Heliophysics Space Weather Research at NASA

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International Space Weather Initiative Steering Group Meeting

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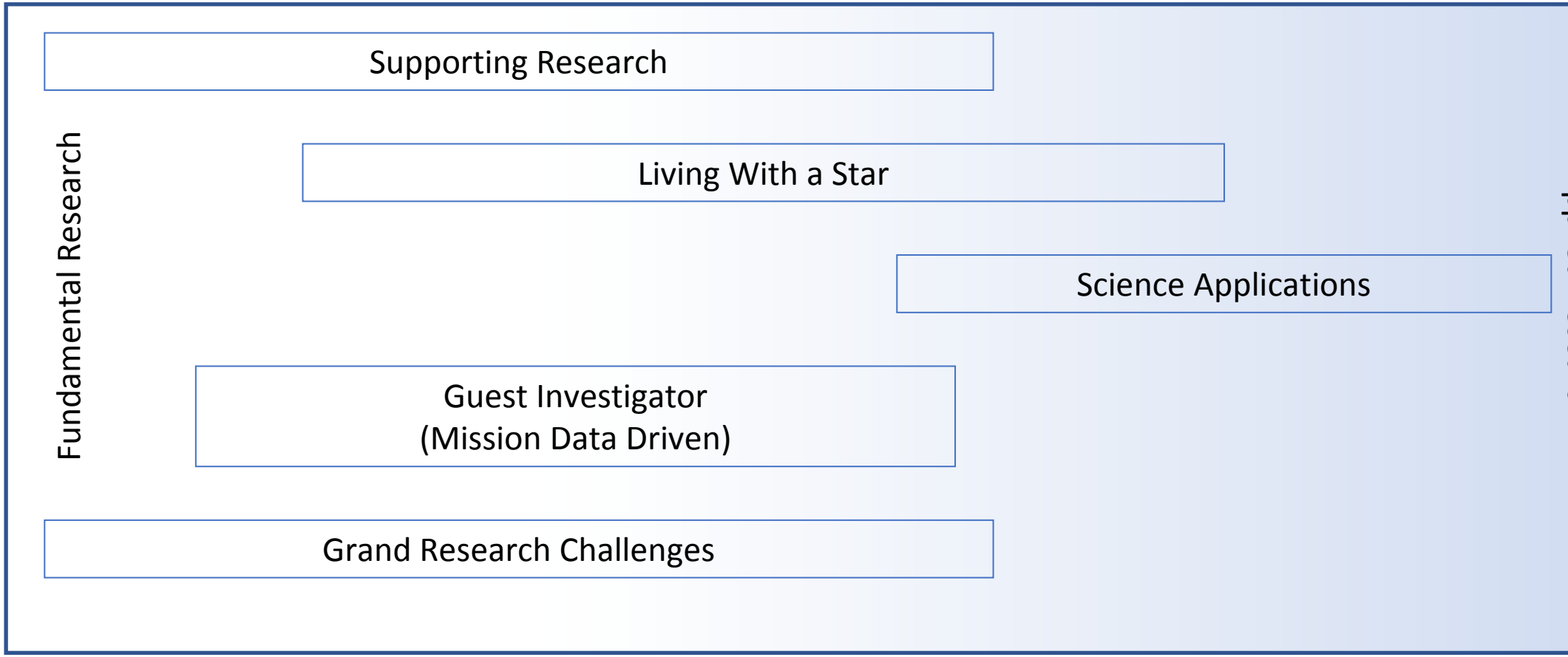
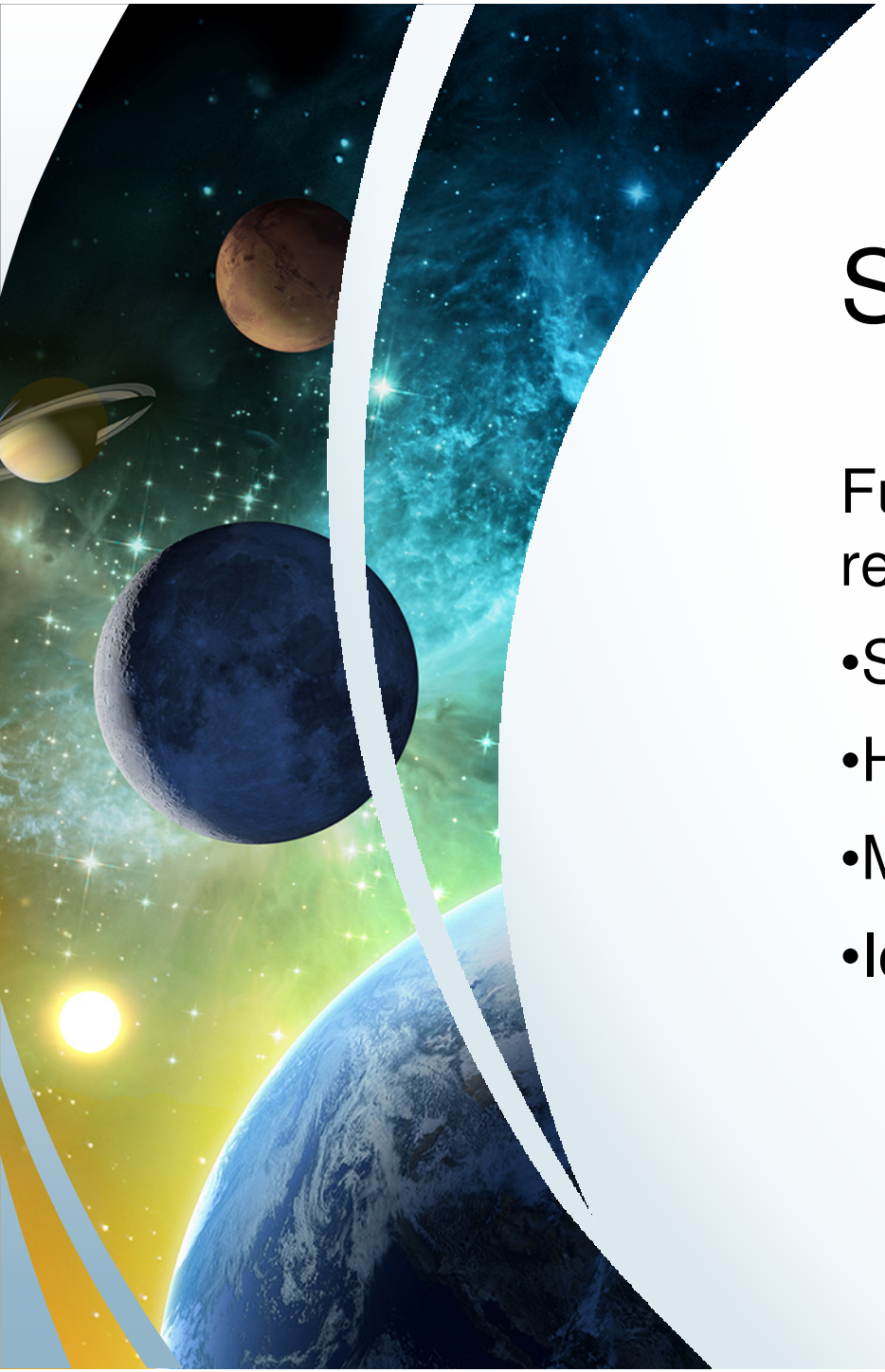
Overview

