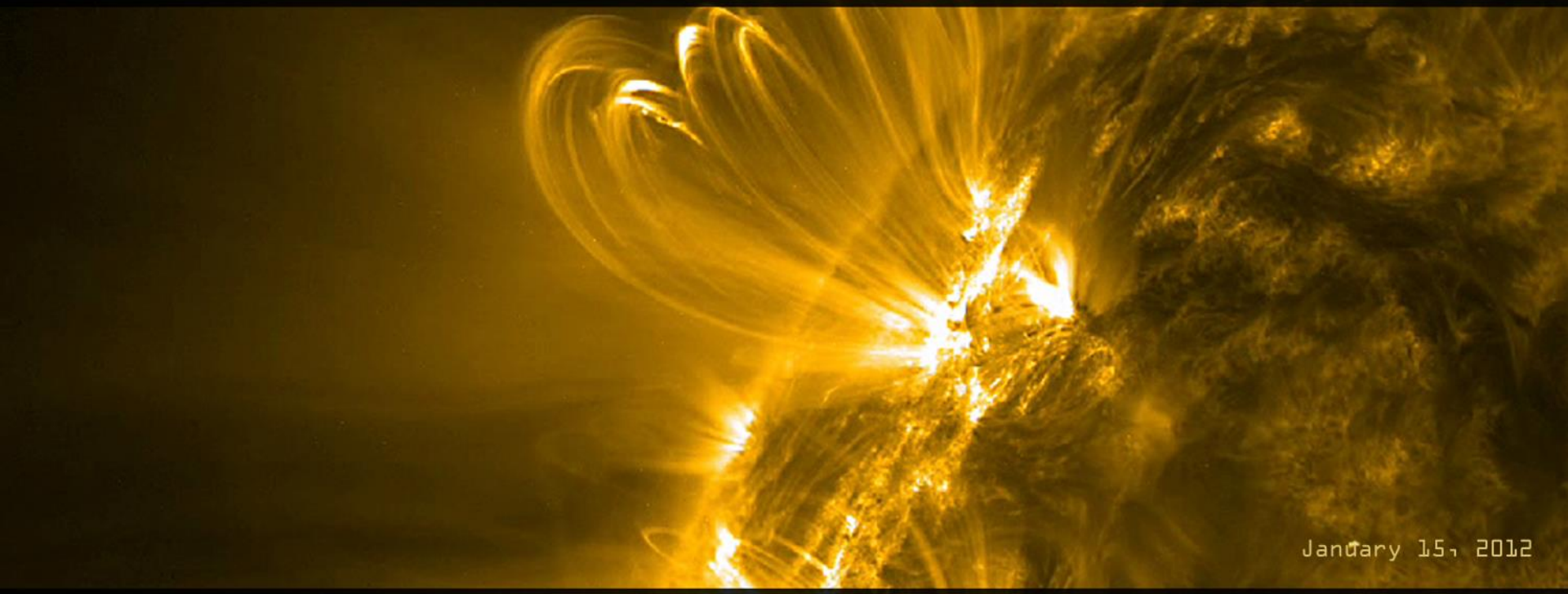
National Aeronautics and Space Administration

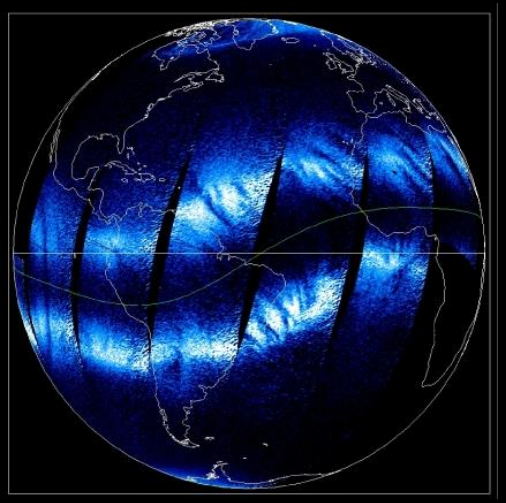


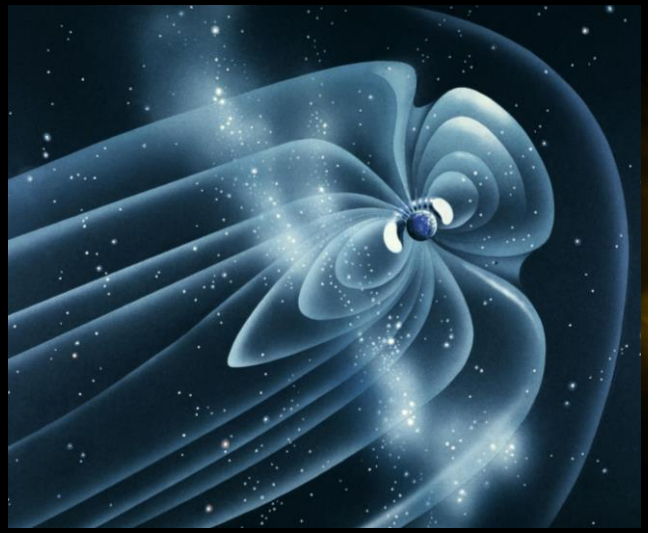
Utility of NASA's Heliophysics Research Fleet for Space Weather Prediction

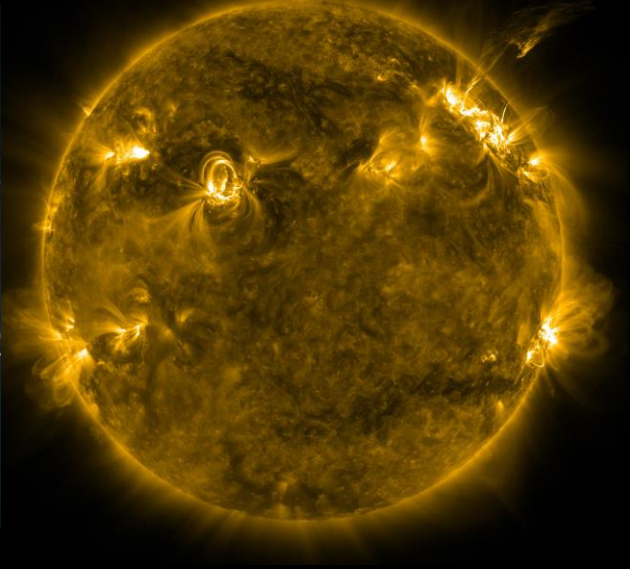
The 2012 Space Weather Workshop, April 25, 2012

