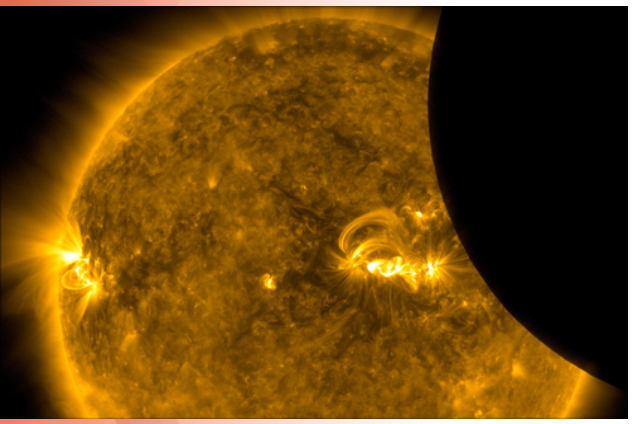
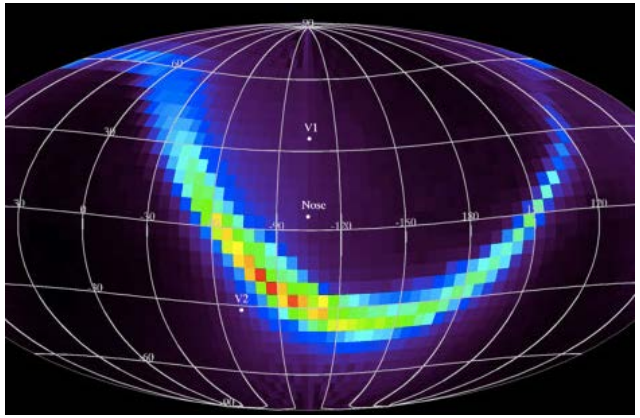
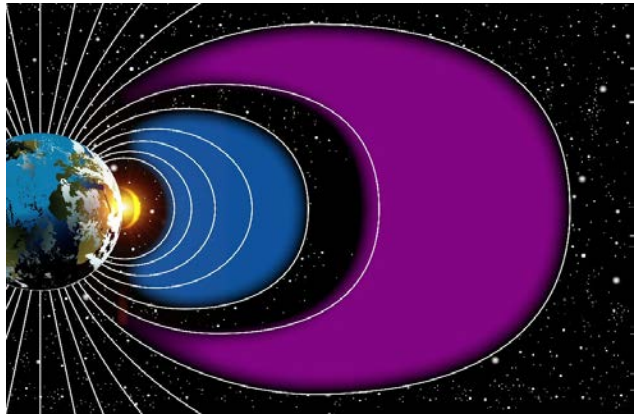
SCIENCE

National Aeronautics and Space Administration







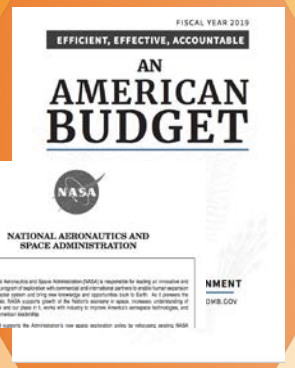
NASA Heliophysics Division Update

Committee on Solar and Space Physics

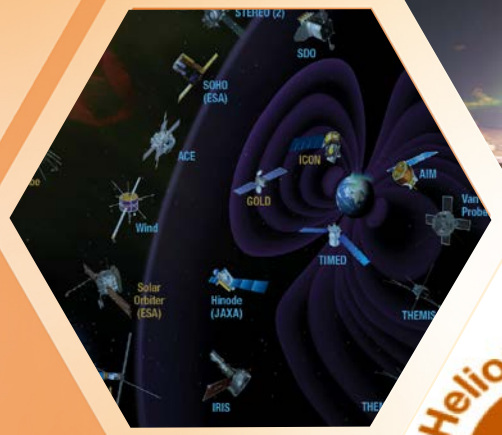
Peg Luce

Acting Division Director
Heliophysics Division

27 MARCH 2018



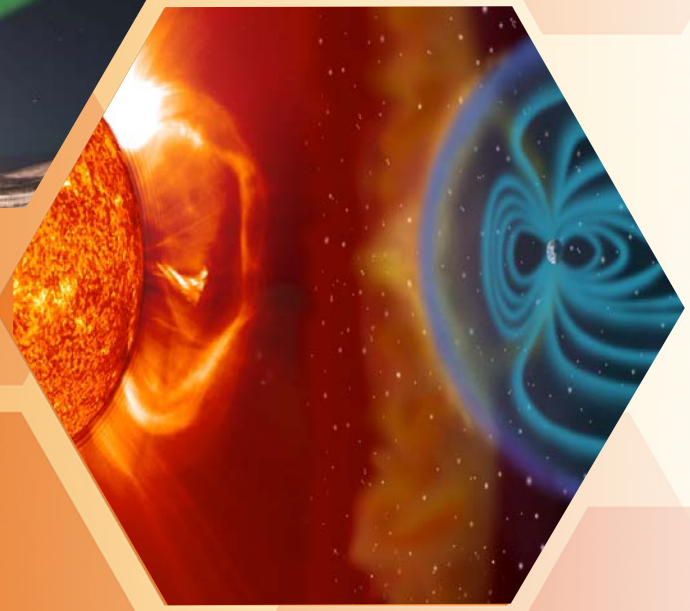
HELIOPHYSICS



Heliophysics Research
Est. 1958

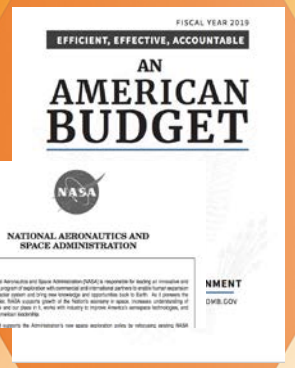
Overview

- What's new at HQ?
- Budget
- Launches
- Heliophysics Missions
  - Implementation, Operations, Formulation
- Research: Space Weather & ROSES
- International/Interagency Collaborations
- Heliophysics committees



Overview
Heliophysics is strong and stable

- Heliophysics program is aligned with SMD strategic objectives:
  - Advance National Science and Exploration Goals
    - Heliophysics is a system science that seeks fundamental understanding and advances exploration
  - Safeguard and Improve Life
    - Space Weather budget increase will strengthen cross-agency collaboration on Research-to-Operations/Operations-to-Research initiatives
  - Execute a Balanced and Integrated Science Program
    - FY19 PBR provides for a balanced Heliophysics portfolio, including enhanced emphasis on small missions, technology development and expanded opportunities for R&A



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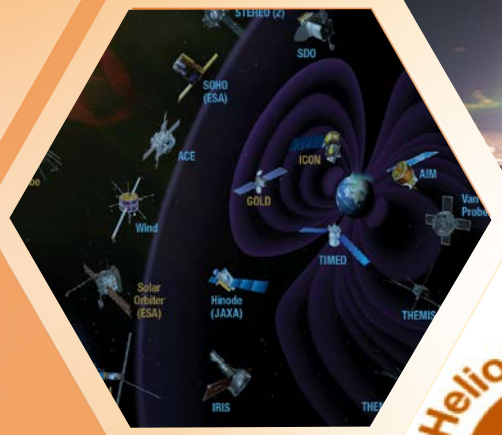

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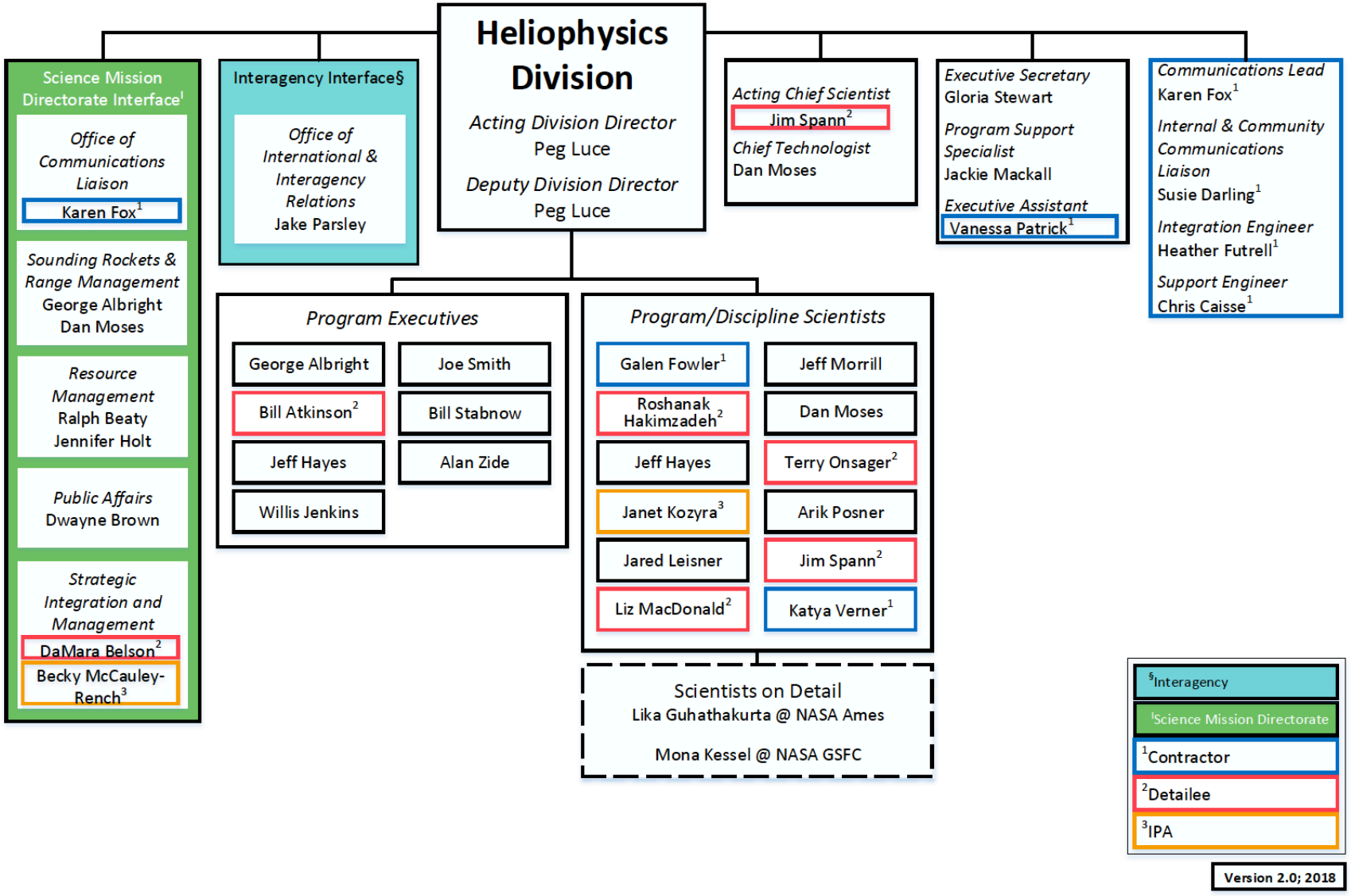
What's new at HQ?



