NASA Heliophysics Space Weather Science and Applications Program: Opportunity & Impact

James Spann

Space Weather Lead, Heliophysics Division

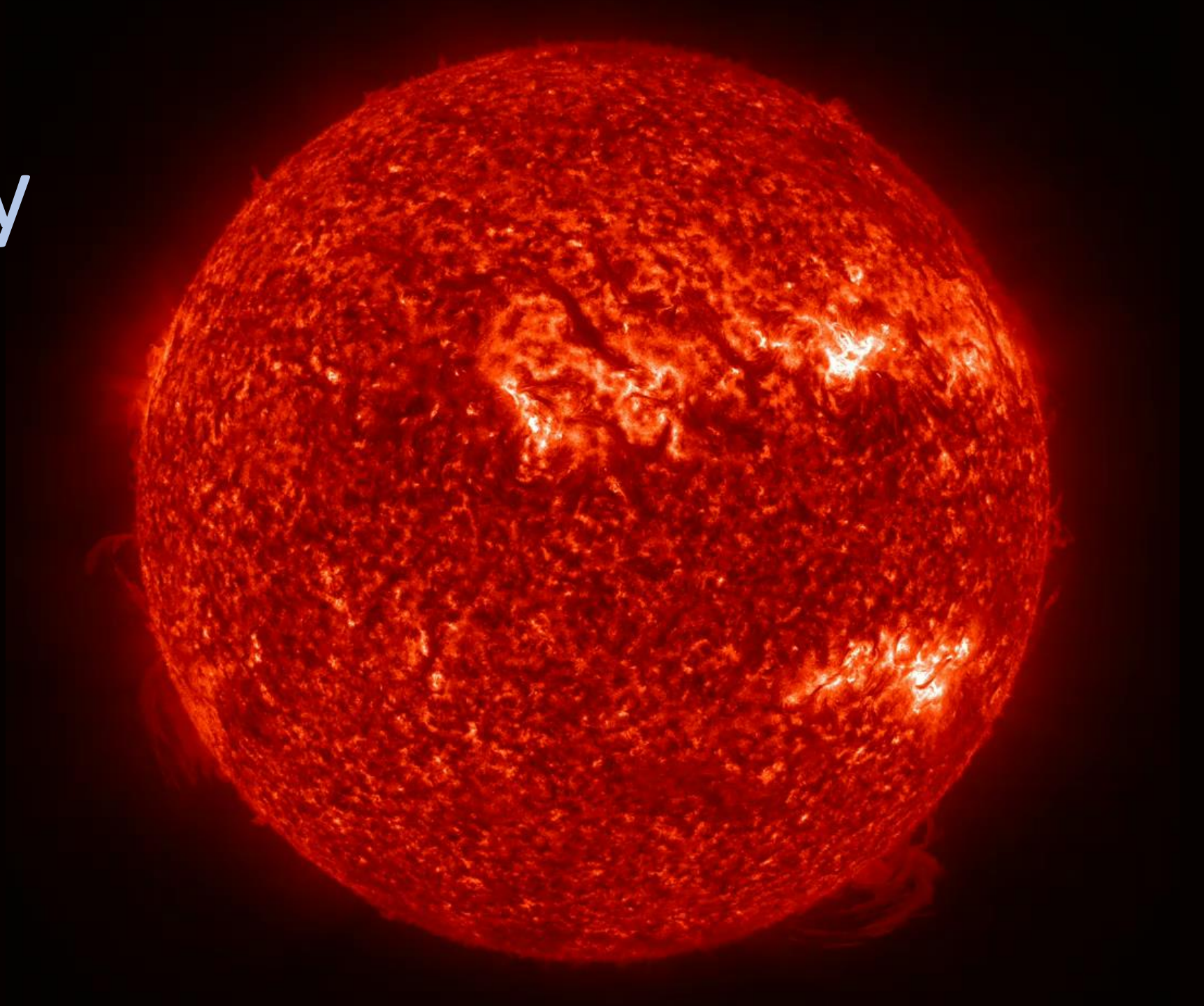
2019 Space Weather Workshop

April 3, 2019

Opportunity & Impact

- Sun-Earth-Solar System Coupled Science
  - Heliophysics System Observatory Evolution
- Access to Space
  - Small Spacecraft
  - Launch Accessibility
- National Space Weather Strategy and Action Plan
  - Space Weather Science and Applications (SWxSA)
  - Exploration Beyond Near-Earth Space

