

Introduction to ILWS

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Why Establish ILWS?

GOAL: Stimulate and strengthen research in solar-terrestrial physics to improve understanding of the Sun-Earth connected system, some aspects of which directly affect life and society.

OBJECTIVE: To stimulate and facilitate:

- Study of the Sun-Earth connected system as a system.
- Synergistic coordination of international research in solar-terrestrial physics.
- Collaboration among potential partners in solar-terrestrial space missions.
- Sharing of scientific data and results.

SOME BENEFITS:

- Places individual agency programs in context of a larger, more comprehensive program.
- Optimizes utilization of international resources applied to scientific research in solar-terrestrial research.
- Enables maximum temporal and spatial coverage of Sun-Earth connected system for addressing underlying physics.

Function of ILWS Working Group

ILWS-WG to address or establish mechanisms to execute the following tasks:

- 1. Develop a programmatic scenario by identifying and synthesizing presently known projects and activities on Sun-Earth processes within individual agencies' programs.**
- 2. Identify potential for collaboration among presently known programs.**
- 3. Consider potential new opportunities to strengthen elements of the program where appropriate.**
- 4. Explore ways to enhance the accessibility and usability of data & other resources, in particular, taking account of recent developments in information technology.**
- 5. Engage the scientific community as necessary in addressing items 1-4.**

Products from September Meeting

1. **Agency points of contact (name, address, phone and FAX numbers, email address).**
2. **Comments on draft charter for ILWS-WG.**
3. **Listing of information available now and identification of mechanisms for developing and updating the ILWS mission plan with:**
 - **Planned missions (missions with identified funding, schedule)**
 - **Potential missions (under serious consideration as future missions)**
4. **Listing of information available now and identification of mechanisms for developing and updating plans for agency contributions to ILWS, including:**
 - **Spacecraft**
 - **Instruments**
 - **Launch**
 - **Tracking**
 - **Ground-based Support**
 - **Data storage/distribution centers**
 - **Ground-based measurements**
5. **Identification of desired Task Groups (e.g. ILWS science working group?)**



International Living With a Star

INTERNATIONAL LIVING WITH A STAR (ILWS)

Brief History

- **Fall, 2000: NASA proposes LWS program which is funded starting fall of 2001.**
- **IACG establishes Task Group to study prospects for developing an ILWS program.**
- **May, 2001: Task Group meets in Tenerife (in conjunction with ESA Solar Orbiter Workshop). Task Group includes:**
 - **Four IACG agencies (ESA, ISAS, NASA, RSA) & IACG secretary.**
 - **CSA, CRL (Communications Research Laboratory, Japan), & NOAA (U.S.).**
- **Task Group concludes:**
 - **ILWS program has substantial potential for stimulating and enabling a new international effort in solar-terrestrial research.**
 - **ILWS provides umbrella for forging necessary international coordination, cooperation, and bilateral and multilateral agency collaborations.**
- **January 2002: IACG accepts recommendation of Task Group to establish ILWS program.**
- **September 2002: First meeting of ILWS Working Group in Washington DC.**

Why Do Science?

		<i>For Utility</i>	
		<i>No</i>	<i>Yes</i>
<i>For Understanding</i>	<i>Yes</i>	Bohr	Pasteur
	<i>No</i>		Edison

From Donald Stokes (Woodrow Wilson School for Public and International Affairs, Princeton University)

The Sun-Earth Connection -- Science in the Pasteur Mode

- *How a star works*
- *How it affects humanity's home*
- *How to live with a star*