Division Leadership:

- Heliophysics Division Director – Nicky Fox to start August 2018
- Acting Chief Scientist – Jim Spann

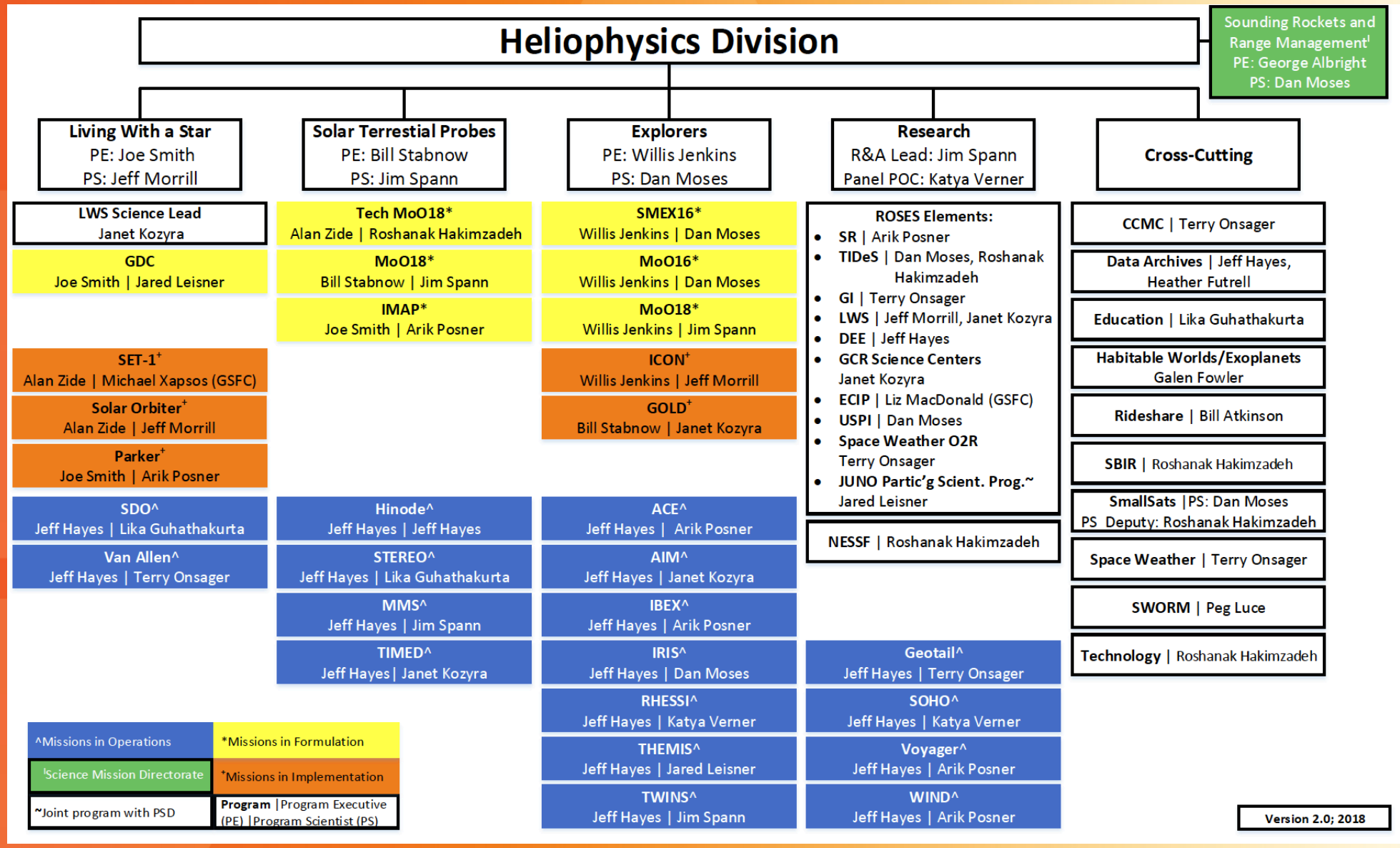
New Assignments:

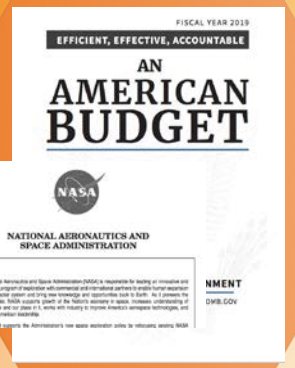
- Lika Guhathakurta – on detail to Ames since May 2017
- Mona Kessel – on detail to GSFC since Jan 2018

New Faces:

- Terry Onsager
  - on detail from NOAA/SWPC
- Roshanak Hakimzadeh
  - on detail from GRC
- Jim Spann
  - on detail from MSFC
- Bill Atkinson
  - on detail from KSC

What's new at HQ?





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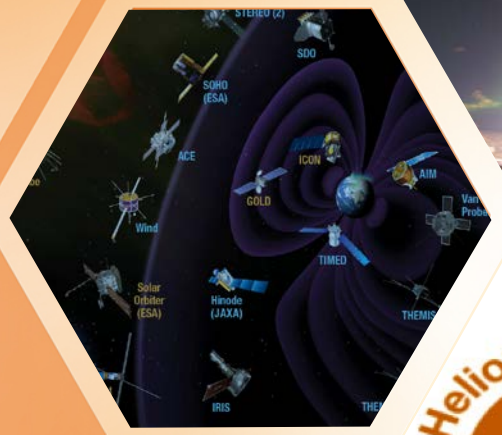

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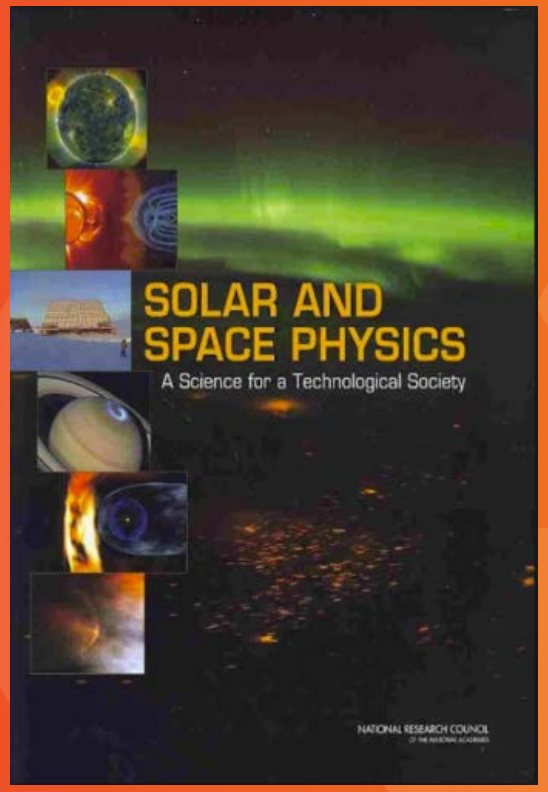
Alignment with Decadal Survey



NASA FY19 President's Budget Request (PBR) and FY18 Appropriation Support:	
0.0 Complete the current program	Extended operations of current operating missions as recommended by the 2017 Senior Review; 5 missions currently in development (SET, ICON, GOLD, SOC and Parker)
1.0 Implement DRIVE (Diversify, Realize, Integrate, Venture, Educate)	Implemented DRIVE initiative wedge in FY15; fully funded in FY17 and onwards
2.0 Accelerate and expand Heliophysics Explorer program	Decadal recommendation of every 2-3 years; Explorer mission AO released in 2016; plan to release next Explorer AO in 2018. Notional mission cadence will continue to follow Decadal recommendation going forward.
3.0 Restructure STP as a moderate scale, PI-led flight program	STP-5 (IMAP) mission AO released with IMAP as a PI-led mission with a LRD ~2024
4.0 Implement a large LWS GDC-like mission	Start of mission formulation targeted for NET 2019; RFI call for innovative ideas yielded 65 responses; inputs will feed into GDC STDT that will start in 2018.