Dr. Barbara Giles, Heliophysics Division Director, NASA Headquarters

Understand the Sun and its interactions with the Earth and the solar system



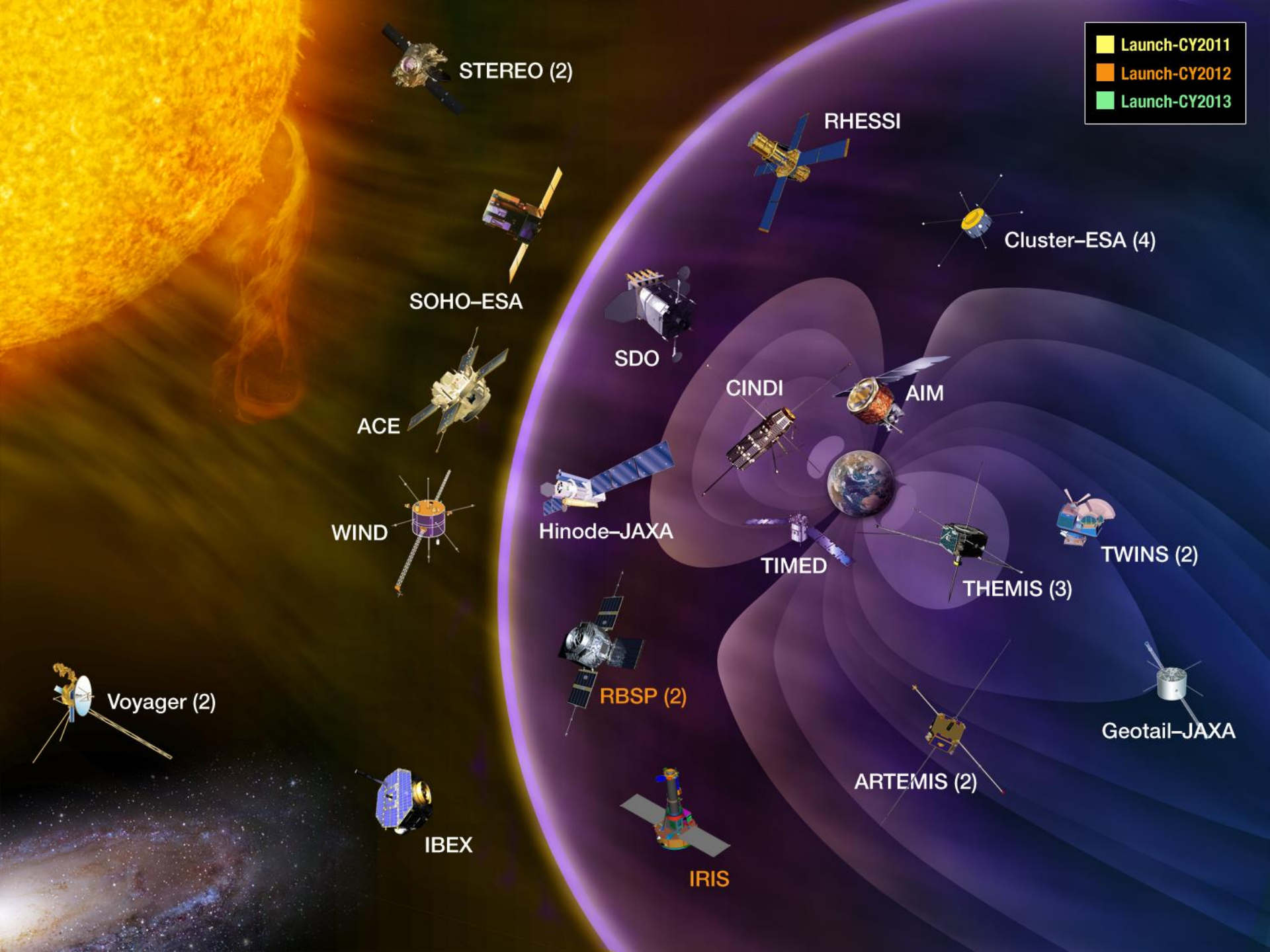


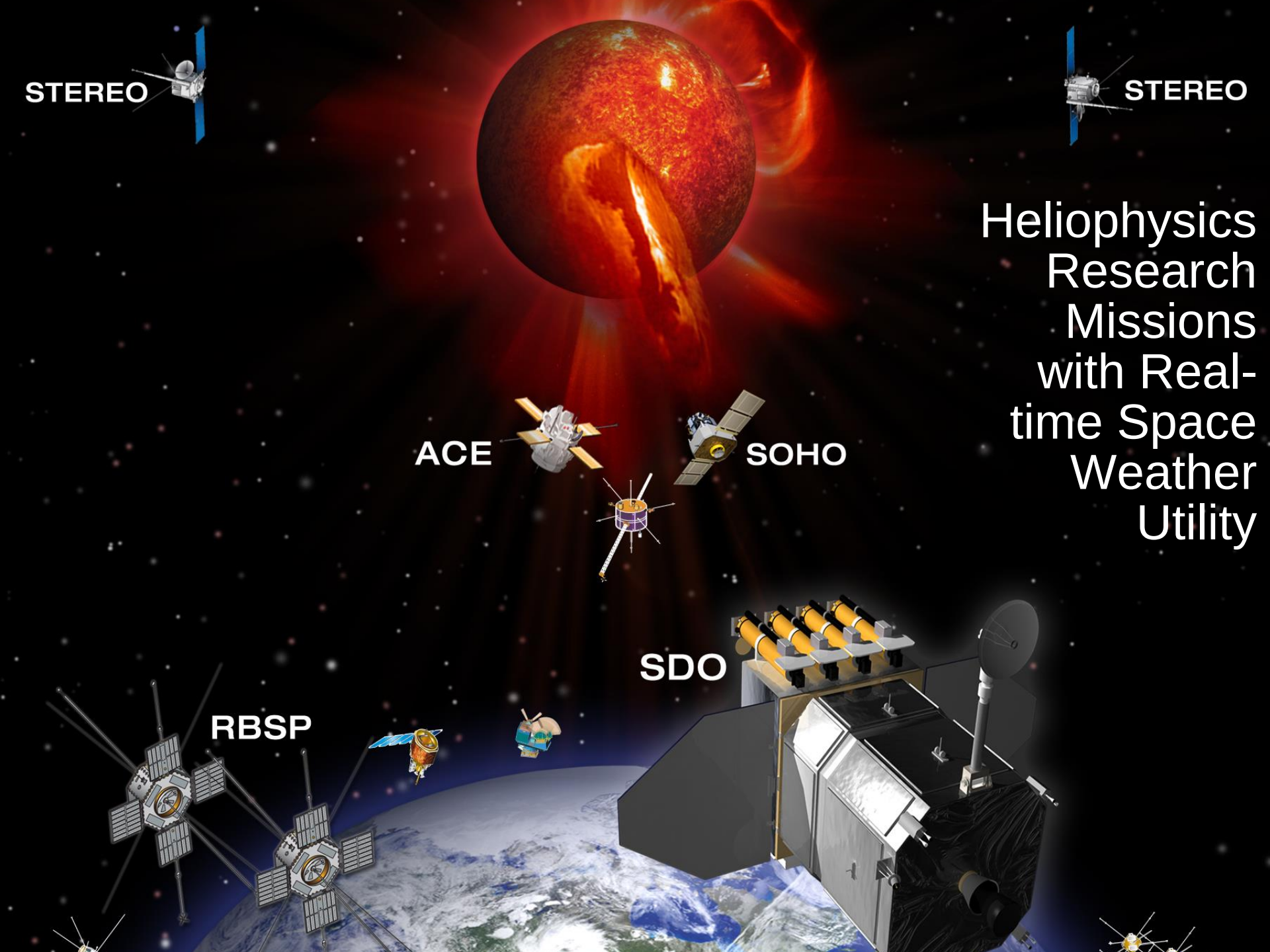


*Understand the f**undamental physical processes of the space environment** – from the Sun to Earth, to other planets, and beyond to the interstellar medium*

