

National Aeronautics and  
Space Administration



# EXPLORESCIENCE

**Heliophysics Division: Updates &  
Opportunities, and Community Input  
Requests**

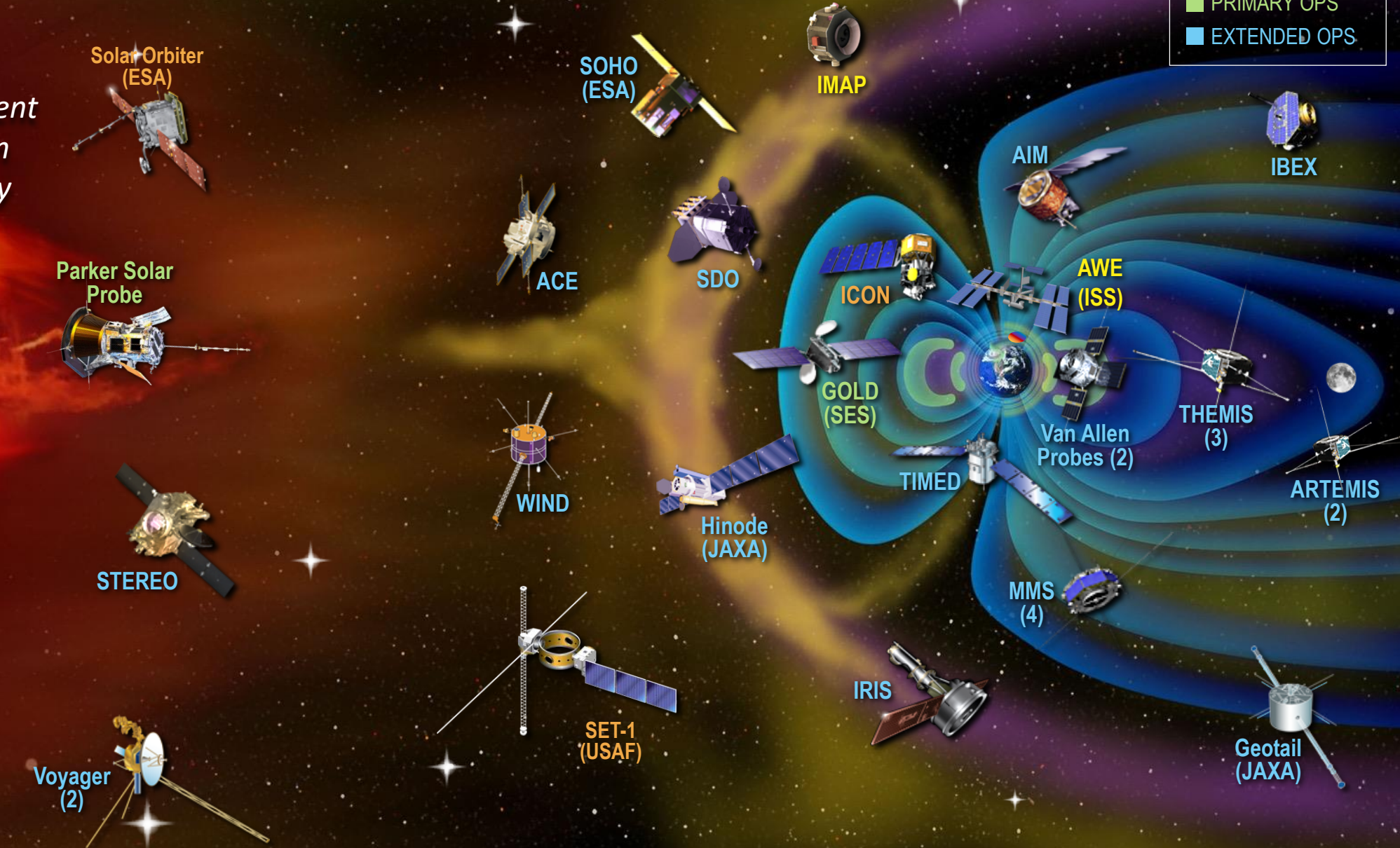
CEDAR June 2019



# Heliophysics System Observatory

■	FORMULATION
■	IMPLEMENTATION
■	PRIMARY OPS
■	EXTENDED OPS

- 18 Operating Missions with 26 Spacecraft
- 3 Missions in Development
- 1 Mission in Formulation
- 1 Mission of Opportunity in Formulation



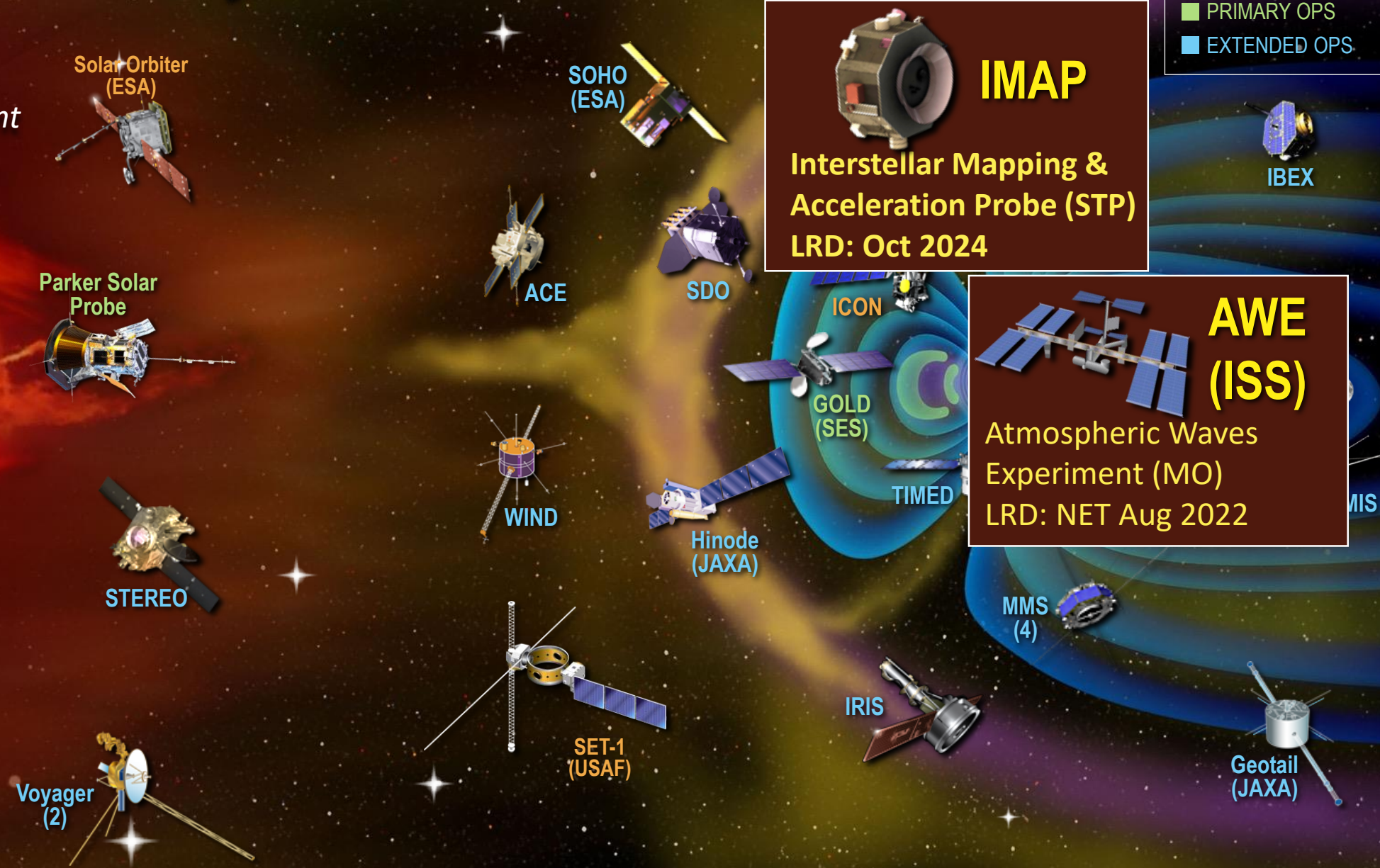


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**Formulation**





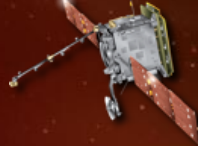
# Heliophysics System Observatory

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## Formulation

Solar Orbiter (ESA)



SOHO (ESA)



## IMAP

**Interstellar Mapping & Acceleration Probe (5<sup>th</sup> STP)**

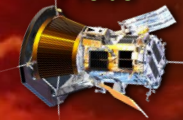
**Orbit:** around L1

**LRD:** Oct 2024

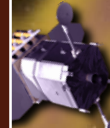
**Science:** Will investigate the acceleration of energetic particles and interaction of the solar wind with the local interstellar medium.

