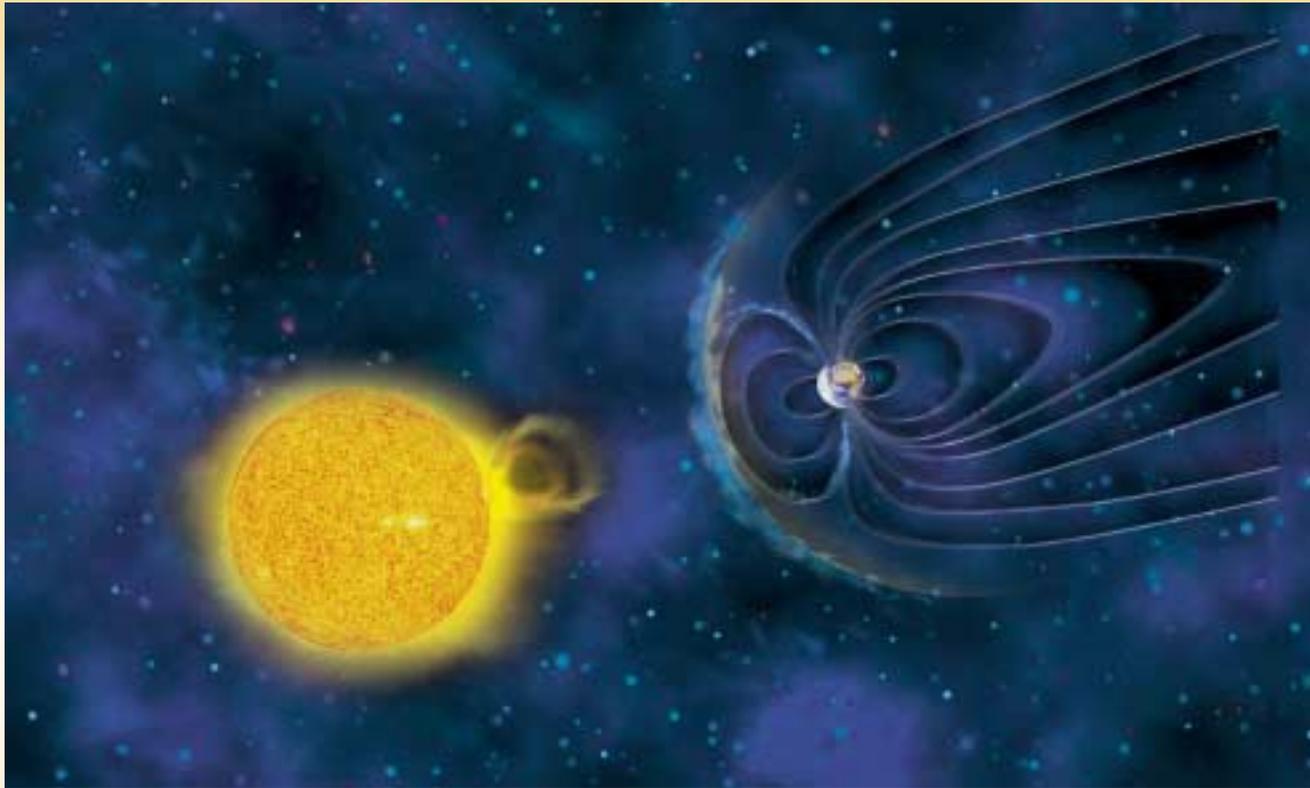




A Compendium of Sun-Earth Connection Education and Public Outreach Activities



Sun-Earth Connection Education Forum

<http://sunearth.ssl.berkeley.edu/scientists/epo.html>

<http://sunearth.gsfc.nasa.gov/scientists/epo.html>

Version 1

December, 1999

SEC EPO



Foreword

In response to NASA's strategic vision for broadly communicating the content, relevancy, and excitement of NASA's missions and discoveries, the Space Science Enterprise has made a strong commitment to a robust education and public outreach (EPO) program. As part of the Enterprise, the Sun-Earth Connection science community has enthusiastically responded to the EPO mandate, sharing the excitement and relevance of its discoveries through innovative and effective resources and programs. All SEC missions are chartered to include EPO components. SEC scientists representing industry, academia, and government are involved in EPO through support by SR&T grants and/or by their own institutions. The Sun-Earth Connection Education Forum, a partnership between Goddard Space Flight Center and University of California at Berkeley, helps cultivate and facilitate the development of partnerships between the SEC community and the communities responsible for formal and informal science, mathematics, and technology education.

To highlight and showcase education outreach efforts of SEC missions, scientists, and research programs, SECEF generated this compendium of SEC EPO activities. Through this compendium, SECEF hopes to

- Identify and disseminate best practices in education and public outreach;
- Help identify high leverage opportunities; and
- Stimulate the involvement of SEC scientists in education and outreach.

Besides creating an inventory of current and planned EPO activities of missions and research programs to promote collaboration and minimize duplication of effort, SECEF is developing an on-line resource directory to provide a single point of access for educators and members of the public to SEC EPO resources. In the compendium you will see many other activities conducted by SEC scientists, EPO specialists, and SECEF staff members.

Thanks for submitting your slides to Lou Mayo and Carolyn Ng. We welcome your contributions and comments to this compendium and our efforts.

Isabel Hawkins and
Richard Vondrak

<http://sunearth.ssl.berkeley.edu/scientists/epo.html>
<http://sunearth.gsfc.nasa.gov/scientists/epo.html>

SEC EPO



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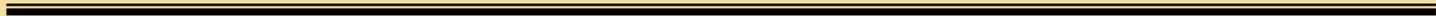
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I. Introduction



What is Sun-Earth Connection?

Sun-Earth Connection Quests and Science Themes:

Quest I: Why Does the Sun Vary?

- Interior Dynamics
- Solar Plasma/Magnetic Field Interactions
- Origin and Evolution of the Corona and the Solar Wind
- Interaction of the Solar Wind with the Interstellar Medium

Quest II: How Do the Planets Respond to Solar Variability?

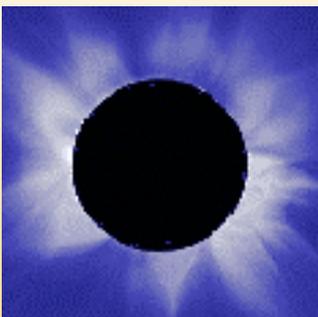
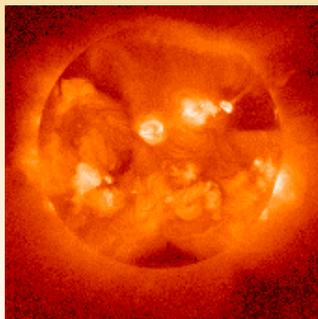
- Solar Interactions with the Earth's Atmosphere and Space Environment
- Comparative Space Environments
- Impacts on Life on Earth

Quest III: How do the Sun and Galaxy Interact?

- Regions Separating the Heliosphere from the Local Interstellar Medium
- Sample Properties of the Interstellar Medium

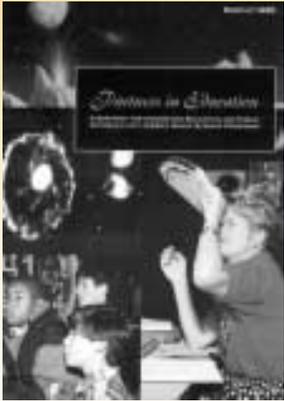
Quest IV: How Does Solar Variability Affect Life and Society?

- Impacts of Space Weather
- Changes in the Earth's Atmosphere
- Origins of Life
- Habitability of Space





Goals of NASA Space Science Education and Public Outreach



Partners in Education,
1995



Education Implementation Plan,
1996

1. Use our missions and research programs and the talents of the space science community to contribute measurably to efforts to reform science, mathematics, and technology education, particularly at the pre-college level, and the general elevation of scientific and technical understanding throughout the country;
2. Cultivate and facilitate the development of strong and lasting partnerships between the space science community and the communities responsible for science, mathematics, and technology education;
3. Contribute to the creation of the talented scientific and technical workforce needed for the 21st century;
4. Promote the involvement of underserved / underutilized groups in Space Science education and outreach programs and their participation in Space Science research and development activities;
5. Share the excitement of discoveries and knowledge generated by Space Science missions and research programs by communicating clearly with the public.



Elements of NASA EPO in Space Science

▪ **Missions**

- All space science missions now have EPO activities
- Missions are the most productive source of EPO products

▪ **Scientists**

- Primarily supported by SR&T grants or by own institutions

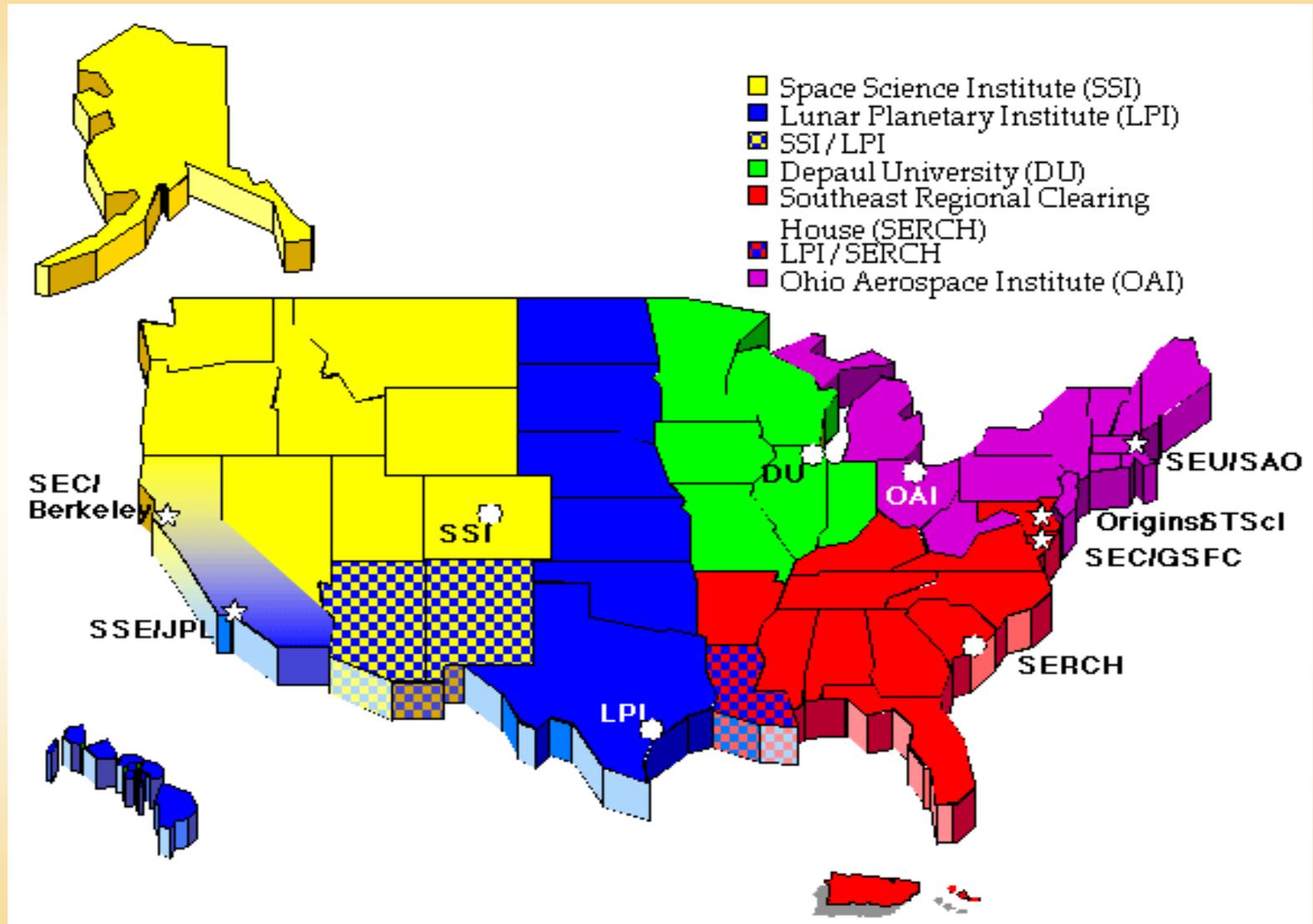
▪ **Sun-Earth Connection Education Forum (SECEF) and three other national forums**

▪ **Five Regional Broker/Facilitators**

▪ **Special Projects**



Space Science EPO "Ecosystem": Forums and Broker/Facilitators





Space Science EPO "Ecosystem": Forums and Broker/Facilitators (cont.)

☐ OSS Education Forums

Astronomical Search for Origins and Planetary Systems (Origins)

Space Telescope Science Institute

Point of Contact: Dr. Carol Christian

Baltimore, MD 21218

Phone: (410) 338-4764 Fax: (410) 338-4767

email: carolc@stsci.edu

Web: <http://origins.stsci.edu>

Structure and Evolution of the Universe (SEU)

Smithsonian Astrophysical Observatory

Point of Contact: Dr. Roy Gould

Cambridge, MA 02138

Phone: (617) 496-7689 Fax: (617) 496-5405

email: rgould@cfa.harvard.edu

Web: <http://cfa-www.harvard.edu/seuforum>

Solar System Exploration (SSE)

NASA Jet Propulsion Laboratory

Point of Contact: Dr. Ellis Miner

Pasadena, CA 91125

Phone: (818) 354-4450 Fax: (818) 393-4217

email: ellis.d.miner@jpl.nasa.gov

Web: <http://www.jpl.nasa.gov/forum>

Sun-Earth Connection (SEC)

NASA Goddard Space Flight Center

Point of Contact: Dr. Richard Vondrak

Greenbelt, MD 20771

Phone: (301) 286-8112 Fax: (301) 286-1683

email: vondrak@gsfc.nasa.gov

Web: <http://sunearth.gsfc.nasa.gov>

University of California, Berkeley

Space Sciences Laboratory

Point of Contact: Dr. Isabel Hawkins

Berkeley, CA 94720-7450

Phone: (510) 643-5662 Fax: (510) 643-5660

email: isabelh@ssl.berkeley.edu

Web: <http://sunearth.ssl.berkeley.edu>

★ OSS Broker/ Facilitators

DePaul University (DU)

Dr. Lynn Narasimhan - College of Liberal Arts and Sciences

2320 N. Kenmore

Chicago, IL 60614

Phone: (773) 325-1854 Fax: (773) 325-7304

email: cnarasim@condor.depaul.edu

Web: <http://analyzer.depaul.edu/NASABroker>

Lunar and Planetary Institute (LPI)

Ms. Pam Thompson

3600 Bay Area Boulevard

Houston, TX 77058

Phone: (281) 486-2175 Fax: (281) 486-2162

email: thompson@lpi.jsc.nasa.gov

Web: <http://cass.jsc.nasa.gov/education/education.html>

Ohio Aerospace Institute (OAI)

Dr. Larry Cooper

7661 Squirrel Creek Drive

Cincinnati, OH 45247

Phone: (513) 245-9897 Fax: (440) 962-3120

email: OSSBroker@oai.org

Web: <http://www.oai.org/oss>

SouthEast Regional ClearingHouse (SERCH)

Dr. Cassandra Coombs - Geology, College of Charleston

66 George Street

Charleston, SC 29424

Phone: (843) 953-8279 or (888) 873-9475 Fax: (843) 953-5446

email: coombsc@cofc.edu

Web: <http://www.cofc.edu/serch>

Space Science Institute (SSI)