*Understand how human society, technological systems, and the habitability of planets are affected by **solar variability and planetary magnetic fields***

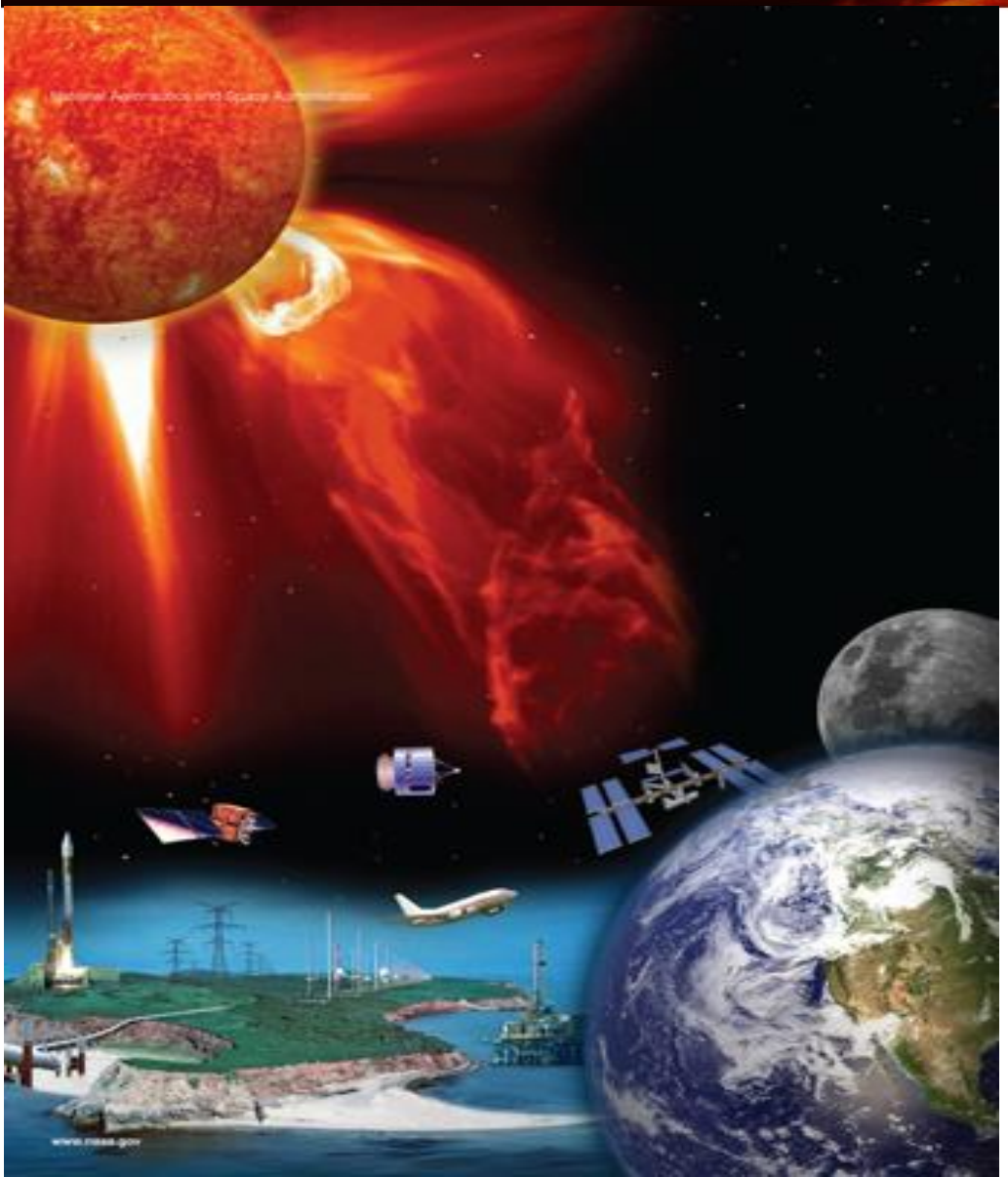
*Maximize the safety and productivity of human and robotic explorers by **developing the capability to predict the extreme and dynamic conditions in space***


