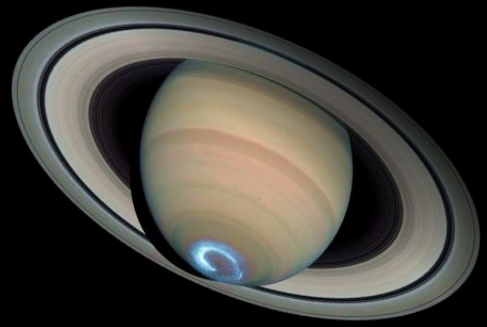
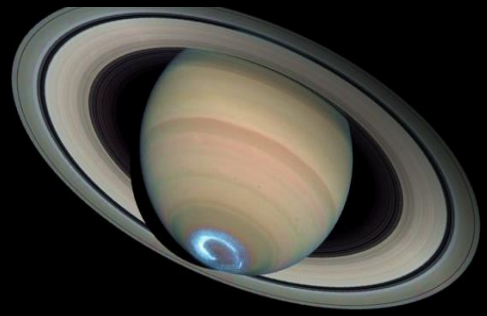
NASA's effort to characterize, understand and predict space weather events and provide an update on international cooperation in SWx Science



Madhulika Guhathakurta
NASA Headquarters
Science Mission Directorate/Heliophysics Division
March 2nd 2015

"Space weather" refers to magnetic disturbances and high radiation levels that result from solar activity.

Auroras, power outages and radio blackouts are some of the many manifestations we experience on Earth.



HUMANS & THEIR ROBOTS ARE MOVING INTO THE SOLAR SYSTEM.
THE REALM OF SPACE WEATHER FORECASTING
IS RAPIDLY EXPANDING.

Space Weather: Why should we care?

Our society is getting much more dependant on technology

The most rapidly growing sector of the communication market is satellite based

- Broadcast TV/Radio,
- Long-distance telephone service, Cell phones, Pagers
- Internet, finance transactions
- 250 million users if GPS

Change in technology

- more sensitive payloads
- high performance components
- lightweight and low cost

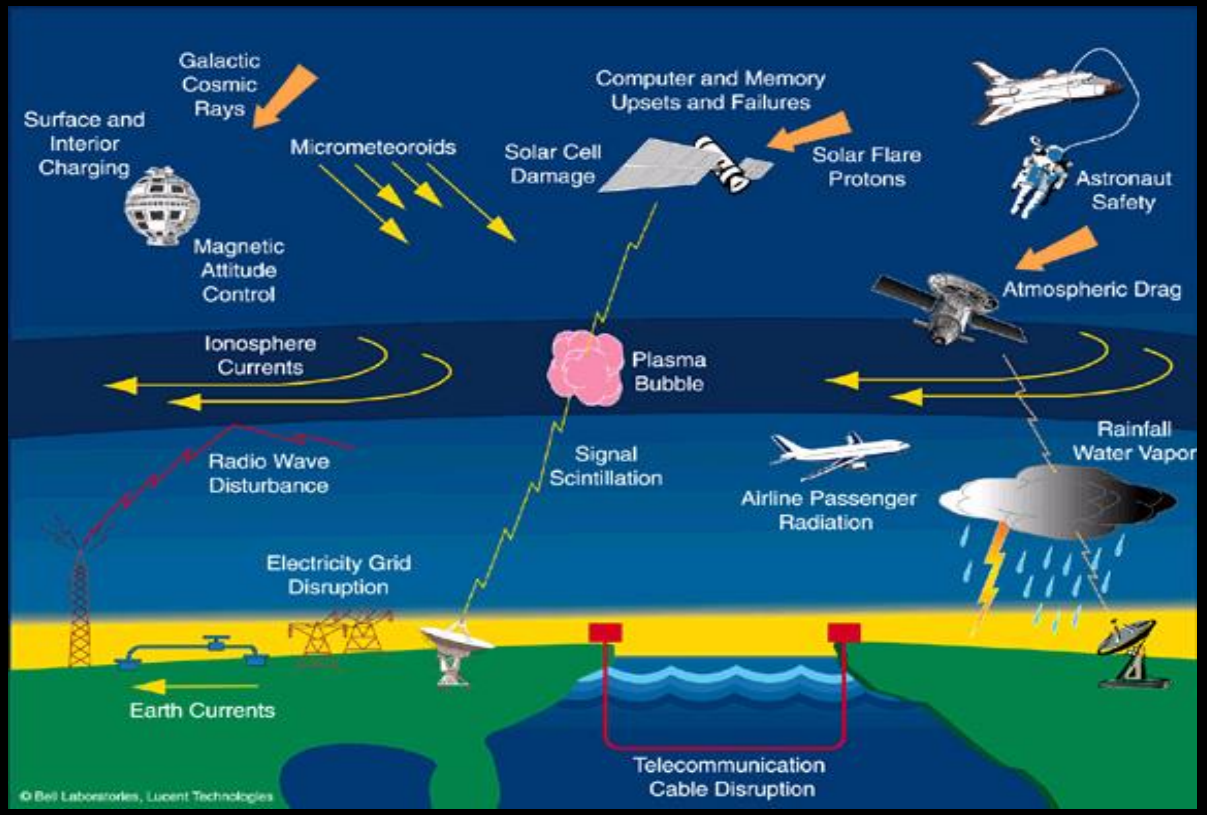
Humans in Space

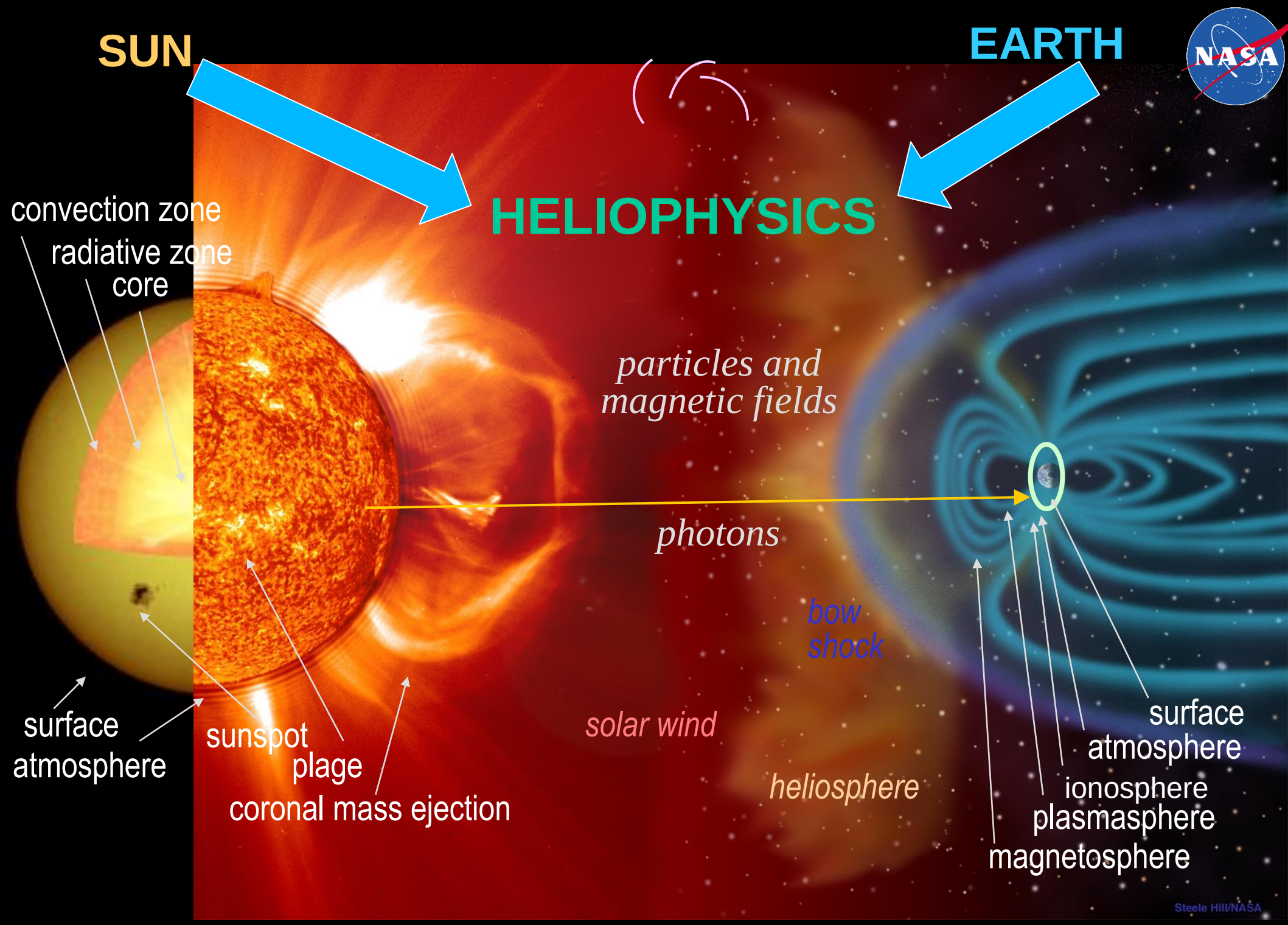
- More and longer manned missions

Space Weather warning will be very important for our society in the future

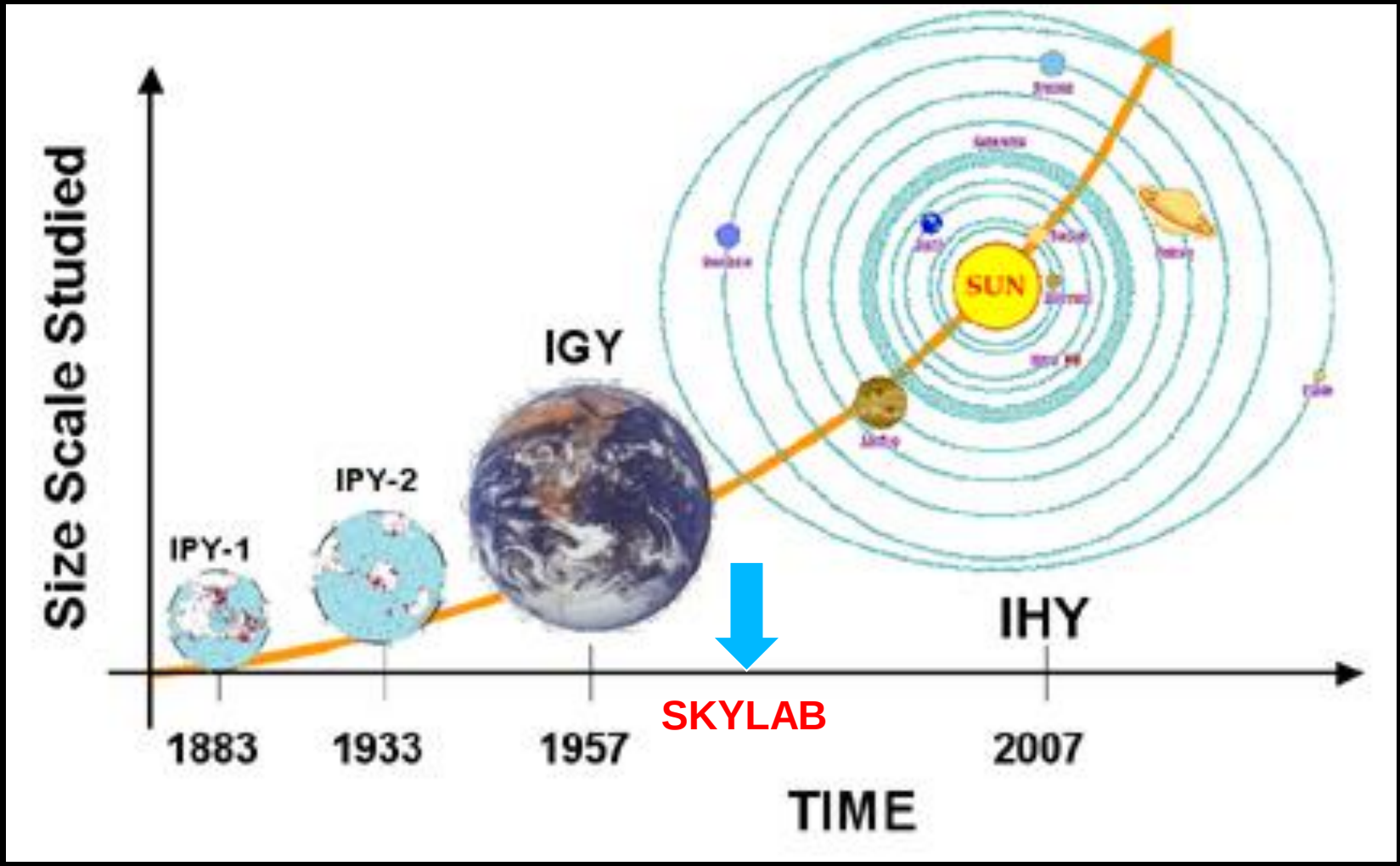
Damages: estimated to 200 M$ per year

- 100 M$ - satellites
- 100 M$ - powergrids
- 10 M$ - communication




SUN
EARTH
NASA
HELIOPHYSICS
convection zone
radiative zone
core
particles and
magnetic fields
photons
bow
shock
surface
atmosphere
sunspot
plage
coronal mass ejection
solar wind
heliosphere
surface
atmosphere
ionosphere
plasmasphere
magnetosphere
Steele Hill/NASA
not to scale

Evolution of System Studies



Heliophysical: A broadening of the concept "geophysical," extending the connections from the Earth to the Sun & interplanetary space.

Heliophysics as a Scientific Discipline

NASA's Earliest scientific successes Explorer 1 in 1958 Radiation Belts) and Mariner 3 in 1963 (Solar Wind), and SkyLab (1973 discovered previously undetected processes and conditions, that directly modulate the Earth. These efforts set the stage for the discovery of the connected system of systems in the solar system that comprise the focus of heliophysics research (past).

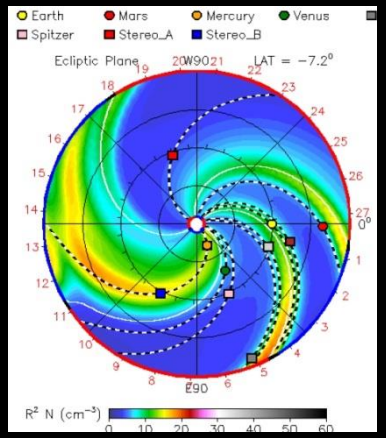
The system of systems is driven by the interaction of three forces, pressure, gravity and magnetism; for which the universal physical processes governing order and disorder have not yet been fully uncovered.

The results of research to date have yielded not only new cultural and intellectual knowledge, but have provided benefits with utility, both, political and economic, to the nation and the world.