Dr. Cherilynn Morrow

1540 30th Street, Suite 23

Boulder, CO 80303-1012

Phone: (303) 492-7321 Fax (303) 492-3789

email: camorrow@colorado.edu

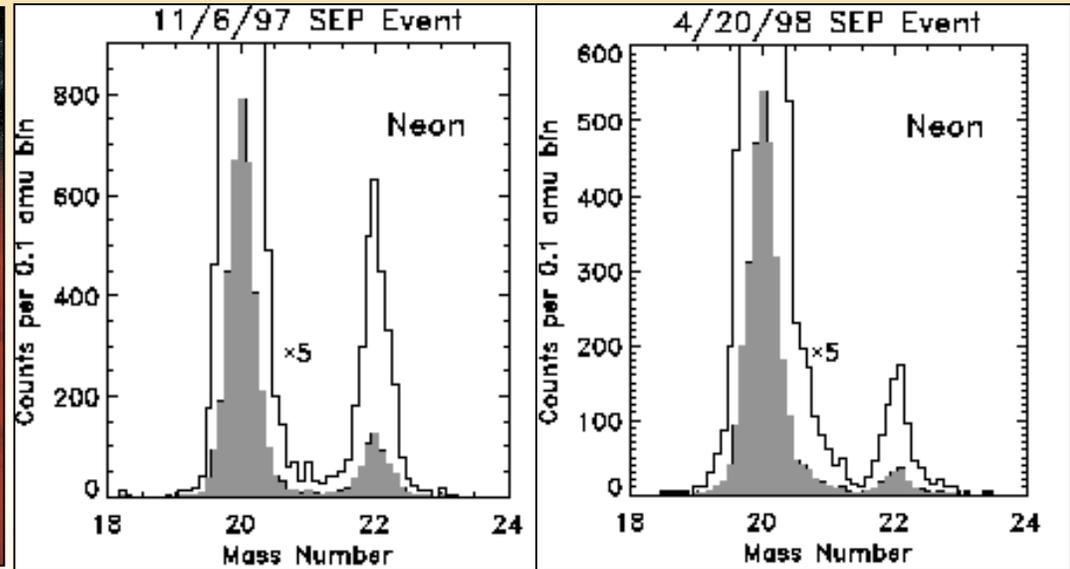
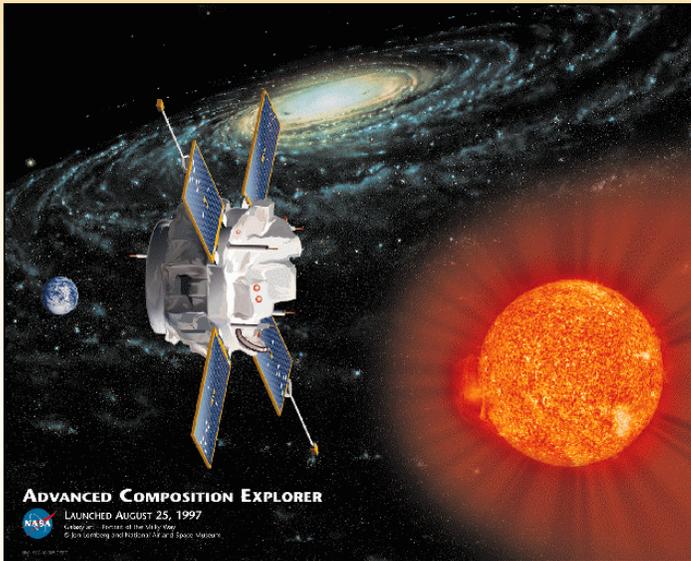
Web: <http://ssibroker.colorado.edu/Broker>



II. SEC EPO Projects and Programs



ACE (Advanced Composition Explorer)



- ACE measures the elemental, isotopic, and charge state composition of solar wind and solar particles with unprecedented resolution.
- It has been discovered that isotopic ratios of solar particles (e.g. $\text{Ne}^{22}/\text{Ne}^{20}$) vary up to a factor of three from event to event, possibly because of mass fractionation during particle acceleration.
- ACE provides real-time solar wind data for space weather predictions by NOAA and USAF satellites.



ACE (Advanced Composition Explorer)

Cooperative Satellite Learning Program (CSLP)



- ACE is a partner with Old Bridge Regional High School (OBRHS) in Old Bridge, NJ in this award-winning program
- Participated in two student conferences at GSFC involving six high schools from three states
- ACE scientist routinely gives talks to OBRHS CSLP classes



ACE (Advanced Composition Explorer)

Web Sites and LHEA Outreach CD-ROM

- **ACE Web sites at all ACE institutions**
 - GSFC ACE Web site has had 26,000 hits to date
- **Cosmic and Heliospheric Learning Center (CHLC)**
<http://helios.gsfc.nasa.gov>
 - Over 70,000 hits to date
 - Includes astrophysics basics, glossary, history of cosmic ray studies, related news stories, related educational activities, and online Q&A
- ***Exploring the Extreme Universe CD-ROM***
 - LHEA science Web sites presented in the context of the larger LHEA mission
 - 4 Learning Centers (CHLC is one) and 16 LHEA missions (CHLC and ACE included)
 - 10,000 copies in first printing (May 99)





ACE (Advanced Composition Explorer)

Development of Educational Briefs and Investigations

- GSFC Earth and Space Science Education Project (GESSEP) Teacher Ambassador Program
- Ambassadors worked in pairs directly with mission scientists
- Three educational briefs and six investigations developed

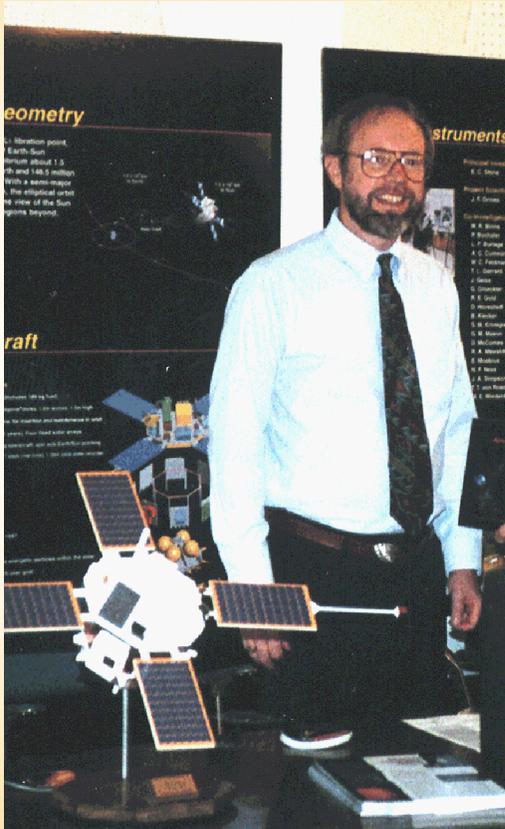


<http://edmall.gsfc.nasa.gov/inv99Project.Site/invhome.html>



ACE (Advanced Composition Explorer)

TV Interviews of ACE Scientist



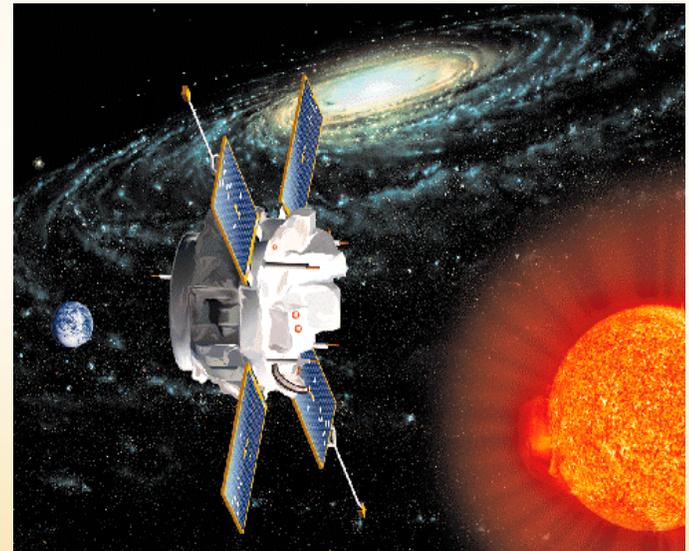
Dr. Tycho von Roseninge was interviewed on November 17, 1998 by 3 local television stations about the Leonids and their effect on spacecraft.



ACE (Advanced Composition Explorer)

Printed Outreach Materials

- **Developed ACE educational/launch brochure, scientific fact sheet, CHLC business cards, ACE paper model kit (also on the WWW), poster, decals**
- **Distributed to tens of thousands:**
 - At NASA- and GSFC-sponsored outreach events (National Space Day, JSC Open House, Education Showcases, Celebrate Goddard Day, etc.)
 - At national and regional teachers meetings (NSTA, NCTM, STANYS), minority schools and programs, GSFC educational programs, and to local teachers
 - At national scientific meetings (AGU, AAS, ASP)
 - At national science museum meeting (ASTC)
 - To other ACE institutions (Caltech, LANL, JPL, University of Delaware, University of New Hampshire) in support of their own outreach programs





Eclipse '98 and '99

Webcasts and Science Museum Events

Total solar eclipses used as a 'hook' to highlight SEC science



- High Visibility
Live@The Exploratorium Webcasts
- National participation of museums
- Extensive Media Coverage
- Interactions between SEC scientists and the public



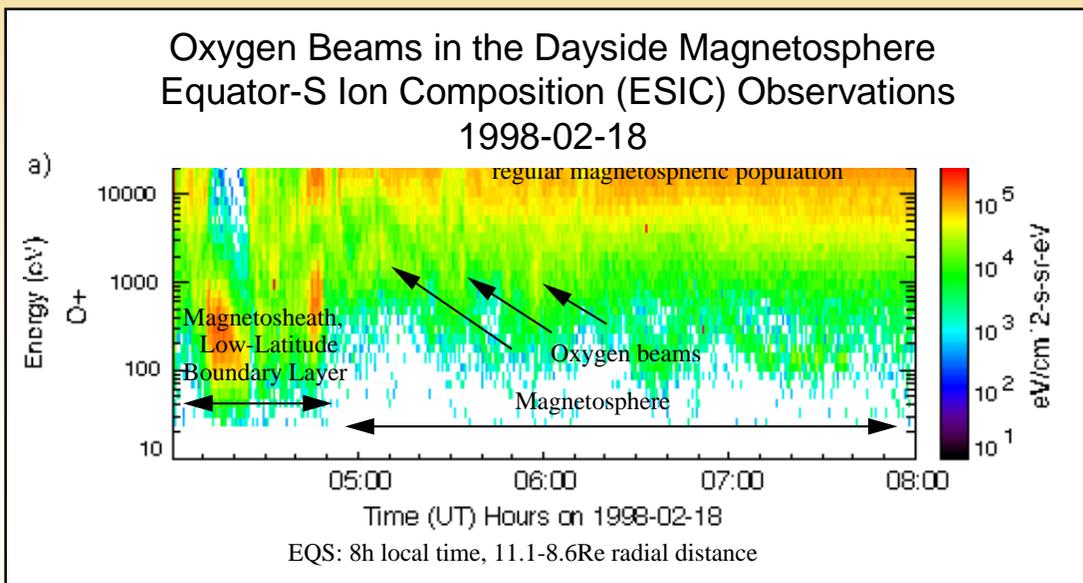
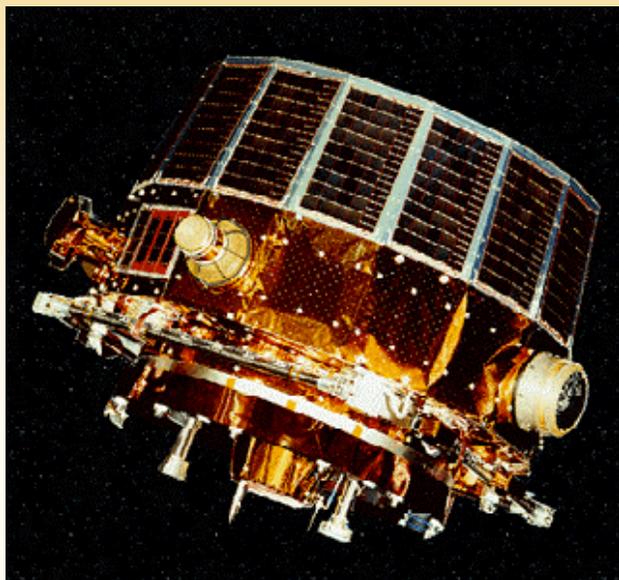
Electric Space: Exploring Our Plasma Universe

- **Electric Space is a 4,200 sq-ft traveling exhibition**
- **Includes 24 interactives**
- **Will reach 1-2 million people**
- **Produced by SSI and funded by OSS/NASA**





Equator-S

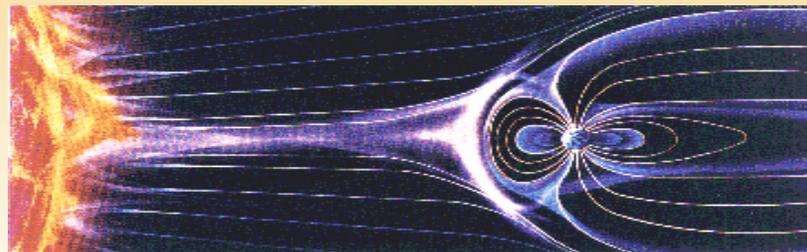


- Equator-S measured particles and fields in equatorial orbit to study the magnetopause and the inner magnetosphere.
- Equator-S discovered energy dispersed oxygen beams of ionospheric origin just inside the morning side magnetopause. Observations show importance of ionospheric plasma even close to magnetopause.
- In conjunction with the GEOTAIL and POLAR missions, the morphological and causal interrelations of aurora, currents, beams, and plasma sheet were studied.



“The Exploration of the Earth’s Magnetosphere”

Dr. David P. Stern, Planetary Magnetospheres Branch, GSFC Code 695



- An educational outreach project on the web.
- A complete **non-mathematical exposition**, for interested citizens, teachers and students, on the Earth’s magnetosphere, its physics, the history of its exploration and unsolved problems
- 35 main files, of which 16 have “history files” attached. Many illustrations and subsidiary files, as well as a cross-linked **glossary**, two **timelines**, a **guide for teachers**, a long **question-and-answer** section, list of **links and resources**, articles “Birth of a Radiation Belt” & “Brief History of Magnetospheric Physics,” and more.
- Covers **magnetism, electrons, ions, plasmas, energetic particles...aurora, discovery of radiation belt, Sun, solar wind, discovery of solar cycle, space weather...motion of charged particles, magnetospheric regions, auroral currents, planetary magnetospheres**, and much more.
- Opened 1995, updated periodically, about 86,000 hits (~8600 users) in March 1999. Selected site of “*Physics Today*,” February 1999.



“From Stargazers to Starships”

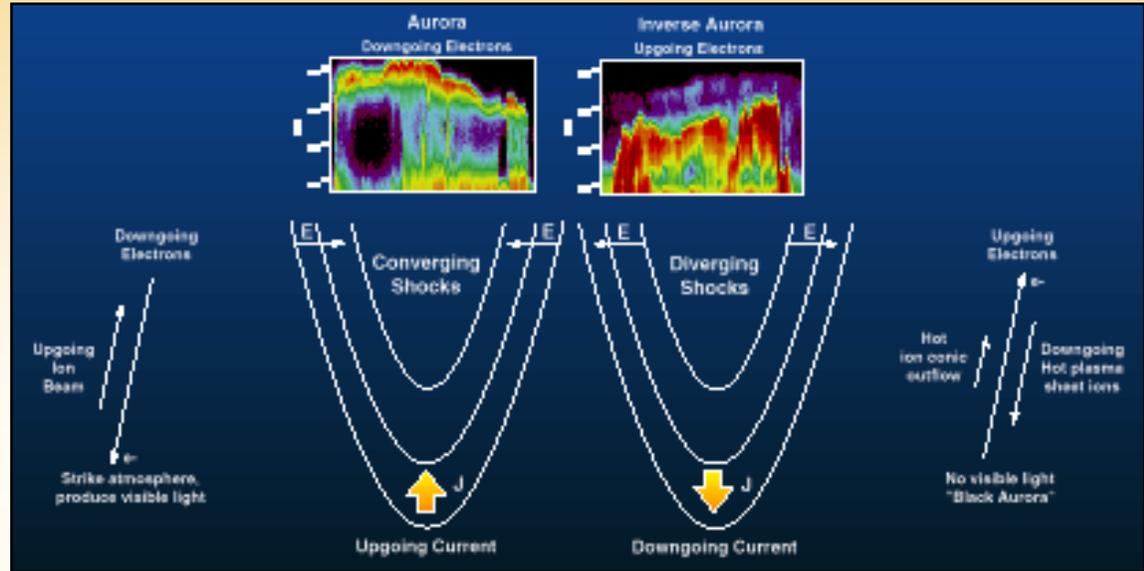
Dr. David P. Stern, Planetary Magnetospheres Branch, GSFC Code 695

- An educational outreach project on the web.
- A complete course, for **high school** and self-study, covering:
 - Basic astronomy,
 - Newtonian mechanics
 - Spaceflight and **space exploration**. **Also:**
 - **11-part** “Mathematical Refresher.”
- Rich in **history** and **space-related applications**, including the story of spaceflight, associated physics, methods of spaceflights (both mainline and offbeat!), and many outside links.
- 79 linked files with many illustrations, as well as a cross-linked **glossary**, two **timelines**, a **guide for teachers**, a list of **problems**, an inventory of **concepts**, cut-out sundial project and much more.
- Opened November 1998, about 130,000 hits (~13,000 users) in March 1999.
- Selected “Astronomy Site of the Week” by Griffith Observatory, December 1998.





