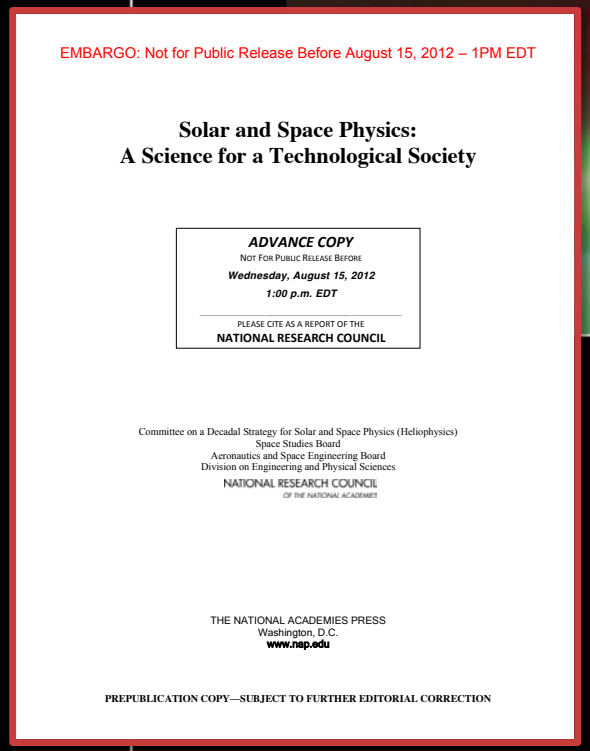
heliophysics

and the 2012 NRC Solar and Space Physics "Decadal Survey" Interim Status



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Solar and Space Physics:
A Science for a Technological Society

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NATIONAL RESEARCH COUNCIL

Committee on a Decadal Strategy for Solar and Space Physics (Heliophysics)
Space Studies Board
Aeronautics and Space Engineering Board
Division on Engineering and Physical Sciences
NATIONAL RESEARCH COUNCIL
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Dr. Barbara Giles • NASA Headquarters
October 12, 2012

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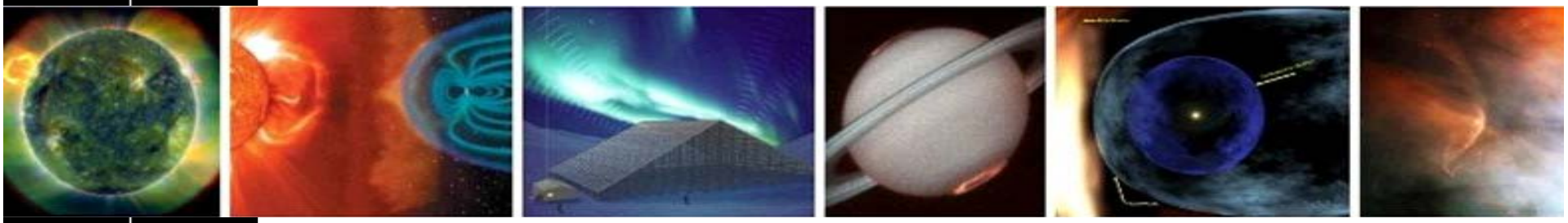


The 2013-2022 NRC Decadal Survey in Solar and Space Physics (Heliophysics): Solar and Space Physics: A Science for a Technological Society

Daniel N. Baker, University of Colorado, Chair
Thomas H. Zurbuchen, University of Michigan, Vice-Chair

National Research Council Staff
Art Charo, Space Studies Board, Study Director
Abigail Sheffer, Space Studies Board