- Space Weather Science Research
  - Supporting Research
  - Science Centers/Theory, Modeling, Simulations
  - LWS
- Space Weather Science Applications Programs
  - 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 Analys



* Not included are the Heliophysics Technology Instrument Development for Science (HTIDeS), and the 22 flight mission programs



Supporting Research

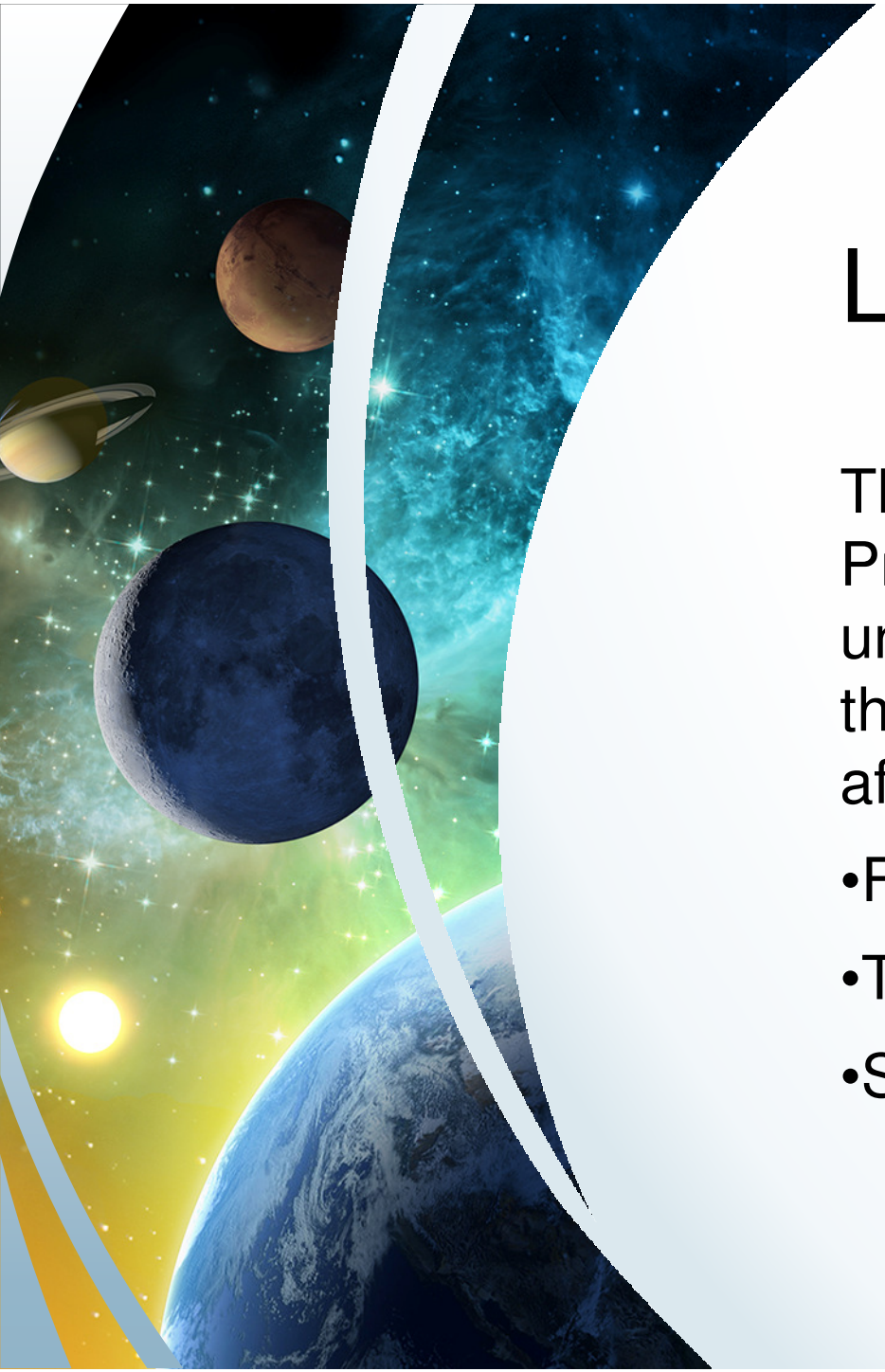
Fundamental Space Research focused in regions

- Solar
- Heliosphere
- Magnetosphere
- Ionosphere/Thermosphere/Mesosphere

Grand Challenge Research

"… critically sized teams of observers, theorists, modelers, and computer scientists to address the most challenging problems in solar and space physics" – 2013 Solar and Space Physics Decadal Survey

- Theory, Modeling, and Simulations – focused teams of critical size to advance understanding
- Science Centers – diverse multi-disciplinary teams addressing key science problems



Living With a Star

The goal of NASA's Living With a Star (LWS) Program is to develop the scientific understanding needed to effectively address those aspects of Heliophysics science that affect life and society

- Focused Science Topics
- Tools and Methods
- Strategic Capabilities

Science Applications

Goal: to develop space weather research activities that result in:

- Complimentary efforts linking fundamental research investigations and operational activities
- More effective and efficient transition of heliophysics science knowledge to operational environment

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 National Space Weather Strategy

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

Heliophysics Space Weather Science Applications Transition Strategy, first meeting held Nov. 28

Space Weather Science Applications Program (1)

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
  - Step 1 proposals due 2/1/19; Step 2 proposals due 4/5/19
- ROSES 2019 will include a SWO2R call

Small Business Innovation Research (SBIR) Program

- Selected two space weather proposals for 2018; continued participation in 2019 SBIR Program

Space Weather Science Applications Program (2)

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
- 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-L1 mission on IMAP launch

NASA-NSF:

- Coordinating ICON & GOLD opportunities (joint NASA mission GI and NSF CEDAR solicitations)
- Co-funding Living With a Star Strategic Capabilities, Science Centers, CCMC
- New opportunity focused on Computational Aspects of Space Weather

NASA-NSF-NOAA:

- Pilot O2R research activity, MOU signed

NASA-USGS

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

International Partners

ESA (Europe):

- Solar Orbiter and SOHO

KASI (Korea):

- Development towards prototype coronagraph (BITSE) for balloon flight in 2019
- Van Allen downlink and SDO data archiving
- KASI Geomagnetic Storm Forecast Model

AEB (Brazil):

- SPORT CubeSat Mission, LRD 2020

ISRO (India):