What is Heliophysics

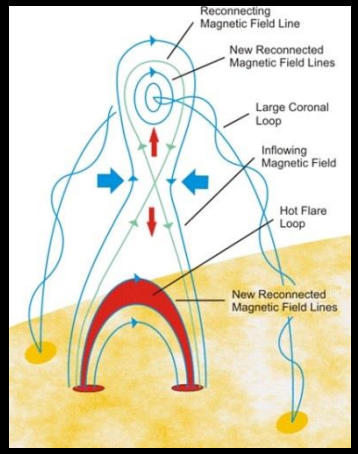
Heliophysics is an environmental science:
a unique hybrid between meteorology and astrophysics

It has an applied branch
space weather



Propagation models of solar disturbances out to 2 AU

And a pure branch
fundamental physical process



Magnetic reconnection

National Space Weather Program 1995

Living With a Star 2000

International Heliosphysical Year 2007

Applications directed science coordinated by NASA community

Applications directed science coordinated by NASA community

Add comparative heliospheric studies

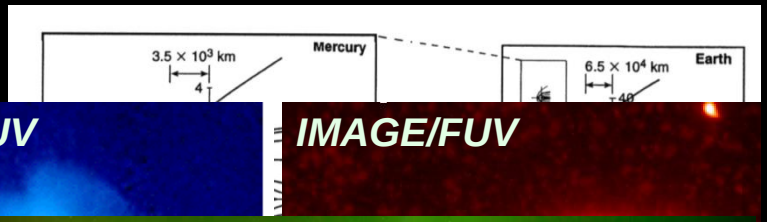
Sun-Earth System Science: Growth from a “consuming” science to a “producing” science for the benefit of humankind

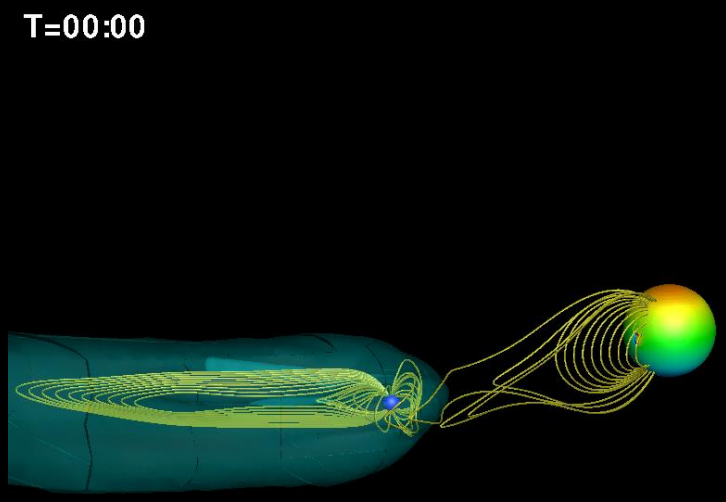
Space Weather is no longer the domain of Earth only!

Space Weather is now Interplanetary!!

Space Weather just became Exopla

Extreme Space Weat





SkyLab Heliophysics GAME CHANGERS

The Corona is hot and controlled by magnetic fields

➔ X-Ray and EUV Variability at Earth **(NOAA R-Scale)**

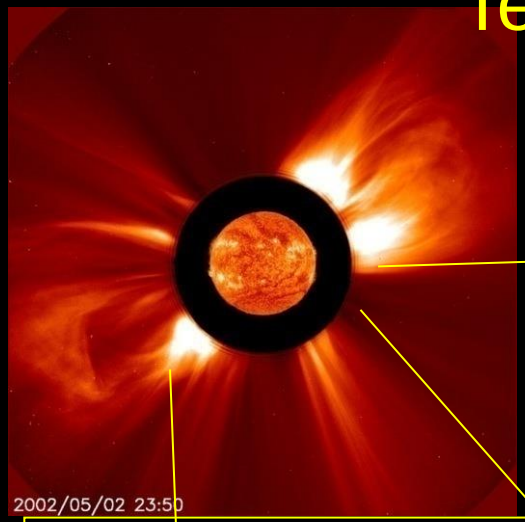
High-Speed Solar Wind originates from coronal holes

➔ Solar Particles Impact Earth **(NOAA S-Scale)**

Mass from the corona is ejected into interplanetary space

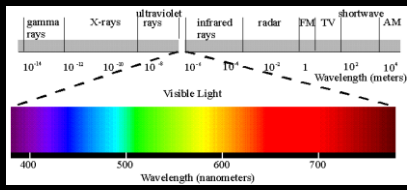
➔ Solar catastrophic events can impact Earth's magnetosphere **(NOAA G-Scale)**

Terrestrial Space Weather



Blame it on *B* *(magnetic field)*

Electro-magnetic Radiation



Ultra Violet and X-ray Radiation

8 minutes

Satellite drag; radio blackouts

R-Scale

Matter

Charged Particle Radiations

10-30 minutes

S-Scale

NOAA Space Weather Scales

Matter

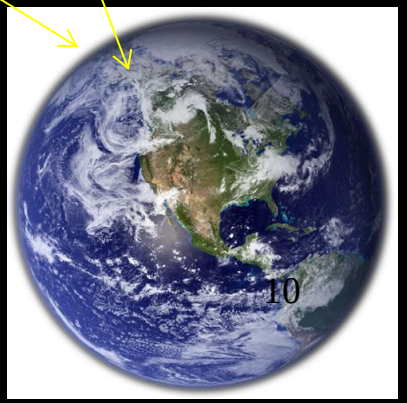
Magnetic Fields

Magnetized Blobs of Solar Material

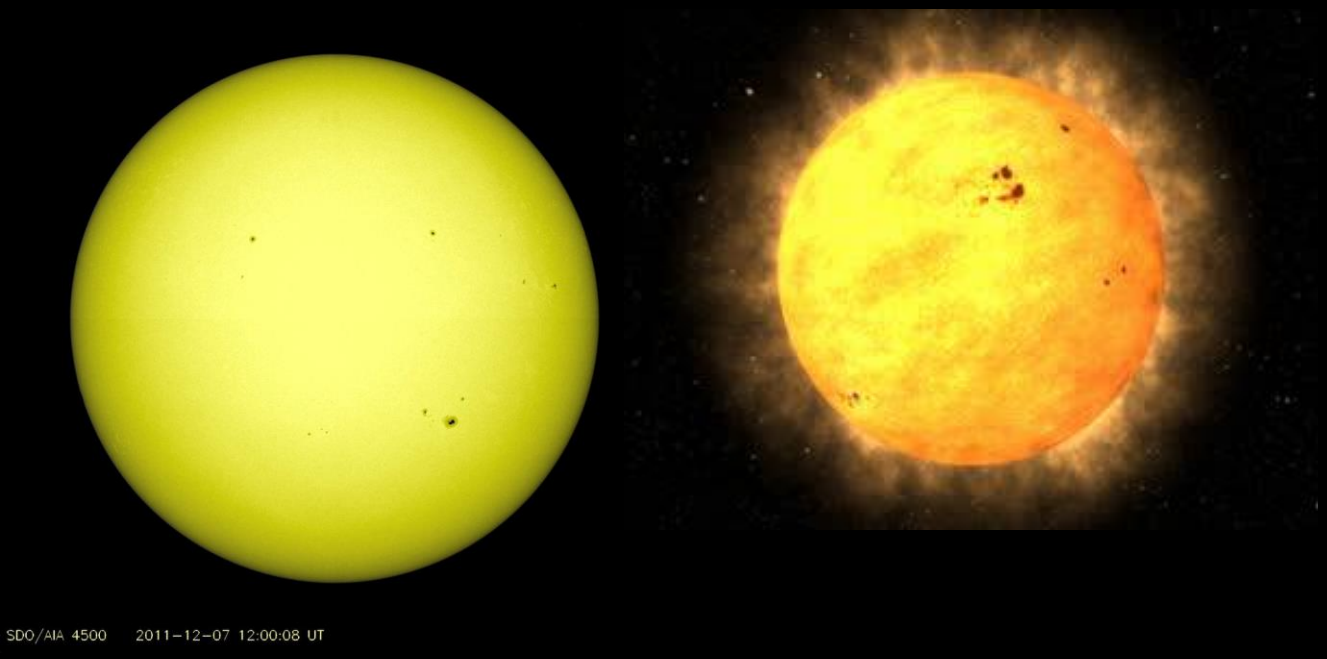
18-96 hours

Radiation: astronaut health. aviation & satellite function

G-Scale



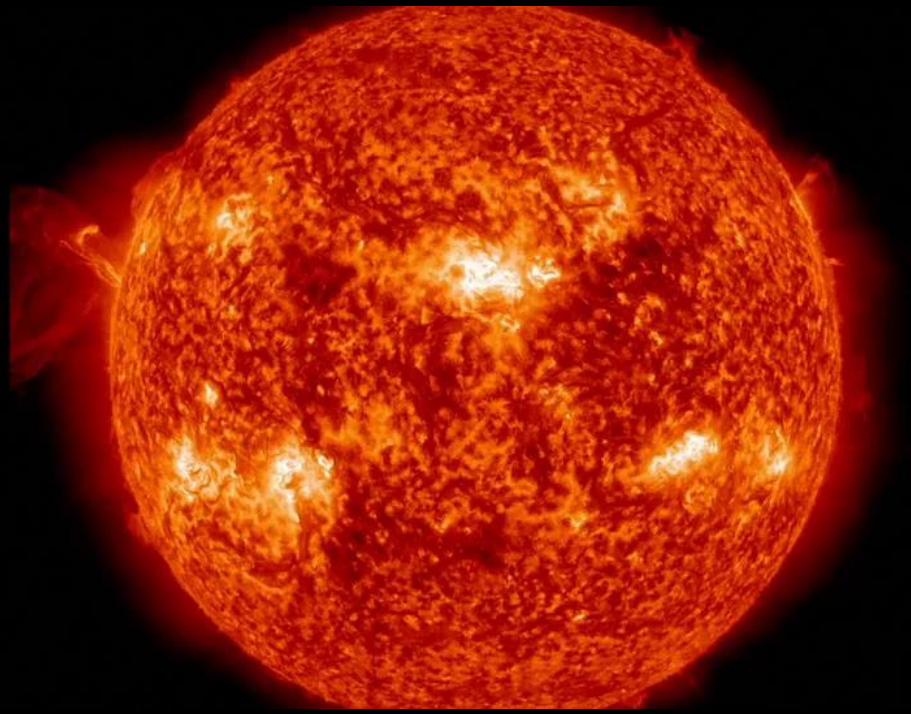
Aurora; geomagnetic storms & radio disturbances



Understanding the Sun and its interactions with the Earth and the Solar System, including space weather

Solve fundamental mysteries of Heliophysics

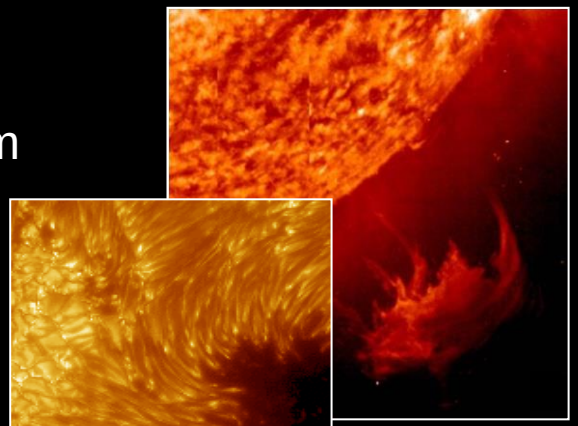
Understand the nature of our home in space

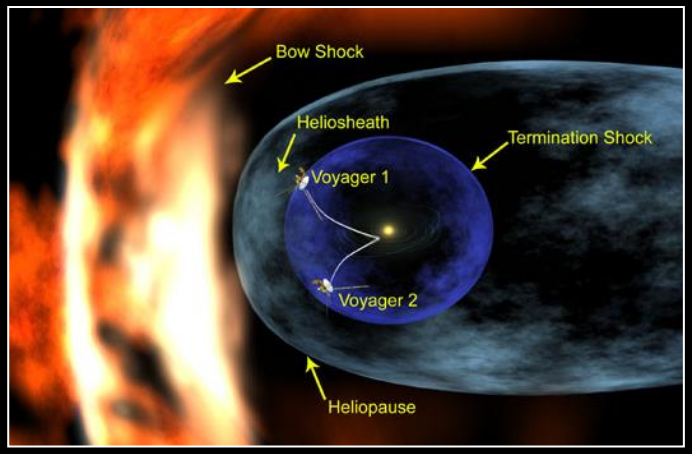


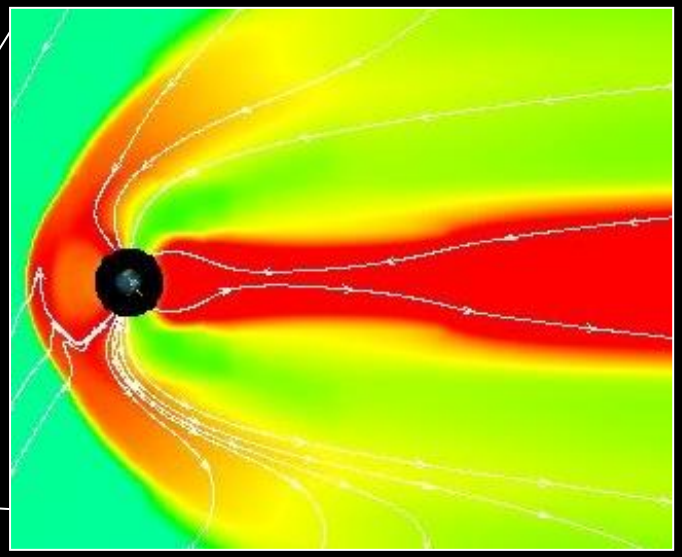
Build the knowledge to forecast space weather throughout the heliosphere