Opportunity & Impact



Opportunity & Impact

Overview

- Space Weather Science and Applications Program
  - Research
  - Infrastructure
  - International and Interagency Partnerships
- New Initiatives
  - Whole Helio Month campaigns
  - NASA Science Mission Directorate Rideshare policy
  - Heliophysics and the Lunar Gateway

NASA Heliophysics Research and Analysis*

* Not included are the investigations of the Heliophysics Technology Instrument Development for Science (HTIDeS) and the 18 operating missions

Space Weather Science and Applications (SWxSA)

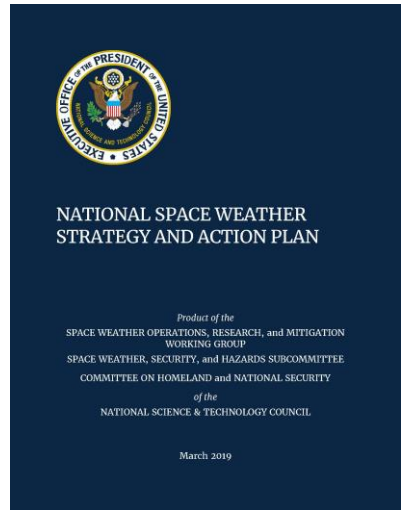
SWxSA Goals

- Support investigations and facilitate related activities in concert with other Heliophysics Division programs, that significantly advance understanding and enable improved characterization and prediction of space weather
- Transition tools, models, data, and knowledge from research to operational environments

Space Weather Science Applications Program

Establishes an expanded role for NASA in space weather science under single budget element

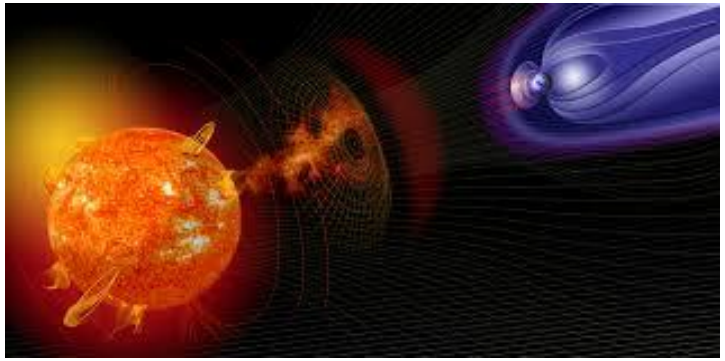
- Consistent with recommendation of the NRC Decadal Survey and the OSTP/SWORM 2019 National Space Weather Strategy and Action Plan

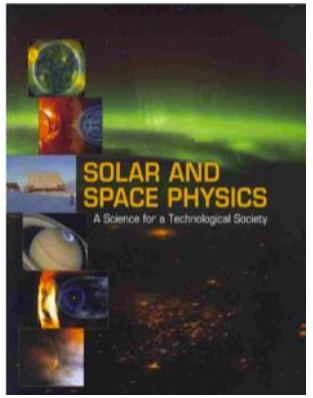


Competes ideas and products, leverages existing agency capabilities, collaborates with other national and international agencies, and partners with user communities

Three main areas of the Space Weather Science Applications Program are:

- Collaboration
- Competed Elements
- Directed Components





SWxSA Strategy

- Implement and manage SWxSA at an agency level as a program with various sub-elements such as competed opportunities and directed efforts
- Leverage internal agency capabilities and collaborations/partnerships with academia, research institutions, industry, other federal agencies, and international space agencies
- Secure the council 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)
- Develop with HEOMD a space weather capability to safeguard human and robotic explorers beyond low-earth-orbit

SWxSA Investigations

SWxSA is 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 predictions with longer lead time.