**Space Weather:** Will broadcast real-time in-situ space weather data

Parker Solar Probe



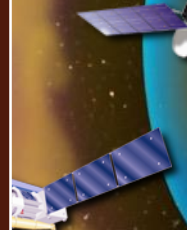
SDO



STEREO



Hinode (JAXA)



Voyager (2)



## AWE (ISS)

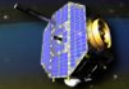
**Atmospheric Waves Experiment (MO)**

**LRD:** NET Aug 2022

**Orbit:** Mounted on ISS

**Science:** Will investigate how atmospheric gravity waves, including those generated by terrestrial weather, impact ITM energetics

IBEX



IS

ARTEMIS (2)



Geotail (JAXA)





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**Solar Orbiter (ESA)**  
LRD: February 2020

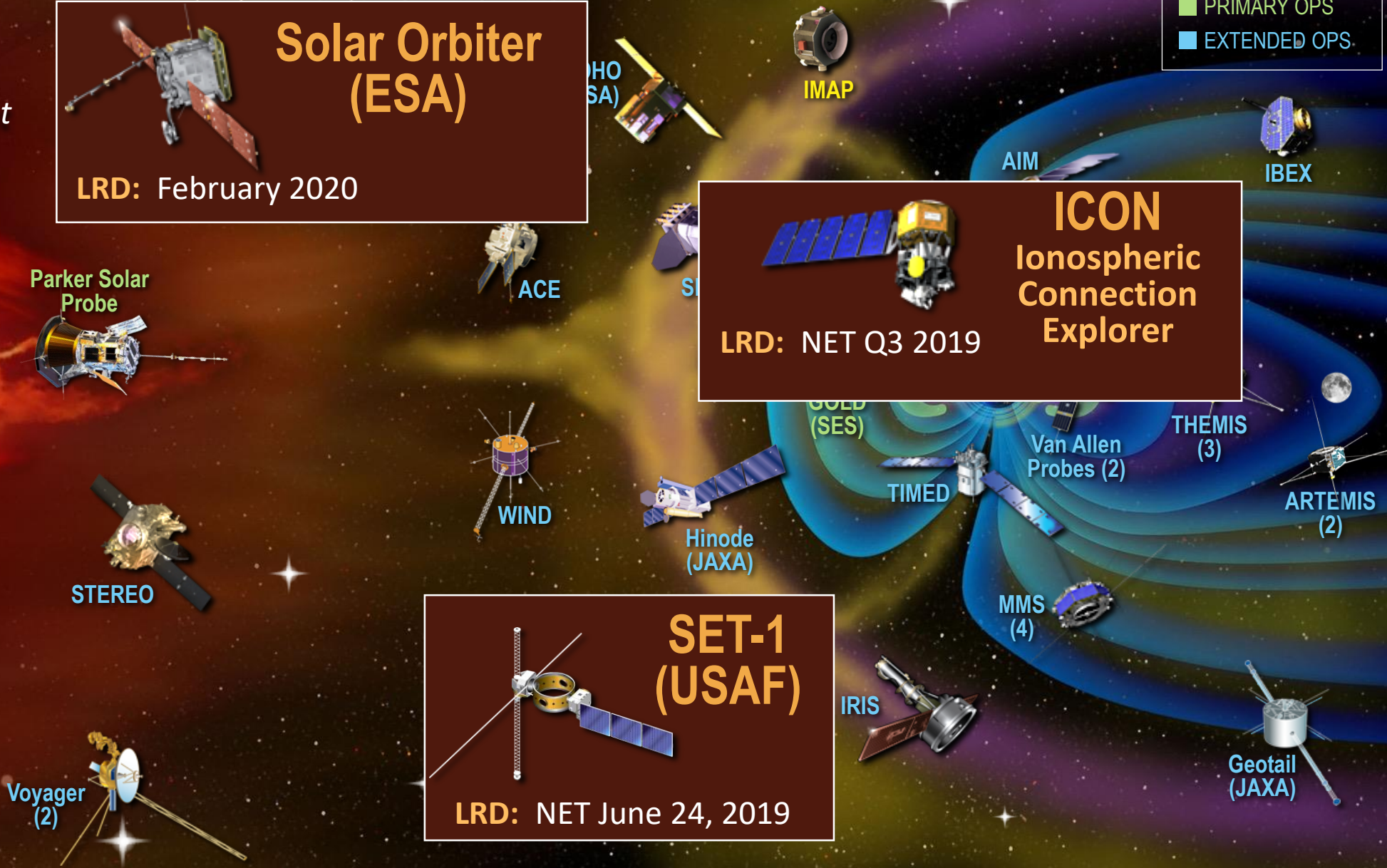


**ICON Ionospheric Connection Explorer**  
LRD: NET Q3 2019



**SET-1 (USAF)**  
LRD: NET June 24, 2019

## Implementation





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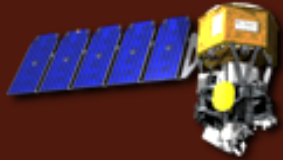
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## Implementation



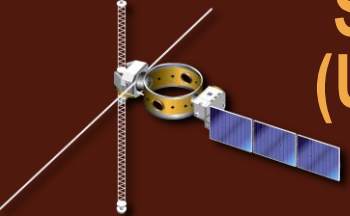
### Solar Orbiter (ESA)

**LRD:** February 2020  
**Orbit:** Elliptical orbit coming as close as 26 million miles from the Sun at times-- closer than Mercury.  
**Science:** In situ measurements alongside remote sensing close to the Sun to relate back to the source regions



### ICON Ionospheric Connection Explorer

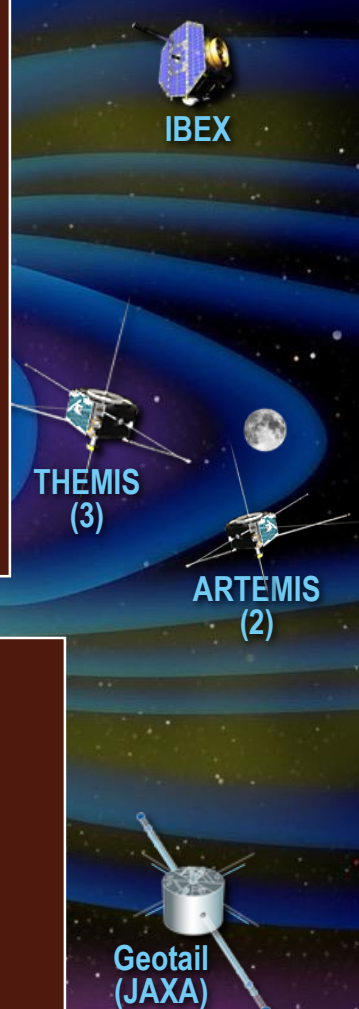
**LRD:** NET Q3 2019  
**Orbit:** 27-degree inclination , 575 km perigee  
**Science:** Will study the interaction between weather systems & space weather driven by the Sun, and how this interaction drives turbulence in the upper atmosphere



### SET-1 (USAF)

**Hosted Payload:** on AFRL DSX spacecraft using ESPA Ring  
**Science:** (1) VLF transmissions in the magnetosphere & feasibility of natural & man-made VLF waves to reduce space radiation; (2) Radiation environment in MEO; (3) Space weather effects on spacecraft electronics & materials

**LRD:** NET June 24, 2019



Voyag  
(2)

WIND

TIME



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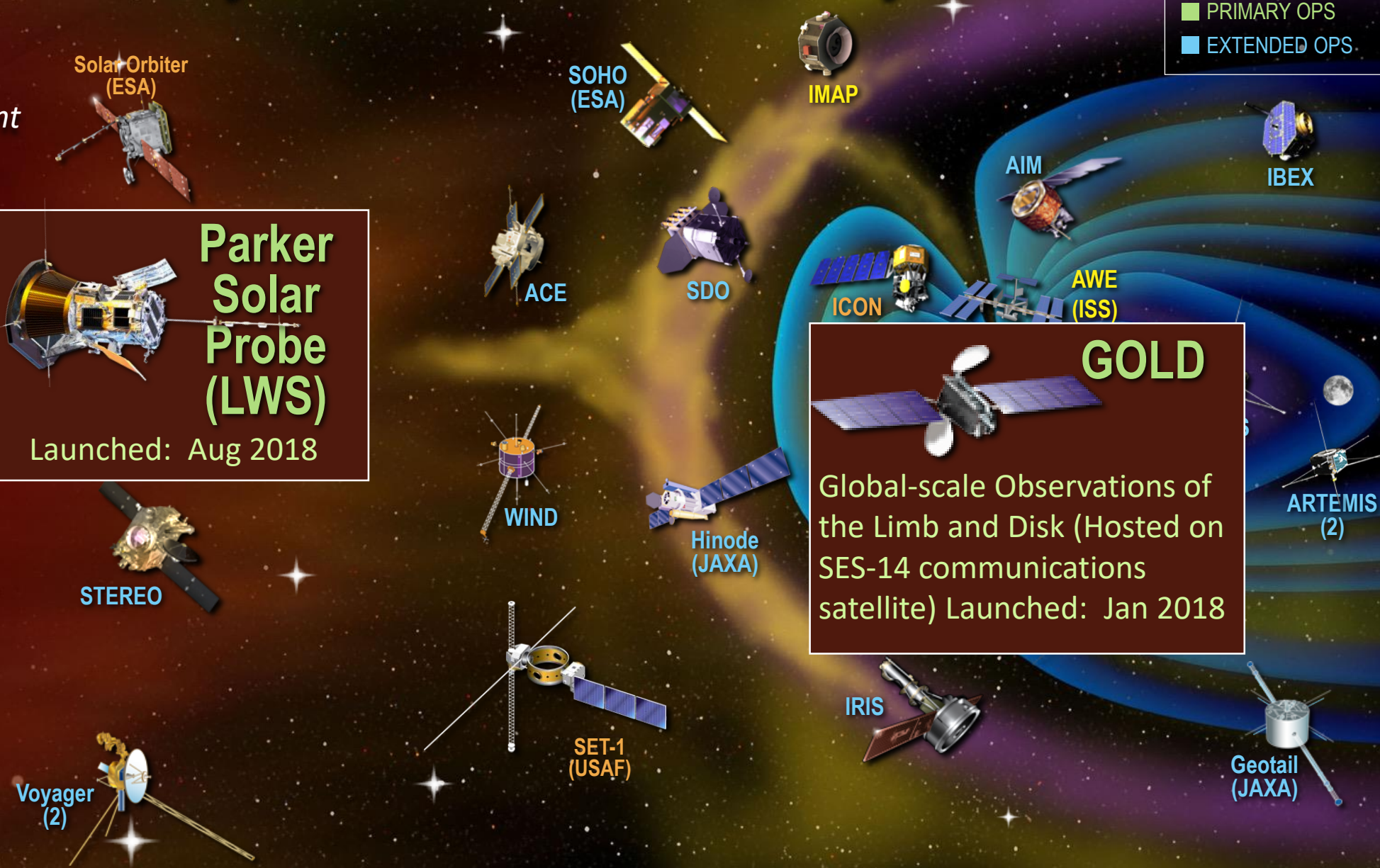
## Primary Ops



