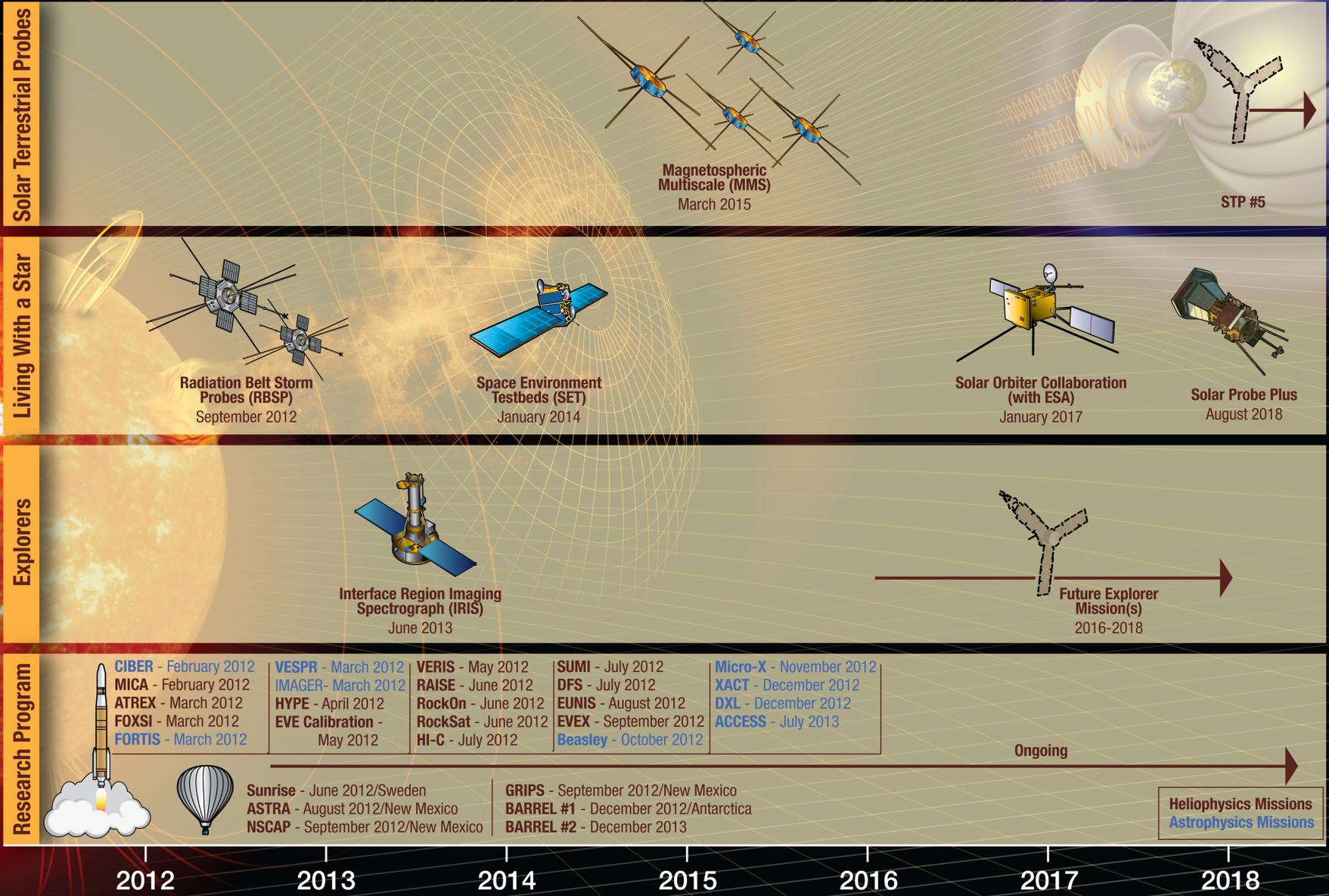


# Heliophysics

Science Mission Directorate  
Division Overview  
July 2-3, 2012  
Dr. Barbara Giles