Space Weather Science Applications Program

3 calls were made between ROSES 2017 and ROSES 2018 in Space Weather Operations-to-Research (SWO2R)

- 8 selections made for ROSES 2017 SWO2R
  - Focus: Improve predictions of background solar wind, solar wind structures, and CMEs
- 9 selections made for ROSES 2018 (1) SWO2R
  - Focus: Improve specifications and forecasts of the energetic particle and plasma encountered by spacecraft
- ROSES 2018 (2) SWO2R selections upcoming:
  - Focus: Improve forecasts of solar energetic particles and heavy ions

Small Business Innovation Research (SBIR) Program for Space Weather

- 2018 - Selected two Phase 1 proposals – evaluation for Phase 2 option in progress
  2019 –Phase 1 proposals received

Space Weather Science Applications Program

Investments in improving Infrastructure

- CCMC enhancement for model assessment and transition
- High-End Computing capability to enable large scale predictive modeling development

Next Steps Benchmarking Activity beginning

- Community input to the update of the Space Weather Action Plan Benchmarks (Winter)
- Geoff Reeves (LANL) will chair community steering group

  Overseen by the Science and Technology Policy Institute, supported by NSF funding

  - Logistics provided by NASA
- Workshop hosted spring/summer where draft document created
- Town Hall in Fall 2019 for final document release

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-NOAA (MOU):

- Collaboration between CCMC and NOAA/SWPC on space weather modeling capability
- Co-funding O2R proposals
- Accommodation for SWFO mission on IMAP launch

NASA-NSF (MOU):

- Coordinating ICON & GOLD opportunities (joint NASA mission GI and NSF CEDAR solicitations)
- Consulted on solicitation design for Science Centers
- Co-funding CCMC
- New opportunity focused on Computational Aspects of Space Weather

NASA-NSF-NOAA (MOU):

- Pilot O2R research activity, MOU

NASA-USGS:

- NASA collaborating with USGS to enable Magneto-Telluric Survey in southwest

International Partners

Next Steps for SWxSA

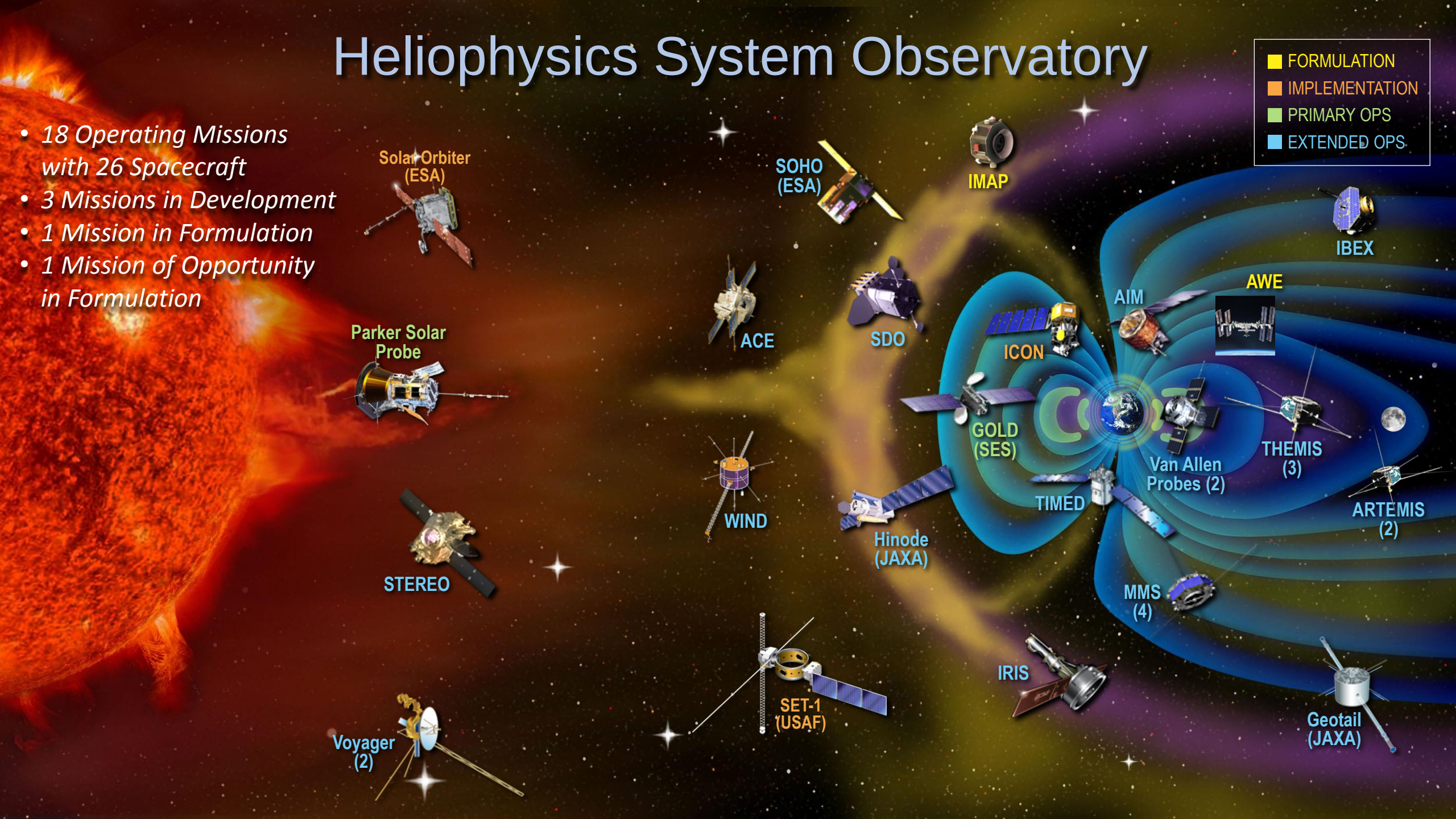
- Develop the NASA Heliophysics Space Weather Science and Applications Strategic Plan
- Coordinate with HEOMD in support of exploration of the Moon and beyond
- Explore options for
  - Strategic instrument development
  - Robust multipurpose space weather package for rideshare opportunities