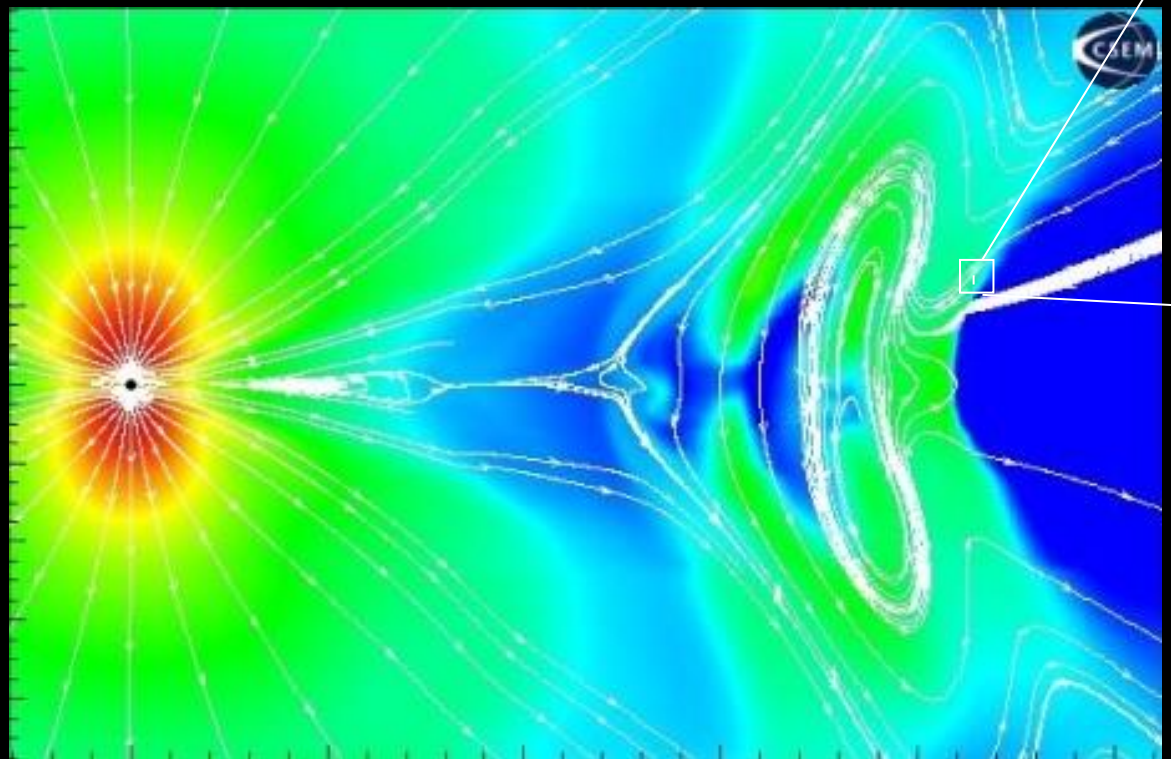
Nature of the Challenge

- A quantitative, predictive understanding of a complex system
- Microphysical processes regulate global & interplanetary structures
- Multi-constituent plasmas and complex photochemistry
- Non-linear dynamic responses



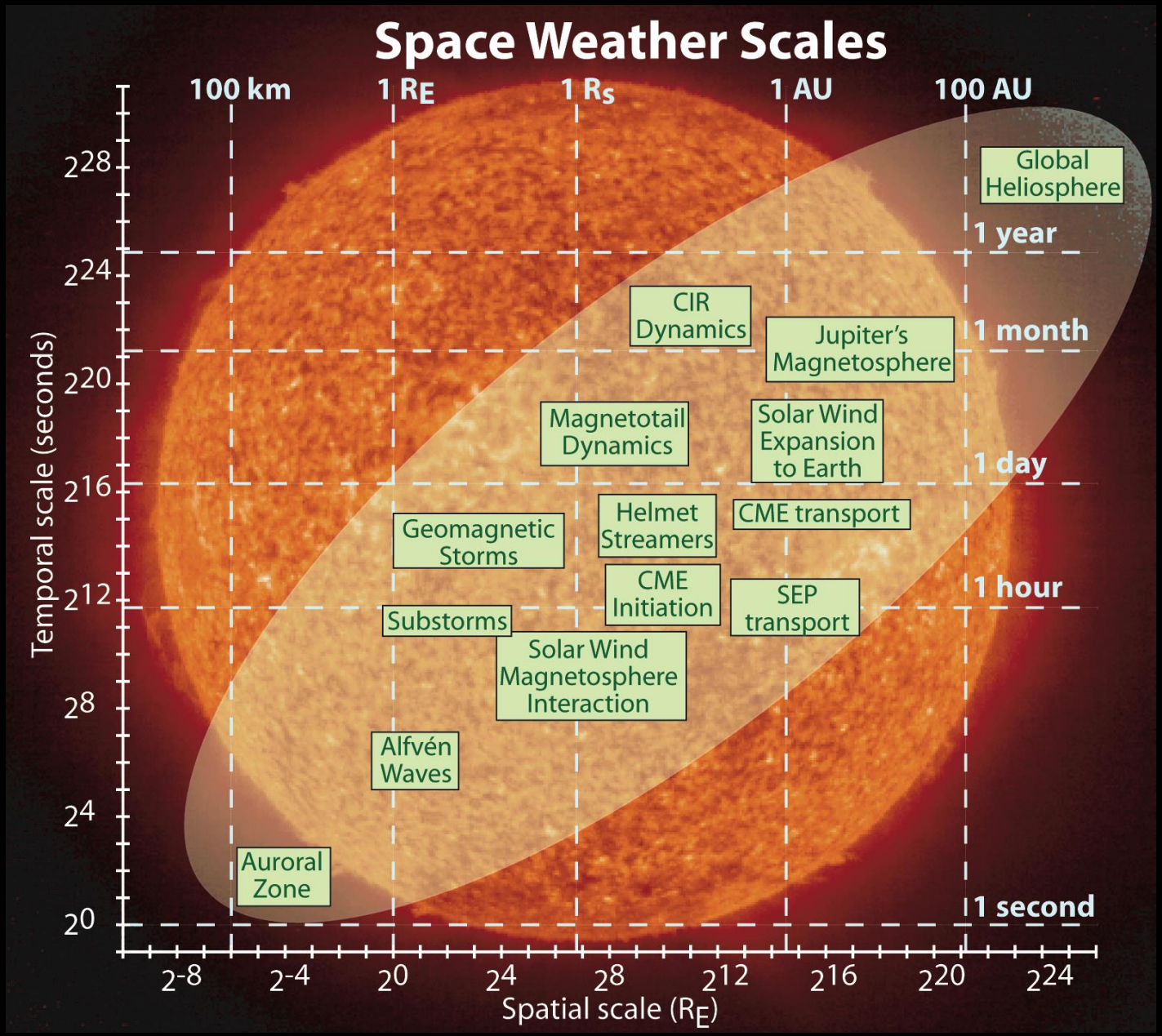






- Integration and synthesis of multi-point observations
- Data assimilative models & theory
- Interdisciplinary communities and tools

This is a complex system with many different temporal and spatial scales
System is Multi-Scale & Couples between Scales



Processes operating at one scale can influence phenomena at other scales.

A quantitative, predictive understanding of a complex system

Microphysical processes regulate global & interplanetary structures

Multi-constituent plasmas and complex photochemistry

Non-linear dynamic responses

Integration and synthesis of multi-point observations.

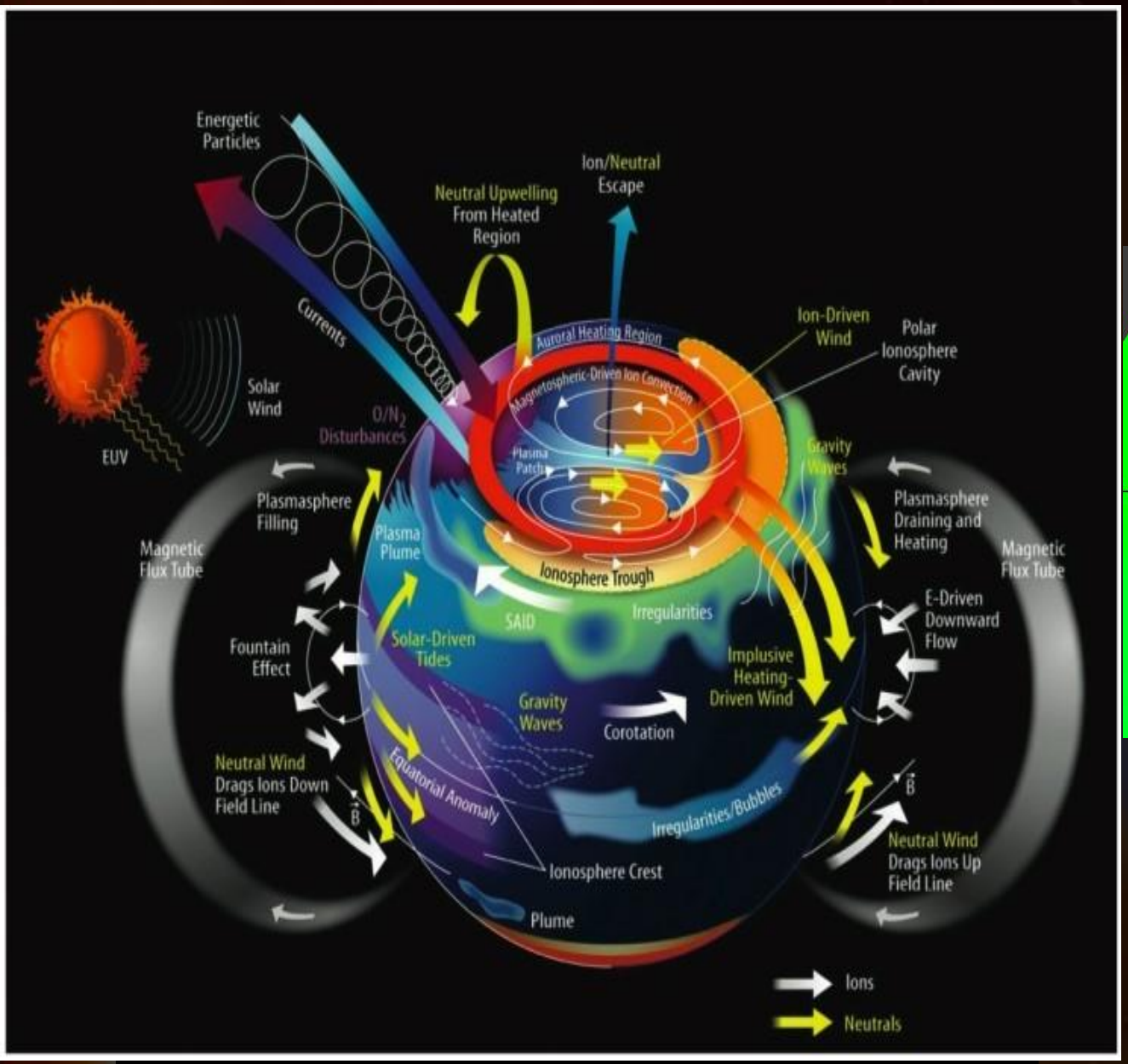
Data assimilative models & theory.

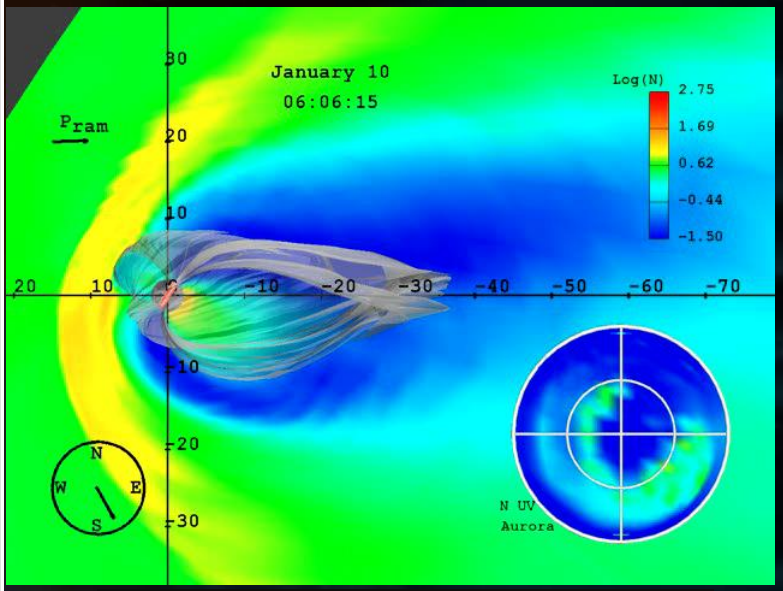
Interdisciplinary communities and tools

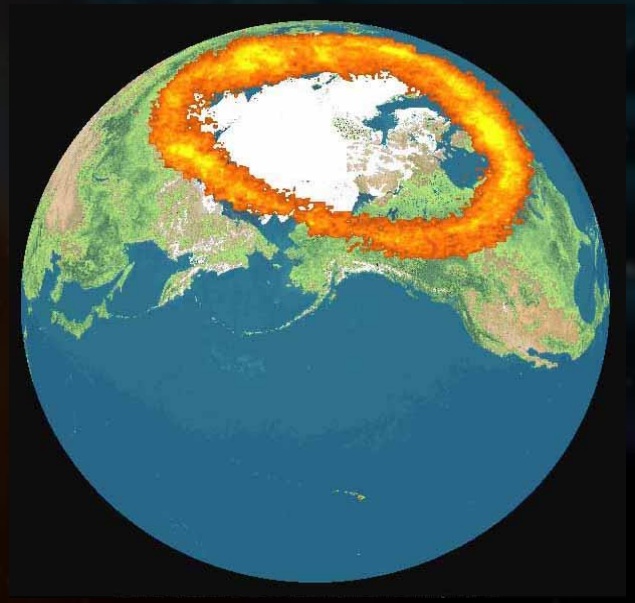
Image credit: T. Gombosi, CSEM, U of Mich

Space Weather's Terrestrial Influence

(an example)







Space weather interacts with Earth's B-Field and can dramatically affect the Earth

HPD is Organized into Four Major Sections

Goal: Understand the Sun and its interactions with Earth and the solar system including space weather

Living With a Star

Goal Oriented Strategic Program that is Relevant to Life and Society

Solve the <u>fundamental physics</u> mysteries of heliophysics: Explore and examine the physical processes in the space environment from the sun to the Earth and throughout the solar system.