The Sun-Earth Connected System

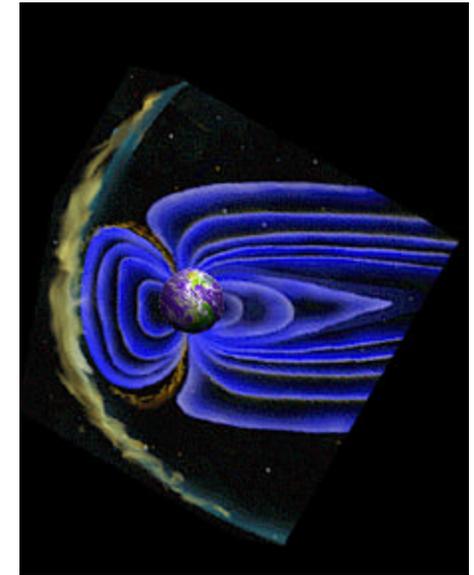
Variable Star



Varying

- Radiation
- Solar Wind
- Energetic Particles

Planet

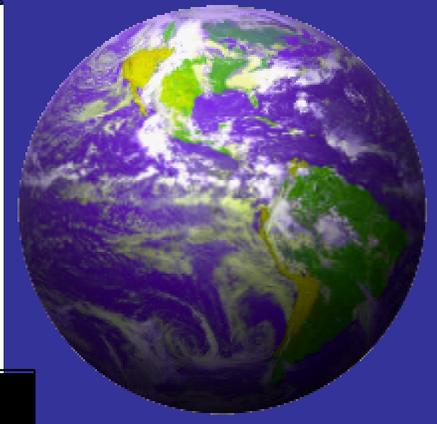
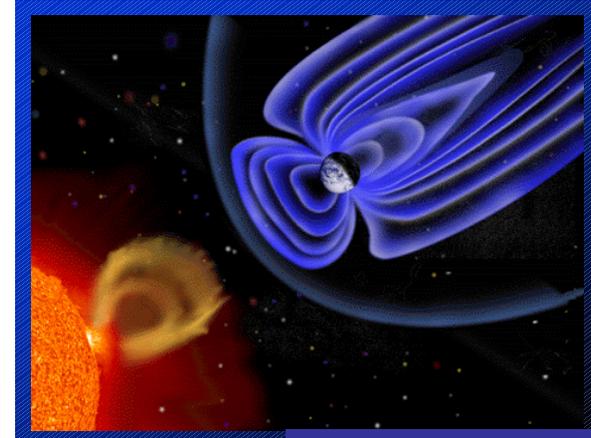


Questions:

- *How and why does the Sun vary?*
- *How does the Earth respond?*
- *What are the impacts on humanity?*

Why Do We Care?

- **Solar Variability Affects Human Technology, Humans in Space, and Terrestrial Climate.**
- **The Sphere of the Human Environment Continues to Expand Above and Beyond Our Planet.**
 - Increasing dependence on space-based systems
 - Permanent presence of humans in Earth orbit and beyond



Solar Variability Can Affect Space Systems

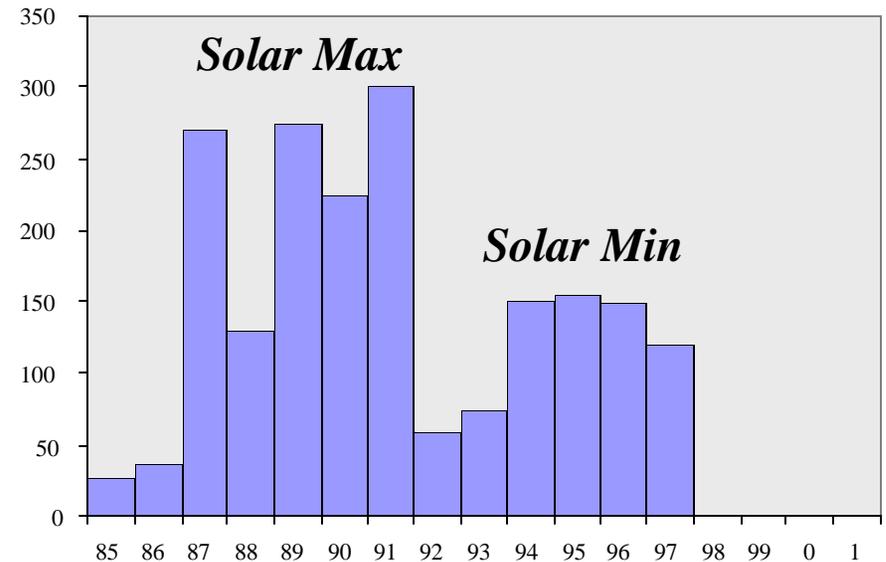
How?

- **Spacecraft charging.**
- **Solar cell damage.**
- **SEU's & damage to electronics.**
- **Atmospheric drag.**

So What?