**Parker Solar Probe (LWS)**  
Launched: Aug 2018



**GOLD**  
Global-scale Observations of the Limb and Disk (Hosted on SES-14 communications satellite) Launched: Jan 2018





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Solar Orbiter (ESA)



SOHO (ESA)



IMAP

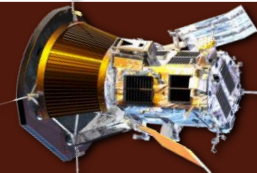
AIM



IBEX



## Primary Ops



### Parker Solar Probe (LWS)

**Launched:** Aug 2018  
**Orbit:** Repeated gravity assists at Venus to incrementally decrease perihelion to achieve a final altitude (above the surface) of ~ 8.5 solar radii  
**Status:** Completed 2 perihelion passes. Next one Sept 1, 2019  
**Science:** Assess the structure & dynamics of the Sun's coronal plasma & magnetic field, the energy flow that heats the solar corona & impels the solar wind, & mechanisms that accelerate energetic particles.



### GOLD

Global-scale Observations of the Limb & Disk

**Hosted on:** SES-14 communications satellite in geostationary orbit  
**Launched:** Jan 2018  
**Science:** Resolves temporal & spatial ITM responses to storms - not possible with historical or other current data. Enables advancing I-T models from climatological descriptions to space weather forecasting  
**Focus:** Effects on ITM of storms, solar EUV variability, atmospheric waves & tides from below & formation & evolution of equatorial plasma density irregularities.

T-1 (AF)

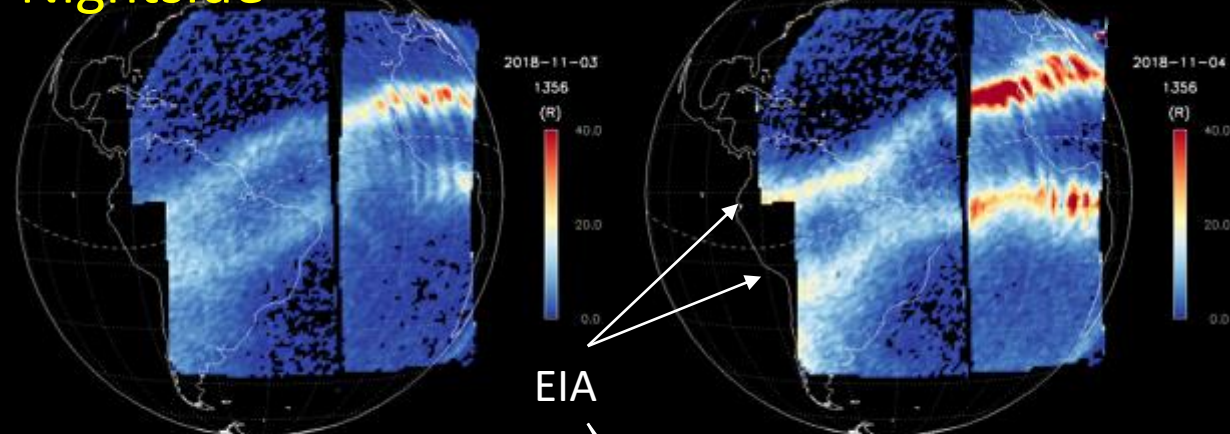




Nightside

Nov 3, 2018

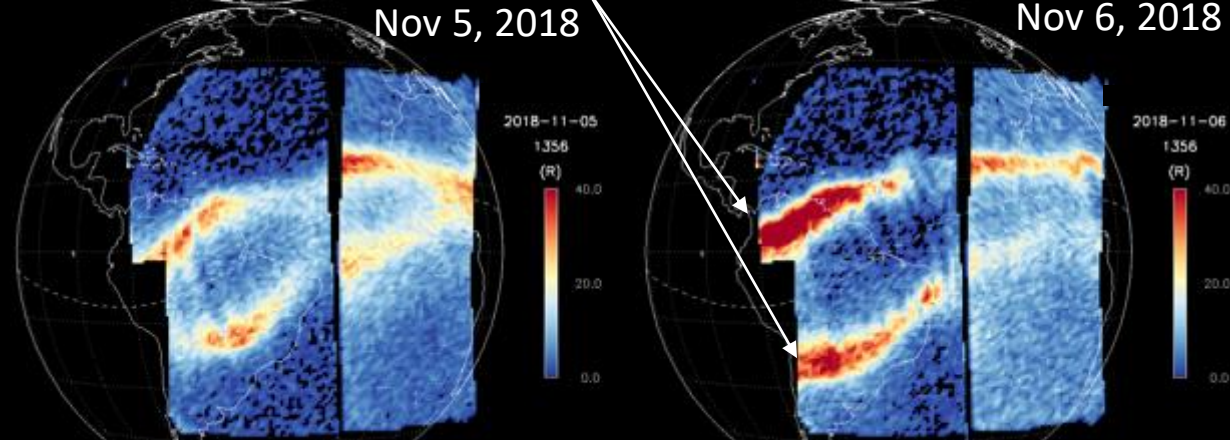
Storm Onset Nov 4, 2018



EIA

Nov 5, 2018

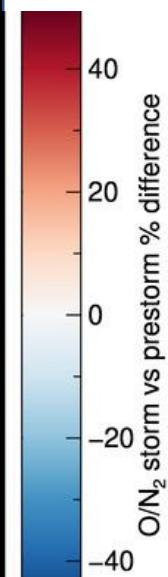
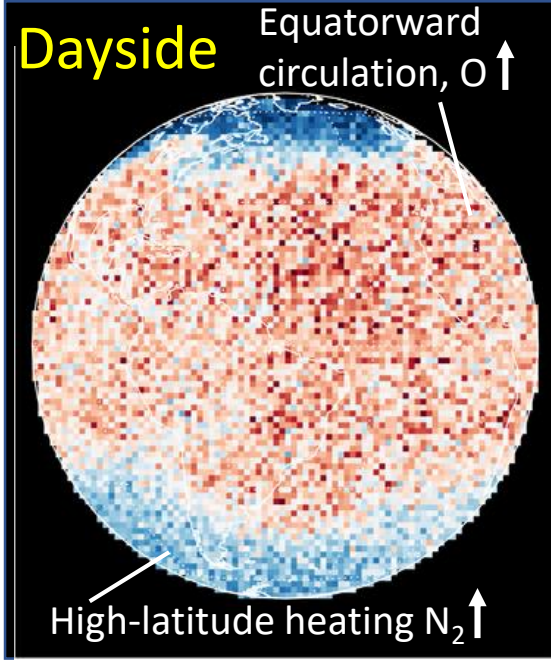
Nov 6, 2018



\*Bubbles seen as depletions in airglow

# GOLD view from GEO orbit allows unambiguous separation of spatial & temporal variability

Nov. 3 – Nov. 4 % change O/N<sub>2</sub> near 160 km (15 UT)



Resolves the temporal & spatial response to solar & geomagnetic inputs - not possible with historical or other current data.

- Global-scale, high-cadence UV images reveal how the EIA and plasma bubbles respond to geomagnetic activity. Capable of following the growth of individual bubbles.

- Enables advancing Ionosphere-Thermosphere models from climatological descriptions to space weather forecasting.
- Slide is about O/N<sub>2</sub>, but GOLD can track temperatures and composition as well.





# Future Missions & Opportunities



A decorative graphic on the left side of the slide features a curved, semi-circular frame containing various celestial bodies: a ringed planet (Saturn), a reddish planet (Mars), a large grey sphere (Moon), and the blue and white horizon of Earth. The background is a vibrant space scene with a bright sun, stars, and nebulae in shades of blue, green, and yellow.