HPD Budget: What's changed and what's the same

What's changed:

- Future Mission funding
  - Helio FY 2019 PBR allows funding up to two SMEX missions and up to two MoOs from SMEX 16 AO
  - Helio FY 2019 PBR adds a Tech Demo MoO (2nd MoO), and an ESPA ring to IMAP
  - GDC (LWS-7) mission formulation has shifted from FY 2018 to FY 2019-20
- R&A Augmentation:
  - Space Weather, CubeSats/SmallSats, Technology Investment, ECIP
  - Wallops Research Range for facility upgrades and maintenance
- Minor changes in Missions in Extended Ops including loss of contact with STEREO-Behind

What's changed continued:

- Missions in development
  - LRD Changes for Solar Orbiter, ICON, SET
    - ICON WAS: Oct. 2017 IS: NET Jun. 14, 2018
    - SET WAS: Jan. 2018 IS: NET Jun. 2018
    - Solar Orbiter WAS: Oct. 2018 IS: Feb. 2020

What's the same:

- GOLD launched as planned in January 2018
- Parker Solar Probe on track for launch by August 2018
- ICON preparing for June 2018 launch
- Operating missions funded according to senior review guidance

FY19 President's Budget Request

HPD FY18 increased by 10.7M

	Op Plan FY17	Planned FY18	FY19	FY20	FY21	FY22	FY23
Heliophysics	674.7	677.8	690.7	690.7	690.7	690.7	690.7
Heliophysics Research	180.8	200.8	242.7	234.3	226.7	217.9	220.6
Heliophysics Research and Analysis (791926)	39.4	49.9	71.2	66.6	58.6	58.6	58.6
Sounding Rockets (962880)	53.3	59.0	61.1	63.1	68.1	60.1	65.1
Research Range (153825)	24.3	24.8	29.6	27.3	25.6	25.6	25.6
Science Planning and Research Support (527813)	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Directed Research & Technology (526310)	0.0	0.0	0.0	0.0	3.9	4.2	4.2
CubeSat (964105)	15.0	15.0	22.0	18.5	10.0	10.0	10.0
Voyager (925575)	5.6	5.6	5.6	5.5	5.5	5.5	4.9
SOHO (789743)	2.3	2.2	2.3	2.3	2.3	2.4	2.2
WIND (958044)	2.2	2.2	2.2	2.2	2.2	2.2	2.0
GEOTAIL (943305)	0.4	0.2	0.2	0.2	0.2	0.2	0.2
SOLAR Data Center (378077)	1.1	1.2	1.3	1.1	1.2	1.2	1.2
Data & Modeling Services (944022)	2.8	2.7	3.0	3.0	3.0	3.0	3.0
Space Physics Data Archive (380543)	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Guest Investigator Program (955518)	11.6	15.2	21.5	21.5	21.5	21.5	21.5
Community Coordinated Modeling Center (382230)	2.3	2.3	2.3	2.4	2.4	2.4	2.4
Space Science Mission Ops Services (385616)	11.5	11.5	11.5	11.6	13.1	11.9	10.7
Solar Terrestrial Probes	38.8	41.6	91.0	89.9	177.7	175.6	247.9
Magnetospheric Multiscale (MMS) (943396)	19.9	17.0	17.0	17.0	15.0	15.0	4.0
STP Program Management and Future Missions (617871)	2.8	8.7	56.2	55.0	145.9	143.6	228.7
Solar Terrestrial Relations Observatory (STEREO) (619595)	6.5	6.5	8.3	8.3	7.3	7.3	6.5
Hinode (Solar B) (511432)	7.0	6.8	7.0	7.0	7.0	7.0	6.3
TIMED (370544)	2.6	2.6	2.6	2.6	2.5	2.7	2.4

FY19 President's Budget Request

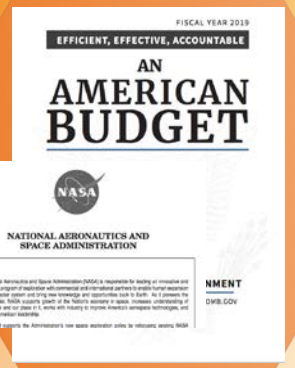
	Op Plan FY17	Planned FY18	FY19	FY20	FY21	FY22	FY23
Living with a Star	368.4	365.4	247.8	103.4	83.5	93.2	127.8
Parker Solar Probe (388443)	232.5	241.6	107.2	30.6	22.1	22.2	21.2
Solar Orbiter Collaboration (996805)	79.9	59.2	62.3	4.1	4.2	4.2	4.3
Van Allen Probes (RBSP) (605745)	13.3	13.0	13.0	9.0	0.0	0.0	0.0
LWS Space Environment Testbeds (499999)	0.7	1.0	0.5	0.0	0.0	0.0	0.0
LWS Science (936723)	23.8	27.1	38.5	38.4	35.3	35.3	35.3
LWS Program Management and Future Missions (937818)	6.2	11.5	14.2	9.3	9.9	19.4	55.8
Solar Dynamics Observatory (SDO) (939252)	12.1	12.0	12.0	12.0	12.0	12.0	11.2
Heliophysics Explorer Program	86.7	70.0	109.2	263.1	202.9	204.1	94.4
Ionospheric Connection Explorer (581067)	39.4	19.0	4.5	1.3	0.0	0.0	0.0
Global-scale Observations of the Limb an (496787)	10.0	8.0	7.7	5.2	0.4	0.0	0.0
Interface Region Imaging Spectogr (IRIS) (649056)	7.7	6.8	7.0	6.5	6.5	6.5	5.9
Heliophysics Explorer Future Missions (516741)	6.0	7.6	67.9	224.6	173.7	175.5	69.4
Interstellar Boundary Explorer (IBEX) (576706)	3.4	3.4	3.4	3.4	3.4	3.4	3.1
TWINS (953004)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
CINDI (953212)	0.3	0.2	0.0	0.0	0.0	0.0	0.0
Aeronomy of Ice in Mesophere (SMEX-9) (956269)	3.0	3.3	3.0	3.0	3.0	3.0	2.7
Time History of Events and Macroscale In (960804)	5.4	5.4	5.1	4.5	4.5	4.5	4.1
Heliophysics Explorer Program Management (062285)	6.1	11.0	5.0	9.1	6.4	6.3	4.9
ACE (910989)	3.0	2.9	3.0	3.0	3.0	3.0	2.7
RHESSI (667339)	1.9	1.9	1.9	1.9	1.4	1.4	1.1

DRIVE Funding Increases as Recommended by Decadal Survey

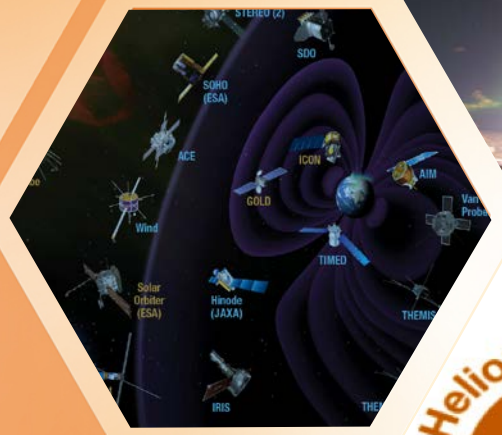
	FY16	FY17	FY18	FY19	FY20	FY21	FY22
FY15 PBR ($M) for DRIVE Elements	107.8	112.4	112.4	112.4			
FY18 PBR ($M) for DRIVE Elements	115	126.2	153.1	174.8	177	177	177
Increase: FY15 PBR - FY18 PBR	7.2	13.8	40.7	62.4	64.6	64.6	64.6
% Increase: FY15 PBR - FY18 PBR	7%	12%	36%	56%	57%	57%	57%
% Increase in Grant Programs	**10%**	**23%**	**58%**	**91%**	**92%**	**92%**	**92%**

DRIVE Elements include:

- Sounding Rocket Program Office
- Guest Investigator
- Research & Analysis (HSR, H-TIDeS, H-GCR)
  - including Heliophysics Science Centers and Early Career Investigator Program
- LWS Science
  - including Space Weather Research



HELIOPHYSICS



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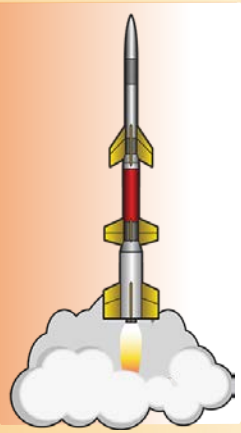
HPD Program Highlights: GOLD

Credit: Arianespace

- Launch Vehicle: Ariane 5
- Launch Site: French Guiana
- Observatory: GOLD hosted payload on SES-14
- Launched on Jan. 25 2018, at 17:20 EST
- Description:
  - GOLD uses an ultraviolet imaging spectrometer to investigate the dynamic region where Earth's uppermost atmosphere meets near-Earth space.
  - Change in this region can interfere with GPS and radio communications, so improving our understanding of the fundamental processes there can improve models to forecast space weather effects.

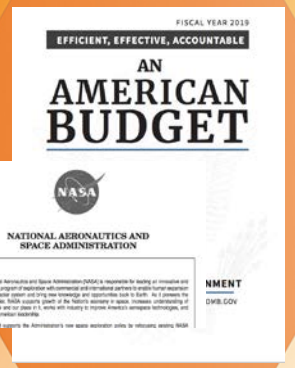


HPD Program Highlights: Sounding Rockets

- Principal Investigator (PI) Azeem successfully launched three flights on Jan. 26 for the Super Soaker mission from the Poker Flat Research Range (PFRR).
- The Diffuse X-rays from the Local galaxy (DXL) mission also launched from PFRR. PI Galeazzi led this flight, which launched on Jan. 19. Data review continues.

Top Photo: Galeazzi DXL launch

Bottom Photo: Azeem Super Soaker launch, time-lapse for three launches



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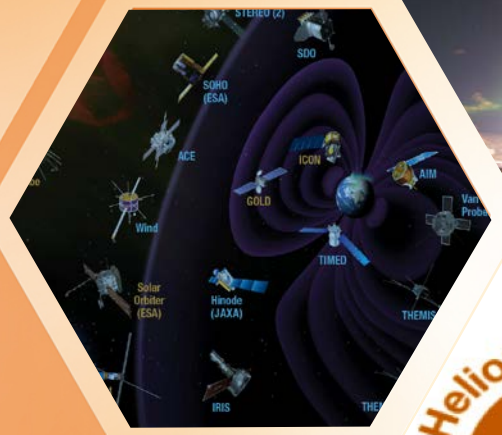