- **Society's dependence on space assets is increasing.**
- **Space assets vital to world economy, communications, weather forecasts.**
- ***Prudence demands that we understand the space environment affecting space systems.***

Satellite Anomalies

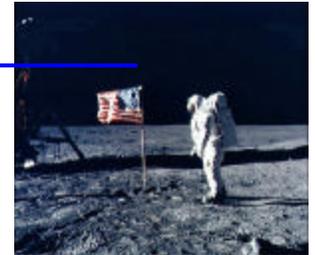


Commercial Comsats

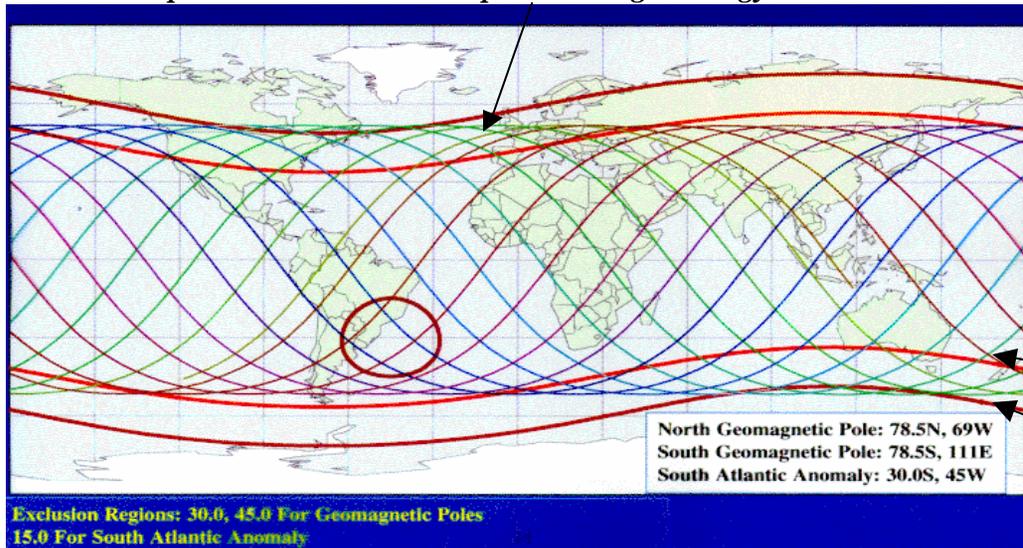
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Solar Variability Can Affect Human Space Flight

- Biological effects of energetic particle radiation are largely unknown.
[Goal: To make radiation exposure *As Low As Reasonably Achievable.*]
- Space Station: "Solar energetic particle events have a significant impact on crew exposures and station operation related to crew safety."
- Mars: "The capability to predict solar particle events 8 hours in advance of their occurrence is thought to be an operational requirement for a safe interplanetary mission."



Space Station Orbit is Exposed to High Energy Solar Particles



Geomagnetic Storm

Quiet Conditions

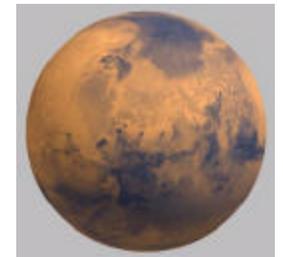
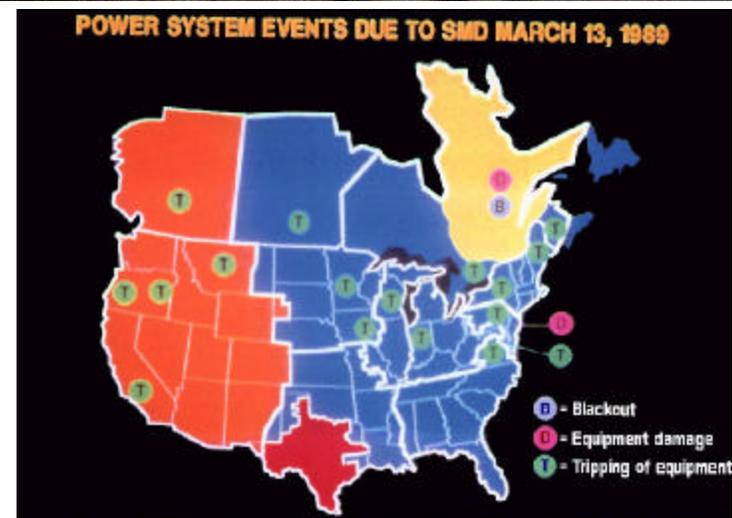
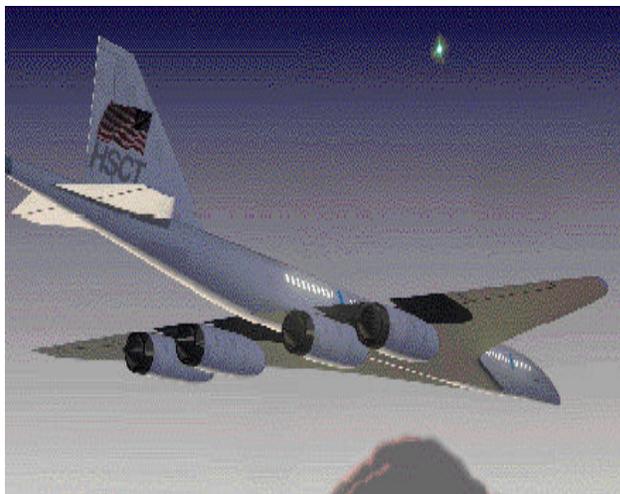