# Geospace Dynamics Constellation

- Decadal Survey identified GDC as next LWS large strategic mission:
  - “...provide the first simultaneous, multipoint observations of how the ionosphere-thermosphere system responds to, and regulates, magnetospheric forcing over local and global scales...”
- Science and Technology Definition Team convened in May 2018
  - Discussions are limited to the science objectives and measurement requirements; no instrument-specific or mission implementation details
  - Study report expected to be delivered July 2019
- LRD anticipated NET 2029



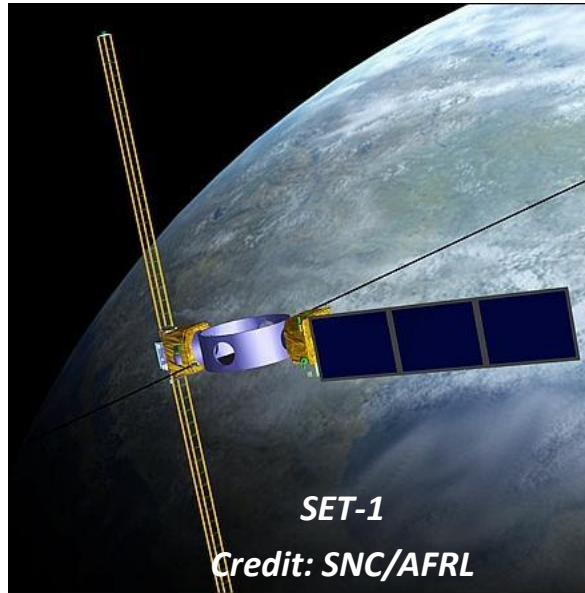
A decorative graphic on the left side of the slide. It features a curved, semi-circular shape containing a vibrant space scene. At the bottom, the blue and white horizon of Earth is visible. Above it, a bright yellow sun glows. Further up, a large, dark blue sphere (likely the Moon) is prominent. Other celestial bodies include a ringed planet (Saturn) and a reddish planet (Mars). The background is filled with a colorful nebula in shades of blue and green, and numerous white stars of varying sizes.

# Heliophysics Opportunities

- **MIDEX 19**
  - Draft AO release date: May 2019
  - Final AO release date: June 30 2019
  - PI managed Cost Cap: \$250M



# Future Rideshare Opportunities



- SMD has embraced rideshare opportunities as a standard practice to maximize mass to orbit
  - Enabling additional opportunities for science community
- SMD has finalized a Rideshare Policy
- Rideshare opportunities on IMAP ESPA Grande
  - Science MO SCM & Technology Demonstration MO SCM (*Mission of Opportunity, Small Complete Mission*)
  - NOAA Space Weather Follow-On
  - If there are open ESPA ports after the above missions are accommodated, they will be offered to other SMD investigations under new Rideshare Policy

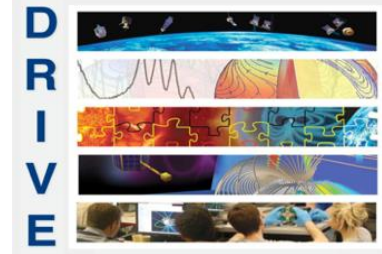




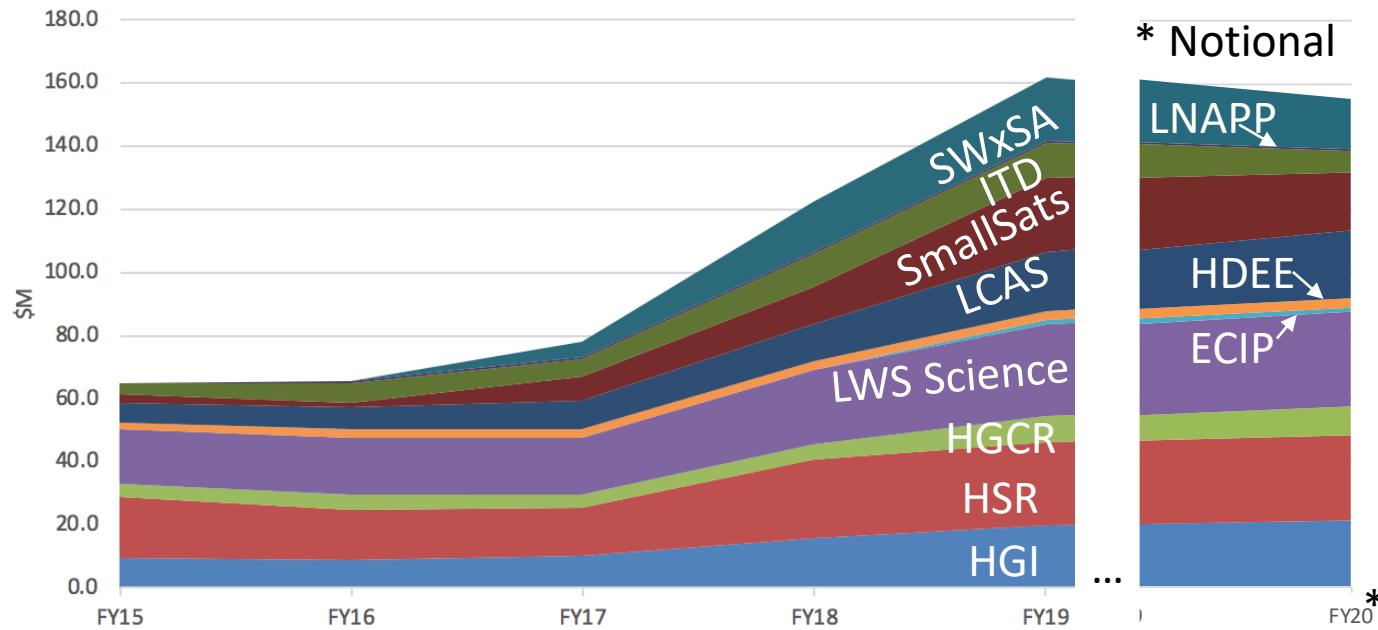
# Research



# Fully Funded DRIVE Program



Heliophysics Research



- Guest Investigator
- Grand Challenge
- Early Career
- Low Cost Access to Space (LCAS)
- Instrument Technology Development (ITD)
- Space Weather Science & Applications
- Supporting Research
- Living With a Star Science
- Data Enhancements
- SmallSats (including CubeSats)
- Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP)

Research DRIVE Elements included:

- **Technology:**
  - Low Cost Access To Space (LCAS): Sub-orbital and CubeSats
  - Instrument Technology Development (ITD) and LNAPP
- **Guest Investigator**
  - Open and Mission Focused
- **LWS Science**
- **Supporting Research**
- **Grand Challenge Research**
  - Including Heliophysics Science Centers
- **Early Career Investigator Program**



# Heliophysics Research



## ROSES 18 Solicitations

Program	Submission to Notify	# submitted	# selected	%
Guest Investigator	4 months	142	37	26.1%
Space Weather O2R	3 months	19	9	47.4%
Data Environment Enhancements	5 months	4	4	100%
Supporting Research	7 months	168	33	19.6%
Early Career Investigator	6.5 months	50	11	22.0%

Awarded

Open Solicitations

Program	NOI/Step-1 due date	proposal due date
Living with a Star	3/12/19	5/9/19
DRIVE Science Centers	3/1/19	6/20/19
2nd Space Weather O2R	3/12/19	5/16/19

## ROSES 19 Solicitations

- Supporting Research
- Guest Investigator Open
- Space Weather O2R
- Technology Inst Dev
- Flight Opportunities R&T
- LWS Strategic Capabilities
- Data Environment Enhancements
- Theory, Modeling and Simulations
- Outer Helio GI (**New**)
- Living With a Star
- US Principal Investigator
- HSO Connect (**New**)



# New ROSES 2019 Program

## Heliophysics System Observatory Connect

- Targeted opportunity to enhance science return from HSO.
- Diverse interdisciplinary teams working together to use the HSO as an end-to-end system.
- Advanced planning of coordinated observing campaigns, integration of data analysis activities, and modeling/simulations.
- Coordinated observations of PSP with:
  - currently operating space missions and ground-based observatories; and
  - observatories not yet launched, but expected to be operational with PSP, such as Solar Orbiter, ICON, Bepi-Colombo, and DKIST.
    - Step-1 proposals due ~ Oct. 2019
    - Step-2 proposals due ~ Dec. 2019





# Community Participation/Input Requests



## *Agile Responses to Short-Notice Rideshare Opportunities for the NASA Heliophysics Division*

a CEDAR Workshop hosted by the  
Committee on Solar and Space Physics (CSSP)  
Wednesday, June 19, 10AM – 12PM  
Santa Fe Hilton Hotel, Mesa B

- Everyone is welcome to attend
- Come learn about plans for a CSSP short report on *Agile Responses to Short-Notice Rideshare Opportunities for NASA HPD* and the CSSP call for community input
- After a brief presentation, the workshop will be an open discussion
- Please participate and contribute your ideas

Question: How to take advantage of short-notice rideshare opportunities:

1. What kinds of heliophysics science at what locations would be enabled by an agile response to rideshare opportunities?
2. What types of payloads are suited to these opportunities and why?

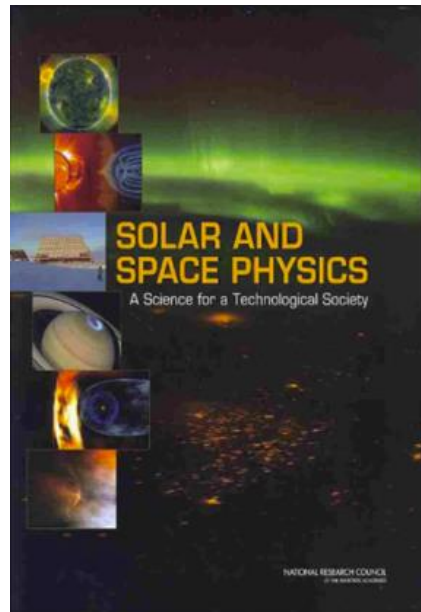
Rationale might include:

- Scientific value in single or multiple locations,
  - Ability to be rapidly deployed with short development times,
  - Ability to be shelved until a launch becomes available.
3. What should HPD consider as they develop and implement a new program that would allow agile responses to future short-notice rideshare opportunities?