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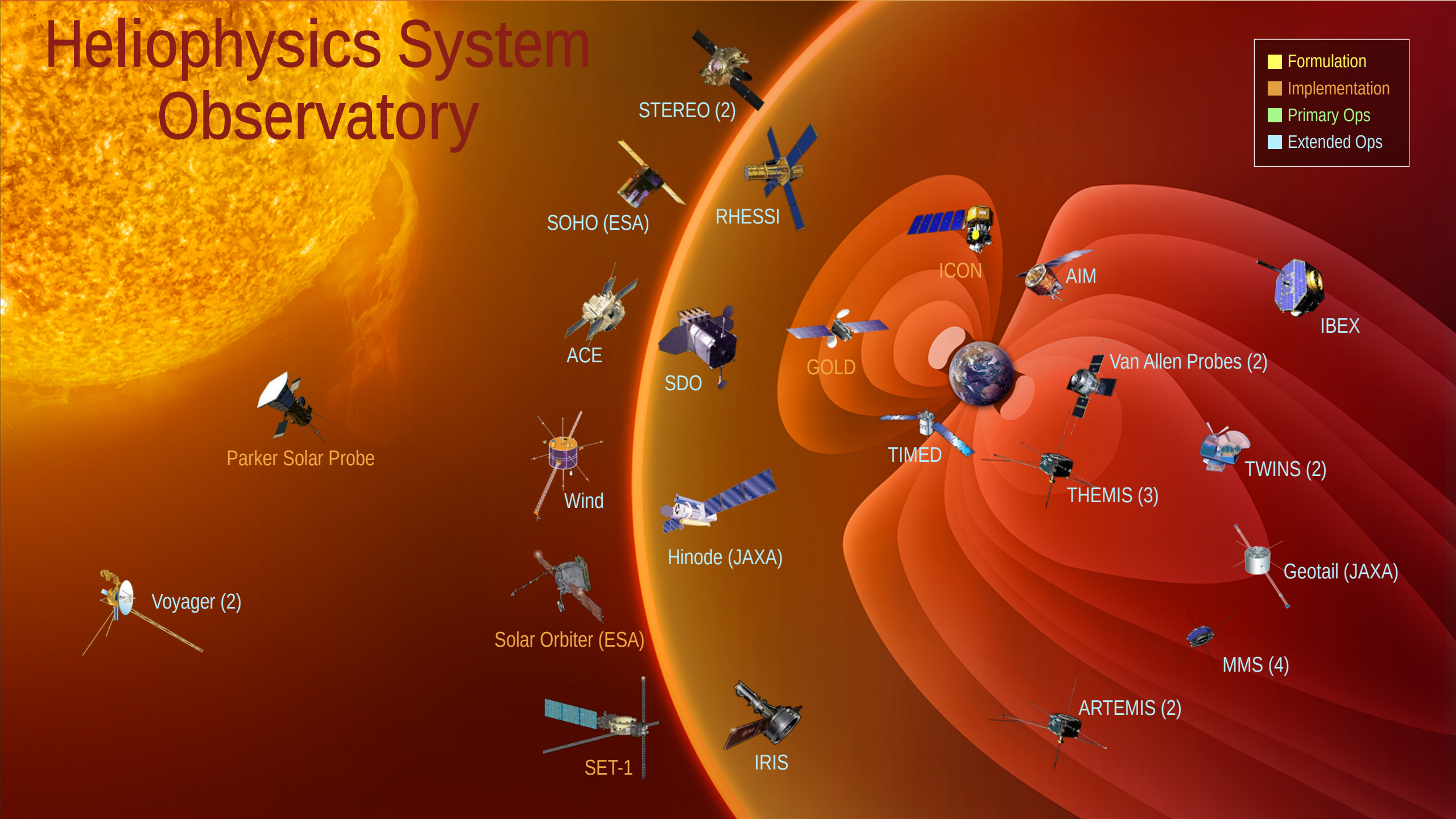
Heliophysics System Observatory



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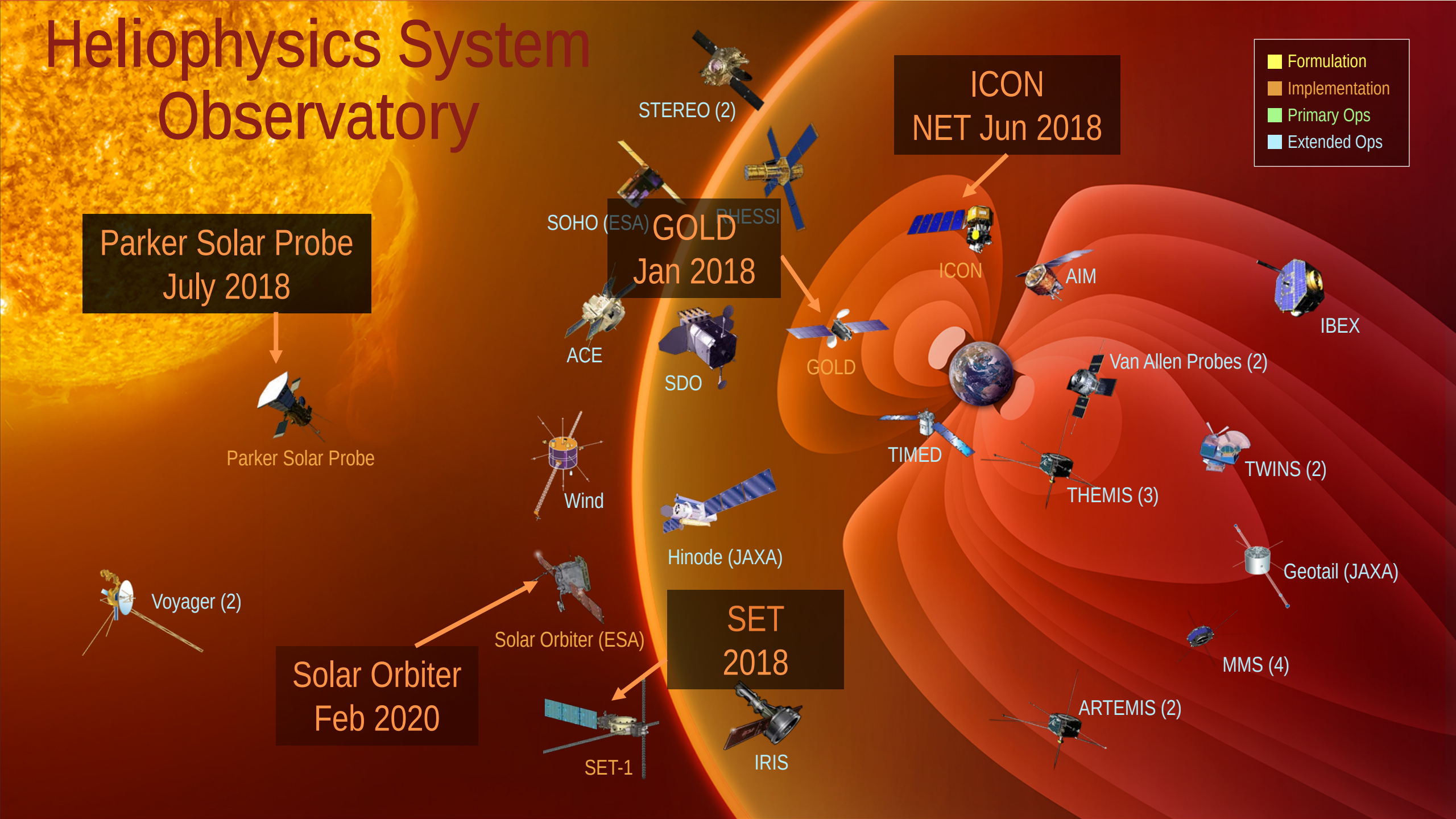
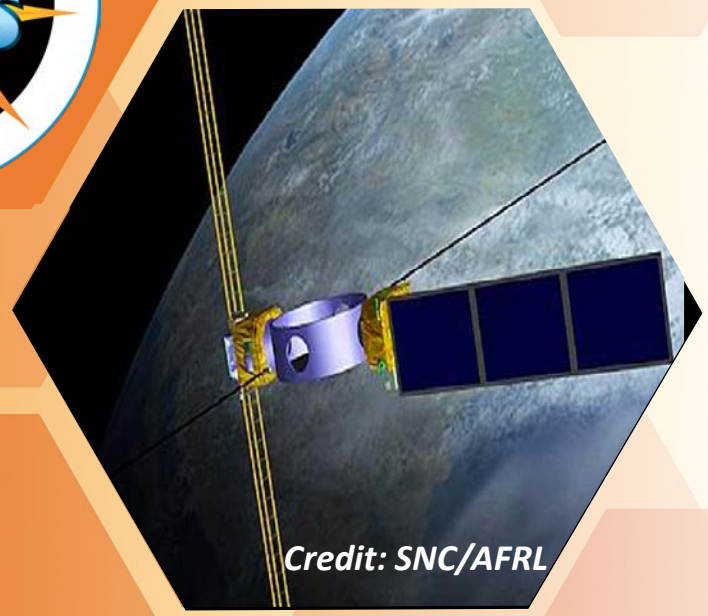


Space Environment Testbed (SET-1) Mission



- Launch Vehicle: Falcon 9 Heavy
- Launch Site: Cape Canaveral
- Observatory: SET-1 hosted payload on Air Force Research Laboratory (AFRL) Demonstration and Science Experiments (DSX) spacecraft
- SET Project Scientist: Mike Xapsos
- Launch window: NET Jun. 2018
- Science Objectives:
  - Define the mechanisms for induced space environment and effects
  - Reduce uncertainties in the definitions of the induced environment and effects on spacecraft and their payloads
  - Improve design and operations guidelines and test protocols so that spacecraft anomalies and failures due to environmental effects during operations are reduced

HPD Program Highlights: ICON

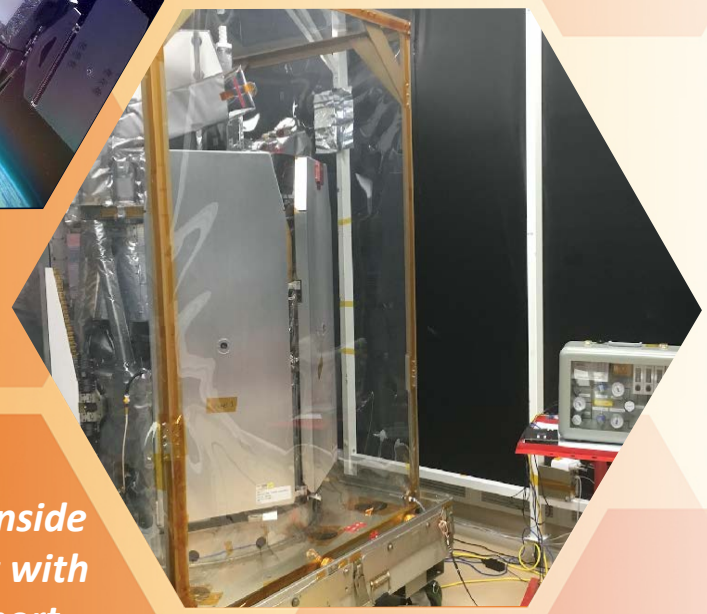


Photo: ICON inside the clean tent with ground support equipment

- Launch Vehicle: Pegasus XL rocket
- Launch Site: Kwajalein Atoll in the Marshall Islands
- LRD: NET June 14, 2018
- Orbit: Around Earth at a 27-degree inclination and at an altitude of some 360 miles
- ICON Mission PI: Tom Immel, UC Berkeley
- Description:
  - ICON will study the frontier of space: the dynamic zone high in our atmosphere where terrestrial weather from below meets space weather above.
  - In this region, the tenuous gases are anything but quiet, as a mix of neutral and charged particles travel through in giant winds.
  - These winds can change on a wide variety of time scales -- due to Earth's seasons, the day's heating and cooling, and incoming bursts of radiation from the sun.
- Upcoming Milestones: LVRR – Apr. 26, Shipment to VAFB – Apr. 30, KDP-E – May 22

