

# 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>	<b>Bohr</b>	<b>Pasteur</b>
	<i>No</i>		<b>Edison</b>

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

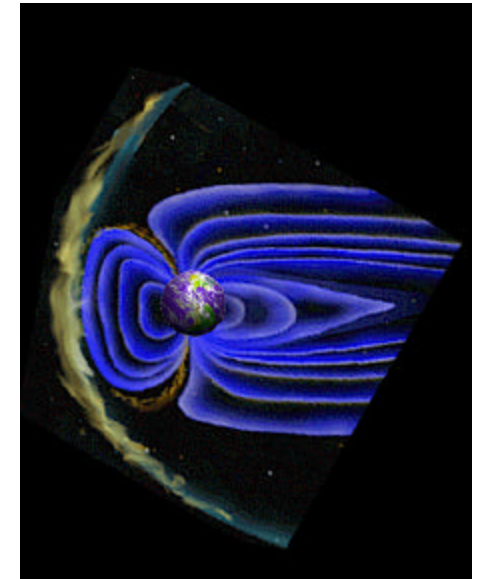
*Variable Star*



## Varying

- Radiation
- Solar Wind
- Energetic Particles

*Planet*



## Questions:

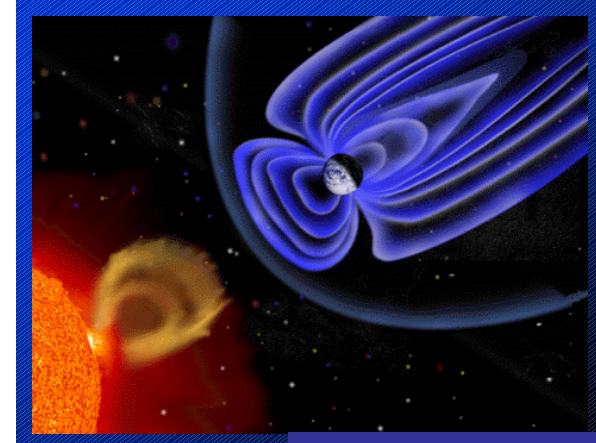
- *How and why does the Sun vary?*
- *How does the Earth respond?*
- *What are the impacts on humanity?*



# Why Do We Care?

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- **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

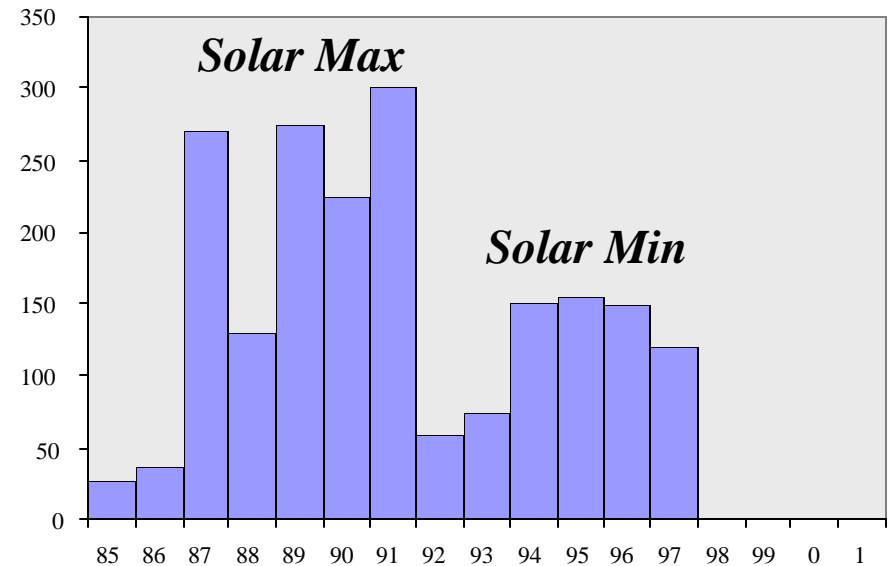
## How?