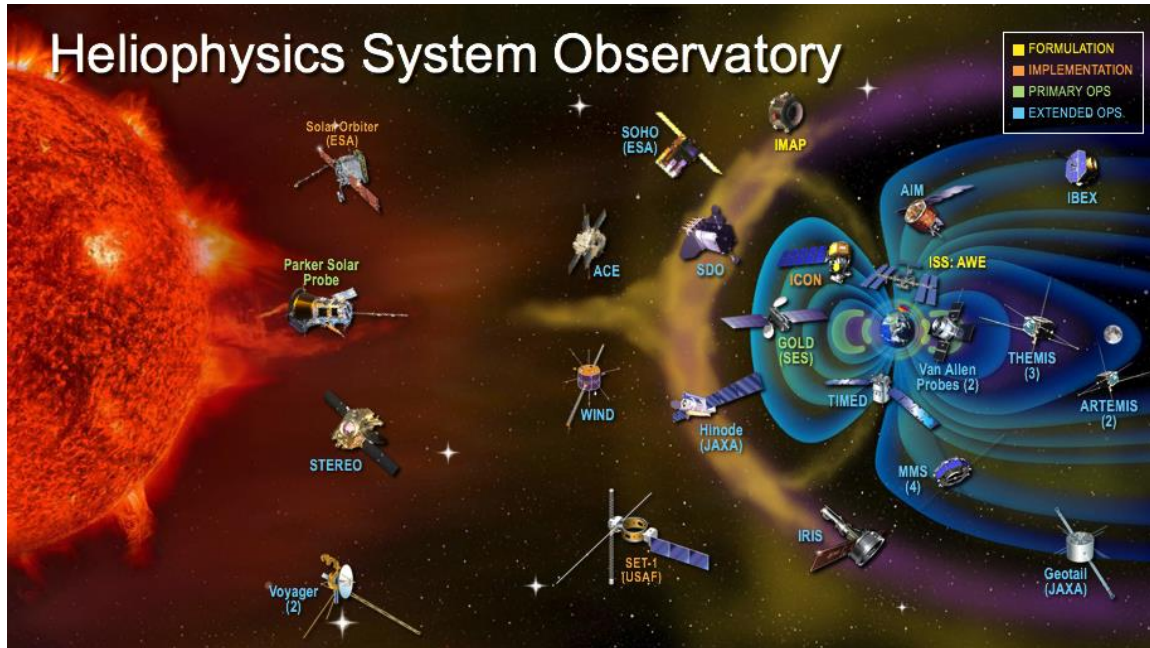


# Midterm Review of Progress Toward Implementing the Solar and Space Physics Decadal Survey Vision

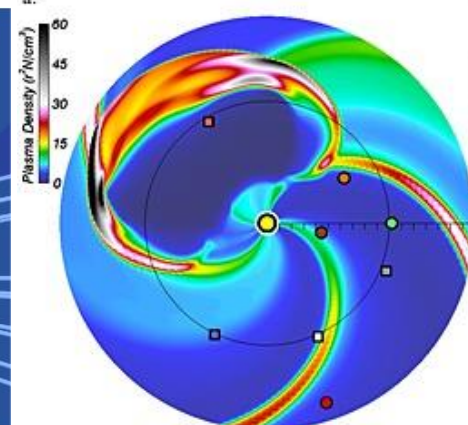
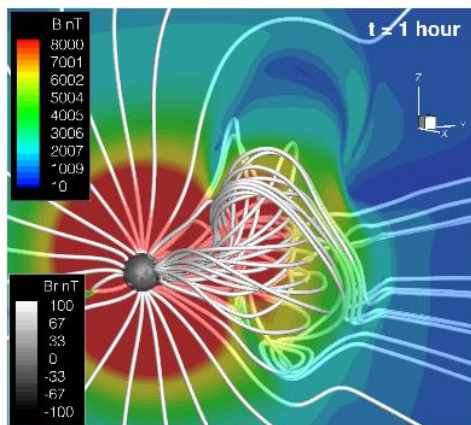
- National Academies has begun a Congressionally-mandated midterm review of progress on Decadal Survey recommendations
- For Information about the study, committee membership, upcoming meetings, and the study “statement of task,” visit [http://sites.nationalacademies.org/SSB/CurrentProjects/SSB\\_188088](http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_188088).
- Community input invited:
  - Via the committee’s mailbox: [ssp-midterm@nas.edu](mailto:ssp-midterm@nas.edu)
    - Most helpful if received prior to August 10
    - Note: Messages circulated to the committee will become part of a document file that will be accessible upon request to any member of the public.
  - Or during Town Halls and/or Poster Sessions at several summer conferences including:
    - **CEDAR 2019** in Santa Fe. Town Hall workshop: "CEDAR and the Decadal survey" -- Wednesday, June 19 from 1:30–3:30 pm.
    - GEM 2019 in Santa Fe. Town Hall -- Monday, June 24 from 5:00-6:00 pm, and Poster on Tuesday evening.
    - SHINE 2019 in Boulder (Aug 5-9): Poster in Session TBD



# Whole Helio Initiative



- Coordinated observation and theory-modeling program covering full breadth of heliophysics **across agencies and disciplines**
- Coordinate Parker, Daniel K. Inouye Solar Telescope (DKIST), Solar Orbiter, & other space, suborbital & ground-based assets
- Track the transit of features through interplanetary space
- Observe and characterize the geospace response
- Integration of theory and modeling throughout solar system and beyond
- Test Run called “Whole Heliosphere and Planetary Interactions” (WHPI) led by Sarah Gibson and Barbara Thompson (<https://whpi.hao.ucar.edu/>)







**THANK YOU!**

The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half shows a similar starry field but with a warm, golden-yellow and greenish glow, suggesting a different nebula or a different spectral filter. The word "Backup" is centered in a white horizontal band.