FAST (Fast Auroral SnapshoT Explorer)

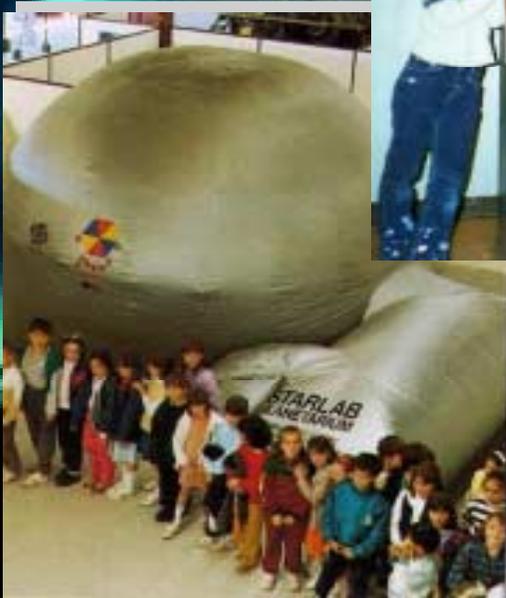


- FAST measures particles and fields with high temporal and spatial resolution in the regions where electrons are energized to form the aurora, and ions are accelerated out of the ionosphere into the magnetosphere.
- FAST discovered the black aurora adjacent to downgoing auroral arcs and it completes the electrical circuit between the ionosphere and the magnetosphere.
- By performing analysis of near-simultaneous data from FAST and Geotail, we hope to gain a better understanding of how processes in the magnetotail couple to the auroral zones.



FAST EPO: *Northern Lights Planetarium Show*

High Leverage for EPO Efforts Through Planetarium Shows



Collaboration with Lawrence Hall of Science provides national distribution of *Northern Lights* planetarium show Activity Guide with every Starlab portable planetarium sold by commercial partner.

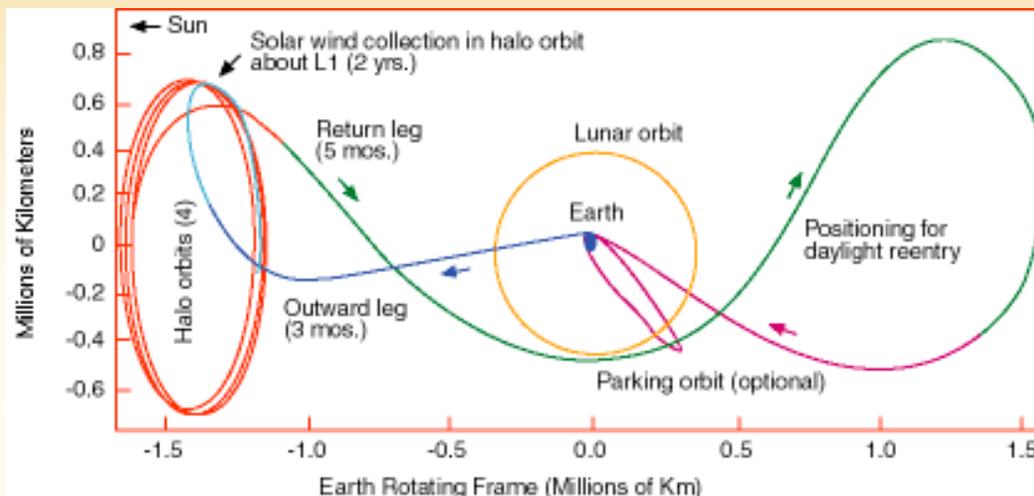
SEC scientists contribute science review, NASA SEC images, and the latest research results for planetarium show.



GENESIS

- Launch in January 2001
- Collect and return solar wind particles in 2003
- Using new Earth lab technology, measure isotopic compositions of oxygen, nitrogen, and noble gases
- Develop a better understanding of original building blocks of the solar system

PLANNED TRAJECTORY



Science Objectives

- To obtain precise measures of solar isotopic abundances
- To obtain greatly improved measures of solar elemental abundances
- To provide a reservoir of solar matter for 21st century science research, eliminating the need for future solar wind sample return missions



GENESIS EPO EXAMPLES

56 Ba	57 *La	72 Hf
88 Ra	89 +Ac	104 Rf

INTERACTIVE SIMULATION: MODELING THE PERIODIC TABLE

for today's students of chemistry

SCIENCE MODULES

classroom materials

58 Ce	59 Pr
----------	----------

FROM A DIFFERENT ANGLE

to stimulate interest

CREATOR'S KITCHEN

ingredients for educators



- ELECTRONIC NEWSLETTER
- WORKSHOPS AND PRESENTATIONS
- SEND A “GENESISGRAM”

Your 100-character message in space



HESSI (High Energy Solar Spectroscopic Imager) Education Outreach

Program Summary

- Internships for middle school master teachers at GSFC and UCB
- Development of classroom activities featuring HESSI discoveries
- Berkeley Ground Station EPO Activities
- High Visibility public activities such as “Live @ the Exploratorium”
- Participate in “Cal Day”
- Program Evaluation from the Graduate School of Education

Partners

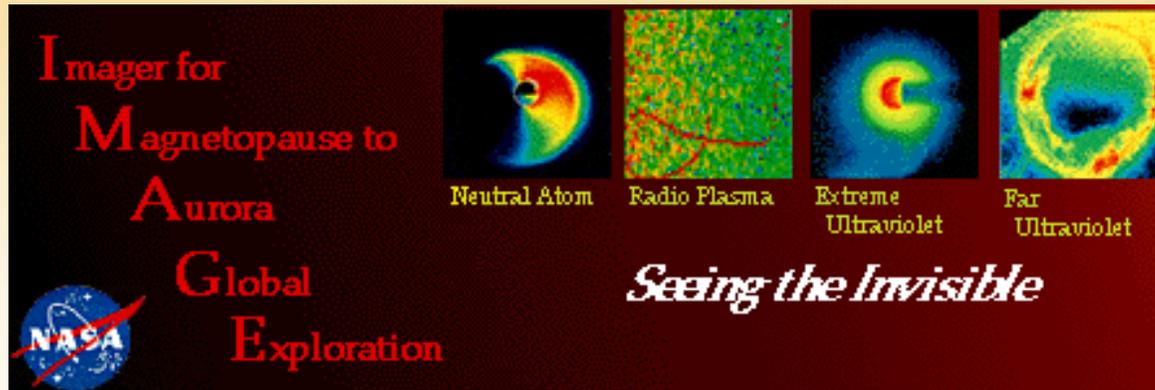
- Science Museums and Centers (Exploratorium and Baltimore Science Center)
- Science Education Gateway (SEGway Program)
- Research Experience and Curriculum Enhancement for Teachers (RECET)
- Planetariums
- GSFC Solar Physics Branch
- SUNBEAMS Program
- SECEF



K-12 Students Performing NASA Satellite Data Flow Demonstration



IMAGE (Imager for Magnetopause-to-Auroral Global Exploration)



Imager for Magnetopause-to-Auroral Global Exploration (IMAGE) is a MidEx satellite whose mission is to directly image the plasmas, energetic particles, and fields in the Earth's geospace environment using state-of-the-art, neutral atom, radio plasma and ultraviolet imaging techniques.

- Launch Date, February 15, 2000 from Vandenberg AFB, Web Casted
- High-visibility events for 2000
 - Alaskan MagNet Program will use IMAGE EUV data in classroom
 - NASA/Quest chats and webcasts with IMAGE scientists

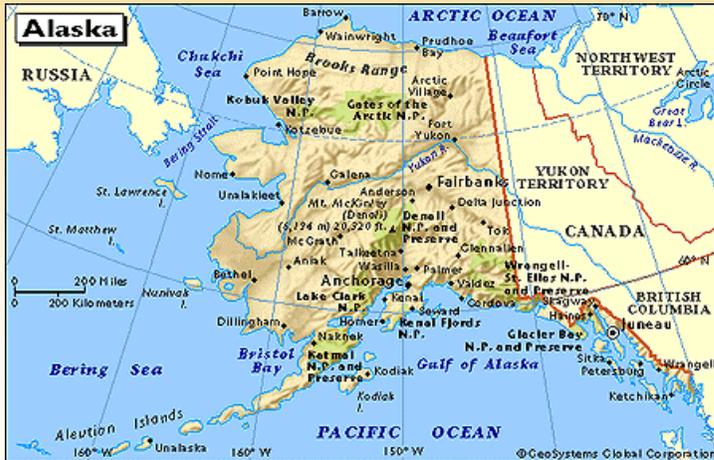


IMAGE/POETRY

- IMAGE Program's Education and Public Outreach effort
- Public Outreach, Education, Teaching and Reaching Youth (POETRY)
- Award-winning website, featuring "Ask the Space Scientist"
- Teacher Resources:
 - ✓ Mini-posters (5), Mission Fact Sheet (1), Brochure (1), Poster(1)
 - ✓ 'Solar Storms and YOU!' math and science workbook, Grades 7-9
 - ✓ 'Northern Lights and Solar Sprites' space science activities, Grades K-6
 - ✓ 'The Mission and Instruments of IMAGE' space science for Grades 10-12
 - ✓ **Soda Bottle Magnetometer Network (MagNet)**
 - Low-cost monitoring of geomagnetic storms
 - Real-time comparison with satellite views of auroral oval (seen by IMAGE and POLAR satellites)
 - Student space weather forecasting under classroom conditions
 - Growing national and international network of participating schools sharing data
 - ✓ **'Blackout!' Event-based Science program** (Addison/Wesley Publishing)
 - Video in production for middle-school students
 - Latest module in a popular science series used by 40,000 teachers



IMAGE/POETRY: Alaskan Schools

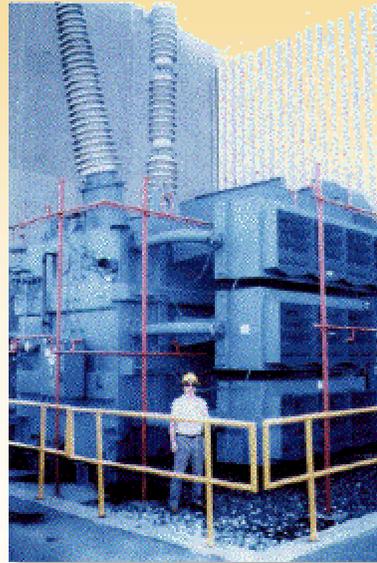


- Collaboration between IMAGE/POETRY and rural schools in Alaska
- Workshop on SEC topics and auroral observations, August 12-14, 1999
- 30 teachers participating, representing 30 'underserved' schools
- Classroom monitoring of geomagnetic events
- Correlation of geomagnetic events with satellite observations of aurora
 - POLAR UV imager observations of auroral oval: 1999-2001
 - IMAGE satellite EUV observations of auroral oval: 2000-2002
 - Comparison of magnetic activity with nightly observations by students



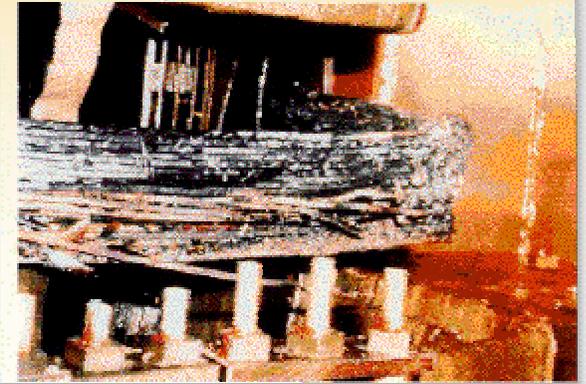
IMAGE/POETRY: Blackout!

Blackout! developed by the Event-Based Science Program through a grant from the National Science Foundation. Written by a team of master teachers, and published by Addison Wesley.



PJM Public Service
Step Up Transformer

Severe internal damage caused by the space storm of 13 March, 1989.

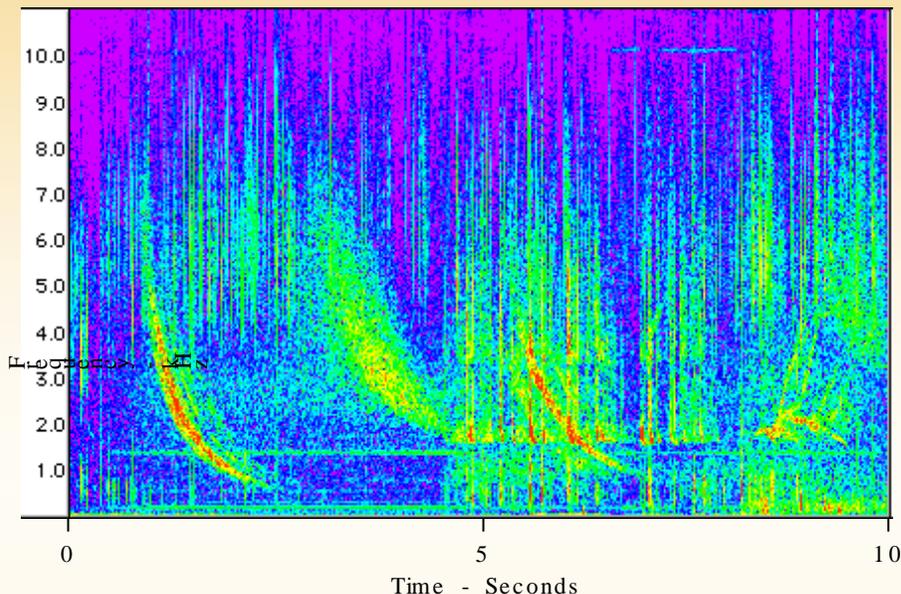


- Collaboration with IMAGE/POETRY and Event-Based Science
- 40,000 middle school science teachers use EBS modules annually
- Highly-regarded, integrated math/science/English curriculum
- IMAGE/POETRY scientist interviews featured
- IMAGE/POETRY soda bottle magnetometer featured 'hands-on' activity
- Accompanying 'Solar Storms' video for students describing SEC issues

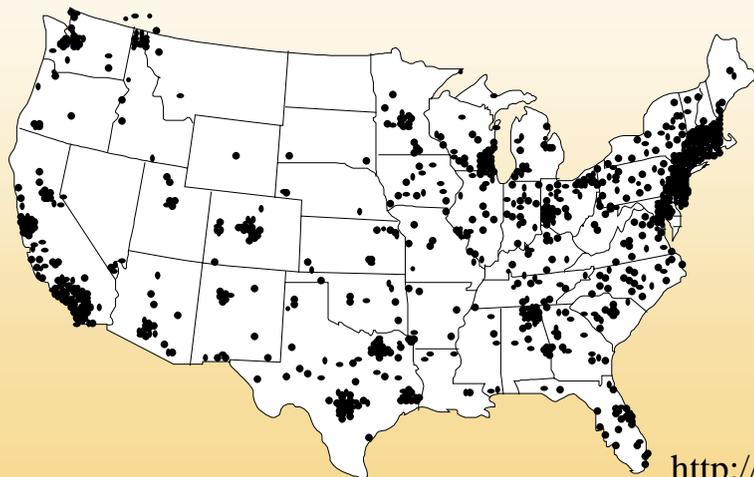


IMAGE/POETRY - INSPIRE:

Interactive NASA Space Physics Ionosphere Radio Experiments



1000 OBSERVING SITES FOR INSPIRE



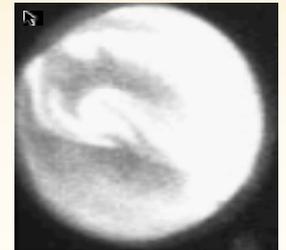
- 1700 VLF receiver kits distributed to schools and individuals around the world
- Reached hundreds of teachers
- Reached thousands or tens of thousands of students
- Held five teacher workshops to train master teachers in classroom use
- INSPIRE - IKI (Space Research Institute, Moscow) agreement to fire pulsed electron beam over INSPIRE sites, eight days per year
- Steve McGreevy on NPR describing Natural Radio (VLF), April, 1999





