CAWSES: Climate and Weather of the Sun-Earth System

Susan K. Avery (Chair)

Duggirala Pallamraju (Scientific Coordinator)

CAWSES Symposium

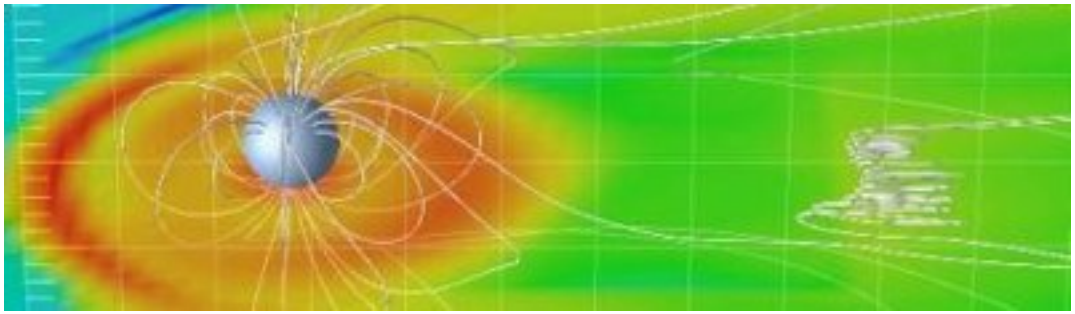
October, 2007; Kyoto, Japan

http://www.bu.edu/cawses

CAWSES Project Office supported by NSF

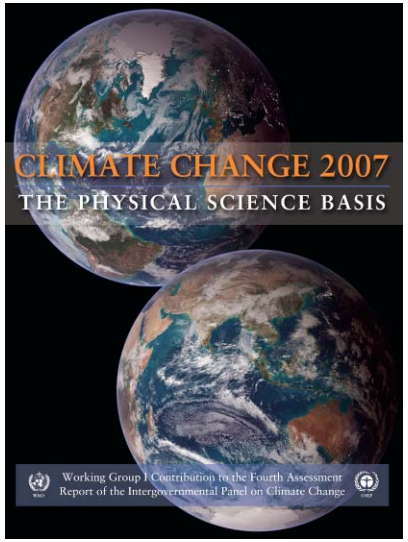
An international program to enhance understanding of the space environment …

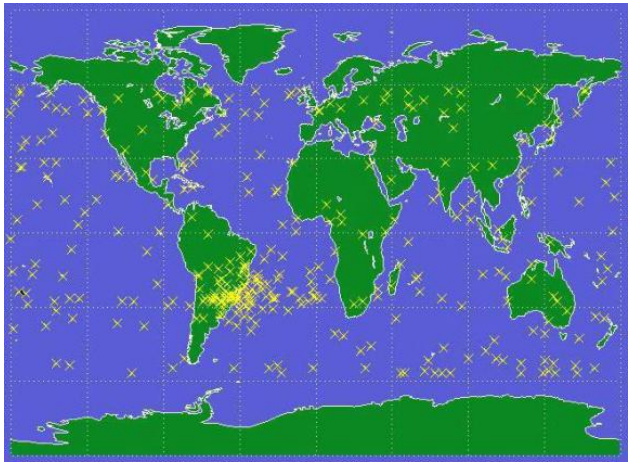
- Integrated systems approach
- Coordinated international activities
  - Observations
  - Modeling and simulation
- Involvement of scientists in developed and developing countries
- Educational opportunities for students