# Backup





# Investments in Next Generation of Heliophysicists

# Early Career Investigator Program (ECIP) – ROSES18



**Haihong Che**  
University of Alabama, Huntsville



**Michael Hartinger**  
Space Science Institute



**Seth Dorfman**  
Space Science Institute



**McArthur Jones**  
Naval Research Lab



**Weichao Tu**  
West Virginia University

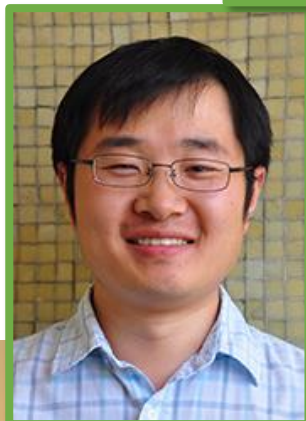


**Christina Kay**  
Catholic University of America



**Maria Kazachenko**  
University of Colorado, Boulder

- Solar
- Helio
- Mag
- ITM



**Xiangning Chu**  
University of Colorado, Boulder



**Kristopher Klein**  
University of Arizona



**Raluca Ilie**  
University of Illinois, Urbana-Champaign



**Reka Winslow**  
University of New Hampshire, Durham





*Students working on RockSat-X payload*



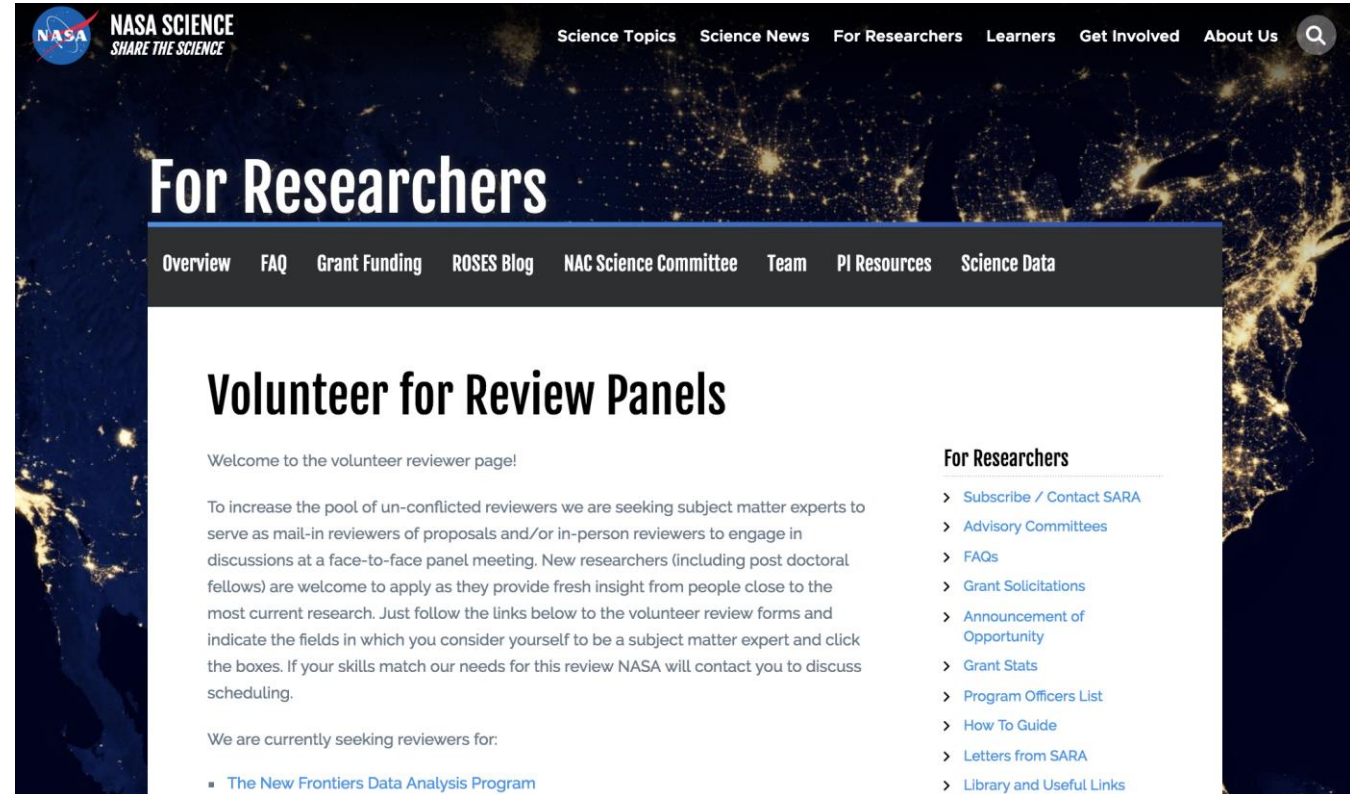
*FDL 2018 team*

# Investments in Future Heliophysics Leaders

- 6 current Jack Eddy Fellows
- 12 NASA Earth and Space Science Fellowship (NESSF) in 2018
  - Future Investigators in NASA Earth and Space Science and Technology (FINESST) replaces the 2019 NESSF call
- 33 students participated in Heliophysics Summer School 2018
- 100+ student participated in RockSat-X sounding rocket
  - launched Aug 13, 2018
- 28 early career professionals took part in Frontier Development Lab in 2018
- IMAP Heliophysics Future Leaders Program
  - Scientists are paired with diverse and high-achieving grad students and post-docs
- IMAP Student Collaboration CubeSat Development
  - University of New Hampshire teaming with Howard University
- RockOn 2019
  - 88 students. Launch NET 6/20

# Volunteer for a Proposal Review Panel!

- We rely on community participation to help with the R&A program's review panels – and we have a full schedule each year.
- This is your chance to see the process in action and provide feedback.
- SARA helps with the solicitation process; please click the link to the right and volunteer for a proposal review panel.



The screenshot shows the NASA Science website's 'For Researchers' page. The header includes the NASA logo and 'NASA SCIENCE SHARE THE SCIENCE'. Navigation links include Science Topics, Science News, For Researchers, Learners, Get Involved, and About Us. The main heading is 'For Researchers', with sub-navigation for Overview, FAQ, Grant Funding, ROSES Blog, NAC Science Committee, Team, PI Resources, and Science Data. The main content area is titled 'Volunteer for Review Panels' and contains a welcome message, a paragraph explaining the need for reviewers, and a list of current opportunities, including 'The New Frontiers Data Analysis Program'. A sidebar on the right lists various resources for researchers.

**For Researchers**

- > [Subscribe / Contact SARA](#)
- > [Advisory Committees](#)
- > [FAQs](#)
- > [Grant Solicitations](#)
- > [Announcement of Opportunity](#)
- > [Grant Stats](#)
- > [Program Officers List](#)
- > [How To Guide](#)
- > [Letters from SARA](#)
- > [Library and Useful Links](#)

<https://science.nasa.gov/researchers/volunteer-review-panels>



# HELIO CONNECTS through Science

We want to share your research! Tell us when you...

- Submit a paper
- Know about an upcoming mission event (ie, 1000 orbits for MMS)
- Do outreach events: school visits, press interviews, stakeholder interactions, etc.

We feature your research via numerous outlets:

- Sharing with the public
  - Internet: [NASA.gov/sunearth](https://www.nasa.gov/sunearth) and [blogs.nasa.gov/sunspot](https://blogs.nasa.gov/sunspot)
  - Social media: Twitter, Facebook, Instagram, Snapchat, etc.
  - Imagery: Videos, visualizations, infographics
- Highlights to NASA leadership: Monthly Science Review
- Media: Press briefings and releases

Let us know at: [bit.ly/SubmitHelioScience](https://bit.ly/SubmitHelioScience)

A screenshot of the NASA website's news section. The main article is titled "FIREBIRD II and NASA Mission Locate Whistling Space Electrons' Origins" dated Nov. 15, 2017. Below the title, it says "Scientists have long known that solar-energized particles trapped around the planet are sometimes scattered into Earth's upper atmosphere where they can contribute to..." and "hurling these energetic electrons on their way witness first hand both the impulsive electro...". To the left, there are "Latest" and "Related" sections with thumbnails for "NASA Detects Solar Flare Pulses at Sun and Earth", "Parker Solar Probe Comes to NASA Goddard for Testing", "Return of the Comet: 96P Spotted by ESA, NASA Satellites", and "Atmospheric Beacons Guide NASA Scientists in Search for Life".

A screenshot of the NASA Sun & Space Twitter profile. The profile name is "NASA Sun & Space" with handle @NASASun. The bio says "17 NASA missions explore the Sun and how it affects space around Earth and other worlds — key knowledge to protect astronauts, satellites, and robotic missions." It lists "NASA Goddard, Greenbelt, MD" and "nasa.gov/sunearth". There are 9,589 tweets, 1,647 following, 101K followers, 1,411 likes, and 15 lists. A tweet from NASA Sun & Space is visible, mentioning "Scientists found that pulses in Earth's ionosphere mirrored X-ray oscillations observed during a solar flare".

An infographic titled "Atmospheric Beacons Guide NASA Scientists in Search for Life". It features a background image of a planet with a bright orange sun. The text explains that new heliophysics research proposes a novel approach to sniffing out exoplanet atmospheres. It states that frequent stellar storms create fluctuating electric waves that scatter particles into space, which cool and form clouds. This process highlights signs of life by breaking down molecules into simpler ones like hydroxyl, methane, and carbon dioxide. The infographic also mentions that these beacons can be detected with current resources and that the study used an Earth science model to calculate how much nitric oxide and hydroxyl would form and how much ozone would be destroyed in an Earth-like atmosphere around an active star.

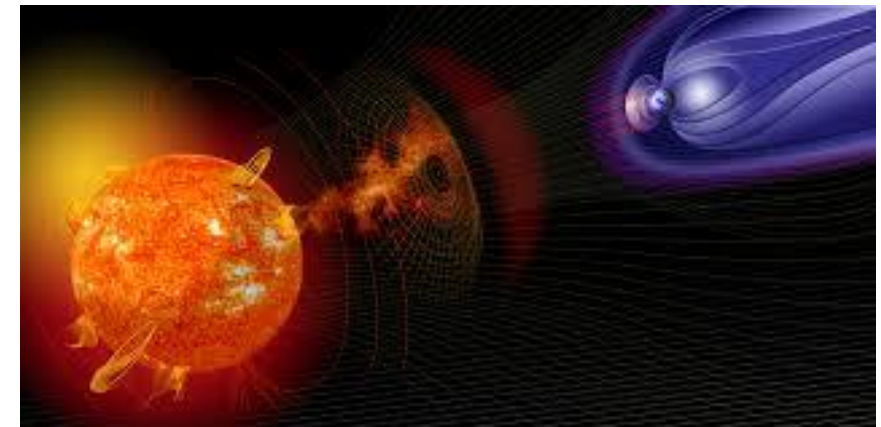
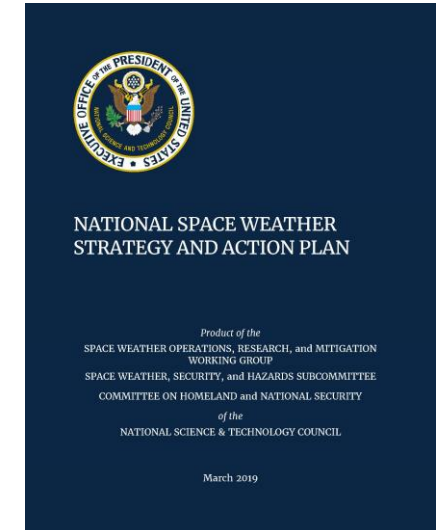
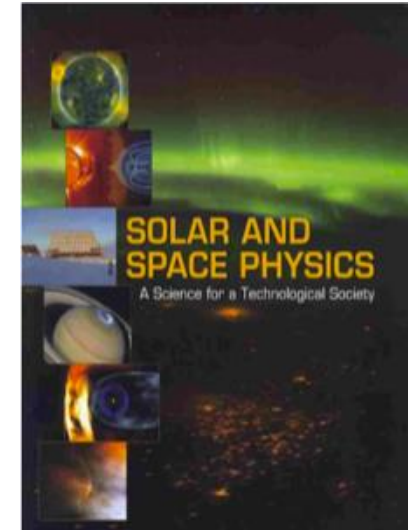