Chart courtesy Ron Turner, ANSER

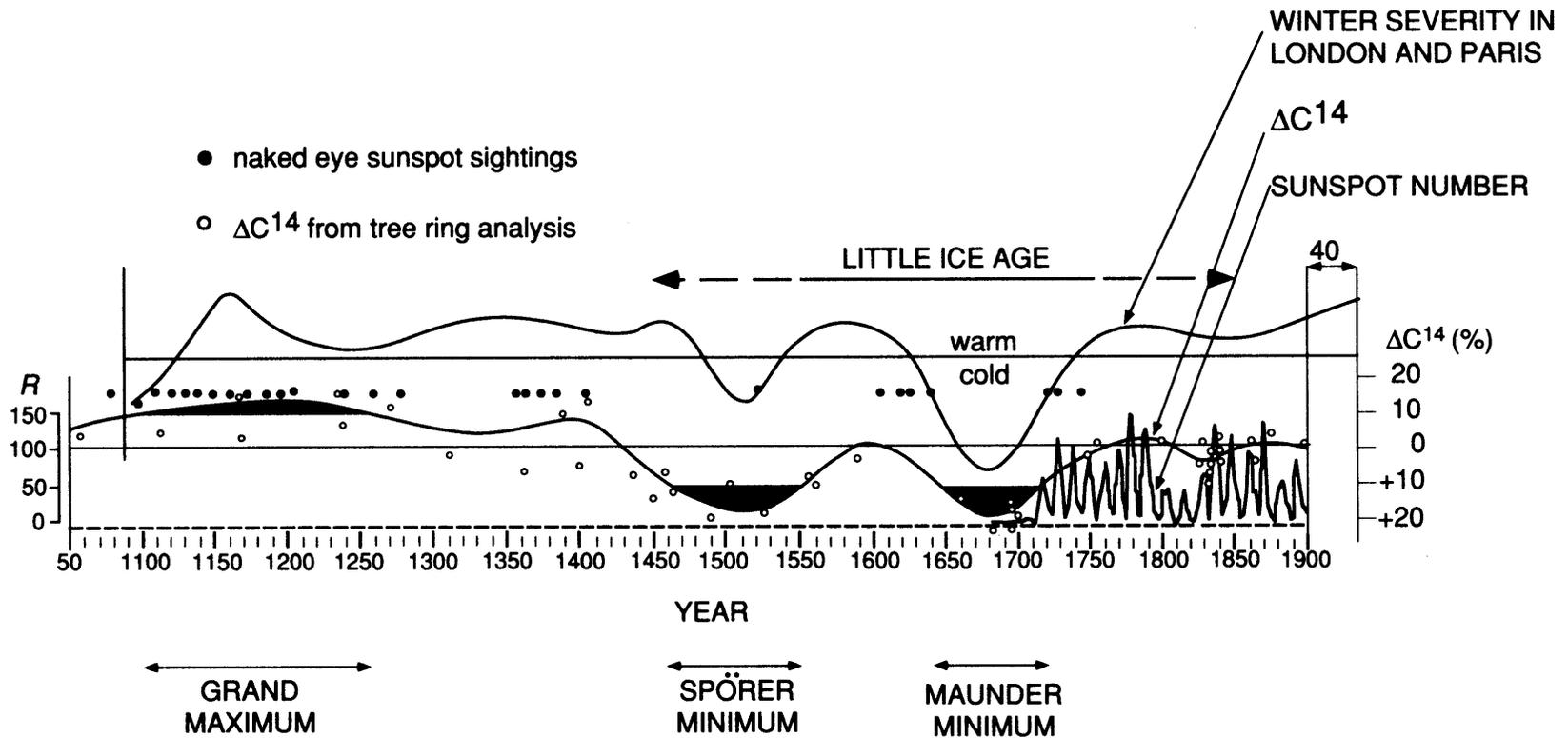
Issue: Requires focused research effort to improve knowledge about risk levels and possible risk mitigation techniques. Enabling research for human voyages beyond Earth.