HPD Program Highlights: ICON

- Instruments:
  - MIGHTI (Michelson Interferometer for Global High-resolution Thermospheric Imaging) instrument observes the temperature and speed of the neutral atmosphere
    - built by the Naval Research Laboratory in Washington, DC
  - IVM (Ion Velocity Meter) will observe the speed of the charged particle motions, in response to the push of the high altitude winds and the electric fields they generate
    - built by the University of Texas at Dallas
  - EUV (Extreme Ultra-Violet) instrument captures images of oxygen glowing in the upper atmosphere, in order to measure the height and density of the daytime ionosphere
    - built by the University of California at Berkeley
  - FUV (Far Ultra-Violet) instrument captures images of the upper atmosphere in the far ultraviolet light range
    - built by the University of California at Berkeley

HPD Program Highlights: Parker Solar Probe

Photo: Installation of Thermal Protection System Simulator onto Parker Observatory in the Space Environmental Simulator

- Launch Vehicle: Delta IV-Heavy with Upper Stage
- Launch Site: Cape Canaveral LRD: July 31, 2018
- Parker Project Scientists: Adam Szabo (GSFC); Nicola Fox (APL)
- Description:
  - Flying into the outermost part of the sun's corona for the first time, Parker Solar Probe will employ a combination of in situ measurements and imaging to revolutionize our understanding of the corona and expand our knowledge of the origin and evolution of the solar wind.
  - It will also make critical contributions to our ability to forecast changes in Earth's space environment that affect life and technology on Earth.
- Upcoming Milestones: PSR – Mar. 29-30, Shipment to Astrotech – Apr. 1, ORR – May 22

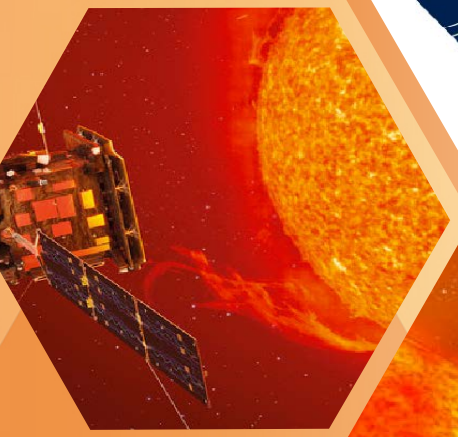
HPD Program Highlights: Parker Solar Probe – Investigations

Mar. 25 Parker Solar Probe Friends and Family Day at GSFC

Credit: NASA/Johns Hopkins APL/Ed Whitman

- Fields Experiment (FIELDS) investigation will make direct measurements of electric and magnetic fields and waves, Poynting flux, absolute plasma density and electron temperature, spacecraft floating potential and density fluctuations, and radio emissions.
  - PI Prof. Stuart Bale; University of California, Berkeley
- Integrated Science Investigation of the sun (IS⊙IS) investigation makes observations of energetic electrons, protons and heavy ions that are accelerated to high energies (10s of keV to 100 MeV) in the sun's atmosphere and inner heliosphere, and correlates them with solar wind and coronal structures
  - PI Dr. David McComas; Princeton University
- Wide-field Imager for Solar PRobe (WISPR) will take images of the solar corona and inner heliosphere. The experiment will also provide images of the solar wind, shocks and other structures as they approach and pass the spacecraft.
  - PI Dr. Russell Howard; Naval Research Laboratory
- Solar Wind Electrons Alphas and Protons (SWEAP) Investigation will count the most abundant particles in the solar wind -- electrons, protons and helium ions -- and measure their properties such as velocity, density, and temperature.
  - PI Prof. Justin Kasper; University of Michigan/ Smithsonian Astrophysics Observatory

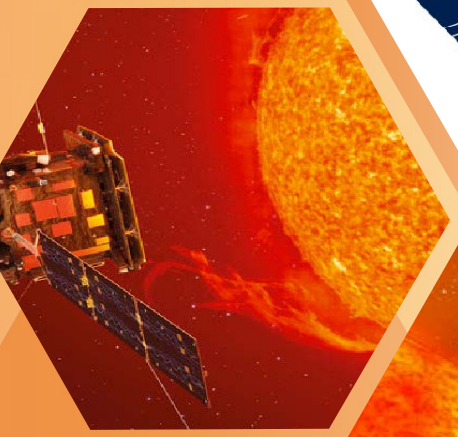
HPD Program Highlights: Solar Orbiter



Photos credit: ESA

- Launch Vehicle: Atlas-V 411
- Launch Site: Cape Canaveral LRD: Feb. 2020
- Solar Orbiter Collaboration Project Scientist: Chris St. Cyr
- U.S. Provided Instruments:
  - HIS (Heavy Ion Sensor) part of SWA, SoloHI (Heliospheric Imager)
- ESA Provided Instruments:
  - EPD (Energetic Particle Detector), MAG (Magnetometer), RPW (Radio and Plasma Waves), SWA (Solar Wind Plasma Analyser), EUI (Extreme Ultraviolet Imager), METIS (Coronagraph), PHI (Polarimetric and Helioseismic Imager), and STIX (X-ray Spectrometer/Telescope). SPICE* (Spectral Imaging of the Coronal Environment), SIS* (Suprathermal Ion Spectrograph) part of EPD
- Description:
  - Solar Orbiter aims to make significant breakthroughs in our understanding both of how the inner heliosphere works, and of the effects of solar activity on it. The spacecraft will take a unique combination of measurements: in situ measurements will be used alongside remote sensing close to the Sun to relate these measurements back to their source regions and structures on the Sun's surface

HPD Program Highlights: Solar Orbiter



Photos credit: ESA

- Instrument: Solar Orbiter Heliospheric Imager
  - Built by Naval Research Laboratory, PI: Russ Howard
- Description: SoloHI is a visible light instrument that images plasma structures (streamers, CMEs, etc) in the solar corona and solar wind. The image intensity is directly related to the density of electrons and dust along the line of sight.
- Instrument: Heavy Ion Sensor, part of Solar Wind Analyzer suite
  - Built by Southwest Research Institute, PI Stephano Livi
- Description: HIS is an ion composition instrument that will measure the 3D velocity distributions and composition of helium and heavy ions. The Time of Flight (ToF) measures particle time of flight, azimuth, and total energy of solar wind ions. The Entrance aperture subsystem (EA-IS) selects alpha particles and heavy ions according to their energy and elevation angle.

HPD Operating Missions

Mission	Launch	Phase	Extension	M-3	M-2	M-1	Cur. M.	Remarks
Geotail	7/24/1992	Extended	12/31/2016					
STEREO	10/25/2006	Extended	9/30/2018					B monthly cadence continues; so far no contact.
THEMIS+Artemis	2/17/2007	Extended	9/30/2018					
AIM	4/25/2007	Extended	9/30/2018					
Hinode	9/23/2006	Extended	9/30/2018					
ACE	8/27/1997	Extended	9/30/2018					
RHESSI	2/5/2002	Extended	9/30/2018					
SOHO	12/2/1995	Extended	9/30/2018					
TIMED	12/7/2001	Extended	9/30/2018					
Voyager 1 + 2	8/20/1977	Extended	9/30/2018					
TWINS A	6/1/2006	Extended	9/30/2018					
IBEX	10/19/2008	Extended	9/30/2018					
Wind	11/1/1994	Extended	9/30/2018					
SDO	2/11/2010	Extended	9/30/2018					
Van Allen	8/30/2012	Extended	9/30/2018					
IRIS	6/27/2013	Extended	9/30/2018					
MMS	3/12/2015	Extended	9/30/2018					

Mission proceeding to meet science requirements

Area of concern - possible reduction in capability

Significant problem – possible or probable loss of mission

Operating Mission Highlights

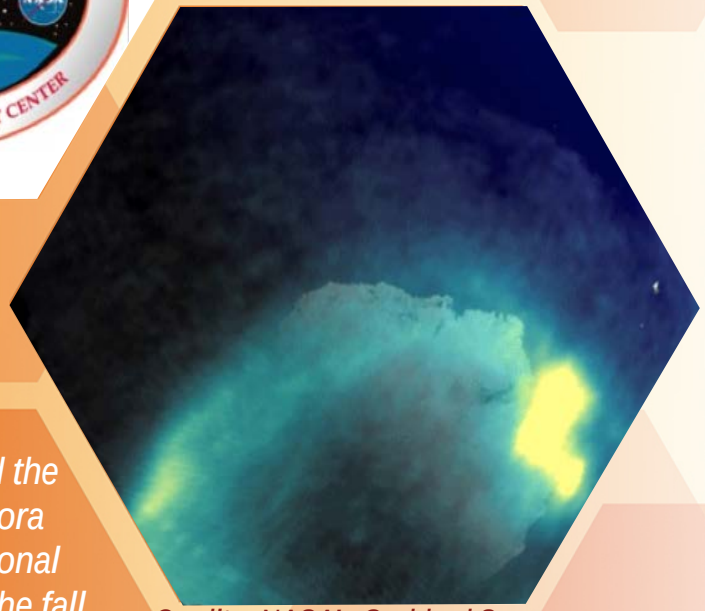


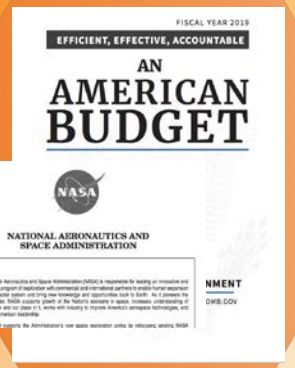
IMAGE captured the South Pole aurora caused by a coronal mass ejection in the fall of 2003.

