Our Goal is to Identify the “Grand Challenges” in Heliophysics

- We plan to hold the first of virtual conference series in 23-27 October 2006.
- This workshop is a testbed toward enabling the international community to address interdisciplinary “Grand Challenges”
  - We want to identify important science questions.
  - We want to identify the technology that must be present in our to carry out the workshop.
    - What works? How well does it work? What more do we need?
Needs Identified

The Big Problems

• Characterizing the simultaneous couplings & feedbacks - requires large (international) data sets
  – Need observations in a range of locations within the system
  – Micro- and macro- scales are both important in space & time
  – Need global specification of key parameters (snapshots not climatologies)

• Identifying the physical mechanisms that underlie the system behaviors - accelerated by the use of high performance computers & cyberinfrastructure
  – Global & assimilative models are the best (and possibly only) means of exploring the system behavior
  – Close coupling between data and models is necessary

New Tools

• Cyberinfrastructure
  – Virtual observatories
    • Data mining
    • Mapping between regions
  – Information commons
    • Electronic journals
    • Software
    • Empirical models

• Virtual Conference/Workshop Facilities --> Distributed dynamic virtual collaborations - The Human Element/
  – Utilize cyberinfrastructure to accelerate the pace of scientific discovery
  – Catalyze interdisciplinary research
    • Educate researchers about the key questions in other disciplines
    • Provide global context
  – Educate international students
  – Build science capacity in developing countries
Our goal is not to run another event study.

- Our goal is to define those problems and locate and analyze the data that enable us to address grand challenges in the study of the interaction of the Sun and Earth.

- In the following slide we provide an example of an event.
Selecting a Grand Challenge Problem in Heliophysics Provides Focus

Criteria

- Problem is interdisciplinary and on a large enough scale that community collaboration using large distributed data sets, and high performance computing are needed to make progress
  - No one team can address the issues.

Preliminary Selection

- Preliminary analysis of CAWSES campaign & comparison events in small interdisciplinary workshops (CEDAR 2005, Stanford CAWSES Space Weather Workshop 2005)
  - We want to build on these pathfinding meetings.

Final Selection of Questions:

- Carried out soon based on inputs from CAWSES, ICESTAR, ILWS, IHY, eGY organizers via the Internet
  - We solicit input from the community.
Unusual Auroral Oval

24 Aug 2005
Min Bz ~ -55 nT;
Duration of -Bz ~ 1.5 hrs; Min Dst ~ -212 nT; Vsw ~ 600 km/s; Max Pdyn ~ 35 nPa
Systematic Signature of Super Substorms

May 15, 2005

Min Bz ~ -40 nT Duration of -Bz ~ 3hrs Min Dst ~-250 nT Vsw ~ 900 km/s Max Pdyn ~ 40 nPa
Unusual Signatures throughout the Sun-Earth System

PRELIMINARY ANALYSIS

- AR 798 anemone active region. [Ayumi Asai, NSRO, 2005]
- Produced CME with high velocity; high dynamic pressure in the sheath
- A major substorm was triggered just as the IMF Bz reached its minimum values
- Unusual auroral oval configuration with large vortex on the dawn side and double oval structures (possibly another vortex) on the duskside. Thick nightside oval & very thin dayside oval. [Kozyra et al., Spring AGU, 2006]
- Evidence for new type of storm-substorm coupling

20 Aug 2005, 00:50 UT
Anemone Active Region [Asai, Stanford Workshop, Dec. 2005]

10:07:15 UT
19:04:01 UT
Super-Substorm Substorm
[Kozyra et al., Spring AGU, 2006]
Return to the Auroral Oval on a voyage of discovery that commemorates the 50th Anniversary of IGY- Be a Part of History

- **Power of IGY’s Past and Present:** In 1957/58 during the International Geophysical Year (IGY) a global picture of substorm phases emerged.

- **Related New Discovery:**
  - In 2005, an unusual auroral oval configuration, not previously reported.
  - Appears to occur systematically during large substorms in the main phase of superstorms.

- **What are the processes at the Sun that produce these extreme disturbances?** In the May and August 2005 events, active regions on the sun were closely associated with coronal holes. How configuration produced? How effect CME release?

- **Does the transit across interplanetary space cause significant modifications to the disturbance?** Short-lived spike of extreme southward IMF.

- **Has geospace crossed the threshold to a different state?**
  - Extreme southward Bz - Does short time frame changes how energy distributed throughout geospace?
  - Large vortex-like structure on the dawnside oval. If mapped to the equatorial plane has implications:
    - For mass and energy transfer from the solar wind into the magnetosphere,
    - For new modes of coupling between storms and substorms,
    - For new types of stormtime energy dissipation within geospace,
    - Consequences throughout the coupled ionosphere/atmospheric system.
CAWSES Focus for IGY Celebration

- **Join a Historical Effort:** Contribute to the historical 50th anniversary by
  - Joining with other scientists worldwide to investigate the state of the Sun-Earth system during extreme events.
  - Test how the human element in science can join together and use cyberinfrastructure to attack grand challenge issues.
    - Explore new electronic capabilities: virtual conference, virtual observatories, assimilative models, global sun-to-Earth models, etc.
- The IHY presents an important opportunity to explore this state using international assets and scientific talent
- Join in a worldwide effort to define the state of the sun-Earth system crossing the threshold to super substorms
What is the state of the Sun-Earth System during Extreme Events?