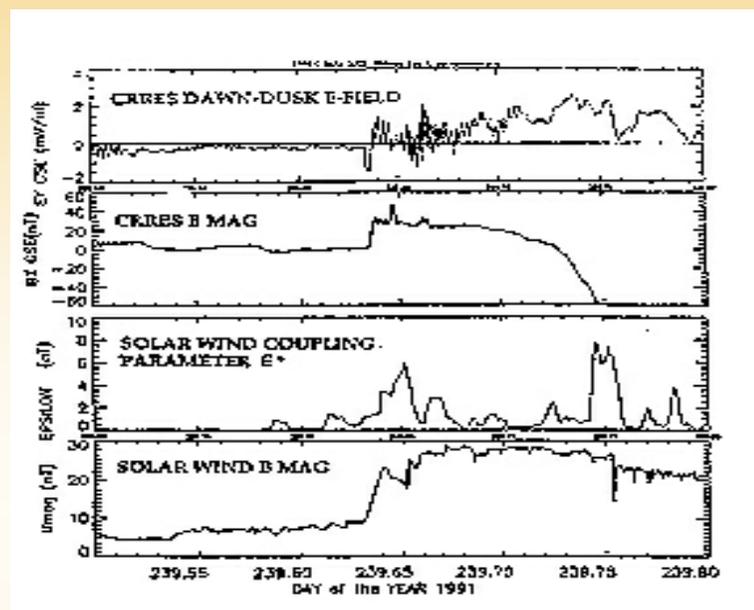
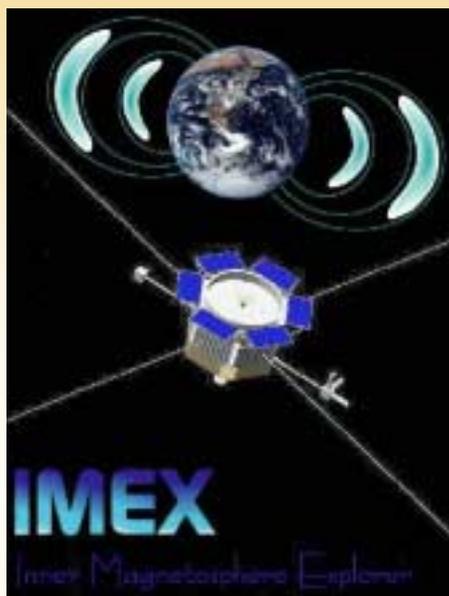
Upcoming Efforts - INSPIRE

- INSPIRE On-line
 - Stream output of INSPIRE receiver at University of Florida Radio Observatory
 - Those who cannot participate by purchasing kits or finding an electromagnetically quiet location will be able to hear, record and analyze audio over the Internet
 - Supported by GSFC Director's Discretionary Fund
 - Will begin in summer of 1999
- Aurora Video and Audio (AVA)
 - System designed for high school use, with a core of ten systems around northern auroral oval
 - All-sky camera utilizing a digital camera with a fisheye lens mounted inside a weatherproof dome
 - INSPIRE VLF receiver system
 - Connection to internet to automatically collect images and sound files and ftp them to INSPIRE archive for use by students world wide
 - AVAs available as kits for schools and individuals to be placed anywhere





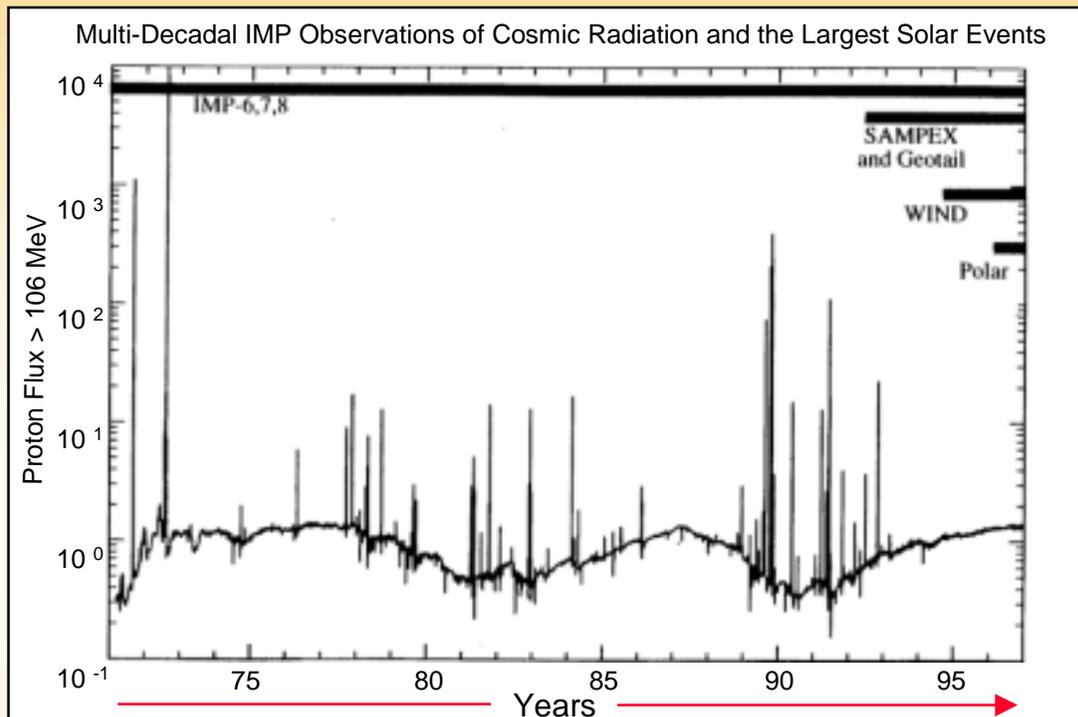
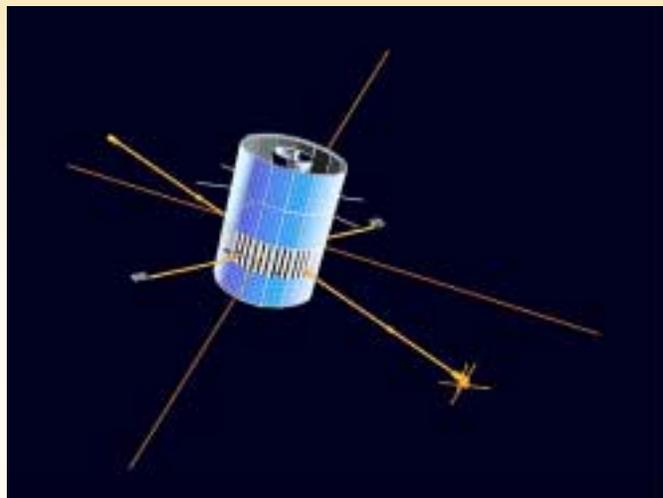
IMEX (Inner Magnetosphere Explorer)



- Launch in 2001
- First mission in the inner magnetosphere to contain a full complement of field and particle detectors while the ACE mission monitors the solar wind full time upstream
- Mission and orbit are patterned after the CRRES mission
- Universities of Minnesota and Colorado will conduct the entire project from start to finish
- Data supports the IMAGE and TWINS missions



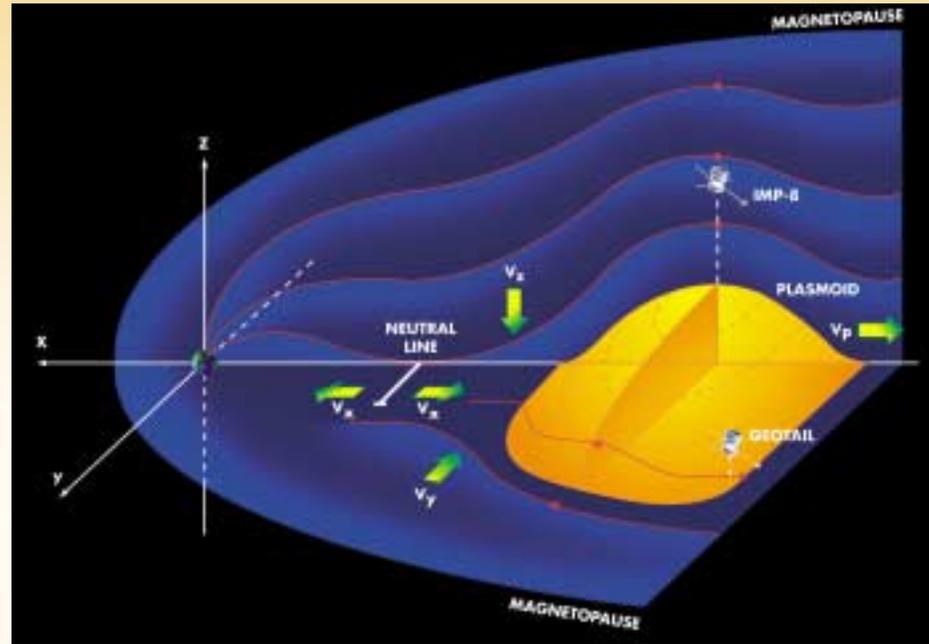
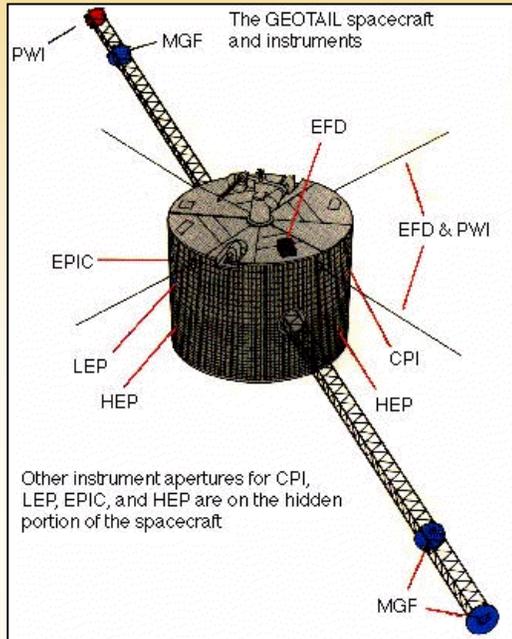
IMP 8 (Interplanetary Monitoring Platform)



- The solar wind and cosmic ray benchmark since 1973. IMP-8 measures the magnetic fields, plasmas, and energetic charged particles (e.g., cosmic rays) of the Earth's magnetotail and magnetosheath and of the near-Earth solar wind.
- Correlation of bow shock activity with auroral and ionospheric variation.
- Data supports the Voyager, Ulysses, SOHO, Wind, ACE, Polar, and Geotail missions.



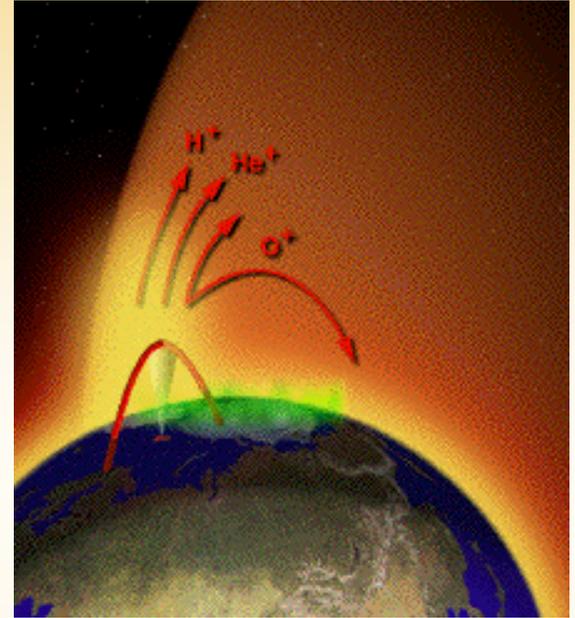
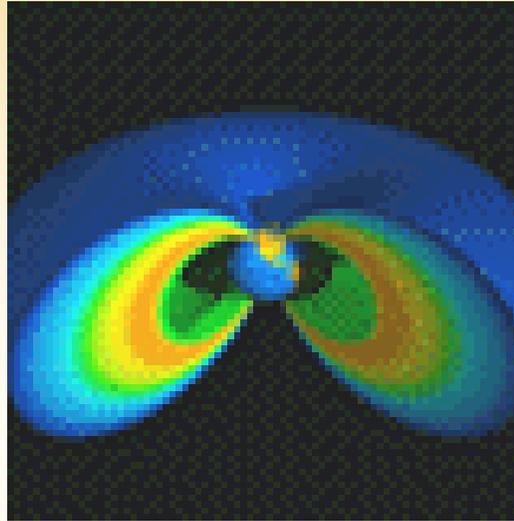
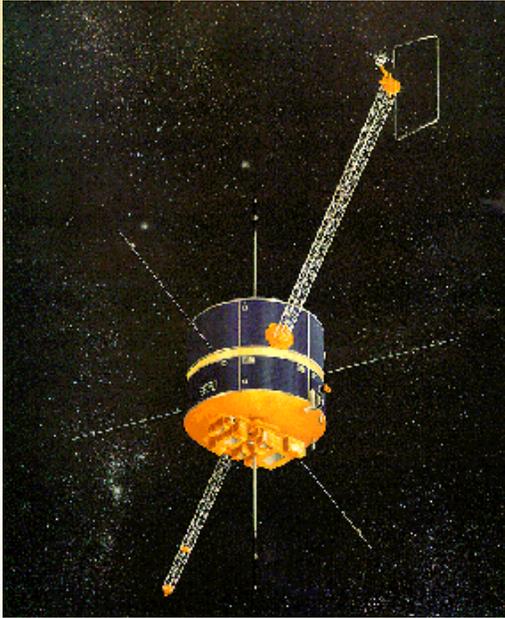
ISTP (International Solar and Terrestrial Physics) - Geotail



- Geotail (ISAS/NASA) studies the dynamics of the Earth's magnetotail over a wide range of distance, extending from the near-Earth region to the distant tail.
- Geotail has discovered the location of the reconnection neutral line in the magnetotail responsible for the energy release which powers most geomagnetic activity.
- Multi-spacecraft observations from Geotail, IMP-8 and other spacecraft are being used to synthesize three-dimensional models of magnetotail structures and dynamics such as plasmoid ejection.



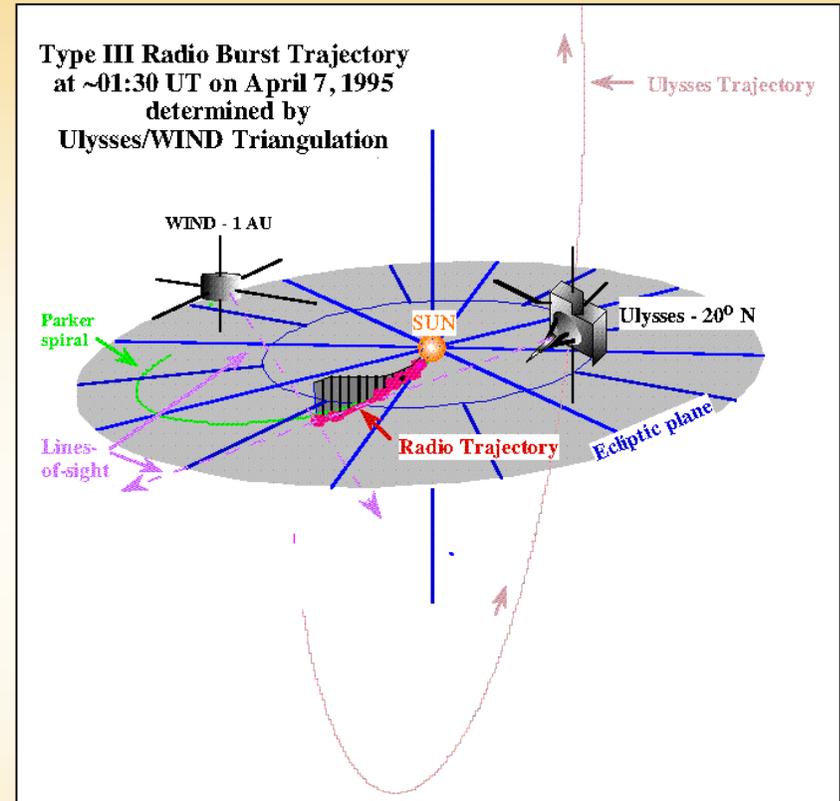
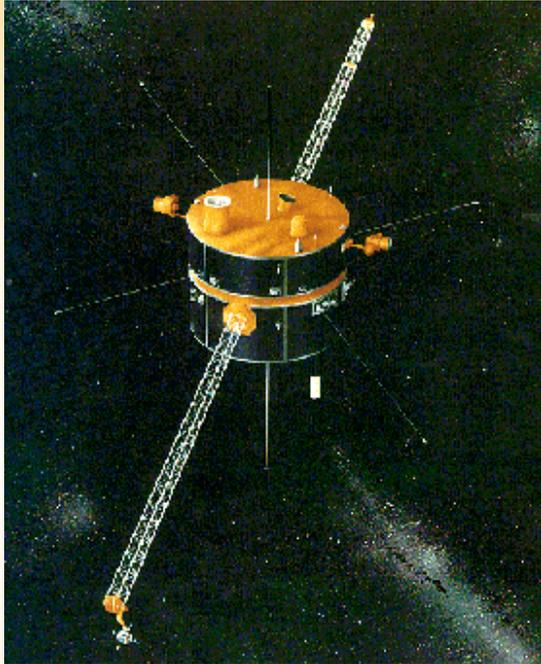
ISTP (International Solar and Terrestrial Physics) - Polar



- Polar measures complete plasma, energetic particles and fields in the high-latitude polar regions; and provides global, multispectral, auroral images of magnetospheric energy deposition into the ionosphere and upper atmosphere.
- Polar and SAMPEX observations revealed that a new radiation belt formed briefly in May 1998, a phenomenon not observed since 1991. Polar provided the first direct, quantifiable evidence that coronal mass ejections, identified by Wind, can cause ions to be ejected from the Earth's atmosphere.