Solar Variability Can Affect Where We Live

- Electric grid disruption and power transformer damage.
- GPS signals, high frequency (HF and VHF) radio communications, and long range radar.
- Microelectronics and humans in high altitude aircraft.
- Telecommunication cables.
- High precision electronic chip fabrication.



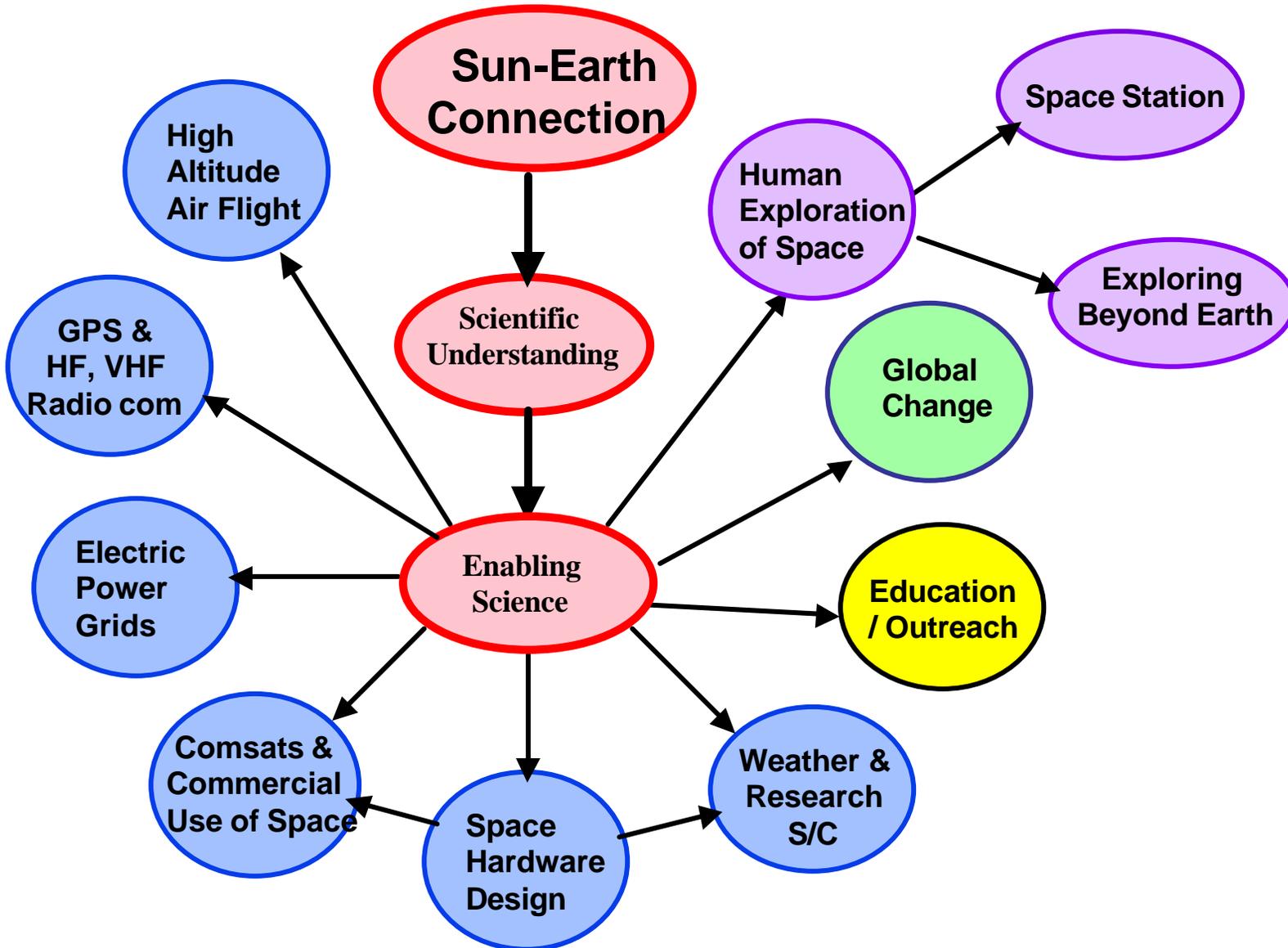
Solar Variability Can Affect Terrestrial Climate



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are needed to see this picture.