# Heliophysics Program 2012-2018



Solar Terrestrial Probes

Living With a Star

Explorers

Research Program

2012

2013

2014

2015

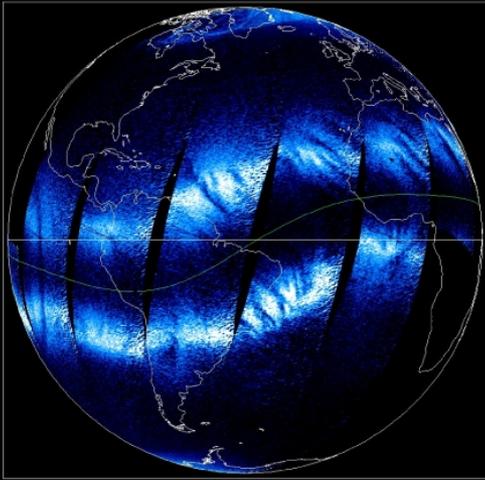
2016

2017

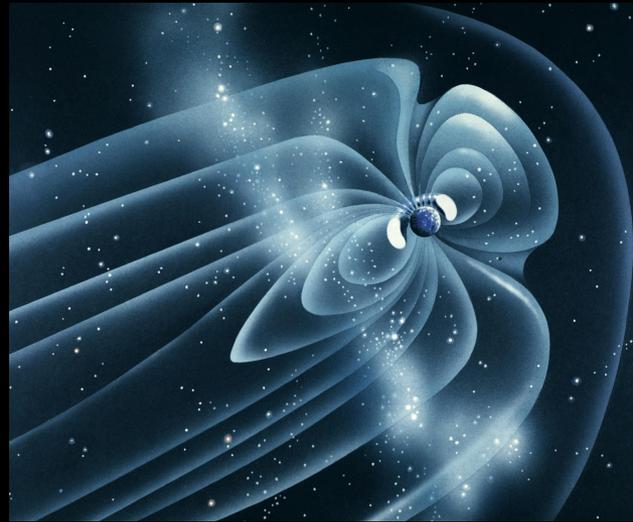
2018

Heliophysics Missions  
Astrophysics Missions

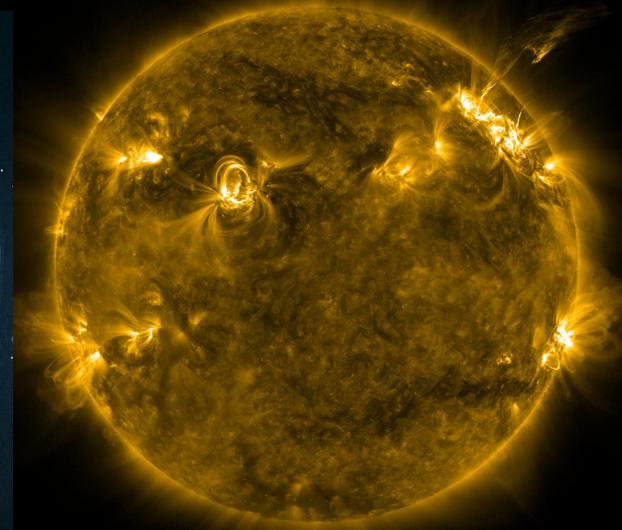
# Understand the Sun and its interactions with the Earth and the solar system



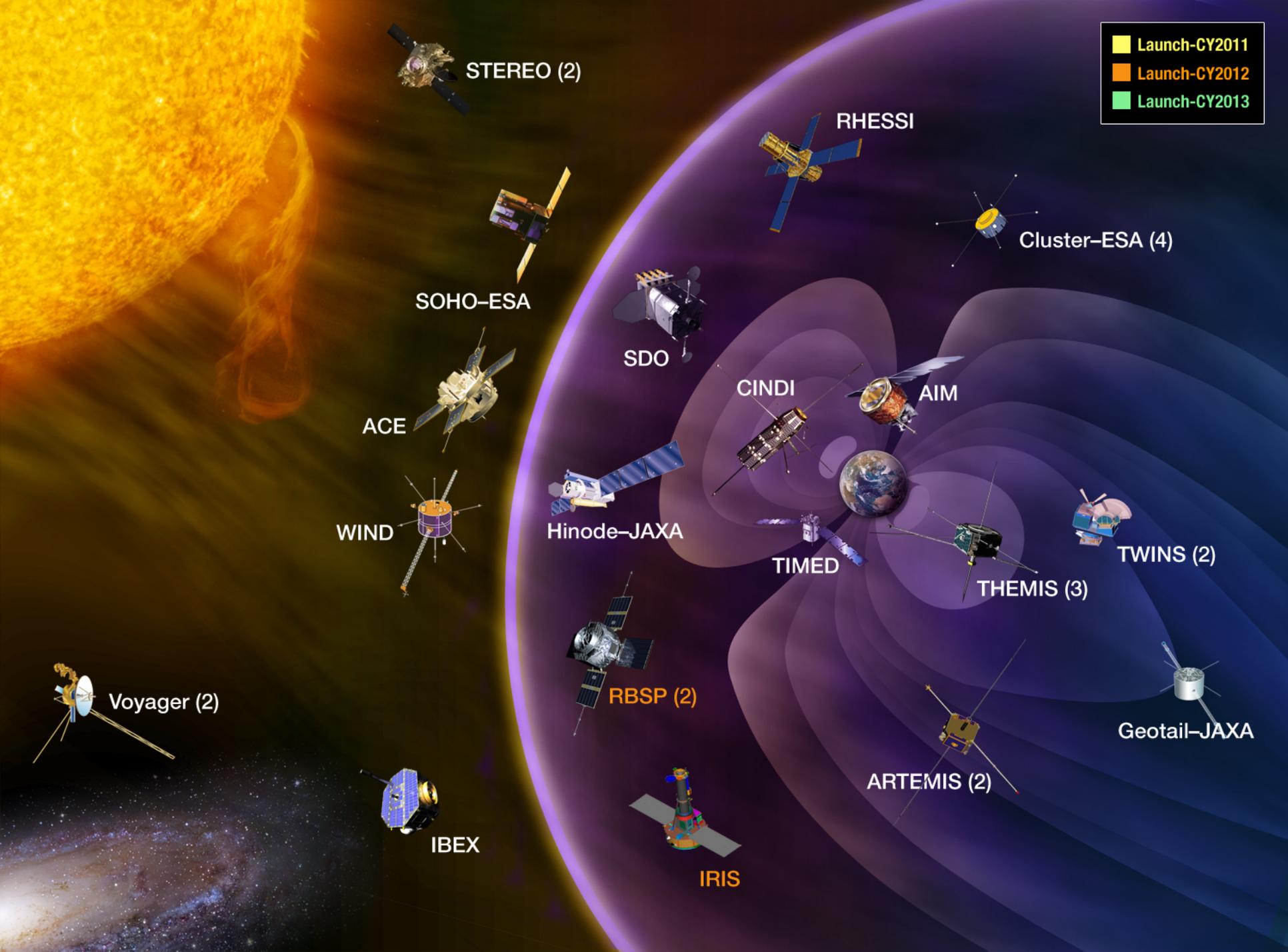
*Understand the **fundamental physical processes of the space environment** – from the Sun to Earth, to other planets, and beyond to the interstellar medium*