ISTP (International Solar and Terrestrial Physics) - Wind



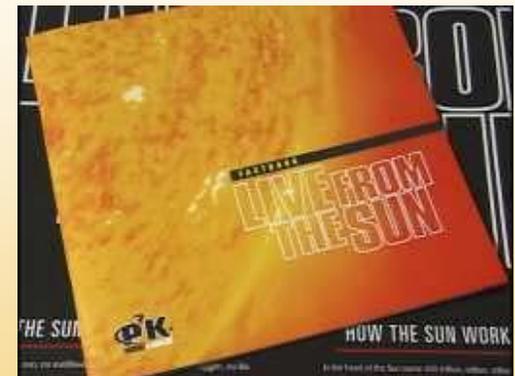
- Wind investigates basic plasma processes occurring in the near-Earth solar wind.
- Tracks CME-associated shocks, measures solar energetic particle bursts, and records the arrival of interplanetary shocks at Earth.
- By simultaneous measurements with a similar instrument on Ulysses, the Wind / WAVES radio experiment imaged the interplanetary magnetic field structure for the first time.



ISTP EPO with ACE and SOHO

LIVE FROM THE SUN

- “Electronic field trip” combines broadcast TV and videotape, Web chats, e-mail Q&A, hands-on activities, and printed materials
- Covers 35% of science standards
- Video/live shows aired March 16, April 13, and November 16, 1999, broadcast by 250 PBS stations and NASA-TV.
- Estimated reach: 1.5 to 2 million teachers and students.
- Produced by Passport to Knowledge, supported by OSS, ISTP, SOHO, ACE, and other agencies





ISTP EPO

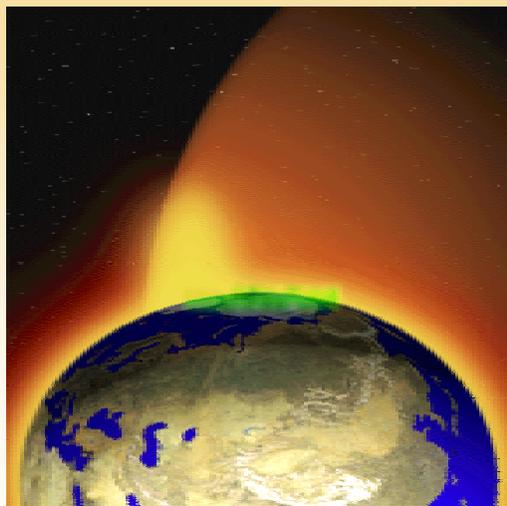
“Connecting Kids to Sun-Earth Connections” Teacher Workshop

- 19 middle- and high-school teachers from eight states met in July 1998 at GSFC
- Focused on inquiry-based science, demos of existing and potential educational products
- Conducted evaluations of workshop, products, and classroom activities:
 - “Importance of contact between teachers and scientists cannot be overemphasized.”
 - “Every minute counted.”
 - “One of the best professional development experiences I’ve had”
- Follow-up: archived lessons, evaluations, and resources on web; contacted teachers using materials in class; activities, lessons incorporated into “Live from the Sun”
- ISTP Workshop Part 2 -- teachers returning in Summer 1999 for development of SEC/ISTP kit





ISTP EPO



Images and Animations

- Created and produced new animations of:
 - **Coronal Mass Ejection and shock wave**
 - **Radiation belts**
 - **Ionospheric outflow into magnetosphere**
 - **Deep di-electric charging of spacecraft**
 - **Earth's Magnetosphere**
- Produced 3-minute video intro to ISTP
- Produced 9-minute and 3-minute montages of Sun-Earth Connections movies/images to spark student, public interest in SEC
- Maryland Science Center will use ISTP videos in its new "SpaceLink" exhibit
- Footage distributed to more than 50 science centers and planetaria nationwide
- Developed themed backdrop to promote awareness of solar maximum at science fairs, education meetings, civic events

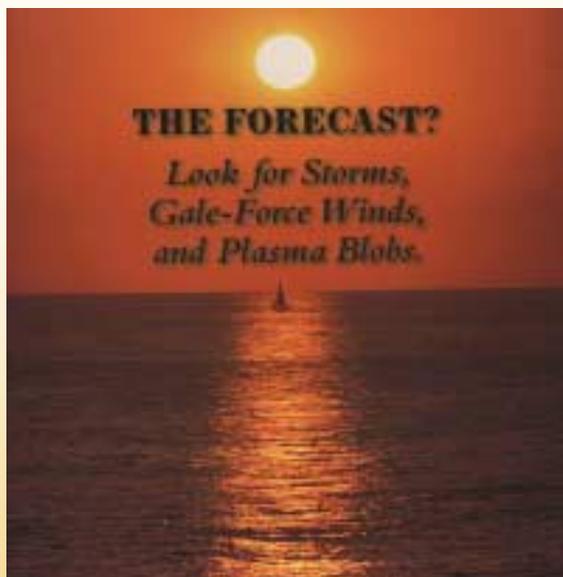




ISTP EPO



- **Storms from the Sun**
 - 80,000 copies printed in English
 - 50,000+ distributed nationally at NSTA, ASTC, NCTM, APS, AGU and other sci/ed meetings
 - Available through NASA CORE
 - Included in “Live from the Sun” teacher kit
 - Also available with movies on the web
- **Tormentas Solares**
 - 10,000 copies of Spanish-language version of “Storms from the Sun” printed in March 1999
 - Nearly half distributed already at NSTA, APS, and through teachers working in inner cities
 - Featured at La Raze conference in July 1999
- **“The Forecast” brochure**
 - Intended as overview of space weather for reporters, educators, policy makers
 - Developed with Space Science Institute
 - Printed 11,000 in 1998; 9,000+ distributed at NSTA, ASTC, press events, workshops

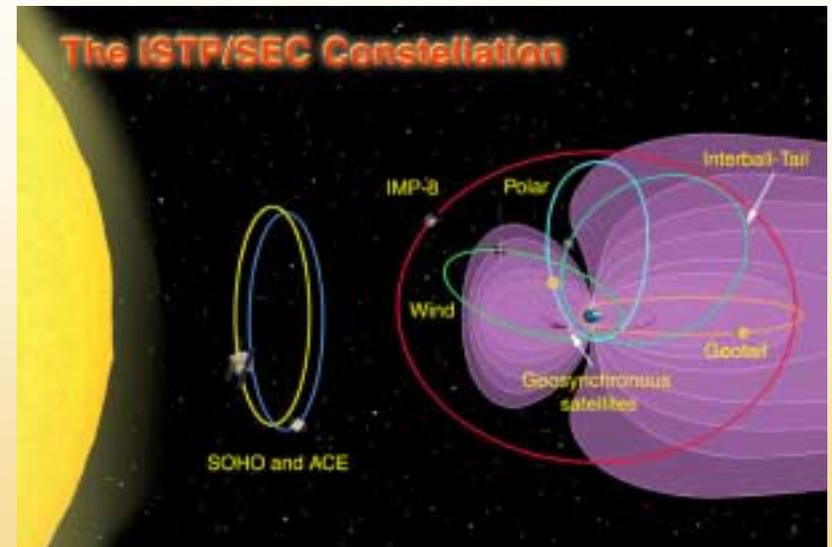




ISTP EPO

SECTRA Workshop -- Aug '99

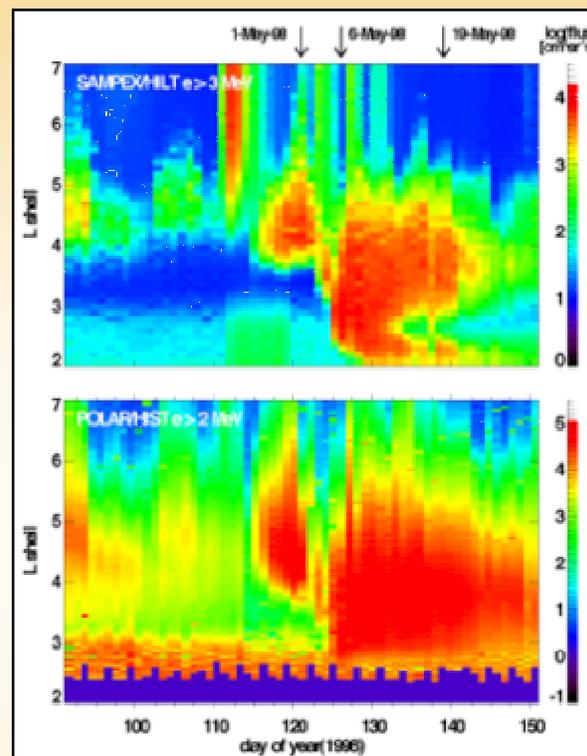
- Workshop for 15 “master” teachers -- leaders in science curriculum development, teacher training
- Hosted by ISTP at Goddard
- Used learning cycle approach to teach latest SEC science in context of national standards
- ISTP scientists worked with participants to develop teacher training workshops
- Modeled after APS Physics Teacher Resource Agent (PTRA) program
- Sent participants home with grants to conduct workshops and in-service training in their home states and districts
- Expected reach: 300+ teachers



SEC EPO



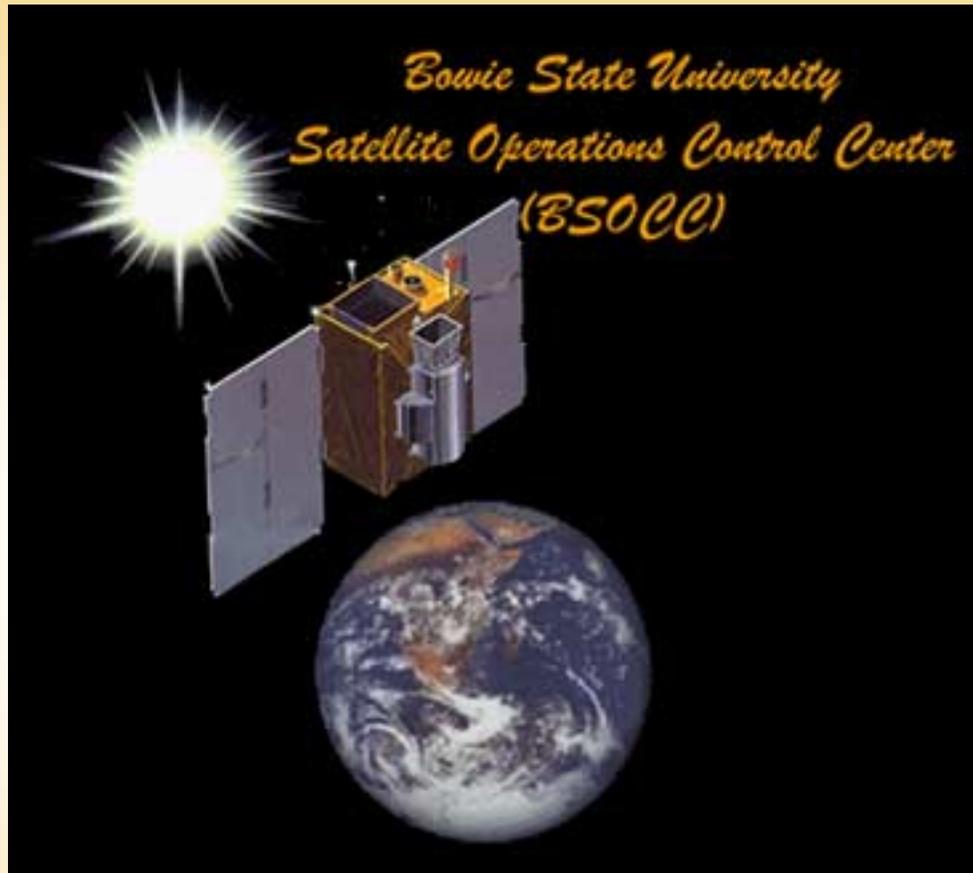
SAMPEX (Solar Anomalous Magnetosphere Explorer)



- SAMPEX measures energetic electrons and ions from low Earth polar orbit to determine characteristics of trapped and interplanetary energetic particle populations.
- In late April - early May 1998, a period of intense relativistic electron increases was observed. During this period several satellites experienced failures and anomalies.
- Related missions include: Polar, SNOE, IMP-8, and ACE.



SAMPEX EPO with Bowie State University



Mike Rice and Todd Watson, AlliedSignal Technical Services Corporation

mrice@bowiestate.edu twatson@bowiestate.edu

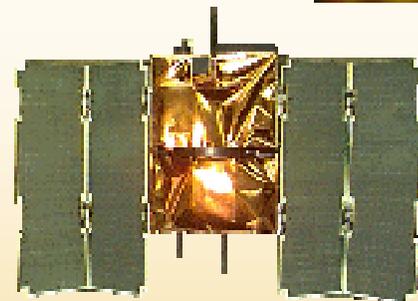
<http://www.sem.bowiestate.edu/projects/bsocc/>



SEC EPO



- **BSOCC is a joint venture between Bowie State University and NASA/GSFC, supported by AlliedSignal Technical Services Corporation.**
 1. Creates an **orbiting satellite operation and control center** on a university campus staffed primarily by **undergraduate students**
 2. Student Flight Operation Team taught skills for SAMPEX operations through two levels of certification:
 - A. Command Controller
 - B. Spacecraft analyst
- **BSOCC staffs NASA satellite operations with high caliber workers at entry-level pay scales**
- **BSOCC mission:**
 1. Ensure health of spacecraft
 2. Develop educational infrastructure
 3. Develop expertise in mission operation
 4. Build partnerships: academia, government and industry



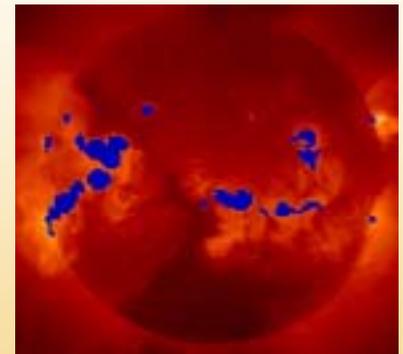
SEC EPO



Science Education Gateway: Sunspots



- Self-guided tour of solar science, ancient and modern
- Students learn to view the sun safely
- On-line investigation guides students through measuring solar active areas interactively.
- Students use Yohkoh solar maximum images to look for correlation between x-ray images and sunspots.
- Teacher support materials:
 - relation to national science education standards
 - program guides
 - student work sheets.





SECEF EPO: Quest Chats

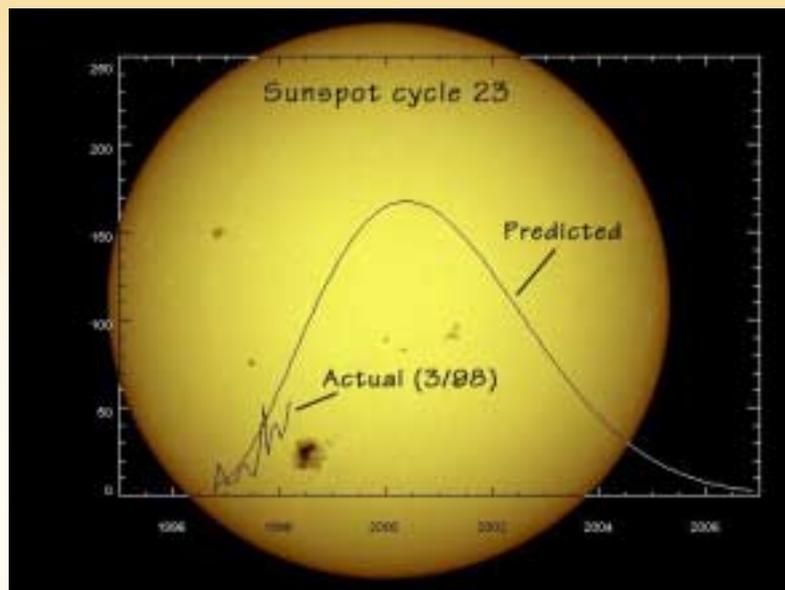


The NASA/Quest program at the Ames Research Center provides web casts and chatroom venues for NASA scientists and is used by a network of thousands of teachers across the USA and world-wide.