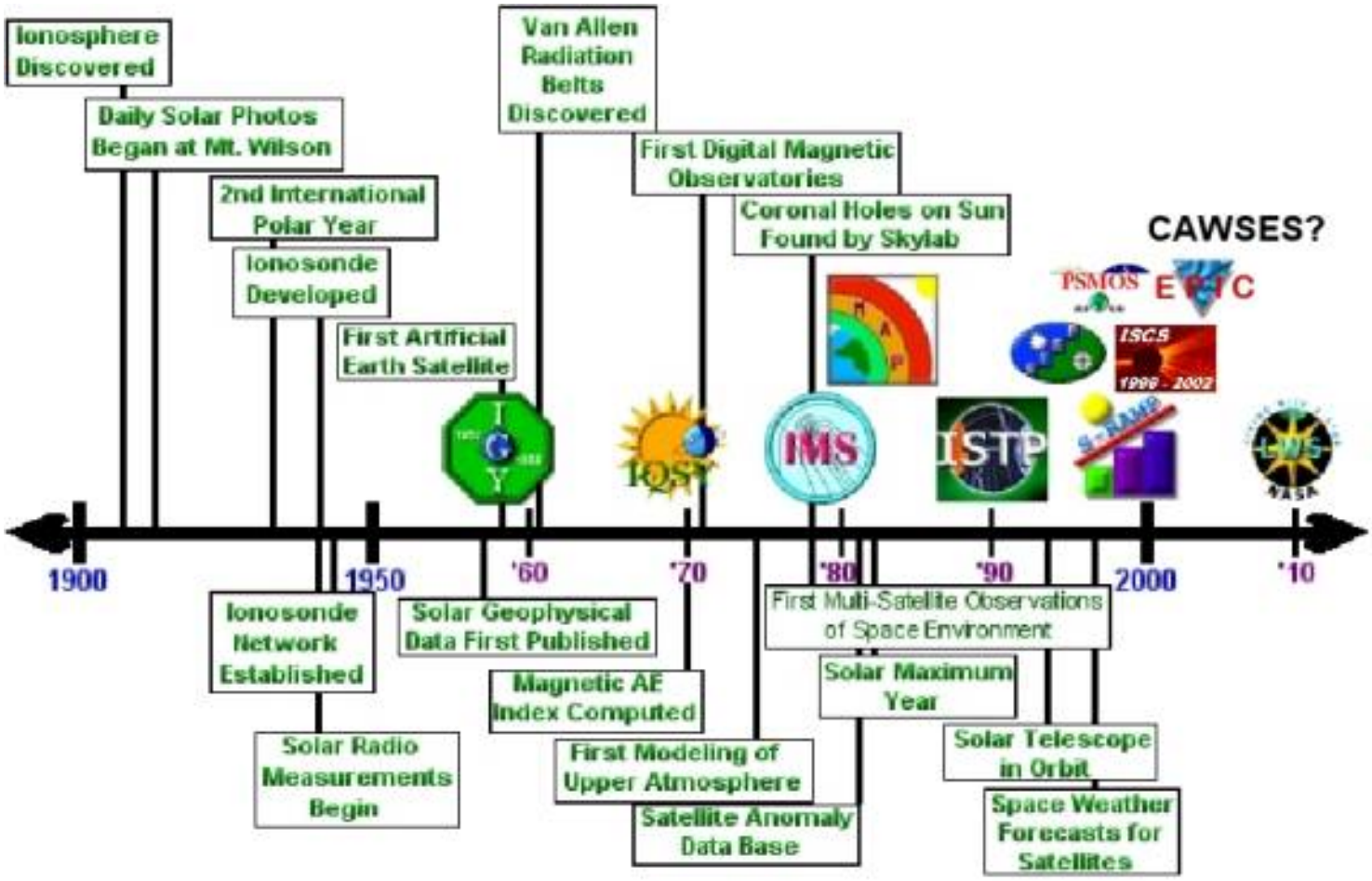
… and impacts on life and society

- **Influence of solar variability on climate**
- **Sensitivity of sophisticated technology to fluctuations in solar-terrestrial environment prompting need for operational forecasting**
- **Impacts of near space environment on human activities in space**