*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

Cluster-ESA (4)

SOHO-ESA

SDO

CINDI

AIM

ACE

Hinode-JAXA

TIMED

THEMIS (3)

WIND

TWINS (2)

Voyager (2)

RBSP (2)

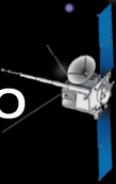
Geotail-JAXA

IBEX

IRIS

ARTEMIS (2)

**STEREO**



**STEREO**



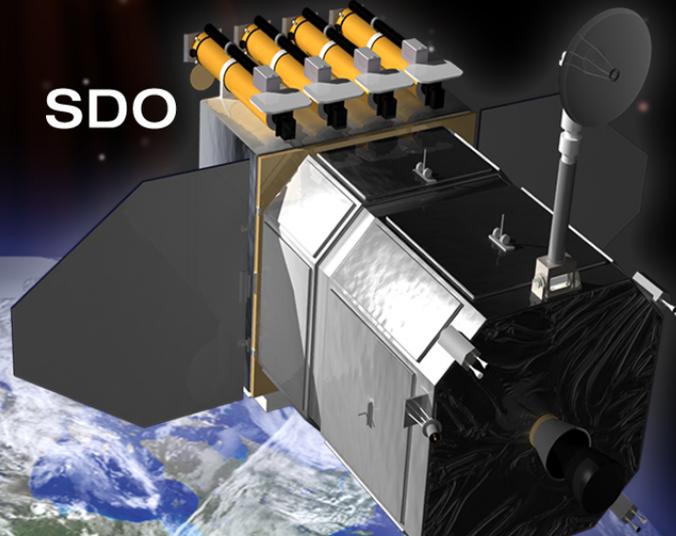
**ACE**



**SOHO**



**SDO**



**RBSP**



**Heliophysics  
Research  
Missions  
with Real-  
time Space  
Weather  
Utility**

# Total Missions / Spacecraft

## 86 / 98

- Astrophysics
- Earth Science
- Heliophysics
- Planetary Science

### Formulation

#### 11 / 11

### Implementation

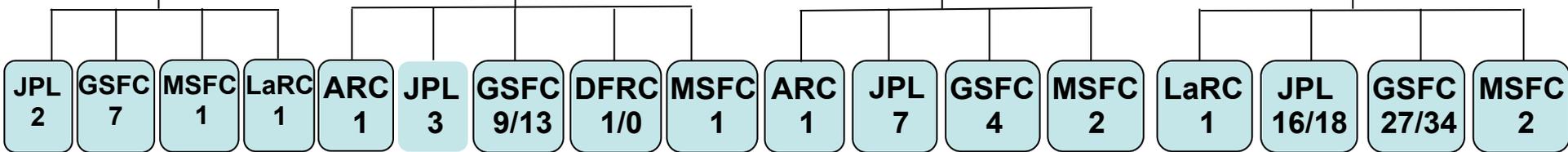
#### 15 / 18

### Primary Ops

#### 14 / 14

### Extended Ops

#### 46 / 55



- |       |                      |          |          |                |                |            |                     |                 |                 |               |           |         |       |     |         |
|-------|----------------------|----------|----------|----------------|----------------|------------|---------------------|-----------------|-----------------|---------------|-----------|---------|-------|-----|---------|
| SMAP  | ICESat-2             | Disc-12  | LADEE    | NuSTAR         | JWST           | SOFIA(1/0) | <i>Strofi</i>       | Kepler          | <i>Herschel</i> | Fermi         | MESSENGER | CALIPSO | GALEX | HST | Chandra |
| GRACE | GEMS                 | SAGE III | ST-7     | <i>Astro H</i> | <i>Rosetta</i> | SDO        | New Horizons        | Spitzer         | <i>Suzaku</i>   | <i>Hinode</i> |           |         |       |     |         |
| FO    | <i>Solar Orbiter</i> |          | OCO-2    | LDCM           | DAWN           | LRO        | Planck              | <i>Integral</i> |                 |               |           |         |       |     |         |
|       | <i>Solar Probe +</i> |          | GPM      |                | Juno           | NPP        | Cloudsat            | XMM             |                 |               |           |         |       |     |         |
|       | OSIRIS-REx           |          | MAVEN    |                | GRAIL          |            | ACRIMsat            | SWIFT           |                 |               |           |         |       |     |         |