- Space Scientists On-line Project Managers: Ms. Sandy Dueck, Ms. Chris Tanski
- Chat room opens on Thursdays at 2:00 EDT, 50-100 participants (schools, individuals, institutions)
- Five space scientists are currently volunteering:
Dr. Sten Odenwald (IMAGE/POETRY), Dr. Daniel Beredichevsky (ISTP),
Dr. Therese Kucera (SOHO), Dr. Perry Gerakines (NRC Postdoc),
Dr. Jim Thieman (SECEF)



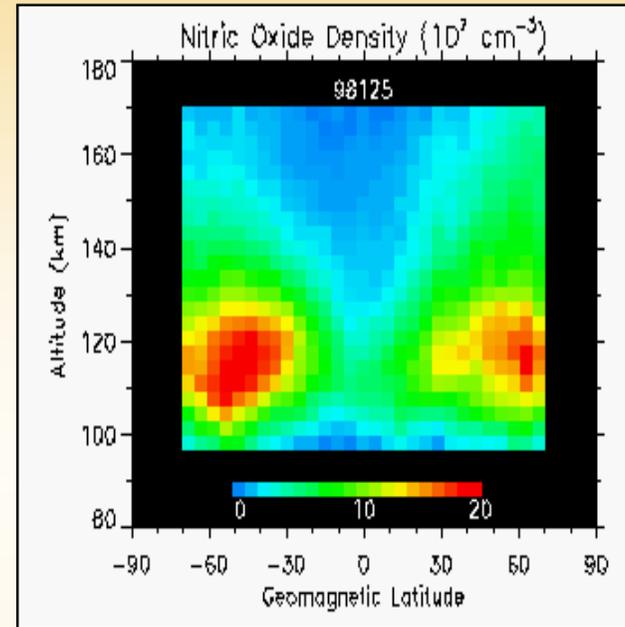
SECEF Public Outreach: *Washington Post*



- “*Solar Storms: Coming to a Sky Near You*”
- Written by Dr. Sten Odenwald (SECEF/IMAGE)
- Written for the monthly, *Washington Post*, “Horizon” section
- Publication date, March 10, 1999
- 3000-word article consisted of 2.5 pages of text and SEC images
- Read by 800,000+ subscribers in the Washington, DC region
- Accompanied the NASA Press release, “*Scientists Find a Way To Predict Huge Magnetic Storms,*” featured on page A2.



SNOE (Student Nitric Oxide Explorer)



- SNOE is a small scientific satellite that is measuring the effects of energy from the Sun and from the magnetosphere on the density of nitric oxide in the Earth's upper atmosphere.
- Temporal correlations occur between nitric oxide (NO) measured by SNOE in the lower thermosphere and very energetic electrons measured by Polar and SAMPEX. The results of a large geomagnetic storm (May 5, 1998) are shown in the figure.



SEEDS IN SPACE

Educational Outreach



GOALS:

- Involve students in a space experiment.
- Create interest and excitement in space science.
- Enhance student's knowledge of science.
- Teach scientific methods.



METHOD:

- *Brassica rapa* seeds were carried into the aurora aboard a NASA BBV sounding rocket. The seeds were included within a science payload.
- Flight seeds and control seeds were sent to participating classrooms to be planted, grown and the results analyzed.



APPROACH:

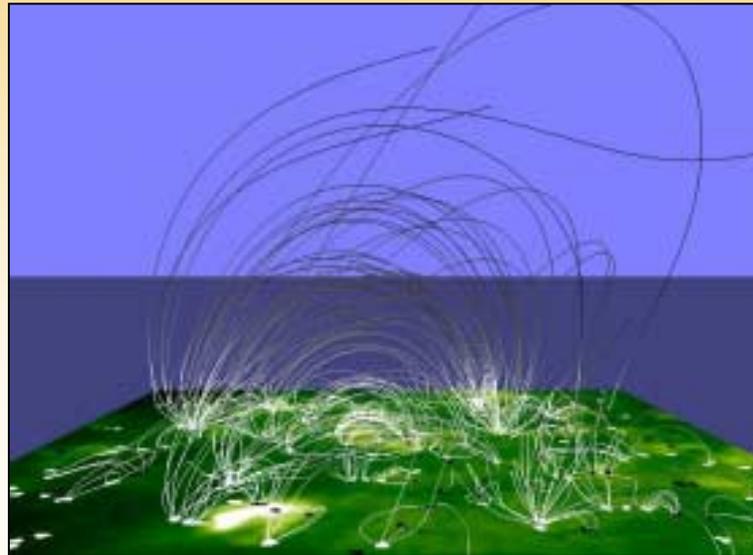
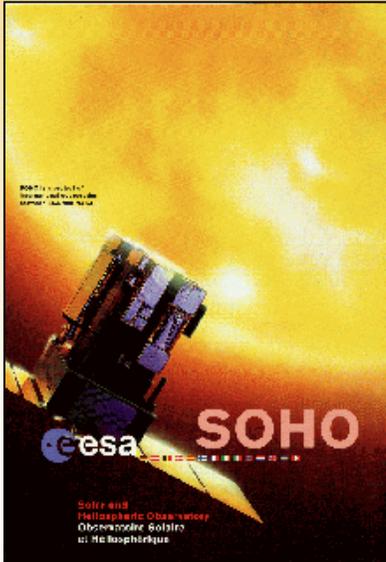
- Distribute Instruction Manuals to the classrooms.
- Scientists visit classrooms.
- Correspondence with the classrooms via e-mail and FAX during launch operations.

Point of Contact:
Andrew Christensen
The Aerospace Corp.
andrew.b.christensen@aero.org

SEC EPO



SOHO (Solar and Heliospheric Observatory)



- SOHO is designed to study the internal structure of the sun, its extensive outer atmosphere and the origin of the solar wind that blows continuously outward through the solar system.
- Magnetic field observations with MDI have shown a surface magnetic energy turnover in a period of about two days. The locations of specific magnetic field change have been identified in terms of time and location with EIT bright points. This defines at least one of the sources of coronal heating.
- Using SOHO observations of CME's directed toward earth, NOAA-SEC has improved its forecasts of enhanced geomagnetic activity.

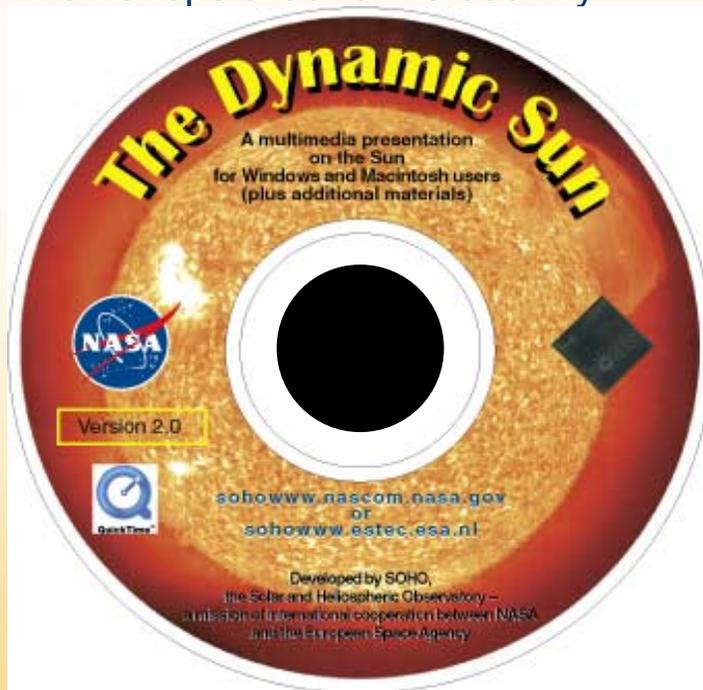


SOHO EPO

- **“The Dynamic Sun” CD-ROM**

- Multimedia, educational presentation on the Sun with over 30 video clips and animations; middle school and high school versions, with teacher’s guides
- 30,000 produced in 1999 (~80 cents each) - 17,000 distributed
- Includes interactive poster, image sets, glossary and FAQs
- Voted best presentation at Dec. ‘98 AGU Teacher Workshop
- Used in numerous teacher workshops around the country

Described by one workshop presenter as “a huge success!”



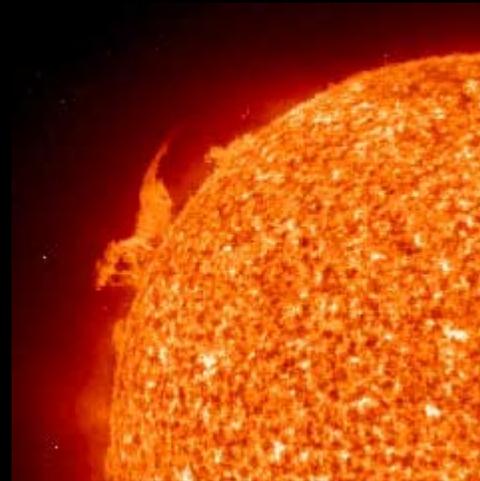
Sample page follows



SOHO EPO

Video clip showing solar activity

The Sun is surprisingly active. The motion captured here occurred over a 12-hour period. The sliding movement of gases follows the lines of magnetic forces. You can also see the boiling type of motion on the surface.



28

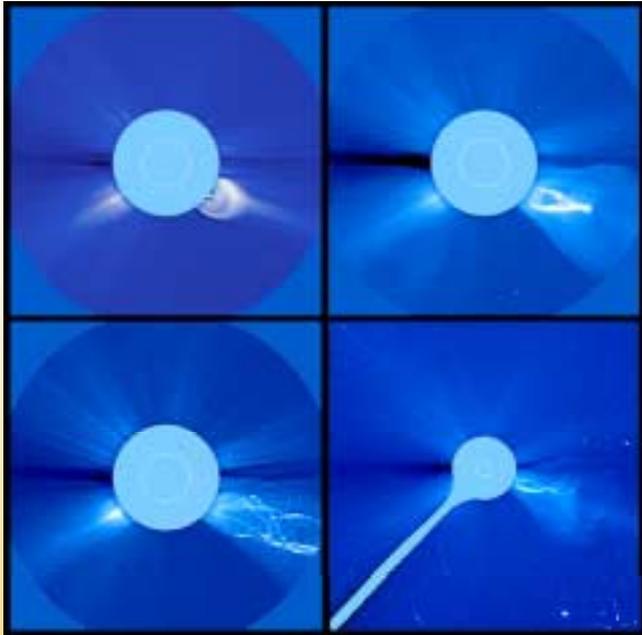
Click on the image to play the video



SOHO EPO

- **New SOHO Video Highlights tape**

- Compilation of the best 50 clips (47 mins.) from SOHO, with over 15 new clips and printed index
- Many clips have appeared on national TV news programs, in the “Live from the Sun” video and TV programs, and others (including an upcoming IMAX film)
- Over 100 copies distributed to film production companies, museums, professors and scientists, including BBC, National Geographic, and Discovery Channel
- Available for use by TV stations through the Goddard TV video file





SOHO EPO

- **Print products**

- New SOHO stickers and cards with web address (inexpensive handouts)
- Package of 12 SOHO images (SOHO Portfolio) with text (updated version)
- NEW elementary school poster on the Sun (near completion)
- NEW slide set of 74 slides, with printed handout (also will form basis for image highlights section for SOHO web site)



New slide



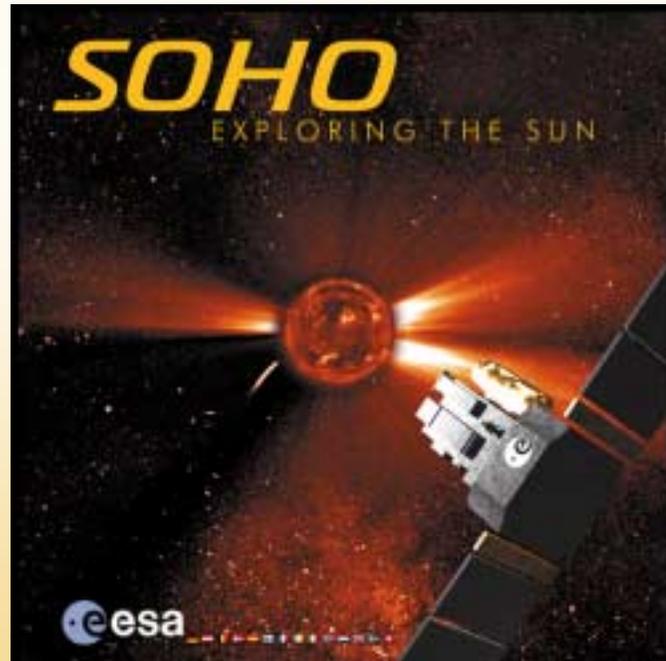
New elementary school poster



SOHO EPO

- **New SOHO CD: "*SOHO: Exploring the Sun*"**

- Worked closely with a Finnish company to direct, edit, and produce the CD
- Initial run of 25,000 to be generated by the end of August
- Will be quite interactive and include over 100 video clips, over 300 images, and music
- Topics covered include SOHO science results, instruments, best images, Sun's processes, Sun-Earth connections, and history of solar exploration

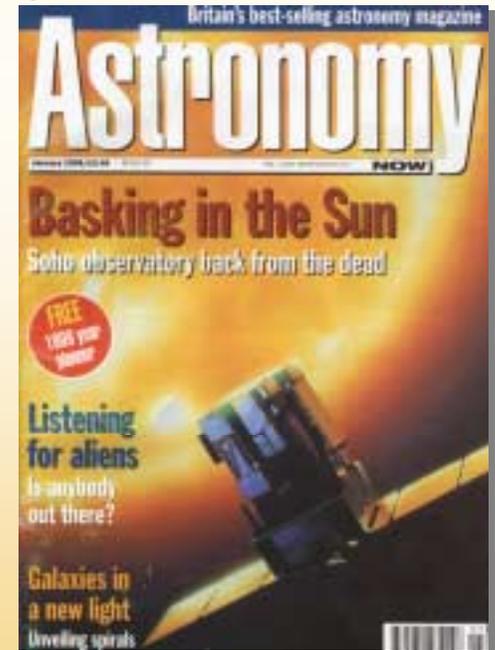




SOHO EPO

Additional EPO Efforts

- “Live from the Sun” learning adventure (from the Passport to Knowledge series)
 - Worked closely with the program and its development
- Presented *The Dynamic Sun* CD to teachers and educators on several occasions
- Developed video and graphics for several NASA HQ presentations
- SOHO materials provided to dozens of museums and publications
 - Cover articles have appeared in *Astronomy Now*, *Science News*, *GEO*, *Aerospace America*, and *Science & Vie*
- Working with an NSF model program to adapt SOHO material for educating deaf students through effective use of visualization





EPO Activities

- Award-winning website
- Video —“Colors of the Sun”
- Posters —“Inside the Sun”
- Six-day Solar Science Curriculum
- Teacher training workshops
- School visits with solar telescope
- Live Webcasts from NASA/Ames

Partnerships

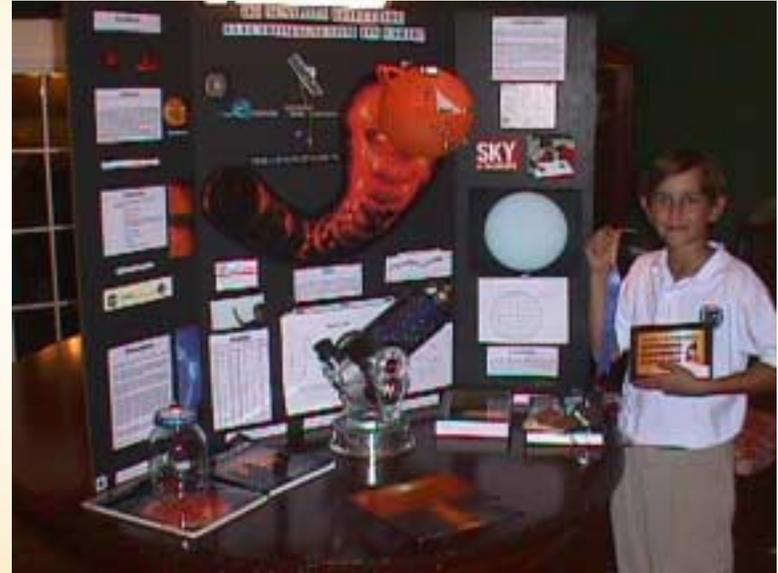
- Project Astro
- Lockheed
- Chabot Observatory and Science Center
- American Association of Variable Star Observers
- NASA Learning Technology Center



SOHO/Stanford Solar Center: Website



- On-line activities grades 2-12
- “Ask a Solar Astronomer”





Space Weather and Public Connection

Dr. Patricia Reiff, Rice University

- The Public Connection creates real-time interactive exhibits for museums and schools.
- SEC science is featured in the “Space Weather” module, which can run alone or as part of their full system, “Space Update.” A “Cosmos Clock” screensaver counts down to the millennium (or to any date you choose).
- 1700 CD’s of the full “Space Update” system have been distributed to museums and schools.
- Several museums have the software on display in updating mode:
 - Houston Museum of Natural Science (since 1995)
 - “Electric Space” exhibit (updated on occasion)
 - Watson Lake Science Center (Canada)
 - Air Force Academy Visitor Center
 - Mystic Seaport Museum
- A “*Space Weather*” CD, featuring the “Space Weather” software plus some other material on SEC, has been developed. 400 copies were distributed at the National Science Teachers Association meeting in Boston, paid for by the IMAGE mission.