Guiding Principles

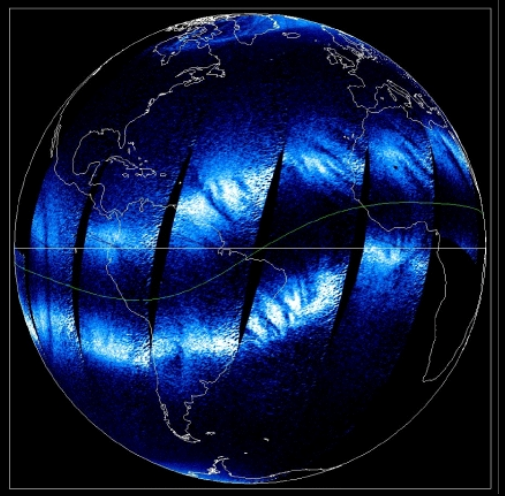
- To make transformational scientific progress, the Sun, Earth, and heliosphere must be studied **as a coupled system**.
- To understand the coupled system requires that **each sub-discipline be able to make measurable advances** in achieving its key scientific goals.
- Success across the entire field requires that the various elements of solar and space physics research programs—the enabling foundation comprising theory, modeling, data analysis, innovation, and education, as well as ground-based facilities and small-, medium-, and large-class space missions—be deployed with **careful attention to both the mix of assets and to the schedule** (cadence) that optimizes their utility over time.
- A proposed program needs to fit a realistic resource envelope and **address research and operational aspects** of the field.

Overarching Goals for a Decade of Discovery

- Determine the origins of the Sun's activity and predict the variations of the space environment.
- Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.
- Determine the interaction of the Sun with the solar system and the interstellar medium.
- Discover and characterize fundamental processes that occur both within the heliosphere and throughout the universe.

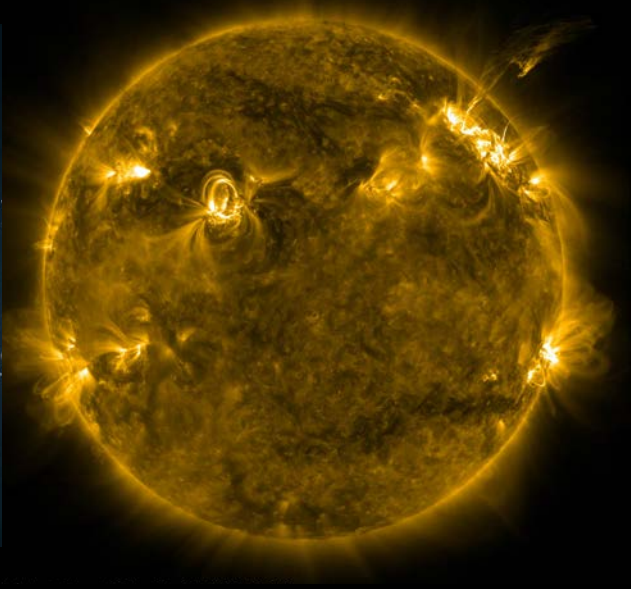
SMD Heliophysics Goals: 2010 SMD Science Plan to now

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***

Decadal Survey Research Recommendations

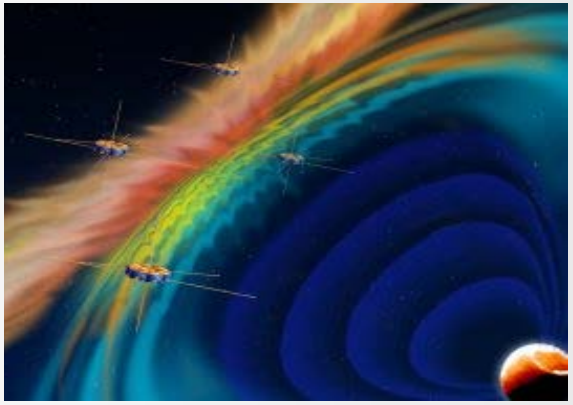
Assumes the Heliophysics budget grows from $650M to $750M by 2024