Launch-CY2011
Launch-CY2012
Launch-CY2013
STEREO (2)
RHESSI
SOHO–ESA
Cluster–ESA (4)
SDO
CINDI
AIM
ACE
WIND
Hinode–JAXA
TIMED
TWINS (2)
THEMIS (3)
RBSP (2)
Voyager (2)
Geotail–JAXA
ARTEMIS (2)
IBEX
IRIS



Heliophysics Research Missions with Real-time Space Weather Utility

Heliophysics and Space Weather (SWx)



STEREO+SOHO resolves 180^{o} ambiguity in halo CME events for a factor of 2 improvement in Earth impact predictions

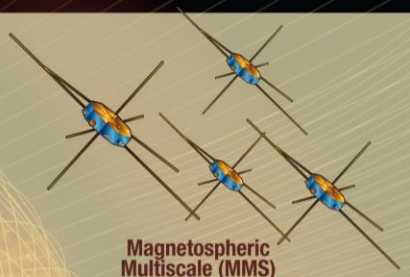
STEREO+ SOHO+SDO removes uncertainty in farside solar evolution - long range forecasts significantly improved

System Observatory assets provide solar event location and start time, and also direction and velocity for SME events. When coupled with CCMC models, the effects and event arrival times are available for all assets in the solar system.

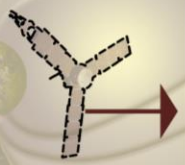
SDO-EVE instrument provides best UV-EUV measurements to those predicting effects on the Earth's ionosphere

Heliophysics Program 2012-2018

Solar Terrestrial Probes



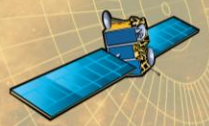
Magnetospheric Multiscale (MMS)
March 2015



STP #5

Living With a Star

Radiation Belt Storm Probes (RBSP)
September 2012



Space Environment Testbeds (SET)
January 2014

Solar Orbiter Collaboration (with ESA)
January 2017

Solar Probe Plus
July 2018

Explorers

Interface Region Imaging Spectrograph (IRIS)
June 2013

Future Explorer Mission(s)
2016-2018

Research Program

CIBER - March 2012
ATREX - March 2012
VESPR - April 2012
EVE Calibration - April 2012

FORTIS - May 2012
FOXSI - May 2012
IMAGER- June 2012
RockOn - June 2012
RockSat - June 2012

SUMI - July 2012
DFS - July 2012
HI-C - July 2012
VERIS - August 2012
RAISE - August 2012

EUNIS - August 2012
EVEX - September 2012
SLICE - October 2012
Micro-X - October 2012
XACT - November 2012

DXL - December 2012
ACCESS - February 2013
HYPE - 2013

Ongoing

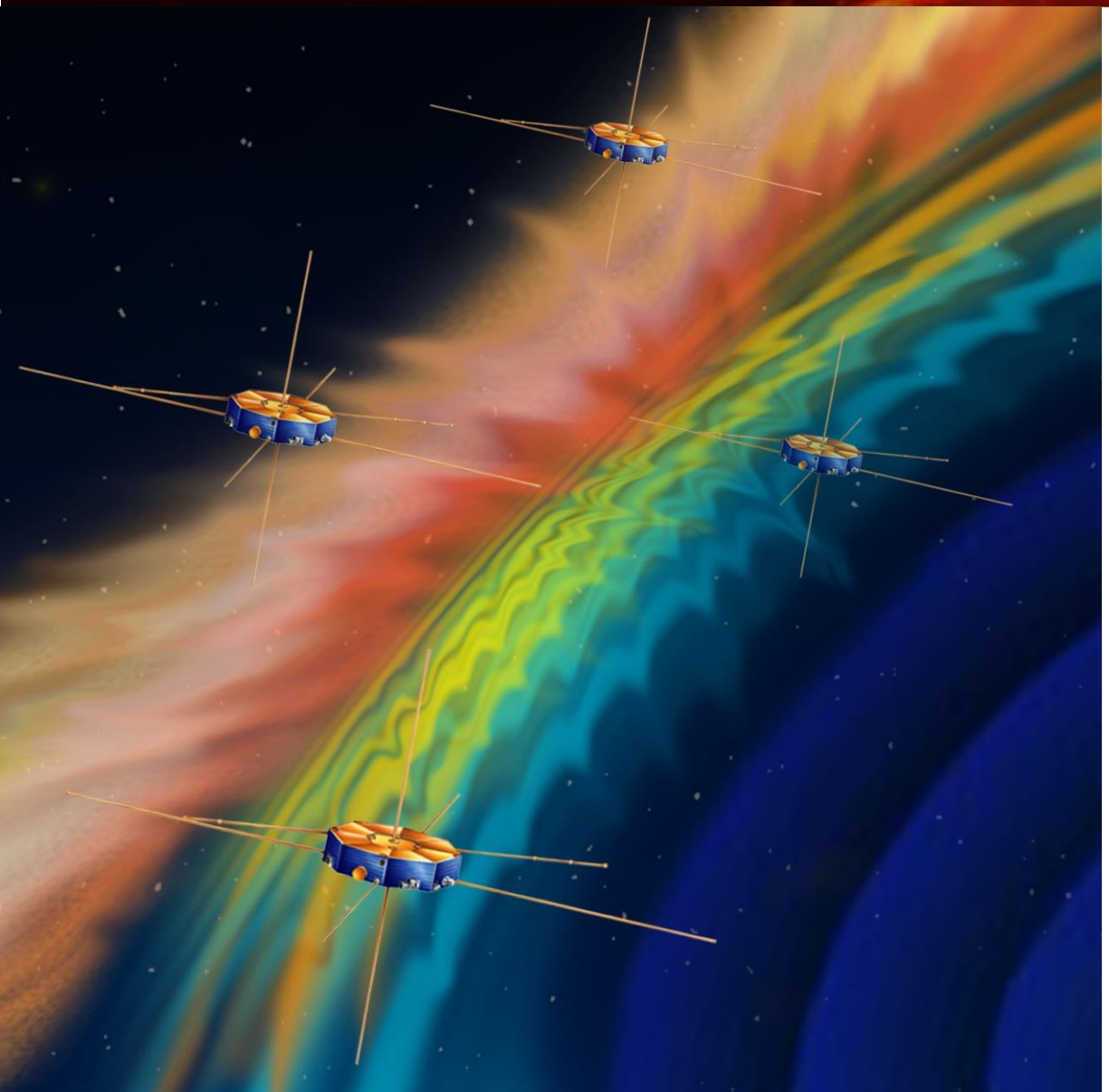
Sunrise - June 2012/Sweden
ASTRA - August 2012/New Mexico
NSCAP - September 2012/New Mexico