Credits: NASA's Goddard Space Flight Center Scientific Visualization Studio/Tom Bridgman, lead animator

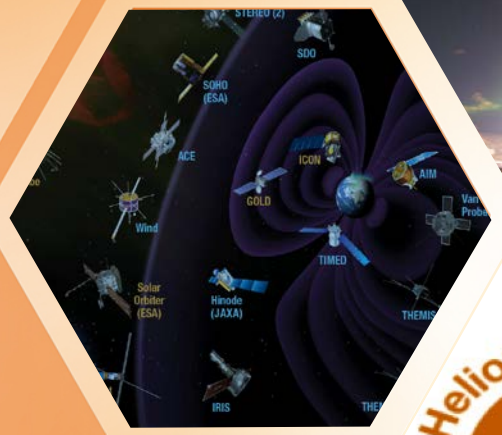
- IMAGE
  - Jan. 20: Amateur astronomer Scott Tilley in Roberts Creek, British Columbia, performed his nightly scan
  - Jan. 21: Tilley published findings on his blog post
  - Jan. 23: Tilley locates IMAGE PI, Dr. James Burch, from Southwest Research Institute in San Antonio, Texas, and emails him about his findings
  - Jan. 31: IMAGE is identified by spacecraft ID
  - Feb. 1: First data files, indicated battery fully charged, and its temperatures were in line with those in 2005 and historic values
  - Mar 4: JHU/APL reported detecting IMAGE's signal for the first time after losing contact on Feb. 24. However the signal was too weak to lock on to
  - Awaiting FCC waiver for APL to communicate with IMAGE

Updates on Missions in Formulation

- SMEX 16 AO
  - Five missions selected for Phase A competition
  - Three Missions of Opportunity (MO) selected for further competition
  - One Cat 3 MO selected for technology development
- IMAP Step 1 selections planned for ~May 2018
  - The IMAP mission destination will be L1, and will carry an ESPA ring to accommodate missions of opportunity and/or a partnered mission on a rideshare
  - Mission of Opportunity solicitations are planned in early CY2018
- GDC
  - 65 RFI responses received
  - STDT being formed
- Mission study teams for DYNAMIC and MEDICI (STP-6, STP-7) will be sequenced after GDC STDT



HELIOPHYSICS



Heliophysics Research
Est. 1958

Overview

- What's new at HQ?
- Budget
- Launches
- Heliophysics Missions
  - Implementation, Operations, Formulation
- Research: Space Weather & ROSES
- International/Interagency Collaborations
- Heliophysics committees

Space Weather Augmentation

- Working with NSF on the following objectives:
  - Co-funding CCMC facility
  - Co-funding Living With a Star Strategic Capabilities
  - NASA-NSF opportunity with multiple NSF Divisions focused on Computational Aspects of Space Weather
- NASA-NOAA (NASA-NOAA MOU) - Collaboration between CCMC and NOAA/SWPC on space weather modeling capability
- NASA-NSF-NOAA - Pilot O2R research activity
  - 1.5 M with equal contributions from each organization
  - NASA-NOAA funding available through ROSES 17
- Some DRIVE Science Centers may implement Space Weather relevant efforts

ROSES17

Element awarded:

- H-DEE; 9 awarded Dec. 6
- H-GIO; 32 awarded Mar. 6, 2018
- H-TIDeS; 34 awarded Mar. 3, 2018
  - LNAPP – 4
  - ITD – 12
  - LCAS (+CubeSat) – 18

Elements awaiting selection:

- H-SR; panel completed Nov 6 – Dec 1

Upcoming Panels:

- H-GI MMS, Mar. 27-30
- H-LWS, 2 weeks between mid-May and early June

Element Step 2 proposals due:

- H-Space Weather Research to Operations (SW R2O), Mar. 30, 2018

Element Step 1 proposals received:

- 24 H-SW R2O proposals received on Feb. 23, 2018

ROSES17 Status

	Proposals (Due Date)			
Element	**Step 1**	**Step 2**	**Awards (Expected)**	**Year 1 ($M)**
B.2 H-SR	194	177	(25-30)	($6.0M)
B.3 H-TIDeS	101	88	34	13.8M
B.4 H-GI Open	193	175	32	$4.9M
B.5 H-GCR TMS	Not solicited in ROSES17			
B.6 H-LWS	136	117	(15-20)	($3.75M)
B.7 H-DEE	15	9	9	0.5M
B.8 H-GI MMS	54	47	(8-10)	(1.3M)
B.9 H-GCR SC	Not solicited in ROSES17			
B.10 DRAFT ECIP	Not solicited, draft call released Dec. 17, comments received 1/19/18 To be solicited in ROSES18			
B.11 SW O2R	24	(3/30/18)	TBD	$1 M

Technology Development: HTIDeS & Sounding Rockets

- Created a dedicated SmallSat activity within HTIDeS for SmallSat investigations; separated from LCAS with approximately double the cost cap
- 18 Total HPD CubeSat investigations have been selected to date
  - One HPD CubeSat mission complete – MinXSS
  - Five HPD CubeSats scheduled for launch in 2018
- 2018 Sounding Rocket Launch Manifest
  - 22 NASA missions + four reimbursable missions
- Selections of new HPD missions to begin in 2018
  - Five HPD CubeSat
  - 15 HPD Suborbital; (13 Sounding Rockets, 2 Balloons)

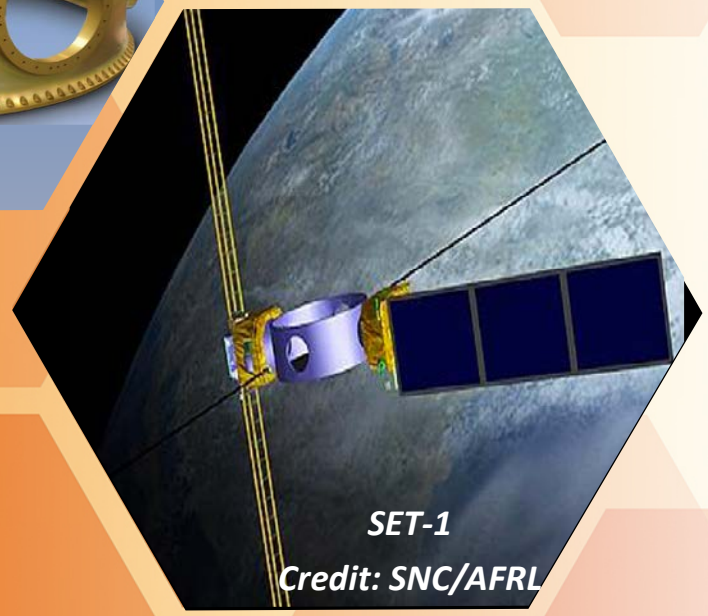
ROSES18

- ROSES18 HTIDeS restructured
  - LNAPP and ITD elements expanded selections via DRIVE
  - Research and Technology (R&T) Flight Program; in-line with NPR7120.8
    - ➢ Split LCAS:
      - CubeSats
      - LCAS (all sub-orbitals)
    - ➢ R&T Prime (Greater than 3.5M total cost)
      - Mandatory formulation study with down-select
- New Elements included in ROSES18 release:
  - B.8 GOLD and ICON Guest Investigator*
  - B.9 H Grand Challenges Research - Science Centers*
  - B.10 H Early Career Investigator Program
  - B.12 H Space Weather Operations to Research

* Element to be released

Poster Blowout 2018 at Goddard Space Flight Center

HPD Rideshare



- SMD has embraced Rideshare opportunities as a standard practice
- SMD has formed a rideshare policy team to develop standard rideshare processes.
- HPD working rideshare opportunity on IMAP consisting of 2 Missions of Opportunity (MoO)
  - Science MoO
  - Technology Demonstration MoO
- This rideshare opportunity is utilizing a standard (non-propulsive) ESPA Grande
- In support of rideshare, HDP is developing a mission-specific ESPA Systems Interface Specification

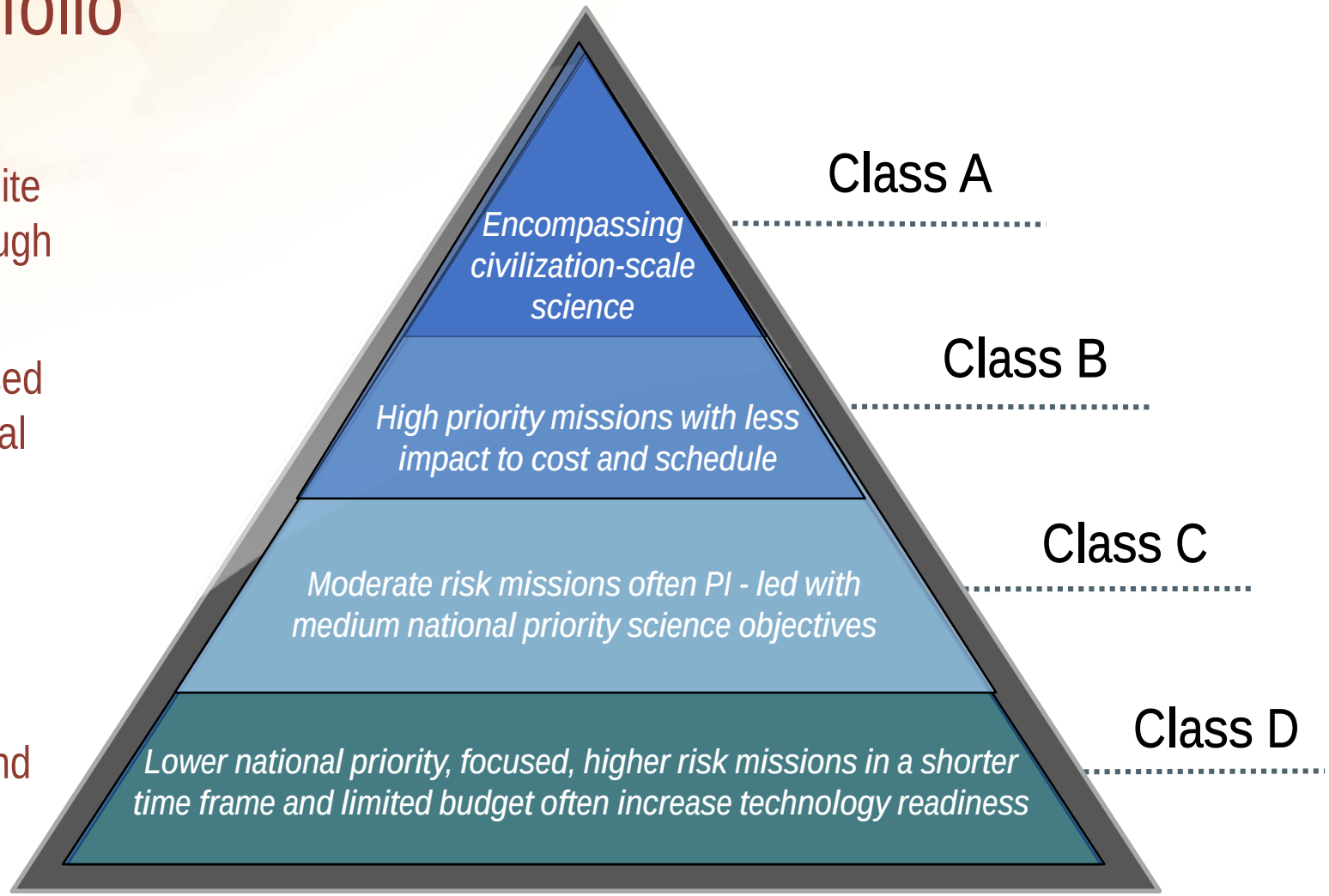
Enable by Innovation
Class D in the Portfolio