Given the massive economic impact of small changes in climate, we should fully understand both natural and anthropogenic causes of global change.

Sun Earth Connections



What can we do about it?

1. **Quantify physics, dynamics, and behavior of Sun-Earth connected system through the range of conditions occurring in the 11 year solar cycle.**
 - **Obtain improved measurements.**
 - **Better understand Sun-Earth disturbances.**
 - **Understand the solar cycle.**
For long-range space weather forecasting & assessing solar role in climate change.
 - **Determine space environmental conditions vs location, time in solar cycle.**
Needed for design of systems to minimize sensitivity to space weather.
2. **Develop predictive models for the system that:**
 - **Demonstrate understanding of physics.**
 - **Have utility for prediction of space weather.**
3. **Minimize impact of space weather on technology and astronauts.**
 - **Develop improved space weather predictions and space environmental design specifications.**
 - **Fly low cost flight test beds for validation of rad-hard, rad-tolerant systems.**

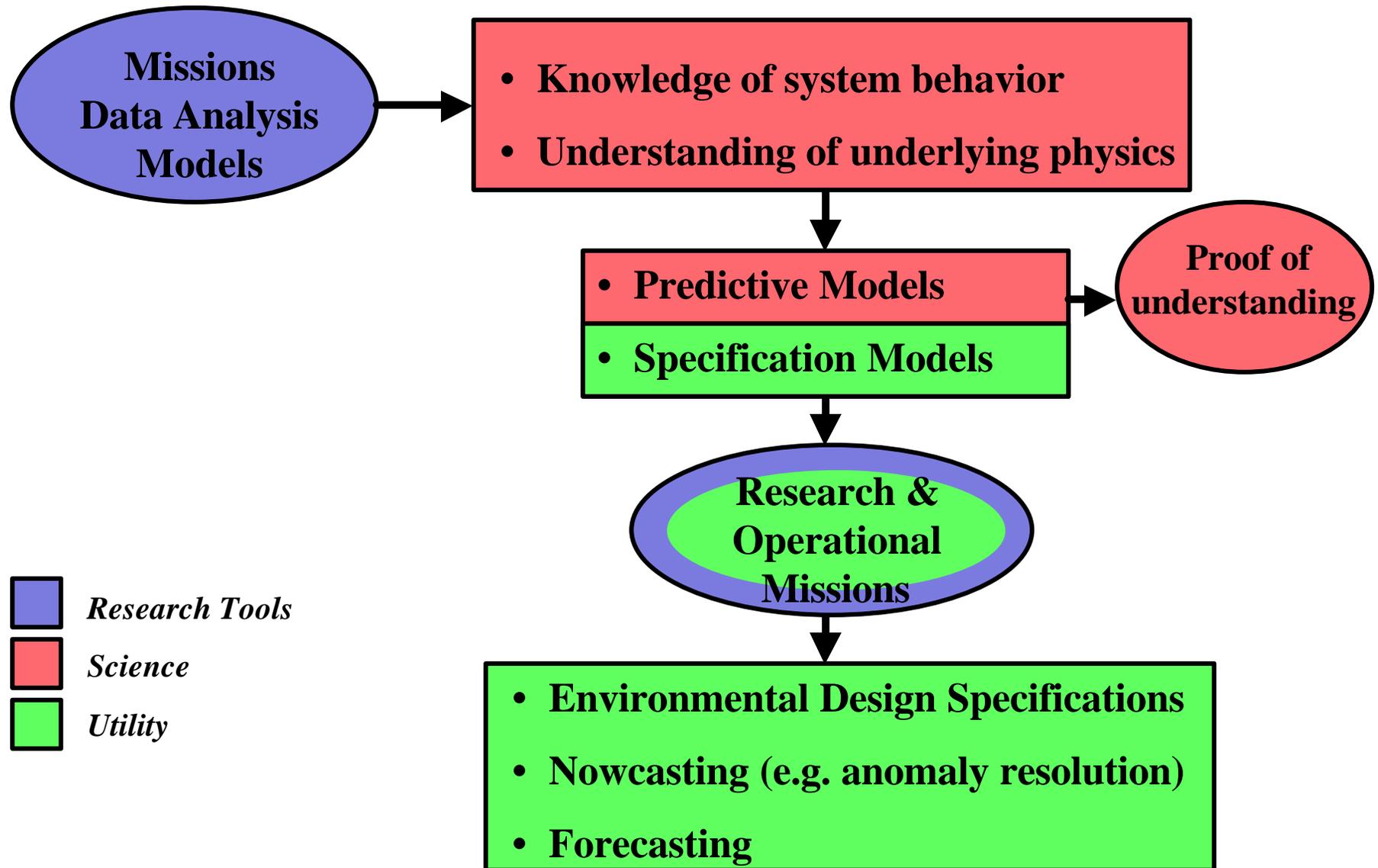
Apply a systems approach.