New Initiatives in Heliophysics

- Whole Helio Month
- Heliophysics Rideshare
- Heliophysics and the Lunar Gateway

Heliophysics System Observatory

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

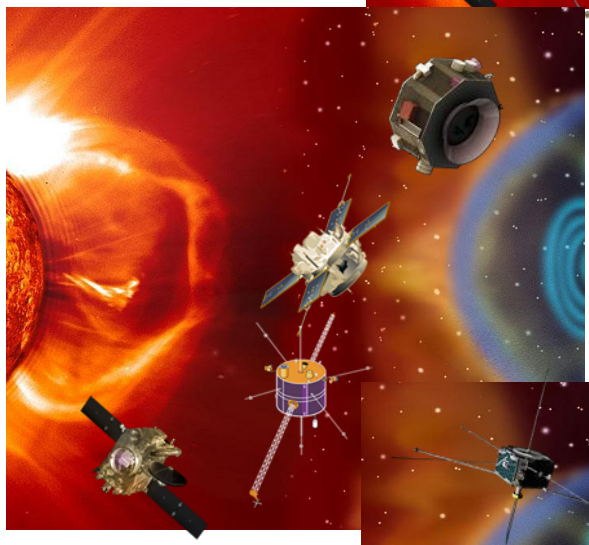


Whole Helio (WHPI) Initiative

- Unique opportunity in Heliophysics allowing coordination in a way we have never done before
- Benchmark for integrated knowledge and assessment of knowledge gaps throughout the system
- Truly “interdisciplinary”

Whole Helio Month

- Coordinated observation and theory-modeling program covering full breadth of Heliophysics **across agencies** and **interdisciplinary**
- Centered on perihelion passes for Parker which are visible from Earth or other planets
- Coordinate Parker, DKIST, SolO, & 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