**SUN & HELIOSPHERE**
- What effect does close proximity to an coronal hole have on the release & propagation of CMEs?
- Does an active region leave a “fingerprint” on the CMEs? Do they have common characteristics?
- How important was propagation in producing extreme spike of IMF Bz?

**MAGNETOSPHERE**
- How important is the duration of the IMF Bz in how energy is apportioned?
- Do vortices have implications for mass & energy transport from solar wind into magnetosphere?
- Do super substorms reflect a new state of the magnetosphere?
- Underlying physical processes?
- Explain some of the unusual features of superstorms?
- New form of storm substorm coupling? New energy dissipation?

**IONOSPHERE - ATMOSPHERE**
- How do these large current vortices effect the state of the ionosphere-atmosphere?
- Strong sources of Joule heating?
- Produce upwelling or other feedbacks to the magnetosphere?
- Dawnside neutral wind vortices?
Crossing the Threshold to Superstorms

Nitric oxide as an agent for cooling & atmospheric coupling
- Changing balance of NO sources
- NO cools atmosphere during storm recovery

New features in ion-neutral coupling due to strong ring current effects
- Evidence superfountain modifies ion-neutral coupling features

Enhanced "ionospheric-source" ions drive strong heating, intensify midlatitude red & ion/ENA auroras
- Direct injection of plasma waves
- Banded-in-energy ions appear
- Plasma waves appear in high %O^+ thermal

Atmospheric effects of Solar flares
- TING Model: showing changes in E-region ionosphere due to auroral & flare inputs

Discovery of soft electrons triggering Great Red Auroras
- UARS/PEM: 09 Nov 1991
- Electron Volts: 37.2, 44.9, 51.6, 55.0, 53.9
- DMSP: extreme Te Peaks

Photo by H. Tsuda.
Return to the Auroral Oval for the 50th Anniversary of the International Geophysical Year.

Welcome to Session 1 of the SEC Virtual Conference, Return to the Auroral Oval. This event was designed to bring together researchers worldwide to investigate the state of the sun-Earth system during extreme space weather events in celebration of the 50th anniversary of the International Geophysical Year. The focus of this session is on understanding Sun-Earth interactions in the context of a complex natural system - from micro to macro level, in both space and time. Transformative science in this area lies at the edges and intersections of individual elements (the Sun, heliosphere, magnetosphere, ionosphere and atmosphere) whose collective behavior determines the global system response.
Continuing progress requires access to a vast developing cyber-infrastructure of large international data sets, high-performance computing and advanced visualization, and the development of new types of interdisciplinary and international research interactions (the human side).

Sponsored by: CAWSES, NASA/LWS, eGY, IHY, NSF, and ICESTAR

Goal: To catalyze interdisciplinary investigations among large groups of researchers worldwide in celebration of the 50th anniversary in 2007 of the International Geophysical Year during which worldwide resources will again be focused on accelerating the pace of discovery in Sun-Earth system science.
International and Interdisciplinary
Sun-Earth Connections Online Conference Series
Grand Challenge Issues and Critical Underlying Processes in Sun-Earth System Science

Draft Series Schedule


Feb 2007: Conf 2. The Quiet Sun and the Geospace Ground State: Data Exchange. (Collaboration with atmospheric coupling - Oct/Nov 2005: focus on wave influences on IT system - mesosphere-stratosphere meteorology on auroral NOx transport )


Include standing session in all of these on analysis of CAWSES campaign results?
Online Conferencing - Apply lessons learned by other groups

Pros

• Cost effective way to bring together geographically dispersed group
• Maximize participation across nations and disciplines
• Easy to source and circulate new material to participants digitally
• Time for reflection: Asynchronous systems give participants the time to review previous messages, check references, and take any amount of time to compose a message.
• Freedom from time zones: Because asynchronous systems allow 24-hr access, people can participate in local time.

