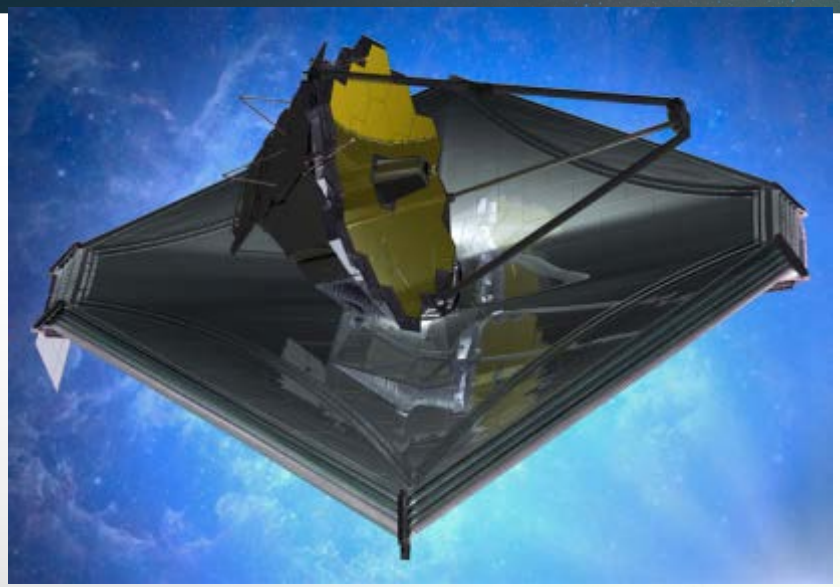
Water Vapor Plumes on Europa

Hydrogen and oxygen emission lines from HST with superimposed Europa image from Galileo

Roth et al. (2013). *Science.*


National Aeronautics and Space Administration
NASA
Astrophysics

JWST
James Webb Space Telescope



Large Infrared Space Observatory

Top priority of 2000 Decadal Survey

Science themes: First Light; Assembly of Galaxies; Birth of Stars and Planetary Systems; Planetary Systems and the Origins of Life

Mission: 6.5m deployable, segmented telescope at L2, passively cooled to <50K behind a large, deployable sunshield

Instruments: Near IR Camera, Near IR Spectrograph, Mid IR Instrument, Near IR Imager and Slitless Spectrograph

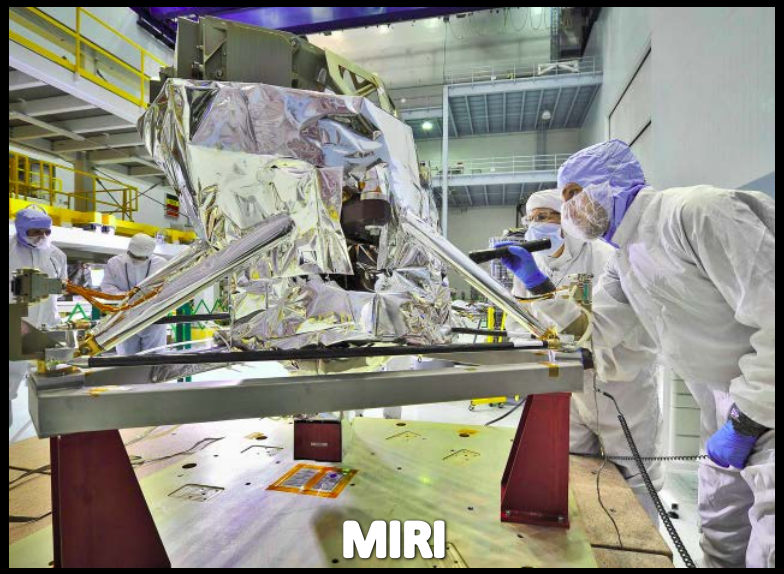
Operations: 2018 launch for a 5-year prime mission

Partners: ESA, CSA

CURRENT STATUS:

- Project has entered its long and challenging Integration and Test activities.
- Technical progress continues to be significant.
  - Instruments are delivered and in integration & test phase.
  - All optics are complete (primary segments, secondary, tertiary and fine steering mirrors) and delivered to GSFC.
  - Telescope wings are complete; backplane support fixture and center section are complete.
  - Spacecraft completed Critical Design Review (Jan 2014).
- Project is performing within the budget, to schedule.
  - Government shutdown did not impact October 2018 launch date.
- FY14 is the peak funding year with many critical activities.