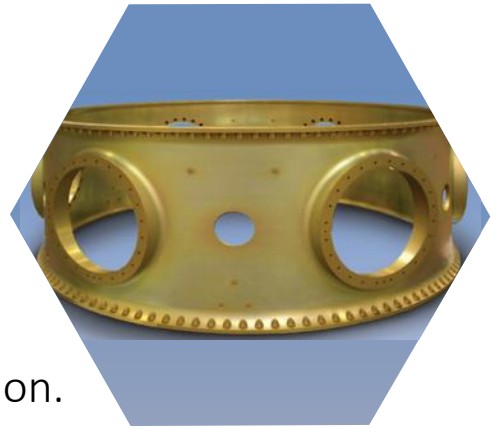


Whole Helio Month

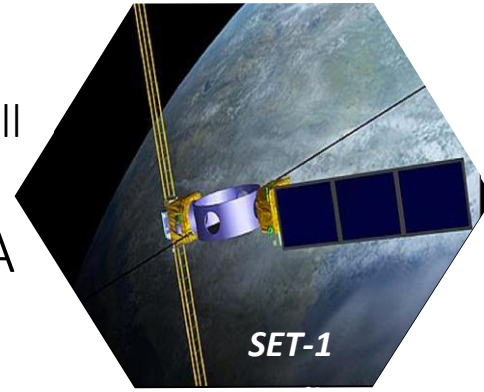
- ”Test Run” this summer centered on Solar Minimum called Whole Heliosphere and Planetary Interactions led by Sarah Gibson and Barbara Thompson (https://whpi.hao.ucar.edu/)
- Novel interdisciplinary scientist program to drive connected research and discovery
  - Large scale IDS teams led by a PI
  - Grants for individual contributors who will provide their data and conduct independent research.
- Follow up workshop after first observing period
  - Collaboration after campaign plus planning meeting for the next campaign.
- Workshops would continue to be scheduled at a regular cadence – organized by IDS teams

HPD Rideshare

- SMD has embraced Rideshare opportunities as a standard practice to maximize mass to orbit
  - Enabling additional opportunities for science community
- SMD has formed a rideshare policy team to develop standard rideshare processes
- The first HPD rideshare opportunity is using a standard (non-propulsive) ESPA Grande
  - Releasing RFI to capture private sector capability and interest in ESPA integration.

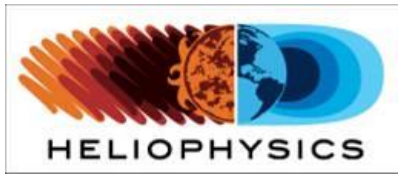


- Rideshare opportunities on IMAP ESPA
  - Science MO SCM & Technology Demonstration MO SCM
  - NOAA Space Weather Forward Observatory
  - If there are open ESPA ports after the above missions are accommodated, they will be offered to other SMD investigations under new Rideshare Policy.
- In support of rideshare, HPD is developing a mission-unique ESPA Systems Interface Specification



SMD Expanded Rideshare Program

- Goal: Implement innovative selection process to allow agility to respond to any given ride opportunity
- Similar to Planetary Science Division call for instrument packages for lunar landers
- Solicit high TRL investigations to create HPD portfolio which could be quickly integrated
- Possibly fund through investigation CDR then hold until ride is available?



Industry

Heliophysics and the Lunar Gateway

- The Gateway presents new opportunities to conduct high priority heliophysics investigations
  - Observing geospace from lunar distances, enables advancement of knowledge and understanding for the coupling of the magnetosphere/ITM/upper atmosphere regions and interactions of the high/mid/equatorial regions can be obtained
  - The platform provides the opportunity to develop sensor technologies and observational capabilities for solar and space physics research
- The Gateway will leverage the application of heliophysics science to mitigate space weather impacts on human exploration at the Moon and beyond.
  - Development of Earth-Independent capability for space weather monitoring and prediction for exploration missions at the Moon and beyond is made possible by the Heliophysics Division Space Weather Science and Application program.
  - In preliminary discussions with HEOMD to establish space weather capability requirements for the Gateway and for human exploration beyond geospace

National Aeronautics and Space Administration

The Dawn of a New Era for Heliophysics

Heliophysics Division, in collaboration with its partners, is poised like never before to:

- Strategically advance understanding of solar and space physics, make amazing discoveries
- Fulfill its role for the Nation enabling advances in space weather
- Engage the public with science knowledge and citizen science
- Develop the next generation of heliophysicists