- 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

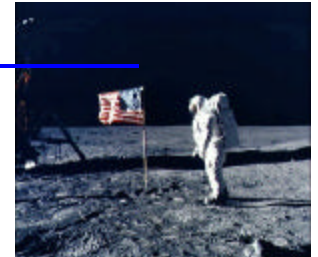


## Commercial Comsats

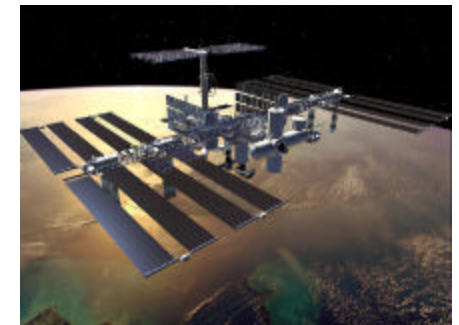
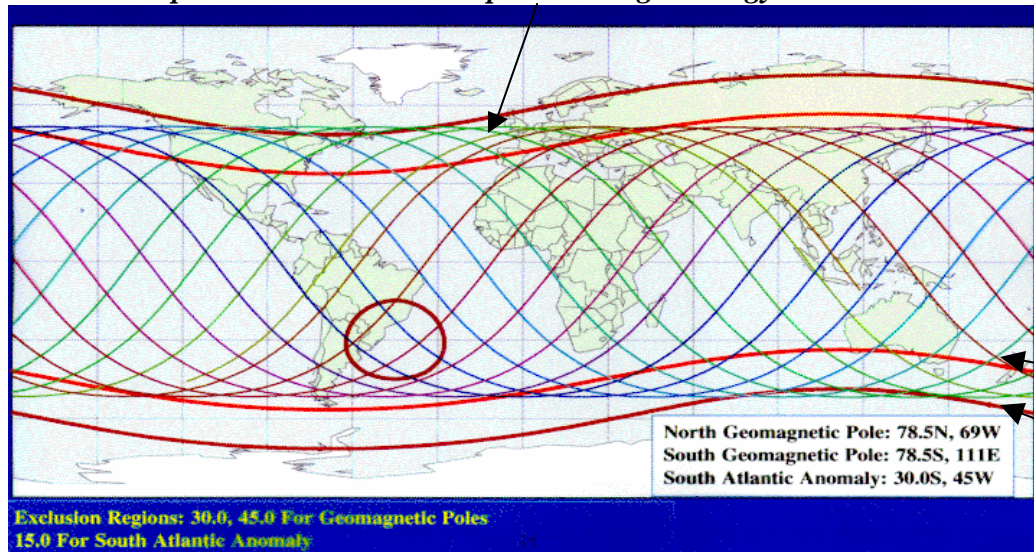
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are needed to see this picture.

