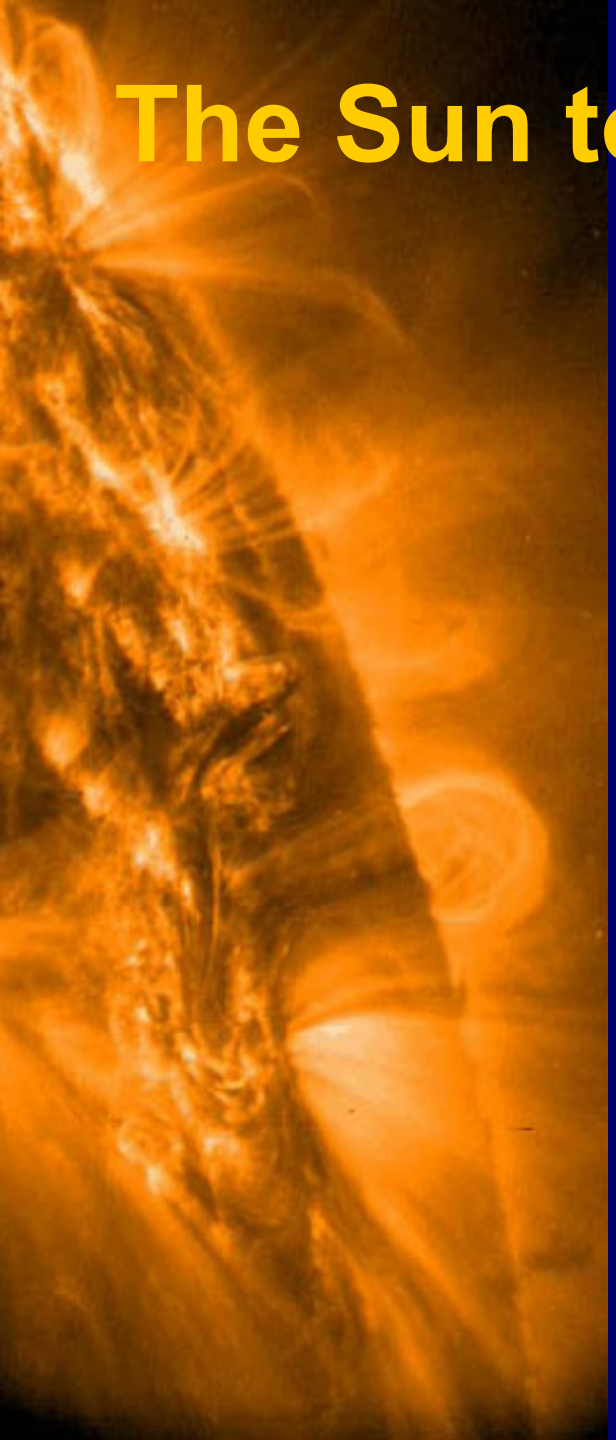
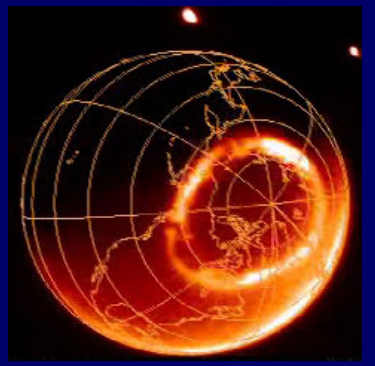


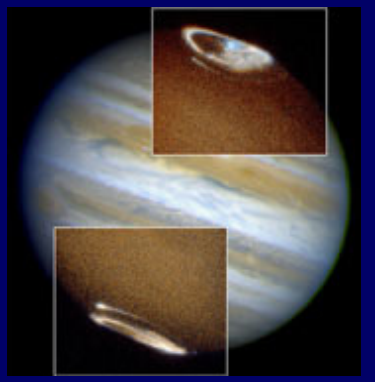
The Sun to the Earth – and Beyond

An Integrated Strategy for Solar and Space Physics, 2003-2013

Planning for the Future: The Decadal Survey as an Expression of Community Data Needs

http://www.nationalacademies.org/ssb/sspsuntoearth.html





Louis J. Lanzerotti
American Geophysical Union

6 December 2002

The Charge to the Survey Committee:

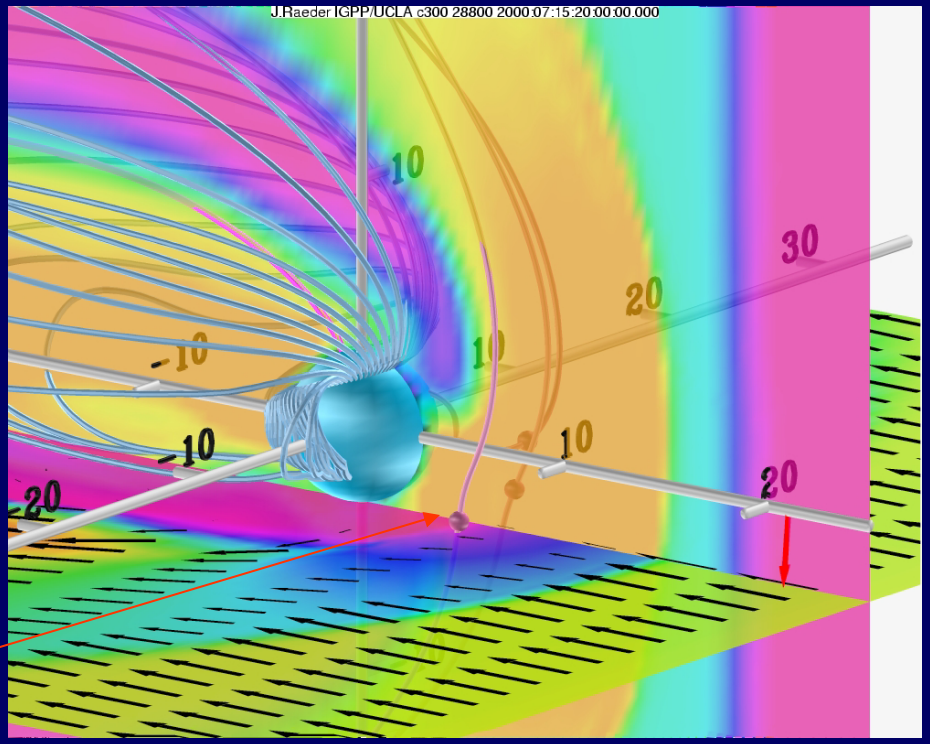
- Conduct a **BROADLY BASED ASSESSMENT** of the scientific priorities of U.S. solar and space physics research programs. Consider contributions from all agencies (NASA, NSF, NOAA, DoD)
- Recommend **PRIORITIES** for the decade 2003-2013, including effective implementation of existing or planned programs.
- Recommend a **SYSTEMS APPROACH** to theoretical, ground-based, and space-based research that encompasses the flight programs and focused campaigns of NASA, the ground-based and basic research programs of NSF, and the complementary operational programs of other agencies such as DoD, DoE, and NOAA.
- Address the **HUMAN ASPECTS** of the field involving education, career opportunities, and public outreach.
- Suggest promising areas for the development of **NEW TECHNOLOGIES**.

Organization of the Study:

Scientific Challenges:

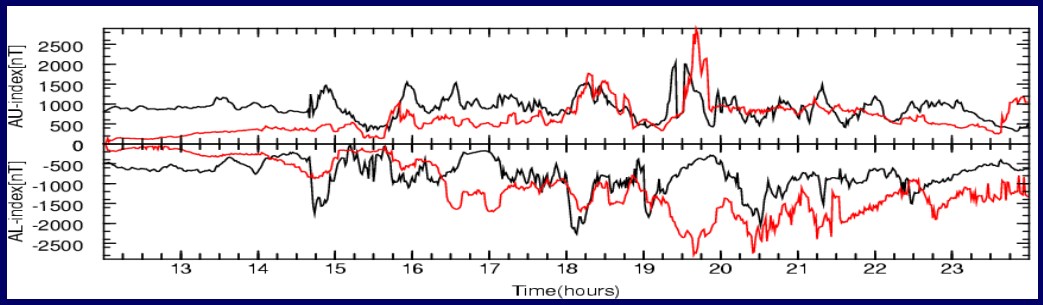
- **The Sun's Dynamic Interior and Corona:** Understanding the structure and dynamics of the Sun's interior, the generation of solar magnetic fields, the causes of solar activity and the origin of the solar cycle, and the structure and dynamics of the corona
- **The Heliosphere and Its Components:** Understanding heliospheric structure, the distribution of magnetic fields and matter throughout the solar system, and the interaction of the solar atmosphere with the local interstellar medium
- **The Space Environments of the Earth and Other Solar System Bodies:** Understanding the space environments of the Earth and other solar system bodies and their dynamical response to external and internal influences
- **Fundamental Space Plasma Physics:** Understanding the basic physical principles manifest in processes observed in solar and space plasmas
- **Space Weather:** Developing near real-time predictive capability for understanding and quantifying the impact on human activities of dynamical processes at the Sun, in the interplanetary medium, and in the Earth's magnetosphere
- **The Astrophysical Context:** Understanding the Sun, heliosphere, and planetary magnetospheres and ionospheres as astrophysical objects and in an astrophysical context

"Global geo-space models are now quantitative: the new challenges are data assimilation, improving the physical realism, and metrics [for] evaluations"



3 GEO GOES s/c (red spheres) cross into magnetosheath at predicted time

Predicted (red) and measured (black) AL indicies



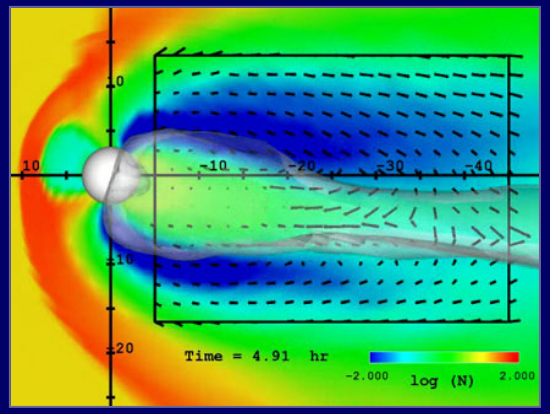
IGPP/UCLA geo-space model; July 14, 2001, event

Recommended Vitality Programs:

Rank	Program	Description
1	**NASA SR&T**	NASA research and analysis program.
2	**National Space Weather Program**	Multi-agency program led by the NSF to support focused activities to improve scientific understanding of geospace in order to provide better specifications and predictions.
3	**Coupling Complexity**	NASA/NSF Theory and modeling program to address multi-process coupling, nonlinearity, and multi-scale and multi-regional feedback.
4	**Solar and Space Physics Information System**	Multi-agency program for integration of multiple data sets and models in a system accessible by the entire solar and space physics community.
5	**Guest Investigator Program**	NASA program for broadening the participation of solar and space physicists in space missions.
6	**Sun-Earth Connection Theory and LWS Data Analysis, Theory, and Modeling Programs**	NASA program to provide long-term support to critical-mass groups involved in specific areas of basic and targeted basic research.
7	**Virtual Sun**	Multi-agency program to provide a systems-oriented approach to theory, modeling, and simulation that will ultimately provide continuous models from the solar interior to the outer heliosphere.