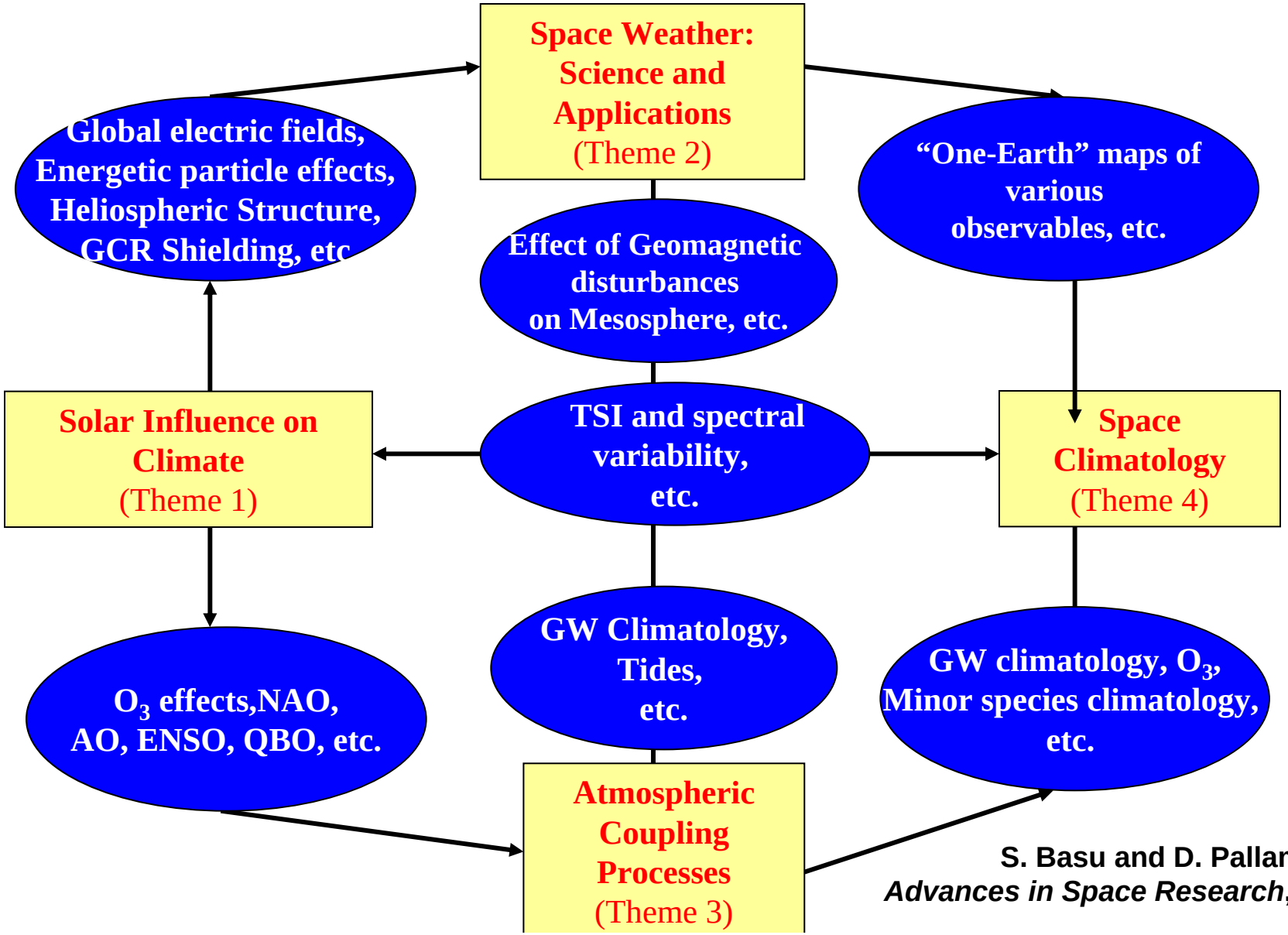




CAWSES Program is a natural evolution of solar-terrestrial research facilitated by SCOSTEP



Systems approach requires integration and coupling of traditional solar-terrestrial components and time scales