Recommendations	Science	Cost
Complete the current Program	Support the existing program elements that constitute the Heliophysics Systems Observatory (HSO) and complete missions in development (RBSP, IRIS, MMS, SOC, SPP).	Assumes no cost growth for any of these elements
DRIVE (Diversify, Realize, Integrate, Venture, Educate)	Strengthen observational, theoretical, modeling, and technical advances with additional R&A capabilities: small satellites; MO&DA funding, science centers and grant programs; instrument development	Program rebalance: move up to $40M/yr into Research
Accelerate and expand Heliophysics Explorer Program	Launch every 2-3 years, alternating SMEX & MIDEX with continuous Missions of Opportunity.	Program rebalance: move$70M/yr into Explorers
Restructure STP line as a moderate scale, PI-led flight program. Implement three mid-scale missions.	Mission 1: Understand the interaction of the outer heliosphere with the interstellar medium; includes L1 space weather observations Mission 2: Understand how space weather is driven by lower atmosphere weather. Mission 3: Understand how the magnetosphere-ionosphere-thermosphere system is coupled and responds to solar forcing.	$520M per mission in FY12$; launches in 2021, 2025, 2029
Start another LWS mission by the end of the decade.	Mission 4: Study the ionosphere-thermosphere-mesosphere system in an integrated fashion.	$1B mission, Launch 2024

Notes: 1) Recommendations listed above are top level, each contains a number of sub-elements
2) Recommendations are listed in priority order, pending budget constraints
3) Recommendations are separable by Agency, only NASA Recommendations are listed here

#1 Priority: NEW Missions:

MMS



Microphysics of magnetic reconnection, particle acceleration, and turbulence

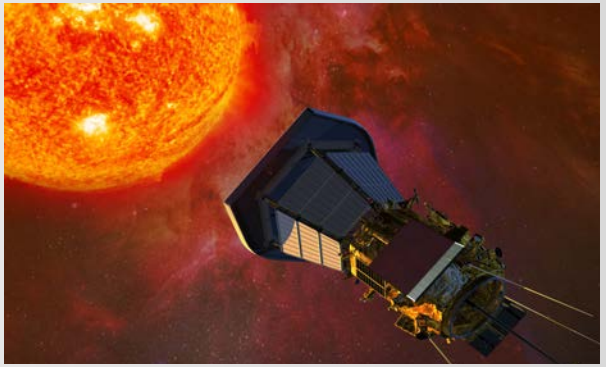
IRIS

Flow of energy and plasma through the chromosphere and transition region into the corona

Solar Orbiter

Determine the origins and causes of the supersonic solar wind, the sun's magnetic field, and massrive eruptions from disturbances on the sun's surface

Solar Probe Plus



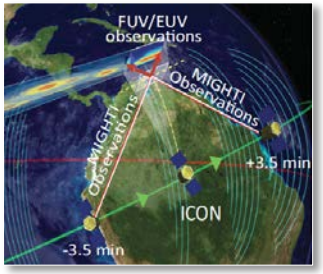
Understand coronal heating and the origin and acceleration of the solar wind

#1 Priority: OUR NEXT EXPLORER(S) WILL BE CHOSEN FROM THESE CONCEPTS

ICON

Ionospheric Connection Explorer

PI: T. Immel UC Berkeley

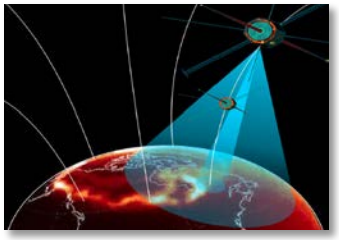


- How neutral atmosphere affects the ionosphere
- How solar wind and magnetosphere affect the ionosphere

OHMIC

Observatory for Heteroscale Magnetosphere–Ionosphere Coupling

PI: J. Burch / SWRI

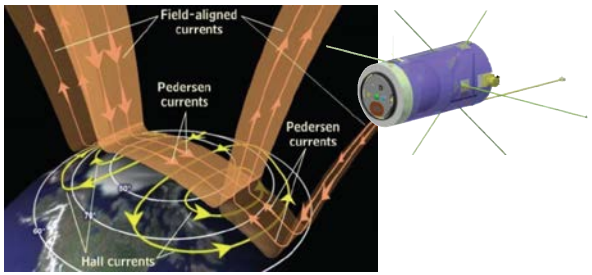


- How magnetospheric EM energy flows downward to power aurora
- How ion outflows are initiated and modify the underlying ionosphere