Space Weather and Public Connection

Dr. Patricia Reiff, Rice University

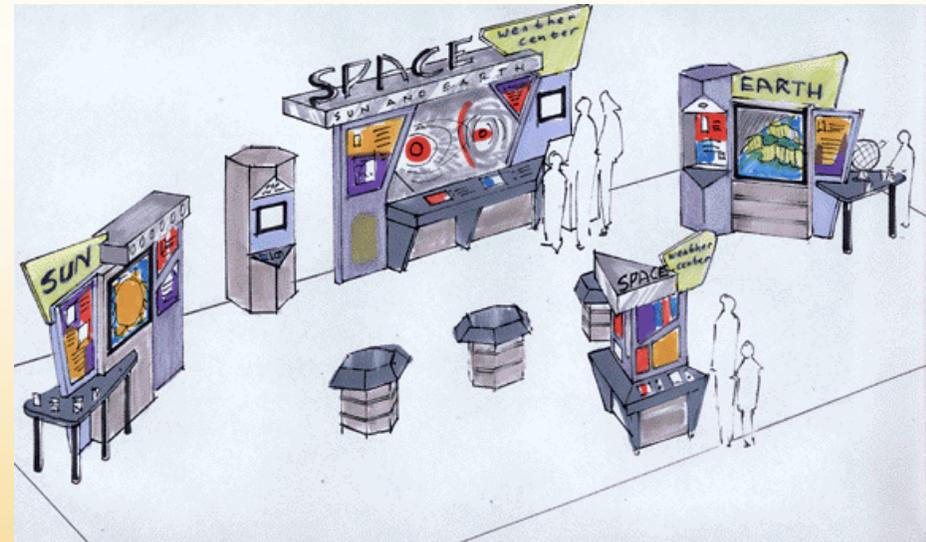
- More material can be included in the “*Space Weather*” CD—let us know if you would like html or other material included.
- The “*Space Weather*” CD will be distributed free from the SECEF and the Broker sites, if resources are available.
- Immersive planetarium shows (projected by 4 - 6 computers on the inside of a dome) are being developed. Material is being actively sought for this exciting and dramatic new medium. The first planetarium with this technology (at the Houston Museum of Natural Science) opened last December.
 - Partial funding for the first show will be given by the IMAGE program. Other projects are encouraged to work with us to create material.
 - Many more planetariums will be using this technology in the next few years. Material that is created now will be useful for a long time.
 - Short segments (1-3 minutes) are most useful that can be used in many kinds of productions.



Space Weather

coming soon to a museum near you

- ACE, ISTP, SOHO, SECEF, IMAGE and HESSI/ SUNBEAMS partnering with Space Science Institute, NSF, and Raytheon
- Integrates interactive, hands-on elements with near-real-time imagery, news, and data from current GSFC missions
- Three key themes: Our Sun/Star is Dynamic; We Live in the Atmosphere of the Sun; Earth Responds to the Changing Sun
- Exhibit will reach 750,000 people/year
- Traveling exhibit will begin tour in March, 2000





SUNBEAMS

Students **U**nited with **N**ASA **B**ecoming **E**xcited **A**bout **M**ath and **S**cience

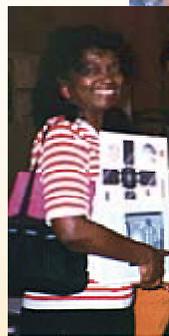
Sharing
the Process
and Excitement
of Science
and Technology



Student
Workshops



Teacher
Workshops

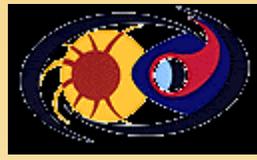


Family Nights

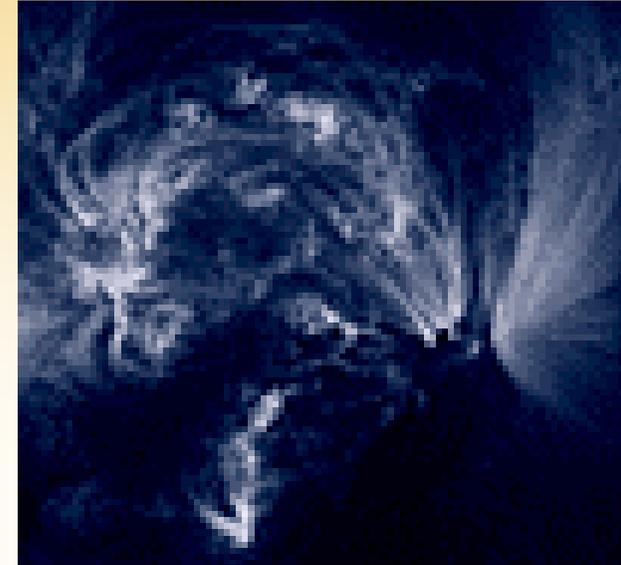
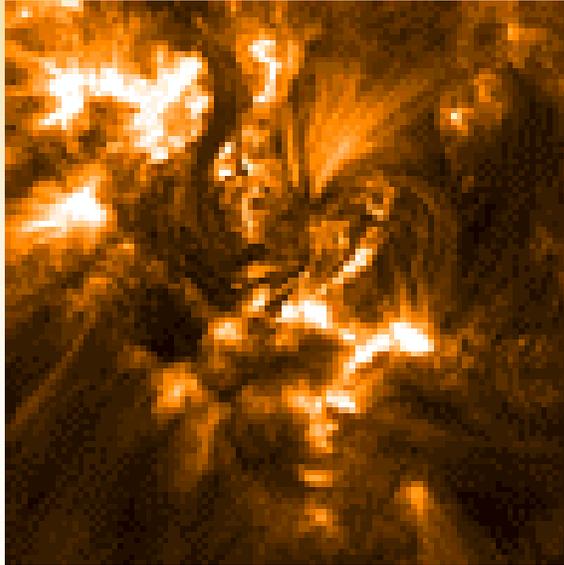
PARTNERS

NASA Goddard Space Flight Center
District of Columbia Public Schools
District of Columbia Alliance of Corporate Partners

<http://space.gsfc.nasa.gov/sunbeams/>



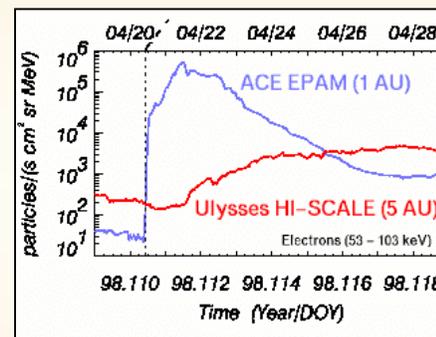
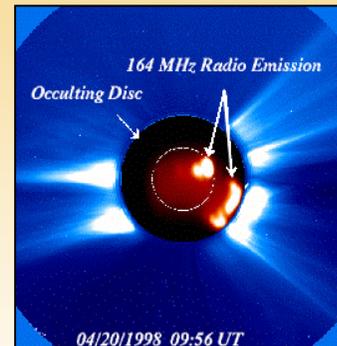
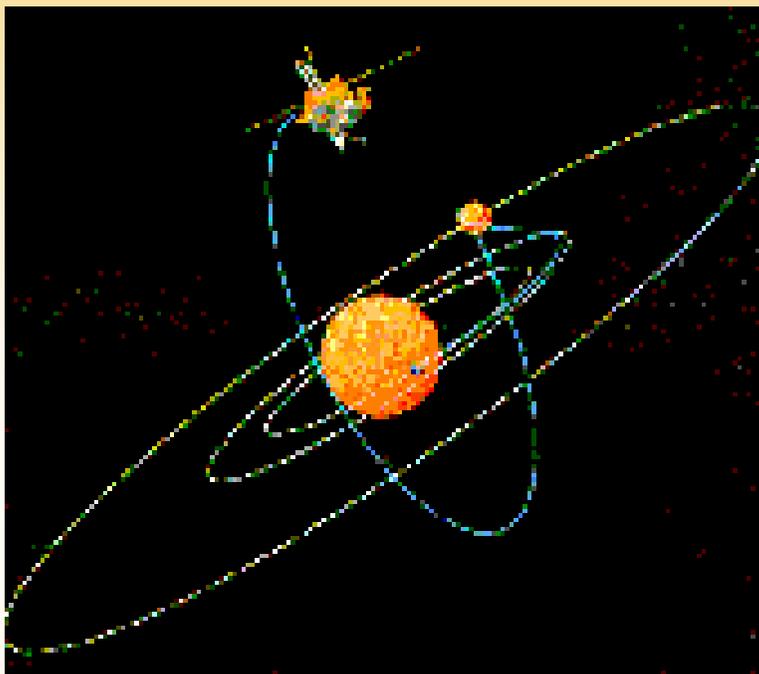
TRACE (Transition Region and Coronal Explorer)



- TRACE explores the three-dimensional magnetic structures which emerge through the visible surface of the Sun—the photosphere—and define both the geometry and dynamics of the upper solar atmosphere—the transition region and corona.
- Factor of 25 increase in spatial resolution allows visualization of coronal dynamics on temporal and spatial scales previously unavailable to observers. New properties of the corona have been observed for the first time.
- TRACE complements SOHO and YOHKOH, and the use of SOHO and Yohkoh's wider fields of view allow contextual understanding of small-scale, rapid coronal variations seen by TRACE.



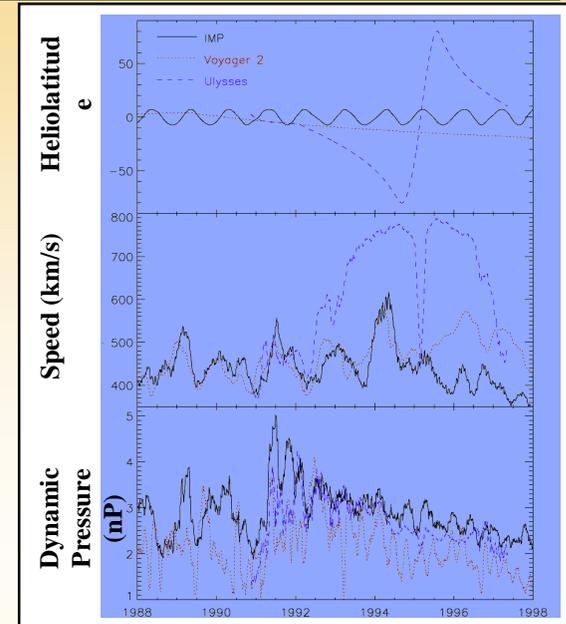
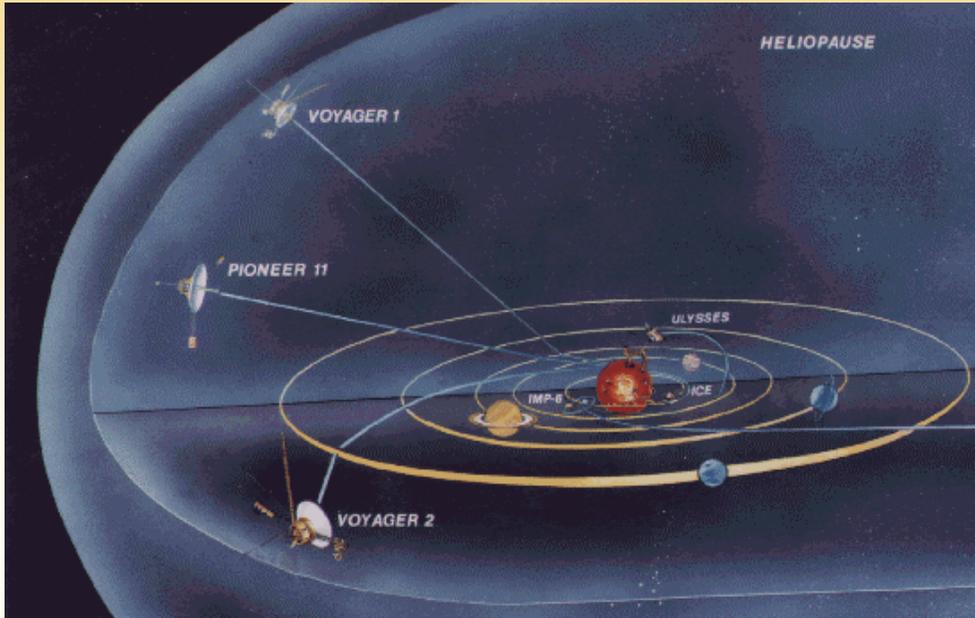
Ulysses



- The ESA/NASA Ulysses Mission is the first spacecraft to explore interplanetary space at high solar latitudes. The primary results of the mission have been to discover the latitudinal properties of the corona and the solar wind.
- Determined—with ACE—the evolution of solar events in interplanetary space between 1 AU and 5 AU.
- Recent highlights include co-observing energetic particles with ACE near Earth and Ulysses at 5 AU.



Voyager 1 & 2



- Now in the distant solar system, Voyager is continuing to characterize the outer solar system environment and search for the heliopause boundary, the outer limits of the Sun's magnetic field and outward flow of the solar wind.
- Global solar cycle variations are detected by the Voyager system. For the first time, we can say that the solar cycle dynamic pressure changes occur at all latitudes and in fast, slow and intermediate speed solar wind. Processes driving both fast and slow solar wind appear to respond in same way to solar cycle changes.
- Recent plasma data from IMP-8, Ulysses, and Voyager 2 show that the solar cycle variation of momentum flux in the solar wind occurs at all solar latitudes and radii.



ULYSSES/VOYAGER Education Outreach



- **Voyager/Ulysses Interview Project**

- Inspiring students grades 9-12 to choose careers in Space Science
- High school students compete for visit to JPL to interview project personnel (scientist, operations team member, managers)
- Combined with a science research project agreed to by their science teachers
- At end of school term, student presents results of research/interview to science class
- JPL project representative attends formal presentations
- Students become project ambassadors among their peers



ULYSSES/VOYAGER Education Outreach

Exhibits

- Voyager/Ulysses Project attends 3-4 exhibit events annually
- Over 52,000 attended JPL's Open House
- Exhibits include displays, models, educational material and activities





ULYSSES/VOYAGER Education Outreach

Educational Events

- Team members present to JPL student/educator tours
- Annual presence at National/Regional Science Teachers Meetings



<http://ulysses.jpl.nasa.gov/outreach/outreach.html>



The *Windows to the Universe* Project

- A multifaceted EPO program, including collaborative efforts with the NSF-funded Space Physics and Aeronomy Research Collaboratory (SPARC), the Mars Program, ISTP, the AGU Space Physics and Aeronomy Open House.
- Statistics 9/98 - 8/99
 - 2,495,753 sessions (users), 60,199,497 hits, 15,305,894 pages served
 - 5803 pages linked, 1270 pages added
 - ~5000 sets of materials distributed
 - 3217 comments, including 1911 Ask A Scientist
 - 510 CDs sold, over 300 to educational institutions



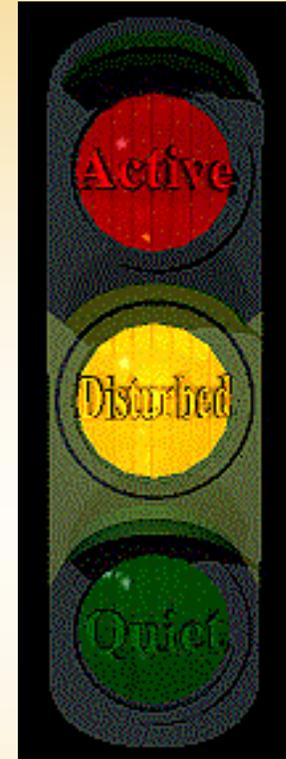
Originally funded by the NASA Learning Technologies Project, currently by the Office of Space Science Informations Systems Program, the NSF-sponsored KDI initiative (through the SPARC project), the JPL Mars Program, and the ISTP SolarMax project.