GRIPS - September 2012/New Mexico
BARREL #1 - December 2012/Antarctica
BARREL #2 - December 2013

Heliophysics Missions
Astrophysics Missions
Planetary Missions

2012 2013 2014 2015 2016 2017 2018

Magnetospheric Multiscale (MMS)



The MMS mission will use Earth's magnetosphere as a laboratory to study the microphysics of magnetic reconnection, a fundamental plasma-physical process that converts magnetic energy into heat and the kinetic energy of charged particles.

These processes — magnetic reconnection, particle acceleration, and turbulence — occur in all astrophysical plasma systems but can be studied in situ only in our solar system and most efficiently in Earth's magnetosphere, where they control the dynamics of the geospace environment and play an important role in space weather.

Radiation Belt Storm Probes (RBSP)

Radiation Belt Storm Probes launch: September 2012

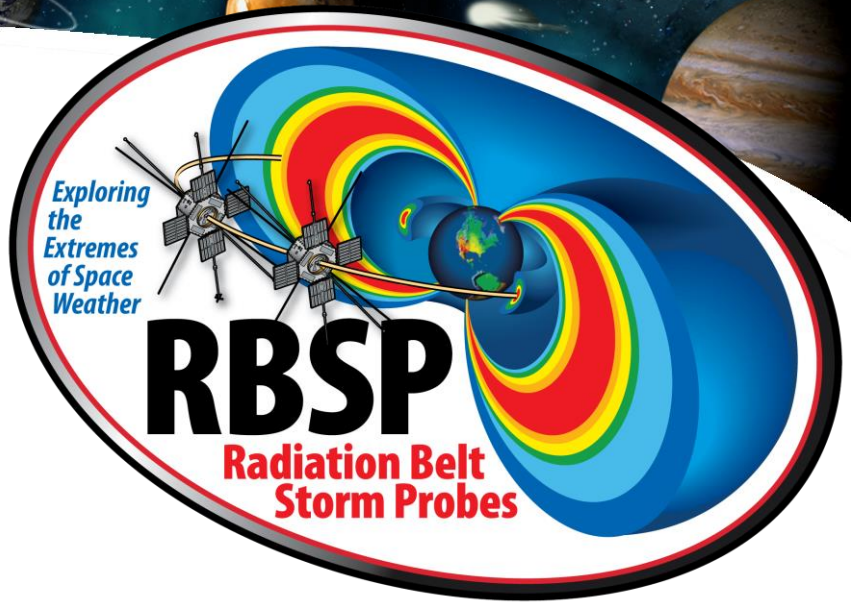
- 2 S/C, 5.8R_E apogee, 600km perigee, 10 degree inclination, 2 year nominal mission lifetime
- The RBSP space weather data will be transmitted like that of ACE and STEREO.
- Ground processing for SWx products will be provided by receiving organization(s).
- The RBSP Space Weather Beacon Network currently includes:

  - Agreements with Czech Republic and Korea

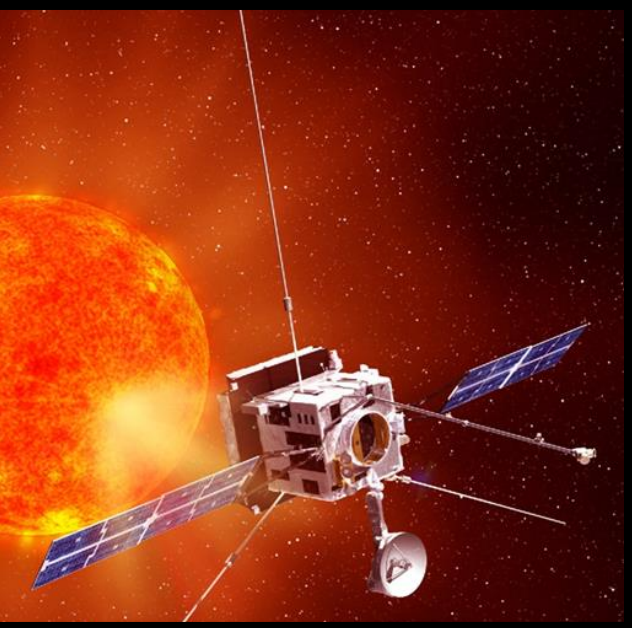
  - Interest from University of Alaska, South Africa, Brazil, & Argentina