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

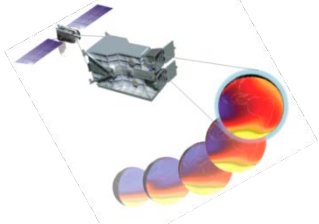
Mission of Opportunity Selections

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

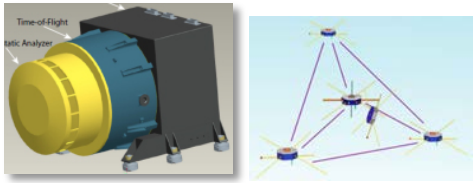


… how the ionosphere and thermosphere respond to geomagnetic storms, solar radiation, and upward propagating atmospheric tides

IMSA on SCOPE

Ion Mass Spectrum Analyzer

PI: L. Kistler / U. New Hampshire

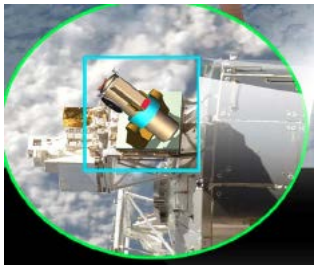


… fundamental processes of reconnection, particle acceleration, and turbulence … focused on the feedback mechanisms between ion and electron scale lengths

CPI on the ISS

Coronal Physics Investigator

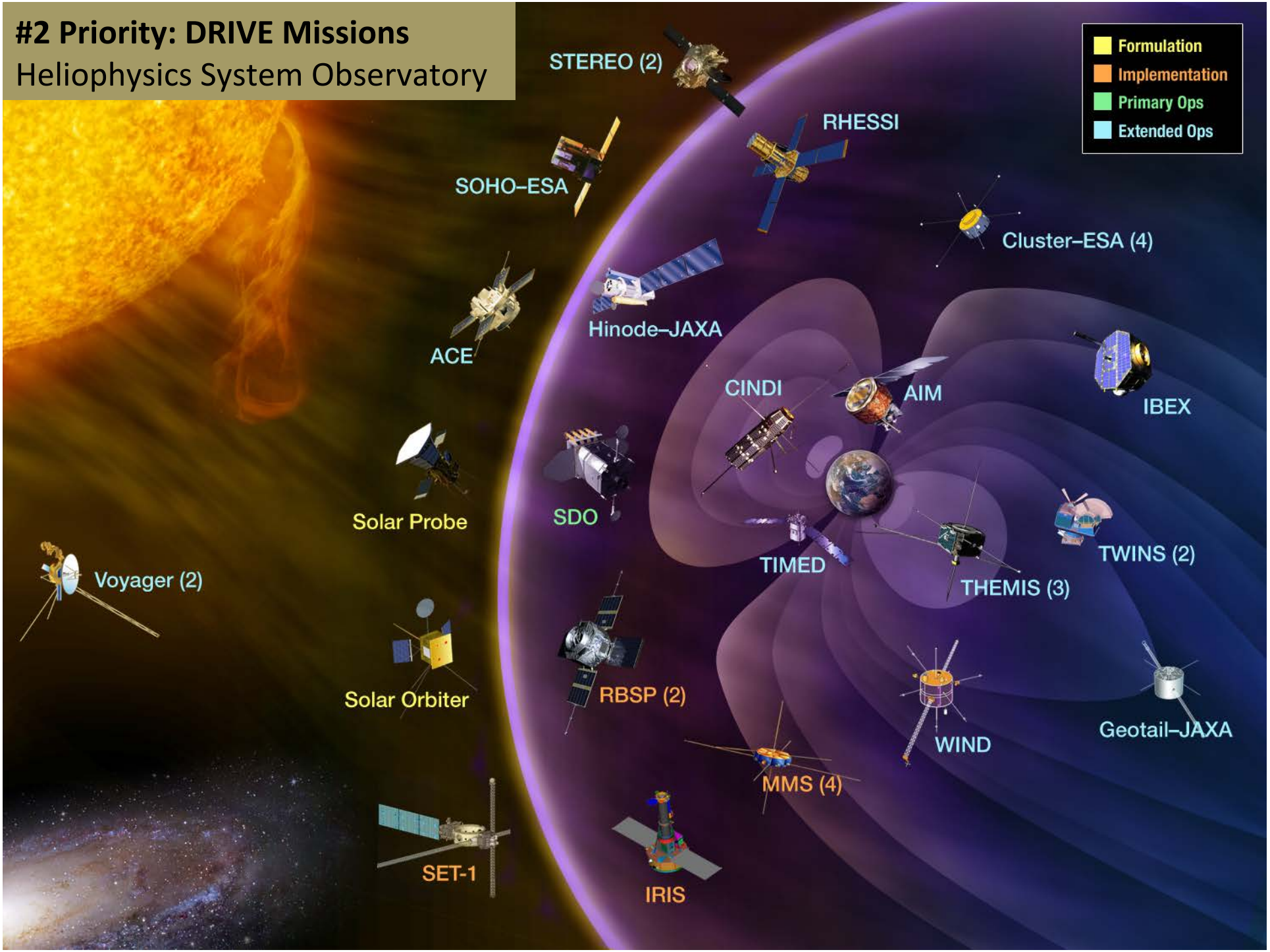
PI: John Kohl / SAO



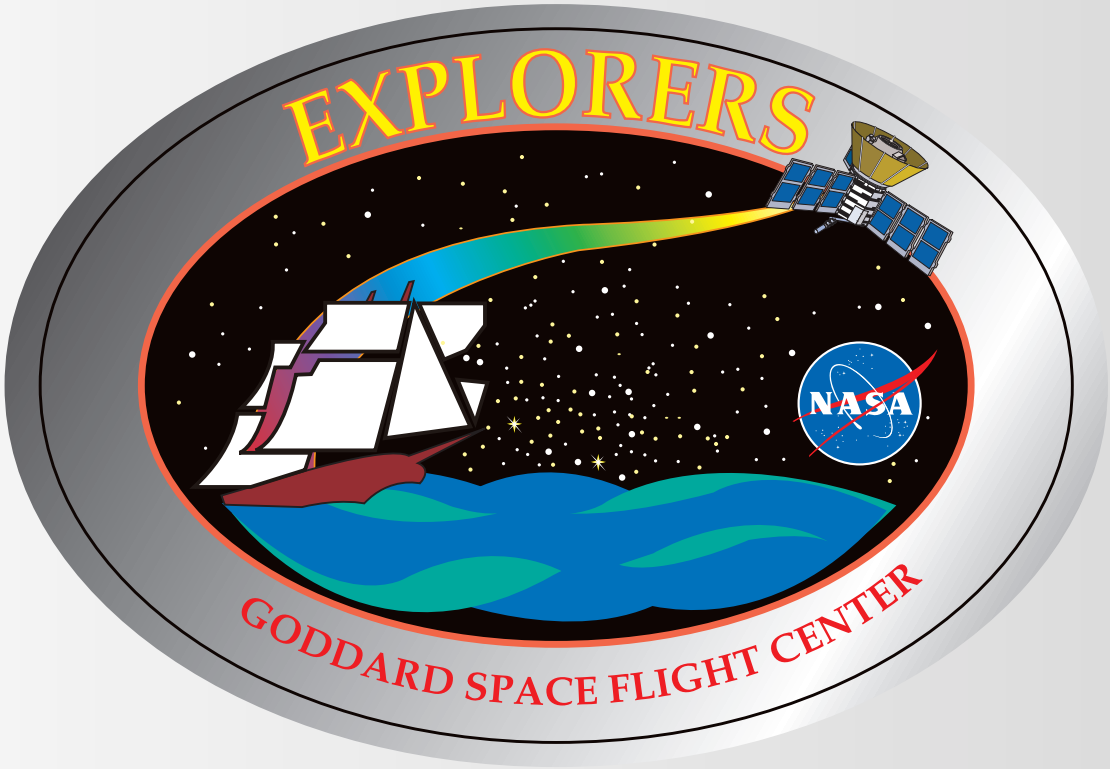
… processes that heat and accelerate the plasma components of the slow and fast solar wind