# 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



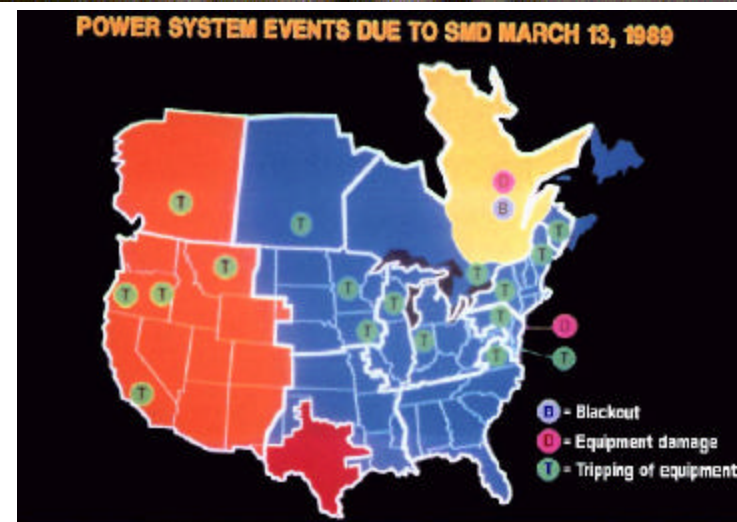
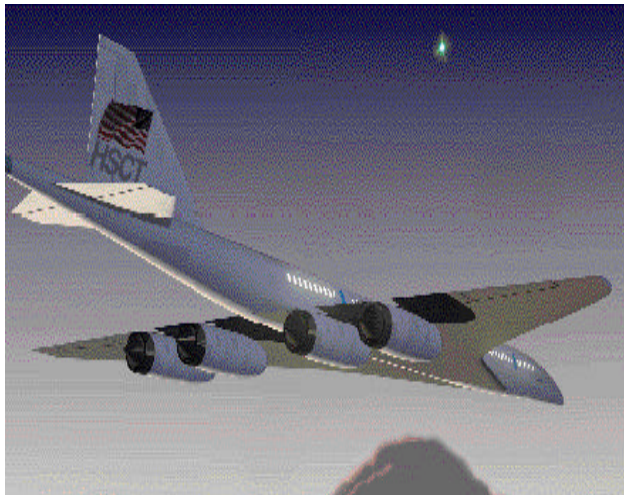
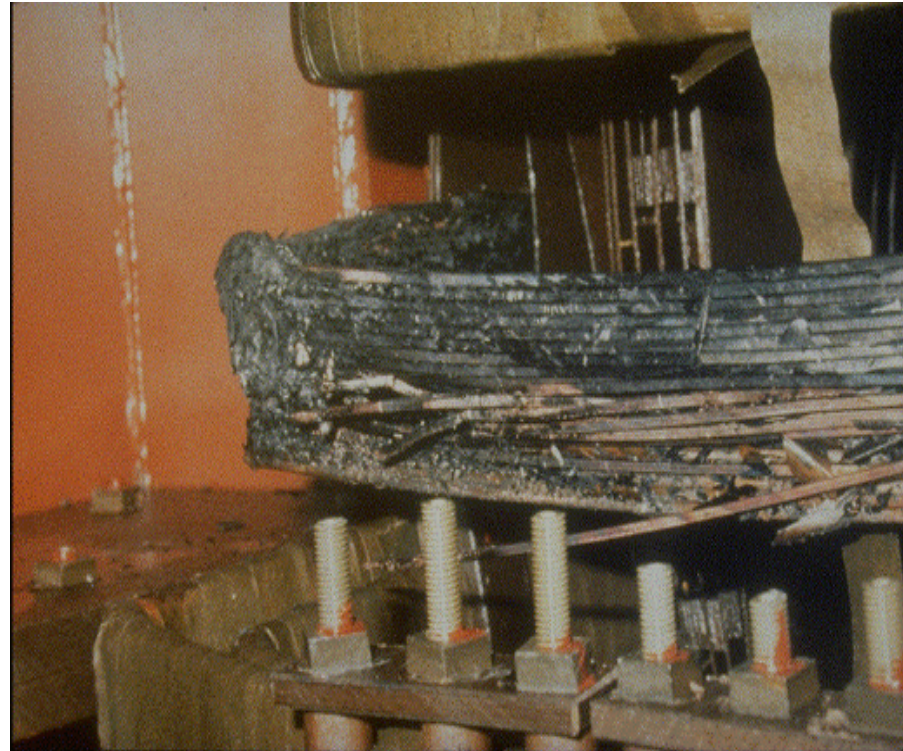
Chart courtesy Ron Turner, ANSER