|       | EX-1                 |          | SET-1    |                | MSL            |            | GRACE (2)           | Aqua            |                 |               |           |         |       |     |         |
|       | EX-2                 |          | RBSP (2) |                | Aquarius       |            | Jason-1             | Aura            |                 |               |           |         |       |     |         |
|       |                      |          | MMS (4)  |                |                |            | OSTM/Jason 2        | SORCE           |                 |               |           |         |       |     |         |
|       |                      |          | IRIS     |                |                |            | QuikSCAT            | EO-1            |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | Voyager (2)         | Terra           |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | <i>Mars Express</i> | TRMM            |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | Mars Odyssey        | Landsat 7~      |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | MER (1)             | ARTEMIS* (2)    |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | Cassini             | THEMIS (3)      |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | MRO                 | STEREO (2)      |                 |               |           |         |       |     |         |
|       |                      |          |          |                |                |            | Deep Impact         | AIM             |                 |               |           |         |       |     |         |

**NOAA Reimbursable:**  
GOES-R series, Jason-3, JPSS-1&2, DSCOVR

RHESSI SOHO TIMED IBEX  
WIND ACE GEOTAIL CINDI  
TWINS-A TWINS-B

6  
Cluster-2 (4)

SOFIA is a mission project but does not add spacecraft

*Italics* = US instruments on foreign mission  
X / Y = # of missions / # of spacecraft

\* New missions two of the THEMIS spacecraft, respectively

~ Operated by another agency

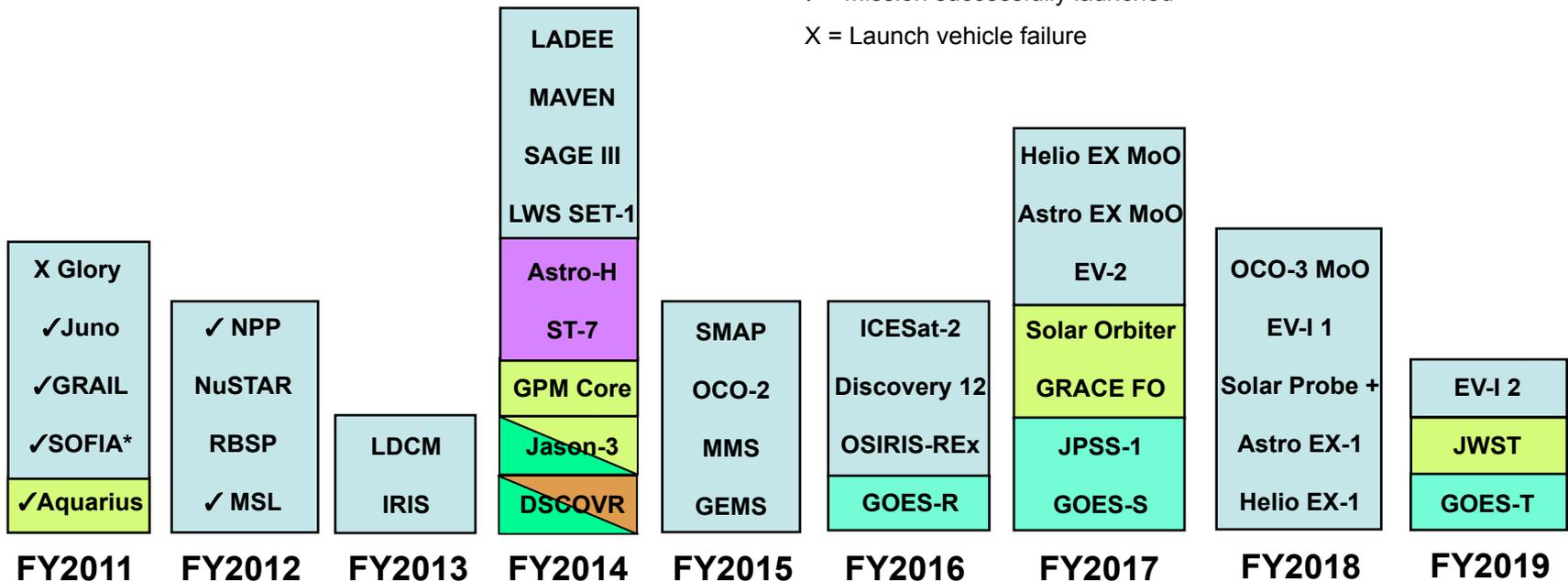
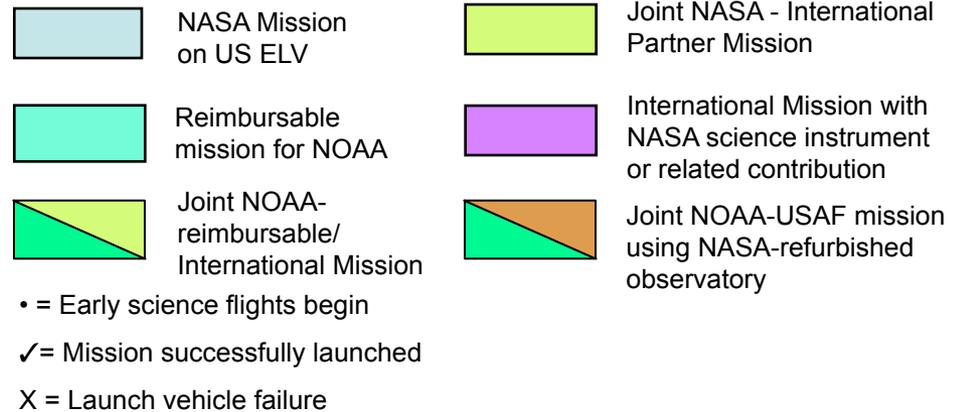
# Being reassessed per new Decadal Survey