  - Contact to determine interest with Australia

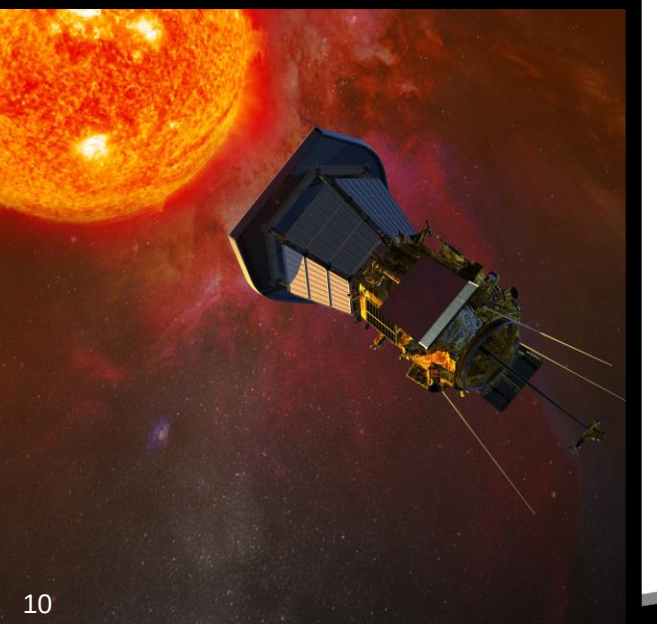
  - Seeking India and Hawaii



Living With a Star (LWS)



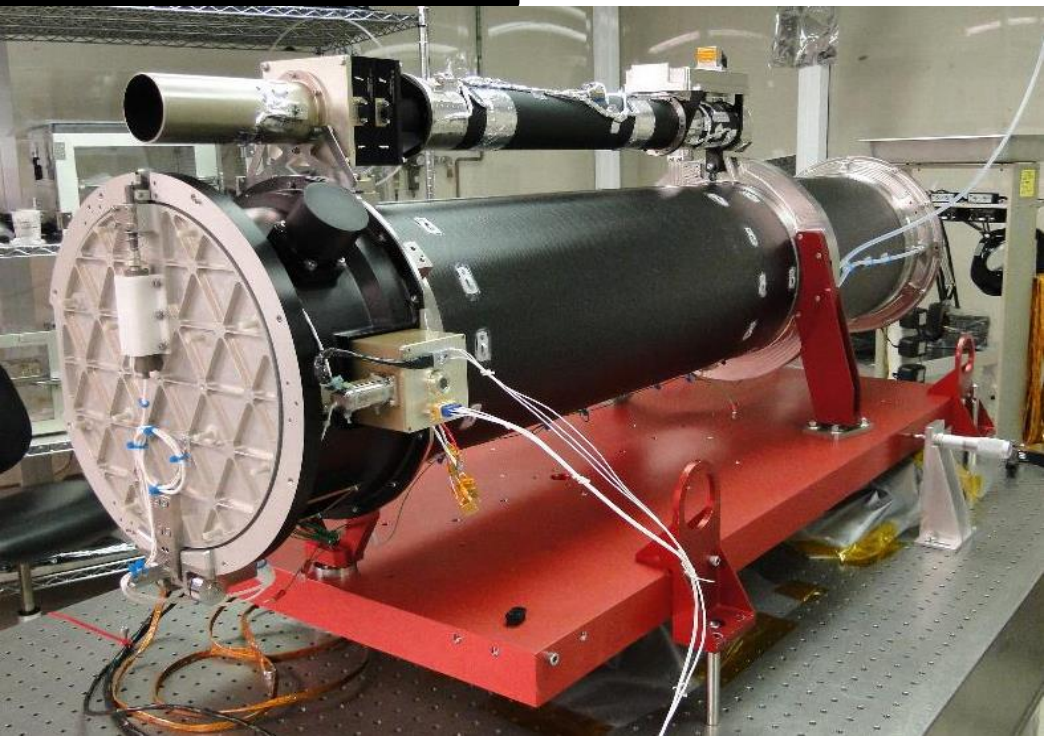
Solar Orbiter Collaboration (SOC):
SOC will unravel how solar transients alter the plasma and magnetic field structure of the inner heliosphere and measure the solar polar magnetic fields for the first time using a combination of in-situ and remote sensing instruments. Launch: 2017



Solar Probe Plus (SPP):
SPP will approach as close as nine solar radii from the surface of the Sun, repeatedly sampling the near-Sun environment. By directly probing the solar corona, this mission will provide essential knowledge and understanding of coronal heating and of the origin and acceleration of the solar wind.
Launch: 2018

Interface Region Imaging Spectrograph (IRIS)

Understanding the interface between the photosphere and corona is a fundamental challenge in solar and heliospheric science. IRIS opens a window into this crucial region by tracing the flow of energy and plasma through the chromosphere and transition region into the corona using spectrometry and imaging.



IRIS is designed to increase our understanding of energy transport into the corona and solar wind and provide an archetype for all stellar atmospheres.