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

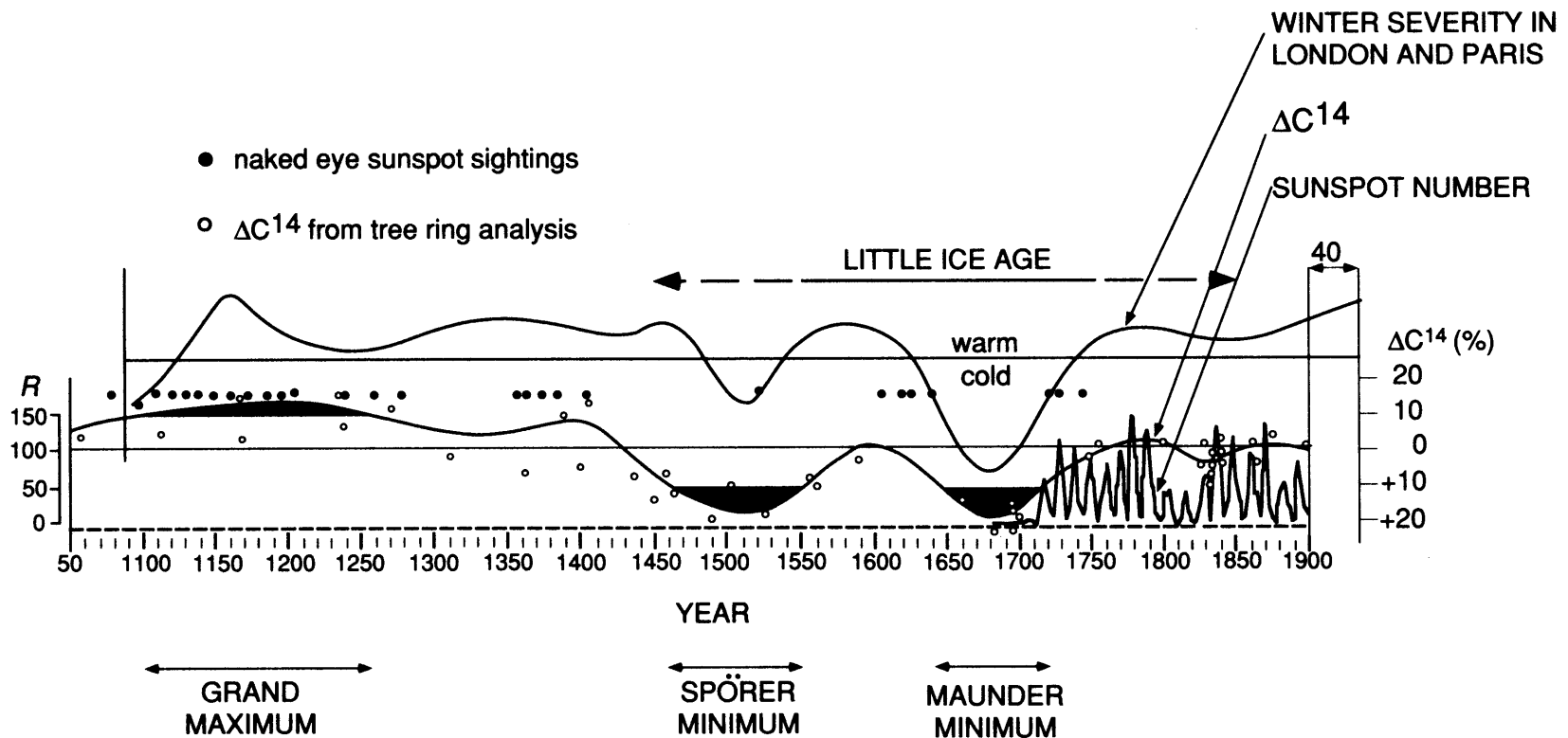


# Solar Variability Can Affect Where We Live

- 