#2 Priority: DRIVE Missions

Heliophysics System Observatory

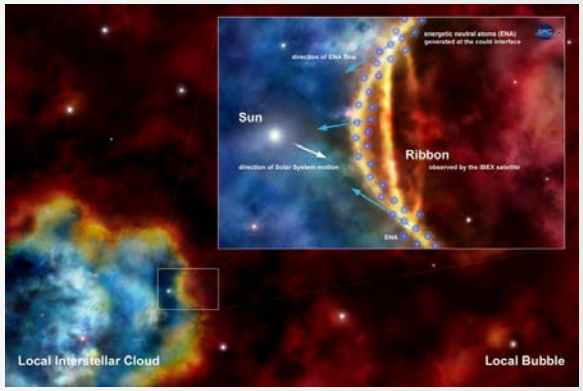


#3 Priority:
New Explorers



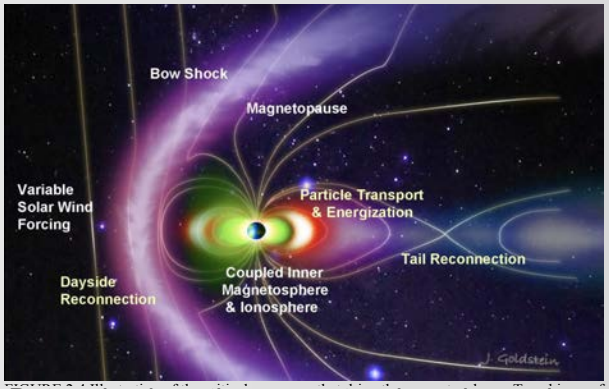
#4 and #5 Priority: New Missions for this Decade Continued

IMAP



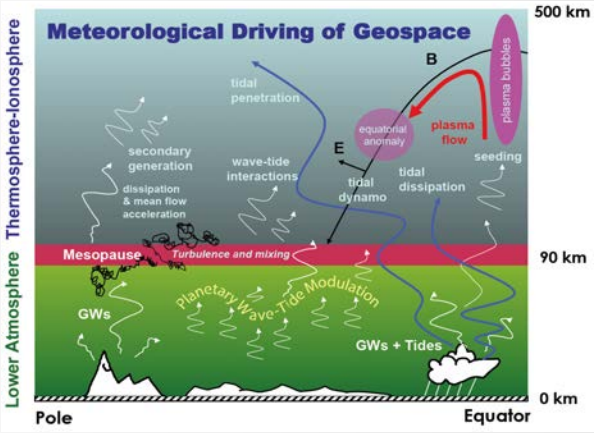
Understand the outer heliosphere and its interaction with the interstellar medium

MEDICI



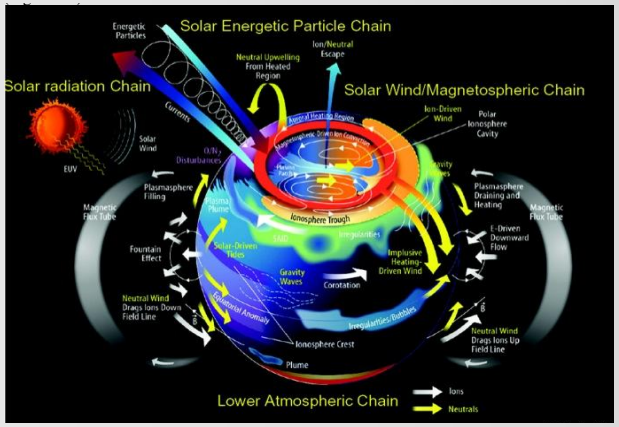
Determine how the magnetosphere-ionosphere-thermosphere system is coupled and how it responds to solar and magnetospheric forcing