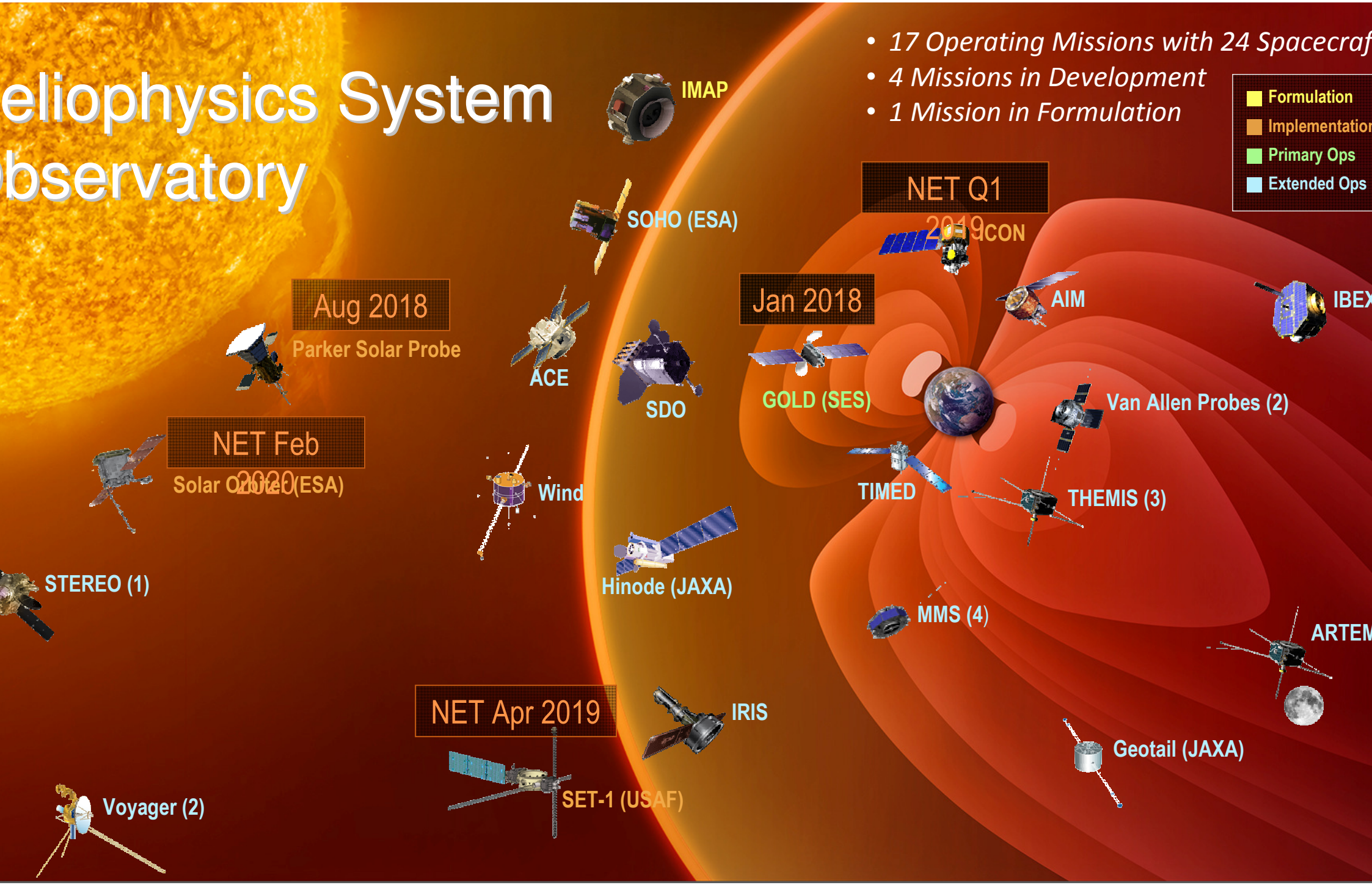
- Three sub-working groups established
- Aditya-1 mission collaboration, space weather modeling, long-term strategic collaboration focus areas

JAXA (Japan):

- Working with JAXA on approach for Next Generation Solar Physics Mission (NGSPM)
- Cooperation on Hinode, Geotai,l and sounding rockets (CLASP and the upcoming CLASP2)