INTERNATIONAL LIVING WITH A STAR (ILWS) GOAL



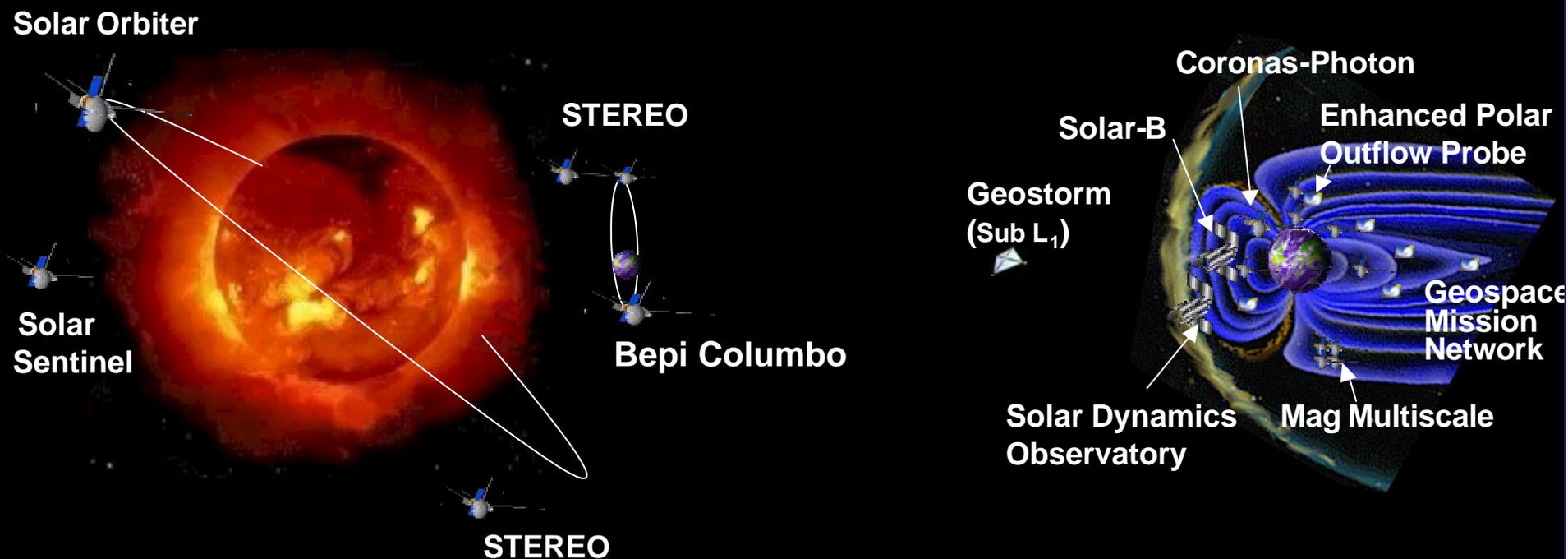
Stimulate and strengthen research in solar-terrestrial physics to improve understanding of the *connected* Sun-Earth system, some aspects of which directly affect life and society.