DYNAMIC



Understand the variability in space weather driven by lower-atmosphere weather on Earth

GDC



Understand how Earth's extended atmosphere absorbs solar wind energy

Future Enabling Budget Scenario

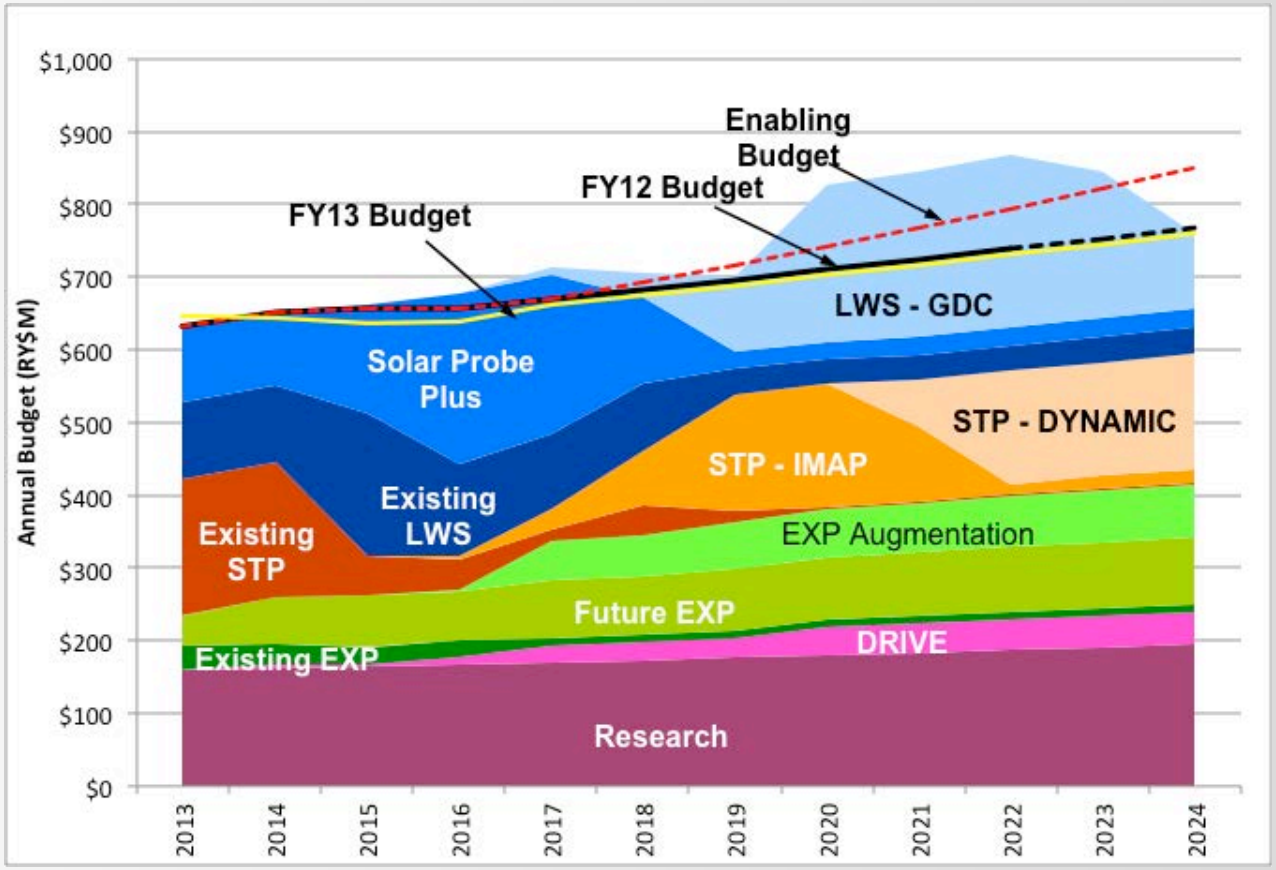


Figure 6.1 from Decadal survey (pg 6-2). Heliophysics budget and program plan by year and category from 2013 to 2024. GDC, the next large mission of the LWS program after SPP, rises above the baseline curve in order to achieve a more efficient spending profile, as well as to achieve deployment in time for the next solar maximum in 2024. President's FY13 budget (yellow line) added separately.

A New Vision for Space Weather and Space Climate