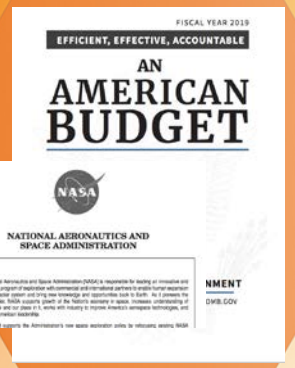
Expand science programs to take advantage of Class D and small satellite rapid innovation to achieve breakthrough science

Enable fast access to space for focused science measurements that fill a critical gap between large flight projects

Leverage technology investments to further improve potential of science instruments

Partner with international agencies and commercial entities to acquire new capabilities of small satellite platforms





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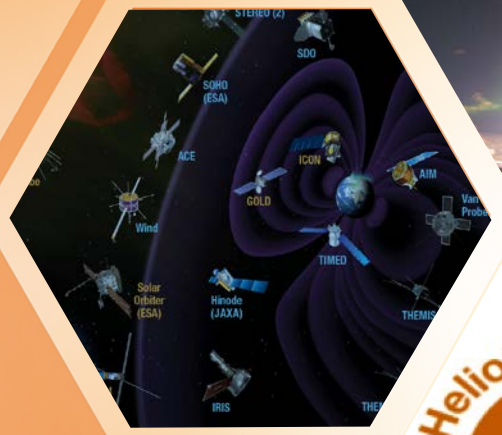

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Intra- and Interagency Partners

Planetary:

- Co-selected LWS grants; joint ROSES Juno Participating Scientist Program

Astrophysics:

- Joint “Impact of Stellar Properties on the Habitability of Exoplanets” research opportunity

NASA-NSF:

- Coordinating ICON & GOLD opportunities (joint NASA mission GI and NSF CEDAR solicitations)
- Science Centers

Additional NSF/NOAA/NASA collaboration previously described with space weather

International Partners

ESA:

- Solar Orbiter
- THOR-US was contingent on selection of ESA M5 mission

KASI:

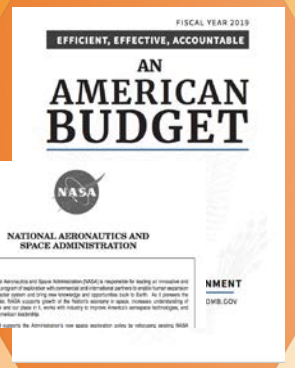
- Development towards prototype coronagraph for balloon flight, BITSE, in 2019; agreement signed October 2017

ISRO:

- Three sub-working groups established
  - 1) Aditya-1 mission collaboration
  - 2) space weather modeling
  - 3) long-term strategic collaboration focus areas

JAXA:

- Working with JAXA on approach for Next Generation Solar Physics Mission (NGSPM)



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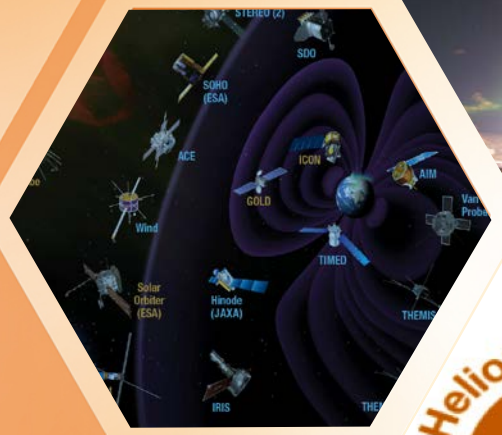

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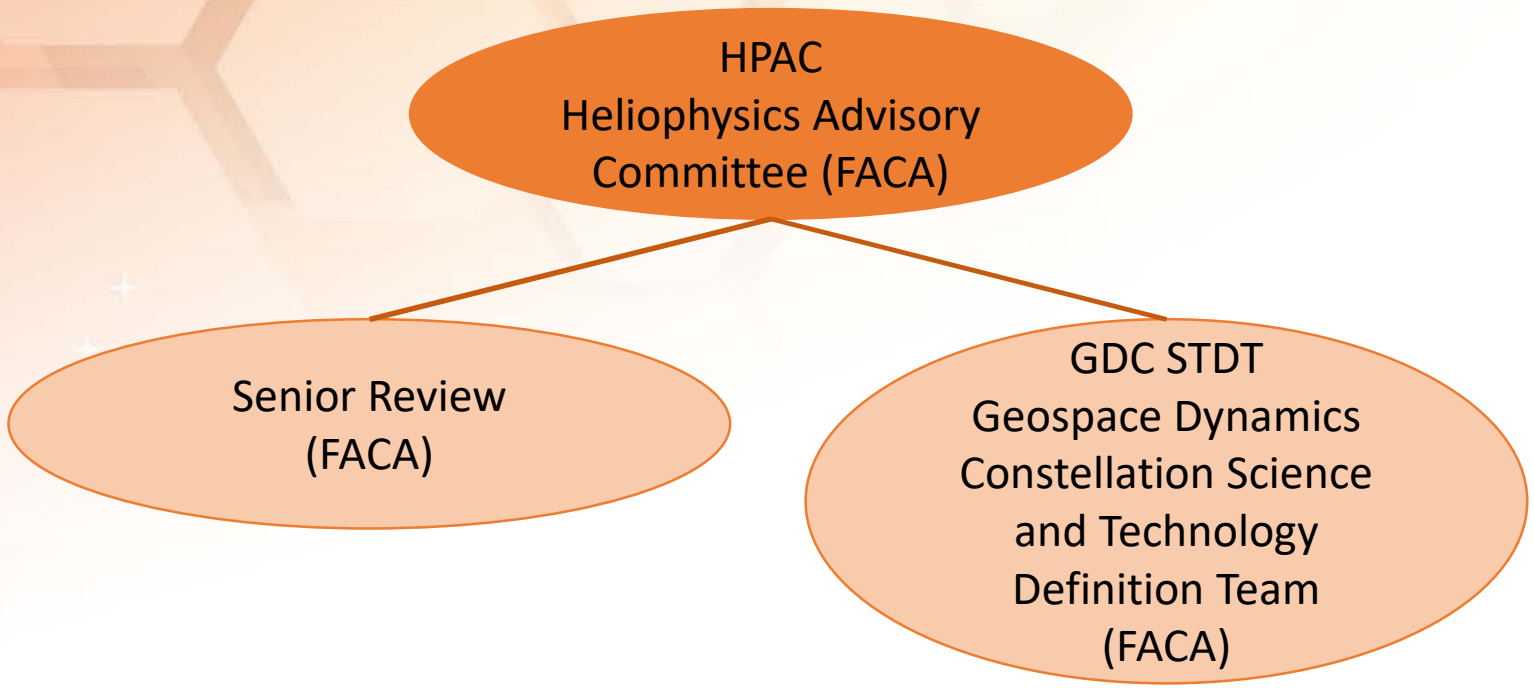
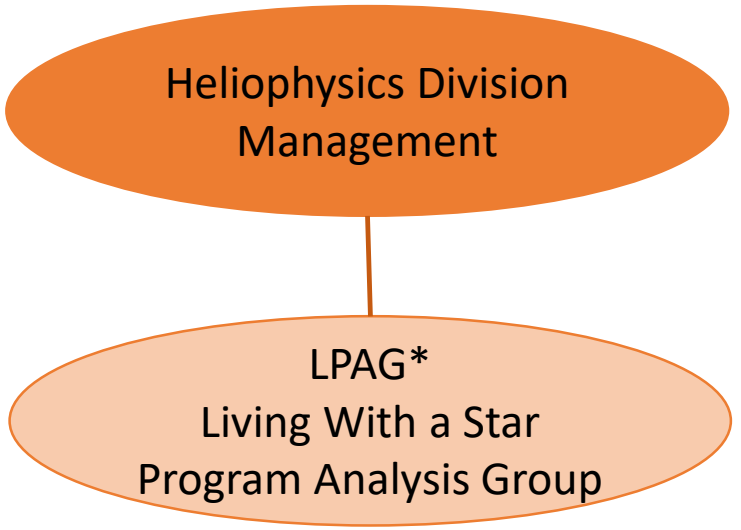
Heliophysics Advisory Committee and Sub-committees