Synthesis for the organization and integration of space physics theory, modeling, and data exploration:

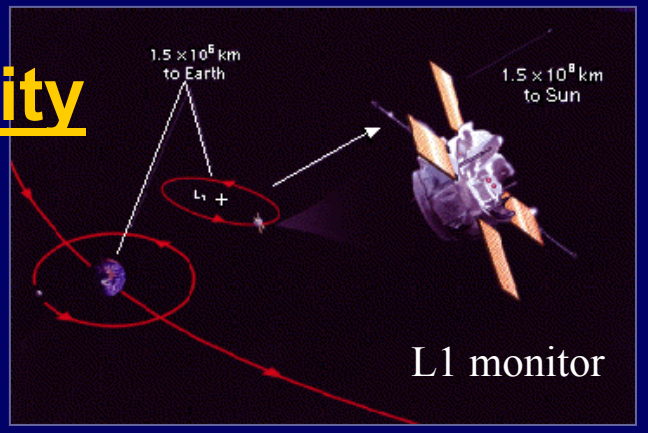
Coupling complexity in space plasma systems



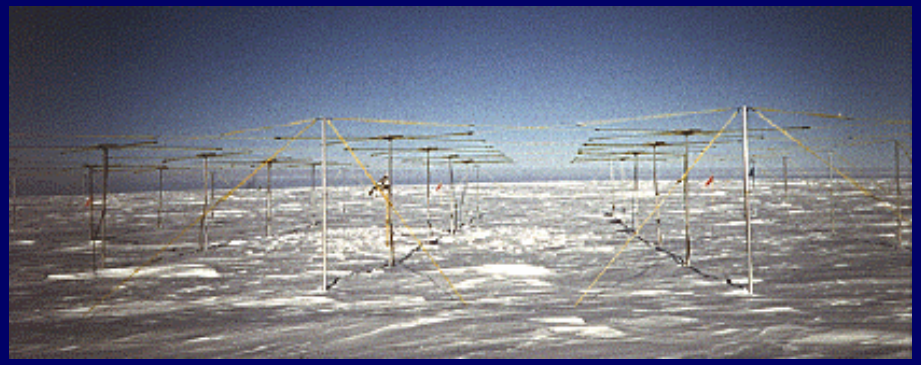
or, equivalently

The science of nonlinearity, multi-scale, and multi-process feedback in space plasma systems

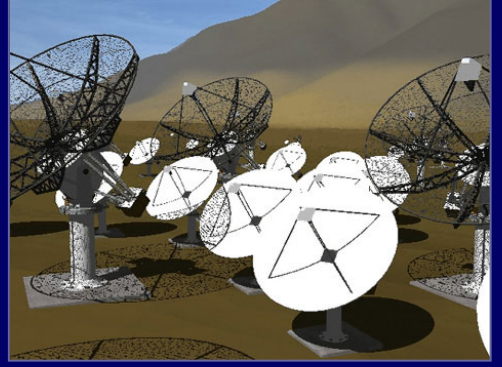
Challenges of Coupling Complexity



1. Formulation of sophisticated models that incorporate disparate scales, processes, and regions, the development of analytic theory, and maintaining a strong connection to basic science
2. Computation
3. Incorporation of coupling complexity into space physics models
4. Integrating theory, modeling, and space- and ground-based observations
5. Data exploration and assimilation
6. Transition of scientific models to operational status in, e.g., space weather activities