Program Update - JWST



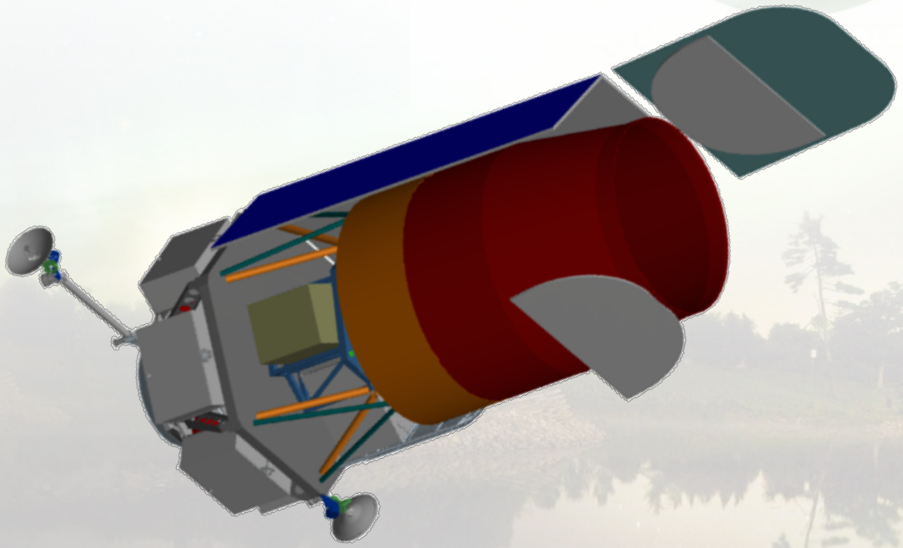
Mirror Status

Flight optics delivered: All mirrors in storage at GSFC

WFIRST / AFTA

Widefield Infrared Survey Telescope with Astrophysics Focused Telescope Assets

- FY15 budget request supports pre-formulation of WFIRST/AFTA, including technology development for detectors and coronagraph (with STMD).
- FY15 request supports Agency/Administration decision for formulation to begin NET FY 2017, should funding be available.



- Recent NRC study on WFIRST/AFTA offers positive view of AFTA, with concerns about technology and cost risks

SOFIA to be put into Storage

- SOFIA's high operating costs cannot be accommodated within the reduced Astrophysics budget request.
- NASA's FY 2015 budget request to Congress proposes to place SOFIA into storage by FY 2015.
- NASA has informed our German partner DLR of this proposal. NASA is working with DLR to identify a path forward for SOFIA.

- **World's Largest Airborne Observatory**
- 2.5-meter telescope
- Capable of observing from the visible to the far infrared
- 80/20 Partnership between NASA and the German Aerospace Center (DLR)
- Mission Ops based at NASA-Armstrong
- Science Ops based at NASA-Ames
- Six First-Generation instruments
  - Four U.S., two German
  - Imaging, Spectroscopy, and Photometry
- Limited Science Ops began 2010
- Full Operational Capability in February 2014

Outline

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

Finding

SOFIA Defunding Process

The decision just weeks after it reached full operational capability to effectively zero-out the funding request for SOFIA (the Stratospheric Observatory for Infrared Astronomy) in FY15 and completely zero it out in FY16 was abrupt and outside the usual and preferred process. The preferred approach involves both a senior review to engage the scientific community in assessing the relative scientific merit of a mission in extended operations, and international comity where decisions affecting international scientific cooperation are reached through considered consultation with one's international partners (the German Aerospace Center or DLR is a 20% partner on SOFIA).