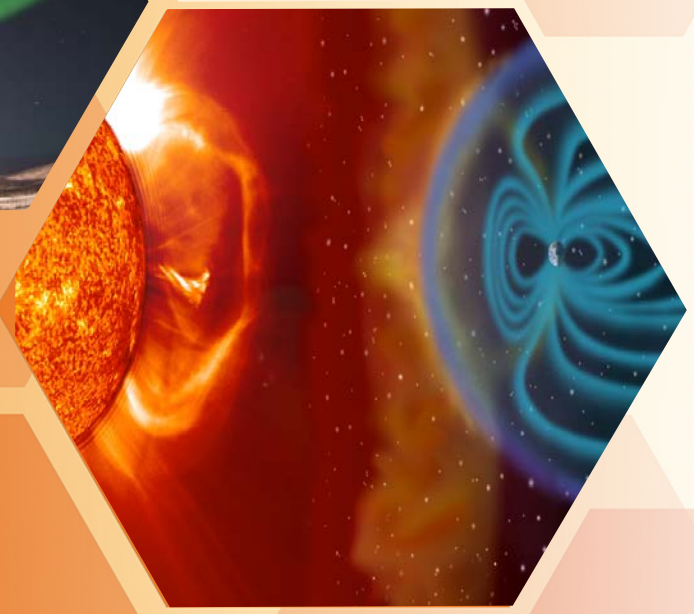




*At the request of HPD management, LPAG can provide reports to HPAC

Sampling of requirements for FACA meetings:

- Public meeting announcements 30 days in advance
- Requires members become Special Government Employees
  - Ethics training and financial disclosure forms
  - US Citizenship



Summary

- Heliophysics program is aligned with SMD strategic objectives:
  - Advance National Science and Exploration Goals
    - Heliophysics is a system science that seeks fundamental understanding and advances exploration
  - Safeguard and Improve Life
    - Space Weather budget increase will strengthen cross-agency collaboration on Research-to-Operations/Operations-to-Research initiatives
  - Execute a Balanced and Integrated Science Program
    - FY19 PBR provides for a balanced Heliophysics portfolio, including enhanced emphasis on small missions, technology development and expanded opportunities for R&A

BACKUP

Acronyms [1/4]

AA	Associate Administrator
ABC	Agency Baseline Commitment
ACE	Advanced Composition Explorer
AFRL	Air Force Research Laboratory
AIA	Atmospheric Imaging Assembly
AIM	Aeronomy of Ice in the Mesosphere
AO(s)	Announcement of Opportunity (Opportunities)
APL	Applied Physics Laboratory
APMC	Agency Program Management Council
ARTEMIS	Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun
BPR	Baseline Performance Review
Cat	Category
CCMC	Community Coordinated Modeling Center
CDF	Common Data Format
CEDAR	Coupling, Energetics, and Dynamics of Atmospheric Regions
CGMS	Coordinated Group for Meteorological Satellites
CINDI	Coupled Ion-Neutral Dynamics Investigations
CMC	Center Management Council
CME	Coronal Mass Ejection
COSPAR	Committee on Space Research
DEE	Data Environment Enhancements
DOE	Department of Energy
DPMC	Mission Directorate Program Management Council
DRIVE	Diversify, Realize, Integrate, Venture, Educate
DSX	Demonstration and Science Experiments
DXL	Diffuse X-rays from the Local Galaxy
ECIP	Early Career Investigator Program
EELV	Evolved Expendable Launch Vehicle
EPD	Energetic Particle Detector
ESA	European Space Agency
ESPA	EELV Secondary Payload Adapter
EUI	Extreme Ultraviolet Imager
EUV	Extreme Ultra-Violet
EVM	Earned Value Management
FACA	Federal Advisory Committee Act
FAST	Fast Auroral SnapshoT Explorer
FIELDS	Fields Experiment
FITS	Flexible Image Transport System
FOV	Field of View
FRR	Flight Readiness Review
FUV	Far Ultra-Violet
FY	Fiscal Year
GCR	Grand Challenge Research
GDC	Geospace Dynamics Constellation
GEM	Geospace Environment Modeling
GI	Guest Investigator
GOLD	Global-scale Observations of the Limb
GPRA	Government Performance and Results Act
GPRAMA	Government Performance and Results Act Modernization Act
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
H-TIDeS	Heliophysics Technology and Instrument Development for Science
HEC	High End Computing
HEK	Heliophysics Events Knowledgebase
HIS	Heavy Ion Sensor
HPAC	Heliophysics Advisory Committee
HPD	Heliophysics Division
HQ	Headquarters
HSCs	Heliophysics Science Centers
IAG	International Astronomical Union
IAGA	International Association of Geomagnetism and Aeronomy
IAMAS	International Association of Meteorology and Atmospheric Sciences
IAU	International Astronomical Union
IBEX	Interstellar Boundary Explorer
ICAO	International Civil Aviation Organization
ICAO	Committee on Earth Observing Satellites
ICON	Ionospheric Connection Explorer
IDL	Interactive Data Language
IMAP	Interstellar Mapping and Acceleration Probe

Acronyms [2/4]

IOC-UNESCO	Intergovernmental Oceanographic Commission - United Nations Educational, Scientific and Cultural Organization
IPA	Intergovernmental Personnel Act
IRIS	Interface Region Imaging Spectrograph
IS IS	Integrated Science Investigation of the sun
ISCU	International Council for Science
ISES	International Space Environment Service
ISFM	Internal Scientist Funding Model
ISRO	Indian Space Research Organization
ISWI	International Space Weather Initiative
ITD	Instrument and Technology Development
ITM	Ionosphere-Thermosphere-Mesosphere
IUGG	International Union of Geodesy and Geophysics
IUPAP	International Union of Pure and Applied Physics
IVM	Ion Velocity Meter
JAXA	Japan Aerospace Exploration Agency
JCL	Joint confidence level
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KASI	Korean Astronomy and Space Science Institute
KDP	Key Decision Point
KSC	Kennedy Space Center
LASP	Laboratory for Atmospheric and Space Physics

LCAS	Low Cost Access to Space
LCC	Life-Cycle Cost
LNAPP	Laboratory Nuclear, Atomic, and Plasma Physics
LPAG	LWS Program Analysis Group
LRD	Launch Readiness Date
LVRR	Launch Vehicle Readiness Review
LWS	Living With a Star Program
Mag	Magnetosphere
MAVEN	Mars Atmosphere and Volatile Evolution Mission
MDAA	Mission Directorate Associate Administrator
MIDEX	Medium-Class Explorers
MIGHTI	Michelson Interferometer for Global High-resolution Thermospheric Imaging
MMS	Magnetospheric Multiscale
MMS	Magnetospheric Multiscale Guest Investigators
MO&DA	Mission Operations and Data Analysis
MoO (MO)	Mission of Opportunity
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
NAC	National Advisory Committee
NAIRAS	Nowcast of Atmospheric Ionizing Radiation System

NAS	The National Academy of Sciences
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Informatio
NESSF	NASA Earth and Space Science Fellowship
NET	No Early Than
NGSPM	Next Generation Solar Physics Mission
NOAA	National Oceanic and Atmospheric Administration
NRA	NASA Research Announcement
NRC	National Research Council
NRL	Naval Research Laboratory
NSAC	National Science Advisory Committee
NSF	National Science Foundation
NSROC	NASA Sounding Rocket Operations Contract
NSRP	NASA Sounding Rocket Program
NSTC	National Science and Technology Council
O2R	Operations to Research
OATK	Orbital ATK
Ops	Operations
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
OSTP	Office of Science and Technology Policy
PBR	President's Budget Request
PCA	Program Commitment agreement
PDR	Preliminary Design Review
PE	Program Executive

Acronyms [3/4]

PFRR	Poker Flats Research Range
PHI	Polarimetric and Helioseismic Imager
PI	Principal Investigator
PP	Program Plan
PPBE	Planning, Programming, Budgeting, and Execution
PS	Program Scientist
PSP	Participating Scientists Program
PSR	Pre-Ship Review
R&A	Research and Analysis
R&T	Research and Technology
R2O	Research to Operations
RAPTOR	Research and Analysis Program Tracking of Resources
RFI	Request for Information
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
ROSES	Research Opportunities in Earth and Space Science
RPW	Radio and Plasma Waves
R_s	Solar Radii
SBIR	Small Business Innovation Research
SBTT	Small Business Technology Transfer
SC	Science Committee
SCAR	Scientific Committee on Antarctic Research
SCOSTEP	Scientific Committee on Solar Terrestrial Physics
SDAC	Solar Data Analysis Center
SDO	Solar Dynamic Observatory
SET	Space Environment Testbeds
SHINE	Solar, Heliosphere and INterplanetary Environment
SIR	System Integration Review
SIS	Suprathermal Ion Spectrograp
SMD	Science Mission Directorate
SME	Subject Matter Expert
SMEX	Small Explorers
SNOE	Student Nitric Oxide Explorer
SOC	Solar Orbiter Collaboration
SOHO	Solar and Heliospheric Observatory
SoloHi	Heliospheric Imager
SPASE	Space Physics Archive Search and Extract
SPDF	Space Physics Data Facility
SPICE	Spectral Imaging of the Coronal Environment
SR	Senior Review
SR	Supporting Research
SRPO	Sounding Rocket Program Office
STDT	Science and Technology Definition Team
STEREO	Solar Terrestrial Relations Observatory
STIX	X-ray Spectrometer/Telescope
STMD	Space Technology Mission Directorate
STP	Solar Terrestrial Probes
SW	Space Weather
SWA	Solar Wind Plasma Analyser
SWAP	Space Weather Action Plan
SWEAP	Solar Wind Electrons Alphas and Protons
SWORM	Space Weather Operations, Research, and Mitigation
SWPC	Space Weather Predication Center
SWRC	Space Weather Research Center
SwRI	Southwest Research Institute
TBC	To Be Confirmed
Tech	Technology
THEMIS	Time History of Events and Macroscale Interactions during Substorms
THOR	Turbulence Heating ObserveR
TIDeS	Technology and Instrument Development for Science
TIMED	Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics
TMS	Theory, Modelling and Simulations
ToF	Time of Flight
TPS	Thermal Protection System
TRL	Technology Readiness Level
TWINS	Two Wide-angle Imaging Neutral-atom Spectrometers
UCB	University of California - Berkeley
UFE	Unallocated Future Expenses
ULA	United Launch Alliance
UM	University of Michigan
UNCOPUOS	United Nations Committee on Peaceful Use of OuterSpace

Acronyms [4/4]

UNH	University of New Hampshire
URSI	International Union of Radio Science
USPI	United States Participating Investigator
UT	Universal time
VAP	Van Allen Probes
VSO	Virtual Solar Observatory
VxOs	Virtual x Observatory
WBS	Work breakdown structure
WFF	Wallops Flight Facility
WIGOS	WMO Integrated Global Observing System
WISPR	Wide-field Imager for Solar PRobe
WMO	World Meteorological Organization
WSMR	White Sands Missile Range