S. Basu and D. Pallamraju, *Advances in Space Research*, 2006

It also requires the engagement of a global scientific community

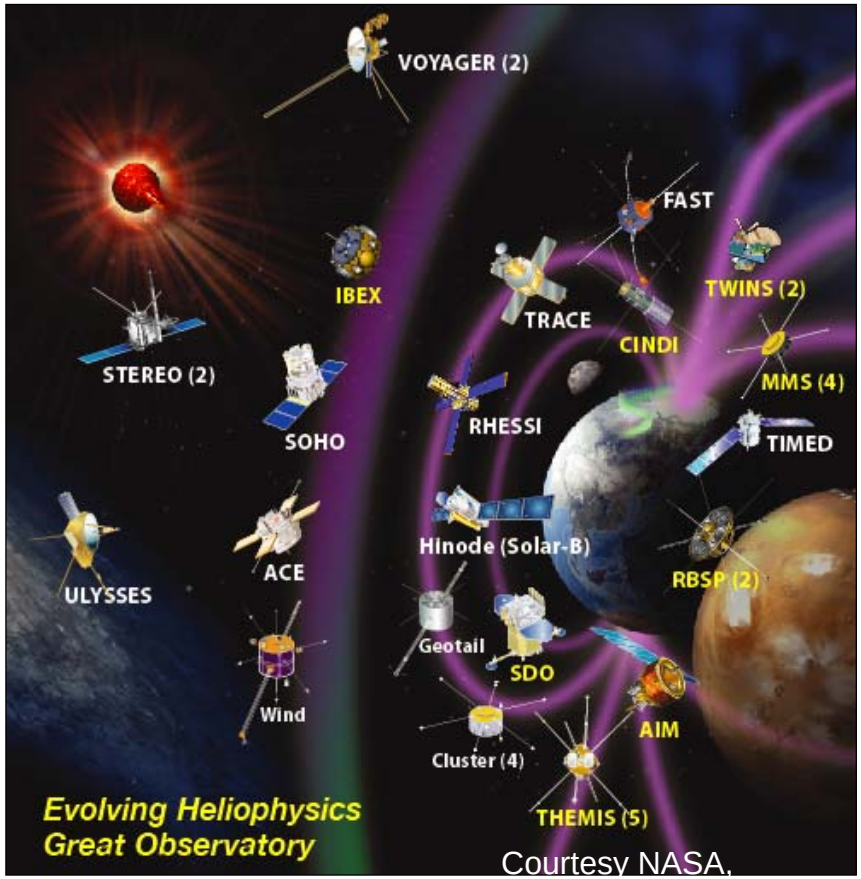
- Science capacity building workshops for developing countries
- Topic/problem oriented workshops
- Educational and outreach programs for students and operational sectors
- Infrastructure for global engagement
  - **Observing facilities and focused campaigns**
  - **Data-bases**
  - **Global models and simulations**
  - **Virtual conferences**
  - **I*Y collaborations**

Virtual Conference was explored as a tool for enhancing scientific collaboration worldwide:

OBJECTIVES

- **Address grand challenges that require expertise that spans nations and disciplines and synthesis of worldwide data sets**
- **Encourage multi-disciplinary and interdisciplinary collaborations**
- **Promote science capacity building in developing countries**
- **Provide a resource for students worldwide**
- **Celebrate the 50th anniversary of the International Geophysical Year**

Goal was to bring cyber-infrastructure into contact with worldwide interdisciplinary scientists (the human element)



Courtesy NASA.

Worldwide Resources

- **Heliophysics Great Observatory**
- **Other scientific satellites: STEREO, Double Star, Hinode, SME, DMSP, GOES, SORCE, LANL GEO, CORONAS, NOAA POES, DEMETER, COSMOS, CHAMP, EOS, etc.**
- **Ground-Based: radars, magnetometers, optical instruments, lidars, riometers, GPS receivers, ionosondes, solar observatories, etc.**

Cyber-Infrastructure

- **Virtual Observatories**
- **Model “runs on demand”**
- **Advance visualization tools**

Virtual Conference has elements similar to a face-to-face conference but takes place completely over the internet.

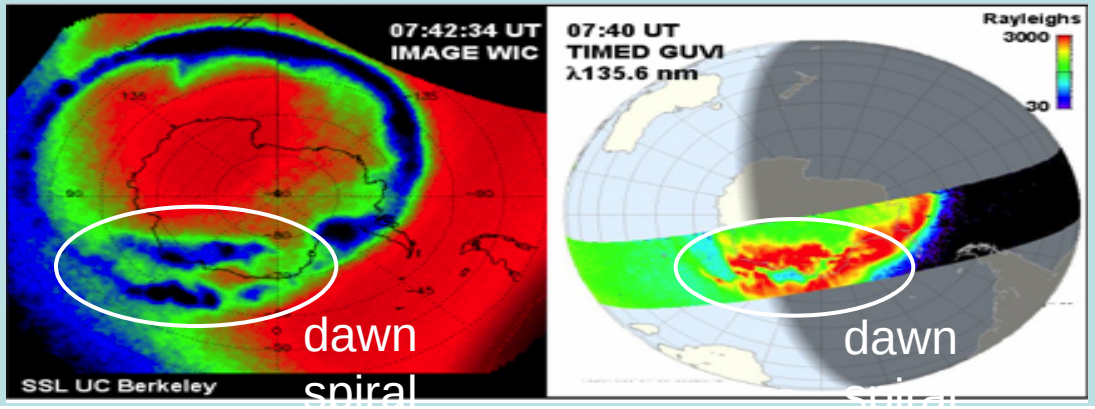
- **Single Sun-to-Earth science topic to highlight interdisciplinary threads**
- **Presentations are text- and graphics- based and asynchronous**
- **Data commons area contains conference data products, shared resources and links to cyber-infrastructure**
- **Discussions take place on message boards**
- **A key element is the use of moderators**
  - **to encourage, clarify and integrate discussions on message boards,**
  - **to "weave together" the inputs into a global perspective.**
- **Archive for ongoing collaborations and future reference.**