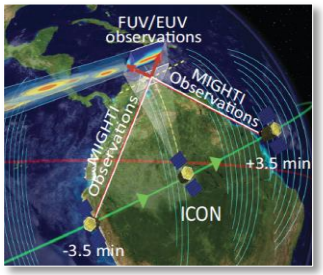
Explorer Mission Downselect: Early CY2013

3 mission concepts; 3 approaches to ionosphere–magnetosphere coupling

ICON

Ionospheric Connection Explorer

PI: T. Immel UC Berkeley

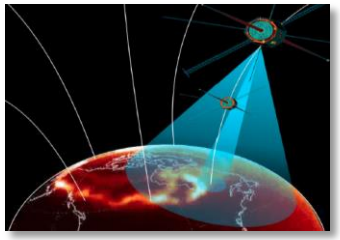


- **How neutral atmosphere affects the ionosphere**
- **How solar wind and magnetosphere affect the ionosphere**

OHMIC

Observatory for Heteroscale Magnetosphere–Ionosphere Coupling

PI: J. Burch / SWRI

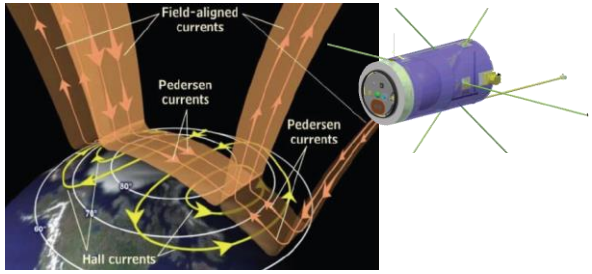


- **How magnetospheric EM energy flows downward to power aurora**
- **How ion outflows are initiated and modify the underlying ionosphere**

ASTRE

Atmosphere-Space Transition Region Explorer

PI: R. Pfaff / GSFC



- **How magnetospheric electric fields drive neutral atmospheric motions**
- **How the neutral-ion transition region regulates the magnetosphere**

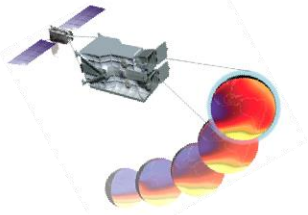
Mission of Opportunity Selections

3 MO concepts; 3 opportunities to augment the Heliophysics System Observatory

GOLD

Global Scale Observations of the Limb and Disk

PI: R. Eastes / U. Central Florida

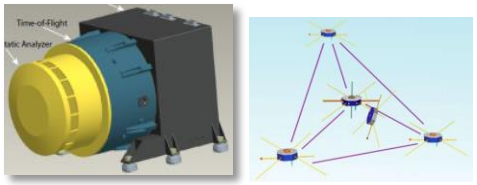


… how the ionosphere and thermosphere respond to geomagnetic storms, solar radiation, and upward propagating atmospheric tides

IMSA on SCOPE

Ion Mass Spectrum Analyzer

PI: L. Kistler / U. New Hampshire



… fundamental processes of reconnection, particle acceleration, and turbulence … focused on the feedback mechanisms between ion and electron scale lengths

CPI on the ISS

Coronal Physics Investigator

PI: John Kohl / SAO

… processes that heat and accelerate the plasma components of the slow and fast solar wind

Heliophysics Division FY13 Budget Content

- Future launches:

September 2012	Radiation Belt Storm Probes (RBSP)
June 2013	Interface Region Imaging Spectrograph (IRIS)
March 2015	Magnetospheric MultiScale (MMS)
2017	Solar Orbiter Collaboration (w/ ESA)
2018	Solar Probe Plus

- Future Mission Selections:

September 2011	Step 1 Explorer and MoO selection (current AO)
February 2013	Step 2 Explorer selection (current AO)
November 2015	Step 1 Explorer and MoO selection (next AO)
January 2017	Step 2 Explorer selection (next AO)

- Supports 17 operating missions (as of Sept 20, 2011)
  - Voyager, Geotail, Wind, SOHO, ACE, Cluster, TIMED, RHESSI, TWINS, Hinode, STEREO, THEMIS, AIM, CINDI, IBEX, SDO, ARTEMIS

- Maintains established Research, Suborbital and Technology Programs

National Partnerships

NASA/NSF Partnership for Collaborative Space Weather Modeling:

The Geospace Sciences Section of the Division of Atmospheric and Geospace Sciences of the NSF and NASA Heliophysics Division (HPD) are supporting collaborations between institutions, including Government laboratories and universities for comprehensive, science-based models of space weather phenomena that will lead to the capability to predict space weather events.

Memorandum of Understanding (MOU) between NASA, NOAA, USAF, DOI & NSF:

As the Earth approaches the peak of the solar activity expected in 2013, our Nation faces multiplying uncertainties from increasing reliance on technology that is extremely vulnerable to the effects of adverse space weather. Federal agencies are working together to develop a unified approach to understand and mitigate potential impacts of space weather events. It is in the national interest that such Federal programs be closely coordinated through an interagency and mutually supportive approach to efficiently and effectively meet the growing need for the delivery of space weather information and services. This MOU will serve as an umbrella agreement that sets forth the general terms and conditions under which the Federal agencies will coordinate and cooperate in activities to improve space weather science and services, and is consistent with the 2010 National Space Policy guidance to strengthen interagency partnerships.

International Space Weather Activities

International Space Weather Initiative (ISWI) Reaches More Than 100 Countries:

• The International Heliophysical Year (IHY) provided a successful model for outreach and the deployment of arrays of small scientific instruments in new and scientifically interesting geographic locations. The ISWI was designed to build on this momentum to promote the observation, understanding, and prediction space weather phenomena, and to communicate new scientific results to the public.

• Recently with the help of the United Nations Basic Space Science Program, the ISWI has reached a new milestone with **610 instruments deployed in more than 100 countries around the world.** These instruments include magnetometers, radio antennas, GPS receivers, all-sky cameras, particle detectors, etc. that provide global measurements of heliophysics phenomena. As a result of this program, scientists from many countries now participate in the instrument operation, data collection, analysis, and publication of scientific results, working at the forefront of science research.

International Living With a Star (ILWS):

• ILWS has very broad international participation: 28 member agencies, working groups with scientists from all over the world, and workshops that provide a forum for the scientific community.

• Significant opportunities have been created from ILWS partnerships, including missions, workshops, and data and modeling activities.

- New mission opportunities: Cross-Scale, EQUARS, Solar-C
- New scientific coordination opportunities: ISWI and NOAA

NASA Participates UN Sustainability Framework:

• With delegate on the Expert Working Group (EWG) on Space Weather for the Working Group on Long-Term Sustainability of Space Activities as part of United Nations Committee on the Peaceful Uses of Outer Space.