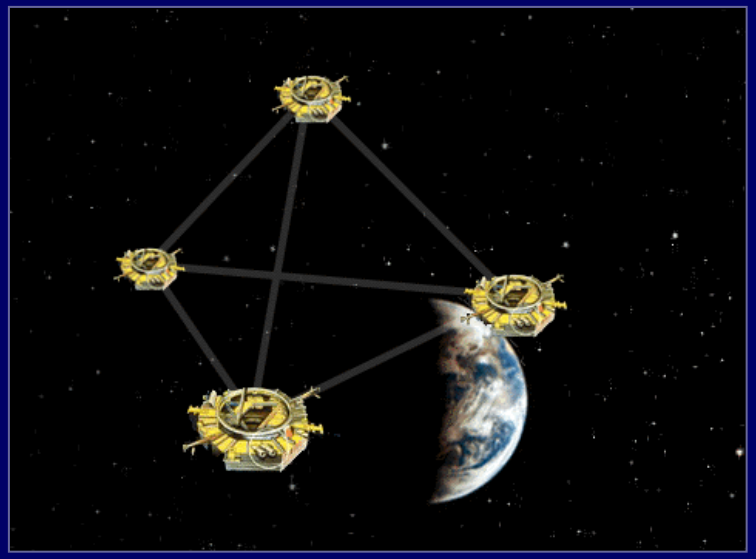


Imaging riometer

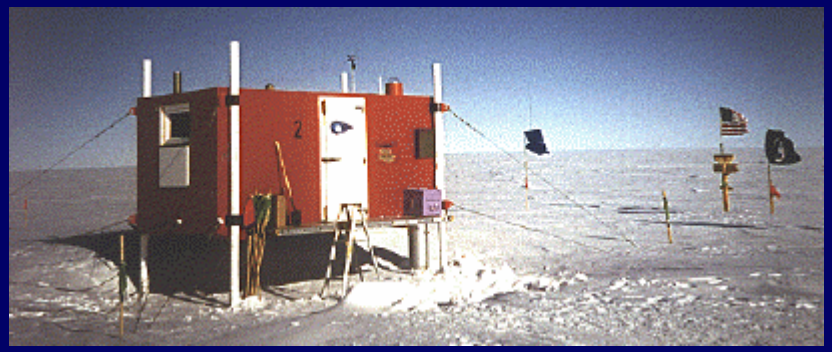


FASR

Progress in solar and space physics often requires correlative analysis of multiple data sets



Magnetospheric multiscale



Automatic Geophysical Observatory

Role of Data Exploration

- ♠ Identify new phenomena and test theory and simulations
- ♠ Observations represent national resource of immediate practical value: NOAA and DoD use in operational modes; industry use for design and operations
- ♠ Other benefits and uses:
  - Defines technologies
  - Training students
  - Some sets fascinating to general public (e.g., sun; aurora)

Alaska aurora

Big Bear H-Alpha

Decadal Survey Recommendations

Technology Challenges:

Gathering and Assimilating Data from Multiple Platforms

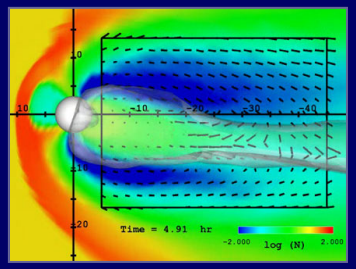
Recommendation: NASA should accelerate the development of command and control and data acquisition technologies for constellation missions

Strengthening the SSP Research Enterprise:

Strengthening the Solar and Space Physics Community

Recommendation: NASA should undertake an independent outside review of its existing policies and approaches regarding the support of solar and space physics research in academic institutions, with the objective of enabling the nation's colleges and universities to be stronger contributors to this research field.

Recommendation: NSF-funded national facilities for solar and space physics research should have resources allocated so that the facilities can be widely available to outside users



Theory, Modeling, and Data Exploration Panel Recommendations

Challenge 4 – Integrating theory, modeling, and observations

The Guest Investigator Initiative

- Mandatory for all new missions
- Both space- and ground-based
- Initiated 3-5 years before launch
- Peer reviewed; annual competition; 3-year duration

Challenge 5 – Data exploration and assimilation

A Distributed Space Physics Information System (SPIS)

- Linking (not duplicating) national and international archives
- Numerous tasks for system (e.g., on-line catalogues; high resolution data and error estimates; software tree maintenance; review evolving standards; generate key parameters; etc.)

Agency	Data Center	WWW Address
NASA	NSSDC	nssdc.gsfc.nasa.gov
NSF	NCAR	cedarweb.hao.ucar.edu (for upper atmospheric data)
NSF	UMD	www.polar.umd.edu (for Antarctic data)
NSF	NSO	www.nso.noao.edu/diglib/ (for solar data)
NOAA	NGDC	www.ngdc.noaa.gov
DoD	NGDC	www.ngdc.noaa.gov
DoE	LANL	Leadbelly.lanl.gov
USGS	NGDC	www.ngdc.noaa.gov

Designated Data Repositories, U.S.