Virtual Conference is a very different medium than a face-to-face conference with important strengths

- Cost effective and convenient
- Lowers time commitment
- In-depth interactions
- Wider range of interactions
- Supports continuing collaborations
- Valuable educational resource

Grand Challenge Science Focus was used for the 1st Virtual Conference: State of the Sun-Earth system during extremes in space weather

15 May 2005



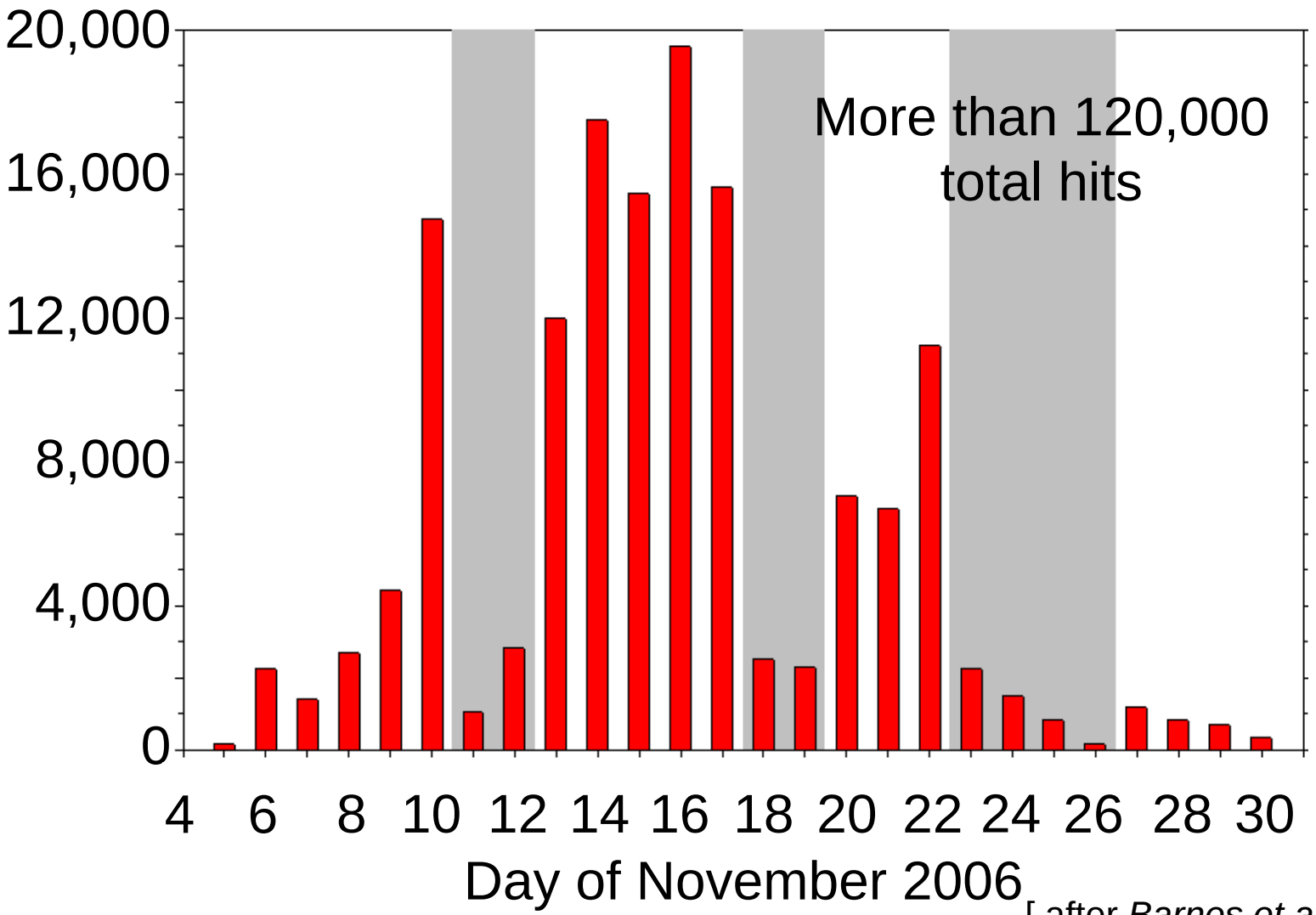
- **Motivated by new observations of auroral spirals during intense substorms**
- **Spirals imply new features in geospace structure and/or energy dissipation**
- **Raise questions about solar sources and about emergent features in geospace**