Strengthen the current National Space Weather Program

- Re-charter the National Space Weather Program
- Multi-agency Partnership for Solar/Solar Wind Observations
  - L1 Solar Wind (DSCOVR, IMAP)
  - Coronagraph and Magnetograph
  - Evaluate New Observations and Platforms
  - Establish a SWx Research Program for Effective Research to Operations Transition at NOAA
  - Establish Distinct Programs for Space Physics Research and Space Weather Forecasting and Specification

Scenario for NASA: Space Weather and Climatology (SWaC) program ~$200M/year augmentation over existing budget

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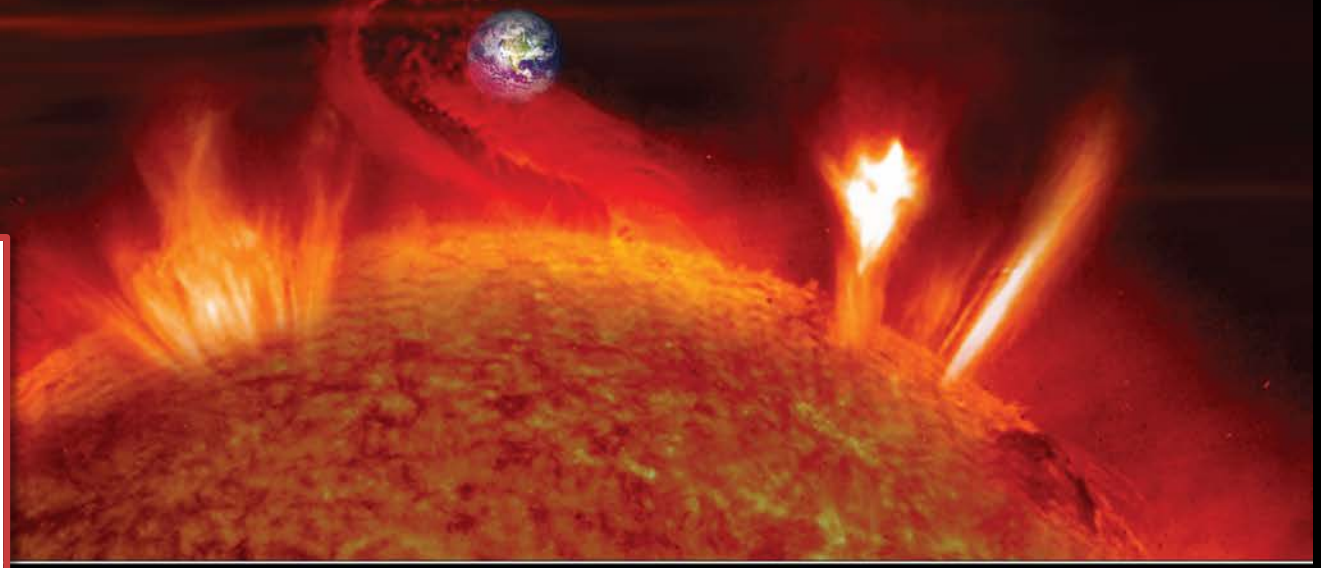

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