# NASA Science Missions By Launch Year

## (Fiscal Years 2011-19 – **FY13 Budget Request**)

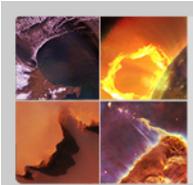
As of 2/13/12

For Internal NASA Planning Purposes Only



# Major Accomplishments

- **We are able to image in 3D solar flares and coronal mass ejections (CME) of the new Solar Cycle 24** with unprecedented resolution in space, time, and wavelength, providing crucial data for improved space weather forecasting models.
- **We are able to track solar storms all the way from the Sun to Earth.** These observations reveal the magnetic underpinnings of CMEs, show us how CMEs evolve in transit, and produce dramatic footage of the storm clouds engulfing Earth.
- **We have discovered that Earth's atmosphere extends farther into space than previously thought.** Nine seasons of Polar Mesospheric Cloud monitoring and 10 years of TIMED observations, show that all layers of Earth's atmosphere—even distant layers like the thermosphere, ionosphere and plasmasphere—are coupled to the weather and climate of our Earth below.
- **We have discovered "magnetic bubbles" at the edge of the Solar System and "alien matter" inside.** The IBEX spacecraft detected atoms from interstellar space penetrating the inner solar system: the chemistry of the Solar System appears to be different from the space outside. Meanwhile, the Voyagers detected a froth of vast magnetic bubbles at the edge of the heliosphere: these bubbles help protect us from cosmic rays.
- **We have developed a new Interplanetary Space Weather forecasting service** for researchers, spacecraft operators, and members of the general public. A joint effort with NSF, DOD, and NOAA, the service tracks solar storms throughout the solar system and is available 24/7 on the Internet.



# Heliophysics Division FY13 Budget Content

- Future launches:

September 2012	Radiation Belt Storm Probes (RBSP) – on track for Aug 2012 launch
June 2013	Interface Region Imaging Spectrograph (IRIS) – on track for Jan 2013 Launch
March 2015	Magnetospheric MultiScale (MMS) – on track for Oct 2014 launch
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

# Heliophysics Budget Features

## What Changed:

- Covers increased launch vehicle costs
- Modest investment in Sounding Rocket Sustainer Motor design activity.

## What's the Same:

- Fully funds missions in formulation/development: RBSP/ BARREL, IRIS, MMS, SOC, SPP.
- Continues support for 16 operating missions (Voyager, Wind, ACE, TIMED, RHESSI, STEREO, THEMIS/ARTEMIS, AIM, IBEX, SDO; *Partnerships*: Geotail, SOHO, Cluster, Hinode; *MO*: TWINS, CINDI).
- Maintains Supporting Research and Suborbital Program