Opportunity & Impact

Acronyms [1/5]

AA	Associate Administrator
ABC	Agency Baseline Commitment
ACE	Advanced Composition Explorer
AFRL	Air Force Research Laboratory
AI	Artificial Intelligence
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
AWE	Atmospheric Waves Experiment
BARREL	Balloon Array for Radiation belt Electron Losses
BITSE	Balloon-borne Investigation of Temperature and Speed of Electrons
BPR	Baseline Performance Review
Cat	Category
CCMC	Community Coordinated Modeling Center
CDF	Common Data Format
CEDAR	Coupling, Energetics, and Dynamics of Atmospheric Regions
CeREs	Compact Radiation Belt Explorer
CGMS	Coordinated Group for Meteorological Satellites
CINDI	Coupled Ion-Neutral Dynamics Investigations
CMC	Center Management Council
CME	Coronal Mass Ejection
COSIE	Coronal Spectrographic Imager in the EUV

COSPAR	Committee on Space Research
DEE	Data Environment Enhancements
Demo	Demonstration
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
ELFIN-STAR	Electron Loss and Fields Investigation with Spatio-Temporal Ambiguity Resolving
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
FDL	Frontier Development Lab
FIELDS	Fields Experiment
FINESST	Future Investigators in NASA Earth and Space Science and Technology
FITS	Flexible Image Transport System
FORT	Flight Opportunities for Research and Technology
FOV	Field of View

Acronyms [2/5]

FOXSI	Focusing Optics X-Ray Solar Imager
FRR	Flight Readiness Review
FSTs	Focus Science Topics
FUV	Far Ultra-Violet
FY	Fiscal Year
G-CHASER	Grand Challenge Student Rocket
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
GUVI	Global Ultraviolet Imager
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
IABG	Industrieanlagen-Betriebsgesellschaft mbH

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
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

Acronyms [3/5]

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
MEME-X	Mechanisms of Energetic Mass Ejection eXplorer
MIDEX	Medium-Class Explorers
MIGHTI	Michelson Interferometer for Global High-resolution Thermospheric Imaging

MinXSS-2	Miniature X-ray Solar Spectrometer
MMS	Magnetospheric Multiscale
MMS	Magnetospheric Multiscale Guest Investigators
MO	Mission of Opportunity
MO&DA	Mission Operations and Data Analysis
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
MUSE	Multi-slit Solar Explorer
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 Information
NESSF	NASA Earth and Space Science Fellowship before FINESST
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

Acronyms [4/5]

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
PEA	Program Element Appendices
PFRR	Poker Flats Research Range
PHI	Polarimetric and Helioseismic Imager
PI	Principal Investigator
PIR	Program Implementation Review
PP	Program Plan
PPBE	Planning, Programming, Budgeting, and Execution
PS	Program Scientist
PSP	Participating Scientists Program
PSR	Pre-Ship Review
PUNCH	Polarimeter to Unify the Corona and Heliosphere
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
SAMPEX	Solar Anomalous and Magnetospheric Particle Explorer
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
SDP	Science Data Package
SES	Societe Europeenne des Satellites
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	Solar Orbiter Heliospheric Imager
SPASE	Space Physics Archive Search and Extract

Acronyms [5/5]

SPDF	Space Physics Data Facility
SPICE	Spectral Imaging of the Coronal Environment
SpWx	Space Weather
SR	Senior Review
SR	Supporting Research
SRO	SmallSats and Rideshare Opportunities
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
SunRISE	Sun Radio Interferometer Space Experiment
SW	Space Weather
SWA	Solar Wind Plasma Analyser
SWAP	Space Weather Action Plan
SWEAP	Solar Wind Electrons Alphas and Protons
SWFO	Space Weather Forward Observatory
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
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
TRACERS	Tandem Reconnection and Cusp Electrodynamics Reconnaissance Satellites
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
UNH	University of New Hampshire
URSI	International Union of Radio Science
USPI	United States Participating Investigator
UT	Universal time
VAFB	Vandenberg Air Force Base
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