# Space Weather



# Space Weather Science and Applications (SWxSA)

- Establishes an expanded role for NASA in space weather science under single budget element
  - Consistent with the recommendation of the NRC Decadal Survey and the OSTP/SWORM 2019 National Space Weather Strategy and Action Plan
- **Competes** ideas and products, **leverages** existing agency capabilities, **collaborates** with other agencies, and **partners** with user communities
- Distinguishable from other heliophysics research elements in that it is specifically focused on investigations that significantly advance understanding of space weather and then apply this progress to enable more accurate characterization and predictions with longer lead time
- Transition tools, models, data, and knowledge from research to operational environments



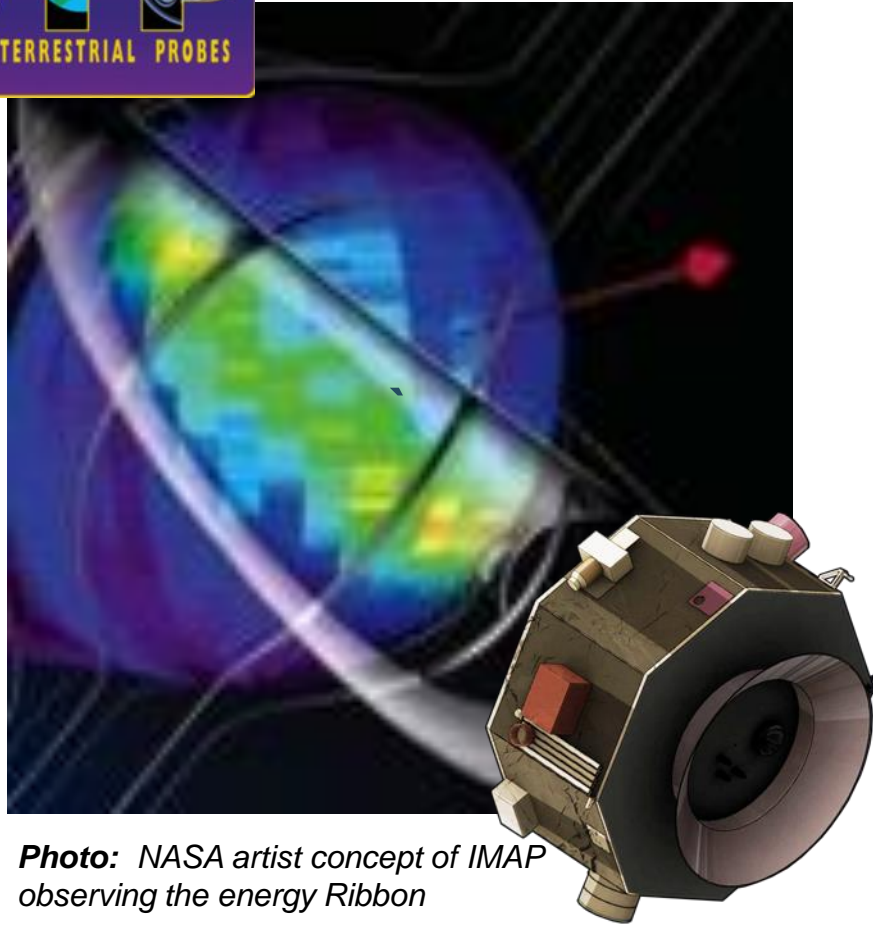
A vibrant, stylized illustration of outer space. It features a large, dark blue planet with a prominent ring system (resembling Saturn) in the upper left. Below it is a smaller, reddish-brown planet. In the center, a large, dark blue sphere (possibly the Moon) is visible. The background is filled with a colorful nebula in shades of blue, green, and yellow, and numerous bright stars. A white, curved line sweeps across the scene from the top left towards the bottom right, separating the image from the text area.

# Ongoing Steps for SWxSA

- Develop the NASA Heliophysics Space Weather Science and Applications Strategic Plan
- Develop with Human Exploration & Operations Mission Directorate (HEOMD) a lunar space environment capability to safeguard human and robotic explorers beyond low-earth-orbit
- Explore options for
  - Strategic instrument development
  - Robust multipurpose space weather package for rideshare opportunities
- Secure counsel of community expertise through the Heliophysics Advisory Committee
- Work in concert with the OSTP Space Weather Operations, Research, and Mitigation (SWORM) Working Group and in accordance to the 2019 National Space Weather Strategy and Action Plan (NSW-SAP)



# Interstellar Mapping and Acceleration Probe (IMAP)



*Photo: NASA artist concept of IMAP observing the energy Ribbon*

**Mission Line:** Solar Terrestrial Probes; selected June 1, 2018

**LRD:** October 2024

**Project Scientist:** David McComas of Princeton University

- Project Management and Mission Operations Center at Johns Hopkins University's Applied Physics Laboratory in Laurel, Maryland

**Orbit:** L1 Lagrangian point

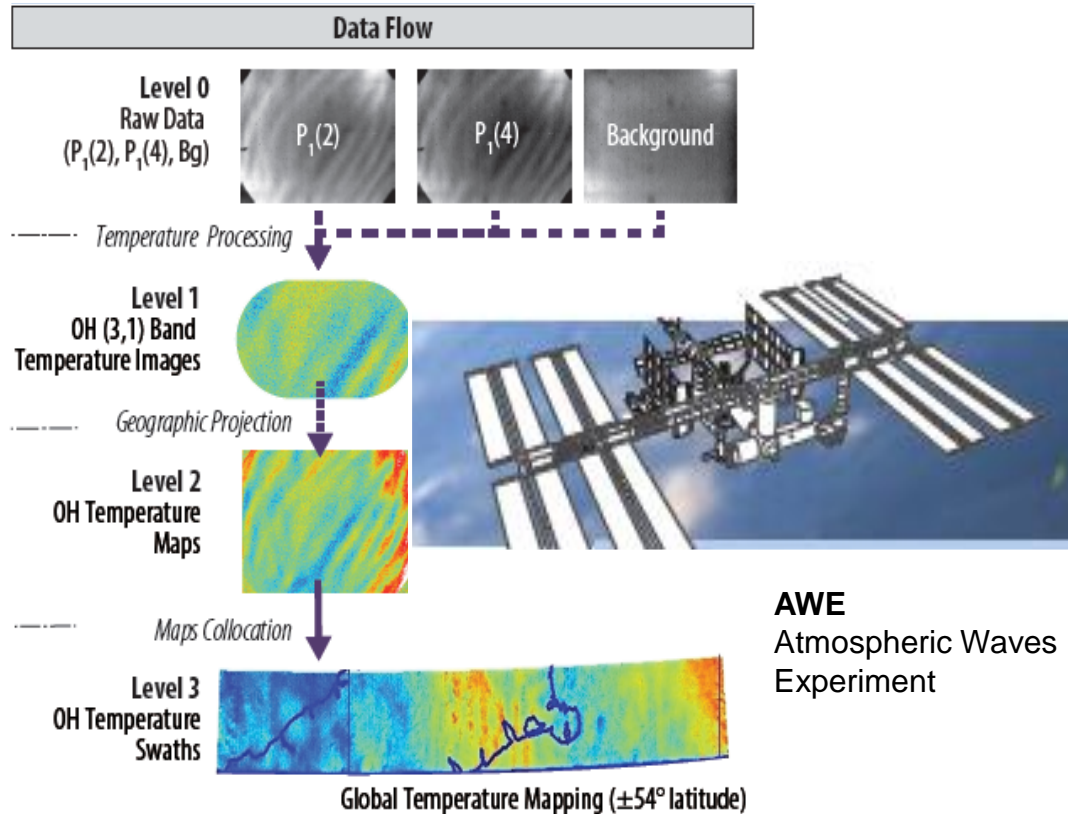
**Description:**

- Sample, analyze, and map particles streaming to Earth from the edge of interstellar space.
- Investigate the generation of cosmic rays in the heliosphere and beyond.
- 10 scientific instruments
- Investigating possible accommodation of a Tech Demo ins

**Rideshare opportunities on the ESPA Grande:**

- Competitive Missions of Opportunity including Tech Demo and Science
- NOAA Space Weather Follow-On L-1

# Atmospheric Waves Experiment (AWE)



- **Mission Line:** Explorer Mission of Opportunity
- **LRD:** NET Aug. 2022
- Attached to the exterior of the ISS
- PI: Mike Taylor, Utah State University
- AWE will focus on airglow to determine what combination of forces drive space weather in the upper atmosphere
- Will investigate how atmospheric gravity waves, including those generated by terrestrial weather, impact the transport of energy and momentum from the lower atmosphere into near-Earth space.