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.



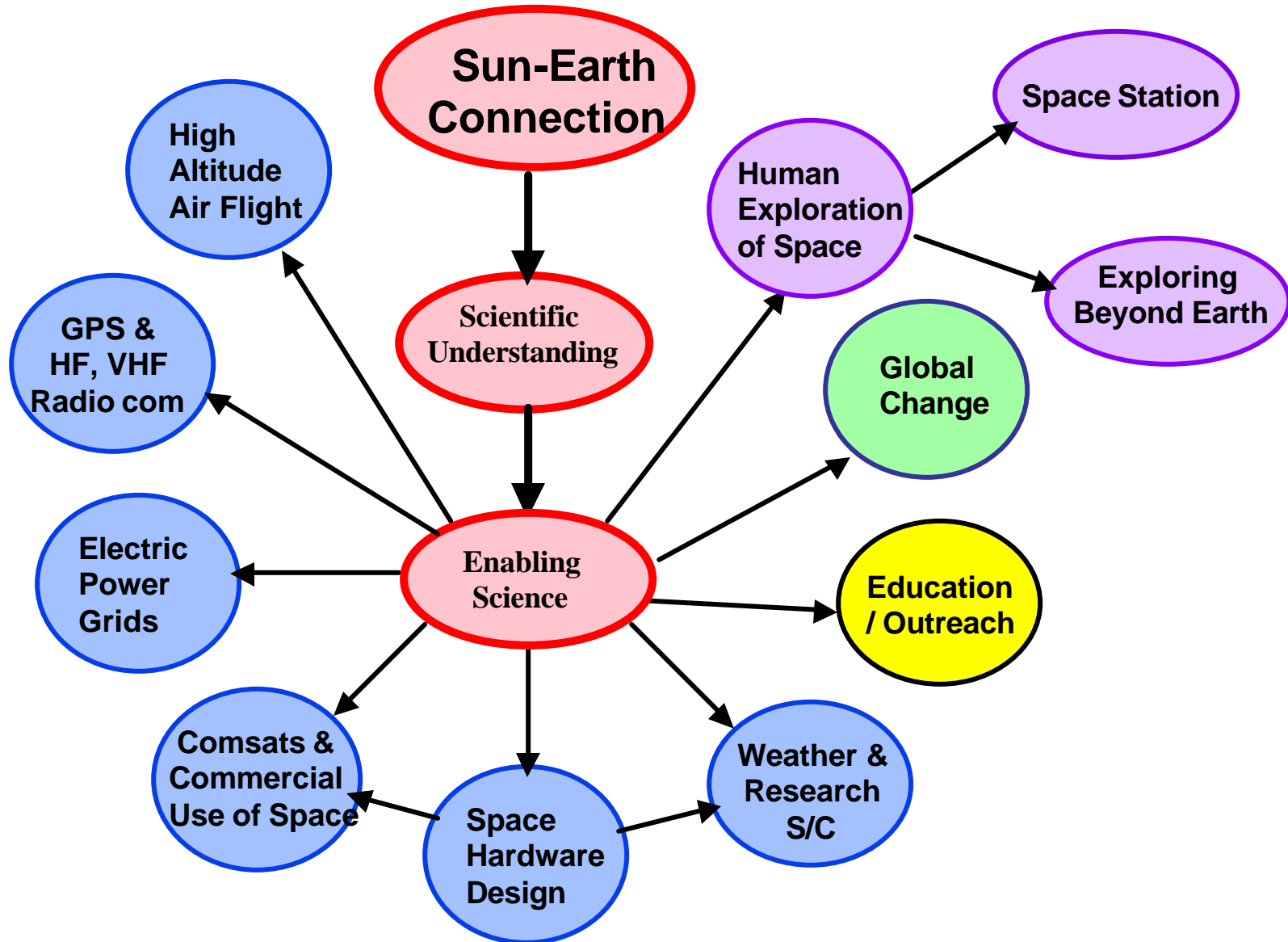
# Solar Variability Can Affect Terrestrial Climate