Build the knowledge to forecast space weather throughout the heliosphere: Develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

Explorers

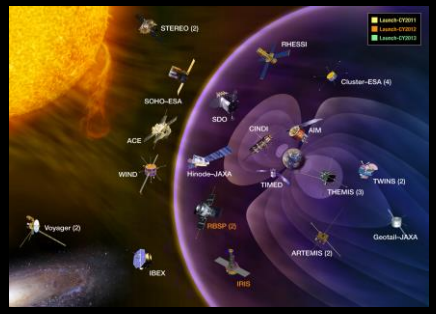
Smaller flight programs, competed science topics, often PI-led

Solar Terrestrial Probes

Curiosity Driven Strategic Mission Flight Programs

Understand the nature of our home in space: Advance our understanding of the connections that link the sun, the Earth, planetary space environments, and the outer reaches of our solar system

Research



Scientific research projects utilizing existing data plus theory and modeling

Heliophysics System Observatory

A coordinated and complementary fleet of spacecraft to understand the Sun and its interactions with Earth and the solar system

Heliophysics has 18 operating missions (on 29 spacecraft): Voyager, Geotail, Wind, SOHO ACE Cluster, TIMED, RHESSI, TWINS, Hinode, STEREO THEMIS/ARTEMIS, AIM, CINDI, IBEX, SDO Van Allen Probes IRIS

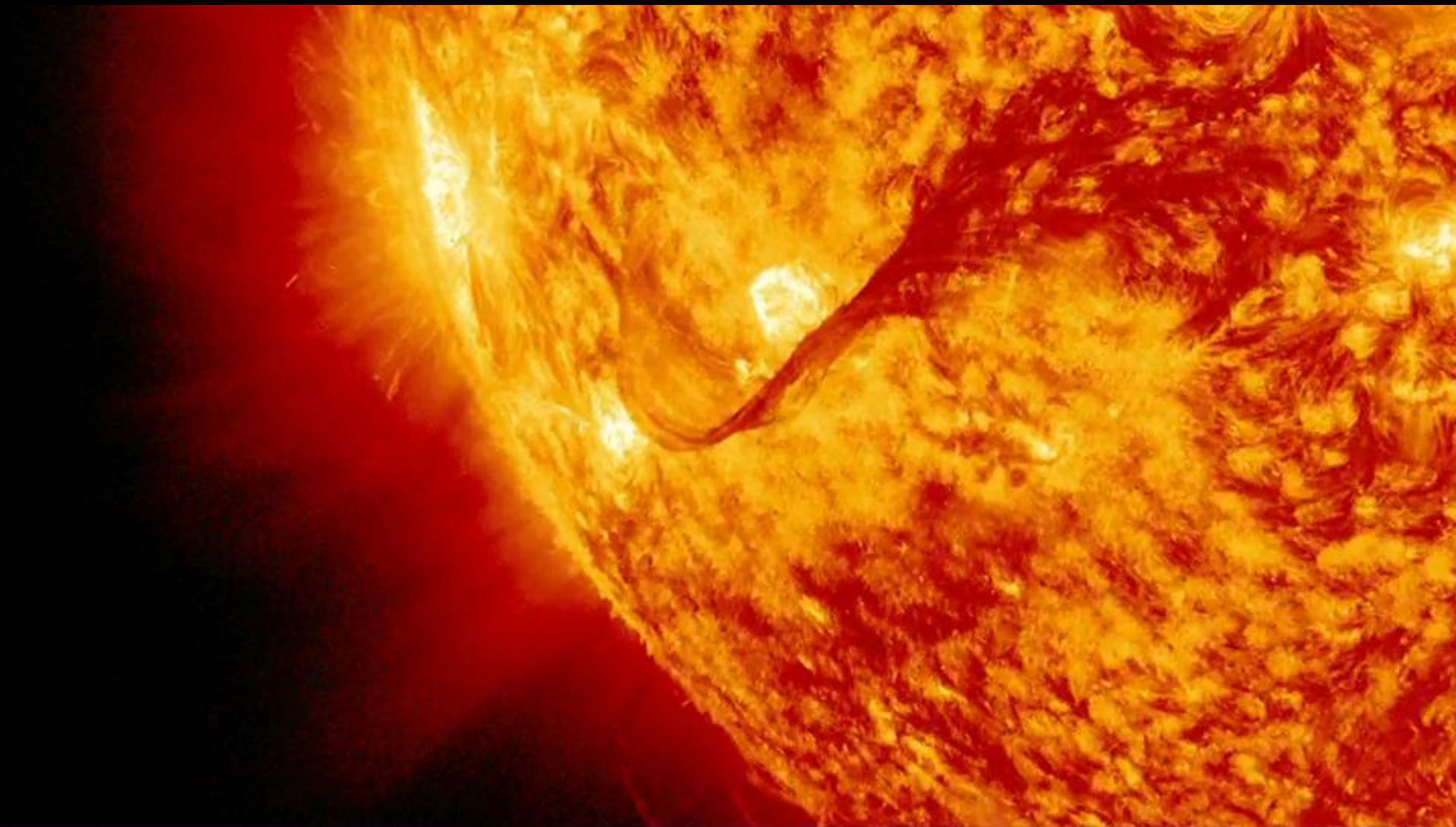
(Missions in red contribute to operational Space Weather.)

6 missions are in various phases of development: SET, MMS, SOC, SPP, ICON, and GOLD

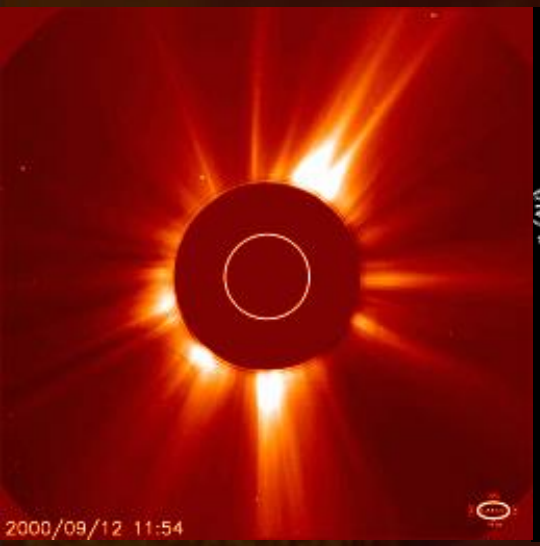
$5.5B total investment in Heliophysics space assets (excluding launch costs)$68M annual operating budget (1.2% per year)

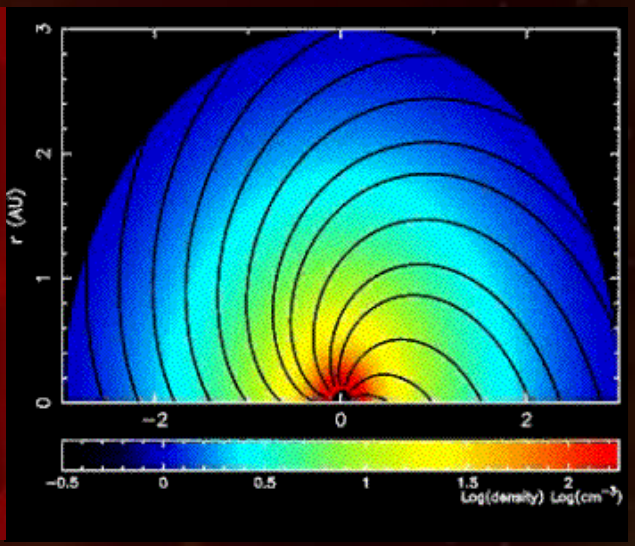
We’re entering a new era of
Interplanetary Space Weather

This is possible because
we’ve got the Sun surrounded.



Interplanetary Space Weather: A New Paradigm

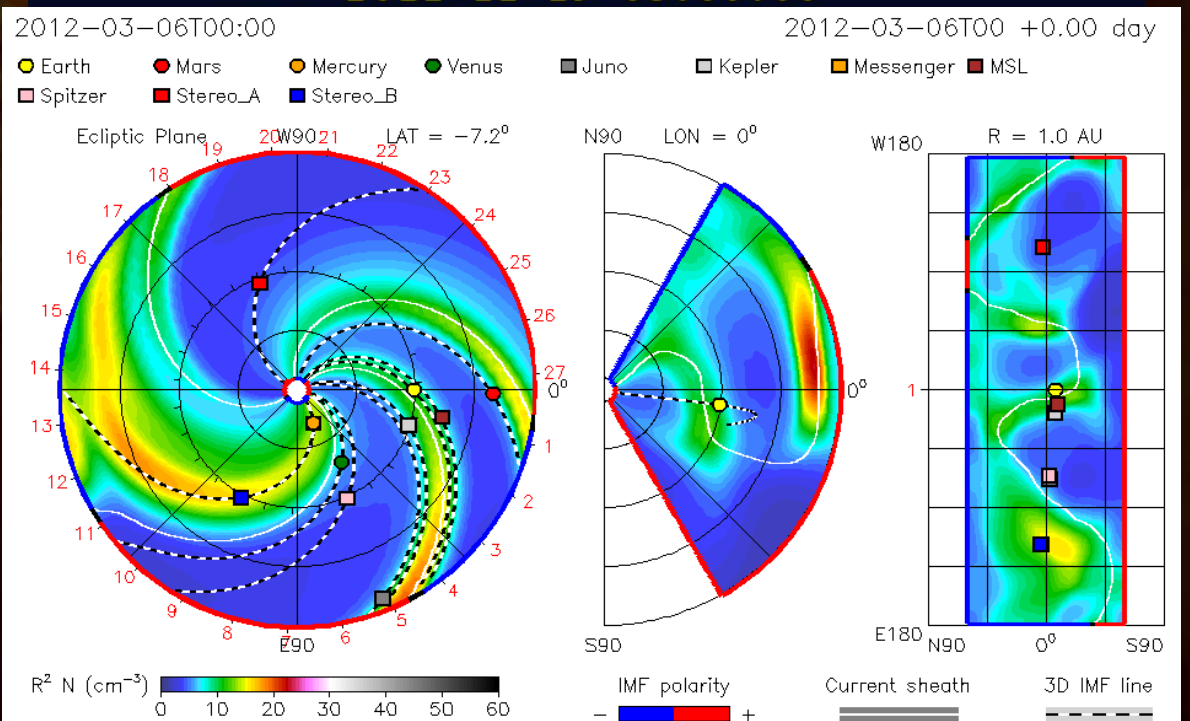




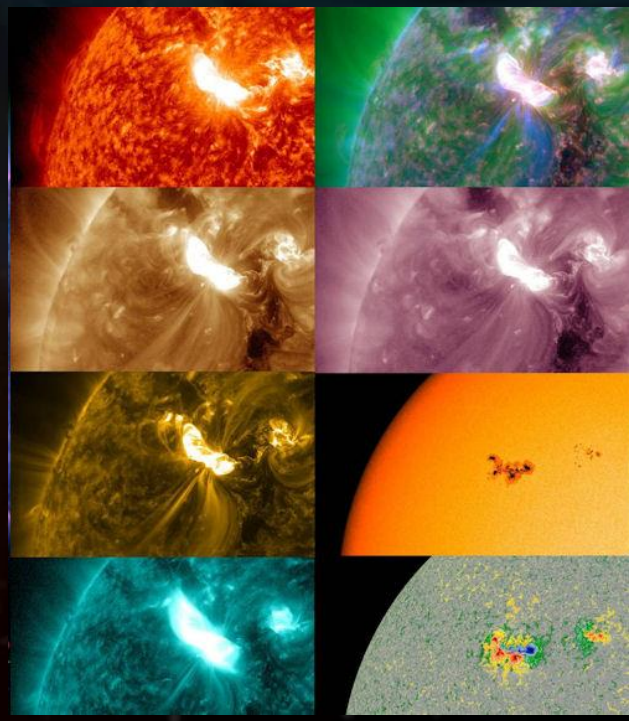
Courtesy: Dr. G. Zank UAH-CSPAR

- Semi-empirical near-Sun module that approximates the outflow at the base of the solar wind
- Sophisticated 3-D magnetohydrodynamic numerical model that simulates the resulting flow evolution out to Earth.

AR1429 unleashed a powerful X5-class solar flare on 7 March 2012, commencing the "St. Patrick Day storms" of 2012. The blast also propelled a massive coronal mass ejection (CME) toward Earth. NASA's Solar Dynamics Observatory recorded the flare at multiple extreme ultraviolet wavelengths



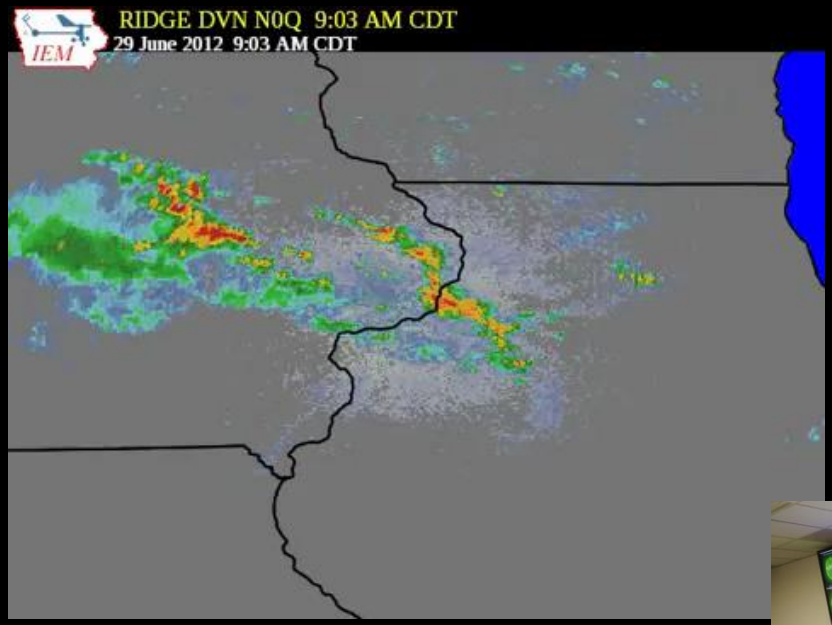
3D CME model run from CCMC/iSWA shows how the CME would propagate through the inner solar system.



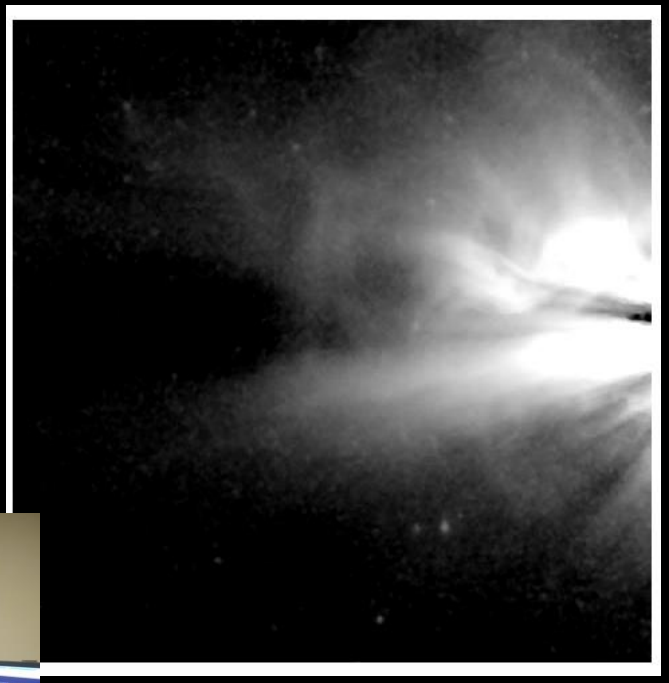
Heliophysics is an environmental science

– a hybrid between meteorology and astrophysics

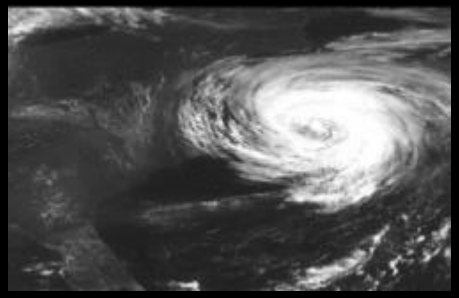
Weather in the mid-west today is Washington's weather tomorrow.