Heliophysics Decadal Survey

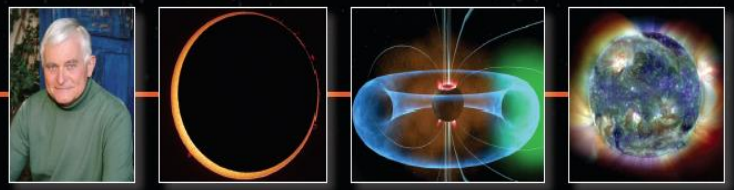
The Space Studies Board organized a broad-based assessment of the scientific priorities of the U.S. solar and space physics research enterprise for the period 2013-2022.

See Progress At:
http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_056864

- **The NRC, NSF, NOAA, and NASA are planning roll-out activities to include the entire science community using a multiple Town Hall format with live feed from the main event in Washington, DC.**
- **Anticipated Completion Date for the Survey: No later than 30 April 2012 ←!!**

2012 Jack Eddy Postdoctoral Fellowships

Application deadline: 11 January 2012



The next generation of researchers …

The goal of this program is to train Sun-Earth system researchers, therefore preference is given to research projects that cross the traditional Heliophysics subdomains of the Sun, heliosphere, magnetosphere, and ionosphere/upper atmosphere, as well as sun-climate investigations. Therefore, proposals that are interdisciplinary are encouraged.

Applicants are expected to have had a PhD for no more than five years at the start of tenure. A UCAR steering committee selects the fellows.

2012 Appointments are listed at:

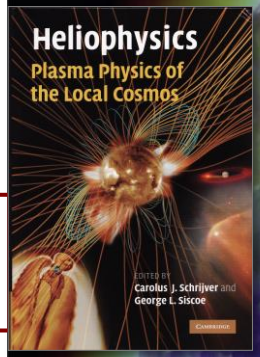
http://www.vsp.ucar.edu/Heliophysics/post-about-alumni-2012.shtml

Preparing the next generation of expert practitioners

The Summer School has two principal aims:

- Deepen the appreciation of the basic science of heliophysics for a select group of students as teachers take them through highly interactive seminars and hands-on working groups, and
- Expand the newly-published textbook series to include labs, problem sets and background materials, from which heliophysics may be taught at universities worldwide.

Choice, the magazine of American Library Association listed Heliophysics Vol I among its "Outstanding Academic Titles, 2010", Choice, v.48, no. 05, January 2011.



Heliophysics

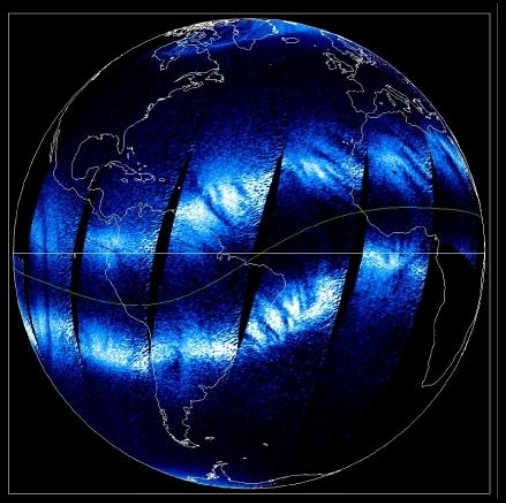
2012 Summer School

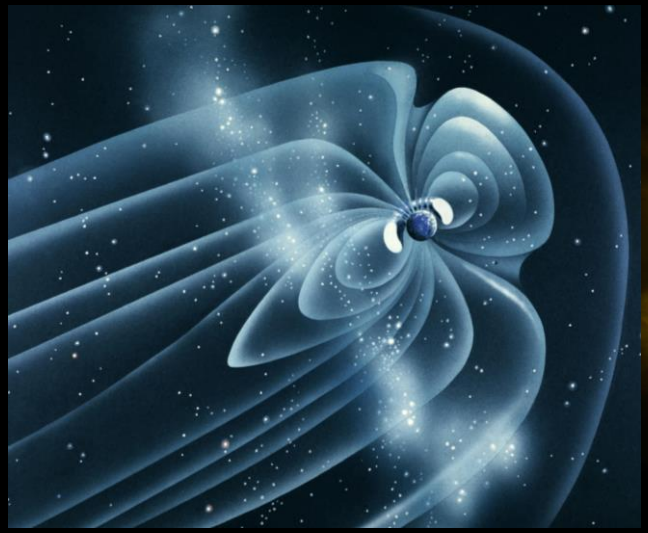
Heliophysical Exploration

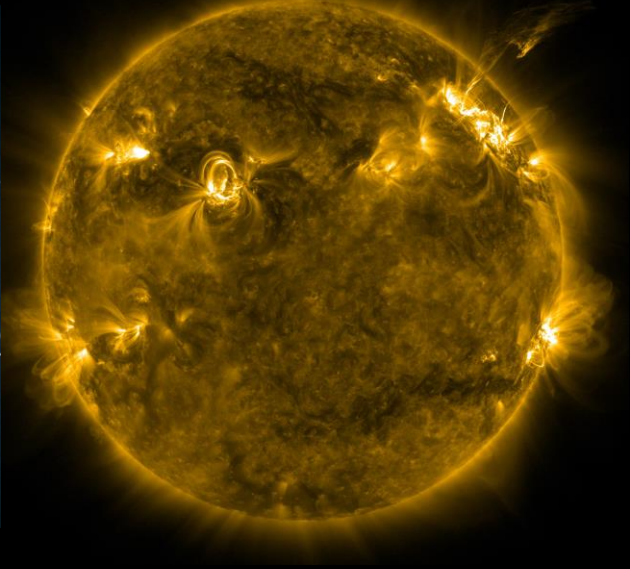
31 May – 7 June 2012

Boulder, Colorado

Understand the Sun and its interactions with the Earth and the solar system







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