Now Initiatives in Heliophysics

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


eliophysics System
bservatory
• 17 Operating Missions with 24 Spacecraf
• 4 Missions in Development
• 1 Mission in Formulation
Formulation
Implementation
Primary Ops
Extended Ops
IMAP
SOHO (ESA)
NET Q1
2019
ICON
Aug 2018
Parker Solar Probe
ACE
SDO
Jan 2018
AIM
IBEX
GOLD (SES)
Van Allen Probes (2)
NET Feb
2020
Solar Orbiter (ESA)
Wind
TIMED
THEMIS (3)
STEREO (1)
Hinode (JAXA)
MMS (4)
ARTEM
NET Apr 2019
IRIS
Geotail (JAXA)
SET-1 (USAF)
Voyager (2)

Whole Helio Month (1/2)

- 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 (2/2)

- ”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

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


National Aeronautics and
Space Administration
Backup

Revised National Space Weather Action Plan

Three components:

•**Protect** – focused on National Security, understanding the impacts to infrastructure and relevant technologies, and mitigating those impacts

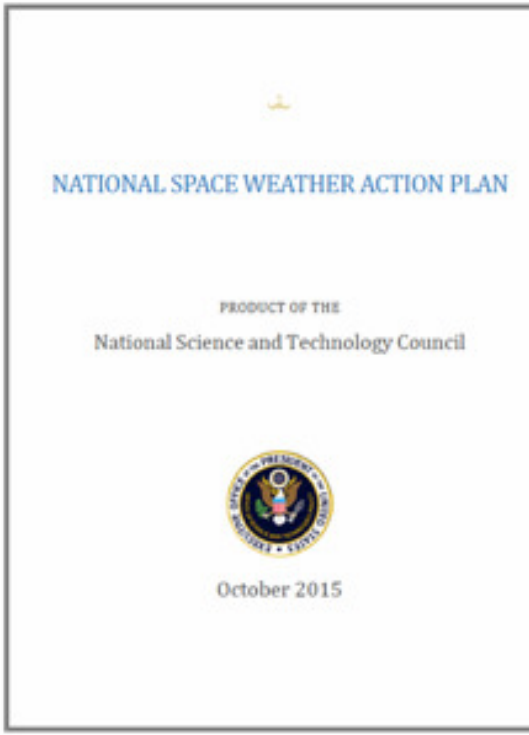
- Lead agencies: DHS, DoD

•**Plan** – focused on planning, testing, evaluating, exercising the plan

- Lead agencies: DoD, DHS

•**Characterize, Forecast, disseminate** – Focused on identifying sustaining capabilities, improved capabilities, understanding of space weather, dissemination of this information

- Lead agencies: DOC/NOAA, NASA



National Space Weather Strategy

Administration Priorities

- Promote leadership, technology, and innovation
- Promote American resilience to threat of natural and induced space weather disasters
- Enhance space weather forecasts, alerts and services
- Space Weather policy extends beyond Low Earth Orbit
- Strengthen space weather capabilities to enhance National Security
- Advance American influence and leadership in space

NASA Strategic Plan, 2018

- Agency Strategic Objective 1.1: Understand The Sun, Earth, Solar System, And Universe,
- Context: Safeguarding and Improving Life on Earth

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
AWE	Atmospheric Waves Experiment
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
COSIE	Coronal Spectrographic Imager in the EUV
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
FOXI	Focusing Optics X-Ray Solar Imager
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 Scienc
HEC	High End Computing
HEK	Heliophysics Events Knowledgebase
HIS	Heavy Ion Sensor
HPAC	Heliophysics Advisory Committee
HPD	Heliophysics Division

Acronyms [2/4]

Q	Headquarters
SCs	Heliophysics Science Centers
G	International Astronomical Union
GA	International Association of Geomagnetism and Aeronomy
MAS	International Association of Meteorology and Atmospheric Sciences
U	International Astronomical Union
EX	Interstellar Boundary Explorer
AO	International Civil Aviation Organization
AO	Committee on Earth Observing Satellites
ON	Ionospheric Connection Explorer
L	Interactive Data Language
IAP	Interstellar Mapping and Acceleration Probe
C-UNESCO	Intergovernmental Oceanographic Commission - United Nations Educational, Scientific and Cultural Organization
A	Intergovernmental Personnel Act
IS	Interface Region Imaging Spectrograph
⍰IS	Integrated Science Investigation of the sun
CU	International Council for Science
ES	International Space Environment Service
FM	Internal Scientist Funding Model
RO	Indian Space Research Organization
WI	International Space Weather Initiative
D	Instrument and Technology Development
M	Ionosphere-Thermosphere-Mesosphere
GG	International Union of Geodesy and Geophysics
PAP	International Union of Pure and Applied Physics
M	Ion Velocity Meter
XA	Japan Aerospace Exploration Agency
L	Joint confidence level
L	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
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
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

Acronyms [3/4]

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
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
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

Acronyms [4/4]

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
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
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

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
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