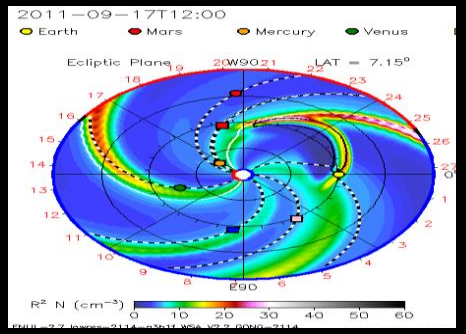
Weather on the sun today is space weather in low-Earth orbit later this week



At NOAA's SWPC, forecaster Dave Marshall sits at the crossroads.

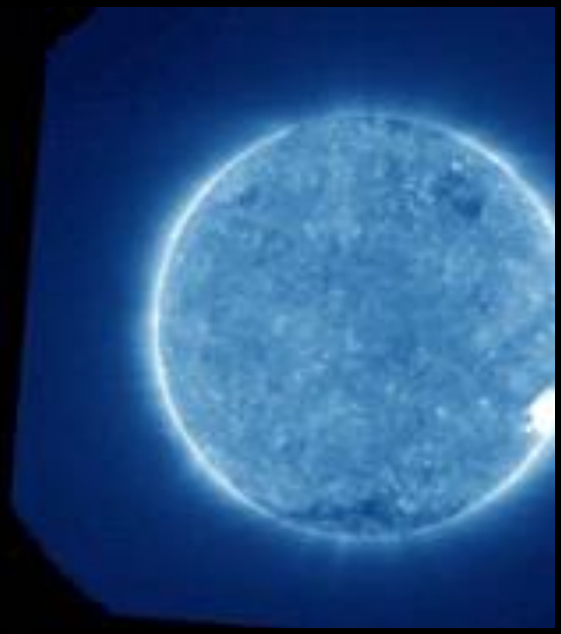


meteorology



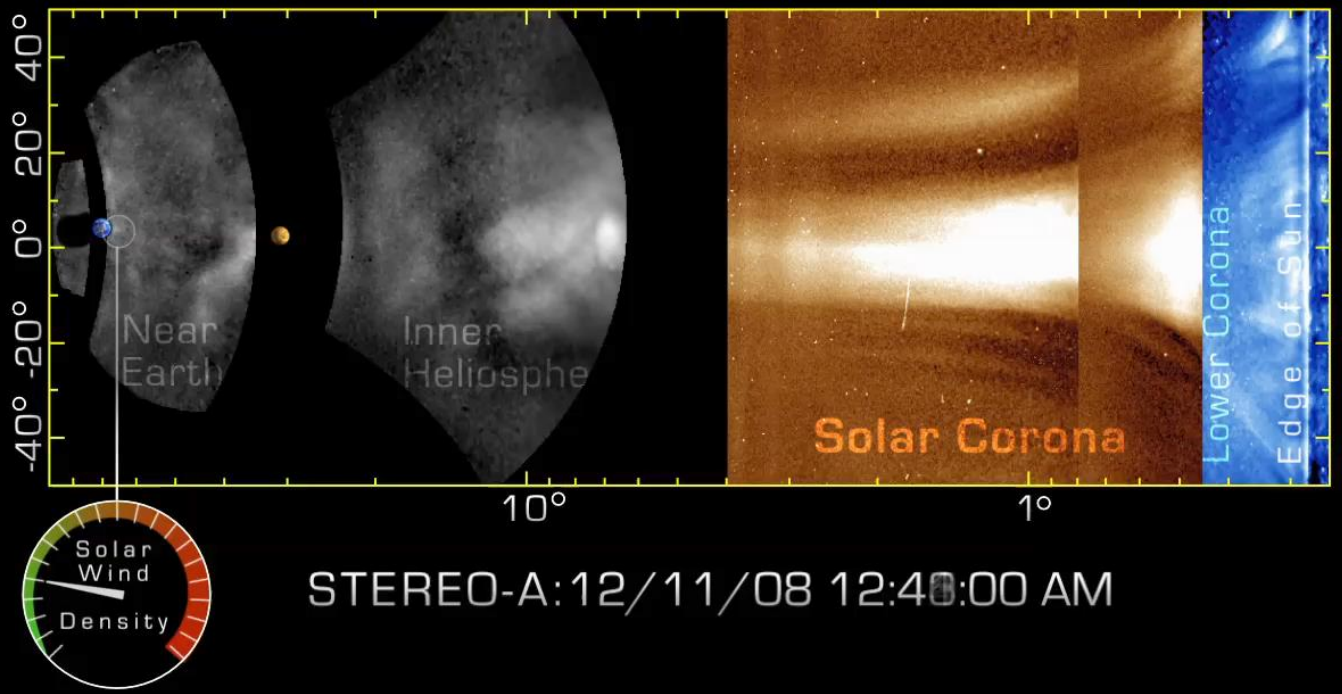
astrophysics

The next frontier in space weather forecasting involves the uninterrupted tracking of storm clouds from the sun to the planets.



NASA's STEREO spacecraft and new data processing techniques have succeeded in tracking space weather events from their origin in the Sun's ultra hot corona to impact with the Earth's magnetosphere

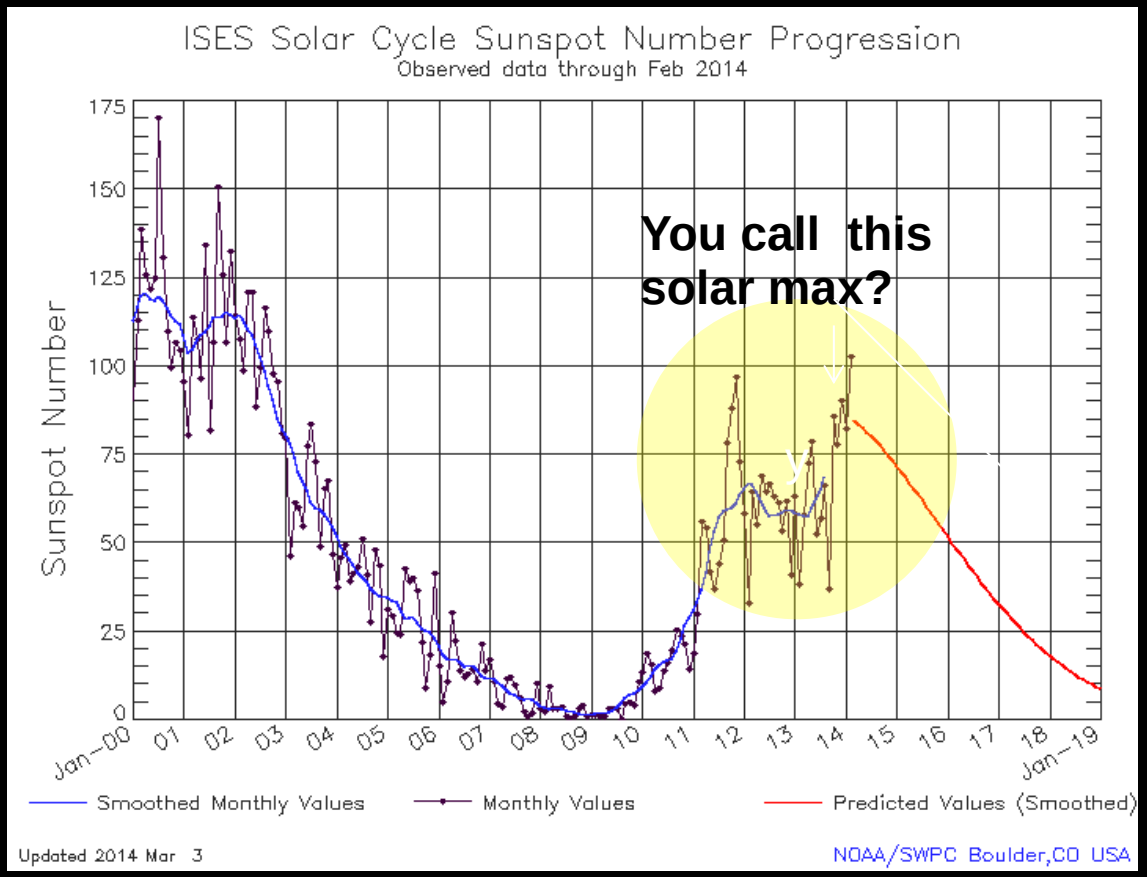
STEREO includes 5 telescopes that monitor the sky at large angles from the Sun



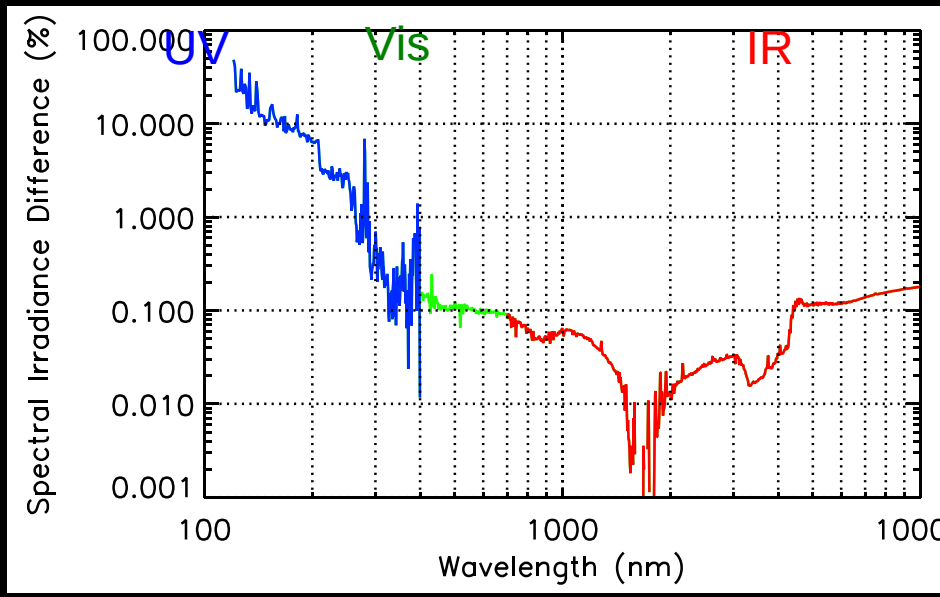
Look out! Solar activity is so low that Solar Max looks a lot like Solar Min.

As the scope of space weather forecasting expands to other planets, it is also expanding in directions traditionally connected to climate research. Climate refers to changes in planetary atmospheres and surfaces that unfold much more slowly than individual storms. There is no question that solar activity is pertinent to climate time scales.

The radiative output of the Sun, the size and polarity of the Sun's magnetic field, the number of sunspots, and the shielding power of the Sun's magnetosphere against cosmic rays all change over decades, centuries, and millennia.



Spectral Solar Irradiance (SSI): SMax vs. SMin



Small variations in the visible (0.1%), but big changes in the UV. ***(UV, EUV and X-ray spectral irradiances are drivers of space weather)***

Space Weather Swings Between Extreme Effects

Solar La Niña (low sunspot number)

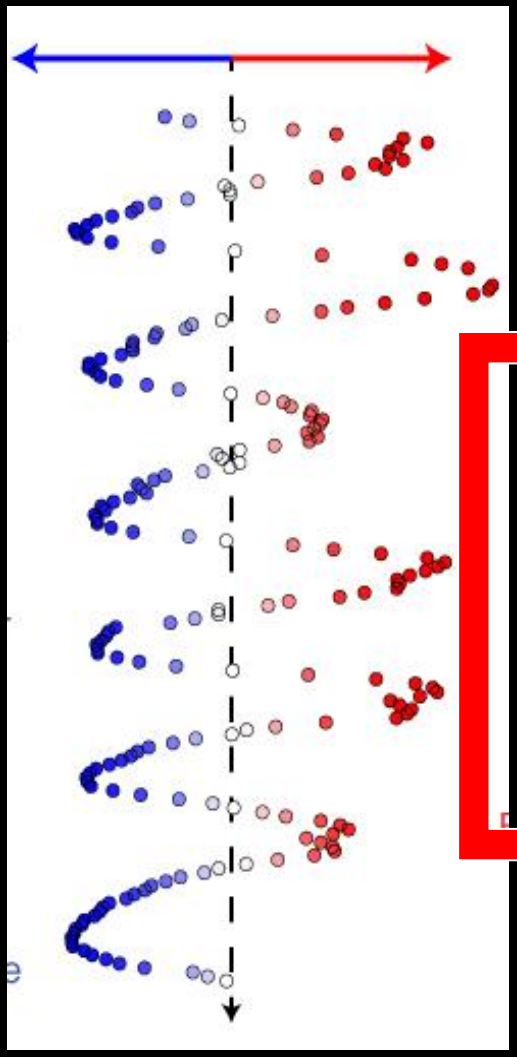
extreme galactic cosmic rays

rapid accumulation of space junk

sharp contraction of the heliosphere

collapse of the upper atmosphere

total solar irradiance changes



Solar El Niño (high sunspot number)

super solar flares

extreme solar “cosmic rays” (energetic particles)