QuickTime™ and a  
Photo - JPEG decompressor  
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.*

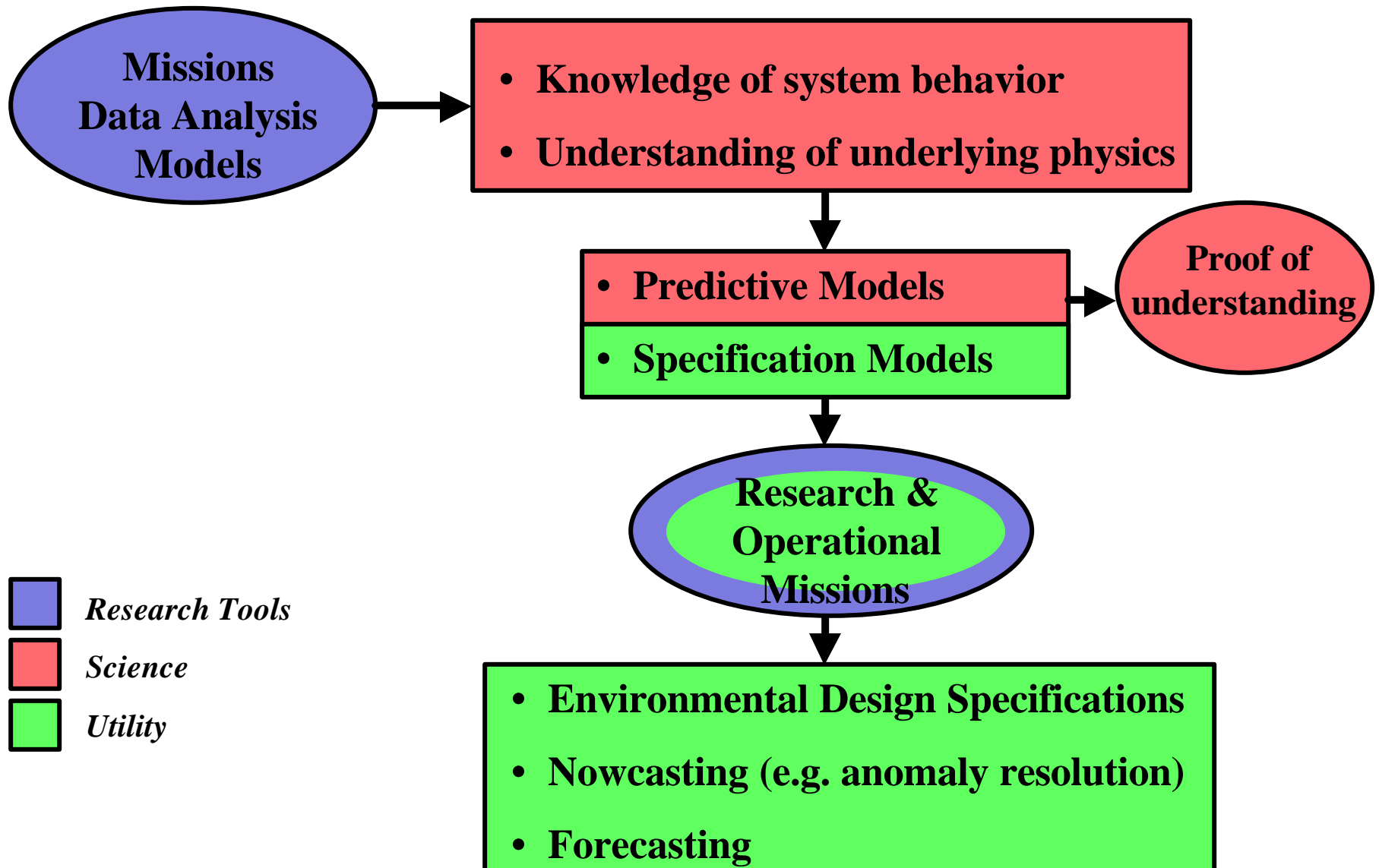
# INTERNATIONAL LIVING WITH A STAR (ILWS) GOAL