Month	Sessions	Ips
Aug-98	106025	91241
Sep-98	111656	99607
Oct-98	162277	145820
Nov-98	195674	174234
Dec-98	153509	134693
Jan-99	244386	216245
Feb-99	309903	273327
Mar-99	288172	252612
Apr-99	268113	231996
May-99	264496	224217
Jun-99	183520	152741
Jul-99	141847	117469
Aug-99	172200	143660



Windows to the Universe: Highlights

- Expansion and revision of content on main *Windows to the Universe* site in the following subject areas (1,270 pages added):
 - Jupiter, Europa, Mars, Geology, Space Missions, Aurora, Solar Eclipse, Life, People, Mythology and Constellations, Space Weather and Aeronomy, Skymaps
 - Explorations - Water on Mars, the Surface of Mars, Search for Extraterrestrial Life, Life on Earth, Does Europa have an Ocean?, The Archaean Age
 - Headline Universe, Ask-A-Scientist, Coloring Book, Games,
 - Developed User Chat and Workbook facilities, leveled content and updated Teacher Resources section with funding from the Ameritech Foundation



• Dissemination

To Scientists

Fall and Spring AGU
3/99, Undergrad Reform Mtg, UM
7/99, IUGG, Birmingham, UK
6/99, CEDAR, Boulder – SPARC

To Educators

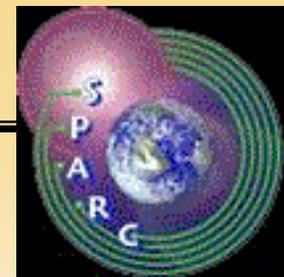
10/98, ASTC
3 Regional and National NSTAs
4 other Michigan Teacher Training Events

To Students and the Public

5 events in the Southeastern Michigan area



SPARC Outreach



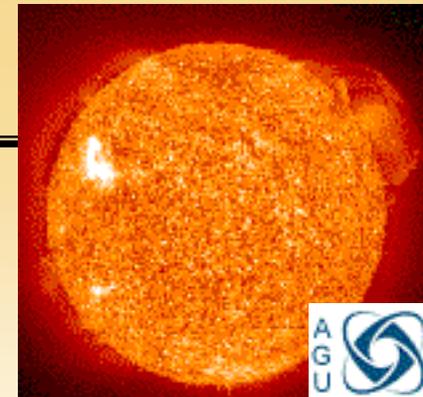
*Space Physics and Aeronomy Research Collaboratory, Dr. Roberta Johnson,
University of Michigan*

- SPARC supported global Space Physics and Aeronomy observation campaigns in April and September, 1999
- SPARC outreach site opened for April campaign, brings data from over 40 ground- and space-based instruments observing Sun and near-Earth space to general public, as well as:
 - introductory and background science content, classroom activities, chat, games, cultural connections, FAQs, comments
- Publicized at NSTAs, local educator workshops, to scientists and to the public
- Statistics
 - April 99 ~400 users per day
 - October 99 ~1100 users per day



AGU SPA Open House

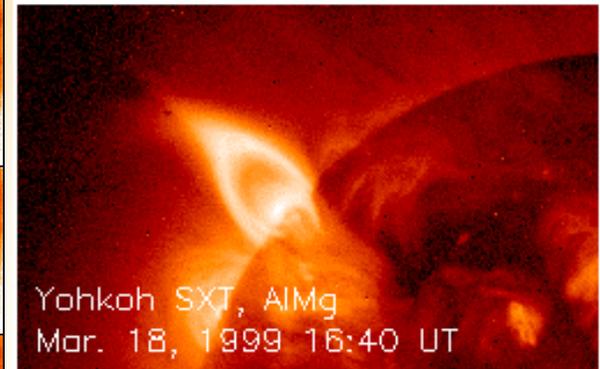
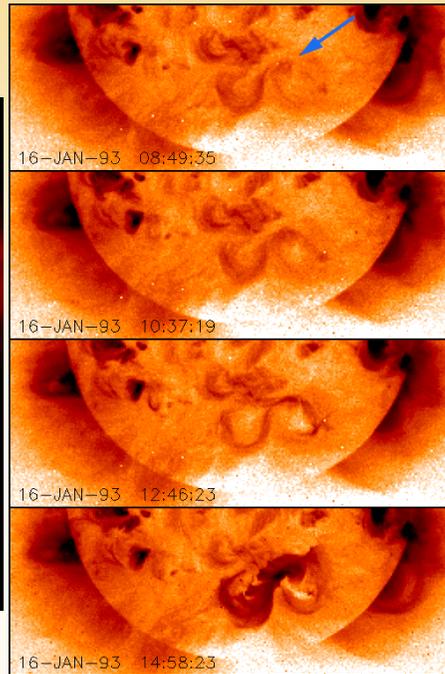
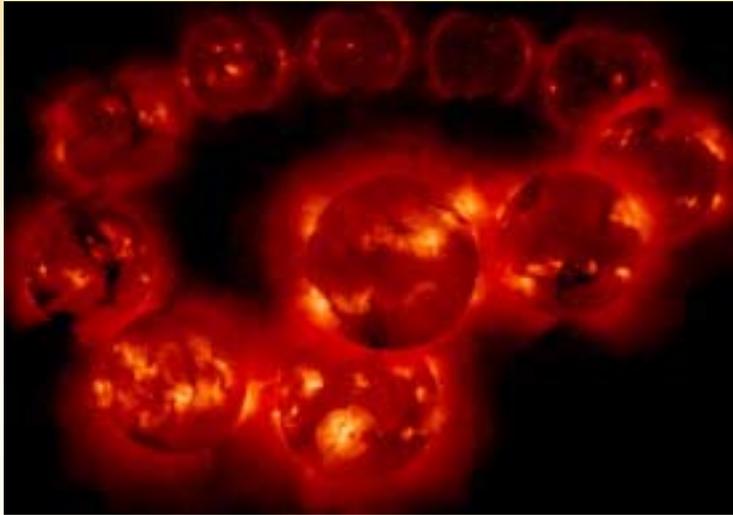
*American Geophysical Union, Space Physics and Aeronomy
Dr. Roberta Johnson*



- **Collaborative effort of the Education and Public Outreach and Web Committees of the SPA section of AGU**
 - Partially funded from AGU Council Funds
- **Goal to provide public access to extensive web-based resources developed by the extended and global SPA community**
 - Searchable archive of educational resources, missions, research groups, data (real-time and archival)
- **Revisions timed to coincide with global Space Physics observation campaigns (SPARC)**
- **Publicized at NSTAs, local educator workshops, and to scientists**
- **Beta release in April ~250 users per day, September results TBD**



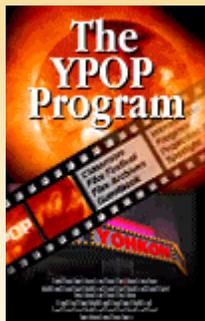
Yohkoh



- Yohkoh (ISAS/NASA) studies the high-energy radiations from solar flares (hard and soft X-rays and gamma rays) as well as quiet structures and pre-flare conditions
- Yohkoh discovered that “S”-shaped soft X-ray structures precede coronal mass ejections (CMEs)
- Provides access to daily solar observations from Yohkoh, SOHO and TRACE used for solar research as well as for space weather data products by other agencies.



Yohkoh Public Outreach Project



- The Yohkoh Public Outreach Project (YPOP)
produced by Lockheed Martin and Montana State University

- Latest Solar Images from Space
Provides access to latest data from Yohkoh, SOHO & TRACE



- Solar Classroom
Collection of hands-on activities for the classroom
- Yohkoh Movie Theater
View pre-packaged movies, or make your own



"WOW!! This is just FANTASTIC!! Wish I had found you sooner. You have done a GREAT job. I teach 8th grade science, and you have done a wonderful job of preparing lesson plans."

"The sundial pages are excellent - just what I think will get the children interested and on to their project"

"EXCELLENT material. I enjoyed the tour immensely. This is a great site for grade school science students."



III. The Sun-Earth Connection Education Forum (SECEF)



What is the Sun-Earth Connection Education Forum (SECEF)?

A national coordination and support structure for the SEC theme to:

- Facilitate the involvement of SEC scientists in education and outreach;
- Help identify appropriate high leverage opportunities;
- Coordinate nationally, and synthesize the education and outreach programs undertaken by SEC flight missions and individual researchers;
- Arrange for the widest possible dissemination and long-term sustainability of SEC education and outreach programs and products;
- Identify and disseminate best practices in education and public outreach; and
- Develop an on-line resource directory to provide a single point of access to SEC EPO resources.



Who is SECEF?

- A partnership between NASA/Goddard Space Flight Center and UC Berkeley's Space Sciences Laboratory
- Additional partnering institutions:
 - Exploratorium
 - GSFC Office of Education
 - Lawrence Hall of Science
 - Pompea & Associates
 - San Francisco and San Jose State Universities
 - UC Berkeley Graduate School of Education; and
 - AIR for evaluation.

Contact information is provided on the next page



Who is SECEF? (cont.)

Contacts for SECEF

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Major Accomplishments of SECEF

- **Coordination of mission education/outreach programs**
 - **Reach out to all current and future OSS missions and many SEC scientists**
 - **Design and build an SEC Resource Directory**
 - **Facilitate participation in Museum Exhibits, Curricula, Planetarium Shows, etc.**

- **Coordination with others within the OSS Ecosystem**
 - **Connections with education/outreach organizations**
 - **Proposal support**
 - **'Match-making' and partnership support**



Major Accomplishments of SECEF (cont.)

- **Coordinated presence at science, education and outreach conferences**
 - **American Astronomical Society, American Geophysical Union, American Physics Society, National Science Teachers Association, National Council of Teachers of Mathematics, Association of Science-Technology Centers, etc.**
- **Working with science museums, planetariums, and public television**
 - **“Passport to Knowledge - Live From...” TV series**
 - **SEC traveling exhibit**
 - **High-visibility public events with science museums**
- **Minority University Interactions**
 - **Interactions with National Black Physics Students Society, National Society of Hispanic Physicists, and tribal colleges**



Upcoming Events for 1999-2000

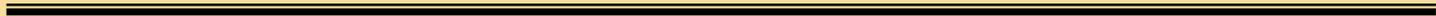
- Solar Max Coordination
 - Live from the Sun
 - IMAGE Satellite Launch
 - HESSI Satellite Launch
 - GEMS Guide - Seasons
 - Space Weather Traveling Exhibit
 - Connections Planetarium Programs
 - Educator Workshops
- Multi-mission and program EPO activities
- More TV broadcasts in the Fall and Spring
- First light and launch
- Launch
- A math and science book on “Seasons”
- Mini exhibit sponsored by GSFC and SSI will debut
- IMAX-quality programs at Rice University
- Teacher training in SEC curriculum topics



Examples of Future SEC Opportunities

Potential opportunities include:

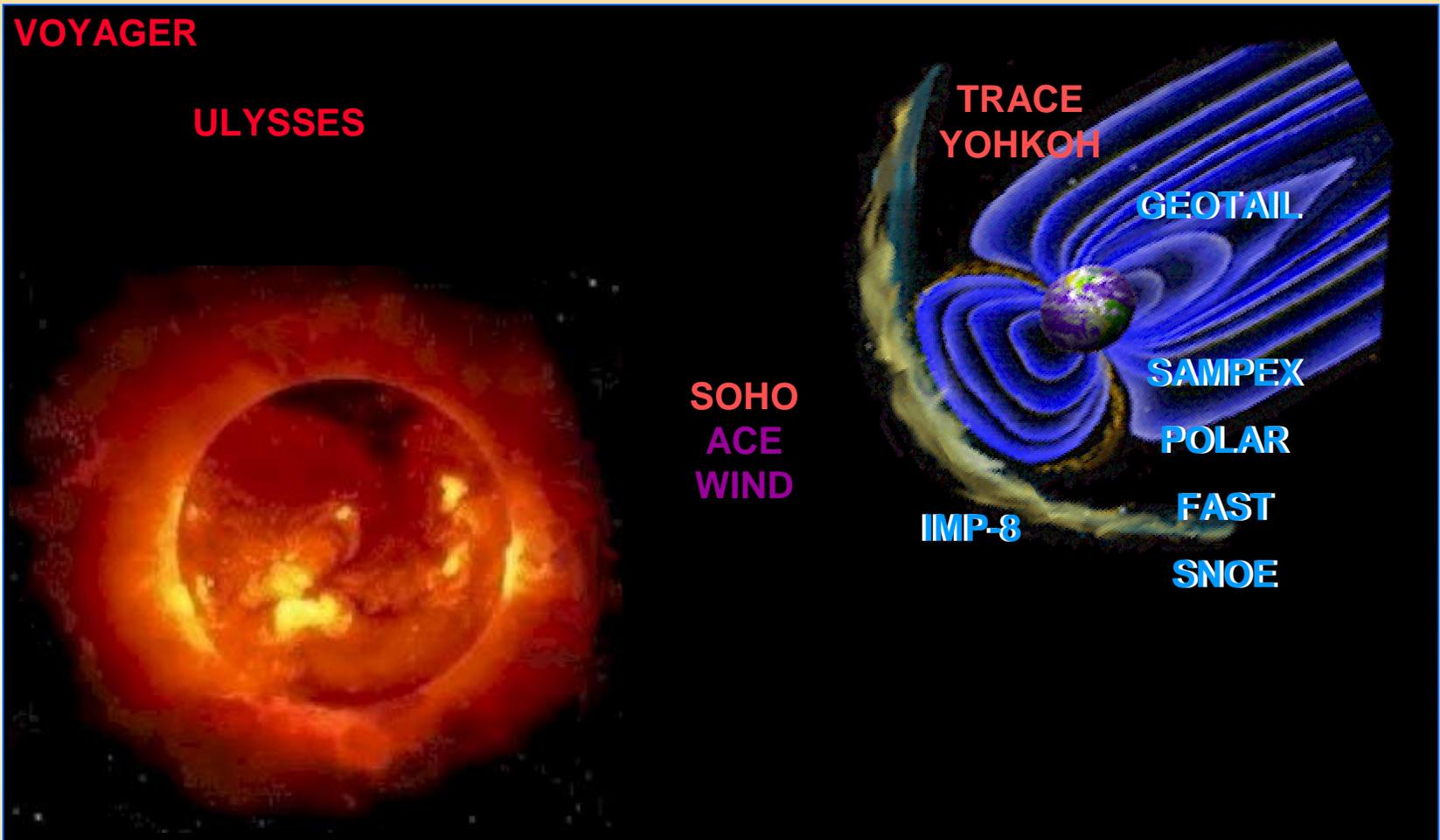
- **Adopt a Constellation Spacecraft**
 - National competition to name the individual satellites
- **Auroral Alert**
 - Network to monitor CME's and image the polar aurora
- **Space Weather Reports**
 - Real time reports for schools and the general public
- **Voyage to the Sun**
 - Multi-media "virtual voyage" to understand the active Sun and its effects on Earth, other planets, life, and society.

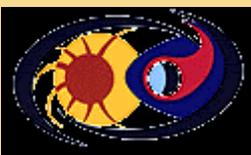


IV. Appendix



SEC Operating Missions





SEC Operating Mission Summary

Missions	Mission Orientation	Program Class	Launch Date
SOHO - Solar Heliospheric Observatory	Solar Physics	International	12/95
TRACE - Transition Region and Coronal Explorer	Solar Physics	SMEX	4/98
Yohkoh	Solar Physics	International	8/91
Ulysses	Heliosphere	International	10/90
Voyager	Heliosphere	Planetary	9/77
ACE - Advanced Composition Explorer	Solar Wind Heliosphere	Explorer	8/97
Wind	Solar Wind	GGG	11/94
IMP-8 - Interplanetary Monitoring Platform	Solar Wind	Explorer	10/73
Polar	Magnetosphere	GGG	2/96
Geotail	Magnetosphere	GGG	7/92
FAST - Fast Auroral Snapshot Explorer	Magnetosphere	SMEX	8/96
SAMPEX - Solar Anomalous Magnetospheric Particle Explorer	Magnetosphere	SMEX	7/92
SNOE - Student Nitric Oxide Explorer	Thermosphere	Student Explorer	2/98
Equator-S	Magnetosphere	International	12/97