# Ionospheric Connection Explorer (ICON)



**Mission Line:** Explorers

**Launch Vehicle:** Pegasus XL rocket

**Launch Site:** Cape Canaveral

**LRD:** NET 3<sup>rd</sup> Quarter 2019

**ICON Principal Investigator:** 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.

**Next Step:** *Awaiting launch*

# Solar Orbiter Collaboration (with ESA)



**Mission Line:** Living With Star

**Launch Vehicle:** U.S. provided Atlas-V 411

**Launch Site:** Cape Canaveral

**LRD:** Feb. 2020

**Solar Orbiter Collaboration Project Scientist:** Chris St. Cyr

## U.S. Provided Instruments:

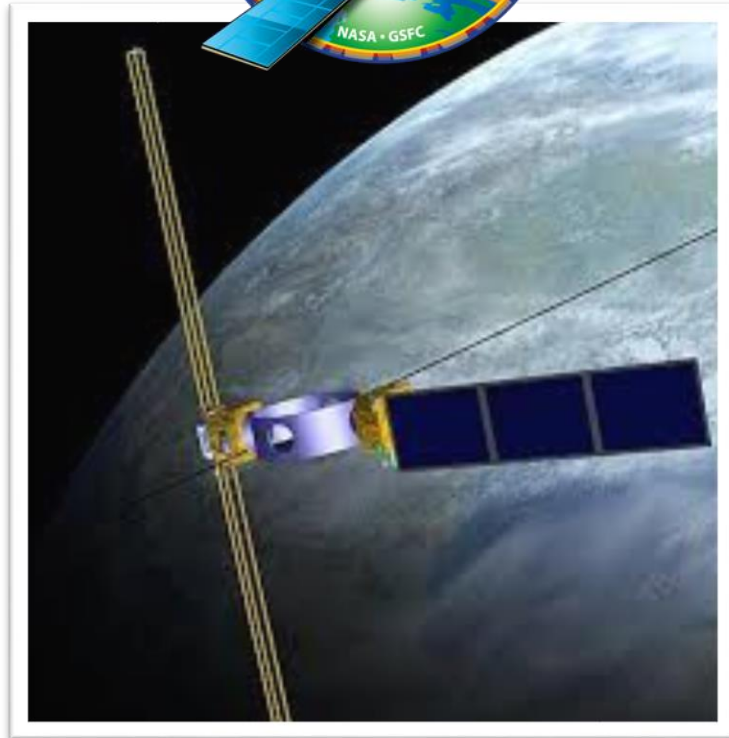
- HIS (Heavy Ion Sensor), part of SWA, and SoloHI (Heliospheric Imager)

## 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.



# Space Environment Testbed (SET-1) Mission



**Mission Line:** Living With a Star

**Launch Vehicle:** Falcon Heavy

**Launch Site:** KSC

**LRD:** NET June 24, 2019

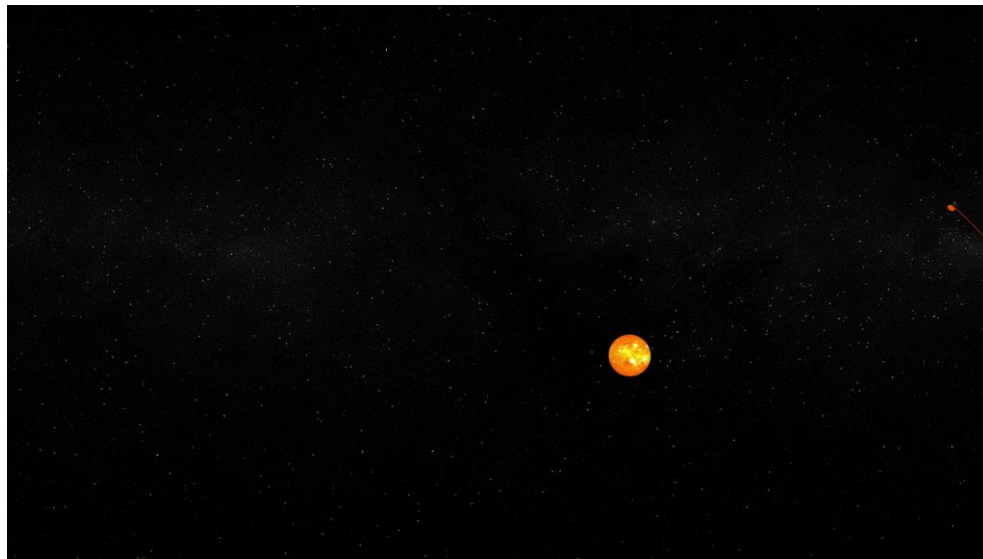
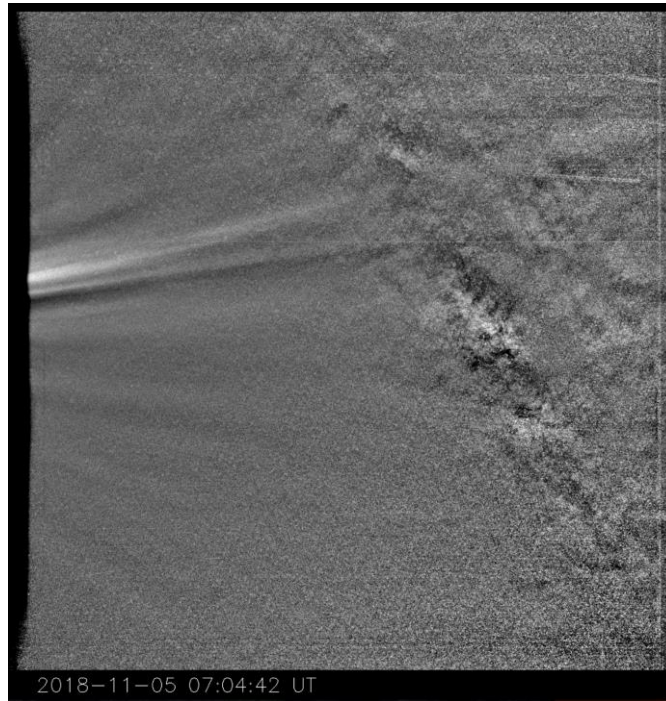
**Observatory:** SET-1 hosted payload on Air Force Research Laboratory (AFRL) Demonstration and Science Experiments (DSX) spacecraft

## **Description:**

- 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



WISPR image from Nov 5, 2018 showing a complex streamer structure being obscured by the Milky Way



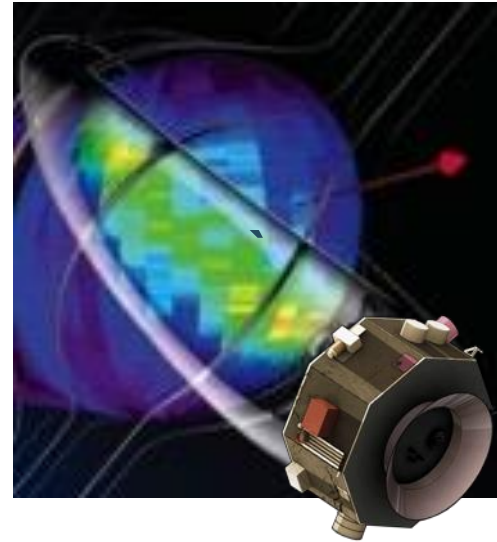
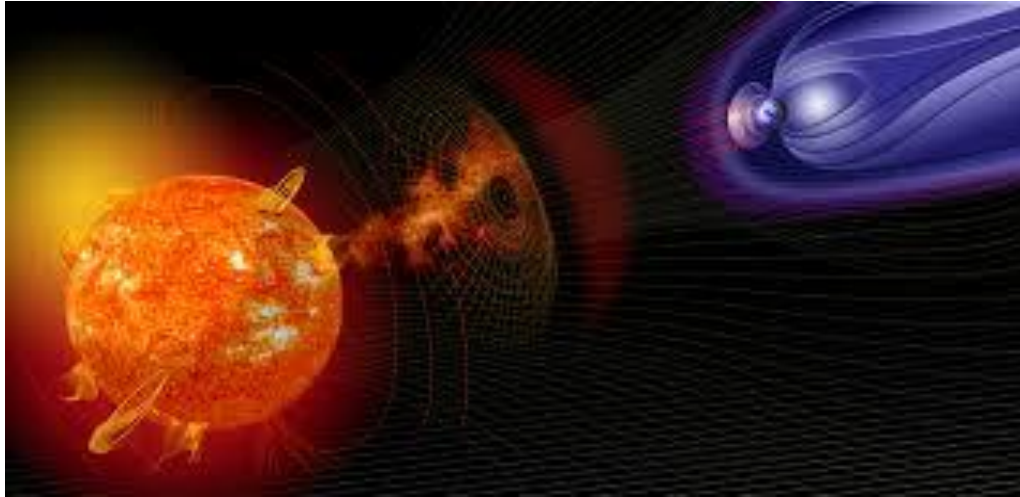
## HSO

# Parker Solar Probe

- First Solar Encounter performed Oct 31–Nov 11 2019
  - Minimum perihelion of  $\sim .17$  AU occurred on Nov. 5, and max speed of 213,200 mph
- Second Solar Encounter performed Mar 30–Apr 10 2019
  - Minimum perihelion occurred on Apr. 4
- Data from orbit 1 and 2 downlinked in April 2019
- Perihelion #3: September 1, 2019
- **Data release: November 2019**
- Venus Flyby #2: December 26, 2019
- Perihelion #4: January 29, 2020
  - Minimum perihelion of  $\sim 0.13$  AU with max speed of 224,200 mph
- Parker performance sufficiently characterized to reduce the RF margin as well as increase instrument on time and data production.



# It is a Great Time to be a Heliophysicist!



- HPD launched its most ambitious mission ever to touch the Sun (Parker), and the first NASA instrument aboard a commercial satellite (GOLD)
  - both within budget and on schedule
- New Missions of Opportunity selected and solicited
- Blazing a trail with enhanced ride share program
- Established the genesis of a Space Weather Science and Applications (SWxSA) in collaboration with sister federal agencies, academia, and industry
- Fully funded Decadal-proposed DRIVE initiative with provisions for early career, technology, diverse elements
  - Equals a very healthy R&A program!
- Instituted a strategic approach following the Decadal Survey recommendations
- Unique opportunity to study the Sun and its effects throughout the Heliosphere