# Heliophysics Program Content

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				<i>(FY14-17 estimates are notional)</i>			
<b>Heliophysics</b>	<b>634.1</b>	<b>620.2</b>	<b>643.7</b>	<b>643.0</b>	<b>633.2</b>	<b>638.3</b>	<b>661.6</b>
<u>Heliophysics Research</u>	<u>160.8</u>	<u>175.2</u>	<u>178.9</u>	<u>162.6</u>	<u>168.5</u>	<u>170.3</u>	<u>171.6</u>
Heliophysics Research and Analysis	34.0	32.9	32.7	31.0	31.5	31.5	31.5
Sounding Rockets	45.9	52.3	56.1	51.6	56.3	53.0	53.0
Research Range	19.5	20.1	20.5	21.0	21.3	21.6	21.7
<u>Other Missions and Data Analysis</u>	<u>61.4</u>	<u>69.9</u>	<u>69.6</u>	<u>58.9</u>	<u>59.5</u>	<u>64.2</u>	<u>65.5</u>
Voyager	4.4	5.3	5.3	5.4	5.4	5.5	5.5
ACE	3.4	3.7	3.7	3.7	3.7	3.8	3.8
SOHO	1.9	2.0	2.1	2.2	1.9	1.9	1.9
WIND	2.1	2.0	2.1	2.2	2.2	2.2	2.2
RHESSI	1.7	1.9	2.0	2.1	2.0	2.1	2.1
CLUSTER-II	2.1	1.5	1.2	0.8			
TIMED	3.0	3.0	2.8				
GEOTAIL	0.3	0.2	0.2				
TRACE	0.3						
SOLAR Data Center	1.0	0.7	0.8	0.8	0.8	0.9	0.9
SEC Data & Modeling Services	3.8	3.7	3.7	3.7	3.8	3.8	3.9
Space Physics Data Archive	1.4	1.4	1.3	1.3	1.3	1.4	1.4
SEC Guest Investigator Program	11.3	10.4	12.1	11.9	10.5	13.8	13.8
CCMC	1.8	2.0	2.0	1.8	1.8	1.8	1.8
Science Data & Computing	4.8	2.8	4.2	4.0	4.2	4.4	4.4
SSC MO Services	9.9	10.1	10.7	11.0	11.3	11.6	11.7
Directed Research & Technology		13.5	11.9	4.4	6.9	7.4	8.4
Science Planning and Research Support	5.2	5.7	3.5	3.6	3.7	3.7	3.8
GSFC Building Support	3.0						

# Heliophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				<i>(FY14-17 estimates are notional)</i>			
<u>Living with a Star</u>	<u>213.4</u>	<u>196.0</u>	<u>229.2</u>	<u>212.2</u>	<u>282.7</u>	<u>336.6</u>	<u>351.7</u>
Radiation Belt Storm Probes (RBSP)	146.1	86.1	37.7	14.5	9.1		
Solar Probe Plus	13.9	49.5	112.1	103.2	137.1	229.3	215.2
Solar Orbiter Collaboration	8.3	21.3	21.3	58.2	102.1	75.6	100.0
<u>Other Missions and Data Analysis</u>	<u>45.1</u>	<u>39.0</u>	<u>58.2</u>	<u>36.3</u>	<u>34.3</u>	<u>31.8</u>	<u>36.5</u>
Solar Dynamics Observatory (SDO)	21.8	15.1	16.3	14.2	9.6	9.6	9.7
BARREL	1.6	1.6	1.9	1.5	0.3		
LWS Space Environment Testbeds	0.4	0.5	0.4				
LWS Science	17.0	15.0	19.8	17.5	17.5	19.8	20.8
LWS Program Management and Future Missions	4.4	6.8	19.8	3.1	6.9	2.4	6.0
<u>Solar Terrestrial Probes</u>	<u>168.3</u>	<u>188.7</u>	<u>189.4</u>	<u>179.8</u>	<u>64.5</u>	<u>46.7</u>	<u>53.4</u>
Magnetospheric Multiscale (MMS)	150.8	170.3	168.3	157.6	42.9	20.4	12.5
<u>Other Missions and Data Analysis</u>	<u>17.4</u>	<u>18.5</u>	<u>21.1</u>	<u>22.2</u>	<u>21.6</u>	<u>26.3</u>	<u>40.9</u>
Solar Terrestrial Relations Observatory (STEREO)	8.2	9.0	8.5	9.6	9.6	9.7	9.7
Hinode (Solar B)	8.0	8.2	8.2	8.4	8.4	8.5	8.6
STP Program Management and Future Missions	1.2	1.4	4.4	4.1	3.5	8.0	22.6

# Heliophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				<i>(FY14-17 estimates are notional)</i>			
<u>Heliophysics Explorer Program</u>	<u>91.7</u>	<u>60.2</u>	<u>46.1</u>	<u>88.4</u>	<u>117.5</u>	<u>84.8</u>	<u>84.8</u>
IRIS	63.5	39.1	12.1	7.3	1.2		
<u>Other Missions and Data Analysis</u>	<u>28.1</u>	<u>21.1</u>	<u>34.0</u>	<u>81.1</u>	<u>116.3</u>	<u>84.8</u>	<u>84.8</u>
Explorer Future Missions		3.8	14.9	63.5	101.0	65.5	65.6
THEMIS	10.9	6.0	4.4	4.6	3.0	5.2	5.2
Aeronomy of Ice in Mesosphere (AIM)	3.5	3.0	3.0	3.1	3.0	3.0	3.0
Interstellar Boundary Explorer (IBEX)	1.5	1.6	4.0	2.5	2.5	4.0	4.0
TWINS	1.0	1.0	1.0	0.6	0.6	0.6	0.6
CINDI	1.3	1.0	0.8	0.8	0.1		
Explorer Management	10.1	4.7	6.0	6.2	6.2	6.4	6.4
<u>New Millennium</u>	<u>0.1</u>						
Space Technology 7 (ST7)	0.1						

# Heliophysics FY12 and FY13 Planned Accomplishments

- Launch of the Radiation Belt Storm Probes (RBSP), IRIS, and the first BARREL balloon campaign.
- MMS will complete Systems Integration Review and start integration and test.
- Solar Orbiter and Solar Probe Plus missions will retire technology development risks before moving from formulation into development.
- Selection of the next Heliophysics Explorer.
  - Develop replacement sounding rocket sustainer motor design, releasing to industry for manufacture. Program to support the launch of ~20 rockets.
  - Conduct Senior Review of Heliophysics Missions, issuing instructions for an in-guide program to support the Heliophysics Systems Observatory.
  - Receive NRC Decadal Survey and conduct strategic planning activities for in-guide deployment of highest priority recommendations.

Colored box: HPD program lines  
 Grey box: efforts supporting program lines  
 Bullet: appears in budget  
 No bullet: not explicitly in budget  
 Grey letters: exists as part of other elements

# FUNDED AND LEVERAGED ACTIVITIES

Funded Programs

	<u>Solar Terrestrial Probes</u> fundamental, universal questions in solar and space physics	<u>Living with a Star</u> physics of the coupled Sun-Earth system that affect life and society	<u>Heliophysics Explorer Program</u> high-priority, highly-focused science not addressed within STP and LWS	<u>Heliophysics Research</u> foundational investigations combining data analysis, modeling, and theory	
Flight Development	<ul style="list-style-type: none"> <li>• <b>MMS</b></li> <li>• STP Future</li> </ul>	<ul style="list-style-type: none"> <li>• <b>RBSP</b></li> <li>• BARREL</li> <li>• SET</li> <li>• <b>SPP</b></li> <li>• <b>SOC</b></li> <li>• LWS Future</li> </ul>	<ul style="list-style-type: none"> <li>• <b>IRIS</b></li> <li>• EX Future</li> </ul>	<ul style="list-style-type: none"> <li>• Research Range*</li> <li>• Sounding Rockets*</li> </ul> <p><i>* Managed for all SMD</i></p>	Flight Development
Research & Analysis	MMS Interdisciplinary Scientists (IDS)	<ul style="list-style-type: none"> <li>• LWS Science</li> </ul>	EX U.S. Participating Investigators (USPI)	<ul style="list-style-type: none"> <li>• Heliophysics Research and Analysis</li> <li>• SEC Guest Investigator</li> </ul>	Research & Analysis
System Observatory	<ul style="list-style-type: none"> <li>• STEREO</li> <li>• Hinode</li> </ul>	<ul style="list-style-type: none"> <li>• SDO</li> </ul>	<ul style="list-style-type: none"> <li>• THEMIS/ARTEMIS</li> <li>• AIM</li> <li>• IBEX</li> <li>• TWINS</li> <li>• CINDI</li> </ul>	<ul style="list-style-type: none"> <li>• Voyager</li> <li>• Wind</li> <li>• ACE</li> <li>• SOHO</li> <li>• SSC MO Services</li> <li>• TIMED</li> <li>• RHESSI</li> <li>• Cluster II</li> <li>• Geotail</li> </ul>	System Observatory
Technology & Data Systems	Tech Development for future missions	Tech Development for future missions	Tech Development for future missions	<ul style="list-style-type: none"> <li>• Solar Data Center</li> <li>• SEC Data &amp; Modeling</li> <li>• Science Data &amp; Computing</li> <li>• Space Physics Data Archive</li> </ul>	Technology & Data Systems

**Space Weather:** Beacon services, R2O, R2A, Intra- & Inter-Agency Coordination, Space Environment Services

• CCMC

**Education and Public Outreach**

**Heliophysics Communications and Event Management**

**International Activities:** ILWS, IHY, UN Committee on the Peaceful Uses of Outer Space, International Space Weather Initiative