Cons

• Restriction of text-based communication: Communication in such an environment, without visual or auditory cues that form 70% of F2F communication, does not come naturally to most people.
• Challenges with group synergy: More difficult to socialize or form a connection with other participants than in an F2F forum. Use of photos helps with this.
• Lack of a captive audience: The greatest benefit of online conferencing - flexibility of access - becomes a liability if you’re trying to move to a more profound analysis of a topic.
Virtual Conference Organization

Conference Hall
“Join us virtually”
Oct 24-27

Plenary Hall
IGY History Keynote
Focused Tutorials

Parallel Sessions
all with moderators
Solar
Heliosphere
Magnetosphere
Ionosphere/Atmosphere
Atmospheric Coupling
Planetary Comparisons

Information
Registration
Help Desk
Organizers
SOC

Data Commons
Archive

Sponsors Area
Library
Presentation
Upload Room
Networking
Break Room
Student Resumes
& Information
Conference
WIKI
Press Room

General Topic
Discussion Board

Session daily summaries of interesting observations & new findings with linked discussion boards

Synthesis Summary & Discussion Board

Extracted Interdisciplinary Topics which contain New Discipline Questions

Interdisciplinary focus groups
Topics for follow-on sessions in virtual conference series.
Keynote: Short history of auroral substorm observations beginning in the IGY 1957-58 and continuing up to new signatures 50 years later.

Focused Tutorials:

On processes and outstanding problems of the various system components from sun-to-Earth with emphasis on aspects relevant to the topics of this conference.

Purpose:

To educate scientists in other disciplines

Resource for students worldwide
Parallel Sessions

Flexiblre session structure
Create cross-disciplinary sections where needed to attack major issues
Moderators create session summaries updated daily
The CCMC Has Made a Commitment to Support the Information Commons
Joint IHY-CAWSES Observation Database

Registrant Information
Name: Email:

Observation Information
Date: Short Description:
Contact Name: Contact Email:
URL:

Longer Description
Something like: My data is really cool it has groovy numbers about many groovy things.

Observatory: Instrument:

Submit Query  Reset
Planned Scientific Organizing Committee

- CAWSES Space Weather Panel and Subpanels, Gang Lu (CAWSES Atmospheric Coupling)
- IHY: Joe Davila, Alex Young
- eGY: Michele Weiss, William Peterson, Peter Fox
- NASA/LWS: Larry Zanetti, Nicola Fox, Danny Morrison, Robin Barnes
- ICESTAR: Kristi Kauristie, Alan Weatherwax, Aaron Ridley
- Others?
• Journal articles about, and relevant to, the selected events & focus areas:

  AGU journals, JASTP, Annales Geophysicae, etc.

  ✴ Began discussions with Judy Holoviak at AGU about a limited conference subscription

  ✴ Other journal discussions to follow

• List of relevant books with links to publishers

• Preprints from participants
Student Resumes & Information

Post of Student Resumes
Student Job Opportunities
Summer Schools
University Space Science Programs
Fellowship Opportunities
Others
Janet Kozyra

University of Michigan, AOSS Department, 1414A Space Research Bldg, 2455 Hayward, Ann Arbor, Michigan, USA 48109-2143
Email: jukozyra@engin.umich.edu, Phone: (734) 647-3550
Fax: (734) 647-3083, URL: http://aoss.engin.umich.edu

Research Interest: Geospace Coupling, Sun-Earth system science

- Interdisciplinary scientist, TIMED (Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics) Mission.
- Co-Chair, CAWSES Space Weather Panel
- Moderator, Interdisciplinary Synthesis Sessions

Thomas Zurbuchen

University of Michigan, AOSS Department, 2429A Space Research Bldg, 2455 Hayward, Ann Arbor, Michigan, USA 48109-2143
Email: thomasz@umich.edu, Phone: (734) 647-6835
Fax: (734) 615-9723, URL: http://aoss.engin.umich.edu

Research Interest: Theoretical models for all major phenomena in solar atmosphere and its expansion into the heliosphere, instrumentation for composition of space plasmas

- Instrument Scientist, Mercury Messenger
Virtual Sessions

- Virtual SEC Conference 1, “Return to the Auroral Oval for IHY”, Oct 23-27
- Virtual SEC Conference 2, ~Feb 07
- Virtual SEC Conference 3, ~May 07
- Virtual SEC Conference 4, ~Aug 07

Face-to-Face Sessions

- SW-Magnetosphere Mexico, Nov 4-8, 06
- Sun-to-Earth session at Fall AGU, Dec 11-15.
- European Space Weather Week, Belgium Nov 13-17
- EGU Mtg, Austria Apr 15-17
- Spring AGU, Mexico, May 21-25
- CEDAR, NM Jun 24-29
- GEM, Snowmass ~Jun
- Sun-Earth Session at IUGG, Italy, Jul 2-13
- SHINE workshop ~July-August
- Int’l CAWSES Symposium, Japan, Oct 23-27
- Fall AGU, USA Dec 10-14
Next Steps

• CAWSES, ICESTAR, ILWS, eGY2007, IHY2007 committees develop plan for science topics, presenters and themes for the Virtual Conference. Community input.

• Collaborators and Presenters fill the Information Commons between now and the eWorkshop

• Key data sets are selected for the Virtual Observatories

• Key data analysis products, tuned to the chosen questions, are produced & made available in the Information Commons (i.e., assimilative maps of potential, field-aligned currents, and electric fields)

• Tentative dates for the campaign is 23-27 October 2006.