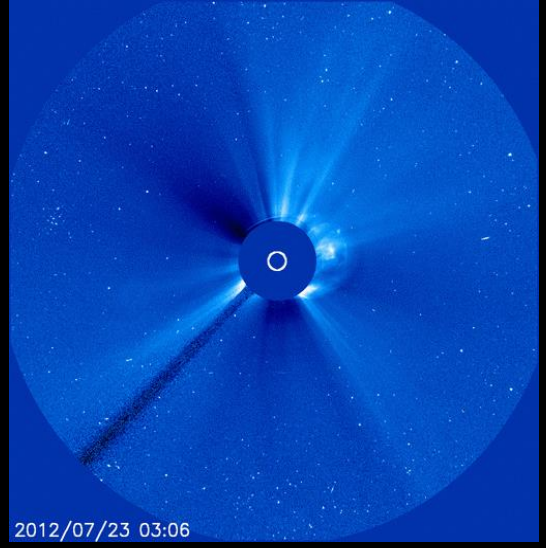
radio blackouts

extreme geomagnetic storms

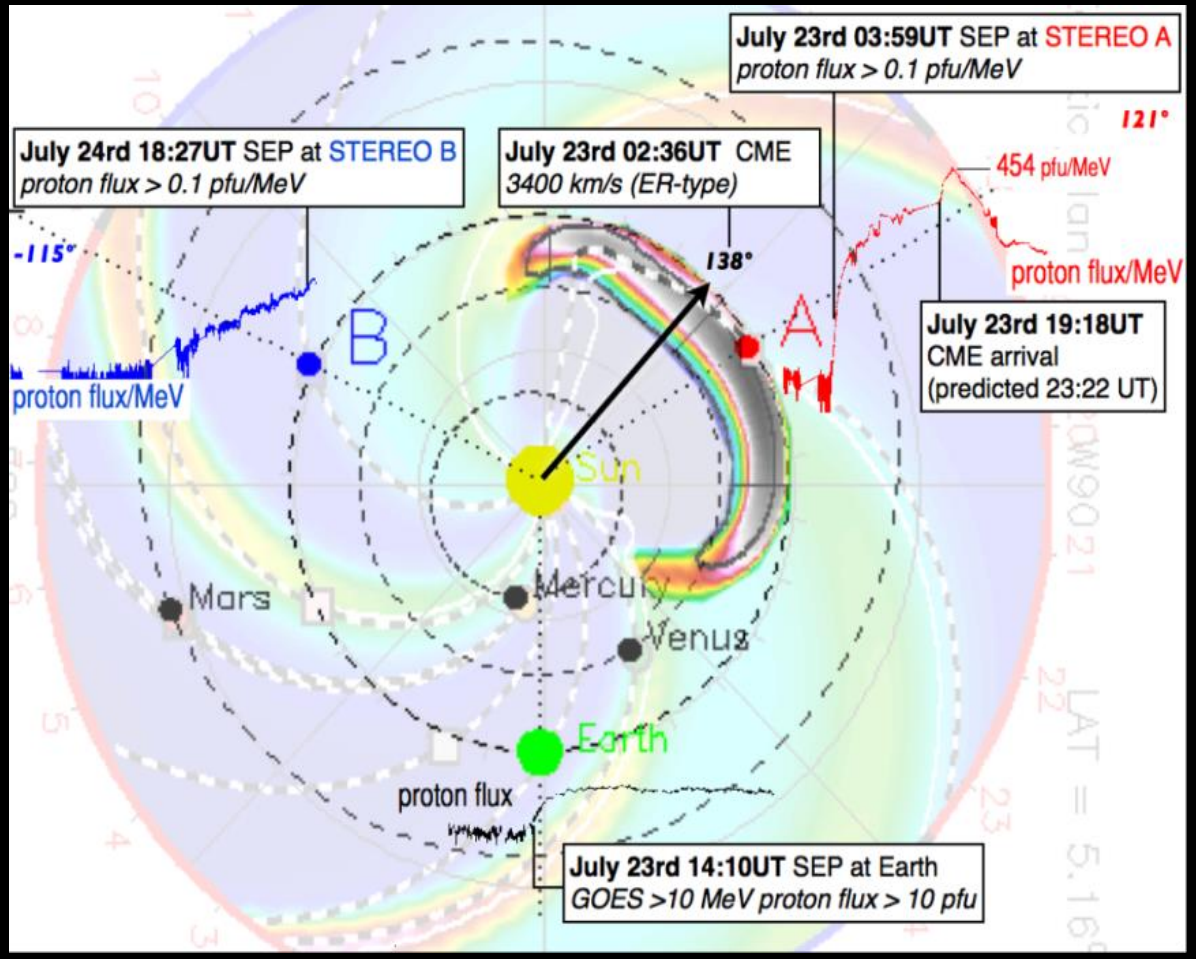
melted power grid transformers – power blackouts

solar wind streams hit Earth

Illustration shows smoothed monthly sunspot counts from the past six solar cycles plotted horizontally instead of vertically. High sunspot numbers are in red and on the right, low sunspot numbers are in blue and on the left. Associated with each high and low sunspot numbers are different space weather impacts experienced at Earth (doi: 10.1002/swe.20039).



July 23, 2012, one of the fastest CMEs of the Space Age rocketed away from the western limb of the sun travelling 3500 km/s.



Surrounding the sun has allowed us to detect major storms that otherwise we might have missed.

A Solar Superstorm Narrowly Missed Earth in July 2012

STEREO-A was in the line of fire, and the spacecraft was hit by a severe solar radiation storm. It was stronger than any proton event observed since 1976. Without STEREO-A, this major event would have passed unnoticed

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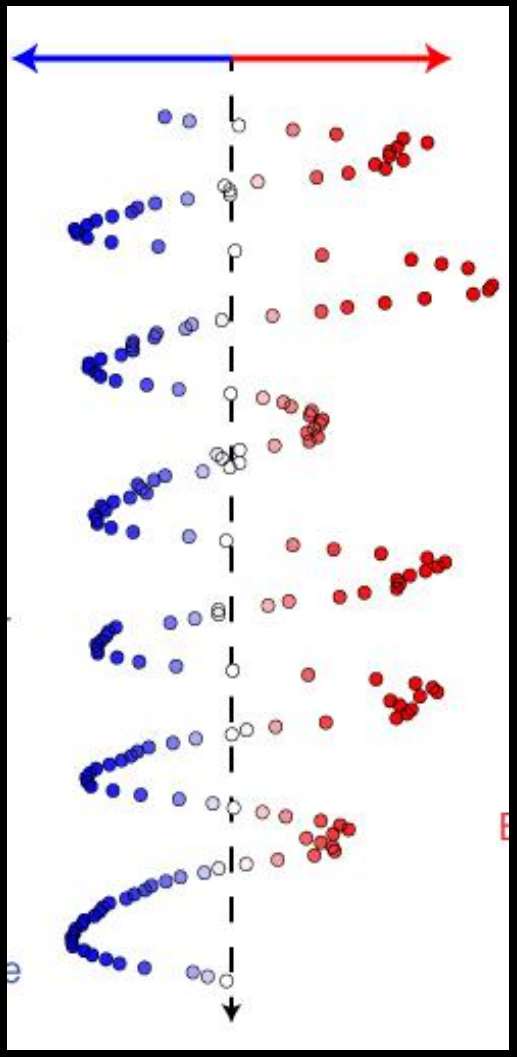

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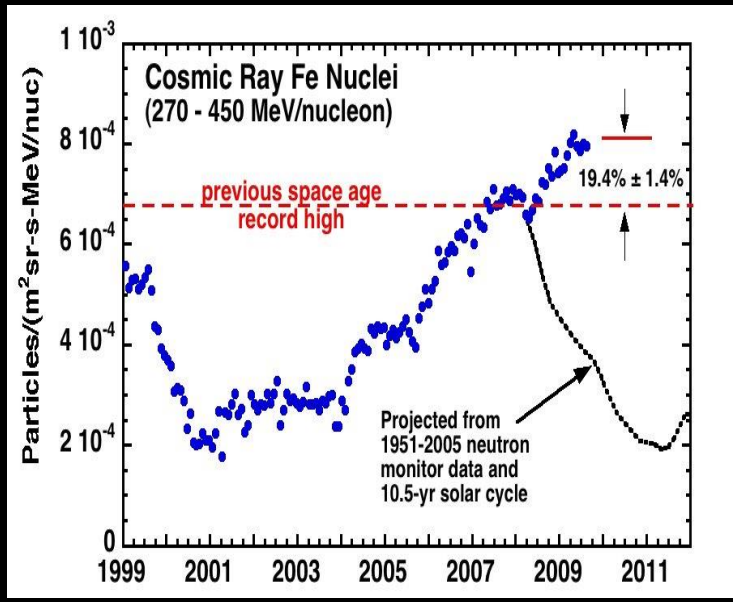
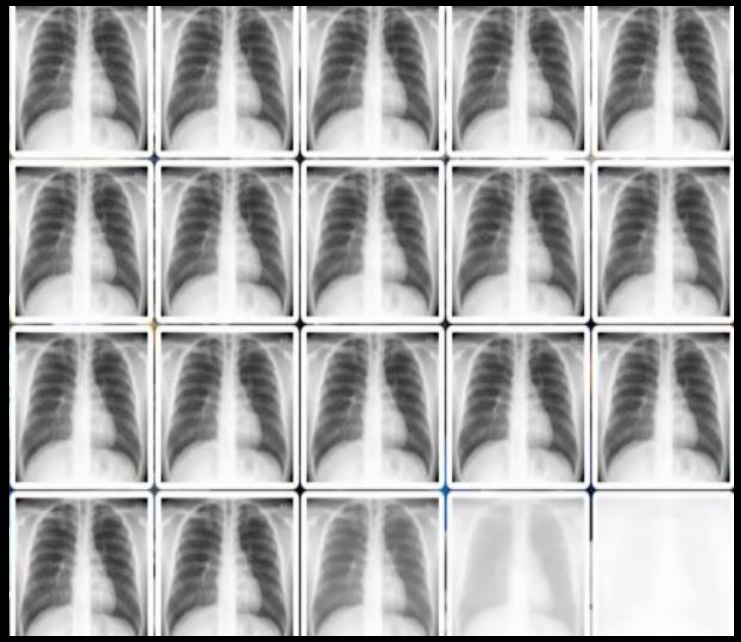
During periods of low solar activity, cosmic rays pose a threat not only to astronauts, but also to ordinary air travelers.

Who's Afraid of a Solar Flare? Cosmic rays are much scarier

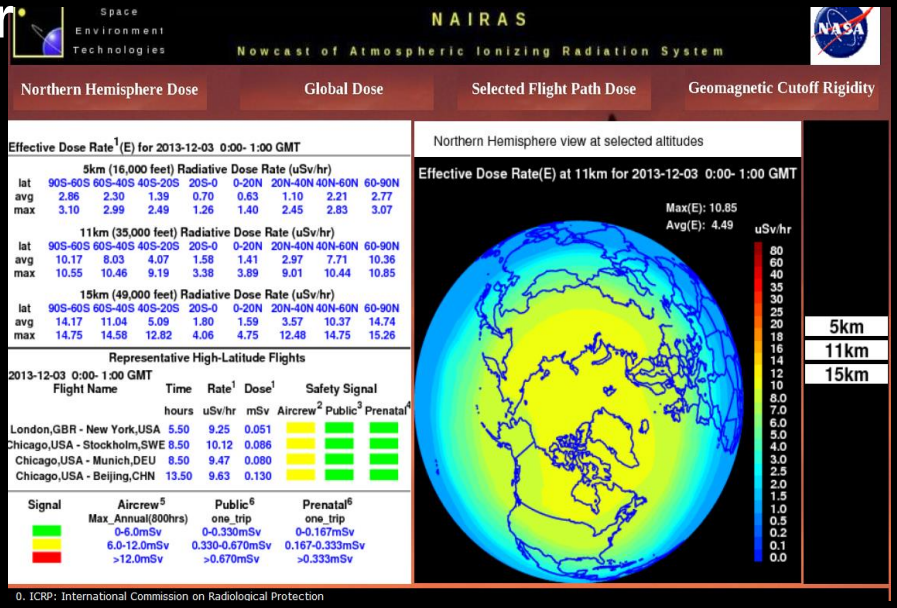
When solar activity is low, cosmic rays are able to invade the inner solar system. During the 2008-2009 solar minimum, cosmic rays surged to record-high levels.



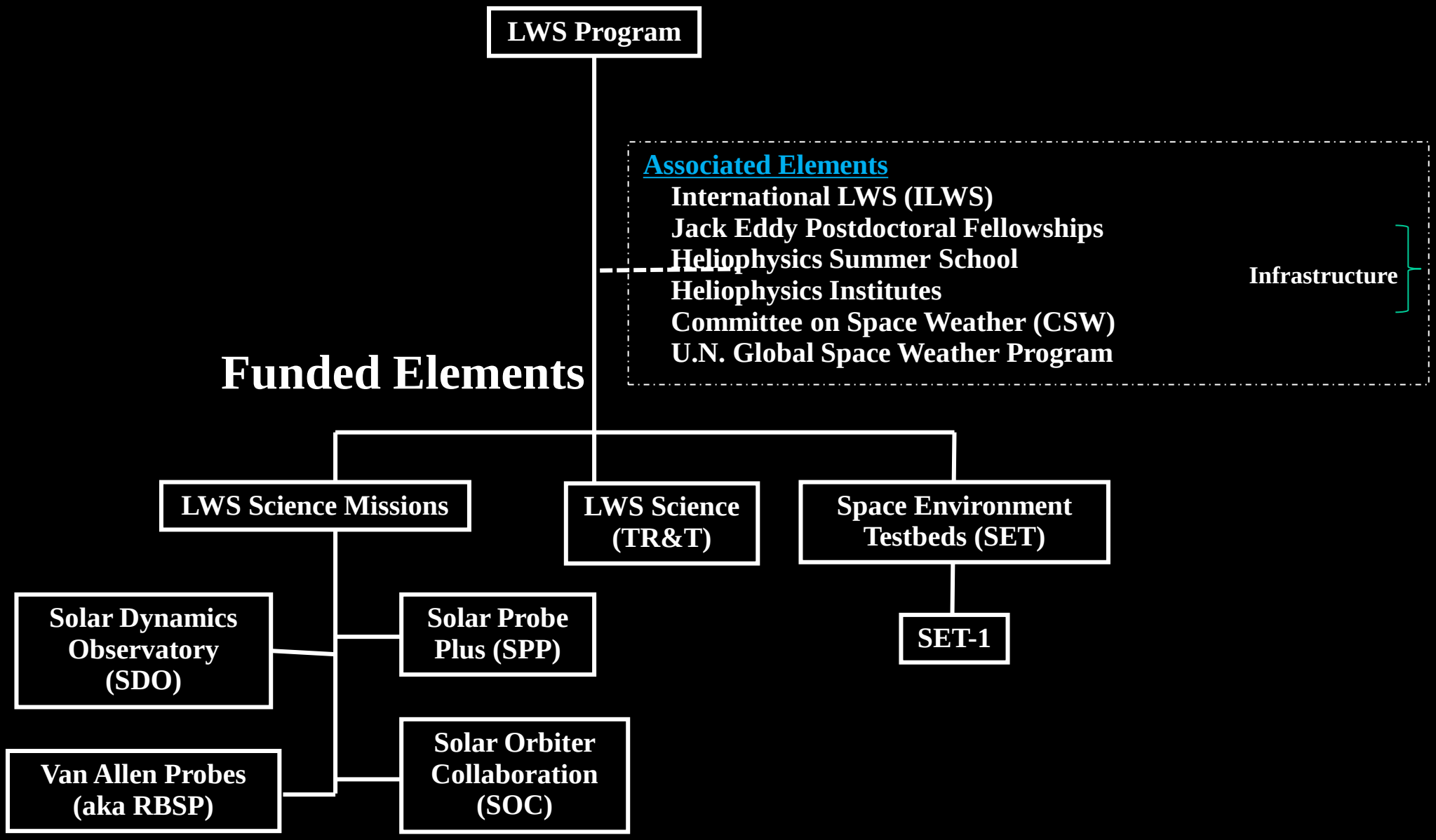
A 100,000 mile frequent flyer receives a dose equivalent to 20 chest x-rays.