Remarkable worldwide participation in the 1st Cyber-Conference

Location of Participants World-Wide

[after *Barnes et al., AGU*, 2006]

With active daily participation
Daily hits on the conference website



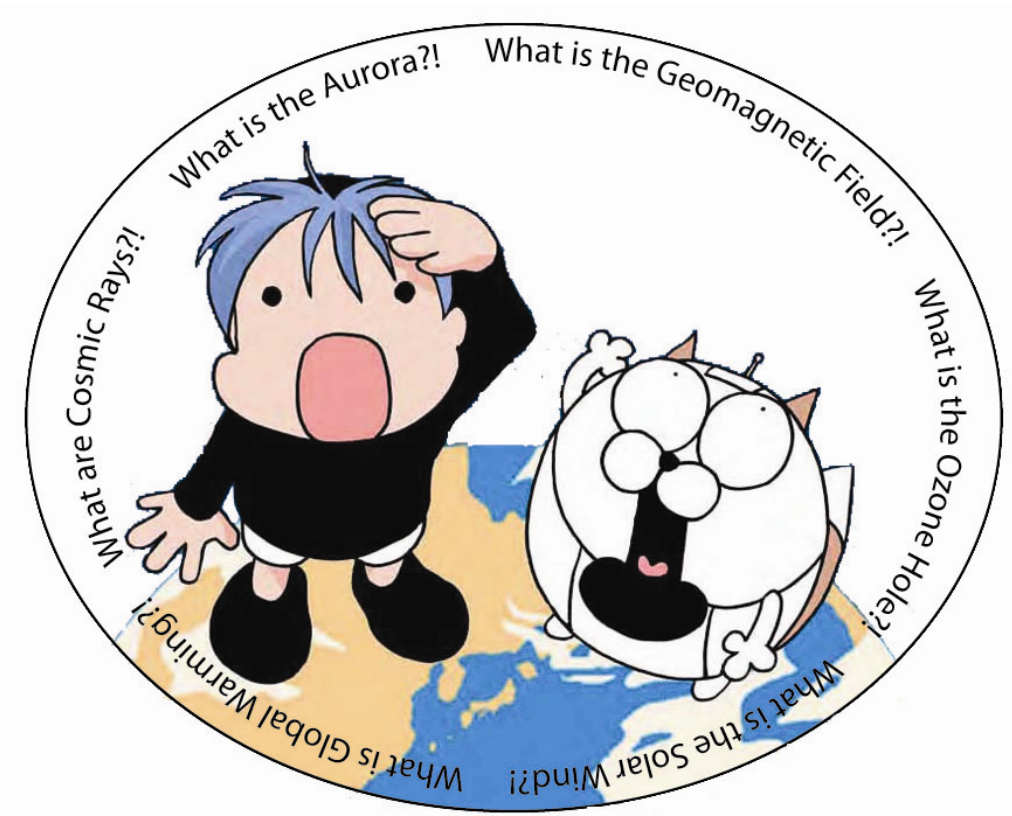
[after *Barnes et al., AGU*, 2006]