**Legislative Affairs, OSTP and OMB Support**

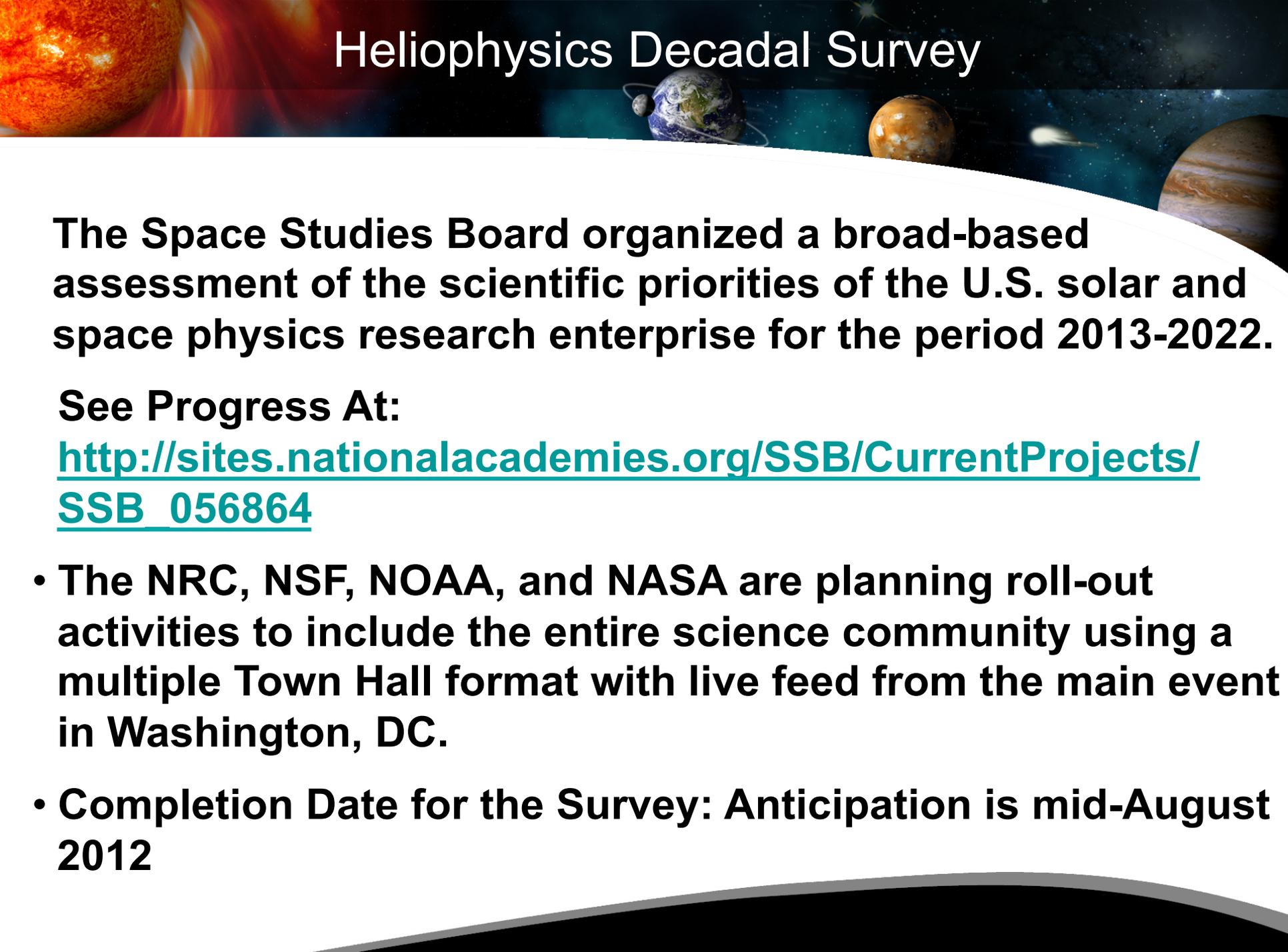
**Strategic Planning:** HPD Roadmap; HPD narrations in NASA Strategic Plan, SMD Science Plan, NASA Performance Report, and Budget Justifications; NAC NRC POC; Heliophysics Subcommittee; NAC Science Committee POC

**Administrative:** Mail, office activities, correspondence, travel

**Resource Management**

**Program Support:** admin budgeting, logistics, HR, PR/Contracting

Coordinated and Leveraged Initiatives →



# 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](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.**
- Completion Date for the Survey: Anticipation is mid-August 2012**

## **In closing ...**

- Explorer Concept Study Reports due to NASA at end of September, Review begins for downselect in Spring 2013.

## **Items you'll hear about from our team members ...**

- Senior Review Guidelines for FY2013
- Follow-up to the submission requirements change in ROSES 2012
- National Research Council release of Decadal Survey and plans for Heliophysics Division response
- Coordination of Inter- and Intra- Agency Space Weather Working Groups

A composite image showing the Sun on the left, the Earth on the right, and the Moon in the foreground on the left. The Sun is a bright yellow-orange sphere with visible solar flares. The Earth is a blue and white planet with visible continents and oceans. The Moon is a large, grey, cratered sphere. The background is a dark space filled with stars.

**How and why does the Sun vary and affect Earth and the rest of the solar system?**