**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.**

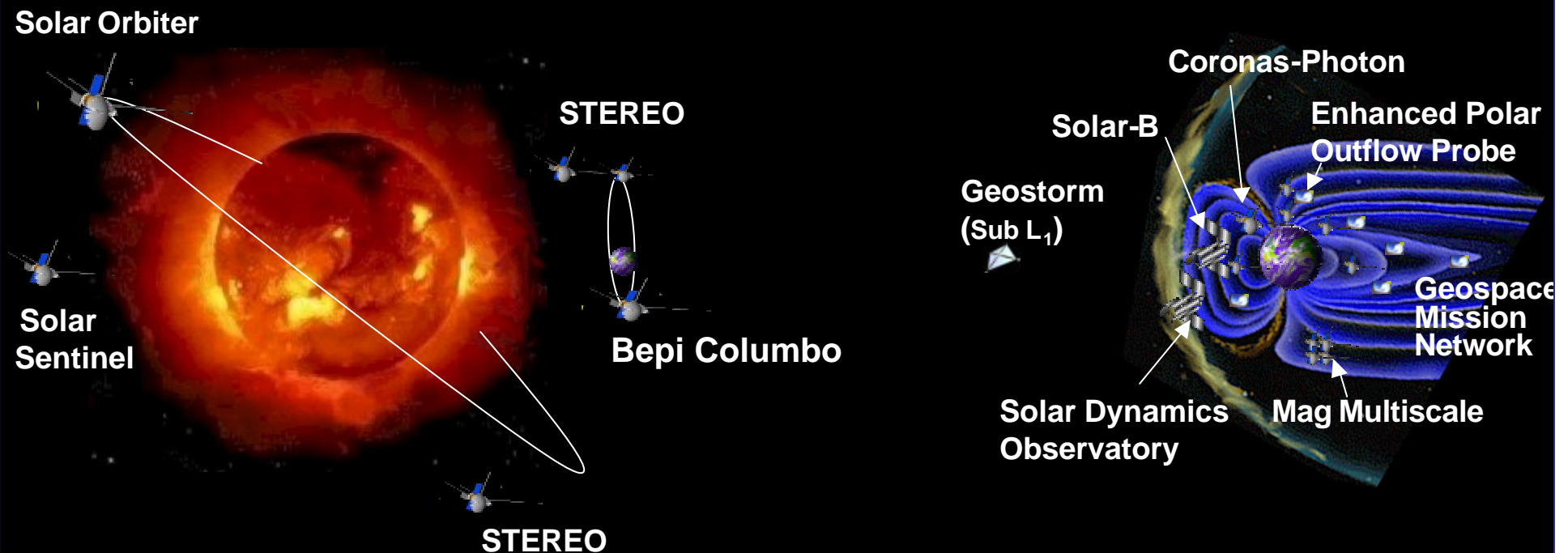


# The Result: Scientific Understanding and Utility



# International Living With a Star

## Some Candidate Missions



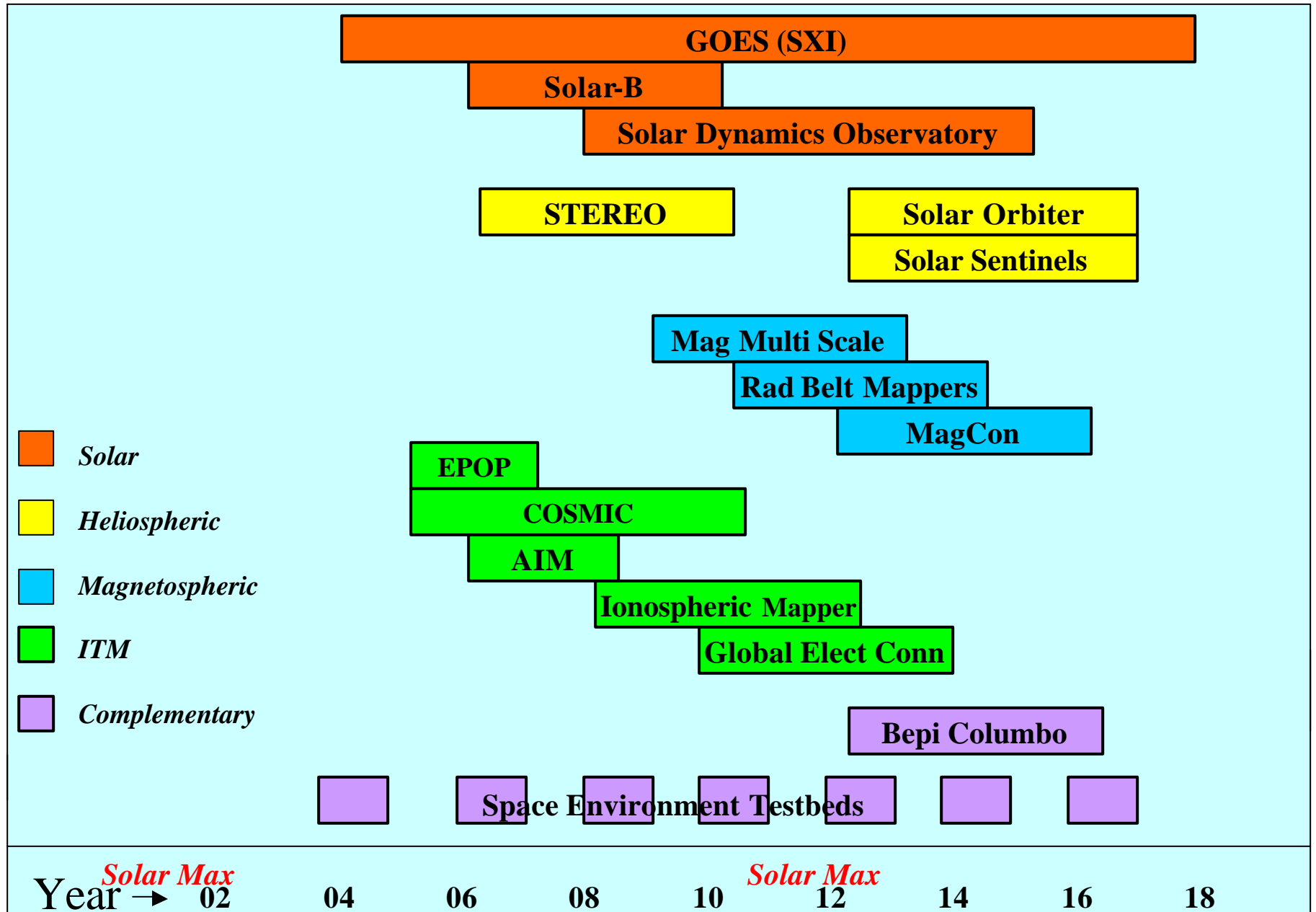
**Distributed network of spacecraft providing observations of Sun-Earth system.**

- ***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