1st Virtual Conference: Science Successes

- **Participants constructed a complete as possible view of the Sun-Earth system, using observations from over 20 satellites and a wide range of ground-based instruments worldwide.**
- **The data alone was not enough. The key ingredient was the high level interpretations by the instrument scientists of the observations. This was one of the great successes of the conference.**
- **Discussions and presentations expanded upon and refined the list of questions**
- **Modified list of questions will be used to structure a follow-on virtual conference scheduled for January 2008 focused on modeling and continuing data analysis.**

Comics are reaching out to major new audiences

Meet Mol and Mirubo, the robotic dog



- **Joint project between STEL at Nagoya University and CAWSES; Supervised by Prof. Y. Kamide**
- **6 topic areas produced; upper atmosphere under development; potential CAWSES topics**
- **Original in Japanese**
- **Available in English and in a blank “balloon” version for translation**
- **12 language translation agreements: Indian (Hindi, Marathi), Thai, Spanish, Swedish, French, Russian, Nigerian, African (Hausa, Igbo, Yoruba, Pidgin)**
- **Pending: Danish, Icelandic, Greenland, Turkish**

CAWSES II: The Next Step Forward

- **July 1 – 6, 2007 Planning meeting, informal discussions at IUGG meeting, and SCOSTEP Bureau meeting: Perugia, Italy**
- **Providing structure for sun-earth community to make progress on science issues that cannot be done without international collaboration**
- **Strategies for this enabling role include:**
  - **International collaboration in integrating observations from various ground-based, in-situ, and satellite-based systems to provide a global-view of the sun-earth system**
  - **Engagement of researchers across the disciplines to attack Sun-to-Earth science issues in a way that funding agencies & universities tend to discourage by their structures**
  - **Use of international collaboration and interdisciplinary efforts for capacity building and graduate student education worldwide**
  - **Scientific strategy and framework that provides focus for the development of support in member nations**

CAWSES Success Stories

- **Generated new support for Sun-Earth system science**
- **Established awareness on necessity to view Sun-Earth system as single entity**
- **Created new community**
- **Enabled face-to-face meetings of experts and students observational campaigns; science focus workshops; capacity building workshops and schools**
- **Spearheaded 1st Virtual Conference**
- **Helped create several data resources and archives for space weather and atmospheric research**
- **Contributed to establishment of chain of global H-alpha observatories for investigation of the Sun**
- **Supported young scientists to participate in various international conferences**
- **Published refereed articles including special issues related to results from CAWSES workshops**
- **Contributed to publication of book on solar irradiance and solar variability**

Essential Elements of CAWSES II

- **International and interdisciplinary focus**
- **Recognize that engagement of disciplines in furthering goals of CAWSES may require disciplinary focus in some selected areas**
- **Passionate theme leaders – communication and integration**
- **Project orientation centered around critical science and technology questions**
- **Concerted effort in creating unique data products which require international collaboration**
- **Integrated modeling of sun-earth system**
- **Opportunity to examine sun-earth system in active and quiescent solar phases**
- **Ensure both geo and solar aspects are included**
- **Integrate with other international programs (IAU, SCAR, IAMAS, IAGA, COSPAR)**
- **Bring additional resources to community**
- **Provide opportunities for collaborations with operational and commercial use sectors**
- **Action arm of SCOSTEP**