The Result: Scientific Understanding and Utility



International Living With a Star

Some Candidate Missions



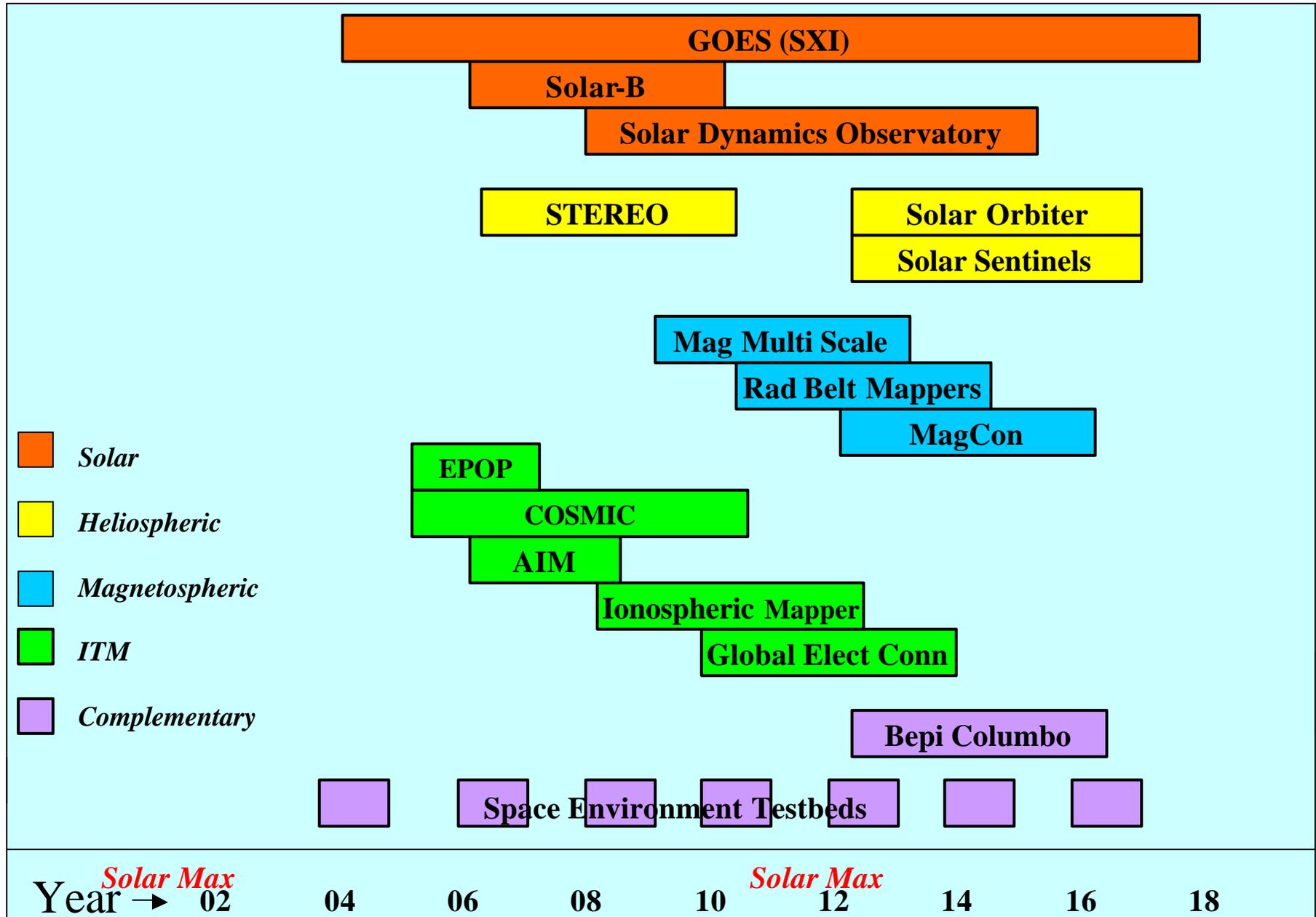
Distributed network of spacecraft providing observations of Sun-Earth system.

- ***Solar-Heliospheric Network*** observing Sun & tracking disturbances from Sun to Earth.
- ***Geospace Mission Network*** with constellations of smallsats in key regions of geospace.

SOME GAPS IN CURRENTLY PLANNED MISSION FLEET

- **Insufficient spacecraft to sample simultaneously all critical regions & phenomena of complex, time-varying geospace environment**
 - **Imaging of upper terrestrial atmosphere, Earth's magnetosphere severely limited in currently planned mission fleet.**
 - **Insufficient number, inadequate spatial distribution of spacecraft making *in situ* measurements.**
- **Solar wind to be sampled at only a few points; no replacement for ACE (launched in 1997) at L1 in an approved (funded) program.**
- **Inadequate measurement of solar high energy phenomena (e.g. flares and energetic particles) currently planned for next solar maximum.**

Some Planned* New Solar-Terrestrial Missions



*Missions with identified funding

International Living With A Star