NASA's experimental *Nowcast of Atmospheric Ionizing Radiation System* keeps track of the danger



Living With a Star (LWS) Program Elements



http://www.vsp.ucar.edu/Heliophysics/summer-about-over.shtml

HELIOPHYSICS

VSP UCAR Visiting Scientist Programs

LWS NASA

About the Science | Overview | Resources

Summer School | About | Apply | Getting Here | Past Years

Postdoctoral Program | About | Apply | Appointment Details

LWS Institute | About | Apply

http://www.vsp.ucar.edu/Heliophysics/summer-about-over.shtml

What is Heliophysics

Heliophysics is all of the science common to the field of the Sun-Earth connections. This fast-developing field of research covers many traditional sub-disciplines of space physics, astrophysics, and climate studies. The NASA Living with a Star program, with its focus on the basic science underlying all aspects of space weather, acts as a catalyst to bring the many research disciplines together to deepen our understanding of the system of systems formed by the Sun-Earth connection.

Two programs have emerged from this effort:

- Heliophysics Summer School
- Jack Eddy Postdoctoral Fellowship Program

CALL FOR APPLICATIONS:
Heliophysics Summer School
Announcement
Deadline: 27 February

CALL FOR APPLICATIONS:
Jack Eddy Fellowships
Announcement
Deadline: 17 January

Our Technology-Dependent Lifestyle is Vulnerable to Solar Flares

Dr. Lika Guhathakurta, NASA astrophysicist and heliophysics expert.

Follow us on:

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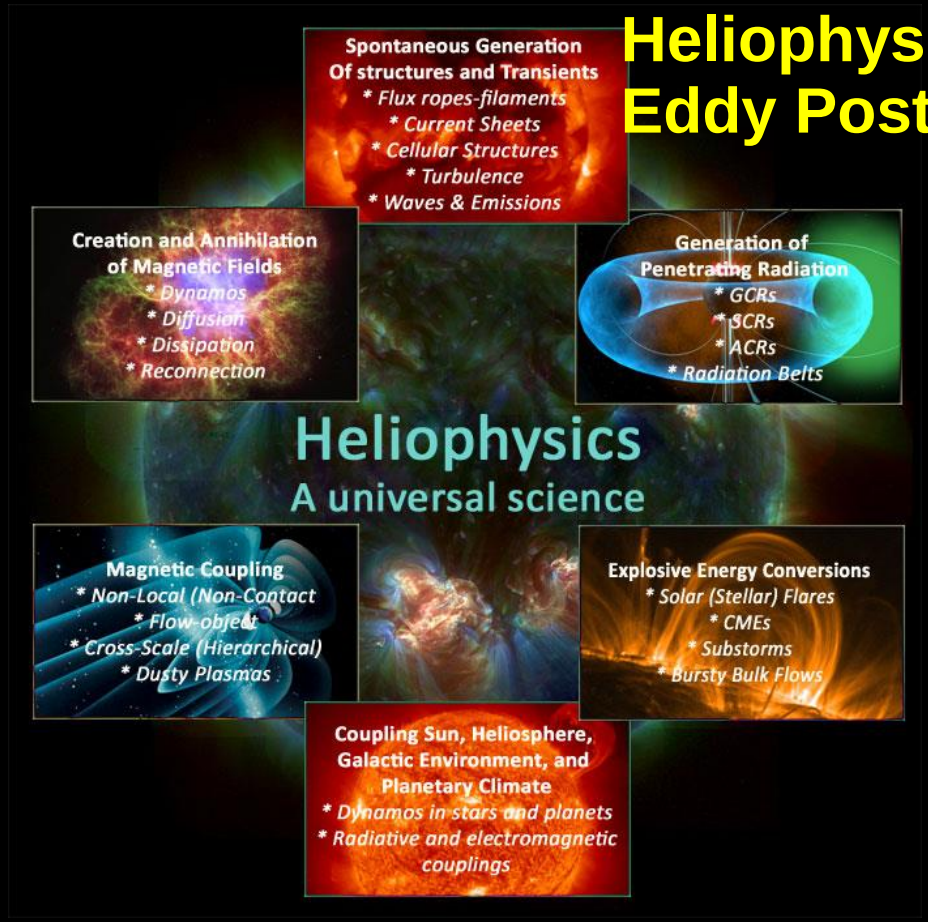
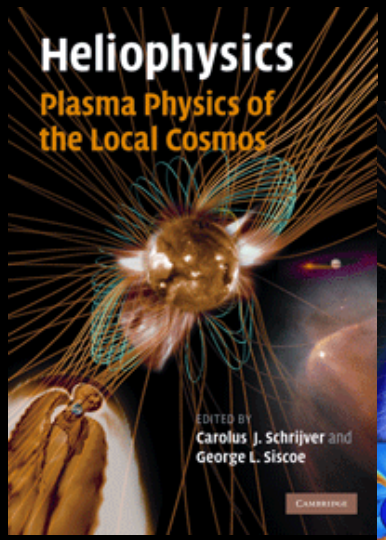
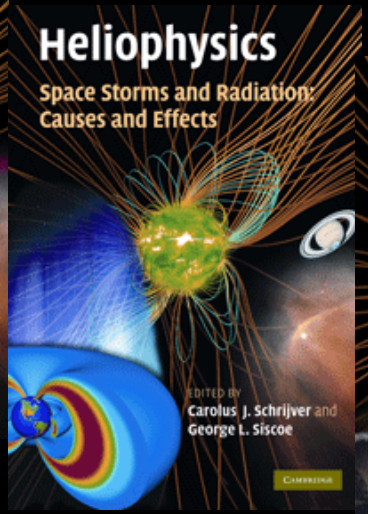
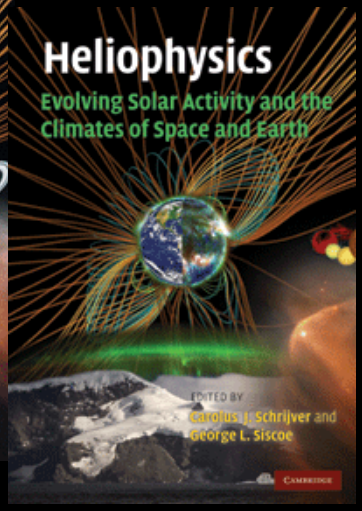
VSP is part of the UCAR Community Programs, which is managed by the University Corporation for Atmospheric Research.
P.O. Box 3000, Boulder, CO 80307 \ Telephone: 303-497-8649

Heliophysics Text Books & Summer School
Eddy Postdoctoral Fellowship









Since 2007-2014, we have had:

Total Students ~250
International Students ~120
PhD Level ~220
Masters Level ~30

Jack Eddy Postdoctoral Fellowship 2010-2014, 17 appointments

To train the next generation of researchers needed in the emerging field of heliophysics, in honor of the pioneering interdisciplinary researcher, Jack Eddy.

Jack Eddy Postdoctoral Fellowships

Objectives

To train the next generation of researchers needed in the emerging field of heliophysics, in honor of the pioneering solar researcher, Jack Eddy.

Relevance to Heliophysics Goals

Appointments are made in areas addressing space weather or the Sun-Earth connection as well as cross-traditional Heliophysics subdomains of the Sun, heliosphere, magnetosphere, and ionosphere/upper atmosphere, and sun-climate.

Implementation Description

Annual call for applications: Due January 2015

Postdocs are placed with experienced scientists at U.S. research institutions and universities.

Three to four new appointments made each year.

Two-year UCAR fellowships, which include relocation allowances and travel allowances to present research

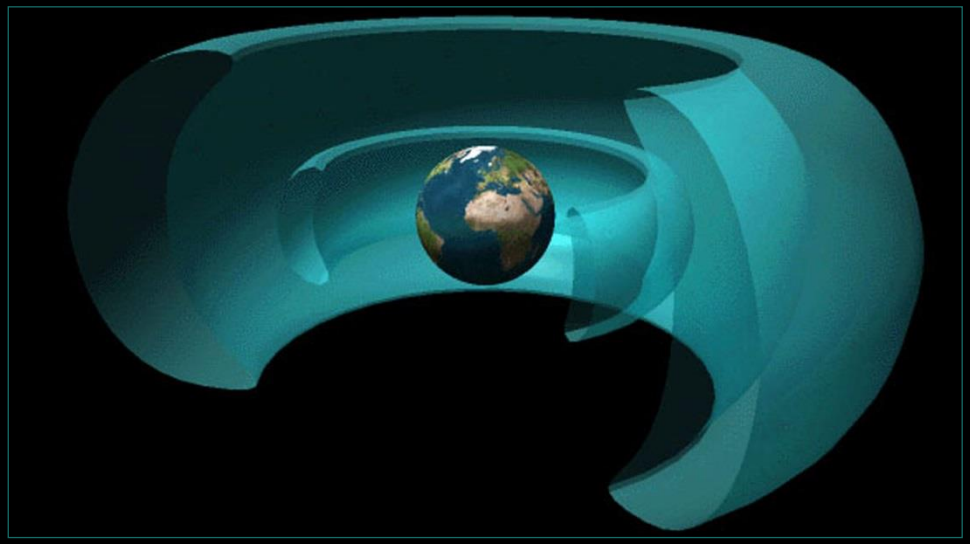
Annual alumni gathering each year at AGU meeting in San Francisco.

Strategy

Seventeen (17) appointments since inception in 2010.

UCAR maintains alumni records to track career path of each fellow.

LWS Institute



Two high radiation regions surround Earth,
the inner and outer Van Allen radiation belts.

Format

Topics chosen annually by NASA LWS and UCAR-appointed steering committee that develops agenda and tasks of relevance to the LWSI overarching mission.

The steering committee is made up of internationally recognized experts.

Teams of 10 to 20 participants are set up through an annual call for applications to participate in each LWSI. Proposals are evaluated by the steering committee and recommendations are made NASA LWS and UCAR.

Purpose

The concept of a LWS Institute, small working group style meetings that focuses on well defined problems that demand intense, direct interactions between colleagues in neighboring disciplines has been created to encourage and facilitate a deeper understanding of the variety of processes that link the Sun's magnetic variability (radiation, solar wind, energetic particles) to Earth's environment and atmosphere.

Thus, the LWS program with its focus on the basic science underlying all aspects of space weather and climate, acts as a catalyst to bring the many research disciplines and applications communities together to deepen the understanding of the system of systems created by the Sun Earth connection.

Implementation

Proposals should focus on:

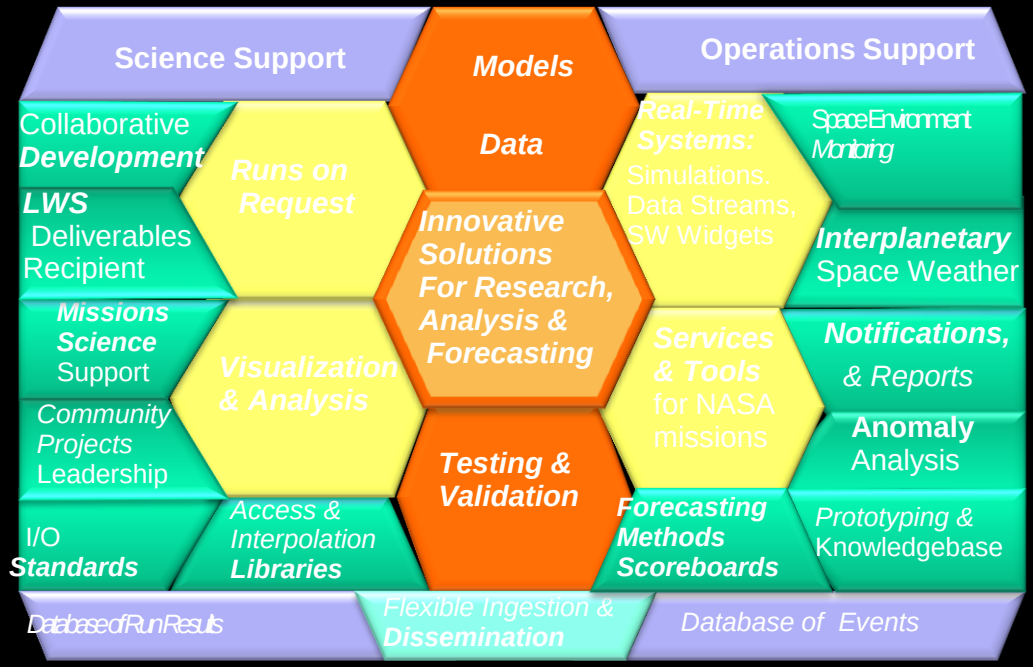
Improving understanding of the processes and/or magnitude of impacts of space weather on the selected system
Identifying the science needed to enable our forecast ability for that system, and
Outlining if not executing, research that may develop abilities to reduce the impacts of space weather on that system

2014 Working Group Topic

Seeking proposals that develop these principles in relation to the effects of Ground Induced Currents (GIC) during CME-driven geo magnetic disturbances (GMD).

Metrics: Reports, publications in peer-review journals and contributions to textbooks that are used to train the next generation of scientists.

Community Coordinated Modeling Center (CCMC)



Mission Statement: Multi-agency partnership to enable, support and perform research and development for the next generation of space science and space weather models.

CCMC Goals:

Facilitate community research and development.
Support transition of progress in research and development to space weather operations (R2O).
Address science and space weather (SW) needs of NASA missions.

Background:

Established in 2000 as an essential element of the NSWP.
Designed to be a flexible, long-term solution to the R2O problem.

CCMC Staff (FY13): Director: *M.Kuznetsova*, Deputy: *M.Maddox*
NASA/Heliophysics: 5.7 FTEs, 5.5WYEs; *NSF*: 1.8WYEs, 3.5 students.

Partners: NASA, NSF, USAF, ONR, NOAA, FAA, DoD, DoE, DHS, research, educational, operational institutions world-wide (ILWS).