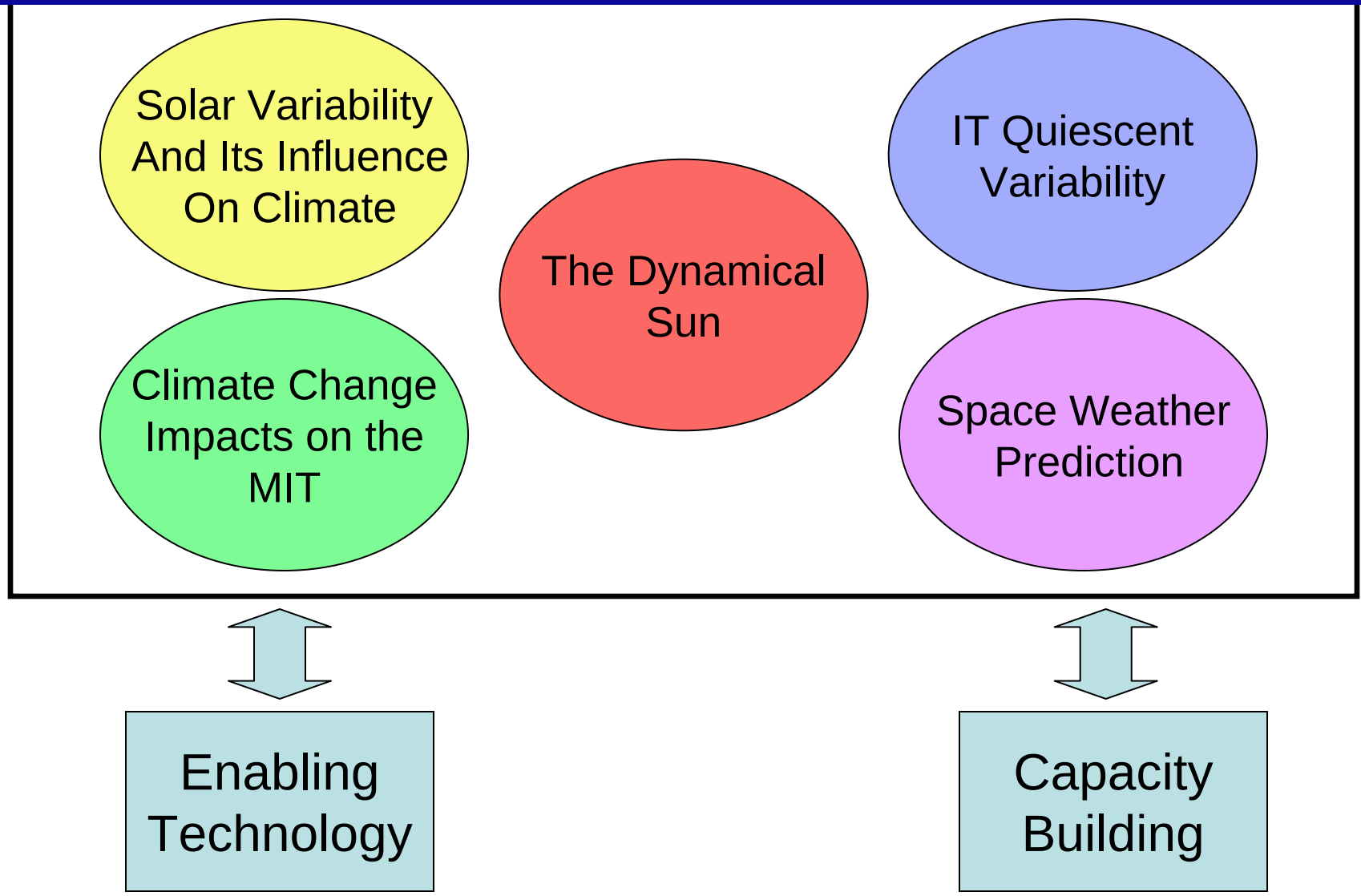
Setting the Science Framework

- **What are the solar impacts on an evolving climate primarily associated with anthropogenic forcing?**
- **How will the upper atmosphere and ionosphere change as a result of lower atmosphere anthropogenic climate change?**
- **What is the quiescent variability of the ionosphere-thermosphere?**
  - **Lower atmosphere**
  - **Residual disturbance effects**
  - **The mesopause as IT gateway (85-100km)**
    - **Gravity waves, tides, planetary waves**
    - **Penetration into IT regions… When and where? To what effect?**
- **How do the dynamics of the solar interior interact with the solar surface? How does that interaction change the dynamics of solar surface processes which impact the radiative forcing of the earth's atmosphere?**
- **How can we improve space weather forecasts through understanding the processes of variability and their predictability?**

Capacity building projects that are transferable and networked

- **Development of international graduate student/early scientist network**
- **Workshops**
  - **Summer school in conjunction with Living with a Star**
  - **Virtual conferences/workshops**
  - **Clearing house of workshop/course modules for insertion into university courses and capacity building workshops**
- **Sustainability of relevant I*Y activities**
- **Comics – in other languages**
- **Engagement with operational and policy communities**

CAWSES II: DRAFT Themes



CAWSES II: Structure and Implementation

- Each interdisciplinary theme as co-leader
- Interdisciplinary project orientation within themes; each project within theme has project leader
- Annual robust planning process
- Capacity building projects that are transferable and networked

CAWSES Town Hall Meeting Tomorrow night after symposium

See you there!