Unique Capabilities and Functions

Expanding collection of models and coupled model chains (>60).
Highly utilized, one-of-a-kind *Runs-on-Request* service since 2001 (> 8000 runs archived, 100s publications, 50-100 runs/wk in 2013).
Integrated Space Weather Analysis (iSWA) system for flexible ingestion and dissemination of SW information: user-configurable web displays for real-time SW monitoring & historic event analysis. > 300 widgets customized for specific missions/applications, using real-time run results, NASA missions data streams, & other sources.
Space Weather Research Center (SWRC): in-house research-based prototyping team providing custom SW services for NASA robotic missions (established in 2010 with GSFC support). Lead: *A.Pulkkinen*.
Testing, validation, and assessment of operational SW modeling capabilities (partnership with NOAA/SWPC and model owners).
Hands-on education: *CCMC-Universities Space Weather Research Education & Development Initiative (SW REDI)*. Lead: *Y.Zheng*.

Benefits to LWS:

Ensure that LWS deliverables (e.g., Strategic Capabilities) are accessed and utilized by the research and operational communities.
Enable collaborative integration of LWS deliverables into end-to-end SW impact prediction systems.
Create flexible, multi-purpose tools and services that enable optimal system science from LWS missions and targeted research.
Identify weak links in data-model and model-model coupling, and lead community efforts to fill those gaps (e.g., MAGIC StatCap).

Benefits to NASA

Maximize return on Heliophysics investment in model development.
Fill critical need for research-based prototyping facility with close proximity to SW modeling and science expertise (GSFC's HSD).
Provide unique interplanetary SW services for all missions.
Promote space environment awareness as an important component of the new emphasis on STEM education.

National Space Weather Program/Office of Science and Technology Policy

NSWP

With the retirement of Mr. Samuel Williamson, NSWP Is being reorganized. Stay tuned.

OSTP

Ensuring that this Nation is prepared to respond to and recover from severe space weather storms is a priority to President Obama and to this Administration. We cannot ignore the potential impact space weather may have on key infrastructures and technologies including the electric power grid, GPS applications, aviation and satellite operations.

- These technologies form the very backbone of the critical technology infrastructure we rely on for so much of what we do today.
- In November 2014, in his role as Chair of the National Science and Technology Council (NSTC), and on behalf of the President of the United States, Dr. John Holdren chartered the interagency Space Weather Operations, Research, and Mitigation **(SWORM)** Task Force.
- The Task Force will develop a National Space Weather Strategy (NSWS) that will articulate high-level strategic goals for enhancing our Nation's preparedness for a severe space weather event.
- In addition, a Space Weather Action Plan will be developed that will establish a process to implement the National Strategy.
- Strengthening America's resilience to space weather is a challenge that will require insight, expertise, and dedication from many; consequently, this will be a coordinated approach across numerous Federal Departments and Agencies.
- Both the Strategy and the Action Plan are expected to be complete in 2015.

International Living With a Star

ILWS Mission:

Stimulate, strengthen, and coordinate space research to understand the governing processes of the connected Sun-Earth System as an integrated entity.

ILWS Objectives:

To Stimulate and Facilitate:

The study of the Sun-Earth connected system and the effects which influence life and society

- Collaboration among potential partners in solar-terrestrial space missions
- Synergistic coordination of international research in solar-terrestrial studies, including all relevant data sources as well as theory and modeling
- Effective and user driven access to all data, results, and value-added products

Brief History:

- January 2002: IACG establishes International Living With a Star Program
- September 2002: ILWS Kickoff Meeting held in Washington, DC
- The first ILWS Task Groups formed in 2002-2003
- January 2003: ILWS officially commences
- February 2013: ILWS celebrates ten years of success with the ILWS Tenth Anniversary Symposium at the United Nations in Vienna, Austria.

ILWS Structure:

- Steering Committee
- Working Group comprised of delegates from 33 member agencies plus contributions from several other agencies and organizations. Meets ~ annually to discuss developments within agencies and identify potential opportunities for coordination.
- Task Groups focusing on ILWS subdisciplines (*e.g.* End Users, Heliosphere/Interplanetary). Task group membership is chosen to achieve international balance.

ILWS Success Stories:

- Partnerships between agencies have created new opportunities to develop and support new missions (such as Hinode, STEREO, Kuafu, SWARM, Koronas-Foton, ePOP, Picard, Solar Orbiter)

- ILWS Community Science Workshop series provides a unique opportunity to focus on space weather science. Prior workshops: Goa, India in 2006; Varna, Bulgaria in 2007; Ubatuba, Brasil in 2009; Beijing, China in 2011; and Irkutsk, Russia in 2013.

We are on the verge of another exciting decade of discovery and international cooperation. ILWS will continue to:

- Articulate a powerful and sustainable vision for our science
- Support data and modeling infrastructure
- Reach out to other international organizations
- Strengthen the international framework of cooperation in order to further the science behind space weather processes

http://ilwsonline.org

ILWS Activities

Sponsored COSPAR/ILWS Roadmap: http://www.lmsal.com/~schryver/COSPARrm/

Advancing space weather science to protect
society's technological infrastructure (*to be published in Adv. in Sp.Res. with a summary article in Space Weather Journal in Spring, 2015)*

COSPAR/ILWS Charge to the Road Map Team:
Focus on high-priority challenges in key areas of research
leading to a better understanding of the space environment and
a demonstrable improvement in the provision of timely, reliable information
pertinent to effects on civiian space- and ground-based systems,
for all stakeholders around the world.

The Road Map prioritized those advances that can be made on short, intermediate and decadal time scales, identifying gaps and opportunities form a predominantly, but not exclusively, geocentric perspective.

Organization of a week long COSPAR/ILWS/SCOSTEP-VarSITI Workshop
ILWS workshop will merge with COSPAR/SWx and VarSITI to hold a workshop in Goa, India in January, 2016. Announcement to come soon.

COSPAR/ILWS symposium on the margings of February 2016 UNCOPUOS is under discussion.

U.N. Global Space Weather Program

History: **The International Space Weather Initiative (ISWI) is a program of international cooperation** to advance the space weather science by a combination of instrument deployment, analysis and interpretation of space weather data from the deployed instruments in conjunction with space data, and communicate the results to the public and students. ISWI is a follow-up activity to the successful IHY 2007, but focusing exclusively on space weather. ***Guhathakurta, M., J. M. Davila, and N. Gopalswamy (2013), The International Space Weather Initiative (ISWI), Space Weather, 11, 327–329, doi:10.1002/swe.20048.***

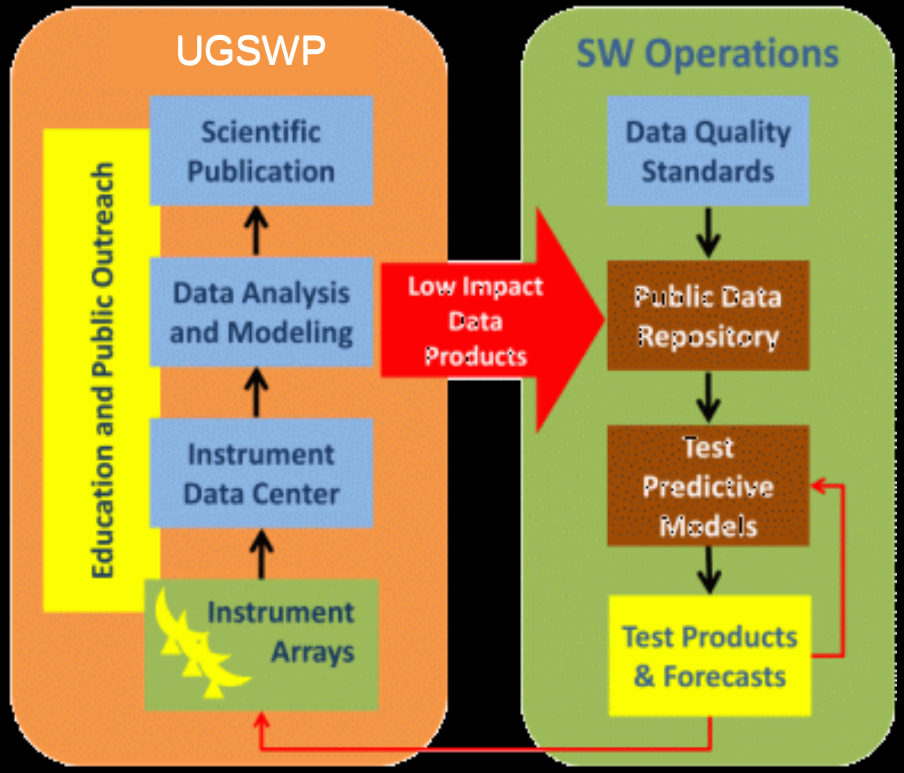
In 2013, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) decided to adopt space weather as a regular agenda item. In response to this permanent presence, ISWI evolved into the U.N. Global Space Weather Program (UGSWP). **UGSWP will continue to focus on international coordination with an emphasis on space weather activities in developing nations. Plans are currently underway to define and launch this exciting new program.**

Objectives:

Instrumentation and data analysis
- Expand existing instrument arrays
- Deploy of new arrays
- Expand data analysis effort for ISWI data and other relevant data bases

Coordinate data products to provide input for physical modeling of the Sun-Earth System
- Input instrument array data into physical models of heliospheric processes
- Provide data products in a form useful for modelling
- Enable Space Weather forecasting

Promote Education, Training and Outreach
- Encourage and support space science courses and curricula in Universities that provide instrument support
- Develop public outreach materials unique to the ISWI, and coordinate the distribution



http://iswi-secretariat.org

Space Weather and Diplomacy
UNCOPUOS (Scientific & Technical Subcommittee) Activities

February 2013: Space Weather became a regular agenda item and a new expert group was formed (2015) to facilitate effort

February 2014: Workshop on Improving Space Weather Forecasting in the Next Decade

February 2015: Workshop on Space Weather Services to Build Global Resilience & Meeting of Space Weather Expert Focus Group

March 2015: Workshop on Space Weather - Science and Data Products from ISWI Instruments

February 2016: COSPAR/ILWS roadmap symposium on the margins of STSC being planned.

iCCMC Ideas

CCMC demonstrated to be a solution for maximizing return on investment to model development and accelerated transition of progress in space science research and development and transition into space weather operations.

Much more is possible if research, educational and operational institutions worldwide join the efforts and establish International Community Coordinated Modeling Center (iCCMC).

iCCMC (like CCMC) should have a flexible non-bureaucratic approach that enables fast response to emerging needs of international space weather research and operational community.

iCCMC primarily focus on tool/system that can be accessed on-line and/or using web services. Web-based tools and systems enable remote collaboration and provide fast community access to the outcome of the development.

iCCMC will take advantage of CCMC years of experience in enabling, supporting and performing research and development for next generation of space science and space weather modeling capabilities.

iCCMC will take advantage of broad variety of space weather models available world-wide.

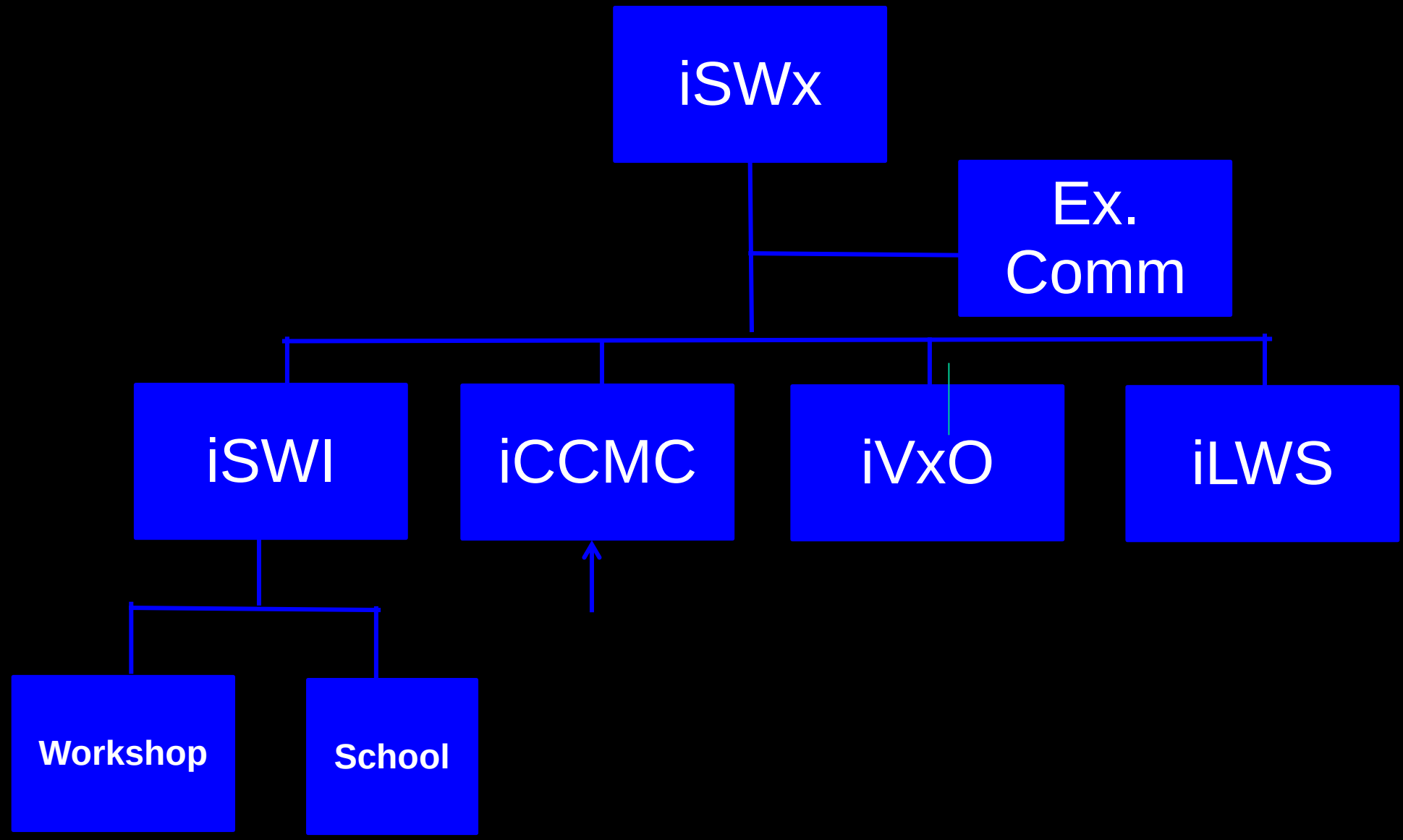
iCCMC will take advantage of distributed computational and storage resources.

iCCMC will take advantage of variety of international observational data streams.

iCCMC will take advantage of CCMC user base for fast exposure and implementation of new models and tools develop by the international research community.

iCCMC will push frontiers and facilitate research, development and operational space weather forecasting in innovative, collaborative and cost-effective ways.

Concept for International Space Weather Action Group



Solar Probe Plus: Humanity's First Mission to a Star